SEPTEMBER 2023

8.

Focus Group Findings

Exploring Queenslanders' views of high voltage overhead and underground transmission infrastructure

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Acknowledgements

We would like to acknowledge the contributions of:

Susantha Wanniarachchi

For his help in seeking copyright for the images included in the document

Members of Powerlink's Customer Panel

Who guided us through the research design elements of the project

Report Reviewers

Who generously gave up their time to provide much needed feedback on the report and chapters

Executive Summary

This chapter details the results of ten online focus groups conducted with a cross section of the Queensland general public in August 2023. In total 78 participants from across regional and metropolitan Queensland participated. Participants were an even mix of gender and ages ranging from 18 – 29 years of age (9%) through to 60+ years of age (13%) with the majority aged between 30 – 39 years of age (38%). Ongoing engagement with First Nations People and some farmers is still underway and will be reported separately.

The aim of the focus groups was to have an expert share a summary of the key findings from the systematic literature reviews and case studies, comparing overhead and underground transmission lines (Chapters 1 – 7), and to document the participants' responses to the information. This included responses to three questions which included: i) *Based on the information provided, what would you say are the benefits and concerns of overhead and underground transmission lines?* ii) *Who should be responsible for decisions about these types of large infrastructure upgrades?* iii) *If you, as an individual or a community, were to have a transmission line come near you, how would you like to be involved in the decision-making process?* As part of the data collection process, participants were also asked to participate in an online brainstorming session and complete pre- and post- surveys to track their individual attitudes and responses.

When first asked about what they believed were the issues and opportunities associated with overhead and underground transmission infrastructure initial themes included safety; maintenance; costs; environmental impacts; aesthetics; and weather. During the discussion it became clear that most participants did not distinguish between transmission and distribution infrastructure. This appears to be an area that could easily be rectified through improved communication. Safety concerns tended to focus on installation and maintenance and for overhead lines extended to issues of vehicle accidents and weather impacts including bushfires. Maintenance issues were around repairs and reliability with overhead lines being seen as easier to repair than underground cables. Costs issues included installation, maintenance and the need to extend or upgrade infrastructure as well as concerns about transitioning from overhead to underground. As expected, aesthetics was in relation to overhead lines creating visual pollution, being unsightly and ruining landscape vistas. In particular the height of transmission lines. In this instance, both overhead and underground transmission were considered to impact the environment with impacts on local wildlife, the need to cut down trees and other vegetation, and taking up a great deal of space. However some participants volunteered they did create opportunities for wildlife corridors and offer perches for birds. Weather issues tended to focus on Queensland's likelihood of cyclones, storms, floods and bushfires with participants noting that all were likely to increase given the impacts of climate change.

After the expert presentation, from the thematic analysis of the transcriptions arising from the focus groups, the largest category of coded responses were concerns surrounding the higher costs associated with the installation of underground transmission cables relative to overhead lines as reflected in the quote:

> *"We've got wide spaces and a huge amount of countryside and obviously [for the costs involved] to be putting in underground power lines in, you know, the middle of the outback would be absolutely ridiculous."*

Most participants were pragmatic suggesting that it would be hard to justify the additional costs of completely undergrounding all transmission lines, but where there were high density populations, areas of natural beauty or environmental sensitivity a hybrid approach with some undergrounding would be justified. There was also recognition that those individuals who would be impacted by transmission lines should be adequately compensated including near neighbours if the lines were to visually impact them.

When it came to decision making in relation to transmission infrastructure, most participants felt it was the role of government as reflected in the quote:

> *"I think that's the reason why we elect a government, to make those big decisions about that type of thing. So I'd be happy to leave them to make those decisions."*

However, there was a suggestion that the use of an expert panel that could weigh up the pros and cons of the various options may also be helpful in instilling confidence in the decision making process.

Participants were keen to emphasise the importance of engaging and consulting with the communities as part of the process. They like the format of using an independent expert, which they felt could be run with a much larger group, even a local community if needed.

> *"I think if you're talking about how I'd want to be involved if it was coming to my area, I think what you did tonight [with the] presentation, you could do that at a community event like at a hall and say this is all the information. Because you've provided me with a lot of information that I didn't know, plus the advantages and disadvantages. So then it helps people to be informed, because sometimes we get forced into decisions without actually knowing the, you know, the pros and cons about it."*

They also recognised that those most impacted should be given greater weighting when it comes to providing input into the decision making. This potentially reflects the recommendations arising in Chapter 6 around the need for collaborative constraint mapping that allows both transmission providers and communities to weight the various constraints to help develop the preferred route for transmission infrastructure. However, once again there was recognition that there was a need for leadership from government on this matter and that not everyone will be satisfied. While it was clear that impacted individuals need to be adequately compensated, it was felt they should not be allowed to block final projects moving ahead if the processes of engagement had been fair (procedural justice). Collaborative processes that took into account the rights and needs of various groups was seen as important in ensuring projects were able to be deployed. Particularly, given the urgency around the need for action on climate change.

It is important to consider that participants in the focus groups were not directly impacted by current or proposed transmission line developments. Consideration needs to be given as to how views may change if a project was going on near their homes or if they were residents who have, or were to be, potentially impacted by transmission lines. One key theme that emerged from the surveys is that many participants are looking for outcomes that can strike a balance between the differing interests and priorities of local communities. The majority of participants being predisposed to solutions that provided a balance between economic and environmental priorities.

1.

Introduction

This study aims to investigate the benefits and trade-offs between overhead and underground transmission line infrastructure, specifically focusing on issues associated with undergrounding new transmission infrastructure. It seeks to establish a clear and consistent approach to the evaluation of overhead lines and underground cable transmission, including the consideration of community concerns around the need for new transmission infrastructure to connect large renewable energy generation projects. It does this through systematic reviews of the literature as well as incorporating experiences of Transmission Network Service Providers (TNSPs) in Australia and overseas. The study has a particular focus on 500kV infrastructure which is expected to be the system voltage for high-capacity transmission lines in Australia going forward.

Historically, transmission networks in Australia developed from the need to transfer large amounts of power from large coal fired power stations, typically co-located near coal reserves, over long distances to major cities and industrial load centres. In contrast, the proposed large scale renewable generation facilities, mainly solar and wind farms, require greater land areas and are largely being located in greenfield areas with little or no existing transmission network infrastructure. These new developments are naturally creating community interest and concerns around a range of potential impacts, including but not limited to: visual amenity; environment; Traditional Owner lands; agricultural land use; and social licence to operate concerns. This has led to questions surrounding when it is appropriate to underground transmission infrastructure and the likely implications of doing so.

To test the Queensland public's response to the information gathered from the systematic literature review (Chapter 6), in August 2023 we conducted ten online focus groups with a cross section of the general public. Additional engagement is planned with First Nations People and some farmers from regional areas of Queensland. However, this process is taking a little longer to ensure key representatives from Indigenous Prescribed Body Corporates can attend. This chapter presents the findings of the focus groups and summarises the key take aways from the engagement process.

2.

Methods

The focus group were structured in 5 stages, including a pre- and post- survey, a brainstorming session to elucidate participants' baseline knowledge of transmission infrastructure, presentation from an expert (Appendix A) and then time for a facilitated discussion and reflection.

Pre- and Post- Survey

Pre- and post- online surveys[1] were used to capture individual views, knowledge and understanding of transmission infrastructure as well as monitor any changes as a result of the focus group discussion. The pre-survey comprised 21 questions, which were predominantly established scales, adapted to the topic of transmission infrastructure. The questions included participant demographics, socio-economic status and baseline levels of knowledge and experiences with overhead and underground transmission lines. The post-survey repeated some of the pre-survey questions to track any changes in opinions. Additional questions focused on instrumental and experiential aspects including social licence, trust and procedural fairness in relation to transmission infrastructure roll out.

The survey was formatted and tested in-house by the project team using Qualtrics. Survey participants were asked to develop a unique identifier to enable pre- and post- surveys to be matched. Survey data was analysed in STATA18. A total of 78 participants completed the pre-survey, with 75 of those 78 participants completing the post-survey.

Brainstorming Issues and Opportunities using Strategy Finder

Following introductions, participants were asked to engage with *Strategyfinder* software. *Strategyfinder* is designed for collaboratively working on messy problems over the Internet. It uses a process and set of 'rules' that have been developed over 30 years in face-to-face working with management teams. The focus of the process is to explore causality – means-ends – so that agreed actions are negotiated with a full understanding of expected outcomes and ramifications. Participants were asked to first provide up to 5 statements of issues or opportunities relating to overhead transmission lines by noting an "I" (Issue) or "O" (Opportunity) after their written statement. They did this anonymously and were encouraged to write in short phrases rather than single words which can be more open to misinterpretation. A blind gather brainstorming process was used to avoid participants influencing one another with their initial responses. Once the overhead activity was complete the process was repeated for underground transmission cables.

During the ideas generation phase, the material was clustered by the facilitator and subsequently revealed and reviewed with participants. Participants were then prompted to make any further contributions once they had reviewed their group's material and, in some cases, offered up new considerations. The views were captured in the participants' own language and revealed their current perceptions of transmission lines at the time.

Expert Presentation and Focus Group Questions

Following the brainstorming activity, an expert presentation was provided. The presentation was based on the findings from the systematic review of literature focusing on technical, economic, environmental, social and cultural considerations to highlight the trade-offs between underground and overhead transmission lines. Participants were also invited to ask any questions of clarification at the end of the presentation.

Following the presentation, the participants were then asked to provide their reflections based on the following questions:

1. Based on the information provided, what would you say are the benefits and concerns of overhead and underground transmission lines?
2. Who should be responsible for decisions about these types of large infrastructure upgrades?

[1] A copy of the pre- and post- surveys can be found at http://hdl.handle.net/20.500.11937/93795

3. If you, as an individual or a community, were to have a transmission line come near you, how would you like to be involved in the decision-making process?

All discussions were recorded and transcribed. The qualitative analysis software NVIVO was used to collate and categorise all responses.

Participant Recruitment

A market research company, Q&A, was used to recruit members of the public based on their location (regional or metro), aged between 18-39 or 40+, and an even mix of gender. This resulted in eight groups from the general public and two groups of small to medium enterprise business owners. Although responses between the two categories did not show any differences. The online focus groups took place during August 2023 and were comprised of between 7 to 9 people and lasted for approximately 2.5 hours.

Participant demographic characteristics

The demographic profiles of participants are provided in Table 1. There was a 50:50 split of male to female participants, with the median age being 40 years. By age category, 9% of participants were in the 18-29 years age bracket, and 13% were above 60 years of age. More than one third (38%) of focus group participants were between 30 to 39 years of age. Of the total, 41% lived in Brisbane metropolitan area whilst 59% lived in regional areas of Queensland. The majority of participants (82%) were born in Australia and 4% of participants identified as Aboriginal and Torres Strait Islander.

Table 2 shows that the participants of the focus groups were more educated as compared to the Queensland average population with 41% holding a Bachelor or Honours degree and 14% a postgraduate degree. Eighteen percent (18%) of participants held a certificate III or IV, with 9% reporting an education level of Year 12 or below.

Table 1. Participants' demographic characteristics

Characteristics	Frequency (n)	Percentage (%)	Australian population (%)[a]	QLD population 2021[2]
Gender				
Male	39	50.0%	49.3%	49.3%
Female	39	50.0%	50.7%	50.7%
Other	0	n/a	-	-
Prefer not to say	0	n/a	-	-
Total	78	100%	100%	100%
Age (n=77)[3]				
18 - 29 years	7	9%	18.9%	12.4%[4]
30 - 39 years	29	38%	14.5%	13.8%
40 - 49 years	17	22%	12.9%	13%
50 - 59 years	14	18%	12.4%	12.6%
60 years or older	10	13%	23%	22.8%
Region				
Metro	32	41%	-	-
Regional	46	59%	-	-
Country born				
Australia	64	82%	66.7	71.4
Outside Australia	14	18%	-	-
Country born				
No	75	96%	-	-
Yes, Aboriginal and Torres Strait Islander	3	4%	3.2%	4.6%
Prefer not to answer	0	0%	-	-

[2] Accessed from https://www.abs.gov.au/census/find-census-data/quickstats/2021/3 on 2023/09/11
[3] Missing data = 1
[4] Includes age 15 to 29

Table 2. Participants' levels of education

Which of the following best describes your educational status?	Frequency (n)	Percentage (%)	QLD 2021[5]
Year 10 or below	1	1.3	18.6
Year 11 or equivalent	-	0	3.9
Year 12 or equivalent	6	7.6	15.5
Trade certificate or Apprenticeship	2	2.6	-
Certificate I or II	-	0	0.1
Certificate III or IV	14	18.0	18.9
Advanced Diploma / Diploma	11	14.1	9.4
Bachelor or Honours degree	32	41.0	21.9
Postgraduate degree (e.g. Masters, PhD)	11	14.1	-
Other (please specify)	1	1.3	-
Not stated/Inadequately described	0	0	11.6
Total	**78**	**100**	**99.9**

[5] Level of highest educational attainment, People aged 15 years and over, Sourced: https://www.abs.gov.au/census/find-census-data/quickstats/2021/3
[6] Bachelor Degree level and above

3.

Results

Focus Group Discussion

Initial concerns and opportunities

The brainstorming information collected on the issues and opportunities in each focus group prior to the expert information session are captured in Table 3. On average, each capture activity lasted for around 10-15 minutes and generated between 20 and 55 statements. There were approximately equal numbers of views for overhead (349) as there were for underground (359) with the total number of statements generated being 708. Based on a review of the clusters generated and reviewed in the focus groups, of the total 12 themes, there were 6 main themes that emerged. These were safety, maintenance, costs, aesthetics, environment and weather. Close examination of the themes and also observation of the discussion that ensued post each brainstorming activity, demonstrates that many of the participants did not distinguish between transmission infrastructure and distribution infrastructure, but saw them as one and the same.

Safety

Safety emerged as one of the two major themes (1st for overhead, 4th for underground). This addressed aspects including safety concerns around the installation and maintenance of transmission infrastructure, residential safety in terms of storm impacts, and other community and residential considerations. Overhead lines were regularly commented upon as having safety concerns after weather events, being hazardous for drivers, creating risks with machinery and tall vehicle use, as well as being subject to vandalism. Bushfire dangers were also identified.

Table 3. Tabulated themes of issues and opportunities captured using Strategyfinder

Themes	Overhead Issues & Opportunities	Underground Issues & Opportunities
Safety	75	43
Maintenance	68	87
Costs	48	61
Environmental Impacts	47	34
Aesthetics	46	51
Weather	36	34
Other	12	11
Jobs	6	4
Alternative Energy Sources	4	1
Electricity Demand	3	11
Technology	3	4
Excavation	1	18
Total	**349**	**359**

Point of entry (roof) was also raised which reinforces that participants did not distinguish between transmission and distribution lines. Safety also touched on issues relating to light, EMF and noise pollution.

Underground cables were seen as safer both from an installation and maintenance perspective, being less vulnerable to weather conditions and driving accidents. However, there was a recurring concern regarding digging, from the perspective of those maintaining them, as well as some concerns about EMF leakage.

Maintenance

Maintenance touched on issues in relation to repairs and reliability and was the other most commented upon theme (2nd for overhead, 1st for underground). Whilst overhead lines were seen as being easier to repair (easier to locate problems), participants held the view that they were more prone to faults, particularly due to adverse weather, vehicular accidents, and vandals. Age of infrastructure was also a consideration.

Underground cable issues focused on the difficulty of identifying them and any problems along with access and repair. There were also concerns on maintenance schedules and their community impact through things such as roadworks. However, underground cables were seen as more reliable (fewer hazards damaging them) and lasting longer (so less maintenance).

Safety and maintenance, costs and maintenance, and maintenance and weather were all often aligned in participants' thinking.

Costs

Cost issues included the installation, maintenance, and extension of lines, and emerged as another frequently raised theme (3rd for overhead, 2nd for underground). Overhead lines were seen as costly to install and maintain (cost of metal, cost of securing the space). There was also a concern regarding the costs of transitioning from overhead to underground. However, alongside this, participants noted that overhead lines were cheaper and more cost-efficient compared with underground. This included being quicker to install and easier to upgrade.

Underground cables were noted as having prohibitively costly maintenance (due to issues relating to technical complexity and additional labour requirements) and construction because of the time needed to install. However, some participants considered they were cheaper to install and maintain as they felt underground lines would likely have a longer life span and be easy to add new services if combined with other cabling e.g., NBN. Also that it would be easier (and therefore cheaper) in new residential developments – again demonstrating confusion with distribution lines.

Aesthetics

Aesthetics focused on the visual impact of the transmission lines and was in the mid-range in terms of the number of comments made (5th for overhead, 3rd for underground). Overhead lines were typically described as visual pollution, ugly, unsightly, ruining a beautiful landscape, diminishing street appeal and an eyesore. The height of the powerlines was commented upon potentially contributing to the negative image.

This contrasts with the views regarding underground lines where participants noted that there were no ugly lines, that there was a cleaner look, that it was better for real estate as the lines were hidden, and that there was a less cluttered landscape. Overall, there was the view that underground lines were superior to overhead lines from the perspective of aesthetics but that both had issues and opportunities.

Environmental impacts

Environment focused predominantly on the natural environment, although did slightly touch on the human environment. Similar, to aesthetics, it was mid-range in terms of the volume of concepts surfaced (4th for overhead, 5th for underground). Overhead lines were seen as interfering with the natural landscape, affecting local animals (in terms of safety and impacting the natural habitat), taking up a lot of space, damaging trees and other vegetation, and requiring trees to be cut down for poles. At the same time seen as creating wildlife corridors and useful perches.

Underground lines were seen as impacting the environment due to the need to dig up of the land, potentially having an impact on the environment through electromagnetic elements seeping into the soil, affecting farm operations and use. As well, that care would be needed in terms of interfering with tree roots and with heritage land. However, when considering the opportunities, underground lines were thought to save wood, were not viewed as a hazard to wildlife, were less impacted by wildlife, and once constructed, allowed green spaces to be developed.

Weather

Weather issues were raised regularly and were mid-range in terms of frequency (6th overhead, 5th underground). As participants were in Queensland, cyclones and tropical storms are a part of life. Overhead lines were seen as attracting lightning strikes, being damaged in strong winds, susceptible to storms, cyclones, and potentially bushfires. Underground lines

were not considered to be as affected by wind or fires (except where they had to be fed by overhead lines), but could be affected by floods. Overall weather was seen as a significant impact on the reliability of service, and as several participants noted, with climate change, this is likely to increase.

Benefits and Concerns Post Information Provision

After the expert presentation participants were asked: *Based on the information provided, what would you say are the benefits and concerns of overhead and underground transmission lines?* From the transcriptions 146 discrete responses were recorded. The majority of responses were either concerns expressed in relation to underground transmission lines (n=70) and those that focused on the benefits of overhead transmission lines (n=27). There were an additional 15 responses in relation to the benefits of underground lines and 16 responses expressing concerns with overhead transmission lines. Those and the other identified comments are presented in Table 4.

The largest single category of coded responses (n=42) were concerns about the higher costs associated with the installation of underground transmission cables relative to overhead lines. A typical response reflecting this view was:

> *"We've got wide spaces and a huge amount of countryside and obviously [for the costs involved] to be putting in underground power lines in, you know, the middle of the outback would be absolutely ridiculous."*

Table 4. List of the key themes in relation to the perceived benefits and concerns

Code Name	Total
Benefits of overhead transmission	**27**
Cost Effective	15
Easier to install	4
Easily replaced	1
Lifespan	1
More effective in rural areas.	4
Safety not a concern	2
Benefits of underground transmission	**15**
Aesthetics	3
Environment	3
Near Urban	3
Safety	2
Security	3
Simpler Maintenance	1
Concerns with overhead transmission	**16**
Aesthetics	6
Cultural	1
Electromagnetic	3
Environmental	4
Impact on land value	1
Safety	1
Concerns with underground transmission	**70**
Difficulty of installation	6
Environmental	3
Installation Cost	42
Land Acquisition	2
Lifespan	4
Maintenance	6
More infrastructure	2
New technology	2
Short Distance	3
Combined benefits overhead/ underground	**17**
Favours HVDC transmission	**1**
Infrastructure planning issues	**3**
Jobs and opportunities	**3**
Pro local power alternatives	**3**
Pro underground in the future	**9**
Unsure of benefits or concerns	**11**

Participants also considered how the cost implications impact other areas of our economy.

> *"I think the problem is that we only have limited of money to spend, whether it's at the state, local or federal level. So if someone said we can either put everything underground or we can have free public healthcare for all, Australia, I'll probably go preferably healthcare. So it's kind of, that's called a problem, because you can say that we got all this money to spend on underground, but we could also just spread it out on overhead and then take the rest of the money [for] something else that we really need."*

There were also 15 responses highlighting the relative cost effectiveness of overhead transmission lines with one respondent saying:

> *"I was pretty much on the fence when this started, and then like a few others I definitely turned more [to] overhead. It's just something to do with it seems cheaper. I know it seems it's cheaper to set up."*

Other participants stated that despite knowing some other issues of concern with overhead transmission lines such as their visual and some environmental impacts, they would choose overhead transmission infrastructure because of their cost effectiveness.

> *"I feel like it is the most cost efficient [way] to go overhead and [finding out] what people's problem are [with] the overhead and trying to solve that problem will be easier and more cost efficient than trying to pursue this underground thing."*

However, proximity and aesthetic issues surrounding overhead transmission lines were still a concern to some participants.

> *"[Let's say] I'm a rural guy [who] all of a sudden [has] got a gas pipeline underneath and overhead transmission lines above. Everybody's going, 'It's cheaper to do it that way and it's fine', but not in my backyard, right?"*

The other high response category were those participants who cited the benefits in combining overhead and underground transmission line technologies based on situation and need (n=17). For example:

> *"I feel that everything needs a nice, even balance. You use overhead where it's going to be more cost effective and you use underground where it's going to be more efficient. And I think that, you know developers, if they're working smart, they will deliver in a way that is environmentally friendly, is cost effective, but also it is going to keep the cost down and keep the power on."*

There was another view that emerged based on the presentation that underground is the preferred option but just not at this stage.

> *"[I] absolutely favour the underground, but I don't think we're ready yet. I think for the moment, we need to [consider] with the practical limitations of underground, to be looking at the overhead."*

Who should be responsible for decision making?

The second question asked participants to consider: Who should be responsible for decisions about these types of large infrastructure upgrades? Eliciting 101 responses from the focus groups (Figure 1), the responses either directly nominated their preferred decision maker or tended to focus on the process itself and what it should entail.

The single highest response in relation to decision makers was the government (n=23). When combined with others citing specific levels of government, (i.e. Federal (n=4), State (n=5) and Local (n=6)) the total was 38 of the 101 responses. There was a feeling amongst those participants that being responsible for these type of projects is what governments are elected to do. For example:

> *"I think that's the reason why we elect a government, to make those big decisions about that type of thing. So I'd be happy to leave them to make those decisions."*

The next highest number of responses (n=14) considered a "cross section of stakeholders", as their preferred option for how decisions are made. These included groups such as technical experts, government, landholders, electrical authorities.

> *"I think it needs to be like a joint consensus of the electricity guys [and] like environmental guys. There's probably loads of other people that should be involved who can help. Yeah, come to some sort of happy medium which ticks kind of every box almost. I know there's never going to be an agreement. If you do overhead, somebody's going to be annoyed. If you do underground somebody's going to be annoyed. I don't know who specifically should be involved, but I think it should be a collaboration."*

In addition, a number of participants commented on the process of decision making rather than specifically who should be making the decision (n=14).

"If they, you know, weigh out the pros and cons. Have a good list and a bad list, and work out that way whether it's going to go underground or above ground, as well as taking in the financial aspect of it."

There were also comments about a lack of trust in the decision makers. With some were sceptical that authority figures would make decisions without the involvement of the community (n=7).

"[Its] normally been decided before you have a say anyway. That's why a lot of people don't have a say because they know that very little makes a change, no matter what is said on how individuals and community should be involved in the decision-making process."

Personal involvement in decision making

The final question asked: If you, as an individual or a community, were to have a transmission line come near you, how would you like to be involved in the decision-making process?

Figure 2 provides the breakdown of the 92 discrete responses from all answers to this question. Three response categories were most prominent and included the need for information (n=32), the need to focus on impacted individuals (n=22) and the use of community groups (n=12).

Regardless of involvement, participants discussed the need for people to be provided with the relevant information to make informed decisions (n=32). For example:

"I think if you're talking about how I'd want to be involved if it was coming to my area, I think what you did tonight [with the] presentation, you could do that at a community event like at a hall and say this is all the information. Because you've provided me with a lot of information that I didn't know, plus the advantages and disadvantages. So then it helps people to be informed, because sometimes we get forced into decisions without actually knowing the, you know, the pros and cons about it."

The second category was that participants felt those people directly impacted by the development should be given a greater weighting when it comes to input into decision making (n=22). This was regardless of how the involvement was carried out.

"It is always interesting weighing up, I guess the needs of the many versus the direct impacts. So that's usually where the consultation lies, is the who is directly impacted and then everyone else can have a say on a consultation process. But usually weight is given to those directly impacted people."

The third main set of responses related to the use of meetings (n=6) and community groups (n=12) as

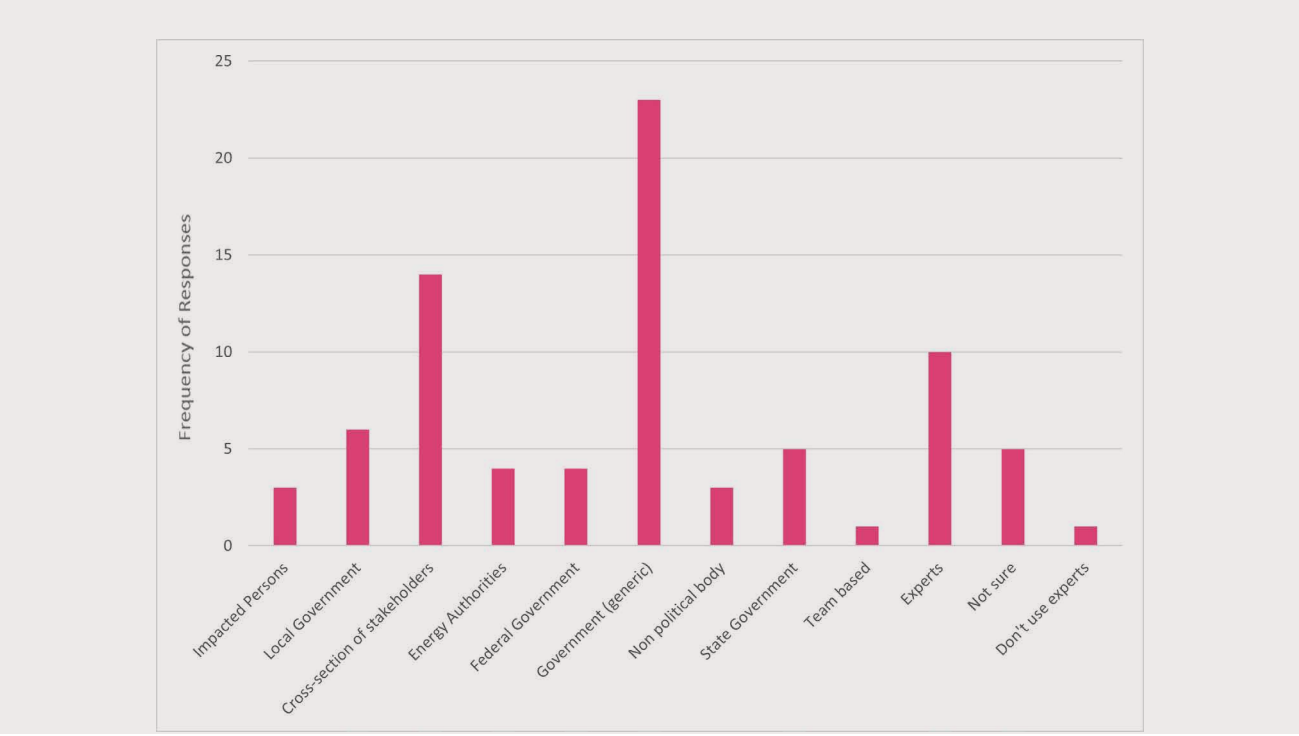


Figure 1. A breakdown of responses to who should be the decision makers

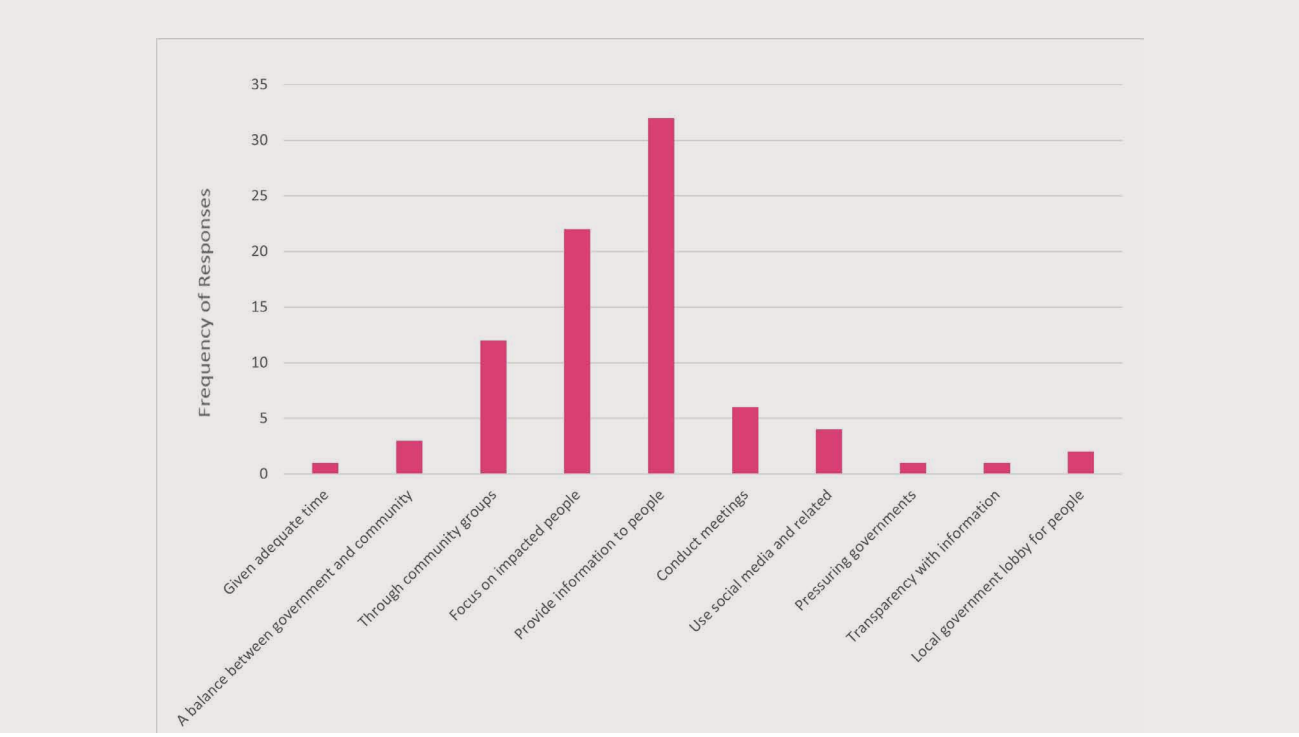


Figure 2. How they would like to be involved in the decision making process

important avenues for contacting people and obtaining feedback on proposed projects.

> *"I would hope that community involvement and information is available. [I hope] that you do information nights not just like this but for the mum and dad consumer. Also do the business evenings where you go: Right! This is what's going to happen, if we are going to underground, it means that these businesses will be impacted in this way [and so on]."*

A final category worth noting were comments that reflected caution in how we involve people in decision making (n=8). Some participants commented on the detrimental impact there can be on the wider community if too much decision making power is given to specific groups.

> *"I've done a bit of work around community consultation as an environmental consultant for a few years. No matter what you propose anywhere, whatever project, you're going to get people who are unhappy. So yes, they need to be consulted, but at the end of the day [we are] a country of 25 million people, predominantly living in cities along the coast [and] I think the benefits overall for overhead power lines outweigh the complaints of a few farmers. If you've been out to rural Queensland, there's a lot of land out there."*

Survey

To capture the individual views of participants more accurately and to complement the qualitative discussion, participants were asked to complete a pre- and post- survey at the beginning and end of the focus groups. A total of 78 participants completed the pre-survey, with 75 of those 78 participants completing the post-survey

Perceptions of climate change and the environment-economy trade-offs

Participants were asked to indicate whether they believed *that climate change is happening now or would happen in the next 30 years* and to indicate how convinced they are that *climate change represents a real problem for Australia* (Likert scale 1=very unconvinced to 7=very convinced). The responses are provided in Figure 3, a and b, respectively. They show that the majority of participants (76%) believe climate change is already happening (Figure 3a) and were convinced (80%) that climate change represents a real problem for Australia, with a mean response of 5.57 (SD=1.62).

Another question asked about the trade-offs between the economy and the environment. *"Energy policy can involve difficult trade-offs between the economy and the environment. Which of the following statements best describes your view?".* There were five possible

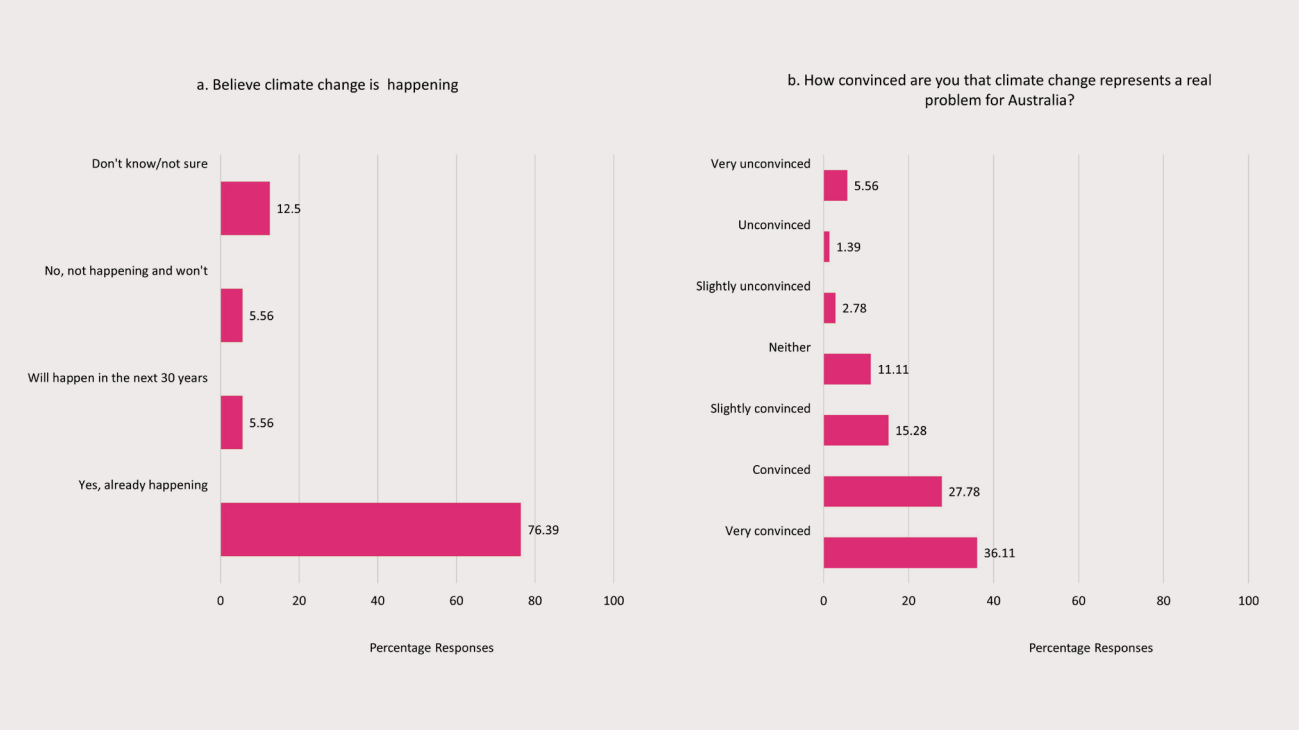


Figure 3. Climate change belief plot

response options, however the majority (64%) of participants indicated *"Both the environment and the economy are important and balancing the two should be the highest priority"*; followed by 26% supporting *"Both the environment and the economy are important, but the environment should come first."*

Awareness of Overhead and Underground Transmission Lines

To ascertain participants' familiarity with transmission infrastructure before being provided with any information, they were asked to indicate their levels of awareness of the two types of transmission infrastructure. Responses included: *i) I have never heard of it; ii) I have heard of it; iii) I have heard of it and could describe it to a friend*. Table 5 provides a summary of their answers. Initially, the majority of participants (64%) indicated they had heard of overhead transmission lines and underground transmission cables (68%). In both instances 24% of participants were confident that they could describe them to a friend. In contrast, at the end of the focus group, the majority of participants felt confident they could describe both underground and overhead transmission infrastructure to friends, indicating a significant shift in the knowledge perception of participants.

Overall support for overhead and underground transmission

Participants were also asked to indicate their level of support for overhead transmission lines and underground cables in both the pre- and post- surveys.

Table 5. Participants' pre- and post- familiarity with transmission infrastructure

	Pre-Survey (%)		Post-Survey (%)	
	Overhead	**Underground**	**Overhead**	**Underground**
Never heard of it	13	8	1	1
Have heard of it	64	68	23	25
Can describe to a friend	24	24	76	73

Responses were measured using a Likert scale (1 = strongly unsupportive to 7 = strongly supportive). Table 6 shows the distribution of responses and illustrates how support changed as a result of participating in the focus groups.

When comparing the difference in mean support between the pre- and post- surveys, there was a statistically significant increase in mean support from 4.2 to 5.7 for overhead transmission lines as a result of the focus groups (Table 7, Figure 4). In contrast, support for underground transmission lines decreased slightly from 5.6 to 5.3. However, this drop in support was not statistically significant. Further analysis by gender and place of birth was not shown to significantly influence support.

Table 8 compares the difference in means across the two types of transmission. Support for underground was significantly higher as compared to overhead during the pre-survey. However, when compared after the focus group, there was no significant difference in support for either.

Table 6. Participant support for overhead transmission lines and underground cables.

	Overhead		Underground	
	Pre- (%)	Post- (%)	Pre- (%)	Post- (%)
Very unsupportive	3	0	0	0
Unsupportive	11	1	0	7
Slightly unsupportive	11	6	0	7
Neither supportive nor unsupportive	39	3	29	7
Slightly supportive	14	17	15	24
Supportive	19	56	29	40
Very supportive	3	17	33	15
TOTAL	**100**	**100**	**100**	**100**

Table 7. Mean T-test assessing respective changes in support for overhead transmission lines and underground transmission cables, pre- and post-

	Pre-		Post-				
	N	Mean	N	Mean	Difference	St Err	p value
Overhead	72	4.2	71	5.7	-1.5	0.2	0
Underground	72	5.6	71	5.3	0.3	0.2	0.15

Table 8. Mean T-test comparing differences in support between overhead lines and underground cables, pre- and post-

	N	Overhead	Under-ground	Difference	St Err	p value
Pre-	72	4.19	5.60	1.437	.23	0.00
Post-	71	5.72	5.28	-.403	.22	.05

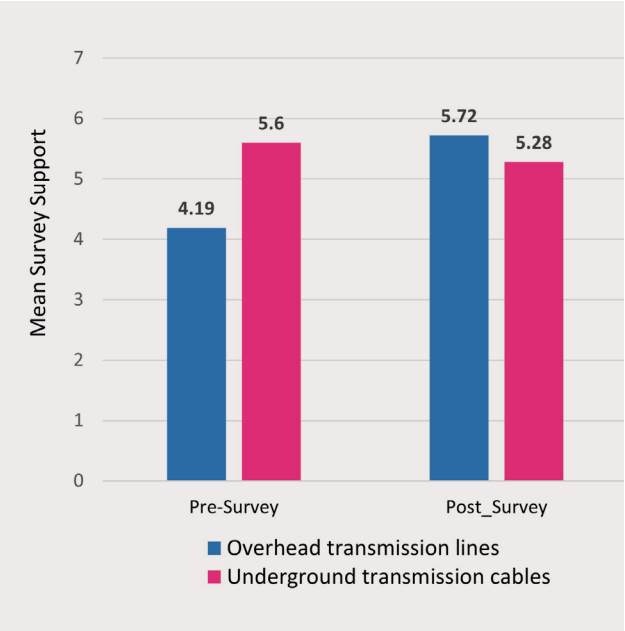


Figure 4. Mean support before and after focus group discussions

Reasons for mid-point selection

Of those who selected the midpoint (4=neither supportive nor unsupportive), a follow up question was asked to better understand their reasons for choosing the midpoint. There were 28 participants who selected the midpoint for overhead lines, indicating that they *do not know enough about overhead transmission line to decide* whilst 39% indicated that the *pros and cons made their support neutral* (Table 9). Of 21 participants who selected the mid-point for underground cables, 71% indicated that they *do not have enough information to make a decision.*

There was a substantial reduction in those choosing the midpoint in the post survey. Only two participants selected midpoint in post survey for overhead lines indicating *the pros and cons made their support neutral.* Whiles amongst the five participants who selected midpoint for underground cables, three indicated *the pros and cons made their support neutral.*

Factors influencing acceptance and a social licence to operate

The literature review showed that technology acceptance and a social licence to operate are influenced by a multitude of factors. These include not only perceptions about the technology itself but more importantly issue relating to procedural and distributive justice, trust, as well as ensuring sufficient regulations are in place to manage safety considerations and to minimise impacts to the environment. The post-survey tested these through a number of questions and responses are detailed below.

Instrumental and experiential factors

The survey questions were adapted from Huijts, Molin and van Wee (2014)[7] to identify how participants evaluated the relative importance people placed on the

Table 9. Reasons for selecting the mid-point

Midpoint selection reasons	Overhead line		Underground cable	
	n	%	n	%
I do not know enough about overhead transmission lines to decide	12	42	15	71
I do not have any feelings either way (positive or negative)	3	11	1	4.8
There are pros and cons, which makes my support neutral	11	39	2	9.2
I did not understand the question	0	0%	0	0%
I have no opinion on this issue	0	0	2	9.2
I don't care	1	3.6	0	0%
Other reason (please specify):	1	3.6	1	4.8
Total (n)	**28**	**100**	**21**	**100**

[7] Huijts NMA, Molin EJE, van Wee B. Hydrogen fuel station acceptance: A structural equation model based on the technology acceptance framework. J ENVIRON PSYCHOL 2014;38:153–66. https://doi.org/10.1016/j.jenvp.2014.01.008.

various factors in relation to overhead transmission using best-worst scaling. These included perceptions of costs to build, usefulness to those living in the vicinity, impacts on the environment, safety, economy and health. Table 10 details the number of responses across the range of factors in relation to overhead transmission lines after the focus groups. The spread of responses suggest that individuals felt overhead lines would be more acceptable in terms of their cost to build, would have some benefit to people living nearby and were relatively safe (Figure 5). However, it appears that participants were somewhat concerned with the potential for negative environmental impacts and indifferent to health effects.

Table 10. Factors influencing acceptance of overhead transmission lines

I expect that overhead transmission lines would...						
	-2	-1	0	1	2	
Be built at too high costs	0	2	5	33	31	Be built at acceptable costs
Not provide benefit for people living nearby	5	14	17	16	19	Provide benefit for people living nearby
Have a very negative effect on the environment	1	26	34	8	2	Have a very positive effect on the environment
Be very dangerous	0	14	29	19	9	Be very safe
Be very bad for the local economy	1	3	27	33	7	Be very good for the local economy
Have a very negative effect on the health of people living nearby	2	9	46	10	4	Have a very positive effect on the health of people living nearby

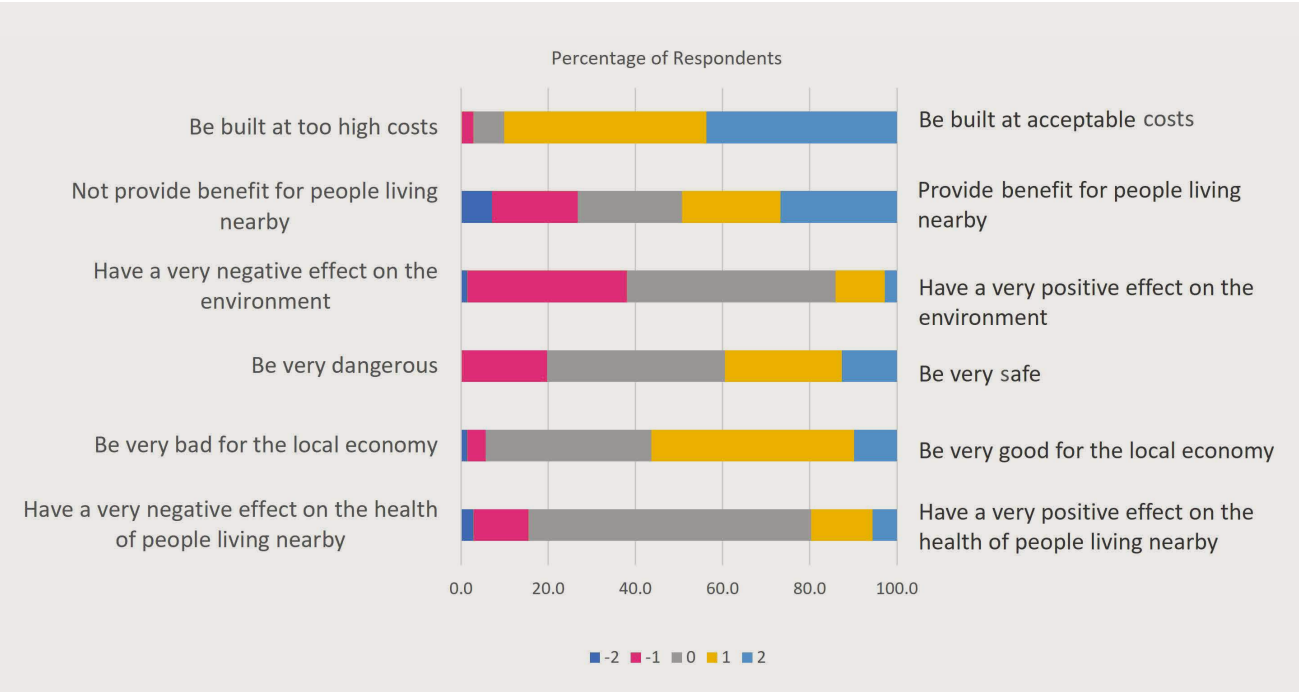


Figure 5. Percentage agreement with factors influencing acceptance of overhead lines

In contrast, Table 11 details the number of responses for underground cables which shows, participants were more positive in relation to all factors with the exception of costs to build when compared to overhead. However, there were still a large group with neutral responses, particularly in relation to effects on the environment, impacts on the local economy and effects on people living nearby (Figure 6). This possibly highlights the complexity of the issue when considering transmission lines, particularly when you are not directly impacted by them.

Table 11. Factors influencing acceptance of underground transmission cables

I expect that underground transmission lines would...						
	-2	-1	0	1	2	
Be built at too high costs	34	22	4	6	5	Be built at acceptable costs
Not provide benefit for people living nearby	0	7	14	25	25	Provide benefit for people living nearby
Have a very negative effect on the environment	0	10	27	23	11	Have a very positive effect on the environment
Be very dangerous	0	2	13	30	26	Be very safe
Be very bad for the local economy	4	11	28	17	11	Be very good for the local economy
Have a very negative effect on the health of people living nearby	1	3	36	20	11	Have a very positive effect on the health of people living nearby

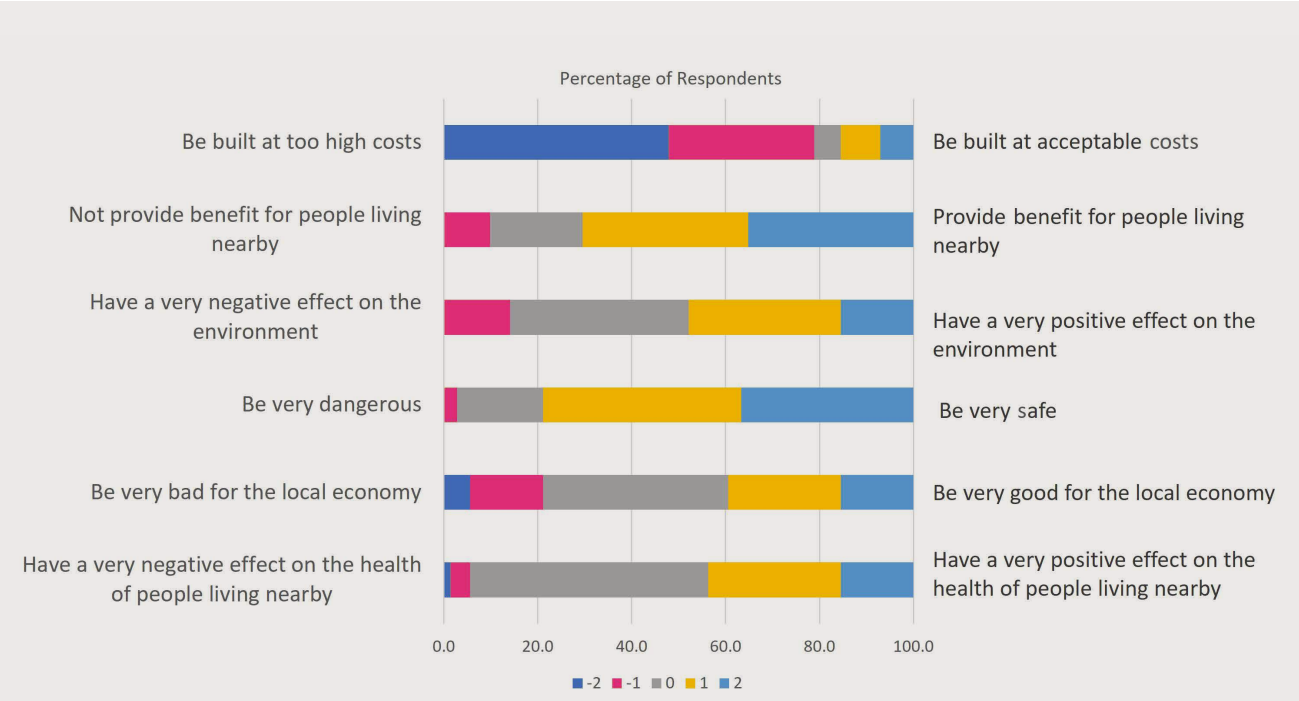


Figure 6. Percentage agreement with factors influencing acceptance of underground cables

Based on the earlier responses of support (Table 6), using the median value of support, participants were split in two categories of either high or low support for overhead and underground transmission infrastructure. For overhead lines, there were 19 participants in the low support cohort and 52 in the high support cohort. While for underground, there were 32 participants in the low support cohort and 39 in the high support cohort. Figures 7 and 8 present the extent to which each cohort's mean response was positive or negative in relation to each of the acceptance factors. The blue colour bar indicates the mean expectation of each factor for the low support cohort and the pink colour bar indicates the mean expectation of each for the high support cohort. It confirms that those who were less supportive of overhead lines were concerned about their uses in local communities and effects on the environment and health. As well, that both cohorts were less comfortable with the costs associated with underground transmission infrastructure.

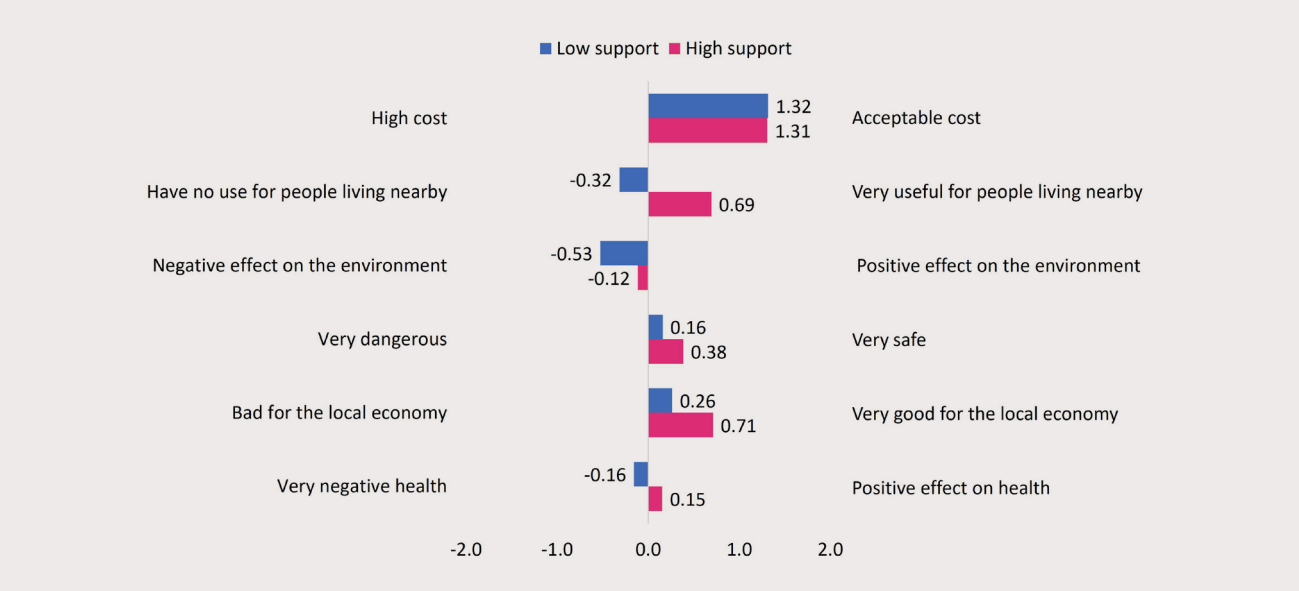


Figure 7. Factors influencing acceptance of overhead transmission lines

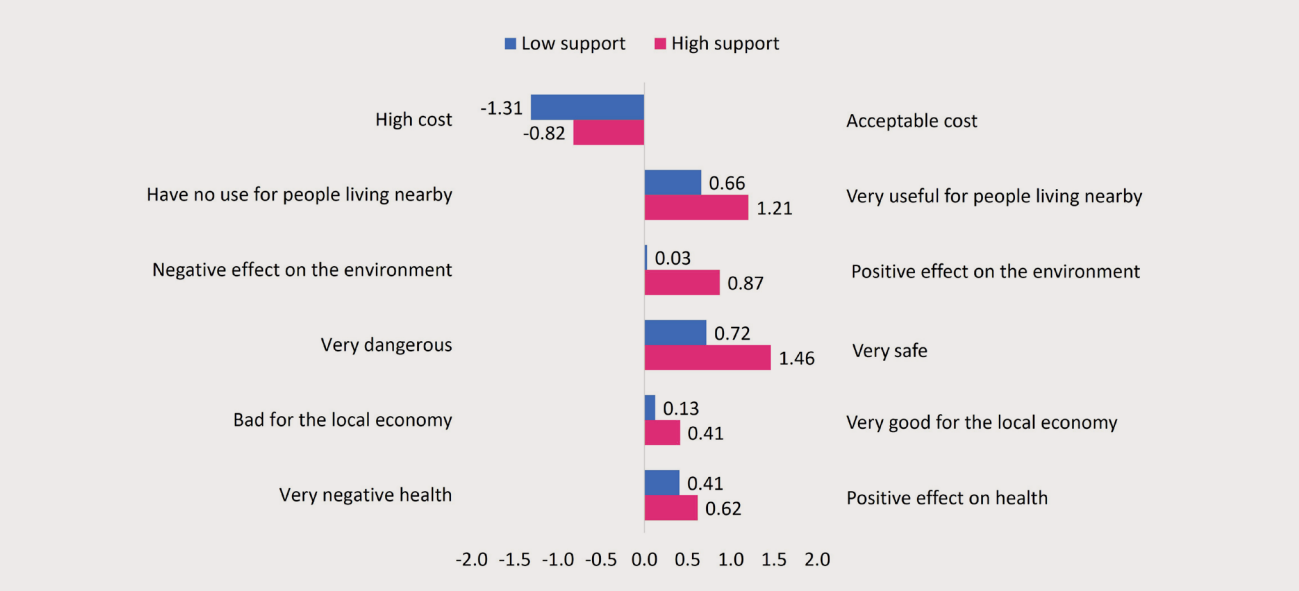


Figure 8. Factors influencing acceptance of underground transmission cables

Distributional Justice

The distributive and procedural justice considerations for transmission projects have been identified as key influencers on their acceptance. Therefore, we investigated participants' perceptions of this through the question, *"When you think about the decisions being made about the placing of an overhead transmission line in your local area, what do you think of the distribution of benefits and drawbacks with respect to yourself and others?"* Responses were in relation to fairness, whether they would be a problem and whether they could be avoided. Using the same method of high and low support cohorts, Figures 9 and 10 illustrate that on the whole perceptions were positive towards both, with some problems foreseen by the use of overhead lines. This potentially relates to the issues that arose in the discussions and were identified in the case studies, such as aesthetics, impacts on the environment and safety.

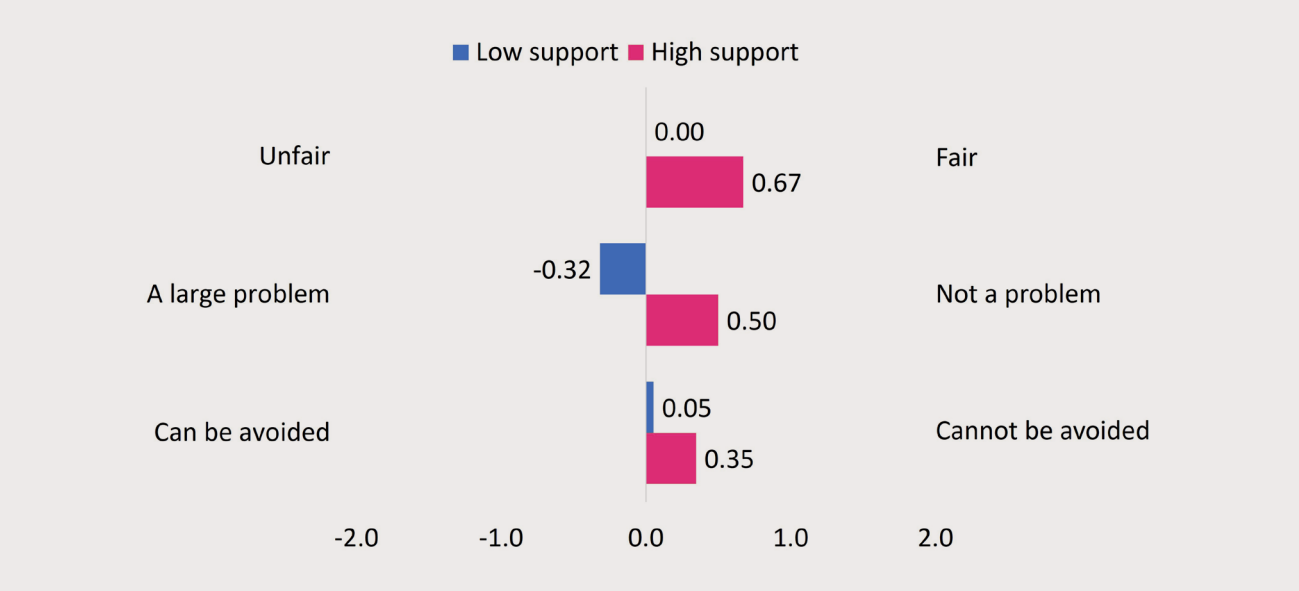


Figure 9. Perceptions of distribution of benefits and drawbacks of overhead lines

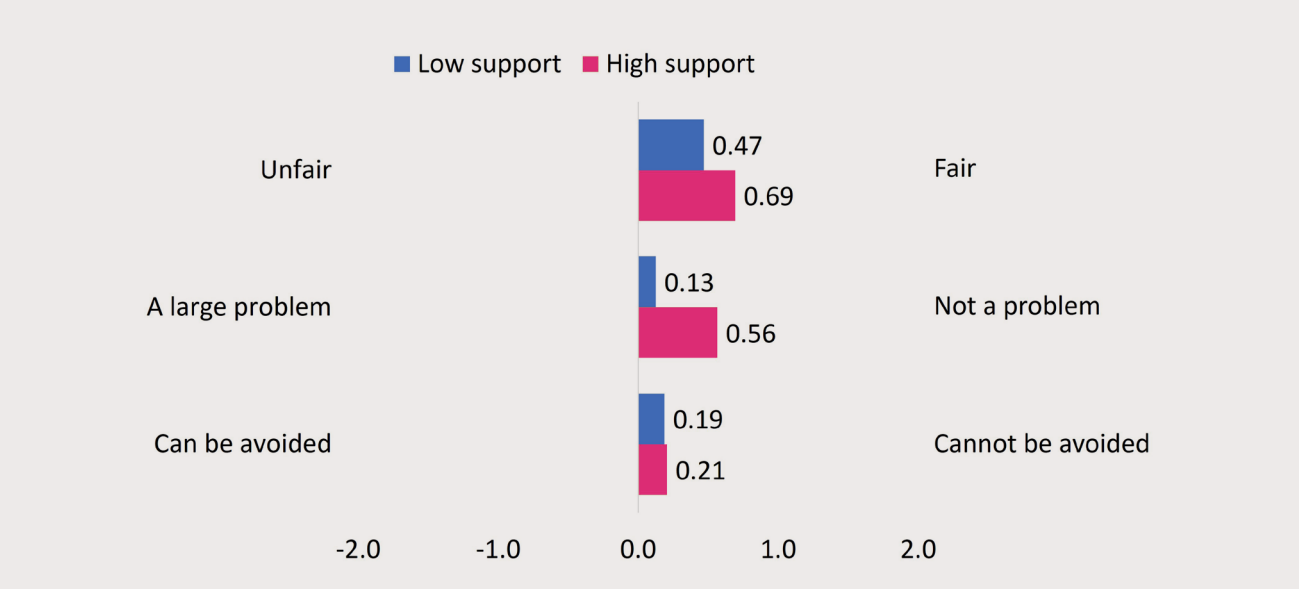


Figure 10. Perceptions of distribution of benefits and drawbacks of underground cables

Trust in Powerlink Queensland

As trust in project developers was identified as crucial for ensuring a social licence to operate and project acceptance, we asked participants to indicate their level of trust in Powerlink Queensland. A series of statements were used that relate to factors linked to a social licence to operate using a Likert scale (1=strongly disagree to 5=strongly agree). The mean responses suggest that most participants had high levels of trust in Powerlink to manage transmission projects appropriately whether they were overhead or underground (Table 12).

Table 12. Trust in Powerlink Queensland in relation to transmission infrastructure

	Overhead		Underground	
I trust that Powerlink...	Mean	SD	Mean	SD
Will make sure that a safe transmission line is put in place	4.2	0.7	4.2	0.6
Have the knowledge and experience to make sure that a safe transmission line is put in place	4.3	0.5	4.1	0.7
Will pay attention and perform safety checks to make sure it stays safe	4.2	0.6	4.2	0.5
Have the knowledge and experience to minimize the impact of the transmission line on the environment	4.0	0.8	4.0	0.8
Have the knowledge and experience to minimize the impact of the transmission line on human health	4.0	0.9	4.0	0.8

Trust in Local, State and Federal Government

When participants were asked to rate their trust in the different levels of government using the same Likert scale (1= very little trust and 5=strongly trust) in relation to engagement and decision making. The mean responses to these statements were much lower than trust in Powerlink. Overall, there was slightly higher trust in local governments compared to state and federal governments (Table 13). The questions may have influenced these responses because they relate to considerations for local residents and engaging meaningfully with communities, which is where local governments would have the most impact.

Table 13. Trust in local, state and federal government

	Local Government		State Government		Federal Government	
To what extent do you trust that your...	Mean	SD	Mean	SD	Mean	SD
Will take the well-being of residents sufficiently into account when planning new transmission projects.	2.9	0.8	2.6	0.8	2.5	0.7
Will make a responsible decision about whether or not to allow a new transmission project to go ahead.	2.8	0.8	2.5	0.9	2.5	0.8
Will meaningfully engage with the community about new transmission projects.	2.8	0.9	2.5	0.9	2.3	0.8

Social norms and consultation expectations

Participants were asked to provide responses to statements relating to their confidence in others (in their local community or wider Australia) to make the right decisions in relation to transmission lines using a Likert scale (1= strongly disagree to 5 =strongly agree). Mean responses showed that overall participants were somewhat confident others would make the right decisions (mean=3.3).

Reflecting issues of proximity and place attachment, individuals were less concerned about being consulted on transmission projects, unless they were in their local area where mean response was much higher. Figure 11 shows that over 70 % of participants either agreed or strongly agreed with the need to be consulted on transmission developments in their local area in contrast to only 22% agreeing or strongly agreeing on the need to be regularly consulted in relation to developments elsewhere in Australia.

Table 14. Average level of participant agreement on decision making and consultation

Statements	Mean	SD
I feel confident others in the Australian community will make the right decisions about transmission line developments elsewhere in Australia.	3.3	0.96
I feel confident others in my community will make the right decisions about transmission line developments in my local area.	3.3	0.98
I should be consulted regularly about transmission line developments elsewhere in Australia.	2.7	0.99
I should be consulted regularly about transmission line developments in my local area.	3.8	0.99

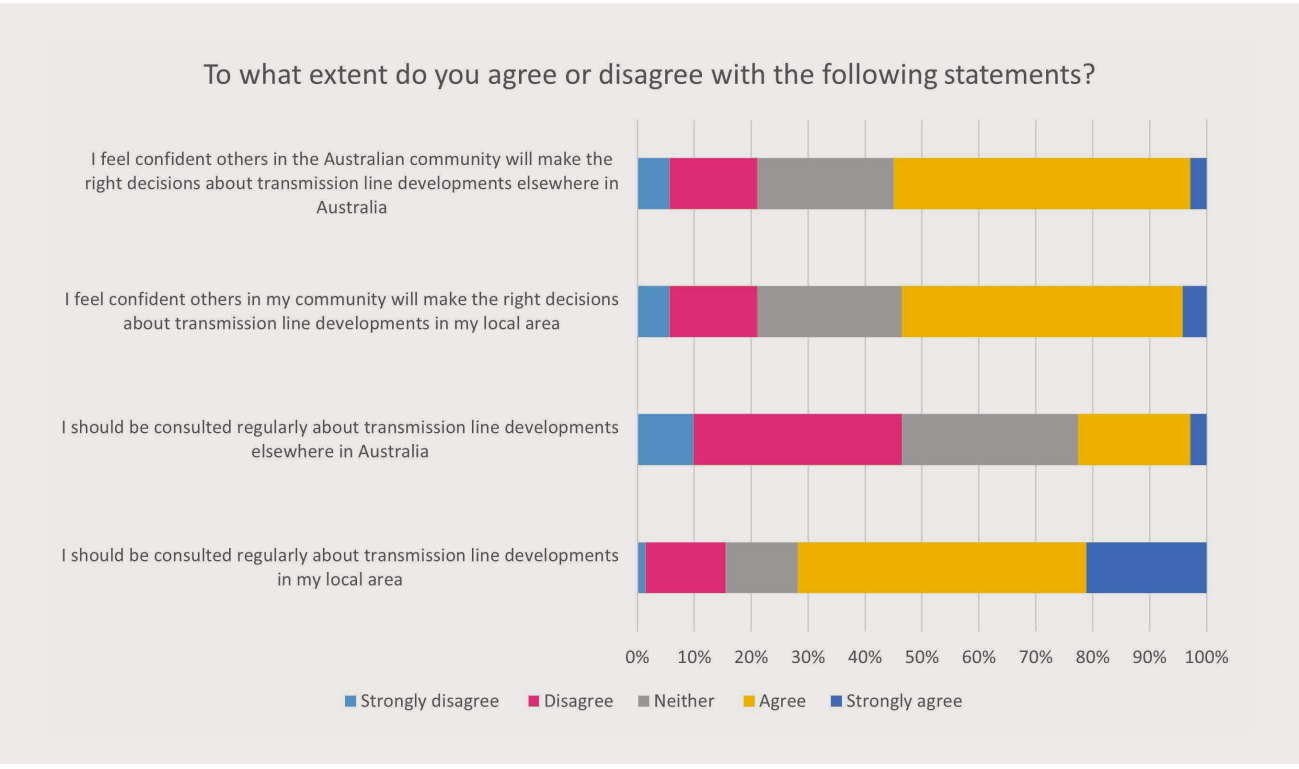


Figure 11. Participants' percentage agreement on decision making and consultation

Discussion

Changing support for transmission lines

Reflecting on the focus groups, the most obvious impact of the expert presentation and ensuing discussion, was the relative shift in sentiment and support from underground to overhead transmission infrastructure. It appears the high cost of underground transmission lines - quoted at 5 to 10 times – seems to have had the greatest impact on the general public's response. Ultimately minimising other concerns that had been raised in the discussions. For example:

> *"I don't like electromagnetic frequency stuff....and don't get me wrong, I really feel for anybody that has overhead powerlines 20 feet from their house. But it seems to me like the underground one, we're all going to have to pay a lot more for, regardless of where we are. And I'm not sure I want to buy into that kind of future."*

> *"Doing the distances we're talking about here, it has to be overhead. There's really no other way, for the cost and for the energy, the maintenance, the inspections. I really think it is really the only option for long distances."*

Conversely the arguments made for the advantages of underground lines such as environmental, aesthetics or reduced maintenance were not sufficient in people's minds to overcome the issues surrounding cost.

> *"The cost is concerning, and I think getting buy in from community over time will be really challenging, particularly if the costs will be passed on. We certainly know from recent examples in terms of a significant costs of power going up, that if people were to be faced with additional costs that would be handed on to them for underground cabling, I think if would be problematic for people."*

Knowledge, Trust, and Decision Making

Another impact of the focus groups was the effect on the participants' perceived knowledge or confidence in the subject matter, which they rated much higher in the post- surveys on the completion of the focus groups. The literature review highlighted the importance of a lack of knowledge in fuelling opposition to projects and the importance of filling knowledge gaps to enhance the acceptance of projects. Whilst this view was not consistent across all the literature, there appears little doubt that the provision of information by a trusted source, the expert, had a significant impact on participants' knowledge and opinions concerning overhead and underground transmission infrastructure. This is reflected in the following quote, highlighting the importance of providing unbiased, accurate information and how it impacts overall perceptions.

> *"I think if you're talking about how I'd want to be involved if it was coming to my area, I think what you did tonight with the presentation, you could do that at a community event like at a hall and say this is all the information. Because you've provided me with a lot of information that I didn't know plus the advantages and disadvantages. So then it helps people to be informed, because sometimes we get forced into decisions without actually knowing the, you know, the pros and cons about it."*

Survey responses also indicated that Queenslanders had a high level of trust in Powerlink, which appears to confirm general confidence in Powerlink's expertise when considering new transmission infrastructure. When it came to trust in the different levels of government, local government received the highest trust. This suggests the importance of proximity, where local councils are closer to where projects are being deployed and potentially seen to have greater interest in local impacts and relatively easy to access.

> *"As far as who makes the decisions, I have got to think maybe (it's hard) it probably should be somewhere around that Council level where the people, you know, if your Council is able to make or at least have certain sway on things. That's the lowest level of government that you can actually front up to and be able to talk to, and deal with. A lot easier than a state member or boardroom member or not."*

Focus group participants demonstrated they had strong connections to their local communities and local issues. This was reflected both in their views on the issues and opportunities initially captured by Strategy Finder where there were many examples identified that were based on personal experience. It was also reflected their feedback and the post-survey responses where the majority of participants felt that consultation should be conducted locally, providing accurate information to impacted communities in some form, whether it is through face to face meetings or via electronic means.

Looking for consensus

Despite the impact that the cost of underground transmission infrastructure had on participant views, a theme that emerged from the survey is that many participants are looking for outcomes that can strike a balance between the differing interests and priorities of local communities. Responses showed that the majority of participants were predisposed to solutions that provided a balance between economic and

environmental priorities. The results also showed that the second highest number of responses relating to transmission lines were participants being in favour of combining underground and overhead technologies to achieve the best outcome. When it came to decision making there was also significant feedback supporting the use of a cross-section of stakeholders and weighing up the "pros and cons" as the preferred decision-making process. This was also reflected in the acknowledgement of balancing the needs of those immediately impacted by projects with the needs of the many as shown in the quote:

> *"I'm not against the idea [of consulting impacted people], but I think we have to be careful with letting 200 people potentially make a decision for 2 million people. Very often when there's censorship or there all the stuff, people are crying out about this. You know, ten people said you shouldn't sell this one product, which means that the rest of the country and not allowed to buy this product because then people didn't like it. Letting people [let] their emotions basically make decisions for the whole country is not really the way to go either. So that's obviously balance point then."*

This response demonstrates participants had some understanding of the complexities and trade-offs involved when trying to reach an acceptable solution.

Caution about outcomes

It is important to consider that participants in the focus groups were not directly impacted by current or proposed transmission line developments. Consideration needs to be given as to how views may change if a project was going on near their homes or if they were residents who have, or were to be, potentially impacted by transmission lines. Participants themselves recognised the issue, that despite what their opinions might be, the people impacted need to be considered the most.

> *"I would say these focus groups in the area that's being impacted would be a really good way of doing it. To obtain that sort of feedback and information. I think get doing through a widespread general survey isn't going to get you the information that you want in a particular area."*

Overwhelmingly, the literature is dominated by concerns residents have with the aesthetics, health, and proximity impacts of overhead transmission lines as was reflected in the Strategyfinder initial results. Given the complexity, uniqueness and context of every project situation, careful planning of the forums used and information provided needs to be well considered. As is the case for any responsible innovation and engagement, reflexivity to assess how projects are progressing and any emerging information needs of individuals and communities will help to move the discussion forward. Highlighting the importance of practices that enforce what the public see as procedural and distributive justice elements for engagement and ultimately project acceptance.

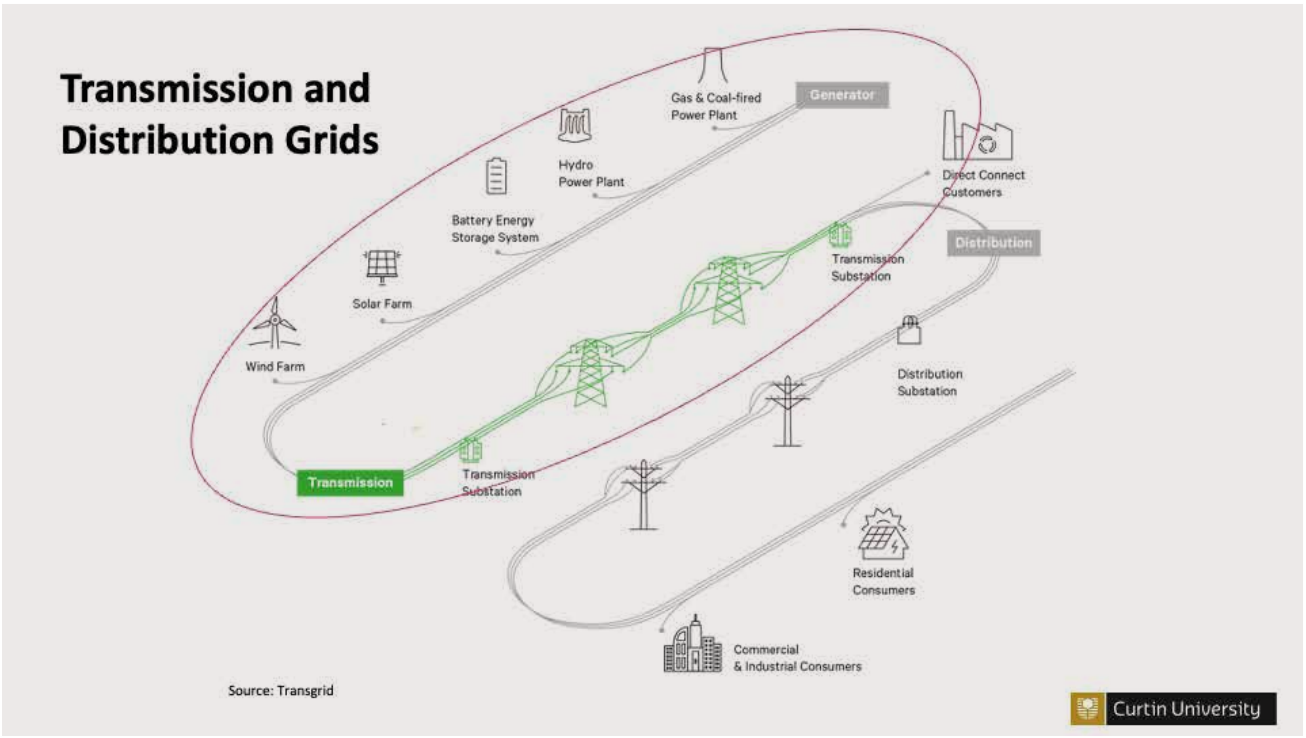
Conclusions

There are a number of conclusions that can be drawn from the focus group discussions.

Key Findings

1. Most importantly that the general public do not distinguish between distribution and transmission lines. Given the significant difference in the two across an electricity network this seems to be an important knowledge deficit that could be overcome.
2. On the whole the participants were very keen to be engaged on the topic and found the focus group format, including a presentation from the expert, as one process that instilled confidence in the participants and how they understood the issue.
3. While it was clear that underground transmission cables were generally more palatable than overhead lines, the majority of participants had a very pragmatic approach to the issue. That is, with the considerable cost differential between overhead lines and underground cables, participants would rather see the additional dollars be invested in other areas such as education and health.
4. There was recognition that it was important that local communities understood the trade-offs between the two choices of overhead and underground, with everyone in favour of impacted individuals being compensated accordingly.
5. Participants also agreed that in some instances, individual land holders will need to be forced to accept projects. In these cases, strong leadership by government was seen as an important and necessary facilitator of projects, particularly in the face of public opposition.
6. Examples provided by participants also reinforced the findings in the literature that the historical context in which projects are occurring will impact positive and negative perceptions of projects. That is, if some communities have not had positive experiences with project developers previously, they are less likely to welcome discussions for new transmission infrastructure projects.
7. The high levels of trust in Powerlink as the organisation responsible for transmission line projects in Queensland suggests participants viewed Powerlink as having the necessary expertise to get the job done, being able to make the ‘right’ informed decisions in relation to project deployment. Research, cited in the social literature review, emphasised the impact that trust at all levels has on acceptance of projects. Feedback and post-survey data supported this including trust in relation to information supplied, trust in project developers and those responsible for projects, as well as trust in the process of engagement including community involvement in the decision making.
8. The review of the literature (Chapter 6) clearly explains the factors that dominate social acceptance and social licence for transmission projects. Ensuring project developers are aware of these will go some way to help minimise the impacts on communities. Similarly, focusing on the enhanced principles for community engagement where co-design, transparency and collaborative processes are at the heart of the processes will also help.
9. Finally, as mentioned and identified in the discussions with focus group participants. There is a need for all stakeholders within communities to work together to optimise a shared outcome that maximises benefits and minimises impacts. While not always possible, the method outlined for co-design and collaborative constraint mapping between transmission providers and communities can help to go a long way in achieving this by creating community buy in for the final route selection and ultimately minimising opposition.

Appendix A: Copy of Expert Presentation

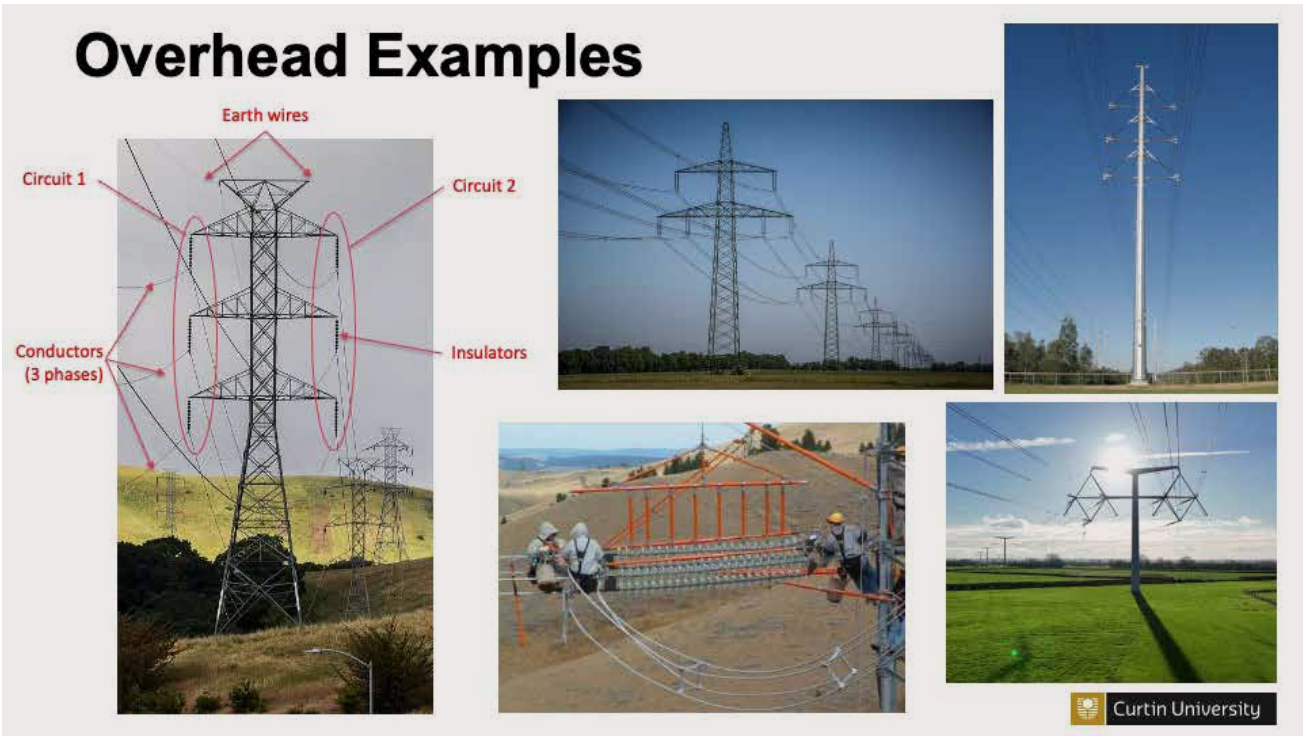


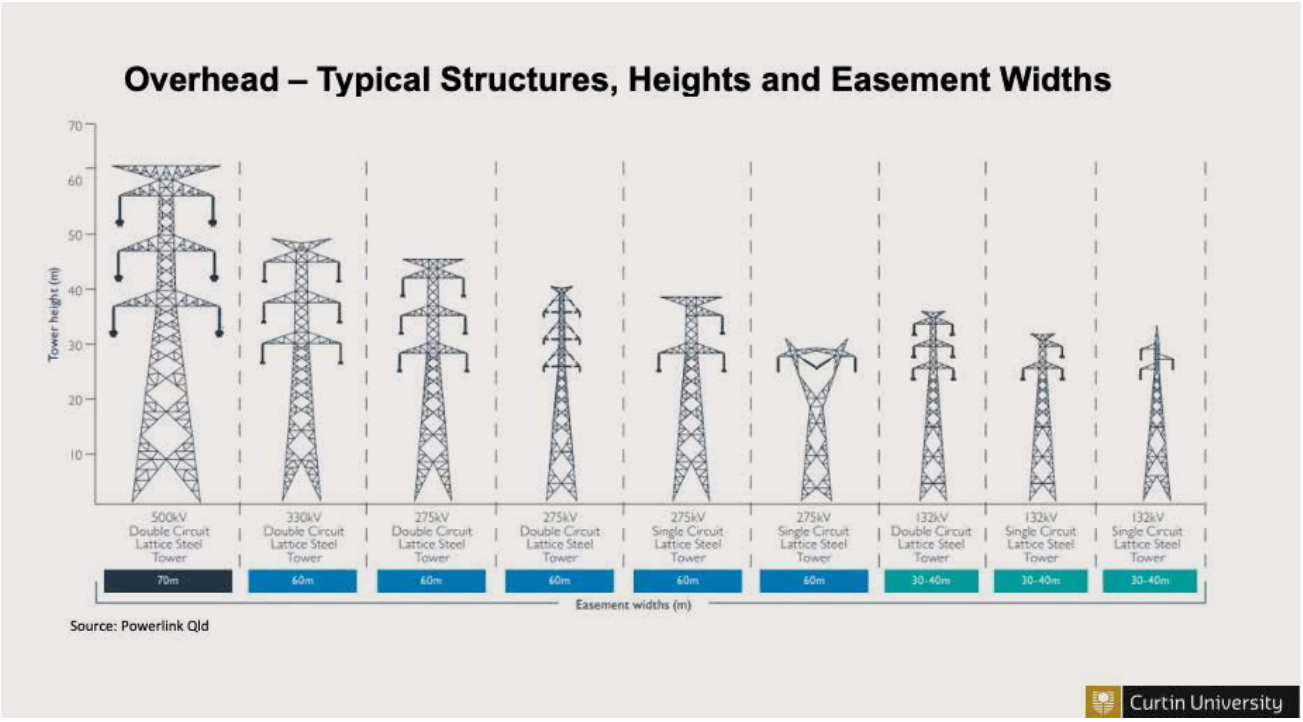
Moving electrons

High Voltage <u>Alternating Current</u> (HVAC) - most used in Australia and worldwide – stepped up (increased) or stepped down (decreased) when required.

High Voltage <u>Direct Current</u> (HVDC) - good for long distances but needs conversion to connect to the main AC grid.

Curtin University


Overhead Examples
Earth wires
Circuit 1
Circuit 2
Conductors
(3 phases)
Insulators
Curtin University

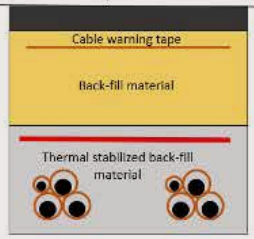

Overhead – Typical Structures, Heights and Easement Widths
Tower height (m)
70
60
50
40
30
20
10
500kV Double Circuit Lattice Steel Tower
330kV Double Circuit Lattice Steel Tower
275kV Double Circuit Lattice Steel Tower
275kV Double Circuit Lattice Steel Tower
275kV Single Circuit Lattice Steel Tower
275kV Single Circuit Lattice Steel Tower
132kV Double Circuit Lattice Steel Tower
132kV Single Circuit Lattice Steel Tower
132kV Single Circuit Lattice Steel Tower
70m
60m
60m
60m
60m
60m
30-40m
30-40m
30-40m
Easement widths (m)
Source: Powerlink Qld
Curtin University

Underground Examples

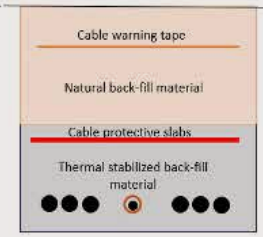
500kV XLPE (cross linked polyethylene) Cable

Source: Sumitomo Electric

Typical Trench cross-sections



Cable in Ducts



Direct Buried Cable

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Technical Aspects /1

	Overhead	Underground
Power Transfer Capacity	2000 MW to 3000 MW per circuit (500kV)	1500 MW to 2000 MW per circuit (500kV), (Significantly less than overhead line)
Feasible maximum line route lengths	Up to 1000km. Overhead lines require less **reactive compensation** plant (per km) compared to underground cables.	40km to 60km **Reactive compensation** plant such as shunt reactors or static var compensators at are required to counteract the more significant capacitive effects of cables compared to an overhead line.
Corridor and easements	60 m for 275/330 kV and 70 m for 500 kV	For double circuit 500kV is in the range of 30 to 40m in a rural situation. Trench installation under wide public roads is also feasible. Land requirements for overhead to underground transition stations

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Technical Aspects /2

	Overhead	Underground
Reliability performance	Outage rate of 0.5 to 1.0 per 100 km/year Overhead lines are exposed to severe weather including lightning strikes. Repair time for faults is much shorter duration.	Less than 1 outage/100km/year Repair time for underground cable faults is a much longer duration than overhead lines due e.g., up to 4 weeks.
Audible noise	Audible noise can sometimes be emitted from overhead transmission lines due to (1) wind effects and (2) a phenomenon known as corona discharge.	No audible noise.
Project timeframes	500kV double circuit for 100km Planning and approvals: 3-5 years Construction: 2 years	500kV double circuit for 50km route length: Planning and approvals: 3 years Construction: 4-6 years
Expected life	60 to 80 years	Greater than 40 years for XLPE cables

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Costs and Economic Impacts

	Overhead	Underground
Capital Costs: • **Planning & design** • **Approvals** • **Environmental offsets** • **Property** • **Construction**	For double circuit line: 275 kV: $2M to $3M per km 500 kV: $5M to $6M per km	For double circuit line: 275 kV: $10 to $15M per km 500 kV: $25M to $30M per km Typically, 5 to 10 times cost of overhead
Operating and Maintenance: • **Maintenance** • **Repairs** • **Energy losses**	0.5 to 1% of capital cost per km per annum for up to 20 years 1 to 2% of capital cost per km per annum during mid life 5 to 10% of capital costs for mid-life replacement of certain line components (e.g., insulators) Energy losses greater than underground.	Expenditure per km per annum is around 40% of comparative overhead line. Energy losses less than overhead due to larger conductor sizes.

* Costs are indicative only.

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HVDC: The Future of Transmission?

DC Transmission Lines
HVDC transmission lines are typically made of overhead lines, underground cables, or a combination of both, and carry the DC power long distances between the converter stations.

AC/DC Converter Stations
These stations are located at the endpoints of the transmission line and are responsible for converting AC power to DC power (rectification) at the sending end and converting DC power back to AC power (inversion) at the receiving end.

More expensive to build
Converter stations and specialized equipment contribute to higher initial costs.

For longer route lengths **HVDC underground** expected to be **3 to 5 times** cost of **HVAC overhead**

Advantages

- Efficient for long-distance transmission
- The most feasible option for long (>50km) off-shore or on-shore transmission cable routes
- Lower Line Losses, however additional losses from converter stations compared to AC
- More compact overhead line structure or towers normally requiring just 2 conductors
- More compact underground cable trench profiles
- Interconnection of asynchronous AC systems
- Controllability and Stability
- Lower Environmental Impact
- EMF generally lower impact than AC for similar voltage

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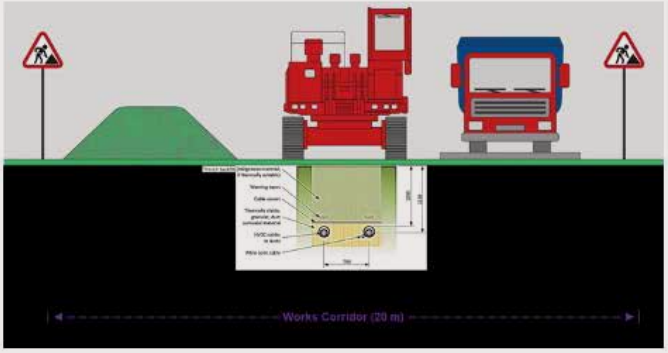
HVDC: The Future of Transmission?



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Electromagnetic Fields (EMF)

EMF - combination of electric and magnetic fields that are generated by electrically energised or charged objects, including power lines, cables, appliances, and electronic devices.

Scientific research on the health effects of EMF from powerlines has occurred since the 1970's.

Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) - *"The scientific evidence does not establish that exposure to extremely low frequency (ELF) EMF found around the home, the office or near powerlines and other electrical sources is a hazard to human health".*

International Commission on Non-Ionizing Radiation Protection (ICNIRP) "*...the currently existing scientific evidence that prolonged exposure to low frequency magnetic fields is causally related with an increased risk of childhood leukemia is too weak to form the basis for exposure guidelines. In particular, if the relationship is not causal, then no benefit to health will accrue from reducing exposure"*

World Health Organization (WHO) – undertakes and sponsors research on the health impacts of radiation including EMF. Considerable information and technical resources are available on their website

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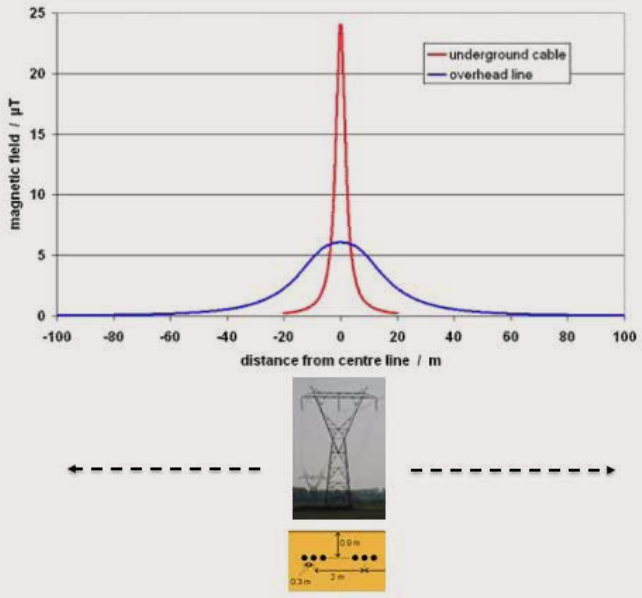
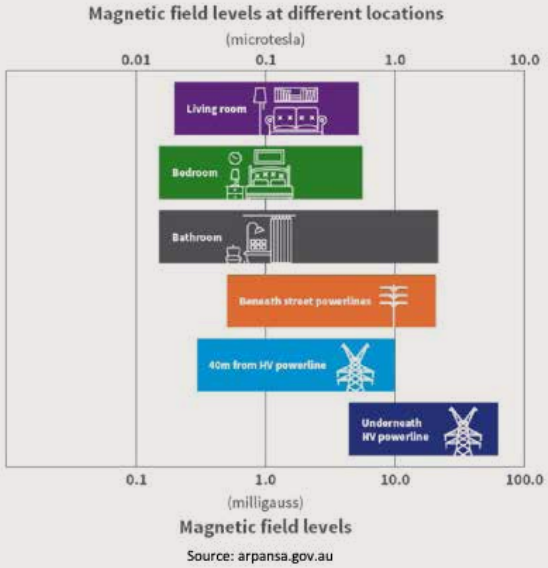
Typical EMF Profiles for Underground and Overhead Lines



Source: emfs.info



Source: arpansa.gov.au

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Environmental Impacts

Habitat loss, fragmentation, and the **alteration of environmentally sensitive areas** are key negative outcomes of the construction of transmission lines on the natural environment.

Clearing of vegetation for easements needed for the construction of both overhead and underground lines is likely to **impact on wildlife habitats** as well as to cause **changes in the microclimate** by restricting the growth of plants and trees.

Effects heightened in **sensitive natural environments** including **watercourses, wetlands and national parks.**

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Environmental Impacts

Overhead: create a barrier effect, where biodiversity is negatively impacted by changes in migrations patterns, collision, electrocution (birds, bats, etc.) but can be mitigated by undergrounding.

Underground: high likelihood of soil degradation and hydrological alterations throughout the lifetime of underground HVAC lines, but likely less than overhead.

Bushfires: of the 32 fires listed in the 2019 NSW Inquiry, two were started by power lines, no distinction was made in the document between distribution or transmission lines. The Royal Commission into National Natural Disaster Arrangements Report 2020 also highlighted the vulnerability of power lines to bushfires and noted that underground power lines were damaged by the fires.

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FIRST NATIONS
CLEAN ENERGY NETWORK

The Principles

1. Engage respectfully
2. Prioritise clear, accessible and accurate information
3. Ensure cultural heritage is preserved and protected
4. Protect country and environment
5. Be a good neighbour
6. Ensure economic benefits are shared
7. Provide social benefits for community
8. Embed land stewardship
9. Ensure cultural competency
10. Implement, monitor and report back

Cultural Heritage

- Recognition of Traditional Ownership and their unique and varied perspectives,
- Consideration of site specific environmental and cultural significance
- Need more effective strategies that allow for greater levels of empowerment amongst communities effected by projects
- Incorporate First Nation requirements into the design of transmission route planning
- Takes time to engage but may not match the timelines of projects

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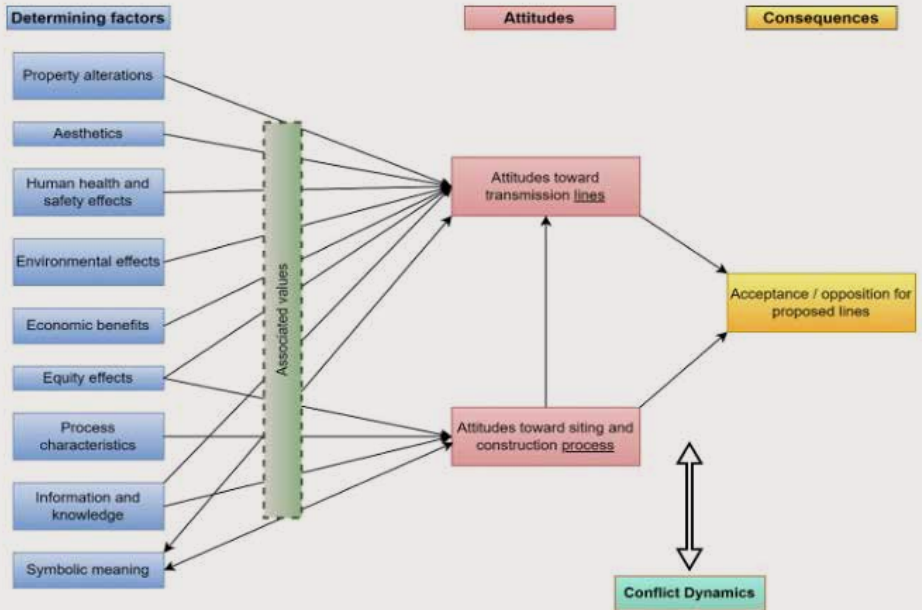
Factors influencing acceptance



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Social impacts

Distributive justice – benefits/burdens

- Visual impacts
- Conflicts with agricultural practices, tourism etc.
- Compensation beyond the landholder

Procedural justice

- Respectful, fair, and transparent
- Flexibility in route decision making
- Adequate time to engage

Context matters

- Historical and current
- Place attachment
- Cumulative impacts

Adequate information to inform decision making

- Trusted expert
- Capacity to engage (time and resources)

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Questions?

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