

# Contents

<b>Preface.....</b>	<b>.ix</b>
<b>1 Introduction.....</b>	<b>1</b>
1.1 Electricity Systems under Transformation .....	2
1.2 Shaping Innovation Towards Sustainability .....	3
1.3 Empirical Foci of the Book.....	4
1.4 Structure of the Book.....	6
References .....	7
<b>2 Transformation and Innovation in Power Systems .....</b>	<b>9</b>
2.1 Systems in Flux: An Everlasting Path of Electricity Innovation .....	9
2.2 Are we Locked in a Carbon (and Nuclear) Trap?.....	13
2.3 Current Stimuli for Change .....	17
2.3.1 Impacts of Liberalization .....	17
2.3.2 Increasing Climate Change Concerns .....	20
2.3.3 Impulses from Technological Change .....	21
2.4 Actors and Institutions of Change .....	23
References .....	24
<b>3 Towards a Systemic Understanding of Innovation.....</b>	<b>29</b>
3.1 Conceptualizing Innovation.....	29
3.2 Sustainability .....	34
3.3 Systemic Perspectives on Innovation in Literature.....	37
3.4 Design of the Innovation Case Studies .....	39
References .....	41
<b>4 Micro Cogeneration.....</b>	<b>45</b>
4.1 Micro Cogeneration as an Innovation Cluster .....	45
4.2 Design Options and Sustainability Potential .....	48
4.2.1 Technological Variations.....	48
4.2.2 Operating Schemes.....	49
4.2.3 System Level Impacts .....	51
4.2.4 Ecological Performance .....	51

4.2.5 Economic Performance.....	53
4.2.6 Micro Cogeneration Scenarios.....	55
4.3 The Innovation Process of Micro Cogeneration .....	56
4.3.1 Evolution of the Innovation System .....	57
4.3.2 Market Setting and Situation to Date.....	59
4.3.3 General Reasons for Slow Diffusion in Germany .....	61
4.3.4 Actors and Coalitions .....	62
4.4 Shaping the Innovation Process.....	67
4.5 Conclusions .....	71
References .....	74
 <b>5 Carbon Capture and Storage.....</b>	 <b>77</b>
5.1 CCS as an Innovation to the Electricity System.....	77
5.2 Design Options and Sustainability Potential .....	78
5.2.1 Technological Variations.....	78
5.2.2 Ecological Performance.....	84
5.2.3 Economic Performance.....	88
5.2.4 CO <sub>2</sub> Mitigation Scenarios for the Electricity System .....	91
5.3 The Innovation Process of CCS.....	93
5.3.1 Research and Development Activities.....	93
5.3.2 CCS Actors and Constellations in Germany .....	96
5.3.3 Development of the Institutional Framework.....	101
5.4 Shaping the Innovation Process.....	103
5.5 The Future of CCS in a Sustainable Electricity System .....	106
References .....	109
 <b>6 Consumer Feedback through Informative Electricity Bills.....</b>	 <b>115</b>
6.1 Introduction .....	115
6.2 Description of Innovation and Design Options .....	116
6.2.1 General Design Options .....	116
6.2.2 Example: Design Options for Electricity Bills in Germany ..	118
6.3 Effects and Sustainability Potential of Consumer Feedback .....	123
6.3.1 Electricity Conservation .....	124
6.3.2 Satisfying Consumer needs .....	126
6.3.3 Case study: Informative Energy Bills in Heidelberg .....	126
6.3.4 Some Conclusions for Feedback Design.....	130
6.4 Process of Innovation and Factors Influencing It .....	131
6.4.1 Origin and Transfer of the Innovation .....	131
6.4.2 Implementation in Germany .....	134
6.5 Possibilities for Shaping .....	140

6.5.1 Short-term and Long-term Options.....	140
6.5.2 Introducing the Informative Electricity Bill: Problems .....	141
6.5.3 The Role of Actors Other than Politics and Utilities .....	143
6.6 Conclusions .....	144
References .....	147
<b>7 Emissions Trading .....</b>	<b>151</b>
7.1 Introduction .....	151
7.2 Design Options .....	152
7.2.1 Scope and Coverage: What Sources Shall be Included?.....	152
7.2.2 Cap: How Much is Allowed?.....	153
7.2.3 Allocation: Who Gets what and how? .....	153
7.2.4 Banking: When can Allowances be Used?.....	158
7.2.5 Commitment Periods: What is the Planning Horizon? .....	159
7.2.6 The Interplay of Design and Sustainability .....	161
7.3 Process of Innovation: Networks, Politics, Institutions .....	164
7.3.1 The Innovation Journey of Emissions Trading .....	164
7.3.2 Gestation: Emerging Practices of Flexible Regulation and New Options in Economic Theory .....	165
7.3.3 Proof of Principle: Creating Spaces for First Developments at US EPA in the Shadow of the Old Regime .....	166
7.3.4 Embedding a Prototype: Project 88 and the Transformation of US Clean Air Policy .....	168
7.3.5 Regime Formation: Linkage with International Climate Policy, the Carbon Industry and EU Emissions Trading .....	170
7.3.6 The Allocation Process .....	173
7.3.7 Possible Future Developments .....	178
7.4 Shaping the Innovation Process for the Sustainable Development of Electricity Systems.....	179
7.5 Conclusions .....	181
References .....	185
<b>8 Network Regulation .....</b>	<b>191</b>
8.1 Introduction .....	191
8.2 Design Options and Sustainability.....	192
8.2.1 Design Options .....	192
8.2.2 Sustainability .....	197
8.3 Process of Innovation .....	201
8.3.1 Development of the ‘Standard Model’ of Network Regulation.....	202
8.3.2 Reopening the ‘Standard Model’: Drivers of Change and the British Case.....	205

8.4 Possibilities for Shaping .....	214
8.4.1 Room for Change in the Standard Model.....	214
8.4.2 Developing Alternatives .....	215
8.4.3 Broadening the Actor Arena.....	216
8.5 Conclusions .....	218
References .....	221
 <b>9 Innovation Dynamics in the Electricity System: Progressing Towards a Sustainable Path? .....</b> 227	
9.1 Overview and Summary .....	227
9.2 Explaining the Innovation Dynamics .....	232
9.2.1 The Dynamic role of Institutions, Actors and Networks .....	232
9.2.2 The Role of Blocking, Competing and Matching Innovations .....	236
9.3 Shaping the Environment for Innovation Dynamics .....	239
9.4 Some Final Remarks.....	243
References .....	245