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# 2025 Energy Efficiency Forecasts Final Report

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# Executive Summary

### *Introduction*

This report presents the 2025 energy efficiency forecasts for Australia's National Electricity Market (NEM), along with Western Australia's South Western Integrated System (SWIS) and the Northern Territory's Darwin–Katherine Integrated System (DKIS). The forecasts extend from 2023–24 (FY2024) to 2057–58 (FY2058). The scenarios modelled align with the Australian Energy Market Operator's (AEMO) draft scenarios for 2025-2026, noting these will be finalised during in 2025 and may eventually differ from those modelled here.

The forecasts focus on energy efficiency in stationary electricity and gas use in residential, commercial, and industrial sectors, with a particular effort made to separate efficiency gains arising from electrification, which are outside the scope of our analysis and modelled elsewhere.

The analysis arises from AEMO's need to account for future energy efficiency trends in key reports and planning instruments, including the Electricity and Gas Statements of Opportunities (ESOO, GSOO) and the 2026 Integrated System Plan (ISP). By identifying how policies, programs, and autonomous (market-led) efficiency gains may reduce energy consumption over time, the forecasts help guide investment and operational decisions.

### *Methodology and Scope*

Energy efficiency improvements are measured relative to a fixed (and largely arbitrary[1]) point in time, FY2015. We first construct a 'frozen efficiency' counterfactual baseline, holding FY2015 energy intensity constant through to FY2058. This illustrates the expected changes in consumption due to the 'growth effect' only – without efficiency change or electrification. Differences between this baseline and actual or projected consumption reflect efficiency changes from two main sources: (1) market-led or autonomous efficiency improvement (AEEI), and (2) policy measures. Our residential and commercial forecasts use stock-turnover models, linking changes in floor area, building vintages, dwelling stock composition and equipment uptake to variations in overall electricity and gas consumption. In the industrial sector, chain-weighted Gross Value Added (GVA) data provides a proxy for output.

Data inputs are primarily from AEMO's consumption datasets, supplemented by public program reporting statistics, and some government projections for major policies, such as appliance standards or state energy saving schemes. This approach ensures consistency with other components of AEMO's forecasting process. The forecasts exclude transport, liquefied natural gas (LNG) exports, and power generation (ANZSIC Division D). The forecasts also avoid double-counting the effects of electrification – to the extent feasible – and also demand response and consumer

[1] Although the choice of this date also reflects the extent of availability of historical energy consumption data.

energy resources (e.g., rooftop solar and batteries). Where policy or program evaluations overlap—such as multiple programs claiming similar outcomes—discounts are applied to avoid overstating total efficiency gains.

***Policy and Scenario Overview***

Numerous policies and programs drive energy efficiency improvements across Australia's residential, commercial, and industrial sectors. At the national level, the **National Construction Code (NCC)** imposes minimum standards for thermal performance and overall energy use in new dwellings and non-residential buildings. Recent revisions in NCC2022 strengthened residential requirements to 7-star (using the Nationwide House Energy Rating Scheme), although there are numerous exemptions and variations at the jurisdictional level. Over time, the NCC is expected to undergo further stringency reviews, potentially raising star ratings or broadening the scope of regulated features (such as building envelopes and fixed equipment). These code upgrades have a large cumulative effect because new buildings last for decades, and each incremental improvement permanently reduces energy demand.

Another major national policy instrument is the **Greenhouse and Energy Minimum Standards (GEMS/E3) program**, which mandates minimum efficiency requirements and labelling for key appliances and equipment. GEMS covers products such as air conditioners, refrigerators, televisions, electric motors, and water heaters. Past expansions of GEMS drove significant savings, and future amendments could extend coverage to emerging technologies (like larger heat pumps) and tighten existing standards. As older equipment retires and is replaced by products meeting newer GEMS specifications, efficiency gains accumulate. Recent studies suggest that a small group of product categories—particularly air conditioning, lighting, and refrigeration—accounts for most GEMS savings to date, but ongoing improvements to other products may become more influential if stringency increases or new categories are regulated.

In addition to these national measures, **state and territory energy savings schemes** play a sizable role. The state programmes modelled are the NSW Energy Savings Scheme (ESS), Victorian Energy Upgrades (VEU), and South Australia's Retailer Energy Productivity Scheme (REPS). These schemes typically require energy retailers to meet annual targets for energy efficiency activities, creating a financial incentive to help households and businesses upgrade equipment or adopt efficient practices. A range of activities are credited, from LED lighting conversions to high-efficiency heating systems, with some schemes increasingly supporting fuel switching where it offers clear energy or emissions benefits. The scale of these programs varies by state, but they collectively drive large improvements in residential and commercial sectors, particularly in lighting, HVAC, and appliances.

Other initiatives complement these major policies. **Commercial Building Disclosure (CBD)** mandates energy efficiency disclosure for large office spaces when they are sold or leased, and potential expansions could extend coverage to more building types or reduce the minimum floor area threshold, driving operational upgrades. **NABERS** is a voluntary national rating system for buildings, which influences offices, hotels, shopping centres, and other commercial facilities to track and improve performance. In the residential sector, some jurisdictions are working toward mandatory energy performance disclosure at point of sale or lease, while the Clean Energy Finance Corporation's **Home Energy Upgrade Fund** supports financing to improve household efficiency.

Finally, for large industrial facilities, the **Safeguard Mechanism** imposes declining emissions baselines, requiring covered entities to reduce onsite emissions or face penalties. While scope-two (grid) emissions are excluded, companies that rely on gas combustion (scope-one emissions) often respond by implementing more efficient processes or equipment. These industrial gas efficiency gains are expected to grow over time as baselines tighten, particularly under more ambitious policy and economic scenarios.

Within this policy landscape, AEMO uses three main scenarios—**Progressive Change**, **Step Change**, and **Green Energy Exports**[2]—to explore how varying economic, technological, and policy conditions could affect the pace and extent of efficiency gains.

- **Progressive Change** assumes relatively weak economic growth and policy ambition. It features fewer or slower updates to the NCC, more modest expansion of GEMS, and limited adjustments to state schemes. In this environment, businesses and households invest less in upgrades, and large industrial users may delay significant efficiency measures unless strictly required. Overall energy consumption still declines relative to the frozen baseline, but at a slower rate.

- **Step Change** aligns with moderate economic growth and policy refinements. It reflects policies consistent with increased policy ambition over time, including incremental NCC improvements every six years, expansions to GEMS (albeit not at the highest possible stringency), and steady increases to state scheme targets. Under Step Change, the Safeguard Mechanism stimulates a moderate level of industrial gas savings, and policies like CBD and NABERS progressively expand in coverage. Efficiency gains remain significant, though not as large as in the most ambitious scenario.

- **Green Energy Exports** envisions higher economic growth, stronger global coordination on emissions, and frequent reviews of building codes and equipment standards. GEMS coverage broadens more rapidly, and state or territory programs set higher annual efficiency targets. The Safeguard Mechanism is effectively stricter (due to faster economic and industrial growth, which means covered facilities must decarbonize even further), and industrial enterprises often deploy best-available technologies to stay ahead of tightening baselines.

[2] This scenario now has two variants: Green Energy Exports and Green Energy Industries. This report primarily focuses on the former, but a Green Energy Industries sensitivity analysis may be found in Chapter 7.

As a result, this scenario delivers the largest efficiency gains, reflecting both policy ambition and accelerated investment in advanced equipment.

Each scenario incorporates Australia's net-zero by 2050 policy goal but differs in the speed of achieving interim targets and the depth of supporting measures. The AEMO scenarios can be compared to the frozen (FY2015) efficiency projection, with the difference between them representing indications of the growing or cumulative impact of energy efficiency change in generating avoided consumption.

### *Sector Highlights*

#### *Residential*

Electricity savings in households stem from code improvements (mainly the NCC) that boost the efficiency of new dwellings, appliance standards via GEMS/E3, and subsidies through programs like NSW ESS or Victorian Energy Upgrades. By 2058, residential electricity savings range from about 50,800 GWh annually under Progressive Change to around 85,900 GWh annually in Green Energy Exports, from a 2015 baseline. Gas savings reach between 42.9 PJ and 58.4 PJ from a 2015 baseline, shaped by better thermal shells (ie, better-insulated and/or more airtight windows and exterior surfaces of the dwelling), improved gas-using technologies (e.g., heaters, hot-water systems), and separate trends toward electrification.

#### *Commercial*

Commercial buildings contribute significant efficiency gains, primarily through incremental NCC updates for new construction and expansions of measures such as CBD, NABERS, and state-funded incentives. By 2058, commercial electricity savings range from roughly 34,000 GWh in Progressive Change to over 75,700 GWh under Green Energy Exports, when compared to a 2015 baseline. Investments in efficient HVAC systems, lighting, and equipment are particularly impactful, and mandatory disclosure or rating programs encourage upgrades in existing buildings. Commercial gas use remains comparatively low, but targeted policies still offer modest gas savings.

#### *Industrial*

In the industrial sector, electricity efficiency is mainly tied to ongoing autonomous improvements, with contributions from GEMS and state energy savings schemes (in NSW, VIC and SA). The Safeguard Mechanism, however, is expected to drive more pronounced gains in gas efficiency by incentivising large emitters to decarbonize or reduce on-site fuel use. Under Step Change and Green Energy Exports, many facilities undertake deeper efficiency retrofits, leading to substantial aggregate gas savings. Progressive Change sees fewer industrial investments, as lower economic growth and policy ambition slow the pace of upgrades. Overall, and drawing on updated advice from DCCEEW, gas savings in the Large Industrial Load (LIL) segment are forecast to more than double those anticipated in the 2024 energy efficiency forecasts (based on the draft 2023 IASR).

### *Conclusions and Recommendations*

Forecast results consistently show higher energy efficiency savings under scenarios with stronger policy ambition. Green Energy Exports stands out for delivering the largest cumulative reductions in electricity and gas consumption, while Progressive Change lags in both economic activity and policy ambition. Of course, energy consumption will also vary by scenario, but our focus in this work is change in energy efficiency and not change in energy consumption. AEMO produces consumption forecasts drawing on this and many other inputs.

In all scenarios, some level of AEEI is assumed, reflecting ongoing technological advances, replacement of older equipment, and changes in consumer preferences, that would occur even in the absence of policy measures.  The impact of policy measures is then discounted for non-additionality to AEEI, to avoid double-counting.

In rare cases, such as the expected impact of the Safeguard Mechanism on the LIL sub-sector, policy designs can be significant enough to 'crowd out' the market-led savings that would otherwise have been expected to occur.

Several recommendations emerge for further refinement of energy efficiency forecasts. First, aligning this analysis more closely with AEMO's electrification forecasts would clarify how much of future gas reductions stem from energy efficiency improvement versus fuel switching. Second, continued monitoring of industrial users subject to the Safeguard Mechanism will help validate assumptions about industrial gas efficiency savings, which may vary if facilities switch to electricity or adopt offsets rather than improving gas efficiency. Third, better data on small business energy usage and gas connections—especially in Western Australia and the Northern Territory—would support more accurate regional estimates. Finally, our assessment is that – despite methodology enhancements that have been implemented the year (see Chapter 2) – the analysis of AEEI or market-led efficiency improvement could be further developed, with benefits for the accuracy of future forecasts.

# 1. Introduction

## 1.1 Background and Context

The Australian Energy Market Operator (AEMO) is Australia's independent system and market operator and planner. Its purpose is to ensure secure, reliable and affordable energy and enable the energy transition for the benefit of all Australians.

In line with this purpose, AEMO undertakes forecasting of electricity and gas consumption, demand and other characteristics on an annual cycle. This cycle leads to the production of annual electricity and gas Statements of Opportunity (ESOO and GSOO), which provide detailed guidance to the energy market with respect to expected future conditions, under a range of scenarios, to inform and encourage efficient investment in the market.

The forecasts also inform biennial updates of the AEMO's Integrated System Plan (ISP), the next of which is scheduled for release in 2026. The ISP is a roadmap for the transition of Australia's National Energy Market (NEM), detailing the directions and changes required for that market to continue to deliver on its key objectives to 2050 and beyond.

As contributions to this process, AEMO commissions a range of research and other inputs. SPR has been commissioned to prepare energy efficiency forecasts for each separate Australian State and Territory in the NEM, the Wholesale Electricity Market (WA), and the Northern Territory (NT), annually to FY2058, for each scenario defined in AEMO's Draft 2025 Inputs, Assumptions and Scenarios Report (IASR). The IASR is expected to be finalised in the first half of 2025, and therefore it is possible that scenario definitions or assumptions will change, relative to those used for these forecasts.

This project commenced on 12 August 2024. An Energy Efficiency Specifications Document was delivered on 26 August. A draft report was delivered in December 2024, which included updated Safeguard Mechanism forecasts from DCCEEW (that were not available until December), and SPR also reviewed early draft CSIRO MSM outputs.

## 1.2 Purpose of this Report

This report presents energy efficiency forecasts for the 2025 – 2026 forecasting round, based on draft 2025 IASR scenario definitions and assumptions. The forecasts are presented by fuel (electricity and gas only), market type, sector, sub-sector, state, region, scenario, end-use type and component type (including market-led and policy-led components). These terms are defined in Chapter 2. Historical years covered are FY2015 - FY2023, while forecast years are FY2024 - FY2058.

In addition, the report provides details of:

- methodologies used in preparing these forecasts, including methodological innovations from past forecasts (2023)
- data sources
- key assumptions
- discounts applied (for example, non-additionalities between one policy and another, and non-additionality of policies to AEEI – see Section 2.2)
- the selection of measures ('components') for forecasting, including with respect to materiality criteria in the National Energy Rules, and including market-led and policy-led components of the total change in energy efficiency
- the mapping of policy measures and assumptions to AEMO scenarios
- energy efficiency trends in the historical period
- a comparison of FY2024 and FY2025 energy efficiency forecasts
- opportunities to further improve forecasts in future.

## 1.3 Forecasting Process

This section provides a brief overview of the approach taken in this project, while further details of methodologies and assumptions can be found in Chapter 2.

### *Desktop Review*

We begin with a desktop review of major policy and program changes and developments since 2023. This process informs which programs we reach out to for further information, and it enables the capture of public domain impact data/projections. During this phase we also research relevant reports, methodological developments or other analyses that may be relevant for the forecasting process.

### *Outreach to Program Managers*

We contacted program managers (or relevant policy agencies) for all the measures that are forecast in this project. The primary purposes were to ensure that the forecasts are informed by the latest information available, and that recent or imminent policy or program changes are reflected wherever possible. In some cases, program managers have in-house impact or evaluation data, and/or can provide additional information that is not in the public domain. We also discussed expectations or potentials for future, longer-term developments, forecasting assumptions and other issues. AEMO personnel generally participated in these discussions.

Also during this phase, we engaged with third-party consultants commissioned by AEMO to contribute to the overall forecasting process – or that have produced relevant analyses and reports – to ensure the greatest possible alignment across common inputs and assumptions. This included Deloitte with respect to economic assumptions and inputs and CSIRO with respect to its MSM and underlying assumptions.

***Specifications Document***

The Specifications Document is an internal report for AEMO that documents the proposed approach, methodologies and key assumptions for the project, including the mapping of policy settings to scenarios and the proposed selection of policy measures for inclusion, taking into account materiality criteria specified in the National Energy Rules, v156, NER 5.22.3b. The content of the Specifications Document is mostly contained within this draft report, updated as appropriate to reflect actual methodologies, data and assumptions used in the draft forecasts.

***Draft Forecasts and Review***

We then prepared the draft forecasts, in line with the information captured in the prior steps and the methodologies set out in the Specifications Document. These were reviewed internally within SPR, then by AEMO staff, then by AEMO's Forecasting Reference Group (FRG). Feedback from these processes was reflected in revised draft forecasts. Further details of forecasts methodologies can be found in Chapter 2, for an overview, and in Chapter 5, for details of sectoral approaches.

## 1.4 Scope and Exclusions

In addition to the National Energy Market (NEM), the regional scope of the 2024 forecasts includes Western Australia (the South Western Integrated System (SWIS), for electricity, and all of WA for gas) and the Northern Territory (Darwin – Katherine Integrated System (DKIS), for electricity, and all of NT for gas).

The sectoral composition of the forecasts includes:

- residential (RES)
- business (BUS)
    - commercial and services (COM)
        - large industrial loads (LILs)
        - small and medium sized enterprises (SMEs)
    - industrial sector (IND)
        - LILs

- SMEs.

AEMO also resolves LNG (liquified natural gas) as discrete sub-sector within industrial, but this sector is not reviewed in the energy efficiency forecasts.

Forecasts are prepared for individual policy measures (that are assessed as 'material' – see Section 3.1), and for market-led efficiency change, with the sum of the two being total energy efficiency change.

Efficiency forecasts are differentiated by their incidence on baseload and heating and cooling load segments, in line with AEMO's own analysis of these segments by region, sector and fuel.

Fuels considered are electricity and gas, with the latter primarily referring to natural gas, but noting that some scenarios may include assumptions regarding gas substitution (eg, to biomethane, hydrogen, or blended gases) and that such substitutions may directly affect energy efficiency. Stationary energy consumption is considered, rather than transport-related energy consumption, and this report does not consider (instantaneous) demand or demand management.

Energy efficiency is defined as a reduction in energy consumption per unit of energy service. 'Energy services' are valuable outputs such as quantities of industrial production, motive power, lighting and space conditioning of homes and buildings, cooking, etc.

Specific scope exclusions are:

- Electrification – while electrification will generally deliver improved energy efficiency, AEMO capture inputs from third party consultants regarding this particular type of efficiency improvement, and we therefore exclude it – to the extent feasible – to avoid double-counting
- Demand response, and change in peak demand – as above, these aspects are also analysed by third party consultants and therefore are not considered here
- Consumer energy resources (CER) – such as rooftop PV, batteries and electric vehicles – are similarly considered by others and therefore not included here. As with electrification, however, we consider CER to the extent to the extent required to distinguish its effects from changes in underlying energy consumption due to energy efficiency change (see Section 2).
- Division D power generation is excluded from our scope.

## 1.5 Key Issues and Challenges

***Energy service demand vs energy demand***

AEMO takes expected changes in energy efficiency into account when preparing its forecasts, because such changes will directly affect the demand for and consumption of fuels, for any given level of energy service demand. Energy services are the reasons we use energy – lighting, heating, cooling, hot water production, motive power, communication, etc. In the literature, energy services are also referred to as 'useful work' or 'exergy'. Generally, the demand for energy services can be related to fundamentals such as population and economic growth, but the demand for fuels or energy carriers (eg, electricity) is not *directly* proportional to such growth. Instead, it depends upon the efficiency with which energy is converted into the useful services that people and the economy require.

### *Energy efficiency change is rarely metered*

A challenge is that – unlike most things that matter in the energy sector – energy efficiency is generally not directly metered or otherwise observed,[3] but must instead be inferred by combining and analysing other data inputs (most importantly indicators of or proxies for useful output – see Chapter 2 for details). Efficiency improvements that have already occurred are, by definition, embodied in metered energy consumption data – metered consumption will be lower than otherwise - but metered consumption can also rise or fall for reasons unrelated to energy efficiency, so the change in consumption from one period to the next cannot be interpreted as efficiency change – at least not without first accounting for all of the other elements that may have contributed to the change. Practically, we estimate how much additional energy consumption would have been required if it were not for the energy efficiency improvement in question. This quantity is the amount of consumption *avoided* due to efficiency improvement.

### *Policy effects are often overstated*

A further perennial challenge is that while *total* energy efficiency change in the historical period can be calculated with reasonable precision, as detailed below, the split of this total between market-led and policy-led effects or components is not directly observable and must be estimated. Generally, the policy-led component can be informed by program reporting statistics or impact evaluations, for existing policies, or else estimated for the future period based on the fundamentals of the policy design for new, changed or potential future policies. However, program statistics rarely deal with the question of additionality, or what outcomes would have been expected in the *absence* of the policy, as a counterfactual to the outcomes that have occurred *with* the policy. To avoid double-counting other effects (including market-led efficiency change and/or the effect of other efficiency policy measures), we have to estimate just the *incremental* or additional impacts of each policy – that is, the impacts that would not have occurred without that policy, but with *all* of the other relevant factors (market-led factors and other policies) in place.

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[3] In simple and well-defined energy using systems, efficiency can be directly metered or monitored. For example, the quantity of energy consumed by a vehicle per kilometer travelled is generally displayed to the driver in real-time. However, to quantify the change in energy efficiency in a whole transport system – or in other sectors – requires different approaches.

*Market-led effects are important but not directly observable*

Considering the market-led component of total efficiency change, this too is inherently a counter-factual construct, as we can't replay history *without* the existing policy measures in place and learn what the market-led efficiency change would have been. The extent of market-led or 'autonomous' energy efficiency improvement (AEEI) is therefore generally estimated with reference to an impoverished literature, particularly in Australia.[4] However, and more importantly, the *joint* effect of AEEI and policy-led change can be (and in this study is) reconciled, in the historical period, with *total* observed energy efficiency change for each sector, fuel and region.[5] This approach (known as top-down, bottom-up reconciliation) limits the possible error, at least in the historical period, to an attribution problem, since if policy-led change is over-estimated, then market-led change must be under-estimated, and vice versa. For the forecast period, we can be informed by these historical trends, for at least the short-medium term, but then scenario narratives – including potential future policy designs – take over the work of characterising market/policy led efficiency changes, and indeed total efficiency change, over the whole forecast period.

As discussed in more detail in Section 2.5, we have trialled a new methodology for estimating AEEI this year, to align our assumptions with those used by CSIRO in its MSM. The overall aim has been to enhance to enhance consistency between the various inputs to AEMO's forecasting process.

*Electrification*

A final challenge highlighted here is that of distinguishing energy efficiency improvement caused by electrification from energy efficiency improvement caused by other factors, as our brief requires us to do.

It should be noted that electrification is a form of energy efficiency improvement. In effect, it is a special case in which efficiency improvement is realised, for a given energy service demand, by fuel switching from fossil fuels to electricity. This can enable many (but not all) energy service demands to be met with lower – often much lower – consumption of energy[6] (by enabling access to heat pump, induction and other energy efficient technologies, replacing relatively inefficient fuel combustion). It can also reduce or eliminate greenhouse gas emissions, by enabling access to renewable electricity, and may substantially reduce the cost of energy consumption to consumers. At the same time, electrification is not always available to cover every energy service demand, at least with today's technologies. AEMO distinguishes electrification from other forms of energy

[4] In the EU and North America, there are specific institutions that generate such analyses regularly, such as the Pacific North-West and Lawrence Berkeley National Laboratories, and the European Commission's Joint Research Centre in Italy.

[5] Except for the industrial sector, where total energy efficiency change cannot be established, at least when using public domain data, for want of a reliable activity or output indicator.

[6] Depending on the generation mix for electricity, electrification may have a larger impact on final energy consumption than on primary energy consumption – however, the greater the share of renewable energy in the generation mix, the less this difference.

efficiency improvement because it has differential impacts in different energy markets – reducing demand for gas or other fossil fuels and increasing demand for electricity – albeit generally by a smaller margin than the reduction in fossil fuel consumption, at least in cases where electrification does lead to higher energy efficiency.

As discussed in Section 2.5.2, our general approach to this challenge is to estimate the share of total change in electrical intensity that is attributable to electrification of gas use, and then attribute only the balance of the change in electrical intensity to energy efficiency (including both market- and policy-led effects). This can be done for the historical period using actual consumption and intensity values. In principle, it could also be done for the forecast period where certain key parameters, including the number of gas connections and gas consumption per connection, are available. However, these parameters were not available to this study. Therefore we have relied on inputs from policy/program managers, where available, or otherwise program-specific assumptions, to estimate the efficiency/electrification split.

## 1.6 Definitions/Glossary

| Term | Definition |
|---|---|
| Additionality/ non-additionality | Energy savings are only attributed to a measure (or effect) to the extent that it can be established that they are *additional* to those that would have occurred in the absence of the measure or effect. The portion of claimed savings that cannot be established as additional are known as 'non-additional' |
| AEEI | Autonomous (or market-led) energy efficiency improvement |
| CBD | Commercial Building Disclosure program |
| COM | The commercial (and services) sector |
| Component | An element of the forecast, representing either AEEI or a specific policy measure |
| Energy efficiency | The amount of energy used per unit of useful work or output.<br>In this project, we distinguish market-led and policy-led efficiency, with the sum of the two equalling total energy efficiency.<br>The energy efficiency savings quantified represent 'avoided consumption', or consumption that would have occurred if not for the improvement in energy efficiency.<br>Note that for the historical period, and by definition, avoided energy consumption is already captured in metered consumption data. |
| ESS | NSW Energy Savings Scheme |

| Term | Definition |
|---|---|
| GEMS/E3 | The national Greenhouse and Energy Minimum Standards (GEMS)/Equipment Energy Efficiency (E3) program |
| HEUF | The Household Energy Upgrades Fund |
| IND | The industrial sector |
| LIL | Large industrial loads |
| Market-led energy efficiency | The fraction of total change in energy efficiency over time that would have been (in the past) or is (in the future) expected to occur in the absence of any of the policy measures noted, including due to autonomous technology change, responses to energy and factor prices, and changing preferences. |
| MEPS | Minimum energy performance standards (note, these may apply to appliances and equipment, or to dwellings/buildings, depending upon the context) |
| MSM | CSIRO's multi-sector modelling |
| NABERS | National Australian Built Environment Rating Scheme |
| NCC | National Construction Code |
| Policy-led energy efficiency | The fraction of total change in energy efficiency over time that is attributable to specific policy measures. Note that policy-led or policy-induced savings are rarely the same as those reported in policy/program statistics, due to the need to account for non-additionality between specific policy measures, and also between policy measures as a whole and market-led efficiency change. |
| REPS | SA Retailer Energy Productivity Scheme |
| SME | Small and medium sized enterprises |
| Total energy efficiency | At the sectoral or sub-sectoral level, the overall change in energy consumption per unit of useful work/output. By definition, total efficiency change is equal to the sum of market-led and policy-led efficiency. |
| VEU | VIC Victorian Energy Upgrades program |

# 2. Methodology, Data Sources, Assumptions and Quality Assurance

## 2.1 Overview

### 2.1.1 Overall Approach

We compile and analyse 'actual' or historical energy consumption and activity/structure data. For the residential and commercial sectors, stock turnover models are used to represent not only the total change in 'activity' in these sectors – where proxies are the net growth in the number or floor area of dwellings and of commercial buildings – but also changes in 'structure', such as the *composition* of the stock by dwelling or building type. For example, if the share of data centres within the commercial building stock were to increase, this structural change would tend increase intensity, independent of other factors. Stock models are not appropriate for the industrial sector given the diversity of outputs from that sector, an alternative metrics or proxies for output are used, as discussed in the following section.

We then construct 'frozen intensity' counterfactual baselines (for each year, region, and sector), taking an historical year (in this case, FY2015) as an arbitrary starting point. Changes in total energy efficiency (useful output per unit energy consumption) are then analysed (by region, fuel, etc), firstly in the historical period. This provides the opportunity to reconcile estimated AEEI and claimed/reported policy effects, to estimate the extent of discounting that may be required to avoid over-estimation of total efficiency change. This analysis then informs the forecast period, noting that both AEEI and policy measures/settings/impacts may all vary by scenario.

As a detail, we note that the term 'energy efficiency' has acquired normative overtones, with 'more' being considered better than 'less'. However, the relationship between useful output and energy consumption is complex and can change for reasons unrelated to energy efficiency. Practical examples include changed occupancy patterns in dwellings (eg, work from home, reduced vacancy rates), changed operating hours for commercial buildings, change in building stock composition, density changes (persons or equipment per sqm of building space), climate changes and others. The term 'energy intensity' is more neutral and be preferred.[7] However, given the brief for this project, we retain the 'energy efficiency' language.

The process summarised above generates robust estimates of *total* energy efficiency change (by sector, region and year) in the historical period. Then, by estimating a) market-led efficiency change or autonomous energy efficiency improvement (AEEI) and b) the incremental savings effects of

[7] Energy intensity is the inverse of energy efficiency, or energy consumption per unit of useful output (or work done). The inter-changeability of these terms in practice is evident in 'miles per gallon' being an efficiency metric, while 'litres per 100 km' is an intensity metric.

specific individual efficiency policy measures (which we model separately, uniquely by sector, region and year), and comparing the sum of these with historical total efficiency, the extent of necessary discounting or calibration of one or other effects can be determined. This follows from the identity that AEEI *plus* policy-led efficiency change must equal *total* efficiency change in each period. AEEI is discussed further in Section 2.5.1.

### 2.1.2 Fuel Mix/Electrification

Our brief in this project is to forecast efficiency change for both electricity and gas, and to distinguish these from fuel switching/electrification. However, fuel switching/electrification almost inevitably changes the efficiency of (at least final) energy use,[8] and energy efficiency is not independent of fuel choices. Practically, then, we are required to estimate the extent of fuel switching/electrification, at least in the historical period, to distinguish this from other forms of efficiency change. Similarly, for the forecast period, we seek to set aside electrification effects, at least to the extent feasible.

Further, since we model stock turnover in the built environment, we cannot avoid making assumptions about which fuels are used in *new* houses and buildings through to the end of the forecast period. In limited cases (VIC and ACT, and for certain sectors) there are already government policies that will affect this, but – for the time being at least – we expect these decisions will mostly be informed by consumer preferences and market choices/incentives applicable at the time of investment. Similarly, the fuel mix of future energy *savings* – both those that are attributable to AEEI and to most (but not all)[9] policy measures – is generally not pre-determined but will reflect the outcome of market-based factors at the time.

To be clear, we do not make forecasts of the overall fuel mix of consumption in any sector, as this is outside the scope of our brief. We limit our focus to a) the fuel mix of new dwellings and buildings, and b) the fuel mix of efficiency savings. For AEEI, different rates of efficiency improvement for electricity and gas are implied by the differing AEEI factors by fuel. For existing policy measures (that are not specific to a given fuel), we take into account the historical/recent fuel mix of savings, as revealed in program reporting data. Also, where jurisdictions provide forecasts of the fuel mix of program-specific savings (such as the share of Safeguard Mechanism savings that are attributable to gas), we apply these assumptions.

More generally, and where relevant, we assume that current trends (documented in this report, amongst others) towards electrification will continue, notably driven by the declining real costs of PV, wind, batteries and electrical end-use devices (heat pumps, electric vehicles, etc), together with

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[8] To the extent that electricity is produced from fossil fuels (with relatively low conversion efficiency), the change in primary energy consumption associated with electrification is reduced. However, this effect does not occur with renewable energy technologies such as solar, wind and hydroelectricity – except for transmission and distribution losses, which also occur for gas.

[9] GEMS/E3 at present only affects electricity use, and the 'activities' eligible for support under state schemes may be specific to particular energy sources.

the significantly faster rise of electrical end-use efficiency, when compared to gas. Further, we note that fuel choices are expressed at least cost when new investments (in buildings, dwellings, equipment) are being made. This is because any premium in capital costs that might be associated with fuel choice is limited to the *incremental* cost only – if any – whereas the costs of changing the fuel mix in existing applications can be significantly higher. Also, design choices – that are only feasible prior to investment – can limit or eliminate even incremental costs associated with fuel choice. In short, we expect faster electrification in new capital as compared to existing, and an increasing share of electricity in *efficiency-driven* savings over time. The latter must be distinguished from increasing gas savings over time that are driven by electrification rather than technical efficiency improvement.

### 2.1.3 Industrial Sector

As noted above, a variation on this methodology is required for the industrial sector. Because the physical outputs of the industrial sector are highly diverse – and often treated as confidential – it is not feasible to construct a model of this output (for example, tonnes of product), equivalent to a stock model for the residential and commercial sectors.[10] However, the gross value added (GVA) series prepared by Deloitte, as another input to AEMO's forecasting process, are chain-weighted indices, observed at the level of ANZSIC Divisions or groups of Divisions, and these can be used (with some qualifications) for energy efficiency analysis, as discussed below.

Chain-weighted indices essentially describe the product (or multiplication) of the quantities of a product sold (Q) and the average sale price in a year (P), and how this changes over time, relative to a fixed (but arbitrary) historical year.[11] A complication is that where such indices are developed for whole Divisions, there can be many individual sub-sectors, and even more products with unique prices, expressed within the one index, and these sub-sectors must be weighted.

For energy efficiency analysis, it is useful to assume a constant price, in order that the resulting index moves solely in proportion to change in the *quantities* sold. In principle, this can provide an 'output' proxy that can be used for energy efficiency analysis. However since, as noted, the indices used here represent whole ANZSIC Divisions, or groups of Divisions, then some way must be found to weight these elements into a single index. In reality, the volumes and the prices of the basket of different products within a sector can be expected to change in a quasi-random manner from year to year, reflecting commodity price cycles, exchange rates, changing ore grades (Mining Division) and many other product-specific factors. Chain-weighted indices at least limit or smooth this

[10] This can be done, but only for one sub-sector at a time, where there are relatively homogenous outputs, and where there is access to data from the relevant companies.

[11] For a more detailed description of chain-weighted indices, refer to the Australian Bureau of Statistics publication, *Demystifying Chain Volume Measures (1)* (undated) or similar.

variability by reweighting (or rebasing) each element within the basket annually, using prices and quantities for these elements from the previous year.

Strictly, a chain-weighted index does not represent *only* the changes in the volume or quantities of products sold, since the effects of multi-year price changes are also represented. To illustrate, if the real price of copper were rising steadily each year, but the quantities sold remained constant over that time, then a chain-weighted index that included copper (eg, GVA for Division B - Mining) would rise over time (other factors remaining the same), even though the quantities sold are not rising. This represents a trade-off that allows the chain-weighted index to remain relevant to the shifting mix of prices and quantities at the sub-sectoral level that occur over time in the real world. Since, for energy efficiency analysis purposes we are interested in physical output (per unit energy consumption), this solution is not perfect. However, it is the best proxy for physical output that is readily available for the industrial sector, and vastly superior to using an economic metric (such as energy consumption per unit GDP). For these reasons, it is used here for the industrial sectors only. Further details of sector-specific methodologies and assumptions are presented in Chapter 5.

## 2.2 Discounts

AEMO is concerned to avoid double-counting or other forms of over-estimation of energy efficiency savings and, for this reason, requests an analysis of the extent to which 'discounts' may be applied to reported savings. SPR notes that it does not apply discounts to reported savings unless there is clear justification for doing so. However, there are two reasons why data documenting claimed energy efficiency savings may need to be adjusted to avoid over-estimation of total and observable efficiency change.

First, as noted in Section 1.5, there is an inherent tendency for efficiency program reporting statistics to over-estimate the actual savings attributable to (that is, *caused by*) that program. This is because such statistics rarely consider the without-program counterfactual as a base case. As the Australian Government cost benefit analysis guidelines note, program impact must be measured on a 'with/without' basis and not on a 'before/after' basis.[12] However, this advice is widely ignored. As a result, what we refer to as 'headline' (or reported) savings typically over-estimate actual savings attributable to the program, and sometimes to a large degree. For example, where a program treats as a KPI the change in energy intensity in its target sectors that occurs over the life of a program or annually – that is, on a before/after basis – the measured change is real data, but simply measuring the change does not establish that it was *caused by* the program in question. In fact, the measured change could reflect, in addition to the program's impact, a range of both market-led and unrelated policy impacts - that is, impacts that should be attributed, in whole or in part, to a *different* effect or policy measure. For example, market-led effects might include:

[12] Australian Government Office of Best Practice Regulation, Cost Benefit Analysis Guidance Note, March 2020, p. 14.

- new and improved technologies and/or technology performance (that would have occurred without the program in question)[13]
- wider technology choice, for example due to supply-chain enhancements or improved trade conditions
- reduced costs (per unit performance) of technologies
- changes in real energy prices, including the relative prices of different fuels/energy carriers
- demand and behavioural changes, including changed business practices, corporate mandates to reduce emissions, the impact of (non-regulated) climate-related financial disclosure, shareholder activism, and many others
- anticipated future changes in any of the above that may affect current decision-making.

Second, the before/after approach does not (typically) take into account the effects of other policy measures operating at the same time, in the same market, that may have contributed to the observed changes. Where this occurs, savings estimates will need to be adjusted or discounted to avoid double-counting. Practically this means that:

1. The impacts of most policy measures are likely to be discounted for non-additionality to market-led efficiency change, with the extent of discounting depending upon the nature of the program reporting practices (or estimation techniques). If, for example, the headline rate of efficiency improvement, as revealed in program statistics, is 3% per year, but we estimate that the AEEI rate (in this sector, region and year) is 2%, then the net impact of the program would be re-set to 1% per year. Failure to do this would over-estimate the *total* efficiency change in that sector/region/year). Note that, in this example, the *total* efficiency change remains at 3% per year (subject to the potential impact of other policy measures, as below), but with only 1 percentage point attributed to the program in question. In this sense, the total is not discounted, but simply attributed differently.
2. The estimated impact of some efficiency policy measures may *also* need to be discounted to take account of specific non-additionalities between policy measures. Examples include:
    a. Between GEMS and NCC energy performance requirements (where, for example, the proposed NCC2025 requirements for (new) non-residential buildings may include savings due to new chiller MEPS)
    b. Between NABERS and state white certificate schemes, some of which provide financial support for increased NABERS star ratings

[13] Programs that actively induce technology development may be an exception, but these are rare in Australia.

c. Between NABERS and CBD, where the CBD program fully overlaps the largest segment of the NABERS program, which is the office for energy program.

3. A small number of modelled policies group energy efficiency and non-efficiency energy or emission reduction activities, such as refrigerant disposal or solar PV installation, in the same funding/certificate scheme. Where these activities can be specifically excluded, such as the REPS scheme, no additional discount is applied, as they are not counted in calculations. Where these activities can't be excluded, such as in the HEUF, an additional discount is applied to ensure these non-efficiency activities are not counted as energy efficiency.

There can also be positive synergies between measures that can lead to their joint impact being larger than the sum of the two if they had been implemented without the other. This can occur, for example, where voluntary measures such as efficiency ratings/disclosure are leveraged by financial incentives, and where the impact of the financial incentives is leveraged by the verification opportunities provided by ratings/disclosure programs. Whether or not such examples lead to a need adjust reported program impacts, and in which direction, depends on the nature of that reporting.

## 2.3 Quality Assurance Processes

QA processes associated with the modelling and forecasts primarily include:

- engaging directly with stakeholders to capture program data and other relevant information, and to help in assessing the impacts associated with measures, including additionality, fuel switching impacts and other performance dimensions for measures
- explicit representation of reported program impacts and any discount factors
- internal review of projections models – with SPR personnel cross-checking each other's work
    - at all key points in the project, including the Specifications for each sector, draft forecasts and final forecasts.

In addition, each of these steps is reviewed by AEMO staff and the Forecasting Reference Group.

## 2.4 Validation Opportunities

Validation opportunities for avoided energy consumption are rare. This follows from the counter-factual, non-metered nature of efficiency change, as discussed in Section 1.5, but also from the rarity of independent and professional policy/program evaluations.

That said, a significant improvement in the confidence associated with the savings estimates for the GEMS/E3 (Greenhouse and Energy Minimum Standards/Equipment Energy Efficiency) program has been facilitated by the fact that Energy Consult was retained by the program to thoroughly update and bring onto a common base year the impacts of all measures under the program.[14] This report provides a strong base for estimating past and future GEMS/E3 impacts.

Also, the recent research noted in Section 2.5.3 (some of which is by SPR and therefore not independent of the current report) does provide validation opportunities for past SPR forecasts of impacts associated with:

- GEMS/E3 program
- NCC2025 commercial building performance
- residential mandatory disclosure.

The SPR research cannot, of course, be treated as validation of our own past forecasts, but it nevertheless provides new and relevant inputs to the 2025 forecasts for:

- non-residential mandatory disclosure (CBD)
- NABERS impact analysis
- commercial building trajectory elements including Code energy performance requirements.

## 2.5 Methodology Improvements and Innovations

While the methodology for the 2024 energy efficiency forecasts is substantially the same as in previous years, there are two major innovations, which are described below, along with other data or research improvements.

### 2.5.1 Autonomous Energy Efficiency Improvement

In contrast to previous forecasting rounds, our assumptions for autonomous energy efficiency improvement now align, to the extent possible, with those use by CSIRO in its multi-sector modelling. CSIRO's modelling draws on the AusTIMES model, originally developed by the International Energy Agency (and known as Markal), which is a linear programming model that identifies least system cost solutions given a wide set a set of assumptions, including relating to technology performance and cost, carbon constraints, and economic drivers.

In AusTIMES, specific efficiency improvement opportunities are identified with a unique set of cost assumptions, ranging from zero to high cost. Then, depending on scenario parameters, more or fewer of these opportunities may be taken up, primarily as a function of their cost-effectiveness. In contrast, and as noted above, SPR is requested to forecast energy efficiency change through the lens of policy- and market-led segments, while AusTIMES does not explicitly model policy interventions and is driven by market fundamentals. Strictly, there is a conceptual difference

[14] Energy Consult, GEMS Data Modelling Project 2022 – Final Report, February 2023.

between CSIRO's definition of AEEI as zero (incremental) cost measures, on the one hand, and SPR/AEMO's concept of market-led energy efficiency, on the other. This is because market factors may lead households or companies to invest in energy efficiency improvement, even if an incremental cost is incurred, whenever this cost expected to be offset by future benefits. On the other hand, no all zero-incremental-cost efficiency improvements will necessarily be adopted by the market if there are non-price barriers to their uptake.

Despite these differences, the two approaches are not likely to be significantly different in outcomes, and therefore we have adopted the AEEI assumptions provided by CSIRO and Climateworks, wherever possible. Where these values were not differentiated by scenario, we have added our own differentiation. Also, as discussed in Section 5.1, we adopt slightly different values for residential gas AEEI, to limit the risk of double-counting electrification effects.

### 2.5.2 Electrification

As noted in Section 2.1.1, the current and expected future trend towards electrification, together with the fact that AEMO treats this as an independent change process from other forms of energy efficiency change, means that it is necessary to distinguish these two effects carefully – and to the extent feasible – to avoid double-counting. That said, quantifying electrification is strictly outside our scope for this project, and also limited by data constraints and other factors,[15] so we do not purport to quantify electrification effects in all cases and sectors.

The approach outline in Section 2.1.1 can be used in historical period, and that can illuminate trends in the split between electrification and other forms of efficiency change in the historical period. However, AEMO's draft 2025 scenario assumptions include differential rates of electrification by scenario in the forecast period. Ideally, the current energy efficiency analysis would take into account updated Gas Statement of Opportunities (GSOO) parameters – such as forecasts of gas connections by sector and region, and gas consumption per connection – as concrete expressions of the degree of electrification expected in each scenario. However, this information was not available to the current project, as it too early in the GSOO cycle. Therefore, we treat future electrification by assumption, and these assumptions are documented in Chapter 4.

[15] For example, many policy measures (eg, NCC energy performance requirements, NABERS, CBD) are essentially fuel-neutral, meaning that the fuel mix of induced savings – including the extent of electrification – is not prescribed by the policy measure itself, but in reality will represent the outcome of decisions made by those affected by these policy measures, responding largely to market forces, which include consumer preferences.

### 2.5.3 Other Data or Research Improvements

Since the 2023 forecasts, a Consultation RIS has been released with respect to NCC 2025 (commercial building) energy performance requirements, and this has been used to update existing Code forecasts.[16]

DCCEEW has been able to share, on a confidential basis, draft analysis that is relevant to mandatory disclosure in the residential and commercial sectors, and this data has been used to refine our past analysis of this measure (for both sectors). As mentioned above, DCCEEW have also shared modelling undertaken by Energy Consult to review the past and expected future performance of the GEMS/E3 programme in light of technological and consumer change.[17]

Since the 2023 forecasts, SPR has undertaken a range of projects that provided relevant inputs to this analysis:

- modelling of expansion options for the Commercial Building Disclosure (CBD) program
- modelling for NABERS expansion options
- input into an updated Commercial Buildings Trajectory
- a 2024 Update to the 2022 Commercial Building Baseline Study, using end-FY2024 historical data (and with future projections aligned with ISP 2024 Step Change). This includes special order data from the ABS and means that the resulting commercial building stock model is as up-to-date as it can be.

The 2024 Update to the Commercial Building Baseline Study was published in October 2024.

[16] The CIE, *Final Report: Increasing the stringency of the commercial building energy efficiency provisions in the 2025 National Construction Code: Consultation Regulation Impact Statement*, April 2024.
[17] Energy Consult, GEMS Data Modelling Project 2022 – Final Report, February 2023.

# 3. Policy Review Summary

## 3.1 AEMO Criteria

In assessing which efficiency policies and measures should be included within the forecasts, the following criteria were identified by AEMO. These derive from the National Energy Rules, v156, NER 5.22.3b:

- A commitment has been made in an international agreement to implement that policy
- That policy has been enacted in legislation
- There is a regulatory obligation in relation to that policy
- There is material funding allocated to that policy in a budget of the relevant participating jurisdiction, *or*
- The Ministerial Council of Energy (MCE) has advised AEMO to incorporate the policy.

AEMO does not have a formal definition of 'material' in the context of the above list. We take into account:

- the amount of funding (per year)
- the duration/certainty of funding
- the size of funding *relative* to the size of the jurisdiction and the sub-sector or end-use targeted
- expected degree of additionality to existing policy measures.

For example, $100 million of energy efficiency funding is *relatively* more significant in Tasmania than in New South Wales, due to the smaller number of energy-using entities in the former. In the case of the ACT, where there are significant measures in place relative to the size of the jurisdiction, we note that this forms only a small part of the NSW NEM region, and the materiality of savings is assessed relative to the combined NSW and ACT consumption.

We have reviewed the AEMC's *Emissions Targets Statement*,[18] which is referenced in the 2025 IASR Scenarios Consultation Paper. As it states, this is primarily a list of targets, rather than of policies, and the majority of initiatives mentioned relate to greenhouse gas abatement or renewable energy initiatives that fall outside the scope of this project. However, in its Table 2.1, the Statement references the National Energy Productivity Target and the Victorian Solar Homes Program (hot

[18] AEMC, Emissions targets statement under the national energy laws, June 2024.

water provisions), and these are discussed in Section 3.4, in relation to their expected impact on energy efficiency change.

## 3.2 Major Measures Included in Analysis

**Table 1** sets out the major policy measures that we have deemed to conform to the NER criteria above. Further details about future policy assumptions by measure and scenario are set out in Chapter 4.

**Table 1: Major Existing Measures Included by Sector**

| Residential | Business - SMEs | Business - LILs | Comments |
|---|---|---|---|
| National Construction Code Energy Performance Requirements | National Construction Code Energy Performance Requirements | | State variations are generally overlooked and/or deemed to be 'equivalent' (eg, BASIX and NCC). Some can be included, such as non-application of Section J (commercial building energy performance requirements) by NT; and of new NCC2022 standards by TAS; for example. |
| Greenhouse and Energy Minimum Standards (GEMS) and labelling | Greenhouse and Energy Minimum Standards (GEMS) and labelling | Greenhouse and Energy Minimum Standards (GEMS) and labelling | Electricity only |
| | Commercial Building Disclosure/NABERS Energy for Offices | | These are modelled jointly to account for significant non-additionalities. |
| ESS in NSW, VEU in VIC and REPS in SA | ESS in NSW, VEU in VIC and REPS in SA | ESS in NSW, VEU in VIC and REPS in SA | Collectively referred to as 'state (energy saving) schemes'. |
| CEFC programme: Home Energy Upgrade Fund | N/A | N/A | |
| N/A | N/A | Safeguard Mechanism | |

## 3.3 Policy Review

### 3.3.1 Residential

*National Construction Code*

NCC2022 came into effect on 1 May 2023, albeit with staged adoption across jurisdictions. NCC2022 involved a move to 7-star minimum thermal shell requirements, plus a 'whole of home' energy budget, with the option of fully or partially offsetting this budget (but not the 7-star requirement) with rooftop PV.[19] NCC2022 requirements were modelled in the previous forecasting round, and no material change has been made to the Code since then. Our models have been adjusted to reflect cases where jurisdictions delayed adoption of NCC2022 standards (most jurisdictions) or have indicated they will not be adopted in the near future (NT & Tas). SA has indicated it will halt future code changes.

NCC2022 also includes 'Whole of Home' (WOH) provisions, which factor in the energy use of fixed appliances such as air conditioners, pool pumps and cooktops, as well as solar, batteries and lighting (plug loads are included by assumption only, not as a variable). The current NCC2022 requirement is for a new Class 1 dwelling to meet 60 points, or 50 points for apartments, with 100 points representing a net energy neutral building (or a building that produces as much energy in a year as it consumes). Because developers and home builders have a range of choices in how they meet this requirement, it is difficult to know in advance which solutions will be preferred. Many households may choose to rely primarily on solar PV to meet the WOH requirement, if they have good solar access, as this will be the most cost-effective solution. However, apartment dwellers, or those with poor solar access, may not be able to access this solution, in which case other solutions – such as adopting more efficient heat pumps for space conditioning and hot water – may be preferred and least cost. In the context of this project, and to the extent that the WOH provisions is to encourage fuel switching, this would strictly fall outside our scope. However, as noted, the outcomes are not prescribed by the WOH provisions themselves but rather will reflect choices by developers and home-owners. Therefore, we cannot rule out that some of the WOH savings may represent electrification rather than other forms of energy efficiency improvement.[20]

[19] Whole of home, in this context, refers only to 'regulated' energy end-uses including the primary space conditioning equipment, hot water, lighting, pool and spa pumps (where present).

[20] In future years, however, CSIRO's Australian Housing Data portal is expected to reveal the actual WOH choices made for new dwellings (at least, those rated under NatHERS), and this information will be able to be used to improve this aspect of the residential forecasts.

*GEMS*

The GEMS and 'E3' (Equipment Energy Efficiency) programs,[21] which include mandatory product labelling requirements and/or minimum energy performance standards (MEPS), has implemented few major changes to the efficiency policy environment in recent years.[22] Since the previous forecasting round there have been several amendments to existing MEPS, including for:

- televisions,
- dishwashers,
- washing machines, and;
- rotary clothes dryers.

A new standard was also developed for digital signage displays.

Some of the standards in place have been largely or wholly overtaken by technology and market changes. This change can be seen in the range of MEPS standards that are set to expire by 2025, including:

- Power (Distribution) transformers - expires 1 April 2023
- Set top boxes - expires 1 April 2023
- Computer monitors - expires 1 October 2024
- External power supplies - 1 April 2025.

An Independent Review of the Greenhouse and Energy Minimum Standards (GEMS) Act 2012 (not program) was released in June 2019.[23] While it found that the legislation is effective, it recommended a range of reforms be implemented in the short, medium and longer terms. A number of administrative changes identified through this process were given effect through the passing of *The Greenhouse and Energy Minimum Standards Amendment (Administrative Changes) Bill 2023.*

The most recent Prioritisation Plan was released in December 2021[24] and notes the following high priority products and proposed actions/status as at October 2021 – see Table 2. It also notes (p. 4) that 23 out of 170 product classes reviewed are currently regulated in Australia and New Zealand, including 10 standards that will sunset by 2025.

[21] GEMS refers specifically to the Greenhouse and Energy Minimum Standards Act 2012, which gives legislative effect to specific standards/labels, while the E3 program is the national program that develops and governs these measures.
[22] https://www.energyrating.gov.au/consultations, viewed online 26/01/2023.
[23] The report notes that this work was undertaken by a partner at law firm Allens but it is as an E3 report – see https://www.energyrating.gov.au/document/report-independent-review-gems-act-final-report, viewed online 26/01/2023.
[24] Beletich Associates, *E3 Prioritisation Plan Stage 2 Report*, December 2021.

### Table 2: GEMS Priorities and Status, October 2021

| High priority product category | Proposed actions | Status at October 2021 |
|---|---|---|
| Air conditioners | New climate zoned labelling and enhanced MEPS | Included in GEMS determination published in 2019 (in force from April 2020). |
| Domestic refrigerators and freezers | Enhanced MEPS | Included in GEMS determination published in 2019 (in force from August 2021). |
| Hot water systems | Under investigation for future opportunities | In 2019, COAG agreed to the introduction of demand response capability requirements for a number of products1 including electric storage water heaters. NZ and NSW progressing work on a water heating strategy. |
| Industrial products | Under investigation for future opportunities | Technical Discussion Papers on pumps, boilers and compressors released for consultation in Nov 2020. Consultation RIS scheduled to be released in 2021-22. Electric motors issues paper released in Jan 2020, but further work halted in 2021, as not possible to implement via GEMS Act. NZ will go out for consultation. See Section 6 below. |
| Lighting | Phasing out mains voltage halogen lamps in AUS and introducing MEPS for LED lamps in line with European Union regulations | Ministerial approval achieved (expected in force by 2023). |
| Non-domestic fans | New regulations | Consultation RIS released May 2017. Work halted during development of Decision RIS, as not possible to implement via GEMS Act. See Section 6 below. |
| Refrigerated display and storage cabinets | Enhanced MEPS and new regulations | Included in GEMS determination published in 2020 (in force from May 2021) |
| Swimming pool pumps | New regulations in AUS | Regulations expected to be in force in late 2022. |
| Televisions | Under investigation for future opportunities including more stringent MEPS | Investigation and consultation underway. Consultation RIS scheduled to be released in 2021-22. |

Given the large number of regulated products at various stages of consumer adoption and subsequent obsolescence, accurately modelling programme impact has proved challenging in previous forecasting rounds. Past regulation impact statements (RISs) and projections of future savings for obsolete technology are likely to be significantly overstated, simply due to market and behavioural changes.

In 2022 DCCEEW commissioned Energy Consult to model the impact of the GEMS programme on energy efficiency outcomes.[25] Building on previous Departmental modelling which found six product classes (air conditioners, electric motors, electric storage water heaters, lighting, refrigerators and freezers, and televisions) account for 97% of GEMS programme energy savings, Energy Consult modelled projected energy and emissions savings to 2040.

For consistency and accuracy, our forecasts adopt the modelling approach employed by Energy Consult in their review, focusing our analysis on the highest impact products. Energy Consult's modelled savings were lower than SPR's in previous forecasting rounds, likely due to Energy Consult pruning previously-modelled savings from obsolete measures and product classes.

[25] Energy Consult, *Final Report: GEMS Data Modelling Project 2022*, February 2023.

*Home Energy Upgrade Fund*

The Home Energy Upgrade Fund (HEUF) is a $1b investment fund administered by the Clean Energy Finance Corporation (CEFC) which aims to lower borrowing rates for energy efficiency projects in households. The HEUF will be delivered through private banks and lenders, which will in turn offer interest rate reductions on borrowing for approved activities.

*Mandatory Energy Performance Standards & Universal Mandatory Disclosure*

In 2022, Commonwealth, State and Territory Energy Ministers released the National Framework for Disclosure of Residential Energy Efficiency Information. The Framework sets out high-level policy settings for a future energy performance disclosure regime for existing dwellings. Policy work on a disclosure regime has continued, with ACIL Allen delivering a CBA a range of possible policy settings in September 2023.

*State Energy Efficiency programmes*

The NSW Energy Savings Scheme (ESS) provides financial incentives to install energy efficient equipment and appliances in NSW households and businesses. The ESS was established in 2009 and since then the scheme claims to have supported projects that will deliver more than 32,500 gigawatt hours (GWh) of energy savings and over $6.1 billion in bill savings by 2029.[26] Scheme rules are updated annually.

Similar to the ESS, the Victorian Energy Upgrade (VEU) programme funds a range of energy efficiency upgrades for households and businesses through a white-ticket (or certificate) scheme which requires energy retailers to surrender Victoria Energy Efficiency Certificates (VEECs) generated by accredited providers when undertaking emission saving activities (1 t/$CO_2$-e ‘deemed’ to be saved generates 1 VEEC). The South Australian Retailer Energy Productivity Scheme (REPS) works in a very similar fashion, though targets are set as a fixed number of GJ of energy in a year.

### 3.3.2 Commercial

*National*

There appears to have been little change in the efficiency policy environment in the commercial sector since our 2023 review. The mooted expansion of the CBD program has not yet occurred, although work is underway towards this end.

NCC2022 did not include any changes to the minimum energy performance requirements for non-residential buildings – despite the *Trajectory for Low Energy Buildings* including a commitment to 3-

[26] https://www.energy.nsw.gov.au/nsw-plans-and-progress/regulation-and-policy/energy-security-safeguard/energy-savings-scheme, viewed online 26/02/2023.

yearly reviews – but these are anticipated to occur in 2025. We noted in Section 2.5.3 that a draft RIS has been published with respect to NCC2025.

A new GEMS standard for large air conditioners (above 65 kW) was implemented in 2022. The December 2021 Prioritisation Plan noted only one of the priority products had reached the Consultation RIS stage as at that date – for fan units. We have not been able to find evidence that a new standard has been implemented in this area. Standards for commercial chillers were set in 2012 and do not appear to have been updated. Our discussions with DCCEEW revealed that the Department will develop an updated Strategic Plan for GEMS in the first half of 2025.

The NABERs program launched a new voluntary rating tool for aged care and retirement living in September 2021, warehouses and coldstores in September 2022, schools in December 2023, and retail stores in June 2024.[27] Our forecasts take into account these non-office sectors for the first time this year, on the grounds that their scope and duration is sufficient to pass the materiality test in the National Energy Rules.

*State/Territory*

At the state/territory level, we note that the NT has committed to implement NCC2019-level energy performance requirements for new non-residential buildings as part of NCC2022, for the first time since 2009, but we also note there has been a change of government in the NT since this announcement was made.[28] In NSW, ESS has been expanded, as noted in the previous section, and updated data has been provided by NSW to assist with attributing savings by sector.

Recent changes to VEU include adding activities relating to cold rooms and commercial and industrial air source heat pump water heaters, and revisions to the activity on refrigerated cabinets, voltage reduction units, lighting (mercury vapour, metal halide and high-pressure sodium lamps) and gas boilers and water heaters.[29]

### 3.3.3 Industrial

Following the termination of the EEO program (referenced above) in 2014, and apart from the coverage of larger, 3-phase electric motors, (2019) under GEMS/E3, there has been little national energy efficiency policy that specifically targets the industrial sector.

However, during the 2023 forecasting round, the Australian Government was consulting on reforms to the Safeguard Mechanism, which applies to around 219 large industrial facilities in Australia.[30] These reforms came into effect in July 2023, with the reformed Mechanism applying a decline rate

[27] https://www.nabers.gov.au/ratings/nabers-accelerate
[28] https://dipl.nt.gov.au/projects/building-energy-efficiency-provisions, viewed online 26/02/2023.
[29] DELWP, Victorian Energy Upgrades, Specifications 2018 – Version 13.0 (applicable from September 2022), 2018.
[30] DCCEEW, *Safeguard Mechanism Reforms: consultation paper*, August 2022.

to covered facilities' emission baselines to align their decarbonisation pathways with Australia's emission reduction targets of 43% below 2005 levels by 2030 and net zero by 2050. Operating with limited information, our previous analysis of the impacts of the Mechanism on energy efficiency modelled a relatively low direct impact.

Strictly the Safeguard Mechanism is a greenhouse gas emissions policy measure and its consequences for energy efficiency are still uncertain. It appears likely that the mooted changes will increase investment in energy efficiency in these enterprises, though the interaction between aspects of the policy will only become clear as it rolls out in coming years. For example, while the use of production weighted baselines should encourage per-unit emission efficiency, the exclusion of Scope 2 emissions from calculations will likely send a much stronger electrification signal.

State and territory programs – ESS, VEU and REPS – cover at least parts of the industrial sector and have realised, and are likely to continue to realise, energy savings in this sector.

## 3.4 Existing Measures Not Included

### 3.4.1 National Measures

In 2021, SPR modelled the efficiency impacts of the Emissions Reduction Fund (ERF) and of the Clean Energy Finance Corporation's (CEFC's) general investment activities. Neither of these initiatives has a primary focus on energy efficiency, although both include this within their scopes. Energy efficiency outcomes of these programs were therefore found to be relatively small, and for this reason, they were excluded from our calculations for the 2023/24 forecasting round.

As noted above, however, recent funding allocations to the CEFC have justified including the Home Energy Upgrade Fund as a material residential energy efficiency policy. We continue excluding the ERF from our forecasts as there have been no sufficiently significant policy or funding decisions since the last forecasting round to justify their inclusion.

NABERS voluntary energy ratings for the non-office sectors were excluded, in past forecasts, but they are brought within the forecasts for the first time this year, as noted above, due to the materiality of the expansions that have occurred recently.

The National Energy Productivity Target, despite being referenced in the AEMC's *Emissions Targets Statement*, is not incorporated into SPR's models, as it is primarily a discussion document, and the material policies set out in it, such as the state efficiency schemes, are captured elsewhere.

### 3.4.2 State and Territory Measures

The ACT operates an Energy Efficiency Improvement Scheme (EEIS) that is significant in the context of that jurisdiction, and doubtless contributes to efficiency outcomes. However, AEMO forecasts are prepared by NEM region, and the ACT is not a NEM region, but forms a relatively small part of the NSW region. For this reason, EEIP and other ACT measures are not included in this project.

Almost all states and territories intermittently establish short to medium-term funding programmes that target energy efficiency in households and businesses. Though these programmes are important, and often achieve meaningful outcomes, the lack of long-term funding certainty makes them difficult to model over the forecast period. The Victorian Solar Boost programme for hot-water systems is one such example of a valuable, but short-term and relatively small funding programme. Given the challenges modelling the impacts of these individual programmes, we have not included any in our models.

Many state/territory governments undertake significant efficiency programs and initiatives within their own operations, including efficiency upgrades to buildings, minimum standards for office accommodation and many others. Similarly, industry initiatives such as those undertaken by the *Better Buildings Partnership* (BBP), by the *Green Building Council of Australia* (GBCA), by *Climate-Related Financial Disclosures* (CFD) and many, many others, are also very likely to be assisting members and clients to improve their energy efficiency, *inter alia*.

### 3.4.3 Other

There are many programs, provisions and voluntary initiatives, by businesses and other organisations, that impact on energy efficiency outcomes – both positively and negatively. Many energy businesses offer information, or advisory services, or apps or other tools, that are designed to enable their customers to use energy more efficiently. Some state-owned enterprises are encouraged by their owners to offer interest-free loans for certain efficiency improvements (or solar or batteries). Some of the larger councils also provide similar services that are significant in the context of their regions.

Since we measure *total* energy efficiency change,in the historical period, and since we forecast *total* energy efficiency change in the future, there is no omission or under-estimation caused by the non-representation of smaller-scale or voluntary energy efficiency initiatives. Instead, it means that the savings from such measures are being counted as AEEI. This implies that If some or all of these measures were in fact modelled separately, this would not change total energy efficiency, because this has already been accounted for. Instead, it would reduce our estimates of AEEI, while increasing the policy-induced fraction of the total.

# 4. Mapping Measures to AEMO Scenarios

## 4.1 AEMO 2025 Draft Scenarios

During this project, AEMO was undertaking a consultation process regarding its draft 2025 scenarios. This analysis, and the resulting forecasts, is therefore based largely on AEMO's *2025 IASR Scenarios Consultation Paper*, July 2024. The final *Inputs, Assumptions and Scenarios Report* for the 2026 ISP is not expected to be published until end-July 2025.[31] However, the description below reflects the latest text provided by AEMO (December 2024), and so it may contain updates from the July 2024 language.

AEMO notes that the National Electricity Rules (NER) are such that, for ISP purposes, all its scenarios apply relevant policies that meet public policy criteria, including international commitments (such as to the Paris Agreement) and legislated policies that are quantifiable within AEMO's modelling scopes. As discussed further below, this commitment is subject to a materiality criterion under Section 5.22.3(b) of the NER.

It also notes that its scenarios do not seek to evaluate the appropriateness or value of government policies; rather, they apply the policies to effectively identify the investments needed to achieve relevant policy objectives or the impact to broader investment needs for the energy transition having regard to policy.[32]

Also, AEMO makes the important point that:[33]

> *There are many possible futures for Australia's energy system, and the goal of scenario development is not to determine which future will occur, but to develop a discrete set of scenarios that embody and communicate key uncertainties. Scenarios need not be normative, that is, describing visions of preferred futures, and do not tend to explore specific solutions (such as high adoption of a particular technology); the impact of specific uncertainties may be explored through sensitivity analysis.*

The proposed scenarios for the draft 2025 IASR reflect a similar scenario collection to the 2023 IASR scenarios, as applied in the 2024 ISP, with adjustments reflecting stakeholder feedback including:

- Reduction in anticipated hydrogen developments associated with exports, yet greater recognition of the diverse production opportunities associated with green commodities (such as green iron, steel, alumina and ammonia),
- Moderation of assumptions regarding forecast growth in CER coordination,

[31] AEMO, *2025 IASR Scenarios Consultation Paper*, July 2024, p. 4.
[32] ibid, p. 9.
[33] ibid, p. 6.

- Increased consideration of emerging commercial loads, in particular the growing role of data centres associated with increased digital services provided in Australia.

AEMO considers that the proposed scenarios continue to provide a broad range of futures to inform regulatory network and non-network investment purposes, and enable identification of emerging system adequacy risks (for reliability and security assessments) as well as test the risks of under- and over-investment (for investment planning purposes).

The draft 2025 scenario are broadly similar to those in the 2024 ISP, with some distinctions:

- The Progressive Change scenario remains characterised by a slow rate of transformation, featuring more challenging conditions that necessitate decarbonisation efforts being deferred to their latest practical point to achieve the intent of relevant policies.
- Step Change remains characterised by a level of energy transition that is consistent with policy including Australia's commitments to international climate obligations.
- Green Energy Exports continues to reflect a high growth case, where economic and technological opportunities support a rapid and significant scale of energy system transformation. Also, as discussed further below, there are now two versions of the Green Energy scenario – Exports and Industries, although these forecasts primarily focus on Green Energy Exports.[34]

### *Step Change*

This proposed scenario refines the 2023 Step Change scenario. It is centred around achieving a scale of transformation that supports Australia's contribution to limiting global temperature rise to below 2°C compared to preindustrial levels. With broader decarbonisation activities outside the electricity sector, Australia's contribution may approach 1.5°C alignment also, though investments to deliver the energy transition would be equivalent to those needed to achieve 2°C alignment only.

The scenario experiences moderate economic conditions on average, with population growth that is also moderate, reflecting long term average trends. Recent economic challenges and current economic conditions affect the starting conditions for the scenario.

In this scenario, consumers continue to provide a key role in the transition, with strong investments in electrification, CER and energy efficiency measures. There is also strong transport electrification, driven by consumer preferences and supported by ongoing government support across various government programs.

Emerging commercial and industrial loads have moderate growth outcomes, with data centres and electrification of larger industries leading to material new electricity consumption, but with greater

[34] Note that the sensitivity analysis in Chapter 7 shows that the energy efficiency outcomes are almost identical in both cases.

potential growth unrealised. While ambition remains for hydrogen production opportunities to develop, these are slower and more focused on domestic opportunities.

Notably, compared to the 2023 Step Change scenario, consumers are more hesitant to share control of their CER, such as via virtual power plants (VPPs) and vehicle-to-grid (V2G), although there remains moderate long-term growth in coordinating these resources.

***Scenario purpose***

To explore the investment needs in a world with strong decarbonisation of the electricity sector, supporting other sectors decarbonising their current energy activities through electrification. Consumers increase their investment in CER, potentially reducing the need for utility-scale alternatives, but the coordination of these resources is more gradual than it could be, with initial difficulties to demonstrate to consumers the great potential value in coordinating these assets as well as reward consumers' choice to provide increased access to their resources to improve the efficiency and effectiveness of the transition.

### *Progressive Change*

This proposed scenario describes a world that aims to achieve Australia's current Paris Agreement commitments of 43% emissions reduction by 2030, amid economic circumstances that are more challenging. The scenario features slower and weaker economic growth domestically, and global ambition to address climate change is less ambitious after current commitments. While achieving current decarbonisation commitments, global action is insufficient to meet the intent of the Paris Agreement to limit temperature rise to less than 2°C, although Australia does more gradually reach a net zero emissions economy by 2050.

With weaker economic conditions, major industrial loads are much more likely to wind up Australian operations in favour of offshore alternatives. Australia's emissions intensive industries are therefore at much greater operational risk, and the scenario explicitly reflects this risk with closures to large energy-intensive loads in each NEM region. Lesser economic and population growth reduces the overall scale of change required to achieve net zero. Lower global investment reduces the speed of technology cost decline, and supply chain challenges relative to other scenarios slow the pace of change affecting Australia's demand for energy.

Progressive Change slows the pace of decarbonisation from consumers and from industry, meaning local benefits from new green industry opportunities are relatively unrealised. With weaker economic activity, consumers are less able to invest in demand side factors such as energy efficiency savings and CER, and they are even less willing also to give operational control of their resources to third parties, instead preferring to maximise their individual benefits, leading to less coordination of these valuable assets.

*Scenario purpose*

To explore investment needs in a world with headwinds to decarbonisation, including lesser growth across Australia's economy. As a consequence, this scenario examines possible over-investment risks in a more slowly growing economy.

### *Green Energy scenario**

This proposed scenario refines the 2023 Green Energy Exports scenario. It reflects very strong decarbonisation activities domestically and globally to limit temperature increase to 1.5°C, resulting in rapid transformation of Australia's energy sectors, utilising all available pathways to net zero including a strong use of electrification, and transformation of other sectors at pace, including action to reduce the emissions intensity of molecular forms of energy. Higher economic growth internationally (and locally) increases technology developments and leads to more rapid cost decline for new tech, and the global demand for green energy is very high given the strong global appetite for low and zero emissions fuel sources. Australia's economy is boosted from hydrogen production opportunities to service domestic and international interest in hydrogen and in green energy products, particularly commodities produced with green energy, such as green iron and steel.

In this future, Australia also embraces a rapid change to the emissions intensity of the energy sector. With strong renewable energy penetration, the opportunity for large-scale development of hydrogen and associated commodities is greater than other scenarios, offsetting emissions intensive components of Australia's economy. Australia's international trading partners, particularly in Asia, provide great opportunities for Australia's potential to develop and deliver green commodities to support their decarbonisation actions. Australia therefore is a relatively strong contributor to global efforts to embrace low/zero emissions alternatives through this transition, with hydrogen replacing declining coal and gas exports.

The scale of the Green Energy scenario – in terms of the quantities of hydrogen produced/consumed/exported, and the value of the associated investments – is smaller relative to previous versions of AEMO's scenarios, respecting stakeholder feedback that the scenario may challenge the plausible boundaries of the energy sector investments to be delivered.

In relation to green commodity exports, exports of hydrogen and value-add commodities are a focus; as the world's largest iron ore exporter for example, and with high renewable energy opportunities, Australia in this scenario is well placed to service the growing global need for green energy commodities.

Considering stakeholder feedback to date, the green energy scenario* will reflect one of two alternatives that are focused around 1.5°C scale decarbonisation actions in Australia, but with more/less embracement of Australia's export potential in this world. In the ISP, AEMO anticipates that one of the scenario variants will be adopted as the scenario narrative, while the other will enable, exploration of the investment impacts of the other variant through sensitivity analysis.

The proposed scenario variants are:

Green Energy Exports – includes development of a hydrogen industry, focusing on value-add hydrogen products such as green iron and steel, for domestic use and export. Also includes significant opportunity for hydrogen production and associated manufacturing users to develop products for export, including hydrogen as an energy carrier.

Green Energy Industries – includes development of a hydrogen industry, focusing on value-add hydrogen products such as green iron and steel, for domestic use and export. The variant excludes those developments that are expected to support hydrogen exports as an energy carrier, thereby representing a materially smaller hydrogen impact on investment requirements than the Green Energy Exports variant.

Both variants are very similar to the 2023 IASR scenario, with domestic and export opportunities, with a reduced level of hydrogen activity – particularly for exports – relative to the 2023 IASR. Value-added commodity developments represent a key potential driver of Australia's economic activity in the medium to long term in this scenario, and Australia is well-placed with strong renewable energy generation potential and critical access to raw materials that may benefit from green energy in conversion processes. The Green Energy Industries variant is thematically identical to Green Energy Exports in all areas of the scenario's key parameters except for a lower level of new investment in value-add commodities and hydrogen exports.

***Scenario purpose***

To explore investment needs in a world embracing very rapid decarbonisation to support the strong potential economic benefits Australia's renewable generation potential. It will therefore identify the scale and speed of investments that may be required to realise this potential in a rapidly decarbonising global economy.

### *Key scenario parameters*

Table 2 summarises decarbonisation targets, key demand drivers, technological trends and other key parameters for each of the scenarios. Details are in the Draft 2025 Inputs and Assumptions Workbook. Scenarios vary by the pace of the transition to net zero, considering global, national and sectoral influences, leading to variations in future energy system needs while achieving the emissions reduction policy objectives of Australia's governments.

### Table 3: Key parameters, by scenario

| Parameter | *Green Energy Exports* | *Step Change* | *Progressive Change* |
|---|---|---|---|
| **National decarbonisation targets** | At least 43% emissions reduction by 2030, and meeting Australia's carbon budget constraint over this period. Net zero by 2050 | At least 43% emissions reduction by 2030, and meeting Australia's carbon budget constraint over this period. Net zero by 2050 | At least 43% emissions reduction by 2030, and meeting Australia's carbon budget constraint over this period. Net zero by 2050 |
| **Global economic growth and policy coordination** | High economic growth, stronger coordination | Moderate economic growth, stronger coordination | Slower economic growth, lesser coordination |
| **Australian economic and demographic drivers** | Higher, with near-term economic growth impacted somewhat by current economic challenges | Moderate economic growth, with near-term economic growth impacted by current economic challenges | Lower |
| **Electrification** | Higher electrification efforts to meet aggressive emissions reduction objectives, with faster pace of adoption | High electrification to meet emissions reduction commitments, with pace of adoption reflecting economic conditions | Electrification is tailored to meet existing emissions reduction commitments, with slower adoption given weaker economic circumstances |
| **Emerging commercial loads** | Emerging sectors such as data centres match opportunities associated with higher domestic economic drivers | Emerging sectors such as data centres match opportunities associated with moderate domestic economic drivers | Emerging sectors such as data centres experience lower growth as weaker economic circumstances limit technology uptake |
| **Coordination of CER (VPP and V2G)** | High long-term coordination, with faster acceptance of coordination | Moderate long-term coordination, with gradual acceptance of coordination | Low long-term coordination, with gradual acceptance of coordination |
| **Energy efficiency** | Higher | High | Moderate |
| **Hydrogen use and availability** | High production for domestic industries, with moderate exports in the short term, and high exports in the longer term | Moderate-low production for domestic use, with minimal export hydrogen | Low production for domestic use, with no export hydrogen |
| **Industrial load closures** | No specific load closures | No specific load closures | Weak economic conditions provide challenging commercial conditions, resulting in |

| Parameter | *Green Energy Exports* | *Step Change* | *Progressive Change* |
|---|---|---|---|
| | | | load closures across key commercial and industrial facilities |
| **Demand side participation uptake** | Higher | Moderate | Lower |
| **CER investments (batteries, PV and EVs)** | Higher | High | Lower |
| **Renewable gas blending in gas distribution network** | Up to 10% (hydrogen), with unlimited blending opportunity for biomethane and other renewable gases | Up to 10% (hydrogen), with unlimited blending opportunity for biomethane and other renewable gases | Up to 10% (hydrogen), with unlimited blending opportunity for biomethane and other renewable gases |
| **Potential for supply chain limitations affecting demand forecasts** | Low | Moderate | High |
| **Global/domestic temperature settings and outcomes** | Applies Representative Concentration Pathway (RCP) 1.9 where relevant, consistent with a global temperature rise of ~ 1.5°C by 2100 | Applies RCP 2.6 where relevant, consistent with a global temperature rise of ~ 1.8°C by 2100 | Applies Representative Concentration Pathway (RCP) 4.5 where relevant, consistent with a global temperature rise of ~ 2.6°C by 2100 |
| **IEA 2024 World Energy Outlook scenario alignment** | *Net Zero Emissions by 2050* (NZE) | *Announced Pledges Scenario* (APS) | *Stated Policies Scenario* (STEPS) |

A. Hydrogen blending into the gas distribution network will need to accommodate the technical requirements of distribution pipelines, as well as the capabilities of connected gas appliances. Higher blends than ~10% by volume are assumed possible for industrial use but may require equipment change and/or shifts to dedicated hydrogen transmission pipelines.

B. RCPs were adopted in the IPCC's first Assessment Report, see https://www.ipcc.ch/report/ar5/syr/.

## 4.2 Differentiating Forecast Energy Efficiency Change by Scenario

Several factors indicate that market-led efficiency improvement would be expected to increase in the faster-change scenarios and decrease in the slower change scenario:

1. Faster global economic growth, internationally and in Australia, can be expected to be associated with higher investment in new capital (capital formation); higher investment in the research, development and commercialisation of new technologies; and improved supply chain efficiencies. Stronger co-ordination is interpreted to mean that there is a stronger international consensus on the priority associated with emissions reductions and

the transition to clean energy, translating into greater availability of lower cost and higher emissions-performance equipment.

2. Faster electrification will drive faster efficiency improvement, as discussed in Section 2, and – for the time being, at least, we perceive this as primarily a market-led effect.
3. The reference to load closures in Progressive Change is consistent with an economic environment in which there would be low levels of investment and capital formation in larger industrial enterprises, and this in turn would generate low rates of efficiency improvement. Declining industrial output levels are also like to lead to process inefficiencies and reduced energy efficiency.

With respect to policy settings, again it seems reasonable to differentiate policy ambition across the three scenarios, due to:

1. Alignment with different World Energy Outlook scenarios, which imply different policy settings.
2. Different RCPs, which imply different levels of policy ambition.
3. Higher 'co-ordination' of CER is likely to be achieved via changed policy settings.
4. Higher electrification "efforts" (as distinct from 'outcomes') is indicative of differential policy settings.

### *Impact of emission reduction targets on policy ambition*

Emission reduction targets do not vary by scenario. All scenarios are expected to meet Australia's current targets which include a 43% reduction on 2005 emissions by 2030, net zero by 2050, *and* carbon budget constraints that apply over time. The carbon budget constraints, in particular, limit the scope for differentiation by scenario – unless higher emissions targets were assumed in some scenarios, which is the not the case in the *2025 IASR Scenarios Consultation Paper* – since they limit the extent to which abatement can be delayed in time without breaching these carbon budget constraints, even if 2030 targets were met (eg, with delayed abatement).

This standard level of emission reduction ambition creates a tension in developing our models, given the need for policy differentiation by scenario. However, no *a priori* assumptions can be made about the role of energy efficiency and efficiency policy within any given emissions scenario, as there are many other abatement options and strategies, and it will be a matter for separate consideration by governments to what extent they wish to prioritise efficiency improvement via enhanced policy settings. By contrast, the degree of market-led efficiency improvement would be expected to vary by scenario, as the scenario narratives imply different rates of technology development, trade, investment, economic growth and many other relevant factors.

### 4.2.1 Other modelling considerations/challenges posed by scenario distinctions

***Blended gases***

A tension we identify is that if there is blending of hydrogen with methane, this would reduce the volumetric energy content of the fuel, and thereby directly reduce gas consumption efficiency. This effect would not be expected occur with biomethane. For this project, we assume that all 'gas' use refers to fossil methane.

***CER***

Higher CER investments can, in some cases only, reduce the efficiency of energy use. The round-trip losses of batteries are an important case in point, but some (but not all) other load management/demand response strategies may also have similar effects, including batch-managed industrial production, where additional heat losses can occur. Most load-control strategies have ambiguous energy efficiency consequences, which depend primarily on whether they degrade energy service quality at the same time as they reduce on-peak energy consumption, and whether there are positive or negative rebounds in off-peak energy consumption. EVs increase the efficiency of energy use, notwithstanding round-trip battery losses, as they have much higher efficiencies, at least in most cases, than the ICE vehicles they replace.

***New Commercial Loads (eg, Data Centres)***

We note that differential rates of emergence of new commercial loads, such as data centres, by scenario would likely be a market-led phenomenon, as we are unaware of any current policy setting that would impact on this. Second, load growth is expected across all sectors, and this in and of itself has no pre-determined consequences for energy efficiency (as distinct from energy consumption). Since data centres have very high energy intensity – for example, per sqm of floor area – when compared to other commercial buildings, new data centre load would be considered – in the factorisation methodology – to cause a change in the *structure* of the commercial buildings sector. The nature of this structural change would be to increase the average energy intensity of the sector, and this could be described as a reduction in the sector's average energy efficiency. However, as noted in Section 2, SPR would not use this language, as there would also be, in this scenario, increases in commercially-valuable outputs, and potentially at an even faster pace than the increase in energy consumption. Therefore, depending upon the metrics chosen, the efficiency of energy use could be shown to increase, at the same time as consumption increases.

The practical challenge here is that there is *extremely* little transparency (in the public domain) as to the actual energy use or intensity of data centres in Australia, as this is considered commercially-sensitive information. Also, there is little agreement on practical and transparent output indicators with which to determine energy efficiency trends. The voluntary NABERS data centre rating tool does not generate meaningful energy intensity estimates, even for the small number of data centres that have been assessed under this program. In effect, data centres are more akin to industrial than to commercial enterprises, and they may need to be treated in this manner (or potentially as commercial LILs) in AEMO's forecasts.

## 4.3 Mapping Future Policy Settings to AEMO Scenarios

As noted, AEMO scenarios are narrative-based and long term. They are framed to be both internally-consistent and yet differentiated in ways, and to degrees, that are explicable with reference to the scenario narratives. Scenarios that run towards 2060 could not assume unchanging policy settings over the next 35 years or more. Also, the scenario narratives themselves imply different policy settings by scenario, but the exact nature of these differences is not stated.

Few forecasters would comfortably predict government policy settings for more than a few months, let alone for 35 years. However, AEMO stresses that its scenarios are not predictions of the future but, rather, they represent detailed analyses of how different futures would be expected to unfold *IF* the key scenario assumptions come to pass. From this perspective, SPR generates differentiated efficiency policy assumptions for the forecast period that are consistent with, and plausible in the context of, the differing scenario narratives. As noted, we offer opportunities for program and policy managers around the jurisdictions to contribute to this process, but we acknowledge that those managers are faced with the same uncertainties as are forecasters, and they also face confidentiality constraints with respect to potential short-term policy changes that are not yet announced. For these reasons, SPR is required to rely largely upon its own judgement, and experience in policy assessment, to develop plausible policy trajectories.

In the context of these forecasts, we would argue that the overall direction – including ambition or stringency – of policy settings in each scenario is more important than specific policy details. However, since we model specific policy measures, we assume changes in specific policy settings and timings in order to differentiate and drive our models. These settings do not amount to recommendations or to 'optimal' policy settings, the identification of which is beyond the scope of this project.

The following sections tabulate key policy settings and assumptions by sector, scenario and measure. Note that the assumptions for and results of sensitivity analyses may be found in Chapter 7.

Note that – almost without exception – our assumptions for future policies, and for the future policy settings for existing policies, do not represent the current or committed intentions of any government. For the most part, such future intentions are unstated. The only exception (at the time of writing) is that ESS targets are set through to 2050.

### 4.3.1 Residential Sector

**Table 4: Energy Efficiency Policy/AEEI Future Assumptions by AEMO Scenario – Residential Sector**

| Policy Domain | Green Energy Exports | Step Change | Progressive Change |
|---|---|---|---|
| **Market-led (or autonomous) energy efficiency improvement** | • 115% of CSIRO AEEI assumptions | • 100% of CSIRO AEEI assumptions | • 85% of CSIRO AEEI assumptions |
| **National Construction Code energy performance requirements** | • 7 star takes effect from FY2024 (but FY2027 in TAS and FY2028 in NT)<br>• 8 star from FY2031 in NSW, VIC, QLD & WA (FY2036 in SA)<br>• 7.5 star from FY 2031 in Tas and FY2036 in NT<br>• 8.5 star from FY2041 in NSW, VIC, QLD & WA (FY2051 in SA & Tas)<br>• 9 star from FY2051 in NSW, Vic, Qld & WA | • 7 star takes effect from FY2024 (but FY2027 in TAS and FY2028 in NT)<br>• 7.5 star from FY2031 in NSW, VIC, QLD & WA (FY2036 in SA, Tas & NT)<br>• 8 star from FY 2036 in NSW, Vic, QLD & WA (FY2041 in SA & Tas, FY2046 in NT)<br>• 8.5 star from FY2041 in NSW, VIC, QLD & WA (FY2051 in SA & Tas)<br>• 9 star from FY2051 in NSW, Vic, Qld & WA | • 7 star takes effect from FY2024 (but FY2027 in TAS and FY2028 in NT)<br>• 7.5 star from FY2036 in NSW, VIC, QLD, SA & WA (FY2041 in SA, Tas & NT)<br>• 8 star from FY 2041 (FY2046 in Tas & SA. 8 star not reached in NT in forecast period) |
| **Appliance and Equipment Standards and Labelling (GEMS/E3)** | • Significant expansion of coverage, least societal life cycle cost stringencies, frequent updating, leading to significant increase in impact. By 2030, energy savings (relative to FY2015) are assumed to be 2.3 times larger (in energy units) | • Expanded scope of measures, higher stringencies and more frequent updating, leading to moderate increase in impact. By 2030, energy savings (in energy units) are assumed to be 2 times | • Some expansion to 2030, representing the effect of recent decisions, but slow declines thereafter, due to measures expiring faster than replacement. By 2030, energy savings are assumed to be 1.7 times larger than |

| Policy Domain | Green Energy Exports | Step Change | Progressive Change |
|---|---|---|---|
| | than they were in FY2023 and 5.4 times larger by 2058. The RES share of total GEMS savings is assumed to decline slowly over time, in line with past trends, for all scenarios. | larger than they were in 2023 and 4.5 times higher by 2058. | they were in 2023 and to remain at or slightly below this level over the period to 2058. |
| **State/territory energy savings schemes** | • ESS targets lifted by 0.2% per year, from 13% by FY2030 to 18.6% by 2058<br>• VEU annual targets lifted from 7.3 million certificates in 2025 to 9.1 million by 2045, when program ceases (note: emission intensity frozen at 2027 levels to avoid exponential increase in surrender obligations)<br>• REPS targets lifted from 3.75 million GJ in 2025 to 6.75 million GJ by 2030, but the program is not continued past this date (in practice, it is likely to be reviewed ahead of 2030 and may be reframed for the post-2030 period) | • ESS targets lifted by 0.1% per year, from 13% by FY2030 to 15.8% by 2058<br>• VEU annual targets lifted from 7.3 million certificates in 2025 to 8 million by 2045, when program ceases (note: emission intensity frozen at 2027 levels to avoid exponential increase in surrender obligations)<br>• REPS targets lifted from 3.75 million GJ in 2025 to 5.75 million GJ by 2030, but is not continued past this date (in practice, the program is likely to be reviewed ahead of 2030 and may be reframed for the post-2030 period) | • ESS targets remain at 2025 levels (13%) until 2058.<br>• VEU targets remain at 2025 levels until 2045, when program ceases (note: emission intensity frozen at 2027 levels to avoid exponential increase in surrender obligations)<br>• REPS targets frozen at 2025 levels and programme ceases at 2030 (in practice, it is likely to be reviewed ahead of 2030 may be reframed for the post-2030 period) |
| **Mandatory Disclosure (potential new policy)** | • Universal mandatory disclosure introduced from FY2027<br>• Additional 0.025% of dwellings upgrading due to disclosure p.a. – 0.8% p.a. by 2058 | • Universal mandatory disclosure introduced from FY2029<br>• Additional 0.025% of dwellings upgrading due to disclosure p.a. – 0.75% p.a. by 2058 | • Universal mandatory disclosure introduced from FY2038<br>• Additional 0.025% of dwellings upgrading due to disclosure p.a. – 0.525% p.a. by 2058 |

| Policy Domain | Green Energy Exports | Step Change | Progressive Change |
|---|---|---|---|
| | • 5.5% EE improvement per upgrade | • 5.0% EE improvement per upgrade | • 4.5% EE improvement per upgrade |
| **Minimum energy performance standards for existing buildings** | • MEPS for rental properties take effect from FY2030.<br>• Initial standards require 5% of rental stock upgrades and 5.5% energy savings.<br>• Higher standards apply from FY2040, requiring 10% of rental stock upgrades and 8% energy savings.<br>• Higher standards apply from FY2050, with another 10% of stock upgraded and 10.5% energy savings. | • MEPS for rental properties take effect from FY2030.<br>• Initial standards require 5% of rental stock upgrades and 5% energy savings.<br>• Higher standards apply from FY2040, requiring 7.5% of rental stock upgrades and 7.5% energy savings.<br>• Higher standards apply from FY2050, with another 7.5% of stock upgraded and 10% energy savings. | • MEPS for rental properties take effect from FY2040.<br>• Initial standards require 5% of rental stock upgrades and 7% energy savings.<br>• Higher standards apply from FY2050, with another 5% of rental stock upgraded and 9.5% energy savings. |
| **Home Energy Upgrade Fund (new)** | • $4,000m invested over 25 years ($12,000m total investment including leveraged private funds)<br>• 0.51% uptake of efficiency upgrades due to HEUF in class 1ai, 0.48% uptake in class 1aii, 0.46% uptake in class 2 | • $2,500m invested over 20 years ($7,500m total investment including leveraged private funds)<br>• 0.4% uptake of efficiency upgrades due to HEUF in class 1ai, 0.38% uptake in class 1aii & 0.36% uptake in class 2 | • $1,000m invested over 10 years ($3,000m total investment including leveraged private funds)<br>• 0.32% uptake of efficiency upgrades due to HEUF in class 1ai, 0.3% uptake in class 1aii & 0.29% uptake in class 2 |

### 4.3.2 Commercial Sector

**Table 5: Energy Efficiency Policy/AEEI Future Assumptions by AEMO Scenario – Commercial Sector**

| Policy Domain | Green Energy Exports | Step Change | Progressive Change |
|---|---|---|---|
| **Market-led (or autonomous) energy efficiency improvement** | Higher, due to:<br>• high international, and higher domestic, economic growth<br>• stronger international co-ordination<br>• higher electrification<br>• higher private investment, capital stock turnover<br>• less load closures.<br><br>Energy prices may be lower, but this effect would be offset by higher rates of investment and capital stock turnover.<br><br>Quantitative assumption for the forecast period is 125% of CSIRO AEEI assumptions. | High, due to:<br>• moderate economic and population growth, internationally and domestically<br>• stronger international co-ordination<br>• high electrification<br>• high private investment, capital stock turnover<br>• less load closures.<br><br>Energy prices may be lower, but this effect would be offset by higher rates of investment and capital stock turnover.<br><br>Quantitative assumption for the forecast period is 100% of CSIRO AEEI assumptions, with an average of 0.33% per year for electricity and 0.11% year | Lower, due to:<br>• slower population and economic growth<br>• less international co-ordination<br>• less electrification<br>• higher technology costs<br>• lower private investment, capital stock turnover<br>• more load closures.<br><br>Energy prices may be higher, but this effect would be offset by lower rates of investment and capital stock turnover.<br><br>Quantitative assumption for the forecast period is 75% of CSIRO AEEI assumptions. |

| Policy Domain | Green Energy Exports | Step Change | Progressive Change |
|---|---|---|---|
| | | for gas. Values for COM LILs are significantly higher until 2030, but lower thereafter, noting there are few energy users in this category. | |
| **National Construction Code energy performance requirements** | NCC2025 is assumed to apply from May 2025, with 3-yearly stringency reviews until the late 2030s. Stringency changes are then assumed to occur less frequently due to saturation effects. By 2058, gross average reference building energy intensities would be 46% of their 2024 equivalents. | NCC2025 is assumed to apply from May 2025, with 6-yearly stringency reviews thereafter. No further changes are assumed after mid-2040s due to saturation effects. By 2058, gross average reference building energy intensities would be 56% of their 2024 equivalents. | NCC2025 is assumed to be delayed until 2032, with 9-yearly reviews thereafter. By 2058, gross average reference building energy intensities would be 66% of their 2024 equivalents. |
| **Appliance and Equipment Standards and Labelling (GEMS/E3 Program)** | Significant expansion of coverage, least societal life cycle cost stringencies, frequent updating, leading to significant increase in impact. By 2030, energy savings are assumed to have increased by 2.3 times their 2023 value, and are 5.4 times higher by 2058. The COM share of total GEMS savings is assumed to increase slowly over time in line with past trends, for all scenarios. | Expanded scope of measures, higher stringencies and more frequent updating, leading to moderate increase in impact. By 2030, energy savings are assumed to have increased by 2 times their 2023 value, and are 4.5 times higher by 2058. | Some expansion to 2030, representing the effect of recent decisions, but slow declines thereafter, due to measures expiring faster than replacement. By 2030, energy savings are assumed to have increased by 1.7 times their 2023 value, and remain at or slightly below this level to 2058. |

| Policy Domain | Green Energy Exports | Step Change | Progressive Change |
|---|---|---|---|
| **State/territory energy savings schemes** | • ESS targets lifted by 0.2% per year, from 13% by FY2030 to 18.6% by 2058<br>• VEU annual targets lifted from 7.3 million certificates in 2025 to 9.1 million by 2045, when program ceases (note: emission intensity frozen at 2027 levels to avoid exponential increase in surrender obligations)<br>• REPS targets lifted from 3.75 million GJ in 2025 to 6.75 million GJ by 2030, but the program is not continued past this date (in practice, it is likely to be reviewed ahead of 2030 and may be reframed for the post-2030 period) | • ESS targets lifted by 0.1% per year, from 13% by FY2030 to 15.8% by 2058<br>• VEU annual targets lifted from 7.3 million certificates in 2025 to 8 million by 2045, when program ceases (note: emission intensity frozen at 2027 levels to avoid exponential increase in surrender obligations)<br>• REPS targets lifted from 3.75 million GJ in 2025 to 5.75 million GJ by 2030, but is not continued past this date (in practice, the program is likely to be reviewed ahead of 2030 and may be reframed for the post-2030 period) | • ESS targets remain at 2025 levels (13%) until 2058.<br>• VEU targets remain at 2025 levels until 2045, when program ceases (note: emission intensity frozen at 2027 levels to avoid exponential increase in surrender obligations)<br>• REPS targets frozen at 2025 levels and programme ceases at 2030 (in practice, it is likely to be reviewed ahead of 2030 may be reframed for the post-2030 period) |
| **Mandatory Disclosure (including CBD and potential future CBD Expansion)** | CBD for Office continues, with faster take up and higher savings than Step Change – however, this also generates earlier saturation effects. The CBD Expansion Roadmap is assumed to be 'high ambition', which delivers significant and early expansion to new sectors, with 3-yearly disclosure. | CBD for Office continues, with take up and savings increasing slowly over time, but with progressive saturation effects. The CBD Expansion Roadmap assumes a 'modest ambition' pathway which delivers significant and early expansion to new sectors, with 3-yearly disclosure. | CBD for Office continues, with take up and savings increasing slowly over time, but with progressive saturation effects. The CBD Expansion Roadmap assumes a 'low ambition' pathway with delayed expansion to new sectors, with 5-yearly disclosure. |

| Policy Domain | Green Energy Exports | Step Change | Progressive Change |
|---|---|---|---|
| **NABERS (voluntary, excluding CBD)** | 1.5% annual growth in floor area rated, but higher saturation effect (offices only, no saturation effect in other sectors due to lower/later take-up). More rapid expansion in non-office sectors. | 1.25% annual growth in floor area rated, moderate saturation effect (offices only, no saturation effect in other sectors due to lower/later take-up). Progressive expansion in non-office sectors. | 1% annual growth in floor area rated, but lower saturation effect (offices only, no saturation effect in other sectors due to lower/later take-up). Slower expansion in non-office sectors. |
| **Minimum energy performance standards (MEPS) for existing buildings (potential new measure)** | Early introduction of MEPS for existing buildings covered by the CBD Expansion Roadmap, more rapid increases in MEPS stringency over time. | Progressive introduction of MEPS for existing buildings covered by the CBD Expansion Roadmap, with moderate stringency MEPS. | No MEPS. |

### 4.3.3 Industrial Sector

**Table 6: Energy Efficiency Policy/AEEI Future Assumptions by AEMO Scenario – Industrial Sector**

| Policy Domain | Green Energy Exports | Step Change | Progressive Change |
|---|---|---|---|
| **Market-led (or autonomous) energy efficiency improvement** | Higher, due to:<br>• high international, and higher domestic, economic growth<br>• stronger international co-ordination<br>• higher electrification | High, due to:<br>• moderate economic and population growth, internationally and domestically | Lower, due to:<br>• slower population and economic growth<br>• less international co-ordination<br>• less electrification |

| Policy Domain | Green Energy Exports | Step Change | Progressive Change |
|---|---|---|---|
| | • higher private investment, capital stock turnover<br>• less load closures.<br><br>Energy prices may be lower, but this effect would be offset by higher rates of investment and capital stock turnover.<br><br>Quantitative assumption for the forecast period is 125% of CSIRO AEEI assumptions. | • stronger international co-ordination<br>• high electrification<br>• high private investment, capital stock turnover<br>• less load closures.<br><br>Energy prices may be lower, but this effect would be offset by higher rates of investment and capital stock turnover.<br><br>Quantitative assumption for the forecast period is 100% of CSIRO AEEI values, with an average of 0.28% per year for SMEs until 2030 and 0.17% thereafter; and 0.84% for LILs until 2030 and 0.3% thereafter – assumptions are not differentiated by fuel. | • higher technology costs<br>• lower private investment, capital stock turnover<br>• more load closures.<br><br>Energy prices may be higher, but this effect would be offset by lower rates of investment and capital stock turnover.<br><br>Quantitative assumption for the forecast period is 75% of CSIRO AEEI assumptions. |
| **Appliance and Equipment Standards and Labelling (GEMS/E3 Program)** | Significant expansion of coverage, least societal life cycle cost stringencies, frequent updating, leading to significant increase in impact. By 2030, energy savings are assumed to have increased by 2.3 | Expanded scope of measures, higher stringencies and more frequent updating, leading to moderate increase in impact. By 2030, energy savings are assumed to have increased | Some expansion to 2030, representing the effect of recent decisions, but slow declines thereafter, due to measures expiring faster than replacement. By 2030, energy savings are assumed to have increased by 1.7 times their 2023 |

| Policy Domain | Green Energy Exports | Step Change | Progressive Change |
|---|---|---|---|
| | times their 2023 value, and are 5.4 times higher by 2058. The IND share of total GEMS savings is assumed to decline slowly over time in line with past trends, for all scenarios. | by 2 times their 2023 value, and are 4.5 times higher by 2058. | value, and remain at or slightly below this level to 2058. |
| **State/territory energy savings schemes** | • ESS targets lifted by 0.2% per year, from 13% by FY2030 to 18.6% by 2058<br>• VEU annual targets lifted from 7.3 million certificates in 2025 to 9.1 million by 2045, when program ceases (note: emission intensity frozen at 2027 levels to avoid exponential increase in surrender obligations)<br>• REPS targets lifted from 3.75 million GJ in 2025 to 6.75 million GJ by 2030, but the program is not continued past this date (in practice, it is likely to be reviewed ahead of 2030 and may be reframed for the post-2030 period) | • ESS targets lifted by 0.1% per year, from 13% by FY2030 to 15.8% by 2058<br>• VEU annual targets lifted from 7.3 million certificates in 2025 to 8 million by 2045, when program ceases (note: emission intensity frozen at 2027 levels to avoid exponential increase in surrender obligations)<br>• REPS targets lifted from 3.75 million GJ in 2025 to 5.75 million GJ by 2030, but is not continued past this date (in practice, the program is likely to be reviewed ahead of 2030 and may be reframed for the post-2030 period) | • ESS targets remain at 2025 levels (13%) until 2058.<br>• VEU targets remain at 2025 levels until 2045, when program ceases (note: emission intensity frozen at 2027 levels to avoid exponential increase in surrender obligations)<br>• REPS targets frozen at 2025 levels and programme ceases at 2030 (in practice, it is likely to be reviewed ahead of 2030 may be reframed for the post-2030 period) |
| **Safeguard Mechanism** | 110% of Step Change savings | As per DCCEEW projections, but discounted by 10% for uncertainty, noting the updated Safeguard Mechanism is too recent to have a | 90% of Step Change savings |

| Policy Domain | Green Energy Exports | Step Change | Progressive Change |
|---|---|---|---|
| | | clear track record with respect to energy efficiency impacts at this time. | |

# 5. Basis of Sectoral Forecasts

## 5.1 Residential Sector

### 5.1.1 Overview

***Historical analysis***

Our residential model uses historical actual energy consumption and activity data to develop an overview of energy efficiency change in the 2015-2023 period. In the residential sector, housing stock data is used to represent not only the total change in 'activity' but also changes in 'structure', such as the *composition* of the stock by dwelling type.

We then construct frozen intensity counterfactual baselines for each region, taking a historical year (in this case, FY2015) as an arbitrary starting point. Growth in energy consumption in this counterfactual case is then a function of housing stock growth and structural change and includes no electrification or efficiency change. This process creates a counterfactual for estimating the extent (and direction) of electrification and energy efficiency effects over the historical period. Distinguishing market-led energy efficiency and electrification in this analysis must be done by informed assumption, with an eye to the consistency of assumptions with both the historical and forecast period.

Observed change in EE from this frozen counterfactual is then compared with the sum of bottom-up quantification of historical electrification, policy led EE change, and AEEI. Comparing observed and calculated EE change gives us an indication of the accuracy of our policy calculation methodologies, which are then applied over the forecast period.

***Forecast period***

Our model includes forecasts for residential activity (housing stock growth and change), over the modelled period, developed using data provided by AEMO. This activity data is differentiated by scenario and is used in all policy and AEEI modelling.

Each policy included in our analysis, set out in Table 4, is modelled separately, reflecting differences in policy design, timelines, and scale. These policy models are differentiated by scenario, with future settings informed by publicly-available information, information sourced from programme managers, or by assumption. The sum of these individual calculations represents total policy-led EE change over the forecast period, by scenario.

In previous ISP rounds forecast AEEI rates have been based broadly on rates in the historical period, though have not been differentiated by end use, dwelling type, or region. In adopting the CSIRO's

AEEI calculations,[35] our model now incorporates a far greater level of granularity on the distribution of AEEI change across the residential sector. Because CSIRO's AEEI assumptions are not differentiated by scenario, we apply loadings to reflect the scenario narrative descriptions.

Combining these two inputs gives us total forecast energy efficiency change in the residential sector over the FY2024 - FY2058 period, by scenario.

### 5.1.2 Housing Stock Growth

Our housing stock model forecasts total residential floor area over the FY2024 - FY2058 period using AEMO electricity connection forecasts and ABS residential floor area and dwelling type data. Total residential floor area is calculated by dividing AEMO's connection forecasts[36] by extrapolated ABS dwelling type data, with each individual archetype figure multiplied by extrapolated ABS dwelling floor area data.[37] This calculation gives a total floor area for each archetype in each scenario, which are then summed to generate total floor area by scenario, as seen in Figure 1.

Scenario differentiation is a function of scenario differences in connection forecasts, with no variation in floor area assumptions by scenario. This limited scenario variation may not necessarily hold true in the real world, as higher or lower economic growth across scenarios may lead to changes in dwelling size. Well-evidenced scenario variation in these data inputs may be a model improvement worth considering in future forecasting rounds.

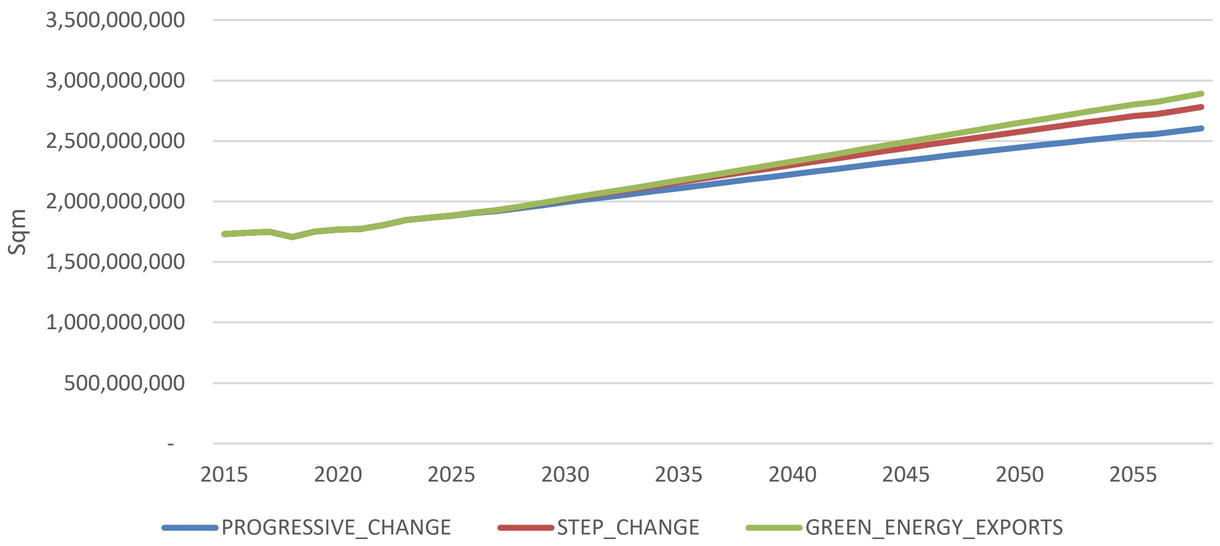


**Figure 1: Residential floor area over forecast period by scenario**

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35 As provided by AEMO for this purpose only.
36 AEMO reference: *SPR_2024_Residential Connections Forecast_V2*
37 Australian Bureau of Statistics (ABS), Building Activity Australia Data Cube, December 2023, released April 2024.

## 5.1.3 Change in dwelling stock composition

In addition to housing stock growth, our model also incorporates projections of change in housing stock over time. As shown in Figure 2, our model uses data provided to AEMO by Deloitte to project the share of new dwelling floor area by dwelling type (standalone house, townhouse and apartment). All scenarios show a trend towards a greater share of apartments in total dwelling area, though this trend is most pronounced in *Green Energy Exports*, and least pronounced in *Progressive Change*. This trend influences modelled results in a number of ways, including shaping jurisdictional AEEI rates (see Section 5.1.5 below), and policy specific results for the NCC and HEUF, which both differentiate by archetype. Our model does not account for the sub-jurisdictional geographic distribution of archetypes, with representative climate zones used for all dwellings in a jurisdiction. Note that the out-of-trend results for FY2025 are data artefacts arising from matching actual historical values to the connection forecasts – in reality, these trends will be smoothed.

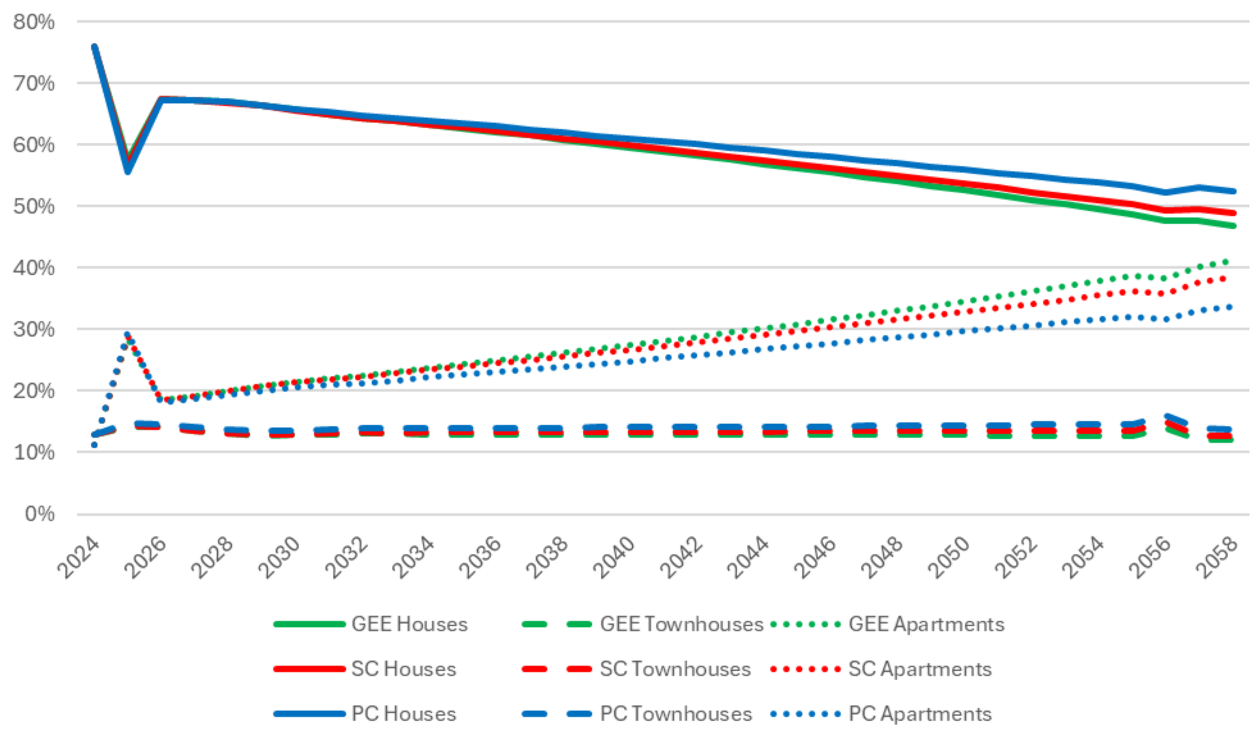


**Figure 2: Annual new dwelling floor area by archetype over forecast period (% of all new dwelling floor area)**

## 5.1.4 New dwelling gas connection rates

Our model includes gas connection phase-down pathways for each building archetype and scenario, shown in Figure 3. The largest contributor to the modelled fall in new residential gas connections over 2024-25 is the Victorian Government's move to ban residential connections from 2024. Given Victoria's large population, and outsized share of total new gas connections, this commitment has a significant impact on total new dwelling gas connection rates. Future new dwelling gas connection rates are differentiated by scenario based on a year in which no additional connections occur – 2030, 2035 and 2040 for Green Energy Exports, Step Change and Progressive Change respectively.

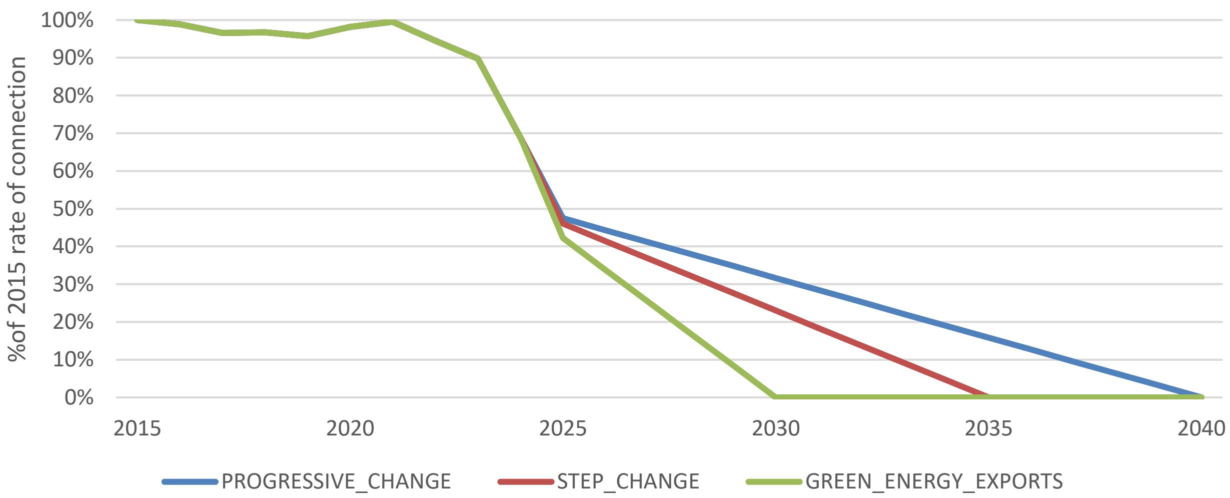


**Figure 3: New dwelling gas connection rates by scenario (% of 2015)**

### 5.1.5 Autonomous Energy Efficiency Improvement

Mapping the CSIRO's AEEI assumptions to our residential model was a relatively simple process, since the residential AEEI rates are represented as annual percentage changes by dwelling type, end-use, and fuel. Our model maps these percentages to jurisdictions using housing stock and end-use shares derived from data provided by AEMO. This process produces state-by-state AEEI assumptions for electricity and gas that reflect differences in fuel mix, dwelling stock composition and energy end-use by state over the forecast period, as shown in Figure 4. Scenario differentiation is generated by applying base results to *Step Change*, while applying a -15% modifier for *Progressive Change* and a +15% modifier for *Green Energy Exports*. In previous forecasting rounds SPR have applied a standard AEEI rate across all jurisdictions – the approach adopted in this forecasting round provides greater granularity to AEEI forecasts.

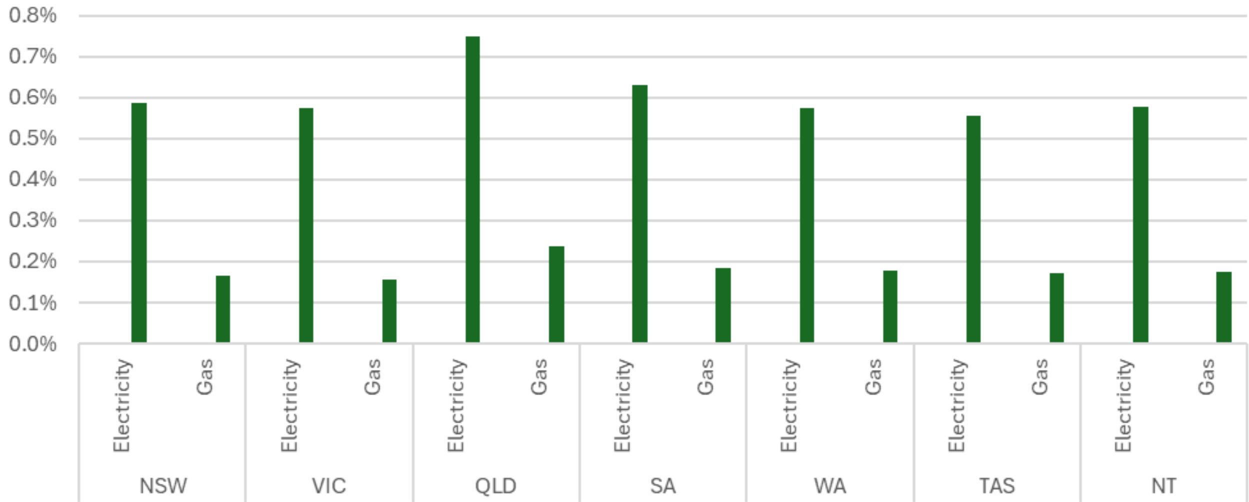


**Figure 4: Annual AEEI rates by jurisdiction by fuel type (Step Change base figures)**

CSIRO's gas AEEI assumptions imply higher market-led savings over the forecast period than SPR has modelled in previous rounds. Given the limited scope for improved technical efficiency in gas combustion (absent thermal shell improvements driven by the NCC and which are captured elsewhere in our model), we were not confident carrying these forecast savings into our model without adjustment. There is also a risk that MSM gas AEEI assumptions include a degree of electrification, which is outside the scope of our analysis. To ensure electrification savings are not double counted in AEMO's models, we applied the same electrification assumption to CSIRO's assumptions as was apparent in the historical period – 66%.

## 5.2 Commercial Sector

### 5.2.1 Overview

The commercial sector methodology largely replicates that used in 2023. However, the commercial building stock model has been updated using the latest historical stock data from the ABS,[38] as embodied in the 2024 Update to the 2022 Commercial Building Baseline Study. Future growth in the commercial building stock is differentiated by scenario based on economic assumptions provided by Deloitte.

We have undertaken an analysis of the extent of electrification in the commercial sector in the historical, and the results are discussed below.

AEEI assumptions have been updated to align with those used by CSIRO in its multi-sector modelling, to improve overall consistency.

[38] ABS special order derived from the Building Approvals series.

### 5.2.2 Commercial Building Stock Model

The commercial building stock model used for these forecasts is based on the SPR's recent *Commercial Building Baseline Study – 2024 Update*.[39] This version adds new data from the ABS on building approvals over FY2022 – FY2024, and also includes some minor revisions to stock totals in the historical period (FY2012 – FY2021). However, there are no significant changes (in the historical period) from the previous 2022 study, while the forecast period has been aligned with (ISP 2024) Step Change assumptions.

This stock data is derived from ABS Building Activity data, but is a special order, not regularly published. For this special order, the ABS disaggregates its building approvals data series – which is normally published as 'value of construction work approved' – into its three constituent parts:

- the number of construction projects approved
- the average floor area of approvals
- the average value per unit floor area approved.

This data is originally structured by SA4 region and uses the ABS Functional Classification of Buildings as a taxonomy (as does the Commercial Building Baseline Study). For the purposes of these forecasts, we map this data to AEMO state/region categories and to NCC building classes and NCC climate zones (1 – 7). The disaggregation by building class enables specific policy measures that apply to, or impact differentially on, specific building types to be modelled appropriately. However, for the most part, we roll the results back up to the whole of jurisdiction/region level for reporting purposes, to minimise complexity.

Since the source data is organised by SA4, it maps directly to whole states and territories. However, our scope for this project requires separate observations for the whole of WA, for gas modelling purposes, and for the SWIS (South Western Integrated System) for electricity modelling. Similarly, it requires separate observations for the whole of the NT for gas, and for the Darwin-Katherine Integrated System (DKIS) for electricity. However, the distribution of building numbers, types and floor areas between these regions, on the one hand, and the whole of the relevant jurisdictions, on the other, is not known. Our solution is to exclude floor area in NCC climate zones 1 and 3 from the SWIS, and to exclude floor area from NCC climate zone 3 from the DKIS, as this provides a reasonable geographic fit with the coverage of the relevant networks. This has the effect of reducing FY2023 floor area in WA (estimated at 90.7 million sqm GFA) down to 78.1 million sqm GFA in the SWIS region, and from just over 8 million sqm GFA in the NT to 6.2 million sqm GFA in the DKIS region. The association of floor area with NCC climate zones is also important for applying reference energy intensities, as discussed in the following section.

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[39] Strategy Policy Research, *Commercial Building Baseline Study – 2024 Update – Summary Report*, October 2024. Reports and data tables available from DCCEEW.gov.au.

ABS approvals data classifies building types on the basis of their stated *primary purpose* as per the approval documentation. However, many buildings contain two or even many *space use* types within a given primary purpose building. As an example, a primary purpose office will sometimes contain areas of retail, residential, car parks, potentially a kindergarten, etc. These space uses are all distinguished within the NCC and, therefore, in our modelling they are assigned different reference energy intensities, which also vary by NCC climate zone. As a result, we need to estimate space use profiles for each primary purpose building type in the ABS data. Details of our methodology for this are contained in the 2022 Commercial Building Baseline Study report[40] – which is more comprehensive than the 2024 Summary Report referenced above. In short, the mapping depends upon the degree of remoteness of the building, as typical space use profiles differ significantly from CBD locations to the outback.

Stock growth in the historical period derives directly from the ABS approvals data, with the implicit assumption that floor area approved is actually constructed. In practice, construction may be delayed in time, details may be varied post-approval, and/or projects may be cancelled. Data on demolitions of existing commercial buildings is close to non-existent, and assumptions with respect to this are discussed in the 2022 version of the Commercial Building Baseline Study.

Future stock growth (net of demolitions) is based on revealed historical relationships (over FY2015 – FY2023) between ABS-documented stock growth (as above) and change in *gross value added – services*, as supplied by Deloitte. As such, growth factors are differentiated by state. However, since the GVA series was not available at a regional level, the SWIS has the same growth factor as WA and the DKIS has the same growth factor as the NT (see Table 7).

### Table 7: Commercial Building Stock Growth Factors by Jurisdiction and Region

| Region | Jurisdiction | Average annual rates of historical (net) stock growth, 2012 - 2023 | Average annual rates of growth in GVA services over same period | Ratio of Gross Construction Rate to Growth in GVA Services |
|---|---|---|---|---|
| NSW | NSW | 1.64% | 2.83% | 57.79% |
| VIC | VIC | 2.29% | 3.10% | 73.76% |
| QLD | QLD | 1.42% | 3.09% | 46.00% |
| SA | SA | 1.07% | 2.02% | 52.85% |
| SWIS | WA | 2.13% | 2.89% | 73.78% |

[40] https://www.dcceew.gov.au/energy/publications/commercial-building-baseline-study-2022, viewed online 14/01/2025.

| Region | Jurisdiction | Average annual rates of historical (net) stock growth, 2012 - 2023 | Average annual rates of growth in GVA services over same period | Ratio of Gross Construction Rate to Growth in GVA Services |
|---|---|---|---|---|
| WA | WA | 2.13% | 2.89% | 73.78% |
| TAS | TAS | 1.08% | 2.19% | 49.13% |
| DKIS | NT | 2.26% | 3.11% | 72.72% |
| NT | NT | 2.26% | 3.11% | 72.72% |

Figure 5 provides a high-level summary of the end-of-financial-year gross floor area totals by scenario. These include all WA and NT floor area, not the SWIS and DKIS subsets.

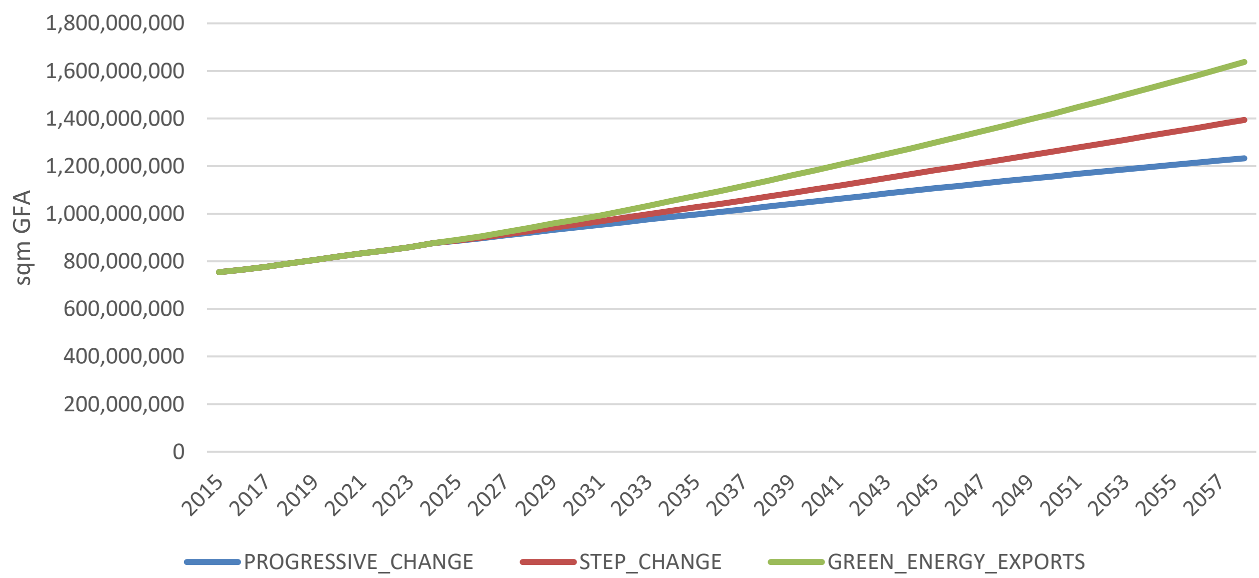


**Figure 5: Total Commercial Building Stock (Gross Floor Area) by Scenario, Australia**

### 5.2.3 Reference Energy Intensities and Fuel Mix

This project requires two sets of reference energy intensities by space use type: one set represents the average intensities for the *existing* building stock (referenced to our base year for this study, FY2015) and a second set that apply to *new* construction work in each year modelled (FY2015 – FY2058).

The first set is calibrated by dividing FY2015 floor area totals into actual fuel consumption in the same year, to ensure that average fuel intensities (which can be resolved at different geospatial levels) sum to known historical consumption totals. These intensities are used for various purposes including frozen efficiency analysis, described further below, and to provide a counterfactual reference for various specific policy measures, also described below. Second, reference intensity values for *new* buildings are required primarily to model the impact of NCC energy performance requirements that apply to new buildings. These values are responsive to Code settings over time, in addition to space use type and climate zone, and thus we develop a time-series of these reference values by scenario.

There is the complexity that the energy intensity of a building is not independent of its fuel mix, other things held equal. An all-electric building will generally use less energy (per sqm) than an equivalent dual fuel building, due to the higher efficiency of electricity vs gas end use. With the overall share of commercial building energy use already dominated by electricity (around 85%, depending upon the jurisdiction and building type), and a greater likelihood of all-electric buildings in future, for cost and emissions-performance reasons, it is critical to model these fuel-based cohorts independently, for new buildings, and that is the approach we take here. Practically this means that we need to define:

1. Three intensity values for each space use type and climate zone combination: the electrical intensity of all-electric buildings; the electrical intensity of dual-fuel buildings; and gas intensity of dual fuel buildings;
2. The fuel mix 'propensities' (expected choices) of new buildings.

With respect to the latter, the average historical fuel mix, even differentiated by state/climate zone, is likely to be a poor guide to the future, as consumer preferences and expectations, relative fuel costs, technology costs, numerous policy settings and other factors all vary over time. Given that buildings are long-lived assets, and given also that it is generally much cheaper to design and build an all-electric building from scratch than it is to convert a dual fuel one,[41] we expect that the fuel choices that will be made for new buildings will increasingly take into account expectations with respect to future policy as well as future market factors (including relative fuel prices). On this basis, we assume that even higher rates of all-electric buildings should be expected in future than today (where, as noted, and on average, some 85% of energy use is already electricity). However, we also take into account the fact that gas use is highly differentiated by jurisdiction, with VIC and NSW together accounting for over 74% of all commercial sector gas use in FY2023.

As a result of the above factors, the look-up table for new building fuel propensities is large and complex, with significant variation by jurisdiction as well as by space use type. For an overview,

[41] Delta Q (and SPR), *ASBEC – Rapid and least cost pathways for decarbonising building operations – building-level technical report*, October 2022.

however, see Figure 6.  We assume no new policies that encourage electrification under Progressive Change, and faster movement towards 100% electric buildings in Green Energy Exports, with more measured movement to the same outcome under Step Change.

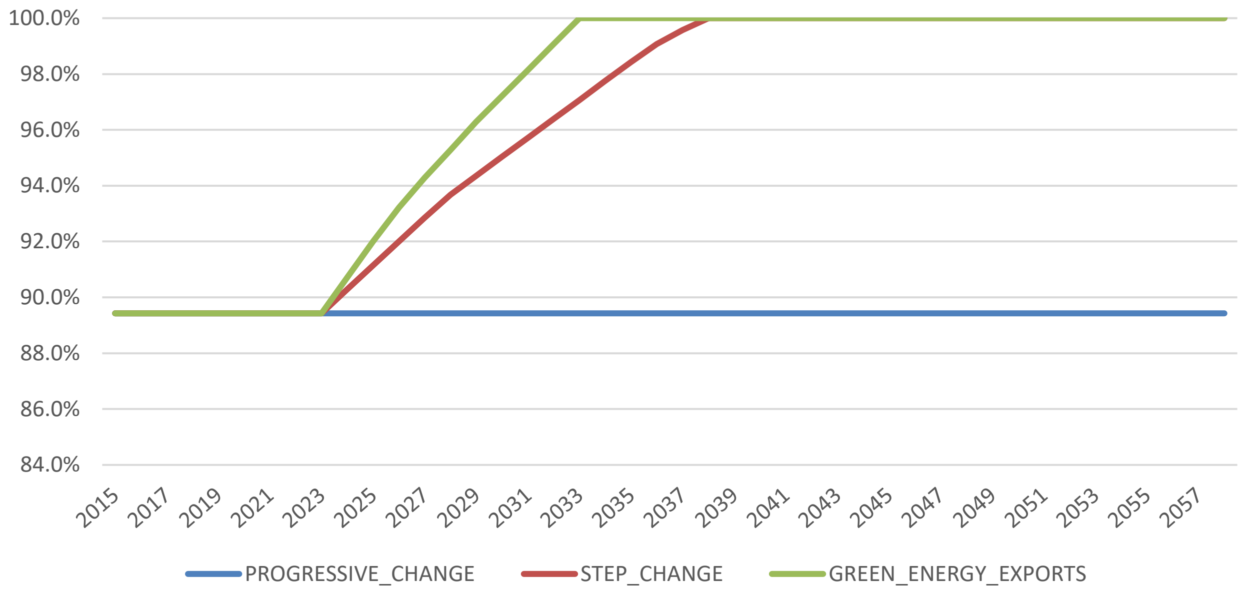


**Figure 6:  Average Propensity for All-Electric New Commercial Buildings by Scenario (simple average of all jurisdictions)**

Also reflecting the factors discussed above, the look-up table for reference new building energy intensities is even larger and more complex than the fuel mix table, as these values vary by space use type, NCC building class, year, three fuel categories, NCC climate zone, and AEMO scenario. However, an overview of the general patterns can be viewed in Figure 7.  Note that for the purposes of these projections, these reference values are assumed to be given effect via changing NCC energy performance requirements over time.

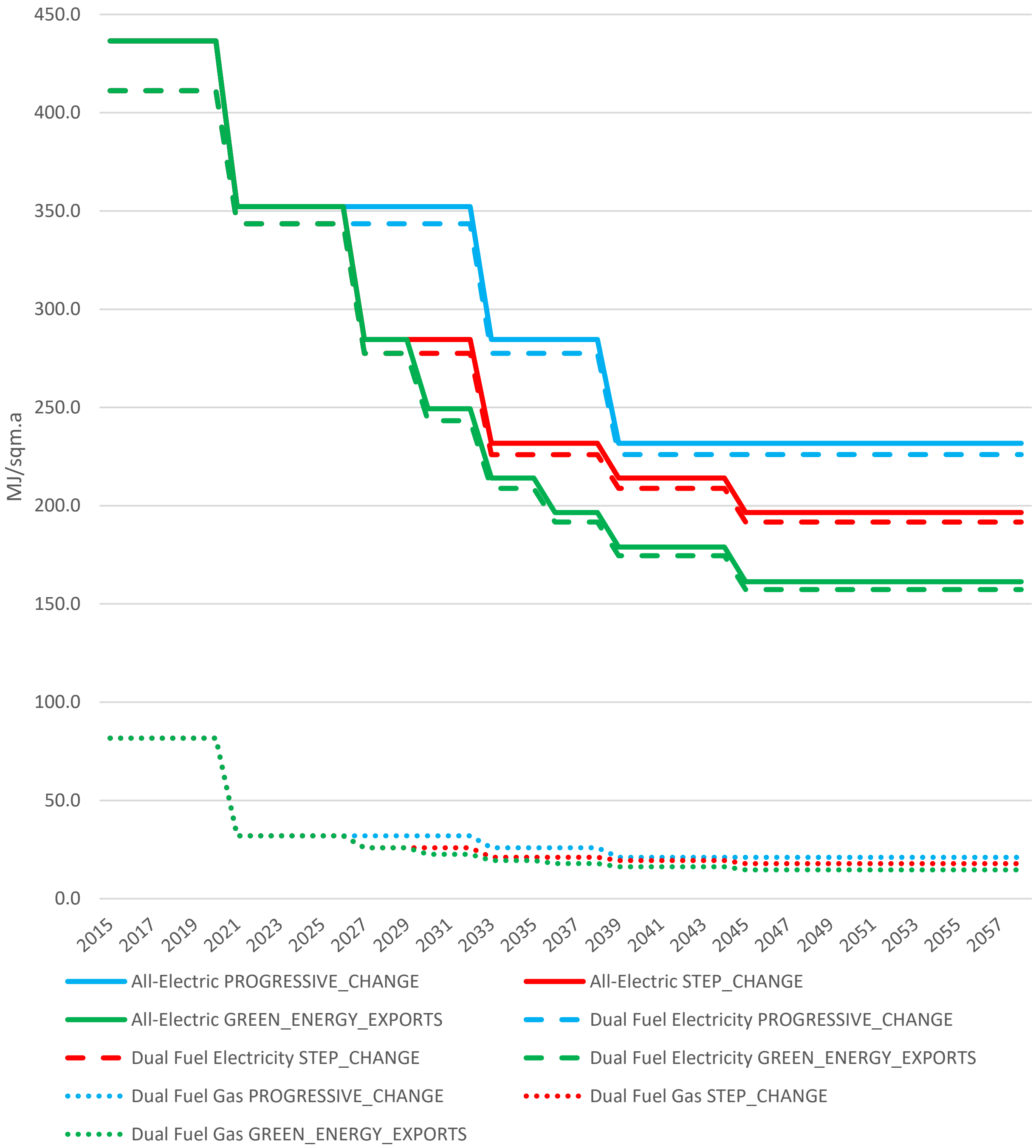


**Figure 7: New Commercial Building Reference Fuel Intensities by Cohort, Australia (simple averages for all climate zones and building types)**

### 5.2.4 Historical Energy Efficiency and Electrification

Historical energy consumption data for this study is derived primarily from AEMO. In past years, we have relied on *Australian Energy Statistics* (AES) for this data, but this source is no longer considered fit for the current purpose. However, AEMO consumption data also has limitations. WA electricity data has a different structure from other jurisdictions, and AES Table F was required to estimate sectoral splits. NT data is only available from FY2019, for both electricity and gas, and is estimated for early periods. The NT data and estimates are considered low-confidence.

Noting these limitations, commercial sector total underlying electricity consumption appears to have risen by 0.8% per year on average over FY2015 – FY2023 on average across Australia. However, the data suggests falling consumption in NT and WA, which is likely to be a data artefact. Therefore, it is likely that actual consumption rose somewhat faster than this, on average across the regions. Total commercial sector gas consumption appears to have fallen at the same rate, just under 0.8% per year, recalling low-confidence estimates for NT (but where commercial gas consumption is very low).

Taking into account the change in commercial building floor area in the historical period, electricity intensity fell by 1.5% per year, despite electrification over this period, discussed further below.

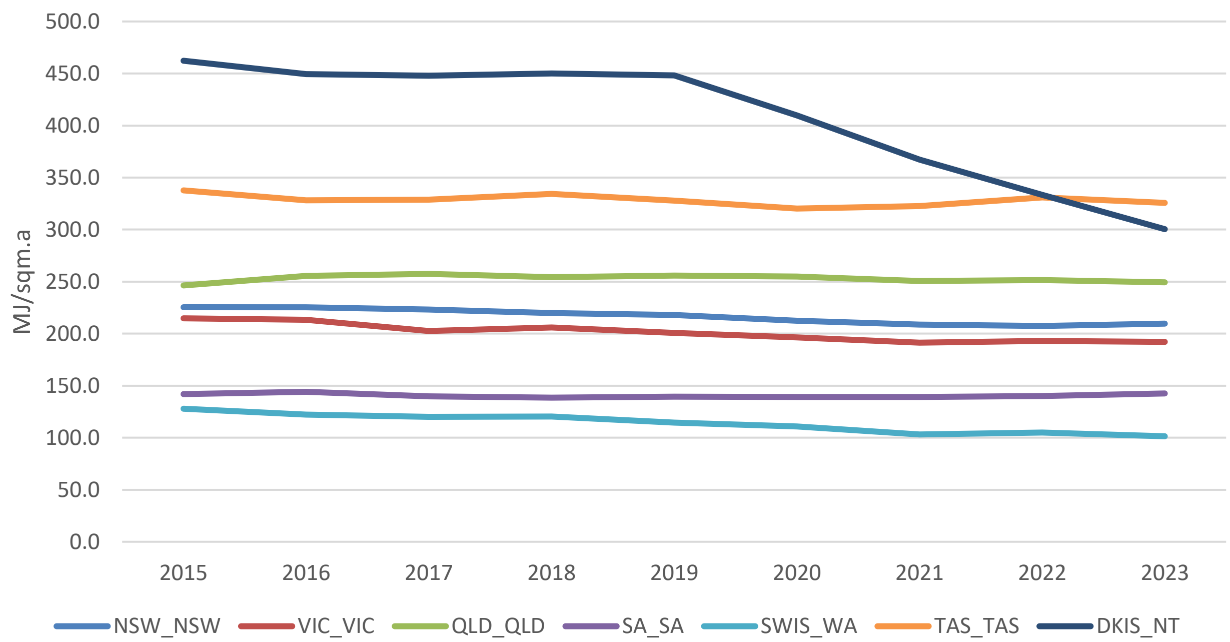


**Figure 8: Average Electricity Intensity, COM by Region**

*NB: The legend categories denote regions then jurisdictions*

Gas intensity fell on average by 1.2% per year. Figure 9 highlights that the most significant reduction occurred in VIC, followed by NSW and SA – which are the three jurisdictions with the highest gas intensity in this sector.

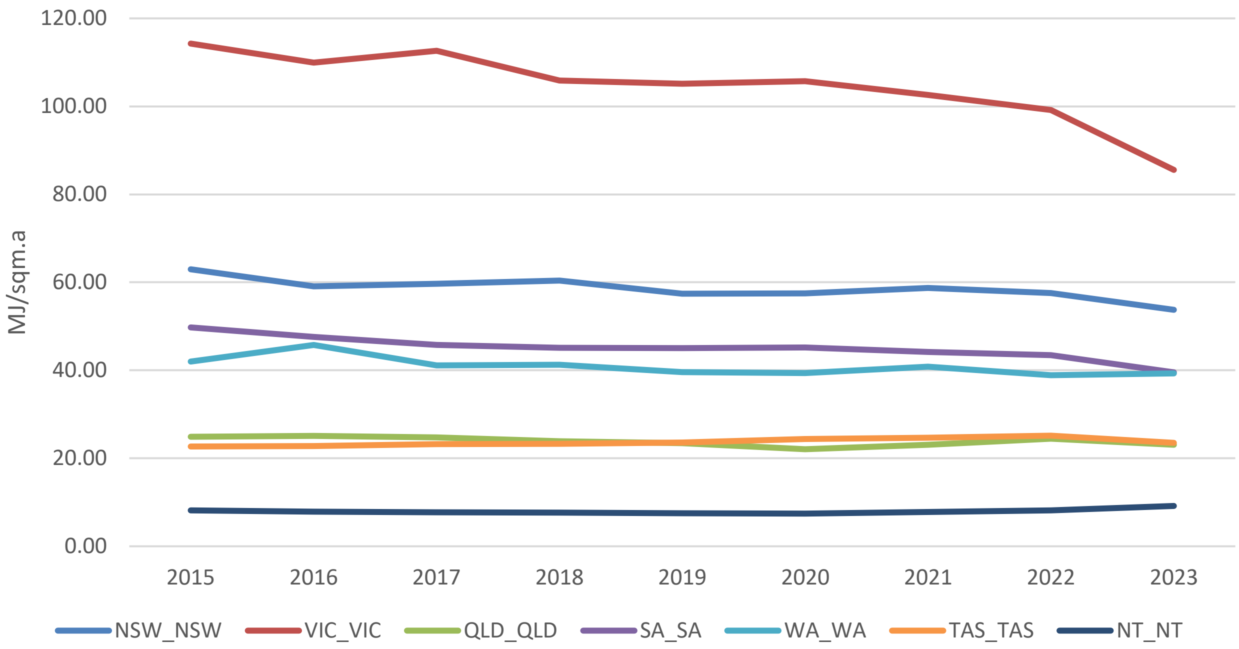


**Figure 9: Average Gas Intensity, COM by Jurisdiction**

As noted in Section 5.2.1, we estimate the split between energy efficiency change over time, on the one hand, and electrification, on the other, for the historical period. Key assumptions are that gas technical efficiency change is low – assumed to be 0.2% per year[42] – while the average co-efficient of performance of electrical end uses substituted for gas is assumed to be 2.5. With no change in energy intensity ('frozen efficiency'), FY2023 electricity sector consumption in the commercial sector would have been some 50,388 GWh, compared to 47,103 GWh in fact. However, electrification tended to push up electrical intensity over FY2015 – FY2023, such that with electrification but without energy efficiency improvement, FY2023 electricity consumption would have been 51,482 GWh. Thus, the actual change in electrical efficiency over this period was (51,482 – 47,103 =) 4,378 GWh. This is illustrated in Figure 10 below, with the energy efficiency effect being the gap between the top and bottom curves, denoted 'EE'.

By separating out the electrification effect we can note that, on average across Australia, the efficiency of electricity use increased by more than 1.7% per year over the period shown, compared to 1.5% per year if the electrification effect were not excluded.

[42] This value is an SPR estimate that has been found to fit with past analyses of efficiency change in Australia, and is comparable to CSIRO AEEI assumptions in this sector.

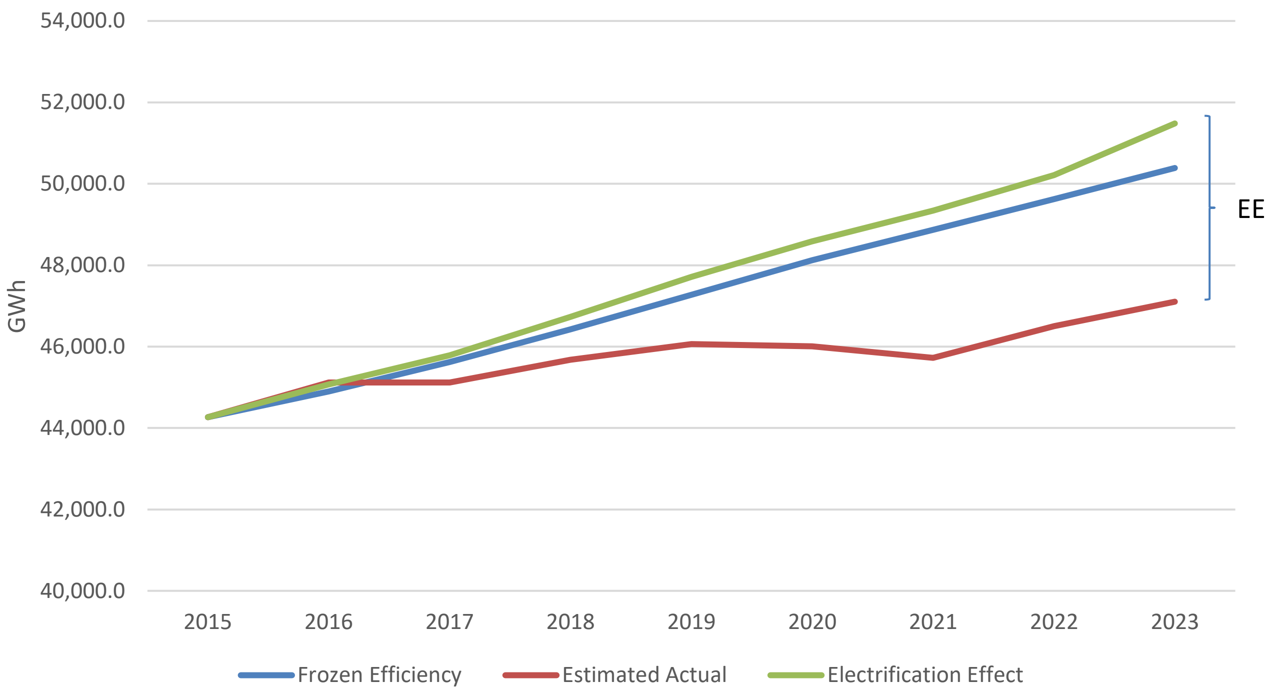


**Figure 10: COM Electricity Actual, Frozen Efficiency, Electrification Effect and Energy Efficiency Effect**

### 5.2.5 Autonomous Energy Efficiency Improvement

AEEI assumptions, as noted in Chapter 2, are based on those provided by CSIRO. Commercial sector rates were available by end-use (but not differentiated by building type). For this project, we weight these end-use assumptions up to a single factor using a typical end-use profile for commercial buildings.

### 5.2.6 Commercial Sector Non-Additionalities (Discounts)

The extent of non-additionality, or overlap, between the measures in the commercial sector is extensive and complex, essentially because there are numerous measures, as well as AEEI, that jointly influence the observed efficiency outcomes. The relevant (and material) components are here modelled to include:

- AEEI
- NCC energy performance requirements
- GEMS
- CBD
- NABERS

- State energy savings schemes (ESS, VEU, REPS).

The individual policies and programs report their impacts independently, generally without taking into account the impact of, or additionality to, other effects or measures.[43] In addition, both NABERS and CBD report as key metrics (but not as the only metrics) the overall change in energy and/or emissions intensities that they observe over time in their target building cohorts. However, the extent to which these measures *cause* the changes they report, and the extent to which these changes are additional to other measures and effects (including AEEI or market-led efficiency change), is not documented. Also, as discussed further below, there are specific non-additionalities between certain measures that we account for here, but which are not generally accounted for in program reporting statistics. As a result, simply summing all the reported savings in the commercial sector, plus an estimate of AEEI, would count at least some of the same savings many times over, leading to estimates of total savings that would be much larger than is evident from actual data.

As introduced in Section 2.2, we approach this problem methodologically by top-down, bottom-up reconciliation, to ensure that, at a minimum, the total (bottom-up) modelled efficiency does not exceed the total (top-down) that is observable in historical data. To avoid a circularity in the data, we apply estimates of the shares of the overlapping effects on commercial sector measures from our *past* forecasts and other analyses – noting that policy/program changes will see these shares evolve over time, and that updated shares can be applied in future forecasts. In addition, we account for the differing segments of the commercial sector that the measures target. For example, NCC energy performance requirements apply to new construction work only; CBD has, to date, only targeted larger offices, and NABERS also offers tools only in specific market segments; NABERS and CBD expansion is modelled for specific building types; state schemes (ESS, VEU, REPS) can apply to any building type.

Based on last year's forecasts, we estimated the following impact shares:

- AEEI ~34%
- NCC ~18%
- GEMS ~8%
- NABERS ~4%
- CBD ~ 17%
- State Schemes ~19%.

However, it is not a simple matter of discounting reported savings by these percentages, as the data sources and underlying reporting concepts vary. We do apply the discounts noted above to CBD

[43] Although there is at least one example where this does occur – NABERS separately accounts for the savings that are attributable to the NABERS 'activity' within ESS.

and NABERS BAU estimates, since their reporting statistics relate to overall totals in the relevant segments of the commercial sector. However, the other measures, and CBD and NABERS expansion plans, are estimated using reporting practices (or RIS estimates) that are specific to the individual measures. However, as noted, there are specific non-additionalities for most of these measures, which are documented in context for each measure. In addition, all measures are discounted for non-additionality to AEEI, but using the updated estimates noted in Table 5.

## 5.3 Industrial Sector

As described in Section 2.1.3, the approach to forecasting efficiency change in the industrial sector is conceptually the same as for residential and commercial, but the output data is series is chain-weighted indices of gross value added rather than direct observations of physical (or economic) output. Deloitte prepare chain-weighted indices of GVA for each ANZSIC Division, but also for a composite 'Industrial Production'. Since energy consumption data is not published at the ANZSIC Division level – noting that AEMO has estimated correspondences for limited financial years, but not a full time-series, and as a one-off project – we are not able to undertake Industrial Sector analysis/forecasts are the Divisional level. Also, Deloitte have not separated their GVA forecasts into LIL/SME segments, and so the energy efficiency forecasts are similarly constrained to the whole of the sector.[44]

### 5.3.1 Historical Consumption and Energy Intensity Trends

As discussed in Section 5.2.4, we source historical consumption data from AEMO primarily. AEMO's preferred segmentation of sectors including Industrial is set out in Section 1.4. We recall that we exclude Division D (power generation) from underlying electricity consumption and include only NT and WA consumption that occurs in the DKIS and SWIS regions respectively. We exclude the LNG sector from gas consumption, but otherwise the data includes all (other) industrial gas consumption in the jurisdictions. NT consumption data was available only from 2020 and is estimated for earlier periods.

Figure 11 summarises total industrial (underlying) electricity consumption by region, as defined above (recalling the legend indicates region then jurisdiction). Overall consumption rose by just under 1% per year over the period shown, and it increased in all jurisdictions. As discussed further below, this data includes electrification effects.

[44] Relatedly, Deloitte do not distinguish GVA on/off specific grids, such as the SWIS vs WA or the DKIS vs NT. Therefore, the implicit assumption in our analysis is that the same rate of change in GVA applies on/off these regional grids. In practice, this may or may not be the case, but this cannot be tested with current data availability.

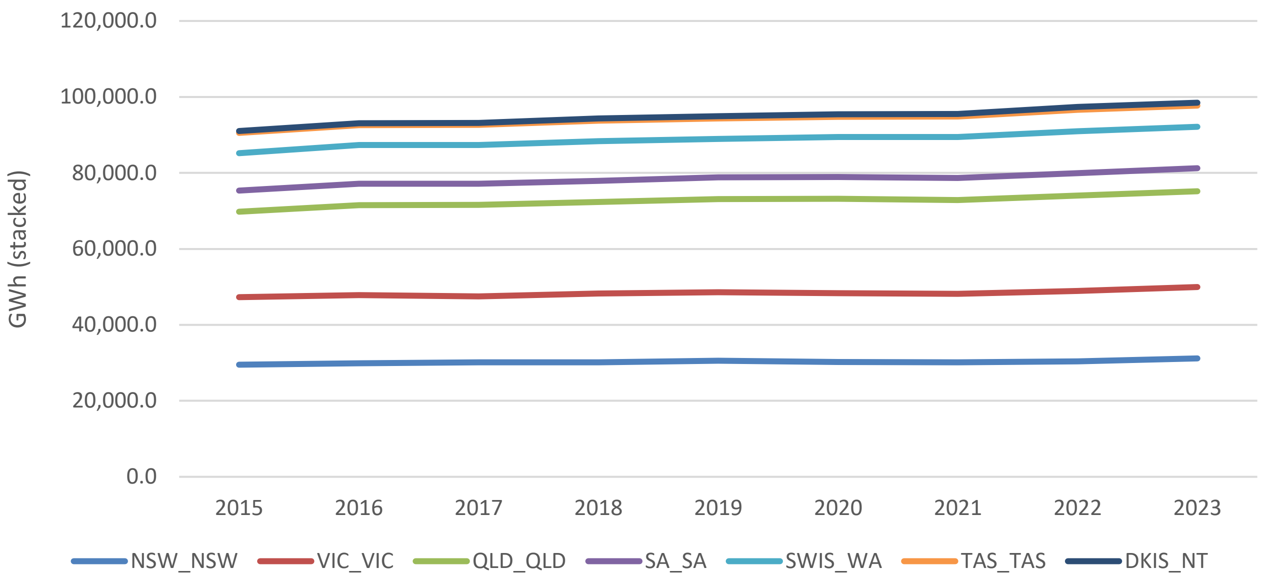


**Figure 11: Industrial Sector Electricity Consumption (Underlying) by Region (excl. Division D power generation)**

By contrast, Figure 12 indicates that industrial gas consumption fell on average over the same period by 1.6% per year, and it increased only in WA (by less than 0.3% per year – noting that this effect is not visible in the figure due to it being a stacked chart).

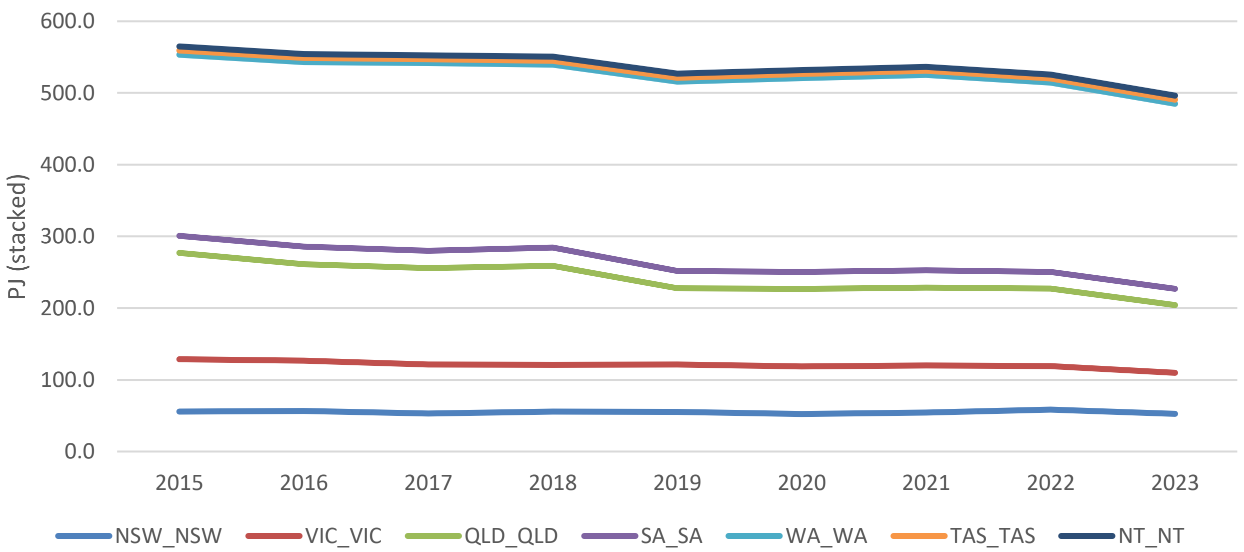


**Figure 12: TD/Industrial Gas Consumption Totals by Jurisdiction (stacked)**

For an overview of historical efficiency trends in the sector, we express energy consumption in MWh per $ million (2024 real) of GVA Industrial Production for electricity (see Figure 13).

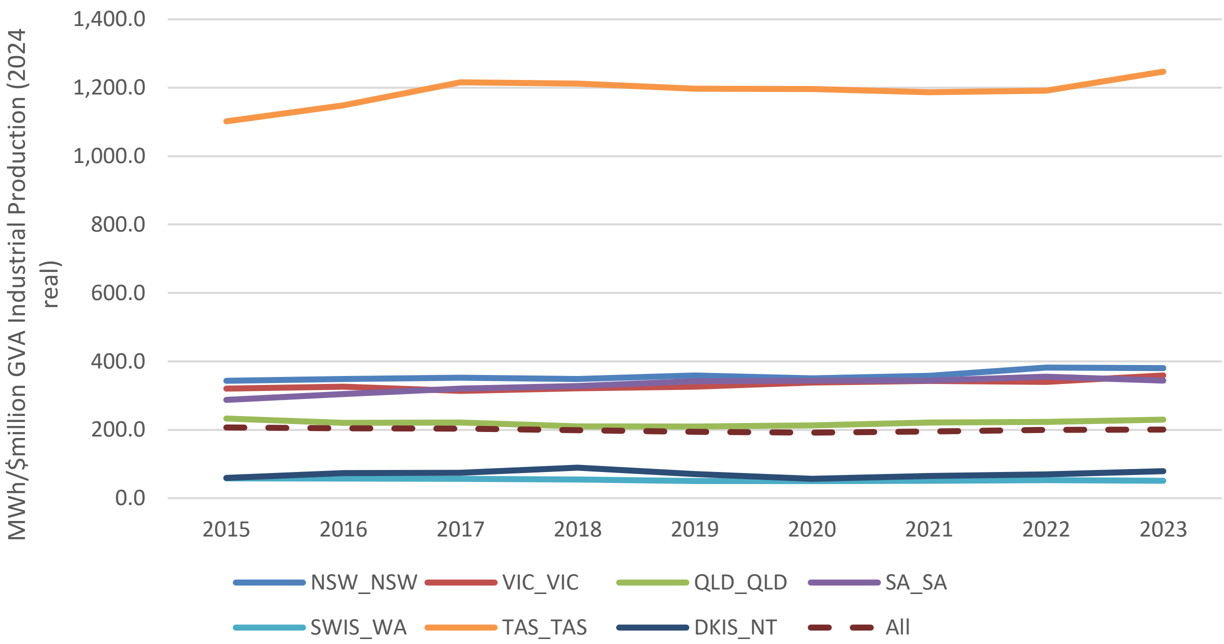


**Figure 13: Electrical Energy Intensity (MWh/$million GVA Industrial Production), Industrial Sector by Region**

This figure highlights, firstly, the unusually high electrical intensity of the industrial sector in Tasmania, which reflects electricity-intensive sub-sectors such as aluminium production. Less obvious is the modest decline in the overall electrical intensity of all jurisdictions (denoted 'All' on the figure and shown as a dashed curve) of just 0.36% per year on average. Electrical intensity declined annually over FY2015 – FY2020, but has been rising annually thereafter, netting out to the modest average annual reduction over this period.

Figure 14 shows equivalent data for industrial gas intensity change in the historical period, measured as GJ of consumption per $million (2024 real) of GVA Industrial Production. The dashed curve, that represents the composite for all jurisdictions, shows a significant downward trend, averaging -2.9% per year. As above, we expect that this is dominated by an electrification/fuel switching effect, as technical gas efficiency improvement over this period is likely to have been modest.

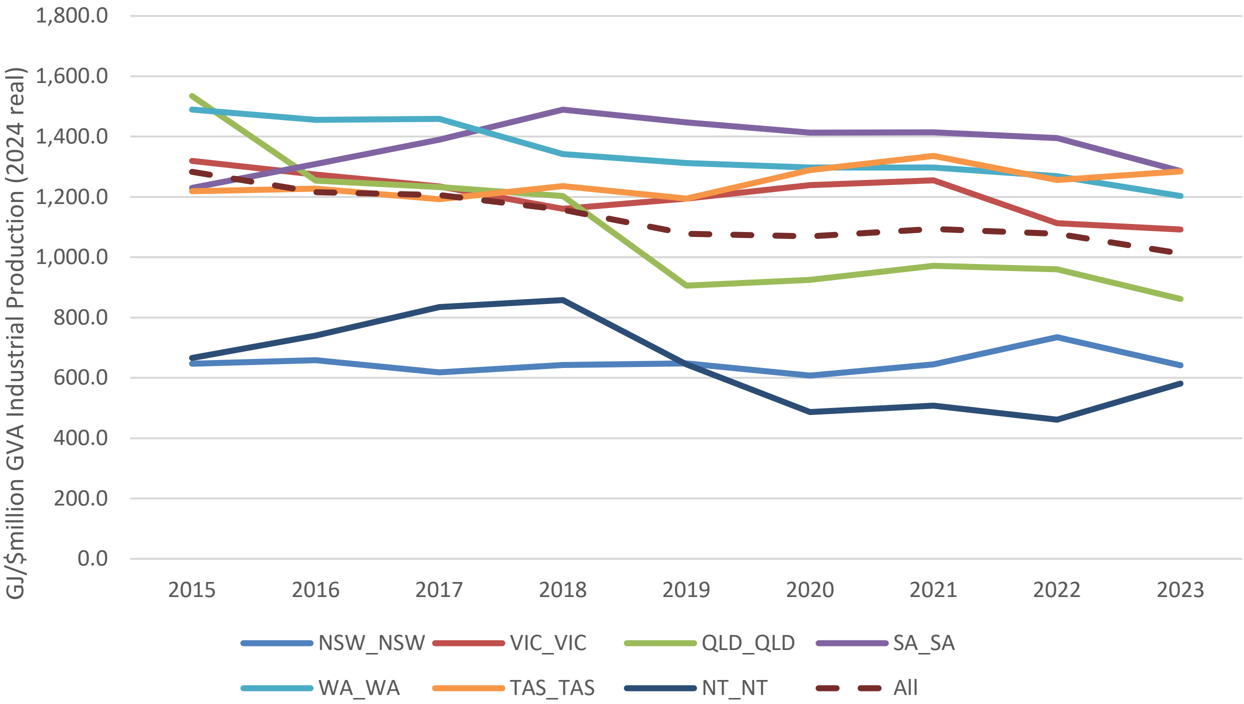


**Figure 14: Gas Energy Intensity (GJ/$million GVA Industrial Production), Industrial Sector by Jurisdiction**

### 5.3.2 Energy Efficiency and Electrification Effects

As discussed in Section 5.2.4, in the context of the commercial sector, it is possible to make an indicative estimation of the energy efficiency and electrification shares of the overall changes in energy consumption noted above. We compare the actual path of electricity and gas consumption to a) a frozen FY2015 efficiency case – which FY2015 energy intensity is assumed to remain constant, while GVA grows over time – and then b) deduct from frozen efficiency our modelled historical energy efficiency change (the sum of AEEI and historical efficiency policy measures). Any residual changes are likely to be – at least primarily – the result of fuel switching, although other effects may have contributed.[45]

Figure 15 shows a counter-factual frozen efficiency path (dashed curve) for industrial electricity consumption, which is the path that would have been taken if there were no change in electrical intensity but with actual growth in GVA (as a result, frozen efficiency can also be denoted as 'the growth effect'). The lower curve shows the efficiency effect, calculated as frozen efficiency minus modelled historical efficiency savings. However, the actual path of consumption is higher than both

[45] As discussed in Section 2.1.3, GVA is not a perfect proxy for change in physical output, and it is possible that multi-year changes in prices or weightings at the sub-sectoral level are also influencing these results.

of these, indicating that something – other than growth in GVA or changes in energy efficiency – pushed up electricity consumption over this period. As above, we assume (for the purposes of this specific analysis) that this is primarily electrification. Note that the y-axis has been adjusted to highlight these effects. Figure 15 indicates that the efficiency effect (EE) avoided some 3,400 GWh in FY2023, while the electrification effect (EL) increased consumption by some 8,400GWh, with a resulting net increase in consumption (relative to frozen efficiency) of just over 5,000 GWh.

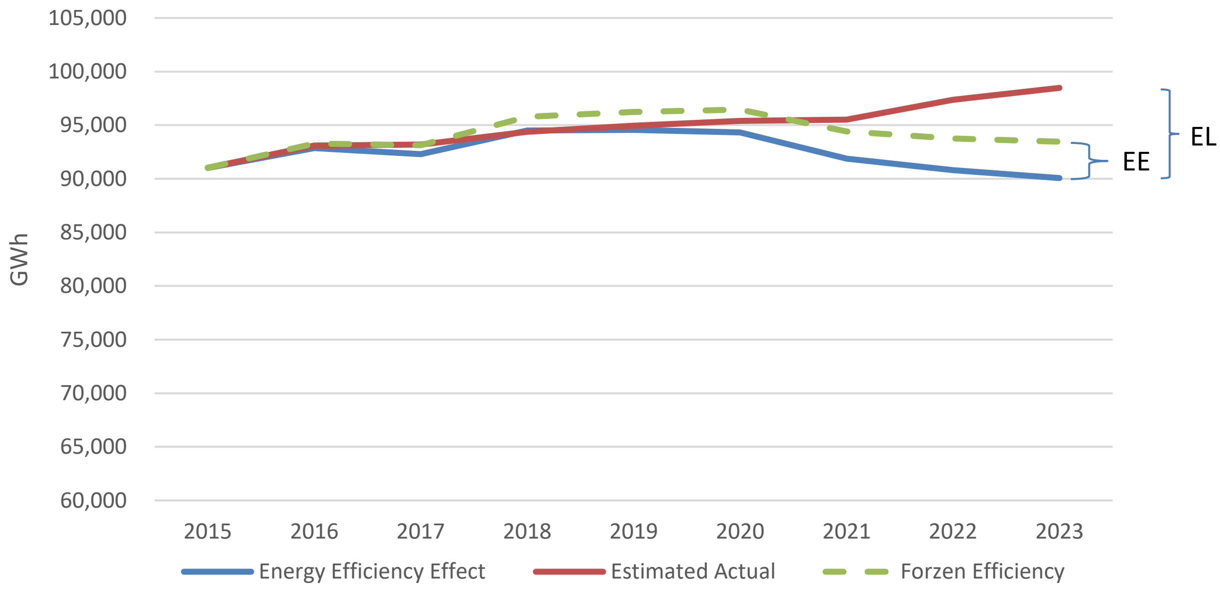


**Figure 15: Estimated Energy Efficiency (EE) and Electrification (EL) Effects, Industrial Sector, Electricity**

Considering industrial gas, Figure 16 shows that, in this case, frozen efficiency would have led to significant growth in industrial gas consumption, due to growth in GVA and output but, first, the modelled improvement in energy efficiency reduced this growth (by 39 PJ) while, second, electrification (or fuel switching) reduced it by a further 108 PJ, leading to a total reduction in consumption, relative to frozen efficiency, of 147 PJ. If electrification is indeed the only explanation of this change (certainty about this would require more detailed analysis, which is outside the scope of this analysis),[46] then it would imply an average co-efficient of electrification of 1:3.5 – that is, 1 unit of increase in electricity consumption for every 3.5 units of avoided gas consumption. Note that the y-axis in Figure 16 is again cropped to highlight these effects.

[46] Other possible explanations could include fuel switching to biomass, or to other fossil fuels such as diesel or coal. The scope of this project does include detailed analysis of electrification effects. However, the analysis shown above does help to differentiate electrification from other types of energy efficiency change.

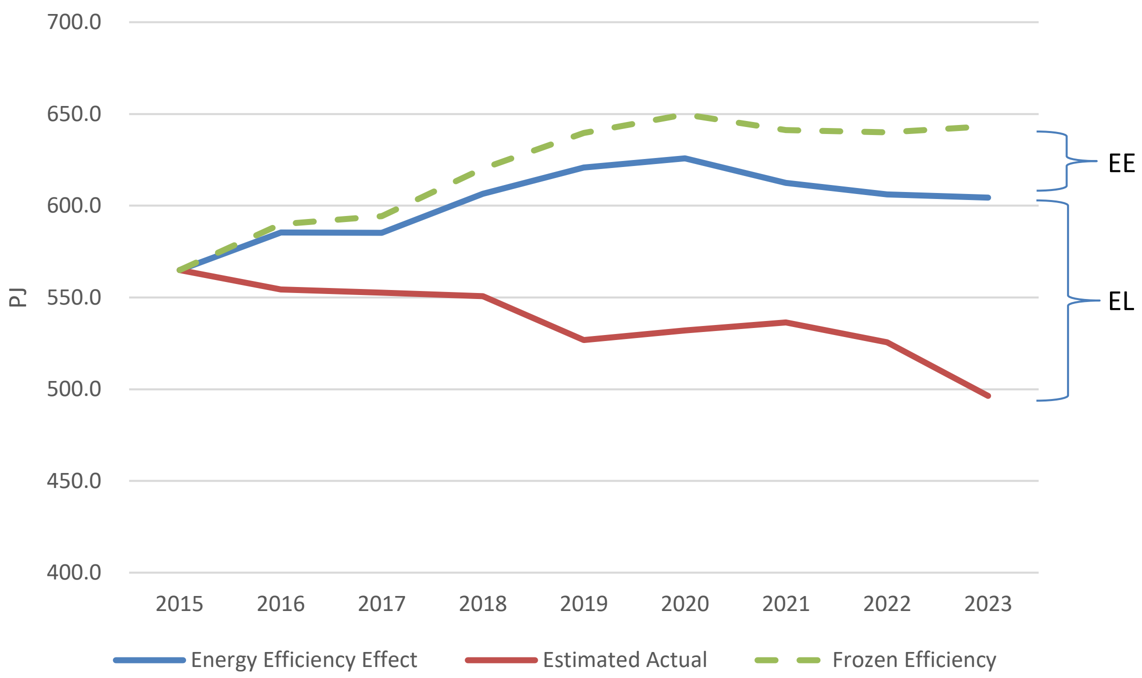


**Figure 16: Estimated Energy Efficiency and Electrification Effects, Industrial Sector, Gas**

### 5.3.3 Autonomous Energy Efficiency Improvement

Industrial sector AEEI estimates were available from CSIRO by sector but not by fuel. Separate values were provided for the 2020-2030 period and for the 2030-2050 period (and this is evident in the results presented in Chapter 6). SPR selected the values for relevant sectors only and weighted them by GVA shares.

# 6. Energy Efficiency Forecasts

## 6.1 Residential

Figure 17 shows residential electrical energy efficiency forecasts by scenario. This figure includes all efficiency policy measures and market-led efficiency improvement, the total of all load/end-use types (Base, Cool, Heat) and all regions. Each scenario leads to distinct EE outcomes over 2025-58, with the divergence accelerating towards the end of the forecast period. As described in Chapter 5, policy ambition and economic drivers are highest in *Green Energy Exports* and lowest in *Progressive Change*, with *Step Change* sitting between the two, though trending towards higher ambition. This leads to annual electrical energy efficiency improvements of 85,929 GWh by 2058 in *Green Energy Exports*, 73,343 GWh by 2058 in *Step Change*, and 50,836 GWh by 2058 in *Progressive Change*. The adoption of the CSIRO's MSM AEEI assumptions has led to greater divergence between scenarios than in previous forecasting rounds, a function of both assumed scenario divergence from these base assumptions, and increased AEEI forecast responsiveness to economic drivers.

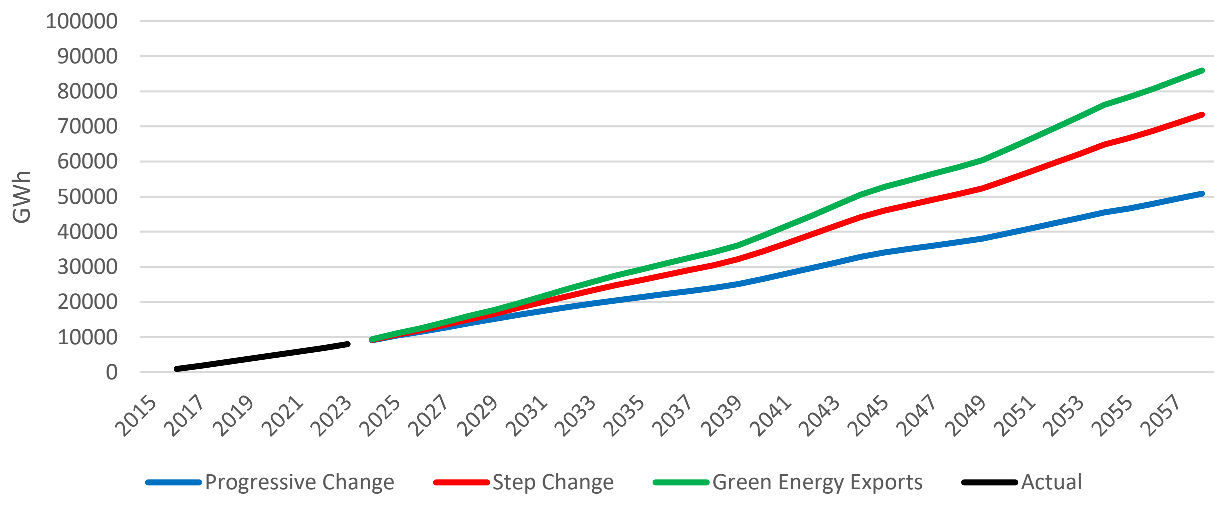


**Figure 17: RES Electricity Energy Efficiency Forecasts by Scenario (all regions, components and end-uses)**

Figure 18 shows residential gas energy efficiency forecasts by scenario. This figure includes all efficiency policy measures and market-led efficiency improvement, the total of all load/end-use types (Base, Cool, Heat) and all regions. As with electricity forecasts, these forecasts show clear scenario differentiation, in line with scenario narratives. Unlike electricity forecasts, which show an increasing rate of efficiency gain, the rate of gas efficiency improvement slows over the forecast period, reflecting increasing electrification and the technical limits of gas-combustion technology.

Our model forecasts annual gas efficiency improvements of 58.4 PJ in 2058 in Green Energy Exports, 51.4 PJ in 2058 in Step Change, and 42.9 PJ in Progressive Change.

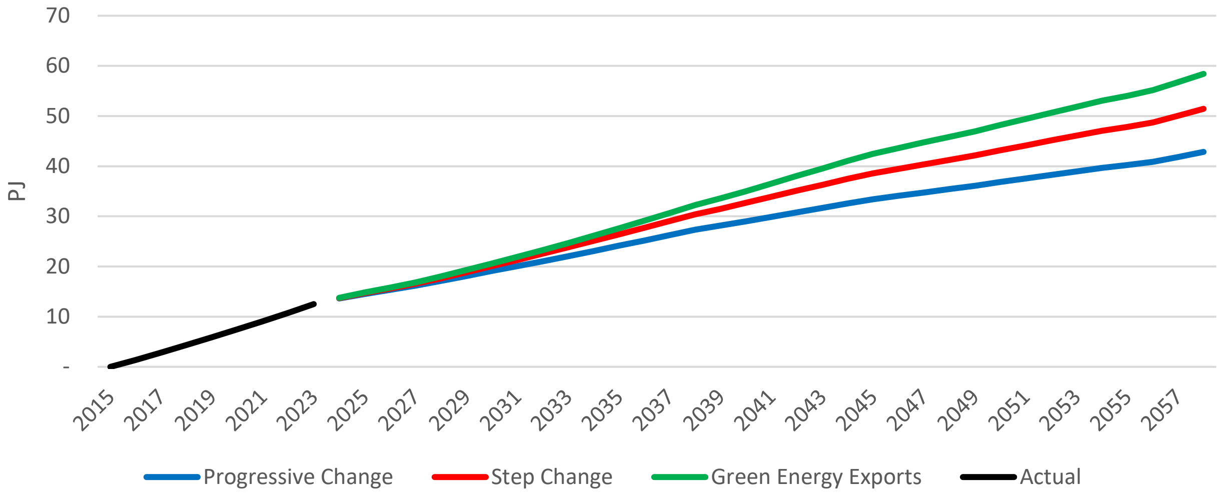


**Figure 18: RES Gas Energy Efficiency Forecasts by Scenario (all regions, components and end-uses)**

### 6.1.1 Energy efficiency forecasts by component

***Electricity***

Figure 19 through Figure 21 shows the contribution of each modelled component to total forecast electrical energy efficiency improvement over the forecast period. In all scenarios, AEEI is the largest single contributor to total energy efficiency change, at an average of 42.4% of cumulative savings from FY2024 - FY2058. The NCC and GEMS are the second and third largest contributors to efficiency change over the period, at 21.9% and 11.1% respectively of cumulative savings (over the whole forecast period). These three components make up an average 75.4% of total savings over the forecast period across all scenarios, with ESS, HEUF, MEPS, REPS, UMP and VEU collectively making up the remaining 24.6%.

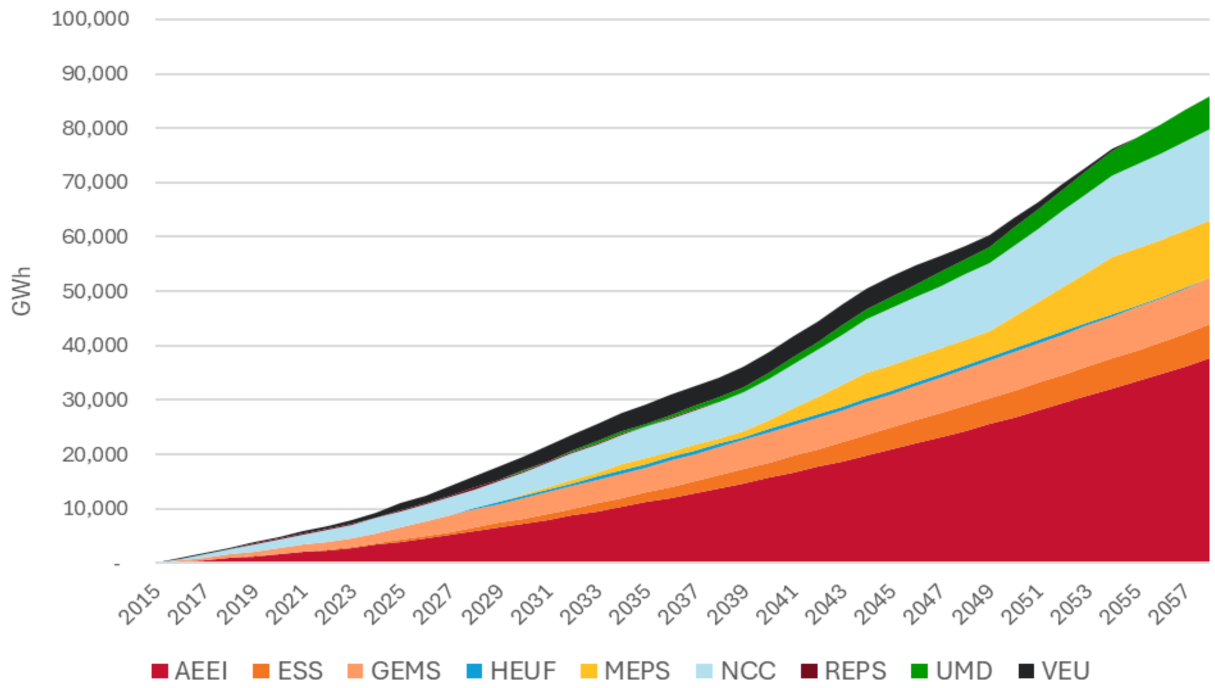


**Figure 19: RES Electricity Energy Efficiency Forecasts by Component, Green Energy Exports**

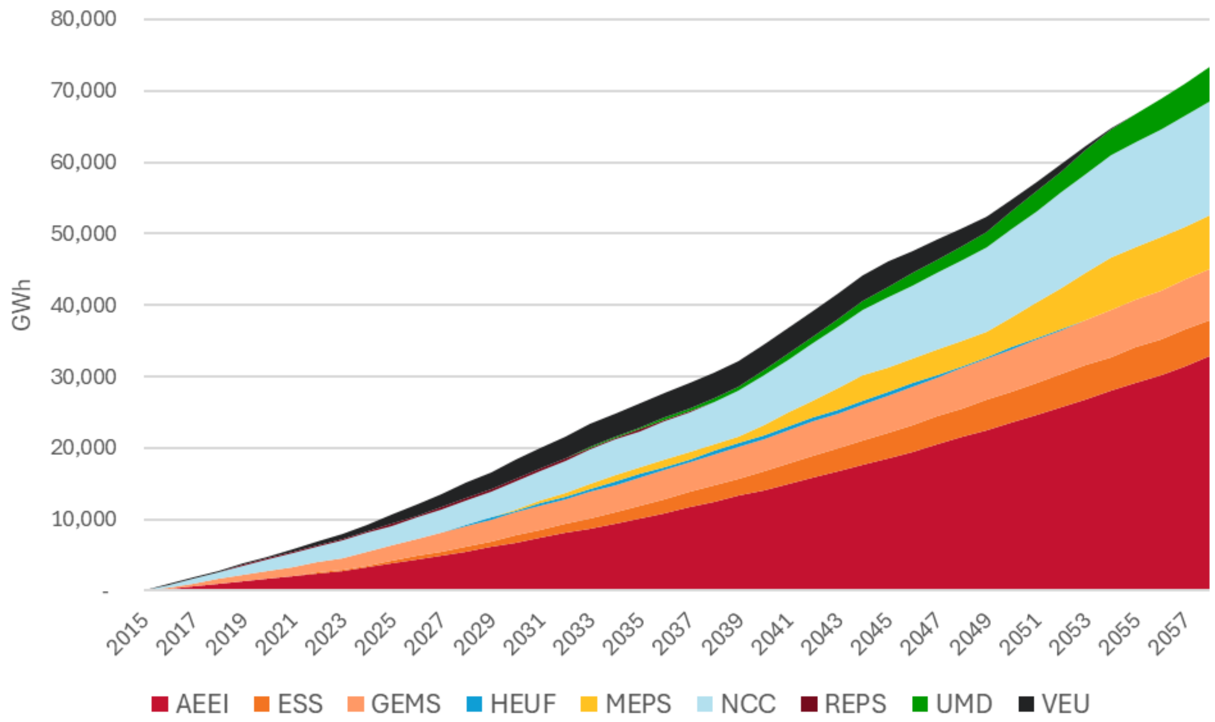


**Figure 20: RES Electricity Energy Efficiency Forecasts by Component, Step Change**

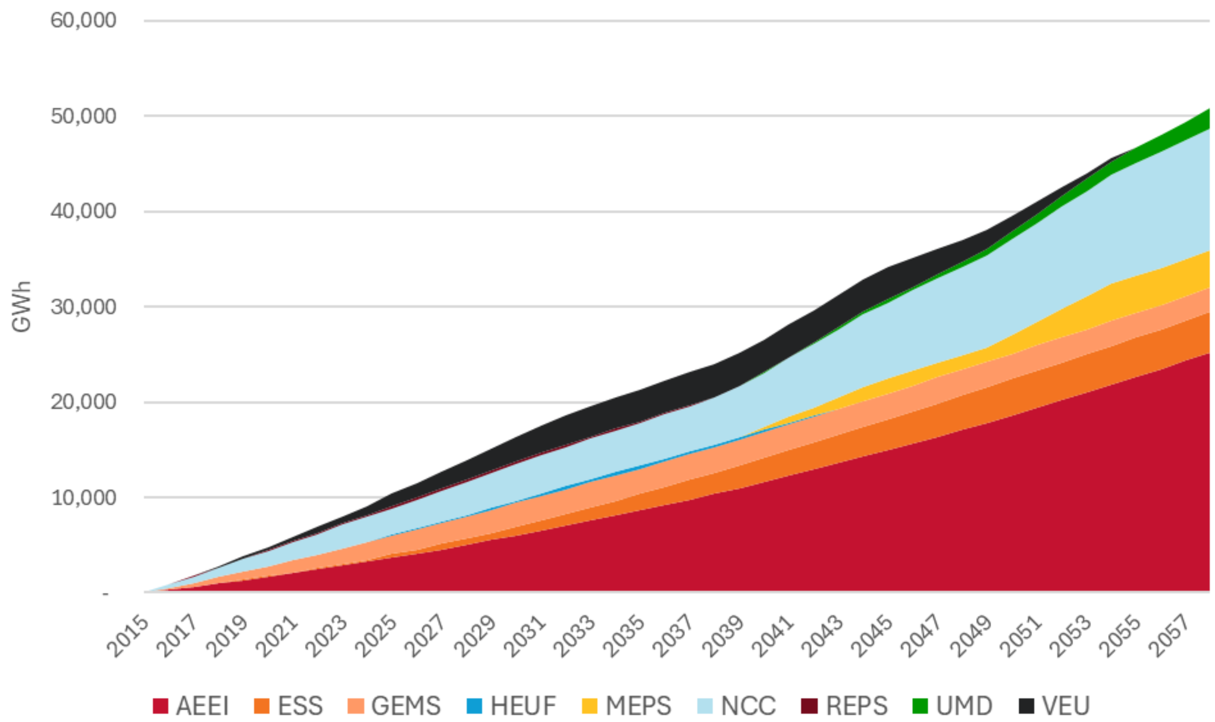


**Figure 21: RES Electricity Energy Efficiency Forecasts by Component, Progressive Change**

*Gas*

Figure 22 through Figure 24 shows the contribution of each modelled component to total forecast gas energy efficiency improvement over the forecast period. In all scenarios, AEEI is by far the largest single contributor to total energy efficiency change from FY2024 - FY2058, at an average of 70.4% of savings. That said, the effect of our assuming lower AEEI rates in the forecast period is evident in the 'elbow' in these curves around 2024.

The NCC is the second largest contributor to efficiency change, at an average of 24.2% of savings across the scenarios. These two components make up an average 94.6% of total savings over the forecast period across all scenarios, with ESS, HEUF, MEPS, REPS, UMP and VEU collectively making up the remaining 5.4% (note GEMS relates only to electrical efficiency).

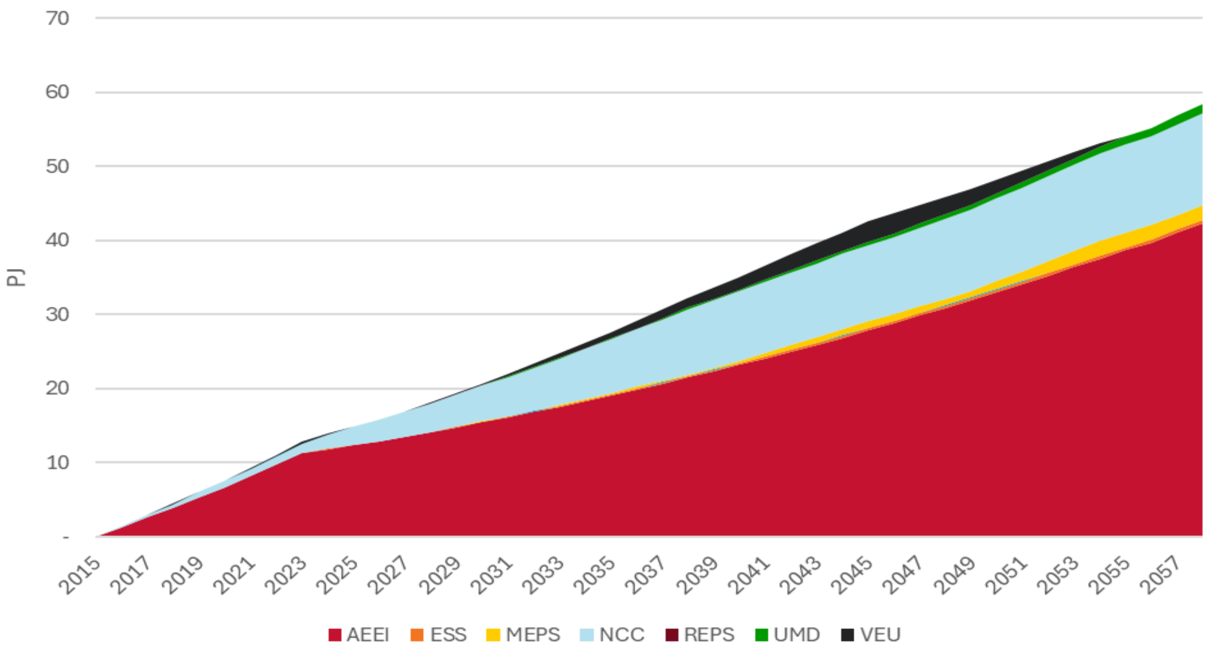


**Figure 22: RES Gas Energy Efficiency Forecasts by Component, Green Energy Exports**

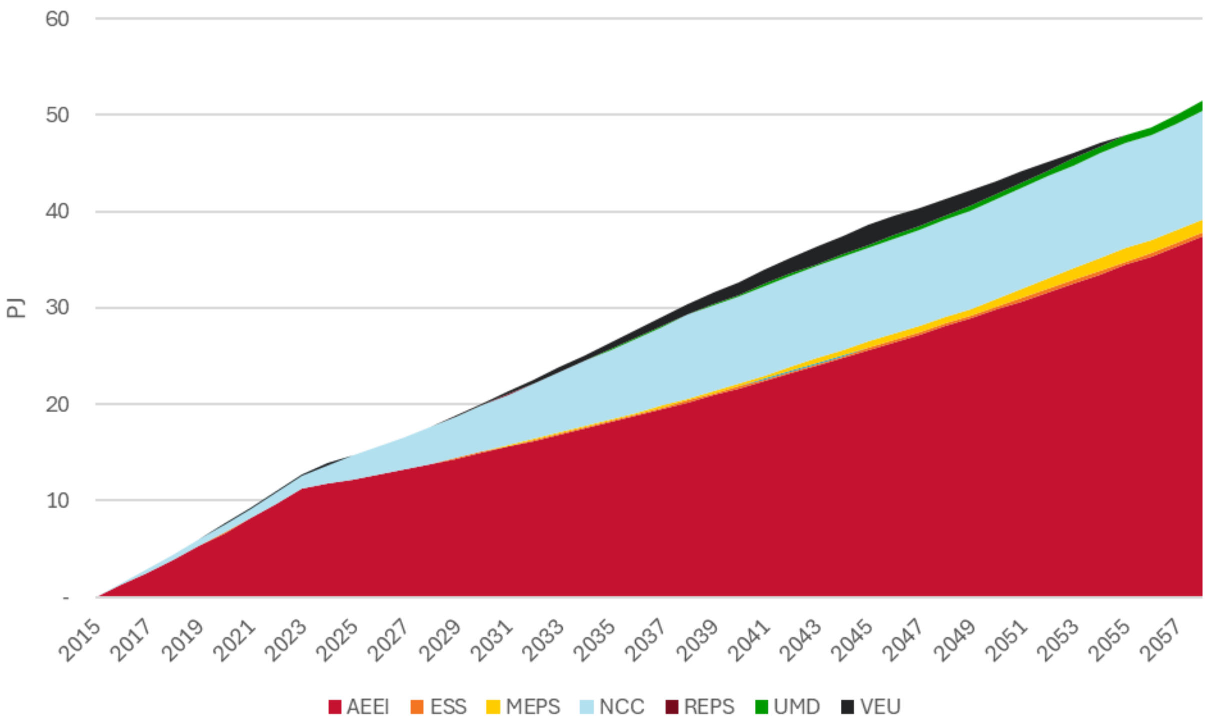


**Figure 23: RES Gas Energy Efficiency Forecasts by Component, Step Change**

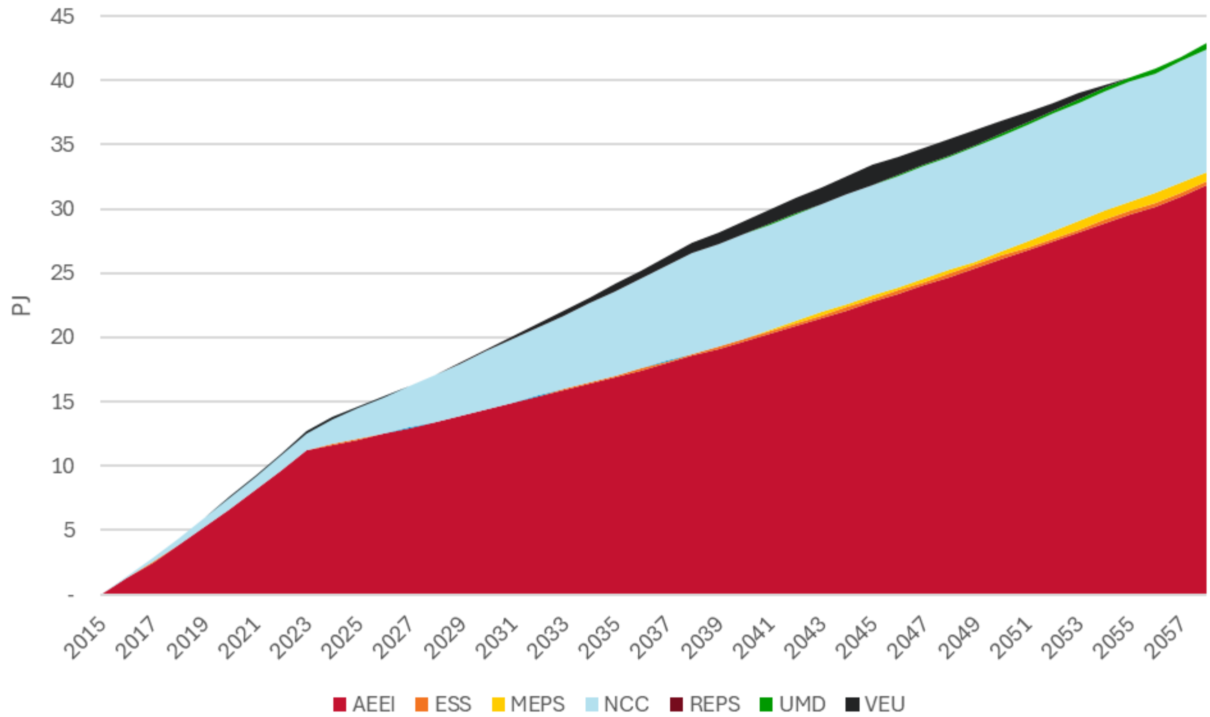


**Figure 24: RES Gas Energy Efficiency Forecasts by Component, Progressive Change**

The following section provides additional background on each component of the residential forecasts and how they are differentiated by scenario.

***National Construction Code***

Given its significant impact on total residential energy efficiency improvements over the forecast period, is it important the NCC stringency trajectories incorporated in our models are realistic. To this end, our 2024 forecasts model slower and more uneven uptake of improved thermal shell efficiencies, reflecting the Northern Territory and Tasmanian's non-adoption of 7-star thermal shell standards, and South Australia's recent announcement of a pause on future stringency improvements for at least ten years. Given three of eight state and territory jurisdictions have diverged from the NCC, it seems likely the pace of future increases in stringency will slow, which is reflected across all scenarios.

***Home Energy Upgrade Fund***

The CEFC targets $2.50 - $3.00 of private co-investment for every $1 of public funds invested, though our model adopts a more conservative $2 co-investment figure, given the Fund's nascence. If the CEFC meets this target in delivering the HEUF, we should expect $3b of spending on energy efficiency activities over the period of the fund's operations (5-10 years). The CEFC has been regularly recapitalised by the Commonwealth to deliver successful programmes; as such, our models include a range of reinvestments and programme lengths across ISP scenarios, from the existing $1b over ten years under Progressive change, to $4b over 25 years under Green Energy Exports.

### *State schemes*

In September 2021, the NSW Government announced expansion of the Energy Savings Scheme (ESS) to cover a wider range of fuel switching activities for household and businesses, as well as higher energy savings targets. The program target is set to increase by 0.5% (of eligible state electricity consumption) from 2022, reaching 13% by 2030. Unless the target is further changed (as it has been roughly every 5 years since 2009), it would remain at 13% of (a growing amount) of eligible consumption until 2050. These targets were incorporated into SPR's models developed for the last forecasting round.

ESS programme managers have indicated there have been no material changes since the last forecasting round which required a significant change to our existing calculations. Forecast liable acquisitions have increased, which were incorporated into our model. Scenario differentiations were made by assumption, with Progressive Change reflecting current policy, and Step Change and Green Energy Exports representing an annual 0.1% and 0.2% increase respectively.

The Victorian Government has announced the extension of the VEU scheme to 2045, though no information has been made public on the trajectory of future targets. The Victorian Government is planning to consult on future scheme design and interim targets for 2026-27 in late 2024, though this information was not public at the time our forecasts were finalised. As such, our models use the existing 2025 target as a future baseline policy setting. Our models now assume higher rate of electrification resulting from the VEU programmes, as a range of gas efficiency activities have been removed from the scheme since the last forecasting round.

REPS scenario stringencies were made by assumption, with current setting representing Progressive Change, and Step Change and Green Energy Exports increasing by 400,000 and 600,000 GJ respectively.

### *Universal Mandatory Disclosure & Mandatory Energy Performance Standards*

The introduction of NatHERS for existing homes in 2025 will establish a tool which could – subject to future government decisions – underpin a future Universal Mandatory Disclosure (UMD) regime.[47] While this measure is not committed, development is well advanced, with a Version 2 of the Home Energy Ratings Disclosure Framework having been released in December 2024.[48] Program

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[47] Note that we use the phrase 'Universal Mandatory Disclosure' for consistency with the 2024 forecasts, but the current practice is that the phrase 'the CBD Expansion Roadmap' covers commercial building disclosure and 'the Home Energy Ratings Disclosure Framework' covers residential building disclosure.

[48] Australian Government, *Home Energy Ratings Disclosure Framework, Version 2*, December 2024.

managers have indicated early implementation of UMD could begin as early as 2026-27 in leading jurisdictions but – to be clear – this is not yet reflected in government commitments and must be considered uncertain. This assumed timeline for UMD is adopted in Green Energy Exports, with the scheme kicking off in 2029 and 2038 in Step Change and Progressive Change respectively.

Given the lack of national coordination on Energy Performance Standards in rental properties (noting existing standards in the Act and work underway to develop standards in Victoria), this policy is not modelled to begin until 2030 in Green Energy Exports and Step Change, and 2040 in Progressive Change. The stringency of Energy Performance requirements is assumed to be higher in more ambitious scenarios.

### *GEMS/E3*

The E3 program develops minimum energy performance standards and/or labels for a wide range of electrical appliances and equipment in Australia, which are given legal effect through the Greenhouse and Energy Minimum Standards (GEMS) Act 2012. This long-standing and highly-successful program has received limited government support for many years, leading to a consistent pattern, in recent efficiency forecasts, of annual downward revisions to impact estimates. The program was reviewed in 2019, and new funding has been provided since the 2023-24 Budget. A new strategic plan for the program is being developed and expected to be published in 2025.

As has been commented on in previous forecasts, a key challenge with quantifying the impact of GEMS/E3 has been that it comprises dozens of individual measures, each having different timeframes and impacts, as quantified in individual regulation impact statements (RISs) which, taken as a set, are not directly comparable. However, in FY2022-23, Energy Consult was commissioned to review and rebase the entire set of measures using a consistent baseline, and also to make forecasts to 2040.[49] This is an excellent piece of work, and it provides a sound starting point for these forecasts. It does pre-date the expansion noted above, but details of the nature of this expansion will not be available until 2025 in any case.

Energy Consult offer two scenarios, and we equate the higher of these with Step Change, the lower with Progressive Change, and we assume that 20% additional savings would be realised under Green Energy Exports when compared to Step Change. The study focuses on residential measures only, it notes that business sector savings would add ~10% to its totals, and so we employ that assumption here.[50] The forecasts have either a 1998 or a 2022 base year, and we rebase them to FY2015 for this project. In line with historical trends, we assume that the residential share of total savings declines slowly over time, from around 78% in FY2015 to 65% in FY2058 (with 30% commercial and 5% industrial), as there is more room for the program to expand into new areas in the business sector instead of residential, which has been its primary focus in the past. We do not model

[49] Energy Consult, *GEMS Data Modelling Project 2022*, prepared for DCCEEW, February 2023.
[50] Although this estimate may be conservative.

individual GEMS measures for this project but rather focus on the overall program impact. Post-2040 impacts are extrapolated in a linear manner.

### 6.1.2 Energy efficiency forecasts by region

***Electricity***

Figure 25 shows modelled electricity efficiency improvements over the forecast period, split by jurisdiction. Victoria sees the greatest share of efficiency improvements from FY2024 - FY2058, at 38% of total savings, reflecting the jurisdiction's large population, larger heating share of total consumption (given significant forecast improvements in heat pump efficiency), and a strong state efficiency programme in the VEU. NSW was the second largest contributor to total forecast electrical efficiency, at 26.3% of total electrical efficiency change over the period, despite a low share of heating and cooling end use, reflecting both its large population and a strong state efficiency programme in the ESS. Although it lacks a strong state policy, Queensland accounts for 19.5% of total electrical efficiency improvement, reflecting higher population growth over the forecast period and an above average share of cooling load as a share of total residential electrical consumption. Of the remaining jurisdictions, Western Australia, Southern Australia, Tasmania and the Northern Territory account for 7.2%, 4.1%, 2.7% and 2.1% of electrical efficiency improvement respectively

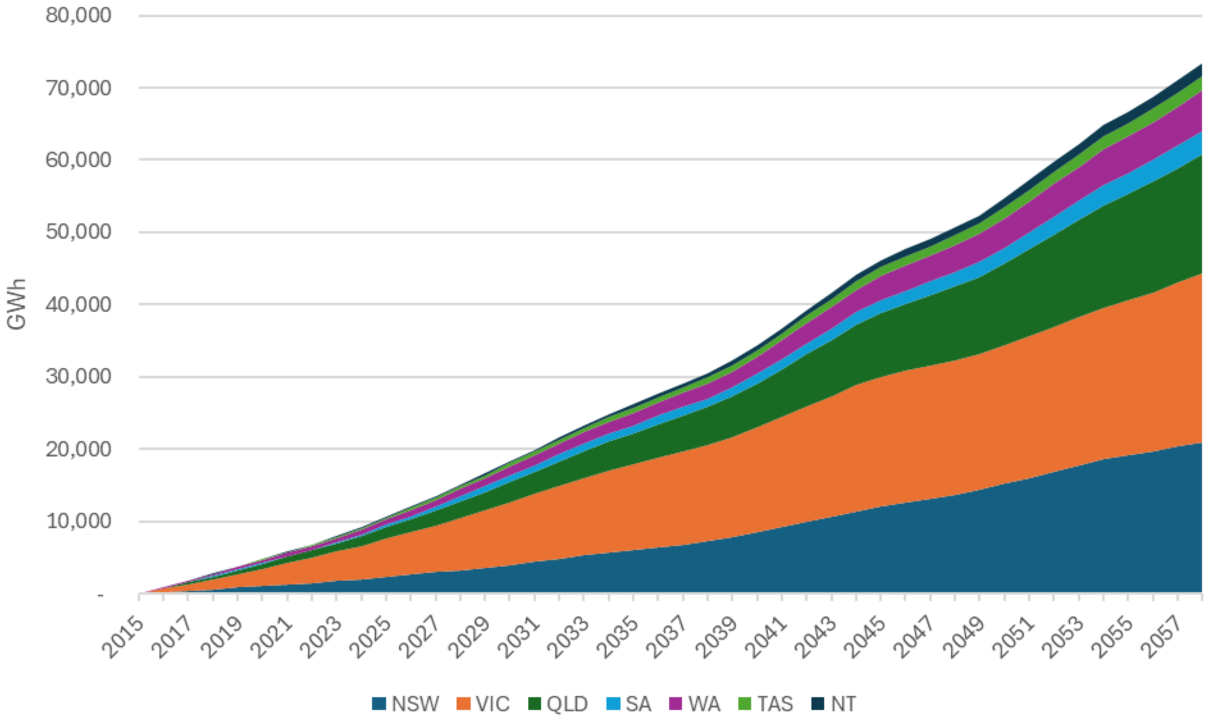


**Figure 25: RES Electricity Energy Efficiency Forecasts by Region, Step Change**

Figure 26 through Figure 32 show the forecast electrical energy efficiency change by scenario for each jurisdiction. Although all jurisdictions share a similar energy efficiency trajectory, the impact of the conclusion of modelled state schemes can be seen in the results for Victoria and South Australia, with the VEU modelled to end in 2045, and REPS in 2030.

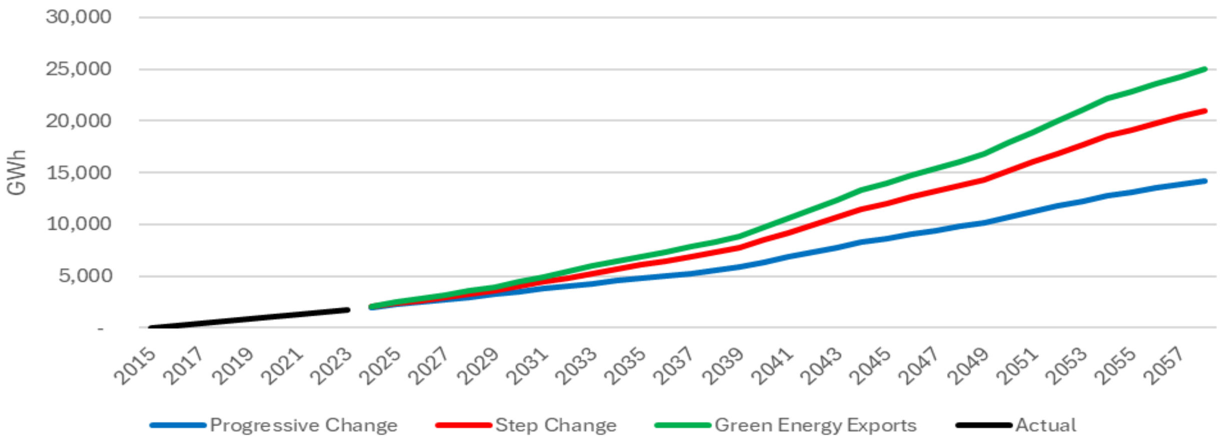


**Figure 26: RES Electricity Energy Efficiency Forecasts, NSW**

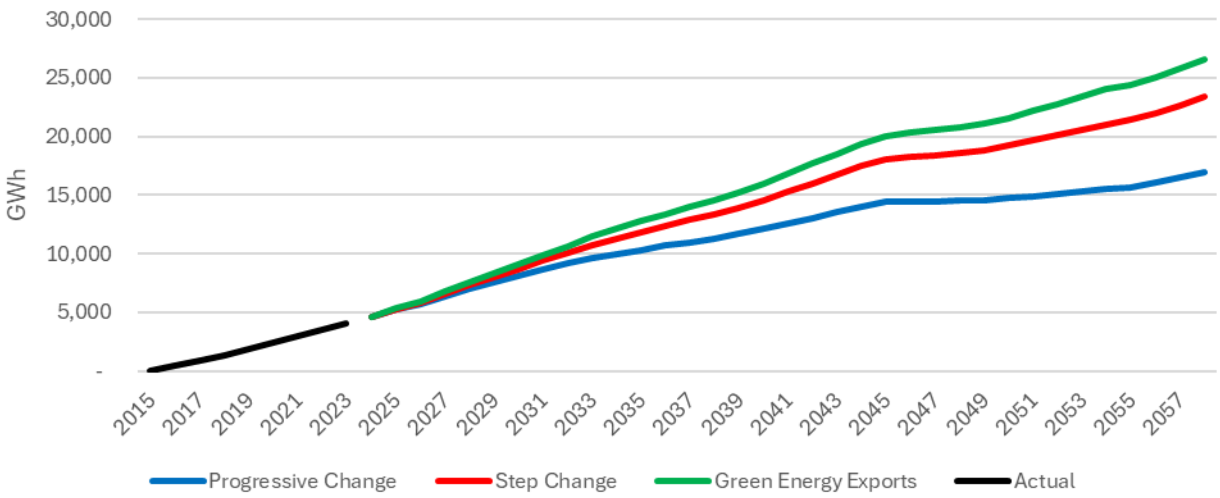


**Figure 27: RES Electricity Energy Efficiency Forecasts, VIC**

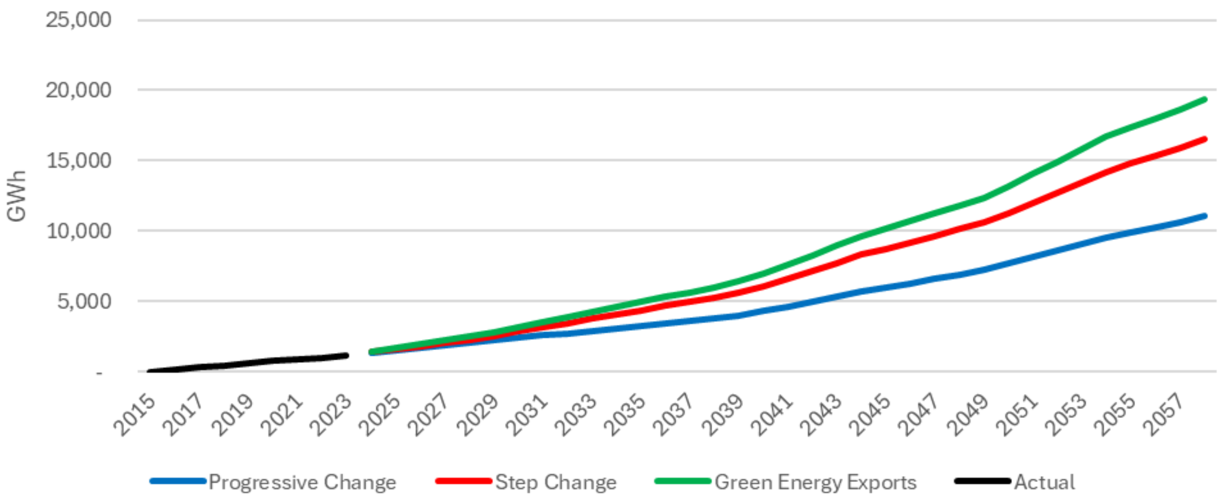


**Figure 28: RES Electricity Energy Efficiency Forecasts, QLD**

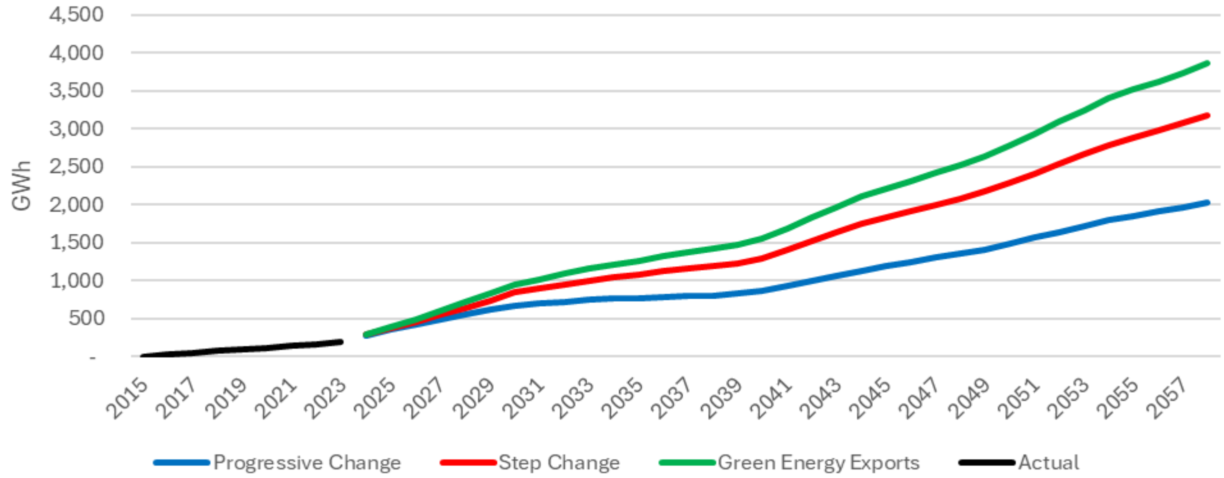


**Figure 29: RES Electricity Energy Efficiency Forecasts, SA**

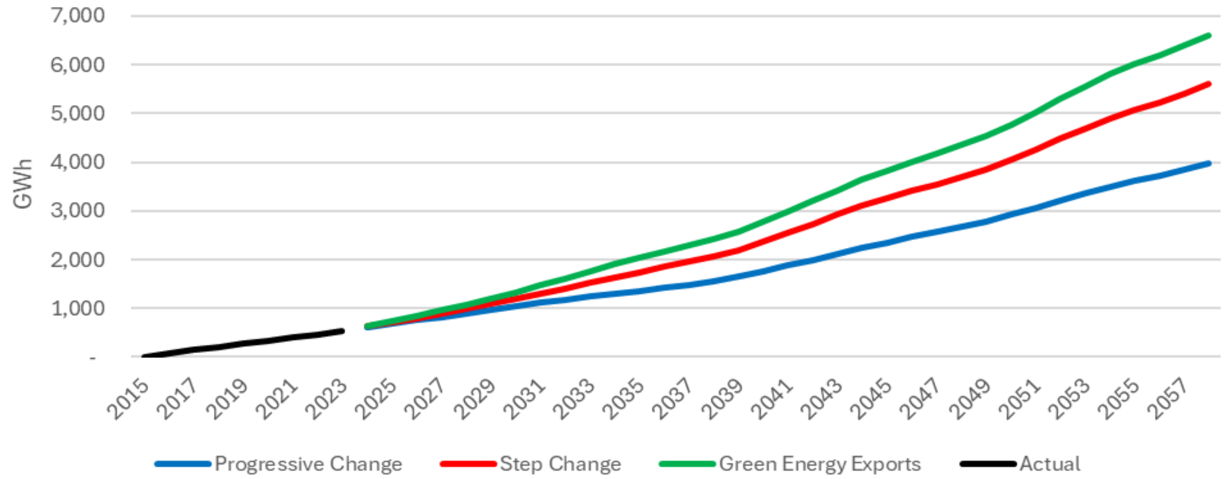


**Figure 30: RES Electricity Energy Efficiency Forecasts, WA**

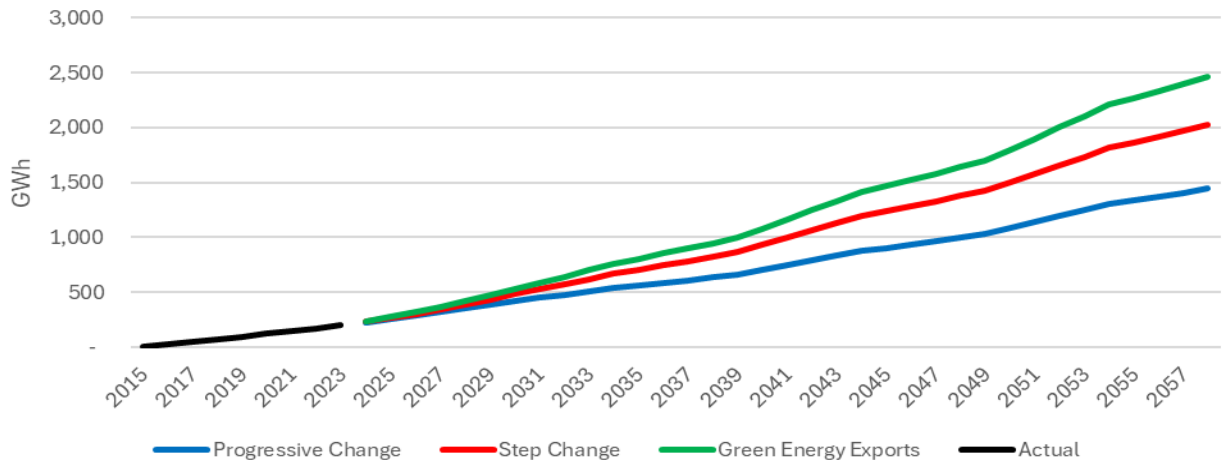


**Figure 31: RES Electricity Energy Efficiency Forecasts, TAS**

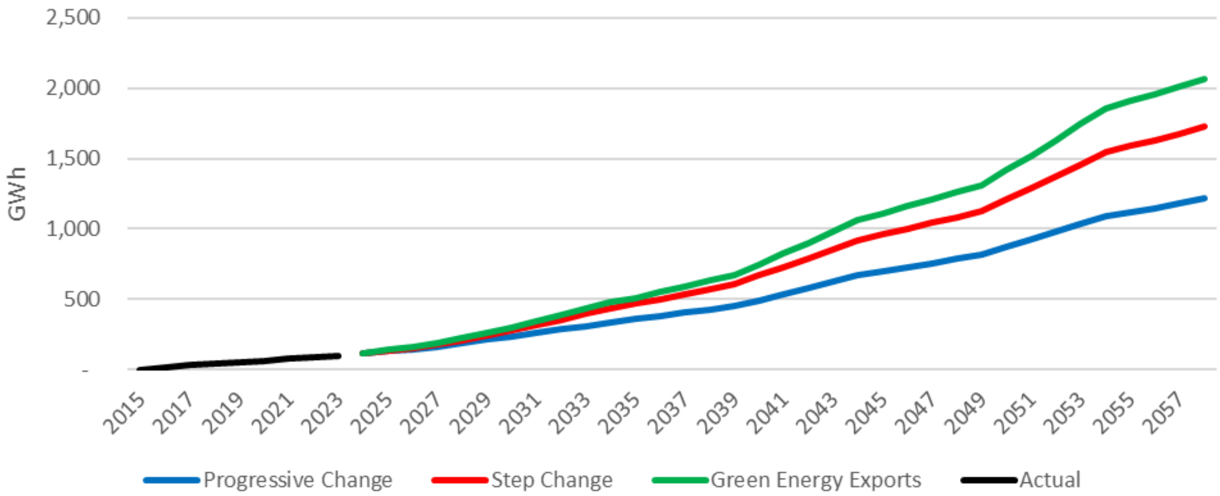


**Figure 32: RES Electricity Energy Efficiency Forecasts, NT**

*Gas*

Unlike electricity efficiency improvements, which broadly reflect the relative (population) size of the relevant jurisdictions, gas efficiency improvements are much less evenly distributed, reflecting the nature of the gas distribution networks and demand drivers, such as the climate. As can be seen in Figure 33, Victoria accounts for 62.3% of total gas efficiency improvements from FY2024 - FY2058, reflecting both the state's much greater heating share of total energy demand, and the outsized share of total residential gas it consumes. NSW accounts for 25.0% of total residential gas efficiency improvement over the period, with all other jurisdictions constituting 12.7% of improvements.

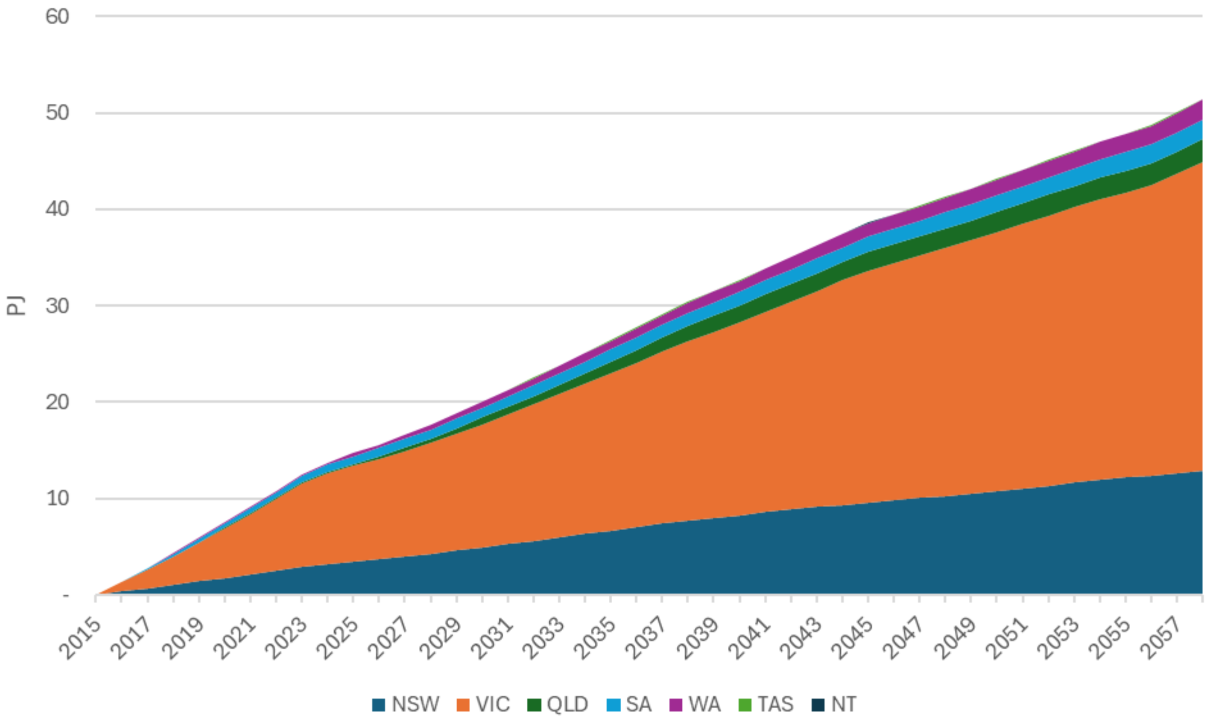


**Figure 33: RES Gas Energy Efficiency Forecasts by Region, Step Change**

Figure 34 through Figure 40 show the forecast gas energy efficiency change by scenario for each jurisdiction. Larger jurisdictions have relatively linear gas efficiency trajectories, albeit with a distinct plateau towards the end of the forecast period, as discussed in Section 6.1, though the impact of the modelled end of the VEU scheme in 2045 can be seen in Victoria's results (Figure 35).

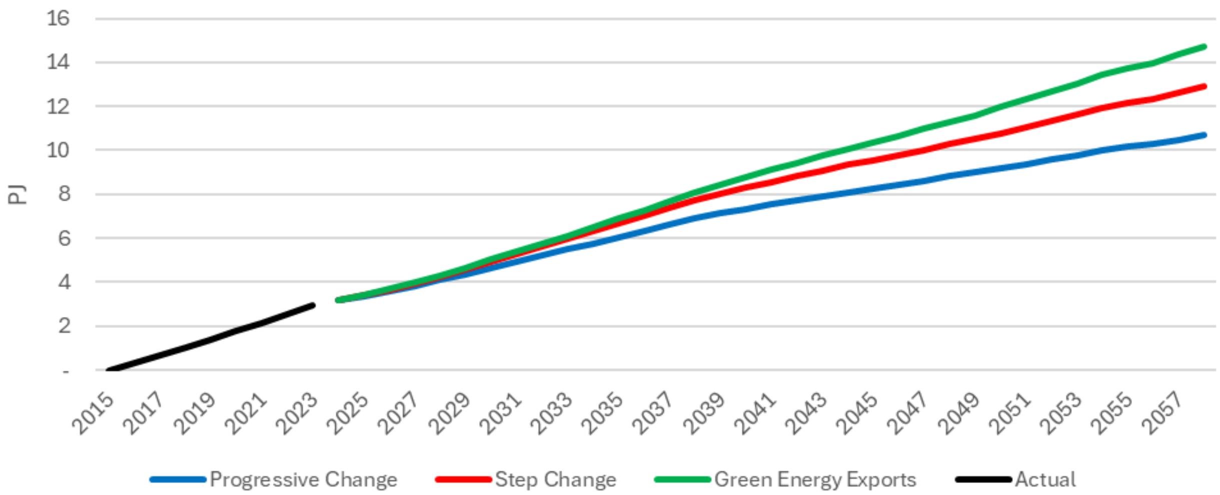


**Figure 34: RES Gas Energy Efficiency Forecasts, NSW**

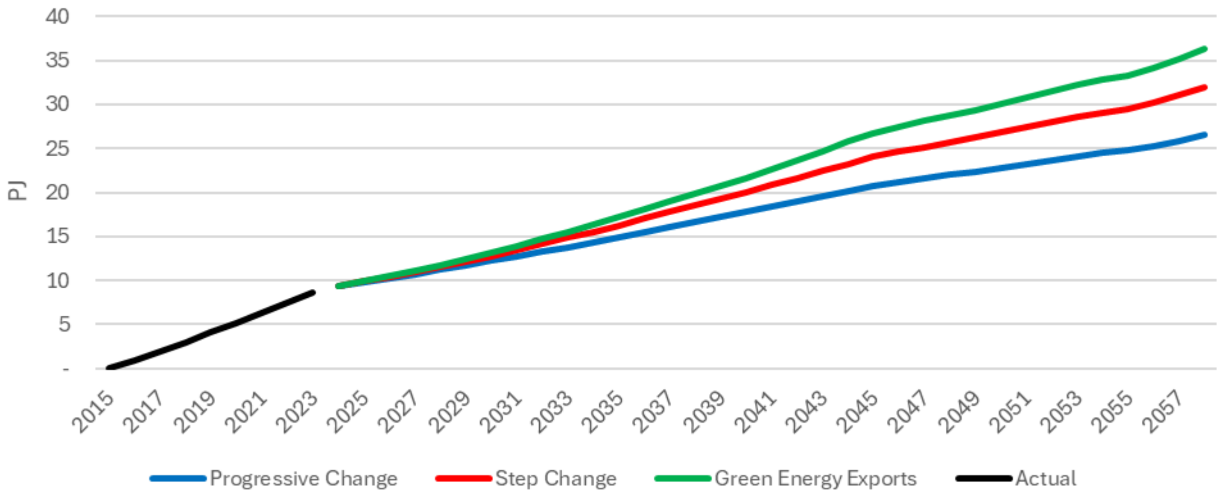


**Figure 35: RES Gas Energy Efficiency Forecasts, VIC**

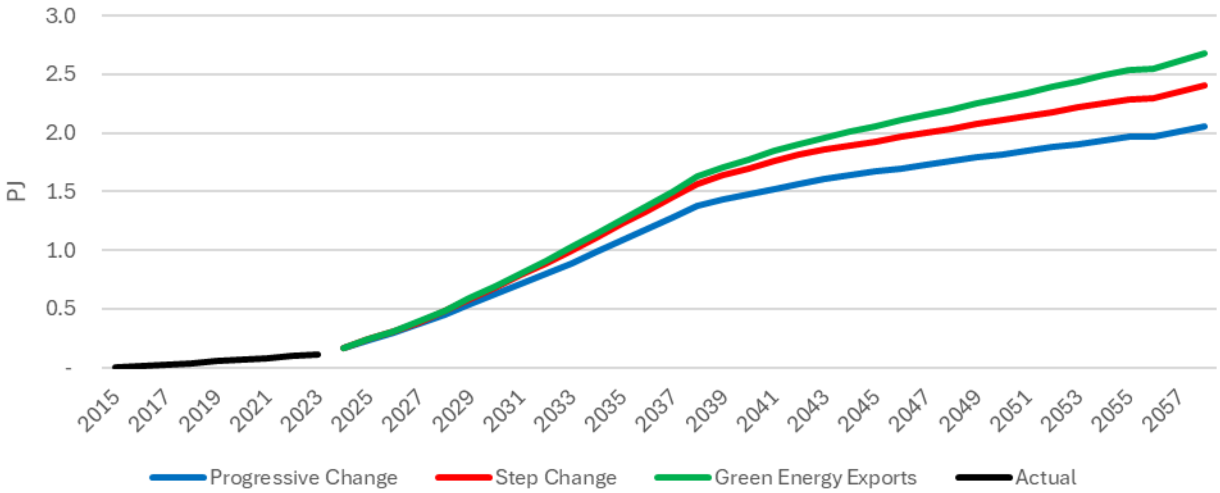


**Figure 36: RES Gas Energy Efficiency Forecasts, QLD**

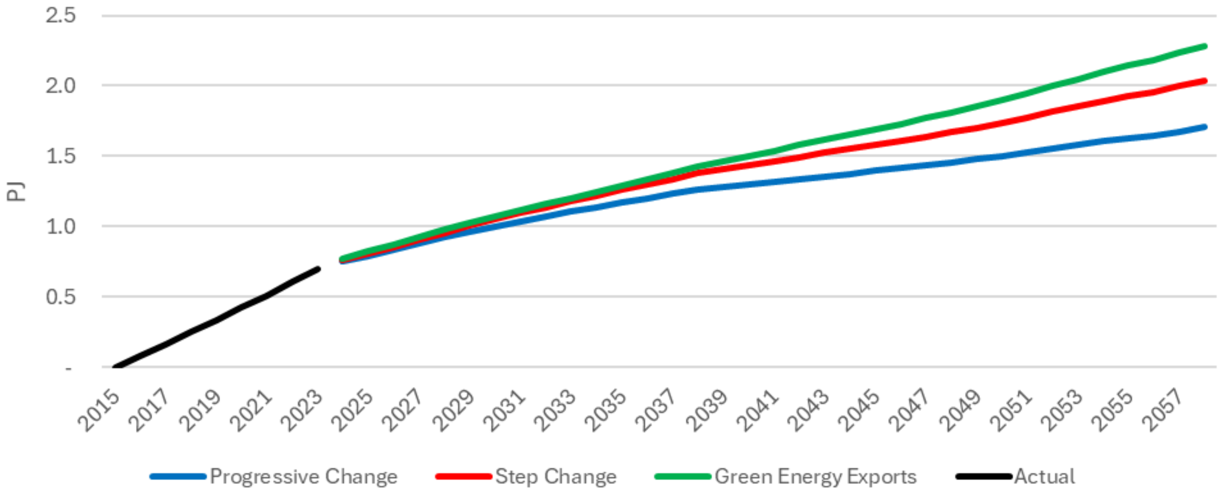


**Figure 37: RES Gas Energy Efficiency Forecasts, SA**

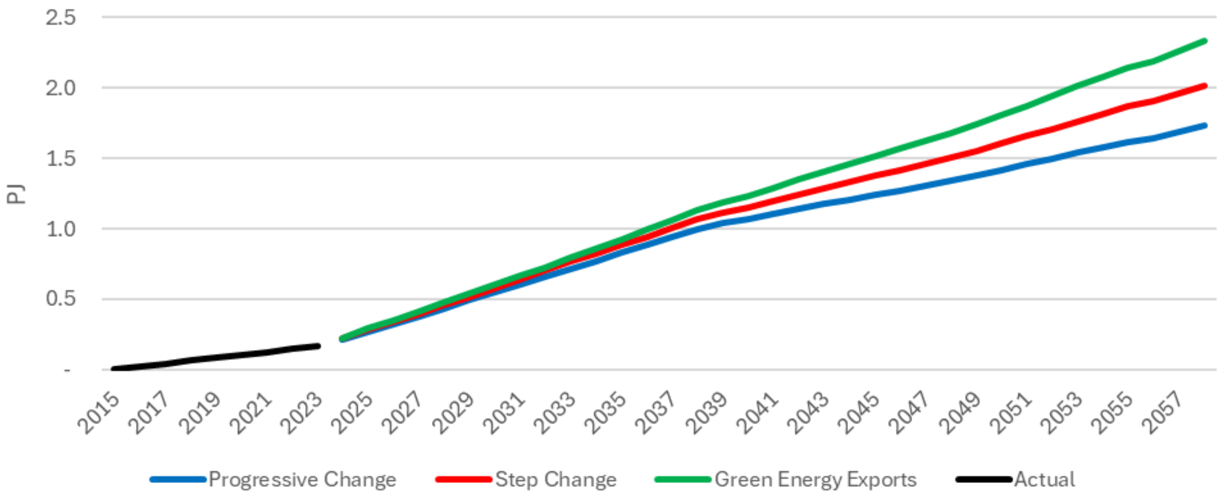


**Figure 38: RES Gas Energy Efficiency Forecasts, WA**

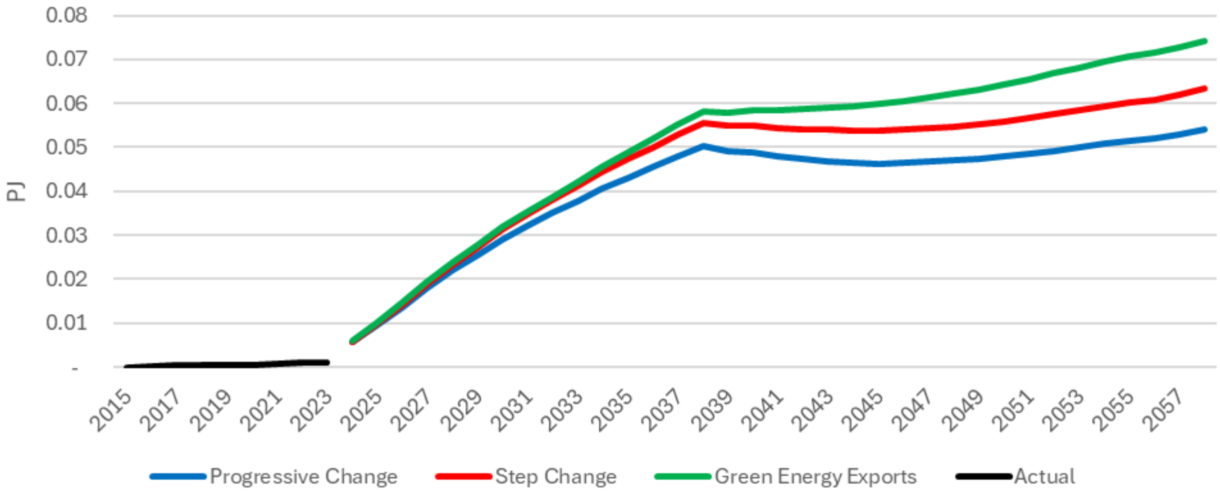


Figure 39: RES Gas Energy Efficiency Forecasts, TAS

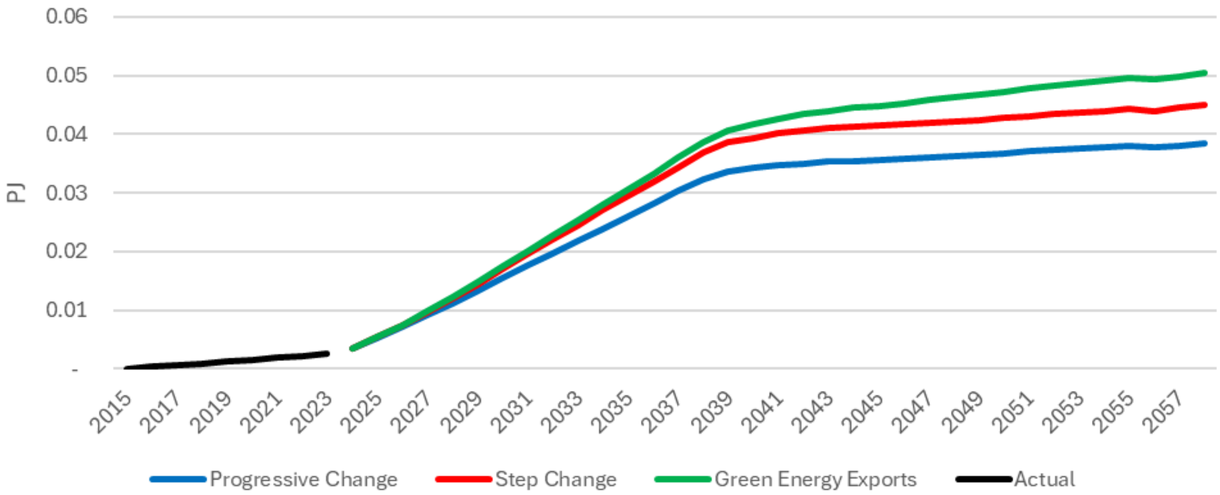


Figure 40: RES Gas Energy Efficiency Forecasts, NT

As can be seen in Figure 39 and Figure 40, future increases to NCC stringency have an outsized impact on energy efficiency in smaller jurisdictions with very low existing gas consumption. Despite these dramatic appearing efficiency curves for Tasmanian and the NT, total modelled energy efficiency change is very small when compared with larger jurisdictions.

### 6.1.3 Comparison with FY2023 Forecasts

#### *Electricity*

Figure 41 shows a comparison between electrical energy efficiency forecasts in the 2023 and 2024 forecasting rounds. Forecast energy intensity improvement over the period is higher across all scenarios in the 2024 forecasting round, albeit only marginally in the case of *Step Change*. This increase is almost wholly attributable to higher AEEI forecasts arising from adopting the CSIRO's MSM assumptions. Given SPR's previous forecasts had extrapolated estimates of past AEEI rates into the future, with no distinction made between jurisdictions, adopting the more granular and detailed MSM assumptions has led to both a refining of and increase to AEEI forecasts.

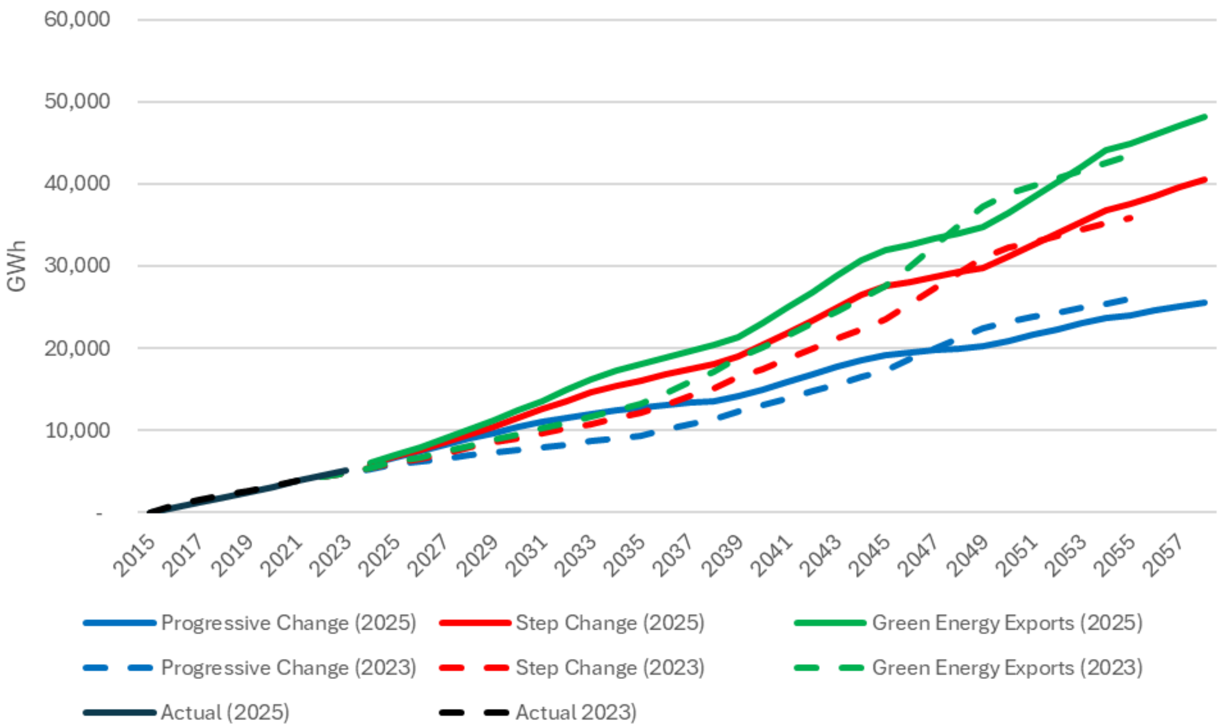


**Figure 41: Comparison of 2023 and 2025 RES Electricity Energy Efficiency Forecasts**

Figure 42 shows a comparison between electrical energy efficiency change in the 2025 and 2023 forecasting rounds without AEEI, that is, energy efficiency change attributable to policy. As can be seen, forecasts are broadly consistent, with earlier efficiency improvement in the 2025 round associated with more ambitious state schemes offset by slower and lower NCC stringency uptake later in the forecast period.

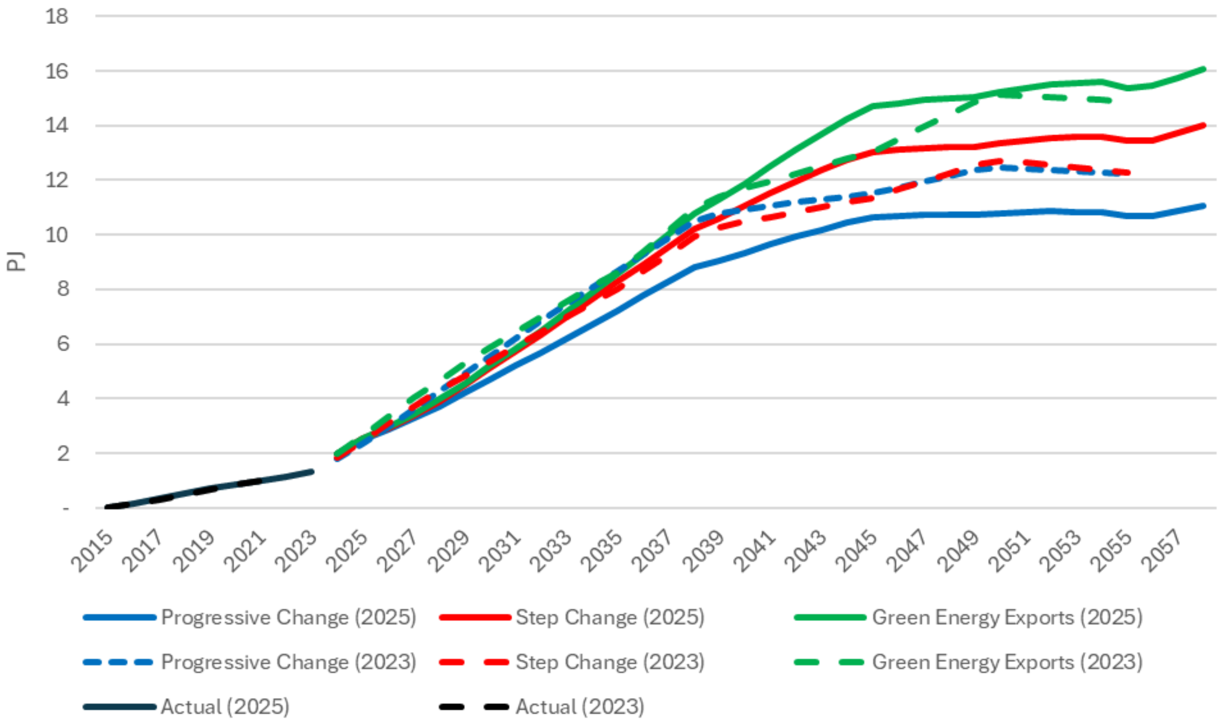


**Figure 42: Comparison of 2023 and 2025 RES Electricity Energy Efficiency Forecasts (no AEEI)**

### *Gas*

Figure 43 shows a comparison between gas energy efficiency forecasts in the 2023 and 2025 forecasting rounds. 2025 forecast savings are lower in *Green Energy Exports*, and *Step Change*, than in 2023, though higher in *Progressive Change*. Scenario forecasts are also significantly more narrowly grouped in 2025 than in 2023, a function of moving from broad assumed AEEI rates to CSIRO's MSM input rates.

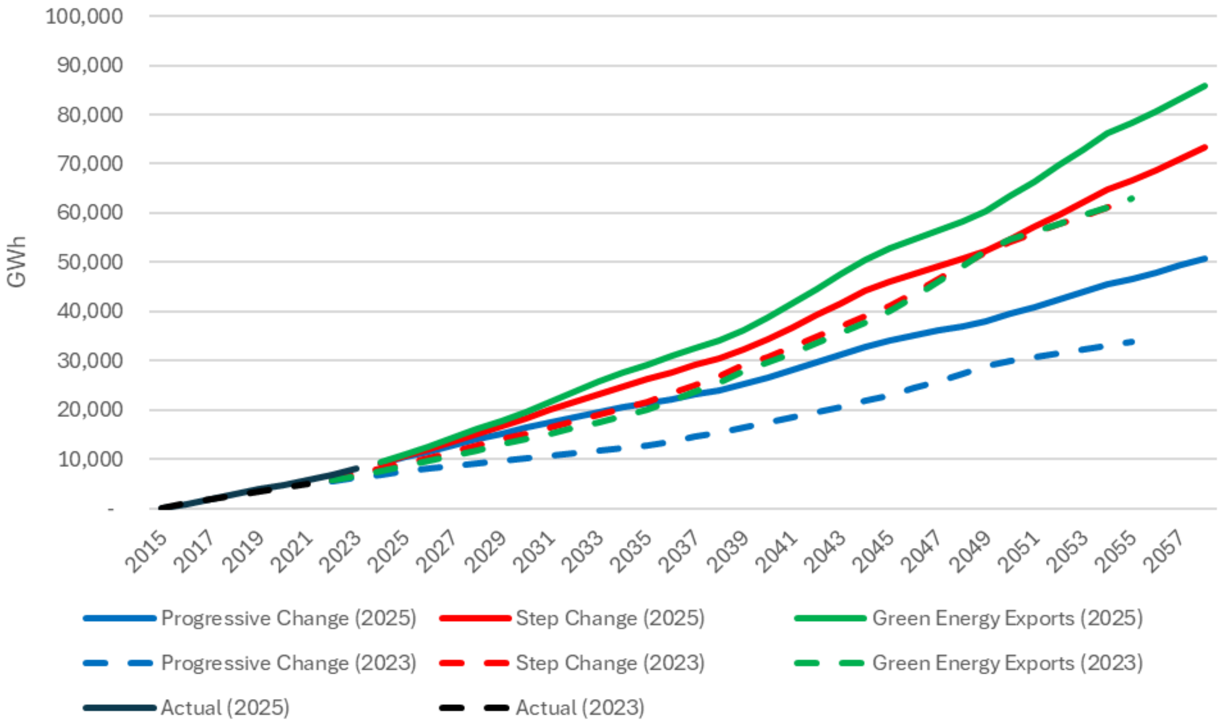


**Figure 43: Comparison of 2023 and 2025 RES Gas Energy Efficiency Forecasts**

Figure 42 shows a comparison between gas energy efficiency change in the 2025 and 2023 forecasting rounds without AEEI, that is, energy efficiency change attributable to policy change. As is shown, the two sets of forecasts are much more closely aligned, with only minor divergence between *Step Change*, and *Progressive Change*, primarily as a result of changes to NCC adoption assumptions which reflect divergences between jurisdictions.

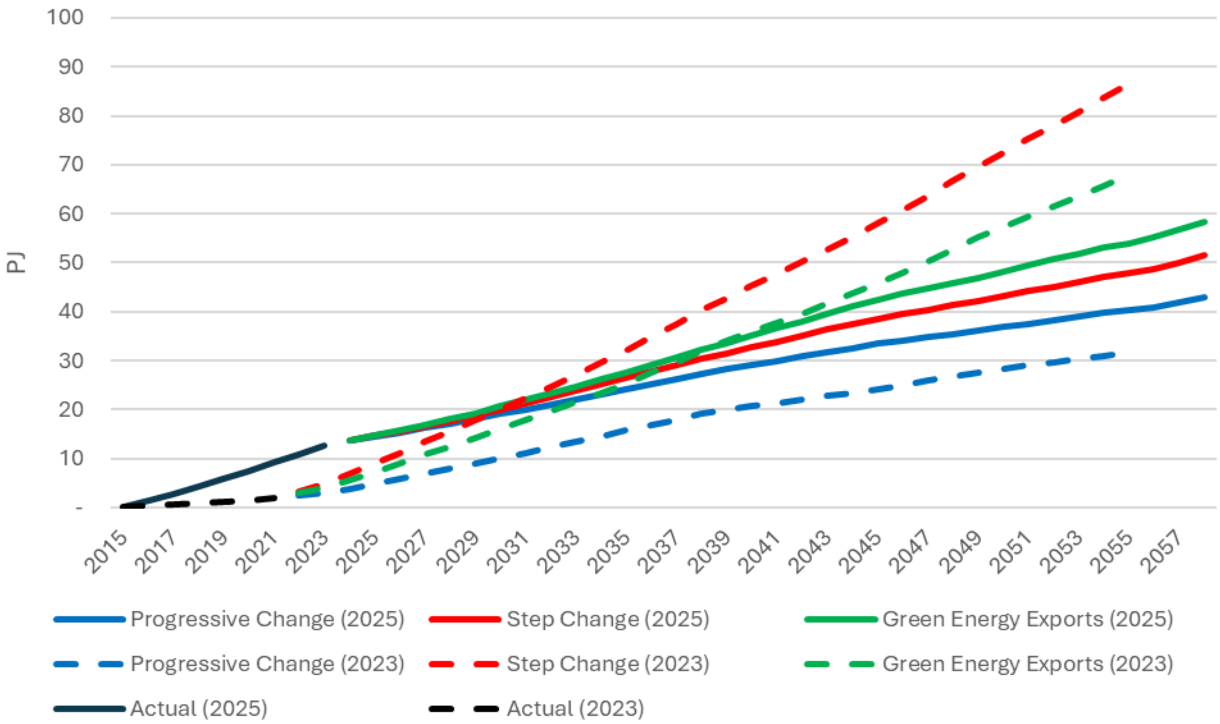


**Figure 44: Comparison of 2023 and 2025 RES Gas Energy Efficiency Forecasts (no AEEI)**

***Impact of changed data inputs on historical gas energy efficiency estimates***

In previous forecasting rounds SPR has relied on Australian Energy Statistics (AES) data in conducting historical analysis of energy efficiency trends. In this forecasting round SPR has instead, where possible, sought to use AEMO data in our models to ensure alignment across ISP inputs. In addition to improved consistency, AEMO data has the benefit of being largely directly metered, unlike AES data, which is often modelled/estimated. Though this change of data inputs did not significantly impact historical electricity analysis, it has had a significant impact on our analysis of gas efficiency change in the 2015-23 period. As can be seen in Figure 45, AES and AEMO residential gas consumption figures are broadly consistent up to 2019, though subsequently diverge. Because our estimate of historical energy efficiency change uses the percentage change in frozen consumption over the period, the roughly ~6 PJ divergence in real consumption leads to an increase of ~10 PJ in apparent gas energy efficiency change in the 2015-23 period. Despite this change, modelled gas energy efficiency change over the forecast period is lower in the 2025 forecasting round than in 2023, as discussed above.

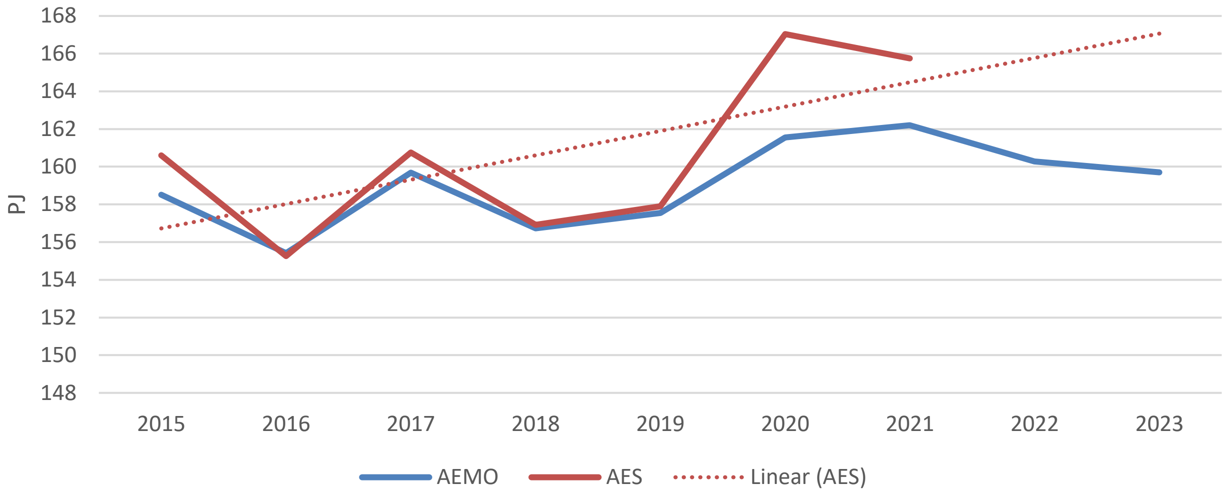


**Figure 45: Comparison of AEMO and AES Residential Gas Consumption Data, 2015-23**

## 6.2 Business

By way of introduction, for the interpretation of the figures that appear below, it is important to recall that these are *total* efficiency savings forecast relative to fixed year, FY2015. To apply these forecasts to another time period – such as from FY2025 or later – they need to rebased to the relevant year. Further, it should be recalled some baseline constructs – particular any linear projections based on past trends – may well already assume some efficiency change. Therefore, these forecasts of total efficiency savings cannot be simply deducted from a baseline that already includes efficiency change.

### 6.2.1 Commercial

***Overview by Scenario***

Figure 46 provides an overview of total electrical efficiency savings– estimated actuals and forecasts – in the commercial sector by scenario. Broadly these forecasts reflect:

1. Differences in the underlying economic conditions, including GVA – services, leading to differences in commercial building stock growth and turnover
2. Differences in policy ambition, as documented in Table 5 in Chapter 4
3. Differences in AEEI, linked to different degrees of co-ordination between countries on at least climate change mitigation in each scenario, flowing through to differential rates of improvement in carbon-conserving technologies and innovation.

Items 2 and 3 are discussed further in the next section, forecasts *By Component*.

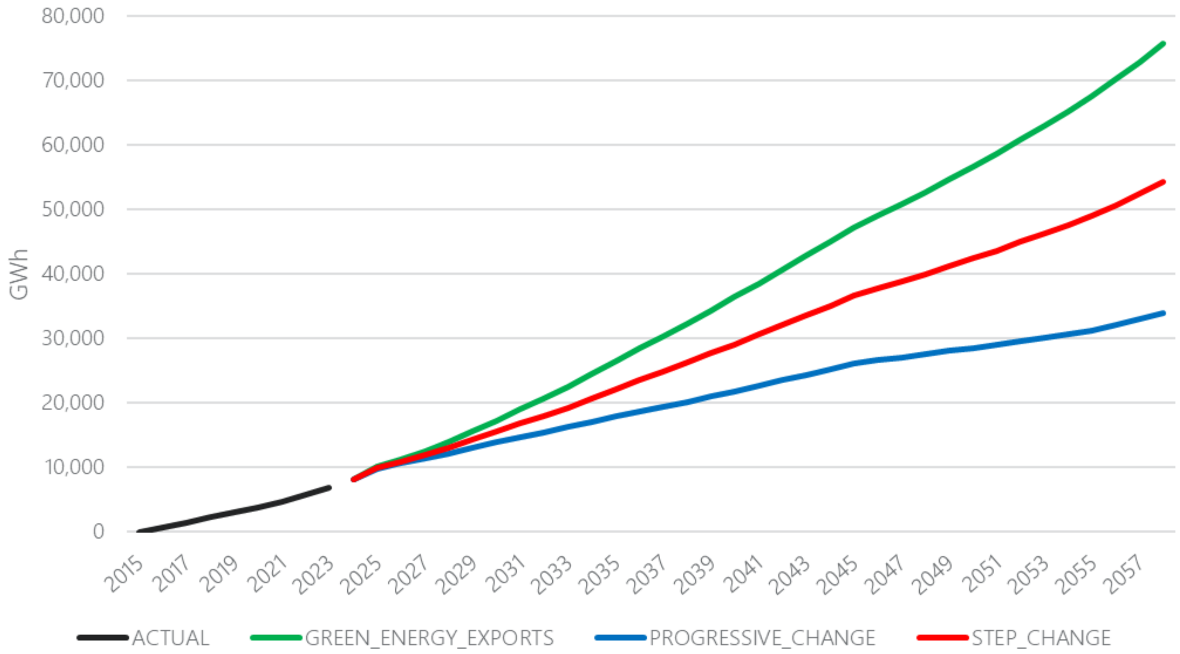


**Figure 46: Commercial Sector Total Energy Efficiency Savings, Electricity, by Scenario**

Figure 47 shows similar data for gas. The shape of savings from 2045 onwards is affected by VEU, as discussed further in the following section. In short, the program has recently been extended to 2045, and we assume that policy-induced savings would persist for around 10 years after that date, reflecting deeming practices and economic life effects. Generally, gas efficiency savings are much lower than electricity in the commercial sector, in part because electricity is already the dominant energy carrier, and we expect the gas share of total energy consumption in the sector to fall over the forecast period. We also recall from Chapter 5 that these forecasts aim to exclude electrification.

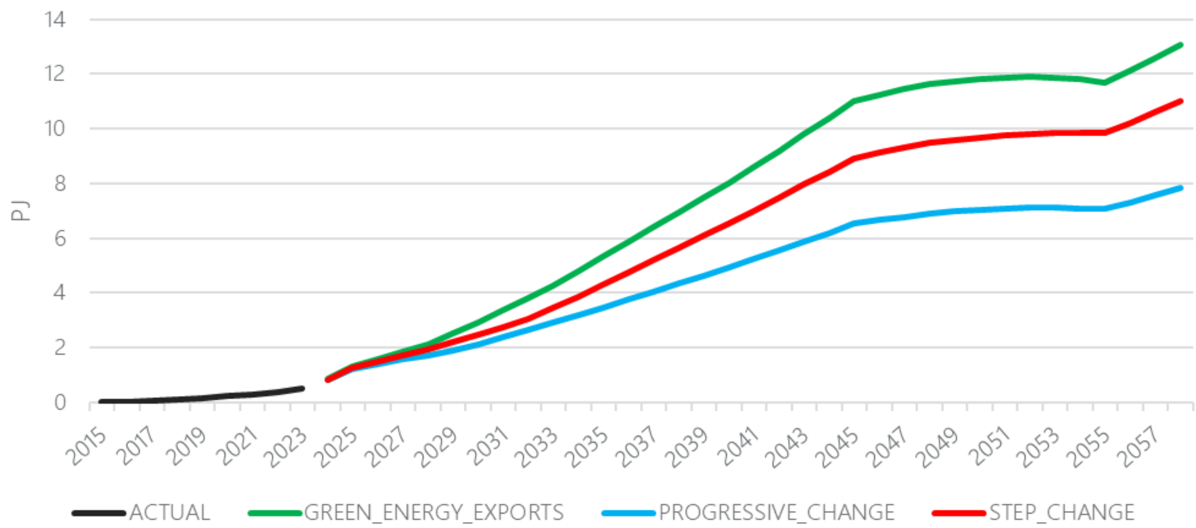


**Figure 47: Commercial Sector Total Energy Efficiency Savings, Gas, by Scenario**

Further insights into the underlying drivers of these forecasts are provided in the following section, which breaks down the total forecasts, for each fuel, by component.

***By Component***

Figure 48 shows the forecast of electricity efficiency savings under the Progressive Change scenario, summed for all regions, while Figure 49 and Figure 50 show the results for the Step Change and Green Energy Exports scenarios respectively. Note that savings by region are presented in the following section.

Under Step Change, total commercial sector electricity efficiency savings are some 54,300 GWh by FY2058, but only 34,000 GWh under Progressive Change, and up to 75,700 GWh under Green Energy Exports assumptions. All three factors noted in the Overview by Scenario contribute to the spread of results, but our analysis suggests that the different policy assumptions (documented in Table 5 in Chapter 4) contribute the largest difference between scenarios.

The slow-down in savings from 2025 reflects an assumption to ESS savings will increasingly relate to the residential sector, leading to lower savings in the commercial and industrial sectors. This effect occurs in all scenarios but is most apparent in Progressive Change, as total savings are smaller in this scenario, magnifying the relative impact of this ESS effect.

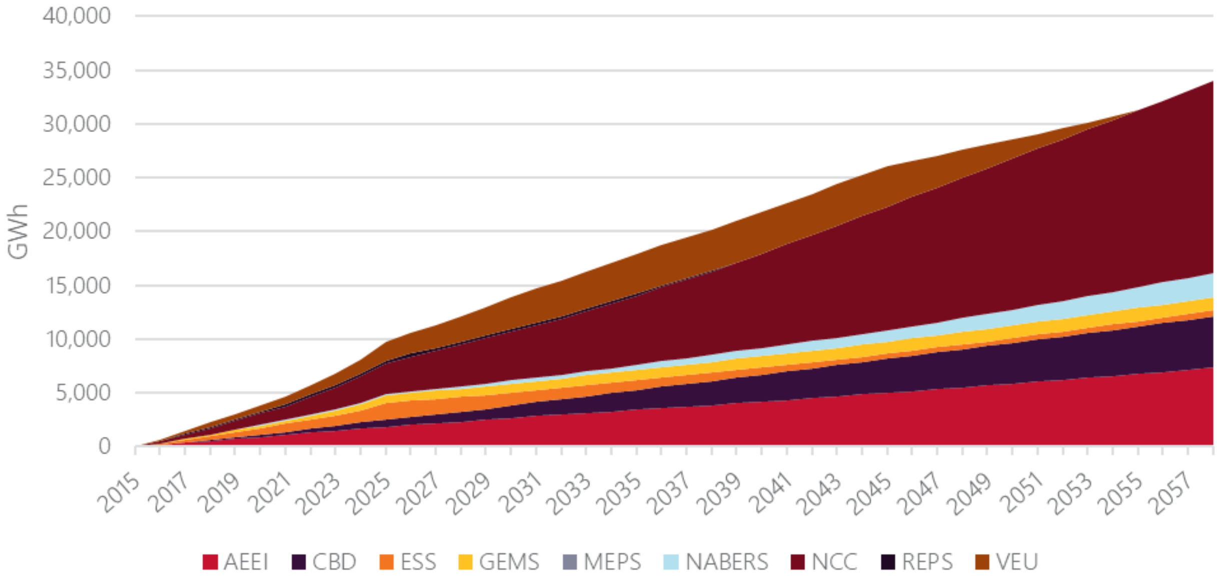


**Figure 48: Commercial Sector Efficiency Savings by Component, Electricity, Progressive Change, All Regions**

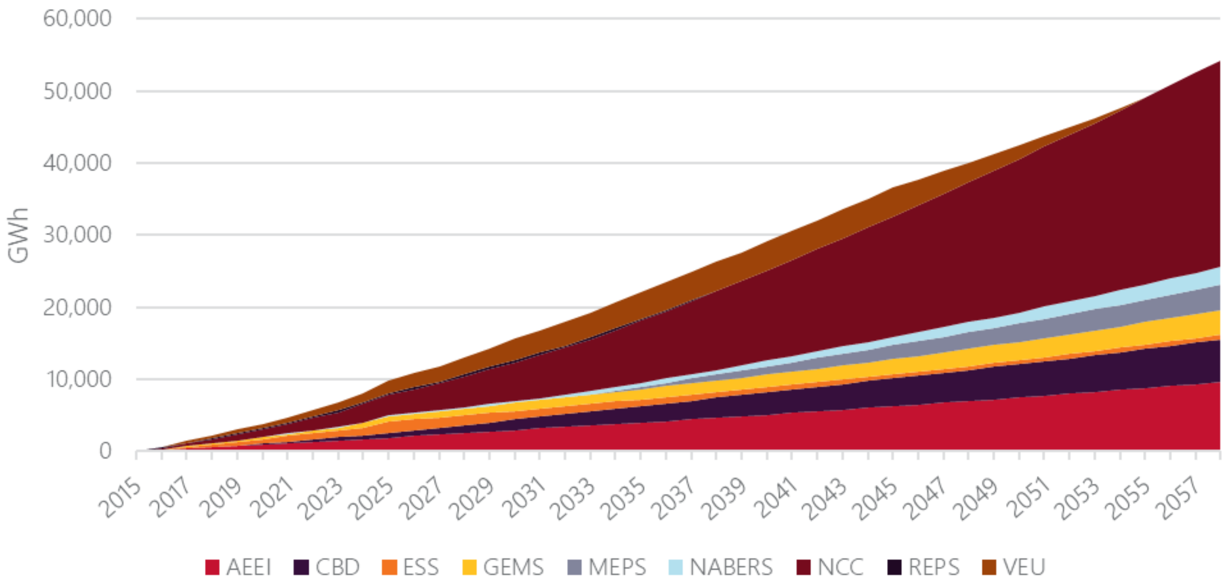


**Figure 49: Commercial Sector Efficiency Savings by Component, Electricity, Step Change, All Regions**

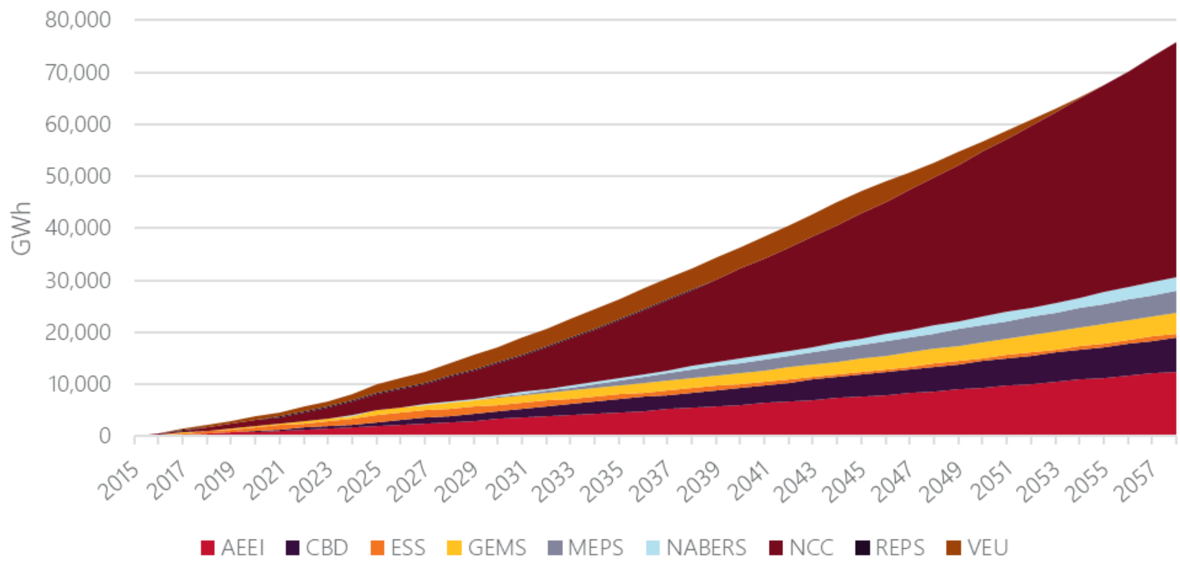


**Figure 50: Commercial Sector Efficiency Savings by Component, Electricity, Green Energy Exports, All Regions**

Turning to gas, Figure 51 to Figure 53 show gas efficiency savings by component for each scenario.

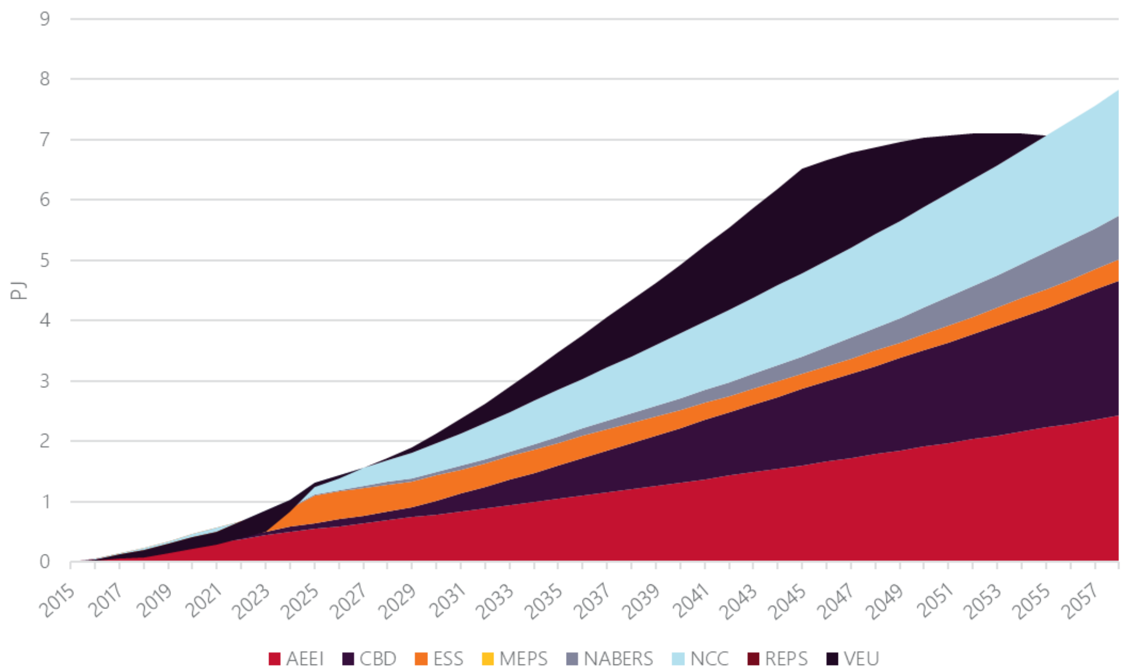


**Figure 51: Commercial Sector Efficiency Savings by Component, Gas, Progressive Change, All Regions**

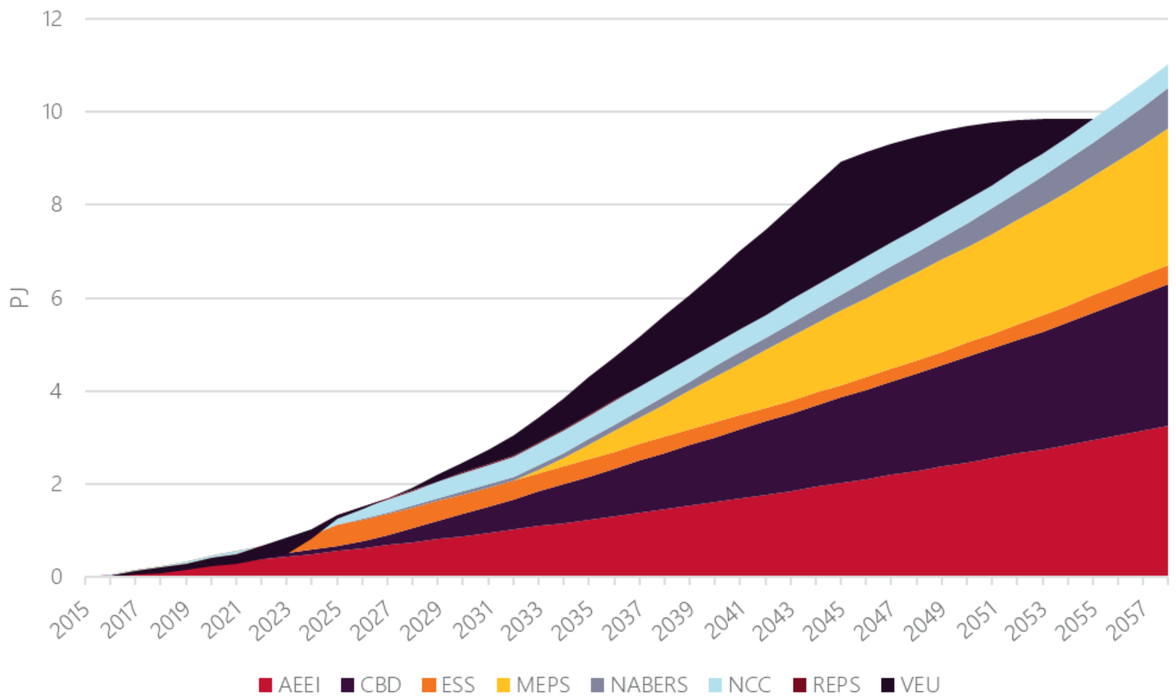


**Figure 52: Commercial Sector Efficiency Savings by Component, Gas, Step Change, All Regions**

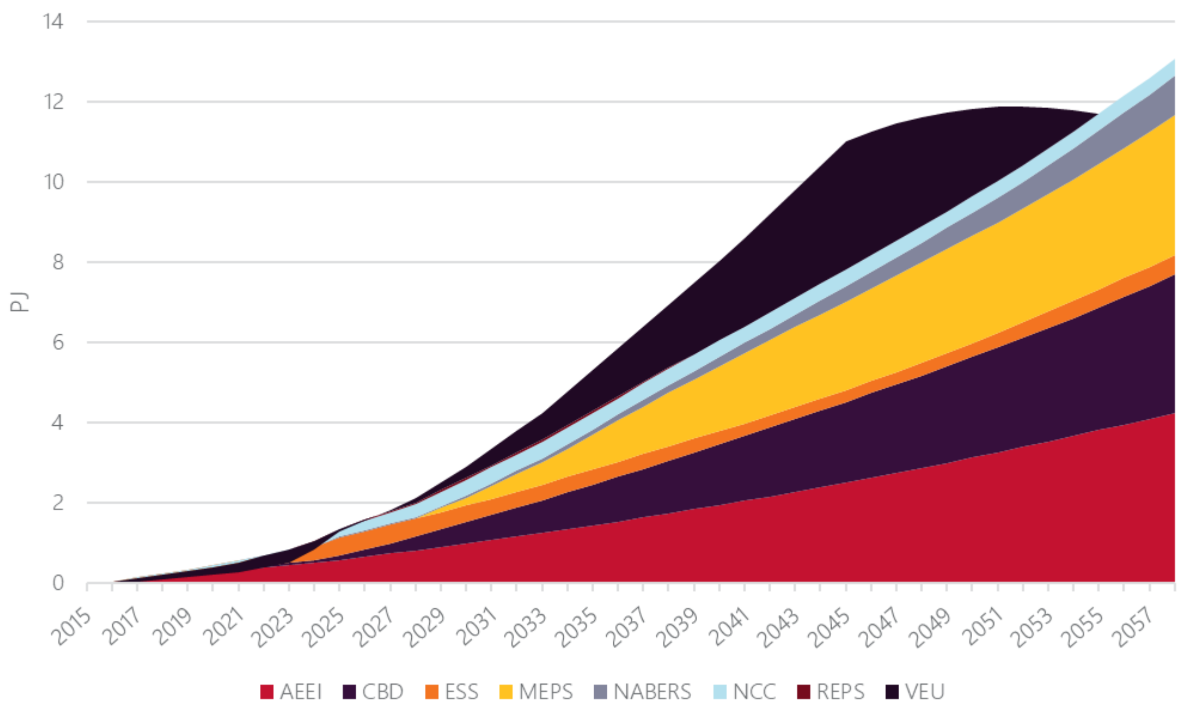


**Figure 53: Commercial Sector Efficiency Savings by Component, Gas, Green Energy Exports, All Regions**

The overarching observation is that gas savings in this sector are small in all scenarios, but it should be recalled that state scheme savings accrue to just one state and therefore are more significant in the context of those regional markets. Each of the components is discussed below.

### *AEEI*

AEEI, efficiency improvement that would be expected in the absence of policy interventions, are estimated by applying the assumptions noted in Table 5 to frozen (FY2015) efficiency projections. This approach ensures that AEEI estimates are not confused with policy-induced effects, *and* it requires that each policy measure must be discounted (as appropriate) for non-additionality to AEEI, to avoid double-counting and over-estimating total efficiency change.

This component is forecast to contribute some 7,300 GWh of electricity savings and 2.4 PJ of gas savings by FY2058 under Progressive Change, and up to 12,500 GWh of electricity and 4.3 PJ of gas under Green Energy Exports, with 9,700 GWh of electricity and 3.2 PJ of gas under Step Change.

In scenarios with lower policy ambition, AEEI contributes a higher share of the total savings by FY2058, but AEEI shares do not exceed 20% in any scenario for electricity, and 30% for gas. As noted in Chapter 5, AEEI assumptions are aligned with those used by CSIRO in its multi-sector modelling as the Step Change scenario assumptions, while these values are varied up and down by 25% for Green Energy Exports and Progressive Change respectively. Overall, the share of AEEI estimated as above is lower than was estimated in 2023 – see 'Comparison with 2023 Forecasts' below.

### *Commercial Building Disclosure (CBD)*

CBD electricity savings in FY2058 are forecast to vary between 4,800 GWh of electricity and 2.2 PJ of gas under Progressive Change, 5,900 GWh of electricity and 3.1 PJ of gas under Step Change, and 6,600 GWh of electricity and 3.4 PJ of gas under Green Energy Exports. The differentiation between scenarios is relatively modest, as the actual energy savings are determined by investment decisions that are not prescribed by the program itself, but will reflect the market factors that apply in future – technology and energy prices, etc – and the preferences of market participants. Arguably mandatory disclosure is simply a strategy to enable efficient market outcomes by ensuring that decision-makers have access to relevant information at the time they are making investment decisions.

However, as with most components, CBD does respond firstly to changing economic assumptions by scenario, with floor area rated and 'conversion rates' (conversion of ratings into upgrades) being the key variables. Beyond that, we differentiate scenarios by policy ambition in line with the scenario narratives (Chapter 4) and our mapping of policy settings to scenarios (Table 5). Broadly these assume no change to CBD for 5 years under Progressive Change; with modest and slow expansion thereafter; changes commencing in FY2026 under Step Change broadly in line with proposals made in a draft roadmap concept developed by KPMG;[51] and a 'high ambition' set of assumptions for Green Energy Exports.

CBD program statistics are available online and provide an excellent resource for quantifying the historical impacts of the program.[52] For our analysis of the existing CBD design – under BAU assumptions – we apply the estimated impact share noted in Section 5.2.6. This includes a saturation effect that arises from the limited size of the target sector (larger commercial offices only), combined with the actual and assumed future duration of the program (under BAU assumptions, the current CBD design would be assumed to remain unchanged until FY2058). These circumstances would exacerbate what may already be an issue for certain buildings or owners, which is that as the same buildings are rated over and over again – sometimes annually – there would be an expectation that the best savings opportunities will be implemented first, leading to the opportunities remaining for future years being increasingly less attractive. It is also true that new economic opportunities will arise due to changing technology or market factors, but these would drive future AEEI, and so they cannot also be assumed as creating additional program savings without double-counting.

A detail is that the saturation effect is likely to be strongest in Green Energy Exports, and weakest in Progressive Change, due to differing volumes of floor area rated in each case. This has a counter-intuitive effect on the relative savings under the three scenarios; however, these effects are swamped by larger effects, such that the savings relativities by scenario line up conventionally overall, as noted above.

For the forecast period, we make use of recent SPR analysis for the program that quantifies the impact of different design choices for the CBD Expansion Roadmap, in addition to projecting the expected future impacts that would be expected with the current scope of the measure. The factors that vary include the coverage of building types, commencement years by building type, energy use/emissions scopes, organisation types, floor area scopes, disclosure triggers, frequency of disclosure where disclosure is periodic, minimum floor area requirements and others. Since the CBD expansion impacts were modelled as only those additional to BAU – which includes discounts for non-additionality to AEEI and other effects, as noted above – there is no need to apply any further discounts on these grounds to the CBD forecasts. Also, we model saturation effects for the CBD expansion roadmap, as well as for BAU. Specifically, we adopt the conservative protocol that floor area that is modelled to be upgraded in a given year under the expansion roadmap is then removed from consideration for future upgrades. In reality, some spaces will be able to be upgraded more than once, cost-effectively, over the forecast period.

[51] KPMG, *Expanding the Commercial Building Disclosure Program*, March 2024.
[52] See https://www.cbd.gov.au/, reviewed online 18/12/2024.

The fuel mix of CBD savings is not prescribed by the program in any way but instead will reflect the judgements of building owners and occupants over time, driven by (largely) market-based factors such as relative fuel and technology costs, but also their preferences and internal policies with respect to factors including greenhouse gas emissions. Practically we assume that the future fuel mix of savings continues to reflect historical shares, as this measure focuses primarily on the existing commercial building stock where the fuel mix is likely to change more slowly than in the new building stock.

***NABERS***

We describe the NABERS component next, even though this is out of the (random) order presented in Figure 48 to Figure 50, due to significant linkages between CBD and NABERS, as covered below.

NABERS is modelled in three components. First is the office for energy component, as has been modelled in past years. As a general approach, we estimate the average rate of change in total energy and fuel intensities (for office tenancies, base buildings and whole buildings) over our historical period (FY2015 – FY2023), applied to the actual floor areas rated (and projected floor area for the future, differentiated by AEMO scenario). We then estimate the additionality of these headline savings by applying the assumptions (or past research) described in Section 5.2.6.

Second, for the first time this year we also model the non-office tools, including shopping centres, hotels, public hospitals, aged care, retirement living, warehouses and cold stores. Note that data centres are not modelled here, as the NABERS tool for data centres does not generate energy intensity metrics that are related to building floor area, while Class 2 common areas (also capable of being rated under NABERS) are residential in nature. The inclusion of these non-office tools recognises their number and significance, but it also engenders challenges, as many of these sub-sectors have limited ratings data (particularly when considering all jurisdictions and all relevant years), which reduces the statistical significance of the program statistics. Practically, no intensity trends could (yet) be established from program statistics for public hospitals, aged care, retirement living, warehouses or coldstores, so these building types were modelled by assumption. In future years, as more of these buildings are rated, these data limitations will ease.

For the forecast period, we model a third element, which follows on from the tight relationship between CBD and NABERS, noted above, and which we expect to remain in place in future. We model this element as only the 'premium' or additional savings that NABERS would be expected to be generated in the presence of an expanded CBD program that covers (in future) some or all of the NABERS-rated building types. This premium would be likely to be generated building owners/occupants that do not have a mandatory reporting requirement under CBD but who value the unique benefits of a NABERS rating. As noted, these are likely to be relatively highly-motivated owners/occupants who are also more likely to take (energy performance upgrade) action in response to a rating/disclosure episode. In evidence, we calculate the 'headline' rate of average annual change in total energy intensity (over FY2015 – FY2023) for NABERS was between -4.5% (tenancies) and -3.5% (base buildings) and -1.8% (whole buildings), compared to between 2% (whole buildings) and 2.9% (base buildings) for CBD.

Given the above, we model this element of NABERS savings by estimating total CBD and NABERS savings (BAU) and expressing the incremental NABERS savings (over those created by CBD) as a percentage of CBD savings. For example, using FY2015 as a base year for both programs (for this exercise only – both started earlier in reality), we estimate that additional or incremental NABERS savings in FY2023 can be expressed as ~5% of the CBD savings in the same year. For the future, however, we assume that NABERS will increasingly be positioned as the 'premium' option, relative to CBD, where only the more highly motivated building owners will be seeking non-CBD ratings, and these owners are likely to be seeking higher-than-CBD levels of energy savings. We term this a 'reverse saturation effect' for NABERS, or it can be thought of a savings premium that results from the particular niches that NABERS occupies now and is expected to occupy in future. Therefore, and to help differentiate AEMO scenarios, we assume that this premium (willingness to invest) will be progressively *higher* as we move from Progressive Change to Step Change and to Green Energy Exports. The underlying assumption here is that the relationship described above between NABERS and CBD for office, continues to hold true for other building types. This is yet to be tested, as the CBD expansion roadmap has not commenced, but it appears a reasonable presumption at this point.

We also assume that the volumes of buildings/floor area rated (under both CBD and NABERS) increase in the same scenario order. Specifically, we assume faster growth in floor area rated in Green Energy Exports (1.5% per year), cf Step Change (1.25% per year) and Progressive Change (1% per year).

On this basis, total NABERS efficiency savings – additional to CBD and AEEI – and representing the sum of the three elements above – are forecast to reach 2,600 GWh of electricity and 1.0 PJ of gas by FY2058 under Green Energy Exports, 2,400 GWh of electricity and 0.9 PJ of gas under Step Change, and just under 2,300 GWh of electricity and 0.7 PJ of gas under Progressive Change.

***ESS***

ESS targets are set to increase by 0.5% (of eligible state electricity consumption) from 2022, reaching 13% by 2030. Unless the target is further changed (as it has been roughly every 5 years since 2009), it would remain at 13% of (a growing amount) of eligible consumption until 2050. These targets were incorporated into SPR's models developed for the last forecasting round. Other factors, including the sectoral split of savings, remain unchanged from 2023. The scenario differentiation assumes that Progressive Change reflects current policy, and Step Change and Green Energy Exports representing an annual 0.1% and 0.2% increase respectively.

On this basis, ESS electricity savings for the commercial sector are expected to peak at nearly 1,500 GWh in FY2026 under Progressive Change, with almost 0.5 PJ of gas savings in the same year, and to fall to lower levels by the end of the forecast period (~530 GWh of electricity and 0.3 PJ of gas). Savings are expected to be only slightly higher under both Step Change and Green Energy Exports, as the key driver of impact is the volume of eligible consumption, which we do not expect to vary greatly across the scenarios.

*VEU*

The Victorian Government has confirmed that VEU will continue to operate through to at least 2045, but future targets have not yet been announced. Ahead of the consultation process on these targets, our models continue to use the existing 2025 target as a future baseline policy setting (as per our 2023 forecasts), but we assume higher rate of electrification resulting from the VEU programmes, as a range of gas efficiency activities have been removed from the scheme since the last forecasting round.

This component is forecast to generate electricity savings peaking at around 3,800 GWh through the late 2030s, and gas (efficiency) savings of up to 1.4 PJ in the mid-2040s, under Progressive Change. These values would be expected to increase to around 4,000 GWh and 2.3 PJ under Step Change, and to 4,300 GWh and 3.1 PJ under Green Energy Exports. We note that these numbers could be expected to increase once new targets are announced, likely during 2025.

*REPS*

REPS targets are set as a fixed number of GJ of energy per year and, at this time, no targets have been set beyond 2025, although the program is expected to continue until at least FY2030. Because of the nature of the target, there is almost no differentiation between scenarios, as it is primarily the size of the target that determines savings – although we model small differences in the timing of savings by scenario. Overall, we assume a linear continuation of current trends to FY2030, but then assume no new targets are set beyond that point, subject to potential future consultations on such targets. We understand such consultations are not expected before the second half of 2025. On this basis, REPS is forecast to generate electricity efficiency savings in the commercial sector peaking at around 300 GWh (and no gas savings) in FY2025, falling to zero after FY2039. As with VEU, the outlook for later-period savings from REPS could change following consultations on future targets.

*GEMS/E3*

The E3 program is described in Section 6.1.1. As noted, forecasts have been improved this year by drawing on Energy Consult comprehensive review and consolidation of impacts.[53] Based on the approach described in Section 6.1.1, we expect the GEMS/E3 program to deliver some 1,200 GWh of efficiency savings in the commercial sector by FY2058 under Progressive Change; 3,300 GWh

[53] Energy Consult, *GEMS Data Modelling Project 2022*, prepared for DCCEEW, February 2023.

under Step Change; and 4,000 GWh under Green Energy Exports. These forecasts should be reviewed in future years in the light of a new Strategic Plan for the program that is expected to be developed during 2025.

*MEPS (Minimum Energy Performance Standards for Existing Buildings)*

This is a potential future measure that is envisaged in KPMG (2024) as an element of the CBD Expansion Roadmap. We note that there is as yet no government commitment to introduce this measure. It is modelled here in the context of AEMO's scenarios, which do envisage policy change over time, in degrees that are differentiated by scenario.

SPR modelled MEPS options as part of the project referred in the CBD section above, and we again draw on this analysis for the current forecasts – noting that there is considerable uncertainty about whether, when and exactly how this measure might be introduced. We recall that a similar measure was modelled in 2023, but our modelling approach this year is able to be more precise, given the extensive work SPR has done in this area since the last forecasts.

Applying MEPS to existing buildings would represent a new policy type in Australia, and – like any new policy – it would require governmental support and may also require the passage of supporting legislation.[54] For these reasons, we assume the there are no MEPS under Progressive Change; modest introduction and expansion of MEPS under Step Change; and wider and earlier application under Green Energy Exports. On this basis, MEPS savings would be expected reach some 3,600 GWh of electricity and 2.9 PJ of gas by FY2058 under Step Change, and over 4,200 GWh and 3.5 PJ under Green Energy Exports. We note that savings assumptions are sensitive to program design assumptions and could be significantly higher than these values if future governments set high policy ambitions.

*NCC*

Figure 48 to Figure 50 results are consistent with those from past years in identifying NCC energy performance requirements as by far the most significant of the commercial sector policy measures, in terms of the total efficiency savings induced (in all scenarios). This results from:

- New building energy performance standards being significantly higher stringency that the older stock that – through stock turnover – it effectively replaces
- This savings effect accumulates over time, as new buildings are constructed annually to higher performance specifications
- The economics of building energy performance improvement (particularly with respect to the building envelope or thermal shell; but also design fundamentals) favours new

[54] Potentially, existing legislation could either cover this or be amended to do so.

construction over retrofit, as do other practical considerations, such as the challenge of retrofitting occupied buildings and, even moreso, those that operate 24/7.

Compared to the previous forecasts, NCC2025 is expected to deliver higher stringencies for non-residential buildings, effective from FY2026, and the policy process to put these in place is well advanced, if not yet certain. We differentiate AEMO scenarios by assuming that stringency reviews – potentially leading to stringency changes – occur every 3 years (as agreed by Energy Ministers but not implemented in reality) under Green Energy Exports, falling back to 6 years under Step Change (in line with recent practice) and 9 years under Progressive Change (indicative of the rate of change in the 2010s).

We assume that the rate of change in stringency slows over time, under all scenarios, due to an expectation of saturation of cost-effective efficiency opportunities over the period to FY2058. This is not to suggest that cost-effective efficiency opportunities will fall to zero, but rather that those opportunities will increasingly be represented by new technologies and changes in relative prices which are market-led rather than policy-led effects. Also, we do expect increasing competition for cost-effective efficiency improvement options to be presented by PV, storage and other demand-management technologies that may deliver higher returns to building owners. These trends are also likely to continue to also reduce the opportunity and actual cost of electricity consumption in buildings, weakening incentives to invest in efficiency improvement. On the other hand, building thermal shell performance requirements may increase in future as an adaptation to a changing climate, and specifically (in the NCC) through the mechanism of the thermal comfort (rather than energy performance) requirements, which aim to ensure comfort and safety for building occupants. This potential is not quantified in the current forecasts.

Also, we recall that we are projecting (underlying) energy efficiency change in this project, and not greenhouse gas emissions; however, it is not implausible that future NCC requirements (for all building types) could be specified in emissions, rather than energy, metrics. Given the potential for on- and off-site PV to contribute to emissions targets, these could prove more cost-effective and more flexible than continuing to set (what are effectively) energy intensity goals (for 'reference buildings'), since it would open up a wider set of compliance options. However, we cannot make forecasts on this basis at this time. We raise it here simply to note that the assumptions that underpin these forecasts could feasibly change in future. That said, for the energy market, the current energy-based targets are more predictable than emissions-based ones would be, since the latter would allow for the energy intensity/demand of new buildings to rise, while still meeting low or zero emissions standards, provided renewable electricity is used to cover this demand.

Forecast savings respond significantly to scenario assumptions both through stock turnover effects and higher/earlier stringency increases in Step Change and Green Energy Exports, cf Progressive Change. Under Progressive Change and by FY20258, we expect this component to deliver some

17,800 GWh of electricity savings and 2.1 PJ of gas savings.  Under Step Change (and Green Energy Exports), gas savings are lower and electricity savings higher, as we assume more new buildings choose all-electric pathways in the latter scenarios.  Specifically, under Step Change we forecast electricity savings reaching 28,700 GWh by FY2058, with 0.5 PJ of gas savings in the same year; while under Green Energy Exports, we forecast electricity savings reaching just over 45,000 GWh by FY2058, with gas savings of 0.4 PJ.

***By Region***

The forecasts by region and scenario, presented in Figure 54 to Figure 56 below, generally show similar relativities between regions, with the notable exception of the three state schemes:  ESS in NSW, VEU in VIC and REPS in SA. Other components are assumed to have similar effects across jurisdictions, broadly in proportion to their shares of national GVA services – although other effects count, such as the jurisdictional shares of new construction work in the sector.

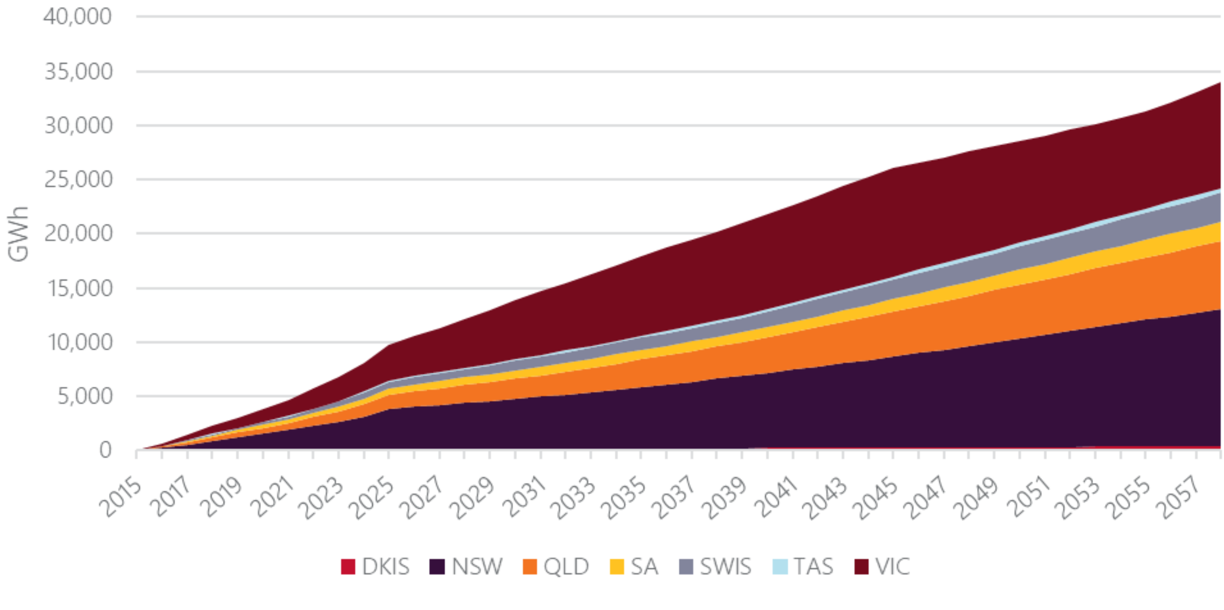


**Figure 54:  Commercial Sector Electricity Efficiency Savings Forecasts by Region, Progressive Change Scenario**

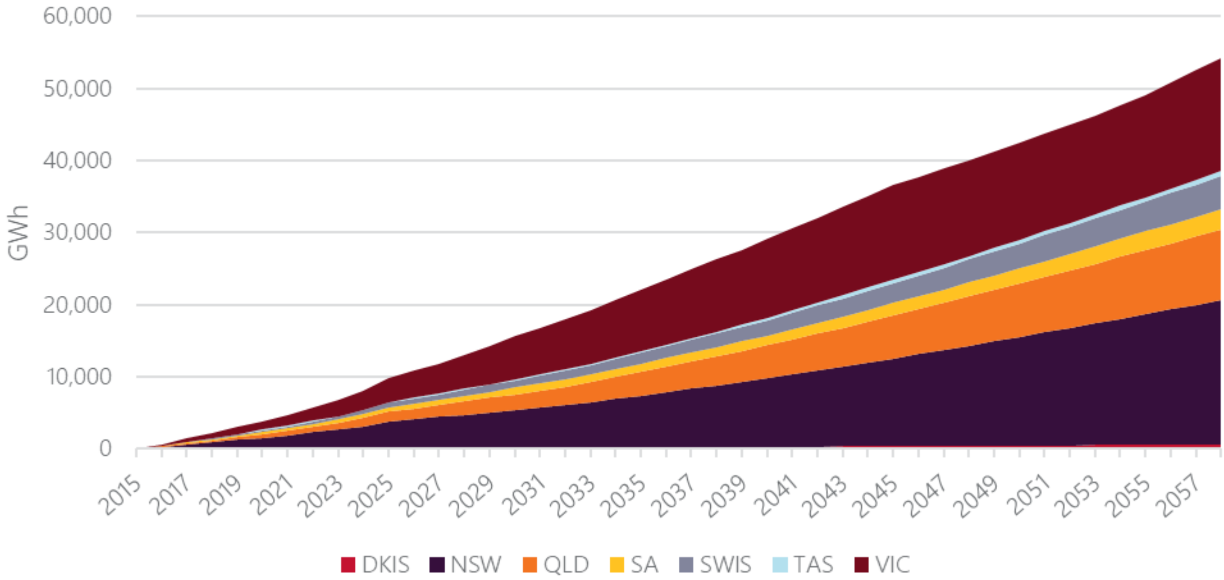


**Figure 55: Commercial Sector Electricity Efficiency Savings Forecasts by Region, Step Change Scenario**

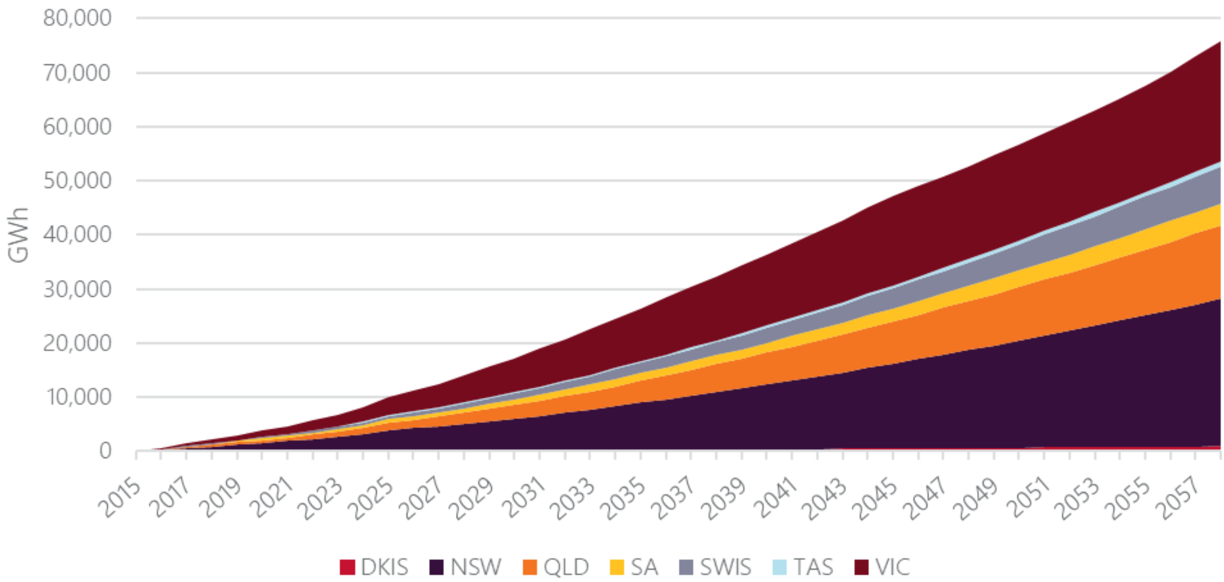


**Figure 56: Commercial Sector Electricity Efficiency Savings Forecasts by Region, Green Energy Exports Scenario**

### *Comparison with FY2023 Forecasts*

Figure 57 shows 2023 and 2025 total commercial sector electricity efficiency forecasts, for all components, load types and regions. The 2025 forecasts are lower, with the key reason being lower assumptions for AEEI, as a result of aligning these assumptions with those in CSIRO's multi-sector modelling. Other (policy) components are generally higher than last year, as is shown in Figure 58 (and discussed further below). Note that the lower AEEI assumptions also apply in the historical period, and this is what accounts for the lower trajectory of savings in the historical period in the 2025 forecasts, when compared to the 2023 forecasts. Another consequence is that the 2025 forecasts start from a lower point, when measured from a 2015 base year, as is evident in the figure. However, AEMO rebases these forecasts in any case, so this difference historical observations will not impact on AEMO's forecasts.

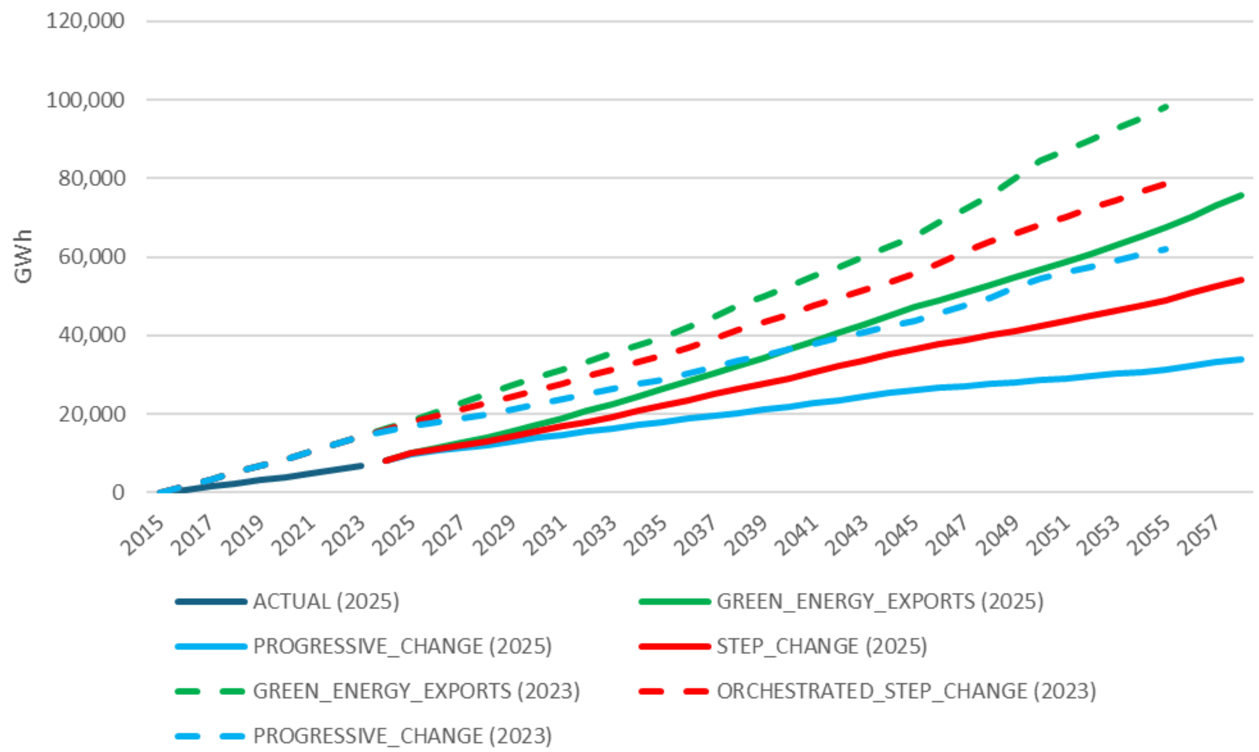


**Figure 57: Comparison of 2023 and 2025 SPR (Total) Energy Efficiency Forecasts, Commercial Sector Electricity**

Figure 58 presents similar data to Figure 57, but excluding AEEI in both forecasts. This highlights the comparison between just the policy components in the two sets of forecasts. It may be noted, first, that the two forecasts now align in the historical period, while the Green Energy Exports (in particular) and Step Change policy components are materially higher in the 2025 forecasts than in the 2023 forecasts, generally from 2030 onwards. The two key contributors to this increase are, first, the CBD expansion roadmap (which is new/anticipated); and second, the NCC energy performance requirements (including plans for NCC2025 and ongoing increases over time). In addition, NABERS savings are materially higher (due to our inclusion of – and also the expansion of – non-office tools), while there are smaller increases from MEPS and state schemes.

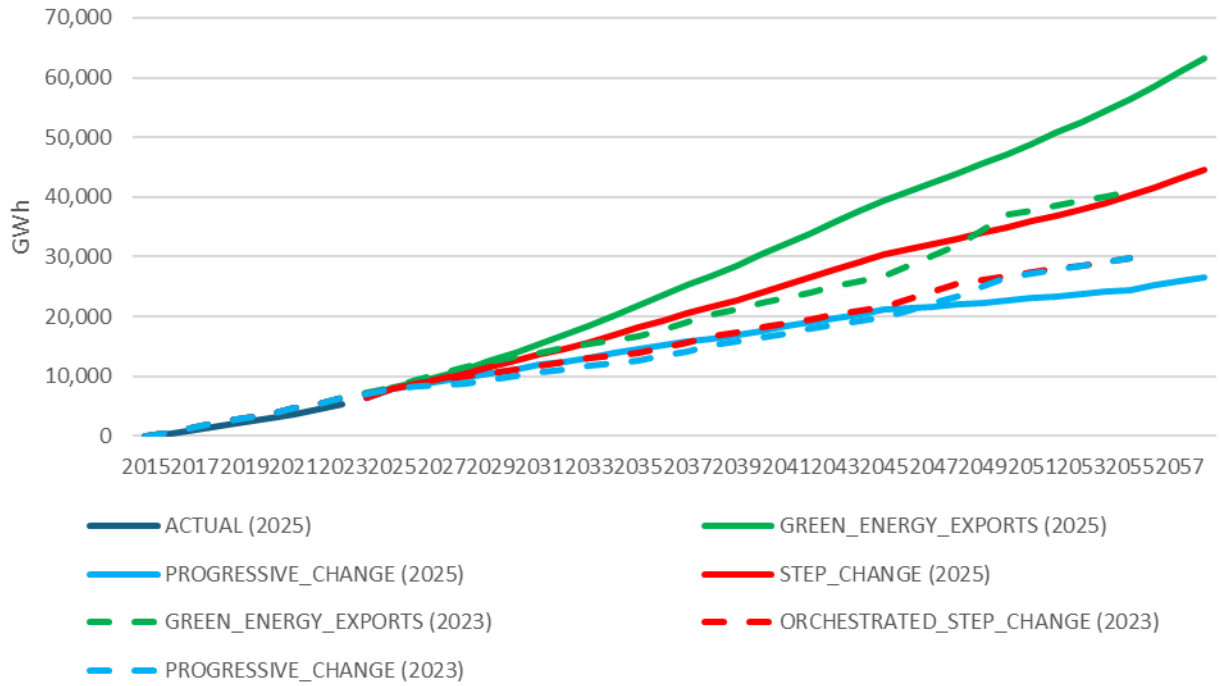


**Figure 58: Comparison of 2023 and 2025 SPR Energy Efficiency Forecasts, Commercial Sector Electricity, no AEEI**

Figure 59 shows a similar comparison for commercial gas efficiency, including AEEI. While the 2025 forecasts are higher than in 2023, the magnitude of the differences is around 6 PJ over 35 years, as gas is a minor fuel in this sector. The increases are due to multiple effects: AEEI assumptions (higher due to alignment with MSM), the CBD expansion roadmap (new since 2023, and including the MEPS component), while ESS and VEU are somewhat higher than in 2023, notably in the later years, due to target extensions. The differences in savings in the historical period is mainly attributable to change in historical energy consumption data sources from Australian Energy Statistics to AEMO internal data.

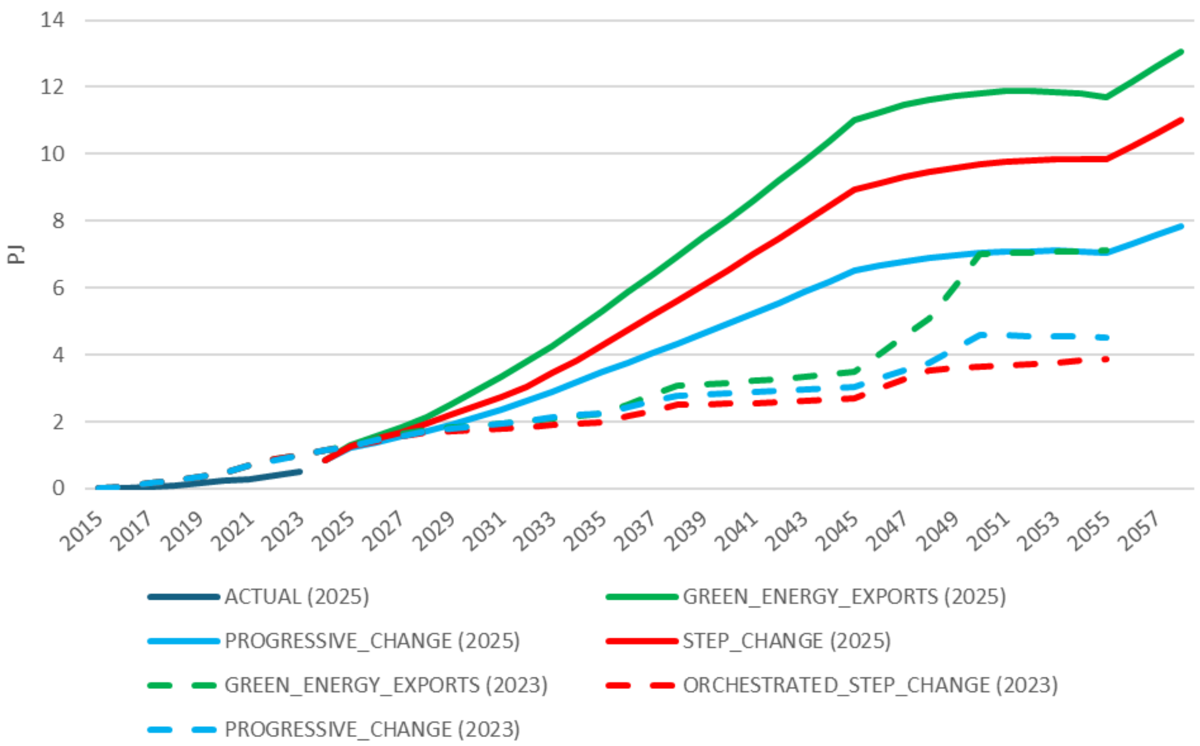


**Figure 59: Comparison of 2023 and 2025 SPR (Total) Energy Efficiency Forecasts, Commercial Sector Gas**

Figure 60 presents the 2023 and 2025 commercial gas efficiency forecasts without AEEI. The overall trends remain the same, but the gap between the forecasts is now smaller. This is consistent with the AEEI assumptions being higher in 2025 than they were in 2023, as noted above.

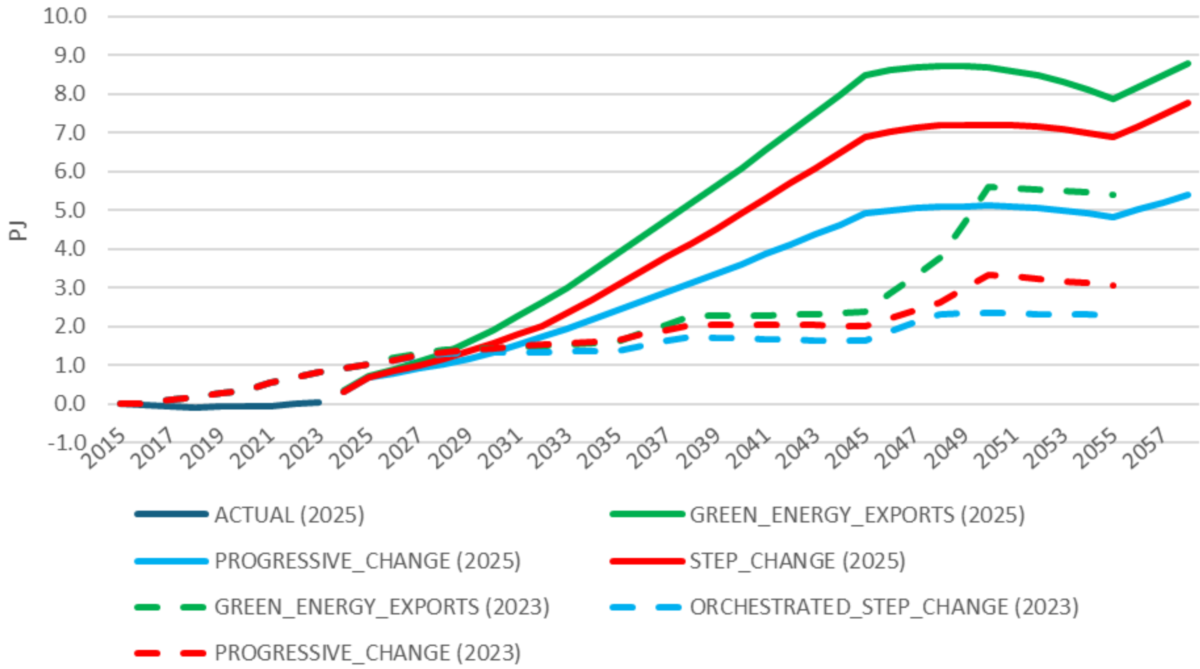


**Figure 60: Comparison of 2023 and 2025 SPR Energy Efficiency Forecasts, Commercial Sector Gas (no AEEI)**

### 6.2.2 Industrial

***Overview by Scenario***

Figure 61 shows an overview of industrial sector electricity efficiency savings by scenario. The overall shape of these curves reflects MSM AEEI assumptions for his sector, which include an inflection at 2030. In reality, such an effect would likely be smoothed over a period of time. The second key influence is the different assumptions for overall GVA for the industrial sector. As discussed further below, there are relatively few policy measures that impact on industrial electrical efficiency, so AEEI dominates the overall savings.

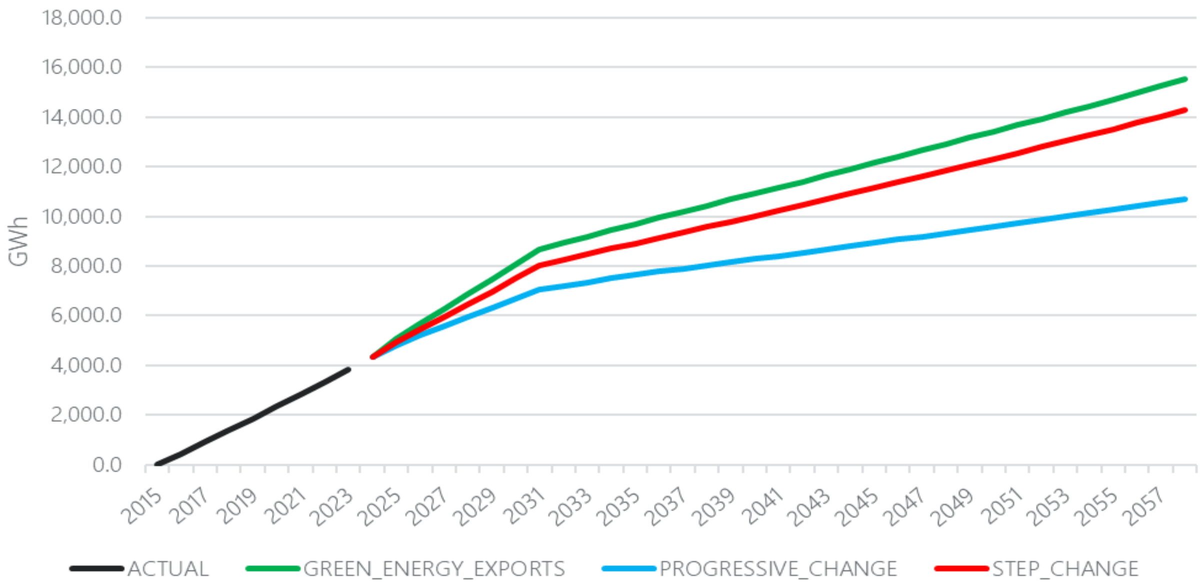


**Figure 61: Industrial Sector Total Energy Efficiency Savings, Electricity, by Scenario**

For gas, Figure 62 indicates that efficiency savings are forecast to be significantly higher than for electricity, due primarily to the impact of the Safeguard Mechanism, as discussed in the following section. For all jurisdictions, gas savings would reach 129 PJ by FY2058 in Progressive Change, 143 PJ in Step Change, and 159 PJ in Green Energy Exports.

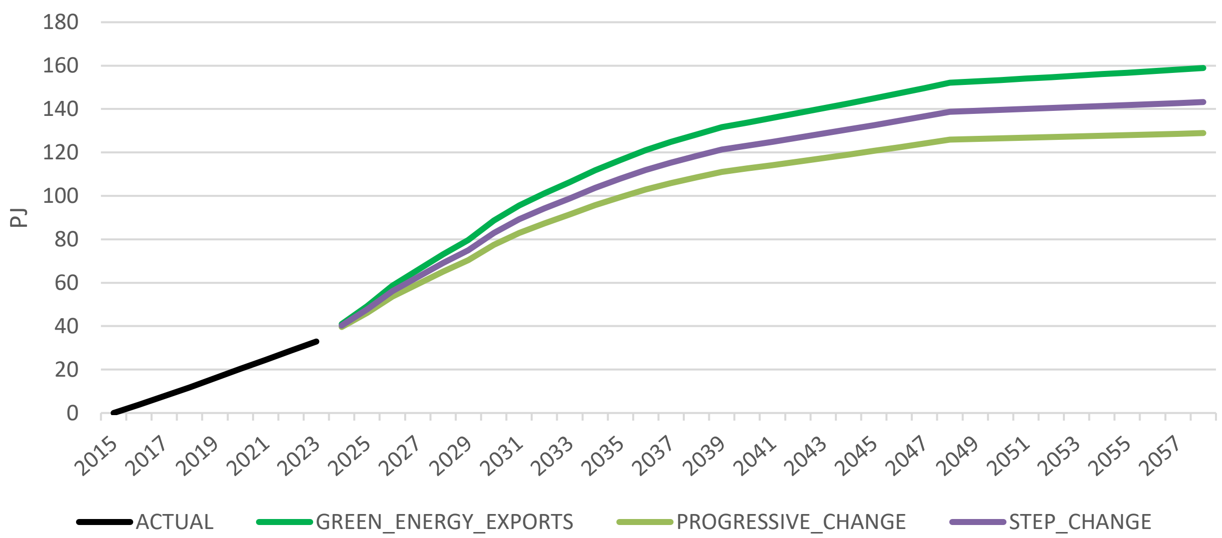


**Figure 62: Industrial Sector Total Energy Efficiency Savings, Gas, by Scenario**

***By Component***

Figure 63 to Figure 65 show forecast industrial electrical efficiency savings by component, for Progressive Change, Step Change and Green Energy Exports respectively. The dominance of AEEI is evident in each case, and while GEMS offers some savings in this sector (for example through industrial motors and larger heat pumps), most of this program's impact is expected to be in the residential and commercial sectors. Contributions that are particularly relevant in a regional market context – but that also have national-scale effects – are made by ESS, VEU and REPS. The Safeguard is assumed not to have additional impacts for electricity, as Scope 2 emissions are excluded from that mechanism.

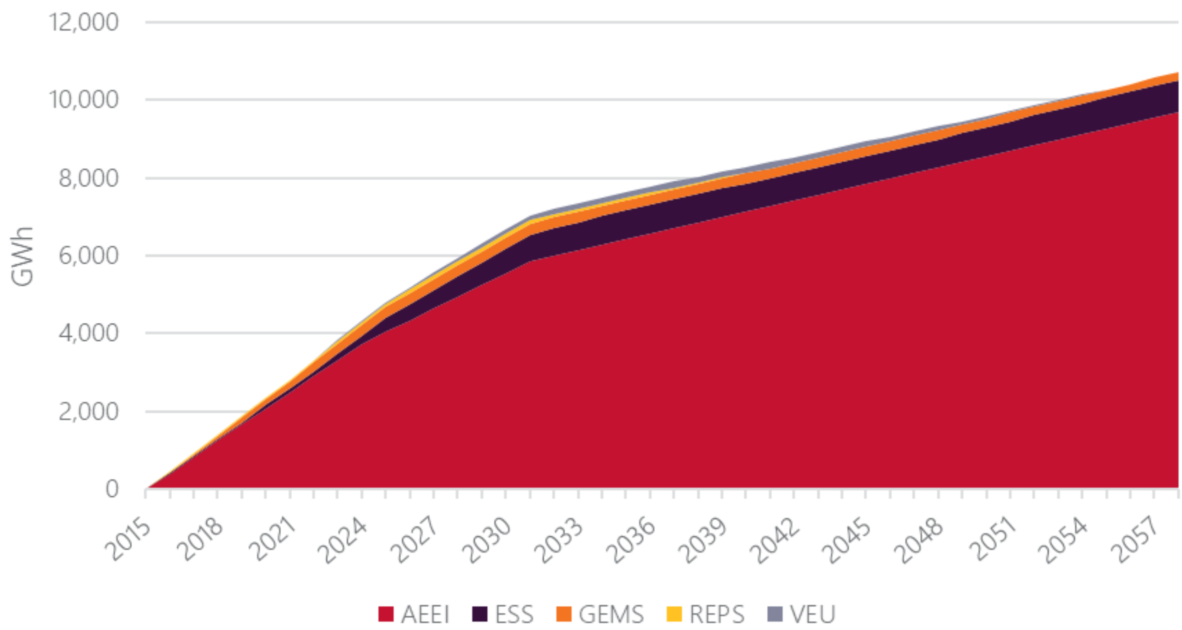


**Figure 63: Industrial Sector Electrical Energy Efficiency Forecast by Component, Australia, Progressive Change Scenario**

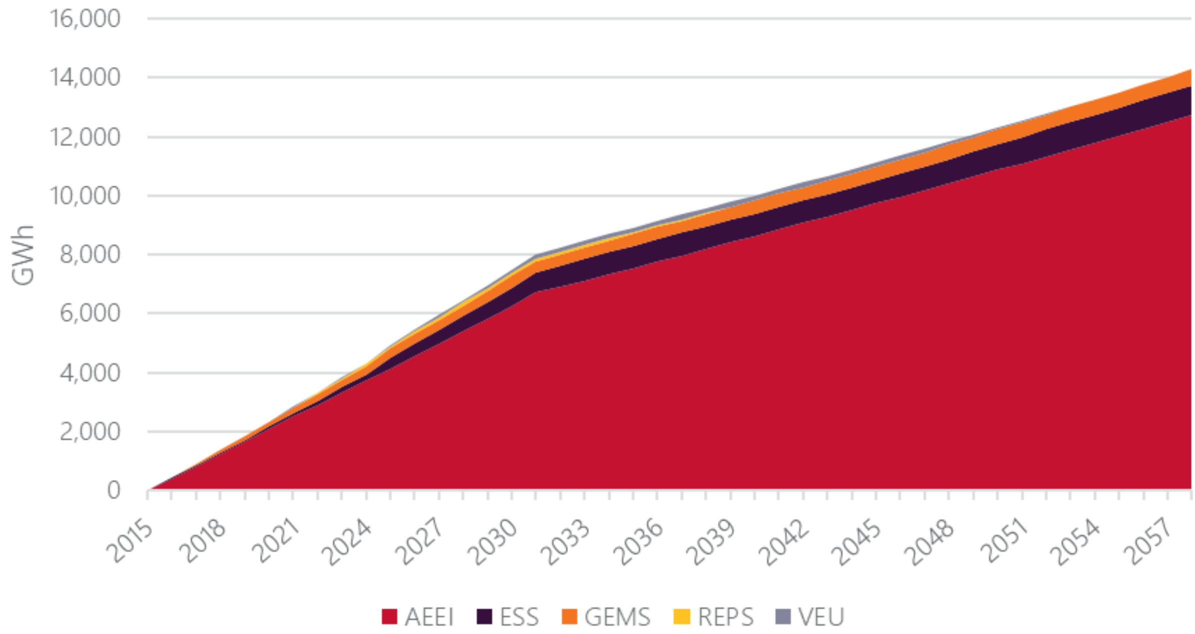


**Figure 64: Industrial Sector Electrical Energy Efficiency Forecast by Component, Australia, Step Change Scenario**

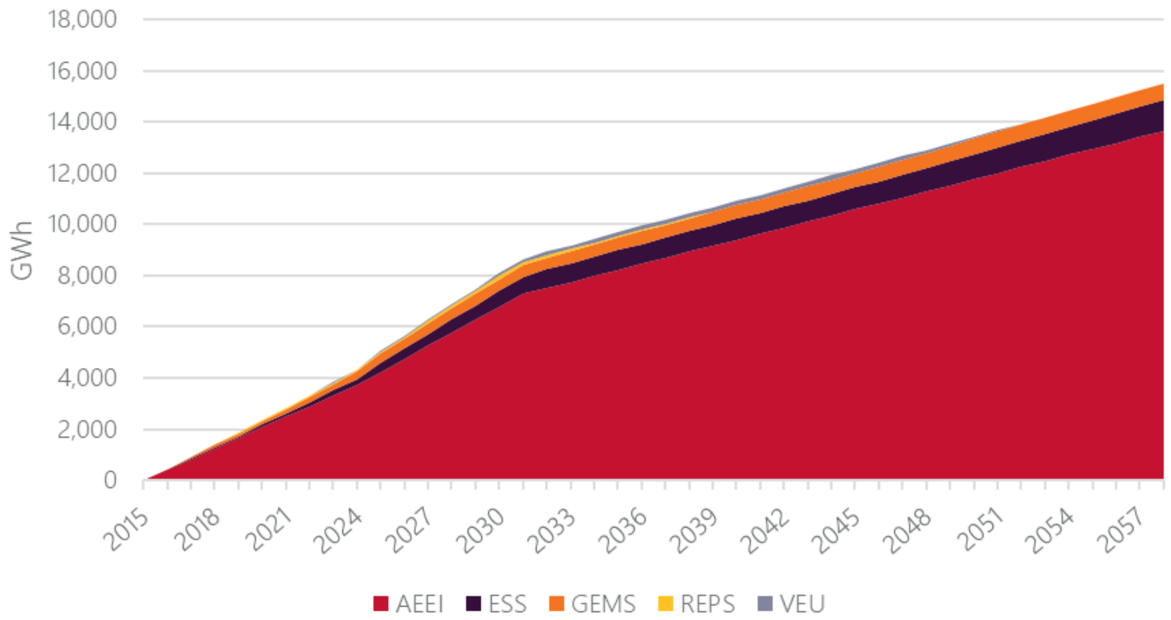


**Figure 65: Industrial Sector Electrical Energy Efficiency Forecast by Component, Australia, Green Energy Exports Scenario**

Turning to gas, Figure 66 to Figure 68 show the industrial sector gas efficiency savings by component, for each of the three scenarios. As noted in the previous section, gas efficiency savings are much higher than for electricity, due to the Safeguard Mechanism (that was revised and significantly expanded in impact from July 2023).

For this analysis we draw on estimates prepared by DCCEEW.[55] These estimates run to 2040, and we extend them by linear projection to FY2050 and assume no further increase in savings after this date, subject to future policy decisions. DCCEEW distinguishes electrification from other efficiency change, so we can be confident that the above results do not include electrification. DCCEEW's latest forecasts are broken down by fuel, and we extract only the gas efficiency savings for this analysis. We also assume a 10% discount for uncertainty with respect to the realisation of expected savings, as the revised Safeguard Mechanism is too new to have a clear track-record in this respect, and other strategies – most importantly, electrification (since Scope 2 emissions are excluded) – may prove more attractive. We also exclude Safeguard savings arising from power generation, as these are also outside our scope, but these are expected to be minor in any case.

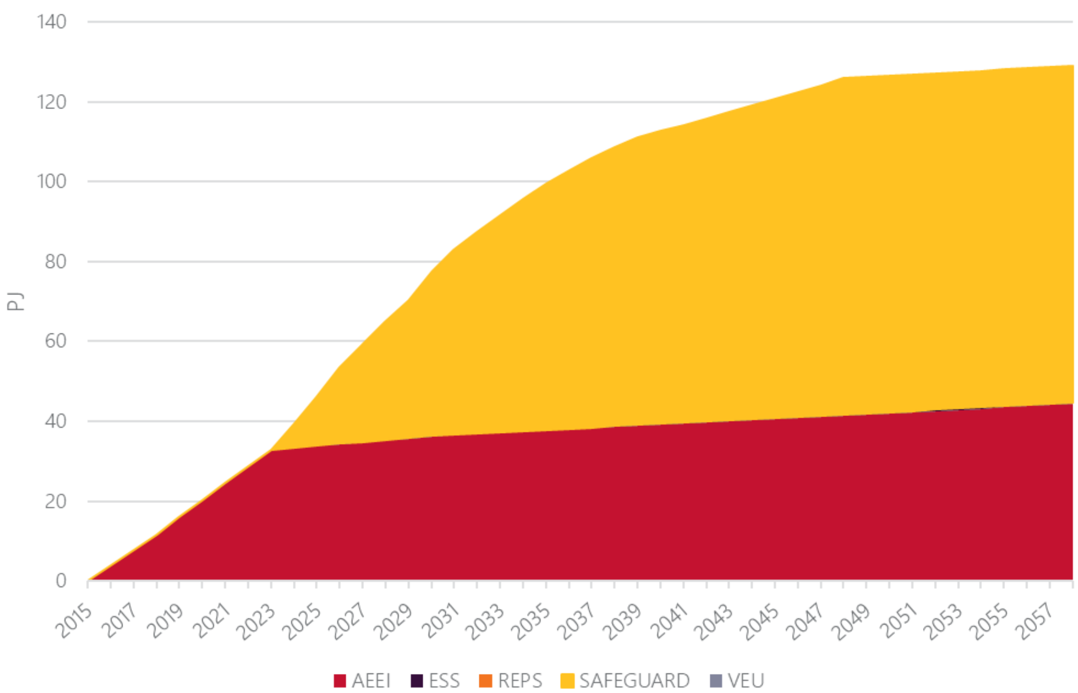


**Figure 66: Industrial Sector Gas Energy Efficiency Savings by Component, Progressive Change**

[55] Provided directly by DCCEEW, with thanks. Related analysis is published in DCCEEW, *Australia's Emissions Projections 2024*, November 2024.

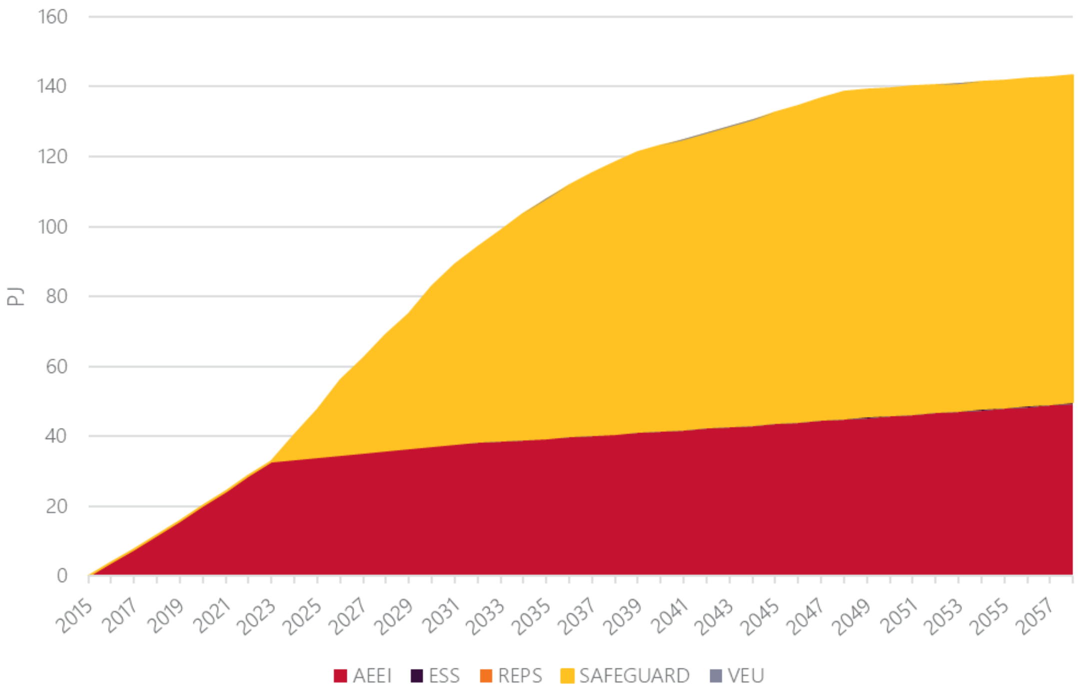


**Figure 67: Industrial Sector Gas Energy Efficiency Savings by Component, Step Change**

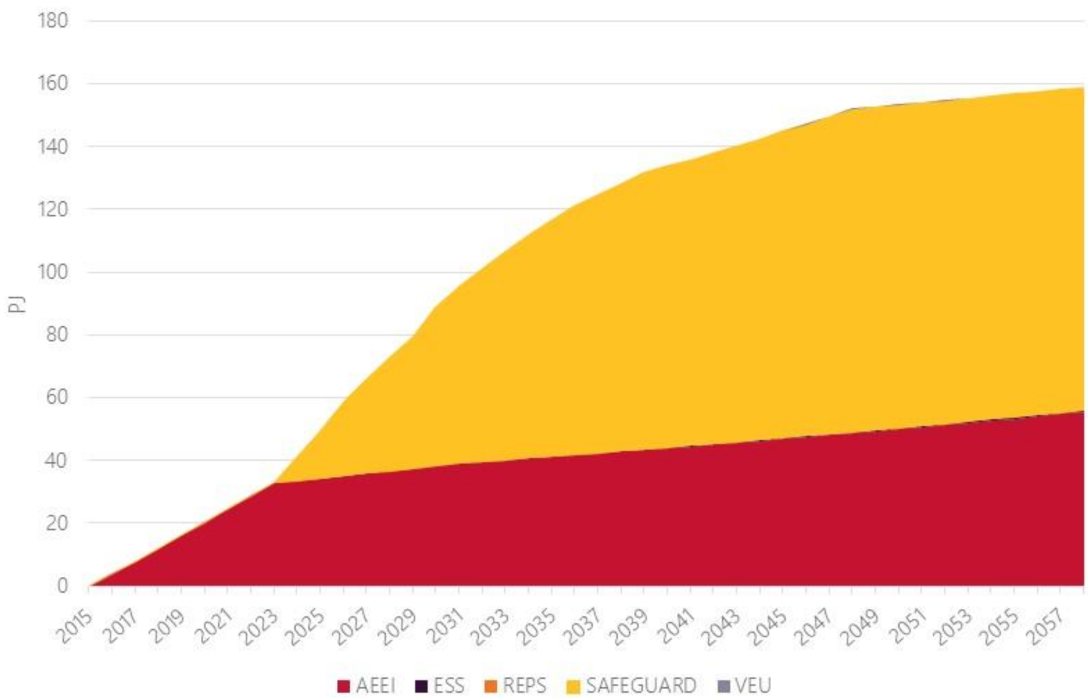


**Figure 68: Industrial Sector Gas Energy Efficiency Savings by Component, Green Energy Exports**

There is limited differentiation of policy effects by scenario, since the Safeguard Mechanism is an emissions abatement policy, and the three AEMO scenarios assume the same emissions targets for each scenario. Therefore, the differentiation is primarily due economic and output variations between the scenarios. However, we associate the DCCEEW projections with Step Change and assume 10% higher savings under Green Energy Exports and 10% lower under Progressive Change.

A key assumption relating to the Safeguard Mechanism, that is evident in the relevant figures, is that Safeguard is expected to fully 'crowd out' any market-led or autonomous gas efficiency improvements that might otherwise have occurred in the LIL sector, since there is a very strong incentive to count all such savings towards a covered enterprise's targets. This is not to say that there would not be market-led efficiency savings in the LIL/Safeguard segment of the industrial sector, but only that these savings are now expected to be reported as Safeguard savings. Therefore, to avoid double-counting, we assume that AEEI is not additional to Safeguards, with this affecting forecasts from FY2023 onwards.[56] The residual growth in AEEI in the forecast period – evident in all three figures – relates exclusively to SMEs.

As with electricity, gas savings are also realised by the state efficiency schemes. These are relatively small in total (totalling less than 1 PJ per year), since we assume that the primary impact of these schemes remains on the residential, and secondarily commercial, sector. We also assume that GEMS continues to focus on electricity, rather than gas, as per current trends. We note that both assumptions could change in future, subject to future policy decisions.

### *By Region*

Figure 69 to Figure 71 show the industrial electricity energy efficiency forecasts by region. Generally, the regional shares reflect the distribution of historical electricity consumption GVA industrial by jurisdiction (as we noted in Section 2 that GVA assumption not differentiated by region, but rather by state and territory). In addition, the state schemes add to savings for NSW, VIC and SA.

[56] We note that this could be conceptualised in the reverse order; that is, that there would be some level of AEEI affecting gas efficiency in the LIL sub-sector, absent the Safeguard Mechanism, and then discount the *additional* impact of Safeguard by this AEEI amount. Mathematically the two approach are identical. Practically, however, we prefer the first approach as it accords with the expected mode of operation and impact of Safeguard, and because the AEEI counter-factual is inherently uncertain. Strategies to reduce this uncertainty are discussed in Chapter 8 – Limitations and Improvement Opportunities.

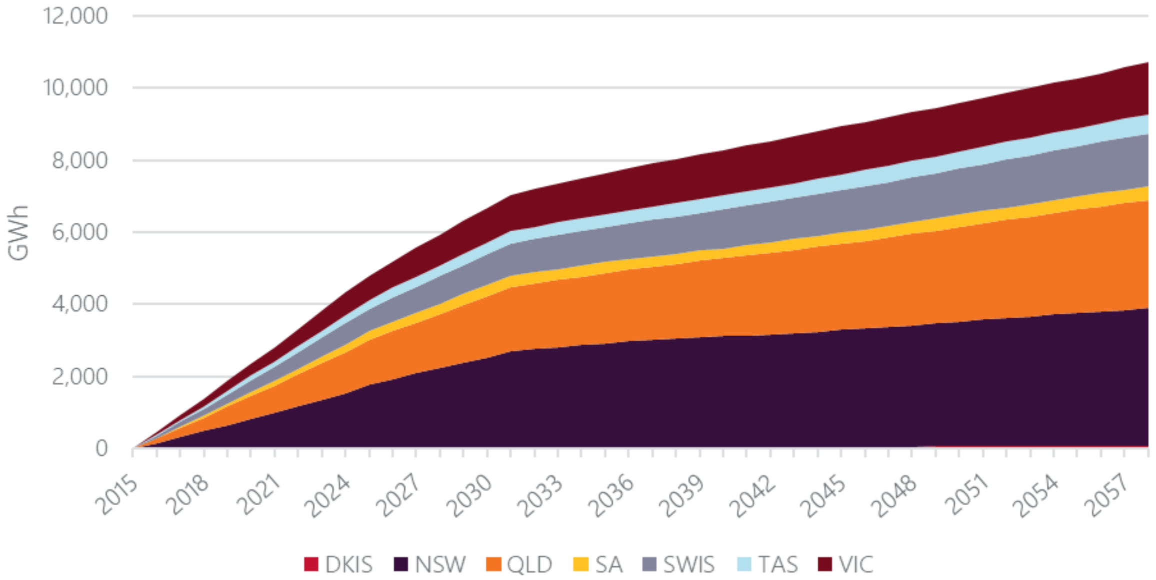


**Figure 69: Industrial Sector Energy Efficiency Forecast by Region, Electricity, Progressive Change Scenario**

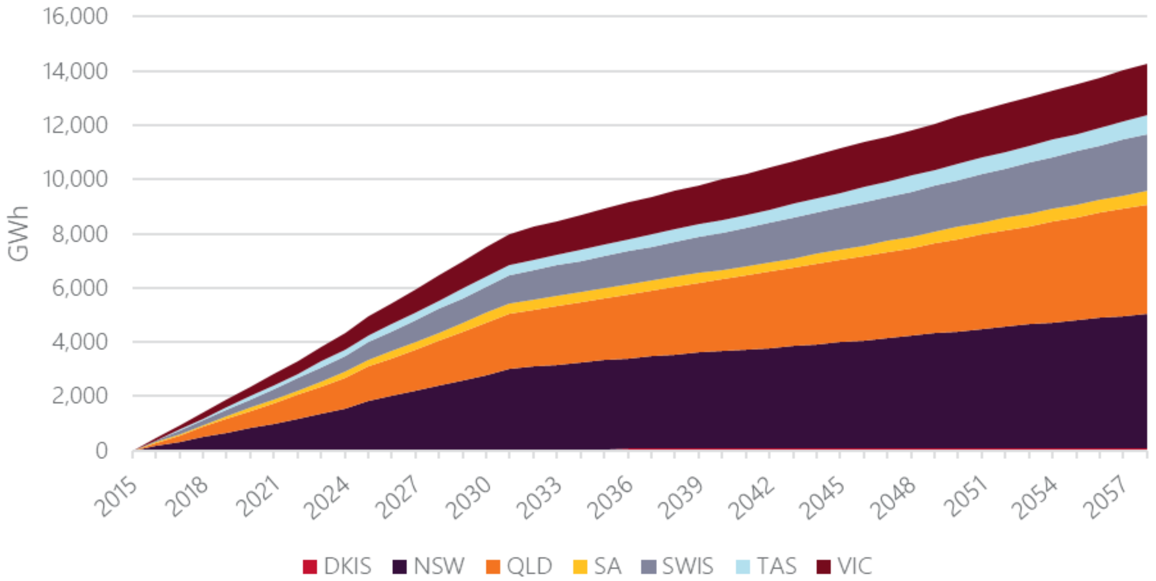


**Figure 70: Industrial Sector Energy Efficiency Forecast by Region, Electricity, Step Change Scenario**

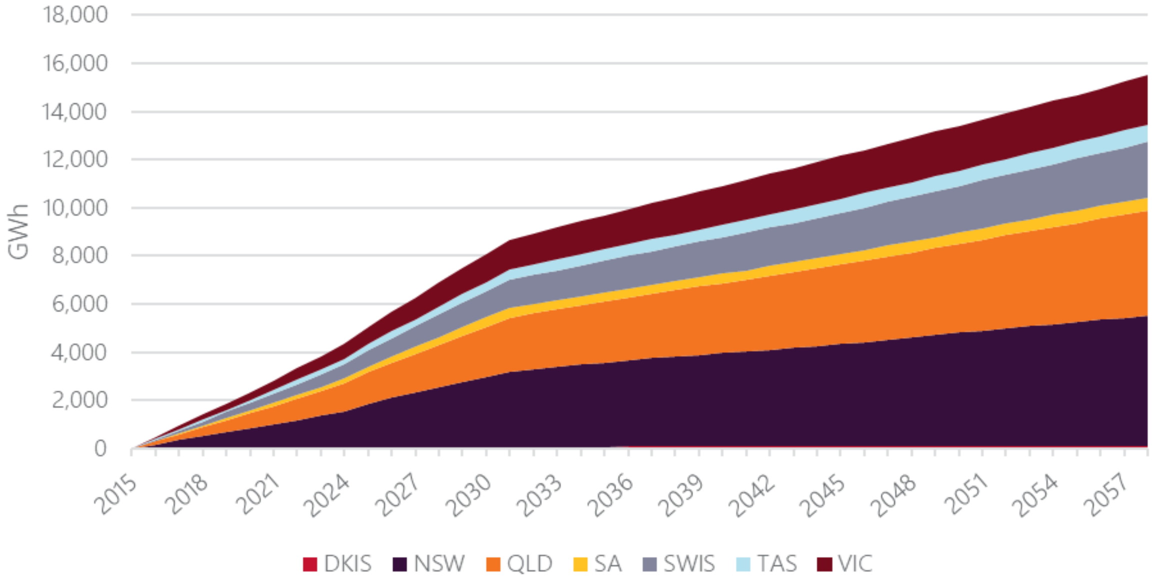


**Figure 71: Industrial Sector Energy Efficiency Forecast by Region, Electricity, Green Energy Exports Scenario**

In the gas market, the state/territory shares are significantly different than those for electricity, since industrial gas (and related output) are relatively concentrated in WA and QLD in particular, as shown in Figure 72 to Figure 74.

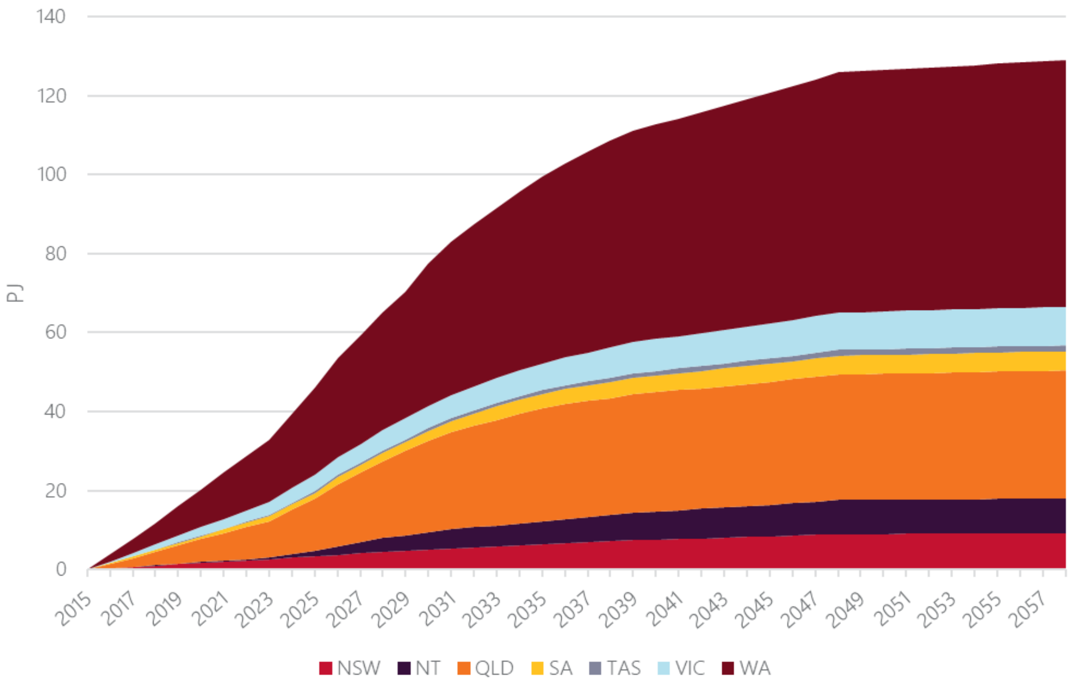


**Figure 72: Industrial Sector Energy Efficiency Forecast by Region, Gas, Progressive Change Scenario**

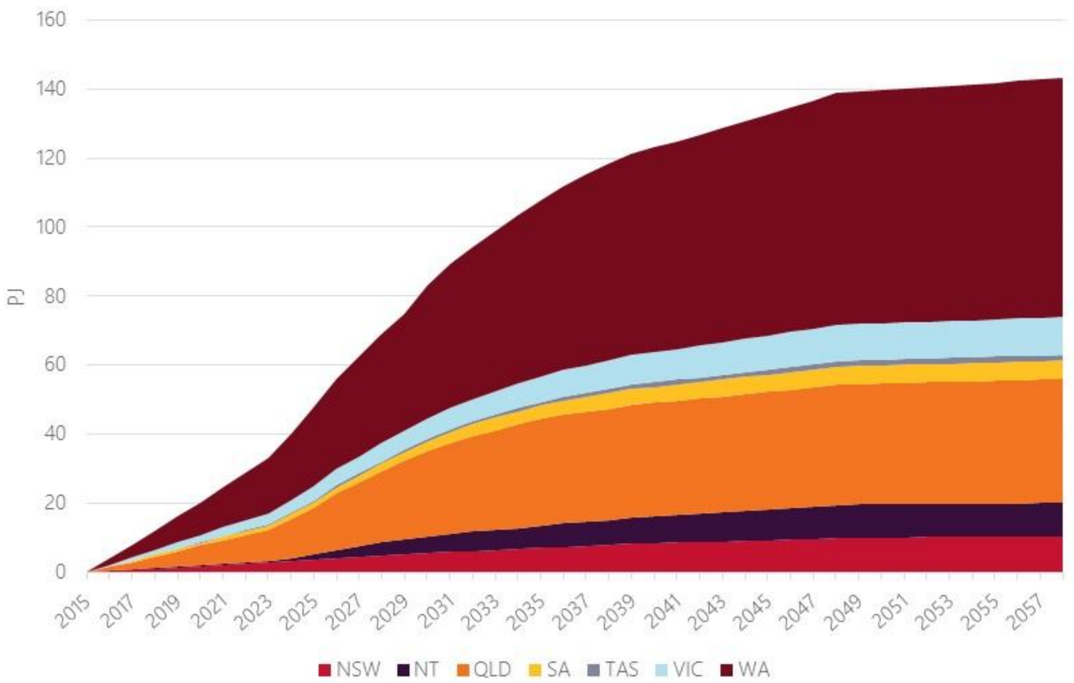


**Figure 73: Industrial Sector Energy Efficiency Forecast by Region, Gas, Step Change Scenario**

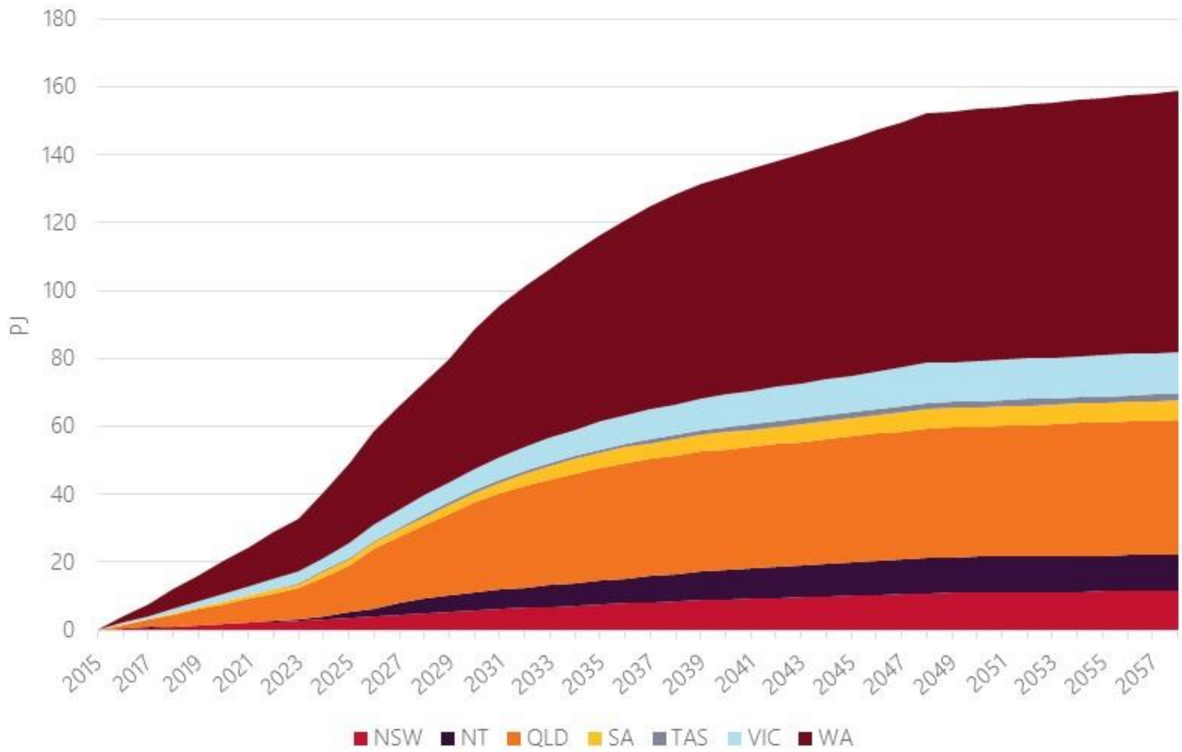


**Figure 74: Industrial Sector Energy Efficiency Forecast by Region, Gas, Green Energy Exports Scenario**

We recall that – to the limit of the underlying data accuracy – these savings exclude LNG and GPG (gas power generation) and, as noted above, they also exclude electrification effects. However, as noted above, since the Safeguard Mechanism creates very strong incentives for electrification incentives, we recommend that the actual efficiency/electrification split of savings induced by Safeguard is reviewed annually, or as often as program reporting allows.

### *Comparison with FY2023 Forecasts*

Figure 75 shows that the 2025 forecasts considerably higher total electrical efficiency savings than in the industrial sector than in the 2023 forecasts. The key reason for the increase is the inclusion of AEEI for this sector for the first time. In the 2023 forecasts, there was no estimate of AEEI for industrial, but this is included in the 2025 forecasts – as is discussed in Chapter 2 (Methodology). As is shown in Figure 77 (discussed further below), the policy-led savings are actually considerably lower in the 2025 forecasts. As was also noted for commercial electricity, the majority of the differences occur in the historical period, and these will not impact on AEMO's forecasts. This can seen by comparing Figure 75 with Figure 76, where the latter is rebased to FY2023.

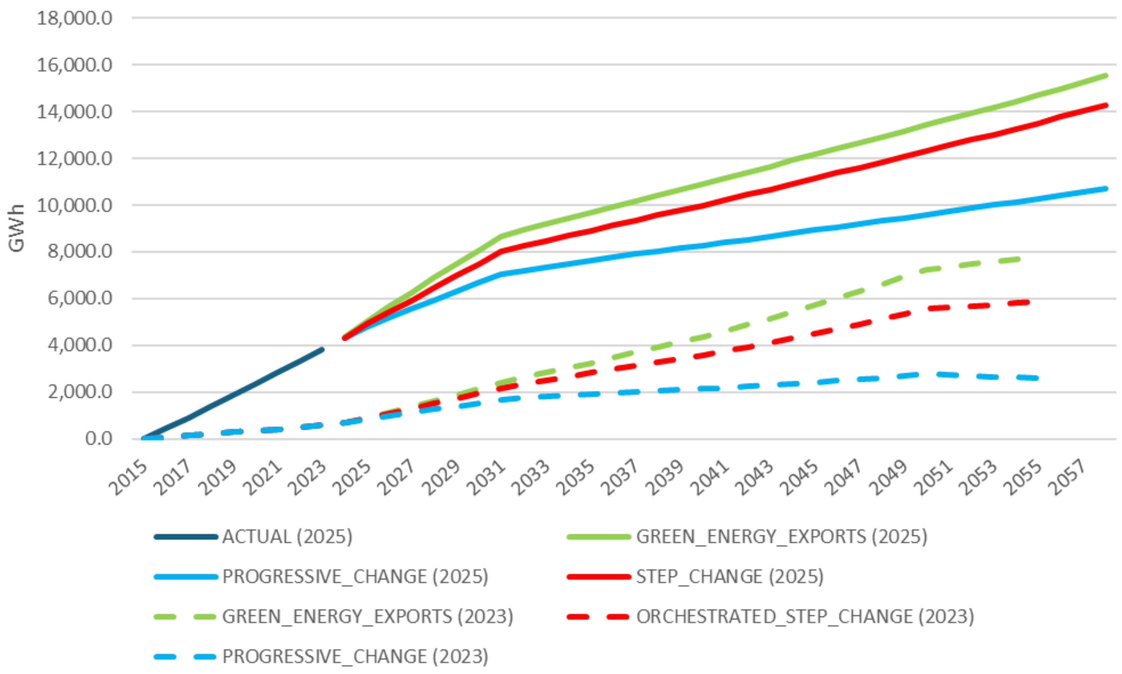


**Figure 75: Comparison of 2023 and 2025 Industrial Electricity Efficiency Forecasts, Australia, by Scenario**

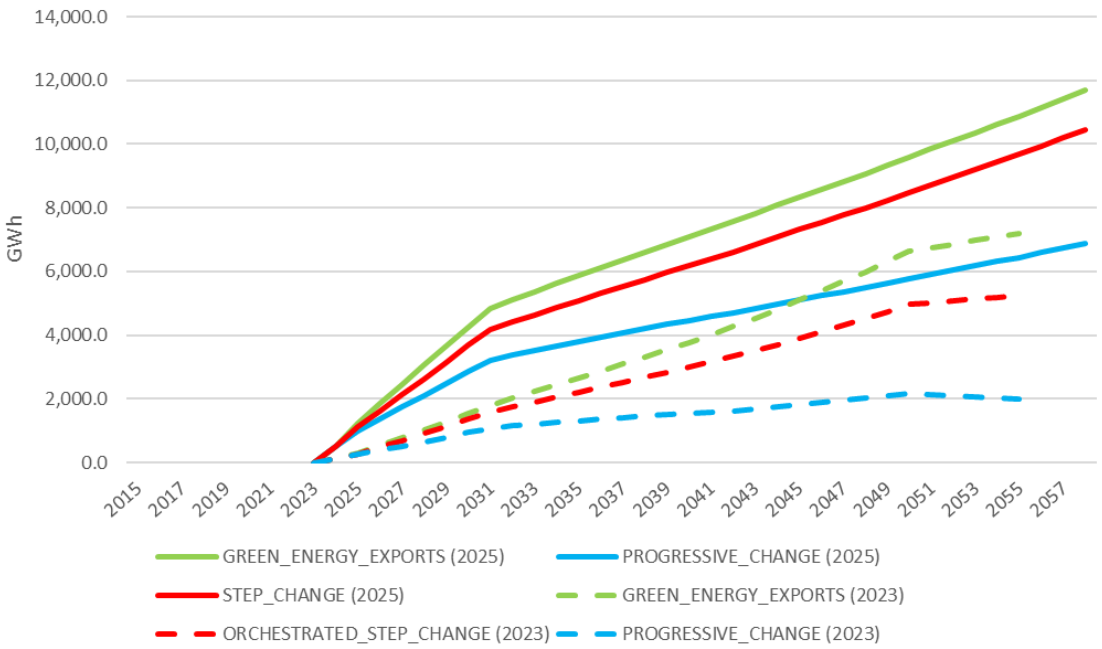


**Figure 76: Comparison of 2023 and 2025 Industrial Electricity Efficiency Forecasts, Australia, by Scenario, rebased to FY2023**

Finally – for industrial electricity – Figure 77 shows the 2023/2025 forecast comparisons by scenario, without AEEI. The first observation is that the gap in the historical period, evident in Figure 75, has closed, which is consistent with the inclusion of AEEI in this sector for the first time in the 2025 forecasts being a key driver of the differences in the foreasts. Second, Figure 77 also highlights that the *policy-led* savings are now forecast to be lower in all scenarios. The key reasons for this are:

- the inclusion of AEEI means that policy measures must now be discounted by the extent of their non-additionality to AEEI, to avoid double-counting
- we have removed the Industrial Assessments (hypothetical) policy, in the 2025 forecasts, as this measure has effectively been made redundant, or implausible, by the Safeguard Mechanism
- a smaller impact is that we now anticipate no electricity savings to be induced by the Safeguard Mechanism, since Scope 2 (electricity-related) emissions are excluded from the measure.

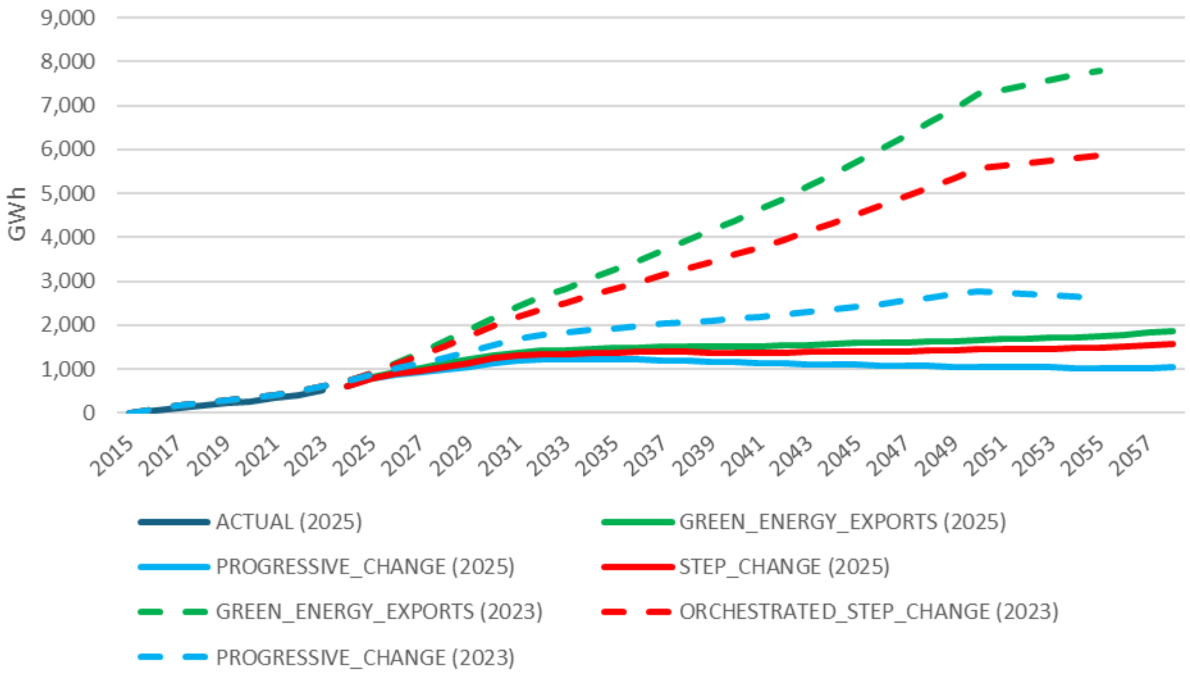


**Figure 77: Comparison of 2023 and 2025 Industrial Electricity Efficiency Forecasts, Australia, by Scenario, no AEEI**

Turning to the industrial gas efficiency forecast comparisons, Figure 78 compares the industrial gas forecasts from 2023 and 2025, by (comparable) scenario. The 2025 forecasts are significantly higher, for two main reasons. First, new data from DCCEEW indicates a much higher impact – and specifically on gas consumption – from the Safeguard Mechanism on LIL gas efficiency, as is discussed further below. Second, the inclusion of AEEI for the first time this year adds to the gap between the two forecasts.

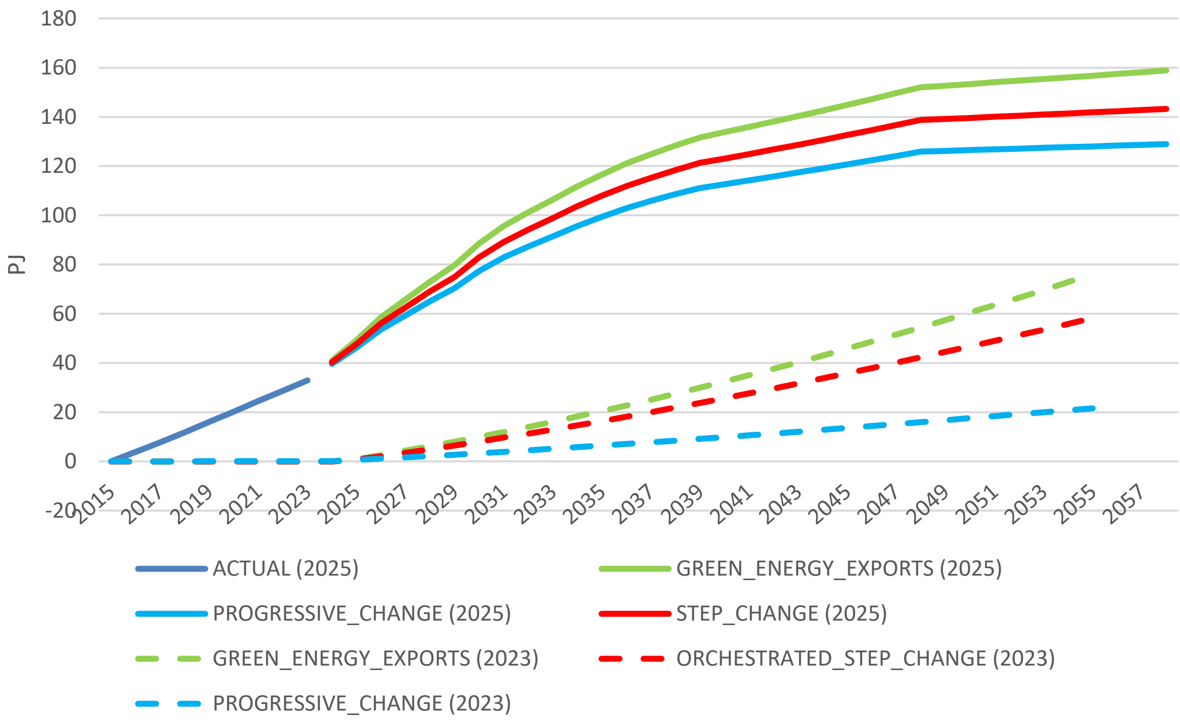


**Figure 78: Comparison of 2023 and 2025 (Total) Industrial Gas Forecasts, Australia, by Scenario**

As with electricity, the gap is smaller in the forecast period than historically, as can be seen for example in Figure 79, which is rebased to FY2023 – and it would be smaller again if rebased to FY2025 or FY2026.

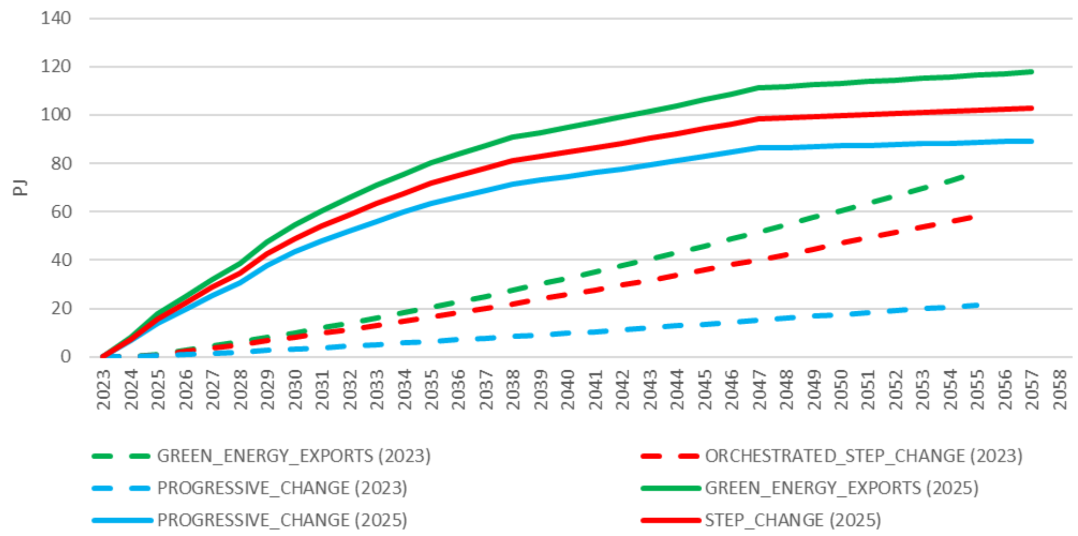


**Figure 79: Comparison of 2023 and 2025 Industrial Gas Forecasts, Australia, by Scenario, rebased to FY2023**

Also, in a similar manner to electricity above, we can remove the effect of the introduction of AEEI this year, with the results shown in Figure 80. The gap between the two forecasts is still significant, due overwhelmingly to the Safeguard Mechanism.

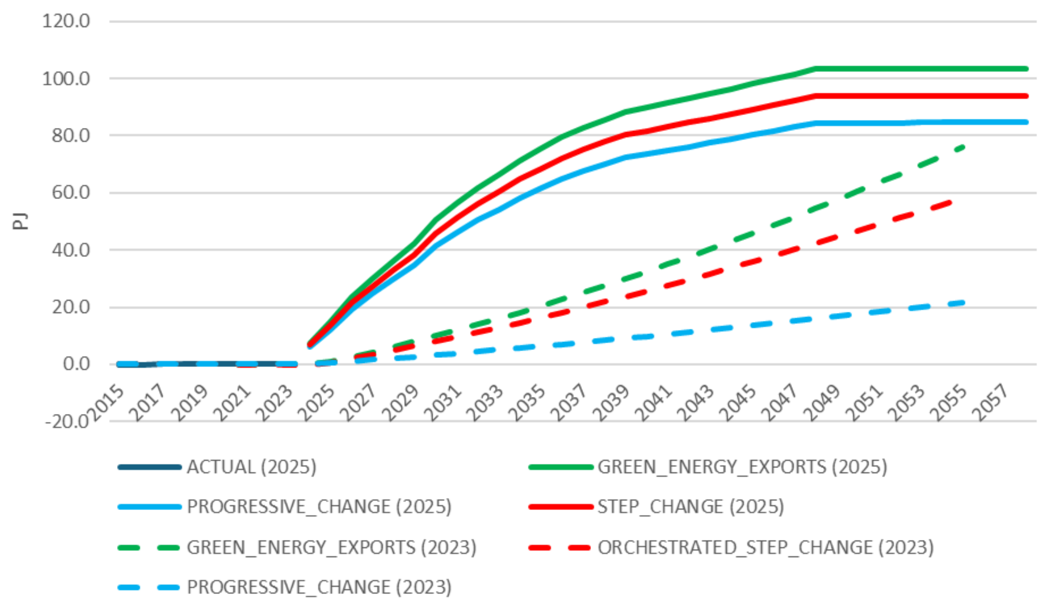


**Figure 80: Comparison of 2023 and 2025 Industrial Gas Forecasts, Australia, by Scenario, no AEEI**

# 7. Sensitivity Analyses

This chapter presents the results of two sensitivity analyses requested by AEMO.

## 7.1 Low-Efficiency Step Change

The low-efficiency sensitivity analysis of Step Change is intended to represent a business-as-usual (BAU) version of Step Change. That is, Step Change economic conditions are assumed, and AEEI is unchanged, but there are no new or amended efficiency policy settings – all of which remain at their current levels through to FY2058 (or earlier, where programs currently scheduled to end before that date.

Comparing Step Change and Step Change_Low_EE provides a useful indication of the gap in efficiency savings that would be expected to emerge over time if policies were not updated/expanded as assumed in Step Change. The Low-EE Step Change also provides a useful counter-factual for the purposes of analysing the potential impacts of policy change, assuming that Step Change economic conditions apply.

### 7.1.1 Residential

***Electricity***

As shown in Figure 81, the *Step Change Low EE* sensitivity broadly follows a similar trajectory to the *Progressive Change* scenario. Though most modelled policies treat *Progressive Change* largely as a continuation of the status quo level of policy ambition, we do model ongoing improvements to NCC and GEMS over the forecast period. *Step Change Low EE* thus largely tracks *Progressive Change* because reduced efficiency arising from NCC and GEMS improvements are offset by higher rates of AEEI in the *Step Change* base scenario. Similarly, higher dwelling constructions in the *Step Change* base scenario (and therefore greater aggregate energy efficiency) are offset by greater ongoing use of fossil gas in new dwellings, leading to lower electricity savings and higher gas consumption.[57]

[57] Gas uptake in new dwellings is assumed to follow current trends in all jurisdictions bar Victoria, where the existing gas phase-out policy remains in place. This approach leads to a longer tail of gas consumption, though all jurisdictions reach 0% gas uptake in new dwellings by the end of the forecast period.

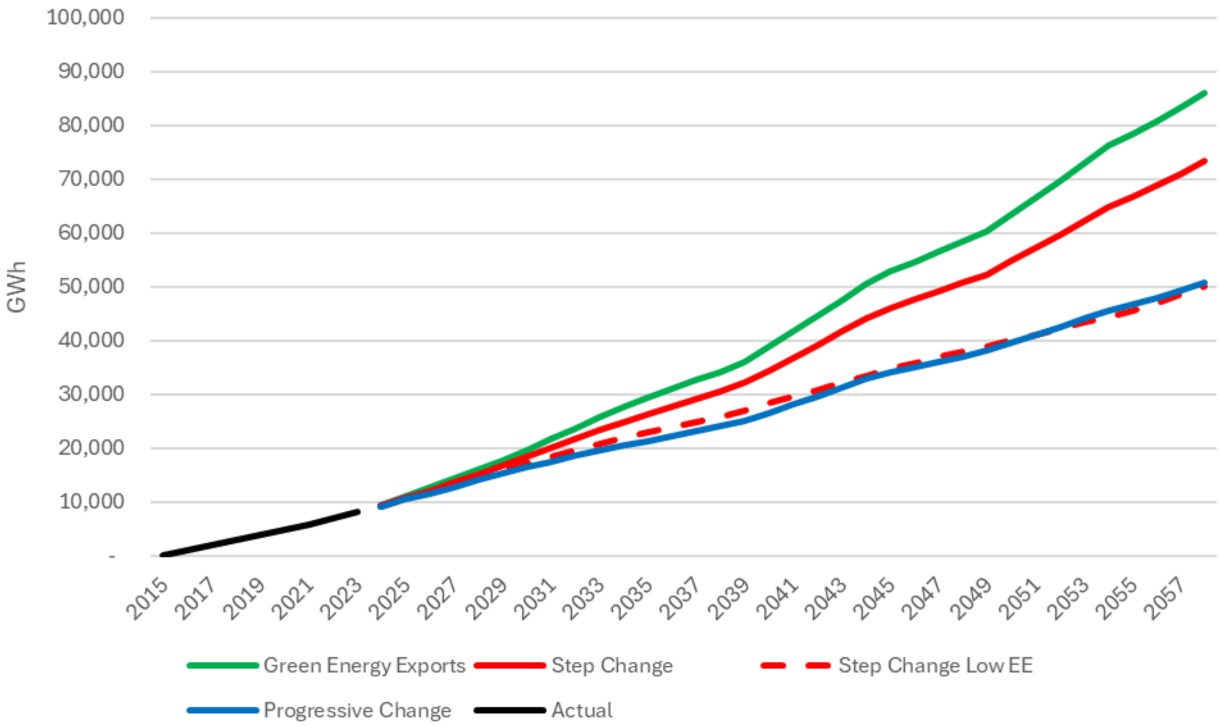


**Figure 81: RES Electricity Energy Efficiency Forecasts by Scenario, including *Step Change Low EE* (all regions, components and end-uses)**

### *Gas*

As shown in Figure 82, gas savings in *Step Change Low EE* largely tracks the *Step Change* base scenario, despite a significant reduction in ambition across modelled policies. As described in Section 6.1.1, the two largest drivers of gas efficiency change in our model are AEEI and NCC. The *Step Change Low EE* sensitivity retains the AEEI rates used in *Step Change,* and actually sees an increase in NCC savings because trend gas connection rates in new dwellings are used over the forecast period (except in Victoria) in lieu of setting fixed dates for an end to new connections (as discussed in Section 5.1.4). The impact of this change is that gas consumption is higher for longer, and so too are NCC gas savings, as more gas is being used in new dwellings, the effect of which largely offsets lower policy savings across other measures.

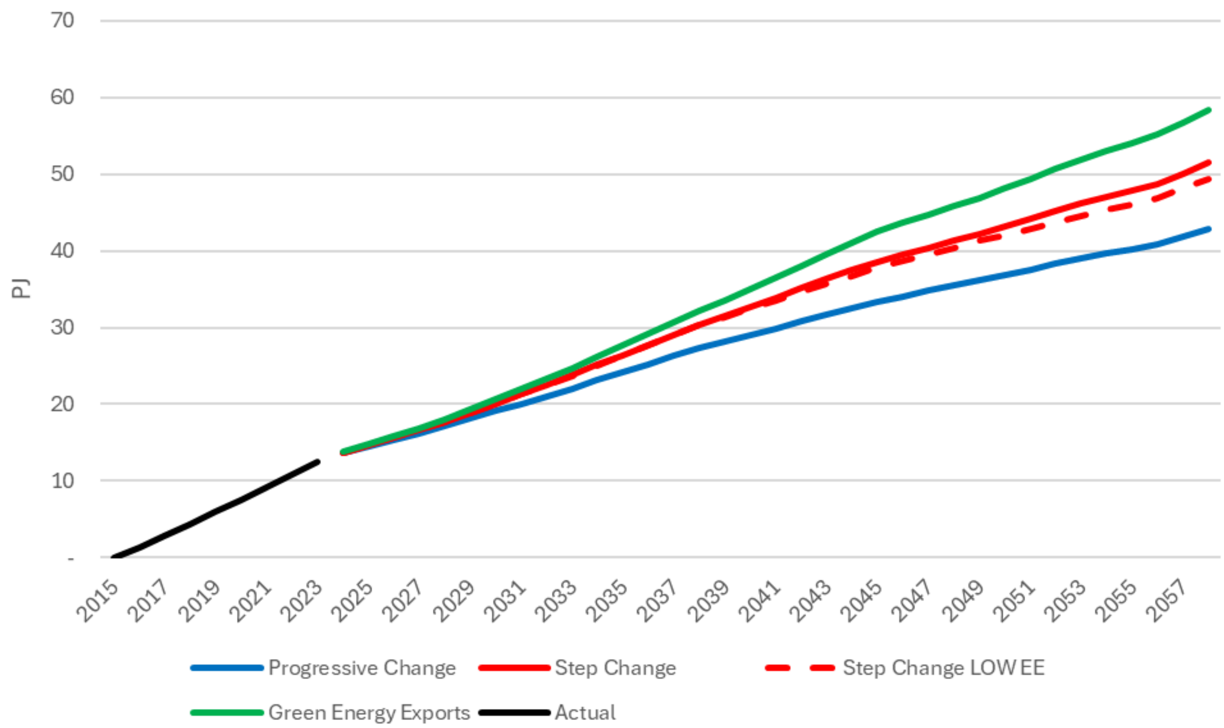


**Figure 82: RES Gas Energy Efficiency Forecasts by Scenario, including Step Change Low EE (all regions, components and end-uses)**

### 7.1.2 Commercial Sector

The key changes to the Step Change scenario that are presented below comprise:

- For the NCC energy performance requirements, fuel intensity assumptions for new reference buildings remain at 2024 levels through to FY2058, although we retain the same fuel mix propensities as in Step Change, as this is assumed to be a market-led, rather than a policy-led, decision
- For CBD, we assume that there is no CBD Expansion Roadmap, which means that future savings result from large offices only, with no changes to the current policy scope or design
- NABERS savings are unchanged, because these reflect voluntary decisions by building owners/managers
- MEPS (for existing buildings) are assumed not to be introduced
- For GEMS, we assume the 'Scenario 1' path is followed in Step Change; that is, no change to Progressive Change, with savings remaining around current levels in the forecast period

- The Safeguard Mechanism is existing policy and is therefore not assumed to change in this Low_EE sensitivity
- State Schemes are assumed to align with Progressive Change settings, with no increase in current target levels (but, in the case of ESS, liable acquisitions continue to grow over time, requiring additional savings).

***Electricity***

Figure 83 shows that the BAU assumptions result in significantly lower energy efficiency savings for electricity in the commercial sector. As noted in Section 6.2.1, AEEI is a relative small factor for the commercial sector, and this is unchanged in the Low_EE scenario. Policy measures contribute the majority of commercial sector electricity savings in Step Change. Therefore, when policy settings are frozen at 2024 levels in the Low_EE scenario, over 18,600 GWh of electricity savings are foregone by FY2058, equivalent to 34.4% of total Step Change electricity savings. Cumulatively over the forecast period, some 266,000 GWh of additional electricity would be consumed if policy settings in this sector remained as they are at present. The largest foregone saving would be from the NCC energy performance requirements, with 10,000 GWh of savings foregone by FY2058. The absence of MEPS for existing buildings would forego more than 3,600 GWh by the same date, and CBD savings would be some 2,500 GWh lower.

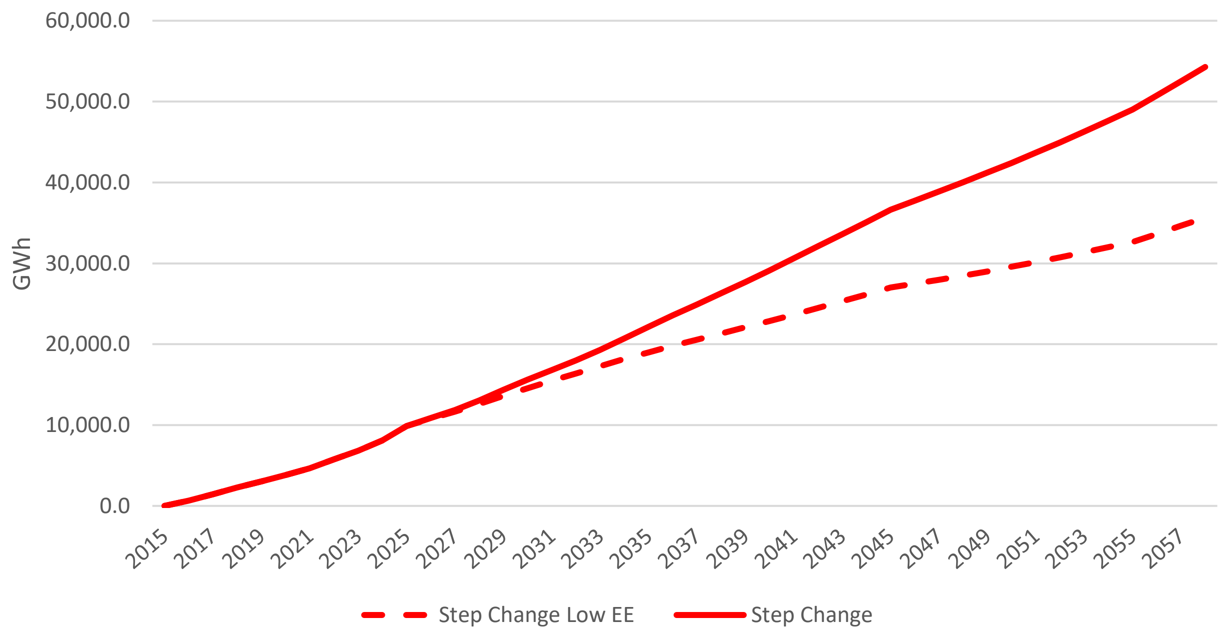


**Figure 83: Commercial Electricity Efficiency Savings, Step Change Low-EE vs Step Change**

*Gas*

Figure 84 shows that a similar pattern occurs in the gas market. The Low_EE version of Step Change realises 5.3 PJ lower gas savings by FY2058, equivalent to 48.2% of Step Change gas savings in that year. The absence of MEPS for existing buildings foregoes nearly 3 PJ, and the assumed non-expansion of CBD foregoes 2 PJ of gas by FY2058. Cumulatively over the forecast period, 95 extra PJ of gas would be consumed if policy setting were frozen at today's levels.

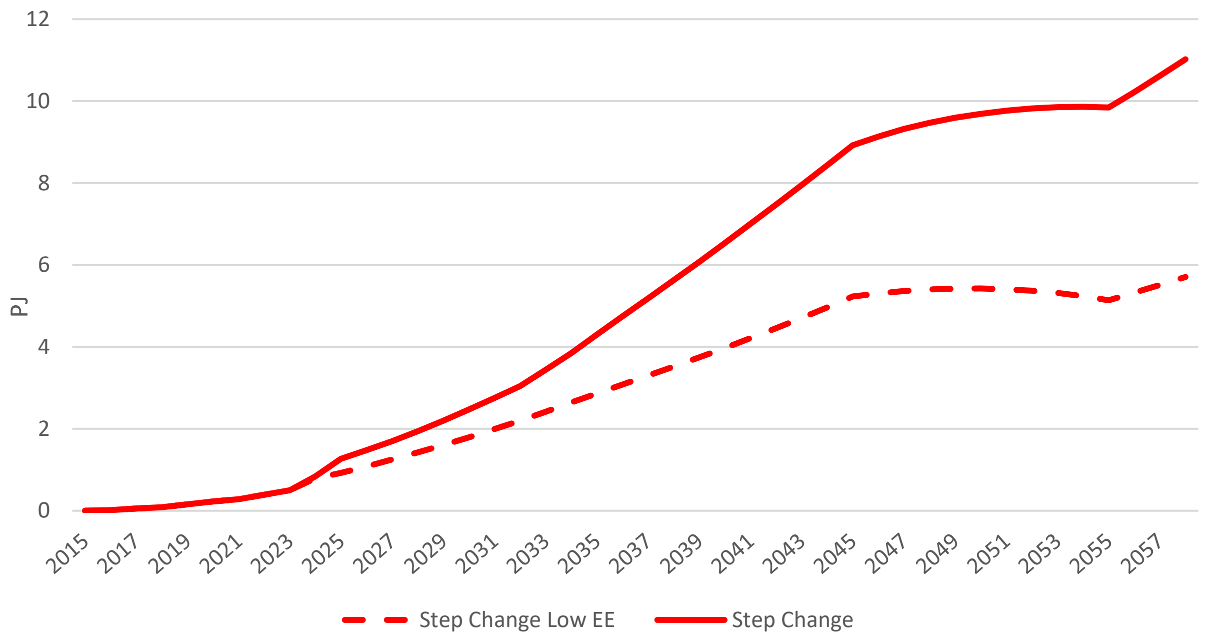


**Figure 84: Commercial Gas Efficiency Savings, Step Change Low-EE vs Step Change**

### 7.1.3 Industrial

By contrast with the commercial sector, the Low-EE version of Step Change is very similar to Step Change for both electricity and gas in the industrial sector. Indeed, in Figure 85 (electricity) and Figure 86 (gas), it is difficult to resolve the differences. For electricity, we estimate that the Low-EE scenario would forego some 430 GWh by FY2058 when compared to Step Change, or 3.1% of Step Change electricity savings. For gas, there is a small loss of Step Change savings of 0.5 PJ by FY2058 (or 0.3%).

For electricity, that there are relatively few measures, and few policy-induced savings, to begin with (in Step Change). Also, there is little change in ESS – which is the largest of the measures in impact terms – as ESS policy targets are already set through to 2050. Therefore, as existing policy, these targets are not assumed to change in the Low_EE scenario. For gas, the Safeguard Mechanism dominates the other measures, and this is also assumed to remain unchanged, as it is also existing policy.

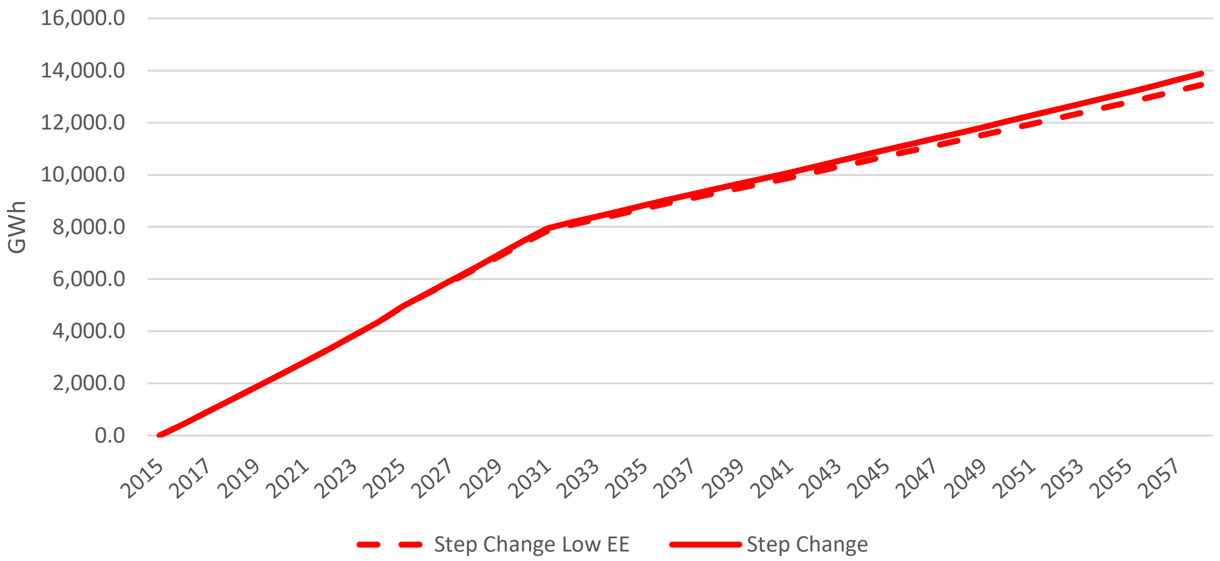


**Figure 85: Industrial Electricity Efficiency Savings, Step Change Low-EE vs Step Change**

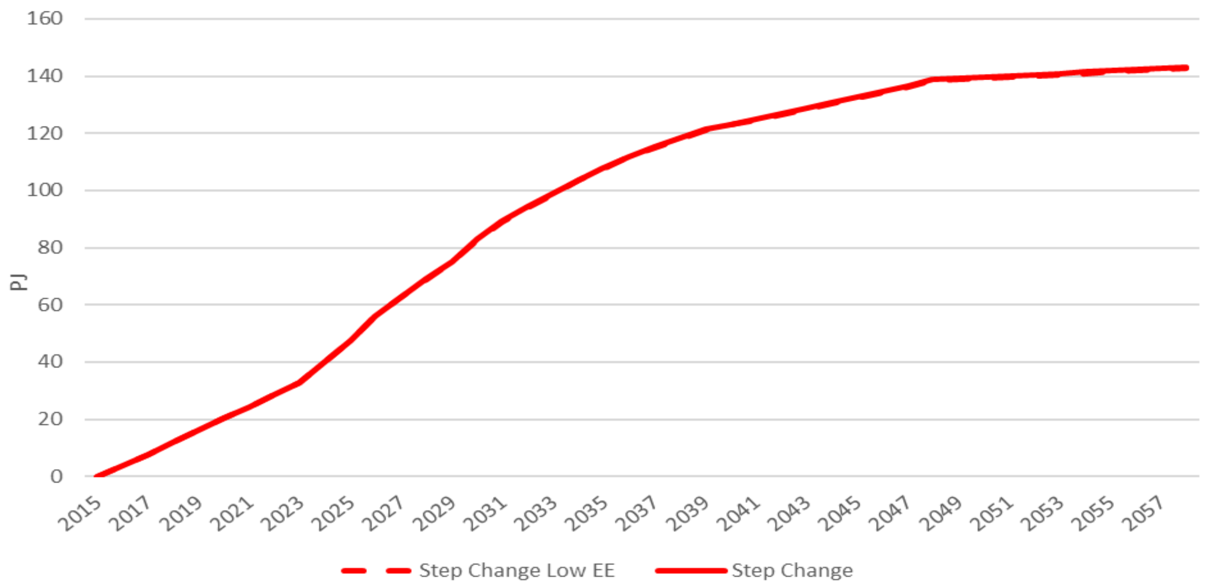


**Figure 86: Industrial Gas Efficiency Savings, Step Change Low-EE vs Step Change**

## 7.2 Green Energy Industries

As discussed in Section 4.1, Green Energy Industries is a sensitivity analysis based on Green Energy Exports. It assumes development of a hydrogen industry, focusing on value-add hydrogen products such as green iron and steel, for domestic use and for export. The sensitivity analysis excludes developments that are expected, in Green Energy Exports, to support hydrogen exports as an energy carrier. Indeed, AEMO notes that Green Energy Industries is thematically identical to Green Energy Exports in all areas of the scenario's key parameters except for a lower level of new investment in value-add commodities and hydrogen exports. As a result, Green Energy Industries implies lower hydrogen production than would occur under Green Energy Exports.

As a result, this sensitivity analysis is confined to IND only, as the scenario narrative above, and also the support economic assumptions, show no change for the RES or COM sectors, relative to Green Energy Exports.

Figure 87, for electricity, and Figure 88, for gas, show that the quantitative differences in energy efficiency improvement between Green Energy Industries and Green Energy Exports are negligible – and therefore hard to distinguish in the figures – amounting to some 250 GWh of electricity and 0.3 PJ of gas by FY2058. The primary explanation is that GVA Industrial is very similar in the two Green Energy variants, with Green Energy Industries just slightly lower than Green Energy Exports. At the same time, all policy settings are assumed to be the same between these two versions of the Green Energy scenario. While there would have been greater difference in AEEI, this effect is diminished for the LIL segment of industrial by the Safeguard Mechanism crowding out any AEEI.

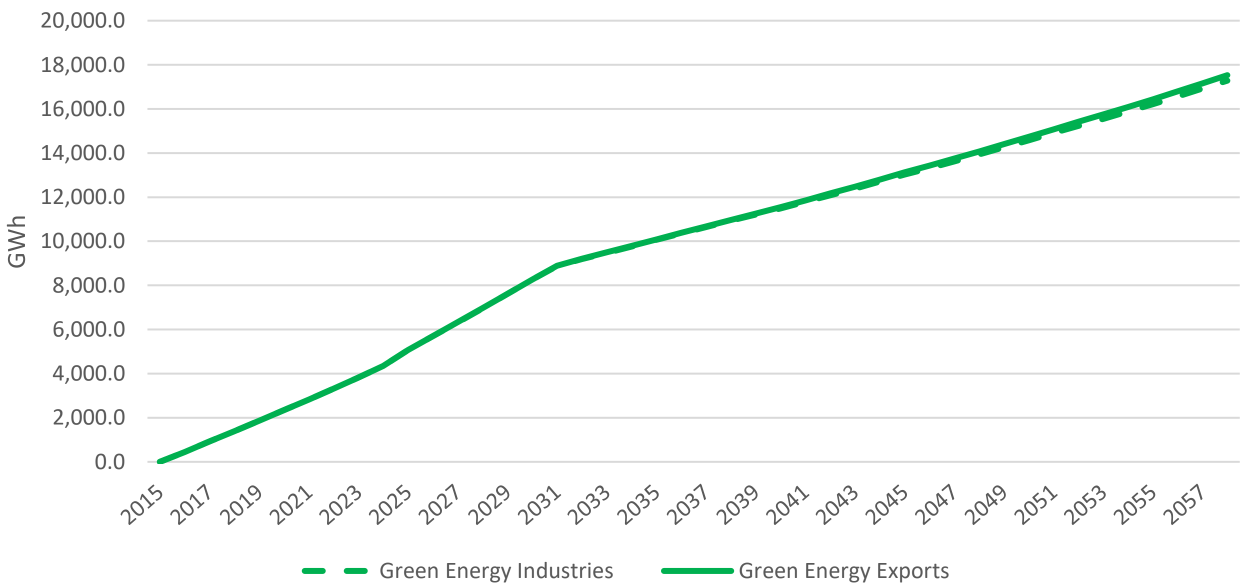


**Figure 87: Industrial Electrical Efficiency Savings, Green Energy Industries vs Green Energy Exports**

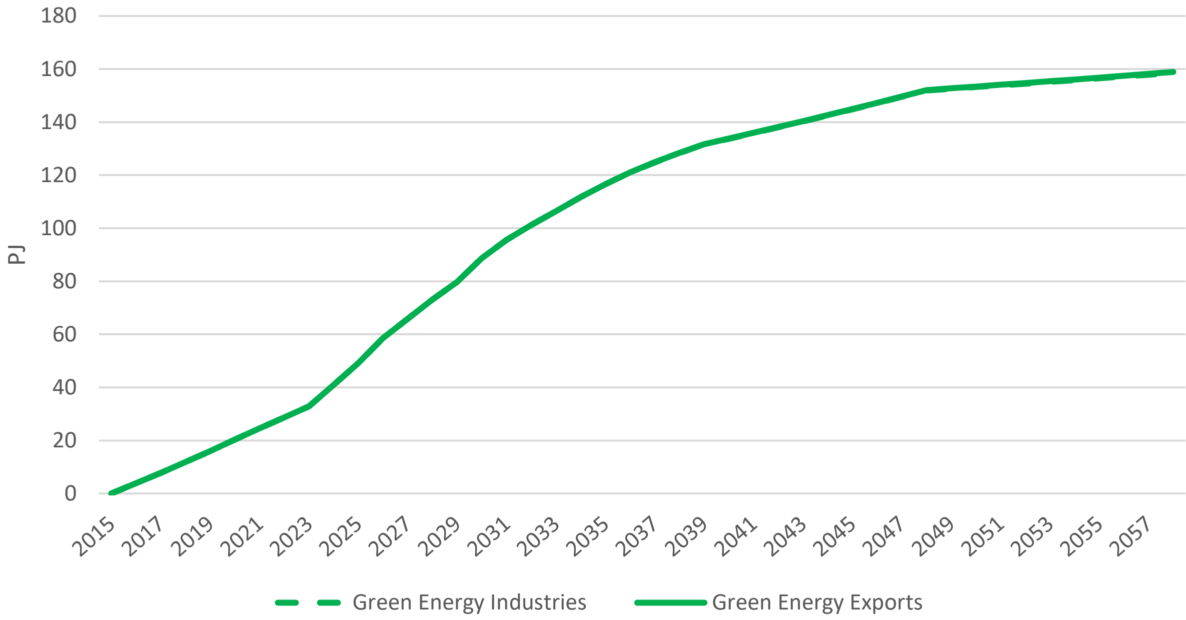


**Figure 88: Industrial Gas Efficiency Savings, Green Energy Industries vs Green Energy Exports**

# 8. Limitations and Improvement Opportunities

## 8.1 Limitations

As discussed in Sections 1.5 and 2.4, the key limitations associated with these efficiency forecasts include:

- the counterfactual, unmetered nature of energy efficiency improvements, which means that efficiency change has to be estimated, even in the historical period
- data limitations, which include limited historical consumption data for the NT, and different data structure for WA when compared to other jurisdictions
- limited independent evaluations of efficiency policy measures, combined with program reporting that generally does not take additionality into account
- uncertainty, and a lack of current/relevant research, on market-led or autonomous efficiency improvement
- the difficulty of distinguishing electrification from other forms of energy efficiency improvement, particularly for policy measures that are not prescriptive of the actions that may be made by households and businesses in response to the policy design; while for the market-led effects, key gas forecast parameters that are relevant to electrification (numbers of gas connections, and consumption per connection, over time) were not available to inform this project.

More generally, we note that these forecasts are a relatively early product in the 2025 – 2026 forecasting round, and therefore they were not able to take full advantage other inputs (including CSIRO/Climate Works Centre's multi-sector modelling) that will become available over time. That said, we acknowledge that we have been able to review early MSM draft outputs, and this provided a useful point of comparison. Second, we noted in Chapter 1 that this project benefited from aligning our past AEEI assumptions with those made by CSIRO/Climate Works Centre, and this will enhance consistency between these two contributions to AEMO's forecasting process.

## 8.2 Forecasting Improvement Opportunities

Following on from the above, there would be potential opportunities to further improve energy efficiency forecasts over time:

### 8.2.1 Energy Consumption Data

These forecasts make use of internal AEMO data with respect to electricity and gas consumption by region and market. As noted, the need to use AEMO data arises from limitations with Australian

Energy Statistics (AES), that particularly impact on the ability to use AES for time-series analysis. As Australia's national and premier data collection, AES would ideally be reviewed and revised to overcome existing discontinuities and to align (to the extent feasible) with metered consumption (and estimated underlying consumption) data used by AEMO and AER, so that there is confidence in the historical energy consumption record in Australia.

AEMO energy consumption data is generated for specific internal purposes and does not align with statistical frameworks such ANZSIC. AEMO has updated correspondences between its categories and ANZSIC, but only for NEM regions. It would be advantageous for this work to be updated annually (to enable time-series analysis in future), and for it to be extended to all jurisdictions, if feasible.

### 8.2.2 Sequencing of Inputs

Arguably there could be benefits from re-arranging the sequencing of forecasting inputs. For example, the MSM provides an overview of all sectors, and many outputs including energy efficiency and electrification observations, and there may be advantage in commissioning this work early in the overall sequence. Second, with electrification a growing driver of overall energy efficiency change, gas sector forecasts of connection numbers and consumption per connection (over time, by region, by sector, by scenario, etc) would provide a concrete expression of the extent of electrification that is forecast. This would enable the energy efficiency forecasts to align with these parameters, particularly later in the forecast period (towards 2050 and beyond), where scenario assumptions regarding 2050 emissions targets might be assumed to constrain feasible gas consumption, at least in the domestic economy. We note that the fuel mix of new dwellings and new buildings will impact on efficiency outcomes over time, independent of other factors.

### 8.2.3 Market-led Efficiency Improvement

As discussed in Section 2.5.1, the 2025 energy efficiency forecasts benefited from aligning AEEI assumptions with those made in the MSM forecasts, with overall impact of increasing alignment and consistency between these inputs. However, our view is that the estimation of market-led energy efficiency improvement remains relatively weak, when compared to policy-led improvement, primarily due to a lack of relevant research in Australia and associated data limitations. Ideally this area would be addressed by commissioning original research, outside of the forecasting rounds (as there is insufficient time or research scope available within those rounds to address such fundamental issues). This could lead, for example, to the market-led component of efficiency change over time being:

- increasingly informed by data rather than assumptions
- reconciled with end-use data by sector, and changing end-use equipment profiles

- reconciled with electrification/fuel-switching behaviours
- also reconciled, as now, with the policy-led component of efficiency change and, therefore, with total efficiency change.

# Appendix 1: Theoretical Framework

Our methodology draws on two key approaches. The first is known as 'factorisation' or 'decomposition', as pioneered by Dr Lee Schipper and the International Energy Agency.[58] This approach examines changes in (E)nergy use (or (E)missions) over time as a function of at least three factors:

- (A)ctivity levels (such as output, growth by sector),
- (S)tructure (the mix of activities within a sector) and
- (I)ntensity (changes in the intensity of fuel use per unit of structure and/or activity).

This generates the 'EASI' identity:

$$\mathbf{E} = \mathbf{A} \sum_{j} \mathbf{S}_j * \mathbf{I}_j \, .$$

In this decomposition:

E represents total energy use in a sector;

A represents overall sectoral activity (e.g. value added in manufacturing);

Sj represents sectoral structure or mix of activities within a sub-sector j (e.g. shares of output by manufacturing sub-sector j); and

Ij represents the energy intensity of each sub-sector or end-use j (e.g. energy use/real US dollar value added),

where the index j denotes sub-sectors or end uses within a sector.

Changes in (F)uel mix can be added, as needed, to create an 'EASIF' identity, although our preference is to apply this framework separately to each fuel – accounting explicitly for fuel switching and electrification effects.

This approach enables an observed or expected change in energy consumption to be attributed to specific effects: an activity effect is a change in consumption driven by a change in activity levels while all other factors remaining constant. Similarly, a structural effect would be the change in energy consumption driven by a change in the structure of a sector (eg, more apartments and less detached houses), and an intensity effect is change in energy consumption driven by a change in energy intensity (or efficiency) with structure and activity remaining constant.

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[58] See, for example, International Atomic Energy Agency et al, *Energy Indicators for Sustainable Development: guidelines and methodologies*, 2005, Annex 3.

Factorisation is a form of 'bottom up' modelling, and its strength (as well as its weakness) is that it is data hungry. It is a key strength, in that data is (to varying degrees) available to quantify the extent of annual change in activity, structure and intensity (and fuel mix, if required) at sectoral or sub-sectoral (or even end-use) levels. When compared to econometric or other modelling approaches, however, there is more time and cost associated with compiling and analysing data under the factorisation approach.

The second approach we bring to these forecasts is stock turnover modelling. Stock growth (eg, numbers of dwellings, floor area of commercial buildings) is a key Activity metric in the factorisation methodology. Second, stock turnover (retirements, conversions, and net change) are key elements of Structural change in the framework. Third, by taking account of stock vintage, it is possible to associate dwellings or buildings with different average energy intensities, in particular in the presence of building code energy performance requirements that are specific to particular vintages. At the same time, future Intensity scenarios can be modelled as a function of projected stock growth (linked to demand drivers) and turnover by scenario.

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