

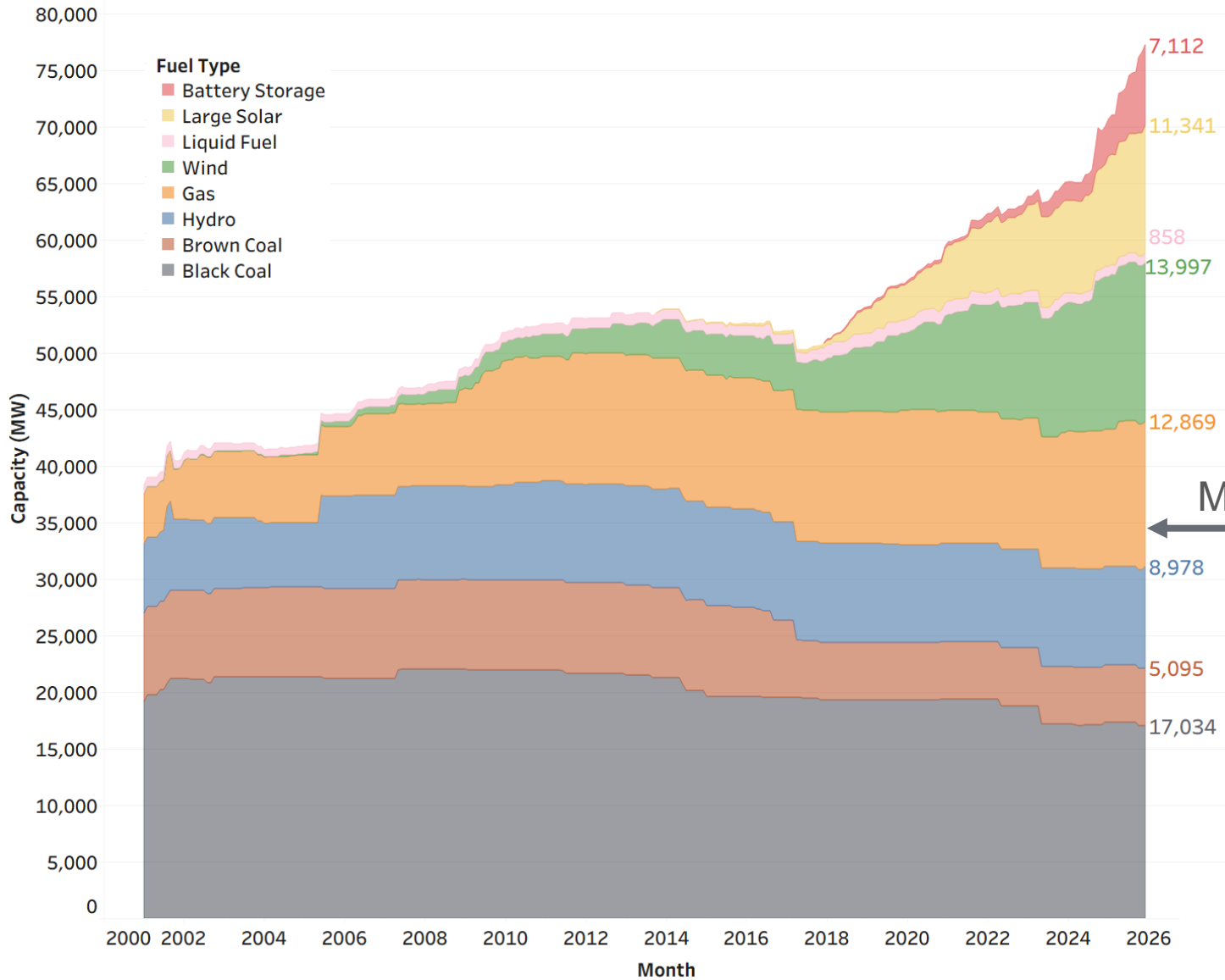


# ESIG Spring Workshop

**Observations on Voltage Control in the  
Australian NEM: Potential Impacts on  
Operations and Forecasting**

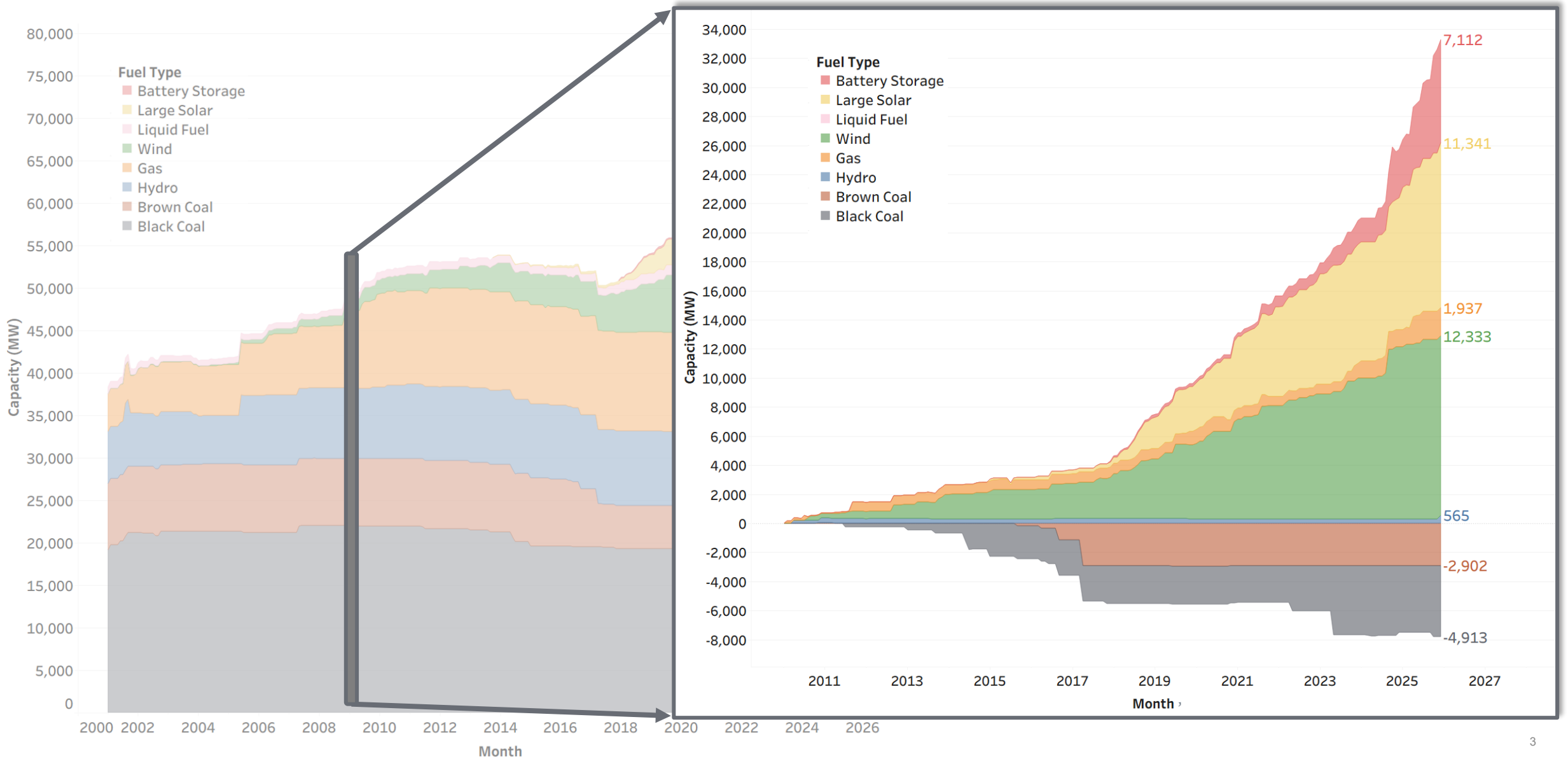
**Jonathon Dyson**

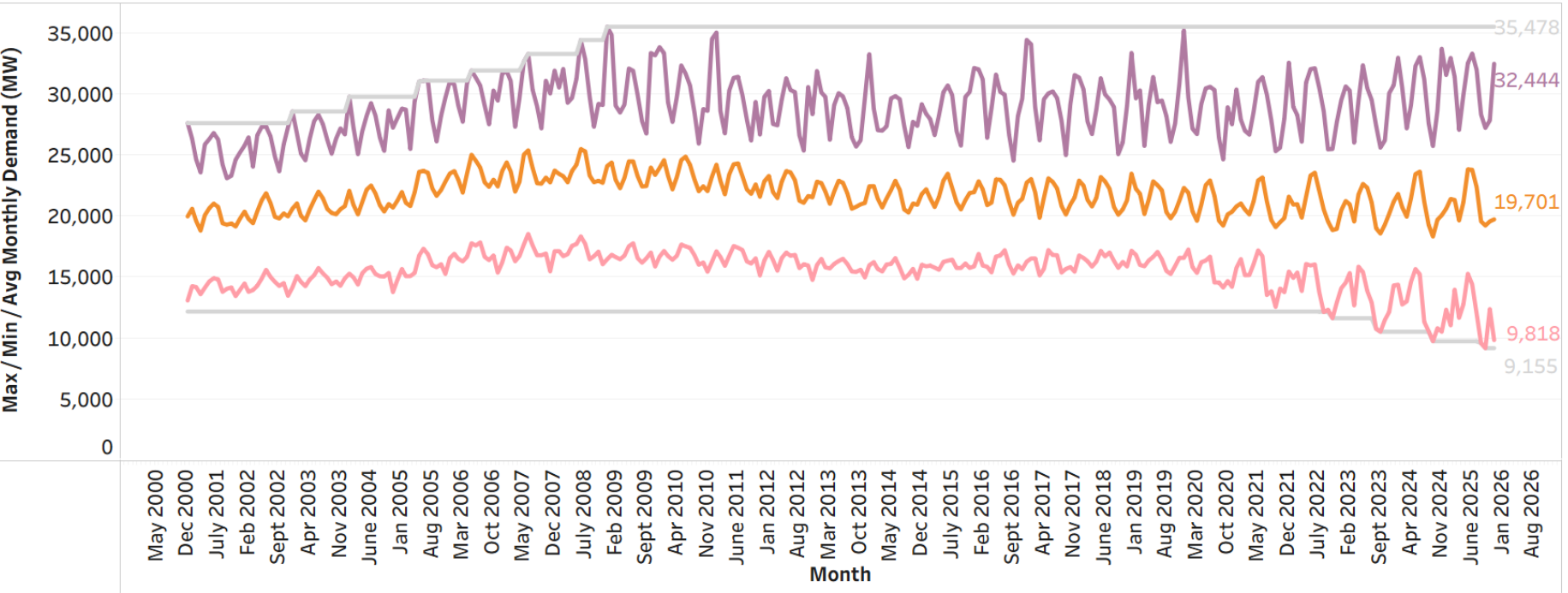
**UNLOCK YOUR  
ENERGY ECOSYSTEM®**



- Installing wind / solar / BESS at pace
- Reducing coal generation

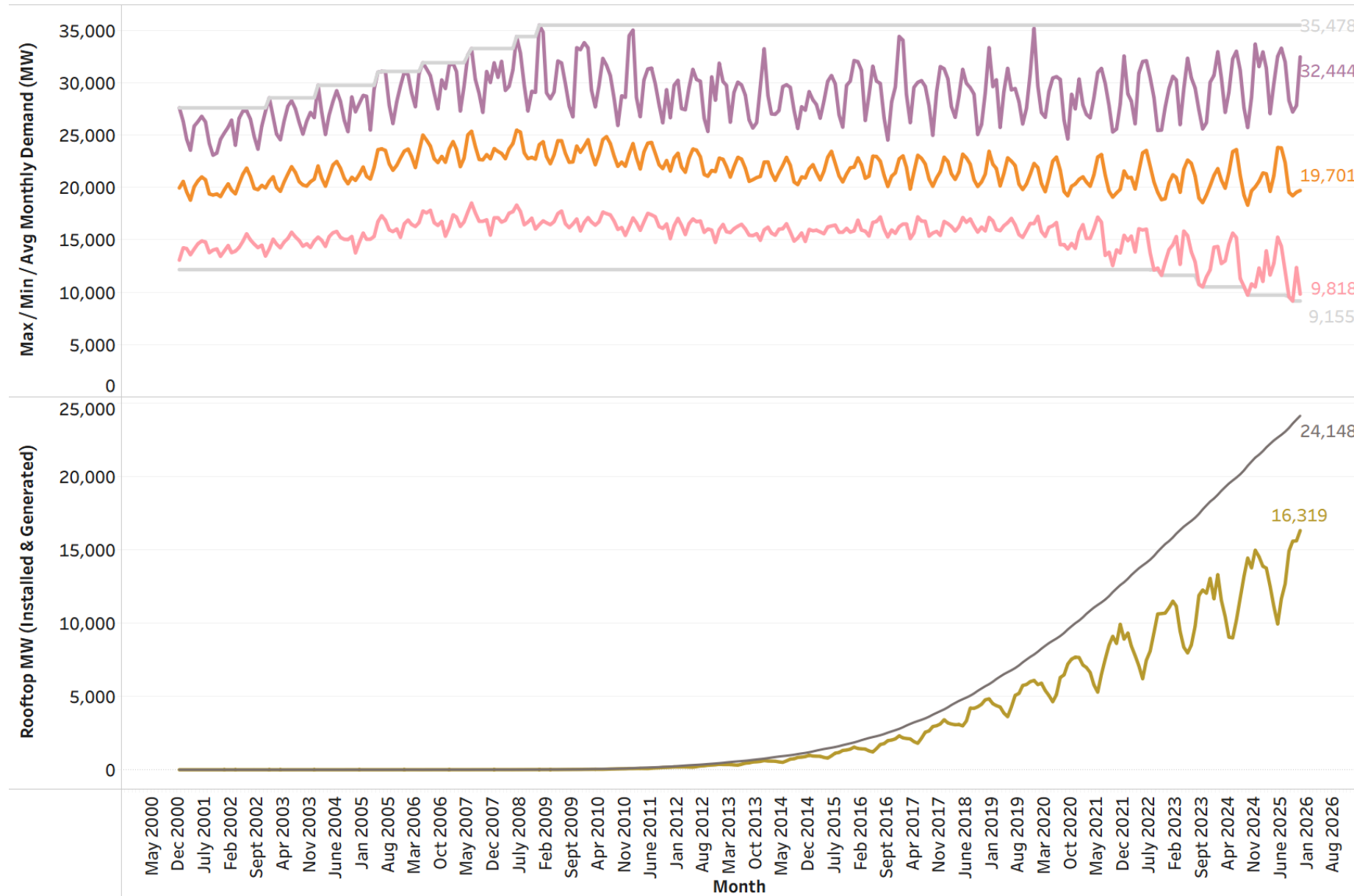
Max demand in 2009 (~35,000MW)





- Legend**
- Historical Max Grid Demand
  - Max Monthly Grid Demand
  - Avg Monthly Grid Demand
  - Min Monthly Grid Demand
  - Historical Min Grid Demand

- Haven't reached Max demand since 2009
- Min Demand now falling

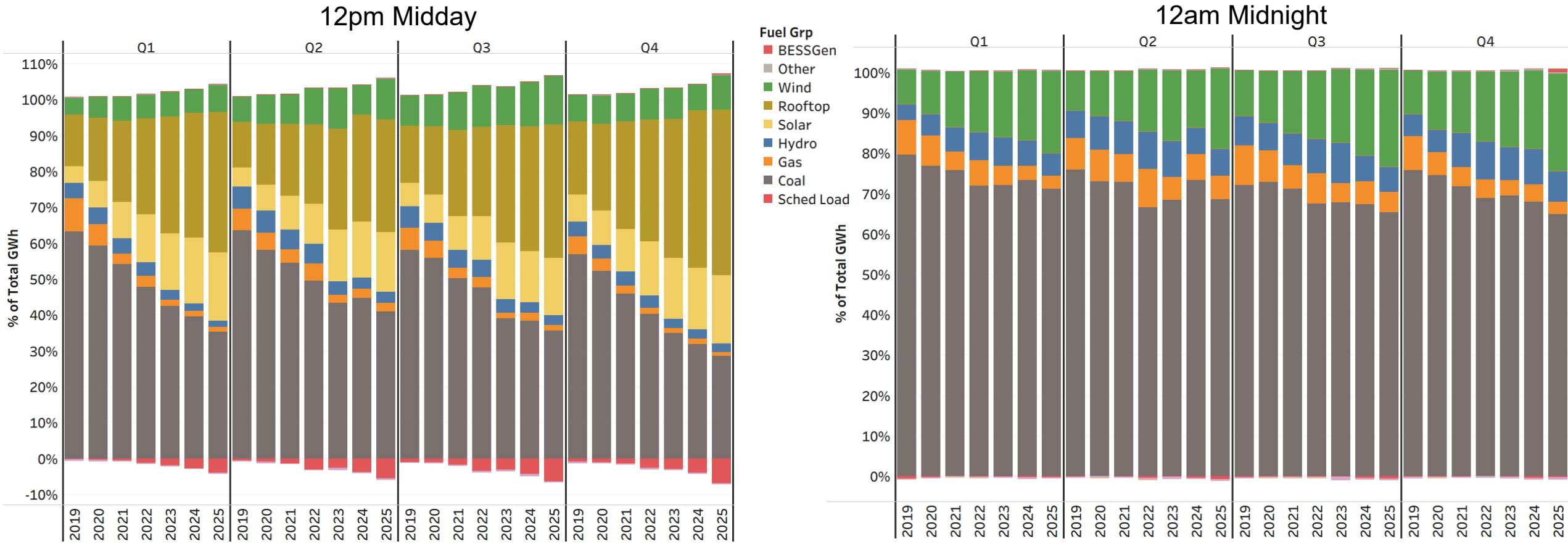


**Legend**

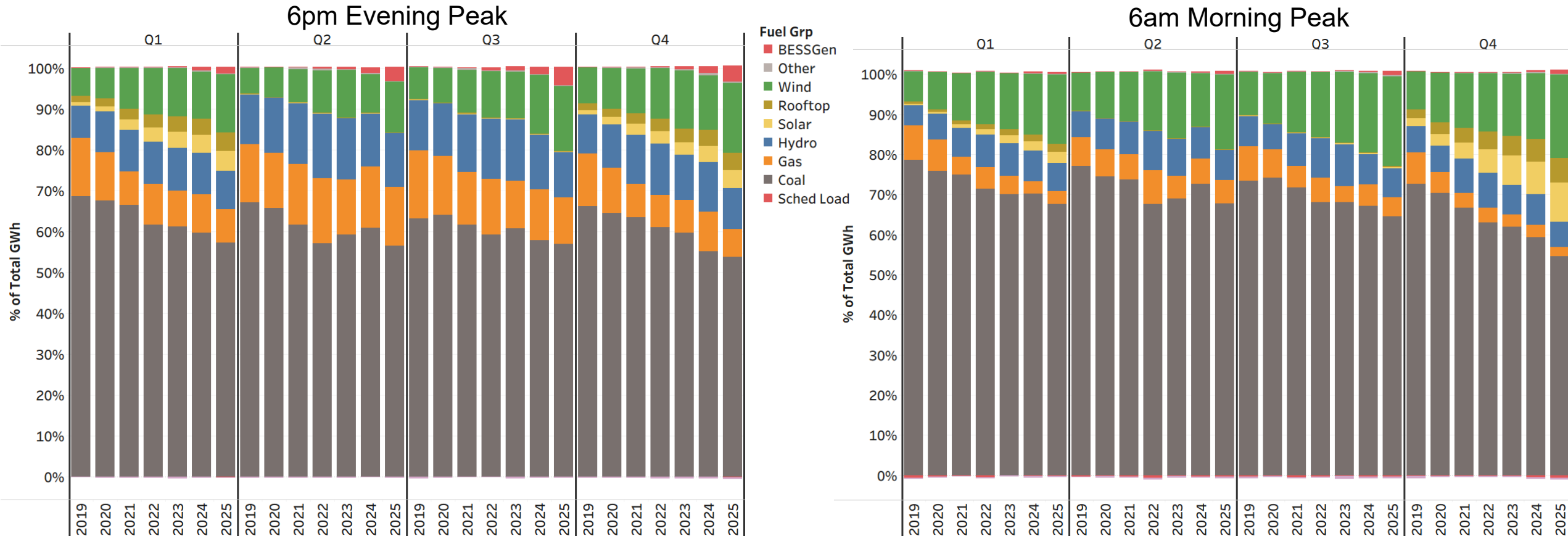
- Historical Max Grid Demand
- Max Monthly Grid Demand
- Avg Monthly Grid Demand
- Min Monthly Grid Demand
- Historical Min Grid Demand
- Installed Rooftop PV
- Max Rooftop PV (measured)

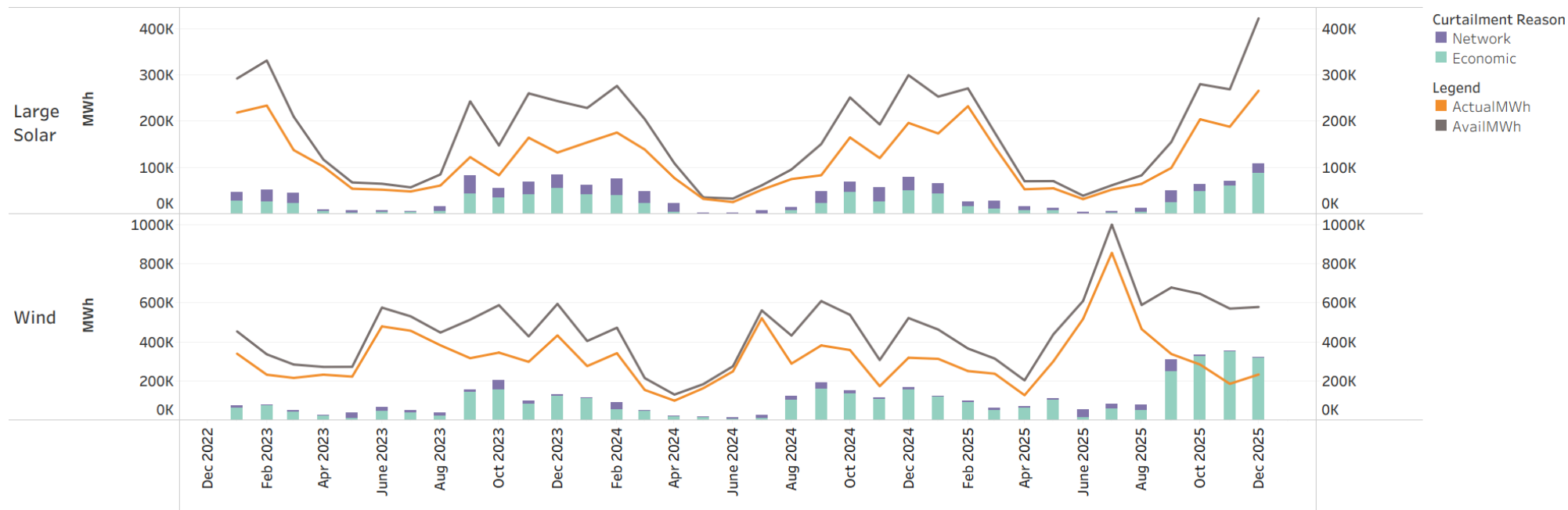
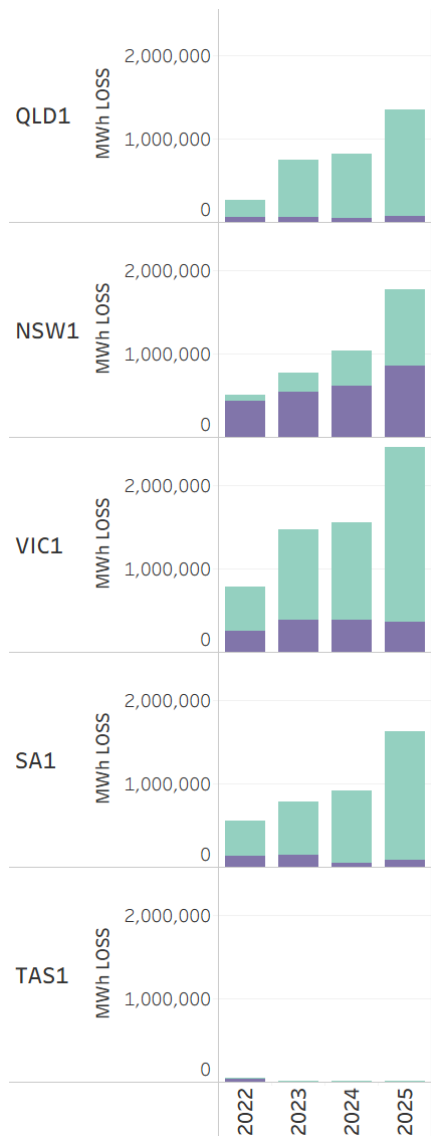
- Haven't reached Max demand since 2009
- Min Demand now falling
- Rooftop PV installed at ~3,100MW/yr
- Max Rooftop measured on the grid now over 16,300MW

- On a MWh basis, the trends are looking good for 12pm (Midday) – note some load increases
- Not so dramatic for 12am (Midnight)

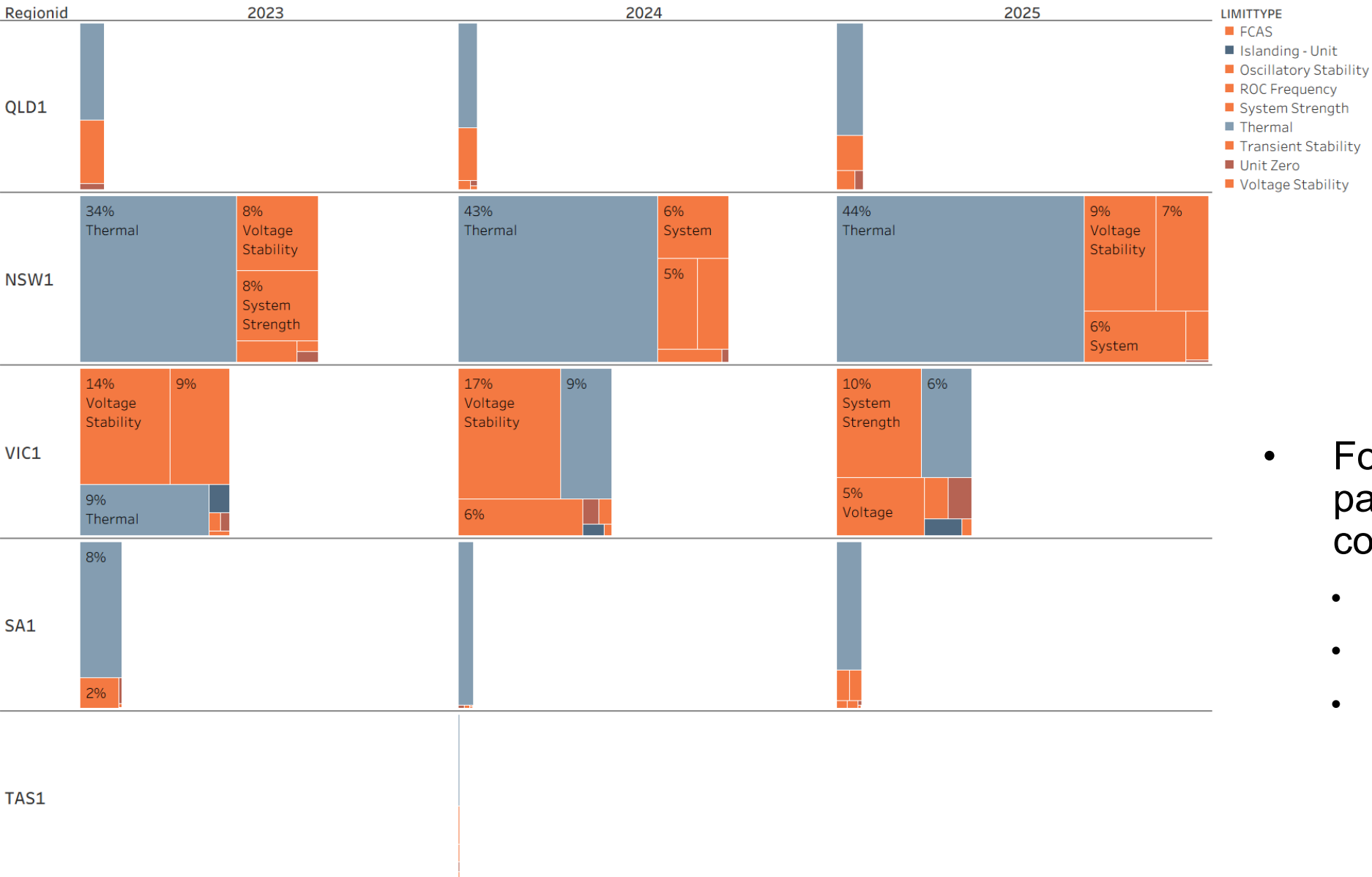


- Trends are ok for 6pm (Evening peak), wind generation has increased & some BESS generation
- Not as healthy for 6am (Morning peak)
- What's happening? Significant amounts of curtailment (economic and network) due to rooftop PV



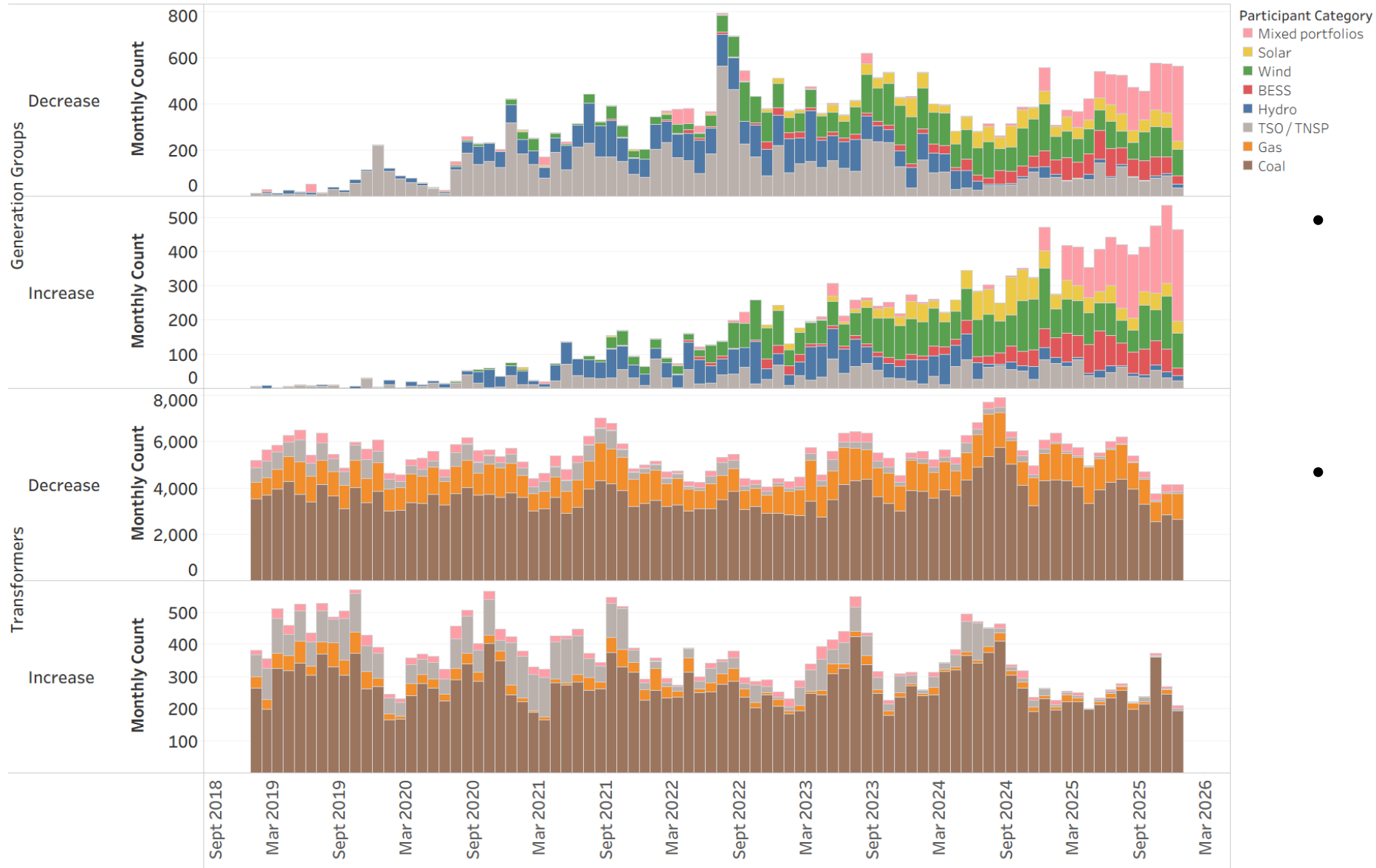


- Constraint Trends show economic constraints to be the largest trend on average, although network curtailment occurs more often in some regions
- VIC/SA regions have significantly lower prices, hence higher percentages of economic curtailment, hence don't hit the same network limits as NSW/QLD



- For wind and solar participants, network constraints are caused by
  - Thermal limits (~55%)
  - Voltage & Stability (~40%)
  - Other (~5%)

- General nature of NEM's Network Constraints
  - If the economic price signals are low, the generation is dispatched lower or turned off
  - If the economic price signals are higher, the generation is all trying to dispatch at the same time, hence network limits met
  - If significant inverter-based equipment is generating (all with similar generation profiles to others in the vicinity), constraint equations can be bouncing in and out of 'bound' state, adding to slow-form oscillations
  - We have seen several '5min bid' oscillations (based on price changes) in regions where Auto-bidding solutions kick in and out
- Under outage conditions, now requiring the inverters or WTG's to be completely turned off for reactive control issues
- Turning off some 330kV/500kV lines for voltage management during the middle of the day to ensure adequate reactive support
- Significant number of GFM inverters coming as well as large Syncons (with flywheels)
  - Recent example in north-west Victoria where a GFM BESS required the nearby 200MVar Syncon to be offline for commissioning tests → was required for a large 200MW solar farm and in-service for only 3yrs



- Increasing amount of voltage support by all generation types (not just the realm of TSO)
- Wind and solar must be able to contribute especially given large installed capability

- The market/investment signals impact the physical (and vice versa)
  - Theoretical 'Market scenarios' for EMT modelling need to stand the test of time
- Get measuring and recording all the critical data NOW!!!
  - Not just the MW installed amount → energy contribution and capacity factor is key to commercial outcomes!
  - Don't assume rooftop or small-scale DER / DPV will always stay a relatively small amount
  - Make sure the control strategies are in place very early on and able to scale
- Renewable generation must be able to do more than just generate MW (anytime, anywhere)
  - Generation at the right time when the network requires it (start hybridisation discussion early)
  - Generation must be able to do frequency control (what is the market signal?)
  - Wind/Solar/BESS must be able to do voltage control (integrated control mechanisms) – it is currently 10 times less in the NEM!
- Price and market signals must be locational, frequent and accurate
  - 5-min dispatch price for variable generation
  - Voltage dispatch instructions will have to be met by wind, solar and BESS generation as coal and gas shutdown

- Most commercial forecasters (at least in Australia!) just do some minor levels of thermal constraint forecasting for a few short years out
  - Some solar generation in NSW was constrained 50-70% of total available capacity (i.e. CF of 10% not 33%)
  - Most new entrants had budget constraints estimates of 1-4%
  - Voltage or oscillatory control needs to have simplified estimation methods included going forward
  - Count of IBR for system stability would be a good start
- Rooftop PV significantly impacting utility-scale generation and prices, hence dispatch profiles
  - Alignment on residential incentives and C&I/Utility market structure must be sound
- When it comes to 50MW-plus hybrid generation forecasting
  - Large scale solar barely financeable in Australia (east and west coast) – increasingly being hybridised (not just co-located) ... this changes the PSCAD/PSSE modelling early in the development process
  - Most commercial modellers (and OEM's) want to keep items separate for their 'cookie-cutter' sales model!
  - The challenge with hybrid operation is the integration of resource forecasting and auto-bidding as small-scale MW deployment is totally different than larger scale, price impacting, levels
- The interaction between GFM and nearby Syncons will be critical to monitor
  - We need increasing levels of SSO monitoring in weak parts of the grid

AZZO is an energy technology & services company, specializing in Energy as a Service, Lifecycle Services and Energy IoT platform. Our solutions range from simple monitoring to advanced control & management of complex energy systems at Generator, BESS, Microgrid and DC's.

