# Does renewable electricity generation reduce electricity prices?

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# About VEPC

- Academic Centre within Victoria University. Foundation funding from Government of Victoria.
- Research team
  - **Asli Kars** – applied maths, PhD (economics)
  - **Steven Percy** – PhD (electrical engineering)
  - **Stephanie Rizio** – (starting Jan 21) – economics, PhD (social psychology)
  - **Dong Wang** - (starting Jan 21) – engineering and economics, PhD (economics)
  - **Bruce Mountain** – engineering, PhD (economics)

- Research agenda:
  1. Retail markets;
  2. Wholesale electricity market design in context of rapid decarbonisation;
  3. Economics of storage.

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# Why this study?

- Credibility gap in official studies: ESB said NEG will reduce wholesale prices by 30% but no change in investment relative to status quo.

- Correlation v causation: “SA, Denmark and Germany have high renewables and high prices, so less renewables means lower prices”.

- So, we consider 4 questions:

    1. Have renewables pushed up retail prices in countries that have enthusiastically pursued renewables?

    2. Do renewable subsidies explain Australia’s high electricity prices?

    3. Does renewables growth in South Australia explain why their prices are higher than in the rest of Australia?

    4. Are customers better off if subsidies are directed to extending the life of existing coal fired generating plants or by promoting renewables?

# The authors

- Hugh Saddler (Adjunct Associate Professor, Crawford School of Government)
- Farhad Billimoria (Visiting Research Fellow, Oxford Institute for Energy Studies, and AEMO)
- Asli Kars (Research Officer, VEPC)
- Steven Percy (Research Fellow, VEPC)
- Bruce Mountain (Director, VEPC)

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# Literature Review

Farhad Billimoria,
Visiting Research Fellow, Oxford Institute for Energy Studies, and AEMO

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# Literature Review

- Rich international literature – backward looking and forward looking
- Merit-order effects clearly evident across Australia, Europe and US
- Bushnell and Novan (2018) – intertemporal and seasonal impacts

| Study | Applicable region | Time period | Average VRE penetration (% of demand) | Decrease in average wholesale price from average VRE |
|---|---|---|---|---|
| Woo et al. 2011 | ERCOT | 2007–2010 | Wind: 5.1% | Wind:<br>$2.7/MWh (ERCOT North)<br>$6.8/MWh (ERCOT West) |
| Woo et al. 2013 | Pacific NW (Mid-C) | 2006–2012 | N/A | Wind: $3.9/MWh |
| Woo et al. 2014 | CAISO (SP15) | 2010–2012 | Wind: 3.4%<br>Solar: 0.6% | Wind: $8.9/MWh<br>Solar: $1.2/MWh |
| Woo et al. 2016 | CAISO (SP15) | 2012–2015 | Wind: 4.3%<br>Solar: 2.6% | Wind: $7.7/MWh<br>Solar: $2.1/MWh |
| Gill and Jin 2013 | PJM | 2010 | Wind: 1.3% | Wind: $5.3/MWh |
| Wiser et al. 2016[a] | Various regions | 2013 | RPS energy: 0%–16% depending on the region | RPS energy: $0 to $4.6/MWh depending on the region |
| Jenkins 2017[b] | PJM | 2008–2016 | N/A | Wind: $1–2.5/MWh |
| Haratyk 2017[b] | Midwest<br>Mid-Atlantic | 2008–2015<br>2008–2015 | N/A | Wind: $4.6/MWh<br>Wind: $0/MWh |

Notes: a – Price effect is estimated impact of RPS energy relative to price without RPS energy in 2013 before making adjustments due to the decay effect discussed by the authors. b – Decrease in average wholesale prices is based on change in wind energy from 2008–2016 (Jenkins 2017) or 2008–2015 (Haratyk 2017), rather than the decrease from average wind reported in other rows.

Source: Wiser et al. (2017)

# Literature Review

- European studies across a variety of countries all found that increasing renewable generation (excluding hydro) had reduced wholesale electricity prices.
  - Germany (Kyritsis et al 2017; Cludius et al, 2014b; Paraschiv et al, 2014; Ketterer 2014; Wurzburg et al, 2013)
  - Austria (Wurzburg et al, 2013)
  - Italy – (Clo et al, 2015)
  - Ireland (Denny, 2017)
- The social costs of renewables is also addressed in some of the reviewed papers with costs of renewables outweighing market benefits in Italy, Spain and Germany (Clo et al, 2015; Gelabert et al 2011; Paraschiv et al, 2014).
- Australian studies include:
  - Empirical analysis of SA and Victoria between Mar-2009 and Feb-2011 by Forrest and MacGill (2013) concludes that wholesale prices reduced by $0.43/MWh in South Australia and $1.42/MWh in Victoria per a 1 % increase in wind generation
  - For the NEM as a whole, Cludius et al. (2014a) found that the average volume-weighted NEM price decreased by $2.30/MWh in the year 2011–12 and by $3.29/MWh in the year 2012–13 as a result of the wind generation merit order effect.

# International Comparison of Household Electricity Prices

Asli Kars, Ph.D.
Research Associate

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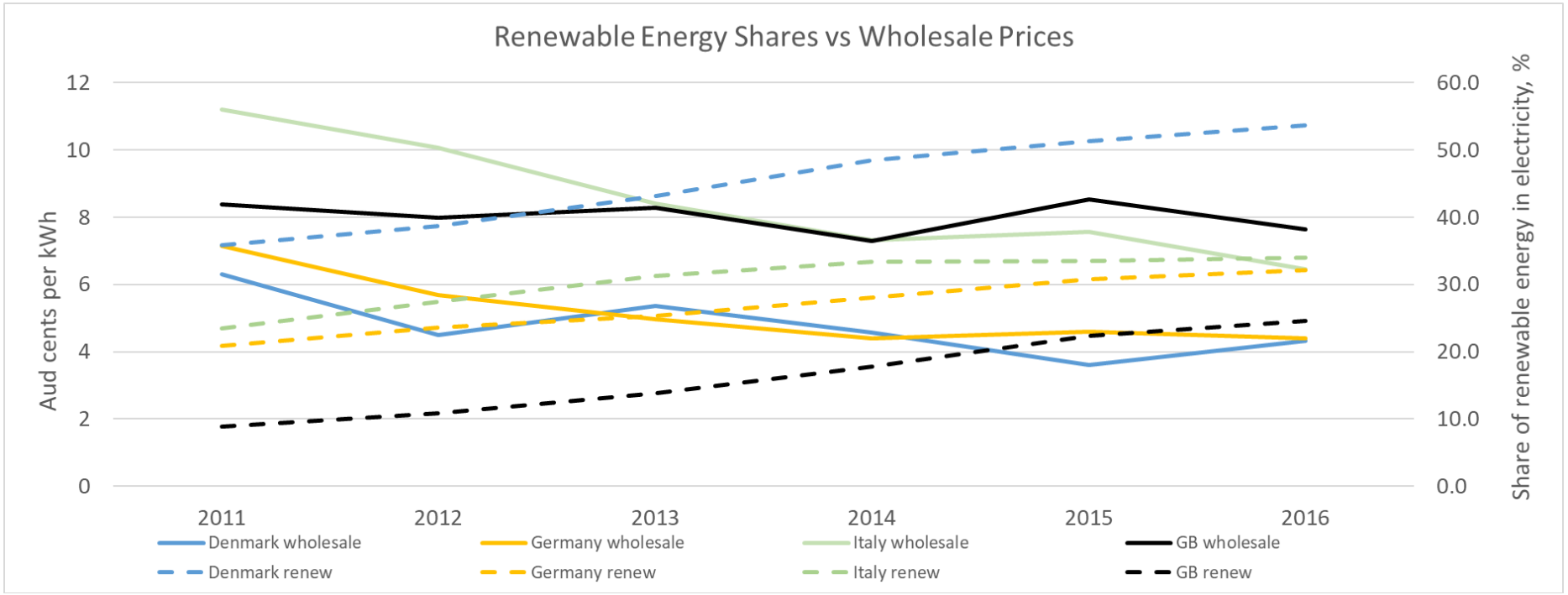
# Wholesale prices went down as renewables went up




Source: Renewable Energy Shares source is Eurostat (https://ec.europa.eu/eurostat) and wholesale prices from ACER (https://www.acer.europa.eu/)

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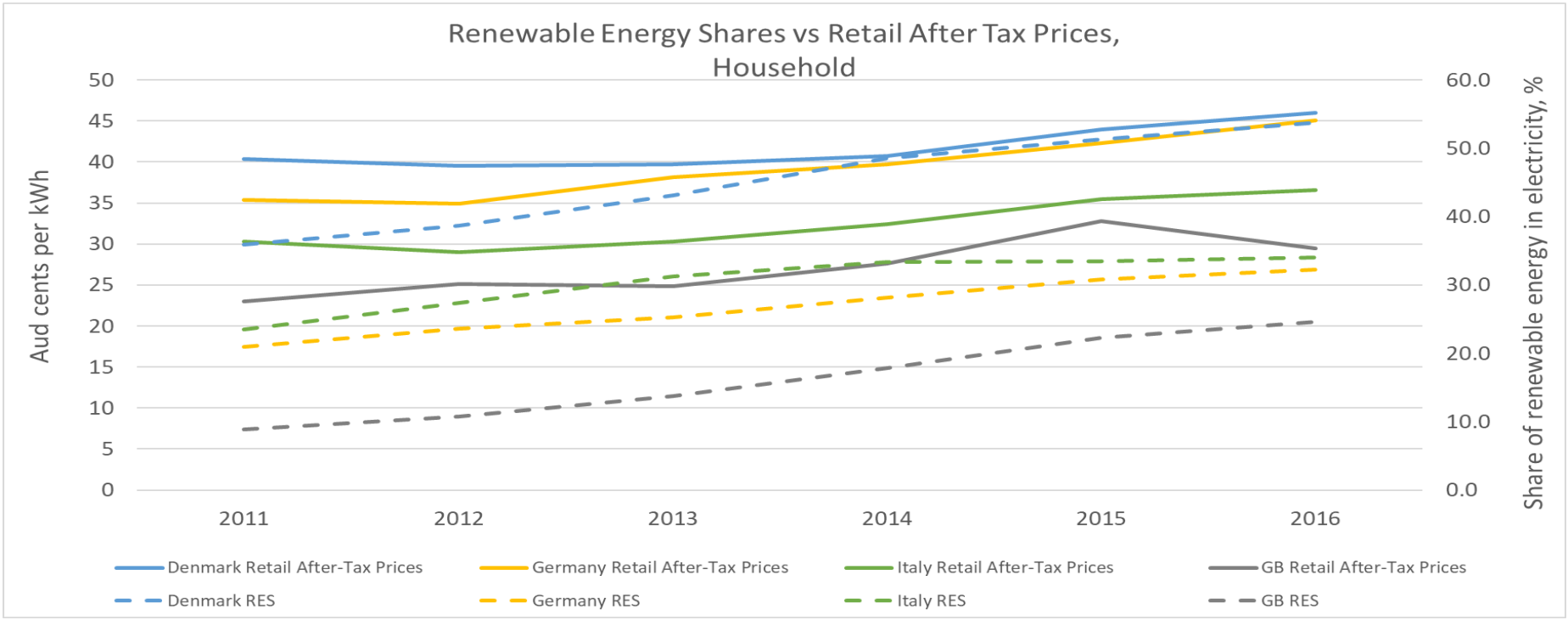
# But prices after taxes also went up as renewables went up




Source: Eurostat (https://ec.europa.eu/eurostat) for consumption Band DC (2,500 kWh < Consumption < 5,000 kWh).

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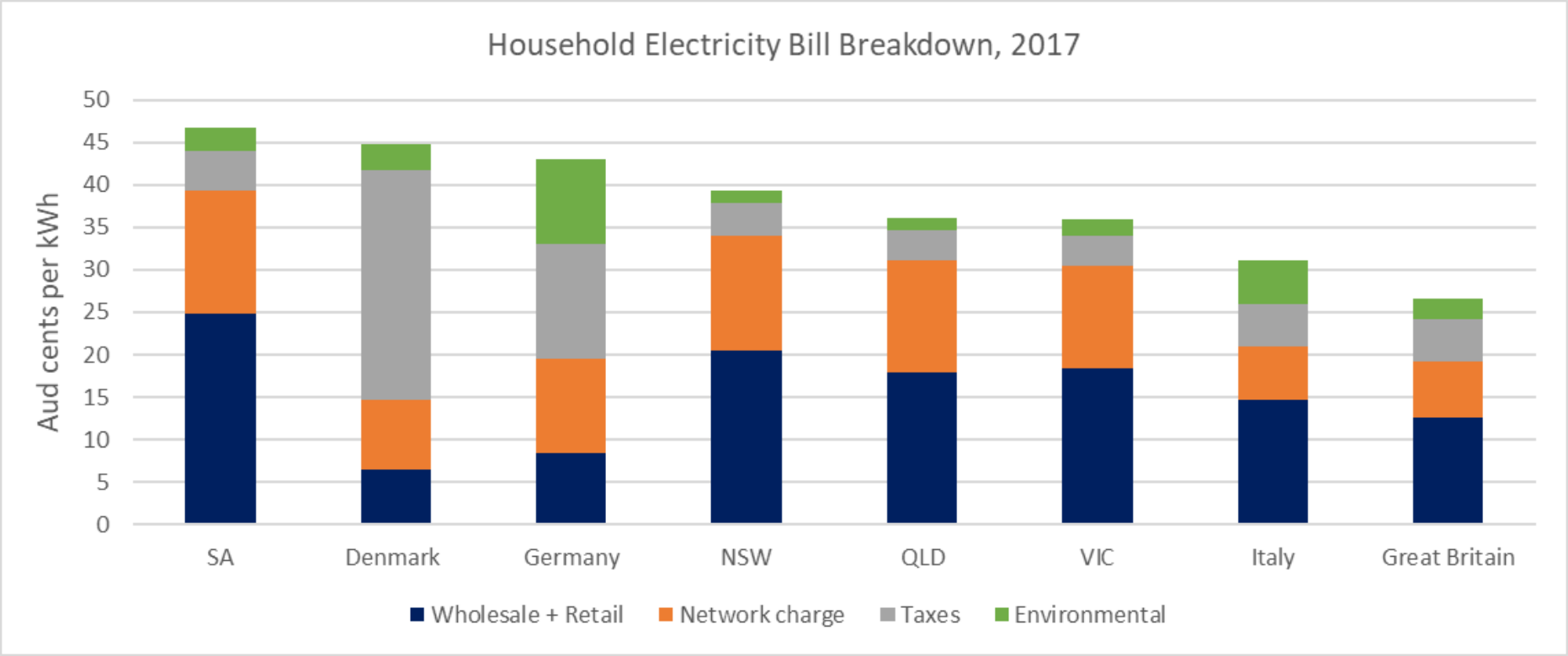
# After taxes, Australia's prices do not compare well




Source: SA, NSW, QLD and VIC data is from [MI] Residential Electricity Price Series for December 2017. Denmark data is from DANSK ENERGY. German data is from BDEW. UK data is from EUROSTAT. Italy data is from ARERA.

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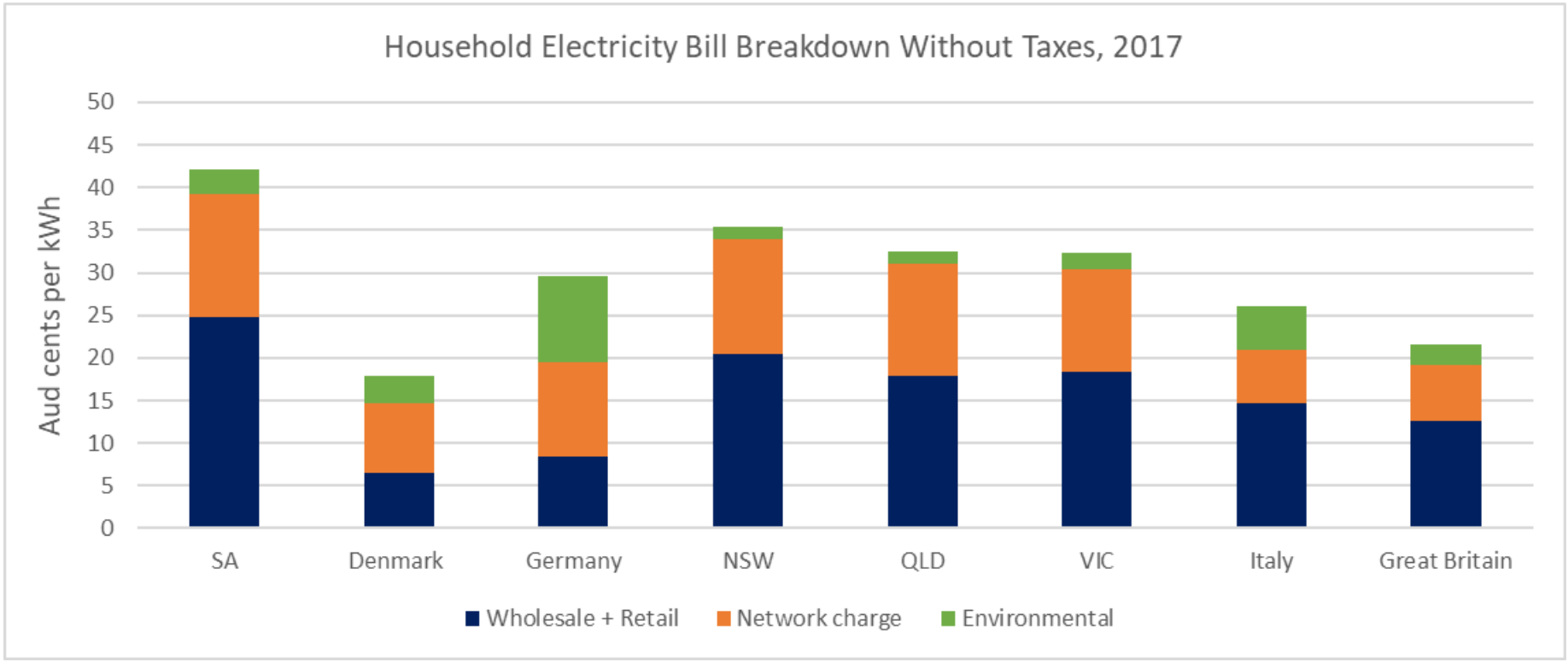
# But before taxes the comparison is even less attractive.

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# South Australia Energy Price Analysis

Dr Steven Percy,
Research Fellow, VEPC

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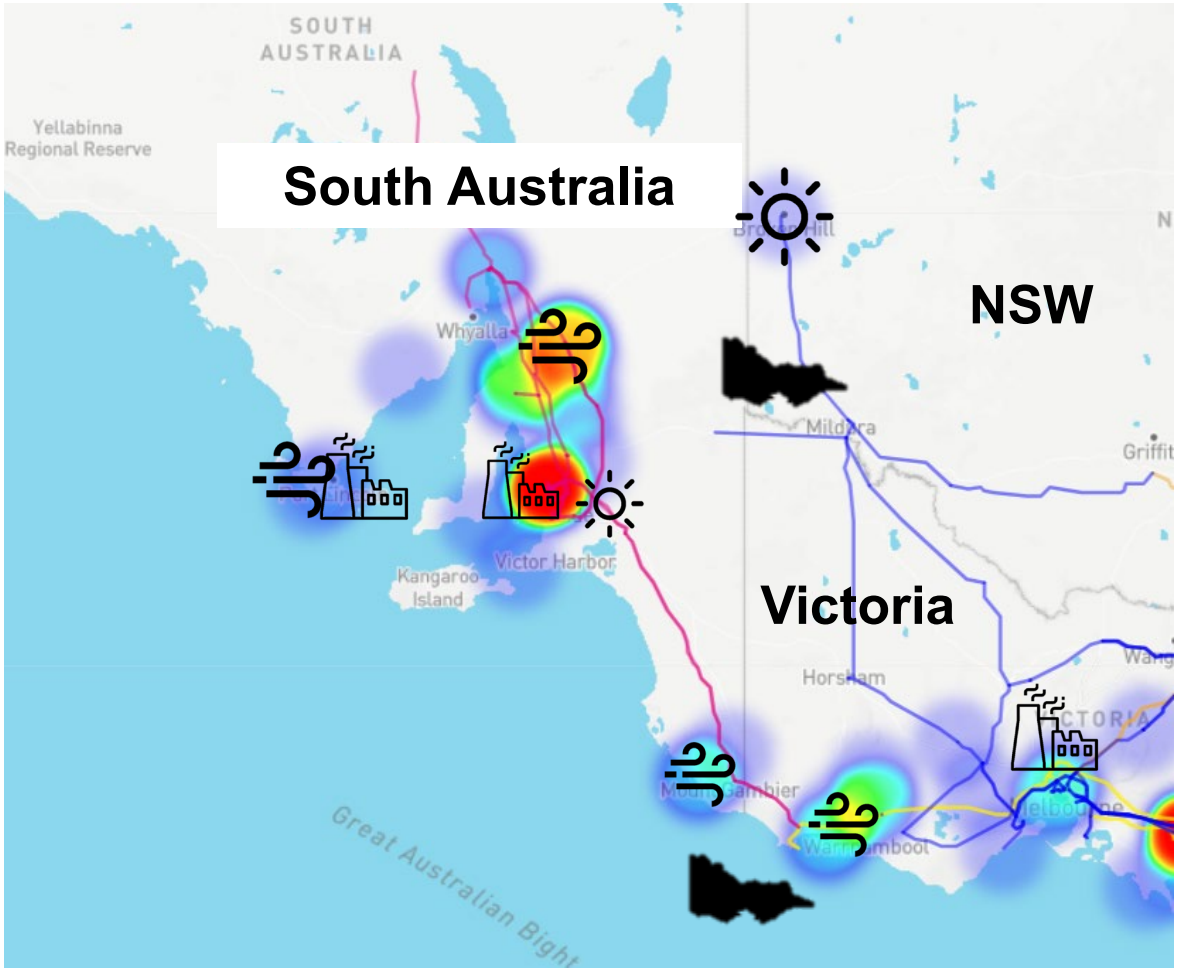
# Outline

1. Introduction to the South Australian energy market
2. Energy market model
3. Model results

# South Australian Energy Generation in 2018




Source: http://www.aemo.com.au/aemo/apps/visualisations/map.html

**3 GW Gas Capacity**

**Two interconnectors with Victoria.**

**0.6 GW of Liquid Fuel Generation**

**1.9 GW Wind Capacity**

**0.2 GW large scale solar and 0.6GW of rooftop solar**

**No coal generation**

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# Snapshot of the South Australian energy transition

| | | 2012-2013 | 2017-2018 | |
|---|---|---|---|---|
| | Wholesale energy price | Average $69 per MWh | Average $98 per MWh | |
| | Demand before rooftop solar | 13.7 TWh | 13.8 TWh | |
| | Wind Generation | 25% of demand | 40% of demand | |
| | Solar Generation | 3.6% of demand | 8% of demand | |
| | Gas Price | $4.8 per GJ | $8.4 per GJ | |
| | Coal Generation | 16% of demand | No Coal! | |
| | SA-VIC interconnector Imports | 12 % of demand | 7% of demand | |

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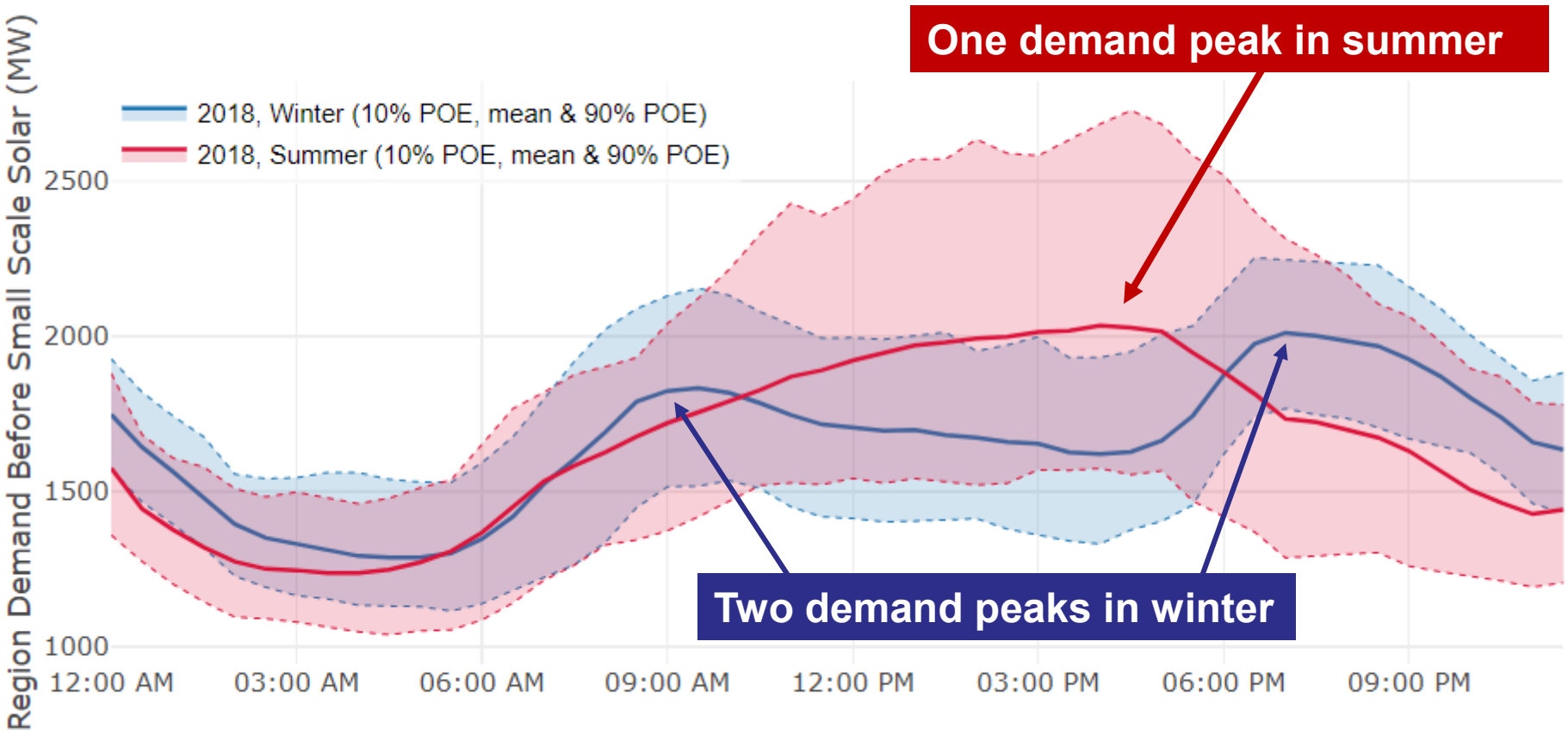
# Seasonality heavily impacts demand in South Australia

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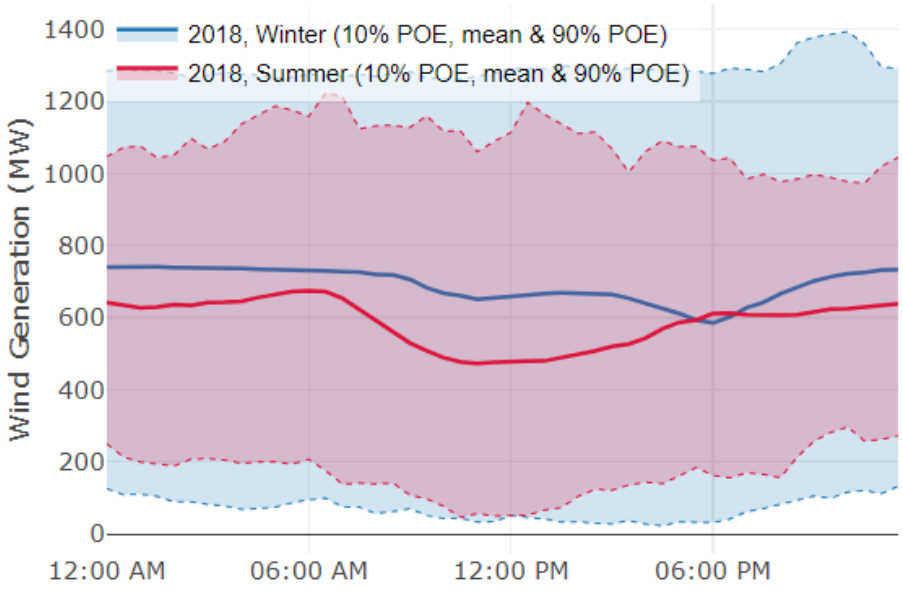
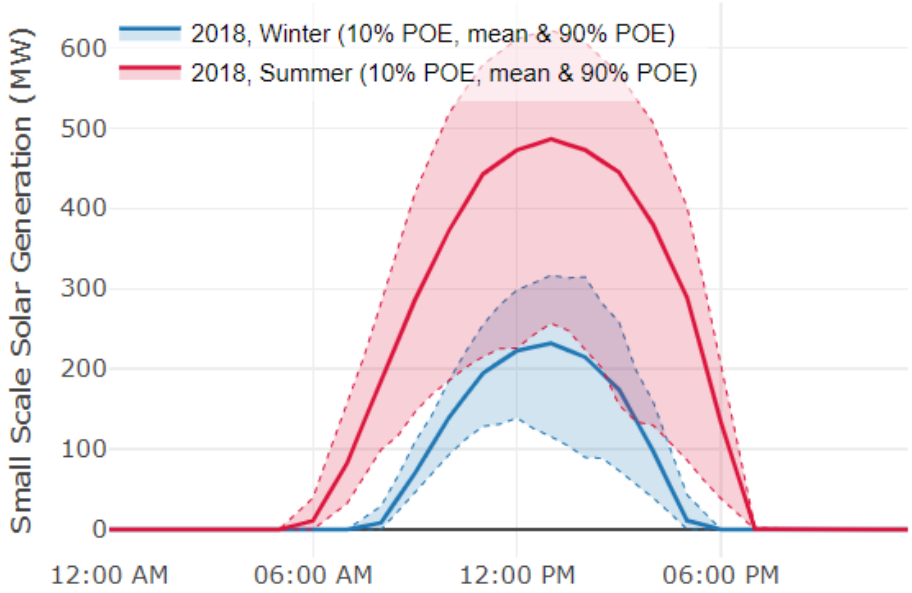
# Seasonality heavily impacts renewable supply in South Australia




**It is windier in winter**




**It is sunnier in summer**

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# Regression analysis has been used to understand the impact of the energy transition on wholesale price

**Model aims**

- Use real market data to understand how renewable energy is impacting price using minimal assumptions

*To understand the future we must understanding the past*

- Model the seasonality and daily variability of supply and demand

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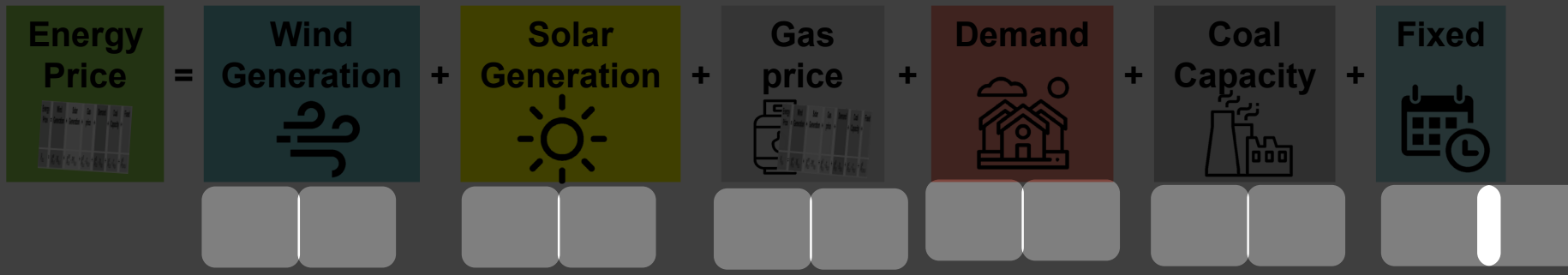
# A linear regression model was fitted to half hourly data to understand the impact of supply and demand on price




**The data**

- 30-minute supply, demand and price data from AEMO.
- 60-minute Bureau of Meteorology gridded solar data and AER Postcode solar capacity
- Daily South Australia ex-ante gas price, provided by AEMO.

**Date range**

1st July 2012 to 30th June 2018 (six financial years)

Consistent with Californian study by Bushnell and Novan (2018), '*Setting with the Sun: The Impacts of Renewable Energy on Wholesale Power Markets*'

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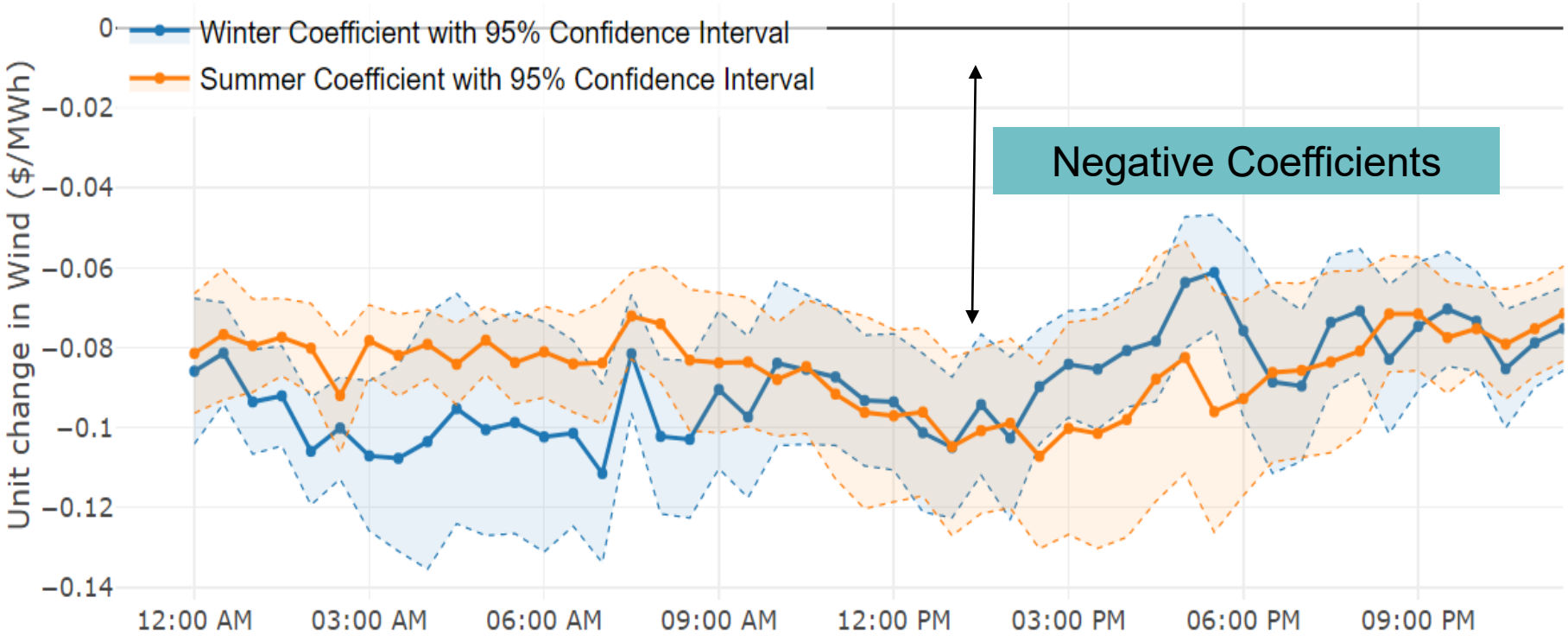
# Wind energy reduces wholesale prices




1MWh of wind generation would reduce wholesale energy prices by $0.09/MWh

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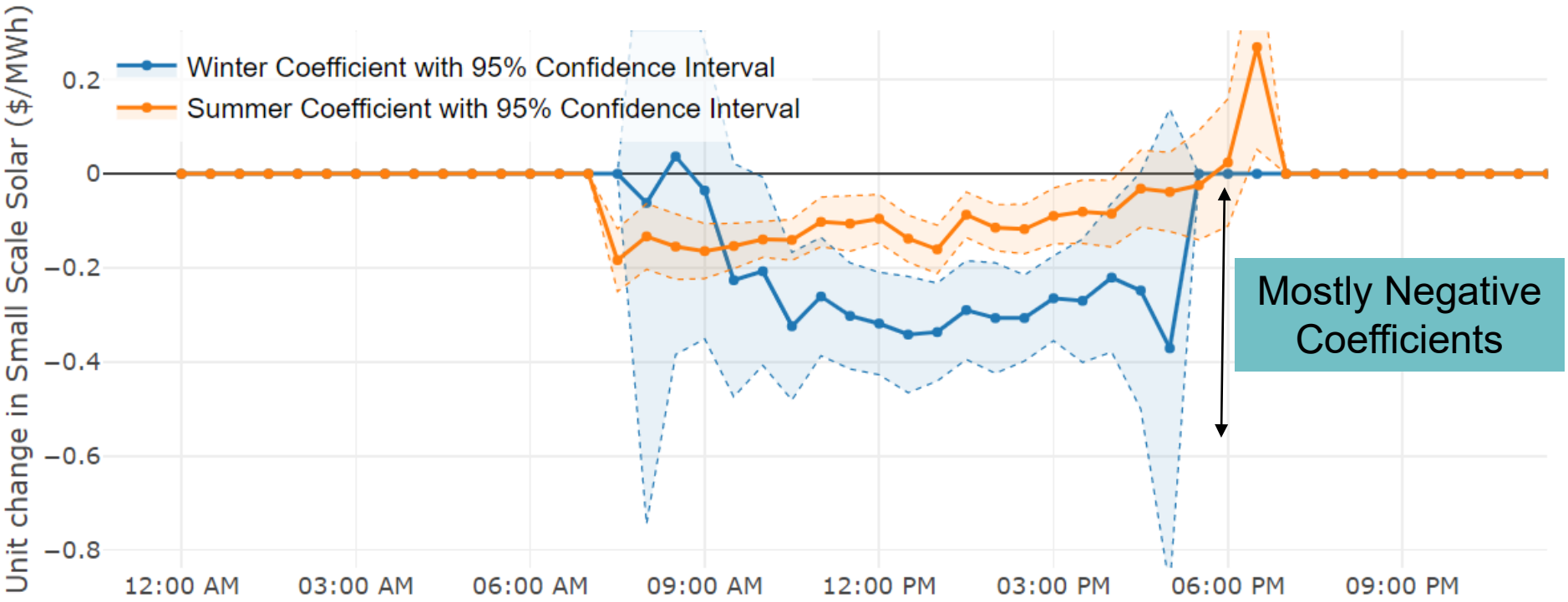
# Rooftop solar reduces wholesale prices




1MWh of Solar generation would reduce wholesale energy prices by $0.21/MWh

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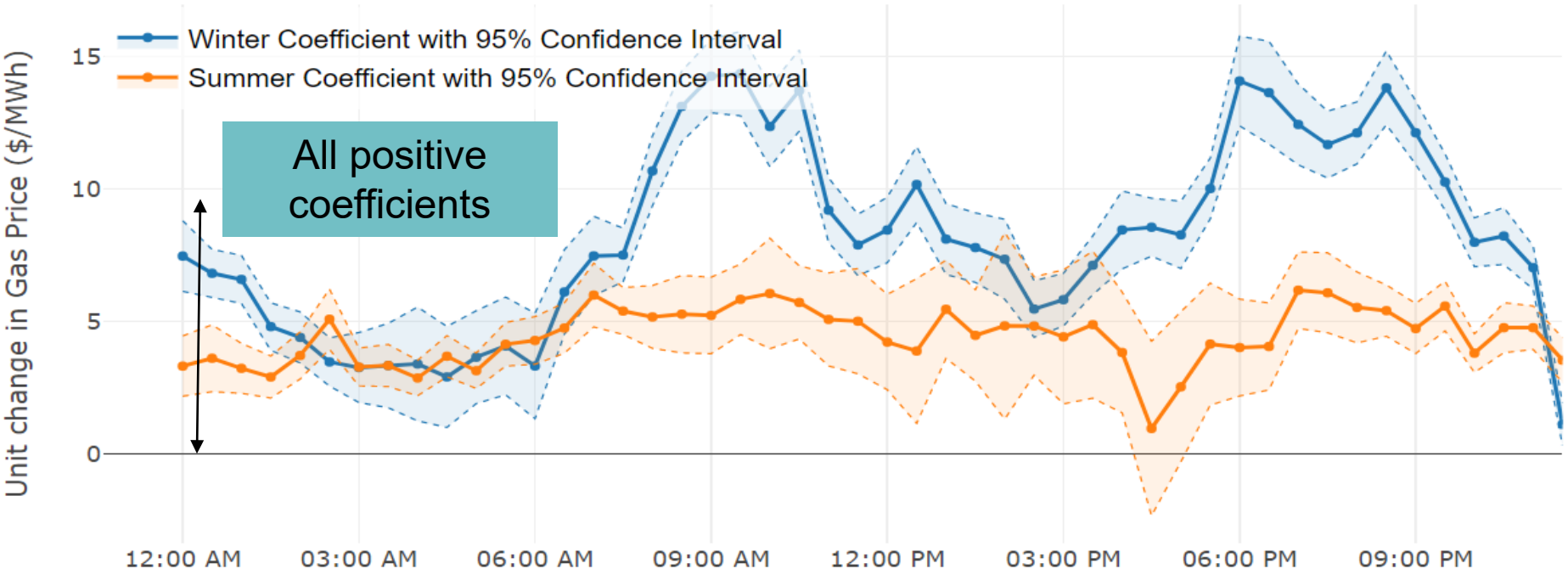
# Gas Price increases wholesale prices




On average $1/GJ change in gas price would increase prices by $6/MWh

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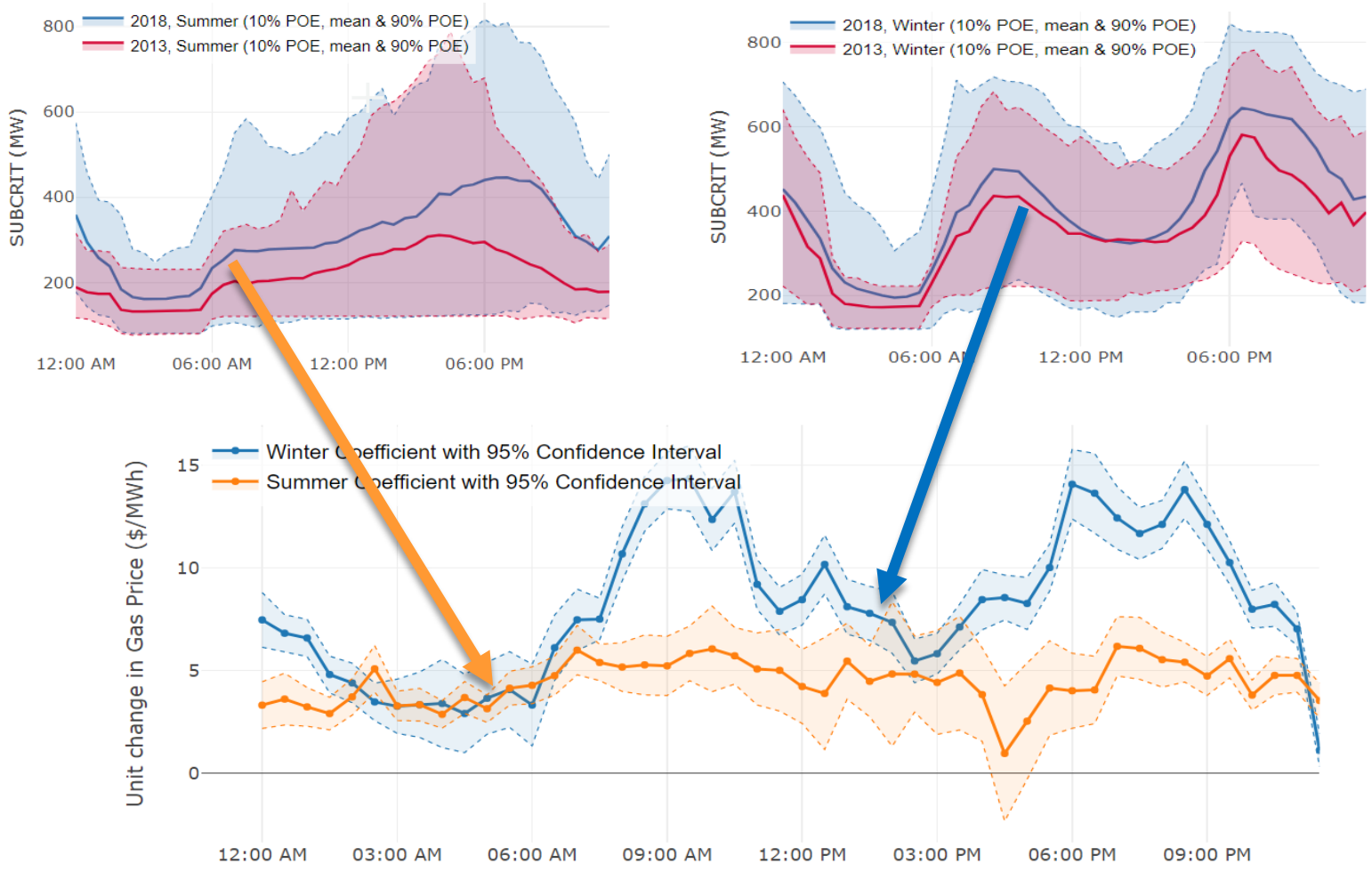
# Gas Price coefficients follow very closely the use of inefficient gas generation

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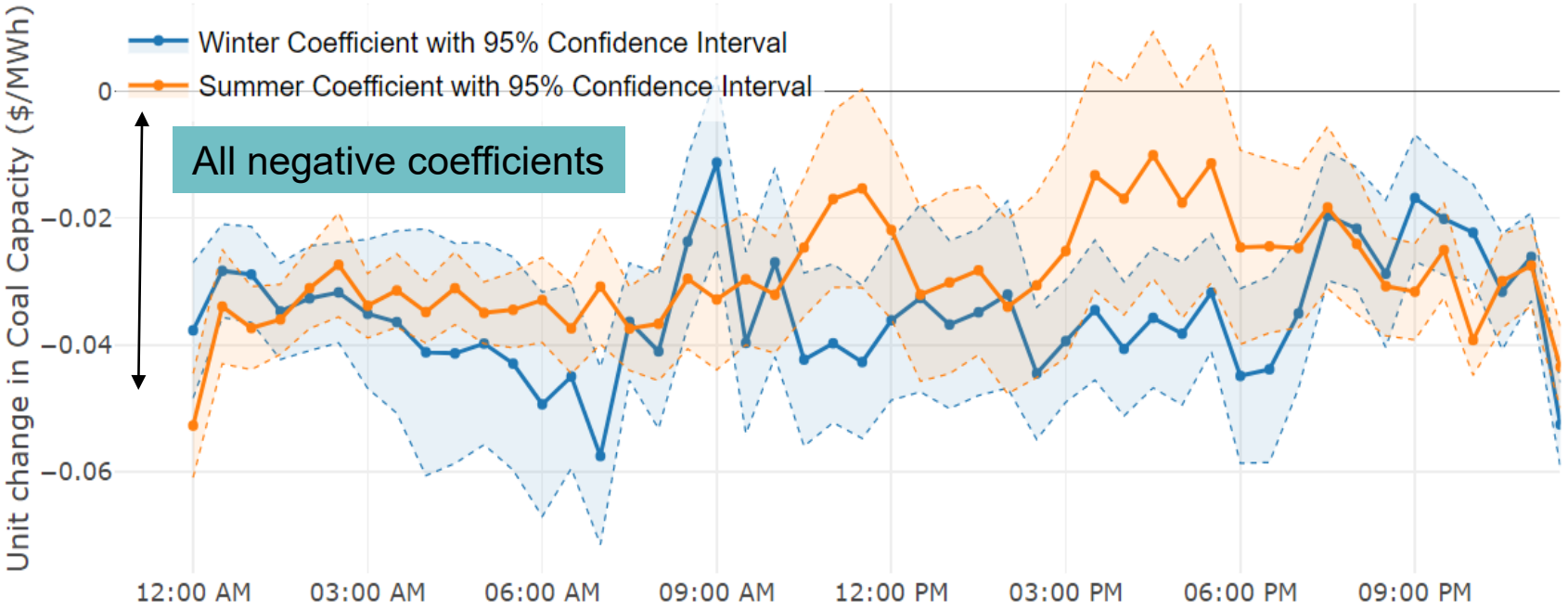
# Available Coal Capacity Reduces Prices




On average 1MW change in available coal capacity would decrease prices by $0.03/MWh

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# In summary:

| | Source | Wholesale price Impact |
|---|---|---|
|  | **Wind Generation** | Wind generation reduces wholesale energy prices |
|  | **Solar Generation** | Solar generation reduces wholesale energy prices |
|  | **Gas Price** | Increasing gas prices increases wholesale energy price |
|  | **Coal Generation** | Coal closure increases wholesale energy prices |
|  | **Demand before rooftop solar** | Demand increases wholesale energy prices |

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# Summary comments

A/Prof Bruce Mountain

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# Main points from literature reviews and international price comparison

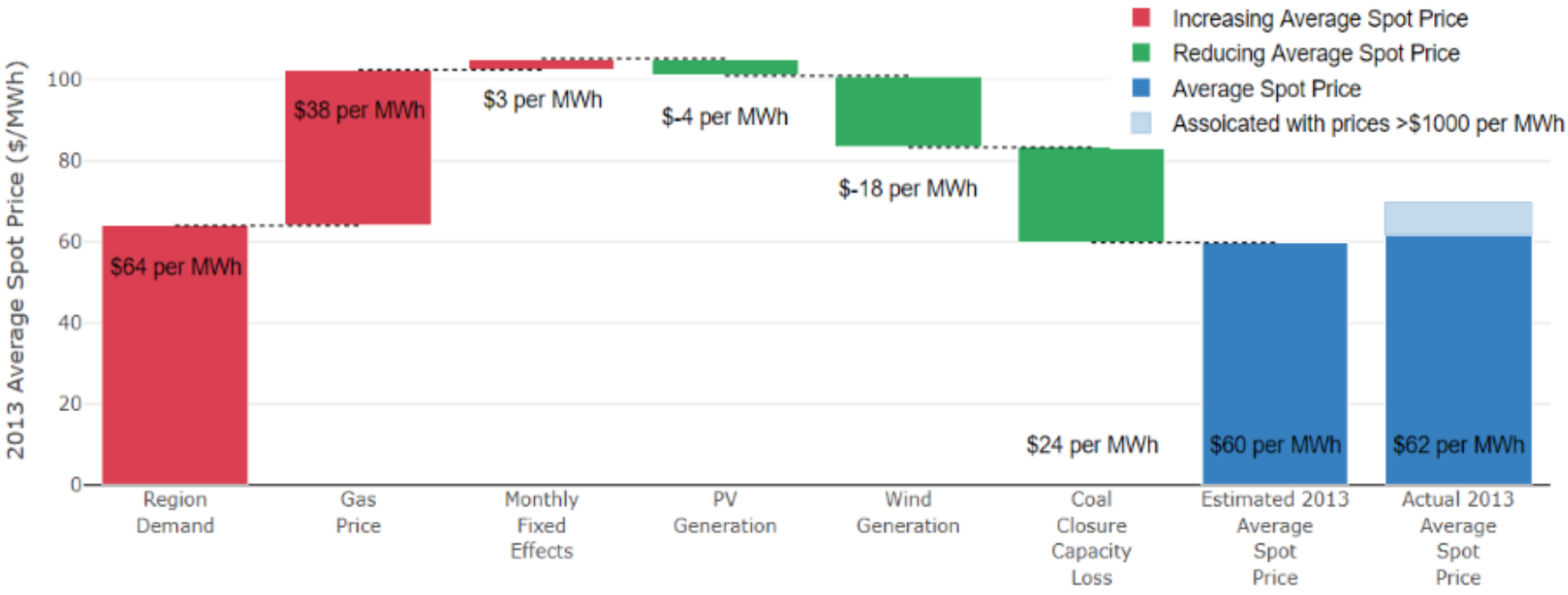
- **Literature review:** renewables reduce wholesale prices

- **International residential electricity price comparison:**

  1. Renewables growth reduced wholesale prices in all countries, but household prices after subsidies are higher in some countries.

  2. Australia's high prices are attributable to much higher wholesale, retail and network charges. Renewables subsidies (and other taxes) are much lower in Australia than in Europe.

# SA price decomposition in 2013

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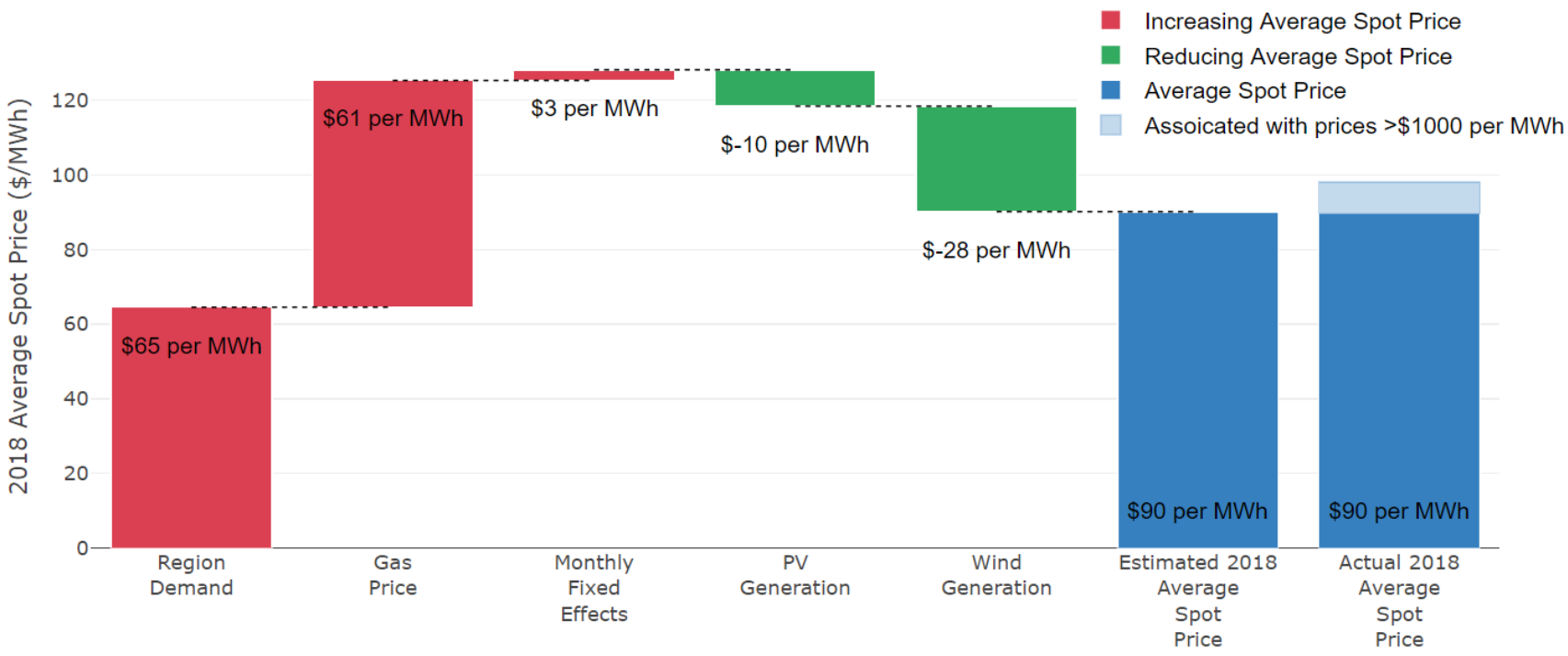
# SA price decomposition in 2018

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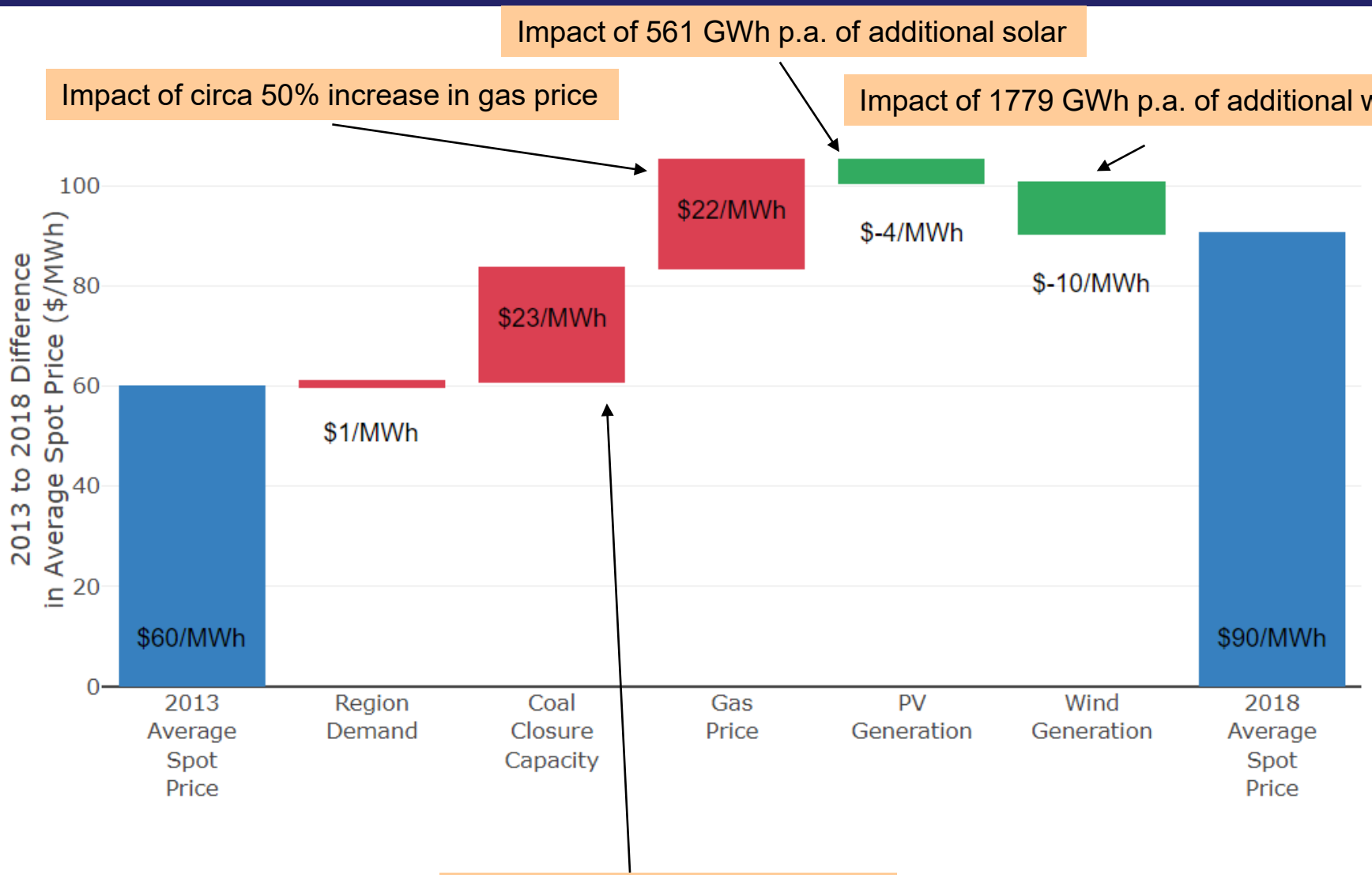
# How do we explain the 50% increase in spot prices from 2013 to 2018 ?

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# Would customers be better off if the life of the Northern coal plant was extended?

1. Northern Power station closure in 2017 raised prices by $13/MWh in 2018.

2. But expansion of wind and solar from 2013 to 2018 (which equals average Northern production in last 4 years) lowered prices by $13.6/MWh.

3. And extending life of Northern would have imposed additional cost (we estimate $20/MWh) to reduce foregone emission reductions.

→ Customers better off if renewables replaced Northern even before counting cost of subsidy to fix plant and mine.

**By comparison**

- Average cost of renewables subsidy from 2013 to 2018: $11/MWh.
- Price reduction attributable to renewables in 2018: $38/MWh.

→ Subsidy paid for itself in price reductions more than 3 times over.

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# Thank you

**Bruce Mountain** (Director, VEPC)

**Steven Percy** (Research Fellow, VEPC)

**Asli Kars** (Research Officer, VEPC)

**Farhard Billimoria** (Visiting Research Fellow, Oxford Institute for Energy Studies, and AEMO)

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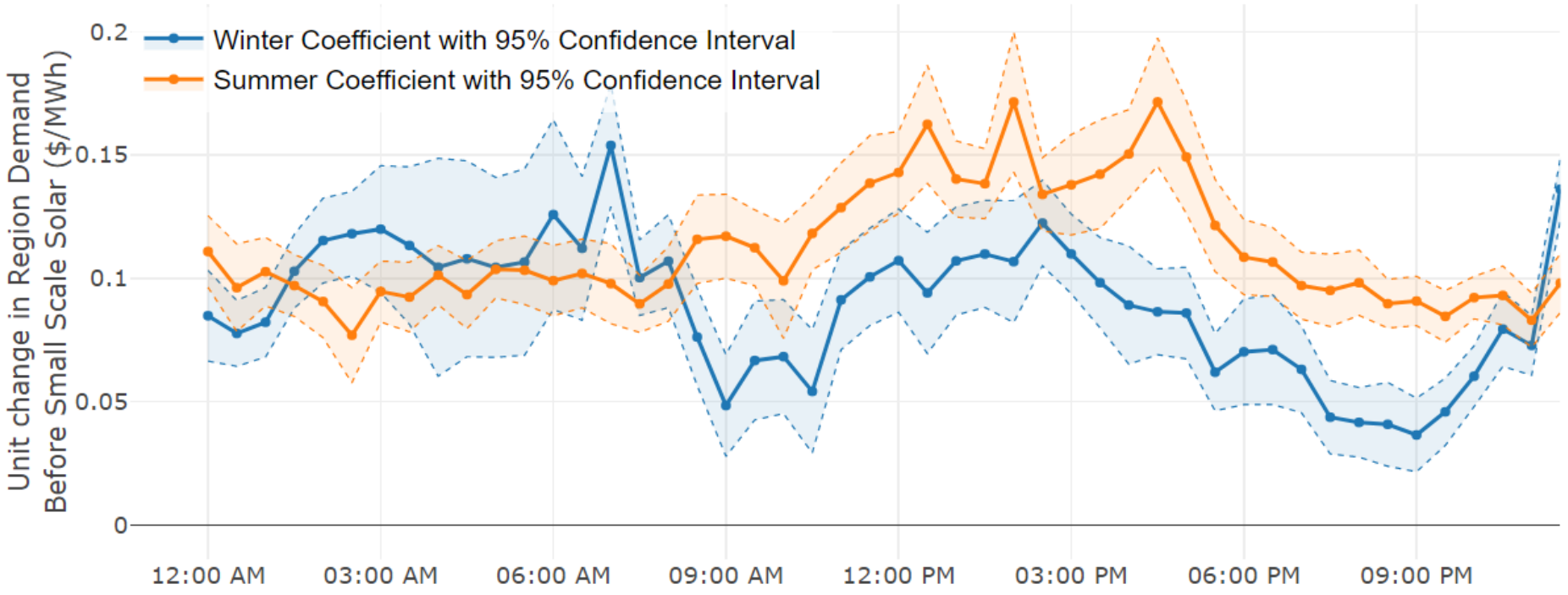
# Region demand increases wholesale prices




On average $1MWh change in Regional demand would increase prices by $x/MWh

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