

# Low Carbon Pulse - Anniversary Edition

## GLOBAL DEVELOPMENTS IN PROGRESS TOWARDS NET-ZERO EMISSIONS



Welcome to the **Anniversary Edition** of Low Carbon Pulse. The first edition of Low Carbon Pulse was published on October 6, 2020, the 28th edition on October 6, 2021. Every two weeks, Low Carbon Pulse seeks to share the current significant news on progress towards net-zero greenhouse gas (**GHGs**) emissions (**NZE**) globally.

To mark the anniversary of Edition 1 of Low Carbon Pulse, the **Global Ashurst Towards Zero Emissions** team has consolidated each edition of Low Carbon Pulse into a **Low Carbon Pulse Compendium (LCPC)**. Also each paper, report and study referenced in Editions 1 to 28 of Low Carbon Pulse has been listed in the back of the Compendium to provide a virtual library as a source of reference. The Compendium is searchable. Having established the **LCPC** and the virtual library, they will be updated as new editions of Low Carbon Pulse are published. Click here to **LCPC**.

This **Anniversary Edition** of Low Carbon Pulse reflects on the past 12 months, and the next 12 months – "**12 months in review and 12 months in preview**". In reflecting, the United Nations Climate Change Conference commencing on October 31, 2021 (**COP-26**) is very much in mind. It is difficult to overstate the importance of **COP-26**. For the author, there appears to be a weight of expectation like never before.

In the week leading up to **COP-26**, Low Carbon Pulse will publish a feature each day on what may be regarded as key agenda items. On October 29, 2021, Edition 29 of Low Carbon Pulse will be published.

### About Low Carbon Pulse:

- **Time and place:** Edition 1 of Low Carbon Pulse was written on a Saturday morning at the Hilton Hotel, Hohola, Port Moresby, National Capital District, PNG. This **Anniversary Edition** was written at Bootless Bay, on Loloata Island, Central Province, PNG, on Saturday October 9, 2021. As well as editions written in PNG, other editions have been written in Cairns, Sydney and Singapore. Before COVID-19, the author spent time "on the road" working with clients on projects and transactions across Asia Pacific, and into MENA. It is likely that future editions of Low Carbon Pulse will be written on Saturdays in equally evocative and wonderful locations.
- **Evolution of Low Carbon Pulse:** Edition 1 of Low Carbon Pulse covered a seven day period, and had a relatively meagre word count. Subsequent editions have covered 14 day periods, with the scope of the subject matter covered increasing over time, reflecting increased progress. The most recent editions of Low Carbon Pulse have been longer than earlier editions as news and trends, and the roles of Governments, Central Banks, International Agencies, Policy Banks and the private sector have been covered ahead of **COP-26**.
- **Reasons to be thankful:** In these unusual times, the author has been fortunate to spend time with clients, and colleagues in Port Moresby, Singapore and Sydney, avoiding lockdown. In many ways, the period from March 2020 has been as satisfying as any in the author's career. Clients and colleagues have maintained a sense of humour, including occasionally laughing, but more often than not grimacing or sighing, or both, at the "sense of humour" of the author. For clients and colleagues in PNG who have hosted me for 12 out of the last 18 months, thank you, including for the recently conferred soubriquet, "the low pulse carbon".

Thank you.

## Framing thinking ahead of COP-26 – reasons to be cheerful

### Perspective of the author:

In Edition [22](#) of Low Carbon Pulse (covering July 12, 2021 to July 25, 2021), following the release of the **Fit for 55** package for the European Union (**EU**), the commencement of the **Emissions Trading Scheme** in the Peoples Republic of China (**PRC**), and the close of applications for the **ScotWind Leasing Scheme**, the author reflected that there were reasons to be cheerful, and in doing so the author reflected on the passage of time, and the importance of not wasting it.

- **"What is past, is prologue"**: With age, the author has had the privilege of re-reading the works of William Shakespeare in his children's high-school years. In *The Tempest*, as Antonio and Sebastian consider a choice to be made, Antonio reflects that : "What is past, is prologue". It is not possible to correct mistakes of the past. It is, however, possible to correct consequences, and not to perpetuate them. Starting from "What is past is prologue", in less than 30 years, we have to achieve **NZE**, we do not forget what is past, we learn from it.
- **"O Brave new world"**: The phrase "O brave new world" is anchored in the canon of English literature, by the gasp of wonder of Miranda in *The Tempest* (1614) and the gag of dark irony of John in *Brave New World* (1932). The author prefers Miranda's wonder, a realisation of a new chapter, in a world less defined than previously, over John's choice of death, removing the possibility of living outside the defined dystopia imagined by Aldous Huxley.

Of course, both *The Tempest* and *Brave New World* are works of fiction, *The Tempest* a work of whimsy, *Brave New World* a work of warning. And yet, they illustrate how mindset can define – seeing a world of endless possibilities or being confined (and ultimately defined) by a degree of difficulty and hard work.

There are always reasons to be cheerful and to be positive. In the context of **NZE**, the "size of the prize" should define, the nature and the difficulty of achieving **NZE** should not confine the need to achieve **NZE**.

In writing this Anniversary Edition of Low Carbon Pulse, the author placed a limit of 10 pages and 10,000 words. This was not easily done. In doing so, some tough decisions were made around what not to include.

### There are pathways to NZE:

- **The causes of climate change are known:**

On August 9, 2021, the Intergovernmental Panel on Climate Change (**IPCC**), published the [Sixth Assessment Report – Climate Change, The Physical Science Basis \(2021 Report\)](#). The **2021 Report** did not change the agenda, but the near certainty of its findings increased the sense of urgency surrounding the agenda, arriving as it did in the middle of extreme weather events in the Northern Hemisphere summer.

It is fair to say that there has been an ever increasing sense of urgency over the last 12 months bookended by the commitment of the **PRC** to achieve **NZE** by 2060 (covered in Edition [1](#) of Low Carbon Pulse), and the United Arab Emirates commitment to achieve **NZE** by 2050 made on October 7, 2021, since May 2021.

- **Why NZE?**

Article 4 of the Paris Agreement provides that: *"In order to achieve the long-term temperature goal set out in Article 2, Parties aim to reach global peaking of greenhouse gas emissions as soon as possible ... and to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals to sinks in greenhouse gas in the second half of the century"*.

To the author, these words are as important to the preservation of a habitable world as the words of The Gettysburg address are to the author's favourite evocation of the concept of democracy.

Article 4 recognises that the continued emission of **GHGs** to the climate system increases the concentration of **GHG** emissions already at large in the climate system, and will result in the continued increase in average global temperatures: existing **GHGs** at large in the climate system have "baked-in" temperature increases as a function of the life-cycle of those **GHG** emissions. A number of reports covered in Low Carbon Pulse have proved this.

Each tonne of **GHG** emitted to the climate system adds to climate change. A reduction in **GHG** emissions slows the rate of change, i.e., slows the rate of increase in average global temperatures. Progressing to, and achieving, **NZE** will result in slow and then stabilised climate change, and the removal of **GHG** emissions will result in the decline of **GHG** emissions in the climate system.

- **What needs to be done is known: GHG emission Reduction, Peaking and Removal (RPR):**

Article 4 of the Paris Agreement contemplates the:

- *reduction* of **GHG** emissions (through Nationally Determined Contributions or **NDCs**);
- *peaking* of **GHG** emissions as soon as possible; and
- *removal* of **GHG** emissions.

Each country that has acceded to the Paris Agreement is at a different stage in **RPR**. Some have peaked already, and are on a downward trajectory through reductions in **GHG** emissions arising, progressing to achieving **NZE**. Other countries have not yet peaked, and some will not peak until later this decade (**PRC**) and others not until sometime after that (India and Indonesia). This is a function of many things, primarily economic development.

The current **NDCs** of each country that has acceded to the Paris Agreement can be found on the [NDC Registry](#). Please note that some countries have committed to increase their **NDCs** (and in so doing to increase the reduction of GHG emissions) but have to do so formally under the Paris Agreement.

It is critical that each element of **RPR** is not viewed as mutually exclusive, each element should be taking place at the same time, and countries that can do more should be doing more. In short, the higher the **NDCs** and the sooner a country satisfies those commitments, the better.

This explains the increased focus on achieving reductions by 2025, 2030 and 2035. It is to be hoped that at **COP-26** that each developed country will increase its **NDCs** materially to each of these five year milestones. Certainly it is hoped that each G 20 country comes away from **COP-26** having committed to a higher **NDC**.

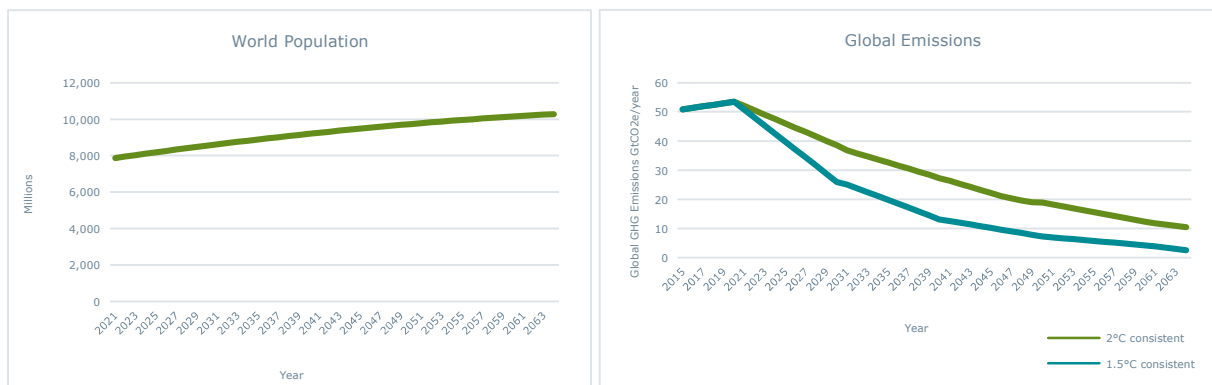
- **The 3D Earth Sized Jigsaw Puzzle:**

The causes of climate change are known. At the core, the cause of climate change is the increased concentration of **GHG** emissions in the climate system: **GHG** emissions cause net-positive radiative forcing, resulting in the accumulation of heat energy in the climate system – **GHG** molecules absorb heat energy.

The root cause of increased **GHG** emissions is the growth in population, the increased prosperity of that population, as a general statement, the resulting increased average life expectancy, and means to achievement of that prosperity, principally the extraction of resources that give rise to **GHG** emissions.

Currently, the expectation is that the global population will peak at 9.7 billion people in 2064, declining to 8.8 billion people by 2100, from 7.75 billion people at the moment. At the same time, as the population and prosperity is to increase, together, we need to transition from **50 Gt CO<sub>2</sub>-e** emissions annually to **NZE** annually by mid-century, or, if we want to avoid the worst effects of climate change, sooner.

If you will, this is currently a 7.75 billion **3D Earth Sized Jigsaw Puzzle**, the number of pieces grows by the minute.



- **Solving the 3D Earth Sized Jigsaw Puzzle:**

The good thing is that, among the growing population, there are chemists and physicists smart enough, and dedicated enough, to have modelled what needs to be done to solve the **3D Earth Sized Jigsaw Puzzle**. On October, 6 2021, two of those smart and dedicated folk, Mr Klaus Hasselmann and Mr Syukuro Manabe, were awarded The Nobel Prize in Physics 2021.

Not only are wonderfully dedicated and smart scientists on the case, the world's largest corporations (including international oil companies and national oil companies) are increasingly engaged on doing what is necessary to progress to achieve **NZE** by 2050, many before 2050.

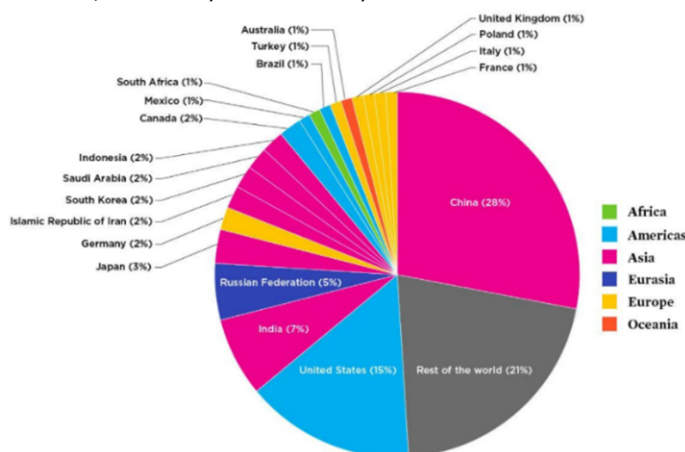
- **Business leaders to take the lead, and to work with Government to develop policy settings:**

Some of the smartest and wealthiest titans of business and industry are blazing a trail to **NZE**, and in doing so are providing leadership and clear recognition that achieving progress to **NZE** is a pathway paved with opportunity. Some of those titans are known for throwing the ball as far as they can down the road, and driving their businesses to chase the ball. This is the time for throwing the ball as far as possible.

As **Bill Gates** says, getting to **NZE** by 2050 "**will be the hardest thing humanity's ever done**".

- **The size of the task:**

The pie chart below shows the countries that emit the greatest proportion of **GHG** emissions in percentage terms. The heavy lifting falls to, and needs to be done by, a relatively limited number of countries, critically by the developed countries, but not by them entirely.



© 2020 Union of Concerned Scientists  
Data: Earth Systems Science Data 11, 1783-1838, 2019

The author has chosen not to include a graphic showing **GHG** emissions by reference to the population of each country, i.e., per capita **GHG** emissions. This non-inclusion reflects the perspective of the author: achieving **NZE** is global world emergency, that needs to be owned by those able best to respond to it.

- **Economic development needed and nuanced – the *PRC* and India are lynch pins:**

Economic development is a function of many things. For example, in the case of the **PRC**, it produces goods for export to countries that are not now manufacturing those goods, in fact the level of trade between the **PRC** and other countries is now greater than the level of trade between the United States of America (**US**) and other countries. The **PRC** is a manufacturing power house, having become so in the last 30 years. The world has benefitted from this.

The **PRC** manufactures goods of a kind used within the **PRC** and that are exported, including goods that are key to the decarbonisation of electrical energy generation, including solar panels and batteries to store electrical energy. Because of the scale of the **PRC** domestic market, and in many instances the lower cost of labour, the unit cost of manufacture is lower than that achievable by manufacturers in other countries. This has contributed to the lower costs of electrical energy globally, particularly the cost of photovoltaic solar, and will continue to do so over the medium to long term.

- **Make commitments if their achievement is realistic:**

For some countries, committing to **NZE** may be some years away, certainly those countries that are continuing to develop. For example, at times during the past 12 months, it has been reported that India and Indonesia might commit to achieving **NZE**. It is a credit to the Governments of both India and Indonesia that they have not done so. There is no point to a country committing to achieving **NZE** if that country is not sufficiently developed to have a clear pathway to **NZE** or if that country is continuing to apply its scarce resources to respond to COVID-19.

That is why the commitment of the **PRC** to achieving **NZE** by 2060 was momentous, likewise its plans to phase out coal-fired electrical energy generation (and retrofitting of coal-fired generation capacity to take hydrogen and hydrogen-based fuels), and its target to achieving peak **GHG** emissions before 2030.

The **PRC** has emerged as a key means to achieving progress towards **NZE**: activities in the **PRC** may be giving rise to the greater percentage of **GHG** emissions, but the **PRC** is committed to achieving **NZE** at the same time. That is key to the achievement of **NZE** globally through the manufacture of photovoltaic solar, and, increasingly, wind turbines. In many ways, the commitment of the **PRC** to achieving **NZE** can be taken as a given.

If countries are not developed sufficiently to commit to **NZE**, they should not do so. Instead, countries that are progressing to **NZE** should increase their rate of progress, and commit to assisting other countries to reducing their **GHG** emissions.

- **Progress on the road to *NZE* - *EU* and *UK*, and hopefully, the *US*, lynchpins:**

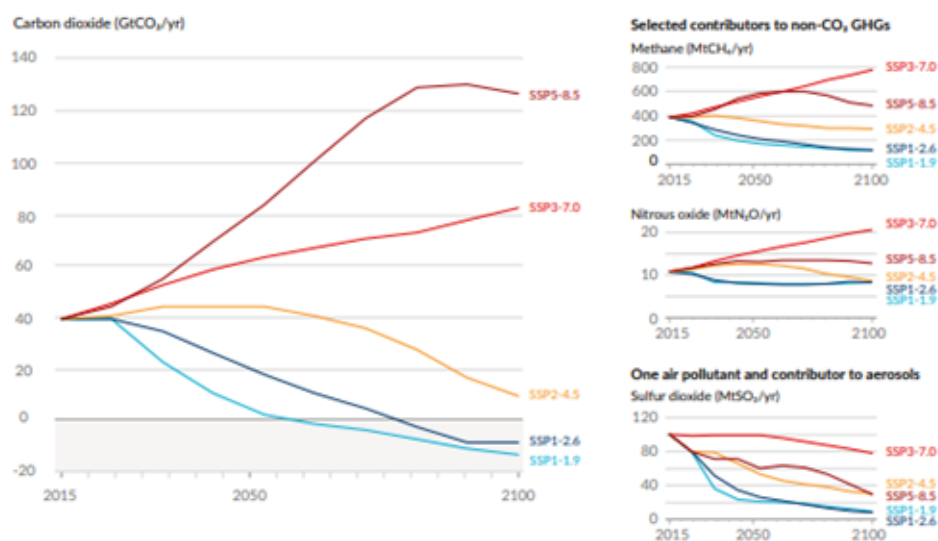
Increasingly, throughout the last 12 months, countries have realised that achieving **NZE** at a country level is not going to be sufficient unless **NZE** is achieved globally. The **EU** and the United Kingdom (**UK**) have been reducing **GHG** emissions for many years, and the **UK** has not only peaked, it has passed the half-way point on the road to achieving **NZE**. The task for countries that have made most progress is to increase the rate of progress to **NZE** as soon as possible. Achieving **NZE**, is not like a game of patience / solitaire.

- **Current direction and rate of travel, and required direction and rate of travel:**

The graphs below are taken from the **2021 Report**, and illustrate the current and required direction of travel in respect of each of the scenarios in the **2021 Report**, and explained in Edition 24 of Low Carbon Pulse.

### Future emissions cause future additional warming, with total warming dominated by past and future CO<sub>2</sub> emissions

a) Future annual emissions of CO<sub>2</sub> (left) and of a subset of key non-CO<sub>2</sub> drivers (right), across five illustrative scenarios



- **Commitments are conceptual, RPR needs to be real:**

One of the themes to emerge over the past 12 months, in particular in the context of the International Energy Agency (**IEA**) **Net Zero by 2050 – A Roadmap for Global Energy Sector (IEA Roadmap)** and the **International Renewable Energy Agency (IRENA) World Energy Transitions Outlook (WETO)** is the need for countries to increase their commitments to reduce **GHG** emissions, and then to deliver on them.

This may appear an obvious point to make, but what both the **IEA Roadmap** and the **WETO** demonstrate is that announced commitments and commitments reflected more formally are not going to be enough to achieve **NZE**.

Under the **IEA Roadmap**, at best, the announced commitments by 2050 are 30 Gtpa of **GHG** emissions (Announced Pledge Case or **APC**), and the commitments reflected more formally are 22 Gtpa of **GHG** emissions (Specific Policy Settings or **SPC**). The best under either **APC** or **SPC** is not enough. Not even close.

Under the **WETO**, **IRENA** models the Planned Energy Scenario (**PES**), effectively modelling the implementation of the then current **NDCs**, alongside **IRENA's 1.5°C Scenario**.

Edition 22 of Low Carbon Pulse covered BloombergNEF's report **Net Energy Outlook (NEO)**: unless the rate of **GHG** reductions increases, the world's carbon budget will be exceeded by 2044: this will mean that neither the **Stretch Goal** nor the **Stabilisation Goal** will be achieved. This outcome is consistent with the **2021 Report**, and that by as early as 2028 we may miss the **Stretch Goal**.

On the basis of the **2021 Report** (and aligned with the **IEA Roadmap**, **WETO** and **NEO**) the United Nations Secretary General, Mr Antonio Guterres, has expressed extreme concern that, without increased **NDCs** and accelerated **GHG** emission reductions, we will take a **Catastrophic Pathway** (see below).

Current commitments and pledges will not be enough.

- **Increased commitments and accelerated implementation will be enough:**

The **IEA Roadmap**, **WETO**, **NEO** and **2021 Report** provide the modelled basis for Ms Greta Thunberg's "blah, blah, blah" speech given at the **Youth4Climate** conference, held in Milan, Italy, coinciding with the Pre-**COP-26** meeting during the week beginning September 27, 2021. Ms Thunberg led the **Fridays for Future** march.

One might not be drawn to the rhetoric of ridicule used by, or directed at, Ms Thunberg. Ms Thunberg is nevertheless right in saying that change is "not only necessary, but urgently necessary". Those who criticise Ms Thunberg are wrong in not accepting the necessity for action, and its scale, and that the necessity is upon us.

While the language and tone of Ms Thunberg is different from that of Mr Guterres' speech to the United Nations General Assembly during the week beginning September 20, 2021, the underlying message is the same. Mr Guterres expressed "extreme concern" that the world is on a catastrophic pathway to a **2.7°C** increase in average global temperatures compared to pre-industrial times (**Catastrophic Pathway**).

- **Pragmatism is needed and continued leadership from the world of business:**

**Politics of rhetoric:** As Ms Thunberg has no doubt realised, it is difficult to shame politicians, and that it is impossible to dislodge apologists for those politicians from their well-upholstered saddles from which they survey their version of the world from their high horses – to many a "world of the woke" and clouded by conspiracy theories expressed in search of listeners and viewers who will listen and watch. Mr Guterres and Ms Thunberg, share the same concerns and no doubt have the same frustrations.

**Business leaders to lead, policy settings to follow:** Leaders in business and business organisations are to the fore. For example, business leaders, Mr Warren Buffet, Mr Larry Fink, CEO of BlackRock, Dr Andrew Forrest, AO, founder of Fortescue Metals Group, Mr Bill Gates, co-founder of Microsoft and Breakthrough Energy, and Ms Shemara Wikramanayake CEO of Macquarie Group, and many others.

Leaders of business bodies, for example, Mr John Denton, AO, Secretary General of the International Chamber of Commerce, have a leading role to play if not the leading role to play.

**Policy settings set, Government and private sector to implement:** Business leaders and business bodies have a global constituency, and those leaders informed by their own good sense and experience (critically, what is and is not achievable), are able better to lead, and are doing so in a way that is pragmatic (climate change is upon us and we need to do something about it).

As noted in Edition 28 of Low Carbon Pulse, the predecessors of the current international oil company were there at the start of industrialisation, and they will be there when we get to **NZE**. It is important to note that none of these business leaders are saying that **NZE** cannot be achieved. It is recognised that achieving **NZE** is a mammoth task, in the memorable words of Mr Bill Gates, "*the hardest thing humanity's ever done*". Each of these leaders is backing the science of climate change and the development of technology to achieve **NZE**.

- **Art and science and technology:**

Two of the author's favourite poets were born in the 16th and 17th centuries: John Donne and Alexander Pope. As a school boy, their poems had the advantage of rhyming, with catchy couplets, memorised more readily, and, in the case of John Donne (at least for the most part), being short. With age, the poems of Donne and Pope reward with repeated reading and reveal layers of meaning, like Emily Dickinson, TS Eliot and WB Yates.

Nearly 150 years before pre-industrial times, Pope mused: "**Nature and nature's laws lay hid in the night. God said, Let Newton be! and all was light!**" The genesis of understanding is science, believe the science.

In simpler times, a time before the periodic table (1817) and two centuries before any understanding of the impact of compounds of elements within it on the climate system, clear thinking folk reflected that: "*Honor and shame from no condition rise. Act well your part, there all the honor lies*" (Pope), and "*No man is an island*" (Donne).

These sentiments resonate. Compound these sentiments with science, and they guide. Many political leaders and business leaders, so guided, are walking, the walk. All need to join to walk in step, ever faster, towards the

achievement of **NZE**. From the inconvenient truth about which Mr Al Gore spoke and wrote in 2000, to the greatest achievement of humanity inside 50 years, all need to play their part.

## 12 months in review ... reasons to be cheerful ...

### The pathway travelled in the past 12 months – key themes:

- **Ways and means are different, the outcome the same:**

**Tools of the trade:** Many reports over the past 12 months have identified the way and means (pathways and roadmaps) to **NZE**. There is no common way or means, it is for each country to find its own way and means. There was criticism of both the **IEA Roadmap** and the **WETO** on the basis that the pathways and roadmaps that they outlined were not achievable and as such flawed, and, in some instances, easily ignored.

It is important to note that neither the **IEA Roadmap** nor the **WETO** purport to be the only way and means of progressing to achieve **NZE**, rather each of them provides a tool-box of ways and means.

**Pragmatism on the way to trade:** In one of the quotes of the year, Ms Jenny Chase Head of Solar, at BloombergNEF, provided for the following assessment: *"I don't think that anyone really knows how they're going to get to net-zero, but the obvious place to start is just to build a load of renewables"*.

When asked by a leading Japanese trading house what its strategy should be in becoming involved in the hydrogen and hydrogen-based fuel projects, the author responded, continue to develop renewable electrical energy projects, and Scope 1 and 2 **GHG** emission reductions; the hydrogen market is not going to go away.

In an equally pithy and robust quote, Mr Mischa Repmann, Senior Environmental Management Specialist, Corporate Real Estate and Services, at Swiss Re is quoted as saying: *"The science is clear, the challenge is massive: Do our best, remove the rest! In other words reduce, reduce, reduce, and in parallel start balancing the emissions through carbon removal"*.

These two quotes demonstrate that while the science is clear, the pathway is not, and there is no one roadmap: progress towards achieving **NZE** is going to be piecemeal, it is going to be iterative. Develop renewable electrical energy, reduce, reduce, and remove, remove, remove, as quickly as possible.

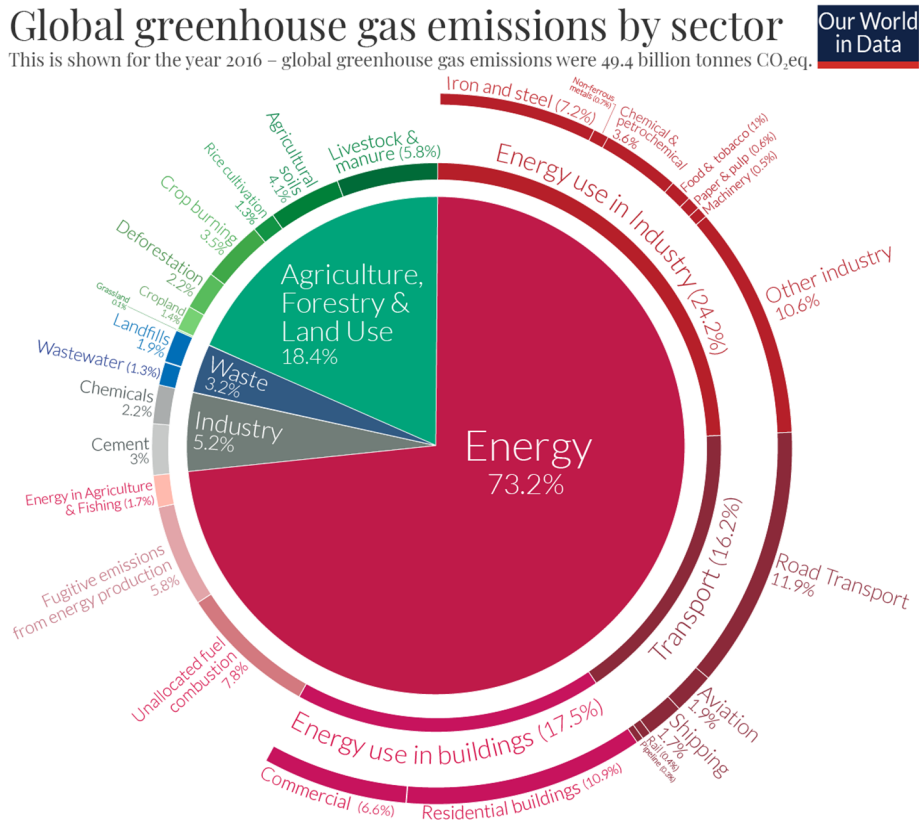
- **There are more than sufficient renewable resources:**

Over the last twelve months a number of atlas of renewable resources have been released: [pumped storage](#), [solar](#) and [wind](#). From the headlines accompanying the release of these atlases, the world has sufficient renewable resources many times over.

For once, the headlines are accurate, and yet incomplete. There are sufficient renewable resources to achieve **NZE**, but they need to be developed ahead of the retirement of existing electrical energy generation and at a rate that allows the production of hydrogen and hydrogen based fuels.

- **Sectoral analysis and geographical awareness:**

The following pie-chart is as good as any in providing a sense of the sectors from which **GHG** emissions arise.



OurWorldinData.org – Research and data to make progress against the world's largest problems.  
Source: Climate Watch, the World Resources Institute (2020).

Licensed under CC-BY by the author Hannah Ritchie (2020).

- **Progress before our eyes:**

One of the joys of authoring Low Carbon Pulse is following the connectedness of change, and the pace of change, in progress towards **NZE**.

Over the last 12 months there has been considerable progress, with development needs and policy setting needs being identified, and the emergence of initiatives to address them. This section (**Progress before our eyes**) reflects on some of the developments and policy settings in which we have seen material and significant progress: off-shore wind field development, battery electric storage systems (**BESSs**), the benefits of scaling up of photovoltaic solar, the development of **HVDC** interconnectors, green iron and steel, ports, and carbon clusters and hubs, and the recognition of the benefits of the reduction in **CH<sub>4</sub>** emissions.

- **Off-shore wind field development:** Edition 1 of Low Carbon Pulse reported on the UK's aim to achieve 40 GW of off-shore wind capacity by 2030 (**40 by 30**), and increase of 30 GW from 10 GW. The acceptance of the need to develop off-shore wind fields appears to be global. The reason for this acceptance varies, but in the **EU** and off-shore of Japan, South Korea and Taiwan, the reason is the area of land required on-shore to develop on-shore wind capacity.

At the time of the announcement of **40 by 30** (likely to move to **100 by 50** as time progresses) it was estimated that the additional 30 GW of off-shore wind capacity would require an area of 9,500 km<sup>2</sup> or an area six times the size of Greater London. While the cost of the development of off-shore wind field capacity remains higher than the cost of on-shore wind farm capacity, the area of land required is such that in many countries around the world are going to have to go off-shore. Even for countries with considerable land, off-shore wind field development is being contemplated to ensure that the electrical energy is generated closer to load.

It is fair to say that proving up off-shore floating wind technology and the yield from floating off-shore wind fields has resulted in what appears to be a shift off-shore. In addition to floating wind, the development of green islands in the North and Baltic Seas, among other things, to produce Green Hydrogen, and the prospect of the use of repurposed existing oil and gas infrastructure to produce Green Hydrogen, is highly encouraging.

- **BESSs:** While the author lives an itinerant life, for many years Australia was called home. For many years the "power poor" relation among the Australia States was South Australia because it has limited reserves of fossil fuels compared to other States, and had an interest patchwork of power generation capacity (well-known to the author). Necessity being the mother of invention, South Australia was an early adopter of renewable electrical energy across the State. In 2017, Tesla installed the world's largest lithium-ion battery in Hornsdale, South Australia – then the biggest **BESS**. The **BESSs** are now bigger, and better, and globally are becoming an integral part of grid (connected) and remote (non-connected) electrical energy systems.
- **Mega-scale photovoltaic solar – lowest cost electricity:** Over a number of months, the successful bids in tenders run by the Gulf Cooperation Council (**GCC**) countries resulted in some of the lowest cost electrical energy since the commercialisation of electrical energy in the late 19th and early 20th century. In this context, and in the broader context, there was an awakening to the Blue and Green Gold of hydrogen and ammonia, as well as the continued realisation of black gold.

The Kingdom of Saudi Arabia (**KAS**), Oman and the United Arab Emirates (**UAE**) have each embraced the development of Blue Hydrogen and Green Hydrogen production capacity (and hydrogen-based fuel, principally ammonia). The existing customers for hydrocarbon based fuels are becoming the customers for hydrogen based fuels. Further the **KAS** and the **UAE** have recognised the transformation of their economies to renewable and hydrogen based economies over time through the development of new urban environments that will use renewable energy and hydrogen.

- **HVDC interconnectors:** One of the developments that has surprised the author is the pace at which **HVDC** interconnector projects are being planned and developed. There are a number of regions of the world with world class renewable resources, solar and wind, but those regions do not have load to support the development of renewable electrical energy projects. President Xi Jinping has recognised the benefits of a global **HVDC** network delivering renewable energy from renewable resource rich countries.

Low Carbon Pulse continues to report on a number of **HVDC** interconnectors that are announced and that are progressing, and expects to report on many more (members of the Global Ashurst Towards Zero Emissions team are working on **HVDC** projects). It is anticipated that HVDC projects will continue to be developed, delivering renewable electrical energy from countries and regions long on renewable resources to countries and regions that are short on renewable resources and long on load.

- **Green Iron and Steel:** Article 2 in the **Shift to Hydrogen: Elemental Change series: [What needs to be decarbonized? And what role can hydrogen play?](#)** outlined the mass of **GHG** emissions arising from the difficult to decarbonise industries, including iron and steel. As the article was being developed, a number of news items were surfacing about the production of Green Steel. As is often the case, the author reads about a project but does not mention it in Low Carbon Pulse until it is taking shape. In late 2020, Hydrogen Breakthrough Ironmaking Technology (**HYBRIT**) came to the attention of the author. By the end of February 2021, the **HYBRIT** project appeared to be well-and-truly progressing, with a pilot project (in Svartöbeat, Lulea, Sweden) for the production of Green Steel up and running, with joint venture participants from "mine-to-mill-to-manufacture". The pilot project was being developed by **HYBRIT Development AB**, with LKAB to supply the iron ore, SSAB to produce the iron and steel, and Vattenfall to supply Green Hydrogen. (See Editions 10, 13, 16, 20, and 25 of Low Carbon Pulse.)

On August 18, 2021, the first fossil-free steel was produced by SSAB and delivered to Volvo Group. It will be interesting to follow the progress of **HYBRIT** as it progresses to produce up to 3 million metric tonnes (**mmtpa**) of fossil-free steel a year, and ultimately up to 5 **mmtpa**.

- **Ports, carbon clusters and hydrogen hubs:** In the **EU** and the **UK**, and elsewhere in the world, for example, Singapore, both Port of Singapore Authority and Jurong, the role of ports and the hinterland of ports has been taken as a given. Ports have a role to play in the import and export, including storage, of energy carriers currently, and this will continue, with fossil fuel derived energy carrier activity being replaced with the hydrogen and hydrogen-based fuel activity, including in some part of the world production (**Hydrogen Hubs**). If those activities are located close to industrial activity with demand for hydrogen and salt caverns for the storage of hydrogen, and in many instances renewable electrical energy from off-shore wind fields, all the better.

The areas around ports in many part of the world have established industries, many of them giving rise to **CO<sub>2</sub>** emissions (**Carbon Clusters**). If those ports and **Carbon Clusters** are located relatively close to depleted oil and gas fields that can accept captured carbon, and store it permanently, all the better. In a number of ports and hinterlands around the world, ports combined with **Hydrogen Hubs** and **Carbon Clusters** have proximity to broader industrialised areas and other ports to provide the supply of hydrogen with demand for it, and emission of **CO<sub>2</sub>** and a use for it. Edition 23 of Low Carbon Pulse featured ports, **Hydrogen Hubs** and **Carbon Clusters**, and in so doing outlined the scope and scale of these **NZE** eco-systems, and their role within the broader economy.

Other editions of Low Carbon Pulse have outlined the role of the Port of Rotterdam Authority (**PORA**), very much leading the way globally in its role around hydrogen and hydrogen-based fuel import, hydrogen production, carbon capture and carbon storage, and interface from the Port of Rotterdam into the northern regions of Europe. Of course other ports (coastal and inland, for example, Hamburg) are responding in similar ways, but **PORA** may be regarded as blazing a trail. For the author, there is no doubt that hydrogen economies are developing, and it is the development (actual and planned) at ports, **Hydrogen Hubs** and **Carbon Clusters** that this is most progressed, consistent with supply and demand developing in tandem.

- **CH<sub>4</sub> is in focus for reduction:** One of the most telling manifestations of progress over the last 12 months has been the action that has been taken to address **CH<sub>4</sub>**. It helps to retrace the progress, critically because it illustrates how quickly, in relative terms, action is being taken.

The Big Three **GHG** emissions are **CO<sub>2</sub>**, **CH<sub>4</sub>** and **N<sub>2</sub>O** (see Edition 24 of Low Carbon Pulse). It has been interesting to follow the dawning realisation of the need to address **CH<sub>4</sub>**, in terms of potency by mass, **CH<sub>4</sub>** is more potent than **CO<sub>2</sub>**, having a global warming potential over a 20 year period of up to 84 times that of **CH<sub>4</sub>**. This has long been known (and by some estimates responsible for up to 30% of the increase in average global temperatures: see Edition 17 of Low Carbon Pulse). Also what has long been known is that **CH<sub>4</sub>** concentrations in the climate system have been increasing over time, in particular since the early to mid-noughties. As noted above, **CH<sub>4</sub>** emissions arise for a number of sources, including fugitive emissions and from **AFOLU**.

On November 23, 2020, 62 oil companies signed an international agreement pledging to report **CH<sub>4</sub>** emissions more effectively as part of the Climate & Clean Air Coalition's Oil and Gas Methane Partnership (see Edition 5 of Low Carbon Pulse). The **IEA** released a Regulatory Roadmap and Toolkit (see Edition 7 of Low Carbon Pulse). At the Leaders' Summit on Climate Change held on April 22 and April 23, 2021, President of Russia, Mr Vladimir Putin, noted the need to reduce **CH<sub>4</sub>**, and this was carried forward (see Editions 15, 16, 17 and 23 of Low Carbon Pulse).

Edition 26 of Low Carbon Pulse repeated that narrative around the potency of **CH<sub>4</sub>**, and noted that this was why in recent Government to Government engagement and publications from many organisations, the reduction of **CH<sub>4</sub>** emissions was towards the top of the agenda. It is estimated that up to 57% of **CH<sub>4</sub>** emissions could be reduced by 2030, reducing the impact of on the climate system by 0.25°C by 2050, and by 0.5°C by 2100 (see Edition 26 of Low Carbon Pulse for a more nuanced analysis).

Edition 27 of Low Carbon Pulse reported that on September 17, 2021, the **EU** and the **US** had signed the **Global Methane Pledge** under which they committed to reduce **CH<sub>4</sub>** emissions by a third within a decade. Clearly there is more that can be done, but it was a start, and a meaningful start, all the more so because it is achievable. In Edition 27 of Low Carbon Pulse, it was noted that the **EU** and the **US** should ensure that as many other countries as possible join them in this critical initiative. It is understood that around a further 30 countries have committed to join the **Global Methane Pledge**.

- **More progress needed:**

Just as there has been progress before our eyes, there has been less progress.

- **Acceleration of CCS / CCUS needed:**

The **IEA** has long expressed the view that carbon capture and storage (**CCS**) and carbon, capture, utilisation and storage (**CCUS**) is required if **NZE** is to be achieved by 2050: **IEA** expressed the view in Q3 of 2020 that achieving **NZE** is virtually impossible without **CCS** / **CCUS**. This view was confirmed in the **IEA Roadmap**, **WETO**, BloombergNEF's **NEO**, and Wood Mackenzie on a number of occasions since May 2021.

**CCS** and **CCUS** is key to the capture of **CO<sub>2</sub>** from current industrial processes and power generation, and to capture **CO<sub>2</sub>** to allow the production of Blue Hydrogen. There is a role for Government in the development of **CCS** / **CCUS** capacity, and in the commercial arrangements that underpin it. The **UK** Government is showing the way, but globally between 4 Gt and 8 Gt needs of **CO<sub>2</sub>** needs to be stored.

- **Blue Hydrogen and Blue Ammonia production:**

If there is one concept that has been repeated more than any other in Low Carbon Pulse (and sibling publications) it is that supply and demand for hydrogen needs to develop in tandem, with supply a little ahead of demand. The will allow investment decisions to be made efficiently with supply side responding to visible and growing demand, and demand side being prepared to make investment decisions based on an assurance of supply and the cost of that supply.

In Article 1 on the **Shift to Hydrogen Series: Elemental Change, Why Hydrogen? Why Now?** (published in early December 2020), the author asked: "Which came first, the supply or demand side?" Answering "... neither they grew together, ... in the case of the chicken and egg there was a hatching, and in the case of hydrogen supply and demand, a matching ... parented by government and business". In the **UK Hydrogen Strategy (UK H2S)** released on August 17, 2021 it is stated that: "developing a hydrogen economy requires tackling the "chicken and egg" problem growing supply and demand in tandem".

The **UK H2S** has a "twin track" approach of developing both Blue Hydrogen and Green Hydrogen capacity (clean hydrogen). The use of **CCS / CCUS** capacity is essential to the development of supply and demand for hydrogen. The "twin track" allows investment decisions now to shift to Blue Hydrogen use, with Green Hydrogen the long-term preferred outcome.

- **Negative Greenhouse Gas Emission Initiatives (NGHGEIs):**

As noted above, to achieve **NZE** it is necessary to reduce, peak and remove (**RPR**). There are many means of removal, and the **2021 Report** devotes narrative to the ways and means. Removal of **CO<sub>2</sub>** from the climate system is as yet to receive the attention required from policy makers. As noted in recent editions of Low Carbon Pulse, the removal of **CO<sub>2</sub>** from the climate system needs to start in earnest, now if not sooner!

The use of **NGHGEIs** is key to the removal of **CO<sub>2</sub>** and to the "decarbonisation" of the **AFOLU** sector. Government to Government, including through Policy Banks, have the ability to formulate policy settings that ensure that certain countries and regions of the world are able to derive value from the preservation of existing use of land, and progress to the development of land use, and land and ocean use that remove **CO<sub>2</sub>**.

- **Higher quality carbon credits and trading platforms:**

Over the last 12 months there has been considerable growth in demand for carbon credits as corporations have committed to the achievement of carbon neutrality and **NZE**. As this market develops further, it is hoped that trading platforms develop that allow for the trade in high quality carbon credits, critically carbon credits that are issued on the basis of actual net absorption of **CO<sub>2</sub>**, rather than notional.

## 12 months in preview ... reason to **RPR** at a faster rate ...

**In facts and stats – the need for acceleration in GHG emission reductions:**

- **Developing world not at peak GHG emissions:** On August 4, 2021, the World Economic Forum (**WER**) released a short [video](#) conveying current key dynamics, projected increases in **GHG** emissions, and that the current rate of progress to **NZE** will not be sufficient: the majority of global **GHG** emissions arise from countries (with over 65% of global population) that have yet to reach peak **GHG** emissions. The **GHG** emissions from those countries are projected to increase by 5 Gtpa (5 billion metric tonnes per annum) by 2040.
- **Growing population, increased urbanisation:** As noted in Edition [22](#) of Low Carbon Pulse (under **Empowering Cities for a Net Zero Future**), the decarbonisation of cities has to be front and centre of policy settings: every month globally an urban area the size of New York City will be developed for the next 40 years. In this context, if the countries that have reached peak emission are to work with countries that have not, to reduce, indeed to avoid, **GHG** emissions, there needs to be close coordination.
- **What does this mean?** Even if the developed countries achieve **NZE** by 2040, this will not achieve **NZE** globally to achieve either Paris Agreement Goal. This is consistent with the analysis of BloombergNEF in **NEO**: unless the rate of **GHG** reductions increases, the world carbon budget (which does not include 5 Gtpa increase noted above), will be exceeded by 2044: this will mean that neither the **Stretch Goal** nor the **Stabilisation Goal** under the Paris Agreement will be achieved. This outcome is consistent with the **2021 Report**, and the **Catastrophic Pathway**.
- **Developed world needs to accelerate progress to NZE, home and abroad / overseas:** As noted in previous editions of Low Carbon Pulse, the rate of investment required to enable countries that have yet to reach peak **GHG** emissions to achieve **NZE** will not be achieved unless developed countries work with those countries to accelerate decarbonisation, while at the same time increasing reductions and removing **GHGs**.

### The path to travelled in the next 12 months:

- **"This is our generation's moon shot":** During the Leaders' Summit held on April 22 and 23, 2021, **US** Energy Secretary, Jennifer Granholm, said that the achievement of **NZE** was this generation's moon shot.  
On May 25, 1961, the late Mr John F. Kennedy, the newly minted president, told the **US** Congress that the **US** "should commit itself to achieving the goal before this decade is out, of landing a man on the Moon and returning him safely to the Earth". There was around 40% support, and around 60% against the idea.  
On September 12, 1962, the late Mr John F. Kennedy delivered his marvellous "We choose to go to the moon" speech: " ... technology has no conscience of its own. Whether it will become a force for good or ill depends on man ... We choose to go to the Moon. We choose to go to the Moon in this decade, and do other things, not because they are easy, but because they are hard ...".  
Combining the concepts and rhetoric of two very different people and eras, achieving **NZE** by 2050 is more than this generation's moon-shot. If we get it wrong it could be our last shot, and it is not a choice, it is an imperative – it is a challenge that we have to accept, and that we cannot postpone, and that we have to win. This is why Ms Thunberg, and her many millions of followers and supporters have a view, a strong view, and they are right to have that view.
- **Avoid any retreat from limiting average global temperatures to 1.5°C increase:**  
Since Edition [1](#) of Low Carbon Pulse, Low Carbon Pulse has referred to the **Stretch Goal** and the **Stabilisation Goal**, the former limiting the increase in average global temperatures to **1.5°C** above pre-industrial levels, the latter limiting the increase in average global temperatures to between **1.5°C** and **2°C** above pre-industrial levels.

The phrase **Stretch Goal** reflected the author's view that it was going to be a stretch to limit the increase in average global temperature to **1.5°C**. The Paris Agreement contemplates a range, and that range is **1.5°C** to **2°C**, and all the science indicates the importance of staying within this range, but not to give up on the Stretch Goal. Further, all policy settings should continue to be framed and calibrated to achieve the **Stretch Goal**.

- **Renewable electrical energy is at the core of achieving NZE:**

Many reports over the past 12 months have identified the ways and means (pathways and roadmaps) to **NZE**. There is no common way or means, it is for each country to find its own way and means, but as noted above the best place to start is to build a load of renewables.

While a number of folk have been doing their own mathematics, and the **IEA Report**, **WETO** and **NEO** each estimated the scale of renewable electrical energy that need to be built, whatever the metric for a load of renewables, it is many loads, loads for loads! It is for Governments to ensure that renewable electrical energy is developed, the load is there.

- **Cities and existing power generation have to be the focus:**

Editions [25](#) and [26](#) of Low Carbon Pulse reported two interesting facts: 25 mega-cities are responsible for 52% of **GHG** emissions arising in an urban setting globally, and 5% of the world's global electrical energy capacity gives rise to 73% of the **CO<sub>2</sub>** emissions arising from the generation of electrical energy globally.

While these are power station by power station, city by city and country by country issues, the facts allow a focus to be applied to policy settings, so as to prioritise decarbonisation electrical energy generation and cities.

- **NGHGIEs to be preferred over Carbon Credits:**

The decarbonisation of the **AFOLU** sector is the most difficult, tied as it is in many countries and regions to cultural, political and social dynamics, and, as populations become more prosperous, tied to choices that people are able to make around the foods that they consume.

In the near to medium term, there is a role for Government to develop and to promote **NGHGIEs** that create value for landholders and countries more broadly, including the value of not using land at all, and using land in ways that results in removal of **CO<sub>2</sub>** from the climate system, in a way that does not denude that value through the sale of carbon credits over the long term for use as off-sets.

In addition, there is a role for Government in the collection of waste land use, and more broadly across waste and waste water arising in both urban-settings and non-urban-settings and the use of that waste to produce bio-energy.

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We bring together lawyers of the highest calibre with the technical knowledge, industry experience and regional know-how to provide the incisive advice our clients need.

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