CLIMATE COUNCIL

A WHOLE NEW WORLD: TRACKING THE RENEWABLES BOOM FROM COPENHAGEN TO PARIS

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Key Findings

1 The renewable energy landscape has changed dramatically since the last major global climate talks in Copenhagen in 2009.

- Plummeting costs and increasing jobs mean that there is a strong economic case for scaling renewable energy that wasn't clear in 2009.
- 4,700,000 new jobs have been created worldwide in renewable energy since 2009, while clean energy investment has grown by 50%.
- The price of solar photovoltaic (PV) modules has dropped 75% and wind power has fallen 30% over the last six years.
- The number of countries with renewable energy policy targets has almost doubled since 2009 providing a substantial driver for growing renewables into the future.

2 The Paris climate talks will accelerate further momentum in the global renewable energy boom.

- Countries' submissions and announcements in the lead up to Paris are locking in future growth in renewable energy.
- More than 100 countries mention renewable energy in their submissions as a component of emissions reduction actions or outcomes.
- Eight of the ten largest emitters have announced plans to scale up renewable energy in the lead up to the Paris climate conference, nearly doubling total annual renewable energy supply, more than tripling renewable electricity generation and nearly a four-fold increase in capacity by 2030.
- The commitments of Brazil, China, the European Union (EU), India, Japan and the United States heading into the Paris climate conference could see these major economies reach 36% renewable electricity generation in 15 years.

3 Renewable energy must expand even more rapidly to avoid the most dangerous impacts of climate change.

- It is incredibly clear that climate change is happening now, driving growing concern worldwide. For instance, in Australia, hot days have doubled in the last fifty years, heatwaves have become hotter, longer and occur more often and extreme bushfire weather has increased.
- Renewable and other zero or low emissions energy will need to triple or quadruple by 2050 to keep global temperature rise to less than 2°C.
- While commitments in the lead up to Paris represent a significant step up for global renewable energy, they are not yet enough to keep global temperature rise to less than 2°C. There will be a focus at the conference and beyond on the need to continually lift global efforts to get on track and transition to a renewable energy future.

1. Introduction

This is a tale of two conferences – and they couldn't be more different.

Six years ago 190 countries met in Copenhagen to discuss a global agreement on climate change. While the conference was widely dismissed as a failure, looking back from today's vantage point it helped accelerate a significant change in the global energy production and use from fossil fuels to renewable energy. Building on this momentum, the Paris climate conference will be another building block in the global renewable energy boom.

In Paris, at the end of November, again more than 190 countries will head into the United Nations Framework Convention on Climate Change (UNFCCC) 21st Conference of the Parties (COP21) with a shared goal to reach an agreement to keep global temperature rise to no more than 2°C above pre-industrial levels. A 2°C rise in temperature has long been considered a threshold that should not be crossed given the potential for catastrophic consequences. For instance, the threshold to trigger the melting of the Greenland ice-sheet, which would eventually raise sea level by about seven metres, inundating major cities worldwide, lies between a 1 and 4°C rise, with the risk increasing through that temperature range.

Burning fossil fuels (coal, oil and gas) for energy is an important contributing factor to climate change. Transitioning the global economy to renewable energy sources, like solar and wind, is a critical solution. The landscape for renewable energy has radically changed since the global climate talks in Copenhagen. There are three key differences:

Firstly, with rapidly falling costs and investment in renewable energy, a critical climate change solution has increased dramatically. Renewables have not only become more affordable, new wind and solar

plants now compete directly with new fossil fuel plants on price and cost in many parts of the world. The price of solar photovoltaic (PV) modules has dropped 75% and onshore wind power has fallen 30% over the last six years. More than 7.7 million people are now employed globally in the renewable energy sector, an increase of more than 4 million jobs in six years. Plummeting costs and increasing jobs mean that today there is a strong economic case for scaling renewable energy that was not as clear in 2009.

Secondly, almost all countries have now made substantive commitments to grow renewable energy. The number of countries with renewable energy targets has doubled since 2009. This has been an important factor driving the dramatic acceleration in renewable energy capacity, the amount of plants generating power. In 2009, the year of the Copenhagen climate conference, more fossil fuelled power was being added annually than renewable energy worldwide. Now, leading into the Paris conference, renewable energy has overtaken fossil fuels to become the preferred source of power generation, with annual renewable energy capacity additions outpacing fossil fuels by 40%. There are now numerous examples of countries, states and cities being largely powered by renewable energy.

Thirdly, it is incredibly clear that climate change is happening now. Whereas in 2009 the discussion focused on future consequences, today scientists are very clear about the impacts we are already experiencing from a changing climate. For instance, in Australia, hot days have doubled in the last fifty years, heatwaves have become hotter, longer and occur more often and extreme bushfire weather has increased.

The structure of the Paris climate conference (30 November to 11 December 2015) is also quite different to previous conferences. Countries have been submitting their Intended Nationally Determined Contributions (INDCs), that is, their national plans to reduce greenhouse gas emissions and to mitigate and adapt to climate change. Renewable energy has been a key feature mentioned in countries' plans for meeting their emissions reductions targets.

However, despite the progress that has undoubtedly been made between Copenhagen and Paris, much more needs to be done to protect us from climate change. Limiting global warming to 2°C requires a 90% reduction by 2050 of CO_2 emissions per unit of electricity generated. This requires both an acceleration of investment and growing capacity in renewable energy, as well as proactive action to tackle climate change.

The more we learn about climate change, the riskier it looks. A 2°C rise in temperature above pre-industrial levels has been established as a policy target, but even this level of warming may drive significant impacts. As scientific knowledge improves, it is becoming clear that risks previously considered to lie only above 2°C may well occur at lower temperatures. With just 0.9°C of warming in Australia we have already witnessed adverse consequences. The incidence of extreme temperatures has increased markedly over the last 50 years, while heatwaves have become hotter, are lasting longer and occur more often. Globally, at a 2°C temperature rise above pre-industrial we are now closer to the risk of crossing thresholds or tipping points, which are large features of the climate system prone to abrupt and/or irreversible change when a critical

threshold level of temperature rise is reached. Examples include loss of the Greenland ice sheet, the partial conversion of the Amazon rainforest to a savanna or grassland, and the largescale emission of carbon dioxide (CO_2) and methane from thawing permafrost. Each of these examples would cause very significant disruptions to the climate system, with knock-on effects for human societies.

At the time of the Copenhagen conference the world was heading towards a 4 to 5°C warmer world by 2100 if drastic action was not taken to reduce our emissions. Despite positive changes, such as renewable energy overtaking fossil fuels to become the main source of new electricity generation capacity globally since Copenhagen, we need to do more. A synthesis of the emissions reduction targets (INDCs) shows that if all countries meet their Paris commitments, the world is still headed for around a 3°C temperature rise by 2100 compared with the pre-industrial levels. Stronger action is clearly required to tackle climate change. The Paris climate conference should be seen as a building block towards reaching the 2°C target. Countries will need to continue to ratchet up efforts over time. Critically, in the lead up to Paris, the ambitions of countries, especially the big emitters like the United States and China, have been increasing with time. We now have a clear picture of where the world stands in relation to meeting the 2°C policy target.

Significant progress has been made since Copenhagen and Paris is an important building block. But much more needs to be done if we are to limit warming to 2°C, including even more uptake of clean technology solutions.

More needs to be done to scale-back reliance on fossil fuels. Many countries continue to subsidise fossil fuels significantly. It is increasingly clear that the vast majority of the world's fossil fuels cannot be mined and must remain unburned. Policies designed to encourage or maintain fossil fuel consumption are incompatible with good climate policy.

Recently the Head of the UNFCCC Christina Figueres commented that "international negotiations don't cause change, they mark it" (The Guardian 2015). The Paris conference will mark substantive change in countries. Paris will mark a significant upswing in global action on climate change and will drive further momentum into the future.

There are a range of important lenses through which to view the Paris conference, one is the level of global action on climate change and whether sufficient progress is, or is not, being made. Another of these lenses is the progress made on renewable energy.

This report explores the dramatic changes in the renewable energy landscape since the Copenhagen climate conference, the renewable energy commitments which have been made by countries in the lead-up to Paris and the forecast for the future of renewable energy.

The world is in the midst of an energy revolution. There has been significant progress from the Copenhagen conference to Paris. The scale of the commitments that countries worldwide have now made, coupled with plummeting costs suggests that renewables will only continue to boom into the future.

2. RENEWABLES POWERING AHEAD SINCE COPENHAGEN

2.1 Towards Paris: Global Renewable Energy Status Check

Heading into the Paris climate conference, the world is in the midst of a transition to renewable energy driven by supportive policies and targets, widespread deployment and rapidly falling costs (REN21 2015a; WRI 2015).

Over the past six years since the Copenhagen climate conference, renewable energy (Figure 1) has grown significantly in installed capacity, proportion of electricity generation, investment and jobs worldwide. At the same time the number of countries with renewable energy policy targets has nearly doubled (Table 1).

Table 1: Global renewable energy growth since the Copenhagen climate talks.

Year	2009 (Copenhagen)	2014 (pre-Paris)
Renewable electricity - cumulative installed capacity (including hydro)	1,230 gigawatts (GW)	1,712 GW
Proportion of global electricity generation	19%	23%
Annual clean energy investment	US$ 206 billion	US$ 310 billion
Global jobs	3.0 million	7.7 million
Countries with policy targets	85	164

Source: REN21 2010; IEA 2011; BNEF 2015a; BNEF 2015b; IRENA 2015; REN21 2015a.

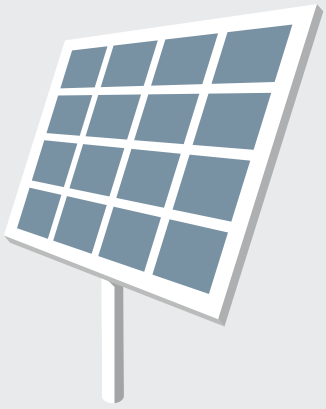
Since the Copenhagen summit in 2009:

- Renewable energy has overtaken fossil fuels to become the main source of new electricity generation capacity globally (IRENA 2014).
- Investment in new renewable energy capacity has exceeded investment in fossil fuels every year since 2009 (BNEF 2015a; BNEF 2015b).
- Major global economic powers, including China, the European Union (EU), the United States (US), India and Brazil are investing heavily in renewable energy and have put in place favourable policies to encourage greater uptake (REN21 2015a).
- The large-scale increase in renewable energy has led to a worldwide surge in renewable energy jobs. Jobs in renewables have more than doubled to reach 7.7 million (REN21 2010; REN21 2015a; IRENA 2015).
- The number of countries with policy targets to grow renewable energy has nearly doubled.

Renewable Energy Technologies

SOLAR

The sun's energy is converted into heat to drive steam turbines, generating electricity (solar thermal) or converted directly into electricity by solar cells (solar PV).



BIOENERGY

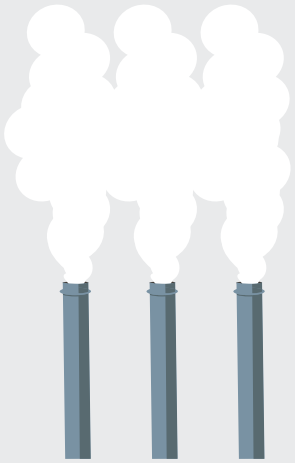
Energy is derived from organic matter (recently living plant or animal material), such as sugarcane waste, landfill gas and algae.

WIND

Wind turns the blades of a wind turbine to generate electricity.

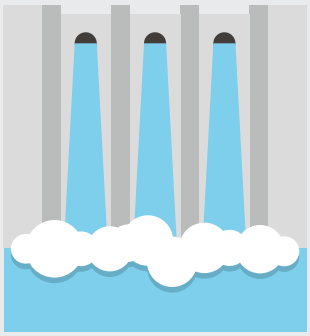
GEOTHERMAL

The earth's natural heat is used to heat water and drive steam turbines to generate electricity.



HYDRO

Flowing water turns water turbines to generate electricity.



OCEAN

The ocean's waves, tides or thermal energy is converted into electricity using a range of technologies.

Figure 1: Renewable energy technologies. **Source:** ARENA 2015. **Note:** Hydro, wind, solar and bioenergy are the major sources of renewable generation and are expected to remain so in the medium term (IEA 2015a).

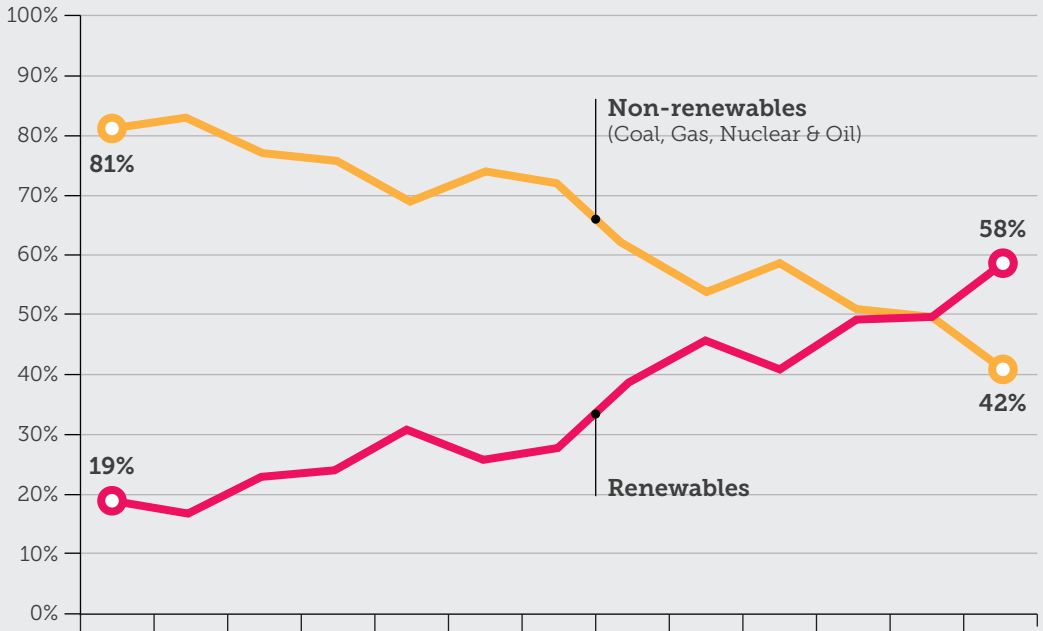
Renewable energy capacity

Renewable energy is now the preferred choice for new electricity generation globally, accounting for more than half of new capacity additions in the last two years (IRENA 2014; REN21 2014; REN21 2015a; Figure 2).

In 2009, 85 GW of new renewable capacity was added worldwide – 15 GW less than the amount of new fossil fuelled power added that year (IRENA 2014). By 2014, annual renewable electricity capacity additions increased to 134 GW, up 58% and outpacing fossil fuelled sources of generation by 40% (IRENA 2014; REN21 2015a; Figure 2).

Since 2009 renewable energy has become the preferred choice for new electricity generation.

Figure 2: Renewables as a share of global capacity additions in GW (2001 – 2013).



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total net capacity added per year	**104**	**134**	**150**	**153**	**134**	**180**	**200**	**174**	**185**	**232**	**234**	**233**	**207**
Renewables	20	22	34	36	41	47	56	67	85	94	115	116	120
Non-renewables	84	111	116	116	93	133	145	107	100	138	118	117	87

Source: IRENA 2014.

In the last two years, renewable energy capacity additions have set world records with 120.9 GW installed in 2013 and 134 GW in 2014 (REN21 2014; REN21 2015a). China, the US, Germany, and India are the countries which have led renewables deployment over the past decade (REN21 2015a).

Renewable energy investment

Globally, investment in renewable power has also increased dramatically. Estimates for 2014 indicate renewable investment globally rose to US$ 310 billion, up from US$ 206 billion in 2009, a 50% increase (BNEF 2015a; BNEF 2015b).

Since the Copenhagen climate conference in 2009, investment in new renewable power capacity has exceeded fossil fuels every year. In 2013 and 2014, renewables led fossil fuels by US$ 90 billion and US$ 111 billion respectively for investment in new capacity (REN21 2014; REN21 2015a).

These countries continue to be the most attractive places to invest in renewable energy because of their stable policy environments and clear renewable energy commitments (EY 2015).

Today, strong and consistent targets and policies supporting renewable energy are about much more than reducing carbon emissions. These policies support mainstream

IN 2014, THE LEADING COUNTRIES FOR INVESTMENT IN CLEAN ENERGY WERE:

CHINA

US$ 89.5 billion
(up 32% from 2013)

JAPAN

US$ 41.3 billion
(up 12% from 2013)

UNITED STATES

US$ 51.8 billion
(up 8% from 2013)

GERMANY

US$ 15.3 billion
(up 3% from 2013)

Source: BNEF 2015b.

Global investment in renewables has outpaced investment in new fossil fuelled power annually since Copenhagen.

Employment in renewable energy increased by more than 150% over the past six years.

economic objectives such as cost-effective and secure sources of energy, attracting investment and growing jobs (EY 2015).

Yet when it comes to fossil fuel subsidies much more work is required despite earlier promises. For example, five years ago members of the G20 committed to phasing out subsidies for fossil fuels. However, in contrast to developments in renewable energy, little progress has been made on removing these subsidies (ODI 2015).

Renewable energy jobs

Since Copenhagen, jobs in renewable energy have grown by over 150% (REN21 2010; IRENA 2015). In 2014, 7.7 million people were employed in the renewable energy sector globally (IRENA 2015). Last year employment grew 18% on the previous year with 1.2 million new jobs created. Nearly a third of all jobs (2.5 million) were in solar PV, and these were mostly based in China (REN21 2015a; IRENA 2015). In some cases, such as in the US, renewable jobs (particularly in non-hydro renewable technologies) have experienced strong growth despite falling employment in the power sector generally (US EIA 2014). As renewable energy tends to be more labour intensive in the short and longer term, building new renewable energy capacity, or investing in energy efficiency creates an additional 1 job per annual GWh more than the equivalent level of new fossil fuel generation (Blyth et al 2014).

Countries powered by high levels of renewable energy

Some countries are already successfully powered by high levels of renewable energy. For example, Iceland and Norway have reached nearly 100% renewable electricity, followed by New Zealand (80%), Austria (68%), Sweden (62%), and Denmark (43%) (New York Times 2013; REN21 2015a). Germany, Italy and Spain all boast around 30% renewables (REN21 2015a).

While some of these countries have access to significant hydroelectric and geothermal energy resources, variable renewables such as wind and solar have also achieved high levels of penetration in some countries. For example, in 2014 Denmark provided 39% of its electricity consumption from wind, and over 20% in Spain (REN21 2015a). This has also been achieved within provinces, states and territories, such as Maine in the US, which generates about 35% of its electricity from biomass and wind (US EIA 2015). In 2014, South Australia wind and solar generated 40% of the State's electricity (Clean Energy Council 2015; Government of South Australia 2015).

2.2 Drivers of the Global Renewables Boom

Steep declines in the cost of renewable energy technologies, particularly solar PV and wind, have been a key factor driving the accelerated rollout of renewable energy. In the past six years, global wind power costs fell 30% and solar PV prices fell 75% (IEA 2015a).

In many parts of the world, renewables now compete directly with new fossil fuelled power plants on price and cost, providing low cost power without the need for government assistance (IEA 2015b). This is particularly the case if the cost of carbon capture and sequestration is considered in new fossil fuelled power plants. Utility scale solar PV projects are already competitive (without subsidies) in several countries (IEA 2015c). Solar PV project developers have tendered record low prices for large-scale solar PV projects in 2014 and 2015. Reported examples of contracts involving low solar PV prices include projects in the United Arab Emirates at 59 US$/MWh, Chile at 65 US$/MWh, India at 71 US$/MWh, Brazil at 87 US$/ MWh and Texas at 50 US$/MWh (CleanTechnica 2014; IEA 2015c; RenewEconomy 2015). For onshore wind projects, tendered prices have been reported in the range of 50 US$/MWh to 75 US$/MWh in countries ranging from the US, Brazil, Uruguay and South Africa (IEA 2015c).

Since Copenhagen, global onshore wind power costs decreased 30% and solar PV prices dropped 75%.

Renewables now compete directly with fossil fuels on price.

Even without including the costs of carbon capture and storage with fossil fuelled plants, new renewable projects are now increasingly the lowest cost option for new electricity generation. The best prices for new onshore wind and utility scale solar PV are now coming in at or lower than the cheapest new coal-fired power generation. And as costs have fallen dramatically for renewable energy in the last six years, the median price of non-renewable energy plants such as gas, coal and nuclear have increased (IEA 2015b).

Following the Copenhagen summit, major emitters - the US and China - have moved from laggards to take leadership on climate change. China's Twelfth Five Year Plan (2011–2015) set ambitious national goals to reduce the carbon intensity of China's energy, to increase the contribution of renewable and non-fossil fuelled energy sources and set significant targets for installed renewable energy capacity (Government of the People's Republic of China 2011). China's embrace of solar PV has seen its annual installation of solar PV capacity grow from 0.3 GW in 2009 to 10.6 GW in 2014 (REN21 2015a; REN21 2015b).

In the US, progress has been led by the states with the majority now having Renewable Energy Portfolio Standards or goals in place. For example, the major economies of California (50% by 2030) and New York (29% by 2015) have set ambitious targets for the proportion of renewables in energy consumed (DSIRE 2015).

Other nations too have stepped up efforts. For instance, Japan introduced feed-in tariffs for solar PV in 2009, and significantly expanded the policy in 2012 to cover all renewable energy technologies which led to dramatic capacity additions (REN21 2015b).

Globally, policy support for renewable energy deployment continues to grow. Since the Copenhagen climate summit in 2009, progress has been made with a majority of countries (164 out of 196) now having renewable energy targets in place, almost doubling the number of countries with targets. Although a small number of countries, such as Australia, Greece, Spain and the United Kingdom have recently reduced support for renewable deployment, the vast majority (including the biggest emitters) are taking steps to enhance rollout (Financial Times 2015; REN21 2015a; WRI 2015).

The best prices for onshore wind and utility scale solar PV are now meeting or beating the cheapest coal-fired power generation.

2.3 Copenhagen to Paris: the Need to Transition to Renewable Energy

Rising global temperatures, driven mainly by the burning of fossil fuels (coal, oil and gas; see, for example, Figure 3) but also from other human activities (e.g. land use cover change and increasing meat consumption), are already driving serious impacts on human wellbeing and, left unchecked, will have even more harmful and potentially catastrophic consequences for humanity.

In response, governments around the world have agreed to keep global temperature rise to no more than 2°C above preindustrial levels (UNFCCC 2010). While 2°C may not sound like much, it is a very substantial change to the Earth's natural systems and will have serious impacts on the lives and livelihoods of people all over the world. Temperatures this year are around halfway to 2°C, with the 2015 global average temperature set to reach 1°C above pre-

Figure 3: Loy Yang Coal Power Station in Victoria

industrial levels (Met Office 2015). This further underlines the importance for global action on climate change.

The UNFCCC has 196 Parties (195 member countries (including Australia) and the economic and political bloc, the European Union). Its goal is to stabilise greenhouse gas concentrations in the atmosphere at a level that will prevent "dangerous human interference with the climate system" (UNFCCC 2014). At the 21st Session of the Conference of the Parties to UNFCCC (COP21) in Paris countries will meet to negotiate a new international agreement on climate with the aim of keeping global warming below 2°C (Republic of France 2015).

To tackle climate change the solution is clear-cut: we need to reduce carbon dioxide (CO_2) emissions to virtually zero by the middle of the century, requiring a rapid rate of reduction in emissions from now. Renewable energy technologies are one crucial solution to climate change allowing us to move rapidly away from fossil fuels and power our economy with low emission energy sources such as the sun and the wind (IPCC 2014).

And while our understanding of climate change and the risks of a high emissions future have increased since Copenhagen, so too has the range of solutions to the problem. Not only are these solutions more feasible and less costly than ever before, some are already being implemented.

While Copenhagen conference was perceived as a failure – it and the subsequent Cancun agreement helped pave the way for countries agreeing to the 2°C target. Further, the UNFCCC, as the main international platform for global climate negotiations, provides opportunities to coordinate climate policy. Such coordination is instrumental in the development of national emissions reduction policies because the global climate negotiations show domestic policy makers that comparable efforts are being taken by key trading partners and allies (OECD 2015). Since the Copenhagen climate summit in 2009, countries around the world have accelerated action on climate change. Thirty-nine countries and over 20 sub-national jurisdictions are putting a price on carbon – up from 35 countries and 13 sub-national jurisdictions in 2013 (World Bank 2015).

Globally, the climate change landscape today stands in stark contrast to where it stood during the Copenhagen climate conference. Many consequences of climate change are already evident, and the risks posed by further climate change are better understood. Further, the more we learn about climate change, the riskier it looks. A 2°C rise in temperature above pre-industrial levels has been established as a policy target, but this level of warming may already drive significant impacts. As scientific knowledge improves, it is becoming clear that risks previously considered to lie only above 2°C may well occur at lower temperatures. With this growing realisation of the consequences of climate change, we have seen an accelerated focus on solutions such as the global growth in renewables. This is important step in the right direction if we are to limit the impacts of future climate change.

However, despite global progress on renewable energy in the past six years, fossil fuel subsidies continue to work to counteract these emissions reduction efforts (such as investing in renewable energy and pricing carbon) by effectively creating an incentive to emit greenhouse gases. The exact amount of global fossil fuel subsidies is difficult to estimate because there is no standard definition or calculation method. Therefore, estimates vary widely from US$ 523 billion to over US$ 1.9 trillion, depending on what is considered a "subsidy" and how exactly they are tallied (Worldwatch Institute 2014). Despite pledging in 2009 to phase out fossil fuel subsidies, all G20 countries continue to subsidise fossil fuels, collectively spending an estimated US$ 452 billion annually on fossil fuels. The amount spent by G20 countries subsidising fossil fuels is nearly four times the amount spent to encourage the uptake of renewable energy (ODI 2015). For comparison, the Green Climate Fund established under the UNFCCC to support climate change adaption and mitigation in developing countries aims to raise US$ 100 billion annually by 2020 (Green Climate Fund 2015). Furthermore, the amount spent by G20 countries subsidising fossil fuels is nearly four times the amount spent to encourage the uptake of renewable energy (ODI 2015).

Despite committing to the 2°C target, G20 countries continue to heavily subsidise fossil fuels.

2.4 Renewable Energy Commitments Leading into Paris Climate Conference

Significant commitments on renewable energy have been made in advance of the Paris climate conference which will drive substantial further increases in renewable energy. Climate change negotiations and summits like the upcoming Paris climate conference are about bringing countries together to galvanise and focus action.

However, the real action happens at the national level through policies and technological innovations. The Copenhagen climate conference, for example, was a watershed event towards establishing the 2°C target and promoting the 'carbon budget' approach, which tells us how much carbon humanity can "spend". And there was a stronger realisation that global emissions need to get to net zero or below. But, after that agreement it was national governments that then needed to implement additional measures to arrest climate change.

Heading in to the Paris climate talks, the majority of countries (102 countries, 87% of INDCs) refer to clean energy actions or outcomes as a key component of their emissions reductions strategies (WRI 2015) and eight of the ten largest emitters have made significant pledges such as:

- China and India will add more than 300 GW of renewable energy capacity (not including large hydro) by 2022 (UNFCCC 2015a; REN21 2015a).
- China has committed to building more clean energy (which won't just be renewables) in the next fifteen years than its entire existing coal fleet and increasing the share of non-fossil fuels in primary energy to 20% by 2030 (The White House 2014).
- India intends to become a "renewables superpower", committed to installing more than 175 GW of renewable energy (100 GW of which will be solar PV) by 2022 (Nature 2015; UNFCCC 2015a). India is targeting 40% of all generating capacity to come from non-fossil fuels by 2030 (UNFCCC 2015a; WRI 2015).

Figure 4: Rio de Fogo Wind Farm, Brazil

- Brazil has committed to renewables making up 45% of its total energy mix in 2030, with 28 to 33% from non-hydro sources. With 75% of its electricity already generated from renewable sources, Brazil has committed to ensuring at least 23% of electricity is generated by non-hydro sources such as solar, wind (see, for example, Figure 4) and biomass (UNFCCC 2015a).

- The US aims to achieve 20% of electricity generated by 2030 from non-hydro renewable energy (WRI 2015).

- Other large emitters such as Japan, Indonesia and Mexico are also targeting increased renewable energy contributions (WRI 2015).

In addition, immediately before the Paris climate talks, an Organisation for Economic Co-operation and Development (OECD) meeting comprising 34 of the wealthiest countries agreed to cut public financing for highly polluting coal-fired electricity by billions of dollars a year (Financial Review 2015; SMH 2015). And the UK recently announced plans to close all coal-fired power stations by 2025 and restrict their use by 2023 (UK Government 2015). In effect, signalling an even stronger transition away from fossil fuels, particularly coal.

In addition to specific commitments for the Paris meeting, global renewable energy momentum continues to build. Eight out of the ten largest greenhouse gas emitters have announced significant upgrades to their renewable energy plans. This includes (WRI 2015; Table 2):

- Renewable electricity generation in Brazil, India, Japan, Mexico and the US increasing 255% by 2030 from 630 TWh/year in 2012 to 2,250 TWh/year in 2030.

- Total renewable energy supply in Brazil, China, the EU and India nearly doubling from 7,980 TWh/year in 2012 to 14,830 TWh/year in 2030.

- Renewable capacity installed growing almost four-fold in Brazil, India, Japan, Mexico and the US from 246GW in 2012 to 856GW in 2030 (WRI 2015).

In the lead up to Paris, eight of the ten largest emitters have announced significant upgrades to their renewable energy.

Table 2: Renewable energy pledges from eight of the ten largest emitters in INDC submissions or announcements in the lead up to the Paris Climate Conference

Country	Renewable energy commitment
China	20% of all energy (consumed) from renewables by 2030
US	20% non-hydro renewable electricity generation by 2030
EU	27% of all energy (consumed) from renewables by 2030
India	40% of electricity generating capacity from non-fossil fuel sources by 2030 175 GW of new renewable capacity installed by 2022
Indonesia	23% of all energy (produced) from renewables by 2025
Brazil	45% of all energy (produced) from renewables by 2030
Japan	22-24% renewable electricity generation by 2030
Mexico	35% renewable electricity generation by 2024

Source: WRI 2015

With the implementation of these national plans, renewable electricity generation in Brazil, China, India, Japan, the US and the EU will reach 36% by 2030. And the carbon intensity of electricity generation (emissions per MWh of electricity generated) is expected to fall 40% between 2010 and 2030 (MILES 2015).

These commitments and cooperation on climate change have been gathering in momentum the past year. In September last year, in a joint announcement by China and the US, China committed to increasing its share of non-fossil fuelled energy to 20% by 2030. This commitment will see China deploy 800 – 1,000 GW of zero emissions capacity by 2030 – equivalent to the total generating capacity of the US (The White House 2014). In January, India also announced an ambitious goal – to install 100 GW of solar capacity by 2022 in a joint announcement with the US (The White House 2015a; see, for example, Figure 5). More recently, the US and Brazil jointly committed to increasing their share of non-hydro renewables in electricity generation to 20% by 2030 – representing a tripling of renewable generation for the US and a doubling for Brazil (The White House 2015b).

However, even increasingly ambitious renewable energy commitments will also need to be complemented by policies to address continued growth in emissions from fossil fuelled power stations, for example through regulating emissions from power plants, legislating for closure or carbon pricing (MILES 2015). This will be particularly important to address fossil fuel emissions in countries where overall electricity demand is growing, which may lead to growing emissions from power generation even in spite of increased renewable energy targets.

Despite global growth in renewable energy for power generation, fossil fuels continue to make up 77% of global electricity production, with coal contributing the largest share (40%) (REN21 2015a). Three quarters of current global coal power capacity is "subcritical" – the most polluting form of power generation (Caldecott et al 2015).

In 2014, coal plant closures in OECD countries were offset by capacity increases in the rest of the world, leading to a net increase of 66 GW in coal power capacity – locking in additional long-term high emissions power generation (IEA 2015c). While growth in emissions from coal power generation has slowed in recent years, in order to meet 2°C scenarios, these emissions need to level out and then fall (IEA 2015c).

In order to meet the 2°C warming limit, there is a global "budget" for the amount of the fossil fuels that can be burned and coal use needs to be eliminated as soon as possible. Even scenarios with only a 50% chance of meeting the 2°C warming limit, mean only 12% of the world's coal reserves can be burned. The vast majority of the world's coal will need to be left in the ground (McGlade and Ekins 2015).

Figure 5: Aerial view of solar photovoltaic plant in Andhra Pradesh, India

2.5 Paris Summit and Beyond: Are Current Actions Sufficient?

Leading into the Paris climate conference, 147 Parties have submitted their INDCs setting out emissions reduction targets and plans to the UNFCCC and more submissions are likely to continue. The parties include all developed nations and three quarters of developing countries under the UNFCCC, covering 87% of global greenhouse gas emissions.

The emissions covered by countries' submissions to the Paris climate conference cover almost four times the proportion of emissions covered by the first commitment period of the Kyoto Protocol - the world's first international emissions reduction treaty that required binding emissions cuts from 37 developed countries (such as Australia, Japan and the US) and the EU (UNFCCC 2011).

Current efforts are still insufficient and could lead to substantial global temperature rise.

Even though the renewable energy commitments in the lead up to Paris will lock in significant growth in renewable energy; so far, the submitted emissions reduction targets will not meet the agreed warming guardrail of 2°C, overshooting by 0.7°C (UNFCCC 2015b), while other studies (e.g. Climate Interaction and MIT 2015) estimate that warming could reach 3.5°C by 2100 under the emissions reduction targets submitted to date. Because of the scale of the climate problem, more action is clearly needed to reduce emissions, including even more uptake of renewable energy and consideration of emerging solutions, for example 'third way' technologies such as schemes to reflect more sunlight or increase carbon dioxide absorption by stimulating plant growth (Talberg and Flannery 2015). The challenge now is for countries to implement pledges into concrete action for meeting these targets and for there to be a periodic review of progress to lock in opportunities for further emissions reductions.

Forecasts indicate costs for renewable electricity are likely to continue to fall. The rate of decline in solar PV costs are expected to average 36-60% from 2010 to 2020 and 12-22% for wind over the same timeframe (IRENA 2012; McKinsey and Co 2012; NREL 2012; EPIA 2013; First Solar 2014).

Limiting global warming to 2°C requires a 90% reduction by 2050 of CO_2 emissions per unit of electricity generated.

Global growth in renewable energy is expected to continue. On current trends, electricity generation from renewable energy is expected to grow by 45% between now and 2020 (IEA 2015c). However, despite the increasing competitiveness of renewable energy, policy uncertainty and regressive policies – particularly in some OECD countries like Australia, Greece, Spain and the United Kingdom – continue to act as a critical barrier to greater renewable energy investment and deployment (IEA 2015c).

Achieving deep cuts to emissions from electricity supply and demand globally by 2050 requires a two-pronged approach:

- A tripling to quadrupling of renewable and other zero or low emissions energy, and dramatic energy efficiency improvements by 2050 (IPCC 2014), and
- Progressive retiring of high emitting fossil fuel generators at faster rates than natural infrastructure replacement would dictate (IEA 2014c), being replaced by clean generation.

Energy storage technologies such as battery storage will also play an important role in supporting this transition and meeting the 2°C target, as renewables become a greater share of countries' electricity supply. Energy storage provides a solution to the intermittency of renewables like solar and wind, enabling a higher share of renewable electricity. Energy storage also provides electricity networks with an alternative to upgrading and extending poles and wires or building new plants to meet peak electricity demand (IEA 2015a). Falling costs for battery storage and the growth in plug-in electric vehicles powered by renewable electricity offers opportunities to start decarbonising the road transport sector (IEA 2015a).

Staying on track to limit global warming to 2°C above pre-industrial levels requires all new-build energy sector investment by 2020 to be near zero emissions and carbon dioxide (CO_2) emissions per unit of electricity generated must decrease by more than 90% by 2050 (IEA 2015d).

Globally, despite the significant progress in the roll-out of renewable energy - record-breaking capacity additions, growth in investment and job creation in recent years – only solar PV installation rates are on track to meet its share of the 2°C target (IEA 2015c). Installation rates of other renewable technologies, such as wind and hydro, are making strong progress but still lag behind levels of deployment needed to meet the 2°C target (IEA 2015c).

The commitments in the lead up to Paris are a significant and important step by major emitters that will further accelerate the global transition to renewable energy, particularly for generating electricity. And while these commitments are not yet in line with achieving the 2°C target, they provide an "entry point" to put the world on a trajectory more in line with that goal (MILES 2015) – they represent a significant shift from where we were in Copenhagen. Paris is a milestone that can be built upon.

To meet the 2°C and transition towards low/zero emission economies, renewable energy must expand even more rapidly to avoid the most dangerous impacts of climate change.

3. THE GLOBAL RENEWABLE ENERGY REVOLUTION

3.1 Paris: Another Building Block for the Global Renewable Energy Revolution

Internationally, major economies and Australia's trading partners (such as the US, the EU, China, India, and Brazil) are making their commitment to fast-tracking the transition to renewable energy clear.

And despite the ups and downs in renewable energy policy in Australia, we retain a huge advantage and opportunity as one of the sunniest and windiest countries in the world. More than 1.4 million Australian households are already embracing and leading the world in rooftop solar PV, and benefiting from the cost savings on their electricity bills (ESAA 2015). Yet our electricity grids as a whole remain dominated by old, inefficient coal fired power and our support for renewable energy is middling (ESAA 2015).

The emissions reduction targets submitted and the Paris climate conference represent an opportunity to carry forward global momentum towards a fossil free world. Renewable energy is technically feasible, economically sound and is being deployed at a rapid rate globally.

Australian households are showing the way for a more secure energy and low emissions future. Blessed with an abundance of renewable resources and technological innovation, Australia has the opportunity to join major economies of the world in this new energy revolution by encouraging innovation in energy, for example, in renewable energy and storage technologies. Economic growth, innovation and job creation opportunities abound in the transition to a renewable future. Australia remains a world leader in rooftop solar and has the chance to capitalise on this position to create new knowledge and technology companies, and to transition our electricity sector. But the longer Australia delays, the greater risk these opportunities will pass us by, and we will become simply technology and equipment buyers, rather than innovators and business creators.

Tackling climate change while developing a prosperous, vibrant and healthy society is possible.

Figure 6: Australian households leading the way in solar pv uptake.

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