

Special

Sustainable energy

Canada has the potential. But pundits say vision and leadership will be the determining factors in Canada's quest for

ENERGY SUPREMACY



POTENTIAL

There can be no doubt, say the two co-editors of an upcoming book entitled *Canada: Winning as a Sustainable Energy Superpower*, that exceptional individuals must emerge to define and help implement a crucial mission ahead.

"Canada has been built and shaped by big projects, led by big visionaries," says Dr. Clement W. Bowman, co-founder of ProGrid Ventures Inc. and founding chairman of the Alberta Oil Sands Technology and Research Authority (AOSTRA).

"Canada has an innovation strategy that has been highly successful in the past, has transformed Canada and can do it again – big projects led by big visionaries," he adds. "Launching big projects, based on Canada's massive energy endowment, is a pathway to wealth generation and future prosperity."

In their new book, Dr. Bowman and Dr. Richard J. Marceau, the provost and vice-president academic at the University of Ontario Institute of Technology, say the country must act quickly.

They write that the current debate on Canada's emergence as a global energy power tends to focus on the export of oil and natural gas. But many, they say, believe that the country has an even greater opportunity to use its energy bounty as a catalyst for nation building and to stimulate far greater economic growth than will be achieved through selling unprocessed resources alone.

In great detail, they outline the steps that need to be taken.

"Canada has an innovation strategy that has been highly successful in the past, has transformed Canada and can do it again – big projects led by big visionaries."

Dr. Clement W. Bowman,
Co-founder of ProGrid Ventures Inc. and founding chairman of the Alberta Oil Sands Technology and Research Authority (AOSTRA)

Two of the most crucial initiatives now ready for implementation, the book points out, are upgrading the bitumen (a heavy, thick and sticky form of crude oil) in Canada's oil sands and creating a national electricity grid.

Canada's visionary track record is well-documented, they explain, proposing specific actions that would transform Canada's place in the world to a position of real influence and real wealth.

"Canada has been successful in the past in its development, thanks to its highly successful 'big project innovation strategy,'" says Dr. Marceau. "Drawing inspiration from past mega-projects, such as the Rideau Canal, the Canadian Pacific Railway, the James Bay Hydroelectric Project, the Trans-Canada Microwave Network, the CANDU nuclear reactor, et al, will help Canada press forward to make the country a world leader in sustainability."

The western oil sands will become one of the major drivers of Canada's future prosperity if "we reverse our tradition of being hewers of wood and drawers of water," Dr. Bowman says. "To do this, we must develop the economic and technical capability to upgrade the raw bitumen from the oil sands to value-added products. If we do this in Canada, the economic benefit will be \$60 billion per year by the end of this decade."

He says the oil sands were at a similar crossroads five times in the past, in 1928, 1948, 1967, 1972 and 1975. Each time, five different visionaries led the way to make

ACTION

CITIZENS, GOVERNMENTS AND INDUSTRY HAVE IMPORTANT ROLES TO PLAY

To help make Canada a sustainable energy superpower, experts say...

CITIZENS MUST:

- Grasp the full impact of the unique energy endowment that nature has bestowed on Canada;
- Understand and appreciate the success of Canada's past big projects, which have shaped the country over the past 200 years; and
- Rally around Canada's successful "big project innovation strategy" to capture this unique opportunity and create new momentum for sustainable economic development.

GOVERNMENTS MUST:

- Listen to and build on public support for the sustainable energy superpower vision;
- Develop plans for big energy projects that will enhance each region and the country as a whole; and
- Seek solutions to barriers that prevent Canada from achieving its full energy potential, through federal-provincial partnerships, government-First Nations partnerships and public-private partnerships.

INDUSTRY MUST:

- Take the initiative to build Canada's competitiveness, wealth and international position;
- Lead, by developing bold plans for "big projects" in our areas of expertise; and
- Proactively build partnerships to implement these big projects.

key shifts in direction.

Now, he says, the oil industry must commit to the commercial application of new environmental technologies that are being developed in the areas of water, the reclamation of mined areas and air. He says that collaboration by both the public and private sectors is essential.

"Individual companies will not be able to do it alone," he notes. "Overcoming previous roadblocks all involved key actions by industry, government and technology organizations."

The second major sustainable energy focus – the creation of a national electricity grid – would produce far-reaching economic, societal and environmental paybacks, says Dr. Marceau.

"Interconnecting provincial grids and new remote hydroelectric projects would have significant benefits in reducing power costs, cutting greenhouse gas emissions, releasing stranded power, taking advantage of time zones and powering a re-energized manufacturing sector," he says.

Without a national grid, electricity exchanges will continue to be primarily north-south rather than east-west, Dr. Marceau adds, which would continue to strengthen the U.S. rather than the Canadian economy. A national grid in Canada would contribute to strengthening both.

"If we cannot move electricity east and west, we will have set up permanent barriers to creating synergies between different types of energy resources and the strength of different regions within Canada's energy system," he says. "Without a national grid, there will continue to be significant disparity in electricity rates across Canada, due to electricity generation from significantly different energy resources."

Dr. Bowman says that the two proposed projects would launch Canada on the way to becoming a sustainable energy superpower, and "convince the world that we are serious."

However, someone in the country must assume leadership, adds Dr. Marceau. "The lack of Canadian leadership is the most significant chasm that needs to be crossed."

STRATEGY

Electrical grid, bitumen upgraders seen in the next wave of big projects for Canada

History has proven that big projects, led by visionaries, are the Canadian innovation strategy.

The successful track record of 12 big projects over the past 200 years is there for all to see. They helped create a nation.

Now, Canada is on the cusp of another wave of big projects in the next 40 years, with nine proposed and two – a national electrical grid and bitumen upgrading – ready for implementation.

"The era of nation-building is far from over," says Jim Prentice, senior executive vice-president and vice chairman of CIBC. "Canada still has enormous untapped resource wealth, and planned megaprojects across the country hold out the promise of unlocking that potential and securing new markets for Canadian energy."

Looking back, Mr. Prentice says, all transformational infrastructure projects have had a number of common elements. They took

years to build and created massive employment and spinoff benefits during construction. They were also financed with both public and private sector money – and that includes the development of the Alberta oil sands.

Over the years, he says, both the government and the private sector more than recouped their investments as the projects became profitable and stimulated the economies of entire regions. **Big projects, Page ES 6**

INSIDE

Nation building:

Canada's enviable economy founded on 'big project' legacy.

[Page ES 2](#)

Tomorrow's big projects:

Innovation and leadership key to achieving Canada's potential.

[Page ES 6](#)

Capital investment:

Enabling economic gain, job creation and environmental benefits today. [Page ES 8](#)



“ Meeting environmental and prosperity demands at the same time is a greater technological challenge than humanity has ever faced – Canada is one of the few nations that have the physical resources and the science and technology to become such a superpower.

In *CANADA: Winning as a Sustainable Energy Superpower*, a team of energy industry experts describe possible pathways for Canada to become the first sustainable energy superpower. **IT IS TIME FOR CANADA TO THINK BIG.** ”

–P. Kim Sturgess, P.Eng., FCAE President, Canadian Academy of Engineering

TO READ THE BOOK ONLINE OR ADVANCE ORDER A COPY OF THE PRINT VERSION, VISIT www.clembowman.info/EnergyPathways.html.

A project undertaken by the Canadian Academy of Engineering. Prepared by the CAE Energy Pathways Taskforce. Edited by Richard J. Marceau and Clement W. Bowman

GLOBAL ENERGY SUPERPOWER

PARTNERSHIPS

New alliance aims to accelerate oil sands innovation and environmental performance

The chief executive officers of 12 leading producers have signed on to the Canada's Oil Sands Innovation Alliance (COSIA). Below, COSIA chief executive **Dr. Dan Wicklum** answers questions about the alliance and its aims.

What is the primary purpose of this alliance?

Through COSIA, participating companies will capture, develop and share the most innovative approaches and best thinking to improve environmental performance in the oil sands. Our focus is on four Environmental Priority Areas: water, land, greenhouse gases and tailings.

COSIA is the hub within which companies will collaborate and innovate on the environment. They remain intense competitors but will use our collaborative model to advance regional environmental performance. It will enable companies to work together to avoid duplication of effort, share collective expertise and build on one another's successes.

Our vision is to enable the responsible, sustainable

growth of Canada's oil sands, while accelerating the pace of improvement in environmental performance.

What distinguishes your organization from others?

Key differences include leadership, line-of-sight and leverage. Company CEOs are giving this alliance their direct attention, and are driving that attention throughout their organizations. We also provide a single sight-line; participating companies will jointly set regional performance goals for the sector and report publicly on progress toward meeting those goals. When I say leverage I mean that companies will retain ownership of their innovations, but in COSIA, environmental innovations will be shared and leveraged. COSIA will remove

barriers to funding, intellectual property and human resources that may otherwise have slowed progress.

We've already seen very significant and tangible environmental results flowing from industry innovation through a number of predecessor organizations. We're working to incorporate the efforts of those organizations into COSIA and take the whole sector to the next level in innovation.

Will other stakeholders contribute to these efforts?

One of COSIA's founding principles is openness. We will connect with those developing innovative solutions, inside and out of Canada. We will listen, respond and work with stakeholders to address evolving regional needs and conditions.



"Innovation is fundamental to any sector, especially one as technology and knowledge intensive as the energy sector. In COSIA, we've developed an innovative model tailor-made for the oil sands."

Dr. Dan Wicklum,
Chief Executive, COSIA

Industry is the driving force behind our alliance, but we are deliberately implementing many different ways that other groups – governments, academics, environmental and Aboriginal organizations, for example – can simply plug-in and contribute to the innovation agenda. We are looking for the best ideas, no matter where they come from.

How important is the acceleration of innovation to Canada's future as a potential sustainable energy superpower? Innovation is fundamental to any sector, especially one as technology and knowledge intensive as the energy sector. In COSIA, we've developed an innovative model tailor-made for the oil sands.

Public expectations of environmental performance are increasing in all sectors, and we aim to meet those expectations. We believe that we can build on previously successful individual company and industry efforts and work together in this new model to accelerate the pace of our collective performance improvement. I'm excited to be part of COSIA.



This research test pond of fine tailings capped with water on Syncrude's oil sands operation demonstrates the potential of environmental performance innovation. PHOTO: ISTOCKPHOTO.COM

PROGRESS

Solvent-driven process promises advantages for bitumen extraction

The day the bulldozers and construction workers arrived to break ground for N-Solv Corporation's pilot plant was a big moment for John Nenniger, the company's CEO and chief engineer.

After almost 15 years of developing and refining a solvent-driven technology to extract oil from underground reservoirs, Dr. Nenniger is now excitedly looking forward to seeing it put to work in Alberta's oil sands, just outside of Fort McMurray.

"We expect to see first oil about a year from now," he says. "The facility is scheduled for completion in December, and our first solvent injection will be in April of 2013."

Dr. Nenniger isn't the only one anticipating the development. If proven as a commercially viable process, N-Solv's bitumen extraction solvent technology – or BEST – could be just what those involved in the oil sands have been looking for: a cost-effective and sustainable way to tap into the underground reservoirs that hold about 80 per cent of Alberta's oil sands bitumen.

This peanut butter-thick substance is essentially a clump of oil, sand, clay and heavy metals. With BEST, a solvent such as propane would be injected as a warm vapour into a "gravity drainage chamber" underground, to coax the bitumen into a maple syrup-like consistency. This dissolved substance would then be pumped up to the surface.

Unlike steam-assisted gravity drainage (SAGD), the most pop-

ular bitumen extraction method in use today, BEST uses no water and operates at significantly reduced temperatures of just 40 degrees Celsius. By comparison, SAGD produces oil at about 230 degrees Celsius to 250 degrees Celsius, and requires massive amounts of water.

Both processes use natural gas to generate heat.

"But our lower-temperature process would see a reduction of about 80 to 85 per cent in the energy required to extract the oil," says Dr. Nenniger.

Another BEST advantage: it dissolves only the surface of the bitumen, leaving behind unwanted materials such as asphaltenes, metals, sulfur and nitrogen. These are typically brought up to the surface in SAGD production and end up as waste.

"So, you end up with higher-quality oil out of the ground, and you don't have to strip off all these metals that end up in landfill," says Alexander Stickler, director of oil and gas technologies at Hatch Ltd., which owns N-Solv, together with Nenniger Inc. and Enbridge Inc.

BEST is "an important step forward for Canada and the global energy landscape," says Murray Smith, Alberta's energy minister from 2001 to 2004 and a member of N-Solv's board of directors.

"It will allow us to significantly reduce the environmental impact and cost of oil production," he says. "It really is a compelling process."

Did you know?

\$5.5 million

Funds contributed in 2010 by oil sands companies to Aboriginal communities in the Wood Buffalo and Lac La Biche regions for school and youth programs, celebrations, cultural events, literacy and community projects, and other programs.

Source: Oil Sands Developers Group

Knowledge is
power.
www.uoit.ca/energy

UOIT is leading the way in sustainable energy research.



LET'S INNOVATE AND ENGINEER A BETTER WORLD TOGETHER

The Canadian Academy of Engineering is the national institution through which Canada's most distinguished and experienced engineers provide strategic advice on matters of critical importance to Canada.

www.acad-eng-gen.ca



UNIVERSITY OF ONTARIO
INSTITUTE OF TECHNOLOGY

THE CANADIAN ACADEMY
OF ENGINEERING

Leadership in Engineering Advice
for Canada



L'ACADÉMIE CANADIENNE
DU GÉNIE

Chef de file en matière d'expertise-conseil
en génie pour le Canada

PROFILE

Riding the green energy wave

Enbridge's Chuck Szmurlo likens the company's growing investments in renewable and alternative energy technology to hopping on a surfboard and riding a wave.

"We see these emerging green technologies not as a threat but as an opportunity," says Mr. Szmurlo, Enbridge's vice president of alternative and emerging technology. "You can either stand by and watch the wave crash over you, or you can get a surfboard and ride that wave. We prefer to ride the wave and create shareholder value while we're doing it."

Riding the wave means that, for over a decade, Enbridge has steadily increased its investments in clean energy technologies. In a matter of 12 years, the company's green power assets have grown from nothing to about \$3 billion, to the point where green energy is becoming the "third leg on the stool" of the company's businesses, along with its oil and gas transportation and delivery operations.

And while Enbridge may be regarded as primarily a pipeline and natural gas distribution company, it's quickly evolving into much more. Today the company's wind, solar, geothermal, waste heat recovery and fuel cell projects across North America have a generating capacity of close to 1,000 megawatts.

More than ever, Enbridge is intent on building its portfolio of renewable and alternative energy technology assets because it realizes that, as a leader in the oil and gas industry, it must take measures to balance its involvement in that sector.

"Increasingly, society is going to transition to a cleaner energy mix. We have to be positioned to make that transition in step with society," says Mr. Szmurlo.

And in building its green portfolio, he says the company can achieve the same kind of returns in renewable energy projects as it has historically in the pipeline and utility sector.

Don Thompson, Enbridge's vice president of green energy, agrees. "We follow exactly the same investment philosophy we have for our other infrastructure assets," he says. "Our investments in renewable and alternative energy projects maintain risk and return characteristics that are similar to our crude oil pipeline business."

At first, Enbridge set its sights on a class of fuel cells fuelled directly by natural gas. While it abandoned an early plan to focus on stationary fuel cells for the residential market, this activity was a stepping stone for other developments.

Then, in 2008, the company launched the world's first hybrid fuel cell designed for gas utility pressure reduction stations. Located next to Enbridge Gas Distribution's Toronto headquarters, the leading-edge facility harvests pipeline energy that would otherwise be wasted and combines it with a fuel cell that operates on natural gas to generate 2.2 megawatts of near zero emissions electricity. Today, Enbridge continues to explore other fuel cell markets such as the northeast United States.

Enbridge has invested in numerous renewable and alternative energy projects throughout North America. And while wind and solar power make up most of Enbridge's renewables portfolio, the company is now turning its attention to start-up companies.

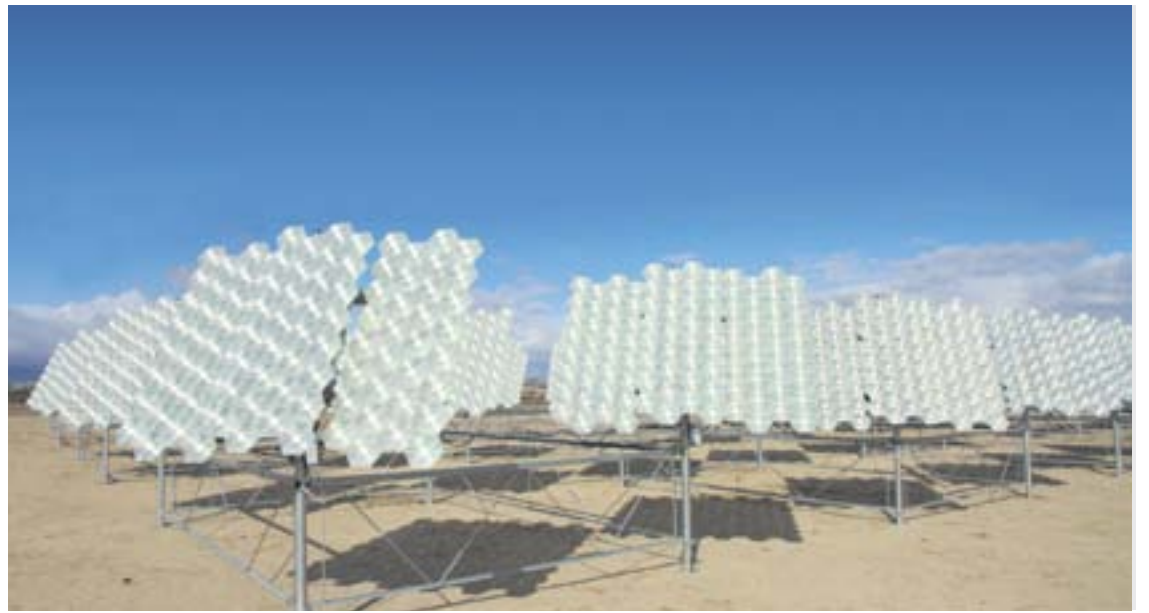
"We're not just investing in green energy projects, we're investing in companies that are helping to bring new innovative technologies to market," says Mr. Szmurlo.

A case in point is one of the company's latest investments in Hydrogenics, which is exploring a new power-to-gas application for electricity energy storage in natural gas pipelines. Together, Enbridge and Hydrogenics will develop a 1-megawatt energy storage project in Ontario to prove the technology at a utility scale. This technology could be particularly advantageous in a market like Ontario's, where large amounts of renewable energy are produced from intermittent sources such as wind. By converting the electricity to gas and storing it in the province's vast natural gas pipeline network, the province could store more renewable energy for long periods, increasing the amount of clean energy that is available for consumers.

It's this kind of forward thinking that is shared by

"We follow exactly the same investment philosophy we have for our other infrastructure assets. Our investments in renewable and alternative energy projects maintain risk and return characteristics that are similar to our crude oil pipeline business."

Don Thompson,
Vice President of Green Energy,
Enbridge



leaders and planners at Enbridge who see a growing role in the green energy sector and are helping to redefine and strengthen its future.

"As a long-term energy player, Enbridge is always looking

for the next opportunity in energy infrastructure," says Mr. Thompson. "We've done it throughout our history, and it's why we continue to look at the next great innovations. Green energy fits with this philosophy."

In 2011, Enbridge invested in Morgan Solar, a Canadian start-up that is commercializing a new line of concentrating photovoltaic (PV) panels that are less costly and have a lower environmental footprint.

PHOTO: ENBRIDGE

WHERE ENERGY MEETS VISION



NEUTRAL FOOTPRINT GLOBAL100

Chuck Szmurlo
V.P. Alternative
and Emerging Technology

We're investing in a greener future through innovation.

Just as a new crop needs water, new technology requires capital. So, at Enbridge we invest substantially in green-power projects and companies—the seeds of a cleaner, greener world. Our commitment to emerging energy solutions spans the continent. It began with wind, solar, geothermal, waste-heat recovery, and fuel cells. Today it includes hydrogen storage, compressed natural gas marine transport, and concentrated photovoltaic panels. Alternative and renewable energy technologies are now integral to who we are.

Enbridge delivers more than the energy you count on. We deliver on our promise to make communities better places to live. It's part of the reason we were named of the Global 100 Most Sustainable Corporations in the World.

Visit www.enbridge.com/alternatives to learn more.

ENBRIDGE
Where energy meets people™

GLOBAL ENERGY SUPERPOWER

NATION BUILDING

Canada's enviable economy founded on 'big project' legacy

Over the last 150 years, Canada has undertaken numerous significant, large-scale projects that dramatically changed the country's business and social landscape. It is especially interesting – and counterintuitive from a normal business perspective – to note that the five projects dealing with energy did not have compelling economics when conceived, or at least economics based on traditional rate of return calculations.

They were driven by a vision that the project would change the nation and open up many new economic opportunities, generating the wealth that is the foundation of the social infrastructure that, for some, defines to a large extent what it means to be a Canadian.

The Canal to Protect Canada

The Rideau Canal was completed in 1832 to provide a secure supply and communications route between Montreal and the British naval base in Kingston. The objective was to bypass the stretch of the St. Lawrence River bordering New York State, a route that would have left British supply ships vulnerable to attack or a blockade of the St. Lawrence River. During blasting, as many as a thousand workers died from disease and accidents.

Colonel John By of the Royal Engineers, who supervised its construction, first came to Canada in 1802 but was recalled to England to serve in the Peninsular War. After the victory at Waterloo, he was dispatched back to Canada to build the Rideau Canal in 1826. The canal was completed in 1832 with 47 masonry locks and 52 dams, creating a 202-kilometre waterway. It has been estimated that 2,000 men worked on the canal each year of its construction. Colonel By was plagued by an initial unrealistic cost estimate of £230,000, and was called before the British Parliament to explain the final cost of £822,000.

Though the canal was conceived and constructed with the defence of Canada in mind, immediately after the canal opened, it played a pivotal role in the early



Originally developed for defence purposes, the Rideau Canal's usefulness as a primary travel route into Upper Canada turned it into a key to the region's economic growth. PHOTO: SUPPLIED

development of Canada, serving as the main travel route for immigrants heading westward into Upper Canada, and for heavy goods such as timber, minerals and grain from Canada's hinterland heading east to Montreal. Thus, its unintended consequence was economic growth.

Uniting Canada – the Canadian Pacific Railway

The Canadian Pacific Railway (CPR) was formed to physically unite Canada and Canadians from coast to coast. Canada's confederation on July 1, 1867 brought four eastern provinces together to form a new country. As part of the deal, Nova Scotia and New Brunswick were promised a railway to

link them with the two Central Canadian provinces – Quebec and Ontario. Manitoba joined confederation in 1870. British Columbia, on the west coast, was enticed to join the new confederation in 1871, but only with the promise that a transcontinental railway be built within 10 years to physically link east and west.

The rocks and muskegs of the Canadian Shield and the mountains of British Columbia created enormous engineering challenges, delays and cost overruns. The man who overcame these problems and achieved the vision was William Cornelius Van Horne. A successful railroad executive in the U.S., Mr. Van Horne became CPR general manager in 1882 to oversee construction of the transcontinental railway over the Prairies and through the mountains.

At the time, the CPR was the longest railway ever constructed, most of it in virgin wilderness. Its successful completion, though troubled by political scandal, significant engineering challenges, delays, cost overruns and financial difficulties, was a remarkable accomplishment of both engineering and political will for a country with such a small population, limited means and difficult geography as Canada.

But the existence of a pan-Canadian, continental railway greatly accelerated the trade of goods from Canada's hinterland to world markets, the settlement and development of Western Canada, the creation of new opportunities and the consequent rapid development of Canada's people and economy.

The James Bay Hydroelectric Power Project

Canada has led the world in the development of numerous hydroelectric power projects, with James Bay in Quebec, Churchill Falls in Labrador and Nelson River in Manitoba being only a few of many significant examples. Major engineering innovations and achievements were incorporated in most large Canadian

hydroelectric projects, either in the design or construction of dam structures or earthworks, generating stations, or long-distance transmission technologies. The James Bay project is an outstanding example, in part because of its numerous innovations in hydraulic engineering, civil engineering, construction engineering and electric power engineering.

The Quebec government began to plan several large hydroelectric power stations in the early 1970s. In 1975, the federal and provincial governments signed an agreement with the Cree of the James Bay region and the Inuit of northern Quebec for the right to develop the James Bay hydro power resources. The project was undertaken in phases with the first phase completed in 1986, eventually resulting in a current installed capacity of 16,000 megawatts. Several transmission lines equipped with advanced compensation were built to bring the power to the province's major load centres.

Robert Bourassa, then Premier of Quebec and for whom the first power station is named, was responsible for launching this mammoth project. A hydroelectric development project on this scale generates not only large economic benefits during its construction phase, but also an ongoing and significant return on investment for generations to come thanks to the renewable nature of rainfall, while producing low-carbon energy.

Thanks to its massive hydroelectric power production, Canada releases only 34 megatonnes of carbon dioxide per exajoule of electrical power, in comparison to the U.S. figure of 162 megatonnes per exajoule.

Adapted from Canada: Winning as a Sustainable Energy Superpower, with permission. To read more about past 'big projects' that helped make Canada a great nation, visit www.clembowman.info/EnergyPathways.html.



Sustainable Solutions for a Better Tomorrow

Sustainability. For Hatch, it's about providing solutions—in energy, metals and infrastructure—that benefit not just our clients' businesses, but the communities in which we work and the environment we all live in.

It's all about incorporating environmental and sustainable design into every one of our clients' projects. Helping companies lower energy costs and reduce greenhouse gas emissions.

Over the last ten years, we have identified more than \$1 billion in energy savings at more than 50 of North America's largest industrial facilities.

We are 11,000 people in 65 offices around the world, with a comprehensive array of technical and strategic consulting services.

We're engineers. We're consultants. We're project and construction managers. And together, we're writing the next chapter in Hatch's legacy of excellence.

Learn more about us at www.hatch.ca



CONSULTING • EPCM • TECHNOLOGIES • OPERATIONAL SERVICES

Did you know?

\$5 billion

Value of contracts secured by Aboriginal-owned companies from oil sands enterprises between 1998 and 2010.

Source: Oil Sands Developers Group



www.sarnialambtonindustrialalliance.com
519-332-1820

Sarnia Lambton Industrial Alliance supports a Canadian solution for the upgrading and refining of Alberta's Oil Sands



ANDERSON WEBB LIMITED



TOOLRITE ENGINEERING

Also supported by



EXPERT OPINION

Ontario's energy advantages can play an integral role in a national energy strategy



By Don MacKinnon,
President, Power Workers' Union

In today's world, Canadian businesses and industries must survive in a global economy where the ability to access competitively priced, low-carbon energy is critical to economic growth. Ontario's unique energy advantage comes from a mix of resources and technology: hydroelectric, nuclear and biomass.

Today, Ontario receives about 70 per cent of its electricity from two sources: hydroelectric and nuclear. Together they provide Ontario's businesses and homeowners with reliable, low-cost, secure, greenhouse gas (GHG) emission-free electricity 24/7. For many decades this has underpinned economic growth in Ontario and provided an electricity system with one of the world's lowest carbon footprints.

Ontario hosts much of Canada's \$6.7-billion-a-year nuclear industry – 160 supply chain companies, 70,000 direct and indirect high-value jobs, and research and development at our universities and colleges that has led to advances in areas like nuclear medicine.

On the environmental side of the ledger, both Ontario and Canada have benefited from nuclear generation. Since 1972, Canada's CANDU reactor fleet has reduced our national GHG emissions by more than 2.4 billion tonnes – that is 90 million tonnes per year – the equivalent of the emissions from 18 million cars. That's a substantial contribution to offsetting Canada's GHG emissions from other forms of energy production.

“Our goal should be to secure higher value from our energy advantages. With decisive leadership, cooperation between our federal and provincial leaders, and a clear integrated strategy, provincial energy advantages can be leveraged to provide strong national economic growth and high-value jobs.”

Refurbishing existing reactors, building new CANDU reactors at the Darlington Nuclear Station and exporting Canadian nuclear expertise has both economic and environmental benefits. In Ontario, new nuclear reactors will create tens of thousands of person-years of new employment, billions of dollars in economic spinoffs and additional environmental benefits. From an environmental perspective a renewed and expanded nuclear fleet will play a critical role in helping displace carbon-emitting fossil fuel electricity generation.

The scheduled closure of the aging 3,000-megawatt Pickering Nuclear Station in 2020 highlights the importance of expediting the new reactor construction at Darlington.

Ontario's vast renewable, carbon-neutral forestry and agricultural biomass resources represent another untapped opportunity to create economic wealth while reducing GHG emissions. Ontario is becoming more and more dependent on natural gas generation to back up intermittent wind and solar generation. This dependency presents two risks for the province. Without its own natural gas resources, Ontario is increasingly reliant on imports of environmentally questionable U.S. shale gas and, even though prices are currently low, natural gas has historically been subject to price volatility. By converting existing coal stations to utilize a combination of biomass and natural gas for peak demand, Ontario can reduce exposure to these risks and limit the need for new natural gas plants and associated transmission lines.

Unlike intermittent wind and solar generation, biomass is a versatile renewable generation technology that can produce electricity when it is needed.

Investments in biomass supply chain infrastructure could help kick start thousands of new jobs and economic benefits for Ontario's agricultural, forestry

and transportation sectors. Powering zero-emission vehicles with these sources of low-carbon electricity can reduce GHG emissions from Ontario's largest source – transportation. Developing a provincial strategy that shifts

from gasoline-dependent cars and trucks to low-carbon electric vehicles would dramatically reduce Ontario's carbon footprint. Concurrently, such a strategy could help our huge automotive sector play a central role in the development and

manufacture of zero-emission vehicles for the 21st century. Achieving energy superpower status requires more than exporting fossil fuels and uranium. Our goal should be to secure higher value from our energy advantages. With decisive

leadership, cooperation between our federal and provincial leaders, and a clear integrated strategy, provincial energy advantages can be leveraged to provide strong national economic growth and high-value jobs.



ONTARIO'S ENERGY ADVANTAGES CAN HELP MAKE CANADA A DIVERSE ENERGY SUPERPOWER

Achieving energy superpower status requires more than exporting fossil fuels and uranium.

Securing higher value from our energy advantages is the key to getting there.

Ontario's nuclear and biomass energy advantages are a case in point.

Both produce safe, reliable, low-carbon electricity.

Canadians benefit from a solid \$6.7 billion a year nuclear industry, 70,000 jobs and R&D related to medicine and fuel recycling.

Using renewable, carbon-neutral biomass with natural gas at our existing coal stations means: electricity production when it is needed; lower GHG emissions; better energy security; and more jobs in agriculture, forestry and transportation.

What's needed? Decisive leadership, a comprehensive strategy and clear investment plans.

For more information please go to www.abetterenergyplan.ca

**FROM THE PEOPLE WHO HELP
KEEP THE LIGHTS ON**



GLOBAL ENERGY SUPERPOWER

FOCUS

Innovation and leadership key to achieving Canada's potential

The 19 authors of *Canada: Winning as a Sustainable Energy Superpower* have put together a slate of **nine big projects they believe will allow Canada to achieve its economic potential over the next 40 years**, while addressing the challenges of climate change. "These projects represent the views of a group of energy enthusiasts who have spent the last year thinking about energy and Canada's future prosperity," says contributor and editor Dr. Clement Bowman. "Our proposals are an open question to Canadians: **'What do you think of our ideas?'**"

1 Shovel-ready Adding bitumen upgrading capacity vital for the Canadian economy, jobs

Bitumen upgrading capacity must be built soon in Canada, or the country risks losing \$60-billion per year in value-added products and associated jobs by the end of the decade.

But that gloomy projection does not have to become a reality, not by a long shot, says Paul Healy, the chairman of the Sarnia Lambton Industrial Alliance in Ontario.

"Canada certainly has the wherewithal to upgrade our own natural resources," Mr. Healy says, adding that while upgraders have been built in Alberta, other regions such as Sarnia-Lambton have the expertise to upgrade and refine bitumen.

According to industry forecasts, production from the Alberta oil sands is poised to triple within the next two decades.

Half of the resulting raw bitumen, the heavy, thick and sticky form of crude oil, could have to be processed outside of Canada.

But this can be largely avoided. The upgrading of bitumen, which involves converting it into high-quality, synthetic crude oil, does not all have to happen in Alberta. Building upgraders in Ontario, for example in Sarnia-Lambton, would ease the processing load.

What's needed, says Clement Bowman, co-founder of ProGrid Ventures Inc., is for Alberta and Ontario to cooperate to develop and apply new environmentally advanced upgrading technologies, optimizing the use of available labour and facilities at both the Alberta Industrial Heartland and the Sarnia-Lambton Petrochemical and Refining Complex.

Sarnia-Lambton is poised to make that work. Mr. Healy says



Bitumen upgrading capacity will mean billions of dollars in economic value and many thousands of jobs for Canada's future.
PHOTO: ISTOCKPHOTO.COM

The \$60-billion figure is a significant understatement of the full impact of bitumen upgrading on jobs and GDP, taking into account the 'multiplier effect.'

Dr. Walter Petryschuk,
Former Suncor Executive

there is no doubt that it can provide support in terms of building and operating upgrader units in Ontario.

"There is an exact match in terms of a skilled workforce, professional engineering services and environmental companies," says Mr. Healy, the president of LamSar Inc., a heavy industrial mechanical contractor with manufacturing facilities in Sarnia. "We can also help with the manufacture of the required modules and equipment that is required in Alberta."

One obstacle, points out Mr. Healy, is the existing shipping corridor between Sarnia and northern Alberta. But he says this "can easily be remedied with federal infrastructure spending to cut a path between the two locations."

Eric Newell, retired chancellor of the University of Alberta and former chair and CEO of Syncrude Canada, believes that upgrading bitumen in Canada maximizes the value-added aspect of the oil sands by retaining economic, employment and social benefits here.

"I feel a good, achievable target is to ensure that 60 to 65 per cent of the bitumen should be upgraded in Canada," he says. "And technology must continue to play a vital role if we are to realize the tremendous potential for oil sands development that must proceed in a sustainable, environmentally and socially responsible manner."

Dr. Walter Petryschuk, former Suncor executive, emphasizes that the \$60-billion figure is a significant understatement of the full impact of bitumen upgrading

on jobs and GDP, taking into account the "multiplier effect."

George Mallay, general manager of the Sarnia-Lambton Economic Partnership, says the creation of a new upgrader in his area would keep highly skilled, well-paying jobs in Canada.

"Over time, we are talking about billions of dollars of economic value to the Canadian economy that would otherwise be lost," he says, adding that 300 to 400 jobs at an upgrader can support 2,000 to 3,000 indirect jobs.

2 Shovel-ready National grid will lower energy costs and emissions and bind the country together, experts say

If timing is indeed everything, then Canada should undertake the next major step in nation-building by connecting existing provincial electrical grids through a new high-voltage, high-capacity transmission system.

Building a national grid now makes sense, in order to lower energy costs and atmospheric emissions, says Ron Nolan, past president of the Canadian Academy of Engineering.

"Building a national grid is like building a national railway," says Mr. Nolan, also chairman of N-Solv Corporation and past president and chairman of Hatch Ltd. "It binds the country together. It becomes crucial, because in the present era of globalization, we are in competition with many countries, but very few have the diversity of Canada. We can take advantage of that."

Historically, Canada's electricity networks have been designed and built on a province-by-province basis, with limited emphasis on provincial interconnections.

Clement Bowman, co-founder of ProGrid Ventures Inc., says that Canada has more electrical interconnections with the United States than between provinces, something that has prevented us from enjoying a uniform low power rate.

He says the interconnection of existing provincial grids through new high-capacity transmission corridors would enable significant reductions in Canada's carbon footprint. This would also improve the business case for intermittent renewables such as wind and solar, assist in the management of regional peak loads, release stranded power and thereby reduce power costs in some markets, while enhancing energy storage capability and providing strategic security advantages through a high-capacity transmission backbone.

"Today, Canada has one of the most sustainable electricity systems in the world. We are a global leader in clean electricity production," says Jim Burpee, president and CEO of the Canadian Electricity Association. "It is important for provinces to work together to set priorities, share resources and maintain reliability, affordability and sustainability."

The various sources of fuel used in electricity generation have a role to play, depending on the

"Building a national grid is like building a national railway. It binds the country together. It becomes crucial, because in the present era of globalization, we are in competition with many countries, but very few have the diversity of Canada. We can take advantage of that."

Ron Nolan,
Past President, Canadian Academy of Engineering

jurisdiction, with each having its particular strengths and benefits, he says. "The key is to find the right mix, to ensure the protection of our environment and further reduce greenhouse gas emissions."

According to a recent report from the Conference Board of Canada, Mr. Burpee says current and future electricity infrastructure renewal investments would create approximately 150,000 new jobs per year and be used to modernize electricity grids, increase efficiency and accommodate growth.

"These investments will provide the foundation for the next generation of Canadian economic growth, and ensure Canada maintains its position as a global sustainable energy superpower," he adds.

Mr. Nolan says there is still large untapped hydro power in Canada that could be made available to a national grid, plus there is potential to introduce nuclear power at different locations. "That would add a big dimension to the renewable generation capacity, which would lower costs as well as atmospheric emissions."

He stresses that a national grid could take advantage of time zone differences as well as varied forms of energy generation and consumption.

"The next step should be a sovereign-funded conceptual study of the preliminary design, costs, schedule and economics," Mr. Nolan says.



The cars of tomorrow...today

McMaster students and the hybrid race car they designed and built.

McMaster University's MacAuto group brings faculty and students together to design the cars of tomorrow, today.

Researchers and students are working with industry, government and academic partners developing and commercializing new technologies and materials that ensure the global competitiveness of Canada's auto industry. MacAuto is also educating a new generation of professionals ideally suited to understanding real-world issues.

macauto.mcmaster.ca



Did you know?

10%

of all people employed in the oil sands are Aboriginal.

1,200

Aboriginal trade apprentices in Alberta – a 400% increase since 2002.

Source: Oil Sands Developers Group

Energizing new ideas for sustainable development

Researchers at Western are collaborating with leading energy companies to discover new technologies that protect our environment.

With support from industry partners, researchers from Western's faculties of Engineering and Science are advancing knowledge related to renewable forms of energy, including solar, wind, water and biofuels.

From graduate studies in our Master's of Environment & Sustainability program to advanced remediation and biofuel research, Western is training students to address both the environmental challenges and opportunities facing our world.

Western provides an academic experience second to none, combining academic and research excellence with life-long opportunities for intellectual, social and cultural growth.

To learn more visit www.westernu.ca



GLOBAL ENERGY SUPERPOWER

3 Nuclear Applications for the Oil Sands

Nuclear technology offers the opportunity for a major 'big project' providing thermal energy to produce steam for the recovery of bitumen from the Alberta oil sands, with a major reduction in greenhouse gas emissions.

To identify the most promising technology path for thermal energy for the oil sands, an ambitious, multi-stakeholder technology development process is needed. Various established and new reactor designs are available, and advances are anticipated in new fuel cycles and technologies (closed fuel cycles, thorium, fusion, etc.) that can resolve public concerns related to early generations of nuclear technology. The nuclear technology of the future promises to be extremely safe, proliferation-resistant and low-waste.

Canada's economy stands to benefit from a strong nuclear industry and synergies with other applied technology clusters such as medical diagnosis and treatment, food safety and sterilization, energy supply, uranium mining and materials science.

Nuclear technology is also key to cutting back on greenhouse gas emissions, says Dr. Keith Hipel, a professor of systems design engineering at the University of Waterloo and senior fellow with the Centre for International Governance Innovation. In the oil sands, the use of nuclear technology would mean that the immense volumes of natural gas now used in production could be exported.

Piping unprocessed bitumen out of Canada may appear economically attractive in the short term, he says, but will result in enormous potential losses in profits and jobs over the longer term. "Upgrading bitumen and our other natural resources in Canada would create billions in profits and thousands of jobs, without erecting barriers to foreign investment."



Canada now has 73,000 MW of hydroelectric power in service, and another 163,000 MW could be developed for a total capacity of 236,000 MW. Doubling our hydroelectric production is within our technical and commercial capability in five major regions of Canada.

4 Gasification of Coal and Biomass

Coal is the world's most abundant and widely distributed fossil fuel, and Canada has more energy in its coal than in oil and gas combined.

Gasification technology has the unique ability to produce electrical power, hydrogen and high-value chemical and petrochemical products; to handle diverse feedstocks; and to capture carbon dioxide, sulphur, particulates and trace metals. There are approximately 150 gasification plants operating worldwide that use coal as their major feedstock, but only one of these captures and utilizes carbon dioxide.

Canada has an opportunity to build coal and biomass demonstration plants, adapted for Canada's low-rank coals and our extensive forestry and agricultural biomass resources. Cost-

effective and environmentally sound technologies developed for Canadian applications will find widespread domestic and international application.

"The advantage of gasification is that it can convert low-grade fuels such as coal, coke produced from bitumen upgrading, biomass and municipal solid waste currently going to landfill into synthesis gas that can in turn be converted into a variety of valuable 'clean' products including electric power, hydrogen, synthetic fuels and chemicals," says Duke du Plessis, senior advisor of energy technologies at Alberta Innovates: Energy and Environment Solutions.

But the gasification technologies currently available are expensive. In order to access this immense potential value, Canada must demonstrate new cost-effective gasification, gas cleanup and carbon capture and utilization technologies, advises Dr. du Plessis.

5 Hydroelectric Capacity Expansion

Hydroelectric development in Canada began in 1881 and continued unabated until the 1990s. Canada now has 73,000 MW of hydroelectric power in service, and another 163,000 MW could be developed for a total capacity of 236,000 MW. Doubling our hydroelectric production is within our technical and commercial capability in five major regions of Canada.

Progress in the efficient use of electricity during the period 1990 to 2010 has reduced the pace of development of new hydro-power, but given this untapped potential and slower pace of the nuclear and wind industry, it is quite possible that Canada is at the dawn of a new rush for this "white gold."

Environmental issues received extensive attention in projects initiated during the 1970s. Best practices for safeguarding the environment while harnessing the

hydroelectric potential of new sites are now extensive.

The new monumental tunnel project to tap considerably more power from the Niagara Falls is a sign of the potential awaiting Canada in low-GHG power.

6 St. Lawrence Seaway Hydroelectric Project

The St. Lawrence Seaway was a project of gigantic proportions – a 3,700-kilometre marine highway that runs between Canada and the United States, from the Atlantic Ocean to the head of the Great Lakes, in the heart of North America. But there is a cloud on the horizon – due to climate change, it is forecast that the Great Lakes will undergo a significant decrease in water level.

To prevent this from occurring, a big project has been planned involving the transformation of the entire St. Lawrence River and Great Lakes basin into a waterfall of some ten reservoirs, with a gigawatt of additional hydroelectric potential.

7 Northern Water Diversion Hydroelectric Project

A companion project to the St. Lawrence Seaway project described above, the Northern Water Diversion Hydroelectric Project would contribute to maintaining the seaway water level by intercepting the Bell and Waswanipi rivers in the Matagami area in Northern Quebec and diverting water from these rivers into the nearby Ottawa River watershed en route to the St. Lawrence River. This project would also generate three gigawatts of hydroelectric power and provide drinking water to a population of 150 million

people, water than now flows into the world's oceans.

8 Liquefied Natural Gas Projects

Over the next 20 years, global demand for natural gas for use in electricity generation, heating and transportation is expected to rise dramatically. Canada will have significant competition in export markets. It is estimated that the U.S. will import up to 50 per cent less gas from Canada than in the past, due to rapid discovery of new domestic reserves. This increases the need for Canada to diversify its natural gas markets, and once markets are considered outside North America, it is necessary to liquefy the gas for ocean transport. B.C. is proposing and leading a new big project to capture a major share of this international market.

9 Bio-refineries

Canada has enormous resources of biomass, from our forests (10 per cent of the world's total) to our agricultural land, which is about the size of France. In addition, invasive species – such as the mountain pine beetle that has caused massive damage to trees in British Columbia – are creating opportunities to add value to biomass that is otherwise waste product.

Bio-refineries should be built to convert these feedstocks into bio-energy, bio-chemicals and a wide range of commercial products, with sustainability principles front and centre. So far, Europe has led in this area, but our research and technology enterprises are determined to become leaders.

Visit www.clembowman.info/EnergyPathways.html to read the book in its developmental stages. Scheduled for publication in the fall, the print version of the book will be available from the Canadian Academy of Engineering.

This report was produced by RandallAnthony Communications Inc. (www.randallanthony.com) in conjunction with the advertising department of The Globe and Mail. Richard Deacon, National Business Development Manager, rdeacon@globeandmail.com.

1000 RESEARCHERS ON A mission.

Here at the University of Alberta, more than 1000 researchers are collaborating on a single challenge: responsible development of our oil sands. They're looking for breakthroughs and continuous improvements – techniques that have less impact on the air, the water and the land. There may be a perception that nobody's working on these challenges. Nothing could be further from the truth.

David T. Lynch
Dr. David Lynch, P.Eng.
Dean of Engineering
University of Alberta

oilsandstoday.ca
A message from Canada's Oil Sands Producers.
The Canadian Association of Petroleum Producers (CAPP) represents member companies that produce over 90 per cent of Canada's natural gas and crude oil, including Canada's Oil Sands Producers.

CAPP
CANADIAN ASSOCIATION
OF PETROLEUM PRODUCERS

University of Alberta, North Campus – Latitude 53.526649, Longitude -113.529623

GLOBAL ENERGY SUPERPOWER

TRANSPORTATION

Driving a sustainable future with electric cars and smart power

Going on a road trip? In the future envisioned by Ali Emadi, this may mean adding a charging cable to your list of things to pack.

Dr. Emadi, a professor of mechanical and electrical engineering at McMaster University in Hamilton and director of the McMaster Institute for Automotive Research and Technology (MacAUTO), sees the roads and highways of the future travelled not by gasoline-burning vehicles but electric cars that plug right into the power grid.

"The next paradigm shift for transportation is electrification," he says, noting that the past 10 to 15 years have seen the introduction of hybrid and plug-in hybrid electric cars, such as the Toyota Prius and, more recently, the Chevy Volt. "The logical continuation of this paradigm shift will be the emergence of the all-electric car."

For this future to materialize, there also needs to be a parallel shift in the electricity sector, says

Motors without rare earth permanent magnet materials are "a game-changing technology for automotive and renewable energy systems, because the price of rare earth permanent magnet materials has gone up about 10 times in the past year alone."

Ali Emadi,
Professor of Mechanical and Electrical Engineering,
McMaster University

Dr. Emadi. Today's power grids need to get smarter by employing technology that will enable them to monitor individual homeowners' usage patterns. That way energy – drawn from conventional as well as renewable sources – can be stored and discharged intelligently.

Research at McMaster is driving both cars and power grids toward this future.

At MacAUTO, researchers are working on electric and hybrid powertrain technology and battery systems that will charge faster and allow cars to go farther, as well as advanced automotive software that can create smart "cognitive" cars. Also in the works is a family of electric motors without rare earth permanent magnet materials, which must be imported, predominantly from China.

"That's a game-changing technology for automotive and renewable energy systems, because the price of rare earth permanent magnet materials

has gone up about 10 times in the past year alone," says Dr. Emadi.

At the same time, McMaster researchers are developing technology for smart "micro-grids" – smaller grids that generate power for individual buildings, industrial sites or communities – with a focus on optimizing energy use, particularly from renewable sources.

"For example, if the price of electricity is cheaper at midnight, the controller will wait until then before charging your car," explains Dr. Emadi. "And if the price goes up in the afternoon, then that's when the controller will discharge the solar energy you've saved to the main grid, so you can sell it at a higher price."

This smart, electrified future is still a few years away at the mass scale, says Dr. Emadi. But for those who understand the need for sustainable energy, it's the inevitable next step in the evolution of transportation and electricity.



Professor Ali Emadi sees the roads and highways of the future travelled not by gasoline-burning vehicles, but by electric cars that plug right into the power grid.

FROM PAGE E5 1

Big projects: Enabling economic gain, job creation and environmental benefits today

And each, in its day, was subject to intense scrutiny and stoked public debate, as is the nature of developments that change the fortunes of nations.

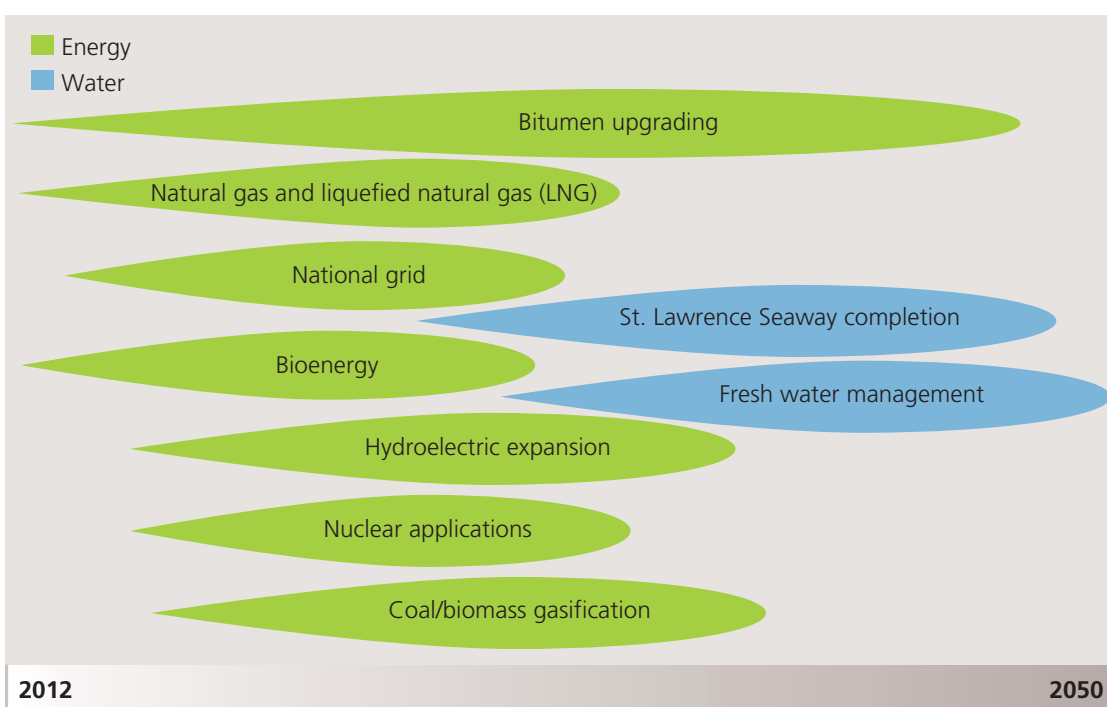
The key to the success of the proposed projects, says Dr. Eddy Isaacs, CEO of Alberta Innovates – Energy and Environment Solutions, is government-industry partnership. That, and having the leadership to ensure that these types of projects can move forward, even though they don't immediately provide economic benefit.

"They will have huge future payback and environmental benefits," Dr. Isaacs says. "And I think some of them will be very critical to position Canada as a global energy leader."

He agrees that the most crucial steps are building new bitumen refining capacity in Canada and establishing a national electrical grid.

"An electrical grid that connects us east to west and north to south would also mean that we could export a lot of clean energy," Dr. Isaacs adds.

In the past, says Clement W. Bowman, co-founder of ProGrid Ventures Inc., Canadian citizens showed that they were in for the long haul and were prepared



Canada's next big projects depend upon leadership that ensures they move forward even in the absence of immediate economic benefit.

to support the big projects that shaped the country's history.

"Not driven by conventional private sector economic horizons,

big projects have enabled infrastructures that have overcome Canada's vast geography and low population," he says. "They opened up opportunities for Canada's entrepreneurs for many decades in the future. Just think of the St. Lawrence Seaway, which brought the Atlantic Ocean into the heart of Canada."

With these new megaprojects, Mr. Prentice sees opportunity on the horizon once again.

"When you tally up the capital investment in oil sands and pipelines, power generation, and electricity transmission and distribution, the grand total is more than one million new jobs over 20 years. We're talking about more than a million jobs when they are most needed," he notes, adding that the final result is equally impressive. "That includes a network of pipelines and ports that will diversify our oil and gas markets beyond the United States, the greening of the North American electricity system and adding value to our energy exports."

"When you tally up the capital investment in oil sands and pipelines, power generation, and electricity transmission and distribution, the grand total is more than one million new jobs over 20 years."

Jim Prentice,
Senior Executive Vice-President
and Vice Chairman, CIBC



An electric grid that connects Canada from east to west and north to south would enable the export of clean energy. PHOTO: ISTOCKPHOTO.COM

ECONOMIC ENABLERS

According to industry experts, new projects and the resulting "multiplier effect" linked to Canada's two energy corridors have the potential to dramatically increase employment.

The Alberta Industrial Heartland

The Alberta Industrial Heartland (AIH) is an industrial corridor northeast of Edmonton, comprised of a cluster of more than 40 companies involved in the petrochemical, chemical, and oil and gas industries. With extensive sharing of feedstocks and products, including hydrogen, methane, ethane, ethylene, oxygen and carbon dioxide, this corridor is an integral part of the North American pipeline network and carries oil, natural gas, ethane, and ethylene to processing plants and markets.

AIH facilitates cost-effective access to the Alberta oil sands, and has excellent road, rail, air and pipeline connections. The region is focused on bitumen upgrading, with a plan to increase upgrading capacity from 150,000 barrels per day (bpd) to 1.7 million bpd by 2017. Over the next decade, the estimated capital expenditure for the area is nearly \$65 billion.

The AIH promotes the region as a global leader in processing, manufacturing and eco-industrial development. More than 6,000 people work within the region's 582 kilometres.

The Sarnia-Lambton Petrochemical and Refining Complex

North America's first oil field was discovered near Sarnia over 150 years ago and led to the construction of Canada's first oil refineries late in the nineteenth century. The companies established in the region in the 1940s, such as Polymer (which later became Polysar), are an example of the collaboration between the public and private sectors on big projects.

The resulting Sarnia-Lambton Petrochemical and Refining Complex has become the major corridor of integrated petroleum and petrochemical industries, and home to many well-known multinational firms.



Products from Sarnia can reach major U.S. markets within two days of truck travel. Major pipelines bring crude oil, natural gas, natural gas liquids and ethane to the Sarnia-Lambton region. Other pipelines carry refinery products to markets across Southern Ontario.

The St. Clair River provides cooling and process water and is part of the St. Lawrence Seaway, which connects the heartland of North America with the markets of the world.

Within Sarnia-Lambton, efforts are under way to develop new sectors that have a logical relationship with the community's existing infrastructure. The merger of the hydrocarbon-based economy with the industrial bio-economy is strongly supported by various community partners, with potential to replace or supplement materials currently produced from petroleum with those made from renewable resources to produce biofuels, renewable chemicals, bio-composites and bio-plastics.

Adapted from Canada: Winning as a Sustainable Energy Superpower, with permission. To read more about past 'big projects' that helped make Canada a great nation, visit www.clembowman.info/EnergyPathways.html.