Climate Change Strategy for South Australia

Submission relating to the Reduce, Lead and Innovate consultation papers.

Oscar Archer PhD
Dayne Eckermann

The sections of this submission refer directly to parts of the identified consultation papers.

It accompanies a larger reference proposal, attached, which was originally submitted to the Nuclear Fuel Cycle Royal Commission.

Reduce

Reduction of greenhouse gas emissions is the goal. Examination of Figure 2 and Table 1 shows the clear opportunity South Australia has for substantial decarbonisation via adoption of scheduled zero-carbon generators, electrification of vehicles, and provision of industrial heat by advanced nuclear capacity.

Figures 3 and 4 tell only part of the energy story for SA. It is consumed electricity (including imports), not capacity, which is responsible for power supply sector emissions. The AEMO SA Electricity Report provides consumption data for 2014-2015 which is highlighted in Figure A.

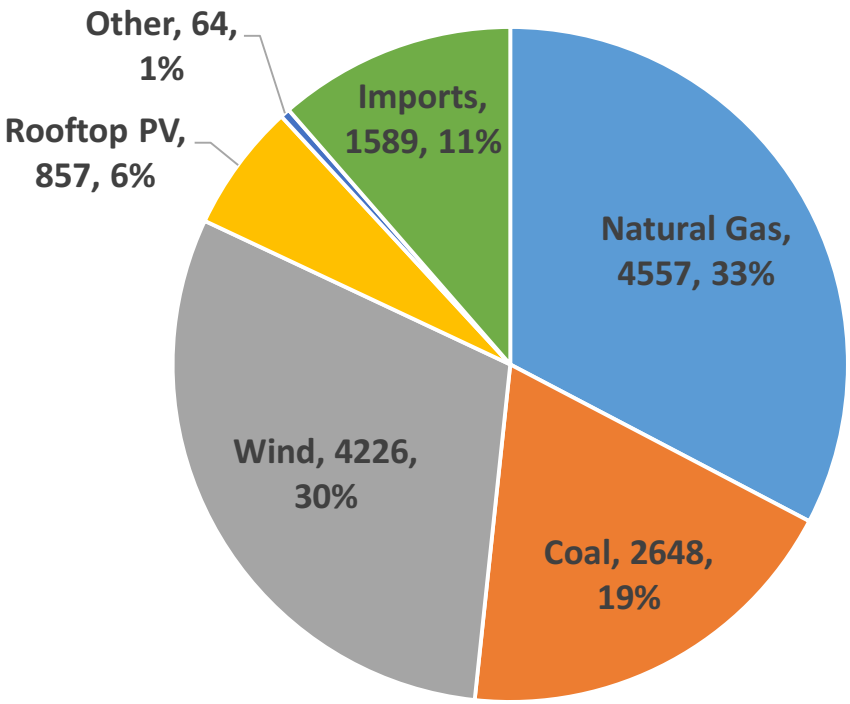


Figure A - 2014-15 South Australian Electricity consumption by source (all figures in GWh) (AEMO)

As Figure 5 in the Reduce paper clearly shows, reliance on substantial interstate imports comes with committed carbon intensity (Victorian imports are on average 1.2 tCO_2/MWh). Renewable capacity in SA is certainly set to grow, but this may be of limited benefit. The rate of rooftop PV addition is on a downward trend according to ESAA[1]. The further planned wind capacity for SA will necessitate upgrades to transmission spines for supply that is only intermittently generated. As noted recently in the literature[2]:

> *The lack of correlation between electricity demand and supply from wind has another long-term impact on overall system costs: the constrained ability to retire other 'baseload' (in reality, 'dispatchable', generators from service. This is best illustrated by the poor correlation between supply and peak demand. During periods of peak demand, only a small amount of the total installed wind capacity can be relied on firmly to be providing electricity; the Australian Energy Market Operator currently assumes only 8.6% for summer and 7.9% for winter peak demand in South Australia (more precisely, for every MW of wind-generating capacity installed, the Market Operator can only rely on a statistically 'firm' 8.6% of that capacity being available during 85% of the top 10% highest demand periods of the year). During periods of low wind penetration, the cost impact is minimal. Pre-existing margins of reserve supply, which insure against the sudden loss of fossil-fuel generators, can also cover the wind variability. As wind-power penetration increases, however, the cost implications become ever more daunting. These subsidised, variable generators supply electricity at low marginal costs (e.g. no fuel requirements, no need for permanent staff at the power plant, etc.). This removes potential generating hours for other (baseload) generators with higher marginal costs to sell power and raise revenue. However, little of this dispatchable generation can permanently exit the market. Most of it must be retained to cover periods of peak demand when wind is generating little electricity. South Australia has 1473 MW of existing and committed registered generation capacity from wind, but the maximum 'firm' contribution is only 93 MW.*

With these limitations in mind, Figure 6 in the paper may be seen as fairly realistic. The previous 10 years has seen intermittent renewable energy come to make up about 40% of regional generation; in the next 10 years about a further 10% is expected to be added. The suggested 50% renewable energy target should be replaced with at least a 90% clean energy target by 2050 which is technology neutral and ideally informed by the current NFCRC process. If reduction of greenhouse gas emissions is really the goal, we can't afford to leave anything in reserve.

[1] http://www.esaa.com.au/policy/esaa_solar__PV_report
[2] http://dx.doi.org/10.1080/03721426.2015.1035217

Lead

Countries and other relevant jurisdictions with low overall emission intensities (tCO_2/MWh) all deploy a suite of renewable (including hydro) and nuclear power. This is in line with recommendations from the IPCC on generation choices to deploy to limit emissions from the electricity sector. To this end of technology neutrality and the fact the renewable electricity choices (Wind and Solar) have flourished in South Australia, the Nuclear Fuel Cycle Royal Commission has provided the perfect forum to establish the extent of the climate friendly credentials of nuclear energy to a high standard of evidence. This input paper will provide context for the formal inclusion of nuclear in current and future climate change planning. It is set out as numbered responses to the issues raised in the Lead consultation paper on page 11 onwards, with additional observations on the chosen figures there-in.

1. Establishment of emission reduction and energy generation targets.

The adoption of wind power capacity in SA's generation mix has resulted in a carbon intensity reduction of roughly one quarter in the last ten years. Paradoxically, average annual net electricity imports from Victorian coal-fired generators have increased substantially (a factor of six to one import:export in 2013-14). Responsible climate policy must recognise the need to reverse this trend. It is necessary to seriously consider new scheduled capacity that is emissions-free yet can more than fill the gaps in the absence of weather-dependent supply[3].

For over a decade it was believed that geothermal energy could fulfil this need, but economical development of SA's remote resources has been effectively abandoned[4]. In place of a renewable energy target, a technology-neutral clean energy target along with a carbon intensity per kilowatt hour limit and expanded electrification goals could allow the state to set and realistically achieve a far more ambitious and effective magnitude of emissions reductions. The results of the NFCRC should be formally recognised in considering the potential for nuclear to be included and supported to a similar extent as other clean technologies.

2. Sectorial and interim targets, and specific policies and programs for emissions reduction

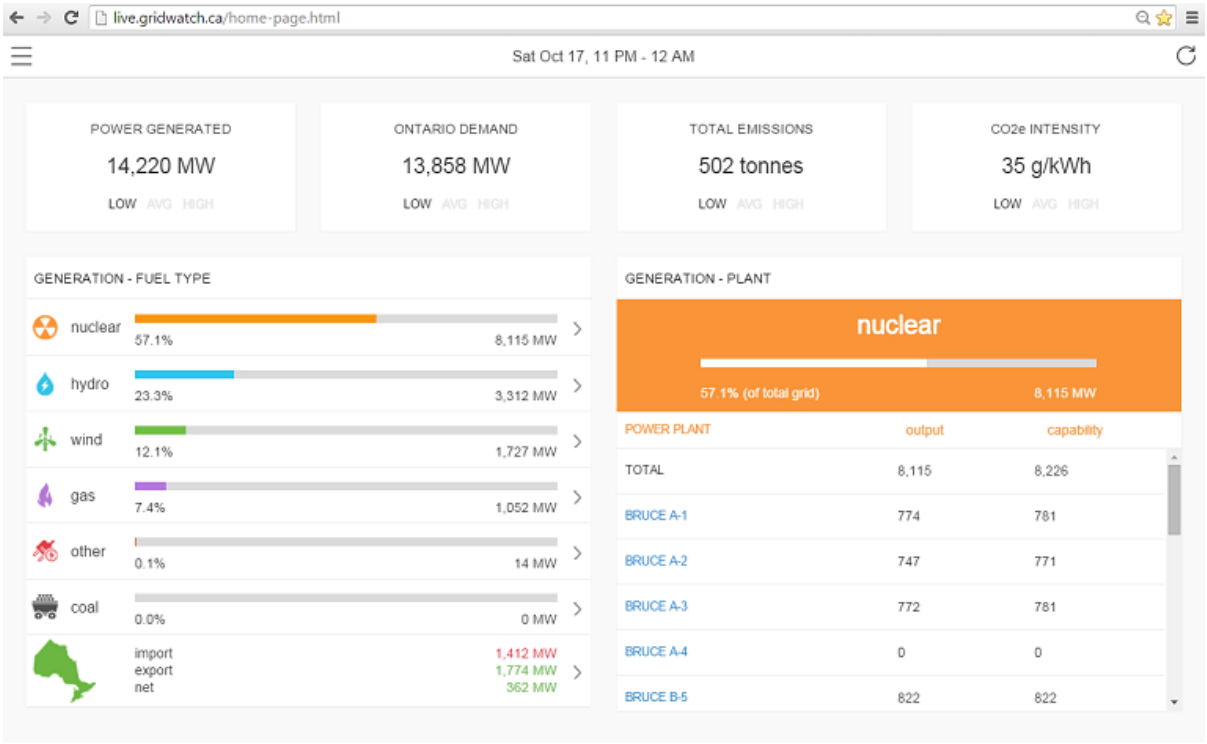
In 2014 the Canadian province of Ontario shuttered its last coal-fired plant, and achieved carbon intensity for its electricity grid of 60 gCO_2eqkWh^{-1} or below. Ontario is a national industrial centre and an energy exporter. This modern-day climate success story revolved mainly around the political commitment to the maintenance and re-commissioning of emissions-free nuclear capacity, alongside support for hydropower, wind and new gas capacity, beginning in with an election pledge in 2003[5]. The following screenshot demonstrates this achievement in real time accessible online[6].

[3] http://dx.doi.org/10.1080/03721426.2015.1035217

[4] http://nuclearrc.sa.gov.au/app/uploads/2015/09/SA-Nuclear-Fuel-Cycle-Royal-Commission-290915.pdf (Page 366)

[5] http://www.slate.com/articles/business/the_juice/2014/08/ontario_s_war_on_coal_how_a_heavily_populated_heavy_industry_canadian_province.html

[6] http://live.gridwatch.ca/home-page.html



3. Encouraging energy efficiency and conservation

Substantial efficiency gains revolving mainly around standby power and climate control within buildings and homes can be achieved by education and enforcing existing regulations. Targeted education on insulation, double glazing and home testing will be effective, as well as support for innovative products which will be suitable for both new structures and existing building retrofit[7].

Conversely, the real climate benefits of pursuing efficiency are invariably limited by rebound - the tendency of efficiency savings to be reinvested. The IEA recently estimated rebound to be as high as 60%[8]. A climate strategy that assesses efficiency measures as a reduction needs to analyse and understand the rebound effect in a South Australian context.

4. Research and development

Recent analysis has suggested that modern nuclear and renewable capacity along with variable loads and storage technologies can be harmonised as the model electricity supply system of the twenty first century[9]. Inclusion of nuclear potential may allow SA to claim the lead in this innovative energy system evolution.

[7] http://www.withouthotair.com/c22/page_155.shtml

[8] http://www.iea.org/w/bookshop/475-Capturing_the_Multiple_Benefits_of_Energy_Efficiency

[9] http://www.sciencedaily.com/releases/2015/07/150714083019.htm

5. Commercialisation of new technologies

This point addresses the commercialisation of new technologies. Please see the attached document in response to the Innovate consultation paper, specifically page 8. The key point to note in this section is that traditional funding models may work for some technologies, such as wind and the renewable certificate scheme, however other options such as revenue from recycling spent nuclear fuel to fund a nuclear generator are innovative ideas that should be pursued. The present economical impasse for the proposed Port Augusta Solar Thermal plant is another technology that may require a funding option outside of the usual RET and grant options.

6. Recognition of climate change action efforts.

There is nothing conceptually impeding these avenues of recognition from applying to industries, communities and groups who contribute substantially to effective bulk emissions mitigation. Recognition should be non discriminatory and reward real emissions reductions and not accounted reductions.

7. & 8. Supporting, encouraging and facilitating action and adaption.

While partnerships and support for innovative clean industries is vital, successful start-ups and potentially revolutionary products and manufacturing should be fully locally enabled. Keeping them in South Australia will return the most benefit to our state. Key to this is the supply of reliable electricity with the potential for significant medium term expansion as South Australia's true innovative and economic capacity begins to be realised. Engagement with industry, particularly the largest users of electricity and emitters of emissions, is essential. Past measures that impose punitive measures on industries or other groups can often invoke a backfire effect even when those groups have complementary climate change strategies.

9. Reporting progress against objects of the Act.

Regular reporting procedures will be important in the potential delivery of the infrastructure necessary for adoption of all clean energy options (Renewables and Nuclear) whilst avoiding the delays observed in some other regions. Commissioning of capacity should be viewed as much as a climate change mitigation measure as would new modern scheduled electricity service or a source of employment, and should be subject to relevant compliance. These reported progresses need to be real and not an accounted figure that has the potential to double count or hide actual emissions.

10. Promoting consistency with national and international policy.

Above and beyond consistency with other national and international climate change actions, South Australia has the potential to step out in front and lead, inspire and

embolden our region in efforts to replace the use of fossil fuels. Pioneering new nuclear technology, integrated with our rich renewable resources and modern industries, and sustainable, responsible development of our enviable uranium resources will be key.

11. Contributing and responding to international events.

This point can be best addressed by the development of impartial, inclusive clean energy source policy. From page 82 of the Intergovernmental Panel on Climate Change 2014 Synthesis Report:

> *Scenarios that are likely to maintain warming at below 2°C include more rapid improvements in energy efficiency and **a tripling to nearly a quadrupling** of the share of zero- and low-carbon energy supply from renewable energy, **nuclear energy** and fossil energy with carbon dioxide capture and storage... or [bio-energy with carbon dioxide capture and storage] by the year 2050.*[10]

Among the various measures clearly described by the IPCC - none of which should be ruled out – the substantial increase in nuclear energy capacity over the coming 35 years must receive attention if a formal ministerial portfolio for climate change is to be informed by the science. It should be noted that the addition of biomass electricity sources should be accompanied by a Carbon Capture and Storage (BECCS) system to limit the emissions from this source. There is contention over the accounting of biomass emissions and whether they are truly revenue neutral[11].

Although Australia's and France's emissions intensities appear comparable in Figure 1 (Page 6 Lead paper), levelising by 2011 GDP for each country reveals that France's emissions are around 60% lower than Australia's[12]. Furthermore, a comparison of 2011 Worldbank CO_2 emissions per capita data (metric tons per capita - Australia: 16.5; France: 5.2) demonstrates more than a three-fold difference[13]. This is a consequence of France's use of majority nuclear energy for electricity since the 1980s, and Australia's overwhelming reliance on coal.

Absent from Figure 2 (Page 7, Lead paper), for the two most ambitious greenhouse gas reduction commitments by China and South Korea, are these countries' reliance on new renewable and nuclear capacity, more so in the former[14]. In addition to over 200 GW of wind and over 100 GW of solar, China intends to have 58 gigawatts (GW) of nuclear

[10] IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp. [https://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full.pdf]

[11] http://www.greenpeace.org/canada/Global/canada/report/2011/10/ForestBiomess_Eng.pdf

[12] http://www.tradingeconomics.com/

[13] http://data.worldbank.org/indicator/EN.ATM.CO2E.PC

[14] http://www.irena.org/remap/IRENA_REmap_RE_targets_table_2014.pdf

electricity in operation and 30 GW under construction by 2020[15]. South Korea plans to increase its fleet of 24 reactors to 35 by 2029, to meet rising demand and replace coal capacity[16].

In the context of Figure 3 (Page 8, Lead paper) it would be instructive to consider the 2012 OECD data for France and Sweden. While Australia was responsible for 23.9 tonnes of CO_2 equivalent per capita, France's number was 5.1 and Sweden's 4.25. Similar to France above[17]. Sweden sources nearly half of its electricity from nuclear power, and the remainder from hydro renewables. It may also be instructive to consider the substantial emissions and human health impacts that a potential reduction of this capacity would have, as provided in a recent article in the journal Energy Policy[18].

[15] http://www.sfen.org/en/le-blog-des-energies/what-action-china-taking-climate-change

[16] http://www.world-nuclear-news.org/NP-South-Korean-energy-plan-sees-two-more-reactors-2207154.html

[17] https://data.oecd.org/air/air-and-ghg-emissions.htm

[18] http://www.sciencedirect.com/science/article/pii/S0301421515001731

Innovate paper

It is the convention, when addressing the potential contribution from electricity generation to action on climate change, to compare technologies on the basis of Life Cycle Analysis of carbon dioxide (and equivalent) emissions. This mining-to-decommissioning gCO_2/kWh metric is often calculated for each technology from meta-studies of many literature sources, so as to provide a set of realistic ranges and probable median values. Many institutions do this, including the IEA and the IPCC.

This submission will look at one particular option that is innovative and if implemented would derive the benefits of the first mover to South Australia. This innovation should be considered on its merits along with other low carbon options in a technology neutral policy in line with the IPCC.

One such meta-study was by Warner and Heath (2012), and it reviewed nuclear energy. While they estimated low values for conventional nuclear plants from many reputable sources, they also included values for fast breeder nuclear reactors. Their median was 0.87 gCO_2/kWh, the lowest median value for any generation technology by at least an order of magnitude[19].

Merely on the basis of this data, such innovative nuclear technology should not be excluded from any serious discussion of climate change action. Fortunately, it is currently offered for first-of-a-kind deployment by a major industrial vendor, and many of the original scientists involved in the proving of this technology during the '80s and '90s are still professionally active. Often referred to as "Generation IV" nuclear power, this type of reactor was designed to mitigate accidents and proliferation concerns, while consuming stocks of used nuclear fuel.

Conventional nuclear energy was instrumental last century for many nations in substantially and rapidly reducing their reliance on imported fossil fuels, mainly oil. France, Sweden and Switzerland are three examples which, to this day, enjoy incredibly low-emissions electricity. More recently, Ontario, Canada, closed its last coal-fired power station following a program of nuclear refurbishment, and now boasts the cleanest renewables- and nuclear-dominated power grid in north America with a large, diverse industrial sector.

The potential local benefits of heading these experiences cannot be understated. South Australia, as a resource-rich part of a socially stable and progressive nation would be seen to be leading the region in the safest, most modern example of an energy technology which will be increasingly important in South East Asia this century. The scope of the envisaged project would potentially integrate much of the state's manufacturing capacity in multifaceted supply, development, construction, logistics and knowledge advancement.

[19] http://onlinelibrary.wiley.com/doi/10.1111/j.1530-9290.2012.00472.x/full

Government merely needs to be led by the basic science in order to provide sufficient support for such game-changing innovation. This proposal needs firm bipartisan political and policy support and confident oversight rather than open-ended public funding.

A large and growing market exists in Asia to provide management services for used nuclear fuel. South Australia is ideally placed to take a prominent global position in servicing that market. This submission proposes an ambitious model of services predicated on providing custody of used fuel, rather than disposal, paired with the committed commercialisation of the infrastructure required to undertake complete recycling of the material while generating zero-carbon electricity. This submission finds such an integrated project delivers net-present value exceeding $28 billion to South Australia. This provides scope for far-reaching economic benefits, including the provision of free wholesale power to the state, the reduction or elimination of some state-based taxation, direct and indirect creation of many thousands of jobs, and sustained funding for leading renewable energy initiatives.

Please find the proposal accompanying this submission.

Transforming our economy. Cleaning our energy. Sustaining our future. Submission to the South Australian Nuclear Fuel Cycle Royal Commission.