ESOO Forecasting Methodology Recap

Wholesale Electricity Market (WEM) Focus

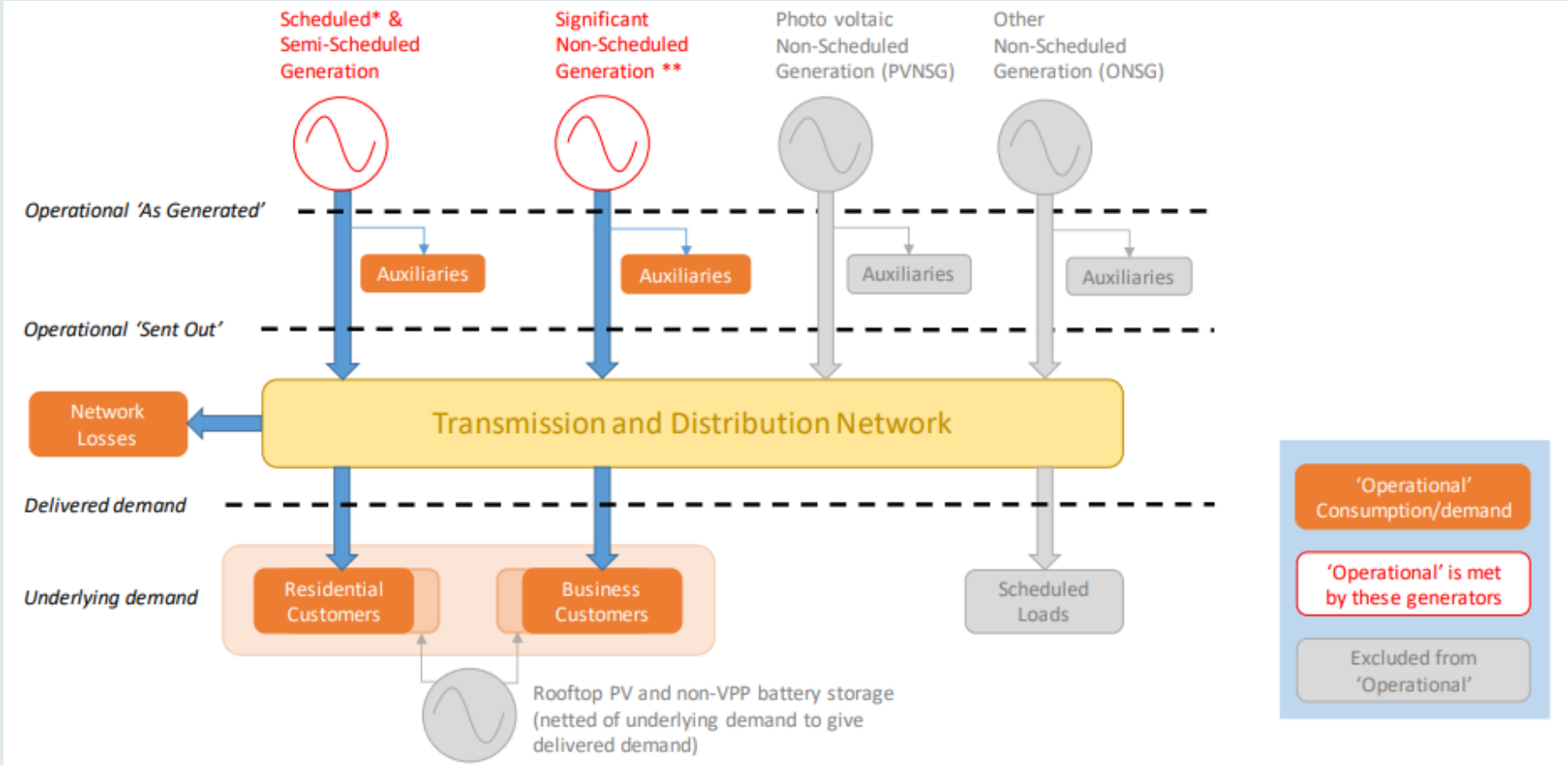
Joachim Tan

Magnus Hindsberger

Agenda

- Energy Consumption Methodology
- Maximum Demand Methodology

Defining demand



* Including VPP from aggregated behind-the-meter battery storage

** For definition, see: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Dispatch/Policy_and_Process/Demand-terms-in-EMMS-Data-Model.pdf

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Forecasting annual energy consumption

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Overview

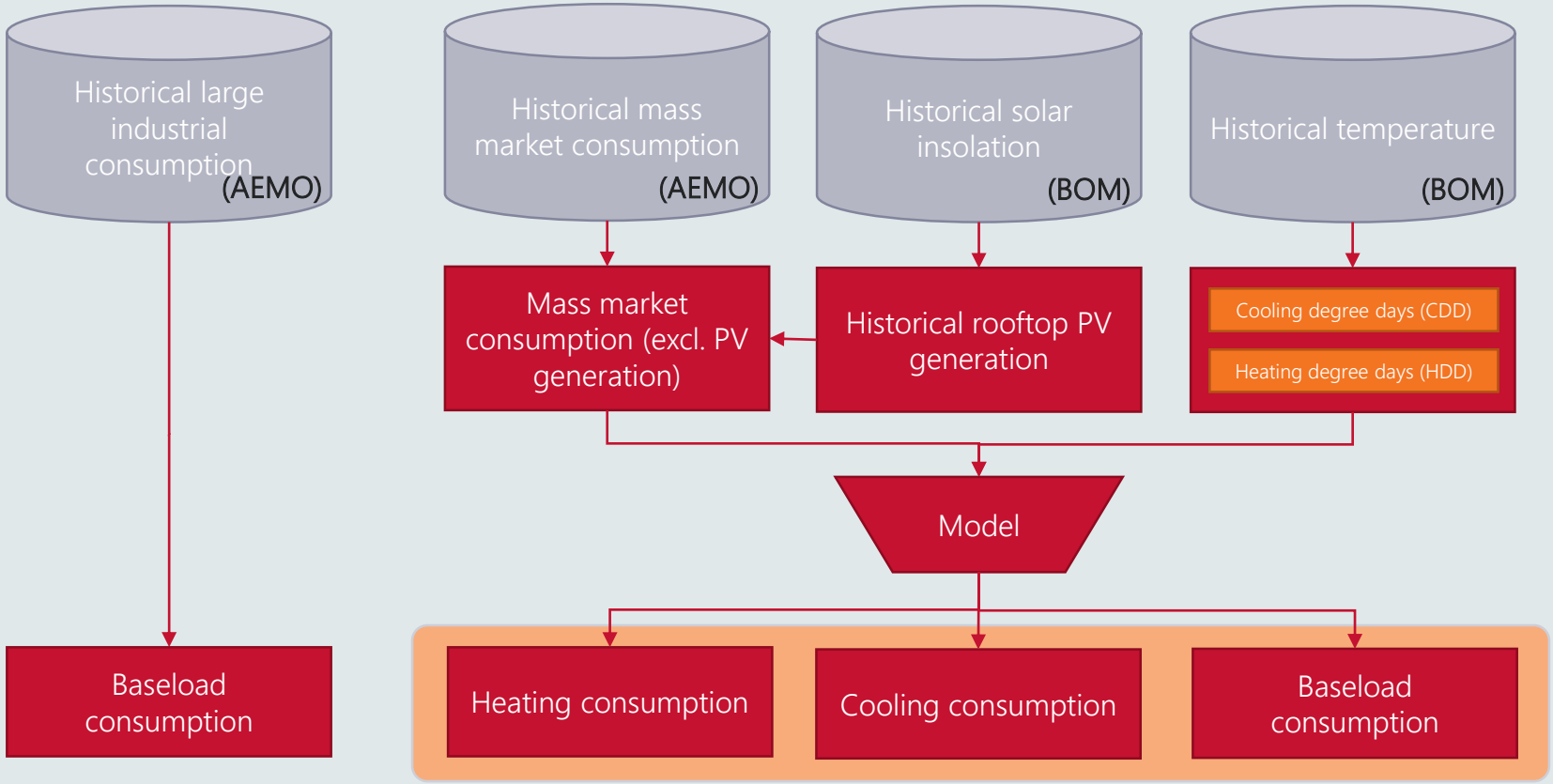
To forecast the WEM, (at least) two forecasts are conducted:

- Annual consumption (energy) forecast
  - Residential
  - Small and Medium Enterprises (SME / mass market), and
  - Large industrial Loads (LILs)

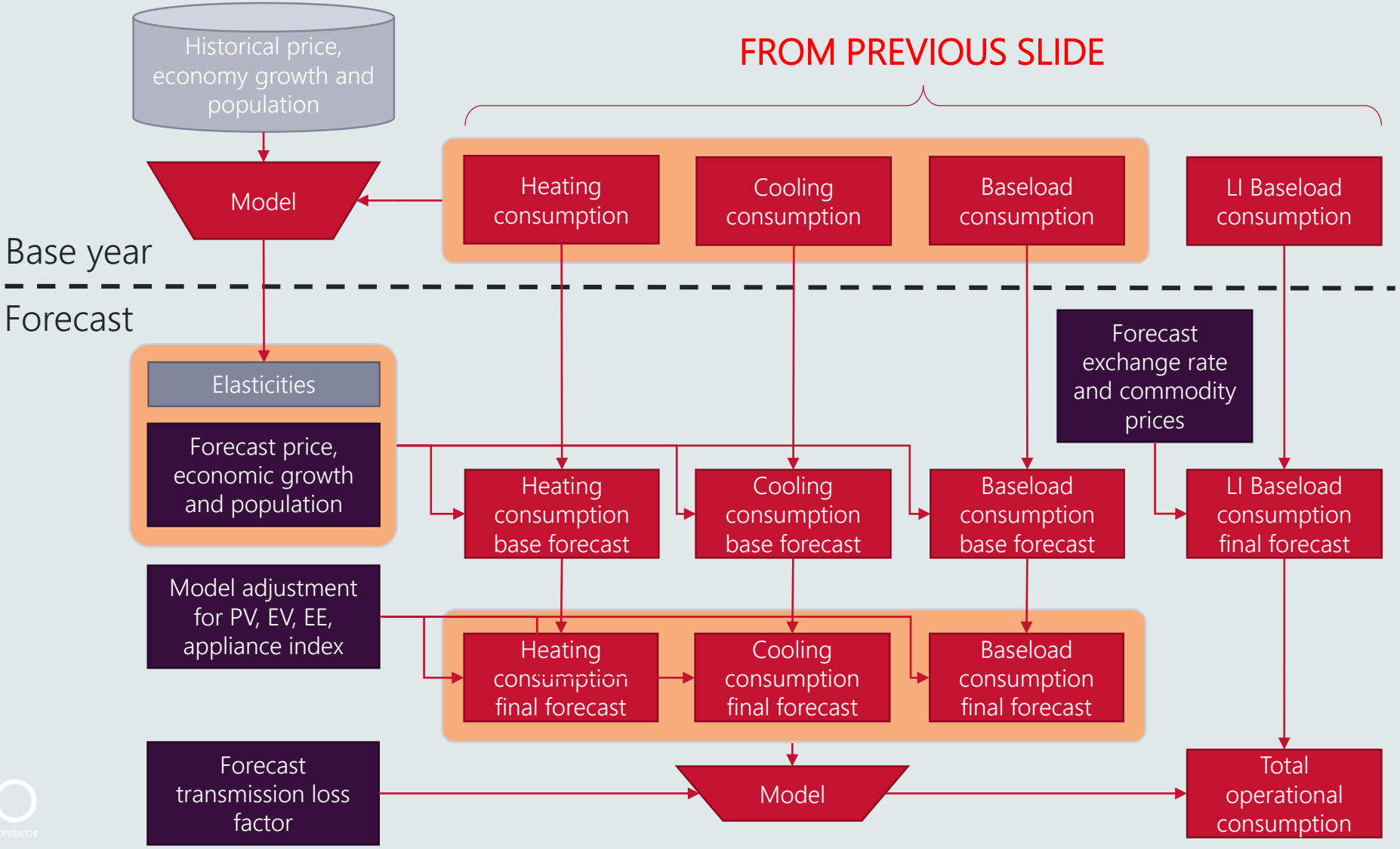
  Growth for each component is based on independently projected growth drivers

- Maximum (peak) and minimum demand forecast
  - Capture trends in cooling/heating demand growth
  - Consider role of Distributed Energy Resources (DER) such as Rooftop PV, batteries and electric vehicles (EVs) in reducing peak demands, or lowering minimum operational (grid) demand

Base year consumption



Forecast consumption



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Input data and assumptions

Key input data and assumptions:

1. Weather/Climate
2. Population/connections
3. Historical demand
4. Economic trends
5. Retail prices
6. Distributed Energy Resources
7. Energy efficiency measures and appliance trends

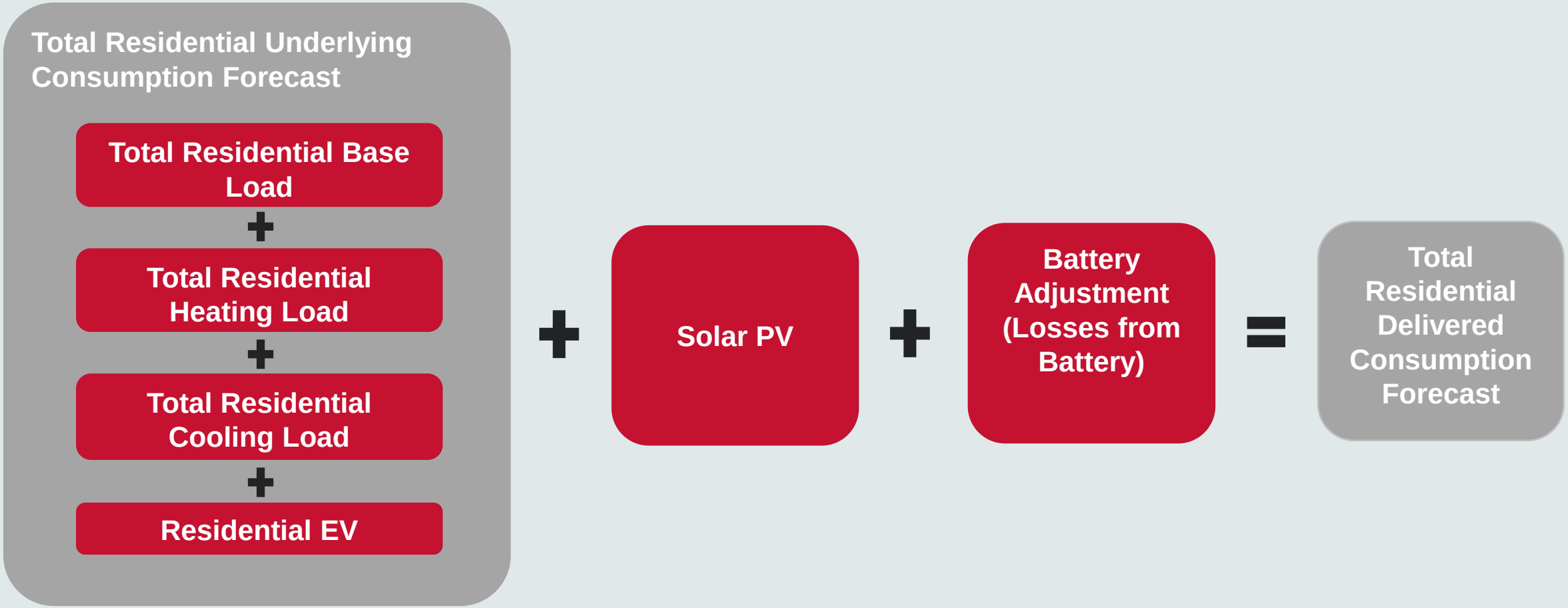
AEMO utilises the most up to date data available to inform the forecasts, including:

- Historical meter data
- BOM/CSIRO
- Housing Industry Association (HIA) and Australian Bureau of Statistics (ABS)
- WA Treasury and Energy Policy WA
- Consultant forecasts
- Participant surveys and interviews for large customers

Residential Model

- Estimate average annual base load, heating load and cooling load per connection, excluding impacts from weather conditions and installed DER resources
- Key components:
  - Baseload
  - Heating load, where the heating load per connection is multiplied by the forecast number of “heating degree days” (HDD)
  - Cooling load, where the cooling load per connection is multiplied by the forecast number of “cooling degree days” (CDD)
  - Appliance trends (energy efficiency) and influence of fuel switching (gas to electric)
  - Penetration and utilisation of DER resources (rooftop PV, batteries and EVs)
  - Impact of retail price movements

Estimate delivered and underlying Residential consumption forecast



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Business Forecasting (NEM)

- **Short term forecast** (defining the Base Year)
  - Develops a weather normalised starting point for the forecasts, based on the most recent year of observed historical consumption, to reflect current consumption patterns

- **Long term forecast** (applying forecast trends to the Base Year)
  - Regression model focusing on population, economic growth and elasticity of consumption to retail price changes
  - Adjusted to capture trends in energy savings from energy efficiency
  - Adjusted to capture climate change impacts, by reflecting anticipated temperature change on the number of heating and cooling degree days
  - Adjusted to capture influence of DER (rooftop PV, batteries and EVs)

Industrial Surveys and Interviews

- AEMO surveys and interviews large industrial loads to capture specific trends in consumption affecting these energy-intensive customers
- A survey and interview process ensures customer-forecast changes to these businesses are captured directly.
- The scenario spread captures a range of economic growth influences on industrial customers, including growth or closure risks

- Survey Process:

1. Identify large industrial users
2. Collect recent actuals and analyse
3. Request survey responses
4. Conduct interviews
5. Finalise Forecasts

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Questions?

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Forecasting maximum and minimum demand

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Introduction

MD forecasts are expressed as probability of exceedance (POE) values from a distribution, rather than a point forecast.

For example, in any given season or year, a 10% POE MD value is expected to be exceeded, on average, one year in ten.

Minimum and maximum demand (MD) forecasts are developed by season using a probabilistic methodology.

Demand is heavily dependent on weather conditions and random variability in response to weather.

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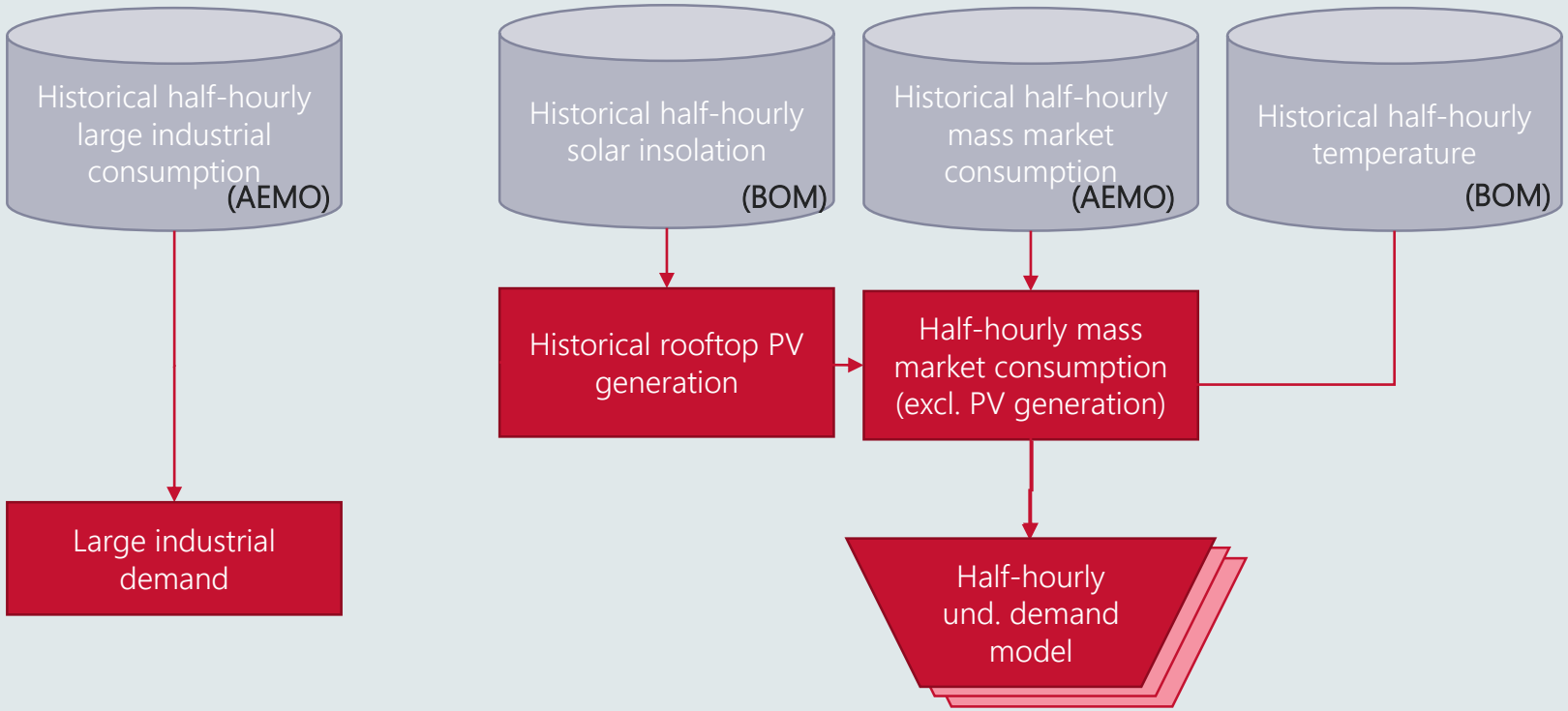
Base year min/max demand



Simulate with synthetic weather years

Underlying demand model:

$$Underlying_{hh} = f(x_{hh}) + \varepsilon_{hh}$$

where

- $f(x_{hh})$ is the relationship between detrended demand and the demand drivers such as weather and calendar/seasonal variables.
- ε_{hh} represents random normally distributed changes in demand not explained by the model demand drivers.

Simulation process:

For each region, for each scenario, for each forecast year, apply demand model to:

- Many synthetic weather years (half-hourly). A synthetic weather-year is constructed by randomly bootstrapping 26 fortnightly weather patterns ("weather blocks") from 20 years of historical weather data , ensuring that a weather block is assigned to the corresponding time of the year.
- Add stochastic component.
- Apply long-term growth indices (heating/cooling/baseload) to underlying.
- Add in forecasts of PV, large industrial load.

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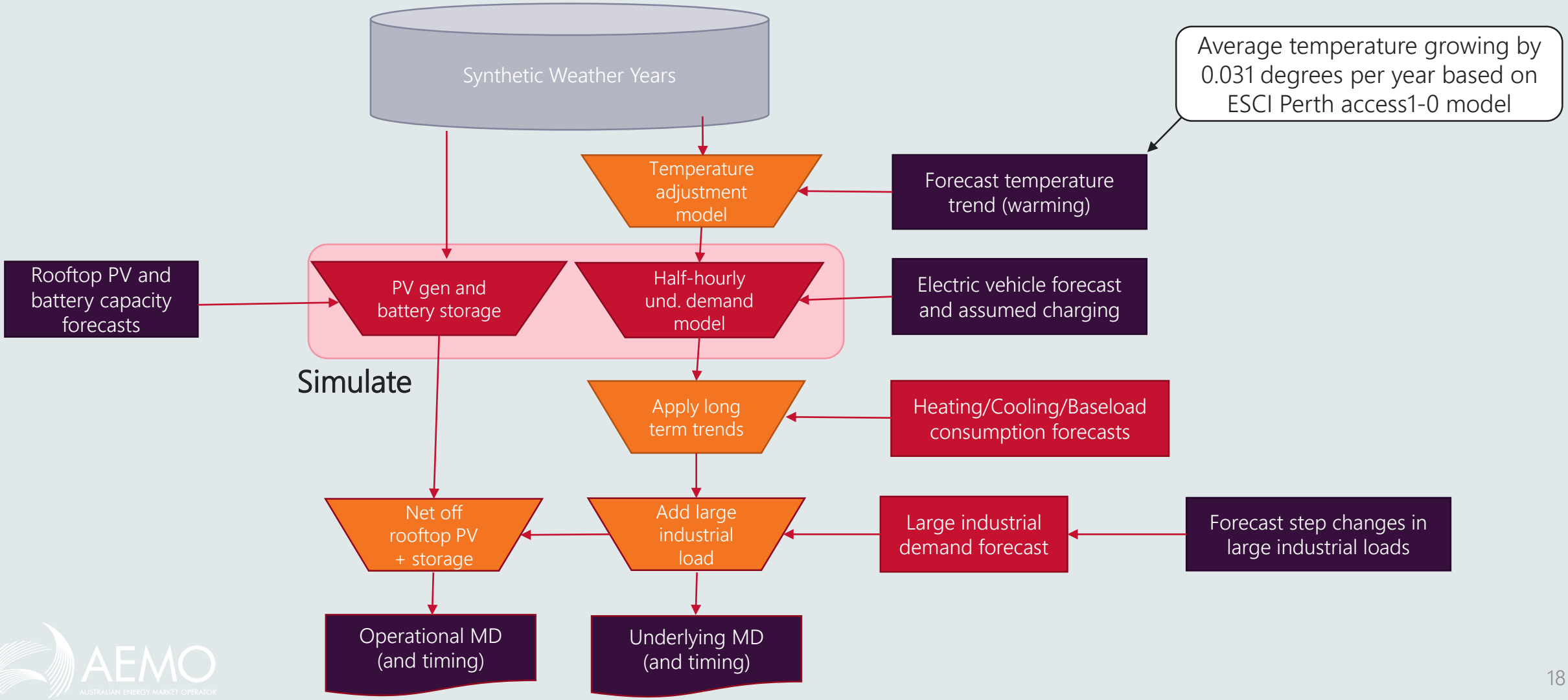
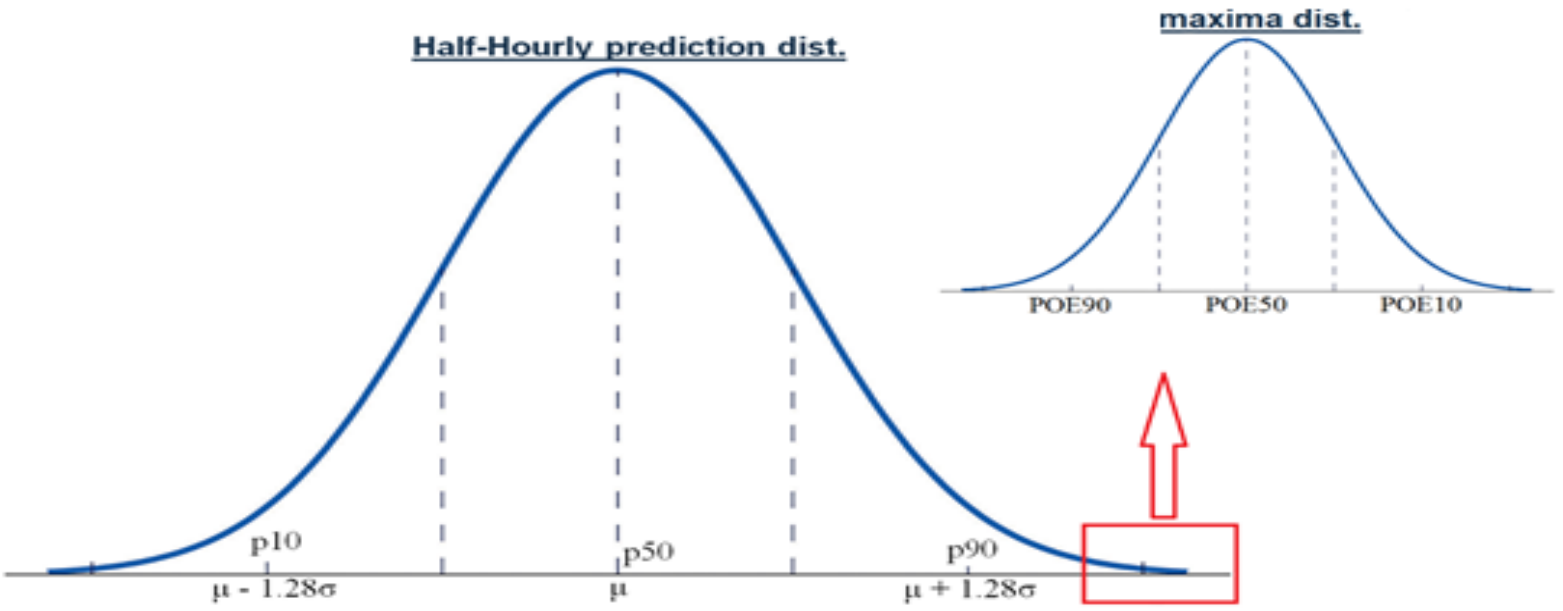
Forecast max/min demand



Probability of exceedance (POE)

AEMO extracts minimum and maximum demand values by selecting the 10th , 50th and 90th percentile as 90%, 50% and 10% probability of exceedance values.

Right figure: distribution of 1,000 yearly maximum demand values.



Left figure: distribution of 17,520 half-hour demand values for a single year.

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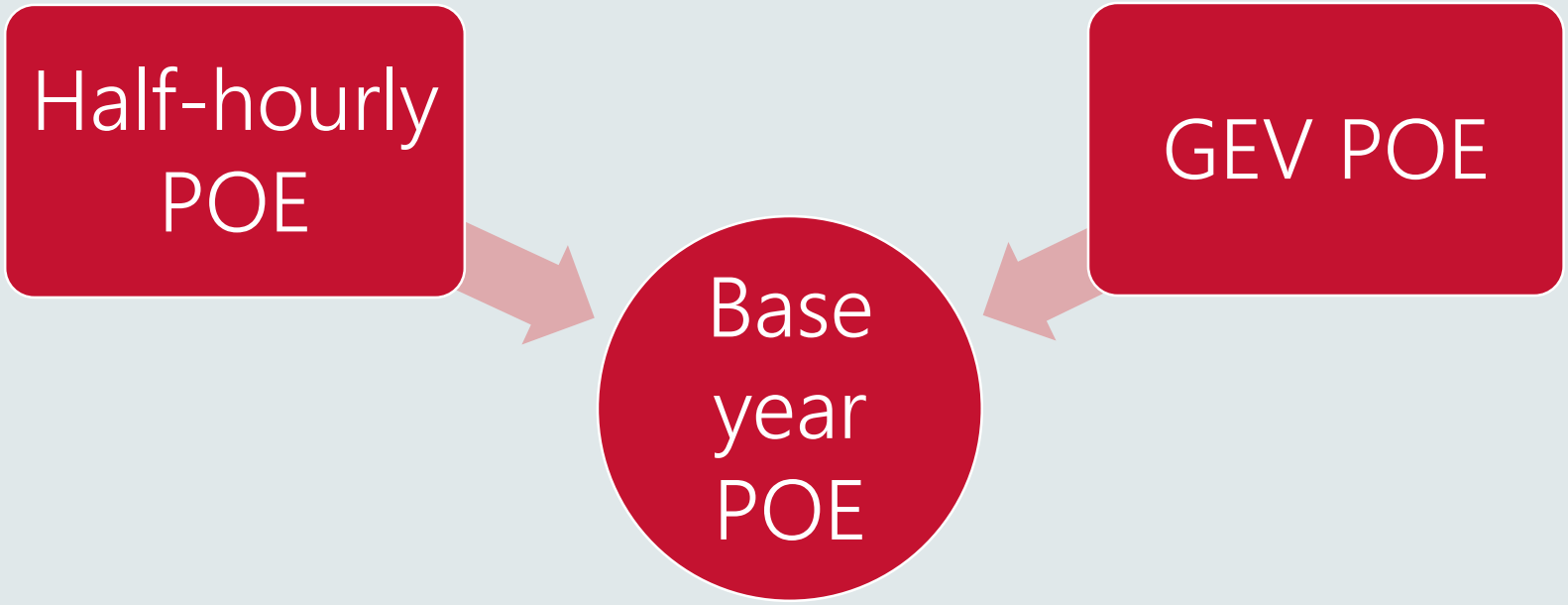
Rebase half-hourly simulation to GEV simulation



This year AEMO will use an ensemble approach, combining the half-hourly model with a Generalized Extreme Value (GEV) model. This will allow AEMO to cross check each model to assess performance and trade off between the strengths and weaknesses of each model.

- Half-hourly model is better at forecasting the transition in timing of demand due to disruptive technology (PV, Battery and EV) but higher resolution models have greater variability
- GEV is better for forecasting short-term maximum demand (1-3 years ahead) but cannot account for structural shifts in demand drivers.

Questions?

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