Access to Energy

Quarterly Bulletin




ISSN 2278 - 5663

Vol 3, 2020

EDITORIAL

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Intermediate Technology in the time of Pandemic

In 1965, Dr. E F Schumacher, an economist, journalist and progressive entrepreneur, wrote a paper for a conference on the *Applications of Science and Technology to the Development of Latin America*, organized by UNESCO in Santiago, Chile. The theme of the paper was how to transfer technology to those not yet in possession of it. Basically, raising a concern that the technologies failed to fit into the actual conditions and limitations of those who need the most. This was the genesis of Intermediate Technology Development Group (ITDG) set up in London by Schumacher based on the principle of smaller working units, communal ownership and regional workplaces utilizing local labour and resources.

The above task can be formulated in four propositions according to his hypothesis. *First*, the workplace has to be created in the areas where people are living now, and not primarily in metropolitan areas where they tend to migrate. *Second*, these workplaces must be, on average, cheap enough so that they can be created in large numbers without this calling for an attainable level of capital formation and imports. *Third*, that the production method employed must be relatively simple, so that demands for high skills are minimized not only in production process itself but also in matters of organization, raw material supply, financing, marketing and so forth. And *finally*, the production should be mainly from local material and mainly for local use. He argued that these four requirements can only be met if there is a regional approach to development (decentralization) and there should be a conscious effort to develop and apply what might be called an intermediate or appropriate technology.

The Covid-19 has shifted the focus from globalization to localization. Countries and populations today are promoting self-sufficiency, shorter supply chains, containments and local employment, control on imports, among others. All of these echo what Schumacher proposed five decades back, and the new normal post pandemic has found relevance in what he described as Small is Beautiful.

The above article is based on excerpts from Schumacher's book *Small is Beautiful- a story of economics as if people mattered*. IT Power (Intermediate Technology Power) is proud to be a Schumacherian initiative.

Large scale Hydrogen storage: The missing link for the Hydrogen transition

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There is growing global interest in hydrogen. The idea of a hydrogen economy is not new, but there are increasing signs that its time may finally be coming. ITP is increasingly involved in projects involving hydrogen. Hydrogen is actually used at large scale already in the chemicals and oil and gas industries. Currently it is almost all produced by the steam reforming of methane applied to natural gas.

According to the Australian Chief Scientist Alan Finkel, *''the global market for hydrogen is expected to reach USD 155 billion by 2022, with a number of Australia's existing trading partners, who are comparatively resource constrained, implementing policy commitments for hydrogen use''*.

The future interest however, is directed at 'green hydrogen', that is hydrogen produced without green house gas emissions. The greatest interest here is to use renewable electricity to split water via electrolysis. There are also a range of earlier stage approaches including; biomass gasification, thermal water splitting, biochemical and photo catalytic processes. Combining fossil fuel based options with CO_2 sequestration is also an option about which there is considerable debate regarding its green credentials.

Every hydrogen energy application requires a stable controllable flow of hydrogen; therefore, it is essential to store hydrogen to maintain a continuous supply. However, there are challenges:

- Hydrogen has a very low volumetric density
- To store a considerable amount of hydrogen in a vessel, hydrogen needs to be compressed to high pressures (up to 700 bar)
- Pressure vessels capable of with standing such pressures are typically small and expensive

There is no green hydrogen application without green hydrogen storage. In order to achieve the transition to a green hydrogen economy, a cheap, large scale, replicable storage technology is needed. One of the key future visions is the idea of international trade in hydrogen as illustrated in Figure 1. This require converting hydrogen to ammonia or cryogenic liquid for shipping. Buffer storages of the order of 500 to 1000t of hydrogen will be needed for such a plant.

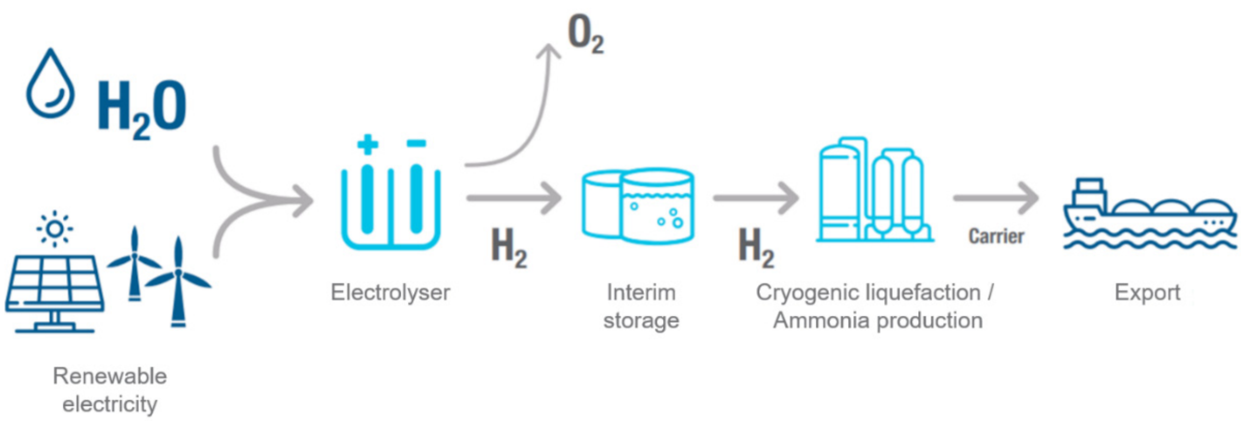


Figure 1 Green Hydrogen production and storage

There are range of hydrogen storage options which are currently in use including (Figure 2).;

- Composite pressure vessels for hydrogen vehicles
- Conventional steel pressure vessels
- Large scale salt caverns where suitable geological salt deposits are available.

Figure 2 Hydrogen storage options currently in use

Vertical Shaft Hydrogen Storage

ITP Thermal[1] has teamed up with the Australian company Abergeldie Complex infrastructure[2] to pursue an innovative idea for Vertical Shaft Hydrogen Storage. The storage concept is an adaptation of proven shaft drilling techniques from the mining industry to storing hydrogen in a vertical cavity built underground (Figure 3). The idea adapts 'blind bore shaft drilling'', a technique that is used to construct large ventilation and access shafts for underground mines.

The Vertical Shaft design offers:

- **Cost effectiveness**

The surrounding rock takes on the duty of containing the hydrogen pressure – no need for costly pressure containment materials

- **Replicability**

The shaft storage construction process can be reproduced in different locations with minimal design adjustment

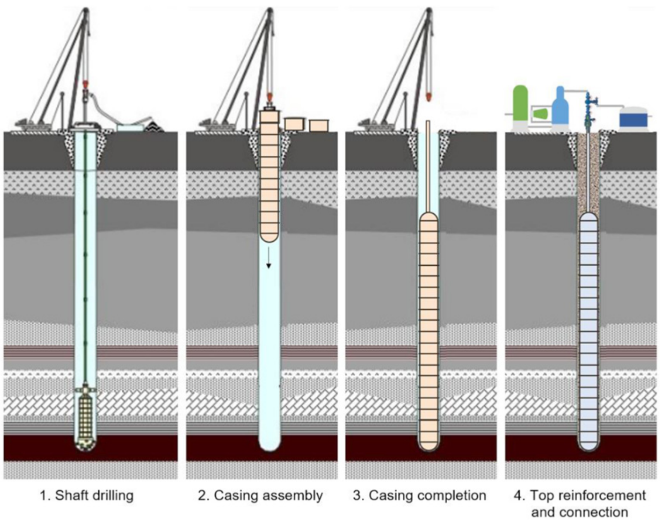
- **Large scale application**

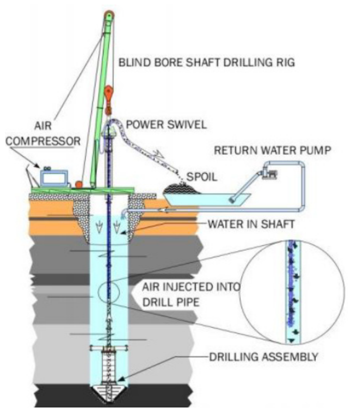
Hydrogen storage sizes of 50 to 500 tonnes per shaft. For larger storage, multiple shafts can be built in the same location

- **Small footprint**

The above ground footprint is very small compared to equivalent pressure vessel storage

The cost comparison graph (Figure 4) clearly indicates that vertical shaft hydrogen storage approach offers a considerably more cost effective solution than any other ground storage option whilst offering modularity and site independence advantages over bespoke lined rock or salt caverns.





Southern Coalfields ventilation shaft, NSW.
Photo: Abergeldie

Figure 3 Construction of a Vertical Shaft Hydrogen Storage System

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[1] ITP Thermal leads activity in thermal, thermochemical, hydrogen and ammonia related work for the ITP Energised group globally. Company website: https://itpthermal.com/

[2] Abergeldie is a leading organisation in rail and transport, energy, water, dams and marine. Company website: https://abergeldie.com.au/

Table 1

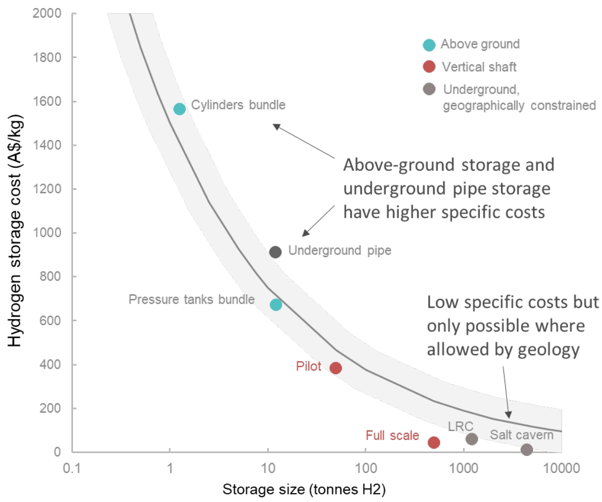

Figure 4 Storage size (tonnes of Hydrogen) vs storage cost (A$/kg)

ITP Thermal and Abergeldie form a well-qualified and capable team to take this technology forward. The main goal is to prove the technical feasibility and the economic benefit of the technology. The team are aiming for a pilot project to be completed in the next few years.

Modern methods to deliver real reductions in Green House Gas (GHG) emissions in air-conditioned buildings

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The current challenge for HVAC engineers is be able to provide a high level of thermal comfort in an energy efficient manner. The authors argue that HVAC engineers must use the vitally important combination of right sizing and energy simulation to first predict, and then achieve, high performance outcomes in air-conditioned buildings. This two-step process benefits from the use of the most accurate algorithms to compute HVAC system sizing, and the application of practical experience and knowledge in the use of energy simulation programs like DesignBuilder which can represent system components and overall system control strategies to represent energy efficient HVAC systems. DesignBuilder incorporates the award winning, USDOE developed EnergyPlus simulation engine.

In many building projects, the energy simulation analysis is carried out by an ESD team, separate from the HVAC design team. The study presents the case for mechanical services engineers to leverage the opportunity of integrating these two functions to deliver exemplary design and performance outcomes. It has demonstrated how incorporation of the ASHRAE Heat Balance Method cooling load calculations into the EnergyPlus energy simulation engine allows for the development of a modern approach for the design of high performance, conditioned buildings, based on the use of right sizing AND energy simulation.

The authors have developed and used this design process for well over a decade. Combined with domain knowledge of HVAC systems, plant and control systems, it has resulted in the successful delivery and continued operation of a number of high performance buildings, particularly office buildings. An independent case study by the Office of Environment and Heritage (OEH 2016), NSW, Australia has documented a reduction of 46% annual electricity consumption for the Base Building (landlord's consumption) for an end-of-life HVAC plant upgrade in a 10,000m^2 office building carried out by the authors using this approach. Hopefully it will encourage more HVAC design engineers to combine their design and sizing skills with energy simulation skills for performance prediction.

Above article is the abstract of a published paper 'Load Calculation and Energy Simulation: The link between design and operation for building design'. The access to the full paper can be requested from the lead author at pcthomas@teamcatalyst.com.au

Scaling up building energy efficiency in emerging markets

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Building sector holds a great potential for achieving significant energy savings and GHG emission reductions, at least cost, in emerging economies. Globally, there has been an increase in both emissions and energy use from the buildings and construction sector. The global final energy consumption in 2018 has increased by more than 8 EJ (about 7%) since 2010 and stood at 127 EJ(*2019 Global Status Report for Buildings and Construction, WBC IEA*). This is mainly because energy efficiency efforts have not kept up with rising number of new buildings being constructed. The energy savings potential in buildings are largely untapped due to continued use of less efficient technologies, alongside lack of effective policies and investments in energy efficient buildings in many emerging markets.

Government policy support has been a key driver in accelerating building energy efficiency, and coupled with mandates/ regulations, helps achieve the set action plans and targets. It is equally important to have awareness and right attitude among consumers to understand the importance of energy efficiency. A few key enablers that help scaling up building energy efficiency markets are discussed below:

1. The adoption of **energy efficiency law(s)** or energy laws with a strong component related to energy efficiency is a new approach to reinforce the institutional setting for energy efficiency. An energy efficiency law gives a more durable status to energy efficiency policies as changing an existing law can often be a complex process. Energy efficiency law also provides a legal framework for adoption of other regulations including those for building energy efficiency. Many countries including India, China, Russia, Canada, Brazil have implemented energy efficiency laws (*World Energy Council study of 2013*).

2. **Building energy codes** have been the first and foremost regulations that has been useful in assuring reductions in energy use and emissions over the life of the building. Building energy codes are a part of building codes and establish minimum requirements that govern building construction. By December 2018, sixty-nine countries had implemented building energy codes that have been used to mandate the deployment of energy efficiency measures.

3. Further, **appliance labelling programmes** and **minimum energy performance standards (MEPS)** are effective instruments which enable authorities to obtain energy savings at a low cost, allow consumers to spend less on electricity, and encourage manufacturers to improve their products and become more competitive against imported, less-efficient products. MEPS specify the minimum level of energy performance that lighting, air-conditioning, electrical appliances and other electrical products must meet or exceed before used for commercial purposes. Around 76 countries as per the World Energy Council study of 2013 have already implemented at least one MEPS.

4. **Energy service companies (ESCOs)**, which offers energy services, design, retrofitting and implementation of EE projects, have facilitated EE implementation and helped mobilize commercial financing for the public sector. ESCO activities exist in many countries to different degrees. As a support mechanism, some countries have also set up public ESCO to act as a market facilitator and with the purpose to implement energy efficiency projects through private ESCOs.

5. **Financial support** in the form of capital subsidies, tax allowances (or exemption from income or sales tax) and accelerated depreciation to encourage energy efficiency investments have proved to be effective enablers for implementation of energy efficiency in buildings. Additionally, world over energy efficiency funds have also been created to provide finance for EE implementation.

6. **Training programs** are necessary to ensure the successful implementation of any project. Systematic programs designed to train energy professionals has helped in building a strong capacity for energy audits and energy efficiency implementation. Many countries have implemented training programmes as well as certification programmes for working professionals and even implemented changes in the standard university curriculum.

7. **Awareness programs** such as targeted awareness campaigns, media campaigns through national TV or Radio programmes has further benefitted the consumers and decision makers with the first-hand information on energy efficiency technologies, policies, costs and others which are needed to make informed choices.

The adoption and development of these enabling actions in emerging economies can effectively help in realizing the benefits of their energy efficiency potential.

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