Sustainable Development in the 21st Century

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Volume 3
Jan-Niclas Gesenhues

Smart Energy in Mozambique
Drivers, Barriers and Options
For Annica and Carlotta

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Preface

This thesis was accepted as a dissertation at the University of Münster in the summer semester of 2019. It is particularly dedicated to the analysis of decentralized and intelligently networked energy sectors.

Countries around the world are undergoing a paradigm shift in energy supply – from centralized, fossil-fueled supply systems to a decentralized, intelligently networked and climate-friendly structure. Some countries in the global south play a key role in this development. Using Mozambique as an example, this study shows how a digitally networked energy supply system can grow "from below". On this basis, strategies are developed that can contribute to achieving some of the United Nations' Sustainable Development Goals - especially in the areas of energy, climate, health, economy and poverty reduction.

My special thanks go to my two supervisors Prof. Dr. Norbert Kersting and Prof. em. Dr. Paul Kevenhörster, for their scientific and moral support throughout the research process.

I am also very grateful to Prof. Dr. Boaventura Chongo Cuamba from Eduardo Mondlane University of Maputo for his support, expertise and networks. Our scientific cooperation led into a partnership project between Mozambican and German institutions, funded by the German Ministry of Economic Cooperation and Development. This project addresses the needs of the renewable energy sector in Mozambique and is a great opportunity to use the scientific insights of this thesis in practice.

This work could not have been done without intensive investigations and expert discussions on site in Mozambique. I would, therefore, like to thank all respondents and express my gratitude to the Heinrich Böll Foundation and the German Academic Exchange Service (DAAD) for funding part of my field research in Mozambique and South Africa.

I was privileged to develop my thesis together with an international group of PhD students with a strong expertise in development politics, digitalization and with much experience from East-African countries. I am especially grateful to my colleagues Phillip Hocks M.A., Dr. Andrew Matsiko and Lia Polotzek M.A. for reviewing the manuscript and for very helpful comments and discussions.

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Jan-Niclas Gesenhues
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List of acronyms

AU  African Union
AC  Alternating current
ALER  Associação Lusófona de Energias Renováveis
AMER  Associação Moçambicana de Energias Renováveis
App  Application
ARENE  Autoridade Reguladora de Energia
CIA  Central Intelligence Agency
CNELEC  Conselho Nacional de Electricidade
DC  Direct current
EDM  Electricidade de Moçambique
EnDev  Energising Development Program
FDI  Foreign direct investment
FUNAE  Fundo da Energia, National Energy Fund of Mozambique
FRELIMO  Frente de Libertação de Moçambique
GDP  Gross domestic product
GIZ  Gesellschaft für Internationale Zusammenarbeit
GWh  Gigawatt hour
HCB  Hydroelectricity of Cahora Bassa
ICT  Information and communication technology
IMF  International Monetary Fund
INE  Instituto Nacional de Estatistica
kV  Kilovolt
kWh  Kilowatt hour
MPD  Ministério de Planificação e Desenvolvimento
MZN  New Mozambican Metical
OAU  Organization of African Unity
OECD  Organization for Economic Co-operation and Development
PayGo  Pay-as-you-go technologies
RENAMO  Resistência Nacional Moçambicana
RSA  Republic of South Africa
SADC  South African Development Community
SASGI  South African Smart Grid Initiative
UN  United Nations
List of acronyms

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<tr>
<th>Acronym</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>UNCTAD</td>
<td>United Nations Conference on Trade and Development</td>
</tr>
<tr>
<td>WLAN</td>
<td>Wireless Local Area Network</td>
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<td>ZANLA</td>
<td>Zimbabwe African National Liberation Army</td>
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List of symbols

\( C \) Cost function
\( D \) Demand function
\( \varepsilon \) Price-elasticity of demand
\( mc \) Marginal costs
\( mr \) Marginal revenue
\( n \) Sample size
\( p \) Price
\( p_o \) Off-peak-price
\( p_p \) Peak-price
\( \pi \) Profit
\( R \) Revenue
\( sd \) Standard deviation
\( u \) Utility
\( \mu \) Average value
\( x^D \) Demanded quantity of the commodity
\( x_i \) Quantity of the commodity \( i \)
\( x_o \) Off-peak quantity
\( x_p \) Peak quantity
\( x^S \) Supplied quantity of the commodity
\( y \) Number of clients