Gas Storage Europe

Introduction GSE

Robert Jan Maaskant, Vice-Executive Secretary

Workshop with DG ENER, 15 July 2015

Gas Storage Europe

About GIE

Gas Infrastructure Europe (GIE) is an European **non-profit lobbying association** representing the sole **interest** of the **infrastructure industry** in the natural gas business

GIE was formally established on 10 March 2005 as a legally independent and non-profit lobbying association with official statutes

GIE has currently **67 members** in **25 European countries**

GIE voices the views of its members vis-à-vis the European institutions, regulators and other stakeholders

GIE mission is to **actively contribute** to the construction of a **single**, **sustainable** and **competitive gas market** in Europe underpinned by a **stable** and **predictable regulatory framework** as well as by a **sound investment climate**


gie
Gas Infrastructure Europe
67 member companies
4 observers
25 countries
Gasum
GASSCO
swede gas
centrica storage
gaslink
EDF
ENERGINET.DK
Shannon LNG (observer)
nationalgrid
Gate terminal
storengy
VNG Gasspeicher
gasunie
Interconnector
energystock
ontras
OPERATOR SISTEMU MAGAZYNOWANIA
GAZ-SYSTEM
SOUTH HOOK
DRAGON LNG
nationalgrid
FLUXYS
Open Grid Europe The Gas Network
RWE
bdew
Dunkerque LNG
creos
INES
NTRAGAS
ENAGÁS
GRTgaz
astora
TAG
OMV
nafta
storengy
elengy
SWISSGAS
GAS CONNECT AUSTRIA
TRANSGAZ
Adriatic LNG
Plinovodi
PSP
reganosa
BBG
TIGF
FOSMAX LNG
EDISON
plinacro
BULGARTRANSGAZ
OLT
REN Armazenagem
REN Atlântico
REN Gasodutos
enagas
GNL ITALIA
SNAM RETE GAS
DESFA
STOGIT

About GIE

GIE is the umbrella organization for its three subdivisions:

Gas Transmission Europe (GTE)

Gas Storage Europe (GSE)

Gas LNG Europe (GLE)

GTE – Gas Transmission Europe
representing Transmission System Operators (TSO)

GSE – Gas Storage Europe
representing Storage System Operators (SSO)

GLE – Gas LNG Europe
representing LNG Terminal System Operators (LSO)


gte
Gas Transmission Europe
30 member companies
25 countries
Gasum
GASSCO
swedegas
ENERGINET.DK
gaslink
nationalgrid
Interconnector
ontras
GAZ-SYSTEM
FLUXYS
Open Grid Europe
The Gas Wheel
creos
eustream
GRTgaz
SWISSGAS
TAG
GAS CONNECT AUSTRIA
TRANSGAZ
Plinovodi
plinacro
BULGARTRANSGAZ
reganosa
TIGF
REN Gasodutos
enagas
SNAM RETE GAS
DESFA


gse
Gas Storage Europe
30 member companies
16 countries
2 observers
centrica storage
nationalgrid
ENERGINET.DK
eDF
energystock
GAZPROM
storengy
VNG Gasspeicher
FLUXYS
RWE
RWE
OPERATOR SYSTEMU MAGAZYNOWANIA
INES
astora
OMV
RAG ENERGY STORAGE
nafta
PSP
storengy
TIGF
EDISON
BULGARTRANSGAZ
REN Armazenagem
enagas
STOGIT


gle lng
Gas LNG Europe
17 member companies
9 countries
1 observer
nationalgrid
Shannon LNG
(observer)
SOUTH HOOK
DRAGONLNG
Gate terminal
FLUXYS
GAZ system
Dunkerque LNG
elengy
reganosa
FOSMAX LNG
Adriatic LNG
OLT
REN Atlântico
BBG
GNL ITALIA
SNAM
enagas
DESFA

GIE officers

GIE President and GIE Board members as of June 2014

Jean-Claude Depail
GIE President
GDF Suez
GIE President is Chairman of the GIE Board and GIE General Assembly

---

GIE Board members

Stephan Kamphues
Open Grid Europe

Jean-Marc Leroy
Storengy

Francisco de la Flor
Enagás

Lubor Veleba
RWE Gas Storage

Gaetano Mazzitelli
Stogit

Nicole Otterberg
E.ON Gas Storage

Wim Groenendijk
Gate Terminal

Torben Brabo
Energinet.dk

Pascal De Buck
Fluxys

Denitsa Beyazova
Bulgartransgaz

Aidan O'Sullivan
Gaslink

GIE staff

GIE Secretariat as of October 2014

Thierry Deschuyteneer
Executive Secretary

Boyana Achovski
Vice-Executive Secretary

Marion Nikodym
Vice-Executive Secretary

Robert Jan Maaskant
Vice-Executive Secretary

Marie-France Engels
Senior Assistant

Marta Wozniak
Junior Assistant

The Secretariat is in charge of the daily management, and facilitates the co-ordination between the Working Groups and other activities on behalf of GIE, GTE, GSE and GLE

The Secretariat is based in:
Avenue de Cortenbergh 100
1000 Brussels
BELGUM
Web : www.gie.eu
mail : gie@gie.eu

GIE Board

Nicole Otterberg, Wim Groenendijk, Gaetano Mazzitelli, Pascal De Buck, Aidan O'Sullivan, Denitsa Beyazova, Stephan Kamphues, Lubor Veleba, Jean-Marc Leroy, Francisco de la Flor, Torben Brabo

GIE General Assembly

Pascal DE BUCK	Angela MARLOVITS	Pieter VAN AARTSEN	Michael SCHMÖLTZER	Christophe POILLION	Christophe BOUVIER
GIE Legal Advisory SG	GIE Security SG	GIE Communication & Strategy TF	GIE Market Rules TF	GIE Security of Supply TF	GIE Investment TF
		Communication Experts sub-TF	Gas Quality sub-TF; Tariff sub-TF; Interoperability sub-TF		

GIE Secretariat

Executive Secretary : Thierry DESCHUYTENEER
Vice Executive Secretary : Boyana ACHOVSKI / Marion NIKODYM / Robert Jan MAASKANT
Assistants : Marie-France ENGELS / Marta WOZNIAK

GTE President
Stephan KAMPHUES

GTE Executive Committee

Denitsa Beyazova, Aidan O'Sullivan, Torben Brabo, Andreas Bolliger

GTE Plenary

Torben BRABO	Aidan O'SULLIVAN
Sustainable Future WG	Investment Climate WG
Denitsa BEYAZOVA, Andreas BOLLIGER	Stephan KAMPHUES
Gas Producers Liaison WG	Communication, Strategy & ENTSOG Liaison WG

WG = Working Group
TF = Task Force
SG = Study Group

GSE President
Nicole OTTERBERG

GSE Executive Committee

Adam Elbæk, Lubor Veleba, Gaetano Mazzitelli, Jean-Marc Leroy, Georg Dorfleutner, László Fritsch

GSE Plenary

Jean-Marc LEROY	Adam Elbæk
Value of Storage WG	Security of Supply WG
Lubor VELEBA	Gaetano MAZZITELLI
Effective Grid Connection WG	Investment WG
Georg DORFLEUTNER	László FRITSCH
New Technologies WG	Transparency WG

GLE President
Wim GROENENDIJK

GLE Executive Committee

Jacques Rottenberg, Francisco de la Flor, Corrado Papa, Pieterjan Renier, Krzysztof Wisniewski

GLE Plenary

Jacques ROTTENBERG	Pieterjan RENIER
Transparency WG	Small scale LNG WG
Corrado PAPA	Krzysztof WISNIEWSKI
Gas Quality WG	Gas Advocacy WG
Francisco DE LA FLOR	
International Organisations Liaison WG	

Gas Storage Europe

GIE activities

	Transmission System Operators	Storage System Operators	LNG Terminal System Operators
Regulatory activities Third-party access, Investments, Transparency…	entsog	gse	gle lng
Policymaking activities 2030 Energy & Climate Framework, Energy Union, Security of Supply, ETS review, Energy Efficiency, CCS, Alternative Fuels for Transport…	gte	gse	gle lng

Gas Storage Europe

GIE Key Messages

Enabling a single European Market

GIE contributes to develop the regulatory framework for natural gas in Europe in a transparent and proactive manner. Our main objective is regulatory stability and predictability; the essential prerequisites for a sound investment climate

Ensuring a backbone for secure supplies

Gas infrastructure is the backbone of the energy supply chain from producer to end-user. Transmission pipelines, storage facilities and LNG regasification terminals are among the physical elements of the gas system which ensure that gas is delivered to customers where and whenever needed

Building the EU energy future

Competition, security of supply and sustainability, main lines of the EU's energy policy. GIE members adhere to the EU energy objectives and continuously pursue technologically advanced solutions to achieve energy policy goals with the highest safety and efficiency

Contributing to a competitive low-carbon European Union

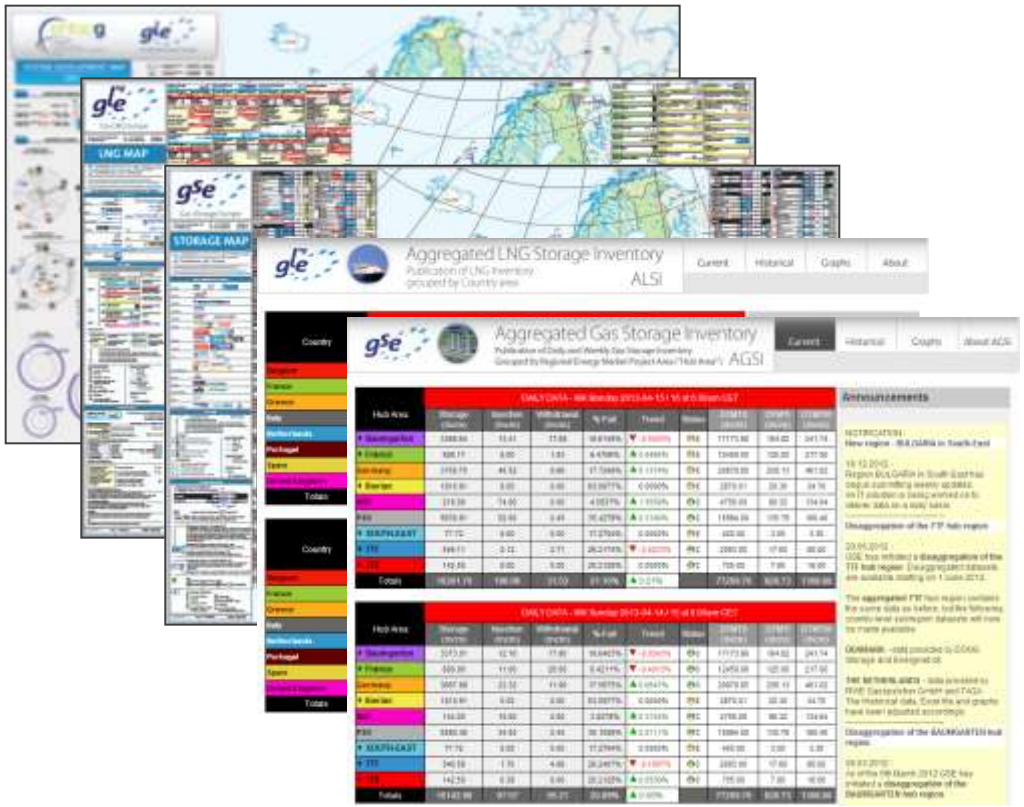
Natural gas has proven to be the cleanest fossil fuel. Gas utilization can reduce CO_2 emissions and therefore to contribute to the "20-20-20" policy. As the past decade has shown, the increased share of natural gas in the European energy mix has led to a significant CO2 reduction in Europe

Gas Storage Europe

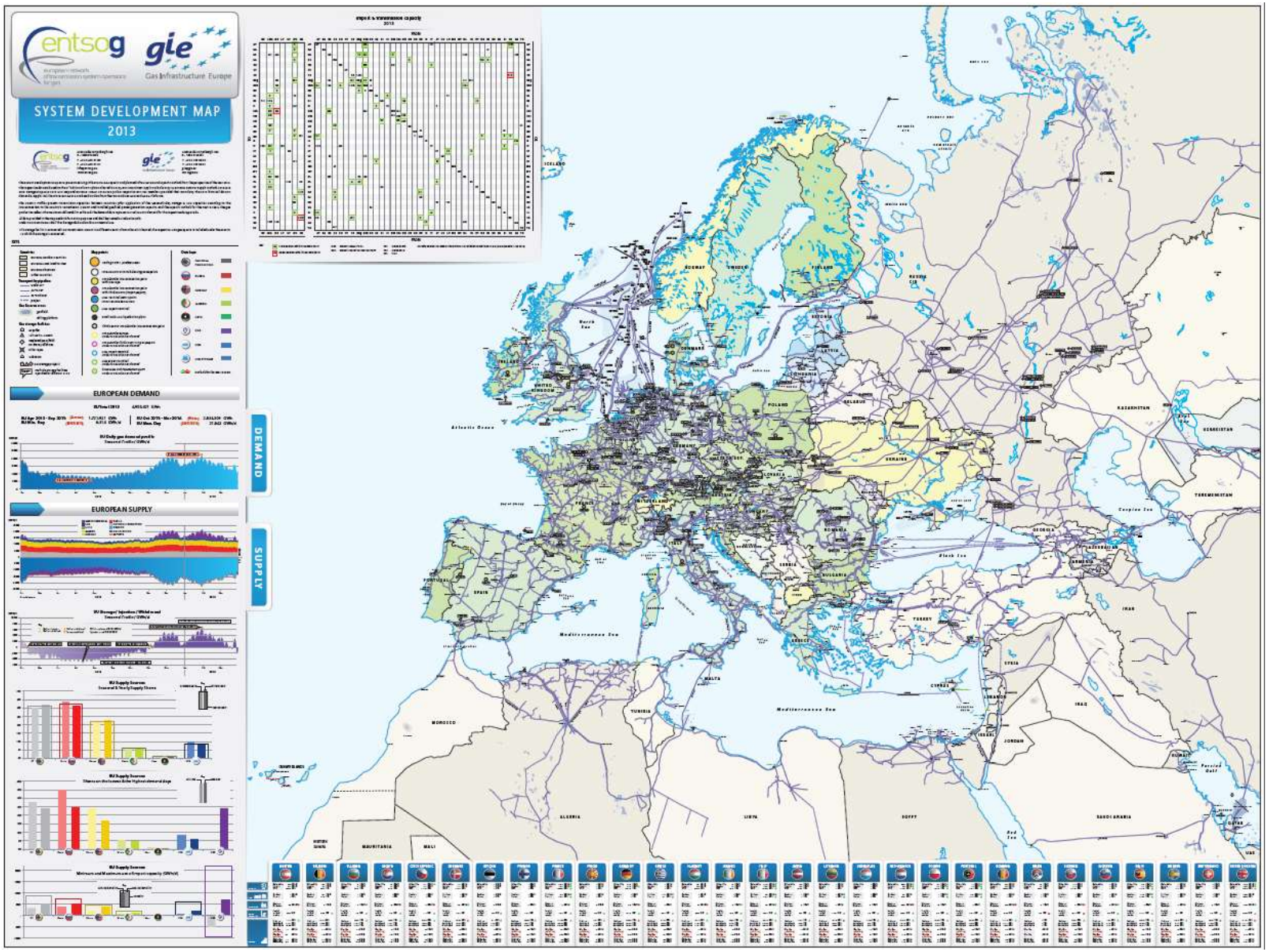
GIE Maps & Data

GIE is regularly publishing Maps & Data and providing Aggregated Inventory data of Storage operators and LNG terminals (AGSI and ALSI)

- SYSTEM DEVELOPMENT MAP
- GTE CAPACITY MAP
- GSE STORAGE MAP
- GSE TRANSPARENCY TEMPLATE
- AGSI+ TRANSPARENCY PLATFORM
- LNG MAP
- LNG INVESTMENT DATABASE
- LNG TERMINALS TRANSPARENCY TEMPLATE
- LNG AGGREGATED INVENTORY (ALSI)
- LNG NEW SERVICES INVENTORY
- SMALL–SCALE LNG MAP

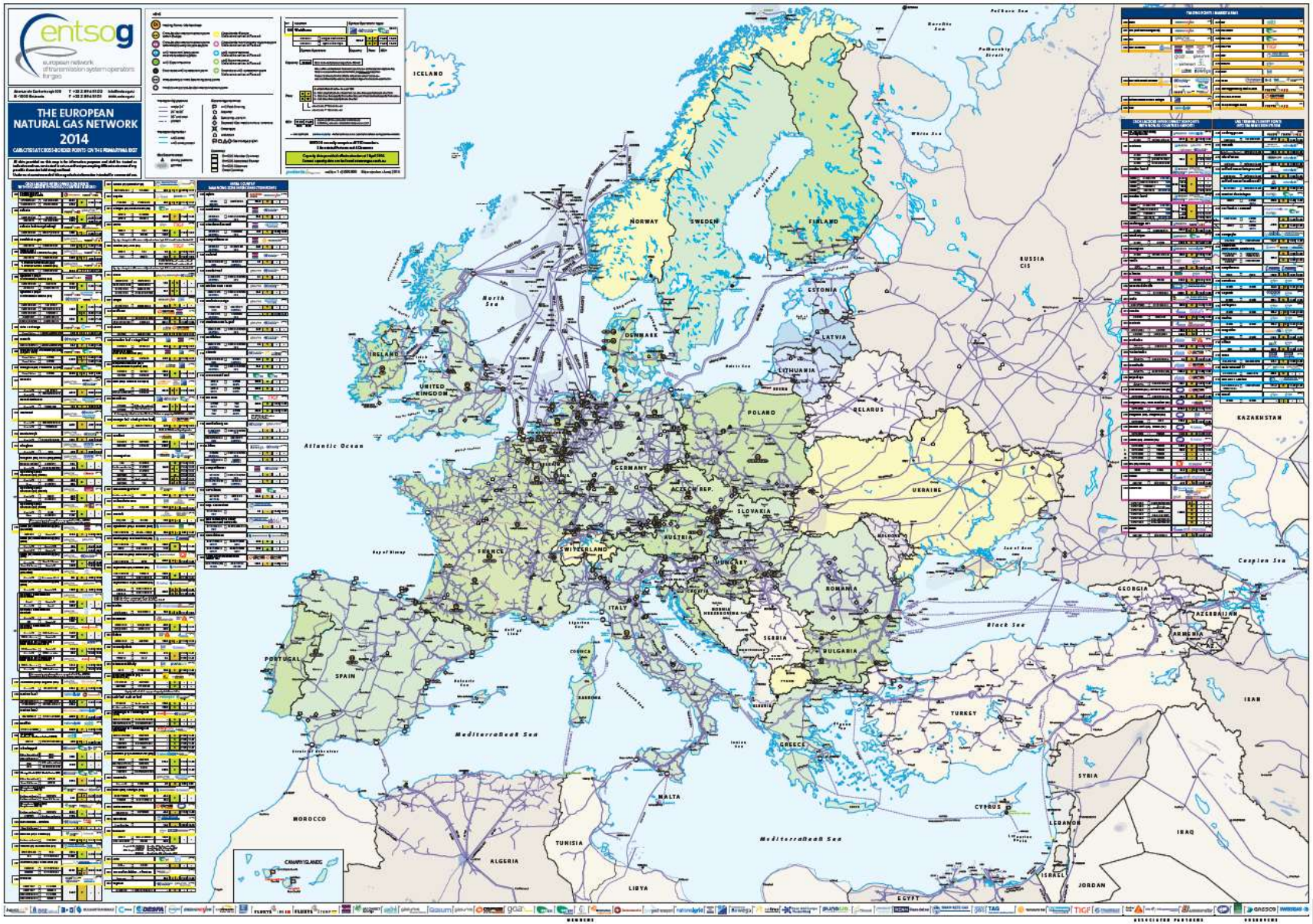


ENTSOG/GIE System Development Map



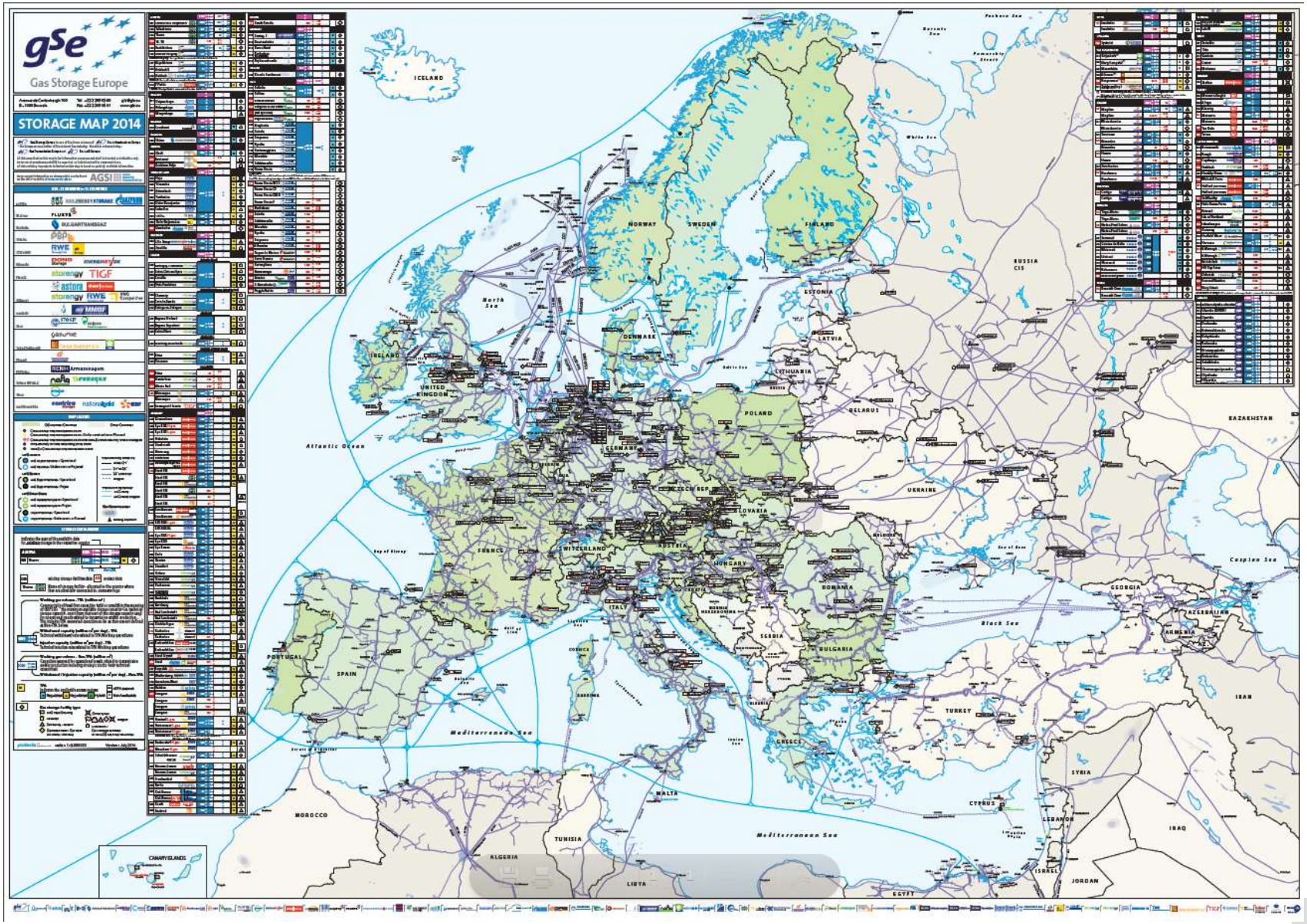
Gas Storage Europe

ENTSOG Network Map



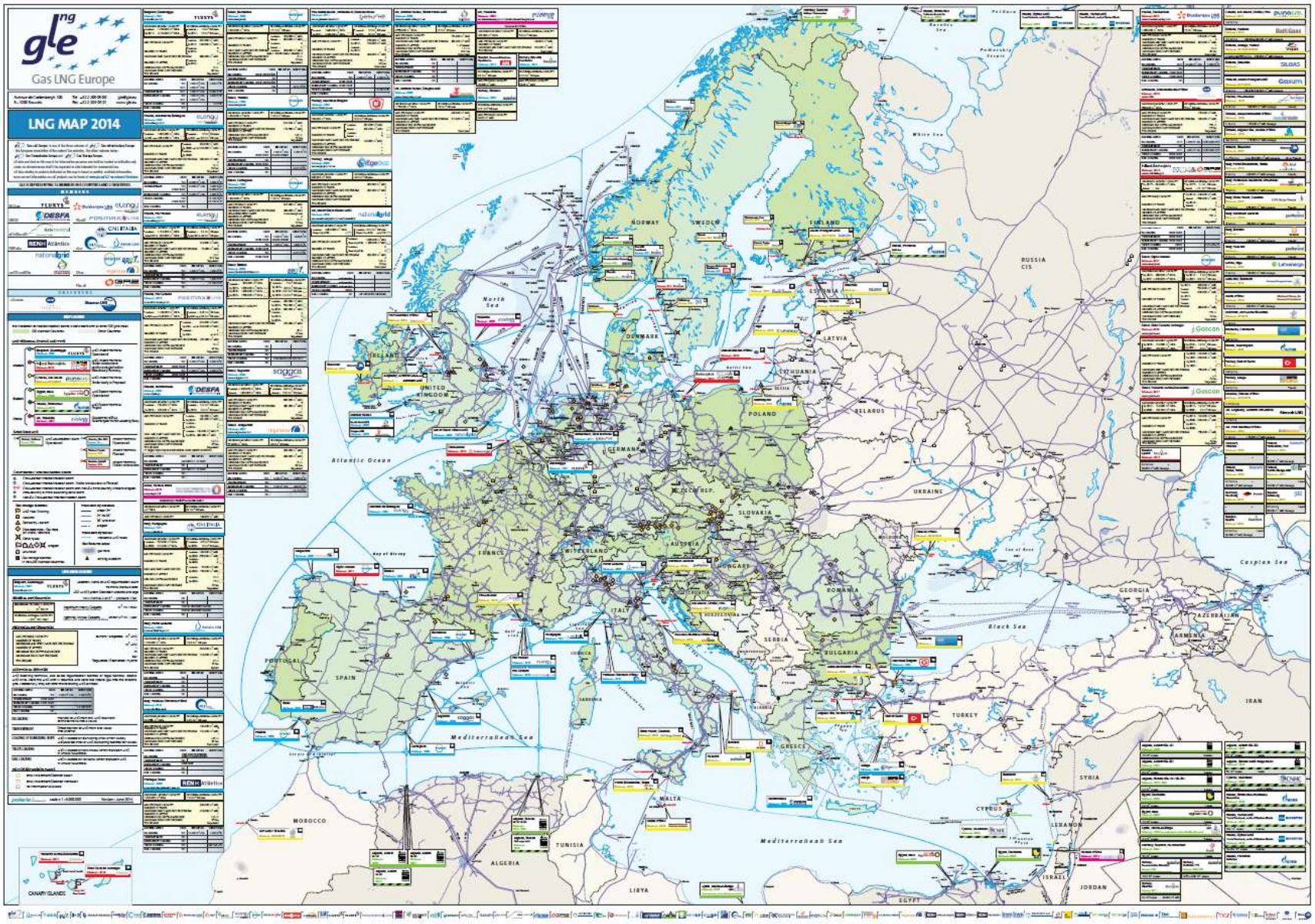
Gas Storage Europe

GSE Storage Map



Gas Storage Europe

GLE LNG Map



GIE AGSI database

AGSI – Aggregated Gas Storage Inventory

GIE members have agreed on a voluntary basis to publish storage inventory as per Regional Energy Market project areas. This initiative is beyond that required by the GGPSSO and Gas Directive and will help provide the information the market needs to operate efficiently and effectively. This information is provided in an aggregated format to guarantee that commercially sensitivity information is not disclosed

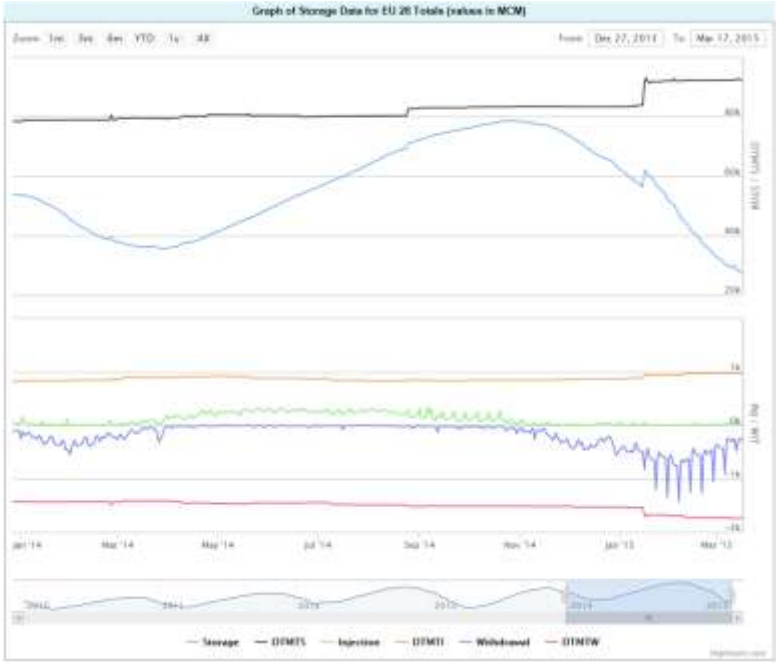
EU 28 Storage Data for Tuesday 17-03-2015

Facility	Storage	Injection	Withdrawal	% Full	Trend	Status	DTMTS	DTMTI	DTMTW
Austria	919.69	0.00	25.81	19.54%	-0.55%	C	4,707.00	44.97	54.41
Belgium	171.70	0.00	2.45	22.38%	-0.32%	C	770.00	7.00	16.00
Bulgaria	196.38	0.00	2.01	35.71%	-0.37%	C	550.00	4.20	3.50
Croatia	291.76	0.00	1.97	53.05%	-0.36%	C	550.00	3.60	5.76
Czech Republic	855.74	0.00	26.00	26.15%	-0.64%	C	3,272.00	34.60	48.19
Denmark	316.00	1.00	4.50	31.14%	-0.35%	C	995.40	8.40	16.20
France	2,369.21	4.56	43.66	19.62%	-0.33%	C	11,955.50	107.70	212.80
Germany	7,806.92	5.92	82.47	31.37%	-0.51%	C	22,339.02	301.07	548.38
Hungary	1,653.70	0.00	15.98	26.13%	-0.25%	C	6,330.00	44.70	78.60
Ireland	-	-	-	-	-	-	-	-	-
Italy	6,221.82	0.00	65.58	37.59%	-0.4%	C	16,558.00	136.22	230.40
Latvia	935.40	0.00	0.00	40.67%	0%	C	2,300.00	17.00	30.00
Lithuania	-	-	-	-	-	-	-	-	-
The Netherlands	1,679.00	0.00	1.68	19.04%	-0.02%	C	8,817.80	86.40	229.20
Poland	1,225.50	0.00	3.00	48.55%	-0.12%	C	2,524.09	25.52	43.45
Portugal	146.45	0.00	0.00	51.23%	0%	C	280.40	2.02	7.14
Romania	-	-	-	-	-	-	-	-	-
Slovakia	819.67	2.29	13.21	24.74%	-0.33%	C	3,313.15	36.75	45.50
Spain	1,491.77	0.00	2.53	65.60%	-0.11%	C	2,274.00	18.30	27.50
Sweden	-	-	-	-	-	-	-	-	-
UK	1,020.80	0.00	30.00	22.08%	-0.64%	C	4,665.58	92.19	135.77
TOTAL EU 28	27,329.80	13.78	315.65	29.64%	-0.34%		92,202.02	971.44	1,732.80

Non-EU Daily Storage data provided on Tuesday 17-03-2015

Facility	Storage	Injection	Withdrawal	% Full	Trend	Status	DTMTS	DTMTI	DTMTW
Ukraine	7,822.63	0.00	15.22	24.48%	-0.05%	C	31,950.00	285.10	269.20
TOTAL NON-EU	7,822.63	0.00	15.22	24.48%	-0.05%		31,950.00	285.10	269.20

*Data on Crimea as of March 12, 2014. Remaining balance in the Crimean storage was 672mcm on March 12, 2014. Updates temporarily



GSE Investment Database 2015

Gas Storage Europe

Storage Investment Database May 2015

Country	Facility/Location	Operator	Investment	Status	Start-up
Poland	Husow	Operator Systemu Magazynowa	expansion	under construction	2015
Poland	Wierzchowice	Operator Systemu Magazynowa	expansion	planned	2020
Poland	Mogilno	Operator Systemu Magazynowa	expansion	under construction	2023
Poland	Kosakowo	Operator Systemu Magazynowa	expansion	under construction	2023
Portugal	Carriço	REN Armazenagen	expansion	under construction	2016
Romania	Sarmasel	Romgaz	expansion	planned	2024
Romania	Ghercesti	Romgaz	expansion	planned	2020
Romania	Moldova	Romgaz	new facility	planned	2018
Romania	Târgu Mureş	Depomures	expansion	planned	2019
Serbia	Banatski Dvor	Srbijagas	expansion	under construction	2017
Slovakia	Láb complex	Nafta	expansion	planned	2019
Slovakia	Velke Kapusany	Nafta	new facility	planned	2019
Spain	Pinasses	Gas Natural Fenosa	new facility	planned	2019
Turkey	Silivri (Marmara)	TPAO	expansion	under construction	2017
Turkey	Tuz Gölü	Botas	new facility	planned	2017
Turkey	Tuz Gölü	Botas	new facility	planned	2019
UK	Hill Top Farm (Cheshire)	EDF Energy	new facility	under construction	2015

Source: GSE investment database, screenshot, detail of database
http://www.gie.eu/index.php/maps-data/gse-investment-database

Transparency platform

Storage Operators Transparency Template

	Macro Area	Submenu
1	Contact	Contact
2	Services and facilities	Technical characteristics
		Products and services
3	How to become a customer/user	How to book capacity
		Contract information
		TSO information
4	Capacities	Primary market
		Secondary market
5	Tariffs and pricing	Pricing/Tariff information
		Fee/Tariff calculator
6	Legal documentation	Storage codes
		Regulation and legislation
7	Operational information	Maintenance
		Operational data
8	Miscellaneous	Projects

For links to the GSE members' Transparency Template related websites, please check the list below:

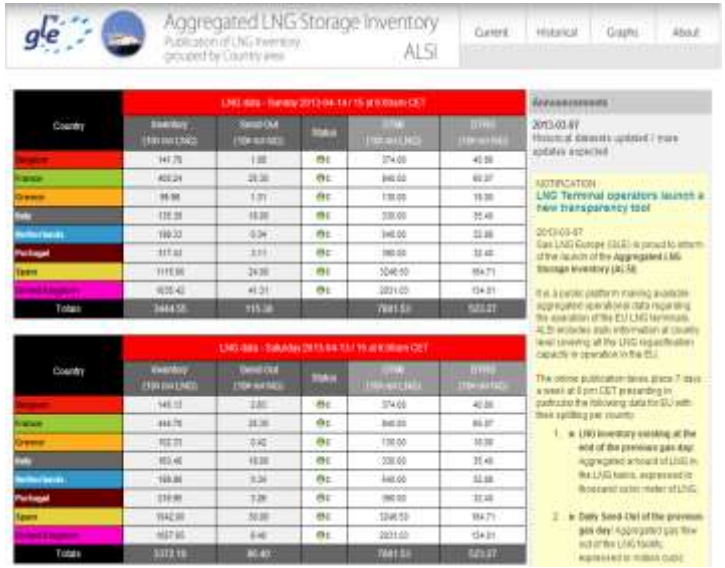
SSO logo	Country	Publication links
astora	DE	Publication Link
BULGARTRANSGAZ	BG	Publication Link
centrica storage	UK	Publication Link
EDF	FR	- tba -
EDISON	IT	Publication Link
enagas	ES	Publication Link
ENERGINET.DK	DK	Publication Link

Source: GSE transparency platform, screenshot, detail of database
http://www.gie.eu/index.php/maps-data/gse-transparency-template

GIE ALSI database

ALSI – Aggregated LNG Storage Inventory

GSE members have agreed on a voluntary basis to publish aggregated operational data regarding the operation of the EU LNG terminals on a daily basis, grouped by country areas. This information is provided in an aggregated format to guarantee that commercially sensitivity information is not disclosed



GIE Annual Conference

GIE is a proud organizer of GIE Annual Conference. Each year top level representatives from the European Institutions, regulatory authorities, international organizations and the natural gas industry meet

ANNUAL CONFERENCE
DUBLIN
23 – 24 APRIL 2015
Hosted by: gaslink Gas System Operator

- 13th GIE Annual Conference in Dublin
- 380 delegates
- "The" annual meeting of gas infrastructure industry in Europe

Gas Storage Europe

Introduction Gas Storage

Robert Jan Maaskant, Vice-Executive Secretary

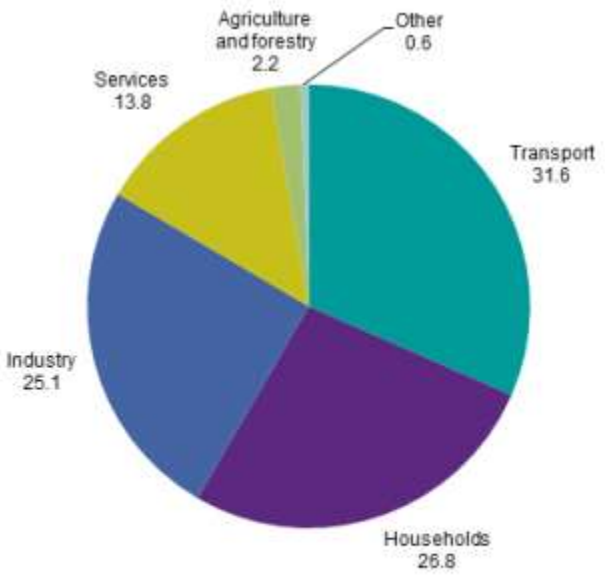
Workshop with DG ENER, 15 July 2015

Gas Storage Europe

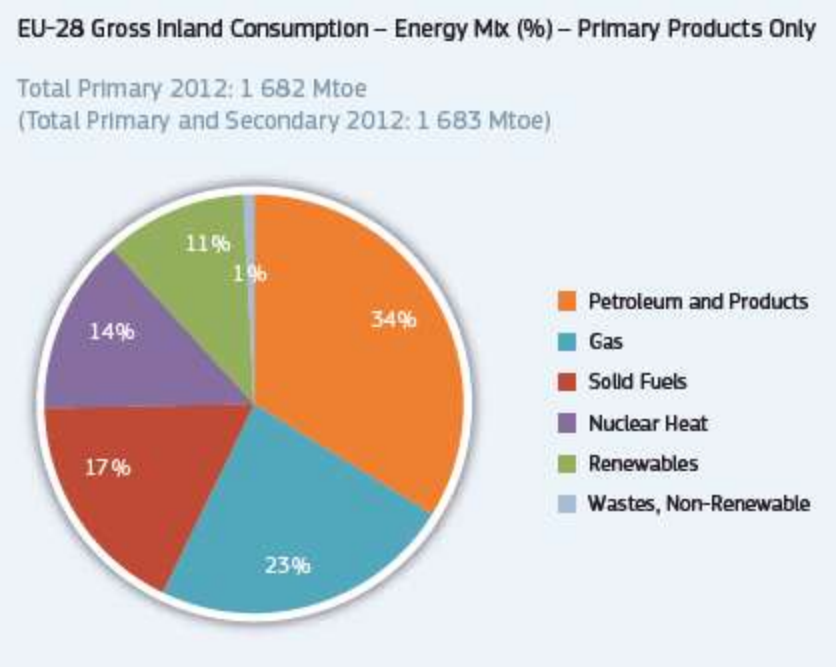
Overview market

Energy: supply and demand

Demand: consumption per sector



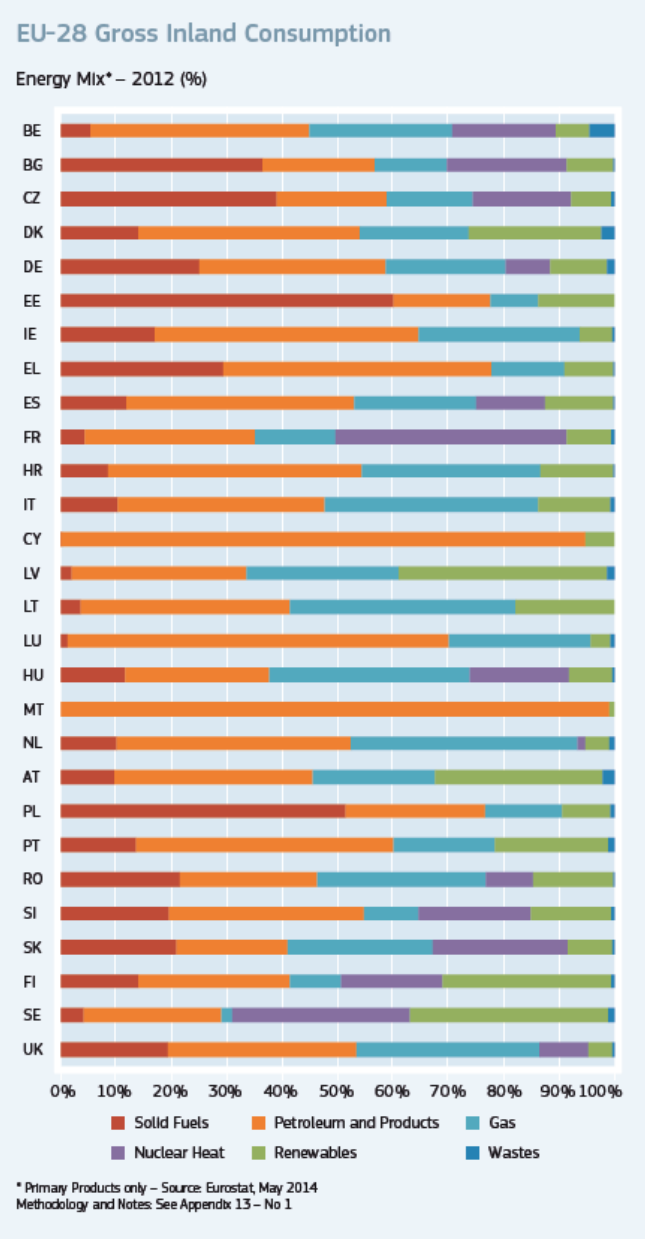
Supply: energy mix



Source: Eurostat
http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Final_energy_consumption,_EU-28,_2013_(%C2%B9)_(%25_of_total,_based_on_tonnes_of_oil_equivalent)_YB15.png

Gas Storage Europe

Energy mix varies significantly per Member State



Source: Eurostat

Gas demand per sector differs significantly per Member State

FIGURE 7: INLAND SALES OF NATURAL GAS IN THE EU-28, SWITZERLAND AND TURKEY, 2013

TWh	Residential & commercial	Industry	Power plants	Transport	Others uses	TOTAL INLAND SALES	% CHANGE 2013/2012
AUSTRIA	22.6	37.5	24.1	2.3	3.7	90.2	-6.0%
BELGIUM	77.3	59.7	45.7	0.3	0.0	183.0	-1.4%
BULGARIA	1.1	11.5	10.3	0.7	4.3	27.9	-6.5%
CROATIA	8.1	9.6	7.7	0.0	4.0	29.5	-5.4%
CYPRUS	0.0	0.0	0.0	0.0	0.0	0.0	-
CZECH REPUBLIC	39.1	47.0	0.0	0.2	1.6	88.0	1.9%
DENMARK	9.1	9.5	5.8	0.0	11.4	35.8	-4.4%
ESTONIA	0.9	1.0	3.9	0.0	1.2	7.0	3.2%
FINLAND	0.9	18.9	17.0	0.0	0.0	36.8	-5.1%
FRANCE	293.8	157.1	30.0	1.2	19.5	501.6	1.6%
GERMANY	441.3	353.0	148.0	2.8	11.0	956.0	6.4%
GREECE	4.6	8.8	28.0	0.2	0.0	41.6	-11.7%
HUNGARY	52.1	23.9	24.3	0.0	3.9	104.2	-7.1%
IRELAND	13.7	7.6	27.5	0.0	0.8	49.7	-5.5%
ITALY	321.3	161.8	228.3	10.4	19.8	741.6	-6.5%
LATVIA	3.2	1.7	10.1	0.0	0.0	15.0	-0.8%
LITHUANIA	3.5	13.7	10.4	0.0	0.3	28.0	-18.5%
LUXEMBOURG	4.8	3.0	3.8	0.0	0.0	11.6	-14.9%
MALTA	0.0	0.0	0.0	0.0	0.0	0.0	-
NETHERLANDS	217.2	139.5	66.0	0.0	8.3	431.0	1.1%
POLAND	68.3	87.7	16.5	0.0	6.0	178.5	0.3%
PORTUGAL	4.6	39.8	3.4	0.0	0.0	47.8	-4.4%
ROMANIA	44.9	54.3	21.4	0.0	12.0	132.6	-8.3%
SLOVAKIA	24.9	18.5	10.6	0.1	0.2	54.3	-2.0%
SLOVENIA	2.6	4.3	0.6	0.0	0.0	7.6	-8.4%
SPAIN	48.2	128.0	156.4	1.0	0.0	333.5	-8.0%
SWEDEN	1.4	5.4	4.8	0.7	0.0	12.4	-4.0%
UNITED KINGDOM	450.4	148.2	225.5	0.0	26.9	851.0	-1.1%
EU-28	**2 159.7**	**1 551.1**	**1 130.1**	**19.9**	**135.1**	**4 996.0**	**-1.5%**
% Change 2013/2012	**2.6%**	**0.7%**	**-12.3%**	**18.4%**	**13.9%**	**-1.5%**	
SWITZERLAND	24.5	12.3	2.4	0.2	0.4	39.8	5.4%
TURKEY	141.0	122.7	224.0	0.9	-3.1	485.5	0.9%

Units: terawatt hours (gross calorific value).
Note: figures are best estimates available at the time of publication.

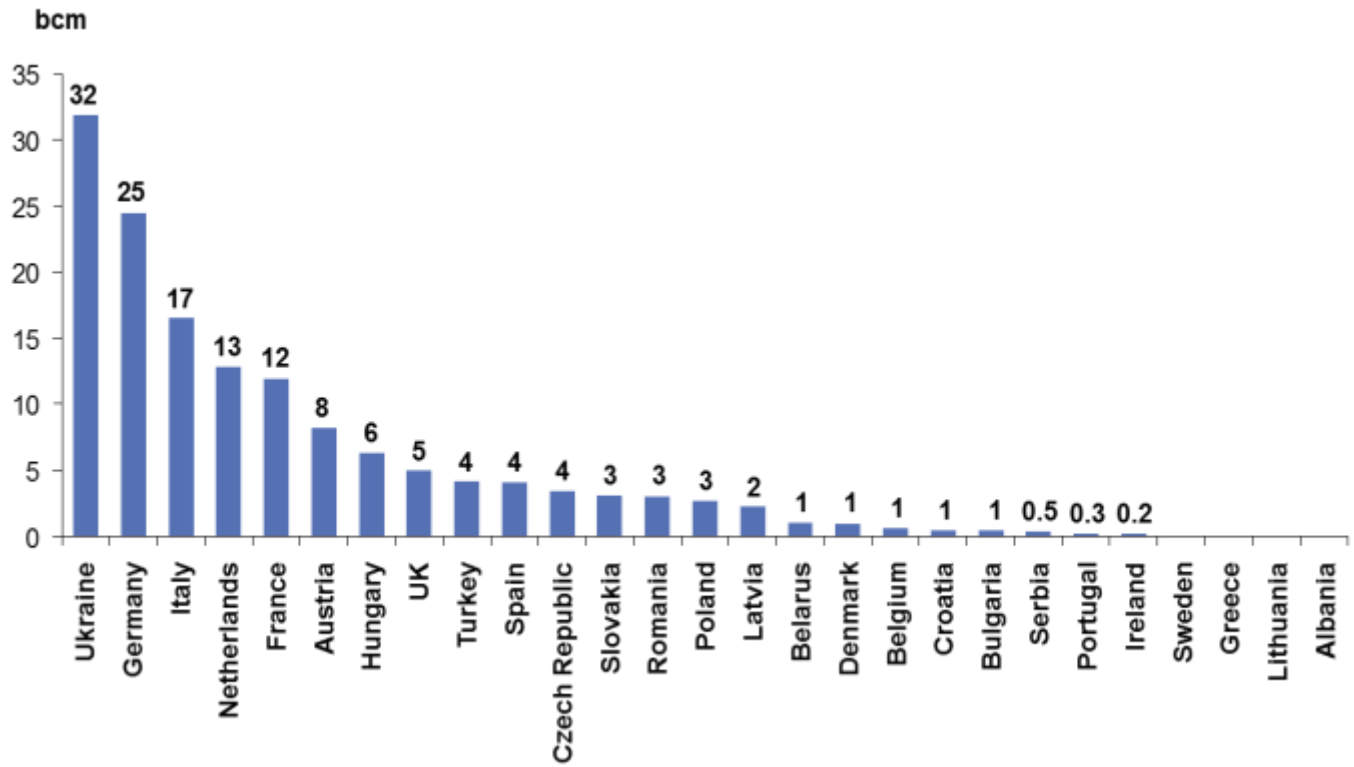
FIGURE 8: EU-28 NATURAL GAS SALES BY SECTOR, 2012 AND 2013

Inland deliveries represent deliveries of marketable gas to the inland market, including gas used by the gas industry for heating and operating their equipment, and includes losses in distribution.

Source: Eurogas, statistical report 2014

Gas Storage Europe

Gas storage capacity also varies significantly



Source: GIE map 2015

Gas Storage Europe

Energy units

Conversion factors

Units glossary

bcm	→	billion cubic metres
GJ	→	gigajoule
GWh	→	gigawatt hour
kWh	→	kilowatt hour
MBtu	→	million British thermal units
mcm	→	million cubic metres
Mtoe	→	million tonnes of oil equivalent
MWh	→	megawatt hour
m^3	→	cubic metres
Pcal	→	petacalories
PJ	→	petajoule
TWh	→	terawatt hour
toe	→	tonnes of oil equivalent
tcm	→	trillion cubic metres

General conversion for units of energy and volume

1 Mtoe = 10 Pcal	→	41.86 PJ (NCV) = 11.63 TWh (NCV)
1 cubic metre (m^3)	→	35.315 cubic feet (cf)
1 mcm of LNG	→	593 mcm of gas

Eurogas conversion factors from volume to energy units

92.3 mcm gas	→	1 TWh (GCV)
1 m^3 of natural gas	→	39 MJ (GCV) = 10.83 kWh (GCV)

Common conversion factors from gross to net calorific value

Natural gas: NCV	→	0.9 GCV
Oil: NCV	→	0.95 GCV
Solid fossil fuels: NCV	→	0.97 GCV

Equivalents

1 gigawatt hour	→	10^6 kWh (GWh)
1 megawatt hour	→	10^3 kWh (MWh)
1 petawatt hour	→	10^{12} kWh (PWh)
1 terawatt hour	→	10^9 kWh (TWh)

Heat unit equivalents

	GJ	kWh	MBtu	th	therm
1 Gigajoule (GJ)	1	277.8	0.948	238.9	9.479
1 kilowatt hour (kWh)	$3.6\ 10^{-6}$	1	$3.411\ 10^{-3}$	0.86	$3.411\ 10^{-2}$
1 Million British thermal units (MBtu)	1.055	293.2	1	252	10
1 therrie (th)	$4.186\ 10^{-3}$	1.162	$3.968\ 10^{-3}$	1	$3.968\ 10^{-2}$
1 therm	0.1055	29.33	$1\ 10^{-1}$	25.2	1

Source: Eurogas, statistical report 2014

Source: http://www.gasstoragebergermeer.com/econverter/

Gas Storage Europe

Introduction gas storage

Gas Storage Europe

Why gas storage?

Why does the gas need to be stored?

The following functions are currently fulfilled by underground gas storage facilities:

- Create strategic reserve in case of interruption of supply (particularly applicable to countries with strong imports dependency)
- Provide seasonal load balancing to meet peak demand (gas is injected to storage between April and October and usually withdrawn between November and March)
- Enable optimised and economic production of natural gas
- Enable daily balancing
- Enable arbitration of gas prices, i.e. commercial optimisation of gas price fluctuations
- Ensure overall optimisation of system functioning, including facilitation of swap transactions
- Sustain transmission by eliminating local system bottlenecks or critical pressure constraint

Source: GSE knowledge center, screenshot FAQ
http://www.gie.eu/KC/faq_C.html

Typical gas demand profile

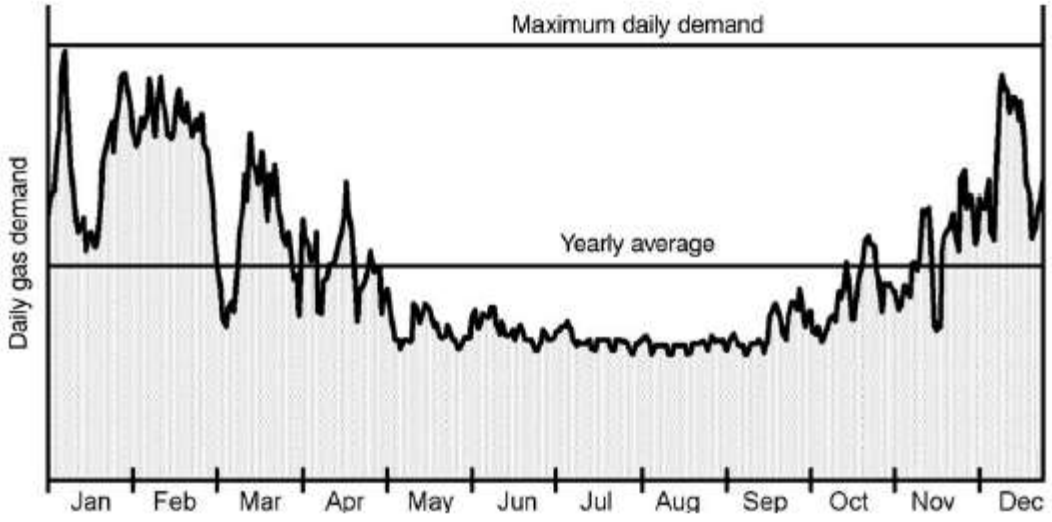


Fig. 1. Typical gas demand profile.

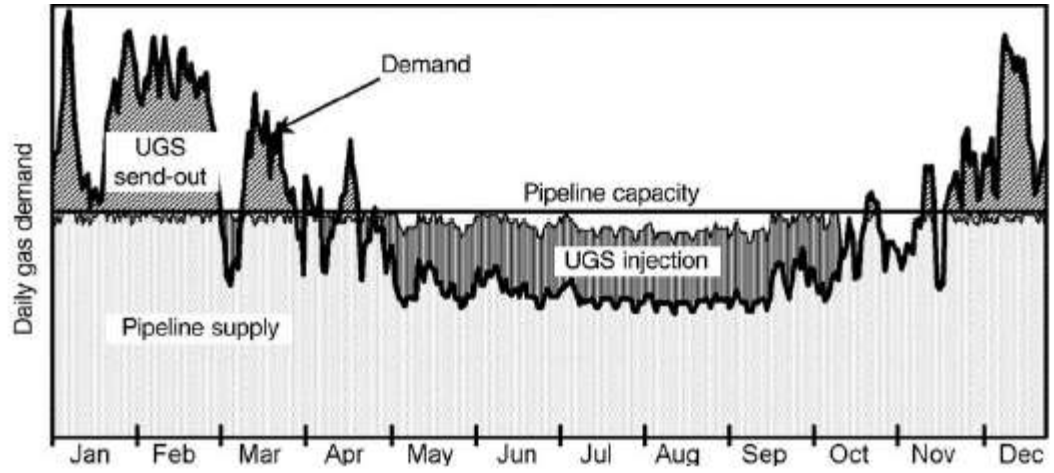
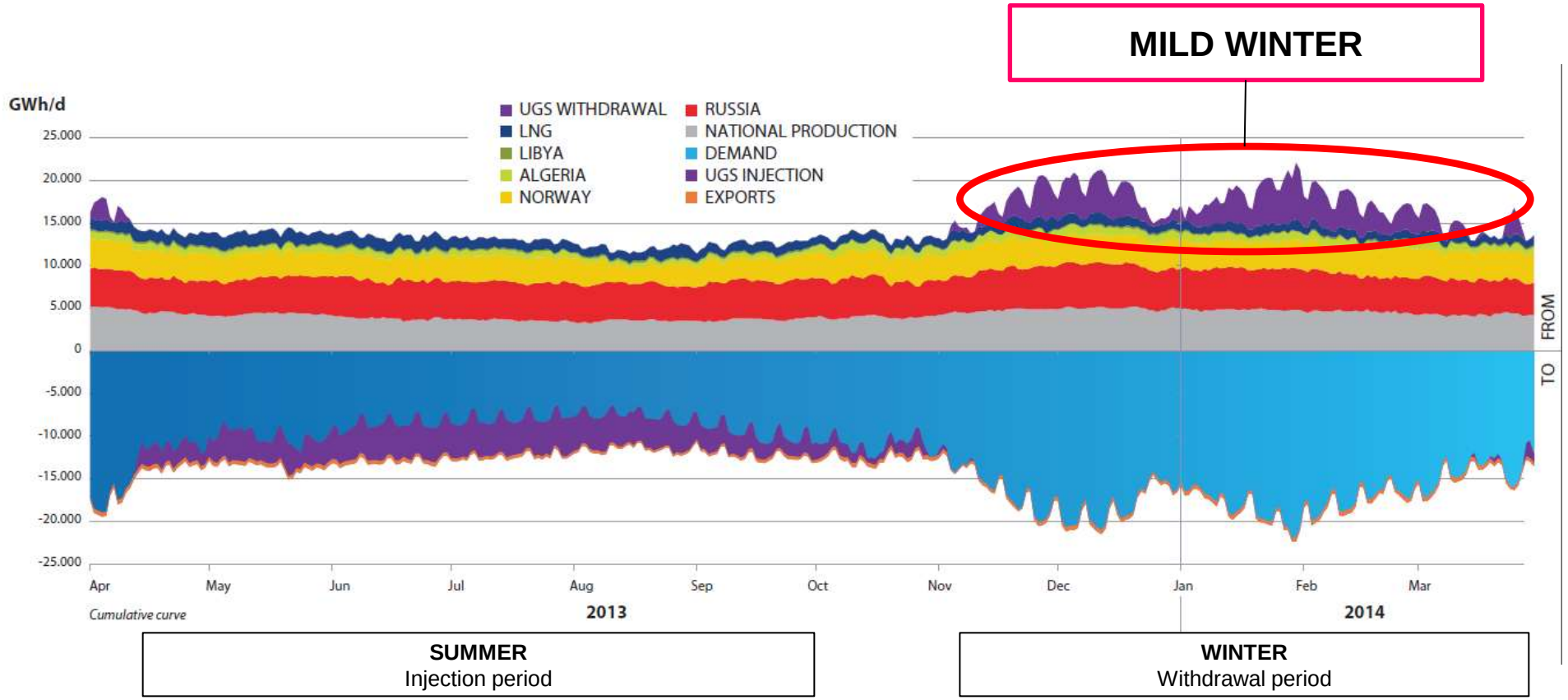


Fig. 2. Illustration of the use of underground gas storage.

Source: Hans Plaat, Underground gas storage: Why and how

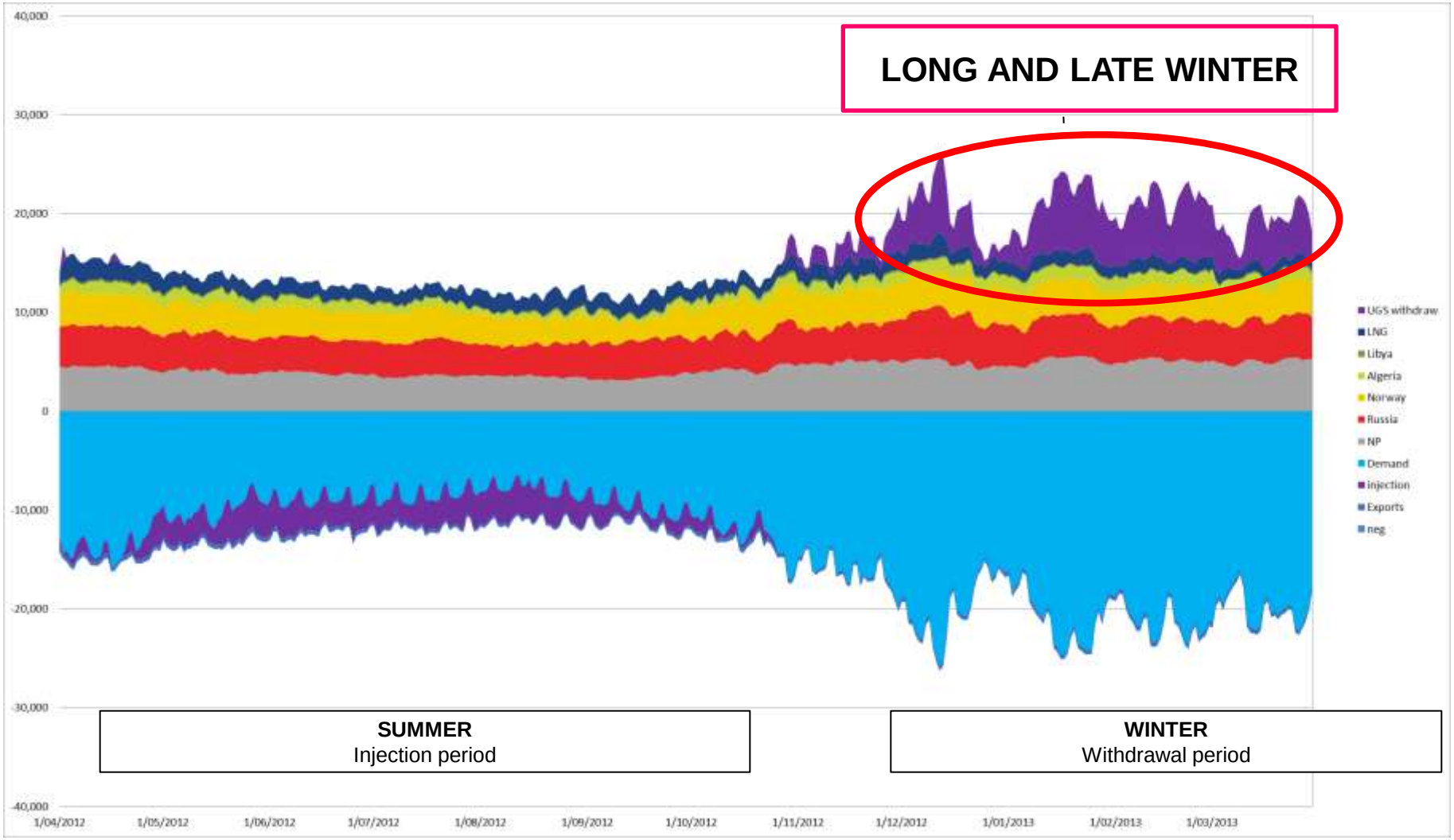
Use of gas storage 2013-2014



Source: ENTSOG data

Gas Storage Europe

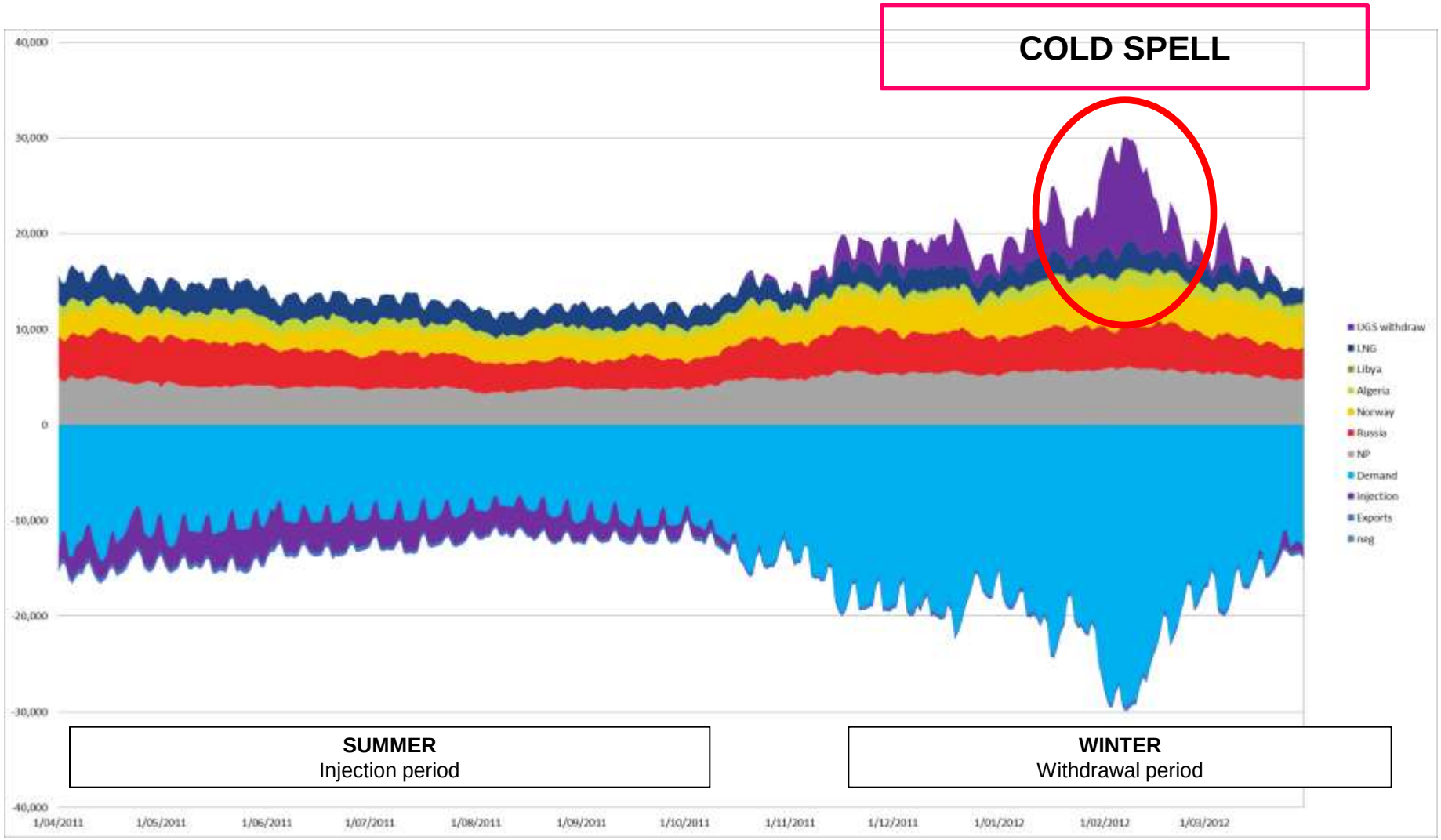
Use of gas storage 2012-2013



Source: ENTSOG data

Gas Storage Europe

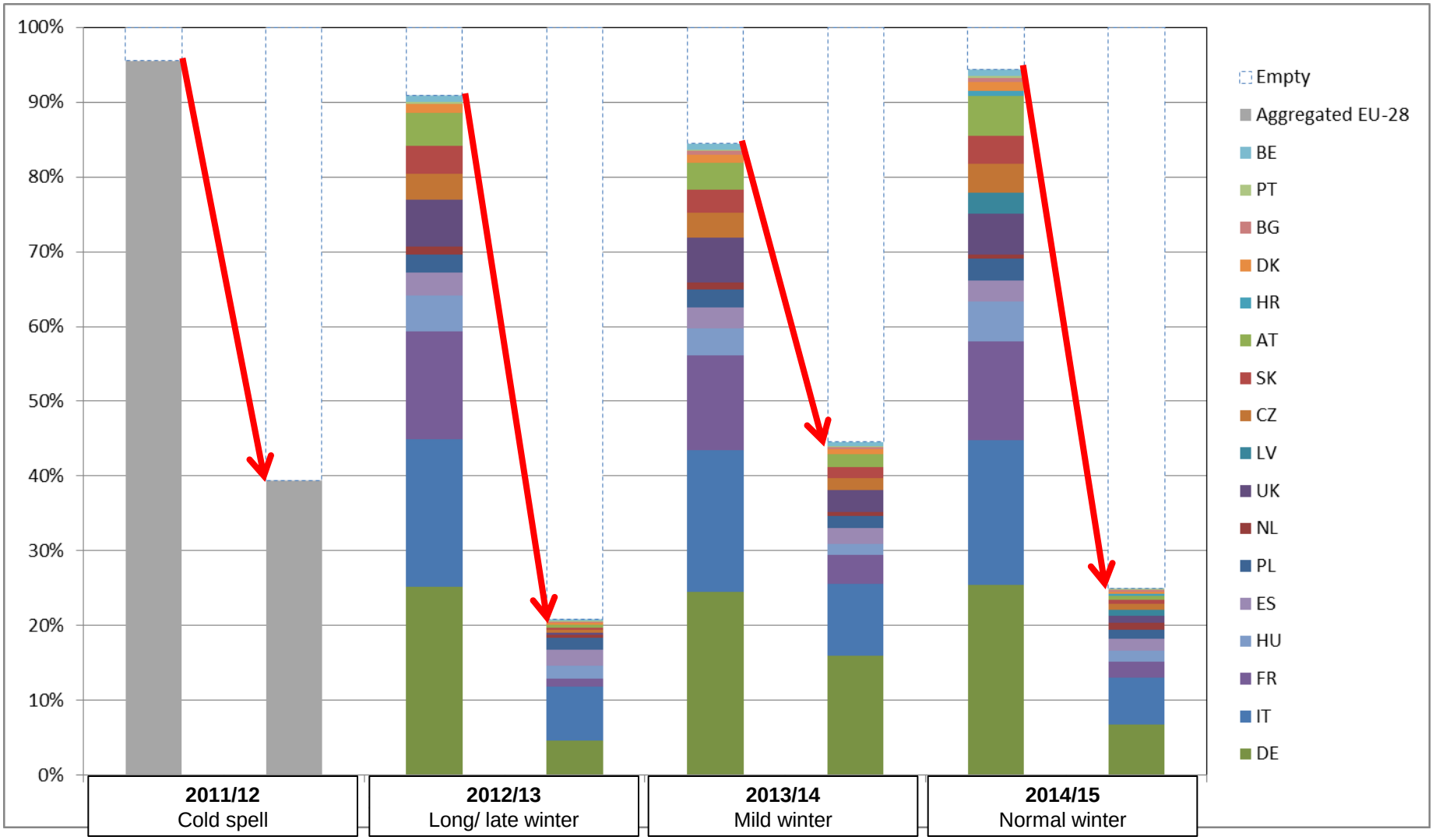
Use of gas storage 2011-2012



Source: ENTSOG data

Gas Storage Europe

Gas storage levels (beginning and end of heating season)



Another way of presenting: Load Duration Curve (LDC)

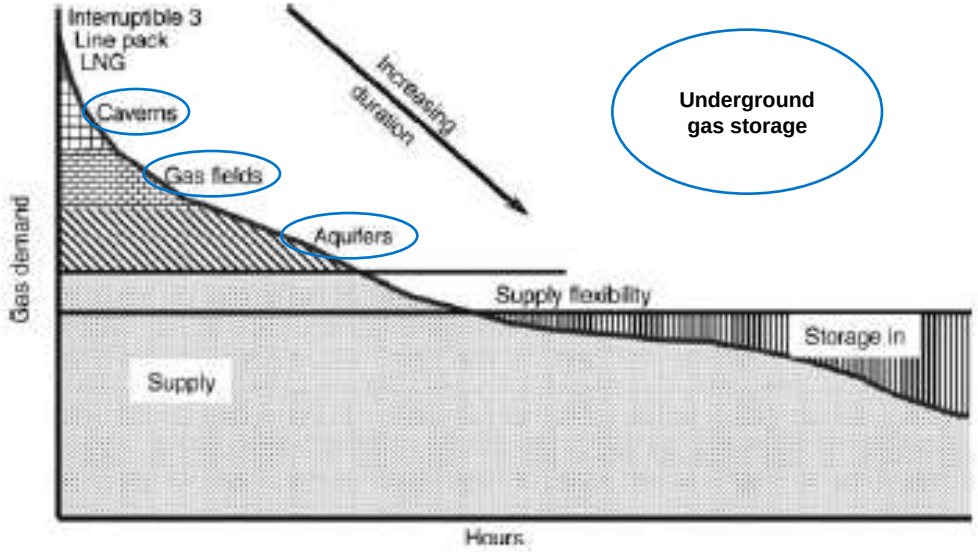


Fig. 7. Position of UGS in the load duration curve.

Load duration curve: hours are ordered from peak demand to low demand
Peak demand is generally covered by the fastest flexibility source

Types of gas storage in EU-28

Porous rock

Depleted gas field:
Total working volume **70 bcm**
Average working volume 1 bcm

Aquifer
Total working volume **17 bcm**
Average working volume 600 mcm

Salt cavern

Salt cavern:
Total working volume **16 bcm**
Size: 40 – 100 mcm per cavern
(often operated in clusters)
Average working volume 350 mcm

Deliverability: fast
(less pressure loss than in porous rock)

Source: Eon Gas Storage, GSE map 2015
http://www.eon.com/en/business-areas/gas-storage-and-transport/underground-storage-facilities.html

Technical aspects of gas storage

Storage

Gas is injected and stored in underground reservoirs to be withdrawn from and re-injected into the transmission system according to gas demand.

- **Reservoir**: Natural gas can be stored in aquifers, salt caverns and depleted gas reservoirs.
- **Wells**: Gas is injected into the underground reservoir or withdrawn to the surface by wells drilled in the ground.
- **Grid connection**: Connection to the transmission system where natural gas is metered.
- **Compressors**: Engines used to increase the pressure of natural gas allowing it to be injected into the underground storage.
- **Gas treatment:** Process used to eliminate residual water, sulphur or other impurities from gas withdrawn from underground storages.

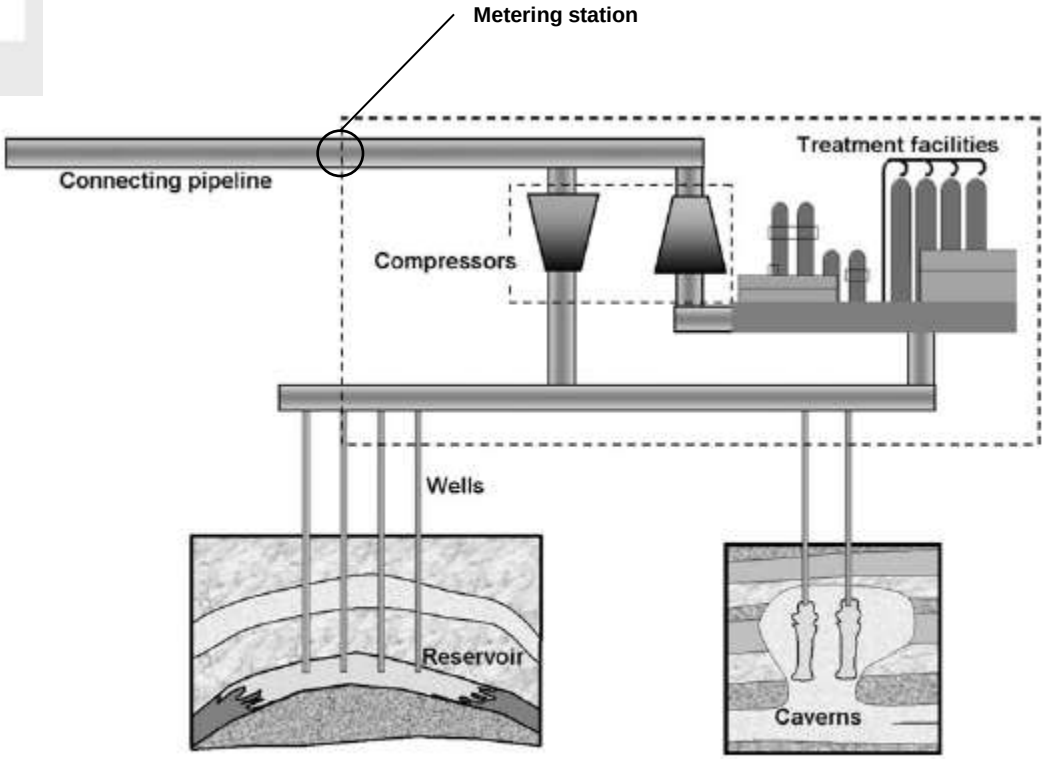


Fig. 9. Components of a UGS facility.

Source: GSE knowledge center, screenshot
http://www.gie.eu/KC/gasinfrastructure_animation.html

Source: Hans Plaat, Underground gas storage: Why and how (metering station added by RJM)

Gas Storage Europe

Some more terminology

Working volume (working gas) – max volume available for withdrawal
Cushion gas (base gas) – gas that stays in reservoir, required for minimum pressure to provide deliverability
Inventory – sum of working volume and cushion gas

Deliverability – amount of gas that can be delivered (withdrawn) in a period. Deliverability decreases when amount of gas in storage decreases (see next page for deliverability curve). Duration is working volume/ deliverability
Injectability – amount of gas that can be injected in a period. Also a curve applies. Duration is working volume/ injectability

Capacity – can refer to working volume and/ or deliverability and injectability (no commonly accepted definition)

Source: Hans Plaat, Underground gas storage: Why and how

Deliverability curve

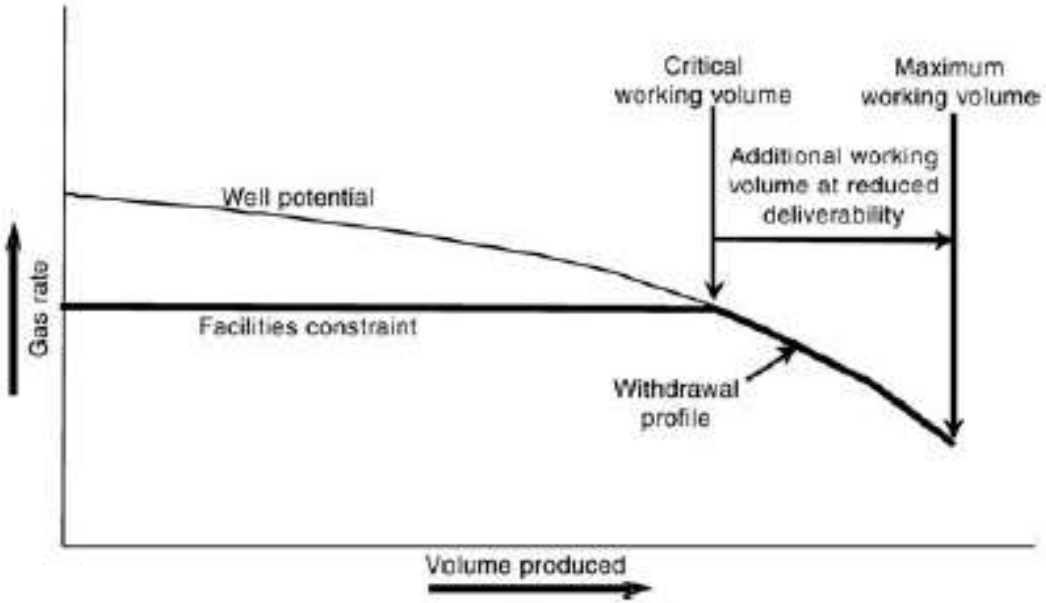


Fig. 11. UGS withdrawal profile.

Source: Hans Plaat, Underground gas storage: Why and how

Gas Storage Europe

Gas Storage Europe

Commercial aspects of gas storage

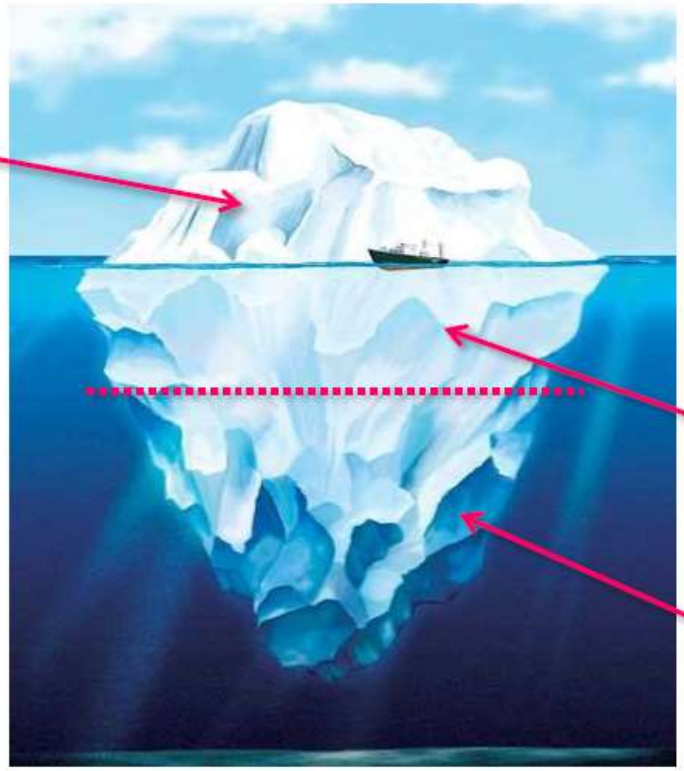
Gas Storage Europe

The Value of Storage is like an iceberg ...

THE VISIBLE

Market values

- Intrinsic
- Extrinsic



THE INVISIBLE

System value

Insurance value

...with the greater part remaining invisible

Gas Storage Europe

"Market values" of Storage

Intrinsic Value

- Based on difference between gas price in summer (injection) and winter (withdrawal).
- Reflects seasonal demand pattern.
- "Static view" of the seasonal forward curve.

Extrinsic value

- Based on shorter-term price differentials : day-ahead, weekend, month ahead etc.
- Dynamic and complex function of price volatility, asset flexibility, optimization strategies.
- Potentially high value from small price variations but limited price visibility.

Gas Storage Europe

"System value" of Storage

Optimized gas production

- Avoided investment in wells and surface facilities (up to 80% of avoided CAPEX).
- Optimized operations and maintenance (plateau vs. swing).
- Maximization of gas production (up to 15% of volume).

Cost-efficient gas transport

- Avoided investment thanks to lower peak load requirement (avoided CAPEX of 9%-16%*).
- Reduced operating and maintenance costs thanks to optimized gas compression.
- Reduction of local bottlenecks.

Storage is 5-7 times less expensive than the extraction of the corresponding reserve and construction of transmission facilities (source : Gazprom)

Gas Storage Europe

"Insurance value" of Storage

Hedge against supply risk

- Timely response to demand at all times: prolonged periods of high demand, cold peaks; back-up for renewables integration etc.
- Safeguard against unexpected high impact events: technical failures (production, pipeline), geopolitical risk.
- Lesser vulnerability and higher bargaining power in politically sensitive situations.
- Avoidance of high social welfare costs.

Some examples:

⇒ 2009 Russia-Ukraine dispute: storage and reverse flows were the main mitigating measures.
⇒ 2012 cold snap: storage was key in covering high demand (up to 55% daily demand coverage)
⇒ 2013 prolonged winter end: prolonged draw-down and cross-border use of storage.

Some more terminology

TPA: regulated, negotiated

Characteristics of contract (varies per jurisdiction)

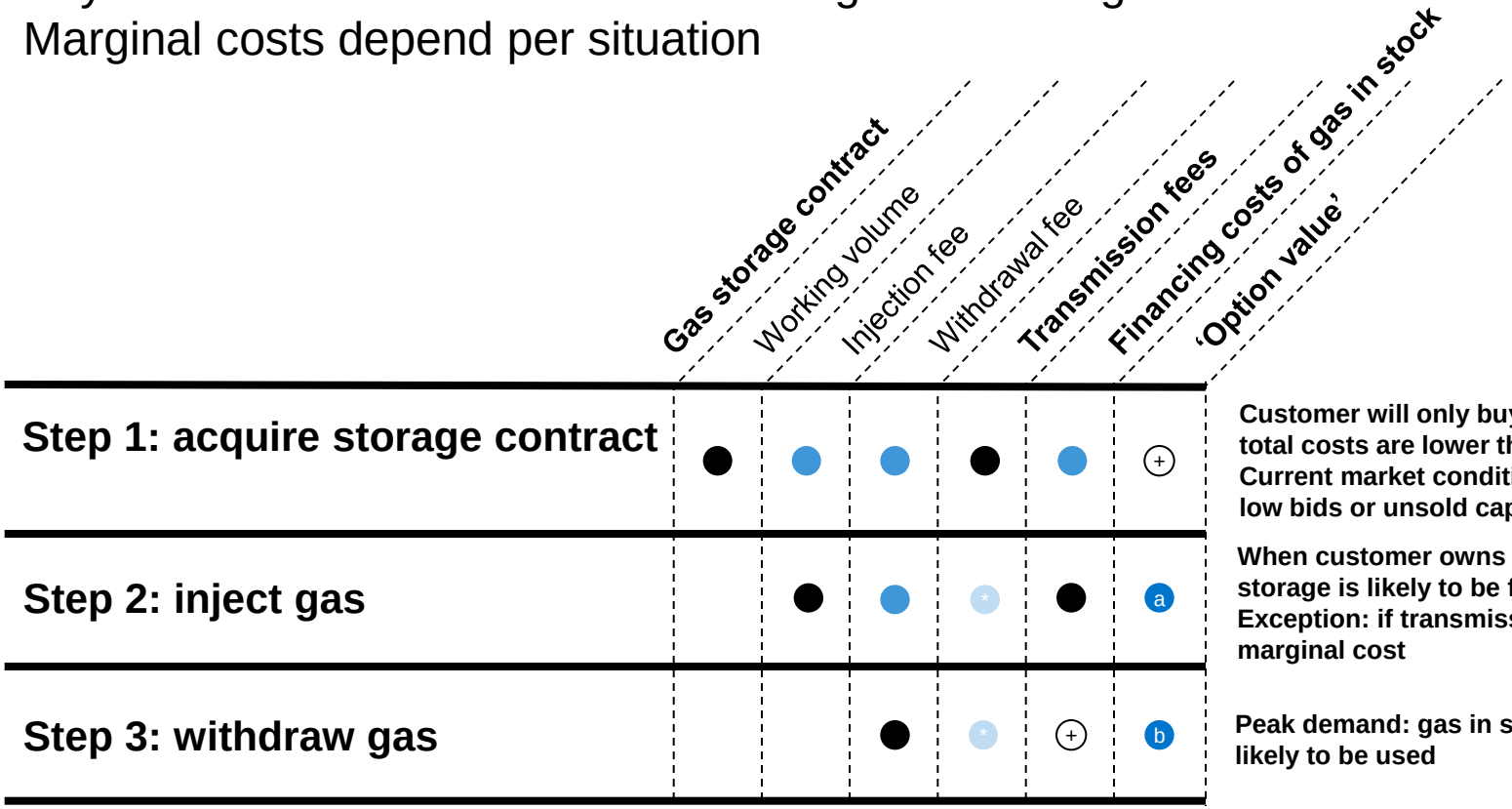
- **Duration:** long-term, 1-3 year
- **Volume and speed**: working volume, deliverability and injectability
  - Depends on characteristics gas storage facility
  - Fast products higher priced, because more extrinsic value captured
- **Delivery point**: flange, hub (including transmission capacity)
- **Related to one storage versus group of sites (storage pool/ virtual storage)**
- **Price:**
  - **Working volume:** price for working volume (generally biggest chunk), can be **fixed** or **indexed to summer-winter spread**
  - **Fee for injection**
  - **Fee for withdrawal**
  - Other fees

Other relevant costs of using gas storage

- **Transmission tariffs**
  (hub: paid by gas storage operator, flange: paid by customer)
- **Opportunity/ financing cost of gas in storage**

How does customer decide to buy and use gas storage capacity?

Buyer must believe that benefits are larger than marginal costs
Marginal costs depend per situation



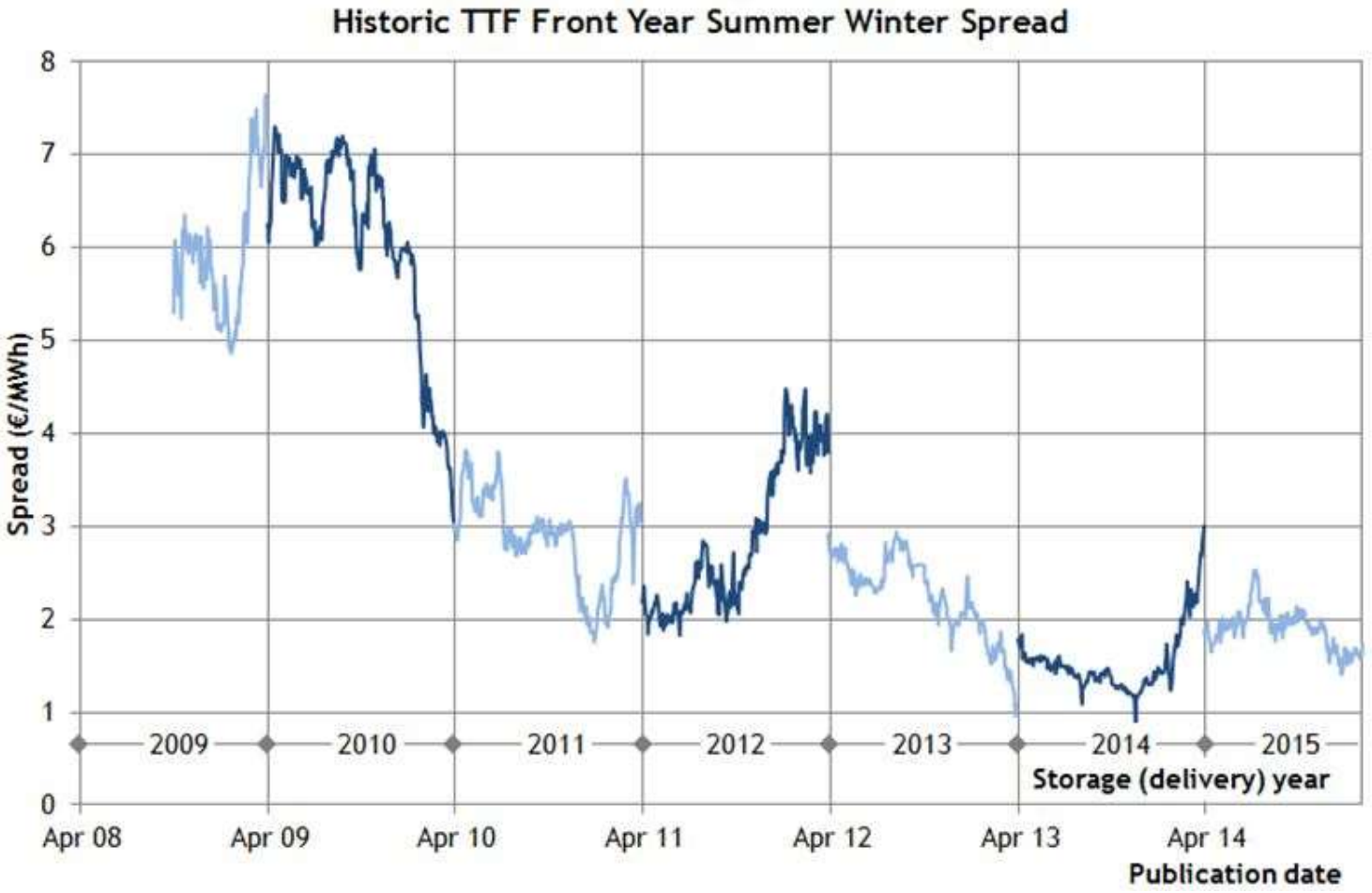
Customer will only buy contract if total costs are lower than benefits
Current market conditions: either very low bids or unsold capacity

When customer owns contract, gas storage is likely to be filled
Exception: if transmission tariffs are marginal cost

Peak demand: gas in storage is likely to be used

- ● Expenditure (cash-out)
- ● Cost to be taken into account (cash-out later but unavoidable when using gas storage contract)
- * Probably no marginal transmission cost for injecting and withdrawing gas, depends on availability and price of short-term transmission capacity
- ⊕ Step 1: option value: see iceberg, Step 3: withdrawal of gas leads to end of financing cost
- a Option of waiting and buying when gas is cheaper (depending on expectations for price fluctuation and speed of facility)
- b Option of waiting and selling when gas is more expensive (idem)

Summer-winter spread is an important driver for gas storage use



Summer-winter spreads currently historically low

Source: Timera Energy, (http://www.timera-energy.com/market-benchmark-for-gas-flexibility-value/) TTF

Wrap-up gas storage

- AGSI+ and ENTSOG data show that gas storages are used, although willingness to pay is low
  - Low prices for indexed contracts
  - Unsold capacity (e.g. failed auctions)

- Market prices are low: risk of decommissioning/ mothballing, not a driver for investments

- Gas storages is key to ensure Security of Supply

Gas Storage Europe

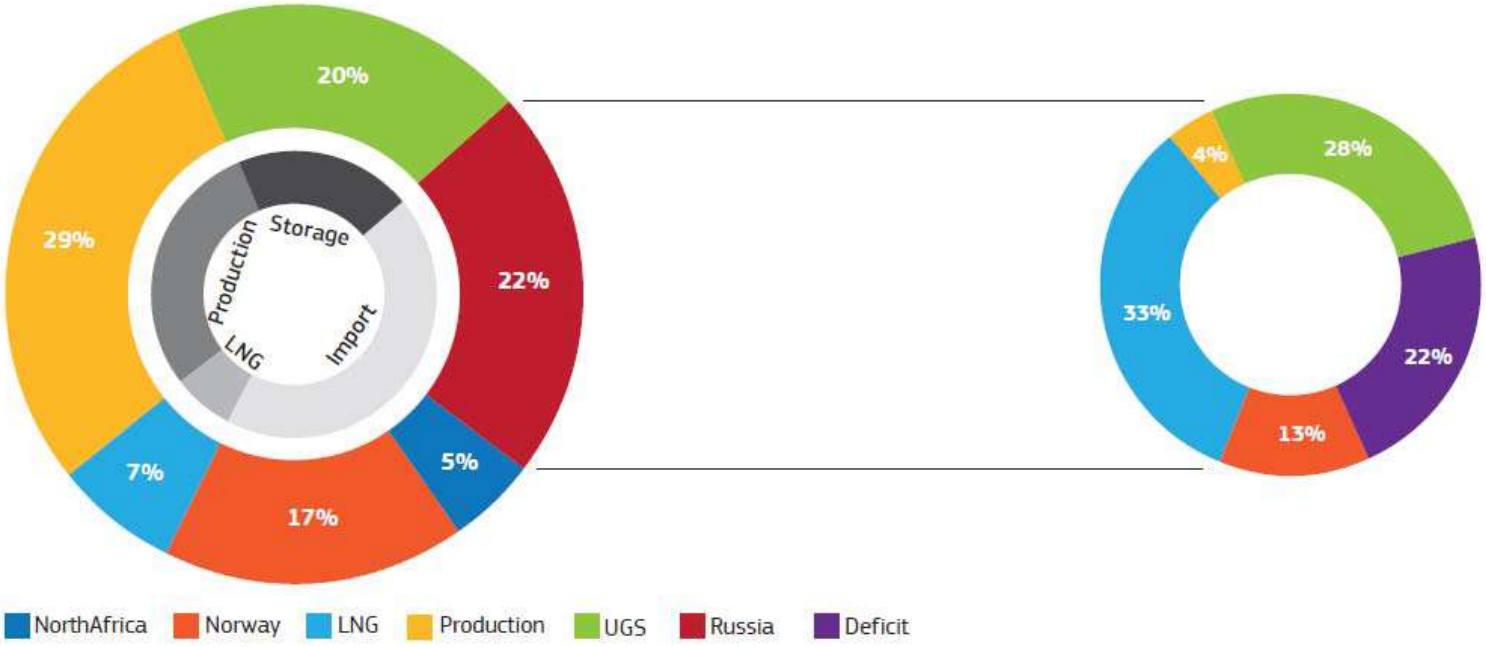
Backup slides

Robert Jan Maaskant, Vice-Executive Secretary

Workshop with DG ENER, 15 July 2015

Gas storage and SoS

European Commission: LNG (33%) and storage (28%) play an important role in case of an interruption of gas supply in East

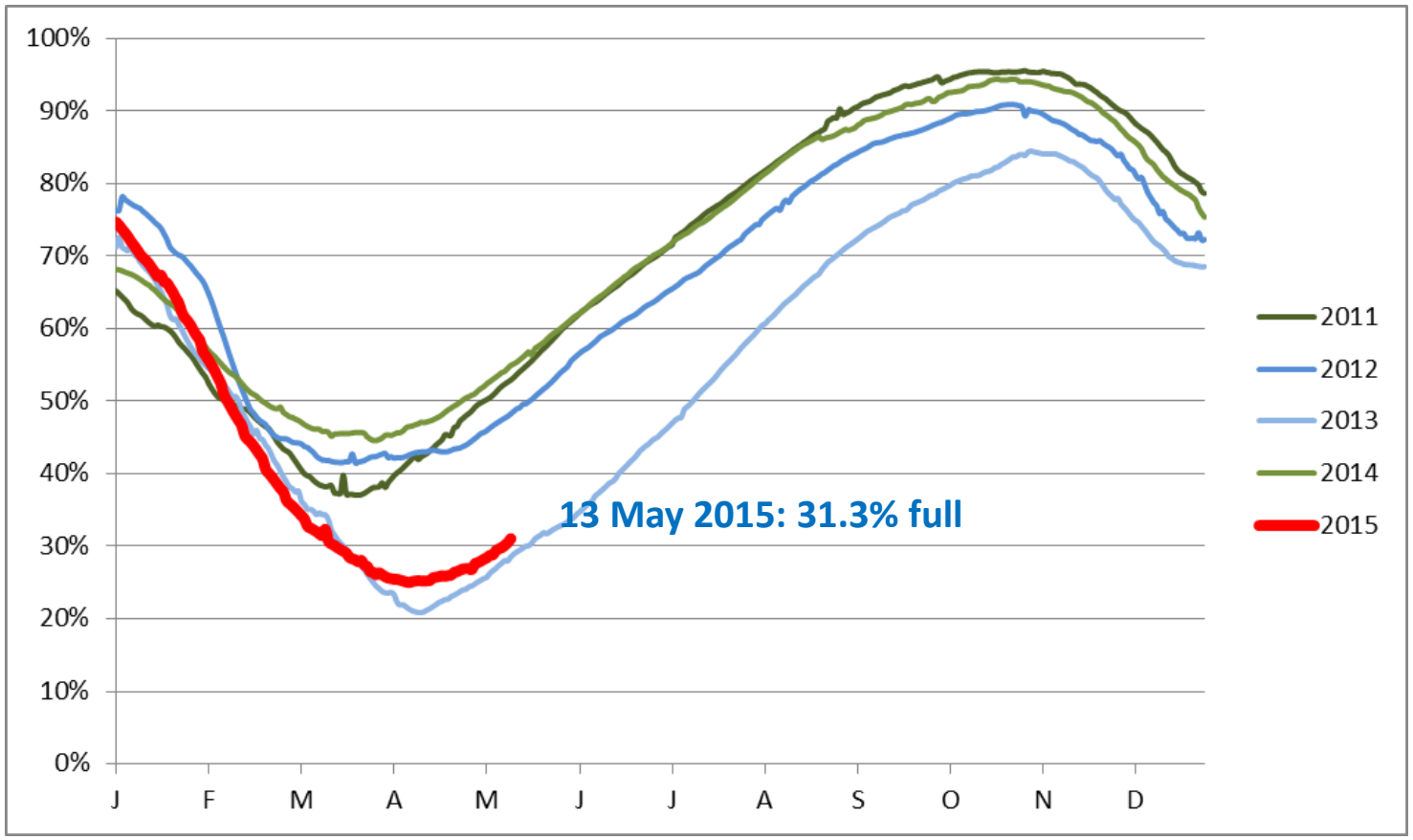


Short-term measures: **use of existing infrastructure**
Medium/ long-term measures: **building infrastructure**

Source: European Commission, Stress test communication, 16 October 2014, COM(2014) 654 final, page 5

Gas storage level (%) – EU 28

13 May 2015: gas in stock 28.3 bcm, 31.3% full
Lowest point on 9 April: 23.2 bcm in stock, 25.0% full



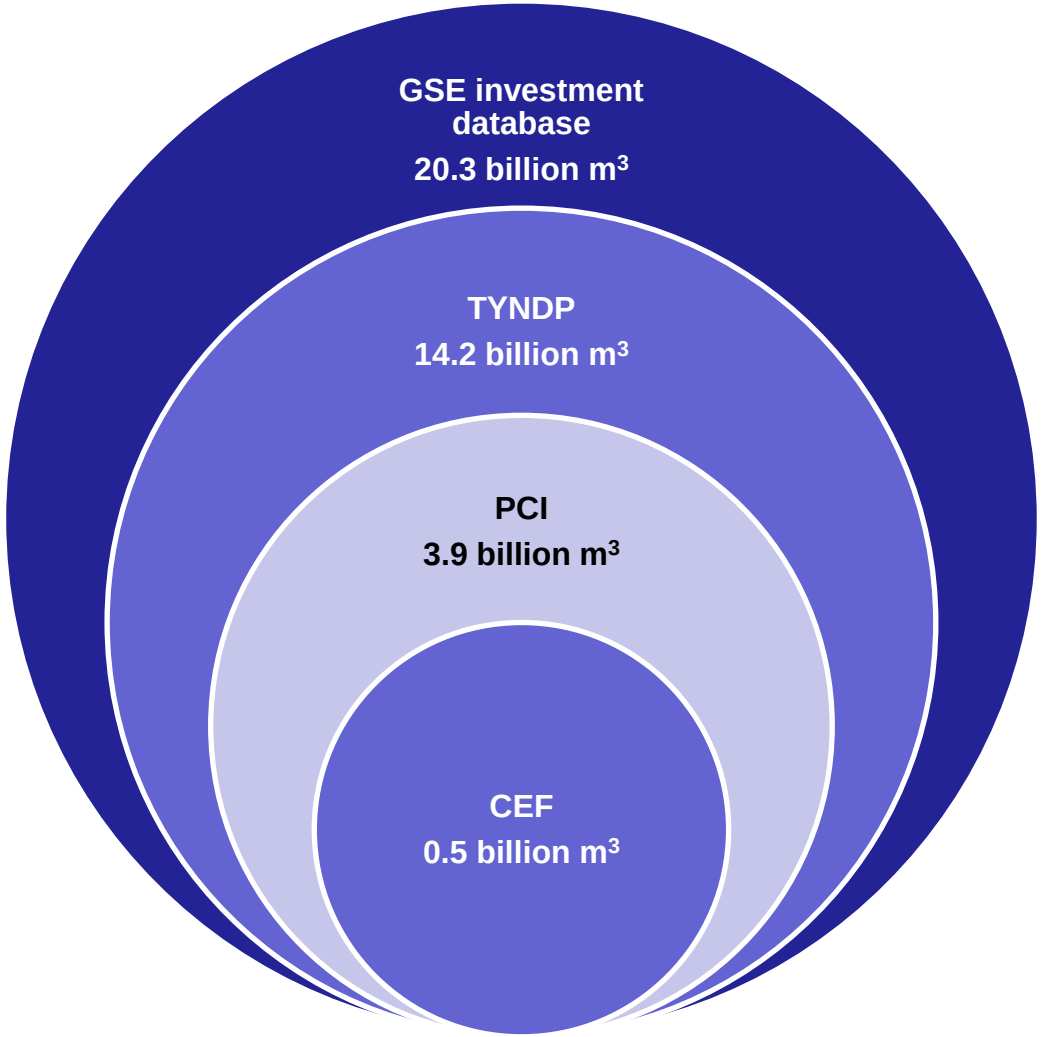
Source: GSE AGSI+ database

Gas Storage Europe

Gas storage use in winter 2014 – 15

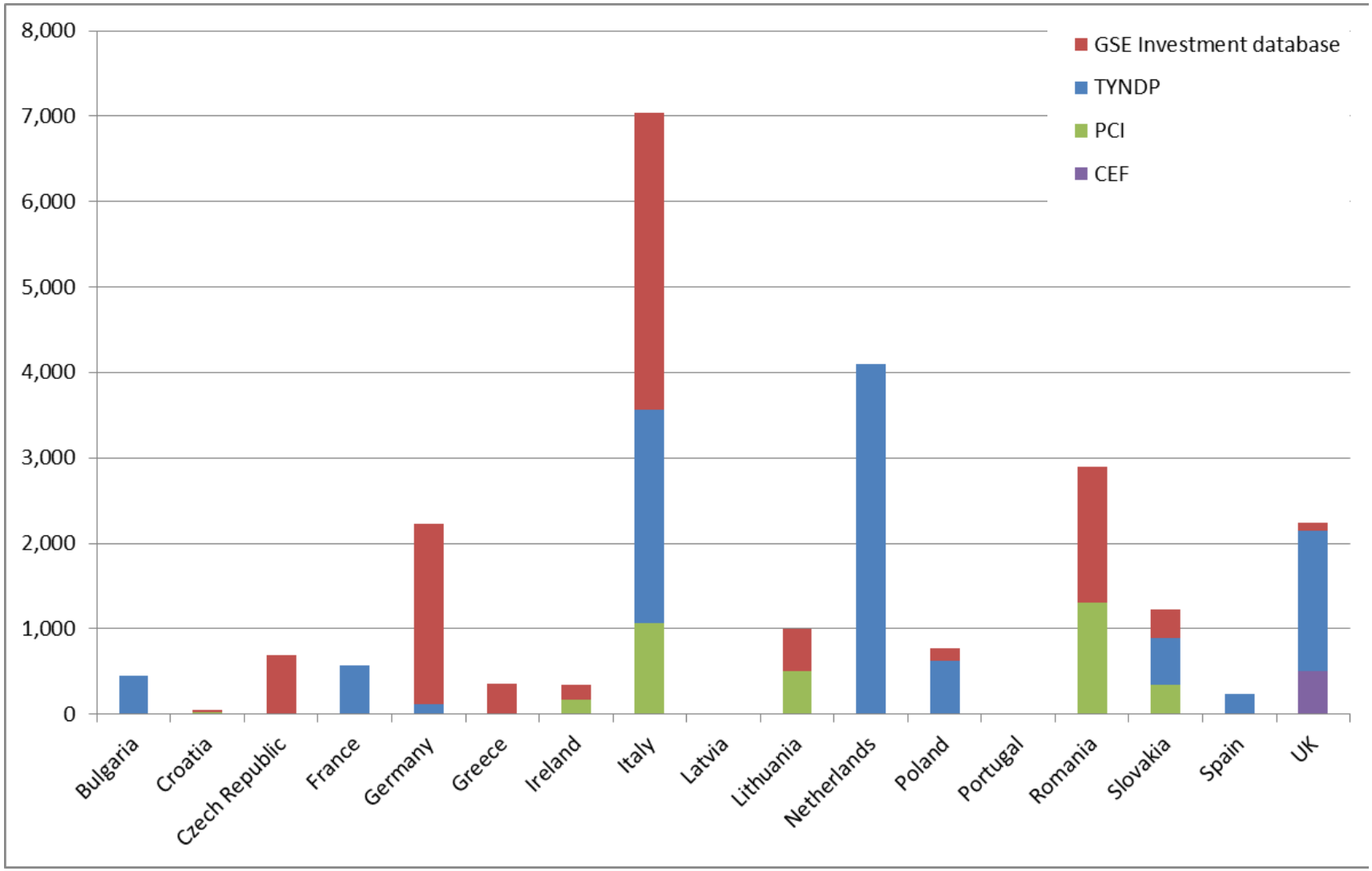
- High gas storage levels before start winter (>90%)
  due to high levels in March 2014
- Relatively warm winter, but significantly higher withdrawal rates
- Gas storage level vary from year to year significantly depending on various factors on the wholesale market

Gas storage projects 2015 – 2024 in EU-28



Source: GSE investment database 2015, ENTSOG TYNDP 2015, DG ENER, projects that will come online in 2015 – 2024

Gas storage projects 2015 – 2024



Source: GSE investment database 2015, ENTSOG TYNDP 2015, projects that will come online in 2015 – 2024