



ROAM CONSULTING

ENERGY MODELLING EXPERTISE

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Supplementary Report (TSY00001) to



Australian Government
The Treasury

Additional Projections of Electricity Generation in Australia to 2050

September 2011



GLOSSARY

Term	Meaning
2-4-C	ROAM Consulting's dispatch modelling software package
CCGT	Combined Cycle Gas Turbine
CCS	Carbon Capture and Storage
DKIS	Darwin Katherine Interconnected System
GJ	Gigajoule
GW	Gigawatt (1000 MW)
GWh	Gigawatt-hour (1000 MWh)
IGCC	Integrated Gasification Combined Cycle
LRET	Large-scale Renewable Energy Target
LTIRP	ROAM Consulting's Long Term Integrated Resource Planning model
MW	Megawatt
MWh	Megawatt-hour
MMRF	Monash Multi-Regional Forecasting Model, used by Treasury to determine electricity demand
MPCCC	Multi Party Climate Change Committee
NEM	National Electricity Market
NTNDP	National Transmission Network Development Plan
NWIS	North West Interconnected System
OCGT	Open Cycle Gas Turbine
PJ	Petajoule
RET	Renewable Energy Target
ROAM	ROAM Consulting
Solar PV	Solar Photovoltaic
SRES	Small-scale Renewable Energy Scheme
SWIS	South West Interconnected System
Treasury	Department of the Treasury
TWh	Terawatt-hour (1000 GWh)
WACC	Weighted Average Cost of Capital

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1) INTRODUCTION

The Department of the Treasury (Treasury) has commissioned ROAM to provide projections for the development of the electricity sector between 2010-11 and 2049-50.

The purpose of this report is to supplement the four existing policy and reference scenarios with two additional policy scenarios, as described below:

- Clean Energy Future scenario — where possible incorporates features of the *Clean Energy Future* package endorsed by the MPCCC, and reflected in the legislation currently before the Parliament; and
- Government policy scenario — includes additional Government-only measures for heavy on-road transport and some of the additional assistance for the steel industry.

The two additional policy scenarios build on the Core Policy scenario presented in the previous ROAM report for the Treasury¹, which has a starting carbon price of \$20 per tonne. Treasury has commissioned this additional work to determine the impact of a carbon price commencing at \$23 per tonne, as agreed by the Multi Party Climate Change Committee (MPCCC).

The methodology used for conducting the investigations for this report is a two-step process:

- Development of a least cost plan for generation and major transmission over the whole of their operating lifetimes, including the retirement of existing generators when they are no longer the least cost means of providing energy supply, inclusive of the costs of carbon emissions; and
- Modelling the least cost planning outcome in a half hourly time sequential manner from 2010 to 2050, observing the market rules for the National Electricity Market (NEM).

This report includes information relating to:

- Emissions;
- Wholesale pool prices;
- Retail pricing; and
- Generation development.

Other forecasts, such as capital expenditure for generation and transmission development, and Renewable Energy Certificate prices, are largely unchanged from the core policy scenario². As such, they have not been reproduced in this summary report.

¹ ROAM Consulting, Projections of Electricity Generation in Australia to 2050, August 2011, http://www.treasury.gov.au/carbonpricemodelling/content/consultants_reports/ROAM_Projections_of_Electricity_Generation_in_Australia_to_2050_20110803.pdf

² Revised charts and tables from the SGLP report including the updated policy scenarios are available at <http://www.treasury.gov.au/carbonpricemodelling>.

2) SIGNIFICANT CHANGES TO THE INPUT PARAMETERS

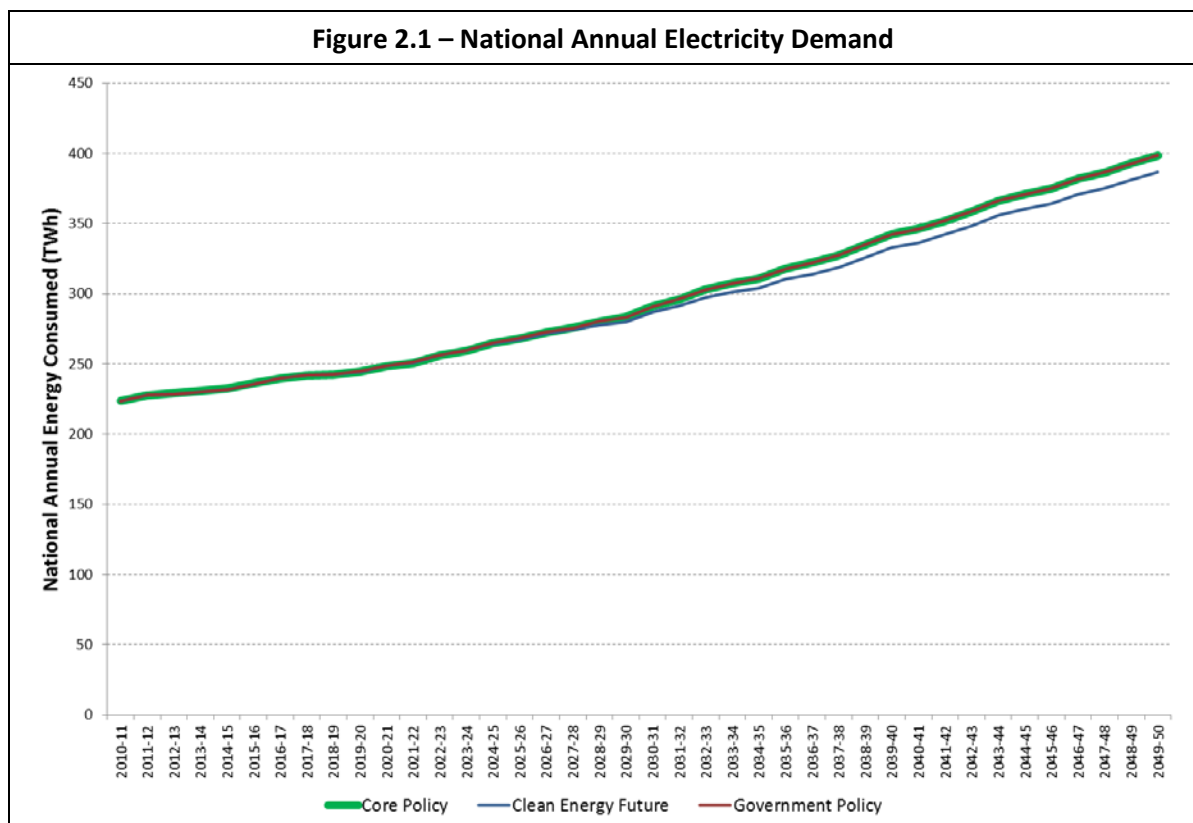
2.1) CARBON PRICE TRAJECTORIES

The carbon price trajectory supplied by the Treasury for the two additional scenarios follows the trajectory agreed by the MPCCC. That is, the starting nominal carbon price is \$23 per tonne in 2012-13, which rises at 2½% per annum real over the next two years. From 2015-16, the carbon price follows the same trajectory as that derived by the Treasury for the Core Policy scenario.

In both additional scenarios the prices modelled are in real 2009-10 dollars, as per the original Treasury modelling.

2.2) ELECTRICITY DEMAND

The national annual electricity demand for each scenario is shown in the figure below.

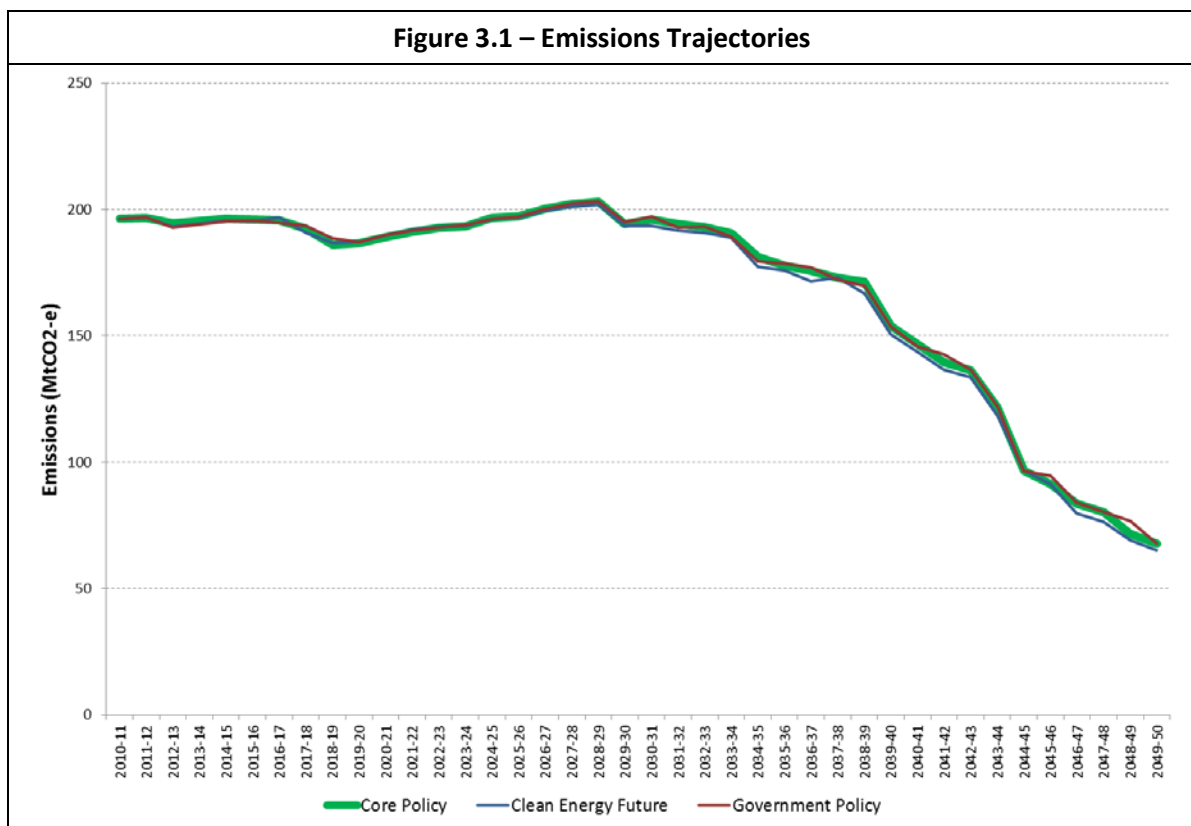


As shown in the figure above, the Government Policy scenario is almost identical to the original Core Policy scenario, in terms of demand. The Clean Energy Future scenario shows a reduction in overall electricity demand, from approximately 2025, with the primary driver for the difference being slower uptake of electric vehicles. All electricity demands have been supplied by the Treasury through the use of the MMRF model.

3) SIGNIFICANT OBSERVATIONS: EMISSIONS

3.1) EMISSIONS TRAJECTORY

Figure 3.1 shows the total annual carbon emissions resulting from electricity generation in the three scenarios. As expected, the total emissions produced by the electricity sector are very similar in the Government Policy and Core Policy scenarios. In the Clean Energy Future scenario, the reduced electricity demand results in slightly lower overall electricity sector emissions. However, a higher emissions intensity of generation in the Clean Energy Future scenario mitigates this impact to some extent.

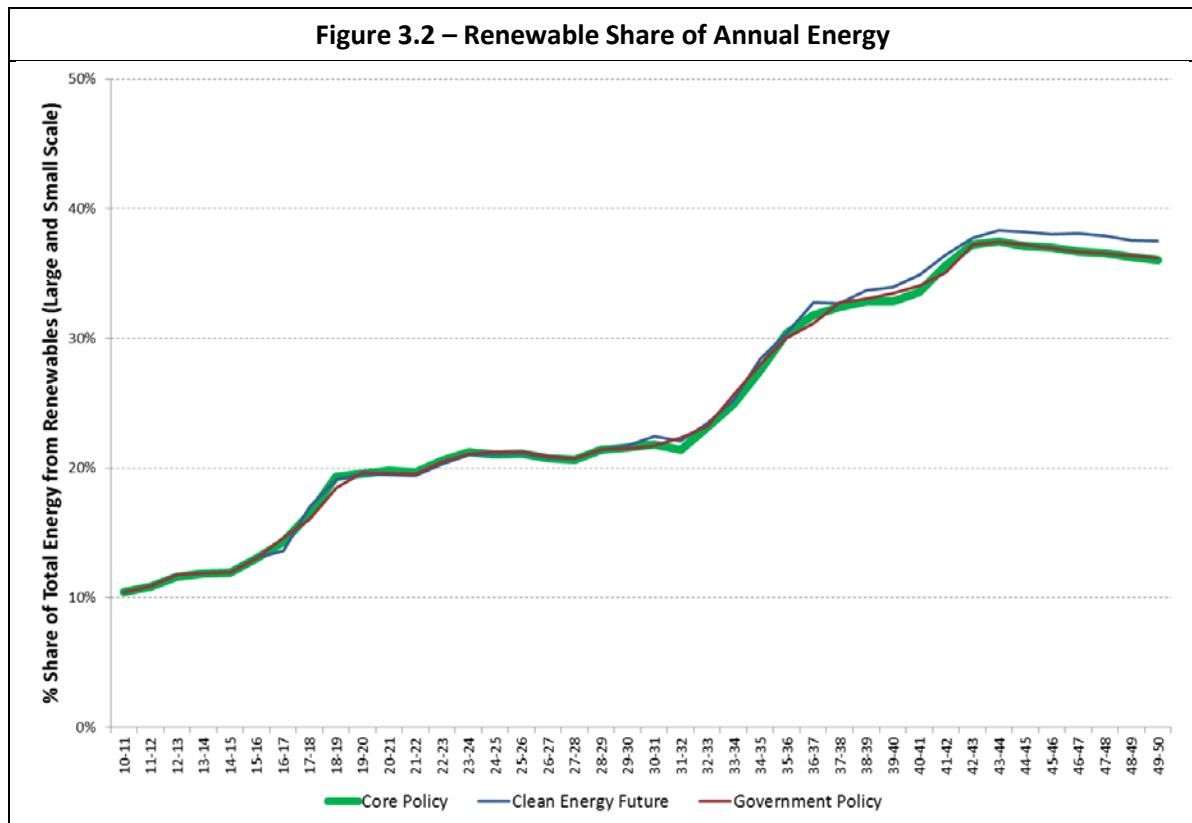


3.2) GENERATION FROM RENEWABLES

Key to management of electricity sector emissions is the increased development of low emissions and zero emissions technologies.

The following figure shows the share of total annual energy provided by renewable generators, inclusive of forecast small-scale distributed SRES-eligible generators such as rooftop PV and solar water heaters. As with the Core Policy scenario, the Clean Energy Future and Government Policy scenarios both achieve the 20% by 2020 renewables target. The share of renewables is slightly higher in the Clean Energy Future scenario, reflecting the lower overall demand for electricity.

Figure 3.2 – Renewable Share of Annual Energy



4) SIGNIFICANT OBSERVATIONS: MARKET PRICES

4.1) WHOLESALE POOL PRICES

ROAM has used the 2-4-C market dispatch software to model the half hourly interaction of electricity supply and demand for the NEM given the new entrant development programs developed using the least cost LTIRP model. Half hourly dispatch is necessary to accurately model pool prices given the intermittent nature of various renewable technologies such as wind and solar as well as random forced full and partial outages. Furthermore, the marginal generator which sets market prices will change throughout the day and year. ROAM uses detailed half hourly generation traces developed from historic Bureau of Meteorology data on wind speeds and solar insolation, correlated to historic electricity demand, to develop the intermittent generation profiles for wind and solar plant. Similarly, a Monte Carlo dispatch technique is used to randomise generator outages. ROAM has conducted 25 iterations of each simulation year to develop 25 alternate outage profiles for each case for each forecast year, which are then aggregated to provide a smoothed estimate of price.

The introduction of the carbon price at \$23/tonne increases wholesale pool prices by approximately 2.5%, relative to the Core Policy Scenario. However from 2015-16 to 2049-50 (beyond the fixed price period), annual average pool prices under the Clean Energy Future and Core Policy scenarios are almost equal. Prices in the Clean Energy Future scenario are marginally lower than those in the Core Policy scenario due to the lower electricity demands.

The following figures show the pool price for each region of Australia under each scenario³.



³ It should be noted that detailed half hourly modelling has not been performed for Western Australia, and as such the prices are reasonable estimates directly from the least cost dispatch modelling using the LTIRP of the SWIS. The SWIS prices are less volatile as the market rules require generators to bid their short run marginal costs, so a half hourly dispatch outcome is less critical. The Northern Territory is not included as no wholesale market exists.

Figure 4.1 – Wholesale Pool Prices

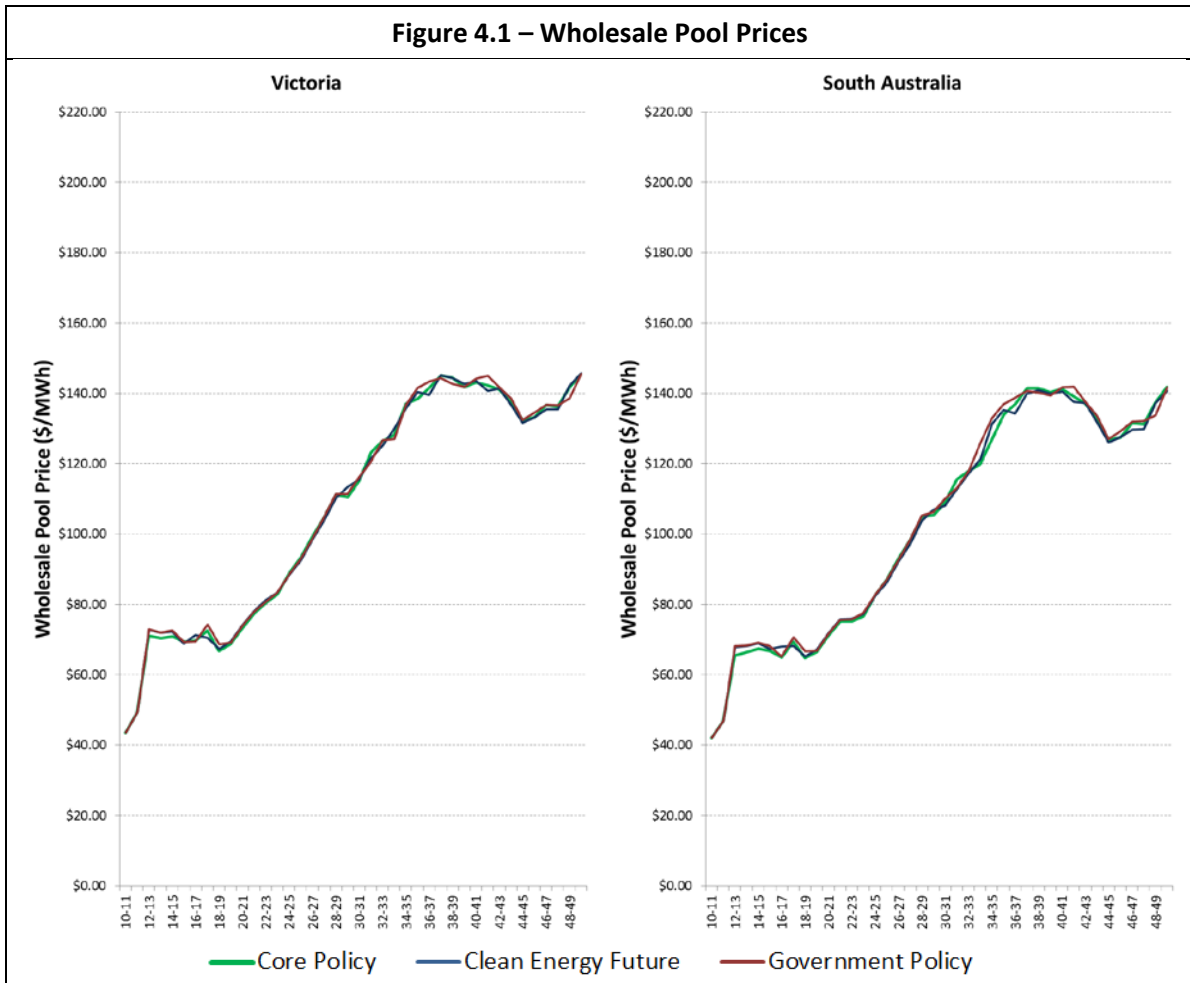
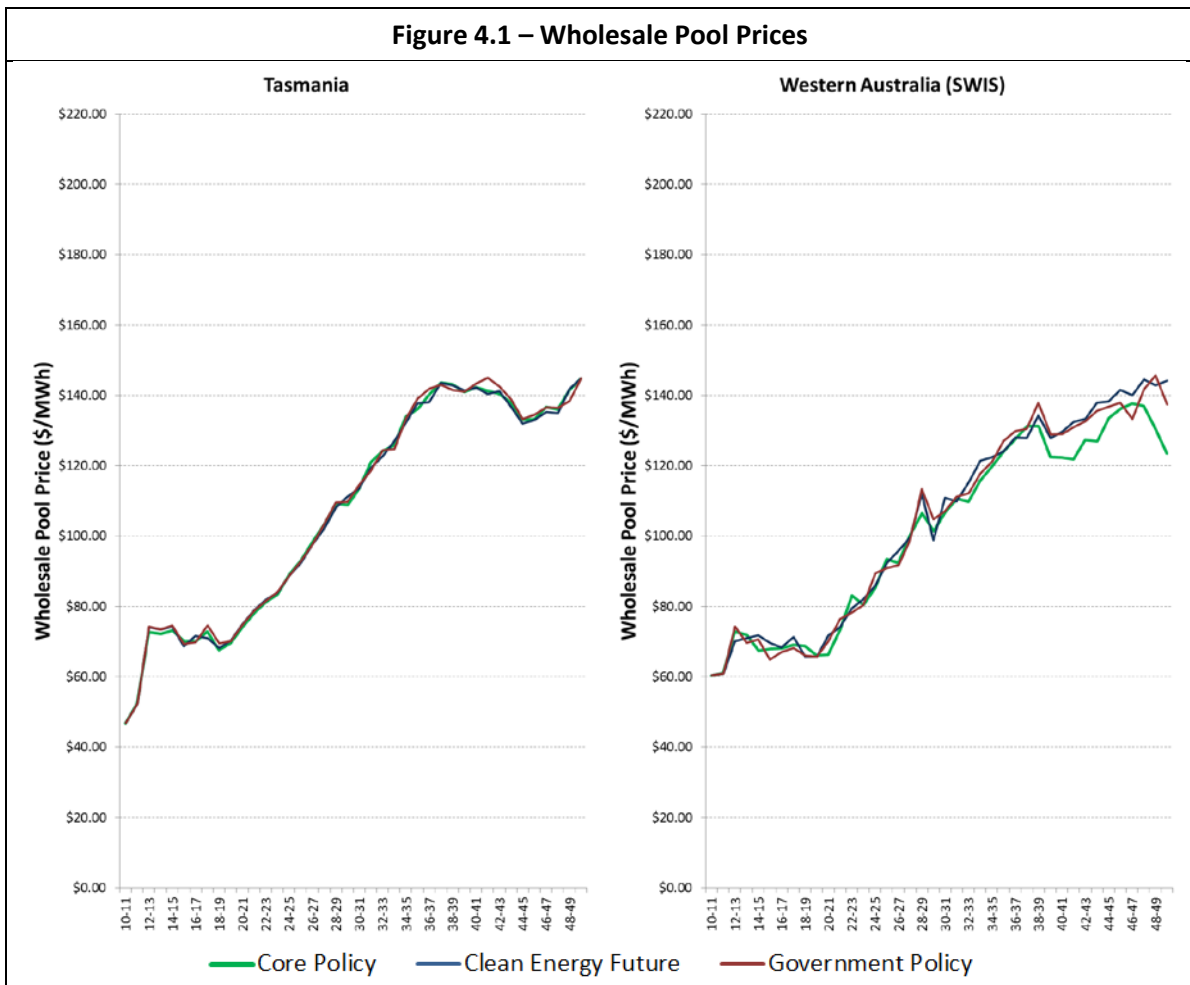
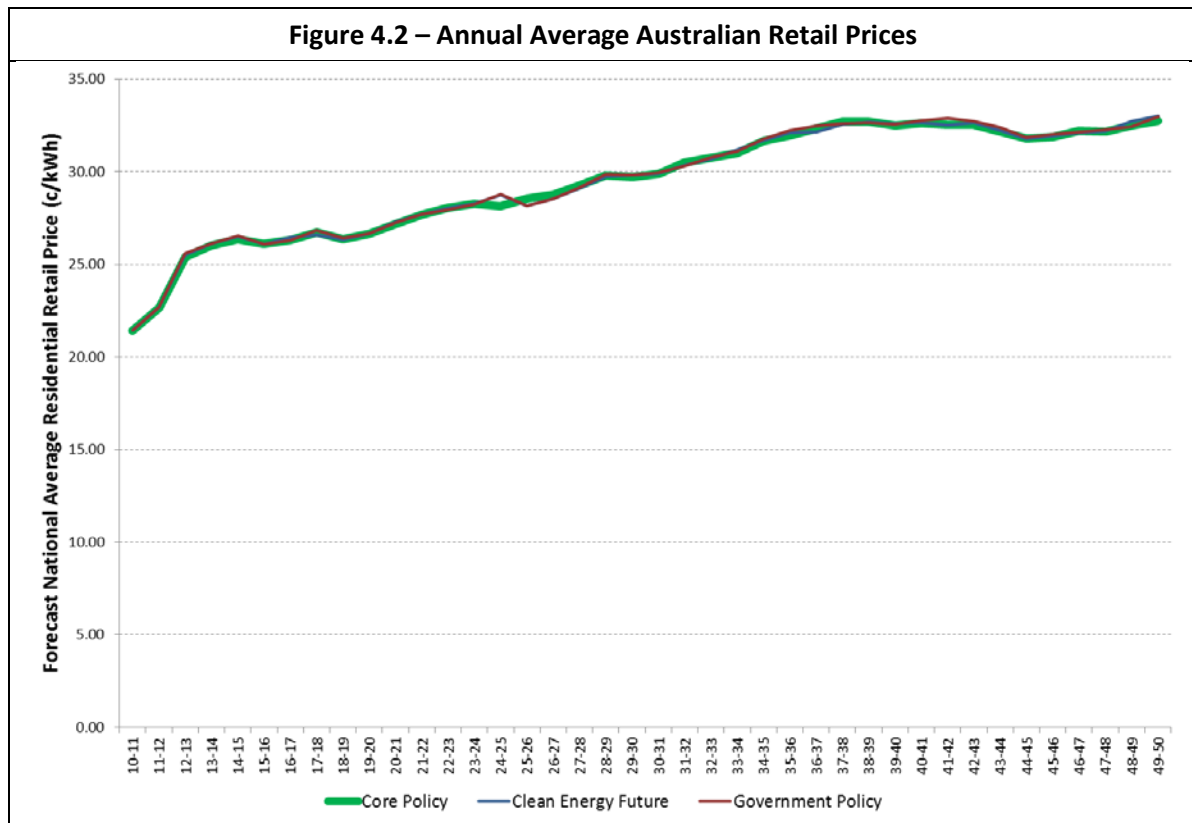


Figure 4.1 – Wholesale Pool Prices



4.2) **RETAIL PRICES**

Retail prices include not only the wholesale cost of electricity, but also costs relating to transmission, distribution and other market policies and initiatives.



The figure above shows that the alternative initial carbon price has very little impact on retail prices. Prices increase by less than 1% in both the Clean Energy Future and Government Policy scenarios relative to the Core Policy scenario.

5) SIGNIFICANT OBSERVATIONS: EVOLUTION OF THE SUPPLY SIDE

5.1) TECHNOLOGY SHARES OF ENERGY

Figure 5.1 below shows the suppliers of energy for each scenario by technology. In both new policy scenarios, the resulting distribution of generation between technologies is very similar to the Core Policy scenario, with the lower electricity demand in the Clean Energy Future scenario driving the most significant difference.

Figure 5.1 – Total Annual Generation by Technology

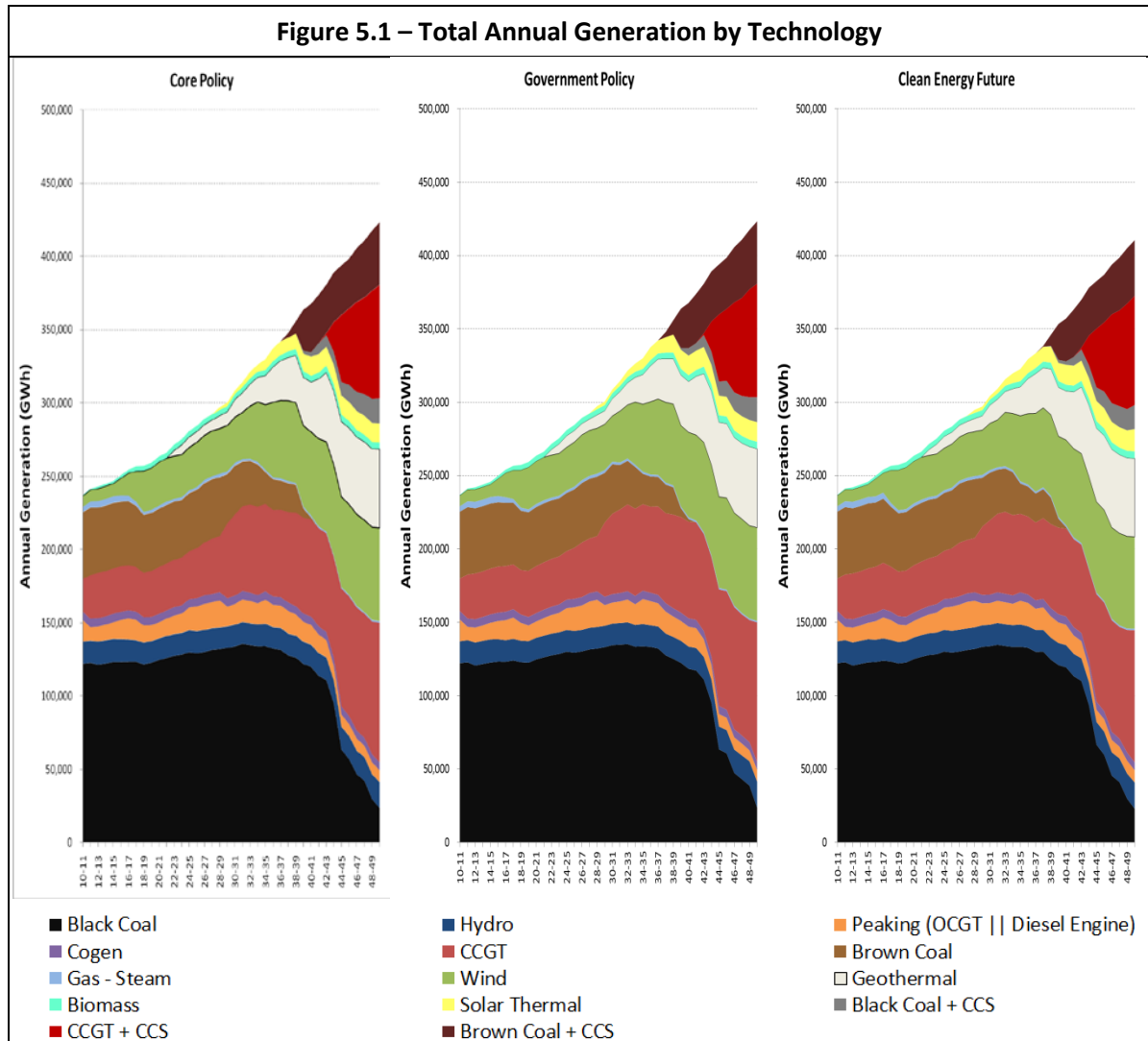
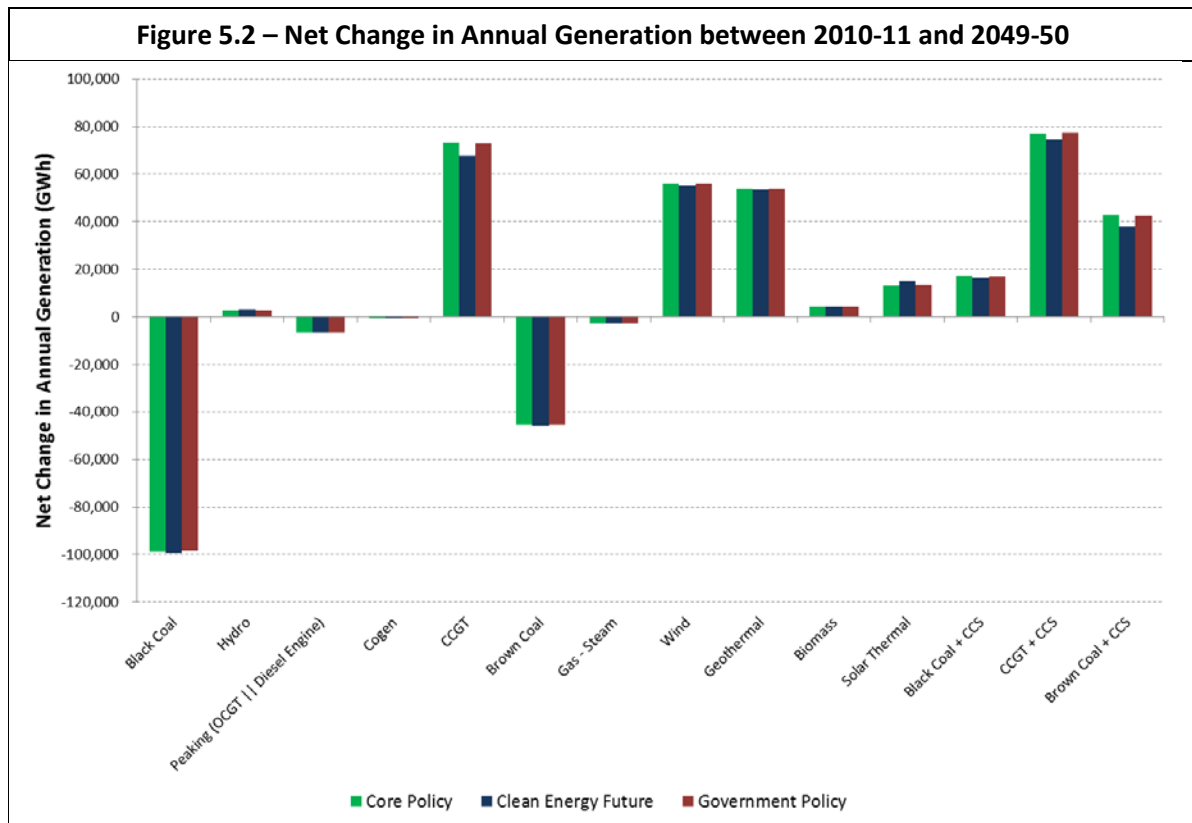


Figure 5.2 – Net Change in Annual Generation between 2010-11 and 2049-50



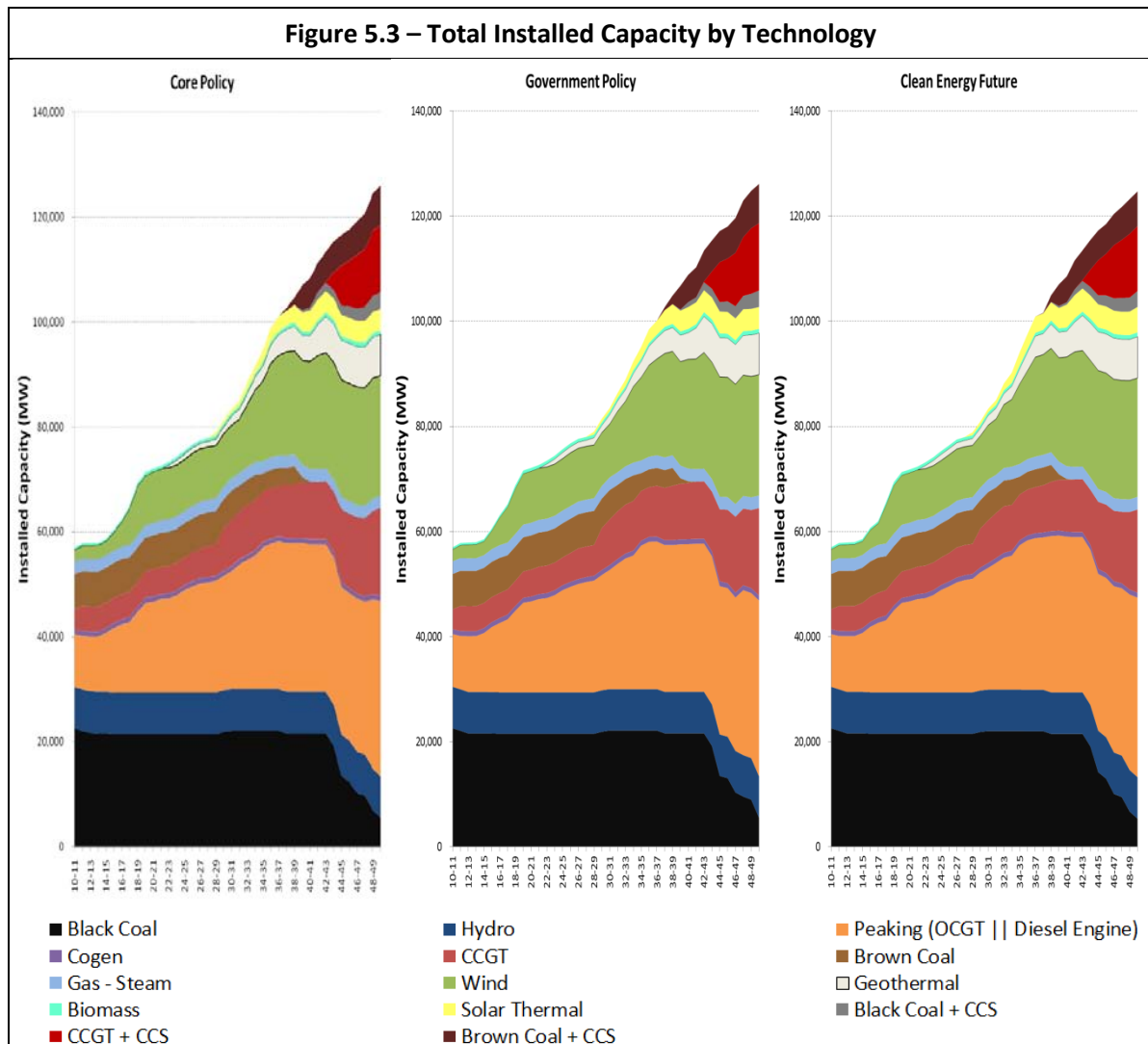
5.2) GENERATION DEVELOPMENT

Figure 5.3 shows the level of installed capacity in Australia in each of the three scenarios categorized by the type of generation. ROAM has not considered the possible introduction of wave energy technologies in this modelling as the scale of such developments is unlikely to be of a level that will materially influence development of other generation.

ROAM’s modelling did not restrict generation types according to their individual emissions levels. However, the modelling did not install any generation that exceeded the 0.86 tonnes CO₂-e/MWh ‘Cleaner Future for Power Stations’ limit.

As shown in the figure, there are no significant differences between the three scenarios over the forecast period. However in the short term, in both the Clean Energy Future and Government Policy scenarios, the higher carbon price hastens the retirement of coal plant, with new peaking gas plant providing reliability support.

Figure 5.3 – Total Installed Capacity by Technology



The net change in capacity for each category of generation over the 40 year period is summarized in Figure 5.4. As the figure shows, the lower overall demands in the Clean Energy Future scenario encourages increased retirements of black coal, and increased peaking plant as the load is 'peakier' with lower overall annual energy consumption. The reduced growth in electricity demand also reduces the opportunities for high capital cost, low operating cost technologies such as carbon capture and storage and geothermal.

Figure 5.4 – Net Change in Installed Capacity between 2010-11 and 2049-50

