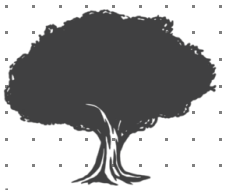
The Energy Transition Evolves, 2019-2024

Five global trends – five years later

August 20, 2024



THE HAWTHORN CLUB

FOR EXECUTIVE WOMEN IN ENERGY

BloombergNEF

Contents

Section 1.	Executive summary	1
Section 2.	Introduction	3
Section 3.	Five global trends in the energy transition	4
Section 4.	North America: Cash Is King!	10
Section 5.	Australia: The Trilemma Down Under	14
Section 6.	Europe: The Future Is Green	18
About us		23

Section 1. Executive summary

This paper, co-authored by The Hawthorn Club and BloombergNEF, provides insights into the energy transition from the Club's Global Summit held in US Spring 2024. It pairs BNEF's global analysis with lived experience from women at the forefront of the transition. We explore five trends of the energy transition, first identified five years ago by Albert Cheung, BNEF's Deputy CEO. The paper outlines how these trends are tracking, what was missed and what has changed, as well as insights on these trends shared by Hawthorn Club thought leaders through a regional lens, with a focus on the US, Australia and Europe.

In some ways, the evolution of the energy transition has been a story of growth: global investment in the energy transition hit $1.8 trillion last year, more than triple the $565 invested five years earlier. In other ways, it's a story of change: electrified transport is now the sector pulling in the biggest investment sums, whereas in 2019 it was renewable energy. Despite a global pandemic, worldwide shocks to the energy transition supply chain, and the outbreak of wars in Europe and the Middle East, the energy transition trends identified in 2019 have not fundamentally changed – but they have entered a new phase.

5

Energy transition trends discussed at The Hawthorn Club's Summit in April 2024

85

Summit attendees

200+

Executives in The Hawthorn Club

Five trends, revisited

Trend 1: The clean transport transition has entered its hardest phase yet. Electric vehicle (EV) sales have skyrocketed, but year-on-year growth rates are now in decline. While early adopters have driven significant sales, the market must now shift to cater to the mass market. Legacy automakers and startups face difficulties in this evolving landscape, with China now leading global EV production. The sector must also overcome infrastructure challenges in deploying sufficient charging stations to support future demand. Besides EVs, sustainable aviation fuel (SAF) is gaining attention due to rising mandates and voluntary commitments. However, SAF faces supply constraints, highlighting the need for policy support to meet growing demand.

Trend 2: Tripling renewables is tough but achievable. At the COP28 meeting in Dubai in late 2023, global policymakers committed to tripling worldwide renewables deployment by 2030. According to BNEF analysis, achieving this goal is crucial for reaching net-zero emissions by 2050, but it requires substantial funding, including doubling annual renewables investments and tripling power grid expenditures by 2030. Solar installations are on track, having quadrupled in the past four years, while wind installations have doubled but still lag needed growth. Having a diverse technology mix is important due to the intermittency of renewables, and this will also necessitate significant growth in energy storage deployment, which must increase 16-fold to meet net-zero targets.

Trend 3: Commodity markets will be increasingly shaped by the energy transition and other shocks. The past five years have highlighted how commodity markets have been shocked by multiple crises impacting the energy transition. Covid-19 caused a significant drop in energy demand and fossil fuel prices. Russia's invasion of Ukraine in 2022 triggered sanctions on Russian gas and oil, leading to an energy crisis in Europe. And a spike in the prices of lithium,

nickel, and cobalt in 2022 prompted battery manufacturers to seek alternatives. Despite these challenges, the energy transition remains a key driver of commodity markets, even though short-term risks have increased.

Trend 4: Materials and supply chains are the new battleground. In 2023 over 90% of global investments in factories for battery, solar components, wind turbines, and hydrogen electrolyzers took place in China, which holds more than 80% of production capacity in key clean-tech segments. Some economies are responding by promoting onshore manufacturing, exemplified by the US Inflation Reduction Act (IRA), which has spurred $123 billion in announced investments. However, many projects are still in the planning stages, and China's established manufacturing base presents a significant hurdle to altering the global supply chain landscape quickly.

Trend 5: Politics (and geopolitics) could change everything. The energy transition is significantly influencing global politics, with two-thirds of the world's population voting for new leaders this year. Elections in the EU, UK, and US could heavily impact the transition. The UK's new Labour Government has ambitious renewable energy goals, while the European Commission's proposed 90% greenhouse gas reduction target for 2040 depends on European Parliament approval. In the US, former President Donald Trump, the Republican presidential nominee, may repeal the IRA, according to the Financial Review. The centrality of the energy transition in these elections underscores its growing importance over the past five years.

Hawthorn Club thought leaders provide their insight on these trends

The US Outlook – Cash Is King! As the Cipher News Clean Technology Tracker highlights, there are many demonstration projects for important clean technologies under construction in the US. Now, there is a need to move to commercial-scale projects more quickly, and in a way that is inclusive of and collaborative with the communities hosting them. Innovation is imperative in a market that faces such complex dynamics. On the one hand, costs are not coming down as expected, due to cheap natural gas, labor shortages, lack of permitting reform, and competition for equipment. On the other hand, there is an insatiable demand for more clean power, driven by net-zero goals, and strong policy drivers in the US, including the Inflation Reduction Act, the CHIPS and Science Act, and the Infrastructure Investment and Jobs Act.

The Australian Outlook – The Trilemma Down Under. Politics in Australia have shifted. For the first time, Australia has both national and state-level governments united in their commitment to moving the country to net zero. This has set the stage for accelerated renewables deployment and a greater focus on storage and modernization of the grid, both of which will need to be underpinned by what Kane Thornton (CEO, Clean Energy Council) termed a "people-centered" transition. The Australian Government has implemented a 'capacity investment scheme' to deliver on its ambition to achieve 82% renewable energy by 2030, committed AU$20 billion to improving the grid, and instituted policy support for a variety of clean energy sectors. The challenge is to match the wall of institutional capital with projects that provide a reasonable risk return profile.

The European Outlook – The Future is Green. Globally, the average growth rate for investment in the energy transition is around 17%; in the European Union and the UK, that rate is 41%. At the macro level, this is good news, but zoom in and one finds challenges. Market design improvements are needed to better incentivize renewables and manage grid operations. The war in Ukraine has made energy security a priority. And while energy security has historically been understood in terms of enough generation capacity, physical security of infrastructure is an increasingly important piece of the puzzle. Optimism regarding emissions reduction targets remains mixed, with political and industry perspectives varying as to these goals' attainability.

Section 2. Introduction

"The executive women from The Hawthorn Club network reflect on the key trends affecting Australia, the USA and Europe, and how that is impacting the energy transition in their regions."
Meade Harris, CEO, The Hawthorn Club

The Hawthorn Club is the international network for executive women in the energy industry. The mission of the Club is to support the appointment of women to senior corporate positions and boards, and to facilitate gender diversity within the energy sector. The executives of the Hawthorn Club are helping to drive the global energy transition.

BloombergNEF is a strategic research provider covering global commodity markets and the disruptive technologies driving the transition to a low-carbon economy. BNEF's global team leverages the world's most sophisticated data sets to create clear perspectives and in-depth forecasts that frame the financial, economic and policy implications of industry-transforming trends and technologies.

The Hawthorn Club and BNEF have a partnership to promote gender diversity in the energy sector.

The Club's annual Global Summit was held in New York City on April 18, 2024 and was attended by 85 of the most influential women in energy from the Club's three regions – North America, Europe and Asia Pacific. Albert Cheung, BNEF's Deputy CEO, revisited the global trends in the energy transition that he first presented five years ago. The thought leaders of The Hawthorn Club then discussed these global trends through a regional lens, with a particular focus on Australia, Europe and the US.

Left to right: Laura Hunt, Managing Director & Co-Head of US Power, Marex; Meade Harris, CEO, The Hawthorn Club. Source: The Hawthorn Club

Section 3. Five global trends in the energy transition

Albert Cheung, Deputy Chief Executive Officer, BoombergNEF
Interviewed by Julie McLaughlin, Managing Director US Energy Practice, Alvarez & Marsal, and North American Advisor, The Hawthorn Club

Much has happened since Albert Cheung first presented his *Global Trends in the Energy Transition* at a Hawthorn Club Summit five years ago in 2019. A global pandemic, worldwide shocks to the energy transition supply chain, and the outbreak of wars in Europe and the Middle East are just a few factors that have shaped the energy transition in profound and lasting ways. At the same time, the energy transition is entering a new phase, as technologies mature and governments adopt ambitious climate goals.

Teasing out the trends in this transition, as moderator Julie McLaughlin noted, is not always easy. So Cheung returned to this 2024 Summit to provide an updated take on the trends, reflect on the past five years in the clean-energy space, and consider where we might be going next.

"Based on our vantage point, we often have a view that feels true – but when we confront the data it is not always consistent with those heuristics. That's why digging into the data is so important."
Julie McLaughlin

Left to right: Albert Cheung, Deputy CEO of BNEF, Julie McLaughlin, Managing Director US Energy Practice, Alvarez & Marsal. Source: The Hawthorn Club.

Trend 1: The clean transport transition has entered its hardest phase yet

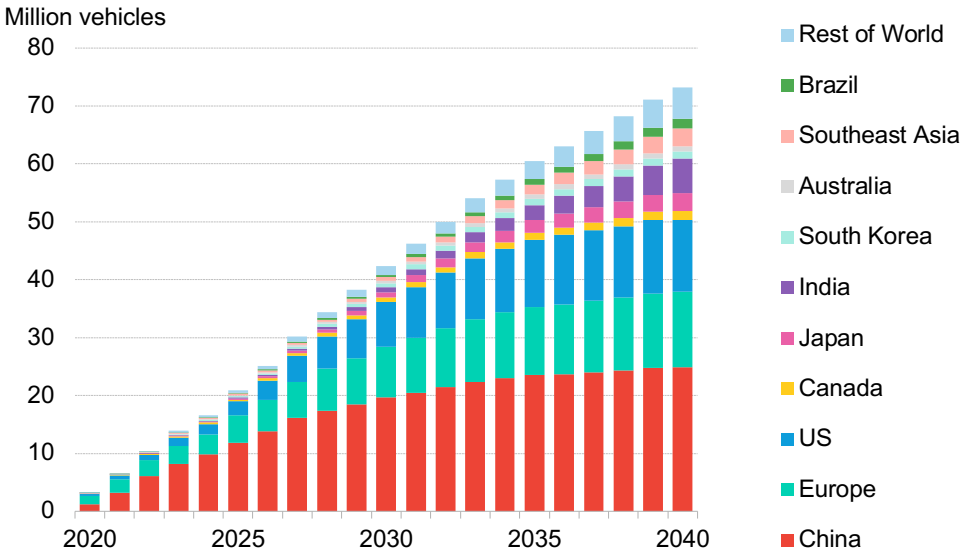
What we said in 2019: EVs and batteries are coming of age

Electric vehicle (EV) sales are growing by orders of magnitude. A decade ago, fewer than 500,000 new EVs were driven off lots worldwide. By 2018, that number had risen to 2 million per annum, and BNEF is forecasting 16.6 million EV sales in 2024. Yet the sector seems to be slowing: even as sales numbers soar, year-on-year growth rates have started to fall.

This has led to a flush of headlines proclaiming that EVs are in trouble, yet Cheung was quick to dispel that notion. "When we talk about entering the hardest phase, we're not saying things are going badly," he explained. Instead, as the early-adoption market nears saturation, automakers will need to pivot to capturing the mass market, which "demands different levels of usability and affordability."

That pivot is tricky. Legacy automakers are struggling to find their footing in a sector currently dominated by startups, while even the most successful startups are facing an evolving market landscape. Five years ago, Norway was the clear global leader in electric-vehicle sales. Today, China's EV market is miles ahead of all others. In some months, EVs will account for 40-50% of sales in China, and Chinese company BYD is jockeying with Tesla to lead global EV sales.

Figure 2: Passenger electric vehicle sales under BNEF's Economic Transition Scenario



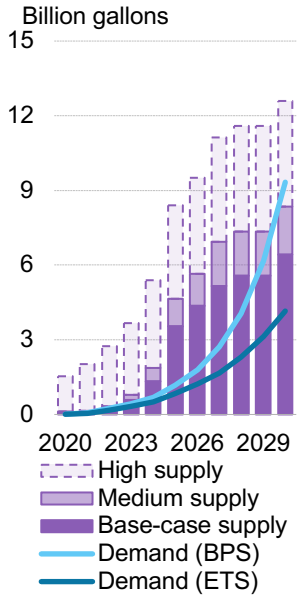
Source: BloombergNEF. Note: The Economic Transition Scenario, which is based on BNEF's New Energy Outlook, assumes no new policies or regulations are enacted that impact the market. It also does not assume any long-term climate targets are hit, or that any combustion vehicle phase-out targets that have been announced by countries, states, cities or companies are achieved. Instead, adoption is primarily driven by techno-economic trends and market forces. For more, see BNEF's Long-Term Electric Vehicle Outlook 2024.

Cheung also pointed out that the EV sector faces the same challenges as any industry that is looking to scale, including the chicken-egg relationship of deploying new technologies and building the infrastructure needed to support them. In the case of EVs, the key challenge is charging infrastructure. According to BNEF's Net Zero Scenario, an all-electric fleet would require deploying 750 million chargers to meet an eye-popping 8 petawatt-hours of demand by the middle of the century. Without the charging infrastructure in place, an all-electric fleet will be stuck in parking lots.

EVs may be the flashiest element of cleaning up transport, but they are far from the only technology helping decarbonize travel. Cheung also spoke about rising demand for sustainable aviation fuel, or SAF. Demand for the fuel is set to build, as mandates such as the ReFuelEU aviation initiative begin to take effect in 2025. Voluntary commitments are also rising, especially as concerns are raised about the credibility of the carbon offset market.

Cheung pointed to a factor that makes SAF relatively unique within the energy transition ecosystem: it's one of the few sectors likely to be constrained by supply. Most of the time, Cheung said, "we're talking about how you stimulate demand. But for SAF, demand is there. It's actually the supply – and specifically the feedstock – that's a challenge." Without additional policy support for SAF supply, BNEF scenarios suggest that demand will soon significantly outstrip demand.

Figure 1: Global demand and supply scenarios for sustainable aviation fuel



Source: BloombergNEF. Note: BNEF's Economic Transition Scenario (ETS) here includes only existing policies. The Boosted Policy Scenario (BPS) includes additional policy mechanisms or targets being developed and under consideration. For more, see BNEF's 2024 Sustainable Aviation Fuel Outlook: Getting Airborne.

"From an opportunity perspective," Cheung observed, "that makes it quite different and quite interesting."

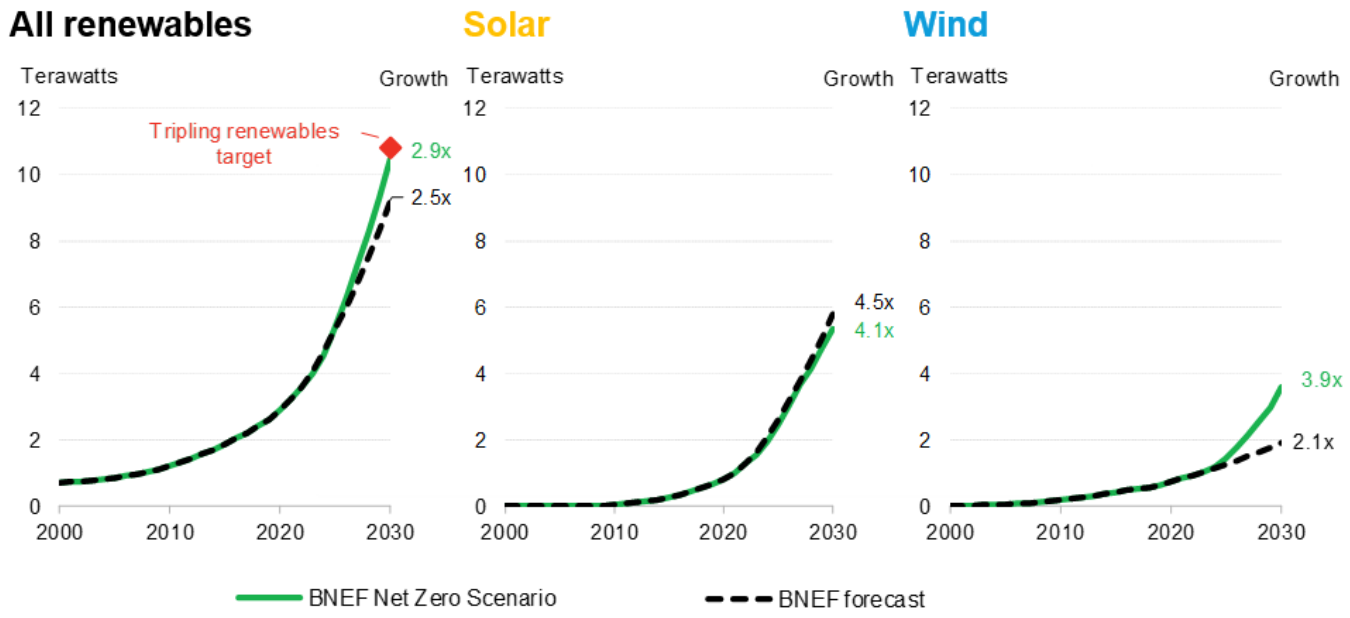
Trend 2: Tripling renewables is tough but achievable

What we said in 2019:
A clean power system is in sight

At the COP28 meeting in Dubai November 2023, global policymakers settled on a remarkable goal: tripling worldwide renewables deployment by 2030. That means global installed capacity would rise from 3.6 terawatts today to nearly 11 terawatts by the end of the decade.

That's the right target, Cheung said, as according to BNEF analysis, tripling renewables is necessary to put the world on track for net zero. But the numbers can be overwhelming. BNEF estimates that hitting this target will require doubling annual renewables investments and tripling power grid spend by 2030.

Figure 3: Renewables build to 2030 under BNEF's Net Zero Scenario and forecast



Source: BloombergNEF, International Energy Agency. Note: The Net Zero Scenario, which is part of BNEF's New Energy Outlook, maps out a pathway to global net zero by 2050. Here, "renewables" include large hydro.

The good news is that solar build is on track to hit that target. Installation rates have quadrupled in the past four years. Wind is a laggard only compared with solar, but while wind installations have doubled over the same time period, they still fall short of the build needed to meet the global goal.

The rub is that with intermittent renewables, the technology mix matters. "The world could most easily triple renewable capacity by relying primarily on solar. However, this would not generate enough clean energy to align with a net-zero path," BNEF wrote shortly before the COP meeting in a research note co-authored by BNEF Head of Power Meredith Annex, who also spoke at the Hawthorn Club Summit.

Intermittency also means that while the COP goal says nothing about energy storage, the technology will be vital to hitting the goal. Under BNEF's scenario, storage deployment needs to grow a jaw-dropping 16-fold to hit net zero.

Nevertheless, Cheung remains optimistic. Tripling renewables "won't be easy," he confirmed. "But it can be done."

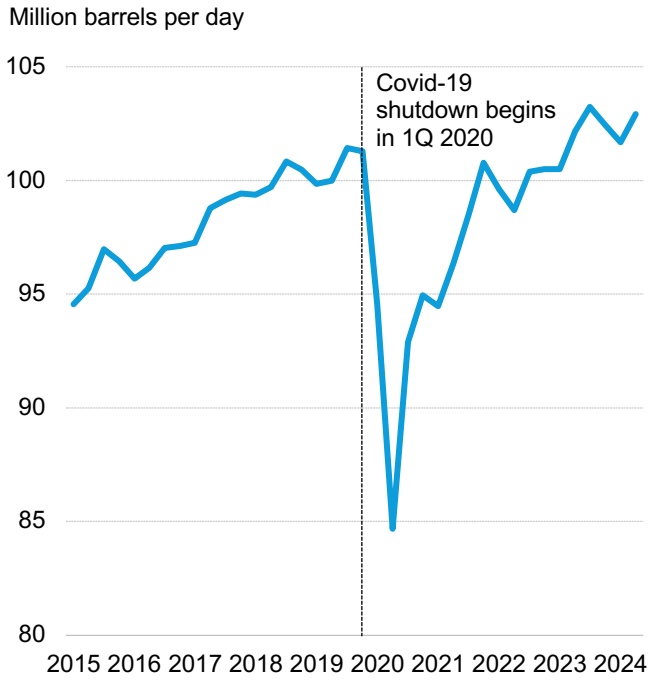
Trend 3: Commodity markets will be increasingly shaped by the energy transition… and other shocks

What we said in 2019: Commodity markets will be increasingly shaped by the energy transition

If the five years since Cheung first presented his "five trends" to the Hawthorn Club have illustrated anything, it's just how easily a spanner can be thrown into the energy transition works. In 2019, "we were looking at different scenarios and considering what they mean for long-term oil demand," Cheung explained. "And then a bunch of short-term stuff happened."

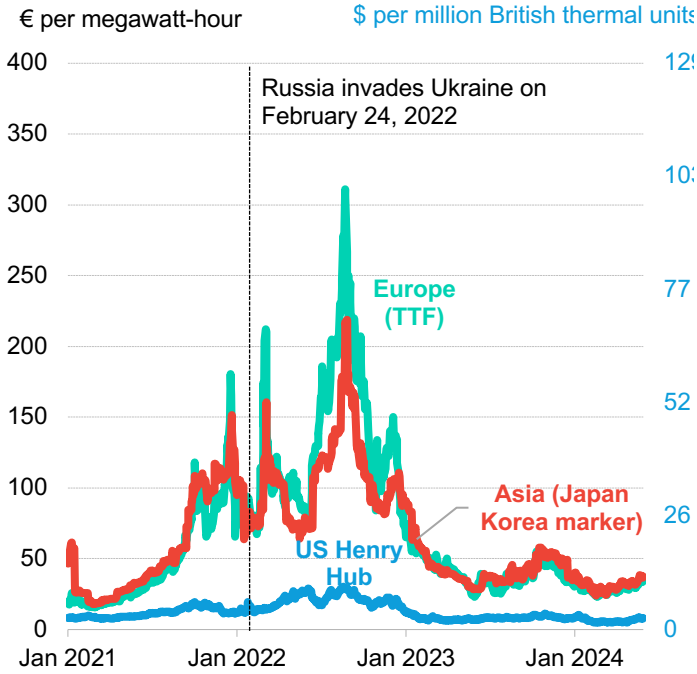
First came the Covid-19 pandemic. As people retreated to their homes, both energy demand and the price of fossil fuels sank. Then Russia's invasion of Ukraine in February 2022 kicked off a slew of sanctions on Russian gas and oil – and an energy crisis in Europe. And a spike in the price of lithium and nickel in 2022 rattled the market, leading some battery manufacturers to look for alternatives.

Figure 4: Average daily global oil demand, by quarter



Source: BloombergNEF, International Energy Agency.

Figure 5: Month-ahead natural gas prices



Source: BloombergNEF; Bloomberg LP {TTFG1MON Index}, {FSNGM1 Index}, {AJKMM1 Index}.

Cheung still sees the energy transition as the "long-term trend driving commodity markets". Yet analysts are now approaching these markets with a greater awareness of the many short-term uncertainties and other factors that are also at play.

Trend 4: Materials and supply chains are the new battleground

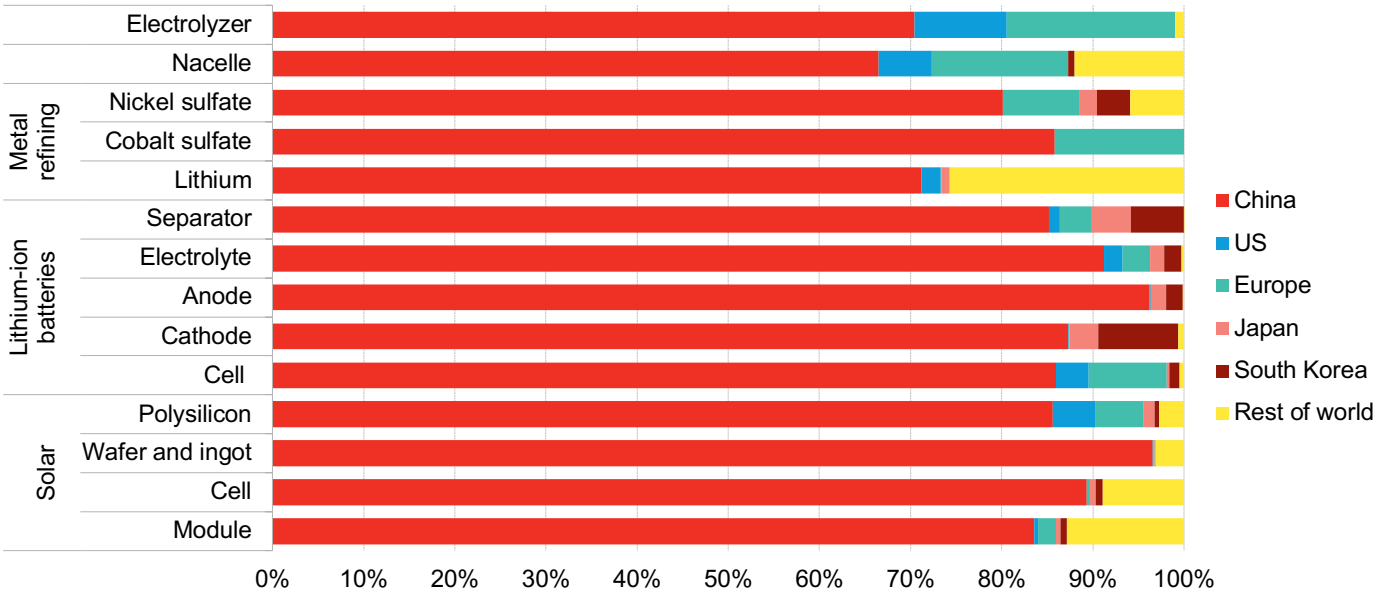
What we said in 2019: Digitalization is the new battleground for energy companies

Revising a key trend away from digitalization might, at first blush, seem surprising. The power demands of data centers, artificial intelligence, cryptocurrency mining and other developments in the digital world are omnipresent in energy transition discourse.

Yet for Cheung, the real "battleground" in the coming years will be materials and supply chains.

More than 90% of global investment in factories for battery and solar components, wind nacelles, and hydrogen electrolyzers in 2023 went to China, according to BloombergNEF research, and China boasts upwards of 80% of global production capacity in 11 key segments of the clean-tech value chain.

Figure 6: Clean-technology production capacity in 2023, by facility location



Source: BloombergNEF. Note: Capacity is by physical facility location, not manufacturer headquarters. Electrolyzers are for hydrogen production, nacelles are for wind. Capacity is by physical facility location, not manufacturer headquarters. Lithium refers to lithium hydroxide and carbonate, and is in lithium carbonate equivalent. Solar, hydrogen, battery components expressed in megawatts (MW), megawatt-hours (MWh), square meters (m²) or metric tons. For more, see BNEF's China's Clean-Tech Dominance Grows Despite Onshoring Push.

Some economies, including those listed in Figure 6, are seeking to benefit more actively from the materials and supply-chain opportunities . The push to onshore manufacturing – or to move it to countries that are signatories of free trade agreements – has been a major impetus behind energy transition policy in recent years. The US Inflation Reduction Act (IRA) is a case in point. Since the law's passage in August 2022, $123 billion in investments have been announced in North America; $114 billion of these are for manufacturing projects in the US. The Biden-Harris administration has also imposed stiff tariffs on Chinese-sourced components. The IRA's guidance on so-called foreign entities of concern, for instance, prevents electric vehicles made with more than a set share of Chinese components from qualifying for crucial tax breaks.

Yet as Cheung stressed, these announced projects are just that: announced. Many have yet to be built, and long lead times and an entrenched manufacturing base in China could make it hard to quickly turn the tide of China's global supply chain dominance.

Trend 5: Politics (and geopolitics) could change everything

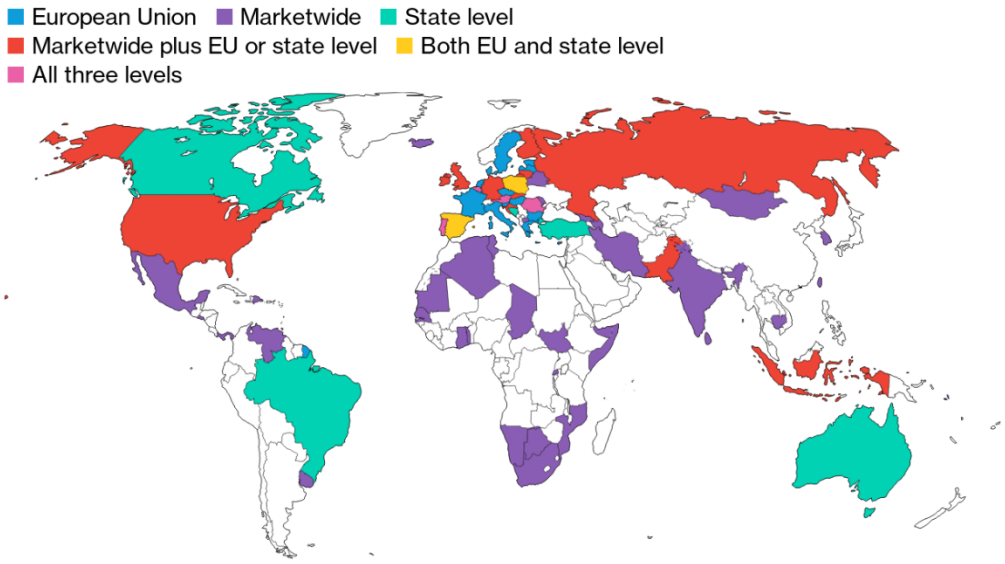
What we said in 2019: The social and political conversation is changing

Trade wars are not the only way that the energy transition is impacting – and being impacted by – global politics. Two-thirds of the world population will go to the polls to elect leaders this year. And some of these elections – including those in the EU, the UK and the US – could have significant impacts on the global energy transition.

The UK Labour Party's landslide win brought with it major energy transition goals, including a decarbonized power system by 2030 and a faster phase-out of gas-powered cars. Yet according to BNEF analysis, implementing these plans will be a challenge.

The European Commission, meanwhile, has proposed an ambitious 90% greenhouse gas reduction target for 2040, which will require the approval of the European Parliament. Yet the success of right-wing parties in the June elections could undermine the proposal. Polls in the US presidential election currently remain narrow, but Trump as the Republican nominee said he may repeal the IRA should he be elected. While a full repeal is considered politically unlikely, there is a risk of partial appeal of different aspects of the IRA.

Figure 7: Economies with elections in 2023



Source: BloombergNEF, public announcements. Note: Data shown are for distinct economies. For more, see BNEF's Wave of Elections Poses Risks for the Energy Transition.

The fact that the energy transition is playing such a role in elections is itself a signifier of how the culture and conversation around the transition has changed in the past five years. "Five years ago, net zero was still a relatively new concept, introduced to us by the IPCC (Intergovernmental Panel on Climate Change) and popularized by figures like Greta Thunberg," Cheung observed. "Today it has become a guiding principle for the energy transition globally."

Section 4. North America: Cash Is King!

Panel discussion:

- Susan Nickey, Chief Client Officer, HASI
- Val Smith, Chief Sustainability Officer, Citi
- Hannah Badrei, Senior Vice President, Global Energy Advisory, Trio
- Melissa Peterson, Head of Onshore and P2X Americas, Ørsted

Moderated by: Amy Harder, Executive Editor, Cipher

Amy Harder opened this panel discussion with a presentation of Cipher's Clean Technology Tracker, an interactive map that focuses on five energy transition technologies at various stages of development around the US: carbon management, clean hydrogen production, hydrogen electrolyzer manufacturing, sustainable aviation fuel, and critical-minerals projects. These are just a few of the technologies that need to progress in order to meet ambitious transition goals and address climate change, in the US and also around the world.

"Five years ago we weren't talking as much about the 'energy transition', we were talking about 'climate change'. The energy transition wasn't seen as inevitable, but there is a sense of inevitability and action today that really underscores the opportunity."
Val Smith

Figure 8: North America panel

From left to right: Amy Harder, Executive Editor, Cipher; Hannah Badrei, Senior Vice President, Global Energy Advisory, Trio; Susan Nickey, Chief Client Officer, HASI, Melissa Peterson, Head of Onshore and P2X Americas, Orsted; Val Smith, Chief Sustainability Officer, Citi.
Source: The Hawthorn Club.

The interactive map highlights emerging stories in the US energy transition. For instance, hydrogen is booming in Texas and Louisiana – a region with deep oil and gas expertise that may aid in the development of new hydrogen projects. Melissa Peterson is excited about the power-to-

X opportunities in the green hydrogen sector.[1] However, this emerging industry will have its own environmental challenges that it will need to manage as it reaps economic benefits.

Cipher's map reveals another story about biofuels as a 'low-hanging fruit' for the carbon management sector. Since 2018, four out of every 10 carbon capture and storage (CCS) projects in the US are for ethanol production facilities that use corn-based biofuels. These facilities produce dense streams of CO_2 emissions, which make CCS easier and cheaper to apply than in other industries.

Cipher's Tracker focuses on five key transition technologies but does not include wind and solar facilities, as there are too many of them to show on the map – which is a good problem to have! Despite this good news, the world is only at the dawn of a clean energy boom. While there are many demonstration projects under construction, there are not that many large projects in operation in the sectors from Cipher's Clean Tech Tracker. Moving from demonstration-scale projects to commercial-scale projects must be done in a way that is inclusive and collaborative with the communities that are hosting them. Harder noted that we will all need to get more comfortable with failure: failure is part of the innovation process, and innovation is an imperative for the energy transition.

Complex cost dynamics

"The ability to pivot quickly and not have a rigid decarbonization strategy is essential in a global commodity marketplace."
Hannah Badrei, PhD

There is an insatiable demand for more clean power, not only from consumers, but also from utilities and large corporations that have set ambitious emission reduction goals. Strong policy drivers in the US – including the Inflation Reduction Act (IRA), the CHIPS and Science Act, and the Infrastructure Investment and Jobs Act – are all acting as tailwinds for setting these targets.

Yet just how these targets will be met remains to be seen. Costs of implementing low-emissions technology projects have not necessarily come down and have even, in some cases, gone up. While we have seen declining costs for renewable energy, costs for many projects have increased due to the lingering impacts of Covid-19 supply chain disruptions, permitting reforms (or lack thereof), labor shortages, stiff competition for industrial equipment, and high costs of capital.

Many ambitious climate goals were set in a very different market, with different dynamics, pre-Covid-19. Demand for low-emission technologies is high, but given the above-mentioned issues, costs can be, too. This complex dynamic can create a disconnect in the market between what customers want and what companies are able to deliver at a price that customers are prepared to pay. In light of this, some corporations are framing their thinking differently, in terms of the return-on-investment profiles of large-scale clean energy projects. In 2019, many corporations were looking at decarbonization strategies that focused on wind and solar, and required quick profits from these investments, whereas there is an increasing realization that there might need to be a longer-term horizon for returns on investment.

Cash is king!

The panel was provocatively called 'Cash is King' and highlights what some called the game-changing injection of clean energy capital in the US through the IRA. With hundreds of billions of dollars' worth of tax incentives, grants and loans, this is the largest investment in clean energy and climate action ever. A host of well-known and well-utilized sustainable finance products already exist, but new and more interesting finance models are now emerging to take advantage

[1] Power-to-X is the concept of taking electrons and converting them into 'X', which is representative of any fuel. This can potentially be used as low-emission fuels in the aviation or shipping sectors.

of the IRA and drive investment in clean energy projects. For instance, traditionally, large banks and insurance companies have benefited from tax equity arrangements, in which a company provides upfront cash for a large-scale new-build project – usually upwards of $50 million – in exchange for tax benefits. New provisions under the IRA are likely to encourage more corporates to enter into in tax equity arrangements, and facilitate clean energy projects beyond just renewable projects. While this set up is still complex, utilizing these tax equity' arrangements has become easier.

New sectors looking for energy transition investment are starting to engage, such as oil and gas majors looking to electrify their oil and gas drilling as part of emission-reduction targets for their production processes. Since the IRA is designed to catalyze further private investment into clean energy, banks are expecting to play a greater role in financing clean technology and supporting clients in the sector. As just one example, Val Smith outlined how Citi is progressing toward its $1 trillion sustainable finance goal by 2030, which includes financing and facilitating renewable energy projects and emerging environmental and social technologies. The bank is measuring emissions for carbon-intensive sectors in its loan portfolios and has set targets to reduce emissions in line with 1.5C.

Manufacturing opportunities, batteries and energy security

"Looking back over the last five years, there are a lot of things we did not get right – some of it negative, but some of it positive. We missed a global pandemic, which has impacted everything from supply chains to regulations to ways of working. We also didn't predict what is the biggest injection of capital into the US to address climate change, with the Inflation Reduction Act."
Melissa Peterson

An overt goal of the IRA and the CHIPS and Science Act is to promote the development of clean technology supply chains and generate manufacturing jobs in the US through subsidies and investment tax credits. This will create jobs not only in the manufacturing sector but also in related sectors, such as training and education, needed to support the industry. In addition to the clear economic benefits, strengthening US supply chains is also intended to reduce dependence on other countries and associated supply chain disruptions, like those seen during the Covid-19 pandemic.

Securing manufacturing supply chains is part of managing energy security. Global leaders are increasingly talking about energy security and maintaining access to low-cost supply of energy and supply chains, given the shocks caused by events such as Covid-19 and the war in Ukraine. This ties into managing broader geopolitical risk, and forms part of this complex dynamic.

As we move away from fossil fuels providing baseload power, a reliable, secure energy supply will increasingly require batteries. This technology sector is ripe for innovation, and is already benefitting from the injection of investment funds. The battery market has advanced over the last five years, but there is still a long way to go. The only type of energy storage currently on the grid that has a 10-hour duration (which is typically considered 'long duration') is pumped hydro; none of the lithium-ion batteries last that long. Advancement in software technology is also enabling what can be done "behind the meter", including empowering consumers with small-scale batteries.

Importance of transmission

A crucial element that links these energy projects and large-scale batteries is transmission lines. Transmission is arguably the most difficult infrastructure to build, while at the same time being the most necessary. One would be forgiven for thinking that permitting for transmission lines (and indeed other clean energy projects) should have gotten easier in the last five years, with more coordination between local and state-level stakeholders; but it has arguably gotten more complicated. Permitting issues have held up projects that otherwise make economic and strategic sense. There was a strong consensus on the panel that improvement and reform of the permitting

process is needed, particularly for new transmission lines. That said, linking back to the carbon management technologies identified in Cypher's Tracker, it is important to remember there are grid-enabling technologies that have already been demonstrated in the UK for example, that can provide up to 200 gigawatts (GW) via good grid management.

Importance of policy frameworks

Strong policy frameworks are needed to ease these transmission tribulations; indeed, strong policy frameworks will need to continue to underpin various aspects of the energy transition. While Europe is doing less than the US on the financial incentive side, it arguably has stronger regulatory mandates and disincentives for carbon-intensive technologies than the US. The panel touched on the role of incentives for early retirement of coal plants and questioned if coal plants continue to have a role as part of a just energy transition (see break-out box). This question will be answered differently in different parts of the world. For example, in Indonesia, Vietnam and parts of Africa, the ongoing use of coal plants is more intrinsically linked to social and development issues and access to energy for basic needs

There is a need for collaboration, not only between markets and developers within a country, but also between different geographic regions in order to facilitate global commodity markets. While the IRA and associated Acts provide a fantastic injection of capital, there will be better outcomes if there is collaboration between policymakers in the US, Europe and other regions.

A just energy transition

A just energy transition entails moving from traditional energy sources to renewable and low-emission sources in a manner that is fair and considers the well-being of all stakeholders. There are many aspects that fall under the banner of a just transition: prioritizing social equity, ensuring fairness in distribution of benefits, addressing impacts on workers and communities, ensuring access to energy, and involving local communities in decision-making. Hawthorn Club member Thrive Renewables, for instance, recently funded the construction of a community-owned wind turbine in Bristol – currently England's largest onshore turbine and a model for just energy transition activities that might be replicated elsewhere.

Section 5. Australia: The Trilemma Down Under

Panel discussion:

- Sara Leong, Chief Asset Management Officer, Clean Energy Finance Corporation
- Laurel Buckner, Vice President, Ventures, BHP
- Jo Spillane, Global Head of Private Capital Markets, Macquarie Capital
- Renee Klimczak, Managing Director, Alvarez & Marsal

Moderated by: Kane Thornton, Chief Executive, Clean Energy Council

"Clean energy technology and projects are maturing quickly. A clean power system is in sight for Australia."
Kane Thornton

Kane Thornton set the scene for this discussion by asking, "Is Australia finally coming of age?" Like a "teenager" (of which Thornton has two), Australia can be a bit like a roller-coaster: sometimes exciting and inspiring with a sense of opportunity, but sometimes frustrating with some real skills gaps.

Figure 9: Australia panel

Left to right: Kane Thornton, Jo Spillane, Global Head of Private Capital Markets, Macquarie Capital; Renee Klimczak, Managing Directorc Alvarez & Marsal; Sara Leong, Chief Asset Management Officer,Clean Energy Finance Corporation; Laurel Buckner, Vice President Ventures, BHP. Source: The Hawthorn Club.

Australian governments are leaning in

The politics in Australia have shifted. With the election of the Albanese government in 2022, the country has – for the first time in its history – both national- and state-level governments united in their commitment to moving Australia to net zero. The impacts of climate change in Australia, including a wave of bushfires and floods over the past several years, have brought climate

change to the forefront of community consciousness, which has helped change the political conversation. While there are still differences between political parties and jurisdictions, there is more alignment in acknowledging climate change and investment in the energy transition, and Australian governments are finally 'leaning in', the panel said. However, Australia's political 'climate wars' look set to be a reopened battleground in the next election, the panel said.

While Australia might be playing catch up for the last ten years, according to the panel, with arguably little political support, there is currently an ambition to develop policy mechanisms, and greater cooperation and coordination between different key actors. This includes the three levels of government, industry, regulators, the Australian Energy Market Operator (AEMO), and the Clean Energy Finance Corporation (CEFC). In response to the US's IRA, and the European Union's Net Zero Industry Act, the Australian Government has introduced its own financial support policies. This includes the up-to AU$1 billion Solar Sunshot program, the AU$4 billion Hydrogen Headstart program, and the AU$20 billion Rewiring the Nation program. While these programs are not in the same financial league as the energy-transition incentives in the US and Europe, they are nevertheless a sign that the Australian Government is serious about the energy transition and recognizes the opportunity to leverage these international financial injections into clean energy. This is critical, the panel said, given that there are only six summers to go to achieve Australia's 2030 targets of 43% emissions reductions from 2005 levels and 82% of renewables on the grid.

Households are part of the solution

EVs are finally coming of age, yet a "messy policy and regulatory environment" stalled their rollout down under. For instance, Australia still has some of the "least stringent fuel economy standards in the world", the panel said. This is now changing, and the percentage of EVs of in the country's passenger vehicle fleet is starting to creep up, from single digits to approximately 10%.

Households are part of the energy transition solution with this increased uptake of EVs, electrification of heating and cooking, home energy efficiency measures, and perhaps most importantly, rooftop solar. With more than one in three homes hosting rooftop solar, Australia has the world's highest per-capita installation rate for the technology. This represents about 17GW of capacity, but more can be done to harness the benefit of this rooftop solar, if combined with small-home storage batteries. This rooftop capacity is already being used as a kind of distributed powerplant that AEMO can draw upon to address system outages or surges in demand. This is particularly useful as closures of baseload coal-fired generators are being brought forward as the pace and urgency around the clean energy transition increases.

Transmission and storage

"The grid, grid, grid, and the grid is what a lot of investors and analysts in Australia continue to focus on," said Thornton. Small-scale energy storage is progressing relatively quickly (to augment the EV and rooftop solar uptake), yet the transition to a clean grid will need to be underpinned by utility-scale storage. Storage is therefore an incredibly important part of the energy transition "jigsaw puzzle". In the past several years, Australia has seen enormous progress on utility-scale lithium-ion batteries, with approximately AU$5 billion worth of investment committed in the last 12 months.

To facilitate the target of 82% of renewables on the grid by 2030, renewable energy zones, or clusters, have been identified across Australia and will form the foundation of large-scale renewable energy production. However, as in most countries, there is a mismatch between the grid's original design for delivering coal-fired power from large baseload power stations, and the

integration of wind and solar. These renewable energy zones will need to be connected to the grid and require extensive additional transmission lines, as “there is no transition without transmission”. The AU$20 billion Rewiring the Nation program is aimed at modernizing the electricity grid through new and upgraded transmission infrastructure. It does this primarily through providing finance at concessional rates to infrastructure providers. The CEFC will be managing the allocation of AU$19 billion of this fund to help “plug financial gaps” between what private investors are prepared to invest in commercially, and the investment needed to facilitate the buildout of this 21st-century grid. In addition to investment in the transmission lines between regions (particularly to connect these energy zones), digitalization and modernization of the grid are vital.

The capital trilemma

Australia has seen its renewable energy more than double over the last five years, as renewables have grown from approximability 17% of the energy mix on the grid to approximately 40%. However, over the last 12 months, new investments in wind and solar have slowed, prompting an increase in the Australian Government’s Capacity Investment Scheme, which aims to deliver about 32GW of renewables and storage capacity by 2030. The Scheme supports a “direct contracting model” seen in other countries such as the UK, and reflects a philosophical shift away from total reliance on the market, to more direct support from the government.

These clean energy transition projects and transmission lines will require billions of dollars in private investment, as well. “Capital is global,” and flows both out of and into Australia. Australian superannuation funds are investing in transition projects in the UK and North America, which represents a huge capital outflow. However, there is even more capital flowing into Australia from investors looking to invest in clean energy projects. Yet while there is a huge appetite for investment in the energy sector – and billions of dollars available – investors struggle to find projects that are structured well and have suitable risk profiles (including a stable policy framework) for a long-term assessment of revenue profiles.

Joanne Spillane highlighted what she saw as the ‘trilemma’ in the panel’s title from a financier's perspective. She reflected on the challenge of balancing the competing demands of providing affordable energy for consumers, with the need for significant investment (and associated cost) of new clean energy projects. The third aspect of the trilemma is while there is a “wall of institutional capital that is looking to invest”, this needs to align with projects that offer a reasonable risk-return profile in a market which is extremely complex.

Spillane remains optimistic, however, and points to a growing sophistication among investors regarding the energy transition. As an example, investors are now more open to acquiring carbon -exposed assets, where additional capital and business plans can accelerate the transition to a low-carbon operating model. This is a concept that most institutional investors had not considered even five years ago. In recent years, it would have been a problematic environmental, social, and governance (ESG) issue to buy an asset that was going to increase the carbon exposure of an institutional investor’s portfolio. This move highlights a shift in investor attitudes towards ESG considerations as the understanding of the need for an orderly energy transition grows. Australia is attracting substantial global investment for grid augmentation projects and new renewable generation as it, like other countries, contemplates the challenging pathway to meeting net-zero targets.

Corporations are leaning in

While these policy measures tend to focus on supply-side issues, Renee Klimczak would like to see corporations do more to reduce energy demand on a significant scale. There are good examples of "corporates leaning in" and using their purchasing power to encourage a move toward utilizing low-emission fuels and technologies. As companies start to focus on their Scope 2 and Scope 3 emission targets, these examples will grow.

People and communities

While there have been a plethora of recent policies and financial incentives to stimulate the energy transition, Australia is still at the beginning of the implementation phase, and significant challenges remain in terms of bringing industry and communities together. Substantial increases in consumer electricity bills are a major social – and therefore political – concern. Social license to operate challenges are also on the rise, and the need to support communities most affected by the grid and renewable energy infrastructure projects. Communities most affected tend to be regional and indigenous communities. There are understandable fears around loss of productive agriculture land, and about some people receiving financial incentives for hosting large-scale infrastructure while their neighbors do not benefit.

People will thus be a major theme for the energy transition over the next five years. Australia needs to bring new people into the energy sector, as well as care for the current workforce and veterans of the "climate wars". A crucial piece of getting the energy transition right and managing the risks and challenges around social license to operate is how industry and governments interact and share the benefits with local communities. Australia needs to develop the energy transition workforce, at a local project scale, but also at the macro industry level. As Thornton said, "To borrow from US Secretary David Crane, we need to bring our best selves" to this challenge.

Optimism and opportunities

The geopolitical risks referenced in the US panel also loom large in Australia. In particular, Australia has a high reliance on China for buying its export commodities and importing goods and services needed for the clean energy sector. Despite this, the panel was optimistic both about the energy transition's increasing pace and about the opportunities it will provide. For instance, the AU$1 billion Solar Sunshot program is geared toward building Australia's photovoltaic solar (PV) manufacturing capabilities, bringing the industry back on shore.

Australia cannot outspend China or the US on policy incentives, panelists observed, but it does have a strategic advantage in its natural resources. For instance, Australia is one of the world's largest producers of lithium, and it has the potential to generate billions of dollars in additional revenue by processing that lithium before exporting it. Copper is another critical mineral that will be crucial for the energy transition and that Australia has an abundance. For instance, an EV requires four times as much copper as a traditional internal combustion vehicle. BNEF forecasts that global annual EV sales will cross 30 million in 2027 – up from slightly north of 1 million a decade before – bringing with them an explosion in demand for copper.

Section 6. Europe: The Future Is Green

Panel discussion:

- Trine Dalsgaard, Vice President of Business Development, Terma A/S
- Mallika Ishwaran, Chief Economist, Shell
- Amanda Peterson Corio, Global Head of Energy, Google
- Tania Songini, Non-Executive Director, Thrive Renewables and the UK Infrastructure Bank

Moderated by: Meredith Annex, Head of Clean Power Research, BloombergNEF

"If the European Union were to be taken as a single bloc, it would be the second-largest destination for clean energy investment in the world."
Meredith Annex

As a backdrop to this discussion, Meredith Annex started with an overview of the energy transition sector in the EU and the UK. In 2023, some $360 billion was invested in the energy transition in the EU as a bloc – making the EU the second-largest market for energy transition investment in the world, after China. One of every five dollars that was spent last year on the energy transition was spent in the EU. And while the global growth rate in energy transition investment was 17%, in the EU and UK combined, the growth rate was a staggering 41%. At the macro-level, this is a good news story. Nevertheless, difficulties and challenges at a more microlevel remain, as discussed by the panel.

Figure 10: Europe panel

Left to right: Meredith Annex, Head of Clean Power Research, BNEF;Mallika Ishwaran, Chief Economist, Shell; Tania Songini, Non-Executive Director, Thrive Renewables; Trine Dalsgaard, Vice President of Business Development, Terma; Amanda Peterson Corio, Global Head of Energy, Google. Source: The Hawthorn Club.

Demand-side focus

A distinctive trend observed in Europe is a greater emphasis on investing in the demand side of the energy transition, including clean transport and buildings, while globally the focus tends toward the supply side. This shift underscores Europe's unique approach to navigating the complexities of its energy transition. Europe is also leading the way with more investment in critical technologies such as CCS, clean shipping, low-carbon heating, hydrogen, and clean industry. Over 30% of global investment in these sectors originates from the EU, making it the world's largest contributor. This leadership is attributed, at least in part, to the robust policy frameworks in place.

The role of different technologies

Mallika Ishwaran welcomed the EU's efforts to put competitiveness at the core of the green transition and the focus on technological diversity to advance towards climate neutrality. There is a diverse range of technologies to address climate change, including hydrogen, bioenergy, CCS, and carbon removal, that are being brought into the fold. This creates a more conducive environment for businesses to invest in suites of decarbonization technologies that match their individual needs. Europe's policy framework provides longer-term certainty for businesses to deploy low-carbon technologies than programs like the IRA, the subsidies of which are set to expire in 2032. The policy framework and history of carbon pricing also offer stability and boost confidence for businesses to make investments in low-carbon technologies, highlighting these aspects as potentially underrated factors in the energy transition.

The war in Ukraine and the onset of Covid-19 have intensified discussions, particularly in the UK, around energy security and the role of oil and gas in the transition. There's a divergence of opinions regarding the revitalization of fossil fuels in the UK. This resurgence is exemplified by "a scramble" for liquefied natural gas (LNG) sourced from the Middle East, and the reopening of licensing for oil and gas exploration projects that were previously halted. Despite this recent uptick in oil and gas demand, there has been a "doubling down" on interest in renewables and storage as a way to guarantee local energy supply. Offshore wind is considered a big part of this solution. In the UK there were 13.7GW of offshore wind installed at the end of 2023, with a target of 50GW by 2030. "We are about 25% of the way there, which isn't a bad place to be, but there's still a lot to do," said Tania Songini. The European Union, which had about 16GW offshore wind as of 2022, is aiming for 60GW by 2030. Despite this, investment rates in wind have actually decreased in recent years. This is at least partly due to permitting constraints, the rising costs of capital, cost increases in labor and equipment, and supply chain bottlenecks. The panel also saw green hydrogen as being a mid-to-long-term replacement for gas.

Improvements are needed in market design

Historically, the UK has demonstrated leadership in market design, i.e. how the energy market is designed to function and incentivize actions to ensure affordable and secure energy supply via the national grid. However, the panel agreed on the need for further market design improvements in both the UK and Europe, to better incentivize the transition to renewable energy, optimize grid operations, and accommodate emerging technologies like EVs. This includes improvements in the wholesale pricing mechanism, better use of demand levers, improvements to contracts-for-difference, and a need for local marginal pricing.

Wholesale pricing mechanisms can undermine renewables investment

Power market design directly impacts investment incentives, and currently undermines the appetite for investment in large renewable energy projects. Over the last two years, the price of gas in Europe has dropped, in part because of very warm winters, which lowered demand for heating. Since gas is usually the marginal (price-setting) power generation source, this has led to lower wholesale power prices, which have in turn impacted profit margins for existing renewables, and the business case for new renewables. Sustained low prices, which are expected as renewables continue to grow, will in turn make it less attractive for developers to build future wind and solar projects.

Relatedly, low or negative wholesale electricity prices exacerbate the premium associated with power purchase agreements (PPAs) for wind and solar. This poses challenges for various participants, particularly on the corporate side, who may struggle to secure contracts or deals, and it makes large-scale wind and solar projects less attractive to developers. Added to this, commodity prices, particularly for oil and gas, are likely to be particularly volatile this decade. This volatility will continue to impact wholesale electricity markets and be reflected in end-use power prices. The sector needs to implement solutions to mitigate the impact of pricing signals that disincentivize renewable projects, as well as increasing demand-side flexibility to respond to high or low periods of renewable energy production.

Demand levers

In recent years, adverse circumstances have shown how effective a demand-side response can be. With the energy crisis precipitated by the Ukraine war, gas demand dropped in the EU in 2022 by 55 billion cubic meters, or 13%, at least in part due to higher prices[2], creating what one panelist called “the biggest demand-response event ever.”

Affordability crisis aside, this event offers good evidence for the effectiveness of demand response incentives, whereby users voluntarily reduce electricity consumption in exchange for a financial benefit. However, such mechanisms are not yet systematically in place to incentivize desired behavior.

Contracts for difference

Contracts for difference, or CfDs, also influence market dynamics and sentiment, which in turn can impact energy prices in the short to medium term. These too need to be reexamined in order to facilitate a more effective market design. Corporations have an important role to play in providing firsthand experience of the energy market and CfD in action. Some corporations have provided feedback to EU bureaucrats in Brussels regarding how CfDs impact buyer behavior, which has important implications for policy.

Local marginal pricing

Energy demand is regional. There are real challenges with efficiently distributing renewable energy such as offshore wind power from Scotland (for instance) to regions like the south of England and London, where it is needed most. Mechanisms like locational marginal pricing and

[2] International Energy Agency, 2023, *Europe’s energy crisis: What factors drove the record fall in natural gas demand in 2022?,* IEA, https://www.iea.org/commentaries/europe-s-energy-crisis-what-factors-drove-the-record-fall-in-natural-gas-demand-in-2022

local distribution zones are ways to tailor market design strategies to specific geographies. Regional pricing could better incentivize investment in renewables infrastructure to address these distribution challenges and ensure that energy reaches areas with high demand. The UK is investigating these options through its Review of Electricity Market Arrangements (REMA).

Guernsey, one of the islands in the English Channel, is a good example of the opportunities, challenges and complexities involved in implementing renewable energy solutions. “It is a microcosm of the energy transition challenges from A to Z on an island of 60,000 inhabitants,” explained Songini. The local community and politicians wanted to achieve energy independence through an offshore wind farm. While an offshore wind farm seemed like a straightforward solution, the reality is more complex due to the need to address the intermittency challenge of renewable generation and find an affordable and longer-duration storage solution, not currently available. The more viable solution today is a second interconnector to France to enhance baseload power, which would buy time to develop the desired renewable and storage options. Guernsey Electricity embarked on a communication campaign engaging multiple stakeholders, including local energy groups and the wider community to explain the decision regarding interconnection to “ensure they were on board” with the solution. This underscores the significance of involving stakeholders in the decision-making process and adapting strategies to consider the unique circumstances of a given community.

Permitting (again!)

Compared with the challenges of offshore wind inherent in the Guernsey example above, onshore wind may seem like a relatively easy option. Yet not even onshore projects can avoid the permitting bottleneck, identified by all panels. Permitting processes are in place to address important issues, but they are also causing significant delays. In recognition of this challenge, Germany has started to streamline the process and reduce the appeal period. This reflects a shift towards a more decisive approach to renewable energy, prioritizing action over prolonged discussions. This might require a trade-off between the dissatisfaction of some stakeholders and long-term energy security and sustainability goals.

Defense and energy security

Given the war in Ukraine’s impact on access to oil and gas, energy security remains a priority. This has historically been thought of in terms of adequate generation capacity, but increasingly the term is being expanded to mean physical security of infrastructure, as well. This was seen in incidents involving multiple explosions on the Nord Stream I and II pipelines in the Baltic Sea, causing gas leaks in 2022.In view of the importance of offshore wind – particularly in the North and Baltic Seas – to achieving Europe’s net-zero goals, European countries must now be conscious of defense considerations for this offshore infrastructure. Defense concerns such as reduced situational awareness can lead to offshore projects being vetoed. In Sweden for instance, eight out of 10 offshore wind projects have been vetoed because of concerns that these projects will inhibit Sweden’s ability to properly surveil and defend national interests. This added layer of complexity can result in further delays in the deployment of renewable energy projects. “We need to work with a new kind of coexistence between defense and offshore infrastructure,” said Trine Dalsgaard. This is not necessarily going to be easy, given the differing priorities and operating frameworks between the sectors, including differences in funding, political sensitivity and the secrecy inherent in defense operations. Nevertheless, there is now a necessity for cooperation between military and civilian entities, and navigating the involvement of entities such as the EU and NATO in addressing these security concerns.

Firming grid capacity

EVs, industry and hydrogen are just three of the factors that will drive up electricity demand in the UK and Europe. This increase in load growth is going to need greater firming capacity as countries move away from fossil-fuel baseload power, and towards greater reliance on long-duration battery storage. This transition should be done in a way that avoids massive price volatility in the market, which, as outlined above, brings its own complications in facilitating investment in renewable energy.

There is a need to incentivize the deployment of energy storage in the grid infrastructure to effectively manage the intermittency of renewable energy resources. Increasing clean firming capacity could also help to mitigate volatility in energy prices by reducing reliance on fluctuating gas prices. Installed large-scale batteries have been used not only to provide backup power but also to participate in selling firming capacity back into the grid. This is a model that can be used in more places, although it will require policy incentives. On the flipside, corporations can also participate in private offtake agreements for large-scale storage projects, helping to finance them. The Advanced Clean Energy Storage (ACES) project was mentioned as a collaboration aimed at providing large-scale energy storage solutions to store excess renewable energy and release it when demand is high, thereby balancing the grid and signaling an industry demand for this technology. As with most new technology, there is a need for significant capital to finance large-scale energy storage projects, particularly those surpassing 500 megawatt-hours, and commercial financing is lacking. To address this gap, the UK Infrastructure Bank has stepped in to provide financial support through various instruments such as loans and equity stakes, aiming to attract commercial lenders and facilitate the scale-up of both established technologies like pumped hydro and emerging storage technologies.

Green hydrogen

The UK Infrastructure Bank could also play a pivotal role in supporting the development of green hydrogen. Songini remains optimistic regarding the potential for both strong production growth and meaningful cost reductions for green hydrogen in the UK and elsewhere. She draws parallels to the significant drop in costs seen in offshore wind energy over the past 15-20 years, expressing hope for a similar evolution in hydrogen technology. However, there is currently a significant gap between the cost of producing green hydrogen and the price that industrial consumers are willing to pay. A recent auction revealed the strike price for green hydrogen was set at $10 per kilogram, significantly higher than the price of traditional grey hydrogen, which is around $2 per kilo.

Optimism and pessimism

There was both optimism and pessimism regarding Europe's progress towards its emission reduction targets. The EU has surpassed initial expectations, with a projected 51% reduction of emissions from 2005 levels, and it has invested significant funding to achieve its 2030 and 2040 targets, thus signaling its commitment to a low-carbon economy. However, recent European elections could well undermine high levels of ambition in some countries. There may also be a disparity in perspective between politicians and industry stakeholders regarding the attainability of low emission targets, which one panelist compared to Hans Christian Andersen's story "The Emperor's New Clothes". There were varying levels of optimism regarding the growth and momentum in sectors such as EVs, aviation, shipping and agriculture. All panelists stressed the need for a sense of urgency and continuous action, emphasizing that infrastructure projects typically have a long lead time and cannot afford delays or periods of diminished attention and effort.

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