Modelling the Long-term Impacts of EV Uptake within a 100% Renewable New Zealand Power System

OERC Symposium 2022

Aleida Powell, Jen Purdie, Michael Jack

What is the Future of Transport in NZ?

Electric!

Transport emissions are NZ's fastest growing source of emissions and account for ~20% of gross emissions

By 2050, New Zealand aims to have net zero transport emissions

To get to net zero NZ needs high uptake of EVs

- Light vehicles (LV)
- Heavy transport (busses, trucks)

- Modelling results from TIMES-NZ and the CCC project **3.2 – 3.7 Million** EVs in 2050
- Currently **40,000** registered EVs in NZ

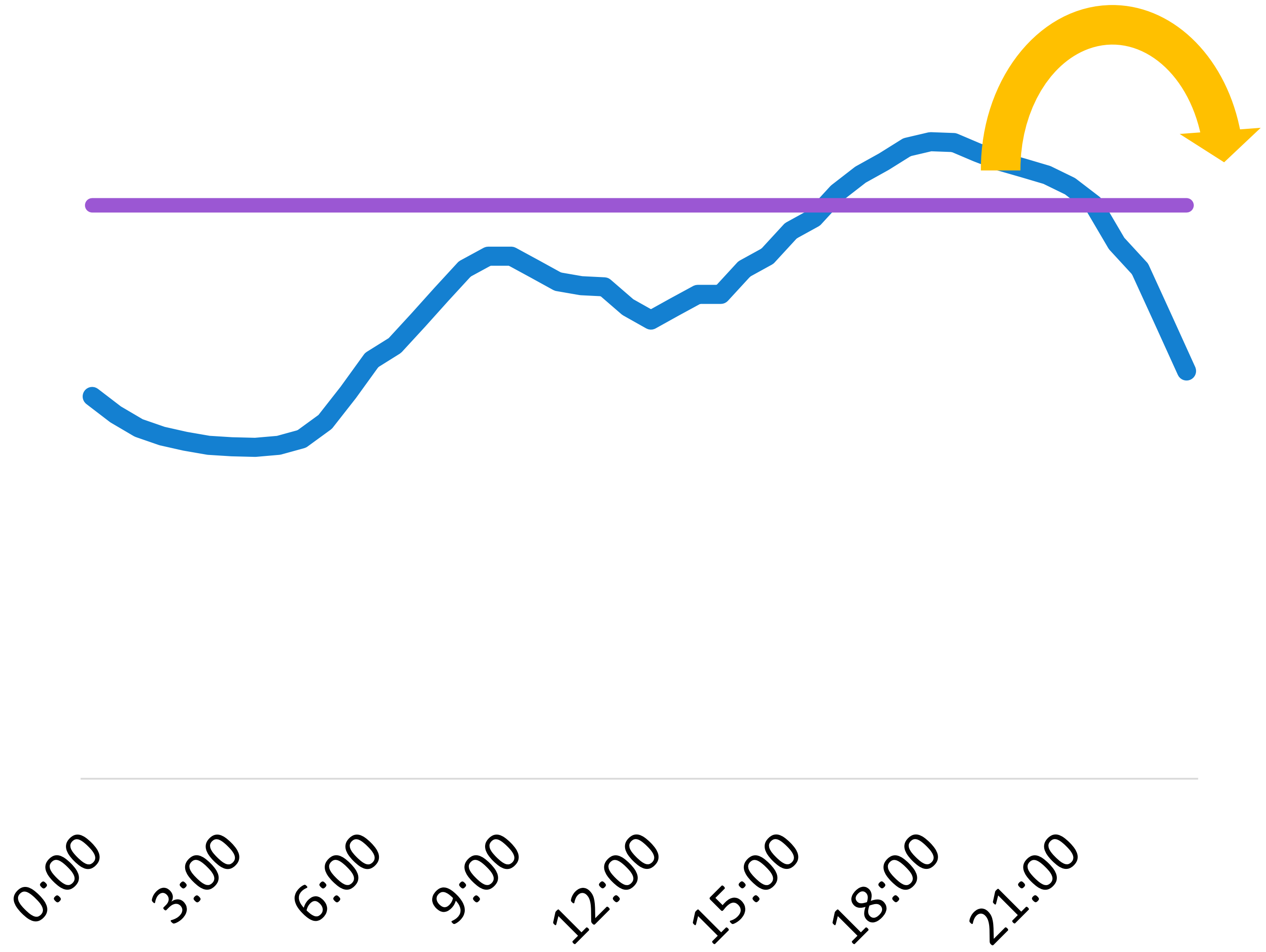
What Will EV Uptake do to the Electricity Grid?

- NZ is aiming for a 100% renewable electricity system by 2030
- Electrifying transport adds demand to a system reliant on variable generation
- Meeting peak demand is an issue
  - Seasonal peak → Winter
  - Daily peaks → morning (7am – 9am) and evening (5pm – 9pm)

What can be done to reliably meet peak demand in the event of high EV uptake?

Managed Charging

- Utility/aggregator controlled, usually with the aim of:
  - Reducing line constraints
  - Reducing CO_2 emissions
  - Reducing cost of charging
- Shown in literature and trials to support EV uptake with reduced investment/impact



Aim of this Study

Use a model of the electricity grid to investigate EV uptake in NZ considering the impacts of:

- Increasing levels of EV uptake
- Different charging profiles
- Potential future dry year impact of EVs

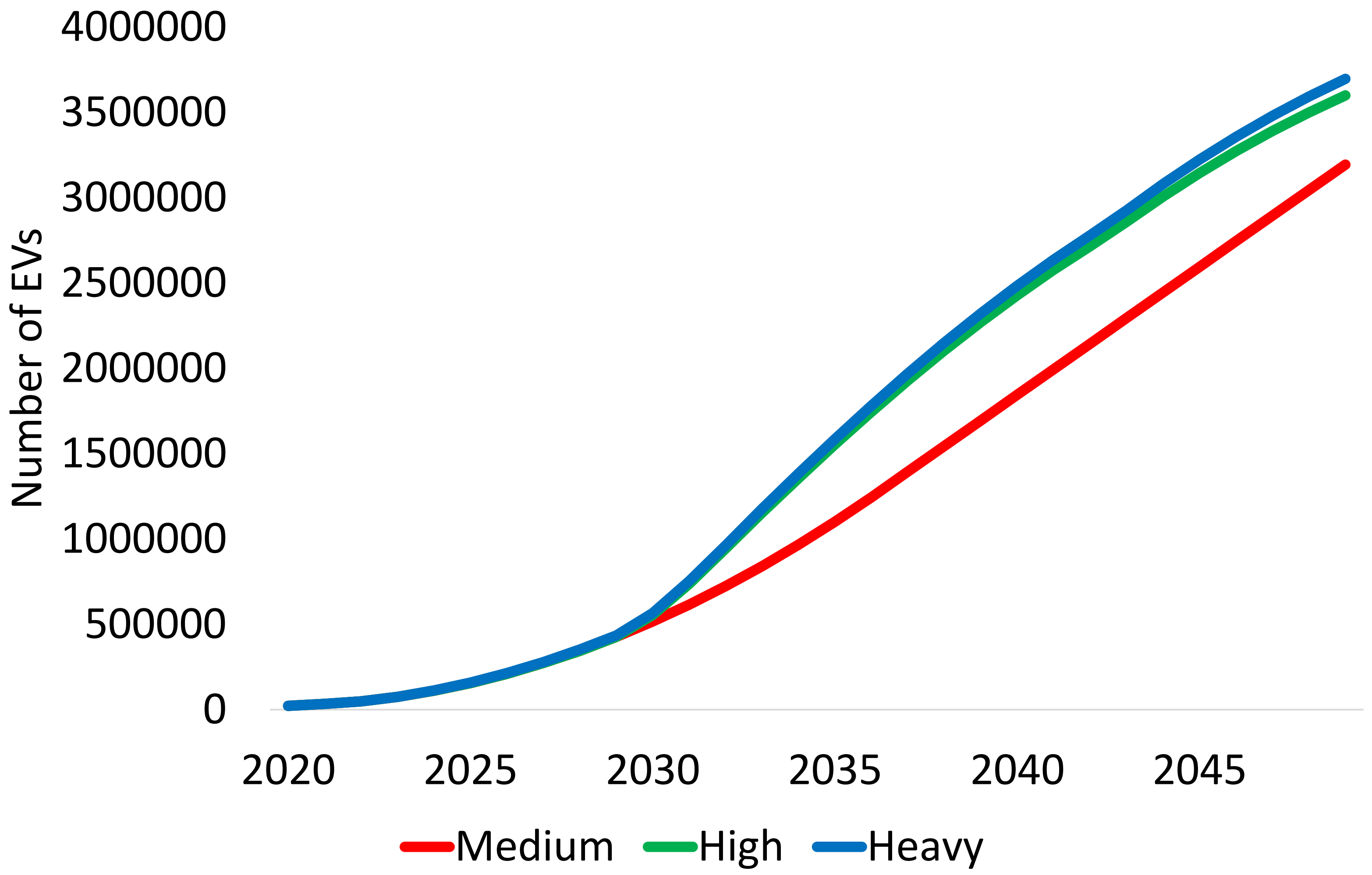
Metrics for quantifying impact

- Peak demand
- Spill
- Generation shortages
- Electricity Price

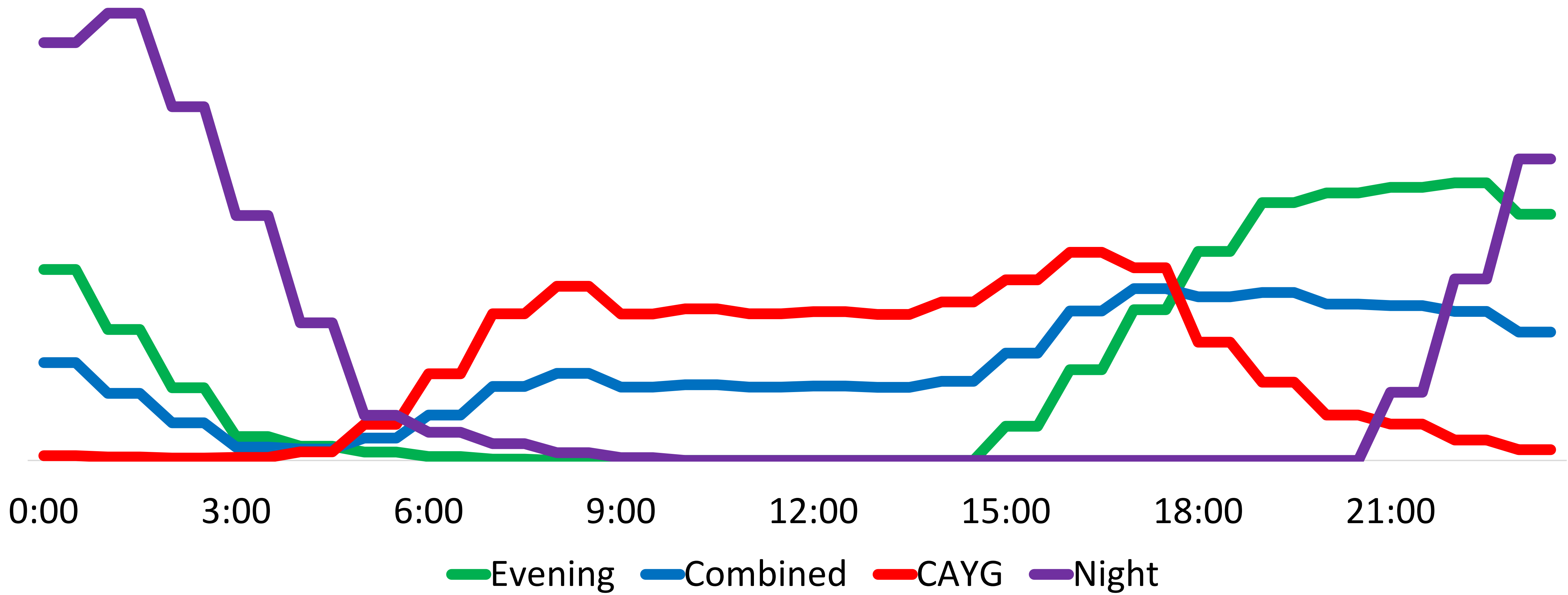
The LPCon Model

- Created by Grant Telfar, owned by Meridian Energy Ltd.
- Model predictions out to 30 years (2020 – 2050)
- Economic optimisation of the NZ power system to find lowest cost solution to balancing supply and demand across the NZ grid
  - Supply: hydro, solar, wind, thermal, batteries
  - Demand: Regional demand predictions, EV uptake
- Model inputs: hydrological histories, demand predictions, EV uptake and battery use predictions, planned outages, Transpower's future upgrades etc….

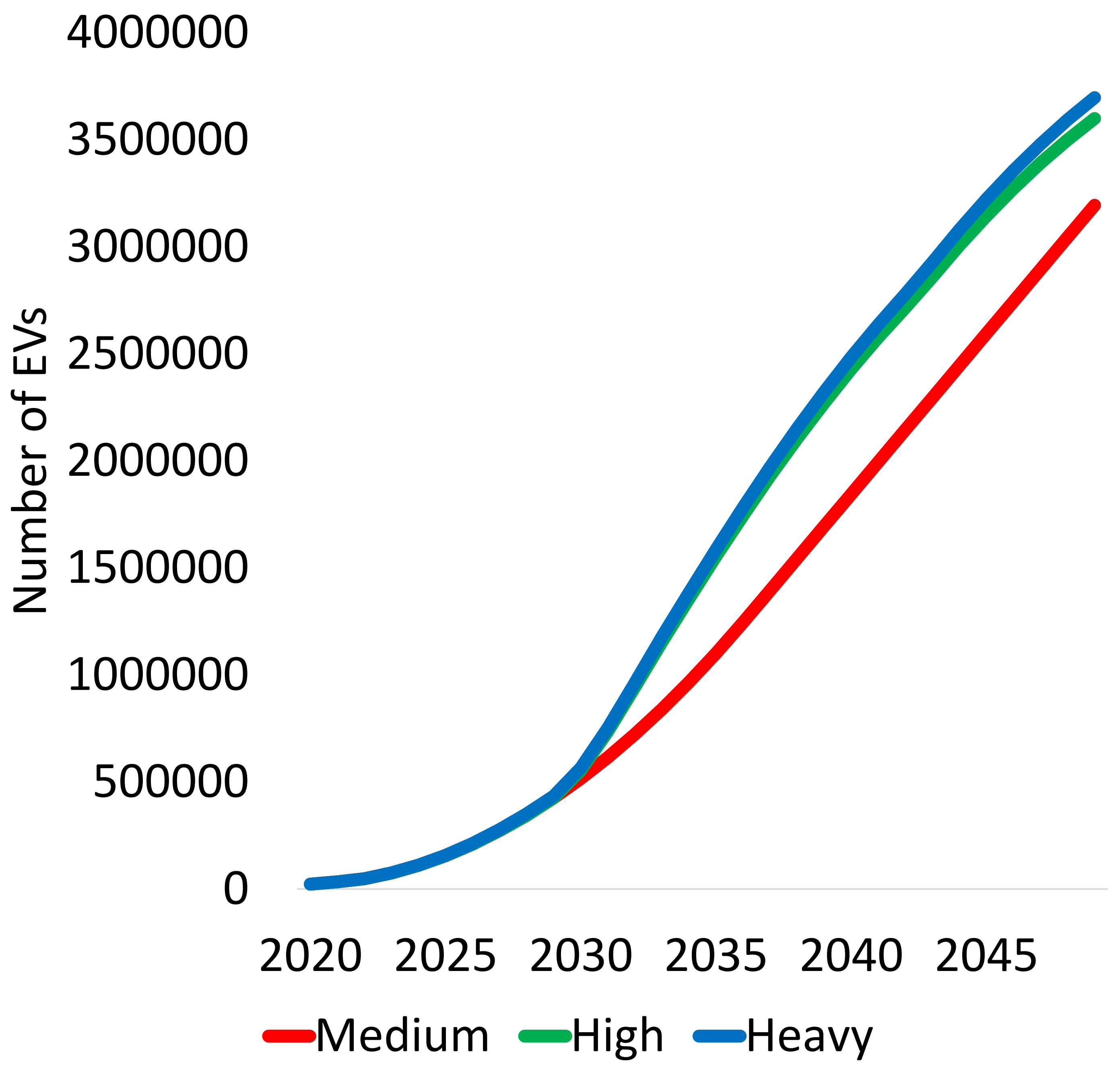
Model Scenarios: Uptake Levels



- **Medium:** Light vehicle EV uptake, similar to MOT projections
- **High:** Climate Change Commissions light vehicle uptake projection
- **Heavy:** Climate Change Commissions light vehicle and heavy vehicle uptake projection



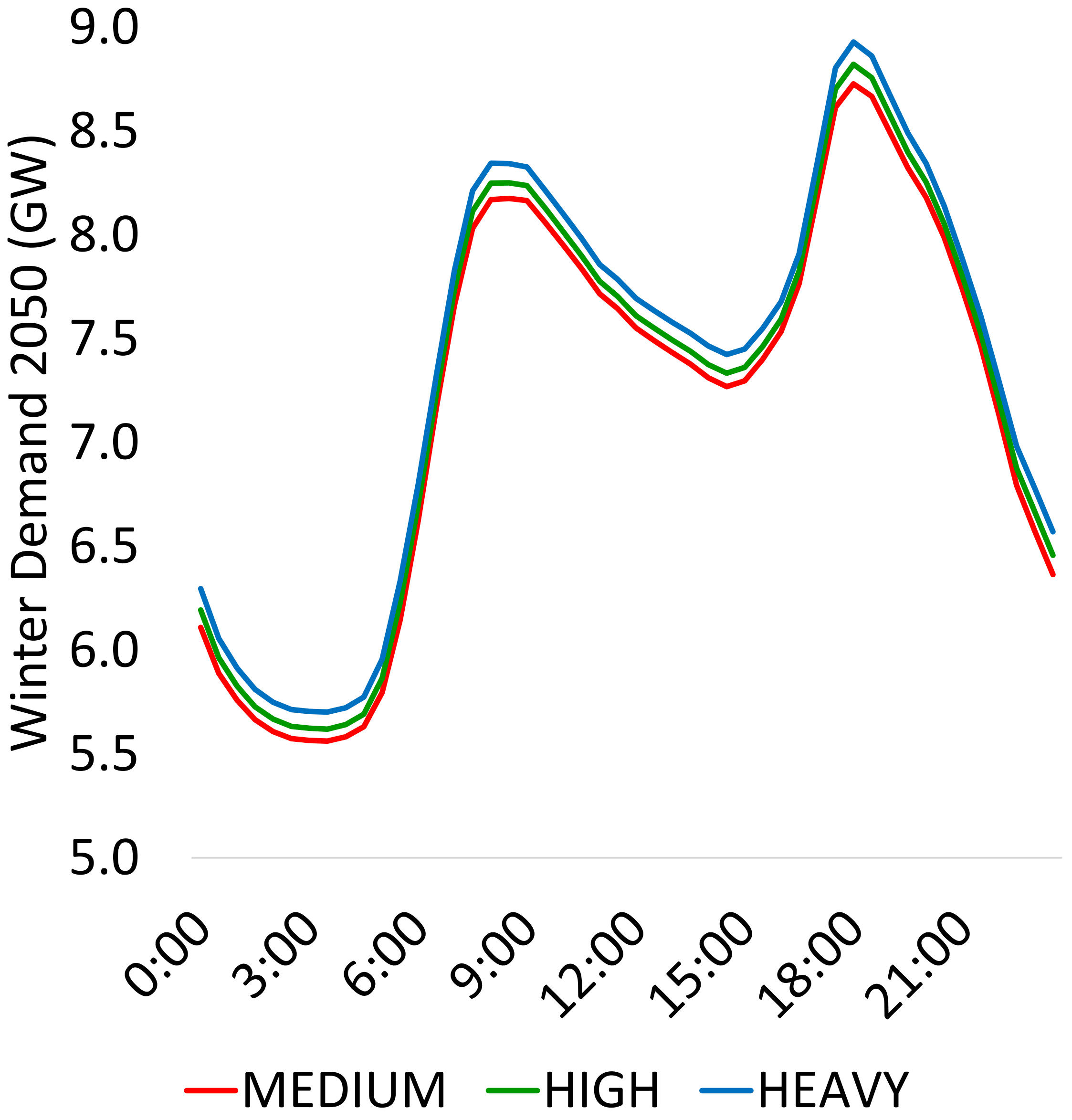
Model Scenarios: Charging Profiles



Preliminary Results:

EV Uptake Level Comparison

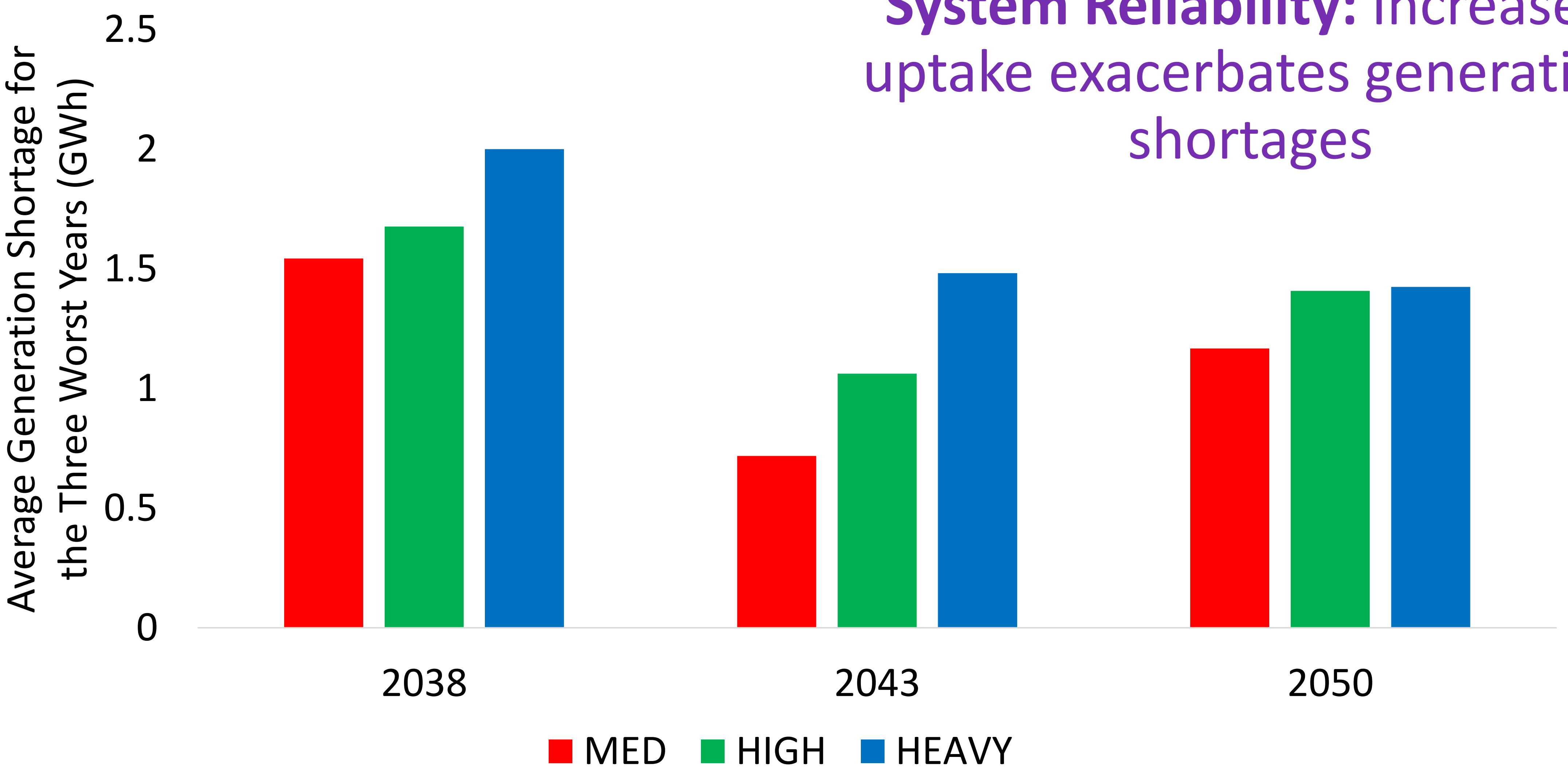
Total Demand – Evening Charging

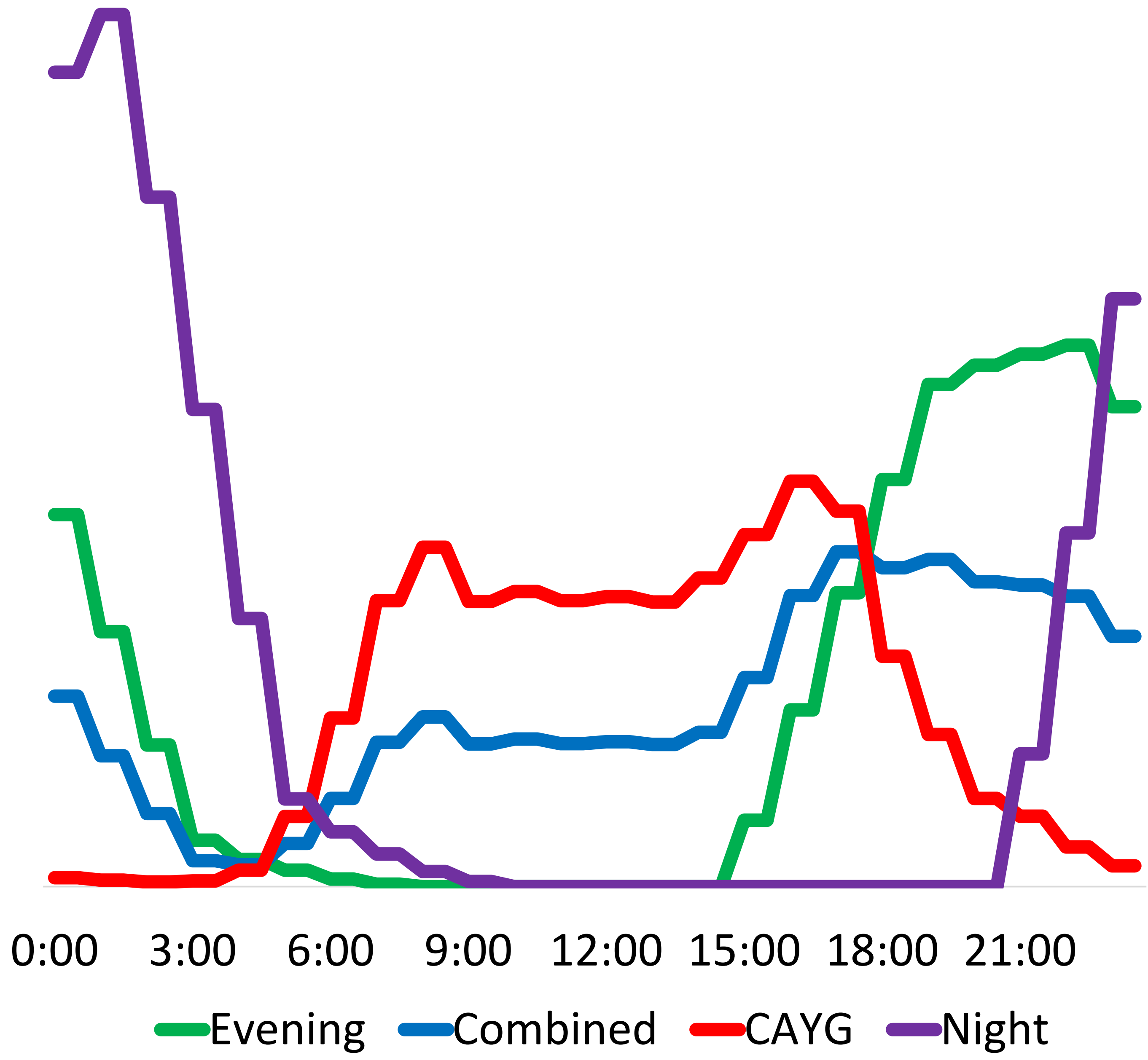


Peak energy demand increase due to electrifying heavy transport is **0.22 GW** (equivalent to **Turitea Wind Farm** operating at **100% capacity**)

System Reliability – Evening Charging

System Reliability: Increased uptake exacerbates generation shortages



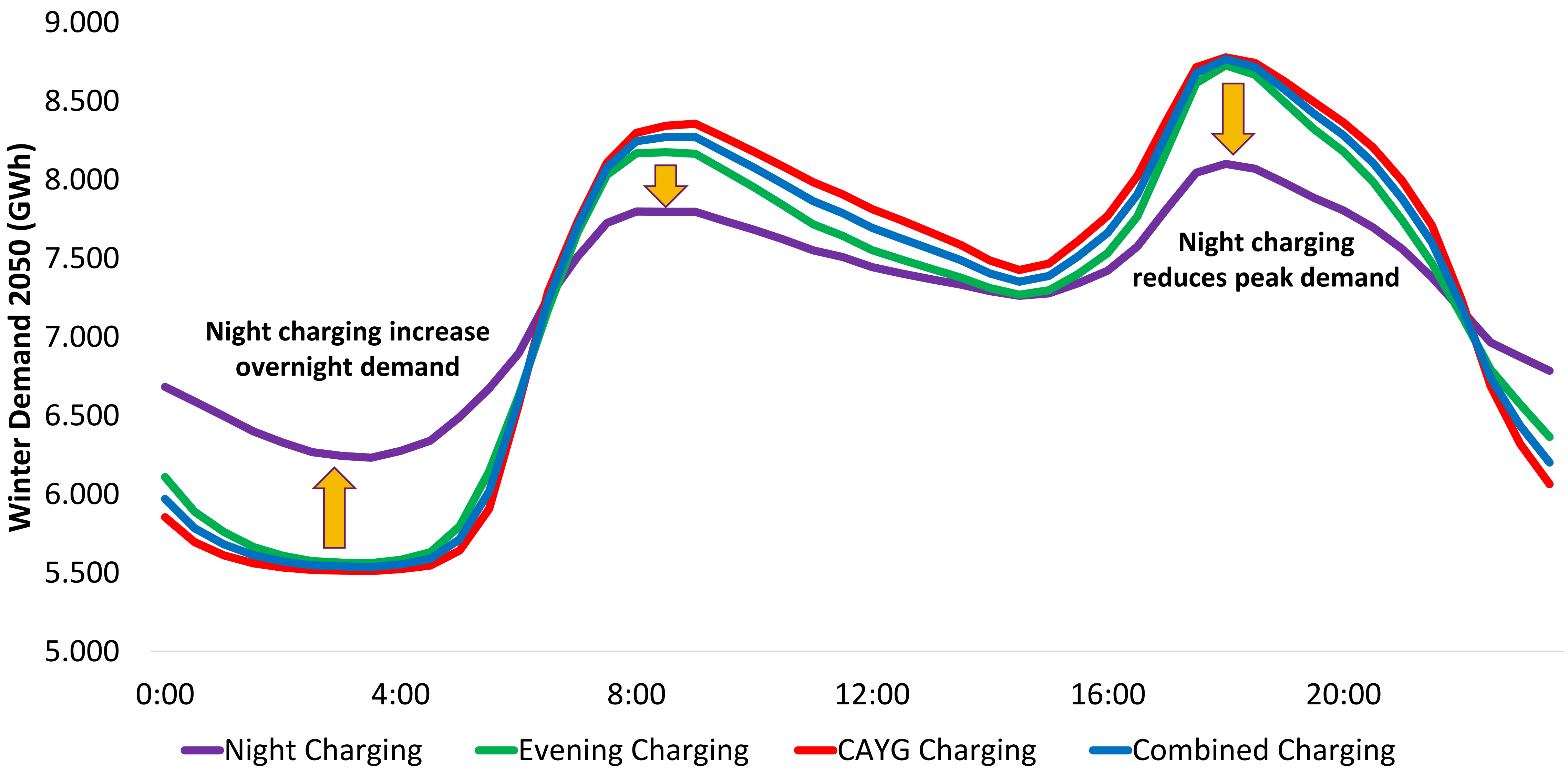


Preliminary Results:

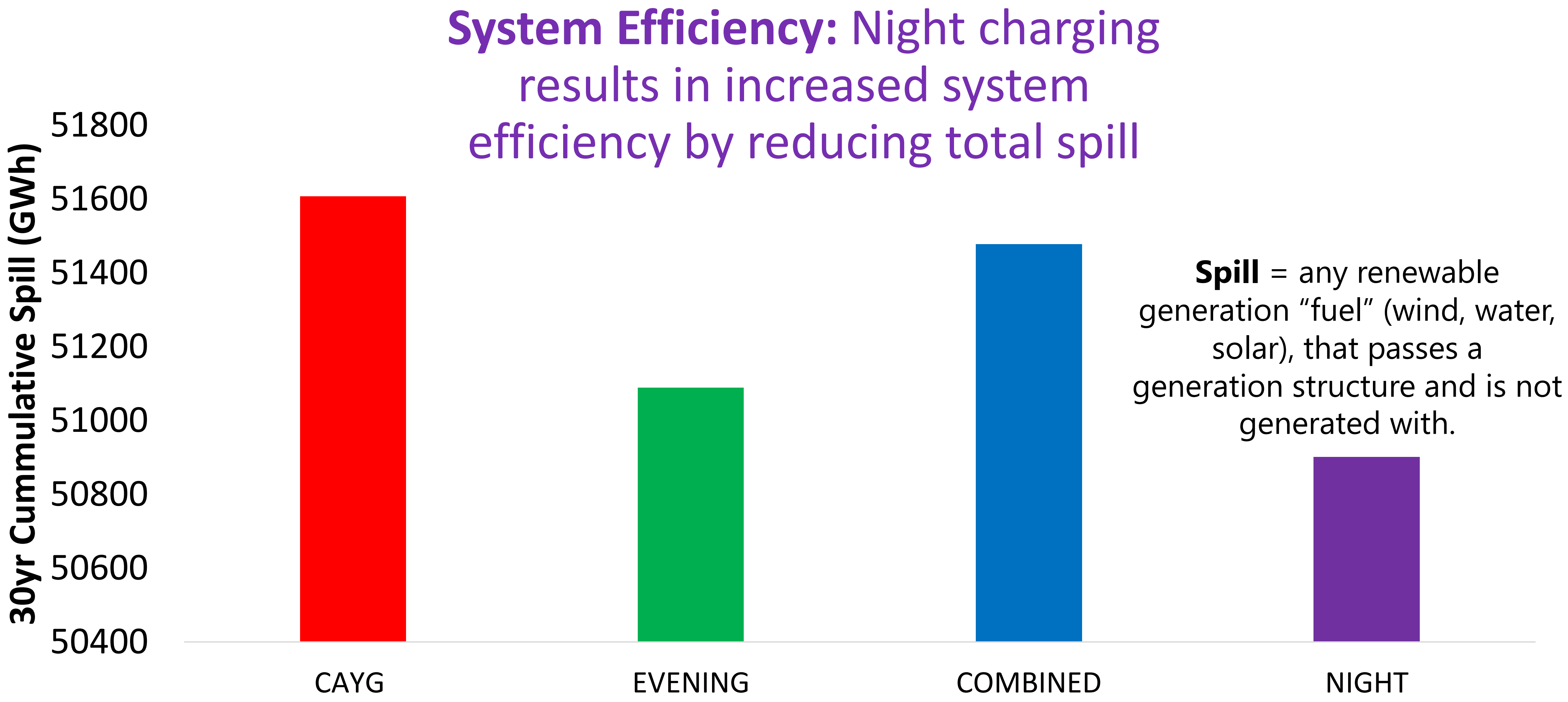
Effect of Shifting EV Charging to being at Night

(High Uptake Level)

Total Demand – High Uptake

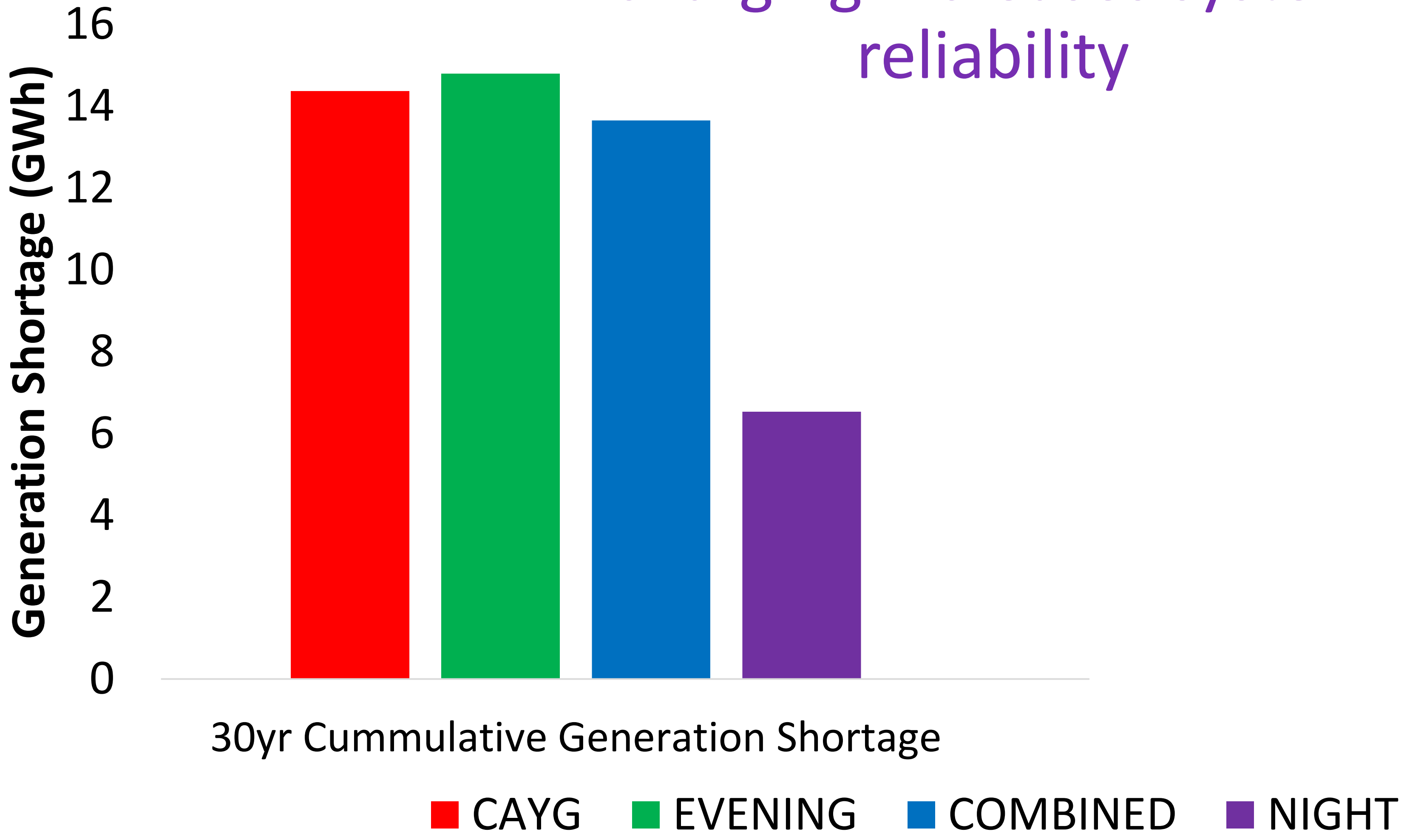


System Efficiency – High Uptake

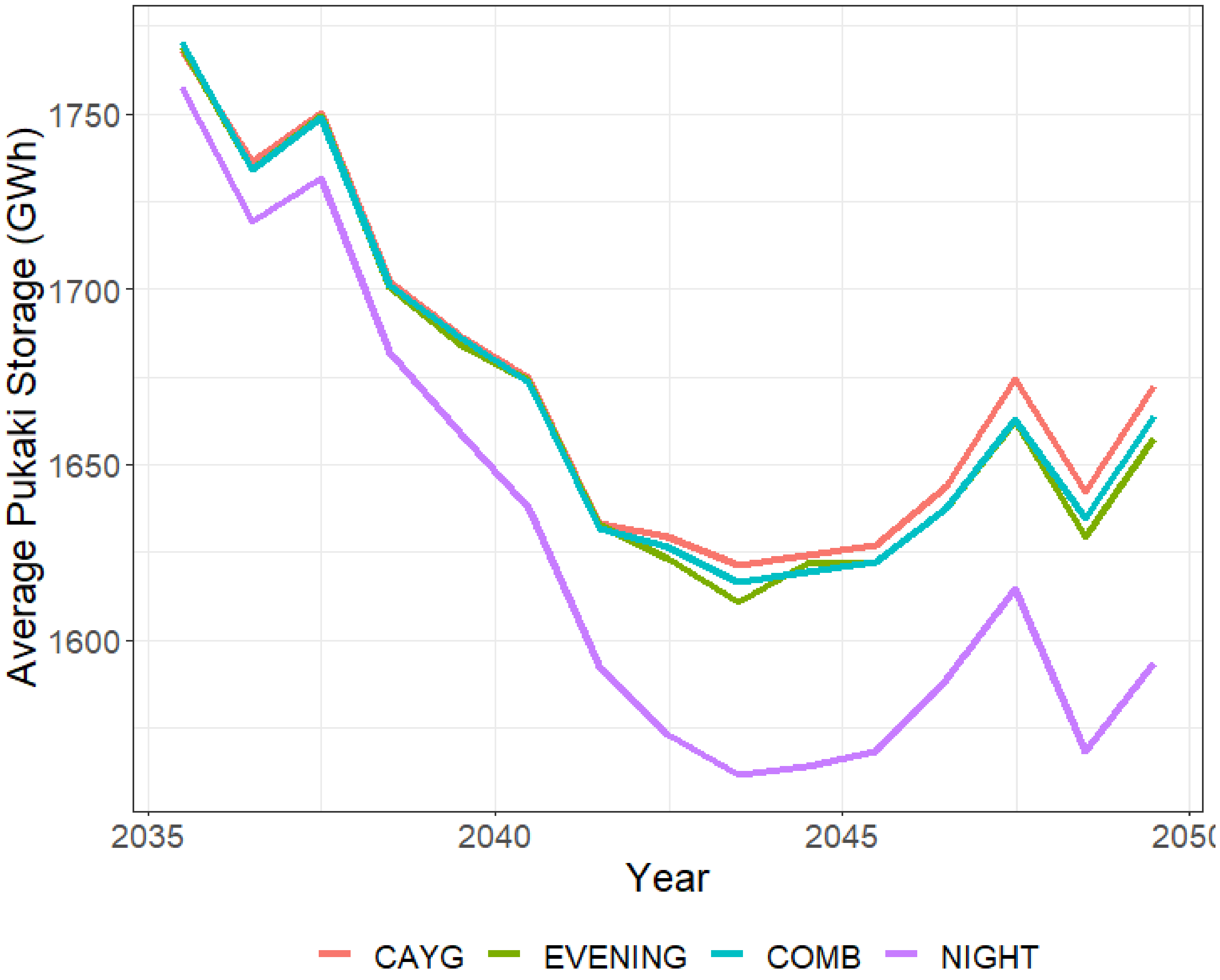


System Reliability – High Uptake

System Reliability: Night charging increases system reliability



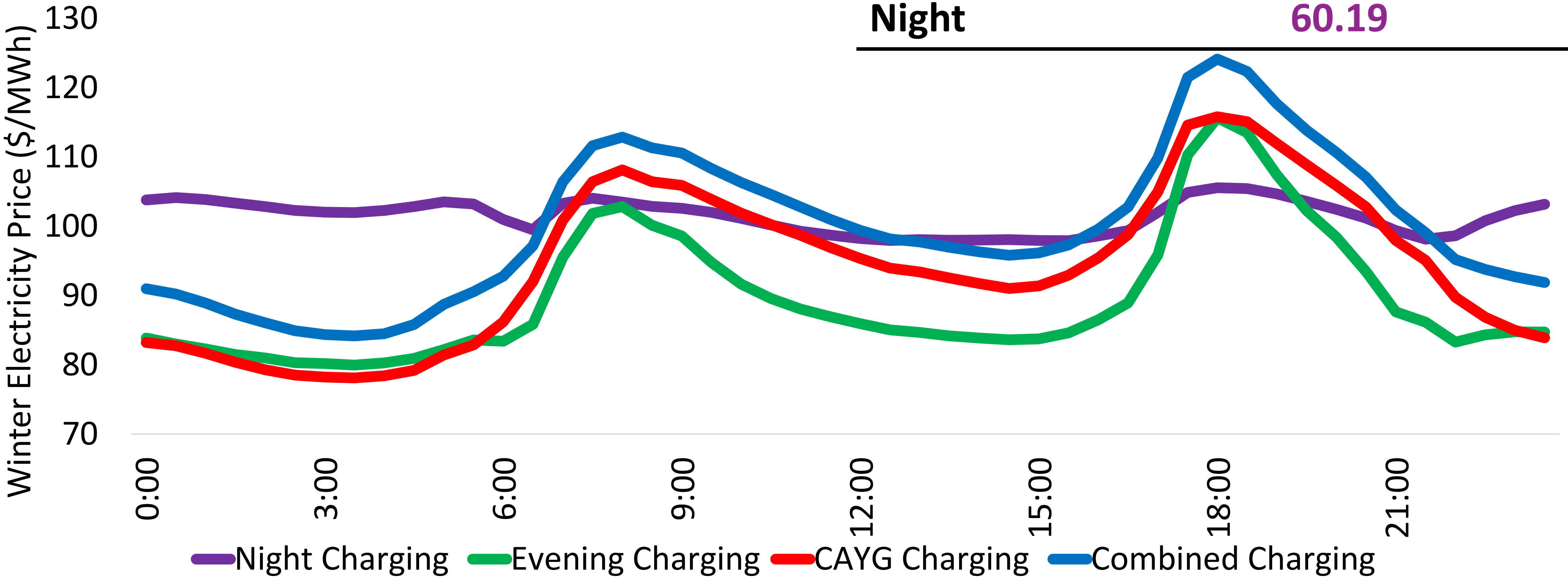
Hydro Generation & Storage



- Night charging uses **more hydro generation** to meet demand than the scenarios with the other charging profiles
- The extra generation is used to **meet EV demand** during the night
- This means that the hydro **storage levels are run lower**
- From 2045 onwards, the reduced hydro storage in the night charging scenario **increases dry year risk**

Average Electricity Price

	Average Price of Electricity for 2040-2050 ($/MWh)
CAYG	54.23
Evening	55.47
Combined	54.71
Night	**60.19**



Results Summary

Increasing levels of EV uptake

- **Increased peak demand (in the absence of managed charging)**
- **Reduced reliability when shortage events occur**

Shifting EV demand to at night through managed charging

- **Reduces peak demand, increases system efficiency and reliability**
- **BUT increased average electricity price and in 2045+ reduced reliability in a dry year**

Thank You

- Michael Jack
- Jen Purdie
- Grant Telfar