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# Uncovering an emerging policy direction for Australian energy and future fuels using a “participatory decision-making” framework

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**Introduction:** An online deliberative engagement process was undertaken with members of the general public to understand what they value or would like to change about the energy system, within the broader context of decarbonizing Australia’s energy networks, identifying a role for future fuels (hydrogen and biogas). Citizens developed a set of principles that could guide Australia’s path toward a low-carbon energy future, reflecting on expectations they place upon energy transition. Next, citizens’ principles were shared with policy-makers in government and policy-influencers from the energy industry using an online interactive workshop.

**Methods:** This study analyses policy-makers and -influencers response to citizens’ guiding principles using the ‘diamond of participatory decision-making’ framework for analysis. Convergence and divergence in diverse, complex and rich views across cohorts and implications thereupon energy policy were identified.

**Results:** Although considerable alignment between multi-stakeholders’ views was noted, key areas of divergence, or what is called the “groan zone” were easily identified in relation to social and environmental justice issues. This groan zone highlights the struggles that energy policy-makers face -the need to listen and respond to citizens’ voices, vs. the need for practical and workable policies that also support overarching government or industry objectives.

**Discussion:** Policy making when the views of different stakeholders align is relatively straightforward. However, this is not the case where the expectations diverge. More creative measures will be needed to address divergent views and expectations whilst maintaining procedural fairness, in this case, using democratic deliberative engagement processes. While the use of deliberative processes is gaining momentum worldwide, particularly concerning climate change and energy transition policies, this paper also highlights the benefits of conducting a robust post facto analysis of the content of the processes. Areas of alignment, where policy can be made and implemented relatively easily without contention are identified. Other areas (such as making electrification mandatory) might be more complex or have unwanted negative social and environmental justice effects. Overall, this paper bridges an analytical

gap between “expectation studies” and participatory research. By borrowing terminology from a participatory research framework we sharpen the concepts in “expectation studies” from a consensus, inclusion and diversity standpoint.

#### KEYWORDS

deliberative engagement process, diamond of participatory decision-making, citizens panels, energy transition, groan zone, future fuels, energy transition, expectations

## 1 Introduction

It is often the case that areas of technological innovation become saturated with exceedingly high expectations of imminent and revolutionary change (Brown, 2003). Heated aspirations, promises, expectations, hopes, desires, and imaginings can often become associated with areas or fields of innovation. Down the track, if too inflated, these hopes and expectations become responsible for seeding many difficulties, disillusionments and disappointments (Brown, 2003; Borup et al., 2006), sometimes leading to controversies (Berti and Levidow, 2014) accompanied by serious costs in terms of reputations, misallocated resources and investment (Borup et al., 2006). However, high hopes and expectations are wishful enactments of a desired future (Borup et al., 2006) and play an instrumental and performative role (Borup et al., 2006; Berti and Levidow, 2014) in organizing actors and activities in the technology innovation space. Expectations can drive the pace and direction of innovation processes and can help describe future roles for self, others and artifacts, serving as ‘coordination devices’ (Konrad, 2006, 2016). However, expectations are subject to temporal and spatial shifts, often swinging between hype cycles and disappointment phases in swift succession (Brown, 2003). These dynamics—sudden shifts and changes—in expectations can have a detrimental effect bringing the very credibility of an innovation field into question (Konrad, 2006) unless processes are in place to manage these shifts properly.

As countries worldwide seek to transition away from fossil fuels, attention is being turned increasingly to lower-emissions energy gaseous technologies such as hydrogen and biogas. As chemical entities, neither hydrogen nor biogas are “new.” However, in their role as alternative fuel sources that can support sustainable energy systems, they sit within a field of innovation that requires intense investment, research and development over a relatively short time frame. A key driver of urgency is the global need to decarbonize quickly to achieve a sustainable energy system by 2050 (International Energy Agency, 2021). A sustainable energy system cannot rely solely on renewable energy technology such as solar, wind and electric vehicles. Instead, large quantities of low-emissions technologies (such as fossil fuel capacity with CCUS, hydro-power, biomass power, nuclear, and hydrogen and ammonia-based plants) may play a critical role in future energy systems (International Energy Agency, 2023). Amongst lower emissions technology, the International Energy Agency (2023) predicts a growing role for lower-emissions gaseous fuels (for both domestic use, transport and export) in place of natural gas in the coming decades as coal and oil continue to be phased out. Low-emissions gases will be used as dispatchable energy sources and drop-in substitutes in natural gas grids as the push is made

to decarbonize energy networks worldwide. A lot of investment, research, and development are required to bring innovative ideas in the field of low-carbon energy innovation to fruition.

## 2 Theoretical framework

Since it is a well-known that new technology suites are often accompanied by hype-disappointment cycles, sometimes to detrimental effect (Brown, 2003; Konrad, 2006, 2016), it is important to study how expectations around low-emissions fuels, and therefore the credibility of the innovation field around them track over time in various parts of the world. For example, in the case of technologies that have begun to break into the market (i.e., three most rapidly growing renewable energy technologies in Germany—wind power, photovoltaics, and biogas), it has been shown that hype cycles play a crucial role in shaping ongoing socio-technical transitions (Kriechbaum et al., 2021). History has shown how fear (of negative affect in the case of photovoltaics in Germany) and pessimism (in regards to profits in the case of photovoltaics in Spain) seeded disappointment cycles (Kriechbaum et al., 2018). In the case of Polish shale gas, negative associations completely closed out the prospects for investors as exploration was abandoned after a series of early disappointments and protests (Lis and Stasik, 2017).

Challenges and opportunities for progressing innovation and implementing low-emissions fuels will vary across regional and country groupings as more and more numbers of players and actors are involved. It has been suggested that when expectations are broadly shared, actors are not only guided by their own expectations but also by the expectations of others, resulting in the mobilization of more actors (Konrad, 2006). As more and more people jump onto the “bandwagon,” creating “self-fulfilling prophesies” (van Lente, 2023), it makes sense to pre-emptively understand what can keep up or slow down the momentum of energy transition in all parts of the world.

Given the urgency of decarbonization, accounting and preparing for a diverse set of expectations to emerge over the next few years will prove fruitful. It has been said that expectations form a triangle along with perception and adoption—where the reality of technology adoption is reinforced by expectations and perceptions (Shi and Herniman, 2023). As transitions unfold and more and more players and actors get involved, the diversity of views, opinions, expectations, and perceptions can be expected to rise. As diversity in expectations rise, complexity of the energy transition and social-technical processes therein will increase.

It is not yet clear, however, how such complexity can be resolved when inclusion of diverse perspectives and expectations is a priority. In participatory approaches, diversity and inclusion are

a must-have and must-do. Although differences are seen to trigger an enduring struggle, the struggle is celebrated (Browne et al., 2018; Carolan, 2022) since it incubates a process of integration—where resolution of diverse perspectives fosters “buy-in” for difficult actions (Kaner et al., 2007). A valuable diagnostic tool—the “diamond of participatory decision-making” exists to negotiate through diversity, take an account of complexity and bring about resolution through an end-to-end participatory process (Kaner et al., 2007; Browne et al., 2018; Carolan, 2022).

Based on the above literature, we formulate a hypothesis: we argue that if “the diamond of participatory decision-making” is applied as a diagnostic tool to understand and classify expectations, it provides insight toward managing forthcoming hype-disappointment cycles. We imagine and compare the energy transition, a socio-technical process, to a large group process, and seek to show how expectations can be leveraged toward consensus decision-making using the “diamond of participatory decision-making” (Kaner et al., 2007) over due course of time. We embark on an “interdisciplinary detour” akin to van Lente (2023), seeking to show how to “*shift the angle, provide a new vocabulary, and sharpen concepts*” (van Lente, 2023) within traditional “expectation studies” (Borup et al., 2006).

In order to make our argument, we limit to the case of renewable energy technologies emerging as energy carriers within the pretext of the energy transition in Australia. We turn toward two participatory research studies from Australia, to briefly describe the contextual nature of the ongoing debate around low-emissions fuels and the projected role of low-carbon gaseous fuels in decarbonized energy networks; and we describe methods available to unpack conversations within this debate so as to establish the credibility of the innovation field around low-emissions fuels by identifying how early expectations are developing, the diversity of views that exist and the work that is needed to include diverse perspectives in managing expectations effectively through an appropriate policy making approach in future.

We collect and compare views held by a representative sample of Australian citizens, policy-makers in government and policy-influencers from industry to show how expectations, across various cohorts, can serve as ‘coordination devices’ to guide policy-making.

Next, we seek to understand what actions are critical in protecting a space for experimentation and learning in the context of pre-competitive future fuel technologies, given that a culture of collaboration is cited as being critical in Australian circles (Kambo et al., 2022). Since future fuels are in the very early stages of development, the need to decarbonize is urgent, and the time frame is short, we seek to understand methods that are effective in managing inevitable hype-disappointment cycles as Australia’s clean energy technology and transition unfolds, heeding participatory values along the way. Unless managed well, hype-disappointment cycles within the transition, may interfere with peoples’ capacity to buy-into, acknowledge, accept, participate and adopt the “new” energy systems being considered for decarbonization in Australia and elsewhere.

Although hype-disappointment cycles have been studied before in the context of alternative fuels (Konrad, 2016; Melton et al., 2016) and European experiences of renewable energy technologies

(Kriechbaum et al., 2018, 2021) and unconventional or shale gas (Lis and Stasik, 2017), this article adds to knowledge and understanding in four key ways. First, it describes innovative methods useful in informing, engaging and eliciting expectations simultaneously amongst stakeholders who might hold diverse, even competing and conflicting values in relation to sustainable energy systems. Second, it describes a method for secondary analysis that is useful in following and unpacking conversations and visually communicating how expectations (public vs. government vs. industry in this case) converge (or not) toward actionable decision points that can be implemented in current or emerging policy. Thirdly, this method highlights how to acknowledge and include diverse perspectives around energy transition exploring the possibility of reaching consensus amongst a diverse set of players whose expectations may not as yet align. The method explicates how diverging expectations may be leveraged toward consensus decision-making in time, through an ongoing social research and engagement agenda; which in turn could feed a participatory policy-making process. Lastly, the method seeks to expand the vocabulary within expectation studies by borrowing useful concepts from participatory research.

We begin by explaining the background as it relates to low-emissions fuels scene unfolding in Australia as a case. In Australia, “future fuels” is used as a term to describe low-carbon gaseous fuels such as hydrogen and biogas and other potential fuels that could come to play a role in decarbonizing Australia’s energy networks (Future Fuels CRC, 2020). As with other advanced economies around the world, the need to decarbonize energy networks in Australia was triggered by directives that seek to redress climate change issues to meet net-zero emissions targets in policies emerging from both the federal and state Australian governments (South Australian Government, 2020; Australian Government, 2022; Government of Western Australia, 2022; New South Wales Government, 2023; Queensland Government, 2023; Commonwealth of Australia, 2024) and from peak body organizations within the gas industry (DNV, 2021; Gas Vision 2050, 2022). Across current government and industry policies, future fuels are presented as “clean” fuel options. Within academic circles, hydrogen and biogas have been described as pro-health (Gill-Wiehl and Kammen, 2022) and necessary, “zero emissions ways to transport energy” (Percy, 2022). A recent scenario modeling has shown that even if total gas use for power decreases in Australia, new gas capacity will be still be needed as a strategic reserve to support renewable energy systems as energy storage reserves to cover for diurnal or seasonal shortages (Net Zero Australia, 2023) and to meet contracted LNG export obligations and forecasted levels of domestic demand (Commonwealth of Australia, 2024). Dissenting authors maintain that renewable hydrogen production continues to be associated with climate-damaging emissions (Kemfert et al., 2022) and will not help Australia achieve its net-zero emissions targets (Wood et al., 2023a). In a scathing criticism, Wood et al. (2023b) hold governments to blame for “*hyping Australia’s hydrogen prospects and hoping for the best, rather than doing the hard work to establish integrated industry policy for proportionate, targeted, and timely support.*” Government reports on the other hand acknowledge a place for hydrogen and biomethane (alongside ammonia and e-methane) on grounds that

these gases possess the potential to substantially decarbonize gas supply chains (Commonwealth of Australia, 2024).

Against the debate described above, we explain the value proposition of this paper below. In the following section, we include literature which explains the value of participatory research in general, and then describe the scope of participatory works currently undertaken within the context of low-emissions or future fuels in Australia and bring into focus studies which further complicate the academic debate described above. We outline the nature of diversity and complexity that has emerged from participatory research studies, showing how expectations from stakeholders contrast with those described in the literature above.

In the literature described above, conflicting views and expectations about the role of future fuels are being witnessed world over. In light of this literature and background, we reiterate the value proposition of our paper. Essentially the methods and results described below offer insight toward managing conflicting expectations in a clean energy transition by relying on time-tested frameworks available in participatory processes. It is often the case that the deployment of new technology at scale creates an uneven distribution of costs and benefits. It is therefore imperative to include a range of voices (and particularly those representing the vulnerable) in the discourse to understand where inequities may emerge. Through this understanding, it becomes possible to balance and distribute the costs, benefits and losses more evenly as the new industry seeks to establish itself. For example, Markard (2018), Carley and Konisky (2020), and Ravikumar et al. (2022) call for local communities to be regularly engaged on how they are being affected by policy or technology interventions with an intent to avoid exacerbating any existing social injustices and inequities. It has also been recognized that clean energy transitions must entail an inclusive approach and remain people-centered, ensuring that the benefits of clean energy are felt widely in society (International Energy Agency, 2023), and social conflicts are avoided as the technologies seek to establish themselves. When community voices are added to the academic debate described in the previous section, additional challenges for managing public expectations in relation to the production, storage and use of future fuels across Australian society become evident.

For example, in a 2018 representative survey of the Australian public, participants were asked what they know about low-carbon gaseous fuels (such as hydrogen and biogas) and how they feel about using them as prospective fuels (Lambert and Ashworth, 2018). Survey findings showed a widespread lack of awareness and knowledge about renewable gases. Similarly low levels of awareness and knowledge were reported in subsequent surveys in 2021 and 2022 (Lambert and Ashworth, 2018; Martin et al., 2021; Lozano et al., 2022; Arratia-Solar et al., 2023). Despite the ongoing academic debates at international and national levels, the Australian public remains persistently unaware of future fuels and the role they might come to play in Australian energy systems. Down the track a drive to push future fuels to market, may meet resistance unless this lack of awareness is suitably addressed.

Reportedly, low awareness levels of hydrogen and biogas (Lozano et al., 2022; Bharadwaj et al., 2023) alongside high perceived risks and low perceived benefits (Emodi et al., 2021), high perceived capital and operating costs (McCollum et al., 2018) and other psychological factors, such as negative experiences, feelings,

affect and mistrust (Huijts et al., 2012, 2019) can negatively impact the acceptance and uptake of any technology. Low acceptance and uptake of future fuels can seed disappointment over time and hamper the levels of investment, research and development that are being asked for in recent scenario models (Net Zero Australia, 2023; such as International Energy Agency, 2023).

Clearly, extensive public education and communication campaigns are necessary to engage, inform and gauge public expectations on an ongoing basis, given the low levels of awareness being reported. To be people-centric, such campaigns also must embrace an empathetic approach and develop mutually beneficial public, industry and government relations (Beasy et al., 2023). Raising awareness in an empathetic way will be a slow and steady process, where extensive time and resources will be needed to build trust that strengthens over time. A slow, steady and ongoing process sits at odds with the urgency being placed upon the world to decarbonize and tackle climate change. In the Australian context, recent participatory research studies have sought to understand and describe the expectations of the general public (Ashworth et al., 2021; Kambo et al., 2023a,b) and personnel within government and industry (Kambo et al., 2022) vis-à-vis renewable energy technologies. These studies have shown what peoples' expectations around sustainable energy systems are and that people's expectations for future fuels cannot be divorced from what has been expected from traditional energy systems. This expectation alone constitutes a great challenge for future fuels. However, to date, this ready data on expectations gathered within these recent participatory studies has not been analyzed in a systematic and holistic way from an "expectation studies" lens.

To bridge this analytical gap, this paper makes multiple theoretical contributions. Firstly, we examine the processes and describe the methods used to elicit expectations from three key stakeholders—citizens (Section 3.1), government and industry personnel (Section 3.2). Secondly, we describe how we appropriated the diamond of participatory decision-making to systematically classify expectations, simultaneously describing diversity and complexity in the discourse amongst these stakeholders (Section 3.3). In Section 4, we explain our results and show how the "diamond of participatory decision-making" proves an effective device to systematically analyze expectations. Finally, in Discussion (Section 5) and Conclusion (Section 6), we describe how this paper adds value to an interdisciplinary enquiry between "expectation studies" and participatory research in four ways: One, we show the value of applying participatory approaches to elicit expectations across a diverse range of stakeholders. Second, we demonstrate how "the diamond," a tool of participatory decision-making, is a useful way to analyze diversity and complexity within expectations. Second, we demonstrate a pathway for consensus decision-making within the renewable energy technology field in Australia and seek the attention of policy makers and decision makers interested in a participatory policy- or decision- making processes. Third, our analysis has proved useful in identifying a course for future actions that are guided by participatory values using an Australian case study. Four, we show how borrowing concepts from participatory research such as "the diamond" and associated terminology enlarge vocabulary and sharpen concepts within expectation studies. We celebrate our success in undertaking a useful interdisciplinary detour.

### 3 Methods

This study uses data from two participatory research studies conducted to elicit expectations of citizens and government and industry personnel. In section 3.1 and 3.2 we briefly describe the methods used to elicit expectations, the key research outputs that emerged, and how we used research outputs as units of analysis in this paper. In Section 3.3 we describe how we appropriated “the diamond” to analyze and classify expectations from the three key stakeholders.

#### 3.1 A participatory process to elicit citizens’ expectations for future fuels

To elicit citizens’ expectations for future fuels and their place within a sustainable energy system, a deliberative engagement processes was used. The process proved to be an innovative research exercise that served as an education and engagement platform whilst simultaneously collecting primary data on the Australian public’s knowledge, values, perceptions, and expectations in relation to energy transition and the role of future fuels in Australia (Ashworth et al., 2021).

Deliberative research involves bringing people together to discuss and address a problem of common concern. Deliberation has been defined as “*mutual communication that involves weighing and reflecting on preferences, values and interests regarding matters of common concern*” (Dryzek, 2002; Mansbridge, 2015). Ashworth et al. (2021) explain that in their process, the term deliberation implied a process which was rooted in weighing alternatives before eliciting an opinion and providing a considered view. To do this, participants were provided access to a range of relevant evidence and expertise on Australia’s energy system, energy transition and future fuels (hydrogen and biogas) prior to their deliberations.

Deliberative engagement processes, or ‘citizens’ panels’ were completed with samples of the public in three regions of Australia—Greater Melbourne, Wollongong/Illawarra, and South Australia. The three samples were defined and differentiated by geographical location (all are located on the eastern side of Australia and connected by a single, extensive electricity network), scale and regionality (i.e., South Australia is a state, Illawarra/Wollongong is a regional community, Greater Melbourne is a very large city) and by their level of exposure to renewable energy development (i.e., highest penetration of renewable energy is in South Australia; Illawarra/Wollongong is emerging as a renewable energy and potentially hydrogen export hub; and Greater Melbourne remains highly reliant on fossil fuels). The goal was to recruit 42 participants for each panel. A market research company was asked to recruit participants toward quotas that would represent the Australian population, to the extent possible, for each location. Basic demographic criteria of gender, age, employment, and CALD<sup>1</sup> status was selected to guide the recruitment. The market research company used an existing market research panel, applying a non-probability quota sampling approach based on the characteristics of the Australian population from the 2016

Census data to identify potential participants, screen for quotas and finalize recruitment. However, due to lengthy time commitment involved in the citizens panels and several unanticipated drop-outs and recruitment difficulties, the actual sample size reduced to 40 (Greater Melbourne and South Australia) and 37 for the Illawarra/Wollongong region (Ashworth et al., 2021).

Activities within the citizens’ panels were designed to elicit views on energy transition with a specific focus on understanding perceptions of the role of renewable gases in future energy systems. Participants shared the aspects of Australia’s current energy system that they value and would like preserved, what they think needs to change, and their expectations for how Australia should decarbonize its electricity system. The citizens’ panels provided a platform for participants to engage, learn and challenge various aspects of the future fuels technologies and concepts through peer learning and facilitated deliberation. The sessions elicited participants’ concerns around safety, risks, inconvenience, costs, reliability and infrastructure continuity as well as opportunities to address climate change risks, create new jobs and economic benefits of a new industry. Overall objectives of the process were to identify:

- opportunities and challenges for the deployment of future fuels in the future energy mix; and
- considerations and trade-offs that policy-makers, industry and citizens need to make to enable decarbonization of Australia’s energy systems.

An essential output of the study was a set of agreed principles developed collectively by the participants that reflect their shared values in current and future energy systems, and outline a set of acceptable and preferred conditions to guide Australia’s path toward a low-carbon energy future (Ashworth et al., 2021; Kambo et al., 2023a,b). In short, citizens’ expectations for Australia’s energy transition and the role of future fuels in enabling the transition are captured in these principles. The citizens’ principles are the first key research output used as a unit of analysis for secondary analysis.

In the next section we describe how these citizens’ principles became the stimulus for a series of online, interactive workshops conducted with government personnel and industry personnel. In the workshops, the full set of citizens’ principles were organized into themes and shared for discussion and response as explained below.

#### 3.2 A participatory process to elicit expectations within government and industry circles

This section describes the method used to effectively gather expectations from personnel within government and industry circles. To ground discussions, the research exercise was designed to continue discussion on citizens’ expectations encapsulated in citizens’ principles. Two online workshops were hosted using Zoom, with interactive activities conducted through the online whiteboarding platform Miro (Kambo et al., 2022). Two separate workshops were conducted—one with “policy-makers” within government and one for “policy-influencers” within the renewable gases and energy industry. Participants were recruited using a

<sup>1</sup> CALD—Culturally and linguistically diverse.

TABLE 1 Identifying thematic brackets where alignment and divergence were observed.

Theme for citizens' principles	A: are expectations aligning?	B: are expectations diverging?
Education, research, and innovation	Yes (Figure 4)	Yes (Figure 5)
Equitable and affordable energy services	Yes	Yes
Transparency and planning	Yes	Yes
Collaboration	Yes	No
Safe for all	Yes	Yes
Reliable energy	Yes	Yes
Energy security for Australian users	Yes	Yes
Incentives, renewables, and net-zero	Yes	Yes

snowball method resulting in 14 government and 25 industry participants. A short presentation was made by the researchers introducing the citizens' principles, explaining how they were bracketed in themes (as shown in column header in Table 1) for further discussion. Next, workshop participants were asked to provide their initial response (to the question below) based on their own experiences in policy-making/influencing, using the collaborative online Miro whiteboards:

*"How do you respond to the principles created by participants in the citizens' panels?"*

The next section explains how the workshop participants' responses and commentary—the second essential research output, were used as a unit of analysis for secondary analysis. Participants responses and comments were left on the Miro whiteboards, adjacent to the relevant citizens' principles. In the next section, we explain how the "diamond of participatory decision-making" was used as an analytical framework to classify citizens', policy-makers', and -influencers' expectations and to demonstrate the complexity and diversity that exists therein.

### 3.3 Qualitative analysis using the "diamond of participatory decision-making" framework

We begin by describing the "diamond of participatory decision-making." "The diamond" is an analytic tool (see Figure 1) that identifies commonalities in language and points of reference between different groups and has been used often to facilitate agreement making and knowledge sharing in large group processes whilst they are live (Kaner et al., 2007).

Figure 1 diagrammatically explains the concept of "the diamond of participatory decision-making" as put forth by Kaner et al. (2007). Kaner et al. (2007) explain that "the diamond" has

three zones describing the dynamics within any group process. The first zone is a "divergent zone," where ideas are free-flowing and judgment is suspended. The second zone is the "groan zone," where group members acknowledge the diversity of ideas generated in discussions and yet struggle to integrate the diversity into any single conclusion. The "groan zone" is described as a direct, inevitable consequence of diversity that exists in any group (Kaner et al., 2007) and is heralded as a moment within group processes where difference is welcomed as a source of potential productive tension (Browne et al., 2018; Carolan, 2022). The third zone is the "convergent zone," where a sense-making occurs, calm descends, and ideas can be consolidated. A successful convergence ends with an actionable or implementable decision point.

Figures 2, 3 diagrammatically explain how "the diamond" was used as framework to analyze the data post facto.

Step 1: The themed principles (as they were presented in the workshops) were placed in the starting point of "the diamond." Each principle was color-coded (see Figures 2, 3) to depict each of the three geographic samples (Greater Melbourne, Wollongong/Illawarra, and South Australia as visually distinct data points. The corresponding responses of government and industry participants were placed in the body of "the diamond," as additional visually distinct data points. Diamonds were constructed for each thematic set of principles. Two types of diamonds emerged as explained below.

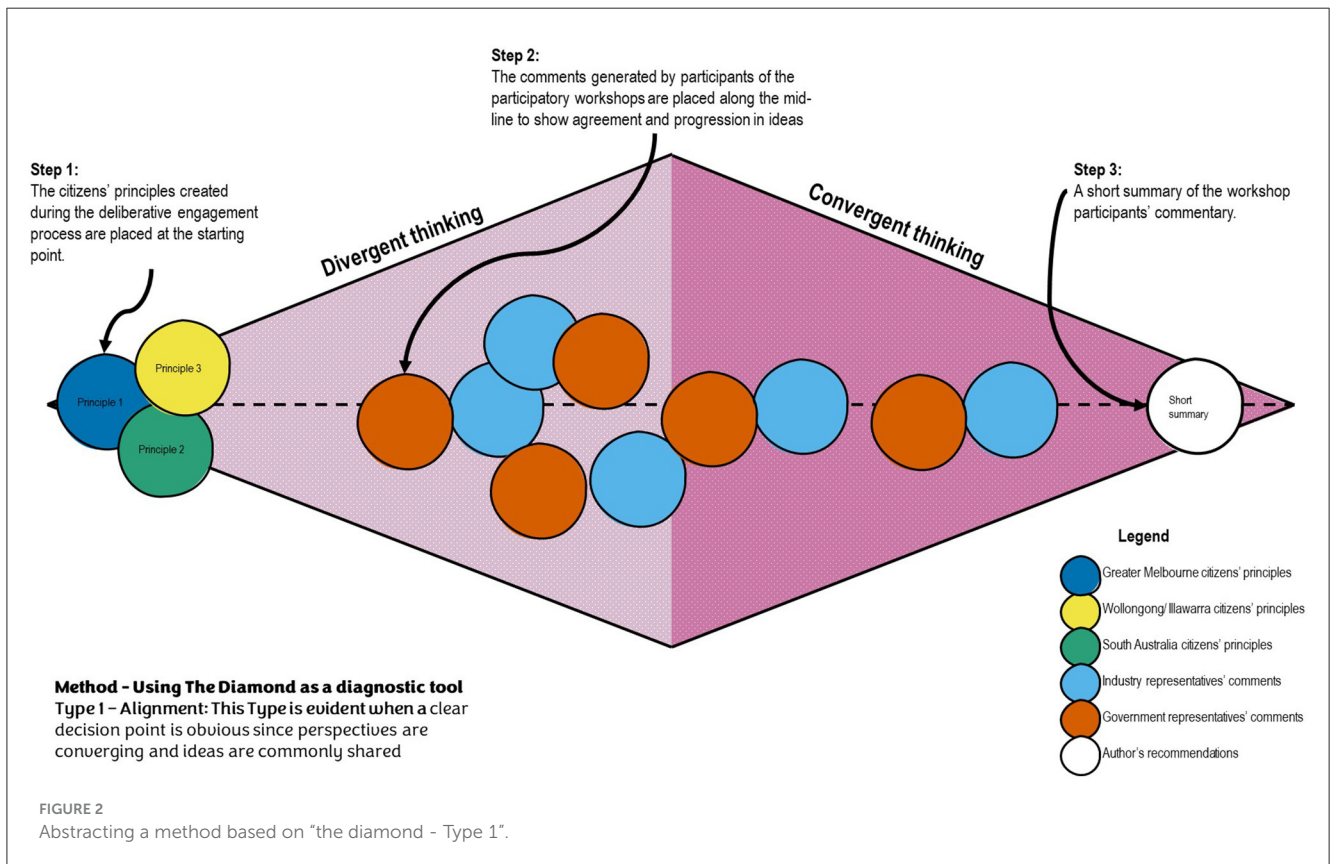
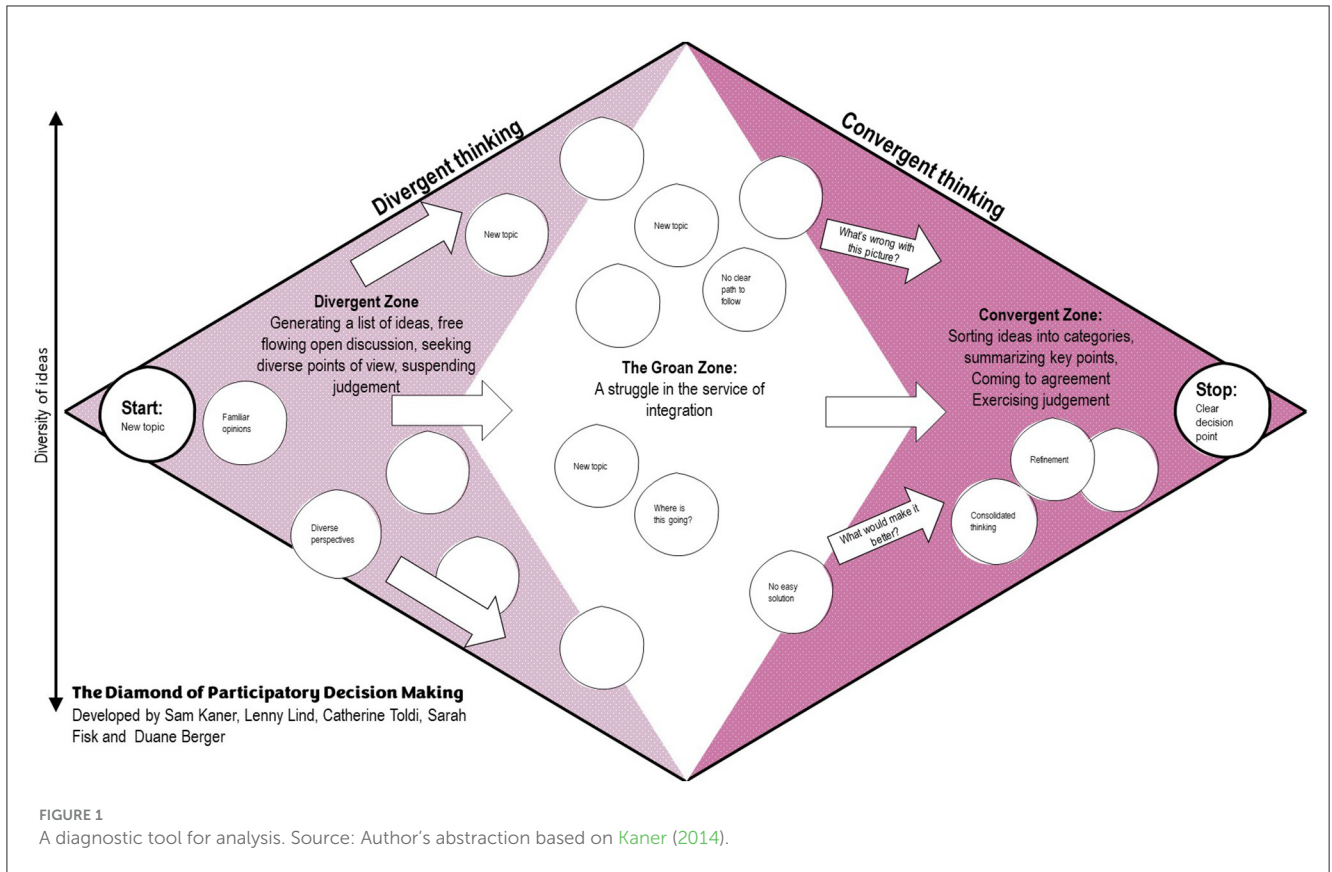
Type 1—Alignment: this type of diamond is flatter as the data points could be positioned easily and cleanly upon a central axis—depicting very little diversity or difference in citizens' principles and the government and industry response to principles (Figure 2). In this case, there appears to be little controversy or areas where there could be tensions in the process of policy making as stakeholder expectations are largely aligned.

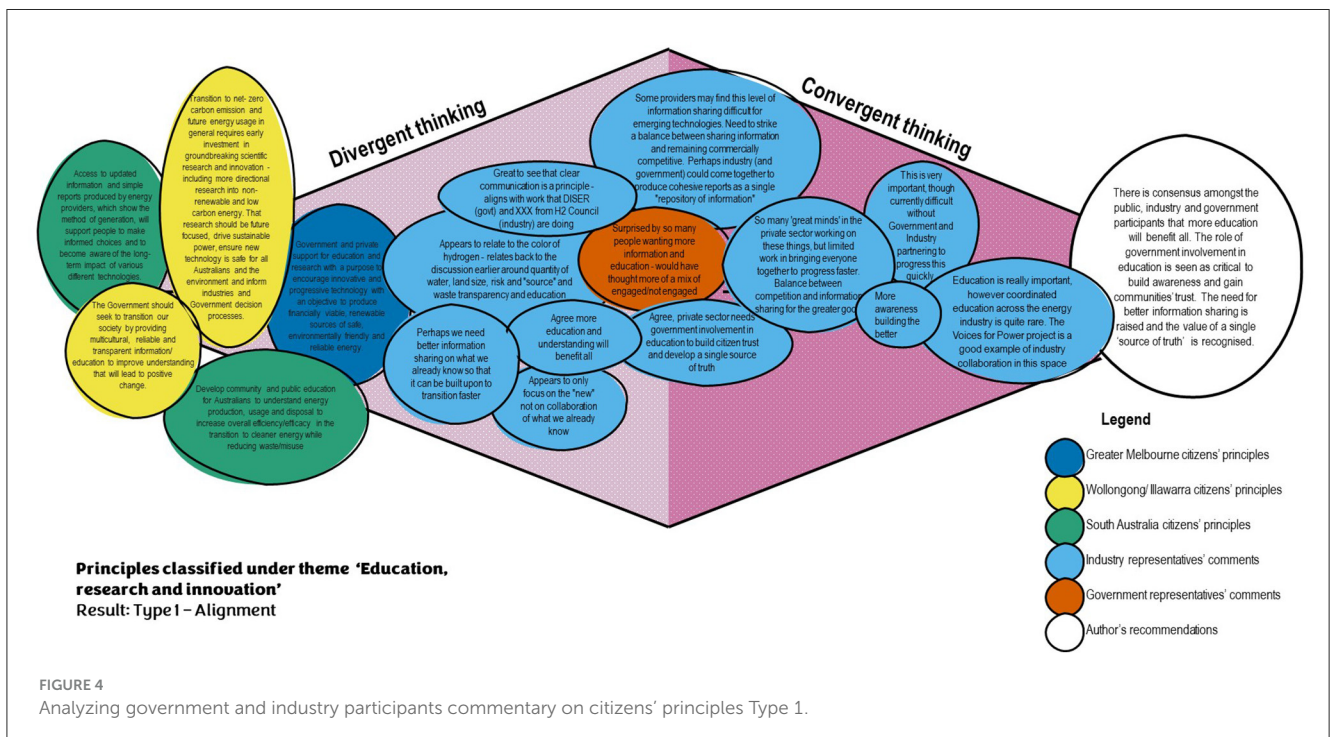
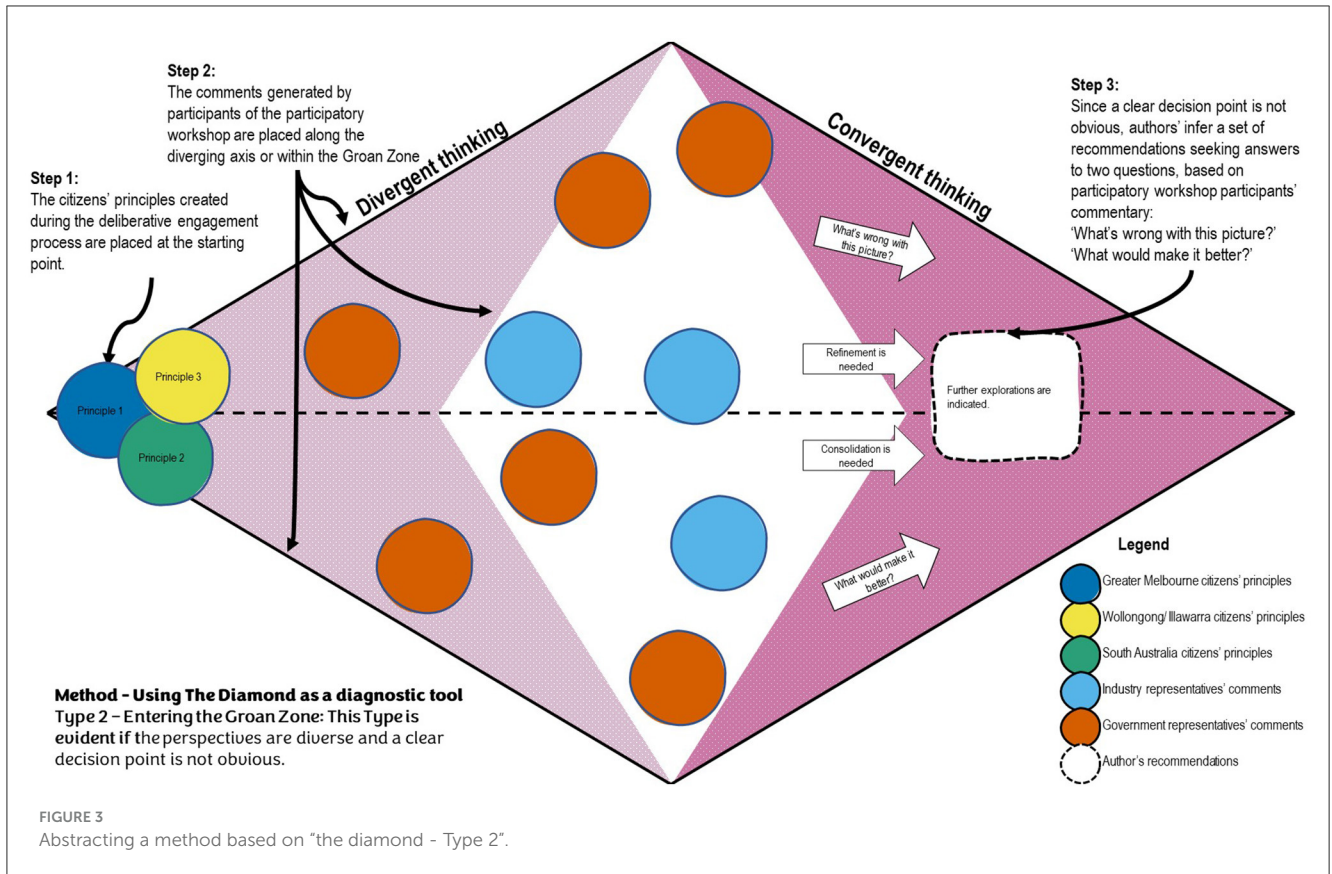
Type 2—Entering the "groan zone:" this diamond is much wider in the middle to accommodate a greater diversity of opinions and it appears that expectations are mismatched (Figure 3). The data was messy and had to be positioned along the diverging (top and bottom axes) to show the volume of difference in views. Although not necessarily disagreeing with the citizens' principles, policy makers and influencers saw many obstacles and struggled with how to realize the hopes and expectations citizens articulated. This struggle to find alignment is described as the "groan zone," where potential for productive tension is observed.

Step 3: As a final step, the components in "the diamonds" were synthesized and summarized using the diagnostic prompts set out in the framework (Kaner et al., 2007). The summaries point to two sets of implications.

For Type 1, or "Alignment" diamonds, the summary of participants' comments point to an actionable and implementable target based on a set of clearly aligned values. Since consensus is the obvious inference in these cases, the information contained in the summaries may be applicable within a national context. The summaries point to issues and aspects that would likely be broadly acceptable to the public if formally implemented in policies.

For Type 2, or "groan zone" diamonds, the summaries identify issues and comments that need further exploration through an ongoing agenda for social research and engagement. From the data (comprising of discourses from both the citizens' panels and the participatory workshops), it is difficult to arrive at an agreed

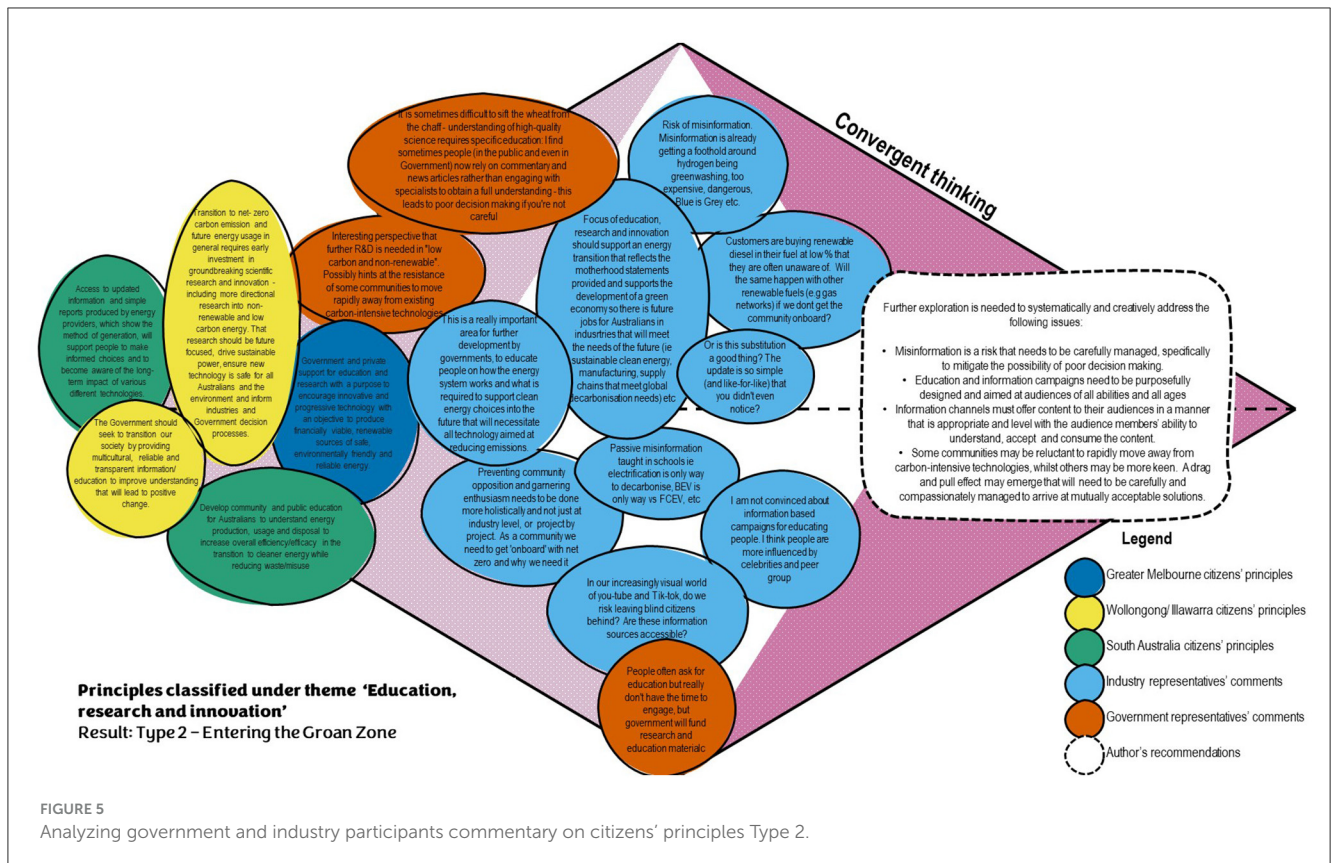




set of reasonable, actionable and implementable targets for the energy transition, without further participation from the players involved. Here, divergent views among stakeholders indicate that the scope for further debate, deliberation, and participation is

wide open. The summaries in this set of diamonds indicate where public expectations for energy transition might prove difficult to manage, especially if hype-disappointment cycles become more evident. They indicate a context-specific, nuanced, not necessarily





systematic or comprehensive set of ideas and aspirations on topics that need further exploration. It is inferred that exploring and engaging on these topics, through participatory social research, may prove to be uniquely meaningful and relevant within more localized contexts.

### 4 Results

From the application of Kaner et al. (2007)'s "diamond of participatory decision making" framework to understand convergence and divergence in discourses on energy transition among the Australian public and policy-makers and influencers, it is clear that there are certain values, aspirations, and expectations in relation to energy transitions and future fuels that are commonly shared and where policy implementation should be least contentious. Table 1 shows how examples of aligned and divergent expectations were evident across all thematic brackets.

Commonly held views and the nature of aligned expectation are discussed in Section 5 (also see detail in Supplementary Table A, Column A). Section 5 (also see Supplementary Table A, Column B) highlights the diversity of views and expectations that were identified, and the nature of complexity involved in resolving such diverse views. A need is indicated for further refinement or deliberation in order to reach a shared understanding (if not agreement) both in the context of energy system transition generally and specifically the role of future fuels within that system (Sections 5).

In short, the identification of the two types of diamonds, successfully proves the value of visually depicting expectations as "coordination devices." As we predicted in our hypothesis (Section 2), we describe four value propositions arising out of the enquiry within this paper (Sections 5) and trace possibilities for the future in Section 6.

In Table 1, it can be seen that the discussion around principles classified under the theme "collaboration," resulted in the creation of only one type of diamond—alignment. By and large all citizens, policy-makers and -influencers input was very clearly aligned and in favor of collaboration. This result alone indicates a favorable atmosphere toward participatory processes in general and indicates that the paper will be well-received by all policy-makers and -influencers seeking collaborative, participatory frameworks.

On the whole, the application of deliberative engagement processes and interactive online workshops have proven useful in eliciting the expectations of key stakeholders through research studies separated in time (Ashworth et al., 2021; Kambo et al., 2022, 2023a,b). The application of Kaner et al. (2007)'s "diamond of participatory decision making" framework for secondary analysis of data emerging from participatory research studies within the wider realm of expectation studies is novel. Secondary analysis described here has proven to be a useful exercise to identify areas of convergence and divergence in the views of three key stakeholders—citizens, government, and industry. Rather than excluding and discarding diversity, the process sheds insights on how to resolve complex issues within the Australian energy transition specifically, the role of future fuels as a case. Analysis

of discourse using “the diamond” framework provided a rich understanding of where public expectations for future low carbon energy systems align with those of government and industry and where policy could be enacted to support these expectations with opposition less likely. Additionally, the framework, and the methods used to apply it in this study are versatile and can be easily adapted to suit people-centric research, where participatory values such as collaboration, diversity and inclusion need to be factored into every step of the process. The method is suitable to any policy-relevant topic, in any country or region and lends itself well to comparative studies across different technological contexts.

## 5 Discussion

In this section we expand on the four propositions arising out of the analysis as follows.

### 5.1 Proposition 1: Participatory approaches offer value in deeply understanding expectations

The first proposition is that participatory approaches prove effective in eliciting, acknowledging, and sharing diverse and complex expectations amongst key stakeholders. Deliberative engagement processes lent themselves well in eliciting expectations from lay citizens who openly admitted to having low levels of awareness and knowledge about the key technological components involved in the energy transition and future fuels (Ashworth et al., 2021; Kambo et al., 2023a,b). It empowered and brought agency back to participants who used their social learnings through the process to construct a series of principles that could be tabled with key personnel within government and industry circles (Kambo et al., 2022). When these principles were shared openly with policy-makers and policy-influencers an honest and transparent discussion ensued and participants openly admitting to the “enabling” and “disabling” factors in relation to citizens’ principles. For example, in an end-to-end participatory process (data collection to analysis, and reporting), the research studies have shown that key values such as energy affordability, reliability and safety are commonly shared and expected, yet there are differences in opinions in how such values can be supported in the implementation of policy that also meets other social objectives such as education, justice, and peaceful resolution of societal expectations.

### 5.2 Proposition 2: Hype-dissapointment cycles can be safely negotiated

The second proposition is that hype-disappointment cycles can be safely negotiated by focusing on those values that are clearly aligned. On the whole Australian citizens, government and industry participants largely agree upon several considerations described below. The second proposition arising out of secondary analysis described within this paper is that although hype-disappointment cycles are inevitable (Borup et al., 2006; Konrad, 2006, 2016; Berti

and Levidow, 2014; Kriechbaum et al., 2018, 2021), they can be safely negotiated if these clearly aligned and shared values become the impetus for any forthcoming actions. The secondary analysis attempted thus far reminds policy- and decision- makers who have in interest in participatory research, energy transition and renewable energy technologies, to keep the focus on the following key attributes, which as demonstrated here, already may have “buy-in” amongst a wide range of stakeholders. In no particular order of importance:

#### Adopt a bipartisan approach toward legislation

The Australian political context has two major political parties that often oppose each other on policy matters—of key relevance to this study is their different priorities in relation to climate change action, which has resulted in Australia lagging behind many other developed countries in relation to climate policy (Ashworth and Witt, 2023). A majority of Australian citizens believe that anthropocentric climate change is happening (Ashworth and Witt, 2023) and in their principles for energy transition articulated the expectation that the two major political parties would find middle ground from which to form bipartisan approaches to enable the legislation of enduring climate action policies, including a long-term vision for energy transition. This analysis shows that participants (from public, government, and industry) have mostly agreed with this sentiment. So, there ought to be confidence that a bipartisan approach to legislating climate action targets would be received well amongst the voting public regardless of support for either political party. Several participants (in each research study) have communicated that they wish to see strong leadership from Australian governments (regardless of which party is in power at the time) in achieving net-zero emissions.

#### Coordination is critical

There is consensus amongst participants that collaboration between researchers, educators and communities is needed to elicit and define socially acceptable decarbonization pathways. Industry participants noted that there are many individual companies and projects who are progressing energy projects and engaging with communities but are doing so without regard to others. Additionally, much research is being conducted on technological advancement by the private sector, but this often occurs in a competitive environment where research findings are not shared. Citizens stated the expectation that governments would play a leading role in energy transition through funding of technology and innovation and in coordinating the dissemination of factual information. Several participants agreed that coordinated planning efforts between state and federal governments could achieve the best outcomes for communities’ wellbeing and environmental health.

#### Safety is top priority

Safety was indicated as a top priority by citizens. Government and industry agreed that safety was their top priority equally and should be a key consideration in all energy policy decisions.

#### Government involvement in public education

Perhaps again reflecting the low levels of awareness on future fuels (Lozano et al., 2022; Arratia-Solar et al., 2023; Bharadwaj et al., 2023, 2024) and energy literacy in general,

there is consensus amongst the public, industry and government participants that there is a need for more education about energy transition. A call is made for more investment into science and technology communication. To ensure consistency and non-bias, this education and communication effort should have significant government involvement. Targeted communication efforts are required to build awareness and gain communities' trust for different energy policies and low carbon technologies, so as to enable and inform individual consumer choices. The need for better information sharing is raised among concern that misinformation is already being spread. Participants seek consistent and trusted information from a "single source of truth," where neutral, fact-based information on sustainable energy systems and future fuels is readily available (an example of this being effective was cited by a citizen in relation to the COVID-19 pandemic, where they relied on and trusted information available on government health departments).

#### **An affordable transition will be an orderly transition**

The Australian electricity network has one of the longest interconnected electricity grids in the world. In total, it extends about 918,000 km (it could circle the equator 23 times; [Energy Networks Australia, 2021](#)). Most Australians enjoy access to affordable, reliable electricity. In the development of their principles, citizens placed high value on equitable access to affordable energy services, with the expectation that energy would continue to be provided at affordable prices as an essential public good. Both government and industry participants understood the expectation that electricity would remain affordable across the grid but pointed out the complexities behind the pricing of electricity, and that economic policy instruments (such as price subsidies, incentives, rebates, etc.) would be needed to keep electricity affordable (especially for fixed-income domestic consumers) and to manage any inequities and vulnerabilities that could arise. The use of economic tools was seen as critical in ensuring an orderly transition which does not compromise the vulnerable and disadvantaged, or remote Australians as the energy market transitions.

### **5.3 Proposition 3: Diverging expectations are opportunities in disguise**

The third proposition is that diverging expectations can be leveraged to construct an agenda for future participatory research, consensus decision-making and participatory policy-making. Although considerable areas of consensus were identified (see previous section) in the discourses where policy making can be relatively non-controversial, industry and government policy practitioners also identified significant obstacles with and questioned the practicality of several citizens' principles. The third proposition of this paper is that resolving the tensions below through future instances of deliberative engagement processes or other suitable participatory approaches will uphold Australian expectations for democratic procedural fairness and help build the necessary social acceptance for future fuels and new energy policies.

#### **A bipartisan approach to legislation but not overstepping the role of government intervention**

Although participants generally agreed that Australia needs a bipartisan approach to be able to implement consistent and robust energy transition policies, some industry participants were wary of too much government intervention in a free market economy and private enterprise. It was explained how the development of new energy technology is a competitive space, with commercial calculations of financial risk and returns underpinning most private investment in energy projects. It was feared that too much regulation or policy directive could undermine commercial drivers of growth and investment which is needed in the early stages of future fuels project development. At the same time citizens expressed a desire for stronger regulation to safeguard community wellbeing and environmental health, with the expectation that government policies will keep industry accountable for their actions in this regard. This suggests that incentives and outcomes-based policies would be more readily implementable than prescriptive regulations or punitive policies.

#### **Safety is complex**

Industry and government participants agreed that the citizens' principles on safety should be upheld in policy but highlighted the emerging nature of future fuels technologies and the uncertainties associated with that. They explained how technical uncertainty makes setting appropriate safety standards and regulations challenging, although there has been much recent development in Australian safety standards with the adoption of international standards that can now be implemented by regulators ([Australian Hydrogen Council, 2023](#)). Another issue raised was how to communicate safety aspects of emerging future fuels technologies to the public, in a way that does not generate fear but is relative to other common types of gases used.

Some industry participants stated that more can be done to improve both communication and management of lifecycle impacts and social impacts, integrate principles of circular economy and ensure environmental protection over the course of time.

#### **Education and information campaigns are complex**

Citizens expect that government led communications will provide consistent, factual information designed to reach audiences of all geographies, abilities and ages. Government participants stated a willingness to fund education campaigns but were concerned that people would not fully engage with such campaigns. Government participants acknowledged that in terms of sustainable energy transition and future fuels, misinformation is a risk that needs to be carefully managed as misinformation can escalate into policy contention and lead to poor decision making. Industry participants explained how information provided by them is usually specific to a project or geography and supported the citizens' principle of government involvement to deliver a more holistic communication campaign. Particularly, citizens have asked for content that explains the long-term impacts of the various technologies being considered—whether renewable or non-renewable—for future energy systems. Citizens would like to better understand systems of energy production, usage and disposal (equally for old and new technologies). Citizens would also like to understand how to increase overall efficiency/efficacy

while the energy network transitions to cleaner energy. Citizens would also like to understand how to reduce waste and misuse of energy. If citizens could access trustworthy information on these topics, it would go a long way in helping them to make informed choices around energy systems with respect to their own unique and personal circumstances. Some government participants also noted that if communities are reluctant to rapidly move away from carbon-intensive technologies compared to others. Any differences that emerge, therefore, will need to be carefully and compassionately managed to arrive at mutually acceptable solutions over time. Where possible, governments are advised to embed and lead deliberative engagement processes into their own operations with a view to demonstrate to public how citizens views are directly upheld in policy. In most cases where independent assessments are valued, governments could consider funding trusted research institutions to conduct deliberative engagement processes on their behalf.

#### **An affordable, equitable, and orderly transition is a terrific goal—but how do we deliver it?**

Although both government and industry participants acknowledged the citizens' expectation for an affordable, equitable and reliable energy system, they communicated numerous difficulties in delivering an energy system which can be reliable, equitable and affordable all at the same time. For example, an industry participant noted that it is extremely challenging to support equity in energy supply and another participant brought attention to the link between location, energy costs and availability. As government and industry participants struggled with the needs expressed by citizens, they identified more areas where consumer education and awareness could help to empower citizens. For example, participants identified that citizens would need more education on how energy reliability and affordability are maintained in Australia and how energy efficient practices and self-generation can help to reduce costs. They also noted the resonance between citizens' principles and the concept of Environmental and Social Governance (ESG) and felt that more work can be done to widely communicate how energy companies currently integrate ESG considerations into their own businesses. Industry participants struggled with the citizens' idea of future fuels as an "essential service" and wondered what form regulations would take and what challenges this concept could bring to industry. Government participants acknowledged that the long-term prospects of the future fuels industry are fantastic, yet there is need to learn from past experience of exporting gas and ensuring that interests of the domestic consumers are protected. One government participant expressed the hope that consumers ought to be willing to pay more for zero carbon energy as it has more value for society.

#### **5.4 Proposition 4: Interdisciplinary detours are immensely valuable**

The fourth proposition is that an interdisciplinary detour into "the diamond" approach, proved useful in enriching the vocabulary and sharpening concepts within expectation studies. For example, we classified expectations within different "zones" in

the "diamond." When expectations are placed in "the divergent zone," "the groan zone," or "the convergent zone," it reminds us of the challenges and opportunities present within socio-technical exchange processes such as the energy transition. Being aware that such zones exist and can emerge in large group discussions—or a country's discourse on energy transition—is in itself significant. In large group processes, this knowledge allows facilitators to be prepared and group management is easy for those who are prepared to resolve such eventualities (Kaner et al., 2007). Comparing this to the larger, more broad scale of energy transition, all actors—specially those in policy- and decision- making are reminded to train themselves as "facilitators" of the energy transition and use these concepts to guide their own large groups toward an actionable set of ideas, whilst simultaneously respecting the rules and values of consensus, collaboration, participation, inclusion and diversity. The paper has shown how "the diamond" process is immensely valuable even for secondary analysis of data collected through separate research studies stretched out over a period time but must increasingly be used by all actors in live discussions.

## **6 Conclusion**

To conclude, this paper set out to understand publics' aspirations and expectations with respect to energy transition and the role of future fuels within the Australian context. A finding based on the methods involved, namely deliberative engagement processes and participatory workshops, is that a diverse range of aspirations and expectations were captured, constructed and communicated, live and post-facto, in context of the energy transition. Whilst engagements were live (whether deliberative engagement processes or participatory workshops), participants from each cohort involved—the general public, government and industry representatives in the Australian case successfully relayed their interests, issues and concerns through their own voice based on their individual and collective understanding.

A finding through subsequent, post-facto "diamond" analysis, was a depiction of alignment vs. divergence in those expectations that were captured through live engagements described above. Where cases of alignment were detected, it is shown how early expectations converge across cohorts—clarifying issues that might easily be resolved through policy intervention. Where cases of divergence are detected, findings explicate the vast extent of work that is needed in the future to manage conflicting expectations effectively.

For example, findings demonstrate how publics' agree on some roles and duties for government, industry and citizenry; how the scope of communication strategies needs to expand; and how much more debate is needed before a widely acceptable course of action can be settled upon. The findings depicted as visual 'coordination devices', explain where processes need to be in place to manage changes and shifts in expectations. A clearer picture has emerged showing areas that need to be addressed in order to build legitimacy for the future fuels. Key among such processes will be education, awareness and engagement campaigns where the scale and impact of future fuels technologies on social and environmental systems is vividly understood in collective psyche through active and patient debate, where many voices are respectfully welcomed and heard; where concerns are validated and resolved through sincere and

considered effort. As actions unfold, it can be expected that the innovation space around future fuels will be fostered and mediated over time.

As a call for future work, all the issues that occupy the “groan zones” described above may be enlarged into several questions for dedicated research to foster the innovation space for future fuels. Specifically, we highlight one central question, that seeks resolution through multiple iterations of research over time: This central question needs a lot more participatory work in the short and long term, offering an opportunity to discover “solutions” through democratic processes such as deliberative engagement, in all parts of the world, where social objectives such as education, justice, consensus, collaboration, participation, inclusion, diversity, and peaceful resolution of societal expectations is a key focus. If governments can directly lean on such methods described here, or fund research institutes to conduct such processes on their behalf, the prospects of maintaining procedural fairness through the course of the transition is strengthened. As long as direct outcomes of the deliberative engagement processes are useful in informing policies, the main question to consider is “How can government, industry and communities find ways to evenly share the costs and benefits of sustainable energy systems and support the development of mutually acceptable decarbonization pathways over due course of time?” Finding participatory ways to engage deeply on this one question, through repeated iterations, with many communities, engaging many actors, is one way to reflexively refine people-centered policy for future energy technology, on any scale—from local, to national to international. Specifically, this question could invite future discussions on policy, to see how stakeholders entertain options for low-carbon finance vs. taxation vs. incentives to spur up (or slow down) low-carbon innovation, climate-friendly international trade, sustainable urban mobility and land use and other issues of importance to stakeholders.

## Data availability statement

The original contributions presented in the study are included in the article/[Supplementary material](#), further inquiries can be directed to the corresponding author.

## Ethics statement

The studies involving humans were approved by EAIT LNR, Research Ethics and Integrity, University of Queensland. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

## Author contributions

AK: Conceptualization, Data curation, Formal analysis, Investigation, Visualization, Writing—original draft,

Writing—review & editing. LK: Data curation, Formal analysis, Visualization, Writing—original draft, Writing—review & editing. AA-S: Writing—original draft, Writing—review & editing. KW: Supervision, Writing—original draft, Writing—review & editing.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fsuep.2024.1400747/full#supplementary-material>

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