# Architecture for New Energy Futures: Community and Infrastructure in a Post-Coal World

by

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Dalhousie University is located in Mi’kmaq’i,
the ancestral and unceded territory of the Mi’kmaq.
We are all Treaty people.

# Contents

# Abstract

For the past 300 years, the coal mining industry has fundamentally shaped the landscapes and communities of Cape Breton, which hosts the majority of Nova Scotia's fossil fuel infrastructure. This thesis mobilizes Cape Breton's clean energy potential to engage a new energy paradigm, in which architecture, technology, and nature intersect to foster dynamic and resilient interactions between communities and the Earth's limited resources.

Focusing on the Lingan Generating Station, anticipated to be fully decommissioned by 2029, this project envisions a post-coal paradigm that situates energy production in an experiential landscape. Encompassing a research centre, a public park, and renewable energy infrastructures, the project addresses a new form of economic and social revitalization within a larger vision for the relationship between energy, community, and culture that is adaptable to other settings in Canada, where the challenges of the Anthropocene are most palpable and can be played out in new energy policies.

# Acknowledgements

This work would not be possible without the encouragement and expertise of my supervisor, Michael Faciejew, thanks for being an incredible resource for the last ten months and helping shape this project into something I’ve really enjoyed developing.

Thank you to my advisor, James Forren, for your helpful advice and innovative ideas.

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# Chapter 1: Introduction

A macro level view of mined coal (Erikkson 2021)

It’s hard to imagine a form of modern life divorced from the ubiquity of fossil fuels. Coal and other combustible energy sources have driven social and cultural change through history as well as ravaged many landscapes. Architecturally, our cities and towns are built upon a centuries-old framework which relies entirely on a virtually unseen network of energy infrastructures abstracted and divorced from their environmental impacts in our daily experiences.

## Coal’s Past

> The discipline of history exists on the assumption that our past, present and future are connected by a certain continuity of human experience. (Szeman et al. 2017, 32)

Coal has been a continuity in Canada’s history, through both geological and political time scales. The extraction, transport and combustion of coal has been a constant force of change that predates the concept of Canada as a nation. Though the cultural ramifications of coal have altered all aspects of society, the physical effects of coal mining in Canada have historically been centred on the island of Cape Breton.

The landscape of northern Cape Breton has been mined for over three hundred years, bearing the physical brunt of the coal mining industry’s impact and continues to play a role in shaping our economy, culture, climate and built environment today.

## As a Social Force

Just as the coal mining industry has shaped the physical landscape of Cape Breton, it has altered the social landscape and culture of the island as well.

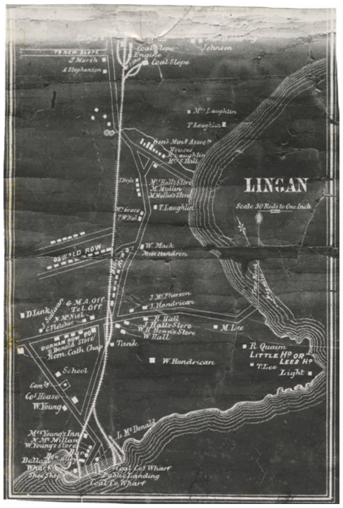
As coal production peaked in the late nineteenth to early twentieth century, labour migration patterns created cities almost overnight around mine sites. This trend has carried to the present, as the largest settlements in Cape Breton remain clustered in the north shore region of the island, to the east of the Bras d'Or lake.

As miners and supporting industries created communities, new combinations of social classes began to interact in towns like Lingan, Glace Bay and New Waterford in ways that had been unlikely in the past.

Author Derrick Price, in speaking about these mining communities notes that "over time these places usually added the structures of more complex living. Schools, churches, shops and pubs followed and people began to acquire houses of their own" (Price 2018, 75-76). Coal and other extractive industries have historically been a socially generative force in the communities that arise.

Though these towns were powering dense urban settlements like Halifax, they remained isolated and lacked the infrastructure of proper, wealthier urban regions, instead embodying what Daryl Leeworthy calls an 'industrial frontier',


An illustration depicting a miner and his family moving into the emerging town of Lingan, then adjacent to the International Colliery. Originally published in Canadian Illustrated News, September 20, 1873; Unknown artist. (Nova Scotia Archives 2023b)




Map of Lingan mine sites and town settlement in 1877; Unknown cartographer. (Nova Scotia Archives 2023a)

namely ‘a region - most prominently a coalfield - which is removed from the influences of a metropolitan centre and which therefore constructs its own identity, its own cultural forms and its own institutions” (Price 2018, 77).

This isolation of these settlements created a deep sense of community, as Jesper Erikkson notes that coal towns saw the birth of new labour movements and new social connections as a result of both their isolation and relative proximity.

> If we talk about deep mines then, an active coal mine would have been years ago the heart of the community. Looking back in time there wouldn't be any televisions, there wouldn't be many radios, or very limited numbers, and very limited media as well, so the connection with the bigger world was limited. So you are more reliant on your friends and neighbours, the community spirit would have been there, everybody knowing everybody else. (Erikkson 2021)

Children in Glace Bay participate in a coal mining class in school in 1911; Unknown photographer. (Nova Scotia Archives 2023d)

As historic mining towns in Cape Breton have suffered intense decline after the collapse of the mining industry, larger communities have splintered into post-industrial ghost towns as citizens flee to the cities and remain removed from their mineral history. Once vibrant communities now suffer from issues of economic decline and outward migration, leading to a loss of community.

### As an Economic Force

Energy has always been synonymous with power. Those who own and oversee the extraction of energy sources have historically been among the wealthiest and most powerful in colonial and capitalist societies. On a national scale, coal mining and resource extraction have historically been one of the largest drivers of the Canadian economy.

A recent Government of Canada report states that “Canada has the third largest per-capita natural resource endowment in the world, accounting for 1.82 million jobs and contributing to 17% of the country's GDP" (Government of Canada. Innovation, Science and Economic Development Canada 2018, 7). As a nation driven by a natural resource economy, notions of identity and region inevitably become tied up in the natural landscape and its offerings.

The wealth and power associated with the control of energy is often entirely removed from the communities most effected by its extraction (Daggett 2019, 23). At the height of coal mining production colonial companies like Dominion (DOMCO) and the General Mining Association (GMA) extracted millions of dollars from Cape Breton's landscape and sent it hundreds of kilometres away to wealthy investors in Halifax, Toronto and the northeastern United States (Donald 1966, 12). As these colonial powers became fractured in the mid twentieth century, the coal industry came to rely heavily on federal subsidies in order to keep the mining towns afloat. The mid nineteen sixties saw the discovery that coal reserves were much lower than initially anticipated, rendering extraction economically unviable without federal intervention (Donald 1966, 17).

Miners at work in Lingan in 1986; Unknown photographer. (Nova Scotia Archives 2023c)

Though recommended for closure in the sixties, the coal mines saw a renewed interest in the seventies, and remained open as a response to the 1973 OPEC oil embargo as a means to lessen Nova Scotia's reliance on foreign oil. Despite this short uptick, coal production and employment declined steadily as the last few economically viable coal seams were exploited. By 1999, all coal mines in Cape Breton had closed, and many former mining towns became shadows of their former selves (Price 2018, 134).

Currently, Cape Breton exists economically as a post industrial economy and many on the island struggle to find work, often leaving for larger cities or western provinces in search of gainful employment (Murray 2022, 15). Though the mining industry is often credited for the wealth and economy of Cape Breton in the nineteenth and twentieth centuries, significant political power and wealth has always remained concentrated on the mainland, while the industry's effects have left the island and its communities polluted, and in economic turmoil.

## Coal in the Present

Though coal remains in the realm of antiquity in the popular consciousness, coal combustion for electricity generation remains a problem into the twenty first century both in Canada and beyond. In 2021, coal became the largest source of electricity generation globally and continues to be traded and mined as countries like Germany and France reopen coal fired power plants to phase out nuclear energy and sever economic ties to Russia (Crownhart 2023). The continued global reliance on coal, and refined petroleum products, has and continues to unconsciously design our built environment while remaining hidden below the surface of modern life.

### And Its Role in Nova Scotia's Climate Crisis

Coal combustion both heavily pollutes the air in Nova Scotia as well as contributing a disproportionate amount of carbon emissions relative to the amount of electricity it creates. This ratio contributes to the heightened effects of climate change that will be felt in Canada in both the present and the coming years. Due in part to Canada's vast landscape, and position

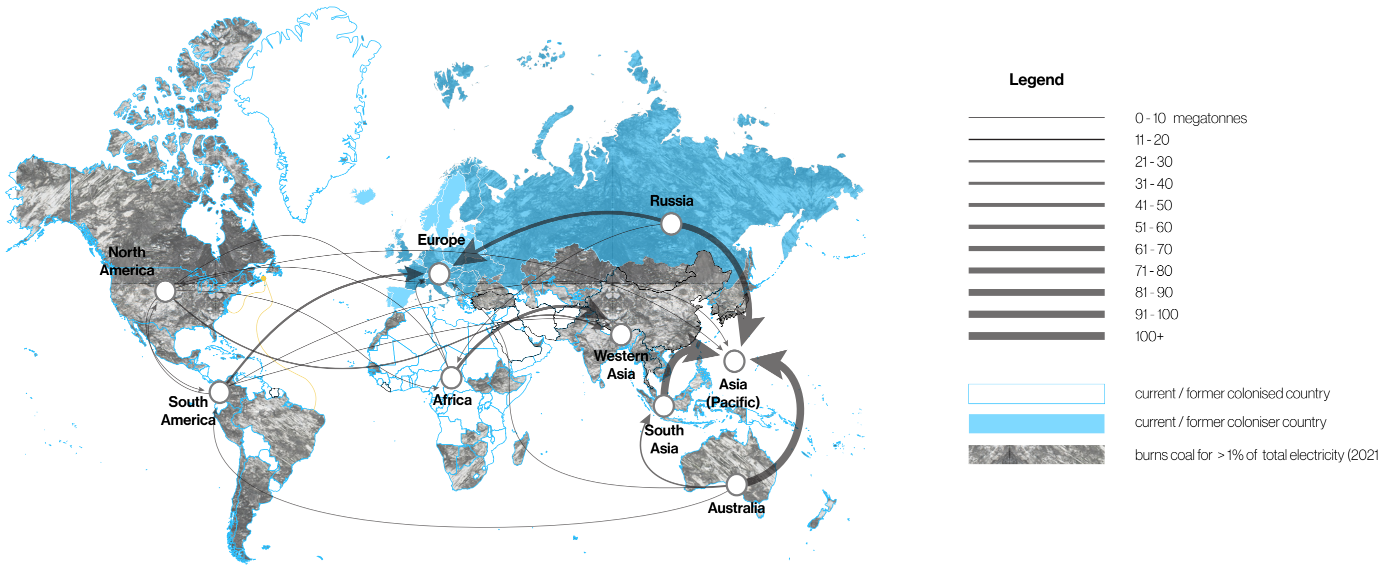
## Global Coal Trade (2021)

Largest Coal Exports (MT)

1. Indonesia (432 )
2. Australia (199)
3. Russia (174)
4. South Africa (63)
5. Colombia (54)

Largest Coal Imports (MT)

1. China (357)
2. India (277)
3. Japan (201)
4. South Korea (138)
5. Taiwan (174)




Map depicting coal use globally, as well as lines of trade in 2021. (Base map from VeMaps 2023), (coal trade data sourced from IEA 2022, 53) (colonial history data from Fisher 2015) in the northern hemisphere the effects of climate change will be greater felt here than in other nations. (Teske 2010, 3)

Focusing on Nova Scotia specifically, as a coastal province, and one that relies on many marine industries for economic survival, the climate crisis will impact Nova Scotians more than their inland province counterparts (Government of Canada. Canada Energy Regulator 2023). Despite bearing the brunt of the economic and physical consequences of climate change, Nova Scotians remain one of the highest per capita polluters when comparing each province and territory's electrical grid.

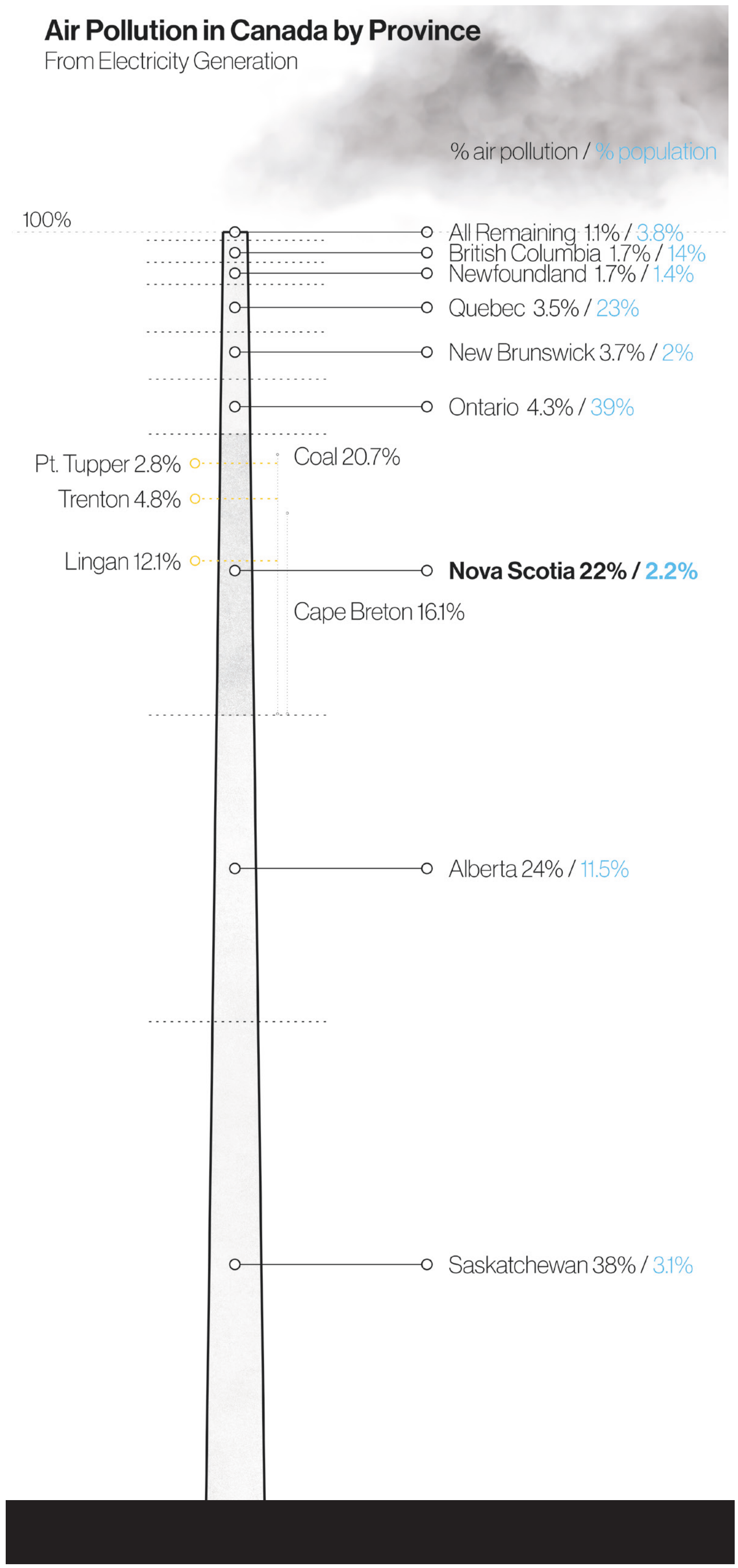
Currently, Nova Scotia generates 80% of its electricity from fossil fuels, and supplies 22% of Canada's air pollution from electricity generation despite only containing 2.62% of the country's population. Of Nova Scotia's 74,000 tonnes of toxic air pollutants in 2021, 73% originated in Cape Breton and 94% came from the combustion of coal (NPRI 2021).

The province of Nova Scotia has pledged to generate 80% of electricity from renewable sources by 2030, but construction delays and funding setbacks have made this goal unlikely to be reached in a mere seven years (Hughes 2022).

### As It Influences Architecture and Design

Designing without severing our ties to fossil fuel reliance situates architecture and design in the parameters of a energy paradigm that is actively hostile to our natural environment. As the climate changes, the architect will have to take on additional responsibilities in order to negotiate their role in and obligation to the planet.

> Architecture is not buildings; buildings are mainly stuff. Architecture is an active connection, a practice which activates a relation between material spaces and their inhabitation;




Air pollution in Canada relative to provincial population.(Data from NPRI 2021)

> and, it structures that relation, it structures what we call the relation between space and polity, as well as the construction of polities themselves. (Turpin 2013, 16)

In the past era of assumed energy abundance, buildings did not require the analysis of energy or materials in their design. The architecture of coal can be thought of as a driver of emissions - though buildings do not emit greenhouse gas directly, their construction and use (inhabitation, heating, cooling, etc) account for 40% of greenhouse gas emissions in North America (Szeman et al 2017, 100). Severing the ties between architecture and coal will liberate buildings from their current adversarial relationship with the climate.

Our environment has already been irreversibly changed, as posited by Ernest Garcia, “the anthropocene is a way to view the future, it can no longer be changed - only mitigated” (Garcia et al 2016, 183), yet our built environment is designed for the climate of the past. Architects can be on the forefront of mitigating the climate crisis, but that requires a sharp shift away from traditional energy intensive paradigms. The architecture of a post coal paradigm needs to consider energy and design in more inventive ways, incorporating architecture across an infrastructural scale of thinking and making.

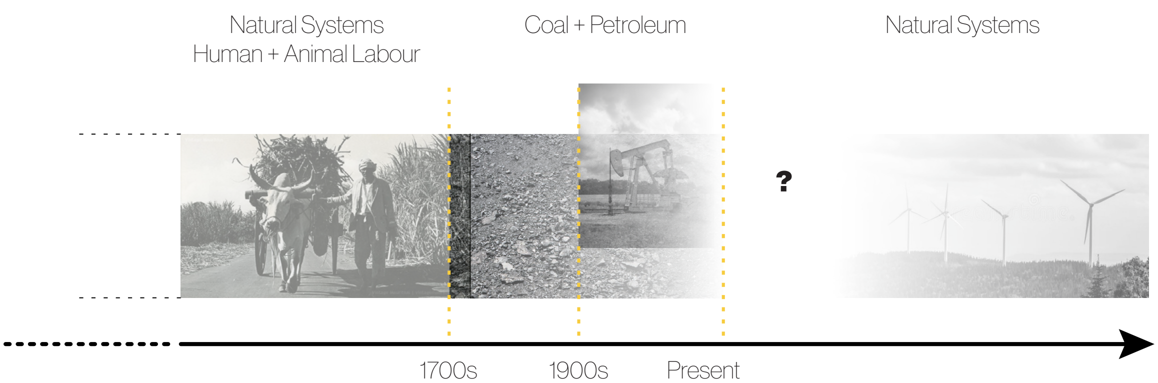
## A Profound Disconnect

A key element of both the anthropocene and late stage capitalism is the disconnect between people and the systems that sustain us. As landscape architect Robert L Thayer notes “on a day to day basis, we don’t comprehend the relationship between nature, technology and landscape in a deliberate or conscious manner, and what interactions we do experience are merely manifestations of our typical lifestyles, tastes and desires” (Thayer 1994, 13).

Many aspects of our societies and daily life are designed to obscure the impact that we have on the planet. This disconnect allows us to cognitively absolve ourselves from our role in the anthropocene, and distance ourselves from the destructive forces and industries of which we rely on and demand.

## From Our Natural World

The cultural removal of humans from our ecosystems has lead to a disconnect between people and their habitats. Intuitively, it's almost innate to value our landscapes - Yi-Fu Tuan coined the term 'tophophilia' in the mid seventies to describe the affective bond between people and place or setting (Thayer 1994, 4). However, as theorized by Ian McHarg, our failure to connect with the landscape in the Western world is due to our prevailing cultural values, largely anthropomorphic and  anthropocentric, which clash with our innate tophophilia. Seeing nature as a conquest removes us from our role within our ecosystems, we need unity with nature to survive (McHarg 1992, 67). This detachment is




**Primary Energy Sources Through History + Significant Transitions**

Timeline of significant energy transitions in recorded history a social value, carried through our institutions and is both conscious and deliberate.

Thayer also posits that our simultaneous love and distrust of technology has forced our ecosystems to the margin culturally, as we romanticize advances in technology at the expense of our landscapes. A similar sentiment is echoed by Leo Marx, a literary historian, who proclaimed that collectively “a rustic and in large part wild landscape was transformed into the site of the world’s most productive industrial machine. It would be difficult to imagine more profound contradictions of value or meaning than those made manifest by this circumstance” (Marx 1964, 23). These industrial machines are most embodied by extractive energy industries, which are situated on the margins of human settlement and consume the landscape for means of profit. Culturally, as we reckon with the tension between our idea of landscape and the reality of our treatment of nature we can begin to reclaim our industrial landscapes to more closely align with the imagined pastoral.

### As a Product of Anthropocenic Society

A key part of Anthropocenic society is the relationship between late stage capitalism and its incentivization of environmental catastrophe.

Our economic model paradoxically excludes the most important human ambitions and accomplishments that are needed for survival, spurring industry to contaminate and sequester natural systems that fulfill our most basic needs for air, water and sustenance (Szeman et al  2017, 95). The ever present push and pull between technophobia and technophilia has lead humanity to shy away from energetic and productive landscapes culturally in favour of either the pastoral and serene ideals of ‘wilderness’ or the intensively productive ideals of industry. This dichotomy has pushed our industrial and infrastructural landscapes to the margins as we romanticize the manufactured and unproductive pastoral landscapes, relegating industrial landscapes to the sidelines (Thayer 1994, 131).

Herman Scheer, a politician and solar energy scholar in Germany advocates for a restructuring of political priorities, our supply of natural resources necessary for life should be paramount. He argues that the “era of plenty is over”, and that energy is the sector most removed from its natural sources, stewardship over land should come before any politically motivated action (Szeman et al. 2017, 99).

The solution to the climate crisis needs to be multi-faceted and address the social aspects of our technological and infrastructural systems. In the words of scholar Cara New Daggett, “Changing only fuels and fuel technologies while keeping in place the globally unequal capitalist growth machine may alleviate some of the carbon accumulation in the atmosphere but will not address the multitude of other ecological problems humans face” (Daggett 2019, 192).

Although transitioning back to natural systems for energy is imperative, the ripple effects onto both the natural and built environments need to be addressed in order to complete the energy transition.

## A Way to Fill the Void

The transition away from coal and other fossil fuels will require a new way of thinking about the built environment, as well as the adoption of renewable energy technology at both the infrastructural and human scales.

## With New Renewable Energies

Despite Canada’s vast potential for renewable energy generation, most clean energy sources remain untapped due to political pressures or gaps in technology.

> Canada can join the Energy [R]evolution by promoting efficiency and renewable energy, and phasing out energy derived from coal, nuclear, and oil. The sustainable future of the planet will not be brought about by further subsidizing of dirty and finite fossil fuels, but by investment in people and local communities who can install and maintain renewable energy sources. (Teske 2010, 11)

As the majority of Nova Scotia’s electricity production remains dominated by fossil fuels - there’s a gap that needs to be filled with emerging clean energy technologies in new and inventive ways, and an attitude to be decided for the life of fossil fuel infrastructure post energy transition.

## With a New Paradigm of Architecture and Energy

The introduction of new energy technologies alone will not be enough to facilitate the next energy transition. A new way of thinking about our built environment and society is needed to reconcile with our complicity in the forces of the Anthropocene.

This thesis will contextualize the need for a new paradigm of architecture and energy by exploring the forces of the coal mining industry in Cape Breton as they relate to the climate crisis, the local economy and culture in the present day.

The proposed design process is guided by the mutual exchange and overlaps between the realms of architecture, technology, nature and infrastructure.

Using the paradigm of renewable energy, the project proposes to transform the Lingan Generating Station in Lingan, Cape Breton and its surroundings into an experiential landscape part of a network of decentralized community scale generative landscapes. This proposed intervention both replaces the existing energy generated and connects users personally to the process of generation through a series of recreational cross programming.

The radical shift from large scale centralized generation to community scale generation pushes the bounds of the current energy park model, often mono-programmed or combined with other productive ideals of landscape (ex. Agriculture) (Pasqualetti 2017, 7). Additionally, this thesis seeks to speculate on the form of an energy paradigm divorced from global capitalism and connected to the public's experience of the natural environment.

In addition to the landscape intervention, the power plant building itself is proposed to be converted into lab/prototyping and community outreach spaces.

## Thesis Statement

The architecture of a Post Coal community will be a decentralized network of infrastructures supported by and designed for the specific communities they power.

The spaces of the next energy transition will exist in spaces that inhabit the simultaneity of architecture, technology and landscape, departing from past paradigms which relegate these as separate and distinct.

# Chapter 2: Canada's Energy Landscape

Canada's colonial history has cemented a legacy that remains today of energy extraction as exploitation. As fossil fuels and capital remain entwined through history, Cape Breton has endured the brunt of the destruction of the energy resource economy in Eastern Canada.

At present Canada employs a range of energy sources for electricity generation, yet remains reliant on fossil fuels which dominate the energy portfolio of provinces in the east.

Though Canada has ambitious targets and funding promises for both climate metrics and renewable energy investments, Canadians remain among the largest polluters per capita in the world, creating a disproportionate share of emissions globally (Environment Journal 2022).

As the effects of the climate crisis continue to manifest locally, it becomes apparent that we are failing to utilize our vast landscape to its full potential for energy generation, instead choosing to continue to prioritize extraction over ecosystems.

## And Cape Breton's History

The landscape of Cape Breton has been a landscape of production since 1723 (Donald 1966, 34). In the 278 years of continuous operational mining, the relationship between wealth, power and carbon has remained constant.

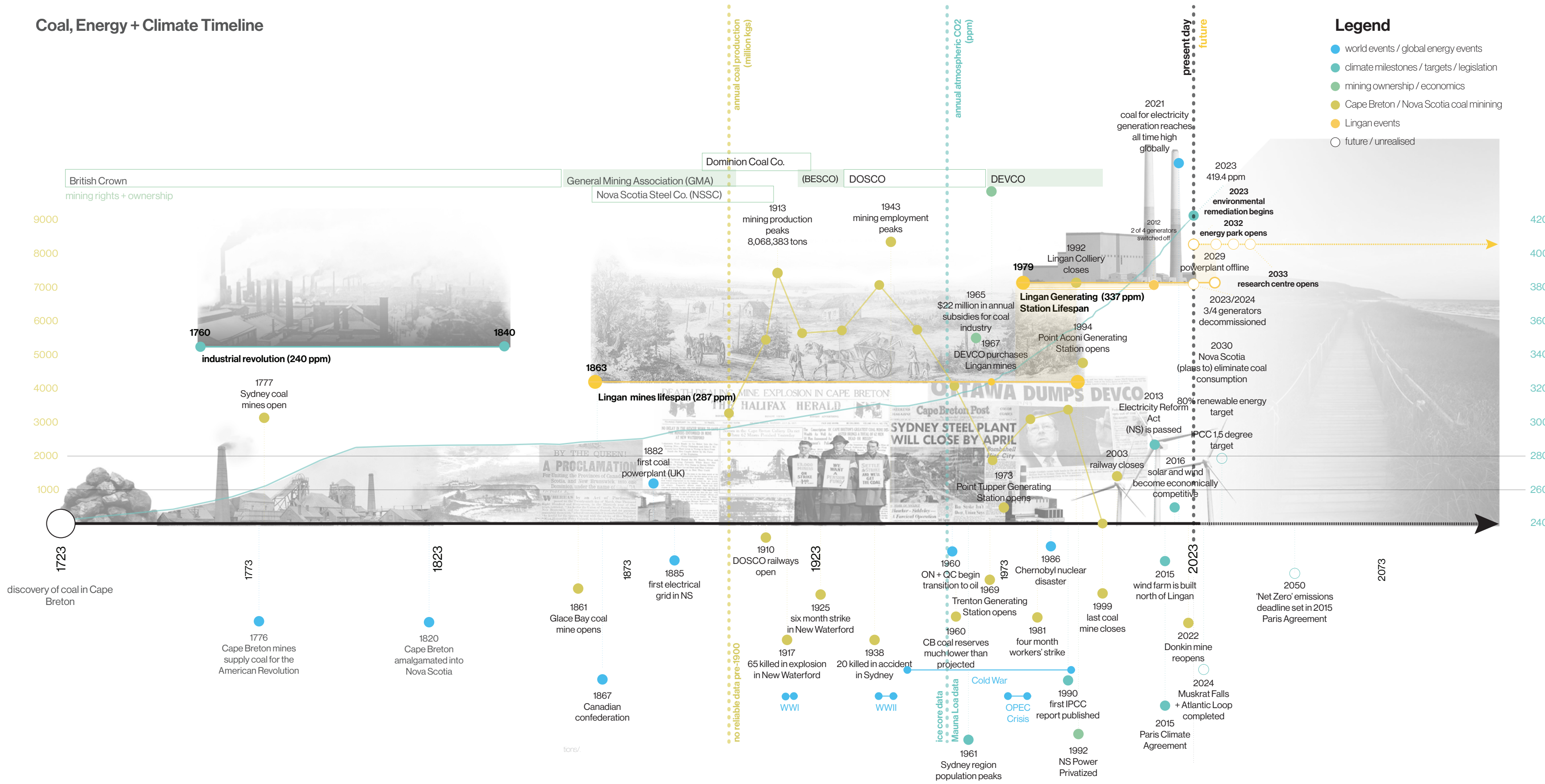
The first mines in Cape Breton were opened after the Duke of York was granted exclusive mining rights by the British colonial government (Donald 1966, 17). In the early nineteenth century, ownership of the coal fields was passed from the British aristocracy to the provisional government, and by 1826 the mining deeds were in the hands of the General Mining Association (GMA), a private monopoly owned by a group of jewelers and goldsmiths in London who were owed a personal debt by the Duke (Gibbs 2017, 145).

In 1858, GMA's monopoly was broken and American capital flooded the Nova Scotian coal market, wholly removed from the day to day operations and extractive nature of the industry. Mining behemoth Dominion Coal Company (DOMCO) began operation in 1890 after the consolidation of all mines in the Sydney area (Gibbs 2017, 45).

While investors in Halifax, Toronto and the United States mined vast profits from Cape Breton Island, the miners faced low wages, toxic working conditions, fatal mining disasters and the suppression of organized labour. The island itself was transformed as forests were cleared for new mining camps, and shafts were carved from the earth to reach the coal seams deep under the Atlantic (Donald 1966, 91 - 92).

Coal production peaked in 1914, but the total number of workers did not plateau until operations ramped up in response to the second world war. As production continued to decline in the mid 1960s, the Donald commission (titled The Cape Breton Coal Problem) found that the remaining coal reserves were much more depleted than initially estimated and the amount of economically viable coal was vanishingly small (Donald 1966, 101). In 1965, the coal mining industry required $22 million ($207 million in 2022) annually in federal subsidies to avoid total collapse.

The Cape Breton Development Corporation (DEVCO), a crown corporation, was created to transfer ownership of




Timeline of significant energy moments in Cape Breton, Nova Scotian and world history. (Data from a series of sources; Bush 2019; Daggett 2019; Donald 1966; 'Electricity Reform Act' 2013;  Gibbs 2017; Govind 2022; Kilvert 2023; MacEwan 1976; and Ministry of Mining and Energy 1944-1997) mining land and equipment to the Canadian government, bail out the private mining companies and gradually shut down mining operations. Operations were planned to cease by the mid 1970s, but the OPEC embargo and resulting oil crisis in 1973 caused production to resume, leaving the mines to remain operational until the closure of the last mine coincided with the closure of the steel mill in 2001 (Gibbs 2017, 32). Nova Scotia's four large scale coal generating stations were erected as a response to the OPEC crisis, in an attempt to lessen dependence on foreign oil, and remain in operation despite their contribution to the climate crisis.

DEVCO ceased operations in 2009, selling the remaining mine infrastructure to private enterprises and leaving the environmental remediation of mine sites to local governments shortly after the 2008 recession (Gibbs 2017, 41). Cape Breton has been at the whim of global energy politics for much of its history due to its privately owned energy infrastructures, creating community centred infrastructures can be a way to regain autonomy in the wake of global market forces.

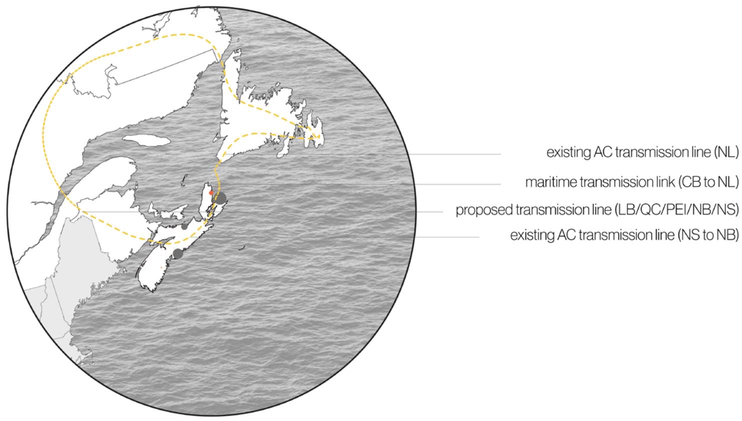
## In Its Current Form

Canada's current energy landscape lags behind other developed nations (Teske 2010, 30). Though many central and western provinces have relatively low carbon emissions from their hydroelectricity generation, Atlantic Canada and the territories rely heavily on fossil fuels for energy generation.

As of 2017, renewables accounted for 18.9% of Canada's energy supply, of that figure, hydro power accounts for 60%, wind and biomass are the next largest contributors at 3% and 1.5% respectively (Natural Resources Canada

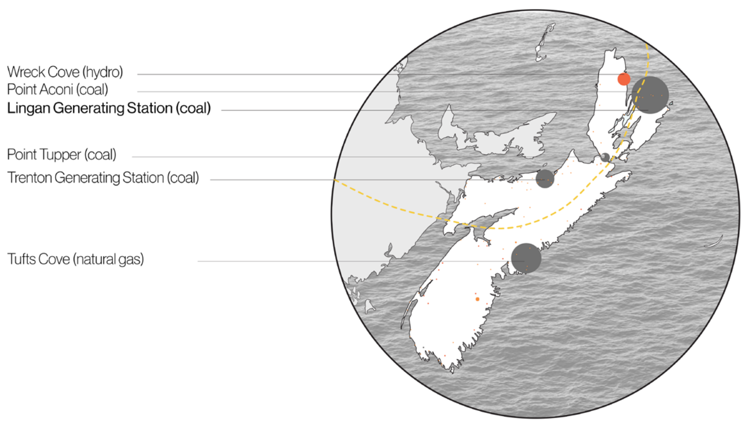
### ATLANTIC CANADA'S ENERGY INFRASTRUCTURE

Proposed 'Atlantic Loop' Infrastructure



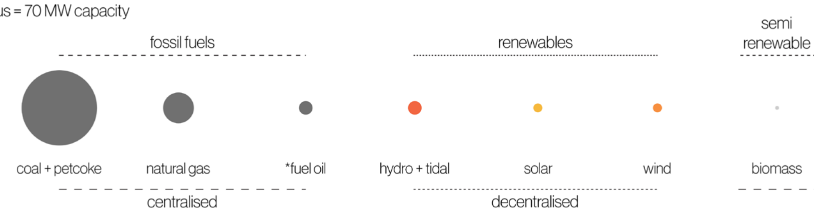

### NOVA SCOTIA'S ENERGY INFRASTRUCTURE (2023)

* fuel oil only used as a back-up source of generation due to cost (2023)

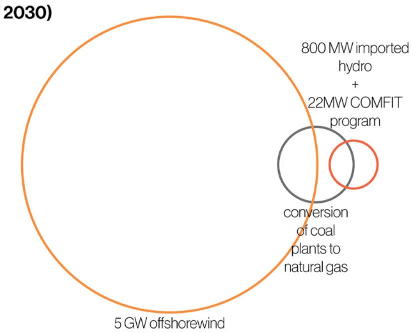



### TOTAL CAPACITY (2023)

1mm radius = 70 MW capacity




### PLANNED INFRASTRUCTURE (POST 2030)

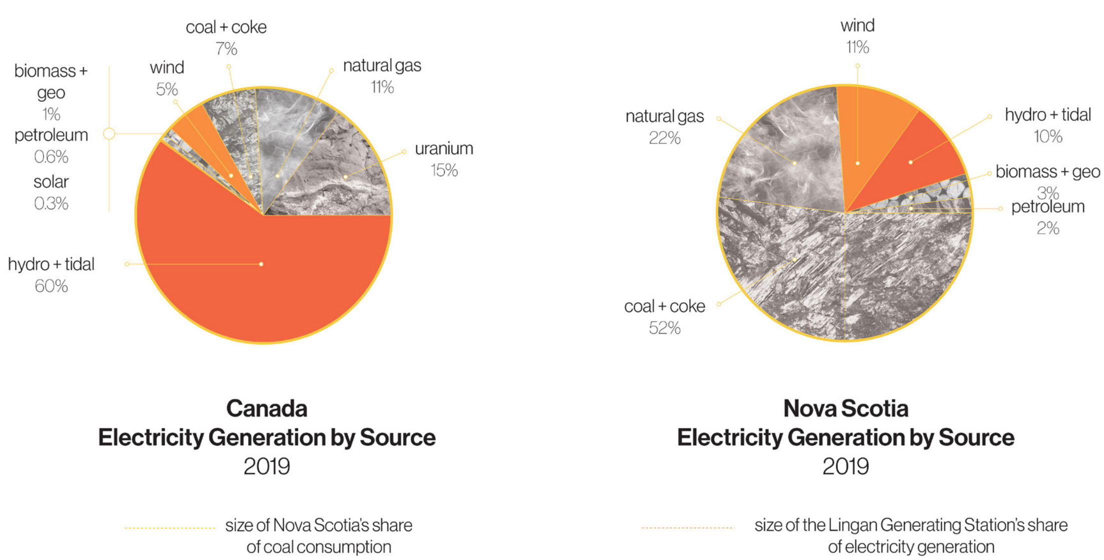



An inventory and quantitative comparison of Nova Scotia's industrial energy infrastructure. Mapping these infrastructures shows the distance from infrastructure and population centres. (Data sourced from Nova Scotia Power 2022).

2017). This figure represents total energy supply, which includes categories like transport which rely almost entirely on petroleum and its by-products. Eliminating transportation and other non-electric energy consumption, renewables make up 65% of Canada's electricity supply. The remaining 45% is composed of oil, diesel, natural gas and coal (Government of Canada. Canada Energy Regulator 2023).

Clean energy is utilized in the most populous provinces in Canada; British Columbia, Ontario, and Quebec all rely on a combination of  hydropower and nuclear for the majority of their electricity (Natural Resources Canada 2017). At present, 80% of Nova Scotia's electricity comes from fossil fuel sources, namely coal and natural gas though the province has pledged to reach a target of 80% renewable energy by 2030 (Environment Journal 2022).

The era of abundant coal has come to an end in Atlantic Canada. In a 1985 survey of Canadian coal reserves, eastern Atlantic provinces (Nova Scotia and New Brunswick) who have historically housed the majority of the Canadian




Comparing the composition of Nova Scotia and Canada's electrical grid composition. (Data from Government of Canada. Canada Energy Regulator 2023) coal market were estimated at 436 mega tonnes remaining, just under 6% of the total national reserves (Government of Canada. National Energy Board 2003, 73).Though domestic coal production has largely ceased (with the exception of the reopening of the Donkin mine east of Glace Bay in September 2022), Nova Scotia Power imports coal from primarily South America or the United States depending on which source is more economically viable (Withers 2022).

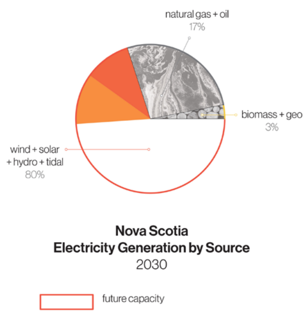
Coal as an energy source is not a uniquely Nova Scotian problem, but the sheer scale and longevity of coal consumption is.

Currently Alberta, Saskatchewan and New Brunswick also  ignite coal for electricity generation, but in smaller proportions. Recent projections show that as the western provinces and New Brunswick are expected to decommission their coal generating stations in the coming years, Nova Scotia's transition relies on the completion of the Maritime Link, an underwater connection to Newfoundland's supply of hydropower whose future remains uncertain (Withers 2022).  Considering the present reliance on coal, Nova Scotia requires bold change in order to play its part in the coming energy transition.

## And its Ambitions in Policy

Though Canada has ambitious climate targets in place, they do not address the need for cleaner energy sources on an immediate time scale.

Focusing on Nova Scotia, the province appears to be more willing to invest in renewable energy projects than other provinces that still use coal for electricity. (Teske 2010, 100)




The planned future of Nova Scotia's electrical grid in 2030 highlighting the portion of currently unbuilt capacity. (Data from Nova Scotia Power 2022).

Time is yet to tell if those investments will be returned upon, or if targets will be met in time.

In 2022, the Canadian government pledged $255 million in federal funding for renewable energy projects in Atlantic provinces (Environment Journal 2022). In addition, this past October, Nova Scotia announced they would be issuing 5MW of leases for off-shore wind producers by 2025.

> Setting this target sends a clear signal to the world that Nova Scotia is open for business and becoming an international leader in offshore wind and green hydrogen development. We are taking every opportunity to develop our renewable energy market, not only to fight global climate change, but also to create green jobs here in Nova Scotia. (Environment Journal 2022)

Though the announcement centred on offshore wind power for green hydrogen production, it signals that at the provincial level there's interest in investing in transitioning our energy portfolio to renewables.

The majority of Nova Scotia's energy transition plan relies on the completion of the Maritime Link, or Atlantic Loop, project. If completed, the Atlantic Loop would link Nova Scotia and New Brunswick to hydroelectric power in Quebec, and the Muskrat Falls project in Labrador (Environment Journal 2022).

Muskrat Falls has been plagued by funding issues and construction delays due to COVID-19, and though completed is not linked to Nova Scotia's grid as of March 2023 (Hughes 2022). A source of funding strife is the recent decision by Emera, the private company which owns and operates Nova Scotia Power, to pull funding for the Maritime Link / Atlantic Loop project in response to proposed rate hike cap legislation (Withers 2022).

Though Nova Scotia is preparing for our energy transition on paper, funding issues and the whims of private companies who control our energy infrastructure make the province's energy transition all but certain on the path to 2030.

## And the Barriers Facing Renewable Energy Adoption

The transition from fossil fuel energy to renewables in Canada will have to contend with numerous technical and social barriers to adoption as technology reaches large scale capacity and public perceptions of clean energy sources are challenged.

### By Technological Limitations

As humanity has transitioned away from human and environmental sources of energy, the technology necessary to process and store energy have become both more complicated and important.

At present, most forms of clean energy capture need technological innovation in order to meaningfully achieve adoption on the same scale as fossil fuel technologies. In his essay "The Deadlock of the Thermo-Industrial Civilization: The (Impossible?) Energy Transition in the Anthropocene", Alain Gras posits that fossil fuels have created self-replicating systems, as both physical means of energy storage and sources of low extraction costs (Gras 2016, 33).

When considering renewable technologies, for example wind turbines, the initial amount of energy required to produce the turbine will not be 'paid off' for a period of years. Coal and other fossil fuels do not have this relationship with initial energy cost as their extraction is reliant on the exploitation of human and historically animal labour - they require no initial fossil fuel ‘investment’ (Gras 2016, 36).

“Coal, which at the beginning used animal energy for its extraction, quickly found the return of the investment in the form of an energy surplus... These energy systems were therefore autopoetic - they produced the conditions for their reproduction” (Garcia et al. 2016, 25). Without advancements in technology, and innovation in their implementation, renewable energy systems are not autopoetic yet. Energy storage remains another barrier to renewable adoption, as energy sourced from environmental phenomena can be unpredictable and dynamic, often not aligning with hourly energy demand (Todd 1993, 66). Additionally, post electrification storage has not been previously considered on a large scale, and remains a design challenge for developed nations as they embark on their energy transitions (Szeman et al. 2017, 441).

Another barrier that renewables face, even when technological advancements are made is the phenomenon of Jevon’s Paradox - named for the British economist who first noticed the problem in the nineteenth century. Jevon’s Paradox posits that increased efficiency leads to a larger increase in adoption that often cancels net efficiency gains of a system overall (Daggett 2019, 57). The technological barriers facing renewable energy adoption have the possibility to be overcome in innovative ways as new spatial and financial strategies are allocated to technological advances.

## By Institutions

On a social and institutional scale, private companies with vested interests in preventing the energy transition and misinformed members of the public can push back and delay renewable energy projects.

As petroleum products remain a global industry, Canadian energy companies seek policies that advance their business interests at the expense of environmental concerns.

> Energy companies have also joined together to advocate for a national energy strategy. In 2009, for example, the major tar sands companies (along with other energy players) formed the Energy Policy Institute of Canada (EPIC), headed by former Cabinet minister David Emerson, with a “singular focus on one task: to draft an energy strategy and policy recommendations.” This approach, however, is rooted in the energy status quo, as shown by EPIC’s Guiding Principles, which include “advance the primacy of the Canada-United States energy relationship” and “help design regulatory processes that aid, rather than impede, responsible energy development. (Teske 2010, 27)

EPIC and similar lobbying groups are part of what Michael Aklin describes as ‘elite push back’. In order to facilitate the transition to renewable energy sources, law makers and institutions as well as industry and energy stakeholders must fully be on board. In his book, *Renewables: The Politics of a Global Energy Transition*, Aklin describes Western nations as being in a condition of ‘carbon lock-in’.

> This condition [...] arises through a combination of systematic forces that perpetuate fossil fuel-based infrastructures in spite of their known environmental externalities and the apparent existence of cost-neutral, or even cost-effective, remedies. Rational corrective policy actions in the face of climate change would include removal of perverse subsidies and the internalization of environmental externalities arising from fossil fuel use. (Aklin 2018, 9)

Aklin argues that in order to move past fossil fuels an external shock that threatens the reliability of fossil fuels, similar to the oil embargo in the late 1970s, is required in order to create a window of opportunity for renewable-friendly laws and policies. In times that inspire uncertainty for the past energy paradigm, public perception and attitudes of the ‘elite’ can be swayed by means of increased public investment and awareness campaigns (2018, 63). As countries grapple with balancing economic interests of the public and industry, the transition to renewables hinges on investment and policy above many other factors.

Though monetary factors remain the primary issue that faces clean energy, gaps in educational programs also limit renewable energy growth, as members of the public are not educated on energy concerns through government campaigns or institutional means.

Virtually all renewable energy education is conducted at the masters level or above, significant creation of energy curriculum is needed in secondary schools and vocational programs in order to reach a wider range of people (Kandpal 2014, 6). These forces combine to create a political and economic landscape that can easily become hostile to clean energy investment, demonstrating the importance of legislation and architectural infrastructures that are not reliant on traditional profit or funding models.

# Chapter 3: A New Way to Consider Energetic Architecture

As humanity begins to transition away from the assumed abundance of fossil fuels that defines our built environment, architecture can explore new ways to engage energy and its intersections with architecture, technology and nature.

“Only by rejecting the argument that oil is economically, politically and technologically necessary, and by acknowledging our complicity in an immoral system, can we stem the damage being done to the planet” (Sheller 2019, 58).

## By Defining the Architecture of Coal

Dubbed ‘Carbon Form’ by theorists like Elisa Iturbe and Mimi Sheller, the formal relationship between coal, carbon and architecture manifests as both spatial consequences and material paradigms.

> We can refer to such assemblages of matter, energy, practices, and meanings as an ‘Energy Culture’, which is embedded in the ongoing processes of mobilizing, energizing, making and doing... Carbon form is therefor the coalescence of our energy culture. Such infrastructuring becomes embedded in ways of life that fall into the background and become a kind of common sense. (Sheller 2019, 57)

In terms of our architectural paradigms and the expression of a built environment that is designed under the premise of abundant energy, spatial configurations ”enmesh the cultural, economic and political aspects of social life within an energy intensive network of space and form” (Iturbe 2019, 11).

Carbon form is more than just an architectural paradigm, it becomes a lens in which we can view the formal relationships in architecture and our society at large.

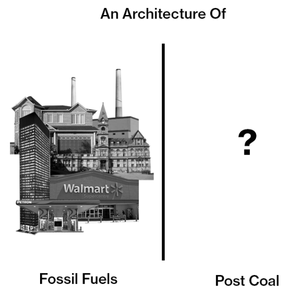



Diagram comparing common forms of architecture to the unknowns of the Post-Coal era.

## As a Set of Assumptions in the Built Environment

The architecture of coal, or 'Carbon Form', relies on a set of assumptions that permeate how we view the space, form and composition of a building.

- Fossil fuels will always be abundant, cheap and readily available
- The surrounding environment is to be conquered or overcome in terms of light, heat, cooling, ventilation, etc
- The same materials and mechanical systems can be deployed regardless of climate
- The form of a building should be simplified regardless of thermal properties
- A building exists in adjacency to infrastructure, and does not contribute to any networks or systems beyond being served by them.

## As a Consequence of Capitalism

Carbon form and economics are inextricably linked, as the economic conditions that fuel the industries of extraction also fuel the proliferation of carbon form. As policies like building codes and zoning laws dictate the size and materiality of buildings, while cost saving measures often push designers and architects toward certain forms and materials. The forces of capitalism converge architecture to universal forms that ignore local differences in climate and site conditions (Sheller 2019, 57).

The ubiquity of fossil fuels, and their ability to be transported - whether tangibly through pipelines and petroleum fueled vehicles or intangibly through the power grid - have created a world where energy is invisible, abundant and regulated to the background of design thought. If the world were to rely on localized, decentralized power and materials then the architecture of developed nations would vary greatly from globalized design trends seen today. Materials and conventions carry embedded attitudes towards energy which permeate the built environment unconsciously. As architects continually serve the needs of building owners, the class divide becomes cemented into the built form just as the (in)consideration of energy does.

### As an Evolving Paradigm

As we enter the third decade of the twenty-first century, carbon form has evolved to co-opt and convolute the ideas of environmentalists. The emerging carbon forms are the trends of greenwashed design that perpetuate a rebranded narrative of climate resilience and global capitalism.

> Architectures of resilience cannot be architectures of growth... The root causes of the climate crisis - profit seeking competition, endless growth, exploitations of humans and nature, and imperial expansion - can't also be the solution to the climate crisis. (Yarina 2019, 86)

Designers can not be universally faulted for perpetuating narratives of infinite growth in the face of limited planetary resources as the omnipresence of neo-liberalism has created universal narratives about the resiliency of capital in the face of all challenges. Designers have to contend with the commodification of all aspects of both the architecture industry and of daily life itself (Yarina 2019, 89).

As architects and designers work with the idea of resilience, they need to consider the ecological narratives that arise in their designs. Theorists like William Braham assert that green buildings adopt visual symbols like green roofs, or minimal solar panel arrays even if they do not meaningfully contribute to the ecology of the project. Once symbols like these become popularized, they become part of green design narratives and are perpetuated through the discipline

(Braham 2016, 78). When buildings aren't looked at holistically, counterintuitive design narratives can manifest in spaces that are only sustainable on paper. The example that Braham uses is the decision to quantify energy code requirements in incremental units (ex. kWh/m²) leading to larger buildings than are otherwise required in order to drive spatially defined metrics down artificially (2016, 85).

The evolution and proliferation of carbon form remains a problem in the architectural field today, designers must adapt and reject the culture of carbon in favour of a new paradigm.

## By Designing Architecture as 'Machine'

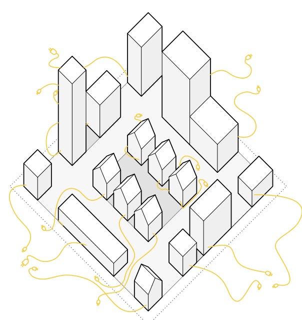


Diagram showing the connection between mechanised architecture and external systems

The paradigm of Architecture as Machine, popularized by Reyner Banham in the mid twentieth century, equates architecture and technology; offering a way for the built environment to conquer the natural environment.

Banham, in his book *The Architecture of The Well Tempered Environment*, critiques then contemporary architects, lamenting the lack of consideration towards the mechanical systems in a building during design (Banham 1969, 25). Banham advocated for the mechanization of the built environment, often speaking of 'environmental controls', imagining that newfound technology would liberate architecture from its environment. Building off of the work of Sigfried Gideon a decade earlier, he stressed the importance of mechanizing a building visually, celebrating its now electrically powered heating, cooling and ventilating systems (Banham 1969, 168).

> By providing almost total control of the atmospheric variables of temperature, humidity and purity, it has demolished almost all of the environmental constraints on design that have survived that other great breakthrough, electric lighting. For

> anyone who is prepared to foot the consequent bill for power consumed, it is now possible to live in almost any type or form of house one likes to name in any region of the world that takes the fancy. Given this convenient climactic package one may live under low ceilings in the humid tropics, behind thin walls in the arctic and under uninsulated roofs in the desert. (Banham 1969, 187)

The perception of environment as 'constraint' reveals the attitude towards energy in Banham's mechanization; as a commodity to enable opposition to the natural landscape.

> Though coded futuristic, the conceit of Banham's position, was that he favoured aesthetically dominant mechanization over a building's function. As Jared Langevin notes "It seems curious that Banham would feel the need to represent the dynamic, non-uniform, and in many ways non-visual elements of his un-house through this series of static images. To Banham, however, a powerful ''image'' served much more than just a visual or formal purpose. Indeed, as we shall see, when executed with the proper intent, Banham believed that such an image could embed itself deep in the emotional experiences of its viewer. (Langevin 2011, 4)

Machine Age architecture was to move away from massive, thermally conserving, architectural elements in favour of the light, the tectonic and the international.

The Pompidou Centre in Paris and its coloured exterior pipes and vents (Slessor 2021)

A prime example of Banham's ideas of high tech, mechanized architecture are embodied in the Pompidou Centre, a museum in Paris France designed by Renzo Piano and Richard Rogers in the 1970s. Iconic for its break from the traditional Parisian architecture of the city centre and the reversal of its building envelope. Contrary to conventional construction, the ducts, pipes and mechanical elements adorn the outside of the building instead of being buried within the walls and roof. The Pompidou Centre celebrates its mechanization visually with each system meticulously colour coded on its facade (red for people, blue for air, yellow for electricity and green for water) (Slessor 2021).

As the building has been upgraded and repaired over the years, for example to increase its energy efficiency, much of the vents and ducts adorning the exterior have been rendered obsolete (Slessor 2021). Though the museum has been hailed for embodying the high tech movement, it no longer contains an honesty about its mechanical systems.

Engaging with architecture as a piece of technology itself discounts all aspects other than performance, which is contingent on contemporary technology and a constant connection to energy. Though performance is an important metric, the reliance on machines designed outside the purview of the architect leaves design at the whim of technological innovation. The extension of this school of thought has lead to a focus on the energy efficiency of a building, and as energy conservation as the dominant means of sustainable architecture discourse, leaving the possibility of generation off the table.

The now demolished Ark in Prince Edward Island in the late 1970s (Jack Todd 1993, 98)

## By Designing Architecture as Power

The paradigm of Architecture as Power, popularized less than a decade after Banham's *The Architecture of The Well Tempered Environment* arose as a response to the Architecture as Machine paradigm. Instead of conceptualizing a building as a piece of technology, Architecture as Power instead equates the natural environment to technology.

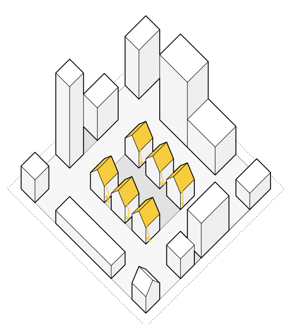



Diagram showing the limited scope of 'Architecture as Power's relationship to energy generation

Categorized by the total reliance on natural systems, this form of architecture seeks to be harmonious with nature for the purposes of eliminating all mechanization in design. The removal of traditional technologies from the built environment plays into existing narratives of self sufficiency and refuge. As ideas like 'Net Zero' become prominent with both architects and government officials, one can interrogate their conception of a building that exists as an island. The net zero building does not contribute to the grid or larger system, and does not pull from it, many of these projects are rooted in survivalist narratives as William Braham notes;

> The survivalist retreat throws the all glass building into the highest relief and provides a shadow narrative for much of sustainable design - situated off-the-grid, built from local materials, and outfitted to produce its own food and power. There are survivalists from every political persuasion, hedging against the risks of societal collapse... Survivalist narratives can also be discerned in the photovoltaic panels, fuel cells, and rooftop gardens of environmental projects in cities and suburbs alike, which are conceived as much to mitigate risk and keep-the-lights-on, as to reduce the environmental impact. (Braham 2016, 201)

Braham's conceit is that anything designed carries with it narratives, and narratives about generative architecture often centre on survival and power above all else. Narratives of survival and power do incorporate energy generation, an improvement on the previous decade's mechanization scheme, but are isolationist in nature and lessen the importance of the architect in design.

One project that embodies the energy as survival and power narrative is 'The Ark', a bio shelter designed in the late 1970s by The New Alchemy Institute, a research group devoted to imagining new sustainable building practices.

The Ark was constructed in Cape Cod in 1977, along with a smaller prototype in Prince Edward Island, which has since been demolished. Dubbed 'living machines', both Ark structures were entirely self contained 'bio shelters' capable of sustaining a small family with many circular resource cycles. One of the New Alchemists' goals was to demonstrate the possibility of self sustainability and living off of the land without sacrificing then contemporary comforts (Jack Todd 1993, 28). Unlike the Pompidou Centre and its celebration of technology, the Ark is reserved in its appearance and does not proclaim its energy attitudes to the world as clearly.

William Braham notes that “even the most ecological survivalist camp is ultimately a private farm without a market town or trade network, and this highlights the dangerous temptation for environmental design” (Braham 2016, 205). He goes on to argue that a full thermodynamic accounting would reveal the many other resources like tools and information which are needed to fulfill current lifestyles (Braham 2016, 201), contradicting the proclaimed total self sufficiency of the Architecture as Power paradigm.

Nancy Jack Todd acknowledges the social limitations of the Ark projects in her 1993 book ‘From Eco Cities to Living Machines’, noting that The Ark’s isolation from infrastructure and high economic cost meant the project had essentially become an expensive isolated homestead rather than the architectural demonstrator that was intended (1993, 47). In comparison to the Pompidou Centre, the Ark failed to achieve the cultural relevancy needed to propel this paradigm to the mainstream.

Though architecture as power improves upon the fossil fuel dependency of architecture as machine, the paradigm fails to consider any energetic principles before the operational energy phase and relies on a vast footprint to reach self sufficiency. In the words of Braham, “the survivalist camp actually mirrors the appeals of the all glass building, on a reduced scale, according to the fears of imminent scarcity that lurk within the wealthy abundance of contemporary civilization” (Braham 2016, 207). Architecture as Power never took the same hold in society as Banham’s mechanization, and is only found in isolated environments.

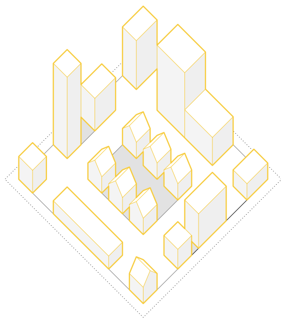



Diagram showing architecture as embodied energy.

## By Designing Architecture as Embodied Energy

The third and most contemporary paradigm to consider is Architecture as Embodied Energy. This paradigm arose in the early twenty-first century by the likes of architects like Kiel Moe and Chris Magwood. With a greater consideration of building materials, architecture is equated to the landscape from which it arose by conceptualizing the physical pieces of the building as manifestations of energy.

In his book, *Convergence: An Architectural Agenda For Energy*, Kiel Moe calls for a rejection of the over complicated building systems that modern architecture relies on, and a return to a holistic attitude to natural systems and energy. “Within the realm of design and construction, the term complexity must be reserved for those organizations and designs that yield self-catalyzing feedbacks and qualities of life” (Moe 2018, 84). Moe advocates for a rejection of the complicated material assemblies and systems set out by most modern building codes, instead proposing a more intentional consideration of how energy flows and systems are incorporated into a building’s envelope and form.

“Architects could intensely design the minimum but most potent and powerful settings and organizations that trigger complexity, or they can continue to just manage complicated sets of imposed information, systems and geometries.” (Moe 2018, 85). Considering a building as a system, rather than an object, eliminates the need for new material layers, new consultants and new energy systems at each step of the project (Moe 2019, 87).

In *Convergence*, the dominant interaction between architecture and energy is that of embodiment. Moe argues that architects should acknowledge and incorporate the energy cost of materials and their transportation, construction and eventual demolition as part of a building's energetic narrative (Moe 2019, 75). In a number of projects, in considering their whole lifespan, the energy needed for operation is dwarfed by the energy cost of the initial materials (Moe 2019, 79). This focus on embodied energy over operational energy is echoed by contemporaries like Chris Magwood, who has written extensively on carbon manifestation and sequestration in architecture.

Moe and Magwood's way of connecting architecture and energy is more comprehensive than past energy paradigms, acknowledging both the importance of conservation and embodied energy, but does not address architecture's potential for energy generation or consider architecture's relationship to wider infrastructures. Though their work is important and addresses previously overlooked issues, there is yet to be wide scale adoption, instead this form of building is found in a small collection of private dwellings.

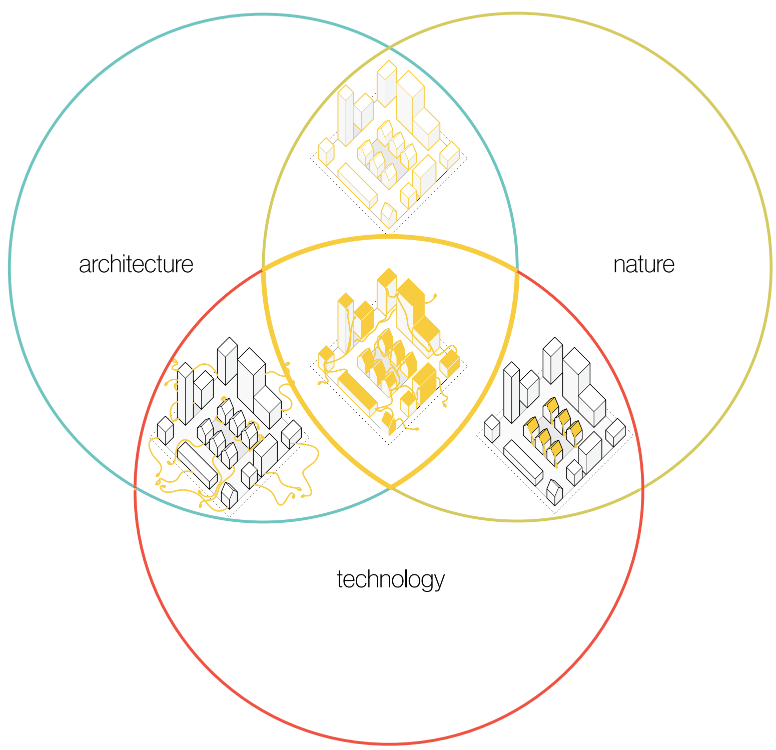
An example of the embodied energy paradigm is Kiel Moe's Stack Haus which was built in Granite Colorado in 2008. This project aims to contrast the paradigm of the multi-layered residential wall with an emphasis on embodied carbon and thoughtful energy performance. In rejecting the conventional building method, the house avoids 'adding a network of externalities with each layer, increasing its ecological footprint' (Moe 2019, 184). The walls are composed of a combination of 6" x 8" spruce timbers, oriented horizontally - perpendicular to a conventional framed wall - acting as all elements in a typical wall (cladding, air/water/vapour barriers, thermal conditioning, enclosure, structure) simultaneously as a complex system.

The Stack House located in Colorado and its natural, local material palette (Moe 2019, 72)

The radical approach to material use eliminates operational energy consumption and minimizes the embodied carbon of the house, in part by sourcing materials locally from central Colorado. The spruce beams were chosen due to their low thermal diffusivity and thermal conductivity compared to conventional materials like steel or concrete (Moe 2019, 187). The complex approach to the energetic properties of spruce demonstrates a methodology where the necessary energy was ‘spent’ on the building’s form, structure, and materials rather than complicated technological systems or externalities. In this way, Moe's work differs greatly from Banham; and demonstrates a level of thoughtfulness in material and the pre-operational building stages not found in the work of Nancy Jack Todd.


Diagram showing 'Community Infrastructure' paradigm.

The success of this project energetically shows that there's a value in considering the thermal properties of materials as well as the physical location where materials are sourced. The concept of an 'energy budget' is a new way to look at the important decisions that come into play when designing energetic architecture. Though there's much innovation in the life cycle analysis portion of the design process, this paradigm lacks the celebration of technology that defines the mid twentieth century attitude towards energy and the inclusion of energy generation seen in the Architecture as Power paradigm.



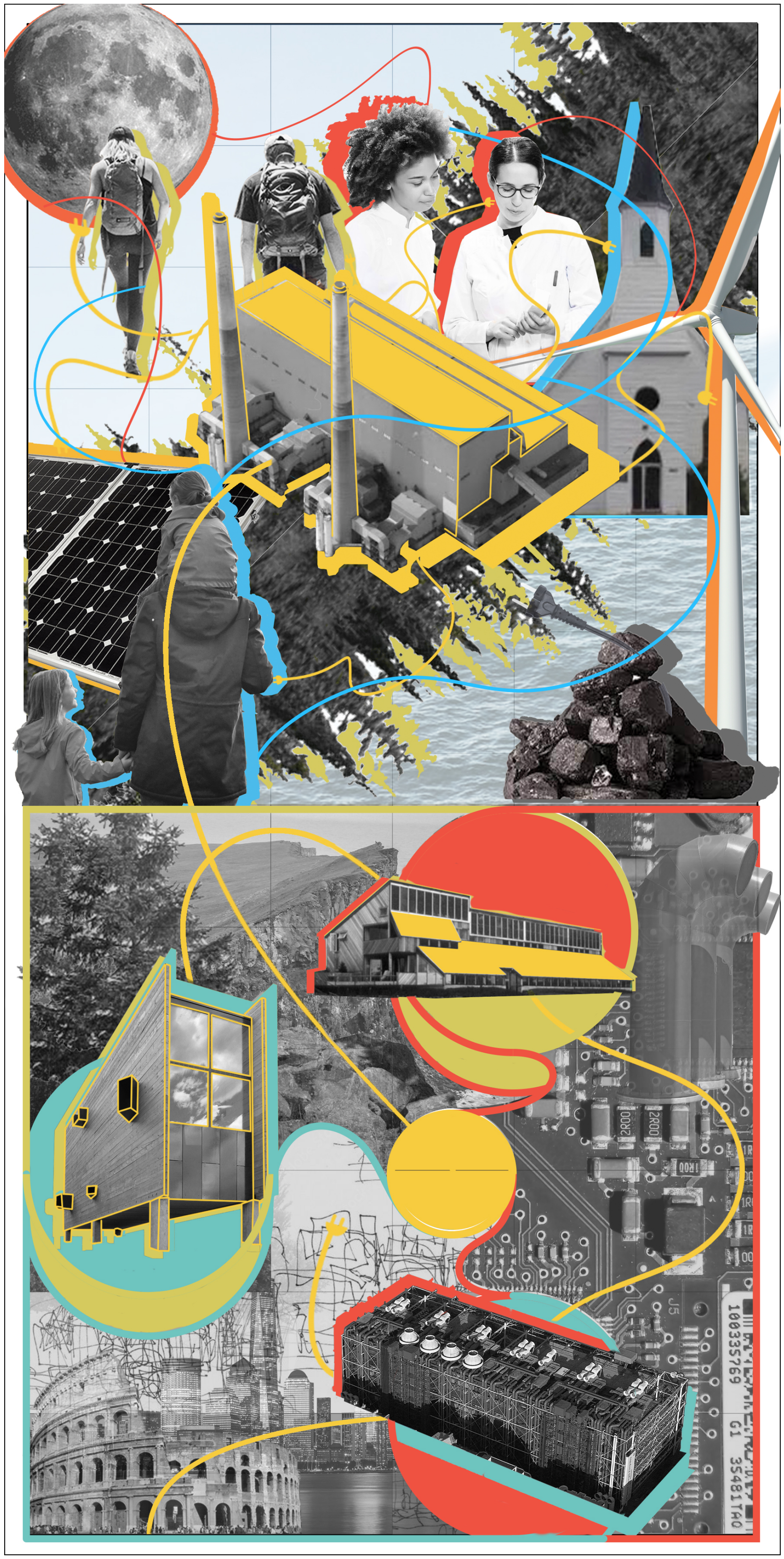

A venn diagram comparing past energetic design paradigms in relation to architecture, technology and nature.

## As We Enter the Post-Coal Era

As architects meaningfully reckon with our changing climate, a changing energy landscape requires a changing energy paradigm in design. Each of the above paradigms considers the categories of architecture, technology and landscape as distinct.

Much like the above paradigms build upon each other and arise as a response to global politics or technology, they all remain small scale and isolated. Neither Power or Embodiment contribute to or engage with larger infrastructures or communities.

This thesis calls for a new paradigm of energy and architecture that emerges from the overlaps and intersections of landscape, technology and architecture. Only when these systems are fully intertwined, can new architectural forms arise that embody the architecture of the next energy transition.

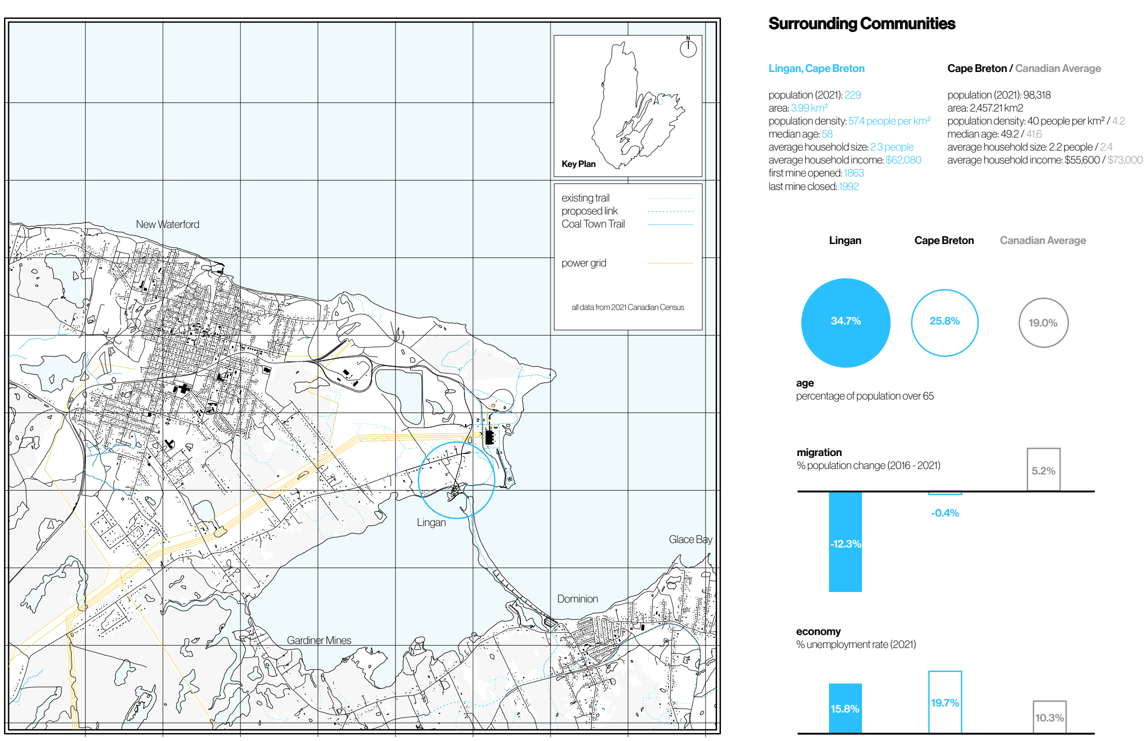


Wish image showing the proposed new relationships between architecture, technology, nature and art

# Chapter 4: Cape Breton's Role

In order to fully incorporate a community and infrastructural scale into the architecture of the next energy transition, the surrounding communities and infrastructural landscapes must be understood in their relation to history and the future. Looking at a community holistically and analysing its landscape, both physical and metaphysical, enables architecture to respond in a meaningful way.

In addition to Cape Breton's rich social history, the island still bears the scars of the coal mining industry in its culture, spatial planning and landscaping. The cultural association with and physical legacy of the former mining industry makes Cape Breton an ideal site for a demonstrator of Post-Coal Architecture.




Map showing Lingan's connections to nearby mining towns and census data comparisons. (Base map from publically available GIS data via GeoNOVA 2012a and GeoNova 2012b). (All population data from Statistics Canada 2023).

## As a Scarred Landscape

Landscape and industry go hand in hand as industry has been pushed to the margins of society, when we consider a landscape as productive we begin to see it through a new lens as its consumed and rebuilt. Failing to incorporate and acknowledge these scarred landscapes into design would be denying history and doing a disservice to the architect.

One of the more visual impacts of the coal mining industry is the scale of deforestation present on former mine sites. As the landscape was mined, trees were clear cut en masse, creating pockets of smaller, shorter and younger forests in previously mined areas (Price 2019, 87). This visual clue quickly identifies previously mined areas even if the mine shafts have been filled and the environmental contamination mitigated.

Less common coal mining attributes in Cape Breton like spoil tips create distinctive landscapes of small rolling hills as vegetation re-grows on closed mines (Price 2019, 35).

As time has progressed many former mine sites have been rehabilitation and remediated, including the former steel mill in North Sydney, which now exists as a public park (Murray 2022, 13). These post-coal landscapes enable architects to view the terrain as a series of histories. Many former industrial sites have retained aspects of the altered landscape as a way to honour heritage and history through large scale remembrance.

## Dotted with Company Towns

Along with the physical changes to the landscape, Cape Breton bears the scars of nineteenth and twentieth century company town planning in its infrastructure and spatial qualities. Analysing and straying from the aesthetics associated with the company town is a visual way to divorce a new form of architecture from the consumptive, extractive past energy form.

Company towns are categorized by the complete and total dominion that a business has over its employees/inhabitants, Many single enterprise communities followed the company town model, most often in manufacturing or mining industries due to their dependence on site specific resources (Garner 1992, 1). As company towns were wholly owned by one business or individual, houses and commercial buildings were often designed by a singular architect to the point of total standardization, creating distinct aesthetics (Garner 1992, 57). The company town model was in part designed to suppress organized labour, often becoming the site of violent clashes between union protestors and company hired goons (Garner 1992, 215).

The community town model is a rejection of productive community, and wholly representative of extractive industries that rely on suppressed labour (both visually and economically) to thrive. An architecture for the next energy transition needs to divorce itself from the company town model and instead engage community on a decentralized non-exploitative level.

## Home to Nova Scotia's Post-Industrial Economy

Though exploitative notions like the company town sought to erode community, many former mining towns have a deep history and sense of identity tied to their mining past. Incorporating and intertwining ties to industry is a way to honour history and bring to light the scale of extractive energy paradigms, as the economic effects of industry leave.

Today, Cape Breton exists in a state of economic decline after the exodus of both the coal mining and steel industries. The island is beginning to grapple with its post industrial economy and what that means for Cape Breton's future. For example, Lingan has massively de-populated in the late twentieth century, declining from a quarter of the province's population in 1914 at the height of the mining industry living in Lingan / New Waterford / Glace Bay (Donald 1966, 47) to now only 229 people in Lingan itself (Murray 2022,17). The Cape Breton Regional Municipality (CBRM) released the *CBRM Forward Economic Development Report* in late 2022 which outlines that:

> The CBRM has experienced significant economic upheaval over the last 20 to 30 years. Once commonly called Industrial Cape Breton due to its reputation as an energy and manufacturing powerhouse, the CBRM now has one of the lowest concentrations of mining and manufacturing employment among urban centres across the country. (Murray 2022, 8)

Additionally, "among the 70+ economic regions across Canada, Cape Breton had the second steepest population decline between 2001 and 2021 (a decline of 13%)" (Murray 2022, 7). The closure of the coal mines in 1999 and steel mill in 2001 meant the loss of a large number of industrial sector jobs, which have not been recovered (Murray 2022, 22).

Cape Breton follows the trend that plagues similar coastal communities in the province. Rural coastal communities are in decline in Nova Scotia, inland rural communities are faring better (Canadian Rural Revitalization Foundation 2016, 67). The declining economy in Cape Breton makes the island an ideal place for forms of rural revitalization through design.

## Home to Nova Scotia’s Coal Infrastructure

The current architecture and infrastructures of Cape Breton were created in response to global energy paradigms shifting, the new forms that emerge should respond to new energy trends in the same manner. Additionally, the immense amount of energy both human and inhuman that was poured into these infrastructures is at risk of being lost if not for reuse.

Nova Scotia’s remaining coal infrastructure was largely built in the late twentieth century as a response to the OPEC oil crisis in the 1970s, generating stations were constructed in Cape Breton in order to maintain proximity to the then operational coal mines. Cape Breton is the home to 3 of the 4 remaining coal and petcoke generating stations in Nova Scotia, 2 (Point Aconi and Lingan) lie within the boundaries of Cape Breton Regional Municipality, and all 4 burn a combination of the two fuels (Nova Scotia Power 2022).

The Lingan Generating Station has the greatest generating capacity of 620MW, Point Aconi accounts for 171 MW, Point Tupper 154 MW (Nova Scotia Power 2022). All four power plants are slated to be permanently decommissioned in 2030 in order to meet the province’s climate action goals (Environment Journal 2022). The impending wide scale decommissioning creates an opportunity for landscapes to be created and reclaimed from former industrial sites. Just as the coal infrastructure on the island arose from the energy shifts of the mid to late twentieth century, new experiential landscapes can arise from contemporary energy shifts.

A view of the Lingan Generating Station from Dominion Beach Provincial Park (NS Power 2022)

## In Post-Coal Identity

In his 1992 book, *Cape Breton: Identity and Nostalgia*, Kenneth G. Pryke notes that “while nostalgia may succeed in legitimating community control over events, it can be a dubious guide to the future and an unreliable means of understanding the past - the question is not whether there should be a link with the past, but rather what past? And what link?” (Pryke 1992, 173). New forms of architecture must respond to the past, but in a way that engages the future.

## And Monumentalizing the Past Through Design

Debra McNab, in her book *Old Sydney Town,* notes that in Cape Breton “the impetus behind appeals to protect the built heritage is quite explicitly an attempt to shape public policy by changing the public’s perception of the past” (Pryke 1992, 181).

McNab also indicates that “the loss of any historic structure severs another link with the past” (Pryke 1992, 182). Speaking specifically to the remembrance of the coal mining industry, there have been many different avenues for monumentalization including preservation, recreation, and celebration. Each of these paradigms builds upon coal’s role geologically, socially, physically or culturally (Graham 2018, 1).

Through analysing these avenues for preserving and monumentalizing past energy paradigms, it becomes apparent that Cape Breton, and Lingan specifically, provide an opportunity to design meaningful landscapes at the infrastructural scale.

A view of Landschaftspark Duisburg-Nord in 2011 (Latz 2011)

As an example of preservation through memorialization, Landschaftspark Duisburg-Nord was designed in 1991 as a way to both reuse a former industrial coal and steel production plant and to emphasize the importance of memorializing an industrial past. The park, though recreational in program, still retains the vats majority of its industrial past both visually and spatially.  An important aspect of the park, is that it is to be experienced through multiple time scales - the past uses of spaces, materials and industrial equipment is not obscured or celebrated directly, but memorialized and acknowledged. The ecologically destructive technologies and their resulting landscapes are preserved and dwelled upon as users experience the park. As time passes, the introduced vegetation begins to consume the decaying infrastructure (Latz 2011).

This attitude towards preservation allows for visitors to experience and understand the past energy paradigm on a personal level as scale, material and spatiality are understood by experiencing the infrastructures as they originally stood.

An opposing example of monumentalization through design is the idea of a Coal House. Appalachian communities in states like West Virginia have constructed buildings physically made of coal in order to preserve a piece of their town's


The front facade of the West Virginia Coal House, clad in locally mined coal (Graham 2018)

mining history (Graham 2018, 2). Though unconventional as a building material, coal can be pressed into masonry and coated with varnish for weather resistance. The West Virginia Coal House specifically was erected in 1933 as a publicity stunt, by the Norfolk and Western Railway (Graham 2018, 3).

The coal house is intended to celebrate the past economic success of the town, choosing to memorialize coal as a source of economic prosperity rather than the cause of present and future ecological destruction. These two opposing angles to monumentalization demonstrate the dichotomy of extractive energy industries effects on communities. On one side, preserving what has been historically a source of wealth, pride in labour and creation of community is a way to celebrate the effects of coal on a landscape. Oppositionally, design should seek to educate and demonstrate the gap in environmental impact between clean and extractive energy paradigms and exist between these two paradigms.

## In Rural Revitalization

As a post-industrial economy, Cape Breton Island is a candidate for rural revitalization. The economic decline of the industrial sector has caused the loss of many jobs both blue and white collar. Knock-on effects of this decline is the island losing young residents, who often move west for better job opportunities, leading to an aging population (Canadian Rural Revitalization Foundation 2016, 6). Two means of rural revitalization are through institutional and educational avenues. Though the municipality identifies the energy sector as an opportunity for job growth, educational programs focused on clean energy are lacking not only in Canada but world wide (Gelegenis 2014, 3).

> The municipality needs to ensure the energy sector remains an important driver of economic activity in the years ahead. The CBRM will need to determine what the new opportunities, particularly in green energy production including wind, offshore/onshore, solar and hydrogen production, and ensure the community is poised to get its share of new public investment in energy infrastructure. (Murray 2022, 16)

According to the findings of the *CRBM Forward* report, Cape Breton University, located in Sydney, has been a success in drawing young people to Cape Breton (Murray 2022, 33).

Additionally, the federal government study, The State of Rural Canada calls for job creation, mechanisms to support local and regional collaboration, and place based approaches for rural revitalization as its primary methods (Canadian Rural Revitalization Foundation 2016, 70).

Finally, institutional or clean energy education may be a suitable candidate for revitalization methods as the same federal study found that rural Nova Scotian communities are more suited and engaged with enterprises that benefit the social or environmental good (Canadian Rural Revitalization Foundation 2016, 71).

One current example of a successful revitalization project is the Verschuren Centre for Sustainability in Sydney. The Verschuren Centre is a partially publicly funded research incubator associated with Cape Breton University. The Centre researches many clean energy adjacent disciplines like biology and chemistry. In the *CBRM Forward* report, the municipality notes that: "Central to the bio-economy opportunity is the Verschuren Centre for Sustainability in Energy and the Environment. The Centre has become a leading Atlantic Canada incubator and accelerator for new ideas and entrepreneurs in the bio-economy space" (Murray 2022, 18).

## In the Creation of a New Energy Landscape

Cape Breton is the ideal setting for the demonstration of new energetic architectures because of its simultaneous connection to both past and future energy paradigms. The island's rich history of coal extraction and consumption have left physical and cultural scars in the landscape and its communities, creating opportunities to memorialize, educate and cement coal as an energy source of the past through design.

In the creation of future energy industries, Cape Breton has vast landscapes with clean energy potential and provides an opportunity for rural revitalization through institutional and energy means.

The architecture of the next energy transition can be demonstrated in the landscapes which embody both paradigms. The dichotomy of coal can be explored in interstitial landscapes that incorporate the past and point towards the future.

# Chapter 5: Design Methodology: Designing Between

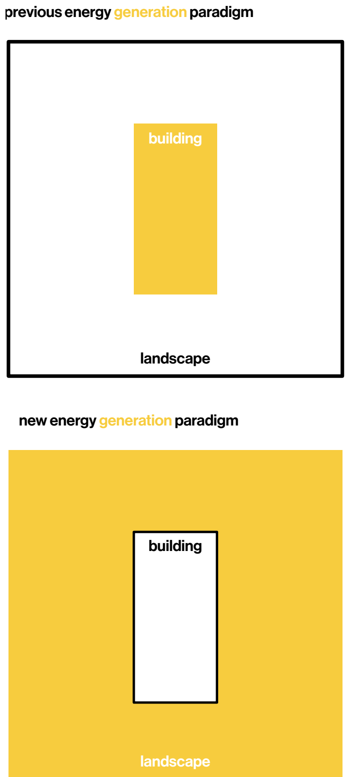


Diagram showing differences between the former and future relationships between site, building and energy generation

> Revolutionary infrastructure is the process of unmaking of petromodernity, of squatting in its ruins, of practicing subscendence rather than transcendence... Over time, through the work of proliferating decentralized small-scale action, the carbon grid world will find itself incrementally disabled by the tapping and redistribution of its materials and energies. (Boyer 2018, 240)

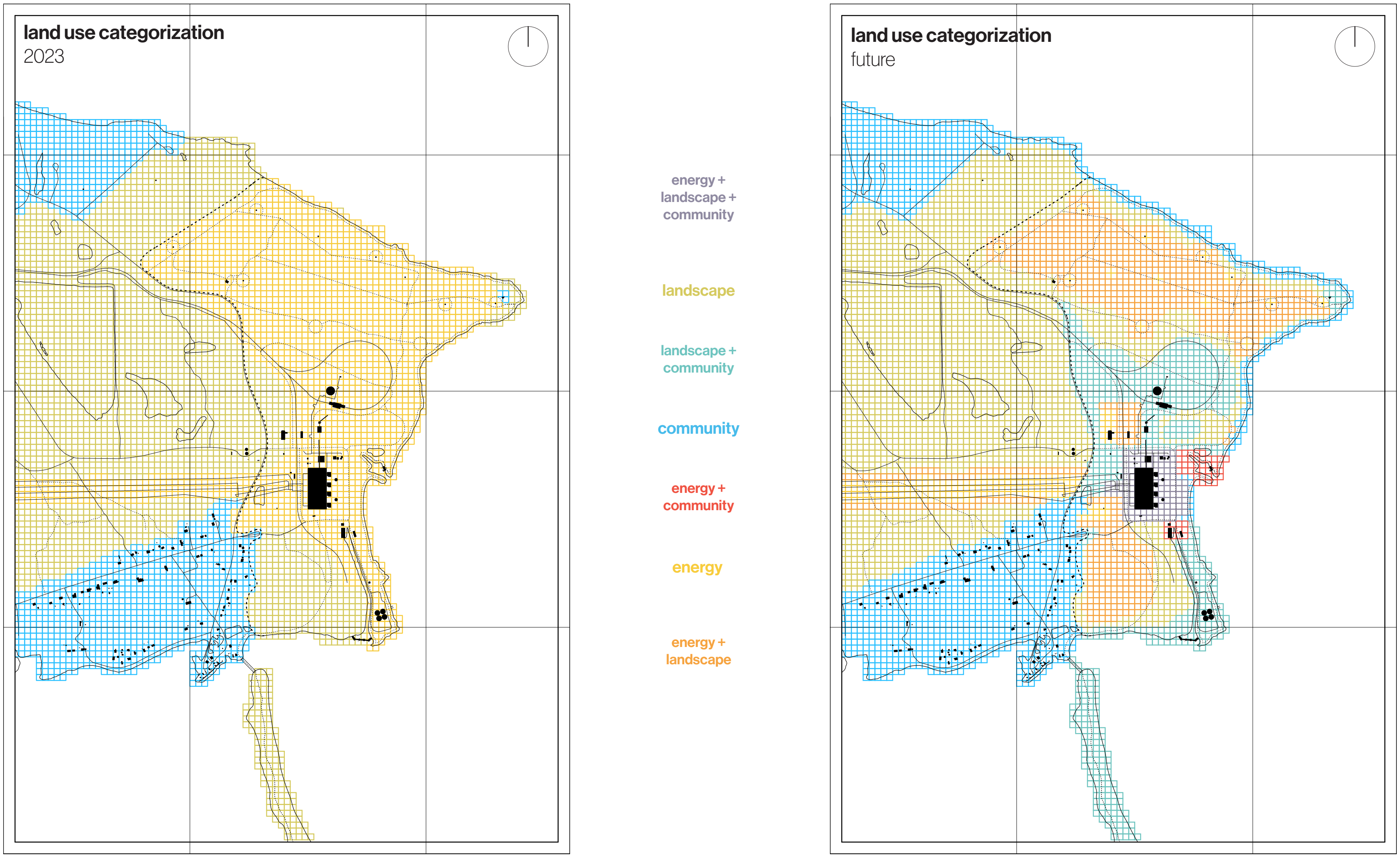
This methodology will provide a framework for the decommissioning of all four remaining coal generating stations in Nova Scotia. This work aims to encompass the overlaps and exchanges between the realms of architecture, technology and nature at varying scales through a series of architectural and landscape interventions.

## The Infrastructural and the Architectural

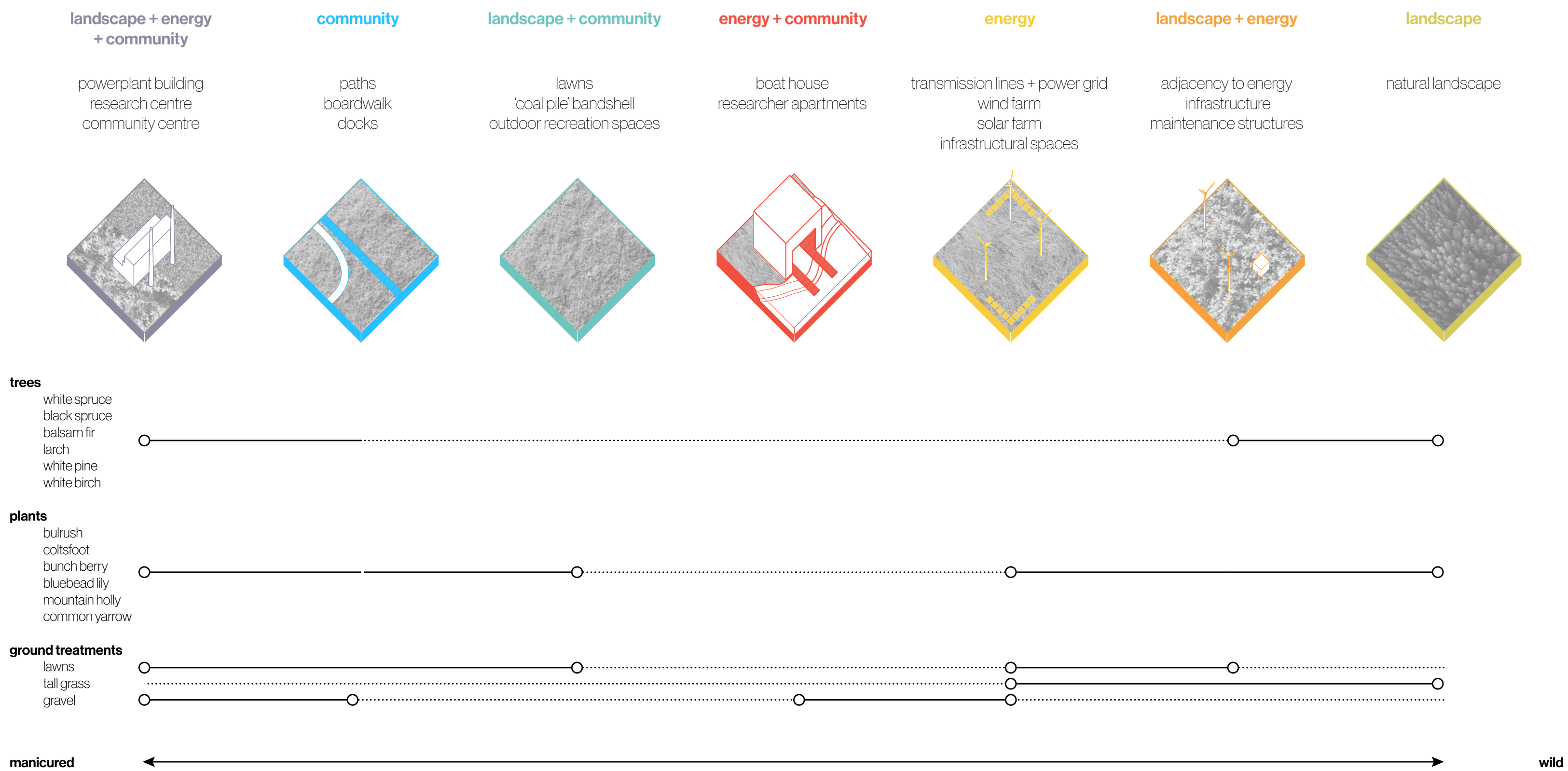
The broadest scale of intervention is to sever functional ties to the coal industry by replacing the energy generation on site with new clean energy sources in the landscape, creating meaningful levels of generation. The connection and proximity to the existing power grid allows for a reorganization of the links and networks of fossil fuel infrastructure into a subscendent experiential landscape.

Through the redesign of the power plant building itself, highlighting and incorporating the infrastructural scale means interventions such as the conversion of industrial railway to passenger rail (in an effort to reduce the amount of cars traveling to the site and link the building to downtown Sydney directly).

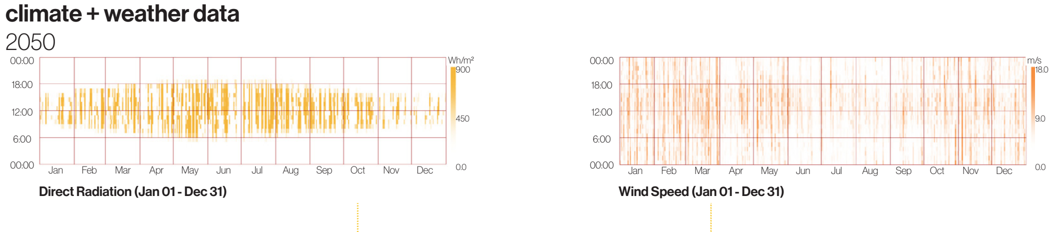
While the physical pieces of coal infrastructure remain, the use and program of each piece of equipment will be divorced from its extractive past and given new life while



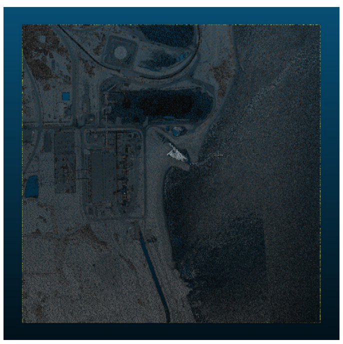

Preliminary site mapping showing current and future land uses.




Planting and ground treatments that correspond to new land uses.




Climate data for Sydney, NS (approximately 15km from Lingan), future shifted to 2050 in accordance with a 'relatively high emissions scenario' (Ek et al 2018).



Analysing a 'piece' of LiDAR data in Cloud Compare in order to visualise the point cloud.

retaining its monumental scale. Silos, boilers and turbines are converted to installation spaces to support educational, natural, or community driven artistic programming.

The energy park landscape will be dotted with smaller energy interventions creating a decentralized network of experiential technologies that rival the scale of generation of the past paradigm.

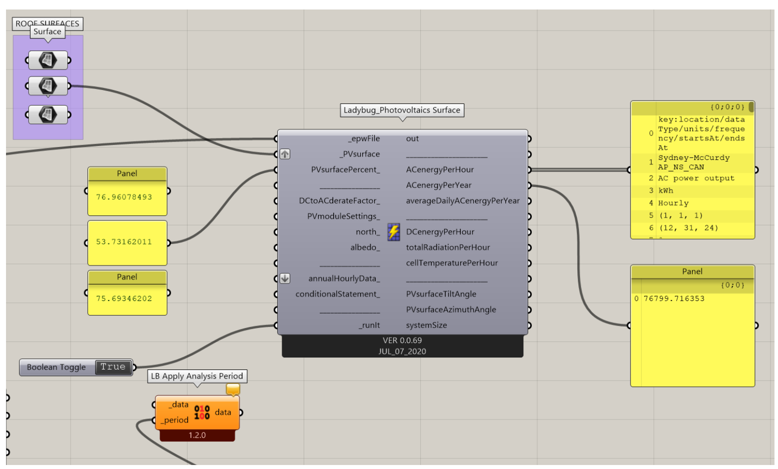
## The Technological and the Natural

The initial design stages for both the site and the building began with extensive digital testing and analyzation of the site and micro climate using publicly available climate data. Initial site testing was performed on a digital site model created by analysing provincially published LiDAR (Light Detection and Ranging) point clouds in Cloud Compare and constructing a Delaunay mesh surface in Rhinoceros 3D. This method of site mapping provides a higher degree of accuracy when testing climate and weather trends compared to relying on traditional GIS data alone.

Once the site model is constructed, climate and weather information was tested against the site to determine the optimal placing of various spaces and infrastructures within the site's micro climate. The climate and weather data for Sydney, Cape Breton (the closest available Canadian

Weather Year for Energy Calculation data set, roughly 15km southwest of Lingan) has been future shifted by the Pacific Climate Impacts Consortium to resemble Sydney's climate in 2050 assuming a 'high emissions scenario' (Ek et al 2018). Digital testing was performed using Grasshopper plug ins like Ladybug, HoneyBee and Eddy 3D to analyse solar, interior energy and wind respectively.

Land use decisions within the energy park are made by mapping current distinct uses (energy, community, landscape) and then abstracting areas of adjacencies into areas of overlap to determine site strategy. The new areas of overlap aid in the creation of distinct land uses which combine public programming and infrastructures both old and new.




A screenshot of photovoltaic panel system modelling results using LadyBug.

The site design incorporates energy generation technologies into the landscape, allowing visitors to experience the merging of technology and landscape as they wander through the hiking trails on the site. The building itself aims to be responsive to environmental phenomena both in terms of performance and experience.

Energy generation calculations are built off of the hydrological forces described by Dr Alex Hay and Dr Bruce Hatcher in their Cape Breton Resource Assessment Report (2012), the method of wind energy calculations is described in the paper ‘Calculating Electric Power and Energy Generated in Small Wind Turbine-Generator Sets in Very Short-Term Horizon’ (Parol 2019). All modeled wind turbines are meant to represent Enercon E70 turbines to correspond to the existing wind farm currently present on the site. Solar energy is calculated with simulated photovoltaic system modeling in LadyBug. All technologies described both in the building and in the park are industry standard as of early 2023, denoting this thesis as a hypothetical demonstrator for the feasibility of both interventions.

## The Architectural and the Technological

The redesign of the generating station will seek to hybridize building technology and architectural form. A key component of merging the form of the building and its technological performance is to engage with architectural technologies in new ways. In an effort to conserve energy during the operational phase of the building, the volume of indoor, actively conditioned space will be greatly shrunk while the footprint remains constant, creating a discontinuous network of interventions within in the generating station itself.

In addition to the physical reduction of conditioned space, an interstitial space will be created between the existing walls of the power plant and the new walls of the research centre where passive conditioning reduces the need for additional heating and cooling loads but remains separate from the exterior environment.

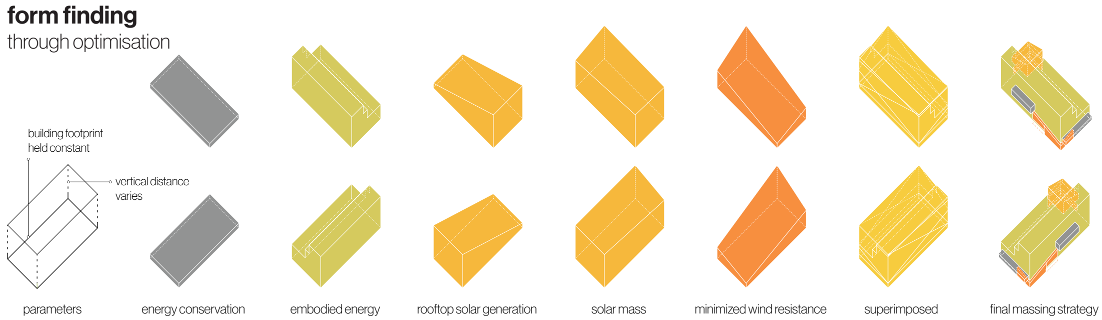
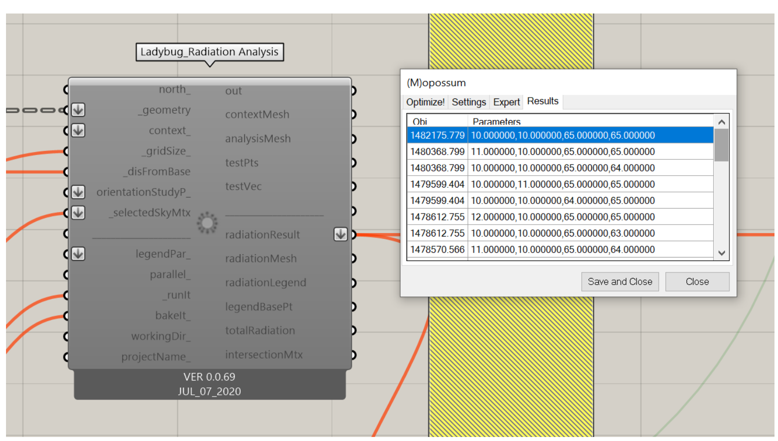



Diagram showing an inventory of ‘optimsed forms’, derived from Opossum calculations, that are used for the building’s additions and subtractions.

## The Natural and the Architectural

In an effort to not waste the embodied energy present in the original structure, the generating station’s steel column grid and concrete walls will be preserved when possible. The new construction interventions will employ materials that sequester carbon and minimize the building’s energetic cost over its lifespan.

An inventory of ‘optimized forms’, created by restricting the building’s footprint and varying its vertical edge lengths, for various energy considerations will be calculated using Opossum 2.0 in order to add and subtract from the existing building massing.




A screenshot of Opossum results, after testing 200 iterations of building edge length combinations.

The industrial equipment of the generating station, will be retained either in place, or scattered through the landscape in order to convey the scale and processes of the past energy paradigm and contrast it with the new.

Finally, the building (both existing and new interventions) will seek to blur the boundary between inside and out with continuous landscaping and ground treatment design that breaches the threshold of the building.

# Chapter 6: Design Interventions

This thesis proposes a series of design interventions that aim to engage the public with energy infrastructures and bring awareness to both past and future energy paradigms. These design interventions act as a demonstrator for the inclusion of new energy technologies in both architecture and landscape.

## Program

The proposed programming largely consists of two main components; a functional energy park and a provincially operated research centre located in the former generating station building. Both the park and building contain many sub-interventions that foster public awareness and engagement with energy systems. Small recreational spaces in the park,

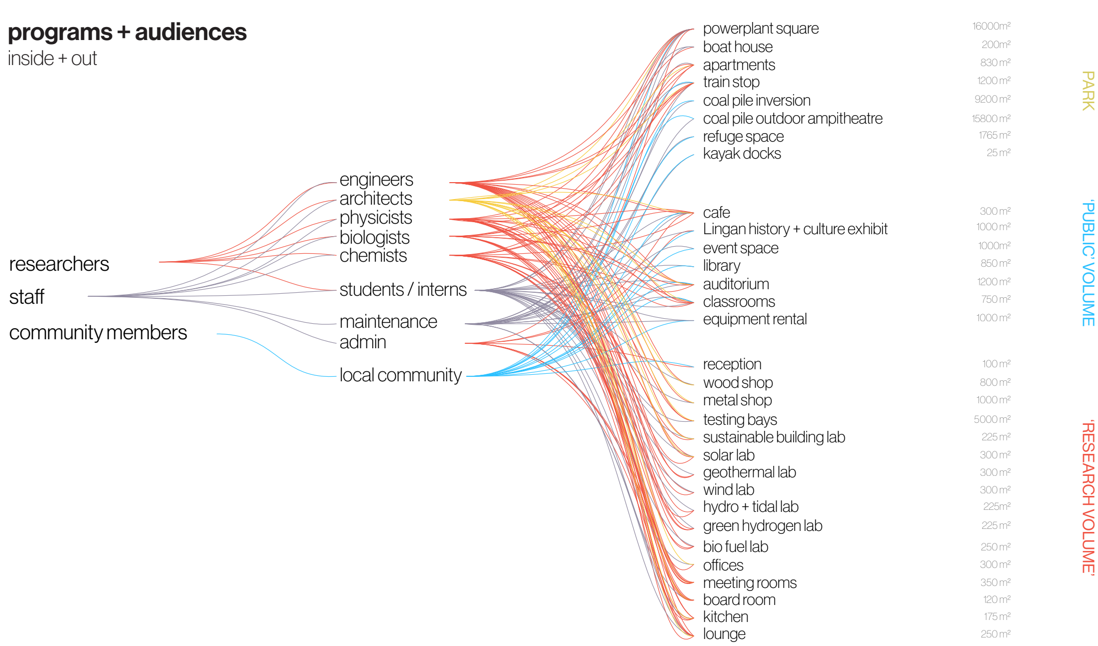



Diagram showing the overlaps and intersections between various user groups within both the building and the park.

and the addition of an educational component within the research centre draw visitors in to demonstrate the enormity and effects on the landscape of both past and present energy paradigms.

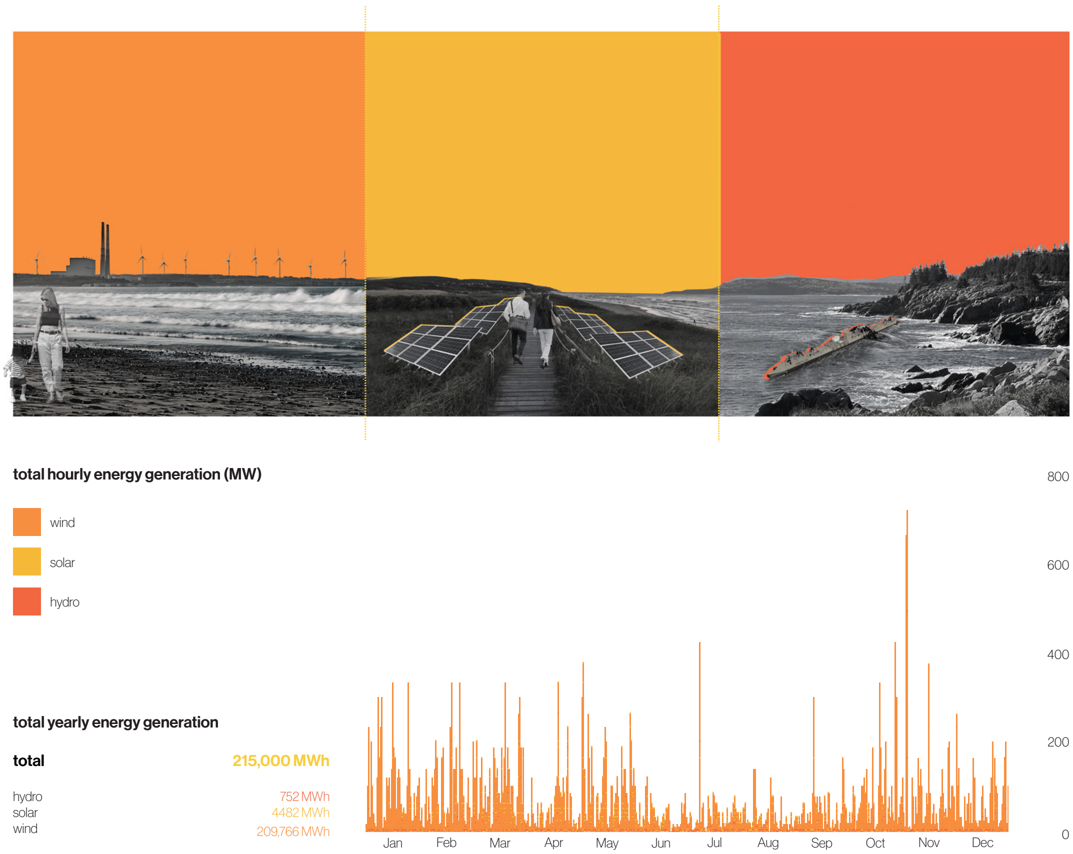
This cross programming operates at multiple scales to engage community groups and researchers as well as to demonstrate an alternative to the traditional energy park model, which maintains the mono-programming and inaccessibility of the former extractive landscape (Pasqualetti 2017, 4).

Addressing the aspect of community engagement, the park component of the proposed interventions returns the landscape to both the people of Lingan and a broader researcher community operating at the regional, provincial and national level. Community members are invited onto the site with recreational programming, suggestive of large scale events like markets, festivals and conferences, in an effort to familiarize the public with non-invasive energy infrastructures and create user groups accustomed to renewable technologies in public landscapes.

Inside the research centre building, a cultural and historical exhibit educates visitors on Lingan's coal mining past and allows for office space to be allocated to advocacy groups, placing them and the wider public in direct conversation with researchers and maintenance staff.

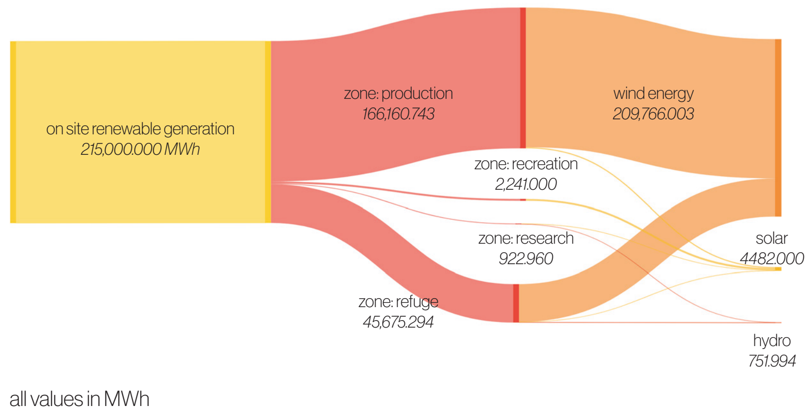
## Site

In addition to the public programming, the site functions as an inhabitable power plant, generating roughly 215,000 MWh of clean electricity annually through a series of energy infrastructures embedded within the public realm of the

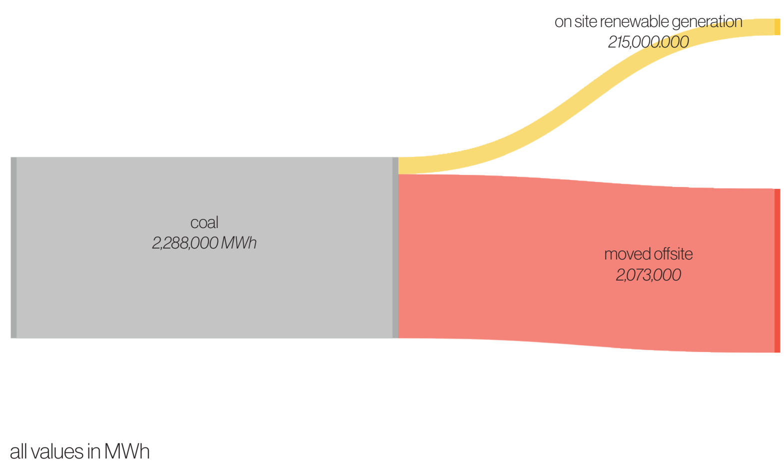



Vignettes showing the integration of various energy technologies into the park, coinciding with recreational programming alongside a graph showing hourly generation throughout the year.

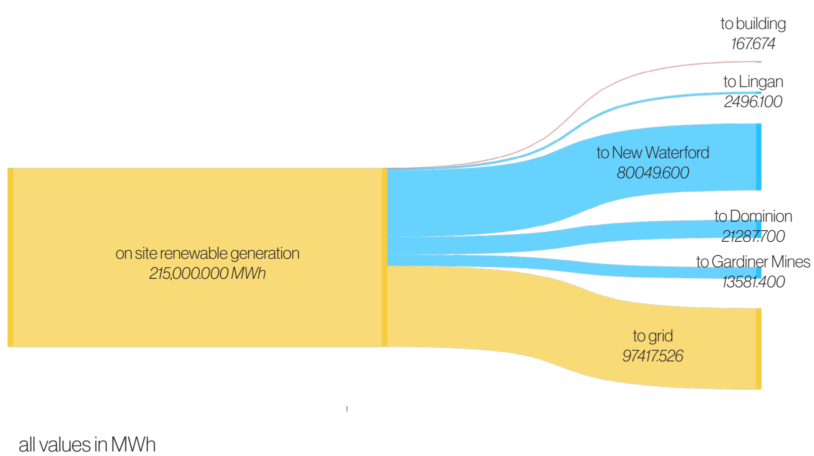
park. Assuming a per capita annual energy load of 10.9 MWh per year for the average Nova Scotian (Government of Canada 2019), the park generates roughly 2.6 times the amount of energy needed to power the towns of Lingan and New Waterford. Compared to the monumental scale of the former coal fired power plant, this community scale generation seeks to both localize the effects of production on the landscape (as opposed to disproportionally externalizing the consequences of generation as seen in the former paradigm) and act as a demonstrator for the creation of similar interstitial landscapes in communities across the province / Canada at large. Each typology of energy technology seeks to engage and educate the public through experiential landscapes at a series of scales.




Mapping energy flows annually from new renewable sources in the park and on the building.




Comparing energy flows of prior paradigm and new paradigm,

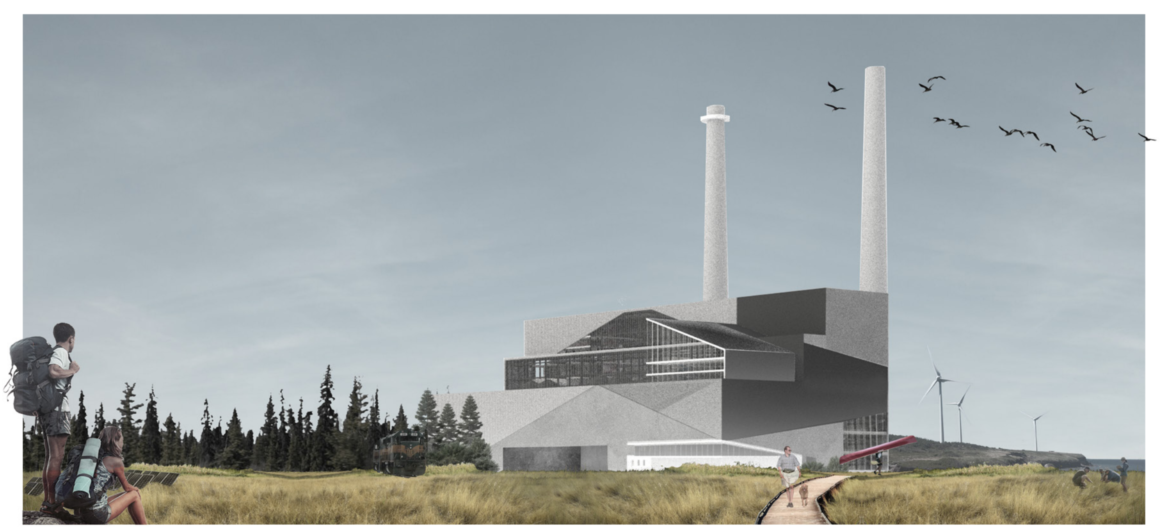



Mapping energy flows annually from new renewable sources to either power the building on site or to be distributed to surrounding communities.

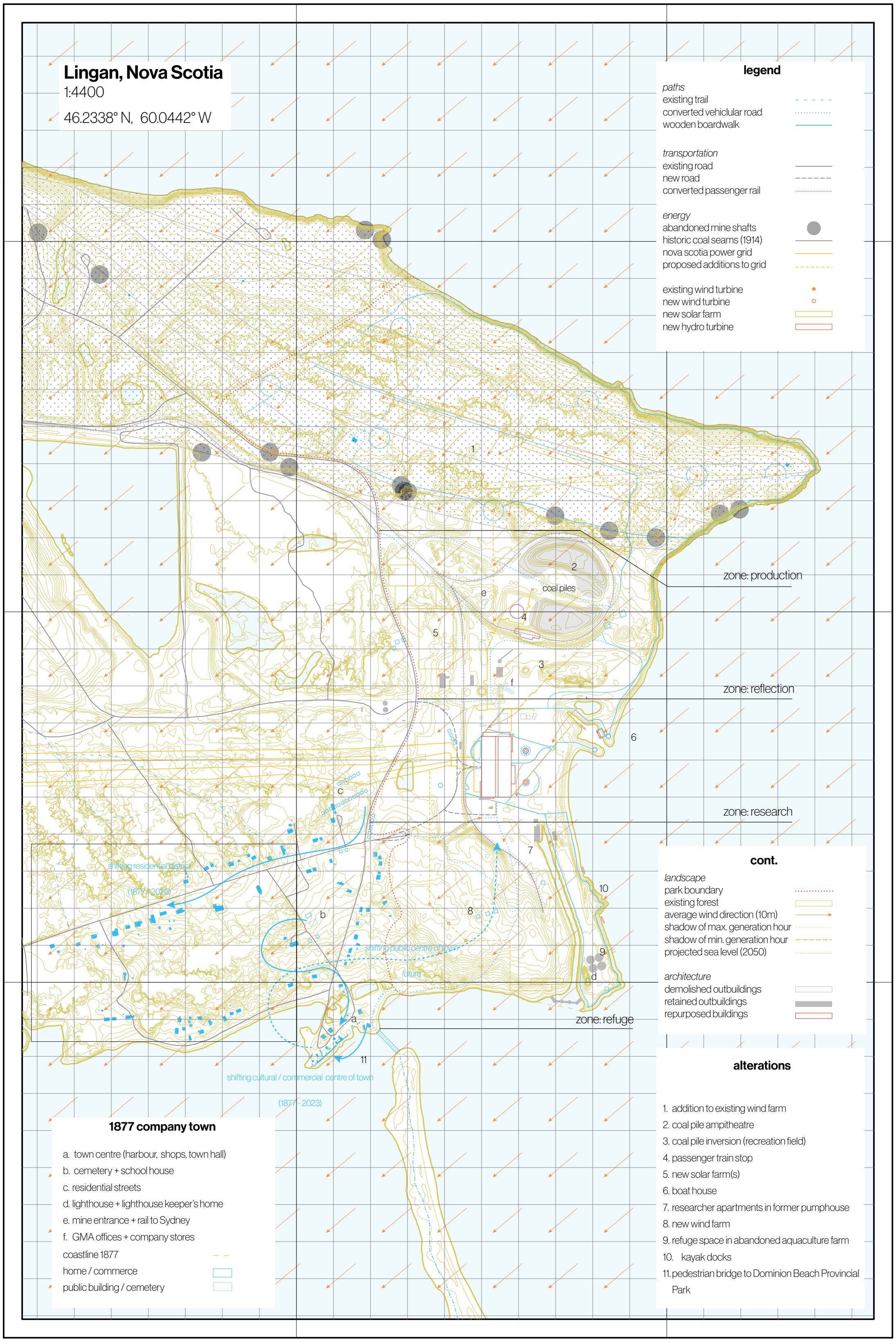
In the park, wind turbines speak to the monumental scale through their visual dominance. Each turbine can be viewed from across the bay, evoking reverence for wind patterns that stretch hundreds of kilometres from the site. The monumental scale visually contrasts the smokestacks of the former power plant, signalling the takeover of the new paradigm and the ruination of the old.

Solar farms are placed adjacent to hiking trails in order to familiarize visitors with photovoltaic panels as they represent the most common form of energy technology in cities and towns. Finally, hydro turbines are immersed in the landscape and demonstrate the smooth integration of technology into the park.

The majority of the vehicular roads within the park's boundaries have been converted to multi-use gravel trails in order to de-prioritize personal vehicle use in favour of the converted passenger rail link to Sydney. A small parking lot equipped with electric car charging is provided to the south of the building in order to facilitate energy storage. A wooden boardwalk circles the park's boundary and coastline in order



Exterior rendering showing the west and south facades of the research centre.




Site plan showing the relationship between the park's natural forces and surrounding community, contains existing and proposed trail networks and interventions. As seen in the comparison between townsites, community has been forced to the margin post 1877. (Base map constructed from LiDAR scans; GeoNOVA 2018) (Road and building data obtained from GeoNOVA 2012a and GeoNOVA 2012b).

to create a visual link to Cape Breton Highlands National Park nearby and provide an accessible route through the site for all.

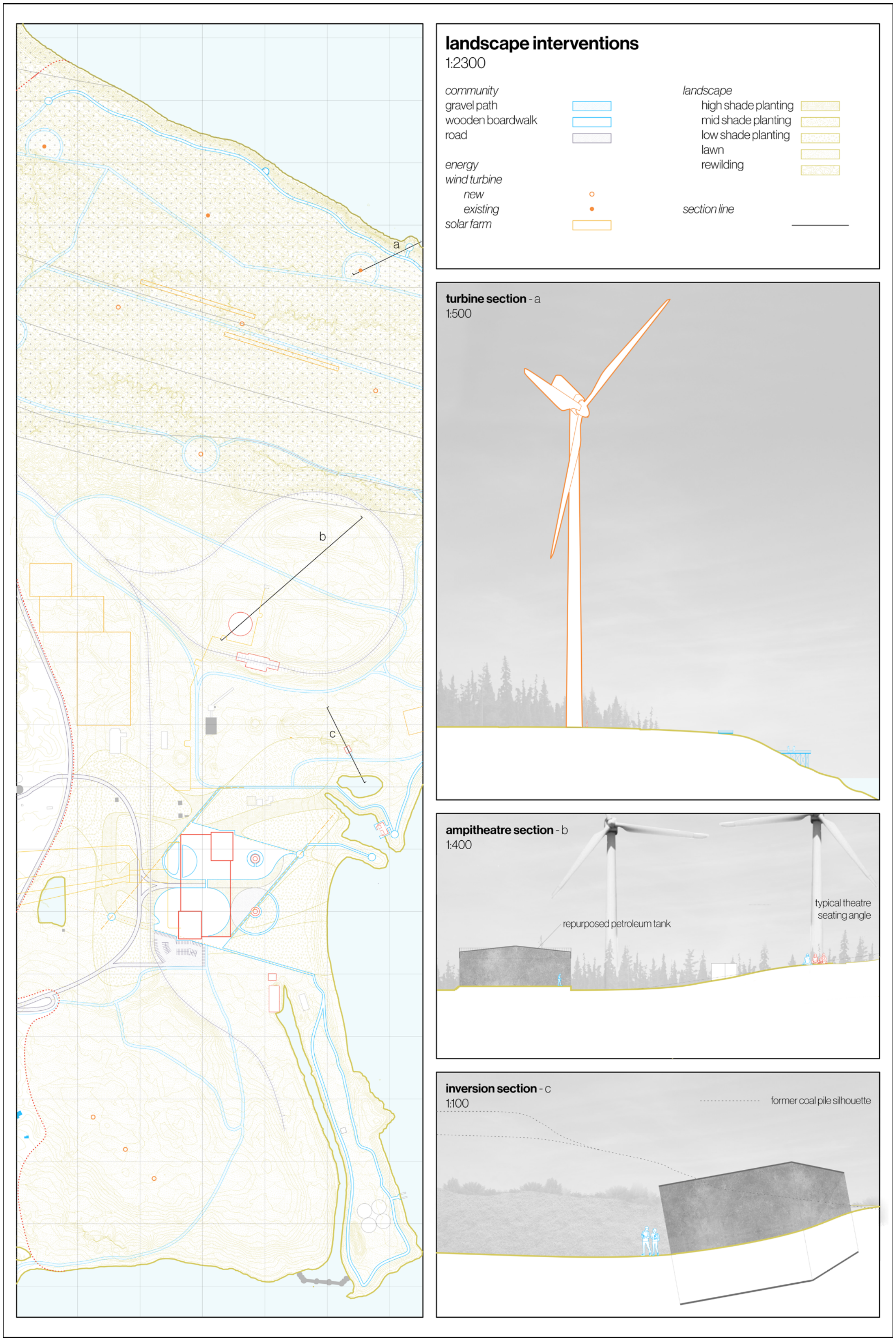
## Energy Park Interventions

The majority of the landscape interventions are recreational in nature and aim to foster a sense of community and connection with the landscape. The broader site is divided into ‘zones’, starting in the north shore of the park for production (containing the majority of the rewilded landscape and energy infrastructures), recreation (containing the former location of the two coal piles), research (containing the research centre) and refuge (a transition zone between the town of Lingan and the park).

Interventions include the spatial reversal of the two current coal piles, one inverted to a void and recreational field to show the scale of the prior extractive paradigm and the other replaced with rubble from the generating station building in order to create an outdoor amphitheatre composed of a rolling hill roughly in line with a typical theatre seating angle.

The aforementioned boardwalk that traces the site’s boundaries is dotted with circular lookout points in the north most zone to juxtapose the productive function of the landscape and the recreational nature of the park.

The final landscape intervention is the conversion of the north smoke stack to include a viewing platform 150m from the ground. These outdoor recreation spaces keep the landscape fundamentally public even amongst the most generative ‘zones’.




Closer site map and sections of key landscape interventions. Base map constructed from provincial LiDAR scans, roads and building locations from publically available GIS data (GeoNOVA 2012), (GeoNOVA 2018).

***And Community Scale Energy Systems***

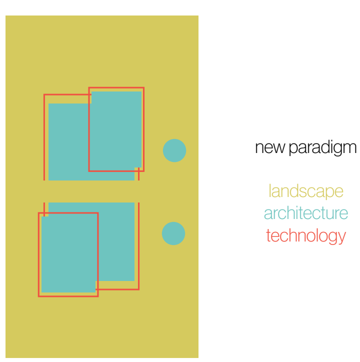
Though the park and its cross-programming support a variety of recreational activities, its primary function is community scale energy generation. Shrinking the scale of production from the prior centralized fossil fuel model enables communities to have autonomy and a sense of conscious empowerment about their energy systems.

Following a publicly owned cooperative model emerging in European communities, community scale decentralized energy systems allow for communities to become stewards over both their landscapes and their infrastructure (Byars 2021). A community-driven model can take advantage of existing legislation and policy initiatives as well as create community members that are invested in the creation and amendment of new laws. For example, existing feed in tariff programs can localize the profits from excess energy and divert capital from global corporations to community funds and initiatives that reinvest in regional projects.

This thesis focuses on a scale of generation which would support the energy demands of the communities that lie on the shore of Indian Bay, namely Lingan, Gardiner Mines, and Dominion as well as the town of New Waterford to the north. In addition to the current energy consumption, the park would supply an excess of over 97,000 MWh back to the provincial electricity grid annually. Communities in this area have had little control over privatized energy generation as profits have been externalized both historically by coal mining companies and presently by Nova Scotia Power. Similar in motivation to the unionization efforts in the early twentieth century, this new model and scale of generation allows for an increased autonomy and public authority over energy infrastructures.

Though this thesis narrows in on a singular energy park, at a national scale this cooperative model would allow for generative spaces in all communities and the reclamation of land previously designated for centralized generation or industrial use. As communities gain authority over energy generation, individual towns and cities would be in charge of determining the specific landscapes, technologies and scales they engage with, creating customized localized energy landscapes not seen in our current models.

Placing communities and energy in direct relation can be a way to increase the consciousness of community members in regards to generation, though the intent is not to create shame and drive individual consumption down, rather to empower members of the public to engage with and appreciate the environments that surround them.


Past and future relationships between architecture, landscape and technology

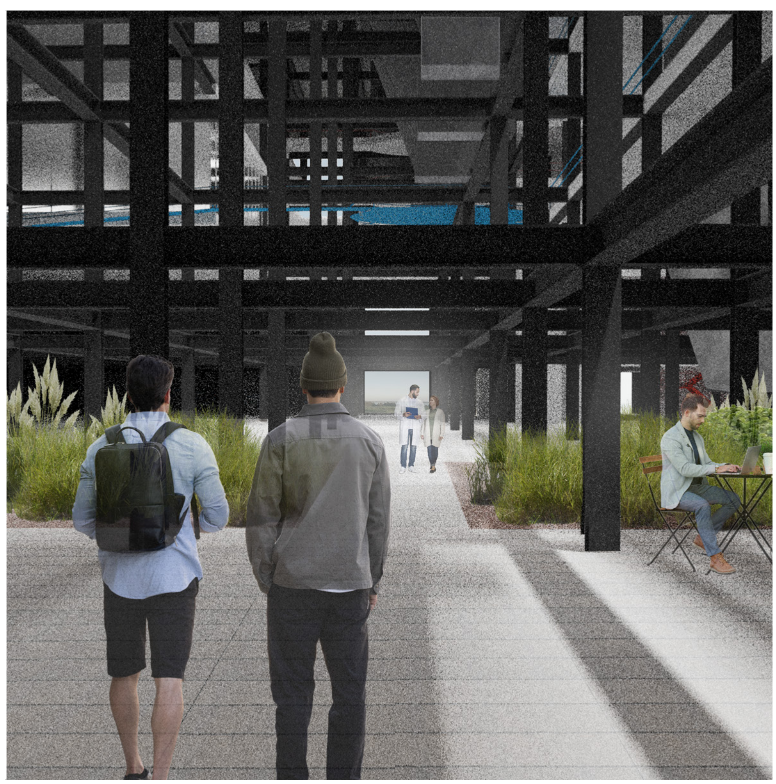
## Power Plant Research Hub

The Power Plant Research Hub proposes to occupy the former interior space of the Lingan Generating Station. Through a range of programming adjacencies and interstitial spaces the building embodies new relationships between energy, architecture, nature and technology.

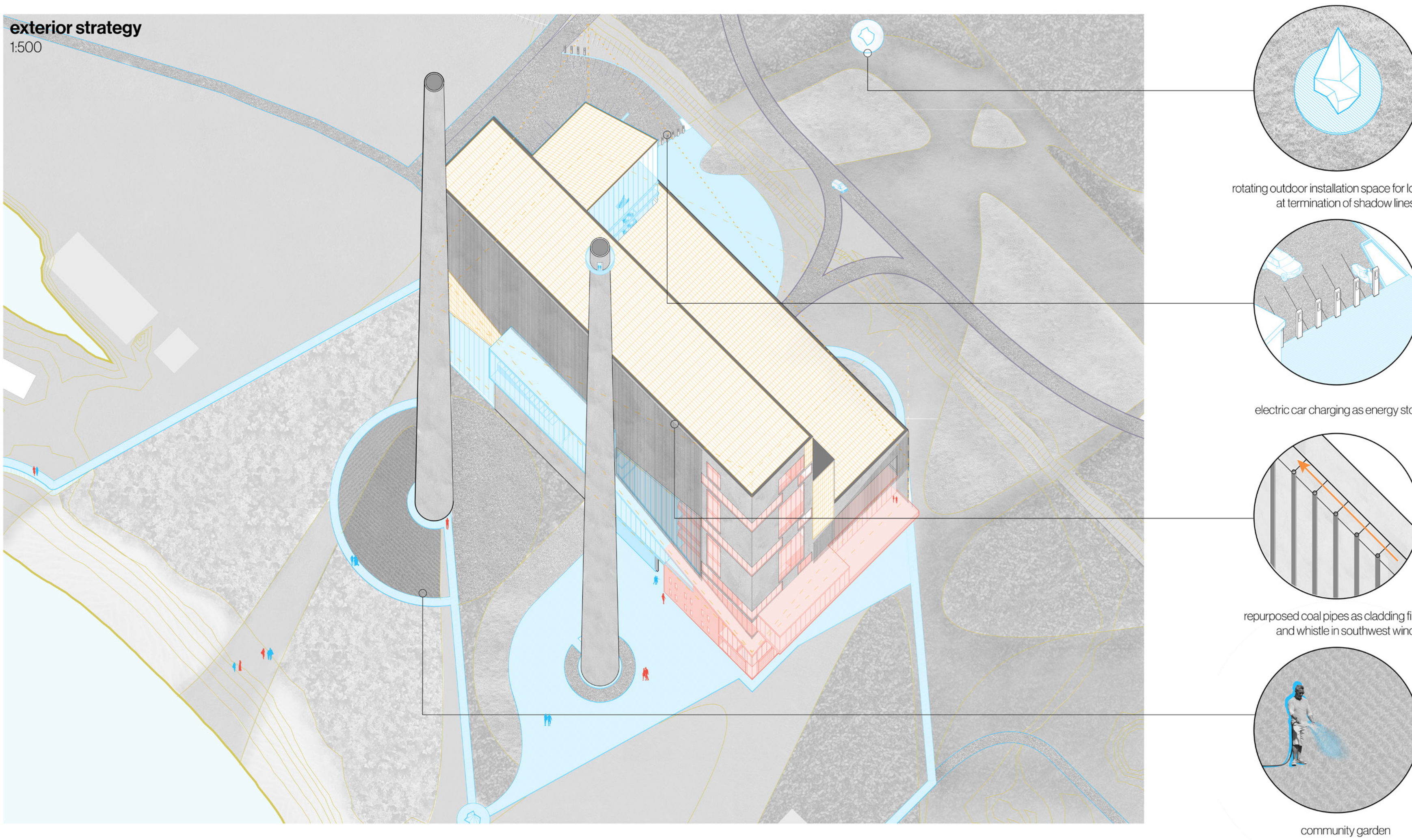
### *Connection to Landscape*

The outdoor space directly adjacent to the building is repurposed as a public square, with paths that act as a sundial to bring attention to maximum and minimum generation days in the year. Levels of shade intensity are used to determine fluid planting strategies as well as the inclusion of a community garden adjacent to the base of the south smoke stack. Intersections of paths are marked with spaces for local artists to exhibit outdoor sculptures that contextualize and memorialize the former coal mining industry on a seasonal basis.

On the ground plane, the high shade planting and wooden boardwalk continue through the building and out the west side, extending the park into the interior of the building. This hybrid indoor-outdoor space draws both community members and visitors into the building in order to demonstrate the radical new juxtaposition of research and public. In the areas adjacent to the public square, visitors can see maintenance staff attending to technologies, researchers testing and analysing the landscape and fellow members of the public hiking and canoeing. The



Interior collage depicting the continuation of ground treatment into the first floor of the building.




Exterior axonometric showing both ground and exterior treatments

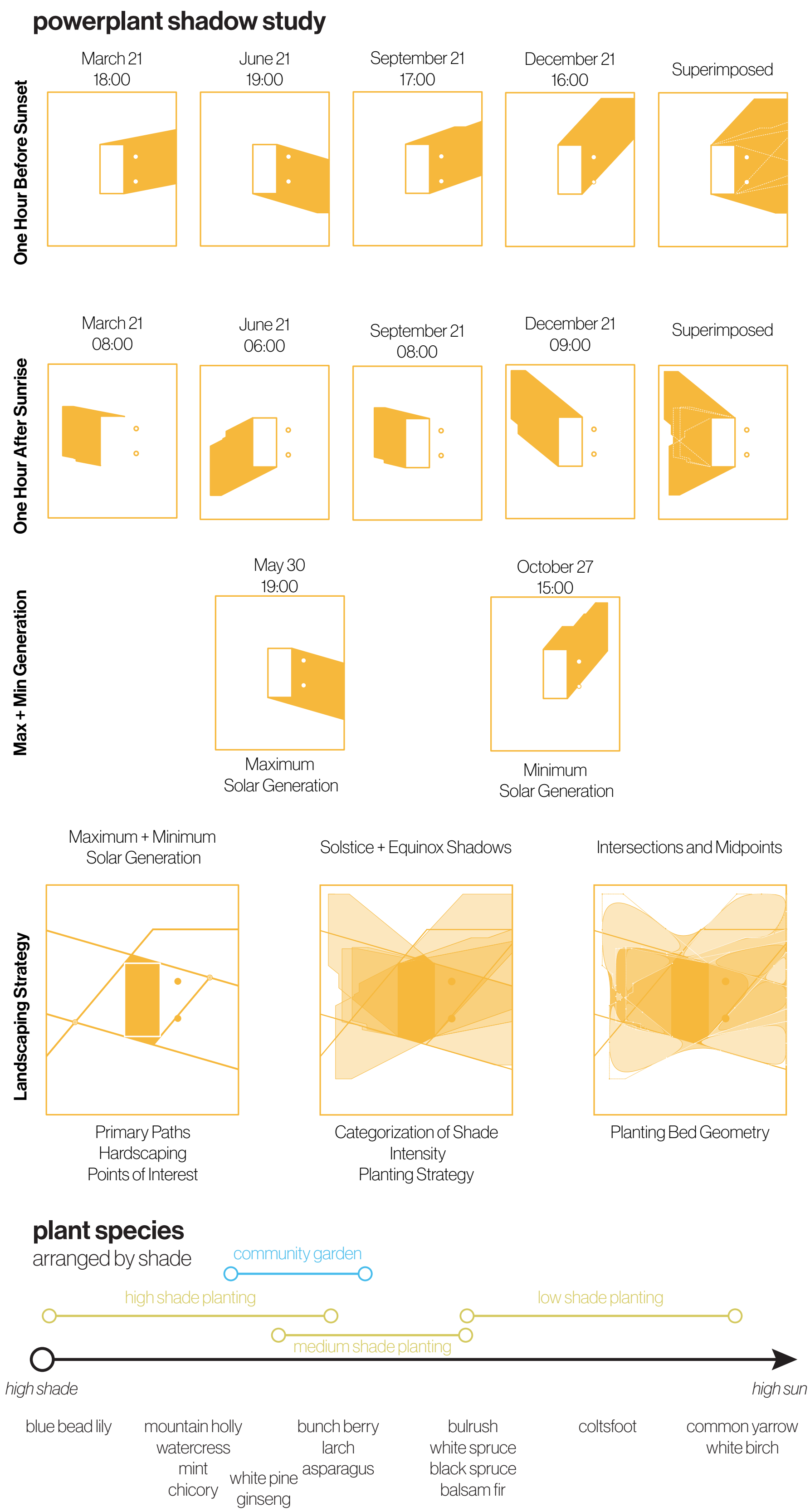



Diagram showing the generating station's shadow at key points of the year and corresponding planting strategies.

intermingling of populations illustrates that the productive and the recreational landscape are one in the same.


Diagram showing cladding strategies over time.

### *Exterior Strategy*

The exterior treatment of the building employs layers of varying energetic elements that are revealed and intersected at specific moments. On the vertical plane, layers of reclaimed coal equipment pipes and photovoltaic cladding cover existing concrete and break to allow new construction to jut forth into the park. As the wind blows predominantly southwest, the pipes whistle and signal attention to the force of the wind. The exterior of the building is functionally generative, conjuring ideas of self-sufficiency but declining to indulge the survivalist narratives of the Architecture as Power paradigm.

As the research facility inside grows, and energy needs change the pipes rust away to reveal more of the new as the building moves further from the coal industry. The newer and more technological elements come into focus as the public grows accustomed to the continuous presence of the research centre and the prevailing energy paradigm changes. Much like Banham's mechanized architecture in the mid century, the exterior expression of the building celebrates its technological functions, and signals to visitors that the new constructed elements are highly precise and efficient.

### *Form and Composition*

Spatially, the exterior form of the building speaks to the negotiation between different energetic considerations, shown in its coalescence of optimized forms, used to create protrusions and subtractions from the existing building. This thesis proposes a synthesis of past energetic architectural practices, and expresses its intents both formally and functionally. As with the cladding strategy, the building expresses the ongoing dialogue between energetic strategies as more of the new construction is revealed to the environment. The new forms that emerge from the shell of the old building embody a different energetic paradigm and should present formally as a visual departure from traditional carbon form.

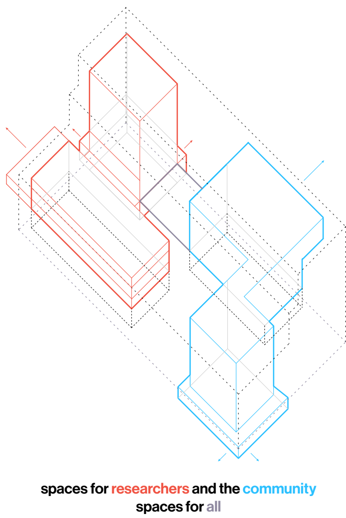



Diagram showing interior vs exterior massing.

The interior composition of the new construction is arranged in two reciprocal L shapes for public and researcher space. Each interior volume is equal in size and prominence, representing the significance of both the public and researcher space in this time of energetic transition. As the two L's interlock, spaces where the public can confront and engage with research are presented. The newly constructed volumes exist wholly inside the original walls of the power plant with a separation of roughly 3.5m from each original wall. This separation deems the existing building as an interstitial landscape that mediates between the new inside and the natural environment outside.

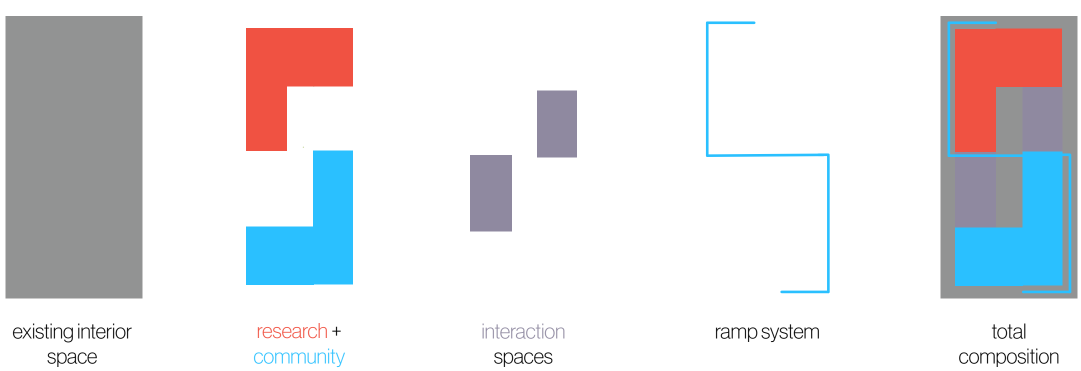
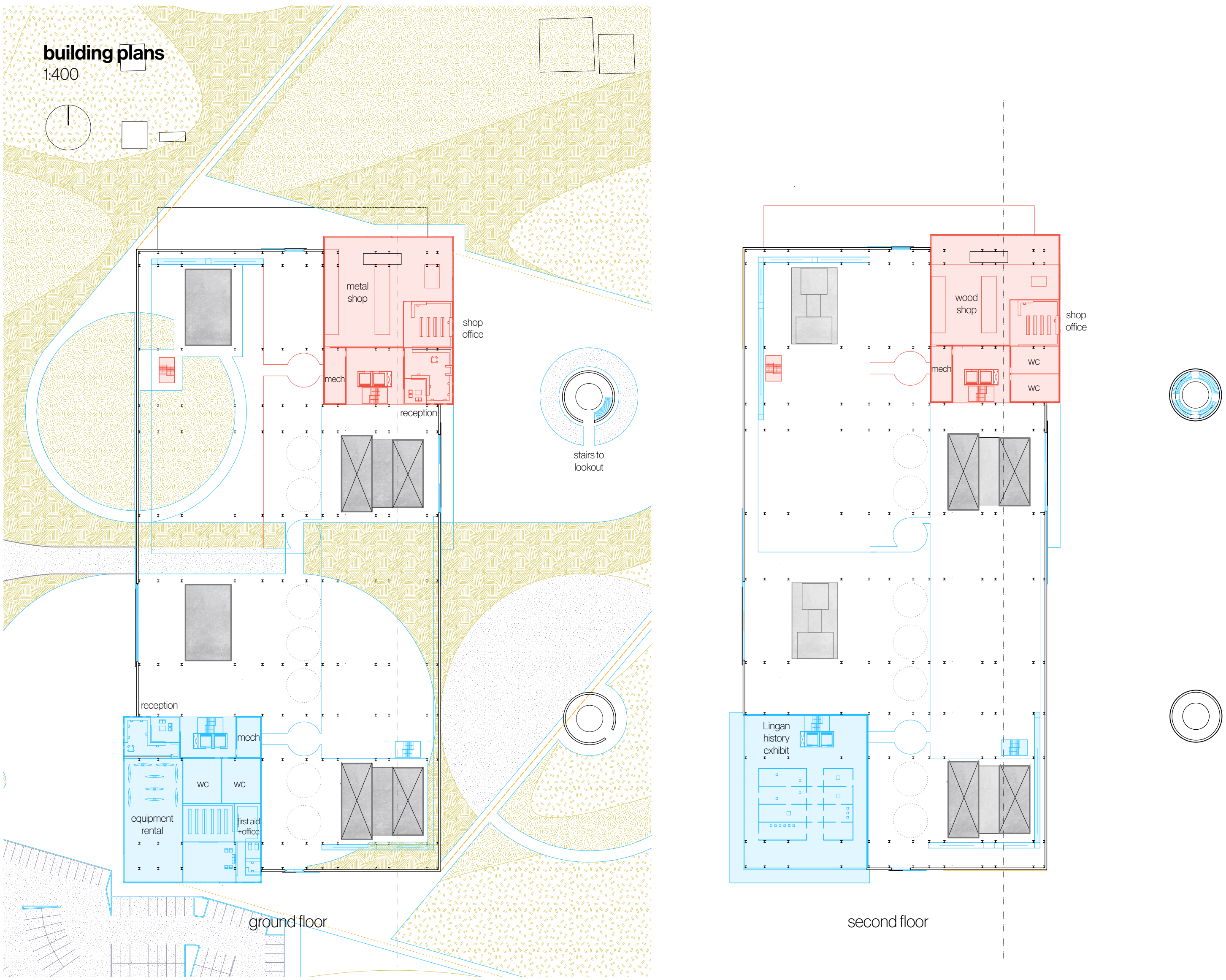
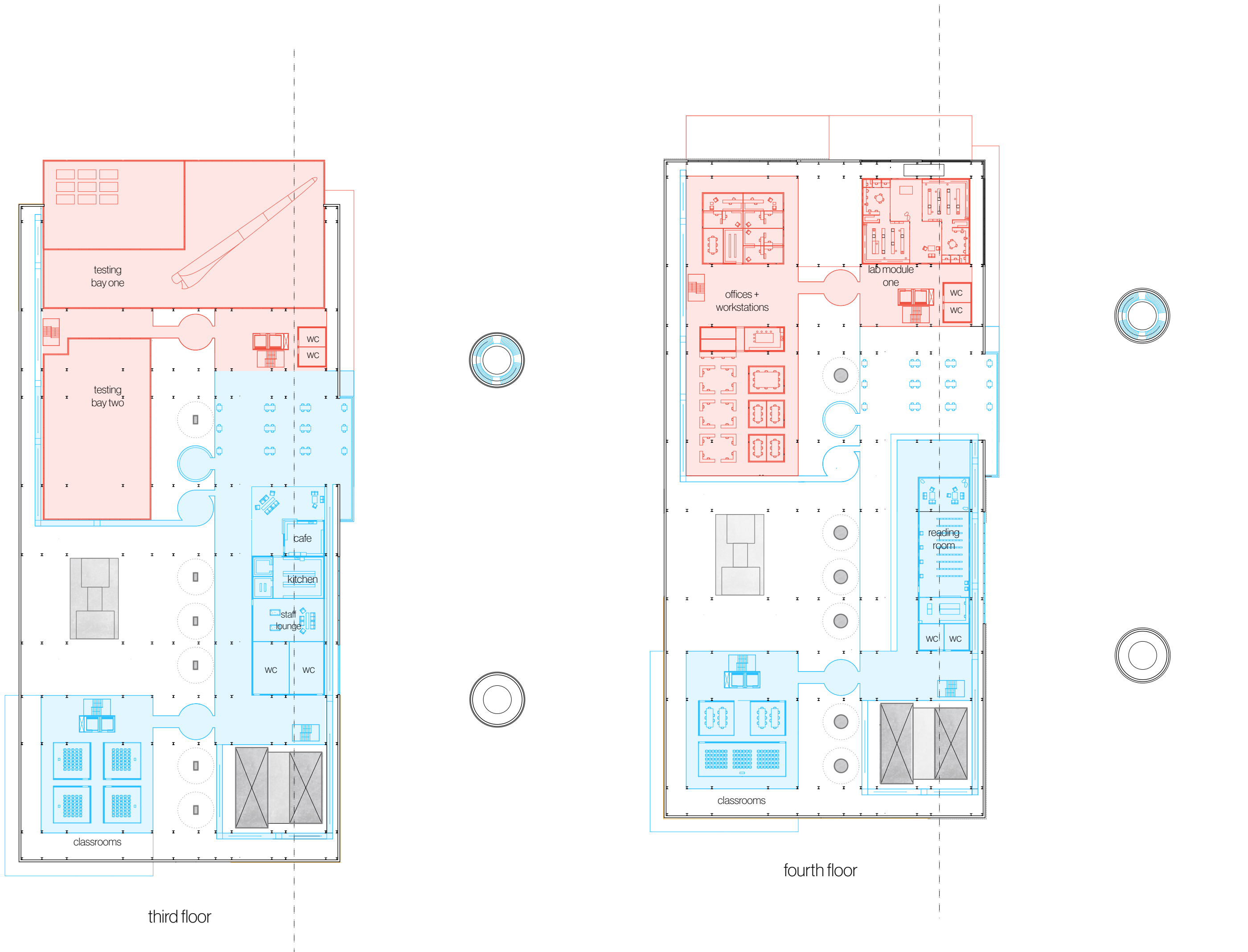


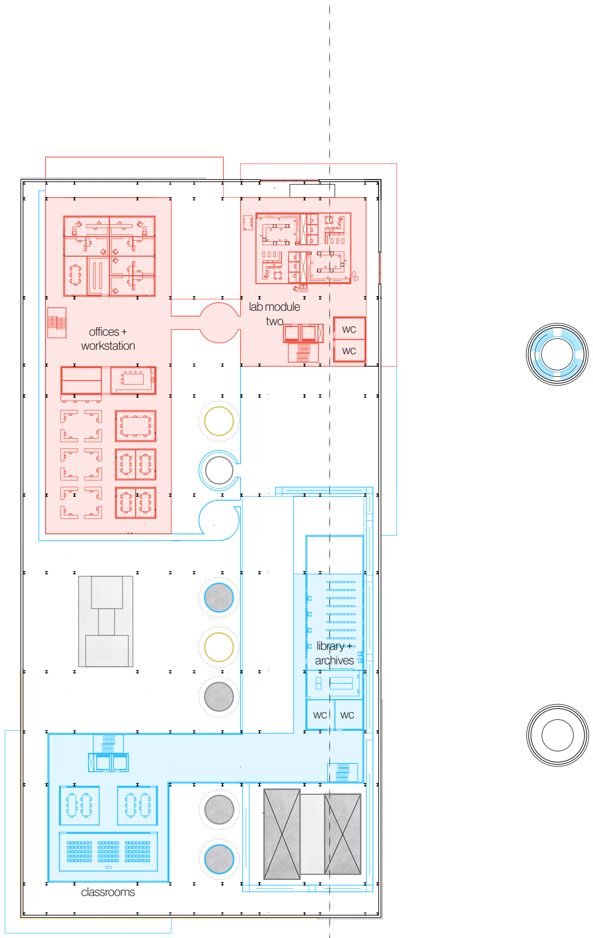

Diagram showing division of interior space by program.



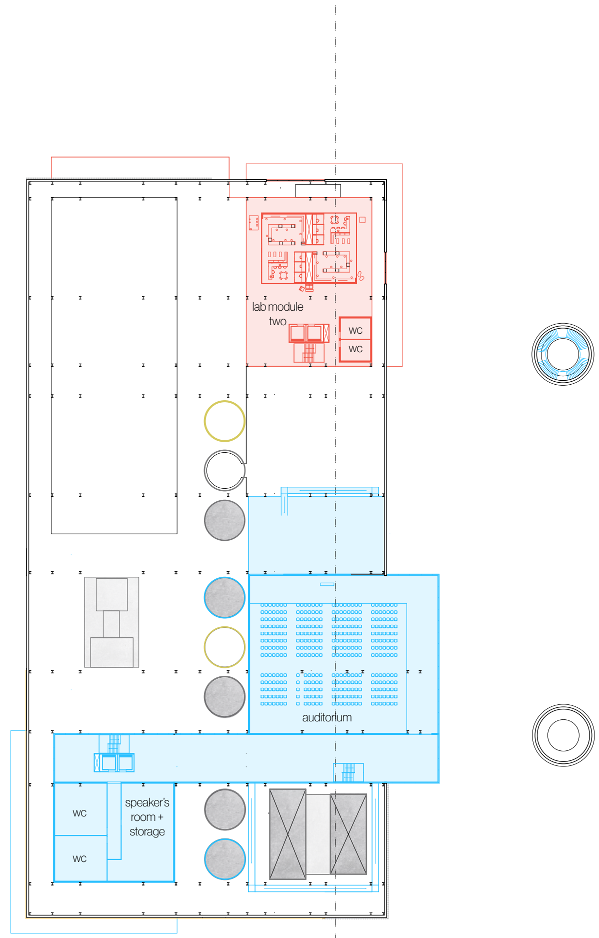

First and second floor plans. Red denotes researcher specific spaces and blue represents publically accessible spaces




Third and fourth floor plans. Red denotes researcher specific spaces and blue represents publically accessible spaces

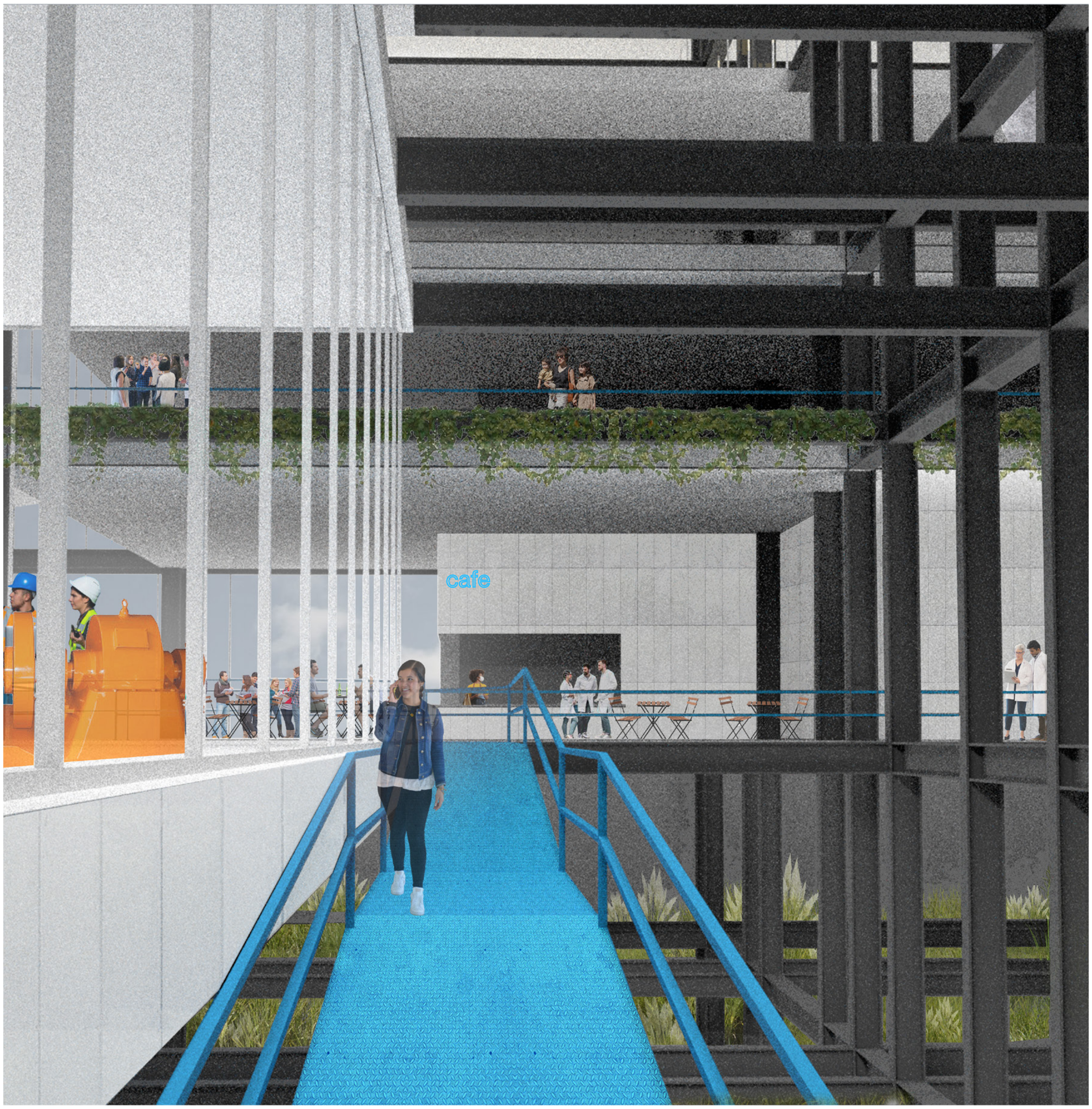


fifth floor



sixth floor

Fifth and sixth floor plans. Red denotes researcher specific spaces and blue represents publically accessible spaces




A blue ramp, to denote public access, wraps around the south wall of the second testing bay as it leads visitors to the cafe.

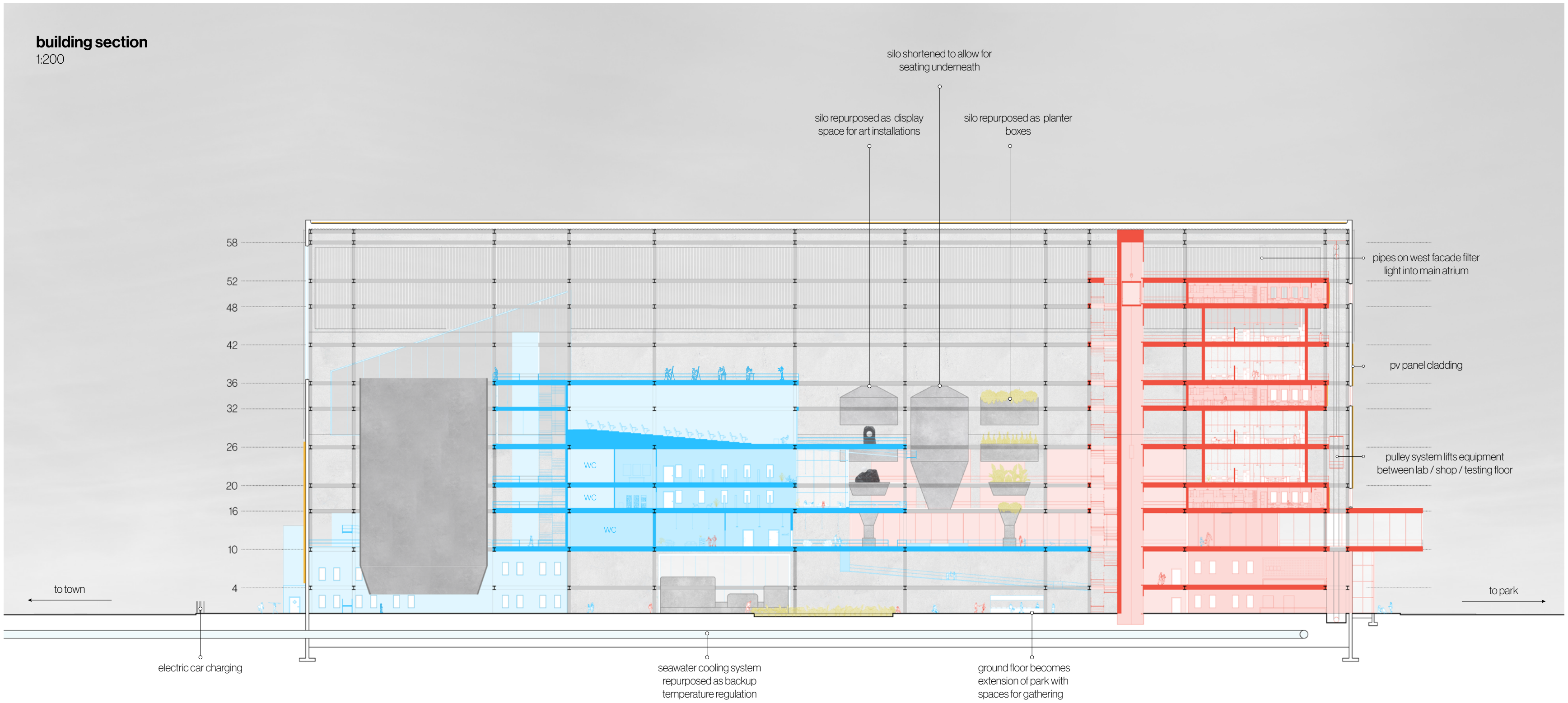
At two key programmatic points, the building breaks free of the existing structure and cantilevers into the landscape.

The testing bay, located on north side of the third floor intersects nature and technology by creating a space for new technologies to be tested against environmental forces. Similarly, the auditorium, located on the east side of the sixth floor, is where energy research is formally broadcast to the community. The two moments of outreach place both the

Visitors mingle on the deck outside the auditorium on the sixth floor and watch researchers mill about on the other side of the atrium.

testing bay and the auditorium within view of the park and wider public, fostering an increased prominence of science and technology in recreational public life as well as inviting increased scrutiny and accountability.

The intersection of the existing walls, structure and equipment with the new construction create spaces which contrast a collective history in need of reflection, and undertake an imagined future in need of optimism and innovation.



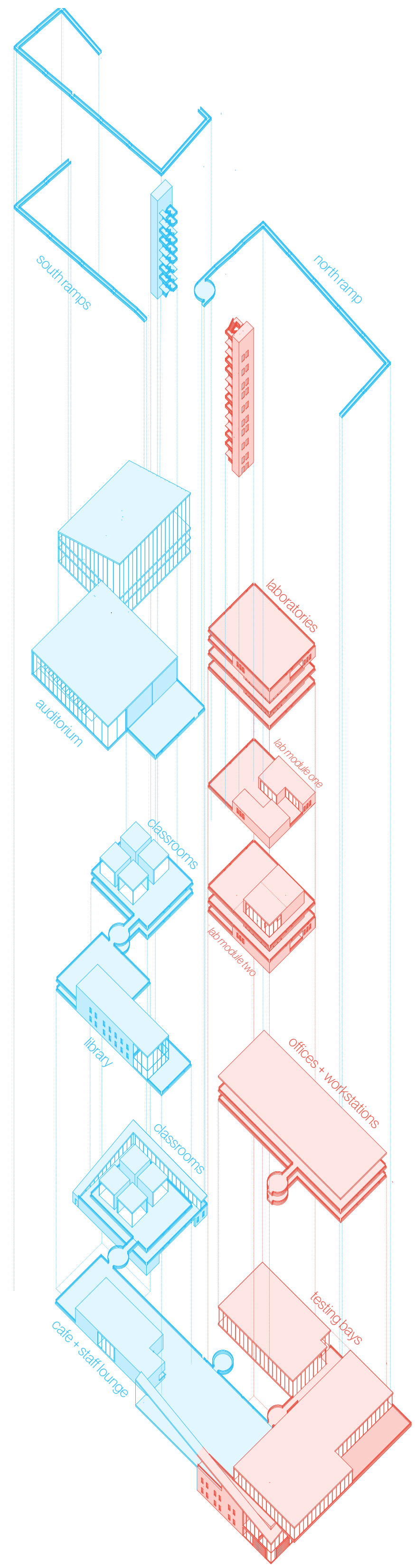

Section looking west, cutting through the main plane of interaction on the third level.

Fundamentally an architecture of transition, each volume intersects with the existing building on the ground floor, bridging the gap between extractive and responsive. A series of ramps that ascend through the building take the public between coal burning equipment and the glass volumes of the new construction as a non-direct route of circulation. As visitors ascend the system of ramps through the building they're continually placed between the old and the new as they traverse the space. This route firmly places the public visitors to the building in direct conversation to learn from he old paradigm and converse with the new.

To explore the next energy paradigm we must inhabit the ruins of the old. The most socially energetic plane is moved from the ground to the third floor in order to highlight the strange, interstitial landscape that has been created. On this plane, researchers are removed from the walled off institutional environments typical of current laboratories and thrust into the public sphere as they share a cafe and lounge with members of the public. Bringing scientific research into this new public realm allows for both informal conversations and educational displays to take place in an effort to understand public concerns about new energy developments or for the public to gain a more technical understanding of proposed policies and legislation.

***Transparencies***

The primary plane of interaction, moved to the third level positions visitors amongst public programming like a cafe and series of classrooms and adjacent to the tower of labs stacked in the northeast corner of the power plant and the interior glass walls of the two testing bays.




Exploded axonometric drawing showing the newly constructed interior volumes and their interaction. Red signals researcher space and blue public.

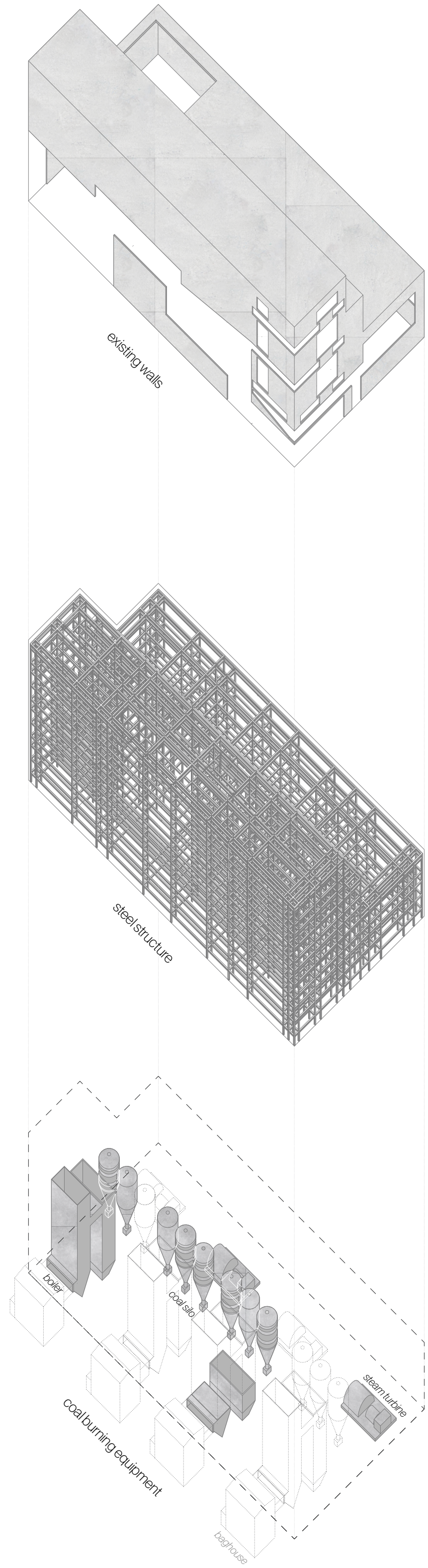
Many of the laboratory and collaborative spaces are open to the main atrium, or are visible through glass walls, inviting the public to view the inner workings of the research centre.

The visual transparency symbolizes the transparency of energy research as the public is beckoned into a world often hidden behind closed institutional doors. Public policy is often proposed under the presumption of an educated and engaged public, but spaces for knowledge creation and public engagement are seldom the same. The transparencies mobilized in both the park and the building allow for researchers to engage and consider the public in their work as well as providing a space for community members to learn and converse with the knowledge that informs policy. The merging of these two formerly separate spheres provides opportunities for development on both sides as well as a stage for community representatives, advocates and legislators to engage both populations simultaneously.

***Repurposing Equipment***

The research centre contains much of the original coal burning equipment maintained in place, often abstracted or repurposed in order to demonstrate scale or contrast with the new paradigm displayed in the building. The east and west entrances to the building force visitors to manoeuver around a steam turbine (west) or boiler configuration (east) immediately after entering the building, creating an instantaneous awareness of the power plant's former life.

Seven of the twelve coal silos have been kept in their original place. A series of catwalks with circular pause points have replaced two of the silos, one for each category of spaces




Exploded axonometric drawing showing the retained elements of the existing building as well as the original configuration of the coal burning equipment.

(public on the south side of the building and researchers on the north). Two have been segmented and converted into planter boxes, bringing the plant species present in the park into the building. Additionally, two silos have been similarly modified in order to display educational exhibits or the work of local artists. The final silos have either been left in place unaltered, or opened to allow visitors to look up into the old equipment and marvel at the scale from above or below.

A view looking up the hollowed out south boiler as people on the sixth floor look down. The retained equipment shows the vast scale of the former coal power plant.

The coal boilers consist of two pieces of equipment, one set for each of the power plant's four generators along the east side of the building. These have been treated similarly to the silos in the silo hall. One intact set remains in the south of the building, wrapped by the ramp that ascends to the sixth floor. This set of boilers has had the top and bottom planes removed in order to allow visitors to gaze down and showcases the enormity of the former function of the building.

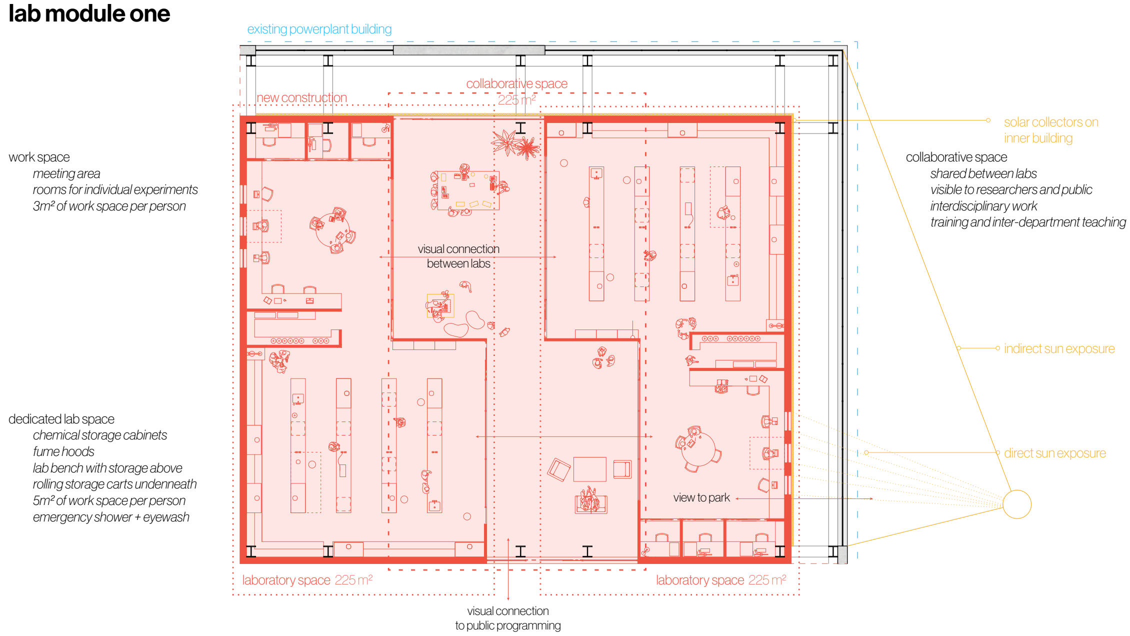
### *Laboratory Scale*

At the human scale, the laboratory is the most generative typology of space in the building. Each workstation and lab bench is aligned with an evocative view of the park, reciprocal lab, or public atrium. These strategic views visually engage the creativity and generative capacity of each researcher.

The labs have been categorized into two repeating modules of two labs and are stacked in the northeast corner of the power plant. Each contains different overlaps and intersections between individual, collaborative and cross disciplinary spaces. Configuring labs in groups of two, as well as providing dedicated inter-disciplinary space seeks to address the issue of silo-ing in parallel research areas. The glass walls present in both modules underscore the transparency that is needed not only between scientists and the public, but between scientific fields that are often split into distinct buildings or campuses inside institutions. Architects and engineers are given space and agency within the collection of labs in an effort to engage both the 'pure' and 'applied' areas of research. Shared space is placed in direct conversation with individual work stations, creating a

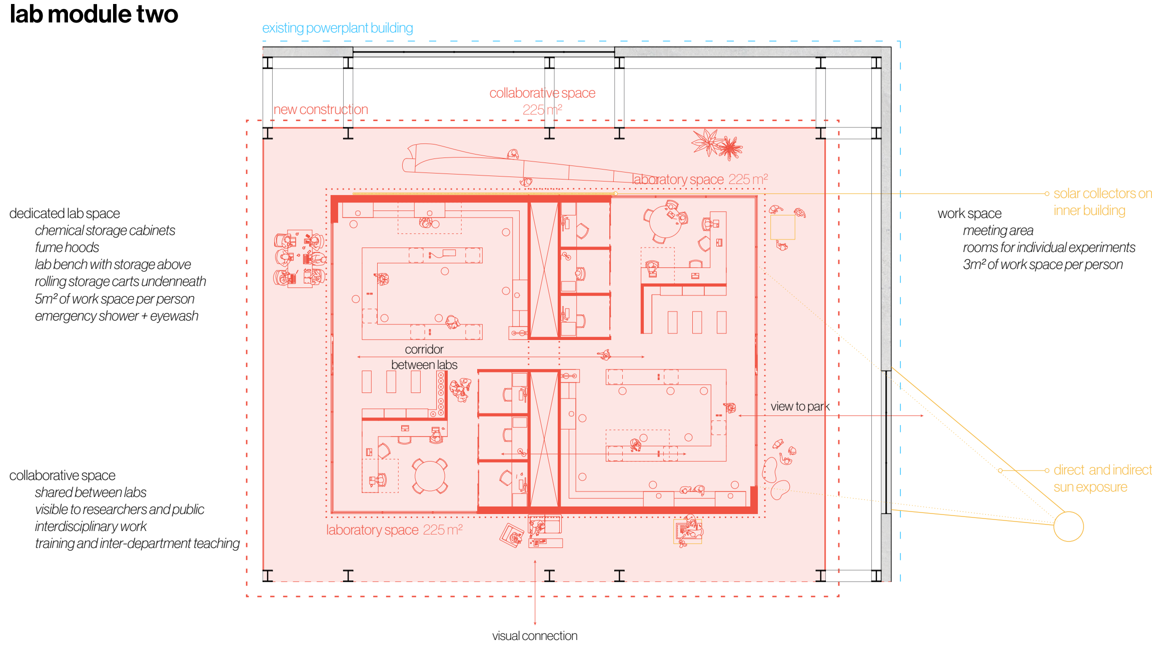
The interior of a lab space, with continuous views of the park and a concentric collaborative space gradient of space between independent and collaborative areas and tasks. The two lab modules are designed to allow for a variety of research areas, some of which might be more photosensitive or require less public visibility for security or privacy concerns.

## lab module one




A closer view of one of the 'lab modules' present in the building. This type of lab repeats on floors 4m in height and provides a higher degree of privacy and environmental control, lending itself to higher security or higher sensitivity research disciplines.

## lab module two

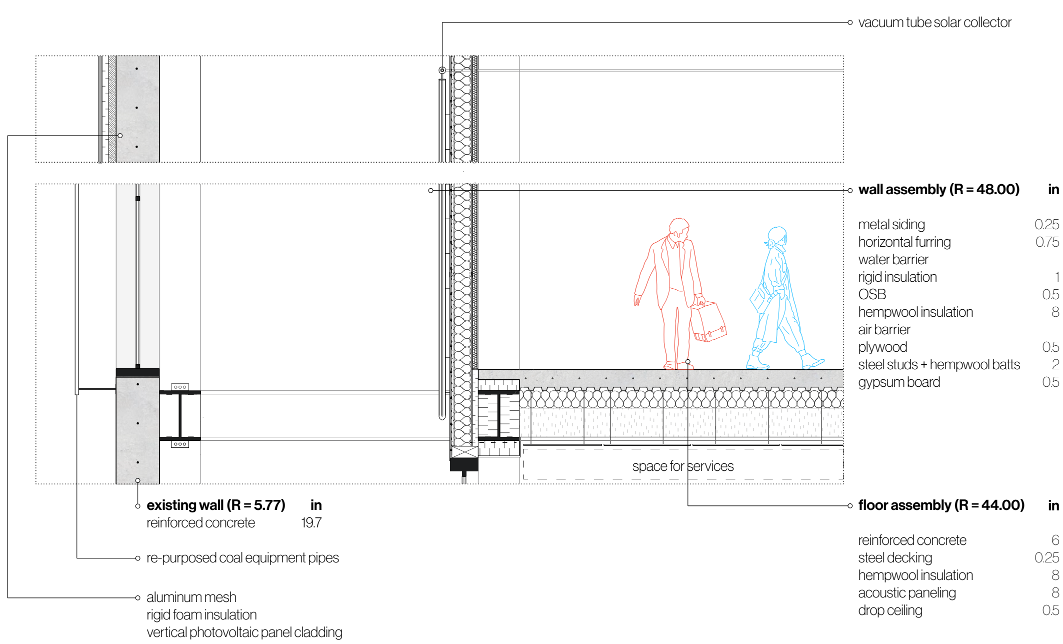



A closer view of one of the 'lab modules' present in the building. This type of lab repeats on floors 6m in height and provides a higher degree of collaboration and visibility, lending itself to interdisciplinary or teaching-focused research disciplines.

***Material Strategy***

The material strategies employed in the building seek to acknowledge the area's industrial past through the use of steel and concrete contrasted with bright painted railings and circulation (red denoting researcher space and blue denoting public space).

Inside the walls, carbon sequestering materials like hemp create insulative performance. Following the paradigm of Architecture as Manifestation, new materials are introduced in an effort to minimize embodied energy but with an increased focus on energy generation and celebration. On interior volume walls, when adjacent to a subtraction from the existing walls, a layer of vacuum tube solar collectors




A detail depicting the relationship between the existing and new construction elemtents of the building as well as their thermal performance.

exchanges heat and reduces the energy load required for hot water throughout the building.

On both the interior and exterior of the original building, concrete is left stripped and untreated in order to create a ‘rough’ condition which evokes images and ruin and decay as the research centre moves further into the future energy paradigm.

# Chapter 7: Conclusion

Currently, the topic of energy conjures many mental images of destruction and extraction in our landscapes, and remains largely absent from our ideas of architecture. This thesis and its research touches upon the histories of an extractive coal industry in Cape Breton as well as an overview of architectural paradigms that incorporate energy in varied ways. Contextualizing energies and theorizing the spaces that will emerge as a result of the next energy transition is a challenging undertaking and requires both a deep understanding of past and the creation of a speculative future. Simply substituting an extractive paradigm for an environmentally responsive paradigm is not sufficient when our emerging energy transition requires new ways of thinking, designing and building. A truly post-coal world understands and acknowledges the permanent effects of our current extractive energy paradigm on our cultural and physical landscapes. Moving forward means conceding the damage and dwelling within spaces and moments that encourage reflection and hope within the technological capacity available to us at present. Though the physical scars are permanent, coal's legacy on architecture can be a moment in time, memorialized in places where its impact is felt the most.

Our current architectural landscape acts as a physical manifestation of our energy culture, though not consciously, we design to reinforce the notions of energy we've internalized both individually and culturally. Re-thinking architecture in a context that's removed from our existing coal paradigm allows for the reversal of this relationship.

Changing the way we view architecture can aid in the creation of a new renewable energy culture.

Methodologically, this thesis's processes of site and climate analysis as well as its methods of design can be applied to any manner of generative architecture, and is not limited to the realm of science or research spaces. A broader understanding of architecture's relationship to nature and technology is required in order to fully understand the energetic potential of our cities and towns. Through design, the exploitation of simultaneities between formerly distinct notions of architecture, technology and nature allow for new considerations of energy at a scale and clarity greater than past paradigms.

The creation and celebration of clean energy is an opportunity to honour Lingan's history as a coal mining town and continue the site's current role in Nova Scotia's energy landscape. These past and future uses make the site an important candidate for determining the future of the province's fossil fuel infrastructure. Canada, and Nova Scotia specifically, has vast untapped reserves of clean energy, investing culturally in renewable technologies will provide new opportunities to create jobs, inviting spaces and new energy landscapes.

Though this thesis's proposed interventions operate at the scale of a cluster of small former mining communities, there is an imagined future where larger towns and metropolises create meaningfully socially engaged energy generation integrated into public space. Breaking free of both the current centralized energy paradigm, and the mono programmed energy park model allows for new possibilities of generative community spaces at a range of scales. Cities could mobilize existing technologies to create neighbourhoods and districts that seek to change how we think of energy and architecture in an urban setting.

The coming energy transition, and the purportedly imminent decommissioning of Nova Scotia's coal infrastructure, is a way to recontextualize how we think of architecture, technology and landscape at both the human and the infrastructural scale. As more of the coming energy paradigm trends towards decentralization, we can begin to cross program energy landscapes with recreational and educational elements in order to foster new relationships between infrastructure and public life.

It perhaps can be possible to both squat in the ruins of the fossil fuel industry and to create new and meaningful spaces in its wake.

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