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How are Indigenous groups participating in large renewable energy project co-ownership? Mapping global progress

Vigya Sharma [a,*], Julia Loginova [a]

[a] Sustainable Minerals Institute, The University of Queensland, Australia

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ABSTRACT

Indigenous co-ownership of renewable energy projects is increasingly proposed as a tangible pathway towards economic reconciliation, enabling Indigenous communities to assert sovereignty over their lands and land use decision-making. This is despite limited empirical understanding of the value of Indigenous co-ownership, how and where it exists, and what its on-the-ground influence may be in advancing Indigenous self-determination and economic resilience. To address this gap, this paper offers a first-of-its-kind foundational, evidence-based knowledge of the state of play on Indigenous co-ownership of large renewable energy projects. We present an original dataset, comprising 61 projects carefully curated to establish a much-needed global baseline on the spatial and temporal trends and patterns across technology, project size, development stage and equity share. Overall, we find evidence of growth in the number of renewable energy projects with Indigenous equity over the last three decades across four jurisdictions. Most projects in Canada (mainly wind) and New Zealand (geothermal) are operational, while many in Australia (mostly solar) and the US (transmission) are in the planning stages. Indigenous equity shares range from 3.2% to full ownership, with minority ownership the most prevalent. Our findings contribute insights into the emerging modes of Indigenous peoples' engagement with the low-carbon energy development globally. As an open-access project registry, it provides the necessary evidence to shape further critical deliberations on the role of co-ownership in the energy transition as a value proposition for First Nations communities. The paper concludes with areas requiring further research, including the need for contextually nuanced grounded assessments of how co-ownership or equity shares may influence Indigenous groups' engagement with renewable energy developments on their lands.

1. Introduction

Indigenous peoples'[1] economic participation in large industrial projects is an area of growing academic and policy interest. Yet, significant gaps remain in our understanding of what such participation involves, what it means for Indigenous groups and whether it can recalibrate longstanding inequitable power relations between Indigenous peoples, states and developers. The energy transition amplifies this issue, given that renewable energy infrastructure poses threats to Indigenous peoples' lands at a scale not witnessed previously [1]. The expansion of mining to source minerals needed for developing large-scale wind, solar and geothermal energy projects[2] also entails significant intersections with Indigenous peoples' lands globally [2]. These interactions can generate economic benefits and opportunities [3]. At the same time, given the urgency of the energy transition, "business-as-usual" approaches may continue, compromising social, cultural and environmental safeguards and exacerbating historical patterns of dispossession, displacement and exclusion [4].

One pathway that intersects with these concerns is Indigenous co-ownership of projects. We apply Kung et al.'s [5] interpretation of Indigenous co-ownership whereby "an Indigenous group or entity, on whose land or territory the project is located, holds shares (equity) in the developer company". Advocates for Indigenous co-ownership argue that these arrangements may empower Indigenous groups by increasing their

* Corresponding author.
E-mail address: v.sharma@uq.edu.au (V. Sharma).

[1] We use "Indigenous" to refer to the First Nations people from around the world, recognising the contested and plural use of this term, which includes Aboriginal peoples, Native peoples, Tribal peoples, Traditional Owners, and other region- and culture-specific terms.

[2] We refer to projects using these technologies (wind, solar, geothermal, hydropower, or a combination with storage) interchangeably as renewable or low-carbon energy projects.

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influence in decisions and enabling a fairer and more equitable distribution of project benefits [6]. Others suggest that it may have additional flow-on effects, including economic independence and self-determination, opportunities for intergenerational wealth creation and greater oversight over the prevention, and where necessary, management of cultural and ecological risks [3]. These calls for Indigenous co-ownership of large industrial projects go beyond other forms of negotiated benefit sharing [7] such as royalties, local employment and business opportunities, and social investment.

As O'Faircheallaigh [8] notes, negotiated benefit sharing is prone to variable bargaining powers, poor alignment between impacts and benefits, and gaps in the implementation of agreement commitments. Arguably, co-ownership in large-scale projects may see a continuation of inequitable bargaining positions [3,9]. Despite obtaining an equity stake in a project, Indigenous peoples may remain excluded from governance and stewardship [5], such as through a "silent partner" arrangement. Alongside the rapidly growing discourse on maximising opportunities from renewable energy expansion for Indigenous peoples, there is a concomitant need to build understanding of the value proposition of Indigenous co-ownership. This is a crucial step, given that current knowledge of the types and nature of present or planned equity participation of Indigenous groups globally remains sparse.

Our paper addresses this gap by documenting patterns and trends of Indigenous peoples' co-ownership through the development and analysis of an original bespoke registry of large renewable energy projects globally. It poses three key questions: first, what trends and patterns of Indigenous co-ownership are emerging in the renewable energy sector? Second, where do local and national conditions drive, enable or equity in renewable energy projects? Third, in what areas is further research needed to build a collective, globally relevant understanding of the motivations for and risks of co-ownership as a means to economic, intergenerational independence for First Nations peoples?

Our first-of-a-kind project registry highlights insights that are a necessary first step in understanding emerging modes of Indigenous peoples' engagement with the global energy transition. The paper advances scholarship in this topic area by collating, curating, and critically reflecting on Indigenous co-ownership patterns and trends in renewable energy projects at a macro scale. In doing so, it offers foundational, evidence-based knowledge and a much-needed baseline that underlines gaps between on-the-ground realities and long-term aspirations for Indigenous self-determination and economic reconciliation. With global climate pressures driving a rapid roll-out of low-carbon energy projects [10], a timely understanding of these issues is crucial for meaningful engagement with Indigenous peoples.

The paper is organised as follows. Section Two provides the policy and academic context that has shaped this research. Section Three describes the paper's methodological design and novelty in building the project registry and analysing the data. We present results in Section Four, highlighting key patterns and trends. Section Five discusses these findings in the context of existing research, identifying critical themes and new insights at the nexus between renewable energy projects, Indigenous peoples and the energy transition. We conclude the paper in Section Six with recommendations for next steps that build on and extend First Nations knowledges, and active participation as rightsholders.

2. Indigenous co-ownership: policy context and current scholarship

Within the discourse on energy transition, there is growing recognition in policy and applied research for extended and meaningful engagement with Indigenous communities. This includes identifying and co-designing systems and processes that minimise risks while distributing equitable benefits. This section draws on current policy aspirations and academic scholarship to highlight how past engagement with large resource projects has shaped contemporary discussions on Indigenous peoples' participation in low-carbon energy development.

2.1. Policy context for First Nations' engagement with low-carbon energy projects

The development and adoption of key international standards, such as the International Labour Organisation's (ILO) Convention 169, the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), and the United Nations Guiding Principles on Business and Human Rights, has led to some progress in advancing respectful engagement with Indigenous groups and organisations [11–14]. While non-binding, they offer guidance on the minimum standards essential for the survival, dignity and well-being of all Indigenous peoples. To navigate renewable energy developments on their lands and territories, Indigenous peoples are asserting their individual and collective rights to influence progress by demanding the right to give or withhold free, prior and informed consent, and negotiate conditions for development that support safeguarding their way of life, health, and cultural existence [15]. In Australia, for example, a small minority of Indigenous groups who hold native title rights and interests in their lands have the legal ability to veto a renewable energy project on their lands. This effective veto power provides authority to First Nations peoples to demand potentially binding cultural heritage and environmental safeguards [16]. For the vast majority of Indigenous peoples in Australia, however, who have weak or no land rights, the need for the renewable energy sector to extend beyond compliance and build respectful relationships with the First Peoples remains urgent [17].

Within this context, governments and the private sector show some progress in supporting systems and mechanisms that enable Indigenous peoples' economic participation in the low-carbon energy transition [17–19]. There is growing international policy consensus that First Nations peoples "must be enabled to self-determine how they lead, participate in, and benefit from the clean energy transition" [18]. Governments in Australia, Canada, and the United States (US) have developed strategies and programs that recognise the significance of meaningful engagement with Indigenous communities in realising their low-carbon energy development ambitions [18,20]. Canada, in particular, has introduced legislation to facilitate Indigenous economic participation, underpinned by its 2021 UNDRIP Act [21].

First Nations' co-ownership of renewable energy projects is positioned as a potential pathway to advance an inclusive low-carbon energy transition and safeguard the philosophical, socio-cultural and financial well-being of rights-holders on whose lands much of this transition will unfold [19]. Holding equity in renewable energy developments may offer Indigenous nations a prospective opportunity to assert their right to self-determination, gain revenue streams, enhance employment, and build technical and governance capacities. First Nations groups seem keen to explore the equity route to support Indigenous-led decision-making about future economic growth and entrepreneurship, land use and restoration, and heritage management [3,16]. This growing interest in exploring co-ownership as a potential means to maximise benefits from the energy transition is evident across Indigenous communities with a shared history of colonisation-led social and economic exclusion, forced cultural assimilation and irreversible damage to their lands and waters [22–25].

2.2. Reflections on past Indigenous engagement with resource projects

Despite these policy aspirations, several questions about the nature and outcomes of Indigenous interaction with the renewable energy sector need further reflection [15]. A positive policy context can help set an ambitious agenda. Still, long-term commitments from industry and government are necessary for meaningful shifts to occur on the ground [26]. Indigenous groups' past engagement with the extractives sector offers critical insights and a cautionary tale of legacy and marginalisation [27]. Episodes of social, cultural and ecological dispossession

faced by Indigenous groups due to large mining and oil and gas sector activities highlight governments' and corporations' entrenched inability to adopt a rights-centred approach when working with Indigenous peoples (Article 32 UNDRIP; Article 15 ILO 169). The destruction of ancient and sacred caves in Western Australia's Juukan Gorge in 2020, copper mining-related water conflicts between mining companies and the Native Americans in the arid western US, and gender-based violence and exploitation linked with the Liquefied Natural Gas (LNG) project in Canada's northern British Columbia are relatively recent examples of ongoing disregard for Indigenous rights to self-determination, and the protection of their lands and cultures [28–31].

There is evidence that the extractives sector has shifted policies to better listen, recognise and acknowledge past experiences of Indigenous groups and organisations [32,33]. In fact, the sector's past poor track record has been a key reason for the need to shift how Indigenous peoples and knowledges are represented in transitions research. In their review of literature focusing on Indigeneity and the field of sustainability transitions, Doyon et al. [34] highlight five key themes that characterise the emerging interface between energy transition scholarship and Indigenous peoples: a definite call for more research in Indigenous landscapes "enmeshed in energy development/transitions"; the reliance on geography as a valuable lens that brings ideas of scale, space, and place to transition projects; a focus on justice given the legacy of absent procedural, distributive and recognition justice in the way past projects have interacted with Indigenous sovereignty; the complex but necessary role of community control, and Indigenous leadership to maximise the potential benefits from energy transition projects; and the need to de-politicise traditional forms of governance to foster Indigenous peoples' participation, empowerment and agency.

As a result of these ongoing developments, a range of partnership types between Indigenous groups, governments and industry have emerged globally. In a study analysing partnership outcomes for Indigenous capacity building, control and benefits from Canada's forestry, energy and mining industries, Bullock et al. [35] identify nine categories of governance arrangements ranging from benefits agreements to Memoranda of Understanding (MoUs) to roles on advisory bodies and economic councils. Their work highlights the need for greater investment of time and resources to build Indigenous capacity, both as "an explicit process objective and outcome of new partnerships" to maximise Indigenous control of, and benefits from, developments on their lands. [35].

One specific pathway that many rightsholder groups have taken to seek self-determination in relation to large infrastructure developments on their lands is negotiated agreements (also known as benefit-sharing agreements). Although their effectiveness varies across regions and depends on factors both internal and external to the Indigenous community, over the last two decades, benefit-sharing agreements between Indigenous peoples and industry have emerged as a prominent intervention [36,37]. Specifically, in the resources sector, agreements have provided the mining industry an opportunity to comply with prevailing legal and regulatory requirements. For the most part, though, these agreements have focused on serving the mining, oil and gas sector's interest in seeking greater reputational returns, and minimising organisational risks over time [32]. In return, and *when* implemented well [8], agreements may help protect sacred sites, monitor the use of Indigenous lands, and provide economic returns to local Indigenous groups, including financial benefits, employment and training. Mining-intensive countries such as Canada and Australia demonstrate some progress in the nature of, and outcomes from, benefit-sharing agreements for First Nations peoples. [36]. These agreements have seen a steady increase in the total value and complexity, evolving into "comprehensive assemblages, with provisions that call for greater participation, transparent communication, and engagement between signatories" [8,32]. Although a progressive step, several cases across Canada and Australia point to inconsistent outcomes that perpetuate injustice and result in a narrow range of mostly short-term economic benefits [36,38,39].

2.3. Indigenous peoples' co-ownership of low-carbon energy projects: promise or pitfall?

Over the last decade, more meaningful ways of engaging with Indigenous groups have therefore been sought to help strengthen traditional forms of agreement-making. Three key, complementing factors may have enabled the timeliness of these efforts. The first is growing global attention to the urgency of an energy transition. This has included a renewed focus on minerals necessary for the transition [2], suggesting potential new greenfield developments to access these mineral reserves, and the roll-out of large renewable energy generation projects using solar and wind technologies, all expanding at a scale not seen before. The second factor is evidence from research that much of the transition will rely on extensive new infrastructure, including transmission lines, which will, in turn, require access to Indigenous lands [40]. Finally, despite the past poor track record of Indigenous dispossession and inequity arising from extractive projects on Indigenous lands, there is a sense of cautious optimism about the opportunities emerging from the transition for First Nations groups - not only from large energy projects, but also from those conceived and deployed at the community and/or micro scales. There are calls to identify ownership pathways that enable greater self-determination, agency and "full and effective participation and shared prosperity" [41] for Indigenous peoples in energy and resource projects that traverse lands with cultural and spiritual significance for First Nations.

According to Krupa et al. [19], "Indigenous-owned clean energy projects come as close to achieving a balanced triple bottom line structure as one is likely to find in energy markets." Many argue that Indigenous co-ownership enables governments and Indigenous organisations to pursue multiple, concurrent policy goals, including Indigenous-led entrepreneurship, and solutions that serve the dual objectives of energy access and climate action [19,42,43]. In their study of an oil pipeline project in Western Canada, Wood et al. [44] suggest how co-ownership can foster trust between industry and Indigenous groups. "In building trust, firms will be able to engage in a transformational relationship with stakeholders and build projects that are not only of mutual benefit but also instil a mindset of co-ownership for the project" (p.585).

Similarly, in a study of Indigenous-owned Economic Development Corporations (EDCs) involved in renewable energy projects in Canada, Savic et al. [45] report that Indigenous participants believed a 50–50 equity partnership could be more meaningful for self-determination than traditional Impact and Benefit Agreement models, and that representation on a partnership's Board of Directors allowed Indigenous groups to "assert their decision-making authority over the project and their land" (p. 8). It may therefore be argued that Indigenous co-ownership represents an aspirational goal for its potential to provide an "opportunity to break with the past, drive sustainability in resource-rich regions, and re-balance the impacts and benefits of mining and energy projects for future communities" [46].

As Kung et al. [5] argue, "there is no archetypical model of Indigenous co-ownership, given the range of possible ownership structures … right and benefits can be negotiated and tailored …[and] control and influences are not automatic and unproblematic outcomes of Indigenous equity participation". Despite being promoted as a potential pathway to greater control for Indigenous peoples and First Nations businesses [47,48], our understanding of what drives co-ownership, what risks accompany such a model of agreement, and under what conditions co-ownership may offer a path to self-determination remains limited. Examples of Indigenous co-owned projects currently available in the literature are few and predominantly located within the OECD (Organisation for Economic Co-operation and Development). Even where an equity partnerships have been established, attributing positive impacts directly to equity participation remains challenging. This is particularly complex in settler-colonial contexts, where Indigenous groups operate within socio-economic and legal systems framed by colonial histories,

practices, and entrenched structural and systemic challenges [47,49].

The rest of the paper explores these co-ownership arrangements to contribute to our collective understanding of the forms they take, where they are situated, and trends and patterns that can be observed in Indigenous organisations' global interface with low-carbon energy developments. This is a vital first step before analysing their on-the-ground contributions to shifting power dynamics, building trust, and addressing historical social, cultural, and economic inequities.

3. Methodological approach and empirical novelty

This study began with the intention to develop an original global registry of large renewable energy projects with Indigenous co-ownership. The objective was to curate a comprehensive, reliable resource for analysing global and national trends and patterns of Indigenous co-owned projects in the renewable energy sector. While Indigenous-led organisations in some nations such as Australia and Canada have invested in maintaining a database of renewable energy projects with Indigenous equity [50,51], these are scale-agnostic, ranging from small community-scale micro grids to medium and large scale projects, and include different modes of Indigenous participation that extend beyond co-ownership. These individual data sources also have a clear in-country focus, and follow their own methodological approach to project compilation. In the absence of a comprehensive, publicly shared global dataset, the project registry was curated and meticulously reviewed over a 14-month period between February 2024 and April 2025 to fill a critical gap in an area of emerging significance: First Nations' participation in large energy transition projects across regions. The research was approved by the University's Human Research Ethics Committee and adhered to high standards of research integrity throughout data collation, curation, and analysis.

We focused on projects larger than 10 MW to capture renewable energy developments that reflect significant commercial engagement, thereby excluding smaller, community-scale projects [52]. Primary data sources included publicly available information sourced online from formal project documentation, corporate and organisational websites, media releases, published reports, and peer-reviewed academic literature. While efforts were made to identify relevant projects in all geographies, including using searches in other languages, only one project was found in the Global South. Projects were included in the registry if they met three criteria: i) they involved low-carbon energy technologies (wind, solar, hydro, geothermal, hydrogen, or "combined" including battery storage and/or transmission infrastructure); ii) they had an announced or operating capacity greater than 10 MW; and iii) they had a documented reference to Indigenous equity or co-ownership, including by First Nations, Aboriginal peoples, Traditional Owners, or specific Indigenous groups). The registry included projects across various stages of development: announced, in development, operational, or cancelled. Where possible, data was cross-referenced across multiple sources to validate accuracy. For example, to ensure we hadn't overlooked any projects, we conducted a cross-check of our dataset against existing (and continually updated) project lists maintained by country-based Indigenous-led organisations. In cases of ambiguous or conflicting information, priority was given to the most recent and direct sources (e.g., project documentation was prioritised over media articles).

The resulting registry includes 61 large renewable energy projects in Australia, Canada, the US, New Zealand and Argentina. This is a new registry, developed with the intent to address the objectives of this paper; as such, we do not claim that the registry is exhaustive. Given the highly dynamic nature of the sector, regular policy changes, commercial confidentiality, and the time-bound nature of data collection, our registry may not capture all existing large projects or reflect their latest status beyond April 2025 (the end date for our data search). There are additional limitations worth noting: the registry offers a macro-level view only, and the approach does not involve ground-truthing with First Nations communities and non-Indigenous actors. We recognise the importance of ground-truthing, and discuss this further in section six (including ideas for researchers and Indigenous partners to build on this work through more collaborative, co-designed, and locally validated approaches).

Our dataset of 61 projects provides a foundational resource for comparative and quantitative analysis. Each project was carefully selected, reviewed and documented using a standardised analytical framework designed to map and understand: i) the diversity in project scale and type, ii) the nature of Indigenous ownership across different jurisdictions, and iii) spatial and temporal trends and patterns. Key variables included project location, size, development stage, primary technology, the year of commissioning (actual or planned), and ownership structure. Projects were grouped by size: small (10 to <100 MW), medium (100 to <500 MW), and large (>500 MW) and Indigenous ownership types: full (100%), majority (50.01–99.99%), equal (50%), and minority (0.01–49.99%).

In addition to visual inspection of temporal trends, we formally tested whether observed changes through time were statistically significant. Annual counts of Indigenous co-owned projects were analysed using Poisson and negative binomial regression for overall counts and by project stage, primary technology, size category and country. Likelihood-ratio tests ($\alpha = 0.05$) were used to assess the significance of temporal and categorical effects. To assess changes in technological diversity over time, projects were grouped into three time periods (1997–2012, 2013–2020 and 2020–2024). For each period, the distribution of projects by primary technology was tabulated hannon diversity index. Higher index values indicate a greater number of technology types with a more even distribution.

A note on researcher positionality:

As researchers, we appreciate the value of accountability and the need to be critical of our individual values and belief systems that inadvertently shape our research worldviews and practice [53]. It is important, therefore, that we reflect on our positionality as academics, and acknowledge the contours of reflexivity, bias and integrity that will have influenced the conception, design and execution of this work [34,54]. We are non-Indigenous, non-white migrant women living and working in the settler state of Queensland, Australia, where land was never ceded. Collectively, our values are informed by our lived experiences shaped by ethnic minority backgrounds and origins in the Global South. We are part of a research organisation with a long, internationally reputed history of working alongside Indigenous peoples and First Nations to foreground their perspectives in our work exploring the social, cultural and institutional aspects of resource extraction and use. We are mindful of the limitations posed by our privileges and their role in shaping how we consume and produce knowledge.

4. Results

This section outlines trends and patterns of Indigenous co-ownership of renewable energy projects, focusing on geographic distribution, changes over time, and the share of equity held by Indigenous groups.

4.1. Geographic distribution of renewable energy projects with Indigenous co-ownership

Of the 61 Indigenous co-owned renewable energy projects in the dataset, the majority (72%, $n = 44$) are located in Canada, followed by Australia (13%; $n = 8$), New Zealand (8%, $n = 5$), and the US (5%, $n = 3$), with only one project found in a Global South country, Argentina. Fig. 1 illustrates the geographical distribution of projects in the dataset, revealing distinct national and sub-national patterns. Each country exhibits distinctive technological preferences. Wind and hydro projects dominate in Canada, while solar and geothermal energy are the primary focus in Australia and New Zealand, respectively. Wind and transmission projects are present in the US. While over three-quarters of all Canadian projects in the registry are operational (77%), a substantial

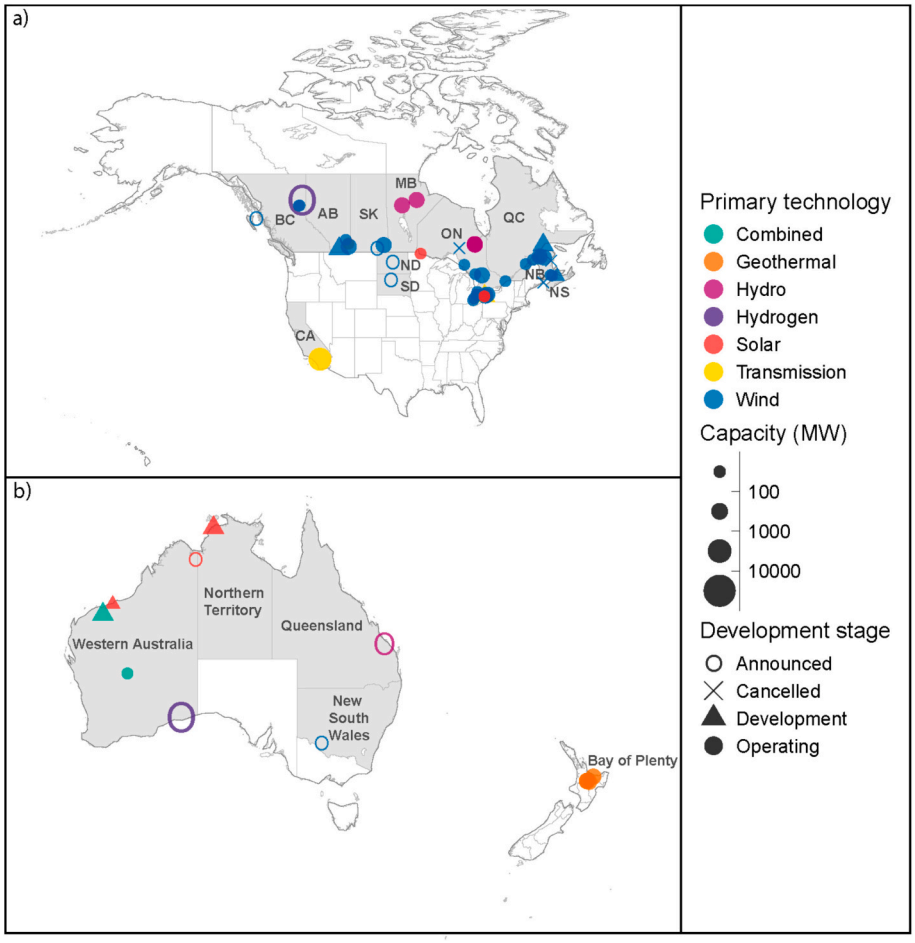

Fig. 1. Map showing the distribution of Indigenous co-ownership renewable energy projects across: a) Canada and the US, and b) Australia and New Zealand, differentiated by primary technology, capacity (in MW) and development stage. Only states and territories that have projects are labelled. Canadian provinces: BC - British Columbia, SK - Saskatchewan, QC - Québec, AB - Alberta, NB - New Brunswick, MB - Manitoba, ND - Nova Scotia; US states: SD - South Dakota, North Dakota, CA - California. One project in Argentina is not shown.

proportion of projects in Australia and the US remain in the announced stage (50% and 67%, respectively).

In Canada, projects are geographically concentrated in Ontario, accounting for nearly half (48%) of the country's Indigenous co-owned low-carbon projects. Other notable provinces include Quebec (14%), Alberta (9%), British Columbia (9%), and New Brunswick (9%), while Manitoba, Saskatchewan, and Nova Scotia each host two or fewer projects. In Australia, more than 60% of all Indigenous co-owned projects are located in Western Australia, with one project each in the Northern Territory, Queensland, and New South Wales. In the US, two Indigenous co-owned wind projects are located in North and South Dakota, while California hosts a single transmission project.

As Fig. 2 shows, nations have different distributions of Indigenous co-owned renewable energy capacity across technologies and development stages. Among all countries, Canada has the largest operating capacity co-owned by Indigenous peoples, accounting for 4% of the national installed renewable energy capacity (4.3 GW of 110 GW) [55]. Wind and hydro make up 95% of this operating capacity, and wind is the only technology represented in projects that are announced or in-development.

In Australia, Indigenous co-owned operating capacity remains limited, contributing just over 0.1% of national installed renewable energy capacity (95 MW of 63.5 GW) [55]. However, Australia has the largest capacity in announced and in-development projects. Announced projects include hydro (50% of the announced capacity), solar (28%) and wind (22%) technologies. Projects in development are dominated by multi-technology combinations (71% of the capacity in development), with solar accounting for the remaining 29%.

In New Zealand, all Indigenous co-owned operating capacity is concentrated in geothermal projects, representing more than 6% of the country's installed renewable energy capacity (507 MW of ~9 GW). In the US, only one Indigenous co-owned wind project appears in the development pipeline.

4.2. Change over time

This section presents changes observed over time across Indigenous co-owned projects (Fig. 3a–d). The registry includes projects dating from 1997 onwards, with the earliest operating project from the late 1990s. As shown in Fig. 3a, over the past three decades, the total number of projects with Indigenous equity has generally increased with a visible spike around 2014. By 2024, 67% ($n = 40$) of all projects in the dataset were operational, while a further seven projects were in development (12%, $n = 7$). An additional ten projects (16%) had been announced (with commissioning expected between 2026 and 2030), while three wind projects in Canada were cancelled during 2021–22. With regard to the number of projects per year, formal statistical testing using Poisson regression indicated a positive but marginally non-significant temporal trend ($\beta = 0.026$, $p = 0.09$), indicating an approximate 2.5% annual increase in projects over time. Although the effect was not statistically significant at $\alpha = 0.05$, reflecting the small sample size and uneven temporal distribution of projects, the observed pattern suggests growing

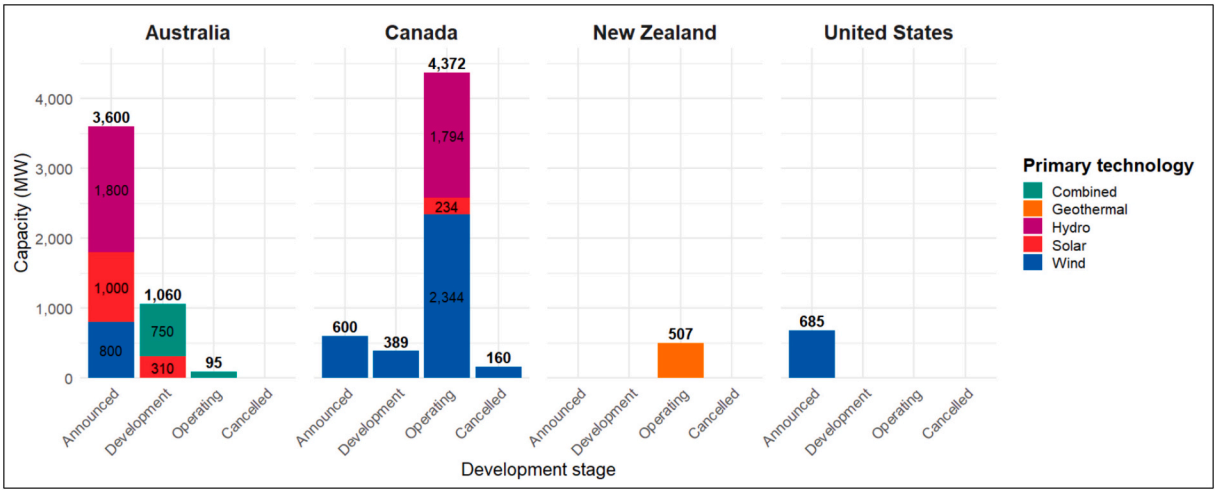

Fig. 2. Renewable energy capacity co-owned by Indigenous groups by technology and development stage. Hydrogen and transmission are not included. One project in Argentina is not included. Colours indicate primary technology.

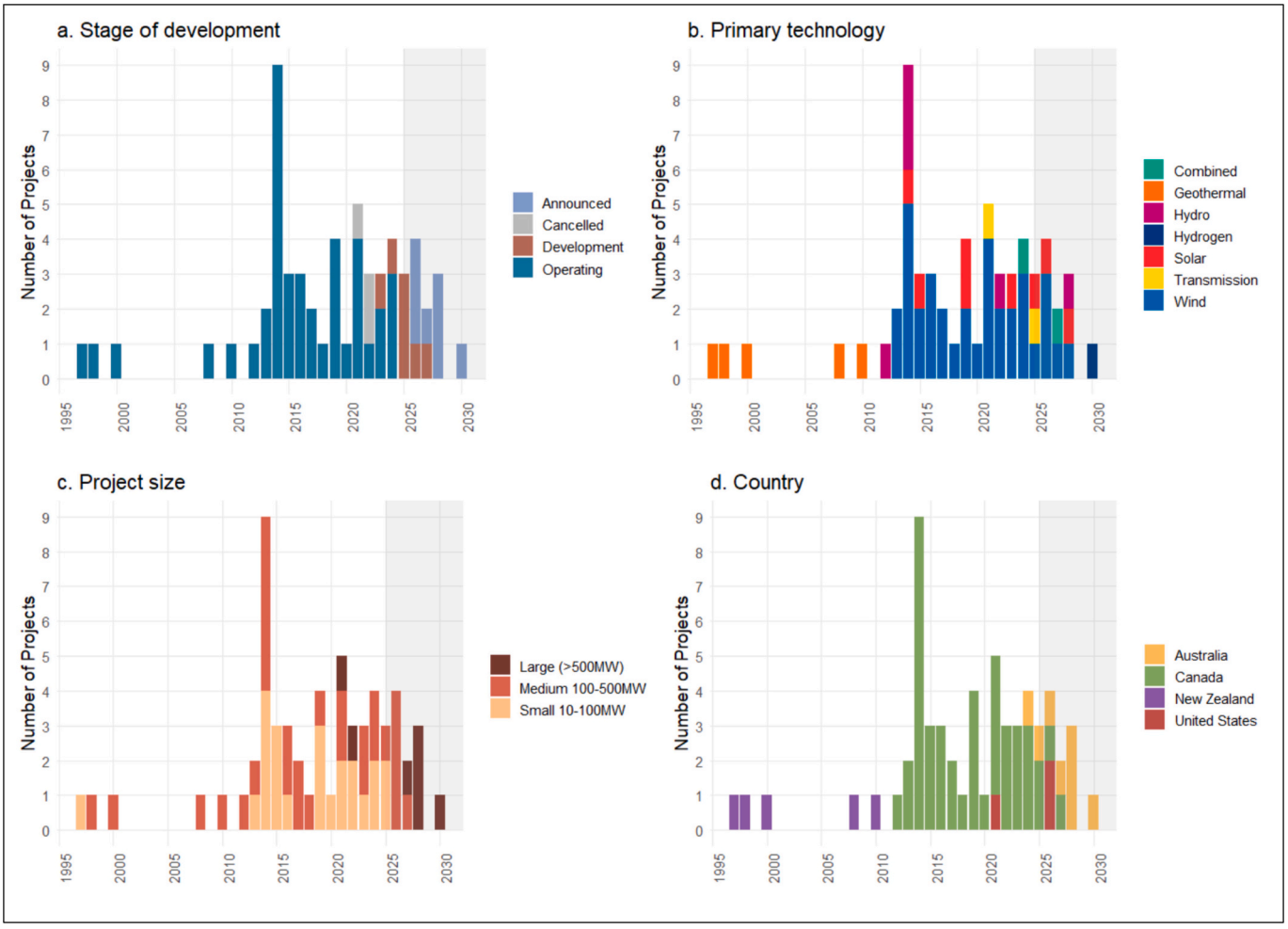

Fig. 3. A panel showing major trends over time – by development stage, primary technology, size and country. Year represents the year of project commissioning, observed or projected for post-2024 projects. For 2 out of 61 projects, the year of commissioning was unclear, so these projects have not been included in the plots. One project in Argentina is not shown.

activity and warrants continued monitoring as additional projects emerge. See Section 6.5 for further discussion on the need for longitudinal monitoring.

With respect to technology types (Fig. 3b), the mix of Indigenous co-owned renewable energy projects has broadened since the first project in the dataset from 1997. Until 2012, only two technologies were present:

geothermal and hydro (commissioned in the 1990s and late 2000s in New Zealand and Canada, respectively). Projects commissioned between 2013 and 2020 include wind and solar. Since 2020, the technology mix has further expanded to include hydrogen, transmission, and combined configurations.

To quantify this change, we calculated a Shannon diversity index. It increased from 0.45 in 1997–2012 to 0.78 in 2013–2020 and 1.27 in 2020–2024, indicating a steady broadening of the technological mix. During the whole period, wind projects were the most common (57%), followed by solar (15%), hydro (10%), and geothermal (8%). Projects related to transmission, hydrogen, and combined technologies (battery storage in combination with wind, hydropower, solar) each account for 3%. Projects for hydrogen development are relatively recent and dominate the current pipeline of announced projects. Similarly, most transmission infrastructure projects with Indigenous equity have emerged since 2020. Negative binomial regression indicated that temporal trends did not differ significantly across technologies ($p > 0.2$).

Country-level patterns show that project activity is unevenly distributed (Fig. 3d). Canada shows the highest level of activity since 2012, with a marked increase in commissioned wind and hydro projects from 2014 onwards. Australia's first projects with Indigenous co-ownership materialised in 2024 with one operating project, three under development, and five announced with expected commissioning from 2028. Of the four primary jurisdictions in our dataset, the US is the least active, with three projects recorded: one commissioned in 2021, and two announced, with commissioning expected in 2026. Statistical testing confirmed significant differences in project counts among countries ($\chi^2 = 9.24$, $p = 0.026$), although no significant variations in temporal trends were detected between countries ($p = 0.75$).

Across technologies, project sizes also vary substantially (Fig. 3c). The three smallest projects in our registry include a 10 MW solar project under construction in Western Australia and two 15 MW wind projects, both operating in Canada's British Columbia. By comparison, some of our dataset's largest projects include the announced 1 GW solar project in Australia's Kimberley region for hydrogen production, currently undergoing Stage 2 feasibility, with a final investment decision likely in 2026,[3] and the 695 MW Keeyask hydropower project, operating in Manitoba, Canada, since 2022. Despite these extremes, nearly 40% of all projects in the registry are small-sized (under 100 MW) (Fig. 4).

Small and medium-sized (100–500 MW) projects have been consistently present since the late 1990s (Fig. 3c). Large-scale projects appear post-2021. Statistical analyses found no significant temporal variation in project size, nor any interaction between year and size category ($p > 0.4$). When project size is considered alongside development stage, the current pool of announced projects with Indigenous co-ownership suggests that medium and large-sized projects will dominate planned activity through 2030. This pattern indicates sustained momentum in equity-sharing arrangements for renewable energy projects across the registry's four primary jurisdictions.

4.3. Indigenous equity participation and partnership models

Patterns of Indigenous equity share across the registry vary widely, ranging from as low as 3.2% to full ownership (100%). Minority ownership is the most common arrangement. As Fig. 5 shows, of the 51 projects in our registry for which equity share data are publicly available, more than half ($n = 29$) involve Indigenous partners holding a minority stake (<50% equity). Within this group, 12 projects (or 40% of minority owned projects) have Indigenous equity shares below 25%. Equal ownership arrangements (50% equity) are less common, accounting for 11 projects (18%), while projects with majority and full ownership are even fewer. Only two projects in our dataset are 100% Indigenous owned, with a further nine projects (15% of the sample) involving Indigenous equity stakes greater than 50%. Overall, this suggests that fully Indigenous-owned or majority-held projects remain the exception. Additionally, ownership details were unavailable or unclear for ten projects, highlighting a lack of transparency in the documentation and public disclosure of equity arrangements (see Section 6).

These patterns are mirrored when considering the distribution of non-Indigenous co-ownership, including both private and public entities. As shown in Table 1, nearly half of all projects (29, or 48%) involve a majority non-Indigenous stake. Equal ownership arrangements account for 18% of projects, while minority non-Indigenous stakes comprise 15%. A small proportion of projects (3%) involve no non-Indigenous ownership. Overall, these patterns reinforce the finding that fully Indigenous-owned or majority-held projects remain uncommon.

Our findings further suggest that Indigenous ownership levels in low-carbon energy projects vary depending on technology type, project size, jurisdiction, and stage of development (Fig. 6).

In terms of technology (Fig. 6a), most Indigenous co-owned wind (46%, $n = 16$), solar (44%, $n = 4$) and hydropower (100%, $n = 6$) projects involve minority ownership. Fully Indigenous-owned projects are rare and limited to just two wind projects. Equal (50/50) ownership is observed in 11 projects, primarily in wind (8), but also in transmission (1), solar (1) and geothermal technologies (1). Majority Indigenous co-ownership is evident in nine projects, including four wind, two geothermal, two solar, and one single combined battery project.

Cross-jurisdictional patterns reveal further variation. Canada includes all ownership types, though minority ownership predominates. Across Australia's eight projects, Indigenous equity is more evenly distributed, with majority or equal Indigenous stakes in three solar projects and one combined technology project, while four projects (one each for wind, hydrogen, hydropower, and combined technology) hold minority Indigenous co-ownership. New Zealand's five geothermal projects display a range of ownership types, from majority to minority Indigenous equity. The US has three projects with varied ownership structures, including one fully Indigenous-owned project.

Indigenous co-ownership patterns also vary by project size (Fig. 6b). Large-sized projects (over 500 MW) show the lowest levels of Indigenous equity. Of the 51 projects in our registry with publicly available ownership data, only seven (less than 14%) projects are large-sized; five of these include minority Indigenous stakes, while one project each involves equal and majority Indigenous co-ownership. Medium-sized projects exhibit a more balanced Indigenous co-ownership pattern, although nearly half (48%; $n = 14$) still involve minority Indigenous stakes. Five medium-sized projects each include majority and equal Indigenous ownership. Small-sized projects offer the greatest variation, with higher proportions of equal (21%) and majority Indigenous ownership (16%). This pattern suggests that smaller-scale developments may offer more accessible pathways for Indigenous communities to secure a greater share of project ownership.

Our findings highlight that ownership structures also vary across different stages of project development and jurisdictions (Fig. 6c). Over half (56%, $n = 22$) of all operating projects have a minority Indigenous ownership stake, with only a single fully Indigenous-owned wind project, located in Canada. Similarly, half of all announced projects ($n = 5$) involve minority Indigenous equity stake (in Australia and Canada), while three recently announced projects (33%) in the US and Australia involve either full or majority Indigenous ownership. By comparison, over 40% of projects currently under development ($n = 3$) involve a 50% Indigenous equity stake, whereas under a third of these projects (n = 2) lack any public information on co-ownership arrangements. The registry also recorded three projects that were announced but subsequently cancelled. Ownership structures for these were less clear. Overall, the data suggest that operational projects are more likely to involve

[3] We acknowledge the fast-changing nature of project status, and that project operations in all cases are contingent on a range of regulatory and financial approvals. Section 5.4 further discusses the fluid nature of equity-based project developments.

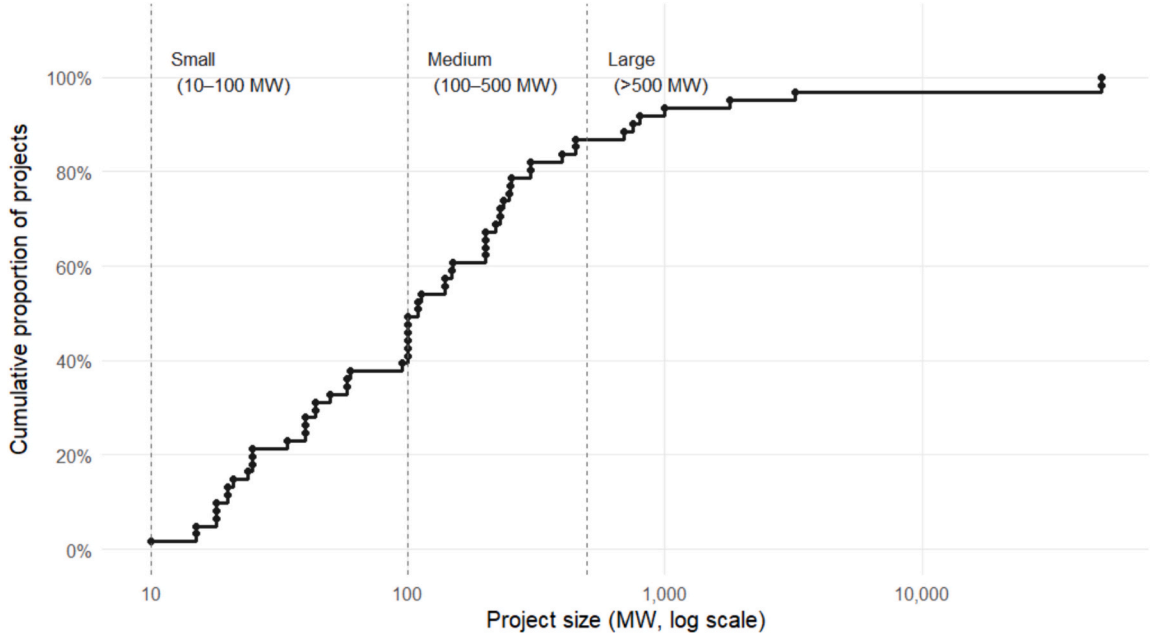

Fig. 4. Cumulative distribution of Indigenous co-owned renewable energy projects by project size. The plot shows the cumulative proportion of projects within project size thresholds: small (10–100 MW), Medium (100–500 MW), Large (>500 MW).

a. Percentage share

Indigenous co-ownership type	Number of projects	% share
Full, 100%	2	3%
Majority (50.01 – 99.99%)	9	15%
Equal, 50.00%	11	18%
Minority, incl.	29	48%
< 24.99%	*12*	
25.00 - 49.99%	*12*	
Unclear minority	*5*	
Unclear	10	16%

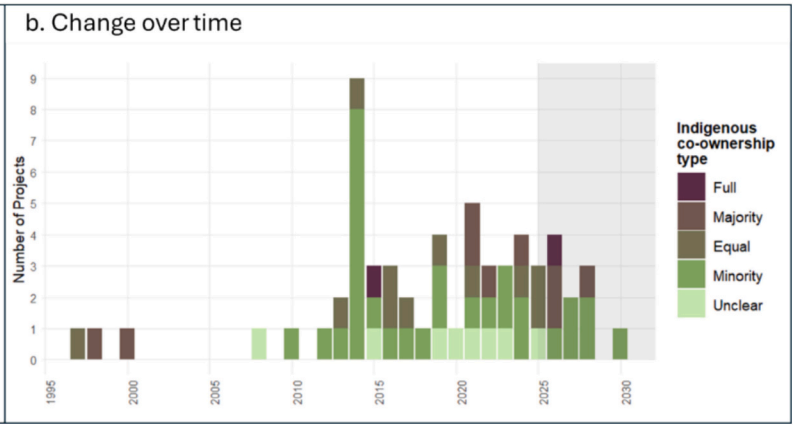

Fig. 5. Indigenous co-owned renewable energy projects by ownership type: a) percentage share, b) change over time. Colour indicates Indigenous co-ownership type.

Table 1
Percentage share of non-Indigenous (public and private) co-ownership.

Non-Indigenous co-ownership type	Number of projects	% share
Majority (50.01–99.99%)	29	48%
Equal, 50.00%	11	18%
Minority	9	15%
Unclear	10	16%
No stake	2	3%

minority or shared equity, while projects with full or majority Indigenous ownership are less common and tend to cluster in earlier stages of development. This indicates that early stages of project development may offer greater opportunities for Indigenous groups to secure equal or majority equity stakes than projects that are already operating.

5. Discussion: mapping progress on Indigenous co-ownership of renewable energy projects

Four critical observations emerge from the results presented above and the existing literature on Indigenous co-ownership of large renewable energy projects. Together, these observations offer important insights into the social, institutional and economic characteristics and conditions that shape Indigenous groups' ability to meaningfully engage in renewable energy development on their lands and territories. These include a focus on i) the type of equity stake most commonly observed; ii) the heterogeneity of institutional, geographic, and market contexts; iii) the motivations of non-Indigenous project partners; and iv) the fast-paced nature of the energy market. Each of these is discussed below.

5.1. *Engagement with large projects but … with a minority stake*

Our analysis demonstrates trends and patterns suggestive of growing Indigenous participation in the co-ownership of large (>500 MW) renewable energy projects. However, the results indicate that minority Indigenous equity is the most common form of co-ownership across large projects. This is unsurprising given that large projects are complex, involving significant human and financial resources and long-term time commitments, with returns on investment often materialising only after several years, if not decades. These projects, therefore, carry a higher

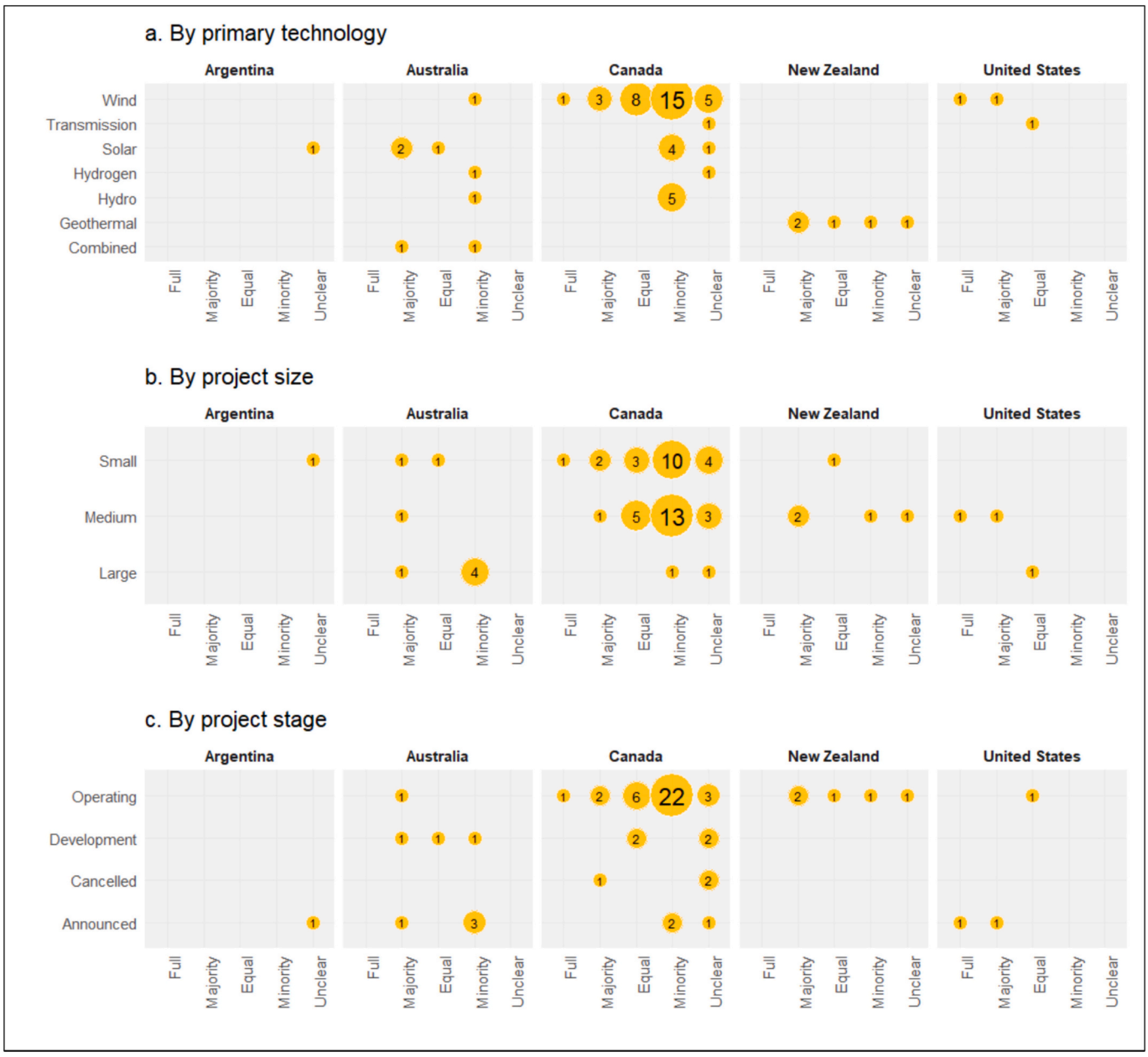

Fig. 6. Distribution of Indigenous co-owned renewable energy projects across jurisdictions and ownership type by: a) primary technology, b) project size, and c) project stage. Bubble size indicates the number of projects in the cross-category.

risk burden. As discussed earlier, most Indigenous groups lack the capacity to independently manage the legal, financial and technical complexities associated with large renewable energy developments. Consequently, they often rely on large public and private organisations to raise the bulk of project finance, provide loan guarantees, and absorb unforeseen risks. These factors enable private investors and large corporations to retain majority ownership stakes in large projects. Indigenous interest in minority co-ownership of large-scale developments appears to be largely technology- agnostic and is instead shaped by the local resource potential of Indigenous peoples' lands and territories.

Despite the predominance of minority ownership, the results nevertheless suggest a trend of Indigenous groups and organisations increasingly engaging in renewable energy co-ownership. Critically, however, this raises an important question: does growth in the absolute number of renewable energy projects with Indigenous equity constitute meaningful progress towards Indigenous self-determination, including sustained agency for decision-making? Canada offers an interesting case in point. Literature often considers it a progressive jurisdiction, with political commitments to reconciliation and the incorporation of UNDRIP into law in 2021 [42]. While this paper does not seek to compare jurisdictions directly, Canada accounts for just under three-quarters of all Indigenous co-owned projects curated in our registry. At the same time, over 54% of Canadian projects involve minority Indigenous ownership. This raises the question of whether such arrangements reflect the emergence of a new business model aligned with Canada's policy and regulatory frameworks intended to support First Nations self-determination? Importantly, it also invites further scrutiny of whether minority co-ownership at scale offers a steady pathway to enhanced social, political and economic agency for Canadian First Nations, particularly when compared with alternate forms of project engagement that do not involve equity participation?

5.2. Spectrum of contexts, policies and capabilities

The results from our dataset point to a diverse spectrum of Indigenous co-ownership patterns in the renewable energy space. These patterns highlight three specific strands of heterogeneity within national boundaries, based on renewable energy resource availability, socio-economic capabilities and institutional support.

Indigenous organisations are shaped by, and as such are entities characterised by, significant differences in their human, legal, and financial capabilities [56]. In Australia, for example, these differences manifest most strongly when comparing remote communities with little experience of, and exposure to, industrial activities on Indigenous peoples' lands and territories with a small number of relatively well-resourced Aboriginal corporations formed in the backdrop of large mining enterprises operating on Indigenous lands. While rare, some successful examples emerge where Indigenous groups are able to catalyse a unifying ambition to pursue pathways to self-determination. The Yindjibarndi Nation's foray into renewable energy project co-ownership in Western Australia's Pilbara region is a case in point [16]. As one of the first groups in the iron-ore rich Pilbara to be granted native title rights to exclusive and non-exclusive possession in 2017 (extending over 13,000 km^2), the Yindjibarndi led early to identify appropriate partners to build and control renewable energy projects on their lands. At the time of founding, the Yindjibarndi Energy Corporation (YEC), a partnership between ACEN and Yiyangu (100% owned by the Yindjibarndi people) was one of the largest Indigenous-led renewable energy initiatives in Australia. With a 25-50% equity across all projects, mandatory approval by the Yindjibarndi for project siting, preferred contracting and economic opportunities for the locals, and an MoU with Rio Tinto [57], a prospective downstream partner seeking renewable energy to decarbonise its iron-ore operations in the Pilbara, the Yindjibarndi equity project is widely considered a leading practice case in Australia. However, it would be misleading to assume that the YEC's experience is commonplace or readily replicable across Australia. Most Aboriginal organisations remain consistently under-resourced and lack the policy and financial support required to translate renewable energy resources on their lands and territories into sustainable social and economic development outcomes [56].

Likewise, diversity in policy support often shapes Indigenous groups' participation in large infrastructure project developments through co-ownership. Ontario in Canada demonstrates well the role of policy in enabling Indigenous co-ownership. With 19 projects spanning wind, hydro and solar development, Ontario hosts just under half of Canada's Indigenous co-owned large renewable energy projects. This progress can be attributed to early supportive provincial policies [48], established transmission infrastructure, a relatively high population density, and the presence of organised First Nations Groups (such as the Pic River First Nation). Ontario's Green Energy Act (2009), repealed in 2019, supported the early adoption of renewable energy and included provisions such as feed-in tariffs and incentives to encourage Indigenous equity participation in energy projects [58]. Enabled further by a well-developed electricity grid, dense population centres, and the presence of some First Nations groups with what has been described as a "clarity of vision" [59], Ontario attracted some of the earliest strategic investments in large-scale energy developments among all Canadian provinces.

5.3. Motivations for (and role of) non-Indigenous actors

A significant focus in the literature on Indigenous co-ownership of renewable energy projects has been on motivations from the standpoint of Indigenous groups and organisations. Their pursuit of self-determination and social and economic agency in decisions concerning developments on their lands is gaining increasing attention in both academic and policy debates. However, the complex nature of large infrastructure projects means that both private sector actors and government agencies can, and often do, play an essential enabling role in facilitating Indigenous participation through equity arrangements [48]. Our results indicate that nearly half of the projects in the registry involve a majority non-Indigenous stake, underscoring that while co-ownership models are expanding, control and decision-making authority often remain weighted towards external non-Indigenous partners.

Two key considerations inform our reflections on the role of the non-Indigenous actors. First, mining activities have historically produced significant adverse social and environmental impacts, including violations of Indigenous rights to land, cultural heritage and benefits from resource development [2,60]. This legacy has strongly shaped contemporary debates on benefit-sharing agreements in the renewable energy sector. Despite the last two decades seeing notable progress in relationships between Indigenous groups and mining, oil, and gas companies, examples of benefit-sharing through Indigenous co-ownership of large resource projects remain limited. Second, there is growing pressure from investors for companies to demonstrate social innovation in project design, execution, and delivery. These demands extend beyond productivity and efficiency to encompass long-term project legitimacy, uninterrupted access to land, and respect for human rights [61,62]. However, there is little empirical evidence examining how such shifts in investor expectations influence private and public sectors engagement with Indigenous organisations in co-owned renewable energy projects.

There is, therefore, a growing need for governments and Indigenous organisations to work collaboratively with the renewable energy industry to assess the social, cultural, and economic returns associated with private sector investment in co-ownership models. Such efforts could help articulate a clearer value proposition for industry actors engaging in joint ownership with Indigenous organisations. Whether these co-ownership arrangements yield primarily symbolic returns for proponents or contribute to more substantive, trust-building relationships warrants deeper examination. Key questions include whether co-ownership arrangements benefit non-Indigenous and Indigenous groups differently, at which stages of the project lifecycle co-ownership may help recalibrate entrenched power asymmetries, and what lessons can be drawn from successful partnerships between large multinationals and Indigenous corporations, particularly with respect to standards of ethics and respect for First Nations' rights.

Existing projects may provide valuable insights into these questions. Examples include ACEN's partnership with the Yindjibarndi Energy Corporation in Australia, Hydro-Quebec's partnership with Canada's Cree communities and the Morongo Band of Mission Indians' majority ownership of a transmission project with Axium Infrastructure in the US. These cases involve relatively well-organised First Nations groups engaging with national and international public and private enterprises across a range of low-carbon technologies, including solar, hydropower, wind, and battery storage.

5.4. A rapidly shifting space inviting innovation from Indigenous groups

We recognise that the findings from our registry inevitably simplify what are often complex and evolving equity arrangements. Drawing on the literature and selected projects from our dataset, we posit that Indigenous equity stakes may change over time as First Nations organisations seek greater control over different stages in the project lifecycle. As Indigenous organisations build technical expertise, financial capacity, and risk tolerance, shifts in ownership structures and partnership arrangements may be both necessary and expected. One such case is the Bow Lake Wind Facility (58.3 MW) in Ontario, Canada, one of the country's first large-scale Indigenous co-owned wind projects [7]. First commissioned in 2015 as a 50-50 partnership between the Batchewana First Nation and BluEarth Renewables Inc. (which continues to operate the facility), the Batchewana First Nation gradually increased its equity to full ownership (100%) by 2024. With a twenty-year power purchase agreement with the provincial grid, and thus a guaranteed revenue stream, the Batchewana First Nation has established a trust to manage benefit distribution from this locally-generated and collectively-

held wealth for the community's long-term well-being [48].

There is also evidence that some Indigenous co-ownership projects involve partnerships among multiple First Nations. This may reflect a project's large spatial footprint across multiple traditional territories, the shared cultural significance of the land, or strategic decisions to pool resources and strengthen financial capacity in pursuit of shared self-determination objectives. Most such multi-Nation partnerships are evident in Canada [48]. A prominent example is the Keeyask Generating Station Project in Manitoba, a 695 MW hydroelectric facility with five partners, including one general partner (590035 Manitoba Ltd., a corporation of Manitoba Hydro) responsible for project operation and management, and four limited partners with restricted management rights and limited financial liability [63]. Three of these partners are the Cree Nation Partners Limited Partnership (comprising Tataskweyak Cree Nation and War Lake First Nation), the Fox Lake Cree Nation, and the York Factory First Nation. Collectively, the First Nation partners hold up to a 25% equity stake, while Manitoba Hydro retains a minimum of 74.99% equity share.

6. Concluding observations and next steps

Indigenous co-ownership of renewable energy projects is an area of increasing global attention for its potential to support self-determination, respect for Indigenous peoples' lands and territories, and enable intergenerational wealth creation. In this paper, our efforts have focused on mapping where Indigenous co-owned projects currently operate or are planned, what forms of co-ownership are observed, and how Indigenous equity participation in renewable energy projects has changed over time.

As a rapidly emerging but under-researched field, this first-of-its-kind global registry has curated 61 projects spanning wind, solar, hydropower, and geothermal energy across Australia, Canada, New Zealand, and the US. With Indigenous equity shares ranging from less than 25% to full ownership, these projects provide a critical evidence base on the current state of Indigenous co-ownership in low-carbon developments globally. In absolute terms, these projects point to emerging shifts in Indigenous groups' engagement with renewable energy resources on their lands and a long overdue potential opportunity to contribute to decision-making about the temporal, spatial and economic use of those resources. In relative terms, however, our dataset of large co-owned projects represents only a small fraction of Indigenous peoples' lands likely to host a significant proportion of low-carbon energy projects over the coming years.

To comprehensively examine the value proposition of Indigenous co-ownership in advancing First Nations rights, agency, and long-term intergenerational well-being, we identify several areas for further empirical work that build on the discussion presented here. We propose five specific next steps below:

6.1. Open-source data

The 61 projects in our dataset are based on publicly available information. It is likely that more co-owned low-carbon energy projects are operating or are planned but remain undisclosed due to commercial or legal sensitivities. For at least ten projects within our database, specific information about governance, legal structures, and financial arrangements was unavailable.

While information sensitivity is necessary in commercial partnerships, better access to data and transparency, particularly around governance, is central to ascertaining the risks and opportunities of co-ownership for Indigenous communities [3].

6.2. Co-designed, reciprocal research with Indigenous groups

Empirical research that examines renewable energy project co-ownership by Indigenous peoples needs to be framed within participatory, reciprocal and co-produced research approaches [34]. For example, Australia's National Science Program outlines seven key principles that underline partnerships with Indigenous peoples: Respect and mutual benefit, Right to Indigenous Cultural and Intellectual Property, Cultural Security and Cultural Safety, Co-design, Indigenous-led governance, relationships-focused, and individual approach [64]. Applying these principles would support research practice to foster "Indigenous-centred" decision making, thus building on traditional knowledge systems to inform contemporary approaches in energy planning [24,34,65,66].

6.3. Co-ownership versus other instruments

There is growing recognition that co-ownership may not always yield expected results in strengthening First Nations agency, self-determination or economic reconciliation [3]. More nuanced analyses are needed to explore the optimal conditions for different types of partnerships. For example, what conditions may result in alternate mechansims such as benefit-sharing agreements becoming preferable to equity stakes, and how consent processes and legacy impacts may shape these choices. Additionally, where Indigenous peoples decide to pursue co-ownership, how may it influence Indigenous agency, self-determination, and risk exposure over time. These are useful prompts to support research endeavours that critically reflect on widespread assumptions regarding the value of co-ownership arrangements for Indigenous groups.

6.4. Geographical reach

As mentioned earlier, our intent in the paper was to establish a global project registry. However, all projects in the database are concentrated in the CANZUS region (Canada, Australia, New Zealand and the US), suggesting clear geographical limitations. It presents no evidence of Indigenous co-ownership in large renewable energy projects in regions that host significant Indigenous populations outside the OECD. These include countries in the Arctic Circle, Central and South America, the Pacific, Asia, the Middle East, and Africa. It would be important to expand the existing registry to these contexts.

6.5. Longitudinal monitoring

Another important next step is to monitor the fast-paced nature of Indigenous co-owned renewable energy project announcements, delays, and cancellations. During the study period for this research, several projects were cancelled or stalled. Understanding factors that drive such outcomes will be valuable for Indigenous groups, governments, and investors. The NaiKun offshore wind project (400 MW) in British Columbia illustrates these challenges. Initially announced as a pioneering renewable energy initiative involving the Haida Nation (with up to 40% equity), the project faced delays, regulatory hurdles, and internal opposition from nearly 80% of the Nation's citizens for the significant financial risks it posed for the community [67]. We recognise that this may not be an isolated case. Tracking project status for such cases is an essential part of building a more complete, collective knowledge of Indigenous participation in large renewable energy projects.

In summary, this paper contributes to a growing body of scholarship exploring Indigenous peoples' co-ownership of renewable energy projects as a potential pathway to self-determination. As a first-of-its-kind global study curating, mapping and characterising large renewable energy projects with varying degrees of Indigenous equity, the paper's insights provide the critical foundations to build further knowledge through the next steps outlined above. Addressing the questions raised here will require a step change from business-as-usual approaches that have long shaped public and private sector engagement with Indigenous peoples. These questions are both necessary and timely, given the projected, unprecedented scale of low-carbon energy development on

Indigenous lands, and the enduring legacy of Indigenous marginalisation in project-related decision-making.

CRediT authorship contribution statement

Vigya Sharma: Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Julia Loginova:** Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Data curation.

Declaration of competing interest

We declare no Conflict of Interest.

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Data availability

Data will be made available on request.

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