The 2022 Energy Crisis: horizontal and vertical impacts of policy interventions in Australia's National Electricity Market

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Abstract

The war in Ukraine and the associated 2022 energy crisis has had far-reaching effects with seaborne prices for coal and gas reaching multiples (5-6x) of their historic averages. While Europe was the epicentre, countries as far away as Australia were impacted. As a major exporter of coal and gas, domestic markets are linked to seaborne prices. Consequently, forward prices for 2023 delivery in Australia's National Electricity Market surged from ~$48 in 2021 to $156/MWh in 2022 – at one point peaking at $247/MWh. Household electricity tariffs were set to increase by 11% in 2023 and 35% in 2024. In late-2022, the Commonwealth Government intervened by setting fuel price caps of $125/t and $12/GJ for coal and gas, respectively. Given an estimated market heat rate of ~8.2GJ/MWh, forward prices reduced to ~$105/MWh. In this article, price increases before- and after-policy interventions are analysed. 2024 tariff increases after policy intervention are forecast to increase by 16.5% (cf.35%), benefiting all customers. State Government hardship policy remains vitally important, however. Underlying levels of fuel poverty in 2024 are forecast at 12.1% pre-policy, and 6.7% after policy intervention, with State-level hardship policies making the larger (3.2 percentage point) contribution to this result.

Keywords: Fuel poverty, policy targeting efficiency, electricity prices.
JEL Codes: D4, L5, L9 and Q4.

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1. Introduction

In Australia's National Electricity Market (NEM), residential electricity tariffs surged over the period 2007-2015, rising +80.5% or +7.7% per annum in real terms[1]. Rising prices coincided with elevated quantities consumed via air-conditioning loads for space cooling[2], and it was at this point that the concept of fuel poverty began to emerge as a broader policy problem in Australia. Indeed fuel poverty, the inability to afford a socially and materially necessary level of energy supply, has a relatively short history in the southern hemisphere (Awaworyi Churchill et al., 2020; Mazzone, 2020).

This led to considerable focus by NEM state governments (i.e. Queensland, New South Wales, Victoria, South Australia and Tasmania) on their respective customer hardship schemes, while policymakers and regulators focused on headline prices. In the years that followed, electricity affordability improved considerably. From 2015-2022, tariffs reduced by -29.2% and various refinements to hardship policies vis-à-vis electricity concessions (i.e. income supports) were implemented (Simshauser, 2021).

In 2022 the war in Ukraine and the associated turmoil in seaborne markets for coal and natural gas sent fuel prices to multiples (viz. 5-6x) of their historic averages, creating an *energy crisis*. The effects are being felt as far away as Australia – as a significant exporter of coal and gas, domestic fuel markets are linked to seaborne prices. And while the majority of thermal plant have long-dated contracts detached from the seaborne markets, marginal plant and output do not – they are exposed to varying degrees to export prices. Sharply rising levels of renewables meant the degree of term-contracted fuel supplies has also been declining. And when combined with unusually high coal plant outage rates, NEM exposure to export price dynamics was further amplified. Forward electricity prices for 2023 delivery in Australia's NEM surged from ~$48 in 2021 to $156/MWh in 2022 (the 52-week average), peaking at $247/MWh in Oct-22. Consequently, gains from falling electricity tariffs over the period 2015-2022 will be quickly unwound, with rising levels of fuel poverty a predictable outcome.

With a backdrop of rising interest rates and sharply higher consumer price inflation, governments intervened. In late-2022, the Commonwealth Government set a price cap of $125/t and $12/GJ for domestic coal and gas, respectively. NEM State Governments will also respond in various ways by refining customer hardship policies and schemes. Australian households have thus far been broadly shielded from these (spot) electricity price dynamics because regulated tariff determinations assume a prudent retailer[3] builds-up a hedge book over a 2- or 3-year period prior to real time[4]. However as each year passes, low-cost hedges from prior periods (i.e. pre-2022 energy crisis conditions) are assumed to be replaced by hedges in current market conditions. As a result, by the 2023/24 financial year household electricity tariffs will have fully impounded the effects of very high wholesale market prices.

[1] This was driven by a series of cost pressures including an episode of policy-induced Averch and Johnson (1962) network investment (+46.2%), wholesale price rises (+17.2%), the introduction of CO_2 prices, renewable certificates and recovery of premium rooftop solar feed-in tariffs (+14.7%) and retail costs (+2.4%).
[2] Air-conditioning take-up rates had risen from ~15% to more than 75% over the decade to 2010. The average Australian dwelling floorspace had risen from ~110m^2 to more than 150m^2 over the same timeframe (with new housing closer to 250m^2 - at the time amongst the largest globally). And during the period 2000-2010, household appliances had risen in number from 46 to 67 and at any point in time, more than half of these would be plugged in and 'on' (see Simshauser and Nelson, 2014).
[3] The concept of the 'prudent retailer' is a theoretical and normative construct used by Australian regulators in tariff determination processes to set a wholesale cost allowance. It describes a 'risk-neutral' approach to hedging by a competitive retailer. Specifically, it is modelled as a balanced portfolio of hedge contracts progressively built-up over a two- or three-year window, using a 1-in-10-year hot weather scenario to minimise the risk of bankruptcy.
[4] The Australian Energy Regulator uses a two-year window in calculating Southeast Queensland's reference tariff, whereas the Queensland Competition Authority uses a three-year window in calculating regional Queensland notified tariffs. Both have the effect of spreading price risks to varying degrees.

In the analysis which follows, residential electricity tariffs and consumer impacts are modelled over a three-year period (2021/22 to 2023/24) using electricity market data and Australian Bureau of Statistics (ABS) microdata, respectively. The modelling is grounded firmly in welfare economics with a primary purpose of assessing 'underlying' levels of fuel poverty, and the cumulative effectiveness of policy responses. To ensure the tractability of results, the data and analysis are focused on the NEM's Queensland region – noting subtle differences exist amongst NEM state electricity tariffs, state climate, state fuel use, state hardship policy and electricity concessions. However, Queensland results can be taken as reflective of overall NEM dynamics without loss of generality.

Modelling results show the 2022 energy market crisis was set to send retail tariffs up 11% in 2023 and 35.3% in 2024, with the underlying (pre-policy) levels of fuel poverty virtually doubling, from 6.3% in 2022 to 12.1% of households in 2024. The Commonwealth Government's intervention seems capable of halving the 2024 tariff increase to ~16.5% (cf. 35.3%). The cumulative effects of Commonwealth and State-level policies on fuel poverty reduce the incidence to 6.7%. Both Commonwealth (price) and State (income support) policies are therefore effective.

This article is structured as follows. Section 2 reviews relevant literature. Section 3 outlines the model and dataset. Section 4 examines the horizontal and vertical efficiency of policy. Section 5 examines the relative efficiency of universal payment schemes vs. targeted schemes. Policy implications and concluding remarks follow.

2. Review of Literature

Energy policy covers a wide array of topics but at its core, collapses down to a simple objective: minimise the cost of supply *subject to* i). a reliability constraint, and ii). an environmental constraint (viz. CO_2 emissions). The central overlay arising from energy policy is *affordability*, the reasons for which are axiomatic. Electricity is an essential service and access to it is considered a basic human right (Tully, 2006). As a non-discretionary item, electricity accounts for less than 3% of average household expenditure in Australia. Crucially however, this is 'on average'. Electricity has long been one of the more regressive commodities in the household 'basket of goods' (Stigler, 1954; Bennett et al., 2002; Simshauser, 2021). That is, the poorer the household, the higher proportion of income devoted to electricity supply (Nelson et al., 2012; Dodd and Nelson, 2021). This review of literature examines a definition and history of fuel poverty, policy options, measurement principles and most importantly given the modelling setup, the concepts of horizontal and vertical efficiency of policy targeting.

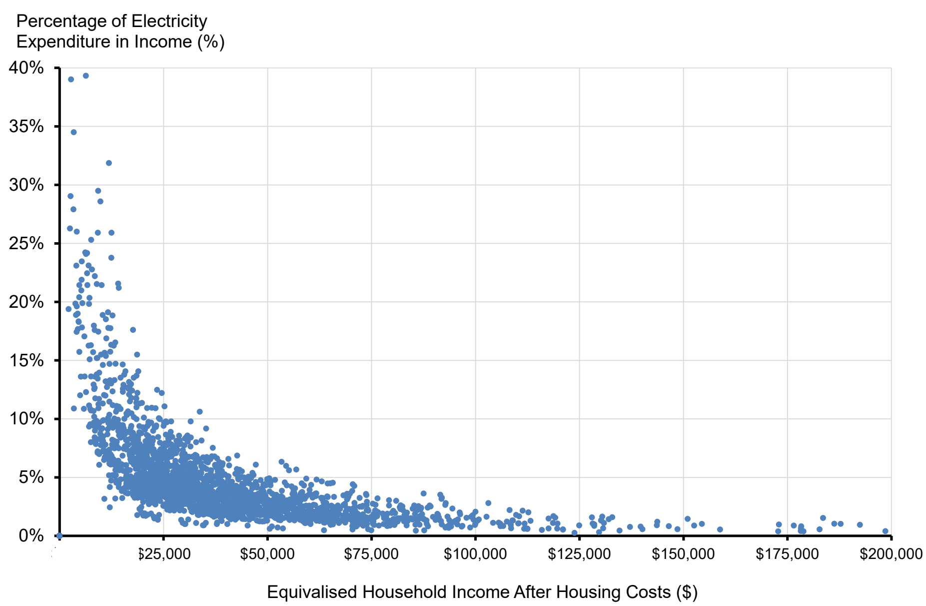
2.1 Definition and history of fuel poverty

Fuel poverty can be thought of as the inability of a household to afford a domestic energy supply considered socially and materially necessary (Guertler, 2012). Charlier and Legendre (2019) define fuel poverty as when a household cannot afford the most basic amount of energy for heating (cooling), cooking, lighting and use of appliances in the home. As a formal concept, 'fuel poverty' can be traced at least as far back as Bradshaw and Hutton (1983) and as a term, is formally used in Ireland, New Zealand and Great Britain (Belaïd, 2018). In Eastern Europe and Australia, the term 'energy poverty' is more commonly used. Other strands of the literature distinguish fuel poverty from energy poverty with the latter being the absence of an adequate supply due to a lack of infrastructure – most commonly associated in economies of a developing nature (see for example Li et al., 2014; Welsch and Biermann, 2017). More recently, fuel poverty and energy poverty seem to be used interchangeably (Chai et al., 2021; Deller et al., 2021).

The problem of fuel poverty existed long before the problem was defined. Indeed, the relationship between incomes and energy affordability has a long history, dating back to the 19th Century literature and the first household expenditure analysis undertaken by Engels in 1857. In his analysis, households were segregated according to their social standing which displayed little variation (i.e. 5.4 – 5.6%) in 'fuel and light' expenditure across groups. However, when the same dataset was reorganised in 1897 by ranking households according to incomes, Engels found a regressive relationship. The Engels Curve would subsequently become a permanent fixture in microeconomics – comprising a basic proposition – for certain household goods (e.g. 'fuel and light'), the poorer the household, the higher the proportion of total expenditure devoted to it (Stigler, 1954).

An Engels curve for Queensland electricity consumers is illustrated in Fig.1, with electricity expenditure measured on the y-axis, and equivalised incomes after housing costs on the x-axis. This relationship is not unique to Australian households. Along with Engel's 1897 dataset of German households, Bennett, et al. (2002) find an identical pattern for households in Great Britain.

Figure 1: Engels curve for electricity expenditure (Queensland, 2021/22)



Data Source: Australian Bureau of Statistics, Simshauser (2021).

Fuel poverty has traditionally been considered a northern hemisphere concept (i.e. cold climate). However, climate change and rising living standards has led to a greater take-up rate of air-conditioners which in turn increased household quantities consumed. Combined with the effects of a warming climate, the fuel poverty problem migrated to the southern hemisphere (Awaworyi Churchill et al., 2020; Mazzone, 2020; Simshauser, 2021). Worldwide heat-related deaths have risen by more than 50% over the past two decades for the aged. Such deaths are a rising problem in Australia (Watts et al., 2021; Awaworyi Churchill and Smyth, 2021a) and globally have risen by 53.7% over the past 20 years.

Fuel poverty is a difficult concept and is *not* the same as poverty (Boardman, 1991, 2012; Bennett et al., 2002; Fahmy, 2011; Hills, 2012). A household can be poor but afford their energy, and conversely, a household with income demonstrably above the poverty line may not be able to afford their energy costs due to household structure or may do so only at the expense of other essential items such as diet (Bradshaw and Hutton, 1983). Most importantly, not every energy consumer who spends above fuel poverty thresholds feels poor, and conversely, not every household who feels poor meets fuel poverty thresholds (Waddams Price et al., 2012). Indeed, as Fig.9 later reveals, quantitatively, there is almost no correlation between post-housing equivalised incomes and energy use in countries such as Australia and Great Britain. This complex income expansion path vis-à-vis energy consumption is why fuel poverty warrants attention at all (Bennett et al., 2002).

2.2 Fuel poverty – policy options

Various options exist for policymakers in dealing with fuel poverty. To simplify a vast literature, options collapse down to three policy categories, which in turn represent the underlying causes of fuel poverty (Thomson et al., 2016):

1. Price: tariff design and associated pricing policies aimed at minimising prices or improving the relative efficiency of prices, including discounted tariffs to vulnerable households – sometimes referred to as ‘social tariffs’ (Bennett et al., 2002; Nelson et al., 2012; Waddams Price et al., Wang, 2012; Lorenc et al., 2013);
2. Quantity: improvements to housing stock, housing insulation, appliance efficiency measures and emerging policies associated the installation of rooftop solar PV – all of which are designed to reduce energy quantities consumed (Boardman, 2012; Belaïd, 2018; Jessel et al., 2019a; Nelson et al., 2019; Mazzone, 2020; Dodd and Nelson, 2022); and

3. Income: income supports typically on a targeted basis designed to subsidise energy costs, either through cash payments or direct credits against utility bills (Welsch and Biermann, 2017; Awaworyi Churchill and Smyth, 2021b; Best et al., 2021; Burlinson et al., 2021; Simshauser, 2021; Chai et al.,2021).

Of these, quantity measures have historically been considered a central source of fuel poverty in western economies (see Boardman, 1991). But as definitions of fuel poverty expanded beyond ‘adequate warmth’, so too has the necessary policy mix. And as Awaworyi Churchill and Smyth (2021a) explain, in the Australian context refining income supports had become critical (see also Chai et al., 2021; Simshauser, 2021).

Invariably the optimal response will require a mix of policy measures, but resolution of that mix is complex because broad-based policy responses can amplify the problem of fuel poverty rather than alleviate it. For example:

- Changes to tariff structures such as introducing inclining block tariffs, which benefit low-use pension households, have the effect of harming low income, large family households who are among the power systems largest residential users (in spite of their incomes) (Simshauser and Nelson, 2014; Simshauser and Downer, 2016; Chai et al., 2021). Similarly, eliminating two part-tariffs (i.e. removing the fixed charge and increasing the variable rate) has the same effect on pensioners and low income, large family households (Bennett et al., 2002; Fankhauser and Tepic, 2007; Waddams Price et al., 2012; Simshauser and Downer, 2016).

- Policies which introduce social tariffs for vulnerable households and are funded by raising electricity prices to all other residential consumers can have the effect of introducing a new batch of otherwise borderline households into fuel poverty (Nelson, et a., 2011; Stockton and Campbell, 2011; Nelson, et al., 2012; Rosenow et al., 2013).

- Similarly in contestable retail energy markets, policies designed to limit the practice of price discrimination or place regulatory price caps on otherwise competitive market outcomes predictably leads to the evaporation of deep discounts – the very products which benefit vulnerable households (Hviid and Waddams Price, 2012; Littlechild, 2015, 2018a, 2018b; Waddams Price and Zhu, 2016; Simshauser, 2018; Esplin et al., 2020).

- Quantity-based schemes are often not well understood by intended recipients, suffer from split incentives, and can produce regressive effects for non-participants if funded through raising tariff structures (Nelson, et al., 2011; Guertler, 2012; Nelson, et al., 2012; Rosenow et al., 2013; Simshauser, 2016).

For clarity, this article focuses only on the impacts of i). electricity price levels, and ii). electricity concessions (i.e. income support) policies currently being deployed by Commonwealth and State Governments, respectively.

2.3 Measuring policy effectiveness

There is a steadily growing body of research on fuel poverty (Jessel et al., 2019) although as Charlier and Legendre (2019) explain, that literature highlights the need for a general theoretical framework – equivalent to Sen's work on poverty (Sen, 1976, 1979). Sen (1976) identifies two basic problems with measuring poverty. First, identifying vulnerable households within the total population (i.e. horizontal measurement and analysis). Second, constructing measures that capture changes in the intensity of poverty to identify programs that alleviate or aggravate the problem, or segments of the problem (i.e. vertical measurement and analysis). This led to Sen's axioms of poverty measurement:

- Monotonicity axiom: headcount ratios fail to capture the change in the intensity of poverty if prices and/or incomes change.

- Transfer axiom: headcount ratios fail to reflect changes in the intensity of poverty if transfers occur from poor to higher income households.

While Sen focused on acute poverty, Townsend (1962) viewed poverty as a relative problem, specifically, families whose resources fall materially below the average of their local community, including in advanced economies, can be considered to be in poverty. These principles from Sen and Townsend have implications for fuel poverty assessments. In the modelling that follows (Sections 3-5), both horizontal and vertical measurement and analysis (Sen) are undertaken with a focus on fuel poverty as a relative problem (Townsend).

Rule-of-thumb thresholds have historically been used to identify different areas of hardship. For example, water poverty is said to be binding when it accounts for 3.5% of household income (Chan, 2016), housing stress occurs at 30% of household incomes (Tanton and Phillips, 2013) and fuel poverty was thought to occur when a vulnerable household's normative cost of energy supply exceeded 10% of income. It should be noted that the 10% threshold is in line with the early work of Boardman (1991) and that there is no 'united definition' of fuel poverty (Thomson et al., 2016; Charlier and Kahouli, 2019). Some analyses use a multidimensional approach incorporating an array of quantitative and subjective metrics (see for example Charlier and Legendre, 2019; Sokołowski et al., 2020; Awaworyi Churchill and Smyth, 2021a; Deller et al., 2021). In the analysis that follows, the 10% threshold is used.

- *On energy quantities consumed*

Early measurement used normative standards for energy quantities consumed (Boardman, 1991, 2012). In Great Britain, the Hills Review argued that relative analysis or 'empirical observation' was more appropriate with a focus on high relative costs and low incomes (Hills, 2012). Empirical analysis revealed the 'demonstrated use' of household energy consumption in Great Britain deviated from the normative view of consumption (see Hills, 2012 and Bramley, 2012, respectively). Consequently, affordability ratios (e.g. 10% for fuel poverty) are appropriate since they align with reported payment problems.

- *On incomes*

Screening by relative incomes is crucially important. Bounds should be established to ensure the focus is on genuinely vulnerable households. Boardman (1991) uses 30th percentile household income prior to testing for fuel poverty. In Australia, housing studies rely on the "40/30 rule" where low-income households are defined as the 40th percentile, with 30% of income defining the point of housing distress (see Rowley et al., 2015; Tanton & Phillips, 2013). In fuel poverty analyses, 40th percentile incomes are often used (e.g. Komives et al., 2006; Chan, 2016) or 60% of median disposable incomes (see Fahmy, 2011; Bramley; 2012; Moore 2012; Hills, 2012; Yamamori, 2019).

Balestra & Tonkin (2018), Simshauser (2021) and the Australian Bureau of Statistics' preferred coincident bound is *Low Economic Resource* households. Specifically, *Low Economic Resource* households are defined by the crossover of Low Income (40th percentile) *and* Low Net Wealth (40th percentile) and when matched equate to ~20th percentile households in a manner consistent with Townsend's (1962) principles (see also Best et al., 2021; Best and Esplin, 2023 on the significance of including wealth).

- *On equivalised incomes*

Ideally, household incomes should be equivalised. The issue here is that two households with the same income, but with varying compositions, are not equal. Households with two adults and no children have less critical necessities than a household with two adults and three children, holding the quality of life constant (Waddams Price et al., 2012; Kessides et al., 2009; Stone, 2006; Oorschot, 2002; Moore, 2012;). Use of the modified OECD Scale is typically deployed for this purpose as it allows differential consumption needs of adults and children, and for the economies of scale that comes with multi-person households (Rowley et al., 2015; Tanton & Phillips, 2013; Bramley, 2012; Hills, 2012; Stone, 2006; Beckerman, 1979).

- *On equivalised incomes after housing costs*

When examining vulnerable household incomes in the context of fuel poverty, the final measurement process should be based on equivalised disposable incomes *'after housing costs'* (see Moore, 2012, Hills, 2012, Chan, 2016; Simshauser, 2021). Housing costs frequently drive the incidence of financial vulnerability as it is typically the least flexible, and largest claim over household incomes (Stone, 2006). Energy use is also correlated with household structure (Simshauser and Downer, 2016; Chai et al., 2021).

For clarity, in this article vulnerable households are defined and measured as *Low Economic Resource* as outlined in Balestra and Tonkin (2018), and the threshold for fuel poverty is 10% of household equivalised disposable income after housing costs.

2.4 Measuring the horizontal & vertical efficiency of policy

In Australia, tax and transfer policies are designed to provide support to vulnerable households and are typically 'highly targeted'. In most instances, targeting is the subject of means testing. Means-tested targeting has the effect of constraining fiscal budget outlays while reducing the dispersion of market incomes, thus assisting social equity (Komives et al., 2006; Oorschot, 2002).

As a policy, targeting usually achieves political support across party lines because the objective of protecting vulnerable households is not considered contentious (Simshauser, 2021; Oorschot, 2002; Besley, 1990). And the case for targeting of vulnerable households (*cf.* universal support) is intuitive because governments face balance sheet constraints (Simshauser, 2021; Creedy, 1996; Oorschot, 2002). Specifically in Australia, progressive politicians support reducing the dispersion of market incomes and its positive effects on reducing the incidence of inequality, while conservative politicians support the normative design as it focuses on those who are genuinely in need of assistance.

Household-level targeting does however require a very focused effort in order to seek out society's poorest (Hoddinott, 1999). Doing so is costly (Besley & Kanbur, 1990; Komives et al., 2006) and consequently the measurement of horizontal and vertical performance of policy and targeting is important.[5] The concepts of horizontal and vertical efficiency of policy are essentially derived from Sen's (1976) axioms. Specifically,

- Horizontal target efficiency refers to the degree to which policy treats 'like households' in the same manner and is measured by way of headcount.

- Vertical target efficiency accommodates Sens axioms by focusing on both the incidence, and the depth of fuel poverty, and whether policy delivers differentially greater support according to relative need.

From a targeting perspective, Australia benefits from its tax and transfer system – being the most targeted in the world (Joumard et al., 2012; Simshauser, 2021). As a typical Anglo-Saxon model, it is *very highly targeted* to low-income groups. Means-testing is used extensively with funding provided by a progressive taxation system.

In Australia, the Commonwealth Government presides over the welfare state but energy policy is primarily the domain of sub-national or State Governments. An electricity concession framework designed by a State Government can rely on Commonwealth Government welfare flags. What this means in practice is that administrative changes to policy decisions (i.e. targeted groups) at the State level involves comparatively low transaction costs.

3. Model and data

The subsequent analysis makes use of models and data from Simshauser (2021), albeit extended to current market conditions. This includes the Horizontal-Vertical Fuel Poverty Model (HVFP Model), microdata from the Australian Bureau of Statistics (Section 3.1), and an electricity tariff model (Section 3.2).

3.1 HVFP Model and Microdata

The HVFP Model commences with Australian Bureau of Statistics microdata, specifically, the Survey of Income and Housing and accompanying Household Expenditure Survey (2015). As

[5] One Reviewer noted beyond the fiscal constraints of government, social tariffs can be constructed and administered by utilities.

Skoufias & Coady (2007) explain, use of microdata is the 'gold standard' for the analysis of poverty. Core elements of the microdata used in the HVFP Model include household formation (i.e. adults, children, aged pensioners, dependents etc), number of bedrooms, electricity costs, household incomes, household wealth, housing costs and the array of Australian Commonwealth Government welfare flags (viz. pension cardholders, seniors cardholders, healthcare cardholders etc).

Just as Computable General Equilibrium Models use indices to forecast base inputs, the HVFP Model also relies on indices for forecasting. Specific indices include population growth, electricity prices, electricity quantities, household incomes and government hardship policy income support. The Consumer Price Index is used as a default where specific indices do not exist. Tab.1 sets out the relative indices used.

Table 1: Base data indices (2016/17 – 2023/24 f'cast)

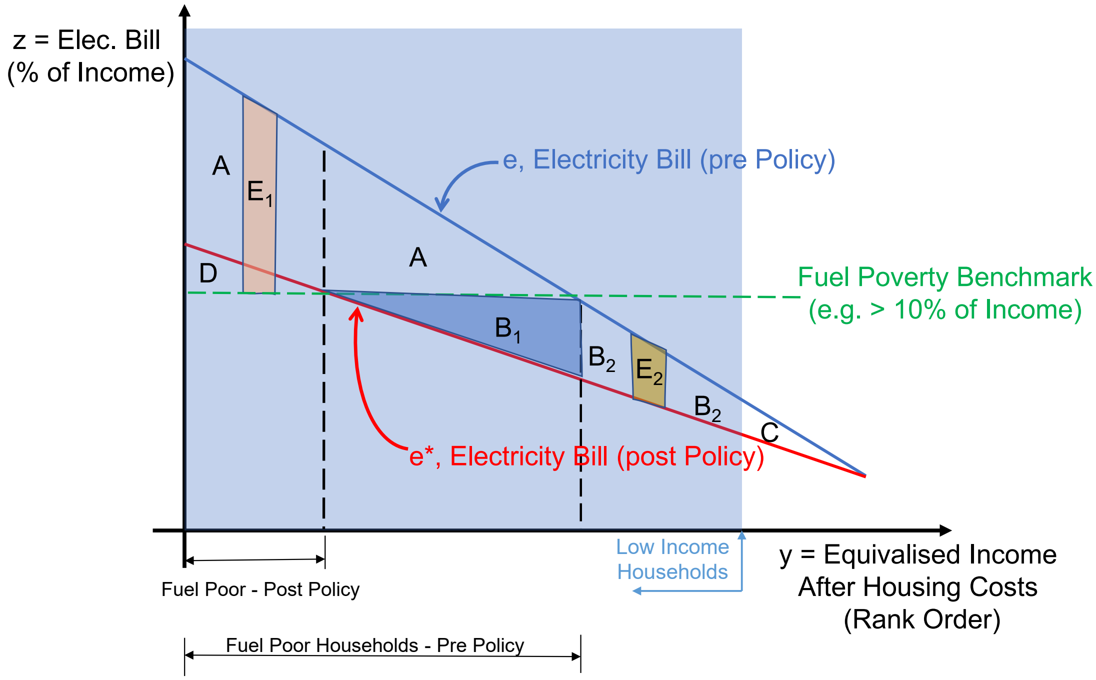
Year	Number of Households	Electricity Tariff	Wage Price Inflation	Consumer Price Inflation	Hardship Payment
2016/17	1,918,491	4.0%	1.9%	1.8%	$324
2017/18	1,947,496	3.4%	2.2%	1.7%	$330
2018/19	1,984,475	-0.8%	2.3%	1.7%	$335
2019/20	2,010,650	-5.3%	1.9%	-1.0%	$341
2020/21	2,027,061	-7.5%	1.6%	4.9%	$337
2021/22	2,092,649	-8.1%	2.4%	5.1%	$354
2022/23	2,124,039	11.0%	3.8%	7.0%	$372
2023/24	2,155,895	35.3%	3.8%	3.5%	$398
Cum. Growth	12.4%	28.8%	21.6%	27.3%	23.0%

On electricity quantities, the model relies on an own-price elasticity estimate of -0.10 (see variously Faruqui, 2008; Faruqui and Palmer, 2011; Borenstein, 2013; Burke and Abayasekara, 2018; AEMO, 2019) noting this is higher than the recent Australian study by Byrne et al. (2021).

The HVFP Model is focused on analysing the horizontal and vertical efficiency of policy, based on Beckerman's (1979) framework as modified by Chan (2016) and later Simshauser (2021). The model is configured to identify changes in fuel poverty in terms of depth and intensity so as to satisfy Sen's (1976) axioms. It also incorporates Townsend's (1962) principles by specifying relative analyses (Besley, 1990; Besley & Kanbur, 1990). Beckerman's framework, adjusted for fuel poverty, and the conceptual objective of the model, is outlined in Fig.2.

In Fig.2, the y-axis assembles households in descending order of electricity bill as a percentage of income (viz. disposable, equivalised, after housing costs). The blue line shows the electricity bill (% of income) prior to policy implementation, and the red line shows the result after policy. The green horizontal line shows the threshold of fuel poverty. The HVFP Model, using the ABS microdata, quantitatively replicates this framework for households in a given region.

Figure 2: HVFP Model structure



Where:

A =	Vulnerable household, successfully targeted (fuel poor)
B_1 =	Vulnerable household, successfully targeted, spill-over benefit (fuel poor)
B_2 =	Vulnerable household, successfully targeted, spill-over benefit
C =	Not vulnerable household, included in error (i.e. inclusion error)
D =	Vulnerable household, fuel poor, successful targeted, inadequate benefits
E_1 =	Vulnerable household, fuel poor, excluded (i.e. exclusion error)
E_2 =	Vulnerable household, not fuel poor, excluded (i.e. exclusion error)

Household segments identified in Fig.2 (i.e. segments A, B_1, B_2, C, D, E_1, E_2) are captured and isolated within the HVFP Model. That is, the model allocates each household according to thresholds of equivalised incomes (x-axis in Fig.2) and electricity costs before, and after, policy treatment (y-axis in Fig.2). The specific model logic for constructing segment results, including the various measures of horizontal and vertical efficiency, are as follows:

$$Total\ Policy\ Cost = \int_{y=0}^{z} e(y)d(y) - \int_{y=0}^{z} e^*(y)d(y) \quad (1)$$

$$Benefits\ received\ by\ Fuel\ Poor\ Households = A + B_1\ , \quad (2)$$

$$Vulnerable\ Household\ Vertical\ Efficiency = \frac{(A+B_1+B_2)}{Total\ Policy\ Cost}\ , \quad (3)$$

$$Vulnerable\ Household\ Spillover\ Impacts = \frac{(B_1+B_2)}{(A+B_1+B_2)}, \quad (4)$$

$$Fuel\ Poverty\ Reduction\ Efficiency = \frac{A}{Total\ Policy\ Cost}, \quad (5)$$

$$Non-Vulnerable\ Inclusion\ Error\ Inefficiency = \frac{C}{Total\ Policy\ Cost}, \quad (6)$$

$$Vulnerable\ Household\ Exclusion\ Error\ Inefficiency = \frac{(E_1+E_2)}{Total\ Policy\ Cost}, \quad (7)$$

$$Fuel\ Poverty\ Inadequacy\ Error = \frac{D}{(A+B_1+B_2)}, \quad (8)$$

3.2 Vulnerable Households in the HVFP Model: Low Economic Resource

A critical parameter within the HVFP Model is the definition of the target cohort for policy purposes. As foreshadowed in Section 2, vulnerable households are identified in a manner consistent with the Australian Bureau of Statistics, Balestra and Tonkin (2018) and Simshauser (2021), viz. 'Low Economic Resource'. Low Economic Resource or LER households are defined as households in the 40th percentile of equivalised household net wealth, *and* 40th percentile of equivalised disposable income. HVFP Model results for LER households are illustrated in Figure 3.

To summarise Fig.3, the 2021/22 Queensland population of 5.2m people comprises 2,092,645 households. The 40th percentile equivalised net wealth ($298,700) and equivalised income ($670) equates to 837,000 households in each segment, with the cross-over of both segments being 380,000 LER households.

Figure 3: Low Economic Resource Households (Queensland, 2021/22)

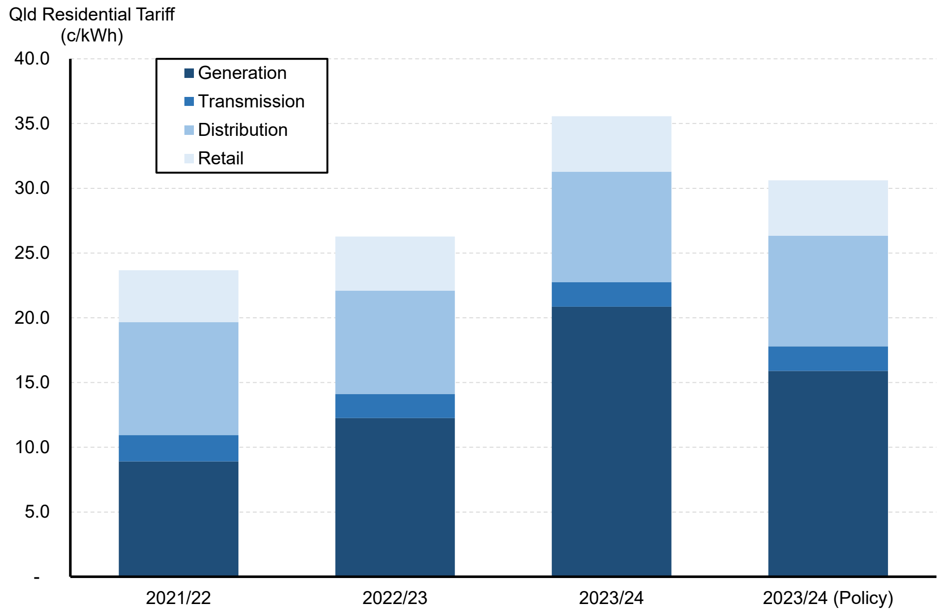
Data Source: Australian Bureau of Statistics, Simshauser (2021).

3.3 Electricity Tariff Model

Household electricity tariffs in the NEM are dominated by conventional two-part tariffs comprising a fixed charge and variable rate. The fixed charge is expressed in c/day and currently forms ~20% of total charges. The variable rate is expressed in c/kWh, typically without time variation (i.e. a flat tariff). Time-of-use tariffs are available on an 'opt-in' basis. In Queensland, most households are also physically connected to a second controlled tariff at discounted rates (i.e. a remote scheduled tariff with 16 hours per day of interruptible supply), with appliances connected comprising electric hot water systems and/or pool pumps.

For 2021/22, Queensland's two-part tariff was set at 88.4c per day (fixed charge) and 19.8c/kWh (variable rate) with the controlled tariff of 17.4c/kWh. When applied to average household consumption (6250 kWh), the average rate equates to 23.85c/kWh as illustrated in Fig.4 (first bar). Fig.4 sets out the cost elements contained in the model, including the forecasts for 2023/24 (pre- and post-policy). Note in 2021/22 generation was 8.9c/kWh (38%), transmission was 2.0c/kWh (9%), distribution was 8.7c/kWh (37%) and retail charges formed the balance, at 4.0c/kWh (17%).

Figure 4: Residential tariff cost elements (6250kWh pa)



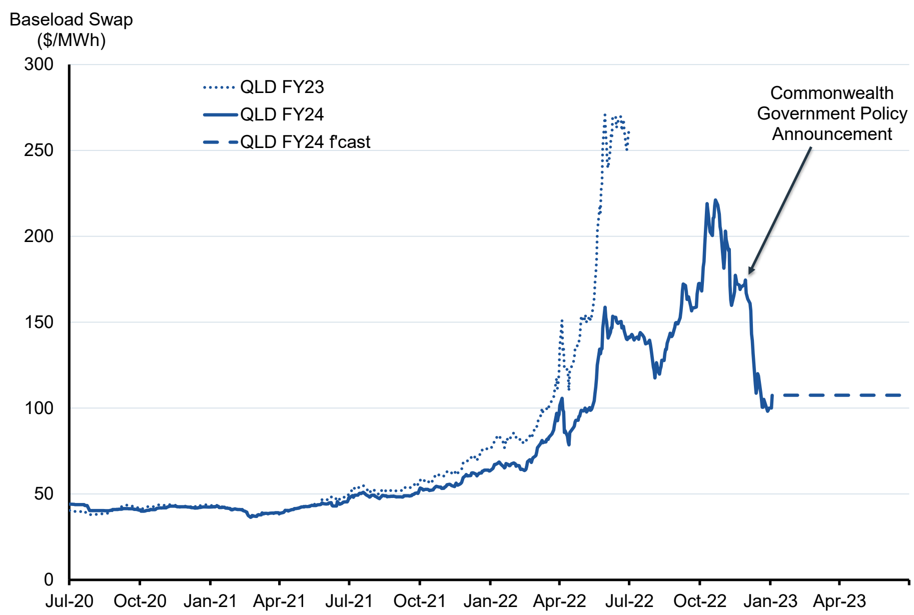
Tariffs for 2022/23 (Fig.4, second bar) increased by 11%, with changes dominated by generation costs (up ~38% to 12.3c/kWh). Wholesale prices surged in the final months prior to the start of the 22/23 year, as Fig.5 illustrates.

Using forward market prices prior to the intervention by the Commonwealth Government in fuel markets (viz. setting coal and gas price caps of $125/t and $12/G), wholesale energy costs were set to rise by a further 70% to ~20.9c/kWh – meaning final tariffs in 2023/24 would rise by ~35.3% (Fig.4, third bar). However, impacts of fuel market interventions on forward prices for the 2023/24 financial year baseload swap contract has been very significant, as Fig.6 illustrates. In Fig.6, prices have fallen from a peak of ~$225/MWh to $107/MWh – and are assumed to remain at this level on the basis of an 8.2GJ/MWh market heat rate in line with (Nolan, Gilmore and Munro, 2022).[6] Under these conditions, generation cost increases may be limited to 30% - meaning final tariffs would increase by ~16.5% (Fig.4, fourth bar). These statistics have been incorporated in the Tab.1 indices, and the HVFP Model accordingly.

[6] The average forward price over the four week period from policy announcement in December 2022 through to the time of drafting (Jan-2023) was $107/MWh, and this is assumed to extent through to the start of the 2023/24 financial year. This aligns reasonably well with the market heat rate set out in Nolan et al. (2022), viz. 8.2GJ/MWh system heat rate and a gas price cap of $12/GJ + $1/GJ transport, such that 8.2GJ/MWh x $13GJ price cap + transport = $106.6/MWh

Figure 5: Run-of-trade - 2022/23 financial year baseload swaps (QLD)

Figure 6: Run-of-trade - 2023/24 financial year baseload swaps (QLD)



3.4 HVFP Model Policy Parameters

Commonwealth Government policy intervention is incorporated in the model in a manner consistent with Section 3.3. Specifically, a 35.3% tariff increase occurs in the model in 2023/24 (pre-policy), and a 16.5% tariff increase for 2023/24 occurs in the post-policy environment in line the results in Fig.4.

State-level hardship policy, the electricity concession, is an income support. Critically, electricity concessions are highly targeted and applied directly against household electricity bills as a credit. All electricity retailers in the NEM have bilateral agreements with NEM state governments which ensures this occurs.

In Victoria, the electricity concession is structured as 17.5% of the bill. In Queensland, the electricity concession comprises an annual fixed payment of $354 (per Table 2) which averages ~25% of the bill for the average household. Payment occurs on a quarterly basis, meaning $88.50 is credited directly against qualifying household electricity bills each quarter (that is, four payments totalling $354 per annum). To be perfectly clear on this, the electricity concession payment is delivered from governments, via energy retailers, as a credit directly against qualifying household electricity accounts. Responsibility for *enrolment* for the concession rests with qualifying households.

State governments are variously working through their policy structures in the current environment. In the case of Queensland, in addition to the electricity concession, a universal income support has been paid to all household customers. $50 was paid in the 2020/21 year, and $175 paid in the 2021/22 year. Subsequent modelling will use $150 for the 2023/24 year in the post-policy environment (noting no announcement on such a payment has been made by the Queensland Government at the time of writing).

4. Results

In the analysis which follows, the HVFP Model will be used to assess the impacts of the electricity price rises on underlying levels of fuel poverty, along with the horizontal and vertical efficiency of the various policy responses from Commonwealth and State Governments. However, it is first necessary to establish a Base Case for the 2021/22 year from which to analyse future movements. 2021/22 was selected because it is the 'tariff year' immediately prior to the War in Ukraine and represents the nadir of the current price cycle.

In the process of establishing a Base Case, the effects of refining policy targeting, and how to interpret horizontal and vertical impacts, are also illustrated (Sections 4.1 and 4.2, respectively). Section 4.3 then proceeds to analyse the impact of price increases over the period 2021/22 to 2023/24 without government interventions or changes to hardship policy. Section 4.4 then examines the effectiveness of Commonwealth Government interventions in the energy markets, and the impacts of State Government policy adjustments to 'electricity concessions'.

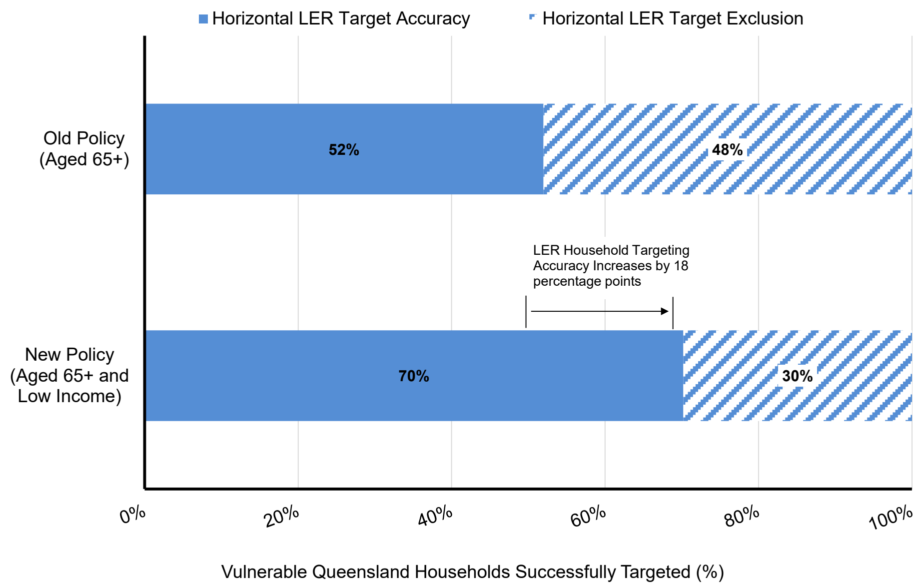
4.1 The concept of horizontal efficiency: improving policy targeting

Horizontal efficiency can be thought of as the accuracy rate of vulnerable household identification measured on a headcount basis. The NEM region of Victoria was the first state to refine such targeting (viz. during the early-2000s). Policy targeting in Victoria incorporated means-tested pension cardholders (low income, aged 65+) and means-tested healthcare cardholders (low-income households of all ages, including families). By way of contrast, in the NEM region of Queensland, its original hardship policy (designed in 1993) focused only on the aged. The implication of this is that low-income non-aged households, and in particular, low-income families, were excluded despite dominating hardship statistics (Simshauser and Nelson, 2012).

By the early-2010s, Queensland policymakers became aware that the sustained run-up in residential electricity tariffs from 2007-2015 (~80.5% cumulative increase in real terms) was causing affordability issues for low-income families. Sharply rising tariffs *prized-open* a political window for policy reform in Queensland during 2016, with means-tested healthcare cardholders formally incorporated. As Figs.7-8 reveal, this would lead to marked improvements in the horizontal accuracy of Queensland's hardship policy.

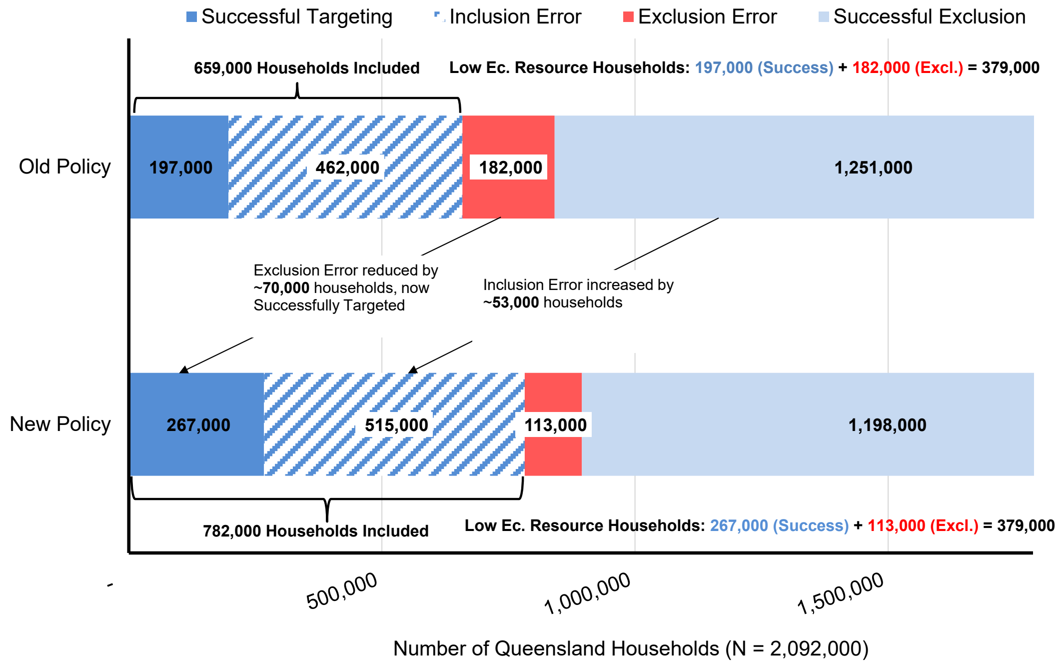
Recall horizontal efficiency measures the extent to which a policy treats ‘like households’ in the same way. The inclusion of means-tested healthcare cardholders casts a wider net in the search for truly vulnerable households because those who qualify are not limited by age, but by wealth and income, thereby enabling low-income households and families to qualify for the electricity concession. HVFP Model results for this change are illustrated in Figs.7-8. Notice in Fig.7 that horizontal target accuracy improves from 52% to 70% of the vulnerable household population.

Figure 7: Horizontal targeting efficiency



The HVFP Model reveals the extent of successful and unsuccessful targeting with the change in policy via Fig.8. Movements between the various categories are clearly marked. Note the change to policy improves target success rates from 197,000 to 267,000 households (+70,000), with the exclusion error category falling from 182,000 to 113,000 households (-70,000).

Figure 8: Horizontal efficiency – inclusion/exclusion & success/error



Improvements come at a cost – households included in error (i.e. those households which qualify for the 'electricity concession' but do not meet the criteria of Low Economic Resource) increase from 462,000 to 515,000 households (i.e. +53,000). Given the electricity concession was $354 during 2021/22, ~$19m is added to program costs (i.e. 53,000 households x $354 per household per annum, assuming 100% take-up rate).

To be sure, inclusion error is an inevitable outcome of the policy. As Hills (2012) explains, it would be naïve to think policies aimed at removing problems faced by 380,000 *Low Economic Resource* households could be dealt with by only treating 380,000 homes. In practical terms a wider group *must* be targeted. In this instance the new policy achieves this, but to be certain we must turn our attention to a vertical efficiency analysis, in Section 4.2.

4.2 The concept of vertical efficiency: improving policy targeting

Sole reliance on headcount metrics (viz. horizontal measurement) overlooks the depth and severity of poverty, and risks violating Sen's (1976) transfer axiom. A vertical analysis examines changes in both the incidence *and depth* of the fuel poverty problem before and after policy. HVFP Model results for 2021/22 are illustrated in Tab.2 with the vertical analysis (i.e. Eq.1-8) illustrated at Lines 1-8 in dollar terms, and in ratio form at Lines 9-16. A detailed horizontal analysis is also produced (Lines 17-27).

Results in Tab.2 reveal the change in policy targeting from 2016 onwards produces an unambiguous improvement in vertical performance. Successful Targeting (Line 1) and Spillover Benefits (Lines 2-3) all record increases. The Vertical Efficiency ratio (Line 9) increases from 29.9% to 33.9%, while inefficiencies due to exclusion reduce considerably, by -$24.5m (Line 6) or -13.1% (Line 14). Benefit inadequacy also reduces by -9.4% (Line 16). The cost of this improvement is an expanded program budget, rising from $233m to $275m at Line 7 (i.e. $354 per annum for 121,000 additional households at Line 23).

Finally, note within the horizontal analysis that the number of fuel poor households successfully targeted rises from 45,000 to 77,000 (Line 17). The 'inherent' level of fuel poverty (i.e. before any policy intervention) is estimated to be 132,000 households or 6.3%, and within those households are 353,000 persons (Line 25-27). After policy, this reduces to 112,000 households or 5.4%.

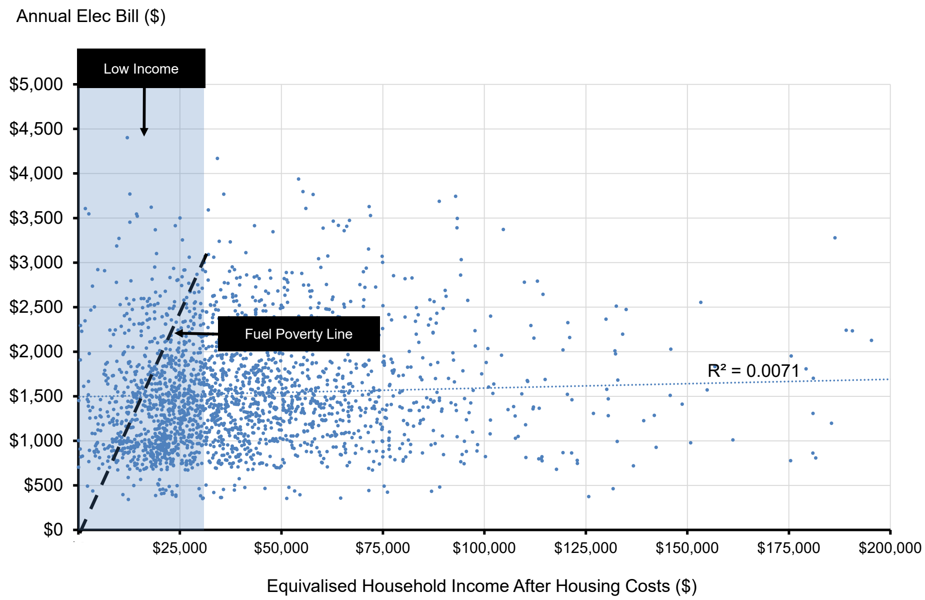
Table 2: Vertical and Horizontal Analysis – Base Case (2021/22 Tariffs)

		POLICY VERTICAL EFFICIENCY		**Old Policy**	**New Policy**	**Change**
LINE		**Policy Settings (Benefit per annum)**		**$354**	**$354**	
1	A.	Successful Targeting (Fuel Poor)		$12,988,000	$22,885,000	$9,897,000
2	B1	Spillover Benefits (Fuel Poor)		$2,989,000	$4,193,000	$1,204,000
3	B2	Spillover Benefits (Low Economic Resource, not Fuel Poor)		$53,870,000	$66,521,000	$12,651,000
4	C	Inclusion Expense (Not Low Ec. Resource, not Fuel Poor)		$163,553,000	$182,387,000	$18,834,000
5	D	Included but Inadequate (Still Fuel Poor)		$15,503,000	$28,549,000	$13,046,000
6	$E_{1,2}$	Exclusion Inadequacy (Low Economic Resource)		$64,541,000	$40,034,000	-$24,507,000
7		Total Program Cost	∑ (A, B1, B2, C)	$233,400,000	$275,986,000	$42,586,000
8		Benefits Received by Fuel Poor	∑ (A, B1,)	$15,977,000	$27,078,000	$11,101,000
		POLICY VERTICAL EFFICIENCY (%)				
9		Vertical Efficiency	∑ (A, B1, B2) / Total Prog. Cost	29.9%	33.9%	4.0%
10		Spill-over benefits	∑ (B1, B2) / ∑ (A,B1, B2)	81.4%	75.5%	-5.9%
11		Poverty reduction efficiency	A / Total Program Cost	5.6%	8.3%	2.7%
12		Spill-over Excess (% of Total)	∑ (B1, B2) / Total Prog. Cost	24.4%	25.6%	1.3%
13		Inefficiency due to inclusion	C / Total Program Cost	70.1%	66.1%	-4.0%
14		Inefficiency due to exclusion	E / Total Program Cost	27.7%	14.5%	-13.1%
15		Inadequate concession benefits	D / Total Program Cost	6.6%	10.3%	3.7%
16		Benefit inadequacy	∑ (D, E) / Total Prog. Cost	34.3%	24.9%	-9.4%
		HORIZONTAL ANALYSIS (Number of Households)				
17	A	Successful Targeting (Fuel Poor)		45,000	77,000	32,000
18	B_1	Spillover Benefits (Fuel Poor)		14,000	20,000	6,000
19	B_2	Spillover Benefits (Low Economic. Resource)		152,000	188,000	36,000
20	C	Inclusion Expense (Not Low Ec. Resource)		462,000	515,000	53,000
21	D	Inadequate Included		31,000	59,000	28,000
22	$E_{1,2}$	Exclusion Inadequacy		182,000	113,000	-69,000
23	F	Total Households Included	∑ (A, B2, C)	659,000	780,000	121,000
24		% of Total Households =	**2,092,649**	31.5%	37.3%	5.8%
25		Fuel Poor LER Households	**Base = 132,000 households**	118,000	112,000	-6,000
26		Fuel Poor LER Households (%)	**Base = 6.3% of households**	5.6%	5.4%	-0.3%
27		Fuel Poor LER Population	**Base = 353,000 persons**	300,000	271,000	-29,000

To summarise Tab.2, all indicators move in a desirable direction with the change in policy. The logical question that follows is what drives such material improvements in both horizontal and vertical policy performance? First, age is not a reliable predictor of aggregate hardship (recall the *Old Policy* only focused on those aged 65+). Second, in Australia and Great Britain at least, there is no clear relationship between energy consumption and household income.

One Reviewer queried this point. However, the quantitative evidence dating back to Engels is clear enough. To be sure, Fig.9 re-organises the Queensland household data and plots energy costs on the y-axis, and incomes on the x-axis. The R^2 is just 0.0071. And Bennett et al., (2002) in an identical analysis found an R^2 of 0.04 for households in Great Britain. The relationship between household incomes and energy costs is a complex one in that it 'scatters' rather than follows a trendline, as one might otherwise anticipate.

Figure 9: After housing cost equivalised Incomes vs electricity bill



Source: Australian Bureau of Statistics, Simshauser (2021).

At this point, our Base Case has been established.

4.3 Vertical and Horizontal Impacts of the War in Ukraine

From 2022, the war in Ukraine caused a global crisis in electricity markets exposed to seaborne prices for coal and/or gas. This included marginal plant in Australia's NEM. Recall from Figs.4-6 these conditions led to sharp increases in wholesale prices and a forecast 35.3% increase in the household tariff by 2023/24 (i.e. prior to Commonwealth Government intervention). The HVFP Model is now used to assess the incidence and severity of fuel poverty in the NEM's Queensland region.

Tab.3 presents annual results for the three years 2021/22 (Base Case), 2022/23 (11% tariff increase) and a forecast for 2023/24 (35.3% tariff increase) with results clearly set out in Columns marked 1, 2 and 3 respectively. The cumulative change in results is reported in Column 4. Note the existing State-level hardship policy concession amount rises annually by the CPI, from $354 to $392. The policy performs well from a vertical perspective with payments to fuel poor (Line 1) rising from $22m to $55m, although axiomatically, with sharply rising tariffs the inadequacy of payments rises significantly – from $28m to $95m (Line 5) or from 10.3% to 29.9% (Line 15).

The horizontal analysis (Lines 17-33) reveals a sharply deteriorating situation, with underlying fuel poor households rising from 6.3% to 12.1% (Line 27), and note in particular the fuel poor population (Line 31) rises from 6.8% to 13.9% - suggesting a rising number of low income multi-person households (viz. children) are being increasingly impacted. Even after the hardship policy, the level of fuel poverty rises from 5.4% to 9.4%. Such results suggest some level of further government intervention is desirable.

Table 3: Horizontal and vertical analysis of tariff increases

		POLICY VERTICAL EFFICIENCY		2021/22	2022/23	2023/24	Change
	COLUMN			1 - Base Case	2	3	4
		Tariff Increase (per Tab.1)		**-8.1%**	**11.0%**	**35.3%**	
LINE		**Policy Settings (Benefit per annum)**		**$354**	**$372**	**$392**	**23/24 v 21/22**
1	A.	Successful Targeting (Fuel Poor)		$22,885,000	$31,257,000	$55,578,000	$32,693,000
2	B1	Spillover Benefits (Fuel Poor)		$4,193,000	$9,917,000	$11,542,000	$7,349,000
3	B2	Spillover Benefits (Low Economic Resource, not Fuel Poor)		$66,521,000	$61,780,000	$43,261,000	-$23,260,000
4	C	Inclusion Expense (Not Low Ec. Resource, not Fuel Poor)		$182,387,000	$191,507,000	$209,418,000	$27,031,000
5	D	Included but Inadequate (Still Fuel Poor)		$28,549,000	$44,311,000	$95,465,000	$66,916,000
6	$E_{1,2}$	Exclusion Inadequacy (Low Economic Resource)		$40,034,000	$45,670,000	$48,538,000	$8,504,000
7		Total Program Cost	∑ (A, B1, B2, C)	$275,986,000	$294,461,000	$319,799,000	$43,813,000
8		Benefits Received by Fuel Poor	∑ (A, B1,)	$27,078,000	$41,174,000	$67,120,000	$40,042,000
		POLICY VERTICAL EFFICIENCY (%)					
9		Vertical Efficiency	∑ (A, B1, B2) / Total Prog. Cost	33.9%	35.0%	34.5%	0.6%
10		Spill-over benefits	∑ (B1, B2) / ∑ (A,B1, B2)	75.5%	69.6%	49.6%	-25.9%
11		Poverty reduction efficiency	A / Total Program Cost	8.3%	10.6%	17.4%	9.1%
12		Spill-over Excess (% of Total)	∑ (B1, B2) / Total Prog. Cost	25.6%	24.3%	17.1%	-8.5%
13		Inefficiency due to inclusion	C / Total Program Cost	66.1%	65.0%	65.5%	-0.6%
14		Inefficiency due to exclusion	E / Total Program Cost	14.5%	15.5%	15.2%	0.7%
15		Inadequate concession benefits	D / Total Program Cost	10.3%	15.0%	29.9%	19.5%
16		Benefit inadequacy	∑ (D, E) / Total Prog. Cost	24.9%	30.6%	45.0%	20.2%
		HORIZONTAL ANALYSIS (Number of Households)					
17	A	Successful Targeting (Fuel Poor)		77,000	111,000	169,000	92,000
18	B_1	Spillover Benefits (Fuel Poor)		20,000	42,000	59,000	39,000
19	B_2	Spillover Benefits (Low Economic. Resource)		188,000	166,000	109,000	-79,000
20	C	Inclusion Expense (Not Low Ec. Resource)		515,000	515,000	526,000	11,000
21	D	Inadequate Included		59,000	70,000	112,000	53,000
22	$E_{1,2}$	Exclusion Inadequacy		113,000	123,000	122,000	9,000
23	F	Total Households Included	∑ (A, B2, C)	780,000	792,000	803,000	23,000
24		Total Households		2,092,649	2,124,039	2,155,895	63,246
25		% of Households Included		37.3%	37.3%	37.2%	0.0%
26		Underlying Fuel Poor Households		132,000	181,000	261,000	129,000
27		Underlying Fuel Poor Households		6.3%	8.5%	12.1%	5.8%
28		Fuel Poor LER Households - Post Policy		112,000	139,000	202,000	90,000
29		Fuel Poor LER Households - Post Policy (%)		5.4%	6.5%	9.4%	4.0%
30		Underlying Fuel Poor Population		353,000	456,000	721,000	368,000
31		Underlying Fuel Poor Population (%)		6.8%	8.8%	13.9%	7.1%
32		Fuel Poor LER Population - Post Policy		271,000	329,000	507,000	236,000
33		Fuel Poor LER Population - Post Policy (%)		5.2%	6.3%	9.8%	4.5%

4.4 Impact of 2022 policy interventions

In late-2022, the Commonwealth Government announced price caps for domestically traded coal and natural gas, which is forecast to moderate residential electricity tariff increases in 2023/24 to 16.5% (cf. 35.3%). In addition, the Queensland Government initiated a ‘universal payment’ to all electricity households in 2021/22 and 2022/23, and in the analysis which follows, this is assumed to continue into 2023/24 at $150 per ‘electricity household’. This income support is in addition to the electricity concession of $392 to vulnerable households. Impacts of these results are sequentially identified in Tab.4.

In Tab.4, Column 1 has been drawn from Tab.3 as the benchmark, comprising the 35.3% tariff increase and $392 electricity concession. Column 2 presents HVFP Model results after incorporating the impact of the Commonwealth Government’s price cap market intervention and the commensurately lower residential electricity tariff increase at 16.5% (noted as ‘$392+CW’). Column 3 then adds in the $150 ‘universal payment’ to all electricity households in Queensland (noted as $392+CW+Univ.). The cumulative change is captured in Column 4.

The first point to note is the relative impacts of Commonwealth and State policies on the incidence of fuel poverty. Recall from Lines 26-27 the underlying level of fuel poverty in 2023/24 is 261,000 households or 12.1%. The cumulative effect of policy is capable of reducing this to 6.9% with the Commonwealth intervention contributing 2.0 percentage points (ppt) and State policies contributing 3.2ppt, of which 2.7ppt comes from the $392 electricity concession and the remaining 0.5ppt from the $150 'universal payment' policy (see variously Lines 27 and 29 across columns 1-3). Collectively these policies have a significant impact with the population defined as fuel poor reducing from an underlying rate of 13.9 to 6.7% (Lines 31 and 33).

Table 4: Horizontal and vertical efficiency analysis of policy responses

		POLICY VERTICAL EFFICIENCY		**2023/24**	**2023/24**	**2023/24**	**Change**
	COLUMN			1 - per Tab.3	2	3	4
		Tariff Increase		**35.3%**	**16.5%**	**16.5%**	
LINE		**Policy Settings**		**$392**	**$392+CW**	**$392+CW+Univ.**	
1	A.	Successful Targeting (Fuel Poor)		$55,578,000	$43,684,000	$64,084,000	$8,506,000
2	B1	Spillover Benefits (Fuel Poor)		$11,542,000	$12,609,000	$22,780,000	$11,238,000
3	B2	Spillover Benefits (Low Economic Resource, not Fuel Poor)		$43,261,000	$54,088,000	$80,958,000	$37,697,000
4	C	Inclusion Expense (Not Low Ec. Resource, not Fuel Poor)		$209,418,000	$209,418,000	$472,585,000	$263,167,000
5	D	Included but Inadequate (Still Fuel Poor)		$95,465,000	$65,718,000	$54,003,000	-$41,462,000
6	$E_{1,2}$	Excluded (Low Economic Resource)		$48,538,000	$48,538,000	$0	-$48,538,000
7		Total Program Cost	∑ (A, B1, B2, C)	$319,799,000	$319,799,000	$640,407,000	$320,608,000
8		Benefits Received by Fuel Poor	∑ (A, B1,)	$67,120,000	$56,293,000	$86,864,000	$19,744,000
		POLICY VERTICAL EFFICIENCY (%)					
9		Vertical Efficiency	∑ (A, B1, B2) / Total Prog. Cost	34.5%	34.5%	26.2%	-8.3%
10		Spill-over benefits	∑ (B1, B2) / ∑ (A,B1, B2)	49.6%	60.4%	61.8%	12.2%
11		Poverty reduction efficiency	A / Total Program Cost	17.4%	13.7%	10.0%	-7.4%
12		Spill-over Excess (% of Total)	∑ (B1, B2) / Total Prog. Cost	17.1%	20.9%	16.2%	-0.9%
13		Inefficiency due to inclusion	C / Total Program Cost	65.5%	65.5%	73.8%	8.3%
14		Inefficiency due to exclusion	E / Total Program Cost	15.2%	15.2%	0.0%	-15.2%
15		Inadequate concession benefits	D / Total Program Cost	29.9%	20.5%	8.4%	-21.4%
16		Benefit inadequacy	∑ (D, E) / Total Prog. Cost	45.0%	35.7%	8.4%	-36.6%
		HORIZONTAL ANALYSIS (Number of Households)					
17	A	Successful Targeting (Fuel Poor)		169,000	141,000	204,000	35,000
18	B_1	Spillover Benefits (Fuel Poor)		59,000	63,000	74,000	15,000
19	B_2	Spillover Benefits (Low Economic. Resource)		109,000	136,000	179,000	70,000
20	C	Inclusion Expense (Not Low Ec. Resource)		526,000	526,000	1,754,000	1,228,000
21	D	Inadequate Included		112,000	81,000	74,000	-38,000
22	$E_{1,2}$	Exclusion Inadequacy		122,000	122,000	0	-122,000
23	F	Total Households Included	∑ (A, B2, C)	803,000	803,000	2,155,895	1,352,895
24		Total Population		2,155,895	2,155,895	2,155,895	
25		% of Households Included		37.2%	37.2%	100.0%	62.8%
26		Underlying Fuel Poor Households		261,000	261,000	261,000	0
27		Underlying Fuel Poor Households		12.1%	12.1%	12.1%	0.0%
28		Fuel Poor LER Households - Post Policy		202,000	159,000	148,000	-54,000
29		Fuel Poor LER Households - Post Policy (%)		9.4%	7.4%	6.9%	-2.5%
30		Underlying Fuel Poor Population		721,000	721,000	721,000	0
31		Underlying Fuel Poor Population (%)		13.9%	13.9%	13.9%	0.0%
32		Fuel Poor LER Population - Post Policy		507,000	374,000	346,000	-161,000
33		Fuel Poor LER Population - Post Policy (%)		9.8%	7.2%	6.7%	-3.1%

Note with the universal payment at Column 3, inefficiency due to exclusion (Line 14) reduces to 0.0%. However, while this and horizontal performance metric improvements are marked, there is a visible deterioration in vertical performance. Vertical efficiency falls to just 26.3% (Line 9) and poverty reduction efficiency reduces to 9.6%, with inefficiency due to inclusion (Line 13) rising to 73.7%.

While the universal payment scheme for 2022/23 was committed, the payment for 2023/24 has not yet been announced. The budget for this policy *could* be channelled into the existing hardship program and lead to marked vertical improvements, the extent of which is analysed in Section 5.

5. Universal Payments vs. Targeted Payments

To improve the vertical (and horizontal) performance of State-level policy, the budget used to originate the $150 universal payment to electricity households could be re-purposed and directed into the existing electricity concessions policy framework. With a budget neutrality constraint, the existing $392 electricity concession could be increased by $400 (i.e. to $792) per qualifying household. The impact of doing has been quantified in the HVFP Model with the results illustrated in Tab.5. The Universal Payment result is once again presented in Column 1, and the alternate policy approach involving a higher (targeted) $792 electricity concession, is presented in Column 2. Note the Total Program Cost (Line 7) is constant at ~$640m.

This policy refinement has beneficial effects on all metrics, with the successful targeting of fuel poor rising to $71m (Line 1), the vertical efficiency ratio rising to 34.5% (Line 9) and fuel poor households being almost halved from their underlying level of 12.1% (Line 27) down to 6.3% (Line 29) through the culmination of State- and Commonwealth policies.

Table 5: Vertical & Horizontal effects of Universal Payments vs. Targeting

		POLICY VERTICAL EFFICIENCY		**2023/24**	**2023/24**	**Change**
	COLUMN			1 - Per Tab.4	2	
		Tariff Increase		**16.5%**	**16.5%**	
LINE		**Policy Settings**		**$392+CW+Univ.**	**$792+CW**	
1	A.	Successful Targeting (Fuel Poor)		$64,084,000	$71,023,000	$6,939,000
2	B1	Spillover Benefits (Fuel Poor)		$22,780,000	$41,840,000	$19,060,000
3	B2	Spillover Benefits (Low Economic Resource, not Fuel Poor)		$80,958,000	$108,442,000	$27,484,000
4	C	Inclusion Expense (Not Low Ec. Resource, not Fuel Poor)		$472,585,000	$419,868,000	-$52,717,000
5	D	Included but Inadequate (Still Fuel Poor)		$54,003,000	$37,543,000	-$16,460,000
6	$E_{1,2}$	Excluded (Low Economic Resource)		$0	$97,314,000	$97,314,000
7		Total Program Cost	∑ (A, B1, B2, C)	$640,407,000	$641,172,000	$765,000
8		Benefits Received by Fuel Poor	∑ (A, B1,)	$86,864,000	$112,863,000	$25,999,000
		POLICY VERTICAL EFFICIENCY (%)				
9		Vertical Efficiency	∑ (A, B1, B2) / Total Prog. Cost	26.2%	34.5%	8.3%
10		Spill-over benefits	∑ (B1, B2) / ∑ (A,B1, B2)	61.8%	67.9%	6.1%
11		Poverty reduction efficiency	A / Total Program Cost	10.0%	11.1%	1.1%
12		Spill-over Excess (% of Total)	∑ (B1, B2) / Total Prog. Cost	16.2%	23.4%	7.2%
13		Inefficiency due to inclusion	C / Total Program Cost	73.8%	65.5%	-8.3%
14		Inefficiency due to exclusion	E / Total Program Cost	0.0%	15.2%	15.2%
15		Inadequate concession benefits	D / Total Program Cost	8.4%	5.9%	-2.6%
16		Benefit inadequacy	∑ (D, E) / Total Prog. Cost	8.4%	21.0%	12.6%
		HORIZONTAL ANALYSIS (Number of Households)				
17	A	Successful Targeting (Fuel Poor)		204,000	141,000	-63,000
18	B_1	Spillover Benefits (Fuel Poor)		74,000	85,000	11,000
19	B_2	Spillover Benefits (Low Economic. Resource)		179,000	136,000	-43,000
20	C	Inclusion Expense (Not Low Ec. Resource)		1,754,000	526,000	-1,228,000
21	D	Inadequate Included		74,000	58,000	-16,000
22	$E_{1,2}$	Exclusion Inadequacy		0	122,000	122,000
23	F	Total Households Included	∑ (A, B2, C)	2,155,895	803,000	-1,352,895
24		Total Population		2,155,895	2,155,895	0
25		% of Households Included		100.0%	37.2%	-62.8%
26		Underlying Fuel Poor Households		261,000	261,000	0
27		Underlying Fuel Poor Households		12.1%	12.1%	0.0%
28		Fuel Poor LER Households - Post Policy		148,000	136,000	-12,000
29		Fuel Poor LER Households - Post Policy (%)		6.9%	6.3%	-0.6%
30		Underlying Fuel Poor Population		721,000	721,000	0
31		Underlying Fuel Poor Population (%)		13.9%	13.9%	0.0%
32		Fuel Poor LER Population - Post Policy		346,000	295,000	-51,000
33		Fuel Poor LER Population - Post Policy (%)		6.7%	5.7%	-1.0%

6. Policy implications and concluding remarks

From a policy perspective, what observations and implications exist for other markets? With respect to the Commonwealth Government's intervention in which the price of fuels were capped at 125/t and $12/GJ for coal and natural gas, respectively:

- As an absolute general conclusion, if energy markets are harming consumers and delivering supranormal profits to resource companies and energy utilities during wartime conditions, policy intervention is unambiguously warranted. This usually comes in the form of special tax on supernormal (wartime) profits (i.e. windfall profits tax) and lump-sum transfers to households. In extreme conditions, market coordination or suspension may be necessary (see variously Cairncross, 1995; Shin and Trentmann, 2021; Pollitt, 2022; Pollitt et al., 2022).

- There is no question that Australia's policy approach of capping the market for fuels will be highly effective in bringing down wholesale electricity prices for the year in which it applies. Year-ahead forward prices in the NEM's Queensland region reduced from an October 2022 peak of $247/MWh to ~$105/MWh in the immediate post-policy environment. Further, the policy creates benefits for all energy consumers (i.e. household and business customers alike).

- From a purely practical perspective, a policy which caps coal and gas prices is possible because Australia is a major exporter of both fuels, and the underlying cost of production is no higher than the imposed price caps. As a result, Australian resource and energy companies should not experience episodes of financial distress per se. Some may experience non-trivial opportunity losses and face strong incentives to maximise export sales over domestic sales, given seaborne prices are currently ~$500/t and ~$40/GJ, respectively.

- The corollary here is that such a policy may have adverse implications for future investment in energy resource developments (i.e. elevated hurdle rates, delayed or cancelled projects). Policymakers no doubt considered this in detail before announcing the policy decision and setting coal and gas price caps.

- On the one hand, domestic demand for thermal coal is declining and as a result, follow-on perceptions of 'sovereign risk' seem a second order issue at best given the objectives of climate change policy.

- On the other hand, natural gas is likely to remain an important transitional fuel for the foreseeable future given the intermittency of Australia's wind and solar resources.

    - Commonwealth policymakers selected $12/GJ because it equated to the marginal cost of new developments, presumably new gas fields in New South Wales. While such a calculation inherently incorporates a level of normal profit, capping a market at the average cost of entry may place marginal investments at risk, given the natural variation and errors in forecast (cf. actual) development costs.[7]

[7] The author was approached by Queensland policymakers on this very point in mid-2022. My advice was to set a gas price cap at circa 20/GJ on the basis that it would strike a balance between the interests of historic gas investments, future investment signals in marginal gas supply and consumer welfare in wartime market conditions. Specifically, a cap of $20/GJ, i). was substantially above any credible price forecast presented to the Board of Directors and used by gas companies to commit to historic resource

- Benefits of Australia's policy approach are near term (viz. forward prices falling to $105/MWh, tariff increases constrained to 16.5%). Costs of the policy may occur over the long run *if investment* in future fuel resources are curtailed as a result.

With regards to State-level electricity concessions policy:

- Constrained state government balance sheets means that targeting is important. The analysis in Sections 3-4 and Section 5 in particular highlight the importance of analysing both the horizontal *and vertical* impacts of policy.

- Universal payments clearly assist households (reducing fuel poverty by -0.5ppt) but when the same program budget is re-purposed to a targeted policy framework, the vertical effectiveness of the policy doubled, from a -0.5ppt reduction to a -1.0ppt reduction in the incidence of fuel poverty.

- It is worth noting that the cumulative effect of targeted hardship policy is capable of reducing the incidence and severity of fuel poverty by -3.7ppts, that is, -2.7ppt reduction via the existing hardship scheme, and a further -1.0ppt by focusing any universal payment.

- While the economics of such a decision is unambiguous, the politics is anything but straightforward. Energy economists must be ever mindful of the broader macroeconomic implications of rising interest rates and broader consumer price inflation – all of which places strains over a wider array of households, beyond those defined as fuel poor. In this regards, even some element of universal payment (i.e. a mix of universal and targeted payments) enhance social welfare given exclusion error and deteriorating household real equivalised incomes after housing costs.

Households in the NEM were initially shielded from the adverse impacts of the 2022 energy crisis because of the way in which electricity tariffs caps are set (i.e. hedge contracts built-up over the preceding 2-3 years). The full impacts of the energy crisis would be impounded in retail tariffs over a two-year timeframe with 2022/23 tariffs set to rise by 11%, and a (pre-policy) forecast of 2023/24 at 35.3%. This would send the underlying rate of fuel poverty from 6.3% to 12.1%. Policy intervention by the Commonwealth Government in the domestic fuel markets, viz. setting price caps of $125/t and $12/GJ for coal and gas, is likely to constrain tariff increases to ~16.5% given a market heat rate of ~8.2GJ/MWh. This policy benefits all consumers and would reduce the rate of fuel poverty by 2.0ppt. However, existing state-level policies remain crucial and are forecast to reduce the incidence and severity of fuel poverty by 2.7ppt. An additional universal payment is capable of making a further contribution of 0.5ppt, and if re-purposed to a targeted payment, 1.0ppt.

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developments, and ii). was half the prevailing price of natural gas, and would therefore benefit end-use consumers significantly, and iii). would minimise moral hazard vis-à-vis industrial consumers who had not managed forward exposures through contracting.

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