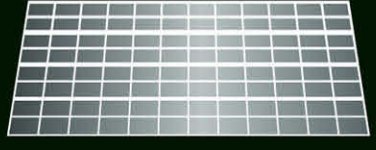
50 GREEN PROJECTS FOR THE EVIL GENIUS



Foreword by
PAUL MARTIN, PC
Former
Prime Minister
of Canada

- Filled with fun, environmentally focused projects
- Covers energy-efficiency, alternative fuels, solar, wind, and hydro power, and more
- Includes plans, schematics, materials lists, and sources

TAB ELECTRONICS

JAMIL SHARIFF

50 Green Projects for the Evil Genius

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50 Green Projects for the Evil Genius

Jamil Shariff

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About the Author

Jamil Shariff is a writer, educator, multidisciplinary freelancer and consultant. His passion is for environmental technology, especially the obscure but useful, like biogas digesters, sandbag houses, or velomobiles. He has been educated in music, English, and politics, and received his Masters in energy and the environment in architecture.

Jamil has worked with well-known environmental groups, like the Sierra Club, and the more obscure, like the Boiled Frog Trading Cooperative, and currently serves on the Board of Directors of the Toxics Watch Society of Alberta. He delights in writing to disseminate his experiences with new technologies, and designing and delivering technology-based courses.

His chronicled experiences range from sucking up used grease from restaurants to fuel the car he converted himself, to building parts of the fiber-glass weather protection on his velomobile himself. The courses he taught range from postgraduate classes on Stirling heat engines, to training sessions on biodiesel production for a local cooperative.

Jamil currently works with a sustainable innovation incubator in Ottawa, Ontario called the Boxfish Group, named for the angular yet rigid fish that car designers are mimicking. He works to bring deep technical understanding to policy conversations that can help government and businesses foster the innovations we need.

To my tenth grade English teacher, who wanted to fail me:

ttthhhbbbbbbbbbbbbbbbbbbbbbth!

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Foreword

People the world over are beginning to realize that a clean environment and a strong economy are two sides of the same coin. This realization, together with some ingenuity, will help to drive the next industrial revolution. We will see the creation of new environmentally friendly industries and buildings. We will set the foundations of a sustainable future.

Everyone can contribute to the global effort to reduce carbon emissions. By getting going we can make improvements in both our environment and our quality of life. New ideas and projects are emerging every day, including some of the technologies you will read about in this book. With more people reading and experimenting along these lines, we will see broader support for change at the individual and social levels. Many people want to make this change and start real progress on the road to a sustainable and prosperous society.

While I was Prime Minister, the Canadian government started the long road with Project Green. We need to make strides now down that road towards getting useful environmentally friendly technologies into the hands of all Canadians. As Jamil mentions, neither politics nor technology alone will, in the end, be sufficient to meet the enormous challenges that our changing climate will pose.

Innovation and the commitment of millions of Canadians, the inventiveness of many so-called "evil geniuses" working away in labs and shops—that is what will make it possible to come out ahead and even more prosperous. But we do need to get serious about this now. Climate change is one of the biggest challenges humankind has ever faced. It challenges us to work together as a planet and as a nation as never before. But we need to make light work with millions of hands. We all need to get interested in seeing what can be achieved in our own households and businesses. Each of us needs to start somewhere getting on the road to a sustainable lifestyle, and there is something in this book for all. I hope you enjoy the book as much as I have.

The Right Honourable Paul Martin PC

Former Prime Minister of Canada

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Acknowledgments

There are always a great many people to thank for their contributions to any work of this nature. To begin with, I am indebted to Gavin Harper for thinking of me for this project and for putting my name forward.

I'm grateful to everyone at the Falls Brook Centre in New Brunswick, for building an interesting learning center and for their help in preparing parts of this book, specifically Terri, Jean Arnold, and Brent Crowhurst. I'd like to thank Dries Callebaut at WAW in Belgium, Bar De Wert of Aerorider in the Netherlands, Rod Miner at Lightfoot Cycles in Montana, and Krash for images of the velomobiles. I owe a debt to John Tetz for pictures and help with the steps involved in building with Zotefoam, and to Dave Eggleston at Pedal Yourself Healthy for help with sections on the Alleweder, as well as to Jurrian Bol at Dutch Speed Bicycles for images of the same. Gary Whitfield at Whispergen was very helpful in providing prompt information and really neat pictures and Stirlingengine.com was kind enough to send a model for my use.

Carl Georg Rasmussen is an inspiration to me for his years of dedication to building a desperately needed vehicle by hand, and I'd like to thank him for teaching me his methods and inspiring me, as well as providing timely photos for the book. Myles Kitagawa has also been an inspiration to me for years, for this as well as permission to quote him, I am grateful. Raphael Khoudry gave eager assistance in compiling images of some projects. Richard Hampton's forethought in keeping a tin-can engine around for years until needed is deeply admired, and his comments on early drafts were greatly appreciated. Vinay Gupta, as always, was ready to do what it took to help have the Hexayurt widely adopted, and Rob and Sky Bicevskis went out of their way to make sure images of the fire piston were good enough for print. I'm very grateful for all of their help.

As ever, my family has been great throughout this journey, and alternately supported me and left me alone when needed. Thanks to all of you, especially to Nashina who looked over some chapters to make sure her older brother wasn't saying silly things.

I'm grateful to Judy Bass, my awesome editor, and Andy Baxter at Keyword, for their expert assistance throughout the publishing process, and to David Fogarty, Pamela Pelton, and David Zielonka, and the other members of the team at McGraw-Hill that guided me and contributed to this work. Last, but certainly not least, I would like to acknowledge the work of Brian Guest, who made the awesome Foreword possible, and the rest of the Boxfish team who are ensuring that my life remains full of interesting technologies and projects.

I'm sure I've missed a couple very important people to thank, and I'm sorry I did, but greatly appreciate their assistance nonetheless. Of course, none of this would have been possible without hundreds of inventive souls who were experimenting and exploring issues and technologies that will be crucial to a sustainable future long before me, and thanks is not enough for their persistence.

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Chapter 1

Introduction

The environment

During the last couple of years, the environment has become a popular topic in the media. In particular, global climate change has been receiving increased attention, due to the mounting evidence that its impact will be global and could be severe—even catastrophic—if mitigating action is not taken quickly.

In the past, topics such as acid rain have received a lot of attention. This in turn spurred action to address the problem, and while the problem hasn't been solved, a lot has been done to address it over the years. The current media focus on climate change may lead to the same kind of increased action, helping to avoid some of its most severe impacts.

Climate change

According to scientists, the warming of the climate, known as global climate change, is now unequivocal. It is increasingly clear that much of this warming is the result of human activity since the Industrial Revolution. Climate change results from the release of particular gases into the atmosphere, called "greenhouse gases" (often abbreviated GHGs); they act not unlike the glass on a greenhouse and trap the sun's heat on earth. These gases exist naturally as part of systems in the earth's cycle and scientists estimate that the earth would be about 30°C colder than it is today if these gases did not exist. The same scientists also note that human activity over the past 100 years has led to a perceptible rise in global temperatures. In 2008, the news is filled with stories about northern ice caps melting and glaciers receding, which are the result of the excess greenhouse gases that are emitted into the atmosphere as a result of human activity.

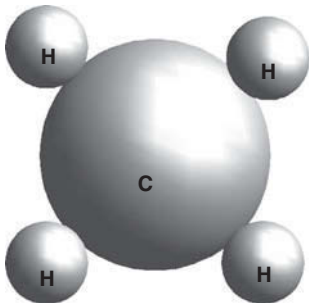

Figure 1-1 *Molecular structure of methane (CH_4), a powerful greenhouse gas.*

The major greenhouse gases include methane (scientifically notated as CH_4—meaning one atom of carbon and four atoms of hydrogen bonded together in a single molecule of methane–see Figure 1-1), nitrogen oxides (NO_x—one nitrogen atom and one or more oxygen atoms), water vapor (H_2O—two hydrogen atoms and one oxygen atom) and carbon dioxide (CO_2—see Figure 1-2). Moreover, there are a number of entirely human-made greenhouse gases in the atmosphere, such as the *halocarbons* and other chlorine- and bromine-containing substances. These gases are emitted in varying amounts through all sorts of natural and human activities; the largest single human source is the

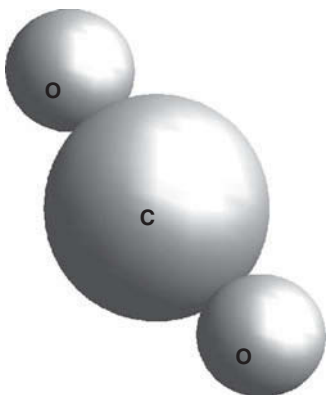

Figure 1-2 *Molecular structure of carbon dioxide (CO_2).*

burning of fossil fuels. These are currently our prime sources of energy, and include coal, gasoline and diesel fuels, and natural gas. We use them to heat our homes, power our cars, and in giant power stations that provide the electricity needed to power our electronics.

The problem

The problem with releasing too many GHGs into the atmosphere is that when the gas rises into the atmosphere it creates a sort of heat blanket, as we mentioned. The effect has been likened to what happens inside a greenhouse—where the glass walls trap the sun's heat—but in this case the greenhouse is the entire planet. Since the earth is an extremely complicated system, this doesn't necessarily mean warmer temperatures everywhere in the world, but that the earth's average temperature will rise, causing an increase in extreme weather events and potentially drastic changes to weather patterns such as droughts and hurricanes.

Recent scientific reports have shown that the projected impacts of climate change could be quite severe. Some expected changes include:

- shrinking Arctic and Antarctic sea ice
- more frequent heat waves
- more intense tropical cyclones (typhoons and hurricanes)
- plant and animal extinctions
- increased flooding due to sea level rise
- increased drought.

There are also sharp differences in how climate change will affect people across regions: those in the weakest economic position are often the most vulnerable to climate change and are frequently the most susceptible to climate-related damages.

Upsetting the balance

The atmospheric balance is being upset by the extra amounts of carbon dioxide and other greenhouse gases being emitted into the atmosphere, largely as a result of human activity. Figure 1-3 shows, very generally, the

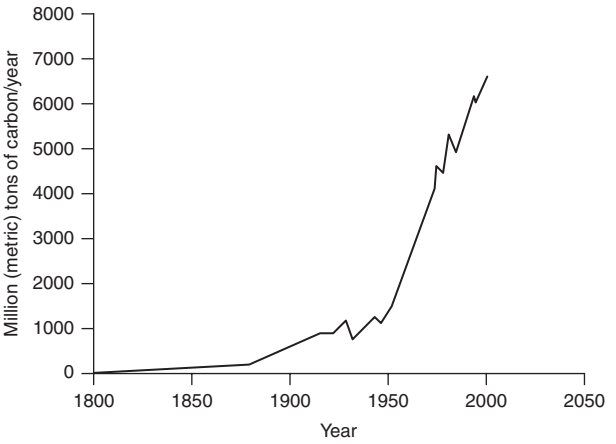

Figure 1-3 *General trend in global emissions over the past century. Used with permission from Gavin Harper's* Solar Energy Projects for the Evil Genius*, McGraw-Hill, 2007.*

trend in our yearly emissions over the last century. The problem with the carbon dioxide that we are releasing into the atmosphere is that most of it comes from sources under the earth's crust (e.g., oil), where it has been stored for billions of years. Before we humans started digging into the ground looking for this black flammable material, most people used wood and other sources that came from recently living things. Trees absorb carbon while they are growing, and when they are burnt the carbon that they release is carbon that was recently in the atmosphere to begin with, so it is a relatively short cycle. On the other hand, when we burn fossil fuels we release carbon into the atmosphere that has been stored away by the earth for billions of years. This extra carbon is causing the earth's temperature to rise, resulting in serious environmental impacts.

So, what's to be done about it?

Doing many things at once

There have been several international agreements related to climate change. The most famous of these is the Kyoto Protocol (named for the Japanese city in which it was signed), which committed all industrialized countries that signed on to collectively reduce their emissions below 1990 levels by the 2008–2012 period. While not all industrialized countries ratified the protocol, most notably the United States, and some countries that did ratify and commit to reductions are not on track to meet their commitments, the Protocol is considered by many

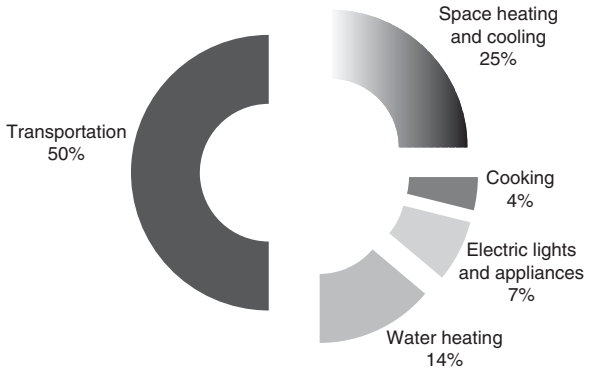

Figure 1-4 *A general idea of the average North American's energy consumption pattern.*

to be an important first step towards avoiding dangerous climate change.

What else can be done, you might ask? Well, the truth is that each of us as individuals has been responsible for emitting several tons of GHGs in the atmosphere each and every year we've been alive. Figure 1-4 shows an approximate breakdown of how the average modern consumer uses energy. This gives us an idea of what areas of our life we should approach first, if we are serious about becoming green. We are each likely to feel the effects of changes to the climate, so it seems reasonable then that each of us should play a part in reducing and managing the changes to the climate. No sustainable change can take place unless we begin and end at the individual level.

There are a great many things that each of us as individuals can do, which can complement actions taken by our governments and the companies that support our lifestyle. We can start with small actions (Figure 1-5 is an example), to help us remember that we are concerned. These will be a start to becoming

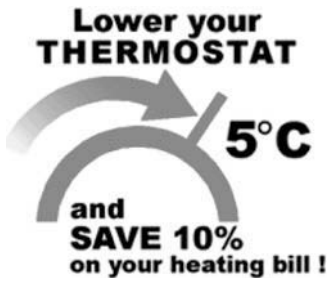

Figure 1-5 *Small actions to reduce energy are* part *of the solution, so long as they don't distract from the larger changes that need to be made.*

"light green," or a little green. We will discuss these simple options early on in the book, and then move on to looking at larger things we can do. Many simple actions, like installing energy-efficient showerheads or looking for local food producers, have groups that have formed around promoting these actions in their area. Readers could think about joining and supporting these groups—and if there isn't one operating where you live, perhaps starting one of your own.

From small to consequential

Small actions are just the beginning, and shouldn't distract us from the big picture. Getting enough environmentally friendly and efficient technology around us that will make a difference to the climate will require us to explore and install new technologies, like solar and wind energy. But, we also need to make good use of our existing technology and act on legislation that is relevant to technology, like feed-in tariffs or innovative bicycle policies.

The first section of the book concentrates on the smaller everyday actions that each of us can take to reduce our own emissions. We then move on to more in-depth projects, in hopes of providing the inductee into green living with an idea of where these little actions are leading. Throughout, we try to acknowledge that technology does not exist in a vacuum, and is therefore only as good as society knows how to put it to use.

Many of the countries that did sign up to the Kyoto Accord did so because they felt pressured by their citizens to react to what was commonly perceived as an urgent issue. An important way in which individuals can bring about change is through popular action designed to put political pressure on government representatives. In the United States, there are established methods of pressuring elected representatives, through elections or lobbying representatives. There are also other, less established ways to get attention, such as those pictured in Figure 1-6. Getting involved with local environmental activism is a good way to let your government know that this is an important issue to you, and that their time in power may be dependent on how much they are paying attention to this issue.

Figure 1-6 *Sometimes the only way to get your voice heard is to use any means at your disposal, including taking it to the streets.*

> Never doubt that a small group of thoughtful, committed citizens can change the world. Indeed, it's the only thing that ever has.
>
> Margaret Mead

Corporations can also be pressured in this way, through campaigns that communicate the importance of this issue. Large and small companies have the ability to dramatically alter their behavior and choose less-polluting alternatives, but they often need incentives to do so. Sometimes this happens because of governments that set the regulations which determine how they operate, and other times by customers who can use their leverage (the threat to cease to buy products from a company) to effect changes. As the title of this section mentions, it is important to do many things at once, because it is unlikely that any one of these actions alone is going to meet the very severe challenges posed by a changing climate. Together they might have a chance.

Lessons learned

The phenomenon of acid rain affected large parts of Canada and the United States, making headlines everywhere about 30 years ago. Acid rain is partly a result of the sulfur in the fuel used in coal-fired electricity-generating stations across the continent. Released as sulfur dioxide (SO_2) into the atmosphere when burnt, it is transformed into sulfuric acid (H_2SO_4) while traveling over long distances in the air, and is then deposited as acid rain over large areas. Acid in the rain reduced the ability of a variety of living organisms to grow, causing long-term effects on populations of fish and animals, and damaging trees and agricultural products.

Online Resources

www.epa.gov/region1/eco/acidrain/history.html—the Environmental Protection Agency gives a good introduction to the problem of acid rain and some of the measures that have been useful in combating the problem.

Because the problem of acid rain crossed state boundaries in the United States, the federal government passed a series of regulations that have changed the way all coal-fired power plants in the country deal with their atmospheric emissions. Through international agreements—among the first international environmental agreements ever—both Canada and the United States agreed to pollution reduction targets through the mandatory introduction of new technologies. The agreement has prevented about 10 million tons of SO_2 from being released into the atmosphere by industrial electricity generators since it was signed. A common technology used to achieve this monumental environmental feat is called flue gas desulfurization (FGS), which is pretty neat. A wet scrubber type of FGS system uses a limestone slurry (think wet concrete), injected into a tall reaction tower where a fan sucks the heated gases from the combustion process. The sulfur dioxide reacts with the limestone slurry and becomes calcium sulfate ($CaSO_4$), which is no longer acidic and is useful for lots of chemical processes. Some power plants are now able to sell their calcium sulfate to other industries and recover some costs.

So a dangerous pollutant is removed from the chimneys of our power plants in a useful and profitable form. Nice to know that not everything that helps the environment has to cost us money. The other important thing to remember is that we had to know that sulfur was a problem in order to have something done about it. Most of us don't think very much about how our car's engine works, but that might change as fuel becomes more expensive and harder to come by. Or, maybe, it will be because we become more aware of what

pollutants are coming out of our tailpipes. Other common acid rain causing emissions include nitrogen oxides (NO_x), which are emitted by, among other things, your cars. Because of similar legislation as that described above for power stations, most cars produced in the last decade came fitted with catalytic converters that use platinum and other metals to reduce the emissions that contribute to acid rain. Catalytic converters have been implicated in slightly lower fuel economy, so there is a tradeoff. However, the result is still that what is coming out of the tailpipe of an old car probably has more pollutants than a newer car, regardless of the fuel consumption.

What have we learned? It is not just about what type of engine or prime mover is used to turn one type of energy into another; it is important to be aware of the details. When burning wood in a fireplace, for instance, one might be tempted to feel good and green about using a renewable fuel. Many people will call using wood for heat carbon neutral, because the carbon being released by the wood was very recently taken out of the atmosphere (unlike the carbon contained in fossil fuels). But if wood is burnt in the absence of oxygen, a lot of that carbon-neutral carbon goes up the chimney as methane gas (CH_4) rather than carbon dioxide (CO_2), which results from a complete burn in the presence of oxygen. Let us focus for a minute on methane, because it is a pretty neat gas.

Depending on how much methane is in a mixture and where it came from, it can have a lot of names. Probably the one most people are familiar with is "natural gas," which is common in parts of North American cities as a home heating fuel, supplied through an underground pipe network. The natural gas supplied through these networks is almost universally a fossil fuel, which is found in the same wells as crude oil that is refined into gasoline. To some oilfield operators it was considered a waste product and vented directly into the atmosphere, until regulations stipulated that the gas should be flared—i.e., burnt like a torch. In parts of Alberta, Canada—where there are a large number of oil and gas deposits under development—it was possible to see flares scattered across the dark skies until recently. In many cases the gas is now captured and used, which is much better for the planet and better for us too, because we have another fuel source available. Contrary to what most people think, natural gas happens to be pretty clean in comparison with some of the other petroleum-based alternatives.

The deal with methane

The problem with releasing methane gas into the atmosphere is that this particular gas has a really big impact on the greenhouse effect we discussed in the first section of this chapter. The Intergovernmental Panel on Climate Change, possibly the most influential group of scientists around the world, estimates that methane gas has over 20 times the greenhouse effect of carbon dioxide in the atmosphere. 20 times! That is really big, especially when you look at what methane and carbon dioxide are composed of (see Figures 1-1 and 1-2).

Note that in both methane and carbon dioxide, there is only one atom of carbon. Remember that methane has 20 times the greenhouse potential of carbon dioxide. Now think back to the wood fireplace you have at the cottage and try to remember what the dampers do: they reduce the air supply. When there is less air reaching your wood fire, more methane is produced. The carbon that the tree absorbed during its lifetime was probably carbon dioxide, but by turning the fire down for the night you could be re-releasing that carbon in a much more dangerous form back into the atmosphere.

Technology and society

When companies and governments are pressured to change the amount of GHGs that they release for their activities, technology is often seen as the most expedient and relevant way to make those changes: e.g., switching to lower carbon-content fuels—from coal to natural gas (which contains less carbon and other pollutants for each unit of useful energy it delivers). The social aspects of using energy, for example driving less by choosing to use other modes (such as biking, walking or taking the bus) for some trips, can be equally important.

Failing to adequately heed both social and technological aspects of technology use can result in unintended consequences. Because we are trying to

make fairly specific changes to our collective impact on the environment, it is necessary to be aware of both sides and not concentrate on either one too heavily.

For example, a more efficient car is only better for the environment if the person driving it continues to drive the same amount as they did before the fuel savings. Consider a person who was driving 100 km per week and spending $50 on fuel, who buys a new fuel-efficient car that allows them to travel 150 km on the same amount of fuel. The environment only benefits if that person continues to drive 100 km a week (saving money on fuel) rather than starting to drive 150 km a week because they can now afford it. Similarly, a more efficient furnace only benefits the environment if the occupants of the building don't use the fuel savings to raise the temperature during the winter.

Starting now

So, while this book's focus is nominally on the technologies that can help you to reduce your emissions, it is important to realize that technology alone is not sufficient. Neither are legislation or social action likely to be enough on their own, but together, by doing many things at once, we might just start to make a significant impact. So, turn down the thermostat, put on a sweater, ride your bike back from the store, and then settle in to read the rest of this book by an energy-efficient light bulb. But if you don't have an energy-efficient light bulb handy, and your bike has a flat, don't panic. You would not be the first to have faced this problem, and it only takes a little evil genius to get going, so keep reading and we'll get there together.

Chapter 2

Transportation

Getting about

Transportation accounts for about half of the energy consumed by the typical North American household. If we are serious about reducing our energy consumption and doing something about this climate change thing, we are going to have to do something about our transportation-related energy consumption. This is one of those things that is going to involve more than just a change in technology, like a hybrid or even hydrogen fuel cell. In addition, we also need to become smarter both about how we as individuals travel, and how we as a society accommodate different types of travel in general. Consideration of this large chunk of emissions is far too often shied away from by otherwise environmentally conscious people, because the scale of change required seems to boggle some minds. It need not be so.

Think about how you got this book. You may have traveled to a bookstore to buy it, perhaps you drove. Could you have walked instead? Why not? In too many cases the answer is because the distances are too great. This is particularly true in suburban and rural areas of the country. The widespread and growing use of the automobile for the past 50 or so years has closed what were once small but thriving rural and suburban commercial centers and increased the distance between locations people frequent, such as their home, office, and shopping centers. When there is not an alternative to a car available for people to use to reach those locations, a condition of automobile dependence is created. The alternative is to increase density and have those common locations we all visit spaced closer together (see Figure 2-1). Urban centers, by their nature, have a greater concentration of people and services, and people who live in such centers might have had a greater chance to buy this book from a store they walked to.

Figure 2-1 *This scene from the busy metropolis of Istanbul shows what transportation options in an urban center look like: trains, cars, and pedestrians.*

Green cities

Studies that looked at individual energy consumption patterns have found that the typical urban (living in a high-density city) dweller's energy consumption is far below his suburban or rural counterpart. The efficiencies in living in urban centers come from many areas, including transportation. Having many people on a train is far more efficient than having many cars on the road (see Figure 2-2), and having shops and houses close together means that people don't have to travel so far in the first place. This flies in the face of my early exposure to what being an environmentally conscious person meant. Like many Canadian children, our family spent the summers camping in the national and provincial parks. We lived in tents, with bugs, carried our own water to the campsite, went fishing, and enjoyed the great outdoors. When I started exploring the environment as an issue later on in life, I, like many