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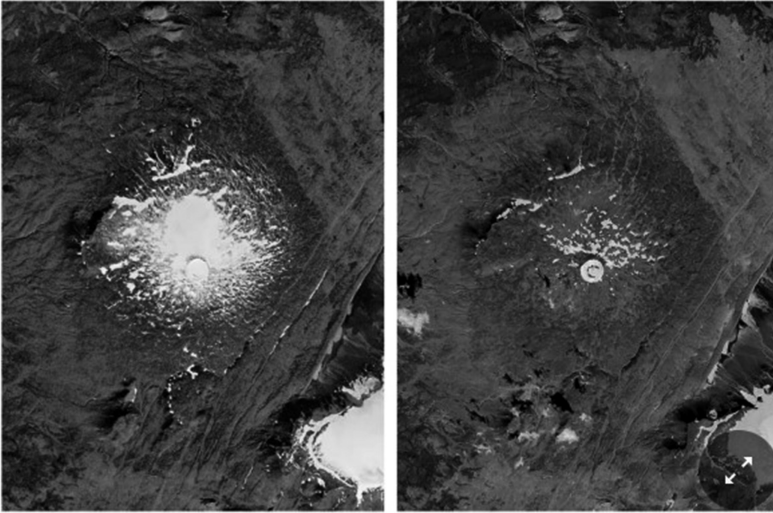
Climate Change—It Is Upon Us



IN 2019, ICELAND hosted a unique ceremony—a funeral to mark the death of its first glacier, Okjökull, killed due to climate change. Though the glacier had already been dead for ten years, Iceland decided to hold the funeral only recently to warn everyone about the devastating impact of climate change.

Around a hundred years ago, Okjökull spanned 38 square (sq) km, which is equivalent to the size of around 6,000 soccer fields. In the next fifty years it shrank to 5 sq km, and in another fifty years it was completely gone. It is estimated that in 200 years, all of Iceland's glaciers will disappear. This might just happen sooner if the world continues to emit carbon at the current rate. To further emphasize this point, a plaque addressing future generations was put at the funeral site. It states: 'This monument is to acknowledge that we know what is happening and what needs to be done. Only you know if we did it.'

Figure 1: Shrinking of Okjökull glacier in Iceland (1986–2019)¹



Photographs: 14 September 1986 (left) and 1 August 2019 (right)—provided by NASA, show the shrinking of the Okjökull glacier. NASA, via Associated Press.

While the death of the Okjökull glacier took over a century to happen, a few recent catastrophic events warn us that the pace has changed. These events just arrive and are upon us with no warning, sometimes at a scale that is staggering and devastating. They have no respect for borders, human or animal life, time of the year, the economic situation, or any of the things that we consider important. These events remind us that we are living in an age of climate transition that is beginning to impact us in a multitude of dangerous and unpredictable ways.

For instance, consider the Atlantic hurricanes that hit Texas, the Caribbean and Dominica in 2017. Harvey, Irma and Maria may sound like average names but the ferocity of these hurricanes was a first, as

¹ Holson, L. (19 August), 'Iceland Mourns Loss of a Glacier by Posting a Warning About Climate Change,' *The New York Times*, 2019.

per hurricane records kept since 1851. Harvey struck the southern US coast with maximum speeds of 215 km/h between 17 August and 3 September.² Irma struck Florida, also in southern US, between 30 August and 16 September at speeds of 295 km/h, and Maria sprang the knock-out punch on the US territory of Puerto Rico in the Caribbean, between 16 September and 3 October, at 280 km/h.

That season of utter destruction is considered the costliest on record, with a preliminary total of nearly 200 billion in damages to the Caribbean islands and parts of the US coast. It is one of only six hurricane seasons on record to feature multiple Category 5 hurricanes—the worst case scenarios of nature’s fury. A Category 5 hurricane has 500 times the power of a Category 1 hurricane.³ As of 2017, only thirty-three Category 5 hurricanes had been recorded in the Atlantic since 1851 when hurricanes first began getting recorded. There were just ten hurricanes in the next 110 years, 1851–1961. But from 1961–1993 (a span of a mere thirty-two years) there were twelve, and in the next twenty-four years, 1993–2017, there were eleven such hurricanes. The frequency of severe storms has clearly increased in recent years.

Tying these hurricanes together was another element—torrential, deadly rain—as seen in the images on social media of drowned homes, overflowing sewage and dams. ‘We have not experienced an event of this magnitude in our modern history,’ said Puerto Rico Governor Ricardo Rosselló.⁴

The raging bushfires in Australia were another such example of a natural catastrophic event causing death, devastation and displacement not just of humans but also of animals in countless numbers. The

² Graczyk, M., and Bajak, F. (25 August), ‘Hurricane Harvey slams into Texas coast, bringing 215 km/h winds and heavy rains’, Associated Press, Global News, 2017.

³ Holthaus, E. (21 September), ‘This Is the Hurricane Season Scientists Tried to Warn Us About’, *Mother Jones*, 2017, web.

⁴ *The Washington Post* (20 September), ‘Hurricane Maria lashes Puerto Rico with force not seen in “modern history”’, 2017.

bushfires that began towards the end of 2019, and continued into early 2020, may have been directly caused by incidents of lightning and arson, but were fundamentally exacerbated by the hottest and driest Australian summer on record.

In the first week of 2020, the capital city of Australia, Canberra, and Sydney experienced the highest temperatures ever recorded in these cities. The wildfires have killed an estimated 1.25 billion animals,⁵ caused more than 100 billion worth of damage to the Australian economy,⁶ and released upwards of 900 million tonnes of CO₂-equivalent in emissions in the atmosphere⁷—all of which will continue to have a further negative effect on the Australian ecosystem.

All of these events are inextricably linked to climate change, and matters are only expected to get worse from here on out.

The year 2019 was also calamitous for India. We saw record floods and climate change-related events unfold through the length and breadth of the country. It was, in fact, the worst year for monsoon-related natural disasters in twenty-five years of record-keeping. From Bihar to Kerala, and Maharashtra to West Bengal, nearly every corner of the country faced the dire wrath of changing climate. And unlike the US or Australia, where poverty levels are not acute, in India the problem was amplified for government authorities planning rescue operations and evacuations, since the average Indian is less prepared to cope on her own when disaster strikes.

Consider what happened in Odisha at the onset of the 2019 monsoon season, for example. In May, that year, Cyclone Fani struck the Bay of Bengal at 185 km/h, severely impacting the states of Odisha and West Bengal, leaving behind a trail of destruction in both states. It was

⁵ World Wildlife Fund (13 January), 'Australia's devastating bushfires', WWF, Australia, 2020.

⁶ Roach, J. (8 January), 'Australia wildfire damages and losses to exceed \$100 billion, AccuWeather estimates', AccuWeather, 2020.

⁷ Rathi, A. and Millan Lombrana, L. (21 January), 'Australia's Fires Likely Emitted as Much Carbon as All Planes', Bloomberg, 2020.

one of the strongest cyclones to devastate India in the last two decades. According to a damage assessment report, more than sixty people lost their lives and 1.5 million people had to be evacuated from their homes in less than forty-eight hours.⁸ Despite the state's preparedness, early warning systems and timely action, the total damage and loss was estimated at more than \$3.5 billion.

Similarly in August 2019, due to incessant rains leading to floods in the state, 121 Keralites died and more than 2,00,000 had to be evacuated from flooded areas. The Kochi airport was shut down for three days due to severe waterlogging. That same month, the city of Vadodara in Gujarat saw 6,000 evacuations and many tragic deaths due to excess rain. The state of Karnataka was battered as well, and nearly seventy people died and around 7,00,000 had to be evacuated. Nearly 4,00,000 people were evacuated from the western-central region of Maharashtra too, and thirty people lost their lives there. Bihar, in the Gangetic plains, saw a similar number of deaths and evacuations. Even the Himalayan belt of Himachal Pradesh and Uttarakhand and the north-eastern region, including the states of Assam and Meghalaya, weren't spared.

In fact, there was not one state in the country that did not experience unseasonal extremities in weather that year—even the National Capital Region (NCR) of Delhi saw an unusual mix of dust storms and hail in 2019. According to a report by ASSOCHAM, the losses to the economy due to the heavy rainfall and storms in Delhi and surrounding areas could be around Rs 8,000-10,000 crore (approximately USD 1.1-1.4 billion). This estimate was based on the impact of the rains and storms on various sectors, including agriculture, real estate, transport and tourism.

All of this should make us wonder whether India is ready for what is to come in the years ahead. Are we prepared to manage the onslaught of extreme weather events that will result from the direct impacts of climate change?

⁸ Government of Odisha (2019), *Cyclone Fani: Damage, Loss and Needs Assessment*, Bhubaneswar, Odisha, pp. i-xxvi.

Choking to death in toxic air

It has been established that the extraction and burning of fossil fuels is the main source of CO₂ and other GHG emissions, which in turn have become a key driver of climate change. Less commonly known is that these emissions are also a major source of air pollution. Air pollution and climate change feed off each other. Air pollutants that are harmful to human health and ecosystems also contribute to global warming and climate change through the greenhouse effect.

In the past few years, India has been lauded as the world's fastest-growing economy in various international forums. Yet, winter after winter, India's cities (mostly northern) have been topping the charts for highly toxic air pollution levels. In the past few years, air pollution data released by the World Health Organization (WHO) has placed India way above and firmly beyond the pollution levels achieved by other countries. Based on WHO's 2018 rankings, India is home to nine of the world's ten most polluted cities.⁹

Globally, in 2018, WHO ranked Kanpur as India's most polluted city, followed by Faridabad and Gaya. Delhi ranked sixth on this list. The situation is grim across all of north India. Ghaziabad, Kanpur, Varanasi, Gaya, Patna, Lucknow, Agra, Muzaffarpur are located in India's most populated and poorest, albeit agriculturally and politically active, states of Uttar Pradesh and Bihar. The cities of Faridabad and Gurgaon, located in the fast-industrializing yet primarily agrarian state of Haryana, adjoin Delhi. Jaipur and Jodhpur are among the most polluted cities in the nearby state of Rajasthan. Srinagar, yet another pollution hotspot which is by no means an industrial city, lies in the northern Himalayan union territory of Jammu and Kashmir.

In December 2018, the venerable peer-reviewed journal *The Lancet Planetary Health* published a study with the key takeaway that India's toxic air had claimed 1.24 million lives in 2017—one in every eight of the

⁹ WHO Global Ambient Air Quality Database (updated in 2018), <https://www.who.int/airpollution/data/cities/en/>

country's total recorded deaths.¹⁰ Read that again. One in every eight deaths in 2017 in India was caused directly or indirectly by the effects of air pollution.

In the last two years, India has not made much significant progress. As per the latest rankings released by the Swiss air quality technology company IQAir,¹¹ twenty-one of the top thirty polluted cities are in India.

For perspective, the Air Quality Index (AQI) readings in the New Delhi area routinely touch 999. The prescribed upper limit for good air quality is 50—beyond this, the air becomes increasingly unhealthy to breathe. India's air, in many ways, therefore, is twenty times worse than the globally accepted standard for good air. More than 800 million people are exposed to this level of poor air around the country. All of this takes an economic toll on the nation as well. A study released by the World Bank in 2016 showed that India lost more than 8.5 per cent of its gross domestic product (GDP) to air pollution in 2013, owing to the cost of increased healthcare.¹² At India's nominal GDP of \$2.94 trillion for 2018, the loss was nearly a quarter of a trillion dollars.

The connections: climate, pollution, energy, food and water

Climate change may not have been the sole cause that led to the unprecedented fury of the Atlantic hurricanes, the raging wildfires that choked Australia, or the cyclones and torrential rains that repeatedly

¹⁰ *Lancet Planetary Health* (1 January), 'The impact of air pollution on deaths, disease burden, and life expectancy across the states of India: The Global Burden of Disease Study 2017', 2019, Vol. 3, Issue 1, E-26 to E39, [https://doi.org/10.1016/S2542-5196\(18\)30261-4](https://doi.org/10.1016/S2542-5196(18)30261-4)

¹¹ Regan, H. (25 February), '21 of the world's 30 cities with the worst air pollution are in India', *CNN*, 2020 <https://edition.cnn.com/2020/02/25/health/most-polluted-cities-india-pakistan-intl-hnk/index.html>

¹² Jain, D. (9 September), 'Air pollution cost India 8.5% of its GDP in 2013: study', *Live Mint*, 2016, <https://www.livemint.com/Opinion/AU3JZ499V8mJKHbUEZEDmO/Air-pollution-cost-India-85-of-its-GDP-in-2013.html>

punished India, or even some of the indirect tectonic shifts that have taken place in politics around the world (caused due to weather-led crises and catastrophes). However, the science is clear—rising average temperatures are a causal factor for huge storms like Harvey, Irma and Maria, and for the Australian bushfires. And this has all kinds of second and third order effects on life, property, economics and politics.

The physics is straightforward. Higher temperatures are warming up the seas, and the energy available in sea water rises exponentially as it warms. Hurricanes convert heat energy into wind energy, ergo, the greater the heat energy, the stronger, larger and rainier the hurricane/cyclone, and monsoon. In the case of Cyclone Fani the temperature of the Bay of Bengal, as the cyclone was forming, was 1 degree centigrade higher than the usual long-term average in the area.¹³ This increased the cyclone's intensity when it hit India's coastline, especially the coastal state of Odisha where it made landfall.

The Intergovernmental Panel on Climate Change (IPCC), a United Nations body founded in 1988, notes that the oceans have retained more than 90 per cent of the excess energy generated by global warming since 1970. If the current trend of climate change continues, there's no getting away from extreme weather events—they will only increase.

Dirty coal and oil are the main contributors towards global warming and climate change. They are also the main sources of energy for the rich, industrialized countries. The need for their cheap and reliable availability and transportation is perhaps the largest cause for war and conflict across the world.

The outcomes: riots, uprisings and tyranny

Discontent in Arabia

The Arab Spring (2010–11) was, as one news headline put it, 'A revolution of the hungry'.¹⁴ I would say that it was not just 'a revolution

¹³ See maps and images depicting sea-level temperature rise in the Bay of Bengal in the article, 'Fani threatens India' on NASA Earth Observatory website: <https://earthobservatory.nasa.gov/images/144992/fani-threatens-india>

¹⁴ Cambanis, T. (23 August), 'The Arab Spring was a revolution of the hungry',

of the hungry' but also a revolution of the thirsty, a good example of the energy-food-water nexus.

Our history books tell us that the Fertile Crescent, the area that stretches from the Egyptian Nile to the mouth of the Tigris and Euphrates, is where agriculture began—where wheat, lentils, chickpeas, olives and even sheep and goats were first cultivated. Today, the states in and around that region are the world's largest net importers of food and depend on North America, Europe and Central Asia for the same. Food is expensive, people are poor, and repressive regimes rely on imported wheat financed through foreign aid.

Why is this so? The MENA—Middle East and North Africa—region is the world's most water scarce region, with average annual per capita renewable water resources amounting to only 340 m³, and annual rainfall averaging a mere 235 mm. The world average for these figures is 1,000 m³ and 800 mm, respectively. The MENA is also a region with a fast-growing population. It is a given that bread riots will bubble up with any disruption in the global food supply, when there's a drought, or when global oil prices fall making grain imports more expensive.

On 17 December 2010, Mohammed Bouazizi, a twenty-six-year-old street vendor in the small Tunisian city of Sidi Bouzid set himself on fire in front of the governor's office. Al Jazeera reported that earlier in the day, the police had confiscated his cart and beaten him because he did not have a permit.¹⁵ He went to the governor's office to file a complaint, but was ignored by the workers. Bouazizi then acquired a gasoline can from a nearby gas station and returned to the governor's office. Less than an hour after his confrontation, Bouazizi doused himself in gasoline and set himself alight. He suffered 90 per cent burns and, despite the

The Boston Globe, 2015, <https://www.bostonglobe.com/ideas/2015/08/22/the-arab-spring-was-revolution-hungry/K15SIkGeO5Y6gsJwAYHejI/story.html>

¹⁵ AFP report, (6 January) 'Tunisian protester dies of burns', Al Jazeera Media Network, 2011, <https://www.aljazeera.com/news/africa/2011/01/201115101926215588.html>

government's worried interest in the case after it went viral in the global media, succumbed to his injuries on 4 January 2011.¹⁶

Within hours of his death, protests began in Sidi Bouzid. Anger and violence swept the country fast and with such intensity that President Ben Ali and his family fled Tunisia on 14 January 2011. The protests quickly spread to several other Arab countries, notably Egypt, Libya, Syria, Yemen, Bahrain, Saudi Arabia, and Jordan. Abdou Abdel-Moneim Jaafar, a fifty-year-old restaurant owner, set himself alight in front of Egypt's parliament in Cairo, sparking off weeks of protest.¹⁷ Eventually, this triggered the resignation of Egyptian President Hosni Mubarak on 11 February 2011.

Most conflicts showing up in the mainstream news media highlight popular angst taking on oppressive rulers, populations at the receiving end of nature's vengeance, or countries trying to manage scarce reserves of energy, water or food. The fights can also be local, more so in densely-populated, poor countries such as India, where every unit of land, water, air, and forest is considered a prize that is either to be possessed or protected.

The more recent case of Venezuela

Venezuela is said to hold the world's largest supply of crude oil and natural gas—what once seemed like a perennial cash cow for the petro-state. However, today the country is running out of food, its currency (the bolivar) has plunged, inflation has soared, and its hospitals are overcrowded. Contributing in no small measure is the political crisis that has taken the nation into endless riots and killings. So what caused Venezuela's rapid descent into chaos? Opinions are divided on possible reasons, including misgovernance, subsidy-based state welfarism and

¹⁶ AFP report, (6 January) 'Tunisian protester dies of burns', Al Jazeera Media Network, 2011, <https://www.aljazeera.com/news/africa/2011/01/201115101926215588.html>

¹⁷ BBC News (17 January), 'A man sets himself on fire in Cairo protest', BBC, 2011, <https://www.bbc.com/news/world-middle-east-12204999>

even US-sponsored stoppage of technology transfer. But the consensus points towards the plunging price of oil, Venezuela's main revenue earner.

In 2014, the price of oil peaked at \$100 a barrel. This provided an economic incentive to producers, including large nation states, to use more sophisticated and expensive technologies to drill deeper in search of oil. At the same time, businesses and countries globally weren't buying more oil—at least, not from the traditional providers. New oil and gas from tar sands and shale from within the US and Canada suddenly and swiftly caused the global price to drop to \$26 in 2016, and the US went from being the world's largest importer of oil to becoming the largest producer.

When prices had peaked at \$100 a barrel in 2014, oil and oil products accounted for 95 per cent of the export earnings and 25 per cent of the GDP of Venezuela. Today, as oil hovers around \$40, Venezuela's income has been cut by a half to three-quarters.¹⁸ The government's earnings have dwindled, yet the state continues to subsidize food and other services for the poor. A plunging currency and runaway inflation have resulted in massive unemployment and income that buys little, not even food.

The oil collapse savaged Venezuela's economy and brought political tensions to a head in the form of a constitutional crisis, mass protests and, in recent times, looting and fatalities. On the night of 21 April 2017, the neighbourhoods of the working-class and the poor of Venezuela's capital Caracas, were engulfed in riots. Two days of demonstrations against Nicolás Maduro's government boiled over into clashes between his opponents and his government's National Guard. The demonstrators went on a rampage, burning tyres on the streets and looting stores. The 'acts of violence', according to the country's attorney-general's office, had left twelve people dead in a *barrio* (neighbourhood) where crowds of looters took on armoured vehicles.¹⁹ A protester was shot dead at

¹⁸ Gillespie, P., Brocchetto, M., and Newton, P. (30 July), 'Venezuela: How a rich country collapsed,' CNN Business, 2017, <https://money.cnn.com/2017/07/26/news/economy/venezuela-economic-crisis/index.html>

¹⁹ Kohut, M. (21 April), 'At Least 12 Die as Rioting Breaks Out in Venezuela', *The New York Times*, 2017.

the entrance to the city's largest *barrio*, the district mayor was quoted as saying.²⁰

But this was only the latest in a never-ending series of protests, riots, lootings and deaths that have bedevilled scarcity-struck Venezuela since 2013, the year that Hugo Chávez (president since 1999), died. A horrible slide for an oil-rich country that barely a decade ago was seen as a model for countries struggling to lift themselves from endemic poverty, inequality, hunger and illiteracy.

The vicious circle of the land-climate-water-food-energy-pollution nexus is upon us. In other words, the declining sources of energy and water supplies, coupled with pollution and climate change, are leading to food shortages that lead to political problems, that lead to energy inflation, that lead to food inflation, and eventually social upheaval and misery.

The oil-producing regions are surely facing extreme volatility, but it's time for the rest of the world—so dependent on imported and dirty fossil fuels—to accept the connections between energy, food, water, climate change, political/social unrest and wars (external and internal).

If the water in the Middle East dries up faster than expected, global oil supplies may decrease even faster than we anticipate as agitations take root in the affected regions. If climate change and pollution from fossil-fuelled automobiles and dirty coal-fired power plants are not kept in check, we will be condemning future generations to extreme hardship, ill health and misery. The time to build a more resilient water-conserving, post-oil, post-coal, post-nuclear, economy is now.

Action towards positive change

For decades, collective action on climate change has been eluding the world's governments. In conference after conference, pledges have been made on paper and in talks to initiate measures to reduce global warming. On the ground, the world's largest emitters and polluters have largely

²⁰ Kohut, M. (21 April), 'At Least 12 Die as Rioting Breaks Out in Venezuela', *The New York Times*, 2017.

ignored the agreements and treaties. Nevertheless, 12 December 2015 marked a major breakthrough.

On that day in Paris at the United Nations Climate Change Conference, or COP21, in an improbable show of unanimity, 195 countries signed a new global climate change agreement. Rich or poor, they agreed to voluntarily limit their GHG emissions to comply with a new benchmark. The COP21 agreement aims to keep warming, 'to well below 2 degrees centigrade above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 degrees centigrade above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change.'²¹

However, it retained a caveat—the COP21 agreement would not bind its member states until it had been ratified by the fifty-five parties that produced over 55 per cent of the world's GHG emissions. By February 2023, the Agreement has been ratified or acceded to by 194 states and the EU, which collectively account for more than 98 per cent of greenhouse gas emissions worldwide. This includes China and the United States, which are ranked first and second, respectively, in terms of CO₂ emissions among UNFCCC members.

Germany for instance, now consistently gets more than a third of its electrical power from renewable energy sources, such as solar, wind and hydro energy. On certain sunny and windy days, the share of renewable energy sources in Germany's power mix goes up to 85 per cent. The country aims to phase out its nuclear power plants by 2022, and has targeted renewable energy sources to meet 80 per cent of its gross power consumption by 2050.

In 2014, India set itself the target of installing 175 GW of renewable energy capacity by 2022, which includes 100 GW from solar, 60 GW from wind, 10 GW from biogas and 5 GW from small hydro-power. In round after round of tariff-based competitive bidding in India, solar

²¹ Report of the Conference of the Parties on its twenty-first session, held in Paris from 30 November to 13 December 2015, Paris Agreement, UNFCCC, 29 January 2016, <https://unfccc.int/sites/default/files/resource/docs/2015/cop21/eng/10a01.pdf>

and wind power tariffs have consistently been at around ₹2.75 per unit (3.9 US cents), lower than all other energy sources, even 'cheap' coal, which averaged over ₹5 per unit (7.1 US cents) for last tendered out new capacity. From the current 121 GW installed capacity, India's renewable energy capacity has been targeted by the government to increase to 175 GW perhaps even 500 GW by 2030. By then, the share of renewable energy is expected to at least quadruple, from the current 9-10 per cent, in India's electricity mix.

China leads the world in clean energy technologies, with five of the world's top six solar photovoltaic (PV) manufacturers, and seven of the top fifteen wind-turbine manufacturers. Not only is it investing nearly \$100 billion a year in domestic renewable energy projects, its overseas investment in green technologies, at nearly \$32 billion, is the world's largest.

Battery storage, considered even now the Achilles heel of solar and wind energy, is gaining traction. In March 2017, Tesla CEO Elon Musk successfully bet \$50 million with Australian billionaire Cannon-Brookes, that Musk's company could build a battery tank within a hundred days to solve South Australia's problem of frequent power blackouts. One such power blackout happened in September 2016 after a powerful storm, with 80,000 lightning strikes and two tornadoes, bringing down the state's power grid.²² Musk's wager was pooh-poohed by most. Tesla won the competitive bid in July 2017, the contract was signed on 29 September and the installation of the battery bank was finished by 23 November. The next day Cannon-Brookes tweeted that he had, 'never been more happy to lose a bet'.²³ After the final tests were concluded, operations began as scheduled, on 1 December.

²² Roberts, D. (20 December), 'Elon Musk bet that Tesla could build the world's biggest battery in 100 days. He won.' *The Vox*, 2017, <https://www.vox.com/energy-and-environment/2017/11/28/16709036/elon-musk-biggest-battery-100-days>

²³ Mike Cannon-Brookes @mcannonbrookes 24 November 2017: Thank you @elonmusk, Tesla's amazing Aussie team, @jayweatherill & all SA Never been more happy to lose a bet. 3x bigger than any in world! Huge step for Australia