Dimayuga *et al.*
Energy, Sustainability and Society (2023) 13:3
https://doi.org/10.1186/s13705-023-00382-8

Energy, Sustainability and Society

REVIEW

Open Access

A review of collaborative research practices with Indigenous Peoples in engineering, energy, and infrastructure development in Canada

Pia Dimayuga[1], Shakya Sur[1], Alex Choi[1], Heather L. Greenwood[1], Tracey Galloway[2] and Amy M. Bilton[1,3*]

Abstract

Background Indigenous Peoples in Canada have survived hundreds of years of colonization and systematic exploitation, including actions carried out in the pursuit of energy resources and infrastructure development in traditional Indigenous territories. Research has been a tool in this exploitation through its legacy of research 'on' rather than 'with' Indigenous Peoples. As societies grapple with reconciliation, including how to build partnerships for sustainable land and energy development, engineering and technical research must use respectful approaches that centre on Indigenous Peoples and Indigenous Knowledge Systems.

Main text This preliminary review aims to be a step to address the lack of literature on respectful research with Indigenous Peoples within the context of engineering, energy, and infrastructure. To this end, we: (a) summarize three key frameworks that have been used in technical research projects for carrying out research respectfully, as defined by Indigenous and Indigenist ways of knowing and doing (Research is Ceremony, Two-Eyed Seeing, and doing research in a "Good Way") and derive from them overarching principles; (b) identify a sample of 13 engineering, energy and infrastructure research projects that report using an Indigenous-centred approach. These relate to five technical areas, whose relevance to Indigenous communities was verified through community partners: water, energy, housing, telecommunications, and food systems; (c) assess the extent to which these 13 projects applied the principles of respectful research when working with Indigenous communities. Among the 13 projects identified, it is evident that some researchers in the fields of engineering, energy, and infrastructure are struggling and striving to engage respectfully with Indigenous communities. However, few include full details of their relationships and interactions with Indigenous communities in their published work.

Conclusions These findings suggest a lack of details on respectful collaboration with Indigenous communities in technical literature. Gaps include a scarcity of evidence that Indigenous communities were involved in high-level decision-making or provided post-project feedback. Further work is needed to embed respectful research principles into the training, processes, and institutions of technical fields. This is essential to ensure ethical partnerships between technical researchers and Indigenous communities.

Keywords Indigenous, Reconciliation, Two-Eyed Seeing, Collaboration, Infrastructure development, Sustainable land use, Sustainable energy development, Technical research, Research ethics

*Correspondence:
Amy M. Bilton
bilton@mie.utoronto.ca
[1] Reconciliation Through Engineering Initiative, Centre for Global Engineering, The University of Toronto, 55 St. George Street, Toronto, ON M5S 0C9, Canada
[2] Department of Anthropology, The University of Toronto Mississauga, 1777 Outer Circle, Mississauga, ON L5L 1C6, Canada
[3] Mechanical and Industrial Engineering, The University of Toronto, 5 King's College Road, Toronto, ON M5S 3G8, Canada

Background

Indigenous Peoples in Canada, like Indigenous Peoples globally, have endured centuries of colonization, assimilation and attempts to erase their unique cultures and ways of life [1]. Colonization is defined as "the process of assuming control of someone else's territory and applying one's own systems of law, government, and religion [2]." Engineering, energy, and infrastructure development industries have been deeply connected to Canada's colonial history and the ongoing process of Indigenous Peoples' dispossession from their lands [3–5].

The Canadian Pacific Railway is one example of colonization through infrastructure [5, 6]. It enabled the mass settlement of Western Canada bringing additional housing, water, and energy infrastructure. However, it cut directly through reserve lands, separating families and close relations, encroached on the homes of already displaced Indigenous Peoples, altered traditional human and animal migration patterns, and changed traditional land use [5, 7]. Other infrastructure projects removed resources from Indigenous communities, such as the draining of Sumas Lake in Abbotsford, British Columbia. This deprived Sumas First Nation of their source of food, medicine, livelihood, and cultural heritage, and destroyed a hotspot of biological diversity [3, 8].

In other examples, for sustainable energy projects, Lac Seul First Nation was flooded without any prior notice in the 1920s, destroying entire community settlements and *manomin* (wild rice) fields [9]. The James Bay hydroelectric project in Quebec has been connected to mercury poisoning in the James Bay Cree Peoples [10]. Although these projects aimed to provide Canada with clean energy, they did not do so for the affected Indigenous communities, many of whom continue to rely on diesel generators [9].

Alongside these examples from industry, research has been used as both a justification and a means of colonization, often dissecting, extracting, appropriating and distributing Indigenous Knowledge without acknowledgement of, or benefit to, communities [11–13]. The result is that Indigenous Peoples may be rightfully distrustful of research and skeptical of any associated benefits [11]. After contact with European settlers, Indigenous Peoples were often framed as the "other", novelties to be studied as compared to the "normal" observer. This positioning can be found in research to this day [13–15]. Early research erroneously concluded that Indigenous Peoples were inferior to Europeans, which justified a paternalistic relationship between European "benefactors" and Indigenous Peoples [11, 14].

These few examples of a deeply problematic history highlight the need to re-examine the way researchers value and build partnerships with Indigenous communities in pursuit of sustainable land and energy use. The terms "collaborative research" and "collaborative technical research" are used interchangeably in this paper to refer to technical research projects that involve work between Indigenous communities and non-Indigenous researchers. From the researchers' point of view, they perceive the community as collaborators [16, 17]. In contrast, the term "respectful research" prioritizes community perception of the partnership. In respectful research, the community considers the work to be collaborative [16], supportive of their struggle for nationhood, self-governance and self-determination [17], and relevant to their community needs [18].

Indigenous scholars and allies emphasize that a requirement for respectful research is commitment to understanding the historical and social contexts in which such action takes place [19]. Many of the challenges faced by Indigenous communities today can be linked directly and/or indirectly to the legacy and ongoing impact of exploitative practices [1, 20]. Moreover, Indigenous communities have considerable research expertise. Indigenous Knowledge Systems, methods, ways of knowing and doing, and traditions stand alongside and even surpass Western empirical methods for generating knowledge [21]. There is a need to frame research in ways that celebrate ongoing Indigenous resilience, resistance and survival instead of solely emphasizing challenges [11, 18].

This paper aims to be a step towards respectful research with Indigenous Peoples by seeking to bridge the work of Indigenous scholars with those who strive to implement respectful principles in the fields of engineering, energy, and infrastructure. More specifically, we: (a) review three perspectives on respectful research that have been used in technical research with Indigenous communities (Research is Ceremony [14], Two-Eyed Seeing [22], doing research in a "Good Way" [18]) and derive from them overarching principles for respectful research; (b) identify 13 examples of technical projects in which these frameworks were applied to research collaborations in the areas of: water, energy, housing, telecommunications, and food systems; (c) assess the extent to which these 13 projects implemented the respectful research principles. We conclude this paper with suggestions of future research and action to further support respectful technical research with Indigenous communities.

Theoretical framework and key terms

Prior to the methods and results of this review, it is necessary to briefly discuss two related areas of literature that informed our analyses: decolonizing and Indigenous research, and ethical guidelines for working with Indigenous Peoples. The first, decolonizing and Indigenous research, is a complex topic on which Indigenous

scholars have written in much more nuanced detail than we are able [11, 23, 24]. In her seminal work *Decolonizing Methodologies*, Linda Tuhiwai Smith calls attention to the ongoing ways in which researchers and research institutions perpetuate and reinforce colonial viewpoints and power structures (e.g., through researcher-determined rather than Indigenous community-determined priorities for funding and study) [11]. She describes research as "a significant site of struggle between the interests and ways of knowing of the West and the interests and ways of resisting of the Other [11]." Decolonizing research demands critical consideration of how power imbalances are embedded in research institutions and seeks to promote Indigenous ways of knowing and doing. More recently, McGregor [23] argues that by pushing against academic systems and privileges, decolonizing research opened a space in which Indigenous research could grow. Rather than reacting to colonial research methods, Indigenous research uses as its starting point Indigenous worldviews, ethics, and values.

A focus on Indigenous worldviews, ethics, and values is fundamental to a second body of literature that informed this review: the growing literature on ethical guidelines for research with Indigenous Peoples. In 2021, Hayward et al. [25] found a total of 20 different research ethics protocols for research with Indigenous communities in Canada. Some of this guidance was published by organizations, such as the Government of Canada [26], but a number were developed by Indigenous communities themselves. These community-led guidelines highlight the diversity between Indigenous communities in Canada and the importance of being aware and respectful of local contexts and traditions. For example, locally developed guidelines for culturally appropriate research with First Nations in the Manitoulin area are structured in accordance to the seven interconnected Grandfather teachings important to an Anishinaabe way of life: respect, wisdom, love, honesty, humility, bravery, and truth [27].

These distinct but inter-related bodies of literature influenced this review in two ways. Firstly, they called into question whether the typical approaches of technical research are appropriate when working with Indigenous communities and led the authors to ask whether more Indigenous-informed approaches to technical research were currently in use. Thus, this theoretical grounding motivated the current topic of study. Secondly, these literatures ask us, as researchers, to think critically about our social positions in relation to our work. In her paper, *Situated Knowledges*, Haraway argues that what we can see and interpret of the world is necessarily partial and influenced by our social positions [28]. Acknowledging only a situated, partial view of the world is also an opportunity to increase understanding by connecting with others who bring their positional views to bear. Our own positionality in relation to this work is considered in the Methods section later in this paper.

Key terms

We use several key terms throughout this manuscript, each of which is defined briefly below. "Indigenous Peoples", in this paper, refers to the "Aboriginal Peoples" recognized in Canada's Constitution Act of 1982, including First Nations, Métis, and Inuit [29]. We acknowledge the significant diversity of nations, languages, histories, and identities within the collective term "Indigenous". While we recognize this heterogeneity, there is nonetheless the shared experience of Indigenous Peoples surviving and resisting within a settler-colonial state [11]. For the purposes of this review, no limitations were placed on the types of Indigenous communities who may have engaged with researchers. This may include, for example, First Nations on reserve as well as Inuit and Métis communities. The one exception is that this review did not focus on the many Indigenous Peoples who live in urban centres today [29]. This decision was made to prioritize communities in which Indigenous Peoples were in leadership and the majority of the community population. This made it easier to identify examples of collaboration with Indigenous communities, and it seemed more likely that researchers would strive for Indigenous-informed approaches when working with Indigenous leadership and majority populations.

The term "Western empirical" refers to methods of knowledge creation that seek to explain natural phenomena through observation, measurement, theory and empirical testing [11, 30]. Among the pervasive colonial knowledge systems and ways of doing, Western empirical methods are often used in technical research. By positioning the Western observer as the objective normal, Western empiricism often claims superiority [13], dismisses or discredits sources of knowledge built on worldviews and methods different from its own, and/or justifies their extraction and examination by colonial researchers [11]. These tendencies can alienate and stigmatize Indigenous ways of knowing, which often prioritize interconnectedness, subjective knowledge, and oral traditions [21, 22].

Traditional Knowledge, sometimes referred to as Indigenous Knowledge or Traditional Ecological Knowledge, represents the "collective knowledge of traditions used by Indigenous groups to sustain and adapt themselves to their environment over time. This information is passed on from one generation to the next within the Indigenous group [31]." Elders and trusted and gifted people within a community are the stewards of Traditional Knowledge. Traditional knowledge is often passed on in the local

Indigenous language through stories and land-based activities [31].

In this paper, we use the term "respectful research principles" to refer to the overarching concepts the authors derived from the three Indigenous and Indigenist research approaches reviewed (Research is Ceremony [14], Two-Eyed Seeing [22], doing research in a "Good Way" [18]). These research approaches include those developed by Indigenous scholars and rooted in Indigenous worldviews (Indigenous approaches) as well as those that are consistent with Indigenous worldviews and may be used by both Indigenous and non-Indigenous researchers (Indigenist approaches). Wilson explains the inclusive term Indigenist by comparing it to the way in which a person can be a feminist without identifying as a woman [32].

Methods

Following from this background and theoretical underpinning, this review aims to identify and summarize respectful research principles from engagement frameworks that have been applied in collaborative technical research projects. This was not intended to be a systematic review, but rather a preliminary assessment of the field to lay the groundwork for a detailed scoping review at a later date.

From the spring of 2019 to summer of 2021, SS and PD gathered engineering and technical research publications that included explicit mention of research collaboration with Indigenous communities. Searches were conducted using LibrarySearch in the University of Toronto's online library system, which draws on the databases Summon and ExLibris. This was supplemented by searches using Google to identify grey literature. A broad definition of grey literature was used that was inclusive of reports as well as non-peer reviewed articles and institutional webpages on research in progress or interim findings. Keywords included "engineering" and "Indigenous" or "First Nation" combined with each of the key topic areas ("water", "energy", "housing", "telecommunications", "food systems"). The relevance of these areas of focus was verified with Indigenous partners in the authors' network. These initial searches uncovered 120 articles.

This sample of articles was reviewed manually by the first author three times in consultation with SS. During the first pass, articles were excluded if they described research carried out in a country other than Canada and, due to our language abilities, were not written in English. Research that described itself as Indigenous-led was also excluded since the scope of this review is focused on collaborations between Indigenous communities and non-Indigenous researchers. Inclusion criteria were applied to verify if the reports: (1) were a collaboration with Indigenous communities and that enough information was presented to allow for further assessment; (2) described a technical project related to one of the five areas of focus (water, energy, housing, telecommunications, food systems); and (3) cited and reported on frameworks for respectful research with Indigenous communities, with a focus on frameworks that were created by/or with Indigenous scholars and/or communities.

The result of this initial review was a sample of 13 collaborative technical reports. Of these, 10 focused on one discrete technical area (water $n=4$, housing $n=3$, food systems $n=2$, telecommunications $n=1$). The remaining three articles reported research related to more than one technical area at a time (housing & food $n=2$, energy & food $n=1$). In a second review, we noted which respectful research principles were implemented and described details of their implementation. A final review was then conducted to ensure that all respectful research principles reported had been captured and to verify the details of their implementation. Comparison between studies was carried out throughout to ensure assessment consistency, as was communication between PD, SS, and AB.

All authors of this review identify as non-Indigenous researchers striving to learn from, and engage respectfully with, Indigenous communities. We come from diverse cultural backgrounds and experiences. One of us (AB) has carried out collaborative work with Indigenous Peoples globally, while another (TG) has worked for years as a settler scholar and ally with First Nations, Métis, and Inuit communities in northern Canada. The remaining authors either have some experience working with Indigenous communities in Canada (PD, SS) or are new to such work (AC, HG). Among us, we bring disciplinary training and backgrounds in engineering (PD, SS, AC, AB), population health (HG), and anthropology (TG).

Our representation of the issues in this paper are filtered through our training, social positions, and privileges. For example, while we can read about Indigenous worldviews, we have not grown up with them, lived them, and connected with others and the land with these worldviews as our guide. In addition, although we have strived to include sources from Indigenous Peoples in this work, we feel the pull of our training and norms within academic structures that prioritize peer-reviewed, published knowledge over that which has been lived and known for generation upon generation within Indigenous communities. These limitations of our positionalities bring to the fore a related issue. That is, whether non-Indigenous researchers should engage in research with or about Indigenous communities. For advice on this issue, we look to Latulippe [30] who suggests that such cross-cultural work is possible and may, at times, be beneficial. However, she stresses that researcher preparation and

commitment to being reflective and transparent about differing worldviews are essential.

Results

In the following results, we first identify and describe principles of respectful research found in our review. We follow this with details and an assessment of the 13 technical research projects that applied the principles of respectful research when working with Indigenous communities.

Three perspectives on respectful research

From the literature, we identified three perspectives on respectful research that have been used in technical research with Indigenous communities (Research is Ceremony [14], Two-Eyed Seeing [22], doing research in a "Good Way" [18]). Below, we provide a brief review of the key tenets of each approach.

Perspective 1: research is ceremony

The phrase "Research is Ceremony" summarizes Shawn Wilson [14] and other Indigenous scholars' explorations of what Indigenist research could be. Through a sacred ceremonial process rooted in Indigenous worldviews, a new collective understanding is created between researcher and participant, dissolving the distinction between these roles. The phrase, "All our relations", succinctly summarizes the idea of relationality, and is used at the start and end of ceremonies. It acknowledges relationships between the living (people, plants and animals), the non-living, past and future generations [33]. Relationality also acknowledges a plurality of interconnected realities and knowledge systems, each uniquely tied to the local culture, language, and land of their respective Peoples and to each person's lived experience [21]. Indigenous knowledges include empirical, traditional, and spiritual knowledges [21, 24].

Relational accountability says that a researcher must be held accountable for the work that is completed and how the research may impact 'all our relations', including the community, the environment, and beyond. Researchers cannot be, nor is it desirable to be, objective, as they are intertwined with the research subject and participants [14].

Wilson allows that "Research is Ceremony" may be used by non-Indigenous researchers, but its components must be well-articulated and honored. The use of "one or two (or 10) talking circles as research tools" does not make a research project Indigenist [32]. As Wilson reiterates, the researcher cannot be separated from their work, "Our own relationships with our environment, families, ancestors, ideas, and the cosmos around us shape who we are and how we will conduct our research. Good Indigenist research begins by describing and building on these relationships [32]."

Perspective 2: Two-Eyed Seeing

Two-Eyed Seeing, advanced by Mi'kwaw Elder Albert Marshall, involves Indigenous and non-Indigenous scholars "learning to see from one eye with the *strengths* of Indigenous knowledges and ways of knowing, and from the other eye with the *strengths* of Western knowledges and ways of knowing, and to using both these eyes together, for the benefit of all [22, 34]." Since its inception, the term has been adopted by many scholars and organizations in various contexts [35–37]. It is well-aligned with integrative and transdisciplinary approaches and it "does not fit into any particular …discipline" but is "a guiding principle that covers all aspects of our lives [22]."

Two-Eyed Seeing recognizes that both Indigenous and Western empirical worldviews are valuable in research. Like Wilson [14] previously, Bartlett et al. [22] recognize that Indigenous and Western empirical worldviews are different from one another and that Indigenous ways of knowing and doing have often been marginalized. Two-Eyed Seeing emphasizes the importance of Traditional Knowledge and the involvement of Elders in education and research. Understanding that every individual can only speak from their experience and knowledge, Two-Eyed Seeing requires the involvement of both Indigenous and non-Indigenous scholars in a co-learning journey. The approach requires acknowledgement that "we need each other", as well as deep self-reflection on the part of all partners to understand their own and one another's values, motivations, knowledges, and actions [22]. Two-Eyed Seeing also emphasizes action rather than just talking, and warns against choosing aspects of Indigenous methods, token inclusion of Indigenous partners, and attempts to absorb Indigenous knowledges into the Western empirical worldview. One must not just engage with Indigenous methods and partners but value them. Token inclusion appended to Western empirical approaches is not only disrespectful but fails to embrace the co-learning journey emphasized by Two-Eyed Seeing and risks rushing the process according to Western timelines [38].

Perspective 3: research done in a 'Good Way'

Doing research in a 'Good Way' is Western empirical research done in a culturally and ethically appropriate way that is in accordance with the four R's of Respect, Relevance, Reciprocity, and Responsibility [18, 39]. Respect involves acknowledging Indigenous worldviews, the community, and their self-determination. Relevance highlights that research should be relevant to the community and peoples' lived experiences. Reciprocity refers to the understanding that both researchers

and participants are positioned as learners and will benefit from the research process. Responsibility reminds researchers that knowledge production is not neutral, and it is the researcher's responsibility to work with the community to avoid negative impacts [18, 24, 39].

To work towards these values, researchers must engage with the community as full, authentic collaborators, in the spirit of "Nothing About Us Without Us" [40]. The community should be involved in all aspects, including initial research design, data collection, analysis, and reporting. Where the scope does not necessarily align with community interests, researchers should consider how project activities can be modified to include relevant community initiatives [18, 40].

An established research approach that complements respectful research principles is Participatory Action Research (PAR) [41–43]. PAR emphasizes that an important outcome of research is to create positive social change for the participants [15]. Another way to practise respectful research is to select methods that are aligned with an Indigenous worldview. For example, methods that allow for individual storytelling and collective sharing that are consistent with Indigenist research methodologies [32, 43, 44].

Like with Two-Eyed Seeing, researchers should reflect on their identities, perspectives, and motives. Communities should expect clear communication of researcher motivations and values. Honesty and self-understanding are paramount in establishing trust, recognizing internal biases and limitations of the research. This can be done by becoming the "learner" instead of the "expert" in a collaboration [15]. However, communities sometimes ask researchers to step into the role of expert to advocate on behalf of the community. Ultimately, researchers must remain flexible to community needs [45].

Common elements in respectful research practices

Table 1 generalizes and summarizes the respectful research principles identified from the literature cited in this section. Five high-level principles are used to group the collaborative practices: (1) researcher cultural competency and awareness of historical context, (2) researcher critical self-reflexivity, (3) community involvement, (4) community benefits, and (5) Two-Eyed Seeing.

Additional considerations and challenges in respectful research

In addition to the three main perspectives for respectful research described above, this review identified four additional key considerations and challenges. Each of these is discussed briefly below.

Resources required for respectful research

Respectful research requires dedicated resources and an extended research timeline to form relationships, build trust, and collaboratively conceptualize, design, and enact the research [18, 40]. Research projects with remote communities will require additional resources for highly recommended in-person meetings. Access may vary by season, with air or ice road sometimes being the only options in the winter [41]. Ritchie et al. [41] identify the proximity paradox: remote communities that may benefit the most from collaborative research, are also the most difficult to collaborate with due to logistical and resource constraints. These authors urge researchers to continue to undertake important work with remote communities and to plan carefully to build in sufficient resources for such engagement (e.g., by building a larger collaborative team with access to a sustained pool of funding).

Data ownership and protection

Given the extractive nature of past research, extra care should be taken with respect to data ownership and protection. Findings may be valuable to the community but may have negative consequences if made public. Elders may wish to pass knowledge onto community youth but be wary of outside appropriation and commercialization, such as happened with the commodification of St. John's Wort, a traditional medicine [48]. The First Nations Principles of Ownership, Control, Access, and Possession (OCAP) [49], provide guidance to ensure that First Nations communities have full control over their data. Memoranda of Understanding (MOU) or research agreements can be co-developed at the start of a research project to document shared understanding between researcher and communities about: research project aims, respective responsibilities, data protection, and ownership [50].

Institutional requirements

In Canada, the Tri-Council Policy Statement on Ethical Research Involving Humans—Chapter 9: Research Involving the First Nations, Inuit and Métis Peoples of Canada [26], is one example of an attempt to embed respectful research practices into institutional requirements. However, there are examples where rigid institutional ethics requirements are at odds with the needs of Indigenous communities. Research participants are typically anonymized to protect confidentiality. In Indigenous contexts, specific knowledges must be directly attributed to the source to protect ownership, therefore participants may wish to be named [14, 18]. Written consent for individual research participants may be incompatible with the oral traditions of Indigenous Peoples as well as specific traditions around how to ask Elders for

Table 1 Respectful research practices

High-level principle	Description
Researcher cultural competency and awareness of historical context	• Recognize and respect traditional sovereignty and self-determination [18, 41, 46, 47] • Learn about Indigenous histories and cultures, including Indigenous and non-Indigenous relations and the colonial context [18, 22, 40, 41, 46, 47] • Be mindful of sources of knowledge. Ideally, knowledge about an Indigenous community should come from the community itself. [46, 47]
Researcher critical self-reflexivity	• Self-examine your values and motivations for doing this research [18, 22, 40, 45, 46] • Acknowledge that your worldview and knowledge base is specific to yourself, and that there may be other ways of thinking and knowing [18, 22, 40, 41, 45–47] • Consider broader power systems and how they impact the research and its context and what can be done to redistribute power to the community within and outside of the research [18, 22, 41, 45, 46] • Position yourself as a co-learner, while acknowledging how your position may be leveraged to support the community (e.g., disseminating findings to government) [18, 22, 40, 41, 45–47]
Community involvement	• Community input is critical in carrying out respectful research [18, 22, 40, 41, 45–47] • Community input should be considered in every phase of the project: developing research questions, methodology, data collection, synthesizing findings and sharing the results [18, 22, 40, 41, 45–47] • Consider who is included when discussing the 'community'. The Chief and Band Council governance structure used in some Indigenous communities are a colonial legacy and subject to frequent turnover, so having a wider view of community is warranted. Consider whether women, youth, and Elders are being included and consulted [18, 22, 45, 46] • Work with the community to establish an advisory group for either the specific project or for all research activities in the community, if it is within the interest of the community [22, 40, 46, 47]
Community benefits	• Research must be relevant to communities [18, 22, 40, 41, 45–47] • Balance research and activities for all partners' benefit [18, 40, 41, 45–47] • Consider how research addresses community needs and whether research can be adjusted to meet additional community needs or provide additional benefits [18, 40, 45, 46] • Hire and train community members for the project to build community capacity [18, 40, 41, 46] • Compensate research participants fairly [18, 40] • Protect participants and communities from negative impacts of the research [18, 40, 41, 45, 46] • Consider whether long-term relationships are being built with the community [18, 40, 41, 45, 46]
Two-Eyed Seeing	• Actively involve, and share decision-making power between, both Indigenous and non-Indigenous research partners [18, 22, 40, 41, 45–47] • Acknowledge and use both Indigenous and non-Indigenous worldviews [18, 22, 40, 41, 45–47] • Develop an advisory group or other mechanism to engage deeply and share power with Indigenous partners at all stages, including defining needs and early planning [35, 38, 42] • Be committed to listening, co-learning, and a variety of knowledges [22, 34, 38, 42] • Foster culturally safe spaces through reflexivity and inclusion of Indigenous traditions [35, 42] • Include methods that explore relationships with Traditional Knowledge (e.g., stories, crafts) [22, 42] • Ensure that consent and sharing of knowledge is done ethically, as validated by communities in addition to institutional ethics processes [35, 42] • Consider what action may follow from the research for both communities and researchers [22, 35, 42]

guidance and knowledge (e.g., offering tobacco ties where culturally appropriate) [51–53].

Community capacity

Community capacity can be defined as the resources a community can provide for a research project. It can be measured in time, money, level of education, and/or experience with the research topic [11, 46]. Community leadership often work on competing issues. Researchers need to work with communities to successfully balance the benefits of research with the time and resource costs of collaboration from the start, either through a MOU [43] or a verbal equivalent, thoroughly discussing and answering the questions of community leaders and Elders before research begins [46].

Collaborative research examples in infrastructure and engineering

As described in Methods, the respectful research principles identified above were applied to a search of research reports in five technical areas: water, energy, housing, telecommunications, and food systems. The aims were to: (a) gain a preliminary perspective on *whether* these principles are being applied in technical research; and (b) to better understand *how* the respectful research principles are being implemented in practice.

Tables 2, 3 and 4 present a summary of the information extracted from the 13 collaborative research reports identified in this review. The results show that only four of the 13 reports provide information to support that they at least partially addressed all five general respectful research principles. Two articles [54, 55] stood out for striving to address all five respectful research principles

Table 2 Assessment of collaborative research in water

		Indigenous Collaboration Technical Research Project Name			
		Res'Eau-Waternet [56]	**Decolonizing water [54]**	**Mercer and Hanrahan [57]**	**Safe drinking water team [58]**
Topic		Water	Water	Water	Water
Type of research		Program	Program	Project	Program
Researcher cultural competency and awareness of historical context	Historical context presented	✓	✓	✓	
	Demonstration of cultural competency		✓		
	Inclusion of researchers' learning experiences				
Researcher critical self-reflexivity	Acknowledgement of researchers' backgrounds and motivations		✓		
	Acknowledgement of broader power systems		✓		
Community involvement	Use of an MOU or research agreement				
	Participatory Action Research	Novel Community Circle Approach	✓		
	OCAP Principles		✓		
	Community advisory group				
	Community input on research questions or activities	✓	✓		✓
	Partner with local Indigenous organizations	✓	✓	✓	
	Inclusion of community widely (e.g., youth, elders, women)		✓		
Community benefits	Community perceptions of local benefits	✓		✓	✓
	Research addressed local need	✓	✓	✓	✓
	Community members hired and trained to support research efforts		✓	✓	
	Evidence of long-term relationships being formed				✓
Two-Eyed Seeing	Inclusion of Indigenous scholars or leaders at a decision-making level		✓		✓
	Both Indigenous and Western empirical worldviews are acknowledged		✓		

through a variety of activities to foster robust collaboration directly with Indigenous communities.

For example, in a report related to energy and food systems [55], the researchers situate their work in historical context and discuss their cultural competency and learning. The researchers also partnered with local Indigenous organizations, sought input from the community on research design, trained local community members as part of the research efforts, and acknowledge both Indigenous and Western empirical worldviews.

Figure 1 provides an overview of how many of the 13 projects showed evidence of implementing each respectful research principle based on our qualitative assessment. Figure 1 also provides detail most relevant to the analysis of this paper on how, within each respectful research principle, collaborations were carried out. The 13 studies were selected because they showed technical collaboration with Indigenous communities; this contributed to the small sample size. Sample size limitation is discussed later in this manuscript. Some observations, however, can still be made.

Table 3 Assessment of collaborative research in housing

		Indigenous Collaboration Technical Research Project Name		
		Sekuwe: My House [59]	**Ecotrust Canada [60–62]**	**CMHC: A Sustainable Northern House [63–65]**
Topic		Housing	Housing	Housing
Type of research		Project	Project	Multiple projects
Researcher cultural competency and awareness of historical context	Historical context presented	✓	✓	
	Demonstration of cultural competency	✓	✓	
	Inclusion of researchers' learning experiences			
Researcher critical self-reflexivity	Acknowledgement of researchers' backgrounds and motivations		✓	
	Acknowledgement of broader power systems			
Community involvement	Use of an MOU or research agreement			
	Participatory Action Research	✓		
	OCAP Principles			
	Community advisory group			
	Community input on research questions or activities	✓	✓	✓
	Partner with local Indigenous organizations			
	Inclusion of community widely (e.g., youth, elders, women)	✓	✓	✓
Community benefits	Community perceptions of local benefits	✓		
	Research addressed local need	✓	✓	✓
	Community members hired and trained to support research efforts	✓		
	Evidence of long-term relationships being formed			
Two-Eyed Seeing	Inclusion of Indigenous scholars or leaders at a decision-making level	✓		
	Both Indigenous and Western empirical worldviews are acknowledged	✓		

First, there is generally little demonstration of critical self-reflexivity, such as researchers' backgrounds and motivations. Second, all 13 projects report some degree of community involvement, but there was less evidence of shared power in high-level decision-making. For example, only three studies report using an MOU or research agreement to clarify community-researcher expectations, and only one discusses receiving research guidance from a community advisory group. Finally, while all projects report that they met local needs they did not all include information to support that Indigenous communities themselves perceived local benefits. This may be because researchers did not provide a feedback/post-project evaluation process that Indigenous communities could use if they wished to do so and had the time and resources to commit to such a process.

Discussion

In a preliminary way, this review has highlighted that relatively few projects in the technical literature describe collaborative work with Indigenous communities and report how they met the respectful research principles laid out by Indigenous scholars. Engineering, in general, is a technical and results-oriented discipline. There is a disciplinary expectation for engineering researchers to focus on the technical details and results in research dissemination. These expectations are perhaps exemplified by the lack of detail on relationship-building and respectful research implementation in the publications reviewed in this study. Such a focus on research as a product rather than a process, however, runs several risks when undertaking work with Indigenous communities. At best, it risks withholding valuable information that could be shared as researchers seek to respectfully engage and learn from Indigenous communities. At worst, it risks reinforcing the colonial legacy of research and doing harm to Indigenous communities.

It is difficult to determine which of these risks are at play without full details of collaborations in research reports. Of the collaborative projects identified in this review, most reported only limited and/or vague information about the research process itself. It is possible

Table 4 Assessment of collaborative research in food, housing, energy and telecommunications

		Indigenous Collaboration Technical Research Project Name					
		Lamalice et al. [66]	**Das [67]**	**FEHNCY [68]**	**Mino Bimaadiziwin Partnership [69]**	**A SHARED Future [55]**	**First Mile Consortium [70–72]**
Topic		Food systems	Food systems	Housing and food systems	Housing and food systems	Energy and food systems	Telecoms
Type of research		Project	Project	Project	Program	Program	Program
Researcher cultural competency and awareness of historical context	Historical context presented	✓	✓	✓	✓	✓	✓
	Demonstration of cultural competency			✓	✓	✓	
	Inclusion of researchers' learning experiences		✓			✓	
Researcher critical self- reflexivity	Acknowledgement of researchers' backgrounds and motivations		✓				
	Acknowledgement of broader power systems					✓	✓
Community involvement	Use of an MOU or research agreement	✓		✓	✓		
	Participatory Action Research	✓	✓		✓		✓
	OCAP Principles		✓	✓	✓		✓
	Community advisory group			✓			
	Community input on research questions or activities	✓	✓		✓	✓	✓
	Partner with local Indigenous organizations		✓	✓	✓	✓	✓
	Inclusion of community widely (e.g., youth, elders, women)			✓		✓	✓
Community benefits	Community perceptions of local benefits	✓			✓		✓
	Research addressed local need	✓	✓	✓	✓	✓	✓
	Community members hired and trained to support research efforts	✓		✓		✓	
	Evidence of long-term relationships being formed		✓		✓	✓	✓

Table 4 (continued)

		Indigenous Collaboration Technical Research Project Name					
		Lamalice et al. [66]	**Das [67]**	**FEHNCY [68]**	**Mino Bimaadiziwin Partnership [69]**	**A SHARED Future [55]**	**First Mile Consortium [70–72]**
Two-Eyed Seeing	Inclusion of Indigenous scholars or leaders at a decision-making level		✓		✓	✓	✓
	Both Indigenous and Western empirical worldviews are acknowledged					✓	

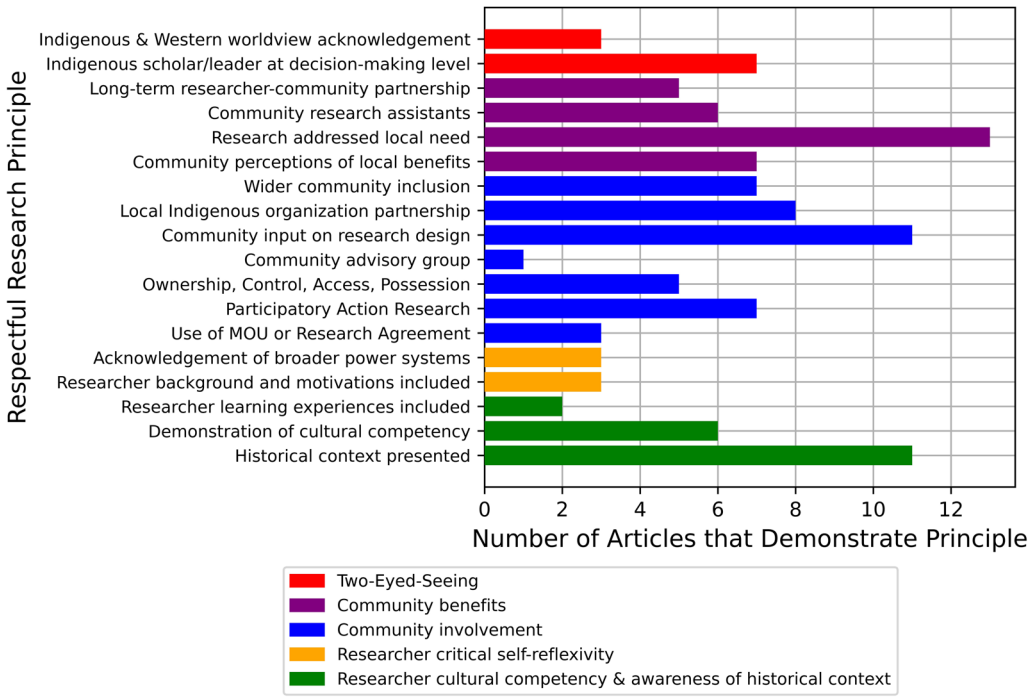

Fig. 1 Number of reports that show evidence of each respectful research principle

that, in some of these cases, the collaborative process was more involved than what the researchers reported. Three possible explanations for the lack of reporting on the collaborations are: a) a results-oriented focus when reporting in a technical field; b) inadequate procedures to allow communities to provide post-research feedback at their available community capacity; c) a desire to keep the specifics of relationship-building between academics and communities private to those involved. Indigenous and academic communities must discuss how to balance these concerns with the need for greater transparency in disseminating project results so that researchers can hold each other to high ethical standards when collaborating with Indigenous communities.

Recommendations

To help avoid the risks at stake when non-Indigenous technical researchers collaborate with Indigenous communities, processes and structures must be adopted that require researchers who engage with Indigenous communities to demonstrate that they have done so in an ethical and respectful manner. Examples of such processes

and structures include: best practices and training for technical teams who wish to do research with Indigenous communities; the inclusion of Indigenous scholars on research ethics boards for proposed work with Indigenous communities; and required reporting on respectful collaboration methods in technical journals when publishing work about projects with Indigenous communities.

Indigenous and Indigenist scholars have highlighted the shortcomings of existing Western empirical research approaches and have provided clear expectations for technical researchers when collaborating with Indigenous communities. Three that are focussed on in this paper include: Research is Ceremony, Two-Eyed-Seeing and research done in a 'Good Way' [14, 18, 22]. Technical researchers should first review this existing information then, according to the guidance of their Indigenous partners, co-develop a plan for respectful engagement.

A related issue, and one which both organizations [73] and scholars have started to examine [74], is that of decolonizing and Indigenizing engineering education and curricula. Though this complex topic is outside our current scope, we feel that such efforts will train a future engineering workforce equipped to engage in respectful partnerships with Indigenous communities both within and outside of academia. This in turn may help engineering evolve away from identifying as an objective and solely technical discipline. Engineers have much social good to offer with their skills and expertise. To carry out respectful work with Indigenous communities, the discipline needs to examine itself, and value and train in relational and subjective approaches. This is fundamental to working with Indigenous communities in an ethical and reciprocal manner.

Limitations

This review was intended to be a step in a process of first identifying whether and how technical researchers are employing respectful research principles identified by Indigenous scholars, and then seeking to bridge gaps between these communities through further research and action. We summarized, in our own words, three well-established respectful, Indigenous research frameworks. Other frameworks that are similar or are less well-known have been omitted [21, 25, 30], including potential guidance from Indigenous communities that is not publicly available. Our review was limited to projects between Indigenous communities and non-Indigenous technical researchers in publicly available reports and journal publications. Indigenous-led projects on topics around energy [75, 76] and housing [77], were discovered, but excluded as outside the scope of this review. Our assessment was conducted only based on the information contained in these reports, which were primarily written by the non-Indigenous collaborators and did not include any reports written in Indigenous languages. Therefore, what is framed as "collaborative" by the authors may not be collaborative from the perspectives of the Indigenous communities [16]. Ultimately, only Indigenous communities themselves can evaluate how respectful a given collaboration was. The lack of reporting on the relationship between researcher and community in studies reviewed made it difficult to determine how researchers viewed Nations [17]. Re-examining projects in the literature to consider how researchers support Indigenous Nationhood could be an important topic for future research.

Finally, we acknowledge and recognize the limitations of our positions as non-Indigenous scholars in writing about this topic. Conducting this review caused us to re-examine the underlying methodological assumptions used when carrying out engineering research, such as approaching Indigenous communities with a pre-formed line-of-inquiry instead of developing the research project with the community from the outset. In future work, we will endeavour to embed shared-decision-making into project timelines and structures from the beginning, through advisory groups and MOUs.

Conclusions

This review highlights a gap between the clear expectations from Indigenous scholars on how to do research with Indigenous communities, and reporting on how those expectations were met within literature on technical collaborations with Indigenous communities. We show that the number of technical reports that seek to implement a respectful research approach with Indigenous communities is relatively small, and that among these, the specifics of the partnerships and steps taken to foster respectful collaboration are sometimes reported only minimally. While these researchers are endeavouring to engage respectfully with Indigenous People, the reporting limits the ability of others to assess the extent to which this research was carried out in an ethical manner as well as to learn from their efforts.

The results of this review raise implications for engineering and other technical disciplines in the context of reconciliation efforts with Indigenous Peoples and future projects that seek strong partnerships for sustainable land and energy use. We suggest that it may be time for engineering researchers themselves, as well as the institutions that train and support them, to look inward and consider what changes to perspectives and approaches may be needed if work is to be carried out with Indigenous communities. Engineering's historical identity as a technical and objective discipline should be expanded to recognize and value subjectivity and relationality. This

is essential to be able to listen to Indigenous communities and work together in an ethical and respectful manner. At an individual and team level, this may begin with becoming familiar with literature on how to collaborate respectfully. Institutional-level structures may help to support these efforts, such as ethics review that includes Indigenous scholars, integration of respectful research principles into training programmes, and space to report on research *process* in addition to results in technical academic journals.

Additional research is also required to further explore issues that this preliminary review identified to provide insight into why some of the respectful research practices appear to be under-utilized or under-reported by technical researchers. The outcomes of such research may help identify how to bring Indigenous scholarship more fully into technical research fields and to tailor this guidance in such a way as to be taken up by more technical researchers. Such aims are especially important as we strive for reconciliation and ethical engagement with Indigenous Peoples alongside technical research that seeks sustainable water, energy, and infrastructure development.

Abbreviations

MOU	Memorandum of Understanding
OCAP	First Nations principles of ownership, control, access, and possession
PAR	Participatory action research

Acknowledgements
The authors would like to thank Ahmed Mahmoud, Roxanna Dehghan, Leslie Walkus and Norman Charlie-Galis for their input during the course of this project and/or review of the manuscript. We also thank the peer reviewers for their valuable feedback to help strengthen this work.

Author contributions
PD and SS identified sources, interpreted data, and drafted the initial manuscript. AC and HG carried out substantive revisions and interpreted the findings for implications and future directions. TG provided crucial input and substantive revisions based on collaborative work with Indigenous communities. AB provided substantial guidance to the conception and design of this literature review as well as critical input throughout the review. All authors read and approved the final manuscript.

Funding
This research was carried out as part of the Reconciliation Through Engineering Initiative, Centre for Global Engineering, University of Toronto. Funding for the Reconciliation Through Engineering Initiative is provided by the Dean's Strategic Fund, Faculty of Applied Science and Engineering, University of Toronto, and the National Research Council Canada's Ocean Program.

Availability of data and materials
Not applicable.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

Received: 24 June 2022 Accepted: 22 January 2023
Published online: 31 January 2023

References

1. Truth and Reconciliation Commission of Canada (2015) Honouring the truth, reconciling for the future: summary of the final eport of the Truth and Reconciliation Commission of Canada. McGill-Queen's University Press, Montreal
2. Facing history & ourselves—colonization. https://www.facinghistory.org/stolen-lives-indigenous-peoples-canada-and-indian-residential-schools/historical-background/colonization. Accessed 15 April 2021.
3. Silver Thetáx Chris, Victor XC, Foulds K, Schneider L (2020) Semá:th Xó:tsa: Sts'ólemeqwelh Sxó:tsa Great Gamma's Lake. Abbotsford: The Reach Gallery Museum.
4. Obomasawin A (2014) Trick or treaty? National Film Board of Canada, Montreal
5. Daschuk JW (2013) Clearing the plains: disease, politics of starvation, and the loss of Aboriginal life. University of Regina Press, Saskatchewan
6. Andrew-Gee E (2020) 'The railways got very wealthy on our land': How rail's colonial past made it a target for blockades. Available via Globe and Mail. https://www.theglobeandmail.com/canada/article-the-railways-got-very-wealthy-on-our-land-how-rails-colonial-past/. Accessed 20 Apr 2022
7. Cowen D (2020) Following the infrastructures of empire: Notes on cities, settler colonialism, and method. Urban Geogr 41:469–486. https://doi.org/10.1080/02723638.2019.1677990
8. Murton J (2008) Creating order: the Liberals, the landowners, and the draining of Sumas Lake, British Columbia. Environ Hist 13:92–125
9. Garrick R (2021) Lac Seul case goes before the Supreme Court. In: Wawatay News. Wawatay News. https://wawataynews.ca/breaking-news/lac-seul-case-goes-supreme-court. Accessed 19 Apr 2022.
10. Turner NJ, Plotkin M, Kuhnlein HV (2013) Indigenous Peoples' food systems & well-being: interventions and policies for healthy communities. Food and Agriculture Organization of the United Nations, Rome, pp 23–38
11. Smith LT (2021) Decolonizing methodologies: research and Indigenous peoples, 3rd edn. Bloomsbury Academic & Professional, London
12. Thambinathan V, Kinsella EA (2021) Decolonizing methodologies in qualitative research: creating spaces for transformative praxis. Int J Qual Methods 20:1–9. https://doi.org/10.1177/16094069211014766
13. Said E (1979) Orientalism 25th anniversary edition. Vintage Books Edition, New York, p 7
14. Wilson S (2008) Research is ceremony: Indigenous research methods. Fernwood Publishing, Halifax
15. Strega S, Brown L (2015) Introduction: from resurgence to resistance. In: Brown L, Strega S (eds) Research as resistance: revisiting critical, Indigenous, and anti-oppressive approaches, 2nd edn. Canadian Scholars' Press, Toronto, pp 1–16
16. Zurba M, Bullock R (2018) Framing Indigenous bioenergy partnerships. Int Indig Policy J. https://doi.org/10.18584/iipj.2018.9.3.5
17. von der Porten S, de Loë RC (2014) How collaborative approaches to environmental problem solving view Indigenous Peoples: a systematic review. Soc Nat Resour 27:1040–1056. https://doi.org/10.1080/08941920.2014.918232
18. Ball J, Janyst P (2008) Enacting research ethics in partnerships with Indigenous communities in Canada: "Do it in a Good Way." J Empir Res Hum Res Ethics 3:33–51. https://doi.org/10.1525/jer.2008.3.2.33
19. Maar MA, Sutherland M, McGregor L (2007) A regional model for ethical engagement: The First Nations research ethics committee on Manitoulin Island. In: Aboriginal Policy Research: volume IV setting the agenda for change. Aboriginal Policy Research Consortium International, London, ON, pp 58–68.
20. Baijius W, Patrick RJ (2019) "We don't drink the water here": the reproduction of undrinkable water for First Nations in Canada. Water 11:1079. https://doi.org/10.3390/w11051079

21. Kimmerer RW (2013) The fortress, the river and the garden. In: Kulnieks A, Longboat DR, Young K (eds) Contemporary studies in environmental and Indigenous pedagogies: a curricula of stories and place. SensePublishers, Rotterdam, pp 49–76
22. Bartlett C, Marshall M, Marshall A (2012) Two-Eyed Seeing and other lessons learned within a co-learning journey of bringing together Indigenous and mainstream knowledges and ways of knowing. J Environ Stud Sci 2:331–340. https://doi.org/10.1007/s13412-012-0086-8
23. McGregor D (2018) From "decolonized" to reconciliation research in Canada: drawing from Indigenous research paradigms. ACME Int J Crit Geogr 17:810–831
24. Kovach M (2015) Emerging from the margins: Indigenous methodologies. In: Brown L, Strega S (eds) Research as resistance: revisiting critical, Indigenous, and anti-oppressive approaches, 2nd edn. Canadian Scholars' Press, Toronto, pp 43–64
25. Hayward A, Sjoblom E, Sinclair S, Cidro J (2021) A new era of Indigenous research: community-based Indigenous research ethics protocols in Canada. J Empir Res Hum Res Ethics 16:403–417. https://doi.org/10.1177/15562646211023705
26. TCPS 2 (2018) – Chapter 9: Research involving the First Nations, Inuit and Métis Peoples of Canada. https://ethics.gc.ca/eng/tcps2-eptc2_2018_chapter9-chapitre9.html. Accessed 20 Apr 2022.
27. Manitoulin Area Aboriginal Health Research Review Committee (2003) Guidelines for ethical Aboriginal research within the First Nations communities of Manitoulin. https://www.noojmowin-teg.ca/images/GEAR_-_FINAL.pdf. Accessed 22 Mar 2022.
28. Haraway D (1988) Situated knowledges: The science question in feminism and the privilege of partial perspective. Fem Stud 14:575–599. https://doi.org/10.2307/3178066
29. Indigenous Services Canada (2020) Annual report to parliament. Government of Canada, Ottawa
30. Latulippe N (2015) Bridging parallel rows: epistemic difference and relational accountability in cross-cultural research. Int Indig Policy J. https://doi.org/10.18584/iipj.2015.6.2.7
31. Assembly of First Nations—Traditional knowledge. https://www.afn.ca/uploads/files/env/ns_-_traditional_knowledge.pdf. Accessed 19 Apr 2022.
32. Wilson S (2007) Guest editorial: What is an Indigenist research paradigm? Can J Native Educ 30:193–195. https://doi.org/10.14288/cjne.v30i2.196422
33. Chartrand P (2007) Niw_Hk_M_Kanak ("All my relations"): Metis-First Nations relations. National Centre for First Nations Governance, Saskatchewan
34. Bartlett C (2004) Integrative knowledge for 'Sense of Place, Emergence, and Participation' workshop. http://www.integrativescience.ca/uploads/articles/2004October-Bartlett-Integrative-Science-Indigenous-Knowledge-collaborative-environmental-planning-CEPI.pdf. Accessed 20 Apr 2022.
35. Forbes A, Ritchie S, Walker J, Young N (2020) Applications of two-eyed seeing in primary research focused on Indigenous health: a scoping review. Int J Qual Methods. https://doi.org/10.1177/1609406920929110
36. David Suzuki Foundation (2018) Reconciling promises and reality: clean drinking water for First Nations. Toronto. https://davidsuzuki.org/wp-content/uploads/2018/02/reconciling-promises-reality-clean-drinking-water-first-nations.pdf. Accessed 20 Apr 2022.
37. Canadian Institutes of Health Research (2015) Institute for Aboriginal Peoples' health: strategic plan 2014–2018. Ottawa. https://cihr-irsc.gc.ca/e/documents/iaph_strat_plan_2014-18-en.pdf. Accessed 20 Apr 2022.
38. Bartlett C (2015) Integrative science and two-eyed seeing: enriching the discussion framework for healthy communities. In: Marshall M, Marshall A, Iwama M (eds) Ecosystems, society, and health: pathways through diversity, convergence, and integration. McGill-Queen's University Press, Montreal QC, pp 280–326
39. Kirkness VJ, Barnhardt R (2001) First Nations and higher education: the four R's—respect, relevance, reciprocity, responsibility. J Am Indian Educ 30:18
40. ITK, NRI (2006) Negotiating research relationships with Inuit communities: A guide for researchers. Ottawa & Iqaluit: Inuit Tapiriit Kanatami & Nunavut Research Institute. https://doi.org/10.25607/OBP-1259.
41. Ritchie SD, Jo Wabano M, Beardy J, Curran J, Orkin A, VanderBurgh D, Young NL (2013) Community-based participatory research with Indigenous communities: the proximity paradox. Health Place 24:183–189. https://doi.org/10.1016/j.healthplace.2013.09.008
42. Peltier C (2018) An application of two-eyed seeing: Indigenous research methods with participatory action research. Int J Qual Methods 17:1609406918812346. https://doi.org/10.1177/1609406918812346
43. Castleden H, Garvin T, Huu-ay-aht First Nation (2008) Modifying photovoice for community-based participatory Indigenous research. Soc Sci Med 66:1393–1405. https://doi.org/10.1016/j.socscimed.2007.11.030
44. Drawson AS, Toombs E, Mushquash CJ (2017) Indigenous research methods: a systematic review. Int Indig Policy J 8:1–27. https://doi.org/10.18584/iipj.2017.8.2.5
45. Diver SW, Higgins MN (2014) Giving back through collaborative research: towards a practice of dynamic reciprocity. J Res Pract 10:M9–M9
46. Tobias JK, Richmond CAM, Luginaah I (2013) Community-based participatory research (CBPR) with Indigenous communities: producing respectful and reciprocal research. J Empir Res Hum Res Ethics 8:129–140. https://doi.org/10.1525/jer.2013.8.2.129
47. Stefanelli RD, Castleden H, Harper SL, Martin D, Cunsolo A, Hart C (2017) Experiences with integrative Indigenous and Western knowledge in water research and management: a systematic realist review of literature from Canada, Australia, New Zealand, and the United States. Environ Rev 25:323–333. https://doi.org/10.1139/er-2016-0114
48. APCFNC (2011) APCFNC elder's project: Honouring traditional knowledge 2009–2011. Atlantic Policy Congress of First Nations Chiefs, Dartmouth
49. The First Nations Principles of OCAP. https://fnigc.ca/ocap-training/. Accessed 21 Jan 2021.
50. Alcock D, Elgie J, Richmond C, White J (2017) Developing ethical research practices between institutional and community partners: a look at the current base of literature surrounding memorandums of understanding in Canada. Int Indig Policy J. https://doi.org/10.18584/iipj.2017.8.4.3
51. Ermine W, Sinclair R, Jeffery B (2004) The ethics of research involving Indigenous Peoples: report of the Indigenous Peoples' Health Research Centre to the Interagency Advisory Panel on Research Ethics. University of Saskatchewan, Saskatoon
52. Wilson DD, Restoule J-P (2010) Tobacco ties: the relationship of the sacred to research. Can J Native Educ 33:29
53. O'Reilly-Scanlon K, Crowe C, Weenie A (2004) Pathways to understanding: "Wahkohtowin" as a research methodology. McGill J Educ 39:29
54. Decolonizing water. https://decolonizingwater.ca/. Accessed 4 May 2021.
55. A SHARED future: achieving strength, health, and autonomy through renewable energy development for the future. http://asharedfuture.ca/. Accessed 16 Jun 2021.
56. RE'SEAU Waternet (2017) Breaking through: achieving socially and technologically sustainable outcomes in drinking water systems for small, rural and Indigenous communities. RE'SEAU Waternet, British Columbia
57. Mercer N, Hanrahan M (2017) "Straight from the heavens into your bucket": domestic rainwater harvesting as a measure to improve water security in a subarctic Indigenous community. Int J Circumpolar Health 76:1312223. https://doi.org/10.1080/22423982.2017.1312223
58. Safe Drinking Water Team. https://www.safedrinkingwaterteam.org/articles. Accessed 16 Jun 2021.
59. Larcombe L, Coar L, Singer M, Denechezhe L, Yassie E, Powderhorn T, Antsanen J, Avery Kinew K, Orr P (2020) Sekuwe (my house): building health equity through Dene First Nations housing designs. Int J Circumpolar Health 79:1717278. https://doi.org/10.1080/22423982.2020.1717278
60. Clayoquot Forest Communities Program (2015) Building for the future: case study—quarter long house in Clayoquot Sound. Ecotrust Canada, Vancouver
61. Wong DH (2011) Green and culturally appropriate building design for Clayoquot First Nations part II: a prototype home design. Ecotrust Canada, Vancouver
62. Wong DH (2011) Green and culturally appropriate building design for Clayoquot First Nations. Ecotrust Canada, Vancouver
63. Semple B (2008) A sustainable house for the Canadian Arctic. In: Home Energy Magazine. Home Energy. http://www.homeenergy.org/show/article/id/503. Accessed 25 Mar 2021.
64. Canada Mortgage and Housing Corporation (2014) Design and construction of the northern sustainable house—Inuvik, Northwest Territories. Government of Canada, Ottawa

65. Canada Mortgage and Housing Corporation (2007) The northern sustainable house: an innovative design process. Government of Canada, Ottawa
66. Lamalice A, Haillot D, Lamontagne M-A, Herrmann TM, Gibout S, Blangy S, Martin J-L, Coxam V, Arsenault J, Munro L, Courchesne F (2018) Building food security in the Canadian Arctic through the development of sustainable community greenhouses and gardening. Écoscience 25:325–341. https://doi.org/10.1080/11956860.2018.1493260
67. Das MK (2017) Rebuilding food security in Garden Hill First Nation Community: local food production in a northern remote community. Dissertation, University of Manitoba.
68. FEHNCY—Food, Environment, Health and Nutrition of First Nations Children and Youth. http://www.fehncy.ca/. Accessed 16 Jun 2021.
69. Mino Bimaadiziwin Partnership. http://ecohealthcircle.com/about/. Accessed 13 Apr 2021.
70. First Mile Connectivity Consortium (2018) Stories from the first mile: digital technologies in remote and rural Indigenous communities. First Nations Innovation and First Mile Connectivity Consortium, Fredericton
71. McMahon R (2014) From digital divides to the first mile: Indigenous Peoples and the Network Society in Canada. Int J Commun 8:25
72. McMahon R, Hudson H, Fabian L (2013) Indigenous broadband policy advocacy in Canada's far north. Paper presented at the role of advocacy in media and telecom policy: a by-invitation experts' workshop, New America Foundation, Washington, September 2013.
73. Engineers Canada (2022) Report on truth and reconciliation in engineering education. Engineers Canada, Ottawa. https://engineerscanada.ca/report-on-truth-and-reconciliation-in-engineering-education. Accessed 24 Oct 2022.
74. Seniuk Cicek J, Steele A, Gauthier S, Mante A, Wolf P, Robinso M, Mattuci S (2021) Indigenizing engineering education in Canada: critically considered. Teach High Educ 26:1038–1059. https://doi.org/10.1080/13562517.2021.1935847
75. Indigenous clean energy indigenous clean energy projects. https://indigenouscleanenergy.com/ice-projects/. Accessed 22 Jan 2021.
76. AKI solutions group about AKI energy. http://www.akienergy.com/about-aki-energy. Accessed 13 Apr 2021.
77. EnviroNative. https://www.facebook.com/environative/. Accessed 13 Apr 2021.

Publisher's Note