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The Energy Transition

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Editorial

"We can fix it." This simple yet powerful sentence is the final item on a five-part list that appears in the opening paragraphs of researcher Seth Wynes' article 'Essentials for Teaching Climate Change' from our Fall 2019 issue of Green Teacher (# 121). The other items on this list about climate change — derived from a publication by Wynes and fellow researcher Kimberly A. Nicholas — are as follows: 1) The Earth is warming. 2) It's bad. 3) It's because of humans. 4) Experts agree.

Indeed, experts agree on the severity of the issue, so much so that the term "climate change" has been justifiably swapped for such synonyms as "climate crisis," "climate disruption," and "climate emergency" in many publications. While some have suggested that these terms are overly alarmist, the situation is undoubtedly alarming, and facing the realities of any challenge is necessary when seeking to address it.

But let's focus on the "addressing it" part for a moment, because another reality of this situation is that a great many people are on the case. One need not look far to find some truly remarkable climate solutions being implemented right now. In fact, the "climate solutions" space is positively overflowing with innovation, collaboration, creativity, and commitment. Spend some time flipping through books like Paul Hawken's *Drawdown* and *Regeneration* or climate journalist Chris Turner's *How to be a Climate Optimist*, and it's hard not to come away without feeling inspired and at least somewhat hopeful.

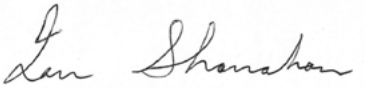
The transition from an energy system powered by fossils fuels to one powered by clean energy sources like wind and solar is well underway and picking up speed. So fast is the energy transition moving that most experts now agree that the worst-case scenarios (warming of 4°C or more above pre-industrial levels) are now off the table. This is not to say that we can just sit back and let the transition play out while we carry on with business as usual. Such a narrative only serves those lobbying for the status quo to protect their profits and/or ideologies. Current projections from Climate Action Tracker have us on course to exceed the Paris Agreement's ambitious 1.5°C target and perhaps also its secondary 2°C target. In other words, we're not out of the woods yet — but there is a viable path forward, provided that we enact responsible policies and scale up existing technologies.

Our goal with this special themed issue of the magazine is to get you better acquainted with the core aspects of the energy transition. The first four articles, all penned by climate and energy journalist Markham Hislop of Energi Media, cover the need-to-know points — think of these articles as a collective "cheat sheet" to the energy transition. The second half of this issue includes outlines for six educational activities created by educators Chloe Faught and Gillian Petrini. While each is geared toward different grade levels across the K–12 spectrum, each one is readily adaptable to different age groups or educational settings or even settings that aren't strictly education-focused. These interactive and inquiry-based activities are meant to get people asking questions about the energy transition and thinking about their role in it, both as individuals and as members of various communities.

I'll end with a mention of "future-casting" — a concept which is the primary focus of the sixth educational activity. "Future-casting" was admittedly not on my radar until quite recently, but it has quickly become an important part of my work as well as my daily musings. Much ink has been spilled in recent years on worst-case scenarios for the future. While some have criticized these bleak imaginings as unhelpful and counterproductive, I do believe that they have been a necessary part of our collective journey to understand the implications of runaway climate change. That said, one could argue that not enough has been written about a future where we actually get the climate threat under control. What does this world look like? Feel like? Sound like? What if we make smart decisions and meet this challenge?

"What if…" is an intriguing couplet that brims with potential and opportunity. The road ahead is sure to be a bumpy one, fraught with pitfalls and unpredictability — but what if we do reach our destination? What if we get this right?

What if…



-Ian Shanahan

Key to article symbols

You will notice in this issue a few new visual cues alongside most articles. These symbols will allow you to quickly identify some important indicators about each piece.

Age groups

Age 5–12 (Elementary)

Age 14–19 (High School)

Age 10–14 (Middle School)

All Ages

Activity/lesson plans indicates that articles include an activity/lesson plan*

*Note: Most articles include practical tips and insights even if they do not all include activity/lesson plans.

From Decarbonization to Building a Clean Energy Economy

Narrative, media, and thinking about the energy transition

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ICE to EVs

By **Markham Hislop**

HOW WE THINK AND TALK ABOUT energy and climate change matters. A lot. Narratives influence public opinion about energy and climate change, which in turn creates the "political space" that determines the types and severity of policies governments can introduce. What may seem clear to a climate activist can be confusing to citizens peppered with climate-denial narratives and climate "slow walking" from corporate leaders. The good news is that energy and climate narratives are now, for the most part, concerned with limiting global warming to 1.5°C by 2100 and accelerating the shift to clean energy.

For a long time, the public narrative was about the science. Was climate change real? Or, just how real was it? Should humans be concerned or was this one of those issues that would be solved with a little ingenuity and some good government policy, like the hole in the ozone layer? After all, the climate alarm bells were ringing during the late 1950s and for decades there didn't seem to be much immediate danger, right?

One reason that the climate change narrative wasn't as effective decades ago as it might have been is the disinformation campaigns run by the fossil fuel industry. We now know that Big Oil (think ExxonMobil) understood the science but chose to actively lobby against measures to limit oil and gas consumption. The US House Committee on Oversight and Reform investigated the American industry's role in propagating anti-climate-change narratives and was alarmed at their findings.

"Big Oil has misled the American public for decades about the reality of the climate crisis," said Ro Khanna, chair of the subcommittee on the environment. "It's past time to hold the entire industry accountable for its role in funding and facilitating that disinformation."

Canadian Big Oil engaged in its own disinformation campaigns. In fact, it has never stopped. Alberta, the epicenter of the industry, was long the province with the highest support for climate science denial. Some industry trade associations have for years issued reports diluting the climate threat and arguing that Canadian oil is somehow "ethical" (because it's produced by a democracy) and "environmentally responsible" (despite sky-high greenhouse

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gas emissions, widespread abandoned wells, and 37 oil sands tailing ponds containing 1.4 trillion litres of toxic waste).

The Canadian industry masterfully influences the national energy conversation by pushing self-serving narratives. Instead of chronicling the rise of renewable energy and the pivot to electric demand technologies like EVs and heat pumps, the Canadian media expends far more ink reporting about the latest spat between Alberta and Ottawa over pipelines or environmental assessment regulations or how the proposed oil and gas emissions cap will harm Canadian producers and kill jobs.

What most Canadians don't see is the behind-the-scenes work of influencers paid directly or indirectly by Big Oil: trade associations like the Canadian Association of Petroleum Producers (CAPP); a multitude of "astroturf" groups who are ostensibly grassroots campaigns but inevitably turn out to have connections to deep pockets in the oil and gas industry; a compliant media — both locally in Alberta, regionally on the Prairies, and nationally in corporate newspapers and television — that accepts industry narratives at face value; and politicians who parrot those narratives and support legislation that erodes climate policy or opposes it in the first instance.

The latest iteration of Big Oil's narrative manipulation is the Oil Sands Net-Zero Pathways Alliance. The northern Alberta oil sands account for 60% of the 5 million barrels per day of oil extraction, making Canada the fourth largest producer in the world. Of the six companies in the Alliance (CNRL, Cenovus, Suncor, Imperial Oil, ConocoPhillips, MEG Energy), five are giants in the sector. Oil and gas accounts for 26% of Canada's emissions, with the oil sands accounting for a whopping 11% all by itself.

"As a significant source of Canada's GHG emissions, we know we must also be part of the solution," said Pathways Alliance Director Al Reid. "That's why we're working together on innovative approaches to achieve our shared vision of net-zero emissions."

What are we to make of this cheery messaging? For starters, we can measure it against the Alliance's own reduction targets. The organization wants to lower emissions by 68 megatonnes (Mt) per year by 2050. The problem is that a recent study by S&P Global's emissions measurement team — the most authoritative source of analysis — puts the oil sands emissions at 72 Mt/year in 2017, 80 Mt/year in 2022, and 90 Mt/year in 2030. Best case scenario, that leaves a shortfall of 22 Mt/year by mid-century. With production rising 500,000 barrels per day by 2030 and possible further increases thereafter, a reasonable expectation is that the emissions target will be missed by an even larger number.

When Canada announced an "immediate" oil and gas emissions cap at COP26 in 2021, the industry opposed it. The explanation for why is pretty clear from the rising emissions numbers. But that doesn't make the Alliance's narrative less effective. When the rising emissions data was released in November of 2022, it received almost no media coverage. Yet the Alliance spokespeople and the oil sands CEOs are quoted often and positively by the media.

Why does it matter that the Alliance's narrative is covered so prominently by the media and plays such a prominent role in national energy discussions?

The oil sands companies have an agenda. They know decarbonization is inevitable. But 100% of their exports go to the United States, which has no carbon price. There is literally no penalty for their heavy crude oil's high carbon-

intensity (68 kgCO2e per barrel average) in the marketplace. The only serious pressure to reduce emissions is coming from the Canadian government. Therefore, the companies prefer to decarbonize on their own terms and on their own timeline (the mid-2030s to 2040s), and to have governments pay as much of the cost as possible (the oil sands bill alone will be $75 billion and CEOs have asked for $50 billion of subsidies to help defray costs).

Thus far, they have been remarkably successful. Despite more than a decade of increasing pressure from climate activists and policymakers, absolute emissions at best plateaued for a few years and are now rising again. Extra costs from carbon pricing and other policies have been miniscule. Continual pushback by the industry, intense lobbying, and expert narrative management in public discourse has all but stalled progress.

Think of it as industry "rope-a-doping" governments. Muhammed Ali used the technique with bigger, stronger opponents like George Foreman and Joe Frazier during the 1970s. He would back up against the ring ropes, rolling with the punches, wearing out the other boxer, until finally in the later rounds he would begin to counter-attack and win the match. Industry is rolling with the punches until it gets what it wants: huge subsidies or a new, more sympathetic government.

Time will tell if the oil and gas strategy succeeds, but it may not because a clean energy narrative has emerged that threatens to forever change energy and climate politics.

Think back three decades to the steadily growing international support for climate action. The climate crisis narrative, largely driven by activists and influential organizations like the Intergovernmental Panel on Climate Change, gathered steam until by the early years of the 21st century, a majority of citizens in most nations demanded action. Canada, though, was widely thought of as "all talk, no action." That started to change in 2015 when the Liberals led by Justin Trudeau came to power. The new government enacted a national carbon tax and methodically drafted policy and regulations to tackle emissions. Still, environmental groups complained about "too little, too slow" as emissions remained stubbornly high in the 730 Mt/year range.

Then the 2020s arrived. First, there was the COVID-19 shock to the global economy. Just as normalcy appeared to be back, Russia invaded Ukraine on February 24th, 2022, plunging Europe into an energy security crisis that bled to other parts of the international economy as prices soared. The Canadian oil and gas industry loudly called for government action to enable exports to Europe, which was really nothing more than the usual narrative management because the country didn't have the required infrastructure, and years would be required to build it.

But what most Canadians missed was Europe's response to Russian cuts to their gas supplies. Only a few months after the invasion, the European Commission launched the REPowerEU Plan. The heart of the plan was to use energy more efficiently, thus reducing demand, but also to accelerate electrification of national economies. More renewables (wind, solar, batteries), more electric vehicles, more electric heat pumps for buildings, and so on. Within months, the Europeans had found new sources of gas, significantly reduced demand, and begun electrification in earnest.

By weaponizing energy, Russia ensured that other nations acted to protect their economies from potential geopolitical manipulation by suppliers. The quickest way to do that? Follow Europe's lead and shift to clean electricity and low-carbon fuels like hydrogen. The change in thinking opened the floodgates for huge investments. For example, global automakers pledged to spend $1.2 trillion by 2030 transitioning to electric transportation and batteries. Policymakers and utilities scrambled to upgrade power grids and build new generation to supply the anticipated new demand for electricity.

And a new narrative emerged during the chaos: that energy insecurity combined with the energy transition has triggered a transformation of global industry and its supply chains. Yes, the climate crisis continued to dominate headlines as decision-makers struggled at COP27 to advance policy. But the conversation began to shift from "how?" to "how fast?" How fast can new mines be built to supply critical minerals? How fast can North America build the refining capacity to turn minerals into battery metals? How fast can new battery factories be built? How fast can new wind and solar farms be erected?

Then the United States passed the $369 billion Inflation Reduction Act. Now, combined with hundreds of billions of dollars in existing programs, the US has declared its intention to catch China and become the global leader in clean energy technologies and industry by the end of the decade. The North American focus of the Act ensures that Canada will be a key cog in the US clean energy machine.

Energy transition has become an economic transformation. The call to phase out fossil fuels has now become the call to build clean energy economies as quickly as possible. Climate policy in the US and Canada is being augmented with industrial policy: government subsidies, regulations, and market support for emerging clean energy industries. And the clean energy race is between North America, Asia Pacific, and Europe.

Finally, the dominant climate narrative is shifting from "the world needs to shift off fossil fuels" to "how fast can we build a global clean energy economy?".

Markham Hislop is a Canadian energy/climate journalist with Energi Media and host of the Energi Talks podcast. He also conducts video interviews with energy experts, writes the *Markham On Energy* energy politics analysis columns, and writes about the energy future. He is frequently interviewed on Canadian radio and television about energy transition issues. This and Markham's other articles in this magazine issue are products of work that Energi Media has been conducting in partnership with Green Teacher on effective education and communication about the energy transition.

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Clean Energy Ready to Displace Fossil Fuels

Why the energy transition is picking up speed

Canva

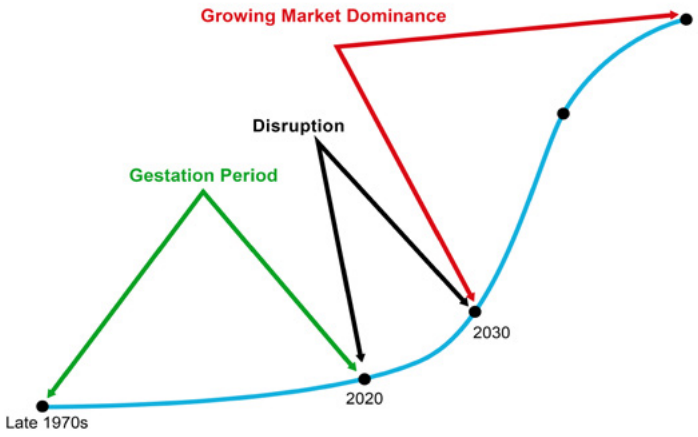
By **Markham Hislop**

THE ENERGY TRANSITION IS a two-sided coin. On one side, is the rise of the new clean energy economy the International Energy Agency (IEA) is talking about. The other side is the decline of fossil fuels (coal, oil, natural gas). The question is, how long will it take clean energy to push "dirty" energy out of global markets? The answer is still uncertain, but a reasonable argument can be made that fossil fuels have already peaked, or soon will, and that the twin shocks of the COVID-19 pandemic and Russian militarism will inevitably lead to irreversible decline in short order.

Kingsmill Bond and his team at the Rocky Mountain Institute say peak demand actually occurred in 2019. They have published an energy transition theory based on peak, plateau, and decline. "The endgame is here. In one country and region after another, demand for fossil fuels is facing inevitable decline," writes Bond. "The rapid growth of new energy technologies is the primary driver of system change." Rapid growth is the result of where the technologies are on the adoption S-curve.

At the beginning of the curve (see graphic), adoption is slow because new technology is expensive and unreliable. Risk is great and the benefits are low. Only Innovators and Early Adopters are willing to pay the high cost. The "gestation phase" began during the 1970s and 1980s as early commercial wind turbines and solar panels were introduced. Lithium-ion batteries and the first modern electric vehicles (EVs) followed during the 1990s. Important enabling technologies like computers, artificial intelligence and machine learning, and the internet all got progressively better and cheaper over the past two or three decades.

Those technologies became increasingly efficient and competitive entering the 2020s, kicking off a stage of intense disruption as the new technologies began to displace the old ones. Now, consumers can't buy electric cars fast enough and renewables will be responsible for 90% of new



Dispatchable and non-dispatchable electricity

Dispatchable electricity (such as coal, natural gas, nuclear, and hydroelectric) power plants generate electricity at all times and their output can be adjusted to suit demand from customers.

Renewable energy is non-dispatchable, meaning generation depends on natural sources (such as wind and solar) that are not available at all times. Recent advances in energy storage (such as compressed air, various types of batteries) suggest that renewables may become dispatchable in the near future.

global power generation, according to the IEA. Heat pumps are set to disrupt building heating and cooling. Hydrogen looks like it will be the fuel for hard-to-decarbonize sectors like steel and cement. Entire industries and their supply chains are being re-engineered or being built from the ground up.

The 2020s are the decade of disruption.

The 2030s will likely be a decade of less disruptive growth as the new technologies dominate a bigger and bigger share of their markets. This is the market dominance phase. The speed of this process varies depending upon the technology. For example, demand for natural gas is expected to last longer than oil because it burns cleaner than coal and oil, and it is used to heat buildings, something electric technology isn't as good at yet.

Wright's Law and learning curves

For millennia, energy has been a commodity. From wood and dung to whale oil to coal to uranium, oil, and gas, energy was harvested or extracted. Now, that's changing. With wind and solar power, energy has become a technology. And technologies behave very differently.

In 1936, American aircraft engineer Theodore Wright hypothesized that every time airplane production doubled, labour costs fell by 20%. Researchers found similar results in many other industries. This became known as a "learning curve" — the more experience an industry gained producing a good, the more efficient it became. Learning curves generally lead to cost declines of 10% to 25% each time output of a good doubles.

Wind and solar energy have followed this rule. The graph to the right shows the plunging cost for producing one megawatt hour of solar electricity over the past decade or so. Can wind and solar costs continue to fall? The IEA forecasts that from 2022 to 2027 renewables will account for 90% of all new global power generation. In that time, the world will "add as much renewable power in the next 5 years as it did in the past 20."

If the learning curve law holds, solar costs could be as low as $10 per megawatt hour by 2050. The US Department of Energy's "SunShot Initiative" aims to reduce costs to $20 per megawatt hour by the end of this decade. Others go even further. Tony Seba of think tank ReThinkX argues that wind, solar, and energy storage will soon produce clean electricity so cheap that by 2030 the marginal cost (the cost of producing the next unit of something) will be almost zero.

A common objection to wind and solar generation is that they are intermittent; the sun doesn't always shine, and the wind doesn't always blow. This is certainly an issue, but one that utilities and power grids are managing ever more effectively (see sidebar). Storage in the form of batteries (short-duration Lithium-ion or longer-duration chemistries such as flow, zinc-ion, etc.) and other technologies like compressed air are becoming increasingly common. Utilities plan to begin using hydrogen later this decade. Trade and market design are useful ways to shift electricity from regions where there are temporary surpluses to meet demand elsewhere. Demand response, lowering consumption when the grid is stressed, is considered a viable option for the near future. There is no single solution for intermittency. But as renewables became the lowest-cost way to make electricity, utilities are finding novel ways to successfully integrate them into the power grid.

"Safe bet" vs. "wild card" clean energy technologies

"Safe bet" technologies are mature, or close to it, and competitive today. Most importantly, they can scale quickly. Examples include electric vehicles and renewable energy — especially solar and wind. "Wild card" technologies are immature and require years, perhaps decades, of further research and development. Examples include small modular nuclear reactors, geothermal, fusion, green hydrogen, and carbon capture utilization and storage (CCUS). Canada is a leader in CCUS, with Alberta intending to use CCUS to decarbonize oil and gas, particularly the oil sands, which generate 11% of Canada's national emissions.

The takeaway from this discussion of "safe bet" and "wildcard" technologies is that there is already plenty of technology to power the energy transition, with even more on the way. Shifting to energy as a technology has unleashed a tsunami of innovation. In fact, some economists believe that the global economy is being disrupted by a 6th long wave of innovation, a modern version of the Industrial Revolution (which encompasses the first two waves), if you will. The current wave is likely to be more intense because of the volume and sophistication of modern innovation.

Peak, plateau, decline

Kingsmill Bond and his team provide a compelling framework for the rapid decline of fossil fuels and the triumph of clean energy.

Fossil fuels still supply over 80% of global energy. The current energy crisis has forced some countries, like Germany, to revive mothballed coal power plants, with coal consumption expected to have reached record highs in 2022. Arguing that fossil fuels peaked four years ago seems a stretch in that context. Nevertheless, even the IEA acknowledges that coal's peak will occur in a few years, oil's peak is expected in 2030, and natural gas will take a decade or two longer.

But Bond's point is that the peak occurs while fossil fuels are dominant, when the competing energy technologies enjoy only a 5% to 10% market share, which makes it easy to miss them. Coal peaked in Europe 20 years ago (albeit there is a temporary resurgence because of Russia's invasion of Ukraine), while today's growth is driven by China and India. US gasoline demand peaked in 2018, but developing economies fuel current consumption growth.

Even after a peak is reached, there are years (sometimes over a decade) of bumpy plateau before decline sets in. During a plateau, the old fossil fuel systems fight back. Producers innovate to lower costs and often they pressure governments (which in Canada own natural resources) for tax breaks and subsidies in order to maintain jobs and local businesses. Plateaus can last a year for specific products, like cars, or a decade for systems like coal or oil.

Once decline begins, fossil fuels use follows one of two models, the Matterhorn or Mount Fuji. According to Bond, "Fuji peaks are slower and longer. You get a plateau at the top for a few years. Matterhorn peaks are quicker and sharper. The plateau is short and is followed by a steep decline."

Coal appears to be a Fuji peak. Just when we think the highest-emitting fossil fuel is dead, an unforeseen event like the current energy crisis comes along to give it new life. Natural gas, with lower emissions and high value as a space-heating fuel, will likely follow a similar pattern, though its peak and decline will likely occur long after coal.

Oil seems destined for a Matterhorn peak. Road transportation accounts for 44% of global oil consumption. Automakers' faster-than-expected switch to EVs suggests that oil demand will peak in 2030. BloombergNEF says that rising demand for aviation fuel and from petrochemical plants could delay oil's peak into a Fuji, but efforts to develop sustainable aviation fuel and green fuels for marine shipping combined with concerns about plastic pollution may make it a Matterhorn after all.

The lesson here is that while the exact trajectory of peak, plateau, and decline is uncertain, the trends are clear.

Conclusion

Even if Bond's argument turns out to be too optimistic, the fact is that everyone, including fossil fuel CEOs, accepts that peak demand will occur in the near future and eventual decline is inevitable. We're no longer debating 'if' but 'when.' The next question is, can policy hasten the transition to clean energy technologies fast enough to reach our Paris Agreement targets?

Designing effective policy is hard. Not long ago, carbon pricing in the form of taxes or cap-and-trade was thought to be the answer. Raise the price of carbon high enough, the argument went, and consumers and businesses will look for alternatives to fossil fuels. Unfortunately, carbon taxes in particular proved to be quite unpopular.

That's the bad news. The good news is that in the past few years, attention has begun to turn from emissions-reducing policy sticks to policy carrots that support building the clean energy industry and supply chains to replace fossil fuels. For example, instead of penalizing drivers for burning gasoline in their cars, the emphasis is now on building EV assembly plants that will supply enough price-competitive vehicles that consumers prefer electric to internal combustion engines. And talk about good timing: plenty of clean technologies (like electric transportation and residential heat pumps) actually save consumers money.

It is the rise of the global clean energy economy that is humanity's best bet for wrestling climate change into submission while building a brighter future for the next generation. Current projections are that we will not meet the Paris climate targets. But given new policy commitments from nations and the now rapid acceleration of clean energy industrialization, there is still optimism in some quarters that we may yet meet them or come very close. The best that can be said, however, is that the climate crisis remains dire even though considerable progress has been made.

Markham Hislop is a Canadian energy/climate journalist with Energi Media and host of the Energi Talks podcast. He also conducts video interviews with energy experts, writes the *Markham On Energy* energy politics analysis columns, and writes about the energy future. He is frequently interviewed on Canadian radio and television about energy transition issues. This and Markham's other articles in this magazine issue are products of work that Energi Media has been conducting in partnership with Green Teacher on effective education and communication about the energy transition.

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Navigating the Energy Transition

Pitfalls and obstacles along the path to a clean energy future

Canva

By **Markham Hislop**

"Over 50% of all our CO2 emissions have occurred since 1990, and a third since 2005. Global emissions will continue to rise on current policies. All we hear from our so-called leaders is 'blah blah blah." — Swedish climate activist Greta Thunberg, October 16th, 2021

As Ms. Thunberg asks over and over, why don't we just get on with the job? Don't we already have enough clean energy technologies (wind, solar, batteries, electric vehicles, heat pumps, etc.)? Given the stakes — intensifying climate-related emergencies, rising energy costs, future prosperity at risk — it shouldn't be this hard, right?

A broad answer to those questions has two parts.

One, it is this hard. In fact, much, much harder than most of us realize. For wealthy nations like Canada and the United States, the current global energy system powers a comfortable lifestyle at an affordable price — a lifestyle that middle-income and developing nations aspire to, which often leads them to invest in the lowest cost energy, like coal. But that energy system is a gargantuan machine with an infinite number of moving parts. Deliberately transforming it in a timely fashion without unduly raising costs on families and businesses is a herculean task. For developing economies, both government support and capital are less available, making the energy transition even more difficult.

Two, humans have been working away at that task for the past 40 years and our efforts are bearing fruit. New energy technologies are now (finally?) better and cheaper, just what is needed for consumers to switch en masse. And the current global energy crisis has convinced many countries that energy security requires domestic solutions — like renewables — rather than imported fossil fuels. Real systemic change has begun, and it will only accelerate going forward. Nevertheless, the transition will still take decades because of the enormity of the job.

And let's not forget about the human propensity to screw things up. Pitfalls abound. Many obstacles — some of them

human, some material — need to be overcome. Here are two energy transition obstacles that will be of particular concern in North America.

Energy system inertia, scaling up challenges

The global energy system has plenty of inertia — the tendency of things to continue on their present trajectory unless bumped off course. According to the International Energy Agency's 2022 World Energy Outlook, unabated (no carbon capture) fossil fuels accounted for 81% of global primary energy in 2010 and 79% 11 years later despite a dramatic rise in low-emission power generation. Imagine the trillions of dollars invested in coal mines and power plants, oil and gas extraction, pipelines, distribution networks, and so on, all over the world. Governments and companies are reluctant to close those plants and infrastructure before the end of their useful life. To use one example, IEA Executive Director Fatih Birol says that "transition is complicated by the relatively young age of coal power plants across much of the Asia Pacific region."

In the IEA's Stated Policies Scenario, which assumes that governments don't follow through with all of their climate pledges, fossil fuels' share of primary energy falls from 74% in 2030 to 61% in 2050. The more ambitious Announced Pledges Scenario has consumption dropping from 69% to 34%, still not enough to achieve net-zero by mid-century. "This calls for nothing less than a complete transformation of how we produce, transport, and consume energy," the IEA said in its net-zero by 2050 roadmap. "A huge amount of work is needed to turn today's impressive ambitions into reality, especially given the range of different situations among countries and their differing capacities to make the necessary changes."

Synchronizing a decline of fossil fuel investment while scaling up low-emission energy to avoid a mismatch between supply and demand is a daunting challenge. Economist Dr. Chris Bataille says the rule of thumb is that wealthy nations will require two to three times more electricity by 2050, while low- and middle-income countries will need four to five times as much. Given that today's power grids (electricity generation, transmission, and distribution) developed over the past 125 years, doubling their size in 27 years seems an almost impossible task and tripling capacity seems, well, a fantasy.

Consider this hypothetical. BC Hydro has 31 hydroelectric power stations with 16,000 megawatts (MW) of generation capacity. The utility has said that Site C, with 1,100 MW of capacity when completed in 2025, will be its last hydro dam. If British Columbia's power needs double in less than three decades, where will that electricity come from? The province has only modest wind and solar resources. There is little public support for nuclear. Geothermal is a possibility, but the technology has not proved it can scale in BC. While neighbouring province Alberta has excellent renewables potential, there is no political appetite to build more east-west transmission interties. The provincial government is looking south to buy cheap California solar, but economists say that the current surplus probably won't last as the state builds out more electricity storage and hydrogen production. Finally, energy efficiency measures will help, but switching to EVs and heat pumps for buildings will require far more energy than efficiency will save.

Some version of BC's conundrum will confront governments around the world. Faced with difficult and costly decisions, the tendency for many will be to delay acting.

The power of incumbents

The first incumbent that comes to mind is the oil and gas industry. Canada is the fifth largest oil and gas producer in the world. At $100 billion per year, oil and gas are far and away Canada's biggest export — roughly twice that of automobiles. Thanks to the "shale gale," the United States is one of the world's biggest oil producers and now a major exporter. The industry in both countries extensively lobbies governments to delay or modify unfriendly regulation. Why? In the case of the Alberta oil sands, which produce 60% of Canada's crude oil and 11% of national greenhouse gas emissions, the status quo is incredibly profitable.

The shale gale

The shale gale or shale revolution refers to the sharp increase around 2007 in the extraction of natural gas from shale rock through horizontal drilling and hydraulic fracturing ("fracking").

Most oil sands projects now break even between $30 and $45 per barrel West Texas Intermediate (WTI). Since WTI averaged $75 in 2022, oil company profits were enormous, billions per quarter for some. But the companies have plans to drive these costs even lower into the mid-$20s to low-$30s range, primarily through the adoption of new digital technologies that replace labour and raise efficiencies. Most oil sands supply is now a "competitive barrel." The companies believe that even if global consumption falls from the current 100 million barrels per day to 25 million by 2050, they will be able to maintain the current production of 4 million barrels per day.

And they are masters at manipulating national energy conversations. The latest strategy is climate slow walking, the idea that we really can't do much to stop climate change so we may as well give up. "Canada's only 1.7% of global emissions; let's talk about China," is an example. Here's another: "I think we're finding out that this is a many-, many-decade transition and it's probably going to look more like diversification than it is like transition, [emphasis added]" Cenovus Energy CEO Alex Pourbaix was quoted saying in the media.

Oil and gas is not the only sector with powerful incumbents who want to resist change to preserve the status quo as long as possible. Electrical utilities are also known for their conservative, risk-averse management culture. For now, Canada's electricity status quo is quite positive compared with countries, like the US, that still use coal. The power grid is already ~80% low-emission, thanks to 60.1% hydropower, 14.9% nuclear, 5.8% wind, and 0.4% solar. Prices are among the lowest in North America. Canada's success, ironically, is also its Achilles Heel.

Canadian utilities have not yet felt much regulatory or market pressure to decarbonize. Most utilities are publicly owned crown corporations that rely upon direction from the government or regulators to plan for climate targets. In BC, which has a very progressive climate plan called CleanBC that aims to lower emissions 40% by 2030, the provincial government has been criticized for not legislating generation or infrastructure targets for BC Hydro. Many other provinces have no climate plan (e.g., Alberta, Saskatchewan) or a weak one (e.g., Ontario). In the absence of explicit direction, utilities tend to stick with existing business models.

"You're hearing [Ontario] incumbents talking very much about big, centralized, capital-intensive infrastructure. It's the newer actors and the newer technologies which are potentially being marginalized," York University Professor Mark Winfield on a recent episode of the Energi Talks podcast, speaking about utilities, the Ontario government, and regulators favouring nuclear and natural gas power plants over renewable energy. "The incumbents are looking to defend their relatively dominant positions in these [electricity] systems and potentially to be the beneficiaries of some very, very large capital investments."

Conclusion

Unfortunately, there is no shortage of potential pitfalls as we frantically build clean energy economies to avoid the worst of climate change and, hopefully, address other important issues, like biodiversity loss, plastic pollution in oceans, and inequality. Sweeping structural changes always create unintended consequences, more so if change is rapid. Energy transition critics fear that giant fleets of robo-taxis will worsen rather than improve urban traffic congestion, for example, or that old EV batteries, solar panels, and wind turbines could overwhelm landfills and cause significant environmental damage.

These and many more hazards await as the energy transition intensifies over the next three decades. In fact, we may as well accept that like energy transitions of the past, this one will be bumpy, sometimes chaotic, and often unpredictable — like energy transition leader California, where rapid adoption of renewables coupled with perhaps premature shutting of thermal power plants led to power shortages and rolling blackouts during the 2020 and 2021 heatwaves. But blackouts were narrowly avoided in 2022 because the state installed record amounts of storage, built new renewable generating capacity, and extended the life of some old backup generators. On several occasions, desperate pleas for consumers to conserve energy also helped.

Doing more than Ms. Thunberg's "blah, blah, blah" entails risk that sometimes leads to unpleasant consequences, as California's experience illustrates. On the other hand, energy system inertia and the power of incumbents often frustrate efforts to change, which has helped create unpleasant climate consequences like severe drought and floods. As the energy transition continues to accelerate, navigating pitfalls on the road to a clean energy future will remain difficult for the foreseeable future.

Markham Hislop is a Canadian energy/climate journalist with Energi Media and host of the Energi Talks podcast. He also conducts video interviews with energy experts, writes the *Markham On Energy* energy politics analysis columns, and writes about the energy future. He is frequently interviewed on Canadian radio and television about energy transition issues. This and Markham's other articles in this magazine issue are products of work that Energi Media has been conducting in partnership with Green Teacher on effective education and communication about the energy transition.

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The Case for Optimism

Why we might be on our way toward a future where we 'get it right'

Canva

By **Markham Hislop**

MUSTERING OPTIMISM IS DIFFICULT in the midst of an energy crisis, sky-high inflation, a war in Europe that could go nuclear, three years of a pandemic that never ends, and humans' seeming inability to stop ravaging the Earth's climate. But what if, instead, we got it right? If we harnessed new technologies to make life better and cleaner? If we built a new global industrial economy based upon clean energy? The proposition that a cleaner, more prosperous world is within our grasp is not as improbable as it sounds, and it suggests the possibility that our children may yet hope for a better future than their parents.

In fact, there are thinkers who believe that a brighter future is more probable, assuming we humans don't screw it up.

Take economist Tony Seba, the former Stanford University lecturer and founder of think tank ReThinkX. Seba and his team investigate disruption caused by new innovations and technologies. In their view, humanity itself is being massively disrupted.

"We are on the cusp of the fastest, deepest, most consequential transformation of human civilization in history, a transformation every bit as significant as the move from foraging to cities and agriculture 10,000 years ago," he writes with co-author James Abib in their book, Rethinking Humanity. "This is not, then, another Industrial Revolution, but a far more fundamental shift."

Energy transition triggers economic transformation

> *"A new energy economy is emerging around the world as solar, wind, electric vehicles, and other low-carbon technologies flourish." – the International Energy Agency, October 2021*

When it comes to energy, the famously staid IEA appears to agree with Seba.

When the COVID-19 arrived in early 2020, the energy transition was already decades old and many of the new clean energy technologies were close to their inflection points on the adoption S-curve and beyond them. The pandemic served as the first shock to the international economy. The second arrived when Russia invaded Ukraine in 2022 and then cut off natural gas exports to Europe. Fossil-fuels-importing countries around the world quickly realized just how vulnerable they were to their suppliers' military and trade aggression. They also realized that generating clean electricity from renewables and producing low-carbon fuels like hydrogen at home, or securing it from trusted allies, would insulate their economies from predatory behavior by bad actors.

The twin shocks galvanized governments, businesses, investors, regulators, and other decision-makers. The United States and Canada, in particular, woke up to an unpleasant fact: North America lagged far behind China in clean energy technology and industry. For example, 77% of the refining and processing capacity to turn critical minerals into battery metals is located in China. Lithium mined in the United States would likely have to be shipped to China for refining, then shipped back, which hardly makes for a competitive fledgling battery industry. Shipping minerals overseas for refining would also add to the emissions intensity of batteries; for example, MIT estimates that manufacturing the Tesla Model 3's 80 kWh lithium-ion battery already creates between 3,120 kg and 15,680 kg of CO2. Even Europe was further ahead thanks to several decades of aggressive climate policies.

One reason North America lags is that during the first two decades of the 21st century, Canada (oil sands) and the US (shale production) invested heavily in hydrocarbon extraction instead of clean energy. Now it has to play catch-up.

A common estimate for the global cost of switching to clean energy technologies and reaching net-zero emissions by mid-century is $100 trillion USD. That means hundreds of billions (if not a trillion or two) of capital per year will be spent in North America on, for example, wind turbines and solar panels, building new wind turbine and solar panel factories, and then building or expanding the supply chains to serve those new factories. Imagine North America undertaking a similar process for heavy industry (e.g., steel, cement), transportation, and building retrofits. Now imagine North America doing all of that while in a race with Asia Pacific and Europe for dominance — or at least competitiveness — in these new and revamped markets.

The job is gargantuan, which is why both countries have revived (and are modernizing) an approach common before 1980: industrial policy and strategy. The idea is for government to collaborate with business and other stakeholders (like labor and civil society) to identify new industrial opportunities, then implement the necessary policies to turn those opportunities into projects with capital investment attached, hopefully building "industrial clusters" and the supply chains to support them. The US and Canada are taking somewhat different approaches.

In August 2022 President Joe Biden signed the $369 billion US Inflation Reduction Act, which, despite its name, was designed as a huge boost to the clean energy economy and the most ambitious climate policy ever enacted by the United States. The Act provided $128 billion for renewable energy and grid modernization, $30 billion for nuclear power, $14 billion for home energy efficiency upgrades, $22 billion for home energy supply improvements, and $37 billion for advanced manufacturing. Electric vehicle incentives of $13 billion were controversial because of a percentage of components had to be manufactured domestically or from a country with which the US had a free trade agreement. Like Canada.

Canada praised the Act and in the Fall Economic Statement created a number of programs to match the Americans. The $15 billion Canada Growth Fund was the centerpiece of the plan, along with 30% investment tax credits for clean technologies and clean hydrogen. More is promised for the spring budget. Critics pointed out that the Statement had missed perhaps the most important part of industrial policy — the strategic approach — and that the federal government was continuing a long history of Canadian economy policy by simply throwing money at the problem. Finance Minister Chrystia Freeland did promise "real muscular industrial policy" for clean energy, but the government's policy has not yet caught up to its rhetoric.

Nevertheless, Canada and the US have recognized that they are behind in the race to build clean energy economies and have begun to act. And North America is not without its own competitive advantages. A big one is innovation.

Innovation

While the US may have lost its manufacturing and industrial advantage to China, the Americans still lead the world in spending on science and research. "From the Internet to biotech and even shale gas, the US [government] has been the key driver of innovation-led growth — willing to invest in the most uncertain phase of the innovation cycle and let business hop on for the easier ride down the way," is how noted economist Marianna Muzzucato describes the American approach to innovation. The Inflation Reduction Act is a new spin on an old strategy.

Canada has historically not done a good job supporting innovation, relying instead on foreign companies to invest and introduce new technologies. But over the past decade or so, Canada has been quietly nurturing an "innovation ecosystem" of public and private actors. If that ecosystem can be activated to exploit opportunities created by the restructuring of global supply chains and the American pivot to clean energy, Canada may be facing a once-in-a-century chance to diversify beyond exports of raw materials like oil and gas, wood, agriculture, and minerals.

Here are some examples of Canadian innovation:

Provincial agency Alberta Innovates is a year or two from commercializing a process to turn oil sands bitumen, which has the consistency of peanut butter, into the feedstock for manufacturing low-cost, light-weight carbon fibre. The innovation comes as EV makers struggle to lower the weight of their heavy vehicles.

The Alberta Carbon Conversion Technology Centre is home to several startups transforming captured CO2 from a nearby gas power plant into cloth, vodka, soap, and even improved concrete. In 2026 Alberta utility Capital Power will be using captured CO2 to make carbon nanotubes, which are already used to manufacture common products like bicycle frames, automobiles, and tennis rackets.

Halifax-based Salient Energy makes a zinc-ion battery to replace lithium-ion for power utility and home energy storage. Zinc-ion is up to half the cost and uses minerals that are common to North America. CEO Ryan Brown says large-scale production of the new battery will start in the next year or two.

Tony Seba's first study, in 2017, was about Transportation-as-a-Service (TaaS) — the use of autonomous robo-taxis to replace private car ownership. The technology hasn't developed as fast as he thought, but American companies like GM-owned Cruise are slowly scaling up.

Canadian startup 7 Generation Capital offers a unique wrinkle on the TaaS business model by providing trucking fleets with electric delivery vans and trucks, the charging infrastructure, and even drivers. The turnkey innovation helps logistics companies electrify their fleets faster by reducing up-front capital costs and making the switch to electric easier.

Vancouver has emerged as an important cluster for hydrogen-demand technologies like fuel cells, anchored by industry leader Ballard Power Systems, which was formed in 1979. Alberta is planning to build hydrogen supply clusters using a hub model. Production will start with blue hydrogen (natural gas, carbon capture), then transition to green hydrogen (clean electricity, water, electrolyzers) as technology costs fall later this decade.

Ontario's auto industry is busy transitioning to the manufacture of electric vehicles. Not only are existing factories being re-designed, but many new battery plants were announced in 2022. Quebec, with its abundant supply of clean and inexpensive hydropower, is also receiving its share of battery plant investments, spurred in part by its thriving electric bus and truck manufacturing sector.

Conclusion

The early 2020s were a tipping point as the twin shocks of the pandemic and Russian militarism triggered the race to build clean energy industry. The focus has now shifted from policy solutions to innovation, capital deployment, the creation of new industrial clusters and their supply chains, and the training and re-training of workers for the new energy economy. Building and deploying new energy technologies, more than any other factor, may finally help the global economy to wean itself from fossil fuels and reach the Paris Agreement targets.

The United States has finally engaged wholeheartedly in the clean energy race. Canada is not quite there yet as much work remains to be done, especially by provincial governments, many of which have been reluctant to enact climate policy and slow to spot the economic opportunities created by the frantic global expansion of clean energy industry.

Seba thinks humanity is "on the cusp of the fastest, deepest, most consequential transformation of human civilization in history," and our brief survey of the global economic transformation triggered by the energy transition supports that argument. But as Seba also points out in his book, realizing the potential of the transformation will require humanity to make good decisions. Will we rise to the challenge? We owe it to the next generation to get it right.

Markham Hislop is a Canadian energy/climate journalist with Energi Media and host of the Energi Talks podcast. He also conducts video interviews with energy experts, writes the *Markham On Energy* energy politics analysis columns, and writes about the energy future. He is frequently interviewed on Canadian radio and television about energy transition issues. This and Markham's other articles in this magazine issue are products of work that Energi Media has been conducting in partnership with Green Teacher on effective education and communication about the energy transition.

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Framework for Energy Transition Lesson Plans

January 2023

Canva

By **Chloe Faught** and **Gillian Petrini**

IN THE FOLLOWING PAGES you'll find six lessons you can use to help guide your students in their understanding of what it means to be a human on this Earth today — to be in a time where our actions as a species have put the Earth in peril of becoming one that is severely disrupted for us as well as the billions of other beings with which we share our home. Our reliance on burning fossil fuels and the resulting carbon emissions have created a climate crisis that requires swift, immediate, and pivotal actions to transition to renewable and clean energy sources that do not emit greenhouse gases. Students today are living in this time of transition — a time that has already been impacted by both the changes in climate and the actions to mitigate climate impacts. It is important that young people are informed, that they have a critical lens, and that they know the urgency of the climate crisis while maintaining a sense of hope grounded in clear-eyed realism. It is also key that they know that the adults they look up to are doing something about this issue — that they are listening and acting. This energy transition is happening now — hopefully orienting us toward a society in balance with our natural systems. The energy transition can give us hope; it is a process wherein students can find promising changes in technology, policy, and behaviours and see that the adults of today are increasingly invested in these changes. Supporting our students in understanding the full complexities of our time and this transition can challenge them to collaborate and work together while developing critical core skills to take action for a sustainable and regenerative world.

Prior considerations

The following considerations offer a guiding framework for each lesson. They are the foundational components, which, when applied, allow for a more holistic learning opportunity that engages students' minds and hearts.

Indigenous worldviews

Interconnectedness

We frame our lessons using an Indigenous worldview of interconnectedness. Interconnectedness includes the relationships among humans; among humans and the land, waters, and other 'more-than-human' beings (all other

living organisms). Interconnectedness also includes the relationship between our ancestors and our future generations. For some First Nations located on Vancouver Island, British Columbia, the concept is called Nuts'a'maat (Hul'q'umi'num) or Tsawalk (Nuuchanulth). As taught to us by our mentor John Harris, a member of the Snuneymuxw Nation, Nuts'a'maat means 'we are all one' or 'everything is connected.' Embedded in this teaching is the importance of relationships with each other to bring both a sense of compassion and kinship toward others. "If you view the trees in your yard, or the salmon in your river, or the whales swimming up the channel, or the eagles flying in the sky — if you view all things are your relatives, you are less likely to do things that will impact them adversely" (John Harris, February 4, 2022). You will likely find that there are similar teachings in the Indigenous communities in your region and we encourage you to explore them. Another way to embrace interconnectedness is to explore your own history — know your roots and the land-honouring traditions your ancestors may have practiced. It is beneficial to engage in all learning with a foundation of understanding of where you are, how you came to this place, and whose lands you are on, all with an understanding of our interwoven connections with each other (both the human world and the more-than-human world). An integral approach used to help build a sense of interconnectedness is circle practice, which involves encouraging sharing, communication, and coming together.

Principles of circle practice

Circles have been a form of non-hierarchical gathering for decision-making, sharing stories, and celebrating since humans have been on this Earth. Circles are a powerful means of connecting with one another to build community. If key principles are practiced, the circle can become a contained place for students to be heard as they share a depth of thoughts and feelings. This practice can bring about a sense of solidarity and a sense of interconnectedness. If guidelines are in place and clear intentions are laid out for the circle, a respectful space and a culture of trust can be established within the class. Establishing expectations for respectful behaviour ensures that everyone feels they can speak openly and be heard. There are many resources available on circle practice as referred to below. Here are four principles to highlight with students prior to engaging in circle:

- **Speak from the heart** (speak your truth; be genuine and authentic; your words are your own; use "I" statements)
- **Listen from the heart** (respectful listening means listening with your whole body, ears, and eyes — giving full attention to whomever is sharing)
- **Be open-hearted** (embrace the chance to connect; be accepting of varying thoughts and ideas; be non-judgemental)
- **Get to the heart of the matter** (be succinct enough so everyone has time to share)

In addition to the four principles above, here are two other important guidelines to frame your circle practice:

- **Silence is honoured** (Anyone can pass; no one is ever forced to share)
- **Confidentiality** (no one shares what was shared by others outside of the circle)

Principles Adapted from Leighton. H. (2021). Principles for the Way of Council [Unpublished manuscript].

Indigenous communities and the energy transition

In addition to this specific Indigenous teaching, we have also highlighted in an extension lesson how Indigenous communities are embracing the energy transition and how this transition has a two-fold benefit — helping remote communities reduce their reliance on fossil fuels and allowing self-sufficiency regarding their energy needs.

Social justice

Most lessons have an element offering an integration of social justice related to the energy transition. The intention is to help ensure that there is an awareness of the complexities of this transition and that there is much that needs to be done to ensure that access to energy is equitable and just. Specifically, it should be noted that those in the Global North most responsible for carbon emissions are less affected by their impacts and that the Global South (inclusive of Asia, Africa, Latin America, and the Caribbean) is largely bearing the brunt of the most devastating climate change impacts. This disparity is becoming ever more apparent.

Gratitude

We believe it is crucial to ground our learning in gratitude, respect, curiosity, and hope in order to keep our students from disengagement and climate paralysis. Lessons often start or end with a circle of gratitude or with a guided question. Educators are encouraged to use this practice of gratitude within these lessons and beyond as an antidote to climate anxiety.

Circle prompt examples for gratitude.

As an opening, here are two examples:

"Today at this moment, I am grateful for ... because..."

"One thing I love about being alive on Earth is..."

As a closing you can consider something as simple as *"One thing that I am grateful for in our day together/this class/this experience is..."*

Climate anxiety/grief/paralysis

Climate change and other large environmental problems such as biodiversity loss are overwhelming challenges, as they have no single solution and they require both individual and, more importantly, collective action. As climate-change impacts are now felt in all parts of the world, social media and daily news feeds are full of ongoing disasters influenced by a warming Earth. It's hard to escape the constant reminders of the peril we face and the accompanying feelings of hopelessness and helplessness. This can provoke climate anxiety and a range of emotions that can also include denial and apathy. A full range of emotions is valid, welcome, and important.

The following lessons may cause strong emotions to be provoked; therefore, educators must be open, mindful, and prepared for this possibility. These six lessons are intentionally framed with a hopeful, solution-oriented approach in order to demonstrate that a vibrant future is possible and that there are initiatives taking place both locally and around the globe to address climate change.

Resources:

The article, *Pedagogical Talking Circles: Decolonizing Education through Relational Indigenous Frameworks*, focuses on talking circles as a pedagogical practice of decolonizing education.

P. Barkaskas, D. Gladwin. (2021). Pedagogical Talking Circles: Decolonizing Education through Relational Indigenous Frameworks. Journal of Teaching and Learning Vol. 15, No. 1 pp. 20-38 Retrieved from https://files.eric.ed.gov/fulltext/EJ1303475.pdf.

This is the introductory portion of the document *BC First Nations Land, Title, and Governance Teacher Resource Guide*. Within this chapter there is an overview of talking and sharing circles.

First Nations Education Steering Committee. (2019). BC First Nations Land, Title and Governance. Planning for Instruction. Retrieved from http://www.fnesc.ca/wp/wp-content/uploads/2019/08/1.5-Planning-for-Instruction.pdf

Both of these resources speak to the need for those experiencing climate anxiety and grief to be heard through honest and open communication as a means of working through these difficult emotions.

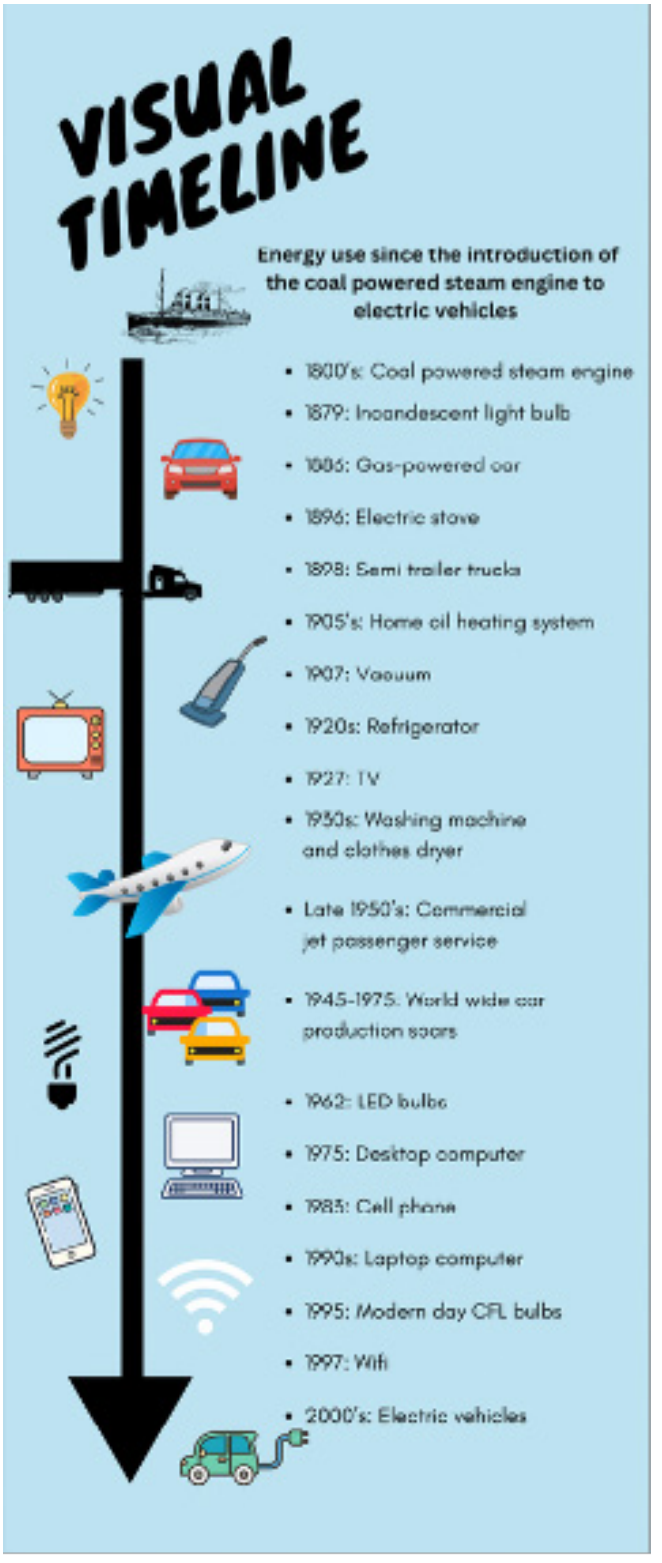
Sheldon-Dean, H. (2022) Kids and climate anxiety: Helping them handle big worries in healthy ways. *Child Mind Institute*. https://childmind.org/article/kids-and-climate-anxiety/

Simon, J. and Schneider, C.M. (2022) Climate change anxiety is real. Here's how you can manage those feelings. *NPR*. https://www.npr.org/2021/10/23/1047753592/anxiety-from-climate-change-isnt-going-away-heres-how-you-can-manage-it

How to use the lessons

In the following lesson outlines, we have provided you with some background knowledge about the energy transition as well as the tools for helping students observe this transition in their own communities and engage in dialogue and critical thinking about it, using pedagogies to spark imagination and hope for the future. The six lessons can be used in isolation or as a climate framework. While each lesson has listed age groups and suggested subject areas, there is information and activities for younger learners that may be tweaked for older learners. We look forward to hearing about how you and your students have used our work.

– Chloe Faught & Gillian Petrini



Background Information

History of Energy:

Every day, our lives depend on energy use — for transportation, the food we eat and how we prepare it, the homes we live in, the products we use, and many other comforts. Energy consumption has grown and continues to grow exponentially. While energy is a necessary part of modern living, we must transition to clean, renewable sources so that we can mitigate rising temperatures due largely to CO2 emissions. Fossil fuels still comprise the vast majority of our energy today. Our reliance on coal, oil, and gas — **energy sources** that are non-renewable — causes increased CO2 emissions and accelerates climate change.

For most of human history, work was done with muscle power, either by humans or non-human animals like horses. Eventually, fire was discovered and humans relied on it as a primary energy source for warmth and cooking food. The burning of biomass — solid fuels such as wood, waste from crops, and charcoal — was the primary energy source around the world for much of the early part of humankind. The need for energy increased exponentially with our increased technological innovations and resulting transportation and industrial activities. In the mid 1700s, the Industrial Revolution brought about the reliance on coal for energy. It was used heavily during this time and enabled further transport of both people and goods. Oil and gas were discovered soon after and became increasingly in-demand, especially with the introduction of the automobile in the 1900s, which became increasingly cheap and mass-produced, further increasing the need for fossil fuels. The addition of hydropower followed, and in the 1960s, nuclear power was introduced. While renewable sources have always been used in varying capacities — from windmills to water mills to passive solar — it wasn't until the late 1980s that they became a more viable energy source with slow but increasing adoption.

The Paris Agreement and commitments to net zero

Now in 2023, fossil fuels still power most of our energy needs, and at a debilitating cost. There is a need to swiftly transition off fossil fuel to low-carbon energy sources. The climate crisis is a direct result of our reliance on energy supplied by the burning of fossil fuels and the UN has declared the following:

The science shows clearly that in order to avert the worst impacts of climate change and preserve a livable planet, global temperature increase needs to be limited to lower than 2C above pre-industrial levels. Currently, the Earth is already about 1.1°C warmer than it was in the late 1800s, and emissions continue to rise. To keep global warming to lower than 2C — as called for in the Paris Agreement— emissions need to be reduced by 45% by 2030 and reach net zero by 2050.

https://www.un.org/en/climatechange/net-zero-coalition

Countries around the world have made varying levels of commitments to reach **net zero** by 2050. The first lesson highlights the innovative ways that some countries are using their resources, natural strengths, and ingenuity to meet the critical demand for clean energy.

There is a broad range of initiatives, from policies put in place for reducing carbon emissions and incentives for accelerating the adoption of electrification of transportation to increasing our access to renewable technology and using renewable energy sources directly. Also highlighted is the critical need to not only reduce CO2 emissions, but to also preserve, expand, and protect natural areas, forests, wetlands, and other green spaces as carbon sinks.

What are Canada's commitments, targets, and policies?

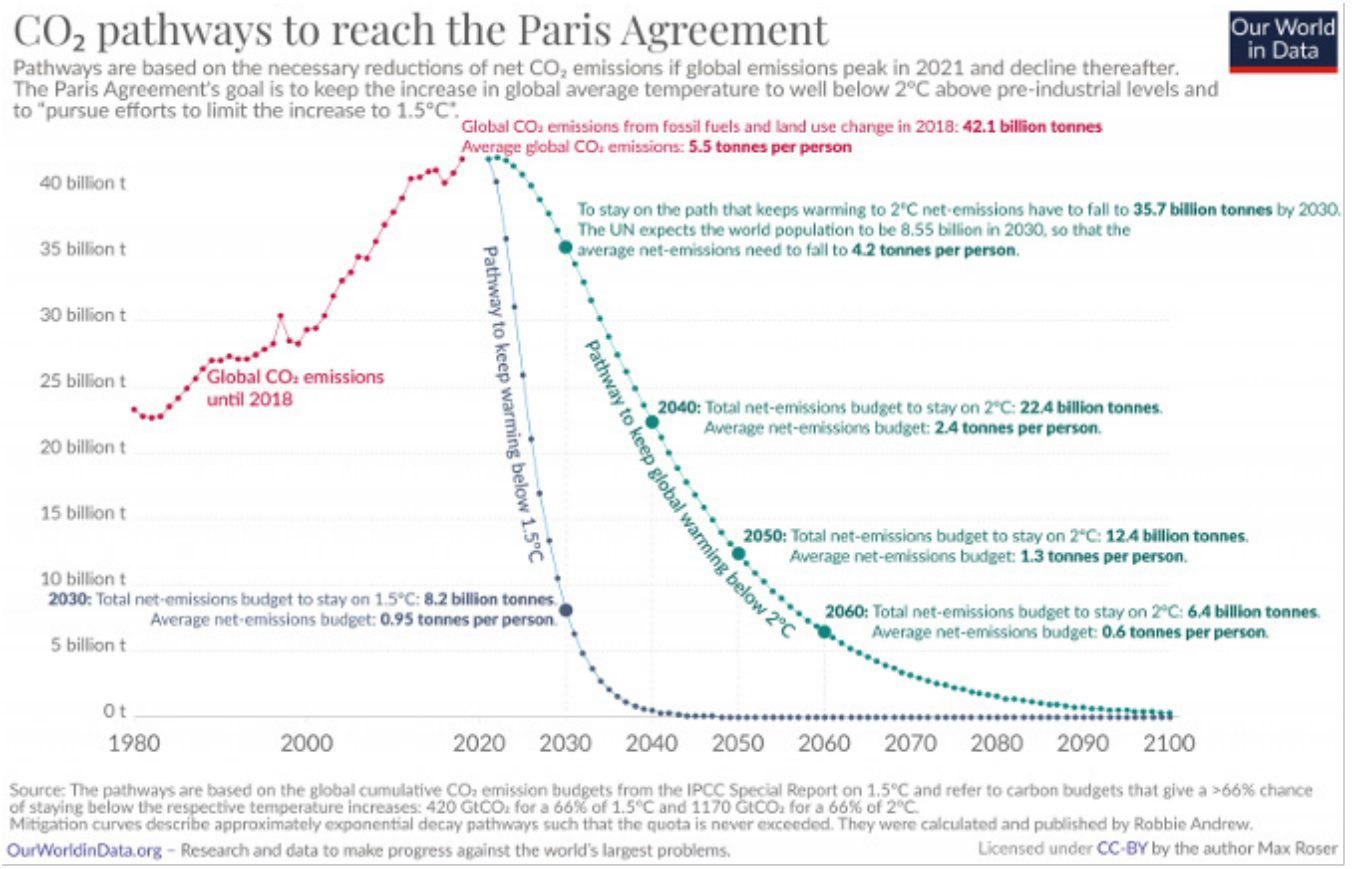
The International Energy Agency (IEA) documents all of its member countries' energy policies. Most countries are members, so if you live outside of Canada you can look up your own country's report and compare it to other countries' policies.

Canada now has a target to "cut greenhouse gas emissions by 40–45% by 2030 from 2005 levels to reach net zero emissions by 2050" (IEA, 2022). Here are some ways Canada hopes to achieve these targets:

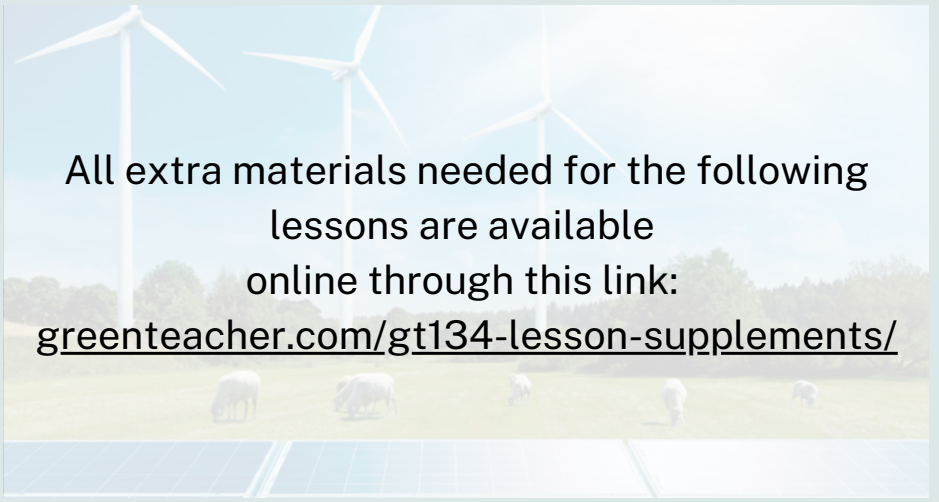
- carbon pricing (carbon tax) scheme with increasing rates over time
- clean fuel regulations
- phasing out unabated coal (burning with no pollution regulations) by 2030
- expanding nuclear plants
- methane regulations
- energy efficiency programs
- decarbonizing the transportation sector

Terminology:

1. **Bias:** When a prejudgment or belief from an individual or organization affects the argument shared about a topic. Sources that are strongly biased often do not provide credible sources for their facts.
2. **Biofuels:** A renewable energy source that produces carbon emissions. Historically, almost all of our energy came from biomass fuels (solid biofuels): peat, dung (poo!), or wood. Today, many people living in poverty only have access to biofuels. As well, we are learning to generate energy from new sources: our sewage, animal waste from farms and food crops (e.g., corn, sugarcane).
3. **Carbon footprint:** Part of an ecological footprint that focuses on the amount of carbon dioxide being emitted by a person or an organization. According to the Footprint Network, the carbon footprint is currently 60% of our ecological footprint (see below).



4. **Credible:** Someone or something that is worthy of being believed.
5. **Decarbonization:** The process of removing carbon-emitting energy sources and converting them to zero-emission sources.
6. **Disinformation:** False information that is deliberately created to mislead people, often spread through social media or biased websites.
7. **Ecological footprint:** A measurement tool that calculates how fast we use resources and create waste in comparison to what nature can provide and support. Usually measured by the number of Earth's needed to support a specific individual.
8. **Energy:** The ability to do work (in these lessons, referenced through the different sources that can provide energy).
9. **Energy self-sufficiency:** When a community or building does not need to buy, connect to, or import energy from an external company or electrical grid to meet its needs — especially important for remote communities that do not have an electrical grid.
10. **Energy poverty:** Hundreds of millions still lack access to sufficient energy, which has consequences for the natural environment and the lives of these people (if they use an inefficient source such as biofuels).
11. **Energy source:** Part of the energy supply, offering energy in its most basic form (e.g., sun, wind, running water)
12. **Energy sovereignty:** Indigenous communities (or other communities) being able to make informed decisions about and supply their own energy needs in a way that is affordable to the community. It is part of the process of decolonization.
13. **Net zero:** Greenhouse gas emissions are at zero, either because there are no emissions or because they are balanced by the equal removal of those emissions (e.g., through carbon capture, utilization, and storage)
14. **Renewable:** A source that can be replenished and renewed naturally
15. **Non-renewable:** A source that once used up is inaccessible and cannot be renewed.
16. **Sustainability:** A complex word that gets used differently, especially in the context of "sustainable development." The UN has 17 sustainable development goals which outline 17 goals with targets that "provides a shared blueprint for peace and prosperity for people and the planet, now and into the future." (https://sdgs.un.org/goals)
17. **Technology:** The application of knowledge to practically aid human life.
18. **Terawatt hours (TWh):** 1 terawatt = 1 billion watts (e.g., an LED light bulb uses 2–18 watts)
19. **Tonne:** 1000 kilograms (~2,205 pounds)



Lesson One: Energy All Around


Overarching inquiry question(s)

How is energy used where we live?

Target age group: Grades 1–4

Curricular competencies (listed in brief)

- Observing in familiar contexts
- Communicating observations and simple predictions
- Demonstrating a sense of curiosity

Summary (learning & pedagogical outcomes, goals, & activities in brief)

In this lesson students will come to notice in familiar environments — their classroom, school, and community — that energy is used every day in our lives. Students will observe energy in use by engaging their senses through active engagement, both indoors and outdoors.

Students should know that there are many different sources of energy and that energy represents the ability to do work. For example, our bodies receive energy from food and preserve energy by drinking water and sleeping, allowing us to move and think. Our human energy allows us to jump, run, play — anything that helps us use our bodies or brains. Humans have used this energy — muscle-powered energy — for many years as an energy source. As time has progressed, humans have used many different energy sources to power devices and machines we rely on, such as light bulbs, stoves, kettles, cars, trucks, washing machines, etc. Each of these requires energy to do its work and this energy needs a source.

Opening

Circle opportunity

If possible, begin with students sitting in a circle, using the circle method ***outlined in our framework***, and offer the question, *what comes to mind when you think of the word 'energy'?* Moving around the circle or through the class, students can share a word or a few words that come to mind when they think of the word 'energy.' At this point, there is no right or wrong answer. The educator can simply do a quick assessment of the group's understanding of energy. Explain that energy is used everywhere. We give our bodies energy with food and restore it with water and sleep so that we can be active. Our human energy allows us to jump, run, and play, and helps us use our bodies and brains. The energy we are going to focus on today is the energy that is used not for our bodies but for the machines and devices that we use every day. These machines and devices don't require food; they need a different kind of energy source. Today we are going to be energy detectives and find evidence of things that need energy and how they get that energy.

Activity

Suggested materials:

1. Energy Detective name tags
2. Magnifying glasses
3. Find the Clues worksheet

4. Sound Map worksheet
5. Clipboards
6. Pencils

Below are six walking energy lessons. Each walk can be done in isolation, although it would be ideal for them to build upon one another (maybe one each day or once a week over a period of a few weeks). The walks have the potential for more complexity so that they can be adjusted for older students. The walks are inspired by Gillian Judson's work on imaginative education and engaging students in learning, based on her resource The Walking Curriculum. With most of the walks, there are opportunities for building interconnectedness within both the school community and the broader community.

1. Classroom walk

For younger students, the role of detective can be enhanced with use of name tags **(see Energy Detective name tags worksheet)** and by getting students to hold a magnifying glass. Students could use the Find the Clues worksheet to record where they find a machine/device that uses energy or the source from where that energy comes (e.g., electrical outlet). Alternate options for documenting their observations could include counting how many things they find or just observing. With older students, documentation could be done with ipads or cameras.
Students should be invited to explore the classroom, looking for as many examples they can find of energy-related items or evidence of energy sources. Begin by demonstrating an example as a whole class to ensure that they understand. This could be done as an "I Spy… "

Example: *"I Spy something using energy that is grey."* (computer)

Give students time to circulate and record. When they seem to have finished, gather again. To begin, students should compare their findings with a Turn and Talk (find a partner and share the found clues). After this is complete, the class can share their findings altogether. The educator should document students' responses so that they can be seen and referenced.

2. School walk

This walk is similar to the classroom walk but takes place around the school. It also involves the same kinds of documentation (based on age level), including the Find the Clues worksheet, counting, noticing, and/or through photo documentation. Have students walk through the school identifying any items they see using energy and signs of energy use. When they seem to have finished, gather again. To begin, students should compare their findings with a Turn and Talk (find a partner and share the found clues). After this is complete, the class can share their findings. The educator should document the responses so that they can be seen and referenced.

3. School walk with the school custodian

Invite the school custodian to join the class on a walk in and around the school. This might include a heating room and any area that is usually not accessible to students. When they seem to have finished, gather again. To begin, students should compare their findings with a Turn and Talk (find a partner and share the found clues). After this is complete, the class can share their findings. The educator should document the responses so that they can be seen and referenced.

4. Community walk

This walk builds upon both the classroom and school walks. Again, students are invited to document their observations in their preferred way, including the Find the Clues worksheet, counting, noticing, and/or photo documentation. This outing could be done as a mindful walk (i.e., intentionally noticing everything around) or it can be done with clipboards and the attached worksheet. Before heading out, remind students to look all around, up, down, side to side, etc. Energy is being used everywhere. At the end of this time, gather again either outside or back in the classroom. To begin, students should compare their findings with a Turn and Talk (find a partner and share the found clues). After this is complete, the class can share their findings. The educator should document the responses so that they can be seen and referenced.

5. Community sound mapping

To extend the community walk, return to a place in the community where a short sound-mapping exercise could be facilitated. Students will be asked to find a spot to sit with their **Sound Map Handout** (in worksheet package), a clipboard, and a pencil. Their job is to just listen and record the sounds they hear, both natural or human-made. Their recordings are simply to be marks of their choosing. They do not need to draw an image of what makes each sound. The marks should be different for the different sounds (e.g., a scribble, a straight line, a circle, shapes or letters, numbers, etc.). The recording process should be briefly demonstrated with the whole class. Students could contribute to a group sound map before making their own individual ones.

Once at the location for the individual sound-mapping activity, students should be on their own in a place where they can sit for 1–5 minutes.

Some ideas for sound mapping spot selection include the following:

- Find a spot on your own, not with others.
- Find a spot that is comfortable (i.e., where you can sit for a period of time).
- Find a spot that is safe (i.e., not on a high wall).

After a successful period of listening, have students complete a Turn and Talk again with a partner. As a group, record the heard sounds in a visible place that the whole class is able to see. Review the sounds collectively, identifying the ones that come from items human have created (e.g., vehicles, devices, machines).

Reviewing evidence

At this point, review the documented sound clues related to energy use. Students should begin to think about how these clues are related to energy and where the energy comes from. This could be a good time to return to the collective gathering/documentation of clues and begin to discuss the energy source for each one.

Table 1: Examples of where energy is used

Classroom	School	Community
Computer (electricity) Light Electrical outlet Phones	Lights (electricity) Electric cables Electrical outlet Heater (in the boiler room)	Cars (gasoline) Trucks (gasoline or diesel) Electrical power lines Lawn mowers

The class can complete a Turn and Talk where they make predictions about the sources of energy for the different places where it is used. From these discussions, the class can come together and share their thoughts. The educator can guide these discussions and talk about the various energy sources associated with each item.

Depending on grade level, the next step would be to begin naming these energy sources as renewable and non-renewable. A conversation about renewables vs. non-renewables would follow. Explain that when non-renewable fossil fuels are used, greenhouse gas emissions are given off that impact the health of our planet and us. Renewable sources emit either no emissions or low-carbon emissions (e.g., biomass like wood).

6. Community renewables walk

The final walk is to look for only renewable energy used in the community. An initial discussion of what this could look like would be beneficial. This might include an overview of such examples as rooftop solar panels or hydroelectric power lines. *(It should be noted that not all electricity is generated from a clean energy source such as hydropower, wind, or solar. Electricity may also be produced from a variety of non-renewable sources such as natural gas, oil, or coal. It differs from one place to the next.)* Encourage students to use all of their senses to find the clues of renewable energy in use. Again, document and discuss the group's findings.

Closing

Each walk should conclude with a closing circle. Sharing may be as simple as naming something they noticed, something surprising, a specific sense used and what they sensed. Students can share moving around the circle, always with the option to pass if they don't want to share.

Extensions

- Journal writing about their observations after each walk
- Further exploration of renewables vs. non-renewables
- Walks in other neighborhoods; other parts of town
- Calculating the number of steps in or the distance of their walks (since walking is powered by renewable energy!)

Lesson Two: Our Changing Energy Use Over Time

Overarching inquiry question(s)

How have energy sources changed over time (past, present, and future)?

Target age group: Grades 4–6

Curricular competencies (listed in brief)

- Questioning and predicting
- Critical thinking (about energy use over time)
- Analyzing information in graph form
- Drawing conclusions from the evidence
- Making and communicating simple predictions
- Listening to the perspectives of others

Summary (learning & pedagogical outcomes, goals, & activities in brief)

In this lesson, students will begin by analyzing information displayed in various graphs. They will be encouraged to reflect on this information about energy use over time and the consequential carbon emissions of this energy use. Students will then be guided through a discussion of the term 'net zero' and the goals set out by the United Nations (UN) to reach net zero by 2050. Reflecting on how this shift might unfold, students will make their own personal connections and predictions through interviewing themselves and others to gain further perspectives.

Suggested materials:

Energy Use Trends PPT: Graphs 1–4
Energy Interview Worksheet x 3

Opening:

Circle opportunity

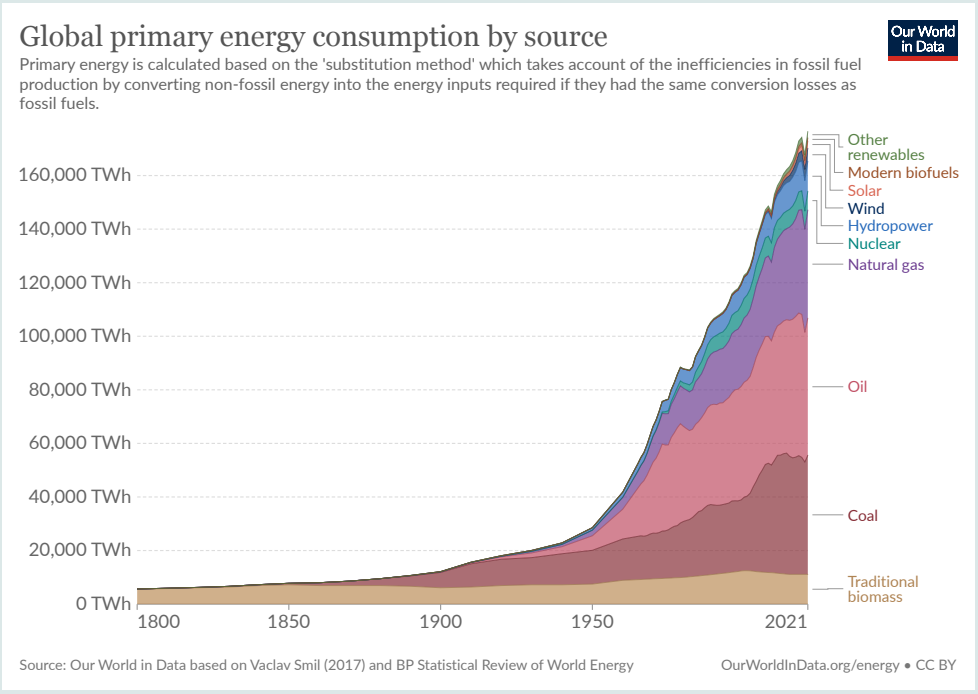
Begin in a circle, using the circle method ***outlined in our framework***, and as an opening question. Either of the following questions could be used. There are no right or wrong answers, and there is always the option to pass.

- What is one technology you could not live without?
- What is one technology that you see as helpful? What is one technology that you see as harmful?

Looking at graphs

Explain that humans have become more and more dependent over time on a greater number of technologies, from lightbulbs and clothes dryers to cars and airplanes. This has meant an ever-increasing reliance on the energy needed to run these technologies.
Invite students to look at Graph 1 and Graph 2 in the worksheets, explaining what each of the graphs is showing.

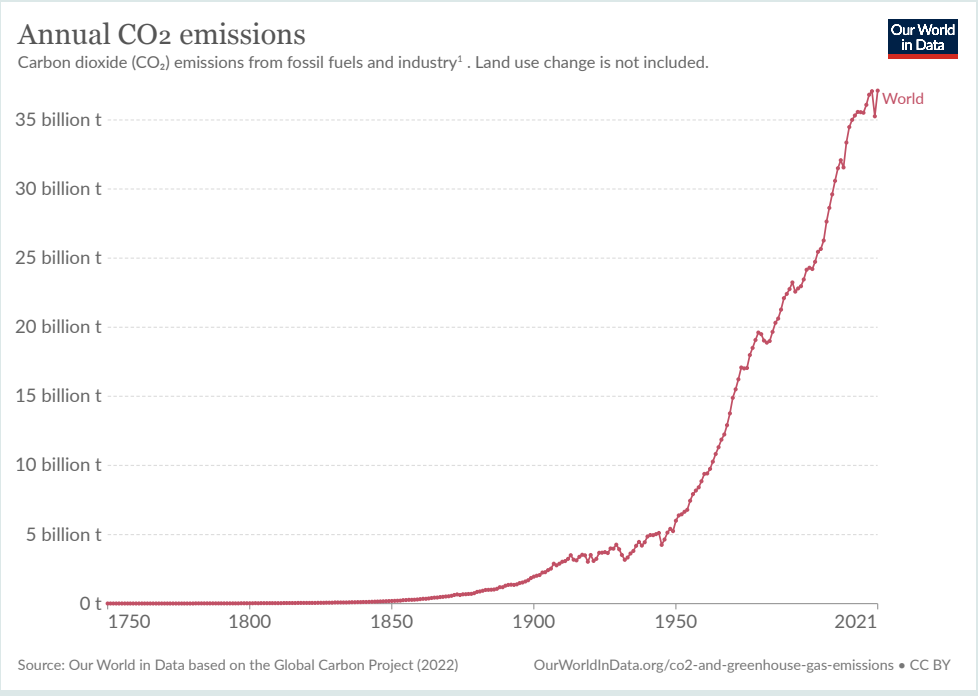
Graph 1: Energy consumption globally (measured in TeraWatts; see definition in backgrounder)



This graph and the interactive from the website show how energy sources have changed since 1800 from traditional biomass (wood, peat, dung) to a variety of mostly non-renewable sources, and then more recently renewable energy sources.

Question: Ask students noticed from this graph, invite students to turn and talk with someone nearby for 1 minute or so, then if time, share out with the larger group.

Graph 2: Global CO_2 emissions from fossil fuels



This graph and the interactive from the website show how carbon dioxide emissions have increased over the last few centuries.

Questions: Ask what students have noticed in this graph. Invite them to turn and talk with someone nearby for one minute or so. Then, if time allows, share out with the larger group.

After viewing the graphs, some insights that may emerge could include the following:

- They all go up.
- Something happens in the 1900s where all the lines go up.
- Something again happens in the 1950s.

Encourage further discussion and thinking by asking the following: *Why do you think the line has gone up? What has happened, especially in the peak periods of increase?*

Give students time to make predictions, turn and talk with nearby partners, and then share out.

Activity

1. The energy transition

As carbon emissions have risen, so too have global temperatures.

Relook at Graphs 1 and 2 and explain that to curb emissions and rising temperatures, the line needs to go down. Show where this line needs to be with Graph 3, explaining what net zero is and that we need to reach net zero by 2050.

Graph 3: CO_2 pathways to reach the Paris Agreement

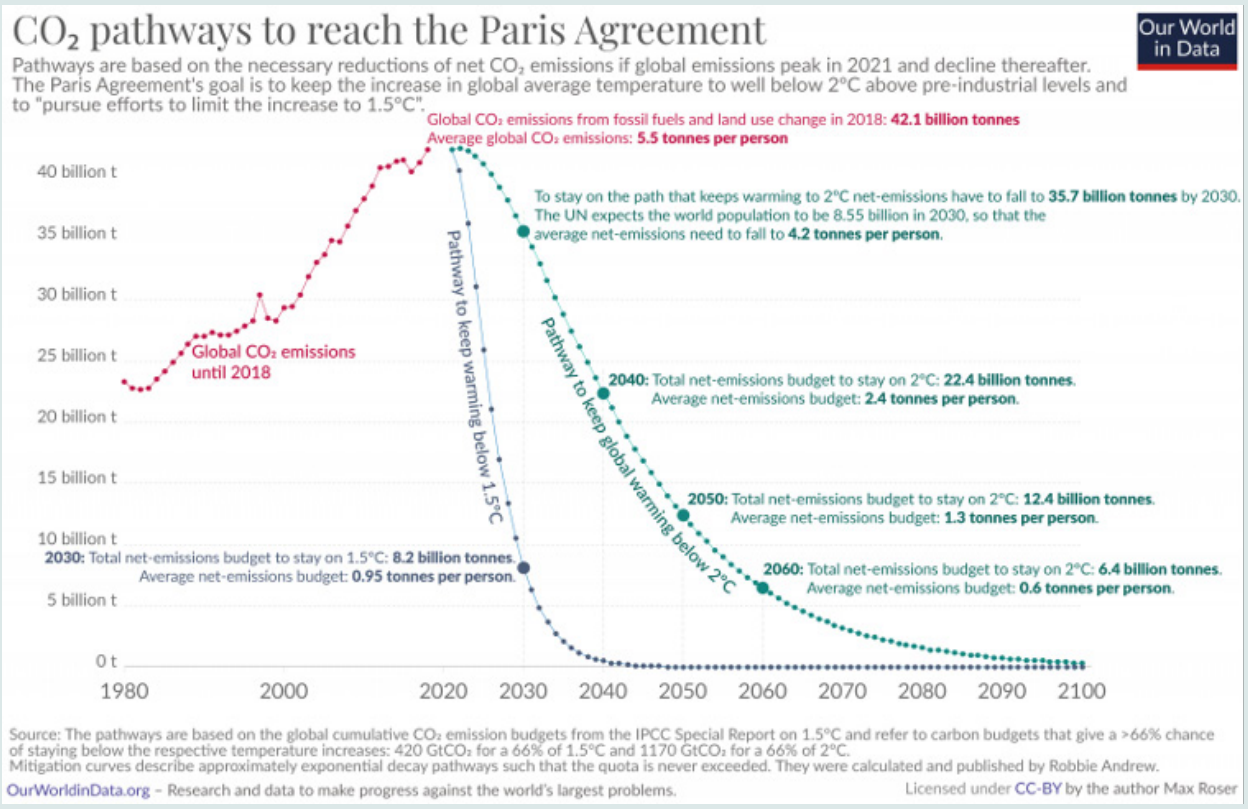
Pause for a discussion or a Turn and Talk.

2. The interview

Explain to students that they are going to be investigating perspectives on energy use over time and projected shifts in energy required for achieving net zero. They will be asking questions of themselves and others to gather various perspectives. Review the interview questions (below) with the class. The interview sheet is found under Lesson 2 in the worksheet package. Students will need three copies. The interview recordings could also be done using a device.

To demonstrate answering these questions, the teacher could share their own answers to just one or all. Another option is for the class to collectively answer one question first.

Graph 3:



This graph shows the current data for CO_2 worldwide as well as projected slopes to reach emissions cuts, with 1.5°C and under 2.0°C as goals.

Interview Questions

- How has energy use changed in your life? What are some examples?
- What do you think needs to happen to reach net zero by 2050? Why do you think this?
- (Net zero means that the amount of greenhouse gases produced is balanced by the amount that can be removed.)
- What do you see as the challenge(s) to making this happen?
- Do you have any ideas for how these challenges could be overcome?
- What is your wish for the future in terms of energy use and sustainability?

First, students reflect on these interview questions, think of their own answers, and record them. Next, students partner up and ask one another to answer these questions and record them. Finally, students choose someone at home to answer these questions and record them, before bringing the answers back to class to share. Names of those interviewed can remain anonymous.

Closing

A beneficial closing would be to have students share with one another their interview recordings from home during partner talk or in small-group discussions. Ask students to reflect on the following when discussing their interview answers:

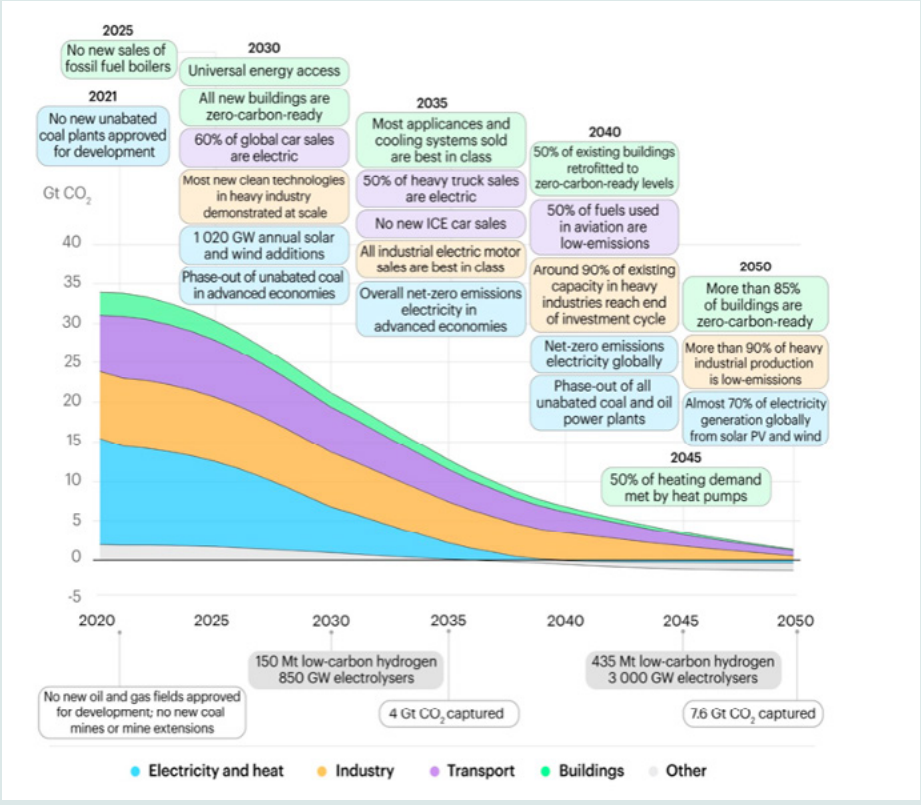
- What were some similarities and differences among those interviewed?
- What was surprising? Was there anything you learned or are wondering about more?

Share out as a whole group either as part of a class discussion or a gallery walk of interview questions.

Finally, share examples of the work and ideas of others. Refer to Graph 4 in the worksheet package to highlight the International Energy Agencies (IEA) plan for reaching net zero.

Questions:
How do any of these actions align with what you heard about in your interviews?
Are there any ideas presented in this that are new to you?

Graph 4: CO_2 net zero pathway



This is an outline of initiatives and subsequent CO_2 reductions proposed by the International Energy Agency (IEA).

Closing circle

As part of a closing circle to this activity, invite students to share the following:
From the ideas heard, if you could put one action in place today to reduce emissions and work towards net zero, what would it be?

Extensions

Language Arts

Interview questions could be made into a story-writing or essay exercise. Students could turn these into multimedia content, such as short videos or podcasts.

Science

Students could make carbon footprint calculations to help them reflect on their own carbon emissions and brainstorm ways to reduce them on a personal level.

Lesson Three: Race to Net Zero

Overarching inquiry question(s)

How are regions of the world achieving or working on achieving net zero?

Target age group: Grades 6–8

Curricular competencies (listed in brief)

- Critical thinking (about net-zero action)
- Forming and communicating opinions
- Listening to the perspectives of others

Suggested materials:

Energy Use Trends PPT: Graph 5
Lesson 3 Country Cards

Summary (learning & pedagogical outcomes, goals, & activities in brief)

In this lesson, students will have an opportunity to learn about initiatives being implemented and policies being put in place by countries around the world. Students will also analyze the carbon dioxide emissions of various countries and consider present and historical responsibility. Students will role play being delegates from various countries. They will share and discuss ideas with one another, recording notes, answering questions, and beginning to form opinions based on their learning.

Opening

Circle opportunity

If possible, students can begin in circle (using the circle method ***outlined in our framework***) with an initial question which could be either of the following:

- *What is an initiative that you think would be most effective for reaching net zero? (based on previous lesson)*
- *What is one thing you can do to reduce carbon emissions?*

Students can share their answers one by one in a circle. Answers can be repeated, and there is always the option for students to pass.

Explain that today they are going to be learning about what countries/regions from around the world are doing to reach net zero.

Graph 5

Next, show students Graph 5 in the worksheet package. This graph shows carbon dioxide emissions per country. The associated website has an interactive component which allows one to see which countries fall into each emissions level. The user can hover over any country to see the country name and emissions per capita (per person). Explain that the darker the color, the higher the emissions. Emissions are in tonnes (one tonne = 1000 kg).

Have students Talk and Turn to share their initial thoughts on this graph. Some guiding questions may include the following:

- What are some of the countries with the highest emissions levels?
- What are some countries with the lowest emissions levels?
- What does the map tell us about emissions levels in the south of the globe vs. the north?

Activity

1. The context

For this activity, students will be representatives of designated countries. They will be given a short piece that outlines what their assigned country is doing to achieve next zero. Students will be given the chance — in role as delegates — to attend a UN climate event where they will be mingling with representatives of countries from around the world.

2. The event

Students will each have a country **(Country Cards 3 worksheet package).** There may be multiple delegates from each country, ideally two or three. There is also the option for students to try finding information about a country of their choice. Students should review their country card. Delegates of the same country can gather prior, ensuring they are confident with all the details.

Before beginning the event and moving around the room, explain that while attending the UN climate event, delegates are to be learning about other initiatives being conducted by countries around the globe. Delegates should be recording the initiatives of other countries for further analysis.

Review some questions that could be asked:

- *What country are you from and tell me about your country?*
- *How are you working towards net zero?*
- *What is the most important action you are initiating?*
- *What are your country's goals for emissions reductions?*

Once everyone feels prepared, students can circulate the room and have conversations with one another, recording details.

3. Graph 5 reflection

Once there has been sufficient time for students to converse with one another, bring the delegates back to meet with those from the same country. Review what they have heard from others.

Together, review the following questions as they pertain to one of the countries in order to stimulate deeper thinking about the actions being taken and the level of responsibility for climate change/emissions levels. Pick any country to review together, referencing Graph 5.

- » *What are the CO2 emissions levels per capita (per person)?*
- » *How do you think this country is doing on the pathway to reach net zero by 2050?*
- » *How do you think this country meets its responsibility as a member of the global community to reduce emissions levels by 2050?*

Once this has been done together, groups can continue to answer these questions for the other countries with which they have met.

After an adequate amount of time, come together as a whole group and ask the following:
If carbon dioxide emissions are causing climate change and the impacts are felt globally, who is most responsible for fixing it?

Closing

Share out

Each student will share one thing they noticed, one thing that surprised them, and one wondering/question they still have. This can be done as a Turn and Talk first and then in a circle with the entire group.

Extensions

Students could do their own research on a country of their choice by referencing the Climate Action Tracker: https://climateactiontracker.org/countries/canada/

Resources used for info on Country Cards.

1. https://earth.org/bhutan-carbon-negative-country/
2. https://thelatch.com.au/icelands-sustainability-innovations/
3. https://net0.com/blog/net-zero-countries
4. https://unfccc.int/news/seven-developing-countries-take-another-important-step-in-the-race-to-net-zero

Lesson Four: Energy Transition Leaders

Overarching inquiry question(s)

How is my community and/or school working toward net-zero emissions and how can we help encourage this transition?

Optional sub-questions

Does my community and school/district have an energy transition plan? If so, how can we help to make it a reality? If not, how should we support the development of one?
How does my community's goals and progress compare with those of other communities?

Target age group: Grades 6–8 (appropriate for Grades 4–12 if adapted)

Curricular competencies

- Developing an understanding of the goals and targets to reach net-zero emissions
- Conducting research and making comparisons about climate targets and action plans at the federal, municipal, and school/district levels
- Examining the importance of both individual and community contributions to climate action due to the complexity of climate change
- Discussing methods for being engaged in your community and the concept of collective action
- Developing climate action goals for your school or classroom and taking action!

Summary (learning & pedagogical outcomes, goals, & activities in brief)

There is strong emerging evidence that educating and engaging students in climate action can lead to large reductions in emissions and that school districts are in the "sweet spot" size of a population to engage in projects due to "cost-benefit optimization when it comes to the global impacts of our local actions" (Kwauk and Winthrop, 2021).

This lesson builds on the previous lesson (which compares net-zero policies and targets worldwide) and involves discussions of these policies at a local level (school-district level is suggested, but municipal or provincial would work too). Students and teachers will begin by looking at some of the targets at the level they have chosen and investigating whether their community or school district has a climate action or sustainability plan.

Together, the class will discuss whether they see any of the climate targets being worked on in their community as well as which ones they don't see. Through this process, students can gain an understanding of how all citizens can be involved in community engagement related to decarbonization.

Using a carbon or ecological footprint tool is suggested to help the class examine which actions collective and individual actions have the biggest impacts.

As a class, students will then develop a climate action plan or decide on a specific activity (such as writing to their municipality or school board or starting a project in the school) that they will undertake so that they can be leaders in the transition.

Source:

Kwauk, Christina and Winthrop, Rebecca. (2021). *Unleashing the creativity of teachers and students to combat climate change: An opportunity for global leadership.* The Brookings Institution: Washington, D.C. https://www.brookings.edu/research/unleashing-the-creativity-of-teachers-and-students-to-combat-climate-change-an-opportunity-for-global-leadership/

Additional background information: Energy use, fossil fuels, and the biggest emitters

Energy use globally accounts for ~73% of all greenhouse gas emissions (Our World in Data). Because of these emissions, it is crucial that we transition to non-emitting energy sources. Although there are a number of ways we can reduce our collective carbon footprint, addressing energy use in our community through our buildings (17.5%), transport (16.2%) and industry (24%) will have the greatest overall impact on our ability to reach net zero.

Suggested materials and tools:

- Footprint Calculator from Global Footprint Network-: A clear and simple web-based calculator that provides data and solutions
- Article on **The First Carbon Neutral School in Canada** or other examples of positive energy projects in schools
- Handout on **Questions for Examining Your Local Climate Plan**

Resources to help guide teachers and students in finding out about emissions & targets

1. Climate Action Tracker: Tracks country targets, policies, and actions
2. **Provincial Climate Action Plans**: Check your Provincial Government or municipality for climate plans. The Center for Climate and Energy Solutions provides a map that shows which provinces and states have climate plans and brief summaries of those plans (a bit out of date)
3. **Emissions:** Statistica.com has interesting graphs with statistics on emissions by province and overall emissions for Canada and other countries.

Opening

Whether you've completed any of the other lessons or not, likely all students beyond early elementary will have heard something about the climate 'crisis' or 'emergency' or about climate change and have some thoughts and feelings about what this means to them and their future. Anxiety, grief, helplessness, and/or apathy are all possible. Please see our ***lesson framework's section on climate anxiety and grief for more information and resources.***

Circle opportunity: To allow for students to access their prior knowledge and feelings in a resperctful and supported way and to stimulate an interest in making changes, use the circle method **outlined in our framework**. Give a bit of a backgrounder about climate change to students and include information about the huge and complex task humanity is faced with in solving this problem. There is not one solution and no easy answers. This can be difficult to comprehend, especially if students have noticed or been impacted by some of the effects of climate change. Sharing feelings in a circle can help bring a sense of community and a common experience that can help bring the class together.

Use this prompt: **When I think about climate change, I feel... because...**

Before moving to the next task, thank everyone for their thoughts and feelings and for being respectful both before and after the sharing. You may wish to bridge this sharing by recognizing why taking action as individuals and as a class can help with certain feelings.

Terminology (listed in the backgrounder)

- **Carbon Footprint:** Part of an ecological footprint that focuses on the amount of carbon dioxide being emitted by a person or an organization. According to the Footprint Network, it is currently 60% of our ecological footprint.
- **Ecological Footprint:** A measurement tool that calculates how fast we use resources and create waste in comparison to what nature can provide and support. Usually measured by the number of Earth's needed to support a specific individual.

Activity

1. (Optional) Begin with a brief overview of national or principal emissions reduction goals (see overview for Canada's goals and resources above). You may wish to complete some or all of Lesson 3 first to give students an understanding of net-zero emissions targets.
2. Give students a case study of a school or district that has taken on climate action, and then discuss as a class how students or school districts are taking action. There are many examples you can draw from, or you can use the one that is provided by **John Paul II Catholic Secondary School.**
   - Suggestions for sources:
     - » UNESCO Associated Schools Network: Ten Canadian School Stories of Climate Action (2018)
     - » Vancouver School Board's Sustainability Plan with links to resources for students, teachers, and families
     - » **Handout article: The First Carbon Neutral School in Canada**
3. After students have completed the reading, discuss the case study, regroup, and then come up with definitions

for what leadership, collective action, advocacy, and activism mean. How do each of these play a role in making changes in your community?

4. Find your municipal or school district's climate action or sustainability plan and take a look at what is in it. Use these questions (below) and/or the **linked handout** to discuss whether the plan (if there is one) is a good one and whether appropriate action is being taken.

- **Worksheet: Questions for Examining Your Local Climate Plan (see worksheet package)**
  - » Does your school district have a sustainability or climate action plan? Y/N
  - » When was it written? Does it have measurable action in it for the district and for schools to follow? Y/N
  - » Does the plan address emissions in these major sectors?

a. Transportation: Plan to convert buses and district vehicles to renewable (electric) sources and plan to encourage active transportation of students and staff (walking, cycling, scootering, etc.).

b. Energy use: Plan to convert boilers using fossil fuels to renewable energy sources; plan to improve energy efficiency in devices or reduce overall energy use in the school (conservation).

c. Buildings and renovations: New buildings or renovations include plans to improve the energy efficiency and sustainability standards (i.e. LEED status).

d. Biodiversity and carbon sequestration: Plans include planting more trees and improving natural landscapes within school grounds to sequester more carbon.

e. Waste: Plans to improve composting and move to zero waste.

f. Food: Plans at places where food/cafeteria services exist to allow or incorporate vegan and vegetarian options.

5. **Circle opportunity:** After students have completed the previous activity, reconvene in circle. Have each student share what they have learned. Consider these prompts:

   What is one thing that you are proud of that is happening in our community?

   What is one thing that you think our community still needs to take action on?

6. **Take action**: Using what was discussed, develop a 'next steps' action plan that your class will carry out. What the plan looks like will vary widely depending on what you discover. Here are some examples of ways you might carry forward the work:
   - » **If your school, district, or community has no climate action plan:** Consider having students write to your school district asking for them to create a climate action plan and make suggestions for what to include. Or ask to speak at a board meeting or hold a climate action event for the community. Perhaps you'd like to include your whole school or other classes by having a student-led teach-in to teach WHY your students think an action plan is necessary.
   - » **If your district/school has a climate plan:** Analyze how your specific school is or is not meeting one or more targets. Perhaps choose a couple to work on. Have students divide into groups to make their own plans for the school or class. Have them present their ideas to the class. Either incorporate them all into one plan or choose one or two actions to take; develop steps for completing goals. Involve your school leaders — teachers, principal, custodians, PAC (Parent Advisory Council or similar), and district staff — to get them involved!

Closing: Celebrate your successes

Whether you have simply learned and engaged in the process of helping your community develop plans, or whether you take actions personally, as a class, or as a school to reduce your carbon emissions and move your school toward net zero, you should celebrate!

Options:

1. A closing gratitude circle to share what students have learned or feel proud of
2. A celebration/party in your class — invite your admin or parents to come and learn and see what your class has created.

Extension: Get creative!

Are your students really engaged and taking action? Present your action plan in a variety of creative ways: writing, public art, music, drama, or media. There have been many successful teach-ins, art displays, or even advertisements that have helped change minds and spur environmental action.
Greenpeace has a variety of toolkits to help you engage, including this one: Tools for Teacher to Empower the Next Generation of Activists

Lesson Five: Global Energy Expo

Overarching inquiry question(s)

How has energy shaped our societies today and which ones should we be investing in for the future?

Target age group: Secondary (Grades 8–12)

Curricular competencies (listed in brief)

- Questioning and Predicting
- Critical thinking (about global energy use)
- Synthesizing information through research to create a non-biased position on an energy source
- Communicating ideas for a position through oral and written work
- Drawing conclusions from the evidence

Summary (learning & pedagogical outcomes, goals, & activities in brief)

Our societies today are shaped by our access to energy and how we've transformed it for transportation, industries, buildings, and personal use. How we produce and use energy has shifted immensely over time in both source and amount. According to Our World In Data, in 1800 we used roughly 5,600 terawatt-hours globally, mostly from biomass (wood, peat, dung), and in 2021 we used roughly 176,000 terawatt-hours, with oil and gas comprising the greatest proportion. How has this shift occurred and what does the future of energy look like?

In this lesson, students will be guided through the data on energy sources, consumption, and use before putting on their own Energy Expo wherein they will represent different energy sectors and investors. Doing so will help students dive into how the energy sector is changing globally as well as the various innovations that are taking place in different sectors. The Energy Expo provides students with an opportunity in groups to examine the data for their sector or role, draw conclusions about the trends, and create a presentation/pitch for investors. Students will apply critical thinking and communication skills as they role-play during the Energy Expo, either for their own class or for other classes in the school.

While different parts of this lesson could be completed within a single class, this lesson is best done over several days — an overview day for learning and to establish the Energy Expo criteria, a day or two for gathering data and setting up the expo, and a day for presenting and reflecting. There is also an extension lesson on Indigenous energy transitions leadership.

Specific terminology

Bias: When a prejudgment or belief from an individual or organization affects the argument shared about a topic. Sources that are strongly biased often do not provide credible sources for their facts.

Credible: Someone or something that is worthy of being believed

Disinformation: False information that is deliberately created to mislead people, often spread through social media or biased websites

Additional Key Information

1. Use the PPT provided (**Energy Use Trends: Canada and World)** to inform yourself and your students about the current global trends in energy use (see Part 1 in Activity).
2. **In addition, here are some key quotes from** IEA report for Canada in 2022 about Canada's energy and emissions:

Canada already has one of the cleanest electricity systems in the world (led by hydropower), with over 83% of production from non-emitting sources, and aims to increase that to 90% by 2030.

The dominant role that hydroelectricity plays in several Canadian provinces, along with the fact that many hydro projects in Canada are large and have sizable reservoirs, will also significantly assist with the integration of variable generation, as wind and solar generation are poised for growth.

The role of nuclear energy is recognised as fundamental to achieving and sustaining Canada's climate change goals and the technology is seen as a long-term source of baseload electricity supply.
Energy production and use in Canada accounts for over 80% of the country's GHG emissions, with fuel combustion in energy industries (including oil and gas extraction, electricity and heat generation, and refining) representing 26%, transportation 26%, buildings 13%, manufacturing industries 9%, and fugitive emissions 7% of overall emissions. Canada's electricity system is 83% non-emitting and among the cleanest in the world, with heavy dominance of hydropower as well as an important role for nuclear. Considerable variation in electricity generation profiles across jurisdictions means that increased interconnectivity across regions will be crucial to ensuring balanced progress across provinces and territories to meet national targets.
Improving the rate of energy technology innovation will be critical to enable the deep decarbonisation across sectors required to achieve net-zero emissions by 2050. To this end, Canada is actively advancing a number of technologies, most recently announcing additional support for carbon capture, utilisation, and storage (CCUS); hydrogen; and small nuclear small modular reactors (SMRs), with a view to serving as a supplier of energy and climate solutions to the world.

Source:

IEA. (2022). *Canada 2022*: Executive Summary. IEA: Paris.https://www.iea.org/reports/canada-2022, License: CC BY 4.0

Suggested materials:

- Student reflection journals
- Energy Use Trends: Canada and World PPT
- Energy Expo Research Notes worksheet
- Credible Sources Checklist
- Comparison Table for Energy Expo Participants

Opening

1. **Concept brainstorm:** Start by writing on the board "renewable" and "non-renewable." If your class is unfamiliar with these terms, you may wish to provide a definition or at least quickly brainstorm different sources of renewable energy. Are all renewable sources net zero? This is something to have your students ponder. (In short, the answer is 'no' — see biomass/biofuels).
2. **Journal prompt**: In one minute, write down all the different ways you use energy in your typical day. Now look over that list. In the next 30 seconds, highlight which ones are from renewable sources and which are from non-renewable sources.
    - Option 1: Now, in the next minute, answer this question by writing or sharing: *If you had to reduce or give up some of the energy you consume, which ones would you choose and to what extent would you reduce?*
    - Option 2: Now imagine that you lived on this land 300 years ago (roughly 1720s — perhaps as an Indigenous person, a fur trader, or an early New France immigrant). What energy sources would you use in a typical day at this time and how do they compare to those of today?
3. **Circle opportunity:** Allow each student to reflect and share one thought they had while doing this journaling exercise.

Activity

The activity in this lesson is divided into two parts and suggested to occur over two–four days.

1. Understanding global energy trends and transitions
2. Global Energy Exposition: See following activity framework on how to divide class, specific goals, timeline, & option

Part 1: Questioning and understanding global energy trends and transitions

Refer to **Energy Use Trends: Canada and World** PPT, where there are a few key graphs from Our World in Data, in order to guide understanding of the data, maps, and graphs and to encourage questioning. Our World in Data provides interactive graphs, and you are encouraged to share these graphs with students, ideally in an interactive way (either together through a presentation or as part of an individual activity). You may wish to explore the site and select your own graphs.

Main messages from the graphs in PPT

- » Global energy consumption is rising and has specific periods (biomass, coal, oil and gas growth, and now renewables.
- » Per capita, Canada is the largest energy consumer in the world.
- » Carbon dioxide levels have grown exponentially, and we'll have to make swift action to reduce emissions to allow for only 2°C warming and even swifter action to maintain 1.5°C of warming.

» Globally, there is a divide between energy-poor countries which do not meet their energy needs and those that do but produce too many emissions.

Part 2: Energy exposition

Now that students have an idea of some of the trends, they are going to put on an Energy Exposition (Expo). In small groups, students will take the roles of representatives from an energy company (dedicated to a specific power source). Students will then create some sort of visual/oral presentation to be featured in their expo booth to educate other participants about the reality of the industry and current trends. *Encourage students to be realistic and non-biased*, even though some industries are biased to protect their earnings.

Steps

1. **Choosing energy sources and groups**: Separate students into groups of three/four and designate an energy source that they will research. Be sure to include a variety of non-renewable (oil, gas, coal, nuclear) and renewable energy sources (see Article 3 for definitions of safe-bet sources like wind, solar & hydro, as well as wild-card sources of energy such as small modular nuclear, geothermal, nuclear fusion, and green hydrogen) as well as others such as modern biofuels.
2. **Researching and presenting**: Give students a class or two to find information on their energy type and its trends and to format their presentation (e.g., visuals on a poster or table work best, but a laptop screen could work if time is short). This topic is a great one for teaching about credible sources of information, as the energy industry includes some entrepreneurs and climate-science deniers who are biased and may be deliberately spreading disinformation to support their industry or beliefs.
   - **Worksheets:**
     - » Students can use the handout **Energy Expo Research Notes** worksheet to guide their research notes.
     - » Use the **Credible Sources Checklist** to guide students in finding credible and unbiased sources.
3. **Presentation day**: Set up for the first few minutes of class; then have other classes come learn or have students alternate between sharing information and mingling and asking questions. This will take most of the class if you want to give time for all students to mingle and learn. Maybe provide some gentle 'mood setting' conference music? Snacks? Door prizes? Student presenters should have 'breaks' to mingle with other presenters to learn about each of the energy sources.
   - **Templates:** See **Comparison Table for Energy Expo Participants** for a fillable table for mingling students to compare each energy source.
4. **Optional**: Provide an exit question or get students to vote on which energy sources they think will provide the greatest potential for the future.

Closing & Debriefing: Circle opportunity

Allow time for each student to reflect on the expo and reflect on the second part of this lesson's overarching inquiry question: *Which energy sources should we be investing in for the future?*

Have students try drawing conclusions about the best sources of energy and how we should use energy (how much and in what way) to preserve a stable climate.

Extension Lesson: Energy Access, Autonomy, and Transition in Canadian Indigenous Communities

Background

As is outlined in one of the graphs from this lesson, energy use, although growing exponentially and contributing to the climate crisis through greenhouse gas emissions, is less accessible to many communities around the world, and there are many who are considered to be in energy poverty.

In Canada, one way this inequity in energy access exists is through lack of access to reliable energy in remote communities. Many of the reserves for Indigenous people do not have access to the electrical grids of towns and and thus must be **self-sufficient**. Many still rely on diesel generators for their communities. For this reason and others such as the need for **energy sovereignty**, many communities are switching to renewable energy sources.

"There are currently 197 renewable energy projects associated with Indigenous communities in Canada, however very few are controlled by Indigenous communities." (Indigenous Climate Hub)

Terminology:

- **Energy self-sufficiency:** When a community or building does not need to buy, connect to, or import energy from an external company or electrical grid to meet its needs — especially important for remote communities that do not have an electrical grid.

- **Energy sovereignty:** Indigenous communities (or other communities) being able to make informed decisions about and supply their own energy needs in a way that is affordable to the community. It is part of the process of decolonization.

Inquiry question(s)

What factors are encouraging Indigenous communities in Canada to seek renewable energy sources for their communities? What are some of the challenges these communities face in terms of energy access transitioning to renewables?

This activity is best done through case study examination and discussion.

Suggested materials:

- Inspiring videos and examples of Indigenous communities converting to net-zero energy sources

Opening

Start with finding an example of an Indigenous nation that is working on a renewable energy project. The Indigenous Clean Energy Project Map created by Indigenous Clean Energy can help you find one near to you. Find a video or a story that can help students understand the concepts of inequity in energy access (energy poverty), and the concepts of self-sufficiency and energy sovereignty for Indigenous communities. Two great examples include the following:

» T'Sou-ke First Nation (see link for video) on Vancouver Island, British Columbia or T'Souke First Nation: Using solar energy to strive for net-zero

» Coastal First Nations village of Klemtu on BC's Central Coast (see link for Video)

» Athabasca-Chipewyan Solar Project reduces diesel dependency and expansion to 3 projects in Alberta

Activity

Research and explore the reasons Indigenous communities are becoming leaders in renewable energy transitions and net zero. Have students select an energy transition project in an Indigenous community or by an Indigenous company. Have students reflect on the challenges that remote communities face in terms of energy access and three of the main reasons communities are leaders in the energy transition: energy autonomy & sovereignty, worldviews and traditions, and sustainability.

Template: Use the Venn diagram in the associated handout to help guide students in their exploration of the case study.
Note: You may want to choose one case study for ALL students to explore or use one of the opening examples to examine more deeply.

Closing circle opportunity: Convene in a circle for students to share their learning. Consider this prompt:

One thing that surprised me about Indigenous communities and energy was…

Other resources

Decolonizing Power Podcasts: Podcasts examining the reasons behind why Indigenous communities may seek out renewable energy projects and energy sovereignty. Waasamoo-Electric (Episode 1, June 7, 2021) features a community making the switch to solar from diesel and highlights the transition to renewable as well as the benefits and challenges.

Reconciliation through Renewable Energy Science Direct Study: A study on the current renewable energy projects on First Nations territories and how many of them are owned or co-owned by Indigenous peoples. This article stresses the need for these projects to be managed by the communities they support — a step toward true reconciliation.

Lesson Six: What Does your Community Look Like in 2080?

Overarching inquiry question(s)

How will an energy transition shape the community you live in today and what might that future look like?

Target age group: Grades 8–12 (adaptable for Grades 4–7 as well)

Curricular competencies (listed in brief)

- Understanding the energy transition taking place and its possibilities
- Evaluating pros and cons of current energy sources in your community
- Envisioning a healthy positive future for Earth and future generations
- Creating a model of that future through the arts

Summary (learning & pedagogical outcomes, goals, & activities in brief)

This lesson builds on the knowledge of energy use, energy distribution, and its associated challenges, as outlined in the previous lessons. It allows students to imagine a future that is free of carbon dioxide emissions and their harmful impacts and full of more desiarable aspects. It is suggested that one or more of the previous lessons be completed prior to this lesson.

The lesson starts with a neighborhood or community walk that includes a brainstorming session about the aspects of where they live that they wish to preserve or alter. In this discussion, students can explore which ways of living and being are most desirable in a sustainable future.

Students will design their future community in 2080 using what they have learned about the energy transition, other CO_2 reduction measures (e.g., various forestry and agricultural practices), and innovative climate change adaptation strategies (if covered). These can include changes in behavior and structure of society, not just the transition of energy. The goal is to open students' imaginations to a future world they would like to inhabit. Students are often very creative and may add in other fun ideas about their future worlds!

Background information

Review some of the background information provided above or complete one of the previous lessons to help bring context to the issue around WHY we want to transition our energy system and some of the associated targets and trends.

In particular, focus on how different parts of our lifestyle and the energy use needed to power it (transportation, buildings, industry, etc.) are generating the most greenhouse gases.

Suggested materials:

- Mapped community walking route
- **Worksheet: What do you like and dislike about your community?**
- Inspiring videos on green energy or sustainable communities

Opening: Circle opportunity

In circle, prior to going on an observation walk, students can share one thing that they love and one thing they wish to change about their community. Address each question one at a time.

1. *What is the thing that you love about your community that you hope never changes?*
2. *What is one thing that you would eliminate from your community if you had the power?*

Activity

1. Community walk and observation

Go on a walk in your community. If possible, plan a route that includes areas that are residential and commercial, places where there is greenspace or other natural features, and places that might be perceived as less desirable. Walking through the community directly surrounding your school will help generate ideas! Here are a few other suggestions for community walks or tours:

Can you go on a tour of the landfill?	Can you get a tour of a heating system powered by a renewable resource or an LEED building?
What about a walk that encompasses a busy road or highway and contrasts it with a park or pathway?	Can you take the bus to the downtown core of your city to compare it with your neighborhood?

Wherever you go, have students fill in the associated worksheet table and questions (two pages)

What do you like and dislike about your community? (based on their observations)

Additional Note: Any of the suggested walks from Lesson 1 could be undertaken to help students engage all their

senses as they think about what kind of future community and way of life they would like to experience. In addition, you could stimulate a discussion about the values that both your students as well as members of broader society hold. Which ones are most important and need preserving for future generations? Which ones do we need to let go of in order to have a healthy and livable world? This will help get students relating to how the actions of today will shape the future in which we live.

2. Be further inspired!

Before students break into groups, debrief the walk and inspire students about the possibilities for the future by showing a video or two that highlights how technology and lifestyle changes could affect the future.
Here are a few strong options:

- Edmonton's Bold Plan for a Net-Zero City (2021)
- Imperial College of London's video and interactive images of the technologies and systems of 2050
- Solid Wood Passive Home Video from Green Energy Futures
- Greenenergyfutures.ca has a whole website and Youtube channel devoted to green energy.

3. Group brainstorm and design your future community

Students will be placed into groups of one–four to imagine the community in which they would like to live in the future. While they can draw from any aspect, including social (amenities, activities) and technology, consider focusing on at least the following aspects of their future world: **transportation, buildings, livable spaces and greenspace, and energy sources.**

Student groups start by sharing with each other their likes/dislikes and reflections from their walk(s) and writing down ideas and concepts that are common to all members. Students can then add to their brainstorming page ideas of how they imagine their future communities.

The following questions may be helpful to help draw out ideas from students:

- What kind of energy is produced and where? How is it shared/distributed?
- What do buildings look like and how are they heated? What are homes like? (detached, apartments, etc.)
- Are there still roads and cars and, if so, how has this infrastructure changed?
- How are other kinds of transportation changing (increasing, decreasing, new forms, etc.)?)
- What is the green space like? What features characterize it? Has it improved for other species or just humans?
- What do future people love most about the place they live?

4. Design through art or storytelling

Once students have finished brainstorming and have a concept of what they want to include, they need a way to 'show it.' A creative project can help bring out the visuals and allow students to continue thinking about the details of how their future community will look, feel, smell, sound, and function. There are many ways to do this, but two that could work well include the following:

- **Storytelling:** Have the group write a short story that imagines a person walking or living in this future world. Students must explain and describe what the world is like.
- **Art:** Have the students create something through some form of art (e.g., drawing, video, digital arts… or even Minecraft!).

Closing: Presentations and closing circle

When the creative projects are finished, highlight them during a gallery walk where students can observe and explore the different worlds. If a storytelling format was used, have students in small groups or as a whole class share their stories.

Closing circle

After students have shared their creative projects, facilitate a closing circle that allows students to reflect on the most profound learning that has occurred during the process of imagining an amazing future world.

Suggested prompts

Before doing this project, I didn't realize how important…
The one thing that I really hope will exist in the future is…

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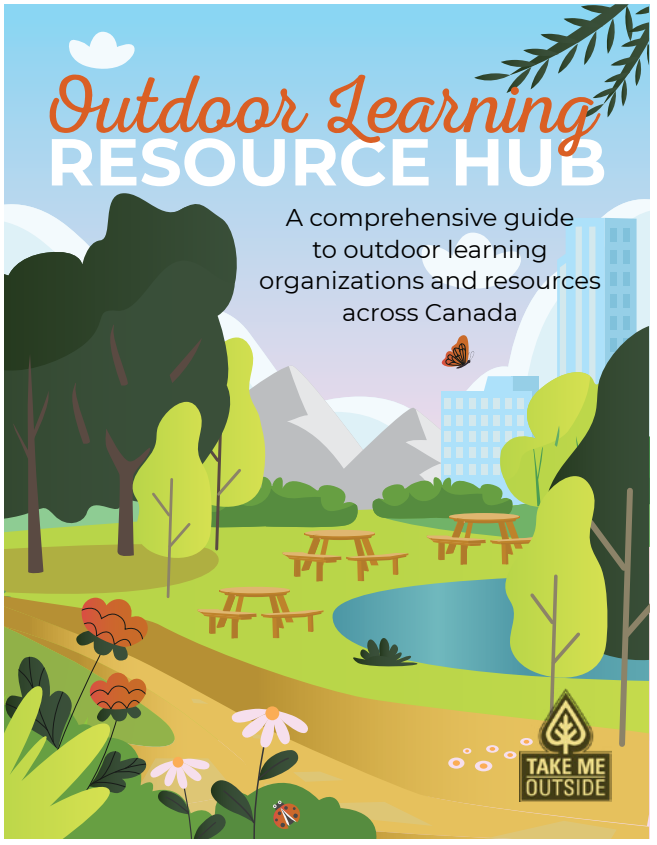

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RHODE ISLAND RIEEA
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AEEA
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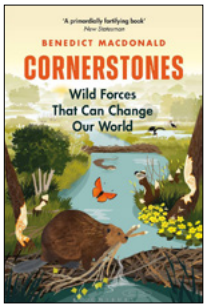
SUBJECT to CLIMATE

Resources

Reviewers: Niki Card, Ian Shanahan, William Straits, Julie Travaglini, Veronica Uzielli, Kim Zumach, and Stacey Widenhofer.

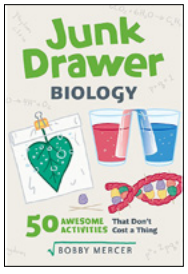
Cornerstones



Benedict MacDonald's Cornerstones examines how keystone species affect their ecosystem, in both positive and negative ways. While some of these species, such as beaver and boar, can be seen as destructive, they have an important place within the ecosystem and without them, chaos can thrive. How have humans' perceptions of the negative impacts of these creatures affected the overall health of the ecosystem? How have we humans affected how the ecological roles of these creatures are viewed? In perhaps unsurprising news, humans have been the driving force behind a lot of our negative views toward both native and non-native invasive species. While this book is focused on the species and ecology of Britain, the challenges and lessons could easily be translated to other regions of the world. – (JT)

Bloomsbury Publishing Plc, 2022, ISBN 978-1-4729-7160-9 (hb), 256 pp., U.S. $24.00 from bloomsbury.com

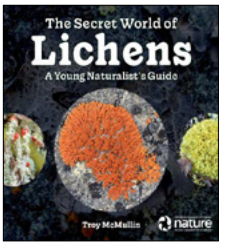
Junk Drawer Ecology



While I beg to differ that most of the items needed for these experiments are laying around in a junk drawer, the premise of this book is good. It contains a wide array of activities for a varied age range, with some activities being tried and true (some may say overdone) and others being new and fairly creative. Some of the more common experiments include activities such as pop bottle terrariums, paper plate biomes, and candy DNA models. Activities like the heat absorption experiment are much more impressive. As someone who does not utilize food in lessons or experiments, I would need to modify many of the activities. And though the book could use some more detail around the introduction and set-up of activities, for the price I think it's worth it. (JT)

Chicago Review Press, 2022, ISBN 978-1-64160-549-6 (pb), 272 pp., U.S. $16.99 from chicagoreviewpress.com

The Secret World of Lichens



As a huge mushroom and lichen nerd, I loved this book! Best for middle and high school students looking for an introduction to the sometimes complicated world of lichens, The Secret World of Lichens includes plenty of definitions, diagrams, and explanations about key terms and identification traits. It is full of close-up, colorful photos of more than 30 species of lichens and includes tons of extra information on how lichens are often used in medicines, foods, poisons, and dyes. My only critique is that I would have liked to see range maps included for the individual species listed, as kids may get excited to look for a species only to discover that its range is thousands of miles away. I would suggest noting the pages of the book that are relevant to your geographical area and having students focus on the species featured there. Written by Troy McMullin. – (JT)

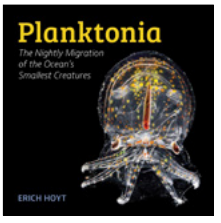
Firefly Books Ltd., 2022, ISBN 978-0-2281-0399-8 (hb), 48 pp., U.S. $19.99 from fireflybooks.com

Water Earth Woman

Water Earth Woman is an engaging 23-minute mini-documentary. It was completed in 2013 and follows the story of Akilan Jaramogi, a forest activist on the Caribbean islands of Trinidad and Tobago. The film highlights the work of Jaramogi and that of her late husband to reforest the hillsides of the islands. The enhancements to the land and community from the reforestation include improved tourism and employment opportunities and an increase in biodiversity. This film is full of hope and emphasizes that small local actions can lead to larger global impacts. Additionally, Jaramogi's story encourages women to step forward to be leaders in their communities, as they have the power to be transformative. Educators who are wishing to share intimate stories of Indigenous change-makers in their classrooms could show this film to students in the middle grades or above. – (KZ)

GoodDocs, 2013, 23 minutes, CAN $9.99 for individual use from GoodDocs.net

Planktonia

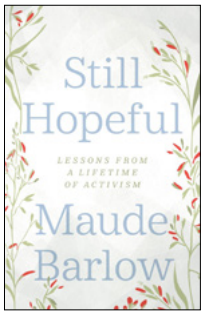


Planktonia is a stunning 176-page book filled with glossy photographs that belongs on the coffee table of any marine enthusiast. As author Erich Hoyt states in his opener, when most people think of migration, they think of large macrofauna storming across the savannah, Humpback Whales or turtles traveling across the oceans, or caribou thundering across the Arctic. However, the largest migration on Earth happens twice each night, as planktonic species from the deep travel toward the surface to feed under the cover of darkness. These zooplankton, most of them less than two centimeters long, are the focus of the incredible macrophotography that graces each page. To supplement the images, Hoyt includes a short descrip-

tion of each subject with relevant and interesting details — where did the name for the Bony-eared Assfish come from anyway? This book is captivating and in addition to finding space on your coffee table, it would make a welcome addition to any K–12 library. – (KZ)

Firefly Books, 2022, 176 pages. ISBN: 978-0-2281-0383-7 US $35.00 from fireflybooks.com.

Still Hopeful

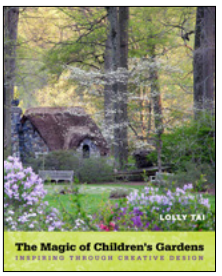


Still Hopeful: Lessons from a lifetime of activism is the book we need right now. Across the 240 pages, Canadian activist Maude Barlow recounts her impressive career. She has been instrumental in advocating for women's rights, access to clean water, and holding governments accountable for their trade deals. This book is informative and brings our current post-pandemic reality into focus through an easily digestible historical lens. And through it all, Barlow weaves in hope. After over six decades as an activist, Barlow sees hope in the movements she has been a part of and hope in the rise of young advocates from around the world. She reminds us that change is a long game and that we should not be discouraged when the results we seek are not immediately apparent. This book is a must-read for educators involved in teaching social justice; it would also fit well into a high school library. While the context of the book is Canada-focused, there are enough references to movements around the world, especially when it comes to trade networks and water, that make it a good read for anyone who is interested in these issues. Recommended for readers aged 14 years and up. – (KZ)

ECW Press, 2022, ISBN: 978-1-7704-1632-1, 240 pp, CAN $21.95 from ecwpress.com

The Magic of Children's Gardens

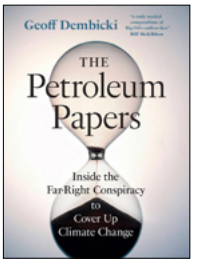
I am working on an Outdoor Space for the Elementary School that I work for, and the book The Magic of Children's Gardens: Inspiring through creative



design has been so inspiring and inspirational during our process. The large images of the maps, designs, and actual spaces that have been created make for a wonderful resource to use as we navigate the creation of our space. I also appreciate the considerations for children, regarding appearance and accessibility in both rural and urban environments. It is helpful to have a plan that is easy to follow for each garden and its respective goals, concept, and design. The spaces showcased in the book are from all across the US and done with all types of budgets. Author Lolly Tai also includes an index at the back of the book with the resources separated out by state so that maybe you can visit a garden near you! – (SW)

Temple University Press, 2017, ISBN: 978-1-4399-1448-9 (pb), 359 pp, $19.99, www.temple.edu/tempress

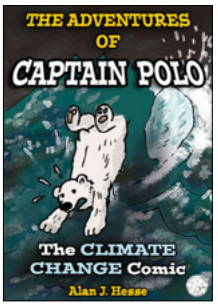
The Petroleum Papers



"There was nothing inevitable about the chaotic [climate] future we face" reads a passage from the introduction to climate journalist Geoff Dembicki's book, which is the result of his deep dive into hundreds of publicly available documents detailing the extraordinary efforts by Big Oil to deliberately sow doubt about climate science over the past 50+ years. Those who have read Naomi Oreskes and Erik Conway's Merchants of Doubt will be familiar with some of the key players and their tactics, but Dembicki provides the most up-to-date account of these insidious machinations, much of it gleaned from internal company documents and slanted media coverage. This first-rate piece of investigative journalism moves quickly, and among its large sections of dispassionate analysis are harrowing stories of people caught in the maelstrom of disinformation and its resulting calamities. The Petroleum Papers documents historic and ongoing efforts to delay climate action, especially in Canada and the US. Secondary and post-secondary educators who teach about climate change would be well advised to give it a read. – (IS)

Greystone Books, 2022; ISBN 978-1-77164-891-2 (hb); 256 pp.; CDN$34.95 from greystonebooks.com/

The Climate Change Comic



Can slapstick and other laugh-inducing devices be used effectively in a children's comic about climate change? Conservationist and cartoonist Alan J. Hesse masterfully balances the severity of climate change — and some of its associated challenges such as the displacement of climate refugees — in this delightful and witty first installment of The Adventures of Captain Polo series. The titular character is an amiable, cap-wearing Polar Bear who finds himself on a worldwide journey after the piece of sea ice on which he is hunting breaks away and sends him southward. Scientific nuggets appear in footnotes at the bottom of several pages, and the back matter includes useful information about climate science and solutions for educators of elementary school students. Hesse's illustrations are fun and accessible, making this adventurous story a terrific educational resource. – (IS)

Alan J. Hesse, 2018; ISBN 978-9942-40-250-9 (pb); 42 pp.; US$5.77 from alanhesse.com/comic-books/polo/

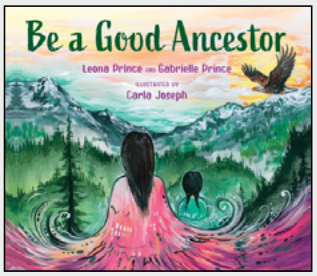
Hear more from author and illustrator Alan J. Hesse on our Talking with Green Teachers podcast, Episode 49: Comics, cartoons, and humour for climate change ed.

Fiona the Fruit Bat

Dan Risken's fascination with bats comes through in this charming story about a young bat's discovery of how to use echolocation in order to fly. Fiona the fruit bat is only told to listen by her mother; she must learn for herself. Through observation and becoming more aware, she indeed sorts it out for herself. K–2 students may be able to relate to having the courage to try something new. Illustrator Rachel Qiuqi's simple artwork is a great match for this story, as there's an innocence about it. The back matter goes into additional detail about the science of echolocation as well as the ecology of fruit bats, all of which lends well to discussions about adaptation. – (VU)

Greystone Kids, 2022, ISBN 978-1-77164-785-4 (hb), 40 pp., CAN $22,95, from greystonebooks.com

Be a Good Ancestor



As a tribute to their ancestors, Leona and Gabrielle Prince of the Lake Babine Nation and Nak'azdli Whu'ten have captured the importance of recognizing the interconnectedness of all living things — including our thoughts, words, and actions — in this engaging book. Each double-page spread features a different way we can be good ancestors through a four-line stanza connecting stages of life or stages of action. Primary-grade children will enjoy the vibrantly coloured acrylic illustrations of Cree artist Carla Joseph that bring these words to life. They are a beautiful reflection of living on the land, and Joseph connects her images with movement using feathers, beadwork, circles, and other Indigenous symbols. This book fits with the Truth and Reconciliation Commission's Calls to Action regarding sharing Indigenous knowledge and values as well as showing how small actions become big when looking at the broader picture. – (VU)

Orca Book Publishers 2022, ISBN 978-1-4598-3140-7 (hb), 32 pp., CAN $21.95, from orcabook.com

Do Trees Have Mothers?

Much scientific research by those such as Suzanne Simard and Monica Gagliano has shown the connection between mother trees and the forest. Charles Bongers

has both written and illustrated this whimsical book to share that concept with young children in Kindergarten and Grade 1. He does so through the voice of Nut, a squirrel, making it easy for children to understand and relate to the content. Bongers' illustrations demonstrate beautifully the way that energy moves from the mother trees through their roots to the saplings, sending information and nutrients. He includes the various roles of trees in cleaning air and water and providing food and shelter. There are references at the end of the book to articles that can help the adult reader to further explain the ways mother trees are able to make connections with other trees in the forest. – (VU)

Douglas & McIntyre, 2022, ISBN 978-1-77162-325-4 (hb), 32 pp., CAN $19.95, from douglas-mcintyre.com

Little Pine Cone

In this charming book, author and meteorologist Johanna Wagstaffe combines a fictional story about Jacky, a pine cone, with lots of scientific information about the importance of fire in a forest ecosystem. It also addresses the danger of large wildfires that get out of control and the increase in their numbers due to climate change. Along with the continuing tale of Jacky and what happens in her forest home before and after a wildfire strikes, each page is full of facts and identifies the many parts of the ecosystem. It also shows how both animals and people react to and prepare for the possibility of fires. We see how Jacky, as a pine cone from a Jack Pine tree, requires fire to fully open and release its seeds and how forests remain healthy with fire. The illustrations by Julie McLaughlin are both colorful and engaging, as they draw the eye to different parts of the page to learn more. This book would be a great addition to a classroom where students are learning about adaptations, habitats, biodiversity, and human impacts. Appropriate for Grades 1–3. – (VU)

Orca Book Publishers, 2022, ISBN 978-1-4598-2830-8 (hb), 32 pp., CAN $21.95, from orcabook.com

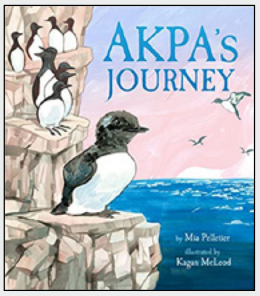
Grandma Lisa's Humming, Buzzing

The experience of the author Lisa Doseff (known in the book as Grandma Lisa) as a Master Gardener is evidenced throughout her book, which includes fine atten-

tion to detail about what truly makes a beautiful pollinator garden. The story, told through rhyme, is of a family coming together to create a garden after buying a new home. Grandma Lisa explains that although the existing garden was "quite nice," it wasn't providing the habitat necessary for bees and butterflies to meet all of their needs. The grandchildren learn through work and play how to create habitats for a wide range of animals and come to understand the web of life. The colorful illustrations by Duncan Robertson bring the story to life, and there is much to explore along with the children on each and every page. This book will enthrall young children in K–4 classes, but also provides great information and inspiration for older students looking to start a pollinator garden at home or school. – (VU)

Pollination Press LLC, 2021, ISBN 978-0-99135-633-1 (hb), 40 pp., CAN $21.95, from pollinationpress.com

Akpa's Journey

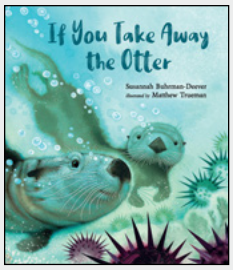


Through Mia Pelletier's words, we join Akpa's life as an egg and hatchling on high cliffs in the Arctic, before diving into the ocean at three weeks (before he can fly), and then swimming with his father to their wintering grounds off the coast of Newfoundland and Labrador, some 1000 km away. Akpa is the Inuktut name for Thick-billed Murre, and we are introduced to more Inuktut words throughout the book. As Akpa learns about the environment and the lives of murres from his parents and those on his journey, so do we. Kagan McLeod's illustrations are realistic and, though simple, are energetic and match the prose well. Children will be fascinated by these birds and their amazing journey, during which they gradually build the strength and feathers to be able to fly. Appropriate for those in Grade 1–3 as they are learning about adaptations, habitats, and growth and changes in living things. I learned a lot too! – (VU)

Inhabit Media, 2022, ISBN 978-1-77227-429-5 (hb), 32 pp., CAN $18.95, from inhabitbooks.com

If You Take Away the Otter

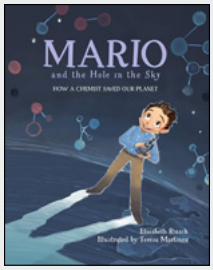
This beautiful book begins by taking readers on a tour of the diversity and interdependence of living things found in one of North America's most fascinating ecosystems, the Pacific kelp forest. Then, If You Take Away the Otter focuses on the integral role the Sea Otter plays in maintaining the health of this forest and describes the true and tragic story of how hunting this keystone species led to a destructive cascade of cause-and-effect interactions:



removing Sea Otters caused sea urchin populations to grow; overcrowded sea urchins turned to the holdfasts of kelp as food, leading to the destruction of kelp forests. But, with joy and optimism, this book concludes by sharing that the successful protection of sea otters has led to the reestablishment of these majestic forests and the organisms that depend upon it. – (WS)

Penguin Random House, 2020, ISBN: 978-0-7636-8934-6, 32 pp, Ages 5–8, CAN $17.99 from penguinrandomhouse.com

Mario and the Hole in the Sky



In 1995, Mario Molina, Sherwood Rowland, and Pail Crutzen were awarded the Nobel Prize in Chemistry for their work identifying the role of chlorofluorocarbons (CFCs) in the destruction of the ozone layer. This intriguing book begins with an eight year-old Mario receiving a microscope as a birthday present. Mario shouts, "¡Increíble!" as he views salt crystals, filthy water, toothpaste, and more through his microscope. This moment of wonder sets him on a lifelong love of science, ultimately leading to his collaboration with "Sherry" Rowland. With beautiful illustrations, Mario and the Hole in the Sky takes the reader through their work together, describing one of our great successes in environmental science and, hopefully, inspiring readers to pursue and solve the problems facing our planet today. – (WS)

Charlesbridge, 2019, ISBN: 978-1-5808-9581-1, 40 pp, Ages 7–10, CAN $17.99 from penguinrandomhouse.com

Old Enough to Save the Planet

Conservation is for all of us. This empowering book celebrates 12 conservation efforts from around the world, all spearheaded by young, everyday activists, aged 7–16. The children you share this book with will be inspired by the efforts great and small, such as those by Felix in Germany combating deforestation, Amy and Ella in the UK promoting plastic recycling, Adeline in Indonesia restoring native habitat, Eunita in Kenya protecting bees, and many more. The back matter of this beautiful and motivational book shares 10 actions all children can take to "help to save the planet" and 10 ways to "make your voice heard." Let Old Enough to Save the Planet inspire your students to identify causes and opportunities at your school and in your community, and to create change. – (WS)

Magic Cat, 2021, ISBN: 978-1-4197-4914-8, 32 pp, Ages 8–12, CAN $16.99 from abramsbooks.com

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