TRACKING THE ENERGY REVOLUTION 2018

Energy *Disrupted*

Five trends driving the global energy transition

CLEAN ENERGY CANADA

March 2018

Contents

TOP 5 TRENDS

Energy, Disrupted
Tracking the Energy Revolution 2018
March 2018 | © 2018 Clean Energy Canada
ISBN: 978-0-9950609-5-1
Cover photos: Shutterstock

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A whole new world

Every year, Clean Energy Canada takes a fresh look at the transition to clean energy, and every year it's amazing how much has changed—and how quickly.

This year is no exception. We identified five disruptive trends that are accelerating the global transition to clean energy. **Just as social media upended communications, the transition to clean energy is rapidly undoing century-old expectations around electricity, transportation, and oil**—and it's happening in market-shifting, sometimes surprising ways.

Canada should look to where the world is headed and not only keep up—we should be near the front. In key areas, our country has room to grow and innovate. At the same time, there are Canadian companies that are thriving and showing us the way forward.

The growing global market for low-carbon goods and services is now worth $5.8 trillion—with a t—and is expected to keep growing by 3% a year.[1] Companies around the world have reaped the rewards. The Clean200, a ranking of the world's biggest publicly traded companies earning significant revenue from clean energy, was launched in 2016 and updated this February; over that year-and-a-half period, Clean200 returns outperformed fossil-fuel ones by a factor of two.[2]

It pays to stay current. For example, two key trends to watch in 2018 are China's dominance over the low-carbon marketplace and the shift away from gasoline-fuelled to electric vehicles. So it's no surprise that China has shown increasing interest in hydrogen-fuelled electric buses, but here's the kicker: it's been an unparalleled boom for two Canadian companies.

Vancouver-based Ballard and Toronto-based Hydrogenics produce fuel cells that convert hydrogen into clean electricity, and nearly half of Ballard's sales now come from China. The company recently cited a record $121 million in annual revenue for 2017.

Elsewhere, however, **Canada needs to catch up with global energy trends—or risk falling behind.**

While our country saw a 68% increase in electric car sales in 2017, we're still trailing other leading nations in terms of adoption. China, France, Germany, Britain, and others have all announced they will ban the sale of gasoline- and diesel-fuelled cars. It's a strong signal to automakers and the oil sector that they need to innovate and evolve—and it's one the Canadian government has yet to send.

Such a signal might also encourage Canada's oil sector to follow in the footsteps of the world's largest oil majors, which are increasingly investing in clean energy—another one of this year's trends to watch. Yet Canadian oil companies lag their global peers. As a recent report from Wood Mackenzie put it, oil and gas companies that adopt renewables early will gain a competitive advantage. As for slow adopters: "They could find themselves at a structural disadvantage."

And lastly, Canadian businesses should look to some of the world's largest corporations for inspiration, at least when it comes to clean energy. As of January, 122 multinational companies had committed to sourcing 100% renewable electricity as RE100 members. Put another way, if those 122 companies were a country, its electricity demand would be the 24th-highest in the world. In 2017, Google, Lego, and Wells Fargo announced they had reached their 100% renewable goals, joining 25 other RE100 members. And while we can celebrate TD Bank Group's participation, it's unfortunately the only Canadian member on the list—compared to 41 companies in the U.S. and 25 in the U.K.

Those American companies aren't exceptions to the rule, either. Roughly half of America's 500 largest corporations now have renewable energy targets, and that percentage is even higher among the top 100.

What does all this boil down to for Canada? In some cases, pressure to catch up. But these energy-disrupting trends are also creating opportunities, as more and more Canadian companies know firsthand.

Clean growth is more than an ideal—it's a reality. **As the world combats climate change, growth is shifting away from century-old fuels and technologies toward clean energy solutions. We would be wise to prioritize present trends over past ones—with an eye to the future.**

Merran Smith, Executive Director,
Clean Energy Canada

1.

TREND NO. 1

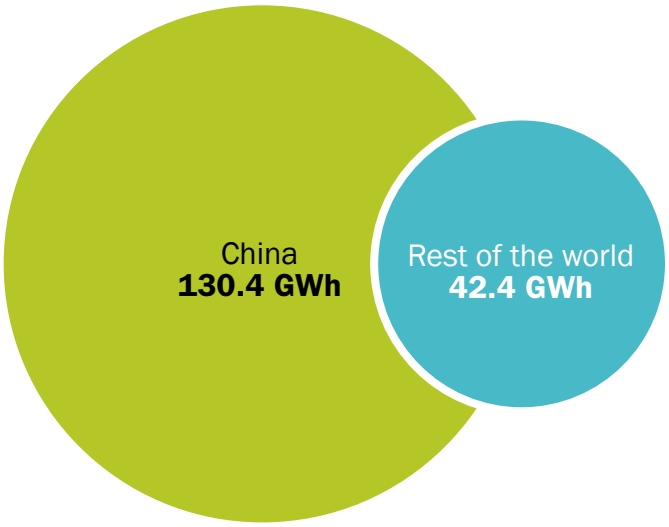
China is selling—and we're all buying

"China, unabashedly, wants to be the Detroit of electric vehicles."

—Anthony Milewski, Pala Investments

IN DECEMBER, CHINA LAUNCHED THE WORLD'S LARGEST CARBON MARKET, WHICH PUTS A PRICE ON POLLUTION (RATHER THAN LETTING COMPANIES PASS ON ENVIRONMENTAL COSTS TO THE PUBLIC).

CHINA HAS ENOUGH BATTERY PRODUCTION PLANNED TO TRIPLE THE REST OF THE WORLD'S[10]



40%

of global clean energy investment in 2017 was in China, accounting for a record **US$132.6 billion**.[11]

THAT CHINA IS A CLEAN ENERGY LEADER is hardly new information, but the world's second-largest economy is also a major market disruptor. This is especially true when it comes to renewable energy and electric vehicles, where China's efforts are colossal in scale—impacting and creating opportunities for countries across the globe.

As for China's motivation? Amy Myers Jaffe of the Council on Foreign Relations summed it up nicely: **"China is banking on clean energy technologies as major industrial exports that will compete with U.S. and Russian oil and gas and make China the renewable energy and electric vehicle superpower of a future energy world."**[3]

Driving the transition

China added more solar than fossil-fuel-based power in 2017, installing a record 53 gigawatts of sun-powered energy, a huge increase over the (already impressive) year before. Solar now represents 7.3% of the country's power-generating capacity.[4]

This push to clean up the country's grid isn't just clearing the air—it's also underpinning entire industries. **China dominates the global supply chain for solar, producing 60% of solar cells and 71% of modules in the world.** Expect this trend to continue: 70% of recently announced supply chain expansions in solar manufacturing were thanks to China.[5]

The Trump administration has certainly taken notice, announcing a 30% tariff on imported solar cells and modules this past January. While the move is intended to protect U.S. solar manufacturers, it may have a chilling effect on the domestic deployment of solar, which in recent years has thrived on increasingly affordable solar panel imports.[6]

Indeed, China has helped make solar power more affordable and more abundant—especially in developing nations like India, its largest international solar customer.[7]

Made in China

China is by many miles the biggest market for electric cars. **Roughly half of all plug-in personal cars sold globally last year were in China**, which saw a 73% increase in EV sales over 2016. The country is also the world's biggest manufacturer of EVs, as domestic cars accounted for 90% of China's sales last year.[8]

Unsurprisingly, its battery business is booming too. Contemporary Amperex Technology already leads the Chinese market for electric car batteries, but now the company is planning to go public (with backing from Goldman Sachs). It will use the money it raises to build a plant that will nearly rival Tesla's Gigafactory in size, putting the company on track to become the world's largest electric battery manufacturer, ahead of Tesla and fellow Chinese behemoth BYD (a long-time favourite of Warren Buffett).[9]

2.

TREND NO. 2

Big Oil is shifting to renewables

THE 150-MEGAWATT MASSIF DU SUD WIND FARM IN QUEBEC IS 50% OWNED BY CANADIAN PIPELINE COMPANY ENBRIDGE
PHOTO: JOAN SULLIVAN

> Societal acceptance of the energy system as we have it is just disappearing."
>
> —Ben van Beurden, CEO of Shell

THE WORLD'S SECOND-BIGGEST publicly traded oil company, **Shell**, announced last year that it will be investing $1 billion, annually, in renewable energy by 2020 (while also divesting all of its Canadian oilsands assets).[12]

But Shell is far from the only oil major with clean energy on its mind.

Statoil has made big investments in offshore wind power, drawing on its experience with offshore oil drilling; the company plans to invest roughly C$16 billion in renewables by 2030.[13] **Total**, a top player in solar and battery power, has similar ambitions, aiming for low-carbon business to account for 20% of its portfolio by 2035.[14] And **BP**, which claims to have the largest operating renewables business among its peers, has invested heavily in solar, wind, and biofuels (most recently $200 million in a solar company).[15]

None of this is surprising, according to a recent report from Wood Mackenzie,[16] which said oil and gas companies that adopt renewables early will be at a competitive advantage. As for slow adopters: "They could find themselves at a structural disadvantage if there is rapid penetration of renewables into the energy mix." The report estimates that Big Oil would need to spend $350 billion on wind and solar power by 2035 if they wanted to have the same market share in renewables that they have in oil and gas.

SPOTLIGHT ON CANADIAN COMPANIES

Among Canadian oil and gas producers, only Suncor has begun diversifying into renewable energy, developing wind power projects and an ethanol plant.[17] But in the past year, **Suncor** has gone in the opposite direction, selling off wind assets and reducing the number of projects it owns from six to four.[18]

Canadian pipeline companies have also been actively involved in renewable energy. **Enbridge** has invested nearly $8 billion in renewable energy projects, including 18 wind farms and four solar operations.[19] But **TransCanada**, once a leading renewable energy developer in the country, has recently been selling off wind, solar, and hydro assets.[20]

3.

TREND NO. 3

Companies are choosing clean energy

WHEN IT COMES TO INVESTING in clean energy, it has become something of a competition between the world's largest corporations. **As of January, 122 multinational companies had committed to sourcing 100% renewable electricity as members of the RE100.** Put another way, if those 122 companies were a country, its electricity demand would be the 24th-highest in the world. In 2017, Google, Lego, and Wells Fargo announced they had reached their 100% renewable goals, joining 25 other RE100 members.[21]

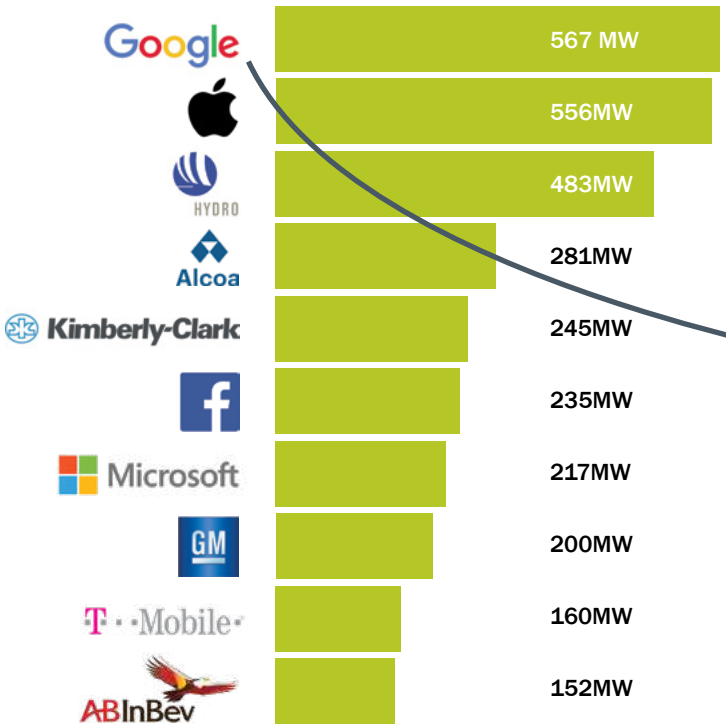
While these companies are indeed laudable standouts, renewable energy commitments have become the new norm. Roughly half of America's 500 largest corporations now have ambitious renewable energy targets. Among the top 100, it's two-thirds. Expect those numbers to keep growing, as initiatives such as the Rocky Mountain Institute's Business Renewables Centre (which helps more than 200 corporations procure clean energy) help streamline the process.[22]

TD Bank

TD Bank Group is the only Canadian RE100 member (compared to 41 companies in the U.S. and 25 in the U.K.).

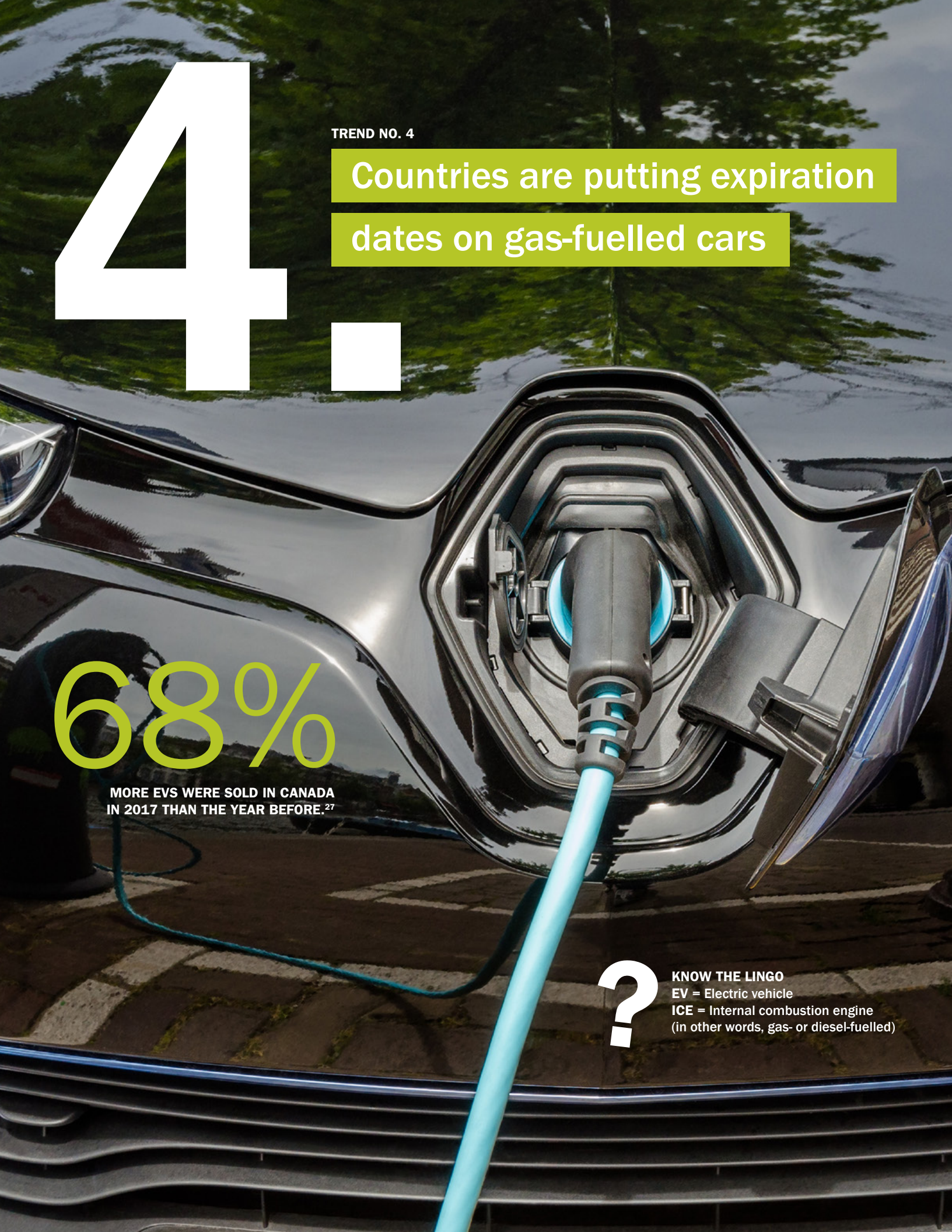
Left and right photos: **Walmart** has installed solar panels on a number of its store roofs. The company plans to run half its operations on clean energy by 2025, with the goal of eventually hitting 100%.[24] Photos: Walmart

TOP 10 COMPANIES BUYING RENEWABLE POWER IN 2017[23]



> Investing in renewable energy is a win-win-win-win—it's right for our customers, our communities, our business, and our planet."
>
> —Kara Hurst, Amazon's worldwide director of sustainability

Google, the world's biggest corporate buyer of clean energy, reached 100% renewable energy for its global operations in 2017.



4.

TREND NO. 4

Countries are putting expiration dates on gas-fuelled cars

68%

MORE EVS WERE SOLD IN CANADA IN 2017 THAN THE YEAR BEFORE.[27]

KNOW THE LINGO
EV = Electric vehicle
ICE = Internal combustion engine
(in other words, gas- or diesel-fuelled)

LAST SUMMER, *The Economist* published a eulogy for the internal combustion engine. "It had a good run," the cover story read. "But the end is in sight for the machine that changed the world."[25]

A growing number of countries agree. And in 2017, many of them announced dates beyond which they will prohibit the sale of ICE vehicles, sending shockwaves through the global automotive and oil sectors.[26]

Automakers respond

It was hard to keep track of all the electric car announcements made last year, but the folks at Bloomberg New Energy Finance did just that. **By the end of 2017, there were 156 EV models to choose from, up from just 97 at the start of 2016. By 2020, the number of available models will grow to 217.**[28]

General Motors will introduce 20 new EVs over the next six years.

As of 2019, all new **Volvo** cars will be fully electric or hybrids.

Volkswagen has pledged 20 electric models by 2020 and 300 by 2030.

Not just cars

Electrification isn't just happening for personal automobiles. It's also accelerating for delivery vehicles and semi trucks. Meanwhile, the *Ampere* in Norway, built in 2015, was the world's first electric ferry (Canadian company Corvus Energy supplied its batteries and charging stations).

And then there are buses. **China put 90,000 fully electric buses on its roads last year**, and in December the city of Shenzhen announced that all 16,359 in its fleet were now electric. For context, New York City has one-third as many buses—and they aren't electric.[30] Other cities around the world, including here in Canada, are starting to introduce electric buses too, realizing they're not only better for the environment—they're cheaper on fuel.

As for the year ahead, China has shown increasing interest in hydrogen-fuelled electric buses, which is good news for two Canadian companies. **Vancouver-based Ballard** and **Toronto-based Hydrogenics** produce fuel cells that convert hydrogen into clean electricity. Growing Chinese demand has equalled an unparalleled boom for both of them. Nearly half of Ballard's sales now come from China,[31] with the company recently citing a record $121 million in annual revenue for 2017.[32]

The eLion is an all-electric yellow school bus. It's manufactured in Quebec by Canadian company Lion Bus and has customers across the continent. Photo: Joan Sullivan

BANNING INTERNAL COMBUSTION VEHICLE SALES IN...

Norway	2025
Netherlands	2030
Scotland	2032
France	2040
Britain	2040
Germany	TBD
China	TBD

5.

TREND NO. 5

Energy is getting smarter

DID YOU KNOW that 90% of all data in the world was created in just the last two years? Civilization has never possessed so much information so quickly, and energy systems are no exception. While digital technologies have been used in energy for decades, **investment in digital electricity infrastructure and software now grows by 20% a year.**[33]

Behold, the virtual power plant

As Netflix and Wikipedia proved, a library need not exist in a physical place. It turns out that's true for power plants too. **Australia will soon be home to the world's biggest virtual power plant**, which will digitally connect solar panels and Tesla batteries installed in more than 50,000 homes.[34] The country launched a similar project last year: a marketplace for people with solar panels and batteries to sell the power they generate to the grid. The goal? A virtual power plant able to store excess energy across thousands of homes and businesses for when it's most needed—ensuring power is available even when the sun isn't shining.[35]

Left and right photos: **Australia will soon be home to the world's biggest virtual power plant.**

THE TECHNOLOGY BEHIND BITCOIN

Not unlike how Airbnb threatened traditional hotels, another kind of technology could soon compete with centralized gas and charging stations. Last summer, eMotorWerks launched a peer-to-peer charging marketplace in California, letting electric car drivers pay each other to use their home chargers. Blockchain, the key technology behind Bitcoin, is used to verify each transaction—no central regulator required.[36]

Indeed, blockchain has a healthy, growing relationship with clean energy. SolarCoin, a digital currency like Bitcoin, also uses the technology—only rather than being mined by computers working out computations, a **SolarCoin** is mined every time you produce a single megawatt of solar energy. Nearly five million SolarCoins have been granted so far.[37]

> "The uptake of rooftop solar is one of the highest in the world per capita in Australia—around 1.6 million rooftops are fitted with solar—and it's being rapidly followed by battery storage."
>
> —Phil Blythe, CEO of GreenSync

Canada's story

Disruption. The word excites some and raises red flags for others. Disruption brings both opportunities and challenges for industries and workers, but Canada can—and should—position itself strategically as the transition to clean energy continues.

Canadians across the country already know there's opportunity because so many are benefitting from it. From cleantech gigs in the city, to electric car manufacturing in the suburbs, to mining the metals used in solar panels in Canada's north—the jobs of the clean energy transition are wide-reaching and diverse.

As we combat climate change, and feel its effects, the transition to clean energy is only going to grow more urgent. In other words, these market-shifting trends are just getting started. We're at the beginning of a transitional century, one destined for the history books.

The question is, what will Canada's story be? It's time to decide.

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