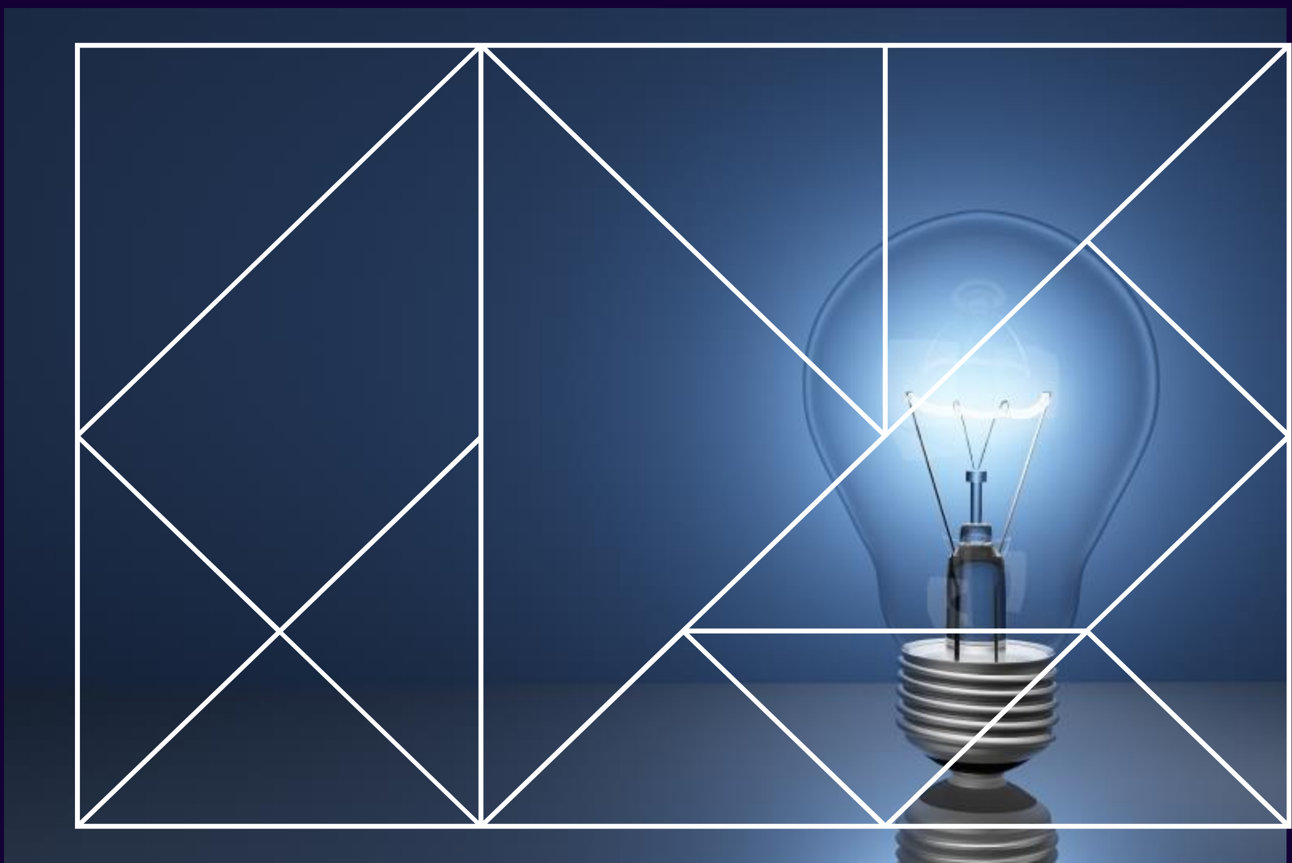
24 August 2021

Report to NSW Department of Planning, Industry and Environment

# Proposed requirements for BASIX in 2022

## Cost Benefit Analysis



## About ACIL Allen

ACIL Allen is a leading independent economics, policy and strategy advisory firm, dedicated to helping clients solve complex issues.

Our purpose is to help clients make informed decisions about complex economic and public policy issues.

Our vision is to be Australia's most trusted economics, policy and strategy advisory firm. We are committed and passionate about providing rigorous independent advice that contributes to a better world.

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# Executive summary

The Building Sustainability Index (BASIX) was introduced in 2004 by the NSW Government to regulate the energy and water efficiency of residential buildings. The scheme is implemented under the *Environmental Planning and Assessment Act 1979* and is part of the development application process in NSW.

BASIX applies to all new residential dwellings. The scheme requires all new residential dwellings (and eligible renovations) to:

— meet building envelope thermal performance standards
— reduce greenhouse gas emissions from operational energy use
— reduce potable water consumption.

BASIX is used to satisfy the National Construction Code (NCC) energy efficiency requirements for new residential buildings in NSW. While the NCC is a national code, states and territories can choose to apply its provisions, with or without amendments, to reflect policy differences. As a result of this, the NCC provisions are applied with variations in some jurisdictions. NSW has separate Performance Requirements and compliance options based on BASIX.

The Australian Building Codes Board (ABCB) is the body responsible for the development of the NCC. In early 2019, the former COAG Energy Council requested the former Building Ministers' Forum (BMF) to update the energy efficiency provisions for residential buildings in the 2022 edition of the NCC, informed by the Trajectory for Low Energy Buildings (the Trajectory).

New energy efficiency provisions for NCC 2022 are currently being assessed by the ABCB. In this context, the NSW Government is reviewing the BASIX minimum requirements for thermal comfort and energy efficiency to align them with the requirements and provisions that are being considered for inclusion in the NCC 2022. Note that the current BASIX requirements for water efficiency remains unchanged.

As part of the NCC 2022 development process, the ABCB has engaged ACIL Allen to develop a Consultation Regulation Impact Statement (RIS) for the proposed increases in energy efficiency requirements for residential buildings. The RIS will include a Cost Benefit Analysis (CBA) of the proposed increases in climate zones that include those in NSW. However, the analysis does not specifically investigate the costs and benefits relative to the current and proposed requirements of BASIX in NSW.[1]

In the context of the policy background outlined above, the NSW Department of Planning, Industry and Environment (the Department) has engaged us to analyse the impacts of aligning BASIX with the increased energy efficiency requirements planned to be implemented in the NCC 2022.

# Proposed policy changes

The energy efficiency policy options proposed for NCC 2022 are the following (Option B is introduced first, because it is the basis for calculating Option A).

- **Option B –** this option sets a maximum annual energy use budget (based on societal cost[2]) for the elements of a building regulated by the NCC (space conditioning, heated water systems, lighting and pool and spa pumps). The budget is based on a 'benchmark home' built with the following characteristics:
  - building shell performance level: equivalent to a 7 star Nationwide House Energy Rating Scheme (NatHERS) rated dwelling
  - heating equipment: equivalent to a 4.5 star rated (Greenhouse and Energy Minimum Standard (GEMS) 2012) heat pump heater (Annualised Energy Efficiency Ratio, AEER = 4.5)
  - cooling equipment: equivalent to a 4.5 star rated (GEMS 2012) heat pump cooler (Annualised Coefficient of Performance, ACOP = 4.5)
  - water heater: instantaneous gas
  - 4 watts per square metre of lighting.

  Under this option, a societal cost of operating this benchmark building is calculated and a new building is deemed to be compliant if it has the same societal cost as the benchmark building. If a piece of equipment (e.g. water heating) is installed that performs worse than the benchmark, this would have to be offset, either through installing other equipment that performs sufficiently better than the benchmark (e.g. cooling) or through the installation of on-site renewables (PVs).

- **Option A –** this option is based on the same energy use budget as Option B, however, the budget is 70 per cent of the Option B benchmark (i.e. a compliant dwelling must achieve savings equivalent to 30 per cent of the societal cost of applying the equipment and building fabric performance level of the benchmark building specified in Option B). For example, if the societal cost associated with the benchmark building in Option B is $1,000 per annum, then under Option A, a societal cost of $700 must be achieved.

  Compliance can be achieved either by improving the performance of the building shell, its equipment or by adding some PVs or a combination of these approaches.

[1] The NCC RIS assumes that the baseline for NSW is a requirement to meet a building shell performance level equivalent to a 6 star Nationwide House Energy Rating Scheme (NatHERS) rated dwelling.

[2] For further details about how the societal cost of energy is defined, please refer to the ABCB Scoping Study (https://consultation.abcb.gov.au/engagement/energy-efficiency-scoping-study-2019/).

No change is proposed to the existing lighting provisions in the NCC under either of the policy options.

Notably, the two proposed options in the NCC would enable a 'whole-of-house' (WoH) approach to achieve compliance. This means that a dwelling's annual energy use can be achieved within an energy budget, allowing a trade-off between the performance of individual building elements (such as the thermal shell, water heating and pool pumps), subject to a minimum level of thermal comfort being achieved (no lower than 7 star NatHERS rated performance, or equivalent)[3].

The policy options considered in this BASIX CBA align with the NCC policies described above.

To provide us with inputs to conduct the CBA in this report, the Department 'translated' the proposed NCC 2022 energy efficiency requirements into new minimum requirements of thermal comfort and energy efficiency in BASIX and provided us with energy flows and capital costs for a sample of dwellings under the Business as Usual (BAU) and under the two NCC policy options. The capital costs provided by the Department are based on the same assumptions used in the NCC RIS.

# Cost benefit analysis

CBA is an analytical tool used to assess the costs and benefits of regulatory proposals. Costs and benefits are examined from the perspective of the community as a whole to identify the proposal with the highest net benefit. The costs and benefits considered are incremental, that is, they reflect only the additional costs and benefits incurred as a result of the proposed policy change.

The costs and benefits that were included in the CBA model are outlined in Table ES 1. Additional details about the approach and key assumptions used in the CBA are discussed in Chapter 2.

**Table ES 1** Costs and benefits included in the CBA

| Category | Impact | Description |
|---|---|---|
| **Benefits** | | |
| Private | Energy savings* | The net increases/decreases in electricity and gas consumption |
| | Savings from the installation of smaller appliances* | Reductions in the capital cost of space conditioning equipment due to the improved thermal shell |
| Community | Network benefits | Deferred network investment for gas and electricity as a result of reductions in peak electricity demand and reductions in gas usage |
| | Air quality benefits | Health benefits from reduced pollution from electricity and gas generation |
| | Reduced carbon emissions | Benefits from reduced greenhouse gas emissions from household energy use |

[3] Trading between the thermal shell and appliances would not be possible when using the Deemed to Satisfy (DTS) elemental compliance pathway.

| Category | Impact | Description |
|---|---|---|
| **Costs** | | |
| Private | Dwelling compliance costs* | Additional capital outlays required to meet the new BASIX targets (including additional outlays associated with thermal bridging mitigation and difficult blocks) |
| Industry | Training costs | Costs associated with adapting to the policy change |
| Government | Administrative costs | Costs associated with administering and communicating the policy change |

Note: those impacts marked with an * indicate they are included in the dwelling level analysis.
*Source: ACIL Allen.*

## Dwelling impacts

The analysis employs a 'bottom-up' approach. Impacts are first calculated at the individual household level for representative Class 1 and Class 2 dwellings in different locations and climate zones across NSW. Reflecting the distribution, number and growth of the NSW housing stock, these representative dwellings are then scaled up to provide a state level evaluation.

The analysis employs 14 indicative/representative dwelling types. These include:

— nine detached houses (labelled DH1 through DH9)
— an attached house development (AH)
— a low-rise apartment complex (LR)
— three different high-rise apartment blocks (HR1 through HR3).

These dwellings represent composites of different locations, dwelling types and compliance pathways. A summary of the key features of the different dwellings modelled are summarised in Table ES 2 below. Additional details about the characteristics of these dwellings and how they were modelled by the Department are provided in Chapter 2.

**Table ES 2** Floor areas and specifications from the dwelling and building sample in BASIX CBA

| | Location | Type | Number of storeys | Gross floor area ($m^2$) [total for multi dwellings] | Number of bedrooms |
|---|---|---|---|---|---|
| | | **Detached houses** | | | |
| DH1 | Blacktown | Average | 2 | 170 | 4 bedrooms |
| DH2 | Blacktown | Affordable | 2 | 145 | 4 bedrooms |
| DH3 | Baulkham Hills | Large | 2 | 440 | 5 bedrooms |
| DH4 | Cessnock | Average | 2 | 170 | 4 bedrooms |
| DH5 | Dubbo | Average | 2 | 165 | 4 bedrooms |
| DH6 | Wagga Wagga | Average | 2 | 190 | 4 bedrooms |
| DH7 | Moss Vale | Average | 2 | 220 | 4 bedrooms |
| DH8 | Moss Vale | Large | 2 | 325 | 5 bedrooms |
| DH9 | Ballina | Average | 2 | 185 | 4 bedrooms |

| | Location | Type | Number of storeys | Gross floor area ($m^2$) [total for multi dwellings] | Number of bedrooms |
|---|---|---|---|---|---|
| **Attached dwellings/townhouses** | | | | | |
| AH | Albion Park | 3 dwellings | 1 | 468 | 3 bedrooms each |
| **Apartment buildings** | | | | | |
| | | | | | |
| LR | Shellharbour | 13 units | 3 | 1,440 | 5 x 3 bedrooms<br>5 x 2 bedrooms<br>3 x 1 bedroom |
| HR1 | Macquarie Park | 219 units | 7 & 28 | 18,376 | 5 x 4 bedrooms<br>48 x 3 bedrooms<br>104 x 2 bedrooms<br>62 x 1 bedroom |
| HR2 | Eastwood | 127 units | 10 & 13 | 9,133 | 18 x 3 bedrooms<br>48 x 2 bedrooms<br>61 x 1 bedroom |
| HR3 | Liverpool | 37 units | 8 | 2,610 | 23 x 2 bedrooms<br>14 x 1 bedroom |

*Source: NSW Department of Planning, Industry and Environment.*

The net impacts of the proposed BASIX changes on the individual sample dwellings described above from a societal perspective (i.e. measured using wholesale energy prices), and considering only the private costs and benefits, are outlined in Table ES 3. The net impact is an on-balance account of the overall lifetime impacts (costs and benefits) of the policy options examined. The table provides estimates of the present value (PVa) of the costs and the benefits, and both the net present value (NPV) and the benefit cost ratio (BCR) of the policy options.

Table ES 3 indicates that, at a dwelling level, all but one of the modelled dwellings would provide a negative return from a societal perspective (i.e. measured using wholesale energy prices) under both policy options. These results indicate that the costs of compliance — given the compliance pathways selected under each policy option — are greater than the lifetime energy savings.

The exception is DH6 which experiences a positive return of $1,006 in NPV terms under Option B. This is driven by a reduction in construction costs of $1,030 under Option B (compared to the BAU) and an increase in energy costs of $24. These cost savings and increased energy costs are largely due to the removal under Option 2 of 3.7kW of solar panels that this house had installed in the overcompliance scenario under the BAU (Option 2 has no solar panels specified).

These results are mainly driven by the use of wholesale energy prices (as a proxy for avoided resource costs) to value the benefits of reduced energy consumption, which results in BCRs and NPVs that are much smaller than if retail energy prices were used. This effect is compounded by the current period of low wholesale energy prices with a number of government policy initiatives incentivising the entry of new energy supply options and a reduction in the demand for energy.

**Table ES 3** Net impacts of the proposed changes to BASIX on individual dwellings from a societal perspective (measured using wholesale energy prices)

| Dwelling ID | Location | NCC climate zone | Dwelling type | Option A | | | | Option B | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | PVa of costs | PVa of benefits | Net impact | BCR | PVa of costs | PVa of benefits | Net impact | BCR |
| **HOUSES** | | | | | | | | | | | |
| DH1 | Blacktown | 5 | Average | 6,712 | 1,057 | -5,655 | 0.2 | 3,177 | 559 | -2,617 | 0.2 |
| DH2 | Blacktown | 5 | Affordable | 5,788 | 1,188 | -4,600 | 0.2 | 2,902 | 740 | -2,162 | 0.3 |
| DH3 | Baulkham Hills | 5 | Large | 5,084 | 1,335 | -3,749 | 0.3 | 8,424 | 1,465 | -6,959 | 0.2 |
| DH4 | Cessnock | 6 | Average | 6,035 | 997 | -5,038 | 0.2 | 3,045 | 375 | -2,670 | 0.1 |
| DH5 | Dubbo | 4 | Average | 5,488 | 1,427 | -4,060 | 0.3 | 3,534 | 424 | -3,111 | 0.1 |
| DH6 | Wagga | 4 | Average | 3,745 | 826 | -2,919 | 0.2 | -1,030 | -24 | 1,006 | -[a] |
| DH7 | Moss Vale | 6 | Average | 5,761 | 1,737 | -4,024 | 0.3 | 4,668 | 1,363 | -3,305 | 0.3 |
| DH8 | Moss Vale | 6 | Large | 7,451 | 1,951 | -5,500 | 0.3 | 4,607 | 1,561 | -3,046 | 0.3 |
| DH9 | Ballina | 2 | Average | 5,222 | 605 | -4,617 | 0.1 | 6,275 | 29 | -6,246 | 0.005 |
| | | | *Composite NSW house* | *6,036* | *1,245* | *-4,791* | *0.2* | *3,844* | *745* | *-3,099* | *0.2* |
| **TOWNHOUSES** | | | | | | | | | | | |
| AH | Albion Park | 6 | Average | 6,015 | 825 | -5,190 | 0.1 | 10,823 | 408 | -10,415 | 0.04 |
| **UNITS** | | | | | | | | | | | |
| LR | Shellharbour | 6 | Low rise | 4,917 | 164 | -4,754 | 0.03 | 5,221 | 64 | -5,157 | 0.01 |
| HR1 | Macquarie Park | 5 | High rise - 28 storeys | 779 | 290 | -489 | 0.4 | 776 | 260 | -517 | 0.3 |
| HR2 | Eastwood | 5 | High rise - 11-13 storeys | 772 | 212 | -560 | 0.3 | 555 | 128 | -427 | 0.2 |
| HR3 | Liverpool | 5 | High rise - 6 storeys | 895 | 510 | -385 | 0.6 | 3,565 | 219 | -3,346 | 0.1 |
| | | | *Composite NSW apartment* | *1,849* | *383* | *-1,466* | *0.2* | *3,517* | *172* | *-3,344* | *0.05* |

[a] A BCR for this dwelling cannot be interpreted the same as for other dwellings as the dwelling does not experience any costs (there are cost savings of $1,030) or benefits (there is an increase in energy costs of $24).

Note: AH, LR, HR1, HR2 and HR3 costs and benefits have been averaged over the number of units within the development. The composite house and apartment are constructed using weights about the propensity of each of the sample dwellings in NSW outline in Table 2.6.

*Source: ACIL Allen analysis based on data provided by the Department.*

## State-wide impacts

Over the next decade, the NSW housing stock is expected to increase by around 435,000 dwellings. Given this, the aggregated compliance costs and energy savings associated with the proposed changes can be considerable.

There area number of additional costs and benefits that would be experienced at the economy-wide level, when compared to the private costs and benefits experienced by individual dwellings. The costs and benefits analysed at a state-wide level are outlined below.

- **Benefits** — the analysis uses three main measures of the potential benefits accruing to each policy option:
  - *Energy benefits* — these are benefits from the saved cost of supplying energy. This is the most certain measure of benefits available and includes the aggregated value of direct energy savings from reduced energy consumption by the sample of dwellings modelled and deferred network investment for gas and electricity as a result of reductions in peak electricity demand and reductions in gas usage.
  - *Benefits from reduced carbon emissions* — this is a somewhat more uncertain measure of benefit. It is clear that carbon emissions represent a cost to society, and that reducing these emissions therefore represents a benefit. However, since the removal of Australia's carbon pricing mechanism in 2014, there is no universally agreed transparent price which can be assigned to these emissions.
  - *Health benefits from reduced electricity and gas generation* — these are benefits from reduced pollution from electricity and gas generation. While it is clear that electricity generated from fossil fuels produces air pollution that damages health, and that reducing these emissions represents a benefit, these benefits are generally regarded as highly uncertain and speculative and should be interpreted as an indicative potential value of the wellbeing that could be generated through energy efficiency upgrades. The true value in dollar terms of these benefits is unknown, but is expected, based on the information available, to be of the same order of magnitude as our estimates.
- **Costs** — the policy options examined entail costs to households, industry and government. The following costs have been included in the analysis:
  - the aggregate capital costs associated with the proposed policy changes
  - costs incurred by the NSW Government to administer the policy and communicate the policy changes
  - costs incurred by industry that cannot be directly passed on to the consumer (such as training costs).

A summary of the quantified direct costs and benefits and the net impact of the proposed changes on NSW is summarised in Table ES 4. Reflecting the level of certainty of different benefits discussed above, the NPV and BCR metrics are presented incrementally by adding benefits from the most certain to the least certain.

Table ES 4 indicates that, at an economywide level, both policy options appear to result in a net cost to society, even when including the somewhat more uncertain measures of benefit (the benefits from reduced carbon emissions and health benefits). This result is mainly driven by:

— the use of wholesale energy prices to value the benefits of reduced energy consumption, which as noted in Chapter 2, results in BCRs and NPVs that are much smaller than if retail energy prices were used
— the high capital costs for households associated with meeting the new targets.

**Table ES 4** Costs and benefits of the proposed policy options, present value ($M, 2021)

| | Option A | Option B |
|---|---|---|
| **COSTS** | | |
| Households - capital costs | 1,353.3 | 1,514.5 |
| Industry | 22.0 | 22.0 |
| Government Costs | 0.1 | 0.1 |
| **TOTAL COSTS** | **1,375.5** | **1,536.6** |
| **BENEFITS** | | |
| **Households** | | |
| Electricity savings | 239.2 | 120.5 |
| Gas savings | 49.9 | 42.7 |
| *Household subtotal* | *289.1* | *163.3* |
| **Society** | | |
| Deferred network investment for gas and electricity | 92.9 | 41.7 |
| Greenhouse emissions savings | 76.7 | 32.5 |
| Health benefits from improved air quality | 32.2 | 12.9 |
| *Society subtotal* | *201.8* | *87.1* |
| **TOTAL BENEFITS** | **490.9** | **250.3** |
| **NET PRESENT VALUES** | | |
| Accounting for energy benefits only | -993.5 | -1,331.6 |
| Accounting for energy benefits + carbon benefits | -916.7 | -1,299.1 |
| Accounting for energy benefits + carbon benefits + health benefits | -884.6 | -1,286.3 |
| **BCR (RATIO)** | | |
| Accounting for energy benefits only | 0.28 | 0.13 |
| Accounting for energy benefits + carbon benefits | 0.33 | 0.15 |
| Accounting for energy benefits + carbon benefits + health benefits | 0.36 | 0.16 |

Note: Using a 7 per cent discount rate.
*Source: ACIL Allen.*

## Distributional impacts

As is standard practice, the CBA of the proposed changes to BASIX was undertaken from the perspective of the broader NSW community, with impacts that are transfers between stakeholders (such as between the government and households, and between households that are subject to the proposed changes and those that are not) netted out. Nevertheless, it is important to consider the implications of some of these transfers on stakeholders, particularly the implications of energy bill reductions on households.

Table ES 5 shows the energy bill savings for the households residing in the dwellings that are modelled to have implemented the proposed BASIX changes, compared to the total costs of the upgrades/changes (in present value terms). The effect on these households is measured using retail energy costs, rather than wholesale energy costs, which leave them better off.

**Table ES 5** Distributional impacts by household, $ per household (present value, 2021 prices)

| Dwelling ID | Location | NCC climate zone | Dwelling type | Option A | | | | Option B | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Capital costs | Energy bill savings (2022-2061) | Net bill savings (household NPV) | Household BCR | Capital costs | Energy bill savings (2022-2061) | Net bill savings (household NPV) | Household BCR |
| **HOUSES** | | | | | | | | | | | |
| DH1 | Blacktown | 5 | Average | 7,152 | 12,321 | 5,169 | 1.7 | 3,530 | 2,868 | -662 | 0.8 |
| DH2 | Blacktown | 5 | Affordable | 6,126 | 12,820 | 6,694 | 2.1 | 3,224 | 3,679 | 455 | 1.1 |
| DH3 | Baulkham Hills | 5 | Large | 5,621 | 8,441 | 2,819 | 1.5 | 9,360 | 9,461 | 101 | 1.0 |
| DH4 | Cessnock | 6 | Average | 6,397 | 11,182 | 4,785 | 1.7 | 3,383 | 1,815 | -1,569 | 0.5 |
| DH5 | Dubbo | 4 | Average | 5,793 | 15,404 | 9,612 | 2.7 | 3,927 | 1,807 | -2,120 | 0.5 |
| DH6 | Wagga | 4 | Average | 4,037 | 5,678 | 1,641 | 1.4 | -964 | -7,922 | -6,959 | -[a] |
| DH7 | Moss Vale | 6 | Average | 6,093 | 14,931 | 8,838 | 2.5 | 5,187 | 6,777 | 1,591 | 1.3 |
| DH8 | Moss Vale | 6 | Large | 8,049 | 14,864 | 6,815 | 1.8 | 5,240 | 5,652 [b] | 412 | 1.1 |
| DH9 | Ballina | 2 | Average | 5,634 | 4,334 | -1,300 | 0.8 | 7,124 | -2,545 [c] | -9,669 | -[d] |
| | | *Composite NSW house* | | *6,418* | *12,257* | *5,839* | *1.9* | *4,287* | *3,416* | *-872* | *0.8* |
| **TOWNHOUSES** | | | | | | | | | | | |
| AH | Albion Park | 6 | Average | 6,403 | 11,400 | 4,996 | 1.8 | 11,753 | 8,826 | -2,927 | 0.8 |
| **UNITS** | | | | | | | | | | | |
| LR | Shellharbour | 6 | Low rise | 5,427 | -381 [c, d] | -5,808 | -[e] | 5,802 | -148 [c, d] | -5,951 | -[e] |
| HR1 | Macquarie Park | 5 | High rise - 28 storeys | 860 | 1,748 | 888 | 2.0 | 860 | 1,465 | 605 | 1.7 |

| Dwelling ID | Location | NCC climate zone | Dwelling type | Option A | | | | Option B | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Capital costs | Energy bill savings (2022-2061) | Net bill savings (household NPV) | Household BCR | Capital costs | Energy bill savings (2022-2061) | Net bill savings (household NPV) | Household BCR |
| HR2 | Eastwood | 5 | High rise - 11-13 storeys | 831 | 3,051 | 2,220 | 3.7 | 605 | 1,668 | 1,063 | 2.8 |
| HR3 | Liverpool | 5 | High rise - 6 storeys | 953 | 2,977 | 2,024 | 3.1 | 3,940 | 1,859 | -2,081 | 0.5 |
| | | *Composite NSW apartment* | | *2,018* | *2,132* | *114* | *1.1* | *3,894* | *1,338* | *-2,556* | *0.3* |

[a] A BCR for this dwelling cannot be interpreted the same as for other dwellings as the dwelling does not experience any costs (there are cost savings of $964) or benefits (there is an increase in energy costs of $7,922 over the life of the dwelling).

[b] Dwelling DH8 is estimated to have negative dollar savings (costs) in the year 2022 under Option 2 (see Table 5.1), but overall positive dollar savings in present value terms over the period of analysis (2022-2061). DH8 has negative dollar savings (costs) in the short-term primarily due to the removal of the 1kW solar panels under the overcompliance BAU case (which represents around 40 per cent of dwellings of this type in the baseline). In the short term, the reduction in energy consumption due to other changes made to the dwelling to comply with Option 2 are not enough to offset the increase in energy from the removal of solar PVs. However, as the heating/cooling equipment reach end-of-useful life (in year 12) and the energy savings associated with the thermal shell kick in the dwelling experiences net energy savings. These net savings increase over the longer-term as the solar PV in the BAU reach their end of life.

[c] Dwelling DH9 is estimated to have small positive benefits in present value terms under Option B ($29) at wholesale level (see Table 3.4) and LR is estimated to have positive benefits in present value terms under Option A ($164) and Option B ($64), however both dwellings are estimated to experience negative benefits at retail level (in present value). Under Option B at wholesale and retail prices DH9 is estimated to experience negative electricity savings (i.e. costs) and positive gas savings and LR is estimated to experience negative electricity savings (i.e. costs) and positive gas savings both at wholesale and retail prices under Option A and Option B. Under wholesale prices, the benefits of gas offset the costs of electricity, resulting in a net decrease in energy bills. This does not occur under retail prices. The relative prices between electricity and gas (i.e. the difference in prices between electricity and gas) are different within the wholesale and within the retail market. In the wholesale market, this relative difference between the electricity and gas prices is smaller which means there is less electricity cost to offset (in percentage terms), but under retail prices, the impact of electricity prices is relatively larger and the value of gas at retail prices is not high enough to offset the additional electricity costs.

[d] Dwelling LR is estimated to have positive energy savings at retail prices in the year 2022 under both policy options (see Table 5.1), but overall negative dollar savings (costs) in present value terms at retail prices over the period of analysis (2022-2061). Both in 2022 and over this dwelling experiences negative electricity savings (costs) and positive gas savings. However, the magnitude of these relative savings changes over time. In 2022 the savings from gas are enough to offset the increased costs of electricity under both options, but over the longer-term, the costs associated with electricity usage (particularly the increases in energy consumption from changes to the thermal shell) exceed the gas savings, resulting in a negative present value over the period of analysis.

[e] A BCR cannot be calculated for this dwelling as the dwelling does not experience any benefits, only costs.

Note: these estimates use retail energy prices. Present values calculated using a 7 per cent discount rate.

*Source: ACIL Allen.*

The impacts in Table ES 5 show a more positive result for households than those results in Table ES 3 (which show the impacts on individual dwellings from a societal perspective - i.e. measured using wholesale energy prices). In particular:

— Under Option A, the proposed changes would result in net benefits for most households. That is, the benefits received by households from the additional energy efficiency measures installed are more than enough to cover the additional costs incurred to implement these measures. The exceptions are households in DH9 and LR, who are estimated to experience net costs from the proposed changes.
— Under Option B, the proposed changes would result in net benefits for half the households and in net costs for the other half. The households that would experience net costs from the proposed changes under this option are those in DH1, DH4, DH5, DH9, AH, LR and HR3.

Notably, the results in Table ES 5 show that there are savings of upfront costs and increase in energy bills (negative savings) for DH6 under Option B. As mentioned before, these cost savings and increased energy bills are largely due to the removal of 3.7kW of solar panels that this house had installed in the overcompliance scenario under the BAU. This example shows that under Option 2 these households will be worse off in the long term as the initial capital costs savings are not enough to offset the higher energy bills throughout the useful life of the dwelling in present value terms.

DH9 under Option B and LR under both policy options are projected to experience only costs and no benefits, as the measures installed as a result of the proposed BASIX changes result in net increases in energy bills in present value terms.

### Housing affordability

Housing affordability is likely to be affected by the proposed BASIX changes in two main ways:

— it may change households' disposable income through the reduction of household costs due to improvements in energy efficiency, which reduces energy bills
— sellers of houses who make additional investments in energy efficiency measures to comply with the proposed BASIX changes may seek to raise their price to compensate for the cost of that investment.

The impacts of the changes to BASIX on housing affordability have been analysed from the perspective of typical households and using widely known affordability indicators. Key points from this analysis are as follows.

— The costs of complying with BASIX are likely to be passed forward to property buyers in the form of a slight increase in house prices. We estimate that, overall, the proposed changes would result in small increases in prices for most houses across NSW under both policy options.[4] On average[5], the price of dwellings across the locations analysed in NSW would increase by around 0.8 per cent under Option A and around 0.7 per cent under Option B.

[4] The exception is dwellings in Wagga which are estimated to experience a small decrease in costs under Option B.

[5] This refers to an unweighted average across all the dwellings and locations analysed.

- By comparison, the cost of building a house went up by 2.1 per cent from December 2019 to December 2020. This is almost on par with the highest expected increase in house prices due to the proposed BASIX requirements (in townhouses in Albion Park under Option B).
- Slightly higher house prices would be reflected in slight increases in mortgage repayments. Lower utility bills would offset these increases. In net terms:
  - all but one household under Option A would experience a net benefit in the first year of the new scheme as the savings arising from lower energy bills are more than enough to offset the increase in annual mortgage repayments. The exception are households in units in Shellharbour who would experience net costs. On average[6], under Option A homeowners across the locations analysed in NSW would experience net benefits in the first year of around $271. Over time, as utility prices changes, these impacts would change.[7]
  - most households under Option B would experience a net cost in the first year of the new scheme as the savings arising from lower energy bills are not enough to offset the increase in annual mortgage repayments. However, some households would experience net benefits (houses in Baulkham Hills, townhouses in Albion Park and units in Eastwood and Macquarie Park). On average[8], under Option B homeowners across the locations analysed in NSW would experience costs in the first year of around $83.
- The proportion of income households used to pay a mortgage would remain broadly the same for all households analysed across both options. This indicator remains broadly unchanged mainly due to the fact that the additional costs of the proposed changes are included in the initial mortgage and hence amortised over time.
- The 'years of gross income' required to purchase a house would increase slightly for four households under Option A and for more than half the households analysed under Option B. This represents a decrease in housing affordability in these markets.
- Overall, the two housing affordability indicators analysed suggest that the proposed changes to BASIX would have no major effects on housing affordability.

[6] This refers to an unweighted average across all the dwellings and locations outlined in Table 5.4.

[7] The best way to measure the effects that these expected benefits would have over time on homeowners is to look at the percentage of income that they would have to dedicate to mortgage repayments over the life of their house. This information is presented in Table 5.7.

[8] This refers to an unweighted average across all the dwellings and locations outlined in Table 5.4.

# Conclusion

This analysis has summarised the potential impacts on the NSW community of proposed changes in the BASIX requirements of thermal comfort and energy efficiency. The analysis has shown that:

- At an economy-wide level[9], both Option A and Option B result in a net cost to society, even when including the somewhat more uncertain measures of benefit (the benefits from reduced carbon emissions and health benefits).
- At a household level[10], the results are mostly positive under Option A and mixed for Option B, with some households projected to be better off with the changes, and some others experiencing net costs from the proposed BASIX changes. In particular:
  - Under Option A, the proposed changes would result in net benefits for most households. That is, the benefits received by households from the additional energy efficiency measures installed are more than enough to cover the additional costs incurred to implement these measures. The exceptions are households in DH9 and LR, who are estimated to experience net costs from the proposed changes.
  - Under Option B, the proposed changes would result in net benefits for half the households and in net costs for the other half. The households that would experience net costs from the proposed changes under this option are those in DH1, DH4, DH5, DH9, AH, LR and HR3.

[9] The impact of the proposed changes to BASIX at the economy-wide level are analysed using wholesale energy prices (as a proxy for avoided resource costs).

[10] The impacts of the proposed changes to BASIX from the perspective of the individual households are analysed using retail energy prices.

# Introduction and background 1

## 1.1 Project context

The Building Sustainability Index (BASIX) was introduced in 2004 by the NSW Government to regulate the energy and water efficiency of residential buildings. The scheme is implemented under the *Environmental Planning and Assessment Act 1979* and is part of the development application process in NSW.

BASIX applies to all new residential dwellings, alterations and additions to dwellings that cost $50,000 or more and swimming pools of 40,000 litres or more. BASIX is used to satisfy the energy efficiency performance requirements in the National Construction Code (NCC) for NSW.

The scheme requires all new residential dwellings (and eligible renovations) to:

— meet building envelope thermal performance standards

— reduce greenhouse gas emissions from operational energy use

— reduce potable water consumption.

The assessment is conducted using an online BASIX tool, which estimates the water and energy consumption and the thermal comfort of a dwelling based on information about floor area, the size, location and type of windows, the type of insulation and the type of hot water system being installed. These estimates are then assessed and scored against specific energy and water reduction targets.

The Nationwide House Energy Rating Scheme (NatHERS) accredited software is one of the options available to satisfy the BASIX thermal comfort requirements for single detached houses. NatHERS software are used to satisfy the thermal comfort requirements for most multiple dwelling developments. Multiple dwelling developments satisfying the Passive House Standard can also be used to satisfy BASIX thermal comfort requirements.

The NCC provides nationally consistent, minimum technical standards for the design and construction of new buildings (and new building work in existing buildings). In addition to structural, fire protection, and health, amenity and accessibility provisions, Section J of Volume One and Parts 2.6 and 3.12 of Volume Two of the NCC address minimum mandatory provisions for energy efficiency. The NCC achieves these nationally consistent minimum standards by specifying Performance Requirements for various types of building work which can be satisfied using a

Performance Solution, a Deemed-to-Satisfy (DTS) Solution or a combination of both. The NCC is maintained by the Australian Building Codes Board (ABCB) and is administered by state and territory governments.

The current minimum energy efficiency requirements for residential buildings in the NCC are:

— for Class 1 buildings, a 6 star rating, or compliance with the DTS elemental provisions
— for Class 2 buildings, an average rating of all units in the block of at least 6 stars, and a minimum for each unit of 5 stars. In addition to the assessment of building fabric, multi-residential buildings are also required to meet a series of DTS requirements.

While the NCC is a national code, states and territories can choose to apply its provisions, with or without amendments, to reflect geographic, climatic, policy or technical differences. As indicated above, NSW has separate Performance Requirements and compliance options based on BASIX.

In December 2018, the former COAG Energy Council released the Trajectory for Low Energy Buildings (the Trajectory) under the National Energy Productivity Plan (NEPP) Measure 31 – Advance the NCC. The Trajectory is a national plan that sets a trajectory towards zero energy (and carbon) ready buildings for Australia and identifies opportunities for the building sector. It proposes:

— setting a trajectory towards zero energy (and carbon) ready buildings
— implementing cost effective increases to the energy efficiency provisions in the NCC for residential and commercial buildings from 2022
— considering options for improving existing buildings.

In early 2019, in response to the Trajectory’s recommendations for ongoing improvements to the energy efficiency provisions in the NCC, the former COAG Energy Council requested the former Building Ministers’ Forum (BMF) to update the energy efficiency provisions in the NCC. In mid-2019, the BMF agreed to the development of enhanced energy efficiency provisions for new residential buildings, informed by the Trajectory.

In July 2019, the ABCB released a scoping study (Energy efficiency – NCC 2022 and beyond scoping study) to seek public comment on a proposed approach and scope of future changes to the 2022 edition of the NCC. After a period of public consultation, the ABCB released an outcomes report in December 2019 that summarised the information received during the consultation period.

The insights gathered through the consultation period on the scoping study were used to inform and refine the scope of changes to the energy efficiency provisions for NCC 2022 currently being assessed by the ABCB.

In this context, the NSW Government is reviewing the BASIX minimum requirements for thermal comfort and energy efficiency to align them with the requirements and provisions that are being considered for inclusion in the NCC 2022.

As part of the NCC 2022 development process, the ABCB has engaged ACIL Allen to develop a Consultation Regulation Impact Statement (RIS) for proposed increases in energy efficiency requirements for residential buildings. The RIS will include a Cost Benefit Analysis (CBA) of the proposed increases in climate zones that include those in NSW. However, the analysis does not specifically investigate the costs and benefits relative to the current and proposed requirements of BASIX in NSW. [11]

## 1.2 This project

In the context of the policy background outlined above, the NSW Department of Planning, Industry and Environment (the Department) is seeking to analyse the impacts of aligning BASIX with the increased energy efficiency requirements planned to be implemented in the NCC 2022.[12] As noted above, these requirements are currently being explored by the ABCB through a RIS that ACIL Allen is undertaking.

In line with the NCC 2022 RIS, the Department engaged ACIL Allen to undertake a CBA of aligning BASIX with the two proposed options currently being analysed for changing the NCC energy efficiency requirements (these options are outlined in more detail in the following section).

This BASIX CBA analyses the impacts of the proposed policy changes in the NCC 2022 in more detail, in particular:

— it expands the dwelling sample to cover more NSW locations than the NCC RIS
— it investigates the costs and benefits relative to the current and proposed requirements of BASIX in NSW.

Notably, while we have attempted to undertake this CBA as consistently as possible with the NCC RIS being developed, policy differences between BASIX and the proposed NCC 2022 requirements have nevertheless resulted in noticeable differences in the analysis. These are outlined in Appendix B.

## 1.3 Proposed policy changes

The energy efficiency policy options proposed for NCC 2022 and being analysed in the NCC RIS are outlined in Section 1.3.1. These policy options have been ‘translated’ by the Department into new BASIX targets for the analysis in this report. Details about these proposed changes in the BASIX minimum requirements for thermal comfort and energy efficiency to align with the NCC 2022 are outlined in Section 1.3.2.

[11] The NCC RIS assumes that the baseline for NSW is a requirement to meet a building shell performance level equivalent to a 6 star NatHERS rated dwelling.

[12] The water requirements in BASIX would remain unchanged.

### 1.3.1 Policy options proposed for NCC 2022

The policy options being analysed in the NCC 2022 RIS are the following (Option B is introduced first, because it is the basis for calculating Option A).

— **Option B** – this option sets a maximum annual energy use budget (based on societal cost[13]) for the elements of a building regulated by the NCC (space conditioning, heated water systems, lighting and pool and spa pumps). The budget is based on a 'benchmark home' built with the following characteristics:
  - building shell performance level: equivalent to a 7 star NatHERS rated dwelling
  - heating equipment: equivalent to a 4.5 star rated (Greenhouse and Energy Minimum Standard (GEMS) 2012) heat pump heater (Annualised Energy Efficiency Ratio, AEER = 4.5) [14]
  - cooling equipment: equivalent to a 4.5 star rated (GEMS 2012) heat pump cooler (Annualised Coefficient of Performance, ACOP = 4.5) [15]
  - water heater: instantaneous gas
  - 4 watts per square metre of lighting.

  Under this option, a societal cost of operating this benchmark building is calculated and a new building is deemed to be compliant if it has the same societal cost as the benchmark building. If a piece of equipment (e.g. water heating) is installed that performs worse than the benchmark, this would have to be offset either through installing other equipment that performs sufficiently better than the benchmark (e.g. cooling) or through the installation of on-site renewables (PVs).

— **Option A** – this option is based on the same energy use budget as Option B, however, the budget is 70 per cent of the Option B benchmark (i.e. a compliant dwelling must achieve savings equivalent to 30 per cent of the societal cost of applying the equipment and building fabric performance level of the benchmark building specified in Option B). For example, if the societal cost associated with the benchmark building in Option B is $1,000 per annum, then under Option A, a societal cost of $700 must be achieved.

  Compliance can be achieved either by improving the performance of the building shell, its equipment or by adding some PVs or a combination of these approaches.

No change is proposed to the existing lighting provisions in the NCC under either of the policy options.

Notably, the two proposed options in the NCC would enable a 'whole-of-house' (WoH) approach to achieve compliance. This means that a dwelling's annual energy use can be achieved within an energy budget, allowing a trade-off between the performance of individual building elements (such

[13] For further details about how the societal cost of energy is defined, please refer to the ABCB Scoping Study (https://consultation.abcb.gov.au/engagement/energy-efficiency-scoping-study-2019/).

[14] Under the latest 2019 GEMS determination, in terms of seasonal ratings, this would equate to 3 Stars i.e. a Heating Seasonal Performance Factor (HSPF) of 4.5.

[15] Under the latest 2019 GEMS determination, in terms of seasonal ratings, this would equate to 3 Stars i.e. a Total Cooling Seasonal Performance Factor (TCSPF) of 4.5.

as the thermal shell, water heating and pool pumps), subject to a minimum level of thermal comfort being achieved (no lower than 7-star NatHERS rated performance, or equivalent)[16].

### 1.3.2 Policy options to align BASIX with NCC 2022

To provide us with inputs to conduct the CBA in this report, the Department 'translated' the proposed NCC 2022 energy efficiency requirements into new minimum requirements for thermal comfort and energy efficiency in BASIX and provided us with energy flows and capital costs for a sample of dwellings under the Business as Usual (BAU) and under the two NCC policy options. The capital costs provided by the Department are based on the same assumptions used in the NCC RIS.

A summary of the policy options considered in this BASIX CBA as provided by the Department are outlined below. The pathways to comply with Options A and B, as modelled by the Department, are discussed in more detail in Section 2.2.3.

— **Business as Usual (BAU)** — the BAU (also referred to as status quo or base case) is an option where there are no changes to the energy efficiency requirements for residential buildings in NSW. The BAU sets up a baseline against which the impacts of the alternative options discussed below are evaluated.
— **Option A** — this option changes the BASIX minimum requirements for thermal comfort and energy efficiency to be consistent with Option A from the proposed NCC 2022. Under this option, the BASIX thermal comfort requirement is set at NatHERS 7 stars and the BASIX energy efficiency requirement is equivalent to the minimum 30 per cent reduction of energy value (as defined by the NCC) from that of the benchmark appliance profile[17].
— **Option B** — this option changes the BASIX minimum requirements for thermal comfort and energy efficiency to be consistent with Option B from the proposed NCC 2022. Under this option, the BASIX thermal comfort requirement is set at NatHERS 7 stars and the BASIX energy efficiency requirement is equivalent to the energy value (as defined by the NCC) from that of the benchmark appliance profile.

## 1.4 Report structure

The remainder of this report is structured as follows.

— Chapter 2 outlines the overarching methodology used for this analysis (including key parameters and assumptions).
— Chapter 3 assesses the impacts of the proposed changes to BASIX on individual households.
— Chapter 4 considers the economywide impacts of the proposed BASIX changes.
— Chapter 5 assesses the distributional and housing affordability impacts associated with the proposed policy changes.
— Chapter 6 concludes the report and presents the study's key findings.

[16] Trading between the thermal shell and appliances would not be possible when using the Deemed to Satisfy (DTS) elemental compliance pathway.

[17] Energy Efficient Strategies Pty Ltd 2020, *Whole-of-House DTS Provisions – Draft Modelling Results*, December.

# Approach and key assumptions 2

This chapter outlines the approach used to undertake the impact analysis for the proposed BASIX changes.

## 2.1 General CBA framework

Consistent with best regulatory practice, the analysis of the impacts of the proposed changes to BASIX was undertaken using a cost benefit analysis (CBA) framework.

CBA is an analytical tool used to assess the costs and benefits of regulatory proposals. Costs and benefits are examined from the perspective of the community as a whole to identify the proposal with the highest net benefit. This approach applies a with / without comparative metric that allows the analysis to specifically isolate the impacts of the incremental change in the BASIX energy efficiency targets from the ever-changing policy landscape.

The following sections outline our approach to some general parameters used in the CBA.

### 2.1.1 Costs and benefits included in the analysis

As is best practice for CBAs, the CBA model developed for this study includes costs and benefits likely to be faced by households, industry, government and society as a whole. The inclusion of a societal dimension reflects the existence of benefits that are not specific to any particular sector, rather they accrue equally across the entire population and, indeed, future generations. The costs and benefits that were included in the CBA model are outlined Table 2.1.

The CBA model quantifies these costs and benefits separately for each policy option under consideration, year-on-year over the period of the analysis.

As noted before, only costs and benefits that are incremental are included in the analysis. That is, only the additional benefits and costs incurred as a result of the proposed policy changes are included in the CBA.

**Table 2.1** Costs and benefits included in the CBA

| Category | Impact | Description |
|---|---|---|
| **Benefits** | | |
| Private | Energy savings* | The net increases/decreases in electricity and gas consumption |
| | Savings from the installation of smaller appliances* | Reductions in the capital cost of space conditioning equipment due to the improved thermal shell |
| Community | Network benefits | Deferred network investment for gas and electricity as a result of reductions in peak electricity demand and reductions in gas usage |
| | Air quality benefits | Health benefits from reduced pollution from electricity and gas generation |
| | Reduced carbon emissions | Benefits from reduced greenhouse gas emissions from household energy use |
| **Costs** | | |
| Private | Dwelling compliance costs* | Additional capital outlays required to meet the new BASIX targets (including additional outlays associated with thermal bridging mitigation and difficult blocks) |
| Industry | Training costs | Costs associated with adapting to the policy change |
| Government | Administrative costs | Associated with administering and communicating the policy change |

Note: those impacts marked with an * indicate they are included in the dwelling level analysis.
*Source: ACIL Allen.*

### 2.1.2 Timeframe for analysis

The analytical timeframe used to model the costs and benefits of the proposed changes to BASIX is based on the following assumptions about the life of the regulation and of their associated impacts.

#### The effective life of the regulation

Consistent with best practice, it is assumed that compliance and enforcement actions begin the year that the amendments take effect (2022) and are modelled to extend for a period of 10 years (that is, compliance costs are modelled for 10 years). After this period, it is assumed that in a normal cyclical policy review, a new CBA results in the BASIX targets being superseded, revised or extended.

#### The life of the regulation’s impact

The additional benefits that would flow from compliance with the new BASIX requirements would depend on the life of the assets installed to meet the requirements. Buildings are typically long-lived assets with a life of 40 years or more, whereas appliances are shorter-lived. In light of this, the following assumptions were used about the expected life of investments installed in new dwellings as a result of the changes in BASIX.

— Investments relating to the building shell last 40 years.

- Investments relating to appliances have a shorter life. In this respect, we followed the assumptions about expected life of equipment made in the NCC RIS, which assigns different lifetimes to each equipment measure as follows:
  - heating and cooling equipment is assumed to have a lifespan of 12 years[18]
  - hot water equipment is assumed to have a lifespan of 12 years.
- For investments related to PV, it was assumed that the solar panels have a lifetime of 20 years and that inverters (which are integral to the operation of the solar panels) last 10 years. It is also assumed that households would replace their inverter in year 11 so that the full 20 year benefits from the solar panels are realised.

In essence, this approach means that the benefits of the energy efficiency measures installed as a result of the proposed changes would generally last as long as the life of the assets (e.g. building shell 40 years and water heating equipment 12 years). The only exception to this is inverters which are treated as a 'package' with solar panels.

### 2.1.3 Discount rate

There is extensive debate around the basis and selection of the appropriate rate to discount the stream of costs and benefits of policy changes related to energy efficiency, as the rate used in the impact analysis has a very significant impact on the value placed on the benefits accumulated in the future over a long period of time.

In accordance with the NSW Treasury Guidelines for Economic Appraisal, the costs and benefits are calculated using a central 7 per cent real discount rate. Further, to assess the sensitivity of the results to the discount rate, we conduct a sensitivity analysis of the results using a lower bound discount rate of 3 per cent and an upper bound discount rate of 10 per cent.

[18] Given the interaction effects between an improved building shell and more efficient heating and cooling equipment, and the fact that these impacts have been separately modelled and provided to us by the Department for this study, to avoid double counting of benefits, we have assumed that for the first 12 years of the analytical period (from year 1 to year 12) only the benefits associated with more efficient heating and cooling equipment are accrued (i.e. the benefits from the improved building shell are assumed to be zero during the first 12 years). The benefits from improved building shell are assumed to kick in from year 13 (when the heating and cooling equipment reaches its end of life) and last until year 40 of the analytical period (i.e. until the building shell reaches its end of life).

### 2.1.4 Cost benefit summary measures

The CBA model includes two summary measures that distil the results of the analysis, as listed in Table 2.2.

**Table 2.2** Summary of measures included in the CBA

| Summary measure | Description | Success measurement | Comparative ability |
|---|---|---|---|
| Net present value (NPV) | Sum of discounted annual net benefits (benefits minus costs) | Policy is beneficial to society if NPV is greater than zero | Provides the ability to compare policy options according to the total economic return of each, where the option with the largest NPV should be favoured |
| Benefit-cost ratio (BCR) | Ratio of the present value of total costs to the present value of total benefits | Policy is beneficial to society if BCR is greater than one | Provides the ability to compare policy options according to the degree to which benefits outweigh costs for each, where the option with the largest BCR should be favoured |

*Source: ACIL Allen.*

### 2.1.5 Compliance and cost pass through

The analysis assumes full compliance with the new BASIX requirements. While in reality not all new constructions are likely to comply with the requirements fully, this is a standard assumption in regulatory analysis.

In addition, consistent with previous CBA and RIS analyses, for this study we assume that the additional compliance costs associated with the construction of a new dwelling are passed through in full to the consumer.

### 2.1.6 Rebates

There are currently a number of rebates and other subsidies for energy efficiency and renewable energy measures in NSW.

While, from a household's perspective, it is reasonable to factor any rebates into the cost of installing energy efficiency measures, as a general rule, subsidies are excluded from CBAs as, from the societal perspective, they do not represent an incremental resource cost, but just a transfer of costs.

In light of this, any subsidies currently in place for energy efficiency and renewable energy measures are excluded from the economy-wide CBA. However, in line with the approach taken in the NCC RIS, rebates for solar PV and solar and heat pump water heaters are included in the distributional analysis (i.e. the analysis of the proposed changes from the perspective of households living in the dwellings that would be subject to the new BASIX requirements).

The rebates are included in the NCC as follows: [19]

- Solar PV — the RIS included an average level of Small-Scale Technology Certificate (STC) rebates over the 10 year period of the regulation (starting in 2022). An average of four years of credits was applied being the average number of credits applicable over the period (current rebates effectively end in 2030).
- Water Heaters (solar and heat pump types only) — for smaller units (those in Class 2 dwellings) an average of 20 STCs was assumed and for larger units (those in Class 1) an average of 25 STCs.

The modelling underpinning the NCC RIS assumes that the STC deeming value for NSW per kW of solar PV installed is 1.382 and a value of $36.50 per STC.

# 2.2 Impact assessment

## 2.2.1 Building sample and aggregation

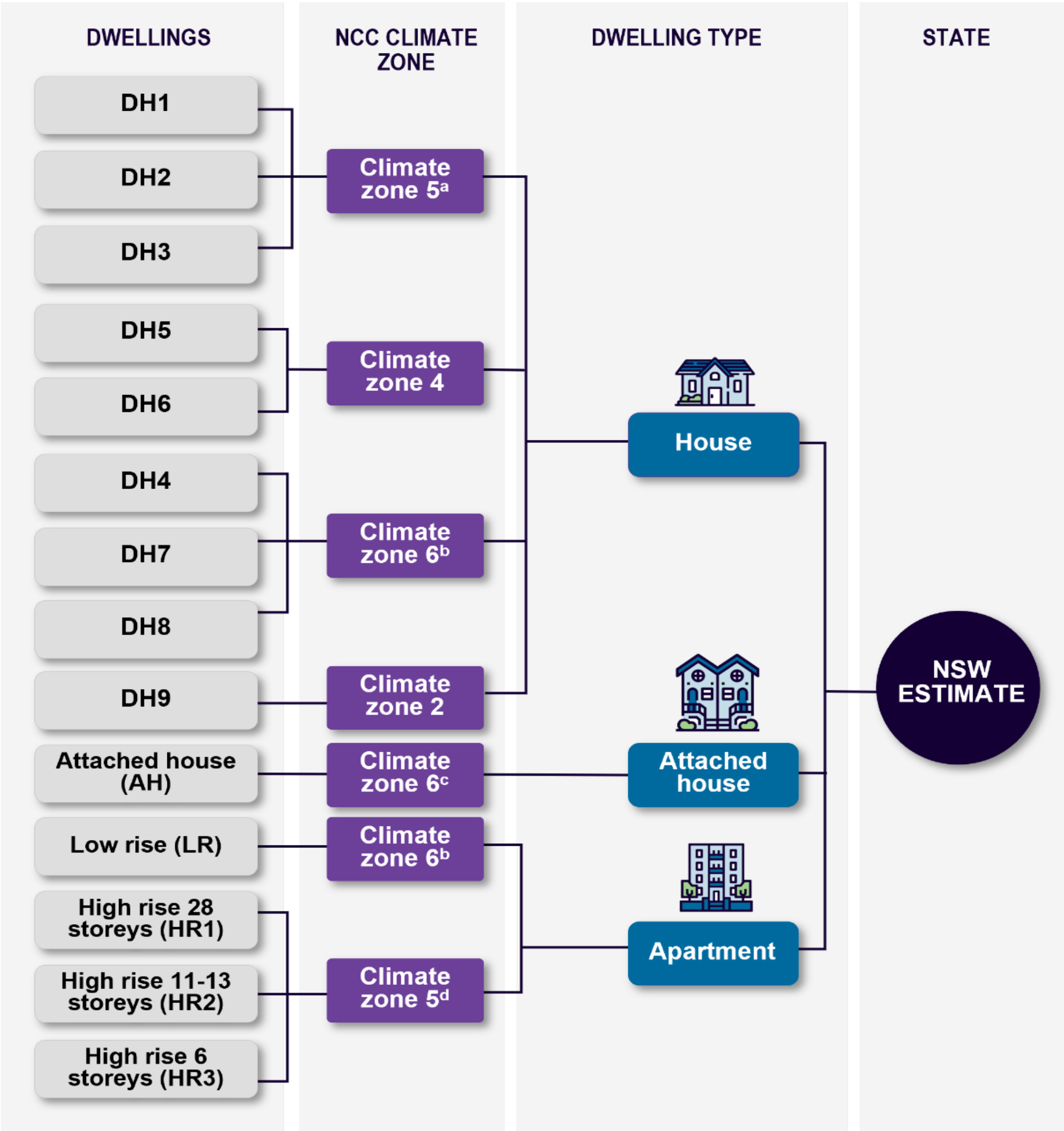
The CBA has been conducted using a ‘bottom-up’ approach that:

- first estimates the benefits (and costs) of the new proposed BASIX requirements at the individual household level for representative Class 1 and Class 2 dwellings in different locations and climate zones across NSW
- aggregates these representative dwellings to state level using information about the distribution, number and growth of the NSW housing stock.

Figure 2.1 illustrates at a high level how dwellings are aggregated, and the following sections provide additional detail.

[19] These are based on the modelling underpinning the NCC undertaken by EES. More details about the treatment of these rebates in EES’s modelling can be found in found in EES’s report ‘*NCC 2022 Update - Whole of House Component’.*

**Figure 2.1** Dwelling sample aggregation




[a] Climate zone 5 is applied to DH1, DH2 and DH3, houses in Western Sydney that are currently located in NCC climate zone 6 – as shown in Figure 2.2. This approach is taken to align with the proposed changes in NCC 2022.
[b] No dwellings were modelled by the Department in NSW climate zones 7 or 8. As such, it is assumed that buildings in these climate zones would experience equivalent costs and benefits as those in climate zone 6. The numbers of houses and apartments currently built in these climate zones are very small (around 5 per cent of houses and 0.4 per cent of apartments in NSW).
[c] Only one attached house was modelled by the Department (in climate zone 6). Given this, it is assumed that all attached houses across the state (regardless of the climate zone they are built in), would experience equivalent costs and benefits as those in climate zone 6.
[d] No apartments were modelled by the Department in NSW climate zones 2 or 4. As such, it is assumed that apartments in these climate zones would experience equivalent costs and benefits to those in climate zone 5. The number of apartments currently built in these climate zones is very small (around 1.2 per cent of apartments in NSW).
Note: all climate zones refer to NCC climate zones.
*Source: ACIL Allen.*

### Representative dwellings

The analysis employs 14 indicative/representative dwelling types. These include:

— nine detached houses (labelled DH1 through DH9)
— an attached house development (AH)
— a low-rise apartment complex (LR)
— three different high-rise apartment blocks (HR1 through HR3).

These dwellings represent composites of different locations, dwelling types and compliance pathways (compliance pathways modelled for this CBA are discussed in more detail in Section 2.2.3). Key features of the different dwellings under Option A and Option B are summarised in Table 2.3 and Table 2.4 below. Additional details about the characteristics of these dwellings and how they were modelled by the Department are provided in Appendix A.

Notably, because BASIX aims to reduce emissions from apartment buildings rather than individual Class 2 Sole Occupancy Units (SOUs), the representative apartment buildings provided by the Department for the CBA include central systems and common areas in addition to individual units. However, to be consistent with the NCC RIS, the impacts of the proposed changes are calculated on a per SOU basis by dividing the energy flows and capital costs for the whole apartment building by the number of units in each building.

Table 2.3 and Table 2.4 set out the modelled locations and climate zone analysis regions included in the dwelling sample. Both the baseline and policy scenarios are affected by where a building is constructed. For example, location influences:

— construction costs
— thermal performance
— investments required to meet BASIX targets
— the BASIX requirements that apply.

The climate zones referred to in the representative dwellings' tables relate to climate zones in NSW as per the NCC (see Figure 2.2). Notably, while NSW has a total of six climate zones (2, 4, 5, 6, 7 and 8), as shown in Figure 2.1, Table 2.3 and Table 2.4, only four climate zones have been modelled. The numbers of houses and apartments currently built in the climate zones not modelled (7 and 8) are very small (see Table 2.5).

**Table 2.3** Representative dwelling sample used for Option A

| Dwelling | Modelled location | Analysis region (NCC climate zone) | Type | Number of storeys | Gross floor area (m2) [total for multi dwellings] | Number of bedrooms | Variant | Current BASIX compliance scenario | NCC 2022 Option A compliance pathway | Weighting |
|---|---|---|---|---|---|---|---|---|---|---|
| **Detached houses** | | | | | | | | | | |
| DH1 | Blacktown | 5 | Average | 2 | 170 | 4 bedrooms | DH 1.1 | Min requirement | Gas hot water | 0.74 |
| | | | | | | | DH 1.2 | Min requirement | Heat pump hot water | 0.06 |
| | | | | | | | DH 1.3 | Over-compliance | Gas hot water | 0.18 |
| | | | | | | | DH 1.4 | Over-compliance | Heat pump hot water | 0.02 |
| DH2 | Blacktown | 5 | Affordable | 2 | 145 | 4 bedrooms | DH 2.1 | Min requirement | Gas hot water | 0.74 |
| | | | | | | | DH 2.2 | Min requirement | Heat pump hot water | 0.06 |
| | | | | | | | DH 2.3 | Over-compliance | Gas hot water | 0.18 |
| | | | | | | | DH 2.4 | Over-compliance | Heat pump hot water | 0.02 |
| DH3 | Baulkham Hills | 5 | Large | 2 | 440 | 5 bedrooms | DH 3.1 | Min requirement | Gas hot water | 0.74 |
| | | | | | | | DH 3.2 | Min requirement | Heat pump hot water | 0.06 |
| | | | | | | | DH 3.3 | Over-compliance | Gas hot water | 0.18 |
| | | | | | | | DH 3.4 | Over-compliance | Heat pump hot water | 0.02 |
| DH4 | Cessnock | 6 | Average | 2 | 170 | 4 bedrooms | DH 4.1 | Min requirement | Gas hot water | 0.42 |
| | | | | | | | DH 4.2 | Min requirement | Heat pump hot water | 0.08 |
| | | | | | | | DH 4.3 | Over-compliance | Gas hot water | 0.42 |
| | | | | | | | DH 4.4 | Over-compliance | Heat pump hot water | 0.08 |
| DH5 | Dubbo | 4 | Average | 2 | 165 | 4 bedrooms | DH 5.1 | Min requirement | Gas hot water | 0.57 |
| | | | | | | | DH 5.2 | Min requirement | Heat pump hot water | 0.03 |
| | | | | | | | DH 5.3 | Over-compliance | Gas hot water | 0.38 |
| | | | | | | | DH 5.4 | Over-compliance | Heat pump hot water | 0.02 |

| Dwelling | Modelled location | Analysis region (NCC climate zone) | Type | Number of storeys | Gross floor area (m2) [total for multi dwellings] | Number of bedrooms | Variant | Current BASIX compliance scenario | NCC 2022 Option A compliance pathway | Weighting |
|---|---|---|---|---|---|---|---|---|---|---|
| DH6 | Wagga Wagga | 4 | Average | 2 | 190 | 4 bedrooms | DH 6.1 | Min requirement | Gas hot water | 0.58 |
| | | | | | | | DH 6.2 | Min requirement | Heat pump hot water | 0.02 |
| | | | | | | | DH 6.3 | Over-compliance | Gas hot water | 0.38 |
| | | | | | | | DH 6.4 | Over-compliance | Heat pump hot water | 0.02 |
| DH7 | Moss Vale | 6 | Average | 2 | 220 | 4 bedrooms | DH 7.1 | Min requirement | Gas hot water | 0.58 |
| | | | | | | | DH 7.2 | Min requirement | Heat pump hot water | 0.09 |
| | | | | | | | DH 7.3 | Over-compliance | Gas hot water | 0.28 |
| | | | | | | | DH 7.4 | Over-compliance | Heat pump hot water | 0.05 |
| DH8 | Moss Vale | 6 | Large | 2 | 325 | 5 bedrooms | DH 8.1 | Min requirement | Gas hot water | 0.52 |
| | | | | | | | DH 8.2 | Min requirement | Heat pump hot water | 0.08 |
| | | | | | | | DH 8.3 | Over-compliance | Gas hot water | 0.34 |
| | | | | | | | DH 8.4 | Over-compliance | Heat pump hot water | 0.06 |
| DH9 | Ballina | 2 | Average | 2 | 185 | 4 bedrooms | DH 9.1 | Min requirement | Gas hot water | 0.29 |
| | | | | | | | DH 9.2 | Min requirement | Heat pump hot water | 0.21 |
| | | | | | | | DH 9.3 | Over-compliance | Gas hot water | 0.29 |
| | | | | | | | DH 9.4 | Over-compliance | Heat pump hot water | 0.21 |
| **Multiple dwellings and apartment buildings** | | | | | | | | | | |
| AH 1 | Albion Park | 6 | 3 dwellings | 1 | 468 | 3 bedroom each | AH 1.1 | Min requirement | Gas hot water | 0.87 |
| | | | | | | | AH 1.2 | Min requirement | Heat pump hot water | 0.03 |
| | | | | | | | AH 1.3 | Over-compliance | Gas hot water | 0.10 |
| | | | | | | | AH 1.4 | Over-compliance | Heat pump hot water | 0.003 |

| Dwelling | Modelled location | Analysis region (NCC climate zone) | Type | Number of storeys | Gross floor area (m2) [total for multi dwellings] | Number of bedrooms | Variant | Current BASIX compliance scenario | NCC 2022 Option A compliance pathway | Weighting |
|---|---|---|---|---|---|---|---|---|---|---|
| LR 1 | Shellharbour | 6 | 13 units | 3 | 1,440 | 5 x 3 bedrooms<br>5 x 2 bedrooms<br>3 x 1 bedroom | LR 1.1 | Min requirement | Gas hot water | 0.90 |
| | | | | | | | LR 1.2 | Min requirement | Heat pump hot water | 0.03 |
| | | | | | | | LR 1.3 | Over-compliance | Gas hot water | 0.07 |
| | | | | | | | LR 1.4 | Over-compliance | Heat pump hot water | 0.002 |
| HR1 | Macquarie Park | 5 | 219 units | 7 & 28 | 18,376 | 5 x 4 bedrooms<br>48 x 3 bedrooms<br>104 x 2 bedrooms62 x 1 bedroom | HR 1.1 | Min requirement | Gas hot water | 0.81 |
| | | | | | | | HR 1.2 | Min requirement | Heat pump hot water | 0.09 |
| | | | | | | | HR 1.3 | Over-compliance | Gas hot water | 0.09 |
| | | | | | | | HR 1.4 | Over-compliance | Heat pump hot water | 0.01 |
| HR 2 | Eastwood | 5 | 127 units | 10 & 13 | 9,133 | 18 x 3 bedrooms<br>48 x 2 bedrooms<br>61 x 1 bedroom | HR 2.1 | Min requirement | Gas hot water | 0.75 |
| | | | | | | | HR 2.2 | Min requirement | Heat pump hot water | 0.08 |
| | | | | | | | HR 2.3 | Over-compliance | Gas hot water | 0.15 |
| | | | | | | | HR 2.4 | Over-compliance | Heat pump hot water | 0.02 |
| HR3 | Liverpool | 5 | 37 units | 8 | 2,610 | 23 x 2 bedrooms<br>14 x 1 bedroom | HR 3.1 | Min requirement | Gas hot water | 0.58 |
| | | | | | | | HR 3.2 | Min requirement | Heat pump hot water | 0.02 |
| | | | | | | | HR 3.3 | Over-compliance | Gas hot water | 0.39 |
| | | | | | | | HR 3.4 | Over-compliance | Heat pump hot water | 0.01 |

*Source: ACIL Allen and NSW Department of Planning, Industry and Environment.*

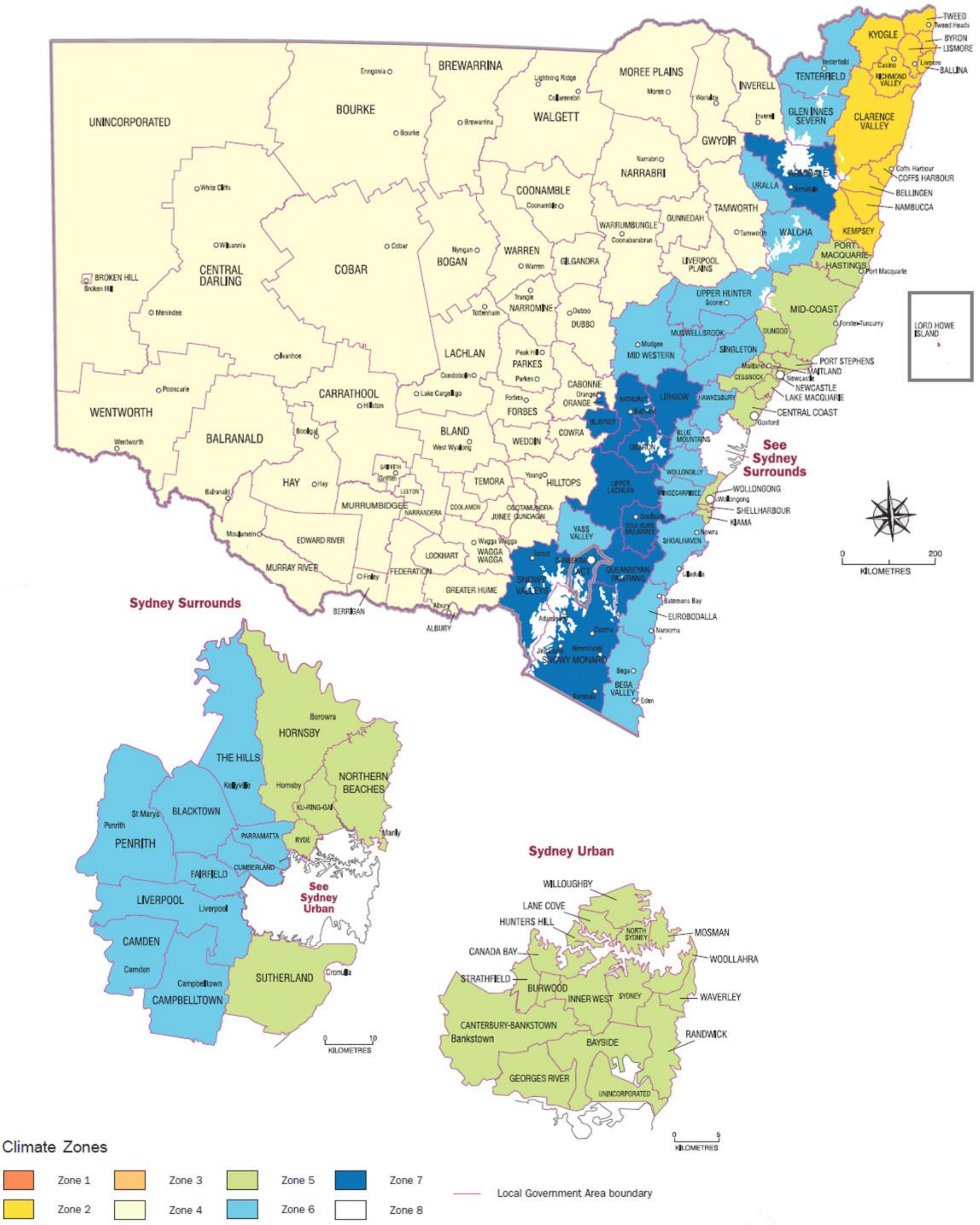
**Table 2.4** Representative dwelling sample used for Option B

| Dwelling | Modelled location | Analysis region (NCC climate zone) | Type | Number of storeys | Gross floor area (m2) [total for multi dwellings] | Number of bedrooms | Variant | Current BASIX compliance scenario | NCC 2022 Option B compliance pathway | Weighting |
|---|---|---|---|---|---|---|---|---|---|---|
| **Detached houses** | | | | | | | | | | |
| DH1 | Blacktown | 5 | Average | 2 | 170 | 4 bedrooms | DH 1.1 | Min requirement | NCC benchmark equipment | 0.80 |
| | | | | | | | DH 1.2 | Over-compliance | NCC benchmark equipment | 0.20 |
| DH2 | Blacktown | 5 | Affordable | 2 | 145 | 4 bedrooms | DH 2.1 | Min requirement | NCC benchmark equipment | 0.80 |
| | | | | | | | DH 2.2 | Over-compliance | NCC benchmark equipment | 0.20 |
| DH3 | Baulkham Hills | 5 | Large | 2 | 440 | 5 bedrooms | DH 3.1 | Min requirement | NCC benchmark equipment | 0.80 |
| | | | | | | | DH 3.2 | Over-compliance | NCC benchmark equipment | 0.20 |
| DH4 | Cessnock | 6 | Average | 2 | 170 | 4 bedrooms | DH 4.1 | Min requirement | NCC benchmark equipment | 0.50 |
| | | | | | | | DH 4.2 | Over-compliance | NCC benchmark equipment | 0.50 |
| DH5 | Dubbo | 4 | Average | 2 | 165 | 4 bedrooms | DH 5.1 | Min requirement | NCC benchmark equipment | 0.60 |
| | | | | | | | DH 5.2 | Over-compliance | NCC benchmark equipment | 0.40 |
| DH6 | Wagga Wagga | 4 | Average | 2 | 190 | 4 bedrooms | DH 6.1 | Min requirement | NCC benchmark equipment | 0.60 |
| | | | | | | | DH 6.2 | Over-compliance | NCC benchmark equipment | 0.40 |
| DH7 | Moss Vale | 6 | Average | 2 | 220 | 4 bedrooms | DH 7.1 | Min requirement | NCC benchmark equipment | 0.67 |
| | | | | | | | DH 7.2 | Over-compliance | NCC benchmark equipment | 0.33 |
| DH8 | Moss Vale | 6 | Large | 2 | 325 | 5 bedrooms | DH 8.1 | Min requirement | NCC benchmark equipment | 0.60 |
| | | | | | | | DH 8.2 | Over-compliance | NCC benchmark equipment | 0.40 |
| DH9 | Ballina | 2 | Average | 2 | 185 | 4 bedrooms | DH 9.1 | Min requirement | NCC benchmark equipment | 0.50 |
| | | | | | | | DH 9.2 | Over-compliance | NCC benchmark equipment | 0.50 |

| Dwelling | Modelled location | Analysis region (NCC climate zone) | Type | Number of storeys | Gross floor area (m2) [total for multi dwellings] | Number of bedrooms | Variant | Current BASIX compliance scenario | NCC 2022 Option B compliance pathway | Weighting |
|---|---|---|---|---|---|---|---|---|---|---|
| **Multiple dwellings and apartment buildings** | | | | | | | | | | |
| AH 1 | Albion Park | 6 | 3 dwellings | 1 | 468 | 3 bedroom each | AH 1.1 | Min requirement | NCC benchmark equipment | 0.90 |
| | | | | | | | AH 1.2 | Over-compliance | NCC benchmark equipment | 0.10 |
| LR 1 | Shellharbour | 6 | 13 units | 3 | 1,440 | 5 x 3 bedrooms | LR 1.1 | Min requirement | NCC benchmark equipment | 0.93 |
| | | | | | | 5 x 2 bedrooms | LR 1.2 | Over-compliance | NCC benchmark equipment | 0.07 |
| | | | | | | 3 x 1 bedroom | | | | |
| HR1 | Macquarie Park | 5 | 219 units | 7 & 28 | 18,376 | 5 x 4 bedrooms | HR 1.1 | Min requirement | NCC benchmark equipment | 0.90 |
| | | | | | | 48 x 3 bedrooms | HR 1.2 | Over-compliance | NCC benchmark equipment | 0.10 |
| | | | | | | 104 x 2 bedrooms | | | | |
| | | | | | | 62 x 1 bedroom | | | | |
| HR 2 | Eastwood | 5 | 127 units | 10 & 13 | 9,133 | 18 x 3 bedrooms | HR 2.1 | Min requirement | NCC benchmark equipment | 0.83 |
| | | | | | | 48 x 2 bedrooms | HR 2.2 | Over-compliance | NCC benchmark equipment | 0.17 |
| | | | | | | 61 x 1 bedroom | | | | |
| HR3 | Liverpool | 5 | 37 units | 8 | 2,610 | 23 x 2 bedrooms | HR 3.1 | Min requirement | NCC benchmark equipment | 0.60 |
| | | | | | | 14 x 1 bedroom | HR 3.2 | Over-compliance | NCC benchmark equipment | 0.40 |

*Source: ACIL Allen and NSW Department of Planning, Industry and Environment.*

**Figure 2.2** Climate zone map, NSW and ACT




*Source: ABCB.*

**Table 2.5** Proportion of dwellings built in NSW by climate zone from 2016 to 2021

| NCC Climate Zone | Class 1 | Class 2 |
|---|---|---|
| 1 - High humidity summer, warm winter | - | - |
| 2 - Warm humid summer, mild winter | 7.05% | 1.02% |
| 3 - Hot dry summer, warm winter | - | - |
| 4 - Hot dry summer, cool winter | 3.80% | 0.23% |
| 5 - Warm temperate | 34.85% | 74.56% |
| 6 - Mild temperate | 49.05% | 23.77% |
| 7 - Cool temperate | 5.03% | 0.40% |
| 8 - Alpine | 0.22% | 0.02% |

*Source: CSIRO Australian Housing Dataset.*

### Aggregation: the NSW housing stock

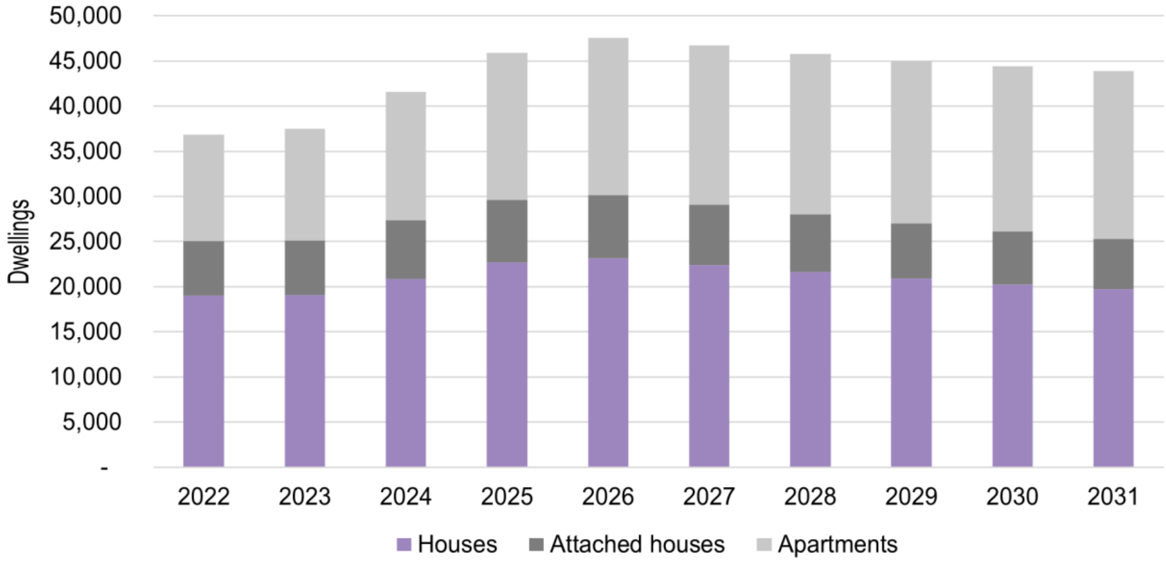
We do not expect that the proposed changes to BASIX would impact on the numbers of new residential buildings constructed in NSW. Nevertheless, growth of the residential stock is a key driver for both costs and benefits of the proposed amendments, and distributional issues in the analysis.

For this analysis, we produced baseline projections of the housing stock in NSW over the period 2022 to 2031. These projections are consistent with the NCC RIS and are primarily based on historical Australian Bureau of Statistics (ABS) approvals data and ABS forecasts of the Australian housing stock. We also used Housing Industry Association (HIA) information on projected dwelling commencements to inform adjustments to our projections in the short term due to COVID-19. Our projections see the number of new dwellings in NSW increase from just above 36,000 dwellings in 2022 to around 44,000 by 2031 (see Figure 2.3). This represents an increase in the housing stock of around 2 per cent per annum.

The numbers of new buildings by climate zone are illustrated in Figure 2.4. Forward projections assume that the distribution of dwellings by climate zone outlined in Table 2.5 remains the same over the analytical period.

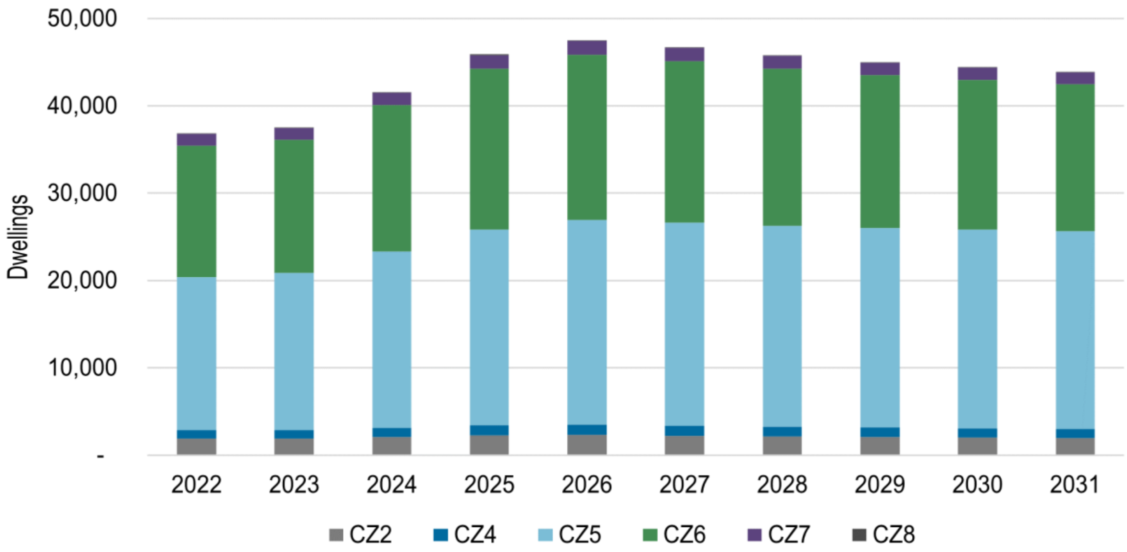
When presenting the results of the analysis at the household/dwelling level, we have included an estimate of impacts of the proposed changes on a composite ‘average’ house, townhouse and apartment in NSW. The composite ‘average’ house, townhouse and apartment in NSW are derived based on the weighting outlined in Table 2.6.

**Figure 2.3** Projected number of new residential dwellings by dwelling type, NSW, 2022 to 2031




*Source: ACIL Allen.*

**Figure 2.4** Projected number of new residential dwellings in NSW by climate zone, 2022 to 2031




Note: Figure includes attached dwellings, detached houses and apartments (SOUs).
*Source: ACIL Allen.*

**Table 2.6** Weightings used to derive a composite 'average' house, townhouse and apartment in NSW

| Dwelling | Weighting |
|---|---|
| **HOUSES** | |
| DH9 | 0.07 |
| DH6 | 0.01 |
| DH5 | 0.03 |
| DH1 | 0.24 |
| DH2 | 0.09 |
| DH3 | 0.02 |
| DH7 | 0.27 |
| DH8 | 0.03 |
| DH4 | 0.24 |
| **TOWNHOUSES** | |
| AH | 1.00 |
| **UNITS** | |
| LR | 0.24 |
| HR3 | 0.61 |
| HR2 | 0.12 |
| HR1 | 0.03 |

*Source: ACIL Allen based on information provided by CSIRO and the Department.*

### 2.2.2 Baseline for analysis

As noted before, the effects of the proposed policy options are estimated by comparing their impacts with the baseline or BAU scenario. The baseline is a projection of the future state of the world in the absence of any policy or regulatory change.

The objective of the CBA is to assess the change brought about by the new proposed energy efficiency requirements in BASIX. As such, the baseline should make specific reference to those factors which would be affected by the regulation and which would affect the estimates of its impact. To this end, to establish the baseline for the analysis in the CBA we consider:

— the current and future energy efficiency of new buildings (including the current level of over compliance with BASIX requirements)
— the growth in the building stock (discussed in Section 2.2.1 above)
— changes in energy consumption and prices (this is discussed in more detail in Section 2.4.1).

The definition of these baseline elements represents the best estimate of how the world might look given the information available today.

Additional information about the current and future energy efficiency of new buildings under the BAU is provided in the section below.

### Baseline energy efficiency

As noted in Section 1.3.2, the Department provided data about the current compliance with BASIX requirements. For modelling purposes, the Department considered two scenarios of current compliance under the BAU:

1. *Minimum compliance scenario* — this scenario assumes a thermal comfort standard equivalent to NatHERS 5.5 – 6 stars, the most common hot water, heating and cooling systems and average size of PV (if applicable) for a proposed development to meet the BASIX energy target within 2 points. For example, for a detached house in Greater Sydney with an energy target of 50, this scenario refers to specifications that result in an energy score between 50 and 52.
2. *Over-compliance scenario* — this scenario includes a thermal comfort standard equivalent to NatHERS 6 – 6.5 stars and the most common hot water, heating and cooling systems and average size of PV (if applicable) for a proposed development to intentionally over-comply with the current energy target by at least 3 points (e.g. an energy score of 53 or higher for a detached house in Greater Sydney).

Using data from July 2017 to June 2020, the Department estimated the proportion of dwellings in the dwelling sample that achieve minimum compliance with the current BASIX requirements, and the proportion of dwellings that over comply. These are shown in Table 2.7.

The current levels of minimum compliance and over-compliance are assumed to remain over the analysis period.

**Table 2.7** Proportion of dwellings in the dwelling sample that achieve minimum compliance and over-compliance with current BASIX requirements

| Dwelling/building sample | Minimum compliance | Over-compliance |
|---|---|---|
| **Detached houses** | | |
| Blacktown (DH1, DH2) | 80% | 20% |
| | | |
| Baulkham Hills (DH3) | 80% | 20% |
| Cessnock (DH4) | 50% | 50% |
| Dubbo (DH5) | 60% | 40% |
| Wagga Wagga (DH6) | 60% | 40% |
| Moss Vale (DH7) | 67% | 33% |
| Moss Vale (DH8) | 60% | 40% |
| Ballina (DH9) | 50% | 50% |
| **Multiple dwellings and apartment buildings** | | |
| Attached houses – Albion Park (AH) | 90% | 10% |
| Low-rise building – Shellharbour (LR) | 93% | 7% |
| High-rise – Macquarie Park (HR1) | 90% | 10% |
| High rise – Eastwood (HR2) | 83% | 17% |
| High rise – Liverpool (HR3) | 60% | 40% |

*Source: NSW Department of Planning, Industry and Environment.*

### 2.2.3 Assumed response to the new BASIX requirements: upgrade pathways

As noted before, the Department 'translated' the proposed NCC 2022 energy efficiency requirements into new minimum requirements for thermal comfort and energy efficiency in BASIX to provide us with energy flows and capital costs for the dwelling sample under the BAU and under the two NCC policy options.

The pathways to comply with Options A and B, as modelled by the Department, are discussed in more detail below. Other specifications and assumptions used by the Department to model the energy flows and capital costs for the dwelling sample are provided in Appendix A.

**Option A**

The Department modelled two possible compliance pathways under Option A.

1. Gas hot water system pathway — this pathway specifies:
   - NatHERS 7 stars thermal comfort performance
   - 5 or 6-star gas instantaneous hot water system for detached houses or central gas hot water systems for apartment buildings.

   The gas hot water system pathway is developed as an improvement of the over-compliance scenario under the BAU to achieve the same BASIX energy score as the electric hot water system scenario.

   Under the gas hot water system pathway, many houses in the modelled sample need small PV systems of less than 1.5 kW to meet the same BASIX energy score as under the electric hot water system pathway. Installation of PV systems is one of the ways to achieve the required BASIX energy score. More efficient air conditioners or solar hot water systems with gas boosters can be specified to achieve the same BASIX energy score. However, these alternatives may not be as readily available in the market as PV systems.
2. Electric hot water system pathway — this pathway specifies:
   - NatHERS 7 stars thermal comfort performance
   - heat pump hot water systems (for detached houses and apartment building), and the benchmark heating/cooling systems (i.e. reverse-cycle 1-phase air conditioners with 3-star (GEMS 2019) rating or AEER of 4.75).[20]

When providing us with the inputs for the CBA, the Department assumed that systems of 1.5 kW capacity would be installed. This assumption is consistent with the approach used in the NCC 2022 and is based on the fact that it is unlikely that systems of less than 1.5 kW would be installed due to the substantial fixed costs of elements such as inverters and the small marginal cost of additional solar panels to reach 1.5 kW.

In addition, for high rise Class 2 dwellings, the Department considered higher BASIX energy targets (more information about these targets is provided in Appendix A). These higher BASIX energy targets are consistent with the proposed targets put forward by the City of Sydney in their 'Planning

[20] Energy Efficient Strategies Pty Ltd 2020, *NCC 2022 Update – Whole-of-House Component: Draft report*, September.

for net zero energy buildings' report[21] in May 2021. To achieve these higher BASIX targets, the apartment buildings require PV systems in the range of 11- 47 kW to be installed. The size of PV systems required are different from that presented by the City of Sydney due to differences in some of the underlying assumptions such as specifications of household appliances.

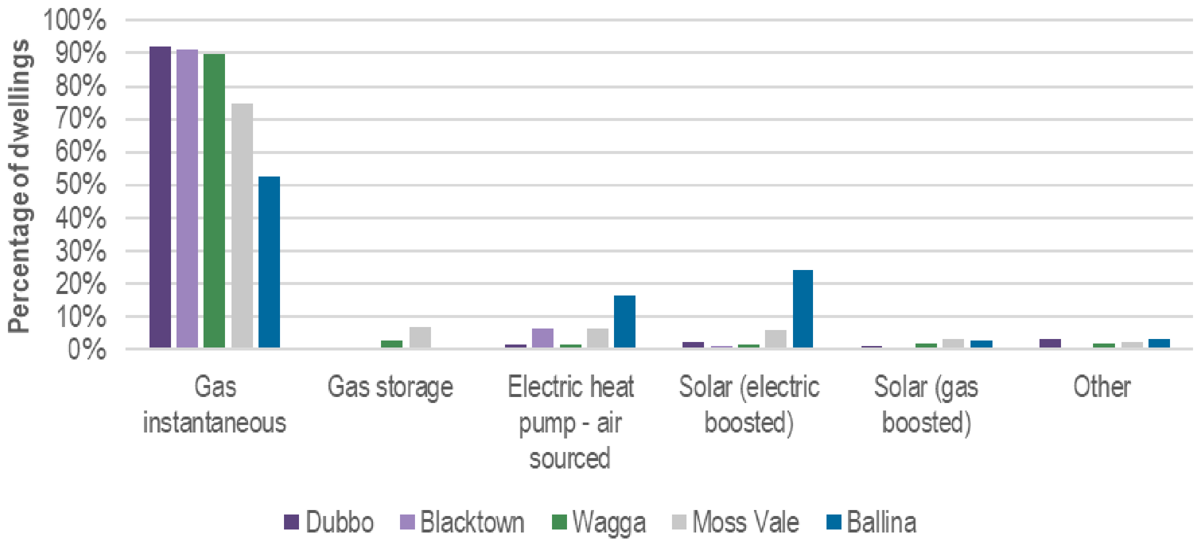
### *Relative uptake of gas and electric hot water systems under Option A*

The existing penetration of hot water systems specified in BASIX single-dwelling projects from July 2017 to June 2020 was analysed to estimate the relative uptake of gas and electric hot water systems for the sample of Class 1 detached houses (DH1 – DH9) under Option A.

Gas instantaneous hot water systems are the most popular in all the five locations of detached houses being considered in the CBA – see Figure 2.5.

It is assumed that similar proportions of gas and electric hot water systems to those in Figure 2.5 would apply after the higher BASIX targets are implemented. Table 2.11 shows the relative proportion of gas and electric hot water system scenarios for the sample detached houses considered in the BASIX CBA.

**Figure 2.5** Distribution of hot water systems in single dwellings in selected LGAs




*Source: NSW Department of Planning, Industry and Environment.*

[21] City of Sydney, WSP, Common Capital, WT Partnership and Elton Consulting 2021, *Planning for net zero energy buildings*, June, https://www.cityofsydney.nsw.gov.au/surveys-case-studies-reports/planning-for-net-zero-energy-buildings, accessed 21 June 2021.

**Table 2.8** Relative uptake of gas and heat pump hot water systems in sample detached houses

| Hot water systems | Sample detached houses | | | | | |
|---|---|---|---|---|---|---|
| | **Blacktown and Baulkham Hills (DH1 – DH3)** | **Cessnock (DH4)** | **Dubbo (DH5)** | **Wagga Wagga (DH6)** | **Moss Vale (DH7 – DH8)** | **Ballina (DH9)** |
| Gas system | 92% | 84% | 95% | 96% | 86% | 58% |
| Heat pump system | 8% | 16% | 5% | 4% | 14% | 42% |

*Source: NSW Department of Planning, Industry and Environment.*

Similar to detached houses, the relative uptake of gas and heat pump hot water systems in attached houses and apartment buildings was determined by the Department using BASIX data from July 2017 to June 2020. Table 2.9 shows the proportion of gas and electric systems in the sample multiple-dwelling developments, noting that most high-rise buildings have centralised systems.

**Table 2.9** Relative uptake of gas and heat pump hot water systems (individual vs centralised systems) in the sample attached dwellings and apartment buildings

<table>
<tr><th></th><th colspan="2">Gas hot water system</th><th colspan="2">Heat pump hot water system</th></tr>
<tr><th></th><th>Individual</th><th>Centralised</th><th>Individual</th><th>Centralised</th></tr>
<tr><td>Attached houses (AH)</td><td>97%</td><td rowspan="2">–</td><td>3%</td><td rowspan="2">–</td></tr>
<tr><td>Low-rise building (LR)</td><td>97%</td><td>3%</td></tr>
<tr><td>High-rise – Macquarie Park (HR1)</td><td rowspan="3">–</td><td>90%</td><td rowspan="3">–</td><td>10%</td></tr>
<tr><td>High rise – Eastwood (HR2)</td><td>90%</td><td>10%</td></tr>
<tr><td>High rise – Liverpool (HR3)</td><td>97%</td><td>3%</td></tr>
</table>

*Source: NSW Department of Planning, Industry and Environment.*

## Option B

The Department only considered one compliance pathway for each sample dwelling under Option B. For detached and attached houses this compliance pathway specifies:

— NatHERS 7 stars thermal comfort performance

— 6-star gas instantaneous hot water systems for detached houses and the benchmark heating/cooling systems (i.e. reverse-cycle 1-phase air conditioners with 3-star (GEMS 2019) rating or AEER of 4.75) are specified. Similar to Option A, if PV systems of less than 1.5 KW are required under this option, 1.5 kW systems are assumed as inputs to the BASIX CBA.

For apartment buildings this compliance pathway specifies:

— an average NatHERS 7-star thermal comfort performance per SOU

— the benchmark heating and cooling systems. Gas instantaneous systems with 6 stars are considered in the low-rise (LR) and the 8-storey high-rise (HR3) buildings, while central gas hot water systems are included in the other two high-rise buildings in the sample (HR1 and HR2).

The BASIX energy outcomes of the apartment buildings are aimed at 3 – 5 points higher than the over-compliance scenario in the BAU, corresponding to PV systems of 4.5 – 20 kW to be supplied to these buildings.

# 2.3 Compliance costs

This section describes some of the assumptions and inputs used to estimate the costs of the proposed changes to BASIX.

## 2.3.1 Change in construction costs

As noted before, construction costs were estimated by the Department following the approach and assumptions used in the NCC RIS. We have assumed that the resource cost of these changes in construction is equal to 90 per cent of the construction costs estimated by the Department.[22] Resource cost is the opportunity cost of allocating resources to the production and installation of the energy efficiency upgrades (instead of some other products or services). In calculating opportunity costs, producer surplus and costs of labour that would otherwise be unemployed are deducted from gross costs. Producer surplus is the difference between what producers are willing and able to supply a good for and the price they actually receive.

The difference in construction costs between dwellings compliant with the current BASIX targets and the proposed BASIX targets is then used in this analysis as the basis for estimating the compliance costs associated with the proposed changes.

The estimated changes in construction costs for Class 1 and Class 2 are outlined in the next chapter.

## 2.3.2 Appliance savings

Improving the thermal performance of new dwellings from 6 to 7 stars could have implications for the choice of space conditioning equipment. Air-conditioning and heating appliances need to be of sufficient capacity to ensure that comfortable temperatures can be maintained within the dwelling under most climatic conditions[23]. As thermal performance improves, the dependence on these appliances to provide comfort decreases and smaller appliances can be installed to provide the same level of comfort.

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[22] The resource cost of different types of construction products varies as there are a number of margins applied throughout the supply chain (e.g. wholesaler and retailer margin and transport margins). A 10 per cent discount on retail costs has been used to approximate the resource cost of construction products based on research by the Reserve Bank of Australia (RBA) that showed that 'the cost of goods accounts for around half of the final sale price of retail items, shared between its two inputs – imports and domestically produced goods... The remainder reflects the cost of distribution. Splitting this into the various inputs involved in distribution shows that around 20 per cent of the final price is attributable to each of labour and intermediate inputs used by distributors, with the final 10 per cent of the sale price being the net profit of wholesalers and retailers combined'. D'Arcy, P., Norman, D. and Shan, S. 2012, *Costs and Margins in the Retail Supply Chain,* RBA Bulletin June Quarter 2012, https://www.rba.gov.au/publications/bulletin/2012/jun/2.html.

[23] ABCB 2006, *Regulation Impact Statement: Proposal to amend the Building Code of Australia to increase the energy efficiency requirements for houses*, March.

Savings from potential reductions in the capital cost of space conditioning equipment due to an improved thermal shell resulting from the proposed BASIX changes (i.e. due to smaller appliances being installed as a result of moving from 6 to 7 stars) were estimated by Energy Efficiency Strategies (EES) for the NCC 2022 RIS process. EES estimated the following average appliance cost savings per dwelling in NSW:

— $145 per Class 1 dwelling
— $112 per Class 2 dwelling (SOU).[24]

Given the building sample characteristics, it was suggested by the Department that these appliance savings are applied to dwelling types that achieve 5.5 – 6 stars from the minimum compliance and over-compliance scenarios under the BAU. This means the appliance savings are applied

— to all Class 2 dwellings,
— to all Class 1 dwellings except the over-compliance scenarios of DH1 and DH2 with 6.5 stars in thermal comfort performance. Half of the appliance savings are applied to the over-compliance scenarios of DH1 and DH2.

Importantly, while these appliance savings have been included in the CBA, EES noted that these benefits may not be achieved in practice due to a number of issues, including the following:

— Delivering these benefits would require the industry to change practices. A 7-star version of a dwelling would have lower peak loads than a 6-star version of the same dwelling. Theoretically, this should lead to the installation of a smaller sized appliance. However, delivering this cost saving would require the industry's appliance sizing practices to reflect the dwelling's energy efficiency. While the Australian Institute of Refrigeration, Air conditioning and Heating (AIRAH) has produced some useful appliance sizing applications, these are not in general use. Until industry appliance sizing practices change (and more accurate appliance sizing guidelines using NatHERS outputs are developed), this will remain a potential benefit rather than an immediately deliverable benefit.
— Heating and cooling appliances only come in incremental sizes. If appliance size increments are too broad, then even allowing for the reduced building load due to improved thermal fabric and higher requirement for appliance efficiency, the next smaller appliance may be too small.

[24] In Class 2 dwellings there may be further savings available. The cumulative savings for all dwellings may reduce the capital cost of energy supply infrastructure for the whole building. This energy supply infrastructure benefit for the whole apartment building has not been estimated or included in the analysis.

### 2.3.3 Difficult blocks

During the NCC 2022 development process, industry advised the ABCB that certain blocks have characteristic that create difficulties for some construction methods to demonstrate compliance via the NatHERS DTS pathway for Class 1 buildings.[25] To provide additional information on this issue, the ABCB commissioned:

- AECOM to undertake an analysis of the additional costs (for insulation, glazing upgrades, etc.) to achieve an improvement from a 6-star to a 7-star rating on a difficult block, when compared with achieving an improvement from a 6-star to a 7-star rating on a 'standard' non-difficult block.[26] This analysis provided cost estimates for a selection of attached and detached houses in a number of locations and climate zones for blocks that:
  - are small and have challenging proportions
  - have poor orientation
  - have problematic topography.

  The estimated changes in compliance costs (from 6 to 7 stars) for a Class 1 dwelling built on a small and narrow difficult block, by climate zone, are shown in Table 2.10.[27]

- SGS Economics & Planning to estimate the proportion of residential lots that fall within the small and narrow lot categories[28] across Australia's major cities.[29] Based on SGS's findings, we estimate that around 8.4 per cent of all Class 1 dwellings in NSW are built on small and narrow difficult blocks.

Using the information from the sources outlined above, we have included in the CBA the additional compliance costs stemming from the proposed changes in BASIX's thermal requirements for Class 1 dwellings built on difficult blocks.

Given the information available, this analysis only includes the additional costs of compliance associated with difficult blocks that are small and narrow. These additional costs are only incurred by Class 1 dwellings that are currently built at 6 stars under the BAU (i.e. a dwelling already built at 7 stars on a difficult block under the BAU would not experience these additional costs).

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[25] These characteristics include (amongst other), small area and challenging proportions, poor orientation and problematic topography.

[26] For additional details of this analysis please refer to AECOM 2020, *Difficult Blocks – Final Report Revision 2,* September.

[27] Importantly, AECOM did not provide estimates for all dwellings across all locations for all of the types of difficult blocks. Any data gaps in this analysis were filled with assumptions provided by the ABCB.

[28] Small lots are defined as lots of less than 300m$^2$ and narrow lots are defined as lots where the length/width ratio is above 1:3.

[29] For additional details of this analysis please refer to SGS Economics & Planning 2021, *Australian Cities Residential Lot Analysis Final Memo*, prepared for the Australian Building Codes Board, January.

**Table 2.10** Additional construction costs to improve from a 6-star to a 7-star dwelling on a difficult block (compared to improving from a 6-star to a 7-star dwelling on a 'standard' non-difficult block)

| NCC climate zone | Additional construction costs ($) |
|---|---|
| **Detached houses** | |
| 2 – Warm humid summer, mild winter | $0 |
| 4 – Hot dry summer, cool winter | $2,200 |
| 5 – Warm temperate | $2,200 |
| 6 – Mild temperate | $1,800 |
| 7 – Cool temperate | $9,000 |
| 8 – Alpine | $0 |
| **Attached houses** | |
| 2 – Warm humid summer, mild winter | $0 |
| 4 – Hot dry summer, cool winter | $0 |
| 5 – Warm temperate | $2,500 |
| 6 – Mild temperate | $2,500 |
| 7 – Cool temperate | $9,000 |
| 8 – Alpine | $0 |

Note: AECOM did not provide estimates for all dwellings across all locations for all of the types of difficult blocks. Any data gaps in this analysis were filled with assumptions provided by the ABCB.

*Source: ABCB and AECOM 2020, Difficult Blocks – Final Report Revision 2, September.*

### 2.3.4 Thermal bridging

Thermal bridging is a localised weakness or discontinuity in the thermal envelope of a building that occurs when there is either a break in the insulation, less insulation or the insulation is penetrated by an element with a higher thermal conductivity. It affects in-service performance, producing heat loss and cold spots that can lead to a build-up of condensation and promote mould growth.

Currently, the NatHERS thermal simulation tools used by a significant proportion of buildings in NSW to satisfy thermal comfort requirements in BASIX do not take into account the added heat losses and heat gains due to thermal bridging, and the current version of the NCC does not have provisions to fully account for thermal bridging in the thermal calculations for residential buildings. This results in an energy efficiency performance gap where new buildings currently rated at 6 stars in reality perform to a lesser standard due to heat leakage. Tony Isaacs Consulting (TIC)[30] estimates that the impact of thermal bridging on the energy efficiency of a dwelling is:

- in timber framed buildings, a reduction in NatHERS ratings of between 0.1 to 0.6 stars
- in steel framed buildings, a loss of performance of between 0.7 and 1.5 NatHERS stars *more than the impact of timber frames* (impacts are highest in cooler climates).

[30] Tony Isaacs Consulting (TIC) 2021a, *DTS Elemental Provisions for NCC 2022*, Draft.

A one-star reduction is, on average, across most NatHERS climate zones, at least a 15 per cent reduction in a dwelling's energy efficiency.[31]

The proposed changes to the NCC 2022 include provisions to account for heat leakage through thermal bridges when calculating insulation requirements. These provisions would only apply to steel frame dwellings. These mitigation measures have been designed to ensure that the performance of dwellings with steel frames is similar to the performance of timber-framed dwellings.

There are several implications of these changes for the analysis:

— The thermal bridging changes in NCC 2022 would result in compliance costs that are *additional* to the costs of moving the thermal shell from 6 to 7 stars (in effect, these costs would be incurred to get buildings to perform as 'true' 6-star buildings).
— Leaving aside the stringency increase from 6 to 7 stars, the thermal bridging changes in NCC 2022 would materialise the benefits of the 6-star rating that were projected in the 2009 RIS[32] for the increase in energy efficiency from 5 to 6 stars.
— Given that the 2009 residential 6-star RIS already accounted for the benefits of achieving a 'true' 6-star rating (i.e. the 2009 RIS assumed that buildings would perform as 6 stars), but did not account for thermal bridging or the costs associated with addressing this issue, the CBA for the NCC 2022 changes will account for the costs of addressing thermal bridging, but not the benefits. This BASIX CBA follows the same approach.
— Given that the NCC 2022 only includes provisions to mitigate thermal bridging in steel frame buildings, the performance gap discussed above will continue in timber frame buildings. The energy flows provided by the Department do not include an adjustment for this gap and hence neither does the CBA. However, additional analysis of the potential impact of these changes in energy flows is provided in Section 5.1.

### Thermal bridging costs

The CBA accounts for the costs of thermal bridging mitigation measures for steel frame buildings proposed in the NCC 2022. These costs, and the impact of the thermal bridging on the heating and cooling loads[33], have been estimated by TIC[34] and are presented in Table 2.11 and Table 2.12.

These costs are applied to steel framed buildings. The proportion of residential buildings that are steel framed is set out in Table 2.13.

The Department noted that 50 per cent of Class 1 dwelling and all Class 2 units in NSW use NatHERS modelling to satisfy the thermal comfort requirements in BASIX. Given this, it has been

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[31] Tony Isaacs Consulting (TIC) 2021b, *Evaluating the impact of thermal bridging on energy savings predicted for the NCC 2022 RIS*, May.

[32] Centre for International Economics (CIE) 2009, *Final Regulation Impact Statement for residential buildings (Class 1, 2, 4 and 10 buildings) - Proposal to revise energy efficiency requirements of the Building Code of Australia for residential buildings*, prepared for the Australian Building Codes Board, December.

[33] As noted in the section above, the changes in energy consumption from thermal mitigation measures are not incorporated in the CBA as these have already been accounted for in a previous RIS.

[34] For additional details of how these impacts were calculated please refer to TIC's report *Evaluating the impact of thermal bridging on energy savings predicted for the NCC 2022 RIS*.

assumed that the additional costs of mitigating thermal bridging apply to 50 per cent of all Class 1 dwellings in NSW and all Class 2 buildings.

**Table 2.11** Impact of steel frame thermal bridging at 6 stars in various climates, Class 1 dwellings

| NCC Climate zone | NatHERS Climate zone | Added cooling (%) | Added heating (%) | Average additional cost of thermal bridging mitigation per dwelling |
|---|---|---|---|---|
| 2 – Warm humid summer, mild winter | 10 | 1.1% | 32.0% | $1,514 |
| 4 – Hot dry summer, cool winter | 27 | 4.6% | 18.8% | $1,682 |
| 5 – Warm temperate | 28 | 3.3% | 22.3% | $1,669 |
| 6 – Mild temperate | 60 | 1.3% | 26.5% | $1,670 |
| 7 – Cool temperate | 24 | -5.3% | 25.1% | $1,689 |
| 8 – Alpine | 69 | 10.7% | 30.6% | $1,680 |

*Source: Energy Efficiency Strategies (EES) 2021, NCC 2022 Update – Whole of House Component, Draft Report, May.*

**Table 2.12** Impact of steel frame thermal bridging at 6 stars in various climates, Class 2 SOU dwellings

| NatHERS Climate zone | NatHERS Climate zone | Added cooling (%) | Added heating (%) | Average additional cost of thermal bridging mitigation per dwelling |
|---|---|---|---|---|
| 2 – Warm humid summer, mild winter | 10 | 0.6% | 8.0% | $99 |
| 4 – Hot dry summer, cool winter | 27 | 0.9% | 3.1% | $137 |
| 5 – Warm temperate | 56 | 0.6% | 5.6% | $160 |
| 6 – Mild temperate | 21 | 0.9% | 2.0% | $126 |
| 7 – Cool temperate | 24 | 0.9% | 2.2% | $160 |

*Source: Energy Efficiency Strategies (EES) 2021, NCC 2022 Update – Whole of House Component, Draft Report, May.*

**Table 2.13** Percentage of dwellings in NSW by structural framing, 2018

| | Timber | Lightweight steel | Double brick | Structural insulated panels | Concrete |
|---|---|---|---|---|---|
| Class 1 | 82% | 14% | 2% | 2% | N/A |
| Class 2 (3 or less storeys) | 83% | 4% | 5% | 2% | 7% |

*Source: Australian Construction insights (ACI) 2018, Framing material use in residential construction, an investigation of the factors influencing framing material choice in residential building: 2018 follow up, September.*

### 2.3.5 Learning rates

Learning effects (or learning rates) refer to the rate at which the cost of energy efficiency measures fall over time as a function of:

— industry learning (e.g. building designers can retrofit buildings to achieve a higher energy efficiency standard at a lower cost)
— costs of building materials and energy efficiency products reducing over time as the increased demand leads to economies of scale in production and technological innovation
— labour costs reducing over time as builders become more experienced with applying new building materials, appliances and techniques that may be required to achieve higher energy efficiency.

There are a few studies that discuss learning rates:

— A study by the Moreland Energy Foundation into how the residential buildings sector has responded to the introduction of the 6 star energy efficiency standard found an annual industry learning rate of 7.5 per cent over the 2014-2017 period (7.1 per cent for Class 1 dwellings and 1.7 per cent for Class 2 dwellings). However, it is noted that this is based on a very limited sample and is not statistically significant.[35]
— An evaluation of the Victorian 6 Star Housing Standard for the Department of Environment, Land, Water & Planning highlights the following estimates for lighting equipment:
  – LEDs are estimated to have experienced a learning rate of 28 per cent per year around the middle part of this decade
  – the International Energy Agency notes compact fluorescent lamps as having experienced a 10 per cent learning rate earlier this decade (other sources note higher values in earlier time periods – noting that this technology first emerged in the 1970s).[36]
— A report by HoustonKemp advising on the methodology to be used for residential building RISs recommends the following:

  *….a cost efficiency rate of 2 per cent year-on-year as a starting point with sensitivities of 1 per cent (lower bound) and 3 per cent (upper bound). These rates are broadly consistent with what is considered in other sectors, eg, the electricity and gas network sector.* [37]

— A 2017 study for the Department of the Environment and Energy reviewed the evidence on learning rates and found that, on average, the prices of energy-related building products had declined only modestly in real terms over the period from 2004 to 2016.[38] Specifically, the real price of a basket of energy-related building products:
  – declined by 0.4 per cent in unweighted terms

[35] Moreland Energy Foundation 2017, *Changes Associated with Efficient Dwellings Project – Final Report*, prepared for the Department of the Environment and Energy.

[36] Strategy. Policy. Research (SPR) 2019, *Evaluation of the Victorian 6-star Housing Standard - Final Report*, prepared for the Department of Environment, Land, Water & Planning, July.

[37] HoustonKemp 2017, Residential Buildings Regulatory Impact Statement Methodology, report for the Department of the Environment and Energy, April, p.22.

[38] Strategy. Policy. Research.2017, Quantifying Commercial Building Learning Rates in Australia: Final Report, Prepared for the Department of the Environment and Energy, June 2017, p. v.

- declined by 0.2 per cent in weighted terms. [39]

— The Low Carbon Living Co-operative Research Centre technical report on building code energy performance which outlines the modelling done for ASBEC's *Built to Perform – An industry led pathway to a zero carbon ready building code* and models the impacts of increased energy efficiency standards for new buildings did not apply learning rates to the prices of building elements used in their modelling. The rationale for doing so was that "while intuitively it is relatively straightforward to posit the existence of learning rates, and to build these into the regulatory benefit-cost analysis, finding hard evidence with which to quantify rates is extremely problematic".[40]

— The 2018 RIS on the inclusion of heating and cooling energy load limits in NatHERS assessments did not apply a learning rate or change in real costs over time (primarily because most scenarios involved net construction cost savings but also because of the minor nature of the changes involved).[41]

— The 2018 Decision RIS for energy efficiency of commercial buildings in the NCC 2019[42] did not include learning rates in the central case analysis as they concluded that there was not enough evidence to support a general learning rate *linked to regulatory change.* The RIS also noted that:

*in some circumstances, buildings constructed under the baseline scenario (i.e. constructed under existing NCC minimum requirements) would also benefit from declining prices of building products. Where the price declines for inputs that are used under both the baseline scenario and where stricter minimum performance requirements apply, there would be no change in the incremental cost of achieving higher standards. Even where the price of inputs used to achieve higher standards (but not necessarily under the baseline) falls, lower prices may encourage greater uptake of these products under the baseline. For example, declining prices has encouraged greater uptake of LED lighting even without the need for regulation.*

And that:

*Where cheaper and more energy efficient technologies (and there are no compromises on other characteristics) becomes available (such as LED lighting), they are likely to be adopted by industry even without the need for regulatory change.*

— Each year CSIRO and the Australian Energy Market Operator (AEMO) produce a report on electricity generation and storage costs with a strong emphasis on stakeholder engagement (the GenCost report). This report includes past data and projections on the capital costs of rooftop solar PV. The GenCost 2020-21 report shows a clear trend of decreasing capital costs for solar systems across the three scenarios modelled (see Figure 2.6) that extends for at least two decades.

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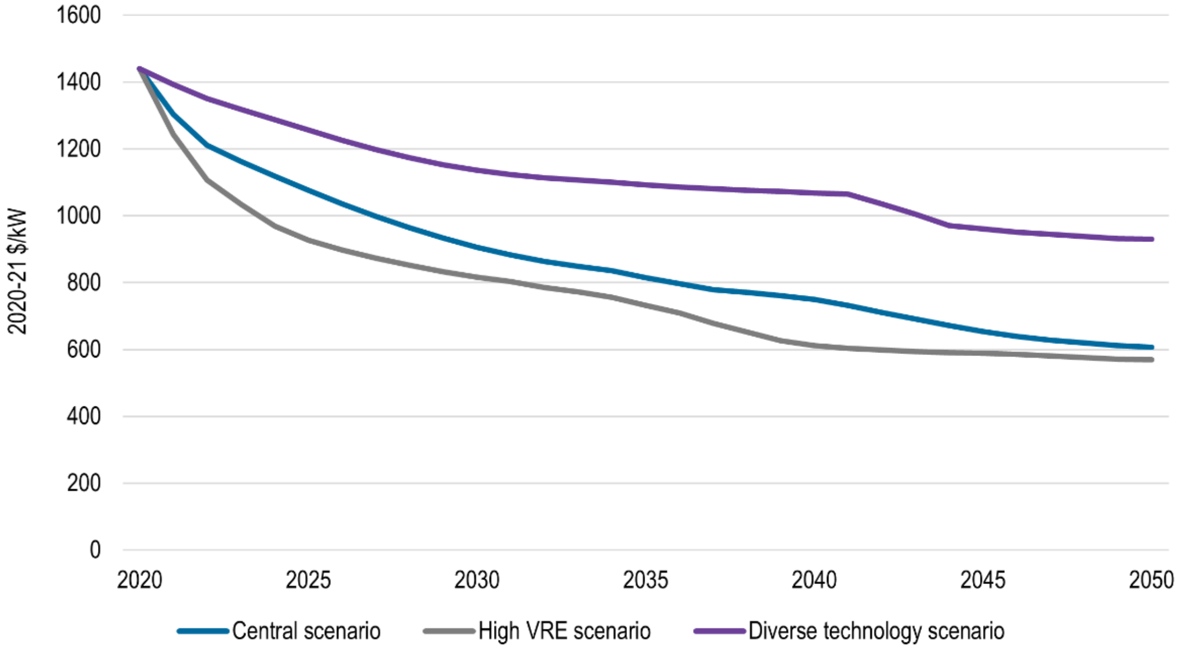
[39] The basket included over 150 energy-related building elements, including insulation products, glazing, and different kinds of mechanical and electrical plant, including lighting, which were priced by quantity surveyors, Donald Cant Watts Corke.

[40] Bannister, P., Robinson, D., Reedman, L., Harrington, P., Moffitt, S., Zhang, H., Johnston, D., Shen, D., Cooper, P., Ma, Z., Ledo, L., The Green, L. 2018, *Building Code Energy Performance Trajectory – Final Technical Report*.

[41] Strategy. Policy. Research (SPR) 2018, *Inclusion of heating and cooling energy load limits in NatHERS assessments, Regulation Impact Statement for decision*, prepared for the Australian Building Codes Board.

[42] Centre for International Economics (CIE) 2018, *Decision Regulation Impact Statement, Energy Efficiency of Commercial Buildings*, prepared for the Australian Building Codes Board, 13 November.

**Figure 2.6** Projected capital costs for rooftop solar PV by scenario




Note: The Central scenario refers to current stated global climate polices (as of late 2020), with the most likely assumptions for all other factors such as renewable resource constraints. The High VRE scenario refers to a world that is driving towards net zero emissions by 2050 and where technical, social and political support for variable renewable electricity generation is high. The Diverse Technology scenario refers to a world where most developed countries are striving for net zero emissions by 2050 but others are lagging such that global net zero emissions is reached by 2070.

*Source: Graham, P., Hayward, J., Foster J. and Havas, L, 2021, GenCost 2020-21: Final report, Australia, June.*

Given the above evidence, for the central case analysis in this CBA we have:

— included the CSIRO's projected reductions in costs (learning rates) of rooftop solar PV (including for inverters)

— not included learning rates for any other upgrade costs. The assumption of zero learning effects for these other costs results in conservative estimates of cost impacts.

The effect of further decreases in overall upgrade costs (including solar PV) was tested via sensitivity analysis.

## 2.4 Benefit assessment

This section describes some of the assumptions and inputs used to estimate the benefits of the proposed changes to BASIX. Benefits that have not been quantified for the purposes of this CBA are discussed in Section 4.5.

### 2.4.1 Changes in dwelling energy consumption

Energy flows for dwellings under the BAU and the upgrade pathways outlined in Section 2.2.3 were estimated by the Department. These energy flows take into account the energy generated by the solar PV systems used within the dwelling and exported.

The difference in energy flows between dwellings compliant with the current BASIX targets and the proposed BASIX targets is used in this analysis as the basis for estimating the benefits associated with the proposed changes.

### Are modelled reductions in energy consumption achieved in practice?

#### *The energy performance gap*

The difference between actual and modelled/calculated energy is called the 'energy performance gap'.

As noted by CIE[43], 'several international studies have found that there has been a tendency for the energy modelling relied on to estimate energy savings in some CBAs of energy efficiency policies to overstate actual energy savings'. In its 2005 public inquiry into energy efficiency[44], the Productivity Commission also noted its concern that the analytical basis for energy efficiency regulations (computer simulations of energy loads within buildings in each climatic zone) may be flawed.

The concerns that modelled energy savings may not be fully realised have been noted by several studies.

- A study of 90 buildings that have achieved a LEED[45] rating in the US found around an 8 per cent Energy Use Intensity (EUI) difference for all of the buildings. The study included both buildings with 'normal' expected uses and some high energy intensity buildings. High energy use buildings (laboratories, data centres and health care) consumed nearly 2.5 times the predicted energy.[46]
- In 2011 the Carbon Trust examined the gap between design predictions and real performance of 28 low carbon buildings (covering many sectors, including retail, education, offices and mixed-use buildings) from the UK Department of Energy and Climate Change Low Carbon Buildings Programme and found that the average gap was about 16 per cent higher operational energy consumption than predicted performance.[47]
- A paper examining existing data on 3,400 German homes and their calculated energy performance ratings (EPR) against the actual measured consumption found that occupants consume, on average, 30 per cent less heating energy than the calculated rating. This phenomenon increases with the calculated rating. The opposite phenomenon, the rebound

[43] Ibid, p. 73.

[44] Productivity Commission 2005, *The Private Cost Effectiveness of Improving Energy Efficiency*, Productivity Commission Inquiry Report No.36, 31 August 2005, p. XXXVIII.

[45] LEED, or Leadership in Energy and Environmental Design, is the most widely used green building rating system in the US administered by the US Green Building Council.

[46] Frankel, M., and C. Turner 2008, *How Accurate is Energy Modeling in the Market?,* Proceedings of the 2008 ACEEE Summer Study on Energy Efficiency in Buildings, Asilomar, California, August, http://newbuildings.org/sites/default/files/ModelingAccuracy_FrankelACEEE2008_0.pdf.

[47] Carbon Trust 2011, *Closing the gap: Lessons learned on realizing the potential of low carbon buildings. Carbon Trust*, London.

effect, tends to occur for low-energy dwellings, where occupants consume more than the rating.[48]

— Majcen, Itard, and Visscher's report on a large-scale study of around 200,000 dwellings in Netherlands comparing theoretical energy use with data on actual energy use shows that energy efficient dwellings consume more energy than predicted.[49]

— A report investigating how multi-unit residential buildings in Toronto use energy and how energy models differ from actual building energy performance found that buildings used 13 per cent more energy than predicted by modelling.[50]

— A Canadian study assessing how well 10 LEED Gold certified social housing buildings in Victoria performed in practice found that two had better actual performance then modelled (1.5 per cent to 29.3 per cent less energy), whereas the other eight consumed between 22.1 per cent and 281.7 per cent more energy than models predicted.[51]

— In terms of commercial buildings, the CIE analysis for the 2018 Decision RIS for energy efficiency of commercial buildings in the NCC 2019 concluded that:

> *Overall, the available (albeit limited) Australian evidence suggests that modelled energy savings are unlikely to be fully realised. This finding is consistent with a number of international studies.*[52]

Furthermore, the CIE analysis concluded that there was a case for assuming that, on average, between 25 per cent and up to 50 per cent of modelled savings were not realised.

Given the potential noted above for modelled energy savings to not be realised in practice, in Chapter 4 we present sensitivity analysis that shows the impacts of the proposed BASIX changes under two alternative realisation scenarios:

— a low realisation scenario where we assume that 50 per cent of modelled energy savings are achieved in practice

— a medium realisation scenario where we assume that 75 per cent of modelled energy savings are achieved in practice.

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[48] Sunikka-Blank, M. and Galvin, R. 2012, *Introducing the prebound effect: The gap between performance and actual energy consumption*, Building Research & Information, 40(3), 260–273.

[49] Majcen, D., Itard, L. C. M., & Visscher, H. 2013, *Theoretical vs. actual energy consumption of labelled dwellings in the Netherlands: Discrepancies and policy implications*. Energy Policy, 54, 125–136.

[50] Sidewalk Labs 2019, *Sidewalk Labs Toronto Multi-unit residential buildings study: energy use and the performance gap*, https://storage.googleapis.com/sidewalk-toronto-ca/wp-content/uploads/2019/06/20224649/SWTO-MURB-Study_-Energy-Use-and-the-Performance-Gap.pdf.

[51] Zhou, Q. and Mukhopadhyaya, P. 2020, *Design Versus Actual Energy Performance in Social Housing Buildings*, https://www.bchousing.org/research-centre/library/building-science-reports/design-vs-actual-performace-social-housing&sortType=sortByDate.

[52] Centre for International Economics (CIE) 2018, *Decision Regulation Impact Statement, Energy Efficiency of Commercial Buildings*, prepared for the Australian Building Codes Board, 13 November, p. 77.

### *Rebound energy consumption*

As noted by the International Energy Agency (IEA): [53]

> *One of the most persistent challenges in energy efficiency policy is accounting for the phenomenon known as the "rebound effect" – where improved efficiency is used to access more goods and services rather than to achieve energy demand reduction. As a result, actual energy demand reductions often fall short of the estimates made during the policy development phase.*

The rebound effect is generally driven by one of three things:

1. the take-back effect, where energy users increase their consumption of energy using services (e.g. heating)
2. the spending effect, where energy users spend financial savings from energy efficiency on other energy consuming activities
3. the investment effect, where investment in energy efficiency leads to an indirect increase in economic activity and energy consumption.

The energy efficiency literature often makes note of this rebound effect as a contributing explanatory factor for the differences between projected and actual energy savings.

Empirical evidence suggests that the rebound effect is real. However, the evidence also suggests that the magnitude of the effect is highly variable and context specific.

— Modelling done by Tony Isaacs and Robert Foster for a 2011 Mandatory Disclosure RIS[54] included a 30 per cent rebound effect (that is, it included a 30 per cent discount to energy savings).

— McKinsey (2009) refers to a rebound effect of 15 to 30 per cent.[55]

— A report by the International Energy Agency (IEA) on the multiple effects of energy efficiency notes that:[56]

> *Direct rebound effects can range from 0% (e.g. in whiteware) to as much as 65% (e.g. electrically heated homes in California) (Hertwich, 2005). However, estimates tend to converge between 10% and 30%.*

This IEA report also refers to a total macroeconomic rebound effect in the range of 10 per cent to 30 per cent in the UK and suggests the rate is similar in other developed countries and higher in developing countries.

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[53] International Energy Agency (IEA) 2015, *Capturing the Multiple Benefits of Energy Efficiency*, November, https://webstore.iea.org/capturing-the-multiple-benefits-of-energy-efficiency, accessed 2 March 2021, page 39.

[54] Allen Consulting Group (ACG) 2011, *Mandatory Disclosure of Residential Building Energy, Greenhouse and Water Performance: Consultation Regulation Impact Statement*, report to the National Framework for Energy Efficiency Building Implementation Committee, March.

[55] McKinsey & Company 2009, *Unlocking Energy Efficiency in the U.S*. Economy, https://www.sallan.org/pdf-docs/MCKINSEY_US_energy_efficiency.pdf, accessed 27 July 2020.

[56] International Energy Agency (IEA) 2015, *Capturing the Multiple Benefits of Energy Efficiency*, November, https://webstore.iea.org/capturing-the-multiple-benefits-of-energy-efficiency, accessed 2 March 2021, page 39.

— O'Leary (2016)[57] suggests than the rebound effect for efficiency alone should be nearer the low end of estimates or around 5 per cent to 10 per cent to expected energy savings.

To ensure that the analysis is realistic in terms of the estimates of reduced energy consumption and the associated reductions in energy costs and GHG emissions, we have assumed a rebound effect of 10 per cent across all fuels (based on the lower bound estimates outlined in the IEA and the assumption that the take-back effect in 6 star new buildings is likely to be relatively small given that they already provide are relative high level of thermal comfort). This in effect means that the projected energy savings from the proposed changes to BASIX are discounted by 10 per cent, resulting in lower GHG abatement and lower bill savings.

Notably, the possibility that a portion of the projected energy savings stemming from the proposed changes to BASIX may not be realised does not necessarily imply that the proposed policy is ineffective. It implies that some of the benefits from the changes are not delivered in the form of energy cost or GHG emissions reductions, but as other type of welfare improvements for society[58]. As noted by IEA: [59]

> *Where energy savings are taken back in the achievement of health benefits, poverty alleviation, improving productivity or reducing supply-side losses, the rebound effect created can be viewed as a net positive outcome, amplifying the benefits of the energy efficiency intervention. Often a rebound effect actually signals a positive outcome from the perspective of broader economic and social goals.*

The existence and magnitude of these other 'rebound' benefits in the context of new housing in Australia has not been explored in a level of detail that would allow its incorporation in the impact analysis, however, our approach to effectively value the rebound effects as zero results in more conservative estimates of the potential impact of the policy.

### 2.4.2 Offset and export of electricity generated by PV

The Department estimated the electricity generated from PV systems installed as a result of the proposed changes using the BASIX calculation algorithm. If the annual electricity generated by the PVs for a detached house is less than the dwelling's total electricity demand, then it is used to offset the electricity demand of the dwelling. When a large PV system is installed that produces surplus electricity from household demand, the additional energy generated is assumed to be exported to the grid.

In apartment buildings, the electricity generated by any PV system installed is attributed to the common areas and shared services (such as lifts and central hot water systems) as it is not

[57] O'Leary, Timothy 2016, *Industry adaption to NatHERS 6 star energy regulations and energy performance disclosure models for housing*, December, https://minerva-access.unimelb.edu.au/bitstream/handle/11343/220478/Tim%20Oleary%20final%20with%20corrections.pdf?sequence=1&isAllowed=y, accessed 2 March 2021.

[58] Notably, as discussed in Section **Error! Reference source not found.**, the objective of the energy efficiency requirements in the NCC have been broadened to include occupant health and amenity (in addition to reductions in GHG emissions).

[59] International Energy Agency (IEA) 2015, *Capturing the Multiple Benefits of Energy Efficiency*, November, https://webstore.iea.org/capturing-the-multiple-benefits-of-energy-efficiency, accessed 2 March 2021, page 39.

feasible to assign PV systems and their output to individual dwellings. If the annual electricity generated by these PVs is less than the total electricity demand of common areas and shared services, then it is used to offset the common area energy demand. Any surplus electricity generated by these PV systems is assumed to be exported to the grid.

The solar PV exports to the grid have been treated in the following way for this analysis at an economy-wide level:

— estimates of the *quantity* of energy saved (in PJ) due to the proposed changes in BASIX include solar PV exports, with the *value* of these solar PV exports based on the solar dispatch weighted wholesale electricity price
— estimates of the *quantity and value* of GHG emissions saved due to the proposed changes in BASIX account for the additional benefits generated by solar PV exports, as these exports would displace coal- (or gas-) generated electricity and hence effectively reduce emissions
— estimates of the *value* of health benefits generated by reductions in coal and gas generated electricity due to the proposed changes in BASIX account for the additional benefits generated by solar PV exports, as these exports would displace coal- (or gas-) generated electricity and hence effectively reduce emissions.

The income generated from solar PV exports to households has been accounted for in the distributional (household) analysis in Chapter 5.

### 2.4.3 Energy prices

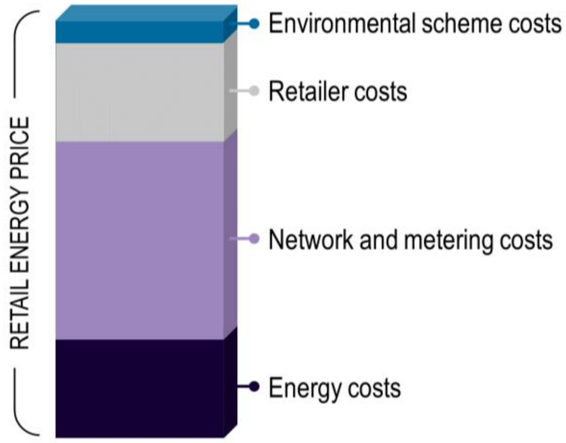
#### Electricity and gas

Any reductions in energy consumption as a result of the proposed interventions would generate benefits to households in the form of reduced energy bills, and at the economy-wide level as a result of a reduction in the overall energy consumed. As such, to estimate the impacts of the proposed changes, it is necessary to have baseline estimates of future energy prices.

In calculating the value of energy savings, it is critical to not confuse benefits with distributional impacts. For example, the benefits of energy efficiency are often misconstrued to include the reduction in retail electricity bills experienced by the customer as a result of their decreased energy usage. It is true that, from the customer’s point of view, this reduction represents a benefit. However, there is an equal and opposite reaction with some of the reductions in costs for these customers that are redistributed to other customers. For example, total network costs would only be reduced if network augmentation can be deferred or avoided. Many of the retail costs of energy (such as costs associated with call centres, revenue and billing collection, customer acquisition and retention, and IT systems) are driven by the number of customers, not by energy consumption. From the perspective of energy efficiency, these costs are ‘fixed’.

The retail energy price broadly comprises four components as illustrated in Figure 2.7.

**Figure 2.7** Components of the retail energy price




*Source: ACIL Allen*

The energy cost component comprises a fixed component (capital and fixed operating and maintenance costs) and a variable component (fuel and variable operating and maintenance costs). In the short run, the variable fuel and operating costs are avoided when energy usage is reduced. Wholesale energy price projections are used as a proxy representing the marginal cost saving associated with the reduced energy from investments in energy efficiency measures in the existing residential building stock.

In the long run, investment in new generation capacity may be deferred or avoided. However, new generation capacity is currently driven by a range of policy initiatives that are incentivising additional new energy supply and reductions in the demand for energy from centralised generation. The impact of increases in energy efficiency requirements in BASIX on the capacity of generation in the wholesale electricity market is not material relative to these policy initiatives.[60]

The network costs are driven by the size (capacity) of the network and the metering costs are driven by the number of customers; they are not driven by energy usage unless that energy usage occurs at the time of peak demand in a location where the network is constrained.

The electricity distributors' revenues are regulated in accordance with a revenue cap – that is, the revenue is fixed in the short term. In the longer term, total network costs would only reduce if:

— there is a deferral in the augmentation of the network, which would only occur if the reduction in energy is at the time of peak demand on the network and in the location where the network is constrained
— the expenditure for replacing the network can be reduced by replacing network components with lower capacity components.

[60] As an example, the minimum objectives of the *Electricity Infrastructure Investment Act 2020 (NSW)* are to construct 12 GigaWatts (GW) of large-scale renewable energy capacity and 2 GW of long-duration storage infrastructure in NSW by 31 December 2029.

The retailer costs comprise the retailer's operating costs and margin. The retailer's operating costs (call centres, revenue and billing collection, customer acquisition and retention, and IT systems) are driven by the number of customers rather than the energy used. These costs would not change as energy usage decreases due to the proposed changes in BASIX.

It is generally assumed that the margin is a percentage applied to the other costs. If energy costs decrease, then the operating margin applied to those costs would also decrease. However, any change in the retail margin represents a transfer of costs – any benefit to the household is a cost to the retailer.

Most of the environmental scheme costs are fixed based on a fixed target that is allocated on the basis of energy usage. As such, the amount recovered per unit of energy used increases as energy usage decreases. The societal costs associated with environmental scheme costs are not reduced as energy usage reduces with more stringent energy efficiency requirements, unless the target changes.

In light of the above discussion, to assess the societal benefit of a reduction in the energy used by new buildings due to the changes in BASIX, we considered the components of the retail prices that would result in a reduction in costs incurred by society – the avoided wholesale energy costs (as a proxy for the avoided resource costs) and the avoided network costs. That is, to assess the economy-wide energy benefits of the scheme we use a capacity and network approach which valued the avoided energy costs based on the avoided wholesale electricity prices and the avoided network costs (discussed in more detail in Section 2.4.4).

This approach is consistent with the Australian Government's handbook on cost-benefit analysis, which states:

> *One of the first tasks for the analyst is to distinguish the allocative effects of a project, that is, the effects due to changes in the use of resources and in outputs, from the distributional effects. Generally speaking it is only changes in resource use that involve opportunity costs. Distributional effects may be regarded as 'transfers' – that is, some individuals are made better off while others are made worse off. Distributional effects do not add or subtract from estimated net social benefit. However, they may affect social welfare if the judgement is made that one group derives more value from the resources than another group.*[61]

The distributional effects referred to in the handbook on cost-benefit analysis would be included in the economy-wide cost benefit analysis if retail electricity prices had been used.

[61] Australian Government, *Handbook of Cost-Benefit Analysis*, January 2006, page 27.

Similarly, the April 2017 Houston Kemp report for the Australian Government *Residential Buildings Regulatory Impact Statement Methodology* recognises that retail electricity prices were historically used to value the energy savings from energy efficiency activities from a societal perspective, which is not accurate. It states that:

> *Previous studies have used reduction in the retail bill as the benefit, which represents the financial savings to households based on existing tariffs. However, we believe a more accurate approach is to estimate the resource cost savings from reduced electricity and gas consumption, ie, reduction in network and wholesale costs.*[62]

And that:

> *To estimate the benefit from reductions in electricity generation costs, average wholesale market prices can be used as they typically represent suitable estimates for the resource cost savings.* [63]

Following the release of the Houston Kemp report, the energy savings from energy efficiency activities have more commonly been valued at a societal level using avoided wholesale and network costs rather than by using retail prices,[64] although retail prices continue to be used to assess the impact at a household level, as discussed in the next section.

Wholesale and retail electricity and gas price projections were generated by our proprietary *GasMark* and *PowerMark* models of the gas and electricity markets for the National Electricity Market, which account for the NSW Electricity Infrastructure Roadmap released in November 2020. Additional information about these models is provided in Appendix C and our projections of wholesale electricity and gas prices in NSW are shown in Figure 2.8 and Figure 2.9.

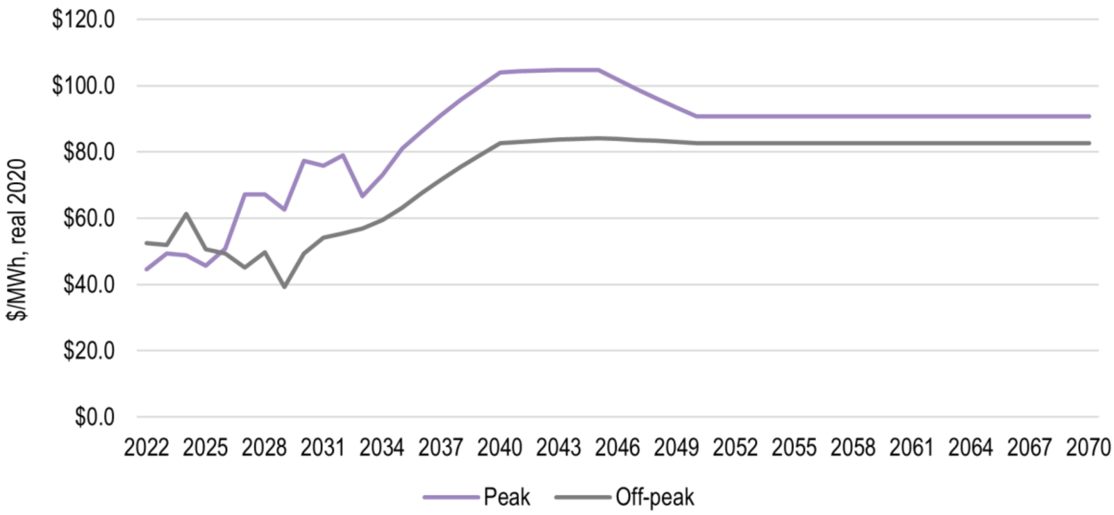
We note that the use of the capacity and network approach results in BCRs and NPVs that are much smaller than if retail energy prices are used. In effect, there is a redistribution of costs from the occupants of a dwelling with increased energy efficiency to other energy users because of the fixed costs discussed above.

[62] Houston Kemp, *Residential Buildings Regulatory Impact Statement Methodology,* 6 April 2017, page 14.

[63] Ibid, page 15.

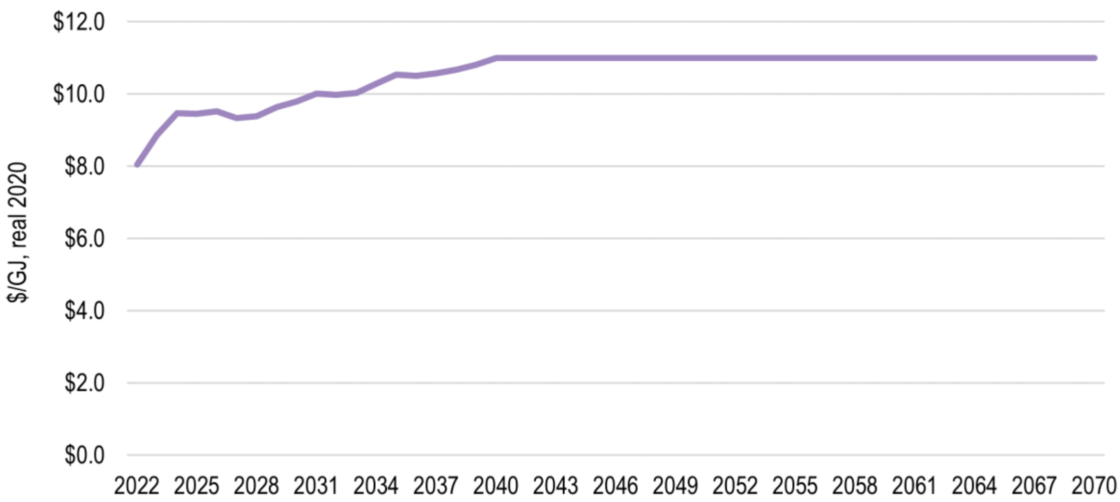
[64] Prior to the release of the Houston Kemp report, the avoided wholesale and network cost approach was used for some analyses but not all.

**Figure 2.8** Wholesale electricity price projections, $ per MWh




Note: Peak times are defined as 7 am to 10pm everyday as per the Department's modelling.
*Source: ACIL Allen.*

**Figure 2.9** Wholesale gas price projections, $ per GJ




*Source: ACIL Allen.*

### *Retail prices for distributional analysis*

As is standard practice, the CBA of the changes to BASIX was undertaken from the perspective of the broader NSW community, with impacts that are transfers between stakeholders (such as between the government and households, and between households that were subject to the increased targets and those that did not) netted out. Nevertheless, it is important to consider the implications of some of these transfers on stakeholders, particularly the implications of energy bill reductions on households.

As such, we have also included a distributional analysis in the report that shows the impacts of the proposed changes on households that are subject to the changes. In contrast to the state-wide analysis, this household analysis is done using retail energy prices.

The retail energy prices used for the analysis of the impacts of the modelled scenarios on households are shown in Figure 2.10 to Figure 2.12. These were based on a number of sources as follows:

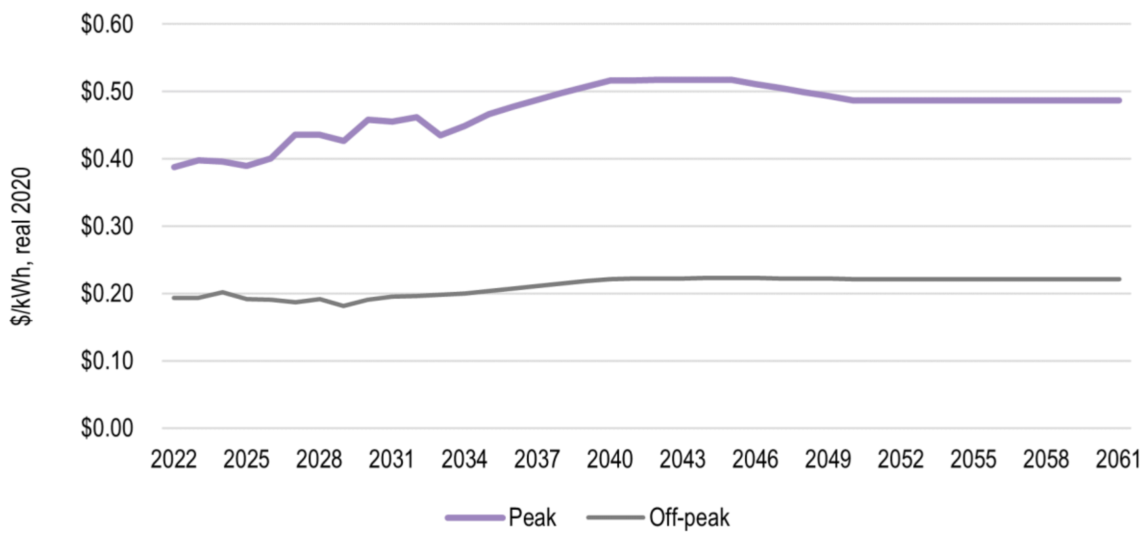
— for retail electricity prices, we used the peak and off-peak prices from EES's Whole of House Report for the NCC 2022[65] for the start year and projected the change in these prices over time using information sourced from our proprietary model PowerMark

— for retail gas prices we used the prices in EES's Whole of House Report for the NCC 2022[66] for the start year and projected the change in these prices over time using information sourced from our proprietary model *GasMark*

— feed in tariffs to value exports to the grid were estimated/projected using the average of the annual large-scale solar dispatch weighted price in NSW in the NEM (wholesale electricity market) plus 6 per cent, which represents loss factors that the retailer will pass onto the end consumer.

For ease of comparison Figure 2.13 and Figure 2.14 compare wholesale and retail prices for both electricity and gas.

**Figure 2.10** Retail electricity prices, dollars per kWh

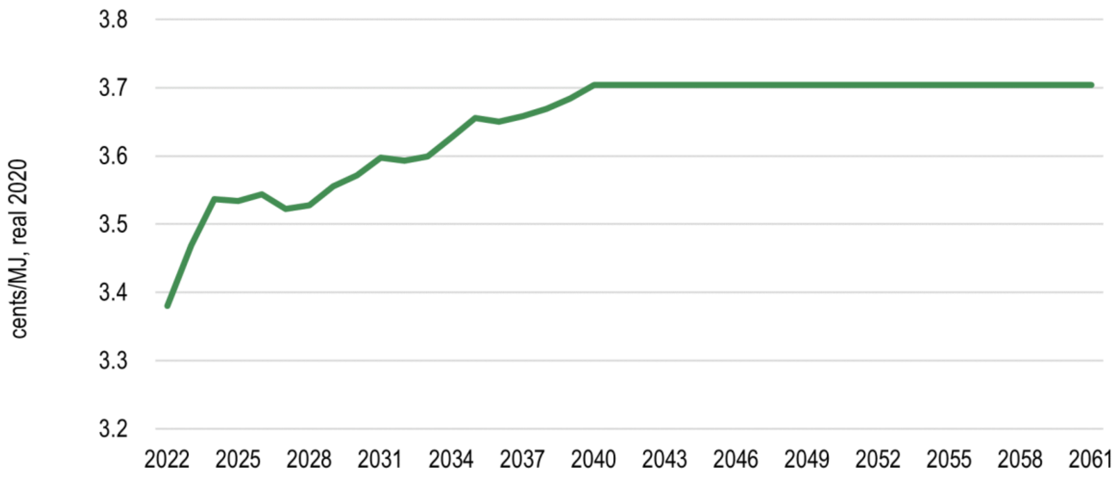



*Source: ACIL Allen.*

[65] EES 2021, *NCC 2022 Update - Whole of House Component, Draft Report*, May.

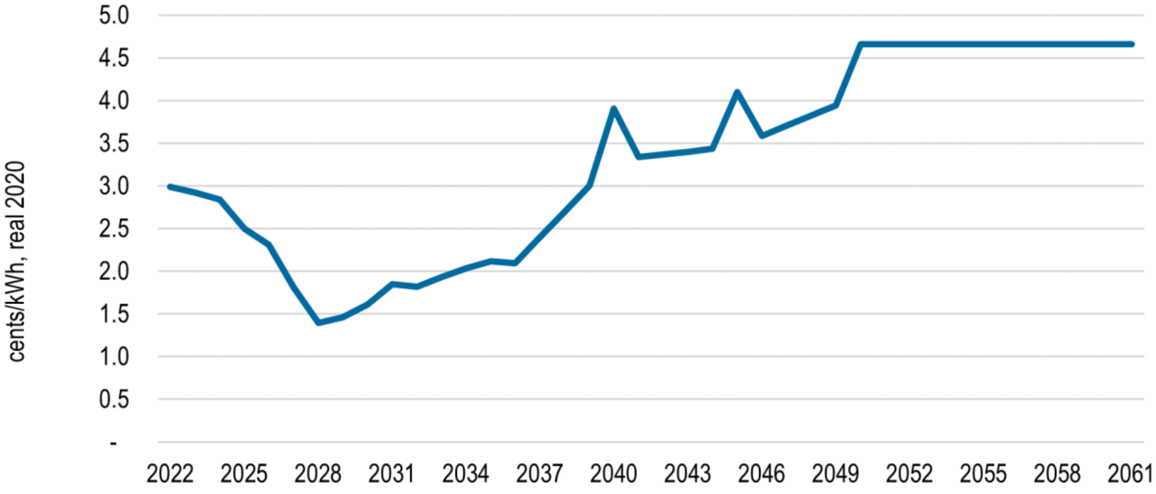
[66] Ibid.

**Figure 2.11** Retail gas prices, cents per MJ



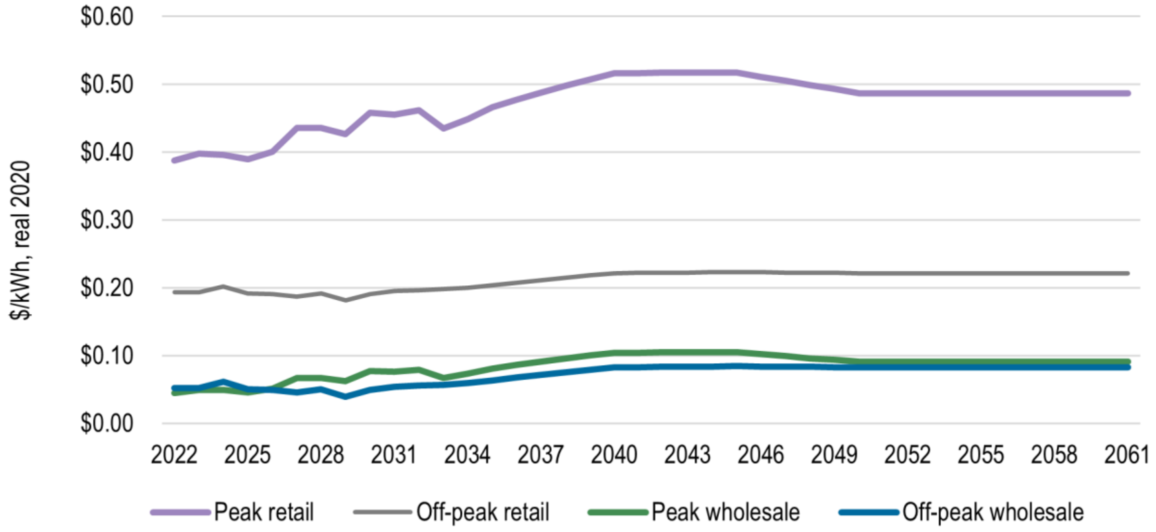

*Source: ACIL Allen.*

**Figure 2.12** Feed in tariff for PV exports to grid, cents per kWh



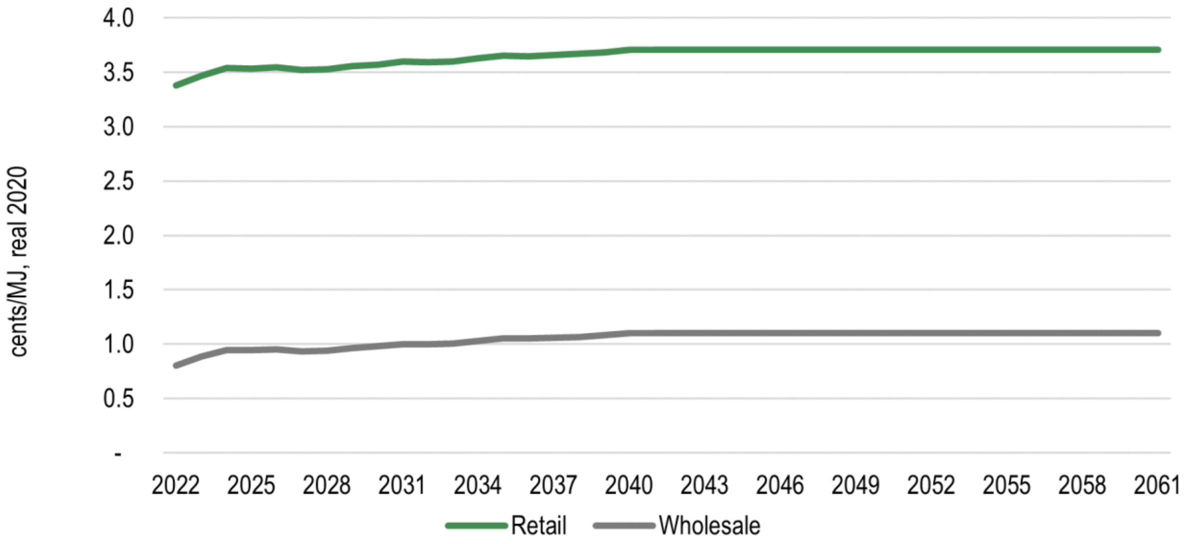

*Source: ACIL Allen.*

**Figure 2.13** Comparison of electricity prices at wholesale and retail prices, dollars per kWh




*Source: ACIL Allen.*

**Figure 2.14** Comparison of gas prices at wholesale and retail prices, cents per MJ




*Source: ACIL Allen.*

### 2.4.4 Deferred electricity network costs

As discussed in Section 2.4.3, the avoided electricity network costs are a function of the reduction in peak demand, and the augmentation expenditure that can be deferred and the replacement expenditure that can be reduced. The deferred electricity network costs have been calculated in two recent analyses relating to energy efficiency[67] by:

1. imputing a reduction in peak demand based on the reduction in energy use by using a conservation load factor (CLF)[68]
2. quantifying the network benefits by applying a dollar value per unit reduction in peak demand.

We have used the same approach to estimate the avoided network costs.

#### Imputing a reduction in peak demand

The most recent RIS for energy efficiency in residential buildings to estimate the reduction in peak demand applied a CLF of 0.4 based on a 2011 SKM MMA (now Jacobs) report and a 2012 Oakley Greenwood/ Marchment Hill report. A 2019 Jacobs report provided the CLFs as set out in Table 2.14, which indicate that this figure likely overstates the peak demand reductions (the lower the CLF, the higher the peak demand reductions for a given reduction in energy use).

Based on the CLFs as set out in the 2019 Jacobs report, we have applied a CLF of 0.50.

**Table 2.14** Conservation load factors

| Residential end-use | Basis / Source | Conservation load factor | |
|---|---|---|---|
| | | Summer 4 pm peak | Winter 6 pm peak |
| Building shell upgrade | Summer cooling + Winter heating | 0.48 | 0.50 |
| Residential cooling | RC AC profile | 0.48 | - |
| Residential heating | RC AC profile | - | 0.50 |
| Residential lighting | Daylight hours & Household occupancy | 2.64 | 0.34 |
| Residential water heating | NZ HEEP study | 1.49 | 1.09 |
| Residential outdoor lighting | Daylight hours & Household occupancy | 2.64 | 0.34 |
| Residential refrigeration | Adjusted cooling profile | 0.70 | 0.90 |
| Televisions and set top boxes | Household occupancy | 0.79 | 0.66 |
| Computers and laptops | Household occupancy | 0.79 | 0.66 |
| Other consumer electronics including mobile chargers, printers et cetera | Household occupancy | 0.87 | 0.73 |

[67] See Strategy. Policy. Research 2018, pp38-39 and Jacobs 2019 pp33-34.

[68] The reduction in peak demand is equal to the reduction in energy consumption divided by the number of hours in the year, divided by the conservation load factor.

| Residential end-use | Basis / Source | Conservation load factor | |
|---|---|---|---|
| Other miscellaneous appliances including kettles, toasters, hairdryers, shavers et cetera | Household occupancy | 0.83 | 0.69 |
| Residential pool/spas | Household occupancy, Ergon Energy profile | 0.73 | 0.84 |

*Source: Jacobs,* 2019 Victorian Energy Upgrades Program, Energy Market Modelling, Final Report*, 17 October 2019, p.37*

### Quantifying the network benefits

The network benefits have been calculated based on the incremental reduction in peak demand in each year and the capital expenditure that would have been deferred by that reduction in peak demand. In the instances where there is increase in peak demand, the estimated capital expenditure required to meet this have been included.

The deferred transmission network benefits have been estimated using the same transmission deferral benefit as used in the 2019 Jacobs report ($500/kW), escalated from 2019 dollars to 2021 dollars. This value was:

> *… based on in-house advice and has been chosen because it conservatively reflects the uncertainty associated with network deferrals, and because the value of transmission deferrals is usually not material.*[69]

We have estimated the distribution network benefit using the forecast capital expenditure on load growth in the most recent revenue determinations for each electricity distributor and the forecast growth in peak demand. Based on this data, we have assumed that the costs associated with growing the electricity distribution network are around $3,000/kW, noting that the cost varies widely across electricity distributors as the demand growth is very low or negative in many electricity distribution areas.

Consistent with the 2019 Jacobs report, we have applied a discount factor of 70 per cent to:

> *… allow for the uncertainty involved in networks actually being able to recoup the benefits from the programs.*[70]

An additional 10 per cent discount factor was applied in Option A to take into account the additional costs that may be incurred by the electricity distributors to accommodate the higher uptake of solar PV systems under that option.

We have also compared this figure to the electricity distributors' forecast Long Run Marginal Cost (LRMC) for supplying residential customers to ensure that it is reasonable.

[69] Jacobs, *2019 Victorian Energy Upgrades Program, Energy Market Modelling, Final Report*, 17 October 2019, p.33

[70] A footnote on page 34 of the Jacobs report indicates that the 70 per cent discount factor was derived from assumptions used in the Department of Climate Change and Energy Efficiency evaluation of a National Energy Saving Initiative.

### 2.4.5 Deferred gas pipeline costs

The deferred gas pipeline costs are a function of the reduction in gas usage, and the capital expenditure that can be deferred.

We have estimated the gas network benefit using the forecast capital expenditure on augmentations in the most recent revenue determinations for each gas distributor and the forecast growth in demand from new connections (noting that demand is generally decreasing from existing connections). Based on this data, we have assumed that the costs associated with growing the gas distribution network are around $15/GJ.

Consistent with the quantification of electricity network benefits, we have applied a discount factor of 70 per cent to allow for uncertainty in being able to recoup the benefits, particularly for new houses in existing suburbs.

### 2.4.6 Reduced greenhouse gas emissions

The avoided greenhouse gas (GHG) emissions associated with the proposed BASIX changes were calculated by:

— estimating the reduction in GHG emissions associated with the proposed changes by applying appropriate emissions intensity factors to energy savings (by source)
— estimating the costs of these emissions by applying an appropriate carbon price series.

More details about the information and assumptions used to produce these estimates are provided below. These are consistent with the method used in the NCC 2022 RIS to value the avoided GHG emissions associated with the proposed NCC 2022.

#### Emissions intensity factors

##### *Electricity*

The GHG emissions from end-user use of electricity vary significantly, based upon the energy mix[71] in each state — and ultimately varies further by distributor and consumer contract.

The Department of Industry, Science, Energy and Resources (DISER) reports emissions factors for end users of electricity in each state and territory, including:

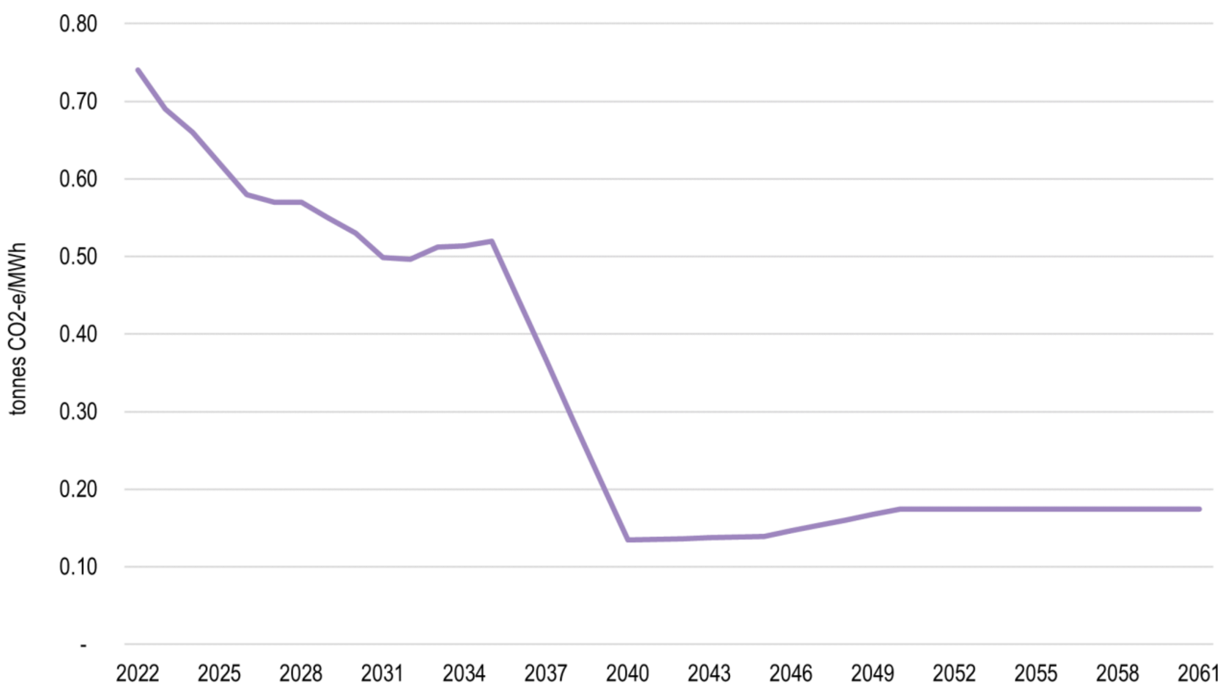
— Scope 2 emissions — these are indirect emissions from the generation of the electricity purchased and consumed
— Scope 3 emissions — these are indirect emissions from the extraction, production and transport of fuel burned at generation and the indirect emissions attributable to the electricity lost in delivery in the transmission and distribution network.

[71] The combination of energy sources used within the electricity market.

In late 2020 DISER released both their latest estimate of emissions factors (which refers to 2017-18[72]) and their emissions projections (from 2020 to 2030) providing an indicative assessment of how Australia is tracking against its emissions reduction targets[73].

To estimate the GHG emissions reductions for the proposed changes to BASIX we used DISER's projections from 2022 to 2030 and then projected the change in emissions factors from 2030 onwards using information sourced from our proprietary model *PowerMark*. As outlined in Appendix A, this approach is consistent with the assumptions used by the Department to determine the BASIX energy scores under Option A and B. It was assumed that emissions flatline after 2050 (see Figure 2.15).

**Figure 2.15** Electricity emissions factors over time




*Source: ACIL Allen and DISER 2020, Australia's emissions projections, December.*

### *Gas*

For natural gas emissions we used the latest estimates of emissions factors for natural gas consumption reported in the National Greenhouse Accounts Factors (Scope 1 and Scope 3 metro). Table 2.15 provides details of the emissions factors used. These are assumed to remain constant over time.

[72] DISER 2020, *National Greenhouse Accounts Factors, Australian National Greenhouse Accounts*, October, https://www.industry.gov.au/data-and-publications/national-greenhouse-accounts-factors-2020, accessed 2 March 2021.

[73] DISER 2020, *Australia's emissions projections*, December, https://www.industry.gov.au/data-and-publications/national-greenhouse-accounts-factors-2020, accessed 2 March 2021.

**Table 2.15** Natural gas emissions factors in NSW, kg CO2-e/GJ

| Scope | Emission factor |
|---|---|
| Scope 3[a] | 13.10 |
| Scope 1 | 51.4 |
| **Scope 1+3** | **64.50** |

*[a] Scope 3 emissions factors based on estimate for metro areas in each state. Estimates for non-metro areas vary slightly, but would not make a significant difference to the overall results.*
*Source: ACIL Allen based on DISER 2020, National Greenhouse Accounts Factors, Australian National Greenhouse Accounts, October.*

### Carbon price

There are multiple approaches to estimate the cost of GHG emissions. Because the burden (costs) of emissions are almost entirely borne by third parties (neither the consumer, nor the electricity generator), it is an example of an economic externality. The value of GHG emissions, therefore, is not internalised in the market, which means that individuals do not make decisions based on the overall impact. This is a classic market failure, making the value of emissions difficult to estimate accurately.

Two approaches have been used to estimate the value of GHG emissions:

— The **social cost of carbon** (SCC, or sometimes rendered as SC-$CO_2$), which tries to estimate the marginal impact of an additional tonne of carbon based on the future costs associated with those emissions. The SCC is inherently difficult to measure, both because of the difficulty in measuring the impact of a tonne of carbon a long time in the future; and because of the assumptions around the discount rate used to evaluate those impacts. Typically, the SCC is given as a very high, high, medium, and low value — deriving from different measures of the discount rate. This is the approach most commonly taken before the advent of carbon markets, and is the approach used in the United States (and in other places throughout the world) to monetise the value of changes in greenhouse gas emissions resulting from regulatory changes. Though, given the uneven distribution of effects of climate change, the SCC *can* vary between countries if the impacts are estimated locally.

— The **resource cost of carbon**, which is based on the current cost of abatement. In the Australian context, this is the value of the spot price for fixed delivery of a tonne of carbon (e.g. Australian Carbon Credit Units – ACCU[74], or equivalent unit – price). The British and European governments have recently moved to carbon variations using the resource cost of carbon approach.

These two methods can be roughly[75] described as a demand-price and a supply-price (respectively). In a perfectly operating market — with accurate information, well-defined property

[74] An ACCU is a unit issued to a person by the Clean Energy Regulator. Each ACCU issued represents one tonne of carbon dioxide equivalent (tCO2-e) stored or avoided by a project.

[75] Very roughly. The resource cost of carbon represents a part of a truncated supply curve, however the social cost of carbon represents an equilibrium price of a modelled hypothecated market. As noted in the text, neither is accurate for myriad reasons. The social cost of carbon is more accurately derived from the

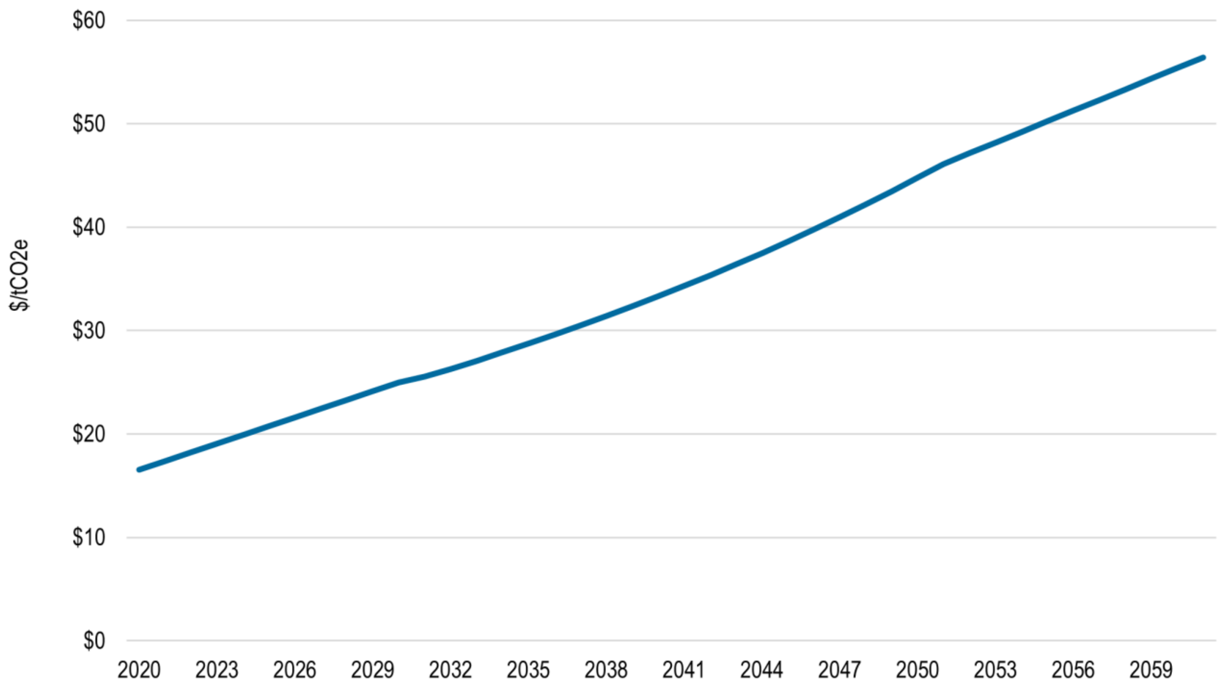
rights, and rational decision making — these two prices would be identical and the carbon market would equilibrate. Both approaches introduce uncertainty and inaccuracy for different reasons. However, both approaches have been used in policy contexts and have been upheld in courts in legal contexts.

For the NCC 2022 RIS analysis, the second approach was used and DISER instructed us to use an ACCU (or equivalent unit) price series to value the avoided GHG emissions. We have followed the same approach for this BASIX CBA.

The ACCU spot price as at December 2020 was $16.55 per tonne.[76] As forward prices for ACCUs are not available, we have projected the change in this price over time using information sourced from our proprietary model *PowerMark*. Using this approach, we estimate that the price per tonne of abatement would reach $25 in 2030 and around $45 in 2050 (see Figure 2.16).

Additional sensitivity analysis was conducted to test the effects of changes to the value of avoided GHG emissions.

**Figure 2.16** Cost of carbon estimates, $/tCO2e




*Source: ACIL Allen estimates based on CER 2021, Quarterly Carbon Market Report December Quarter 2020, March.*

demanded abatement, and the resource cost of carbon is more accurately derived from the *current* supply costs of carbon.

[76] Clean Energy Regulator (CER) 2021, Quarterly Carbon Market Report December Quarter 2020, March, http://www.cleanenergyregulator.gov.au/DocumentAssets/Documents/Quarterly%20Carbon%20Market%20Report%20-%20Quarter%204%20December%202020.pdf.

### 2.4.7 Health benefits from improved air quality

The mining and combustion of coal for electricity generation in Australia produces air pollution containing particulate matter, nitrogen oxides, sulphur dioxide, as well as other emissions. These can cause health problems such as respiratory illness and can also affect local economies.

Particulate matter, sulphur dioxide and nitrogen oxides are the main power station emissions contributing to health damage costs. These emissions are associated with respiratory and cardiac diseases.

The estimate of the economic impact associated with the health damage costs from these emissions is based on estimates of health benefits of implementing energy efficiency and clean energy measures produced by Scorgie et al. (2019) for the NSW Government.[77] In this report, the authors estimated health damage costs of coal-powered electricity generation of AUD$2.40 per MWh of total energy generation.[78]

As the estimates in this study were in 2016 dollars, the $2.40 per MWh figure was converted into 2020 dollars using inflation rate estimates from the ABS. This produces a 2020 figure of $2.55 per MWh (being for NSW, this figure relates to electricity generated from black coal).

This figure was then multiplied by the difference in the electricity generated from coal in NSW over time as a result of the proposed changes to the NCC sourced from our proprietary model *PowerMark*, see percentage of coal generated in Figure 2.17[79] Notably, these estimates are not driven by the specific electricity reductions from the proposed changes to BASIX. Instead, they are calculated based on the overall reductions in electricity across jurisdictions being driven by the changes proposed to the NCC[80]. This approach was used in recognition that electricity reductions in one jurisdiction does not necessarily translate into reductions in electricity generated in that jurisdiction, as that energy could be source from somewhere else in the NEM.

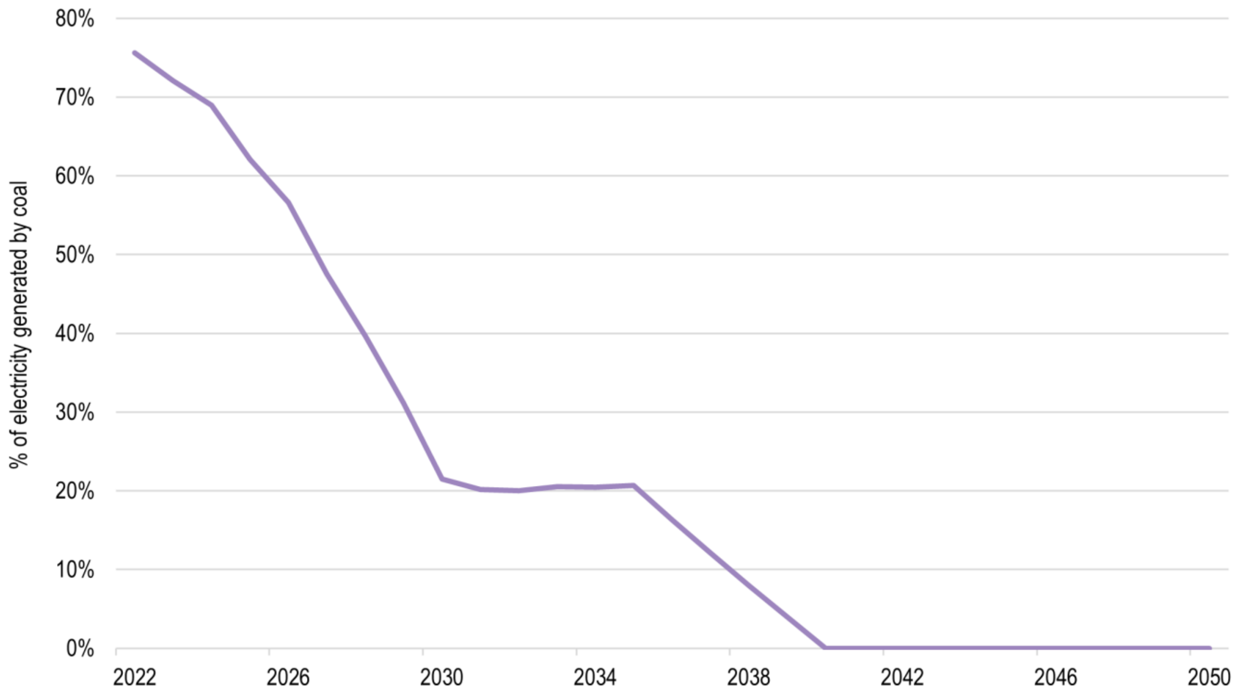
[77] Scorgie Y, Mazaheri M, Chang L, Ryan L, Fuchs D, Duc H, Monk K and Trieu T 2019, *Air Quality and Public Health Co-benefits of Implementing Energy Efficiency and Clean Energy Measures in New South Wales*, Final Report, report prepared by the NSW Office of Environment and Heritage, February.

[78] This estimate represents the health cost reductions per MWh reduction in total energy generation due to energy demand reduction and are based on the life years gained approach for the medium demand shock scenario and the 2026–2118 period (excluding ramp up), and assuming a 7 per cent discount rate. This is the same estimate used by the NSW Government in other cost benefit analyses of energy efficiency policies.

[79] It is assumed that the percentage of electricity generated in NSW after 2050 is zero.

[80] And hence the estimated health benefits from reduced coal-generated electricity for NSW are the same in this BASIX analysis and the NCC RIS for Option 1.5. Benefits under Option 2 are different between the BASIX analysis and the NCC analysis as the health benefits for Option 2 in both analyses were scaled according to the relative difference of electricity saved between Option 1.5 and 2.

**Figure 2.17** Percentage of electricity generated from coal




*Source: ACIL Allen.*

In addition to health benefits from reduced pollution from coal generated electricity, we used estimates from the Australian Academy of Technological Sciences and Engineering (ATSE) report on the Hidden Costs of Electricity Generation[81] on the health costs associated with emissions from Australian combined cycle gas power stations ($0.74 per MWh in 2009 dollars) to estimate the health benefits from reductions in gas-generated electricity and reductions in natural gas use.[82] In 2020 dollars this figure is $0.92 per MWh. This figure was then multiplied by the difference in the electricity generated from gas in NSW over time as a result of the proposed changes to BASIX (sourced from our proprietary model *PowerMark*) and the gas savings calculated previously.

[81] ATSE 2009, *The Hidden Costs of Electricity: Externalities of Power Generation in Australia*, https://www.atse.org.au/wp-content/uploads/2019/01/the-hidden-costs-of-electricity.pdf, accessed 4 March 2021.

[82] While ATSE's estimates relate to combined cycle gas power stations, using natural gas (whether to generate electricity or for other purposes) emits NOx and PM10 particulates and a lower level of SOx and hence it was considered that ATSE's estimates could be used as proxy for the health damage costs of natural gas use on an equivalent per PJ basis.

# Impact on individual dwellings 3

This chapter summarises the impacts of the proposed BASIX changes on individual sample dwellings from a societal perspective (i.e. measured using wholesale energy prices).

As noted in Chapter 2, costs and benefits have been calculated using expected (or common) compliance pathways for all dwelling types. These compliance pathways reflect the assumed likely market response of a new dwelling under the proposed policy settings as observed in data collected by the Department and modelling undertaken for the NCC 2022 by TIC and EES.

## 3.1 Individual dwelling benefits

As outlined in the previous chapter, households are set to benefit from the proposed changes in BASIX targets through:

— reduced energy consumption
— reductions in the costs of space conditioning equipment due to the improved thermal shell.[83]

For those households with both electricity and gas connections, the reduced energy consumption may reflect either a decrease in both electricity and gas consumption, or a decrease in one at the expense of another.

Modelling data on a dwelling's energy consumption under the new proposed policy settings was provided by the Department. This data is provided in Table 3.1. In some cases, the proposed policy settings result in an estimated decrease in:

— electricity consumption of as much as 56 per cent under Option A (for DH5) and as much as 25 per cent under Option B(for DH3)
— gas consumption of as much as 43 per cent under Option A (for LR) and as much as 72 per cent under Option B (for DH6).

[83] These are captured in the individual dwelling costs outlined in the following section as cost offsets.

As discussed in Chapter 2, energy savings resulting from the proposed changes are locked in for the life of the installed measures — which is as much as 40 years. The value of these savings in Present Value Terms (PVa) using a central discount rate of 7 per cent is provided in Table 3.2. These values have been calculated using the data in Table 3.1 and the estimates of wholesale energy prices outlined in the previous chapters. Benefits to the AH, LR, HR1, HR2 and HR3 dwellings have been averaged over the number of dwellings within the development.

Depending on the nature of the dwelling, the proposed changes can generate:

— lifetime benefits of between $164 (LR) and $1,951 (DH8) under Option A
— lifetime costs of $24 for DH6 and lifetime benefits of between $29 (DH9) and $1,561 (DH8) under Option B.

**Table 3.1** Policy impacts on annual energy consumption by scenario and dwelling type

| | | Baseline | | Option A | | Difference (Option A minus Baseline) | | Option B | | Difference (Option B minus Baseline) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dwelling** | **Location** | **Electricity, kWh/yr** | **Gas, MJ/yr** | **Electricity, kWh/yr** | **Gas, MJ/yr** | **Electricity, kWh/yr** | **Gas, MJ/yr** | **Electricity, kWh/yr** | **Gas, MJ/yr** | **Electricity, kWh/yr** | **Gas, MJ/yr** |
| **HOUSES** | | | | | | | | | | | |
| DH1 | Blacktown | 7,381 | 13,626 | 4,676 | 12,776 | -2,705 | -850 | 6,291 | 13,626 | -1,090 | 0 |
| DH2 | Blacktown | 7,233 | 14,581 | 4,429 | 12,776 | -2,805 | -1,805 | 5,942 | 13,626 | -1,291 | -955 |
| DH3 | Baulkham Hills | 11,519 | 16,428 | 9,035 | 14,362 | -2,484 | -2,065 | 8,610 | 15,327 | -2,910 | -1,101 |
| DH4 | Cessnock | 7,234 | 14,223 | 4,945 | 11,927 | -2,289 | -2,297 | 6,447 | 13,626 | -787 | -597 |
| DH5 | Dubbo | 6,785 | 16,390 | 2,991 | 17,527 | -3,794 | 1,137 | 6,443 | 12,586 | -342 | -3,804 |
| DH6 | Wagga | 3,220 | 45,225 | 2,686 | 33,783 | -535 | -11,441 | 8,057 | 12,639 | 4,837 | -32,586 |
| DH7 | Moss Vale | 12,261 | 12,111 | 8,375 | 10,802 | -3,885 | -1,309 | 9,612 | 12,111 | -2,648 | 0 |
| DH8 | Moss Vale | 15,203 | 13,501 | 11,046 | 12,028 | -4,157 | -1,472 | 12,402 | 13,501 | -2,801 | 0 |
| DH9 | Ballina | 4,396 | 13,746 | 3,770 | 8,922 | -626 | -4,824 | 4,807 | 12,427 | 411 | -1,319 |
| | *Composite NSW house* | *8,683* | *13,880* | *5,850* | *12,106* | *-2,833* | *-1,774* | *7,331* | *13,121* | *-1,352* | *-759* |
| **TOWNHOUSES** | | | | | | | | | | | |
| AH | Albion Park | 4,258 | 14,558 | 2,070 | 12,745 | -2,187 | -1,813 | 3,294 | 9,601 | -964 | -4,957 |
| **UNITS** | | | | | | | | | | | |
| LR | Shellharbour | 3,810 | 13,562 | 4,550 | 7,682 | 740 | -5,880 | 4,401 | 7,859 | 591 | -5,704 |
| HR1 | Macquarie Park | 4,421 | 8,501 | 3,918 | 7,860 | -503 | -640 | 3,899 | 8,501 | -521 | 0 |
| HR2 | Eastwood | 4,269 | 7,471 | 3,530 | 8,217 | -739 | 746 | 3,700 | 8,912 | -569 | 1,441 |
| HR3 | Liverpool | 4,286 | 9,544 | 3,620 | 7,789 | -665 | -1,755 | 4,011 | 7,968 | -274 | -1,576 |
| | *Composite NSW apartment* | *4,173* | *10,237* | *3,845* | *7,816* | *-329* | *-2,421* | *4,065* | *8,071* | *-108* | *-2,166* |

Note: AH, LR, HR1, HR2 and HR3 benefits have been averaged over the number of units within the development. The composite house and apartment are constructed using weights about the propensity of each of the sample dwellings in NSW outline in Table 2.6.

*Source: ACIL Allen based on data provided by the Department.*

**Table 3.2** Present value of benefits at 7% discount rate (measured using wholesale prices), $/dwelling

| Dwelling ID | Location | NCC climate zone | Dwelling type | Option A | | | Option B | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Electricity | Gas | Total | Electricity | Gas | Total |
| **HOUSES** | | | | | | | | | |
| DH1 | Blacktown | 5 | Average | 989 | 68 | 1,057 | 559 | 0 | 559 |
| DH2 | Blacktown | 5 | Affordable | 1,043 | 145 | 1,188 | 663 | 77 | 740 |
| DH3 | Baulkham Hills | 5 | Large | 1,169 | 166 | 1,335 | 1,376 | 88 | 1,465 |
| DH4 | Cessnock | 6 | Average | 813 | 185 | 997 | 327 | 48 | 375 |
| DH5 | Dubbo | 4 | Average | 1,491 | -63 | 1,427 | 172 | 251 | 424 |
| DH6 | Wagga | 4 | Average | 4 | 822 | 826 | -2,350 | 2,326 | -24 |
| DH7 | Moss Vale | 6 | Average | 1,631 | 105 | 1,737 | 1,363 | 0 | 1,363 |
| DH8 | Moss Vale | 6 | Large | 1,833 | 118 | 1,951 | 1,561 | 0 | 1,561 |
| DH9 | Ballina | 2 | Average | 222 | 383 | 605 | -64 | 93 | 29 |
| | | | *Composite NSW house* | *1,102* | *142* | *1,245* | *689* | *56* | *745* |
| **TOWNHOUSES** | | | | | | | | | |
| AH | Albion Park | 6 | Average | 702 | 123 | 825 | 80 | 328 | 408 |
| **UNITS** | | | | | | | | | |
| LR | Shellharbour | 6 | Low rise | -232 | 396 | 164 | -317 | 381 | 64 |
| HR1 | Macquarie Park | 5 | High rise - 28 storeys | 238 | 51 | 290 | 260 | 0 | 260 |
| HR2 | Eastwood | 5 | High rise - 11-13 storeys | 272 | -60 | 212 | 244 | -116 | 128 |
| HR3 | Liverpool | 5 | High rise - 6 storeys | 385 | 124 | 510 | 110 | 110 | 219 |
| | | | *Composite NSW apartment* | *218* | *166* | *383* | *27* | *145* | *172* |

Note: negative numbers reflect negative energy savings (i.e. increase energy costs) when compared to the baseline. AH, LR, HR1, HR2 and HR3 benefits have been averaged over the number of units within the development. The composite house and apartment are constructed using weights about the propensity of each of the sample dwellings in NSW outline in Table 2.6.

*Source: ACIL Allen based on data provided by the Department.*

## 3.2 Individual dwelling costs

The proposed changes to BASIX would require households to invest in measures to improve energy efficiency and thermal comfort outcomes.

The nature of the required investments has been assessed by the Department based on the modelling undertaken by TIC and EES for the NCC 2022 RIS. These estimates (in present value terms and adjusted to reflect the resource costs as outlined in Section 2.3.1) are summarised in Table 3.3. All costs, except for the replacement of PV inverters after ten years, are incurred at the time of construction. These costs also include reductions in the costs of space conditioning equipment due to the improved thermal shell, which are treated as cost offsets.

As with the benefits, costs incurred vary substantially between dwellings. For example, the estimated additional costs associated with DH6 under Option A are $3,745, while the additional costs for DH8 under the same scenario are almost double, at $7,451. Similarly, under Option A, the additional compliance costs for an apartment in a low rise building (LR) are more than five times the additional costs for an apartment in any of the high rise buildings modelled (HR1 to HR3).

While for most dwellings the additional costs of complying with Option B are lower than the costs of complying with Option A, there are some dwellings for which the costs of Option B are higher. In particular, the additional costs to comply with Option B for DH3, DH9, AH, LR and HR3 are higher than under Option A. Option A requires either no heating or cooling systems or air conditioners with low energy efficiency. To satisfy Option B, air conditioners with higher energy efficiency are required, resulting in higher capital costs than Option A.

On the other hand, compliance with Option B in DH6 results in savings of construction costs. The base case and the gas hot water scenario with Option A are specified with evaporative coolers and gas fixed flued heaters. Replacement of these systems with reverse-cycle air conditioners result in cost savings as listed in Table 3.3.

**Table 3.3** Policy impacts on construction costs by dwelling type, present value at 7% discount rate, $/dwelling

| Dwelling ID | Location | Option A | Option B |
|---|---|---|---|
| **HOUSES** | | | |
| DH1 | Blacktown | 6,712 | 3,177 |
| DH2 | Blacktown | 5,788 | 2,902 |
| DH3 | Baulkham Hills | 5,084 | 8,424 |
| DH4 | Cessnock | 6,035 | 3,045 |
| DH5 | Dubbo | 5,488 | 3,534 |
| DH6 | Wagga | 3,745 | -1,030 |
| DH7 | Moss Vale | 5,761 | 4,668 |
| DH8 | Moss Vale | 7,451 | 4,607 |
| DH9 | Ballina | 5,222 | 6,275 |
| | *Composite NSW house* | *6,036* | *3,844* |

| Dwelling ID | Location | Option A | Option B |
|---|---|---|---|
| **TOWNHOUSES** | | | |
| AH | Albion Park | 6,015 | 10,823 |
| **UNITS** | | | |
| LR | Shellharbour | 4,917 | 5,221 |
| HR1 | Macquarie Park | 779 | 776 |
| HR2 | Eastwood | 772 | 555 |
| HR3 | Liverpool | 895 | 3,565 |
| | *Composite NSW apartment* | *1,849* | *3,517* |

Note: negative numbers reflect negative costs (i.e. a decrease in construction costs/cost savings) when compared to the baseline. AH, LR, HR1, HR2 and HR3 costs have been averaged over the number of units within the development. The composite house and apartment are constructed using weights about the propensity of each of the sample dwellings in NSW outline in Table 2.6.

*Source: ACIL Allen based on data provided by the Department.*

## 3.3 Net impact on dwellings

The net impacts for each dwelling in the sample under each policy option are provided in Table 3.4. The net impact is an on-balance account of the overall lifetime impacts (costs and benefits) of the policy scenarios examined. The table provides estimates of the PVa of the costs and benefits, and both the NPV and the BCR of the policy change.

Table 3.4 indicates that, at a dwelling level, all but one of the modelled dwellings would provide a negative return from a societal perspective (i.e. measured using wholesale energy prices) under both policy options. These results indicate that the costs of compliance — given the compliance pathways selected under each policy option — are greater than the lifetime energy savings.

The exception is DH6 which experiences a positive return of $1,006 in NPV terms under Option B. This is driven by a reduction in construction costs of $1,030 under Option B (compared to the BAU) and an increase in energy costs of $24. These cost savings and increased energy costs are largely due to the removal under Option 2 of 3.7kW of solar panels that this house had installed in the overcompliance scenario under the BAU (Option 2 has no solar panels specified).

These results are mainly driven by the use of wholesale energy prices (as a proxy for avoided resource costs) to value the benefits of reduced energy consumption which, as noted in Chapter 2, results in BCRs and NPVs that are much smaller than if retail energy prices are used. This effect is compounded by the current period of low wholesale energy prices with a number of government policy initiatives incentivising the entry of new energy supply options and a reduction in the demand for energy.

**Table 3.4** Net impacts of the proposed changes to BASIX from a societal perspective (measured using wholesale energy prices), by dwelling type

| Dwelling ID | Location | NCC climate zone | Dwelling type | Option A | | | | Option B | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | PVa of costs | PVa of benefits | Net impact | BCR | PVa of costs | PVa of benefits | Net impact | BCR |
| **HOUSES** | | | | | | | | | | | |
| DH1 | Blacktown | 5 | Average | 6,712 | 1,057 | -5,655 | 0.2 | 3,177 | 559 | -2,617 | 0.2 |
| DH2 | Blacktown | 5 | Affordable | 5,788 | 1,188 | -4,600 | 0.2 | 2,902 | 740 | -2,162 | 0.3 |
| DH3 | Baulkham Hills | 5 | Large | 5,084 | 1,335 | -3,749 | 0.3 | 8,424 | 1,465 | -6,959 | 0.2 |
| DH4 | Cessnock | 6 | Average | 6,035 | 997 | -5,038 | 0.2 | 3,045 | 375 | -2,670 | 0.1 |
| DH5 | Dubbo | 4 | Average | 5,488 | 1,427 | -4,060 | 0.3 | 3,534 | 424 | -3,111 | 0.1 |
| DH6 | Wagga | 4 | Average | 3,745 | 826 | -2,919 | 0.2 | -1,030 | -24 | 1,006 | -[a] |
| DH7 | Moss Vale | 6 | Average | 5,761 | 1,737 | -4,024 | 0.3 | 4,668 | 1,363 | -3,305 | 0.3 |
| DH8 | Moss Vale | 6 | Large | 7,451 | 1,951 | -5,500 | 0.3 | 4,607 | 1,561 | -3,046 | 0.3 |
| DH9 | Ballina | 2 | Average | 5,222 | 605 | -4,617 | 0.1 | 6,275 | 29 | -6,246 | 0.005 |
| | | | *Composite NSW house* | *6,036* | *1,245* | *-4,791* | *0.2* | *3,844* | *745* | *-3,099* | *0.2* |
| **TOWNHOUSES** | | | | | | | | | | | |
| AH | Albion Park | 6 | Average | 6,015 | 825 | -5,190 | 0.1 | 10,823 | 408 | -10,415 | 0.04 |
| **UNITS** | | | | | | | | | | | |
| LR | Shellharbour | 6 | Low rise | 4,917 | 164 | -4,754 | 0.03 | 5,221 | 64 | -5,157 | 0.01 |
| HR1 | Macquarie Park | 5 | High rise - 28 storeys | 779 | 290 | -489 | 0.4 | 776 | 260 | -517 | 0.3 |
| HR2 | Eastwood | 5 | High rise - 11-13 storeys | 772 | 212 | -560 | 0.3 | 555 | 128 | -427 | 0.2 |

| Dwelling ID | Location | NCC climate zone | Dwelling type | Option A | | | | Option B | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | PVa of costs | PVa of benefits | Net impact | BCR | PVa of costs | PVa of benefits | Net impact | BCR |
| HR3 | Liverpool | 5 | High rise - 6 storeys | 895 | 510 | -385 | 0.6 | 3,565 | 219 | -3,346 | 0.1 |
| | | | *Composite NSW apartment* | *1,849* | *383* | *-1,466* | *0.2* | *3,517* | *172* | *-3,344* | *0.05* |

[a] A BCR for this dwelling cannot be interpreted the same as for other dwellings as the dwelling does not experience any costs (there are cost savings of $1,030) or benefits (there is an increase in energy costs of $24).

Note: AH, LR, HR1, HR2 and HR3 costs and benefits have been averaged over the number of units within the development. The composite house and apartment are constructed using weights about the propensity of each of the sample dwellings in NSW outline in Table 2.6.

*Source: ACIL Allen analysis based on data provided by the Department.*

# 4 State-wide impacts

The previous chapter considered the impacts of the proposed BASIX changes on individual dwellings. This chapter considers the overall benefits and costs of the proposed changes at the state-wide level.

## 4.1 State-wide benefits

The state-wide analysis uses three measures of the potential benefits accruing to each scenario:

1. *Energy benefits* — these are benefits from the saved cost of supplying energy. This is the most certain measure of benefits available and includes the aggregated value of direct energy savings from reduced energy consumption by the sample of dwellings modelled and deferred network investment for gas and electricity as a result of reductions in peak electricity demand and reductions in gas usage.
2. *Benefits from reduced carbon emissions* — this is a somewhat more uncertain measure of benefit. It is clear that carbon emissions represent a cost to society, and that reducing these emissions therefore represents a benefit. However, since the removal of Australia's carbon pricing mechanism in 2014, there is no universally agreed transparent price which can be assigned to these emissions.
3. *Health benefits from reduced electricity and gas generation* — these are benefits from reduced pollution from electricity and gas generation. While it is clear that electricity generated from fossil fuels produces air pollution that damages health, and that reducing these emissions represents a benefit, these benefits are generally regarded as highly uncertain and speculative and should be interpreted as an indicative potential value of the wellbeing that could be generated through energy efficiency upgrades. The true value in dollar terms of these benefits is unknown, but is expected, based on the information available, to be of the same order of magnitude as our estimates.

Each of these benefits are explained in more detail below.

### 4.1.1 Energy savings

Table 4.1 summarises the expected energy savings that would accrue to the NSW community as a result of the proposed policy changes. The amounts of electricity and gas saved from the policy change are a result of two factors:

— how an individual dwelling is impacted by the policy (see Table 3.1 and Table 3.2)

— how the housing stock grows and develops over time (see Figure 2.3).

As shown in Table 4.1, it is estimated that under Option A electricity consumption in NSW would decrease by 72.5 PJ over the period of analysis, and gas would decrease by about 16 PJ. The reduction in energy consumption under Option B would be smaller, with electricity projected to reduce by around 31 PJ and gas by 19.4 PJ.

The value of these energy reductions is also presented in Table 4.1. It is estimated that Option A would provide benefits to the NSW economy worth around $289 million in present value terms, and Option B would deliver around $163 million in benefits.

**Table 4.1** Impacts of proposed BASIX changes on energy consumption (2022-2070)

| | Option A | Option B |
|---|---|---|
| **Energy saved (PJ)** | | |
| Electricity (incl. PV exports) | 72.5 | 31.4 |
| Gas | 16.3 | 19.4 |
| Total | 88.7 | 50.7 |
| **Present value of energy savings ($M)** | | |
| Electricity (excl. PV exports) | 239.2 | 120.5 |
| Gas | 49.9 | 42.7 |
| Total | 289.1 | 163.3 |

Note: Savings account for the rebound effect discussed in Chapter 2. Present values at 7 per cent discount rate.
*Source: ACIL Allen.*

### 4.1.2 Deferred network investment for gas and electricity

As outlined in Sections 2.4.4 and 2.4.5, two types of network benefits have been estimated in the analysis:

— benefits from deferred electricity network costs as a result of reductions in peak demand

— benefits from deferred gas pipeline costs as a result of reductions in gas use.

As noted in Section 2.4.1, there is a degree of fuel substitution in the modelled dwellings, which means that there are likely to be some offsetting effects between gas and electricity network investments. To take this effect into account we have modelled the impacts on both electricity and gas networks.

Consistent with the approach used to estimate energy savings at the economy-wide level, as new cohorts of dwellings are built, the network benefits (and energy savings) associated with BASIX increase, and then start to decrease in the future as the features installed to comply with the new targets reach their end of life. Once investments reach the end of their life, the opposite effect occurs — energy savings (and their associated network benefits) fall. In this way, the net impact on the network is considered.

Table 4.2 outlines the network benefits associated with the proposed changes to BASIX in present value terms over the modelled period. As shown in this table, broadly, total net network benefits are positive under both policy options. Savings under Option A are more than double the savings under Option B.

**Table 4.2** Deferred network investment for gas and electricity, present value (2022-2070, $M 2021)

| | Deferred electricity network costs | Deferred gas pipeline costs | Total |
|---|---|---|---|
| Option A | $91.4 | $1.4 | $92.9 |
| Option B | $40.5 | $1.2 | $41.7 |

Note: Negative values represent increases in cost. Present values at 7 per cent discount rate.
*Source: ACIL Allen.*

### 4.1.3 Greenhouse gas emissions

The reductions in energy consumption would result in a reduction in the associated GHG emissions. It is estimated that on average, the changes proposed under Option A would reduce emissions from the NSW housing stock by around 6.8 Mt CO2-e over the period 2022-2070, and by around 3.4 Mt CO2-e under Option B (see Table 4.3). The present value of these savings is around $77 million under Option A and approximately $33 million under Option B.

**Table 4.3** Cumulative impacts of proposed BASIX changes GHG emissions (2022-2070)

| | Option A | Option B |
|---|---|---|
| **Emissions saved (Million Tonnes CO2-e)** | | |
| Electricity (incl. PV exports) | 5.8 | 2.2 |
| Gas | 1.0 | 1.2 |
| Total | 6.8 | 3.4 |
| **Present value of GHG savings ($M)** | | |
| Total (incl. electricity and gas) | 76.7 | 32.5 |

Note: Savings account for the rebound effect discussed in Chapter 2. Present values at 7 per cent discount rate.
*Source: ACIL Allen.*

### 4.1.4 Health benefits from improved air quality

The mining and combustion of coal for electricity generation and the burning of gas (whether to generate electricity or for other purposes) produce air pollution which can cause health problems such as respiratory illness.

Based on the method described in Chapter 2, we estimated the health benefits associated with the improvement in air quality due to a reduction in electricity generated by gas and coal and with the reduction in gas use. These are outlined in Table 4.4. As shown in this table, it is estimated that Option A would provide health benefits to the NSW economy worth around $32 million in present value terms, and Option B would deliver around $13 million in benefits.

**Table 4.4** Present value of health impacts over the period 2022-2070, $M

| | Option A | Option B |
|---|---|---|
| Benefits from reduced coal-powered electricity generation | 23.5 | 8.1 |
| Benefits from reduced gas-powered electricity generation | 7.4 | 3.7 |
| Benefits from reduced gas use | 1.2 | 1.0 |
| **Total** | **32.2** | **12.9** |

Note: Accounting for the rebound effect discussed in Chapter 2. Present values at 7 per cent discount rate.
*Source: ACIL Allen.*

## 4.2 State-wide costs

The proposed changes to BASIX would involve substantial costs for the NSW economy. Costs at the state-wide level include:

- an aggregation of those costs incurred by individual dwellings
- costs incurred by the NSW Government to administer the policy and communicate the policy changes
- costs incurred by industry that cannot be directly passed on to the consumer (such as training costs).

These are discussed in more detail in the sections below.

### 4.2.1 Capital (compliance) costs

The aggregate capital costs associated with the proposed policy changes are summarised in Table 4.5. Most capital costs (except for inverters as discussed in Chapter 2) are only incurred during the initial dwelling construction and therefore do not create a cohort effect as is the case with energy savings. As outlined in Table 4.5, it is projected that the proposed changes would impose costs of $1.35 billion over the life of the policy under Option A and $1.51 billion in costs under Option B.

As noted before, these estimates take into account the costs:

— of changes to equipment and building shell to meet the new targets
— of thermal bridging mitigation measures
— associated with improving the thermal shell from 6 to 7 stars for buildings on difficult blocks
— savings associated with smaller appliances due to improving the thermal shell from 6 to 7 stars.

**Table 4.5** Present value of state-wide capital costs to meet the new BASIX targets, $M

| | Option A | Option B |
|---|---|---|
| Capital costs | 1,353.3 | 1,514.5 |

Note: Present values at 7 per cent discount rate.
*Source: ACIL Allen.*

### 4.2.2 Administration costs

It is assumed that a once off administration cost of $100,000 would be incurred in the first year of the policy change. This would reflect the costs of communicating the changes to industry and ensuring the sector is appropriately informed.

It is not proposed that the Government undertake any additional enforcement (or other) activities that would incur additional costs.

### 4.2.3 Industry compliance costs

The industry compliance costs refer to the costs that industries affected by the proposed changes (e.g. the construction industry) would incur beyond the direct costs of energy-efficient materials and designs to comply with the amended BASIX requirements. These costs include:

— Training costs — these are one-off costs incurred by industry stakeholders to familiarise themselves with the new requirements in BASIX. These costs include:
  – the time invested in familiarising themselves with the relevant aspects of the new targets
  – any fees associated with attending associated professional development seminars.
— Redesign costs — these include costs related to redesigning buildings and building products to meet the new BASIX requirements.

Following the approach in the NCC 2022 RIS, only training costs are included in this BASIX CBA. While it is recognised that industry would incur redesign costs, there are no reliable estimates of the magnitude of these costs. This is an area where the NCC 2022 RIS will ask for input from stakeholders during the consultation period.

To calculate the training cost for industry associated with the proposed changes to BASIX, we estimated:

— the number of industry stakeholders in the residential construction industry directly affected by the proposed changes
— the training costs projected to be incurred by each stakeholder.

### Stakeholders directly affected by the proposed changes

The main stakeholder groups that are likely to be directly affected by the proposed changes to BASIX and would need to undertake training to understand the proposed changes are:

— construction managers
— architects and building designers
— building surveyors
— thermal performance (NatHERS) assessors.

The estimated number of these stakeholders that are involved in the construction of residential buildings in NSW is outlined in Table 4.6. These figures were derived using estimates of the number of people in each relevant occupation Australia-wide sourced from two recent RISs related to changes in the NCC[84,85], growing these numbers to 2020 using ABS estimates of employment growth in the Australian construction industry, and splitting them by jurisdiction using estimates of the share of residential construction employment by state derived from Input-Output (IO) tables.

**Table 4.6** Estimated number of industry stakeholders directly affected by the proposed changes to BASIX, 2020

| Occupation | People to be retrained in NSW |
|---|---|
| Construction managers | 13,808 |
| Architects and building designers | 3,558 |
| Building surveyors | 582 |
| Thermal performance (NatHERS) assessors | 2,026 |
| **Total** | **19,974** |

*Source: ACIL Allen based on information sourced from CIE 2021, Proposal to include minimum accessibility standards for housing in the National Construction Code, Decision Regulation Impact Statement; SPR 2018, Inclusion of heating and cooling energy load limits in NatHERS assessments, Regulation Impact Statement for decision; and ABS data.*

[84] Strategy. Policy. Research (SPR) 2018, *Inclusion of heating and cooling energy load limits in NatHERS assessments, Regulation Impact Statement for decision*, prepared for the Australian Building Codes Board.

[85] Centre for International Economics (CIE) 2021, *Proposal to include minimum accessibility standards for housing in the National Construction Code, Decision Regulation Impact Statement*, prepared for the Australian Building Codes Board, February.

### Training costs incurred by each stakeholder

As noted above, the training costs incurred by affected stakeholders include:

— the time required for training

— the fees associated with attending formal training (e.g. for professional development seminars).

Following assumptions used by the ABCB's recent accessibility RIS[86], it has been assumed that each person who requires retraining would require a total of 9.5 hours of training, including:

— 2 hours to attend a seminar/webcast to explain the proposed changes

— 3.75 hours of Continuous Professional Development (CPD)[87]

— 3.75 hours of self-paced learning.

In addition to this, it has been assumed that 20 per cent of architects and building designers would also undertake four hours of additional training on NatHERS to understand how to use NatHERS to comply with the new requirements.

The opportunity cost of this time has been valued using estimates of hourly earnings for each of the affected occupations. For consistency, these earnings (except for NatHERS assessors[88]) have also been sourced from the ABCB's accessibility RIS, escalated to 2021 dollars and adjusted using an on-cost multiplier of 1.75 to account for non-wage labour on-costs.[89] The indicative hourly earnings used to value the time invested in training for occupations undertaking retraining are outlined in Table 4.7.

**Table 4.7** Indicative hourly earnings for occupations requiring retraining

| Occupation | $/hr 2021, excl. taxation | $/hr 2021, including on-costs |
|---|---|---|
| Construction managers | 61.68 | 107.94 |
| Architects and building designers | 35.39 | 61.93 |
| Building surveyors | 41.46 | 72.55 |
| Thermal performance (NatHERS) assessors | 39.13 | 68.47 |

Note: assumes 230 working days per year and 7.5 hours per working day.

*Source: ACIL Allen estimates based on information sourced from CIE 2021, Proposal to include minimum accessibility standards for housing in the National Construction Code, Decision Regulation Impact Statement; and Australian Government Job Outlook.*

[86] Ibid.

[87] It is assumed that this CPD training is additional to other training that would otherwise occur (i.e. that this retraining does not replace other training that would have occurred).

[88] Annul earnings for NatHERS assessors were sourced from the Australian Government Job Outlook (https://joboutlook.gov.au/occupations/other-architectural-building-and-surveying-technicians?occupationCode=312199) and multiplied by 0.8 to exclude taxation (this is equivalent to assuming that each of these assessors has an average tax rate of 20 per cent). Annual earnings are then converted to hourly rates assuming 230 working days per year and 7.5 hours per working day.

[89] The Commonwealth Regulatory Burden Measurement Framework Guidance Note by the Office of Best Practice Regulation (OBPR, p.11) states that average weekly earnings need to be 'scaled up using a multiplier of 1.75 (or 75 per cent as it is input into the Regulatory Burden Measure) to account for the non-wage labour on-costs (for example, payroll tax and superannuation) and overhead costs (for example, rent, telephone, electricity and information technology equipment expenses).'

In addition to the time costs, industry stakeholders would incur CPD seminar fees. It has been assumed that the cost per hour of CPD training is $50 (excluding GST). This assumption is in line with what is currently charged by industry organisations providing training to members.

The total estimated training costs for industry stakeholders in NSW are presented in Table 4.8.

**Table 4.8** Total retraining costs for industry (including training time and training fees), $2021

| Occupation | Time costs | Training fees | Total |
|---|---|---|---|
| Construction managers | 14,158,708 | 2,617,782 | 16,776,489 |
| Architects and building designers | 2,269,651 | 746,507 | 3,016,158 |
| Building surveyors | 401,139 | 110,344 | 511,483 |
| Thermal performance (NatHERS) assessors | 1,317,957 | 384,139 | 1,702,096 |
| **Total** | **18,147,454** | **3,858,772** | **22,006,227** |

*Source: ACIL Allen.*

# 4.3 Net impact on NSW

A summary of the quantified direct costs and benefits and the net impact of the proposed changes on NSW is summarised in Table 4.9. Reflecting the level of certainty of different benefits discussed in Section 4.1, the NPV and BCR metrics are presented incrementally by adding benefits from the most certain to the least certain.

Table 4.9 indicates that, at an economywide level, both policy options appear to result in a net cost to society, even when including the somewhat more uncertain measures of benefit (the benefits from reduced carbon emissions and health benefits). This result is mainly driven by:

— the use of wholesale energy prices (as a proxy of avoided resource costs) to value the benefits of reduced energy consumption, which as noted in Chapter 2, results in BCRs and NPVs that are much smaller than if retail energy prices are used

— the high capital costs for households associated with meeting the new targets.

**Table 4.9** Costs and benefits of the proposed policy options, present value ($M, 2021)

| | | Option A | Option B |
|---|---|---|---|
| **COSTS** | | | |
| Households - capital costs | | 1,353.3 | 1,514.5 |
| Industry | | 22.0 | 22.0 |
| Government Costs | | 0.1 | 0.1 |
| | **TOTAL COSTS** | **1,375.5** | **1,536.6** |
| **BENEFITS** | | | |
| **Households** | | | |
| Electricity savings | | 239.2 | 120.5 |
| Gas savings | | 49.9 | 42.7 |
| | *Household subtotal* | *289.1* | *163.3* |

| | Option A | Option B |
|---|---|---|
| **Society** | | |
| Deferred network investment for gas and electricity | 92.9 | 41.7 |
| Greenhouse emissions savings | 76.7 | 32.5 |
| Health benefits from improved air quality | 32.2 | 12.9 |
| *Society subtotal* | *201.8* | *87.1* |
| **TOTAL BENEFITS** | **490.9** | **250.3** |
| **NET PRESENT VALUES** | | |
| Accounting for energy benefits only | -993.5 | -1,331.6 |
| Accounting for energy benefits + carbon benefits | -916.7 | -1,299.1 |
| Accounting for energy benefits + carbon benefits + health benefits | -884.6 | -1,286.3 |
| **BCR (RATIO)** | | |
| Accounting for energy benefits only | 0.28 | 0.13 |
| Accounting for energy benefits + carbon benefits | 0.33 | 0.15 |
| Accounting for energy benefits + carbon benefits + health benefits | 0.36 | 0.16 |

Note: Using a 7 per cent discount rate.
*Source: ACIL Allen.*

# 4.4 Sensitivity and breakeven analysis

## 4.4.1 Sensitivity analysis

A sensitivity analysis was conducted to address five areas of uncertainty. For each of these areas, the analysis was conducted as follows:

— discount rate — a low discount rate of 3 per cent and a high discount rate of 10 per cent were tested, consistent with advice from NSW guide to cost benefit analysis

— industry costs — an increase in industry costs of 50 per cent and a decrease in industry costs of 50 per cent were tested

— carbon prices — we tested a decrease in carbon prices of 50 per cent and two increase scenarios, where carbon prices are two times and 4.5 times the price used in the central case[90]

— rebound effect — a decrease in rebound effect to zero and an increase in rebound to 30 per cent in line with some higher estimates discussed in Section 2.4.1

— energy savings achieved in practice — a medium realisation scenario where 75 per cent of the modelled energy savings are achieved in practice and a low realisation scenario where only 50 per cent of the savings are achieved in practice.

[90] An increase of 4.5 times the prices is equivalent to a carbon price in 2022 of roughly $75 per tonne of abatement.

The results of the sensitivity analysis are provided in Table 4.10. This table shows that:

- Under Option A lower discount rates produce a lower net cost to society. This is because a lower discount rate increases the value of both costs and benefits, but the magnitude of the benefit increase more than offsets the increase in costs. The opposite effect happens under Option B, where a lower discount rate produces a more negative result (in this case, a higher net cost to society). This is a reflection of the ratio of costs and benefits under each option, which under Option B results in the cost increase being larger than the benefit increase, resulting in a net increase in costs.
- Higher discount rates produce a lower net cost to society under both option as the magnitude of the reduction in costs (which are mostly experienced in the first few years of the analysis) more than offsets the reductions in benefits.
- If industry costs are decreased or increased by 50 per cent, the NPV for the policy options changes marginally:
  - from -$885 million under the initial ‘standard’ assumptions for Option A, to -$874 million or -$896 million (a change in the net impact of the scenario of 1.2 per cent)
  - from -$1.29 billion under the initial ‘standard’ assumptions for Option B, to -$1.28 billion or -$1.30 billion (a change in the net impact of the scenario of around one per cent).
- If carbon prices decrease by 50 per cent, the NPV for Option A decreases by around 4 per cent, from -$885 million to -$923 million, and the NPV for Option B decreases by 1.3 per cent, from -$1.29 billion to -$1.30 billion.
- If carbon prices increase by 100 per cent (i.e. if they double), the NPV for Option A improves by 8.7 per cent, from -$885 million to -$808 million, and the NPV for Option B improves by 2.5 per cent, from -$1.29 billion to -$1.25 billion.
- If carbon prices are 4.5 times higher (i.e. if they increase by 350%), the NPV for Option A improves by around 30 per cent, from -$885 million to -$616 million, and the NPV for Option B improves by around 9 per cent, from -$1.29 billion to -$1.17 billion.
- If rebound effect is assumed to be zero, the NPV for both options improves. In Option A it improves by 3.7 per cent to -$852 million and in Option B it improves by 1.7 per cent to -$1.26 billion. Increasing the rebound effect has the opposite result, making both options perform worst.
- Under a medium realisation scenario (where 75 per cent of the modelled energy savings are achieved) the net losses under Option A would increase by 6.4 per cent from -$885 million to -$942 million. The net losses under Option B would increase by around 3 per cent from -$1.29 billion to -$1.33 billion.
- Under a low realisation scenario (where only 50 per cent of the modelled energy savings are achieved) the net losses under Option A would increase by 16.5 per cent from -$885 million to -$1.03 billion. The net losses under Option B would increase by around 8 per cent from -$1.29 billion to -$1.39 billion.

**Table 4.10** Sensitivity analysis — impact of sensitivity tests on the NPV under each policy option ($M, 2021)

| | Option A | Option B |
|---|---|---|
| *NPV under standard assumptions (as per* Table 4.9) | -885 | -1,286 |
| **Discount rate** | | |
| Decrease to 3% | - 743 | - 1,296 |
| Increase to 10% | - 880 | - 1,212 |
| **Industry costs** [a] | | |
| Decrease costs by 50% | - 874 | - 1,275 |
| Increase costs by 50% | - 896 | - 1,297 |
| **Carbon price** [a] | | |
| Decrease price by 50% | - 923 | - 1,303 |
| Increase price by 100% | - 808 | - 1,254 |
| At $75 (increase by 350%) | - 616 | - 1,173 |
| **Rebound effect** [a] | | |
| Decrease rebound to 0% | - 852 | - 1,264 |
| Increase rebound to 30% | - 950 | - 1,330 |
| **Performance gap** [a] | | |
| 50% of modelled energy savings are achieved in practice | - 1,031 | - 1,385 |
| 75% of modelled energy savings are achieved in practice | - 942 | - 1,325 |

[a] Changes are modelled as level changes applied evenly for all years, all building classes, and all climate zones (i.e. not year on year change).

*Source: ACIL Allen.*

## 4.4.2 Breakeven analysis

Breakeven analyses are common practice in situations where the degree of benefit associated with a proposal is uncertain. It involves a simulation process where key parameters of the model – in this case, the energy prices and the costs of the upgrades – are varied until the net impacts calculated through the model equal zero. In other words, it answers the questions:

— how much would the energy prices have to increase for the proposed policy options to break even to society in cost-benefit terms?

— how much would the upgrade costs have to decrease for the proposed policy options to break even to society in cost-benefit terms?

This breakeven analysis is similar to the sensitivity analysis outlined above only the parameters are varied to achieve a particular outcome, i.e. they are varied until the net present value equals zero.

The results of the breakeven analysis are provided in Table 4.11. As shown in this table:

— the wholesale energy prices would need to be more than four times higher under Option A and more than eight times higher under Option B for the BASIX changes to break even for society

— the costs of upgrades would need to be around 15 to 35 per cent of the current costs for the BASIX changes to break even for society.

**Table 4.11** Breakeven analysis [a]

| | Option A | Option B |
|---|---|---|
| Percentage change in wholesale energy prices to breakeven | 306% | 788% |
| Percentage change in compliance (capital) costs to breakeven | -65% | -85% |

[a] Breakeven point is where the benefits of the policy option minus its costs equal zero (in net present terms, calculated at state-wide level at 7 per cent discount rate).
Note: All changes are modelled as level changes applied evenly for all years (i.e. not year on year change).
*Source: ACIL Allen.*

# 4.5 Non-quantified benefits

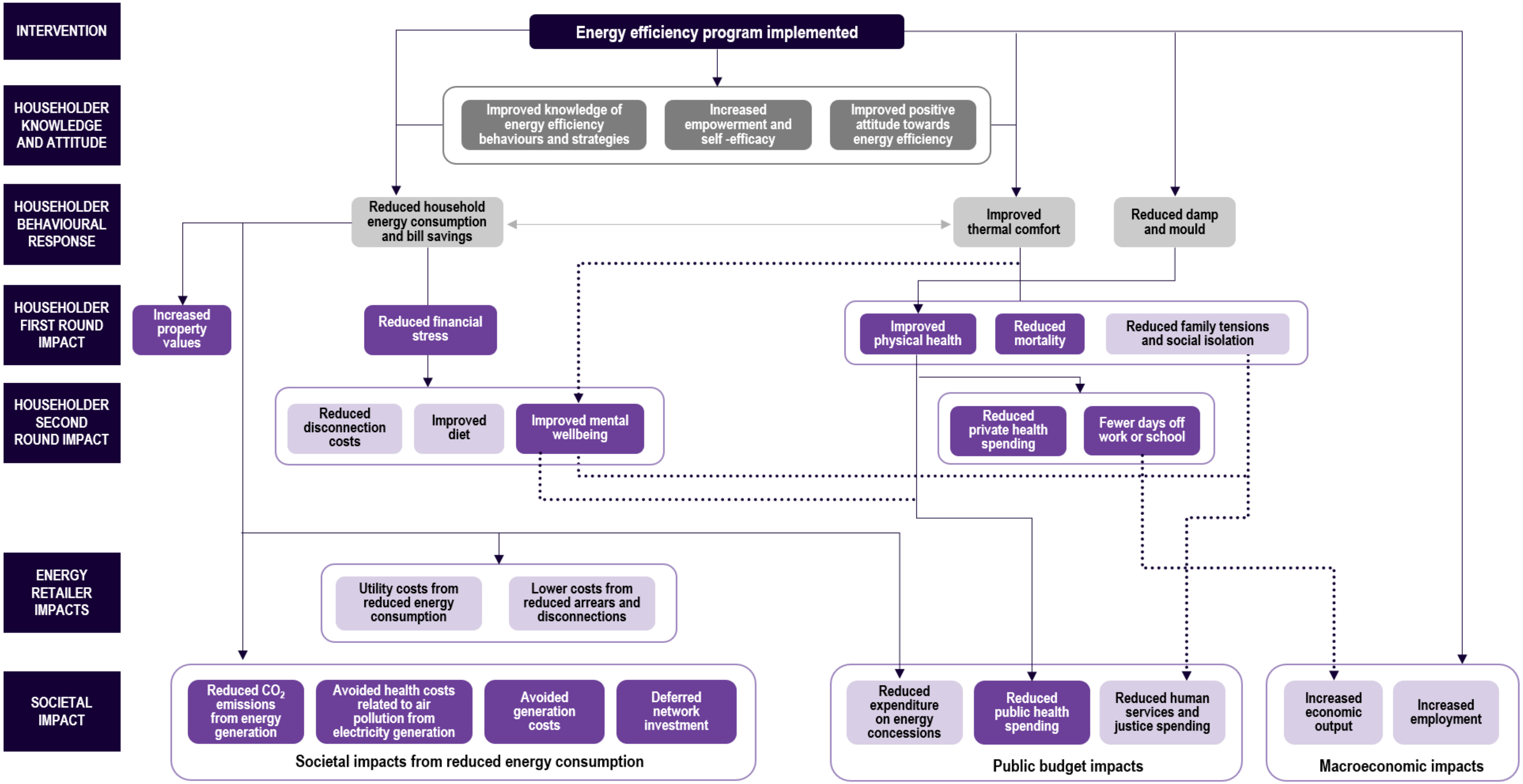
In addition to the impacts quantified in the CBA of the proposed nee BASIX targets, there are a number of other impacts (both costs and benefits) associated with energy efficiency – both private and public that cannot be quantified due to a lack of existing data for the Australian context. These multiple impacts were mapped in our report *Assessment Framework for the Multiple Impacts of Household Energy Efficiency* (2017) (see Figure 4.1) and include the impacts of energy efficiency on:

— health[91] and wellbeing
— the energy system
— the overall economy
— other participant benefits.

These benefits are briefly discussed in the sections below.

[91] As noted in Section 2.4.7, health benefits are partially modelled.

**Figure 4.1** Energy efficiency impacts logic map




Note: impacts presented in a darker shade are, to date, underpinned by a more substantial evidence base than those in a lighter shade.
*Source: ACIL Allen.*

### 4.5.1 Health and wellbeing

Residential energy efficiency actions can result in a number of health-related impacts in addition to the direct observable energy savings. Health and wellbeing impacts can materialise through three main pathways:

1. Improved thermal quality – which reduces mortality from hot and cold extremes, as well as symptoms of a range of diseases such as respiratory and cardiovascular diseases, allergies, arthritis and rheumatism. Alleviation of chronic thermal discomfort can also contribute to improved mental wellbeing. Other indirect impacts (or co-benefits) of thermal quality that have been suggested in the literature, but are not yet well-established[92] include:
   – lessened family tensions if installation of energy efficiency measures allows more areas of the dwelling to be heated, lessening the need for the family to crowd into a single heated room
   – reduced social isolation if energy efficiency measures reduce occupants' embarrassment with their uncomfortable conditions
   – improved social cohesion and sense of community among residents
   – higher rates of school attendance
   – healthier lifestyles
   – improved access to local services.

2. Improved air indoor quality and reduced dampness – which can lead to improved physical health, and reduced mortality and morbidity.

3. Reduced household energy consumption and bill savings – reduced spending on energy as a result of an energy efficiency intervention can lead to reduced financial stress among households experiencing energy bill pressure. This in turn can have other positive indirect effects, including:
   – reduced disconnection costs
   – improved mental wellbeing – energy efficiency may lead to improved mental health and wellbeing outcomes through reducing financial stress related to high energy bills and fear of falling in debt
   – reduced malnutrition and obesity if funds freed up from lower energy bills are used to purchase better quality food.

[92] IEA 2015, *Capturing the Multiple Benefits of Energy Efficiency*, November, https://webstore.iea.org/capturing-the-multiple-benefits-of-energy-efficiency.

The health effects of proposed changes in BASIX through pathways 1) and 2) above are likely to be immaterial as new dwellings built under the BAU (i.e. under the current BASIX targets) already provide a good level of thermal comfort and indoor air quality. For example, a study that examined the possible correlation of building energy ratings with heat-related health hazard during heatwave based on case data from Melbourne's 2009 heatwave conditions found that:[93]

> *[the] mortality rate from a Melbourne 2009 type [event], as well as, future more intense heatwave[s] may reduce by 90% if [the] entire [stock of] existing lower energy star rated houses can be upgraded to minimum 5.4 star energy rating*

This indicates that an increase from a 5.5-6 stars to 7 stars as proposed to align BASIX with the NCC 2022 is unlikely to have a material effect in the mortality related to extreme weather events.

The health and wellbeing benefits associated with residential energy efficiency are more substantial when comparing the proposed BASIX targets with older building stock.

As discussed in Chapter 3, the proposed changes to BASIX would result in net benefits for some households, and net costs for others. Those households experiencing a net reduction in energy bills could experience some of the benefits outlined in pathway 3) above, while those experiencing a net increase in bills could experience the opposite effects.

### 4.5.2 Energy system

As noted in our 2017 report[94], energy efficiency interventions can lead to tangible benefits along the entire energy supply chain, if this consideration is taken into account during the design stage. The benefits for energy providers include[95,96]:

- improved system reliability
- enhanced capacity adequacy
- better ability to manage peak demand
- opportunities to defer generation and network infrastructure investments (these have been quantified in this CBA and outlined in Section 4.1.2)
- reduced price volatility in wholesale markets.

Additional benefits specific to low income or vulnerable households include improved ability to manage energy bills, which in turn can lead to reduced arrears, unpaid debts and collection costs for energy utilities. To the extent to which these costs are borne by the utilities, the savings can (in a competitive market) be assumed to ultimately accrue to non-participants in the form of lower utility

[93] Alam, M, Sanjayan J, Zou P X W, Stewart M and J. Wilson 2016, *Modelling the correlation between building energy ratings and heat-related mortality and morbidity*, Sustainable Cities and Society, 22: 29-39.

[94] AAC 2017, *Multiple Impacts of Household Energy Efficiency: an Assessment Framework*, report to Energy Consumers Australia, October, https://www.acilallen.com.au/projects/energy/multiple-impacts-of-household-energy-efficiency-an-assessment-framework.

[95] Lazar, J., Coburn, K. 2013, *Recognizing the full value of energy efficiency, The Regulatory Assistance Project (RAP)*, https://www.raponline.org/knowledge-center/recognizing-the-full-value-of-energy-efficiency/.

[96] IEA 2015, *Capturing the Multiple Benefits of Energy Efficiency*, November, https://webstore.iea.org/capturing-the-multiple-benefits-of-energy-efficiency.

bills. If hardship or payment assistance programs are funded from general tax revenue, cost savings can be regarded as societal benefits[97].

Energy modelling undertaken for the NCC RIS projects that the wholesale electricity price will be up to 11.0 per cent lower under the proposed changes to the energy efficiency requirements in the NCC 2022. These reductions may flow through to NSW consumers through lower retail electricity prices, although they will be offset by increases in network charges with the fixed network costs recovered over a smaller energy base.

### 4.5.3 Overall economy

There are two potential impacts of energy efficiency interventions on the overall economy:

- Public budget impacts — energy efficiency interventions can reduce public spending through:
  - reduced expenditure on energy concessions (if households receiving energy concessions reduce their energy consumption)
  - reductions in public health spending due to the health impacts discussed above
  - reduced demand on human services and the justice system due to improved mental wellbeing and reduced family tensions.
- Macroeconomic impacts — the macroeconomic impacts of energy efficiency cover effects occurring at national, international and regional levels. Energy efficiency may result in changes in the overall economy through two main sources of impact:
  - investment effects which arise from increased expenditure on energy efficient goods and services, which leads to higher production in these sectors but lower production in other sectors of the economy
  - energy demand reduction effects that operate through reduction (cost savings) in relation to energy-related expenditure leading to increased disposable income and higher business profits.

These two effects combined can lead to changes in macroeconomic variables such as Gross Domestic Product (GDP), employment, energy prices and the trade balance[98].

Furthermore, the reduction in public spending may lead to a reduction in taxation or a redirection of funds to other government policies and programs, which may be used to stimulate the economy. The investment effects may lead to further investment by industry in innovation to support a low carbon economy, although it would be difficult to distinguish the effects from the proposed changes to BASIX from those that are occurring under BAU.

[97] Lazar, J., Coburn, K. 2013, *Recognizing the full value of energy efficiency, The Regulatory Assistance Project (RAP)*, https://www.raponline.org/knowledge-center/recognizing-the-full-value-of-energy-efficiency/.

[98] IEA 2015, *Capturing the Multiple Benefits of Energy Efficiency*, November, https://webstore.iea.org/capturing-the-multiple-benefits-of-energy-efficiency.

### 4.5.4 Other participant benefits

As noted by ACIL Allen[99] a number of other impacts linked to energy efficiency have been hypothesised, but there is insufficient available evidence to accurately quantify. The only impact that may be relevant to the proposed new BASIX targets is the potential creation of additional new business opportunities through demand for additional energy efficiency and renewable energy.[100,101]

[99] AAC 2017, *Multiple Impacts of Household Energy Efficiency: an Assessment Framework*, report to Energy Consumers Australia, October, https://www.acilallen.com.au/projects/energy/multiple-impacts-of-household-energy-efficiency-an-assessment-framework.

[100] Kenington, D., Wood, J., Reid, M., & Klein, L. 2016, *Developing a Non-Energy Benefits Indicator Framework for Residential and Community Energy Efficiency Programs in New South Wales*, Australia, International Energy Policies & Programmes Evaluation Conference. Amsterdam

[101] GEER Australia 2017, *Power Shift Project Two Deliverable 1: Overview of Energy Efficiency Co-Benefit*, Group of Energy Efficiency Researchers Australia.

# Distributional analysis and housing affordability 5

This chapter analyses the impacts of the proposed changes to BASIX stringency from the perspective of the individual households affected by the changes. In particular, it analyses the net impacts of the changes on energy bills and on housing affordability for homebuyers across a number of indicative areas across NSW.

## 5.1 Distributional impacts

As is standard practice, the CBA of the proposed changes to BASIX was undertaken from the perspective of the broader NSW community, with impacts that are transfers between stakeholders (such as between the government and households, and between households that are subject to the proposed changes and those that are not) netted out. Nevertheless, it is important to consider the implications of some of these transfers on stakeholders, particularly the implications of energy bill reductions on households.

Table 5.1 shows the changes in energy consumption by households residing in the dwellings that are modelled to have implemented the proposed BASIX changes in 2022 and the overall dollar impact of these changes for the first year of the scheme (2022)[102]. Table 5.2 shows these energy bill savings compared to the total costs of the upgrades/changes over the life of the dwellings (2022-2061) in present value terms. The effect on these households is measured using retail energy costs, rather than wholesale energy costs, which leave them better off, over and above the reduced resource cost. The difference is, in reality, transferred to others in the community.

[102] The amount of energy saved and its value change year on year based on changes to fuel prices and over the medium to long term, based on when the measures installed under the BAU and to comply with the new BASIX targets reach their end of life.

As shown in Table 5.1, some NSW households experience some fuel switching after the BASIX changes are implemented. Overall, most households would experience an overall reduction in energy bills in 2022. However, as shown in some cases in Table 5.2, a reduction in energy bills in the first year of the new BASIX targets would not always translate in overall reductions in energy bills in present value terms over the life of the dwelling. This is due to the complex interactions of:

- the magnitude of the change brought about by the changes (relative to the baseline)
- the life of the measures installed both under the BAU and policy options (sometimes, as some measures reach their end of life energy savings increase or decrease)
- fuel switching between the BAU and the policy options
- the price of fuels (gas and electricity) and their relative and absolute differences over time
- the timing of the changes (decreases in energy in the short term are more 'valuable' than the same decreases in the longer term).

For instance, dwelling DH8 is estimated to have negative dollar savings (costs) in the 2022 under Option 2, but overall positive dollar savings in present value terms over the period of analysis (2022-2061, see Table 5.2). DH8 has negative dollar savings (costs) in the short-term primarily due to the removal of the 1kW solar panels under the overcompliance BAU case (which represents around 40 per cent of dwellings of this type in the baseline). In the short term, the reduction in energy consumption due to other changes made to the dwelling to comply with Option 2 are not enough to offset the increase in energy from the removal of solar PVs. However, as the heating/cooling equipment reach end-of-useful life (in year 12) and the energy savings associated with the thermal shell kick in the dwelling experiences net energy savings. These net savings increase over the longer-term as the solar PV in the BAU reach their end of life.

In contrast, households living in LR dwellings would experience a small decrease in annual energy bills under Options A and B in 2022 but they are projected to experience overall negative dollar savings (costs) over the life of the dwellings (2022-2061, see Table 5.2). Both in 2022 and over this dwelling experiences negative electricity savings (costs) and positive gas savings. However, the magnitude of these relative savings changes over time. In 2022 the savings from gas are enough to offset the increased costs of electricity under both options, but over the longer-term, the costs associated with electricity usage (particularly the increases in energy consumption from changes to the thermal shell) exceed the gas savings, resulting in a negative present value over the period of analysis.

No heating and cooling systems are specified in the LR dwellings under the minimum compliance scenario of the base case (more details about this are provided in Appendix A). The proposed BASIX changes under Options A and B will require air conditioners to be installed in the dwellings, resulting in more electricity consumption and higher bills for heating and cooling.

The overall impacts over the life of the dwellings outlined in Table 5.2 show a more positive result for households than those results in Table 3.4 (which show the impacts on individual dwellings from a societal perspective — i.e. measured using wholesale energy prices). In particular:

— Under Option A, the proposed changes would result in net benefits for most households. That is, the benefits received by households from the additional energy efficiency measures installed are more than enough to cover the additional costs incurred to implement these measures. The exceptions are households in DH9 and LR, who are estimated to experience net costs from the proposed changes (in fact, LR does not experience any benefits, only costs).
— Under Option B, the proposed changes would result in net benefits for half the households (DH2, DH3, DH6, DH7, DH8, HR1 and HR2) and in net costs for the other half. The households that would experience net costs from the proposed changes under this option are those in DH1, DH4, DH5, DH9, AH, LR and HR3.

Notably, the results in Table 5.2 show that there are savings of upfront costs and increase in energy bills (negative savings) for DH6 under Option B. These cost savings and increased energy bills are largely due to the removal of 3.7kW of solar panels that this house had installed in the overcompliance scenario under the BAU (Option 2 has no solar panels specified). This example shows that under Option 2 these households will be worse off in the long term as the initial capital costs savings are not enough to offset the higher energy bills throughout the useful life of the dwelling in present value terms.

DH9 under Option B and LR under both policy options are projected to experience only costs and no benefits, as the measures installed as a result of the proposed BASIX changes result in net increases in energy bills in present value terms (as explained in more detail above).

**Table 5.1** Annual energy savings per household based on retail energy prices

| Dwelling ID | Location | NCC climate zone | Dwelling type | Option A | | | | | Option B | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Energy savings | | Dollar savings in 2022 ($) | | | Energy savings | | Dollar savings in 2022 ($) | | |
| | | | | Electricity (kWh/yr) | Gas (MJ/yr) | Electricity | Gas | Total [a] | Electricity (kWh/yr) | Gas (MJ/yr) | Electricity | Gas | Total [a] |
| **HOUSES** | | | | | | | | | | | | | |
| DH1 | Blacktown | 5 | Average | 2,705 | 850 | 808 | 29 | 837 | 1,090 | 0 | 96 | 0 | 96 |
| DH2 | Blacktown | 5 | Affordable | 2,805 | 1,805 | 787 | 62 | 849 | 1,291 | 955 | 109 | 33 | 142 |
| DH3 | Baulkham Hills | 5 | Large | 2,484 | 2,065 | 294 | 71 | 365 | 2,910 | 1,101 | 439 | 38 | 476 |
| DH4 | Cessnock | 6 | Average | 2,289 | 2,297 | 695 | 78 | 774 | 787 | 597 | 36 | 20 | 56 |
| DH5 | Dubbo | 4 | Average | 3,794 | -1,137 | 965 | 16 | 981 | 342 | 3,804 | 55 | 22 | 77 |
| DH6 | Wagga | 4 | Average | 535 | 11,441 | 191 | 199 | 390 | -4,837 | 32,586 | -731 | 534 | -197 |
| DH7 | Moss Vale | 6 | Average | 3,885 | 1,309 | 736 | 45 | 781 | 2,648 | 0 | 163 | 0 | 163 |
| DH8 | Moss Vale | 6 | Large | 4,157 | 1,472 | 603 | 50 | 654 | 2,801 | 0 | -35 | 0 | -35 |
| DH9 | Ballina | 2 | Average | 626 | 4,824 | 150 | 156 | 306 | -411 | 1,319 | -257 | 19 | -238 |
| | | *Composite NSW house* | | *2,833* | *1,774* | *696* | *60* | *756* | *1,352* | *759* | *69* | *16* | *84* |
| **TOWNHOUSES** | | | | | | | | | | | | | |
| AH | Albion Park | 6 | Average | 2,187 | 1,813 | 798 | 17 | 815 | 964 | 4,957 | 645 | 30 | 675 |
| **UNITS** | | | | | | | | | | | | | |
| LR | Shellharbour | 6 | Low rise | -740 | 5,880 | -38 | 49 | 11 | -591 | 5,704 | -7 | 43 | 36 |
| HR1 | Macquarie Park | 5 | High rise - 28 storeys | 503 | 640 | 69 | 22 | 91 | 521 | 0 | 70 | 0 | 70 |
| HR2 | Eastwood | 5 | High rise - 11-13 storeys | 739 | -746 | 222 | -25 | 196 | 569 | -1,441 | 139 | -49 | 90 |

| Dwelling ID | Location | NCC climate zone | Dwelling type | Option A Energy savings Electricity (kWh/yr) | Option A Energy savings Gas (MJ/yr) | Option A Dollar savings in 2022 ($) Electricity | Option A Dollar savings in 2022 ($) Gas | Option A Dollar savings in 2022 ($) Total [a] | Option B Energy savings Electricity (kWh/yr) | Option B Energy savings Gas (MJ/yr) | Option B Dollar savings in 2022 ($) Electricity | Option B Dollar savings in 2022 ($) Gas | Option B Dollar savings in 2022 ($) Total [a] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HR3 | Liverpool | 5 | High rise - 6 storeys | 665 | 1,755 | 134 | 27 | 161 | 274 | 1,576 | 110 | 21 | 131 |
| | | | *Composite NSW apartment* | *329* | *2,421* | *101* | *26* | *126* | *108* | *2,166* | *84* | *17* | *101* |

[a] A negative value represents an increase in energy bills.
*Source: ACIL Allen.*

**Table 5.2** Distributional impacts by household, $ per household based on retail energy prices (present value, 2021 prices)

| Dwelling ID | Location | NCC climate zone | Dwelling type | Option A Capital costs | Option A Energy bill savings (2022-2061) | Option A Net bill savings (household NPV) | Option A Household BCR | Option B Capital costs | Option B Energy bill savings (2022-2061) | Option B Net bill savings (household NPV) | Option B Household BCR |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **HOUSES** | | | | | | | | | | | |
| DH1 | Blacktown | 5 | Average | 7,152 | 12,321 | 5,169 | 1.7 | 3,530 | 2,868 | -662 | 0.8 |
| DH2 | Blacktown | 5 | Affordable | 6,126 | 12,820 | 6,694 | 2.1 | 3,224 | 3,679 | 455 | 1.1 |
| DH3 | Baulkham Hills | 5 | Large | 5,621 | 8,441 | 2,819 | 1.5 | 9,360 | 9,461 | 101 | 1.0 |
| DH4 | Cessnock | 6 | Average | 6,397 | 11,182 | 4,785 | 1.7 | 3,383 | 1,815 | -1,569 | 0.5 |
| DH5 | Dubbo | 4 | Average | 5,793 | 15,404 | 9,612 | 2.7 | 3,927 | 1,807 | -2,120 | 0.5 |
| DH6 | Wagga | 4 | Average | 4,037 | 5,678 | 1,641 | 1.4 | -964 | -7,922 | -6,959 | -[a] |
| DH7 | Moss Vale | 6 | Average | 6,093 | 14,931 | 8,838 | 2.5 | 5,187 | 6,777 | 1,591 | 1.3 |
| DH8 | Moss Vale | 6 | Large | 8,049 | 14,864 | 6,815 | 1.8 | 5,240 | 5,652 [b] | 412 | 1.1 |
| DH9 | Ballina | 2 | Average | 5,634 | 4,334 | -1,300 | 0.8 | 7,124 | -2,545 [c] | -9,669 | -[d] |
| | | | *Composite NSW house* | 6,418 | 12,257 | 5,839 | 1.9 | 4,287 | 3,416 | -872 | 0.8 |
| **TOWNHOUSES** | | | | | | | | | | | |
| AH | Albion Park | 6 | Average | 6,403 | 11,400 | 4,996 | 1.8 | 11,753 | 8,826 | -2,927 | 0.8 |

| Dwelling ID | Location | NCC climate zone | Dwelling type | Option A: Capital costs | Option A: Energy bill savings (2022-2061) | Option A: Net bill savings (household NPV) | Option A: Household BCR | Option B: Capital costs | Option B: Energy bill savings (2022-2061) | Option B: Net bill savings (household NPV) | Option B: Household BCR |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **UNITS** | | | | | | | | | | | |
| LR | Shellharbour | 6 | Low rise | 5,427 | -381 [c, d] | -5,808 | -[e] | 5,802 | -148 [c, d] | -5,951 | -[e] |
| HR1 | Macquarie Park | 5 | High rise - 28 storeys | 860 | 1,748 | 888 | 2.0 | 860 | 1,465 | 605 | 1.7 |
| HR2 | Eastwood | 5 | High rise - 11-13 storeys | 831 | 3,051 | 2,220 | 3.7 | 605 | 1,668 | 1,063 | 2.8 |
| HR3 | Liverpool | 5 | High rise - 6 storeys | 953 | 2,977 | 2,024 | 3.1 | 3,940 | 1,859 | -2,081 | 0.5 |
| | | | *Composite NSW apartment* | 2,018 | 2,132 | 114 | 1.1 | 3,894 | 1,338 | -2,556 | 0.3 |

[a] A BCR for this dwelling cannot be interpreted the same as for other dwellings as the dwelling does not experience any costs (there are cost savings of $964) or benefits (there is an increase in energy costs of $7,922 over the life of the dwelling).

[b] Dwelling DH8 is estimated to have negative dollar savings (costs) in the year 2022 under Option 2 (see Table 5.1), but overall positive dollar savings in present value terms over the period of analysis (2022-2061). DH8 has negative dollar savings (costs) in the short-term primarily due to the removal of the 1kW solar panels under the overcompliance BAU case (which represents around 40 per cent of dwellings of this type in the baseline). In the short term, the reduction in energy consumption due to other changes made to the dwelling to comply with Option 2 are not enough to offset the increase in energy from the removal of solar PVs. However, as the heating/cooling equipment reach end-of-useful life (in year 12) and the energy savings associated with the thermal shell kick in the dwelling experiences net energy savings. These net savings increase over the longer-term as the solar PV in the BAU reach their end of life.

[c] Dwelling DH9 is estimated to have small positive benefits in present value terms under Option B ($29) at wholesale level (see Table 3.4) and LR is estimated to have positive benefits in present value terms under Option A ($164) and Option B ($64), however both dwellings are estimated to experience negative benefits at retail level (in present value). Under Option B at wholesale and retail prices DH9 is estimated to experience negative electricity savings (i.e. costs) and positive gas savings and LR is estimated to experience negative electricity savings (i.e. costs) and positive gas savings both at wholesale and retail prices under Option A and Option B. Under wholesale prices, the benefits of gas offset the costs of electricity, resulting in a net decrease in energy bills. This does not occur under retail prices. The relative prices between electricity and gas (i.e. the difference in prices between electricity and gas) are different within the wholesale and within the retail market. In the wholesale market, this relative difference between the electricity and gas prices is smaller which means there is less electricity cost to offset (in percentage terms), but under retail prices, the impact of electricity prices is relatively larger and the value of gas at retail prices is not high enough to offset the additional electricity costs.

[d] Dwelling LR is estimated to have positive energy savings at retail prices in the year 2022 under both policy options (see Table 5.1), but overall negative dollar savings (costs) in present value terms at retail prices over the period of analysis (2022-2061). Both in 2022 and over this dwelling experiences negative electricity savings (costs) and positive gas savings. However, the magnitude of these relative savings changes over time. In 2022 the savings from gas are enough to offset the increased costs of electricity under both options, but over the longer-term, the costs associated with electricity usage (particularly the increases in energy consumption from changes to the thermal shell) exceed the gas savings, resulting in a negative present value over the period of analysis.

[e] A BCR cannot be calculated for this dwelling as the dwelling does not experience any benefits, only costs.

Note: these estimates use retail energy prices. Present values calculated using a 7 per cent discount rate.

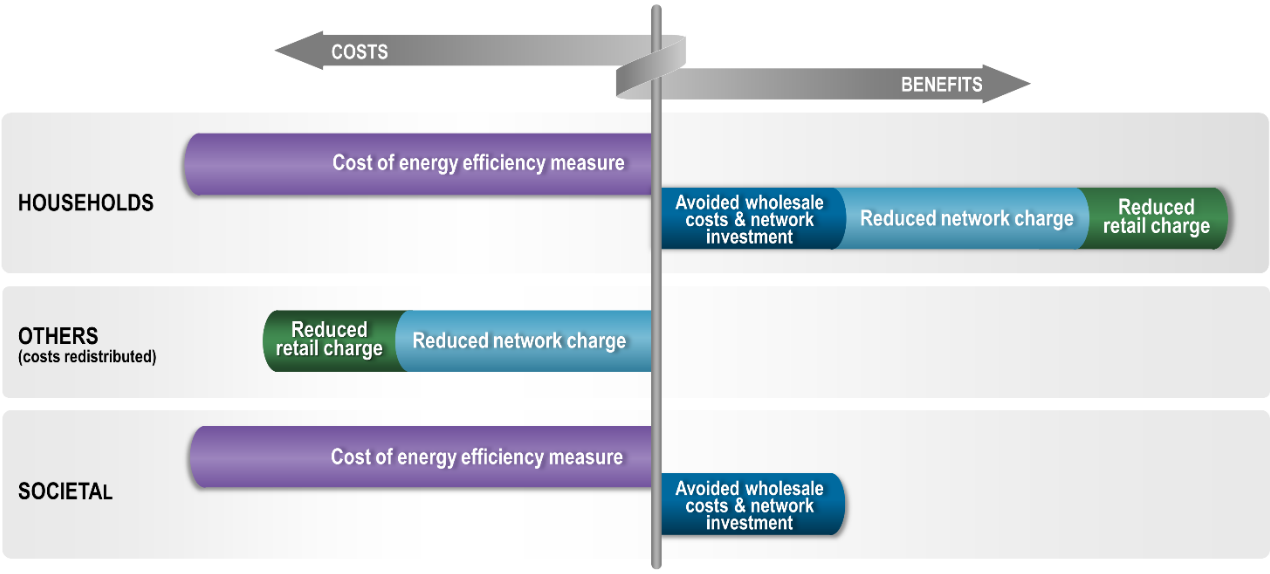
*Source: ACIL Allen.*

### 5.1.1 Understanding distributional impacts

It may appear odd that the impacts of the proposed changes to BASIX are more favourable at a household level than at the societal level.

This is because the value of energy savings for households is greater than the resource savings to society overall. Fixed network costs and energy retail costs still need to be recovered by energy retailers. Thereby, a large part of the household's benefit is a result of a transfer between individuals — from society as a whole to other energy users. This is illustrated in Figure 5.1.

**Figure 5.1** Redistribution of costs and benefits




Note: The scale of impacts are illustrative only.
*Source: ACIL Allen.*

The energy charges that are reduced for households, but which do not result in costs being avoided, are transferred to other energy users — even those who have nothing to do with the proposed changes to BASIX — through higher energy prices. The benefit to households that are subject to the proposed changes to BASIX is exactly offset by increased costs elsewhere. This type of transfer is called a pecuniary externality. In modelling the net impacts, this transfer at an economy-wide level is accounted for by using wholesale energy prices and avoided network investment (as a proxy for avoided resource costs), which is why it is used in this CBA.

While it is true that households can be made better off, this is because a large part of this benefit is transferred to the rest of society. Because the impact analysis has to consider all net impacts, including these transfers, at the society level, a large part of the benefit to households must be offset in headline net present value results when assessing the policy overall.

## 5.2 Housing affordability

As illustrated in Figure 5.2, housing affordability is determined by a range of factors influencing demand and supply. Housing supply is driven by factors such as land availability, construction costs, profitability for developers and infrastructure costs such as water, power, sewerage and public transport. Housing demand is driven by factors such as the number and type of households looking for housing, household income and preferences (such as size, location and tenure type), investor demand and interest rates.

In the context of this report, housing affordability is likely to be affected by the proposed BASIX changes in two main ways:

— it may change households' disposable income through the reduction of household costs due to improvements in energy efficiency, which reduces energy bills (and the economic resources required to produce these services)

— sellers of houses who make additional investments in energy efficiency measures to comply with the proposed BASIX changes may seek to raise their price to compensate for the cost of that investment.

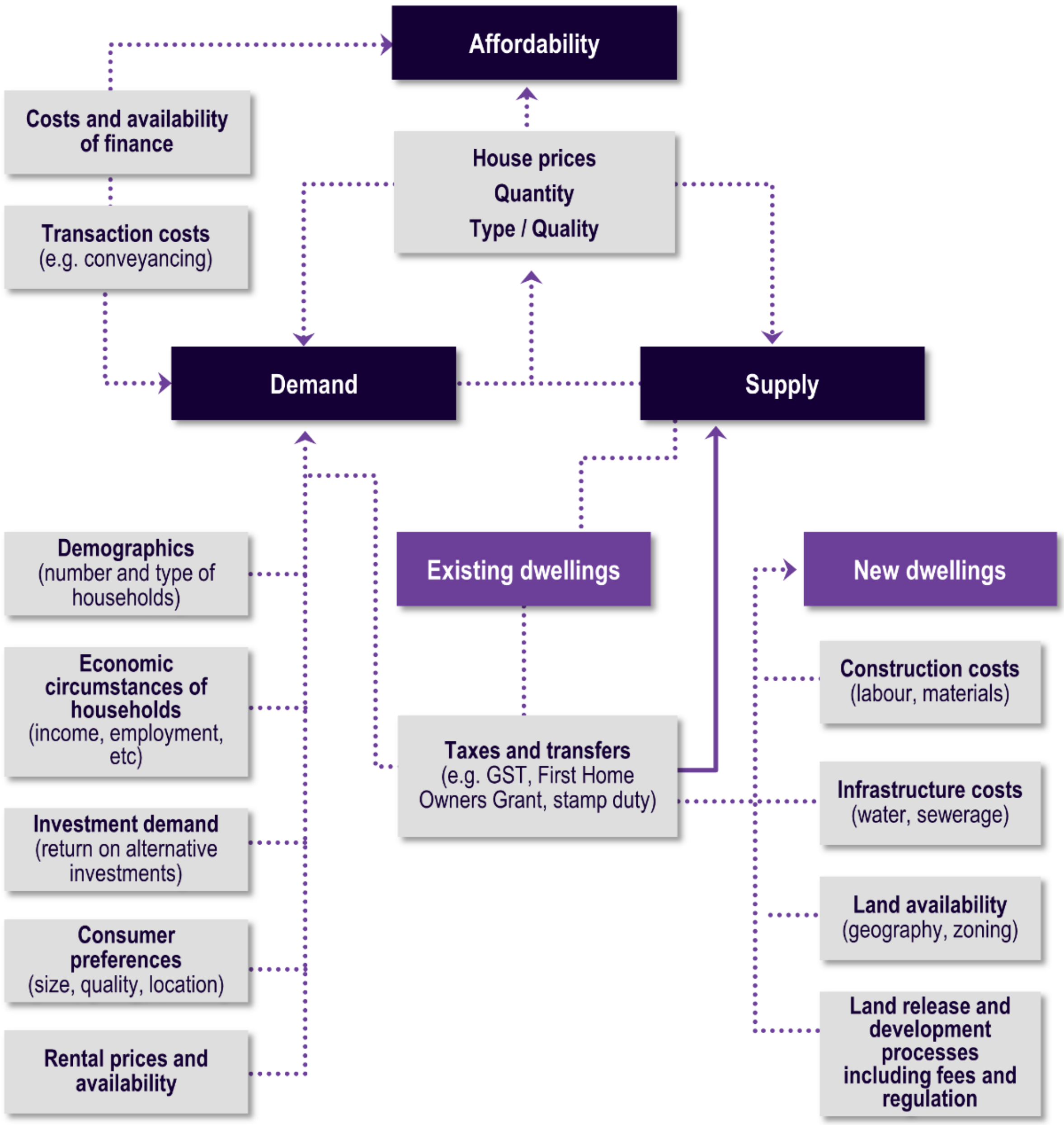
When you look at these factors, some house prices may go up, and some may go down. The outcome for every dwelling is not clear, but the average outcome is likely to reflect overall changes in real resource use (which relates to the cost of complying with the new requirements and the benefits of avoided energy use).

There are many parties in the property market that would be affected by the proposed changes to BASIX. Sometimes the seller would be the one paying the costs, and sometimes it is the buyer of the property that would enjoy the benefits of the investment, so there is a question about which party bears the costs or enjoys the benefits.

This situation is similar to analysis of the incidence of taxes and charges. Sometimes the legal incidence of the tax is on the supplier and sometimes it is found that, through market mechanisms, the cost of this tax is passed forward to consumers. So, the legal incidence of a tax can be different to the economic incidence. This often depends on the nature of competition in the market, with more competitive markets resulting in greater pass through.

The property market is already a very competitive market with tight margins. As such, it is likely that the costs and benefits of the new BASIX stringency settings would be passed forward to the final buyer of a property (i.e. to households). This provides a conservative basis for estimating the effect on housing affordability. It is possible that some buyers would do better, and it is also possible that some sellers would do better. This section of the report analyses the average effect for the community at large.

**Figure 5.2** Factors affecting housing affordability




*Source: Adapted from National Housing Supply Council (NHSC) 2010, 2nd State of Supply Report, Canberra, April 2010.*

## 5.2.1 Impacts on typical households

While housing affordability is examined in the next section using a selection of widely accepted indicators to measure housing affordability, it is useful to have a discussion about what the proposed BASIX changes could mean from the perspective of typical households.

The proposed changes to BASIX would require an up-front investment, while the benefits of lower energy use would accrue over time. As mentioned above, the costs of complying with BASIX are likely to be passed forward to property buyers in the form of slightly higher house prices.

Table 5.3 shows the effects that costs of complying with the new BASIX target would have on median house prices in different NSW regions. As shown in this table, overall, the proposed changes would result in small increases in prices for most houses and units across NSW under both policy options.[103] On average[104], the price of dwellings across the locations analysed in NSW would increase by around 0.8 per cent under Option A and around 0.7 per cent under Option B.

**Table 5.3** Impact of the proposed BASIX requirements on median house prices across selected locations in NSW

| Local Government Area (LGA) | Option A | | | Option B | | |
|---|---|---|---|---|---|---|
| | Current house price | House price under new BASIX | % Change | Current house price | House price under new BASIX | % Change |
| **HOUSES** | | | | | | |
| Ballina | $850,000 | $855,634 | 0.7% | $850,000 | $857,124 | 0.8% |
| Wagga | $399,000 | $403,037 | 1.0% | $399,000 | $398,036 | -0.2% |
| Dubbo [a] | $360,000 | $365,793 | 1.6% | $360,000 | $363,927 | 1.1% |
| Blacktown | $795,000 | $801,882 | 0.9% | $795,000 | $798,449 | 0.4% |
| Baulkham Hills [b] | $1,326,000 | $1,331,621 | 0.4% | $1,326,000 | $1,335,360 | 0.7% |
| Moss Vale [c] | $920,000 | $926,288 | 0.7% | $920,000 | $925,192 | 0.6% |
| Cessnock | $420,000 | $426,397 | 1.5% | $420,000 | $423,383 | 0.8% |
| **TOWNHOUSES** | | | | | | |
| Albion Park | $540,000 | $546,403 | 1.2% | $540,000 | $551,753 | 2.2% |
| **UNITS** | | | | | | |
| Shellharbour | $540,000 | $545,427 | 1.0% | $540,000 | $545,802 | 1.1% |
| Liverpool | $500,000 | $500,953 | 0.2% | $500,000 | $503,940 | 0.8% |
| Eastwood [d] | $760,000 | $760,831 | 0.1% | $760,000 | $760,605 | 0.1% |
| Macquarie Park [d] | $760,000 | $760,860 | 0.1% | $760,000 | $760,860 | 0.1% |

[a] Price is for Western Plains Regional LGA.
[b] Price is for the Hills Shire LGA.
[c] Price is for Wingecarribee Shire Council LGA.
[d] Price is for Ryde LGA.
Note: Median house prices as at December quarter 2020 sourced from NSW Department of Communities and Justice Rent and Sales Report No. 135, April 2021.
*Source: ACIL Allen based on NSW Department of Communities and Justice.*

There are many ways to put these impacts into context. One way of putting these house price increases into context is to compare them to increases in the cost of building a house from one year to another. For instance, the cost of building a house in NSW went up by 2.1 per cent from December 2019 to December 2020. This is almost on par with the highest expected increase in house prices due to compliance with the proposed BASIX requirements (in townhouses in Albion Park under Option B).

[103] The exception is dwellings in Wagga which, as shown in Table 3.3 are estimated to experience a small decrease in costs under Option B.

[104] This refers to an unweighted average across all the dwellings and locations outlined in Table 5.3.

Another way to put these increases into context is to consider how much extra a household would have to pay in mortgage repayments because of these price increases. Table 5.4 presents these impacts. Notably, as the cost of complying with the new BASIX requirements would be included in the house price, homebuyers would not have to pay it upfront, rather, this extra cost would become part of their annual mortgage payments. As indicated in Table 5.4, the increases in repayments range:

— from $37 per annum (or around 70 cents per week) for a unit in Eastwood, to $306 per annum (or around $6 per week) for a house in Blacktown under Option A
— from $27 per annum (or around 52 cents per week) for a unit in Eastwood, to $522 per annum (or around $10 per week) for a townhouse in Albion Park under Option B. Notably, under this option, a household buying a house in Wagga would experience a decrease in repayments of $43 per annum.

However, repayment increases would be offset by lower energy bills as a result of the energy efficiency improvements in the house. These lower bills would have the effect of increasing household disposable income as lower bills imply the availability of extra funds for spending on other items such as mortgage repayments. These savings for the first year of the scheme are also presented in Table 5.4. As shown in this table:

— all but one household under Option A would experience a net benefit in the first year of the new scheme as the savings arising from lower energy bills are more than enough to offset the increase in annual mortgage repayments. The exception are households in units in Shellharbour who would experience net costs. On average[105], under Option A homeowners across the locations analysed in NSW would experience net benefits in the first year of around $271. Over time, as utility prices changes, these impacts would change.[106]
— most households under Option B would experience a net cost in the first year of the new scheme as the savings arising from lower energy bills are not enough to offset the increase in annual mortgage repayments. However, some households would experience net benefits (houses in Baulkham Hills, townhouses in Albion Park and units in Eastwood and Macquarie Park). On average[107], under Option B homeowners across the locations analysed in NSW would experience costs in the first year of around $83.

[105] This refers to an unweighted average across all the dwellings and locations outlined in Table 5.4.

[106] The best way to measure the effects that these expected benefits would have over time on homeowners is to look at the percentage of income that they would have to dedicate to mortgage repayments over the life of their house. This information is presented in Table 5.7.

[107] This refers to an unweighted average across all the dwellings and locations outlined in Table 5.4.

**Table 5.4** Impact of capital outlays to comply with proposed BASIX requirements on mortgage repayments

| Local Government Area (LGA) | Option A | | | | | Option B | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Annual mortgage payments | | | Offset (savings) from lower utility bills in 2022 ($) | Net impact ($)[b] | Annual mortgage payments | | | Offset (savings) from lower utility bills in 2022 ($) | Net impact ($)[b] |
| | Currently ($) | Under BASIX ($) | Change ($)[a] | | | Currently ($) | Under BASIX ($) | Change ($)[a] | | |
| **HOUSES** | | | | | | | | | | |
| Ballina | $37,768 | $38,019 | $250 | $306 | $56 | $37,768 | $38,085 | $317 | -$238 | -$555 |
| Wagga | $17,729 | $17,908 | $179 | $390 | $211 | $17,729 | $17,686 | -$43 | -$197 | -$154 |
| Dubbo | $15,996 | $16,253 | $257 | $981 | $724 | $15,996 | $16,171 | $174 | $77 | -$98 |
| Blacktown | $35,325 | $35,630 | $306 | $840 | $534 | $35,325 | $35,478 | $153 | $108 | -$45 |
| Baulkham Hills | $58,919 | $59,168 | $250 | $365 | $115 | $58,919 | $59,335 | $416 | $476 | $60 |
| Moss Vale | $40,879 | $41,158 | $279 | $768 | $489 | $40,879 | $41,109 | $231 | $144 | -$87 |
| Cessnock | $18,662 | $18,946 | $284 | $774 | $489 | $18,662 | $18,812 | $150 | $56 | -$94 |
| **TOWNHOUSES** | | | | | | | | | | |
| Albion Park | $23,994 | $24,279 | $285 | $815 | $530 | $23,994 | $24,516 | $522 | $675 | $153 |
| **UNITS** | | | | | | | | | | |
| Shellharbour | $23,994 | $24,235 | $241 | $11 | -$230 | $23,994 | $24,252 | $258 | $36 | -$222 |
| Liverpool | $22,217 | $22,259 | $42 | $161 | $119 | $22,217 | $22,392 | $175 | $131 | -$44 |
| Eastwood | $33,769 | $33,806 | $37 | $196 | $159 | $33,769 | $33,796 | $27 | $90 | $63 |
| Macquarie Park | $33,769 | $33,808 | $38 | $91 | $53 | $33,769 | $33,808 | $38 | $70 | $32 |

[a] Negative changes denote a decrease in mortgage repayments.

[b] Impacts are for the first year of the proposed BASIX targets. Negative net impacts represent an overall cost to households (i.e. a situation where the increase in mortgage repayments is higher than the increase in the household's annual disposable income).

Note: Based on median house price data from the December Quarter 2020 sourced from NSW Department of Communities and Justice Rent and Sales Report No. 135 and the following mortgage assumptions: prime borrower, standard loan, 20 per cent deposit (i.e. Loan to Value ratio (LVR)=80 per cent), standard variable lending rate of all institutions for new loans to owner occupiers of 2.78 per cent p.a. (as at 31 March 2021, sourced from the Reserve Bank of Australia (RBA)) and a 25 year repayment period. Includes the impacts on house prices outlined in Table 5.3.

*Source: ACIL Allen.*

### 5.2.2 Housing affordability indicators

This section details the impacts of the proposed changes to BASIX on a number of housing affordability indicators.

#### Measurement basis

There are a range of approaches that can be used to measure and assess housing affordability. We have used two widely known affordability indicators to evaluate the potential impacts of the proposed changes to BASIX on housing affordability. These are outlined below.[108]

— *The ratio of mortgage repayment to household income* — this measure indicates the proportion of gross income used for mortgage repayments. Financial institutions have traditionally applied a rule of thumb of not allowing households to take out home loans requiring more than 30 per cent of gross income to service. An increase in this measure represents decreased housing affordability.

— *The median multiple* — the median multiple (or house price to income ratio) reflects the 'years of gross income' required to purchase a house within individual housing markets. A generally accepted definition of affordability is that house prices should not cost more than three times the median household gross income to be affordable. An increase in this measure represents decreased housing affordability.

#### Methodology used in affordability analysis

In broad terms, the analysis of the affordability indicators presented in this section was undertaken as follows.

1. First, we estimated the impact of the proposed BASIX requirements on house prices using the estimated costs of complying with the new requirements. These impacts are outlined in Table 5.3.
2. Second, we estimated the impact of the proposed BASIX requirements on household disposable income. These impacts are outlined in Table 5.5. In reality, overall household incomes are not expected to change with the new BASIX requirements. However, future occupants of properties that have had an energy efficiency improvement as a result of the new requirements would experience relatively lower utility bills. This would have the effect of increasing household disposable income as lower bills imply the availability of extra funds for spending on other items such as mortgage repayments. Therefore, for the purposes of this analysis, such increases in disposable income are reflected as increases in gross median household income so that the benefits of the new BASIX requirements can be reflected in the housing affordability indicators.

   Table 5.5 include estimates of changes in disposable income using two approaches:

   – One where current income is adjusted by including the present value of the lifetime benefits of the proposed BASIX changes in the calculation. While this approach accounts in full for variations in future energy prices, it assumes that all future benefits are received today, which means that income for subsequent years would be the same as in the BAU. The results under this approach are shown in the 4th and 9th columns in the table. While

[108] These are the same indicators used in the NCC 2022 RIS.

informative, this approach is unrealistic as households would only receive the benefits from the implemented changes on a year on year basis.

– A second approach where current disposable income is adjusted by including in the calculation only the value of the benefits of the proposed BASIX changes in the first year of the scheme (2022). The results of this approach are shown in the 6th and 11th columns in the table. While this approach is more realistic, it does not account for changes in the value of benefits on a year on year basis as energy prices change.

Focusing on the second approach described above, Table 5.5 shows that the new BASIX target would result in negligible increases in gross median household income (or, in reality, disposable income) for most of the analysed households under both options (the exception is households in townhouses in Albion Park under Option B[109]).

3. Third, we calculated two sets of affordability indicators:
   – a set of affordability indicators for the representative LGAs in NSW being analysed based on current median house prices and disposable income
   – a set of affordability indicators for the same representative locations based on the median house prices and disposable income under the proposed changes to BASIX requirements. These indicators are estimated on the assumption that the costs and benefits associated with the proposed changes are fully passed through to property buyers with the costs of the proposed change reflected as increased house prices and the benefits reflected as increased disposable incomes.

[109] This is a result of increases in energy bills experienced by these households from the proposed changes (see Table 5.2**).**

**Table 5.5** Impacts of proposed BASIX changes on gross median household disposable income

| Local Government Area (LGA) | Option A: Current BASIX [a] | Option A: Under new BASIX (lifetime benefits) [b] | Option A: % Change | Option A: Under new BASIX (1st year benefits) [c] | Option A: % Change | Option B: Current BASIX [a] | Option B: Under new BASIX (lifetime benefits) [b] | Option B: % Change | Option B: Under new BASIX (1st year benefits) [c] | Option B: % Change |
|---|---|---|---|---|---|---|---|---|---|---|
| **HOUSES** | | | | | | | | | | |
| Ballina | $55,350 | $59,684 | 7.8% | $55,655 | 0.6% | $55,350 | $52,805 | -4.6% | $55,111 | -0.4% |
| Wagga | $77,581 | $83,259 | 7.3% | $77,971 | 0.5% | $77,581 | $69,659 | -10.2% | $77,384 | -0.3% |
| Dubbo | $72,883 | $88,287 | 21.1% | $73,864 | 1.3% | $72,883 | $74,690 | 2.5% | $72,959 | 0.1% |
| Blacktown | $98,036 | $110,488 | 12.7% | $98,876 | 0.9% | $98,036 | $101,118 | 3.1% | $98,144 | 0.1% |
| Baulkham Hills | $135,394 | $143,835 | 6.2% | $135,759 | 0.3% | $135,394 | $144,855 | 7.0% | $135,871 | 0.4% |
| Moss Vale | $76,492 | $91,417 | 19.5% | $77,261 | 1.0% | $76,492 | $83,157 | 8.7% | $76,636 | 0.2% |
| Cessnock | $67,439 | $78,621 | 16.6% | $68,213 | 1.1% | $67,439 | $69,254 | 2.7% | $67,496 | 0.1% |
| **TOWNHOUSES** | | | | | | | | | | |
| Albion Park | $76,951 | $88,350 | 14.8% | $77,766 | 1.1% | $76,951 | $85,777 | 11.5% | $77,626 | 0.9% |
| **UNITS** | | | | | | | | | | |
| Shellharbour | $76,951 | $76,570 | -0.5% | $76,962 | 0.0% | $76,951 | $76,803 | -0.2% | $76,987 | 0.0% |
| Liverpool | $88,811 | $91,789 | 3.4% | $88,972 | 0.2% | $88,811 | $90,670 | 2.1% | $88,942 | 0.1% |
| Eastwood | $102,334 | $105,384 | 3.0% | $102,530 | 0.2% | $102,334 | $104,001 | 1.6% | $102,423 | 0.1% |
| Macquarie Park | $102,334 | $104,082 | 1.7% | $102,425 | 0.1% | $102,334 | $103,799 | 1.4% | $102,403 | 0.1% |

[a] Median household income (that is, the midpoint when all people are ranked in ascending order of income) for each analysed LGA in 2020 calculated using ABS data.
[b] Disposable income includes the present value of the lifetime benefits of the changes, calculated using a 7 per cent discount rate.
[c] Disposable income includes only the value of the benefits in the first year of the scheme (2022). These benefits vary on a year on year basis as energy prices change.
*Source: ACIL Allen.*

### Affordability impacts

Table 5.6 summarises the impact of the proposed changes to BASIX on an average house in different NSW regions. As mentioned earlier in the report, while the new requirements would result in investments in some measures that require up-front capital, the benefits of lower energy use would accrue over time. To allow the comparison of these costs and benefits, all the impacts in Table 5.6 are reported in NPV terms using a real discount rate of 7 per cent.

As shown in this table, while the proposed changes would generally increase the costs for dwellings across the state (except for houses in Wagga that experience a decrease in construction costs), these increased capital costs would be offset by reduced expenditure on energy. In net terms, the proposed scheme would generate:

- under Option A:
  - additional costs for households in houses in Ballina and units in Shellharbour
  - benefits for all other households modelled
- under Option B:
  - benefits for households in houses in Baulkham Hills and Moss Vale and units in Eastwood and Macquarie Park
  - additional costs for all other households modelled.

**Table 5.6** Impact of the proposed changes to BASIX on an average house in selected LGAs in NSW

| Local Government Area (LGA) | Option A | | | Option B | | |
|---|---|---|---|---|---|---|
| | Total lifetime costs ($) | Total lifetime benefits ($) | Net impact ($) | Total lifetime costs ($) | Total lifetime benefits ($) | Net impact ($) |
| **HOUSES** | | | | | | |
| Ballina | $5,634 | $4,334 | -$1,300 | $7,124 | -$2,545 | -$9,669 |
| Wagga | $4,037 | $5,678 | $1,641 | -$964 | -$7,922 | -$6,959 |
| Dubbo | $5,793 | $15,404 | $9,612 | $3,927 | $1,807 | -$2,120 |
| Blacktown | $6,882 | $12,452 | $5,570 | $3,449 | $3,081 | -$368 |
| Baulkham Hills | $5,621 | $8,441 | $2,819 | $9,360 | $9,461 | $101 |
| Moss Vale | $6,288 | $14,924 | $8,636 | $5,192 | $6,665 | $1,473 |
| Cessnock | $6,397 | $11,182 | $4,785 | $3,383 | $1,815 | -$1,569 |
| **TOWNHOUSES** | | | | | | |
| Albion Park | $6,403 | $11,400 | $4,996 | $11,753 | $8,826 | -$2,927 |
| **UNITS** | | | | | | |
| Shellharbour | $5,427 | -$381 | -$5,808 | $5,802 | -$148 | -$5,951 |
| Liverpool | $953 | $2,977 | $2,024 | $3,940 | $1,859 | -$2,081 |
| Eastwood | $831 | $3,051 | $2,220 | $605 | $1,668 | $1,063 |
| Macquarie Park | $860 | $1,748 | $888 | $860 | $1,465 | $605 |

Note: these estimates use retail energy prices. Present values calculated using a 7 per cent discount rate.
*Source: ACIL Allen.*

Table 5.7and Table 5.8 show the effects of the proposed changes in BASIX on the two affordability indicators estimated for this report (estimated using the discounted lifetime benefits and the benefits only in the first year of the scheme).

The proportion of income used to pay a mortgage outlined in Table 5.7 would remain broadly the same for all households analysed across both options. Notably:

— Past analyses have included the present value of the lifetime benefits of the changes in the calculation of this ratio. While this approach accounts in full for variations in future energy prices, it assumes that all future benefits are received today, which means that ratios for subsequent years would be higher as all the benefits would have been counted in the first year. The results under this approach are shown in the 3rd and 6th columns in the table.

— Using only the value of the benefits in the first year of the scheme (2022) the proportion of income required for mortgage repayments (shown in the 4th and 7th columns in the table) would increase for some dwellings. However, these increases are minor (a percentage point in all cases). This approach does not account for changes in the value of benefits on a year on year basis as energy prices change.

— This indicator remains broadly unchanged mainly due to the fact that the additional costs of the proposed changes are included in the initial mortgage and hence amortised over time.

The 'years of gross income' required to purchase a house (calculated using the value of benefits in 2022) outlined in Table 5.8 increase slightly for four households under Option A and for more than half the households analysed under Option B. This represents a decrease in housing affordability in these markets.

Overall, the two housing affordability indicators analysed suggest that the proposed changes to BASIX would have no major effects on housing affordability.

**Table 5.7** Impacts of the proposed BASIX changes on the proportion of income used for mortgage repayments

| Local Government Area (LGA) | Option A | | | Option B | | |
|---|---|---|---|---|---|---|
| | Currently | Under new BASIX (lifetime benefits)[a] | Under new BASIX (1st year benefits)[b] | Currently | Under new BASIX (lifetime benefits)[a] | Under new BASIX (1st year benefits)[b] |
| **HOUSES** | | | | | | |
| Ballina | 68% | 64% | 68% | 68% | 72% | 69% |
| Wagga | 23% | 22% | 23% | 23% | 25% | 23% |
| Dubbo | 22% | 18% | 22% | 22% | 22% | 22% |
| Blacktown | 36% | 32% | 36% | 36% | 35% | 36% |
| Baulkham Hills | 44% | 41% | 44% | 44% | 41% | 44% |
| Moss Vale | 53% | 45% | 53% | 53% | 49% | 54% |
| Cessnock | 28% | 24% | 28% | 28% | 27% | 28% |
| **TOWNHOUSES** | | | | | | |
| Albion Park | 31% | 27% | 31% | 31% | 29% | 32% |

| Local Government Area (LGA) | Option A | | | Option B | | |
|---|---|---|---|---|---|---|
| | Currently | Under new BASIX (lifetime benefits)[a] | Under new BASIX (1st year benefits) [b] | Currently | Under new BASIX (lifetime benefits)[a] | Under new BASIX (1st year benefits) [b] |
| **UNITS** | | | | | | |
| Shellharbour | 31% | 32% | 31% | 31% | 32% | 32% |
| Liverpool | 25% | 24% | 25% | 25% | 25% | 25% |
| Eastwood | 33% | 32% | 33% | 33% | 32% | 33% |
| Macquarie Park | 33% | 32% | 33% | 33% | 33% | 33% |

[a] Disposable income includes the present value of the lifetime benefits of the changes.
[b] Disposable income includes only the value of the benefits in the first year of the scheme (2022). These benefits vary on a year on year basis as energy prices change.
Note: Cells highlighted in red denote a decrease in affordability. Based on median house price data from the December Quarter 2020 sourced from NSW Department of Communities and Justice Rent and Sales Report No. 135, the median household income (that is, the midpoint when all people are ranked in ascending order of income) for each analysed LGA in 2020 calculated using ABS data, and the following mortgage assumptions: prime borrower, standard loan, 20 per cent deposit (i.e. LVR=80 per cent), standard variable lending rate of all institutions for new loans to owner occupiers of 2.78 per cent p.a. (as at 31 March 2021, sourced from RBA) and a 25 year repayment period.
*Source: ACIL Allen.*

**Table 5.8** Impacts of the proposed BASIX changes on the median multiple

| Local Government Area (LGA) | Option A | | | Option B | | |
|---|---|---|---|---|---|---|
| | Currently | Under new BASIX (lifetime benefits)[a] | Under new BASIX (1st year benefits) [b] | Currently | Under new BASIX (lifetime benefits)[a] | Under new BASIX (1st year benefits) [b] |
| **HOUSES** | | | | | | |
| Ballina | 15.4 | 14.3 | 15.4 | 15.4 | 16.2 | 15.6 |
| Wagga | 5.1 | 4.8 | 5.2 | 5.1 | 5.7 | 5.1 |
| Dubbo | 4.9 | 4.1 | 5.0 | 4.9 | 4.9 | 5.0 |
| Blacktown | 8.1 | 7.3 | 8.1 | 8.1 | 7.9 | 8.1 |
| Baulkham Hills | 9.8 | 9.3 | 9.8 | 9.8 | 9.2 | 9.8 |
| Moss Vale | 12.0 | 10.1 | 12.0 | 12.0 | 11.1 | 12.1 |
| Cessnock | 6.2 | 5.4 | 6.3 | 6.2 | 6.1 | 6.3 |
| **TOWNHOUSES** | | | | | | |
| Albion Park | 7.0 | 6.2 | 7.0 | 7.0 | 6.4 | 7.1 |
| **UNITS** | | | | | | |
| Shellharbour | 7.0 | 7.1 | 7.1 | 7.0 | 7.1 | 7.1 |
| Liverpool | 5.6 | 5.5 | 5.6 | 5.6 | 5.6 | 5.7 |
| Eastwood | 7.4 | 7.2 | 7.4 | 7.4 | 7.3 | 7.4 |
| Macquarie Park | 7.4 | 7.3 | 7.4 | 7.4 | 7.3 | 7.4 |

[a] Disposable income includes the present value of the lifetime benefits of the changes.
[b] Disposable income includes only the value of the benefits in the first year of the scheme (2022). These benefits vary on a year on year basis as energy prices change.
Note: Cells highlighted in red denote a decrease in affordability. Based on median house price data from the December Quarter 2020 sourced from NSW Department of Communities and Justice Rent and Sales Report No. 135 and the median household income (that is, the midpoint when all people are ranked in ascending order of income) for each analysed LGA in 2020 calculated using ABS data. The impact of the proposed BASIX changes on disposable income re outlined in Table 5.5 and the impacts on house prices are outlined in Table 5.3.
*Source: ACIL Allen.*

# 6 Conclusion

This analysis has summarised the potential impacts on the NSW community of proposed changes in the stringency of BASIX's energy efficiency targets. Importantly, this study is not an assessment of BASIX's overall performance, nor is it a CBA of the entire BASIX mechanism.

The analysis has shown that:

- At an economy-wide level[110], both Option A and Option B result in a net cost to society, even when including the somewhat more uncertain measures of benefit (the benefits from reduced carbon emissions and health benefits). This result is mainly driven by the use of wholesale energy prices (as a proxy for avoided resource costs) to value the benefits of reduced energy consumption, which results in BCRs and NPVs that are much smaller than if retail energy prices are used. Wholesale energy prices are currently low with a number of policy initiatives increasing the supply of energy and decreasing the demand for energy.
- At a household level[111], the results are mostly positive under Option A and mixed for Option B, with some households projected to be better off with the changes, and some others experiencing net costs from the proposed BASIX changes. In particular:
  - Under Option A, the proposed changes would result in net benefits for most households. That is, the benefits received by households from the additional energy efficiency measures installed are more than enough to cover the additional costs incurred to implement these measures. The exceptions are households in DH9 and LR, who are estimated to experience net costs from the proposed changes.
  - Under Option B, the proposed changes would result in net benefits for half the households and in net costs for the other half. The households that would experience net costs from the proposed changes under this option are those in DH1, DH4, DH5, DH9, AH, LR and HR3.

[110] The impact of the proposed changes to BASIX at economy-wide level are analysed using wholesale energy prices.

[111] The impacts of the proposed changes to BASIX from the perspective of the individual households are analysed using retail energy prices.

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# Appendices

# Overview of the sample buildings modelled A

*This appendix was written by the Department and attached to this report to provide additional details about the sample of buildings used as inputs to the BASIX CBA and the assumptions made when modelling the individual dwelling impacts for the analysis.*

## A.1 Sample buildings

BASIX thermal comfort requirements and energy targets were last updated in July 2017. Some of the buildings considered in the CBA underlying the July 2017 changes[112] are included in the building sample for this report. Their specifications, based on data captured in the BASIX database from 2017 to 2020, were updated to reflect the specifications provided by BASIX users to satisfy the current BASIX targets.

### A.1.1 Detached houses

Nine detached houses are included in the BASIX CBA from the following locations. Floor areas, heating and cooling loads and the specifications of fixed energy systems vary between these houses.

— Blacktown (2 houses)
— Baulkham Hills
— Cessnock
— Dubbo
— Wagga Wagga
— Ballina
— Moss Vale (2 houses).

[112] Allen Consulting Group 2013, *Benefit-cost analysis of proposed BASIX stringency changes*, July, https://basix.nsw.gov.au/iframe/images/4050pdfs/Allen_Benefit_Cost_Analysis.pdf, accessed on 20 May 2021

The three houses in Western Sydney (two in Blacktown and one in Baulkham Hills) are classified into affordable, average and large houses based on the following criteria informed by BASIX data from July 2017 to June 2020:

— a large house represents the top 5 per cent of the dwellings from Baulkham Hills in terms of floor areas
— an affordable house represents the bottom 25 per cent of the dwellings from Blacktown in floor areas, excluding granny flats (i.e. less than 60 $m^2$ floor area)
— the average of the remaining 70 per cent is attributed to an average house.

In Moss Vale, the two houses are classified into average and large houses, with the top 10 per cent of the dwellings in terms of floor areas used to define a large house.

In Moss Vale and locations other than Blacktown, the average floor area from the BASIX data (excluding granny flats, or dwellings less than 60$m^2$) is used to determine the size of the average house. A summary of the floor areas of the nine detached houses being considered in the CBA is included in Table A.1.

## A.1.2 Multiple dwellings and apartment buildings

The following multiple dwellings and apartment buildings are considered in the BASIX CBA:

— three attached houses from Albion Park in the South Coast
— one low-rise buildings (3-storey high) in Shellharbour
— three high-rise developments from Greater Sydney:
  – two-building developments (7 and 28 storeys) in Macquarie Park
  – two-building developments (10 and 13 storeys) in Eastwood
  – one 8-storey building in Liverpool.

All these building types and locations, with the exception of the high-rise building in Macquarie Park, were considered in the CBA underlying the July 2017 BASIX changes[113]. The three high-rise developments are considered to align with the higher energy targets being proposed by the City of Sydney in the “Planning for net zero energy buildings” report[114] released in May 2021.

A summary of the building characteristics of the multiple dwellings and apartment buildings considered in the CBA is included in Table A.1.

[113] Ibid.

[114] City of Sydney, WSP, Common Capital, WT Partnership and Elton Consulting 2021, *Planning for net zero energy buildings*, June, https://www.cityofsydney.nsw.gov.au/surveys-case-studies-reports/planning-for-net-zero-energy-buildings, accessed 21 June 2021.

**Table A.1** Floor areas and specifications from the dwelling and building sample in BASIX CBA

| | Location | Type | Number of storeys | Gross floor area ($m^2$) [total for multi dwellings] | Number of bedrooms |
|---|---|---|---|---|---|
| **Detached houses** | | | | | |
| DH1 | Blacktown | Average | 2 | 170 | 4 bedrooms |
| DH2 | Blacktown | Affordable | 2 | 145 | 4 bedrooms |
| DH3 | Baulkham Hills | Large | 2 | 440 | 5 bedrooms |
| DH4 | Cessnock | Average | 2 | 170 | 4 bedrooms |
| DH5 | Dubbo | Average | 2 | 165 | 4 bedrooms |
| DH6 | Wagga Wagga | Average | 2 | 190 | 4 bedrooms |
| DH7 | Moss Vale | Average | 2 | 220 | 4 bedrooms |
| DH8 | Moss Vale | Large | 2 | 325 | 5 bedrooms |
| DH9 | Ballina | Average | 2 | 185 | 4 bedrooms |
| **Multiple dwellings and apartment buildings** | | | | | |
| AH | Albion Park | 3 dwellings | 1 | 468 | 3 bedroom each |
| LR | Shellharbour | 13 units | 3 | 1,440 | 5 x 3 bedrooms<br>5 x 2 bedrooms<br>3 x 1 bedroom |
| HR1 | Macquarie Park | 219 units | 7 & 28 | 18,376 | 5 x 4 bedrooms<br>48 x 3 bedrooms<br>104 x 2 bedrooms<br>62 x 1 bedroom |
| HR2 | Eastwood | 127 units | 10 & 13 | 9,133 | 18 x 3 bedrooms<br>48 x 2 bedrooms<br>61 x 1 bedroom |
| HR3 | Liverpool | 37 units | 8 | 2,610 | 23 x 2 bedrooms<br>14 x 1 bedroom |

*Source: NSW Department of Planning, Industry and Environment.*

# A.2 Policy options and scenarios considered in the CBA

Three policy options are considered in the CBA for each sample building. A base case reflecting compliance with current BASIX requirements and two other cases (Options A and B as described in the body of the report) reflecting the proposed changes in the BASIX minimum requirements of thermal comfort and energy efficiency. Options A and B are consistent with the proposed changes to the NCC 2022. Differences of the base case from Options A or B are used to determine the marginal costs and benefits associated with the proposed changes in BASIX requirements.

### A.2.1 Base case:

This case is specified to achieve NatHERS 5.5 – 6 stars in thermal comfort and the current BASIX energy requirements.

Two scenarios (compliance pathways) are considered in the base case:

— **Minimum compliance:** in addition to a thermal comfort standard equivalent to NatHERS 5.5 – 6 stars, this scenario includes the most common hot water, heating and cooling systems and average size of PV (if applicable) for a proposed development to meet the BASIX energy target within 2 points. For instance, for a detached house in Greater Sydney with an energy target of 50, this scenario refers to specifications that result in an energy score between 50 and 52.

— **Over-compliance:** in addition to a thermal comfort standard equivalent to NatHERS 6 – 6.5 stars, this scenario includes the most common hot water, heating and cooling systems and average size of PV (if applicable) for a proposed development to over-comply with the current energy target by at least 3 points – or an energy score of 53 or higher for a detached house in Greater Sydney.

Using BASIX data from July 2017 to June 2020, Table A.2 shows the proportion of minimum and over compliant scenarios for the nine detached houses and the five multi dwellings and apartment buildings in the dwelling sample.

**Table A.2** Proportion of minimum and over-compliance scenarios in the building sample

| Dwelling/building sample | Minimum compliance | Over-compliance |
|---|---|---|
| **Detached houses** | | |
| Blacktown, Baulkham Hills (DH1, DH2, DH3) | 80% | 20% |
| Cessnock (DH4) | 50% | 50% |
| Dubbo (DH5) | 60% | 40% |
| Wagga Wagga (DH6) | 60% | 40% |
| Moss Vale (DH7) | 67% | 33% |
| Moss Vale (DH8) | 60% | 40% |
| Ballina (DH9) | 50% | 50% |
| **Multiple dwellings and apartment buildings** | | |
| Attached houses (AH) | 90% | 10% |
| Low-rise building (LR) | 93% | 7% |
| High-rise – Macquarie Park (HR1) | 90% | 10% |
| High rise – Eastwood (HR2) | 83% | 17% |
| High rise - Liverpool (HR3) | 60% | 40% |

*Source: NSW Department of Planning, Industry and Environment.*

### A.2.2 Option A

Option A is one of the proposed changes to the BASIX minimum requirements of thermal comfort and energy efficiency. This option is consistent with Option A from the proposed NCC 2022.

Under this option, the BASIX thermal comfort requirement is set at NatHERS 7 stars. The BASIX energy target is equivalent to the minimum 30 per cent reduction of energy value (as defined by the NCC) from that of the benchmark appliance profile[115]. Building shell thermal performance is set at NatHERS 7 stars.

Two scenarios are considered under Option A:

— **Electric hot water system**: in addition to NatHERS 7-star thermal comfort performance, heat pump hot water systems and the benchmark heating/cooling systems (i.e. reverse-cycle 1-phase air conditioners with 3-star (GEMS 2019) rating or AEER of 4.75)[116] are specified.
— **Gas hot water system:** under this scenario a gas instantaneous hot water system is specified in addition to thermal comfort performance being set at NatHERS 7 stars. This scenario is developed as an improvement of the over-compliance scenario in the base case to achieve the same emission reduction as the electric hot water system scenario.
— For many sample houses (DH1 – DH9) and the attached house (AH), small PV systems of less than 1.5 kW PV are needed to meet the same BASIX energy score as the electric hot water system scenario. More energy efficient air conditioners or solar hot water systems with gas boosters can also achieve the same BASIX energy score, but they may not be as readily available in the market as PV systems.

  Systems of 1.5 kW capacity are assumed as inputs to the CBA, as it is not likely that systems of less than1.5kW would be installed due to the substantial fixed costs of elements such as inverters. The marginal costs of additional PV panels to reach 1.5kW is also relatively small. This assumption is consistent with the NCC 2022 RIS.

  Higher BASIX energy targets of 40, 35 and 30 are considered for the three high-rise buildings in the sample (for HR3, HR2 and HR1, respectively). These higher BASIX energy targets are consistent with the proposed targets put forward by the City of Sydney in their “Planning for net zero energy buildings” report[117] in May 2021. To achieve these higher BASIX targets, the apartment buildings require PV systems in the range of 11– 47kW to be supplied to the buildings.

  The proposed BASIX energy targets put forward by the City of Sydney are considered under Option A because they apply to apartment buildings, unlike the proposed NCC requirements that apply only to individual units. The 8-storey apartment building in the sample (HR3) considered in the CBA has the same energy score as Option A from the proposed NCC 2022. The energy scores from other higher apartments buildings in the sample (HR1 and HR2) are lower than Option A from NCC 2022 because these buildings have more and larger common areas than HR3.

[115] Energy Efficient Strategies 2020, *Whole-of-House DTS Provisions – Draft Modelling Results*, December.

[116] Energy Efficient Strategies 2020, *NCC 2022 Update – Whole-of-House Component: Draft report*, September.

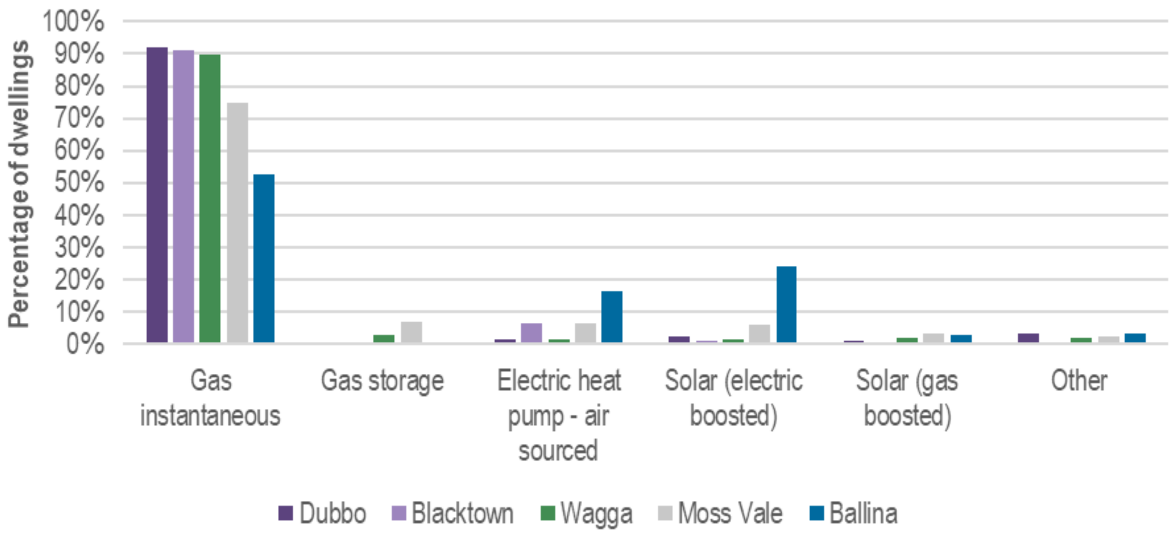
[117] City of Sydney, WSP, Common Capital, WT Partnership and Elton Consulting 2021, *Planning for net zero energy buildings*, June, https://www.cityofsydney.nsw.gov.au/surveys-case-studies-reports/planning-for-net-zero-energy-buildings, accessed 21 June 2021.

### Relative uptake of gas and electric hot water systems under Option A

The existing penetration of hot water systems specified in BASIX single-dwelling projects from July 2017 to June 2020 was analysed to estimate the relative uptake of gas and electric hot water systems for the sample houses (DH1 – DH9) under Option A.

Gas instantaneous hot water systems are the most popular in all the five locations of detached houses being considered in the CBA – see Figure A.1.

**Figure A.1** Distribution of hot water systems in single dwellings in the selected LGAs




*Source: NSW Department of Planning, Industry and Environment.*

It is assumed that similar proportions of gas and electric hot water systems to those in Figure A.1 would apply after the higher BASIX targets are implemented. Table A.3 shows the relative proportion of gas and electric hot water system scenarios for the sample detached houses considered in the BASIX CBA.

**Table A.3** Relative uptake of gas and heat pump hot water systems in sample detached houses

| Hot water systems | Sample detached houses | | | | | |
|---|---|---|---|---|---|---|
| | **Blacktown Baulkham Hills (DH1 – DH3)** | **Cessnock (DH4)** | **Dubbo (DH5)** | **Wagga Wagga (DH6)** | **Moss Vale (DH7 – DH8)** | **Ballina (DH9)** |
| Gas system | 92% | 84% | 95% | 96% | 86% | 58% |
| Heat pump system | 8% | 16% | 5% | 4% | 14% | 42% |

*Source: NSW Department of Planning, Industry and Environment.*

Similar to detached houses, the relative update of gas and heat pump hot water systems is determined informed by BASIX data from July 2017 to June 2020. Table A.4 shows the proportion of gas and electric systems of the sample multiple-dwelling developments. Most high-rise buildings have centralised systems specified.

**Table A.4** Relative uptake of gas and heat pump hot water systems (individual vs centralised systems) in sample multiple dwellings and apartment buildings

| | Gas hot water system | | Heat pump hot water system | |
|---|---|---|---|---|
| | **Individual** | **Centralised** | **Individual** | **Centralised** |
| Attached houses (AH) | 97% | – | 3% | – |
| Low-rise building (LR) | 97% | | 3% | |
| High-rise – Macquarie Park (HR1) | – | 90% | – | 10% |
| High rise – Eastwood (HR2) | | 90% | | 10% |
| High rise - Liverpool (HR3) | | 97% | | 3% |

*Source: NSW Department of Planning, Industry and Environment.*

### Option B

Option B is an alternative of the proposed changes to the BASIX minimum requirements of thermal comfort and energy efficiency. This option is consistent with Option B from the proposed NCC 2022.

Under this option, the BASIX thermal comfort requirement is set at NatHERS 7 stars – same as Option A. The BASIX energy target is equivalent to the energy value (as defined by the NCC) from that of the benchmark appliance profile[118].

Only one scenario is being considered for each sample dwelling/building under Option B. For detached and attached houses, 6-star gas instantaneous hot water system and the benchmark heating/cooling systems (i.e. reverse-cycle 1-phase air conditioners with 3-star (GEMS 2019) rating or AEER of 4.75) are specified. If PV systems of less than 1.5 KW are required under this option, 1.5 kW systems are assumed as inputs to the BASIX CBA.

Similar to the sample detached houses, average NatHERS 7-star thermal comfort performance and the benchmark heating and cooling systems are considered for the sample apartment buildings. Gas instantaneous systems with 6 stars are considered in the low-rise (LR) and the 8-storey high-rise (HR3) buildings, while central gas hot water systems are included in the other two high-rise buildings HR1 and HR2.

The BASIX energy outcomes of the apartment buildings are aimed at 3 – 5 points higher than the over-compliance scenario in the Base Case, corresponding to PV systems of 4.5 – 20kW to be supplied to the buildings.

[118] Energy Efficient Strategies Pty Ltd 2020, *NCC 2022 Update – Whole-of-House Component: Draft report*, September.

# A.3 Other specifications and assumptions

Specifications of lighting, fixed/portable appliances, dwelling size and occupancy, breakdown of energy consumption for various end uses, peak and off-peak electricity consumption pattern and electricity greenhouse gas emissions factor are important to evaluate the changes between the current BASIX and the proposed requirements considered in the CBA.

## A.3.1 Specifications of lighting and fixed/ portable appliances

Lighting, and all fixed/portable appliances, except for hot water, heating/cooling and PV systems, remain unchanged between the cases for each sample dwelling or building. For all the cases:

- CFL light fixtures are assigned to living/dining, kitchen, bedrooms and hallways. Bathrooms and laundry lights are included with ventilation units.
- Gas 4-burner cooktops and electric under bench ovens are considered.
- The number of lifts (if specified) and their specifications remain the same.

## A.3.2 Dwelling size and occupancy

Dwelling size and the number of assumed occupants (or occupancy) remain unchanged across all cases in each sample dwelling.

## A.3.3 Breakdown of energy consumption for various end uses

Total yearly energy consumption for building shell, hot water, ventilation, cooling, heating, lighting, cooking, appliances (white goods) and other (plug loads) are obtained from the BASIX calculation algorithm. Building shell energy demand is the annual assessed (or theoretical) energy based on heating and cooling loads equivalent to the NatHERS star ratings specified in each scenario. Electricity generated by PV is also estimated from the BASIX calculation algorithm.

## A.3.4 Peak and off-peak electricity consumption

Peak and off-peak electricity consumption for various end-uses and services are informed by household energy monitoring data collected by the University of New South Wales in a research projects funded by the CRC for Low Carbon Living[119]. Proportions of peak and off-peak energy consumption for various end uses and services are listed in Table A.5.

[119] CRC for Low Carbon Living, Validating and improving the BASIX energy assessment tool for low-carbon dwellings: final report, 26 Mar 2019, <https://apo.org.au/node/230251>, accessed on 20 May 2021

**Table A.5** Proportions of peak and off-peak energy consumption for various end uses and services

| End use/service | Peak (7 am – 10 pm) | Off-peak (10 pm – 7 am) |
|---|---|---|
| Building shell | 75% (average of heating and cooling) | 25% (average of heating and cooling) |
| Heating | 66% | 34% |
| Cooling | 82% | 18% |
| Hot water | 73% | 27% |
| Lighting | 72% | 28% |
| Appliances + ventilation + other | 71% | 29% |
| Cooking | 92% | 8% |
| Common area (based on lift energy use profile) | 80% | 20% |

*Source: NSW Department of Planning, Industry and Environment.*

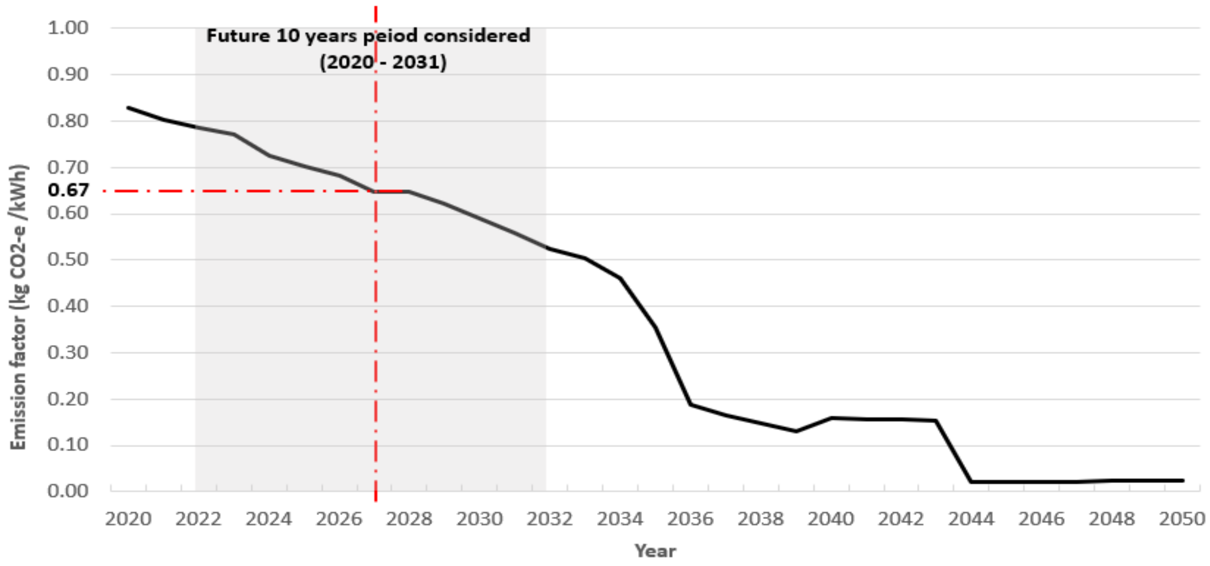
## A.3.5 Greenhouse gas emission factors from grid electricity

BASIX currently uses a greenhouse gas emission factor of 1.062 kg $CO_2$-e/kWh of electricity when calculating the energy scores (as percentage reduction of emissions from the benchmark of 3,292 kg $CO_2$-e/person/day) from proposed developments.

Based on emission projection data obtained from various sources such as the published National Greenhouse Accounts factors and the Department of Industry, Science, Energy and Resources (DISER), Figure A.2 shows that emission factor from grid electricity in NSW will be reduced significantly in the next two to three decades.

As uncertainties of projections often increase with time, a 10-year average from 2022 to 2032 (or 0.67 kg $CO_2$-e/kWh) is considered for calculating the energy and cost inputs provided by the Department for the BASIX CBA.

**Figure A.2** NSW electricity greenhouse gas emission factor derived from various estimates




*Source: NSW Department of Planning, Industry and Environment.*

### A.3.6 Offset and export of electricity generated by PV

Electricity generated from PV systems is estimated from the BASIX calculation algorithm. If the annual electricity generated by PV from a detached house is less than the total electricity demand, it is used to offset the electricity demand of the house. When there is a large PV system which produces surplus electricity from household demand, the additional energy generated is assumed to be exported to the grid for the purpose of the CBA.

In apartment buildings, the required PV system is attributed to the common areas and shared services (such as lifts and central hot water systems) as it is not feasible to assign PV systems to individual dwellings. If the annual electricity generated by PV is less than the total electricity demand of common areas and shared services, it is used to offset the common area energy demand. Any surplus electricity generated by the PV system is treated as being exported to the grid.

## A.4 Costing assumptions

The compliance costs for each dwelling modelled in the CBA were developed using the same assumptions as those being used in the NCC 2022 RIS sourced from EES[120]. The costs used in the NCC 2022 RIS vary with jurisdictions, and the costs shown below are specific to NSW.

[120] Energy Efficient Strategies Pty Ltd, *NCC 2022 Update – Whole-of-House Component: Draft report*, September 2020

### A.4.1 Building shell improvement costs

These costs relate to the costs of moving from NatHERS 6 stars to 7 stars and vary by location and by type of dwelling. These costs were developed using the same assumptions as those being used in the NCC 2022 RIS sourced from EES[121]. Building shell improvement costs for houses and apartment units in Western Sydney and Southern Highlands, for example, are shown in Table A.6.

**Table A.6** Building shell improvement costs

| | Houses | Apartment units |
|---|---|---|
| Western Sydney | \$11.35 /m$^2$ | \$4.44 /m$^2$ |
| Southern Highlands | \$14.73 /m$^2$ | \$9.95 /m$^2$ |

*Energy Efficient Strategies Pty Ltd, NCC 2022 Update – Whole-of-House Component: Draft report, August 2021*

### A.4.2 Appliance costs – individual systems

#### Heating/cooling systems

The supply and installation costs of central gas ducted systems or room reverse cycle split air conditioners vary with star ratings. They are expressed in terms of the costs per unit floor area being serviced. Table A.7 lists the costs of 1-star and 5-star central gas ducted systems and room reverse-cycle split air conditioners as an example.

**Table A.7** Costs of heating/cooling systems

| | 1 star | 5 stars |
|---|---|---|
| Central gas ducted systems | \$25.29 /m$^2$ | \$26.47 /m$^2$ |
| Room reverse cycle split a/c | \$35.12 /m$^2$ | \$66.00 /m$^2$ |

*Energy Efficient Strategies Pty Ltd, NCC 2022 Update – Whole-of-House Component: Draft report, August 2021*

#### Hot water systems

The costs for hot water systems (including supply and installation) for heat pump and gas instantaneous systems vary between a typical detached house or townhouse with 3 to 4 people and a typical apartment unit with 2 to 3 people being serviced. The costs of heat pump and gas instantaneous systems catered for a typical house or townhouse and an apartment unit are shown in Table A.8.

**Table A.8** Costs of hot water systems

| | House or townhouse (3 – 4 people) | Apartment unit (2 – 3 people) |
|---|---|---|
| Heat pump | \$4,196 | \$3,870 |
| Gas instantaneous | \$2,182 | \$1,832 |

*Energy Efficient Strategies Pty Ltd, NCC 2022 Update – Whole-of-House Component: Draft report, August 2021*

[121] Energy Efficient Strategies Pty Ltd, *NCC 2022 Update – Whole-of-House Component: Draft report*, September 2020

### PV systems

The costs for the supply and installation of PV systems, either including or excluding small-scale technology certificate (STC) rebates, are determined based on peak capacity. The costs of 1.5kW and 10kW systems, for example, are shown in Table A.9.

Inverters are assumed to cost $806.2 per unit in NSW.

**Table A.9** Costs of PV systems

| | 1.5 kW | 10 kW |
|---|---|---|
| Photovoltaic panels (incl. rebates) | $2,756 | $11,553 |
| Photovoltaic panels (ex. rebates) | $3,562 | $13,889 |
| Inverter costs | $806 | $2,336 |

*Source: Energy Efficient Strategies Pty Ltd, NCC 2022 Update – Whole-of-House Component: Draft report, August 2021*

### Central hot water systems for apartments

The costs of central hot water systems for apartments specific to BASIX with gas boiler as the reference in compliance scenarios are outlined in Table A.10.

**Table A.10** Costs for central hot water systems for apartments

| | Cost relative to reference |
|---|---|
| Gas boiler (reference) | 0 |
| Solar gas boosted [1] | $500 /m$^2$ of collector area<br>(or $240 - $430 per SoU in the apartment blocks considered in this CBA) |
| Heat pump [2] | $2,200 / dwelling |

*Source: 1) Increased Stringency of BASIX Energy Index for Residential Flat Buildings, AECOM, July 2013. 2) Greater Parramatta Urban Renewal Area - Increasing BASIX Study, Kinesis for Parramatta Council, Oct 2020*

# Differences with NCC 2022 RIS

# B

As mentioned throughout the report, while we have attempted to undertake this CBA as consistently as possible with the NCC RIS, policy differences between BASIX and the proposed NCC 2022 requirements have nevertheless resulted in noticeable differences in the analysis. The main differences are summarised in the points below.

— Baseline used for analysis — the NCC RIS baseline assumes that all Class 1 buildings are at least 6 stars and all Class 2 buildings have an average rating for all units in a block of at least 6 stars, and a minimum for each unit of 5 stars. The baseline cases in the BASIX CBA are specified to achieve 5.5 – 6 stars in thermal comfort and the current BASIX energy requirements. In addition, the baseline used for the NCC RIS is dynamic with respect to the assumed penetration of solar PV in future years, while the baseline in the BASIX CBA is static.

— Case studies analysed — the NCC RIS analyses one representative Class 1 detached dwelling in NCC climate zones 2, 4, 5, 6, 7 and 8 and one representative Class 2 SOU in NCC climate zones 2, 4, 5, 6 and 7. Attached Class 1 dwellings were not separately modelled in the NCC RIS. In comparison, the BASIX CBA analysis is based on a sample of nine detached houses, an attached house development, a low-rise apartment complex and three different high-rise apartment blocks across a sample of NSW locations and climate zones.

— Treatment of Class 2 dwellings — because BASIX aims to reduce emissions from apartment buildings rather than individual Class 2 SOUs, the modelling in this report is based on representative apartment buildings which include central systems and common areas in addition to individual units (to calculate the impacts of the proposed changes on a per SOU basis we divide the energy flows and capital costs for the whole apartment building by the number of units in each building). In contrast, the modelling for Class 2 in the NCC RIS is based solely in individual units.

— Energy targets for high rise Class 2 dwellings — in comparison to the NCC RIS analysis, the BASIX CBA considered higher BASIX energy targets for high rise Class 2 dwellings. These higher BASIX energy targets are consistent with the proposed targets put forward by the City of Sydney in their 'Planning for net zero energy buildings' report in May 2021. To achieve these higher BASIX targets, the apartment buildings require PV systems in the range of 11- 47 kW to be installed.

— Compliance pathways — the way in which buildings are assumed to comply with the proposed requirements under the NCC and BASIX are different. For instance, under the NCC analysis buildings with solar PV in the baseline are assumed to always keep at least the same amount of solar panels to comply, while in some cases in BASIX solar panels are removed to comply under the new targets. Another example is the assumption under the NCC that the only pathway to comply with the NCC 2022 requirements for Class 2 dwellings is via high efficiency equipment as solar PV is assumed to not be feasible for these dwellings. In contrast, because BASIX takes a 'whole of building' perspective with respect to Class 2, the new targets for apartments can be met through the use of PV, which in many cases provides a more cost effective solution.

— Use of solar PV systems in Class 2 buildings — as noted above, BASIX's whole of building approach for Class 2 buildings allows the use of PV to reach the required energy targets, while the modelling underpinning the NCC RIS does not.
— Peak and off-peak prices — because the inputs to the BASIX CBA provided by the Department were broken down into peak and off-peak electricity use, we were able to apply peak and off peak prices to the BASIX energy flows. This distinction was not possible under the NCC RIS analysis.
— Treatment of pools — dwellings with pools are separately modelled in the NCC RIS to reflect the NCC 2022 requirements on pool and spa pumps. In contrast, pools are not separately modelled in the BASIX CBA.
— Therma bridging costs — in the NCC RIS, thermal bridging costs are applied to all Class 1 and Class 2 dwellings in NSW that are steel framed. In contrast, given that data from the Department shows that only 50 per cent of Class 1 dwelling and all Class 2 units in NSW use NatHERS modelling to satisfy the thermal comfort requirements in BASIX, we have assumed that the additional costs of mitigating thermal bridging in the BASIX CBA apply to 50 per cent of all Class 1 dwellings in NSW and all Class 2 buildings.
— Government costs — Government costs in the NCC RIS do not reflect the costs expected to be incurred by each jurisdiction when implementing the proposed changes to NCC 2022. Instead, they reflect costs that would be incurred by the Australian Government but that have been notionally allocated by jurisdictions using statistics of employment in residential construction by state to complete the CBA by jurisdiction. The government costs included in the BASIX CBA reflect the administration costs estimated by the Department to communicate the BASIX changes to industry.
— Life of heating/cooling and shell impacts — in the NCC RIS investments relating to heating and cooling include a mixture of both shell and equipment measures and are assumed to have an average life of 30 years[122]. In contrast, for the BASIX CBA the Department separately modelled and provided to us the impacts of an improved building shell and more efficient heating and cooling equipment. Given the interaction effects between an improved building shell and more efficient heating and cooling equipment, to avoid double counting of benefits, for the BASIX CBA we assumed that for the first 12 years of the analytical period (from year 1 to year 12) only the benefits associated with more efficient heating and cooling equipment are accrued (i.e. the benefits from the improved building shell are assumed to be zero during the first 12 years). The benefits from improved building shell are assumed to kick in from year 13 (when the heating and cooling equipment reaches its end of life) and last until year 40 of the analytical period (i.e. until the building shell reaches its end of life). The overall effect of this is that dwellings in the BASIX CBA receive an additional 10 years of benefits when compared to dwellings in the NCC RIS.

[122] This reflects the fact that building shell improvements have a mixture of lifespans from 40 years for insulation, down to 15-20 years for door seals and that heating and cooling equipment has an average lifespan of 12 years (separate energy flows for the building shell were not separately provided by technical advisors providing input for the NCC RIS).

# Overview of ACIL Allen energy market models

# C

This Appendix provides an overview of two of our energy market models that were used to provide inputs to our cost benefit analysis:

— PowerMark, which simulates the wholesale electricity market
— GasMark, which simulates the wholesale gas market.

## C.1 PowerMark

PowerMark has been developed over the past 20 years in parallel with the development of the National Electricity Market (NEM). PowerMark is a complex model with many unique and valuable features. It provides insights into:

— wholesale pool price trends and volatility
— variability attributable to weather/outages and other stochastic events
— market power and implications for generator bidding behaviour
— network utilisation and generation capacity constraints
— viability of merchant plant and regional interconnections
— contract and price cap values
— timing, size and configuration of new entrant generators
— demands for coal, gas and other fuels; and
— the cost outlook for buyers of wholesale electricity.

PowerMark effectively replicates the Australian Energy Market Operator's (AEMO's) settlement engine — the SPD engine (scheduling, pricing and dispatch). This is achieved through the use of a large-scale linear programming (LP)-based solution incorporating features such as quadratic interconnector loss functions, unit ramp rates, network constraints and dispatchable loads. The veracity of modelled outcomes relative to the AEMO SPD has been extensively tested and exhibits an extremely close fit.

In accordance with the NEM's market design, the price at any one period is the cost of the next increment of generation in each region (the shadow or dual price within the LP). The LP seeks to minimise the aggregate cost of generation for the market as a whole, while meeting regional demand and other network constraints. Figure C.1 is a simplified diagrammatic representation of the model and its methods of combining input data from the supply and demand modules to produce a price and dispatch result for each region and power station for each period.

PowerMark is very flexible. Additional elements, such as regions, interconnectors, generators or loads can be easily added and their characteristics varied through time. PowerMark has been applied to several different market designs — gross pools, net pools, regional and nodal structures.

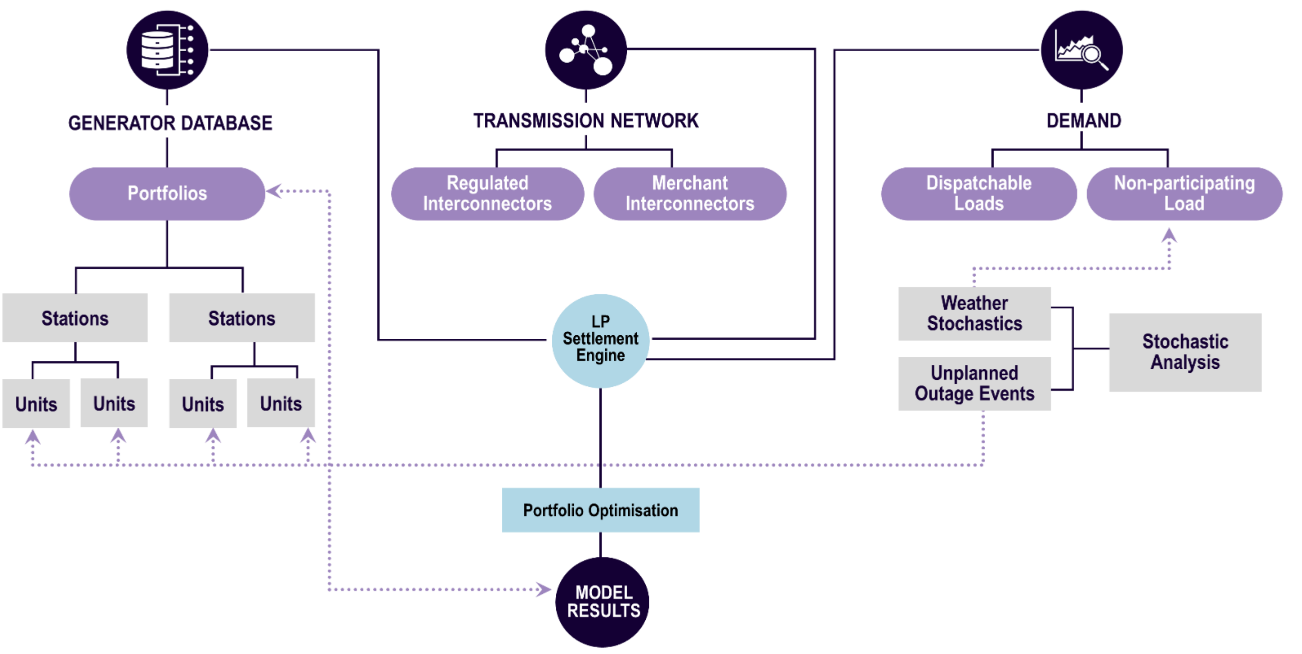
A distinctive feature of PowerMark is the inclusion of a portfolio optimisation module. This component which is almost always employed when modelling energy-only markets, allows selected portfolios to seek to maximise net revenue positions (taking into consideration contracts for differences) for each period. These modified generator offers are then resubmitted to the settlement engine to determine prices and dispatch levels. Each period is iterated until a convergence point (based on Nash-Cournot / Supply Function equilibrium theory) is found.

The benefits of the optimisation module are twofold:

— portfolios structure their generation offers in an economically rational way. From past experience, this optimisation process generates strategies which align with the behavioural reality in the marketplace; and
— second-round effects from fundamental changes to the market — such as a policy change, addition or closure of generators, transmission augmentation or creation of additional regions, can automatically be incorporated without imposing explicit constraints or directions for incumbents.

PowerMark can be configured to run at varying time intervals — from 5 minutes (288 period days) through to 180 minutes (8 period days). Typically, the model is run hourly or half-hourly to meet client requirements and establish a reasonable price resolution.

**Figure C.1** PowerMark model structure




*Source: ACIL Allen.*

# C.2 GasMark

*GasMark Global* (GMG) is a generic gas modelling platform developed by ACIL Allen. GMG has the flexibility to represent the unique characteristics of gas markets across the globe, including both pipeline gas and LNG. Its potential applications cover a broad scope — from global LNG trade, through to intra-country and regional market analysis. *GasMark Global Australia* (GMG Australia, or *GasMark*) is an Australian version of the model which focuses specifically on the Australian market (including both Eastern Australia and Western Australia), but which has the capacity to interface with international LNG markets.

The model can be specified to run at daily, monthly, quarterly or annual resolution over periods up to 30 years.

## C.2.1 Settlement

At its core, *GasMark* is a partial spatial equilibrium model. The market is represented by a collection of spatially related nodal objects (supply sources, demand points, LNG liquefaction and receiving facilities), connected via a network of pipeline or LNG shipping elements (in a similar fashion to ‘arks’ within a network model).

The equilibrium solution of the model is found through application of linear programming techniques which seek to maximise the sum of producer and consumer surplus across the entire market simultaneously. The objective function of this solution, which is well established in economic theory[123], consists of three terms:

— the integral of the demand price function over demand; minus
— the integral of the supply price function over supply; minus
— the sum of the transportation, conversion and storage costs.

The solution results in an economically efficient system where lower cost sources of supply are utilised before more expensive sources and end-users who have higher willingness to pay are served before those who are less willing to pay. Through the process of maximising producer and consumer surplus, transportation costs are minimised and spatial arbitrage opportunities are eliminated. Each market is cleared with a single competitive price.

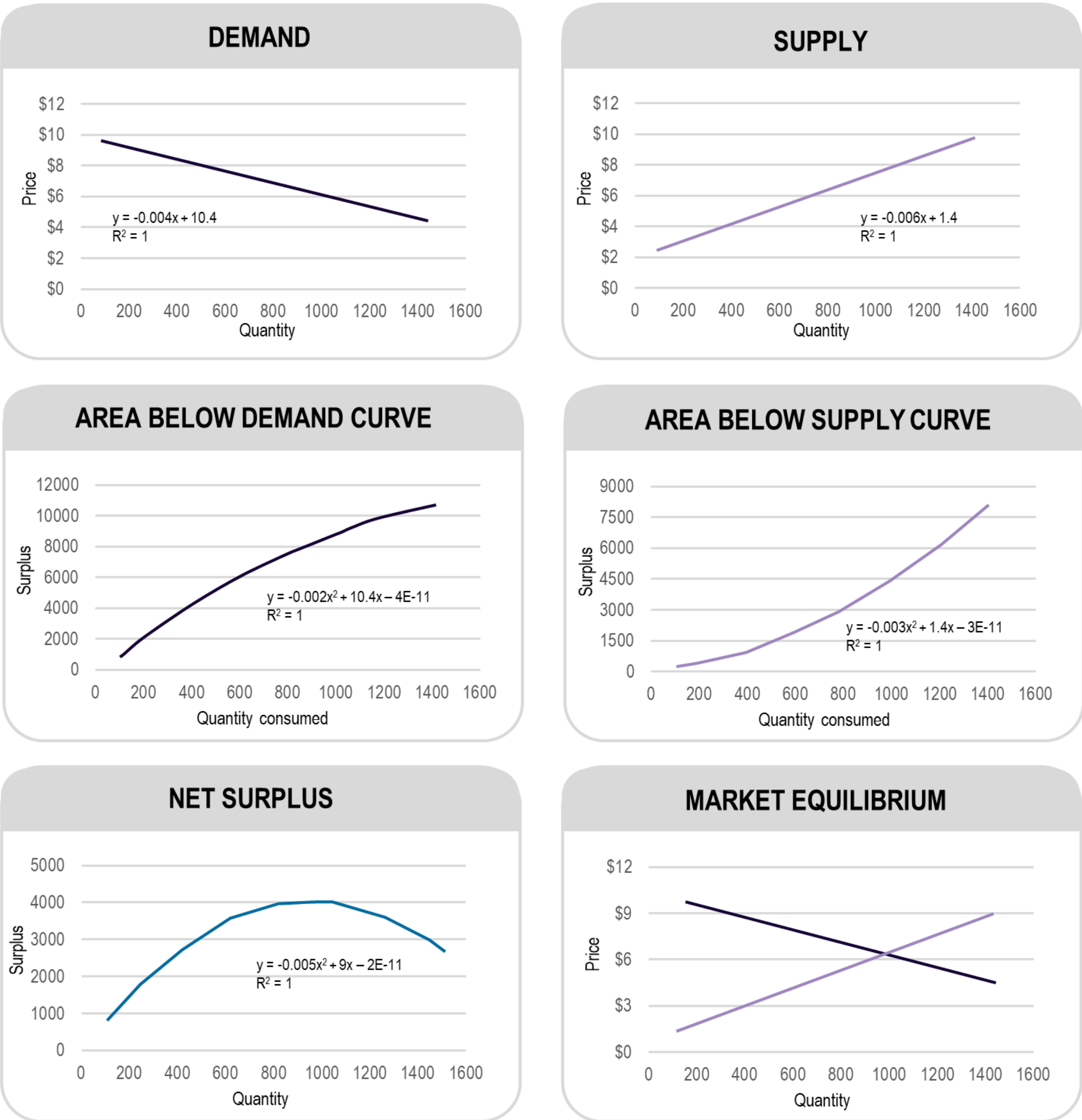
Figure C.2 seeks to explain diagrammatically a simplified example of the optimisation process. The two charts at the top of the figure show simple linear demand and supply functions for a market. The figures in the middle of Figure C.2 show the integrals of these demand and supply functions, which represent the areas under the demand and supply curves. These are equivalent to the consumer and producer surpluses at each price point along the curve. The figure on the bottom left shows the summation of the consumer and producer surplus, with a maximum at a quantity of 900 units. This is equivalent to the equilibrium quantity when demand and supply curves are overlayed as shown in the bottom right figure.

[123] The theoretical framework for the market solution used in GMG is attributed to Nobel Prize winning economist Paul Samuelson.

The distinguishing characteristic of spatial price equilibrium models lies in their recognition of the importance of space and transportation costs associated with transporting a commodity from a supply source to a demand centre. Since gas markets are interlinked by a complex series of transportation paths (pipelines, shipping paths) with distinct pricing structures (fixed, zonal or distance based), GMG Australia also includes a detailed network model with these features.

Spatial price equilibrium models have been used to study problems in a number of fields including agriculture, energy markets, mineral economics, as well as in finance. These perfectly competitive partial equilibrium models assume that there are many producers and consumers involved in the production and consumption, respectively, of one or more commodities and that as a result the market settles in an economically efficient fashion. Similar approaches are used within gas market models across the world.

**Figure C.2** Simplified example of market equilibrium and settlement process




*Source: ACIL Allen.*

### C.2.2 Data inputs

The user can establish the level of detail by defining a set of supply regions, customers, demand regions, pipelines and LNG facilities. These sets of basic entities in the model can be very detailed or aggregated as best suits the objectives of the user. A ‘pipeline’ could represent an actual pipeline or a pipeline corridor between a supply and a demand region. A supplier could be a whole gas production basin aggregating the output of many individual fields, or could be a specific producer in a smaller region. Similarly, a demand point could be a single industrial user or an aggregation of small consumers such as the residential and commercial users typically serviced by energy utility companies.

The inputs to GMG Australia can be categorised as follows:

— **Existing and potential new sources of gas supply**: these are characterised by assumptions about available reserves, production rates, production decline characteristics, and minimum price expectations of the producer. These price expectations may be based on long-run marginal costs of production or on market expectations, including producer’s understandings of substitute prices.

— **Existing and potential new gas demand**: demand may relate to a specific load such as a power station, or fertiliser plant. Alternatively, it may relate to a group or aggregation of customers, such as the residential or commercial utility load in a particular region or location. Loads are defined in terms of their location, annual and daily gas demand including daily demand profiles, and price tolerance.

— **Existing, new and expanded transmission pipeline capacity**: pipelines are represented in terms of their geographic location, physical capacity (which may vary over time), flow characteristics (uni-directional or bi-directional) and tariffs.

— **Existing, new and expanded gas storage facilities**: Storage is represented in terms of geographic location, physical capacity (which may vary over time), injection and withdrawal rates, storage efficiency and tariffs.

— **Existing and potential new LNG facilities**: LNG facilities include liquefaction plants, regasification (receiving) terminals and assumptions regarding shipping costs and routes. LNG facilities play a similar role to pipelines in that they link supply sources with demand. LNG plants and terminals are defined at the plant level and require assumptions with regard to annual throughput capacity and tariffs for conversion.

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