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Original research article

# The great energy transition of the 21st century: The 2050 Zero-Carbon World Oration<sup>☆</sup>

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## ABSTRACT

Looking back from 2050, this article is written in the form of a speech reflecting on the great energy transition of the 21st Century. The central questions addressed in the speech are:

- How, despite facing so many tough ecological, economic and political challenges, have we made such remarkable progress over the last 30 years towards the creation of a zero carbon economy?
- What have been the key turning and tipping points – the key events, decisions and actions – that have driven the global energy transition at such remarkable speed and scale?
- What actions do we need to take to keep repairing the damage caused by the failure of nation states to reduce emissions with sufficient urgency in the first quarter of the 21st Century?

## 1. Introduction

Good evening. I am delighted to be with you tonight to deliver the *Zero-Carbon World Oration* for 2050. As you are aware this annual oration was inaugurated by the UN Secretary General in 2025 in order to inform and strengthen actions required to accelerate progress in creating a just and resilient zero carbon global economy.

In preparing tonight's 2050 Oration I have been acutely aware of the vision we are all seeing of the tragic loss of life from the most recent of the climatic catastrophes which continue to sweep across planet Earth – the Great Inundation of the Ganges Basin. I'm sure I speak for us all in expressing my profound sorrow and compassion for the many millions of lives overwhelmed by this terrible event.

The grim scenes we have seen in the cities and villages of India and Bangladesh over the last few weeks are one more stark reminder of the need to continue to accelerate progress in achieving our three crucial global priorities:

- creating and sustaining a just and resilient zero carbon economy;
- strengthening our capacity to efficiently and equitably sequester CO<sub>2</sub>; and
- protecting and assisting the individuals and communities most vulnerable to the ravages of our climatically disrupted world.

My task tonight however is to focus on the first of these great challenges by addressing three key questions.

- How, despite facing so many tough ecological, economic and political challenges, have we made such remarkable progress over the last 30 years towards the creation of a zero-carbon economy?
- What have been the key turning and tipping points – the key events, decisions and actions – that have driven the global energy transition at such remarkable speed and scale?
- What actions do we need to take to keep repairing the damage caused by the failure of nation states to reduce emissions with sufficient urgency in the first quarter of the 21st Century?

I'd like to begin by sharing some brief observations on the way this challenge looked back in 2017 – at the beginning of the transition period. Following a summary overview of major energy transition trends and outcomes over the last 30 years I then move on to outline five key drivers of the great Energy Transition. My presentation concludes with some reflections on the significant challenges which still lie before us.

<sup>☆</sup> Transcript of the 2050 Zero-Carbon World Oration. Delivered by: Professor Teuila Apatu, Director, Global Institute for Climate and Energy Transitions, Auckland, Aoteroa New Zealand. This article is written in the form of a fictional speech delivered in 2050 by a fictional character 'Professor Teuila Apatu'. Other fictional characters referred to in the speech are also indicated in footnotes. The backcasting historical narrative of the 21st century energy transition described in the speech attempts to describe one plausible narrative of the way in which a rapid energy transition might unfold, informed by a range of modelling and scenario studies.

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## 2. Turning the tide: from the Paris Agreement (2015) to the Jakarta Climate and Energy Summit (2025)

By 2015 the key elements of the post-carbon economy roadmap were well understood: rapid reduction in energy demand through improved energy efficiency and reduced consumption; comprehensive electrification of energy supply; rapid replacement of fossil fuels by renewables; low carbon agriculture and forestry; carefully managed bio-sequestration; and the actions needed to ensure that the energy transition was undertaken in an equitable and resilient way [1].

There was also widespread recognition that the most significant roadblocks preventing rapid de-carbonisation were social and political rather than technological. These roadblocks included:

- the power and influence of the fossil fuel industry and other vested interests;
- political paralysis and denial;
- social and technological path dependencies;
- financial, governance and implementation constraints; and
- the dominant neoliberal economic paradigm of unsustainable consumption and inequitable wealth distribution

I have two powerful memories from the period 2015–2017 which I'd like to share with you. The first, in Paris in December 2015, was a moment of genuine elation as I joined thousands of delegates in leaping to my feet to applaud the announcement by COP 21 Chair Laurent Fabius that 195 nations had approved the Paris Agreement [2].

Most of us at the time recognized that the Paris Agreement was far from perfect, sharing journalist George Monbiot's astute analysis that "by comparison to what it could have been, it's a miracle. By comparison to what it should have been, it's a disaster." [3]. We very well understood that the COP21 national emission reduction commitments would need to be rapidly strengthened if we were to have any hope of keeping global warming below 2°. Indeed, many of us were also increasingly aware that a strong emphasis on negative emissions would be required to have any real chance of keeping global warming to 1.5 or even 2°.

We were, however, hopeful that ratifying the Paris Agreement would send a powerful message to political leaders and global investors that the rapidly accelerating global shift from fossil fuels to renewable energy was now unstoppable. As a young climate activist I also remember being struck by a conversation with the UNFCCC Secretary at that time, Christiana Figueres, who highlighted the ways in which the Paris Agreement signaled a shift in the locus of power from nation states to sub-national governments and cities as well as to civil society, business and research communities.

My second, far more traumatic memory came only twelve months later, in November 2016, at COP22 in Morocco. I vividly recall the shocked faces of delegates receiving the news that Donald Trump had been elected President of the United States. To what extent, we wondered, would the election of this autocratic champion of climate change deniers and fossil fuel billionaires derail climate and energy action at the very moment at which it needed to be rapidly accelerated? Of even more concern, would the Trump Presidency drive a further deterioration in the erosion of trust in scientific methods and evidence? Reflecting back on this extremely challenging historical moment led me to reread some of the publications which I remember finding particularly useful at that time. I'd like to share a few observations from three of these.

The 2015 Report, *World in Transition: A Global Social Contract for Sustainability* produced by the German Advisory Council on Global Change brought together a broad array of research and analysis on the sources and drivers of large scale technological, social and economic transformations [4].

I remember being particularly struck by the Report's conclusion that "avoidance of dangerous climate change, and the aversion of other

threats to humankind as part of the Earth system" would need to go "far beyond technological and technocratic reforms" and would in fact require the creation of "a new global social contract for a low-carbon and sustainable global economic system." This new social contract, the Report argued, would in turn require the creation of a "culture of attentiveness (born of a sense of ecological responsibility), a culture of participation (as a democratic responsibility), and a culture of obligation towards future generations (future responsibility)." [5].

The 2016 *World Energy Scenarios* Report produced by the World Energy Council reminded us, on the other hand, just how hard it might be to bring about the political, economic and technological transformations required to actually construct and sustain such a social contract [6]. None of the scenarios outlined in this report envisaged emissions reduction pathways fully consistent with a 1.5C global temperature rise. They did however provide a provocative and prescient tool for understanding how the next 35 years might unfold. The 2016 Report proposed the following three energy transition scenarios.

- *Hard Rock*: The outcome in 2060 is a fractured world, with a diverse set of economic, energy and sustainability outcomes. Nationalist interests prevent countries from collaborating effectively on a global level, with limited attention to addressing climate change.
- *Modern Jazz*: The outcome in 2060 is a world with a diverse set of resilient and lower-carbon energy systems. A highly complex and competitive market landscape drives efficiency, innovation, open access to information and rapid deployment of new technologies.
- *Unfinished Symphony*: By 2060, the world is 'ticking on the same clock' and has shifted to a resilient, integrated, global low-carbon energy system. There is global unified action on security, environmental and economic issues, and global institutional and national governments support enabling technologies [7].

Informed by an increasingly sharp understanding of the urgency of the emission reduction task, many climate and energy researchers also focused closely on the speed with which large scale energy transitions could occur [8]. While the dominant view rightly noted the long timeframes generally required for large scale energy system transitions, we were also keen to learn from historical examples of relatively rapid technology transition narratives – the shift from horse power to the internal combustion engine for example or the extraordinary explosion in the use of mobile phones [9].

In fact, as we now know, the energy transition of the last thirty years can best be understood as a fiercely contested, uneven and incomplete journey from 'Hard Rock' through 'Modern Jazz' to 'Unfinished Symphony'. As the great Indonesian energy and climate visionary, President Asoka Hartano,<sup>1</sup> noted in her opening speech to the 2025 Jakarta World Climate and Energy Summit:

"Many commentators at the time saw the Trump/Pence Presidency as heralding the final triumph of globalized fossil fuel corporations overseeing a fractured, feudalised world of nuclear armed kleptocracies. We can now see that this was, in fact, the last gasp of a dying world order. The financial, technological and political momentum driving the shift from fossil fuel world to a clean energy economy was too great. The divisions between the champions of the old and new economy were too deep. The political resistance of the Climate Emergency and Energy Justice movements was too determined. This great gathering, to be known from here on as *Jakarta 2025*, will, I believe, be seen as a game changing tipping point in the transition to a new earth system informed by a profound sense of responsibility to all human beings of current and future generations; to other species and to the Earth's ecology which sustains us all."

The third document I'd like to refer to is *A Roadmap for Rapid*

<sup>1</sup> President Asoka Hartano is a fictional character.

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