Co-creation with Industry: Backup of Electricity Import to Singapore

For Feedback

Problem Statement

- **Background:** At SIEW 2019, Regional Power Grids was announced by the EMA as a key measure to decarbonise our power sector. Since then:
  - EMA has on 30 June 2021 closed a RFP to trial 100MW of imports from Peninsular Malaysia via the existing interconnector. EMA is also embarking on the Lao PDR-Thailand-Malaysia-Singapore Power Integration Project (LTMS-PIP).
  - Beyond these, many interested industry players have also submitted interesting electricity imports proposals to EMA.
  - A number of proposals are proposing to supply more than 600MW of electricity each, which is much larger than the typical CCGT unit size (~400MW) that are installed in our power system.

- **Problem Statement: If electricity imports are to play a meaningful role in our power sector, the outage risk of electricity imports will have to be addressed in a reliable and economically efficient manner.**
  - EMA notes that electricity imports have a different reliability profile compared to CCGTs. The outage of individual CCGTs are typically rectified in a span of days or several weeks. In comparison, for electricity imports via subsea cables, a sufficiently severe outage (e.g. cable damage) may take up to several months to repair.
  - To ensure system reliability, EMA envisages that electricity imports will have to be supported by backup capacity in Singapore that can respond quickly and be able to sustain output for months.
  - Such backup capacity could also be designed as a pooled service (i.e. similar to reserves today) that serves to mitigate outages of electricity imports and local generation. This would help to reduce the cost of backup to the system.

- To prepare for the future entry of electricity imports, EMA wishes to engage industry players and experts to design and refine solutions that can address the problem statement, and further seeks interest from parties who could provide these solutions as a service.
  - EMA has yet to decide how much electricity imports the power sector should accommodate, hence the backup solutions should ideally be scalable to handle GW-scale imports.

BACKGROUND

Today, reserves are procured from the electricity market to support our system, using a N-1 philosophy.

- Today, EMA plans for sufficient reserves to ensure continued supply if an individual CCGT unit were to undergo a forced outage.
- 2 reserve products are procured from the SWEM to provide such backup.

	Primary Reserve	Contingency Reserve
Max. capacity procured	~600MW	~600MW
Coverage period	9 seconds to 10 mins after outage	>10 mins after outage
Provided by	Online generation, typically CCGTs and Interruptible Load	

- Reserve product costs are allocated to the generators each period based on
  - Quantity Supplied: Injection Energy Quantity (IEQ) of each period
  - Probability of failure of the generator

Electricity Imports will require a different design methodology than local CCGTs due to potential size and duration of outage.

- The probability and length of outage differ between local CCGT and electricity imports
  - Today, individual CCGT units typically trip once or twice a year, and can be restored within the span of days or weeks depending on the cause of outage.
  - In comparison, electricity imports outages have an expected unplanned outage rate that could differ from CCGTs (depending on distance and sea-related risks), as such incidents could take up to 6 months to repair, depending on the severity of outage (e.g. subsea cable failure).
  - Hence, EMA needs to plan for events when a CCGT trip happens while an electricity imports outage is being repaired (i.e. simultaneous outages). In EMA's prelim view, **long-term dedicated backup is needed for imports, sized according to the largest electricity import source.**

- Furthermore, the system must cater for an instantaneous loss of that source's entire supply, to prevent blackout.
  - The existing fleet of dispatched CCGTs can only provide 600MW of primary reserves. Furthermore, existing CCGTs are not fast enough to respond to a >600 MW contingency.
  - **Hence additional fast response capacity is needed to cater for import sources >600MW. <1 second response time to ensure frequency remains in safe zone. Primary reserves today are insufficient to provide this support.**

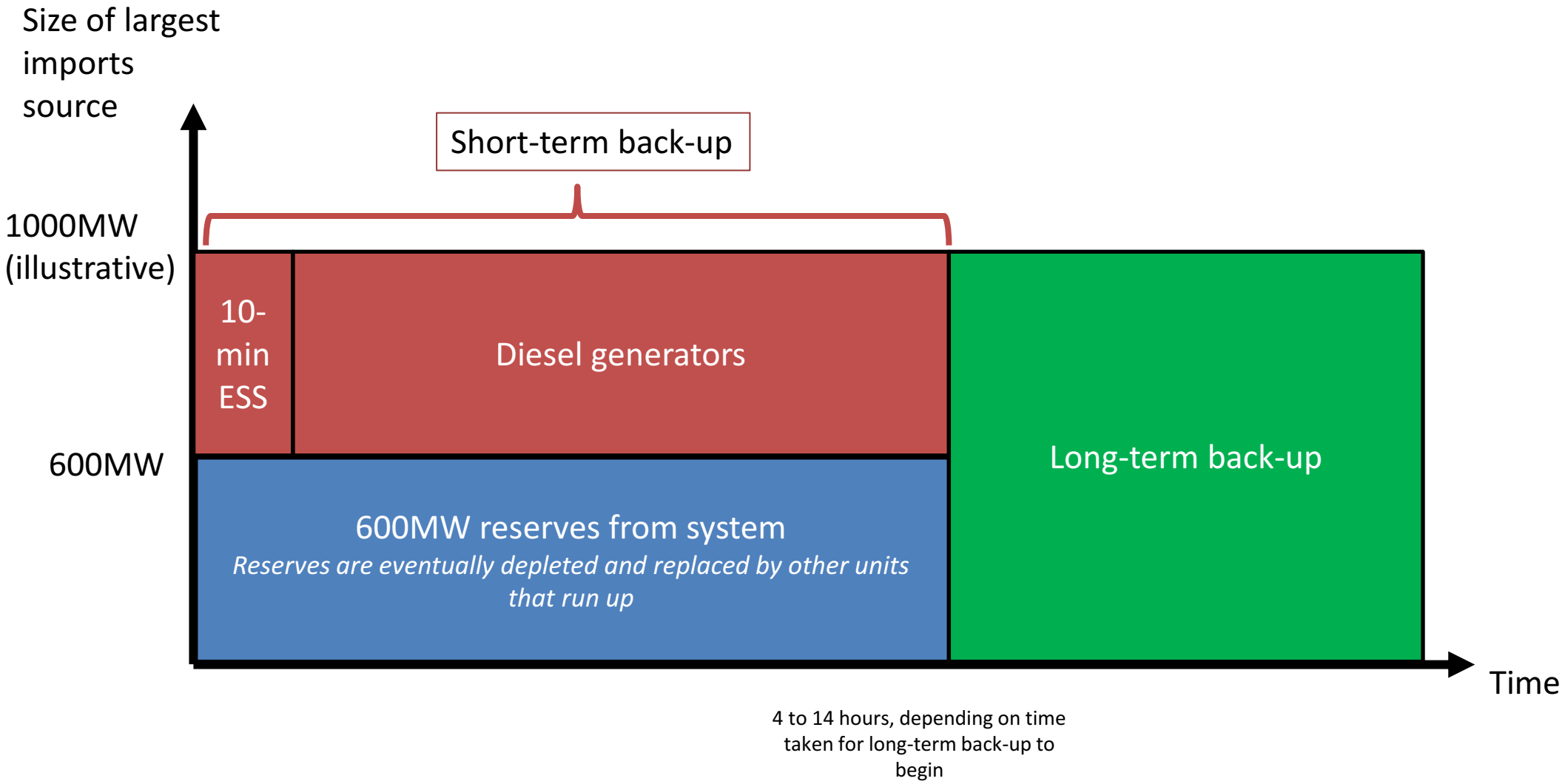
POTENTIAL DESIGN FOR BACKUP CAPACITY

Draft design for capacity to back-up imports

1. The design philosophy is as follows:
   a. EMA will cater for **sufficient reserves to handle one instantaneous outage at any one time** (e.g. failure of CCGT or imports). This is sized to the largest imports source from a single supply project (or local generation if applicable).
   b. If an imports failure is anticipated to be long-duration, then separate back-up capacity will be activated to replace the loss of imports, such that reserves can be replenished to cater for a future outage. This could also be sized to the largest imports source from a single supply project (backup capacity could also replace a long duration failure of local generation if applicable, but in the first instance should be used for imports. Calibration is needed to determine how to avail this backup to local generation outages).

2. Operationally, this will work as follows:
   a. The system will continue to procure primary and contingency reserves. EMA anticipates that we will eventually need to procure 600MW of primary and contingency reserves.
   b. In the event of an imports failure, primary reserves will instantly react to the failure, to arrest the fall in frequency. Contingency reserves will be activated subsequently to restore system to normalcy and ensure continuous supply of electricity.
   c. For imports > 600MW in size, there are insufficient primary and contingency reserves to support this imports source. Hence additional fast-response capacity will be needed to react simultaneously with primary and contingency reserves. Such additional fast response capacity provides a **"Short-term Backup"** to the system.
   d. If imports failure is anticipated to be long-duration, separate back-up capacity (dedicated for imports) will be activated to supply electricity. Such separate and dedicated capacity will provide a "**Long-term Backup**" to the system. Primary and contingency reserves will be allowed to replenish to cater for the next outage event.
   e. As a starting point, capacity used to provide Short-term Back-up and Long-term Back-up is dedicated for imports, and should be assumed to be unavailable for other services. Nonetheless EMA is open to ideas where capacity for Short-term and Long-term Back-up is eventually used for other services.

Illustration of short and long-term back-up examples



Potential estimated capacity, types and cost allocation for backups

Type of back-up	Capacity Requirement	Examples of supply solutions	Who bears cost of back-up capacity
Primary and Contingency Reserves	**600MW for primary reserves** **600MW for contingency reserves**	• CCGTs, via SWEM reserves market (similar approach adopted today)	All generators and importers
Short-term backup	**Size of single largest import source that exceeds 600MW** Must be fast-response. <1 second response time to ensure frequency remains in safe zone. Able to sustain until long-term backup takes over)	• New energy storage systems (ESS) until long-term backup starts-up • ESS that can last 10-min, followed by new diesel generators that run until long-term backup starts-up • Possible fast-reaction demand response that can be sustained until long-term backup starts-up	Only Importers > 600MW in size
Long-term backup	**Entire size of single largest import source** Able to sustain output for months EMA notes that this back-up may hardly be activated for imports outage (e.g. < once per year), if imports are sufficiently reliable.	• CCGTs on cold start. (EMA understands that CCGTs may take between 4 to 14 hours to ramp-up from cold start) • New OCGTs or Gas Engine Generators on cold start	All Importers *(Note. EMA may waive the need for this service if there is sufficient generation capacity in the system to meet our reliability requirements)*

A centralised pool of imports backup may be more efficient for the entire system.

- One way to ensure sufficient backup is for individual electricity importers to provide local backup for their own imported supply.

- However, EMA believes that doing so is not ideal from the system's point of view as there will be duplication of assets used (e.g. land) and poor utilisation of the over-procured backup. Instead, EMA views that a centralised pool of backup will be more resource- and cost-efficient for the system. Such backup capacity could act as a common safety net for all importers, and may also be tapped on by local generation. This is similar to the treatment for reserves.

- Regardless of the procurement method, EMA will have the right to activate the backup services to cater to any imports outage.

EMA is keen to hear industry's feedback on imports backup design and interest to participate

1. Overall design of backup capacity philosophy
   a. Is the interaction between reserves and short-term backup for imports appropriately designed (i.e. requiring separate short-term backup for imports >600MW)?
   b. Is it necessary to require separate backup capacity to be dedicated for imports?
   c. How might backup capacity for imports be better used to concurrently serve other system needs?

2. Feedback on imports short-term backup design (technical requirements, sizing, market design)
   a. Are there more cost effective means of providing short-term backup capacity, besides depending on ESS & diesel generators? The solutions should optimize for cost, land-take and development time without compromising function. These solutions should also consider options from existing generation supply in Singapore.
   b. How might such backup capacity be better used to concurrently serve other system needs?

3. Feedback on imports long-term backup design (technical requirements, sizing, market design)
   a. Are there more cost effective means of providing long-term backup capacity, besides CCGTs? The solutions should optimize for cost, land-take and development time without compromising function. These solutions should also consider options from existing generation supply in Singapore.
   b. How fast can cold-start CCGTs come online and inject their maximum output into the grid?
   c. How might such backup capacity be better used to concurrently serve other system needs?

4. Please indicate to EMA if you are interested to be a provider of backup service, and share details regarding your proposed solution.

Please share your feedback via https://go.gov.sg/ema-industry-cocreation-imports-backup

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