THIS WEEK

EDITORIALS

CLIMATE Seals on South Georgia show response to global warming **p.384**

WORLD VIEW Chile needs better scientific governance now **p.385**

PIGEON Museum bird specimen is dead like a dodo **p.387**

The wrong kind of carbon cut

The repeal of Australia's carbon-pricing scheme — the first time a nation has reversed action on climate change — sets a worrying example for other countries mulling steps to reduce emissions.

Climate politics tends to frustrate those convinced that action is needed to halt global warming, but 2014 has seen the stirrings of optimism once again. The European Union (EU) and the United States have both announced concrete plans to curb emissions beyond 2020, and China has signalled a growing willingness to tackle pollution seriously at home and find ways to take part in a binding international climate agreement scheduled to be signed in Paris next year.

So how much does Australia's decision to scrap its carbon-pricing scheme after just two years matter? As we report on page 392, the move was expected and may not directly affect the odds of reaching a meaningful international agreement in 2015 — but it does threaten to undermine the political momentum that has been building up and that must be sustained if the world is to get its act together on the key environmental issue of our time.

A growing body of research indicates that parts of Australia, already plagued by frequent heat, drought and floods, are excessively vulnerable to climate change and its effect on extreme weather. But the nation has also gained symbolic significance in the global debate (and dispute) over the policy and economics of climate change. Climate issues tend to have an enormous influence on domestic policy-making in Australia — from the 1997 Kyoto Protocol (Australia's late signature helped to push it into effect) and the ill-fated 2009 Copenhagen climate summit, to the ongoing debate over cap-and-trade and carbon pricing. Discourse and political battles Down Under can serve as a preview of what is coming up in the greater climate-policy arena.

So are carbon taxes and emissions-trading schemes doomed? Certainly not. Economists have consistently recommended carbon pricing as the most effective way to tackle climate change. And the market-based mechanisms that have been established in Europe, North America and, increasingly, Asia, have by and large helped to control emissions and to stimulate innovation of clean-energy technologies.

Some schemes certainly function better than others. The EU's mandatory emissions-trading system for about 12,000 large industrial emitters is hampered by loopholes and market failures that prevent it from being more efficient. But with reforms under way — emissions allowances are increasingly being auctioned rather than allocated free of charge — the system will remain the cornerstone of EU climate policy.

Australia's scheme, which involved a mere 350 companies, also proved relatively effective in reducing emissions during its short life. Its repeal, and the political circumstances that spurred the move, might seem a bizarre tale of missed opportunity.

Champions of carbon taxes tend to ignore that although people in democratic societies are willing to pay for environmental policies, they are willing to pay only so much. Prime Minister Tony Abbott has politically capitalized on that iron law, rather than taking a risk on telling voters that the modest price they did pay for the scheme is a much-needed investment in the future of their children. But politics is not rational, and future generations are not today's voters. Australia's decision highlights the crude reality that political decision-making does not necessarily follow the logics of science and economics. Politics tends to follow short-term consumer preferences that are all too easily influenced and confused by the power and money of carbon producers. Australia, one of the world's richest countries and a leading per capita carbon emitter, must do more to reassure the rest of the world that it is ready to join global efforts to tackle climate change. If it does not, it would send a devastating signal to rising economies such as China that will play a key part in negotiations leading up to an international climate agreement. These nations must be involved in global climate action, but they will hardly be persuaded to sign up if an industrial power the size of Australia falters.

"Political decision-making does not necessarily follow the logics of science and economics."

The opportunity for the Australian government to prove its determination is not far off: by April 2015, some nations including Australia are supposed to lay on the negotiating table their offers for the climate conference in Paris in December next year, so that others have enough time to scrutinize the numbers. Australia's current emissions-reduction goal — 5% below 2000 levels by 2020 — is not just modest, it is an affront.

Abbott has won a political battle at home — but to be taken seriously abroad, he must show that he wants to serve his nation more than he wants to appease the fossil-fuel industry. ■

Fusion furore

Soaring construction costs for ITER are jeopardizing alternative fusion projects.

Fusion energy promises to combine the benefits of renewable resources — clean, carbon-free electric power — with the best qualities of fossil fuels: power day and night, without regard for the vagaries of weather.

The reality is much messier. Fusion power demands heating certain isotopes of hydrogen or other light elements to hundreds of millions of kelvin until they form ionized plasma. The plasma is contained by magnetic fields in a toroidal (doughnut-shaped) chamber until the nuclei fuse and convert mass into energy.

Physicists have struggled to harness fusion for more than six decades. Only in 2006 did an international consortium sign an agreement to start work on ITER, the first reactor designed to 'ignite' fusion plasma such that it will be able to sustain its burn and generate

more energy than it consumes. ITER has been under construction since 2010 on a site next to the Cadarache nuclear-research facility north of Marseilles, France, but building costs have soared to roughly US$50 billion — 10 times the original figure — and the schedule has slipped by 11 years. Instead of 2016, ITER is expected to start its first burning-plasma experiments in 2027— but only if the ITER team can solve technical challenges. ITER's plasma chamber follows the tokamak design that has dominated fusion-energy research since the 1970s. Multiple magnetic coils, fuel injectors and the like make tokamaks large and complex.

Even more problematic is the fusion fuel that ITER will ultimately use: a mix of the hydrogen isotopes deuterium and tritium. The mixture has the virtue of igniting at just 100 million kelvin, lower than other potential fuels, but it also produces most of its energy as neutrons, which will damage the reactor walls — and make the reactor radioactive, producing another nuclear-waste-disposal problem.

Given these realities, the prudent course for the world's funding agencies would be to support research into alternative fusion fuels, such as deuterium–helium-3 or proton–boron-11 — which require higher temperatures to ignite, but produce very few neutrons — as well as alternative reactor designs that would be simpler, cheaper and more in line with the kind of plant that power companies might buy (see page 398).

But that is not happening, because of ITER. The treaty that set up the project requires each of the seven ITER Organization members (the European Union, China, India, Japan, Korea, the Russian Federation and the United States) to contribute a fixed portion to the cost of construction — whatever that happens to be. Overruns have left fusion programmes with little cash for anything but ITER and the research efforts that support it.

The European Union, responsible for 45.5% of the cost, has been able to keep up by moving money from other projects. But the 9.1% borne by the United States, which historically has been by far the most willing to fund alternative concepts, could not have come at a worse time for the nation. In 2009, as ITER's costs increased, fusion-programme managers in the US Department of Energy were told by the administration of President Barack Obama that they would have to fulfil their share of ITER from a flat budget. In the ensuing crunch, nearly all the department's alternative fusion-research programmes have been cancelled.

Congress is furious. This year, the Senate voted to cancel the US contribution to ITER in fiscal year 2015, although the House of Representatives voted to maintain that contribution by boosting the fusion budget. Those contradictory decisions will have to be reconciled in the final budget. But in the meantime, following a congressional mandate in last year's budget resolution, the energy department has convened a panel of scientists to devise a ten-year strategic plan for fusion-energy research — something the agency has not had for many years.

"ITER promises to provide insights that will be invaluable in any future power reactor."

Both of these activities provide openings for Congress and the energy department to restore some of the funding for alternative fusion research. Academic projects worthy of consideration include a radically simplified design for a fusion power reactor developed by Thomas Jarboe and his group at the University of Washington in Seattle: they believe that it could be built for about one-tenth of the cost of a tokamak. And among the small fusion start-up companies worth considering for a federal small-business grant is Lawrenceville Plasma Physics in Middlesex, New Jersey, which is trying to exploit a configuration known as a dense plasma focus to build an extremely compact reactor that does not emit neutrons.

And ITER? For all its problems, ITER promises to provide scientists with key insight into the physics of burning plasmas — insight that will be invaluable in any future power reactor, whatever its design. On balance, assuming no more major delays or cost surprises, the United States and the other partners should continue their support for ITER — but they must not allow it to drive fusion energy into a dead end. ■

A fate sealed

Exploring how species adapt to climate change requires long-term studies, not snapshots.

As the world warms, fish can swim north and butterflies can head to higher ground, but what is a 2-metre-long, 200-kilogram Antarctic fur seal stranded on a remote island to do? More to the point, what are several million of them to do?

The common refrain for species facing climate change is that they must migrate or adapt — or perish. Some, such as trees, will find it difficult to move their ranges quickly enough. And others, including polar bears, already live at the limit of their habitable range, so have nowhere to go.

Adaptation is nature's best response to a crisis: after all, evolution and natural selection have been turning niche problems into opportunities for billions of years. It is no coincidence that people who are opposed to action on curbing carbon emissions talk up humanity's ability to adapt as if it were a deliberate choice of action; some species just make it look so easy.

But adaptation is not as simple as it looks, especially if future generations are to benefit from the changes. As a special issue of the journal *Evolutionary Applications* made clear in January (see go.nature.com/8pruey), researchers too often infer that a species is responding to threats such as global warming through genetic evolution, just because the change seems to be the right thing for that species to do in the circumstances. Of course it would seem intuitive that a particular sea bird has evolved to be smaller with climate change: a warmer world saps less of the bird's internal warmth, so it can be lighter — right?

Not always. As a study on page 462 of this issue makes clear, the situation is often more involved than that. Back to the Antarctic fur seals (*Arctocephalus gazella*) on that remote island, the polar outpost of South Georgia. On the front line of exposure to rising temperatures and with little scope for migration, the fur seals seem a prime example of a species that must adapt to survive, and quickly. Sure enough, as a genetic analysis of the population over the past few decades indicates, breeding female seals have become more heterozygous — a standard measure of Darwinian fitness and of an individual's resilience in the face of environmental adversity.

Again, this simple narrative is intuitive: of course the seals would respond to stressful conditions with greater genetic capacity to deal with them.

Why, then, has the study found that the fur-seal population is shrinking? Heterozygosity is valuable, but not heritable. The average heterozygosity of the seal pups being born has not changed. But the number of less-heterozygous pups that survive to breed has declined — the less fit are being weeded out as expected. The survivors are older when they breed and do so less often than in previous decades, which contributes to the observed 25% reduction in the population.

What is driving this effect? Climate change, or its proxy of locally changed weather patterns, seems to have an indirect role. Models suggest that weather changes reduce the availability of the seal's preferred food, Antarctic krill. So too, however, could altered fishing practices and the recovery of whale numbers.

What is a seal to do? The answer is more complicated than it seems. But so is the question. ■

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