

Underground Gas Storage Worldwide data bank

Optimising Underground Gas Storage Capacities

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Venue: World Gas Conference 2012



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Agenda

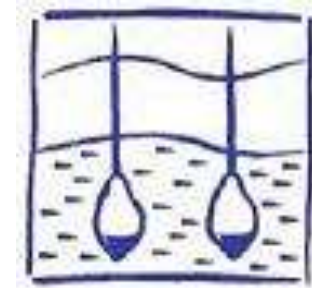
- Scope of UGS basic activity study
- UGS database structure
- UGS World map
- Multi language UGS Glossary
- Analysis
- UGS Records
- Conclusions

List of members

Full name	Country	Note
Joachim Wallbrecht	Germany	
Frederick Metzger	USA	
Remy Champavere	France	
Fabien Favret	France	
Emmanuelle Wicquart	France	
Dmitry Pavlenkov	Russia	
Leif Hansen	Denmark	
Ana Maria Garcia Dominguez	Spain	
Michael Kreuz	Austria	
Eddy Kuperus	Netherlands	Part-time
Ladislav Goryl	Slovakia	Leader
Vladimír Lorenc	Slovakia	
Ding Guosheng	China	
Kangwon Lee	Republic of Korea	
Qing Wang	China	
Rosa Maria Nieto	Spain	
Wieslaw Rokosz	Poland	Part-time
Genta Takagi	Japan	Part-time

Scope of UGS Basic Activity Study

- UGS World Data Bank
 - Porous storages
 - Caverns
- UGS World map
- UGS Glossary
- Trends in UGS business
 - Storage Demand General Trends
 - Storage demand forecast in major regions
 - General, commercial and technological issues
 - New opportunities for storage
 - Database analysis
 - National trends



UGS Database - Structure



UGS World Data Bank - Data actuality 2010/2011

- Storage status (in operation, planned, potential)
- Structure (General data, Contact data, Storage capacity data, Technical data, Horizon data)

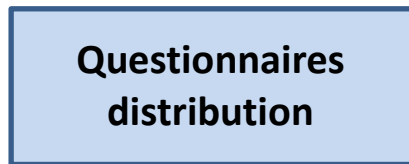
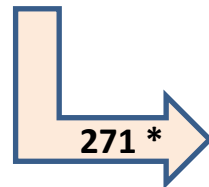
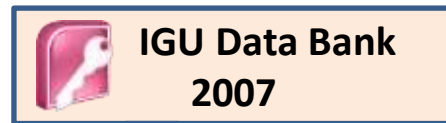


MS Excel tables in Metric and English units

UGS ID	Name of UGS Facility	Region	Nation	State	County	Actuality of	Reference Y	Reference
2229	Bethel	North America	USA	Texas	Anderson	2010	2012	AGA-UGS-Report 2010
2231	Beynes Profond	Europe	France	Yvelines	Yvelines	2010	2012	IGU WOC2, SG2.L, 2012 Study
2232	Beynes Supérieur	Europe	France	Yvelines	Yvelines	2010	2012	IGU WOC2, SG2.L, 2012 Study
2233	Bickford	North America	Canada	Ontario	Lambton	2010	2012	AGA-UGS-Report 2010
2234	Bierkang	Europe	Germany	---	---	2010	2012	IGU WOC2, SG2.L, 2012 Study
2235	Bilcuresti	Europe	Romania	Romania	---	2010	2012	IGU WOC2, SG2.L, 2012 Study
2236	Billy Creek	North America	USA	Wyoming	Johnson	2010	2012	AGA-UGS-Report 2010
2237	Blithesau	North America	USA	Louisiana	Brenville Bossier	2010	2012	AGA-UGS-Report 2010
2238	Black Creek	North America	Canada	Ontario	Lambton	2010	2012	AGA-UGS-Report 2010
2239	Blackhawk	North America	USA	Pennsylvania	Beaver	2010	2012	AGA-UGS-Report 2010
2240	Blue Lake DBA	North America	USA	Michigan	Kalkaska	2010	2012	AGA-UGS-Report 2010
2241	Ekuesater	North America	Canada	Ontario	Lambton	2010	2012	AGA-UGS-Report 2010
2242	Boehm	North America	USA	Kansas	Morton	2010	2012	AGA-UGS-Report 2010
2243	Bogorodchumkoe	CIS	Ukraine	---	---	2010	2012	IGU WOC2, SG2.L, 2012 Study
2244	Bon Harbor	North America	USA	Kentucky	Daviess	2010	2012	AGA-UGS-Report 2010
2245	Bonikowo	Europe	Poland	wielkopolskie	Poland	2010	2012	IGU WOC2, SG2.L, 2012 Study
2246	Boone Mountain	North America	USA	Pennsylvania	Elk, Clearfield	2010	2012	AGA-UGS-Report 2010
2247	Booth Creek	North America	Canada	Ontario	Lambton	2010	2012	AGA-UGS-Report 2010
2248	Borders North	North America	USA	Kansas	Meade	2010	2012	AGA-UGS-Report 2010
2250	Box Elder	North America	USA	Montana	Blaine & Hill	2010	2012	AGA-UGS-Report 2010
2251	Brehm	North America	USA	Kansas	Pratt	2010	2012	AGA-UGS-Report 2010
2252	Breitbrunn/Eggstätt - B + C	Europe	Germany	---	---	2010	2012	IGU WOC2, SG2.L, 2012 Study
2253	Bremen Lesum SWB	Europe	Germany	---	---	2010	2012	LIBES / published data

UGS Database – Data origination

- 117 replies
- 567 storage facilities covered by US member Fred Metzger
- Others complemented from publicly available domain (GSE, websites...)



International Gas Union, Working committee 2: Underground gas storage, Study group 2.1				
The data from the questionnaires may be shared by IGU and UN/ECE. In case you are not allowed to publish all data please fill in at least part of the questionnaire. Please fill in the column "D". In case you want to provide comments or details please use the column "E".				
Gas volumes are related to temperature and pressure at normal conditions: 273,15 K (0°C) and 1,01325 bar				
Parameter	Explanation	Date of previous IGU UGS Survey 2009	Update of Data for IGU UGS Survey 2010	Comments
General Information / Company				
1. Title Name				
2. Last Name				
3. Company		Rohal Aufbauges. AG		
4. Street		Schwabenbergstr. 18		
5. City		Vörs		
6. ZIP		A-1015		
7. Nation		Austria		
8. Tel. No.				
9. E-Mail address				
10. Web site		www.rohal.at		
General Data				
11. UGS ID	UGS ID is a numerical string (limited to a UGS facility, read only, robot).	2954	2956	
12. Name of UGS Facility		Putzkarthen IV-Phase		
13. Extension of existing UGS / Green Field UGS Project	Please select one option	<input type="radio"/> Extension of existing UGS <input checked="" type="radio"/> Green Field UGS Project	<input type="radio"/> Extension of existing UGS <input type="radio"/> Green Field UGS Project	
14. Storage Status	Please select one option	<input type="radio"/> Potential <input type="radio"/> Planned - feasibility phase <input type="radio"/> Planned - design / planning phase <input type="radio"/> Planned - committed / budget approval <input checked="" type="radio"/> Planned - under construction <input type="radio"/> Postponed (Please specify the reason)	<input type="radio"/> Potential <input type="radio"/> Planned - feasibility phase <input type="radio"/> Planned - design / planning phase <input type="radio"/> Planned - committed / budget approval <input type="radio"/> Planned - under construction <input type="radio"/> Postponed (Please specify the reason)	
15. Permitting		<input type="radio"/> All permits granted <input type="radio"/> Under application	<input type="radio"/> All permits granted <input type="radio"/> Under application	

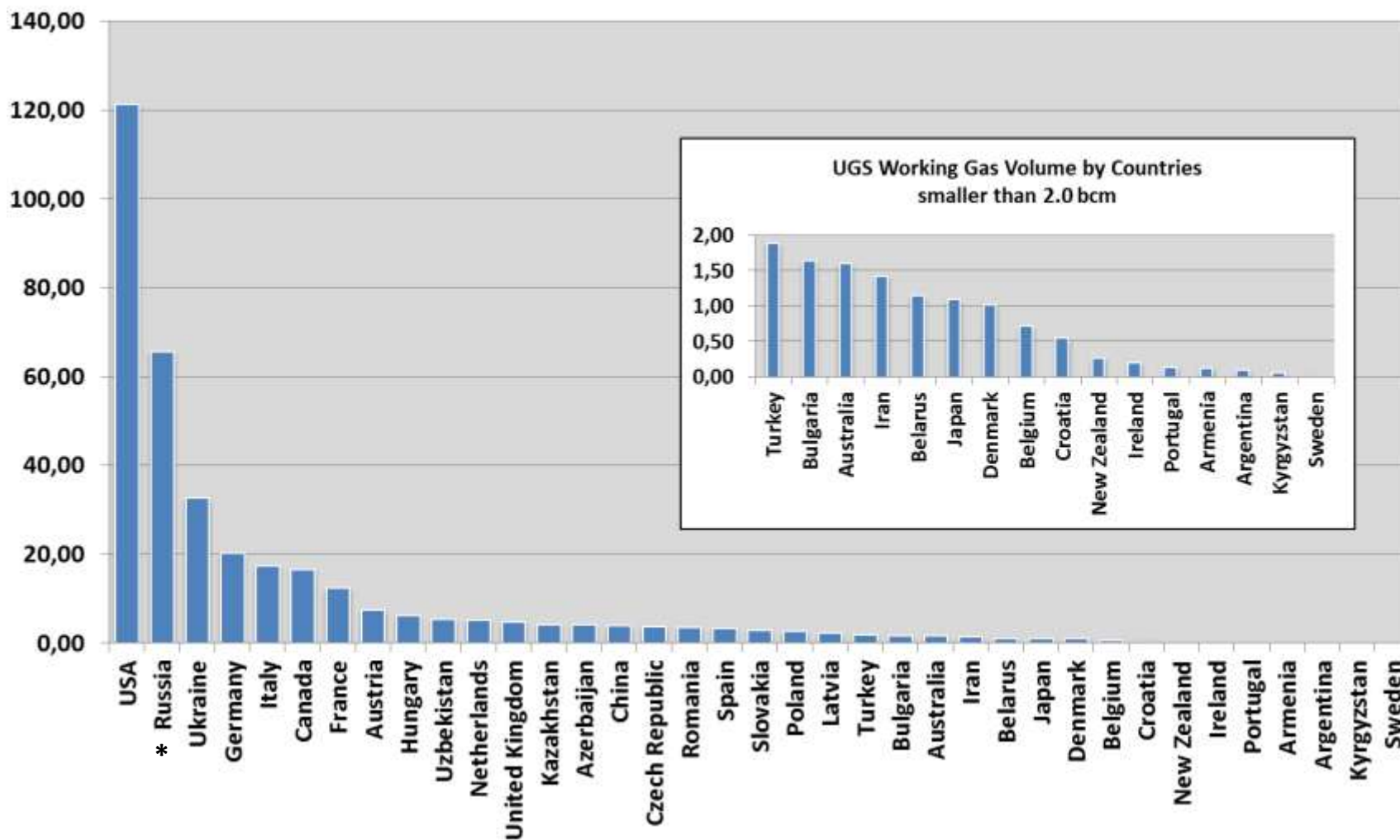
*without data for the North America – supplied separately

UGS Database – Basic figures

World	No. of UGS Facilities 2007	WGV (bcm) 2007	No. of UGS Facilities 2010	WGV (bcm) 2010
UGS in operation*	630	322.5	693	358.8
Planned developments in existing UGS	45	16.7	32	16.1
Planned new (Greenfield) UGS	90	76.8	120	102.5
Potential	4	21.4	31	22.0
Planned and potential developments	139	114.9	183	140.6
Total - UGS in operation and planned	720	414.9	844	499.4

* without 40 bcm long term strategic reserves of Russia

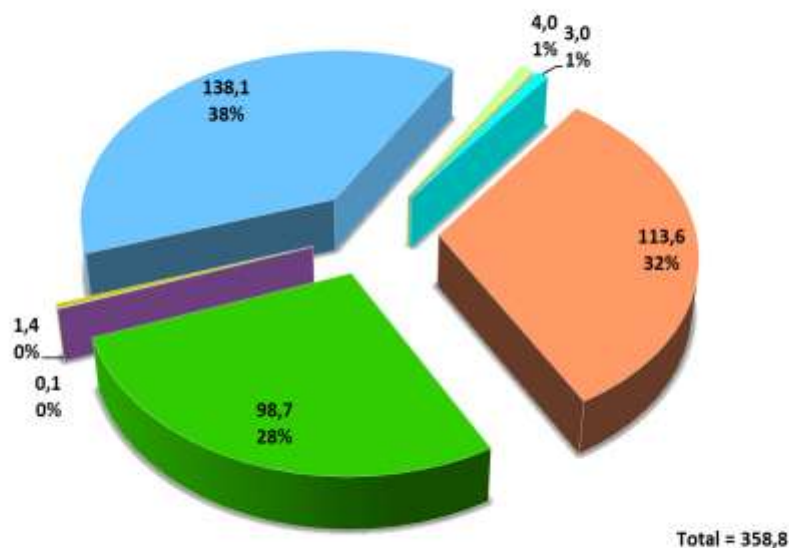
UGS WGV (bcm) distributions by countries



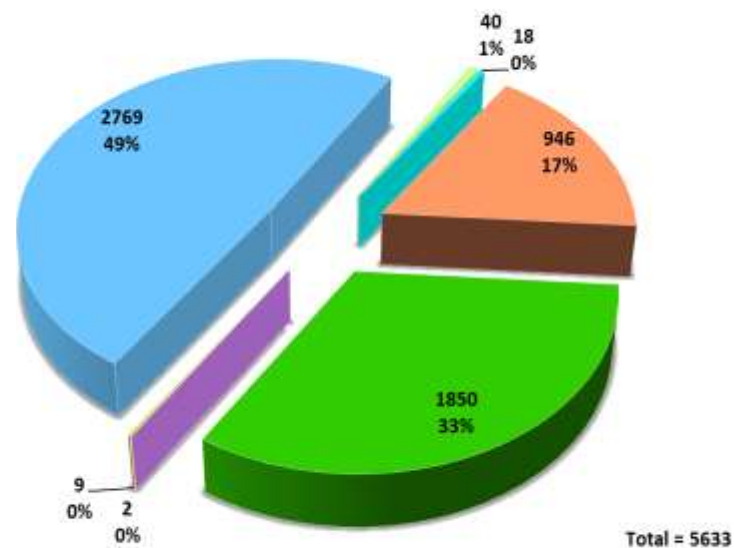
* without 40 bcm long term strategic reserves of Russia

UGS WGV & PWR distributions by regions

Working Gas Volume (bcm)

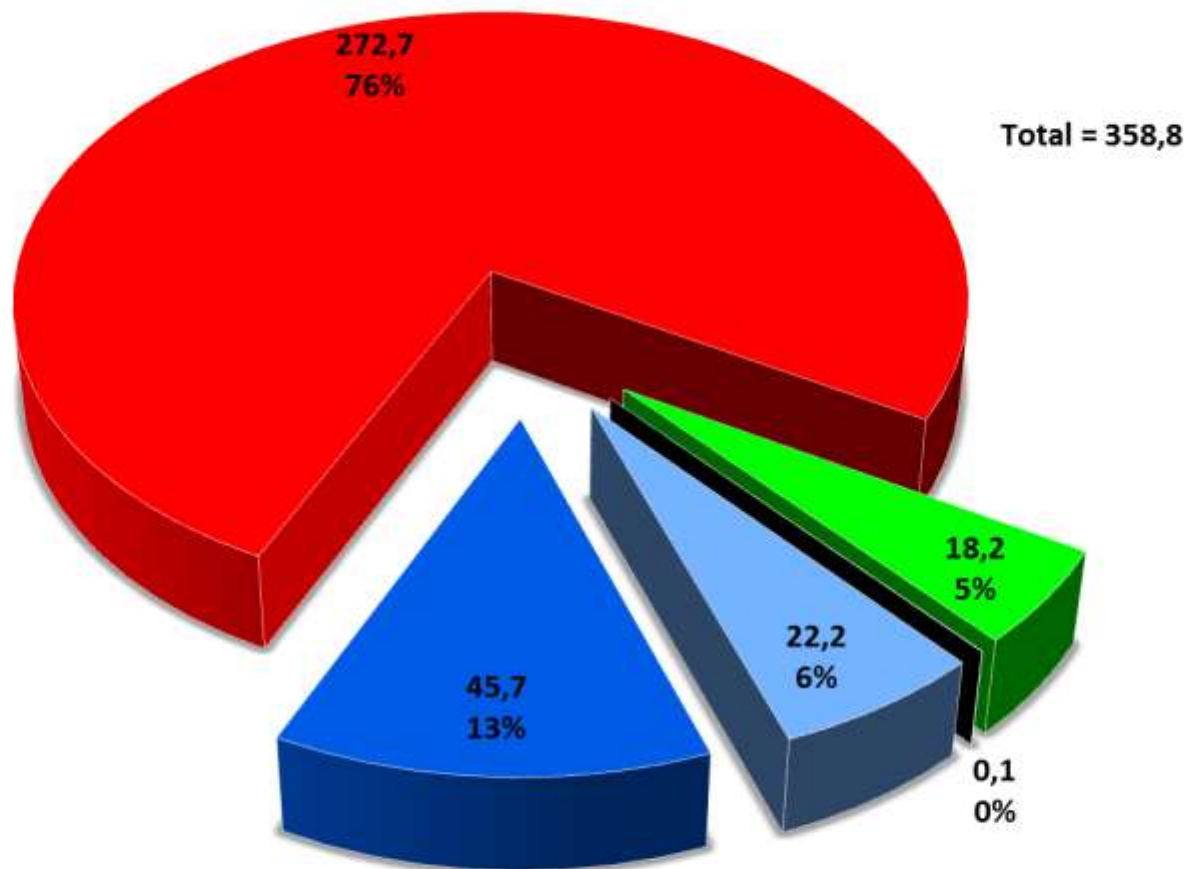


Peak Withdrawal Rate (mcm/d)



■ Asia
 ■ Asia Pacific
 ■ CIS
 ■ Europe
 ■ L.America & Caribbean
 ■ Middle-East
 ■ North America

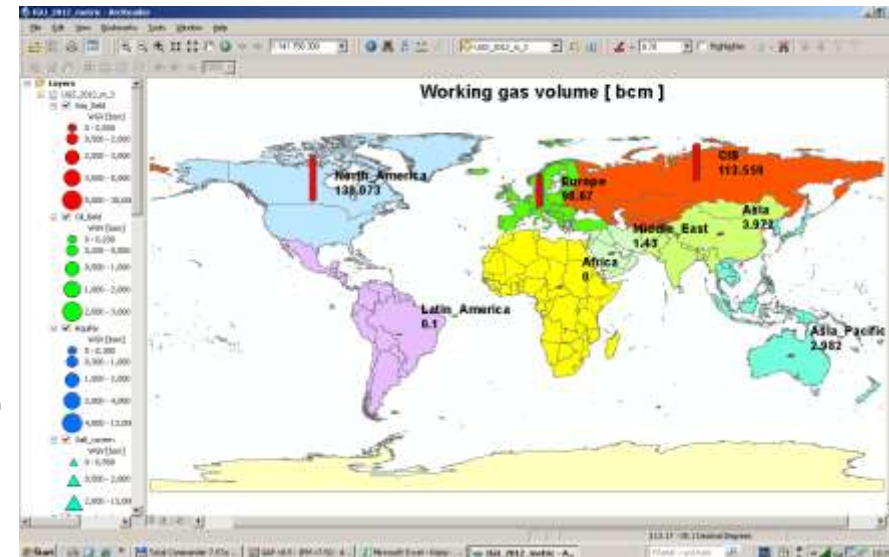
UGS WGV (bcm) distribution by storage types



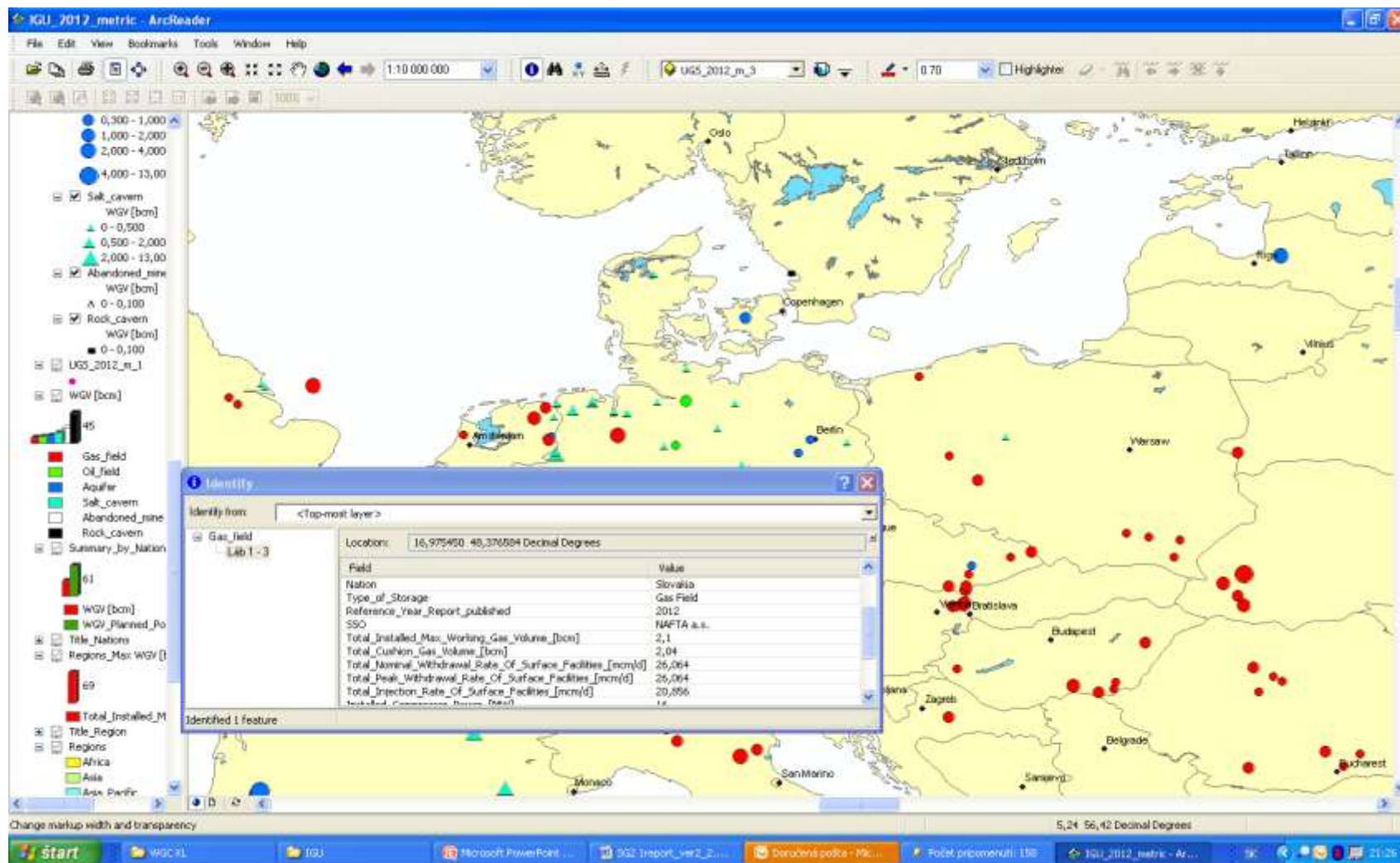
■ Aquifer ■ Gas Field ■ Oil Field ■ Rock Cavern ■ Salt Cavern

UGS World Map

- Geo-referenced visualisation of storage data from UGS Data Bank
 - SI units
 - English units
- Accessible via Arc reader - a part of WGC proceedings
- Several visualisation layers
 - Regional WGV
 - WGV by countries (in operation/planned)
 - WGV by countries (storage types)
 - Storage data



UGS World Map & storage data



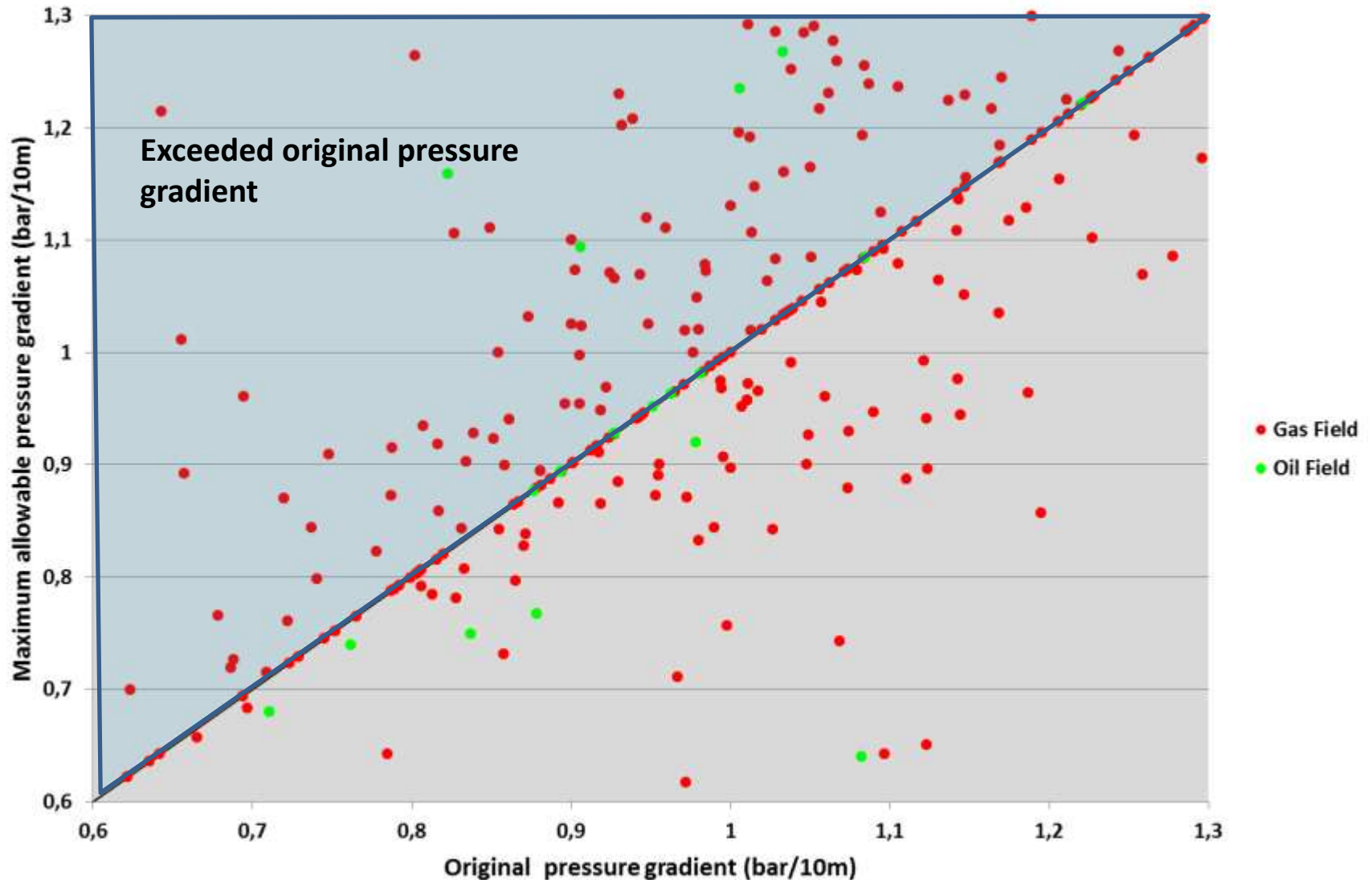
UGS Glossary – Relevant technical terminology

■ Glossary available in 13 different languages:

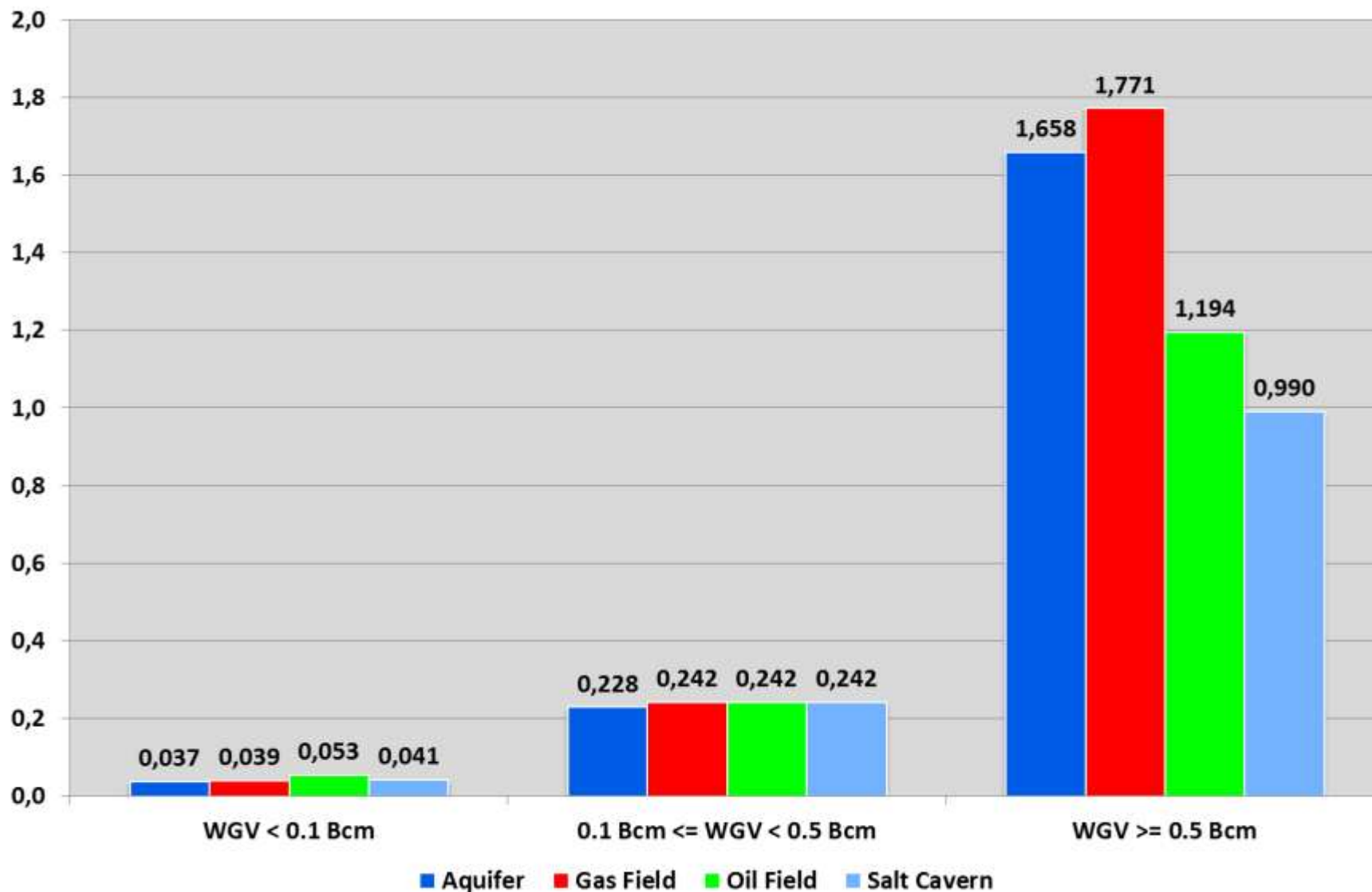
- English
- Russian
- Italian
- Ukrainian
- French
- German
- Japanese
- Danish
- Serbian
- Portuguese
- Slovak
- Czech
- Croatian

UGS Glossary – English	
Glossary of relevant technical Underground Gas Storage Terminology	
Term	Definition
Underground Gas Storage (UGS)	All subsurface and surface facilities required for the storage and for the withdrawal and injection of natural gas. Naturally or artificially developed containments in subsurface geological strata are used for the storage of natural gas. Several subsurface storage horizons or caverns may be connected to one common surface facility. All of this is referred to as the underground gas storage location
Type of Storage	There are several types of underground gas storage facilities, which differ by storage formation and storage mechanism: Pore storage - Storage in aquifers - Storage in former gas fields - Storage in former oil fields Caverns - Storage in salt caverns - Storage in rock caverns (including lined rock caverns) - Storage in abandoned mines
UGS in Operation	Storage facility capable to inject and withdraw gas
Greenfield Storage Project	New underground storage development project, not related to any existing storage facility
Storage Capacity	Total ability of a storage facility to provide working gas volume, withdrawal rate and injection rate
Inventory	Total of working and cushion gas volumes stored in UGS
Cushion Gas Volume (CGV) or Base Gas	Gas volume required in a storage field for reservoir management purpose and to maintain an adequate minimum storage pressure for meeting working gas volume delivery with a required withdrawal profile. In caverns, the cushion gas volume is also required for stability reasons. The cushion gas volume may consist of recoverable and non-recoverable in-situ gas volumes and/or injected gas volumes

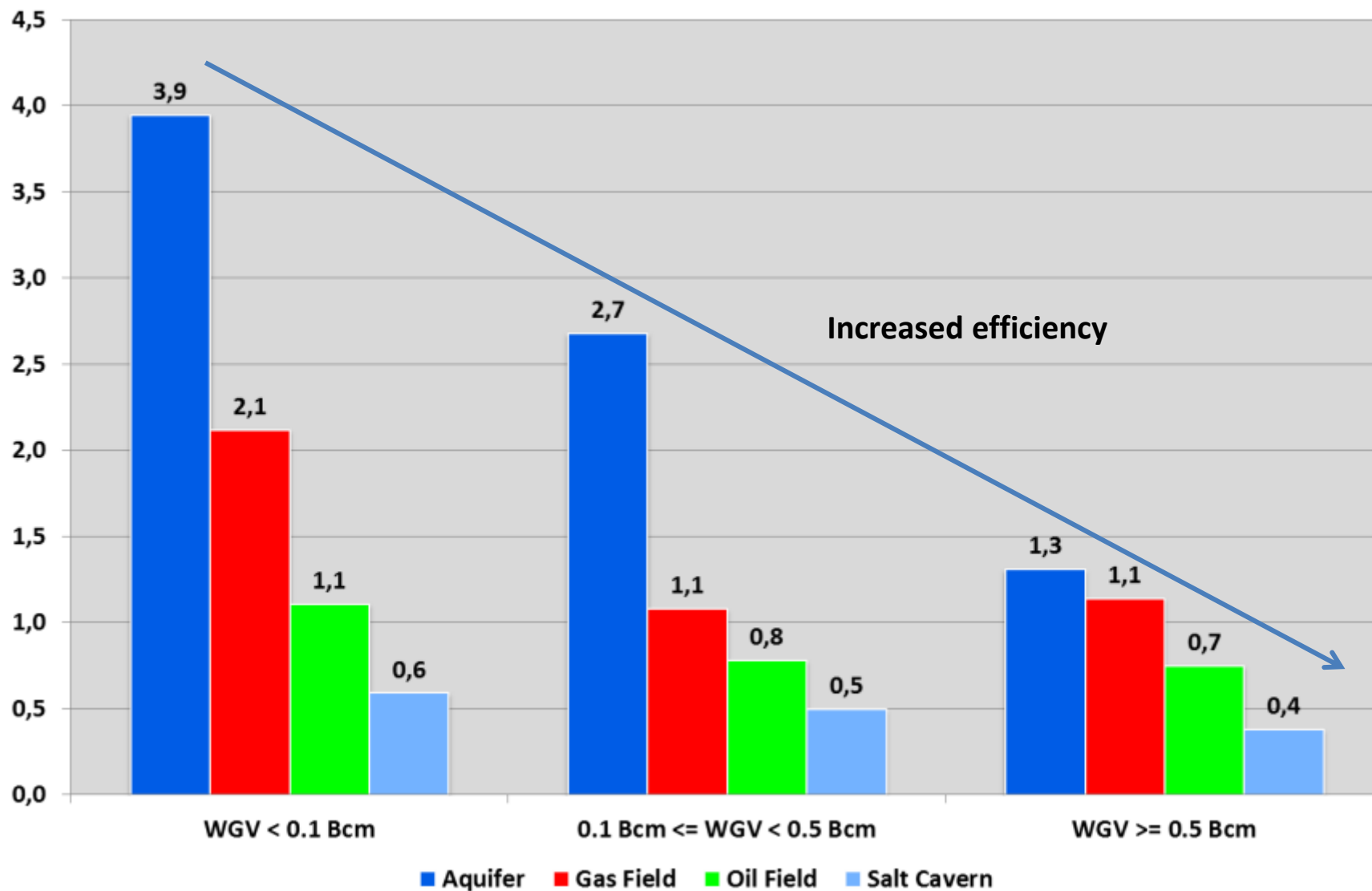
UGS Analysis – Increase of maximum allowable pressure gradient



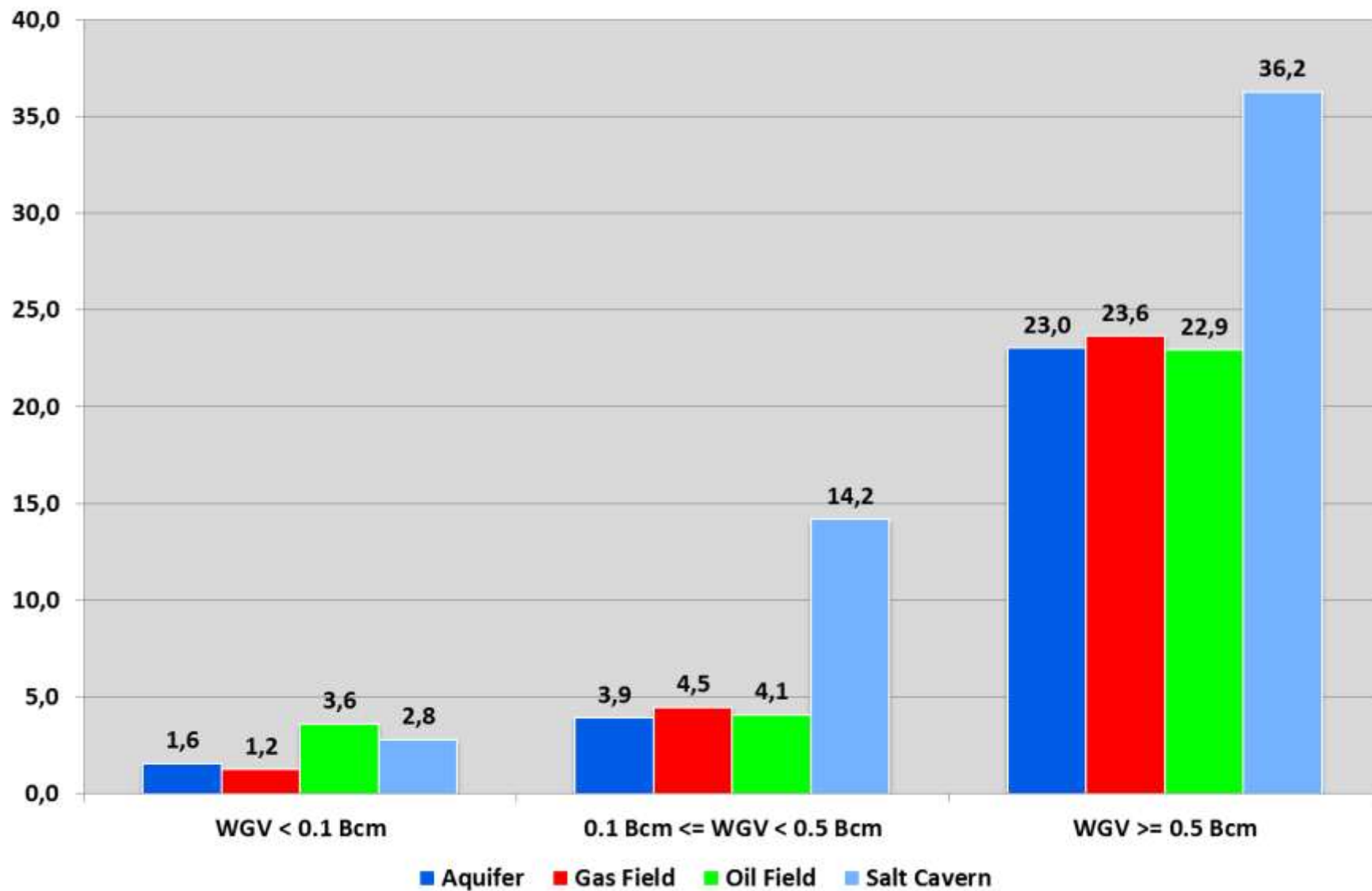
UGS Analysis-Average WGV (bcm)



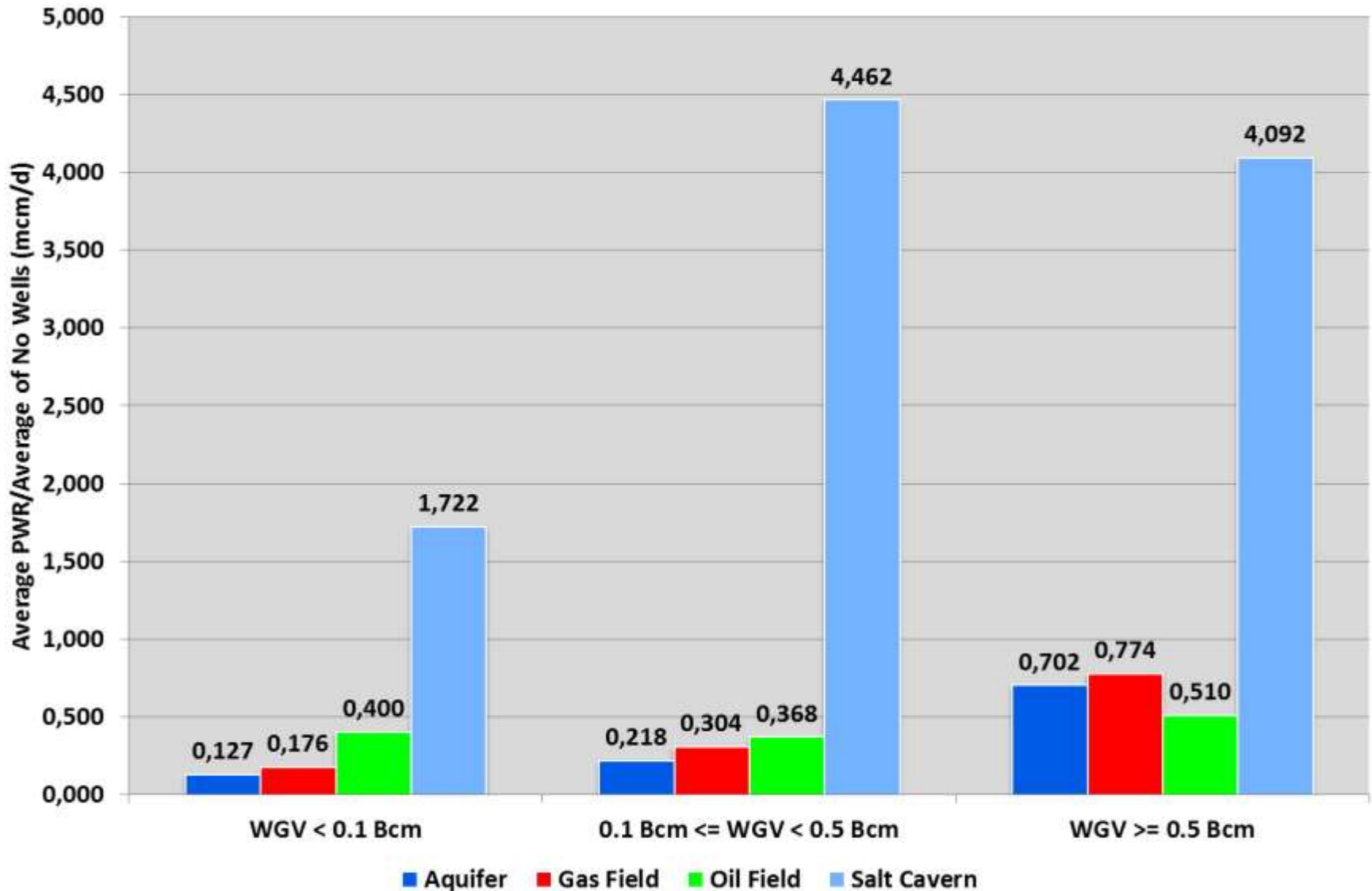
UGS Analysis – CGV/WGV



UGS Analysis-Average PWR (mcm/d)

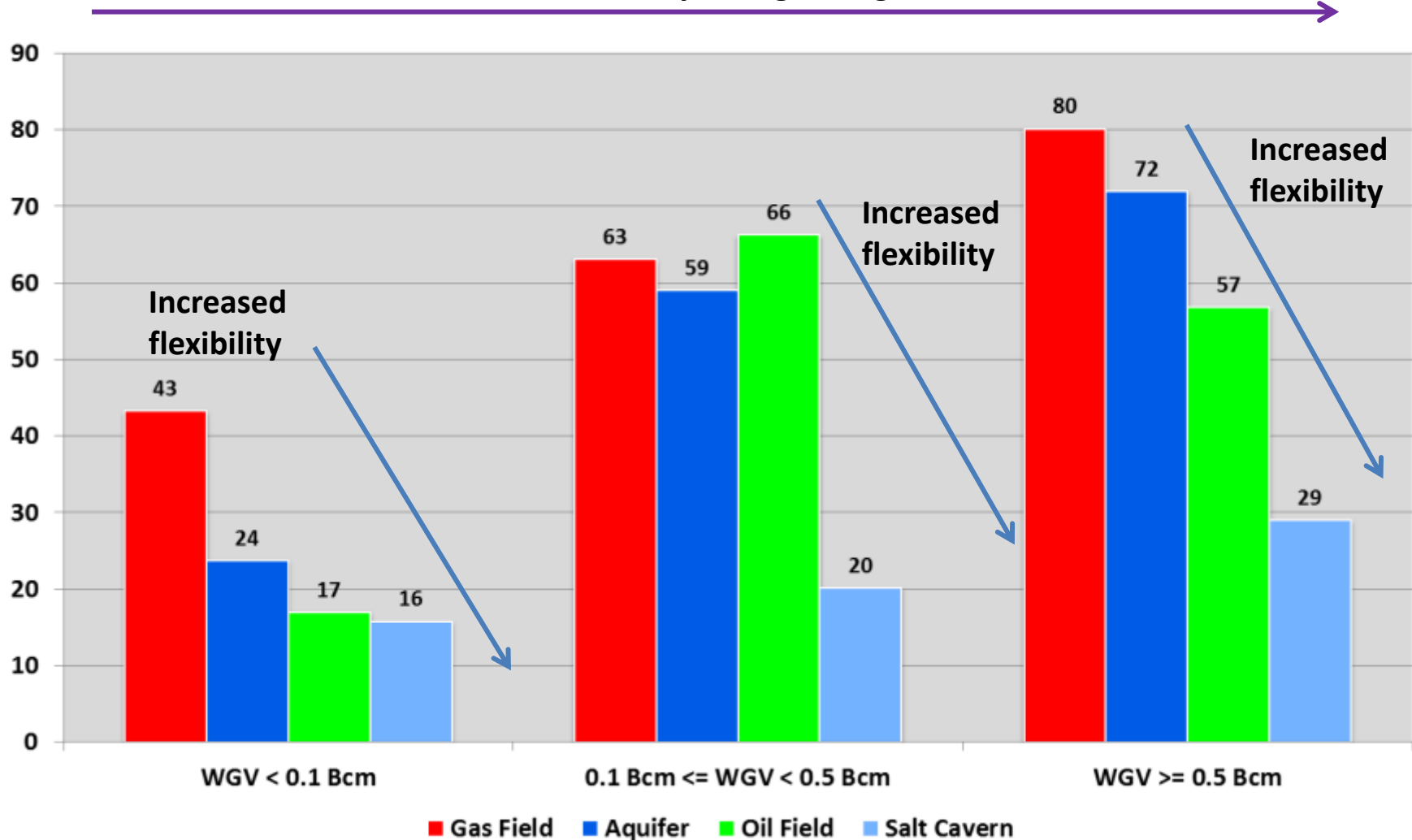


UGS Analysis - Average PWR/Average Number of Storage Wells

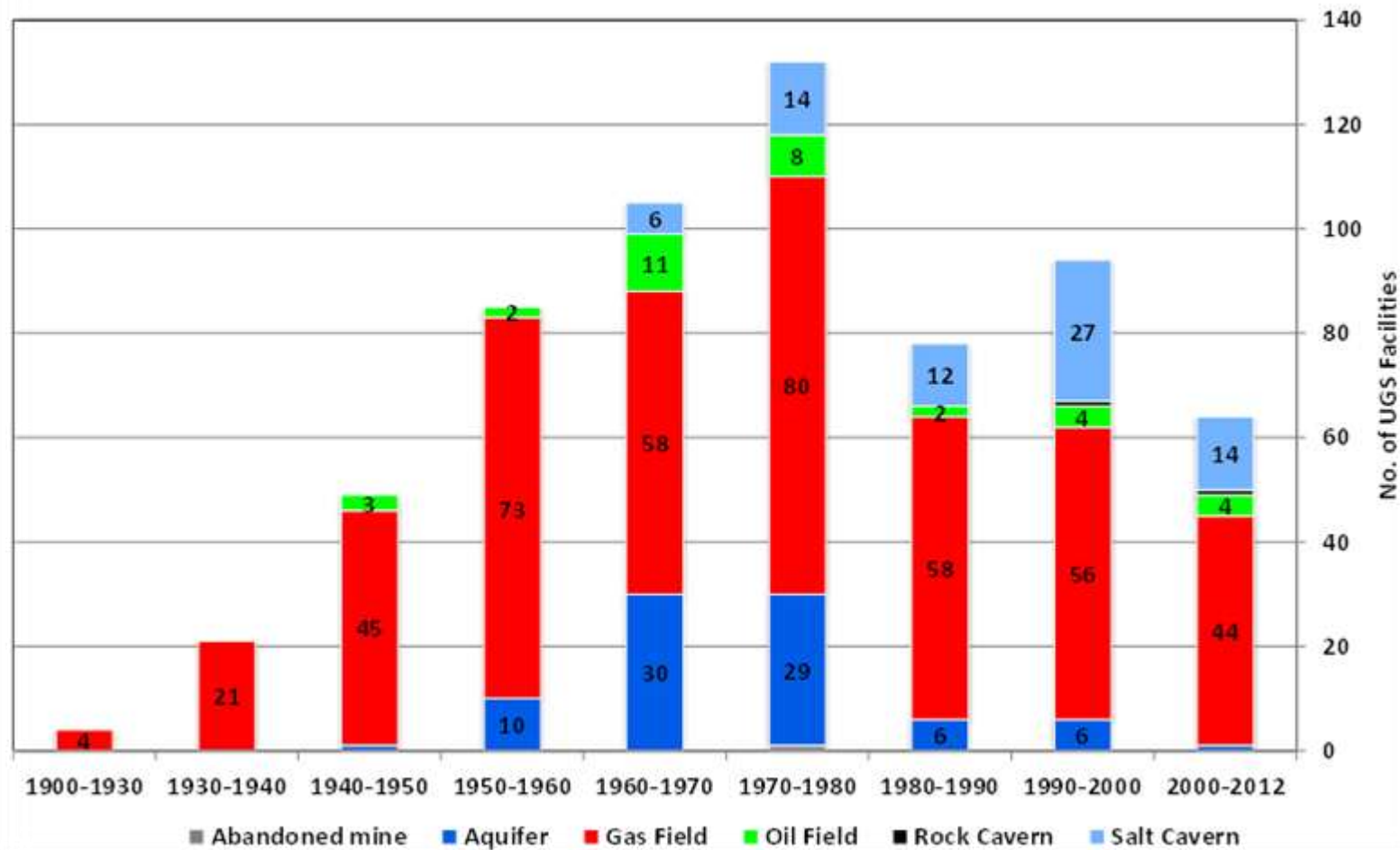


UGS Analysis-Theoretical numbers of days for withdrawal

Decreased flexibility with growing WGV



Age distribution of UGS facilities



UGS Records

	Gas & Oil Fields	Aquifers	Salt Cavern
max. WGV (bcm)	23,8 Severo-Stavropolskoe, RUS	9,0 Kasimovskoe, RUS	2,0 Epe E.ON, GER
max. PWR (mcm/d)	180 Severo-Stavropolskoe, RUS	71 Kasimovskoe, RUS	71 Egan, USA
max. IR (mcm)	148,1 Severo-Stavropolskoe, RUS	56,2 Kasimovskoe, RUS	24,0 Byley/Holford, UK
min. Depth (m)	56 Buffalo, USA	137 Doe Run Upper, USA	193 Yaggy, USA
max. Depth (m)	3 963 Gramma Ridge, USA	2 100 Kalle, GER	1 800 Hornsea(Atwick), UK
min. Pressure gradient (bar/10m)	0,40 Diadema, ARG	1,01 Wilfred, USA	0,97 Regina North, CAN
max. Pressure gradient (bar/10m)	1,70 Midway, USA	1,73 Buchholz, GER	2,11 LI.Torup, DEN
max. No of Storage wells	941 Bilche-Volicko-Ugerskoe, UKR	287 Kasimovskoe, RUS	115 Arcadia, USA
Age of the oldest one (years)	96 Zoar, USA	66 Doe Run Upper, USA	51 Morton 16 Field, USA

- **Storage database represents a unique technical source of data for**
 - Reference document
 - Overview of storage industry & its continual development
 - Analysis

- **Storage data expanded in this triennium**
 - Number of storage facilities as well as categories
 - However; not all the categories filled in as required
 - Planned and potential projects show high volatility

- **Focus in the next triennium**
 - Data expansion especially for new projects
 - Glossary expansion
 - Improvement of co-operation with other bodies (UN ECE, etc.)

Thank you for your attention

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SG 2.1 – Study Group leader

NAFTA a.s.

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Abbreviations

- CGV Cushion Gas Volume
- GSE Gas Storage Europe
- IR Injection Rate
- PWR Peak Withdrawal Rate
- SI metric units
- UGS Underground Gas Storage
- UN ECE United Nations Economic Commission for Europe
- USA (US) United States of America
- WGC World Gas Conference
- WGV Working Gas Volume
- WR Withdrawal Rate