



Tracking the Energy Revolution - Global

The Top 10 Trends Propelling the Global
Clean Energy Transition

 CLEAN ENERGY CANADA

Clean Energy Canada | Tracking the Global Energy Revolution 2015

TABLE OF CONTENTS:

Tracking the Energy Revolution - Global 2015

Pg 4	#1 - A New Hope: Renewables Stall Out Carbon Pollution
Pg 7	#2 - As Solar Prices Drop, Affordability Rises
Pg 9	#3 - Tesla's Gigafactory Poised to Unleash Battery Revolution
Pg 11	#4 - 100 Percent Renewable Energy Goes Mainstream
Pg 14	#5 - Climate Diplomacy Rising: Superpowers Move From Finger-Pointing to Handshaking
Pg 16	#6 - Wind Spreads Like Wildfire
Pg 18	#7 - Developing World Plugging In to Renewable Power
Pg 21	#8 - Carbon Pricing is Fast Becoming the New Normal
Pg 23	#9 - Global Clean Energy Economy Surging
Pg 25	#10 - Divestment Movement Gains New Allies
Pg 27	Policy Recommendations for The Global Energy Revolution



Tracking the Energy Revolution – Global 2015
July 2015
© 2015 Clean Energy Canada

All rights reserved. Permission is granted to reproduce all or part of this publication for non-commercial purposes, so long as the source is cited as "Clean Energy Canada."

Clean Energy Canada (cleanenergycanada.org) is a climate and energy think tank housed at the Centre for Dialogue at Simon Fraser University. We work to accelerate our nation's transition to a clean and renewable energy system. Follow us on Twitter via [@cleanenergycan](https://twitter.com/cleanenergycan).

Each Monday we publish the Clean Energy Review, a free weekly digest of climate and clean energy updates from across Canada and around the world. Subscribe at cleanenergycanada.org/review.

Available digitally at trackingtherevolution.ca

Tracking the Energy Revolution - Global

The Top 10 Trends Propelling the Global Clean Energy Transition

Executive Summary and Recommendations:

Each year, Clean Energy Canada produces Tracking the Energy Revolution, a pair of annual assessments detailing the current shift to clean energy, both within our borders and around the world. This edition identifies 10 policy, technology, and business trends and milestones that both defined and propelled this global shift in 2014. Along the way, we also flag alternate perspectives, challenges and developments that stand to temper each of these trends. Note: Trends appear here in no particular order.

1. A New Hope: Renewables Stall Out Carbon Pollution
2. As Solar Prices Drop, Affordability Rises
3. Tesla's Gigafactory Poised to Unleash Battery Revolution
4. 100 Percent Renewable Energy Goes Mainstream
5. Climate Diplomacy Rising: Superpowers Move From Finger-Pointing to Handshaking
6. Wind Spreads Like Wildfire
7. Developing World Plugging In to Renewable Power
8. Carbon Pricing is Fast Becoming the New Normal
9. Global Clean Energy Economy Surging
10. Divestment Movement Gains New Allies

We've pulled together data from many sources and sectors to show that the energy transition is no longer just the domain of dreamers and early adopters. Instead, policy tools like carbon pricing (see Number 8), are quickly becoming "the new normal."

You are looking at the global edition. The companion to this report, *Tracking the Energy Revolution — Canada*, is the only comprehensive assessment of our nation's clean energy performance. We will release it in September.

We produce these assessments to inform governments and to inspire policy leadership in the global climate and clean-energy landscape, so that Canada can benefit from the opportunities these changes present. Each assessment includes policy recommendations.

Credits:

Clean Energy Canada is a climate and energy think tank housed at the Centre for Dialogue at Simon Fraser University. We work to accelerate our nation's transition to a clean and renewable energy system.

Executive Director, Clean Energy Canada: Merran Smith

Policy Director, Clean Energy Canada: Dan Woynillowicz

Communications Director and Editorial Director, Clean Energy Canada: James Glave

Senior Policy Advisor, Clean Energy Canada: Sarah Petrevan

Senior Analyst and Lead Researcher, Clean Energy Canada: Jeremy Moorhouse

Communications Manager and Researcher, Clean Energy Canada: Shanna Killen

Interactive design by Signals Design Group

Executive Summary:

We kicked off last year's inaugural edition of this report with the observation that clean energy had made the leap from "boutique" to "big." That trend continued in 2014, as the global energy revolution went into high gear. The most remarkable piece of evidence: The International Energy Agency (IEA) found that global growth in greenhouse gas emissions stalled in 2014, even as the economy continued to grow. The agency attributed this to the ramp-up of renewable energy and the payoff of efficiency policies.

Investors moved USD\$295 billion into renewable energy-generation projects—an increase of 17 percent over 2013. Further, declining technology costs are giving us more bang for our buck; with declining technology costs each invested dollar now yields more turbines and panels on the ground, and more megawatts, than it did just a few years ago. Meanwhile, the broader clean-energy market, including buildings, vehicles, and more, grew to USD\$788 billion—even as the price for oil began its freefall.

The oil price crash may have dominated the headlines as of late 2014, but since oil is primarily a transportation fuel, it didn't slow the steady rise of renewable electricity. Enough such electricity now moves through power grids to power roughly half of all homes on Earth.

Hydro, solar, and wind have long driven the energy revolution, but wind took a back seat in 2013. That's no longer the case: Thanks to renewed policy certainty in the United States, in 2014 wind again roared back to full strength.

We also noted the start of construction on the Tesla Motors Gigafactory, which some analysts expect will slash the cost of home, vehicle, and utility batteries, disrupting at least three established business models and reducing fossil-fuel dependence in each case.

The global political landscape is undergoing a tone shift; clean energy is moving out of the "nice to have in the mix" bucket and into the critical column. The United States, Canada's largest trading partner and the welcome recipient of a great deal of Canadian clean hydroelectricity, signed cooperative climate agreements with China, Mexico, and India—where Prime Minister Modi set the aggressive goal of bringing electricity to every household in the country, powered in part by a huge scale-up in solar, wind, and hydro.

More nations moved to price carbon, and the divestment movement crossed a symbolic threshold when investors moved \$50 billion in capital out of fossil stocks while picking up some powerful new allies in houses of worship around the world.

As we count down to the UN Paris Climate talks, we hope this assessment proves useful to clean energy observers, enterprising business leaders with an eye abroad, and to federal and provincial political leaders looking to capitalize on the global clean-energy opportunity.

One final note:

Nobody said this was going to be easy. Many challenges lie ahead, and the scale of change that is taking place has opponents and setbacks. We outline some of these alongside with each milestone and trend we highlight.



1: A New Hope: Renewables Stall Out Carbon Pollution

Renewable energy investment surges ahead while carbon emissions plateau

Massive global investments in efficiency plus solar, wind, hydro, and other clean technologies appear to have stalled the global growth of carbon pollution.

Story Highlights:

- Carbon emissions leveled off in 2014—and we can credit the growth of renewable energy and energy efficiency.
- Utilities boosted the world’s renewable electricity capacity by eight percent in 2014.
- In total, investors poured twice as much money into new renewable-electricity projects than into new fossil fuel projects.

Over view:

Climate disruption isn’t the only reason that leading economies and companies have been steadily ramping up the amount of renewable power feeding into their electricity systems.

But it is the big one.

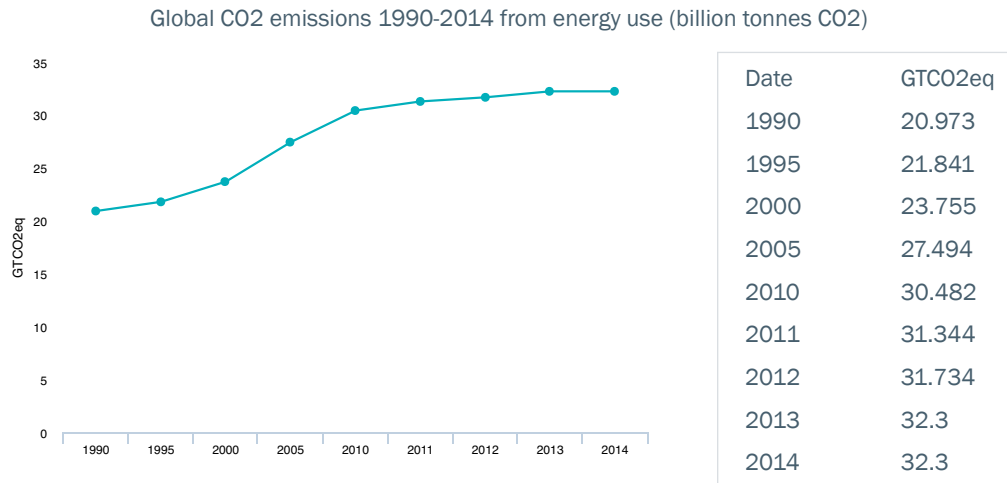
This past year, their efforts appear to be paying off. Massive global investments in solar, wind, hydro, and other clean power-generation technologies—combined with sustained efficiency efforts—appear to have stalled the global growth of carbon pollution.

Renewable energy and energy efficiency effort prevented carbon emissions from rising in 2014.

According to the International Energy Agency (IEA), global greenhouse-gas emissions leveled off in 2014—even though the economy continued to grow. It was the first time in 40 years that greenhouse-gas emissions stopped increasing without help from an economic downturn.

Global emissions of carbon dioxide stood at 32.3 billion tonnes in 2014 (source: International Energy Agency)—unchanged

from the previous year. Make no mistake, that's still a huge bill that we're passing on to future generations, and the agency expects emissions will continue rising again next year. But efforts to mitigate the damage may be making more of a dent than previously believed.



The IEA attributes the halt in emissions growth to the steady growth of renewable energy and energy efficiency policies. Around the world, utilities added 123 gigawatts (GW) of renewable electricity to their grids in 2014—increasing the world's renewable energy capacity by eight percent. Wind and solar were neck and neck, with utilities and companies bringing online almost 50 GW of each.

In total, investors poured twice as much money into new renewable-electricity projects than into new fossil fuel projects¹. This estimate excludes investment in replacement capacity for fossil fuel and renewable energy facilities.

Last year financiers moved USD\$295 billion into renewable electricity—a 13 percent bump from 2013. While impressive, that's still USD\$153 billion below the investment needed to prevent dangerous climate disruption, according to the United Nations Environment Program.

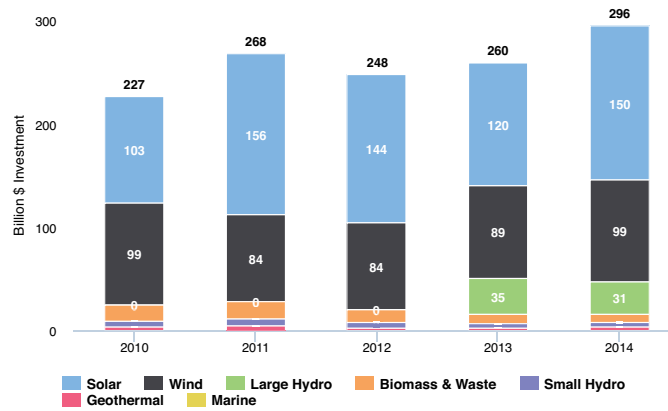
Thanks to these investments—and those made previously—there are now 6,500 TWhr worth of clean electrons moving through the world's power grids. That's enough to power roughly half of all homes on Earth². Put another way, the world's current total supply of renewable electricity could have powered nearly everything on the planet in 1980³.

¹ See Methodology Document

² See Methodology Document

³ See Methodology Document for Calculation

Renewable Energy Investment



*Note: Above chart excludes large hydro, which in 2013 amounted to USD\$35 billion and in 2014 amounted to USD \$31 billion.

Investment in Billions					
	2010	2011	2012	2013	2014
Solar	103	156	144	120	150
Wind	98	84	84	89	99
Large Hydro (>50 MW)	N/A	N/A	N/A	35	31
Biomass & Waste	16	17	12	9	8
Small Hydro (<=50 MW)	6	7	6	5	5
Geothermal	3	4	2	2	3
Marine	0	0	0	0	0

As we went live with this report, the agency had yet to release the fine print on its own analysis. Still, those looking for signs of hope have just found one.

The world's renewable energy supply today could have powered nearly everything on the planet in 1980.

Food for Thought:

The assessment above focuses on electricity—but electricity isn't the only kind of energy. In 2013, fossil fuels comprised 87 percent of the world's primary energy consumption, and low-carbon sources—including nuclear, hydropower, wind, solar, and biomass—made up just 13 percent. That ratio hasn't changed since 1999, which means our energy supply hasn't actually become any cleaner. We haven't yet hit the inflection point where the fraction of energy sourced from low-carbon sources expands and the proportion of energy sourced from fossil fuels shrinks.

Trend 1 Citations:

- "Global Energy-related Emissions of Carbon Dioxide Stalled in 2014." IEA. March 13, 2015.
- "Global Trends in Sustainable Energy Investment 2009." United Nations Environment Programme. 2009.
- Shah, Vishal, and Jerimah Booream-Phelps. "Crossing the Chasm." Deutsche Bank. February 27, 2015.
- Plumer, Brad. "Clean Energy Is Growing Fast - but It's Not Yet Winning the Race against Fossil Fuels." Vox. April 15, 2015.



2: As Solar Prices Drop, Affordability Rises

Solar and wind prices are nipping at the heads of fossils and nuclear power

The average cost of solar and both onshore and offshore wind will compete directly with fossil fuels in most markets by 2025.

Story Highlights:

- In 30 countries, electricity from residential solar panels are now cheaper than wholesale grid electricity.
- International Renewable Energy Agency figures suggest that new solar and onshore and offshore wind will compete directly with fossil fuels in most markets by 2025.
- The costs of bringing new wind and solar plants online continues to decline around the world.

Overview:

For years, critics of renewable energy have insisted that renewable power, while nice to have in the mix, is just too expensive to deploy at scale. That might have been true at one point, but it's no longer the case.

The International Renewable Energy Agency forecasts that onshore wind, offshore wind, and solar will compete directly with fossil fuels in most markets by 2025.

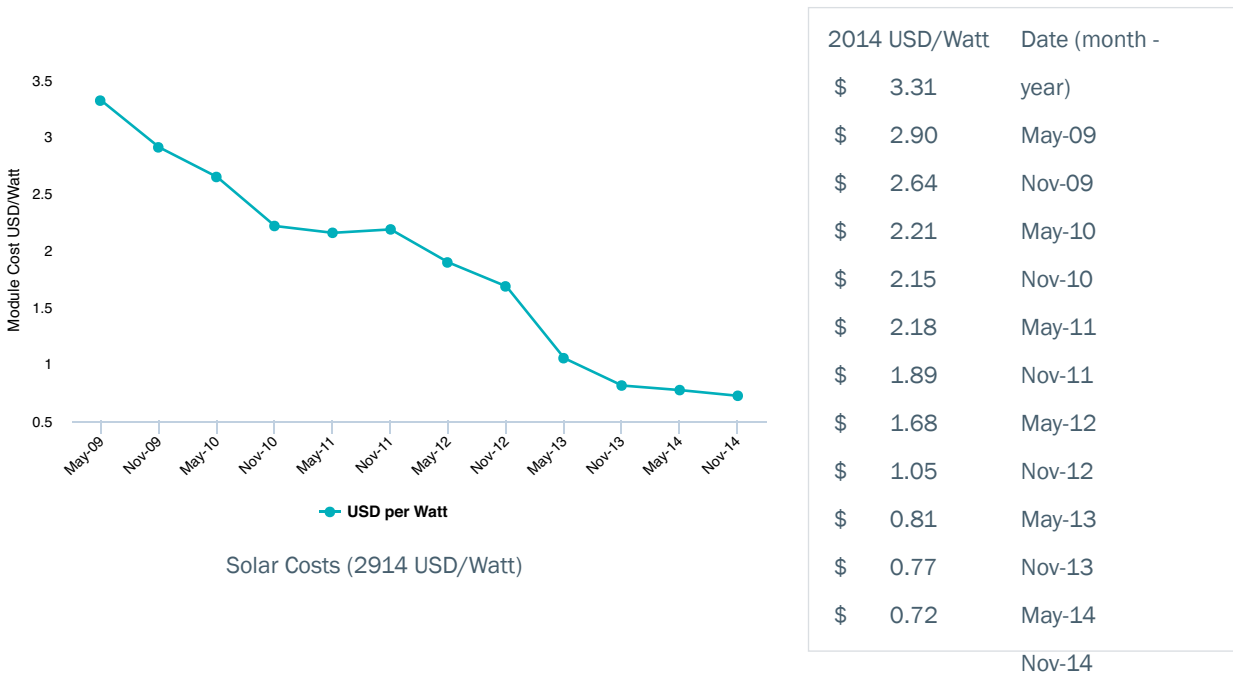
Solar has been getting cheaper every year, a trend that's expected to continue—albeit less precipitously. Over the past five years, solar-module costs have dropped by 73 percent. That's a slightly leaner decline than last year, as the price in 2014 began to settle after several years of dropping like a stone.

Taken together, China and Germany have bolted on more than a third of the world's total solar capacity.

Still, cheaper solar means more affordable clean electricity for your buck. In 30 countries, rooftop solar electricity is now cheaper than residential electricity from the grid⁴. The International Renewable Energy Agency (IRENA) again this year did the math on renewable- energy employment, and concluded that 2.5 million people work in solar PV jobs worldwide. It's an encouraging cycle: A price drop drives investment, which leads to projects, which creates employment.

⁴ See methodology document for calculation

Dropping Solar Costs in 2014
Adapted from IRENA - Renewable Power Generation Costs in 2014



About 2.5 million people work in solar PV jobs worldwide.

You don't need a crystal ball to know where this is going. Solar is quickly becoming cheaper than fossil fuels in all jurisdictions. IRENA expects that, by 2025, on a global basis average costs of solar (along with onshore and offshore wind) will compete directly with fossil fuels⁵.

In 30 countries, solar panels, in combination with batteries, are cheaper than wholesale electricity from the grid.

Food for Thought:

Solar may be clean from a greenhouse-gas perspective, but like every energy generation technology, the sector has other challenges that will need to be addressed as it scales. Though the industry is exhibiting leadership with respect to panel recycling and disposal, PV panel components do include several "conflict minerals" from countries with poor health and safety regulations. Panel production also generates toxic byproducts. That said, there's simply no such thing as a clean, reliable, cost-effective—and 100-percent pollution-free—electricity source. And solar is no exception.

Trend 2 Citations:

- "Renewable Power Generation Costs in 2014." IRENA. 2015.
- Shah, Vishal, and Jerimah Boorem-Phelps. "Crossing the Chasm." Deutsche Bank. February 27, 2015.
- Yakabuski, Konrad. "The Darker Side of Solar Power." The Globe and Mail. May 27, 2015.
- "SolarScorecard.com | 2014." SolarScorecard.com | 2014. 2014.
- Smith, Merran. "Solar Power Isn't Perfect, But It's the Best We've Got." The Huffington Post. March 31, 2015.

⁵ Without subsidies, without accounting for greenhouse gases or public health costs, but also not including the additional costs of addressing the variable output of renewable energy.



3: Tesla's Gigafactory Poised to Unleash Battery Revolution

New generation of cheaper, smaller, better batteries could prove a transportation game changer.

Electric vehicle battery prices have plunged in the past five years, and a looming supply surge could drop them an additional 30 percent.

Story Highlights:

- Tesla Motors plans to have its Gigafactory running in 2017, supplying 35 gigawatt-hours of batteries for an estimated half-million vehicles that Tesla expects to be building annually as of 2020.
- Once operational, the plant will double the global quantity of lithium batteries that were available as of 2013. Tesla expects its gigafactory batteries will be 30 percent cheaper than average prices today and hit USD\$210/kwh.
- Accessible batteries will mean more than just cheaper electric vehicles; batteries also make it easier for countries, companies, and individual homeowners to build more wind and solar.

Overview:

Last year, Tesla Motors began pouring the foundations of a manufacturing plant designed to drive down the price of lithium batteries and, by extension, its cars. As of early May 2015, Tesla had logged USD\$800 million worth of pre-order revenue for its Powerwall home storage system and utility-scale Powerpacks, two products the plant will build.

When up and running in 2017, the five million square foot Gigafactory will allow Tesla Motors to double production of vehicle, home, and utility lithium batteries above today's levels. The company designed the plant to short-circuit an ungainly supply chain. Steel, aluminum, copper and other raw materials will come in one door, and finished power packs will roll out the other.

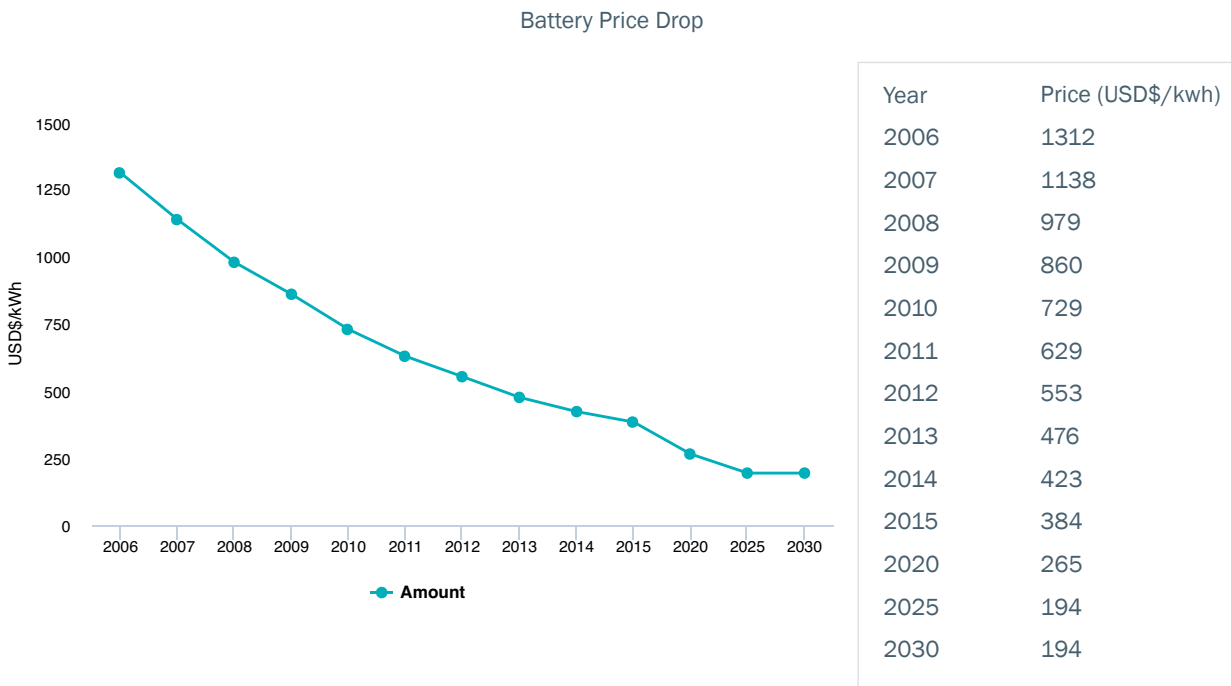
This will allow Tesla to open the floodgates on a half million vehicles per year—its production goal for the end of this decade.

Once open, the Gigafactory will double the supply of global lithium battery supply (compared with global volume available in 2013). Some analysts expect battery prices will drop by 30 percent and hit \$210/kwh

⁶ Adapted from Nykvist, B., & Nilsson, M. (2015). Rapidly falling costs of battery packs for electric vehicles. *Nature Climate Change*, 5(April), 100–103. doi:10.1038/nclimate2564

While electric vehicle battery prices have dropped 40 percent in the past five years, the looming surge in supply from the Gigafactory is prompting speculation that prices will drop by another 30 percent and hit USD\$210 /kwh⁶. That's well ahead of what analysts have previously predicted. Further, in an effort to encourage competition, in 2014 Tesla released all the patents for its technologies.

If the speculators are correct, Tesla won't just be a poster child for an electric car that only the so-called one percent can afford. It will truly be "the people's car."



Accessible batteries mean more than cheap electric vehicles. Batteries are also a key—though by no means the only—ingredient in the global energy revolution. By making it possible to store energy and draw on it when the wind isn't blowing or the sun isn't shining, they make it easier to build more wind and solar.

The Gigafactory won't even open until 2017, but it could well go down in history as a key site where the global shift away from fossil fuels began in earnest.

Food for Thought:

While lithium-ion battery prices are dropping, few are choosing storage at home or on the grid. According to Deutsche Bank, residential solar with battery backup is cheaper than the grid in only six countries globally, a much lower number than the 30 where solar alone makes sense. Deutsche Bank expects that number to creep up as battery prices fall. On the utility side, lithium-ion batteries are a commercial technology and are used for energy storage and to help electricity grids run smoothly. Unfortunately, they provide a paltry 0.1% of grid connected energy storage⁷. Hydro dams provide most of the world's 145 GW of storage⁸. Battery prices will have to drop significantly before energy storage becomes standard practice.

Trend 3 Citations:

- Randall, Tom. "Tesla's Battery Grabbed \$800 Million in Its First Week." Bloomberg.com. May 8, 2015.
- Shah, Vishal, and Jerimah Booream-Phelps. "Crossing the Chasm." Deutsche Bank. February 27, 2015.

⁷ Bloomberg New Energy Finance (2015) Energy Storage Market Lithium Ion Batteries.

⁸ International Energy Agency Energy Perspectives (2014) Total Storage Capacity.



4. 100 Percent Renewable Energy Goes Mainstream

Businesses, cities, and whole countries are committing to a future beyond fossil fuels

One sentence summary: A growing body of technical research is giving familiar brands, leading-edge cities, and whole nations the confidence they need to aim high.

Story Highlights:

- 45 countries and 60 Fortune 100 firms have adopted 100 percent renewable electricity targets.
- More than 45 cities around the world have a 100 percent renewable electricity goal, including Vancouver, Sydney, Copenhagen and San Francisco.
- Stanford University professor Mark Jacobson has developed 100 percent renewable energy plans for every U.S. state. Each plan shows how renewable energy alone could power everything.

Overview:

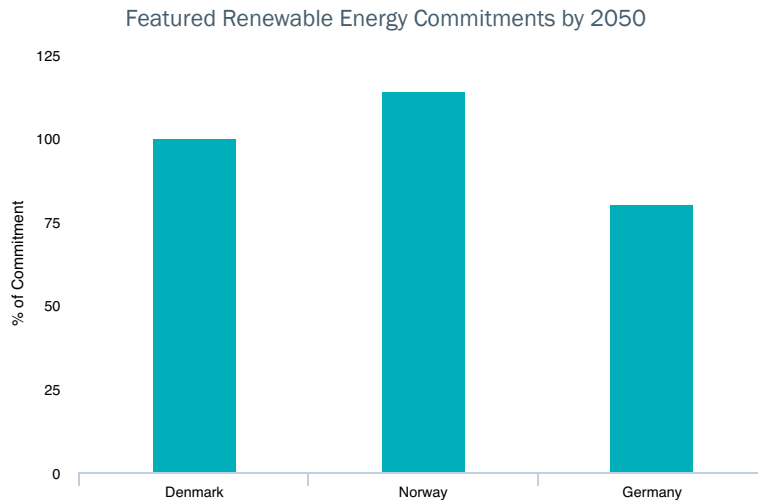
Close your eyes and picture a city, or a whole country, powered by clean and renewable energy. Until recently, you might as well have wished upon a star.

No longer. A growing crowd of cities, companies, and nations—such as Denmark—plan to meet their heating, cooling, transportation, and electricity needs entirely from wind, sun, water, and other clean sources.

The movement's North American father is Stanford University professor Mark Jacobson. His landmark 2009 study showed that the world can theoretically power itself without fossil fuels or nuclear power plants by 2050. In 2012, the research formed the basis of a spin-off organization, The Solutions Project, which has produced energy-transition profiles for every U.S. state, and enjoys star-power support. (Hello, Mark Ruffalo!)

If California were to commit to 100 percent renewable energy, and the initiative would pay for itself in only three years via air and climate pollution cost savings.

Other forecasts and modeling exercises by Germany and Japan demonstrate that a 100 percent renewable goal is well within reach. They've given confidence to a growing network of 45 cities—including San Francisco, Copenhagen, Sydney, and as of 2015, Vancouver—now working towards 100 percent targets.



A series of recent studies suggest 100 percent renewable energy is not only technically achievable, but also cost-effective.

At the national level, beyond Denmark, Norway has set its sights on producing enough renewable electricity for itself and its neighbours with a 114 percent renewable electricity target by 2050. Norway’s target is greater than 100% because it plans to produce more renewable energy than it needs, exporting surplus to other European countries. Germany is on track for an 80 percent clean grid by 2050.

The private sector is also on board. As we reported last year, IKEA, Google, Apple, and Unilever have all set global targets to run their businesses on 100 percent renewable energy.

These early leaders are opening the space for others to follow, and legitimizing the idea that 100 percent renewables is the benchmark to reach for.

Food for Thought:

If our goal is limiting the threat of truly dangerous climate disruption, and soon, then 100 percent renewable energy might not actually be the most cost-effective strategy. In fact, some argue that such a “pure” approach could divert resources away from other technologies, and make those targets harder to hit. For example, The Breakthrough Institute advocates for nuclear power; others such as Simon Fraser University energy economist Mark Jaccard argue carbon capture and storage will be a necessary and inevitable part of the mix. The 450 Scenario in the International Energy Agency’s World Energy Outlook—a technical roadmap to keeping carbon concentrations below perilous levels—envision a significant role for both nuclear and carbon capture in cost-effectively achieving deep reductions. That said, the WEO has consistently underpredicted growth in renewables.

Trend 4 Citations:

- “50 States, 50 Plans.” The Solutions Project. March 18, 2015.
- “Energy Target in 2050.” Umwelt Bundesamt. July 2010. <http://bit.ly/1e5FtoK>.
- “Energy Rich Japan.” Energy Rich Japan. October 1, 2003.
- “Renewable Energy.” SF Environment.
- “Projects in Europe.” Go 100% Renewable Energy : Europe. 2015.
- “Decentralised Energy Master Plan.” City of Sydney. December 2013.
- “Support 100% Renewable Energy in Vancouver.” City of Vancouver. March, 2015.

- "Energy Strategy 2050." IEA. May 12, 2014.
- "National Renewable Energy Action Plan (NREAP)." IEA. October 30, 2013.
- "Renewable Energy Country Profiles European Union." IRENA. June 1, 2013.
- "Green Power Partnership." EPA. April 27, 2015.
- "450 Scenario: Method and Policy Framework." World Energy Outlook. 2014.
- De Vox, Rolf, and David De Jager. "World Energy Outlook Hides the Real Potential of Renewables." EnergyPosteu. March 14, 2014.



5. Climate Diplomacy Rising: Superpowers Move From Finger-Pointing to Handshaking

The world's two biggest polluters move to cut carbon and dial back fossil fuel reliance

Blame China? Not anymore. President Obama last year brokered a historic diplomatic agreement between the two biggest climate polluters.

Story Highlights:

- The world's two largest climate polluters have agreed to cooperate and work towards separate targets.
- China intends to peak greenhouse gas emissions around 2030 and will work to increase the share of non-fossil fuels (including nuclear) in its total energy mix to around 20 percent by 2030.
- The United States set a new stronger target to reduce emissions across its economy.

Overview:

Not long ago, China and the United States—the world's two largest carbon polluters—spent much of their time scapegoating one another for the climate crisis, both behind closed doors and in the court of public opinion.

That posturing effectively ended in November 2014 with the signing of the U.S.-China Joint Announcement on Climate Change. If the parties make good on their commitments, the United States will slash its carbon emissions below 2005 levels, while China will halt growth of greenhouse gas pollution and double the proportion of renewable and nuclear electricity on its grids.

When China reaches its goal, it will produce an additional
5,290 (TWhr)
worth of renewable and nonrenewable nuclear energy

That's enough to power everything in Canada twice over⁹. Each year after 2020, the U.S. will need to cut emissions twice as fast as they are doing now to hit their target.

⁹ See *Methodology Document*

On both counts, that's good news for Canada. We already send enough electricity south each year to light up the equivalent of 4.3 million Canadian homes¹⁰. This agreement, plus President Obama's Clean Power Plan—plus more than 30 transmission links between Canadian and American power grids—adds up to a recipe for Canada to profitably export surplus renewable electricity.

Of course, we won't be shipping electrons to China, but the nation's new commitment is good news for our 434 purveyors of clean-energy innovations, services, and expertise¹¹.

Despite the fact that Canada's federal government remains largely indifferent to the global shift away from fossil-fuel power generation, our utilities and private-sector players are well positioned to jump into the pool.

China intends to peak its greenhouse gas emissions by around 2030 and intends to boost the share of non-fossil fuels in primary energy consumption to around 20 percent by 2030.

Food for Thought:

Dig into the details, and President Obama's Clean Power Plan isn't actually as ambitious as it first appears. The Environmental Protection Agency (EPA) plan projects that by 2030, coal will still provide 30 percent of America's power. According to one recent analysis, the states with the deepest coal reliance have some of the weakest targets for reducing their emissions. That said, the EPA acknowledges it is likely overestimating continued coal use, and underestimating growth in renewables.

Trend 5 Citations:

- "U.S.-China Joint Announcement on Climate Change." The White House - Office of the Press Secretary. November 11, 2014.
- Grunwald, Michael. "5 Reasons Obama's Transformative Power Plan Won't Transform Anything." Politico - The Agenda: The Future of Power. May 1, 2015.

¹⁰ See *Methodology Document*

¹¹ *Analytica Advisors, 2015 Canadian Clean Technology Industry Report*



6: Wind Spreads Like Wildfire

Developers and utilities are cashing in investment in wind power

One sentence summary: Following a down year marked by policy uncertainty, wind surged back to stronger levels of investment in 2014.

Story Highlights:

- Last year, the world also broke the 2012 record for new wind installations by bringing nearly 50 GW of new wind capacity online; that's three wind turbines each hour.
- Governments and developers built 50 percent more wind capacity in 2014 than 2013—the most turbines ever built in a single year.
- There's now enough wind energy produced globally to power the Canadian economy nearly twice over.

Overview:

In energy circles, solar panels often get the lion's share of attention—but last year wind really stole the show. Propelled by USD\$100 billion in investment, and a stronger policy environment in the United States (the culprit behind a sluggish 2013) developers and utilities installed the most turbines ever in a single year¹². This marked a 50 percent increase in additional capacity over 2013. Last year, a new wind turbine began rotating somewhere on the planet every 20 minutes. By the time you finish this report, another will have entered service.

Humans are now harvesting enough wind to meet the electricity needs of roughly 300 million homes¹³. That's something to celebrate, and a fact to refute anyone who claims that renewable energy doesn't have what it takes to power the world.

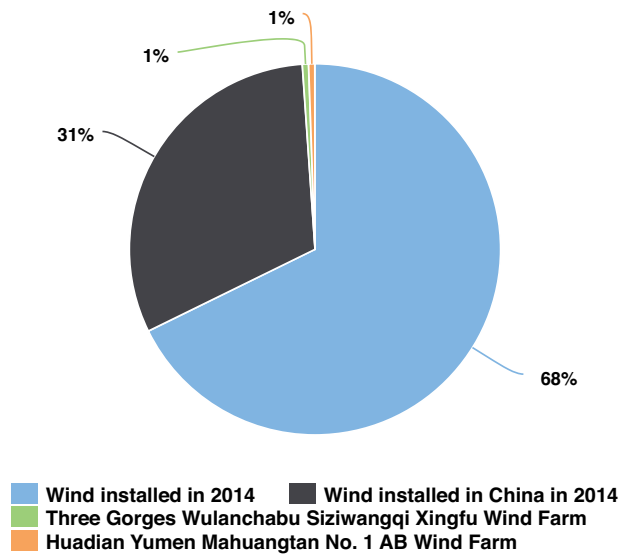
Breezes now generate enough electricity on a global basis to power Canada's economy twice over.

Of course, any story about wind's rebound is also a story about China. That nation now has 100 GW worth of turbines within its borders. China now houses one third of the world's installed wind capacity.

¹² Bloomberg New Energy Finance (2015) Market Database. See methodology document for more information

¹³ See methodology document

China Drives Most Wind Installed in 2014



Chinese utilities inaugurated two of the three largest wind farms brought online last year. Over a year, those stations will produce enough electricity to light up the equivalent of 1.7 million Chinese homes¹⁴. A project off the coast of England rounded out the top three largest new projects.

Last year the world broke the 2012 record for new wind installations by bringing nearly 50 GW of new wind capacity online. That's nearly three wind turbines each hour.

Food for Thought:

China has added great deal of new wind capacity—but still struggles to plug all of those shiny new white towers and blades into its electricity system. A recent analysis found that a typical Chinese wind project is completed within one year, but the supporting grid connections to get those electrons flowing take twice that long.

Trend 6 Citations:

- Yang, Jianxiang. "China Wind Power 2014: Curtailment Issues 'hopefully Resolved' by End 2015." October 22, 2014.
- Yuanyuan, Liu. "China Curtails Less Wind Energy in 2014." Renewable Energy World. November 20, 2014.

¹⁴ See methodology document



7. Developing World Plugging In to Renewable Power

The path to prosperity is lined with solar panels

Last year alone, India built USD\$7.6 billion worth of renewable energy (up 14 percent from the previous year) in its quest to install 175 GW of clean generation by 2022.

Story Highlights:

- Investments by developing countries in renewables were almost equal to investments by advanced economies—USD\$131 billion to USD\$138 billion. These investments were up 36 percent from last year, according to Bloomberg New Energy Finance.
- In 2014, India committed to deliver electricity to every citizen in India, and said it will install 175 GW of renewable energy by 2022 to make it happen.
- Thanks in part to India's commitment and renewable energy price drops, India should join the top five builders of renewable energy in 2015. Ernst and Young have already bumped India into the top five in its Renewable Energy Attractiveness Index.

Overview:

Fossil-energy companies have long argued that only “affordable” coal will lift developing nations out of poverty. But last years numbers pointed to a much brighter future.

Leaders in these countries have seen the writing on the wall. They've concluded renewable energy is the smarter, cleaner path forward, and are putting policy in place to make it happen.

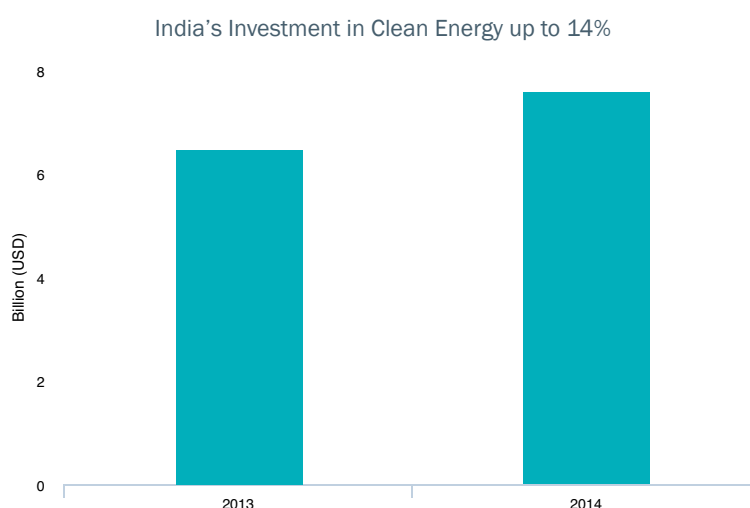
Investments in clean-energy projects in developing nations—in regions such as Africa, South America, and the Caribbean—climbed an impressive 36 percent from 2013. Last year, developing nations together invested almost as much in new clean-power generation (USD\$131 billion) as did the rest of the world (USD\$138 billion).

There's a simple explanation: Leaders in these countries have seen the writing on the wall. They've concluded renewable

energy is the smarter, cleaner path forward, and are putting policy in place to make it happen. Last year, Climatescope, a Bloomberg New Energy Finance research initiative, reviewed 55 developing economies and found 359 policies helping to support clean-energy investment

In 2014, India committed to 175 GW of renewable energy by 2022 to provide electricity to every citizen in India.

For a good example, look to the Indian subcontinent. Coal remains India's largest source of energy, but last year Prime Minister Modi committed to install 175 GW of renewable energy by 2022, to provide electricity to every citizen. India installed USD\$7.6 billion¹⁵ worth of clean-energy generation equipment in 2014, up 14 percent from the previous year.



A recent study by The Institute for Energy Economics and Financial Analysis found that, without even counting climate impacts, solar and wind are poised to surpass coal as India's cheapest electricity option. That's because India relies heavily on expensive imported coal, while the costs of coal's clean competitors continue to drop.

Bloomberg New Energy Finance expects India will join the top five builders of renewable energy in 2015, and Ernst and Young has bumped the nation into a top-five spot in its annual Renewable Energy Attractiveness Index.

The government expects renewable energy development will generate
\$160 USD billion
in economic activity over the next five years.

In short, like many emerging economies, India is well on its way to doing what the old guard said it could never do: Provide millions of its citizens with reliable, affordable, and clean electricity.

¹⁵ Bloomberg New Energy Finance (2015) Renewable Electricity Database

A recent study by The Institute for Energy Economics and Financial Analysis found that, even without counting climate impacts, solar and wind are poised to surpass coal as India's cheapest electricity option.

Food for Thought:

Developing countries are embracing renewables in an effort to deliver power to their growing populations. But they also continue to invest significantly in fossil fuels, namely coal. A recent survey of seven separate projections of India's future energy needs and likely emissions—from government departments, the World Bank, and The Energy and Resources Institute (headed until recently by former IPCC chairman Raj Pachauri)—state that both coal-fired power and Indian greenhouse gas emissions are set to increase substantially. “By 2030, coal use is projected ... to be 2.5 to three times current levels,” the report says. Even with stringent policy action, all but one study predicts coal combustion will more than double current levels.

Trend 7 Citations:

- “Global Trends in Renewable Energy Investment 2015.” Frankfurt School-UNEP Centre/BNEF. 2015.
- “Renewable Energy Country Attractiveness Index June 2015.” EY. June, 2015.
- “Full Text of Budget 2015-16 Speech.” The Hindu. February 28, 2015.
- “Briefing Note Indian Power Prices.” IEEFA. May 6, 2014.
- “Provisional Coal Statistics 2013-2014.” Government of India Ministry of Coal. 2014.
- N. Das, Krishna. “India Says Clean Energy a \$160 Billion Opportunity over Five Years.” Reuters India. 27 Feb. 2015.
- Rose, David. “Why India Is Captured by Carbon.” The Guardian. 27 May 2015.



8: Carbon Pricing is Fast Becoming the New Normal

Another 10 national governments step up to the carbon-pricing plate

Within a couple of years, more than half of the global economy will be subject to some kind of carbon price.

Story Highlights:

- Globally, 39 national and 23 sub-national jurisdictions have implemented or plan to implement carbon pricing programs.
- Developing countries in the process of rolling out their carbon pricing policies include Brazil, Chile, Thailand, Indonesia and South Africa.
- More than 360 investors endorsed the 2014 Global Investor Statement on Climate Change, which unanimously called for a price on carbon. Their collective assets total USD\$24 trillion.

Overview:

This past year, 10 countries—Brazil, Chile, Costa Rica, Korea, Mexico, Russia, South Africa, Thailand, Turkey, Ukraine—joined the winner's circle of economies that either implemented a price on carbon pollution or committed to do so.

Carbon pricing is fast becoming the new normal. As climate disruption begins to bite hard, governments around the world are requiring polluters to start paying the now largely hidden costs of their activities. Carbon taxes and emissions trading systems help level the playing field and make clean energy more competitive with fossil fuels.

All told, 39 countries and more than 23 sub-national jurisdictions have either priced carbon or committed to do so. We are approaching a tipping point; within a couple of years, more than half of the global economy will be subject to some kind of carbon price¹⁶.

The private sector is taking notice too. More than 1,000 companies and investors spoke up about carbon pricing as a must-have policy. More than 360 investors signed the 2014 Global Investor Statement on Climate Change, which called for a price on carbon. Collectively, their assets total USD\$24 trillion.

¹⁶ See methodology document

According to Canada's Ecofiscal Commission, the world's emissions trading schemes are valued at about

\$30 billion USD

worth of renewable and nonrenewable nuclear energy

Welcome to the new normal. It is no longer a question of if governments should implement carbon pricing; instead it's which mechanism they will choose and when it will be up and running.

Food for Thought:

Though an important tool in the climate leadership box, carbon pricing is far from a silver bullet. Just ask California and British Columbia, home to a cap and trade system and a carbon tax, respectively. Those jurisdictions have pushed down emissions via a basket of policies that address energy efficiency, low-carbon fuels, and renewable electricity. And as British Columbia is now learning, those policies need continual strengthening and tightening to stay effective in the face of growing economies and populations.

Trend 8 Citations:

- "The Way Forward - A Practical Approach to Reducing Canada's Greenhouse Gas Emissions." Canada's Ecofiscal Commission. April 2015.
- Kossoy, Alexandre. State and Trends of Carbon Pricing 2014.
- "State & Trends Report Charts Global Growth of Carbon Pricing." The World Bank. March 28, 2014.
- "2014 Global Investor Statement on Climate Change." 2014 Global Investor Statement on Climate Change. September 18, 2014.



9: Global Clean Energy Economy Surging

Clean energy doesn't begin and end at the nearest power receptacle. The global products and services market is now worth CAD\$790 billion.

Countries are jostling to compete in the clean energy economy, now valued at CAD\$790 billion and expected to grow to CAD\$1.8 trillion by 2022

Story Highlights:

- The global clean energy market is now CAD\$790 billion. Under a business as usual scenario, Canadian cleantech revenues will still grow to CAD\$18 billion by 2022, but if Canada competes in its weight class, revenues could swell to CAD\$34 billion over the same period.
- Czech Republic is now beating Canada in the global market share in exporting clean energy products. Canada's market shares have fallen the most compared to the other 24 largest exporting countries, dropping five points in market shares last year.
- This drop comes with a real cost for Canada—about CAD\$8.7 billion in lost export opportunities in 2013 alone.

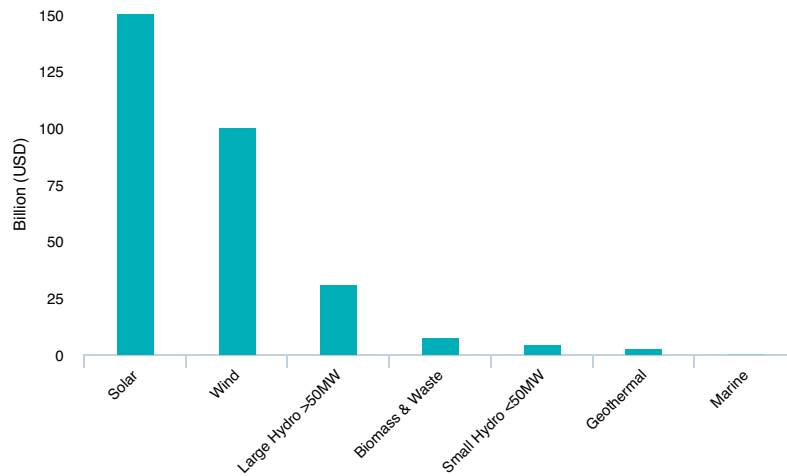
Overview:

Turbines, solar panels, hydroelectric stations, geothermal power plants, and other renewable-energy facilities are iconic indicators of a clean-economy shift—but this story isn't just about electricity. The bigger clean energy picture encompasses a wide range of products and services such as biofuels, energy efficiency software, green buildings, electric vehicles, smart grids, and other business sectors.

In 2014, around the world these sectors collectively brought in CAD\$790 billion. And it's growing steadily. The global clean-energy products market has grown a healthy nine percent over the previous year. For early-mover economies such as Germany, China, and the United States, it's proven a significant generator of wealth, employment, and public revenue. In 2013, these three leaders controlled 40 percent of the clean-technology export market, worth some CAD\$400 billion, and employed 3.6 million people¹⁷.

¹⁷ Analytica Advisors Inc., *Canadian Clean Technology Industry Report*.

2014 Investment in Renewable Electricity



And things are only looking up. According to Analytica Advisors, this global market for clean-energy products is expected to more than double to CAD\$1.8 trillion over the next seven years. That’s bigger than the 2014 posted revenues of the four largest oil companies by revenue—Sinopec Group, China National Petroleum Corporation, Royal Dutch Shell, and ExxonMobil¹⁸.

Out the 24 largest exporting countries, Canada’s market share has fallen the furthest, dropping five points last year.

Canada’s share last year came in at CAD\$7 billion, or 0.9 percent of the global market¹⁹. That’s punching below our weight—and poor performance comes with a price tag. Since 2005, Canada dropped from 14th to 19th place in exports of clean technology, of which clean energy technology is a subset. That means we’re losing out on \$8.7 billion a year in lost exports of clean technology²⁰. That’s about the same value as the exports from all of Canada’s metal mines—think copper, iron, and nickel.

If Canada continues on this path, revenues will still grow to perhaps CAD\$18 billion by 2022 according to Analytica Advisors, but if Canada competes in its weight class, revenues could swell to \$34 billion over the same period²¹.

This year, Canada’s clean tech sector employed just shy of 50,000 people—exceeding numbers from the forestry sector.

Food For Thought:

Despite our competitive advantages in niche markets, such as automotive fuel cells and building management systems—and established innovation clusters in Montreal, Toronto, Vancouver, and even Halifax—Canada’s clean-energy sector faces a tough uphill slog accessing a wider array of global markets. That’s because early movers such as Denmark, Germany, Switzerland, and The Netherlands are already well-established cleantech players. And when it comes to mass manufacturing capability, well, nobody beats China. In short, the global opportunity looms large, but we have a lot of catching up to do to reach it.

¹⁸ See methodology document for calculation.

¹⁹ Analytica Advisors Inc., Canadian Clean Technology Industry Report.

²⁰ Analytica Advisors Inc., Canadian Clean Technology Industry Report.

²¹ Analytica Advisors Inc., Canadian Clean Technology Industry Report.



10. Divestment Movement Gains New Allies

Is it time to move your money?

The global effort to marginalize fossil fuel companies began attracting mainstream players and front-page attention.

Story Highlights:

- From Stanford University to the World Council of Churches, wealthy organizations are shunning investment in dirty energy.
- Caretakers of a family fortune built on the backs of the Standard Oil empire, the Rockefellers announced divestment of \$50 billion from fossil fuels over the next five years.
- “Activists, such as the Pope, are now explicitly and effectively forcing people and institutions into a moral choice on climate.”

Overview:

In 2014, the climate-change-divestment movement passed a milestone. At last fall’s United Nations Climate Summit in New York, investors pledged to move USD\$100 billion out of fossil stocks and into clean energy.

At the United Nations Climate Summit, investors pledged to move
\$100 billion USD
out of fossil stocks and into clean energy

The Rockefeller Brothers Fund proved the most notable example. Caretakers of a family fortune built on the backs of the Standard Oil empire, the Rockefellers announced divestment of \$50 billion from fossil fuels over the next five years.

Though profs and students have done most of the divestment grunt work (earning wins at Stanford University and the University of Glasgow, among others), wealthy individuals are shunning investments in dirty energy, and religious leaders have helped set the tone. The list includes the World Council of Churches, a fellowship of more than 300 churches that

represent some 590 million people in 150 countries. Last fall, Archbishop Desmond Tutu said: “Climate change is the human-rights challenge of our time.” Even Pope Francis flagged climate as one of the “great cataclysms we witness,” setting the stage for a major mid-2015 address he will deliver to the world’s 1.2 billion Roman Catholics.

They aren’t yet panicking in the boardrooms, but as David Roberts has written, the divestment movement is proving effective on a different plane. It is gradually rebranding coal, gas, and oil holdings as morally, ethically, and socially unacceptable—just as activists did with South African wines and diamonds in the age of apartheid. “[Activists], like the Pope, are now explicitly and effectively forcing people and institutions into a moral choice on climate,” writes Roberts.

Food For Thought:

Critics of divestment argue that the tactic is actually counterproductive, because fossil fuels are so deeply embedded not only in our economy, but in the very fabric of society. Instead, companies such as NEI Ethical Funds recommend institutions hang onto their oil and gas shares and leverage them to pressure these companies to transform from within. “You can’t change a company you don’t own,” argues Bob Walker, the company’s vice president. It boils down to pressure, and where it is best applied: On the inside, or out on the streets.

Trend 10 Citations:

- “Investors Commit to Decarbonize \$100 Billion in Investments - UN Climate Summit 2014.” UN News Center. September 25, 2014.
- Goldenberg, Suzanne. “Heirs to Rockefeller Oil Fortune Divest from Fossil Fuels over Climate Change.” The Guardian. September 22, 2014.
- “Divestment Commitments.” Fossil Free. September 15, 2013.
- “World Council of Churches Endorses Fossil Fuel Divestment.” 350.org. July 10, 2014.
- Roberts, David. “College Students Are Making Global Warming a Moral Issue. Here’s Why That Scares People.” Vox. April 29, 2015.
- Bickis, Ian. “Carbon Divestment Fails to Catch on in Canada.” Metro News. May 27, 2015.



Policy Recommendations for Canada

The trends, milestones, and shifts outlined here all point to one conclusion: Energy systems, markets, and societal values are rapidly changing in response to climate disruption—and those mitigation efforts may be starting to move the needle.

Given that Canada is a resource economy and one of the world's leading fossil fuel suppliers, the implications of this shift for our future competitiveness are profound. While these societal shifts are incredibly hopeful, they aren't getting nearly enough play in Canada's media, on Parliament Hill, on #cdnpoli, or anywhere else in this country. Here's what Canada needs to do:

1. Make clean energy a trade priority.

Given the size and potential of the global clean-energy market, the federal government must lower barriers for Canadian firms keen to export low-carbon innovations, services, and know-how. This pie is growing larger, but our share is small and getting smaller. We need to turn that around. The clean-energy economy is the economy of the future. It's the horse our federal government needs to back with strategic supportive policy instead of assuming, as it does now, that the oil industry is the only thoroughbred on the track.

2. Collaborate with clean energy leaders.

This past year, the United States inked agreements on climate action and collaboration on clean-energy products, services, and know-how with China, India, and Mexico. The United States reportedly invited Canada in on its partnership with Mexico, but Ottawa declined. Though Ottawa did sign a trilateral clean energy deal with the United States and Mexico as we completed this assessment, unlike his partners, the federal natural resources minister made no mention of climate change in his statement. So we'll say it again: The world is changing around us. These economies represent a huge opportunity for Canada's clean-energy innovators. It is time to step up our ambition.

3. Play a constructive role in the Paris 2015 Climate Talks.

The next global climate deal will shape the global clean-energy transition. Nations with a record of leadership will have the credibility to shape the talks and their outcome. Before negotiations get to crunch time, Canada needs to have a clear plan to deliver on its new target. A national renewable

energy target would help boost our credibility, too. We can't afford to be offside, and we can't afford to be on the outside.

Be Part of the Solution

We hope this assessment has left you inspired and primed for action. Would you like to help us continue to tell this story? If so, we invite you to sign up for The GRID on www.cleanenergycanada.org, our rapid-response social-media news alert service. We'll drop you a line when an opportunity presents itself to speak up for clean energy leadership—be it a supportive tweet, post, or letter to the editor, or a quick note to an elected leader. We'll also invite you to help correct misinformation when it appears in the media.

Sign up today!