GBES – Ground-Breaking Energy Storage

One-Page Outline (GBES-00)

This note sketches out the main performance characteristics of GBES – a novel grid-scale energy storage concept. If developed, GBES will compete in the high-power, high-energy market. Pumped hydroelectric storage (PHES) dominates this segment, accounting for >95% of all storage operated by the electricity supply industry (ESI). Key GBES parameters include:

Power Rating (Discharge): The ESI operates storage systems up to 3GW at present. The GBES power range will be ~100MW to multi-GW – the larger, the better because of benefits of scale.

Power Rating (Charge): PHES takes longer to charge (pump mode) than to discharge (turbine mode) due to energy losses in the cycle and because the pump rating is usually less than the turbine rating. This will be a limitation when future networks need to harvest large and erratic surpluses of wind, solar and other variable renewables. A quirk of the GBES concept enables asymmetric charging at a multiple of the discharge rate (a 1GW storage unit could fast-charge at >3GW, without much increase in capital cost).

Energy Rating: Today's high-energy systems typically have 6-10 hours delivery capability (charging overnight to help meet the next day's peak and to provide regulation/reserve services). GBES is intended for similar applications, but with 20-40 hour capability at negligible marginal cost – and >100 hours at moderate cost. This will help future networks during multi-day periods of low (or very high) renewable energy production.

Round-trip Efficiency: Similar to PHES ~80% (in principle, GBES should be slightly better).

Life and Cycle Life: Similar to PHES (~50 years and >10,000 cycles – basically, there is no limit to the number of cycles, other than the lifespan of ESI infrastructure).

Location and Footprint: GBES can be located in flat or hilly terrain. It can also be situated offshore or within inland bodies of water. This is its main advantage over PHES, which can only be used by networks in mountainous regions – and GBES would typically have an order of magnitude smaller footprint.

Speed of Response: Start up, load following, ramp-up and ramp-down performance is better than that of spinning reserve power stations or specialist gas turbine peakers. It is comparable to modern PHES equipped with variable speed pumping.

Utilisation: Typical PHES utilisation is around 1,000 equivalent hours/year at rated output power. This should improve to 1,500-2,000 hours in future, when erratic wind/solar resources provide more feast and famine opportunities. GBES can achieve >3,000 delivery hours/year (perhaps >4,000) because it can charge quickly and store much more energy than other technologies with the same rated output.

Cost: Early-stage cost estimates are notoriously unreliable, but GBES and PHES have features in common. Commercial GBES should have $/kW capital costs similar to PHES – lower at high powers because of scaling benefits. $/kWh capital costs should be distinctly better, when 10s of hours of energy storage are required. The round-trip $/MWh cost of the storage function should take this still further, due to higher annual utilisation (aiming for low tens of $/MWh). However, the principal opportunities for GBES are in regions where the terrain is unsuitable for PHES (i.e. most of the world) and so the two would seldom be in direct competition.

The purpose of this note is to provide a quick one-page outline. If it is of interest, please contact Frank Escombe for a fuller description (features, applications, operating principle and development challenges). The principle is reassuringly straightforward, undoubtedly valid and has been shared by concepts other than GBES for >150 years! We will be delighted to tell you more.

EscoVale Consultancy Services

One Brightlands Road, Reigate, Surrey RH2 0EP, UK

Email: escovale@escovale.com Tel & Fax: +44 1737 230820 Website: www.escovale.com