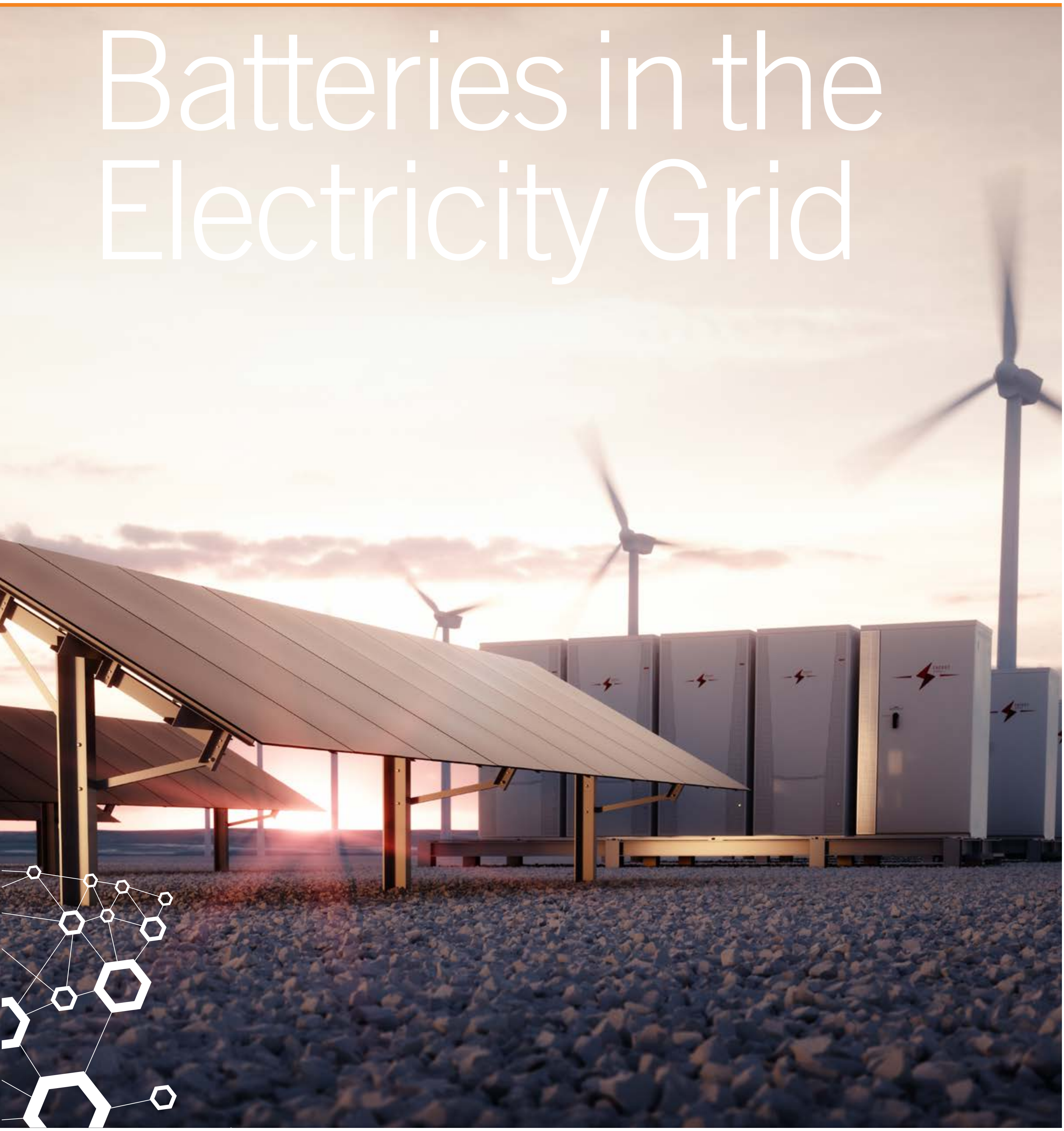
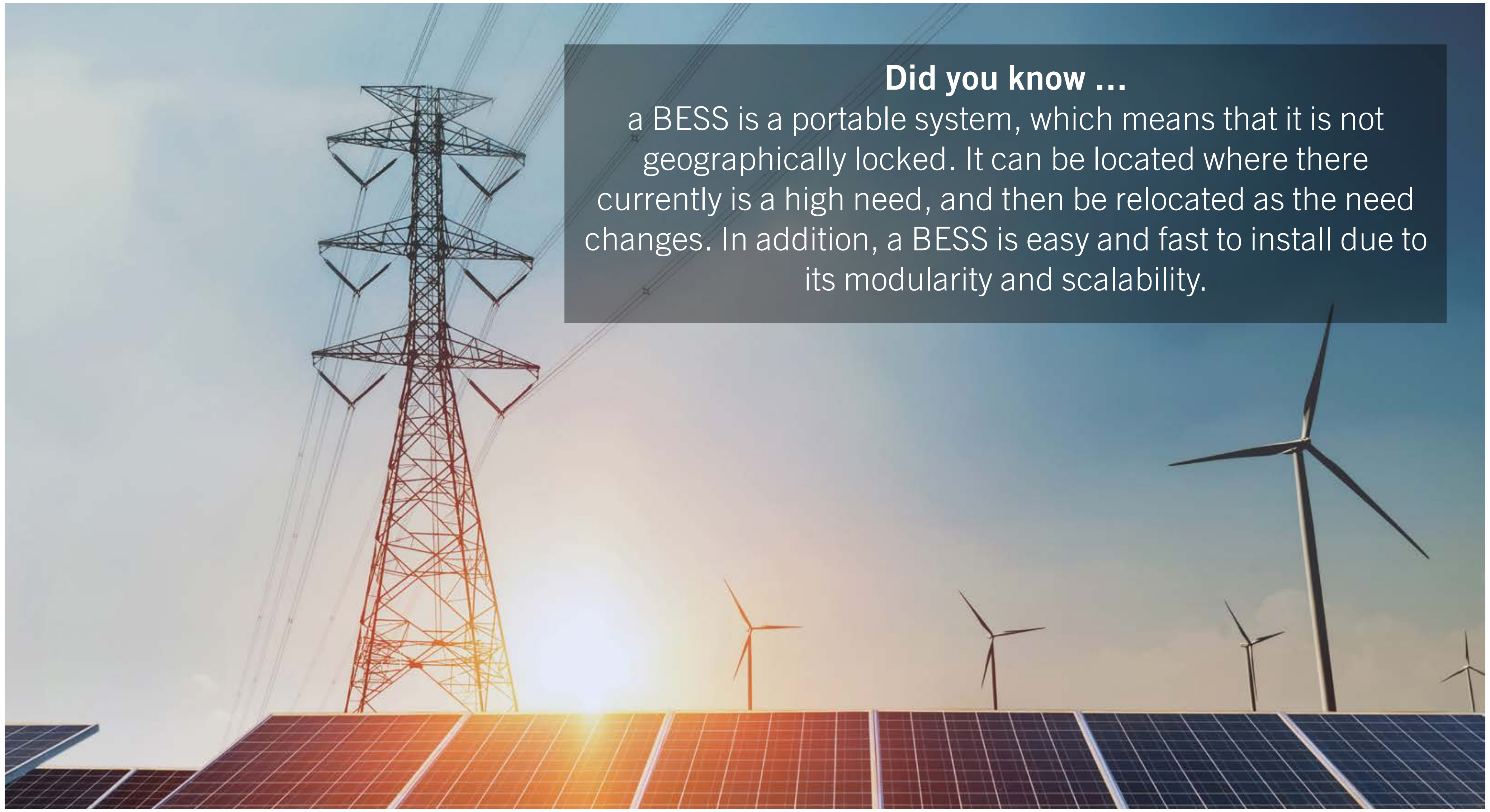
PÖYRY POINT OF VIEW - MAY 2019

Batteries in the Electricity Grid



How to manage the increased need for grid flexibility?

The global energy system is under transformation. The energy transition from a centralized, fossil fuel based energy system to a more decentralized, renewable energy based system will challenge the balancing of electricity supply and demand. This stresses the importance of grid flexibility. In this challenge, energy storage will play a valuable role as it can provide flexibility and support the renewable energy integration.



BATTERY ENERGY STORAGE

Because of the operational benefits and anticipated cost decline, batteries are expected to become an important storage technology in the energy transition. The promises of using stationary and grid connected battery energy storage systems (BESS) have grown due to their attractive technological characteristics. More specifically, Li-ion batteries demonstrate technological advantages and valuable application possibilities in the electricity grid. They are currently showing the best compromise in terms of market readiness, cost, lifetime and energy density, compared to other battery technologies.

POSSIBILITIES WITH BATTERY ENERGY STORAGE

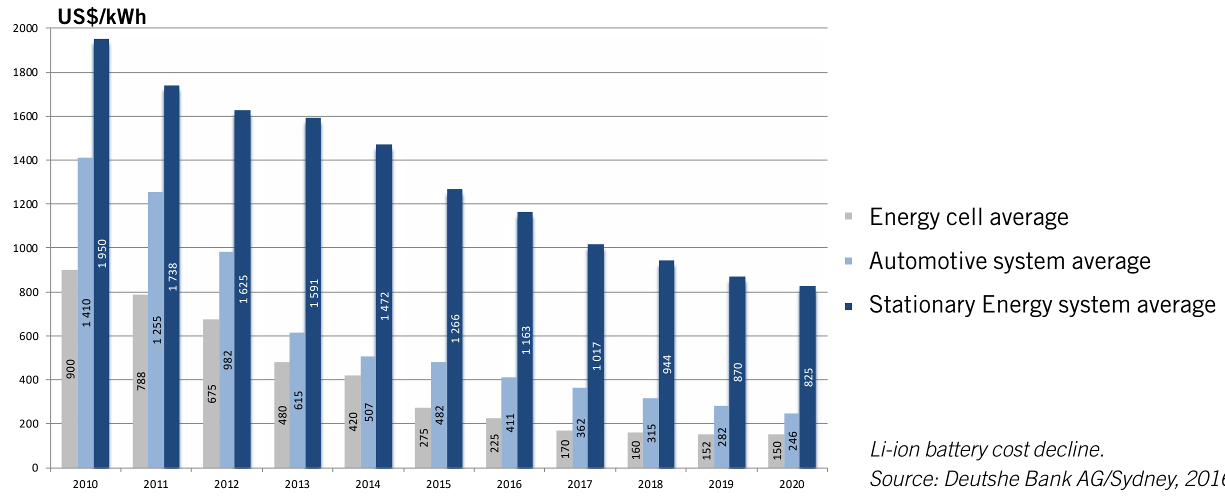
When installing a BESS, flexibility can be provided through several possible applications in the power system. Frequency regulation is one example. It is crucial to control the frequency in the power system to correct for deviations. As Li-ion BESS can react to power fluctuations with a response time of milliseconds, the technology is well suited for frequency regulation. Another possible application of BESS is renewable energy time shift. The target is to shift renewable energy generation from off-peak hours to on-peak hours, thus enabling a higher share of renewable electricity production in the power system. Shortly, this refers to storing energy in the BESS when the demand is lower than the supply, and injecting power into the system when the demand is high. This application is also related to arbitrage (i.e. purchasing energy when prices are low, and selling energy when prices are high). Li-ion BESS is suitable for electricity trading since it can operate in both fast and slow trading platforms.

There are also valuable benefits of BESS for grid owners. Transmission and distribution (T&D) upgrade deferral is one of them. By integrating a BESS, grid investment costs could be reduced, and future power shortage problems could be avoided. In many cases of T&D upgrade deferral, the BESS is only used a few times a year for the desired benefit, which makes it possible to provide other services during the remaining time.

In addition to these applications, BESS is also suitable for services such as grid stabilization due to voltage fluctuations (voltage support), smoothing the power or voltage output from intermittent power units with strong feed-in fluctuations (capacity firming), black start and uninterrupted power supply.

THE STORAGE SYSTEM

A stationary BESS consists of several components. To begin with, battery cells are interconnected to create battery packs, which together form the base of the BESS. In addition to the battery packs, there are three management systems; battery management system (BMS), energy management system (EMS) and power conversion system (PCS). The BMS is responsible for the safety and thermal management of the battery packs. The EMS manages the system control and utilization of the BESS. Lastly, the PCS converts the electricity from DC to AC and controls the power flow.



Li-ion battery cost decline.
Source: Deutshe Bank AG/Sydney, 2016

THE SOLUTION: FUTURE BUSINESS SETUP

In Sweden, implementing BESS in the power system is a promising solution to increase grid flexibility. A proposed setup is that a Li-ion BESS is installed and connected to the local or regional electricity grid, at a location well motivated from the local or regional grid owner's perspective. A convenient placement of a BESS is dependent on, for example, local or regional grid bottlenecks, or the location of power shortage problems. The possibility Pöyry sees, is that the BESS is owned and operated by a commercial actor. In this way the BESS can provide a wide range of services and benefit several different electricity market actors. This includes the benefits for the local or regional grid owner, as well as the possibility of, for example, electricity trading.

To maximize the economic incentives and the profitability of the investment, the BESS is used for combined applications. For example, the BESS can participate on the frequency regulation markets and electricity trading market. Furthermore, grid services can be sold to the local or regional grid owner, either directly to the grid owner or through a trading platform for grid services (such market is not yet in place; however, it is likely that it will be established in the future). By purchasing services from the BESS, the gird owner would obtain benefits such as T&D upgrade deferral and power shortage avoidance, without investing in and owning a BESS.

DRIVING FORCES

There is an urgency to increase the grid flexibility in the near future. Within 10-20 years, flexibility is going to be a considerable issue, which needs to be handled. The nuclear phaseout in Sweden is scheduled to 2040, and thereafter there will certainly be an increased flexibility demand. Also, there is a likelihood of power shortage problems in the Swedish cities in the upcoming years. This is due to an escalation of applications for increased power output from regional grid owners, as well as a growing population in the cities. Therefore, there is a need for actions soon. BESS could be part of the solution to both the flexibility need and the power shortage problems, due to its advantageous applications.

In addition to the need for flexibility in a future power system based on renewables, secondary usage of electric vehicle (EV) batteries is a promising driving force for BESS. In the times to come, a large amount of EV batteries will be decommissioned due to the recent years' fast growing EV market. Secondary usage extends the life-time of the batteries, reduces the resource exploitation and has a considerable economic advantage over new batteries. Even though battery prices have dropped over the years, a second hand market for batteries could decrease battery costs for stationary BESS even further.

CASE EXAMPLE

Hornsdale Power Reserve in the South of Australia is currently the world's largest Li-ion BESS with a power output of 100 MW and an energy capacity of 129 MWh. The storage facility is owned and operated by Neoen and the supplier of the facility is Tesla, with the Tesla Powerpack system. The main purpose of the battery storage facility is to stabilize the South Australian electricity grid, and 70 MW/10 MWh of the discharge capacity is reserved by the South Australian Government for system security services, such as frequency regulation. The remaining 30 MW/119 MWh is available for Neoen for market participation and electricity trading. Hornsdale Power Reserve has operated since December 1, 2017 and has delivered according to the high performance and market impact expectations.

According to the European Commission's regulations in the "Clean Energy for All Europeans" package, which will be transposed into the Swedish law during 2019, grid owners are not allowed to own and/or operate a BESS. However, in special cases (when a number of conditions are fulfilled), grid owners could be granted to invest in storage facilities.

CHANGES IN MARKETS AND THE REGULATORY FRAMEWORK

The implementation of BESS in the Swedish electricity market is dependent on markets for flexibility and grid services, as well as coordination between these markets. These kinds of markets are on their way, and there are several ongoing projects exploring preconditions for such markets. Moreover, until now, the regulatory framework has been rather unclear when it comes to energy storage, which has led to uncertainties. These unclarities are about to be clarified with new laws and regulations, which will enable potential businesses for BESS.

Also, grid tariffs and taxes are changing in a beneficial way for BESS. Dynamic tariffs (i.e. power based tariffs) that reflect the congestion in the grid are a way to provide price signals for flexibility markets. Such tariffs are favorable for BESS, and are currently considered by several Swedish grid owners. Furthermore, Swedish electricity taxes have recently changed, and the previous issue of double taxation of electricity when using battery energy storage is no longer a problem. This is due to an amendment in the Swedish Energy Taxation Act that came into force in beginning of 2019, which removed double taxation of electricity.

Did you know ...

an EV battery is typically replaced when the capacity is below 70-80 % of the initial capacity. These batteries are still sufficiently good for applications provided by a stationary BESS.

CONCLUSION

The development of BESS has been rapid, and the knowledge about batteries and grid connected BESS has not kept up with the fast pace. Thus, Pöyry sees a need to increase the understanding about BESS and its beneficial areas of usage. To manage the future need for flexibility in the electricity grid, BESS is a promising and suitable part of the solution. BESS can contribute to grid flexibility, and at the same time provide other valuable applications for multiple actors in the electricity market. Even though the need for flexibility is not a problem now, ways to manage the issue has to be considered within the near future. By the time of the nuclear phase out, there will be major instabilities in the electricity grid if solutions are not in place. Therefore, keys to grid flexibility need to be evaluated and planned for well in advance.

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