Energy Policy 71 (2014) 40–51

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Distributional effects of the Australian Renewable Energy Target (RET) through wholesale and retail electricity price impacts

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HIGHLIGHTS

- The Australian RET has complex yet important distributional impacts on different energy users.
- Likely wealth transfers from residential and small business consumers to large energy-intensive industry.
- Merit order effects of wind likely overcompensate exempt industry for contribution to RET costs.
- RET costs for households could be reduced if merit order effects were adequately passed through.
- Need for distributional impact assessments when designing and implementing clean energy policy.

ARTICLE INFO

Article history:
Received 27 November 2013
Received in revised form
20 February 2014
Accepted 4 April 2014
Available online 3 May 2014

Keywords:
Renewable energy
Electricity market
Distributional effects

ABSTRACT

The Australian Renewable Energy Target (RET) has spurred significant investment in renewable electricity generation, notably wind power, over the past decade. This paper considers distributional implications of the RET for different energy users. Using time-series regression, we show that the increasing amount of wind energy has placed considerable downward pressure on wholesale electricity prices through the so-called merit order effect. On the other hand, RET costs are passed on to consumers in the form of retail electricity price premiums. Our findings highlight likely significant redistributive transfers between different energy user classes under current RET arrangements. In particular, some energy-intensive industries are benefiting from lower wholesale electricity prices whilst being largely exempted from contributing to the costs of the scheme. By contrast, many households are paying significant RET pass through costs whilst not necessarily benefiting from lower wholesale prices. A more equitable distribution of RET costs and benefits could be achieved by reviewing the scope and extent of industry exemptions and ensuring that methodologies to estimate wholesale price components in regulated electricity tariffs reflect more closely actual market conditions. More generally, these findings support the growing international appreciation that policy makers need to integrate distributional assessments into policy design and implementation.

1. Introduction

Australia implemented the world's first national Mandatory Renewable Energy Target (MRET) based around green certificate trading in 2001. The original target of an additional 9500 GWh of ‘new’ renewable generation each year by 2010 was comfortably achieved with contributions from biomass, hydro, solar and, most particularly, wind deployment. Amendments to the scheme undertaken in 2009–10 with bipartisan political support, have established the goal of deriving the equivalent of at least 20 per cent of Australian electricity from renewable sources by 2020 (Australian Government, 2012). In 2011, the target was split into two parts with separate targets, the Large-Scale Renewable Energy Target (LRET) covering utility scale renewable projects, and the Small-Scale Renewable Energy Scheme (SRES) covering residential solar. In this paper, we focus on the LRET and associated investment in (predominantly) wind energy.[1]

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http://dx.doi.org/10.1016/j.enpol.2014.04.008

[1] The SRES and the associated build-up of distributed photovoltaic electricity generation in Australia is likely to also have non-negligible distributional effects, the estimation of which is also impacted by the various State-based feed-in-tariffs that supported PV's initial deployment (Nelson et al., 2011). Furthermore, the amount of self-generated solar energy consumed by households owning rooftop PV also plays a role (Cai et al., 2013).

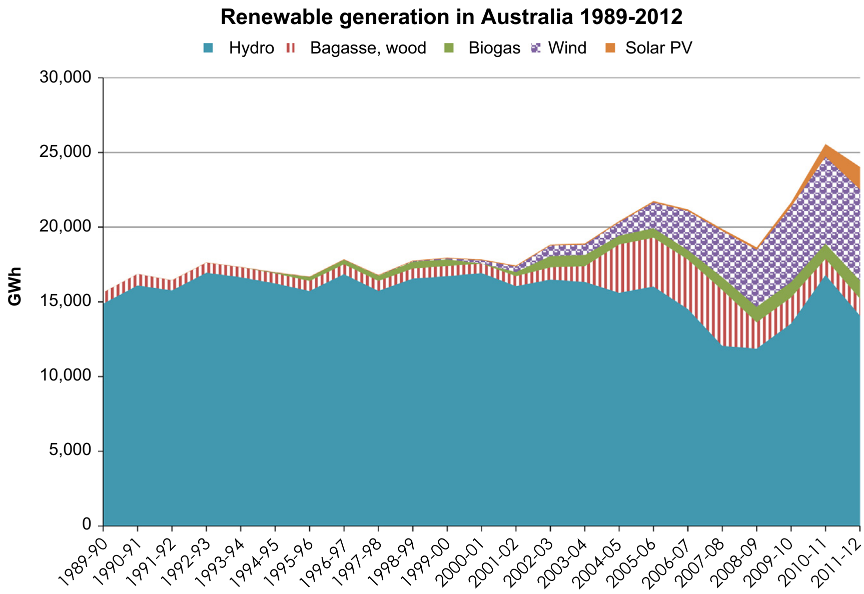

Fig. 1. Renewable generation in Australia1989-2012.
Source: BREE (2013), own illustration.

The RET places a legal obligation on entities that purchase electricity on the wholesale market to surrender a certain amount of green certificates each year in proportion to their market share. The liable parties are mainly retailers (also known as suppliers and Load Service Entities in some other industries) and a few large electricity consumers that directly purchase electricity on the wholesale market. Each certificate represents 1 MWh of electricity generated by 'new' (that is, not pre-existing hydro) renewable energy sources. These Renewable Energy Certificates (RECs) can be created by accredited large-scale renewable energy projects, generating LGCs (and small-scale renewable energy systems for the SRES). RECs provide the additional revenue stream, beyond energy market returns, that is required to implement renewable energy projects. There is an active market between liable parties and certificate providers for these RECs with associated spot and forward prices that vary according to renewable energy project costs and electricity prices.

Since its inception the RET has driven considerable investment in renewable energy projects, and an increasing percentage of electricity consumption is now being provided from new renewable generation (Fig. 1). This expansion of electricity generated by renewables has several competing impacts on electricity prices in the short run. On the one hand, an increased penetration of renewables in wholesale electricity markets tends to lower the spot price. This is due to the so-called merit order effect by which renewables that have close to zero short run marginal costs displace higher operating cost generation and hence lower the overall price required for supply to meet demand within the wholesale electricity market (see Section 2).

On the other hand, the cost of green certificates, reflecting the additional investment costs of renewable generation, is added to the retail price of electricity by the retailer who passes the costs of complying with their target on to consumers, or is paid for directly by users who manage their own compliance. Besides a wholesale component and renewable energy scheme charges, residential retail prices also include charges for transmission and distribution networks. These network costs are, indeed, the major cost component. In 2012–13 residential retail prices in the Australian National Electricity Market (NEM) comprised estimated cost components for transmission networks of 8% and distribution networks of 37%, a wholesale component including carbon costs of 37% and a retail component of 17% that included an allowance for LRET and SRES costs of 3–4% (Fig. 2).

Our analysis focuses on those components of retail prices which are directly affected by the RET in the short term, namely the wholesale component and green scheme charges. We do not consider transmission or distribution network charges in the analysis. Instead, the aim of this paper is to investigate how the potential financial benefits of the RET (lower wholesale prices in the short run) and its costs (increased retail prices due to the cost of green certificates) are distributed amongst different groups of electricity consumers, and how design choices about the implementation of the RET affect this distribution. In particular, a number of so-called energy-intensive trade-exposed industries are largely exempt from contributing to the costs of the RET, while they could still benefit from the reduction in wholesale prices driven by the scheme. The importance of this question has been noted by some stakeholders. For example, in their submission to the review of the RET, the Independent Pricing and Regulatory Tribunal of New South Wales notes: "As the overall RET target is kept constant, these exemptions raise the costs of complying with the scheme for all other customers, particularly as the exempted industries can be large users of electricity and account for a significant proportion of electricity use in Australia. To date, little analysis has been publicly provided on the impact of these exemptions including the costs and benefits to other electricity customers." (IPART, 2012b, p. 11). The Climate Institute (2012) has also raised concerns regarding these wealth transfers.

Furthermore, this issue has been raised in some other jurisdictions. In particular, a similar study has been conducted for Germany and its Renewable Energy Support Act (EEG). The EEG also exempts energy-intensive companies from contributing to the cost of the policy. In their paper Cludius et al. (2013) conclude that the merit order effect likely overcompensates energy-intensive consumers by a factor of twenty for their contribution to the cost of the EEG. This, therefore, makes the scheme more costly than it might otherwise be for households and small business.

We expect that the Australian Renewable Energy Target (RET) has also led to potentially significant distributional transfers between households and large electricity consumers. As noted

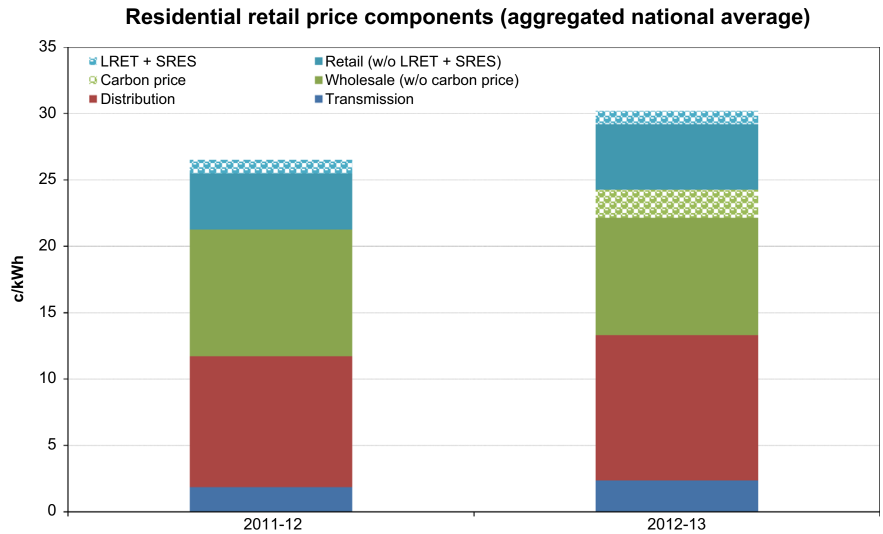

Fig. 2. Residential retail price components (aggregated national average).
Source: AEMC (2013b), own illustration.

above, a large share of industrial consumption is currently partially exempt from complying with the RET. Furthermore, financial RET benefits to end-users – lower wholesale prices – may not be completely passed forward to households through the process of setting retail tariffs by regulators. Analysing and addressing distributional effects can play a key role in achieving broad social consensus on the fairness and hence appropriateness of policy implementation (United Nations, 2006). As an example, the Australian Government introduced a large household assistance programme alongside its introduction of a carbon price with the explicit intent of addressing potentially adverse distributional impacts arising from the policy, particularly on vulnerable households (Australian Government, 2011).

Distributional issues, however, did not seem to feature greatly in public discussions regarding the design and implementation of the extended RET (MacGill and Passey, 2009). More recently, however, major rises in retail electricity prices have focussed greater public attention on cost drivers within the industry. Most of these price increases have been driven by growing distribution network expenditure. However, renewable energy policy support including the RET has also contributed and raised questions of overall schemes costs and also their distribution. Discussions are set to intensify in the future as LRET costs are expected to rise, as a result of both the progressively increasing level of the target (obligations on retailers to source their electricity from renewable sources are currently expected to more than double over the next six years)[2] and rising LGC prices due to higher financing costs for renewables projects (IPART, 2013). Furthermore, an abolition of the carbon price and an associated fall in wholesale electricity prices would also be expected to drive up prices for LGCs. Finally, results of this study not only have implications for the RET, but also, more generally, for ongoing discussions about the potential need and possible nature of reform of both electricity wholesale and retail markets in Australia.

The paper is structured as follows. We first present the method and data for estimation of the merit order effect of wind energy in the Australian National Electricity Market (NEM). We also discuss the market for Renewable Energy Certificates, reflecting the costs of the RET and point out existing exemptions from the RET. Finally, we present a framework for determining the net impact of the RET on electricity prices. Section 3 presents regression results of the reduction in wholesale prices caused by the merit order effect of wind in the Australian NEM in 2011–12 and 2012–13. We use these results together with information on RET costs in regulated retail tariffs to derive impacts of the RET on retail electricity prices for a range of pass-through rates for both the reduction in wholesale prices and RET costs. Section 4 discusses potential effects for individual electricity consumers and how these are related to the retail tariffs they receive. Finally, Section 5 highlights the potential policy implications of these findings and concludes.

2. Material and methods

2.1. Estimating the merit order effect of wind in the Australian National Electricity Market (NEM)

The expansion of renewable generation in the NEM, in particular the large growth in wind capacity since the inception of policies promoting renewable generation, has had a notable influence on the price of wholesale electricity. As with any additional supply, the expansion of wind generation has placed downward pressure on wholesale prices. However, this phenomenon is more pronounced in the case of wind generation due to the fact that it has a very low short run marginal cost. This systematic correlation between spot price and wind generation in the short run is known as the merit order effect of wind generation.

The supply curve, or merit order, within a wholesale electricity market is constructed by ordering the bids of all generators from lowest to highest. In a scenario where no market power exists these bids should equate to the marginal costs of the generators and therefore the supply curve reflect the aggregate marginal cost curve for the market. At the intersection of the supply and demand curves, the spot market price is set. All generators with lower marginal costs receive this uniform price and serve demand over the period of the wholesale spot market, which lasts half an hour in the NEM. Wind tends to shift the supply curve to the right, due to its low marginal cost

[2] See the forecast of the Clean Energy Regulator for the Renewable Power Percentage (RPP) representing the rate of liability under the RET, which is projected to reach 23% in 2020, rising from 10% in 2014 (http://ret.cleanenergyregulator.gov.au/For-Industry/Liable-Entities/rpp).

Table 1
Descriptive statistics – Price variables ($/MWh).
Source: AEMO Database.

Variable	Mean	Standard Deviation	Min	1st Percentile	Median	99th Percentile	Max
2011–12							
Price	29.24	30.22	–65.54	13.89	27.69	60.71	3566.00
Price-censored	29.06	12.13	1.00	13.89	27.69	60.71	415.00
2012–13							
Price	60.56	68.86	–185.40	39.16	52.40	194.64	3353.34
Price-censored	58.73	31.44	1.00	39.16	52.40	194.64	415.00

of generation. This is called the merit order effect (see Forrest and MacGill, 2013 for an in-depth discussion of the merit order effect).[3]

The merit order effect is a well-documented phenomenon (IEA, 2011). In general, two ways of estimating the effect exist. The first approach uses an electricity market model which compares two scenarios, one with and one without the inclusion of renewables and looks at the difference in resulting electricity wholesale prices (de Miera et al., 2008; Sensfuß et al., 2008; Weigt, 2009). The second approach uses time-series analysis of historical price and load data (Cludius et al., 2013; Forrest and MacGill, 2013; Gelabert et al., 2011; Jónsson et al., 2010; Woo et al., 2011). While the specification of an electricity market model has the potential to capture longer term effects, it requires careful calibration of a counterfactual scenario and available market models generally have significant limitations. Time-series analysis, on the other hand, does not have to make assumptions about alternative developments, but can only analyse short term effects, neglecting issues such as investment costs in new generation or networks. It may also struggle to resolve the impact of renewables against a wide range of other potential market drivers. Some techniques can include elements of both approaches (McConnell et al., 2013). See Würzburg et al. (2013) for a review of studies on the merit order effect to date.

The Australian National Electricity Market (NEM) includes the states of New South Wales, Victoria, Queensland, South Australia and Tasmania (the Australian Capital Territory is included in the NSW region of the NEM). It covers around 90% of Australia's population and electricity demand. The wholesale spot market is unique in that it is ‘energy only’ with no capacity market or technical forward market, is compulsory (gross pool) for all generators larger than 30 MW, uses five minute dispatch with 30 minute averaged pricing, requires participants to manage their own unit commitment and allows participants to rebid their price-quantity offers on a five minute basis (MacGill, 2010). The NEM spot market is characterised by its extremely volatile prices by comparison with many other markets and during the study period operated under a market ceiling price in any half hour of $12,900/MWh and a market floor price of –$1000/MWh. At present, each of the regions in the NEM has only limited interconnection with other regions and therefore each region has its own dynamic wholesale price (AER, 2012).

The calculation builds on Forrest and MacGill (2013) who calculate the merit order effect between 2009 and 2011 for South Australia and Victoria. We extend this analysis by calculating the merit order effect for the NEM as a whole for the two years 2011–12 and 2012–13. The wholesale price in the NEM is modelled as a function of the feed-in of wind ($wind_t$) and total demand

[3] Note that depending on the way in which renewable generation is included in the electricity market, it might also be represented as a reduction in demand. The overall effect in this stylised model, however, is identical.

Table 2
Descriptive statistics – Demand and wind variables (MW).
Source: AEMO Database.

Variable	Mean	Standard Deviation	Min	1st Percentile	Median	99th Percentile	Max
2011–12							
Demand	23,275	3064	15,895	17,381	23,566	29,660	31,959
Wind	619	338	0	61	580	1395	1620
2012–13							
Demand	22,819	3072	15,466	17,120	23,064	29,791	32,561
Wind	701	390	4	56	649	1584	1932

($demand_t$). The logarithmic transformation of the price takes account of the fact that the effect of wind is expected to be higher at the high demand end. Dummy variables for seasonal trends on a daily timescale and a binary variable for weekends is also included. To account for transient changes, an autoregressive term is included in the model (Eq. (1)).

$$\ln(price_t) = c + \gamma \ln(price_{t-1}) + \alpha_1 wind_t + \beta_1 demand_t + \sum_j \mu_j S_{jt} + \eta_1 W_t + \varepsilon_t \tag{1}$$

We use half-hourly data on wholesale spot prices, demand and wind aggregated across the five regions of the NEM. The data was extracted from the database located on the Australia Energy Market Operator (AEMO) website (www.aemo.com.au). A national wholesale spot price variable was created using a demand weighted average of the regional prices (Table 1) while demand and wind were added across regions (Table 2). For each of the data series used in the analysis the Phillips–Perron test for stationarity was conducted and all series were found to be stationary as expected, thus alleviating the concern of spurious regression results.

At high levels of demand, price spikes can be observed that do not correspond to marginal costs and are the result of a lack of competition in these situations (Twomey and Neuhoff, 2010). Therefore, the spot price variable has been censored to between the values of 1 $/MWh and 415 $/MWh, reflecting a reasonable estimate of the lowest and highest short run marginal costs of generators in the NEM. Consequently, the estimate of the merit order effect can be considered to be representative of ‘standard’ conditions in the market and not those periods effected by extremely low and high price events. It is expected that this approach leads to a more conservative estimate of the merit order effects due to the asymmetric magnitude and frequency of low and high price events. Further, by taking a national approach, we determine an estimate of the merit order effect of the NEM as a whole, and neglect potential interregional differences and interconnection effects.

Average half-hourly demand was about 400 MW lower in 2012–13 than in 2011–12, which can be explained by a range of reasons, such as weather conditions, a rising share of distributed energy sources and

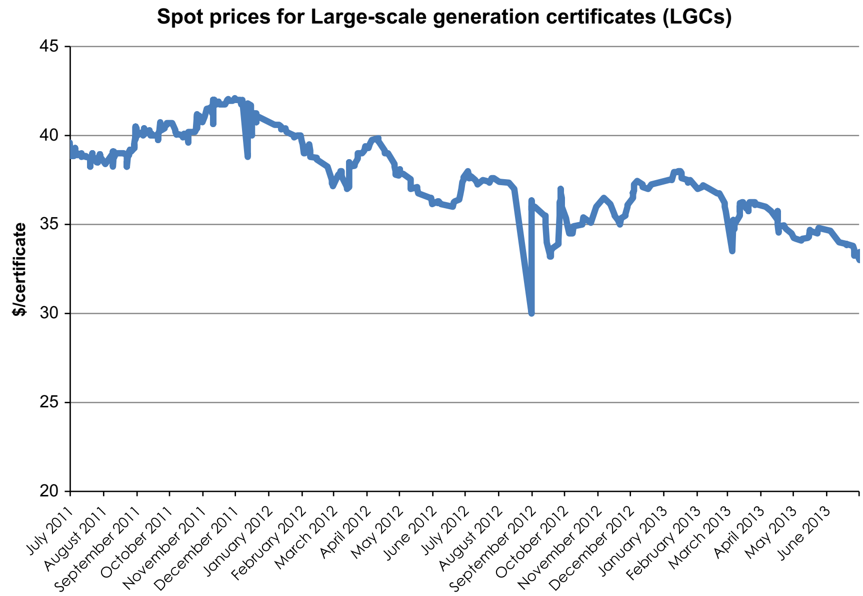

Fig. 3. Spot prices for Large-scale generation certificates (LGCs).
Source: Data provided by Nextgen, own illustration.

industrial shutdowns (IES, 2013). Average electricity generated by wind increased by 100 MW. Wholesale spot electricity prices, however, nearly doubled between 2011–12 and 2012–13. The main driver of this difference is the introduction of the fixed carbon price in July 2012, and, to a lesser extent, the fact that moderate weather conditions and significant hydro availability coupled with falling demand and increased feed-in of renewables made 2011–12 a year of historically low wholesale prices. Retail prices rose by 15% between the two years, with the wholesale component including the carbon price being responsible for 38% of this price rise, and rising transmission and distribution network costs for 43% (AEMC, 2013b).

2.2. The market for Renewable Energy Certificates (RECs), RET costs and exemptions

Each year, liable parties under the RET – that is, those that make "relevant acquisitions of electricity" – have to submit a mandated number of certificates. In practice these liable parties are mostly retailers, although there are some end-users that acquire their obligation directly from renewable energy projects (Climate Change Authority, 2012). The exact number of certificates to be submitted is determined by the Renewable Power Percentage (RPP), which is applied to the amount of electricity bought by each liable party. The percentage is set at a level that ensures the 20% target of the RET will be reached in 2020. The shortfall charge is set at 65 $/MWh. As certificate purchases are tax deductible, while the shortfall charge is not, the penalty is larger in real terms.

Each Renewable Energy Certificate (REC) represents 1 MWh of electricity generated by accredited renewable energy projects. Fig. 3 shows the evolution of spot prices for Large-scale Generation Certificates (LGCs) for the time period under investigation. LGC prices have fallen from around $40 in mid-2011 to below $35 in mid-2013. In theory, certificate prices should reflect the difference between the price of electricity that can be earned on the wholesale market and the long run marginal cost of the most economically efficient renewable generation technology. The price is, however, also influenced by political events impacting the current and expected stringency of renewable energy policy. Nelson et al. (2013) note that prices have generally been lower than this expected difference. This is mainly due to uncertainty regarding the future of the RET and an oversupply of permits that occurred due to a multiplier for credits generated by small-scale solar, which had been introduced in 2009 when the target was expanded. This oversupply was one of the reasons for splitting the target into the two different components in 2011.

Two types of exemptions from liability under the RET exist: (i) self-consumption and (ii) Emissions-intensive trade-exposed industry (EITE). Since the Renewable Power Percentage (RPP) and therefore the impact of RET costs on electricity prices depends on the total liable electricity consumption, the more exemptions, the more expensive the scheme becomes for the non-exempt parties: "The broader the base for liability, the smaller the impact for any individual liable party. For this reason, it is generally more efficient and equitable to keep exemptions to a minimum." (Climate Change Authority, 2012)

The original MRET had a clearly articulated principle that energy consumers should pay according to their consumption (Tambling, 2003). However, exemption provisions were introduced together with the expansion of the RET in 2009 and took effect in 2010. Eligible activities can apply for partial exemption certificates (PECs). PECs remove RET liability for the volume of electricity (in MWh) which is specified in the PEC. Those PECs are then passed on from the exempt user to their retailer under the assumption that the retailer then has lower liability and passes only a fraction of RET costs on to the EITE activity.

The rationale behind exempting certain industries is that some industries compete within an international market and thus may not be able to pass RET costs on to consumers in the form of higher prices. Consumers might, instead, substitute their product with one produced by a company that does not face environmental regulations in their country. Furthermore, industry might decide to relocate to jurisdictions with less stringent environmental regulation. This process of shifting greenhouse related emissions abroad is called 'carbon leakage'. The true extent of carbon leakage depends on both the emissions- and trade-intensity of the industry in question and other barriers that might impede relocation of production or substitution of consumption, such as transportation costs or local factors (Droege et al., 2009; European Commission, 2010).

The list of EITE activities that qualify for RET exemption is the same as for exemptions from the Australian carbon price. Highly emissions-intensive activities include aluminium and zinc smelting, petroleum refining, the manufacture of iron and steel and the manufacture of newsprint. They are exempt from 90% of RET costs.

Table 3
Electricity consumption exempt from complying with the RET.
Source: Clean Energy Regulator, own illustration.

TWh	60% exempt	90% exempt	of which Aluminium
2011	0.68	26.86	18.43
2012	1.00	32.46	21.85

Moderately emissions-intensive activities include the manufacture of wood, paper and glass products, as well as certain chemical processes and are exempt for 60% of their electricity consumption. In 2011, 27.5 TWh of electricity consumption were exempt from paying for RET costs, mostly at a 90% rate, while in 2012 33.5 TWh were exempt, which corresponds to about 15% of total electricity consumption in Australia. 65% of these exemptions were granted to the aluminium industry (Table 3).[4]

2.3. Estimating the net impact of the RET on electricity prices

The net effect of the RET on electricity prices faced by consumers in the short run depends on the pass-through of both the merit order effect and the certificate cost. We estimate indicative net effects for nine combinations of possible pass-through rates as illustrated in Table 4. Analysed pass-through rates of RET costs range from 100% to 10%, corresponding to the exemption rates (0% for households and small business; 60% or 90% for energy-intensive industry), while the pass-through effect of the merit order effect is analysed at indicative levels of 0%, 50% and 100% (representing a case where electricity prices are not, partially or fully aligned to wholesale price movements).

Pass-through of the merit order effect to an individual consumer depends on whether or not retail prices or tariffs are aligned to wholesale price movements. The extent to which this is the case is expected to depend on (i) whether a user is subject to a regulated retail tariff or has the ability to negotiate their own contract and, in case the user is on a retail tariff, (ii) the method by which the wholesale energy purchase cost allowance is calculated by the regulator in the user's jurisdiction.

The pass-through of RET costs is likely to primarily depend on the extent of exemption from RET costs of the individual consumer, therefore, we analyse pass-through of RET costs at 10% (exempt industry, high exemption), 40% (exempt industry, medium exemption) and 100% (no exemption, households and small business). In jurisdictions with regulated retail prices, the approach taken by the regulator to determine the green scheme allowance will again play a role.

3. Results

3.1. The impact of the RET on prices in the Australian National Electricity Market (NEM)

This section presents results of the regression model for the two years 2011–12 and 2012–13 respectively (Tables 5 and 6). The years were analysed separately due to the introduction of the carbon price and its impact on wholesale prices. In order to account for the fact that the data has been censored a Tobit model has been used to estimate the parameter coefficients in the model. Furthermore, due to the possible presence of serial correlation, statistical significance was assessed by looking at the maximum of standard errors from the Tobit model and an OLS model with Newey–West standard errors.

All coefficients are estimated highly precisely and have the expected sign, i.e. additional generation by wind has a negative impact on the electricity price, while additional demand has a positive impact. The coefficients can be used to estimate the expected price reduction at a specific wind output. From these results, it is possible to develop an estimate of the total merit order effect, i.e. the average price reduction by calculating the volume weighted average price difference over the analysis period (see Forrest and MacGill (2013) for further information on the estimation strategy).

This represents a short run estimate of the merit order effect, as it does not take into account long run changes in generation capacity due to additional wind generation. The estimate of the merit order effect in 2012–13 is higher by approximately \$1/MWh. This is a result of higher wind penetration and the introduction of the carbon price leading to higher operating costs of the marginal generation that wind displaces.[5]

3.2. RET costs in regulated retail tariffs

Retailers pass the costs incurred by purchasing Renewable Energy Certificates (RECs) on to consumers in the form of higher electricity prices.[6] In jurisdictions where retail prices are regulated, regulators have to set a green scheme allowance for prices to be set by the retailer. In order to determine the green scheme allowance, jurisdictions apply the Renewable Power Percentage (RPP) in a given year to the expected Large-scale Generation Certificate (LGC) price. Jurisdictions use different approaches to estimate the expected LGC price. Some base their estimations on the observed prices of LGCs on the market (Queensland, the ACT and Tasmania) while others use an electricity market model to derive the least cost option of reaching RET targets (New South Wales, South Australia).

LRET allowances for retail prices set in 2011–12 and 2012–13 in the different State and Territory jurisdictions are shown in Table 7. For New South Wales, Queensland, South Australia, Tasmania and the ACT, allowances shown are those set by the respective regulator for regulated retail tariffs. The retail electricity market is deregulated in Victoria, but retailers have to publish a standing offer price, which the Australian Electricity Market Commission (AEMC, 2013b) uses to calculate an indicative component of LRET costs in retail prices.

As an indicator for LRET costs, a volume-weighted average using residential electricity consumption by State from ESAA (2013) of the allowance for LRET costs in regulated retail tariffs (Table 7) is calculated at 3.38 \$/MWh in 2011–12 and 5.29 \$/MWh in 2012–13. This estimate represents LRET costs for households and small business, as covered by regulated retail tariffs. It has to be noted that cost recovery in a regulated electricity tariff may overstate the costs of green certificates and not represent competitive market prices. Indeed, some of the approaches used by NEM jurisdictions to determine this allowance have led to estimated LRET certificate prices that are considerably higher than the observed spot market price. Therefore, LRET costs for industry

[4] Exemptions are not granted for the MRET share of the RET, i.e. for the first 9500 GWh everyone is fully liable. If this provision was removed, it would add another 0.36 \$/MWh to RET costs for remaining liable parties (Climate Change Authority, 2012).

[5] While our analysis focusses on the effect of the Large-scale RET and associated wind generation, the recent rise in photovoltaic generation installed in the NEM (as a result of the SRES and State-based feed-in tariffs) is also expected to have considerable merit order effects (cf. McConnell et al., 2013, who model the hypothetical impact of 5 GW of distributed photovoltaic generation installed in the NEM in 2009 to 2010).

[6] Therefore, in a concentrated market like Australia, retailers generally do not have an incentive to minimise RET costs. That is why some large users would like to opt into the scheme and manage their liabilities directly (Climate Change Authority, 2012).

Table 4
Combinations of pass-through rates used in analysis.

	Pass-through RET costs		
	100%	40%	10%
Pass-through merit order effect			
0%	Electricity price not aligned to wholesale price movements; not exempt from RET costs	Electricity price not aligned to wholesale price movements; 60% exempt from RET costs	Electricity price not aligned to wholesale price movements; 90% exempt from RET costs
50%	Electricity price partially aligned to wholesale price movements; not exempt from RET costs	Electricity price partially aligned to wholesale price movements; 60% exempt from RET costs	Electricity price partially aligned to wholesale price movements; 90% exempt from RET costs
100%	Electricity price fully aligned to wholesale price movements; not exempt from RET costs	Electricity price fully aligned to wholesale price movements; 60% exempt from RET costs	Electricity price fully aligned to wholesale price movements; 90% exempt from RET costs

Table 5
Regression results 2011–12.

2011–12			
R-squared	0.6594		
Root MSE	0.1908		
Observations	17,568		
	Coefficient	S.E.	*t*-stat
Price (t−1)	0.587338	0.006109	96.140
Wind	−0.000060	0.000005	−12.530
Demand	0.000030	0.000001	23.600
Constant	0.791780	0.033021	23.980
Add. Controls: Dummies for seasonal trends and weekends			
Total MO Effect	−2.30	$/MWh	

Table 6
Regression results 2012–13.

2012–13			
R-squared	0.5301		
Root MSE	0.2078		
Observations	17,520		
	Coefficient	S.E.	*t*-stat
Price (*t*−1)	0.577430	0.007144	80.83
Wind	−0.000039	0.000005	−7.48
Demand	0.000032	0.000001	22.31
Constant	1.062013	0.039886	26.63
Add. Controls: Dummies for seasonal trends and weekends			
Total MO Effect	−3.29	$/MWh	

that can buy LGCs directly from this market or may have individual arrangements with their retailer might well be lower.

3.3. Estimated net impact of the RET on electricity prices

The combination of pass-through rates displayed in Table 4 is applied to estimated merit order effects of −2.30 $/MWh in 2011–12 and −3.29 $/MWh in 2012–13 and volume-weighted average LRET costs of 3.38 $/MWh in 2011–12 and 5.29 $/MWh in 2012–13.

Table 7
LRET scheme allowance in NEM jurisdictions.
Source: IPART, 2013; IPART, 2012a; IPART, 2011; QCA, 2012; QCA, 2011; ICRC, 2012; ICRC, 2011; AEMC, 2013b

LRET allowance ($/MWh)	NSW	VIC	QLD	SA	TAS	ACT
2011–12	2.67	4[a]	2.96	4[a]	8[a]	5[a]
2012–13	4.55	7[a]	4.10	4[a]	12[a]	4.24

[a] as modelled in AEMC (2013b); NSW numbers are given for Energy Australia.

Table 8
Indicative LRET costs in $/MWh for different assumptions on pass-through.

2011–2012		Pass-through RET costs		
		100%	40%	10%
Pass-through merit order effect	0%	3.38	1.35	0.34
	50%	2.23	0.20	−0.81
	100%	1.08	−0.95	−1.96
2012–2013		Pass-through RET costs		
		100%	40%	10%
Pass-through merit order effect	0%	5.29	2.11	0.53
	50%	3.64	0.47	−1.12
	100%	1.99	−1.18	−2.77

Table 8 displays indicative net effects per MWh for the different combinations of pass-through rates. Our results for 2011–12 and 2012–13 indicate that individual consumers situated in the upper left-hand corner with high pass-through rates of RET cost and low pass-through rates of the merit order effect faced net costs, while individual electricity consumers that were shielded from RET costs and see high pass-through of merit order effects are likely to have experienced net benefits. Costs for remaining consumers could have been reduced if those consumers experiencing net benefits from the policy contributed to a larger extent to the cost of the RET.

Larger effects in 2012–13 can both be attributed to the expansion of wind capacity and the introduction of the carbon price, which increased the marginal cost of electricity generation

Table 9
Energy purchase cost results for standalone LRMC and market-based approaches of calculating the wholesale allowance.
Source: IPART, 2013; IPART, 2012a; IPART, 2011; QCA, 2012; QCA, 2011.

$/MWh	NSW: Energy Australia	NSW: Country Energy / Origin Essential	NSW: Integral Energy / Origin Endeavour	QLD	Mean market price in the NEM
2011–2012					
Standalone LRMC	67.66	63.60	70.98	64.44	
Market-based	48.82	46.52	50.76	46.50	29.24
2012–13					
Standalone LRMC	87.76	84.35	91.51		
Market-based	68.24	66.86	72.64	41.59	39.40[b]

all exclusive carbon costs; [b]assuming a mean carbon intensity in the NEM of 0.92 $t\ CO_2$/MWh (AEMC, 2013b)

displaced by wind and therefore merit order effects (see Section 3.1), as well as higher LGC prices in regulated retail tariffs as used in this analysis. In general, higher wholesale prices should lead to lower prices for renewable certificates. This is the case, because the certificate price covers the cost difference between what can be earned on the electricity market by a renewable generator and what it costs to build it. However, regulator estimations for renewable certificates were increased between 2011–12 and 2012–13, since alternative assumptions regarding the cost of capital (WACC) were applied. This is partly due to uncertainty surrounding the political future of renewable energy policy in Australia (cf. Nelson et al., 2013).

Overall, estimated merit order effects in 2011–12 and 2012–13 are not high enough to fully compensate every electricity consumer for their cost contribution to the RET. However, merit order effects do have the potential to significantly reduce RET costs if they are passed forward to consumers. Note that this effect might not hold in the long run, as the effect of increased renewable generation on wholesale electricity prices in the long run depends on its effect on investment and divestment decisions in the electricity industry and, more generally, future electricity market design.

4. Discussion

As stated above, the net effect of the RET on an individual consumer, i.e. their position on Table 8, is likely to depend on certain consumer characteristics. In this section we explore further consumer characteristics that influence (i) the pass-through of merit order effects and (ii) the pass-through of RET costs and the role of regulators in those jurisdictions with regulated retail prices.

4.1. Pass-through of merit order effects

The pass-through of merit order effects depends on the extent to which electricity prices of consumers are aligned to wholesale prices. Large users typically obtain negotiated and often tailored contracts with retailers within the competitive market. These tailored contracts may include significantly longer time periods than the standard one to three year contracts for small customers and can potentially include varying levels of wholesale spot price exposure depending on the energy user's particular requirements, risk appetite and load curtailment opportunities. The contracts are often based on forward prices. However, forward prices should generally respond to merit order effects as well, as otherwise arbitrage between the two contracts would be possible (Sensfuß, 2011). At present, future wholesale prices are generally flat or even lower than current spot prices as market participants expect a reduction or elimination of the carbon price.

Residential and small business consumers, on the other hand, are subject to regulated or competitive market offers from retailers. Determinations of regulated tariffs are available online from the regulatory authority in each State. Information for contracts for small consumers that are not on a regulated tariff is hard to obtain. The AEMC notes that unregulated contracts for small consumers "will generally be lower than regulated or standing offers" (AEMC, 2013b p. 23).

Generally, two different approaches are used by regulators to determine the wholesale component of a regulate tariff: (i) a Long run marginal cost (LRMC) approach and (ii) a market-based approach. The LRMC can be modelled using a number of different approaches, including the standalone approach, the average incremental cost (AIC) approach and the perturbation (or Turvey) approach. The standalone approach assumes that no generation capacity currently exists and therefore, that demand is met by constructing new generation capacity in a least cost manner to meet the demand. The standalone approach is popular amongst regulators in Australia due to its relative simplicity and because it can be readily applied to different demand profiles. In particular, its applicability to different demand profiles means that the LRMC can be calculated for customers for individual distribution areas using their respective load profiles.

The AIC and perturbation approach both utilise electricity market investment models to produce estimates of the LRMC. The AIC approach estimates the LRMC by determining the average costs of meeting all future increases in demand. The AIC can be volatile or possibly undefined when future demand is not strictly increasing. The perturbation approach estimates the LRMC in a given year by 'perturbing' demand with a permanent increase and finding the average costs to meet this perturbation.

Market-based energy purchase costs are estimated by forecasting spot and contract prices and then estimating an effective hedging strategy for the load that the respective retailers serve. Alternatively, a hedging strategy can be applied to observed prices in the futures market. From this the total costs of purchasing electricity are calculated as the cost of purchasing a hedged position in the market.

The different modelling strategies applied by the regulators in New South Wales and Queensland in 2011–12 and 2012–13 are summarised in Table 9. Generally, energy purchase cost results are higher using a standalone LRMC approach than a market-based approach. One reason for this difference is that each approach to estimating the LRMC implicitly incorporates the merit order effect to a different extent and the extent is often driven by the assumptions used in undertaking the modelling, in particular the treatment of the Renewable Energy Target. The standalone approach, as it is typically applied, does not include the effect of renewable generation on price. Typical modelling using the standalone approach assumes that demand must be met by a mix of coal- and gas-fired generation and ignores renewable

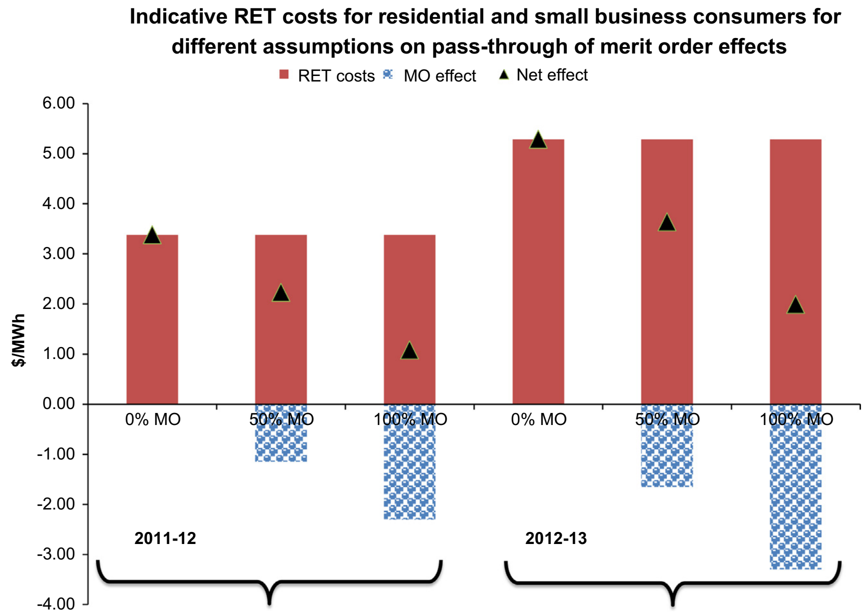

Fig. 4. Indicative RET costs for residential and small business consumers for different assumptions on pass-through of merit order effects.

Table 10
Approach to estimating the wholesale component of regulated retail tariffs.
Source: IPART, 2013; IPART, 2012a; IPART, 2011; QCA, 2011; ICRC, 2011; AEMC, 2013a.

	NSW	QLD	SA	TAS	ACT
2011–12					
Standalone LRMC	100%	50%	100%	100%	
Market-based		50%			100%
2012–13					
Standalone LRMC	100%		100%	50%	
Market-based		100%		50%	100%

generation sources, such as wind, as they are not cost competitive in the absence of the RET (Frontier Economics, 2011). In their review on best practice retail price methodology, the AEMC (2013a) notes that a perturbation LRMC method produces "useful insights" into the interaction between the LRET and the wholesale electricity price, while the AIC and standalone methods are less likely to do so (p.38). Since the electricity market hedging model used for the market-based approach is calibrated to the NEM, it does take into account generation by renewable energy sources and therefore incorporates the impact of the merit order effect of renewable generation (e.g. Frontier Economics, 2011).[7]

Fig. 4 illustrates the impact different pass-through rates of the merit order effect had on indicative net effects for residential or small business consumers in 2011–12 and 2012-13. These consumers are expected to face full RET costs, illustrated by the top bars. However, net costs can be reduced significantly, when the reduction of wholesale prices, caused by increased wind generation, is passed through to consumers. Therefore, methods of calculating the wholesale component in regulated retail prices that are likely to capture merit order effects are expected to reduce the overall cost of the LRET for these small consumers. If the wholesale component in the regulated tariffs is not reflective of the actual costs of purchasing electricity on the wholesale market by the retailer, this constitutes an additional profit for retailers, financed by regulated electricity consumers.

Generally, jurisdictions have moved away from standalone LRMC towards market-based approaches during the past two years (Table 10), which may be attributed to the attempt to "place downward pressure on regulated retail prices" (IPART, 2013 p. 11) given that "[standalone] LRMC ignores prevailing conditions in the electricity market, which can be influenced by a range of factors and which can have a significant influence on energy purchase costs" (QCA, 2012 p. 22). Regulators use both forecast prices and publicly available future or forward prices in their market-based energy purchase cost estimates, depending on how liquid they judge the futures market. The AEMC (2013a) suggests that using prices observed on the futures market is likely to lead to more efficient and transparent results and regulators acknowledge that "the main benefit of using market forward prices over modelled forward prices is that it is more transparent" (IPART, 2013, p. 60).

4.2. Pass-through of RET costs

The pass-through of RET certificate costs is likely to mainly depend on the level of exemption of the individual consumer. Fig. 5 shows estimated indicative effects for industry that received 90% exemption from RET costs in 2011–12 and 2012–13.

If some of the merit order effect is passed through to these electricity consumers, they are likely overcompensated for their contribution to the costs of the RET. If this contribution was increased, this would lower the cost for remaining (non-exempt) consumers. Note that the estimated average LRET costs employed in this analysis are a weighted-average of the LRET allowance in regulated tariffs and may therefore be higher than the costs companies with tailored contracts (or that buy LGCs directly on the market) actually face. On the other hand, there may be issues with retailers exerting market power towards exempt consumers and not compensating them for the whole value of the PEC (AIGN 2012).

For electricity consumers receiving a regulated retail tariff, the regulator has to estimate a green scheme allowance. In order to do so, a price forecast for LGCs needs to be made. Again, regulators

[7] Although both the perturbation LRMC approach and market-based methods using future prices are considered to be efficient estimates of future wholesale electricity costs, estimates might diverge on a year-by-year basis (AEMC, 2013a). This may have several reasons, including assumptions made in the models, NEM market design that encourages particular behaviour by incumbents and new entrants, the fact that the RET is driving generation investment in the absence of an energy market signal and finally, falling demand.

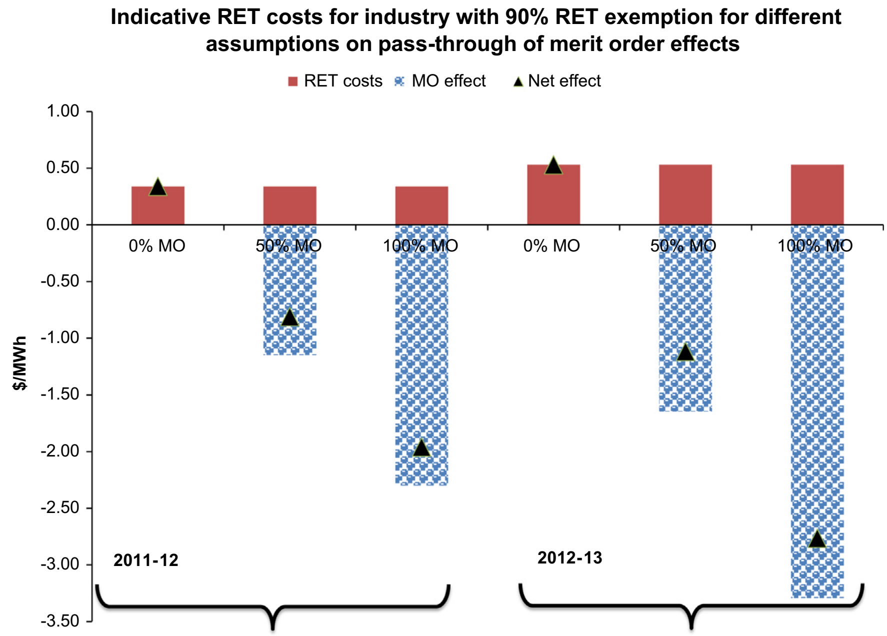

Fig. 5. Indicative RET costs for industry with 90% RET exemption for different assumptions on pass-through of merit order effects.

Table 11
LGC price estimates by regulators and average spot market prices.
Source: IPART, 2013; IPART, 2012a; IPART, 2011; QCA, 2012; QCA, 2011; ICRC, 2012; ICRC, 2011; ACIL Tasman, 2011.

$/certificate	NSW	QLD	ACT	Average spot price
2011–12	37.20	41.05	41.00	39.60
2012–13	46.75	41.90	43.33	35.85

Table 12
Effect of higher WACC on modelled LGC price.

	2011–12	2012–13	2013–14
IPART (2011) ($2011–12/certificate)	37.20	38.67	
IPART (2013) ($2012–13/certificate)		46.75	51.69

have adopted differing methods when estimating the green scheme allowance in their retail tariffs. New South Wales uses an LRMC approach (IPART, 2011), while Queensland and the ACT use market-based approaches (QCA, 2011; ICRC, 2011). To date, estimated LGC prices have been close to observed market prices (Table 11).[8]

In their recent review of regulated electricity prices, IPART has considerably increased the forecast for prices of LGCs. This increase is mainly due to the application of a higher weighted average cost of capital (WACC) in the LRMC framework for LGC costs. Table 12 shows estimated LGC costs in the 2011 review and the 2013 review. Estimated prices are higher than observed spot market prices for LGCs, which could mean that more than 100% of RET costs are passed through to regulated electricity consumers.

[8] ROAM Consulting (2012) comment on the fact that modelled LGC prices are generally higher than observed spot market prices. They assume that most LGCs are contracted through power purchase agreements (80%), while the spot market is only used for short term liabilities (20%).

5. Conclusions and policy implications

Since its inception in 2001, the Australian Renewable Energy Target (RET) has spurred considerable investment in renewable electricity generation. Using time-series regression, we highlight that the increasing amount of wind energy fed into the NEM has placed a considerable downward pressure on wholesale electricity prices through the so-called merit order effect.

On the other hand, costs of the RET are passed on to consumers in the form of higher retail electricity prices through 'green' surcharges imposed by retailers who are liable parties under the scheme. The net impact on a particular energy user depends on a number of factors. These include whether or not they are largely exempt from paying for the cost of the RET, and the extent to which lower wholesale electricity prices are passed through into retail electricity prices paid by consumers.

Our findings suggest that the financial benefits and costs of the RET for energy consumers could potentially be more equitably distributed. While it is impossible to estimate net effects for individual consumers with certainty, our analysis points to two key policy implications (i) the potentially large financial transfers between energy users arising from the current level (and extent) of RET exemptions for some favoured large energy-intensive industries and (ii) the question to what extent the, perhaps only short term, benefits of the RET in putting downward pressure on wholesale prices are passed through to different energy consumer classes.

Contrasting the estimated reduction in wholesale prices with the costs of the RET to exempt industries, suggests that some companies might be currently significantly overcompensated for their contribution to the costs of the RET by the merit order effect of wind, particularly those exempt from 90% of RET costs. There is scope for re-examining these assistance rates in light of reduced wholesale prices due to merit order effects, as a broader liability base could reduce the cost of the RET for remaining electricity consumers, and, in particular, households.

Furthermore, when evaluating the impact of the RET on electricity prices, both its costs, but also its benefits should be taken into account. At the moment the focus is on RET costs added to the retail price of electricity. However, the distributional effects of the RET are likely being worsened at present by regulators not adequately passing on lower spot prices through to residential households and small businesses on default regulated tariffs due to their various methodologies for estimating wholesale energy purchase costs. If retailers passed through more of the reduction in wholesale prices, induced at least in part through additional renewable generation, the overall impact of the RET on retail electricity prices could be considerably smaller.

There might be a case for removing the regulation of retail prices in some jurisdictions. However, all consumers including households and small business already have the right to opt-out of a regulated tariff and take up a market offer. Some States have removed default regulated tariffs entirely. However, there are concerns regarding the level of effective competition being achieved within competitive retail market arrangements given the current dominant positions of three major vertically integrated 'gentailers' in the NEM. It remains to be seen whether an oligopoly of retailers would show greater appetite for passing reduced wholesale prices on to consumers. Therefore, the first step could be for governments to give some guidance on how regulators could better incorporate reduced wholesale prices due to merit order effects in retail tariffs, as in the AEMC report on best practice retail price methodology (AEMC, 2013a).

Finally, the distributional impacts of energy and climate policy are commonly not a primary focus of policy makers given effectiveness and efficiency objectives. They often only come into view after the policies have been operating for some period of time. Our analysis highlights the potential value of considering distributional issues ex-ante when designing and implementing energy and climate policy, especially the level and scope of any exemptions offered as 'so-called' compensation to particular parties. While there are both environmental and economic reasons for exempting some industries from complying with the full costs of such policies, regulators have to keep in mind that any of those exemptions will generally increase the costs for the non-exempt parties. As such, the estimated distributional effects are not an inherent feature of the RET or any renewable energy support policy, but the result of design choices made when implementing the policy.

There exist other dimensions of distributional issues in relation to renewable energy policies, such as between households of different income groups (cf. Neuhoff et al., 2013) or between producers and consumers of electricity (cf. Hirth and Ueckerdt, 2013), which have not been addressed here. Note, that our study examines short run effects of renewable energy generation on the wholesale price for electricity. Whether reduced wholesale prices due to renewable generation are a long term phenomenon depends on their impact on investment and divestment decisions in the industry and the future design of electricity markets. As always, further work is required to better understand these important issues.

Acknowledgements

The authors would like to thank Denzil Fiebig of the School of Economics (UNSW, Australia) for helpful comments. This work was supported through a range of funding sources including the Commonwealth Environment Research Facilities (CERF), an Australian Research Council (ARC) Discovery Grant and the Australian Renewable Energy Agency (ARENA).

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