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Viewpoint

Net Zero in the Maelstrom: Professional Practice for Net Zero in a Time of Turbulent Change

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Abstract: The net zero transition is examined as a process of technical change that has rapidly accelerated and now faces social, economic and political transformations that can enable this rapid transition. The illustration of a maelstrom, with barrels that can enable survival, is used to show that professional practice during the turbulent period of change needs new net zero standards reflected in new processes and regulations for business accounting, energy, urban and transport planning, as well as new approaches for the just transition and Indigenous/local engagement. Australian examples are provided to show the beginning of such a maelstrom process to illustrate the significance of this agenda in 2023.

Keywords: net zero; transition; professional practice; urban planning; energy planning; transport planning

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1. The Maelstrom

In 1841, Edgar Allan Poe published the short story 'A Descent into the Maelstrom' [1]. He describes a situation where a ship is wrecked and caught in a whirlpool from which a sailor escapes by holding on to a barrel. Since then, going over waterfalls in a barrel has become a sporting challenge for a few brave souls. Climate change has become a similar challenge that increasingly resembles a maelstrom as the increased intensity of weather extremes is pushing the rate of change. Al Gore at COP27 suggested that the extremes are happening because the extra heat in the atmosphere is equivalent to the effect of 60,000 Hiroshima atomic bombs being used daily [2]. Communities are thus experiencing a climate change-based set of emergencies, based on new phenomena such as atmospheric rivers and bomb cyclones [3] dropping meters of water per hour and causing floods, mudslides and tree devastation [4].

This paper adopts the maelstrom as a symbolic state of where our global civilization is at and tthe attempts to use our barrels to escape the critical situation in which we find ourselves. Net zero is now the critical focus for those seeking to emerge from the maelstrom in 2023.

The front page of the original Climate 100+ website (Figure 1) was the inspiration for the maelstrom symbol as the organization of banks and finance companies that chose to present their ideas for the future was based around a waterfall as the main image to help them attract attention. The website sets out the ways on which the finance groups from across the world had committed funds for net zero projects, now standing at USD 68 trillion. For me personally, this commitment from the world of finance is a very important step forward in the climate battle where I have been for many decades, including the last ten years in IPCC as a lead author in AR5, the 1.5C report and the AR6 report in 2022. In this period, I have felt as though the world was slowly coming down the river of climate mitigation, at every step feeling as though we were accelerating but not quickly enough, and then, after the Paris Agreement, we suddenly went over the edge and into the waterfall. The Net Zero River lies below the waterfall, quietly and peacefully proceeding, but we are

in the thick of the maelstrom right now, and we are trying to find ways of landing safely. It is not just a simple, linear transition; it is a maelstrom. We need some barrels to hold onto.

Figure 1. The maelstrom as depicted by Climate Active 100+ on their website.

2. What Happened to Throw Us into the Maelstrom?

The big change was the Paris Agreement at COP21, where unanimous commitments to net zero by 2050 became the foundation for legally based, climate mitigation targets and strategies in 2016. The process for the world leaping ahead in this way was set out by Christiana Figueres, who was the UN Coordinator for COP21 [5]. The fundamental difference in this event was the production of a document, in the year leading up to the COP21, that was progressively agreed to by the world's major business and finance organizations together with the world's major environment and climate groups. The resulting 'Groundswell Initiative' was the start of the maelstrom as it brought the core drivers of social and economic change into the same arena as the UNFCCC's normal nation-state process. Governments really had no choice but to agree to such a powerful collaboration of business and civil society.

The waterfall thus could be seen ahead in the immediate period after COP21, with a net zero river beyond, but the subsequent processes that were unleashed to try and achieve net zero outcomes were very new with major shifts in what professional advice and the science behind them could offer to the world as they approached the edge. The changes were not included in any manual despite the foundations having been set up in laboratories, innovative businesses, and demonstration projects over the previous decade. The waterfall is therefore a professional practice maelstrom, full of risks and innovations but providing opportunities for transformation and a lot of excitement as we all proceed through the rapid change phase of the big transition to renewable energy.

The most significant scientific innovations that provided the basis for business recognising that climate change mitigation based on renewables was now economically sensible and indeed provided many very attractive opportunities are set out in the IPCC AR6 Mitigation Report [6] and summarized in Figure 2.

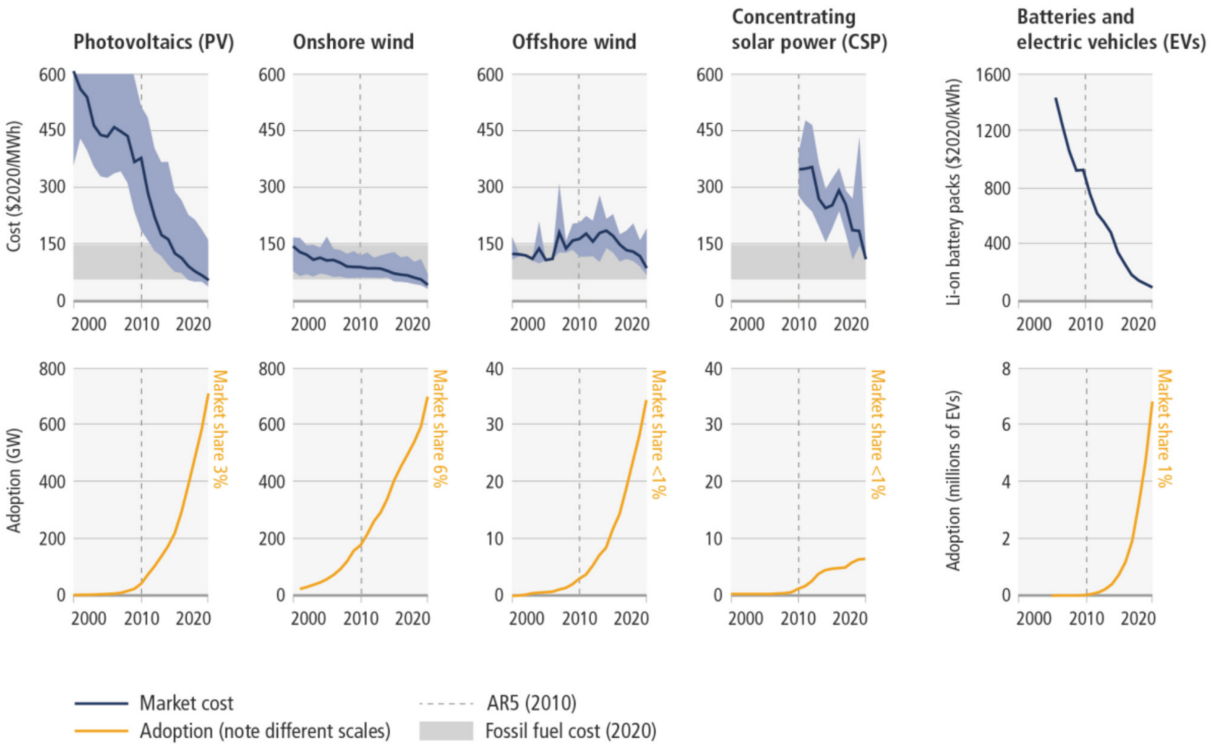

Figure 2. Trends in cost adoption for key renewable technologies in the maelstrom. Source: [6] (Figure SPM.3).

The dramatic drop in cost in the 2010s was not predicted by major groups such as the International Energy Agency but are now seen to be the basis for the new economy. Approximately 90% of new power is solar and wind, and over 90% of new storage is batteries [7,8]. This kind of change is much faster than any linear projection would predict and is historically associated with notions of disruption.

Disruption has generally only been applied to the information technology revolution, but futurologist Tony Seeba applied it to the dramatic changes now observable in solar, batteries and electric vehicles. He calls the process phase-change disruption and uses exponential declining cost curves from these technologies to predict the maelstrom we are in and ways to emerge from it [7–9].

The changes that are discussed by Seeba suggest an almost inevitable process of technological change. However, all the breakthroughs in science, engineering and economics require work of scientists such as Martin Green, who was able to transport breakthrough technologies in solar technology to China and enable mass production to reduce the costs [10]. It is important to recognize the human dimension of these changes as we move into this new period where the possibilities of a complete, renewables-based net zero future is becoming a certainty. All the changes that see us through the maelstrom will require similar leadership, but increasingly leadership by professionals who must now apply the technology to social, economic, cultural, and institutional change.

The maelstrom is real, but the way out requires considerable creativity and courage as the old ways are firmly stuck in professional practice. Despite Seeba's optimism, many changes to professional practice are required to become the barrels necessary to see us through the turbulent period of necessary change that is now happening. This is discussed in the IPCC Mitigation Report [6] in terms of socio-technical transitions that are a necessary part of any innovation being adopted, but they were probably not considered quite like the acceleration of change now being unleashed. This paper suggests that the almost linear processes often outlined in socio-technical transition theory are now accelerating so rapidly

that the changes are more like a maelstrom, but perhaps we can still find some barrels to see us out.

The benefits of socio-technical transition theory, as used in IPCC [6], are that the theory suggests the kind of policy changes needed to enable technologies to be adopted and mainstreamed. The policy processes are different for different technological implementation levels (TIL). In Chapter 10 on Transport in the AR6 Mitigation Report [6], the Chapter produced Figure 3 below that set out the approaches needed to guide professional practice in the three main areas of change: high TIL electric vehicles in land transport; medium TIL levels in demand management for cities, lifestyles and cultural change; and low TIL levels for shipping and aviation based around hydrogen-derived fuels. It also shows the expected time for such changes to happen. The high TIL EV technologies that are very ready mean that professional practice requires governments to be less oriented to subsidies or regulations that force change, and more oriented to enabling the new markets to work and to changing old regulations and frameworks that can enable the new technology, not the old technology. However, other lower TIL technologies need a lot of help with the transition and must have stronger government interventions, especially in R&D.

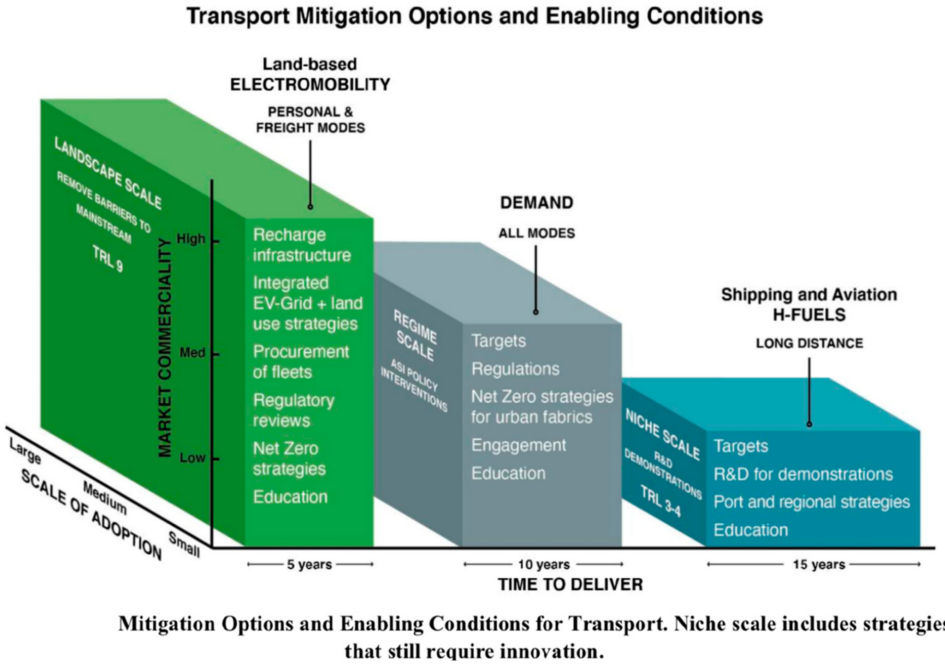

Figure 3. The main professional practice barrels for change in transport as seen by IPCC Mitigation Report [6] (Figure 10.22), the time expected for their delivery, and the types of strategies required.

The guidelines or barrels outlined below are designed to help us through the maelstrom. Seeba [11] asserts that the changes will happen very quickly; for example he suggests that 95% of the world market for land vehicles will be electric by 2030. It would be very pleasing to see this happen; however, there are also serious barriers that are being set up by some big companies that are trying to suggest there is no maelstrom and that business will inevitably continue as usual, with fossil fuels. Certain media strategies support this [12,13], presenting myths about the dangers of electrification and the potential limits to growth due to critical mineral shortages despite scientific assessments showing they are minimal and manageable compared to those caused by the business-as-usual approach [6].

The situation is exacerbated by the world of geopolitics, where dramatic short-term oil, gas and coal price rise due to the war in Ukraine, meaning that there is a political battle between short- and long-term issues as we enter the maelstrom [14]. This is an ancient issue, but for the world of finance, where 20-year pay-backs must be considered and national responsibilities must account for planetary responsibilities, the need to transcend short-

term profits has never been more obvious. However, it will be a constraint on some parts of the economy changing rapidly.

The constraint on change that is the focus of this paper is the need to change professional practice. People working in energy, transport, architecture, town planning and other relevant policy areas use the 'manuals of modernism', the guides for professionals created around the old fossil fuel economy. These guides are part of their training, professional development, and mind-set; however, they are no longer relevant to the world of net zero climate resilient development. The brother of the sailor who survived the maelstrom in Edgar Allan Poe's classic story chose to cling to his post at the helm in the ship as it sank rather than taking a barrel and jumping into the whirlpool as did the one who survived. The paper will mostly outline the barrels that can help us re-establish a professional practice that could help see us through the maelstrom.

The paper outlines three barrels or processes for reaching net zero outcomes through the maelstrom and into the mainstream of economic, social and political life through changes in professional practice:

- Establishing accounting standards and assessment processes for net zero that do not allow greenwashing;
- Establishing energy planning, urban planning and transport planning strategies and regulations that create net zero grids, precincts and corridors in cities; and
- Establishing rural and regional net zero projects, mostly using hydrogen, that involve appropriate just transitions and local engagement with Indigenous communities.

Each of these barrels will be outlined in concept and some illustrations applied from Australia to show the start of our turbulent journey through the waterfall of rapid change that is happening globally.

3. Barrel 1: Setting New Accounting Standards and Assessment for Net Zero

Since the Paris Agreement established the global goal of net zero emissions by 2050, there has been a proliferation of claims and voluntary commitments to net zero emissions by governments, institutions, and private sector companies around the world. While this trend towards net zero commitments has been broadly welcomed, scientists and non-government organisations have increasingly raised the alarm that such claims often amount to dangerous greenwashing. They argue that net zero promises are being used by some companies and governments to delay the urgent action that is required to address climate change. The IPCC AR6 Mitigation Report [6] and the IEA 2022 World Energy Outlook [15] now show that no further new fossil fuel projects can be allowed and make economic sense. However, to set in motion the removal of all carbon pollution from all sources and phase out fossil fuels from the global energy mix as fast as possible, there needs to be much clearer global guidance on accounting for what net zero means so that proper assessment can be conducted. This requires a new kind of accounting that can enable a trustworthy net zero result. The changes to accounting are now happening and become the basis of Barrel 1. The key issue is a way in which accounting systems can help to seriously consider net zero emissions.

Accountability for Net Zero

The United Nations Expert Group on Net Zero Commitments for Non-State Entities (UN Expert Group) [16] and the International Standards Organization (ISO) [17] have separately released new detailed standards and benchmarks for policies, plans and commitments to meet net zero emission requirements by private sector companies and sub-national governments. The COP 27 in Sharm El Sheikh adopted the Non-State Entities report unanimously. This is the first time that such benchmarks have been established at an international level.

The new standards are designed to differentiate genuine efforts towards tackling climate change and decarbonization from greenwashing exercises that simply facilitate

business as usual in emission-intensive industries, cities and regions thus delaying the changes that are needed to achieve internationally agreed safe climate temperature goals.

The United Nations Secretary General presented the report from the High-level Expert Group on Net Zero Emissions Commitments of Non-State Entities [16] in the final session of COP 27 in November 2022. The report was called Integrity Matters: Net Zero Commitments by Businesses, Financial Institutions, Cities and Regions. This report provides guidelines for non-state entities making commitments to net zero emissions. The report is intended to 'draw a red line around greenwashing' and has made recommendations 'to prevent dishonest climate accounting and other actions designed to circumvent the need for deep decarbonization'. As António Guterres, the UN Secretary General, stated,

> *"We urgently need every business, investor, city, state and region to walk the talk on their net zero promises. We cannot afford slow movers, fake movers or any form of greenwashing."*

This is the first time the UN has published criteria and standards that apply to net zero emission pledges by large corporations, financial institutions, and cities and regions.

The International Organization for Standardization (ISO), a worldwide federation of national standards bodies, set new net zero Guidelines [17] so they are 'aligned to the objectives of the UN Expert Group and the UN Framework Convention on Climate Change (UNFCCC)'. The Guidelines enable a common, global approach to achieving net zero greenhouse gas emissions through alignment of voluntary initiatives and adoption of standards, policies and national and international regulation.

This document provides guidance for governance agencies and other organizations on the ways to effectively contribute to global efforts to limit warming to 1.5 °C by achieving net zero emissions no later than 2050. It provides guidance on a common and equitable contribution and recognizes the capability of individual organizations in contributing to achieving global net zero. This document, when used in combination with applicable science-based pathways, provides guidance for organizations seeking to set robust climate strategies [17].

Both the UN Expert group and the ISO net zero guidelines contain a strong and clear message. Net zero commitments and policies must contain a number of additional critical features in addition to a net zero target by 2050 in order to be credible.

Some of the critical requirements for net zero plans include: delivery of actions for immediate and absolute reductions in carbon pollution, establishment of interim targets that are aligned with science-based safe climate (1.5 degrees) temperature scenarios, coverage of all emissions including indirect (scope 3) pollution, support forthe phase out of fossil fuel use not growth and consistency of all lobbying/advocacy with this, absence of reliance on the use of offsets where other measures to avoid and reduce pollution are available, delivery of stronger action where there is high current or historical emissions, regular reporting on targets, and independent verification of emission reductions.

The two reports change much of the world's approach to energy and climate change governance. This is the first time that such net zero benchmarks have been established at an international level, and they are destined to majorly influence the response of companies and government to the global decarbonization challenge. They can guide us in this period of rapid change as global markets increasingly take up the challenge of achieving net zero emissions; Weiss [18], in a report for Energetics, suggests that 'capital markets are leading the way to net zero'.

Mandatory climate risk disclosure does not by itself create requirements for companies to adopt emissions reduction goals or other actions. Instead, it changes the business culture and much more effectively ensures that businesses will follow it to guarantee their profits for future projects. This allows the market to assess climate risks as financial risks and ensures companies disclose sufficient information about their climate risk strategies to allow informed decisions by investors, especially regarding the application of these strategies to global guidelines and best practice. For regulators, the information can be used to pursue companies for greenwashing, where their commitments are not backed by credible plans.

Companies will be forced to become more transparent about their climate goals and strategies, but standards they will be held to will depend on decisions of investors, regulators, and the broader community. That is where the new international standards for net zero apply as they have been agreed to by every nation, including Australia.

4. Australian Examples of Barrel 1 Net Zero Accounting

In Australia, 2023 began with a flurry of climate activity, with a new Government committed to climate action after a decade of assuming the position of a global recalcitrant. A Climate Act was delivered in the first year of office based on the election commitment of 43% reductions by 2030. The new commitments began immediately to reshape the net zero guidelines in order to meet the targets, which mostly concerned removing loopholes allowing companies to avoid climate responsibilities.

Two key mechanisms that have been used in the past to justify net zero emissions were reviewed as the reality of their effectiveness was under significant scrutiny. First, after the review, the use of offsets for carbon credits removed one major category of illusory offsets based on 'avoided deforestation' [19]. Second, the carbon trading mechanism for large polluters, the Safeguard Mechanism, was reviewed to ensure annual reductions were at least 4.9% per year, which meant they could not be increased, as many companies were doing [20]. However, the most significant report from the new Australian Government was the introduction of mandatory climate risk disclosure as part of all financial activity [21]. This was associated with recent findings by the national regulator ASIC [22], who reported greenwashing among some companies.

In Australia, these new guidelines will be applied to all companies and are likely to be the basis for all assessment by state EPA's and their own agency climate strategies, as well as by all Federal agencies as they seek to implement their global responsibilities. This is the new world of post-greenwashing net zero, and most countries will be producing such guidelines as we hurtle into net zero. It is not guaranteed that all gas and coal companies will be forced to follow these guidelines, yet. As Verstegen [23] sets out, there are many loopholes remaining from the previous government that were set in place to allow growth in gas and coal production whilst hiding behind the other parts of their sector of mining and manufacturing that have clearly begun the net zero transition (see below in Barrel 3). This is not fair on those making the necessary steps to the future.

The number of Australian public companies making voluntary net zero emission commitments doubled in 2022 [24], representing approximately 70% of the collective market capitalization of major public companies [25]. This reflects a clear preference in the market for companies that are taking decarbonization seriously. However, some are not, finding the new guidelines hard to apply and wishing to proceed as though business-as-usual is the real politics of climate change. These companies may not withstand this turbulence in the market.

The biggest problems are observed in the oil and gas sector, where net zero is considered to require more gas for the transition. Major companies such as Woodside and Santos plan to ramp up fossil fuel production by exploiting some of the world's largest undeveloped fossil fuel basins over the coming decades. Both companies have made net zero commitments which involve offsetting some direct emissions from their fossil fuel production in future decades while ignoring the billions of tonnes of indirect 'scope 3' emissions from combustion of the fuels they will produce [26]. This will no longer be possible to argue in public assessment processes and by the world of finance.

These and other inconsistencies at the heart of many net zero commitments become very obvious when they are compared against the new standards for net zero. As professional practice adopts these accounting guidelines across all aspects of project development and assessment, the outcomes for guiding us through the maelstrom will become clearer every day.

5. Barrel 2: Establishing Energy Planning, Urban Planning and Transport Planning Strategies and Regulations That Create Net Zero Grids, Precincts and Corridors in Cities

The role of cities in the maelstrom will be critical, as this is where innovation has been trialed and then mainstreamed historically [27–29]. The processes needed to help us through this maelstrom will need to include the following: energy planning that enables the best combinations of distributed renewables and large-scale renewables to create affordable, reliable and fossil fuel-free grids, urban planning that establishes net zero precincts, and transport planning that creates net zero corridors to enable renewably charged electric transport to spread through cities.

5.1. Electricity Planning for Net Zero

The big changes in electricity planning require an understanding of the fact that the new distributed energy resources require a different kind of grid [30]. This means that the old manuals of grid management need significant revision. Power systems everywhere are rapidly decarbonizing and are the major sectoral leader of the past decade [6]. Figure 4 shows the dramatic reduction in the costs of solar and wind, which are now cheaper than any other form of energy.

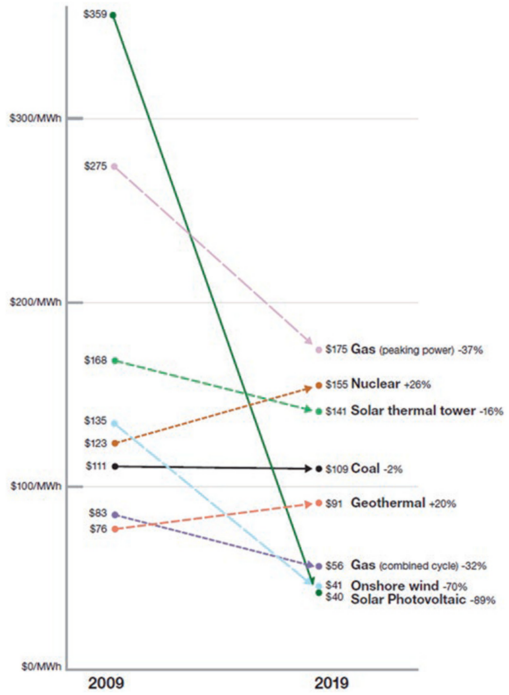

Figure 4. Costs of power sources in the maelstrom. Source: [31].

Seeba [32] predicts these costs for renewables will continue to decline, with 70% lower costs than fossil fuel-derived power by 2030. If true, these cost reductions will continue to drive a maelstrom of change, but the processes within the systems of professional practice will still need to be addressed. In order to make the most of this historically least-cost system, all grid utilities face issues associated with the ways in which the demand curve on its diurnal cycle can be met as the system phases out coal (baseloads not being required in digitally managed power that can respond to immediate demands), diesel (in smaller systems that can become renewable with adequate back-up storage) and gas (used for peaking but potentially replaceable by mixtures of solar, wind and batteries)—see the energy chapter in IPCC [6]. These changes are even more significant in the Global South as not only is the renewable power cheaper to produce, but it also works best at small village scale and can be applied to slum housing as well as rural villages [33].

As is shown in Figure 4, the costs of peaking gas and coal are considerably higher than those of solar and wind but are requiring very different professional practice to integrate into a grid. Issues revolve around integration of local renewable power production that is behind the meter into a system that is built for one-way traffic in electrons from centralized power station to decentralized customers [30]. With the advent of distributed power systems, the professional practice requires new tariffs, new regulations to enable the most efficient outcomes (not just those that protect the old centralized system) and a range of demonstrations to ensure that the way forward through the maelstrom can switch to net zero but also create a better and fairer economy [34].

5.2. Urban Planning for Net Zero

The big issues of urban planning for net zero concern the way to enable cities to re-urbanize and regenerate around net zero technology. This requires net zero buildings which need to be located in precincts able to generate power and store it and include other benefits that are part of the place-making created through precincts. In the IPCC Mitigation Report [6], the emphasis in each of the chapters on Cities, Demand, and Transport is placed on the need for urban regeneration in precincts. The rationale derived from Creutzig [35] in more European urban fabric is that carbon emissions can be reduced by approximately 25% through this approach to urban planning, and in my work [36], the savings in urban regeneration could be as high as 300% compared to highly sprawled new suburbs.

Thus, the other major professional practice change in urban planning is to recognize the fact that different parts of the city have different opportunities for change, which are based on history and especially the associated transport priorities [37]. These different urban fabrics have very different densities, and the combinations of new technologies need to be applied differently. Table 1 summarizes these differences.

Table 1. Different urban development strategies for net zero in different urban fabrics. Source: [37].

Net Zero Urban Spatial Planning Tools	Central City Walking Fabric	Inner City Transit Fabric	Outer Suburb Automobile Fabric	Peri-Urban and Rural Bioregional Fabric
1. Solar design	Strong transport carbon reductions but harder to implement solar design on buildings. Solar design essential for energy efficiency.	Easier to implement solar design on buildings and harder on transport carbon reductions. Solar design essential for efficiency.	Easy to implement solar design on buildings and much harder on transport carbon reductions. Solar design essential for efficiency.	Easier to implement solar design on buildings and harder on transport carbon reductions. Solar design essential for efficiency.
2. Electric transit activated corridor design	Electric metro trains, buses, and Trackless Trams need to service city centre with very few electric cars.	Electric metro trains, buses, and Trackless Trams need to service stations on corridors with some electric cars feeding in.	Electric metro trains, buses, and Trackless Trams can be built to service corridors, but mostly electric cars are used.	Electric buses and Trackless Trams have some potential, but mostly electric cars are used.
3. Local shared E-micro-mobility and walkability design	Last-mile support for transit focused on central function of walkability.	Essential support for transit stations along with walkability.	Necessary to build into any new and old station precincts but must mostly try to reduce impact of electric cars.	Electric bikes can work for local trips, but mostly cars need to be accommodated.

5.3. Transport Planning for Net Zero

Transport planning for net zero mostly concerns accommodating the market for electric vehicles. Most attention is directed towards cars, and their use is now growing super exponentially (see Figure 5), with China leading, at 20% of their car market being adapted, heading towards at least 30% by 2030 [38].

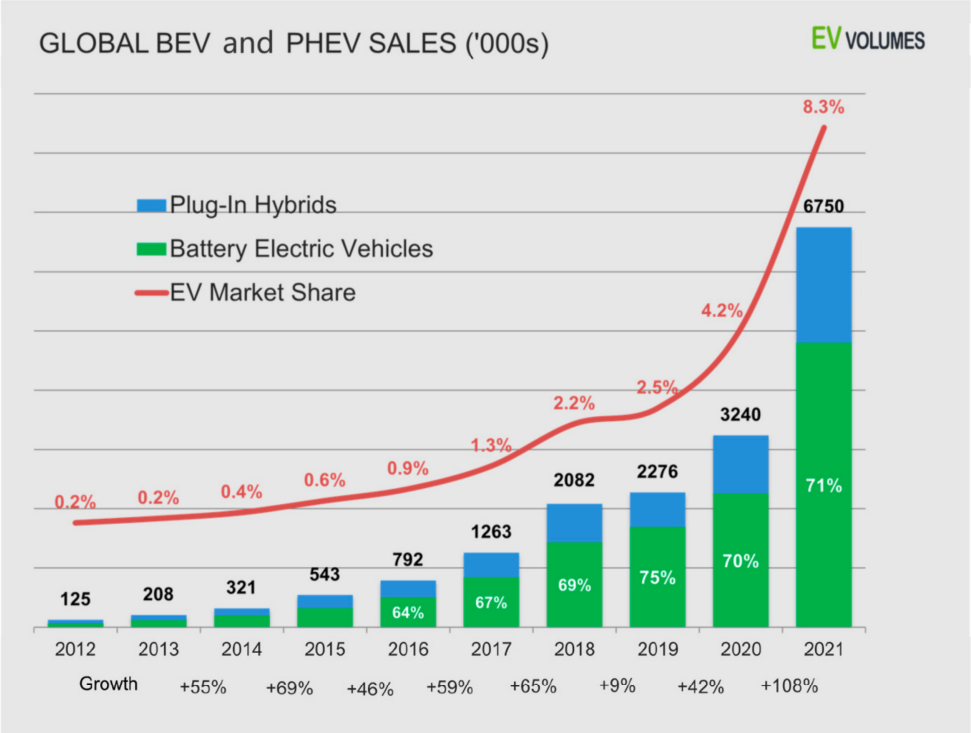

Figure 5. Super exponential growth in electric vehicles. Source: [39].

Government fleets and recharge sites are major ways that this maelstrom on the car market can be handled as is the case with the US, where 50% of EV government fleets by 2030 and 500,000 charging points are targeted as the new goals [38]. Much quicker adoption in global markets is suggested by Arbib and Seeba [9], who propose that 95% of the car market will be electric by 2030 based on cost curves.

Perhaps the most encouraging data originates from Bloomberg New Energy Finance [40], which has tracked the less spectacular side of electric vehicles, two/three wheelers and buses, mostly in the Global South. Whilst car markets remain at around 9% globally and vans and trucks at a mere 1%, buses have reached 44% and 2–3 wheelers 42% of global markets. These changes have occurred mostly in China and India but are rapidly happening across the Global South, driven by the demand for a better product on the streets of cities, towns, and villages. This is a model of the possibility to make the transition to net zero in turbulent times rapid and popular, led by the Global South.

The combination of smart systems into a new mid-tier transit system from China has begun to cause interest in the new Trackless Tram technology and its ability to assist in the transition to net zero cities, especially in older suburbs that need urban regeneration [41]; see Figure 6.

The core idea in a net zero corridor builds on emerging Movement and Place Strategies [38] that convert some important main roads from being mostly traffic channels to having a major role in mid-tier transit. The place qualities are designed in accordance with density built around the station precincts and walkable urbanism. This can therefore facilitate the use of e-micromobility and other EV's, with the station hub providing a major recharge facility [42]. Figure 7 shows the design of a net zero corridor.

Figure 6. The new electric Trackless Tram in China showing its tram-like quality with modern sensors that enable its rail-like ride quality. Source: CRRC.

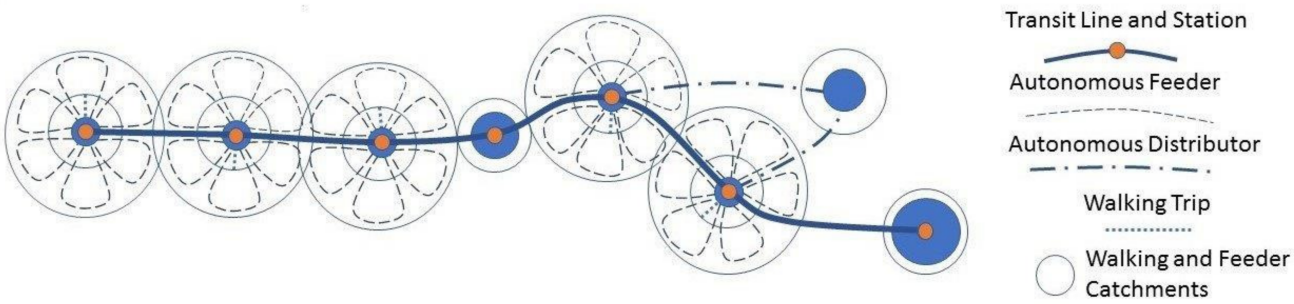

Figure 7. Net zero corridor showing mid-tier transit along a main road with station precincts integrated into net zero power. Source [43].

The concept has been applied to Bulawayo, in the Global South, showing its value in achieving net zero and the SDG's [44].

6. Australian Examples of Barrel 2: Net Zero Grids, Precincts and Corridors

6.1. Net Zero Grids

Local innovation, due to being an isolated grid, provides considerable benefits for the transition due to local uptake of rooftop solar energy generation and opportunities to phase out much of the transmission and distribution systems in large-scale regional grids. This is the case in Western Australia, where rapid change in the adoption of renewables is undermining the old grid professional practice. The Distributed Energy Resources Roadmap set the framework for a dramatic growth in rooftop solar energy generation [45]. Figure 8 demonstrates the large area currently planned which will move into being a Stand-Alone Power area, the role of microgrids and local DER power systems within the 'mesh network' (see next section).

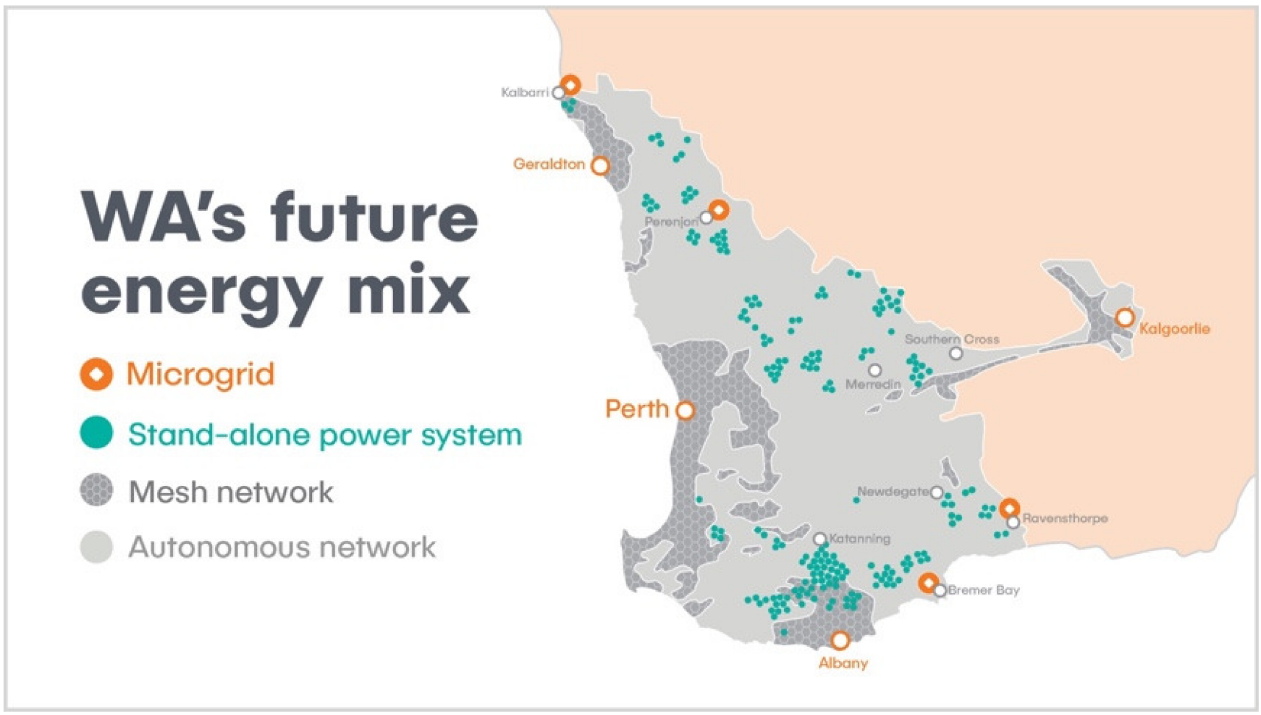

Figure 8. The South West Integrated System in Western Australia showing the transition underway to reduced size of the grid. Source: Western Power website.

'Massive uptake of rooftop solar' was the headline in a media release by the WA Government in 2022 [46] announcing the phase out of coal before it was originally planned. The rooftop solar excess power (after it has been used in the household) reached over 80% in 2022/23. Issues for the grid have emerged in recent years due to the need for storage and balance in the solar growth. In the maelstrom, we need to work out a way to proceed with balance provided by a combination of local wind power and hydrogen created from excess solar power during the day in order to enable the replacement of final fossil fuel (gas). This will require considerable creativity in the changing regulations, as well as the integration of EV recharging into the system, which is a major research goal in the next three years [42].

6.2. Net Zero Precincts

One of the innovations that has become a feature of the Western Australian transition is the delivery of net zero precincts beginning to demonstrate a way to share solar using community batteries and community recharge of electric vehicles. Key demonstration precincts have been researched to show the following. Solar ENERGY can be shared using blockchain in WGV, a redevelopment project involving affordable housing [47]—see Figure 9. Solar energy, batteries, community water for irrigation and EV recharging can be shared using the strata title company system in an inner-city East Village [48]—see Figure 10 demonstrating the various components of a net zero precinct. Solar energy, batteries, EV's, and permaculture gardens can be shared using a community governance model in a rural eco-village called Witchcliffe [49].

6.3. Net Zero Corridors

Australia has been setting up net zero corridors for partnership projects in many cities under my applied research group's direction [50]. The resulting research outcomes have focused on the new electric Trackless Trams that seem to offer the best opportunity to enable urban regeneration along a corridor of new station precincts as outlined above. Figure 11 shows a conceptual drawing of one proposed station precinct which is net zero in design and could spread into its surroundings through its microgrid.

Figure 9. The WGV net zero development in Western Australia. Source: DevelopmentWA.

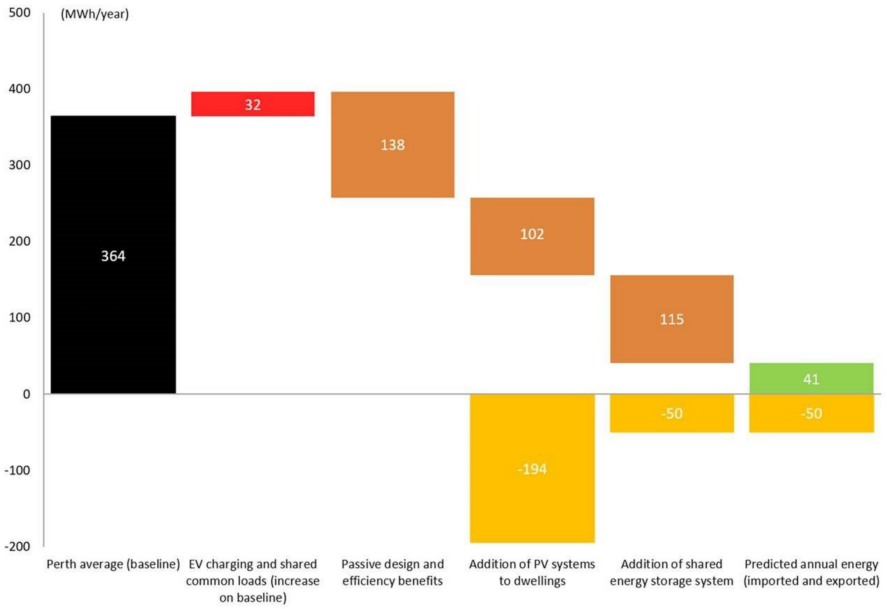

Figure 10. Modelling net zero for new East Village in Western Australia. Source: [48].

Figure 11. Net zero corridor in concept using a Trackless Tram and net zero station precincts. Source: [50].

7. Barrel 3: Establishing Rural and Regional Net Zero Projects, Mostly Using Hydrogen, That Involve Appropriate Just Transitions and Engagement with Local Indigenous Communities

The economics of delivering renewables is so far ahead of all other options (see Figure 4) that it is now a highly competitive market process for renewables to replace all other options that have been in place over long periods of time. New projects that suggest peaking gas and nuclear power are likely to be cheaper and will require much more substantial review processes to deeply investigate their rationales; they are no longer competitive at a fundamental cost level, but they can prove useful if the professional practice systems necessary to support the new technology are not in place. The politics of this transition will be painful, and the new processes will need to be highly collaborative and culturally attuned if they are to be successful.

This section examines the ways in which the maelstrom needs to involve everyone. The new economy is emerging rapidly in cities where cheap solar energy, batteries and EV's can be easily applied. However, the process must function in rural and regional areas where primary production is located and large areas of land are finding new functions in the economy. Land use changes are going to be a major feature of the future, as agriculture becomes more and more oriented to its own net zero agenda, but also of the way land can be the source of carbon sequestration for the longer-term agenda of reducing global temperatures to below 1.5 °C [6]. However, the big challenge in the rural and regional maelstrom will be the hydrogen agenda in industry.

As suggested in IPCC [6] and the section above discussing Figure 3, hydrogen is not yet cost-effective for many rural and regional functions, but it will be unavoidable as a core element in the transition [51]. The rural and regional transition will be a very bumpy maelstrom as the solutions are not emerging as easily as in the cities.

The appropriate way to consider hydrogen projects in rural and regional areas is to set up major demonstrations to sort out the technical issues and to ensure the planning processes can be fully inclusive as the solutions will need all the help available. This should be the basis for the social processes of seeking equity and social justice in the maelstrom using the just transition process and the Indigenous engagement process. Both can help illustrate a way to ease the chaos of change in the maelstrom of rural and regional transition. As before, Australia will be used to illustrate the maelstrom changes.

7.1. Hydrogen Projects in Rural and Regional Areas

The idea of a Hydrogen Economy enabling everything to become net zero has had a parallel life and until now was always an option for all parts of the economy. It is now clear that solar-batteries-EV's and associated electrification of everything is likely to be a much cheaper and easier solution than hydrogen for most economic activity. However, as Whitehead et al. [51] suggest, there are some areas of the economy where the use of hydrogen will be unavoidable, mostly focused in rural and regional areas. As outlined above, the fuels for shipping (likely to be ammonia) and aviation (likely to be synthetic jet fuel) will all need to be created from hydrogen after splitting water using renewably based electrolysis. However, the biggest focus for hydrogen use will be on industry processing that replaces coal and gas in reducing minerals to metals and other industrial products.

Hydrogen production and application in rural and regional mining and industrial processing will need significant changes in regulations, processes and strategies. The storage and distribution of hydrogen will need to be minimized as it is thermodynamically and chemically challenging—it is not a like-for-like swap for gas. Much of the systems will need significant scaling up before they can enable significant decarbonization, but this will need to be planned. In all the plans, a focus on industrial siting will be required to employ hydrogen production and to be optimally near either where a mineral is mined or taken to a regional port [51]. It is likely, therefore, that regional ports will play a big role in this part of the net zero economy.

As with the solar-battery-EV maelstrom of change, there will be much turbulence in the professions as these technologies and strategies are developed.

7.2. Just Transitions

The social equity implications in all this turbulence are huge and well recognized [6]. They are expressed in the SDG's which are meant to be achieved during the process of creation of all this decarbonization and in the new finance plan to cover reparations for the Global South that was agreed upon at COP27. The actual just transition outcomes are emerging but need increased attention. These outcomes are being instituted in some places as coal mining communities are phased out, and are rarely a simple matter of re-training old skills for new ones but instead require implementing new job strategies relevant to existing areas [52]. It is an opportunity for rebuilding new economy jobs into struggling areas and to improve equity in general. The German model is considered to be a good model, as seen on the example of coal [53].

7.3. Local Indigenous Community Engagement

Perhaps the largest impact of decarbonization and the creation of hydrogen-related jobs on rural and regional areas is the impact on local communities that have existed for long periods of time, especially the Indigenous people in such areas, especially in the Global South. Many places are developing strategies for Indigenous engagement in the net zero agenda [6].

Indigenous rights are now being highlighted in the maelstrom as large projects for producing hydrogen from solar power (mostly) are requiring very large amounts of land to trap the sunshine. These areas have been largely left over from the previous economy, often considered worthless, and are now rapidly gaining new value. Indigenous settlements and land entitlement have often been pushed into these areas that were not considered useful for the past economy. Their time has come.

Indigenous land title is now a fundamental part of the next economy so professional practice will need to use all the engagement processes possible (legally required and ESG-required) to enable true use of the land in ways that assist Indigenous people in achieving economic advantages they did not have before and at the same time retain the importance of the land and its features to such groups [6,54]. Again, this should be seen as a major opportunity.

8. Australian Examples of Barrel 3: Rural and Regional Hydrogen with Just Transitions, and Local Indigenous Engagement

Before examining the specific issues of hydrogen applications in rural and regional areas, it is worthwhile showing that Australia's rural and regional areas continue to play a large and growing role in the provision of all the critical minerals necessary for this turbulent transition to net zero. Australia provides more than half of the world's lithium with rapid growth in new mines as well as dramatically increasing local processing [55]. There are detailed strategies for each of the 20 or so critical minerals being developed in Australia for the global market and for the basis of the new economy in Australia. Some have called the opportunities a Lithium Valley [56] and a Renewable Energy Superpower [57,58]. Australia's mining sector is not known for missing new economic opportunities and the resource sector has been expanding considerably (in Australia and many other parts of the world) as the focus has shifted to providing the minerals and metals behind the world's new economy [59].

9. Just Transitions

Australian rural and regional areas were the last to implement climate action and policy opportunities with climate denialism led by their politicians [60]. The inequities that were associated with the decline of coal, oil and gas-related jobs were part of this political discussion. However, the shift to seeing the future differently has happened since

the maelstrom changes of recent years, and now there are many places that are planning a just transition based on hydrogen-related activities. These are starting in coal fields, then oil and gas, though the latter industries are still planning expansion as outlined above. The Just Transition movement in unions and communities is now active [61] and government programs have been introduced with a focus on rural and regional areas, especially on regional ports as outlined in the first Annual Climate Change Statement to Parliament [62]. The Statement also showed that Indigenous local engagement is now seen as critical to achieving climate change objectives, especially in remote areas.

10. Indigenous Local Engagement

The Juuken Gorge incident in the Pilbara region of Western Australia was a major turning point for mining, not just in Australia but probably worldwide [63,64]. A cave containing traces of human activity from 46,000 years ago was blown up as routine iron ore mining by Rio Tinto was being conducted. The resulting outrage led to the dismissal of the CEO and the legal change to prevent such disasters [65]. It is important to observe that professional practice associated with Indigenous engagement in the mining company had been phased out of the core management processes in the company due to their roles not being seen as 'core business' [63]. Such activity must now be a core driver for the processes of establishing mining and all other industry activity in the future rural and regional economy.

Western Australia is a major producer of minerals, producing the largest proportion of iron ore, gold, lithium, zinc and nickel in the world, and very high proportions of alumina and the new critical minerals such as rare earths as outlined above. This is based on a very large proportion of the state having an exposed crust due to billions of years free from volcanic activity and millions of years free from glaciation (soil building), which makes the area poor for agriculture but rich for mineral harvest. It is also a state with an established finance and innovation support base for mining, which has existed since the gold rush in the 1890s. This highly established industry is now adapting rapidly to the new net zero agenda [66].

The mining industry began preparing for the new global trade opportunities that they saw arising from net zero immediately after the Paris Agreement was signed [67]. All the big mining companies are developing net zero strategies and are setting up first the easy steps with solar-based electrification of mining processes, transport, and mining settlements [68]. The next steps are focusing on hydrogen production using solar and wind power and hydrogen as the basis of processing minerals [69]. The obvious links to large investment in regional ports for export are becoming clear [70].

All the mining groups and major companies are recognising that the large-scale production of solar and wind power in their regions cannot happen without close engagement of Indigenous communities, engagement not just because it is required, but because the people involved have such a strong stake in their land and know a lot about its proper management. The resulting partnerships based on Native Title Agreements are all aiming to provide long-term employment and create new settlements that are appropriate for their areas [71]. The core professional practice will need to ensure that Indigenous needs are being met or they will fail.

In many of the papers and reports relating to the rapid changes now underway to achieve net zero, the phrase "regenerative development" is often used as a way of showing the positive aspects of development that are now available [72]. In particular, seeing as the idea of regenerating the atmosphere is now feasible, we can begin to repair climate change. This is an obvious focus; at the same time, however, commentators are suggesting that this can be achieved in a way that regenerates the economy and also regenerates communities as they are given new opportunities such as those provided by just transition strategies and by serious Indigenous culture engagement.

11. Conclusions

The turbulence of our time is a chance to focus on the fact that professional practice is seeking ways to reach net zero at a time of rapidly reducing cost in the main technologies of solar, wind, batteries, and electric vehicles. Some technological optimists such as Tony Seba predict very rapid change and tend to make it seem inevitable with the greatest changes occurring by 2035. However, this paper used the analogy of taking hold of barrels in the maelstrom to demonstrate a guide on the way that we indeed will need to grasp the opportunities for applying these technologies, especially if we want a more just solution that enables the Global South to benefit. We can ride the waterfall down in a safe and rapid transition to net zero, but it will require many demonstrations in professional practice to show a way to implement net zero strategies through changes in accounting, energy planning, transport planning and urban planning as well as rural and regional strategies that can set up just transitions and the regeneration of Indigenous communities. The maelstrom needs to be seen as an opportunity to prepare for the next economy in a way that regenerates not only the atmosphere and the economy but also social equity and long-term issues such as meeting Indigenous needs. The net zero river flowing out from the base of the maelstrom will undoubtedly have many surprises, but a rapid period of turbulent change will occur before we can complete this transition.

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