Review of changes to the Authority's TPM CBA Model

Reviewer: Nick Porter

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1 Introduction

1.1 Reviewer's Credentials

Nick Porter has 7 years of experience in analytical and modelling roles in the NZ, Australia, EU and UK energy sectors. In summary:

1. 3 years at Trustpower, where he held analytical roles in Energy Trading and Strategy/Regulation. Primary responsibilities included power market model development, revenue risk model development, and reporting on power market outcomes.
2. 2 years at Tilt Renewables, where he held the role of Corporate Finance/Commercial Analyst. Primary responsibilities included financial model development, revenue risk model development, and analytical support for equity/debt raising, PPA negotiations, and support for other contract negotiations.
3. 1.5 years at Baringa Partners as a Senior Consultant in their Energy Markets & Analytics Team, and six months where he has worked as an independent consultant, but primarily contracted to Baringa Partners. His time with Baringa has included a wide range of energy analytics projects, primarily centred on EU/UK market modelling (whole systems modelling, power market modelling, capacity expansion, asset modelling) and advisory, but has more recently been involved in more APAC-centred projects. Note that Baringa is not involved in any way with this review.

Projects that are particularly relevant to the CBA model review:

1. Internal model review for Baringa's Climate Transition model. This involved a review of the conceptual design and key inputs behind Baringa's global climate change scenario model, as part of the sale of Baringa's Climate Solutions Modelling Suite to Blackrock: https://www.blackrock.com/corporate/newsroom/press-releases/article/corporate-one/press-releases/blackrock-to-acquire-baringa-partners
2. Developing a rolling intraday trading model in Python to simulate optimal trading in the UK's continuous gas and electricity markets. This differed from a conventional day-ahead asset optimisation tool, as it simulated not just the optimal asset dispatch, but also the re-hedging (churning) decisions that traders make as the within-day prices fluctuate. This model was used in the valuation of a gas peaker owner/operator and energy trading firm as part of a sell-side due diligence process. The model has since been used across a wide range of battery storage and gas peaker asset valuations both within the UK market and various Pan-EU markets.
3. Developed and delivered a stochastic crude and refined product price simulation and earnings at risk (EaR) tool in Python for a UK-based refinery.
4. Rewrote a gentailer's short/medium term monte-carlo price simulation model in Python (previously VBA/Excel hybrid), significantly improving on runtime and usability.
5. Developed a Monte Carlo auction simulation package in Python to simulate bidding behaviour for a seabed auction for offshore wind development.

1.2 Methodology

This work has been undertaken to review the changes made to the TPM CBA code following release of Transpower's TPM proposal. The author of the code, Sense Partners, has provided the reviewer a list of changes for review. The review has focussed on identifying programmatic issues within the new code additions, and testing for any unforeseen consequences that these additions may cause within the broader program.

Note that this review does **not** cover the following:

1. Whether the changes are reflective of changes to the charging methodologies as outlined in the TPM's proposal.
2. Whether the model owner's algorithms are fit for purpose.
3. Reviewing the input dataset.
4. Reviewing any code outside of the list of amendments provided by Sense Partners.

Table 1 Executive summary: ratings of findings

Conclusion	Description
Green	Observation or query for which clarification is required.
Yellow	Minor model remedial actions are proposed in light of this finding. The finding does not prevent the model from being implemented or its continued use, and has small severity.
Amber	Significant remedial actions are proposed in light of this finding. Clear and immediate steps should be taken to rectify the issue in order to proceed with the implementation of the model or to continue using the model, as a failure to do so may impact the output produced by the model in a material way.
Red	The finding has a material impact on the output of the model and requires immediate attention before the model can be implemented or its use continued. A failure to address the finding is typically associated with results produced by the model that are factually wrong, unintuitive, or nonsensical, and may materially impact the continued viability of the model and its use.

1.3 Findings, Observations, and Queries

The full list of observations and finding is shown in the table below. For more detail, please refer to the following section, noting the change number in the table below relates to the code change numbering in the next section.

#	Findings	Suggested Action	Rating and resolution status so far
1	**Observation 1:** Tasman mill exit reduces TRK TOU demand by exactly 80%.	Being a very round fraction, consider whether a more precise load reduction is reasonable.	Unresolved but immaterial
2	**Observation 2:** Numerous hard-coded numbers throughout the code (investment dates, capacity reductions, among others).	After some updates from the first round, some hard-coding still exists, but fixing may result in additional risk at this point.	Some hard coding resolved, but some more added with recent changes
3	**Finding 1:** The Gen_l list contains two regions that don't appear to have generation (i.e. no rows in data_gen dataframe): MDN and OTA, resulting in errors in the dmnd function due to concatenating empty rows	Consider whether these regions can be removed from gen_l list	
4	**Finding 2:** Extremely immaterial, but Central_OH_in_BBC and Central_OH_in_BBC_with_tiwai: r_s variable should be 0.5842 rather than 0.584.	Fix number	

1.4 Full list of changes reviewed

MC #	Description	Lines
1	New input files for allocating BBCs	48, 49
2	Revised expenditure elasticity, to capture increased demand growth from electrification (see 'Scenarios.xlsx' for values used).	90
3	Revised plant closure parameters and new plant closure parameters	123-130
4	New rule that there is no new investment in thermal plant after 2030.	139-141
5	New transmission charge parameters and calculations to allow for	
	Explicit modelling of the balance of effects of fixed vs variable charges	233,234
	Scenarios around the allocation of BBCs to generation customers	237-256
6	Function that updates consumer expenditure and prices amended to include a price floor and to account for costs of fixed charges in consumer expenditure	289-341
7	Somewhat trivial changes to way that projected revenue and components of revenue are calculated	363-375
8	Functions for recalculating custome shares of existing BBCs (aob_adj) and future BBCs (benefit_adj)	451-466
9	Functions for adjusting customer shares of AMD (amd_adj) and customers growth in AMD (AHAMD_f)	491-512
10	Revision to function (gen_aob_update) allocating transmission charges to generation customers	581-634
11	Changes to the generation investment function to	

	Update exogenous investment and decommisioning	769-809
	Accommodate investment of batteries alongside renewables, but limiting scope for duplicate investment in the same project (one with and one without batteries)	e.g. 810
	Account for cost spreading effects of new generation investment, in terms of tha sharing of interconnection charges	826-829
	Allow for separate consideration of profitability of peaking generation	888-921
12	Changes to the price expectations function to e.g. account for high exogenous growth and tiwai departure	952-975
13	Add historical price and expenditure data to the 'dmnd' function, to allow for analysis of price levels relative to historical experience	1137-1149
14	Change consumer interconnection charge allocations to allow for	
	adjustments to residual charges for plant closure	1199-1204
	allocation of BBCs based on categories of BBC: standard vs simple	1211-1295
	adjustments to BBCs when plant closes	e.g. 1237-1240
	change in allocation o new BBCs if the simple method is reviewed and changed	e,g, 1241-1246
15	Distinguish between different effects of residual and BBC charges on consumer demand / incremental costs	1305-1312
16	Change calculation of demand to be based on price levels relative to historical averages, instead of year by year percentage price changes	1357-1448

17	Add fixed charegs to consumer expenditure	1503, 1508
18	Limit the size of changes in demand affecting transport costs to avoid excessive changes	1536-1543
19	Implement investment decisions prior to consumers choosing demand levels	1659
20	Adjust BBC/AOB charges for plant closure	1689-1692

The reviewer has also checked that the following scenario data has been incorporated correctly into scenario-specific files

Variables/code changes	**Filenames**	**Expenditure elasticity**	**Tiwai closure**	**Huntly closure**	**Residual % of IC revenue**	**Opex in BBC**	**Gen default benefit share %**	**Review year**	**Gen BBC initial share%**
Var	XXX.py	m_e	twi_off	hly_off	r_s	opex_r	gen_bbc_shr	review_yr	gen_initial_aob
Central	Central.py	1.0225	2024	2024	0.609	0.0345	0.471	2099	0.4045
Central_OH_in_BBC	Central_OH_in_BBC.py	1.0225	2024	2024	0.5842	0.0452	0.471	2099	0.4045
Central_7525	Central_7525.py	1.0225	2024	2024	0.609	0.0345	0.25	2099	0.355

Central_9010	Central_9010.py	1.0225	2024	2024	0.609	0.0345	0.1	2099	0.3218
Central_review_7525	Central_review_7525.py	1.0225	2024	2024	0.609	0.0345	0.25	2027	0.4045
Central_review_9010	Central_review_9010.py	1.0225	2024	2024	0.609	0.0345	0.1	2027	0.4045
Central_with_tiwai	Central_with_tiwai.py	0.577	2099	2026	0.609	0.0345	0.471	2099	0.4045
Central_OH_in_BBC_with_tiwai	Central_OH_in_BBC_with_tiwai.py	0.577	2099	2026	0.5842	0.0452	0.471	2099	0.4045
Central_7525_with_tiwai	Central_7525_with_tiwai.py	0.577	2099	2026	0.609	0.0345	0.25	2099	0.355
Central_9010_with_tiwai	Central_9010_with_tiwai.py	0.577	2099	2026	0.609	0.0345	0.1	2099	0.3218
Central_review_7525_with_tiwai	Central_review_7525_with_tiwai.py	0.577	2099	2026	0.609	0.0345	0.25	2027	0.4045
Central_review_9010_with_tiwai	Central_review_9010_with_tiwai.py	0.577	2099	2026	0.609	0.0345	0.1	2027	0.4045