NATURAL GAS STORAGE AND ITS REGULATION

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OVERVIEW: WHAT IS STORAGE

• Storage activity performs injection of natural gas into facilities when supply > demand, and extraction (withdrawal) when demand > supply

• Usually the injection/withdrawal process is a seasonal cycle: injection during summer, and extraction during winter

• It is cheaper to store gas near markets than to build larger pipelines if production wells are “far away”

• Short-term cycles and non-cyclical operation driven by commercial opportunities are increasingly common, notably in advanced markets
OVERVIEW: TECHNOLOGY

• Facilities: underground geological formations (depleted oil/gas fields, aquifers, and salt cavities), LNG sites.

• Strong technical links with production activities (know-how, equipment, sites).

• Storage activity is characterised by:
  • medium-term horizon in development (2-6 years)
  • long-term horizon in operation (20-40 years)
  • high capital intensity
  • limited economies to scale
Storage system scheme (depleted fields or aquifers)
OVERVIEW: PERFORMANCES

- Storage facility performances: space, injection and withdrawal rates (deliverability)
- May increase performances by raising pressure, within limits
- Deliverability also increases with more wells
- Peak deliverability falls as working gas is used up
- Depleted fields: large space / slow injection and withdrawal
- Aquifers: similar, more costly
- Salt cavities: less space/fast injection and withdrawal
- LNG: little space/slow injection-fast withdrawal (peak shaving, short term cycling)
Investment costs (€cent/Mcm of working gas; source: A. Cretì, 2009)
OVERVIEW: STORAGE TYPES

• Depleted fields are by far dominant and cheapest if available
• Aquifers require larger investment, notably in non-recoverable gas needed to achieve reservoir pressure (base or cushion gas)
• Salt cavities and LNG facilities are far smaller by space but more flexible and fast
• Salt cavities are more costly than other UGS but require less base gas, hence cost is less related to gas prices
Storage plants by type, existing and new

Figure 46 Shares of existing types of storages based on volume capacity
- Depleted field: 69%
- Aquifer: 19%
- Salt Cavity: 10%
- LNG Peak Shaving: 2%

Source: GSE

Figure 47 Investments in storage, all investments (long term)
- Depleted Fields: 68%
- Aquifers: 26%
- Salt cavities: 4%
- LNG Peak Shaving: 2%

Source: GSE
STORAGE FUNCTIONS

• Flexibility / load management
• Balancing
• Emergency reserve in case of supply failures ("strategic storage")
• Curbing price fluctuations (buffer role)
• Exploiting price fluctuations (commercial or speculative role)
STORAGE AS A FLEXIBILITY TOOL

• Seasonal fluctuations:
  - gas demand dominated by winter heating peak
  - in warm climate markets, summer peak from electricity peak due to air-conditioning
  - in temperate or larger markets, double peak may occur

• Short-term swings
  - cold spells
  - weekends

• Daily fluctuations
  - mostly covered by linepack pressure changes

• Balancing:
  - physical balancing of network by TSO
  - commercial balancing by shippers
COMPETING FLEXIBILITY TOOLS

• Production flexibility
  - most effective if close to market, e.g. in U.K.
  - production wells are normally less flexible

• Import flexibility
  - most effective if close to market, e.g. from Norway into NW Europe
  - normally more expensive, but this may change for mature infrastructure

• Linepack
  - usually a substitute for short term swings only
  - may have a larger role for smaller markets, notably in case of large transit flows

• Customer interruptibility
  - notably power producers, large industry
STORAGE AND OTHER FLEXIBILITY TOOLS IN ADVANCED MARKETS

• Virtual storage (or parking)
  ➢ a market service offering similar performances but based on a combination of flexibility tools
  ➢ shippers may be interested in the performances of services rather than on how these are provided

• Spot markets
  ➢ may provide flexibility services in a better way even if users do not know how

• Regulation of storage only - rather than flexibility services - may distort the market and prevent innovation
STRATEGIC STORAGE

- Reserve to be used in case of supply interruptions
- Direct or indirect Public Service Obligation
- Not for general market usage
- Controlled by government
- Maybe shared (e.g. Italy) or dedicated facilities (e.g. Hungary)
SEASONAL STORAGE DEMAND DRIVERS (1)

- Gas consumption demand swings (Ramboll 2008 study estimates):
  - 1 unit of residential and commercial demand requires ~ 0.8 units of storage WG
  - 1 unit of industrial and power generation demand requires ~ 0.4 units of storage WG
  - Renewable energy likely to require more – very important future driver!
  - 1 unit of lost domestic gas production, replaced by long distance imports, requires ~ 0.3 units of storage WG
SEASONAL STORAGE DEMAND DRIVERS (2)

- Availability of other flexibility tools
  - Domestic or “close” production
  - LNG terminals
  - Easily interruptible customers, e.g. multi-fuel power stations
- Distance of remote sources
- Pipeline usage flexibility
  - Theory forecasts lower load factors of pipelines as markets get more mature
MATCHING DEMAND SWINGS: EXAMPLES (Source: Creti, 2009)
COMMERCIAL STORAGE (1)

- Exploitation of seasonal price fluctuations, geographical price spreads
- Storage may be regarded as an “option”
  - often private investment decisions follow the “option” model
  - invest if justified by expected seasonal spreads
- Price seasonality common due to swinging demand
  - only partly reduced by commercial storage
  - seasonality recently reduced
COMMERCIAL STORAGE (2)

• Greater focus on short term, high deliverability storage, due to
  - more open and global markets
  - liquid hubs
  - backing up intermittent renewable generation
  - “storage” of renewable power?
  - daily pipeline balancing requirements
• Larger role of “fast cycling” (LNG, salt caverns)
• Companies expect increase in storage value
• More open TPA to pipelines may increase opportunities to use cross border storage
  - mostly used by incumbents so far
COMMERCIAL VS. BUFFER STORAGE

- Private sector prefer to exploit short term arbitrage opportunities by low cost facilities
- Limited bulk storage investment after liberalisation
- Buffer role of storage
  - traditional use in agricultural markets to curb price fluctuations of primary consumption goods
  - governments may dislike large price swings and act to counter them
  - not much used in oil and gas markets
  - in the oil market, this role has been played by OPEC, rarely by IEA
POLICY ANALYSIS OF STORAGE: MAIN ISSUES

- Is storage adequately provided by markets?
- Is there enough competition?
  - among storage companies
  - by other flexibility services
- Or: is regulation necessary?
- Is regulated monopoly more efficient than competition?
- Should storage be integrated with transmission and / or distribution?
- Should strategic storage be mandatory?
IS STORAGE ADEQUATELY PROVIDED BY MARKETS? (1)

• The private sector tends to provide mainly short term, low cost facilities (e.g. LNG storage)
• The private sector tends to provide bulk storage to cope with demand fluctuations:
  ➢ as a function of source distance
  ➢ as a function of demand variability
  ➢ if its value is higher than producing the resource
• Ramboll (2008) study found that new storage investment plans exceed likely demand by 30-50%
  • but not all plans are implemented
IS STORAGE ADEQUATELY PROVIDED BY MARKETS? (2)

• In the past, several integrated companies probably provided relatively large storage capacity, as they were under strict government control and overstated risk of supply cuts, and pass through costs

• Newcomers may like to invest more to be independent of incumbents, due to TPA difficulties

• Not all current plans likely to be implemented but demand for seasonal storage likely to be satisfied by markets
STORAGE WORKING GAS VS. MARKET SIZE (Bcm)
DID STORAGE DEVELOP AFTER LIBERALISATION?
STORAGE WORKING GAS DEVELOPMENT: COMMENTS (1)

- In some cases, facilities are used mostly by foreign markets, e.g., Western Austrian sites by Germany.
- Geology helps to explain why countries are “long” or “short” towards the model, e.g., Belgium.
- Total EU available WG increased by 22.5% between 2006 and 2011 – far more than consumption – as production declines.
- Similar but unequal development in regulated regimes (+19%).
STORAGE WORKING GAS DEVELOPMENT: COMMENTS (2)

• Significant new investment expected, notably in increasingly liquid and “short” markets (UK, Poland, Spain, Germany/Austria, Romania, NL, Italy...)
• Widespread feeling that storage is still scarce in most markets
• Do storage prices reflect the feeling?
REGULATED & Negotiated “BUNDLE” PRICES

2004 2011

€/cm³ (MWh)

Austria  Belgium  Bulgaria  Czech Republic  Denmark  France  Germany (ECN)  Germany (WAGS)  Hungary  Italy  Netherlands  Poland  Portugal  Romania  Slovakia  Spain  United Kingdom
THE PRICE EVOLUTION (1)

• Average prices of “bundles” up by 25% between 2004 and 2011 (8 sites)
  ➢ Bundle: working gas units with associated average injection & withdrawal capacity
• New flexibility products available besides traditional ones
• Some convergence achieved, standard deviation decreased by 35% as highest prices (Germany) fall
• Regulated storage no longer cheaper on average (2% less than negotiated)
THE PRICE EVOLUTION (2)

- Higher prices for new costly facilities (e.g. small salt caverns, aquifers)
- Lower prices in some (but not all) Central & Eastern Member States, with lower historical costs & Opex
- Variability of prices (including regulated) may be due to sharp differences in cushion gas valuation
- In Western Europe, relatively cheaper deals where auction-based allocation prevails (Netherlands, U.K.)
REGULATION OR COMPETITION? (1)

- Negotiated tariffs work better with STS competition (it assures no discrimination), or if other flexibility tools available
- If substitutes are weak, TPA regulation is necessary
- High market concentration in most European countries
- Markets may inherit dominant positions of incumbents, with fully depreciated facilities
- Gas storage is a potentially competitive industry, but in practice it may be an essential facility
- Little antitrust action, capacity release
REGULATION OR COMPETITION? (2)

- Storage has long been bundled with transport
- Bundled service may be more efficient but less transparent, discourage competition
- Transmission operators still often control storage
- TPA to storage required
- TPA may be negotiated or regulated
- Functional and administrative unbundling
- 3rd Package (Directive 2009/73/CE) requires legal unbundling of storage operators
Market concentration of gas storage capacity
(source: Ramboll, 2008)
THIRD PARTY ACCESS REGIMES IN THE EU

- Most EU Member States have chosen negotiated TPA
- British case:
  - ✓ Regulated tariffs
  - ✓ → Auctions
  - ✓ → Competition

IS THERE ENOUGH COMPETITION?

• In 2008-9, EU regulators found limitations in access to storage
• Amendments to the existing Guidelines of Good Practice proposed
  ➢ Standard booking processes to be introduced
  ➢ Transparency of used capacity, to be published on day-ahead basis
  ➢ Restrictions of re-nomination rights
  ➢ Auctioning of non-nominated capacity
NEW GUIDELINES OF GOOD PRACTICE FOR STORAGE OPERATORS (1)

• Published February 2011, not legally binding
• Not the best timing as 3rd Package implementation looming
• Several proposals watered down
• Main new requirements (Capacity Allocation)
  • Start allocation by an Open Subscription Period
  • If demand exceeds supply, allocate by auction
NEW GUIDELINES OF GOOD PRACTICE FOR STORAGE OPERATORS (2)

• Main new requirements (Congestion Management)
  - SSO to implement secondary market
  - Share forecasts with users, maximise interruptible capacity

• No limitation of re-nomination rights introduced
  - it may be at odds with SoS

• Some improvement for short term trade but new entrants must invest in long term capacity for serious challenges
STORAGE TARIFF REGULATION:
AVERAGE LEVEL

• Valuation criteria as usual but...
• Cushion gas valuation at opportunity cost
  ➢ often most difficult issue
• Inadequate valuation may lower current tariffs but discourage new developments
  ➢ Producers may prefer selling the gas
• Long term gas prices may be a reasonable solution
STORAGE TARIFF: STRUCTURE

- Usually three components:
  - Revenues from Space = RoR x (net value of underground assets + cushion gas) + depreciation of underground assets
  1. Related to maximum available space
     - Revenues from peak day withdrawal capacity = RoR x (net value of above-ground assets: compressors) + depreciation
  2. Related to annual maximum delivery capacity
     - Revenues from gas volumes injected and delivered = operating costs
  3. Related to injection / extraction energy
ACCESS RULES (1)

• First come first serve common
• Pro-rata
  ➢ both may favour incumbents or “lucky” players
• Auctions
  ➢ incumbents may be strongest bidders
  ➢ economic theory shows incentive to hoard capacity by dominant players, to create or preserve bottlenecks, prevent newcomers' entry
  ➢ however, capacity hoarding is more costly for incumbents under auctions than under regulated tariffs
  ➢ vertical integration increases scope for capacity hoarding
ACCESS RULES (2)

- **Open seasons**
  - suitable for new facilities
  - less common in storage than in transmission
  - lower economies of scale should facilitate new developments

- **Merit orders / PSOs**
  - usually introduced to ensure storage availability for premium users, e.g. households in winter
  - implementation difficulties as actual use is hard to detect, stored gas may be “hijacked”
PENALTIES

- May be related to storage role in balancing
- It may be hard to disentangle imbalances on storage from transportation use due to metering problems
- Most storage flows are common to several shippers and need be estimated
- Penalty regime may aim at preserving storage deliverability by setting usage guidelines
SHOULD STRATEGIC STORAGE BE MANDATORY? (1)

- In a competitive market, companies are likely to underestimate risk of supply disruptions or expect such risk to be tackled by public policy (moral hazard)
- Therefore, some countries require strategic storage by direct obligation or by defining indirect PSO, e.g. contingency plans for emergencies
- In fact most countries require some form of strategic storage but in several cases these are controlled by suppliers or TSOs.
SHOULD STRATEGIC STORAGE BE MANDATORY? (2)

• Others think that strategic storage is too expensive and that risk is overstated
  ➢ Official GSE position
  ➢ Suppliers are interested in keeping flows going
• Strategic storage obligation may be ineffective as it may “crowd out” commercial storage
• Discriminatory measures against imports would encourage faster depletion of domestic resources
• Discriminatory storage obligations based on source of supply hard to implemented in open markets, where the origin of supplies becomes uncertain
SHOULD STRATEGIC STORAGE BE MANDATORY? (3)

• Lack of coordination may lead to arbitrage opportunities among different national regimes
• Optimal strategic storage should be an international decision, but countries may prefer to free-ride and expect help from “richer” neighbours
• Strategic reserves should be kept separate and under direct state control, as for petroleum
STRATEGIC STORAGE IN THE EU

- Obligations to stockpile gas needed in case of extreme weather conditions (usually 1/20 winter) or other emergencies:
  - TSO (DK, CZ, BG, BE)
  - Shippers, on non-EU imports (IT, PL)
  - Suppliers (FR, ES, HU)

- Obligation to supply in extreme weather or other emergencies without stockpiling obligations:
  - Suppliers (DE, UK)
ALTERNATIVE OPTIONS TO STRATEGIC STORAGE

• International dedicated facilities
  - few available, mostly in Ukraine, North Sea

• Increased co-operation
  - feasible if risks are weakly correlated (e.g. diverse suppliers, consumption patterns)

• Improve fuel switching by power & steam producers
  - environmental and technical problems
  - costs very variable, high if new capacity needed

• Use cushion gas
  - may damage some facilities
  - acceptable on voluntary basis
IMPACT OF SECURITY OF SUPPLY REGULATION
(994/2010): REQUIREMENTS

• N-1 formula applies to peak (daily) demand
• Supply standards applicable to protected customers, i.e. residential + max 20% SME + single fuel district heating
• Article 8. Protected customers entitled to:
  ➢ 7 days’ supplies under extreme (1/20) peak temperatures
  ➢ 30 days’ supplies in case of exceptionally high demand
  ➢ 30 days’ supplies in case of largest supply infrastructure interruption under average winter conditions
SUPPLY REQUIREMENTS (REG. 994/2010, ART. 8) AND STORAGE SPACE

Storage WG compared to SoS regulation requirements (ratio)

- 30 days largest source interruption
- 30 days 1/20 winter demand

Countries and their storage requirements: Austria, Belgium, Bulgaria, Czech Republic, Denmark, France, Germany, Hungary, Ireland, Italy, The Netherlands, Poland, Portugal, Romania, Slovakia, Spain, United Kingdom.
PEAK CAPACITY SOURCES

% of annual consumption

- Storage withdrawal
- Import
- Production (flat)

- United Kingdom
- Spain
- Slovakia
- Romania
- Portugal
- Poland
- Netherlands
- Italy
- Ireland
- Hungary
- Germany
- France
- Denmark
- Czech Republic
- Bulgaria
- Belgium
- Austria
SECURITY OF SUPPLY CONSTRAINTS: N-1 RULE

- applies to peak (daily) demand
- requires adequate capacity if largest source not available, storage essential (as shown by Jan. 2009 emergency)
IMPACT OF SECURITY OF SUPPLY REGULATION (994/2010): COMMENTS

- Strategic storage obligation rejected
- Any obligation may be satisfied jointly with other Member States
- Even if storage were the only source to cope with supply disruptions, it is usually more than enough
- Peak requirement may be harder to achieve at end of winter for some countries
REFERENCES