Careers in Renewable Energy

Your World. Your Future.

UPDATED 2ND EDITION

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Introduction

In 1987, running a side-by-side refrigerator used about 950 kilowatt hours of electricity and cost about $150 a year. A comparable refrigerator now uses half the electricity, to the benefit of both environment and wallet.

In 1975, there were 3,775,427 automobiles on the streets of metropolitan Los Angeles. As of 2012 there were more than 5,800,000. Air-pollution levels, however, have fallen roughly in half in the intervening decades, and an increasing number of the automobiles now on the road are hybrids or rely on biodiesel or other renewable fuels.

As long ago as the 1890s, a third of the homes in southern California were equipped with solar water heaters. By the 1920s, the number had

fallen to almost none. The number began to rise again in the 1970s. And so did the use of solar power generally. As of 2007, along with a substantial number of homes with solar thermal hot-water systems installed, fully half a million homes in Southern California were receiving direct solar power, either from solar electricity plants or from rooftop photovoltaic panels. And by 2030, the Department of Interior projects, solar facilities will occupy 154,000 acres of federal land in the state, providing the lion's share of energy to consumers in the Golden State.

California is not alone: across North America, Europe, and Asia, businesspeople, municipalities, and other governments are working to transform the world's energy mix.

These are changing times indeed. Students, workers, consumers, businesspeople, and government officials are increasingly aware that humans have been placing terrific stresses on the environment, as global warming, water shortages, mass extinctions of plant and animal species, and the dwindling supply of fossil fuels attest. In times of trouble, uncertainty, and even crisis, as entrepreneurs will tell you, there are opportunities. And, as the preceding examples suggest, there are reasons to be optimistic, for a rising generation of students, workers, consumers, businesspeople, and government officials—people, in short, from every walk of life and from every corner of the world—is more and more committed to the idea that we can bring the most important power of all to bear on the problem of where our power comes from—that being brainpower.

Look at it this way: a championship bicycle racer burns as much energy as a handheld hair dryer. So does a cheetah running at full clip. Our brains use about as much as a refrigerator bulb, whether we're thinking hard or barely sentient. It doesn't tax us too much to think, hard and long, about what we can do to lessen our footprints on the land. We have a big problem at the outset: the world's people use nearly 80 million barrels of oil a day, and there is much work to do to wean ourselves from our addiction to irreplaceable fossil fuels.

This book is about the many ways in which we can do that by working with "soft," renewable forms of energy: power derived from the wind, the sun, the sea, the earth, and biological sources, power that causes little or no damage and that can constantly be replaced. Getting there requires a lot of brainpower—and some elbow grease, too.

Jobs in many of those renewable forms of energy were once few and far

between. These days, though, companies are going lean, clean, and green. In every profession, in every walk of life, individual consumers, institutions, and corporations are looking to do things better and smarter in the work of producing and using energy and in lessening our dependence on fuels that will one day run out—perhaps sooner than we think.

As high school and college graduates will quickly discover, all other things being equal, there is no better time to learn environmentally responsible habits and put them to work in the marketplace. "Green jobs" are becoming ever more common, and demand for green things is on the rise, even as increased calls for energy independence are in the air. New fields are emerging as a result: a few years ago, there was no such thing as someone who brokered carbon trades, for instance, and very few builders and buyers who used terms such as "green building."

The fastest-growing professions within the so-called green-jobs realm, according to Kevin Doyle, president of the Boston-based consulting company Green Economy, are environmental engineers, hydrologists, environmental-health scientists, and urban and regional planners. Employers with such positions to fill look for students who major in engineering, mathematics, earth sciences, environmental studies, public policy, and economics—but also who come from liberal arts or science backgrounds generally, as long as they can think through a problem and communicate solutions to it.

The green-job phenomenon is also an important aspect of the trades these days, and skilled workers are needed to build, install, operate, and maintain the workings of green energy: rooftop solar panels, geothermal piping, wind turbines, fuel cells, wave rotors, radiant flooring, the list goes on and on.

U.S. Energy Consumption per Person

In 1949, energy use per person was 215 million Btu. In 2011, it was 312 million Btu.

SOURCE: WWW.EIA.GOV

Going green involves all of us. The world is in trouble. Or, perhaps better put, we're in trouble in the world. Getting us out of our current fix is going to take a lot of thought, a lot of work—and a lot of energy.

Careers in Renewable Energy

In this book, we'll look closely at dozens of careers within the broad renewable-energy field. Where possible, we'll use firm figures and talk dollars and cents. For instance, according to the *Environmental Business Journal*, the green industry in the United States in 2005 was about $265 billion, employing 1.6 million people. Green businesses had been growing at a rate of about 5 percent annually since then until the Great Recession hit in 2007. Had the job-growth trajectory continued at a normal pace, 85,000 new jobs would have opened up each year, and now that the recession is abating, job growth is trending toward this number. Some of these jobs are new. Others are new wrinkles on old fields such as the law, architecture, or business administration. Some are quite old: we need farmers to produce the makings of biofuel, for instance, and smooth-talking politicians to convince their colleagues to part with research money and provide grants and tax incentives so that homeowners and businesses can retrofit to take advantage of the energy-efficient, clean technologies of today and tomorrow.

And, as always, we need inventors, entrepreneurs, and visionaries to bring us new technologies and spread the word about them—the same people who, once upon a time, brought us electricity. We hope that some of the information you'll find in the pages ahead will inspire those kinds of people to get going on the big solutions we need to our big problems—and the big opportunities they occasion.

Knowledge Is Power

We also focus here on some of the places that offer training for entering the world of renewable energy: trade schools, community colleges, four-year colleges and universities, and graduate programs, along with professional organizations that sponsor workshops, conferences, and other continuing-education opportunities.

Because so many aspects of the green-energy field are new, there are not always abundant programs to match them. At MIT, for instance, that world-renowned school, there is no major as such in "renewable energy,"

though the interested student will find plenty of fields, from engineering to physics to business, that deeply concern themselves with renewable-energy matters. With guidance, a student could even design his or her own program with some of the courses scattered about in several departments, such as:

- Alternate Energy Sources
- Ecology I: The Earth System
- Ecology II: Engineering for Sustainability
- Fundamentals of Advanced Energy Conversion
- Material Science
- Mechanical Engineering
- Multiscale Analysis of Advanced Energy Processes
- Ocean Wave Interaction with Ships / Offshore Energy Systems
- Sustainable Energy

Not everyone can go to MIT, of course. Not everyone wants to, and not everyone needs to. Many community colleges offer training in alternative energy technology, for instance, in which students, one catalog tells us, "are introduced to design issues associated with home construction, com-

Green transportation is just one of the sectors where jobs can be found. Photo: Hydrogen fuel cell bus in Amsterdam; courtesy of Shell Hydrogen.

munity development and passive solar design." That particular program is made up of required courses that are as rigorous as MIT's, at first glance:

- Business English
- Building the Human Environment
- Construction Materials and Equipment Safety
- Building Construction Methods I
- Solar Home Design
- Intermediate Algebra

Add another year's study to that made up of the following courses, and you'll earn an advanced certificate:

- Introduction to Computer Information Systems
- Technical Drafting & CAD Fundamentals
- Micro Economics Principles
- Blueprint Reading
- Building Construction Methods II
- Photovoltaics and Wind Power
- Innovative and Alternative Building Techniques
- Technical Problem Solving

That's quite a full plate. Any program of study is going to be. The payoffs are immediate, though, not just in the sense of preparing a student to enter the renewable-energy field, but also in rewarding that student for his or her labors and preparation.

Of course, those with college training have greater earning power, generally speaking, than those without it. According to the University of Wisconsin Engineering Career Service (*https://ecs.engr.wisc.edu*), for

Oil for Transportation / Coal for Electricity

In 2011, transportation got 93% of its energy from petroleum, 3% from natural gas, and 4% from renewable energy.

In 2011, 92% of coal's energy went to electric power for the public, plus 8% to industrial.

SOURCE: WWW.EIA.GOV

instance, in 2013, a man or woman holding a bachelor's degree in civil and environmental engineering and entering the profession earned a median of $54,223 at the outset; a degree in industrial engineering commanded $61,505; and one in mechanical engineering brought slightly less, $60,798. Add a master's degree to the qualifications, and those figures rose to $55,096, $65,710, and $77,129 respectively. Add a Ph.D., and the entry-level pay for a mechanical engineer climbed to $86,125. The school did not place a civil and environmental or an industrial engineer in jobs 2013, so no figures are available—but we can assume they would show a similar spread.

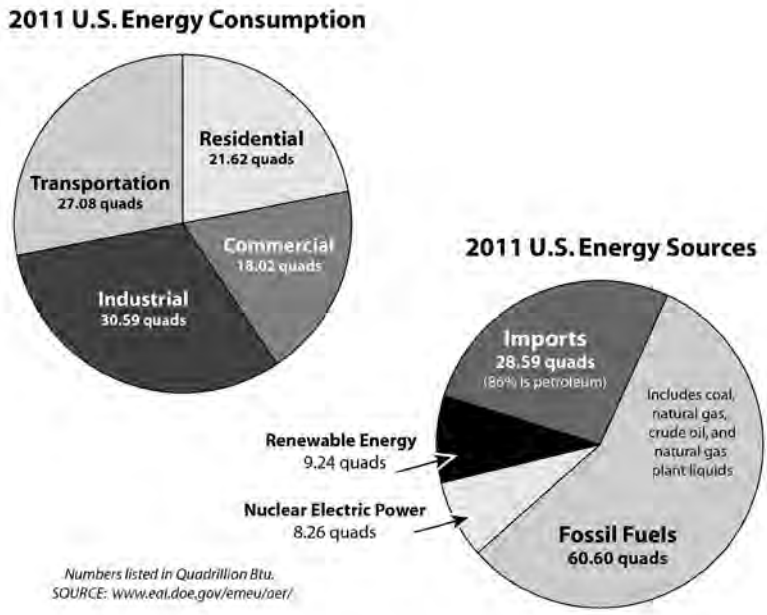
Knowledge is power. And, in the renewable-energy field, knowledge is money, too. In this book, we hope to provide access to all the sources you'll need in order to make the career in renewable energy that's just right for you. ❖

Where To Study Renewable Energy

Scott Sklar is president of The Stella Group, Ltd. optimizes high-value energy efficiency and renewable energy technologies for facilities or buildings, blends financing, and insures applications are standardized, modular, and web-enabled. Sklar teaches two unique interdisciplinary courses on sustainable energy at The George Washington University (GWU) and is an affiliated professor at the international sustainable graduate university (CATIE) in Costa Rica. In December 2012, Sklar was appointed by Acting Secretary Rebecca Blank to serve on as Vice Chairman of the Department of Commerce Renewable Energy and Energy Efficiency Advisory Committee, term ending June 2014. His co-authored book, *A Consumer Guide to Solar Energy,* is in its third printing, and he lives in a solar home and has solar on both his office buildings.

We asked him to name the ten schools he would recommend to a student interested in pursuing a career in renewable energy, and these are his picks:

- Arizona State University
- Bradley University
- Colorado State University
- George Washington University
- Massachusetts Institute of Technology (MIT)
- North Carolina State University
- Syracuse University
- University of California (Merced)
- University of Central Florida
- University of Nevada (Reno)



Life-Cycle Engineering

A quiet revolution is underway in engineering classrooms in Canadian universities, prompted by a climate change crisis that has unleased a torrent of new green technologies. It's called Life-Cycle Engineering. And, simple put, it means engineers will design products that can be manufactured while leaving a minimal environmental footprint. LCE involves estimating the environmental costs and social benefits at every stage of the life cycle—starting with raw material extraction, through product processing, transport, distribution and finally disposal. More importantly, this "cradle-to-grave" approach to engineering allows the engineer to sift through the hype and critically analyze the true impact of so-called green technologies – their promise and their pitfalls.

Source: Sumitra Rajagopalan, thestar.com

Google Goes Green in a Big Way

Google wanted to find a way to reduce energy costs at its Mountain View "Googleplex" as well as make a statement in support of clean energy. E1 Solutions engineered a way to mount 10,330 Sharp solar modules on every available rooftop plus the carports.

By installing the largest solar power system ever installed at a single corporate campus, the 1.6 megawatt-system will save Google more than $393,000 annually in energy costs, and the system will pay for itself in approximately 7.5 years. And CO_2 emissions are reduced by 3.6 million pounds per year!

Source: E1 Solutions, www.eispv.com