Dieter Seifried and Walter Witzel

Renewable ENERGY

THE FACTS

Renewable Energy – The Facts

Dieter Seifried and Walter Witzel

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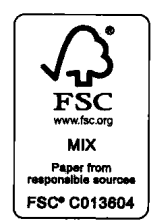


Contents

List of Figures

Foreword

There are dark clouds on the horizon. Climate change – long researched, discussed and denied – is increasingly making its presence felt. Drawn up by more than 2000 climate researchers from around the globe, the International Panel on Climate Change's (IPCC) 2007 report has a clear message: the Earth will inevitably heat up by more than 2°C above the temperature of the preindustrial age. Additional warming would have enormous consequences for mankind and the environment, and a global economic crisis can only be avoided if the global community works closely together.

'The time for half measures is over', former French President Jacques Chirac once said, commenting on the challenges of climate protection. 'It is time for a revolution – an awareness revolution, an economic revolution, and a revolution of political action.'

Unlike the three industrial revolutions (the first with the steam engine, loom and railways; the second with crude oil, cars and chemistry; and the third with information technology and biotechnology), the fourth industrial revolution will have to be part and parcel of a transition to a solar economy – and it will have to be a global revolution.

Despite all the talk, global energy consumption continues to rise from one year to the next. Industrial nations have only adopted modest climate protection policies, and energy consumption is skyrocketing in the most populous developing nations of China and India. We are called on to cut global greenhouse gas emissions in half by 2050; at the same time, poor countries continue to fight for their right to economic development. Therefore, our global switch to a renewable energy supply must be based on a dual strategy: greater energy efficiency and the fast development of renewable energy.

The dark clouds on the horizon do indeed have a silver lining of sorts. Behind them is a blue sky and a shining sun. The fourth industrial revolution of efficiency and solar power will make our energy supply safer. No longer will we fight for oil, and the battle against poverty will be won. Millions of new jobs will be created, and national economies and consumers will face less of a financial burden. The only thing to fear is inaction.

But the fear of inaction should be taken seriously. The main energy efficiency technologies and eco-efficient products – from cars that get 80 miles per gallon to cogeneration systems and homes that produce more energy than they consume – are already available. Seifried and Witzel show a wide range of these convincing options in practice and discuss the political reasons for society's reluctance to become more efficient.

In *Renewable Energy – The Facts*, the authors concentrate on the second major challenge we face: covering all of our (drastically reduced) global energy consumption with renewables. They convincingly show the great technical and economic potential of solar energy alongside that of wind, water and biomass, each of which can be considered indirect solar energy.

And that's not all. They also show that a narrow focus on technical potential is near-sighted. The drastic structural change in our energy sector and society will only come about if society undergoes an innovation process. In addition to technologies, this process requires the will to march on into sunnier days. It also requires proper institutional and market conditions – and different consumer behaviour, both in terms of purchases and product use.

The questions seem to be endless, but the answers are provided in the book you hold in your hands. *Renewable Energy – The Facts* is a manual for the fourth industrial revolution.

Rainer Griesshammer
Rainer Griesshammer is a member of the board at the Institute of Applied Ecology and a member of the German Advisory Council on Global Change.

Preface

'Renewables are the way of the future' – 20 years ago, this was a minority opinion. Back then, our energy supply came from fossil sources (coal, oil and gas) and from nuclear power. Power providers did not believe that solar energy could ever make up a large share of the pie and merely spoke of it as the 'spare tyre', which was good to have on board, but not something you would want to rely on all the time.

Over the past few years, opinions have begun to change. Markets for renewable energy sources are booming around the world. At the same time, the negative effects of our fossil-nuclear energy supply become clearer all the time:

- The dramatic impact on the climate of our uninhibited consumption of fossil energy is causing glaciers and polar ice to melt at rates previously unimagined. Ironically, the deserts are also expanding. Higher temperatures foster the spread of malaria and cholera, and extreme weather events, such as the European heatwave in the summer of 2003 and Hurricane Katrina in 2005, are becoming common. The warnings from researchers about the catastrophic consequences and the tremendous costs of climate change are only becoming more urgent. For instance, in a study published in October 2006, Nicholas Stern, the former chief economist at the World Bank, argued that climate protection is the best economic policy. While a lack of effective climate policies could cause damage amounting to up to 20 per cent of global gross domestic product (GDP), Stern calculated that proper climate protection would only cost 1 per cent of global GDP.[1]
- Crude oil and natural gas are becoming scarcer. Prices skyrocketed in 2008 leading up to the economic crisis, while the war in Iraq was a reminder that most of the world's oil reserves are in an unstable part of the world.
- The reactor disaster in Chernobyl (1986) tragically demonstrated that there is no such thing as safe nuclear power. Indeed, mishaps continue to this day, such as in the summer of 2006 in Forsmark, Sweden, and Biblis, Germany. Furthermore, we still do not know how to safely dispose of nuclear waste, which is why we need to stop making it as soon as possible.

These and other reasons clearly illustrate that our fossil/nuclear energy supply is not sustainable and has no future. At the same time, we are currently witnessing the beginning of the Solar Age and a boom in renewables, though perhaps 'witnessing' is not the right word – we are bringing this change about ourselves. Obviously, solar power is not a marginal player. Instead, it is the only sustainable energy source we have and will be a central pillar of our future energy economy alongside prudent energy consumption.

The trends over the past few years leave room for no other conclusion; solar energy is no longer a marginal player.[2] In 2006, the number of solar arrays installed in Germany crossed the threshold of 1 million. In only seven years, from 1999 to 2005, the industry

increased its sales more than tenfold, equivalent to average annual growth of around 50 per cent. In 2005, 45,000 people were employed in the solar sector, which posted €3.7 billion in revenue. By 2020, that figure is expected to increase another sevenfold.

Wind power has grown even faster. Policies in the 1990s got things going, bringing about increasingly powerful wind turbines. For many years, Germany was the world's leader in wind power and was only overtaken by the US in 2008. At the end of 2008, Germany had installed a total capacity of 23,903 megawatts (MW) of wind power. The 20,301 wind turbines in the country generated 40.4 terawatt-hours (TWh) of wind power that year, equivalent to 7.5 per cent of Germany's power consumption. The figure from 2006, only two years earlier, was 5.7 per cent; that year, wind power overtook hydropower as the biggest source of renewable energy.

Nowadays, the payback from policies to promote wind power is clear. German firms are global market leaders. Modern wind turbines are being exported in large numbers because in good locations wind power is cheaper than power from conventional central plants. At the end of 2007, some 90,000 people were employed in the German wind power sector.

Long overlooked, biomass recently moved to centre stage. A number of communities heat new buildings with renewable wood, and wood pellets ovens for detached homes and multi-family units have become genuine competitors for oil and gas heaters. Within just three years, the number of these environmentally friendly boilers rose tenfold. In addition, a growing number of farmers are now growing energy crops. Plantations of rapeseed are a source of additional income alongside biogas digesters.

All of these steps go in the right direction in our opinion, and they are all the results of government policy, such as Germany's Renewable Energy Act (EEG). But Germany is not a special case. A number of countries have adopted similar policies, called feed-in tariffs (FITs). Some 60 countries worldwide have adopted FITs, making it the leading policy instrument to promote renewables worldwide.

Wind power continues to boom worldwide (see www.ewea.org/fileadmin/ewea_documents/documents/press_releases/2009/GWEC_Press_Release_-_tables_and_statistics_2008.pdf). For instance, in 2008, installed wind power capacity rose by some 30 per cent, while the grid-connected photovoltaics (PV) capacity grew by more than 70 per cent.[3] Overall, a total investment of €120 billion (2008) underscores the growing economic importance of the sector.

Crucially, China, the most populous country in the world, has set some ambitious targets for itself. By 2020, renewables are to make up 15 per cent of the country's power consumption. In particular, China installed some 13 gigawatts (GW) of wind capacity in 2009 alone, bringing it more than halfway to its target of 20GW by 2020 – and making China the global wind leader for that year.[4] China also has ambitious plans for other renewable sources of energy, which all goes to show that renewables are a genuine option for developing and newly industrialized countries.

Though the US did not ratify the Kyoto Protocol, more than 300 mayors – from Chicago to New York, Los Angeles and New Orleans – have stated their support for the treaty.[5] And though former President George W. Bush came from the oil sector and was surrounded by consultants from the oil industry, renewables boomed during his

administration more than ever before as the country worked to make itself less dependent on foreign energy imports.

Clearly, energy policy is in a transitional period. Renewables are quickly becoming more important. In this book, we navigate our readers through this process and provide them with facts and good reasons for this change. We also present strategies for the quick transition to the Solar Age:

- The book first provides information about the many ways that solar energy can be used. We start with the direct use of solar energy: solar thermal and PV. The former creates heat; the latter, electricity (Chapters 2–4). The sun is also the engine behind our climate; wind, clouds and rain are the result of insolation. Likewise, plants (biomass) could not exist without light. Biomass, wind power and hydropower are therefore thought of as indirect ways of using solar energy. Finally, geothermal is yet another renewable source of energy (Chapters 5–7). We round off this presentation of energy sources with an overview of new energy technologies often mentioned in the context of renewable energy, such as fuel cells (Chapter 8).
- The second part of the book focuses on the overall potential of solar energy. We discuss not only the possibilities of various types of solar energy, but also how they are currently used in Germany, Europe and worldwide. A scenario for the expansion of renewables illustrates our future prospects (Chapter 9). A number of arguments against the expansion of renewables are also repeatedly voiced in the debate about our future energy supply. In Chapter 10, we respond to some of the most common charges with some basic facts.
- The last two chapters concern how the solar energy future we describe can become a reality. Chapter 11 provides an overview and assessment of various types of policies. Largely considered the best policy, feed-in tariffs are the focal point. But the long-term expansion of renewables will have to include additional instruments, such as for the heating sector. We also briefly present the history of the concept behind feed-in tariffs, which go back to the Aachen Model of 'cost-covering compensation'. Finally, in Chapter 12 we present a number of examples of creative marketing strategies that have successfully sped up the implementation of renewable energy (mainly in communities). In doing so, we hope to provide some ideas of how people and communities can become involved in addition to actions taken by big energy players.

Renewable Energy – The Facts has a special design: each page of text has a chart juxtaposed. The concept is intended to give readers a quick overview of the topic. At the same time, we as authors are forced to cover each issue on exactly one page. In some cases, some ancillary ideas had to be deleted and moved into footnotes. To facilitate readability, we have also added a glossary of technical terms. Interested readers will also want to consult the list of important publications and websites to help them keep up with current events and find additional information on special topics.

This book is a translation of the third edition of the German publication; some of the data in the German book were updated for the English publication.

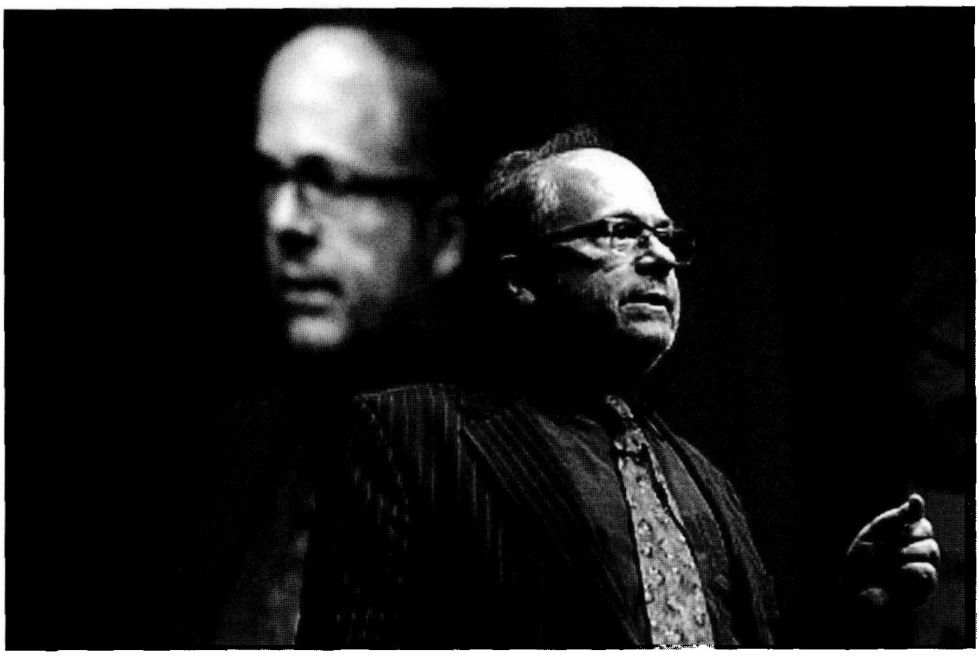
We hope that you enjoy the English version of this book and find that it provides you with the basic knowledge you need to get involved in sustainable energy policy. There

may be many setbacks to come, but one thing is also certain: the course of the sun cannot be stopped.

Dieter Seifried and Walter Witzel
Freiburg, March 2010

PS All the figures in this book can be downloaded at www.earthscan.co.uk/onlineresources. We hope they prove useful to you in your presentations and awareness-raising.

New Paths to the Future



Dear Readers,

In the battle against climate change, practical expertise in energy efficiency and renewables is in higher demand than ever. After all, renewable energy represents a truly long-term alternative compared to finite, environmentally unfriendly fossil energy sources – which are also unsafe in terms of security. The inexhaustible power of the sun is not the only way to fulfil our responsibility to future generations; wind, water and renewable bioenergy are of help and can be used as well.

Renewables offer genuine hope for development because they can provide decentralized energy in developing countries; therefore, they are used wherever poverty and a lack of energy would go hand-in-hand. They are also useful wherever people already have a lack of means to deal with the consequences of the wrong energy policy and environmental disasters such as droughts, floods and hurricanes.

Renewable Energy – The Facts provides a number of important answers to a lot of such urgent questions. It offers the latest information and technical explanations, including interesting examples and how to put guidance into practice. An agency of German development cooperation, InWEnt (Capacity Building International, Germany)