

Introduction

In the case of climate change, there is no Plan B because there is no Planet B.

—Christiana Figueres (2013), Executive Director,
United National Framework Convention on Climate Change

When asked if I am pessimistic or optimistic about the future, my answer is always the same: If you look at the science about what is happening on earth and aren't pessimistic, you don't understand the data. But if you meet the people who are working to restore this earth and the lives of the poor, and you aren't optimistic, you haven't got a pulse.

—Paul Hawken (2009), environmentalist, eco-entrepreneur, and author

The seeds for a new American revolution in learning—about climate, energy, and understanding and minimizing human impacts on the environment—have already been planted. Indeed, they are already starting to sprout and take root. Transforming education about climate and energy will be critical if we are to respond successfully to what may someday be seen as the greatest crisis humanity has ever faced. To succeed, this fledgling revolution needs one vital ingredient: **YOU** and your willingness to step up to the challenge to help transform teaching and learning for the 21st century.

EVIDENCE

This book accepts the findings of the data and peer-reviewed research of the Intergovernmental Panel on Climate Change (IPCC), the U.S. National Climate Assessment, the National Science Academies around the world, the International Energy Agency, and the U.S. Energy Information Administration. Their reports tell us the following:

- Climate change is happening.
- Human activities, especially the burning of fossil fuels and related actions, are responsible for current climate and other related global change.
- The causes and consequences are complex, significant, and serious.
- There are many things that can be done to reduce impacts and prepare for changes that are well underway.

- Energy conservation, providing energy equity and access, and moving from fossil fuels to low-carbon and renewable energy sources are important steps to reduce climate risks.

Methodically establishing and building on foundational knowledge about key concepts—weather and climate, water and carbon cycles, energy in general and in our lives in particular, and the impact of human activities on the planet—will equip learners and thereby society to make effective, informed, and evidence-based decisions.

CLARIFYING TERMS

The topics of climate and energy are brimming with technical terms and jargon, and the glossaries from the *Climate* and *Energy Literacy* frameworks are included in the appendices of this book to help define many of them. But two terms—*climate change* and *global warming*—deserve to be addressed up front.

Both are often used synonymously by the media and sometimes by scientists themselves. Both are inadequate and imprecise in ways that can lead to confusion. The term *climate change* is often used as shorthand for human-caused disruption of the climate system, but climate naturally varies widely and sometimes wildly. It is always changing, sometimes slowly, sometimes abruptly. When the term *climate change* is used, it is not always clear whether natural variability of the climate system, the explicit influence of human activities on climate, or both are being referred to. The differences are important, for first understanding naturally occurring variations and processes of change is a vital and often overlooked step to being able to accurately attribute to what extent human activities contribute to current and future changes in climate.

Global warming, which is more widely recognized and accepted by the public than *climate change*, is also problematic as a term. By emphasizing hotter temperature, it obscures the fact that a disrupted climate may in the near term trigger record low temperatures or storm events on a local or regional scale, seemingly contradicting the predicted warming. Moreover, a warmer world may seem cozy and appealing when winter winds blow, but as we will examine, sustained heating of the planet's atmosphere and surface over the coming years will result in more negative impacts than positive ones.

Recent research by Leiserowitz and colleagues (Leiserowitz, Feinberg, Rosenthal et al., 2014) has found that the term *global warming* garners higher levels of emotional engagement, support for national and personal action, and public understanding than the term *climate change*. While *climate change* can be dismissed with a glib “but climate always changes,” *global warming*, flawed though it may be, does convey the reality: that the entire planet is heating. The cause: human activities.

A more accurate term for these two somewhat flawed terms is *global change*, which includes other aspects of the Earth system beyond climate. The U.S. Global Change Research Program, for instance, focuses primarily on human disruption of the climate system, but also examines other human impacts on the biosphere, such as invasive species, habitat destruction, and other environmental damage caused by human factors that may not now be directly related to increased heat in the atmosphere. As with the term

climate change, global change also requires understanding naturally occurring processes and rates of change in order to effectively measure and understand human contributions to the observed and projected changes.

While this book does refer to climate change numerous times, the overall aim is to encourage broad climate literacy that includes an understanding of natural variability but that is particularly attuned to what the National Research Council's *K–12 Framework on Science Education* and the *Next Generation Science Standards* describe as “human impacts” on climate and, by extension, other components of the Earth system. By understanding these human impacts we can problem-solve them and better address their causes, effects, risks, and possible responses.

This book is meant to complement and enrich environmental education efforts and the wide range of green school-related initiatives that focus on energy savings and a healthy learning environment, as well as contribute to efforts to improve science, technology, engineering, and mathematics (STEM) education.

PURPOSE

The aim of this book is to help spark conversations about climate and energy literacy and how to improve it, deepening our own and other learners' understanding and appreciation for the role of these twin topics in our lives. Most importantly, this book emphasizes that there are many things we can do to minimize these impacts and prepare for changes already underway, but we need to be informed and educated in order to be smart about addressing climate challenges and wise about energy use in our lives.

This book's purpose is not to convince anyone about the findings of climate science or make the case for a particular policy or technical solution; there are already many books that tackle those topics. Nor is this book really about conserving energy, addressing overconsumption, reducing carbon footprints, or comparing and contrasting climate and energy policy options. This book is meant to complement and enrich environmental education efforts and the wide range of green school-related initiatives that focus on energy savings and a healthy learning environment as well as contribute to efforts to improve science, technology, engineering, and mathematics (STEM) education. While the findings of climate and energy research and related implications are touched on, the emphasis here is on teaching and learning about these vital topics.

THE GOOD NEWS

There has been a convergence of factors that have been years in the making that form a near-perfect confluence of opportunities: freely available, world-class, high-quality learning resources, the revolution in mobile-learning through smart phones and tablets, new comprehensive science education standards, and in some communities the transformation of schools into living laboratories, that will allow us to make significant and rapid headway toward preparing our children and future generations for the known and unknown challenges of the future.

THE BAD NEWS

That said, we do need to acknowledge the reality of our current state of climate and energy illiteracy. On top of the impact of global change caused by human activities on the Earth system in general, we as parents, educators, leaders, citizens, and responsible human beings have done an abysmal job overall of ensuring that climate and energy are taught and taught well. We can and must do better. It is imperative that we provide students with the knowledge and critical thinking skills they need to make good energy choices and informed climate decisions throughout their lives.

MORE GOOD NEWS

Fortunately, as a society we are beginning to take positive steps to resolve this issue of climate and energy illiteracy. Much more needs to be done, but as we will explore in depth, there are stellar educators, high-quality learning resources, educational frameworks and standards, and motivated, innovative learners that we can all benefit from and be inspired by. And while we are in many ways just beginning to build momentum and critical mass, we have begun to graduate high school and college students who have the essential climate and energy literacy—the knowledge and know-how—that they will take with them into their careers, their communities, their lives.

It is also good news that by their very complexity and far-reaching connections, climate and energy are, for practical and pedagogical reasons, ideal interdisciplinary and integrating themes in education. They touch on nearly every aspect of our lives and link with other vital issues of the 21st century, including water, economics, food, poverty, commerce, political processes, and civic engagement. Climate and energy are complementary themes. They can begin to be formally taught beginning in kindergarten and naturally bring together science and mathematics with virtually any other topic or discipline.

Indeed, climate, energy, and sustainability are already being used in education as themes for inquiry and expression in language courses, art, music, and history as well as nearly every scientific discipline. Books like *Empowering Young Voices for the Planet* (Cherry, Texley, & Lyons, 2014) showcase examples of how youth can be effectively engaged and empowered. Such efforts offer examples for how we can address the gaping hole in our current system of teaching and learning. Ultimately, these dual topics can and should be taught, in age and developmentally appropriate ways, throughout the K–12 grade levels, into higher education and/or career paths and through ongoing lifelong learning, emphasizing problem-solving and opportunities to minimize risks and maximize resilience.

AUDIENCE

While this book is primarily meant for educators to benefit the 76 million students in the United States, I hope it will be of interest to others as well: parents and grandparents who want their school-age children to have skills to confront and meet the challenges of

the 21st century, administrators and policymakers, corporate leaders and decision makers, foundation officers and philanthropists, and other citizens of the planet who share the desire to do everything they can to prepare today's young people and future generations for global change.

COUNTERING CLIMATE CONFUSION AND ENERGY ERRORS

What are the key obstacles in overcoming our illiteracy? A National Research Council report (2011), *Climate Change Education: Goals, Audiences, and Strategies*, has identified some of the obstacles. In the case of climate change, the science is complex, crosscutting many disciplines, sometimes falling through curricular cracks; it hasn't been well coordinated (or funded); and the topic, while scientifically robust, can be politically and ideologically charged, which may contribute to a climate of controversy or confusion in the classroom. In the case of energy, the dynamics are similar in terms of the complexity and cross-disciplinary nature of the science, and controversy can arise when it comes to hot-button topics like nuclear power, coal mining, or hydraulic fracturing for natural gas. We will touch on these issues in this book, but the issue of controversy, real or manufactured, is important to address up front.

There is no scientific debate as to whether humans are significantly altering the climate and environmental systems, primarily through the burning of fossil fuels and associated activities that disrupt ecosystems. Despite the consensus of the scientific community on this important point, there is still substantial confusion. It is important to acknowledge that there are real debates and disagreements about various topics, such as ice sheet dynamics, the pace and scale of species extinctions, energy extraction and generation, or how rapidly sea levels will rise along vulnerable coasts. At the same time, we must be wary of myths designed to distract from the implications of current scientific findings.

NEXT GENERATION SCIENCE STANDARDS

The 2013 release of the Next Generation Science Standards (NGSS), which are “by the states, for the states” and not national standards, cover a wide range of science topics employing inquiry-based pedagogical strategies, offering enormous opportunities to incorporate climate and energy studies across grade bands. Many states and school districts have already adopted these new standards. Science teachers around the nation are planning ways to implement the concepts, practices, and core ideas in their classrooms whether or not their states are currently planning to adopt them. An essential NGSS goal is to help all students develop a solid understanding of key scientific processes and findings. The ongoing study of climate and energy fits well with this goal.

In elementary grades, for example, students learn how human activities can impact the Earth's systems, but they also discover there are ways to minimize those impacts. Through observations, they learn how weather and climate are related but are different processes, and they learn the role of energy in our lives. Building on the foundational knowledge established in elementary school, middle school students are introduced to more complex systems, including how human activities, particularly fossil fuel energy consumption and habitat destruction, are altering the climate and ecosystems. In high

school, students further explore the physical and biologic processes involved with climate and energy and examine how human impacts can be minimized and appropriate technological and engineering solutions be deployed that can transform society and protect the environment.

The goals of NGSS are noble and challenging: shared standards that *all* students master measured by appropriate assessments that will ideally bolster inquiry, systems thinking, and problem-solving skills.

Educators need support to master the content themselves as well as acquire effective psychological strategies and the pedagogical tools. Appropriate professional development is imperative. Even with limited funding, we can begin to turn the tide of climate and energy illiteracy through support and leadership at the local, state, and national level, forging partnerships between public and private sectors, emphasizing teacher professional development, high-quality resources, youth empowerment, and collective impact.

GETTING STARTED

In **Chapter 1**, we will review the current scientific findings and relevant data around climate and energy science, explore the origins of the study of these and related topics, including profiling some of its pioneers, and build the case for fostering climate and energy literacy. **Chapter 2** offers some guiding principles based on education research about effective educational practices in general, focusing on science education in particular, with an emphasis on climate and energy, making the case for why these interlocking, complex topics rooted in well-established core sciences and on the frontiers of cutting-edge research should be taught throughout the curriculum. This will require leadership, collaboration, and cooperation between faculty, with the additional support of administrators and parents.

The Next Generation Science Standards (NGSS) and elements of the Common Core standards for language arts and mathematics as they relate to teaching climate and energy are examined in **Chapter 3**. When successfully deployed, NGSS will help ensure that essential climate and energy literacy, a hybrid of knowledge and know-how, is achieved by graduation.

In **Chapter 4** we will drill into the specifics of the *Climate Literacy* framework, and in **Chapter 5** we will do the same for the *Energy Literacy* framework. Examining the essential principles and fundamental concepts of each, we highlight high-quality resources across grade levels that support climate and energy science literacy. These two chapters provide practical advice and point to high-quality learning resources, including activities that can be immediately implemented by classroom educators.

Chapter 6 examines noteworthy educational programs focused on climate and energy and the elements that make them successful. **Chapter 7** is devoted to dealing with climate change skepticism and denial inside and outside of classrooms, examining the different levels of reaction, from dismissive to alarmed, and related pedagogical challenges for each group. We will delve into reasons why doubt and denial may arise and suggest when and how best to counter various forms of denial, fatalism, and apathy. In **Chapter 8**, the focus is on initiating climate and energy conversations, which have been too often missing in

society, and exploring how a major initiative or public-private partnership linking national, state, and local level efforts may be an effective approach to rapidly scaling up effective climate and energy literacy practices and programs.

Finally, three appendices providing supplemental materials are included. **Appendix I**, Voices for Climate Education, is a collection of statements from a number of organizations on the imperative of teaching about climate change basics. **Appendix II** and **Appendix III** are selected excerpts of the *Climate Literacy* and *Energy Literacy* frameworks discussed in Chapters 4 and 5. These texts identify the essential principles and fundamental concepts related to climate and energy, their influence on society, and society's influence on them.

HOPE

One book cannot solve every problem. But it is hoped that readers will find this book helpful as an introduction to the topic, a practical resource for educators, and as a source of inspiration for starting the conversations and forging the partnerships necessary to create more climate-aware, energy-efficient schools, and science savvy individuals and communities. Your help in cultivating and tending the seeds that have been planted and are now sprouting will help ensure that many of these fledgling efforts can mature to provide shade and fruit for generations to come. The stakes are high, the challenges daunting. As Ana Unruh-Cohen sums up in her haiku:

As Scientists agree.

Climate change: It's real, it's us

It's bad but there's hope!