**Medium Duration Energy Storage, 2024.**

Sometimes we take stuff for granted. The “middle child” is famously neglected and under-appreciated, but often even-tempered and productive. An event held at the IMechE Headquarters on Jan 12th of this year addressing *Medium Duration Energy Storage* (MDES) highlighted how the analogy applies in the family of energy storage technologies. MDES technologies have been under-appreciated and under-nurtured but will nonetheless take on the main responsibilities of balancing electricity grids in the coming generation.

To most people, “energy storage” intrinsically means batteries – and there is no doubt that batteries will (and already do) play an important role in ensuring that short-term excesses of electricity supply can be absorbed and that similarly-brief shortfalls in the available electricity supply from low carbon generation sources can be compensated using supplementary power from batteries. The batteries that we know (mainly Lithium-ion) are the glamorous and somewhat-flighty members of the family.

In recent years, realisation has dawned that the periods of sustained excess or shortfall in a future Net-Zero world will tend to persist for far longer than the <4hrs spells where conventional batteries excel. Attention has turned to hydrogen and other synthesised fuels as a cost-effective way to store energy for hundreds (and even thousands) of hours. ‘Quite right too – since only fuels can provide cost-sensible solutions for such long times. Synthetic fuels are the mature lynchpins of the family – the ultimate protectors against external disruptions, the eldest child on whom the others can always depend.

But what about the middle ground – the periods in the range ~4hrs to ~200hrs over which the costs of batteries per unit of stored energy make them relative unsuitable and over which the very poor turnaround performance and high power-costs of using hydrogen (or synthesised fuels) to “store electricity” also make this unattractive? In the future, more than 90% of all of the energy that comes out of storage (or other grid-balancing provisions) will emerge in this “Medium Duration” range of times. The (September 2023) report on Large Scale Electricity Storage published by the Royal Society showed that it is both possible and affordable for the UK to operate an energy system in which wind and sunshine provide most of the primary generation and in which making hydrogen and re-generating electricity forms the basis for nearly all storage. Modelling work supporting that report also showed that overall system costs can be reduced by upwards of 5% if a suitable blend of MDES technologies is incorporated. In that case, >65% of all energy emerging from storage is discharged from the MDES systems and >50% of the spend on storage facilities would get dedicated to these. The MDES technologies are the steady grafters of the family, the doers of chores, the competent-but-quiet ones.

MDES2024 was the third event in a series started in March 2020. All have been arranged to take place at the IMechE HQ in Westminster and the strong association with Mechanical Engineering is not accidental. Nearly all of the main candidate technologies are (thermo-)mechanical in nature.

MDES2024 and its predecessors were made possible by funding support from the Research England *Policy Support Fund* and Westminster was the optimal location because the main problem now to be solved for affordable Net Zero systems is how to ensure that the MDES technologies develop to the point where they can deliver major cost savings and other benefits based around stimulated economic activity to the UK. Batteries and hydrogen are each enjoying hundreds of millions of pounds of direct government support and quite rightly so. The MDES technologies are getting some support – but it is not nearly proportionate. This is especially ironic in the UK which fathered all mechanical engineering and which has especially strong opportunity to profit from MDES technologies because of its relative wealth of wind resources and relative dearth of solar and other potential sources of green energy.

Professor Seamus Garvey of the University of Nottingham opened the MDES2024 event by reprising the huge relevance of MDES technologies as solutions for the UK and the amazing opportunity to develop solutions for ourselves first before exporting widely. His co-chair, Tom Bent, reiterated the disproportionately low attention that these technologies still seem to attract.

The programme for MDES2024 featured three startup companies supported under the DESNZ-funded “Longer Duration Energy Storage” (LODES) competition: RheEnergise Ltd., Cheesecake Energy Ltd. and SynchroStor Ltd. It also featured three research projects funded by EPSRC. There were technology talks on compressed air energy storage, pumped-thermal (and other thermal) energy storage, pumped-hydro energy storage (including the use of extra-dense liquid) and on one non-mechanical MDES technology – the Iron-Air battery by Form Energy Ltd.. If that talk had one big message, it was that MDES markets are going to be very big and they should properly be approached with ambitions that are “billion-dollar-big”.

The penultimate session was dedicated to system modelling and very useful insights were achieved into just how substantial the effects of MDES are likely to be. The modellers were united in agreeing on the strength of the value that can be added by MDES in the UK. There were some differences about the estimates of how much MDES will be present in a cost-optimised system but the exact optimal quantities of MDES are highly sensitive to assumptions about performance and cost values.

The final session comprised a busy panel session led by Tom Bent in which four energy-industry experts presented views and interacted with inputs from both the cohort in the room and the set of online attendees. Some of the main emerging themes were:

1. The discussion on MDES is extremely timely and topical, given the recently opened consultation into the UK policy framework for “Long Duration Storage” (whose definition fully includes MDES).
2. Revenue support instruments are needed which reward technology for doing the right thing at the right time in the right location. Without these there will be insufficient investor, lender and developer confidence; storage assets will not materialise. This is particularly true of MDES technologies which have longer lives and high CapEx.
3. Long term policy certainty is especially important for those researching and developing new technology to answer system needs.
4. The UK made early advances in battery installation due to a conducive investment environment, and accessible market structure; but is currently losing its early lead as other markets offer higher less-risky returns for the scarce resource of capital.
5. Low-cost debt is a vital component in making storage viable and affordable. Support instruments are one route that allows new infrastructure to secure cheaper debt.
6. Most MDES technologies provide multiple services to the grid and add so greater value; but we are not near having a market structure that can reward them suitably.
7. MDES technologies can make a vitally important contribution to national system resilience and asset diversity.
8. No model can perfectly accommodate and predict all unknown future parameters and developments – particularly innovation; we should not delay introducing support for new assets, while we vacillate over a relatively minor degree of disagreement and uncertainty. Achieving some learning-by-doing in the space of MDES is vital now.
9. Many stakeholders would like to see time-series data and cost/performance assumptions underpinning all policy decisions. Understandably, commercial analysts and academic experts invest in developing the models are not necessarily keen to share those models but the data can be open.
10. The pipeline of engineers required to execute and install storage assets remains a serious concern, as in other areas of energy transition.

All of the presentations and the videos of the event are available at [www.era.ac.uk/events/MDES2024](http://www.era.ac.uk/events/MDES2024). The current government consultation closes on March 5 and details can be found at   
<https://assets.publishing.service.gov.uk/media/659bde4dd7737c000ef3351a/long-duration-electricity-storage-policy-framework-consultation.pdf>

**MDES2024: MEDIUM DURATION ENERGY STORAGE 2024  
*An event enabled by funding from Research England, Policy Support Funding*January 12, 2024 at The IMechE, 1 Birdcage Walk.**



**09:15 - 10:45: ADVANCES IN COMPRESSED AIR ENERGY STORAGE (CAES)**

* Isothermal CAES for Decentralised Energy Grid: Dr. Yasser Mahmoudi (Manchester Univ)
* Sustainable & Affordable CAES, Dr. Edward Barbour (Loughborough Univ)
* High Performance CAES through elevated temperature thermal storage, Dr. Wei He (KCL)
* Offshore CAES - FLASC, Dr. Daniel Buhagiar (FLASC B.V)
* CAES with Stored Heat, Dr. Mike Simpson (Cheesecake Energy Ltd.)

**10:45 - 11:15: REFRESHMENTS**

**11:15 - 12:30: ADVANCES IN MEDIUM DURATION ENERGY STORAGE SOLUTIONS**

* Iron Air: Enabling Ultra-Low Cost Multi-Day Storage, Cillian Totterdell (FORM Energy)
* Pumped hydro without the mountain, Lizzi Gold (RheEnergise)
* Small-scale Pumped Hydro projects. Mr. Jonathan Cox (AECOM)

**12:30 - 13:30: LUNCH**

**13:30 - 14:30: THERMAL ENERGY STORAGE**

* Topologically Engineered Thermal Stores, Dr. Adriano Sciacovelli (Univ. of Birmingham)
* PRISMA: Compressor Integrated Energy Storage, Dr. Adrian Alford (Innovatium)
* SynchroStor - a Pumped Thermal E.S. system, Prof. Win Rampen (Univ. of Edinburgh)

**14:40 - 14:50: REFRESHMENTS**

**14:50 - 15:35: MODELLING AND MEDIUM DURATIONS ENERGY STORAGE**

* The benefits of blending storage types, Dr. Tony Roulstone (Cambridge)
* Whole-system value of MDES&LDES solutions in Net Zero Futures, Prof. Goran Strbac (Imperial College)
* Monetising Medium Duration Storage, Dr. Iain Staffell (Imperial College London)

**15:40 - 16:40: PANEL SESSION: POLICY AND MARKET ISSUES AFFECTING MDES**

Panel Session chaired by Tom Bent (Paces Ltd.)

* Nina Skorupska, CEO of the REA (Association of Renewable Energy and Clean Technologies)
* Prof. Ian Arbon (Independent Consultant, EngineeredSolutions)
* Dr. Iain Staffell (Imperial College London)
* Sam Hollister (LCP UK)