allowed us to decompose and thereby examine the contributions of each of the individual changes they made to the DICE model. In version A, we replaced their modifications of the exogenous state variable forecasts with ones that matched the original DICE2007 forecasts at the end of each 10-year period. Specifically, we linearly interpolated between the decadal time-steps of the exogenous scenarios for total factor productivity growth, carbon emissions from land changes, and carbon intensity of production used in DICE2007. In version B, we also removed the modification Cai *et al.* made to the radiative forcing function. In version C, we re-calibrated the carbon cycle and temperature response function parameters using an annual time-step to maintain the intended behaviour of the climate component of DICE2007 and its ability to match the original forecasts from MAGICC.

Figure 1 presents the optimal tax path for all five versions: DICE2007, Cai *et al.*, A, B and C. Comparing Cai *et al.* with A indicates that their modification of the exogenous state variable forecasts reduces the optimal tax path by a small amount (an average of 2% over the time period shown in the figure). Contrasting A with B indicates that the modification Cai *et al.* made to the forcing function also reduces the optimal tax path by a small amount (an average of 4%). Finally, comparing B with C indicates that the failure of Cai *et al.* to re-calibrate the carbon cycle and temperature response parameters appropriately when moving from the decadal to the annual time-step reduces the optimal tax path by roughly 37% on average. Therefore, this change in the simulated behaviour of the climate system — and not the integration error associated with the size of the time step — seems to be the main source of the roughly 50% deviation in the optimal tax path found by Cai *et al.*

We are not attempting to defend all aspects of the simplified climate modelling in DICE, which fails to capture certain features of the Earth system dynamics that could have important implications for climate policy[6]. However, in light of the results of Cai *et al.* and their potential policy implications, it is important to understand the real effect that the choice of the time step in DICE has on the model's results — which, as shown above, is minor. ❐

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Additional information

Supplementary information is available in the online version of the paper.

Disclaimer

The views expressed in this article are those of the authors and do not necessarily reflect the views or policies of the US Environmental Protection Agency.

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CORRESPONDENCE:

Australia's falling emissions

To the Editor — Six months after Australia's carbon pricing mechanism came into effect there has been an 8.6% reduction in emissions from the electricity sector[1]. Not surprisingly, most of this reduction has come from factors not directly related to the introduction of a price on carbon. Scheduled curtailment of coal-fired generators along with the shutdown of much of a major brown-coal generator due to flooding has reduced emissions intensity. Decreased electricity demand from lower manufacturing output and continuing energy efficiency measures have also played a part.

But it has been the contribution from residential photovoltaic (PV) panels that has surprised many. In 2011–2012, solar PV is estimated to have generated 0.9% of energy in Australia, playing an important role in the observed emissions reduction[2].

Although this is a small percentage of overall demand, it needs to be considered in terms of Australia's PV capacity five years ago. In 2008, Australia only had 23 MW of installed PV capacity[3]. Following the introduction of generous subsidies, combined with a substantial drop in the price of equipment, the rate of PV installation increased dramatically. Australia now has more than 2 GW of PV capacity, forecasted to generate 2,473 GW h or 1.3% of national annual electricity in 2012–2013[2].

As retail electricity prices continue to increase across Australia — and with PV approaching parity with main grid prices in some locations — PV systems can now achieve payback periods within 10 years for residential applications. The commercial uses for PV are largely unrealized, but represent significant opportunities for growth, as larger systems can be deployed more cost effectively, and load during the day can be more closely matched to generation.

Within the next 10 years, it has been estimated by Australia's Energy Market Operator that PV could provide 3.4% of annual electricity in Australia based on medium growth projections[2]. And this could be a conservative estimate. An analysis by investment bank UBS in early 2013 suggests that electricity demand could be reduced by up to 9% by 2020 in the key solar markets of Germany, Italy and Spain[4]. PV deployment on this scale will represent a significant drop in emissions, as this demand would no longer need to be met by the centralized energy market.

This is all occurring as new PV technologies are progressing through the pipeline. In Australia, one focus of the national science agency is on cheap modules of printable organic thin-film PV panels. Other technologies enabling widespread uptake, such as battery storage, are on the cusp of a rapidly declining price trajectory. These are just some of the examples of 'game-changers' in making PV generation available on a mass-market scale. And although this may result in cheap, grid-independent electricity for customers, ubiquitous global PV will also be doing so much more for the world's targets for climate change mitigation. ❐

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