

Table of contents

EXECUTIVE SUMMARY	11
STRUCTURE OF THE SURVEY.....	16
1. OVERVIEW OF UNDERGROUND GAS STORAGE	18
Current capacity	18
A sustained growth	18
Three main markets	18
Depleted fields still dominate.....	19
Historical development of UGS capacity in the world	21
Panorama of UGS facilities in the world	22
2. FUTURE STORAGE NEEDS	25
WORLD	25
Global gas demand prospects: high global growth and contrasted regional development	25
Global storage trends: a sustained growth by 2030 driven by Asia and the Middle East.....	26
Storage projects.....	29
NORTH AMERICA	34
Major supply and demand trends.....	34
Main trends in future storage.....	34
Challenges.....	36
Adequacy of storage needs with planned projects.....	36
EUROPE	37
Major supply and demand trends.....	37
Main European storage trends	39
Future storage needs and projects	43
Current and future challenges.....	47
CIS	48
Major supply and demand trends.....	48
Main storage trends and prospects	48
Future storage needs and projects	50
ASIA-OCEANIA	51
Major supply and demand trends.....	51
Main storage trends and prospects	52
MIDDLE EAST	56
Gas market and storage trends	56
CENTRAL AND SOUTH AMERICA	56
Gas market and storage trends	56
3. CHINA: THE BIRTH OF A GIANT STORAGE MARKET	59
Chinese gas market	59
UGS is still in its infancy.....	61
Storage development lags behind gas consumption and transportation trends	61
12th Five-Year Plan: ambitious development	62
New UGS capacities driven by increasing demand and security of supply.....	64
UGS may total 75 bcm in 2030, i.e. 12% of world capacity	65
Challenges ahead and proposed reforms	65
4. EUROPE: CHALLENGING TIMES FOR GAS STORAGE OPERATORS AND DEVELOPERS	67
European gas storage market in 2013	67
Fast development of salt cavern storage	68

Contrasted European situations	69
A new regulatory landscape	70
A more competitive European storage business	70
A transparent storage market	71
Evolution of storage products and services toward more flexibility	71
Development of a secondary market for storage capacity	72
Unfavorable gas market conditions	72
A negative impact on storage operators, developers and security of supply	74
Falling storage usage	74
Significant drop in storage products prices	76
Cancellation of new projects	76
Implications for security of supply	77
Way forward	79
5. GAZPROM'S STORAGE STRATEGY IN EUROPE	80
Gazprom's interests in the EU	80
Gazprom storage expansion in Europe	82
Gazprom rises to fourth in European gas storage league	84
Regulatory regime	85
Unbundling of transmission and trading activities	85
Legal regime applied to Gazprom's UGS	85
Asset swaps with Wintershall	85
Gazprom's storage strategy and objectives	86
ANNEX 1: Gazprom involvement in European storage	88
6. USA: SHALE GAS SPURS A NEW WAVE OF SALT CAVERN STORAGE DEVELOPMENT	91
A fast growth in salt cavern storage	91
A trend driven by growing shale production, trading and demand by the power sector	93
A trend dominated by the Producing region	95
An expected continued growth in salt cavern storage	96
7. THE DIFFERENT TYPES OF UNDERGROUND GAS STORAGE	99
Depleted field reservoirs	101
Aquifer reservoirs	101
Salt caverns	102
Abandoned mines	103
Rock caverns	103
Lined rock caverns (LRC)	103
Unlined rock caverns	104
LNG caverns	104
Technological improvements in UGS	105
New technologies	106
Compressed Air Energy Storage (CAES)	106
Carbon Capture Storage (CCS)	107
Hydrogen storage (H ₂)	107
ANNEX 2: Storage terminology and definitions	109
8. THE ROLE OF UNDERGROUND GAS STORAGE	111
The operational functions of underground gas storage	111
Adjusting supply and demand	111
Balancing needs and optimization of the overall transmission network	112
Strategic storage for supply security	113

The commercial role of underground gas storage	114
Price arbitrage: seasonal and flex spreads	114
The key role of storage at market hubs	115
New services	116
Independent storage owners/new entrants	117
Gas grid balancing	117
Managing long-term contracts ToP obligations	118
Optimization of production	118
Upcoming role: support to intermittent power supply	118
Different roles according to market development	119
Alternatives to gas storage: the different flexibility tools	119
Flexibility in gas production and imports: 'swing' gas	120
LNG tanks and Flexible LNG	120
Short-term market trading	121
Peak shaving units	121
Linepack and low pressure storage	121
Customer interruptible contracts/fuel switching	122
Different choice of flexibility tools	122
ANNEX 3: New commercial storage products/services	123
Europe	123
Hub services in the United States	125
9. ECONOMIC ASPECTS OF UNDERGROUND GAS STORAGE	127
Storage costs	127
Storage costs vary according to each single site	127
Overall costs	128
Capital costs	128
Operating costs	131
Main parameters influencing unit costs	131
Range of investment costs by type of storage	132
Investment costs of recent/planned storage projects	135
Expansion costs are much lower	135
The value of storage	136
Cost-based (cost of service) valuation	136
Least cost planning	137
Seasonal valuation or intrinsic value	137
Option-based valuation (extrinsic value)	138
10. REGULATORY ASPECTS	140
CANADA	140
UNITED STATES	140
The Federal Energy Regulatory Commission's role in UGS	140
Market deregulation	141
Impact of FERC Order 636	141
FERC Order 678	141
EUROPE	142
Main steps in European gas storage legislative process	143
The Third Energy Package	144
Unbundling (art. 15)	147
Guidelines of Good Practice for Storage System Operators (GGPSSOs)	149
Security of supply, Regulation 994/2010/EC	149
Strategic storage	150

Gas Target Model (GTM), 2012.....	152
ANNEX 4: Guidelines for Good TPA Practice for Storage System Operators, CAM and CMP for storage, as amended in 2011	154
11. NORTH AMERICA.....	158
CANADA	158
Overview of gas storage in Canada	159
Storage projects	163
UNITED STATES.....	165
Overview of UGS in the US	167
Historical development of UGS facilities in the United States	168
Regional distribution and role of storage	169
Current storage activity	172
Storage operators in the US	174
Storage projects	175
12. CENTRAL AND SOUTH AMERICA.....	178
ARGENTINA	178
Overview of gas storage in Argentina	178
MEXICO	180
Overview of gas storage in Mexico	181
13. EUROPE	184
ALBANIA	184
Overview of gas storage in Albania.....	184
AUSTRIA	185
Overview of gas storage in Austria	185
Storage projects	186
Legal framework and access to storage	188
BELGIUM	190
Overview of gas storage in Belgium.....	191
Legal framework and access to storage	192
BOSNIA.....	195
Overview of UGS in Bosnia	195
BULGARIA.....	196
Overview of UGS in Bulgaria.....	196
Storage projects	196
Legal framework and access to storage	197
CROATIA	198
Overview of gas storage in Croatia	198
Storage projects	198
Legal framework and access to storage	200
CZECH REPUBLIC.....	201
Overview of gas storage in the Czech Republic	201
Storage projects	202
Legal framework and storage access	204
DENMARK.....	205
Overview of gas storage in Denmark	205
Storage projects	206
Legal framework and access to storage	207
FRANCE.....	209
Overview of gas storage in France	210

Storage projects	211
Legal framework and storage access	213
GERMANY	216
Overview of gas storage in Germany	217
Storage projects	218
Legal framework and access to storage	221
GREECE	224
Overview of gas storage in Greece	224
HUNGARY	225
Overview of gas storage in Hungary	225
Storage projects	227
Legal framework and access to storage	228
IRELAND	230
Overview of gas storage in Ireland.....	230
Storage projects	230
Legal framework and access to storage	233
ITALY	234
Overview of gas storage in Italy.....	235
Storage projects	236
Legal framework and access to storage	239
LATVIA	243
Overview of gas storage in Latvia	243
Legal framework and access to storage	243
LITHUANIA.....	245
Overview of gas storage in Lithuania	245
NETHERLANDS	246
Overview of gas storage in the Netherlands	246
Storage projects	247
Legal framework and storage access	248
POLAND	251
Overview of gas storage in Poland.....	252
Storage projects	253
Legal framework and access to storage	255
PORTUGAL.....	257
Overview of gas storage in Portugal	257
Storage projects.....	257
Legal framework and access to storage	257
ROMANIA	259
Overview of gas storage in Romania.....	259
Storage projects	260
Legal framework and access to storage	261
SERBIA	263
Overview of UGS in Serbia.....	263
Storage projects	264
Legal framework	264
SLOVAK REPUBLIK	266
Overview of UGS in Slovakia.....	266
Storage development.....	267
Legal framework and access to storage	267
SPAIN.....	269

Overview of gas storage in Spain	269
Storage projects	270
Legal framework and access to storage	272
SWEDEN	274
Overview of gas storage in Sweden	274
Legal framework and access to storage	275
TURKEY	276
Overview of UGS in Turkey	276
Storage projects	276
Legal framework	278
UNITED KINGDOM	280
Overview of gas storage in the United Kingdom	281
The role of UGS facilities in winter time	283
Storage projects	284
Legal framework and access to storage	288
14. CIS	291
ARMENIA	291
Overview of gas storage in Armenia	291
AZERBAIJAN	292
Overview of gas storage in Azerbaijan	293
Storage projects	293
BELARUS	295
Overview of UGS in Belarus	295
Storage projects	295
GEORGIA	298
Overview of gas storage in Georgia	298
KAZAKHSTAN	299
Overview of UGS in Kazakhstan	299
KYRGYZSTAN	301
Overview of UGS in Kyrgyzstan	301
RUSSIA	302
Overview of gas storage in Russia	303
Storage projects	303
UKRAINE	308
Overview of UGS in Ukraine	310
Leasing of storage to foreign companies	312
UZBEKISTAN	313
Overview of UGS in Uzbekistan	313
15. MIDDLE EAST	316
IRAN	316
Overview of gas storage in Iran	316
16. ASIA-OCEANIA	319
AUSTRALIA	319
Overview of gas storage in Australia	321
Storage projects	323
CHINA	324
INDIA	324
Overview of gas storage in India	325
JAPAN	325

Overview of gas storage in Japan.....	326
Storage projects.....	326
NEW ZEALAND.....	327
Overview of gas storage in New Zealand	328
PAKISTAN	328
Overview of gas storage in Pakistan	330
SOUTH KOREA	331
Overview of gas storage in South Korea	331
TAIWAN.....	332
Overview of gas storage in Taiwan	332
ACRONYMS AND ABBREVIATIONS	333
MAIN CONVERSIONS	335
LIST OF TABLES, FIGURES, MAPS AND BOXES	336
TABLES.....	336
FIGURES.....	337
MAPS.....	339
BOXES.....	340
REFERENCES	341