


CANADA'S ENERGY TRANSITION

Getting to Our Energy Future, Together

GENERATION ENERGY
COUNCIL REPORT














GENERATION ENERGY
The Conversation Continues

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In 2017, the Government of Canada launched Generation Energy – an open and inclusive nation-wide dialogue with stakeholders, experts and individual Canadians to envision what a low-carbon energy future would look like for Canada over the course of a generation. Building on the results of that dialogue, the Minister of Natural Resources formed the Generation Energy Council to prepare this report in order to answer four crucial questions:

- What should Canada's energy future look like over the long term?
- What generational goals should we strive to achieve?
- What principles should guide us?
- What are the potential pathways and milestones along the way?

In answer to these questions, this report takes a generational view. As a Council, we've looked beyond the current tensions and debates. Our focus instead is on our shared future – the broad and deep shifts occurring in the world's climate and energy systems, and the imperative that Canada must act now to navigate the energy transition successfully.

JUNE 2018

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PART I. INTRODUCTION

A New Energy Vision for Canada

Reports like this are the kind of thing you think you should get down to reading but rarely do. Most people just want to use energy to make their lives run smoothly, not ponder its future. But we're hoping you stick with it on this one, because this subject is too important to lose you on.

An energy transition is underway – and will continue to roll out over the course of a generation, roughly between now and 2040. It is the greatest shift of this kind the world has seen in generations. For nations like Canada that embrace this shift, it can represent a big change for the better. This transition has the potential to change how you switch on the lights, heat your home and get to work – maybe even the kind of work you do when you arrive there.

This transition is a big deal. And it represents a real opportunity for Canadians – we know it can help us build a better country, avoid the impacts of climate change, and redefine Canada's role in a changing world. This report is a proposition for Canadians – an invitation to imagine Canada's energy future, and then to join together to build it.

What kind of country do you want to be living in a generation from now? What legacy do you want to pass on to your children and grandchildren? Do you want Canada to be a leader or a follower?

In 2017, the Generation Energy dialogues gathered the ideas of more than 380,000 Canadians about Canada's energy future. They said they wanted to see the economic prosperity, diverse social fabric, environmental quality and high international regard that define our country sustained. And they shared a collective vision of our energy future built on three pillars: it must be affordable, reliable and clean.

The first two of these pillars have long been in place, and we all agree they must be maintained. But it is the demand for clean and efficient energy to power our homes, businesses and transportation systems – and the wave of technological innovation underway globally in response to that same demand – that drives the need for a new energy vision in Canada.

TERMINOLOGY

A full glossary has been included at the end of this report. Some of our most frequently used terms:

CLEAN ENERGY – For the purposes of this report, clean energy refers to electricity produced from renewable energy (hydro, wind, solar, geothermal, etc.), as well as energy efficiency solutions

NON-EMITTING – refers to electricity produced from sources that produce no carbon pollution, such as hydro, wind, solar, nuclear, geothermal, and tidal

TRANSITION PATHWAY – A mix of technology, investment, business strategies, and government policy that enables Canada to transition from its current energy system to a low-carbon energy system over the next generation (roughly by by 2040)

CLEANTECH – Emerging knowledge-based products and services that improve operational performance, productivity or efficiency while reducing costs, inputs, energy consumption, waste or pollution

Canada has already made strong commitments to embrace this transition, pledging under the Paris Agreement on Climate Change to substantially reduce its greenhouse gas emissions and agreeing on a plan to do that through the Pan-Canadian Framework on Clean Growth and Climate Change. And across the country, many cities, Indigenous communities, institutions, businesses, and people like you have already begun to adopt ambitious clean energy and low-carbon programs of their own.

This might sound like just feel-good talk, but that framework – which nearly every province and territory has endorsed – represents the broadest consensus on climate and energy issues our country has ever achieved. Along with the shift now underway in the global marketplace for energy and other resources, these commitments require us to act now to transform our energy systems to ensure they can meet changing needs at home and abroad.

CANADA'S CLIMATE COMMITMENTS

At the outset, we want to emphasize that the global energy transition is inspired in part by changing market and technology dynamics for energy products and services but the primary motivation is the urgent need to cut global greenhouse gas emissions to address mounting risks and impacts of climate change. Accelerating the transition to a low-carbon economy today will reduce the costs of inaction.

For these reasons, Canada joined with the vast majority of the world at the Paris climate talks in 2015 in committing to global action, pledging to reduce carbon emissions 30 percent below 2005 levels by 2030, with deeper reductions beyond that.

To achieve this goal, the federal, territorial, and majority of provincial governments all agreed to the Pan-Canadian Framework on Clean Growth and Climate Change. Here are the most important commitments in that plan:

- carbon pricing in all jurisdictions by 2018
- acclerated nationwide coal phaseout by 2030
- nationwide strategy for electric vehicles by 2018, accelerated deployment of charging infrastructure
- implementation of a federal clean fuel standard
- establishment of a nationwide net-zero energy building code by 2030, and energy use labelling for buildings by 2019
- renewed support for industrial efficiency, including the adoption of energy management systems
- reduction in methane emissions from the oil and gas sector of 40-45 percent by 2025

The Global Race is On

We're headed into challenging terrain, and there's still a lot of uncertainty about the pace of change in the Canadian and global energy marketplace. What's certain is that our climate is changing rapidly. Unless we can start to reduce emissions now, we will soon have to grapple with the human and financial costs of more frequent and extreme storms, floods, heat waves, droughts and forest fires.

The transition to a low-carbon economy necessary to overcome these challenges is a global race, and it won't wait for us. Within a generation, countries like Canada will be using less fossil fuels, and renewable power and other non-emitting sources of energy will command a much larger share of the world's energy supply. Leading economies the world over – from China and India to the US and Europe – are investing tens of billions every year to develop the new technologies, services and knowledge that will supply the world with cleaner and more efficient energy. As part of this global boom, Canada's clean energy sector can contribute new energy products and services to developing markets. Oil and gas will also continue to be part of the global energy mix, and Canada must innovate to lower carbon and costs in order to compete for that demand.

There's real risk involved in falling behind in this energy transition, in failing to build the momentum – and public and investor confidence – required to achieve it.

Canada must step on its accelerator.

Two Tracks, One Prosperous Destination

In the face of long-term uncertainties and rapidly changing energy markets worldwide, Canada needs to start out on this journey along two tracks. First, we need to rapidly transform our energy production, distribution and consumption systems at home so that they are as clean and efficient as possible – and do more than they ever have before to protect our air, land and water. This will require governments, businesses and citizens alike to make energy transformation a top priority and step up with the new tools and decisive steps necessary to make it happen.

Navigating this first track successfully will require Canada to speed up its shift to low-carbon solutions for our electricity use, transportation, industrial activities, and heating and cooling needs, as well as nurturing new businesses and developing clean energy technologies and energy efficiency solutions to make the shift possible. By doing this at home, we can also stake out a leading position in some of the fastest-growing sectors of the global economy.

On the second track, we must continue to accelerate the development of low-carbon technologies for use in our existing oil and gas sector to reduce carbon pollution, cut costs, and create new value-added products and services. Oil and gas companies will need to take greater initiative, rapidly innovating to stay competitive in global markets. And that will require them to establish carbon footprints smaller than their competitors.

A GLOBAL CLEANTECH BOOM

The global clean technology market is estimated to grow to $2.2 trillion by 2022. Here are some key metrics for Canadian performance to date in the sector:

- **Canada ranks fourth on the Global Cleantech Innovation Index**
- **Canada's cleantech industry contributed $59.3 billion to GDP in 2016**
- **Canada's cleantech industry employs an estimated 274,000 Canadians**
- **Nearly 80 percent of Canadian cleantech firms are exporters, and together they generated $11.5 billion in exports in 2016**
- **Canada is ranked fourth worldwide and first in the G20 in terms of potential to produce cleantech start-up companies over the next decade**
- **Canada's share of the global clean tech market has fallen 12 percent in the last decade**

Transitioning along these two tracks won't be easy. Canada has long used its abundant natural resources – including oil and gas, forests, agriculture, metals and minerals – to drive much of our economic prosperity. But the future is not the past. Our energy transition requires a shift to a more diversified, knowledge-based economy like the ones contributing to growth in other parts of the world. Finding our new competitive advantages will take significant effort on the part of all Canadians. But the costs of inaction represent a level of risk that cannot be ignored. What's more, the marriage of the existing strengths of our resource sectors with an innovative wave of new technologies will open up new market opportunities.

Canada's Starting Line

Few other countries on earth have been blessed with a range of energy resources as rich and diverse as ours. Owing to our abundant hydropower, growing renewable power and storage capacity, and various nuclear facilities, nearly 80 percent of our electricity already comes from emissions-free sources. We started out ahead of the game. Now we have to commit to winning it.

Our head start will only carry us so far, however, because electricity is only a small portion of all the energy we use as a nation. We produce most of our emissions in industrial activities, transportation and heating. Our most challenging work lies ahead.

The potential rewards, though, more than justify the effort. This transition represents a unique, once-in-a-generation opportunity to find a stronger and more stable place in the energy economy for regions and communities that weren't previously well connected to it. The shift to a low-carbon economy will involve many and varied energy projects nationwide, and these offer new opportunities to build real, durable partnerships with Indigenous and rural communities by investing directly in their energy future. It provides a chance to expand access to affordable, reliable and clean energy across the country – not to mention giving Canadians a much greater range of choice in the kind of energy they use and when and how they use it.

The good news is we are already part of this transition. Canadian companies in every sector have begun to invest in greater energy efficiencies, slash carbon pollution, and seek customers at home and abroad for clean energy solutions.

You've probably heard the shorthand name for some of the innovations driving this transition – cleantech – but that's only one small part of picture, and it leaves out all the opportunities created by vital work such as retrofitting buildings and adding renewable energy to the grid. For Canadian children in school today, growing economic sectors like these are where many of them will find stable, lifelong careers.

Canadian governments – federal, provincial, territorial, municipal and Indigenous – have also begun to introduce the kinds of climate and energy policies that will enable every part of our economy, including our energy and resource sectors, to thrive. If we get the balance right, this kind of coordinated approach across governments and jurisdictions can reduce carbon pollution, while spurring innovation, supporting Canadian productivity, and providing a solid foundation for future actions. But there's a lot of work still to be done.

Indigenous Leadership in Canada's Energy Transition

Canada's relationship with Indigenous Peoples should play an important role in the success of our energy transition. Indigenous peoples already play a leadership role as pathfinders – stewards of the land, environment and natural resources. Both Indigenous and non-Indigenous Canadians see the value of greater Indigenous participation in Canada's energy future and want to ensure that Indigenous communities benefit more directly from energy development.

Work is already underway on a renewed relationship with Indigenous peoples. The Government of Canada has committed to an upfront recognition of rights, respect and cooperation as a foundation for change. Indigenous leaders at local, regional and national levels are currently engaging with senior levels of government on initiatives such as the implementation of the Pan Canadian Framework on Clean Growth and Climate Change and the development of a new framework for the recognition and implementation of Indigenous rights. These processes also include collaborative development of new mechanisms for greater Indigenous involvement in regulatory decision-making on energy projects.

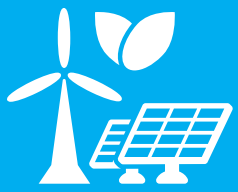
As part of this new relationship, Indigenous peoples must be included as partners in shaping Canada's energy future. By embracing Indigenous participation in the energy transition, Canadian and Indigenous leaders alike can create a powerful lever for change, accelerating progress on economic reconciliation, reducing poverty and increasing prosperity. This transition is an opportunity for Indigenous Peoples and communities to take their place at the table and help drive the evolution of Canada's energy sector.

AN ENERGY POWERHOUSE

Canada's resource wealth positions it among the world leaders on every front in the energy sector. Some highlights:

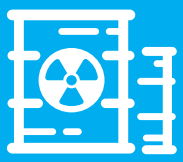
Electricity:
81 percent of Canadian electricity is generated from non-emitting sources, 2nd highest in the OECD

Hydroelectricity:
Canada is the world's 2nd largest producer



Renewable energy:
the world's 4th largest producer

Wind energy:
the world's 8th largest producer



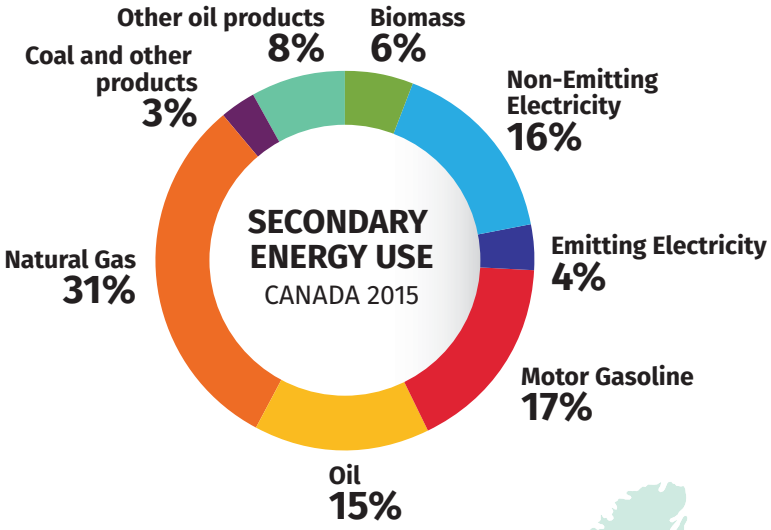
Uranium: the world's 2nd largest producer

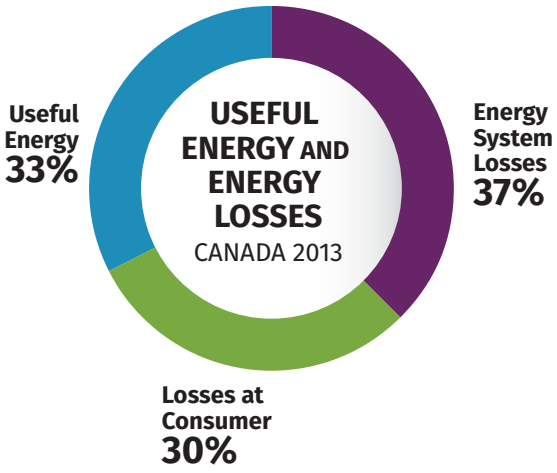
Nuclear power: the world's 6th largest producer

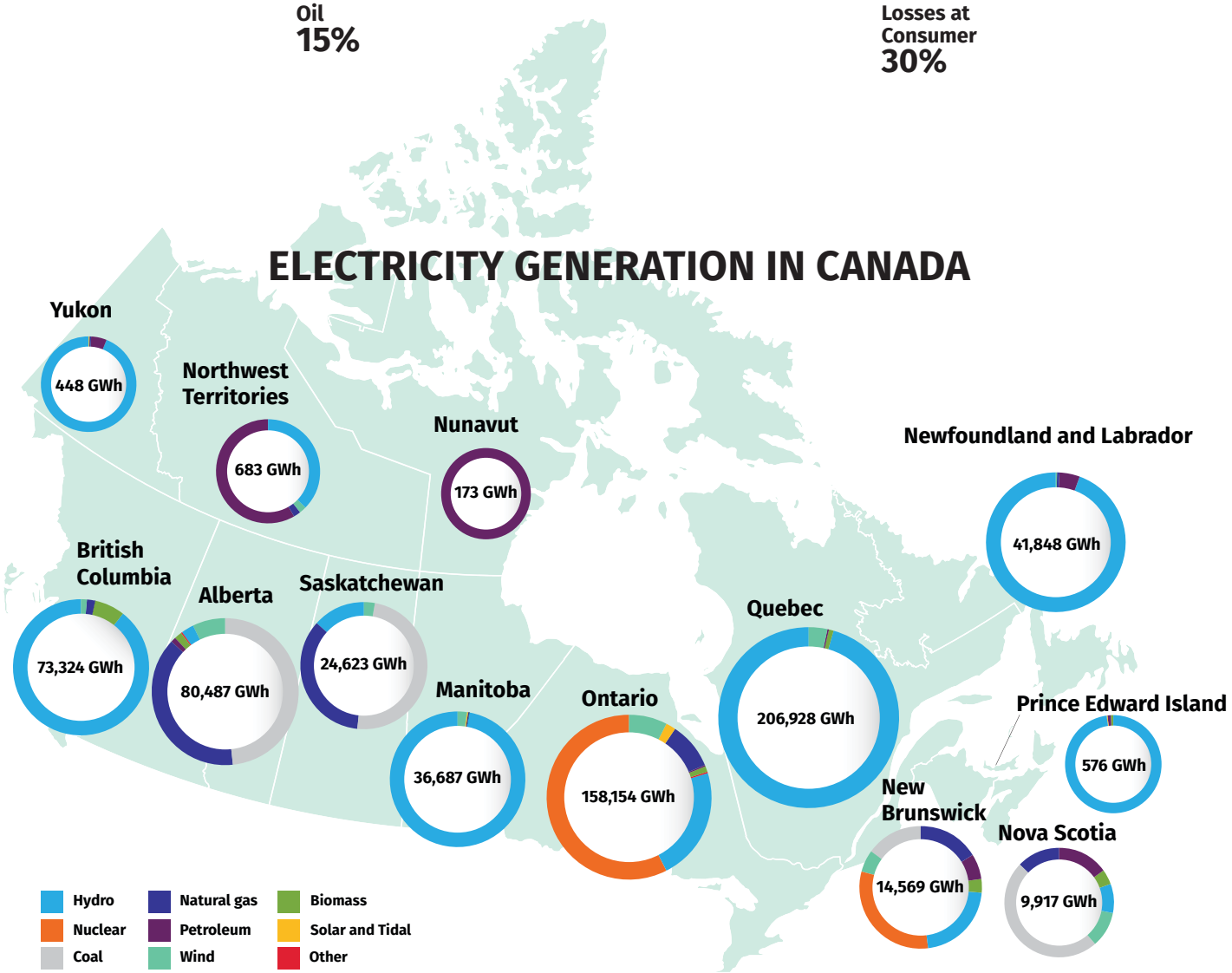
Biofuels: the world's largest biomass reserves per capita, comprising about 7 percent of worldside potential biomass energy resources

Oil and gas: the world's 4th largest oil producer and 3rd largest exporter, the world's 4th largest natural gas producer and exporter

A Snapshot of Canadian Energy Use







The Road Ahead

An ambitious vision is one thing, but getting there will be all about the details – clear, credible actions that governments, businesses and individuals need to take to navigate this transition. And we recognize that the way the transition unfolds will be influenced by many factors – some within our control, some we can reasonably anticipate, and still others that will catch us by surprise.

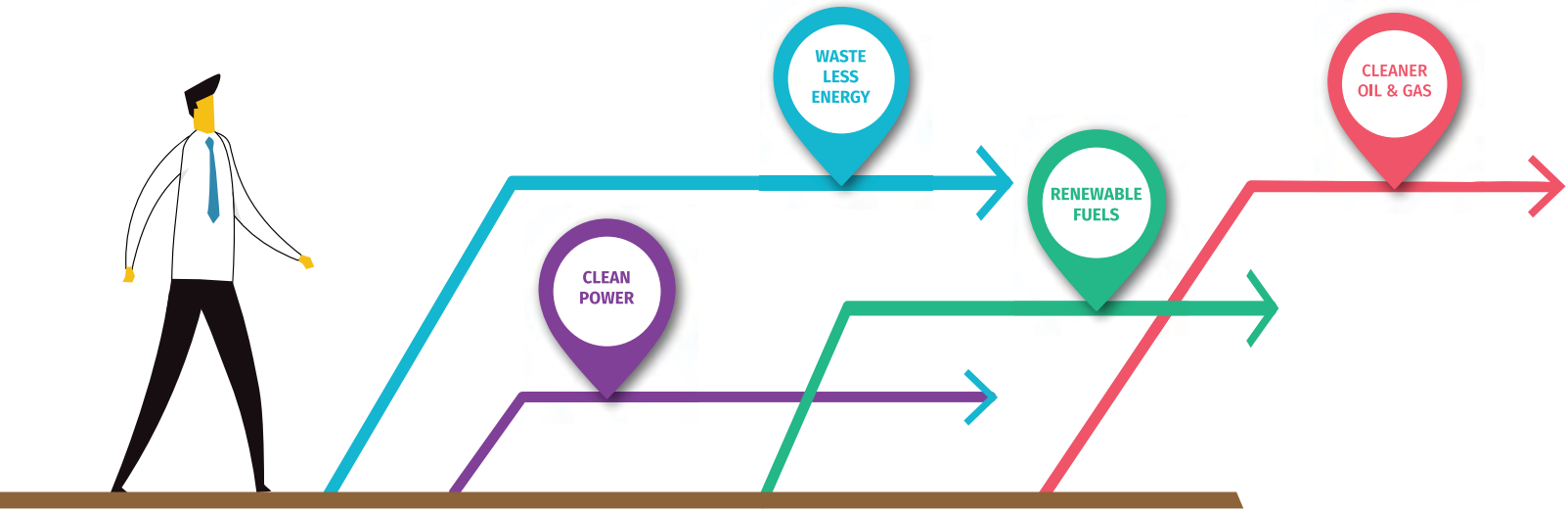
That's why we are presenting the path forward as a portfolio of four complementary pathways and one pathfinding relationship. The direction and pace of travel on these pathways is becoming clearer, and we already know some of the actions we must take.Along the way, we'll need to respond to changing circumstances in Canada and around the world. But it is crucial to keep heading in the right direction – and to accelerate our transition, starting now.

Four Pathways for the Energy Transition:

Here are the four main pathways, all of which must be pursued for Canada to reach its low-carbon future:

1. Wasting Less Energy

It's rarely the most glamourous part of the energy business, but some of Canada's greatest opportunities to save money, cut greenhouse gas emissions and create jobs can be found in slashing energy waste. Fully one-third of our Paris emissions commitment could be achieved by improving energy efficiency, which will also make our businesses more competitive internationally and leave more money in consumers' pockets.



2. Switching to Clean Power

With Canada's head start on clean power, it can complete the transformation to a nearly carbon-free electricity grid more easily than many places. There is a bigger challenge – and substantial opportunity – in growing our supply of clean and non-emitting electricity to build on our headstart by switching more of our heating systems, transportation and industrial processes to electricity, a process we refer to as "clean electrification."

3. Using More Renewable Fuels

Alongside reducing energy demand and boosting the use of clean electricity, we will continue to require liquid and gas fuels in transportation, heating and cooling, and some industrial processes. We must reduce the impact of those fuels by expanding Canada's capacity to produce and use cleaner fuels – biofuels and biogas from plants and waste, for example – that can heat homes, power vehicles and support manufacturing with much less carbon pollution.

4. Producing Cleaner Oil and Gas

In the changing global marketplace, competitiveness in the oil and gas sector will depend on cutting both costs and greenhouse gas emissions. By improving efficiency, using clean power and cleaner fuels, and introducing new technologies to capture and store carbon emissions, Canada's oil and gas industry can shrink its carbon footprint and increase its energy productivity

One Pathfinding Relationship

In addition to these four pathways, which largely address the way energy is produced and used, there is an additional pathfinding relationship that must to followed to address the role of Indigenous Peoples in Canada's energy future. This relationship recognizes the unique leadership responsibilities and opportunities that Indigenous Peoples and their governments have in energy development and management.

If we navigate these pathways successfully Canada can emerge a generation from now as a leader in this energy transition worldwide. Along the way, we will attract investment, create jobs, and ensure economic prosperity which will yield advantages for Canada on a global scale.

What this really means is that all Canadians have the opportunity to become a part of this transition. Because this is a process that will involve virtually every aspect of everyday life, it represents an opportunity for every Canadian. Not just through the actions of our governments but in our homes and businesses, in our workplaces, in our commutes and in our communities, we can all be catalysts for change and champions of Canada's energy transition.

PART II. GUIDING THE VISION

Our Five Principles

Generation Energy envisions Canada's transition to a low-carbon energy system guided by these principles:

1. A RESPONSIBLE TRANSITION ... reducing carbon pollution to align with Canada's climate goals for 2030 and beyond

2. A SUSTAINABLE TRANSITION ... providing clean, reliable, affordable energy solutions to all Canadians while taking a leadership role in environmental stewardship on all fronts

3. A PROSPEROUS TRANSITION ... spurring innovation and entrepreneurship to create jobs, attract the best talent, provide opportunities for retraining, and enhance Canadian competitiveness in a carbon-constrained global marketplace

4. A COLLABORATIVE TRANSITION ... integrating Indigenous values into the process at every step and creating opportunities for reconciliation and new partnerships with Indigenous peoples

5. AN INCLUSIVE TRANSITION ... engaging and informing Canada's many diverse communities and every economic and social sector, while strengthening collaboration among all levels of government

PART III. VISION

Canada a generation from now

The Generation Energy Vision

For most Canadians, the point of the energy transition now underway is not the process but the result. You don't want to look at schematic diagrams of the engine – you want to know where we're going. So, let's pay a visit to four Canadian households a generation from now and see where the transition has taken them.

Before we do, a few comments on the framing of this section of the report. This is one vision of what life could look like a generation from now. Our four households are meant to be illustrative and not prescriptive. We have tried to steer away from Utopian views and we acknowledge this is an ambitious and optimistic glimpse of Canada's energy future. So, while the energy systems that we have today will not disappear - a generation from now there will still be suburban streets and gas stations - we have deliberately focused on what might be different about how Canadians use and see energy in their daily life a generation now because these are the areas in which we need to accelerate change.

OUR ASSUMPTIONS ABOUT CANADA A GENERATION FROM NOW

To depict the possible future we've imagined here, we've made the following assumptions:

We've imagined a Canada where the four pathways laid out later in this report are broadly representative of how life unfolds in the years to come.

We assume that Canada remains committed to achieving the goals it set out at the Paris climate talks and in the Pan-Canadian Framework.

We assume that Canada's oil and gas sector continues to make significant strides in reducing carbon pollution.

We assume that successive governments significantly increase support to convert grids to clean electricity, improve energy efficiency and electrification in every sector of society, provide companies and entrepreneurs with the tools and support to create a wave of innovation in energy and cleantech, and pursue the lowest polluting and most cost-effective options for all other fuels, including fossil fuels and biofuels.

We assume that in the generation between now and these scenes, Canada reaches a tipping point, beyond which the most enticing and affordable solutions for homes and businesses are also the cleanest ones and the growth of the low-carbon economy creates a momentum that transforms clean energy technology into a substantial mainstream industrial and economic force nationwide.

Small Towns and Suburbs

A Generation From Now

Consider a Canadian town on the sea coast a generation from now. Historically, the town was a place for fishing and processing catches for customers across the water. But even before the big changes of recent years, this coastal town's place in Canada had begun to transform. Its proximity to a major nearby city, at the outer edge of a daily commute and an easy day trip for tourists, meant that it grew into a suburb surrounding its' pretty historic harbour. A generation from now, it is a tourist destination with sturdy small-town roots and metropolitan challenges – and opportunities on both fronts.

For a homecare nurse living on one of those suburban streets (let's simply call her "the Nurse") life straddles these two worlds. Much of her work is in the city and inner-belt suburbs, but the enhanced regional transit network allows her to live comfortably in this nearby coastal town. A fast electric ferry can drop you right downtown in under an hour, and dedicated bus and shared vehicle lanes connect the coastal town by road to nearby suburbs in as little as twenty minutes. She drives sometimes but prefers the range of transit options. That way, she can check in on clients digitally en route. Electric ferries and buses, autonomous shared vehicles that pick up other subscribers en route – it all would've seemed a little exotic a generation ago, but this is the routine now.

On the commute, the Nurse's thoughts sometimes turn to the small resource town far inland where her parents grew up and her cousin who still lives there. His spouse comes from a family of new Canadians. Let's call them "the Local" and "the New Canadian." The energy transition is well underway in that traditional resource town as well, and her cousin talks about how it all started with the "Passive House".

At first, people had trouble getting past the name. But folks soon learned that the design behind it – which was mostly about zealous insulation and structural details designed to trap and radiate heat – started with a conservation experiment in Saskatchewan in the 1970s. And after all, what was more Canadian than a well-insulated house?

The Local and the New Canadian live in a classic prewar home on an older street in town. Their home isn't a Passive House, but enough of the design has become part of building codes as every level of government pursued "net zero" energy use over the years that it is a model of efficiency nonetheless. The house still looks the same as it did in family photos from the street, but inside, it bears many of the same features as a Passive House. The walls have been thickened to allow for more insulation, and the windows are the most efficient ones on the market. The house verges on zero-emissions with a ground-source heat pump out back.

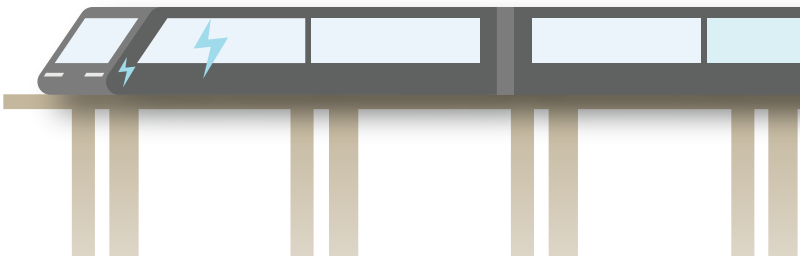
There are solar panels on the roof – this patch of farm country turned out to be much more lucrative for solar than locals might've guessed – and the regional grid mixes wind power (lots of it), large-scale solar (more than you'd think), a couple of gas-fired cogeneration plants (newly outfitted with carbon capture and reuse technology), and interties with a neighbouring region rich in hydropower to help the local utility's energy storage facilities balance the supplies of wind and solar.

The Local continues to have a career in the oil and gas sector working on a technology that reduces carbon pollution from production and turns the waste carbon dioxide into feedstock for the concrete industry, reducing emissions and turning a profit in one go. Through these kinds of innovations, carbon pollution from Canada's oil and gas production has dropped significantly from where it was a generation ago and continues to decline. Cleantech and digital technologies have combined to reduce costs and pollution, and energy companies have diversified their product mix beyond fuel -- including chemicals for advanced plastics used in electric vehicles and the special lubricants that keep wind turbines turning.

The New Canadian, meanwhile, is a field representative for a renewable energy company that operates several wind farms in the area. Her work includes training locals on day-to-day maintenance and helping her firm use big data and machine learning to optimize the way the farms interact with other producers on the regional electricity grid. She does most of the work from a home office. Their old house is a bit of an empty nest these days. Their only child, a daughter, is at technical college an hour's drive away, studying to become a technician for the biofuel industry. Her tuition is partially subsidized through a program aimed at encouraging more young people to develop skills for what everyone started calling "the bio-economy" once it took off .

In small towns like this one, the real change was to begin seeing the wind turbines and gas wellheads that share the farm fields of the region as pieces of the same energy sector that has made Canada prosperous and helped keep its economy strong. It's a very similar recalibration of vision to the one that the Local's cousin, the Nurse, has experienced in her suburban town on the coast.

The Nurse had worries of her own in the early days of the energy shift. The coastal town was one of many that had pledged to convert to 100-percent renewable



energy, and the move seemed risky at the time. A single parent with two young kids in tow, the Nurse could just barely manage the mortgage on the brand-new suburban house. And she was a bit skeptical about the bells and whistles that came with the place. The most confusing part at first was the energy trading agreement. The house had a small bank of solar panels on the roof, which were integrated with the charging port and batteries in her EV. And the whole neighbourhood was part of a trading system operated by the local utility, which shifted power loads around the region as needed. Now, she rarely pays much on her electricity bill and her car is ready and waiting with a full charge each morning.

It all feels commonplace now. At the Nurse's house, an electricity management app sends reminder notifications to her household digital assistant, which nudges her verbally to make her preferred choices. The heat pump proved a good investment in the long term compared to other options. And the town recently completed its renewable energy transition when the local industrial park completed a major retrofit to district heating and cooling – a biomass-powered system that burns pellets made from the regional forestry industry's waste.

When the Nurse waits for her ferry to the city down at the harbour these days, the view is comforting in both its old and new details. There are still buildings made of weathered wood and bobbing fishing boats – the postcard details that draw the tourists. But there are plenty of signs that enough is happening in the town that her kids could build their lives here one day. There's the converted warehouse by the dock, for example, which houses the head office for a booming greenhouse business attracted by the low energy costs, emissions-free grid, and access to a major port. A company doing offshore wind projects up and down the coast has an office in the old warehouse as well.

It was new, unexpected ventures like these combined with new opportunities for growth in old ventures that eventually won over so many Canadians in resource-dependent communities to the benefits of the low-carbon economy. Many had seen themselves as inextricably linked to a single industry and were wary of dramatic changes. But smart investments guided by targeted incentives by government smoothed the transition and enabled these sorts of towns to find new niches while evolving their established industries at the same time.

The Big City And The Rural North

A Generation From Now

Let's move on to a midrise condo near the centre of a major Canadian city a generation from now. This has been a prime location for significant new housing construction in urban Canada for decades by now, but this building in particular was constructed in the mid-2020s.

For a family of three living in one of the condo's three-bedroom units, the day begins, as most days always have, with hot showers and breakfast, the morning routine. The married couple work steady nine-to-five jobs – one in financial services in the downtown core, the other for a design firm specializing in energy-efficient retrofits in the suburbs, so let's call them "the Designer" and "the Banker" – and there's a grade-schooler to wake and dress and feed.

The shower in this case draws its hot water from one of the several tanks in the building's basement that provide for the needs of all 30 units in the building. But these tanks don't heat the water with a boiler – instead, they drew electricity from the grid overnight, when it was cheapest. The building also strips away the heat from its wastewater before sending it into the city sewers to help with space heating. These are just two of the many ways that condos across the city have found to trade energy services and pass on the savings to residents. And these systems also help keep the grid reliable and resilient.

The condo building was constructed several years earlier to the latest nationwide codes, which were the first to mandate hyper-efficiency and clean energy on all new residential and commercial buildings. Interior heating and cooling is via air-source heat pumps. Electricity still comes from the provincial grid – now powered by a 100% zero-emissions sources including hydro, nuclear, and renewables. The grid now meets over 50% of the province's energy demand (up from 20% a generation ago), including burgeoning demand from EVs charging in the parking lot. This expansion has been driven in part by changes to provincial utility regulations several years ago that enabled utilities and their customers to take advantage of infrastructure, technologies and business models that integrate electricity production, conservation, storage and use. "Hybrid" distribution systems that bring together an array of clean and low-carbon energy sources for homes and businesses are now common.

There's an app on the couple's handheld devices to orchestrate and monitor the morning routine. Lights and appliances have been set to turn off automatically once they sit idle for a certain amount of time, thermostats scale down automatically in empty rooms. Anywhere there might be waste, a monitor is on the case. Overall, this particular family's highly energy efficient home uses 1/10th of the energy of the average Canadian household a generation ago.

For the Banker, the day's commute is usually a quick one. An app on her handheld device lays out her options: trains are arriving on time at the LRT stop two blocks away, and a real-time video feed reveals more slush in the bike lanes than she likes. The car share would be quicker and there's a vehicle parked one block over, but due to high demand this morning, it'd be triple the price of transit. She kisses her daughter goodbye and heads for the LRT and a 15-minute commute to a downtown office tower.

The stock markets still churn up and down, of course, but these are good times in Canada's financial sector. Her bank just closed a big deal to build new production facilities in Canada for a major energy storage company drawn by the opportunity to use Canada's clean electricity grids. Economies that took a carefully managed approach to the disruptions of the global energy transition are in the minority, and Canada has emerged as a safe, stable place to invest, not only in its busy cleantech sector but also in energy and other resource sectors that have shrunk their carbon footprints and gained strategic positions internationally by slashing waste and boosting efficiency. For a Canadian company cutting logs, digging minerals or exporting natural gas these days, there is real value in being able to demonstrate that its products came from a country with an almost entirely emissions-free grid and stringent laws protecting water, wilderness and wildlife.

Back at the family's condo, the daughter has decided she can handle a little slush – she wants to ride her bike to school today. She knows her route well, and it's on safe, physically separated cycle tracks the whole way.

The Designer heads down to the basement, starts up the family EV, and touches the on-board tablet's standard pop-up query ("The Usual?") to agree to the daily commuter route. He drives the car himself as far as the main street three blocks away because he enjoys the performance as it accelerates at the drop of a hat, then hands the controls back to the digital system, flips to the tab containing his office documents, and settles in to check the morning meeting's agenda.

He learns his first order of business on arrival will be prep for a sales trip to Asia the following week. His design firm built its reputation on extensive retrofits to large apartment and office buildings to slash their energy bills. They recently merged with a company that uses artificial intelligence technology to improve energy management systems for commercial buildings. The demand for new tools like these to improve consumer energy choices has gone global, and his firm sees limitless opportunities in China and India.

The traffic moves a little better than it did a generation before – it's far from perfect, but major transit investments and congestion charging have combined with the growing consumer preference for cycling, shared rides and auto-piloted vehicles making smarter lane and route choices to make it all flow smoothly enough the designer is never distracted from his work prep by a sudden stop-and-go lurch.

The city eventually gives way to suburbs where former bedroom communities have brought transit and

some midrise density to their cores and often play host to business clusters of their own. There's one the Designer passes on the way to his office park that is known for movie and videogame studios, international producers attracted over the years by Canada's highly trained technicians and the clean energy on the grid. And there's another with a logo the Designer has always liked that combines an Inukshuk with a gas well. It's a partnership between a Canadian energy company and several Indigenous people in the North – stories about successful partnerships of that sort have been staples of the Canadian business press for years, held up as symbols of the synergies between cleantech, energy and Indigenous communities determined to shape their own energy and economic futures.

This company operates an LNG plant on the northern part of the west coast, but still has roots in an old municipal gas utility in the city. One of the company's employees, is one of the handful of Indigenous employees who divides his working time between this facility and field maintenance in his home community in the North. Let's call him "the Vice President". His story is in some ways familiar – Indigenous people from Northern communities have been coming to cities to find work for generations – but it's a refreshing change that not just the wages but the profits from his employer flow back to the community.

The Vice President's home community had long been involved in environmental management in the region. Some years back, that led to an investment opportunity for the community – an equity position along with more than a dozen other First Nations. The fact that the LNG plant was powered by renewable electricity was a major factor in the community's decision to participate in this project.

When he's back in the North, Vice President's stays with his sister and her family. And there he sees firsthand just how much his community's relationship with energy has changed. Energy was not traditionally a good news story in their community – like most other commodities that came from the south, it was a maddeningly expensive necessity, characterized by the noise and pollution of diesel generators.

But in this Northern Indigenous community a generation from now, the topic of energy is a better one. The electricity that keeps the lights on and the home warm through long winter nights comes not via clouds of diesel but from banks of solar panels, spinning wind turbines near the big lake nearby, and a new energy storage bank to make the whole system more reliable. Folks weren't quite sure what a "microgrid" was when the topic was introduced by local entrepreneurs working with an energy partner from the south, and there were worries about cost and reliability. But as an equal partner in the development, the new grid operator is now the Nation itself. It delivers power to its own community, earns investment returns, and provides the affordable electricity and economic support needed to develop more local businesses. The new power system also created new jobs – everything from administrative staff to executives. And those first power bills, smaller than ever before, improved the quality of life for residents throughout the community.

The Vice President's sister works for the First Nation's grid operator in a management position. Her spouse, meanwhile, works in the community's bustling tourist economy, taking visitors out into the bush on elaborate package tours to learn a little of the traditional ways Indigenous people lived off the land for generations. Let's call them "the Manage" and the "Tour Guide".

Their home, like all the newer homes in the community, follows building standards consistent with those across Canada. The windows and walls are well insulated, the power reliable, and there's even a household-sized battery system in the back hallway that stores enough power to guarantee all will be well for several days in the event anything goes wrong. There's also a cooperative greenhouse providing locally grown produce, cutting food costs compared to food flown in from the south and making a new energy efficient refrigerator affordable.

As in many Northern families, life remains divided between the small, traditional northern community and the cities down south. One of the family's children is in university there, studying environmental law and business administration, with an eye toward starting a company back home after she graduates. The other, still in elementary school, is working on a science project that uses virtual reality technology to explore her grandfather's fishing grounds.

Back in the city down south, the Designer arrives at his office, plugging his car into a convenient workplace charging unit provided by his company. He consults briefly with his colleague, who is recently married. He and his husband were drawn to the city despite the high rents because their skill sets were in such demand in this city, with its seamless connections to nationwide professional networks and global markets.

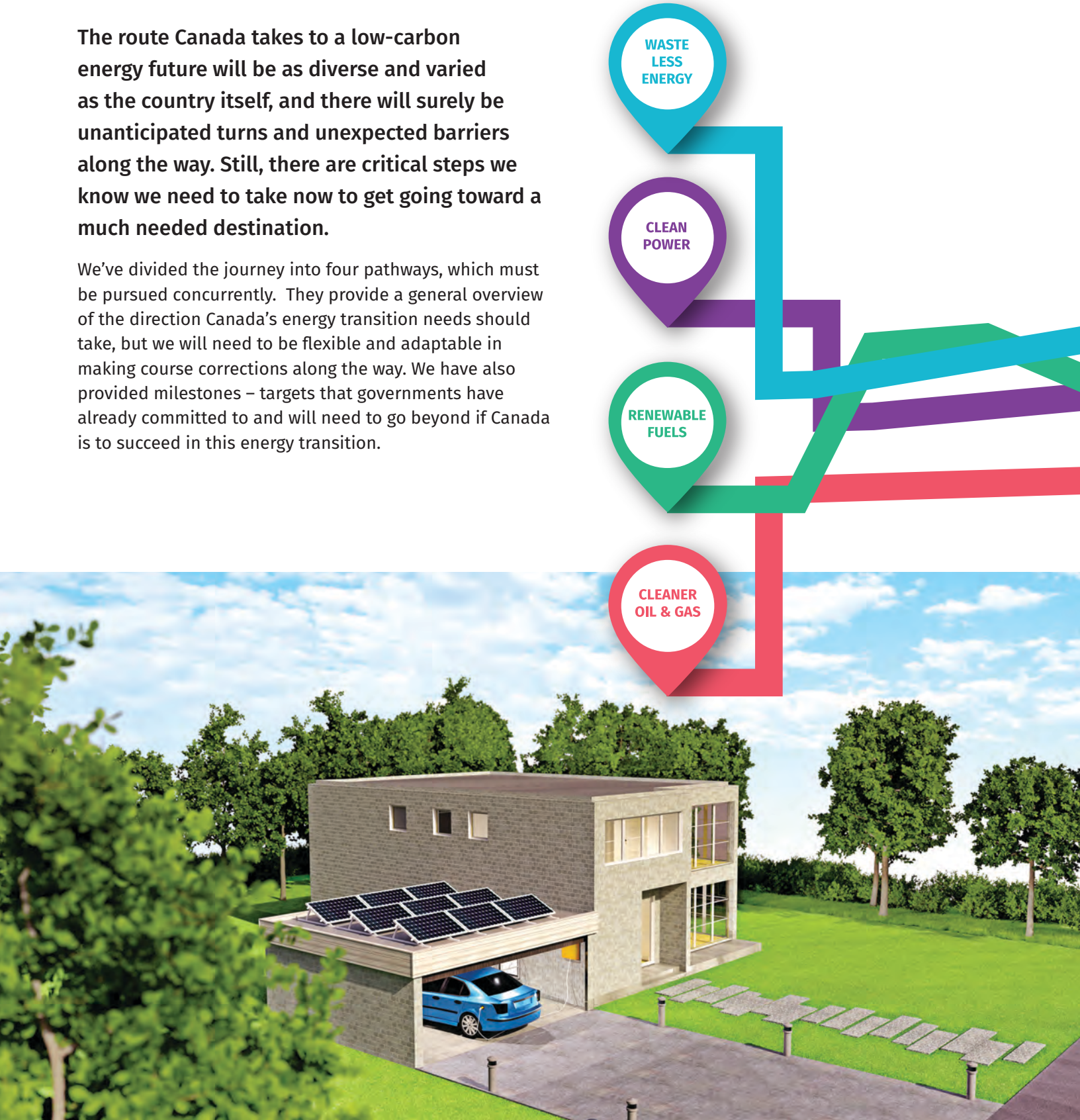
The transition has touched every sector of the economy and every community in the country, but Canada is a very urban country, and the cornerstone of the whole process was making its cities work well and prosper. That's why the most important part of the day for the Designer and the Banker might be the moment they arrive back home, content to be building their lives in the middle of this big city and optimistic for their daughter's future.

And far away to the north, an Indigenous community enjoys some of the same prosperity, connected to the same new economic opportunities. For too long, Indigenous communities did not have access to the same economic tools as the rest of Canada – basic infrastructure such as reliable and affordable electricity and clean and safe drinking water. But in this community a generation from now, much work has been done to heal the wounds of the past, celebrate Indigenous culture as an intrinsic part of what it means to be Canada, and provide a similar standard of living, with room to nurture both new enterprises and a traditional way of life.

PART IV. CANADA'S ENERGY TRANSITION PATHWAYS

The route Canada takes to a low-carbon energy future will be as diverse and varied as the country itself, and there will surely be unanticipated turns and unexpected barriers along the way. Still, there are critical steps we know we need to take now to get going toward a much needed destination.

We've divided the journey into four pathways, which must be pursued concurrently. They provide a general overview of the direction Canada's energy transition needs should take, but we will need to be flexible and adaptable in making course corrections along the way. We have also provided milestones – targets that governments have already committed to and will need to go beyond if Canada is to succeed in this energy transition.



1 WASTING LESS ENERGY

TOOLS

SKILL AND TALENT ATTRACTION AND DEVELOPMENT

POLICY AND REGULATION

GOVERNMENT PROCUREMENT

COMPETITIVE BUSINESS ENVIRONMENT

see appendix p.59

Efficiency – the energy we don't use – is the cheapest energy resource at our disposal and the only one that saves consumers money and reduces the cost of doing business. Indeed the world has seen an unprecedented decoupling of economic growth and energy consumption in recent years. We've been talking about doing more with less in Canada since the 1970s and although some progress has been made, we still have a lot of room for improvement when it comes to energy efficiency.

Fortunately, wasting less energy today means getting smarter and more deliberate, not going without – and the tools to slash our energy use have never been more readily at hand. Wasting less energy may lack the excitement of an electric car or the visible virtue of solar panels, but pursuing this energy efficiency pathway may well be the most significant single action we take in this transition to meet our climate goals.

Canada is currently improving its energy efficiency by about one percent every year. By doubling that to two percent every year by 2025 and then increasing again to three percent per year by 2030, we can meet at least one third of our Paris emissions targets through efficiency measures alone. Doubling and tripling the current pace of year-to-year efficiency boosts is a very ambitious goal, but also an essential one. It can create over a hundred thousand jobs, save businesses and consumers money, and make our economy stronger.

There is no more essential first step toward Canada's low-carbon economy than boosting our nation's energy productivity. And by minimizing the investment needed in electricity production, renewable fuels and fossil fuels over the next generation, it makes all the other pathways shorter, easier and more economical to navigate.

DECOUPLING – AN HISTORIC TURNING POINT

For many decades, GDP growth and increased energy use have been parallel, mutually reinforcing factors in economic success. A critical cornerstone of the energy transition is the decoupling of growth from using more energy. From 1990 to 2015, Canadian energy use increased about 30 percent while GDP increased by nearly 80 percent. Energy efficiency improvements result in improved energy productivity in the economy, which means the Canada's economy can continue to grow while using less energy.

Canada's Energy Efficiency Pathway runs along four main tracks:

Regulations:

Making efficiency the norm requires baking it into virtually everything we do – from the buildings we build and operate, to the equipment and vehicles we purchase and use, to the way we develop and re-develop our cities. Better codes and standards, coordinated at every level of government, will make the efficient choice not the virtuous choice but instead the obvious one.

Investment:

Conservation-focused financing, incentives, and other fiscal tools will encourage the flow of public and private capital into the residential, commercial, industrial, and transportation sectors and develop a robust efficiency marketplace. It will also make it easier for homeowners, companies and institutions to become part of that market and earn returns by investing in energy efficiency.

Procurement:

Utilities have a leading role to play by prioritizing energy conservation among their resources – treating it as a valuable and profitable commodity purchased from homeowners, businesses and institutions. Governments meanwhile can use their purchasing power to blaze the trail for businesses and individuals by making efficiency a requirement when buying goods and services, and they can cut their own energy use and save public money at the same time.

Infrastructure:

Much of our energy use is dictated by our current infrastructure, from the design of cities and towns to the transportation systems we use to get around them and link them together. To makes these systems more efficient, we will need smart land use development and re-development, better access to local transit and active transportation, and the introduction of low-carbon long-distance travel options.

SMALL ACTIONS, BIG SAVINGS

In Nova Scotia, the country's first energy efficiency utility is demonstrating that when governments are ready to lead, Canadians are keen to waste less and save more. With more than 100 partners and more than 200,000 participants, the utility's efficiency programs are already saving Nova Scotians $110 million every year.

LOWER CARBON METAL

For more than 20 years, aluminum smelters across Canada have been waging a sustained campaign against energy waste. As a result, greenhouse gas emissions are down more than 30 percent in the Quebec aluminum industry, and a state-of-the-art smelter in British Columbia has cut emissions by nearly 50 percent. Today, Canada's aluminum industry is the most carbon-efficient producer of aluminium in the world.

Wasting less energy presents many opportunities for Canadians beyond simply saving money on energy bills. As we proceed down this pathway, here are some of the most promising opportunities likely to emerge:

The emergence of an efficiency business sector as economic activity and jobs are generated with the work of improving the efficiency of homes, buildings and industrial sites across Canada.

Boosting industrial productivity through performance requirements and wider implementation of certified energy management systems, which are currently voluntary in Canada and are in place in less than one percent of industrial facilities. If only eight percent of Canadian industrial facilities implemented such a system, it could save enough energy to power over one million Canadian homes for a year.

Getting around more efficiently by improving fuel efficiency requirements for personal and freight vehicles; introducing incentive programs; implementing next-generation technologies such as autonomous vehicles; the use of efficiency technologies and better data to guide delivery routes; and transportation demand management programs that can stop the growth of kilometers traveled and help reduce emissions.

Conserving with data by taking an integrated, systems approach to the energy performance of vehicles and buildings, and by giving Canadians greater control of their energy use through the use of smart appliances, big data and digitization.

Using smart urban design to ensure that land use, live/work spaces, distributed energy, electrified and active transportation networks are intrinsically more efficient, and that street orientation, building sites and building designs are compatible with new renewable energy technologies.

Taken together, these opportunities have the potential not only to save money for Canadians and Canadian companies everywhere but to generate new economic opportunities in everything from the building trades to manufacturing efficient equipment and materials. What's more, an economy that produces more with less energy is a more competitive one in the global marketplace. This is why wasting less energy is the backbone of Canada's transition to a low-carbon economy.

Photo credit: 8th Avenue Development Group

THE EVOLUTION OF THE PASSIVE HOUSE

The hyper-efficient design behind the "Passive House" traces its origins to the Canadian prairie, when the Saskatchewan Research Council commissioned the Saskatchewan Conservation House in 1976 to demonstrate energy-saving home design technologies and techniques. The concept jumped the pond to Germany, where it evolved into the Passivhaus design standard. Recently, it's hopped back again, with dozens of new Passive House designs under construction or completed across Canada. Vancouver, for example, is now home to an 85-unit apartment building constructed to Passive House specifications, meaning each apartment will require only one-tenth as much energy as a typical Canadian apartment.

Efficiency Milestones

Overarching Milestone

Canada's rate of economy-wide energy efficiency improvement grows from 1 percent per year today to 2 percent per year by 2025 and 3 percent per year by 2030, bringing our energy productivity in line with leading jurisdictions in Europe and the United States.

For freight transport

- By 2030, decouple Canada's freight-related emissions from economic growth
- By 2030, bring fleet average fuel efficiency in line with best-in-class standards worldwide
- By 2030, achieve a significant shift to rail for long-distance transport.

For buildings

- By 2040, provinces and territories have all adopted and implemented a federal model code requiring all new construction to achieve net-zero energy
- A model code requiring significant energy performance improvements during major renovations is introduced in 2022 and adopted by all jurisdictions in 2025
- By 2025, all homes and buildings have labels that conveys their energy performance to prospective buyers, renters and lessors
- By 2040, Canadian homes and buildings are at least as energy efficient as leading cold climate jurisdictions worldwide

For personal transportation

- Vehicle fleet average fuel efficiency is aligned with best-in-class standards
- By 2040, single passenger trips are halved in all medium and large cities by ensuring that Canadians have a sufficient range of transportation options including transit, ride-sharing programs and cycling

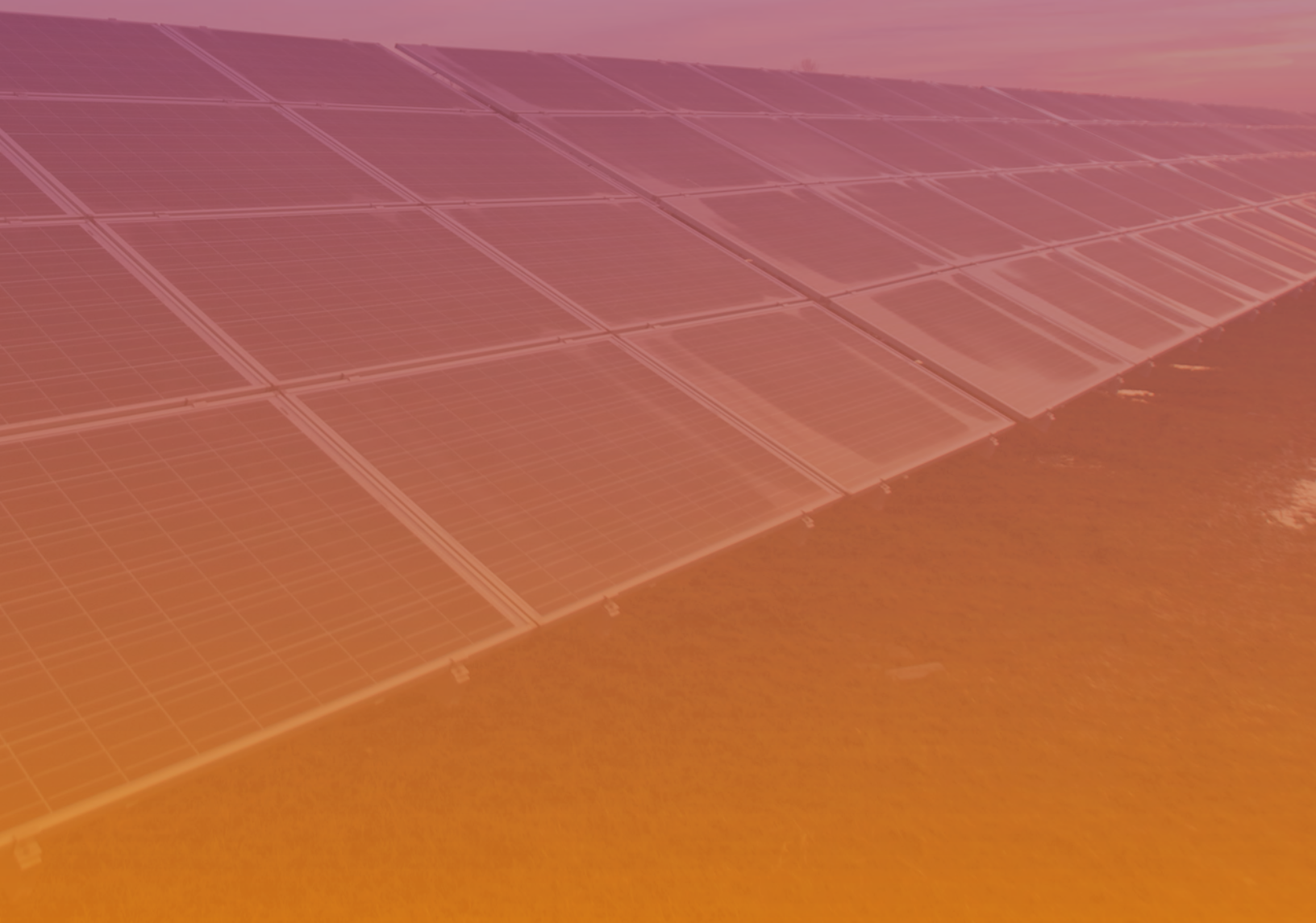
For industry

- By 2030, 75 percent of industrial energy use benefits from energy management systems
- By 2040, Canadian industry meets or exceeds U.S. energy productivity

For utilities

- By 2022, regulatory frameworks across Canada enable and encourage utilities to procure energy efficiency and peak demand reductions as the first priority energy resource

2 SWITCHING TO **CLEAN POWER**



Using clean power means not only more clean electricity on our grids but also relying on electricity for more of our energy needs. For Canada to take its place as a leader in the low-carbon economy a generation from now, we will have to use electricity to power more of our daily activities at home and in industry, and we must increase the amount of our electricity supply that comes from sources that do not create carbon pollution.

Fortunately, Canada begins with a head start – nearly 80 percent of our electricity is generated from emissions-free sources, thanks to our abundant hydroelectric power, multiple nuclear facilities and fast-growing wind and solar capacity. But electricity accounts for only 20 percent of our overall energy use today – to increase that share substantially, we will need to significantly expand our clean electricity generating capacity. That's why this pathway represents such an enormous opportunity – pursuing it will require major infrastructure investments nationwide, as well as restoring public confidence that this expansion can occur in an environmentally responsible way without causing a spike in electricity costs. With the costs of renewable energy plummeting and demand booming worldwide, there are huge economic rewards to be reaped, and strategic advantage to be exploited, by an aggressive shift to clean electricity now.

TOOLS

POLICY AND REGULATION

DRIVING INNOVATION

COMPETITIVE BUSINESS ENVIRONMENT

see appendix p.59

There are two decisive steps required to navigate this pathway:

1. ***Clean our grids***, by bringing more non-emitting electricity sources on board while ensuring grid stability and affordability aren't compromised, and by working with neighbouring jurisdictions to improve transmission networks.

2. ***Use more clean power***, by giving consumers, institutions and businesses more opportunities to choose clean electricity for transportation and heating. This second step means we'll certainly need more electricity than ever a generation from now, which means Canada's electricity grids will have to get more connected, more local, more efficient and much smarter even as we cut our emissions.

Canada has been using clean power for generations, but the amount varies considerably depending on where you live, and there is even greater variation regarding options, feasibility, ease and cost as each jurisdiction looks to increase their share. In some provinces, power generated by burning natural gas in place of coal will be part of the transition by cutting emissions now while providing stability for next steps.

There are four main strategies for continuing to navigate this pathway in the years to come:

- **Clean the Supply:** Converting power grids to clean electricity to reduce carbon pollution, accomplished through planned transitions brought in on time frames that allow us to control the costs to ratepayers and businesses.
- **Improve the Infrastructure:** Upgrading grids and making them smarter with the introduction and dissemination of smart grid technology, distributed generation by small-scale producers, and locally and regionally controlled microgrids, as well as developing grid interties with neighbouring jurisdictions to improve efficiency and reliability and bring non-emitting power to regions that have limited potential for clean generation as the mix of power sources changes.
- **Shape the Demand:** Electrifying both new energy demand and energy use currently reliant on fossil fuels. The feasibility of this step will vary by region based on cost and availability but may include switching from natural gas to electricity for heating, using electric vehicles, and converting industrial processes from fossil fuels to electricity.
- **Build New Partnerships:** Developing clean electricity projects in partnership with Indigenous communities nationwide to enable new economic development. switching from natural gas to electricity for heating, using electric vehicles, and converting industrial processes from fossil fuels to electricity.

SMALLER GRIDS, BIG OPPORTUNITIES

As Canada's electricity systems make room for smaller scale and more decentralized grids, Canadians will see new choices for energy production and use. In particular, the shift to digitalization and the rise of prosumers will create many new opportunities as grids become smarter, more flexible, more secure and more distributed.

- **DIGITALIZATION** refers to the use of digital communications technologies to enable better multi-directional communication between the various elements of the electricity system, which can improve the collection, sharing, and analysis of electricity system data and operation of the grid.
- **PROSUMERS** are energy customers who generate some of their own energy and sell it back to the grid, for example through rooftop solar panels or air-source heat pumps. This is made possible in part by the decentralized management of energy systems enabled by digitalization.

Photo credit: Hydro-Québec

A QUEBEC MODEL FOR EV CHARGING INFRASTRUCTURE

Québec is home to Canada's first electric vehicle charging network, the Electric Circuit. Today, the network includes mostly 1,500 charging stations in Quebec and Eastern Ontario and serves more than 23,000 EV drivers. Quebec's EV charging network is a model for utility-led infrastructure projects and has prevented more than 4,000 tons of CO_2 emissions.

Canadians have already begun to reap rewards from their work on this pathway. In addition to substantial growth in Canada's renewable energy sector, which already employs more than 200,000 people, there are Canadian clean power companies operating coast to coast – many forging partnerships with Indigenous groups to bring clean energy to their communities.

Here are some of the most promising opportunities for Canadian leadership as the world shifts to clean power:

- **Developing new business models for utilities:** Canada's utilities will need to find new ways of managing networks, using existing infrastructure more effectively, and offering many more options to customers as they operate new energy networks that are much more distributed and multi-directional. Advanced smart distribution and storage networks can be employed to help consumers get the energy they need, at the best prices, all while ensuring the grid's reliability and efficiency.
- **Generating our own power:** As grids decentralize, small-scale renewables drop in price, and microgrid and smart-grid technology introduces more flexibility and choice, Canadian businesses, communities and individuals will have many more ways to get involved in power production. Homeowners and businesses that install renewables can sell excess power back to the grid, and there will also be opportunities for producing power from waste and cutting heating bills through district energy systems.
- **Attracting businesses that put a premium on clean power:** Pacesetting international technology companies are major clean energy customers, and that trend is already spreading well beyond the high-tech business. Canada will see opportunities to offer a cost-effective carbon-free option for data centres and block chain operations, industrial and manufacturing facilities, even movie and videogame productions.
- **Manufacturing for electric vehicles:** As a major manufacturer of automobiles and parts, Canada has an opportunity to become a maker of tools and components for electric transportation systems to be used across Canada and beyond. This goes beyond cars, trucks and buses there will be opportunities in every aspect of the transportation sector, from mining lithium and cobalt for batteries to manufacturing storage systems and electric drive trains.
- **Commercializing energy storage technology:** To provide more flexibility for the entire electricity system, new storage technologies can integrate excess renewable power with other energy sources to upgrade grids.
- **Exporting clean power:** Canada is already a clean energy exporter, and this is a market that will only grow in the coming years, particularly the United States looks for options to reduce carbon pollution on its grid even as demand continues to grow.
- **Co-generating of electricity and industrial heat:** On industrial sites where very high heat is part of the daily operations, there will be a growing role for alternative fuel sources like geothermal as well as cogeneration plants whose excess electricity can be sold back to the grid.

As clean electricity technologies spread nationwide over the generation to come, this new economic activity can boost Canada's strategic advantage and enhance our reputation globally as a clean energy leader. There are irresistible opportunities in this fast-growing multi-billion-dollar global industry, but there is also steepening competition and a need to build public and consumer confidence regarding costs and convenience. Still, the rewards far outweigh the risks. A generation from now at the end of this pathway, Canada can be home to a clean electricity powerhouse, forming the backbone of a thriving industrial sector nationwide as a beacon for international customers and investors seeking pollution-free grids.

THE COMING STORAGE BOOM

New technologies to store energy will be a critical component of future electricity grids that rely on a range of sources, including intermittent sources like solar and wind, for their power. This goes well beyond batteries. In a small Ontario town on the shores of Lake Huron, for example, a Canadian start-up company is building a facility to store electricity by turning it into compressed air and pumping it into a depleted underground salt cavern. It can then be released on demand to spin a turbine and generate electricity for delivery back to the grid as it expands.

RIDING THE ELECTRIC BUS WAVE

Some of the keenest adopters of electric transport in Canada are not individuals but transport systems. Some examples:

- In Winnipeg, five all-electric buses are now part of Winnipeg Transit's fleet. Manufactured by a Winnipeg company, the buses have passed cold-weather testing on the prairie and point the way to wider adoption in the years to come.
- In Vancouver, the transit authority has unveiled a plan to introduce electric buses to its fleet, starting with four vehicles using charging systems manufactured by two Canadian firms.
- In Edmonton, the municipal government has announced that it will purchase electric buses exclusively for its transit system starting in 2020.

Clean Power Milestones

Overarching Milestone

By 2050, clean electricity is the single largest source of energy supply in Canada. (Electricity today generates 20 percent of total energy supplies.)

Reducing carbon intensity

- By 2030, 90 percent of electricity is produced by non-emitting sources.
- By 2050, nearly 100 percent of electricity is produced by non-emitting sources.

Electrifying transport

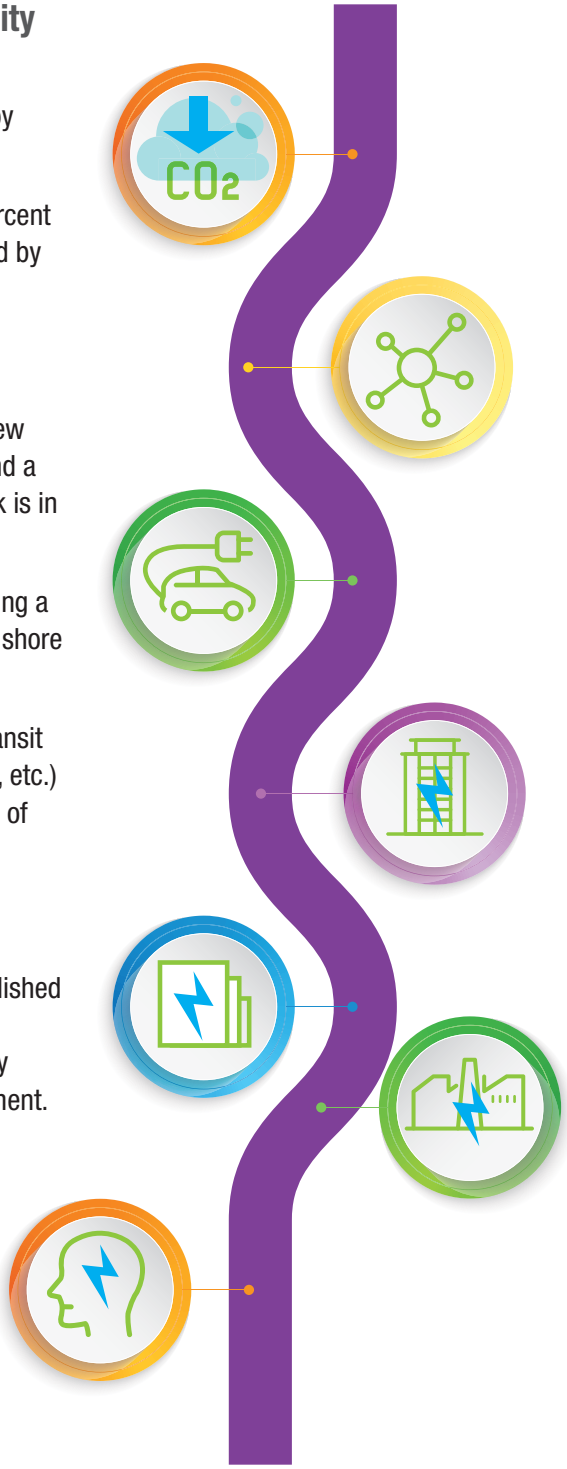
- By 2030, 30 percent of new vehicle sales ware EVs and a national charging network is in place
- By 2030, most ships visiting a Canadian port connect to shore power while in port.
- By 2025 all new mass-transit lines (light rail, streetcars, etc.) use non-emitting sources of power.

Energy Storage

- By 2030, Canada is established as a global centre for energy storage technology development and deployment.

Consumer Preference

- By 2030, the majority of Canadians have the option of becoming prosumers – able to power their lives with the clean energy of their choice



Connectivity

- By 2030, more than 50 percent of off-grid, remote communities have access to non-emitting energy technologies, and 100 percent by 2050.
- Canada's national and international grid connections is expanded to encourage non-emitting electricity use and exports.

Electrifying buildings

- By 2050, electricity is the primary energy source for homes across Canada.
- By 2050, commercial and institutional buildings with appropriate roof size and orientation are required to have solar installation.

Electrifying industry

- A generation from now, new industrial development finds it economical to use electricity for on-site activities

3 USING MORE RENEWABLE FUELS

Alongside electrification, our energy transition will require more renewable fuels to add to the liquid and gas fuels as part of our affordable and reliable energy mix over the generation to come. These renewable fuels will be particularly important for transportation, heating and cooling, and in some industrial processes, including steelmaking, chemical production, mining and cement making. In addition to using more renewable fuels, we will continue to improve the quality of our oil and gas fuels to reduce emissions.

Here are the most important steps on this pathway:

- switching to cleaner fuels wherever possible;
- blending cleaner fuels such as biofuels and renewable gas into the existing fuel supply;
- expanding the supply of cleaner fuels to improve availability.

Particularly important among these cleaner fuels are:

- **biofuels** produced from agricultural, forestry and municipal waste materials
- **renewable natural gas** (RNG), which can be collected from farm waste, municipal landfills and wastewater treatment facilities, or generated directly from biomass
- **hydrogen**, which has potential roles both as a fuel source and as an energy storage application.

TOOLS

PUBLIC CONFIDENCE

DRIVING INNOVATION

SKILL AND TALENT ATTRACTION AND DEVELOPMENT

COMPETITIVE BUSINESS ENVIRONMENT

POLICY & REGULATIONS

see appendix p.59

A MUNICIPAL WASTE POWERHOUSE

Edmonton, Alberta, is home to a world-class municipal waste processing facility that turns the stream of waste that the city can't recycle into clean biofuels and green chemicals (such as ethanol and methanol), boosting the city's waste diversion rate from 50 to 90 percent.

These fuels can often be directly substituted for current fuel supplies, so this Pathway provides a cost-effective way to boost productivity while reducing carbon pollution in sectors where zero-emissions options remain further off. And Canada already has a competitive advantage on this pathway, owing to our abundant and diverse range of feedstocks for these low-carbon fuels. Canada is currently home to pacesetting companies nationwide that use municipal waste, forestry industry waste, and many other feedstocks to make renewable fuels and other value-added products.

This Pathway presents an opportunity for Canada to become an international leader in the emerging bio-economy, where renewable resources and waste streams are converted into fuels and value-added products—including captured carbon dioxide as a feedstock. The rise of the bio-economy is already well underway in Canada, and it presents not just an opportunity to reduce carbon pollution but a way to create jobs, boost economic competitiveness and potentially become a significant export sector.

By some estimates, products from bio-refineries could supply as much as a third of the global chemical industry and replace up to 80 percent of the petrochemical feedstock for the pharmaceutical and diagnostic products industries by 2030. While the market is growing rapidly, global leaders such as Finland are investing heavily in this sector. Canada has the resources to become a bio-economy leader, but there's also a real danger of falling behind.

Canada's path to leadership is clear, and it breaks down like this:

- Canada's resource wealth provides abundant feedstock to expand the use of cleaner renewable fuels and value-added products;
- these renewable fuels are a key component in the development of Canada's bio-economy, a potential strategic advantage enabling Canada to compete at global scale in a fast-growing economic sector; and
- the bio-economy represents a platform upon which to establish Canada among the leaders in the circular economy, as it grows worldwide over the next generation.

FROM SURPLUS TO HEAT

North America's first utility-scale project to convert surplus renewable power into hydrogen gas for storage, at which point it can be blended with natural gas for use in home heating, is under construction in southern Ontario.

A CARBON POLLUTION VACUUM

A B.C. start-up company has begun field testing of a system designed to remove carbon dioxide directly from the air and combine it with renewable energy to produce biofuel. The concept is still many years from commercial application, but is a potential step-out solution to global GHG emissions with its demo site in Canada.

Building out the bio-economy is also an important step in positioning Canada as a leader in the "circular economy." The industrial symbiosis that a circular economy would create by sharing waste streams and feedstock among industrial sites and across industry sectors could be a major leap forward along the path to a low-carbon economy.

In addition, technologies that employ hydrogen gas as a fuel or for energy storage are already well established in Canada. This is a potential strategic advantage for Canada as the next generation of more affordable and efficient hydrogen fuel cells see greater use, both as fuel for vehicles at industrial work sites and as a way of storing variable renewable energy sources like wind and solar as part of an integrated next-generation electricity grid.

Canada is also a world leader in in Carbon Capture, Use and Storage (CCUS), a technology that in the longer term could significantly reduce the carbon emissions arising from fossil fuel use at industrial sites. The next generation of these technologies has potential to be employed at a smaller scale and at a broader range of industrial facilities than is economically viable with current technology. There is also potential further out to employ this technology to remove carbon dioxide directly from the air.

The Cleaner Fuels Pathway does not come without its challenges, which include upfront costs for new infrastructure needed to make renewable fuels affordable and widely available, and the need to attract investors to projects and technologies that are capital-intensive and require significant investment in research and development, as well as extended time horizons. The opportunities on this pathway also often require coordinated action across government jurisdictions and between industries that don't have a history of collaboration (waste management facilities and fuel suppliers, for example, don't naturally think of themselves as partners).

Investing in cleaner fuels offers a range of tools for boosting competitiveness, and it could give rise to a robust new economic sector producing a diversity of cleaner fuels for transport and industrial uses, along with many other value-added products.

WHAT IS A CIRCULAR ECONOMY?

A circular economy is a system that closes the supply loop and encourages the use of cleaner and longer lasting raw materials, as well as the repurposing, reuse and upgrading of all waste streams into valuable low-carbon products. The energy transition outlined in these pathways can encourage connections between industrial sectors in order to share supply and waste streams.

WHY A CIRCULAR ECONOMY IS IMPORTANT

A more circular economy will:

- reduce waste
- encourage greater resource productivity
- boost competitiveness
- establish a better foundation from which to address future resource security and scarcity issues
- reduce the environmental impacts of production and consumption, including carbon pollution

Renewable Fuels Milestones

Overarching Milestone

Over the next generation Canada is positioned among the global leaders in the bio-economy, leveraging our abundant resources and energy expertise to develop lower carbon fuels and value-added products.

Clean Fuel Standard and Cleaner Fuels

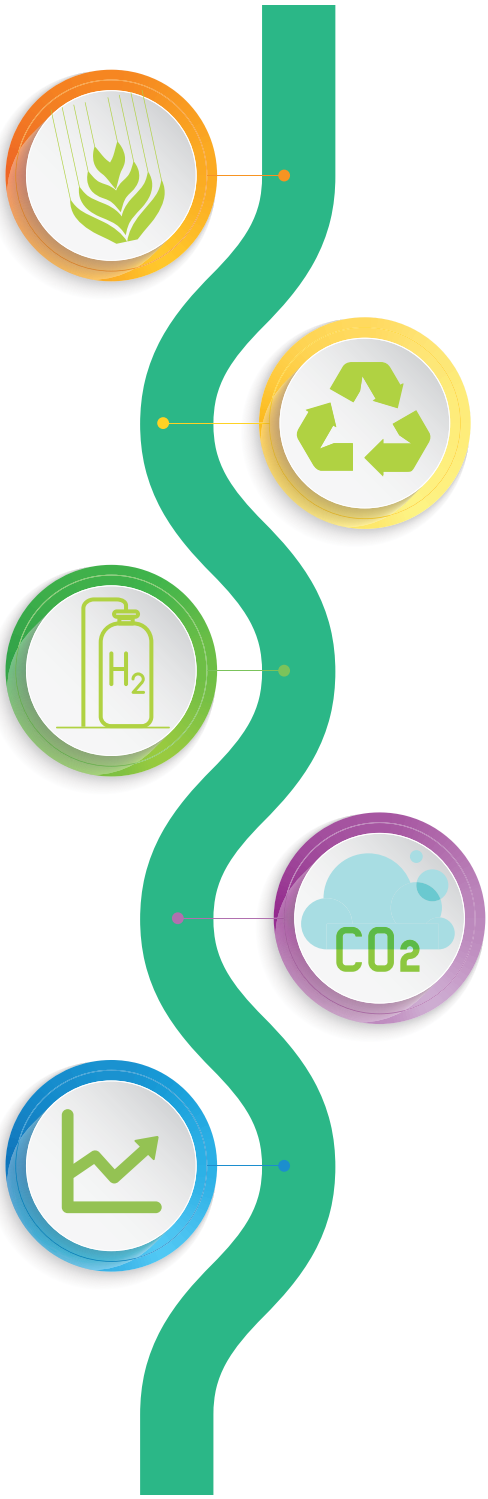
- A Clean Fuel Standard is implemented to deploy low-carbon fuels, electrification, and other technologies, to reduce Canada's annual greenhouse gas emissions by 30 million tonnes by 2030.
- Cleaner fuel use increases by 60% by 2040
- The number of advanced bio-refineries in Canada increases to 10 by 2030, and continues to increase thereafter.

Hydrogen

- By 2040, establish a leading hydrogen and fuel cell technology cluster and export trade.

Measurement, Monitoring and Transparent Reporting

- By 2020, establish a credible and transparent measurement, monitoring and reporting system to better inform purchasing decisions by providing comparative environmental, cost and performance data across a broad range of fuel types (conventional fuels, renewable fuels, hybrid solutions, etc.).



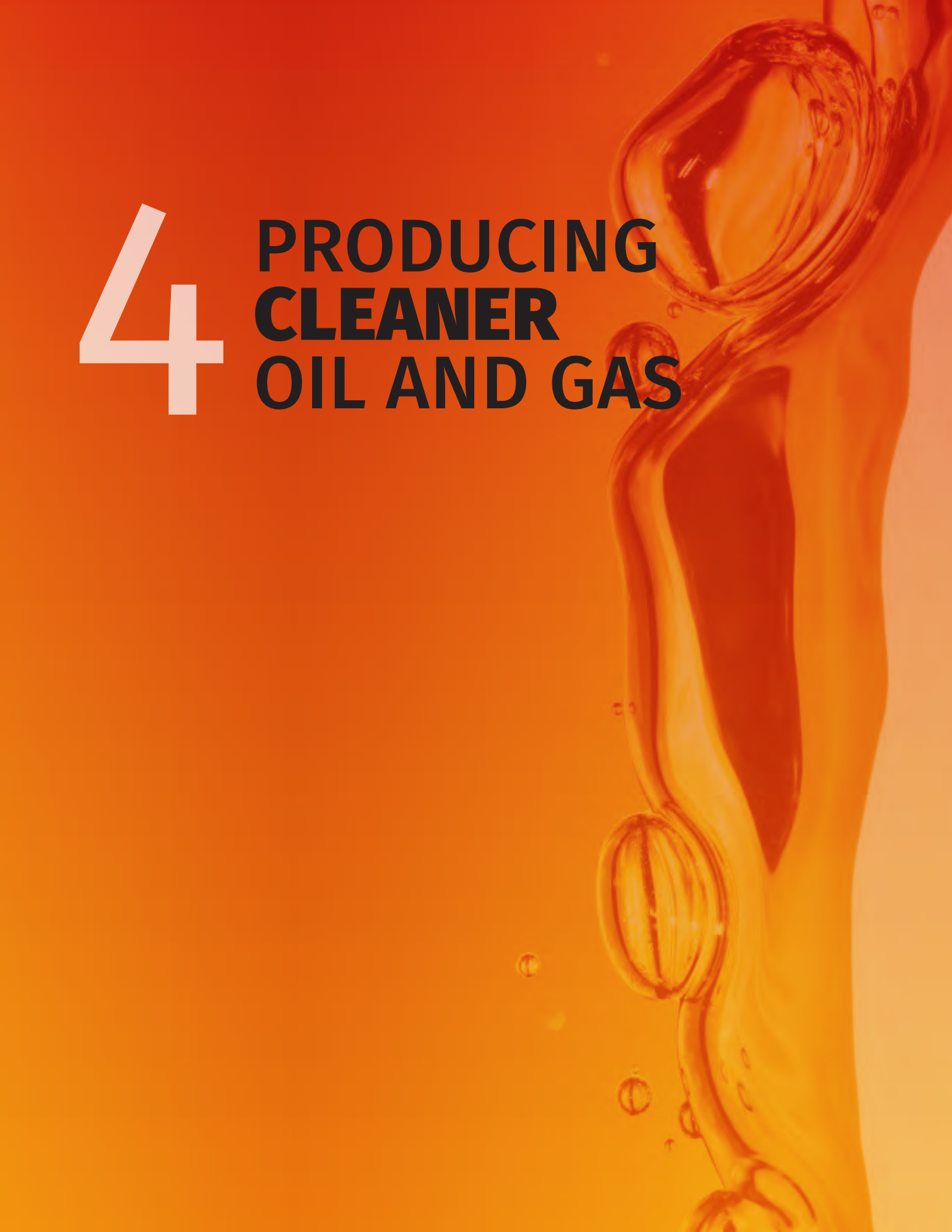
Bio-Economy and Circular Economy

- Strengthen current national bio-economy strategy by 2020 and develop a harmonized national strategy for the circular economy by 2025.

Carbon Capture Use and Storage

- Next generation CCUS technology is commercially viable for smaller scale industrial applications by 2030 or later.

4 PRODUCING CLEANER OIL AND GAS



TOOLS

PUBLIC CONFIDENCE

DRIVING INNOVATION

SKILL AND TALENT ATTRACTION AND DEVELOPMENT

COMPETITIVE BUSINESS ENVIRONMENT

POLICY & REGULATIONS

see appendix p.59

Even as the world moves toward a low-carbon future, the low cost and abundance of oil and gas mean they will continue to have a role to play in the global energy economy in the next generation. As in other industrialized economies, Canadians will be using less energy, including less oil and gas, at home.

Canada is the fourth largest producer of natural gas and home to the world's third largest oil reserves. But simply having those resources won't be enough to compete in rapidly transforming global energy markets. Canada's oil and gas production must be both cost and carbon competitive in domestic and international markets as the world seeks the most affordable and least polluting supplies in a carbon constrained economy.

To achieve this goal Canada should set its sights on a few key priorities:

- ***reducing emissions*** per unit of oil or natural gas produced;
- ***improving the cost competitiveness*** of Canadian oil and gas; and
- ***expanding the scope*** of value-added oil and gas products and services for both domestic and export markets.

BLOWING OFF STEAM IN THE OIL SANDS

A number of oil sands production companies are advancing new technologies that use solvents instead of steam generated by burning natural gas to extract oil from deeply buried oil sands deposits, significantly reducing carbon emissions per barrel of oil produced.

The generation to come promises to be a tumultuous one for the oil and gas sector worldwide – an era of mounting competition both between producers within the industry and with new sources being developed outside it. For oil and gas producers, pursuing this pathway starts with their own energy use, because using less energy reduces both their carbon pollution and their production costs. This is not a new challenge for Canadian oil and gas producers – the pursuit of lower costs and less energy use has been a focus of the business for years.

Canada's oil and gas producers will need to pursue a wide range of strategies to overcome barriers as they develop new low-carbon technologies. These include high costs, the difficulty of obtaining financing, the lack of flexibility in regulations to enable new technology, and long-time lags between testing and large-scale commercial implementation.

Here are some of the most important ways to respond to both the challenges and the opportunities in this Pathway:

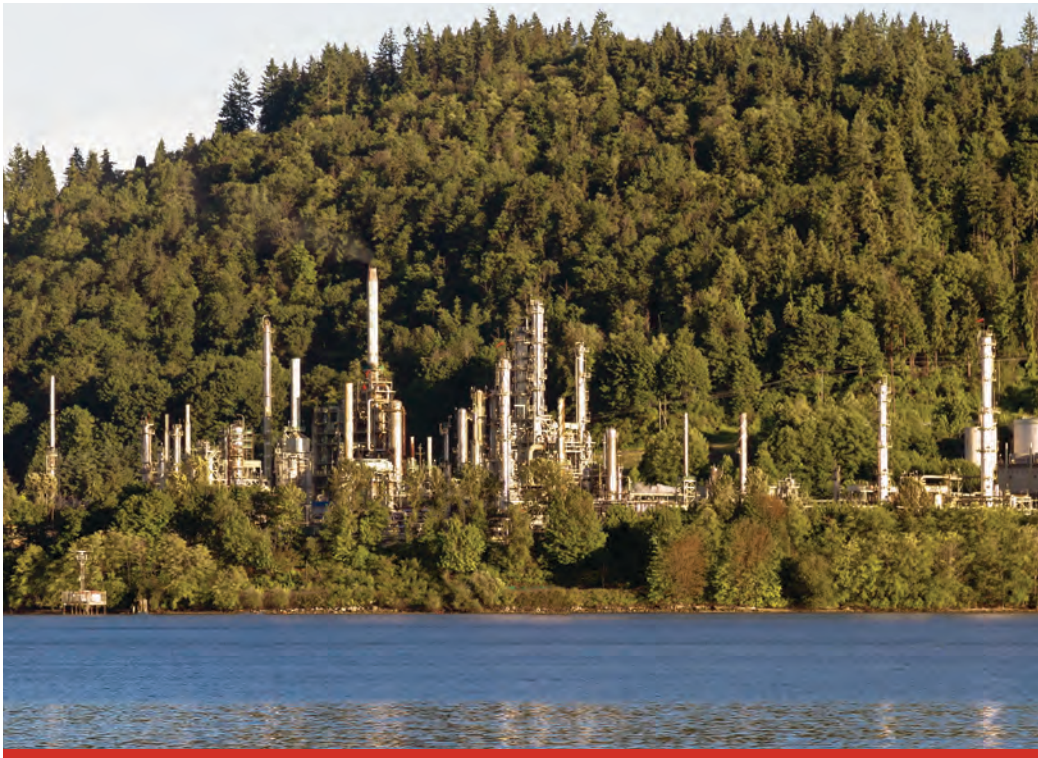
- Developing new processes for lower cost and more energy efficient extraction of crude oil (including the use of solvents and other new technologies to reduce or eliminate the use of natural gas to generate the steam needed to extract underground oil sands deposits) as well as in downstream upgrading, refining and transportation;
- Continuing to improve the cost and carbon competitiveness of Canada's oil, natural gas and natural gas liquids production by developing and implementing new technology, by applying innovative new systems and processes, and by ensuring that Canada has competitive policies and regulations that both protect the environment and attract investment;
- Significantly reducing methane emissions at oil and gas extraction and processing sites through more efficient equipment design; improved measurement, monitoring and reporting; and accelerating replacement of existing equipment;
- Reducing the cost of and improving access to clean grids for natural gas extraction and LNG delivery, so that lower carbon Canadian LNG can displace higher carbon LNG supplies from elsewhere in the world;
- Developing and implementing next-generation carbon capture, use and storage (CCUS) technologies to reduce carbon dioxide and other emissions created during the extraction of oil and gas, and potentially using the captured carbon dioxide as a feedstock for value-added products; and
- Diversifying the product mix produced by the oil and gas sector, with a particular emphasis on uses with lower life-cycle greenhouse gas emissions such as petrochemicals, non-combustion uses for bitumen, and using carbon dioxide to produce other products such as biofuels.

CARBON CAPTURE PIONEER

A project under construction near Edmonton will be the largest CCUS facility in the world, collecting carbon dioxide from industrial sites (including an oil refinery and a fertilizer plant) and transporting it to sites in central and southern Alberta for enhanced oil recovery and permanent storage.

This pathway also presents a chance for Canada's long-standing expertise in resource extraction to connect more directly with the emerging cleantech economy. The expertise and technological innovations created in pursuit of CCUS, for example, can create a strategic advantage as this technology becomes more prominent in the global marketplace, positioning Canada to export technology and expertise for both CCUS and value-added products made from captured carbon dioxide.

Producing cleaner and more competitive oil and gas represents a significant opportunity for Canada's oil and gas sector. Its large and growing carbon footprint has hindered its ability to obtain public approval for new infrastructure projects in Canada and tarnished Canada's energy brand abroad. A redoubled effort to shrink that footprint while continuing to play a significant role in the global energy economy could provide a major boost to the brand and demonstrate how a resource-based economy like Canada's can support the transition to a lower carbon future.



CANADA'S PETROCHEMICAL ADVANTAGE

More than 95 percent of all manufactured products rely on chemistry – including such sectors as green buildings, sustainable transportation, clean energy and sustainable agriculture are dependent on chemicals. Canada's petrochemicals industry has made significant reductions in greenhouse gas emissions and energy intensity. It is well positioned to grow, with secure supplies of low-cost natural gas liquid feedstock and ready access to low-carbon fuel supplies like hydroelectricity and biomass to power its industrial processes, an advantage over international competitors who are reliant on higher carbon energy such as oil and coal.

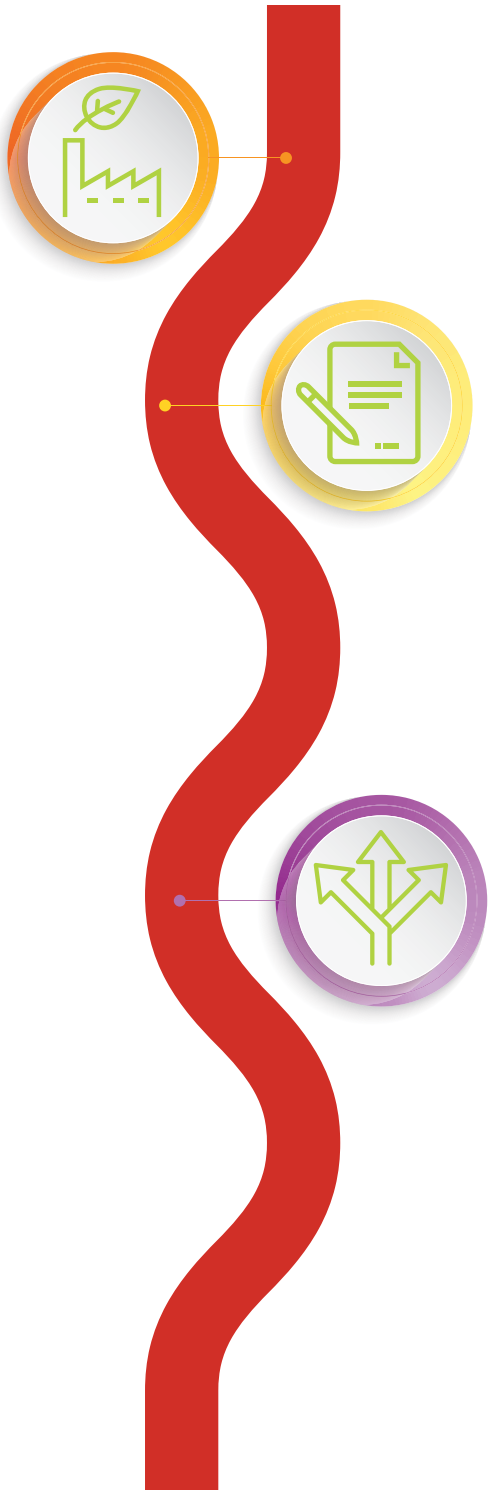
Cleaner Oil and Gas Milestones

Overarching Milestone

Reduce costs and carbon pollution of Canada's supply of crude oil, natural gas and natural gas liquids to levels per unit of production lower than competing supplies in the market by 2030, with further improvement thereafter.

Cleaner Production

- Canada is among the suppliers of the cleanest LNG in the world to global markets, enabled by clean electrification.
- By 2025, reduce methane emissions by 40 to 45 percent from 2012 levels, with ongoing improvements thereafter.
- By 2030, reduce life-cycle greenhouse gas emissions for oil sands extraction to levels lower than competing crudes in global markets.
- By 2020 to 2025, next-generation CCUS projects are ready for demonstration-scale operatio, with commercial application by 2030 or later,and the eventual goal of generating revenues that offset the cost of carbon capture.
- Integrate renewable energy at a significant scale into oil and gas extraction within five years, and introduce advanced power generation (e.g. fuel cells, small modular nuclear reactors, etc.) within the next 20 years.



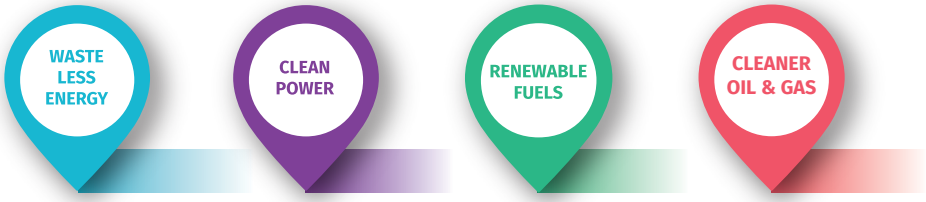
Regulations

- Develop a trusted and effective regulatory system, including a life-cycle approach to greenhouse gas emissions, as measured by objective third party assessment of key attributes relative to competing jurisdictions.

Diversify Product Mix and Enhance Market Access

- By 2030, a more diversified mix of oil and gas products, services and solutions to domestic and global markets has a measurably significant impact on industry and government revenues.

We've outlined these **four pathways** to make this energy transition, but the full impact is seen in the way these pathways intertwine and mutually reinforce each other.

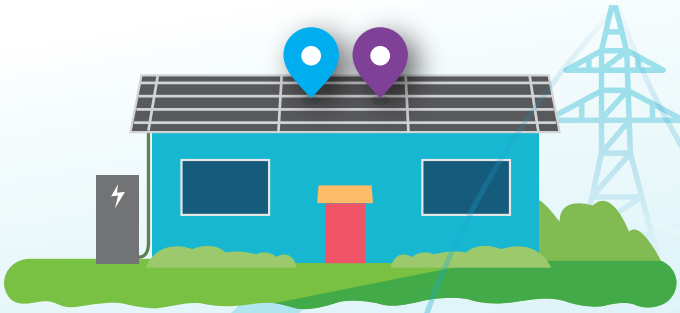


FOR COMMUNITY

Many homeowners will be **'prosumers,'** producing electricity to heat and power their **efficient homes and vehicles**, and **selling excess power to the grid.**

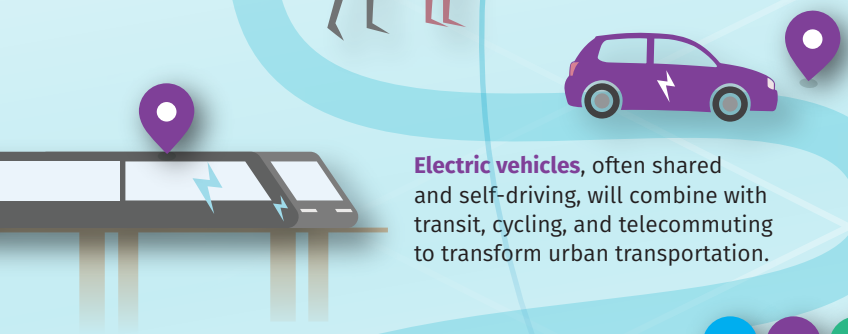
ACROSS CANADA A GENERATION FROM NOW, THE WAY WE MAKE AND USE ENERGY WILL BE DIFFERENT.

All of the services energy provides— from transportation to heating, cooling, and hot water, to motors and lighting and wifi — will all work together seamlessly, enabled by cross-cutting tools like AI* and other advanced systems for optimizing energy production and use.



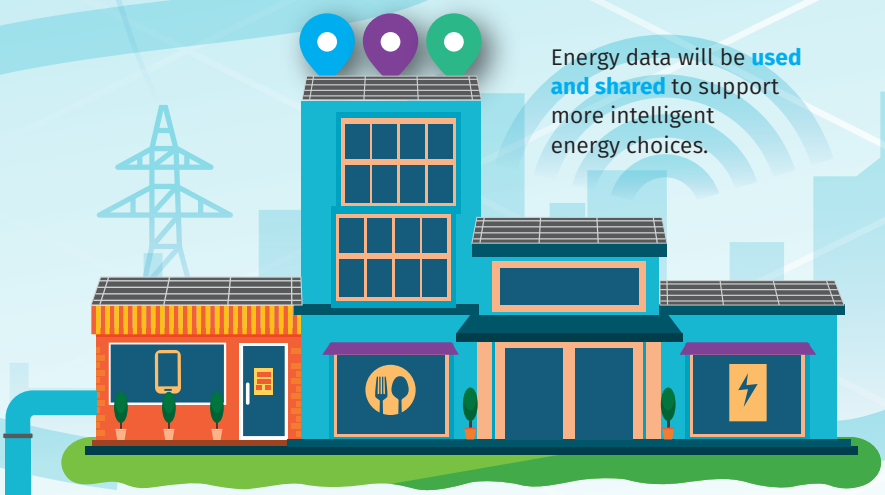
Buildings will be **super-efficient**, thanks to new building codes that require improvements like more insulation and better windows.

Electricity will come primarily from renewable and non-emitting sources. More production will be local and distributed.



Electric vehicles, often shared and self-driving, will combine with transit, cycling, and telecommuting to transform urban transportation.

Energy data will be **used and shared** to support more intelligent energy choices.



Municipal and other waste will be converted to **biofuels** and **renewable natural gas**.

District energy systems will use **waste heat** from industry and municipalities

More **efficient** homes, offices and factories, outfitted with **integrated energy management systems** and **next-generation storage**, allow for a lower cost and more reliable grid, as more access to decentralized renewable energy increases.

* *AI : Artificial Intelligence*

** *See page 37 for more information on the Circular Economy*

FOR

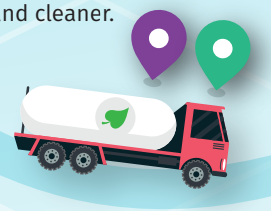
INDUSTRY

Canada's competitive advantage will be enhanced by new energy efficiencies and opportunities across the four pathways. The re-use of waste, and access to clean energy and new technologies will make Canada's industries leaders in energy transition.

Electricity generation will come from **non-emitting, renewable** and **traditional** sources. Some electricity generating stations will use both conventional and **renewable natural gas** (produced from forestry, farm and municipal waste). Their CO_2 emissions will be captured.

Carbon capture from gas power plants will fuel industrial greenhouses, which will in turn produce organic waste used for **biofuels**.

Biofuels will complement **electrification** to make moving people and goods more efficient and cleaner.



The rise of the **circular economy** creates opportunities to turn waste into energy sources, which in turn make industrial processes cleaner.**

Long distance transport will run on a mix of options including **conventional fuels** and **biofuels**.

Waste from heavy industry, agriculture, forestry and municipalities will be refined into biofuels.

Industries will use **energy and resources more productively** and switch to renewable and non-emitting **electricity**.

Electrification and **improved production methods** help reduce CO2 from the oil and gas sector, making it more competitive.

5 PATHFINDING WITH INDIGENOUS PEOPLES

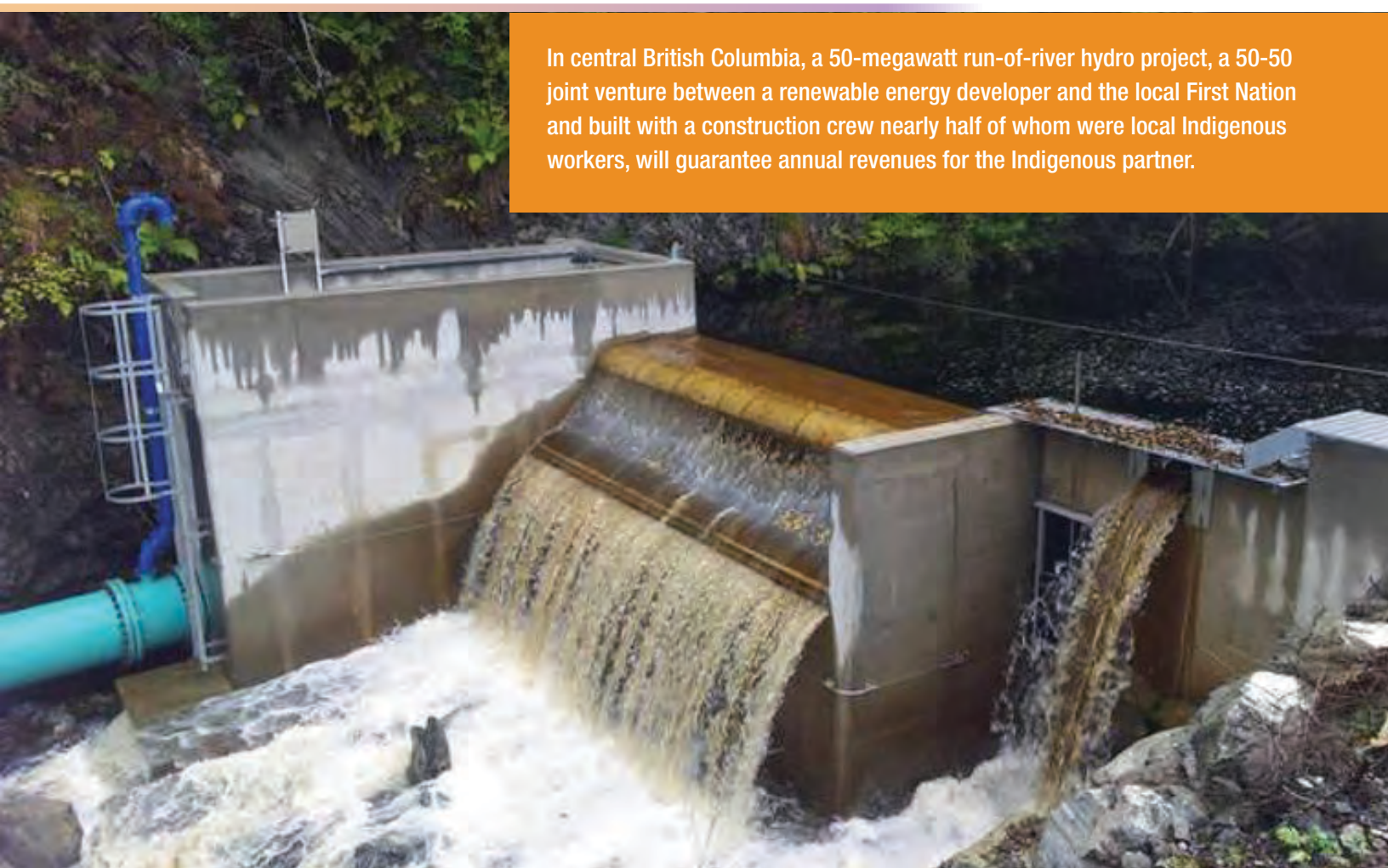
A new model has begun to emerge for Canada's relationship with Indigenous peoples, and Indigenous participation in all aspects of the energy transition can become a powerful lever for change as part of this new relationship.

Indigenous representatives and organizations who participated in the Generation Energy dialogues and other recent forums have identified several factors that can increase Indigenous involvement in projects and initiatives to help Canada meet its climate and energy goals. Among them:

- Indigenous peoples require improved regulatory systems with more formal roles in energy project assessment and review, as well as in decision making, monitoring and active participation in the projects themselves.
- Though ownership and management of energy systems, Indigenous governments and businesses can build capacity to meet their own energy needs and provide their communities with more affordable, reliable and sustainable energy.
- A young, growing and increasingly engaged generation of Indigenous youth can use new technology and new energy systems together to advance reconciliation, sustainability and self-determination within their communities.

AN INDIGENOUS WAVE OF RENEWABLE ENERGY :

The relatively small scale, modest capital cost and decentralized nature of renewable energy sources such as wind, solar and run-of-river hydro has inspired a wave of Indigenous-owned energy projects and 50-50 partnerships between renewable energy companies and First Nations across Canada. There are already an estimated 31 such projects underway or completed across Canada.



In central British Columbia, a 50-megawatt run-of-river hydro project, a 50-50 joint venture between a renewable energy developer and the local First Nation and built with a construction crew nearly half of whom were local Indigenous workers, will guarantee annual revenues for the Indigenous partner.

In northwestern Ontario, a 60-megawatt wind farm, half owned by the First Nation whose territory it stands on, opened in 2015 as one of the largest wind power partnerships in the country, sending enough power to the grid for 15,000 homes and employing First Nation members as maintenance crew.

This Council has neither the mandate nor the expertise to address this issue in full. We can, however, confirm that new opportunities are emerging for Indigenous peoples in Canada to provide leadership on energy strategy and energy development. A diverse range of parties interested in acting on these opportunities has begun to come together. In order to accelerate outcomes, we recognize the importance of the following:

- Building mutually beneficial and respectful relationships requires political will, joint leadership, trust, accountability, and transparency. This requires substantial commitment by all parties involved.
- Recognizing the knowledge and perspectives of Indigenous elders and keepers of Traditional Knowledge regarding community ethics, concepts, and practices can serve as a guide for the use of Traditional Knowledge in Canada's energy transition.
- Engaging Indigenous peoples in the energy transition in a collaborative and solutions-oriented manner will lead to better economic, social and environmental outcomes.

Many Indigenous communities in Canada have already begun to navigate their own pathway to Canada's energy future. The federal government and Indigenous leaders and communities need to establish a dialogue for specific actions that will enable greater Indigenous involvement in all aspects of Canada's energy transition. A focus on the following issues will help ensure this dialogue achieves tangible results.

Involvement:

A Dialogue about the role of Indigenous Peoples in the energy transition must continue and find ways to reflect the different geographic needs, interests and opportunities of Indigenous communities. This can be advanced by:

- Developing new models for collaboration and governance based on guiding principles such as the recognition of rights and next-generation approaches to partnership, both within the context of current government-to-government discussions and outside of them
- Building awareness among Canadian Indigenous Peoples about global opportunities with Indigenous Peoples around the world to share best practices and discuss new trade and investment. This could include, for example, Indigenous participation in international trade delegations and other forums with investors and customers.

Investment:

Indigenous Peoples and communities need better access to capital designed to meet their needs and help create certainty for investments in Indigenous clean energy and low-carbon projects. This can be advanced by:

- Dedicating financing to provide cost-competitive, Indigenous investment in clean and low-carbon energy projects.
- Establishing funding to support Indigenous participation in energy projects or opportunities.
- Scaling funding and investment to enable energy development processes and projects that range from small projects like roof-scale solar on a community to school to large ones like the development of a local energy system at community scale.

Capacity:

Indigenous communities need better access to technical and business expertise that integrates the application of Traditional Knowledge with energy development. This can be advanced by:

- Establishing a centralized resource for energy information to enable interested Indigenous communities, businesses and individuals to share best practices and obtain independent advice, which can provide the foundation for training and capacity building in the planning, development and operation of energy projects.

In northeastern Alberta, a First Nation took advantage of the Alberta government's Indigenous Solar Program in 2017 to finance a 25-kilowatt solar power project on the roof of its local school, with costs split 60-40 between the First Nation and the province.

PART VI. ADVICE

The energy transition may be the single greatest challenge of our generation, but it is also our greatest opportunity—a bold and urgent national mission to build a better Canada. We urge the federal government to use its resources and influence to complete the actions outlined below.

LEAD THE ENERGY TRANSITION

1. Create a Plan for Canada's Energy Transition

Canada will need a clear strategy and plan that integrates our energy vision, principles and pathways with Canada's climate commitments and our domestic and global energy interests, as well as a commitment to execute it practically it through cooperation among federal, provincial, territorial and Indigenous governments. We urge the federal government to:

- **Develop an integrated Energy Transition Strategy and Plan** informed by research, modelling, policy and indicator-tracking and by roadmaps for each of the four pathways—Energy Efficiency, Clean Electrification, Renewable Fuels, and Producing Cleaner Oil and Gas.
- **Rally governments at every level to build a strong national consensus on the energy transition** because success requires that crucial federal efforts are aligned with and complementary to provincial, regional and local programs, underpinned by a shared vision and action plan for Canada's energy future.

2. Build a Unified Government Platform to Guide the Energy Transition

Other nations have functionally integrated energy, climate and industrial development into a single ministry or department, leading to more durable policy and more robust, cross-functional planning and execution. We urge the federal government to:

- **Integrate the government functions of energy, climate and economic development** (business, industry, investment, technology, innovation, infrastructure, human resources, etc.). This is a fundamental governance and structural issue, which needs to be addressed in Canada if momentum toward a low-carbon economy is to be sustained.
- **Create a transparent Canadian Energy Information Organization –** to provide a single window to timely, objective and credible energy-related data2 to support informed decision-making on public policy related to energy, and to improve understanding amongst stakeholders and the public.This national organization would have some independence from the federal government. Where practical, data collection should be coordinated with ECCC to ensure an integrated energy and climate data set and supporting analysis.

3. Walk The Talk

The federal government is Canada's single largest owner and lessor of buildings and vehicles, as well as consumer of energy. Building on the Centre for Greening Government, government should move immediately to lead by example, without waiting for the broader plan. We urge the government to revisit and implement its own:

- Procurement rules for buildings and equipment, to ensure that government occupied space, whether leased or owned, is among the most energy efficient in the nation.
- Procurement rules for government vehicles, to ensure that government fleets, whether leased or owned, are the most efficient and electrified in the nation.
- Energy management rules to ensure that government's total energy footprint is the first to meet national energy efficiency and clean energy goals.
- Investment rules to ensure that government's capital investments support the clean energy transition.
- Procurement, investment and management rules to ensure they support, encourage and showcase Canadian clean energy businesses.

4. Establish an Independent Climate & Energy Transition Institute

We urge the federal government to establish an independent, credible, evidence-based, transparent institute1 to ensure Canada's energy transition is linked to Canada's climate objectives and commitments.

- The scope should include independent analysis, modelling and research, report on progress, advice to government on areas for prioritization, and engaging Canadians in the conversation about energy and climate.
- The Institute could be realized without significantly more resources by revising the mandate and governance of the Canadian Expert Institute on the Pan Canadian Framework to address energy transition in more detail, in-line with the scope noted above, appropriately funded and staffed on a longer-term basis to fulfill the mandate.

DRIVE CHANGE

5. Get the Codes and Standards in Place

While there are many new codes and standards that could be implemented to support energy transition, we encourage the federal government to put a priority on implementing new regulatory tools that are already part of current plans. In particular we urge the federal government to:

- **Expand energy labelling.** Consumers and the broader marketplace cannot make informed decisions without credible information. Labelling of home and building energy performance is already required in Europe, parts of the U.S., and beyond, and is urgently needed for buyers and renters/lessors of homes and buildings across Canada.
- **Support the introduction of new world-class building codes.** Canada's residential and commercial building energy codes have steadily improved. The federal government has signalled its intent to adopt "model" energy codes that establish best-in-class expectations, both for new homes and for retrofitting the existing stock. While adoption of the codes themselves is a provincial jurisdiction, the federal government can work to ensure rapid implementation.
- **Implement new standards for low-carbon fuels** and natural gas processing that will enable Canada's fuels to become progressively cleaner and more cost-effective at reducing emissions.

6. Enable Regulatory Processes to Support Energy Transition

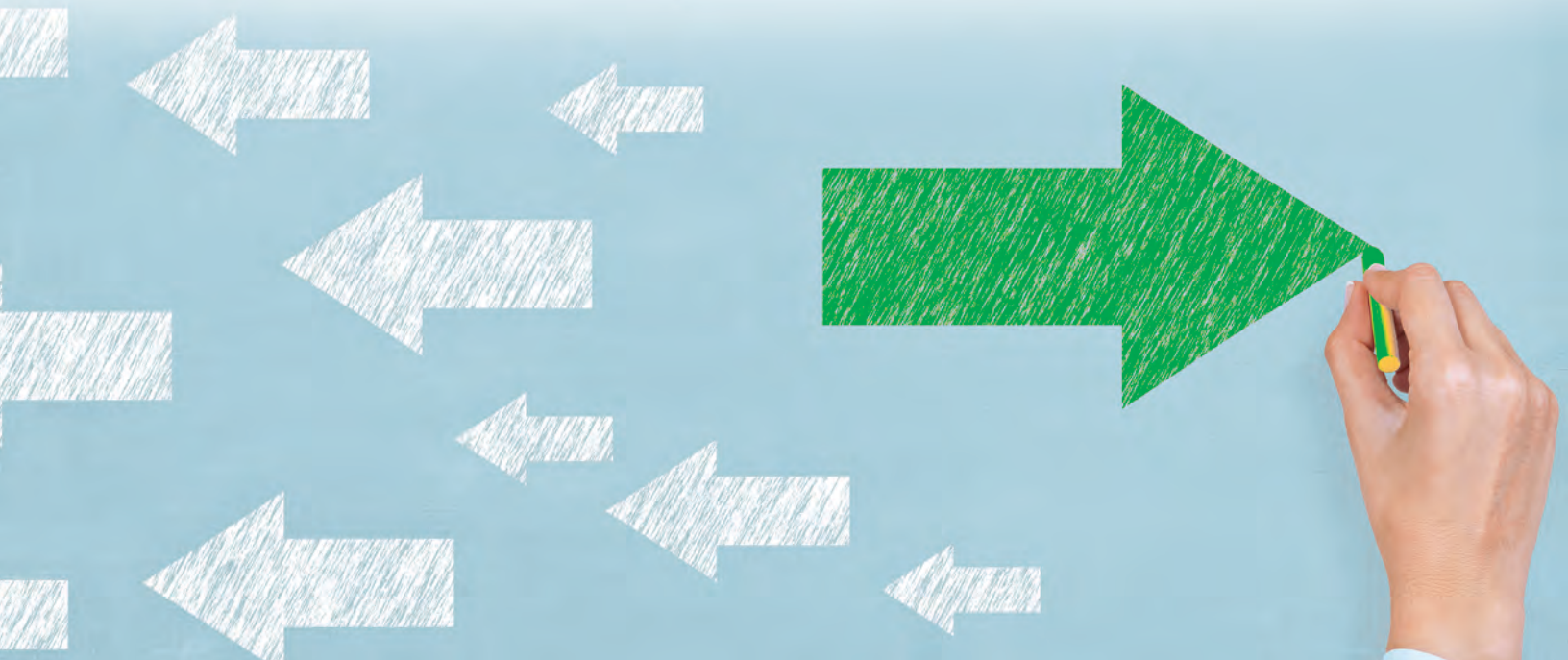
Modernizing and integrating the policy and regulatory system is fundamental to accelerating energy transition. This applies across multiple jurisdictions, as well as across different sources and uses of energy, and different energy delivery mechanisms. The federal government should:

- **Provide leadership in the integration of energy policies and regulations across multiple jurisdictions.** Encourage a more aligned approach to policy and regulatory frameworks among provincial, territorial, municipal and Indigenous governments, so as to improve regulatory effectiveness and transparency.
- **Support changes toward a more effective, integrated framework for utility regulation within provinces**. While respecting provincial and municipal jurisdiction, the federal government should actively encourage and support efforts to: (i) adapt regulatory rules to the goal of accelerating the energy transition, and (ii) remove silos and align the regulatory system with the shift to more integrated energy systems - heat, power, transport, waste, etc.
- **Continue to advance current efforts for Indigenous inclusion** in modernized energy assessment and regulatory processes, based on recognition of rights, respect, co-operations and partnership.
- **As an element within established regulatory review processes, support consideration of the role a proposed project and new technologies could play in accelerating progress on energy transition**. Early project planning phases should include an assessment of a potential project's contribution to the transition to a lower carbon economy. Fast-track regulatory review options should be considered for projects and new technologies that meet pre-established criteria.

7. Invest In Canada's Energy Transition

Canada's energy transition will require a shift from the status quo to ensure adequate and predictable private and public investment to de-risk, accelerate and strategically attract capital to new technologies, products and infrastructure. We recommend the federal government:

- **Introduce policies, programs and frameworks to deliver and stimulate strategic investment in Canada's energy transition**, including but not limited to:
  - Dedicating current and enhanced future funding to energy solutions that improve Canada's overall carbon profile, reduce climate related risk, and maximize the GHG reductions per dollar.
  - Enhancing the ability to aggregate and commercialize small and medium sized projects (for example retrofits, generation, EV charging, biofuels) including through public procurement and business development supports.
  - Offering fiscal and other incentives – such as capital cost depreciation, other tax treatments and strategic initiatives – to encourage energy efficiency, distributed power generation and use of cleaner energy sources in homes and businesses.
- **Ensure the Canada Infrastructure Bank's mandate includes attracting private and public investment** to implement the energy transition. This can include credit enhancements, other strategic de-risking mechanisms and specialized financing approaches that highly leverage public capital.
- **Ensure that Indigenous Peoples and communities have access to affordable capital** designed to meet their needs and help create certainty in investment in Indigenous led and/or supported clean energy and low-carbon infrastructure projects, by:
  - Expanding access to funding and financing to support early engagement, capacity development and equity investments that advance participation in energy transition, and meet the different needs of Indigenous communities through the creation of an Indigenous Energy Transition Fund.
  - Streamline existing funding and investment programs to maximize the value of resources dedicated to Indigenous participation in energy projects.



EMPOWER CANADIANS

8. Accelerate The Generation Energy Conversation

The federal government's conversation with over 380,000 Canadians about the future of energy in our nation was a proactive and collaborative starting point. We urge the federal government to:

- **Promote a culture shift about energy** by supporting Canadians and Canadian businesses as they seek to develop and take advantage of new energy sources and technologies, specifically
- **Engage Canadians** in the energy transition conversation with a clear vision of Canada's competitive, low-carbon economy, enabled by clean, efficient and affordable energy systems and ensure the co-benefits of a low-carbon economy are broadly understood.
- **Support workers and communities** in their efforts to make their workplaces and living spaces clean and competitive.

9. Empower Canada's Indigenous Peoples

Indigenous Peoples must be included as important partners in Canada's energy future. We urge the federal government and interested Indigenous leaders and communities to:

- **Establish a focused mechanism and process** to provide specific actions that can ensure Indigenous involvement in all aspects of Canada's energy transition, including the development of an integrated energy transition strategy and plan, and new structural and institutional capacities required to execute that plan.
- **Advance prosperity by respecting inherent treaty and indigenous rights** to empower indigenous people's communities and businesses to initiate, plan and invest in clean and low-carbon energy projects.

10. Demonstrate Canadian Leadership on Energy Transition

Attract business and investment to Canada and strengthen Canada's position in global markets for our energy products, services and solutions by earning a reputation for leadership in energy transition. Taking the advice outlined above will have the effect of significantly improving Canada's energy brand. We urge the federal government to:

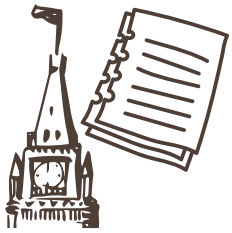
- Engage Canadians and the international community in a new Canadian energy narrative framed on our policy leadership and our progress on our goals and challenges as demonstrated by results from our energy transition plan.
- As part of this narrative, highlight our existing strengths, such as our clean and low-carbon electricity grid and the opportunity to power low-carbon businesses in Canada today.

CANADA'S ENERGY TRANSITION TOOLKIT

1. Innovation

Tool – Driving Innovation:

Accelerate the energy transition through investment in research and development, demonstration and commercialization, and the conversion of new knowledge into products and services. This tool includes funding, policies, collaboration and other mechanisms that can support the adoption of new ideas, management systems and operating models.



2. Rules Of The Game

Tool – Policy and Regulations:

Support the energy transition through government actions at every level, while ensuring that Canada's energy systems continue to provide affordable and reliable energy. Tools include national goals and targets, carbon pricing, performance codes and standards, sector-specific permitting requirements (such as emissions caps), labelling and management systems, and the development and zoning procedures that guide decision-making by industry, consumers and other levels of government.

Tool – Government Coordination:

Support and advance an unprecedented level of coordination and alignment of the policies and programs needed to enable the energy transition among federal, provincial/territorial, municipal and Indigenous governments, particularly as new energy systems and technologies emerge. Tools include synchronizing policies and regulations across multiple levels of government regarding community design and growth, codes and standards, infrastructure and trade, and voluntary and mandatory reporting. Collaboration at senior levels of government can be fostered by joint forums such as the Energy and Mines Ministers Conference.

Tool – Regulatory Design:

Design new regulatory frameworks to be more integrated, transparent, streamlined, predictable and agile, in response to rapid and disruptive technological change, new market dynamics and the need to increase public and investor confidence.

Tool – Government Procurement:

Make use of public purchasing power to support the energy transition by ensuring cost-competitive procurement processes for buildings, vehicles, equipment, infrastructure (see Tool below), materials and services. Tools include screening criteria using carbon and energy metrics and support for demonstration and commercialization of technologies and services. Public sector procurement policies can also influence supply chain management policies and practices adopted by the private sector.

3. Investment & Markets

Tool – Infrastructure Investment:

Target investments toward strategic infrastructure that is essential to the energy transition. Tools could include EV charging, interprovincial systems for energy transmission and transportation, systems for remote and distributed generation, green banks (e.g. the Canada Infrastructure Bank), innovation clusters based on public/private partnerships, and new financing mechanisms to attract private capital and prioritize investments.

Tool – Competitive Business Environment:

Make use of a suite of measures including laws and policies, taxation treatments, trade and market development initiatives, and investment attraction strategies to give Canada's small, medium and large energy sectors the ability and visibility to innovate and compete on an even footing domestically and globally.

CANADA'S ENERGY TRANSITION TOOLKIT

Competitive Business Environment (cont'd):

Tools include trade policies and programs aimed at:

- improving the efficiency of existing interprovincial and international trade corridors;
- boosting Canadian participation in the development of national and international standards that can help open up markets for new Canadian energy products and services;
- attracting foreign investment in Canadian energy innovation; and,
- enhancing Canadian access to export markets for our energy products and services.

4. Building Capacity

Tool – Skills and Talent Attraction and Development:

Develop coordinated strategies and partnerships among all levels of government, the private sector, and the labour market that ensure the relevant human resources and skills are in place to implement energy transition. This can include retraining, mentorship and accreditation programs related to trades, buildings and construction, as well as digital skills and technical training to support the application of new technologies that advance efficiency and emissions reductions across all of Canada's energy systems. It also includes new collaborative strategies to both retain and attract world-class talent to Canada's energy transition.

Tool – Entrepreneurship and New Business Models:

Modify regulations, target incentives, and develop mentorship networks and other support for the development and growth of new business and ownership models, including shared, distributed and circular economy platforms.

5. Engaging Canadians

Tool – Public Confidence:

Encourage greater public confidence in energy-related institutions and decision making processes through improved public access to information and credible 'big data' regarding energy sources, costs, and options. Put information into the hands of individuals and businesses to allow them to make smart choices for themselves and engage more effectively in broader decision-making processes on energy issues.

Tool – Behavioural Change:

Implement financial signals such as rebates, rewards, incentives and discounts to help Canadians embrace change and greater personal responsibility for the way in which they use energy. Financial tools that can overcome inertia or make a compelling business case are particularly useful for encouraging the use of more advanced technologies and creating opportunities for households and neighbourhoods to participate as "prosumers" who use, generate, store and sell energy at the local level.

PATHWAY – SPECIFIC TOOLKITS

WASTE LESS ENERGY

Wasting Less Energy

1. Tool – Skill and Talent Attraction and Development: Education and training to ramp up the workforce needed for planning, implementation and maintenance of retrofits and net-zero new construction, delivery of demand management programs, development of integrated urban plans, and other key jobs in the efficiency sector.

2. Tool – Policy and Regulations: Codes, standards and requirements are needed to predictably and continuously improve the efficiency of Canada's vehicles, equipment, buildings, industry and land use. The federal government can directly regulate the first two, and can encourage and support provincial and municipal governments in promulgating others.

3. Tool – Government Procurement: Governments – federal, provincial and municipal -- can be market leaders by demonstrating efficient new construction and dbuilding retrofits, disclosing energy use, incorporating zero emission vehicles into fleets, and using the most efficient equipment. The public procurement process needs updating to ensure life-cycle energy use and greenhouse gas emissions reductions are key to the bidding and selection process.

4. Tool – Competitive Business Environment: Because energy efficiency is distributed throughout the economy, support and investment is needed in businesses and programs that originate and aggregate efficiency projects, for services that support conservation, for initial deployment of innovative technologies to accelerate commercialization, and for services.

CLEAN POWER

Switching to Clean Power

1. Tool – Policy and Regulation: The pace of change will create significant pressure on federal and provincial governments to create regulations for new technologies as they emerge. Governments will need to stay ahead of the curve to avoid slowing the transition, in particular regarding international and internal efforts to standardize codes and standards. Support will also be needed to attract investors in those clean energy sectors that are not yet cost competitive. Governments at every level will need to find ways to create incentives and support for these new technologies and help them find support among the general public.

2. Tool – Driving Innovation: To spur innovation in the clean power sector, government support is needed for research, development and demonstration activities tha are technology-neutral to allow the largest set of potential solutions. Specific targeted programs can complement broader and more flexible programs to improve their effectiveness. For example, R&D of clean technologies may reduce their overall mitigation cost, thereby potentially making it easier to achieve a given GHG emissions target.

3. Tool – Competitive Business Environment: Building out the clean power supply and transmission infrastructure at the scale required over the next generation will require major investments of both public and private capital. Canadian companies will need to develop new business models and entrepreneurs running new companies must develop the new technologies to attract investors and build affordable and reliable grids.

PATHWAY – SPECIFIC TOOLKITS

RENEWABLE FUELS

Using Renewable Fuels

1. Tool – Public Confidence: Consumer habits, well-established standard operating procedures, and jurisdictional issues will need to shift to successfully navigate this pathway. One way to accelerate this shift is to boost public confidence in new fuel types by ensuring quality and affordability, and improving consumer access.

2. Tool – Driving Innovation: Innovation efforts on the Cleaner Fuels Pathway should prioritize:

- technologies to produce cleaner natural gas (e.g. renewable natural gas and hydrogen) and build integrated electricity and natural gas systems;
- development of "drop-in" low-carbon fuels with fuel properties and specifications that align with conventional fuels (avoiding new investments in infrastructure and engine conversions); and
- development of next generation biofuels and smaller scale CCUS.

3. Tool – Skill and Talent Attraction and Development: Introduce education and training programs that develop new skills specifically for the emerging bio- and circular economies.

4. Tool – Competitive Business Environment: Help find both public and private capital for investment in the facilities and infrastructure required to enable wider access to cleaner fuels.

5. Tool – Policy & Regulations: Adopt and implement a clean fuel standard, as well as carbon pricing and other policy and regulatory tools, to accelerate a cost-effective transition to lower carbon fuels.

CLEANER OIL & GAS

Cleaner Oil & Gas

1. Tool – Driving Innovation: Enable public and private sector collaboration to diversify the product slate from the Canadian oil and gas sector, with the specific objectives of improving environmental performance and economic competitiveness.

2. Tool – Competitive Business Environment: Ensuring the necessary infrastructure and trade relationships to deliver oil and gas products and services to a diversity of markets.

3. Tool – Policy and Regulations: Ensure new policies and regulations (like the Alberta Climate Leadership Plan carbon pricing and emissions limit) stimulate reductions in the greenhouse gas intensity of Canada's oil and gas sector, while ensuring competitiveness is not compromised. Utilize other public policy tools, such as offsets and international credits, to ensure Canada's domestic leadership is recognized in a global context.

4. Tool – Skill and Talent Attraction and Development: A highly skilled Canadian workforce will contribute to progress within Canada and create opportunities to export this know-how.

5. Tool – Public Confidence: Leadership in public policy and industry performance, along with more effective engagement and communications, could improve the overall public perception of the oil and gas sector as an important participant in the transition to a low-carbon economy, both across Canada and globally.

GLOSSARY OF TERMS

Bio-economy – an economy that relies on renewable natural resources to produce food, energy, products and services.

Biofuels – liquid, solid and gaseous fuels (e.g. ethanol, biodiesel, wood pellets and renewable natural gas) that are derived from biomass.

Carbon Capture Utilization and Storage (CCUS) – an integrated suite of emerging technologies designed to capture carbon dioxide emissions produced from large industrial processes (such as electricity generation and oil and gas production).

Circular Economy – a shift from the current linear economy, in which feedstocks enter the supply chain at one end and finished products and waste exit at the other, to a circular system, in which raw material use and waste are minimised and a product at the end of its life is used again to create further value.

Clean Energy – for the purposes of this report, clean energy refers to electricity that is produced from renewable energy (hydro, wind, solar, geothermal, tidal, etc.) and energy efficiency.

Cleantech – for the purposes of this report, cleantech refers to emerging knowledge-based products and services that improve operational performance, productivity or efficiency while reducing costs, inputs, energy consumption, waste or pollution.

Competitive Advantage – for the purposes of this report, competitive advantage is a condition or circumstance that places a company, energy sector or country in a favorable business position relative to competitors. For instance, Canada's access to abundant sources of clean electrical generation provides its industrial and energy sectors with a competitive advantage in a global low-carbon economy.

Digitization – the introduction of large-scale data into modern energy systems, enabling greater connectivity, intelligence, efficiency and reliability. Digitalized energy systems can enable consumers to better understand and control their energy usage, allow prosumers to participate more actively and efficiently in energy markets, and create opportunities for both utilities and third-party developers to offer advanced solutions to enable both.

Non-Emitting – electricity produced from sources that produce no carbon pollution, such as hydro, wind, solar, nuclear, geothermal, and tidal.

Paris Agreement – On December 12, 2015, Canada and 194 other countries signed onto the Paris Agreement to fight climate change by limiting the global average temperature rise to less than 2°C and to pursue efforts to limit the increase to 1.5°C. As part of this agreement, Canada agreed to reduce greenhouse emissions to 30 percent below 2005 levels by 2030 and 80 percent below 2005 levels by 2050. The agreement also contains provisions for enhanced international collaboration and transparency on the tracking, reporting and trading of carbon emissions.

Passive House – a rigorous standard for energy efficiency in building design, resulting in structures that require very little energy for heating and cooling. The passive house concept was pioneered in Saskatchewan in 1976. Today this concept is an essential tool in Canada's efforts to make all new Canadian home net-zero energy ready by 2030.

Prosumer – a term for an individual who both consumes and produces a product. In the energy sector, "prosumers" typically use energy while also producing it (most commonly from on-site solar panels) and sell surplus power back into the electricity grid. Prosumers also participate in "demand response" programs through which they provide energy to the market by shifting their demand according to the needs of the grid.

Renewable Natural Gas – biogas or natural gas produced from waste (e.g. agricultural, forestry, landfills) that has been upgraded to a quality similar to conventional natural gas, and which can be mixed with conventional natural gas supplies for use in homes, industry and equipment without any modifications.

Smart Grid – an electricity distribution network that uses digital communications technology to detect and react to local changes in usage. The development of smart grids allows utilities to more efficiently prevent or repair problems on the grid, while enabling prosumers to play a greater role in ensuring demand and supply are in sync at the lowest overall cost.

Transition Pathway – a combination of technology, investment, business strategies, and government policy that enables Canada to transition from its current energy system to a low-carbon energy system over the next generation (roughly between now and 2040).