Synthetic demand traces - Update

27 September 2023

Forecasting Reference Group

Purpose and agenda

The purpose of this presentation is to *inform* the FRG on the progress made in developing synthetic traces since last presented at the April 2023 FRG.

Agenda:

- Background
- Recap of April 2023 FRG update
- New developments
- Example outcomes
- Next steps

Timing	Relevant topic	Responsible
Sep 2021	FRG presentation 2: Demand Traces – why change?	AEMO
Dec 2022 – Apr 2023	FIP consultation	AEMO, Stakeholders
Apr 2023	FRG presentation 3: Synthetic demand traces	AEMO
Today	**This presentation**	**AEMO**
2024 (expected)	Demand Forecasting methodology consultation	AEMO, Stakeholders

Why AEMO is moving to synthetic demand traces

See 26 April FRG presentation 3 slides 4-6 for further background

- AEMO's current approach for creating demand traces is based on recent historical demand traces which are scaled to match forecast values for annual consumption and seasonal max/min demand. This provides a degree of confidence the modelled traces giving a realistic load shape.
- However, there are significant limitations too
  - Limited number of years that are representative for current user behaviour and appliance uptake. As demand need to align with wind and solar outcomes, it restricts the diversity of outcomes that can be modelled for renewable generation.
  - Mild historical years that are grown to 10% demand conditions are stretched beyond what may be deemed realistic.
  - Different growth rates of energy and max/min demand (should that be forecast) may over time stretch demand too.
- Moving to synthetic traces will help to address these problems.

Recap of April 2023 FRG update

Project component	Status
New simulation engine (Databricks) in production	Done
Annual bootstrapping implemented as option	Done
New residual model	Testing ongoing
HH-model improvements (humidity/heatwave)	Done
ONSG sub-model	Testing ongoing
LIL sub-model	Testing ongoing
Sim engine enhancements to extract traces	Done
Test if GEV model is still required	To come
Scaling of resulting traces	To come
Creation of consistent wind and solar traces	To come

On some days, the implemented improvements are significant, which is important when producing traces, where accuracy for each half-hour is essential.

Significant improvement to accuracy (MAPE – mean average percentage error)

	MAPE
Actual	
Improved model 3	1.88
Improved model 2	2.56
Improved model 1	2.76
Current approach	3.60

Tested as part of 2023 ESOO

New developments

Since the April 2023 FRG presentation, AEMO has:

- Used GEV model as validation only, as the ESOO 2023 modelling showed that with the improved half-hourly model formulation, rebasing of the forecast was not required.
- Revised modelling of large industrial load to improve variability and the potential impact of that maximum and minimum demand.
- Completed onboarding of half-hourly traces for other non-scheduled generation.
- Completed review of residual model.
- Revised logic to be used for leap years.
- Implemented a function to smooth forecast outcomes without changing extreme values.

Synthetic Traces

Using weather observations from the reference year to make predictions.

Shift of weather observations forward and backward by 1-3 days to cover the day of week for an entire week.

Incorporating residuals into the forecast to compensate for the unexplained component

Reference Year		Dayshifts		Residual Cases		
2007 - 2022		*-3,-2,-1,0,1,2,3*		*1 - 25*		
16	x	7	x	25	=	2800 simulated half hourly traces

Each of these traces can be seen as a synthetic trace

2800 min/max demand

Large Industrial Load

Bootstrapping the Large Industrial Load (LIL) demand at daily level to add variation and enhance in particular the minimum demand POE forecast.

SA LIL Demand

SA Underlying Max Demand Distribution

90% POE

10% POE

50% POE

Example traces

The synthetic traces will differ depending on day of week and variations arising from model residuals

Dayshifts

Dayshifts will capture the impact of high temperatures on demand depending on day of week and public holidays

Dayshift = 0
Dayshift = -2

Residuals

Using observed in-sample residuals to capture the component cannot be explained by weather

Residual case = 1
Residual case = 20

Example traces

Synthetic traces accurately reflect the impact of actual historical weather on demand

SA **Underlying** Demand **Actual** Outcomes – Season year 2020

SA **Underlying** Demand **Synthetic** Trace – Season year 2023 forecast, ref year: 2020, dayshift: 0, residual case: 20

The synthetic trace accurately replicates the actual demand profile, indicating the model's great accuracy, noting it has three years of additional consumer energy resources added and therefore slightly higher peaks and more low demand points.

It reflect the impact of real weather conditions across reference years on demand and retains the El Niño–Southern Oscillation (ENSO) phrases.

SA **Operational Sent Out** Demand **Actual** Outcomes – Season year 2020

SA **Operational Sent Out** Demand **Synthetic** Trace – Season year 2023 forecast, ref year: 2020, dayshift: 0, residual case: 20

Example traces

Synthetic traces change as more consumer energy resources are added over time

SA **Underlying** Demand Synthetic Trace – Season year **2023** forecast, ref year: 2020, dayshift: 0, residual case: 20

The growth of maximum demand is driven by demographic and economic factors mainly and maintains a similar shape of the peaks for an additional 10 years of growth.

SA **Underlying** Demand Synthetic Trace – Season year **2033** forecast, ref year: 2020, dayshift: 0, residual case: 20

The rapid decline of minimum Operational Sent-out demand and number of low demand events in general is attributed to the increased penetration of PV systems into the market.

SA **Operational Sent Out** Demand Synthetic Trace – Season year **2023** forecast, ref year: 2020, dayshift: 0, residual case: 20

SA **Operational Sent Out** Demand Synthetic Trace – Season year **2033** forecast, ref year: 2020, dayshift: 0, residual case: 20

Next steps in the project

- Consider how to implement components currently accounted for in the demand trace growing process:
  - Electrification impacts
  - Coordinated EV charging
  - Any adjustments to initial year, e.g. in relation to retail prices
- Define trace metadata to assist selection
- Ensure alignment is maintained with wind, solar and transmission rating traces

Q3+Q4 2023

- Engage with FRG ahead of trialling the use of these traces in 2024 ESOO, with synthetic traces expected to supplement the use of “historical weather year” traces in that ESOO

Q1 2024

- Embed process and intended use in the Electricity Demand Forecasting Methodology through AEMO’s 2024 consultation on that document

Q2-Q4 2024

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