

Preface

There is a clear need to change the present global energy system in order to achieve sustainability. A transition from the fossil fuels based system seems to be inevitable due to environmental concerns, including the threatening consequences of global warming and climate change, due to geopolitical problems, and ultimately due to depletion of fluid fuels (oil and natural gas). Although such a fundamental change may cause economic hardship, this may be minor compared to the havoc that the continuous and unwieldy use of finite and polluting fossil fuels will ultimately cause. This transition will require not only change in energy sources, but also in energy carriers and in technologies required to convert them to the useful forms of energy we need. The most obvious carriers that may be used in the future are electricity and hydrogen, both non-polluting and both can be produced from any of the energy sources. Although the energy carriers of the future may be envisioned with some certainty, at least based on present knowledge, the transition to that energy future is less predictable.

Fuel cells are devices that convert hydrogen to electricity – directly, efficiently and with no harmful emissions. A great deal of time, money and effort has been invested in fuel cell research, development and demonstrations since the late 1990s. A fuel cell industry is being developed. Fuel cells have great potential to serve the energy needs of transportation, and for stationary as well as portable power generation.

While the radical change of the global energy system, although inevitable, will require some form of global consensus, and therefore will take a long time, fuel cells may be ready for the market in the near term or even now. Some fuel cells may run on natural gas or other readily available fuels, and delivery of hydrogen may not be so critical for some applications. In these cases the fuel cells are just another electricity generation technology competing with the existing technologies.

This book presents an in-depth analysis of the fuel cell industry and markets, concentrating on the disruptive nature of this technology, value chain structure, strategies of relevant players, alliances among firms, interorganizational learning, management of developing new markets, diffusion of innovative technologies and venture capital dynamics. It also provides an overview of the policies that support hydrogen and fuel cell technologies in major countries around the world.

What readers must keep in mind is that fuel cells are ultimately not just another competing electricity generation technology. The market forces alone may not be sufficient to commercialize fuel cells. As energy converters fuel cells are only a part of a larger energy system chain, and it may be difficult to introduce and commercialize only one component of that chain (absent situations where hydrogen is not needed). Most likely, fuel cell emergence will be caused by what appears to be an inevitable change of the entire energy system. Fuel cells may actually create a need for hydrogen and thus accelerate this transition, creating a 'positive feedback loop' effect.

A perceptive and objective observer may notice that fuel cells are catching on more slowly than initially envisioned or expected. The ambitious promises from the early-2000s, necessary to attract the investors, have not yet come to fruition. Fuel cells are still in the demonstration phase heavily subsidized by the government programs. The reasons are numerous, but the key issues are that: (1) fuel cell technology was not ready for the market; and (2) the market was not ready for fuel cells. In the meantime, tremendous efforts have been devoted to both basic and applied research and development, not only providing better understanding of the processes that take place within the fuel cell but also addressing crucial technological issues. Significant efforts have also been applied to engineering and manufacturing of fuel cell components, stacks and systems. Although the financial momentum and initial enthusiasm may be gone, the potential of hydrogen as an energy carrier of the future and fuel cells as the key technology for converting hydrogen into more useful forms of energy has not changed. What is important is that hydrogen and fuel cell technologies will be ready when the global energy shift creates the need for them.

I am convinced that the next revolution, after the industrial, automobile, electricity and information revolutions of the last few centuries, will be an energy revolution. Just as all the other revolutions were prompted by a technological invention so powerful that it made changes in everyday life and allowed development of new products and services previously unimaginable, I also know that fuel cells are one of those powerful technologies that will foment the next revolution – the energy revolution.

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