



## Original research article

# “The ketchup effect”: Challenges in reconciling growth and justice in Northern Sweden’s green transition

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## ABSTRACT

A green transition powered by large-scale, renewable energy is under way in northern Sweden, featuring innovations in fossil-free mining, green steel production, and lithium-ion battery manufacturing. These new initiatives are the most ambitious in decades, envisioned by companies and politicians as a bright, green future for a region haunted by a history of population and economic decline. However, to meet the demands of growing green industries, the north will have to attract an additional 100,000 residents and increase its renewable energy production thirteen-fold. Building on interview data with key stakeholders in Norrbotten and Västerbotten, Sweden’s two northernmost counties, this article investigates the drivers behind this green growth and examines the challenges that municipalities and industries will face in achieving it. In the long term, can the demands of a growing green economy be met while delivering justice to the rural and Indigenous Sámi populations of the region who have alternative visions for land use in the north? To answer this question, this article lays out a framework that complements existing approaches to justice in green transitions, identifying potential incongruences between growth and justice. This framework emphasizes the need to take into account four factors – order, timescale, agendas, and actors – which ultimately shape the priorities, possibilities, and justice of green transformation outcomes.

## 1. Introduction

*“I wouldn’t use the chicken and egg approach, but the ketchup effect—everything at once. It would be great to do the infrastructure first, but we can’t... If we don’t grasp this opportunity there is a risk that this part of the world will become some sort of museum, and there will be nothing to live from.”*

(Economic Development Official, June 2022)

Sweden has long been a global frontrunner in climate change policy [1,2]. At a national level, Sweden has committed to emitting net zero greenhouse gasses by 2045, which is to be accomplished by reaching a fossil-free car fleet by 2030, reducing CO<sub>2</sub> emissions by 75 % by 2040, and producing 100 % of energy through fossil-free sources by 2040 [3,4]. Sweden’s two northernmost counties, Norrbotten and Västerbotten, are key sites in achieving these goals [5]. Producing 93 % of iron in the EU [6] and reportedly hosting the largest deposit of rare earth metals in Europe [7], northern Sweden’s economy revolves around

resource extraction, processing, and export [8]. A successful green transition in Sweden’s north alone, which entails developing carbon dioxide-free sponge iron and producing fossil-free steel, has the potential to decrease national greenhouse gas emissions by nearly 10 % [9]. Greening the north has therefore become a policy priority not only locally, but also at national and EU levels, for example through the European Commission’s Just Transition Fund [10]. Although the government that took office in October 2022 has a greater focus on continuing Sweden’s nuclear production than its predecessors, the fundamental commitment to climate goals and challenges of the transition remain.

Since 2010, other industrial actors have also found a home in the north. These include data centers, which are attracted by the cool climate, resilient renewable energy grid, and stable political system [11], as well as Northvolt, a company producing lithium-ion batteries to supply Europe’s electric car manufacturers (Fig. 1). Powering innovations in mining and steel production as well as these additional industrial developments requires a thirteen fold increase in renewable

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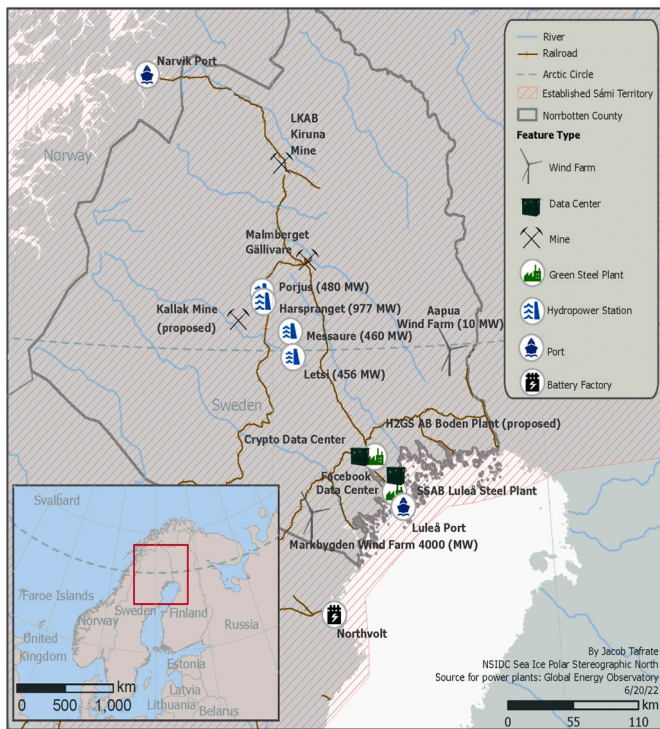


Fig. 1. Map of industrial and energy developments in Norrbotten and Västerbotten, Sweden.

energy production, over SEK 700 billion (USD 64 billion) in investment [12,13], and tens of thousands of new workers. Political dissonance over environment and land use, particularly between the Swedish government and Indigenous Sámi communities, also poses challenges to achieving this green growth in a way perceived as just by all interests [14].

As in many resource extraction-dependent regions, northern Sweden has faced a history of disappointments and reckoning with the myth that a large mine or factory will save the region from economic and demographic collapse. Now, a 400 % projected increase in the demand for rare earth metals by 2030 and global pressure to decarbonize iron and steel production (industries which contribute seven to 9 % of global CO<sub>2</sub> emissions [15]) are fueling hopes for large-scale investment in the region. As municipalities and industries go all-in for a vision of a growing, green north, some interests and groups, in particular Sweden's Sámi population, may be left behind. In order to investigate whether these ambitious growth objectives can be achieved while delivering justice to impacted communities, this research asks: *Which challenges will municipalities and industries face in achieving the projected economic and demographic green growth in Sweden's north? In the long term, can the demands of the region's green transition be met justly, and if so, what conditions must be satisfied?*

To answer these questions, this article first introduces the study's research methods before examining discourses around green growth and just transitions. The article then discusses the political impetus for growth, the changing energy landscape, and the population growth upon which this green transition depends. Lastly, this article analyzes whether the scale and urgency with which these changes must occur stand in the way of delivering just outcomes to local residents. This article contributes to an ongoing conversation about who benefits and who carries the burden of green transitions by exploring how the urgency, scale, and whole-of-society nature of the changes, similar to the way that ketchup can surge out of a bottle, leave little time or space to achieve a just outcome for the local population.

## 2. Materials & methods

### 2.1. Case description

The north has historically been dubbed Sweden's "land of the future" or "natural resource pantry," referring to its opportunities in logging, hydropower, and iron ore production aimed to supply development in the south [16–19]. This characterization of Sweden's north, along with a systematic erasure of the Swedish state's colonial history [20], has effectively rendered invisible the Sámi and Tornedalians who have traditionally inhabited the land and continue to use it [17,21,22]. From the late 19th to the middle of the 20th century, the environment began to be regarded as a source of economic value, fueling the development of logging and mining industries around which towns started to form [23,24]. The industrialization of the north was partially driven by a corporative political culture bringing government, industry, and interest groups into consensus about the central role of technological development and productivity in building the modern welfare state [25,26].

The northern industrial economy stagnated in the 1950s and 1960s, prompting young people to leave the region in pursuit of employment and education in the south. The loss of residents in child-bearing ages resulted in low birth rates, compounding population decline [27,28]. Consequently, rural municipalities dealt with the highest share of elderly residents in the whole country [27,29]. The combined economic and population decline presented a gloomy outlook for the region, which has suffered a series of unfulfilled promises of economic and social revitalization. Several steel producers and mining companies have proposed new industrial ventures across the north only to suffer bankruptcy or abandon plans, even after preparations have been made for their arrival [30]. Consequently, municipal and regional actors strive to combat the ongoing processes of out-migration, net population decline, and cutbacks in social services, most recently by tapping into national and global discourses about the growing need for green energy and industry.

Now, Sweden's green megaproject hinges on expanding the mining and data center industries, rapidly developing new renewable energy infrastructure, and attracting thousands of skilled workers to the north, all predicated on a vision of growth. The 2020s are seeing a "mining renaissance" in Sweden, with a projected threefold increase in mining production by 2025, all the while conflicts between mining and other activities increase [31]. The Swedish state has indicated that the jobs created and income generated by the mining industry underpin the country's social safety net [17]. However, critics have observed that not only do local economies and residents not reap the financial benefits of hosting mining and energy production activities, the national economy in fact does not see much of the profit; rather, it is foreign investors who benefit [19].

The transition underway in the north encompasses changes across systems and sectors, its success dependent on political processes, social acceptance of change, and impacts on local populations [32]. Ultimately, the north will need to reckon with the justice implications of this planned growth: who will benefit, who will lose, and whose preferences are not considered at all? Mining and energy developments in Sweden's north have consistently been found to disrupt reindeer herding activities [22,33], yet considerations of the impact of the green transition on Sámi communities are largely absent from policy discussions [34,35]. Additionally, previous research has identified that Indigenous groups, tourist businesses, and environmentalists, among others, value the conservation of the land upon which these industrial developments will occur more highly than the perceived benefits of growth [19]. Lastly, immigrant and other social minority groups are almost entirely absent in literature about justice in such transitions, despite being expected to comprise the majority of population growth in the region.

## 2.2. Methodological approach

To investigate the challenges presented by Sweden's green transition, our interdisciplinary research team conducted a series of interviews and site visits in the region, prioritizing human-centered methods in order to capture the descriptive and explanatory data often missing in energy and technological transition research [36]. Interviews were supplemented with data on population and migration trends from Statistics Sweden as well as official government publications, information on municipal websites, and statements on the Sami Parliament's website. The case study focuses on Luleå, the regional center and largest settlement in Norrbotten. Other towns and sites in the region were also included since they host the many industrial and energy initiatives underpinning the green transition.

In May and June of 2022, we conducted 27 semi-structured interviews with key informants. In order to identify prospective interviewees, the team initially employed a purposeful sampling method, reaching out to 24 organizations and companies representing a diversity of interests and whose scopes were relevant to this research [37]. These actors were found via searches on municipal and county websites and in local news articles or by recommendations from colleagues. Of these 24, six did not respond or were unavailable, most of which were representatives of private companies (such as Facebook, SSAB, LKAB, H2 Green Steel, and Markbygden wind farm). Several prospective interviewees either deferred us to a colleague better suited to the project's scope or, at our request, recommended additional organizations of relevance in a process of snowball sampling [38]. While snowball sampling can be limited in that the selection of participants is influenced by the biases and interests of those who recommend them, we ensured that a diverse pool of initial interviewees was recruited via purposive sampling so that subsequent recommendations represented an array of interests. Because the purpose of this research is not to evaluate justice but rather to understand factors that may inhibit it, we sought to interview actors with a wide range of perspectives rather than attempt to speak to every member of a group or coalition of actors.

Before interviews were conducted, all interviewees signed forms that outlined the management of data, according to the EU's General Data Protection Regulation (GDPR) protocol and gave consent for the anonymized data to be used in publications produced by the research team. Each interview drew on a set of semi-structured questions that explored the role of the organization in the context of the region's development and growth as well as its foreseen challenges. The interviews lasted approximately one to two hours and took place in the interviewees' offices or private meeting spaces at the Luleå University of Technology (LTU).

As the data was collected, it was logged and organized in order to identify a saturation point, which we reached after conducting approximately two thirds of the interviews [39]. Saturation was identified when no new themes or details emerged that would either enhance or change our initial interpretation of the data. Interviews were conducted with representatives of municipal offices in Luleå, Boden, and Kiruna, including urban planning, societal development, labor market development, youth services, and social and welfare services, as well as municipality-owned companies, including public transit, tourism, and business development. Interviews were also conducted with representatives of county and regional offices, including transit and regional development. Researchers, activists, and Sámi community leaders were interviewed in Luleå, Boden, and Jokkmokk. Private actors included data center managers. A comprehensive list of interview types can be found in [Appendix A](#).

We also conducted eight site visits in key industrial locations across the north, which were identified via local newspapers or recommendations from interviewees. Sites included the LKAB iron ore mine in Kiruna, the Northvolt battery factory in Skellefteå, hydroelectric plants throughout the region, the Markbygden wind farm near Piteå, and several privately operated data centers as well as two sites of prospective

industrial development: the proposed Gällöck mine, northwest of Jokkmokk, and the H2 Green Steel mill in Boden. The purpose of the site visits was to collect observational data, particularly since many private actors declined or were unavailable for interviews, as well as for the team to get a sense of the scale and geographical distribution of the transition.

The team employed an inductive approach to analyzing the data collected through interviews and site visits, allowing themes to emerge throughout. Inductive methods focus on a broad, yet systematic, collection of data through which detailed observations are abstracted to more generalizable ideas or theories [40]. Inductive methods acknowledge ambiguity in scientific knowledge and, therefore, place emphasis on the importance of appropriate observations in our efforts to comprehend real-world events [41]. This methodological approach allowed us to be open to contextual details related to the broader narrative of the green transition. Akin to a grounded theory approach [42], we used the case of the Luleå region as a single empirical phenomenon to develop a foundation for a generalizable theory.

We used a thematic analysis [43] that identified the primary themes of the interview—what issues the interviewee wanted to talk about—and listed the experienced positive and negative attributes related to the green transition in their organizational capacity. The themes that emerged from the interviews were then merged and compared using a structured template to list the empirical findings and analyze the data.

## 3. Theoretical framework

Policymakers in northern Sweden have unequivocally identified the industrial expansion and energy innovations taking place as the cornerstone of the country's green transition. Simultaneously, their view of a greener future in the north is inseparable from a vision of growth across sectors. The current framing of the on-going industrial development, along with historical narratives, are premised on linking sustainability to growth. Therefore, to inductively investigate the on-going industrial transition, the research team developed an interview guide around two concepts: green growth and a just green transition.

### 3.1. Defining green growth

The concept of green growth originated with calls to adjust economic activity in order to improve social equality and relieve pressure on the environment while increasing global wealth [44]. The concept has since entered mainstream policy discussions as a method of driving both global and local economies forward while minimizing the environmental and social impacts of the developments necessary to do so [45,46]. Some international organizations herald growth as the most effective road to a sustainable future because of its capacity to reduce poverty, improve health and educational outcomes, and overall increase quality of life [47,48]. Conversely, the OECD suggests that a failure to grow threatens the strength of public welfare and social cohesion in countries such as Sweden [49].

However, green growth has been criticized for its lack of definitions of environmental limits [50]. Grömling & Klös [51] problematize the growth approach, questioning whether the gains and losses of growth can be distributed equitably within a paradigm of continued economic development. They raise doubts about at which levels inequalities will be considered (individual, regional, national, etc.), finding that in order for individuals to benefit from growth, they will need access to knowledge and capital, infrastructure, and favorable political conditions. Barry [52] similarly doubts the capacity for growth to repair the economic, social, or ecological destruction it can cause, questioning whether generating wealth, jobs, and tax revenue will necessarily offset growth's costs; in other words, "greening" current approaches to human development will not necessarily deliver just outcomes. While conversations across sectors about the role of growth in a green future continue, we find that there is a gap in exploring the relationship

between green growth and justice. Is there such a concept as *just green growth*? What is the role of growth in a just green transition?

### 3.2. Defining a just green transition

The confluence of economic, technological, and social changes northern Sweden is undergoing can be understood as a sociotechnical transition, an arena for potentially radical shifts in how a society values and uses technology [53,54]. A sustainable or green transition can represent a disruptive and systemic change [55] perhaps even better understood as a complete structural transformation of society [56,57], the characteristics and direction of which can be difficult to govern or engineer [58].

While the term “just transition” originated within unions and labor movements in the 1980s [59], it has, with time, been applied to environmental, climate, and energy contexts [54,60]. While the scope of the term has broadened to the point that it has become ambiguous and over-defined [54], it offers the potential to integrate across many approaches into an overarching and consolidated framework for achieving justice gains [56,59]. In the context of environmental and climate challenges, defining justice depends on philosophical and political positions [56] and is subject to locally relevant social values that inform public opinion [54]. Fundamentally, approaching justice in the context of green energy transitions is predicated on the idea that some individuals, groups, and lands are more vulnerable to environmental, political, or social changes than others [61,62].

Literature on just transitions identifies four primary forms of justice that, while connected, are often temporally distinct. Recognition justice describes the acknowledgment and respect for existing rights, livelihoods, and cultures within a particular space or sector [56]. Procedural justice concerns the formal legislative and governmental processes through which various interests and groups participate and engage in decision-making [56,59]. Distributional or compensatory justice has to do with managing the costs and benefits of a development, drawing on John Rawls’s 1971 *Theory of Justice* [59]. Restorative or corrective justice aims to restore trust between a perpetrator of violence and an affected individual or community by repairing the harm done as well as punishing the offender [59]. In addition to these four forms, alternative conceptualizations have been explored within the context of transitions. For example, contributive justice proposes that societies must enable people to participate in civic life [63]. An Indigenous perspective might reject any approach to justice defined or moderated within the confines of a legal system or state that has imposed itself upon a people without consent [64,65]. Each of the forms of justice to be considered through a green transition also has a spatial dimension, as economies, resources, labor conditions, and opportunities vary across regions [66–69].

Perhaps most significantly, the definition of justice used will inform the goals of the actor using it, regardless of the approach taken; the many interests, stakeholders, and goals present within a green transition context make it likely that justice for one group or interest might be an injustice to another [52,70]. The complex ecosystem of actors involved in green transitions includes commercial actors, the public sector, and the public or individuals. Among these groups, commercial actors tend to have greater resources and power [57]. This categorization is, of course, impacted by the current neoliberal paradigm, which features a heavy pro-growth bias and prioritizes sustained or even increased energy use to meet growing production and consumption demands [52]. Upham et al. [57] find that transitions occurring on accelerated time-scales may struggle to secure equity for all actors. In this sense, a just transition is about “accepting and navigating trade-offs between different dimensions of justice, equity, and participation rather than a predetermined ‘win’ across all of those dimensions” [57].

### 4. Data/results

In order to explore these ideas, the research team utilized an

inductive analysis of the data that generated three broad themes related to the green transition in northern Sweden: political impetus, the energy-industry nexus, and population or labor requirements. While interconnected, each of the themes presents both a distinct logic of argumentation for growth and the specific sectoral challenges related to the green transition. The purpose of the following results and analysis sections is not to evaluate the level of justice in Sweden’s green energy transition, but rather to bring attention to factors that might stand in the way of securing justice through aforementioned mechanisms.

#### 4.1. The political impetus for rapid, far-reaching growth

The historical desire for growth among municipal authorities in the north is due, in part, to their responsibility to provide public services. Although a unitary state, Sweden has devolved the delivery of a number of services to the municipal level; “three-quarters of the average municipality’s budget is devoted to welfare services, including education, health, and social care” [71]. This devolution creates a strong relationship between the services provided and the working population, as the delivery of services requires local income tax revenue. In order to fulfill these demands, local officials orient policy towards population growth.

Historically, Norrbotten has been confronted with de-population consistent with the booms and busts experienced in most natural resource-based economies. The region has also seen internal migration from small municipalities to larger centers, such as Luleå, which have been able to maintain their populations. The regional de-population has led to the consolidation of services as decreases in tax revenue for municipalities increase per capita expenditures [72,73], making economic and population growth an appealing vision for municipalities.

While no new steel mills have been built in Europe in the last 50 years, Norrbotten and Västerbotten have become home to two new fossil-free steel plants, new hydrogen factories, and battery factories. Interviewees across public and private sectors indicated that tech giants are attracted to the north due to an abundance of clean energy and opportunities to compete in the markets for greener products: Northvolt seeks to contribute lithium-ion batteries to the first completely fossil-free car; Facebook powers its data centers with renewable energy, aided by a cold climate; and SSAB envisions leading the steel industry into its fossil-free chapter. Local politicians who were interviewed noticed a distinct increase in outreach from both big and small companies in recent years, recognizing that even if half of the new business projects do not materialize, this will still be the biggest investment in a Swedish region since the 1950s.

Interviews with municipal officials in Luleå pointed to the historic link between the steel industry and the municipality as a driver for growth. Transportation linkages via rail and sea were developed to allow steel (and iron) transportation both domestically and abroad, making Luleå a primary hub in northern Sweden. Today, the new developments in steel production are viewed in a similar light, with the future of growth in the municipality highly dependent on the success of these endeavors. From the municipality’s perspective, their role is to help support regional industrial development through a plan that facilitates a population increase from 80,000 residents to 100,000. According to the municipal officials, this entails increasing the annual population growth from 300 to 400 people per year to 1000 over the next three to five years. Upon reaching the 100,000 threshold, “the city grows by itself.”

Apart from the need to increase the supply of green energy, these new industrial expansions require a fast and steady inflow of competent staff, who bring with them their families, spurring a need for more housing, schools, and healthcare. Interviewees in business and political sectors universally cite a need for an additional 100,000 residents across the north to meet the demands of the expanding green industry. Population growth on this scale has not occurred in the north since the last industrial expansion in the late 1800s. According to our interviews, Luleå municipality is developing urban infrastructure in pursuit of

simultaneously attracting new businesses and prospective (tax-paying) residents. In order to coordinate the efforts to enable such rapid population growth, Luleå and nearby municipality Boden are collaborating on competence supply, residential area planning, infrastructure, and business development with the common goal “to be a forerunner region in the endeavor to realize a sustainable green transition” [74,75].

On one hand, this level of growth solves impending problems of an aging and declining population. Attracting a young, skilled workforce will shift the current demographic outlook and develop a new tax base while meeting industry needs. This is crucial, as municipalities in Sweden are responsible for delivering high-quality key public services, but are heavily dependent on financial support to do so [76]. While shrinking municipalities with low tax revenue are offered relief from the Swedish state via municipal equalization [72,73], the upkeep of fixed assets are not included in these calculations [77]. Luleå municipality’s Vision 2040 outlines a strategy for growth that aims to capitalize on the predicted economic growth and develop other aspects related to social sustainability such as health, culture, and lifestyle. Importantly, many of these ambitions hinge on the municipality’s ability to integrate new residents, though interviews with municipal staff revealed that many of the specifics around planning are undecided.

From an economic development perspective, the historic relationship between Luleå and industry as well as the existing hydroelectric power capacity has spurred interest beyond the steel industry. With the current abundance of carbon emission-free energy through hydroelectric power, municipal officials believe that companies have expressed a high level of interest in Luleå because of customer-driven demand for environmentally responsible operations. In Nordic countries, subnational actors like municipalities take the lead in implementing green energy initiatives [32], so while these investments are welcome (to enable population and economic growth) the massive influx of high-energy consumption business development raises questions about the region’s energy supply in the future.

#### 4.2. Rapidly increasing energy production to power industrial expansion

While this abundance of renewable energy has attracted industrial giants to the north, the scale of growth anticipated will require significant increases in infrastructure and generation capacity. The projected demand for energy in Sweden presents a “historic structural transformation,” according to Robert Andrén, director general at the Swedish Energy Agency [78]. Indeed, plans made in 2020 became obsolete just two years later. Moreover, the transition is taking place in the wake of Russia’s invasion of Ukraine, which led the EU to cut oil and coal imports from Russia while Russia limited the flow of natural gas to Europe.

Historically, Sweden has been a net international exporter of energy and domestically, the north exports energy generated through its many hydropower plants to the south. Today, nearly half of Sweden’s energy demand is met by hydropower [79]. The Lule River in Norrbotten is the largest source of hydropower in Sweden, and all fifteen hydropower plants along it are run by the state-owned Vattenfall AB. While hydropower has consistently represented about 50 % of total energy generation since 1990, wind power is taking an increasing share. Once completed, the Markbygden wind farm in Piteå, Norrbotten, will be Europe’s largest onshore wind farm.

Despite the energy abundance of the north, demands in the coming decades, both to power new industrial developments and to meet the needs of a growing population, will exceed supply. Mining companies and data centers that currently rely on the bountiful and inexpensive energy production in the north will have to compete with the demands of carbon dioxide-free iron ore mining and fossil-free steel manufacturing. The energy needs of Norrbotten will increase 13-fold, from 8 TWh in 2019 to approximately 107 TWh in 2050. Energy production in Norrbotten was approximately 15.5 to 18.5 TWh per year between 2012 and 2019 and it is projected that production will increase to only 30 TWh by 2030 [12]. Nationally, the utility Svenska Kraftnät

anticipates that demand will increase by 44 TWh per year by 2027 while currently envisioned production will only grow by 17 TWh per year (Fig. 2). Prices for electricity are expected to begin rising in 2025 and by 2027, Sweden will no longer be an electricity exporter because production will not be able to keep up with the growing demand [80]. In the longer term, Sweden’s current use of 140 TWh/year is expected to double to 280 by 2035 and reach as high as 370 by 2045.

Over the past forty years, Sweden has significantly increased its use of nuclear and wind energy while reducing a reliance on fossil fuels (Fig. 3). To meet the demand at the highest end of the predicted needs, Sweden would have to add new generation capacity at a pace never seen before, at an expansion rate of over 6 TWh per year by 2030, increasing to over 12 TWh per year by 2035 [82]. Martin Johansson, an official at the Swedish Energy Agency, sees the greatest potential from offshore wind and increased nuclear power, but these will not be ready until the 2030s, even if they are approved in the next few years. Only onshore wind can provide more capacity in the short term [83]; from 2024 through 2030, Sweden plans to increase onshore wind capacity by 20 % by adding 81,850 GW to the existing 400,000 GW [84].

Such construction comes directly at odds with Sámi reindeer herding communities across the north [85], whose territories cover about 55 % of Sweden. Interviewees from these communities expressed that existing wind farms disrupt herding, which is both an economic and traditional activity, due to both the physical imposition of the machinery as well as the noise they generate, and that they have observed a loss in biodiversity in areas surrounding turbines. One interviewee said that their community did not have the resources to engage or push back against such developments, especially given the seasonality and time-intense nature of their profession. Interviewees referred us to statements issued by the Sámi Parliament in Sweden, which, as early as 2009, made clear that any new infrastructure construction would have to take place in a manner that did not unduly disrupt traditional practices, that permitting processes should be updated to take into account Sámi needs, that the Sámi Parliament should play a role in any siting decisions, and that the Parliament should be provided the resources to ensure that its participation is meaningful [86]. It also stressed the need to consider alternatives, such as increased energy efficiency, reduced consumption, and localized small-scale energy production in southern Sweden as ways of minimizing the need for new infrastructure in the first place.

The Sámi Parliament notes a multitude of obstacles that limit outcomes that take into account their interests, including environmental code enforcement that manages noise, emissions, and road construction without consideration of how reindeer use the land, courts that typically favor infrastructure development rather than reindeer husbandry, health complications based on fear and worry resulting from being excluded from the decision-making process about the fate of their traditional lands, a lack of knowledge among municipal government officials and staff about Sámi conditions, the existence of Sámi villages spread across numerous municipal boundaries and therefore not aligned

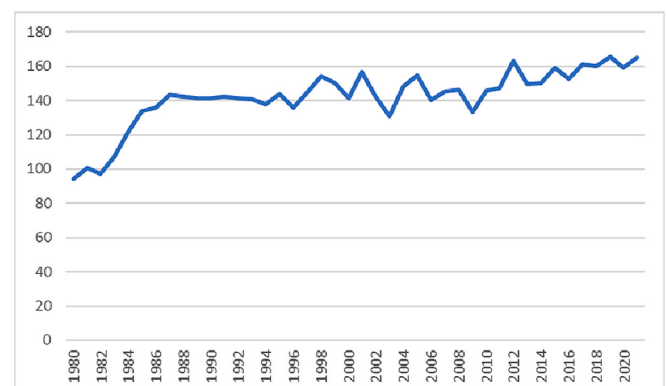


Fig. 2. Swedish electricity generation (TWh) [81].

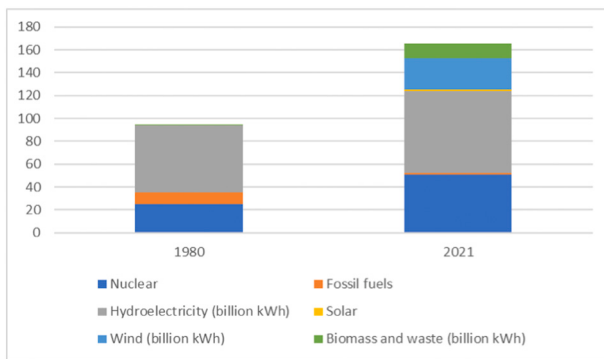


Fig. 3. Sweden's electricity mix [81].

with municipal planning processes making input into the process difficult, and that financial compensation from the infrastructure developer often goes to the state or landowner rather than to the Sámi community affected by the construction [86]. Some data is becoming available to measure the extent of these damages. For example, through 2018, industrial development, tourism, and military uses have rendered 34 % of reindeer herding land unavailable to herders in the Laevas reindeer herding community [87]. Meanwhile, municipal and regional interviewees mentioned that they are aware of the inequitable spatial distribution of energy production across Sweden, though in reference to rural and northern residents in general rather than Sámi communities in particular.

In addition to discord regarding the development of new infrastructure, the north will have to grapple with replacing existing and aging wind power infrastructure, balancing new wind development with the right-wing government's renewed interest in nuclear power, and increasing transmission capacity, without which greater energy generation has no means of reaching the final user [82]. In interviews, municipal and private actors emphasized the scale of the system-wide energy transformation needed yet exhibited doubts about its feasibility in such a short timeframe. Community and Indigenous interviewees expressed grave concern about the infringement of energy infrastructure on their traditional practices and livelihoods.

#### 4.3. Labor changes and population

In order to fulfill the ambitious plans for the region's green transition, municipal officials cite a need for an additional 100,000 residents to move north over the next few decades. This would consist of 20,000 new hires in industry, 2000 at H2 Green Steel alone, 5000 to work on required infrastructure, 10,000 subcontractors, 10,000 to work in services and culture, 15,000 to work in the care sector and schools. Many of these new workers are anticipated to bring immediate family members and relatives with them, amounting to an additional 30,000 people, as the municipalities and industry emphasize that their goal is to hire permanent employees and not to depend on fly-in/fly-out workers [13]. Accordingly, both Luleå and Boden are investing in new international or English language education, from pre-school to upper secondary education [88]. Interviewees across municipal and regional levels expressed that labor needs for this green transition go far beyond specialized mining and energy engineering skills; they anticipate an increase in the society-wide labor needs, from bus drivers to engineers, teachers, nurses, and more.

Interviewees identified several challenges in achieving these goals, referencing historical trends of decline or stagnation and cultural obstacles. In Luleå alone, politicians have accelerated the timespan for city population growth by ten years [89]. By 2040, Luleå envisions an annual growth of 1100 residents, which will require the annual construction of approximately 600 new housing units [89]. Interviews with Luleå municipal officials highlighted some of the challenges with the plan for

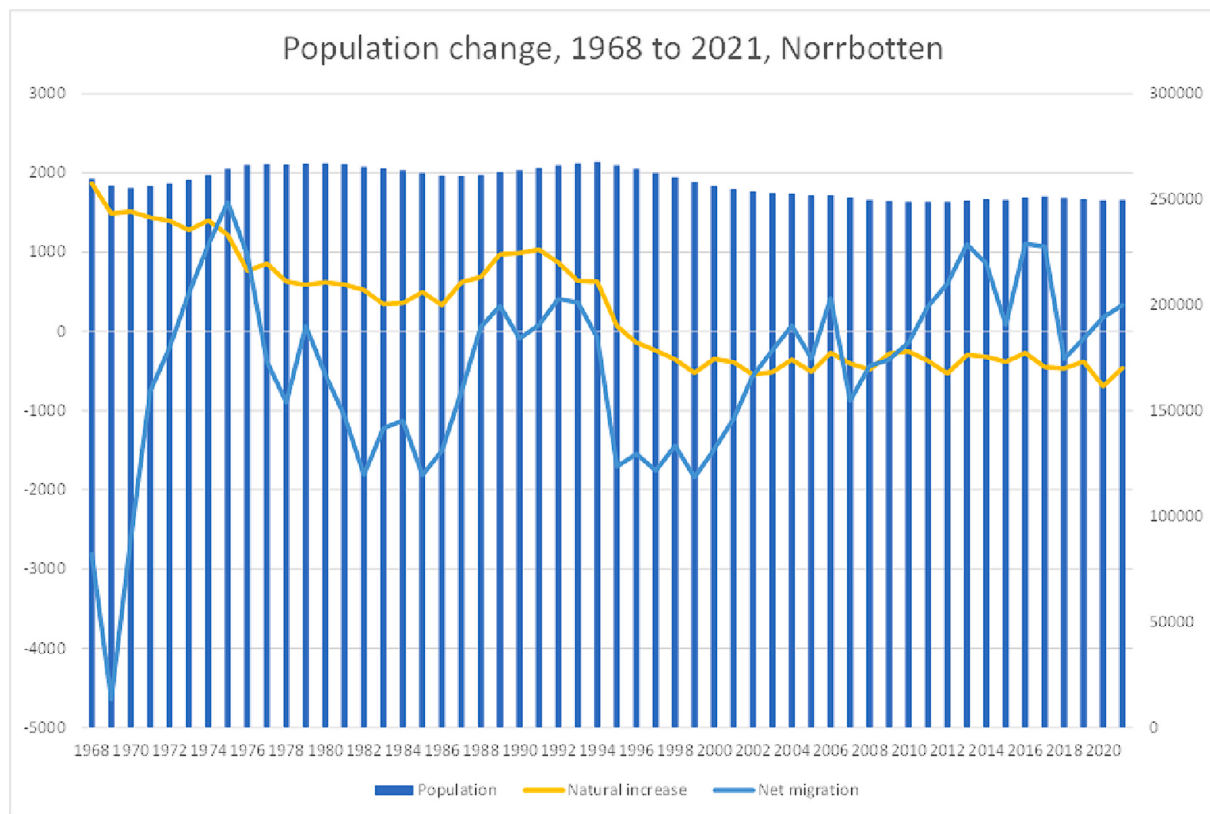
rapid expansion, particularly the balance between developing the infrastructure necessary for 20,000 additional inhabitants while maintaining the current five-minute city standard.

While the population of Sweden has increased by 22 % since 1990, the population of Västerbotten has grown by only 9 % and the population of Norrbotten has declined by 5 %, with changes due to both natural increase (births minus deaths) and net migration (in-migrants minus out-migrants). From 1968 to 2021, Sweden's population grew by 2.5 million, 68 % of which was due to immigration rather than natural increase. Västerbotten had a net migration gain of 19,000 over this period, consisting of a net gain of 42,000 from abroad and a net loss of 23,000 to the rest of Sweden. Norrbotten had a net migration loss of 25,000 over this period, consisting of net gain from abroad of 42,000 – about the same as Västerbotten – but a net loss to the rest of Sweden of 67,000 (Fig. 4).

Meeting the needs of expanding industries and the public services needed to support them requires both developing the existing local workforce as well as attracting a new labor pool. In developing local capacities, municipal officials indicated that they are working with businesses to identify skills that are transferable between sectors; for example, former workers in heavy industries have the appropriate problem-solving skills necessary to operate data centers. However, there is a lack of regional, sector, and company-specific knowledge about exactly which skills will be in demand and which individuals might need additional training or education to remain employed. Still, local transfers and re-skilling will not sufficiently meet new labor demands; the vast majority of labor will need to be sourced from outside the north. While municipal and private actors believe that investment in services and job opportunities in green industry serve as a big enough draw to attract residents from the south of Sweden, an LKAB survey identified that only 30 % of Swedes living in the south would even consider moving to Norrbotten [90], a statistic consistent with the historical loss of population to the south. The region's historical decline, among other factors, dissuades residents of the south from moving to the north. Therefore, many of the current and future efforts to attract a capable workforce hinge on the ability to market the municipality to people outside Sweden, along with providing the amenities and creating an environment that entices them to stay. Consequently, attracting foreigners requires that municipalities work with large employers to ensure that factors other than job security can be secured, such as housing, places in schools, and family or spousal visas.

With the high levels of immigration into Sweden, the percentage of the population that is foreign-born has risen at both national and regional levels. In 2000, the percent foreign-born in Sweden was 11.3, in Västerbotten 5.3, and in Norrbotten 7.3. In 2021, the percent foreign-born in Sweden was 20, in Västerbotten 11, and in Norrbotten 12. Despite increases in migration from abroad, several challenges remain in recruiting and attracting foreigners to the north. Available and affordable housing was identified as a core requirement, without which potential migrants will not consider moving. For international families, guaranteed places in schools and the availability of English-language schools (which have, up until recently, been nonexistent) are crucial. Municipalities are also focused on tailoring urban planning and development to meet the needs of the population likely to move – young professionals and families who value the amenities of urban centers without compromising access to nature, space, and the outdoors. Notably, Luleå municipality is incorporating a gender lens in its urban planning for attractiveness; planners expressed that wives and mothers are more likely than their male partners to pay attention to quality of education, public safety, and availability of green space and parks, among other factors. They suggest that this demographic is more likely to make decisions about their families' future place of residence, so tailoring urban development projects to them is more likely to attract new residents.

Despite envisioning “people from all around the world” moving to Norrbotten, northern municipalities anticipate several challenges accompanying a large population influx of primarily non-Swedes.



**Fig. 4.** In Norrbotten, the population declined by about 10,000 between 1968 and 2021. This was through a combination of natural increase of 14,000 and net out-migration of about 25,000.

Immigrants will likely struggle to integrate, having to learn a new language and culture as well as acclimatize to the extreme seasonal variations in temperature and daylight. Municipalities are also anticipating a shift in the gender and age distribution of its population. Norrbotten has consistently had the highest male sex ratio in Sweden due to high female out-migration from the region. Historically, single young professionals, often men, have migrated to the north for employment opportunities, cultivating a masculinized culture contributing to a vision of the north (and its work environments) as rough and rugged [91]. This expectation can pose challenges to the attractiveness of the region to new migrants, particularly women with families. An additional challenge is catering to a projected younger population; Luleå municipality, for example, admits that they do not make much effort to retain university students in the area or attract recent graduates from the south. Investment in services and amenities frequented by younger populations may be necessary at a municipal level in order to build a socially sustainable and equitable future.

## 5. Discussion

Northern Sweden's green transition requires sweeping changes across sectors and cities. While a transition can be understood as a disruption resulting from multiple changes occurring at different levels simultaneously [92], the developments taking place in the north are perhaps better conceptualized as a sociotechnical transformation, requiring large structural and systemic changes across spheres of production, governance, labor, and culture. We suggest that northern Sweden's green transition is indeed a societal transformation. The interviews revealed how much is *unknown* and *unclear* with regard to how this transformation will and can take place. Significant challenges were identified by interviewees across sectors: green technological advancements must be accelerated, significantly more renewable energy

production is required, and labor is in high demand but cannot be recruited without rapid developments in housing and social infrastructure. The question that remains, then, is whether this green transformation is feasible at such a grand scale. Yet, with the feasibility of growth as the central question, implications for justice are relegated to an afterthought.

Our analysis revealed that decision-makers in northern Sweden are not prioritizing justice as the green transformation unfolds. While political and private sector interviewees identified elements of the transformation that could potentially harm certain groups, they ultimately argued that expediency is favored above ensuring just outcomes. The region's green growth was consistently justified by reference to the necessity of meeting national and global climate goals while ensuring that the north reverses its history of population and economic decline.

Specifically, our analysis revealed four key factors that have implications for justice particular to the scale and urgency of the growth-oriented green transformation. While the forms of justice typically applied to transitions (recognition, procedural, distributional, and restorative) are relevant to this case, we did not find that they sufficiently capture the full picture of priorities and implications. Rather, 1) the order in which developments occur, 2) the timescale, 3) the agent driving the transformation, and 4) the groups involved, each play a role in shaping justice considerations and outcomes.

First, the order in which developments must occur shapes the outcome. The Swedish transition is marked by an absence of a strong fossil fuel sector, which, in other regions of the far north and Europe, impinges on transition possibilities. Countries with strong and powerful fossil fuel industries tend to support the maintenance of a petrostate [93] and feature slow green energy transitions [94]. However, exceptions exist, such as in Denmark, where a thriving wind energy sector has replaced a heavy reliance on fossil fuels.

Due to this absence in Sweden, few industries needed gradual

replacement; instead, governmental and private actors have begun implementing the green transformation with full force. While municipalities previously worked sequentially in planning their growth alongside industry needs, they now pursue all elements in parallel. Several municipal and regional actors in northern Sweden noted repeatedly in our interviews that rather than planning chronologically or with path dependencies in mind, technological innovation, energy production, labor migration, housing construction, and infrastructure development all must happen simultaneously. This so-called “ketchup effect” approach has a range of practical limitations: for example, new employees cannot move and begin working until there is housing available to them, but new housing cannot be constructed before the necessary water and electricity infrastructure is in place, which in turn requires greater municipal investment in services. The overarching consequence of the ketchup effect is a lack of ability to plan for, measure, or monitor the impacts of any one development. It is assumed that social and environmental changes will naturally follow economic and technological transformations, with limited planning for how the latter will cause the former.

Second, it follows that the timescale at which the transformation occurs affects the ability of decision-makers to prioritize justice issues. The speed at which changes occur limits the capacity for justice mechanisms to be implemented: traditional land users might be consulted on a prospective industrial development project, but even if they object, initiatives to construct housing for new workers and apply for construction permits may already be underway, undermining the integrity (and perhaps the outcome) of the consultation. A quick transition puts pressure on decision-makers to forego mechanisms that might increase justice outcomes in favor of efficiency or expediency. A slower transition would allow for consultation with the residents of areas that will be most affected by the construction of energy infrastructure or distribution of new mining permits, improving their ability to shape the process. In northern Canada, for example, consultation processes with local Indigenous groups have significantly delayed the construction of energy infrastructure due to prioritization of consensus regarding distribution of benefits and mitigation of impacts on land. While local consultation is deeply enshrined in the Swedish political process, the accelerated timeline of the green transformation has reduced consultation processes by a matter of years. Governmental and private actors justify this acceleration by referring to the pressures of global climate change and needing to meet national greenhouse gas-emission goals. These pressures are mobilized to position environmentalists and reindeer herders as antagonists to the overall transition.

Third, the agenda of the actor driving the transformation determines its nature. Among the possible agents are 1) industry, 2) politicians advocating climate policy, 3) civic leaders who prioritize social services provision, and 4) groups whose main concern is where the new energy infrastructure will be sited [94]. In her analysis of the political economies of energy transitions in Brazil and South Africa, Hochstetler describes these four as policy arenas [94], but here we focus on the main actors pushing the policies. An industry-led transition places the needs of a region’s mining and manufacturing sector in front, with considerations of climate, social services, and infrastructure-siting secondary. A climate-led transition would emphasize efforts to reduce greenhouse gases above all, with secondary concern for social services, industry, and infrastructure location. Emphasizing social services would place housing, transportation, and municipal services at the top of the list, with industry, climate policy, and infrastructure secondary. Finally, a focus on preserving land for traditional uses would position industry, social services, and climate policy secondary to environmental and cultural priorities. In practice, each of these four agents seeks to shape the nature of the transformation.

In northern Sweden, a strong coalition of industry and government actors with shared agendas is driving this transformation forward [14]. The coalition assumes that the resulting economic growth and employment opportunities will serve as a locomotive for the entire

region. Industry sees the current moment as a chance to position northern Sweden favorably to compete in the growing international market for green products that allow consumers to maintain their current standards of living without producing greenhouse gasses. By transforming mining practices, the technology used to produce steel, and energy generation technologies, the big players in the field (LKAB, SSAB, H2GS, and Vattenfall) will gain a significant share of a growing, lucrative market. LKAB’s discovery of rare earth metals in the region in early 2023 only adds to the possibilities.

Rather than driving the transformation, alignment with climate policy and improved service provision become co-benefits of industrial expansion. The new developments are justified as driven by climate policy and governmental actors assume that growth will create the opportunities for new housing and infrastructure needed for the future. All actors interviewed supported the overarching greening of energy production, infrastructure, and manufacturing, but environmental and Indigenous interviewees expressed doubts about the climate policy or service provision as the motivations behind the transformation. Non-governmental actors were not confident in the assumption that the growth will solve social and environmental problems. Most obviously, these developments require development of land historically and currently used by Sámi reindeer herders. While greening the northern economy might contribute to national and global climate goals and local service provision, it may directly harm local populations who depend on the land for other purposes. Ultimately, the priorities of the actors driving the transformation are not the same as the priorities of the most impacted populations.

Fourth, owing to the factors listed above, the groups and individuals implicated in the transformation have varying degrees of access to representation and decision-making capacity. The pathways that government and industry have identified as key to a successful green transformation align to form a pro-growth coalition in which each supports the other’s development. The strength of this collaboration and certainty about the direction northern Sweden must take in order to thrive economically leaves little room for disagreement about the particulars of the transformation, much less the direction itself. While no actor expressed opposition to a green transition in general, interviews revealed that the emphasis on growth most impacts Sámi residents, whose livelihoods and traditions are at stake. When questions about growth revolve around *when* new energy generation can be installed, not *where*, *how*, or *to what ends*, the preferences of Sámi and rural communities are overlooked. Indeed, our analysis confirmed earlier findings of lacking recognition and procedural justice for both Sámi and rural residents in the north [17,95]. For example, Sámi communities often lack the resources to file lawsuits [17,34] and are insufficiently consulted [96], complicating their ability to influence the procedures by which justice can be better secured—a sentiment echoed in our interviews. There are some small signs of progress. While the Swedish state usually addresses Sámi rights through legislation and public commissions, Sámi communities are now working to use the courts to secure their rights [97]. The Swedish Supreme Court’s January 2020 decision in the Girjas case gives the Sámi village extensive control over hunting and fishing rights, rejecting earlier attempts by the Swedish state to limit these rights [97]. According to this decision, Sámi rights are based on “immemorial prescription” of their traditional use of the land, rather than customary law, suggesting that the rights of the Swedish Indigenous population is growing as a political issue in Sweden.

Each of these four factors – scale, urgency, agendas, and actors – shape the priorities, possibilities, and justice of the processes and outcomes of the green transformation. Together, these factors illustrate that justice is not prioritized – and at times not even considered – in mainstream decision-making about the north’s green future. The consequence of the scale and urgency with which this green growth is pursued is precisely that decision-making actors are not employing a consistent framework to analyze the potential benefits and harms to various groups in the process.

While governmental and private actors acknowledge that some groups, such as Sámi, rural, or immigrant communities, may be disproportionately harmed by developments or overlooked in planning processes, they maintain that the green growth is necessary to ensure the future of the region, country, and world and that, with time, this very growth is in fact capable of delivering positive outcomes for these impacted populations. These sentiments echo the logic of green growth embraced in the neoliberal paradigm: that economic growth, particularly with goals of reducing emissions, will result in social and environmental gains. While this may occur at the global or even national level, our analysis reveals that locally, such outcomes are not guaranteed. Of course, there is a range of opinions regarding the merits of growth; many local politicians and residents interviewed described both the pluses and minuses they anticipated – for example, a bigger economy and more workers likely would lead to greater opportunities and improved demographics, but also crowding and higher food and housing prices. Nevertheless, without a clear roadmap that integrates the concerns of marginalized or neglected communities, northern Sweden's green transformation risks reproducing injustices locally as the price for improving environmental outcomes globally.

## 6. Conclusion

Achieving the urgency and scale of sociotechnical changes needed to mitigate and adapt to a changing climate will inevitably require that decision-makers make trade-offs between local concerns and global priorities. Yet, in pursuing a growth-oriented model of green development with high land-use and energy costs, decision-makers in northern Sweden risk inflicting injustices on local populations. Similar challenges are found in Sweden's neighbor, Finland, where research suggests that participatory governance can help ensure just economic development [98], thereby highlighting the benefit of future comparative research across the Nordic region to further develop the relationship between justice and the green transformation. The scale and rapid timeline of green developments undertaken in the north aligns with global, EU-level, and national priorities to reduce greenhouse gas emissions and harvest raw materials in a greener way. Although these developments might improve sustainability globally, it is important to acknowledge that they still sustain a pro-growth capitalist paradigm in which industry interests risk taking priority above social and ecological justice gains locally [99].

It is precisely in the characterization of these changes as a green

transformation, rather than just a transition, that such dilemmas can be acknowledged and given room for exploration. Interviewees across sectors and interests repeatedly emphasized that changes of this scale and urgency in economic investment, infrastructure development, and population changes have never before occurred in Sweden's north. However, with the region's history of exploitation of both land and people, do these events risk sustaining and replicating the injustices of the 19th and 20th centuries? Or, when such a grand societal transformation is taking place, is it possible to consider new ways of ensuring that local populations have access to resources and participation mechanisms to shape their own vision of a greener future?

## CRediT authorship contribution statement

**Zoe Garbis:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Timothy Heleniak:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Gregory Poelzer:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Charlotta Söderberg:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Robert Orttung:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data statement

Interview data is not publicly available due to its sensitivity, as per the requirements of the Institutional Review Board.

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## Appendix A

### Locations and affiliations of interviewees

| Location          | Municipal & regional staff | Researchers & experts | Private companies | Sámi & environmental organizations |
|-------------------|----------------------------|-----------------------|-------------------|------------------------------------|
| Luleå             | 10                         | 5                     | –                 | 1                                  |
| Boden             | 3                          | –                     | 1                 | –                                  |
| Kiruna            | 2                          | 1                     | –                 | –                                  |
| Jokkmokk          | –                          | –                     | –                 | 2                                  |
| Norrbotten Region | 2                          | –                     | –                 | –                                  |

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