INQUIRIES For a Sustainable Future

A Decision-Making Approach to the Study of Selected Canadian Issues

ENERGY Making Sustainable Choices
To the Teacher

Inquiries for a Sustainable Future: A decision-making approach to the study of selected Canadian Issues is designed to have students investigate a number of topics that are critical in determining what policies governments and corporations might adopt and what actions individual Canadians might undertake to move Canada in the direction of a more sustainable future. Each of the Inquiries includes a short introduction that outlines the urgency of the issue, followed by a collection of readings that introduce the essential parameters of the problem/debate. The aim is to engage the students in considering the economic, environmental, and social implications of possible responses to the challenges presented, to assess the merits of the possible responses, and to contribute to the realization of those responses judged to be in keeping with the principles of sustainable development.

This “decision-making approach” is in keeping with the pedagogy associated with problem solving. Students are asked in each case to consider:
  o What is the problem?
  o What are the alternatives?
  o What is the best choice?
  o What might my school or I do to promote positive changes?

It is also in keeping with the pedagogy associated with active citizenship that suggests that students should move from understanding to action and thereby develop those skills that are essential to responsible and effective citizenship.

Finally, in considering the best response, it is in keeping with the belief that education should help students become system thinkers who appreciate the complexity of issues, recognize the interplay of relevant factors and connect the dots (environmental, social, economic)

Resources for Rethinking (R4R.ca), a project developed by Learning for a Sustainable Future, provides teachers access to lesson plans, curriculum units and other teaching resources that integrate environmental, social and economic spheres through learning that is interdisciplinary and action oriented in accordance with the above pedagogical principles.

Titles in the Inquiries series include the following:

  o Energy: Making Sustainable Choices
  o The Disappearance of the Northern Cod
  o The West Coast Salmon Fishery
  o Canada’s Fresh Water
  o Sustainable Cities
  o Agriculture and Agribusiness
  o Sustaining Canada’s Forests
  o Sustainable Transportation
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## Suggested Student Activities and Supporting Resources

The table below provides a number of suggested student activities, links these to the relevant readings, and identifies a number of R4R resources that help students accomplish the suggestions. R4R resources marked by an asterisk have a strong action component.

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<thead>
<tr>
<th>Suggested Student Activities</th>
<th>Recommended Readings</th>
<th>Suggested R4R Resources: visit <a href="http://www.r4r.ca">www.r4r.ca</a></th>
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| Work in cooperative groups to investigate and report on selected energy issues. | • The Role of Fossil Fuels in a Changing Climate  
• Benefits of Renewable Energy  
• Climate Change is Happening | • [Natural Gas. A Cleaner Energy Solution or Just Another Fossil Fuel?](http://www.r4r.ca)  
• [Who Will Take the Heat](http://www.r4r.ca)  
• [Renewables Are Ready](http://www.r4r.ca)  
• [Three Hundred Years of Fossil Fuels](http://www.r4r.ca)  
• [Energy Dialogue: Wind Power](http://www.r4r.ca)  
• [Energy Dialogue: Fracturing](http://www.r4r.ca)  
• [Crude Awakening](http://www.r4r.ca)  
• [Connections to Climate Change in Grades 11 and 12 Science](http://www.r4r.ca)  
• [Teaching Sustainability in High Schools](http://www.r4r.ca) |
| Select one of the media—newspapers, television, magazine, Internet—and report on their coverage of energy issues over a week/month | • Can Canadian Oil Sands Survive Falling Prices?  
• Getting It Right On Gas  
• Fracking: Unlocking the Great Debate  
• Energy East Pipeline: What You Need to Know | • [Communities Divided Over Natural Gas](http://www.r4r.ca)  
• [Crude Awakening](http://www.r4r.ca)  
• [Fracking Hell](http://www.r4r.ca)  
• [Natural Gas. A Cleaner Energy Solution or Just Another Fossil Fuel?](http://www.r4r.ca) |
### Assess the degree to which the Readings represent a balanced coverage of energy related issues. Whose voice is being heard? Are there voices that are absent? Are there relevant issues not addressed by the readings?

- The Energy Report, World Wildlife Federation
- A Deal In Paris
- Canada’s Action on Climate Change
- Renewable Energy Has a Variability Problem
- Climate Change Controversy
- Climate Change, Poverty and Women*
- Dirty Air and Bright Lights
- Fueling the Future
- Making the Change

### Identify the organizations that should be represented in a round table discussion of energy policies; working in groups investigate the perspective of each of these; “stage” a round table in which the competing perspectives are heard.

- The Energy Report, World Wildlife Federation
- Benefits of Renewable Energy
- A Deal in Paris
- Canada’s Action on Climate Change
- Ontario’s Cap and Trade
- My 2050 School’s Toolkit
- Climate Change Controversy
- Climate Change, Poverty and Women*
- Get Real on Climate
- Renewables Are Ready
- Making the Change

### Outline the criteria that should be used in determining an effective and sustainable energy policy? Do the policies put forth by the Readings respect these criteria? Outline a policy framework in keeping with the criteria outlined.

- A Deal in Paris
- The Energy Report, World Wildlife Federation
- Canada’s Action on Climate Change
- Ontario’s Cap and Trade
- Eritrea’s Success Story
- Serious Game
- My 2050 School’s Toolkit
- Inuit Observations on Climate Change
- Climate Change Connections and Solutions*
Identify possible actions students might undertake at the individual, class, school, and community level to promote sustainable energy production and consumption. Outline a set of criteria to determine which actions are likely to be both effective and “do-able”. Design and execute a plan of action based upon conclusions reached.

* To assist with the action project planning and completion, see LSF’s *Engaging Students in Sustainable Action Projects*

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INTRODUCTION

Our Dependence on Energy

Few people care about the source of our energy supply except when it is disrupted, but virtually all of us care about energy services, which range from the basic needs demanded by human beings everywhere — cooking, heating and lighting — to the hallmark of modern society, motors, appliances, wide-ranging mobility and various industrial processes. Because the world cannot function without regular supplies of energy, a significant section of the global economy is devoted to providing these services when and where required.

Lighting a room, for instance, is not achieved merely by flicking a switch; it is the last step in a long chain of conversion events. Energy resources — for example, the unrefined oil and natural gas recovered from wells driven deep into the Earth’s crust and the coal that is sandwiched between terrestrial sediments — must first be extracted. The primary energy (crude oil) is then transported to a refinery to be processed into a wide range of products, and from there oil is shipped to a power plant to be burned (and thus converted from chemical to thermal energy). The heat produced during combustion powers a turbine, which in turn drives an electric generator (converting thermal to mechanical to electric energy). Eventually, the electricity travels through wires until it reaches the end-use appliance — the incandescent lamp — where it is transformed into radiant energy.

The uneven distribution of the world’s fossil fuels (oil, natural gas and coal) necessitates a flourishing worldwide trade in energy commodities. The amount of recoverable fossil fuel will eventually run out and, in the interim, (if it is fully combusted) the prospect presents a possible threat to the environment.

How do we reconcile our burgeoning demand for energy with the need to maintain a viable global ecosystem?

From: Energy for the Planet Earth by Ged R. Davis
Energy: Making Sustainable Choices

In 1998 a five-day ice storm in Eastern Canada cut off the electrical supply to hundreds of thousands of Canadians. For days, sometimes weeks, people were without light and heat for the coldest part of the Canadian winter. Offices and factories were closed and everyday life brought virtually to a halt. In 2013 Eastern Canada was hit once again by an ice storm. Ice-coated tree branches snapped, pulling down power lines and leaving 380,000 customers without power in Ontario and tens of thousands in Quebec and the Maritimes. These storms are vivid reminder of how our ancestors lived only a century ago and a demonstration of how dependent our modern society is on our power supplies and the energy sources that fuel them.

In the past century, Canada has moved from an agricultural to a post-industrial, urban society thanks to an abundance of energy sources — coal, oil and gas, hydro and nuclear power — and efficient production and distribution infrastructures. But today other factors, more long range and profound in their effects than ice storms, are causing us to rethink the ways we use energy and the sources that provide it. The first is that fossil fuels — coal, oil and gas — are finite resources and will one day be depleted. The second is the realization that the use of fossil fuels can have a disturbing effect on the environment, contributing to air pollution, acid rain, and the greenhouse gases that are affecting the global climate.

The challenge of climate change forces the global community to find strategies to reduce industrial emissions that are contributing to global warming. In 2013, Canada contributed 1.67% of greenhouse gas emissions (rich countries are responsible for seven out of every 10 tons of carbon dioxide emitted since the industrial revolution). At the international conference on climate change at Kyoto, Japan, in 1997, each party to the treaty set its own binding target. Canada undertook to make a six% reduction in emissions from the 1990 level by 1212. Under the Copenhagen Accord, the 2009 successor to the Kyoto Protocol, Canada committed to reducing emissions to 17% below 2005 levels by the year 2020. In 2011 the Canadian government, citing costs and lack of success in meeting targets, announced its decision to formally withdraw from the Kyoto agreement. Meeting the most recent goals agreed to at the 2015 climate change conference in Paris will demand drastic changes in industrial practices, in transportation (which is the major contributor of emissions) and in public attitudes and lifestyles.

The search for sustainable energy will focus attention on energy efficiency, on carbon pricing, on alternative energy sources (such as wind and solar power), and on new technologies and processes (including new transportation fuels). The complex relationship between energy sources and production, the natural environment, and economic progress are at the centre of questions about energy sustainability. Finding a response to global warming may set a new path towards a more sustainable energy strategy for the 21st Century. In considering what that response might be, it is necessary that we define the problem, outline the alternatives, and identify the best choices. Finally, we must consider what we may do individually or collectively to promote positive change.
HISTORICAL AND CURRENT PATTERNS OF ENERGY USE AND CONSUMPTION

Moving to the Third Phase

Tracing the Relationship between Technology, Economic Development and Energy Use

Solving energy problems, today as in the past, depends on the technologies that are available and the rate at which they evolve. Since the middle of the 19th Century, sources of power have shifted from wind, water, and wood to coal and, more recently, to oil and natural gas. The interplay of energy and technology, as exemplified by the three phases of the Industrial Revolution, accounts for the changes.

During the first phase, which emerged in the early 18th Century, the dominant technologies were coal mining, the smelting and casting of iron, and steam-driven rail and marine transport (adapted by James Watt to provide power for transport and the blast of iron smelters). The smelters in turn provided materials for constructing the steam engine, locomotives, rails, ships, and mining equipment. Through the creation of a transportation infrastructure and the machines to run factories, rapid industrialization was possible.

Toward the end of the 19th Century, the world was again transformed — this time by electric power, internal-combustion engines, automobiles, airplanes, and the chemical and metallurgical industries. Petroleum emerges as a fuel and a food-stock for the petrochemicals industry. Toward the end of the 20th Century, society embarked on a third phase of the Industrial Revolution, characterized by a shift to computers, advanced materials, optical electronics, and biotechnology.
The third phase impact on global patterns of energy consumption is not yet certain, for application of technology depends on what society considers its objectives to be and especially on whether the public will embrace more of a sustainable world view or not. In a sustainable world, the balance of new initiatives would shift from producer to consumer, from energy supply to energy services, and from quantity to quality of energy. As we learn more about the relation human beings have with their planet, we may find that rather than viewing energy as a commodity to be exploited from planet Earth, we will increasingly need to think and act in terms of energy for planet Earth. Our dependence on energy will persist, but it must do so in the context of an ecologically sound planet. This means human beings may well have to apply all their inventiveness to develop new energy technologies so as to guarantee the long-term quality of their habitat.

Adapted from: Energy for the Planet Earth by Ged R. Davis
Energy Supply and Demand: Trends and Prospects

Energy demand is expected to increase considerably in the coming years as the result of population growth and economic development (EIA, 2015). Many people in the world are currently experiencing dramatic shifts in lifestyle as their economies make the transition from subsistence to industrial or service-based. The largest increases in energy demand will take place in developing countries where the proportion of global energy consumption is expected to increase from 46 to 58% between 2004 and 2030 (EIA, 2007). Per capita consumption figures are, however, likely to remain well below those in Organisation for Economic Co-operation and Development (OECD) countries. Energy consumption in developing countries is projected to grow at an average annual rate of 3% from 2004 to 2020. In industrialized countries, where national economies are mature and population growth is expected to be relatively low, the demand for energy is projected to grow at the lower rate of 0.9% per year, albeit from a much higher starting point. About half of the increase in global energy demand by 2030 will be for power generation and one fifth for transport needs – mostly in the form of petroleum-based fuels (EIA, 2007).

Much of the increase in energy demand will result from rapid economic growth in Asian economies, especially China and India. Energy demand in the developing countries of Asia is projected to grow at an average rate of 3.7% per year, far higher than any other region (Figure 1). Asia will more than double its energy consumption over the next 20 years, and is expected to account for around 65% of the total increase in energy demand for all developing countries. Although the energy consumption of developing countries in other regions is expected to grow at a slower pace than in Asia, rates are still expected to exceed the global average. While all regions will play a role in future energy supply and demand, the enormous consumption increases projected in Asia make the region of key interest in future energy development. The vast majority of the world’s energy is generated from non-renewable sources, specifically oil, coal, and gas (Figure 2). Just over 13% of global energy is derived from renewable sources, 10.6% of which comes from combustible renewables and renewable municipal waste. The remainder of renewable energy comes from hydro, geothermal, solar, wind, and tidal and wave sources.

Projections of total global energy consumption show that – unless checked by international agreement – between 2004 and 2030, fossil fuels will provide the bulk of the increase, with nuclear and other sources providing relatively minor contributions in absolute terms.

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**Figure 1:**

**Figure 2**

**Energy Information Administration (EIA)**
The EIA of the U.S. Government provides statistical data on energy sources, including renewable and alternative fuels such as biomass.

**Organisation for Economic Co-operation and Development (OECD)**
The OECD provides a forum in which governments can work together to share experiences and seek solutions to common problems.
In percentage terms, gas and coal are likely to show the greatest change with increases of 65 and 74% respectively. Oil consumption is expected to increase by 42% while nuclear and renewables, starting from a much lower baseline, are expected to increase by 44 and 61% respectively. The ultimate contributions from different sources will be highly dependent on policy directions. Projections should therefore be viewed primarily as a point of departure for further discussion.

From: [Green Facts: Facts on Health and the Environment](#)
TODAY’S ENERGY CHALLENGES

Climate Change Is Happening

Our Earth is warming. Earth's average temperature has risen by 1.4°F over the past century, and it is projected to rise another 2 to 11.5°F over the next hundred years unless we change current patterns of production and consumption. Small changes in the average temperature of the planet can translate to large and potentially dangerous shifts in climate and weather.

The evidence is clear. Rising global temperatures have been accompanied by changes in weather and climate. Many places have seen changes in rainfall, resulting in more floods, droughts, or intense rain, as well as more frequent and severe heat waves. The planet's oceans and glaciers have also experienced some big changes—oceans are warming and becoming more acidic, ice caps are melting, and sea levels are rising. As these and other changes become more pronounced in the coming decades, they will likely present challenges to our society and our environment.

Humans are largely responsible for recent climate change. Over the past century, human activities have released large amounts of carbon dioxide and other greenhouse gases into the atmosphere. The majority of greenhouse gases come from burning fossil fuels to produce energy, although deforestation, industrial processes, and some agricultural practices also emit gases into the atmosphere. Greenhouse gases act like a blanket around Earth, trapping energy in the atmosphere and causing it to warm. This phenomenon is called the greenhouse effect and is natural and necessary to support life on Earth. However, the buildup of greenhouse gases can change Earth's climate and result in dangerous effects to human health and welfare and to ecosystems. The choices we make today will affect the amount of greenhouse gases we put in the atmosphere in the near future and for years to come.

Climate change affects everyone. Our lives are connected to the climate. Human societies have adapted to the relatively stable climate we have enjoyed since the last ice age, which ended several thousand years ago. A warming climate will bring changes that can affect our water supplies, agriculture, power and transportation systems, the natural environment, and even our own health and safety.

Driving Forces behind fossil fuel production/consumption (Uncertain variables)

1. Economic Growth Rate
2. Energy Consumption Growth Rate
3. Investment Requirements
4. Demographic Changes
5. CO2 Emissions
6. Technology Development and Innovation
7. Global Energy Intensity
8. Oil Prices
9. Development of Alternative Energy Sources

Source: World Energy Scenarios to 2050: Issues and Options
Some changes to the climate are unavoidable. Carbon dioxide can stay in the atmosphere for nearly a century, so Earth will continue to warm in the coming decades. The warmer it gets, the greater the risk for more severe changes to the climate and Earth’s system. Although it's difficult to predict the exact impacts of climate change, what's clear is that the climate we are accustomed to is no longer a reliable guide for what to expect in the future.

We can reduce the risks we will face from climate change. By making choices that reduce greenhouse gas pollution, and by preparing for the changes that are already underway, we can reduce risks from climate change. Our decisions today will shape the world our children and grandchildren will live in.

From: United States Environmental Protection Agency, 2015
The Role of Fossil Fuels in a Changing Climate

Human activities are releasing greenhouse gases into the atmosphere. Rising levels of greenhouse gases are expected to cause global warming and, hence, climate change. By absorbing infrared radiation, these gases control the flow of natural energy through the climate system. The climate must somehow adjust to the “thickening blanket” of greenhouse gases in order to maintain the balance between energy arriving from the sun and energy escaping back into space.

Greenhouse Gases Overview

Gases that trap heat in the atmosphere are called greenhouse gases.

**Carbon dioxide (CO₂):** Carbon dioxide enters the atmosphere through burning fossil fuels (coal, natural gas, and oil), solid waste, trees and wood products, and also as a result of certain chemical reactions (e.g., manufacture of cement). Carbon dioxide is removed from the atmosphere (or "sequestered") when plants absorb it as part of the biological carbon cycle.

**Methane (CH₄):** Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices and from the decay of organic waste in municipal solid waste landfills.

**Nitrous oxide (N₂O):** Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste.

**Fluorinated gases:** Hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are synthetic, powerful greenhouse gases that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for stratospheric ozone-depleting substances (e.g., chlorofluorocarbons, hydrochlorofluorocarbons, and halons). These gases are typically emitted in smaller quantities, but because they are potent greenhouse gases, they are sometimes referred to as **High Global Warming Potential gases** ("High GWP gases").

Each gas's effect on climate change depends on three main factors:

**Concentration, or abundance,** is the amount of a particular gas in the air. Larger emissions of greenhouse gases lead to higher concentrations in the atmosphere. Greenhouse gas concentrations are measured in parts per million, parts per billion, and even parts per trillion. One part per million is equivalent to one drop of water diluted into about 13 gallons of liquid (roughly the fuel tank of a compact car).

**How long** do they stay in the atmosphere? Each of these gases can remain in the atmosphere for different amounts of time, ranging from a few years to thousands of years. All of these gases remain in the atmosphere long enough to become well mixed, meaning that the amount that is measured in the atmosphere is roughly the same all over the world, regardless of the source of the emissions.
How strongly do they impact global temperatures? Some gases are more effective than others at making the planet warmer and "thickening the Earth's blanket."

For each greenhouse gas, a Global Warming Potential (GWP) has been calculated to reflect how long it remains in the atmosphere on average and how strongly it absorbs energy. Gases with a higher GWP absorb more energy per pound than gases with a lower GWP and thus contribute more to warming Earth.

From: United States Environmental Protection Agency, 2013

Global Warming Potential Describes Impact of Each Gas

Certain greenhouse gases (GHGs) are more effective at warming Earth ("thickening the blanket") than others. The two most important characteristics of a GHG in terms of climate impact are how well the gas absorbs energy (preventing it from immediately escaping to space) and how long the gas stays in the atmosphere.

The Global Warming Potential (GWP) for a gas is a measure of the total energy that a gas absorbs over a particular period of time (usually 100 years), compared to carbon dioxide.[1] The larger the GWP, the more warming the gas causes. For example, methane’s 100-year GWP is 21, which means that methane will cause 21 times as much warming as an equivalent mass of carbon dioxide over a 100-year time period.[2]

- Carbon dioxide (CO$_2$) has a GWP of 1 and serves as a baseline for other GWP values. CO$_2$ remains in the atmosphere for a very long time; changes in atmospheric CO$_2$ concentrations persist for thousands of years.
- Methane (CH$_4$) has a GWP more than 20 times higher than CO$_2$ for a 100-year time scale. CH$_4$ emitted today last for only about a decade in the atmosphere, on average.[3] However, on a pound-for-pound basis, CH$_4$ absorbs more energy than CO$_2$, making its GWP higher.
- Nitrous Oxide (N$_2$O) has a GWP 300 times that of CO$_2$ for a 100-year timescale. N$_2$O emitted today remains in the atmosphere for more than 100 years, on average.[3]
- Chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), hydrochlorofluorocarbons (HCFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF$_6$) are sometimes called high-GWP gases because, for a given amount of mass, they trap substantially more heat than CO$_2$.


Source from: http://www.epa.gov/climatechange/images/science/GWPDiagram.jpg
Climate Justice and Equity

For a number of years, there have been concerns that climate change negotiations will essentially ignore a key principle of climate change negotiation frameworks: the common but differentiated responsibilities. This recognizes that historically:

- Industrialized nations have emitted far more greenhouse gas emissions than developing nations (even if some developing nations are only now increasing theirs) enabling a cheaper path to industrialization;
- Rich countries therefore face the biggest responsibility and burden for action to address climate change; and
- Rich countries therefore must support developing nations adapt to avoid the polluting (i.e. easier and cheaper) path to development — through financing and technology transfer, for example.

This notion of “climate justice,” according to some critics, has been ignored in the past by many rich nations and their mainstream media, making it easy to blame China, India, and other developing countries, or lend credence to the “false balancing” argument that, if they must be subject to emission reductions, then so must China and India. There may be a case, critics argue, for emerging nations to be subject to some reduction targets, but the burden of reductions must lie with industrialized countries.

The demand for equality of sacrifice has provided the industrialized world with a rationale for not taking measures many think are critical. The Kyoto Protocol was ultimately rejected by the US because of the asymmetrical obligations it imposed on the signatories. A number of other major countries, including Canada, Japan, and Russia took a similar position to that of the US, arguing that any successor treaty must apply equally to all major economies. It is generally accepted, however, that those industrialized nations that have been industrializing since the Industrial Revolution bear more responsibility for human-induced climate change. This is because greenhouse gases can remain in the atmosphere for decades.

With a bit of historical context then, claims of equity and fairness take on a different meaning than simply suggesting all countries should be reducing emissions by the same amount. The 2015 climate change conference in Paris (COP21) has addressed the issue by acknowledging “common but differentiated responsibilities and respective capabilities, in the light of different national circumstances.” This language is essential to a country like India, which believes it will need some time before it can reach peak emissions, given the need to provide 300 million people with electricity. The agreement calls on rich countries to engage in “absolute” reductions in emissions, while calling on developing ones to continue enhancing their mitigation efforts. The Paris agreement also commits to $100 billion a year in climate financing for developing countries by 2020, with a commitment to further finance in the future.

Adapted from: Global Issues by Anup Shah, 2016
POSSIBLE RESPONSES

The Energy Report, World Wildlife Federation

Overview

According to the best science, to avoid the worst effects of climate change, we must reduce greenhouse gas emissions by 80% below 1990 levels globally by 2050 (at the 2015 Climate Change Conference in Paris, the parties agreed to set a goal of limiting global warming to less than 2 degrees Celsius compared to pre-industrial levels). In *The Energy Report*, WWF outlines the most far-reaching scenario for how the world can transition to providing nearly 100% of its global energy requirements from renewable sources by 2050.

Achieving 100% Renewable Energy by 2050

**Imperative and urgent**: It is essential that we move to maximum use of renewable energy and top energy efficiency as quickly as possible – our current dependence on fossil-based fuels is the most significant contributor to climate change.

**Possible**: The Ecofys (a company designed to provide sustainable energy solutions) scenario demonstrates the technical potential – a pathway to a fully renewable global energy system with in-depth analysis into key sectors – such as industry, buildings, and transport.

**Significant Impact**: Achieving 100% renewable energy by 2050 will mean more cost-effective energy, improving quality of life on a global scale. It will have implications in a range of areas including agriculture, forestry, and lifestyles that will require attention and management.

**Requires consideration and debate on challenges**: The Energy Report is one scenario among many, highlighting the need for debate and discussion about the various scenarios and options for the transition to sustainable, renewable energy.

What does this mean for Canada?

The world is changing. As an important producer and user of energy, Canada must be prepared to meet changing expectations and demands. Top priorities for Canada include:

- **Investment in conservation and efficiency**: Canada has a valuable opportunity to conserve energy and improve efficiency in everything from government and business policy to material goods. As a northern country with extensive energy needs, Canada will see extensive benefits from these investments.

- **Transition to renewable, sustainable energy**: Canada has great potential for renewable, sustainable energy and is well placed for this transition. These changes require investment on a greater scale than ever before in Canada, as well as the support of both business and government.
• **Reform of transportation and urban design:** As one of the most urbanized countries in the world, Canada needs to shift to livable cities with electrified transportation, fuelled by renewable energy. The emissions savings from these changes could have an important role in reducing the impacts of climate change.

**Challenges Ahead**

WWF recognizes that numerous challenges will need to be addressed on the road to reaching this goal by 2050. We must:

- Find ways to conserve energy without compromising growth or development
- Enable electrification by switching to renewable sources
- Ensure everyone has an equal right to energy
- Limit the impact of land use required to meet energy needs
- Make choices in our own lives to affect energy supplies
- Raise capital to support renewable energy as a viable long-term economic investment
- Make the advances required to achieve the 100% renewable energy vision about the energy report

Benefits of Renewable Energy

What is Renewable Energy?
Renewable energy is classified as energy that comes from resources like sunlight (known as solar), wind, geothermal heat, and rain that are constantly replenished. Renewable energy can serve as a replacement to electricity, motor fuels, rural energy, and heating. Many people might discount renewable energy sources right off the bat just by looking at the definition. They wouldn’t hesitate to question why it is necessary to switch to sources like sunlight, wind, or rain. The way they see it, these are not very reliable sources of energy.

Of course, the shortcomings are all things that can, with time and money, be fixed due to the rapid technological advancements our country makes on a nearly annual scale. The benefits of renewable energy sources are breathtaking, and while we may not quite be in a position to fully switch over to renewable energy sources just yet (requiring a balance of renewable energy and other sources for now), it is imperative that we look ahead to the future.

Advantages of Renewable Energy

1. **Renewable energy is, well, renewable!** This means it has infinite sustainability and we will never run out of it. Other sources of energy like coal, oil, and gas are limited and will run out some day. Renewable energy can reduce our dependence on fuels and energy from foreign governments. Strong winds, heat within the earth, moving water, and shining sun can provide a vast and constant energy resource supply.

2. **Environmental Benefits:** Renewable energy is clean and results in little to no greenhouse and net carbon emissions. It will not deplete our natural resources and has minimal, if any, negative impacts on the environment, with no waste products of Co2 or other, more toxic products. Use of renewable energy will dramatically scale back the amount of toxic air pollution released into the atmosphere by other methods. It also enables us to protect the environment from toxic pollutions, which in turn keeps people healthier.

3. **Reliable Energy Source:** Our dependence on fossil fuels has increased considerably in the last few decades. The result is that our national security continues to be threatened by our dependence on fossil fuels, which are vulnerable to political instabilities, trade disputes, wars, and price fluctuations. This impacts more than just our national energy...
policy. Solar and wind plants, on the other hand, are distributed over large geographical areas and weather disruptions in one area won’t cut off power to an entire region.

4. **Economic Benefits:** Renewable energy is also cheaper and more economically sound than other sources of generated energy. It is estimated that as a result of renewable energy manufacturing, hundreds of thousands of stable jobs will be created. Thousands of jobs have already been created in numerous European countries like the United Kingdom and Germany, which have adopted measures to manufacture renewable energy. Renewable energy amenities require less maintenance, which reduces the costs. Switching to renewable energy sources also means that the future of our energy is returned back to the people: to communities, families, farmers, and individuals.

5. **Health Benefits:** Studies have consistently shown that renewable energy is good for your health. In 2013 researchers at MIT reported that air pollution in the United States accounts for more than 200,000 premature deaths each year and 52,000 of these fatalities are related to electricity generation from fossil fuels\(^1\). Greater reliance on renewable sources of energy means cleaner air that will save lives and millions of dollars in health care costs annually.

6. **Stabilize Energy Prices:** Switching to renewable energy sources also mean steady pricing on energy. Since the cost of renewable energy is dependent on the invested money and not the increasing or decreasing (or inflated) cost of the natural resource, governments would only pay a small amount in comparison to the needlessly heavy pricing of the energy sources we are witnessing currently.

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**From:** Conserve Energy Future 2016

\(^1\) MIT News, 2013

**Additional Information**

- [The Top Seven Renewable Energy Sources](#)
Renewable Energy Has a Variability Problem

Renewable energy has a variability problem and pretending that it does not – at the very least on a public perception level – won’t make this issue go away. The wind does not always blow, nor does it always blow steadily, and clouds can obstruct sunlight. Wind and solar are variable sources of energy and this poses certain unique challenges that need to be addressed. At times an entire region can experience periods of a day or sometimes even a week where usually available wind or solar energy is largely absent. Wind energy in particular is variable over short time scales with gusting wind producing peaks and troughs in power output that can cause voltage problems because of the unevenness of the power being put onto the grid.

Increasingly this variability problem is being seized upon by the opponents of wind and solar power as a cardinal argument against the very idea of renewable energy. By not addressing this issue, by not quantifying and, where needed, costing for it, proponents of renewable energy are allowing the issue of variability to be employed as an effective argument by those who are ideologically opposed to renewable energy. The variability of wind and solar is an effective talking point because it does in fact represent a real problem with wind and solar power and this issue is increasingly being employed by opponents of renewable energy no matter what the underlying reason may be that is really motivating their opposition.

Wind, solar, and wave energy all depend in different ways directly on the prevailing weather, and weather is a chaotic and difficult-to-predict system with a lot of turbulent variability both over both short and long durations. Although it is possible to get average or mean values for potential wind or solar energy for some geographic locations and to predict on average what the potential energy yields will be for a given site it is pretty much impossible to predict or guarantee what the energy profile for a site (or region) will be in any given future instant. The accuracy of weather predictions decreases rapidly the further out in time that they are projected; so it is difficult to predict what a site’s energy production will be in say… a week.
Wind, solar, and wave energy vary over short duration time scales in addition to the longer more predictable seasonal and diurnal fluctuations. Wind gusts and swirls; wind is a chaotic laminar flow on the boundary of the earth/water to atmosphere interface. While preferred wind sites are selected in part because the wind blows steadily and does not gust and shift directions, all sites experience short duration peaks and troughs of power output in addition to longer duration swings between periods of stable weather patterns.

The solar energy output of a site will drop quite suddenly (especially for photovoltaic arrays) when a cloud wanders between the collectors and the sun and then surge back on when the cloud floats away and the sunshine returns to irradiate the mirrors or PV modules of the site. Solar energy also cycles with seasonal variations in the incident solar irradiance, and of course the sun does not shine at night.

By far most waves are wind-generated, though not necessarily primarily by wind that is blowing where the waves are being harvested to produce electricity. Wave energy can also propagate for some time after wind has calmed. In fact some offshore deep-water floating platform wind turbine designs integrate wave energy collection into the floating deep-water energy-harvesting platform.

From: Green Economy Post by Chris de Morsella

Additional Information

- Problems with Alternative Energy
A Deal in Paris

The 2015 United Nations Climate Change Conference, COP 21, was held in Paris, France. The conference negotiated the Paris Agreement, a global agreement on the reduction of climate change. The agreement will become legally binding if joined by 55 countries that together represent 55% of global greenhouse gas emissions.

Some highlights:
- It calls for “holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change.” This language recognizes the scientific conclusions that an increase in atmospheric temperatures of more than 2 degrees Celsius (or 3.6 degrees Fahrenheit) would lock the planet into a future of catastrophic impacts including rising sea levels, more devastating floods and droughts, widespread food and water shortages, and more powerful storms. It also recognizes the scientific conclusions that warming of just 1.5 degrees Celsius (or 2.7 degrees Fahrenheit) could present an existential threat to low-lying island nations that would be inundated by sea level rise at that rate of increase. But while those nations celebrated the inclusion of that 1.5 degree target, it is more aspirational than practical. The national plans submitted for the conference would probably result in an increase above 3 degrees Celsius.
- To achieve reductions goals, countries should “reach global peaking of greenhouse gas emissions as soon as possible, recognizing that peaking will take longer for developing country parties, and to undertake rapid reductions thereafter.” Advocates say this wording sends a clear message to the fossil-fuel industry that much of the world’s remaining reserves of coal, oil, and gas must stay in the ground and cannot be burned.
- The agreement acknowledges “the importance of averting, minimizing and addressing loss and damage associated with the adverse effects of climate change.” This was deemed crucial by poor and small-island countries that suffer the most from extreme weather and from long-term impacts like droughts. However, this provision “does not involve or provide a basis for any liability or compensation,” a point that wealthy nations, which did not want to be held financially liable for climate change, insisted on.
• Ahead of the agreement, 186 countries submitted plans detailing how they reduce their greenhouse gas pollution through 2025 or 2030. The agreement requires all countries to submit updated plans that would ratchet up the stringency of emissions by 2020 and every five years thereafter, a time frame that the United States and the European Union urged; India had initially sought a 10-year review cycle.
• The deal requires a global “stocktake” — an overall assessment of how countries are doing in cutting their emissions compared to their national plans – starting in 2023, every five years.
• The deal requires countries to monitor, verify, and report their greenhouse gas emissions using the same global system. The United States has insisted that an aggressive system of counting and verifying each nation’s emissions is crucial to the success of any plan.
• The agreement, which takes effect in 2020, calls on nations to establish “a new collective quantified goal” of at least $100 billion a year in climate-related financing by 2020.
• When countries update their commitments, they will commit to the” highest possible ambition,” but the agreement does not set a numeric target. It acknowledges “common but differentiated responsibilities and respective capabilities, in the light of different national circumstances.”

From: Key Points of the Paris Climate Pact, New York Times 2015
Canada’s Action on Climate Change

The Government of Canada has declared itself committed to working with international partners to achieve a low-carbon, climate-resilient economy by “holding the increase in the global average temperature to well below 2°C.” Part of that commitment involves supporting the poorest and most vulnerable countries in adapting to the adverse effects of climate change. Nationally, the government will join with the provinces and territories to establish a pan-Canadian framework for combating climate change that will ensure the provinces and territories have targeted federal funding and the flexibility to design their own carbon pricing policies.

The government has also announced its intention to invest in clean energy and clean technology by establishing an endowment of $2 billion in a Low Carbon Economy Trust Fund and by phasing out subsidies for the fossil fuel industry.

The Energy Efficiency program is part of this technological trust. It is investing $195 million between 2011 and 2016 to maintain the Government of Canada's momentum to improve energy efficiency in Canada – at home, at work and on the road. These efforts will make the housing, building, and equipment stock more energy efficient, energy performance more visible, and industry and vehicle operations more efficient. Improving energy efficiency will contribute to a cleaner environment, reducing greenhouse gas emissions (GHG) while saving Canadians money and making the most of our natural resources.

The ecoENERGY Efficiency program features the following components:

- **Buildings**: includes information on energy consumption in commercial and institutional buildings in Canada.
- **Housing**: provides information aimed at making the housing sector in Canada achieve significant reduction in the nation's energy footprint.
- **Energy Star**: identifies energy-efficient products designed to save money on our energy bills and fight climate change.
- **Industry**: provides information on the efforts of government and industry to promote energy efficiency and reduce greenhouse gases.
- **Transportation**: informs Canadians, businesses and governments about fuel efficient vehicles.

From: Natural Resources Canada, 2016
SOME CASE STUDIES

Ontario’s Cap and Trade
Through a cap and trade system, Ontario is putting a hard ceiling on the amount of greenhouse gas each sector can emit into the air.

Cap
The "cap" puts a limit on how many tonnes of greenhouse gas pollution that businesses, institutions, and households can emit. This cap is set at a specific amount, which drops each year to encourage lower emissions; for example, the cap declines by 3% to 4% per year in the programs in place in Quebec and California. Companies must have enough allowances (or credits) to cover their emissions if they exceed the cap.

To comply, companies can generally:
• invest in clean technologies to become more efficient
• burn less fossil fuels
• purchase additional credit

Trade
The "trade" refers to a market where companies can buy or sell carbon credits, also known as allowances. These credits are linked to every tonne of greenhouse gas they emit (or do not emit).

For example, if a company emits more GHGs than permitted by the cap, it could purchase credits to come into compliance. These credits would be available for purchase from a company that reduced its GHG emissions levels to below the cap.

Transition
Consistent with the phased approach used in both Quebec and California, Ontario is proposing a transition period for large emitters to help them make the shift to low carbon. During the initial phase of a cap and trade program, Ontario is proposing to provide a portion of the credits for free.
Benefits of Cap and Trade
Cap and trade can spur the development of new clean technologies, bringing jobs and economic benefits in the growing global market for climate-friendly products. The money collected through a price on carbon can be used help businesses and homeowners reduce their carbon footprint and foster innovation.

Value
Companies will be rewarded for reducing their carbon footprint. If you pollute less, you pay less.

Partnership (Quebec and California)
Ontario has signalled its intent to link its program with similar programs operating in Quebec and California, which will:
- enable access to a bigger pool of low-cost emissions reductions
- work to set a common price for carbon across jurisdictions
- take advantage of existing program designs to:
  - make the transition to low carbon as economical as possible
  - simplify administration for industries operating in multiple jurisdictions
  - create a large, stable market that works to lower emissions

From: Ontario Ministry of the Environment and Climate Change, 2016
Energy-Efficient Seasonal Lights: Add Energy Savings to Your Christmas List

Just before Christmas 2003, Natural Resources Canada (NRCan) and BC Hydro Power Smart joined forces with manufacturers and lighting retailers in British Columbia to promote energy-efficient seasonal light strings. The light strings use light-emitting diode (LED) technology. The campaign was designed to educate consumers about the benefits of seasonal LED (SLED) technology as well as increase purchases through market-based incentives. BC Hydro Senior Vice-President of Distribution, Bev Van Ruyven said, "LED lights use 95% less energy than incandescent, translating to significant savings for the customer and energy savings for BC Hydro."

SLED lights are not made with glass or filaments so are less prone to break. They don't produce a lot of heat, making them less of a fire risk. These impressive characteristics mean that these lights are expected to last up to seven times longer than regular lights. Replacement strings do not have to be purchased as often, and households can decorate to their liking knowing that they are consuming very little energy.

The introduction of SLED lights in British Columbia was the first anywhere in Canada. The British Columbia pilot project was designed to speed up the introduction of energy-efficient seasonal lights across Canada and meet the four following objectives:

- to introduce and demonstrate the benefits of energy-efficient technology to residential customers
- to increase sales of SLED lights in B.C. though rebate and promotional programs so that, by 2008, 20% of seasonal lights in use are SLED
- to gauge consumer and retailer acceptance of the product
- to achieve significant electrical energy savings during the peak demand heating season

LED technology has proven energy and cost-saving capabilities. Compare the performance of regular incandescent lights, mini-incandescent lights, and SLED lights required to decorate an eight-foot Christmas tree on the table below:

<table>
<thead>
<tr>
<th>Seasonal Light</th>
<th>Energy Used/Year (kWh)</th>
<th>Cost/Year ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular Incandescent</td>
<td>96.88</td>
<td>5.81</td>
</tr>
<tr>
<td>Mini-Incandescent</td>
<td>23.25</td>
<td>1.40</td>
</tr>
<tr>
<td>SLED</td>
<td>1.86</td>
<td>0.11</td>
</tr>
</tbody>
</table>

* This figure is based on the assumptions that the lights are in use 31 days a year for five hours a day and that consumers are paying 6 cents per kWh for energy.
The Bright Idea
Several market-based incentives were used to promote sales of the SLED lights in British Columbia. BC Hydro administered, while NRCan and the manufacturers (Fiber Optic Designs and Toprio Electronics) shared the cost of a $5.00 mail-in rebate coupon on lights bought from various retailers. The campaign goal was to have 3,000 coupons redeemed. That goal was surpassed by 23,512 coupons! In total 11% of the 470,000 SLED light strings sold during the fall and winter season in B.C. were purchased with a coupon. A separate promotional activity funded in part by NRCan and the manufacturer Conglom Inc. provided an in-store rebate of $2.00 at Costco, where they sold 100% of the 19,800 Luminus Brand LED lights they had in stock. A trade-in pilot project was carried out by a limited number of retailers in lower mainland areas of B.C. This initiative encouraged 1,709 consumers to bring in older, energy-intensive incandescent light strings in exchange for one new SLED light string. NRCan, the manufacturer Toprio Electronics and BC Hydro together covered the promotion and product costs of this project. As well, Toprio Electronics was responsible for the safe disposal and/or recycling of the returned incandescent lights.

Approximately 2.5% of all BC Hydro's Households participated in the 2003 promotional activities. SLED lights comprised 9% of the seasonal light market in BC. The fact that most retailers sold 100% of their SLED stock demonstrates that these strings were well received by retailers and the public. The future success of these little lights will be based on increased customer acceptance nation-wide and will eventually translate into excellent energy savings for all Canadian residents.

A Bright Future
An energy savings of approximately 10 kWh per string is achieved with SLED lights in comparison to traditional seasonal lights. The initial energy savings target for this pilot project was 2.61 GWh, however the actual energy savings generated by this campaign were tabulated at 4.01 GWh. With every GWh there is a reduction of 360 tonnes of greenhouse gas (GHG) emissions. This campaign prevented the release of 1,444 tonnes of GHG emissions in B.C.

The SLED Lights are a practical way to reduce energy consumption especially at a time of year when BC Hydro experiences its greatest power demand. The lights make the holiday season colourful and festive without adding excessive pressure on the power grid. "The energy cost of operating a string of LED lights is a fraction of the cost of conventional holiday lights," said the Honourable John Efford, Minister of Natural Resources Canada. "These lights have the potential of making a significant dent in the electricity consumed by festive lighting, thereby helping to reduce greenhouse gas emissions produced in Canada." This pilot project proved that the public in B.C. is very interested in SLED lights. These lights will be available to the rest of Canada, so everyone can keep savings in mind when writing up next year's Christmas list.

From: BC Hydro and Natural Resources Canada

Additional Information:
- Use Energy – Efficient Christmas Lights & BC Hydro News
Eritrea’s Success Story in Renewable Energy Development

Eritrea, a country in north east of Africa, has been actively engaged in the development and utilization of different renewable energy sources, especially wind, since the first few years of independence when a preliminary survey was conducted to study wind velocity in different parts of the country. Soon after, they established a department within the Ministry of Energy and Mines called the “Development of Renewable Sources of Energy.” This department became instrumental in initiating a number of tasks and studies on how to explore pollution-free, renewable (unlimited) sources of energy in Eritrea.

The department, in 2003, commenced the “Eritrean Wind Energy Scheme” and the “Wind Energy Application” Pilot Project that was partially financed by the UNDP and the Global Environment Facility. The plan was to provide electricity for seven villages in the Southern Red Sea region including Assab, Edi, Berasole, Beilul, Gahro, and Rahaita by installing three sample wind turbine generators that have the potential of generating an electricity of 750 Kilowatts. Wind speeds of over 7 knots (around 12 km per hour) are required to produce sufficient electricity, and along the Eritrean Red Sea coast, wind speed can reach up to 10 knots and more.

The head of renewable energy department, Eng. Abi Gebremedhin, disclosed that, currently, wind-powered electric generators in Assab alone cover 20% of the city’s electricity consumption. The development of such cheap and affordable renewable energy has contributed a lot to the lives of the people in the area, who mostly make their living from fishing. They can now save their meager supply of fuel to drive as far as the Red Sea to find rich fishing grounds.

They are now able to make ice from the electricity powered by these wind turbines, so that they can keep the fish fresh while transporting, storing and trading the catches. The availability of such energy, in addition to saving about 684,000 liters of fuel oil and reduce carbon dioxide emission by 1,700 tons each year, it also contributes to preserving the potential of the local fishing industry. Eng. Abi also said that, after the success of the pilot projects in Assab, similar wind turbines with a capacity of up to 30 Kilowatts have also been installed in Edi, Berasole, Beilul, Rahaita, Gahro, and Dekemhare both for electricity and pumping water for irrigation purposes.

From: Tesfa News, 2011
School Buses Go Green in Virginia

Thousands of students in Virginia are breathing cleaner air, thanks to the hard work of several school districts and a small army of Virginia Clean Cities (VCC) stakeholders. Through the Clean School Bus USA Middle Peninsula Project, VCC helped four counties in the state's Middle Peninsula and Piedmont regions deploy bio-diesel, idle reduction, propane, and other emissions-reduction strategies in their school bus fleets from March 2008 through December 2010.

"We've taken some important first steps toward lower emissions and reduced dependence on foreign oil," said Roger Kelly, transportation director for Gloucester County Public Schools. "Everybody needs to be doing everything they can to set solutions in motion for the next generation."

Laying the Foundation

VCC laid the foundation for the project through early outreach to school districts, inspiring school boards to pass resolutions to reduce petroleum use in bus fleets. As a result, local champions were ready and willing to take action when funding opportunities became available from the U.S. Environmental Protection Agency’s (EPA) Clean School Bus USA program, the Virginia Department of Environmental Quality (VDEQ), the Mid-Atlantic Regional Air Management Association, and other sources.

School districts in four counties used $39,000 to install diesel oxidation catalysts on 70 buses to reduce diesel emissions. VCC estimates the devices averted at least 39 tons of emissions during the 32-month project period, and they continue to contribute to improved air quality today. The project also paid up to $0.06 per gallon toward the use of B5 (5% bio-diesel, 95% petroleum diesel) by two school districts.

Cost and Savings

Together, they used 347,080 gallons of B5 during the project, reducing emissions of both carbon dioxide and particulate matter by about 3%. Districts in two counties installed 24 engine block heaters and conducted driver training to reduce idling time by 23%, resulting in total estimated emissions reductions of more than 5 tons per school year. A pilot project in Gloucester County Public Schools put five Blue Bird propane school buses on the road. Funds from EPA and VDEQ subsidized the incremental cost of purchasing the buses, and now the district is benefiting from lower emissions, reduced petroleum use, lower fuel costs, quieter operation, and higher driver satisfaction.

From October 2009 to November 2010, the five buses saved almost $7,000 in fuel and maintenance costs and averted 8.4 tons of greenhouse gas emissions.

"The only complaint I've had was from one parent whose daughter is missing the bus because she can't hear it rumbling down the street like she used to," Kelly said.

Switching for Efficiency in the Yukon: The Fridge Exchange

Major appliances account for a significant portion of a home's energy use. Refrigerators in particular are significant because they run all the time. A unique initiative based in Canada’s Yukon Territory is tackling the replacement of older, inefficient refrigerators by offering incentives to encourage switching to energy-efficient models. In an effort to reduce greenhouse gas emissions produced by diesel-electric generation, the Yukon Development Corporation offers residents of the Yukon's diesel communities a $200 rebate to program applicants who purchase an ENERGY STAR qualified, high-efficiency refrigerator and turn in their old, working refrigerator.

How the Fridge Exchange Works

The Fridge Exchange Program includes full-circle responsibility from purchase incentives to appropriate waste management. The program covers the cost of delivering the new refrigerator and the removal of the old fridge, addressing a significant economic barrier for remote communities. To be eligible, the old appliance must be at least 10 years old and in working condition. Residents of the Yukon's hydroelectric communities are also eligible to participate in the program and receive all the associated benefits with the exception of the rebate.

Benefits

As well as reducing the demand on the power supply system, the Fridge Exchange Program helps Yukoners save money and reduce personal greenhouse gas emissions. With a new ENERGY STAR qualified fridge, savings can be up to $145 per year for a residential electricity bill. There is also free delivery of the ENERGY STAR qualified fridge and removal of the old fridge. The program also strives to increase local availability of ENERGY STAR qualified refrigerators that in turn will reduce the demand on Yukon's hydroelectric grid.

The Yukon Development Corporation ensures proper handling by removing the refrigerant and recycling the steel from all old units collected under the program. Part of the program evaluation will include an estimation of the amount of refrigerant collected and the amount of steel recycled.

In addition, the Centre also delivers community workshops linking energy efficiency, EnerGuide, and ENERGY STAR to savings and the reduction of greenhouse gas emissions that contribute to climate change. The program also rewards retailers for sales of ENERGY STAR qualified refrigerators by offering a $20 incentive to the salesperson for each unit sold. The incentive also applies to ENERGY STAR qualified clothes washers and dishwashers.
Challenges

ENERGY STAR qualified models generally cost more than less-efficient models. This poses an economic barrier. A key to this challenge involves making people aware of the longer-term benefits and savings of an ENERGY STAR qualified appliance. There has also been lower than anticipated participation in the program from remote communities, which are typically less affluent than Whitehorse. Also, the range of ENERGY STAR products, while on the rise across Canada, is not available in a full complement of sizes and other features desirable to Yukon households. This underlines the importance of retailers working closely with manufacturers and suppliers to determine the latest ENERGY STAR qualified models that will meet their customers' needs.

The program has been well received by communities across the Yukon. In the first year of the program, over 75 Yukon fridges were exchanged. All Yukon appliance retailers are participants in the program. Original estimates of greenhouse gas reductions appear to have been conservative. Present calculations indicate that the average Yukon household participating in the Fridge Exchange will save three quarters of a tonne of greenhouse gases per year. The program began in March 2002 and was extended to March 2004. The 2003 Fridge Exchange concentrated on opportunities to increase energy efficiency through green procurement and through joint promotion of energy-efficient appliances with local retailers.

From: Natural Resources Canada, 2016
SOME CURRENT DEBATES

Can Canadian Oil Sands Survive Falling Prices?

As oil prices crashed over the last half of 2015, a lot of attention has focused on what this means for frackers in the U.S., as well as the national budgets of a lot of large, oil-producing countries, such as Russia and Venezuela. In short, it’s not good. But what about Canada? The country is the world’s fifth-largest oil producer, and only Saudi Arabia and Venezuela have more proven reserves of crude.

Almost all of Canada’s reserves (and production) are in the form of oil sands, which are among the most expensive types of crude to produce. There are pretty much two ways to do it: one is to inject steam into wells deep underground to heat up a thick, gooey type of oil called bitumen; the other is basically to strip-mine large tracts of land and extract a synthetic blend of oil out of the earth and sand.

Taken together, both methods require about 17% more energy and water than conventional oil wells and also result in similarly higher levels of carbon emissions. That has made oil sands a particular target of environmentalists. Now the Canadian oil sands producers have to contend with an even greater opposing force: economics. If Canadian oil sands are more expensive to produce than most other oil, how can they survive in the face of prices that are nearly 50% cheaper since June?

A few things play to their favour. The first is that their costs are more akin to a mining operation than conventional oil drilling. Oil sands projects require massive upfront investments, but once those are made, they can go on producing for years with relatively low costs. That has made oil sands (and the companies that produce them) quite profitable over the past few years. Suncor Energy (SU) and Cenovus Energy (CVE) are two of the biggest oil sands producers in Canada. Both have profit margins that would be the envy of a lot of major oil companies. At Suncor, earnings before interest, taxes, depreciation, and amortization (EBITDA), a basic measure of a company’s financial performance, have risen from 11.7% in 2009 to 31% through the first nine months of 2014. Exxon Mobil’s (XOM) EBITDA so far this year (2016) is about half that at 14.3%.
That cost structure may give oil sands producers an advantage over frackers in the U.S., who operate on a much shorter time horizon. Fracked wells in the U.S. tend to produce most of their oil within about 18 months or so. That means that to maintain production and rates of return, frackers need to keep reinvesting in projects with fairly short life spans, whereas an oil sands projects, once up and running, can continue to chug along even in the face of lower prices, since its costs are spread out over a decade or more rather than over a couple years. That should keep overall oil sands production from falling and help insulate oil sands producers from lower prices, at least for now.

**GRAPHIC: The Only Oil Worth Owning**

“They’re safer than the frackers,” says Carl Evans, an oil analyst at Genscape. “The sentiment up in Calgary has very much been that growth will push through this price dip, while U.S. production will start to come off highs.” Evans says the breakeven costs for bitumen oil sands projects that are already up and running can be as low as $10 to $20 a barrel. Right now, the price of Canadian oil in Alberta is about $40 a barrel.

This isn’t to say that future investments won’t get cut if prices stay where they are. But those cuts won’t show up in future production growth for years. A total of 14 new oil sands projects in Canada are scheduled to start next year with a combined capacity of 266,000 barrels a day, according to data published by *Oilsands Review*. That’s 36% more than were started in 2014. Since most of those investments have already been made, those projects are probably safe. Even for projects that are only partially paid for, investors will still probably be loath to stop halfway.
“You don’t stop a project mid-cap-ex,” says Greg Sharenow, a portfolio manager at Pacific Investment Management Company (Pimco) and former senior energy economist at Goldman Sachs (GS). “We’ll see a pause in new investments, but you probably won’t see shut-ins without real distress,” he says.

From: Bloomberg Business, 2014

Additional Information
- PBS Newshour
- Tar Sands Debate 1
- Bruce Hyer on the Hill: Northern Gateway Pipeline

Fracking: Unlocking the Great Debate
The use of hydraulic fracturing or fracking has grown considerably more popular in the past decade. As extraction of diminishing traditional reserves becomes more expensive, the technique has been “credited with spurring an oil and gas renaissance across North America, unlocking billions of barrels of oil and trillions of cubic feet of gas.” The allure of gaining access to reserves of natural gas estimated to meet our projected energy needs for the next 100 years carries considerable weight in political and economic camps. Conversely, the potential health and environmental risks associated with unconventional methods of drilling have served as a rallying cry for fracking’s opponents.

The intense debate over fracking can be framed as an epitome of the struggle or tension between contrasting worldviews: environment vs. economy, short- vs. long- term, biodiversity vs. monoculture. While arguably all oversimplifications, they are indicative of the chasm between conflicting positions. If an essential challenge of meaningful education is to deal with controversial issues, the polarizing nature of the fracking debate provides potential for rich, multi-faceted student learning opportunities. It is time to enter rough waters and examine the elements of the controversy: the arguments used to both support and oppose the practice.

What is the Process of Hydraulic Fracturing?
Fossil fuels account for 81% of the current global energy supply. Vertical hydraulic fracturing (pumping fluid into existing oil and gas wells) has been used since the 1940s, while the horizontal technique became widespread in the 1990s. The latter involves drilling vertically downward toward a gas-bearing rock formation and then curving the well in a horizontal direction deep within the rock formation. Horizontal drilling actually costs 80% more than vertical drilling, but it increases efficiency by 400%, thus the technique has been a boon to oil and gas companies. The recent expansion of hydraulic fracturing extracts natural gas from harder to access unconventional sources trapped in rock formations such as shale gas, coal bed methane, and tight gas. Millions of litres of water and thousands of litres of chemicals are injected underground at a high pressure in order to create fractures in the rock, allowing gas to flow up the well.
Arguments For and Against Fracking

Fracking has significant potential consequences, regardless of whether one supports or opposes the technique. The corporate arguments purport increased reserves of energy, high-skill jobs, and government revenues, low energy prices, and a “cleaner bridge” fuel as the world moves towards less-damaging, renewable sources of energy. Conversely, the associated risks of fracking include increased greenhouse gas emissions, damages to the natural environment, waste and contamination of water, and an assault on aboriginal rights. The lines drawn are clearly antithetical — proponents claim “the waste water generated in the process can be disposed of or treated safely; opponents say run-off, industrial accidents and cost-cutting make contamination inevitable.”

A deeper opposition contends that hydraulic fracturing is being grasped as a means of buttressing an ailing growth economy that is the root cause of many of our social and environmental woes.

A plethora of material from both proponents and opponents to hydraulic fracturing is available online. Check out ProCon.org for examples from both sides.

From: “Unlocking the Great Fracking Debate”, B. Tulk, Green Teacher, 104, Fall 2014

2 Council of Canadians, 2014
Get It Right on Gas

We are in the midst of a natural gas revolution in America that is a potential game changer for the economy, environment and our national security — if we do it right.

The enormous stores of natural gas that have been locked away in shale deposits across America that we’ve now been able to tap into, thanks to breakthroughs in seismic imaging, horizontal drilling and hydraulic fracturing, or “fracking,” are enabling us to replace much dirtier coal with cleaner gas as the largest source of electricity generation in America. And natural gas may soon be powering cars, trucks, and ships as well. This is helping to lower our carbon emissions faster than expected and make us more energy secure. And, if prices stay low, it may enable America to bring back manufacturing that migrated overseas. But, as the energy and climate expert Hal Harvey puts it, there is just one big, hugely important question to be asked about this natural gas bounty: “Will it be a transition to a clean energy future, or does it defer a clean energy future?”

That is the question, because natural gas is still a fossil fuel. The good news is that it emits only half as much greenhouse gas as coal when combusted and, therefore, contributes only half as much to global warming. The better news is that the recent glut has made it inexpensive to deploy. But there is a hidden, long-term, cost: a sustained gas glut could undermine new investments in wind, solar, nuclear, and energy-efficiency systems — which have zero emissions — and thus keep us addicted to fossil fuels for decades.

That would be reckless. 2012’s global extremes of droughts and floods are totally consistent with models of disruptive, nonlinear climate change. After record warm temperatures in the first half of 2012, it was no surprise that the Department of Agriculture designated more than half of all U.S. counties — 1,584 in 32 states — as primary disaster areas where crops and grazing areas have been ravaged by drought.

That is why on May 29, 2012 the British newspaper The Guardian quoted Fatih Birol, the chief economist for the International Energy Agency, as saying that “a golden age for gas is not necessarily a golden age for the climate” if natural gas ends up sinking renewables. Maria van der Hoeven, executive director of the I.E.A., urged governments to keep in place subsidies and regulations to encourage investments in wind, solar, and other renewables “for years to come” so they remain competitive.

Moreover, while natural gas is cleaner than coal, extracting it can be very dirty. We have to do this right. For instance, the carbon advantage can be undermined by leakage of uncombusted natural gas from wellheads and pipelines because methane — the primary component of natural gas — is an extremely powerful greenhouse gas, more powerful than carbon dioxide. The big oil companies can easily maintain high drilling standards, but a lot of fracking is done by mom-and-pop drillers that do not. The standards that can make fracking environmentally O.K. are not expensive, but the big drillers want to make sure that the little guys have to apply them, too, so everyone has the same cost basis.
On July 19, Forbes interviewed George Phydias Mitchell, who, in the 1990s, pioneered the use of fracking to break natural gas free from impermeable shale. According to Forbes, Mitchell argued that fracking needs to be regulated by the Department of Energy, not just states: “Because if they don’t do it right, there could be trouble,” he says. There’s no excuse not to get it right. “There are good techniques to make it safe that should be followed properly,” he explains. But, the smaller, independent drillers are “wild;” “it’s tough to control these independents. If they do something wrong and dangerous, they should punish them.”

Adds Fred Krupp, the president of the Environmental Defense Fund who has been working with the government and companies on drilling standards: “The economic and national security advantages of natural gas are obvious, but if you tour some of these areas of intensive development the environmental impacts are equally obvious.” We need nationally accepted standards for controlling methane leakage, for controlling water used in fracking — where you get it, how you treat the polluted water that comes out from the fracking process, and how you protect aquifers — and for ensuring that communities have the right to say no to drilling. “The key message,” said Krupp, “is you gotta get the rules right. States need real inspector capacity and compliance schemes where companies certify they have done it right and there are severe penalties if they perjure.”

Energy companies who want to keep regulations lax need to understand that a series of mishaps around natural gas will — justifiably — trigger an environmental backlash to stop it.

But we also need to get the economics right. We’ll need more tax revenue to reach a budget deal in January. Why not a carbon tax that raises enough money to help pay down the deficit and lower both personal income taxes and corporate taxes — and ensures that renewables remain competitive with natural gas? That would ensure this gas revolution transforms America, not just our electric grid.

A version of this op-ed appeared in print on August 5, 2012, on page SR13 of the New York edition with the headline: Get It Right On Gas.

Additional Information
- Controversy Over Shale Gas Fracking Hits New Brunswick
- Oh, Canada’s Become a Home for Record Fracking
Energy East Pipeline: What You Need to Know

What Is It?
Energy East is a proposed 4,600-kilometre pipeline by Calgary-based energy corporation TransCanada. It would stretch from Alberta to an export terminal in New Brunswick and could carry up to 1.1 million barrels of crude oil per day.

The pipeline would be built by converting an existing natural gas pipeline to one suited for oil transportation, as well as constructing new sections of pipeline to complete the route.

Where Will It Run?
The pipeline would begin in Hardisty, Alta., (southeast of Edmonton and about 100 kilometres from the Saskatchewan border), and end at Irving Oil Ltd.’s refinery in Saint John, N.B. Along the way, it would run through Saskatchewan, Manitoba, Ontario and Quebec. Montreal and Quebec City are both along the proposed route.

The Canadian Press

TransCanada Corp.’s proposed pipeline project would carry 1.1 million barrels a day. In December, TransCanada filed an amended application with the National Energy Board. The new application makes almost 700 changes to the original proposed route in order to minimize the impact on environmentally sensitive areas.3
What Is the Timeline?
Energy East was first proposed in 2013. If the National Energy Board approves TransCanada’s amended proposal, construction is set to start in 2018, with the pipeline up and running by 2020.

What Will It Cost?
The project was originally estimated to cost $12 billion, but when the amended application was filed, the estimated cost had risen to $15.7 billion, not counting the value of the existing natural gas pipeline that would be incorporated into it.

Why Is It Controversial?
The Energy East debate basically comes down to the economy versus the environment. On the one hand, it could be a boon to the economically depressed west, where low oil prices have led to large-scale job losses, as the cross-country pipeline would give Canada’s struggling, landlocked oil industry access to world energy markets. It is also estimated that it would create 2,300 direct and indirect jobs in New Brunswick, which had an 8.9% unemployment rate (higher than the Canadian average of 7.1%) in December 2015.

However, many are concerned about the environmental impact an increased demand for oil could have. The Pembina Institute, an environmental think-tank, released a report in 2014 that found producing the amount of crude needed to fill Energy East might generate an extra 32 million tonnes of greenhouse gases each year.

Municipalities close to the pipeline’s proposed route, including aboriginal communities, have expressed concern about the potentially disastrous possibility of a spill.

A lot of the debate has been divided by region, with westerners coming out in favour of the pipeline and Quebecers speaking against it. This has raised concerns that the pipeline debate is a threat to national unity. Interim Conservative leader Rona Ambrose has said it is "creating divisions in the country.”

Who Opposes the Pipeline?
At a news conference, more than 80 mayors in the Greater Montreal area announced their opposition to the pipeline. Montreal mayor Denis Coderre spoke on the group’s behalf, saying the project "still represents significant environmental threats and too few economic benefits for Greater Montreal."

After meeting with Prime Minister Justin Trudeau, Coderre dialled his opposition back a bit, saying that while TransCanada has more work to do if it wants to garner community support, "at the end of the day, it’s all about respect, being responsible and having a balanced approach [between economic growth and sustainable development]."

A telephone survey conducted by the polling firm SOM late last year found that 57% of Quebecers opposed Energy East.
In May 2015, more than 60 organizations, including the David Suzuki Foundation and Greenpeace Canada, signed a letter to the National Energy Board asking that it overhaul its review process and begin evaluating the Energy East project again only when more information had been submitted.

Who Supports the Pipeline?
Alberta politicians have thrown their weight behind the project, touting the economic benefits. Calgary Mayor Naheed Nenshi said that "Energy East is about energy independence for Canada. It not only allows us to get market access, it allows us to serve Canadian customers with Canadian energy."

Alberta Premier Rachel Notley has also voiced her support for the project. "Tens of billions of dollars in revenues, to be shared among all provinces, are at stake over our access to more markets for our oil," she said.

Ontario Premier Kathleen Wynne has flip-flopped on the issue. She had expressed concerns about the pipeline in the past, but the Alberta NDP government’s climate-change plan, which caps oilsands emissions, has made her more inclined to work with the western province on Energy East. She gave her tentative support to the project at a news conference in January 2016.

"The people of Ontario care a great deal about the national economy and the potential jobs that this proposed pipeline project could create in our province and across the country," she said.

3 CBC News, 2015
4 TransCanada, 2015
5 Pembina Institute, 2015
WHERE TO FROM HERE

Paths to the Future

The road ahead will not be without obstacles and detours. The investments required for achieving a sustainable energy system are sizable, the economic forces to be overcome are well organized, and the challenges to human ingenuity are enormous. Still, when economic historians look back on the mid-nineties, they may well decide that the world had already embarked on a major energy transition by then — just as, with hindsight, we can say the same about the 1890s. Today, as then, economic, environmental, and social pressures have made the old system unsustainable and obsolete, and the process of change is quietly gaining momentum. Slowly, people and governments are rising to one of the most fundamental challenges humanity has ever faced: passing on to our children a natural environment that has not been substantially degraded.

A new generation of private entrepreneurs, grassroots activists, and policy innovators is already laying the groundwork for an energy transition. Just who will emerge as the Thomas Edison or Henry Ford of the coming energy revolution is unclear, but they are almost certainly out there today — inventing new electric vehicles, assisting villagers to install solar lighting systems, and fighting before regulatory commissions to reform the utility industry. After two decades of mainly uphill battles, the forces of change may finally be gaining ground in the effort to forge a more sustainable energy system. If a persuasive vision of that energy system comes into focus soon, the transition is likely to accelerate — solving energy problems that have plagued humanity for decades, and creating a host of new economic opportunities.

Moving to the Preferred Future: Suggestions for Student Action

Acting on learning moves beyond the investigation of an issue to identifying solutions and working towards a desired change in personal lifestyle, in school, in the community, and on the planet. The premise is, if something is worth knowing, it is worth acting upon.

From: Connecting the Dots, 2012

Action projects:
- are experiential and offer authentic, relevant, meaningful opportunities for learning
- cater to different learning styles
- foster a natural relationship between the school and the wider community
- cultivate skills, knowledge, attitudes necessary for active citizenship

The resource, Engaging Students in Sustainable Action Projects, provides a detailed overview of the action process and includes activities to support each step in the design and implementation of an action project.

While the more involvement of students in deciding what action to pursue the better, a small sample of energy–themed action ideas is provided below. The links have been included as ‘food for thought’.

- **Solar Oven Fundraiser:** Investigate the problems associated with solid fuel cooking in the developing world. Design and build a solar oven for use in ‘solar cook-offs’ to raise awareness and funds. Work with an NGO to purchase and deliver solar ovens to those most in need.
  - http://www.purdue.edu/discoverypark/energy/assets/pdfs/Cancel_Sanchez.pdf

- **One Million Lights Project:** Many families living in developing countries experience rolling blackouts that often leave them in darkness on a recurring basis. In response, a physics class from New Brunswick launched what it called its ‘Million Lights Project’. Using a 3-D printer, the students hope to build and deliver a million solar flashlights to send to countries in need.

- **Create and perform or perform a drama/musical production to highlight and educate:** Performing arts can be a powerful way to engage students and inform a wider audience about important issues related to energy and climate change.
  - http://penguinonthinice.com/penguinz/
• **Conduct an energy audit at school:** Design an audit tool or adapt an existing one to address your needs. Collect and analyze the data. Make recommendations and work with the administration to implement them.
  

• **Shift Energy Use off Peak Demand Time:** Contact your local energy utility to learn how you can help reduce the risk of blackouts. Discover the best time to use big appliances and explore simple ways to shift your use ‘off peak’. Practice what you learn and develop a communication strategy to encourage others to do the same.
  
  http://www.peakstudents.org/students/energyactions/offdemand.asp

• **Get the Message Out:** Partner with an elementary school in your area to mentor younger students and spread the word about energy/conservation issues. Develop a board or on-line game or write a storybook to deliver an energy education program.
  