

Contents

Preface.....	ix
1 Introduction.....	1
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
2 Transformation and Innovation in Power Systems	9
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
3 Towards a Systemic Understanding of Innovation.....	29
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
4 Micro Cogeneration.....	45
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
5 Carbon Capture and Storage.....	77
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 ₂ 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
6 Consumer Feedback through Informative Electricity Bills.....	115
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
7 Emissions Trading	151
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
8 Network Regulation	191
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
 9 Innovation Dynamics in the Electricity System: Progressing Towards a Sustainable Path?	 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