The Climate Classroom

Volume I

Sample Chapters

Introduction

Young people around the world are responding in growing numbers to the climate crisis which they now inherit. They are striking on Fridays in countries throughout the world, demanding action from their governments. But governments have shown for forty years how slow they are to move into a green economy . . . especially when the oil economy is so lucrative.

We face two great challenges: we must free ourselves from the forces which are determined, for a profit, to destroy our battered planet. And we must build a clean energy economy that restores the natural health of our planet. We must cut the lines to the anchors dragging behind us, as we hoist the sails that will carry us steadily into a century of health and prosperity, democracy and peace.

To tackle the great challenges of the 21st Century, students need a new approach to education, one which goes far beyond what is available in most classrooms today. During the autumn semester, students become thoroughly engaged with **The Climate Crisis: the Problem**. And during the spring semester, they brim with hope and determination as they explore **The Clean Energy Renaissance: the Solution**.

These two courses, equal in weight to the other major courses in the curriculum, will go far beyond the old pattern of read the text, listen to the lecture, take the exam. The teacher and students together will invite a series of **guest experts** to speak in the classroom: farmers who have watched their crops wither as droughts scorch their fields, a meteorologist who can explain weather patterns, a medical expert who can speak about the medical dangers of a warming planet, and a clean energy engineer who can describe the enormous progress that we are already making as we harness the sun and the wind.

A major innovation in both courses will be the **research done by the students** themselves. The oil companies fooled us by lying to us for decades about the dangers of burning oil. We must never let that happen again. By doing their own research, students learn how to dig deep *for their own answers*, in the library and online. They become experts at research, a skill that will benefit them for the rest of their lives.

They will write a growing number of three-page essays, based on their research, thus developing their professional writing skills. And they will make ten-minute oral presentations to their classmates, thus sharing what they have learned.

At the end of each semester, the students will organize **an all-day conference** to which they invite the members of their community. On a Saturday in December, and on a Saturday in May, students will share their bounty of knowledge with hard-working adults who perhaps have not had enough time to fully understand the importance of the melting of the Arctic ice cap, or the weakening of the jet streams, or the opportunities for powering their home town with 100% clean energy within the next ten years.

Every graduating class can make a contribution to their school—with another dozen solar panels on the roof, with a wind turbine at one end of the football field—until the school is powered with 100% clean energy.

As the climate crisis increasingly dominates our daily life, schools may consider making both courses a requirement for graduation. Everyone gets educated, and everyone becomes a citizen of the world.

* * *

On *the global level*, a day in the classroom becomes even more exciting. We are going to **weave our schools together** all around the planet, so that students who live near the wildfires in California can work together with students who live near the wildfires in Siberia and Spain and Indonesia and Australia and the Canadian Arctic. We're going to weave our schools together so that students who have been blasted by hurricanes in New Orleans and New York City and on islands in the Caribbean can work together with students who have been blasted by typhoons in Indonesia and the Philippines and China and Japan. We're going to enable students to skype with each other, so they can share their research about drought and the collapse of agriculture, about new cases of malaria, and about water desalinization plants powered by both solar and wind power.

The students will also share their music, and their poems, and their hope.

We're going to weave a network between schools and clean energy companies around the world. **Professional engineers and eager apprentices** will explore global solutions to global problems. Students will benefit because they are working toward

future jobs, future lifetime careers, and the companies will benefit because they are training future workers, future visionaries.

We will also weave a vibrant web between the schools of the world and the **indigenous peoples** of the world. The Sami people, who have herded their reindeer on the Arctic tundra for thousands of years, have a far deeper understanding of snow, and the seasons, and the health of mountain lakes, and the migration of salmon, than the dreary politicians in Oslo with their latest regulations on the size of reindeer herds. We must listen to the native peoples who have lived on the land for centuries. They are the teachers who have been too long ignored.

Students and experts together will create an **online Climate Library** which focuses on the twin themes of the climate crisis and clean energy. Students in a small, remote school will have access to state-of-the-art information in a growing number of languages. The library will of course be free for anyone to use.

As local schools organize a climate conference for their communities, so shall the students of the **Global Classroom** meet every few years for regional conferences, and global conferences.

Their discussions of climate issues will no doubt develop into discussions about new economic systems, new legal systems, and new political systems. Some of the students, in this **First Global Generation in Human History**, will emerge as the leading scientists, engineers, economists, lawyers, statesmen, and writers of the 21st Century.

The students will study together, beginning as early as grade school; they will grow up together, trading valuable insights; and they will become a professional generation able to launch the **Renaissance of the 21st Century**.

The Oil Boys? When the taxidermist is done with them, we can put them in glass cases on display in the Museum of the Dark Ages.

* * *

In addition to everything else, students will find their **purpose**. As they do their own research, they will feel a growing sense of empowerment, and purpose. As they find their way toward a career which excites them, their sense of purpose will grow.

And as they see that yes, they *are* contributing toward building a far better world, that passionate purpose will motivate them for the rest of their lives.

* * *

The Climate Classroom, divided into two volumes to cover the two semesters, should serve not as a definitive text book, but as a *springboard* for further research, and for great classroom discussions.

No quiz. No exam. Your exam is the next sixty years of your life.

* * * * *

John Slade

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Teaching career on the high school and university levels in:
California, Illinois and New York,
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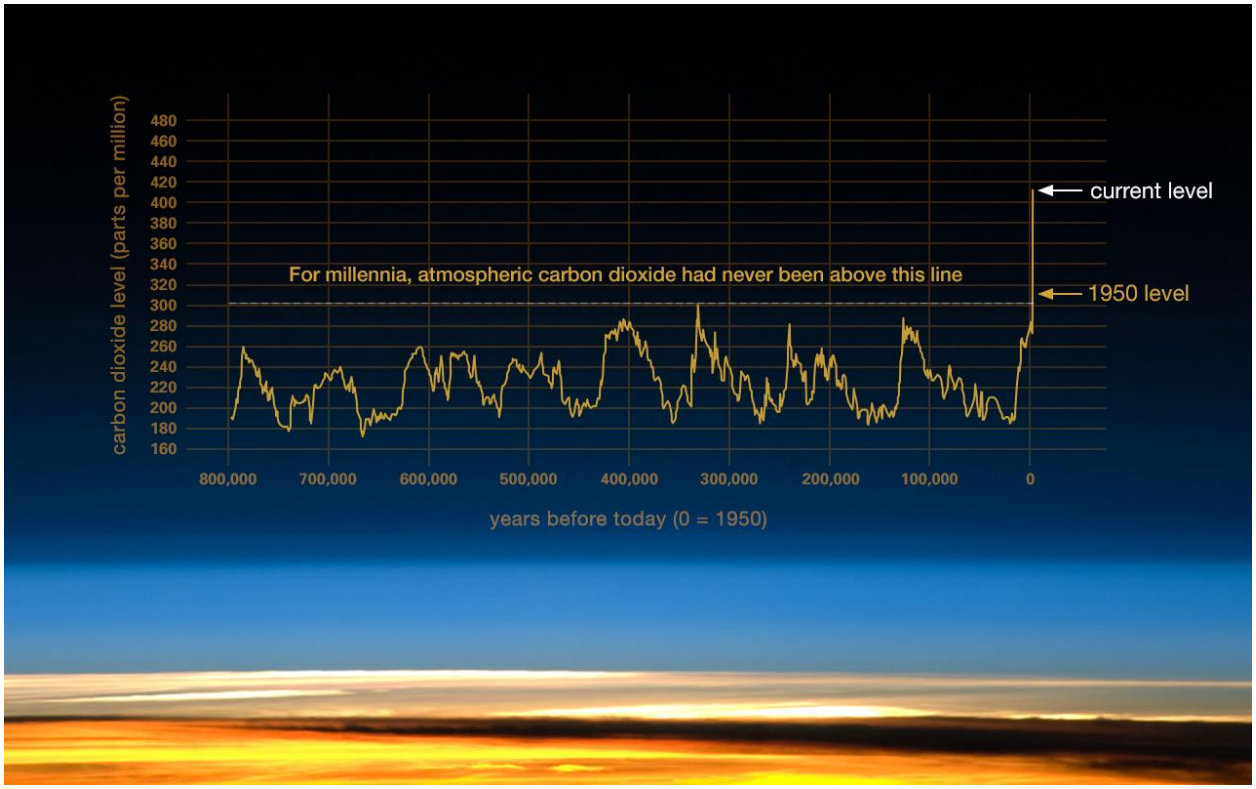

Carbon dioxide in Earth's atmosphere during 800,000 years.

From the National Aeronautics and Space Administration, NASA, Washington, D.C. [1]

Chapter Three

Student Research

Student research can of course extend far beyond the classroom. Students can explore the school library, the town library, and the library of a nearby university. They can look for recent publications in a bookstore. They can dig deep into the exhibits and archives of a museum. They can interview people who have an important story to tell.

And—as children of the 21st century—they can explore every possible subject on the Internet.

Research begins with little steps. Emily, a high school student, lives in a town where people once went skiing in the winter in deep, fluffy snow, and swimming in the summer in a cool, clean lake. Emily's grandmother has shown her an old black-and-white photograph of Emily's grandmother and grandfather when they were first married: they are both on skis, facing the camera, on a snowy trail through a snowy forest. Beside Emily's grandmother is a big black dog named "Jet". Jet loved to run through the snow.

Today, because the winters are warmer, the snow falls as rain, which freezes at night and becomes a sheet of ice. The town authorities spread salt on the roads and gravel on the sidewalks. Emily's grandmother is afraid of going out in the winter, because she might fall on the ice and break her hip.

Emily's grandmother also has pictures of the bride and groom during the summer, when they took a picnic to the park, and swam in their funny bathing suits in Jefferson Lake. The water was clean and fresh, fed by streams from the forest.

Today, the streams sometimes dry up during the summer. The water level goes down, and the water becomes so warm that algae blooms, turning the lake green. Emily and her friends can still swim, but she uses ear plugs to keep her ears from getting infected.

Emily's grandmother once said, very quietly, "I'm glad I lived when I did."

That's when Emily's research began. After school, she visited the town library and found a series of yearbooks chronicling the town's history back to 1910. She

looked at pictures of horses pulling sleighs on snowy roads. She was amazed by the amount of snow that buried Main Street—cars disappeared beneath heaps of snow, store windows were hidden—during the "Big Dump of 1932". Skiers raced down the slopes on Walnut Hill.

Emily noticed that during the 1950s, the snow in the pictures was not as deep. A color photograph from the 1980s showed the town Christmas tree in Perkin's Park, surrounded not by white snow, but brown grass. The caption reads, "What happened to our White Christmas?"

Emily talked with her Climate Crisis teacher, who recommended that she write to the National Snow and Ice Data Center at the University of Colorado in Boulder. In her email, Emily asked for information on temperatures and snowfall in her part of the country during the past century. She mentioned that she was writing a climate report for school.

After only two days, the National Snow and Ice Data Center emailed to her a dozen links to various studies on climate trends and weather conditions in her part of the country.

Emily spent an entire weekend reading through those studies. She talked about them with her teacher. She talked about them with her grandmother. She talked about them with her friends.

One of the links took Emily to the NASA Global Climate Change website, where she found a graph charting the amount of carbon dioxide in Earth's atmosphere from 800,000 years ago until today. She learned that scientists can measure the CO_2 in ancient air bubbles trapped in the ice of Antarctica and Greenland. Ice cores from deep in the ice contain bubbles from as far back as 800,000 years ago. In 2013, carbon dioxide rose above 400 parts per million for the first time in that vast expanse of geologic time. Emily studied the "spike" shooting up at the end of the graph, showing the level of CO_2 today.

That spike scared her.

The NASA report stated, "This recent relentless rise in CO_2 shows a remarkably constant relationship with fossil-fuel burning, and can be well accounted for based on the simple premise that about 60% of fossil-fuel emissions stay in the air." [2]

But why, she wondered, did the level of CO_2 emissions keep rising, when scientists had been warning us for over thirty years that our own massive pollution

caused global warming? She should see a line angling *down* at the end of the graph, not a spike shooting *straight up*.

When Emily asked her teacher why people kept polluting the atmosphere, when they knew that the pollution was warming the planet, her teacher suggested, "Look up '*fossil fuel subsidies*.'"

After a few minutes of online research, Emily found an article in **The Guardian**, a British newspaper, with the headline, "America spends over $20 billion per year on fossil fuel subsidies. Abolish them." She read quotes from a report by Oil Change International, a research organization in Washington, D.C., which stated that "in 2015-2016, the federal government provided $14.7 billion per year to the oil, gas, and coal industries, on top of $5.8 billion of state-level subsidies . . . for production subsidies." A total of $20.5 billion was paid to fossil fuel companies so that they could continue to produce the products which were poisoning the planet. $2.5 billion of that amount subsidized "the exploration of new fossil fuel resources." *New* fossil fuel sources!

And that was just in America. She read further, "Globally, the figure is around $500 billion" in total fossil fuel subsidies per year.

So while Emily and her friends were going to school and doing their homework and practicing basketball and looking forward to the Christmas dance, the government was doing its best to make that spike shoot right off the top of the graph.

Why?

Now she read, "In the 2015-2016 (American) election cycle, oil, gas, and coal companies spent $354 million in campaign contributions and lobbying, and received $29.4 billion in federal subsidies in total over those same years—an 8,200% return on investment." [3] Emily was certainly not the star student in mathematics, but she now understood that some people were not concerned with the spike, or with the gradual disappearance of snow, or with the clouds of green algae in the too-warm water of Jefferson Lake. They were not concerned with melting Arctic ice cap, nor with the starving polar bears. They were not concerned with the wildfires that burned around the planet.

They were concerned only with how much money they could stuff into their pockets.

Emily felt very uncomfortable, for she had never before been critical of her government. But now . . .

She talked about these oil subsidies with her teacher. She talked about them with her grandmother. She talked about them with her friends.

* * *

Emily wrote a three-page essay about her research. She wrote a clear and concise Introduction Paragraph, stating the purpose of her essay. She wrote a series of Development Paragraphs, each with a Topic Sentence which contained the paragraph's key idea, along with other sentences which provided evidence, examples, or further explanations. And she wrote the Conclusion Paragraph, in which she summarized the information and made a final concluding statement. She gave credit to her sources with footnotes and a bibliography.

When her teacher returned her essay with some corrections, Emily saw a gold star at the top. During the course of the year, it would be the first of many gold stars.

Emily stood in front of her class and gave a five-minute oral presentation (which stretched to twelve minutes) about her research. She was nervous at first, but when she talked about Jefferson Lake—the warm, green water, the dry streams—she could see that the students were listening carefully. They had all been swimming in Jefferson Lake. Nobody wanted to watch it turn into Jefferson Mud Hole.

Her voice became stronger when she showed her audience the NASA graph of carbon dioxide in the atmosphere for the past 800,000 years. "Look at that spike," she told her fellow students. "That's where we are now. And we are in big trouble."

When she spoke about the oil subsidies, her voice was not only strong, but vibrant with anger. "In conclusion," she said, glancing at the clock on the classroom wall, "I have decided that the only car I will ever buy is an electric car. I will never, *never* purchase a car fueled by oil."

She paused, then she added, "If everyone in our generation made the same promise—to each other and to planet Earth—that the only car we will ever drive is an electric car . . . then within five years, every automobile company around the world would produce inexpensive electric cars . . . for the Electric Generation. And *that* would be the end of oil."

Emily nodded to her teacher, a nod of gratitude, then she returned to her seat.

The classroom was very quiet, for she had just planted the first seeds of the Oil Boycott. Would anyone join her?

* * * * *

Chapter Four

Day One: the Holocene

Dear teachers and students,

As you can see, you are not alone as you design and teach a course on a subject which is complex, global, and constantly evolving. You will have help from a *team* which includes members of your community, and professional scientists. Everyone from a local farmer to the United Nations Intergovernmental Panel on Climate Change is ready to provide you with up-to-date information. As the students pursue their research and write their essays, the subjects which they choose will provide teachers with leads as they develop their lectures.

Take a look at the educational treasures created by the National Aeronautics and Space Administration, NASA, at https://climate.nasa.gov/resources/education/ . Here you will find a multitude of images and videos designed for students by highly qualified scientists. Teachers can introduce this website to their students on the first day of class, and ask them to spend an hour that evening exploring the site. Right away, students will understand that this course, **The Climate Crisis**, is about *their world today*, and that the scope of the course is global.

Look for the NASA Graphic: "The relentless rise of carbon dioxide levels in the atmosphere." That graphic can be the very first image which teachers show to the students at the beginning of this course. (You might make a poster-sized print and put it up on the wall.) Explain to the students that scientists sample the air bubbles in ice cores drilled in Antarctica, reaching back as far as 800,000 years ago. Then point to the unprecedented spike and tell the students, "We are here, at the top of this spike, shooting upwards. If we continue on this trajectory, the world as we know it is not going to survive."

Now the Big Picture: "Your generation has an enormous job. You must *stop* the steady increase of carbon dioxide pollution in our atmosphere. We must replace energy from coal and oil with energy from the sun and the wind, so that the spike on the graph begins to angle down, down, down . . . toward the normal level where it belongs."

Pause.

"That is your job. That is why you are taking these two courses, first on the Climate Crisis, and then on Clean Energy. Your generation, around the world, must work together to bring carbon dioxide levels down to where they have been for at least 800,000 years."

Now the students are beginning to feel that important sense of Purpose.

* * *

We turn now to the subject of the lecture on the first day of class, the **Holocene**, our present geologic epoch, which began roughly 12,000 years ago at the end of the last ice age. The warm, steady climate of the Holocene has enabled human beings to progress from primitive villages to advanced civilizations. However, for a number of reasons, we are now capable of destroying not only ourselves, but much of the natural world in which we live. We are bringing to an end the extraordinary Holocene epoch which enabled us to flourish.

Let's take a look at two events which have occurred within the past three million years. These two events may at first seem distantly related—or entirely unrelated—but the relationship between a geophysical phenomenon and **our long human journey** is crucial to our future survival.

Three million years ago, our human ancestors walked upright on the plains of eastern Africa, where they made tools from stones and mastered the uses of fire. Eventually, they migrated north into what is now the Middle East, and thence west into Europe and east into Asia. Our ancestors steadily evolved—the fossil skulls which we find today show an increase in the size of their brains—and thus they turned their attention from hunting and gathering what food they could find . . . to growing an unprecedented range of food themselves. The hunters became farmers.

(You can here show on the screen a map of the Fertile Crescent. Look on the Internet for "Fertile Crescent, images", and you will find a multitude of maps.)

In one particular region, where two major rivers, the Tigris and the Euphrates—fed by the snow in the mountains of Turkey—flowed down onto a broad plain, our ancestors developed irrigation. They drew water from the rivers into a growing network of canals, so that they could bring water to a growing patchwork of gardens. The farmers domesticated both plants and animals, and thus grew a surplus of food.

This reliable abundance of food enabled them to turn their attention to other things beyond mere survival.

Because they stored increasing quantities of wheat—the large seeds could be kept in baskets during dry periods, then planted when the rains returned—the farmers needed a system of writing to keep track of annual harvests. The first writers in human history were not poets, nor historians, but *accountants* who kept track of wheat, barley, flax, peas and lentils, as well as cows, goats, sheep and pigs.

The people who lived in the **Fertile Crescent** did not stop with agricultural abundance and writing. They built cities of increasing size and complexity. They developed a code of law to keep the growing populations under control. They traded with other people who arrived in caravans from the west (Europe) and from the east (Asia). They invented the wheel. And they developed a system of mathematics which not only helped them in their business transactions . . . but enabled them to track the movements of the sun and the moon and the stars.

It seems that the more they did, the more they could do. Progress became a concept in their daily lives.

The Fertile Crescent—which encompassed the modern states of Egypt, Israel, Palestine, Jordan, Cyprus (a nearby island in the Mediterranean Sea), Lebanon, Syria, and Iraq, along with parts of southern Turkey and western Iran—became the **Cradle of Civilization**, blessed with rivers fed by snow and ice in the mountains, blessed with abundant sunshine, and blessed with people who used their intelligence to build a better world.

Those clever people, with their ever-evolving cultures, were aided by the stable climate of the **Holocene**, a geological epoch which began roughly twelve thousand years ago, at the end of the last ice age. The great sheets of ice which covered the northern portions of Europe, Asia and North America had melted, leaving vestiges of ice high in the mountains. The world was still cold enough that snow could replenish this mountain ice, winter after winter . . . and yet the world was warm enough that the ice would melt, summer after summer, feeding the great rivers that flowed down to the plains. The ice melted and the rivers flowed, enabling the farmers to divert the water into irrigation canals so they could water their crops.

Domesticated plants and animals from the Fertile Crescent made their way into the world. Writing and mathematics and codes of law made their way into the world. The fruits of a Golden Age—marred by unrelenting wars—became the foundation of our modern world today. The torch was passed from Babylon, a port town on the

Euphrates River, to the peoples of our modern world, who grow their wheat and shear their sheep, and who hire accountants to keep electronic business records, and argue cases in court, and point their rockets toward the stars. The early flute, made from a reed, and the early drums, made from animal skins stretched over a gourd, have become a symphony orchestra. The early letters made with a sharp stick on the damp surface of a tablet of clay, have become the great libraries of the world.

Progress is as much a part of our daily lives as our morning cup of coffee.

* * *

However, we now threaten to bring to an end the benevolent Holocene epoch. We have wrapped a blanket of carbon pollution around our world, a blanket which holds in the heat from the sun. The warming atmosphere is now melting the precious, fragile ice high in the mountains. As the glaciers melt, they become a diminishing source of water for the streams and rivers down in the valleys. In addition, as the atmosphere warms, the snow which once replenished the glaciers is now beginning to fall as rain. The rain runs down the mountain slopes during the winter, and leaves no water for the spring and summer.

The great rivers of the world, which have watered civilizations for centuries, may soon become troughs of mud.

The warming atmosphere is also warming the oceans, which in turn melt any ice which floats on them, including the **Arctic ice cap**, to which we now turn our attention.

During the same three million years of human development—and certainly, during the Holocene epoch—something else was happening in the world. Planet Earth has always experienced extended periods of warming and cooling, caused by various factors such a the wobble of its axis or the gravitational pull of distant planets in the solar system. About three million years ago, Earth became cool enough that a curved cap of ice formed at the top of the planet, where it floated on the Arctic Ocean. [1]

(Teachers can now show NASA's images of the Arctic ice cap expanding and shrinking during the winter and summer.)

During the Arctic winter, when Earth's axis pointed *away* from the sun and the top of the planet was thus dark and cold, the cap of ice expanded until it reached the northern coastlines of Asia, North America and Europe. During the Arctic summer,

when Earth's axis pointed *toward* the sun and the top of the planet was brightly lit all day and all night, the cap of ice shrank, exposing the open water of the Arctic Ocean to the warming sunshine.

The Arctic ice cap, a thin curving sheet of white ice and snow, *reflected* most of the summer sunlight back into space. The dark open water of the Arctic Ocean, wrapped around the edges of the ice cap, *absorbed* most of the sunlight, which warmed the water. The reflective ice cap has helped to maintain fairly stable temperatures on planet Earth for three million years, by reflecting sunlight which otherwise would have warmed the Arctic Ocean, and thus the planet itself.

Like the Holocene, the geological epoch which has provided the Fertile Crescent (as well as the rest of the world) with a stable climate for twelve thousand years, the Arctic ice cap has provided the planet with a balance of temperatures—neither too hot nor too cold—for three million years, during the period of our long human journey.

But now, as the oceans around the world are warming, the Arctic Ocean also becomes increasingly warm, and it thus melts the Arctic ice cap—only a few meters thick— from underneath. The ice cap melts around the edges, shrinking in surface area. It also becomes thinner, more fragile, and thus more likely to crack and break when buffeted by storms.

During the dark winters, the ice cap no longer reaches as far south. During the sunny summers, the ice cap shrinks more and more to the north, thus exposing more and more open water to the warming rays of the sun.

The more the ice cap shrinks, the warmer the Arctic Ocean becomes. And the warmer the ocean becomes, the more it melts the ice from underneath and the more the ice cap shrinks. The entire process *accelerates*, as we have observed with satellite surveillance since 1979.

The great shield of ice which has reflected sunlight for eons of time—and thus has kept global temperatures fairly stable— is now shrinking at an unprecedented rate. The Arctic Ocean is now warming at an unprecedented rate. The **dominoes** begin to tumble. The winds that blow across the surface of the ocean become warmer. They in turn warm the vast land area that wraps around the Arctic Ocean: northern Russia, Alaska, northern Canada, and northern Scandinavia. As the tundra warms, the permafrost—a subterranean layer of ice, a vestige of the last ice age—begins to thaw. As the ice rots, it releases increasing amounts of both carbon dioxide and methane, produced by bacteria from the decay of ancient plants and animals long buried beneath

the permafrost. The carbon dioxide and especially the methane contribute to the greenhouse gasses which wrap around the planet . . . and again the warming process accelerates.

Do you see? We ourselves are causing the end of the Holocene, the gift of a warm, stable climate that has lasted for twelve thousand years. And though we know that we are warming the oceans, melting the ice, warming the tundra, thawing the permafrost, and thus releasing unknown amounts of methane into our already poisoned atmosphere . . . we continue to burn the coal and oil.

Why?
And how can we stop this suicidal madness? [2]

* * *

Let us conclude this lecture with a few additional questions.

How long before the Arctic ice cap has shrunk to half of its original size?
It already has.

How long before the ice cap disappears completely?
We don't know.

How warm will the Arctic Ocean become, when it is no longer capped by the protective ice?
We don't know.

How much unnatural heat will the ocean currents which pass through the warming Arctic now carry around the planet, on the surface and deep below?
We don't know.

How much methane lies trapped beneath the permafrost, waiting to be released into the atmosphere?
We don't know.

How warm will planet Earth become with the release of growing amounts of methane?

We don't know.

We do know, however, that the warmer the oceans, the more powerful the hurricanes and typhoons.

The warmer the oceans, the sooner the coral reefs die.

And this is just the beginning. There are more dominoes than we even know about. The warmer the atmosphere above the Arctic Oceans, the weaker the jet streams; the weaker the jet streams, the more wildly our weather will fluctuate.

As the Gulf Stream becomes warmer in the warming Arctic, it becomes *less dense*. As the salt water in the Gulf Stream is diluted by fresh water from the melting Arctic ice cap, and from the melting Greenland ice cap, it becomes *less dense*. The Gulf Stream thus develops a diminishing tendency to sink to the floor of the ocean, as it has for eons of time on its deep journey around the planet. Instead, it may back up upon itself, as it already appears to be doing. One of the major global ocean currents is thus knocked off course. What dominoes will that trigger on the other side of the planet?

The climate crisis is coming like a freight train, and we are all standing right on the tracks.

* * * * *

No one ever went to war over a wind turbine.

Chapter Fourteen

Pioneers with Vision

Today I would like to give you some good news. Some *really* good news.

Beginning back in the 1970s in Denmark, a group of visionaries in that small country planted the seed of what has become not only a major industry in the 21st Century, but a transformation in our way of thinking. While the rest of the world mumbled and bumbled and stumbled along with its old, dirty, stupid way of thinking, little Denmark planted the seeds of a Renaissance.

Way back in 1898, an enterprising Dane named Hand Smith Hansen bought a blacksmith shop in Lem, on the west coast of Denmark, which he ran as a family business. If you wanted your anchor fixed, you took it to Hansen.

Following the devastation of World War Two, Hansen's son Peder took over and expanded the business. **Vestas**, as the company was now called, manufactured household appliances such as food mixers and kitchen scales. In 1950, the company began to make agricultural equipment for local farmers. In 1956, Vestas built cooling units for refrigerated transportation. And in 1968, Vestas built hydraulic cranes.

Then during the 1970s, the ever innovative Peder Hansen hired an engineer, Birger Madsen, who wanted to develop the technology that could turn power from the wind into electricity. Hansen also hired two inventors, Karl Erik Jørgensen and Henrik Stiesdal, who had developed a wind turbine with three blades, but did not have the money for commercial production.

Careful to avoid ridicule from their customers, the team at Vestas developed their wind turbine in secret. Meanwhile, they sold kitchen appliances, farm plows, refrigeration units for transporting milk, and hydraulic cranes for trucks.

Then, in 1979, Vestas sold and installed its first wind turbine, with three blades, able to produce 30 kilowatts per hour. The seed was planted, and it would begin to grow. [1]

* * *

Meanwhile, what was happening out in the world? The usual madness.

On October 6, 1973, Egypt and Syria attacked Israel on the Jewish holy day of Yom Kippur, starting the 1973 Arab-Israeli War. On the night of October 8, Israel went on nuclear alert, ready to retaliate with an unknown number of nuclear bombs.

On October 12, American President Richard Nixon ordered an airlift to provide weapons and supplies to Israel. The Soviet Union responded by supplying weapons and equipment to its Arab allies. The regional conflict had rapidly expanded into a global confrontation involving the two superpowers and their nuclear arsenals.

On October 16, six oil-producing countries—Saudi Arabia, Iran, Iraq, Abu Dhabi, Kuwait, and Qatar—in retaliation for the American support for Israel, announced that they were going to both increase the price for their oil, and cut back on oil production. This was the beginning of the "oil embargo" which disrupted the entire global economy. In the United States, cars waited in long lines at gas stations to fill their tanks with gas.

On October 26, the Yom Kippur war ended, but the oil embargo continued until March 17, 1974. [2]

The American response to this oil crisis was to increase domestic production of oil, especially in Alaska. People bought smaller cars, but these cars continued to burn oil. Norway had recently discovered oil in the North Sea; the Norwegians were suddenly blessed with an abundant product which they could sell at a good price to an eager international market.

The 1973 oil crisis was followed six years later by the 1979 oil crisis, caused by the upheaval of the Iranian Revolution. The mutual slaughter of the Iran-Iraq War during the 1980s further disrupted the oil market. Despite its invasion of Afghanistan in 1979 and the ten years of war that followed, the Soviet Union became a leading producer of oil in the world.

Decade after decade, **the evil twins, oil and war**, continued to dominate world events. No one, except a few quiet Danes, designing wind turbine blades and gear boxes in their factories by the windy Atlantic, seemed to see a need for doing things any differently.

* * *

Today in 2019, forty years after the first Vestas wind turbine spun its three blades in the abundant and inexhaustible wind, Vestas Wind Systems is the largest

wind turbine company in the world. Vestas operates manufacturing plants—plants which provide thousands of jobs—in Denmark, Germany, India, Italy, Romania, the United Kingdom, Spain, Sweden, Norway, Australia, China, and the United States. Vestas employs 24,400 people around the world, people who earn an excellent salary while they help to bring clean energy to a planet which has been severely damaged by oil. [3]

On February 10, 2019, 21.6% of Europe's electricity was produced by wind turbines, both onshore and offshore. Valiant Denmark produced 104% of the electricity that she needed, a surplus of 4% which she sold to her neighbors at a profit.

Germany produced 66% of its electricity on that day from the wind. *Two-thirds!*

The Netherlands produced 33%. *One-third!*

Two small Baltic nations, which became independent as recently as 1991, have achieved heroic progress: Lithuania produced 26%, and Estonia produced 22%.

Poland, despite political upheavals since its independence in 1989, produced 22%, and is now about to build its first offshore wind turbines. [4]

And though Russia is not listed, I will add that Vestas and Russia are working together to launch the wind turbine industry in a country which has been slow to give up its reliance on oil. In 2018, Vestas opened a nacelle assembly factory in Nizhny Novgorod, where imported parts will be assembled for turbines that will spin in the Russian winds.

In December of 2018, Vestas opened a rotor blade plant in the Ulyanovsk region, where blades 62 meters long will be manufactured for imported Vestas turbines, which will operate in Russia's first wind turbine parks. The contract specifies that turbines must include "65% local content", which encourages the Russian manufacture of wind turbine components. The factory is 51% owned by Vestas, and 49% by Russian partners. [5]

From a certain perspective, one could conclude that visionary Denmark . . . won the Cold War.

* * *

Young People of the World, on one hand, you have been born at a time of impending disaster on planet Earth. An appalling mess has been dumped into your laps.

On the other hand, you have been blessed by being born in the early years of a new epoch in human history, an epoch of enormous potential. International investors are now pouring increasing amounts of money into renewable energy. During the next five years, 2019 to 2024, investors will allocate an anticipated 210 billion dollars to rapidly growing clean energy industries. While the coal and oil industries are laying off workers, clean energy industries are hiring freshly educated workers by the tens of thousands.

China is the world leader in wind power generation, followed by the European Union, the United States, and India. Even industry experts have been amazed at how rapidly the prices of wind and solar energy have dropped during the past two decades, making them competitive with coal and oil. Rapid progress in battery technology has enabled companies to combine energy production with energy storage, making solar energy available at night, and wind energy available when the winds diminish.

"Water electrolysis uses an electrical current to split water molecules into hydrogen and oxygen." If the electrical current is produced by the sun or the wind, then we have "green hydrogen", a fuel with the potential to power "trucks, trains, buses and ships—and as the basis for carbon-neutral synthetic fuels that could be used for aviation." Already, a hydrogen-powered train (painted bright green) runs in eastern Germany, announcing the future every time it pulls into Leipzig.

Green hydrogen can be produced in remote areas, as in Tibet where the wind is strong, or the Sahara Desert, where the sun is bright.

Liquid hydrogen can be stored in tanks and transported on trucks and ships, so that hydrogen produced in one area of the world during the sunny summer can be used in another area of the world during the dark winter. [6]

I heartily recommend that every school subscribe to www.rechargenews.com , the daily online journal which follows the progress in solar and wind energy around the world. In its archives, you can look up your own country and read about the latest projects. **Recharge News** offers a two-week sample for free, so that you can take a close look at this gold mine of information. I call it the Good News Magazine.

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Young People of the World, the boom is just beginning. Invite the sun and the wind into your classrooms. They have been waiting for a long, long time to go to work with you.

The major impediments to progress today are the government officials who receive campaign contributions (bribes) from coal and oil. Our job, as we learn about the climate crisis, and as we explore the many benefits of clean energy, is **to vote, vote, vote** for people who will promote a clean and prosperous future.

What if . . . we believed in ourselves, and not the thugs of the world?

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