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Markus Lehner
Robert Tichler
Horst Steinmüller
Markus Koppe

Power-to-Gas: Technology and Business Models



Springer

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Markus Lehner · Robert Tichler
Horst Steinmüller · Markus Koppe

Power-to-Gas: Technology and Business Models

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Markus Lehner
Industrial Environmental Protection
Montanuniversität Leoben
Leoben
Austria

Markus Koppe
Institute for Environmental Management
Johannes Kepler University
Linz
Austria

Robert Tichler
Horst Steinmüller
Energy Institute
Johannes Kepler University
Linz
Austria

ISSN 2191-5520

ISBN 978-3-319-03994-7

DOI 10.1007/978-3-319-03995-4

ISSN 2191-5539 (electronic)

ISBN 978-3-319-03995-4 (eBook)

Library of Congress Control Number: 2014943943

Springer Cham Heidelberg New York Dordrecht London

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Printed on acid-free paper

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Preface

The change in the supply structure for energy is mainly driven by the imminent climate change. Other incentives may be strategic considerations, or generally a paradigm shift in the way our industrial system, and the necessary power supply is operated. The energy supply of the future will implement renewable sources at least to a greater extent as today. Beyond any controversy, increasing portions of renewable energy, particularly wind and solar power, already cause local discrepancies between supply and demand in the power grid.

There are several possibilities to approach the challenges of a changing energy system. For the time being, the extension of the power grid, load management and energy storage facilities are possible measures to meet the requirements of renewable energies. Depending on the future rate of renewable energies, most or even all of these measures have to be implemented. In terms of storage systems, also seasonal storage possibilities are needed. One promising option for long-term storage is the conversion of renewable electricity to chemical energy carriers, like hydrogen, methane, methanol, formic acid, fuels or the hydrogenation of aromatic hydrocarbons.

The intention of this book is to give a brief, but comprehensive overview of the Power-to-Gas technology, one of the chemical storage options for renewable energies. Many researcher groups are currently working on different aspects of this concept. Power-to-Gas plants in a demonstration scale were recently started or are under construction. Therefore, it is not possible to give a concluding résumé of this technology at present. Furthermore, the Power-to-Gas concept is a flexible technology providing a multitude of possible applications. In order to cope with this situation, we tried to describe the current state of the art, actual research and development activities as well as future challenges, without making a claim to be complete. The second part of this book deals with business models focusing on the economic dimension of the Power-to-Gas technology respectively of the Power-to-Gas system, which requires not only business analysis but also comprehensive macroeconomic and systemic analysis.

Currently, the Power-to-Gas technology is economically not feasible. Both, still technological and systemic developments are required. But, in the opinion of the

authors, the long-term storage of renewable energies will be a crucial backbone of the future energy system. If we do not develop technologies today, we will not be able to meet the requirements of tomorrow.

The authors would like to thank Dipl.-Ing. Aaron Felder, Dipl.-Ing. Phillip Biegger, Prof. Dr. Josef Draxler, Lukas Rebhandl, and Fabian Frank for reviewing parts of the manuscript, and Mark Read as well as Jed Cohen, M.S. for transforming and partly translating the text to a readable English.

Leoben, May 2014
Linz

Markus Lehner
Robert Tichler
Markus Koppe
Horst Steinmüller

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Chapter 1

Storage Options for Renewable Energy

In the recent years, the European energy policy has agreed on the increased integration of renewable energy sources in the energy system, and large efforts are being made to implement renewable energy. This tendency is not limited to the European market, but is a basic development in many regions. The energy policy is primarily based on climate change policy aims and demands, however further parameters are relevant in the portfolio of intentions for increasing the percentage of renewable energy sources, such as reduction of the import dependency and increasing the domestic value or price stability. To some extent, relatively high expansion rates in the implementation of energy systems based on renewable sources can be achieved, such as in Germany and China, for example.

The increasing share of renewable energy sources, in most cases coupled with an absolute increase of production, includes as well as advantages, challenges and problems. With this in mind, this book concentrates on the challenges of a continuous increase in the volatile portion of energy production caused by renewable energy sources.

Renewable energy sources are being forced into all areas of energy systems: in the area of mobility with respect to fuel, thermal area (both as energy sources in the segment of space heating as well as in process heat) and in electricity. This book focuses on the challenges in the area of electricity production. The areas of heat and mobility are therefore in this respect not relevant for the problem of necessity of storage systems for volatile production lines (certainly however as a demand in the Power-to-Gas plant produced energy as detailed in Chaps. 2 and 5). As a consequence, only the challenges of volatile power production on the basis of renewable energy resources will be dealt with.

The continuous increase of the volatile portion of power production based on the energy policy road maps is not equal in all regions. Renewable energy sources for the production of electricity such as water power or biomass show, in comparison to wind energy or photovoltaic, less temporal fluctuation in the production. Therefore, all regions with high or strongly increasing shares of wind and solar power in their electricity production portfolio are or will be confronted