THE SOCIAL COST OF CARBON AND IMPLICATIONS FOR THE ACT

26 MAY 2021

ACT Climate Change Council

ACKNOWLEDGMENT OF COUNTRY

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Cover: Black Mountain looking north east, Richard Poulton.

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1. Background

In July 2018, the ACT Climate Change Council (hereafter, the Council) produced a briefing paper entitled "The Social Cost of Carbon and public investment to reduce ACT greenhouse gas emissions.[1]" The paper outlined the rationale for the use of the Social Cost of Carbon as a minimum measure for public investments to compensate for any possible future overshoot in emissions above the interim greenhouse gas (GHG) targets recommended[2] by Council in 2017. Now set out in law,[3] those interim targets for the Australian Capital Territory (ACT) are to reduce greenhouse gas emissions (from 1990 levels) by:

- 40% by 2020 (this target has been met)
- 50 to 60% by 2025
- 65 to 75% by 2030
- 90 to 95% by 2040, and
- 100% (net zero emissions) by 2045.

The Council recommended that the ACT not rely on offsets to cover any possible future emissions overshoot of these targets, but rather to invest in directly supporting and accelerating the Territory's path to net zero emissions by an amount no less than the Social Cost of Carbon associated with emissions overshoot above the target. The Council also recommended that the Social Cost of Carbon be applied in any cost-benefit analyses used to inform public investments or policy and regulatory decisions in the ACT.

Council's 2018 briefing provided background on the concept of the Social Cost of Carbon, an estimation of how it is used in policies and decisions elsewhere, and suggested that a value of **70 AUD per tonne of CO_2** emitted as a reasonable starting point for consideration by the ACT government. This new Council report updates that information, drawing on recent developments in climate change science, estimates of the Social Cost of Carbon, and policy undertakings.

Council's update is particularly relevant to two actions in the ACT Climate Change Strategy,[4] namely:

Action 5.5: Ensure the social cost of carbon and climate change adaptation outcomes are considered in all ACT Government policies, budget decisions, capital works projects and procurements.

Action 5.11: Invest an interim price of $20 per tonne of emissions from government operations into measures to meet the Zero Emissions Government (ZEG) target from 2020–21, and arrange for an independent body to develop a social cost of carbon for application from 2025.

We return to these two actions of government in Section 8 with specific recommendations for how the Social Cost of Carbon might be applied.

1. ACT Climate Change Council (2018) The Social Cost of Carbon and public investment to reduce ACT greenhouse gas emissions.
2. ACT Climate Change Council (2017) Letter from the ACT Climate Change Council to Minister Rattenbury on interim GHG targets (19 October 2017)
3. ACT Legislation Register (7 August 2018) Climate Change and Greenhouse Gas Reduction (Interim Targets) Determination 2018
4. ACT Government (2019) ACT Climate Change Strategy 2019-2025, https://www.environment.act.gov.au/cc/act-climate-change-strategy

2. What is the Social Cost of Carbon?

The Social Cost of Carbon is the value of the net damage caused by to society by adding a small amount of carbon dioxide into the atmosphere. As generally used in policy, the (incremental) Social Cost of Carbon is defined as net monetary cost associated with the climate change impacts resulting from the emission of a tonne of carbon dioxide (tCO_2) in a given year.[5]

Said differently, the Social Cost of Carbon can be viewed as the net benefit to society by avoiding emitting a tonne of CO_2 in a given year. Social costs for other greenhouse gases can also be defined, such as the social cost of methane (SCM) and nitrous oxide (SCN),[6] the social cost associated with climate impacts through emissions of methane and nitrous oxide gases, respectively, into the atmosphere.

The impacts of emitting greenhouse gases are diverse and far-reaching, including[7] reductions in food security, water shortages, economic and health-related damages due to extreme weather events (including an increased risk of severe wildfire, for example, or deaths due to heat waves), ecosystem damage and loss, psychological stress, increased human migration and conflict. Consideration must also be given to the possibility that at some degree of warming, the Earth System (or some of its sub-systems) will cross a threshold[8] beyond which human efforts to address climate change will be largely ineffectual.[9]

Although low levels of warming may incur some social benefits in some localities (e.g., lengthening of growing seasons), when aggregated globally, the damages associated with substantial global warming outweigh these local benefits, particularly for warming above 1°C.[10, 11] This is why the Social Cost of Carbon is calculated as a net cost. Average global warming is currently about 1.1°C,[12] with 2020 being 1.24°C above the pre-industrial level. Consequently, the net effect of emitting greenhouse gases is currently a 'cost,' not a 'benefit' to society, and the marginal cost of greenhouse gas emission will increase non-linearly over time.[13]

5. US IWG (2021) Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990, Accessed here: https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf
6. https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/20/executive-order-protecting-public-health-and-environment-and-restoring-science-to-tackle-climate-crisis/
7. See, e.g. IPCC SR1.5 (2018) Intergovernmental Panel on Climate Change Special Report on Global Warming of 1.5°C. Accessed at: http://ipcc.ch/report/sr15/
8. Lenton, T.M. et al. (2019) Climate tipping points — too risky to bet against. Nature, 2019; 575 (7784): 592. Accessed at: https://www.nature.com/articles/d41586-019-03595-0
9. Steffen W et al. (2018) Trajectories of the Earth System in the Anthropocene. Proc. Natl. Acad. Sci. (USA) doi:10.1073/pnas.1810141115 and associated Appendix https://www.pnas.org/content/pnas/115/33/8252.full.pdf
10. Ricke, K., Drouet, L., Caldeira, K. and Tavoni, M. (2018) Nature Climate Change, 8, 895-900, and references cited therein. Accessed at: https://www.nature.com/articles/s41558-018-0282-y
11. Kompas, T., Pham, V. H., & Che, T. N. (2018). The effects of climate change on GDP by country and the global economic gains from complying with the Paris Climate Accord. Earth's Future, 6, 1153–1173. https://doi.org/10.1029/2018EF000922
12. WMO (2020), WMO Statement on the State of Global Climate in 2019, WMO-No. 1248, accessed at: https://library.wmo.int/index.php?lvl=notice_display&id=21700
13. Kompas, T., Pham, V. H., & Che, T. N. (2018). The effects of climate change on GDP by country and the global economic gains from complying with the Paris Climate Accord. Earth's Future, 6, 1153–1173. https://doi.org/10.1029/2018EF000922

Furthermore, because greenhouse gases (CO_2 in particular) remain in the atmosphere for considerable lengths of time (decades to millennia) and continue to warm the Earth every year they persist in the atmosphere, and because the impacts of warming are net negative and tend to be non-linear and cumulative, the accumulated cost of emitting CO_2 grows rapidly over time. Even if the world were to reach net-zero emissions at some point in future, some of these costs will continue to accumulate, though at a substantially slower rate.

Complications and Uncertainties in Quantifying the Social Cost of Carbon

Whereas the concept of the Social Cost of Carbon is relatively easy to state, it is difficult to arrive at a common agreement as to the 'social cost' of carbon for several reasons, including:

a. Not all social damages due to climate change can be quantified (e.g., irreversible losses, including those due to crossing irreversible thresholds in the Earth System).

b. Not all quantifiable damages can be fully described by an 'economic cost' (e.g., deaths due to climate change).

c. Our understanding of the impacts of climate change continues to evolve, almost always in the direction of more severe negative impacts occurring at lower global warming values than previously thought.[14]

One consequence is that even the highest justifiable Social Cost of Carbon is likely to be an underestimate of the true social cost of emission. Furthermore, the social costs of emitting carbon are currently an externality: the cost is borne disproportionately by those who emit the least, by younger generations more than older generations, and most of the cost is not reflected in the marketplace of those activities that are responsible for the emissions.

Nevertheless, it is valuable to attempt to estimate the Social Cost of Carbon in order to more fully understand the cost of inaction on climate change, and to weigh alternate opportunities for emissions mitigation.

How the Social Cost of Carbon is Estimated

Scientists and economists estimate the Social Cost of Carbon using models for the climate and for the economy, and their interaction. These models are called Integrated Assessment Models, or IAMs.

As with any model, the output is determined by the model structure, representation of processes, and inputs (for example, inputs that define scenarios). Critical scenarios for IAMs may cover:

1. How will population and economy grow at different places in the world? How quantity of emissions, particularly CO_2, will humans emit over time? (socio-economic component)
2. How will the climate and other parts of the Earth System react to these emissions? (climate component)
3. How will these changes influence human well-being, and how are they quantified and monetized? (damages component)
4. How much value does society place on avoiding these damages? (discounting component)

14. Zommers Z., Marbaix P., Fischlin A., Ibrahim Z.Z., Grant S., Magnan A.K., Pörtner H.-O., Howden M., Calvin K., Warner K., Thiery W., Sebesvari Z., Davin E.L., Evans J.P., Rosenzweig C., O'Neill B.C., Patwardhan A., Warren R., van Aalst M.K., & Hulbert M. 2020. Burning embers: towards more transparent and robust climate-change risk assessments. Nature Reviews Earth & Environment. doi: 10.1038/s43017-020-0088-0

The incremental Social Cost of Carbon is calculated by repeating the preceding steps after introducing a small additional amount of emissions, in order to see what effect this has on the damages. Results vary greatly depending on model and scenario (how these questions are answered). In order to obtain a better understanding of the full range of plausible futures and to estimate the uncertainty in the results, the IAMs must be executed hundreds of thousands of times.

Once a large subset of model runs has been completed, the outcome is often summarised by using a 'central value' (such as the average, mean or mode) of the distribution of all results for the Social Cost of Carbon. Often a more precautionary value is also quoted for the 95% percentile of all model runs.

As a consequence of the computational intensity required, the individual components of IAMs are simplified, so that each result can be obtained more quickly.

Climate models are simplified, generally ignoring Earth system feedbacks (in which some Earth systems move out of equilibrium, emitting more CO_2) and other highly complex Earth system processes. Typically, the most recent climate model results and processes have not yet been integrated into IAMs.

As a consequence, Social Cost Carbon estimates lag behind the actual science and are a substantial simplification of actual physical and social considerations. In particular, IAMs inadequately represent the changes in climate extremes as emissions grow, which is particularly problematic since this is what drives most of the costs.

Simplification in the socio-economic component is also necessary; not all countries may be individually represented, for example, let alone smaller socioeconomic entities. The damage components of IAMs are able only to reasonably assess a relatively small number of types of deleterious effects, often a subset of those directly tied to measures of economic health. The models may calculate how much GDP is cut by climate impacts, but often do not allow damages to alter the rate of GDP growth, meaning that they could underestimate the severity of economic losses.[15]

In addition, irreversible and discontinuous effects cannot be adequately represented within an IAM, resulting in further underestimation of the social cost. Crucially, for some human and environment subsystems decisions about emissions are existential, and thus more appropriately compared to decisions made in the face of a global, escalating threat such as the COVID-19 crisis or global economic collapse.

15. Evans, S., Pidcock, R., Yeo, S. (2017) Q&A: The Social Cost of Carbon, Carbon Brief, Accessed at: https://www.carbonbrief.org/qa-social-cost-carbon

3. Discount Rates

In order to attempt to put a price today on climate damages, including those in the future, economists use the concept of a 'discount rate,' which quantifies how much money (benefit) in the hand now is 'valued' more than money (benefit) in future. The higher the discount rate, the more value is placed on current rather than future benefits.

As an example, a discount rate of 1% implies that benefits accrued on generational timescales (80 years) are valued at 45% of present benefits. A 3% discount rate, by contrast, values generational benefits at only 9% of present benefits.

This concept is used by companies thinking about investment decisions, for example, and is adjusted to reflect the perceived relative risks, opportunity costs and longevity of an investment. The use of discount rates in applying a Social Cost of Carbon is, however, complex for a number of reasons.

First, not all social impacts can be easily translated into economic terms.

Second, due to the long duration of climate impacts that result from decisions made today, the choice of discount rate has a major impact on the evaluation of the Social Cost of Carbon. Most impacts of human-induced climate change will continue for centuries into the future. The longevity of these impacts argues for low discount rates, and possibly declining discount rates over time, as is being increasingly argued for environmental public projects with benefits extending over very long timescales, for example.[16, 17]

Third, given the extent to which the impact of climate change damages will be borne by younger and unborn generations that are not able to fully participate in the climate action and investment choices made now, there are reasonable arguments for even lower discount rates to be considered, further increasing the Social Cost of Carbon as evaluated for today.

Finally, some climate impacts involve the crossing of biophysical thresholds (tipping points), the devastating and irreversible consequences of which cannot be captured in standard economic theory.

In the end, the choice of a social discount rate is primarily an ethical one, not a technical one.

In practice, discount rates of about 1% to 7% have been applied to calculate the Social Cost of Carbon in today's monetary units. A recent survey of **200 economists specialising in discounting produced a distribution of social discount rates with a median value of 2%; three-quarters of the economists considered this median value acceptable.**[18] The Stern Review[19] used a social discount rate of approximately 1.4%.

The Intergovernmental Working Group (IWG) on the Social Cost of Greenhouse Gases established by Presidential order in January 2021[20], has written a Technical Support Document[21] explaining the IWG interim recommendations released in February 2021[22], and providing substantial further comment and justification. The document concludes that although the interim values to be used through January 2022 are based on calculations using discount rates of 5%, 3% and 2.5% that were used in regulatory analyses between 2010 and 2016, **"new data and evidence strongly suggests that the discount rate regarded as appropriate for intergenerational analysis is lower."**

16. Knoke, T., Paul, C. and Härtl, F. (2017). "A critical view on benefit-cost analyses of silvicultural management options with declining discount rates." Forest Policy and Economics, 83: 58-69.
17. Freeman, M.C., Groom, B., Panopoulou, E., Pantelidis, T., 2015. Declining discount rates and the Fisher effect: inflated past, discounted future? J. Environmental Economics and Management, 73, 32–49.
18. Drupp, M. A., Freeman, M. C., Groom, B. and Nesje, F. (2018) "Discounting Disentangled." American Economic Journal: Economic Policy, 10 (4): 109-34. DOI: 10.1257/pol.20160240
19. Stern, N. (2007). The Economics of Climate Change: The Stern Review. Cambridge: Cambridge University Press. doi:10.1017/CBO9780511817434
20. https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/20/executive-order-protecting-public-health-and-environment-and-restoring-science-to-tackle-climate-crisis/
21. US IWG (2021) Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990, Accessed here: https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf
22. https://www.whitehouse.gov/briefing-room/blog/2021/02/26/a-return-to-science-evidence-based-estimates-of-the-benefits-of-reducing-climate-pollution/

4. Related, but Different, Carbon Price Concepts

We caution that the term 'Social Cost of Carbon' is often used for somewhat different concepts, which can confuse discussion, estimates and any application of the concept to policy or investment decisions.

For example, governments can put a 'price on carbon,' via a form of taxation, introducing an emissions trading scheme, or introducing border adjustment mechanisms amongst many other options. These are seldom based on the Social Cost of Carbon, however. Nor do they need to be – for example, a carbon price may be set based on assessments of effectiveness of driving down emissions. If it is lower than the Social Cost of Carbon, then that simply demonstrates policy efficiency (the marginal cost is much less than the marginal benefit).

Similarly, the cost of carbon 'offsets' is not based on current or future costs of emitting greenhouse gases, but rather on a market price for promising to 'offset' that emission elsewhere. Since climate change is already a form of market failure with large external costs borne by society at large, market mechanisms are unlikely to fully reflect the Social Cost of Carbon.

In the context of ACT Government policy needs, for a carbon price could be used as the mechanism for internally pricing the emissions associated with government operations as a means of reserving capital for the investments needed to achieve the Zero Emissions Government (ZEG) target by 2040. Such a price could be determined by evaluating the projected cost and timing of the measures required to achieve the ZEG and bringing this back to a net present value per tonne of CO_2 emitted today. This approach has the benefit – and challenge – of requiring that at least a first-order plan and evaluation of costs for the net-zero achievement must be generated, and regularly updated, to determine a suitable cost. In this manner, there is some assurance that the reserve created by the carbon price is capable of achieving the desired end result.

In the short term, and in the absence of a costed plan for achieving net zero within Government operations, such a carbon price can be estimated using the more general Social Cost of Carbon approach discussed in this report. However, there is a reasonable argument that over the next five years a carbon price based on costed measures to achieve net zero within government operations should be produced to ensure that the budget reserved for the task is better tuned to the projected costs.

5. Current Estimates of the Social Cost of Carbon

Estimates of the global Social Cost of Carbon vary widely; values published in the years around 2015 ranged from as low as 10 USD to as high as 1000 USD per tonne of CO_2.[23]

A recent detailed report by the US National Academies[24] has highlighted the many reasons for this variance and made recommendations for improving the reliability and usefulness of future estimates, focussing on the more realistic scientific underpinnings, characterising uncertainties and improving transparency of methods and assumptions.

Historical data indicate that the climate costs to Australia are large. The economic cost of climate change to Australia is estimated to have doubled since the 1970s,[25] with about 35 billion AUD in losses reported in the 2010s. This is expected to rise if emissions are not curbed sharply. Australians are five times more likely to be displaced by a climate-change related disaster than someone living in Europe.[26]

The Social Cost of Carbon can also be calculated on a country rather than a global basis. The value will vary by country and, in particular, by the capacity to adapt to climate change. However, this introduces more uncertainty, and ignores the global nature of climate change, international trade, global politics and the global economy more generally.

A recent study[27] assessing 140 countries and 57 economic commodities, and climate damage functions related to effects of sea level rise, losses in agricultural productivity, temperature effects on labour productivity and human health, found that annual damages from these impacts of climate change upon Australia could exceed 100 billion (AUD) by 2038, and exceed 1.89 trillion (AUD) by 2050.[28] This study also indicates that climate damages rise sharply with increased warming, considerably faster than the quadratic function used in some IAMs.[29]

23. Ricke, K., Drouet, L., Caldeira, K. and Tavoni, M. (2018) Nature Climate Change, 8, 895-900, and references cited therein. Accessed at: https://www.nature.com/articles/s41558-018-0282-y
24. National Academies of Sciences, Engineering and Medicine Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide (National Academies, Washington, 2017). Accessed at: http://www.nap.edu/24651
25. Steffen, W. and Bradshaw, S. (2021) Hitting Home: The Compounding Costs of Climate Inaction, and references cited therein. Climate Council of Australia Ltd. Accessed at: https://www.climatecouncil.org.au/resources/hitting-home-compounding-costs-climate-inaction
26. Steffen, W. and Bradshaw, S. (2021) Hitting Home: The Compounding Costs of Climate Inaction, and references cited therein. Climate Council of Australia Ltd. Accessed at: https://www.climatecouncil.org.au/resources/hitting-home-compounding-costs-climate-inaction
27. Kompas, T., Pham, V. H., & Che, T. N. (2018). The effects of climate change on GDP by country and the global economic gains from complying with the Paris Climate Accord. Earth's Future, 6, 1153–1173.
28. Kompas, T. cited in Silvester B. (2020) Trillions up in smoke: The staggering economic cost of climate change inaction. New Daily, 10 September 2020. https://thenewdaily.com.au/news/national/2020/09/10/economic-cost-climate-change based on the modelling framework set out in Kompas, T., Pham, V., Che, T. (2018) The effects of climate change on GDP by country and the global economic gains from complying with the Paris Climate Accord. Earth's Future 6 https://doi.org/10.1029/2018EF000922
29. Nordhaus, W.D. (2017) Revisiting the Social Cost of Carbon, PNAS, 114, 7, 1518-1523. Accessed at: https://www.pnas.org/content/114/7/1518

Although useful to highlight the global inequities in bearing the full cost of climate change, a global Social Cost of Carbon is gaining recognition as an appropriate metric for policy decisions in many countries, including the US and Canada.

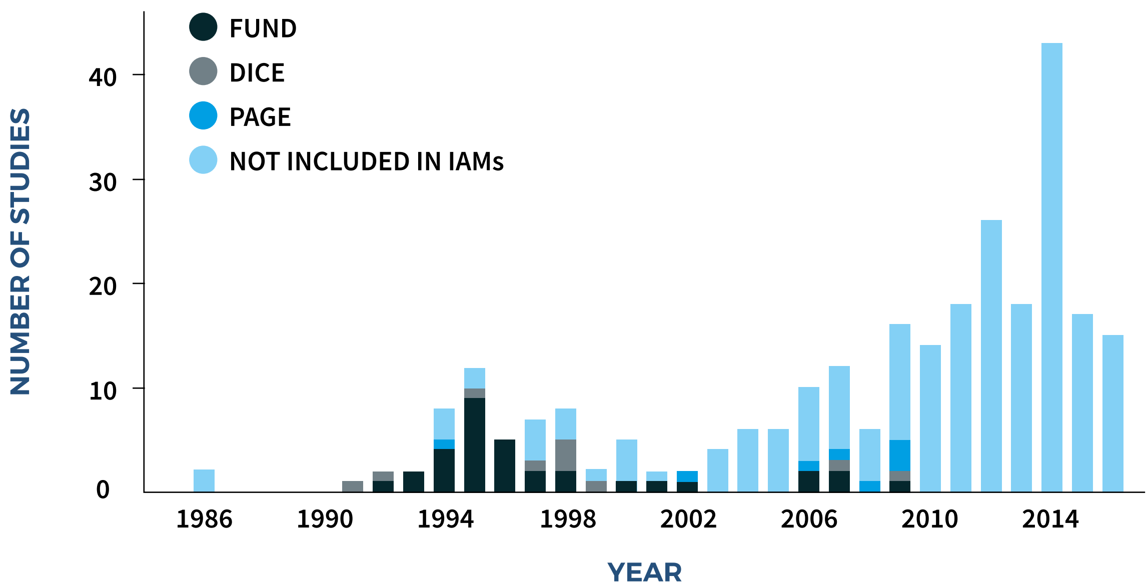
Recent research by Ricke et al.[30] has reinforced the expectation that the Social Cost of Carbon will vary between countries, and noted the inappropriateness of using constant discount rates across countries and across time. Importantly, the study notes that using a global Social Cost of Carbon, the sum of individual values across all countries, is most appropriate to meeting the goals of the UN Paris Agreement. Results for the (adopted) most likely assumptions yield a **median global Social Cost of Carbon of 417 USD per tonne of CO_2 emissions, with a 'reasonable' (66% confidence) range of 177–805 USD**. Currently, 1 USD is about 1.3 AUD.

It is important to note that the Ricke et al. study does not include costs associated with adaptation, biodiversity loss, cultural loss, tipping points in the climate system, climate effects with very long-term consequences (sea level rise and ocean acidification), all of which would increase the Social Cost of Carbon. Nor does it address interconnectivity issues such as trade adjustments, or future adjustment in the macro economy that could decrease the Social Cost of Carbon.

The enormous amount of research yet to be factored into the IAMs used to estimate the Social Cost of Carbon is represented graphically in Figure 1 below, which is reproduced directly from (Figure 5 of) the US IWG Technical Summary Document,[31] based on information only out to 2016. Show in blue are the number of studies each year (out to 2016 only) that have not been taken into account in the IAMs used to estimate the interim Social Cost of Carbon that the US will use until the new values are published, no later than January 2022.

FIGURE 1: NEW RESEARCH (UP TO 2016) ON CLIMATE IMPACTS NOT YET INCLUDED IN US IAMS

(Source: US IWG Technical Support Document, February 2022)



30. Ricke, K., Drouet, L., Caldeira, K. and Tavoni, M. (2018) Nature Climate Change, 8, 895-900. Accessed at: https://www.nature.com/articles/s41558-018-0282-y

31. US IWG (2021) Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990, Accessed here: https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf

6. Examples of using a Cost on Carbon in Policy Decisions: A Sampler

As noted above, there are many ways to formally recognise the deleterious effects of emitting greenhouse gases (and thus the benefits of reducing emissions) by pricing carbon in some way.

This section provides of sampler of policy approaches taken by jurisdictions ranging in size from the EU to individual states in the US. Not all of these use the Social Cost of Carbon approach, and consequently often result in a 'value' for carbon that underestimates the costs of emissions to society.

Canada

In December of 2020, the Prime Minister of Canada announced that it will gradually increase its federal carbon tax on fuels from **30 CAD per tonne of CO_2 in 2020 to 170 CAD per tonne in 2030**.[32, 33, 34] Currently, the Canadian (CAD) and Australian (AUD) dollars are near parity.

Canadian provinces and territories can maintain or develop their own carbon pollution pricing as long as it meets federal benchmark requirements.[35] In addition to this, the Canadian Greenhouse Gas Pollution Pricing Act,[36] adopted on 21 June 2018, also mandates a carbon trading system for large industry.

Canada is also in the process of updating the Social Cost of Carbon estimates used in its regulatory analyses, as they have **concluded their current estimates are a likely underestimate of climate-related damages to society**.[37]

Europe

The emissions trading scheme (ETS) in the European Union, which currently covers 45% of Europe's greenhouse gas emissions,[38] is an example of using market policy to, in effect, put a price on carbon. The performance of the EU carbon market did not result in large reductions in emissions in the period 2012 to 2017 when prices were as low as 5 Euro per tonne CO_2-e.

In 2015, the Union decided to impose, as of 1 January 2019, a 'market stability reserve' (MSR) that would reduce the number of allowances (permits to emit greenhouse gases) in the system. This appears to have bolstered the price to around 25 Euro per tonne CO_2-e, which – despite the influences of COVID-19 – has increased sharply to over **52 Euro per tonne of CO_2-e**[39] following the US 2020 election and the announcement by the EU of stronger emissions

32. https://www.cbc.ca/news/politics/carbon-tax-hike-new-climate-plan-1.5837709
33. https://climatechoices.ca/canadas-climate-plan/
34. Canadian Government (2020) A Healthy Environment and A Healthy Economy, Accessed at: https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/climate-plan/healthy_environment_healthy_economy_plan.pdf
35. https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work.html
36. https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/greenhouse-gas-annual-report-2019.html#toc2
37. Proposed Clean Fuel Regulations (published for public comment on 12/20/20) http://www.gazette.gc.ca/rp-pr/p1/2020/2020-12-19/pdf/g1-15451.pdf
38. The Economist (27 Feb 2021) Coming into its own. v438, p 63-64 https://www.economist.com/finance-and-economics/2021/02/24/prices-in-europes-carbon-market-the-worlds-biggest-are-soaring?
39. As given by https://ember-climate.org/data/carbon-price-viewer/ at the time of this report. Note that this price is currently rising sharply.

targets of 55% reduction (rather than 40% reduction) on 1990 levels.[40] Currently, one Euro is about 1.6 AUD. The EU ETS is not based on the Social Cost of Carbon.

UK

Since 2012, the UK has adopted what it terms a hybrid approach to the evaluation of the cost of carbon. While the Stern review used a full social cost of carbon model, the uncertainties in this led to a proposal in 2009[41] to use a marginal cost of abatement model, on the grounds that this would be a better reflection of real costs, and more certain. However, this was again updated in 2012[42] to use the hybrid approach, which takes its central value from futures contracts on the EU ETS, but calculates upper and lower limit values based on a marginal cost of abatement basis. This approach is not based on the Social Cost of Carbon or other measures of climate damages.

In April 2019[43] (pre-Brexit; post Brexit policy in this area is not known), the central scenario short term traded carbon values from ranged from £13.84 per tonne CO_2-e in 2020 to £80.83 per tonne CO_2-e 2030. High scenario values per tonne CO_2-e ranged from £27.69 to £121.24 across the same time range while low scenario values ranged from £0-£40.41. The current EU ETS price is equivalent to £48.45 indicating that these scenarios may be significant underestimates. Currently, one British £ (GBP) is about 1.8 AUD.

USA

On 20 January 2021, the day the Biden administration was sworn in, the 'Executive Order on Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis[45]' was issued by the new President. Among other directives, the order established an Interagency Working Group on the Social Cost of Greenhouse Gases with the instruction to:

a. publish an interim SCC[46], SCN, and SCM within 30 days, which US agencies were directed to use to monetize the value of changes in greenhouse gas emissions resulting from regulations and other relevant US agency actions until final values are published; and

b. publish a final SCC, SCN, and SCM by no later than January 2022.

Guidelines for how to update the Social Cost of Carbon have been published in a report of The National Academies of the US[47], and the Biden administration has indicated it will follow these guidelines.

The interim values have now been released[48], and have been set equal to estimates used in US policy in 2017 (before the Trump administration enacted measures that reduced them to nearly zero), adjusted for inflation. Those previous values were based on estimating the global (not local, or national) cost of carbon. Until the new values are derived and published (by January 2022), the US will use the interim values given in the tables shown in Appendix A, detailed in the Technical Support Document[49] issued by the US IWG. In 2021, these values for one tonne of CO2 emission are **15 USD, 52 USD, 78 USD, for discount rates of 5%, 3% and 2.5% respectively**. Currently, 1 USD is about 1.3 AUD.

40. https://ec.europa.eu/commission/presscorner/detail/en/IP_20_1599
41. Carbon Valuation in UK Policy Appraisal: A Revised Approach, UK Department of Energy and Climate Change 2009.
42. Updated Short-Term Traded Carbon Values for Use in UK Policy Appraisal, UK Department of Energy and Climate Change, 2012
43. Updated Short Term Traded Carbon Values Used in UK Public Policy Appraisal, April 2019, UK Department of Business, Energy and Industrial Strategy
44. The UK figures are expressed in 2018 pounds and represent a trade price in a given year rather than the integrated value across a longer timeframe.
45. https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/20/executive-order-protecting-public-health-and-environment-and-restoring-science-to-tackle-climate-crisis/
46. SCC is the abbreviation used here for the Social Cost of Carbon.
47. National Academies of Sciences, Engineering and Medicine Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide (National Academies, Washington, 2017). Accessed at: http://www.nap.edu/24651
48. https://www.whitehouse.gov/briefing-room/blog/2021/02/26/a-return-to-science-evidence-based-estimates-of-the-benefits-of-reducing-climate-pollution/
49. US IWG (2021) Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990, Accessed here: https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf

An alternate value for the Social Cost of Carbon of 155 USD is given for the 95% percentile (at 3% discount rate). The 95% percentile value is higher or equal to the value found in 95% of the IAM simulations used by the IWG. This more precautionary estimate of the Social Cost of Carbon is meant to encapsulate a realisation that climate damages may be underestimated in the median value of the IAM simulations, and more be appropriate when considering investment in climate action as a form of 'insurance' against future damages.

The US Technical Support Document (TSD) stresses "the range of **four interim SC-GHG estimates presented in this TSD likely underestimate societal damages from GHG emissions**." Note that this statement applies even to Social Cost of Carbon given for the 95% percentile at a 3% social discount rate.

In its technical report, the US IWG also published interim values for the social cost of methane and nitrous oxide, the two other primary anthropogenic greenhouse gases. These values are reproduced in Appendix A of this report.

New York State

In a guidance document for all its state agencies, New York State has set a 2021 "price on carbon" of **127 USD per tonne CO_2**, and recommends a **2% discount** rate.[50] In other words, New York State has advised that all state government entities attach a price to CO_2 emissions of 127 USD per tonne to all decision-making, and value future impacts using a 2% discount rate. New York has not specifically referred to this value as a social cost.

Other US States

In addition to New York, several other states in the US have adopted policies related to the Social Cost of Carbon, including California, Colorado, Illinois, Maine, Maryland, Minnesota, Nevada, New Jersey, Virginia and Washington State.[51] A few examples follow.

In early 2019, Washington State enacted a law requiring the use of the Social Cost of Carbon in utility resource planning, specifying that utilities should use the **(US) IWG Social Cost of Carbon at the 2.5% discount rate**.[52]

In April 2020, the Virginia state legislature passed the Clean Economy Act requiring the State Corporation Commission, Virginia's electric utility regulator, to use the Social Cost of Carbon to assess the impacts of building fossil fuel-fired generators, using the best available science, including that used by the IWG.[53]

In early 2019, the Colorado State Legislature passed a bill requiring the utilities commission to evaluate "the cost of carbon dioxide emissions" in resource planning, using the IWG Social Cost of Carbon values initially and increasing to **46 USD per tonne in 2020**.[54]

Table 1 below summarises the estimates for and uses of a cost of carbon discussed in this report. Note that the EU ETS values and the UK values are prices on carbon used in policy, but are not structured as nor intended to represent damages associated with carbon emissions. Values in 2020 AUD are rounded to the nearest 5 AUD.

50. Government of the State of New York (2020) Establishing a Value for Carbon, Guidance for Use by State Agencies, https://www.dec.ny.gov/docs/administration_pdf/vocfguid.pdf
51. The Cost of Carbon Pollution, Institute for Policy Integrity, Accessed at 4 April 2021: https://costofcarbon.org/states
52. Wash. Sen. Bill. 5116 (signed by Gov. Inslee on May 7, 2019)
53. Va. Code. Ann. § 56-585.1(6) (2020); see also H.B. 1256.
54. Colo. Sen. Bill 19-236 (passed May 3, 2019).

TABLE 1: COSTS ON CARBON DISCUSSED IN THIS REPORT

PER TONNE OF CO_2 EMITTED UNLESS OTHERWISE NOTED (In **bold** are estimates for the Social Cost of Carbon)	IN NATIVE CURRENCY UNIT	APPROXIMATE EQUIVALENT IN 2020 AUD[55]
ACT Climate Change Council recommendation (2018)	**70 AUD (2018)**	**75 AUD**
Scientifically calculated median value from Ricke et al (2018)	**417 USD (2018)**	**565 AUD**
Scientifically calculated reasonable (66%) confidence range from Ricke et al (2018)	**177 – 805 (2018)**	**240 – 1100 AUD**
Canada carbon fuel tax (2020 to 2030 ramp up)	30 – 170 CAD (2020)	30 – 170 AUD
EU ETS on carbon market price on CO_2-e (26 May 2021)	52.6 Euro	85 AUD
UK central scenario short-term traded price of carbon (2020-2030 ramp up) based on 2019 predictions	14 – 80 GBP (2019)	25 – 145 AUD
USA value operating until January 2022 update (2.5% discount rate)	**78 USD (2020)**	**100 AUD**
USA precautionary estimate (95th percentile, using 3% discount rate) operating until January 2022 update	**155 USD (2020)**	**200 AUD**
New York State price on carbon (2% discount rate)	127 USD (2019)	170 AUD
Washington State (IWG value at 2.5% discount rate)	**78 USD (2020)**	**100 AUD**
Colorado State	**46 USD (2020)**	**60 AUD**

https://www.inflationtool.com/us-dollar/2018-to-present-value?amount=417 and https://www.ofx.com/en-au/exchange-rates/ were used inflation factors and exchange rates.

7. Recommendations for the use of Social Cost of Carbon in ACT Policy

The ACT Climate Change Council commends the ACT government's leadership in formally recognising that greenhouse gas emissions are associated with substantial, growing social costs, by ensuring "that the social cost of carbon and climate change adaptation outcomes are considered in all ACT Government policies, budget decisions, capital works projects and procurements."[56]

This commitment extends to emissions from the Government's own operations and to reinvest the Social Cost of Carbon associated with Government operations[57] into further emissions reductions, rather than relying on offsets.[58, 59]

This whole-of-government approach is particularly appropriate given that the social costs associated with greenhouse gas emissions touch nearly every aspect of life, and thus nearly every Government portfolio. Health, city services, treasury, economic development, environment, community services and other areas of Government will experience climate-related costs that are likely to continually increase at least until global emissions are brought to net-zero. Introducing a Social Cost of Carbon across all areas of government is an important tool in a consistent, forward-looking approach to avoid future climate damage.

We note that adopting and implementing an ethically-considered and evidence-based value for the Social Cost of Carbon into all Government decisions demonstrates that the ACT does not wish to 'externalise' to others the social impact of its own emissions. Such leadership increases the Territory's profile as a global leader in climate action and sends a strong signal to those with whom it does business that the social cost of greenhouse gas emissions will be considered in all interactions.

To assist in the best use of the Social Cost of Carbon, the ACT Climate Change Council makes two sets of recommendations. The first is related to best practice for a clear framework for implementation. The second reflects Council's considered view about the specific value and social discount rate that the ACT might now use, and how this might be monitored and revised in future.

Best Practice

The effective use of a Social Cost of Carbon in decisions requires a clear framework for implementation, as it is easily misused. **Council recommends that**:

1. The Social Cost of Carbon is expressed as series of annual figures (as per the US IWG tables in Appendix A)
2. These figures are incorporated as a cost in the year they fall based on the emissions in that year.
3. For transparency, consistency and clear signalling, a common Social Cost of Carbon and a social

56. ACT Climate Change Strategy 2019-2025, Action 5.5
57. ACT Climate Change Strategy 2019-2025, Action 5.11
58. ACT Climate Change Strategy 2019-2025, p6.
59. As noted in Section 5, a reasonable argument can be made that the value used in the ZEG policy should be based on the marginal cost of abatement, as this would provide better assurance that the sums reserved are appropriate to the project costs of achieving the stated target. However, in the short term at least, the Social Cost of Carbon discussed in this document is a reasonable stand-in for such a cost, and offers the advantage of standardising government policies.

discount rate is used across all decisions.[60] The discount rate will inform the values of the Social Cost of Carbon used for projects and decisions that extend over multiple years.

4. The Social Cost of Carbon is updated regularly and often to reflect the best and most recent research and ensure that its use is consistent with overall policy goals regarding climate change.
5. The sources and reasoning leading to a particular choice for the Social Cost of Carbon are detailed and made publicly available.
6. Guidelines are developed as to how the Social Cost of Carbon is to be applied within decisions, and that these guidelines be made publicly available, so that they can also become a potential tool for business and other jurisdictions.
7. Consideration be given to implementing policy for other major greenhouse gases, either through the simplified use of CO2-e or via independently derived values as used in the US IWG analysis, and reflected in the tables of Appendix A.

The Social Cost of Carbon in ACT Policy: value, discounting, and regular updating

With regard to the specifics of the value of Social Cost of Carbon and social discounting rate to be used, the **Council recommends that**:

1. The ACT Government adopts a global Social Cost of Carbon that reflects currently available research, best practice implementation, a precautionary stance toward future damages, and a recognition of the disproportionate intergenerational burden of the social damages associated with continuing emissions.
2. A maximum interim social discount rate of 2% be adopted for implementation of the Social Cost of Carbon in all ACT Government decisions beginning in 2022-23. The important choice of discount rate has a strong ethical component. Council has chosen a social discount rate of 2%:
   a. to reflect Council's understanding of the stated concerns about climate change by ACT residents and its effects on future generations,
   b. considering advice from the Drupp review of economists,[61] which yielded a median value of 2% for the recommended social discount rate, and
   c. noting that the US IWG has said that 5%, 3% and 2.5% social discount rates are very likely to be inappropriate for an intergenerational analysis.
3. As a practical compromise for policy, a minimum interim Social Cost of Carbon be set at 204 AUD/tonne CO_2 for the 2022-23 fiscal year, and fully implemented by the ACT Government in that year. This value is based on a Social Cost of Carbon of 200 AUD in 2020, propagated forward with a 2% discount rate to 2022. It is a practical interim compromise, in the sense that it is:
   a. similar to the current interim (precautionary) US IWG estimate for the 95th percentile value (at 3% discount rate) and to the high-cost of abatement scenario of the UK. We note that the US IWG has warned that all its interim working values for the Social Cost of Carbon, including the 152 USD (about 200 AUD) 2020 precautionary value are likely underestimates.

60. That said, the financial model for a given decision will have its own duration and discount rate. The Social Cost of Carbon figures represent the net present value of the cost of the carbon emissions in each year, so it is valid for these to be further compounded by the financial discount rate for the particular decision.

61. Drupp, M. A., Freeman, M. C., Groom, B. and Nesje, F. (2018) "Discounting Disentangled." American Economic Journal: Economic Policy, 10 (4): 109-34. DOI: 10.1257/pol.20160240

b. lower than the low end of the 66% confidence range for the Social Cost of Carbon calculated by Ricke et al. (2018)[62], which is about 240 AUD.

c. almost certainly an underestimate of the full Social Cost of Carbon.

4. Test cases be performed in the 2021-22 fiscal year, using these values, to assist with the formulation of Government-wide guidelines.

5. The value for the Social Cost of Carbon and the social discount rate be reviewed and updated in light of new research and international developments (including the expected January 2022 US IWG revised Social Cost of Carbon figures) every three years thereafter, for implementation no later than in the fiscal year 2025-26.

For clarity, the annual Social Cost of Carbon recommended by Council for the period 2020 to 2050 are presented in Appendix B.

The ACT Climate Change Council would welcome the opportunity to continue to work with the ACT Government on innovative uses of the Social Cost of Carbon in guiding outcomes to the benefit of the Territory and responsible, effective action on climate change.

62. Ricke, K., Drouet, L., Caldeira, K. and Tavoni, M. (2018) Nature Climate Change, 8, 895-900. Accessed at: https://www.nature.com/articles/s41558-018-0282-y

8. Appendix A: US Tables for the Social Cost of Greenhouse Gases

This Appendix lists the social cost of greenhouse gases that will be used in US government decision making until January 2022, when a major revision will take place.

Tables are taken from the technical report of the US IWG.[63] The US document uses the terms SC-CO_2, SC-CH_4 and SC-N_2O for the social costs of carbon (dioxide), methane and nitrous oxide per tonne, respectively. All values in 2020 USD.

TABLE A-1: ANNUAL SC-CO_2, 2020-2050 (IN 2020 DOLLARS PER METRIC TON OF CO_2) DISCOUNT RATE AND STATISTIC

Emissions Year	5% AVERAGE	3% AVERAGE	2.5% AVERAGE	3% 95 PERCENTILE
2020	14	51	76	152
2021	15	52	78	155
2022	15	53	79	159
2023	16	54	80	162
2024	16	55	82	166
2025	17	56	83	169
2026	17	57	84	173
2027	18	59	86	176
2028	18	60	87	180
2029	19	61	88	183
2030	19	62	89	187
2031	20	63	91	191
2032	21	64	92	194
2033	21	65	94	198
2034	22	66	95	202
2035	22	67	96	206
2036	23	69	98	210
2037	23	70	99	213
2038	24	71	100	217

63. US IWG (2021) Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990, Accessed here: https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf

Emissions Year	5% AVERAGE	3% AVERAGE	2.5% AVERAGE	3% 95 PERCENTILE
2039	25	72	102	221
2040	25	73	103	225
2041	26	74	104	228
2042	26	75	106	232
2043	27	77	107	235
2044	28	78	108	239
2045	28	79	110	242
2046	29	80	111	246
2047	30	81	112	249
2048	30	82	114	253
2049	31	84	114	253
2050	32	85	116	260

TABLE A-2: ANNUAL SC-CH_4, 2020 - 2050 (IN 2020 DOLLARS PER METRIC TON OF CH_4) DISCOUNT RATE AND STATISTIC

Emissions Year	5% AVERAGE	3% AVERAGE	2.5% AVERAGE	3% 95 PERCENTILE
2020	670	1500	2000	3900
2021	690	1500	2000	4000
2022	720	1600	2100	4200
2023	750	1600	2100	4300
2024	770	1700	2200	4400
2025	800	1700	2200	4500
2026	830	1800	2300	4700
2027	860	1800	2300	4800
2028	880	1900	2400	4900
2029	910	1900	2500	5100
2030	940	2000	2500	5200
2031	970	2000	2600	5300
2032	1000	2100	2600	5500
2033	1000	2100	2700	5700
2034	1100	2200	2800	5800
2035	1100	2200	2800	6000
2036	1100	2300	2900	6100
2037	1200	2300	3000	6300
2038	1200	2400	3000	6400

Emissions Year	5% AVERAGE	3% AVERAGE	2.5% AVERAGE	3% 95 PERCENTILE
2039	1200	2500	3100	6600
2040	1300	2500	3100	6700
2041	1300	2600	3200	6900
2042	1400	2600	3300	7000
2043	1400	2700	3300	7200
2044	1400	2700	3400	7300
2045	1500	2800	3500	7500
2046	1500	2800	3500	7600
2047	1500	2900	3600	7700
2048	1600	3000	3700	7900
2049	1600	3000	3700	8000
2050	1700	3100	3800	8200

TABLE A-3: ANNUAL SC-N_2O, 2020-2050 (IN 2020 DOLLARS PER METRIC TON OF N_2O) DISCOUNT RATE AND STATISTIC

Emissions Year	5% AVERAGE	3% AVERAGE	2.5% AVERAGE	3% 95 PERCENTILE
2020	5800	18000	27000	48000
2021	6000	19000	28000	49000
2022	6200	19000	28000	51000
2023	6400	20000	29000	52000
2024	6600	20000	29000	53000
2025	6800	21000	30000	54000
2026	7000	21000	30000	56000
2027	7200	21000	31000	57000
2028	7400	22000	32000	58000
2029	7600	22000	32000	59000
2030	7800	23000	33000	60000
2031	8000	23000	33000	62000
2032	8300	24000	34000	63000
2033	8500	24000	35000	64000
2034	8800	25000	35000	66000
2035	9000	25000	36000	67000
2036	9300	26000	36000	68000
2037	9500	26000	37000	70000
2038	9800	27000	38000	71000

Emissions Year	5% AVERAGE	3% AVERAGE	2.5% AVERAGE	3% 95 PERCENTILE
2039	10000	27000	38000	73000
2040	10000	28000	39000	74000
2041	11000	28000	39000	75000
2042	11000	29000	40000	77000
2043	11000	29000	41000	78000
2044	11000	30000	41000	80000
2045	12000	30000	42000	81000
2046	12000	31000	43000	82000
2047	12000	31000	43000	84000
2048	13000	32000	44000	85000
2049	13000	32000	45000	87000
2050	13000	33000	45000	88000

9. Appendix B: Recommended ACT Interim Values for the Social Cost of Carbon

This Appendix lists the interim values for the Social Cost of Carbon (per metric tonne CO_2) recommended by the ACT Climate Change Council for all ACT Government decision-making beginning in the fiscal year 2022-23. Values are in 2020 AUD.

TABLE A-3: ANNUAL SC-N_2O, 2020-2050 (IN 2020 DOLLARS PER METRIC TON OF N_2O) DISCOUNT RATE AND STATISTIC

Emissions Year	AUD PER TONNE CO2 EMITTED 2% SOCIAL DISCOUNT RATE
2020	200
2021	202
2022	204
2023	207
2024	209
2025	211
2026	213
2027	215
2028	217
2029	220
2030	222
2031	224
2032	226
2033	228
2034	230
2035	233

Emissions Year	AUD PER TONNE CO2 EMITTED 2% SOCIAL DISCOUNT RATE
2036	235
2037	237
2038	239
2039	241
2040	243
2041	246
2042	248
2043	250
2044	252
2045	254
2046	256
2047	259
2048	261
2049	263
2050	265