STORAGE: OPTIMISING POWER GENERATION ASSETS USING UNDERGROUND SALT CAVERNS

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Unlike other forms of energy, electricity and gas cannot be temporarily stored in large quantities very easily. This is precisely why they tend to be the most volatile commodities in terms of price in open, freely traded markets. Gas demand has become increasingly more variable in Australia and unconventional gas supply operations in particular function much better with access to large gas storage capacity so that gas production operations do not essentially respond to gas demand swings and vice versa.

The large LNG export trains at Gladstone will present very large gas demand swings during both planned and unplanned outages. Additionally as renewable energy sources increase, installed electricity generation facilities in general have become increasingly less reliable. While variable electricity demand has been a historical issue the introduction of less reliable renewable generation has exacerbated this issue. The role of gas-fired power generation for backstopping renewable power sources has increased.

Both gas and electricity are capital and infrastructure intensive industries and they function much better in terms of capital efficiency and operational reliability when storage is incorporated at various points along the value chain. The commercial storage of electricity is not as widespread as the commercial storage of large quantities of gas globally, but large underground salt beds have been successfully used for both applications for decades and increasingly so as markets evolve.

Subsurface halite (salt) beds in situ are extremely soluble, highly incompressible, and are thought to be almost impermeable below about 300 metres from the ground elevation. They are nonporous and therefore represent a unique host material for the development of large caverns and storage of materials that do not cause dissolution of salt. Canada was a pioneer in this area with LPG storage in solution-mined salt caverns since the late 1940s and gas since 1961.

England was the first country to store crude oil in salt caverns during the 1950s. Thousands of salt caverns have been brined across Europe and North America whenever geological conditions are favourable and many materials other than hydrocarbons are now stored and cycled in these underground salt caverns. Figure 1 is a map of the major salt deposits known to exist at this time on various continents globally.

While gas resources, including gas reserves, have been the focus in Australia historically, the unprecedented tightening of gas supply and demand in the East coast due to the three large LNG export facilities at Gladstone has resulted in a reliable gas deliverability issue that has and will continue to impact East coast gas pricing levels and the availability of reliable gas supplies to non-LNG demand.

Underground gas storage can play a major role in the provision of reliable swing capacity and short term gas inventories that enable much less supply disruption and less domestic market price volatility in a tight gas supply/demand scenario. Gas-fired power generation can also be a major contributor to short term gas demand fluctuations. The most preferred method of gas storage for non-seasonal or shorter term swing capacity is underground salt caverns.

Salt caverns brined out of thick salt beds or domes are essential large pressure vessels that, unlike depleted gas reservoirs, can cycle gas in and out at tremendous rates. This buffer between gas production facilities and gas demand can lower gas supply costs and improve gas supply reliability as has been demonstrated for decades overseas.

Open access gas storage facilities that are connected to large gas pipelines are the key to accommodating the requirements of any tight gas supply

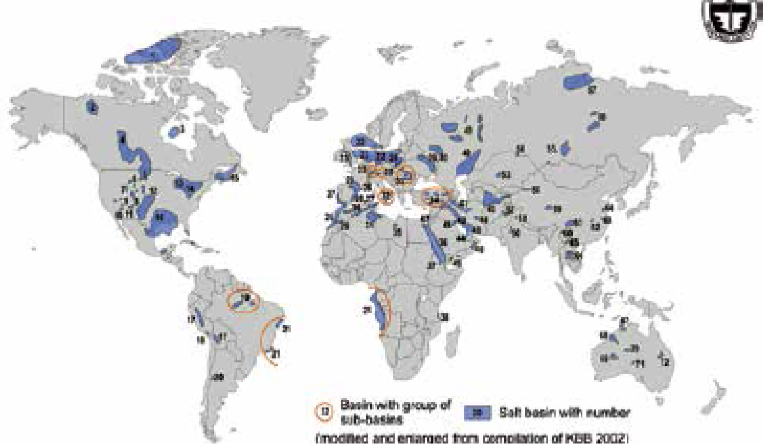


Figure 1: Major underground salt deposits worldwide
Source: KBB Underground Technologies (2002

and demand scenario. In Australia, only the relatively small Iona gas storage facility located in southwest Victoria in the onshore Otway Basin and the relatively small Mondarra gas storage facility located in Western Australia's onshore Perth Basin are currently available and used by third parties who contract for gas storage services. The remaining gas storage facilities operating in Australia are owned and operated by gas production joint ventures and are not generally available to the market.

Gas-fired power use

Salt caverns formed in underground salt deposits have at least two proven applications for the optimisation of power generation assets. First, the role of gas-fired power generation in Australia has evolved to become more of a peaking power supply. This new role has created some interesting challenges to the gas industry, not least of which is to provide large quantities of supply to gas-fired peaking power plants that respond to extremely volatile and short term electricity price signals.

The gas industry globally has discovered that short term, firm, gas-fired power generation demand is a perfect match for the characteristics of underground salt cavern gas storage.

The value of fast cycling, salt cavern gas storage has increased substantially with the volatile gas demand load profile associated with many gas fired power generation facilities operating in the new electricity market structures. The gas fired peaking power plant and the salt cavern gas storage facility do not have to co-exist on the same site, which is the ideal case whenever the electricity grid coincides with the location of underground salt deposits.

The second, and perhaps less well known application of salt cavern storage to the power generation industry, involves the generation of green power from wind and solar power generation facilities. These facilities are not that reliable since they rely on the availability of sufficient wind and sun and this does not match the demand for electricity generally.

Compressed air energy storage (CAES) facilities utilising salt caverns have been used for more than 30 years and this application is becoming more popular with the current 'dash to green energy' and the ensuing increase in wind and solar power.

CAES facilities utilising salt caverns exist at McIntosh, Alabama in the United States (Alabama Electric Cooperative's 110 MW facility built in 1991) and at Huntdorf, Germany (E.ON's 290 MW CAES plant built in 1978) where electricity generated in periods of low demand is used to pump air into underground salt cavern storage. This high pressure air is later used to generate electricity during periods of high demand.

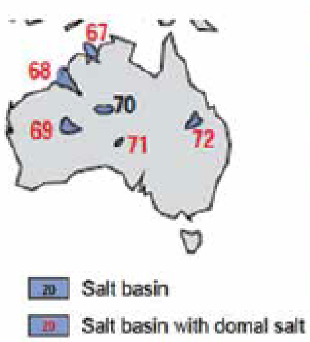
The price differential between the low and high demand periods more than offsets the cost of CAES including all energy losses (approximately 50% round trip efficiency compared to 98% for gas storage). This application is gaining popularity as large wind farms and large solar facilities seek ways to increase their reliability and project economics. Large scale distributed energy storage is vital for significant distributed penetration of variable renewable energy sources in an integrated manner to help assure energy security.

Salt caverns used for CAES and gas storage are used in ways that cycle air and gas pressure respectively on a daily and weekly basis. Salt caverns provide the ideal storage container for they are characterised by greater injection/withdrawal rates, greater pressure variation rates and numerous cycles over the anticipated operating lifetime than any other type of storage. While salt caverns have a long history of extensive use for liquid hydrocarbon and petrochemical storage the use of salt cavern storage for gas and compressed air has been relatively recent (past 30 years) and the popularity is growing with applications to better serve the power generation market as it evolves with a new market structure and with increasing environmental awareness and concern.

CAES is very complementary to both solar and wind generated power as the intermittency of these green power sources can be problematic and significantly deteriorate the economics of such projects. CAES is becoming popular with developers of both solar and wind power projects as they seek to both reshape the power generation curve into the higher priced periods of greater power demand and to provide reliability of power as required.

Australia has a few known world class underground salt deposits (Figure 2). Although well-established overseas for decades, the solution mining of underground salt deposits has yet to be performed here. Unfortunately, the salt deposit locations do not coincide with the large population centres very well. The Devonian age Boree Salt deposit located in Queensland's Adavale Basin is of interest to both the electricity and gas industries located in southeast Queensland (see salt deposit #72 in Figure 2).

It is only a matter of time before Australia taps into this valuable resource. Utilising a mineral for storage in Australia is indeed pioneering. Innovative Energy Consulting has been a pioneer in this regard promoting this activity in the Adavale Basin for the past decade. Tellus Holdings is another salt developer promoting this activity in the Northern Territory for the past five years.



No of Salt Basin	Name of Salt Basin	Age of Main Salt Formation
67	Bonaparte Gulf	Devonian
68	Canning	Silurian
69	Officer	Precambrian
70	Amadeus	Precambrian, Cambrian
71	Arckaringa	Cambrian
72	Adavale	Devonian

Source: KBB Underground Technologies

Figure 2: Major salt deposits in Australia