UNIVERSITY OF CAMBRIDGE
Faculty of Economics

CAMBRIDGE WORKING PAPERS IN ECONOMICS

Fuel poverty in Queensland: horizontal and vertical impacts of the 2022 energy crisis

Paul
Simshauser

Abstract

In 2022, wholesale prices in Australia's National Electricity Market (NEM) rose to $225/MWh, up from $75/MWh a year earlier. The war in Ukraine led to a global tightening of coal and gas markets, and the effects were felt acutely by the NEM's marginal coal- and gas-fired plants given tight links to seaborne prices. Household electricity tariffs are set for the financial year ahead but the wholesale cost element is built-up over the preceding three-year period, in line with forward hedging practices of prudent energy retailers. Consequently, households have been shielded from 2022 spot market dynamics in 2021/22 tariff determinations. However, by 2023/24 the impacts of wholesale price rises will be impounded into retail tariffs. In this article, fuel poverty in the Queensland region of the NEM is examined over three distinct periods, 2015/16, 2021/22 and 2023/24. These periods coincide with high (2015/16), low (2021/22) and expected high (2023/24) residential electricity tariffs. Results reveal an underlying level of fuel poverty in Queensland at 8.1% of households in 2015/16, falling to 6.8% in 2021/22 and rising to at least 10.0% in 2023/24. Queensland's hardship policy unwinds these results by 1.6, 1.1 and 2.9 percentage points, respectively. 2023/24 tariff increases overwhelm existing hardship policy settings although policy performance operates as an automatic stabiliser, rising in effectiveness as price rises.

Reference Details

CWPE 2257
Published 12 January 2023

Key Words Fuel poverty, policy targeting efficiency, electricity prices.
JEL Codes D4, L5, L9, Q4

Website www.econ.cam.ac.uk/cwpe

UNIVERSITY OF CAMBRIDGE | Energy Policy Research Group

Fuel poverty in Queensland: horizontal and vertical impacts of the 2022 energy crisis

EPRG Working Paper 2216

Cambridge Working Paper in Economics CWPE2257

Paul Simshauser[♣♠]

Abstract

In 2022, wholesale prices in Australia's National Electricity Market (NEM) rose to $225/MWh, up from $75/MWh a year earlier. The war in Ukraine led to a global tightening of coal and gas markets, and the effects were felt acutely by the NEM's marginal coal- and gas-fired plants given tight links to seaborne prices. Household electricity tariffs are set for the financial year ahead but the wholesale cost element is built-up over the preceding three-year period, in line with forward hedging practices of prudent energy retailers. Consequently, households have been shielded from 2022 spot market dynamics in 2021/22 tariff determinations. However, by 2023/24 the impacts of wholesale price rises will be impounded into retail tariffs. In this article, fuel poverty in the Queensland region of the NEM is examined over three distinct periods, 2015/16, 2021/22 and 2023/24. These periods coincide with high (2015/16), low (2021/22) and expected high (2023/24) residential electricity tariffs. Results reveal an underlying level of fuel poverty in Queensland at 8.1% of households in 2015/16, falling to 6.8% in 2021/22 and rising to at least 10.0% in 2023/24. Queensland's hardship policy unwinds these results by 1.6, 1.1 and 2.9 percentage points, respectively. 2023/24 tariff increases overwhelm existing hardship policy settings although policy performance operates as an automatic stabiliser, rising in effectiveness as price rises.

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

Contact p.simshauser@griffith.edu.au
Publication October 2022
Financial Support N/A

♣ Professor of Economics, Centre for Applied Energy Economics & Policy Research, Griffith University.
♠ Research Associate, Energy Policy Research Group, University of Cambridge.

Fuel poverty in Queensland: horizontal and vertical impacts of the 2022 energy crisis

Paul Simshauser[♣♠]
October 2022

Abstract
In 2022, wholesale prices in Australia's National Electricity Market (NEM) rose to $225/MWh, up from $75/MWh a year earlier. The war in Ukraine led to a global tightening of coal and gas markets, and the effects were felt acutely by the NEM's marginal coal- and gas-fired plants given tight links to seaborne prices. Household electricity tariffs are set for the financial year ahead but the wholesale cost element is built-up over the preceding three-year period, in line with forward hedging practices of prudent energy retailers. Consequently, households have been shielded from 2022 spot market dynamics in 2021/22 tariff determinations. However, by 2023/24 the impacts of wholesale price rises will be impounded into retail tariffs. In this article, fuel poverty in the Queensland region of the NEM is examined over three distinct periods, 2015/16, 2021/22 and 2023/24. These periods coincide with high (2015/16), low (2021/22) and expected high (2023/24) residential electricity tariffs. Results reveal an underlying level of fuel poverty in Queensland at 8.1% of households in 2015/16, falling to 6.8% in 2021/22 and rising to at least 10.0% in 2023/24. Queensland's hardship policy unwinds these results by 1.6, 1.1 and 2.9 percentage points, respectively. 2023/24 tariff increases overwhelm existing hardship policy settings although policy performance operates as an automatic stabiliser, rising in effectiveness as price rises.

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

1. Introduction

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). environmental constraints, which in the 21st century translates to CO_2 emissions. A central tenet arising from energy policy is *affordability*, the reasons for which are axiomatic. Electricity supply is an essential service and access to it is considered a basic human right (Tully, 2006). As a non-discretionary household 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' (see Stigler, 1954; Bennett et al., 2002; Simshauser, 2021). It presents as a near perfect example of an Engels Curve (as Fig.1 later reveals) – that is – the poorer the household, the higher proportion of income devoted to energy supply.

In Australia's National Electricity Market (NEM), residential electricity tariffs surged over the period 2007-2015, up +80.5% or +7.7% per annum in real terms. 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%). The effect of higher electricity tariffs was further

♣ Professor of Economics, Centre for Applied Energy Economics & Policy Research, Griffith University.
♠ Research Associate, Energy Policy Research Group, University of Cambridge.

amplified by rising household consumption levels. 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). Consequently, with sharply rising electricity prices *and* quantities consumed, the concept of *fuel poverty* began to emerge as a policy problem in Australia for the first time. As a working definition, *fuel poverty* occurs when energy costs exceed 10% of *(vulnerable)* household income *after* housing costs.

Fundamental reforms to electricity customer hardship policy in Queensland would occur in 2016/17 in response. The '*Old Policy*', which can be traced back to 1993, provided a $319 payment (in 2015/16$) to qualifying households, but was highly targeted to aged households viz. 65+ years. Households in possession of a Pension Card or Queensland Seniors Card would qualify for the payment. Following the 2016/17 reforms, *category targeting policy* was expanded to incorporate low-income households via adding the means-tested Healthcare Card to the category of qualifying households. Just as the *'New Policy'* was implemented, retail electricity tariffs fell significantly through to the 2021/22 financial year. Consequently, the incidence of fuel poverty also fell significantly. However, the impacts of the 2022 energy market crisis will inevitably unwind these gains as retail electricity tariffs begin to surge once again.

The 2022 war in Ukraine created a tight market for coal and natural gas, sending prices to multiples of their historic averages. Australia is a significant exporter of both fuels and consequently, local markets have tight links to seaborne prices. And while a majority of thermal plants have long-dated contracts de-linked from seaborne prices, the marginal plants do not – they are exposed to varying degrees to export price dynamics. Sharply rising levels of renewables means the degree of term-contracted fuel supplies have also been declining. Collectively, this has driven wholesale prices sharply higher, rising from $75/MWh in 2021 to $225/MWh in 2022.

Household electricity tariff caps in the Queensland region of the NEM assume a prudent retailer[1] builds up a hedge book over a 3-year period prior to real time. Consequently, households were completely shielded from the spot price dynamics during the 2022 energy market crisis. However, as each year passes, low cost hedges from prior periods are assumed to be replaced by current market conditions, and thus by 2023/24 the household electricity tariff will have risen sharply.

This article analyses changes in fuel poverty in the NEM's Queensland region over three distinct timeframes, and under various hardship policy settings. The timeframes examined are as follows:

- 2015/16, which forms the peak of the previous 2007-2015 price cycle, and also straddles the pre- and post-policy reform era;

- 2021/22, which formed the nadir of electricity tariffs in the current price cycle, and

[1] The concept of the 'prudent retailer' is a largely theoretical and normative construct used by regulators in tariff determination processes in the NEM to set a wholesale cost allowance. In turn 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 three-year window, using a 1-in-10-year hot weather scenario to minimise the risk of bankruptcy. In theory, any retailer who follows this hedging strategy should earn a fair return on capital. In practice, deviation from this benchmark approach can produce higher profits, or bankruptcy.

- A forecast for the 2023/24 year, to capture adverse effects of the 2022 energy market crisis.

In each of these three timeframes, three policy settings are also analysed, viz. the 'Old Policy' which focused on the aged, the 'New Policy' which adds low-income households to category targeting, and a 'Changed Mechanism' in which the $319 annual payment is altered to a budget neutral variable payment (i.e. commencing at 23% of the bill). Additionally, a payment made to all housholds (i.e. universal policy) is also compared with the existing category targeting policy.

The analysis is set out in a three-period model using Australian Bureau of Statistics (ABS) microdata with three fuel poverty policy settings. Modelling is grounded in welfare economics with a focus on *horizontal* and *vertical efficiency*. For clarity, *horizontal efficiency* refers to the degree to which policy treats 'like households' in the same manner. By contrast, *vertical efficiency* refers to the incidence and depth of fuel poverty, and in particular, whether policy delivers differentially greater support according to relative need.

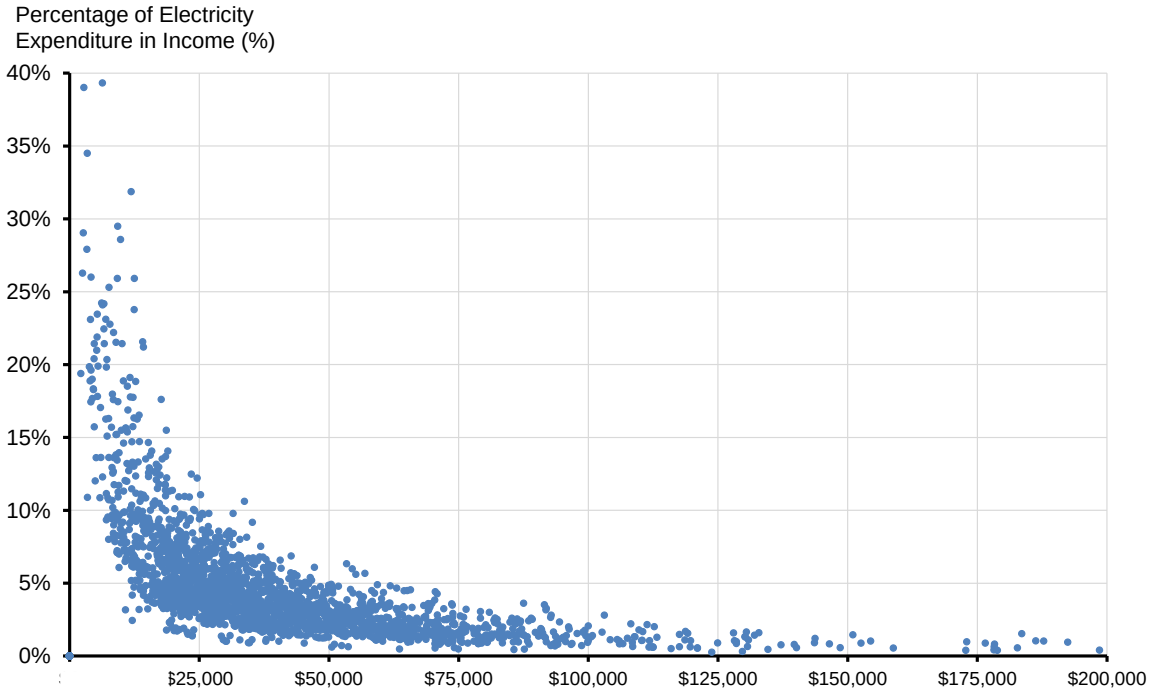
Key findings are as follows. Reforms to Queensland's hardship policy in 2016/17 had a profound effect on both horizontal and vertical efficiency. Horizontal accuracy vis-à-vis vulnerable or *'Low Economic Resource'* households increased from 51% to 69%, while vertical efficiency increased from 31% to 35%. By any metric examined, the policy adjustments made by the Queensland Government prove to be welfare enhancing. From a dynamic analysis perspective, the underlying ('pre-policy') level of fuel poverty was 8.1% of households in 2015/16. Falling tariffs reduced this to 6.8% in 2021/22. The current surge in electricity prices appears set to drive fuel poverty to at least 10.5% of households by 2023/24. Policy can reverse as much as 2.9 percentage points of these underlying numbers, noting effectiveness rises as the intensity of fuel poverty rises.

This article is structured as follows. Section 2 reviews relevant literature. Section 3 outlines the dataset used. Section 4 examines horizontal and vertical efficiency results of policy. Section 5 examines the relative efficiency of category targeting vs. universal payment schemes. Concluding remarks follow.

2. Review of Literature

The relationship between income and energy dates back to 19th century literature and the first household expenditure analysis undertaken by Engels in 1857. In his initial analysis, households were segregated according to their social standing but this 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 surprising relationship. The 'Engels Curve' would become a permanent fixture in microeconomics via a basic proposition – for certain household goods, the poorer the household, the higher the proportion of total expenditure devoted to it, and 'fuel and light' formed part of this category of goods (Stigler, 1954). An Engels curve for Queensland electricity consumers is illustrated in Fig.1. Note the x-axis measures after housing cost household incomes and the y-axis measures against the proportion of income devoted to electricity.

Figure 1: Engels curve for electricity expenditure (Queensland households)



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

2.1 Definition

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) and can be traced at least as far back as Bradshaw and Hutton (1983). The term "fuel poverty" is commonly used in Ireland, New Zealand and Great Britain Belaïd (2018) *fuel poverty*. In Eastern Europe, 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 (Welsch and Biermann, 2017). Most commonly, fuel poverty and energy poverty are used interchangeably. In this article, the term fuel poverty is applied in the British sense albeit noting that Queensland's tropical climate means 'fuel' translates to the retail electricity bill given the low requirement for space heating and commensurately (very) low use and market share of natural gas vis-a-vis Queensland households. Specific thresholds and measurement of fuel poverty is examined later in Section 2.2, noting it has changed over time.

Fuel poverty has traditionally been considered a northern hemisphere concept. However, climate change has led to a greater take-up rate of air-conditioners which in turn has increased quantities consumed. Combined with the effects of a warming climate has meant fuel poverty has migrated to the southern hemisphere (Simshauser, Nelson and Doan, 2011; Awaworyi Churchill, Smyth and Farrell, 2020; Mazzone, 2020; Awaworyi Churchill and Smyth, 2021a, 2021b; Simshauser, 2021). Globally, heat related deaths have risen by more than 50% over the past two decades for the aged and is 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 for those aged 65+.

Above all, fuel poverty is *not* the same as poverty (Hills, 2012). Poor households may be able to afford their energy whereas a household well above poverty thresholds may

find themselves in financial distress due to high energy costs – perhaps due to household structure (Bradshaw and Hutton, 1983; Waddams Price et al., 2012). And, high income households may spend well above fuel poverty thresholds, but are not by definition fuel poor. This income expansion path in relation to energy consumption is complex, and explains why fuel poverty warrants attention in energy economics (Bennett et al., 2002).

2.2 Measurement principles

There is a steadily growing body of research on fuel poverty (see Jessel et al., 2019). Sen (1976) identifies two basic problems with measuring poverty. First, identifying vulnerable households within the total population (i.e. horizontal measurement). 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). This led to Sen's classic axioms of poverty measurement:

- Monotonicity axiom: headcount ratios fail to capture the change in the intensity of poverty if incomes and/or prices 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 (i.e. families whose resources fall materially below the average their local community, including in advanced economies, can be considered to be in poverty). The principles of Sen and of Townsend have implications for fuel poverty measurement.

Rule-of-thumb thresholds have historically been used to identify different areas of household hardship. For example, 10% of incomes for fuel poverty (Boardman, 2012), 3.5% is typically used for drinking water (Chan, 2016), while housing distress is thought to be 30% (Tanton and Phillips, 2013). However, analysing incomes is also important and 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". Here, 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 is 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 ABS preferred coincident bound is *Low Economic Resource* households – that is, vulnerable households are defined by the crossover of Low Income (40th percentile) *and* Low Net Wealth (40th percentile) and when combined equates to ~20th percentile households in a manner consistent with Townsend's (1962) principles (and is subsequently illustrated using applied Queensland data in Section 3.1).

Ideally, equivalised household incomes should also be used. 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 OECD Scale (modified) 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 hosueholds (Rowley et al., 2015; Tanton & Phillips, 2013; Bramley, 2012; Hills, 2012; Stone, 2006; Beckerman, 1979).

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).

Historically, fuel poverty commenced by focusing on vulnerable households whose cost of energy supply exceeded 10% of income, with energy use based on a normative standard (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 in Great Britain revealed the 'demonstrated use' of household energy consumption 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.

For clarity, in this article vulnerable households are defined and measured as *Low Economic Resource* as outlined in Balestra and Tonkin (2018) and Simshauser (2021), and the threshold for fuel poverty is 10% of household equivalised disposable income after housing costs.

2.3 Measuring 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, category targeting is the subject of means testing. Means-tested category targeting has the effect of constraining fiscal budgets while also reducing the dispersion of market incomes, thus assisting social equity (Komives *et al.*, 2006; Oorschot, 2002).

Targeting, as a policy, usually achieves political support across party lines because the objective of protecting vulnerable households is not considered contentious (Simshauser, 2021; Oorschot, 2002; Besley, 1990). 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.

The case for the category targeting of vulnerable households (*cf.* universal support) is intuitive because governments face balance sheet constraints (Simshauser, 2021; Creedy, 1996; Oorschot, 2002). 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 category targeting is important.[2]

The way in which to consider category targeting horizontal efficiency (i.e. a simple headcount measure) is set out in Table 1.

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

Table 1: Horizontal Efficiency of Category Targeting

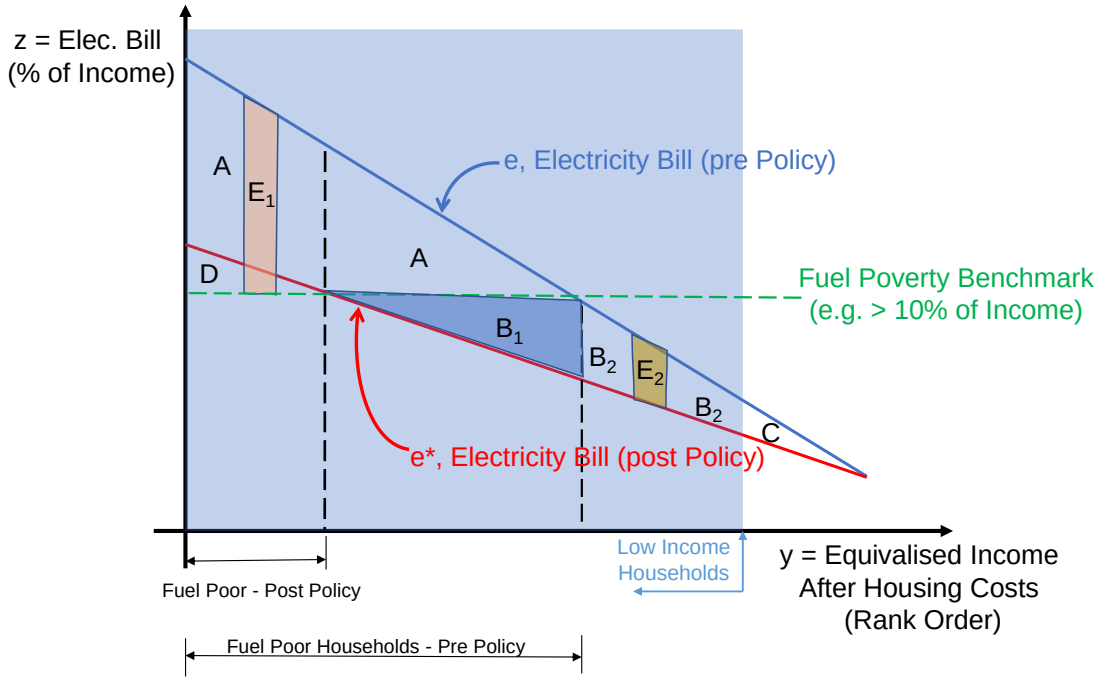
	Low Income	High Income
Included	Success	Inclusion Error
Excluded	Exclusion Error	Success

Headcount measures are necessary, but not sufficient, because they fail to reveal the depth of the poverty problem. Accordingly, such measures must be accompanied by a more sophisticated analysis.

Beckerman's (1979) policy efficiency framework, modified by Chan (2016) and later Simshauser (2021), is ideally suited to fuel poverty assessments. It identifies changes in fuel poverty in terms of depth and the intensity of the problem, which in turn satisfies Sen's (1976) axioms. It also has the effect of incorporating Townsend's (1962) principles (see also Besley, 1990; Besley & Kanbur, 1990; Creedy, 1996; Harding & Mitchell, 1992; Hoddinott, 1999; Yamamori, 2019). Beckerman's framework, adjusted for fuel poverty, 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. Each area of Fig.2 is clearly marked (A..E_2) and explained below including the formulas for construction. To summarise the obvious, when horizontal *and* vertical targeting rises in efficiency, fuel poverty is reduced in both depth and severity (Simshauser, 2021; Chan, 2016; Beckerman, 1979).

Figure 2: Vertical Efficiency of Category Targeting



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 =	Vulnerbale 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)

From these variables, various measures of vertical efficiency can be constructed:

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

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

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

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

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

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

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

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

From a category 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 extensively used, with funding provided by the progressive taxation system.

In Australia, the Commonwealth Government presides over the welfare state but energy policy is largely the domain of sub-national or State Governments. An electricity concession framework designed by a State Government can rely on the Commonwealth Government and the associated welfare flags. What this means in practice is that the administrative cost of schemes at the State level are low in transaction cost terms.

3. Data

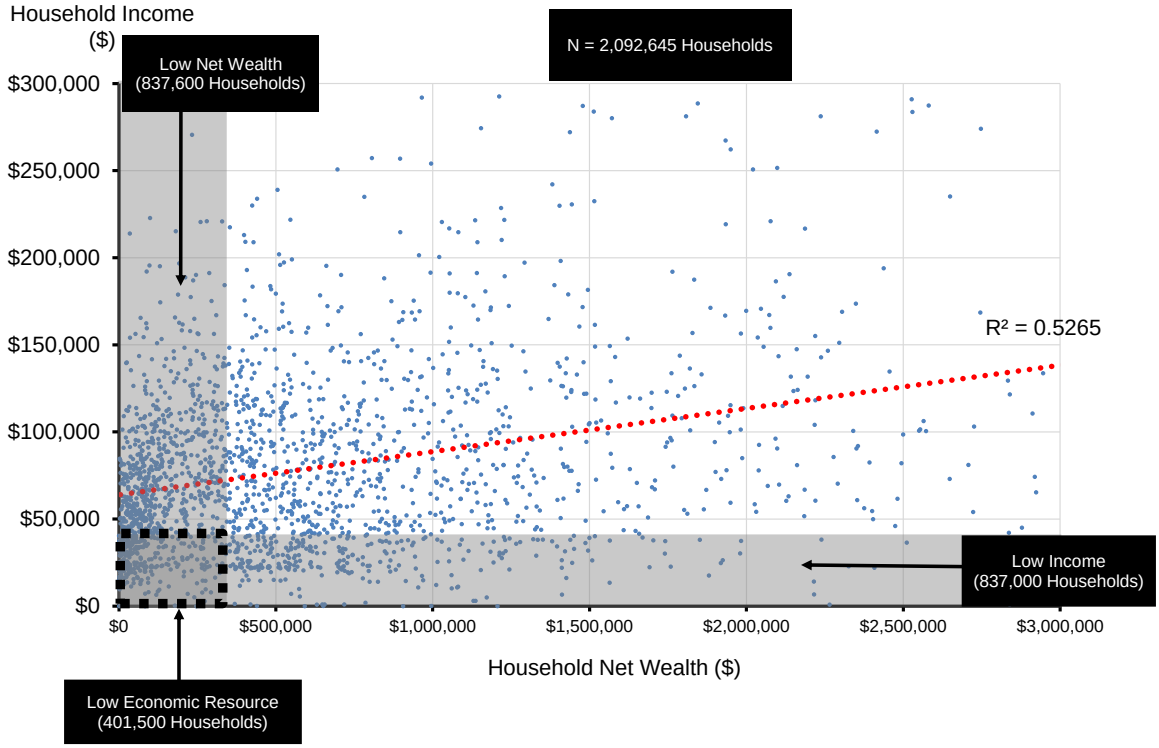
As Skoufias & Coady (2007) explain, microdata is ideal for the analysis of poverty. This article relies on 2015 data compiled by the ABS, viz. Survey of Income and Housing and an accompanying Household Expenditure Survey. This data formed the basis of the model as used in Simshauser (2021) and is further extended in the present analysis. Specifically, the base data as at 2015/16 is analysed and rolled-forward using various indices to gauge likely changes in 2021/22 and 2023/24. Indices include household numbers, Consumer Price Index and Wage Price Index, an electricity tariff index, forward estimates of inflation, wages and electricity prices using Commonwealth Government (July 2022 forecasts), own price elasticity of -0.1 and published energy markets data, respectively (see Appendix I).

3.1 Defining Vulnerable Households: Low Economic Resource

A critical parameter in the analysis is how to define the target cohort for policy treatment. For this purpose, the subsequent analysis defines vulnerable households in a manner consistent with the ABS, Balestra and Tonkin (2018) and Simshauser's (2021) definition, viz. 'Low Economic Resource' households. As noted in Section 2, this is defined as households in both the 40th percentile of equivalised household net weath and 40th percentile equivalised disposable income. The Queensland dataset, this is 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 household income ($670) equates to 837,000 households in each segment, with the cross-over being 401,500 'Low Economic Resource' households.

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



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

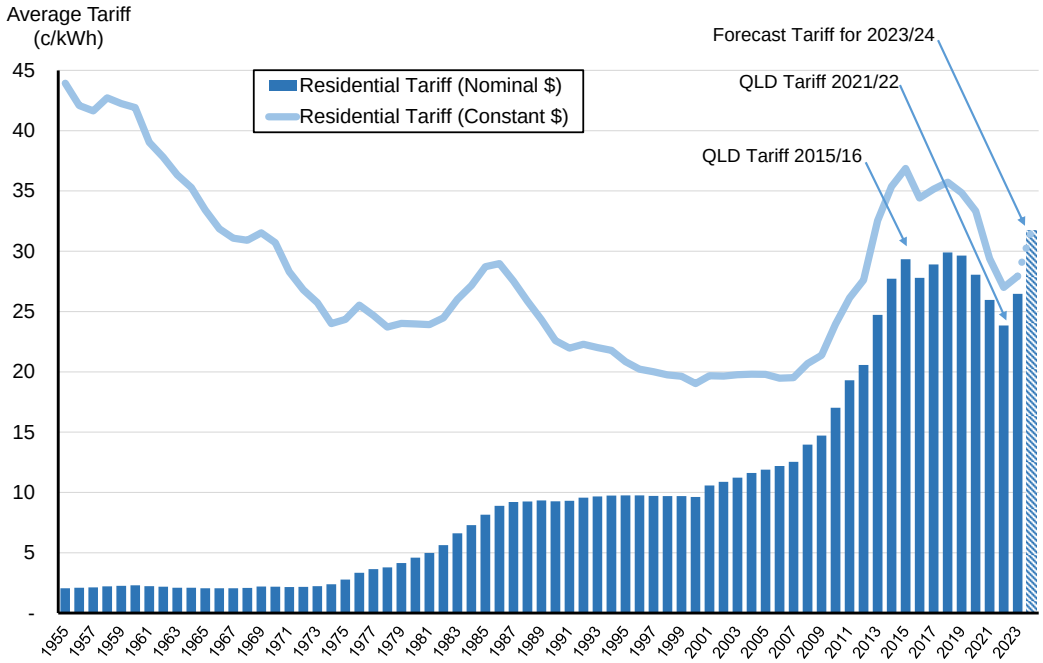
3.2 Queensland Household Electricity Tariffs

Section 1 noted Queensland electricity tariffs at the household level have been through distinct cycles over the past decade. Fig.4 presents the available history of household electricity tariffs over the period 1955-2024*f* in nominal and real terms.[3]

Recall the subsequent analysis focuses on three points in time. First, 2015/16 which straddles an elongated period of sharply rising tariffs over the period 2007-2015 *and* Queensland's hardship policy reform. Second, 2021/22 which evidently represents the nadir of the recent tariff cycle. And finally, 2023/24 to incorporate the current turmoil being experienced in wholesale energy markets. Tariffs at these points in time are highlighted in Fig.4.

[3] The rate presented in Fig.4 is constructed by reference to Tariff 11 (general supply) and Tariff 33 (household hot water & swimming pool pumps on ripple control) with the latter assumed to comprise ~30% of household load.

Figure 4: QLD Average Residential Electricity Tariff (1955-2024*f*)



Data Source: Simshauser (2021).

3.3 Queensland Electricity Hardship Policy

Queensland's electricity customer hardship policy comprises an annual income support, with the delivery mechanism comprising a fixed payment of $319 per annum (2016/17) rising to $354 in 2021/22 and projected to be $392 in 2023/24. In practice, the payment is delivered by energy retailers in quarterly payments on target household electricity accounts. Recall in Section 1 that qualifying households include the following category targets:

1) Pension Cardholders,
2) Queensland Seniors Cardholders (nb. Cardholders are not means-tested), and
3) Heathcare Cardholders, from 2016/17 with an expanded program budget.

The historic *category targeting* prior 2016/17 focused on the aged demographic (65+ years) via segments 1). and 2). above. Policymakers in Queensland were aware that parameters required reform by the early 2010s when a series of affordability issues combined (i.e. rising house prices, rising electricity tariffs per Fig.4). The sustained run-up in residential electricity tariffs from 2007-2015 *prized-open* a political window for a major policy reform in 2016/17. The reforms which followed incorporated segment 3). The basis for doing so was initially set out in Simshauser and Nelson (2014) and later in Simshauser (2021) – and to summarise, low income families dominated Australian energy market hardship statistics.

To improve horizontal efficiency, segment #2 should ideally be removed (or closed to new entrants) but the political economy of such a decision is exceedingly complex. To improve vertical efficiency, the payment mechanism could be altered from fixed to variable, viz. from $319 per target household to ~23% of the target household bills, holding the program budget constant.

To summarise model parameters being analysed in Section 4:

- The model simulates three reference years, viz. 2015/16, 2021/22 and 2023/24 (per Fig.4) with payments of $319, $354 and $392, respectively;

- The *Old Policy* targets households aged 65+years;

- The *New Policy* expands category targeting by including low-income households (via the Healthcare Card) and was designed to enhance horizontal and vertical efficiency;

- The *Changed Mechanism* examines a budget neutral variable rate rather than the fixed payment (i.e. 23%, 29% and 25% across the three reference years, respectively); and

4. Modelling Results

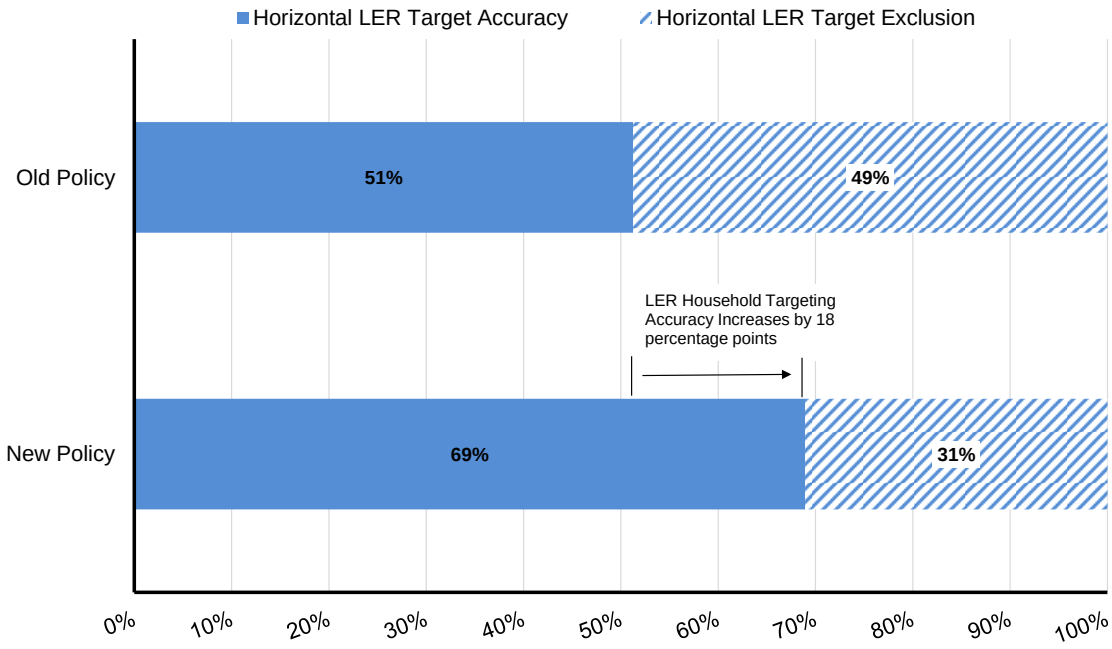
Modelling outcomes are designed to analyse vertical and horizontal efficiency. To begin with, the horizontal efficiency of the 2016/17 reform to policy is assessed.

4.1 Horizontal Efficiency: adjusting Category Targeting Policy

Recall horizontal efficiency measures the extent to which a policy treats 'like households' in the same way. The initial policy in Queensland was limited to the aged (65+ years), but the *New Policy* from 2016/17 expanded the category targeting to include 'Healthcare Cardholders'. The Healthcare Card is a means-tested welfare card which naturally casts a wider net in the search for vulnerable households because it is not limited by age, but by wealth and income, thereby enabling low-income households and families to qualify for the electricity concession for the first time. The significance of this change is that low-income families, not aged pensioners, dominate electricity customer hardship statistics in Australia's National Electricity Market (Simshauser and Nelson, 2014).

Fig.5-6 illustrate the impact on horizontal efficiency of changing the category targeting from a focus purely on aged households (*Old Policy*) to category targeting which includes Healthcare Cardholders as well (*New Policy*). Recall from Fig.3 there were 401,500 households that met the definition of vulnerable, measured as *Low Economic Resource (LER)*. Of these, 51% were successfully targeted under the Old Policy, whereas the New Policy expands this to 69% of LER households (see Fig.5). Fig.6 shows the detailed movements of households using the framework outlined in Section 2.3 (viz. success/error vis-à-vis inclusion/exclusion) and the microdata set scaled to the 2021/22 year.

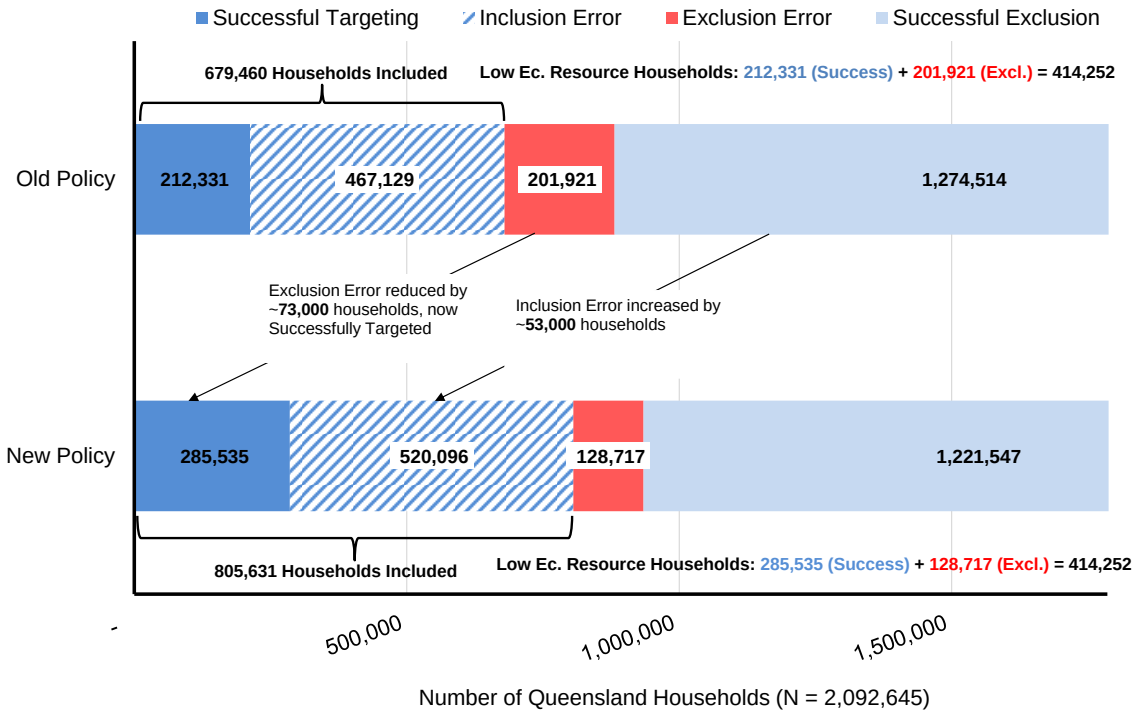
Figure 5: Horizontal Efficiency – New Policy



Note from Fig.6 that the exclusion error has been reduced quite significantly, from 201,900 households to 128,700 households, and those successfully targeted has increased to 285,500.

A central objective of category targeting is to maximise 'Successful Targeting' and to minimise 'Inclusion Error' (see Fig.5-6). On the one hand, the New Policy increases horizontal efficiency from 51% to 69% or 73,000 households, yet on the other, 'Inclusion Error' increases by 53,000 households.

Figure 6: Horizontal Target Efficiency – Old Policy vs. New Policy (2021/22)



Inclusion Error is of course an inevitable outcome of the policy. As Hills (2012) explains, it would be naïve to think policies aimed at removing problems faced by the 414,000 *Low Economic Resource* households could be dealt with by only treating 414,000 homes. In practical terms a wider group *must* be targeted. In this instance the New Policy appears to achieve this, but to be certain we must turn our attention to a vertical efficiency analysis.

4.2 Vertical and Horizontal Efficiency of Category Targeting Policy

Sole reliance on a horizontal efficiency analysis overlooks the depth and severity of poverty and violates Sen's (1976) transfer axiom. Any analysis of vertical efficiency is intended to examine depth of the problem of fuel poverty, and whether policy provides differential support in line with overall (vulnerable) household need. We have established that the New Policy significantly improves horizontal targeting performance (cf. Old Policy). Table 2 provides further insight by analysing it's vertical effectiveness and compares the Old Policy, New Policy, and the New Policy with a Changed Mechanism (i.e. a variable 23% payment instead of a fixed $319 payment in 2015/16). Note the program budget (Table 2, Line 7) under the Old Policy is $189m and rises to $224m with the New Policy and Changed Mechanism.

In Tab.2, the vertical efficiency metrics outlined in Section 2.3 (Eq. 1-8) appear variously in absolute terms (Lines 1-6) and in ratio terms (9-16). In addition, a comprehensive *horizontal analysis* is also presented (Lines 17-26). First, note at Line 1 that Successful Targeting increases from $13.7m to $23.4m via the New Policy, and is higher again under the Changed Mechanism at $32.9m. When combined with the Spill-over Benefits (Lines 1-3), each policy change involves a clear increase in vertical efficiency (Line 9), from 31.2% to 35.2% and 36.1%, respectively. The inadequacy of policy reduces with the policy changes also, which is measured by the sum of Lines 5-6 and is expressed in ratio form at Line 16, declining as it does from 41.2%, to 34.9% and 30.8%. To summarise, each change in policy enhances the vertical efficiency of category targeting.

Lines 17-27 provide a granular horizontal analysis. Key results here include the expansion of households included (Line 23) from 594,000 (Old Policy) to 703,000 (New Policy and Changed Mechanism). It is also worth highlighting the *'inherent'* number of fuel poor households (Line 25) is 153,000 households or 8.1% of the household population (Line 26). Moving through the policy options can reduce this to 121,000 households (Line 25) or 6.4%. Critically, while the Old Policy leads to a reduction of people in fuel poverty from 383,000 to 313,000, each change in policy reduces this further, to 295,000 (New Policy) and to 268,000 (Changed Mechanism).

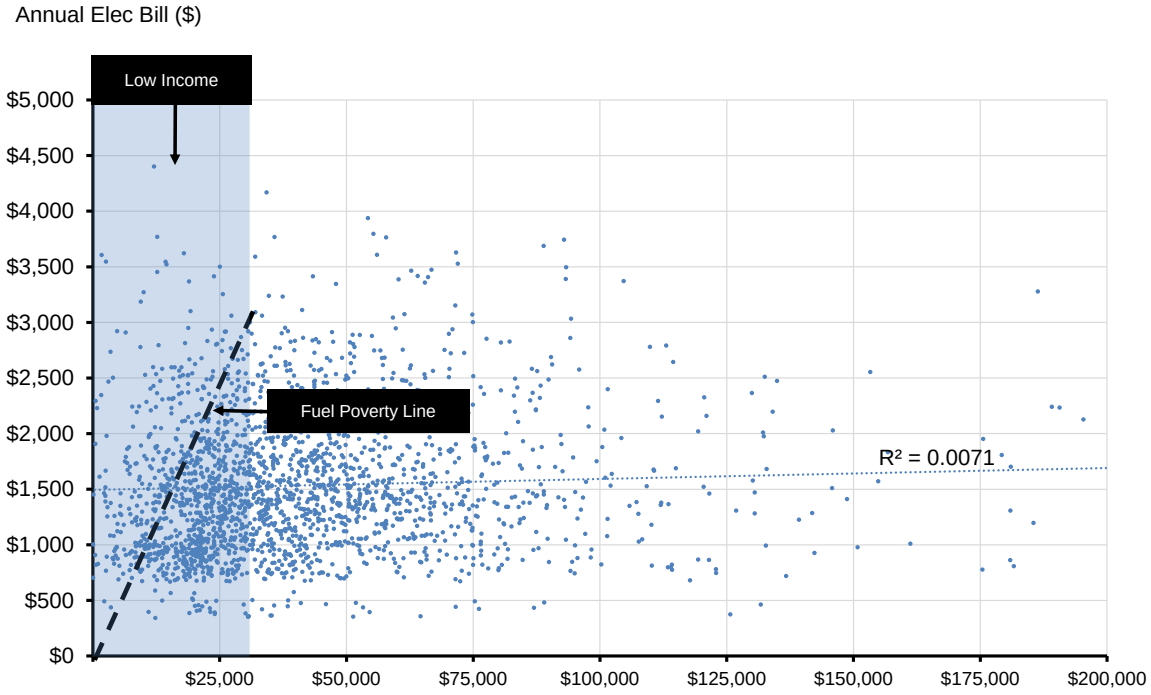
Table 2: Vertical & Horizontal Efficiency – 2015/16

		POLICY VERTICAL EFFICIENCY ($ per annum)		**Old Policy**	**New Policy**	**Chg Mechanism**
LINE		Benefit per annum		**$319**	**$319**	**23%**
1	A.	Successful Targeting (Fuel Poor)		$13,764,000	$23,446,000	$32,903,000
2	B_1	Spillover Benefits (Fuel Poor)		$4,086,000	$5,733,000	$6,341,000
3	B_2	Spillover Benefits (Low Economic Resource, not Fuel Poor)		$41,252,000	$49,743,000	$41,702,000
4	C	Inclusion Expense (Not Low Ec. Res	`	$130,550,000	$145,334,000	$143,512,000
5	D	Included but Inadequate (Still Fuel Poor)		$21,684,000	$42,382,000	$33,127,000
6	$E_{1,2}$	Exclusion Inadequacy (Low Economic Resource)		$56,361,000	$35,928,000	$35,928,000
7		Total Program Cost	∑ (A, B1, B2, C)	$189,652,000	$224,256,000	$224,459,000
8		Benefits Received by Fuel Poor	∑ (A, B1,)	$17,850,000	$29,180,000	$39,244,000
		POLICY VERTICAL EFFICIENCY (%)				
9		Vertical Efficiency	∑ (A, B1, B2) / Total Prog. Cost	31.2%	35.2%	36.1%
10		Spill-over benefits	∑ (B1, B2) / ∑ (A,B1, B2)	76.7%	70.3%	59.4%
11		Poverty reduction efficiency	A / Total Program Cost	7.3%	10.5%	14.7%
12		Spill-over Excess (% of Total)	∑ (B1, B2) / Total Prog. Cost	23.9%	24.7%	21.4%
13		Inefficency due to inclusion	C / Total Program Cost	68.8%	64.8%	63.9%
14		Ineffeciency due to exclusion	E / Total Program Cost	29.7%	16.0%	16.0%
15		Inadequate concession benefits	D / Total Program Cost	11.4%	18.9%	14.8%
16		Benefit inadequacy	∑ (D, E) / Total Prog. Cost	41.2%	34.9%	30.8%
		HORIZONTAL ANALYSIS (Number of Households)		**Old Policy**	**New Policy**	**Chg Mechanism**
17	A	Successful Targeting (Fuel Poor)		56,000	92,000	92,000
18	B_1	Spillover Benefits (Fuel Poor)		22,000	30,000	32,000
19	B_2	Spillover Benefits (Low Economic. Resource)		129,000	156,000	156,000
20	C	Inclusion Expense (Not Low Ec. Resource)		409,000	456,000	456,000
21	D	Inadequate Included		34,000	63,000	61,000
22	$E_{1,2}$	Exclusion Inadequacy		177,000	113,000	113,000
23	F	Total Households Included	∑ (A, B2, C)	594,000	703,000	703,000
24		% of Households N =	1,887,425	31.5%	37.3%	37.3%
25		Fuel Poor LER Households	Base = 153,000 households	131,000	123,000	121,000
26		Fuel Poor LER Households (%)	Base = 8.1% of households	6.9%	6.5%	6.4%
27		Fuel Poor LER Population	Base = 383,000 persons	313,000	295,000	268,000

To summarise Tab.2, all indicators move in a desirable direction with each change in policy. The logical question that follows is what drives such material improvements? Two key parameters are responsible:

i. First, Engels revision of his 1957 data (in 1897) demonstrated there is not a clear relationship between energy consumption and household incomes – a trend which holds to this day (per Fig.1). Note in Fig.7 where the electricity bll and incomes form the x and y axis respectively, the R^2 is only 0.0071. Bennett et al., (2002) found an R^2 for Great Britain of 0.04. 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 expect.

Figure 7: After housing cost equivalised Incomes vs electricity bill (QLD)



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

ii. Second, the nature of fuel poverty is poorly correlated with age as Simshauser and Nelson (2014) illustrate. Their analysis allocated 2.5m Australian energy customer households into 'age buckets' and found customer hardship was most prominent in the *'family formation'* cohort (viz. ages 30-55, with the median being 44 years). This cohort was also shown to consume considerably more power than all other age groups. Consequently, any policy which a). includes low-income families and b). provides higher support to high energy use households, can be expected to perform better vis-à-vis vertical efficiency. And, the *New Policy* is designed to capture low-income families, while the *Changed Mechanism* is designed to provide higher support to higher users. Above all, by deliberately targeting multi-person family households, more 'people' are benefiting from the policy as implied by Line 27 of Table 2.

4.3 Vertical and horizontal efficiency in 2021/22

The next set of model results focuses on 2021/22 market conditions. Over the period 2015/16 to 2021/22, Queensland electricity tariffs reduced by 14.2% in nominal terms or 29.2% in real terms, and as a result, a very different picture emerges. Tab.3 once again examines the Old Policy, New Policy and Changed Mechanism. The program budget rises $233.3m (Old Policy) or $279.9m (New Policy) in line with consumer price inflation *and* population growth. The Changed Mechanism rises to 30% of the bill while holding the program budget constant. The overall vertical efficiency metrics remain broadly consistent with Tab.2, with the combination of Successful Targeting and Spill-over benefits (Lines 1, 2, 3) and therefore Vertical Efficiency (Line 9) continuing to favour the New Policy (35.2%) over the Old Policy (31.2%), and the Changed Mechanism over the existing fixed rate of $354 per annum with vertical efficiency rising to 36.1%.

The horizontal analysis at Lines 17-27 shows that despite a significantly higher population set (i.e. 205,000 more households in 2021/22 vs the Base Year, at Line 24),

the incidence of *underlying* fuel poverty has fallen from 153,000 or 8.1% of households (Tab.2, Lines 25-26) to 143,000 or 6.8% of households in Tab.3. Policy is then capable of reducing the incidence of fuel poverty down to 110,000 or 5.3% of households. This result is being primarily driven by declining electricity tariffs and rising Queensland Electricity Rebate income support – rising as it did with inflation from $319 to $354 per household (or 29% of the household bill).

Table 3: Vertical & Horizontal Efficiency – 2021/22

		POLICY VERTICAL EFFICIENCY ($ per annum)		**Old Policy**	**New Policy**	**Chg Mechanism**
LINE		Benefit per annum		**$354**	**$354**	**29%**
1	A.	Successful Targeting (Fuel Poor)		$13,652,000	$24,189,000	$33,473,000
2	B_1	Spillover Benefits (Fuel Poor)		$2,977,000	$4,873,000	$7,200,000
3	B_2	Spillover Benefits (Low Economic Resource, not Fuel Poor)		$56,107,000	$68,065,000	$58,855,000
4	C	Inclusion Expense (Not Low Ec. Resource, not Fuel Poor)		$160,663,000	$178,858,000	$176,457,000
5	D	Included but Inadequate (Still Fuel Poor)		$15,767,000	$30,412,000	$21,377,000
6	$E_{1,2}$	Exclusion Inadequacy (Low Economic Resource)		$69,361,000	$44,215,000	$44,215,000
7		Total Program Cost	∑ (A, B1, B2, C)	$233,399,000	$275,985,000	$275,985,000
8		Benefits Received by Fuel Poor	∑ (A, B1,)	$16,629,000	$29,062,000	$40,673,000
		POLICY VERTICAL EFFICIENCY (%)				
9		Vertical Efficiency	∑ (A, B1, B2) / Total Prog. Cost	31.2%	35.2%	36.1%
10		Spill-over benefits	∑ (B1, B2) / ∑ (A,B1, B2)	81.2%	75.1%	66.4%
11		Poverty reduction efficiency	A / Total Program Cost	5.8%	8.8%	12.1%
12		Spill-over Excess (% of Total)	∑ (B1, B2) / Total Prog. Cost	25.3%	26.4%	23.9%
13		Inefficency due to inclusion	C / Total Program Cost	68.8%	64.8%	63.9%
14		Ineffeciency due to exclusion	E / Total Program Cost	29.7%	16.0%	16.0%
15		Inadequate concession benefits	D / Total Program Cost	6.8%	11.0%	7.7%
16		Benefit inadequacy	∑ (D, E) / Total Prog. Cost	36.5%	27.0%	23.8%
		HORIZONTAL ANALYSIS (Number of Households)		**Old Policy**	**New Policy**	**Chg Mechanism**
17	A	Successful Targeting (Fuel Poor)		47,000	82,000	82,000
18	B_1	Spillover Benefits (Fuel Poor)		15,000	24,000	33,000
19	B_2	Spillover Benefits (Low Economic. Resource)		159,000	192,000	192,000
20	C	Inclusion Expense (Not Low Ec. Resource)		454,000	505,000	505,000
21	D	Inadequate Included		32,000	61,000	51,000
22	$E_{1,2}$	Exclusion Inadequacy		196,000	125,000	125,000
23	F	Total Households Included	∑ (A, B2, C)	660,000	780,000	780,000
24		% of Households N =	2,092,645	31.5%	37.3%	37.3%
25		Fuel Poor LER Households	Base = 143,000 households	128,000	119,000	110,000
26		Fuel Poor LER Households (%)	Base = 6.8% of households	6.1%	5.7%	5.3%
27		Fuel Poor LER Population	Base = 361,000 persons	306,000	271,000	214,000

4.4 Forecast vertical and horizontal performance in 2023/24

In this next set of model results, the 2021/22 dataset is projected forward to 2023/24 to ascertain likely effects of the 2022 energy crisis. Recall while wholesale prices increased in 2022, the basis upon which residential electricity tariff caps are set accounts for forward hedging undertaken in prior years. Consequently, the 2023/24 year provides for an interesting analysis in that it will incorporate more (but possibly not all) of the price impacts from the 2022 market shocks, and the high inflationary / low wage growth environment which characterises contemporary Australian household budgetary conditions.

After declining by -14.2% from 2015/16 to 2021/22, electricity tariffs are forecast to rise +33.2% from 2021/22 to 2024 in nominal terms. Over the same period, consumer price inflation is expected to rise by +8.4% while average weekly earnings are expected to increase by +7.6%. Unsurprisingly, when combined this has a profound worsening effect on forecast fuel poverty metrics for Queensland, as illustrated in Tab.4.

The first point to note from Tab.4 is the rise in program costs, up from ~$275m in Tab.3 to ~$315m in Tab.4 (New Policy). This has been driven by Queensland's rising

population (+63,000 households) and the inflation-adjusted payment of $392 per household. The second point to note in Tab.4 is the very sharp increase in forecast incidence of *underlying* fuel poverty, from 143,000 or 6.8% of households in 2021/22, to 226,000 or 10.5% of households in 2023/24f (Lines 25-26) – up 83,000 households. Policy options are however proportionately more effective in reducing the incidence of fuel poverty, with a 2.9 percentage point drop in 2023/24 (New Policy *and* Changed Mechanism) compared to a 1.1-1.5% percentage point drop in 2021/22 – the policy thus presenting as an *automatic stabiliser.* In Tab.4 some of the horizontal metrics suggest an indifference between the *New Policy* and the *Changed Mechanism* (see Lines 25-26). However, note the result horizontal result at Line 27, and vertical efficiency metrics (Lines 1-3, 5, 8, 9, 11, 15-16) confirm the *Changed Mechanism* remains the superior policy option.

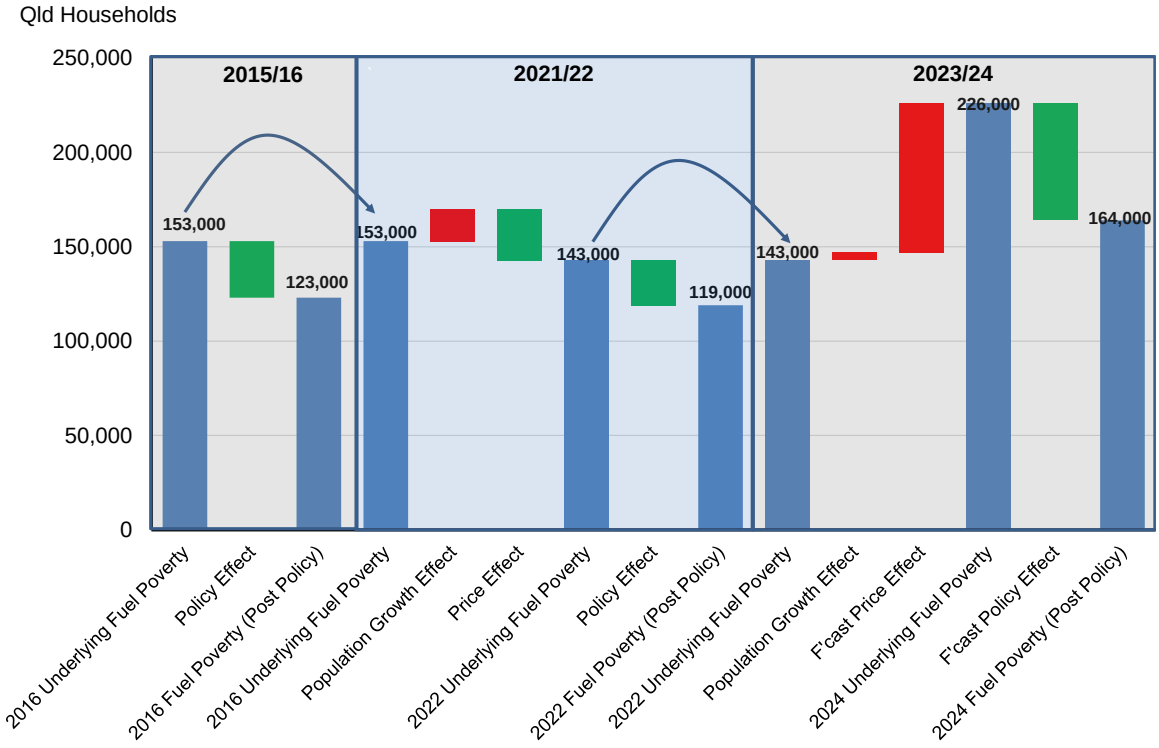
Table 4: Vertical & Horizontal Efficiency – 2023/24*f*

		POLICY VERTICAL EFFICIENCY ($ per annum)		**Old Policy**	**New Policy**	**Chg Mechanism**
LINE		Benefit per annum		**$392**	**$392**	**25%**
1	A.	Successful Targeting (Fuel Poor)		$26,807,000	$43,834,000	$58,375,000
2	B_1	Spillover Benefits (Fuel Poor)		$8,213,000	$12,041,000	$12,017,000
3	B_2	Spillover Benefits (Low Economic Resource, not Fuel Poor)		$48,311,000	$55,324,000	$43,483,000
4	C	Inclusion Expense (Not Low Ec. Resource, not Fuel Poor)		$183,329,000	$204,117,000	$201,440,000
5	D	Included but Inadequate (Still Fuel Poor)		$35,230,000	$69,048,000	$54,792,000
6	$E_{1,2}$	Exclusion Inadequacy (Low Economic Resource)		$79,246,000	$50,516,000	$50,516,000
7		Total Program Cost	∑ (A, B1, B2, C)	$266,661,000	$315,315,000	$315,315,000
8		Benefits Received by Fuel Poor	∑ (A, B1,)	$35,020,000	$55,875,000	$70,392,000
		POLICY VERTICAL EFFICIENCY (%)				
9		Vertical Efficiency	∑ (A, B1, B2) / Total Prog. Cost	31.2%	35.3%	36.1%
10		Spill-over benefits	∑ (B1, B2) / ∑ (A,B1, B2)	67.8%	60.6%	48.7%
11		Poverty reduction efficiency	A / Total Program Cost	10.1%	13.9%	18.5%
12		Spill-over Excess (% of Total)	∑ (B1, B2) / Total Prog. Cost	21.2%	21.4%	17.6%
13		Inefficency due to inclusion	C / Total Program Cost	68.8%	64.7%	63.9%
14		Ineffeciency due to exclusion	E / Total Program Cost	29.7%	16.0%	16.0%
15		Inadequate concession benefits	D / Total Program Cost	13.2%	21.9%	17.4%
16		Benefit inadequacy	∑ (D, E) / Total Prog. Cost	42.9%	37.9%	33.4%
		HORIZONTAL ANALYSIS (Number of Households)		**Old Policy**	**New Policy**	**Chg Mechanism**
17	A	Successful Targeting (Fuel Poor)		89,000	142,000	142,000
18	B_1	Spillover Benefits (Fuel Poor)		42,000	62,000	61,000
19	B_2	Spillover Benefits (Low Economic. Resource)		123,000	141,000	141,000
20	C	Inclusion Expense (Not Low Ec. Resource)		467,000	520,000	520,000
21	D	Inadequate Included		47,000	83,000	84,000
22	$E_{1,2}$	Exclusion Inadequacy		202,000	129,000	129,000
23	F	Total Households Included	∑ (A, B2, C)	679,000	2,155,895	803,000
24		% of Households N =	2,155,895	31.5%	100.0%	37.3%
25		Fuel Poor LER Households	Base = 226,000 households	184,000	164,000	165,000
26		Fuel Poor LER Households (%)	Base = 10.5% of households	8.5%	7.6%	7.7%
27		Fuel Poor LER Population	Base = 593,000 persons	445,000	384,000	362,000

4.5 Summary of fuel poverty result

A high-level summary of the (horizontal) incidence of fuel poverty and the effect of category targeting, population growth and electricity price changes are presented in the Fig.8 waterfall chart. Note in Fig.8 there are three distinct panels for each of 2015/16 (Section 4.2, Tab.2), 2021/22 (Section 4.3, Tab.3) and 2023/24 (Section 4.4, Tab.4).

Figure 8: Dynamic analysis of fuel poverty



In 2015/16, the underlying level of fuel poverty was 153,000 households. Policy reduced this to 123,000 households. In the 2021/22 panel, the waterfall chart commences with the underlying fuel poverty result from 2015/16 of 153,000 households. Population growth over this period was significant and assuming a normal distribution would increase the underlying level of fuel poverty in Queensland to 170,000 households (+17,000). However, the sharp rundown in electricity tariffs over this period (per Fig.4) had the effect of reducing the incidence of fuel poverty by 27,000 households, meaning the underlying level of fuel poverty in Queensland in 2022 was 143,000 households. Policy then reduces this further, to 119,000 households.

The forecast for 2023/24 in Fig.8 starts with the 2021/22 result of 143,000. Two effects drive the underlying result higher, population growth (+4,000 households) and rising electricity tariffs (+79,000 households) with underlying fuel poverty in 2023/24 totalling 226,000. Policy appears capable of reducing this by 62,000 households to 164,000 households.

5. The efficiency of Universal Payments vs. a Category Targeting Policy

During 2020/21 the Queensland Government initiated a $50 payment to all households ('universal payment') in the form of an 'ownership dividend' via a credit on all electricity bills. Although designed as a one-off payment, it was subsequently replicated in 2021/22 with a $175 ownership dividend under a *'cost of living' policy* initiative (partially funded by infra-marginal rents of government-owned generators, and rising export coal royalties). This policy may plausibly be repeated in future years if household electricity tariffs remain elevated. Consequently, the final analysis set out below examines the efficiency of universal payments vs. the category targeting policy.

By way of brief background, approximately 60% generation assets and all transmission and distribution network assets in Queensland are still owned by the State.

Establishment of the National Electricity Market in the 1990s entailed various waves of restructuring, deregulation and privatisation across the various jurisdictions. But privatisation was comparatively minimal in Queensland (viz. ~65% of energy retailers, ~40% of generation, 0% of networks), unlike the southern NEM regions of New South Wales, Victoria and South Australia where 100% of electricity assets were sold.

Tab. 5 illustrates the impact of a $115 universal payment (i.e. $115 being the approx. midpoint of the two prior ownership dividends of $50 and $175), and contrasts this with category targeting policy results using 2023/24*f* data.

For ease of analysis, the first column of results in Tab.5 reproduces the New Policy result from Tab.4 with qualifying households receiving $392. The second column in Tab.5 illustrates the combined impact of $392 New Policy *and* a Universal Payment by way of an ownership dividend of $115 per household. Notice at Lines 20 and 22 of Tab.5 that the 'Inclusion Expense' rises to 1,742,000 households, and 'Exclusion Inadequacy' falls to zero (i.e. the universal payment applies to all households and none are excluded).

The third and final column in Tab.5 holds this expanded program budget of $561 million constant (see Line 7) but deploys the additional fiscal resources (i.e. the 'ownership dividend') entirely to the category targeting policy. Consequently, horizontal results at Lines 17-27 are largely identical in the first (New Policy) and third (Targeted) columns (ex-Lines 21, and 25-27 owing to the higher funds allocated). Under these policy conditions, the incidence of fuel poverty (141,000 households) reduces below underlying levels in 2021/22, that is 143,000 households per Tab.3.

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

		POLICY VERTICAL EFFICIENCY ($ per annum)		**New Policy**	**Universal Pmt**	**Targeted**
LINE		Benefit per annum		**$392**	**$115 all + $392**	**$788**
1	A.	Successful Targeting (Fuel Poor)		$43,834,000	$59,933,000	$66,044,000
2	B_1	Spillover Benefits (Fuel Poor)		$12,041,000	$19,824,000	$33,386,000
3	B_2	Spillover Benefits (Low Economic Resource, not Fuel Poor)		$55,324,000	$76,952,000	$98,450,000
4	C	Inclusion Expense (Not Low Ec. Resource, not Fuel Poor)		$204,117,000	$404,406,000	$363,230,000
5	D	Included but Inadequate (Still Fuel Poor)		$69,048,000	$59,901,000	$46,165,000
6	$E_{1,2}$	Exclusion Inadequacy (Low Economic Resource)		$50,516,000	$0	$89,895,000
7		Total Program Cost	∑ (A, B1, B2, C)	$315,315,000	$561,115,000	$561,110,000
8		Benefits Received by Fuel Poor	∑ (A, B1,)	$55,875,000	$79,757,000	$99,430,000
		POLICY VERTICAL EFFICIENCY (%)				
9		Vertical Efficiency	∑ (A, B1, B2) / Total Prog. Cost	35.3%	27.9%	35.3%
10		Spill-over benefits	∑ (B1, B2) / ∑ (A,B1, B2)	60.6%	61.8%	66.6%
11		Poverty reduction efficiency	A / Total Program Cost	13.9%	10.7%	11.8%
12		Spill-over Excess (% of Total)	∑ (B1, B2) / Total Prog. Cost	21.4%	17.2%	23.5%
13		Inefficency due to inclusion	C / Total Program Cost	64.7%	72.1%	64.7%
14		Ineffeciency due to exclusion	E / Total Program Cost	16.0%	0.0%	16.0%
15		Inadequate concession benefits	D / Total Program Cost	21.9%	10.7%	8.2%
16		Benefit inadequacy	∑ (D, E) / Total Prog. Cost	37.9%	10.7%	24.2%
		HORIZONTAL ANALYSIS (Number of Households)		**New Policy**	**Universal Pmt**	**Targeted**
17	A	Successful Targeting (Fuel Poor)		142,000	208,000	142,000
18	B_1	Spillover Benefits (Fuel Poor)		79,000	70,000	79,000
19	B_2	Spillover Benefits (Low Economic. Resource)		141,000	188,000	141,000
20	C	Inclusion Expense (Not Low Ec. Resource)		520,000	1,742,000	520,000
21	D	Inadequate Included		65,000	78,000	65,000
22	$E_{1,2}$	Exclusion Inadequacy		129,000	0	129,000
23	F	Total Households Included	∑ (A, B2, C)	803,000	2,155,895	803,000
24		% of Households Population =	2,155,895	37.3%	100.0%	37.3%
25		Fuel Poor LER Households	Base = 226,000 households	164,000	156,000	147,000
26		Fuel Poor LER Households (%)	Base = 10.5% of households	7.6%	7.2%	6.8%
27		Fuel Poor LER Population	Base = 593,000 persons	384,000	359,000	311,000

6. Policy implications and concluding remarks

This article analysed fuel poverty in Queensland over recent price cycles. The 2015/16 year was selected as it straddled an era of major hardship policy reform (i.e. broadening the category targeting) and coincided with the end period of the 2007-2015 price cycle. The 2021/22 year represented the low point in the current price cycle, and 2023/24 was selected as it will impound the adverse effects of the 2022 energy market crisis (noting retail tariffs lag spot market dynamics by a few years).

The Old Policy was designed in 1993 and was, evidently, narrowly focused on those aged 65+ years. The New Policy included means-tested Healthcare Cardholders, and model results suggest changes were warranted. The horizontal efficiency of policy targeting increased from 51% to 69% (Fig.5) and vertical targeting efficiency increased from ~31% to ~35%, while the inefficiency arising from exclusion fell from ~30% to ~16% (Tab.2).

Changing the fixed payment to a variable rate, holding the program budget constant, also made marginal gains to vertical targeting efficiency. But political calculus often takes on a different form to economic calculus – changing from a $319 fixed payment to a circa 25% variable rate provides additional support to low-income families, but very low volume consumers (e.g. a single pensioner household) would be worse off. Consequently, such a change requires expending some level of political capital.

The change in policy in 2015/16 led to better targeting (i.e. horizontal efficiency rising from 51% to 69%) which meant 73,000 households were successfully included under the New Policy – per Fig.6. However, the cost of this was a rise in the inclusion error by +53,000 households. To be perfectly clear, it more desirable to minimise under-coverage and exclusion error than it is to minimise inclusion error, subject to fiscal constraints (Hoddinott, 1999).

Spill-over benefits to Low Economic Resource households not in fuel poverty (in Figure 2, sections B_1 and B_2) improved with the policy changes. Targeting is not designed entirely for the purpose of reducing poverty. Spillovers which benefit vulnerable households can be thought of as a positive side-effect that are welfare enhancing (Creedy, 1996). It is for this reason that Equation 3 was amended through the addition of sections B_1 and B_2. Cash benefits to low-income families are known to have strong redistributive impacts (Joumard, Pisu and Bloch, 2012).

If there is any cause for reflection with the present analysis, it is horizontal targeting peaking at 69%. Category targeting of vulnerable households in Queensland cannot be materially enhanced without a non-trivial blowout in the inclusion error rate (which would adversely impair the scheme's fiscal efficiency or practical effectiveness). Those households that have slipped through the cracks for whatever reason must therefore be targeted beyond the present policy and to maintain the levels observed in 2021/22, fiscal support would need to be increased (e.g. other policies exist for this purpose, such as unemployment benefits, rental supplements, rooftop solar PV schemes etc).

Finally, current conditions associated with the 2022 energy crisis mean the magnitude of the fuel poverty problem in Queensland will increase. The forecast of 2023/24 conditions suggest underlying fuel poverty of 226,000 or 10.5% of households. A sensitivity case in Appendix II which tests for a 30% tariff increase in 2023/24 rather than the 15% used in the Appendix I assumptions suggests this could rise to 247,000 or 11.5% of households. The New Policy is effective in reducing such outcomes and operates as an automatic stabiliser of sorts – the higher the incidence of fuel poverty, the

more impact the policy seems to have. The addition of the universal policy has a materially positive impact on these results and has the benefit of capturing low economic resource households that have slipped through category targeting. Conversely, on balance vertical efficiency is maximised if those same fiscal resources are channelled through the category targeting framework.

7. References

Averch, H. and Johnson, L. (1962) 'Behavior of the Firm under Regulatory Constraint', *Amercian Economic Review*, 52(5), pp. 1052–1069.

Awaworyi Churchill, S. and Smyth, R. (2021a) 'Energy poverty and health: Panel data evidence from Australia', *Energy Economics*, 97. Available at: https://doi.org/10.1016/j.eneco.2021.105219.

Awaworyi Churchill, S. and Smyth, R. (2021b) 'Widening the safety net', *Nature Energy*. Nature Research, pp. 856–857. Available at: https://doi.org/10.1038/s41560-021-00891-w.

Awaworyi Churchill, S., Smyth, R. and Farrell, L. (2020) 'Fuel poverty and subjective wellbeing', *Energy Economics*, 86, p. 104650.

Balestra, C. and Tonkin, R. (2018) 'Inequalities in household wealth across OECD countries: Evidence from the OECD Wealth Distribution Database', *OECD Statistics Working Papers*, 33, pp. 1–69.

Beckerman, W. (1979) 'The impact of income maintenance payments on poverty in Britain, 1975', *The Economic Journal*, 89(354), pp. 261–279.

Belaïd, F. (2018) 'Exposure and risk to fuel poverty in France: Examining the extent of the fuel precariousness and its salient determinants', *Energy Policy*, 114(June 2017), pp. 189–200.

Bennett, M., Cooke, D. and Waddams Price, C. (2002) 'Left Out in the Cold? New Energy Tariffs, Low-Income Households and the Fuel Poor', *Fiscal Studies*, 23(2), pp. 167–194.

Besley, T. (1990) 'Means Testing versus Universal Provision in Poverty Alleviation Programmes', *Economica*, 57(225), pp. 119–129.

Besley, T. and Kanbur, R. (1990) *The Principles of Targeting*, *The World Bank Working Paper 385*. Available at: https://doi.org/10.1007/978-1-349-21587-4_5.

Boardman, B. (1991) 'Fuel Poverty is Different', *Policy Studies*, 12(4), pp. 30–41.

Boardman, B. (2012) 'Fuel poverty synthesis: Lessons learnt, actions needed', *Energy Policy*, 49, pp. 143–148.

Bradshaw, J. and Hutton, S. (1983) 'Social policy options and fuel poverty', *Journal of Economic Psychology*, 3, pp. 249–266.

Bramley, G. (2012) 'Affordability, poverty and housing need: Triangulating measures and standards', *Journal of Housing and the Built Environment*, 27(2), pp. 133–151.

Chan, W.W. (2016) *Rethinking water and energy affordability in Australia: an analysis of the efficiency, effectiveness and equity of current policy*. PhD Thesis. PhD Thesis, Australian National University.

Creedy, J. (1996) 'Comparing Tax and Transfer Systems: Poverty, Inequality and Target Efficiency', *Economica*, 63(250), p. S163.

Guertler, P. (2012) 'Can the Green Deal be fair too? Exploring new possibilities for alleviating fuel poverty', *Energy Policy*, 49, pp. 91–97.

Harding, A. and Mitchell, D. (1992) 'The efficiency and effectiveness of the tax-transfer system in the 1980s.', *Australian Tax Forum*, 9(3), p. 277.

Herscovitch, A. and Stanton, D. (2008) 'History of Social Security in Australia', *Family Matters (Aust Institute of Family Studies)*, (80), pp. 51–60.

Hills, J. (2012) *Getting the measure of fuel poverty*.

Hoddinott, J. (1999) *Targeting: Principles and Practice*. International Food Policy Research Institute - Technical Guide #9.

Jessel, S., Sawyer, S. and Hernández, D. (2019) 'Energy, Poverty, and Health in Climate Change: A Comprehensive Review of an Emerging Literature', *Frontiers in Public Health*, 7(December), pp. 1–19.

Joumard, I., Pisu, M. and Bloch, D. (2012) 'Income inequality and growth: the role of taxes and transfers', *OECD Journal: Economic Studies*, p. 14.

Kessides, I. *et al.* (2009) *Toward defining and measuring the affordability of public utility services*, *World Bank Policy Research Working Paper 4915*.

Komives, K. *et al.* (2006) *The Distributional Incidence of Residential Water and Electricity Subsidies*, *World Bank Policy Research Working Paper 3878*.

Mazzone, A. (2020) 'Thermal comfort and cooling strategies in the Brazilian Amazon. An assessment of the concept of fuel poverty in tropical climates.', *Energy Policy*, 139(December 2019), p. 111256.

Moore, R. (2012) 'Definitions of fuel poverty: Implications for policy', *Energy Policy*, 49, pp. 19–26.

Oorschot, V. (2002) 'Targeting welfare: on the functions and dysfunctions of means-testing in social policy.', in. World Poverty: Studies in poverty, inequality and social exclusion. P. Townsend, & D. Gorden (Eds.), Bristol: Policy Press., pp. 171–193.

Rowley, S., Ong, R. and Haffner, M. (2015) 'Bridging the Gap between Housing Stress and Financial Stress : The Case of Australia', *Housing Studies*, 30(3), pp. 473–490.

Sen, A. (1976) 'Poverty: An Ordinal Approach to Measurement', *Econometrica*, 44(2), pp. 219–231.

Simshauser, P. (2021) 'Vulnerable households and fuel poverty: Measuring the efficiency of policy targeting in Queensland', *Energy Economics*, 101(June), p. 105405.

Simshauser, P. and Downer, D. (2016) 'On the inequity of flat-rate electricity tariffs', *Energy Journal*, 37(3), pp. 199–229. Available at: https://doi.org/10.5547/01956574.37.3.psim.

Simshauser, P. and Nelson, T. (2012) *The Energy Market Death Spiral - Rethinking Customer Hardship*, *AGL Applied Economic and Policy Research - Working Paper No.31, Brisbane.* Available at: http://aglblog.com.au/wp-content/uploads/2012/07/No-31-Death-Spiral1.pdf.

Simshauser, P. and Nelson, T. (2014) 'The consequences of retail electricity price rises: Rethinking customer hardship', *Australian Economic Review*, 47(1), pp. 13–43.

Simshauser, P., Nelson, T. and Doan, T. (2011) 'The Boomerang Paradox, Part I: How a Nation's Wealth Is Creating Fuel Poverty', *Electricity Journal*, 24(1), pp. 72–91. Available at: https://doi.org/10.1016/j.tej.2010.12.001.

Skoufias, E. and Coady, D. (2007) 'Are the Welfare Losses from Imperfect Targeting Important ?', *Economica*, 74, pp. 756–776.

Stigler, G.J. (1954) 'The Early History of Empirical Studies of Human Behaviour', *Journal of Political Economy*, 62(2), pp. 95–113.

Stone, M.E. (2006) 'What Is Housing Affordability? The Case for the Residual Income Approach', *Housing Policy Debate*, 17(1), pp. 151–184.

Tanton, R. and Phillips, B. (2013) 'A Measure of the Depth of Housing Stress and its Application in Australia', *Economic Papers*, 32(1), pp. 99–109. Available at: https://doi.org/10.1111/1759-3441.12015.

Thomson, H., Snell, C. and Liddell, C. (2016) 'Fuel poverty in the European Union: a concept in need of definition?', *People Place and Policy Online*, 10(1), pp. 5–24.

Townsend, P. (1962) 'The Meaning of Poverty', *The British Journal of Sociology*, 13(3), pp. 210–227.

Tully, S. (2006) 'The Human Right to Access Electricity', *Electricity Journal*, 19(3), pp. 30–39. Available at: https://doi.org/10.1016/j.tej.2006.02.003.

Waddams Price, C., Brazier, K. and Wang, W. (2012) 'Objective and subjective measures of fuel poverty', *Energy Policy*, 49, pp. 33–39.

Watts, N. *et al.* (2021) 'The 2020 report of The Lancet Countdown on health and climate change: responding to converging crises', *The Lancet*, 397(10269), pp. 129–170.

Welsch, H. and Biermann, P. (2017) 'Energy affordability and subjective well-being: Evidence for European Countries', *Energy Journal*, 38(3), pp. 159–176. Available at: https://doi.org/10.5547/01956574.38.3.hwel.

Yamamori, T. (2019) 'The Smithian ontology of "relative poverty": revisiting the debate between Amartya Sen and Peter Townsend*', *Journal of Economic Methodology*, 26(1), pp. 70–80.

APPENDIX I - Indicies

Table A1 – Electricity, Wages and Consumer Price Inflation Rates

Year	No. of Household Elec. Accounts	Electricity Tariff (T11 and T33)	Wage Price Inflation	Consumer Price Inflation	Real Electricity Tariff Growth	Real Wages Growth	Hardship Payment
2015/16	1,887,425						$319
2016/17	1,918,491	4.0%	1.9%	1.8%	2.2%	0.0%	$324
2017/18	1,947,496	3.4%	2.2%	1.7%	1.7%	0.5%	$330
2018/19	1,984,475	-0.8%	2.3%	1.7%	-2.5%	0.6%	$335
2019/20	2,010,650	-5.3%	1.9%	-1.0%	-4.3%	3.0%	$341
2020/21	2,027,061	-7.5%	1.6%	4.9%	-12.4%	-3.4%	$337
2021/22	2,092,649	-8.1%	2.4%	5.1%	-13.3%	-2.7%	$354
2015/16 - 2021/22	10.9%	-14.2%	12.9%	15.0%	-29.2%	-2.0%	11.0%
2022/23	2,124,039	11.0%	3.8%	5.5%	5.5%	-1.8%	$372
2023/24	2,155,895	20.0%	3.8%	2.8%	17.3%	1.0%	$392
2022/23 - 2023/24	3.0%	33.2%	7.6%	8.4%	24.8%	-0.8%	3.5%

Sources: Qld Competition Authority, Australian Energy Council, Australian Bureau of Statistics.
(Grey shaded boxes are forecasts, all other data are published actuals)

APPENDIX II – Sensitivity

Table A2 - Tariff sensitivity: 30% increase in 2023/24 (cf. 15% in Table 5)
Comparison of New Policy and Universal Payment

		POLICY VERTICAL EFFICIENCY ($ per annum)		**New Policy**	**Universal Pmt**	**Targeted**
LINE		Benefit per annum		**$392**	**$115 all + $392**	**$788**
1	A.	Successful Targeting (Fuel Poor)		$45,684,000	$68,690,000	$75,207,000
2	B_1	Spillover Benefits (Fuel Poor)		$25,065,000	$19,255,000	$34,461,000
3	B_2	Spillover Benefits (Low Economic Resource, not Fuel Poor)		$77,541,000	$68,764,000	$88,212,000
4	C	Inclusion Expense (Not Low Ec. Resource, not Fuel Poor)		$326,238,000	$404,406,000	$363,230,000
5	D	Included but Inadequate (Still Fuel Poor)		$28,958,000	$73,481,000	$58,579,000
6	$E_{1,2}$	Exclusion Inadequacy (Low Economic Resource)		$141,020,000	$0	$89,895,000
7		Total Program Cost	∑ (A, B1, B2, C)	$474,528,000	$561,115,000	$561,110,000
8		Benefits Received by Fuel Poor	∑ (A, B1,)	$70,749,000	$87,945,000	$109,668,000
		POLICY VERTICAL EFFICIENCY (%)				
9		Vertical Efficiency	∑ (A, B1, B2) / Total Prog. Cost	31.2%	27.9%	35.3%
10		Spill-over benefits	∑ (B1, B2) / ∑ (A,B1, B2)	69.2%	56.2%	62.0%
11		Poverty reduction efficiency	A / Total Program Cost	9.6%	12.2%	13.4%
12		Spill-over Excess (% of Total)	∑ (B1, B2) / Total Prog. Cost	21.6%	15.7%	21.9%
13		Inefficency due to inclusion	C / Total Program Cost	68.8%	72.1%	64.7%
14		Ineffeciency due to exclusion	E / Total Program Cost	29.7%	0.0%	16.0%
15		Inadequate concession benefits	D / Total Program Cost	6.1%	13.1%	10.4%
16		Benefit inadequacy	∑ (D, E) / Total Prog. Cost	35.8%	13.1%	26.5%
		HORIZONTAL ANALYSIS (Number of Households)		**Old Policy**	**New Policy**	**Chg Mechanism**
17	A	Successful Targeting (Fuel Poor)		101,000	229,000	157,000
18	B_1	Spillover Benefits (Fuel Poor)		62,000	81,000	86,000
19	B_2	Spillover Benefits (Low Economic. Resource)		111,000	167,000	126,000
20	C	Inclusion Expense (Not Low Ec. Resource)		467,000	1,742,000	520,000
21	D	Inadequate Included		39,000	84,000	73,000
22	$E_{1,2}$	Exclusion Inadequacy		202,000	0	129,000
23	F	Total Households Included	∑ (A, B2, C)	679,000	2,155,895	803,000
24		% of Households Population =	2,155,895	31.5%	100.0%	37.3%
25		Fuel Poor LER Households	Base = 247,000 households	185,000	166,000	161,000
26		Fuel Poor LER Households (%)	Base = 11.5% of households	8.6%	7.7%	7.5%
27		Fuel Poor LER Population	Base = 671,000 persons	441,000	410,000	353,000