

Contents

1	Introduction	1
1.1	Background of Sustainable Manufacturing	1
1.2	Energy Consumption Review in the US Automotive Industry	4
1.3	Energy and Environment Management in Automotive Manufacturing	7
1.4	Smart Energy and Environment Management Using Data and Model-Based Analytics	9
1.4.1	Example Decision Problem in Energy Management: A Cost Comparison of Pneumatic and Electric Actuator Systems	14
1.5	Outline of Chapters	20
1.6	Exercises	23
	References	26
2	Energy Performance Analysis: Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DES) for Energy Performance Analysis	29
2.1	Background of Energy Performance Analysis	29
2.1.1	Background of the Auto Manufacturing Process and the Energy Consumption	31
2.1.2	Literature Review	33
2.1.3	Energy Performance Assessment	35
2.2	SFA for Energy Performance Analysis	37
2.3	DEA for Energy Performance Analysis	41
2.4	Illustrative Study	44
2.5	Summary	51
2.6	Exercises	51
	Appendix A: Derivation of the Log Likelihood Function and First-Order Partial Derivatives for Cost Frontier Model	52

Appendix B: Getting Started with Excel Solver for SFA and DEA Analyses	56
References	76
3 Energy Decision-Making 1: Strategic Planning of Sustainable Manufacturing Projects Based on Stochastic Programming	79
3.1 Background of Planning Sustainable Manufacturing Projects in the Manufacturing Industry	79
3.1.1 Literature Review	81
3.2 A Problem Formulation in Stochastic Programming	83
3.2.1 Objective Function	83
3.2.2 Constraints	86
3.3 Sample Averaging Approximation as a Solving Method	87
3.4 Illustrative Study	89
3.4.1 Carbon Cost Scenario Generation	89
3.4.2 Parameter Settings for a Hypothetical Plant	91
3.4.3 Assumptions and Cases for Study	92
3.4.4 Results.	93
3.5 Summary	96
3.6 Exercises	97
Appendix: Methods and Standards for Preparing Scope-3 Carbon Footprints.	99
References	107
4 Energy Decision-Making 2: Demand Response Option Contract Decision Based on Stochastic Programming	109
4.1 Background of Energy Demand Response	109
4.1.1 Motivating Example	110
4.1.2 Activity-Based Costing	113
4.1.3 Activity-Based Plant Energy Forecasting Method	118
4.1.4 Literature Review	119
4.2 Chance-Constrained Stochastic Programming for Strategic Decision Making.	121
4.3 Decision Model for Determining Energy Demand Response Option Contract.	123
4.4 Illustrative Example.	124
4.4.1 Identification of Input Parameters	126
4.4.2 Reduction in the Rate of Energy Demand (kW) for State-Transition Flexible Activities.	127
4.4.3 Reduction in the Rate of Energy Demand (kW) for QoS Flexible Activities.	127
4.5 Summary	132
4.6 Exercise	133
References	133

5	Pattern-Based Energy Consumption Analysis by Chaining	
	Principle Component Analysis and Logistic Regression	137
5.1	Background of Energy Consumption Analysis	138
5.2	Technologies for Pattern Training and Inference	140
5.2.1	Principle Component Analysis (PCA)	140
5.2.2	Multinomial Logistic Regression	142
5.2.3	K-Means Clustering Algorithm	143
5.3	A Classification Model for Energy Consumption Pattern	
	Training and Inference	143
5.3.1	Training Steps: Design Time	144
5.3.2	Inference Steps: Real Operation Time	146
5.3.3	Scikit-Learn Machine Learning Library in Python	146
5.4	Illustrative Example	147
5.5	Summary	152
5.6	Exercises	153
	Appendix: Getting Started with IPython Notebook for Energy	
	Pattern Analysis	153
	References	176
6	Ontology-Enabled Knowledge Management in Environmental	
	Regulations and Incentive Policies	179
6.1	Background of Energy and Environment Knowledge	
	Management	179
6.2	EU-ETS and Waxman-Markey Bill (W-M Bill)	183
6.2.1	European Emission Trading Scheme (EU-ETS)	183
6.2.2	Waxman-Markey Bill (W-M Bill)	183
6.3	Technologies for Semantic Data Management	185
6.3.1	Description Logic (DL)	185
6.3.2	Semantic Data Model: RDF	186
6.3.3	Semantic Data Query: SPARQL	186
6.4	ERIPAD Ontology	187
6.4.1	TBox and ABox	187
6.4.2	Knowledge Acquisition and Dissemination in ERIPAD	188
6.5	Illustrative Example of Knowledge Management	
	with ERIPAD	192
6.5.1	Semantic Queries with Apache Jena Fuseki	192
6.5.2	CO ₂ Emission Management Decision Process	
	with ERIPAD	192
6.6	Summary	195
6.7	Exercises	195
	References	197

7	Energy Simulation Using EnergyPlus™ for Building and Process Energy Balance.	199
7.1	Background of Energy Simulation and EnergyPlus	199
7.2	Illustrative Example 1: Assessment of the Use of Air Conditioning Economizer	202
7.2.1	What Is an Air Conditioning Economizer?	203
7.2.2	Modelling and Simulation with EnergyPlus	203
7.2.3	Analysis Results	205
7.3	Illustrative Example 2: Assessment of the Use of a Mist Collection System with Different Ventilation Strategies	207
7.3.1	What Is a Mist Collection System?	207
7.3.2	Dynamic Ventilation Strategy for a Mist Collection System.	210
7.3.3	Modelling and Simulation with EnergyPlus	210
7.3.4	Analysis Results	214
7.4	Summary	215
7.5	Exercises	215
	Appendix: Getting Started with EnergyPlus for Manufacturing Process Simulation	216
	References	244
8	Energy Management Process for Businesses	245
8.1	Importance of Energy Management to Business.	246
8.2	Integrating Energy Management into the Global Business Plan	248
8.2.1	Make a Commitment.	248
8.2.2	Business Planning.	249
8.2.3	People	250
8.3	Establishing Targets and Public Goals	250
8.3.1	Data Management	250
8.3.2	Data Verification and Assurance	252
8.3.3	Establishing a Baseline	252
8.3.4	Science-Based Targets	254
8.4	Benchmarking, Budgets, and Forecasts.	256
8.4.1	Benchmarking	256
8.4.2	Budgets and Forecasts	257
8.5	Action Plan	261
8.5.1	Sufficiency Plans.	261
8.5.2	Energy Projects and Conservation	262
8.5.3	Check Progress.	263
8.6	Energy Management Tools	264
8.6.1	Internal Recognition	264
8.6.2	External Recognition	265
8.7	Exercise	266
	References	267

9	Energy Efficiency Accounting to Demonstrate Performance	269
9.1	Selling the Need to Fund Projects	269
9.1.1	Strategic Plan	271
9.1.2	Accountability	273
9.1.3	Data Systems	273
9.2	Developing Energy Efficiency Projects	276
9.2.1	Energy Project Tracking.	276
9.2.2	Energy Project Technology.	278
9.3	Prioritization of Projects	279
9.3.1	Energy Use	279
9.4	Closing the Gap to Benchmark with Energy Efficiency	281
9.4.1	Energy Drivers	281
9.4.2	Design Energy Efficiency into New Processes and Facilities	284
9.5	Measurement and Verification	286
9.5.1	M&V Baseline Plan	287
9.5.2	Post-retrofit M&V	288
9.6	Exercise	289
	References	290
Index	291

Analytics for Smart Energy Management

Tools and Applications for Sustainable Manufacturing

Oh, S.-C.; Hildreth, A.J.

2016, XI, 295 p. 117 illus., 96 illus. in color., Hardcover

ISBN: 978-3-319-32728-0