

Index

Table of Contents

Table of Contents i

List of Figuresvii

Executive summary 1

1 Introduction to smart buildings 3

 1.1 Introduction 3

 1.1.1 Definitions and brief history of commercial building automation 4

 1.1.2 From building automation to smart buildings 6

 1.1.3 Smart buildings are an integral part of smart cities 9

 1.2 Types of commercial building automation 10

 1.2.1 HVAC and energy management systems 10

 1.2.2 Lighting and window control systems 11

 1.2.3 Fire safety, security and access control 12

 1.2.4 Elevator and escalator management 13

 1.2.5 Audio, video and entertainment 14

 1.2.6 Water management 14

 1.2.7 Other types of building automation 15

 1.2.8 Building management systems 17

 1.3 Building automation market segments 20

 1.3.1 Government buildings 20

 1.3.2 Healthcare buildings and hospitals 20

 1.3.3 Hospitality buildings and hotels 21

 1.3.4 Office buildings 21

 1.3.5 Production buildings and factories 22

 1.3.6 Retail outlets 22

 1.3.7 Commercial building stock by region 23

 1.3.8 New buildings versus existing buildings 26

 1.4 Macro trends 26

 1.4.1 Global population growth and urbanisation 26

1.4.2	Sustainability	30
1.4.3	Increasing energy demands	31
1.5	Market drivers	32
1.5.1	Energy consumption of commercial buildings	32
1.5.2	Optimising energy consumption in commercial buildings	35
1.5.3	The next frontier – zero energy buildings.....	35
1.5.4	Operational efficiency.....	36
1.5.5	Occupancy comfort and productivity.....	38
1.5.6	Space optimisation.....	40
1.5.7	Regulations and standards	40
1.5.8	Grants, loans, rebates and deductions.....	41
1.6	Technology drivers	42
1.6.1	Big data and data analytics.....	43
1.6.2	Cloud and edge computing	44
1.6.3	Deep learning and artificial intelligence	44
1.6.4	Wireless connectivity.....	44
1.7	Market barriers.....	45
1.7.1	Lack of clarity on return on investment.....	45
1.7.2	Competitive markets versus oligopolies	46
1.7.3	Proprietary solutions and lack of interoperability.....	47
1.7.4	Security and privacy concerns.....	47
1.8	Industry consortiums, certifications and standards	48
2	Networks and communications technologies	57
2.1	Overview	57
2.1.1	Integration in building automation	57
2.1.2	Approaches to establishing interoperability.....	58
2.1.3	Network protocols and topologies.....	58
2.1.4	Technology choices of product OEMs	60
2.1.5	Combine IT networks and building automation networks or keep them apart?.	62
2.2	Building automation protocols	62
2.2.1	BACnet	63
2.2.2	DALI	64

- 2.2.3 KNX..... 64
- 2.2.4 LonWorks 65
- 2.2.5 M-Bus 66
- 2.2.6 Modbus 66
- 2.2.7 OpenTherm 67
- 2.2.8 SNMP 68
- 2.3 Networking technologies..... 69
 - 2.3.1 Bluetooth 69
 - 2.3.2 EnOcean..... 70
 - 2.3.3 Li-Fi..... 71
 - 2.3.4 LPWAN 71
 - 2.3.5 Power over Ethernet..... 72
 - 2.3.6 Thread 73
 - 2.3.7 Wi-Fi..... 74
 - 2.3.8 ZigBee 75
 - 2.3.9 Z-Wave 76
- 2.4 Wireless versus wired communications 77
- 3 Technology providers and OEMs..... 81
 - 3.1 Market overview..... 81
 - 3.2 HVAC and energy management 81
 - 3.2.1 75F..... 82
 - 3.2.2 Autani 84
 - 3.2.3 Automated Logic (Carrier)..... 85
 - 3.2.4 BuildingIQ..... 87
 - 3.2.5 Cimetrics 89
 - 3.2.6 Danfoss 90
 - 3.2.7 Delta Controls (Delta Electronics)..... 92
 - 3.2.8 Distech Controls (Acuity Brands) 93
 - 3.2.9 Entouch Controls 94
 - 3.2.10 KMC Controls 95
 - 3.2.11 KGS Buildings 96
 - 3.2.12 Lynxspring 97

3.2.13	Regin	98
3.2.14	Senseware.....	99
3.2.15	Telkonet.....	101
3.2.16	Verdigris Technologies.....	102
3.3	Lighting and window control	103
3.3.1	Acuity Brands	104
3.3.2	Cree Lighting (IDEAL Industries).....	105
3.3.3	Digital Lumens (Osram)	106
3.3.4	Enlighted (Siemens).....	106
3.3.5	Legrand	107
3.3.6	Leviton	109
3.3.7	Lutron Electronics	110
3.3.8	Silvair	111
3.3.9	Signify.....	112
3.3.10	Somfy	115
3.3.11	View	117
3.4	Fire safety, security and access control	118
3.4.1	AMAG Technology (G4S).....	118
3.4.2	Assa Abloy.....	120
3.4.3	Axis Communications (Canon)	122
3.4.4	Carrier	123
3.4.5	Motorola Solutions	125
3.4.6	Nortek Security & Control	127
3.4.7	Tyco (Johnson Controls).....	128
3.4.8	Zaplox.....	129
3.5	Elevator and escalator management	130
3.5.1	KONE.....	130
3.5.2	Otis	132
3.5.3	Schindler	134
3.5.4	ThyssenKrupp	136
3.6	Audio, video and entertainment	138
3.6.1	AMX/Harman (Samsung)	138

- 3.6.2 Crestron Electronics 140
- 3.6.3 Elan Home Systems (Nortek Security & Control) 142
- 3.6.4 Extron 143
- 3.7 Water management 144
 - 3.7.1 Apana 144
 - 3.7.2 Banyan Water 146
 - 3.7.3 Hydropoint Data Systems 147
- 4 Building management system and application vendors 149
 - 4.1 Market overview 149
 - 4.1.1 Go-to-market strategies 149
 - 4.1.2 Return-on-Investment 151
 - 4.2 Building management system vendors 152
 - 4.2.1 ABB 153
 - 4.2.2 Bosch 154
 - 4.2.3 Honeywell 156
 - 4.2.4 Johnson Controls 157
 - 4.2.5 Kieback&Peter 160
 - 4.2.6 Sauter 161
 - 4.2.7 Schneider Electric 163
 - 4.2.8 Siemens 165
 - 4.3 Building automation application providers 167
 - 4.3.1 bGrid 167
 - 4.3.2 Facilio 168
 - 4.3.3 J2 Innovations (Siemens) 169
 - 4.3.4 Metrikus 170
 - 4.3.5 SkyFoundry 171
 - 4.3.6 Switch Automation 173
- 5 Market forecasts and conclusions 175
 - 5.1 Market trends and analysis 175
 - 5.1.1 Market penetration of building automation 176
 - 5.1.2 New value proposition for building occupants 178
 - 5.1.3 The covid-19 pandemic creates opportunities for new building applications .. 179

5.1.4	BloT enables integration of different building functions	179
5.1.5	The impact of 5G on the building automation market	180
5.1.6	Regional differences continue to be important	180
5.1.7	Building automation systems increasingly being targeted for cyberattacks	182
5.1.8	When is the right time for building owners to engage?	182
5.1.9	Mergers and acquisitions	183
5.2	Europe	188
5.2.1	Shipments	188
5.2.2	Installed base	189
5.3	North America.....	190
5.3.1	Shipments	191
5.3.2	Installed base	191
5.4	Rest of World outlook	192
5.5	Cellular IoT device shipments and connections	194
	Glossary	197

Index

List of Figures

Figure 1.1: Schematic overview of building automation 4

Figure 1.2: Building automation timeline 6

Figure 1.3: Benefits of smart buildings 8

Figure 1.4: The Distech Controls Eclypse HVAC controller 11

Figure 1.5: Signify Interact gateway, sensor and lamps 12

Figure 1.6: Examples of a fire protection system and a video surveillance system 13

Figure 1.7: Overview of Building Management System (BMS) architecture 18

Figure 1.8: Commercial building stock (US 2017) 23

Figure 1.9: Commercial building stock (EU28+2 2017) 24

Figure 1.10: Commercial building types in EU28+2 25

Figure 1.11: Global population growth segmented by continent (World 2019–2100) 27

Figure 1.12: Urban population, % of total (World 1960–2018) 28

Figure 1.13: Number of major cities worldwide 28

Figure 1.14: Countries with the largest number of major cities (World 2018) 29

Figure 1.15: Energy consumption by commercial building type (USA 2012) 33

Figure 1.16: Energy use in US commercial buildings by end uses (USA 2012) 34

Figure 1.17: Building size vs energy used (USA 2012) 34

Figure 1.18: Total Cost of Ownership of a building 36

Figure 1.19: Building lifecycle cost over 40 years, including costs of retrofit 37

Figure 1.20: Environmental factors that enhance employee productivity 39

Figure 1.21: Pendulum shift in expertise required to run buildings 43

Figure 2.1: Building protocols market share (North America 2019) 59

Figure 2.2: Building protocols market share (Europe 2019) 60

Figure 2.3: Examples of technology choices by product OEMs 61

Figure 2.4: Comparison of wired vs. wireless for building automation 78

Figure 3.1: The 75F Central Control unit and Smart Node 83

Figure 3.2: The WebCTRL interface 86

Figure 3.3: 5i Intelligent Energy Platform 88

Figure 3.4: The NovoCon digital actuator on top of the AB-QM 4.0 PICV	91
Figure 3.5: The Entouch dashboard	95
Figure 3.6: The KMC Commander IoT platform.....	96
Figure 3.7: Senseware devices	100
Figure 3.8: An example of a Telkonet EcoSmart installation	102
Figure 3.9: Signify Interact	114
Figure 3.10: Animeo range overview.....	116
Figure 3.11: The Kidde Fire Systems IntelliSite Remote Monitoring System	124
Figure 3.12: Avigilon H4 Multisensor camera featuring self-learning video analytics	126
Figure 3.13: ThyssenKrupp’s MAX portal.....	137
Figure 3.14: The AMX Enova DVX-3266-4K presentation switcher.....	139
Figure 3.15: The Crestron Flex MM tabletop video conferencing system	141
Figure 3.16: Apana sensor	145
Figure 3.17: Banyan Water’s water management system	146
Figure 4.1: Building Management System vendors (North America and Europe 2019)	152
Figure 4.2: Metasys system architecture	158
Figure 4.3: The Metasys UI on different devices.....	159
Figure 4.4: The Qanteon BMS.....	161
Figure 4.5: The Sauter Modulo 6.....	162
Figure 4.6: Example of an EcoStruxure Building architecture	164
Figure 4.7: Siemens’ Desigo building automation system and components.....	166
Figure 4.8: The Switch Platform dashboard.....	173
Figure 5.1: BA shipments, installed base and revenues (Europe and NA 2019–2024).....	176
Figure 5.2: M&As in the building automation space (World 2004–2018)	185
Figure 5.3: M&As in the building automation space (World 2018–2020)	186
Figure 5.4: Connected system shipments by application area (EU28+2 2019–2024)	189
Figure 5.5: Installed base by application area (EU28+2 2019–2024)	190
Figure 5.6: Connected system shipments by application area (N. America 2019–2024) ..	191
Figure 5.7: Installed base by application area (North America 2019–2024).....	192
Figure 5.8: Cellular connections (Europe and North America 2019–2024).....	195