

Contents

1	Sustainable Supply Chains: Introduction	1
	Yann Bouchery, Charles J. Corbett, Jan C. Fransoo, and Tarkan Tan	
1.1	Sustainable Supply Chains: What's New?	1
1.2	Sustainable Supply Chains: What's Really New?	3
1.3	Principles Underlying This Book	4
1.3.1	Economic Drivers of Sustainability	5
1.3.2	What You Measure Is What You Get	6
1.3.3	Supply Chain Operations Are Key to Sustainability	7
1.3.4	Sustainability as a Direction, Not a State	8
1.3.5	Sustainability Involves Wider Range of Stakeholders	8
1.4	The Future of Sustainable Supply Chains	9
1.4.1	More of the Same	9
1.4.2	What's Around the Corner	10
	References	11
 Part I Measuring Environmental Impacts in Supply Chains		
2	Introduction to Life Cycle Assessment	15
	Jeroen Guinée and Reinout Heijungs	
2.1	LCA: What Does It Address and How Has It Developed?	15
2.1.1	LCA in a Nutshell	17
2.1.2	History of LCA	18
2.1.2.1	The Past of LCA (1970–2000)	18
2.1.2.2	2000–Present: The Era of Elaboration	20
2.2	Overview of LCA	21
2.2.1	Goal and Scope Definition	21
2.2.2	Inventory Analysis	23
2.2.3	Impact Assessment	26
2.2.4	Interpretation	31
2.2.5	LCA in Practice	32
2.3	Examples of LCA Applications	33

2.4	Developments in and Challenges to LCA	35
2.4.1	Development of Consequential LCA	35
2.4.2	Broadening LCA to Life Cycle Sustainability Assessment (LCSA)	36
2.4.3	Dealing with Uncertainty in LCA	37
2.4.4	Simplifying and Streamlining LCA	38
2.4.5	Ex Ante and Prospective LCA	39
2.4.6	Standardization of LCA Methods Beyond ISO	40
2.4.7	Bridging LCA and Supply Chain Analysis	41
	References	41
3	Carbon Footprinting in Supply Chains: Measurement, Reporting, and Disclosure	49
	Tasseda Boukherroub, Yann Bouchery, Tarkan Tan, Jan C. Fransoo, and Charles J. Corbett	
3.1	Introduction	49
3.1.1	The Science of Climate Change	50
3.1.2	Motivations for Carbon Footprinting and Reporting	53
3.2	How Can a Carbon Footprint Be Measured?	55
3.2.1	The GHG Protocol	55
3.2.2	Methodologies for Measuring the Carbon Footprint	58
3.3	Supply Chain Carbon Footprinting	61
3.3.1	Importance of Scope 3 Emissions	61
3.3.2	An Example from a Telecommunications Company	62
3.3.3	Emission Allocation in the Supply Chain	67
3.4	Discussion	69
3.4.1	How Can We Get Information in Practice?	69
3.4.2	How Accurate Is Accurate Enough?	71
3.4.3	How Can We Extend the Horizons Beyond Carbon?	73
	References	73
4	Water Footprint Assessment in Supply Chains	77
	Arjen Y. Hoekstra	
4.1	Introduction	77
4.2	Footprints, Life Cycle Assessment, and Input-Output Modeling	78
4.2.1	Methods to Trace Natural Resource Use and Pollution over Supply Chains	78
4.2.2	The Water Footprint Concept	82
4.3	Direct and Indirect Water Footprints of Different Sectors of the Economy	86
4.3.1	The Importance of Water Use in the Primary Sector	86
4.3.2	Food and Beverage Products	88
4.3.3	Transport	88
4.4	Challenges	89
4.4.1	The Need to Take a Supply Chain Perspective	89

4.4.2	The Need to Incorporate Temporal and Spatial Variability in Water Footprint Assessment	90
4.4.3	Measuring and Reporting	92
4.4.4	Water Stewardship and Transparency	93
4.5	The Need to Establish WF Benchmarks	94
4.6	Water Footprint Reduction Goals and Possible Trade-Offs	94
4.7	Conclusion	95
	References	95

Part II Operational Aspects of Sustainable Supply Chains

5	Green Logistics	101
	Edgar E. Blanco and Yossi Sheffi	
5.1	Introduction	101
5.2	The Environmental Impact of Logistics	103
5.2.1	GHG Emissions	103
5.2.1.1	Activity-Based Calculations	105
5.2.1.1.1	Distance-Based	105
5.2.1.1.2	Weight-Distance-Based	106
5.2.1.2	Mode-Specific Adjustments	110
5.2.1.2.1	Rail	110
5.2.1.2.2	Waterborne Navigation	110
5.2.1.2.3	Aviation	111
5.2.1.3	Carbon Footprint Calculations in Transportation: A Primer	112
5.2.1.3.1	Air Transport	113
5.2.1.3.2	Road Transport	113
5.2.1.3.3	Rail Transport	114
5.2.1.3.4	Water Transport	115
5.2.2	Pollution	115
5.2.2.1	Air Pollution	115
5.2.2.2	Water Pollution	118
5.2.3	Noise and Vibration	120
5.2.4	Packaging Waste	120
5.3	Measuring Green Logistics Impacts	121
5.3.1	GHG Emission Measurement in Logistics	122
5.3.2	GHG Standards and Scopes	123
5.3.3	GHG Allocation	124
5.3.4	GHG Metric Trade-Offs	126
5.4	Green Logistics Strategies	126
5.4.1	Network Design	129
5.4.2	Vehicle Routing	130
5.5	Case Studies: Implementing Green Logistics Strategies	133
5.5.1	Customer Collaboration: OfficeMax and Boise, Inc.	134

5.5.2	Competitor Collaboration: Ocean Spray and Tropicana.....	135
5.5.3	Supplier Collaboration: Caterpillar and Part Suppliers ...	136
5.5.4	The EPA SmartWay Program	137
5.5.4.1	History.....	137
5.5.4.2	Program Structure.....	138
5.5.4.3	Impact	139
5.6	Beyond Green Logistics	139
	References.....	140
6	Green Inventory Management	143
	Johan Marklund and Peter Berling	
6.1	Introduction.....	143
6.1.1	Costs and Emissions Associated with Ordering Items	145
6.1.2	Costs and Emissions Associated with Holding Items in Stock.....	146
6.1.3	Costs and Emissions Associated with Not Satisfying Customer Demand on Time	147
6.1.4	Challenges in Green Inventory Management.....	149
6.2	Green Inventory Management Under Deterministic Demand.....	151
6.2.1	The EOQ Model with Environmental Considerations	151
6.2.2	Extensions of the EOQ Model	156
6.2.3	Deterministic Multi-echelon Models with Environmental Considerations	157
6.3	Green Inventory Management Under Stochastic Demand	159
6.3.1	Single-Echelon Models for Green Inventory Management	159
6.3.1.1	Newsvendor Models with Environmental Considerations.....	159
6.3.1.2	Multi-period Models with Environmental Considerations.....	164
6.3.2	Stochastic Multi-echelon Models with Environmental Considerations	169
6.4	Concluding Remarks About Findings, Practical Implications, and What Remains to Be Done.....	173
	References.....	174
7	Green Network Design and Facility Location	179
	Josué C. Velázquez-Martínez and Jan C. Fransoo	
7.1	Introduction.....	179
7.1.1	Facility Location and Carbon Emissions	180
7.1.2	Trade-Off Between Cost and Carbon Emissions in the Facility Location	182
7.2	Green Facility Location Models	184
7.2.1	Traditional Facility Location Models	184
7.2.2	Carbon Emissions in Facility Location Models	186

7.2.2.1	Analytical and Continuous Models	187
7.2.2.2	Discrete Models	188
7.3	Practical Implications of the Green Location Models	190
7.4	Directions for Future Work	191
	References	192
8	Operational Implications of Environmental Regulation	195
	Ximin (Natalie) Huang and Atalay Atasu	
8.1	Introduction and Motivation	195
8.2	Background on Environmental Regulation	196
8.3	Trash or Treasure?	198
8.4	End-of-Life or Used Product Recycling?	200
8.5	Durability or Recyclability?	202
8.6	Durable or Consumable Products?	203
8.7	Collective or Individual Producer Responsibility?	205
8.8	The Individual System or the Network?	209
8.9	Product Design or Recycling Process Improvements?	211
8.10	Local Regulation or Global Goals?	213
8.11	Conclusion: The Devil in the Details	214
	References	216
9	Food Loss, Food Waste, and Sustainability in Food Supply Chains	219
	Renzo Akkerman and Frans Cuijssen	
9.1	Introduction	219
9.2	Distinguishing Food Loss and Food Waste	223
9.3	Drivers of Food Loss and Food Waste	224
9.3.1	General Classification of FLW Drivers	224
9.3.2	Primary Production	224
9.3.3	Distribution/Consolidation	226
9.3.4	Processing	226
9.3.5	Distribution/Wholesale	227
9.3.6	Retail	228
9.3.7	Foodservice	228
9.3.8	Consumer	229
9.4	Reduction and Reuse of Food Loss and Food Waste	230
9.4.1	Reduce and Reuse Hierarchies	230
9.4.2	Food Loss and Food Waste Reduction and Reuse Strategies	231
9.4.3	Food Loss and Food Waste in Relation to Food Security	235
9.5	Conclusions	236
	References	237

10	Demand Management for Sustainable Supply Chain Operations	241
	Niels Agatz and Moritz Fleischmann	
10.1	Introduction	241
10.2	Environmental Impact of Customer Demand	243
10.2.1	Source	245
10.2.2	Make	246
10.2.3	Deliver	247
10.2.4	Return	248
10.3	Sustainability-Oriented Demand Management	249
10.3.1	Demand Management Levers	249
10.3.2	Models for Sustainability-Oriented Demand Management	251
10.4	Conclusions	256
	References	257
 Part III Business Models and Strategy in Sustainable Supply Chains		
11	Supply Chain Collaboration for Sustainability	263
	Tarkan Tan, Yann Bouchery, and Joerg Hofstetter	
11.1	Introduction	263
11.1.1	From If to How	263
11.1.2	A Focus on Internal Improvements Is No Longer Adequate	264
11.1.3	Collaboration via Industry Initiatives	264
11.1.4	The Way to Hell Is Paved with Good Intentions	265
11.1.5	Supply Chain Collaboration	265
11.2	Where to Exert Carbon Abatement Efforts in Eastman's Supply Chain?	266
11.3	Supplier Sustainability Assessment and Improvement at Philips	269
11.4	Improving Sustainability in the Upstream Supply Chain: How Barry Callebaut Influences Sub-supplier Practices	271
11.5	Conclusions	274
	References	277
12	Green Technology Choice for Deep Decarbonization	279
	Anton Ovchinnikov and Jay Mackinnon	
12.1	Introduction: Definition, Motivation, and Structure of the Chapter	279
12.2	Macro-Level Analyses	281
12.2.1	Landscape of Decarbonization	281
12.2.2	Opportunity for Decarbonization: Carbon Arbitrage	283
12.2.3	Cost of Failing to Decarbonize	284
12.3	Decarbonizing Energy	286

12.3.1	Cost of Low/Zero-Carbon Energy Sources Reached Parity with Fossil Fuels	288
12.3.2	Intermittency Is a Major Challenge for Renewables	289
12.3.3	Energy Storage Technologies for Decarbonizing Energy	290
12.4	Decarbonizing Industry	295
12.4.1	Demand-Side Mechanisms	296
12.4.1.1	Consumers' Willingness to Pay More for Decarbonized Products	296
12.4.1.2	Producers' Willingness to Pay for Decarbonized Inputs	298
12.4.2	Supply-Side Mechanisms and Technologies in Main Polluting Industries	300
12.4.2.1	Steel Industry	300
12.4.2.2	Cement Industry	301
12.4.2.3	Carbon Capture and Storage	301
12.4.3	Policy Mechanisms	303
12.4.3.1	Government Incentives and Green Technology Choice Decisions	303
12.4.3.2	Impact of Competition on the Efficacy of Government Incentives for Green Technology Choice Decisions	306
12.5	Conclusions	310
	References	311
13	Business Implications of Sustainability Practices in Supply Chains	317
	Mark Pagell and Zhaohui Wu	
13.1	What Are the Key Questions	317
13.2	What Is Known: The How and Why of Sustainability	318
13.3	Findings and Practical Implications: The Four Trajectories	320
13.3.1	The Wait and See Trajectory: The Average Firm	320
13.4	Conclusions	332
	References	332
14	Moving from a Product-Based Economy to a Service-Based Economy for a More Sustainable Future	335
	Ioannis Bellos, Hang Ren, and Mark Ferguson	
14.1	Introduction	335
14.2	From Products to Services	336
14.2.1	Leaving the "Product Comfort Zone"	337
14.2.2	The Strategy of Servicizing	338
14.3	The Economic and Environmental Impact of Servicizing Models	340
14.3.1	Servicizing: The "Triple-Threat Business Model?"	340

14.3.2	Assessing Business Model Performance Against the Triple Bottom Line	341
14.3.3	Servicizing: Possible Environmental Issues	342
14.4	Implementing a Servicizing Strategy	343
14.4.1	Possible Transition and Implementation Challenges from Adopting Servicizing	343
14.4.2	From an Economy Based on Products to Services and Now, to Collaborative Consumption?	347
14.4.3	Design Tools That Can Facilitate Servicizing	348
14.5	Conclusion	350
	References	351
15	Closed-Loop Supply Chains: A Strategic Overview	355
	James D. Abbey, V. Daniel R. Guide, and Xichen Sun	
15.1	Understanding a Closed-Loop Supply Chain	356
15.1.1	The Core of a Closed-Loop Supply Chain	357
15.1.2	Overview of Closed-Loop Supply Chain Activities	358
15.1.2.1	Examining Closed-Loop Supply Chain Flows	360
15.2	A Framework for Matching Product Design and Core Competencies	362
15.2.1	Quadrant I: Quality, Durability, and Maintainability	364
15.2.2	Quadrant II: Multiple Lifecycle	365
15.2.3	Quadrant III: Single Lifecycle	366
15.2.4	Quadrant IV: Third-Party Reuse	367
15.2.5	Contrasting the Quadrants	368
15.3	Design and Core Competence: One Size Does Not Fit All	369
15.3.1	Vertically Integrated CLSC Strategy	371
15.3.2	Outsourcing CLSC Strategy	371
15.3.3	Hybrid CLSC Strategy	372
15.4	Choosing a Closed-Loop Supply Chain Strategy	372
15.4.1	The Role of Third-Parties Revisited: When and How to Maintain Control	374
15.4.2	Leasing as a Strategy to Facilitate CLSC	375
15.5	Closing the Loop	377
	References	378
16	Toward a Circular Economy: A Guiding Framework for Circular Supply Chain Implementation	379
	Saman Amir, Niloufar Salehi, Malvina Roci, Susanne Sweet, and Amir Rashid	
16.1	Introduction	379
16.2	Background	382
16.2.1	Closing the Loop: Moving Toward Loop Closure by Design or Intention with CSC	382
16.2.2	Supply Chain Frameworks and Circularity	384

16.2.2.1	Frameworks in the Linear Supply Chain Context	385
16.2.2.2	Frameworks in the Closed-Loop Supply Chain (CLSC) Context	386
16.2.2.3	Frameworks in the Circular Supply Chain (CSC) Context	387
16.3	Proposed Framework	388
16.4	Case Studies	391
16.4.1	White Goods Case Company Overview	395
16.4.2	Automotive Case Company Overview	396
16.5	Discussion and Conclusions	397
	References	401
17	Reusable Packaging for B2C Supply Chains	405
	Sandra Transchel, Mahyar Taheri-Bavil-Oliaei, and Moritz Petersen	
17.1	Introduction	405
17.2	Theoretical Foundation	407
17.2.1	Fundamentals of Reusable Packaging	408
17.2.2	Organization of Reusable Packaging Systems	409
17.2.3	Drivers and Challenges of Reusable Packaging Solutions	412
17.3	Reusable (Primary) Packaging in the FMCG Industry	414
17.3.1	Development of Reusable Packaging Systems in FMCG Markets	414
17.3.2	Challenges for Large-Scale Adoption	416
17.4	Reusable Packaging in E-Commerce	417
17.4.1	Factors Influencing the Environmental Benefits	418
17.4.2	Challenges for Large-Scale Adoption	420
17.5	Reusable Packaging in Takeaway Food Systems	421
17.5.1	Regulations and Governance	422
17.5.2	Classification of Reusable Packaging Systems in Takeaway Food Services	423
17.5.3	Cost Structures for Customers and Restaurants	425
17.6	Future Directions of Reusable Packaging in B2C Markets	426
	References	429
18	Sustainable Non-Renewable Materials Management	433
	Vered Blass, Amit Ashkenazy, and Tzruya Calvão Chebach	
18.1	Introduction	433
18.2	Materiality Risks to Firms and National Economies	435
18.2.1	Growing Demand	435
18.2.2	Mining Industry Market Structure	436
18.2.3	Price Instability	436
18.2.4	Geopolitical Constraints	437
18.2.5	Effects of COVID-19	438
18.2.6	Availability of Alternative Supply Through Recycling ...	438

18.2.7	Social-Environmental Impact	439
18.2.8	Criticality Implications	440
18.2.9	How Does Raw Material Extraction Affect Different Sectors of the Economy?	440
18.3	Managing Risks with Material Flow Analysis	442
18.3.1	Introduction to Material Flow Analysis	444
18.3.2	How Can MFA Be Utilized in Strategic and Operational Planning?	444
18.3.2.1	Using MFA to Optimize Production Processes	445
18.3.2.2	Using MFA to Identify and Weigh Pollution Sources	445
18.3.2.3	Using MFA to Analyze Products and Identify Hidden Trade-Offs	446
18.3.2.4	Using MFA to Design a More Efficient and Effective Recycling Scheme	447
18.3.3	How Could Firms Integrate MFA with Cost Analysis?	447
18.4	Building Material Resiliency Through Policy	449
18.4.1	National Assessments	449
18.4.2	National Materiality Strategies	450
18.4.3	National and International Trade Policies	450
18.4.4	National Policies on Circularity	451
18.5	Summary and Key Lessons	452
	References	453
19	Supply Chain Risk and Resilience Management as Enablers for Sustainability	457
	Kirstin Scholten and Mark Stevenson	
19.1	Introduction	457
19.2	Supply Chain Risk Management	459
19.2.1	Risk Identification	459
19.2.2	Risk Assessment and Analysis	463
19.2.3	Risk Management Strategies	464
19.2.4	Risk Monitoring	467
19.3	Supply Chain Resilience	468
19.4	Conclusions	473
	References	474
 Part IV The Social Dimension of Sustainable Supply Chains		
20	Improving Social and Environmental Performance in Global Supply Chains	481
	Barchi Gillai, Hau L. Lee, and Sonali V. Rammohan	
20.1	Introduction: Social and Environmental Problems in Global Supply Chains	481
20.2	Setting Expectations Between Buyers and Suppliers	484

20.3	A Framework for Continuous Improvement: Sense and Response	484
20.4	Sense and Respond Practices	486
20.4.1	Sense	486
20.4.1.1	Traceability	486
20.4.1.2	Visibility	487
20.4.1.3	Monitoring	488
20.4.2	Response	490
20.4.2.1	Reactions to Violations	491
20.4.2.2	Incentives	491
20.4.2.3	Supplier Collaboration and Capacity Building	493
20.4.2.4	Proactive Product and Process Design	494
20.4.2.5	Shared Value: Extended Value Creation and Community Development	494
20.4.2.6	Cascading Responsible Practices to the Extended Supply Network	495
20.4.2.7	Advocacy	495
20.5	Business Benefits of Sustainable Supply Chain Programs and Other Insights	496
20.5.1	Effectiveness of Sense and Response Practices	496
20.5.2	Business Benefits of Sustainable Supply Chain Programs	496
20.5.3	Obstacles to Implementation	498
20.6	Summary	499
	References	500
21	Social Responsibility in Supply Chains	505
	ManMohan S. Sodhi and Christopher S. Tang	
21.1	Introduction	505
21.2	Literature Review	507
21.2.1	Corporate Social Responsibility and Environmental, Social, and Governance	507
21.2.2	Sustainability	508
21.2.3	The Poor, the Bottom of the Pyramid, and Shared Value	509
21.2.4	Stakeholder Resource-Based View	510
21.3	Related Findings and Practical Implications	512
21.3.1	Social Enterprises	513
21.3.2	The Poor as Suppliers	514
21.3.3	The Poor as Distributors	515
21.3.4	Working Capital Lending for the Poor as Suppliers or Distributors	515
21.3.5	Practical Implications for Large Companies	517
21.4	Future Research	518

21.4.1	Developing Case Studies	518
21.4.2	Social Enterprise.....	519
21.4.3	Developing a Better Understanding of the Poor	519
21.4.4	Impact Studies	520
21.4.5	Monitoring Suppliers	520
21.4.6	Understanding the Role of Markets and Government in Improving Social Welfare	521
21.4.7	Improving the Lot of Smallholder Farmers in Developing Countries.....	521
21.4.8	Distribution Models Using the Poor	522
21.4.9	Lending Working Capital to the Poor.....	523
	References	524
22	Cross-Sector Partnerships for Sustainable Supply Chains	529
	J. Balaisyte, M. Besiou, and L. N. Van Wassenhove	
22.1	Introduction.....	529
22.2	Literature Review	531
22.2.1	Partner Selection and Partnership Formation.....	533
22.2.2	Partnership Implementation and Post-Formation Management	534
22.3	Empirical Study: Case Description	536
22.3.1	Case 1: Partnership in Zambia	537
22.3.1.1	Formation of the Partnership	537
22.3.1.2	Evolution of the Partnership.....	538
22.3.1.3	Challenges and Outcomes	539
22.3.2	Case 2: Partnership in Ukraine.....	539
22.3.2.1	Formation of the Partnership	539
22.3.2.2	Evolution of the Partnership.....	540
22.3.2.3	Challenges and Outcomes	540
22.3.3	Case 3: Partnership in Uganda	540
22.3.3.1	Formation of the Partnership	541
22.3.3.2	Evolution of the Partnership.....	541
22.3.3.3	Challenges and Outcomes	542
22.4	Propositions and Research Implications	542
22.4.1	Propositions	543
22.4.2	Research Implications	545
22.5	Conclusions and Practical Implications	546
	References	548
	Index	551