Sufficient Communities through Integrated Energy Systems:

Increased Food Security in Newfoundland and Decreased Dependencies through Import-Replacement

by
Kirsten Sheppard-Neuhofer

A thesis
presented to the University of Waterloo
in fulfilment of the
thesis requirement for the degree of
Master of Architecture

Waterloo, Ontario, Canada, 2018

Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

While perceived as equal to other provinces, Newfoundland is Canada's version of a third world province with the illusion of equality. To use Jane Jacob's term, Newfoundland has a backwards economy, an economy which does not produce or diversify adequately and instead depends on a vast quantity of imports[1]. The province itself acts as an outport, and needs to detach from the exploitation by larger global metropolitan areas. This dependency on external consumers has been a pattern that has led to ongoing economic dependencies, seen in a number of exploitations such as ceding coastlines and fishing rights to foreign countries, the removal of a customs barrier that protected local farms in 1949, the overfishing of the offshore fishery by European trawlers resulting in a moratorium that disrupted the islands livelihood, and the dependence on food imports. Communities struggle to maintain a quality of life against external economic pressures and exploitation of community resources. As a result, the Island is plagued by youth out-migration and depopulation, and lack of local control over their natural resources. Newfoundland is dependent on the global market for maintaining their quality of life, leaving the province vulnerable.

Two struggles are emphasized: the extreme vulnerability and dependence on global imports that result in a lack of human basic needs, and the dangerous exploitation of the Island's energy resources. There is particular vulnerability to the global market with respect to food resources and produce, as ninety percent of the island's fruits and vegetables are imported[2], and the imported produce lacks the quality that Canadians have come to expect. This thesis suggests that the intersection of food security and reducing the exploitation of island resources through a municipality-owned utility creates a framework for more resilient development that is grounded in local conditions.

This thesis is founded on a speculative future scenario, where Beothuk Energy's proposed wind farm in St Georges Bay, Newfoundland is used as the sole energy resource for a year-round regional greenhouse complex that supports the Port-au-Port peninsula through import-replacement, education, and community involvement. The complex aims to increase community self-sufficiency in the region by supplying basic human needs locally, reducing the need for imported produce by establishing a more effective and less vulnerable relationship with the landscape and systems. The design exploration is aligned with proposing an alternate vision to the province's desolate future in order to spark a conversation among those involved, encourage a daily life that is sufficient and desirable, and facilitate an awareness of the benefit of using local energy for import replacement. The Port-au-Port peninsula is used as a case study in order to provide Island communities with an example of how their own unique resilience can arise.

1 J. Jacobs, *Cities and the Wealth of Nations: Principles of Economic Life* (New York: Rondom House, 1984), 43.

2 A. James Quinlan, *Building agricultural capacity in Newfoundland and Labrador* (St Johns, NL, Canada: The Leslie Harris Centre of Regional Policy and Development, Memorial University, 2012), 4.

Acknowledgements

I would like to thank the following people whose contributions helped make this thesis possible:

My supervisor Jane Hutton and advisor Val Rynnimeri, your insightful direction and conversations made this an enjoyable process.

All the conversations, adventures and design feedback certainly shaped and inspired the design response in this thesis.

My friends, for reminding me that life is about balance.

My brother, for lending me his baby to avoid potholes on site.

And finally, my family, for making sure that I had every opportunity. This is just the beginning.

To my family, for their constant support and encouragement.

Table of Contents

List of Illustrations

All illustrations, maps, and photographs have been produced by the author unless otherwise sourced in the list below.

Introduction

Part 1: Situating the Crisis

Part 2: Island Flows

Part 3: Effective Responses

Part 4: Design Exploration

Part 5: Growth

Appendix

Fig. 0.1 Visualization of future wind farm and greenhouse complex on St. George's Bay, Newfoundland and Labrador. View from NL-460, Port au Port East, Newfoundland.

Fig. 0.2 Newfoundland in Global Context

Fig. 0.3 Imports entering the port in St. John's

While perceived as equal to other provinces, Newfoundland is Canada's version of a third world province with the illusion of equality. To use Jane Jacob's term, Newfoundland has a *backwards economy*, an economy which does not produce or diversify adequately and instead depends on a vast quantity of imports.[1] The province itself acts as an outport, a peripheral province of Canada, and needs to detach from the exploitation by larger global metropolitan areas. The communities and towns are extremely vulnerable and rely on massive imports of food from other provinces and overseas, which leaves the province with only a three day supply of food[2], meaning fresh vegetables and fruits become a luxury. Both urban and rural Newfoundland suffer, however with larger travel times across the island, the rural areas suffer extensively. As of 2011, 41 percent of the island resides in rural areas.[3] Supporting these rural populations requires extensive reevaluation of import and food production. Communities must look to their own resources and emerging opportunities to support their future populations and ultimately the future of the communities.

The reality of exploitation and hardship is not new; it is reflected in Newfoundlanders history, stories, songs, and art. Newfoundland was founded upon an unforgiving sea and relentless nature. The needs of each community and resources of each environment are diverse and dynamic in type and opportunity. With emerging wind energy industries, and a new energy farm slated for production in St. Georges Bay, there is an opportunity to respond and envision more self-sufficient communities. Three wind farm projects have been initiated in Newfoundland in the last decade; a new point of designing for resiliency can respond to this food import crisis in order to improve resident's quality of life.

This thesis suggests that the intersection of food security and reducing the exploitation of island resources through a municipality-owned utility creates a framework for more resilient development that is grounded in local conditions. This thesis is founded on a speculative future scenario, where Beothuk Energy's proposed wind farm in St. Georges Bay, Newfoundland is used as the sole resource of energy for a regional greenhouse complex that supports the rural peninsula through import-replacement, education, and community involvement.

1 J. Jacobs, *Cities and the Wealth of Nations: Principles of Economic Life* (New York: Rondom House, 1984), 43.

2 Lauren Power, "Overcoming Insecurities: Food Security Network NL and the State of Food in our Province," *The Overcast: Newfoundland's Alternative Newspaper*, June 1, 2015, accessed May 5, 2017, https://theovercast.ca/overcoming-insecurities-food-security-network-nl-and-the-state-of-food-in-our-province/.

3 Statistics Canada. Population, urban and rural, by province and territory (Newfoundland and Labrador). *Census*. February 4, 2011. Raw data.

Government issued reports on the health crisis, the increased need and market for organics and locally produced food, and reports on bringing residents into the island, are indicators that a new direction is needed. There are few, if any, sustainable future projections that do not include an increase in locally grown food for the sustainability of future societies. The Newfoundland Government is exploring long-term vitality of the regions, showcased in articles such as *Live Here, Work Here, Belong Here (2015-2025)*, *Government Renewal Initiative (2016)*, *Wholesale and Other Opportunities In the Vegetable Industry of Newfoundland and Labrador*, and *Food First NL Annual Report 2015 - 2016*. However, the built environment is not examined, and the role of architecture is ignored.

The incoming St. Georges Bay wind farm is under a 20-year contract with Newfoundland Hydro, to provide energy to the island as well as sent across the harbor via the Maritime Link into Nova Scotia to sell south of the border.[4] A future projection of a city-owned utility that gives the local community control over the utility is forefront of the thesis' speculative future scenario. The scenario will investigate the renewable energy resource as the main supply of energy to be used in the growth of vegetables in a controlled environment greenhouses that promotes import-replacement and strengthens residents' quality of life by increasing the self-sufficiency of rural environments.

The implementation of a renewable city-owned utility will not only effect quality of life of residents by reducing the need for vegetable imports, it will improve community development and learning, and community contribution to the issue at hand. The future of community self-sufficiency in Newfoundland is dependent on strengthening residents' quality of life and understanding the importance of import-replacement.

Approach--Why

Newfoundland communities are unique in comparison to other provinces and the larger cities of Canada; they offer a quality of life that has evolved in close relation to the land and surrounding ecological resources. The emerging industry of wind energy has entered the province in 2007, with the new development slated for production in St. George's Bay in 2019.[5] With the coastal winds predicting to provide 180-megawatt supply of renewable source for energy and materials, as

4 Katie Breen, "Wind power for sale: Energy company says N.L. should buy, stimulate west coast economy," *CBC News*, June 13, 2016, accessed April 1, 2017, http://www.cbc.ca/news/canada/newfoundland-labrador/wind-power-for-sale-energy-company-says-n-l-should-buy-stimulate-west-coast-economy-1.3628097.

5 James Risdon, "Beothuk signs deal with Copenhagen Infrastructure to develop wind farm in Newfoundland," *The Chronicle Herald,* September 28, 2016, accessed September 22, 2017, http://thechronicleherald.ca/business/1400981-beothuk-signs-deal-with-copenhagen-infrastructure-to-develop-wind-farm-in-newfoundl.

well as being a core economic generator[6], the area offers much potential to be re-imagined as a self-sufficient and less vulnerable community. A need for research focused on the shared fundamental circumstances of rural communities towards a more effective relationship with the surrounding natural systems is evident. This thesis research will address this relationship with an emphasis on the role of architecture and design in long-term envisioning of a community network with a higher quality of life.

Given the small population and size of Newfoundland communities, quality of life is largely influenced by economic flows from local industries and the emerging wind energy farm operation.

Newfoundlanders have continued to inhabit the island and exhibit pride through provincial flags and traditions regardless of hardships, demonstrating the current level of resiliency of Newfoundland communities. This indicates a desire for residents to not only endure, but to continuously seek a better life for their community. While townships actively search for opportunities and strategies to immediately address unemployment and healthcare dilemmas, strategies for a longer-term vision, both at a community and natural resource level are not generally pursued. As the interim report of the Canadian Senate Standing Committee on Agriculture and Forestry studying poverty (2006, p. v) suggests,

> The rural poor are, in many ways, invisible. They don't beg for change. They don't congregate in downtown cores… they rarely go to the local employment insurance office because the local employment insurance office is not so local anymore. They rarely complain about their plight because that is just not the way things are done in rural Canada, [and] the rural poor are also under-researched. With few exceptions, the academic and activist communities have been preoccupied with studying and highlighting the plight of the urban poor."[7]

A long term vision of a higher quality of life for residents of rural populations is needed, and it needs to be acknowledged that the rural poor exist within the walls of Canada.

In this thesis, design is used as a tool for envisioning an alternate future for Newfoundland communities. Designed vignettes have the ability to visualize how daily life can differ from the current status, and visually construct a place of opportunity and community; and diagrams are valuable in showing how resource, government and food flows can be

6 ibid.

7 Canada., Parliament., Senate., *Understanding freefall the challenge of the rural poor* (Ottawa: Senate, 2006).

localized and optimized to restructure communities imports and enhance a community in terms of resident participation, more stabilized employment, community learning events as well as unique living and working environments.

Architecture can communicate between the accepted, traditional community and the envisioned community by connecting residents, transient inhabitants, daily life, and identity through visualization. A built environment crafted through utilization of local resources and execution of import replacement serves to enhance the quality of life while shaping community identity. It is essential that architecture and the built environment encourage a daily life that is sufficient and desirable. It is the role of architecture to aid society in re-envisioning its future.

In addition to crafting a built environment, design communicates across multiple disciplines. Design can influence decision-making among government officials, residents, and investors, through the process of visualization. As philosopher John Thackara describes,

> "The critical issue – for people, organizations, and governments alike – is knowing where we want to be. The imaginary, an alternative cultural vision is vital in shaping expectations and driving transformational change. Shared visions act as forces for innovation, and what designers can do— what we can all do— is imagine some situation or condition that does not yet exist but describe it in sufficient detail that it appears to be a desirable new version of the real world."[8]

The most important role of design is to provide this alternative vision. Through visions, residents, industry and government become involved in a shared process. This is important, as an alternate vision allows groups of people spanning multiple disciplines to share a common ambition.

This thesis takes a soft systems approach to sustainability as defined by Anthony M H Clayton and Nicholas J Radcliffe in *Sustainability a Systems Approach*. With applying a soft system approach, thinking or design should be regarded as a contribution to problem solving, rather than as a goal-directed methodology.[9] One of the issues Newfoundland communities face is food security, but it is only one facet to the overall problem that is causing depopulation. The problem is not highly defined, and cannot be reviewed as an independent issue and thus "an open-ended approach is needed, where the outcome is not seen as being an optimal

8 John Thackara, *In the bubble: designing in a complex world* (Cambridge, MA: MIT Press, 2006), 26.

9 Anthony M. H. Clayton and Nicholas J. Radcliffe, *Sustainability: a systems approach* (London: Earthscan publications, 1997), 186.

Fig. 0.4 Campbells Creek looking towards the proposed wind farm on St Georges Bay

solution to a particular problem, but a continuous learning process."[10] The vignettes in the design exploration aspire to propose a sense-and-respond design, where the communities themselves and the government come together to address how the built environment best responds to the community's needs. In *Sustainable Community Development*, Research ecologist and consultant, Chris Maser comments that,

> "In order to address the likely consequences that the proposed actions of a community may create in the larger context of shared landscape patterns, the value of doing so must be built on the aggregate of communal shared visions from the bottom up, from cooperation and coordination among the communities themselves. It cannot be imposed by state authority from the top down…It is the net effect of the collective visions of all the communities as implemented on the ground that actually governs the future patterns of the landscape within the state."[11]

The approach of the framework in the design exploration is aligned with the idea of proposing an alternate solution to the province's desolate future in order to spark a conversation among those involved. The first step to solving an ongoing issue is realizing that there is a problem with the current situation.

Context

There is a divide between large towns and their supporting networks of rural communities. Rural communities are often undervalued, perceived as of secondary importance. Newfoundland has grown into a peripheral region of the world, and is seen as the 'outport' of Canada, where the rural outports, used to describe coastal communities other than St. Johns's, became peripheral to the government.[12] The physical and social characteristics differ, and thus the economic and regional structure should differ. The potential for future growth is poor; deaths are out-numbering births; populations are declining.[13] Newfoundlands separation from mainland and island composition, emphasizes the province's need to rely on neighboring communities for support. Anthony M H Clayton and Nicholas J Radcliffe speak to how "the economy…was an organic whole, and that if economic growth was to take place, it must be in harmony with all aspects

10 Ibid, 187.

11 Chris Maser, *Sustainable community development: principles and concepts* (Florida: St. Luice Press, 1997), 140.

12 Victor L. Young, *Collected research papers of the Royal Commission on Renewing and Strengthening Our Place in Canada* (St. Johns, N.L.: Royal Commission on Renewing and Strengthening Our Place in Canada, 2003), 342.

13 Newfoundland and Labrador Statistics Canada. Annual Estimates of Population for Canada, Provinces and Territories. Sept 27, 2017. Raw data. http://www.stats.gov.nl.ca/statistics/population/

of the society, especially local communities."[14] This divide indicates a need for new approaches to enhance the quality of life needed to sustain population. If communities are continuing to struggle to maintain a desirable quality of life and maintain the necessary population, what will the environment in Newfoundland be in 50 years?

Newfoundland's economic decline can be traced to processes accompanying the industrial era of development. After the customs barrier that protected local firms was removed in 1949, after confederation with Canada, local manufacturing and agriculture production went into decline. Construction and resource booms from industrialization ended in the 1970s and mechanization reduced the amount of needed workers[15]; unemployment hit 20%.[16] After European trawlers depleted the northern cod population and the consolidation of fisheries and technologies depleted the job industry, Newfoundland communities then found homage in natural resource extraction. The move away from small-scale, diversified local economy based on a number of industries, moved toward a single-resource economy based on an industry which extracts and exports a non-renewable resource.[17]

14 Clayton, Anthony M. H., and Nicholas J. Radcliffle. *Sustainability: a systems approach*. London: Earthscan publications, 1997, 109.

15 Miriam Wright, *Royal Commission on Renewing and Strengthening Our Place in Canada: consultation document: Newfoundland and Labrador History in Canada, 1949-1972* (St. Johns, NL: The Royal Commission, 2003).

16 Statistics Canada, Unemployment Rate, Monthly, Canada and Provinces, Labour Force Survey. Dec 1, 2017. Raw Data. http://www.stats.gov.nl.ca/statistics/labour/PDF/UnempRate_Monthly.pdf

New and shared long-term visions of resilient communities are important to envisioning the future of Newfoundland communities. The current systems employed by rural economies are out-of-date, restrain innovation and endanger the future resilience of rural communities. Greg Halseth, Professor of Geography at University of Northern British Columbia and Canada Research Chair in Rural and Small Town Studies, addresses the future of rural communities in The Next Rural Economies. Halseth describes how,

> "dynamic-of-localities work emphasizes understanding how actors interplay with each other, how they mobilize resources by using and constructing networks in order to achieve their objective, how their actions create particular profiles of development for an area and how this whole dynamic can be influenced by parameters established, and resources located, in the broader political, administrative, socio-

17 Rick Rennie, "Iron Ore Mines of Bell Island," Newfoundland Heritage Web Site, 1998, accessed September 22, 2017, http://www.heritage.nf.ca/.

cultural, and economic contexts."[18]

Halseth demonstrates how groups of citizens, political and professional associations can combine to resolve issues, maintaining that, "the key to managing change lies within the grasp of local and regional actors, but that central governments can facilitate these processes."[19] As emerging technologies arise, the dynamic-of-localities needs to be addressed to understand how relationships to neighborhood communities and their architecture can respond to new resources. These communities need to evolve in a creative way in order to enhance the quality of life for the inhabitant.

With the newly constructed Maritime link, a connection platform for energy to be transferred to Nova Scotia and beyond, and the TransCanada highway corridor, a new vision of energy infrastructure and wind energy sources have the opportunity to capitalize on this network condition to aid import-replacement in order to benefit Island residents. Research ecologist and consultant, Chris Maser discusses the opportunities that arise when understanding that the world operates as a connected network. In a unified systemic world view that acknowledges "all relationships are systems supporting systems ad infinitum... [and] the behavior of a system depends on how individual parts interact as functional components of the whole...the whole is understood as through the relation/interaction of its parts."[20] Maser's discussions of a unified systemic world strengthens this concept of the network where the linear commodity-oriented process currently upheld in rural environments can be re-envisioned, where all communities are part of the whole system. He strongly iterates that "we must change our world view to a systems approach, where the indicators of both ecological and economic health are rooted in the quality of the relationships between and among the parts."[21]

Methodology and Structure

The thesis methodology is structured into five parts to achieve a vision of a more desirable quality of life for Newfoundland communities. Together, the parts examine and explore community's long-term resilience through a multiscale approach and systems design. Various sources of information were influential during the process of this thesis as it synthesizes a range of fields not normally explored together as a whole, including the phenomena of single-industry communities, exploitation, quality of life on island communities, health concerns, and architecture and design.

18 Halseth, Greg. The Next Rural Economies: Constructing Rural Place in Global Economies. Wallingford, CABI Publ., 2010, 145.

19 Ibid, 144.

20 Chris Maser, *Sustainable community development: principles and concepts* (Florida: St. Luice Press, 1997), 49.

21 Ibid, 140.

The methodology seeks to use a case study, the Port-au-Port peninsula, to address the role of architecture in achieving a resilient quality of life that can be applied to struggling communities across the island.

The first part, Issue and Crisis in Newfoundland, introduces the ongoing depopulation issue, global exploitation and food security crisis that plagues the island. It provides a contextual understanding of the two main issues investigated in the thesis: the food crisis and exploitation of resources.

The second part, Island Flows, examines the Newfoundland ecosystem through a multitude of scales and relevant trends. This approach identifies similar behaviors of organization between natural and human systems and identifies the instability of the current system. With this understanding we begin to manage a healthy and vibrant biosphere. Population flows, food processes, energy flows, government structuring, and climatic and geographical analysis is evaluated at a provincial scale in order to demonstrate their effect on the island and its ability to restructure the current exploitation into resiliency.

The next part, Effective Responses, reviews the two converging ideas of controlled greenhouse environments and existing municipality-owned energy utilities. The chapter examines three case studies of controlled environments that are responses to food insecurity, and four case studies of different approaches to regional energy networks that are responses to varying degrees of exploitation.

The fourth part, Design Exploration, proposes a new condition and a vision for a resilient community network. A framework for resilience will embrace innovation, where the traditional relationship between community and resource base is strengthen. This section seeks to envision a built environment that will emerge when the new wind resource acts as an important local energy source used to replace imports of vegetables through locally operated greenhouses running off of renewable, local energy. The architectural response is intended to imagine daily life under new approaches to resiliency where the role of architecture and design is discussed in terms of how it can influence decision-making as well as generate places that encourage resident involvement. The architectural response is focused on bringing together the ideas of local resource integration and strategies to easily implement the systems and represented through images that portray the alternate vision of daily life under a desirable quality of life.

Part 5 addresses the scaling effect of the systems approach. The provincial impact will be reviewed. A large scale is applied, looking at the broad condition of isolated communities with respect to future resiliency. This section seeks to envision Newfoundland communities through a networked system of resources, where connected greenhouses support a cluster of communities with similar issues with an appropriate architectural response. As well, it envisions regions where the environment and daily life are responsive to unique characteristics of place. The need for responsive living environments resource communities is essential to sustaining such regions in Newfoundland.

Presumptions

In order to create a wind powered design unseen in the province to date, the thesis makes a number of presumptions.

This thesis assumes that the minimum USDA requirement of food is being consumed on the island. USDA requirements can be found in the Dietary Guidelines for Americans 2015-2020 Eighth Edition.

Sizing of the controlled greenhouse environment is constructed using general sizing knowledge based on chosen vegetables in Part 4, Crop Analysis. This is used in a fictional future scenario and by no means prescribes the needs of every community, and is used primarily to determine design requirements that relate to a realistic model.

There is a variety of emerging renewable energy production technologies, but this thesis assumes that the St. George's Bay wind farm will be constructed and sold to the Stephenville community after the contract expires.

The St. Georges Bay wind farm does not have a chosen wind turbine model to date. For research purposes, SWT-7.0-154 Siemens Gamesa is chosen to be represented. This turbine has been used by the same investor (Copenhagen Infrastructure Partners) in Denmark.

There is no accurate prediction on the future of vegetable production on the island, but it is certain that new strategies and agendas must begin to be developed to ensure future generations will have the potential to sustain generations to come. It is assumed that the communities will continue to be populated, and not decline to the point of resettlement.

The climate data assumes pre-climate change information, and does not take into account climate change.

Wind information is interpolated from the NASA 50m hub heights and Beothuk Energy information available. It is an estimation of the possible energy extraction and does not claim to be accurate.

Wind power information is interpolated from the formula:
Energy (kWh) = Power (kW) * time (hours)

The grow lights used in the greenhouse complex for data purposes are Black Dog LED Phytomax800, which are pre-approved in the USA and Canada.

’

Part 1 situating the crisis

Newfoundland from within reveals only a fraction of its nature. Its heart is on the outside; there its pulse beats, and whatever is alive inside its exoskeleton is alive by accident. The sea clothes the island as with a garment, and that garment contains the vital principle and soul of the national life of Newfoundland.

-Geographer J. D. Rogers (1911), Sense of Place: Loss and the Newfoundland and Labrador Spirit

The Crisis

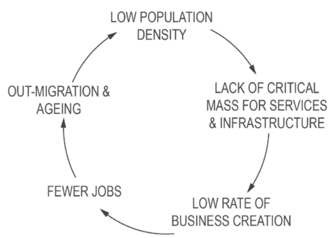


Fig. 1.1 The Circle of Declining Rural Regions

Overall
The province of Newfoundland and Labrador is continuously being challenged by population loss and youth migration. The population is scattered around the coastline, historically built around the Northern cod industry that was laid out by European settlers. After severe over fishing of the Atlantic Ocean by European trawlers and off-shore fisheries, in 1992 a cod moratorium was set in place; the coastal towns suffered. In the last decade, economic development in other industrial resources, such as offshore oil extraction, have boomed; however, this wealth is gained through exploitation of non-renewable resources, where the province nor residents profit, and as such, is not sustainable.

The province needs to detach from the exploitation by larger global metropolitan areas. This is seen in the exploitation and monopoly of oil companies, high prices of food imports, and most predominantly in the 1969 contract of Churchill Falls to Quebec hydro by the Smallwood government.

Newfoundland has changed; the primary sector of fishing and agriculture is no longer dominant, the population is shrinking and aging, and young working-age islanders are migrating. According to the interim report of the Canadian Senate Standing Committee on Agriculture and Forestry, the main trends that have shaped rural Canada in the past are likely to shape it in the future, specifically "a stagnant or declining rural population, which is also an aging rural population".[1]

Although there are numerous success stories, the outcome of these trends can lead to what is called "the Circle of Declining Rural Regions". Culturally, rural areas differ from the urban as "there are some strong ideas about self-sufficiency in rural areas... ideas about self-sufficiency are really important to people."[2]

The island of Newfoundland faces many issues, but two struggles are emphasized in this thesis: the extreme lack of local fruits and vegetables, which are basic needs, and the dangerous exploitation of island resources.

Food Security
Newfoundland and Labrador is particularly vulnerable to the global market with respect to food resources and produce. The island composition emphasizes the fragility of the food transit lines.

There is an extreme lack of locally produced food, where people have come to rely on imported food in order to survive. With food imports reaching 90% of

1 Canada. Parliament. Senate. Understanding freefall the challenge of the rural poor. Ottawa: Senate, 2006, 21.

2 Ibid, vii.

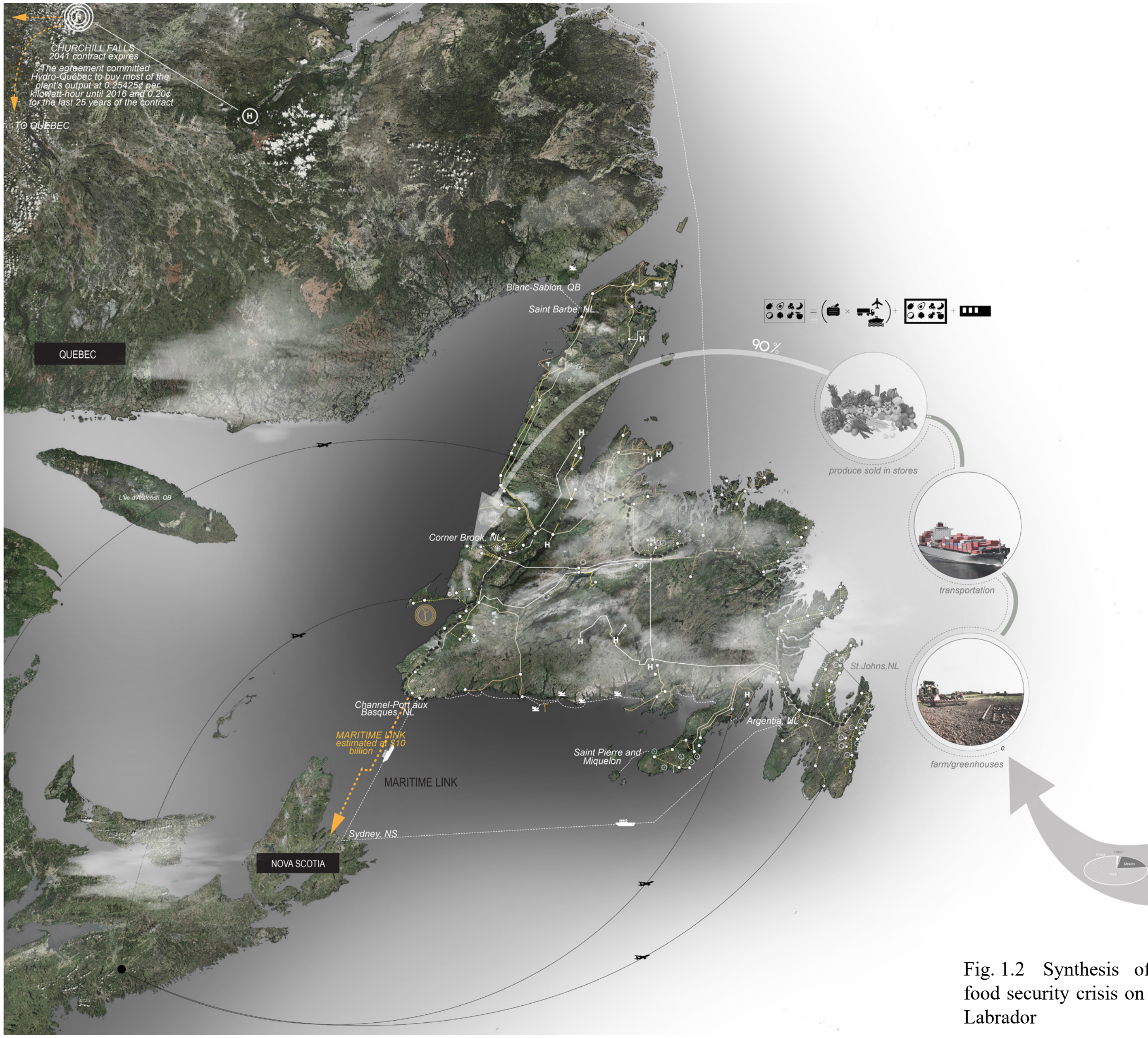


Fig. 1.2 Synthesis of the energy exploitation and food security crisis on the island of Newfoundland and Labrador

Fig. 1.3 Empty aisles plague the grocery store, with much produce arriving near its expire date

the total amount consumed[3], Newfoundlanders have become vulnerable. Dependent on other provinces and countries for basic needs becomes problematic. With treacherous, unwavering weather, access to this food can become challenging. According to an article in The Overcast, Newfoundland's Alternative Paper, the island has only two-to-three days of food security[4], this means that if ice cover is too dominant in the ocean and the boats get stuck, the island has only enough food for three days, there after the residents must rely of packaged and canned items. Newfoundlander Lauren Power continues in her article that, "with federal cuts to Marine Atlantic, and the straits which are chocked-blocked with ice for most of the winter, it wouldn't take a worldwide apocalypse to cut us off from the mainland."[5]

Food is imported into the country by ship. Marine Atlantic owns two ships, MV Blue Puttees, along with her sister ship the MV Highlanders, at 199.5m in length and 2,840 lane meters on the vehicle decks.[6] The ships bring produce across the Atlantic ocean into Port-aux-Basque and St. John's, a 6-hour and 16-hour trip respectively. High waves during the harsh winters make this lifestyle even more severe, as marine transportation is highly dependent on weather conditions. The predominant winds across Newfoundland are westerly. In the fall, the waves on the southern coast can become violent. The waves are larger in the months of transition when the temperature of the water has yet to catch up with that of the air. This difference causes high winds, and high winds cause larger waves.

Ice build-up is created by the large amount of snow fall in the West and Avalon regions, and it is common for the ships to get stuck in the ice. This influences imports, and in turn influences the produce transported into the island.

Exploitation

Newfoundlanders are no stranger to exploitation. Even as wealth grew in the late 19th century, Britain was still handing over coastal waters and lands to foreign countries. The United States was granted fishing rights, and up until 1904, a valuable and extensive section of the coastline was ceded to France as the "French Shore." Newfoundlanders were being told where and how to fish. Neither the people nor their leaders did much, and the one was not accountable to the other. Years later Dr. Michael Staveley (1982) would write:

3 Lauren Power, "Overcoming Insecurities: Food Security Network NL and the State of Food in our Province," *The Overcast: Newfoundland's Alternative Newspaper*, June 1, 2015, accessed May 5, 2017, https://theovercast.ca/overcoming-insecurities-food-security-network-nl-and-the-state-of-food-in-our-province/.

4 Ibid.

5 Ibid.

6 Ibid.

> In any Canadian province... prosperity is largely a function of natural resource endowment over which the provinces have, by constitution, sole ownership and control. Fisheries, however, because they are mobile and a common property resource, are an exception to this rule. By entering Confederation, it was Newfoundland's misfortune to lose ultimate control of its most important resource industry... in the 1950's, benign neglect by Ottawa and internal structural problems arising from divided jurisdiction insured the fisheries would slip further into decay.[7]

This exploitation extends to the customs barrier that protected local farms being removed in 1949, the overfishing of the offshore fishery by European trawlers resulting in a moratorium that disrupted the islands livelihood, to the regulation of oil companies, causing oil to regularly sore over $1.41 a litre.

The province advocates and practice what is known to Jacobs as import-substitution, where "completely developed factories (producing foreign imports) be set down arbitrarily any place- in little towns, in the countryside, usually wherever jobs are needed… only to bankrupt countries instead of helping them prosper"[8]. Multiple industries including mining and army bases have come into small rural communities to create a short-lived boom, where the communities eventually decline after the industry is dismantled.

The main exploitation reflected upon in the thesis is Newfoundland and Labradors Churchill Falls hydro plant, where Newfoundland is exploited in the 1969 contract with Quebec, and the cost of electricity is stagnant until the contract expires in 2041.[9] Quebec Hydro owns transmission lines in Quebec that would allow Newfoundland and Labrador to sell to the south, however is refused access. The contract made to Quebec by the Smallwood government in 1969, greatly favors Quebec. To halt this exploitation, Newfoundland and Labrador is creating a Maritime Link, connecting transmission lines to Nova Scotia underground. So far, 10 billion

7 Victor L. Young, *Collected research papers of the Royal Commission on Renewing and Strengthening Our Place in Canada* (St. Johns, N.L.: Royal Commission on Renewing and Strengthening Our Place in Canada, 2003), 351.

8 J. Jacobs, *Cities and the Wealth of Nations: Principles of Economic Life* (New York: Rondom House, 1984), 44.

9 Cleo Research Associates, *Collected research papers of the Royal Commission on Renewing and Strengthening Our Place in Canada*, Power Politics and Questions of Political Will: A History of Hydroelectric Development in Labrador's Churchill River Basin, 1949-2002 (St. Johns, N.L.: Royal Commission on Renewing and Strengthening Our Place in Canada, 2003).

Fig. 1.4 Ships transport goods and pedestrians from Sydney, Nova Scotia to Port aux Basque, Newfoundland

Fig. 1.5 Oil prices are regularily above the normal prices in the rest of Canada

Fig. 1.6 Boats struggle to travel through ice in early May 2017

dollars has been spent in creating this link.[10]

Synthesis

The thesis suggests that the intersection of food security and reducing the exploitation of island resources creates a framework for more resilient development that is grounded in local conditions. Herein, architecture becomes a way to reflect upon a future scenario, where a pro-active process allows Newfoundlanders control over natural resources and using it to benefit the community by reducing community's vulnerability. It becomes a way to engage with, and respond to, the needs of local people as a means of building a paradigm of self-sufficiency.

With emerging industries, and the new energy farm, there is opportunity to respond and envision a more resilient community. With three wind farms opening in Newfoundland in the last decade, a new point of designing for resilience can respond to this food vulnerability crisis. With the introduction of this new industry there is opportunity to link the production of energy with the creation of fresh food, reducing the need for imported produce. This offers opportunity for community restructuring towards a more effective relationship with the surrounding landscape and systems.

10 Jeff Myrick, "Maritime Link Benefits Agreement Creates Local Economic and Employment Opportunities," Emera Newfoundland & Labrador, November 26, 2014, accessed December 31, 2017, http://www.emeranl.com/en/home/newsinformation/newsannouncements/Benefits-Agreement.aspx.

Fig. 1.7 Energy lines travel across the island

Part 2 island flows

"The most important scientific challenge facing humanity is to understand the co-evolution of the natural world and the human constructed world that together form the biosphere of our planet. Only with this understanding can we begin to manage our affairs such that the biosphere is healthy and vibrant, both now and in the future."

James J. Kay, Henry A. Regier, Michelle Boyle, and George Francis. An Ecosystem Approach for Sustainability: Addressing the Challenge of Complexity.

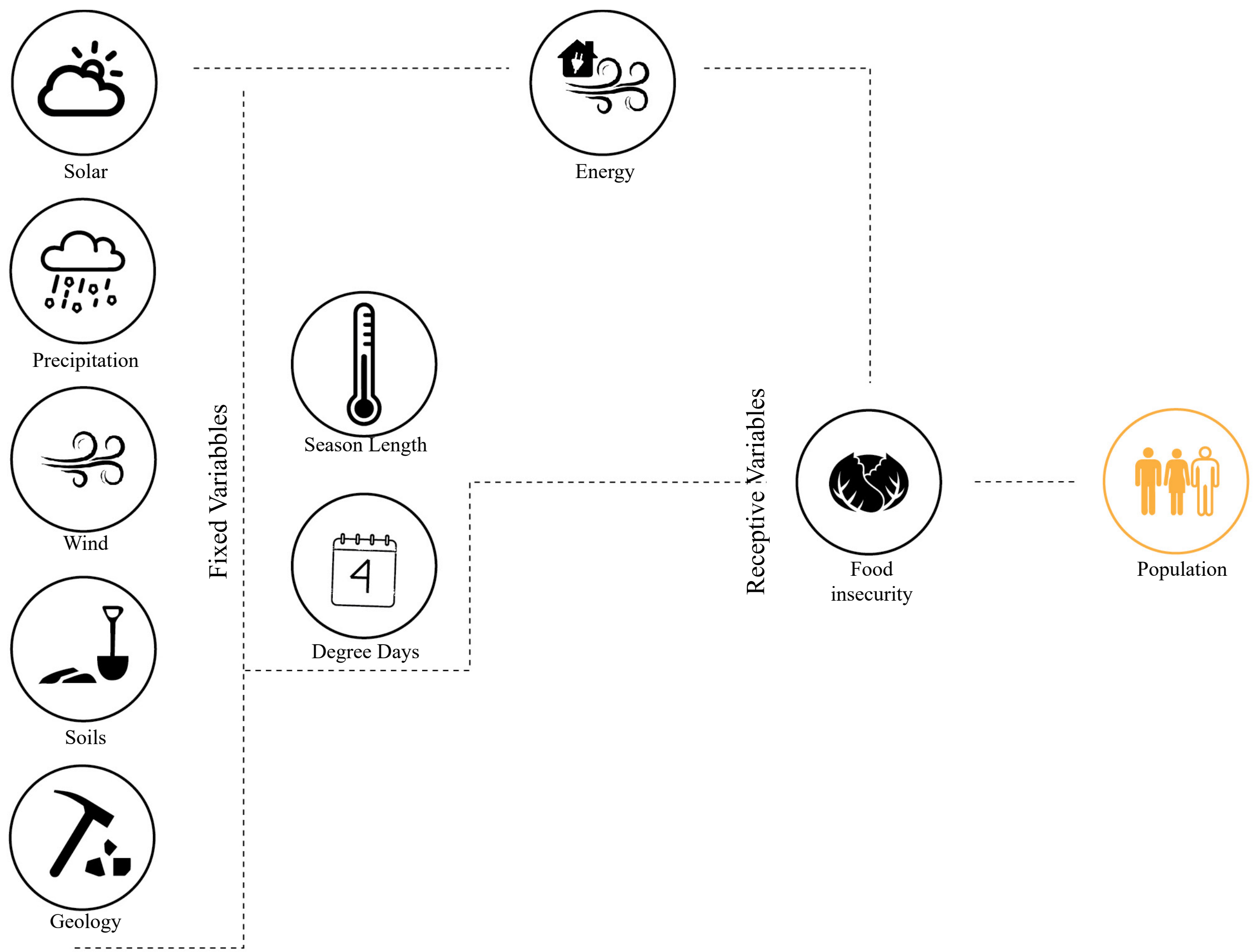


Fig. 2.1 The Island has a number of fixed variables that cannot be altered, however, they can be used to manage the receptive variables of the province.

Island Flows

The following section examines the Newfoundland system using a provincial scale to understand the co-evolution of the human constructed world and the natural world. Together they create a biosphere that is currently not conducive to supporting an independent food system. Newfoundland is dependent and vulnerable to the global market, with the following systems identified as a cause of the instability of the current system, and its inability to support traditional vegetable growth. With an understanding of the fixed and receptive processes, we can begin to manage a healthy and vibrant biosphere. Population flows, food flows, energy flows, government structuring, and climatic and geographical analysis is evaluated in order to demonstrate their effect on the island and its ability to be restructured in order to turn current dependency into resiliency.

Fig. 2.2 A residential street goes empty with no sign of pedestrians or vehicles.

Fig. 2.3 St. John's population center is the only community seeing an influx of people.

Newfoundland is consistently being challenged by population loss and youth migration. Unemployment rates continue to soar, currently sitting at 12%,[1] the highest in the country. Low natural population growth (births less deaths)[2] and migration toward more prosperous provinces is high.[3] Migration and seasonal out-of-province migration is common, with employment opportunities arising in Western provinces such as Alberta with the growing oil industry and Ontario with service opportunities.

Migration to the province capital, St. John's, also became popular, as the only community that has not undergone population decline since 1990.[4] The Newfoundland Economic Research and Analysis Division Department of Finance underwent research into the future projections of St. John's population where the medium and high scenarios indicate slight population increases by 2031[5], however, the results of the research suggest that out-migration from rural areas will continue and at an accelerated rate.[6]

Out-migration is seen among many rural youth, with 55% of those surveyed indicating that they intend to move to an urban center, and only 37% of former rural youth residing in urban centers indicate that they intend to return to a rural community.[7] The study suggests that there is a need for a youth strategy, and the Discussion Paper offers direction for improving youth opportunities in order to more actively participate in Canada's rural economic growth and diversification.[8]

One of the government's first response to the issue was to introduce the infamous strategy of Resettlement. The first resettlement program, Centralization, was introduced in 1954 and offered voluntary residents small sums of money to relocate to larger, more accessible areas of their choosing. As a community-focused venture, government required a unanimous vote from all community members to resettle.[9] The social consequences were severe, where rumors were

1 Statistics Canada, Unemployment Rate, Monthly, Canada and Provinces, Labour Force Survey. Dec 1, 2017. Raw Data. http://www.stats.gov.nl.ca/statistics/labour/PDF/UnempRate_Monthly.pdf

2 Statistics Canada, Estimates of Demographic Components Newfoundland & Labrador, Demography Division. 1971-72 to 2015-16. Raw Data.

3 Statistics Canada, Net Interprovincial Migrants by Age Groups and Sex, Demography Division. 1971-72 to 2014-15. Raw Data. http://www.stats.gov.nl.ca/statistics/population/PDF/NetMig_AgeSex_BS.pdf

4 Statistics Canada. 2011 and 1991 Population by province and territory (Newfoundland and Labrador). *Census*. February 4, 2011. Raw data.

5 *Population projections for the City of St. Johns* (St. Johns, NL: Economic Research and Analysis Division, Dept. of Finance, 2014), 1.

6 *Rural youth study, phase II: rural youth migration: exploring the reality behind the myths: a rural youth discussion paper* (Ottawa, Ontario: Rural Secretariat, 2002), ii.

7 *Rural youth study, phase II: rural youth migration: exploring the reality behind the myths: a rural youth discussion paper* (Ottawa, Ontario: Rural Secretariat, 2002), ii.

8 Ibid

9 Melanie Martin, "Resettlement," Resettlement, July 2007, accessed September 23, 2017, http://www.heritage.nf.ca/articles/politics/resettlement.php.

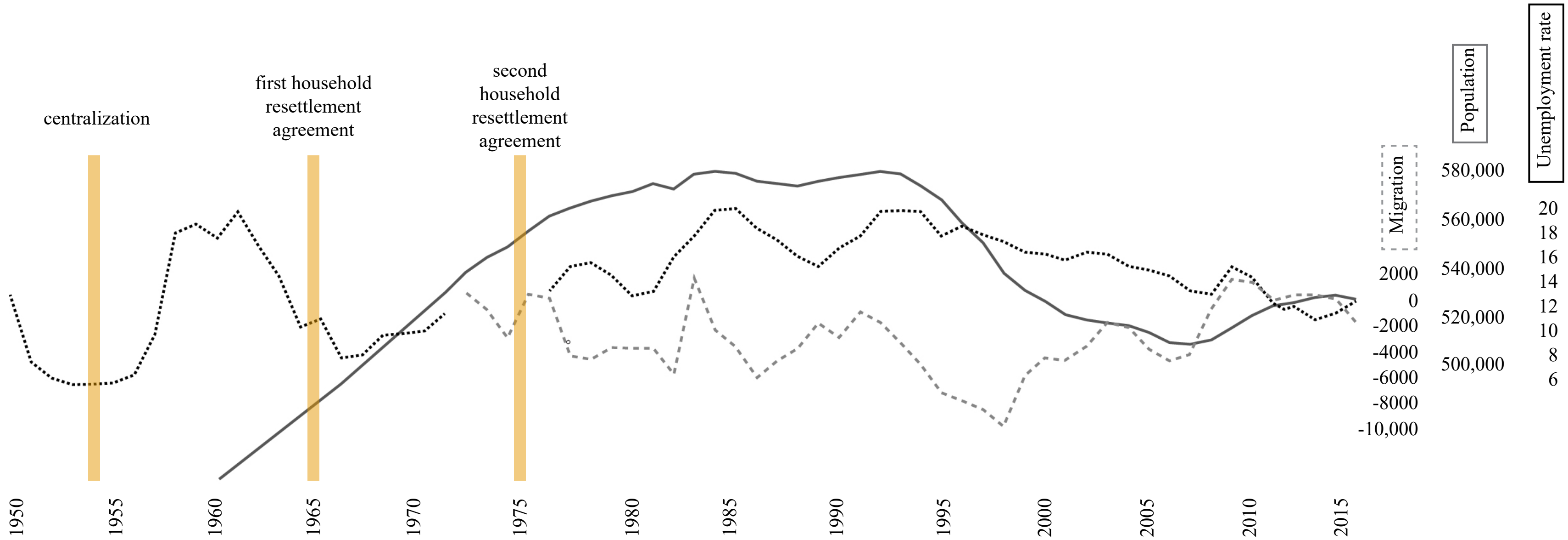


Fig. 2.4 Net migration, unemployment rate and population migration

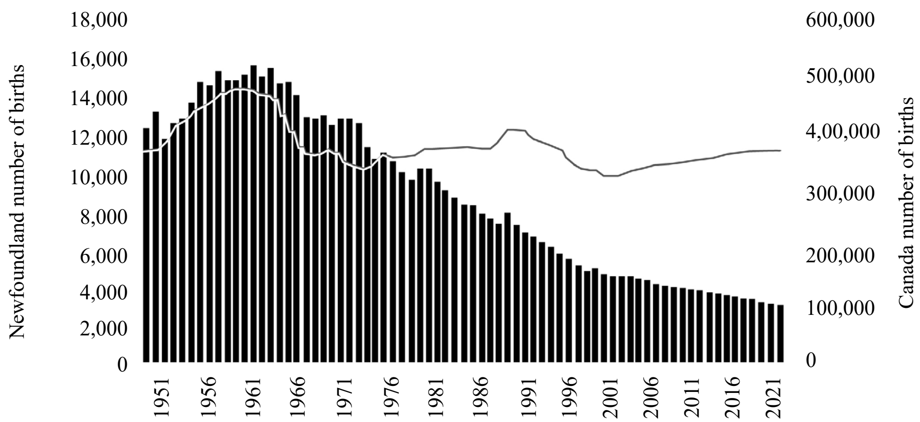


Fig. 2.5 Newfoundland births compared to Canada births (1951 - 2021)

Fig. 2.6 House of John Moss being pulled from Flat Island into the Burnside community during Resettlement, 1958.

Fig. 2.7 $85,000 or best offer sign in window of vacant commercial building.

circulated by residents, fostering fear. This was also an issue when the program was renewed, as the First Household Resettlement Agreement (1965-70) and Second Household Resettlement Agreement (1970-75) brought in by the Smallwood government represented a government policy designed to redistribute the rural population within a certain region.[10] This type of structural change involved concentration into or near larger centers offering goods and services and employment opportunities, and also required less people to agree to resettle.[11] In only two decades, over 250 villages disappeared, some around for centuries.[12] The government of the day saw resettlement as advancing towards modernization[13], however many of the governments promises of more and better employment opportunities in the growth centers were not realized and resettlement meant unemployment and welfare to many resettlers, with some returning and commuting to their old fishing grounds.[14] This resettlement of outports continues today, including outports Great Harbour Deep (2002), McCullum (2015), and Little Bay islands (tbd). Many resettlers still see resettlement as a shameful part of Newfoundland and Labrador's history.[15]

The word resettlement continues to evoke strong emotion, and as a theme resettlement has made its way into Newfoundland and Labrador's visual and performing arts, literature and music. The issue of resettlement and migration is captured in the Newfoundlander performing group Buddy Wasisname and the Other Fellers. The group lyrics focus on Newfoundlanders speaking to them after a concert in Sudbury,

> And I know how some of them came to meet On one warm, clear April day
> To see our show and to see us all go
> And how we left and they stayed
> And I know the tears in big Johnny's eyes
> When our visit came to an end
> And when Ray played one last familiar tune I know how they waltzed once again.
> So I'm not saying, "It's wrong to leave"
> I'm not saying "It's right to stay"
> All I know is, of all those who left
> They talk of leaving again.[16]

This migration and resettling causes a disconnect that is seen in many migrating residents. It is difficult to weigh out the benefits of resettlement versus the trauma associated with such an uprooting of people.[17] Resettlement will go down in Newfoundland and Labrador's history as a controversial issue, forever divided between two viewpoints.

10 Parzival Copes, *The resettlement of fishing communities in Newfoundland* (Ottawa, 1972), 99.

11 Ibid, 129.

12 Melanie Martin, "Resettlement," Resettlement, July 2007, accessed September 23, 2017, http://www.heritage.nf.ca/articles/politics/resettlement.php.

13 Ibid.

14 Ibid.

15 Ibid.

16 Victor L. Young, *Collected research papers of the Royal Commission on Renewing and Strengthening Our Place in Canada* (St. Johns, N.L.: Royal Commission on Renewing and Strengthening Our Place in Canada, 2003), 355.

17 Melanie Martin, "Resettlement," Resettlement, July 2007, accessed September 23, 2017, http://www.heritage.nf.ca/articles/politics/resettlement.php.

Fig. 2.8 Population comparision between 1990 and 2010. Decline is widespread across the entire island except for the slight increase in the metropolitian centre of St. John's. Circles are proportionately scaled to population size.

1990 population

2010 population

⁎ — centers over 2000 people

---- ferry routes

Fig. 2.9 Eerily vacant, pedestrian and vehicular trail along the Stephenville Airport bestoes a sign stating *Please drive with caution, our children are using this street for recreation, obey the 40 km speed limit.*

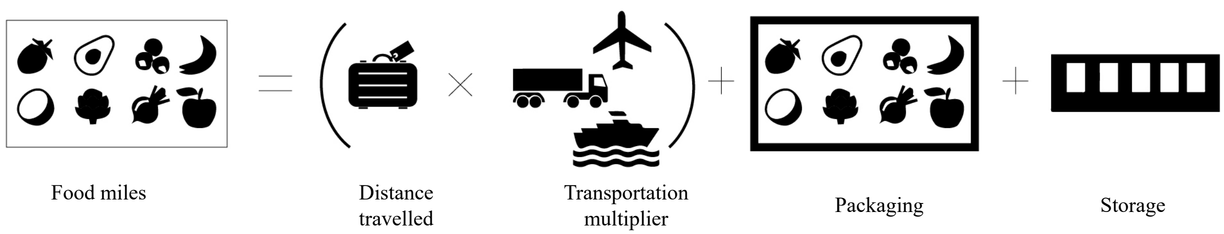


Fig. 2.10 Food Mile Calculation

Newfoundland and Labrador has a reliance on imports that leaves the island with only a two-to-three day supply of food.[1] According to the Food Security Network of Newfoundland & Labrador (FSN, now known as Food First NL), bare grocery shelves are only part of the bigger picture of the province's food problems.[2] In an article written for The Outcast, Newfoundland's Alternative Paper, Kristie Jameson, Executive Director of FSN, states that,

> "the issue of food security is so incredibly complex, and tied to so many other issues in the province…as a province, we're quite dependent on outside food sources, which are brought in through this large and quite complicated food system that's quite vulnerable … leading us to higher cost, lower quality, and poor availability of healthy fresh food across the province."[3]

FSN is a provincial non-profit organization that promotes community-based solutions to ensure physical and economic access to adequate and healthy food for all. They work with government, community organizers, community gardens, and others to improve access to healthy food in the province, while also helping to raise awareness of the issues. Access to local produce is an ongoing issue and is currently making its way into mainstream media.

Newfoundland imports the majority of their produce from other provinces and internationally. Because the large distance the imports must travel, the added disadvantage of food miles is added onto the food. The concept of food miles, the distance food travels before being consumed, dates back to a 1994 report called *The Food Miles Report: The dangers of long-distance food transport*. Food miles are dependent on the distance travelled, the type of transportation, and packaging and storage time before distribution. The report infers that, "over-processed, over-preserved and over-packaged produce can mean that consumers buy foods of lower nutritional value. For instance even after only 24 hours, spinach and asparagus, stored at room temperature, lose 50% of their vitamin C content."[4] Pesticide residues on foods and pollution from transport can also pose additional risks.[5] Imported produce enters the Island at Port-au-Basque, where it travels across the TransCanada highway to their destination, which spans over 7,821km. The vast

1 Lauren Power, "Overcoming Insecurities: Food Security Network NL and the State of Food in our Province," *The Overcast: Newfoundland's Alternative Newspaper*, June 1, 2015, accessed May 5, 2017, https://theovercast.ca/overcoming-insecurities-food-security-network-nl-and-the-state-of-food-in-our-province/.

2 Ibid.

3 Ibid.

4 Angela Paxton, The food miles report: the dangers of long-distance food transport (London: SAFE, 1994), 8.

5 Ibid.

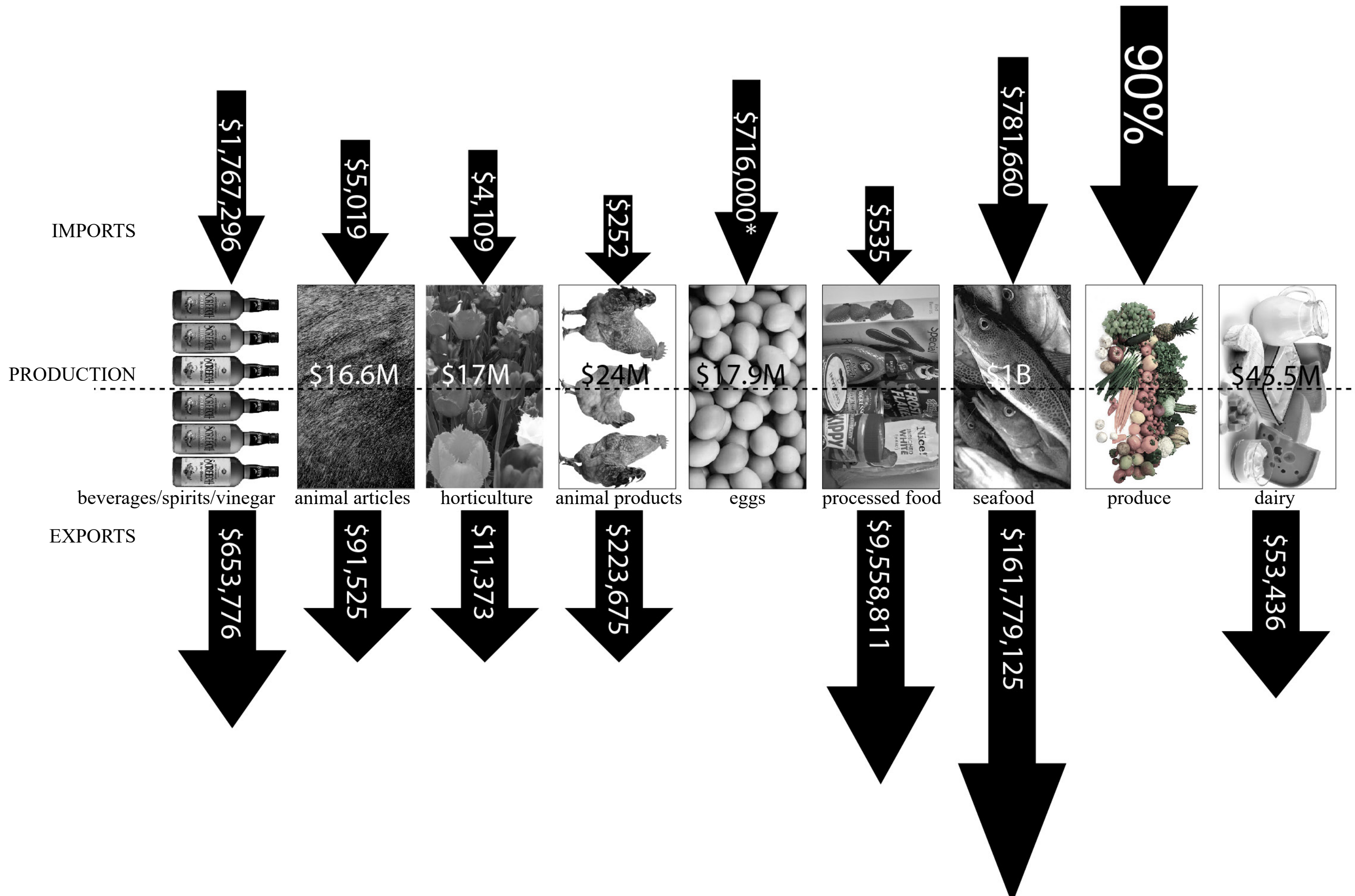


Fig. 2.11 Import, exports and provincial production of Newfoundland and Labrador. Available data is taken from both 2012 and 2017 data sources. *mathematically interpolated

Fig. 2.12 Stores and flyers put non-perishable items on sale, making up for the lack of produce.

majority of produce Newfoundlanders consume is imported which effects health negatively, and ultimately lowers quality of life on the Island.

A look at the weekly grocery flyers or a walk down a grocery isle emphasizes the food crisis, where non perishable and canned items, soft drinks, junk food and processed meats and food is on special, not the fresh food.

The key agricultural sectors in Newfoundland and Labrador are dairy, poultry, horticulture, eggs (supplies 96% of fresh table eggs consumes in the province) and fur sectors.[6] According to Newfoundland and Labrador's Agriculture Industry report, the province's top exports were alcoholic beverages and exports of processed products (made up largely of beverages) were valued at $17.5M in 2012 and accounted for 96% of Newfoundland and Labrador's agriculture and agri-food exports.[7]

6 Canada., Agriculture and Agri-Food Canada., Newfoundland and Labrador's Agriculture Industry (Ottawa: Agriculture and Agri-Food Canada, 2013), 1.

7 Ibid, 2.

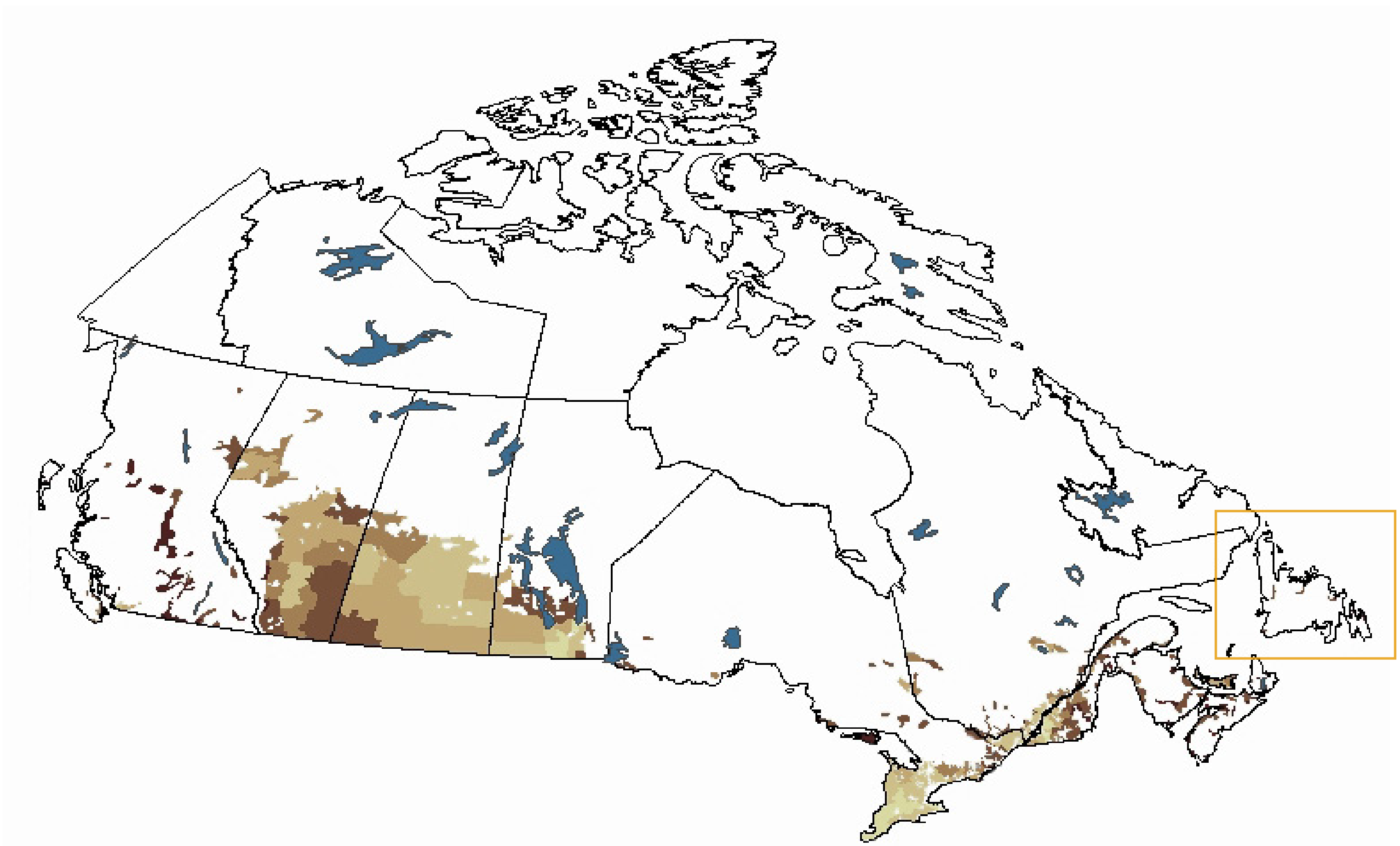


Fig. 2.13 Farm land distribution in Canada. Newfoundland lacks the farm land required to produce crop, instead importing from around the globe.

Newfoundland and Labrador lacks the farmland and conducive climate, referred to in the climatic section, to produce vegetables. The province has the lowest farm acreage of all Canadian provinces, home to 77,349 out of 160,155,748 Canadian acres of farmland, and declining at the quickest rate.[8] The current number of farms in the province, 510, is down from its peak of 4226 farms in 1935.[9] Without the available resources, production of food is impossible to sustain population, and thus residents must rely on imports which effects residents' quality of life.

8 Statistics Canada, Census of Agriculture, 2006 and 2011. http://www.statcan.gc.ca/pub/95-640-x/2011001/p1/p1-01-eng.htm. 2016-01-25

9 Ramsey, R.D. 1998. Issues Affecting the Development of Agriculture in Newfoundland: A Case Study of the Lethbridge-Musgravetown Agricultural Development Area. Rural Research Centre, Nova Scotia Agricultural College, Research Paper No. 30.

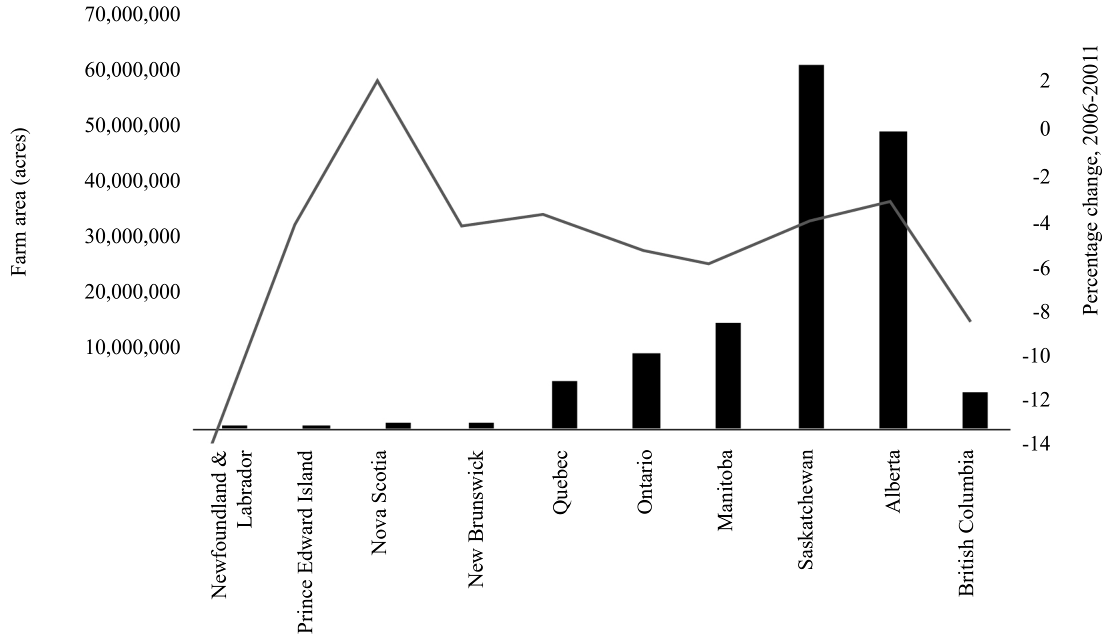


Fig. 2.14 Farm Land Distribution

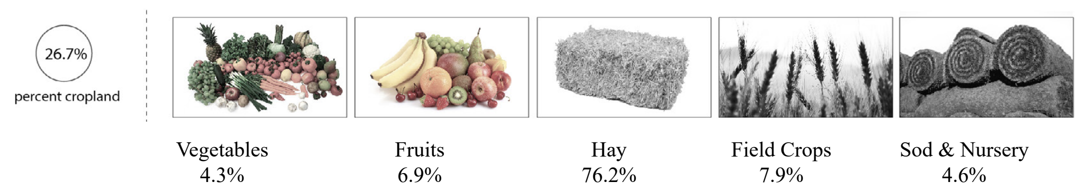


Fig. 2.15 26.7% of farm acrage is used for crop production, of that only 4.3% is used for vegetables

Energy Flow System

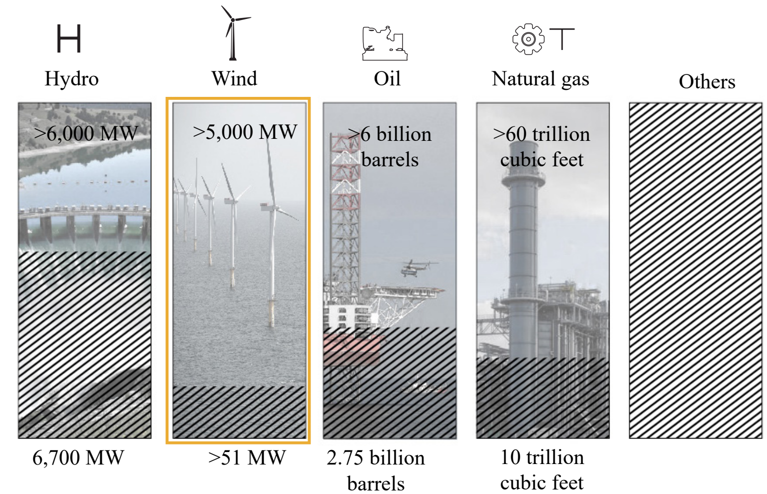
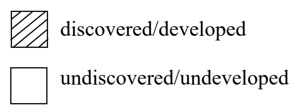


Fig. 2.16 Newfoundland and Labrador's 'Energy Warehouse'. The undeveloped wind energy sector is high, demonstrating the potential for the renewable energy.



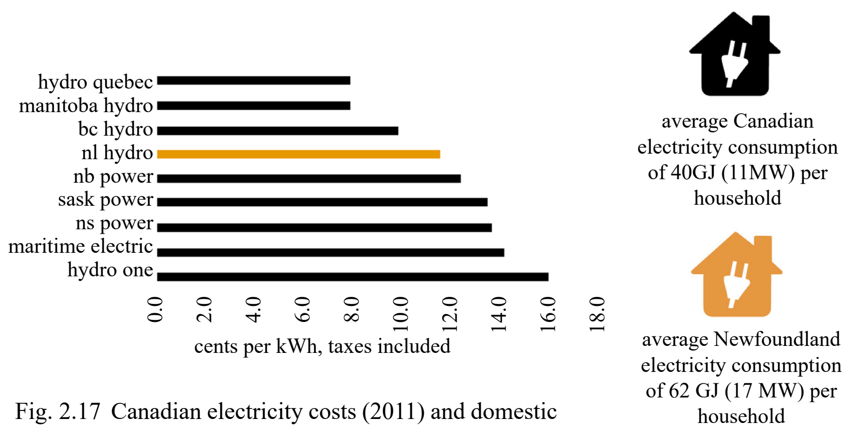


Fig. 2.17 Canadian electricity costs (2011) and domestic requirement

Newfoundland and Labrador possess multiple approaches to energy generation, including hydroelectric, emerging wind farms, biomass, oil, natural gas and diesel generators for isolated communities, which are often costly. The province holds numerous renewable electricity generation assets, including hydroelectric projects at Bay d'Espoir, Cat Arm, Upper Salmon, Hinds Lake and Upper Churchill, however, the province has significant undeveloped potential.[1] According to a 2007 Energy Report, Newfoundland and Labrador was expected to produce almost 45 per cent of Canada's conventional, light crude oil and generate 12 per cent of Canada's hydroelectricity, but more importantly, the province's undeveloped energy potential is even greater than the energy they now supply.[2] The province has the ability to meet all of their own energy needs and still provide significant energy for export to other jurisdictions where energy demand also continues to grow. The total developed clean, renewable electrical generation plus the identified additional potential is 18,000 Megawatts (MW).[3] Although the province has the capacity to meet their own needs, the consumer cost of electricity is higher than Hydro Quebec,

1 *Focusing our energy: Newfoundland Labrador energy plan* (St. Johns, NL: Newfoundland and Labrador, 2007), 30.

2 Ibid, 2.

3 Ibid, 6.

Manitoba Hydro and BC Hydro.[4]

On the Island, approximately 65 per cent of electricity capacity comes from hydropower, while 35 per cent comes from thermal-fired generation that is subject to price volatility.[5] The island has an isolated electricity grid, so demand from residential and business customers must be supplied on the island. Supply and demand is kept in balance each day, only the electricity needed by customers is produced. If customer demand reaches the maximum supply available, customers are asked to conserve electricity.[6] Overflow does not occur with the Provincial utility.

Wind generation that can be integrated into the current Island system is limited to only 80 MW, primarily because the Island's reservoirs have a limited capacity and the Island is not yet connected to a larger market that can absorb the short-term overflow of power.[7] Until the Island is connected to the North American grid, the generated wind power

4 "Electricity Rates," NL Hydro | Power Your Knowledge, accessed September 24, 2017, http://www.poweryourknowledge.com/rates.html.

5 *Focusing our energy: Newfoundland Labrador energy plan* (St. Johns, NL: Newfoundland and Labrador, 2007), 31.

6 "System Information," Newfoundland & Labrador Hydro, accessed September 24, 2017, https://www.nlhydro.com/system-information/.

7 Focusing our energy: *Newfoundland Labrador energy plan* (St. Johns, NL: Newfoundland and Labrador, 2007), 37.

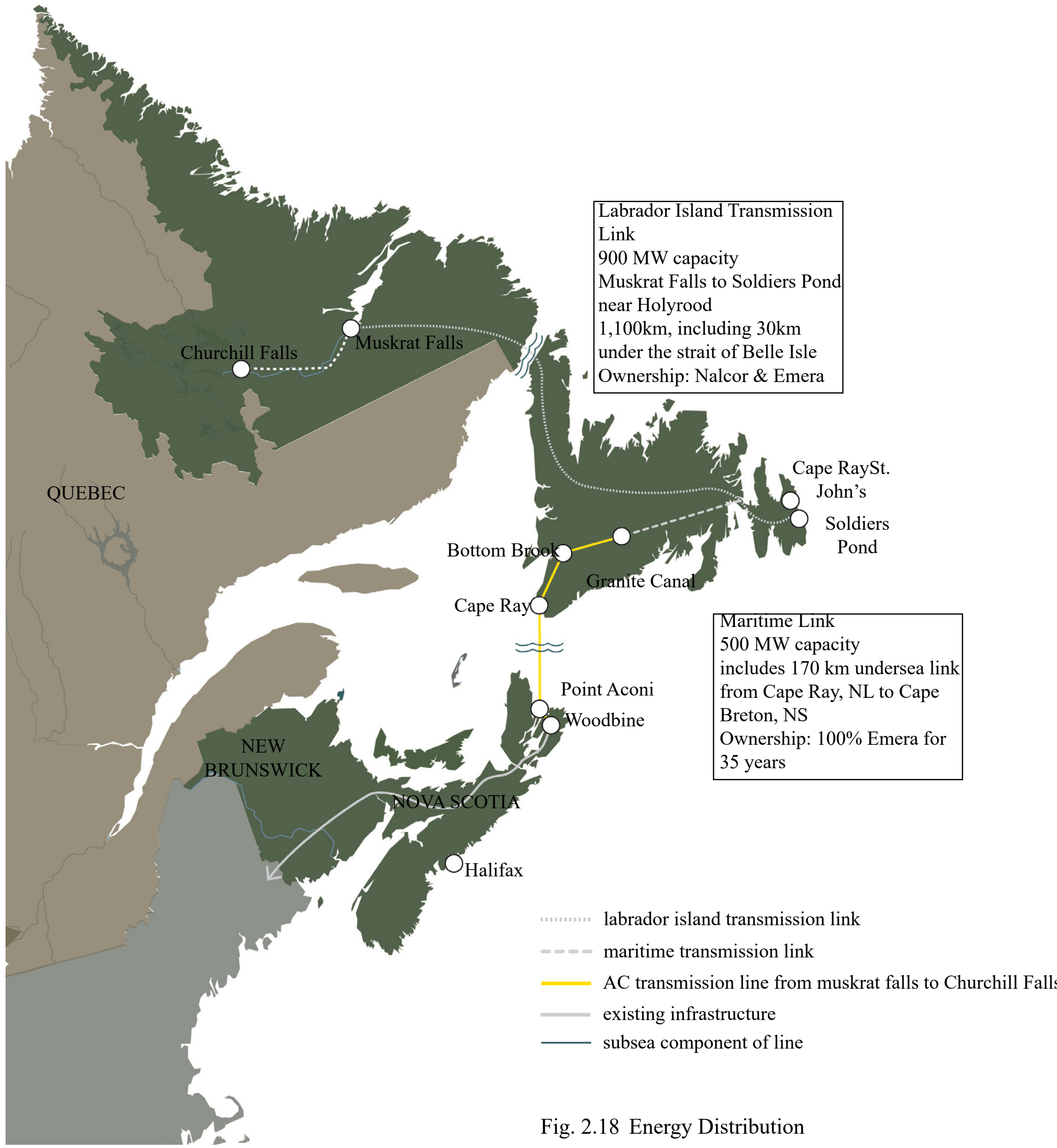


Fig. 2.18 Energy Distribution

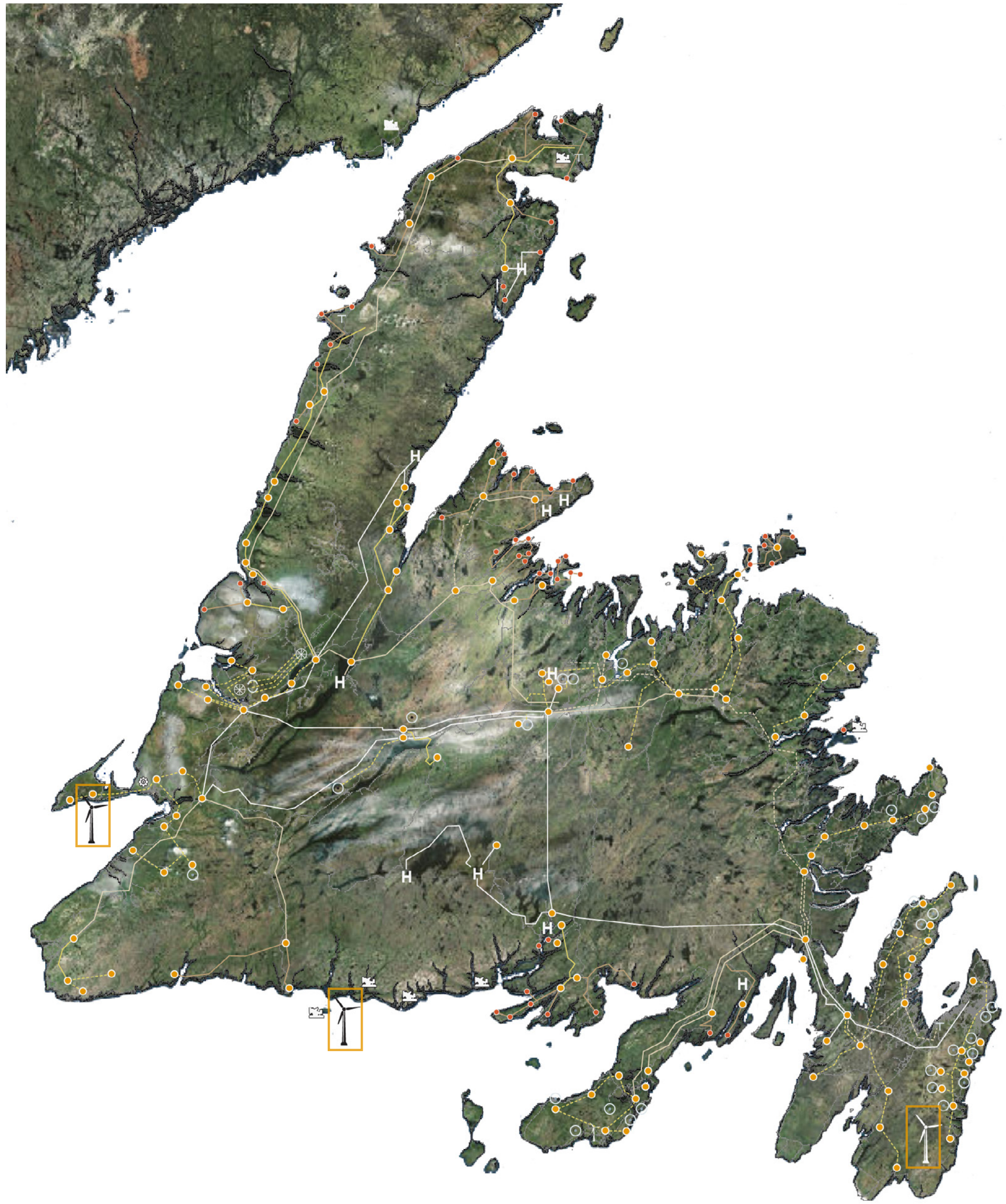


Fig. 2.19 Isolated energy grid across the island allows for a monopoly on prices and companies.

- terminal station
- diesel plant
- gas turbine
- hydro plant
- thermal plant
- wind generator
- frequency convertor
- operator by Nalcor
- operator by NF Power
- corner brook pulp & paper
- 230kV
- 138 kV
- 69 kV
- low voltage
- customer owned

will be used to reduce generation and emissions at Holyrood and help meet demand growth, as without a transmission link it is not feasible to replace the power generated at the Holyrood facility.[8] A transmission link between the Island and Labrador providing access to the rest of the continent and the new Maritime link connecting the Island to Nova Scotia, will facilitate development of substantial wind resources.

Exploitation

The 5,428 MW Churchill Falls power station, located in Labrador, is the third largest hydro-electric generating station in North America and is the second largest underground power station in the world.[9] However, because of agreements negotiated in the 1960s, the province does not experience the full economic or electrical benefit of the asset. While the project has generated an estimated net revenue of $20 billion (as of 2006), Newfoundland and Labrador has only received approximately $1 billion.[10] There were many issues with the 1969 Churchill Falls contract, initially set by the Smallwood government to achieve the dream of a diversified economy, stepping away from traditional dependence on the cod fishery. Two main problems with the contract still plagues the Island today; the courts of Quebec, not Newfoundland and Labrador, would hear disputes related to the contract, and that Hydro-Quebec insisted that an automatic 25 year extension be included in the 40-year contract, during which time it would get to purchase power at a reduced price.[11] In place of an escalation clause, the contract stipulated that there was to be a reduction in the price paid by Hydro-Quebec for Churchill Falls power, remaining at 2.0 mills (2/1000ths of a Canadian dollar) until the termination of the contract in 2041.[12]

The lack of an escalation clause and the decreasing pricing arrangement doomed the province, as less than 30 years into the contract Hydro-Quebec was averaging $600 million in gross revenues per annum when Newfoundland and Labrador averaged $23 million per year.[13] Essentially, Hydro-Quebec acquired 96 per cent of the benefits from Churchill Falls, while the owner of the resource received only 4 per cent.[14] Selling the power at less-than-market prices that did not keep up with basic inflation threatened the long-term financial viability of the corporation and the contract put

8 Ibid, 37.

9 Victor L. Young, *Collected research papers of the Royal Commission on Renewing and Strengthening Our Place in Canada*, A History of Hydroelectric Development in Labrador's Churchill River Basin (St. Johns, N.L.: Royal Commission on Renewing and Strengthening Our Place in Canada, 2003), 7.

10 Ibid, 7.

11 Ibid, 7.

12 Ibid, 8.

13 Ibid, 7.

14 Government of Newfoundland and Labrador, "Background on Churchill Falls," (Churchill Falls Media Briefing October 9, 1996,) p.3.

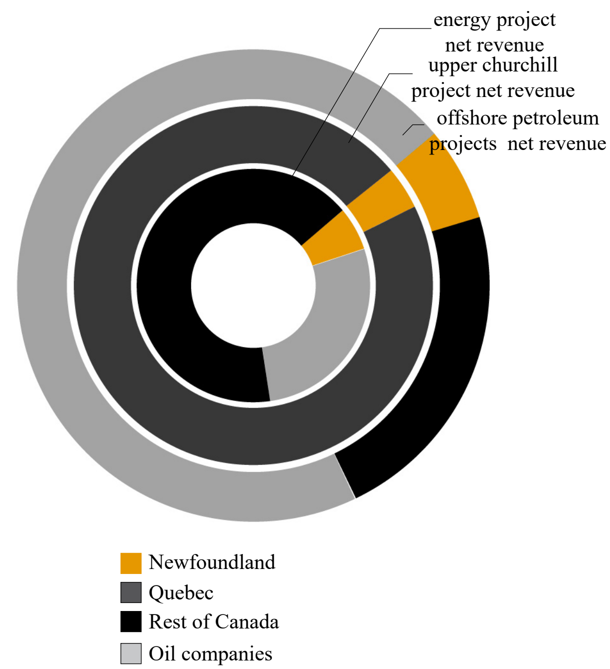


Fig. 2.20 Net Revenue. Newfoundland benefits the least from Energy projects, the Upper Churchill project, and the offshore petroleum projects.

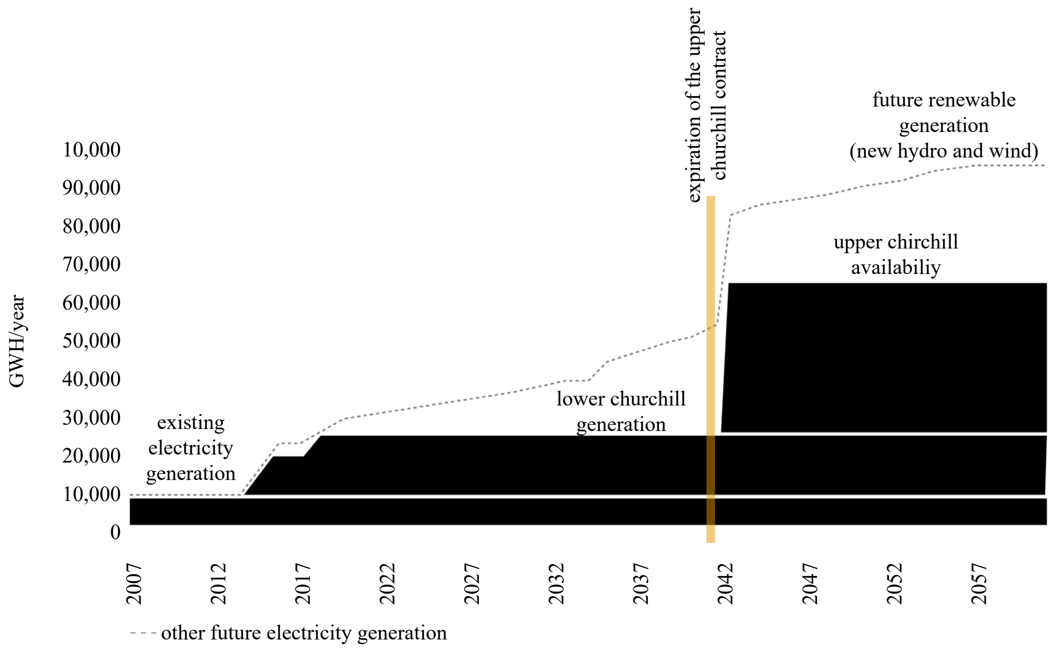


Fig. 2.21 Potential opportunity for renewable electricity generation (2007 - 2060). After the expriation of the Upper Churchill contract, future renewable energy generation drastically raises, providing an opportunity to create energy for new uses, such as aiding greenhouse development in order to lower the islands food vulnerabilty and raise quality of life.

Hydro-Quebec to assume full control of the entire Churchill Falls operation if it became insolvent.[15] Consequently, throughout the 1970s and 1980s the province of Newfoundland and Labrador had to spend almost $700 million on alternative energy sources to compensate for not being able to access Churchill Falls power.[16]

In 2007, the Newfoundland and Labrador government produced a report explaining the new Energy Plan developed to combat the provinces long history of exploitation of wealth that was managed and controlled for the benefit of outside interests rather than for the people who live and work in the province. This Energy Plan announces that it will ensure that Newfoundlanders and Labradorians become the principal beneficiaries of the great supply of energy resources, which the report refers to as their Energy Warehouse.[17]

This plan is developed looking into the future when the Upper Churchill contract expires and the province is in the position to receive the full benefit from this resource. The report declares that,

15 Victor L. Young, *Collected research papers of the Royal Commission on Renewing and Strengthening Our Place in Canada*, A History of Hydroelectric Development in Labrador's Churchill River Basin (St. Johns, N.L.: Royal Commission on Renewing and Strengthening Our Place in Canada, 2003), 8.

16 Ibid, 8.

17 *Focusing our energy: Newfoundland Labrador energy plan* (St. Johns, NL: Newfoundland and Labrador, 2007), 6.

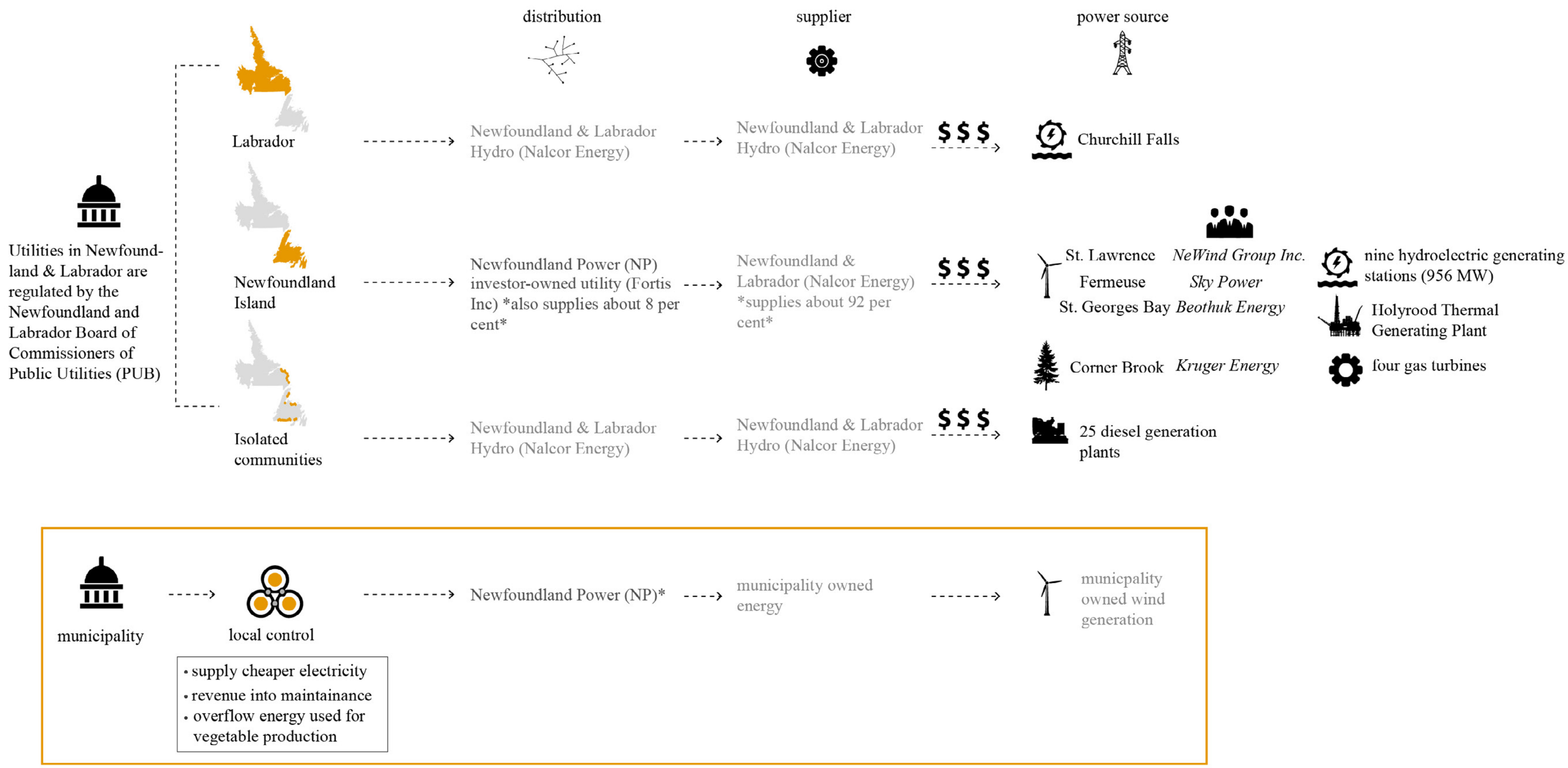


Fig. 2.22 Structure of energy control. NLHydro and Newfoundland Power hold a monopoly on energy generation and distribution, with Bill 61 prohibiting further development of resources. With more local control this energy can benefit the community instead of investors and external officials.

> Between now and 2041, we will carefully plan and make decisions, not only to ensure Upper Churchill's success in the future, but also to maximize benefits from our current and future resource development.[18]

The Provincial Government's plan for Newfoundland and Labrador's energy future complements and builds on other recent initiatives to reflect a confident new vision for the province, including, the *Skills Task Force*, *Innovation Strategy*, *Poverty Reduction Strategy*, *Immigration Strategy*, *Climate Change Action Plan* and the *Northern Strategic Plan for Labrador*.

Structure

The Provincial Government obtains value from energy projects through royalties, corporate income taxes and profits from Crown corporations. The revenues generated from energy resources are determined by the sale price, the costs to develop the energy and the legislation agreements to secure the Provincial Government's share of the net revenues.[19] Historically, the previous agreements that govern the province's energy resources have not provided the province with a fair return on the use of resources.[20] As Newfoundland and Labrador's renewable electricity resources are the foundation for a sustainable economy, the report acknowledges that the province must maintain control over them, and once investments in renewable generation projects are recovered, they can produce electricity at very low cost.[21]

Wind energy is becoming popular among the Eastern coast landscape; with Fermuse and St. Lawrence wind farms already constructed in Newfoundland and Nova Scotia's landscape blanketed with the tall encompassing structures. Beothuk Energy is now ready to spend $1 billion on a new wind farm in Stephenville. Kirby Mercer of Beothuk Energy gave an update in July 2017, updating the public of the potential 600 new jobs.[22] The companies key investor, Copenhagen Offshore Partners, have secured the private funding to build a fabrication plant at the port of Corner Brook, with the facilities to maintain and service the wind farm in St. Georges Bay area based out of Stephenville.

Although the energy plan promotes that the provincial ownership of the investments will benefit the people of the province, political barriers have been the primary impediment to wind to date as the province currently holds a bill, Bill 61, which de

18 Ibid, 14.

19 Ibid, 11.

20 Ibid, 11.

21 Ibid, 31.

22 Gary Kean, "Beothuk Energy says it is ready to spend $1 billion to create new wind farm industry," The Western Star , July 20, 2017, accessed September 24, 2017, http://www.thewesternstar.com/news/local/2017/7/20/beothuk-energy-says-it-is-ready-to-spend--1-billion-to-create-ne.html#.

facto makes renewable energy development against the law. Any private sector or renewable energy company is prohibited to come into Newfoundland to build a renewable energy source or to sell or transmit it on the grid. It is illegal to build wind turbines in the province. Bill 61 was passed in 2012 in preparation for the Muskrat Falls hydroelectric project. The bill amends the *1994 Electrical Power Control Act* to,

> provide to Newfoundland and Labrador Hydro the exclusive right to supply, distribute and sell electrical power or energy to a retailer or an industrial customer in respect of the business or operations of that retailer or industrial customer on the island portion of the province, subject to certain exceptions; and require that a retailer or an industrial customer buy electrical power or energy from Newfoundland and Labrador Hydro in respect of the business or operations of that retailer or industrial customer on the island portion of the province.[23]

Utilities in Atlantic Canada hold a monopoly in their regions, Mercer acknowledges that Beothuk's plan to develop wind energy is disrupting the marketplace, resulting in the length of the project.[24]

Regardless of political powers, wind energy farms have sprung up on the island. In 2008, Hydro signed a 20-year power purchase agreement for a 27 MW wind farm located in the community of Fermeuse on the Southern Shore, Avalon Peninsula.[25] The Fermeuse wind farm is located on the southern shore of Newfoundland that's been operational since May 2009, cost $43M to complete and can supply enough power for approximately 7500 households.[26] Beothuk Energy, based in St. John's, announced its plans to build 30 wind turbines in the St. Georges Bay. It's estimated they would generate 180 megawatts of clean, green energy, costing less than 10 cents per kilowatt hour to produce.[27] Beothuk pegs the estimated cost of the project at about $400 million, funded entirely through private investment.[28] The Newfoundland Company would sell the energy to Nova Scotia's Emera, and Nalcor,

23 Bill 61, 47th General Assembly Cong. (2012) (enacted).

24 Gary Kean, "Beothuk Energy says it is ready to spend $1 billion to create new wind farm industry," The Western Star , July 20, 2017, accessed September 24, 2017, http://www.thewesternstar.com/news/local/2017/7/20/beothuk-energy-says-it-is-ready-to-spend--1-billion-to-create-ne.html#.

25 "Wind," NL Hydro | Power Your Knowledge, accessed September 24, 2017, http://www.poweryourknowledge.com/wind.html

26 Ibid.

27 "Beothuk Energy eyes Maritime Link for wind power conduit," CBCNews, April 18, 2014, , accessed September 24, 2017, http://www.cbc.ca/news/business/beothuk-energy-eyes-maritime-link-for-wind-power-conduit-1.2542080.

28 Ibid.

Fig. 2.23 St Lawrence Wind Turbines is the first commercial wind farm in Newfoundland and Labrador, located about one kilometer northwest of the community of St. Lawrence on the Burin Peninsula.

Fig. 2.24 Fermuse Wind Turbines in Fermeuse, 90km from St. John's. (http://iwais.compusult.net/web/guest/optional-site-visits)

Fig. 2.25 Beothuk Energy wind farm proposal

if they're interested.

NLHydro holds a monopoly on energy generation on the island with the private investor company, Newfoundland Power, monopolizing the distribution lines. In the following Part 3: Effective Responses, the alternative handling of energy is reviewed in four case studies. These projects showcase the benefits of a local energy source and how it can lead to stronger community resilience where local control benefits the community rather than the government control. With an allowable overflow on the Island grid, energy can be used to run year-round greenhouses to aid in food security crisis.

Climate Flows

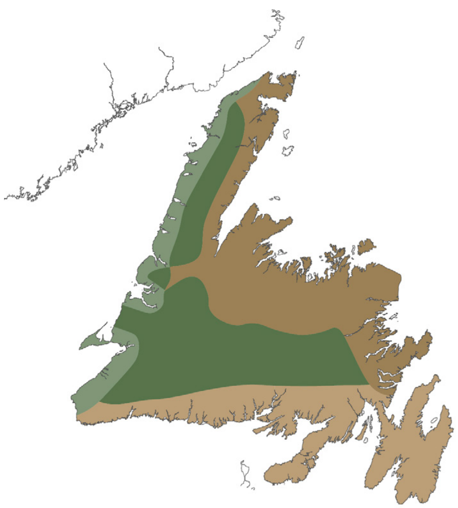


Fig. 2.26 Island climate zones

Newfoundland climate is not conducive to growing most vegetables outdoors. The low seasonal temperatures and short growing season make it difficult to grow produce. The climate differs throughout the island, influenced by the St. Lawrence gulf, mountain ranges and variation in elevation. There are four climate zones:

The **west coast** experiences the oceans influence off of the Gulf of St. Lawrence. This normally reduces temperature extremes but causes an increase in precipitation, especially during transition months in fall and early winter, when snowfalls are most frequent. Strong wind speeds descend from long-range mountains during the winter months.[1]

In the **western mountains and central uplands**, the increase in elevation create lower temperatures, heavier cloud cover and precipitation, and stronger winds and snow accumulations.[2] Vegetation growth also decreases considerably with elevation, and certain species did not grow or thrive equally well in different locations.[3]

The **northeast coast and central lowlands** is dryer than the rest of the Island with occasional low winter temperatures in valleys. The area has cool, late springs near the coast, where ice continues into May, but have generally warmer and sunny summers.[4]

The **south coast and avalon** have mild winters with a variation in snow cover. The area has heavy rainfall, cool summers and low cloud cover and fog.[5]

Along with a short growing season, Newfoundland is plagued with low seasonal temperatures that directly affect the crop selection of the province. The island is known for their berries that abundantly grow across the land and most, if not all, residents fill up their empty cured beef buckets along the trails and highway. Most of these berry plants are not native to the land, but brought over by European settlers for their health qualities, including red and black currants, the dogberry, bakeapple, partirage berry, marsh berry, and the raspberry, blueberry and cranberry.

Incidentally, regions suffering from the harshest conditions are also the most suitable for harvesting wind energy and rainwater. The high winds causes high precipitation, ideal to harvest for rain water systems.

The following pages spatialize the average temperatures, the short growing season, growing degree days, precipitation and wind found on the Island. Although the weather patterns across the island differ, the climate is not conducive for most growth and an alternative growing system must be taken into consideration.

1 Climate Characteristics, 2014, accessed September 24, 2017, http://www.heritage.nf.ca/articles/environment/seasonal.php.

2 Ibid.

3 E. F. Woodrow, Pedoclimatic zones of the island of Newfoundland (St. Johns, Nfld.: Dept. of Agriculture, 1987), 5.

4 Climate Characteristics, 2014, accessed September 24, 2017, http://www.heritage.nf.ca/articles/environment/seasonal.php.

5 Ibid.

Average Temperature

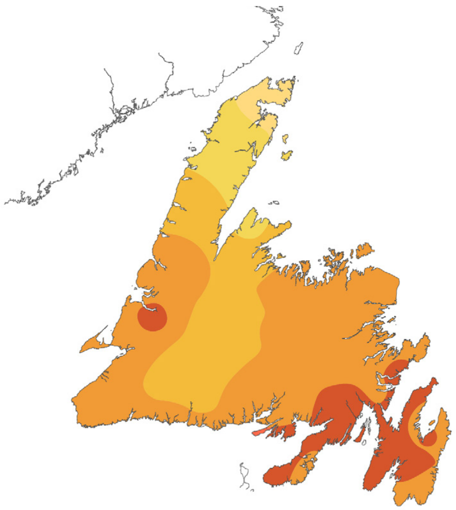
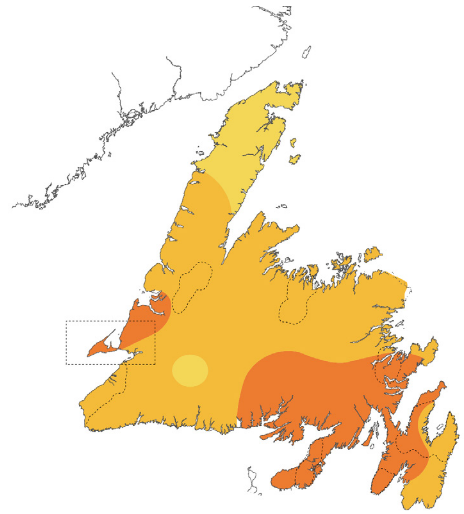
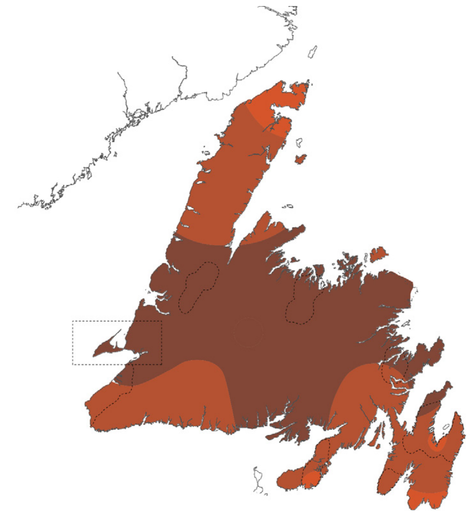


Fig. 2.27 Yearly average temperature (⁰C)

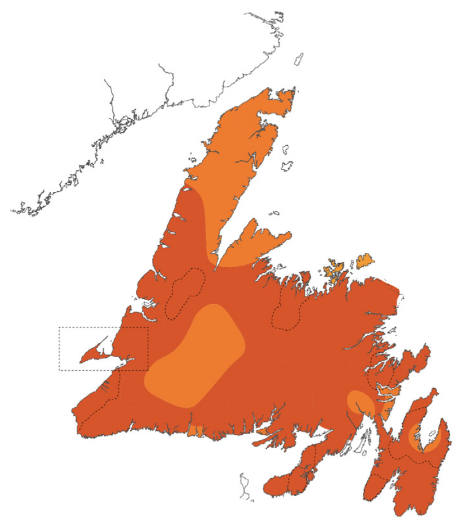
- 5.0 - 7.9
- 4.0 - 4.9
- 3.0 - 3.9
- 2.0 - 2.9
- 1.0 - 1.9



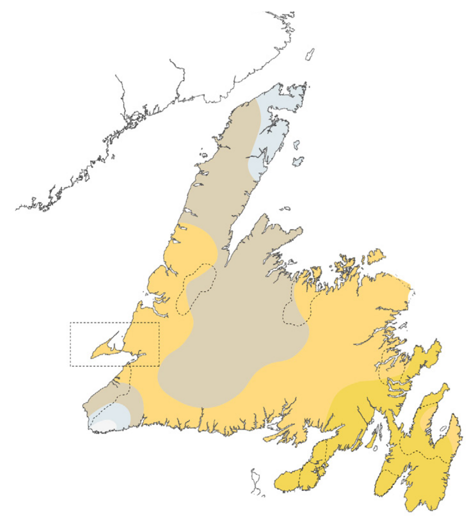
Spring



Summer



Fall



Winter

Fig. 2.28 Seasonal average temperature (⁰C)
Seasonal temperatures sit at a cool level, non conducive to growing most crops.

- 14.0 - 19.9
- 12.0 - 13.9
- 6.0 - 11.9
- 2.0 - 5.9
- 0.0 - 1.9
- -4.0 - -0.1
- -6.0 - -4.1
- -8 - -6.1
- -12.0 - 8.1
- -20.0 - -8.1

Growing Season

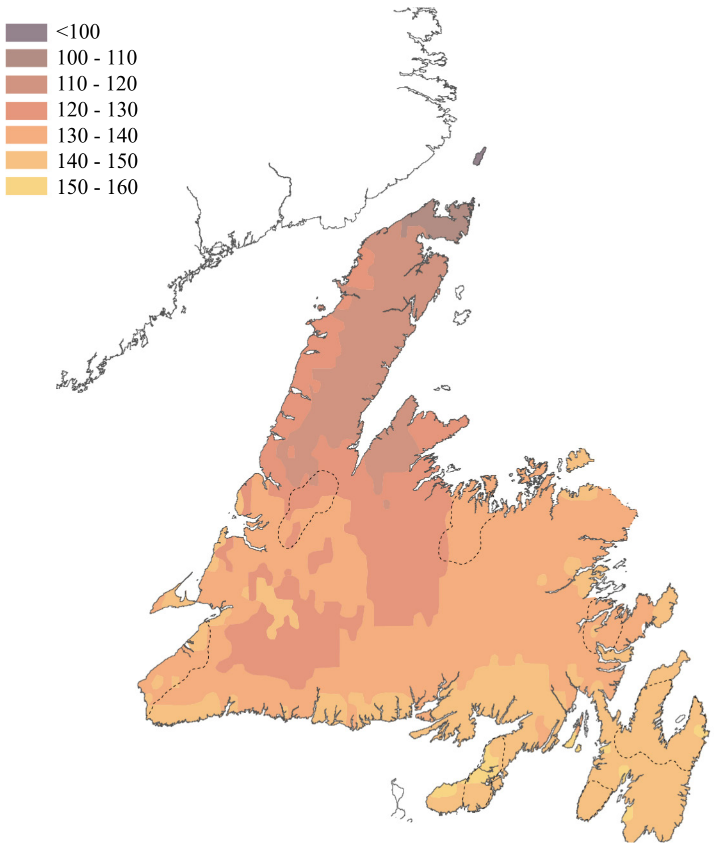


Fig. 2.29 Length of growing season (days per year). Measured in days starting from the estimated seeding date (10 days after average daily temparatue is above 5°C) until fall frost (minimum daily temperature is 0°C) or until October 31st - which ever comes first. This is the same time period used to calculate effective growing degree days.

Fig. 2.30 Berry-pickers encroach on an energy corridor during berry season.

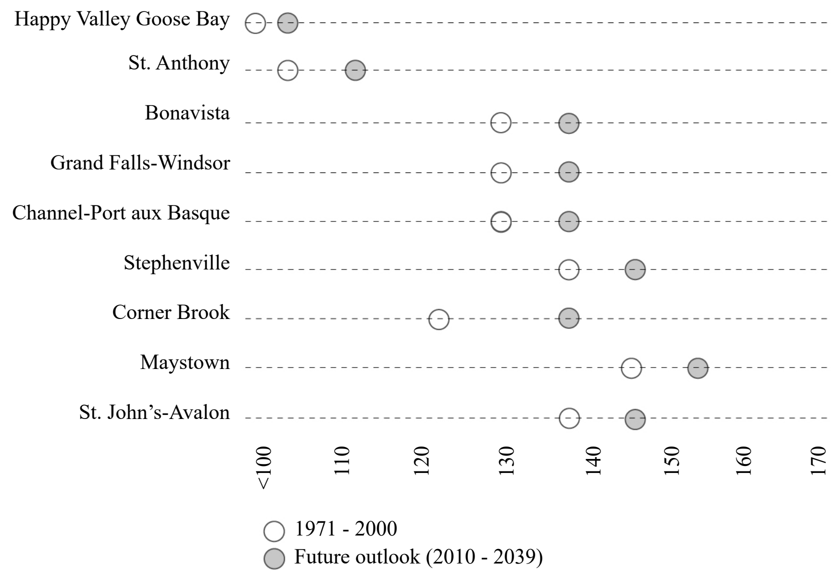


Fig. 2.31 Average growing season, current and future

Growing Degree Days

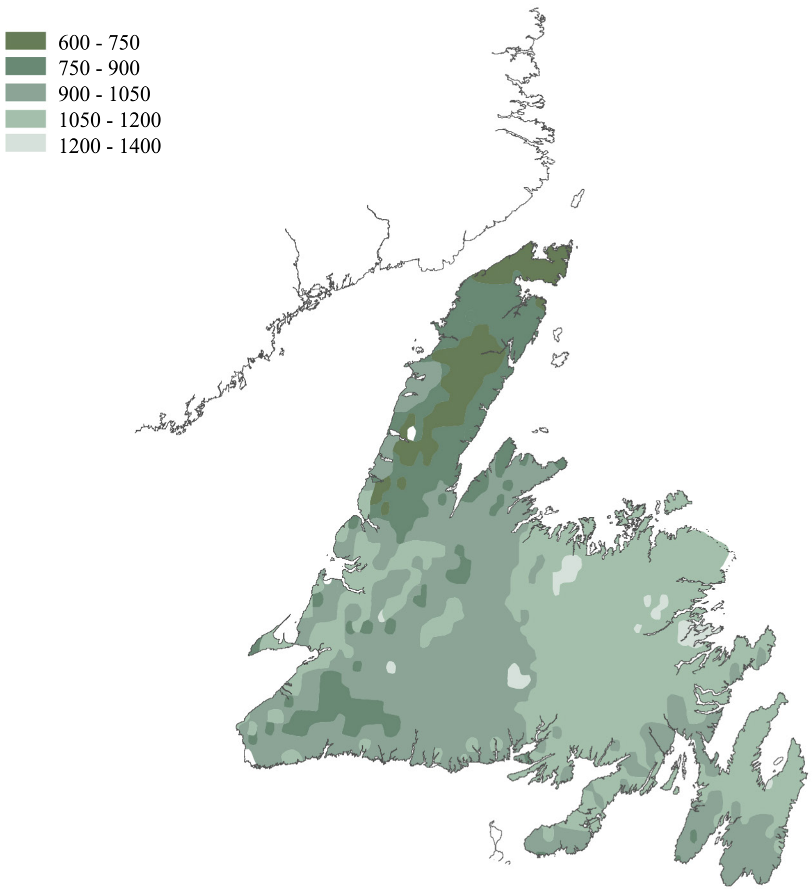
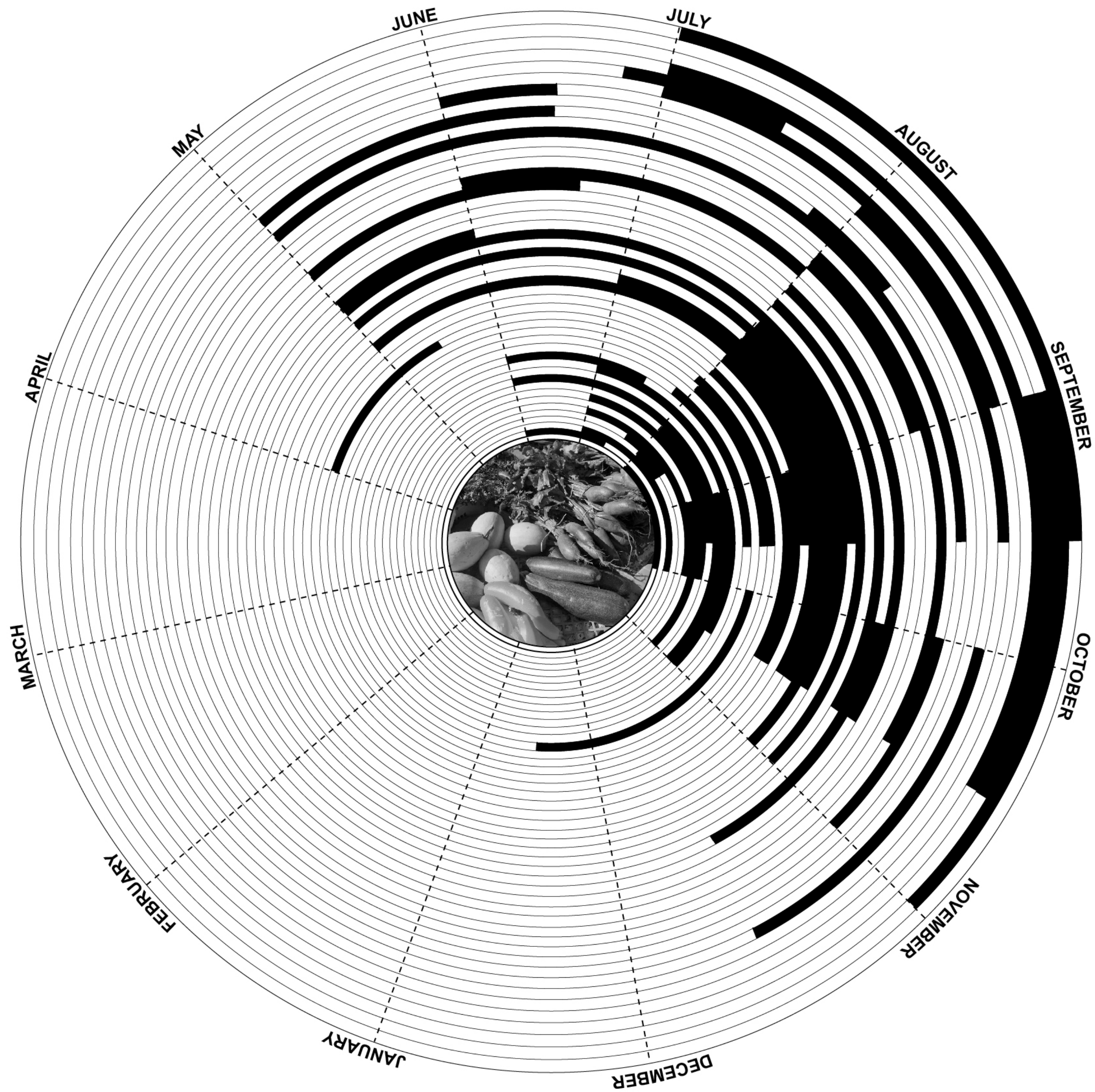


Fig. 2.32 The effective growing degree days (1971-2000) for native crops to grow in Newfoundland.

Fig. 2.33 The crops that are grown are traditionally considered cold season crops, heavily grown in August, September and October. List of crops starting from inside circle.

apple
asparagus
beets
blackberry
blueberry
broccoli
brussel sprouts
cabbage
cantelope
carrot
cauliflower
chard
cherries
corn
cranberries
cucumber
eggplant
fiddleheads
garlic
grapes
green beans
green onion
kale
leek
lettuce
melon
mushroom
nettles
onion
parsnip
pear
pea greens
peas
pepper
potatoes
pumpkin
radish
raspberry
rhubarb
rutabaga
spinach
squash
strawberry
tomato
turnip
winter squash
zuccini


JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY

Precipitation

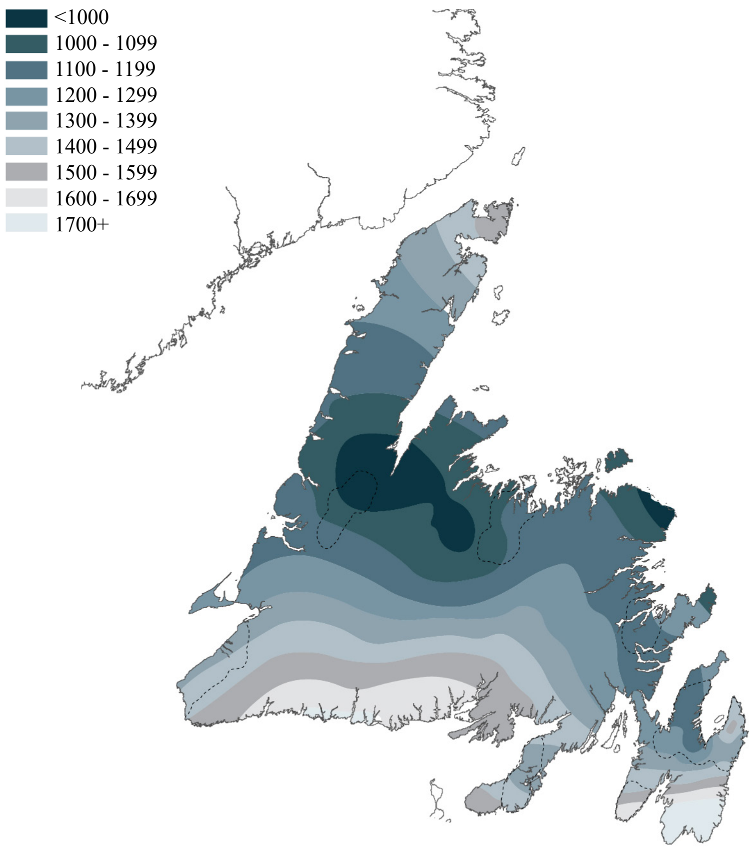


Fig. 2.34 Mean annual rainfall

Rain and snow accumulation is high among the entire island. This inhibits sunlight hours and growing days, however, there is opportunity to harvest this precipitation.

Fig. 2.35 Snow accumulation on the island. Photo taken in Twilligate, Newfoundland.

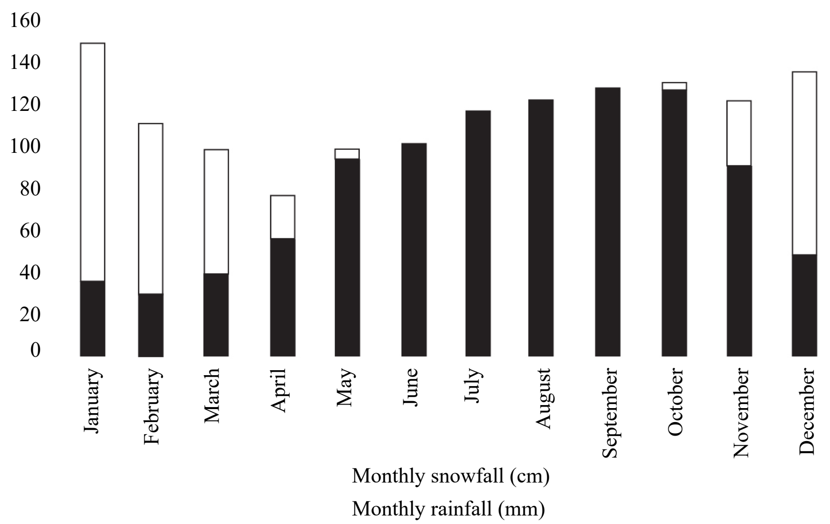
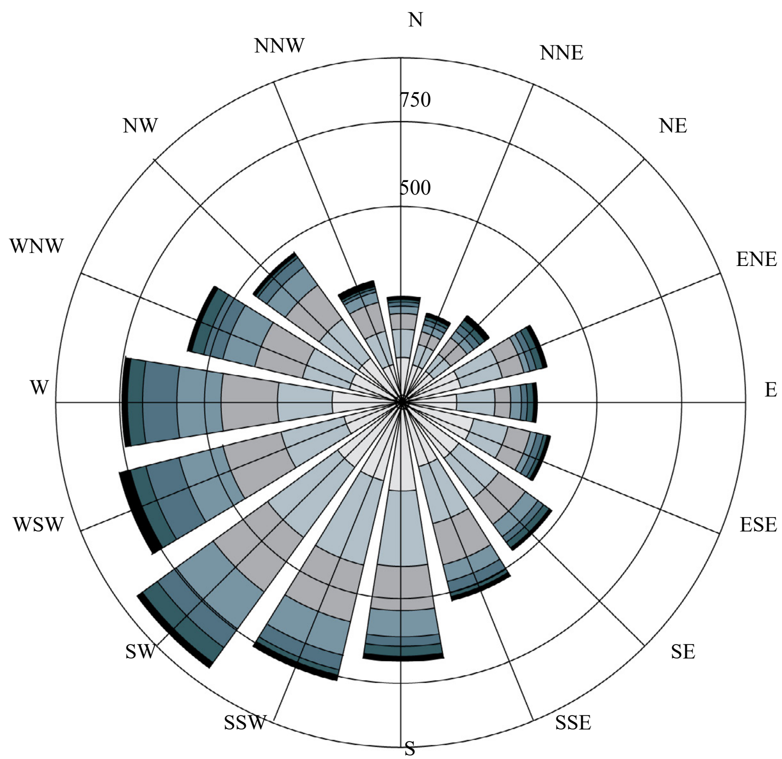


Fig. 2.36 Preciptation

Wind



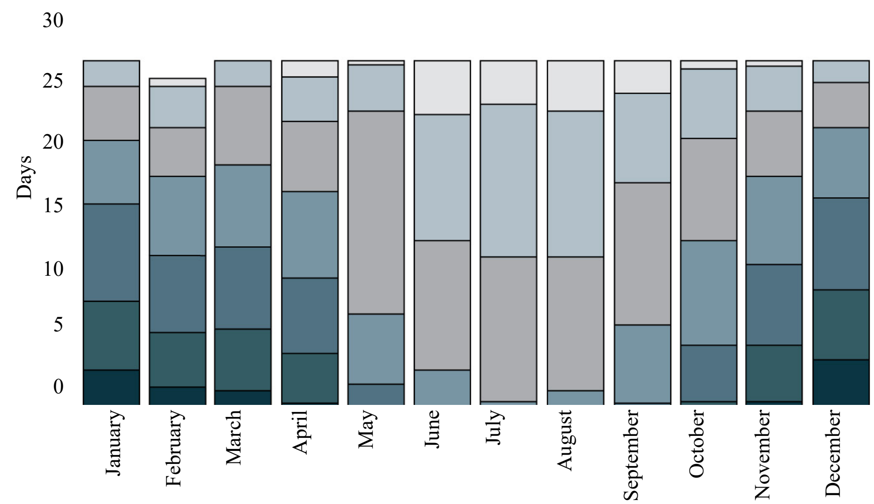
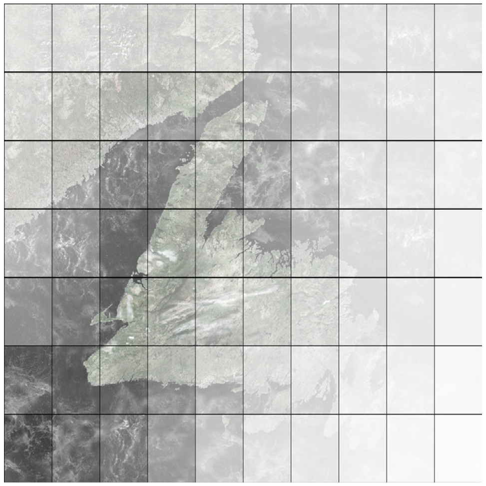
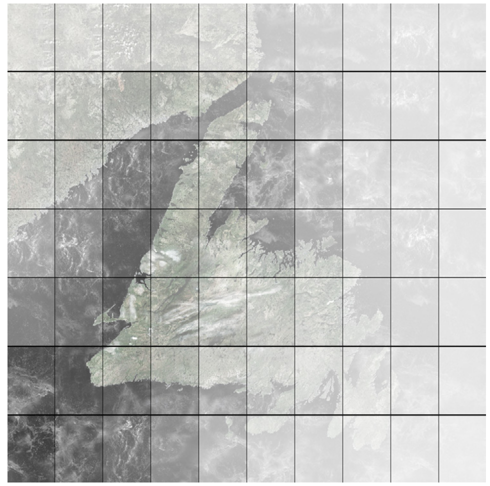
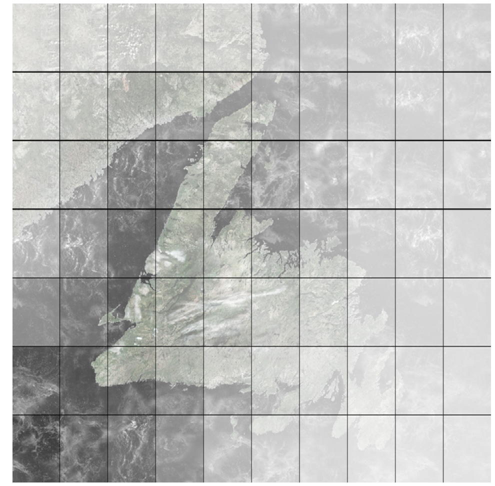
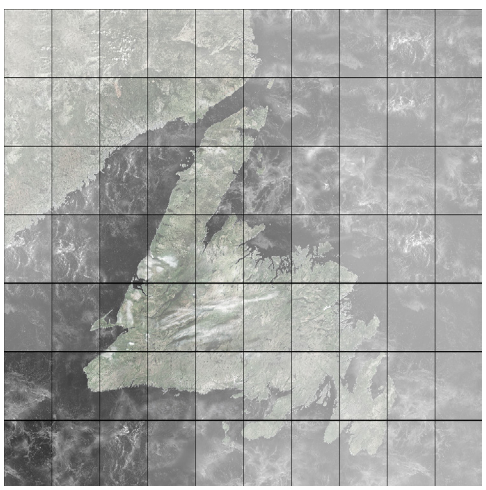


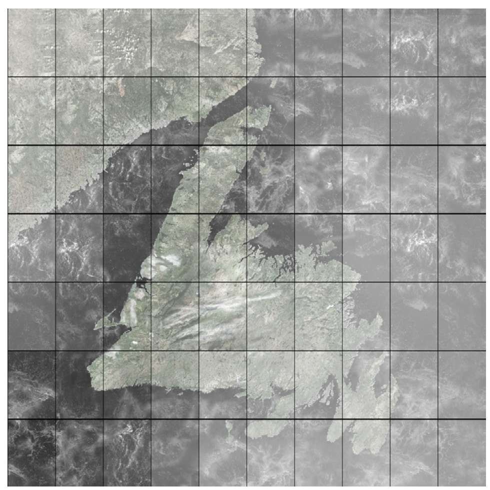
Fig. 2.37 Demonstration of how many days within one month where it can be expected to reach certain wind speeds. Monsoons create steady strong winds from December to April, but calm winds from June to October. With stronger winds in the colder months, wind energy generation is at its greatest.

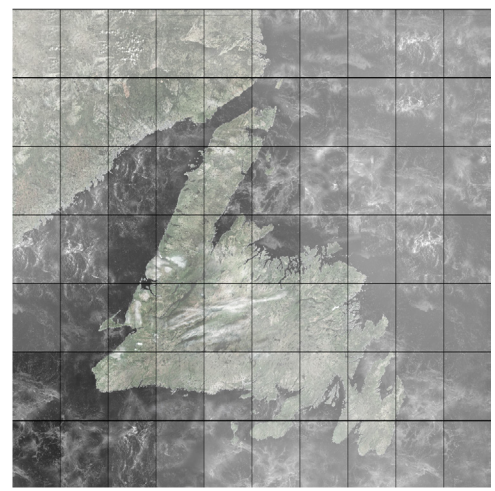

January Wind Speeds

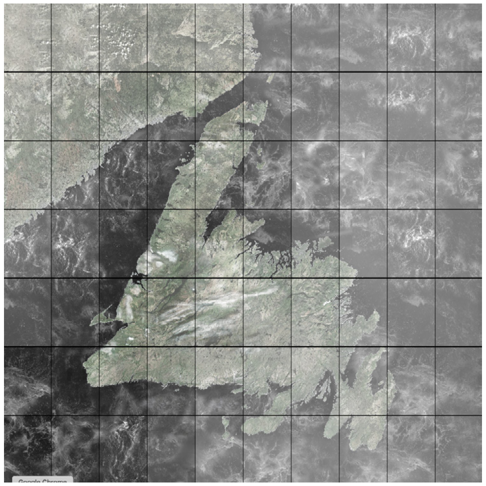

February Wind Speeds

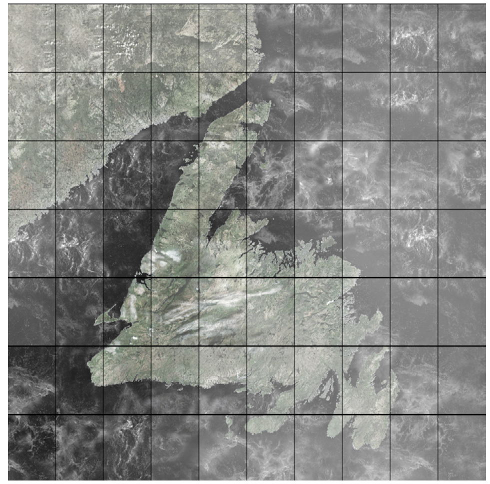

March Wind Speeds

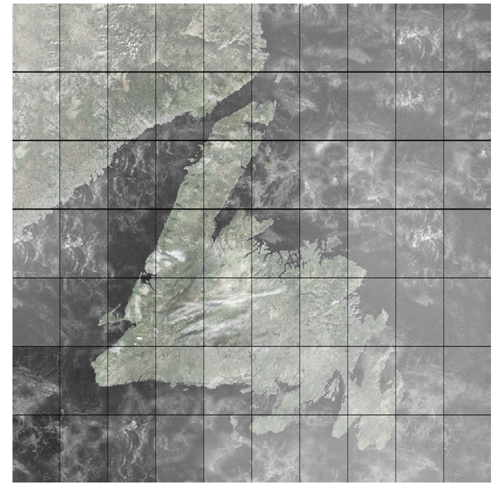

April Wind Speeds

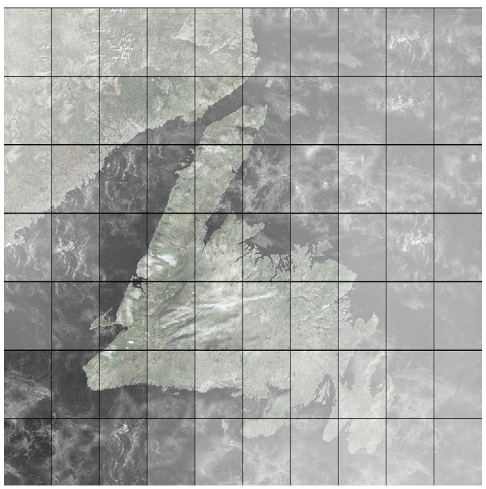

May Wind Speeds

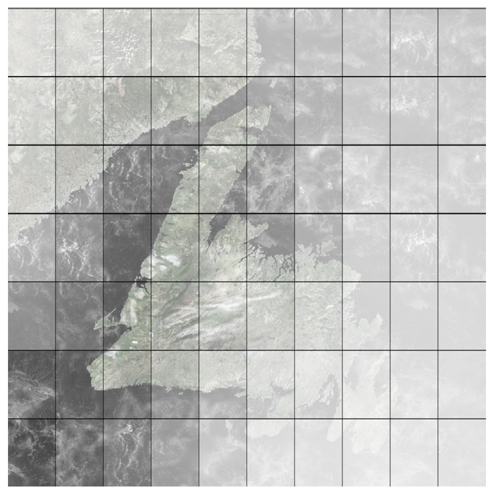

June Wind Speeds


July Wind Speeds


August Wind Speeds


September Wind Speeds


October Wind Speeds


November Wind Speeds

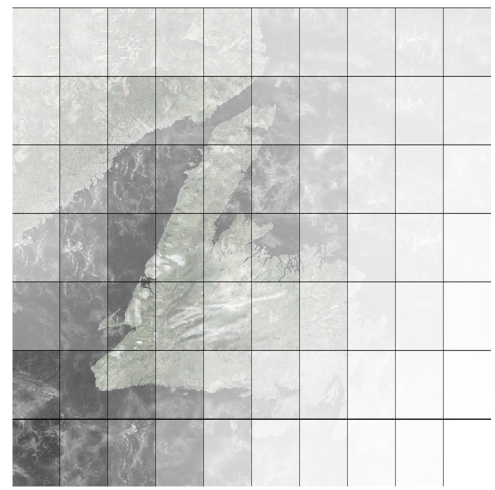
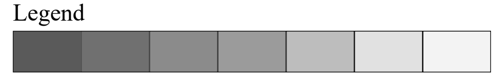

December Wind Speeds

Fig. 2.38 Monthly average wind speed across the island at 50m.

Legend



4.50 m/s 11.60 m/s

Fig. 2.39 *Clockwise from top right*, Low grassy landscape of Western Newfoundland, Rocky landscape of the Norh East, Geology formations of the Western coast, Port-au-Port peninsula.

Newfoundland and Labrador is the easternmost province in Canada, commonly referred to as *The Rock*. At 108,860km^2, the island portion of the province is one of the largest islands in the world, comparable to the size of Iceland at 103,000 km^2. The landscape varies greatly across the island, from limestone barrens in the Northern Peninsula to the thick boreal forests of central Newfoundland and the glacial barrens and massive cliffs along the coast of the Avalon Peninsula.

The island of Newfoundland marks the site where a continental plate separated 600 million years ago and collided 200 million years later.[1] The island occurs at the northeastern boundary of the Appalachian Mountain system, an ancient mountain chain that once travelled the east coast of North America from Newfoundland to Alabama. However, erosion has worn down the Appalachians to a gently terrain, with only a few upland areas.

The geology of Western Newfoundland is important to the province's commerce because of the rich and varied minerals. Many mining opportunities have arose, including the carbonate rocks that formed the zinc mine at Daniel's Harbour (1990), the limestone that is used for the cement manufacturing plant in Corner Brook, ophiolite complexes mined at York

1 A. B. Ryan, "Geology of the West Coast of Newfoundland," *Newfoundland Journal of Geological Education* v7, no. 2 (1983): accessed September 25, 2017, http://www.nr.gov.nl.ca/nr/mines/outreach/education/westcoast.html.

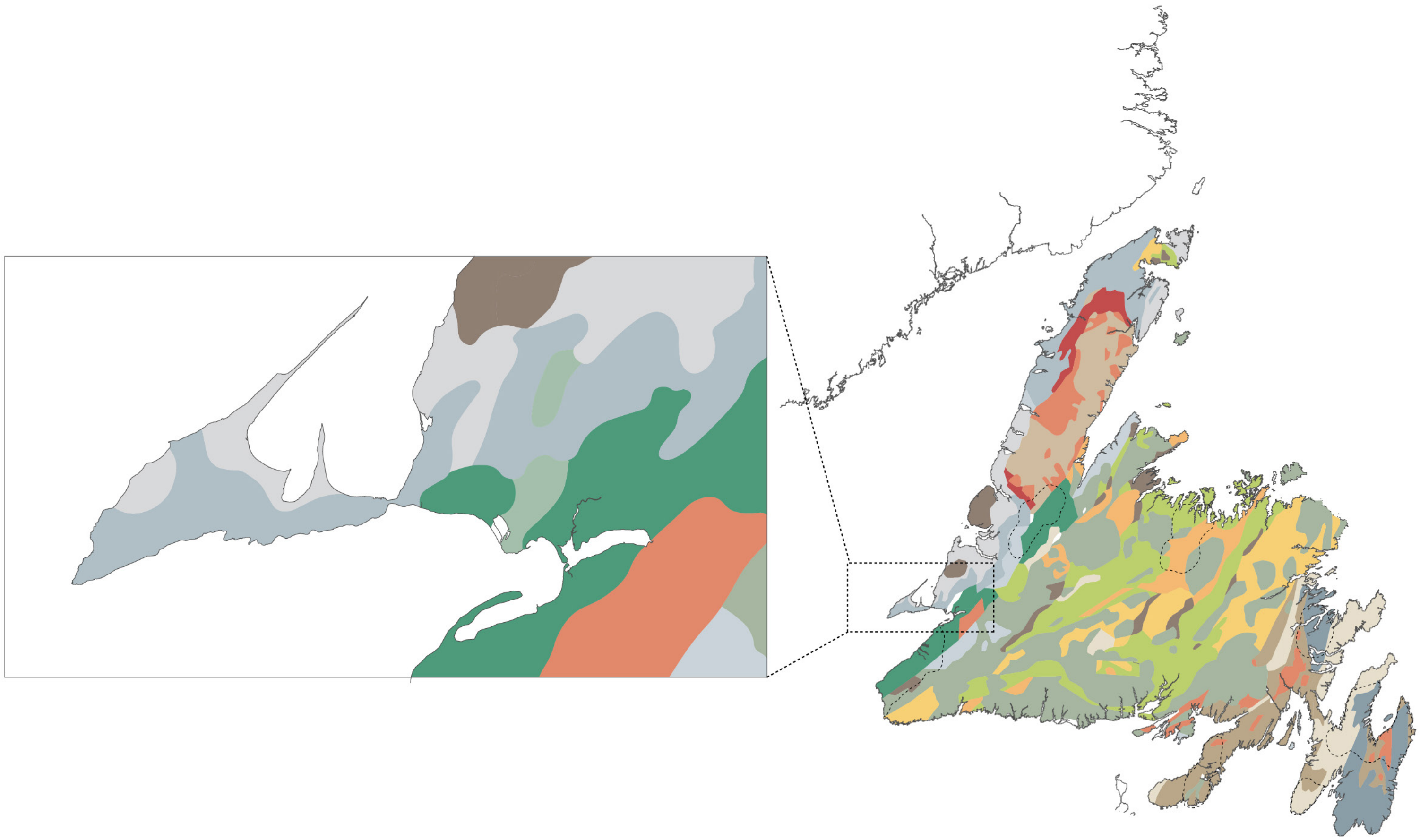


Fig. 2.40 Geology of Newfoundland

Helikan
- Granite rocks

Ordovician to Devonian
- Granitic and gabbroic intrusions

Proterozoic II to Cambrian
- Granitic and gabbroic intrusions

Devonian to Carboniferous
- Subaerial, lacustrine fluvial and delaic clastic sedimentary rocks; volcaniclastic rocks

Silurian
- Shallow marine and subaerial clastic sedimentary rocks; volcaniclastic rocks

Cambrian to Silurian
- Marine clastic sedimentary rocks; islan volcanic and volcaniclastic rocks d-arc

Cambrian to Ordovician
- Ophiolitic mafic - ultramatic rocks, pillow lava and related intrusions

Cambrian to Ordovician (gander Zone)
- Clastic metasedimentary rocks and migmatitic equivelants

Proterozoic II to Ordovician (Humber Zone)
- Authochthonous and parauthocthoous clastic and metasedimentary rocks
- Platformal limestone and dolostone; includes clastic and metasedimentary rocks
- Allochthonous sedimentary, matic volcanic and minor metamorphic rocks
- Basal clastic and carbonate sedimentary rocks

Proterozoic II and III (Humber Zone)
- Orthogneiss, paragneiss and amphibolite

Proterozoic III to Ordovician (Avalon Zone)
- Subaerial and marine clastic sedimentary rocks; minor limestone

Proterozoic III (Avalon Zone)
- Marine and deltaic clastic sedimentary rocks; minor limestone
- Matic and feisic volcanic and volcanistic rocks

Fig. 2.41 *Top*, harvested wood from the forests, commonly found accross the island. Used for fire wood, building materials and pulp. Photo taken in Fogo Island, Newfoundland. *Bottom*, Common vegetation found across the island. Photo taken in Twillingate North.

Harbour, gypsum mined at Flat Bay, uranium exploration is Deer Lake and St. George's Bay, and coal was mined near Howley and Robinsons during the construction of the Newfoundland Railway.[2]

The land has always been a source of wealth for Newfoundlanders, however, not with respect to crop production. The soils located across the island prevents non-native crops from growth. Potato rot disease and the golden nematode found in the soil prevents exporting of vegetables as it disturbs non-native plants and contaminates the crop.[3] Newfoundland's relatively cool summers and abundant rainfall encourage development of wart disease and cause high losses in wet seasons. Infections of the disease are relatively high in the St.Georges Bay area and in the Port-au-Port region, moderate to severe infestations have been noted in the Great Northern Peninsula, along the north coast and in central Newfoundland and the disease is severe on the Avalon, Bonavista and Burin peninsulas.[4] Potato wart occurs only in Newfoundland, whereas the golden nematode has been found in Newfoundland and Vancouver Island.[5] If either contaminant is introduced outside of the province, particularly to Prince Edward

2 Ibid.

3 Control of potato diseases in Newfoundland (Ottawa: Dept. of Agriculture, 1968).

4 Ibid.

5 Ibid.

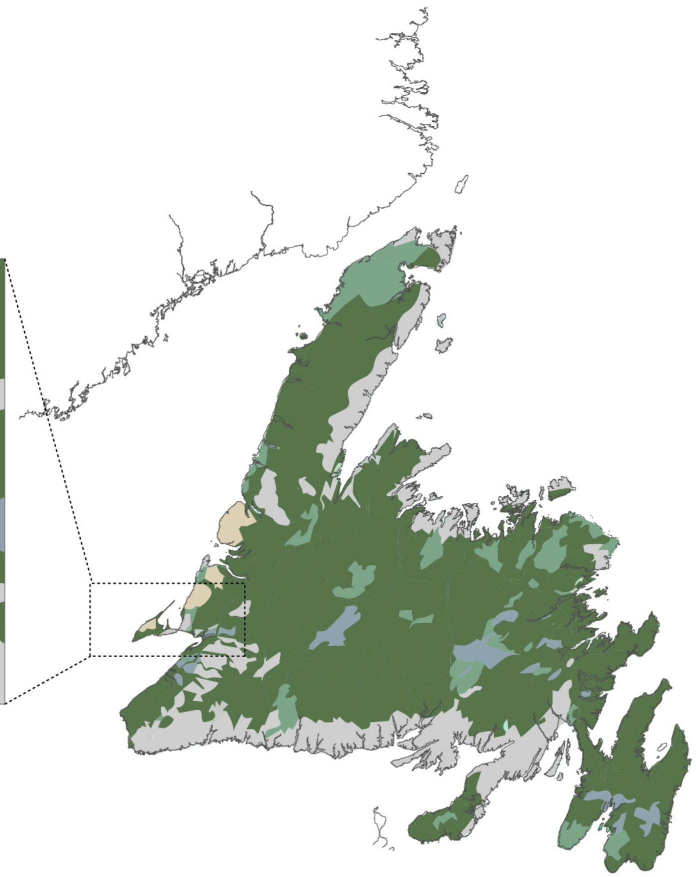


Fig. 2.42 Soils of Newfoundland

The Georges Bay area have humo-ferric podzols, brunisols, and gleysois soils that are medium to moderately course textured. Balsam fir forests predominate the area. Humo- ferric podzol soils lack Bh or Bhf horizons at least 10cm thick. These soils are mainly found under coniferous and mixed forest vegetation and are occasionally suitable for heath and shrub vegetation.

Island or New Brunswick, many countries would place a restriction on Canadian potatoes.[6]

The Newfoundland landscape is an extensive mixture of bogs, barrens, rock outcrops, water bodies and mineral soil. Soils conditions vary across the landscape and some areas are more suitable than others for agricultural use. The soils are very acidic and the main soil limitation to crop growth is low fertility.[7] A high content of magnesium matched with low calcium found in the soils, also cause poor growth and reduces yield.[8] The soils found on upland barrens are very coarse, usually very stony, and are often quite shallow, due to high wind exposure and temperature limitations, whereas the boreal forest is characterized by dominantly coniferous species, indicative of deeper soils.[9] The more favorable soils and better climatic conditions for agriculture are usually found on elevated ridges, along river terraces and on coastal lowlands, however the soils still require regular fertilization to supplement elements necessary for plant growth.[10]

Limitations such as extreme stoniness and wet soils that require drainage improvements, create management problems and additional cost for land clearing. The extreme topography also restricts the use of land for agriculture, preventing use of farm equipment and creates erosion hazards.

6 Ibid.

7 "Fisheries and Land Resources," Soil Survey | Forestry and Agrifoods Agency, accessed September 25, 2017, http://www.faa.gov.nl.ca/agrifoods/land/soils/soilsurvey.html.

8 F. Hender, Soils of Stephenville: Port aux Basques map sheet, Newfoundland (Ottawa: Research Branch, Agriculture Canada, 1989), 27.

9 "Fisheries and Land Resources," Soil Survey | Forestry and Agrifoods Agency, accessed September 25, 2017, http://www.faa.gov.nl.ca/agrifoods/land/soils/soilsurvey.html.

10 Ibid.

Fig. 2.43 Dense wood of inner Newfoundland. Photo taken on route to Corner Brook. *Bottom*, wildflowers in Eastern Newfoundland.

Fig. 2.44 Wildflowers grow on the rolling terrian in Eastern Newfoundland.

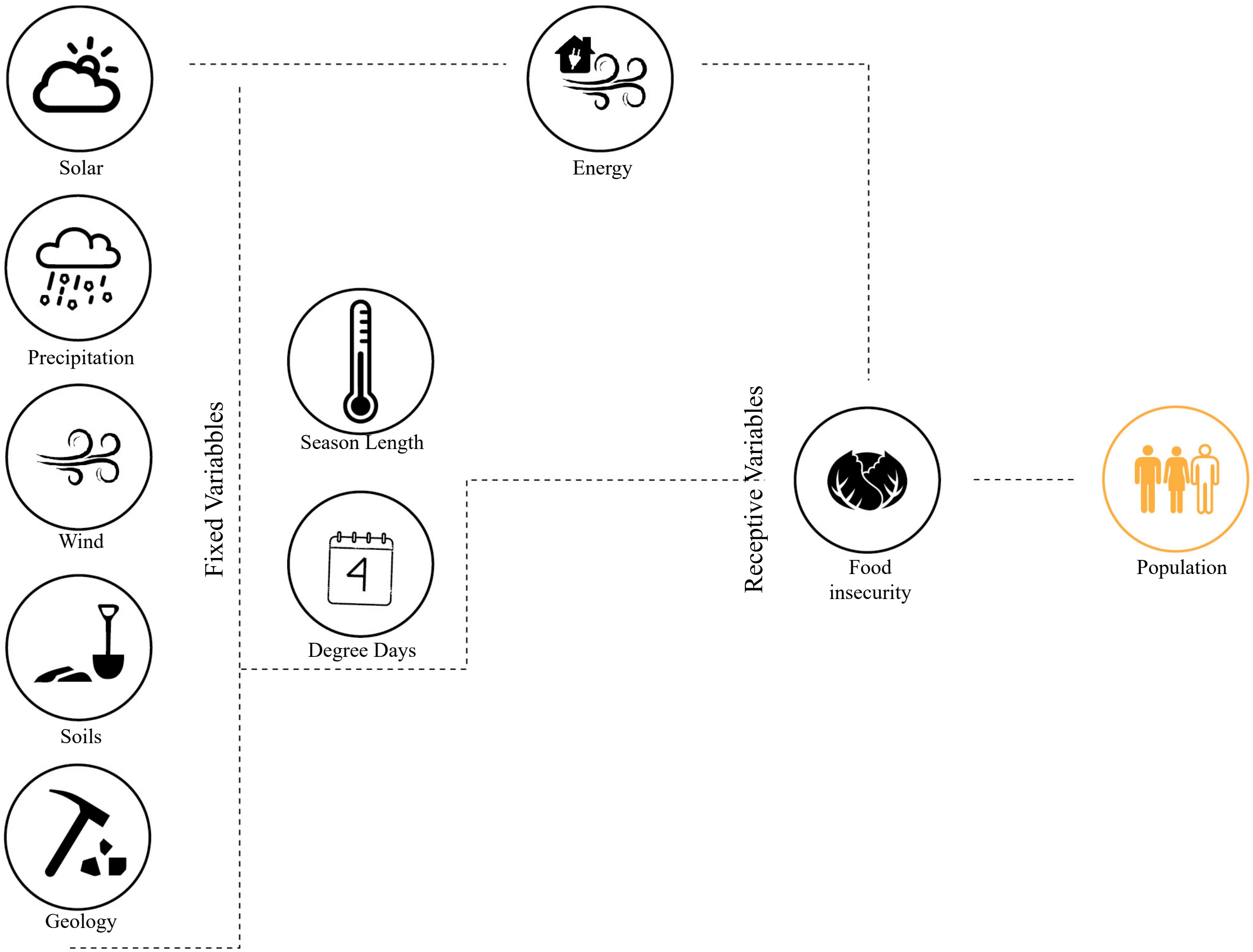


Fig. 2.45 The Island has a number of fixed variables that cannotbe altered, however, they can be used to manage the receptive variables of the province.

Synthesis

Newfoundland is accustomed to exploitation and vulnerability. In this chapter, the specifics that define Newfoundland's current crisis and conditions that exacerbate it's dependencies have been investigated. The patterns of climate, the remarkable ancient geography and geophysical structures of Newfoundland and Labrador accounts for the extraordinary diversity of the place. Farm land is sparse and even on the agricultural land vegetables are not being produced. This leaves the island dependent on exports and in turn vulnerable to the global market. On the provincial level, population and quality of life is depleting as residents leave to find employment opportunities and communities where basic human needs are met. Energy production is strongly connected to external forces, and although the provincial government is regulating the system and trying to halt this exploitation, they are in turn creating a monopoly that in itself exploits the Islanders.

Through this analysis, it becomes clear that the patterns of nonconducive climate, exploitation of energy, food crisis, population decline and geological features are inherently linked. Flows in one aspect affect the other and vice versa. Shortage of resources is often a catalyst for population instability, which causes further resource degradation, bringing about a state of permanent crisis.

This thesis argues that the dominant actors of this system are resilient, capable of changing and adapting to new paradigms as needed. The shift to renewable resource extraction, from the fishery, pulp mills, mines and oil extraction, demonstrates the adaptability and self-reliance of the people. This demonstrates that the Islanders may be able to corroboratively adapt to future conditions. A synthesized approach weaving long term food management and incoming renewable energy locally may prove to be a viable re-organization strategy.

Part 3 effective responses

"Separated as we are from the sources and processes of our food supply, and the culture that goes with it, we carry around a burden of expectations and ignorance that may often be as destructive as it may be well meaning"

- Michael Hough, Cities and natural process: a basis for sustainability

In the following section, the two converging trends of controlled greenhouse environments and existing municipality-owned energy utilities are reviewed. In order to understand how renewable energy can benefit Newfoundland's vulnerable import-replacement situation, precedents of controlled greenhouse environments and municipality-owned utilities are reviewed. The controlled environments precedents add knowledge to the benefits of greenhouse systems, while the municipality-owned energy utilities precedents acknowledge a new way to envision how a community can run a greenhouse complex affordably. Although the St. George's Bay wind farm is currently private-investor owned, the opportunities for future publically-funded and city-owned wind farms across the island is high.

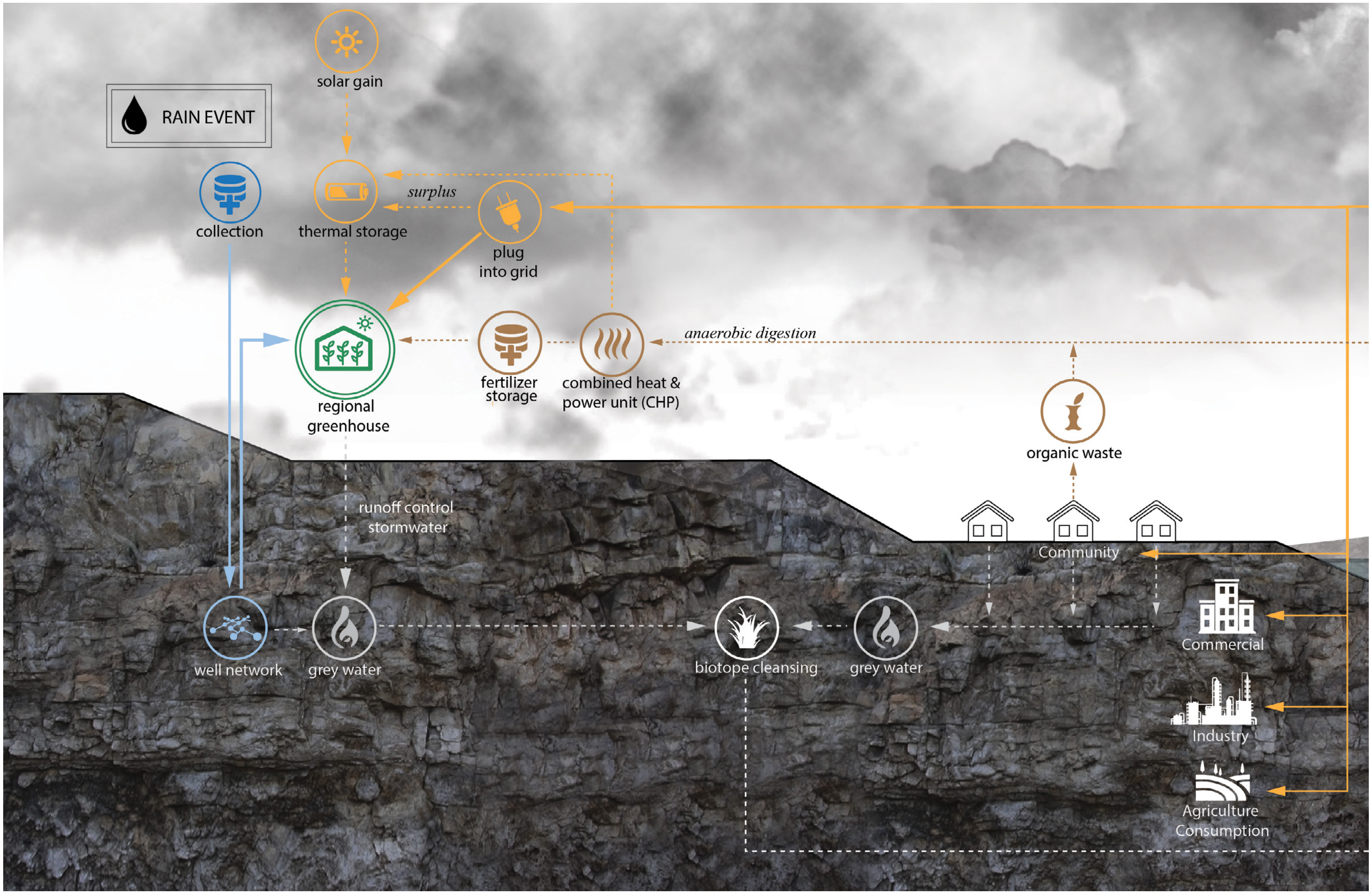
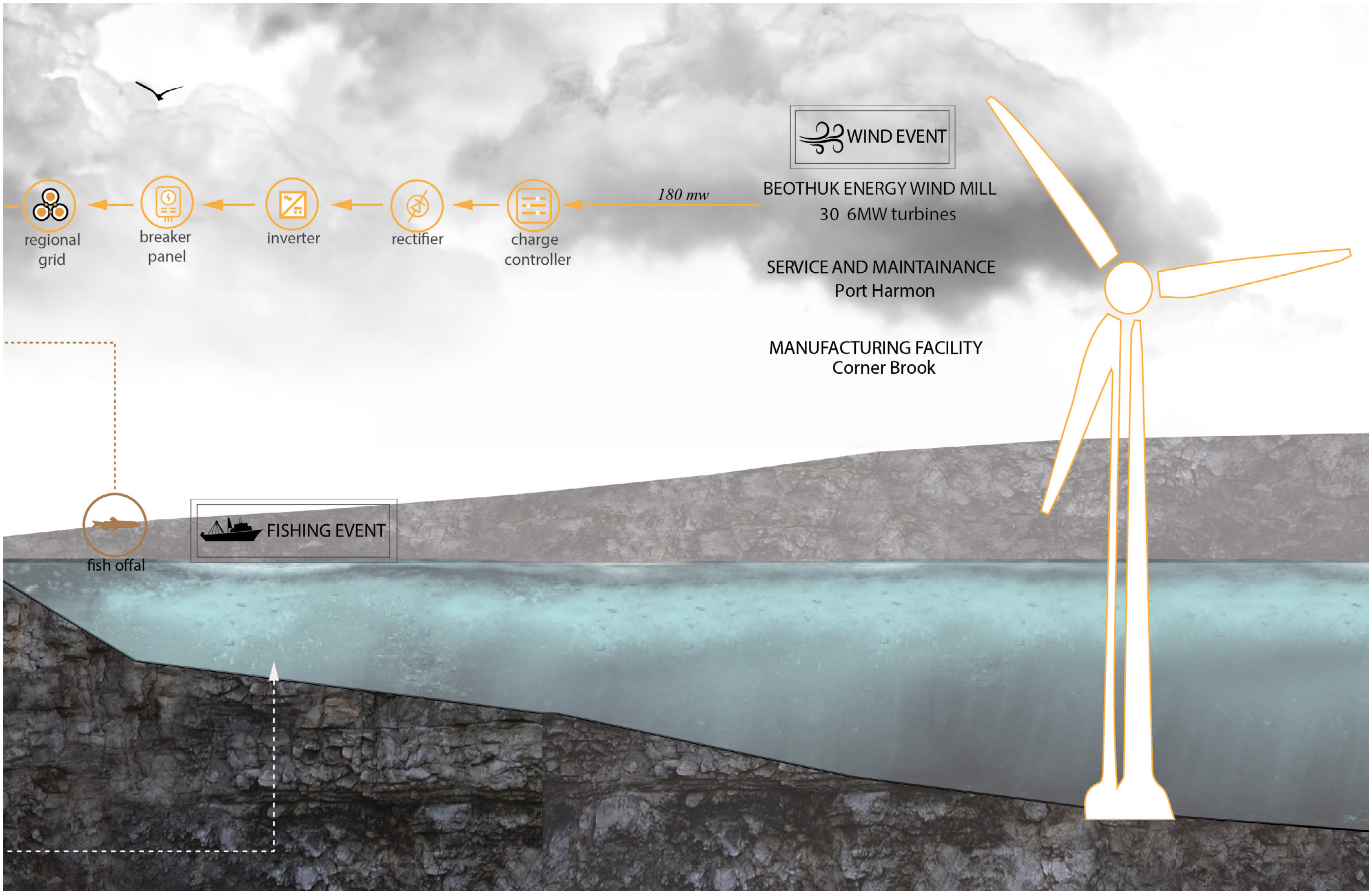


Fig. 3.1 Proposed organization of greenhouse processes assuming a municipality owned wind energy farm


regional grid
breaker panel
inverter
rectifier
charge controller
180 mw
WIND EVENT
BEOTHUK ENERGY WIND MILL
30 6MW turbines
SERVICE AND MAINTAINANCE
Port Harmon
MANUFACTURING FACILITY
Corner Brook
FISHING EVENT
fish offal

Controlled Enviroments

Greenhouses that offer a protected and controlled environment prove to be the most feasible strategy for agricultural production in areas plagued with low seasonal temperature and a short growing season. They allow for temperature control and protection against the harsh weather that accompanies colder regions. However, in regions where greenhouse farming is a dominant industry, greenhouse deployment can affect the landscape substantially, consuming considerable areas of open land. The high consumption of land mass is also one of the major objections against wind energy deployment.

There is an abundant amount of unoccupied land in Newfoundland, especially in the center as communities arouse along the coast for fishing purposes. Consequently, the Island is a great candidate for both the greenhouse environment and wind creation as the vast open waters hold off-shore wind farms. In the creation of a hybrid system that combines wind energy generation, and production of food resources, the effectiveness of each can be increased and land area use optimized.

Although space is of little concern, without proper soil and proper climate conditions, Newfoundland's landscape is not conducive to growing crops in the traditional sense. A controlled environment offers a system that allows for these complications. W.F. Gericke of the University of California termed the hydroponic system, defined as the science of growing plants without the use of soil.[1] His application of hydroponics proved to be viable when providing food for troops stationed on nonarable islands in the Pacific in the early 1940s. The problem of food security on the rocky islands that are normally incapable of producing such crops was solved through practicing large scale hydroponics.[2]

The use of hydroponic greenhouses continued after World War II, expanding throughout the world.[3] The effectiveness of the hydroponic and the expanding greenhouse industry is examined in the following section. These precedents start to give an idea of how multiple functions and systems can be synthesized into a hyper-effective hybrid that combats food insecurity in order to raise quality of life for the community, while using the built environment to demonstrate community cohesion.

1 Howard M. Resh, *Hydroponic food production: a definitive guidebook of soilless food growing methods ; for the professional and commercial grower and the advanced home hydroponics gardener* (Santa Barbara, CA: Woodbridge, 1985), 23.

2 Ibid.

3 Ibid.

Fridheimar Greenhouse

Friðheimar farm in Reykholt, Iceland, is a family business run by Knútur Rafn Ármann and his wife Helena Hermundardóttir. The greenhouse complex grows tomatoes and cucumbers year-round for the small surrounding population. The greenhouse complex began as a single 1,174 m² greenhouse until installing lighting in the older buildings, and building a new 1,000 m² greenhouse with a complete lighting system.[1] The complex was then expanded to include an equestrian center, tourist services with reception facilities, an outdoor arena, a horse show for tourists, and greenhouse tour visits. The crop-growing space was later enlarged by 60%, and visitor facilities opened in the Atrium of the greenhouses where a range of food products and souvenirs were developed, made of tomato and cucumber.

Growing Environment

Greenhouse growing is practiced at the country's main low temperature fields. The northern location and isolation means fewer plant pests and diseases and the warm ocean currents from the south give the country a temperate temperature.

Like Newfoundland, the Icelandic climate is not conducive to traditional agricultural methods, a large amount of the country's produce is imported from growing regions in Italy or Britain, or cultivated in hydroponic greenhouses.[2] Iceland's unique geology allows for conditions that allow use of geothermal energy, which is used to heat and sterilize the soil and greenhouses and to produce carbon dioxide and electricity.[3] By converting the energy in rivers and geothermal steam to electricity, it is possible to illuminate plants and overcome the dark winters. Volcanic products such as pumice are used in significant quantities as growing media instead of soil.[4]

Fridheimar Farms's annual production is approximately 300 tons, totaling 18% of Iceland's total tomato market.[5] The tomatoes are harvested every day of the year despite the climate conditions and long, dark and cold winters.

Control computers in the greenhouses control heat, humidity, carbon dioxide and lighting. Control computers are linked with fertilizer blenders that water the plants according to a pre-determined schedule. Weather stations on the rooftops obtain information on wind speed, wind direction, temperature and sunlight. This allows the owners to monitor status, change settings and control watering worldwide.

1 Knútur Rafn Ármann and Helena Hermundardóttir. *Iceland: A Land of Greenhouses*. Islenskt grænmeti. Poster

2 Porthönnun, "About Friðheimar," Friðheimar, June 07, 2013, accessed September 25, 2017, http://fridheimar.is/en/about-fri%C3%B0heimar.

3 Ibid.

4 Ibid.

5 Ibid.

Fig. 3.2 Fridheimar Greenhouse, 2015, cherry tomato plant growing in hydroponic system.

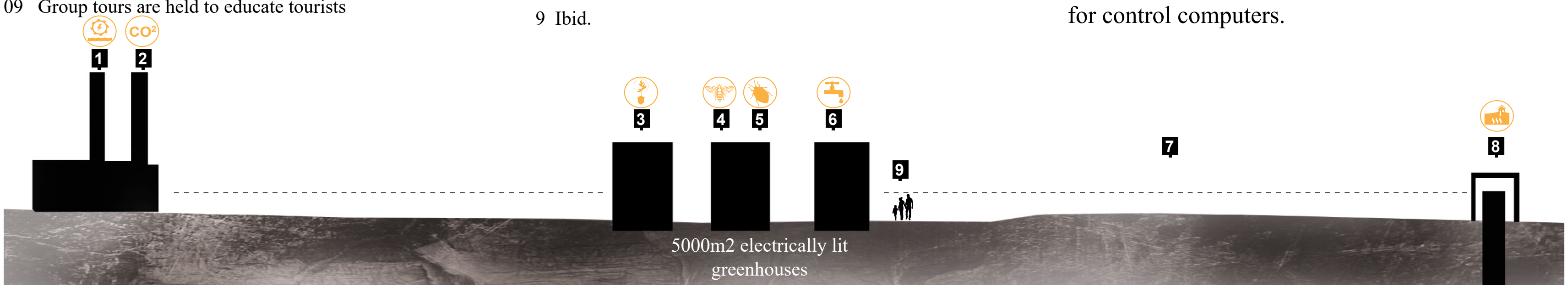
Fig. 3.3 Fridheimar Greenhouse, 2015, greenhouse attrium with cafe and tourist services.

Fig. 3.5 Map of Iceland

neovolcanic zone
main low temperature fields
glaciers
mountainous zones
roads

Fig. 3.4 Greenhouse Processes

01 Electric power used at Fridheimar is about 1.2 megawatts
02 Carbon dioxide is derived from natural steam at Haedarendi
03 Grow lights allow year-round production
04 Bumble bees are imported from Holland to pollinate
05 No pesticides are used as biological control is effecitve
06 Water for irrigation is taken from the same source of drinking water
07 Pomice, volcanic tuff, growing medium controls moisture
08 100,000 tons of hot water a year is taken from a borehole 200 metres from the complex
09 Group tours are held to educate tourists



Economic Implications

The government and Farmers' Association of Iceland signed a 10-year Adaptation Agreement in 2002, for the purpose of improving the competitiveness of domestic growers in relation to imports.[6] The main goals of the Adaptation Agreement were to reduce consumer prices on imported, as well as domestic, produce, improve efficiency and competitiveness of domestic growers and secure the income basis of local vegetable growers.[7] Since the agreement, consumer prices for vegetables have decreased by 31-55%, local production has increased considerably, and the efficiency and competitiveness of growers has increased.[8] At the same time, growers have pursued new product development and put more effort into marketing Icelandic vegetables.[9]

6 Knútur Rafn Ármann and Helena Hermundardóttir, Iceland: A Land of Greenhouses (Islenskt grænmeti).

7 Ibid.

8 Ibid.

9 Ibid.

Local Implementation

Recently, the farm has opened up the greenhouses for group tours to educate the public on gardening and greenhouse agriculture. One greenhouse was converted into a cafe and bar, which serves lunch every day, spearheaded by well-known Icelandic chef and farm neighbor Jon K.B. Sigfusson. It also houses a little shop that sells bottles of its tomato soup, freshly picked tomatoes, and jars of tomato jam, sauces, and preserves. Half the building still functions as a working greenhouse with long, tall vines of green and red tomatoes.

Connection

Friðheimar farm uses the Island's latent natural resources to overcome the poor climatic conditions and improve the quality of life of Islanders by providing local produce, while reducing consumer prices. Newfoundland struggles with similar issues, and can learn from the systems Iceland has put in place. The Island's latent wind resources could be put to use by providing illumination for plants to overcome the dark winters and provide electricity for control computers.

Chris Snellen Lettuce Greenhouse

Chris Snellen's hydroponic lettuce farm began when the infamous cucumber greenhouse in Mount Pearl was dismounted. Snellen was paid to remove, and keep, all of its production materials. Fully equipped, Frank Myrick an employee in the Sprug greenhouse, and Chris Snellen began to hydroponically grow produce in order to offer a fresh and local vegetable year round.

Growing Environment

More than 25,000 individual heads of lettuce grow in the old Swift Meats packing plant on Hamilton Avenue in St. John's.[1] Five kinds of lettuce, including frilly green lettuce and Red Fire, thrive in the insulated basement. Snellen keeps his subterranean lettuce production system at a comfortable 22 C.[2] In the space, 200 metal halide lamps emit 1,000 watts of power each, combined with the constant light, *mauzy* temperatures and specific tube spacing.[3]

Every 42 days, Snellen and his wife harvest about 3,000 heads of lettuce from the 5,000-square feet of growing space in the basement.[4] The lettuce start as a seeds that are dropped into cubes of basalt fibre, a growing medium in which seeds can root.

1 Mandy Cook, "Sprung Up," The Independent News, November 23, 2007, , accessed September 25, 2017, https://issuu.com/theindependentdotca/docs/2007-11-23.

2 Ibid.

3 Ibid.

4 Ibid.

Once sprouted, the cubes are transferred to pipes spread out on racks, where they are hooked up to the watering system. The hydroponic system water the plants with fortified elements such as calcium, iron and phosphorous that is pumped into one end of the slanted pipe. Based on a gravity-fed system, the roots are nourished every two minutes to ensure healthy growth.[5]

Economic Implications

Snellen has perfected a growing system and produce that he can market to isolated communities so that fresh, locally grown produce can replace imported varieties.[6] Snellen plans to expand his production by building an atrium on the roof of his building, but is struggling to find capital to do so. In 2007, he auditioned his idea to CBC TV's Dragons' Den, where entrepreneurs pitch their ideas to millionaires. He asked for $500,000 for 49% of the business, but unfortunately got declined as the net profit for his venture was not high enough for the investors.[7]

As of 2013, Snellen moved his warehouse to an alternate location after a proposal to develop the property into a urban-agriculture-real-estate project was shifted into a more residential space after the booming real estate market caused developers to

5 Ibid.

6 Ibid.

7 "Dragons Den," *Newfoundland Hydroponic Lettuce Grow-Op*, CBC, December 3, 2007..

Fig. 3.6 Snellen underneath the hydroponic growing operation, Independent, November 2007

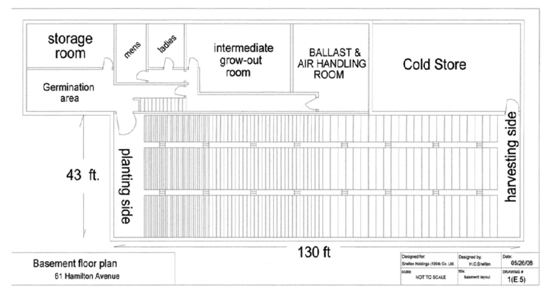


Fig. 3.7 Snellen's simple and efficient floor plan of the hydroponic operation, Independent, November 2007

Fig. 3.8 Map of Newfoundland

- greenhouse
- towns
- extremely remote
- roads

Fig. 3.9 Greenhouse Processes

01 Electric power used at Snellen's farm is about 200 metal halide lamps emitting 1,000 watts of power each
02 Carbon dioxide is derived from a local brewery
03 Grow lights allows year-round production
04 Water for irrigation is fortified with nutrients to sustain proper growth
05 Basalt fibre is used as a growing medium in which seeds can root

change their plan.

The initial proposal involved transforming the warehouse into condos which would co-exist with the hydroponic farm, recycling carbon dioxide and residual heat from an on-site laundromat to grow and enrich the lettuce.[8]

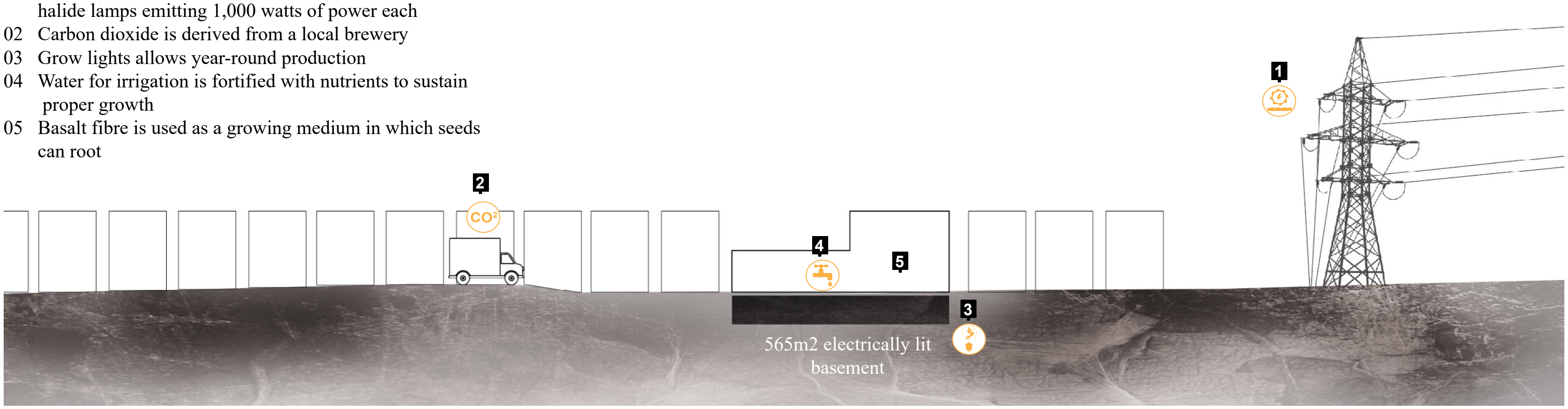
Although in an alternate location. Snellen is now optimistic working with one of the major breweries in town on a system to trap and recycle their CO2 emissions to enrich the lettuce.[9] He also has plans to grow spinach and basil, as they are two leafy greens that should flourish in the sunlit space, plus any other vegetable he decides to experiment with.

Connection

Snellen has had hardships in his production and would benefit from investor opportunities. Dragons Den refused Snellen's proposal as he refused to raise consumer pricing, as he wants his produce to be affordable to the consumer. Even without investor backing his operation has proven to be successful and demonstrates that Newfoundlanders need a solution to the lack of fresh, local produce.

8 "Lettuce, new houses, and the buzz at the corner store," The Lettuce Farm, April 13, 2013, , accessed September 25, 2017, http://www.thelettucefarm.com/news.html.

9 Ibid.



Growing Power is a nonprofit organization and land trust of urban farms in Milwaukee and Chicago. The organization strives to provide equal access to healthy, high-quality, and affordable food for people from diverse backgrounds in all communities, through the development of Community Food Systems. The greenhouses grow over 200 varieties of crops on 300 acres of land.[1]

Growing Environment

Growing Power harvests more than one million pounds of fresh micro-greens, fruits and vegetables each year in year-round greenhouses, farm locations, community gardens, and numerous Milwaukee production sites.[2] Its facilities headquarters, 5500 W. Silver Spring Drive, Miwaukee includes seven large greenhouses, a kitchen, indoor and outdoor training gardens, aquaculture system and a food distribution facility.

Growing Power grows their own nutrient rich soil through vermicomposting and the complex composts regionally generated food and organic waste to create high quality, nutrient-rich compost.[3] The compost is made with recycled food waste, farm waste, brewery waste, and coffee grounds from the surrounding area.

Economic Implications

Growing Powers goal as a non-profit organization is to generate half of their operating budget through produce sales in order to be as economically sustainable as possible.[4] In order to provide high-quality educational opportunities each year, the complex relies in part on the generous contributions of individuals and foundations.[5]

Currently the six greenhouses feed approximately 10,000 people a year, but the organization is set to expand to feed 25,000 people.[6] Growing Power and TKWA have worked together to develop plans for an ambitious new facility, the world's first working urban Vertical Farm.[7]

Local Implementation

The organizations dedication to sharing knowledge manifests within the simplicity of Growing

Fig. 3.10 The Kubala Washatko Architects, vision for the new urban vertical farm.

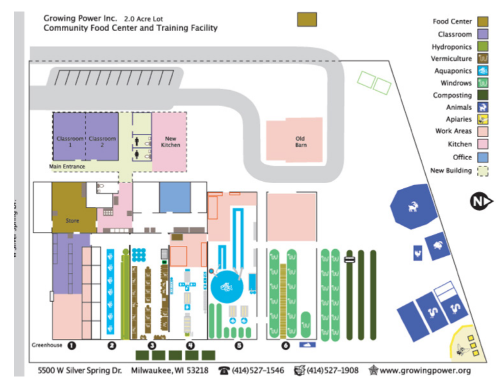


Fig. 3.11 Current Growing Power, Milwaukee headquarters.

1 "Together We Are Growing Power," Growing Power, 2014, accessed September 25, 2017, http://www.growingpower.org/.

2 Ibid.

3 "Together We Are Growing Power," Growing Power, 2014, what we grow, accessed September 25, 2017, http://www.growingpower.org/. http://www.growingpower.org/education/what-we-grow/

4 "Together We Are Growing Power," Growing Power, 2014, accessed September 25, 2017, http://www.growingpower.org/.

5 Ibid.

6 Sean Ryan, "Growing Power growing in Milwaukee," Milwaukee Business Journal, November 28, 2010, , accessed September 25, 2017, https://www.bizjournals.com/milwaukee/blog/real_estate/2010/11/growing-power-growing-in-milwaukee.html?surround=etf&ana=e_article---%20By%20Sean%20Ryan%20%E2%80%93%20Real%20Estate%20Reporter.

7 "Growing Power Vertical Farm," The Kubala Washatko Architects Inc, accessed December 20, 2017, http://www.tkwa.com/growing-power-vertical-farm/.

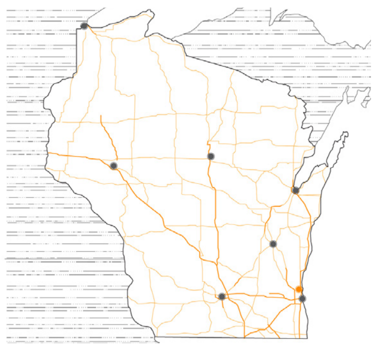


Fig. 3.12 Map of Milwaukee and Growing Power Inc network
- greenhouse complex
- towns
- other states
- roads

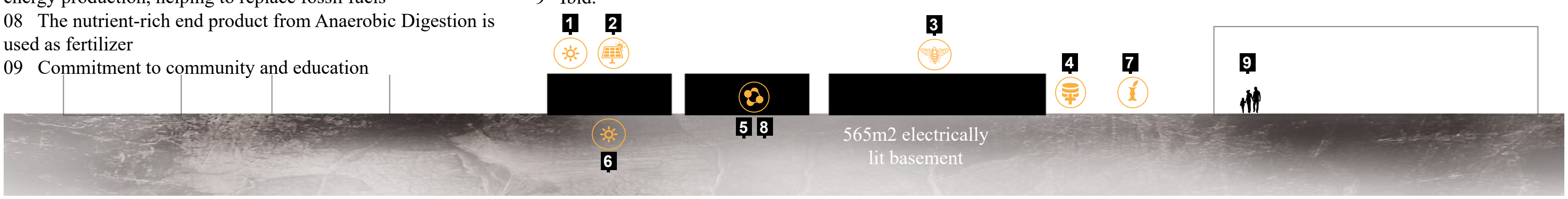


Fig. 3.13 Greenhouse Processes
01 The sloped surface of the building absorbs sunlight
02 Roof-mounted photovoltaic panels and thermal solar panels generate a portion of the building energy needs
03 Apiary is filled with European Honey Bees/Apis Mellifera
04 Rainwater falling on the building is collected and stored
05 A closed loop of water and nutrients circulates throughout the building; fish wastes are used as food for plants, while plants clean and filter the water for fish
06 Heat generated by the sun is stored in thermal mass in the ground under the building and used to warm the building
07 Anaerobic digestion produces a methane suitable for energy production, helping to replace fossil fuels
08 The nutrient-rich end product from Anaerobic Digestion is used as fertilizer
09 Commitment to community and education

Powers growing methods, education and technical assistance, and food production and distribution. The connection to the community provides opportunities for individuals and communities to network and work in partnership to promote food security and environmentally sound production practices.

The complex provides over 5000 individuals with tours of the Community Food Center each year and convenes numerous national workshops on site at facilities.[8] The complex sponsors several national conferences that focus on food security and provides technical assistance on site, and runs numerous collaborative projects and training projects, including a partnership with the Boys and Girls Club of Greater Milwaukee to train city youth in gardening, in addition to hosting interns year-round.[9] The organization also conducts workshops in greenhouse production such as aquaculture, aquaponics, vermiculture, horticulture, composting, soil reclamation, food distribution, beekeeping, and marketing.[10]

8 "Together We Are Growing Power," Growing Power, 2014, Milwaukee Farms, accessed September 25, 2017, http://www.growingpower.org/.

9 Ibid.

Growing Powers product is distributed a variety of ways, ranging from vendors such as restaurants and cafeterias to the Farm-to-City Market Basket program, a program that allows residents in low-income areas of Milwaukee to purchase a weekly basket of food at a subsidized rate.[11] Currently, Growing Power distributes more than 300 market baskets on a weekly basis.[12]

Connection

Growing Power's strength lies in their connection to the community and learning opportunities. They produce a product, but they also put importance and time into ensuring the community understands the importance of sufficiency. Through national conferences, youth training, year-round interns and collaborative projects, the greenhouse center offers a way to understand how community coherence is important when designing a greenhouse complex.

10 Ibid.

11 Ibid.

12 "Together We Are Growing Power," Growing Power, 2014, Produce, accessed September 25, 2017, http://www.growingpower.org/produce/

Controlled environments address the food security crisis and how the built environment can promote community invovlement and aid the development of a more sustainable quality of life. However, in order to combat the cooler climate and soil issues of the Newfoundland landscape, alternative solutions have to be reviewed. In order to light, heat, and run hydroponic systems, the greenhouse complex needs a continuous stream of energy. An unexploitative solution with respect to the new wind farm resource may be the answer.

Municipal utilities allow local governments to make decisions that directly affect the community by buying power on the open market or their own building generation facilities. However, the shift from public/private investor utility to municipality utility is arborous. Many attempts fail under the extreme opposition, as the powerful utilities have the money and resources to oppose. Notably, in 2002, San Francisco attempted to municipalize, but a $2 million campaign by Pacific Gas and Electric defeated the ballot initiative.[1]

Creating a new utility is complicated and expensive, the process could require a city to purchase transmission lines, and consist of many legal fights.

However, despite the complexity, many municipalities have succeeded. Jefferson County, Wash., voted in 2008 to split from Puget Sound Energy to reduce rates, create local jobs and increase renewables; its new utility started in 2013. Winter Park, Fla., citing unreliable service, did the same in 2005, and now its public utility is recovering from early financial problems.[2]

Many communities have also taken control of their power supply through a less intense approach, community choice aggregation, or CCA. This lets community's buy energy from where they choose, while the utility continues to own and manage the power lines, removing much of the upfront cost of municipalization. Marin County, Calif., adopted CCA in 2010 and now offers at least 27 percent renewable power at competitive rates.[3] But CCA is not legal in many areas.

The following precedents begin to offer insight into the possibilities of a municipality-owned utility and the benefits of taking control of local resources.

1 Ngai Pun, *Social Economy in China and the World* (Abingdon, Oxon: Routledge, 2016), 129.

2 Nathan Rice, "Boulder, Colo., votes for energy independence -- from its utility," *High Country News*, December 28, 2011.

3 Joshua Emerson Smith, "Focus: More cities, counties choosing green energy sources," *The San Diego Union-Tribune*, August 4, 2016, , accessed September 1, 2017, http://www.sandiegouniontribune.com/news/environment/sdut-cca-california-community-choice-aggregation-2016aug14-story.html.

As of September 2016, Boulder, Colorado moved forward with a bid to create a local electric utility. With a local utility, Boulder can choose its power sources, in order to shrink its carbon footprint. It also would be the first U.S. city driven to municipal power primarily for environmental reasons.[1] By encouraging local and energy efficient power production, the city hopes keep energy rates competitive, cut more carbon, and reinvent the electric grid.[2]

The city will separate from the Minnesota-based corporate utility, Xcel Energy, to pursue locally produced, clean power. It would be a ballot measure, which would raise a tax to pay for planning the utility.[3]

The City of Boulder filed a supplemental application with the Colorado Public Utilities Commission (PUC) asking for approval to transfer the electric system assets necessary to operate a municipal electric utility. These assets are currently owned by Public Service Company of Colorado, also known as Xcel Energy. Boulder's application requests only the facilities necessary to deliver electricity to customers within the city limits in order to achieve the community's energy goals.[4] Boulder is not requesting to transfer any generation plants or transmission assets that serve the city, or any assets used to serve Xcel customers.[5]

The PUC has agreed that the city has the right to create a local utility. Boulder's separation plan will allow the city to provide electric service to all customers within city limits, along with maintaining Xcel Energy's ability to serve customers in Boulder County.[6]

The application requests that the city utility be a wholesale customer of Xcel Energy for a limited period of time.[7] By gradually reducing its demand for power from Xcel in coordination with Xcel's increasing need for electric resources to serve customers outside of Boulder, the city could facilitate an easy transition. The resources released by Boulder could instead provide power to other

1 Nathan Rice, "Boulder, Colo., votes for energy independence -- from its utility," *High Country News*, December 28, 2011.

2 Ibid.

3 Ibid.

4 Jeannine Anderson, "Boulder moves ahead in bid to create its own public power utility," *American Public PowerAssociation*, September 30, 2013, , https://www.publicpower.org/periodical/article/boulder-moves-ahead-bid-create-its-own-public-power-utility.

5 "Boulder Energy Future," Energy Future, accessed September 13, 2017, https://bouldercolorado.gov/energy-future.

6 Ibid.

7 Jeannine Anderson, "Boulder moves ahead in bid to create its own public power utility," *American Public PowerAssociation*, September 30, 2013, , https://www.publicpower.org/periodical/article/boulder-moves-ahead-bid-create-its-own-public-power-utility.

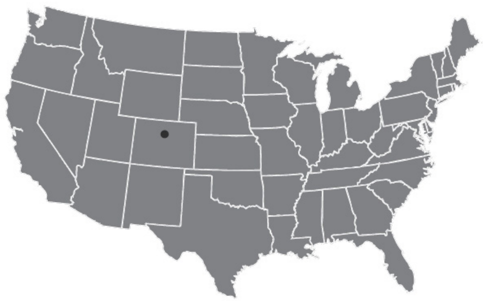


Fig. 3.15 Boulder, Colorado, United States of America has been exploring municipalization since 2010 as a way to reduce the carbon intensity of the electric supply.

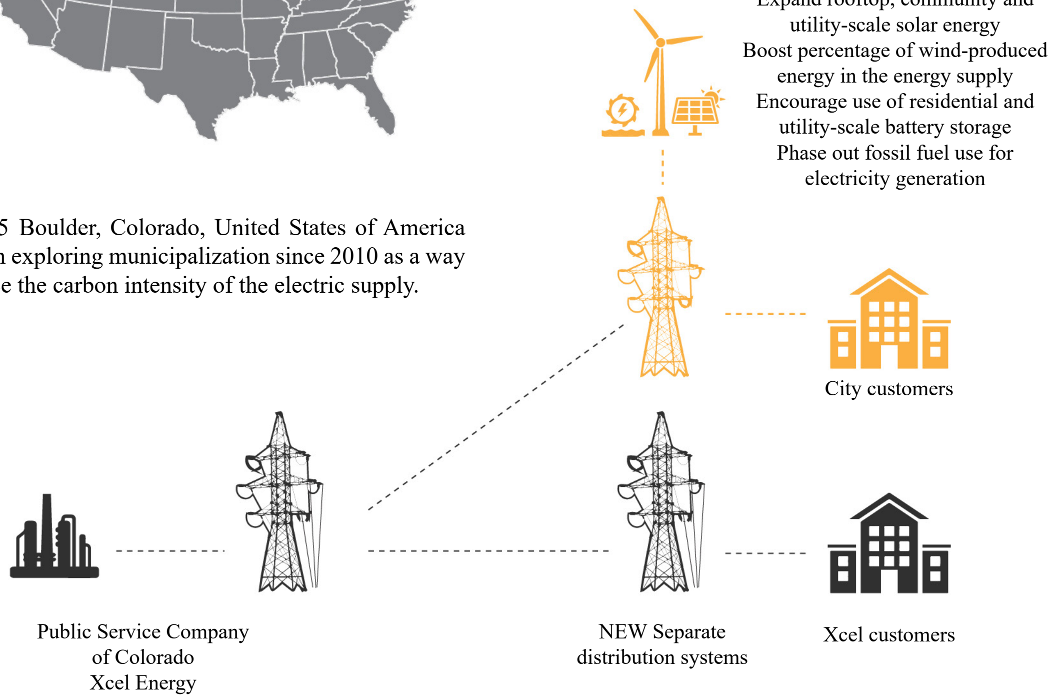


Fig. 3.14 Boulder, Colorado desired municipalization proposal. The current Xcel Energy distribution system will separate, one servicing city customers and one serving Xcel customers.

customers, avoiding the expense of developing new energy supplies. With this approach, the city will be able to more quickly decrease emissions and increase their renewable sources of energy than it would by remaining a retail customer of Xcel.[8]

The new municipality utility aims to improve safety, reliability and efficiency, while integrating new technology and local generation and increase customer choice.[9]

Connection

Boulder is exploring municipalization in order to reduce their carbon footprint and to remove themselves from the limitations the Xcel monopoly has on their energy supply. With new local control they have the ability to reach their goal to transition to 100 percent renewable electricity and 80 percent reduction in carbon emissions by 2050.[10]

Newfoundland struggles with the same issues, such as lack of local control, that comes with a monopolized utility, and could benefit from a similar strategy as Boulder. By separating distribution systems, the major utility can continue to provide power out of the city limits while allowing city customers, or even only the greenhouse complex, to explore a cleaner, less exploitative source of energy generation.

8 “Boulder Energy Future,” Energy Future, accessed September 13, 2017, https://bouldercolorado.gov/energy-future.

9 Ibid.

10 Ibid.

The Electric Utility Department began serving retail electric customers on June 1, 2005, as the City of Winter Park established its own municipal electric utility. In a referendum election of September 9, 2003, the citizens of Winter Park voted to exercise the buy-out option, with the largest voter turn-out since 1988, with 69% in favor, in the city's franchise agreement with Progress Energy Florida and to have the city own and operate its own utility.[1]

The city's previous utility, Progress Energy, is a $9 billion corporate giant that has been aiming for a 30 year monopoly contract that offers no guarantees for better reliability and local accountability.[2] To transition to the municipal utility, the city has built two electric substations and purchased Progress Energy Florida's electric distribution facilities within the city. The City has created their own customer service, meter reading, billing, vegetation management and all the policies and procedures necessary to operate a utility.[3]

This process was an extremely costly endeavor, with the city commission split on the issue.[4] Progress Energy also caused legal challenges and threatened to quit paying franchise fees; the utility has community involvement issues as well.[5]

The city utility now has 14,100 electric customers, with an annual revenue of $48.2 million.[6] The utility only deals with distribution, and does not own any energy generation.

The original electric system was built in 1913 by the city, but sold to predecessor Duke Energy in 1927. A vote was held 20 years later to repurchase the system, but the vote failed and the franchise was renewed. In 1971 the franchise was renewed early for an additional 30 years. When the franchise expired in 2001, the City Commission authorized study, where feasibility study, legal battles, arbitration followed, where finally in 2003, arbitration set the purchase price at $42.3 million.[7]

Because a vote to repurchase the system failed and the franchise was renewed again in 1971, the procedure for holding a vote had not been done in Florida since the 1940s. This unfamiliarity,

Fig. 3.16 Advertisement by the governement for creation of a munipality-owned utility.

1 "Electric Utility." City of Winter Park. Accessed May 13, 2017. https://cityofwinterpark.org/departments/electric-utility.

2 Civic Center, "Electric Utility 10th Anniversary," news release, June 1, 2015, https://cityofwinterpark.org/docs/departments/electric-utility/10th-anniversary-presentation-2015-06-01.pdf, 4.

3 "Electric Utility." City of Winter Park. Accessed May 13, 2017. https://cityofwinterpark.org/departments/electric-utility.

4 Civic Center, "Electric Utility 10th Anniversary," news release, June 1, 2015, https://cityofwinterpark.org/docs/departments/electric-utility/10th-anniversary-presentation-2015-06-01.pdf, 7.

5 Ibid, 7.

6 Ibid, 2.

7 Ibid, 8.

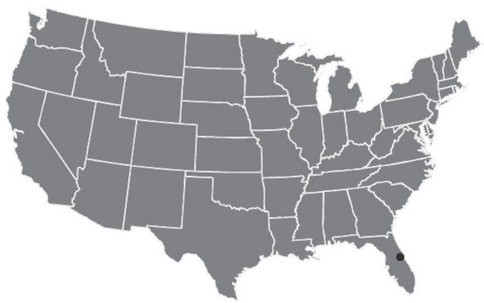


Fig. 3.18 Winter Park, Florida, United States of America

Fig. 3.17 Winter Park, Florida municipalization proposal. The city purchased the distribution system after the current franchise expired in order to become independent of the monopoly.

Progress Energy legal challenges and threat to quit paying franchise fee, and Progress Energy's community involvement lead the city commission to be.

However, the city claimed that local control and accountability, reinvestment of profits locally, and improved reliability of the energy system would follow with the municipal utility.

In a ten year aniversary of the new utility, the city reported that the success of the vote was because of the educated and involved community, good attorneys and consultants, help from FMEA, APPA & other municipalities, and that the Progress Energy Florida's tactics did not prove viable.[8]

Connection

Owning the distribution system would require Newfoundland to buy from both the private-investor company Newfoundland Power, and NLHydro. This would increase local control, where the community could invest back into the community through programs and education, however, this procedure is extremely costly, and may not be the best option for smaller communities. The next two examples may prove to be more feasible.

8 Civic Center, "Electric Utility 10th Anniversary," news release, June 1, 2015, https://cityofwinterpark.org/departments/electric-utility/, 24.

All but two coastal counties in California have adopted or are exploring the government program, Community Choice Aggregation (CCA), uses an increase of renewable energy and delivers it at lower rates than investor-owned utilities in California.[1] The government-run operations take the authority to buy and sell power away from investor-owned utilities. The private energy companies continue to operate the electrical grid, but elected officials decide which power generators to contract with or invest in, namely non-renewable or renewable projects.

The adoption of CCA in California has emerged in coordination with climate change.[2] The program allows cities and counties to purchase power on behalf of their residents and businesses to provide cleaner power options at a competitive price.

According to executive director of the San Diego nonprofit Climate Action Campaign, Nicole Capretz, "CCA is one of the most powerful tools available to tackle the climate crisis because it fundamentally changes the rules of the game... decisions can be made locally in the public interest, rather than at some faraway location that mostly cares about lining the pockets of corporate executives."[3]

Community Choice Energy programs are revenue-based, they are self-supporting from an existing revenue stream such as electricity bills.[4] The electricity rates consumers pay to an electric supplier or an investor-owned utility are directed to support the group purchase of electricity through a local CCA program.[5]

The local community choice provider can reduce the region's carbon footprint by providing a higher mix of clean energy sources than the existing monopoly utility. For example, in Sonoma County, the electricity service of their community choice energy program (Sonoma Clean Energy) provides 1.5 times more renewable energy than the area's traditional utility, and creates 30 percent less greenhouse gas emissions.[6]

In the past, electric rates were set without any input from customers. A local community choice program gives local control and accountability of rates. The local community choice program would offer a choice of providers and create competition that encourages innovation and improved pricing.

In 2011, legslature barred large utilities from using consumer dollars to lobby against CCA, after bitter fights between supporters of CCA and Pacific Gas & Electric in broke out in Marin County.[7]

For more than a century, consumers have largely either bought power from investor-owned or municipal utilities. In both cases, the public or private utility maintains its own electrical infrastructure, as well as develops its own power plants or buys electricity from a third party.[8]

Over time, a local community choice program can buy increasing amounts of power from local sources, helping support local jobs and local economic development. A local community choice program can also apply to develop new programs and incentives better targeted to a communities needs.

1 Joshua Emerson Smith, "Focus: More cities, counties choosing green energy sources," *The San Diego Union-Tribune*, August 4, 2016, , accessed September 1, 2017, http://www.sandiegouniontribune.com/news/environment/sdut-cca-california-community-choice-aggregation-2016aug14-story.html.

2 Ibid.

3 Ibid.

4 Kayla Race, "What is Community Choice Energy?" Climate Action Campaign, July 19, 2017, , accessed December 23, 2017, https://www.climateactioncampaign.org/2015/07/01/what-is-community-choice-energy/.

5 Ibid.

6 Ibid.

7 Joshua Emerson Smith, "Focus: More cities, counties choosing green energy sources," *The San Diego Union-Tribune*, August 4, 2016, , accessed September 1, 2017, http://www.sandiegouniontribune.com/news/environment/sdut-cca-california-community-choice-aggregation-2016aug14-story.html.

8 Differences, "Differences Between Publicly and Investor-Owned Utilities," California Energy Commission, , accessed December 23, 2017, http://www.energy.ca.gov/pou_reporting/background/difference_pou_iou.html.

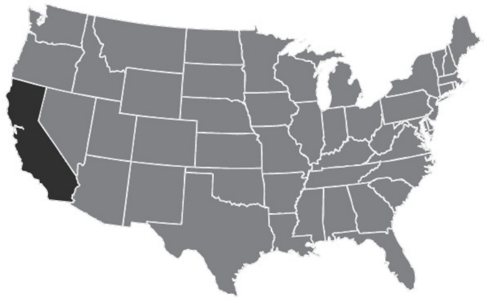


Fig. 3.20 California, United States of America

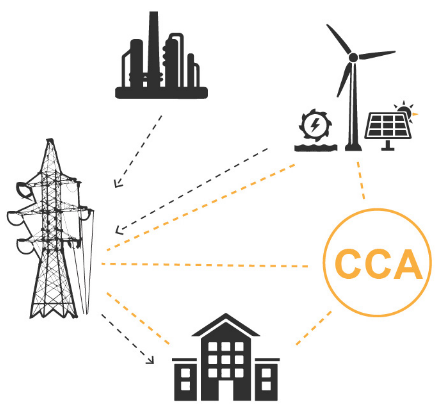


Fig. 3.19 California Community Choice Aggregation model. By introducing this entity, the city has the ability to choose there energy source.

Unlike non-profit municipal utilities, CCE programs do not face the challenge of intensive capital, valuing, purchasing, and maintaining expensive utility infrastructure.[9] The CCE model offers a hybrid approach that exists between the investor-owned utility and a municipal utility. Community Choice Energy programs have the benefit of controlling power supply and generation without the financial burden of purchasing and maintaining utility infrastructure.[10] It is a great option for municipalities who want control and flexibility over their power supply, but don't want the financial and operational challenges of owning their own utility.

Connection

It is illegal to have a CCA in most areas, however, if Newfoundland were to evaluate their situation, CCA may be beneficial to the community. This way the greenhouse complex could opt to use wind energy to operate the functions of the controlled environment, while not requiring the capital to own their own utility. This soft approach would give the community local control and ensure cost efficiency.

9 Kayla Race, "What is Community Choice Energy?" Climate Action Campaign, July 19, 2017, , accessed December 23, 2017, https://www.climateactioncampaign.org/2015/07/01/what-is-community-choice-energy/.

10 Ibid.

The city of Falkenberg sits on the windy coast og Halland County, with a population of 39,000.[1] The scenic area attracts 40,000 seasonal tourists, with a historic towncenter and a history of salmon-fishing dating back to the 1600s.[2]

The town has been implementing a municipal plan for sustainable development since 1995, reaching out to schools, businesses, workshops, and the media to raise community awareness.[3]

City planners use sustainable development objectives as guidelines while city planning, and city officials mandate that all municipal departments must adopt sustainable development goals.[4]

Falkenberg has developed a windmill farm of ten 660-watt wind turbines that produce 12.5 gigaatt hours of electricity a year, an average of 1.43 MW.[5] This allows for complete heat and power for 600 homes for a year.

The city has established a non-profit co-operative that now owns the wind farm. City residents and businesses can join the cooperative for US$500 per year per household, then buy electricity for one-half the going market price.[6]

The wind farm reduced the coal-generated electricity by 12.5 gigawatt hours, previously purchased from Denmark.[7]

The total cost for the windmill farm was US$650,000, however, the city recieved a government subsidy for 15 percent of the cost.[8] The city's investment was paid down after 9 years, and is expected to run between 25 - 30 years with good maintainance, and 90 percent of the wind turbine materials can be recycled and reused at the end of their life.[9]

It is valuable to have a municipality owned uility, as it can be used as a toll to realize political ideas and ambitions, the utility can take risks by testing new technology and it gives citizens the opportunity to participate.[10] If a large corporation enters the area, it is hard to get local support.[11]

Neighboring communities have similar wind

Fig. 3.21 Advertisement by the governement for creation of a munipality-owned utility.

1 Sarah James and Torbjörn Lahti, *The natural step for communities: how cities and towns can change to sustainable practices* (Gabriola Island, BC: New Society Publishers, 2008), 33.

2 Ibid.

3 Ibid.

4 Ibid.

5 Ibid, 34.

6 Ibid, 34.

7 Ibid, 34.

8 Ibid, 35.

9 Ibid, 35.

10 Tore Wizelius, Windpower ownership in Sweden: business models and motives (New York, NY: Routledge, 2014), 150.

11 Ibid.

Fig. 3.22 Falkenberg, Halland County, Sweden

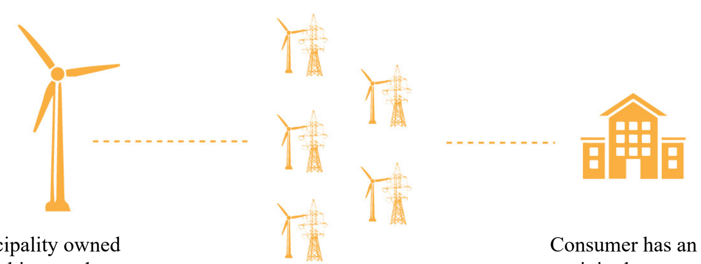


Fig. 3.23 One of Swedens Business Models

resources, however, not much windpower is installed, demonstrating that municipality policy matters. Politicians in Falkenberg have a strong interest in environmental issues, which has attracted others to the municipality with similar interests.[12]

Sweden has been creative in their ownership model, where a legal framework for a consumer cooperative, and marketed and sold shares to consumers.[13] This combats the monopoly of, where all consumers purchase power from one utility. This cooperative venture allows the consumer to choose whether or not to by shares in wind cooperatves. It still allows those to purchase power without a membership, however energy costs will be the same as market value.

12 Ibid, 151.

13 Ibid, 150.

The windpower plant was developed by municipal utility, Falkenberg Energi in 1998, and is managed by an umbrella company. The ten wind turbines have eight different owners; three are cooperative accotiations, one local, one national and one regional farmers co-op. Four are windpower limited companies, and the housing enterprise. The umbrealla company does not own shares in the turbines, it is a company formaed to manage the windpower plant for the owners' benefit. The eight owners own shares in in the umbrella company. Income from the turbines are pooled together alog with the costs, and the profit is divided among th owners.[14]

Connection

Falkenberg is a similar community size to the Port-au-Port Peninsula and affirms that a localized energy farm and utility is feasible for such a small area.

By creating a cooperative venture, the wind farm offers local control and reduces the effect of a monopoly by giving choice. Each wind turbine has has a distinct owner, this leaves opportunity for a greenhouse utility to own shares in however many wind turbines required to operate the complex.

14 Ibid, 101.

Synthesis

The preceding case studies offer insight into the possibilities associated with controlled greenhouse environments and the opportunities that come with local control over natural resources and using it to benefit the community by reducing vulnerability. It becomes a way to engage with, and respond to, the needs of local people as a means of building a paradigm of self-sufficiency.

Part 4 design exploration

"The most important role of design is to provide an alternative vision. Through visions, residents, industry and government become involved in a shared process."

- John Thakara, In the bubble: designing in a complex world

Site Selection

The design proposal is situated along the west coast of Newfoundland, on the Port-au-Port Peninsula, near the town of Stephenville. As the rest of the island, it suffers from unemployment, loss of schools, and depopulation. The seasons in this area of Canada have heavy impact on the populations and economy. A drive through the communities will demonstrate the reality of the issue with the real estate signs dominating the landscape. Although permanent resident counts are quite meager, the summer population of this area swells.

Stephenville was first known as an Acadian Village established because of poverty and conflict existing in Nova Scotia and the excellent fishing grounds that Western Newfoundland had to offer. The small town of Stephenville would eventually become a very important refueling stop for American aircrafts on route to Europe when in 1941 the town was chosen for a U.S. military Air Force base.[1] The purpose of the base changed over the years, but the number of jobs that were required to support the base exceeded the town's population. People from various parts of Newfoundland moved into the area with this availability of work. There were economic, social and cultural changes in the town because of the base. Today, owned and available to the public, Stephenville Airport is an alternate stop for flights from other parts of Eastern Canada.[2]

The peninsula is approached by one road to the town, a treacherous drive in the winter months given the high precipitation count in the area. These communities have withstood the effects of the resettlement program, with populations as low as 92 residents.[3] Many people will seasonally inhabit a community throughout the fishing seasons (as the winters are quite severe). Many residents leave their families to move out to the west of Canada to work in the oil sands during the winters in order to provide for their families. Many schools have shut down in the past, resulting in the establishment of Piccadilly Central High from the amalgamation of students who formerly attended Bishop O'Reilly High School of Port au Port West, Notre Dame du Cap of Cape St. George, and Our Lady of Lourdes High School of Lourdes.[4]

The proposed greenhouse complex site is north of Abrahams Cove along an energy corridor in the center of the peninsula. The center of the peninsula is completely forested with the exception of the

1 Heritage Partner Project, "Stephenville the American Influence," Stephenville Introduction, , accessed December 23, 2017, http://www.heritage.nf.ca/articles/society/stephenville-introduction.php.

2 "Economy," Town of Stephenville, Newfoundland, , accessed December 23, 2017, http://www.townofstephenville.com/visitors/economy/.

3 Statistics Canada. 2011 Population by province and territory (Newfoundland and Labrador). *Census*. Raw data.

4 "Piccadilly Central High School - Home of The Pirates," accessed December 23, 2017, http://piccadillycentralhigh.weebly.com/about.html.

Fig. 4.1 The majority of the island is empty of communities and housing and consists of road connecting the sites.

Atlantic Minerals Canada mine. The geology of the site gives extreme fluctuations in elevation.

In the months of seasonal transition, when the water is either warmer or colder than the air, winds gain significant speed and thus creates a potential energy that is a latent condition of the island and can produce enough power to service not only the homes along the West coast, but also the greenhouse complex to increase the poor quality of life.

The St. Georges Bay is prime location for off shore wind turbines as the area produces strong, consistent winds, shallow water and offers the conditions that Beothuk Energy needs such as close proximately to a service port in Corner Brook and airport.[5] All the infrastructure required is already existing.

It is clear that the outports along the coast are in a state of social decline. It is in a state of depopulation. The off seasons push the populations to larger economic centers including St, John's, Stephenville, Port Aux Basque, or out of province to make their living. However, Newfoundlanders try to maintain living in the place they grew up - but with depleted cod stocks, the unused airport and army base, and very little effort put into reversing the damage - the future looks grim.

This is the situation and site for this thesis.

5 Stephanie Kinsella, "Beothuk Energy lands European backer for wind farm on west coast," *CBC News*, October 2, 2016.

Newfoundland is connected by the trans-Canada highway that extends from Port aux Basque to St. John's. Along the highway clusters of networks arise where communities are connected by road that extends to 90 minute travel times. Stephenville's connectivity includes communities that stretch from the western tip of Mainland to the town of Stephenville and South to St. Georges Bay.

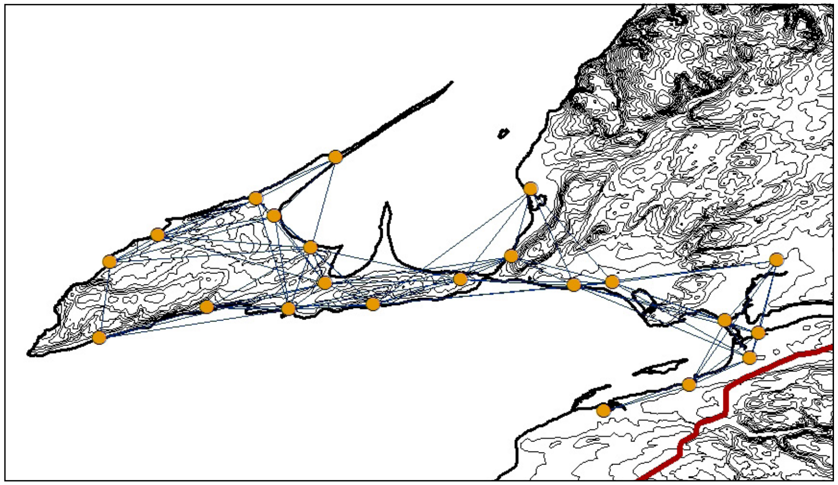


Fig. 4.2 30 Minute Distance Network, 1 : 1,000,000

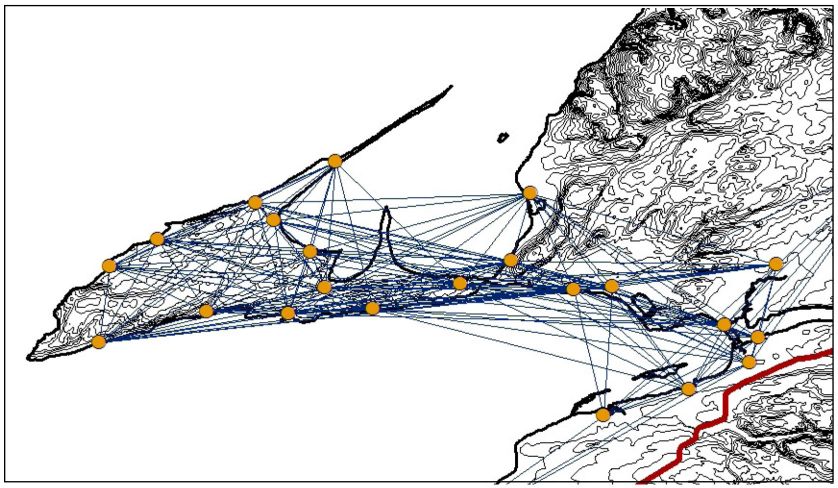


Fig. 4.3 60 Minute Distance Network, 1 : 1,000,000

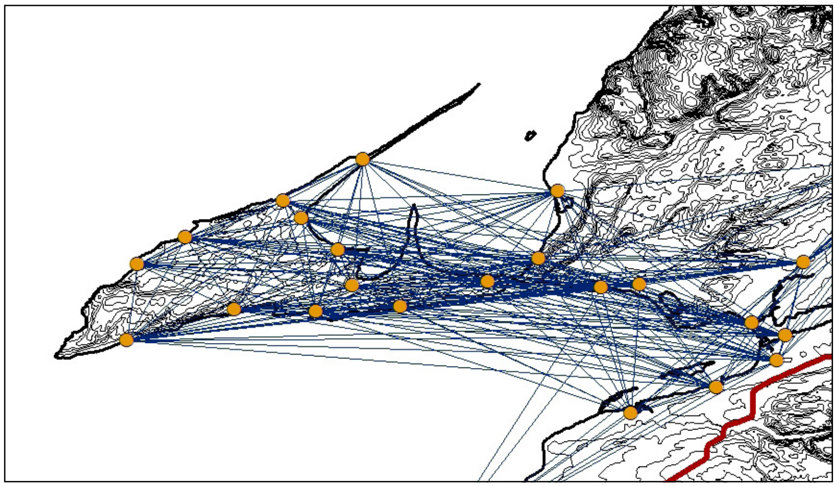


Fig. 4.4 90 Minute Distance Network, 1 : 1,000,000

Fig. 4.5 Empty aisles plague the grocer, with much produce arriving near its expire date

The network area is serviced by two grocers, the local Dominion and Colmans. These grocers service the 11 communities located in the island portion of the peninsula as well as Kippens, Stephenville, and Stephenville Crossing, a population totaling approximately 17,000.[1] These grocers that do exist carry little produce and struggle to carry enough to fill the space. Fruits and vegetables are imported and transported to the stores with the added food miles, making the produce less fresh. Both grocers are located in the heart of Stephenville, leaving those on the island over 90 minutes away from basic household items. Those living on the island peninsula commonly have treacherous driving conditions, leaving them with the only option of corner store grocers. This is common among rural and outport Newfoundland communities.

According to Food First NL, "Newfoundland and Labrador has the most corner stores per capita, as well as the highest proportion of corner stores in rural areas, of all of the provinces or territories in Canada. Since many smaller communities do not have a supermarket nearby, corner stores play a larger food role in the province than in other places in Canada."[2] These small stores are central to rural communities as they have always stocked a range of items like groceries, snacks, and other products for everyday use. Convenience store food offerings, however, are often stocked based on long shelf-life and low wastage, meaning that fresher, healthier foods are harder to come by.[3] Cathy Mah, Food Policy Lab, Memorial University, states that "rural stores have a long history of being more than businesses; of serving as community hubs. A healthy corner store strengthens that role, and needs good public policy supports to do so."[4]

Along with *Food First NL*, and the *Healthy Corner Stores NL (HCSNL) project*, the government released a document titled the *The Way Forward: A vision for sustainability and growth in Newfoundland and Labrador*. The document iterates that the "Provincial Government must be redesigned to address our economic, social and fiscal challenges. We must position our province as a competitive place to live, work, do business and raise a family. We must think and act in a way that is long-term and across Government. We can no longer afford to be bound by short-term, reactionary thinking."[5] Each year, the Government announces the actions to take to help realize their vision. They will measure progress through targets such as:

1 Statistics Canada. 2011 Population by province and territory (Newfoundland and Labrador). *Census*. Raw data.

2 "Healthy Corner Stores NL," Food First NL, accessed September 23, 2017, http://www.foodfirstnl.ca/our-projects/healthy-corner-stores-nl.

3 Ibid.

4 Ibid.

5 Canada., The Way Forward: A vision for sustainability and growth in Newfoundland and Labrador (Government of Newfoundland Labrador), 2.

Fig. 4.6 Produce section of the local Dominion grocery store, one of two grocers that service approximately 17,000 people.

Fig. 4.7 Body mass index, overweight or obese, self-reported, adult

By 2022, Newfoundland and Labrador will have increased its food self-sufficiency to at least 20 per cent. Our province is currently only about ten per cent self-sufficient in its food requirements.[6] And by 2025, Newfoundland and Labrador residents will increase their rate of vegetable and fruit consumption by five per cent. The current provincial rate is 25.7 per cent, while the national rate is 39 per cent.[7] The government has published multiple documents on food sufficiency, and health benefits, however, with no solution, nor the role that architecture and design.

A 2014 Statistics Canada report shows the high obese and overweight rate in Canada. The national average sits at 54%, where the highest rate is in Newfoundland and Labrador (67.5%) and the lowest rate found in British Columbia (48%).[8] This is a global epidemic, however, the high rates in Newfoundland can be seen as situational. Without a healthier lifestyle and healthier fresh food, the province's obesity and overweight rate will continue to rise. According to researcher and associate professor at Memorial University Laurie Twells, "it's a three-pronged approach, so whether we put more of our resources into prevention,

6 Ibid, 42.

7 Ibid, 43.

8 Stats Can. Body mass index, overweight or obese, selfreported, adult, by sex, provinces and territories (Percent). http://www.statcan.gc.ca/tablestableaux/sumsom/l01/cst01/health82beng.htm

whether we focus on the management piece in terms of adults and just even helping them maintain body weight, or whether we start treating patients.”[9]

This weight crisis corresponds to the high diabetes rate in the province. A healthier option grown and produced locally has the opportunity to provide the province with not only with food security, but also offer a healthier lifestyle to combat the rising overweight rates and bring them to par with the rest of Canada.

Fresh groceries are basic needs, however, it proves especially difficult for rural communities. The proportion of residents who report eating fruit and vegetables at least five times daily was lower than the national average (39.5%) in many provinces, but rates are substantially low in Newfoundland and Labrador and Nunavut.[10]

To address this issue, a designed greenhouse system called Sprung Greenhouse was constructed in 1988 targeting the food security crisis, opting to grow tomatoes and cucumbers. The greenhouses disgraced the current government and went under economic stress after most of the cucumbers were unused for human consumption and sent to be used for fertilizer or exported outward.[11] Because of increasing travel costs, the program fell under disrepair. This could have been avoided with research into the common consumption of Newfoundlanders preferred diet as research has shown that on average a Newfoundlander consumes 1/2 cucumber per year, and the average family spends $1.56 on cucumbers.[12]

Sprung Greenhouse is used as an anti-precedent and should be taken as an example to review the best way to move forward with a new controlled environment greenhouse. For this reason, the thesis highlights the produce that will strengthen the food crisis, focusing on three issues: the likelihood of consumption by residents, health requirements set by the USDA, and the demand. This thesis does not attempt to produce a top-down approach to design nor chose produce for the communities as each community will have their own culture and need. But instead uses the three categories as a way to create a realistic vision of how a greenhouse complex can thrive in the community network by providing a vision of sufficiency.

9 “Fatter, not fitter, in N.L., study says,” CBCNews, March 5, 2014, http://www.cbc.ca/news/canada/newfoundland-labrador/fatter-not-fitter-in-n-l-study-says-1.2560989.

10 Pérez, Claudio E. 2002. “Fruit and vegetable consumption.” Health Reports. Vol. 13, no. 3. Statistics Canada. http://www.statcan.gc.ca/studies-etudes/82-003/archive/2002/6103-eng.pdf.

11 “The Sprung Greenhouse,” The Sprung Greenhouse, , accessed December 23, 2017, http://www.heritage.nf.ca/articles/politics/sprung-greenhouse.php.

12 Jenny Higgins, The Sprung Greenhouse, accessed September 23, 2017, http://www.heritage.nf.ca/articles/politics/sprung-greenhouse.php.

Fish and Brews

Jiggs Dinner

Cold Plates

Fig. 4.8 Popular Newfoundland dinners

To determine the likelihood of resident consumption, the top traditional dishes found in Newfoundlanders homes across the province are identified with respect to dietary foods. The three top foods are fish and brewis, jiggs dinner, and cold plates.

Fish and Brewis
The recipe may vary from community to community and household to household, but the primary ingredients are always the same: Cod fish, hard bread and scrunchions, salted pork fat cut into small pieces and fried. Both the rendered fat and the liquid fat are then drizzled over the fish and brewis.

Jiggs Dinner
Salt beef (or salt riblets), boiled together with potatoes, carrot, cabbage, turnip, and cabbage or turnip greens. Pease pudding and figgy duff are cooked in pudding bags immersed in the rich broth that the meat and vegetables create. Condiments are likely to include mustard pickles, pickled beets, cranberry sauce, butter, and a thin gravy made from the drippings of the roasted meat.

Cold Plates
A Newfoundland cold plate is something everyone in the province will know, and every family will have their own variation. Traditionally a cold plate was a weekly occurrence. After the Sunday roast of beef, ham, chicken or turkey the leftover cold meats would be served up for supper with a variety of deli-type potato salads, pasta salad and cole slaw. Cranberry sauce, cole slaw, picked beet potato salad, mustard potato salad, egg and apple potato salad, leftover roast beef, ham and leftover turkey. Traditional Newfoundland Dressing, a breadcrumb, onion and summer savoury based stuffing for poultry which is universally used in Newfoundland and tomatoes if in season.

The 2015–2020 Dietary Guidelines for Americans

Vegetable subgroup	Examples
Dark-Green Vegetables	Broccoli, Spinach, Leafy Salad Greens (including romaine lettuce), Collards, Bok Choy, Kale. Turnip, Greens, Mustard Greens, Green Herbs (Parsly, Cilantro)
Other Vegetables	Lettuce (iceberg), Onions, Green Beans, Cucumbers, Celery, Green peppers, Cabbage, Mushrooms, Avocado, Summer squash, zucchini, Cauliflower, Eggplant, Garlic. Bean sprouts, Olives, Asparagus, Peapods (snowpeas), Beets
Red and Orange Vegetables	Tomatoes, Carrots, Tomato juice, Sweet potatoes, Red peppers (hot and sweet), Winter squash, Pumpkin
Starchy Vegetables	Potatoes, Corn, Limas, Plaintains, Cassava
Legumes (Beans and Peas)	Pinto, White, Kidney and Black beans, Lentis, Chickpeas, Limas, Split peas, Edamame

Fig. 4.9 Examples of Vegetables in Each Vegetable Subgroup

is designed to help Americans eat a healthier diet. Intended for policymakers and health professionals, the Dietary Guidelines outline how people can improve their overall eating patterns. According to USDA requirements vegetables are organized into 5 subgroups based on their nutrient content: dark-green vegetables, starchy vegetables, red and orange vegetables, beans and peas, and other vegetables.[13] A vegetable is chosen from each category, in order to design a greenhouse that delivers the proper amount of nutrients for the network to be sustainable if it were to be cut off from outside imports.

In 2006, the Vegetable IAS Committee met with two grocery wholesalers in the province, Dominion and Sobeys. Both organizations communicated a commitment to buy locally grown produce.[14] There was an indication from both companies that fresh produce would be a commodity that they would be interested in purchasing locally rather than through import in order to increase the freshness of the produce when it arrived at the retail locations.[15] The wholesalers also all agreed that the province should be producing more traditional, root vegetables on a larger scale. The report showed that the carrot, rutabaga, cabbage and potato, were all high on the list of commodities. The companies are willing to pay local producers the equivalent amount of money as they do for imported produce, meaning the price available to local producers is the same as the price paid for produce on the mainland plus the freight charges to deliver the produce to this province.[16]

The organizations require consistent quality and a consistent level of supply to operate successfully with local producers. Given the short growing season in Newfoundland, the report suggest that the greenhouse approach to supplying vegetables may be the best solution for consistent supply.[17]

The following pages investigate the crops that would benefit the region based on the likelihood of consumption by residents, health requirements set by the USDA, and the demand given by the Vegetable IAS Committee. They are analyzed to predict proper sizing requirements of greenhouse elements for the design exploration in order to give a reasonable alternate visualization of a greenhouse complex.

13 *Dietary guidelines for Americans*, 2015-2020 (New York, NY: Skyhorse Publishing, 2017).

14 Canada., Department of Natural Resources Forestry and Agrifoods Agency, Wholesale and Other Opportunities In the Vegetable Industry of Newfoundland and Labrador, by Blaine Hussey (2007), 27.

15 Ibid.

16 Ibid.

17 Ibid.

Fig. 4.10 One of the few corner store grocers that communities rely on for grocerys.

Fig. 4.11 Leaf lettuce

Dietary Guidelines: romaine and leaf lettuce is in the subgroup of dark green vegetables, where adult men are recommended a weekly intake of 1.5-2.5 cups, and adult women are recommended 1.5-2 cups.
Greenhouse type: hydroponic
Sunlight: between 10 and 12 hours of light per day
Light exposure: full sun (light shading in warm temperatures)
Plant spacing: 18–30 cm (20–25 heads/m2)
Germination time: 3 - 7 days, 13–21 °C
Harvest: 30-60 days to fully mature
Temperature: 15 - 22°C (flowering over 24 °C)
pH levels: 6.0 - 7.0

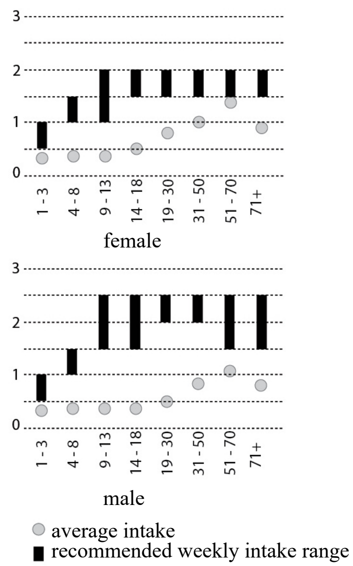


Fig. 4.13 USDA requirement

Consumer trends for vegetable consumption have been changing in this province, particularly in the population centre of St. John's, where the traditional root vegetable market is on the decline, while vegetables such as lettuces are on the rise.[18]

18 Canada, Department of Natural Resources Forestry and Agrifoods Agency, Wholesale and Other Opportunities In the Vegetable Industry of Newfoundland and Labrador, by Blaine Hussey (2007), 4.

Stephenville Network		cups of green vegetables / year (USDA standards)					
age group	population	male average consumption	female averge consumption	male minimum recommended intake	female minimum recommended intake	male upper range recommended intake	female upper range recommended intake
0 - 3	720	4680	4680	9360	9360	18720	18720
4 - 8	770	5005	5005	20020	20020	30030	30030
9 - 13	910	5915	11830	35490	23660	59150	47320
14 - 18	1110	7215	14430	43290	28860	72150	57720
19 - 30	1590	20670	31005	82680	62010	103350	82680
31 - 50	4280	83460	111280	222560	166920	278200	222560
51 - 70	5470	142220	177775	213330	213330	355550	284440
70+	2055	40072.5	40072.5	80145	80145	133575	106860
total population	16905						
total cups required/year		309237.5	396077.5	706875	604305	1050725	850330
		705315		1311180		1901055	

Fig. 4.12 Required green vegetables for Stephenville network

Fig. 4.14 Head cabbage

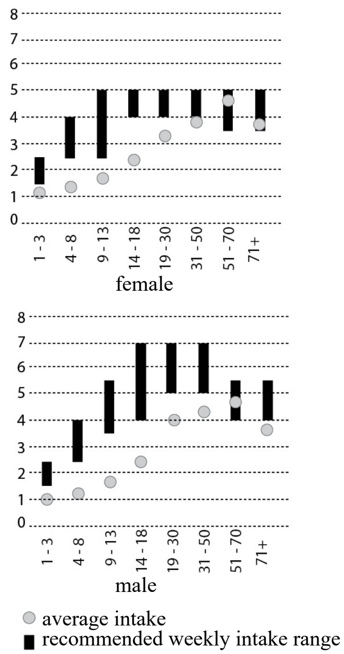


Fig. 4.16 USDA requirement

Cabbage is a crop that is considered traditional in the province. There is a gradual decline in the demand for traditional crops, including cabbage at the retail level, however, there is still a significant potential for cabbage since the province supplies less than a quarter of their cabbage.[19] If produced locally, the demand for the traditional crop could rise, given the freshness of the produce would no longer have the added food miles associated with the crop. If the crop were to be supplied for the entire year and inventories were managed properly, it would provide a consistent cash flow throughout the year for Producers.[20]

19 Canada, Department of Natural Resources Forestry and Agrifoods Agency, Wholesale and Other Opportunities In the Vegetable Industry of Newfoundland and Labrador, by Blaine Hussey (2007), 15.

20 Ibid.

Dietary Guidelines: cabbage is in the subgroup of *other* vegetables, where adult men are recommended a weekly intake of 5-8 cups, and adult women are recommended 5-6 cups.
Greenhouse type: hydroponic
Sunlight: 4+ hours/day
Light Exposure: full sun
Plant spacing: 60–80cm(4–8 heads/m2)
Germination time: 4–7 days, 8–29 °C
Harvest: 45–70 days from transplanting
Temperature: 15–20 °C (growth stops at > 25 °C)
pH levels: 6–7.2

Stephenville Network

age group	population
0 - 3	720
4 - 8	770
9 - 13	910
14 - 18	1110
19 - 30	1590
31 - 50	4280
51 - 70	5470
70+	2055
total population	16905
total cups required/year	

cups of other vegetables / year (USDA standards)

male average consumption	female averge consumption	male minimum recommended intake	female minimum recommended intake	male upper range recommended intake	female upper range recommended intake
18720	18720	28080	28080	46800	46800
24024	26026	50050	50050	80080	80080
66248	66248	82810	59150	130130	118300
72150	69264	115440	115440	202020	144300
165360	132288	206700	165360	289380	206700
489632	445120	556400	445120	778960	556400
682656	682656	568880	497770	782210	711100
203034	203034	213720	187005	293865	267150
1721824	1643356	1822080	1547975	2603445	2130830
3365180		3370055		4734275	

Fig. 4.15 Required other vegetables for Stephenville network

Fig. 4.17 Vine Tomato

Dietary Guidelines: tomatoes are in the subgroup of red and orange vegetables, where adult men are recommended a weekly intake of 5.5-7.5 cups, and adult women are recommended 5.5-6 cups
Greenhouse type: hydroponic
Sunlight: Hydroponically grown tomato plants need 16-18 hours of light
Light exposure: full sun
Plant spacing: 40–60 cm (3–5 plants/m2)
Germination time: 4–6 days
Harvest: 50–70 days till first harvest; fruiting 90–120 days up to 8–10 months
Temperature: 13–16 °C night, 22–26 °C day
Humidity: 85–90 percent RH
pH levels: 5.8 to 6.3

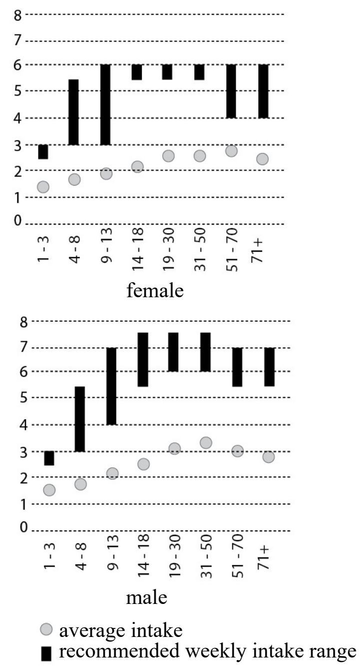


Fig. 4.19 USDA requirement

There is a definite need for types of tomatoes in the province. Both the wholesale market and the restaurant industry has indicated a desire to purchase locally grown produce such as tomatoes and lettuces, as it is difficult to obtain fresh produce that is suitable to serve to their clientele.[21] The Fairmont in St. John's is one such restaurant that has expressed interest.[22]

Standard tomatoes represent a high value crop with significant potential, whereas cherry/grape tomatoes which are also a high value crop has less profitability because of the high labour costs associated with harvesting. [23]

21 Canada, Department of Natural Resources Forestry and Agrifoods Agency, Wholesale and Other Opportunities In the Vegetable Industry of Newfoundland and Labrador, by Blaine Hussey (2007), 27.

22 Ibid.

23 Ibid, 29.

Stephenville Network

age group	population
0 - 3	720
4 - 8	770
9 - 13	910
14 - 18	1110
19 - 30	1590
31 - 50	4280
51 - 70	5470
70+	2055
total population	16905
total cups required/year	

cups of red/orange vegetables / year (USDA standards)

male average consumption	female averge consumption	male minimum recommended intake	female minimum recommended intake	male upper range recommended intake	female upper range recommended intake
28080	24336	46800	46800	56160	56160
37037	35035	60060	60060	110110	110110
53235	47320	94640	70980	165620	141960
75036	63492	158730	158730	216450	173160
128154	107484	248040	227370	310050	248040
361660	289328	667680	612040	834600	667680
426660	412438	782210	568880	995540	853320
152275.5	133575	293865	213720	374010	320580
1262137.5	1113008	2352025	1958580	3062540	2571010
2375145.5		4310605		5633550	

Fig. 4.18 Required red/orange vegetables for Stephenville network

Fig. 4.20 Carrot

Dietary Guidelines: carrots are in the subgroup of red and orange vegetables, where adult men are recommended a weekly intake of 5.5-7.5 cups, and adult women are recommended 5.5-6 cups.
Greenhouse type: soil
Soil: Light, loose, friable and loamy soil
Sunlight: 6+ hours/day
Light exposure: partially shady
Plant spacing: 6.5 – 7.5cm apart for maturing crops
Germination time: 1 to 3 weeks
Harvest: 70 to 80 days to mature
Temperature: 16° to 18° C
pH levels: slightly acidic soil, pH 6.0–6.8
Comments: if a hydroponic system is used choos a system that doesnt immerse the carrots in the water.

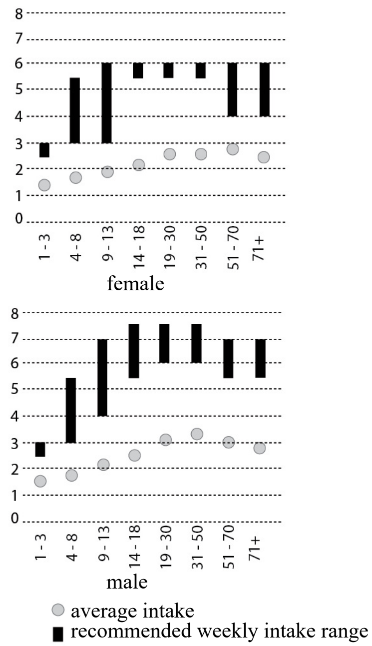


Fig. 4.22 USDA requirement

Stephenville Network

age group	population
0 - 3	720
4 - 8	770
9 - 13	910
14 - 18	1110
19 - 30	1590
31 - 50	4280
51 - 70	5470
70+	2055
total population	16905
total cups required/year	

cups of red/orange vegetables / year (USDA standards)

male average consumption	female averge consumption	male minimum recommended intake	female minimum recommended intake	male upper range recommended intake	female upper range recommended intake
28080	24336	46800	46800	56160	56160
37037	35035	60060	60060	110110	110110
53235	47320	94640	70980	165620	141960
75036	63492	158730	158730	216450	173160
128154	107484	248040	227370	310050	248040
361660	289328	667680	612040	834600	667680
426660	412438	782210	568880	995540	853320
152275.5	133575	293865	213720	374010	320580
1262137.5	1113008	2352025	1958580	3062540	2571010
2375145.5		4310605		5633550	

Fig. 4.21 Required red/orange vegetables for Stephenville network

Locally produced carrots have great opportunity for Producers in this province. Local carrot production comprises less than 15% of the carrots available at the retail stores, and the long storage shelf-life of carrots means that the Vegetable Industry could be supplying carrots to the Wholesalers for 10 months of the year. [24] Like cabbage, this traditional crop represents considerable cash flow opportunity.[25]

24 Canada, Department of Natural Resources Forestry and Agrifoods Agency, Wholesale and Other Opportunities In the Vegetable Industry of Newfoundland and Labrador, by Blaine Hussey (2007), 15.

25 Ibid.

Fig. 4.23 Potato

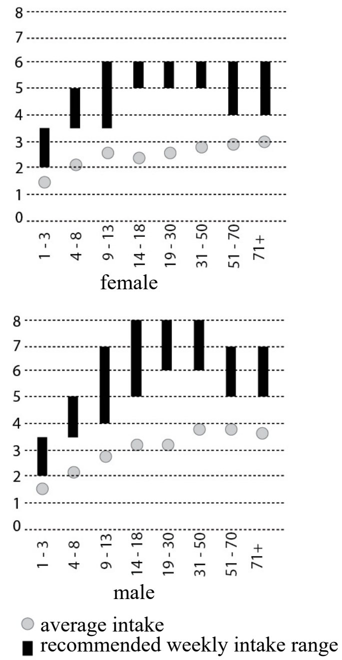


Fig. 4.25 USDA requirement

Fresh potatoes represent the biggest opportunity for Producers in the province, as local potatoes account for only 7.1% of the potatoes marketed at retail stores.[26]

Fresh potato consumption in 2005 was approximately 35.6 million pounds, where NL production was only 10 million pounds.[27]

Currently, White potatoes comprise the majority of potatoes consumed, but the red and yellow varieties continues to increase in popularity.[28] The crop can be stored for 12 months, so the volume of potatoes consumed could easily be produced and supplied locally.[29]

26 Canada, Department of Natural Resources Forestry and Agrifoods Agency, Wholesale and Other Opportunities In the Vegetable Industry of Newfoundland and Labrador, by Blaine Hussey (2007), 20.

27 Ibid.

28 Ibid.

29 Ibid.

Greenhouse type: aeroponics (root tuber production) and soil
Soil type: well-drained, loamy soil rich in organic matter
Seed storage: cool store at 4-5 degrees for three weeks before planting and remove for warm up period of 1 week
Sunlight: 6+ hours/day
Light exposure: full sun
Plant spacing: 20 to 30cm betweed seed, row width is 75 to 90cm.
Germination time: 2 - 5 weeks
Harvest: 7-8 weeks (50 days)
Temperature: soil temperature 12° - 15°C, air temperature 7° to 26°C
pH levels: 5.0 - 5.5

Stephenville Network

age group	population
0 - 3	720
4 - 8	770
9 - 13	910
14 - 18	1110
19 - 30	1590
31 - 50	4280
51 - 70	5470
70+	2055
total population	16905
total cups required/year	

cups of starchy vegetables / year (USDA standards)

male average consumption	female averge consumption	male minimum recommended intake	female minimum recommended intake	male upper range recommended intake	female upper range recommended intake
28080	28080	37440	37440	65520	65520
42042	42042	70070	70070	100100	100100
66248	66248	94640	82810	165620	141960
89466	72150	144300	144300	230880	173160
136422	107484	248040	206700	330720	248040
422864	333840	667680	556400	890240	667680
568880	426660	711100	568880	995540	853320
203034	165633	267150	213720	374010	320580
1557036	1242137	2240420	1880320	3152630	2570360
2799173		4120740		5722990	

Fig. 4.24 Required starch vegetables for Stephenville network

Fig. 4.27 Legumes

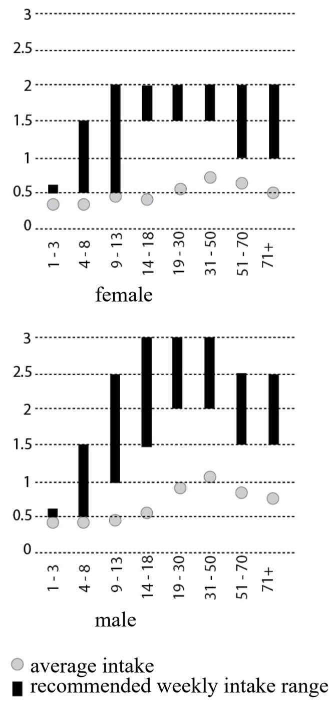


Fig. 4.28 USDA requirement

Legumes are protein-rich and they also increase the amount of nitrogen available to plants through biological nitrogen fixation, reducing the need for fertilisers.[30]

New research carried out by Legume Futures, a team of international scientists confirmed the environmental benefits of introducing legumes and found that in such cropping systems, overall nitrous oxide emissions reduced by approximately 20-30 per cent and fertiliser use was down by 25 per cent to almost 40 per cent in some cases.[31]

30 "More reasons to grow legumes," Daily Nation, May 27, 2016, accessed September 25, 2017, http://www.nation.co.ke/business/seedsofgold/More-benefits-of-growing-legumes/2301238-3221422-d2juht/index.html.

31 Ibid.

Dietary Guidelines: the subgroup of legume vegetables recommend a weekly intake of 5.5-7.5 cups for adult men, and recommend 5.5-6 cups for adult women
Greenhouse type: hydroponic
Sunlight: 6+ hours
Light exposure: full sun
Plant spacing: 2.5cm apart in 7.5cm wide band (bush varieties 20–40 plants/m2, climbing varieties 10–12 plants/m2)
Germination time: 8–10 days, 21–26 °C
Harvest: 50–110 days to reach maturity depending on variety
Temperature: 16–18 °C night, 22–26 °C day
Humidity: 70–80%
pH levels: 5.5–7.0
Comments: It is important to choose the right varieties according to the location and season.

Stephenville Network

age group	population
0 - 3	720
4 - 8	770
9 - 13	910
14 - 18	1110
19 - 30	1590
31 - 50	4280
51 - 70	5470
70+	2055
total population	16905

cups of legumes / year (USDA standards)

	male average consumption	female averge consumption	male minimum recommended intake	female minimum recommended intake	male upper range recommended intake	female upper range recommended intake
0 - 3	7488	7488	9360	7488	11232	11232
4 - 8	8008	8008	10010	10010	30030	30030
9 - 13	11830	11830	23660	11830	59150	47320
14 - 18	17316	11544	43290	43290	86580	57720
19 - 30	37206	24804	82680	62010	124020	82680
31 - 50	122408	83460	222560	166920	333840	222560
51 - 70	113776	85332	213330	142220	355550	284440
70+	37401	26715	80145	53430	133575	106860
total cups required/year	355433	259181	685035	497198	1133977	842842
	614614		1182233		1976819	

Fig. 4.26 Required legume vegetables for Stephenville network

The basic need of healthy and available food is nonexistent to the Newfoundland community. In meeting this objective it is important to have an agricultural industry which is agronomically feasible, economically viable, environmentally responsible and socially acceptable.[1]

The 1996 publication of *Nutrition for Health: An Agenda for Action* outlines four key directions determined by national food and nutrition experts to help realize change. These include:

- Reinforcing healthy eating and physical activity practices.
- Supporting vulnerable populations.
- Enhancing the availability of safe, high quality food which supports healthy eating.
- Supporting food and nutrition research.[2]

In this design exploration, design can help visualize what such changes might look and feel like. Envisioning the emergence of a sufficient community and a community-defined vision of an alternate vision allows interest groups such as government and residents, a glimpse at the potential for a broadened quality of life. The following desing proposal is intended to illustrate why design matters in long-term decision making and the possibilities that can arise with local control over energy sources to aid import-replacement.

In *The Natural Step for Communities*, planner and economist, Torbjorn Lahti, offers his experience in studying eco-municipalities and realizing across-the-board change to sustainable practices that effect municipal government and the larger community:

- Attract community citizens who are interested in change as a network of *fire souls* can facilitate the community change process.
- Raise awareness through education, as education fosters a shared understanding
- Identify a guiding vision, as attractive shared visions are driving forces in change processes.
- Offer a community-defined vision of the future. As well, a leadership process that facilitates the common vision.
- People become interested in sustainable development only when someone sells it to them in the best possible way.
- Need to introduce in a manner that creates the greatest possible engagement between the municipality and the community.[3]

The following pages aim to educate communities and facilitate an awareness of the benefit of using local energy for import replacement.

1 Randy Ricketts, *An overview of the Newfoundland and Labrador agrifoods industry: 2004* (Corner Brook, NL: Department of Natural Resources, 2004), 1.

2 *Eating healthier in Newfoundland and Labrador: provincial food and nutrition framework and action plan (phase 1: 2005-2008)* (St. Johns, N.L.: Government of Newfoundland and Labrador, 2006), 4.

3 Sarah James and Torbjörn Lahti, *The natural step for communities: how cities and towns can change to sustainable practices* (Gabriola Island, BC: New Society Publishers, 2008), various.

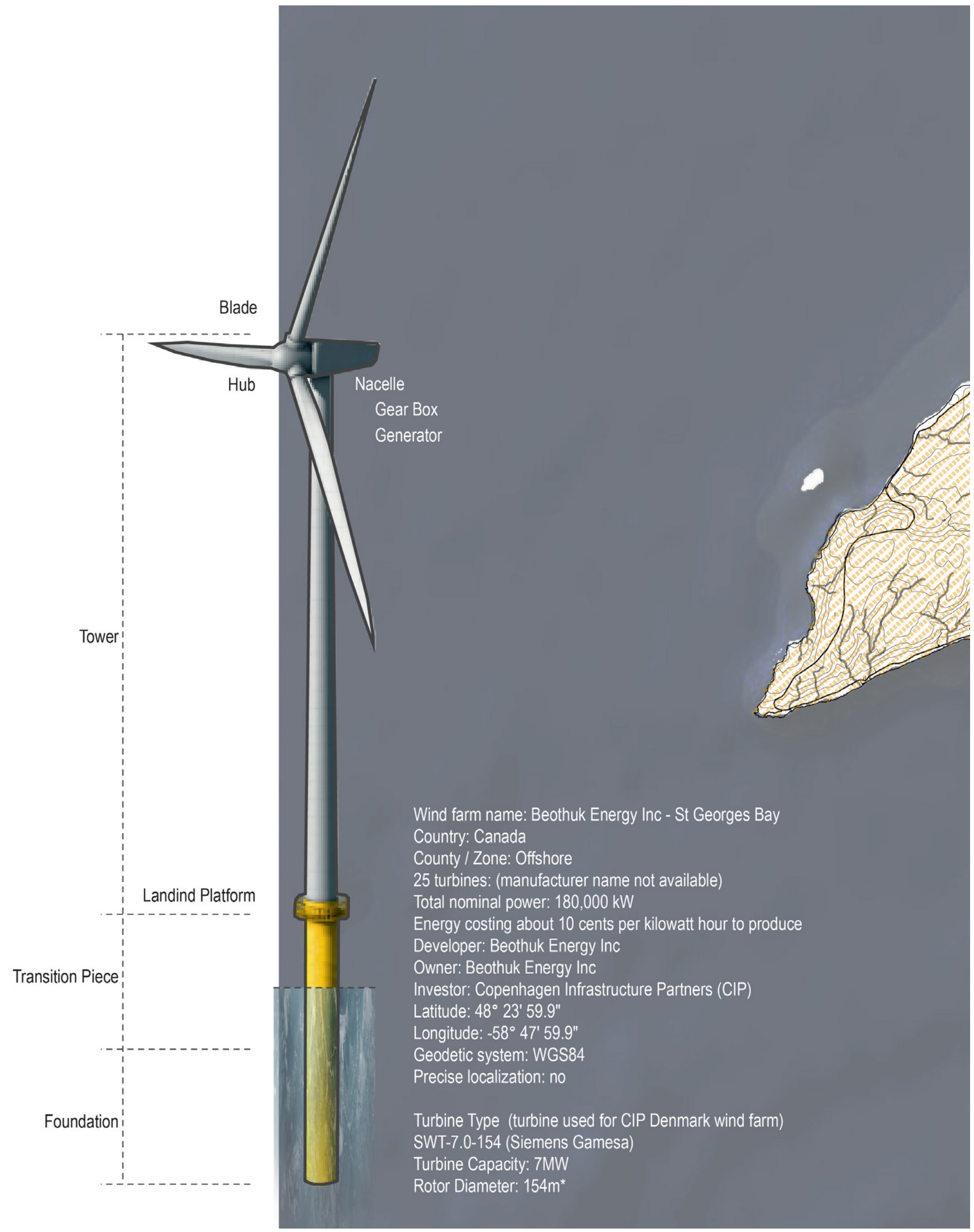
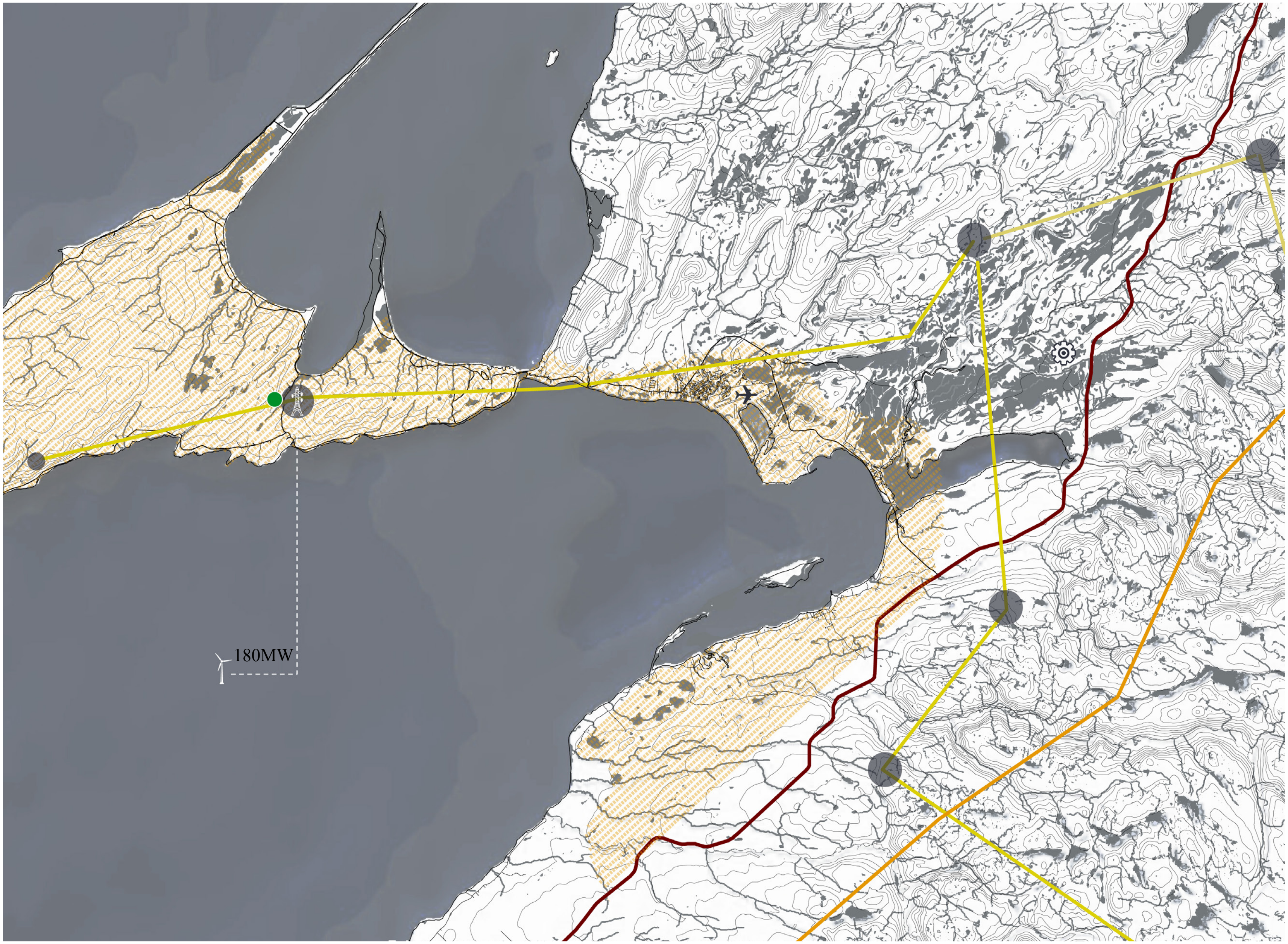


Fig. 4.29 Potential wind energy plan

The Beothuk Wind Farm has a capacity of 180MW. Using this wind energy to heat and power grow lights in the greenhouse complex will replace the need for vegetable imports for the surrounding area.


180MW

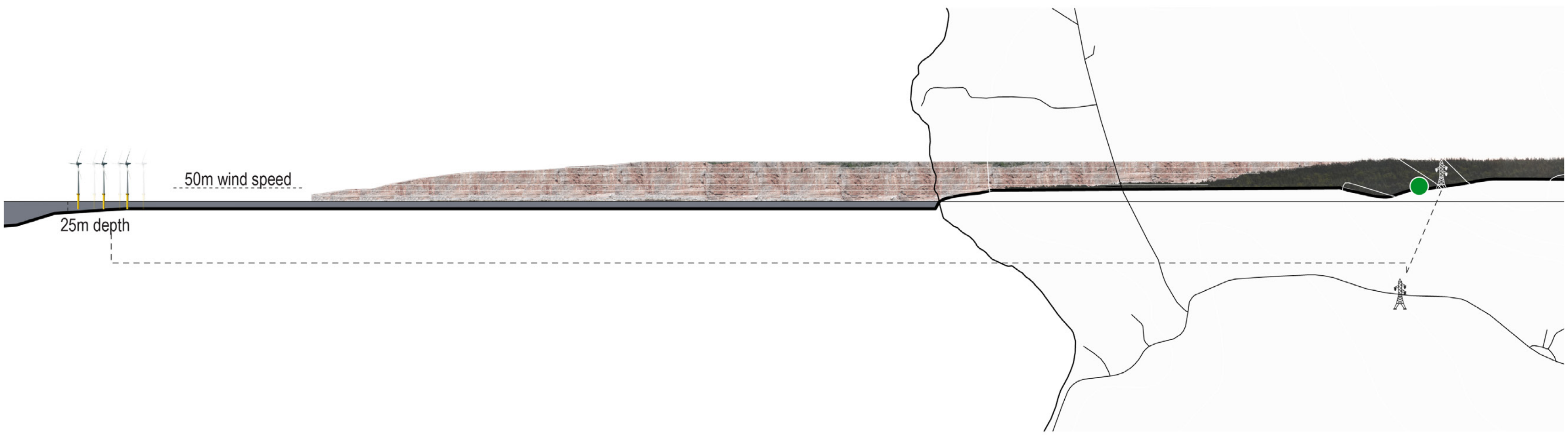
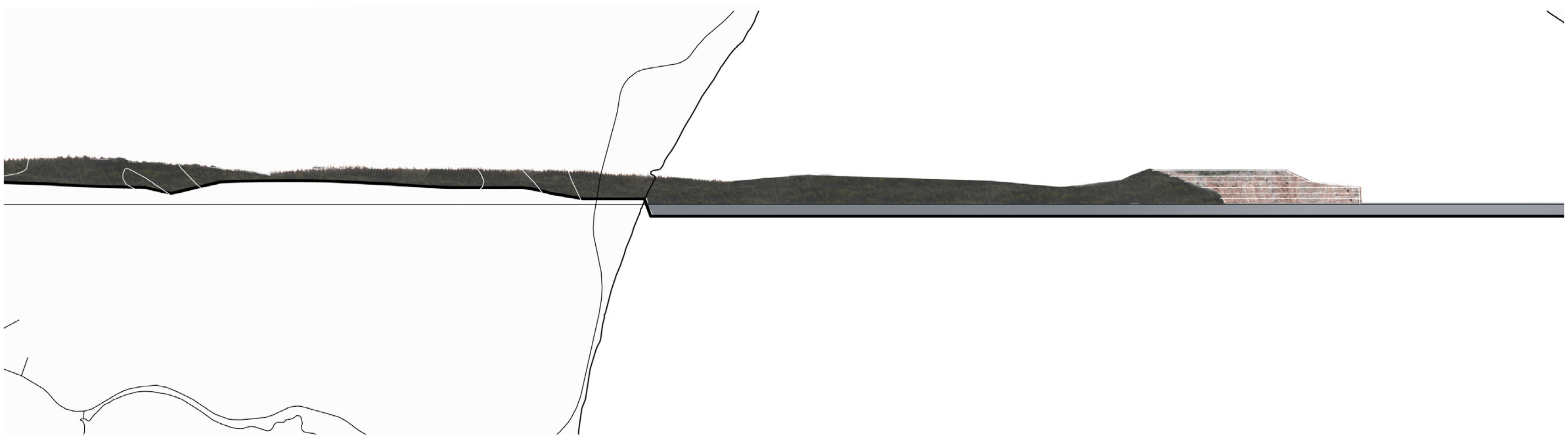


Fig. 4.30 Potential wind energy section



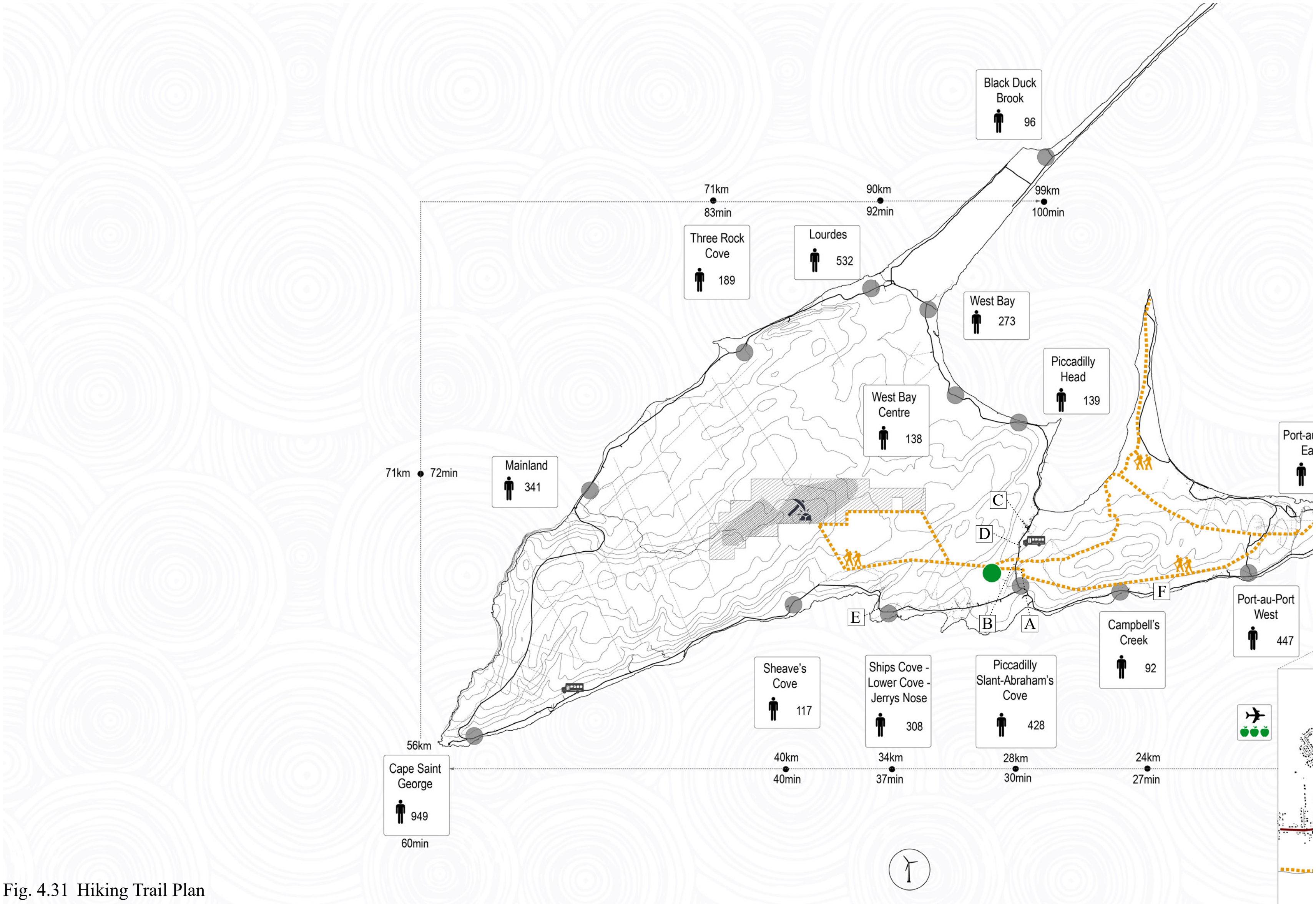


Fig. 4.31 Hiking Trail Plan
Hiking network along industrial areas including the Stephenville airport, Water resource plant, Quarry.

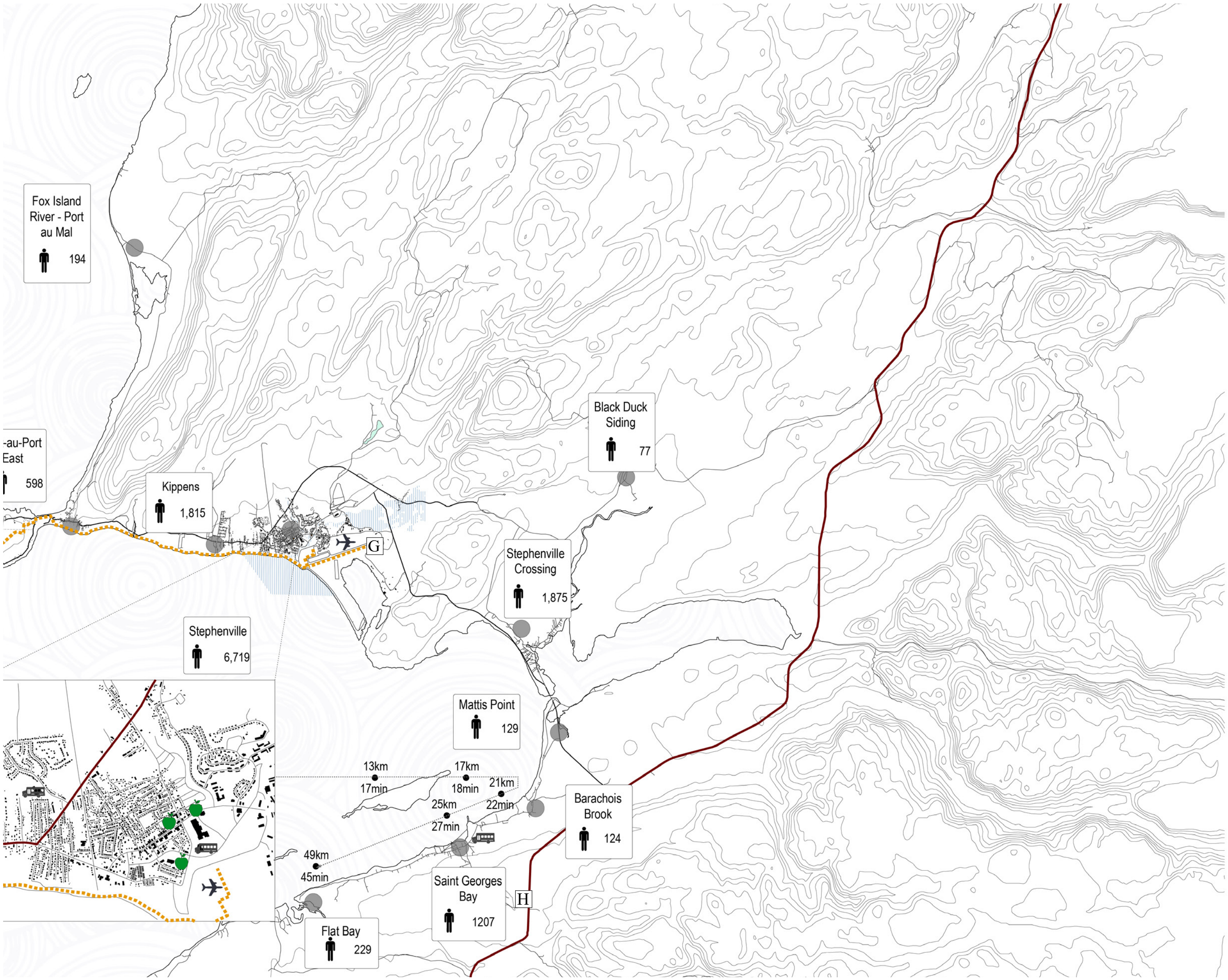

Fox Island River - Port au Mal
194
-au-Port East
598
Kippens
1,815
G
Black Duck Siding
77
Stephenville Crossing
1,875
Stephenville
6,719
Mattis Point
129
13km
17min
17km
18min
21km
22min
25km
27min
49km
45min
Barachois Brook
124
Saint Georges Bay
1207
H
Flat Bay
229

Fig. 4.35 View A: Energy transitor across the road facing East of the project site.

Fig. 4.34 View B: Hydro corridor facing West, selected project site for the greenhouse complex.

Fig. 4.32 View C: Olivers restaurant 5km from the project site

Fig. 4.33 View D: Piccadilly High School located 10km from the project site educates the entire peninsula from grade 9 to 12.

Fig. 4.36 View E: Atlantic Minerals Limited Quarry

Fig. 4.39 View F: Entrance to Port-au-Port Peninsula

Fig. 4.37 View G: Elaine’s Variety Corner Store

Fig. 4.38 View H: Stephenville Airport base

Fig. 4.40 Site Plan (1:6000)

Program and Design Strategies

The complex consists of three major bar structures, an education and research bar, community and distribution bar, and production infrastructure.

The structure imposes on the vast landscape in a similar way native ships and industrial airplanes position themselves among the rock. Even with its imposing power, the structures gently touch the rock surface, careful not to disrupt the landscape. The structure uses the native technique to position itself atop of the rock, instead of leveling the varied topography, saving on construction costs.

The project site is unique among other rural areas in Newfoundland. It's history does not respond solely to fishing grounds and instead pushed towards an industrial port when the Stephenville Army base and airport was established in 1941.[1] This gives an opportunity for the design of the complex to take a large, warehouse approach, as this type of construction has been widely accepted in the area for generations.

The structures are constructed of wood and steel, two materials that are affordable and easy to transport to the rural area. Newfoundland's available forested landscape and local wood mills, reduces cost for the material, and the simple, modular form produces a structure that is easily adjusted and constructed with little labor speciality, providing construction jobs to the local community.

The structure is placed along an energy corredor, where a long line of energy transisters extend beyond the greenhouse complex reminding the visitors and workers that the unique Newfoundland environment is responsible for the growth and production of this new sustainable living.

A path cuts through the education, distribution and production bars, creating a pathway that connects the programs, facing toward the St. Georges Bay wind energy farm. A Mezzanine level on the pathway allows visitors to gaze toward the ocean and the beauty of the large turbine structures.

Visitors are engaged in both food and fitness activities through the design of the surrounding complex, where walking and hiking trails surround the complex, allowing a view into the workings of food sustainability and allowing tourists to be exposed to the natural hiking trails of Newfoundland.

Education Bar
The structure includes an innovation center with bottling facilities, branding tutoring, and tool rental, classrooms and a community kitchen. Classrooms extend into a community garden to establish a foundation for new neighborhood gardeners and

1 Heritage Partner Project, "Stephenville the American Influence," Stephenville Introduction, , accessed December 23, 2017, http://www.heritage.nf.ca/articles/society/stephenville-introduction.php.

youth, and bleeds into the landscape allowing space for cooler crop production and flaura during the summer months. Classrooms are used for engagement in summer job training programs, provide training, mentoring, and coaching for individuals to obtain increased agricultural and growing capacity and includes a children facility with each classroom with it's own garden plot that is planned and planted by the children, the harvested produce is given to families with children at the facility.

The complex would work closely with Piccadilly Central High School to develop a cirriculum where sustainable practices are exemplified and offer schools, government agencies, farmers, activists and community members opportunities to learn from and participate in the development and operation of community food systems.

Community Bar
The community food centre offers a space where people can market and distribute local food and crafts, and where the greenhouse can sell its own produce. A distribution space allows for packaging and shipment to other grocer locations.

Tours of the Community Food Center are given in order to educate visitors on sustainable practices. The complex holds numerous national workshops on site at facilities.

A kitchen and cafe, and conference center offers space for hands on activities, and large scale

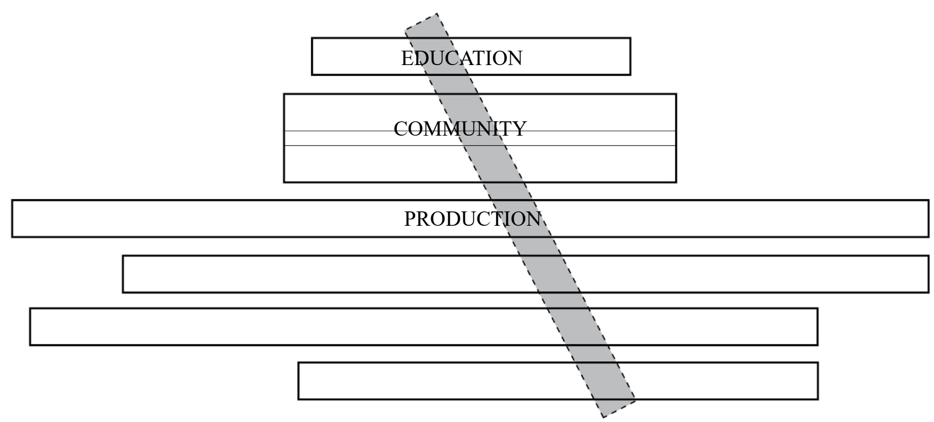


Fig. 4.41 Parti Diagram

demonstration projects.

Production Bar

The surrounding environment and neighbouring activities are considered when making decisions regarding the location and layout of the place of production.

By placing the structure on shores, variation in topography is ignored, reducing the amount of standing water within the production areas.

In order to control contamination and pests, a major issue concerning Newfoundland soils, the South side of the bar is used for greenhouses using soil, and the North side of the production bar grows hydroponic crops, with production rooms placed between greenhouses where the crops are most similar. Because of the soil issues, the flow of plant material is separated, with both types of greenhouse designed to separate the location of the propagation, production and processing and packaging areas, as well as separate shipping and receiving areas in order to locate areas for composting or disposal of organic debris away from the place of production.

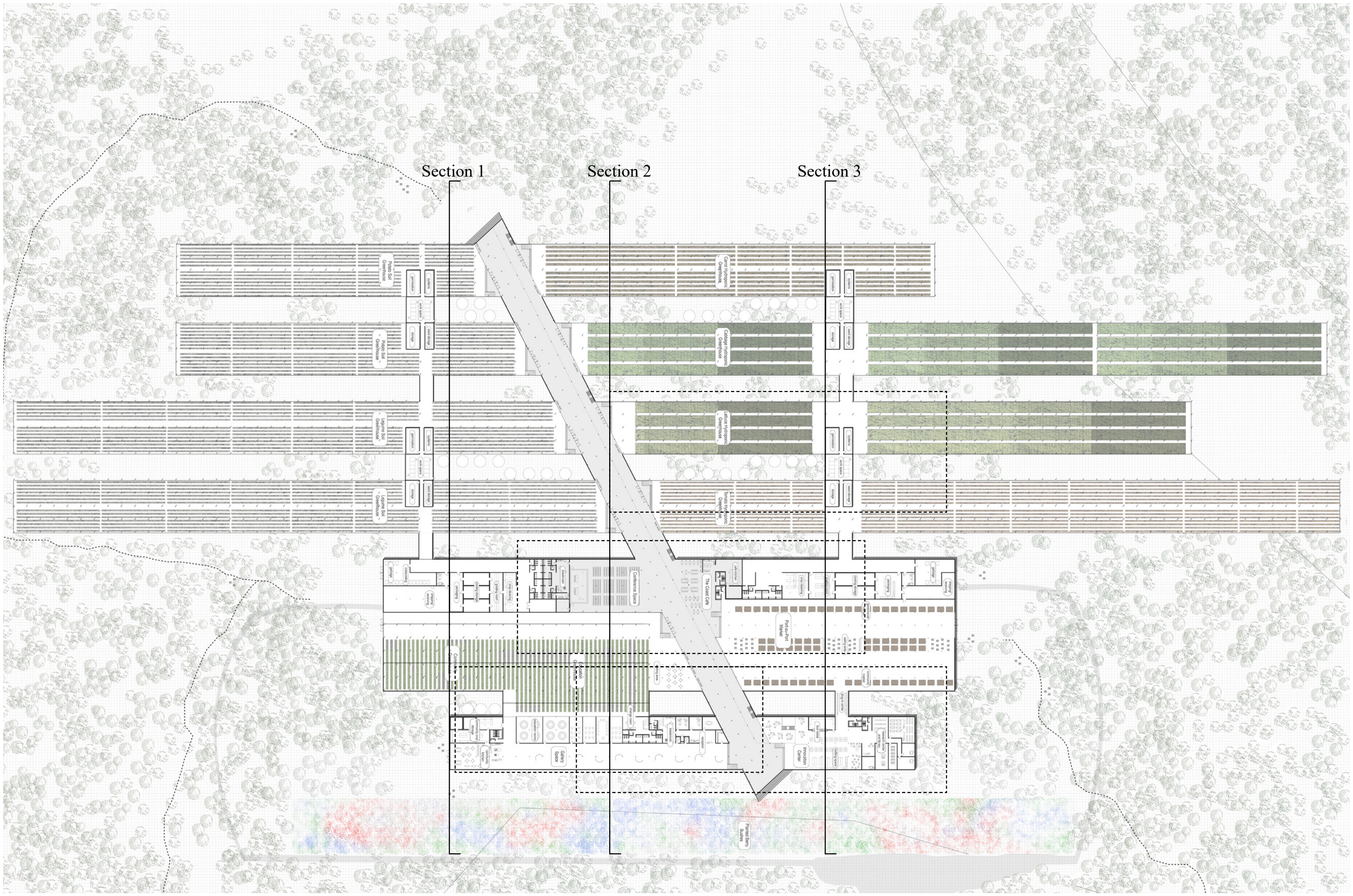


Fig. 4.42 Floor Plan
Plan of greenhouse complex

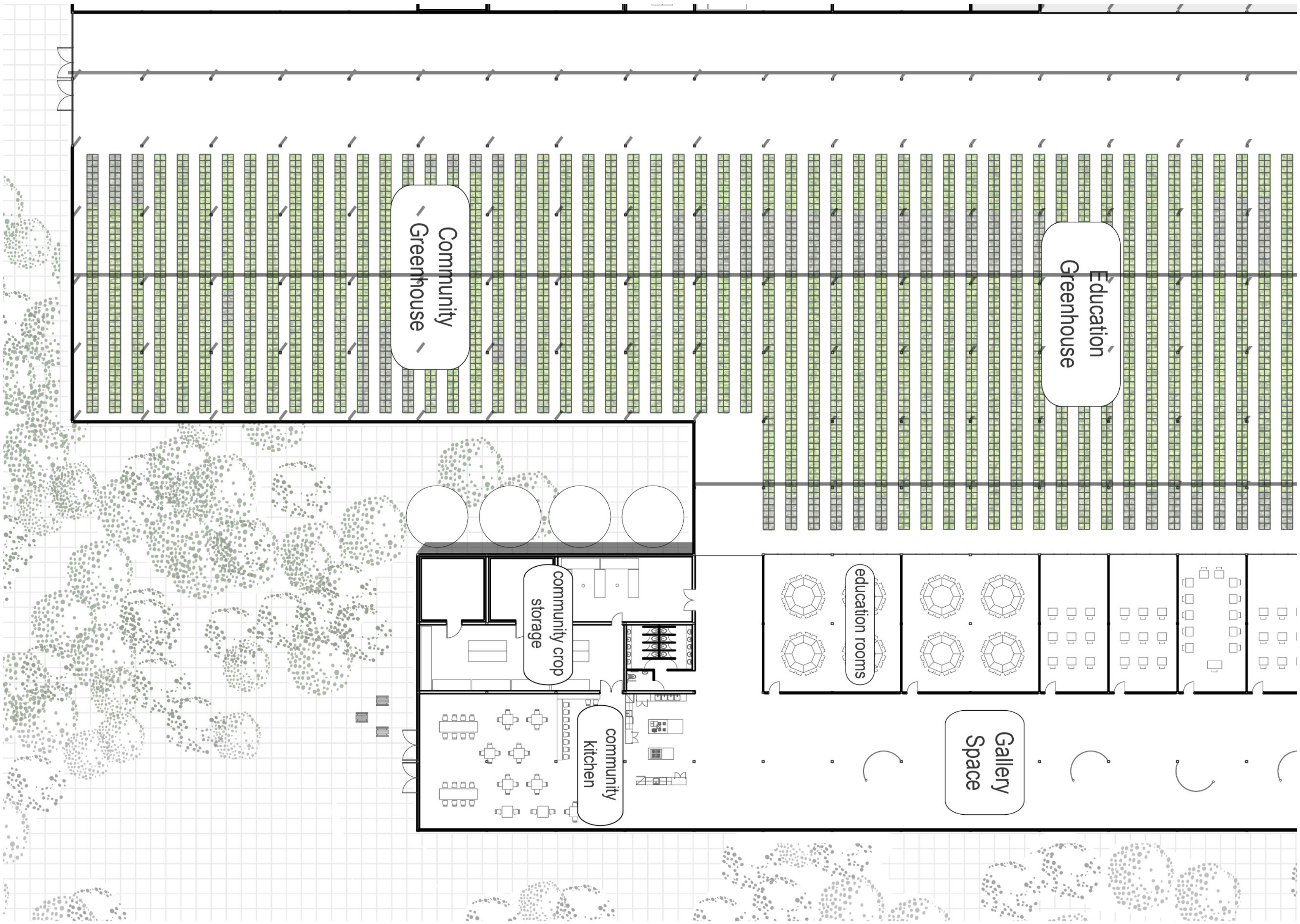
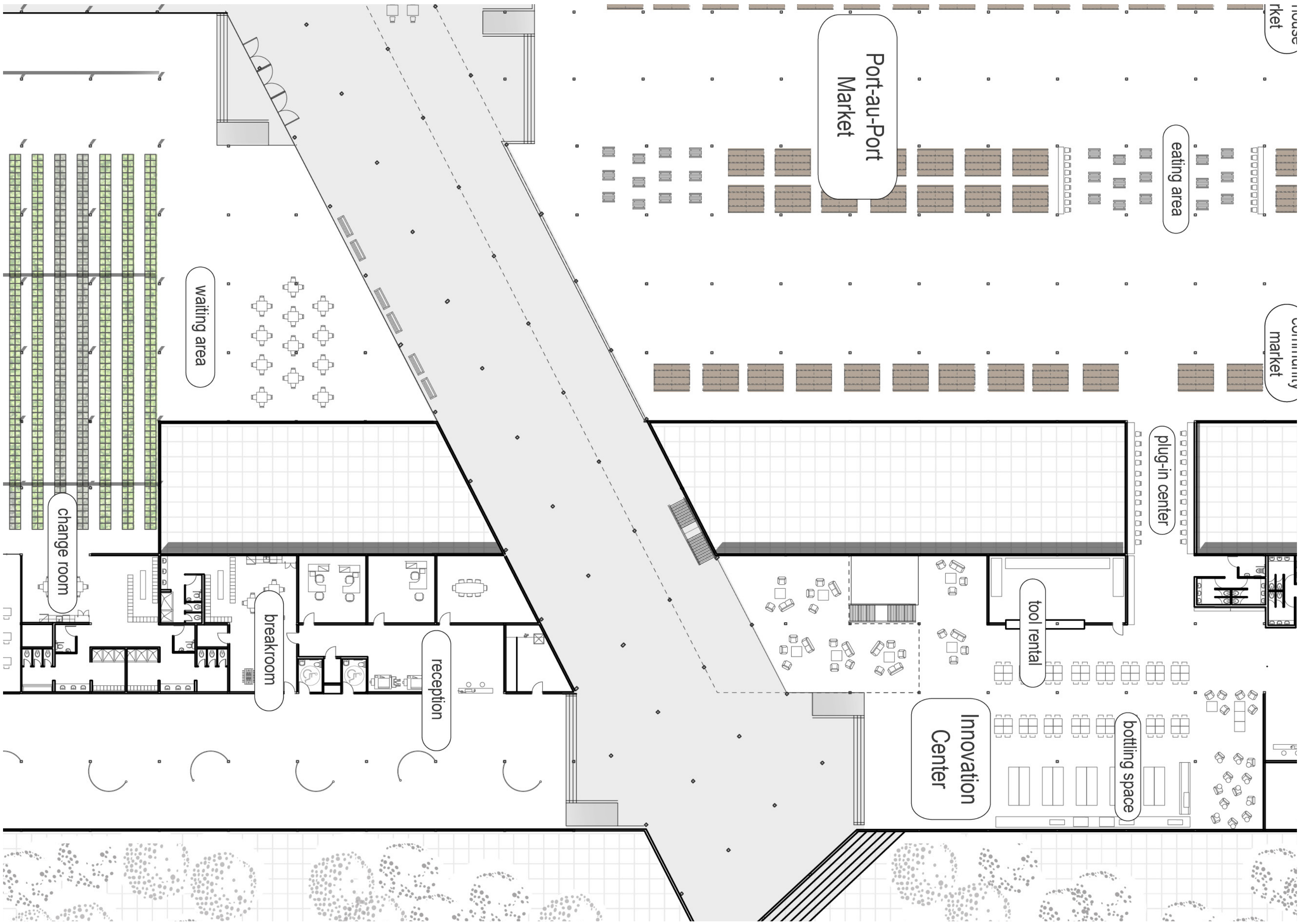


Fig. 4.43 Community Garden and Education Rooms Plan, 1:500


Port-au-Port Market
eating area
waiting area
plug-in center
change room
breakroom
reception
tool rental
Innovation Center
bottling space

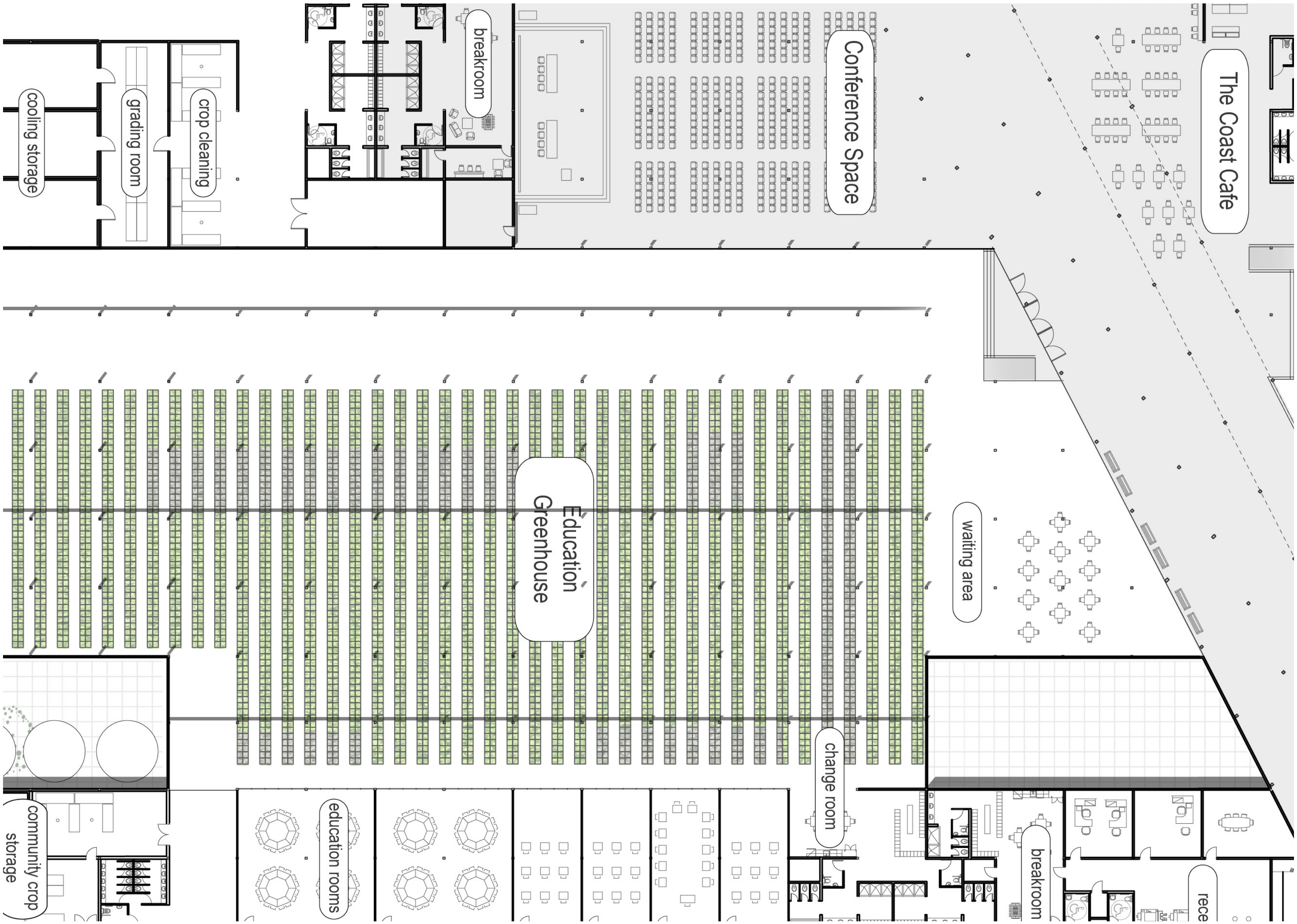
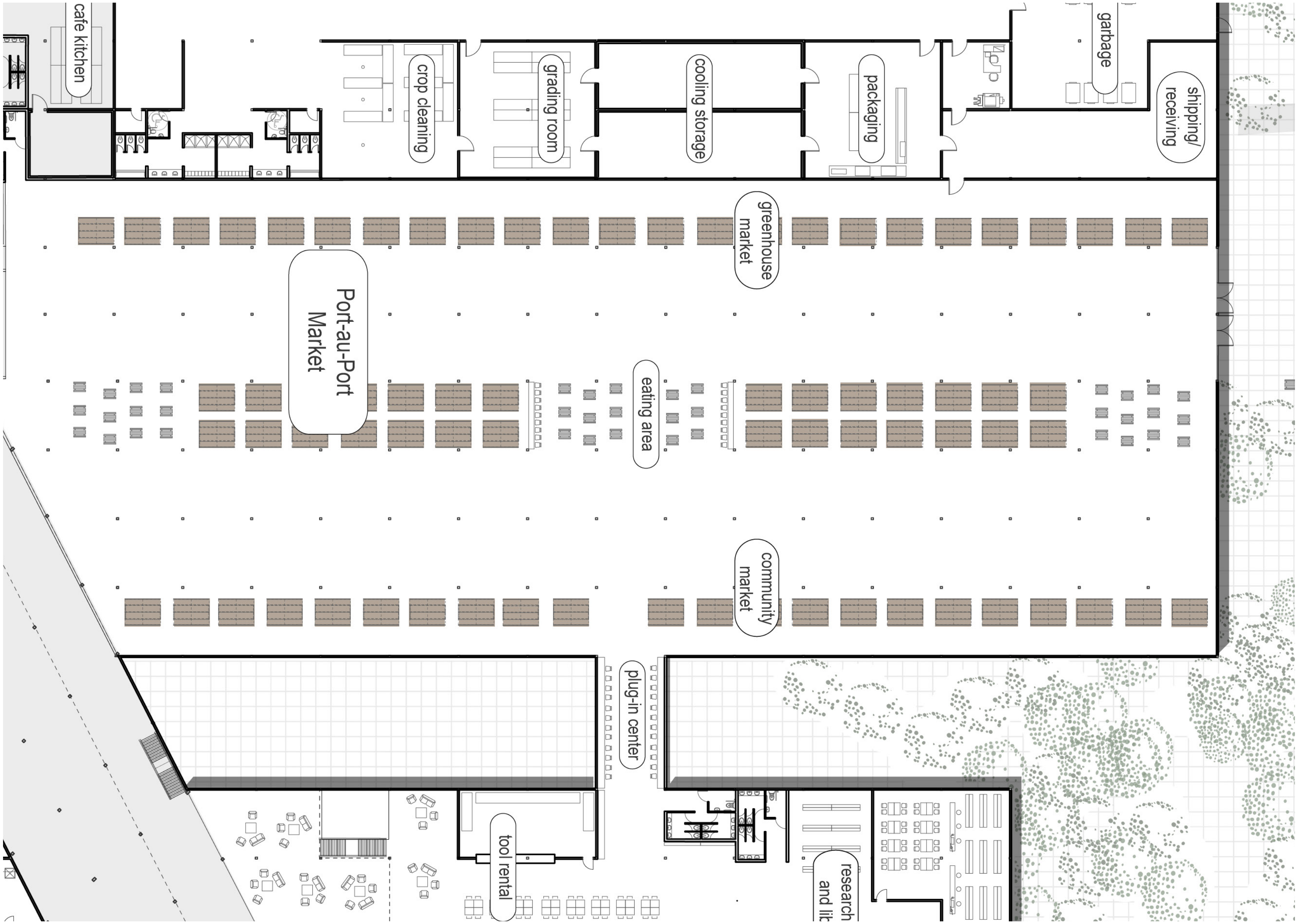


Fig. 4.44 Bottling Station, Innovation Center and Market Plan , 1:500


cafe kitchen
crop cleaning
grading room
cooling storage
packaging
garbage
shipping/
receiving
greenhouse
market
Port-au-Port
Market
eating area
community
market
plug-in center
tool rental
research

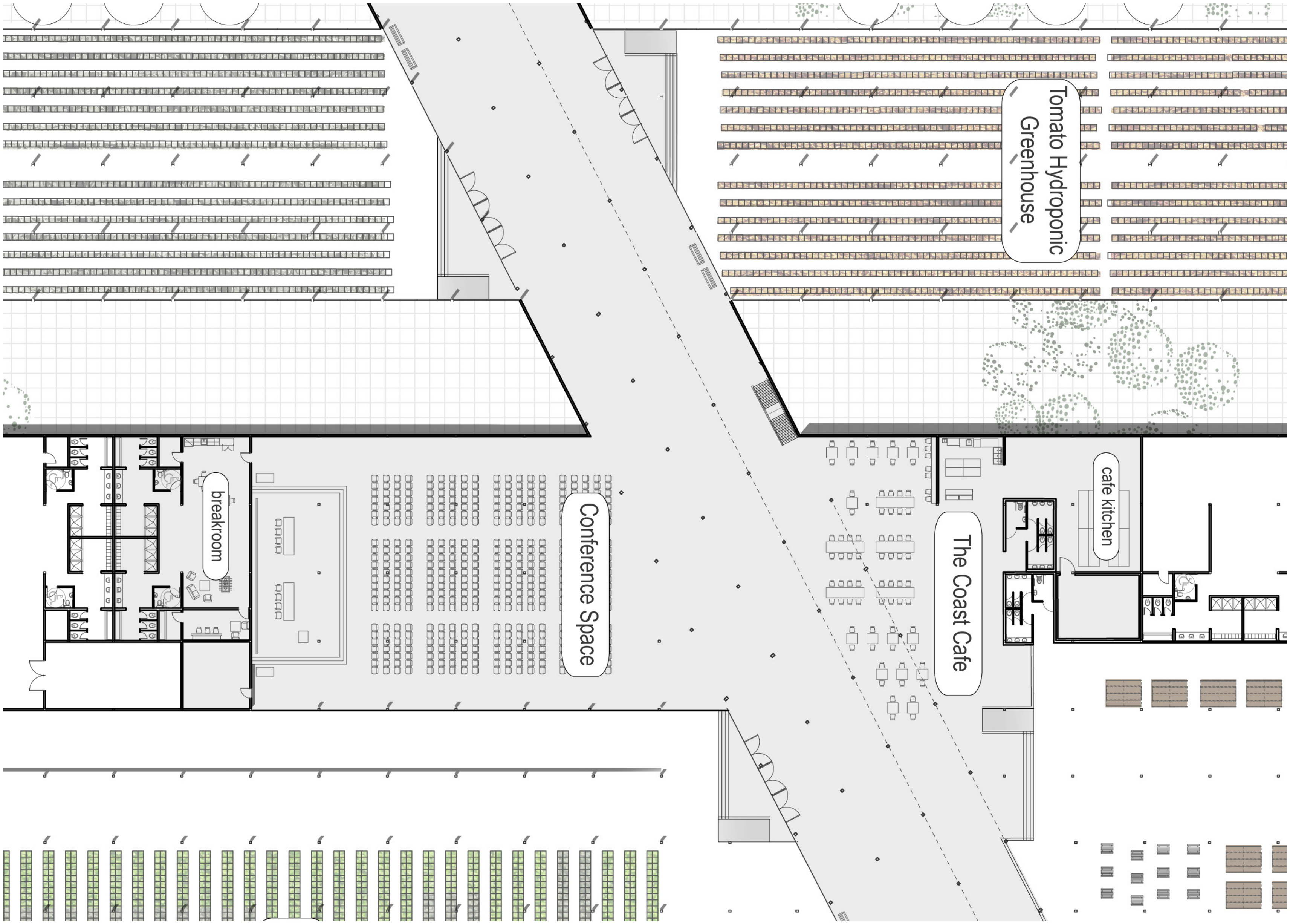
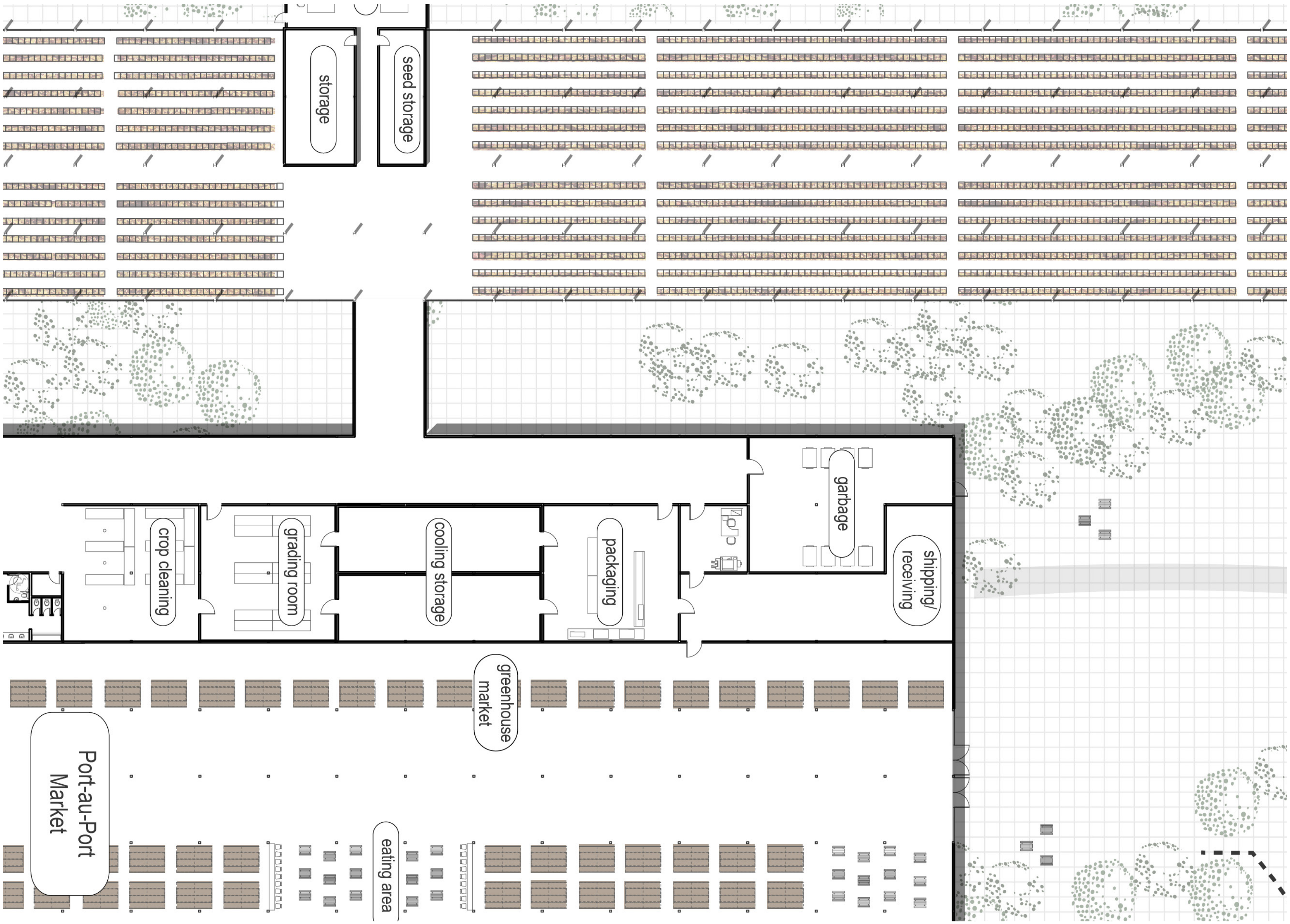


Fig. 4.45 Conference Room and Cafe Plan, 1:500


storage
seed storage
garbage
crop cleaning
grading room
cooling storage
packaging
shipping/
receiving
greenhouse
market
Port-au-Port
Market
eating area

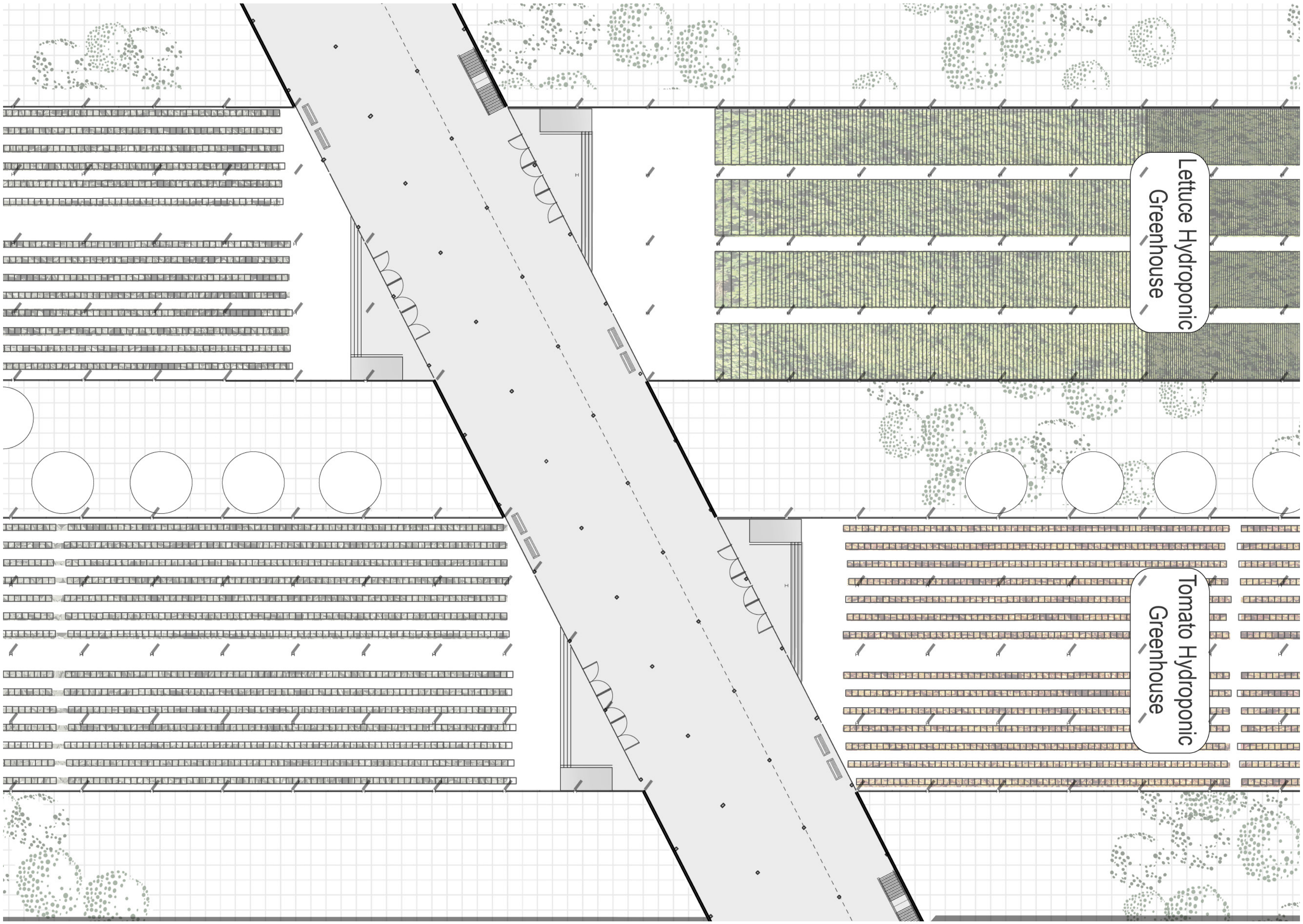
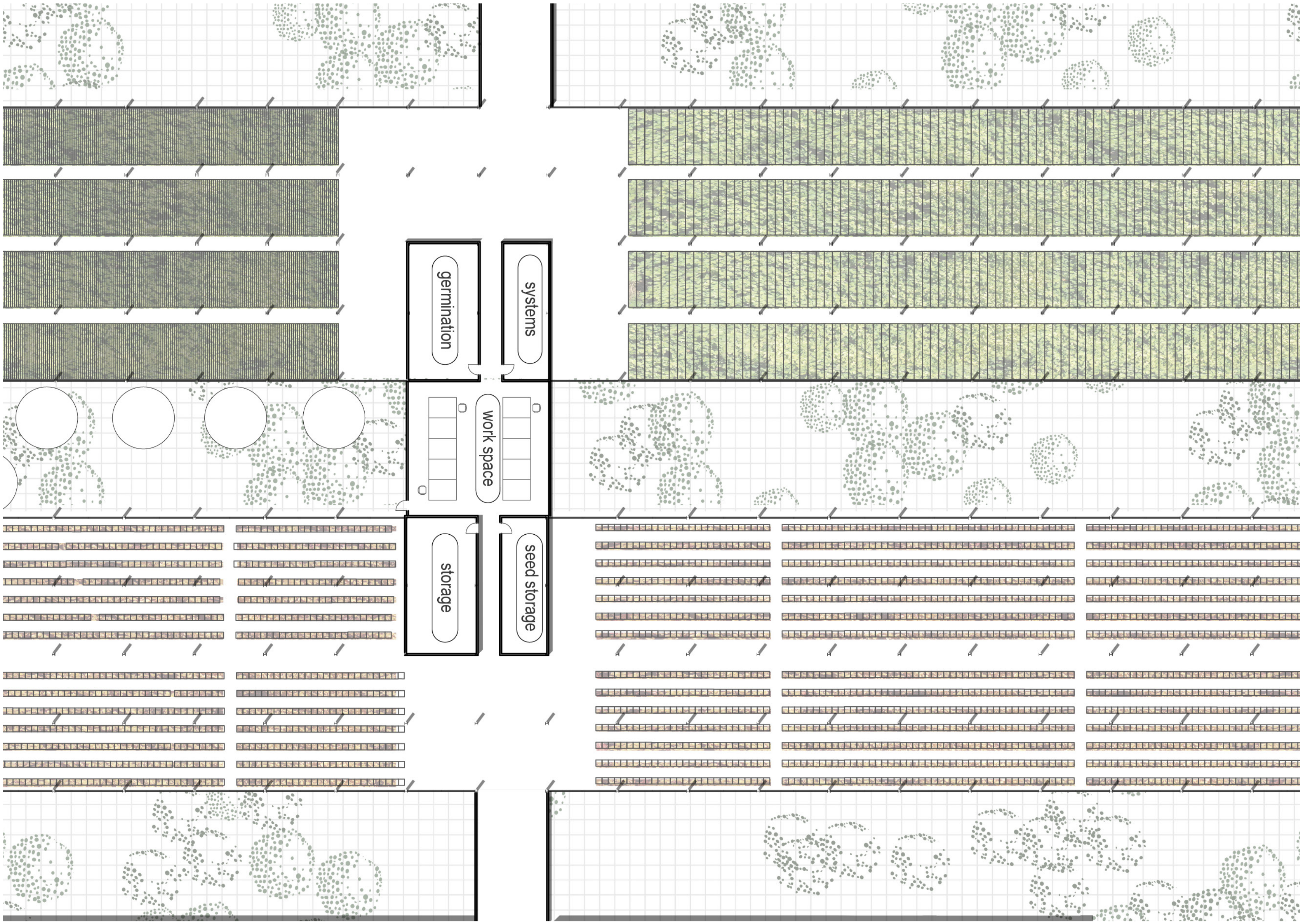


Fig. 4.46 Greenhouse and Workroom Plan, 1:500


germination
systems
work space
storage
seed storage

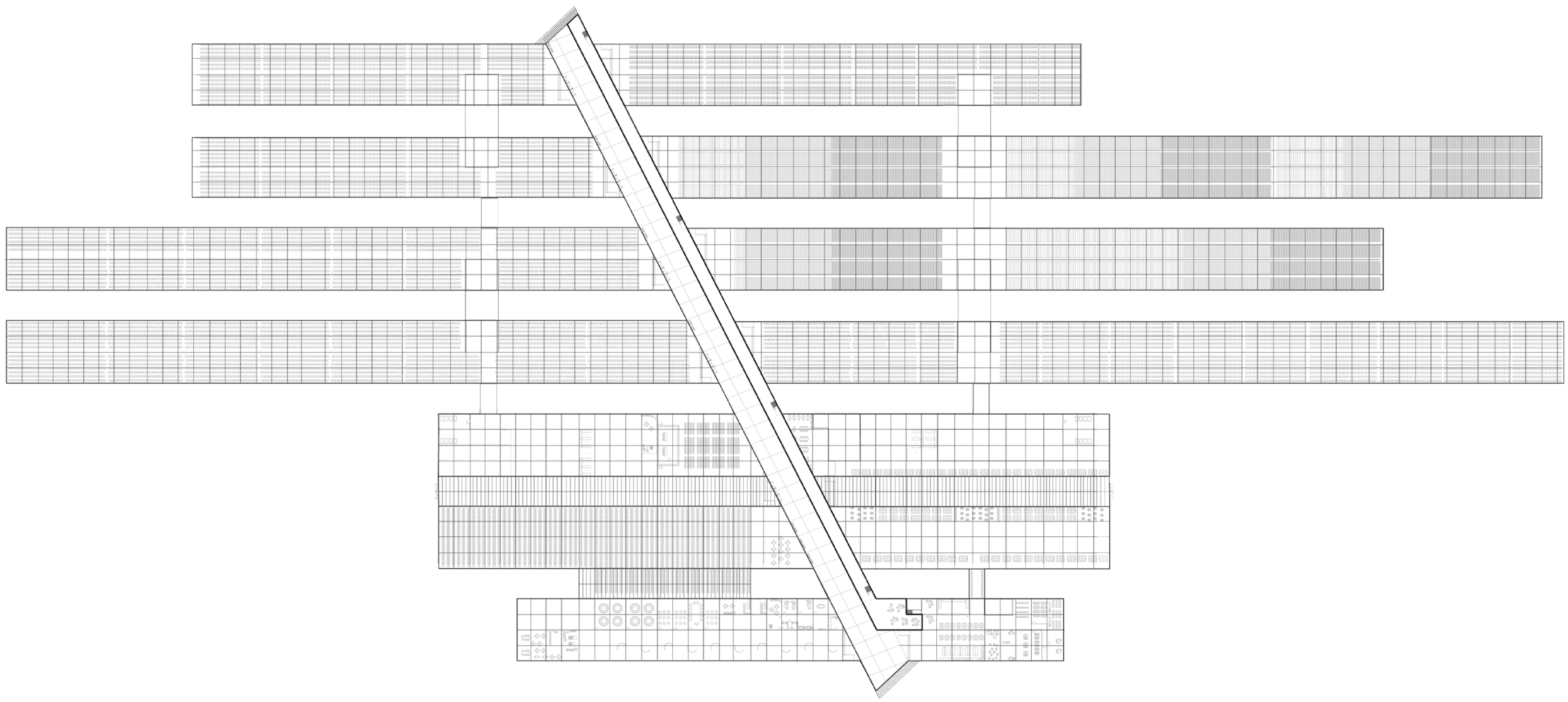


Fig. 4.47 Skywalk Plan
Plan of mezzanine facing south-west towards the Stephenville wind farm.

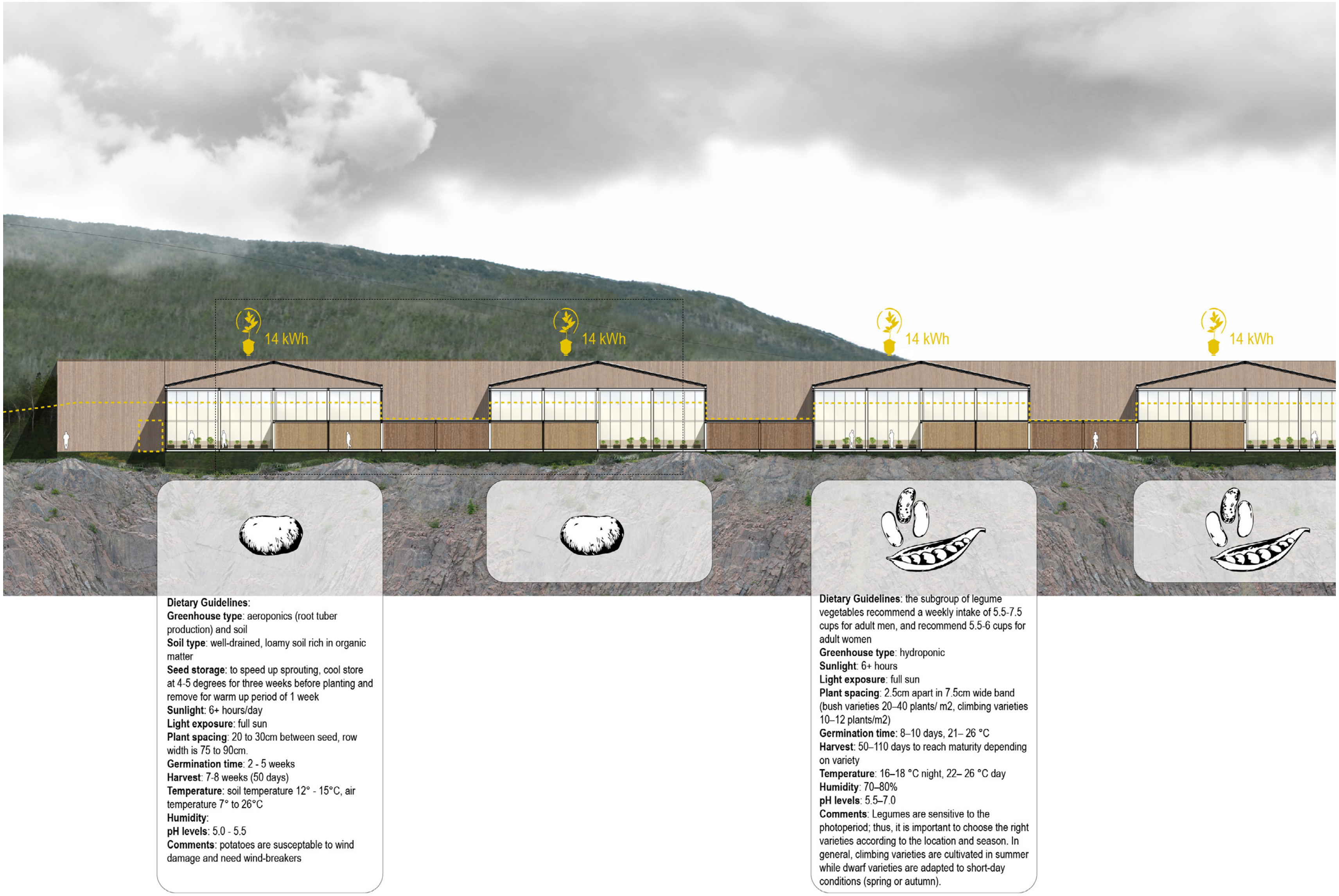


Fig. 4.48 Section 1: section through soil greenhouses, vermiculture soil creation, distribution and community greenhouse


14 kWh

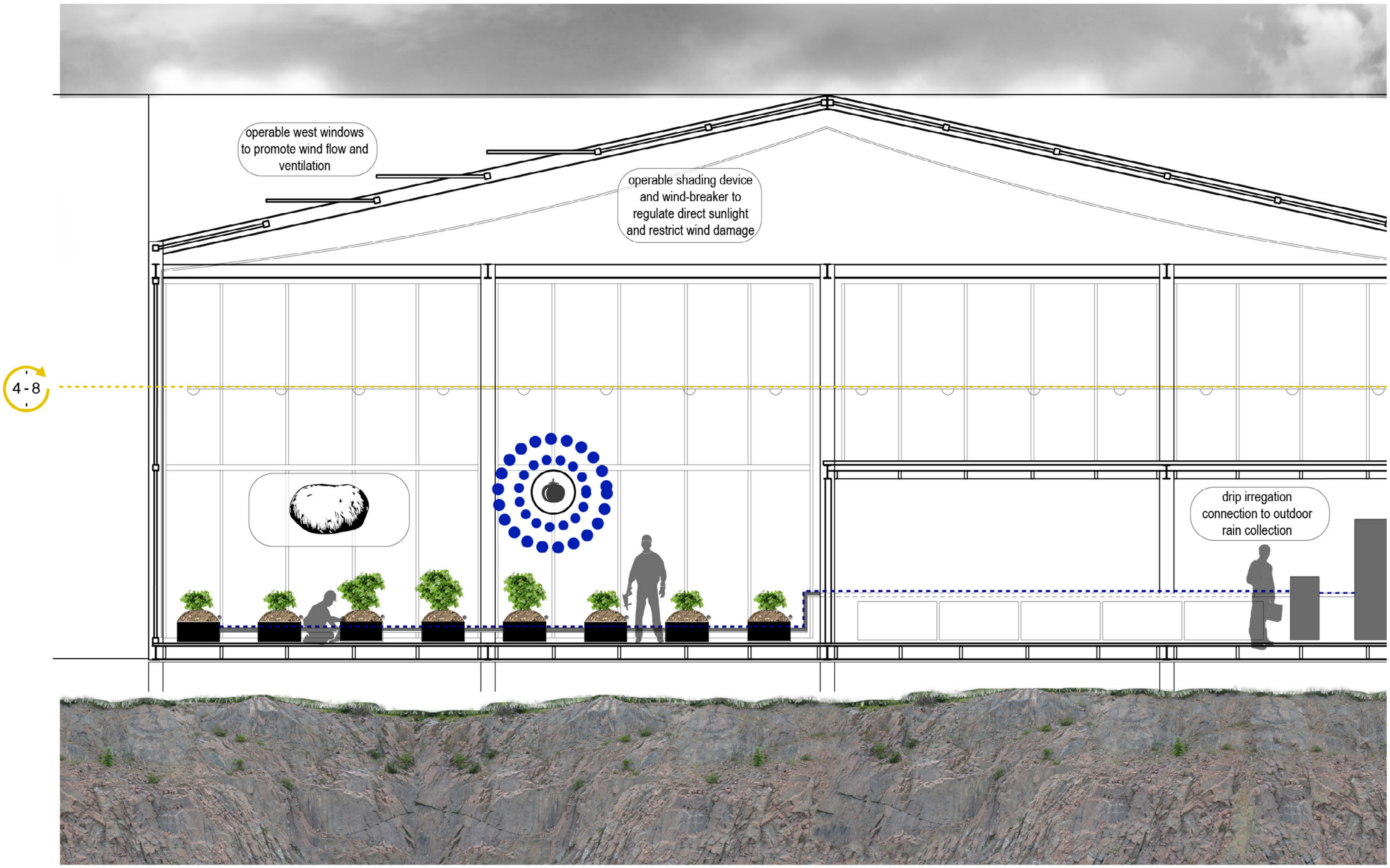
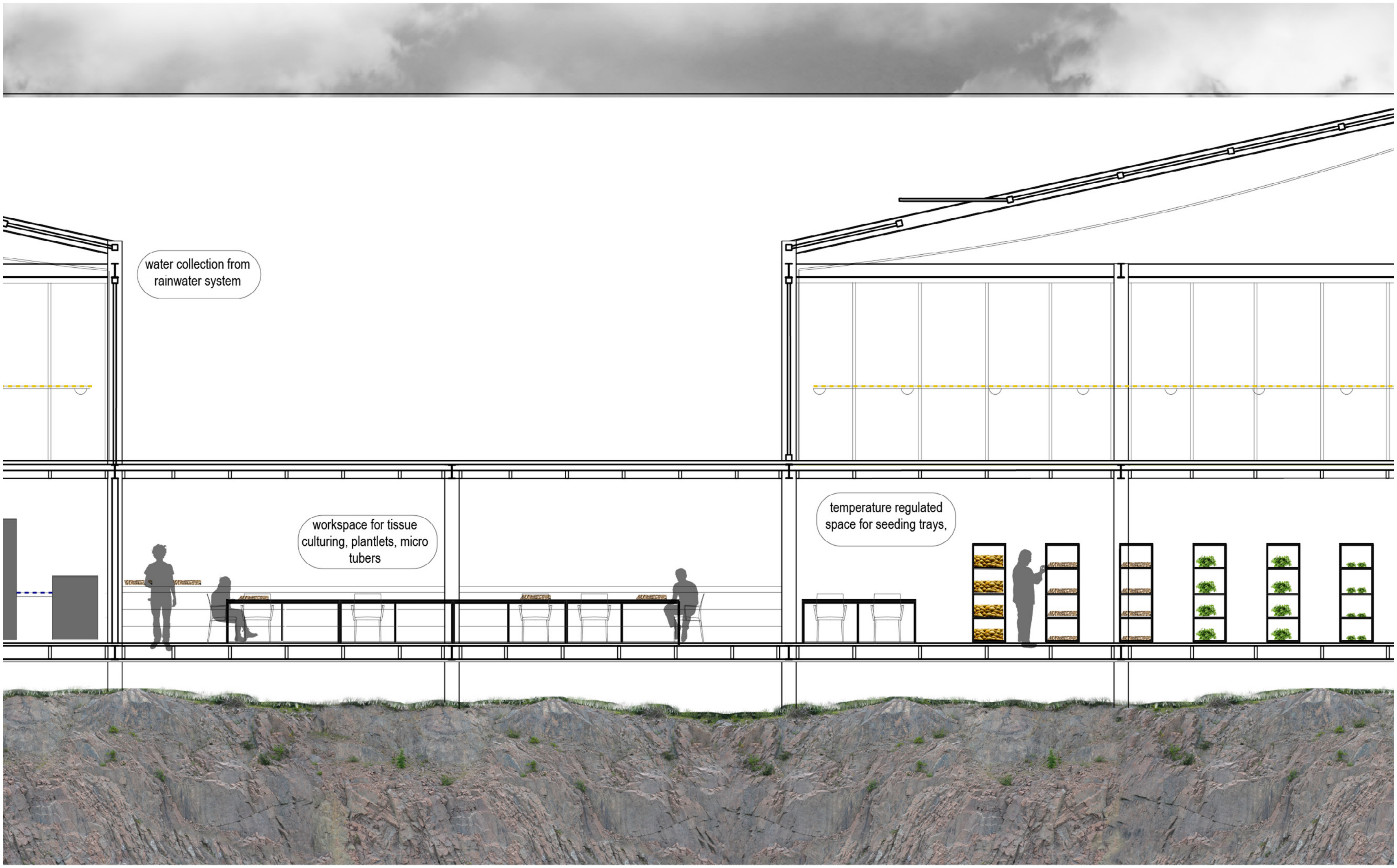


Fig. 4.49 Section 1a: section through soil greenhouse and production rooms


water collection from rainwater system
workspace for tissue culturing, plantlets, micro tubers
temperature regulated space for seeding trays,

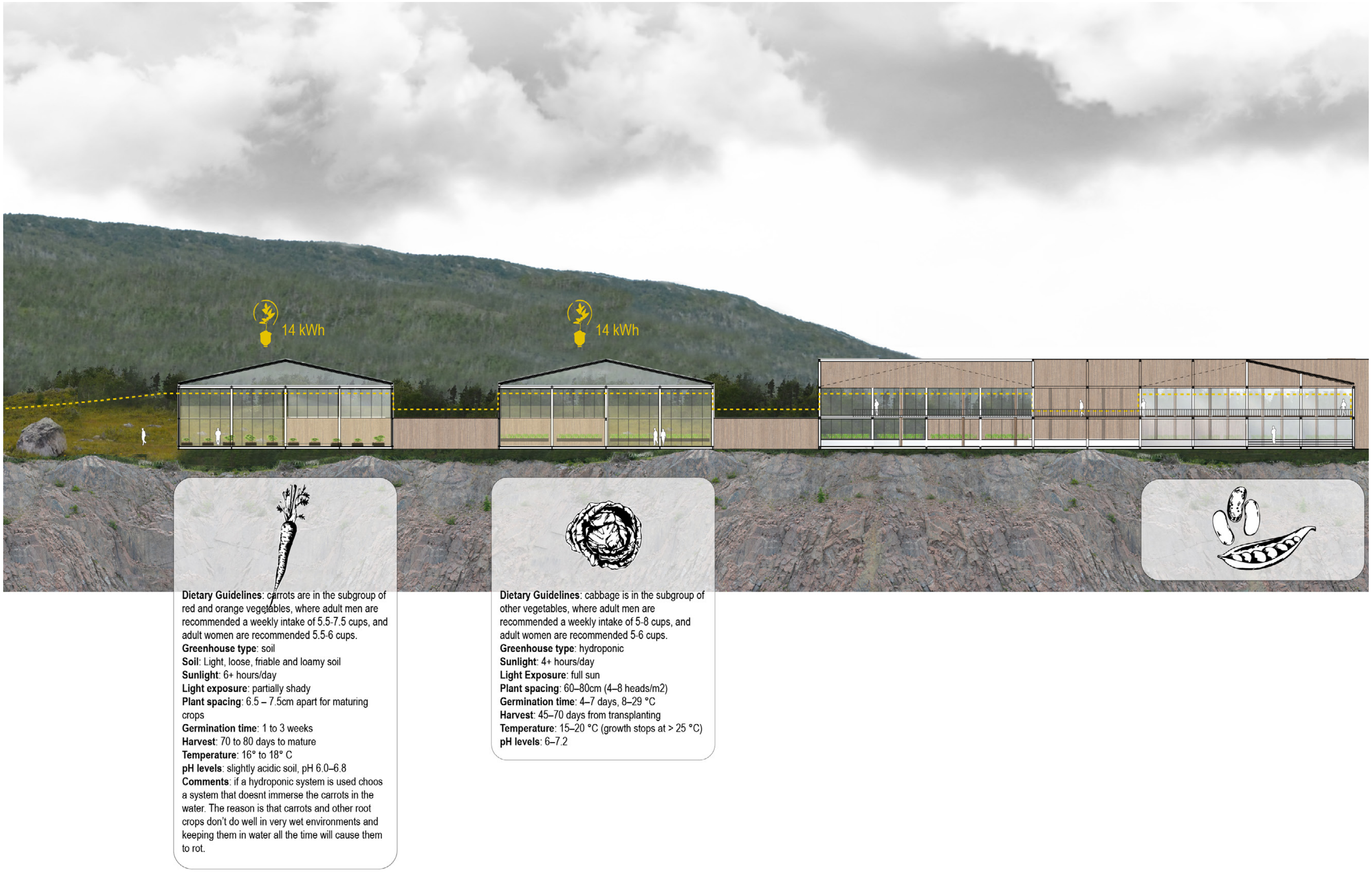


Fig. 4.50 Section 2: section through the hydroponic greenhouses, sky-pathway, conference room, community greenhouse, and education rooms


14 kWh
14 kWh
14 kWh

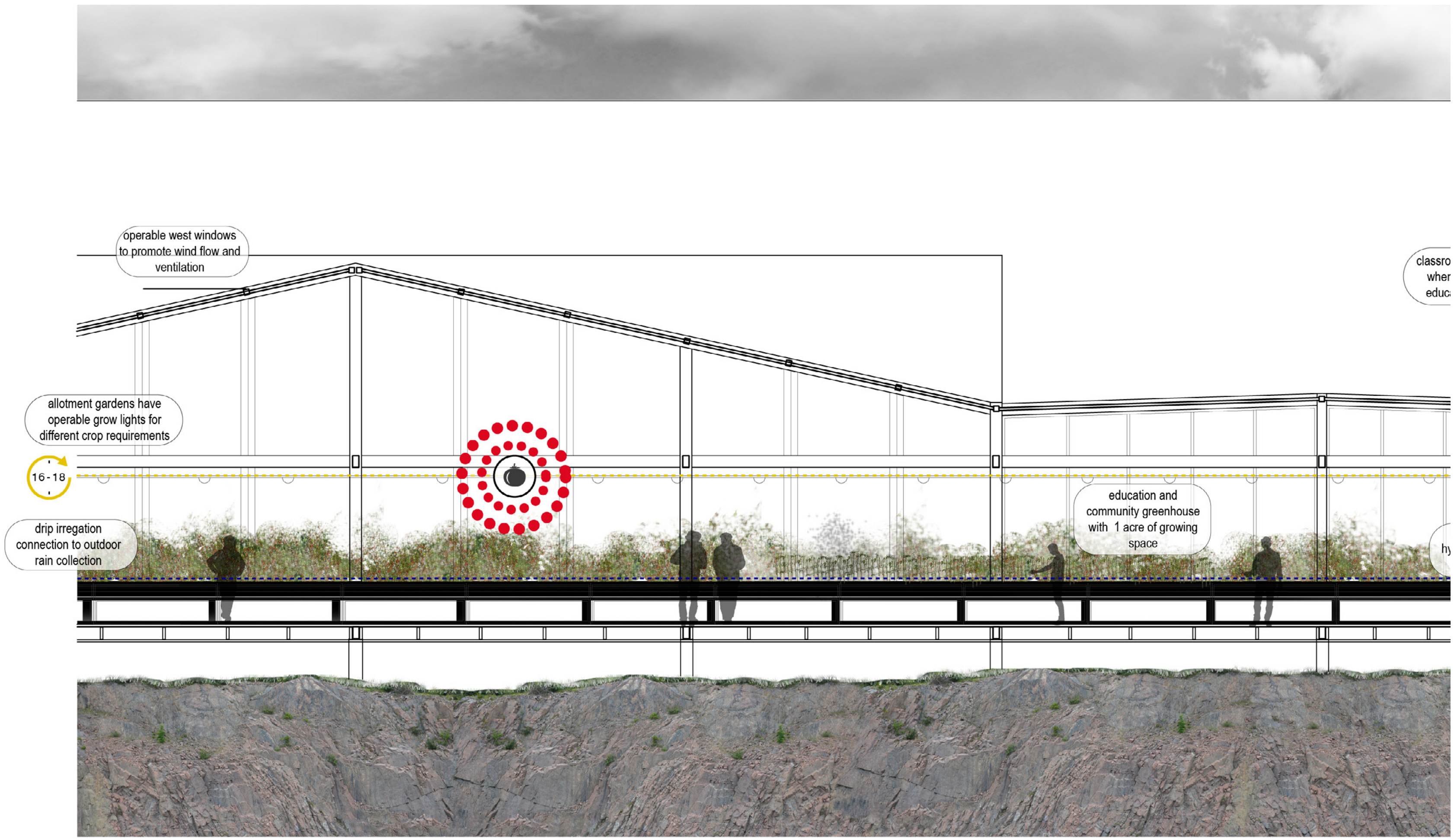
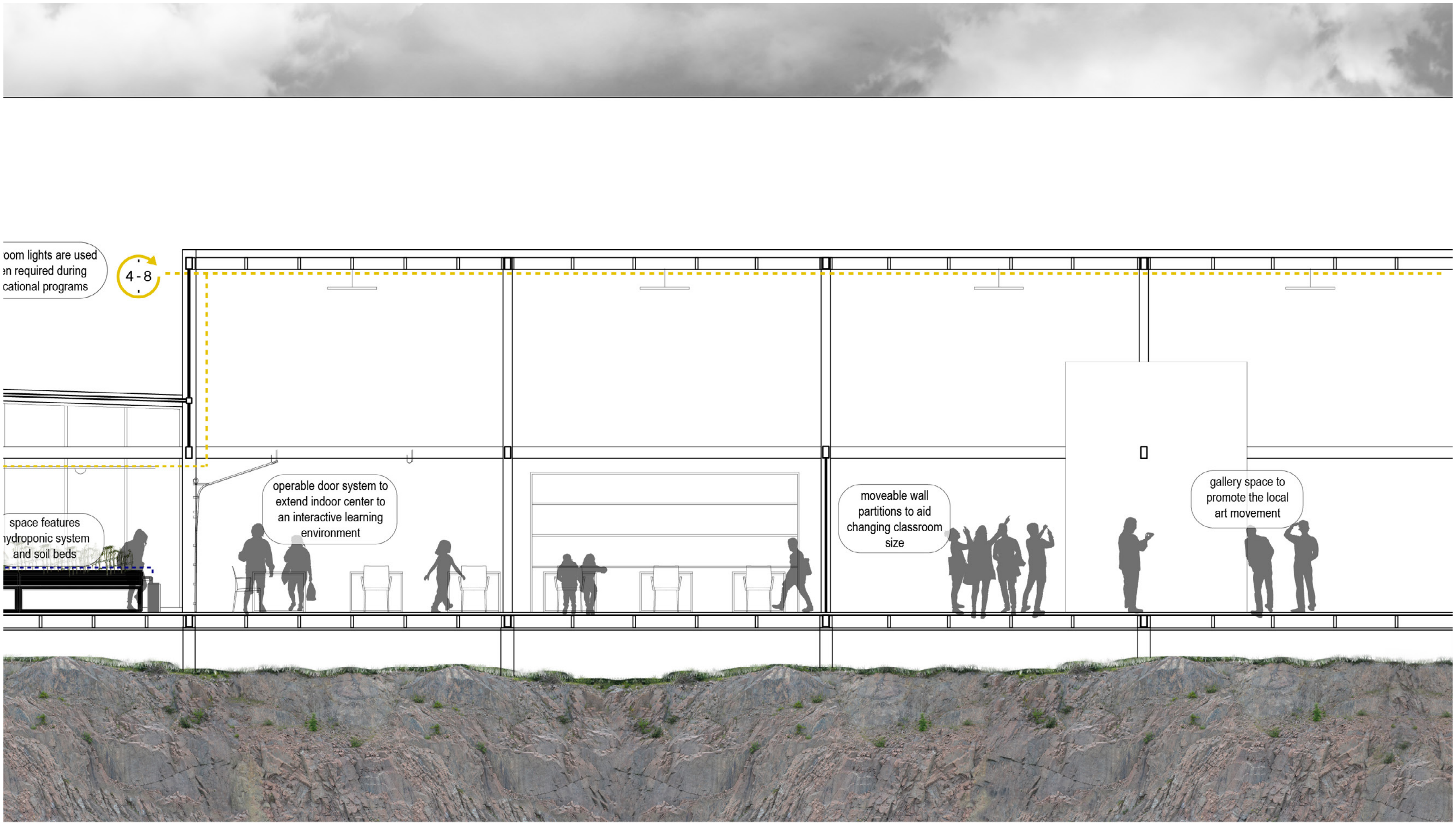


Fig. 4.51 Section 2a: section through community garden, education rooms, and gallery space


oom lights are used
en required during
cational programs
4 - 8
operable door system to extend indoor center to an interactive learning environment
space features
ydroponic system
and soil beds
moveable wall partitions to aid changing classroom size
gallery space to promote the local art movement

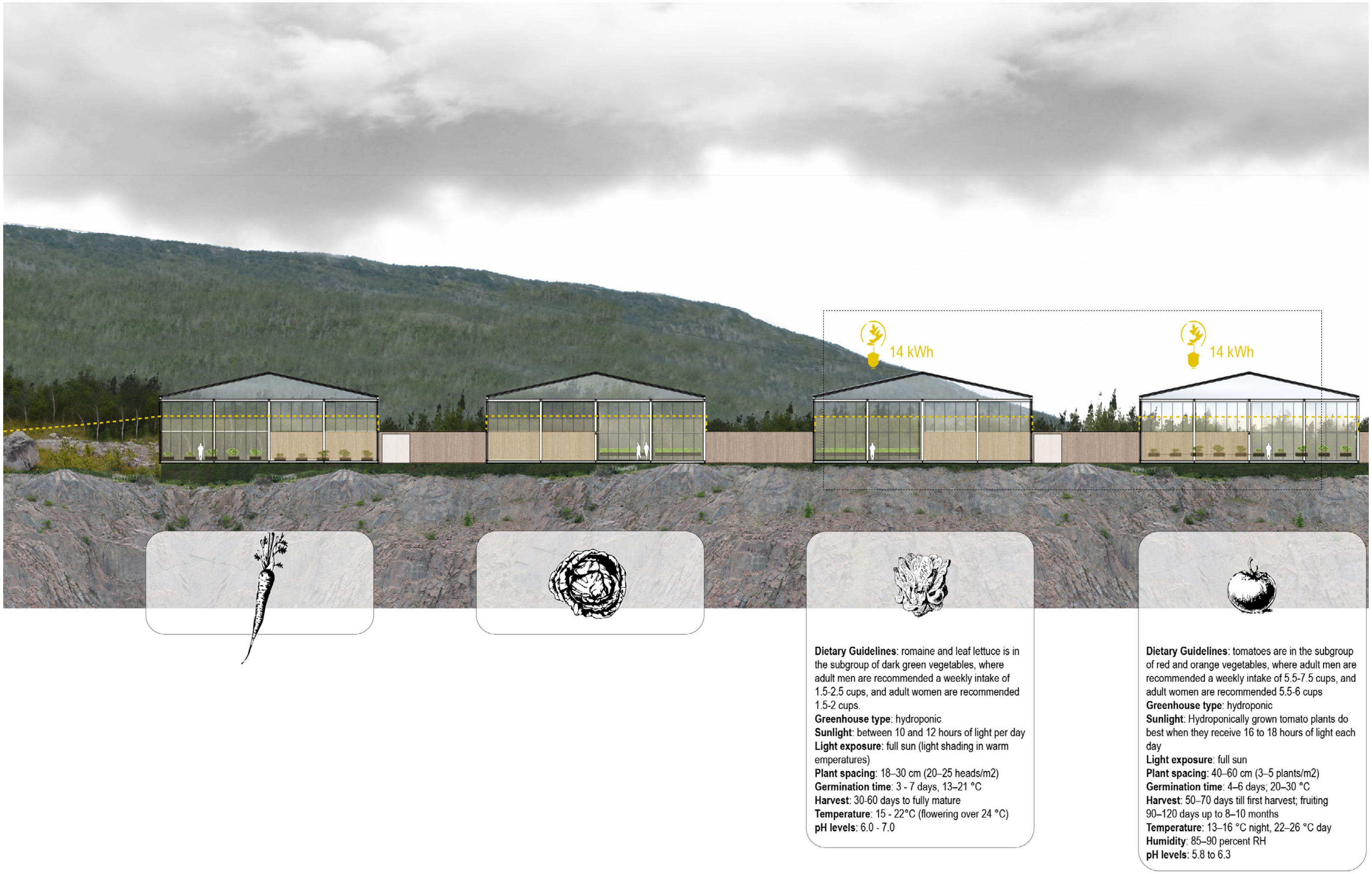


Fig. 4.52 Section 3: section through the hydroponic greenhouses, production rooms, marketplace, innovation centre and bottling space.


14 kWh
14 kWh

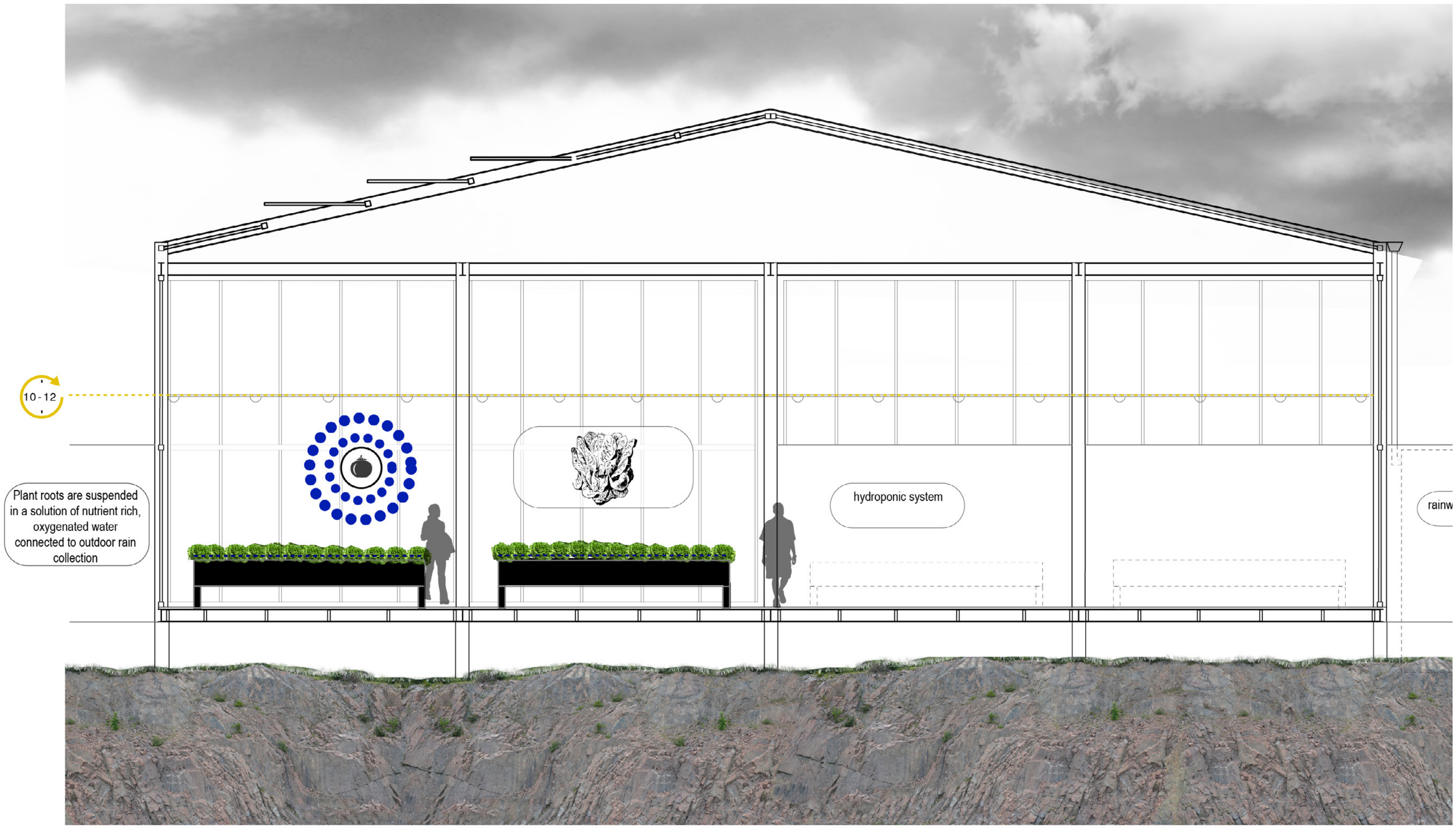


Fig. 4.53 Section 3a: section through hydroponic greenhouses


16 - 18
ater collection bins
rainwater collection bins
drip irregation
connection to outdoor
rain collection

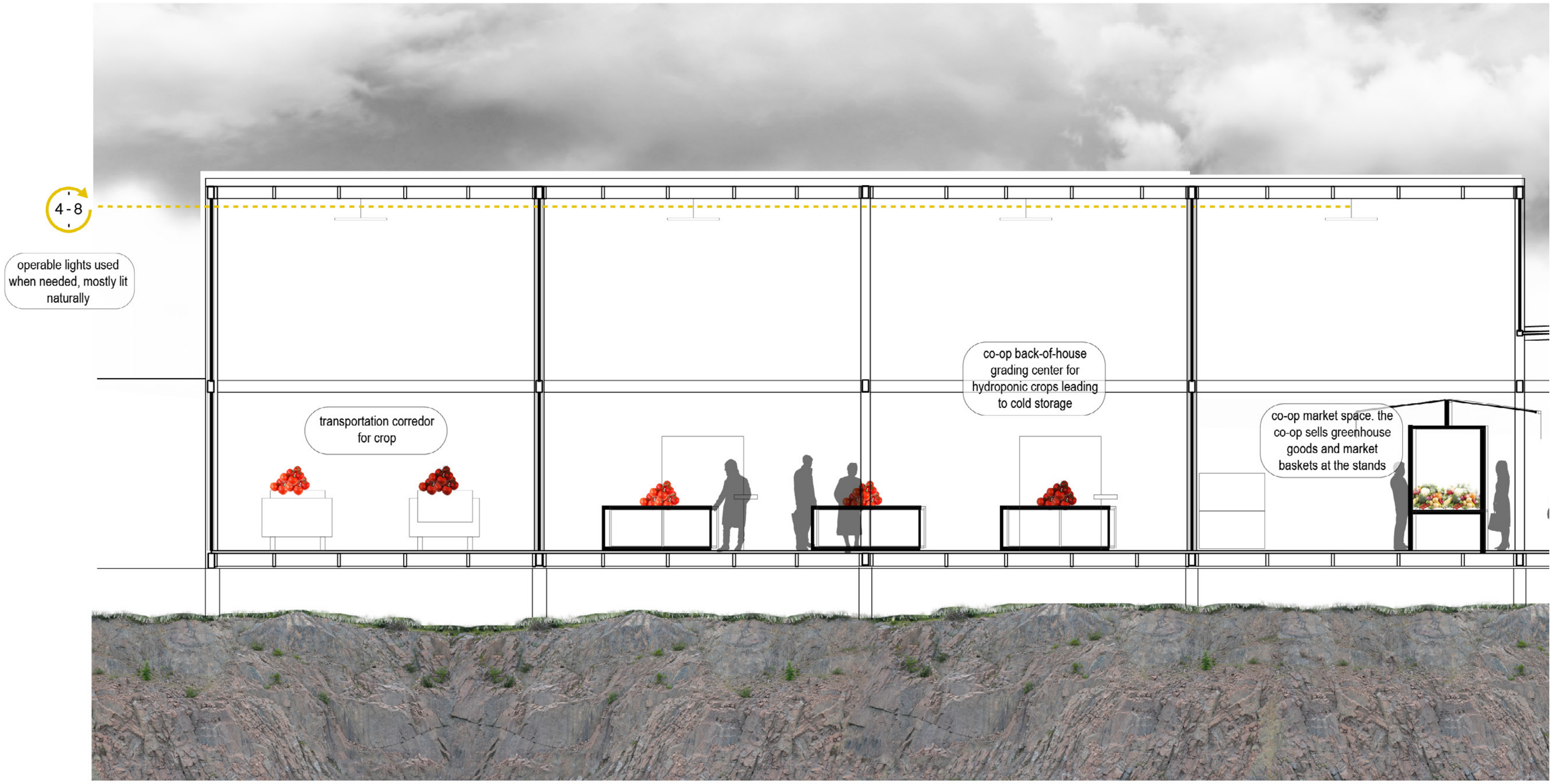
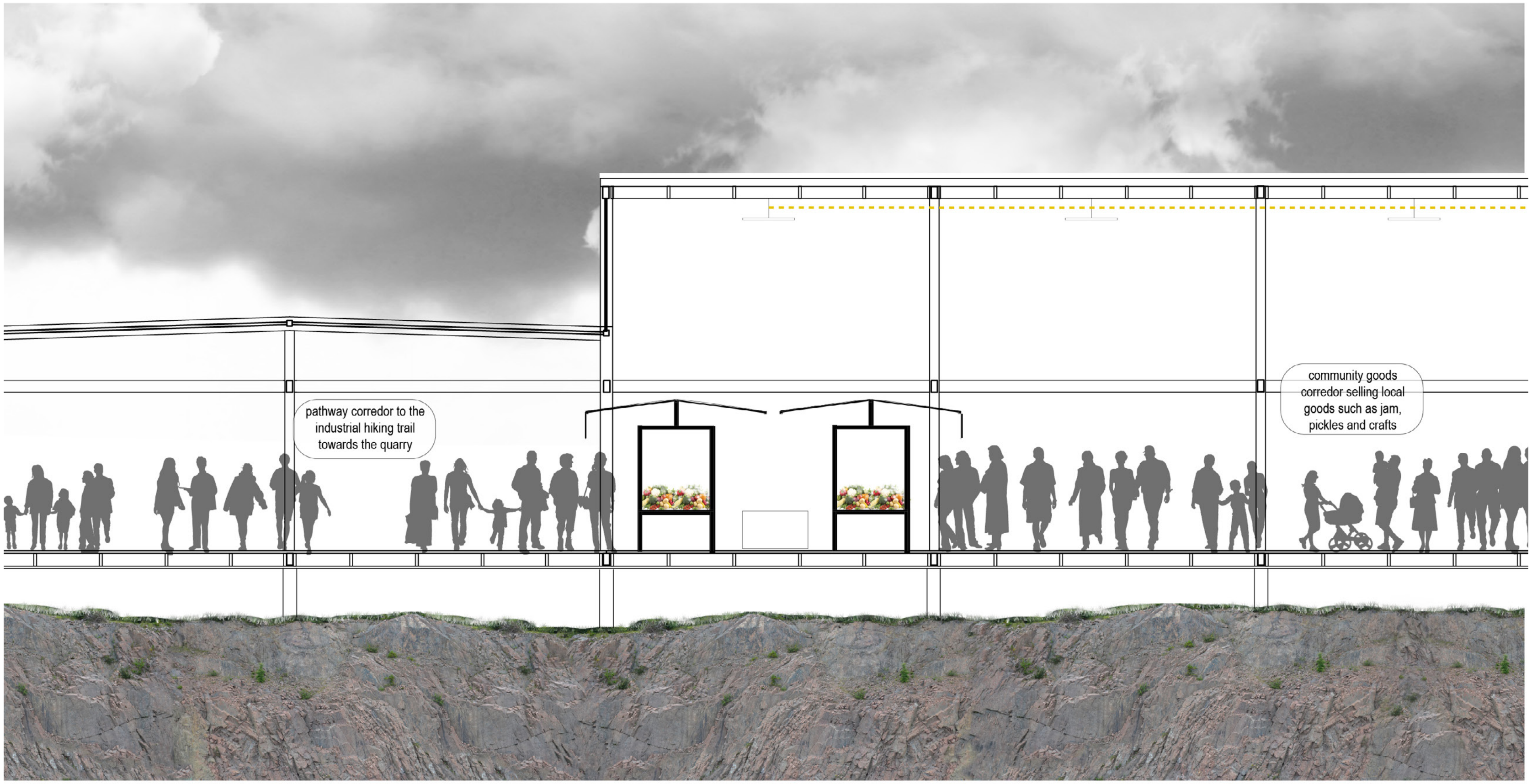


Fig. 4.54 Section 3b: section through distribution production room, and greenhouse market space


pathway corredor to the industrial hiking trail towards the quarry
community goods corredor selling local goods such as jam, pickles and crafts

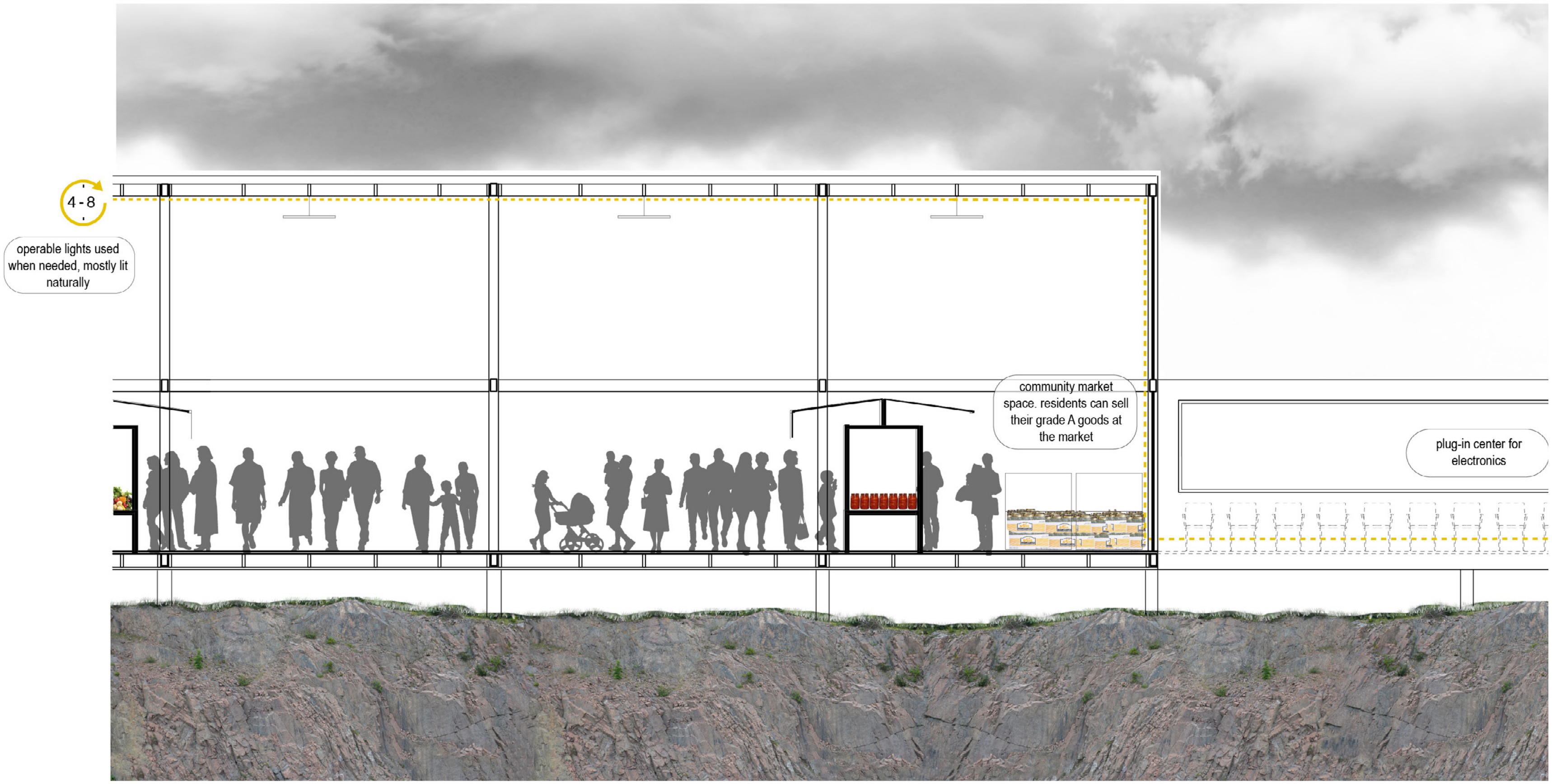


Fig. 4.55 Section 3c: section through community market space, innovation space and bottling space

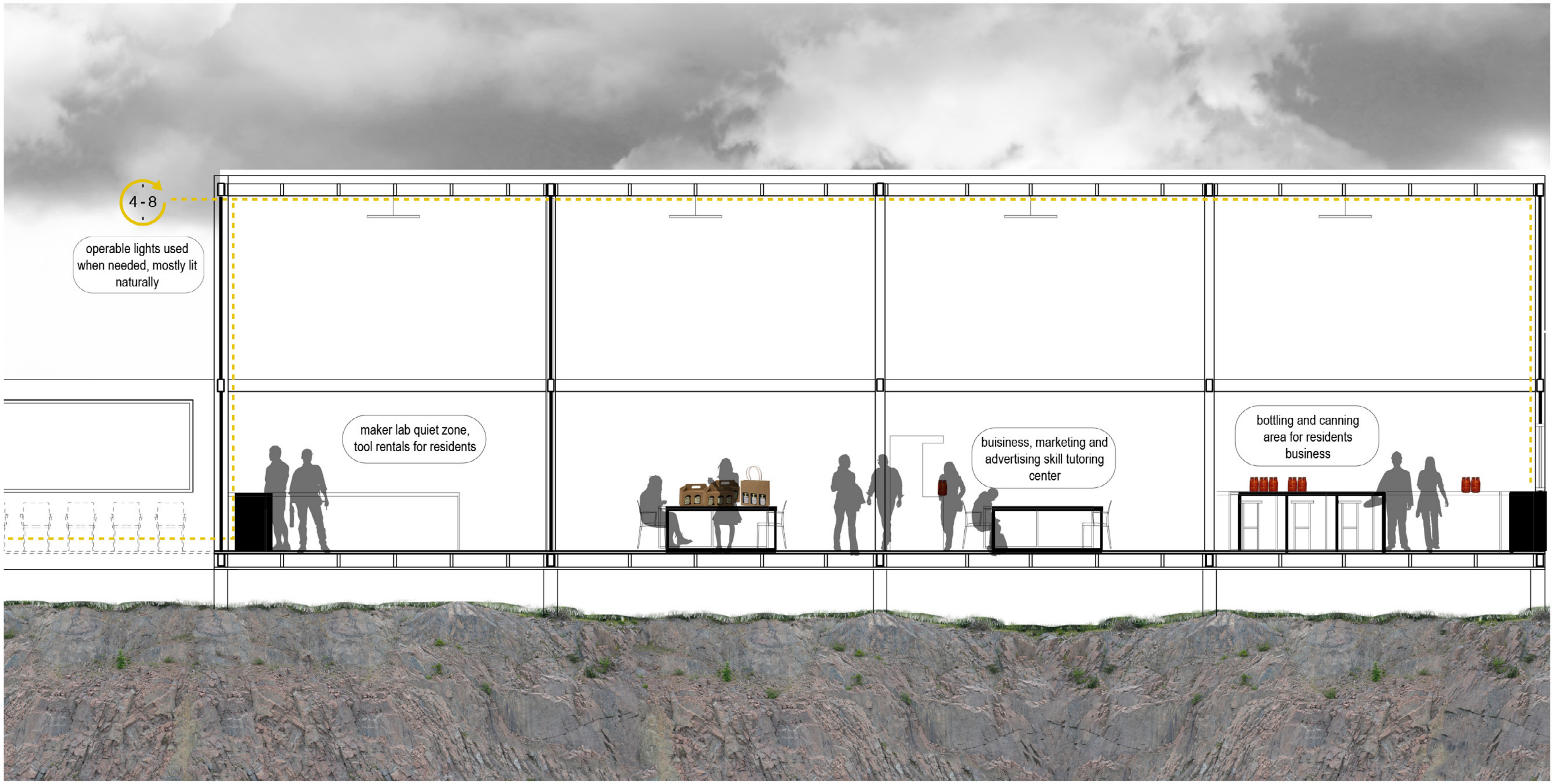

4-8
operable lights used when needed, mostly lit naturally
maker lab quiet zone, tool rentals for residents
buisiness, marketing and advertising skill tutoring center
bottling and canning area for residents business

Fig. 4.56 Community Garden

Fig. 4.57 Production Greenhouse

Fig. 4.58 Education rooms and classrooms

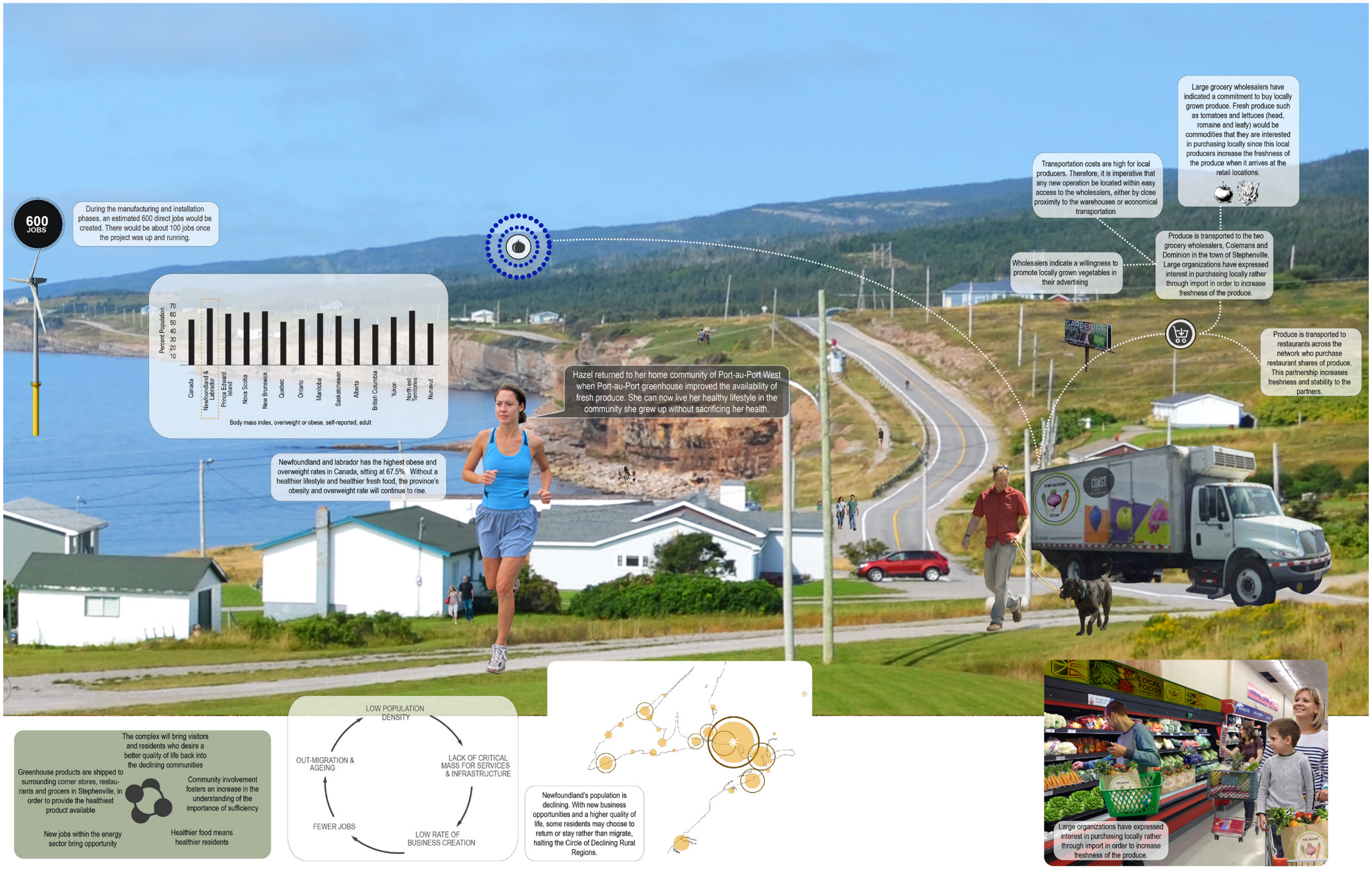


Fig. 4.59 Business opportunities and resulting impact

Fig. 4.60 Innovation Center

Fig. 4.61 Skywalk

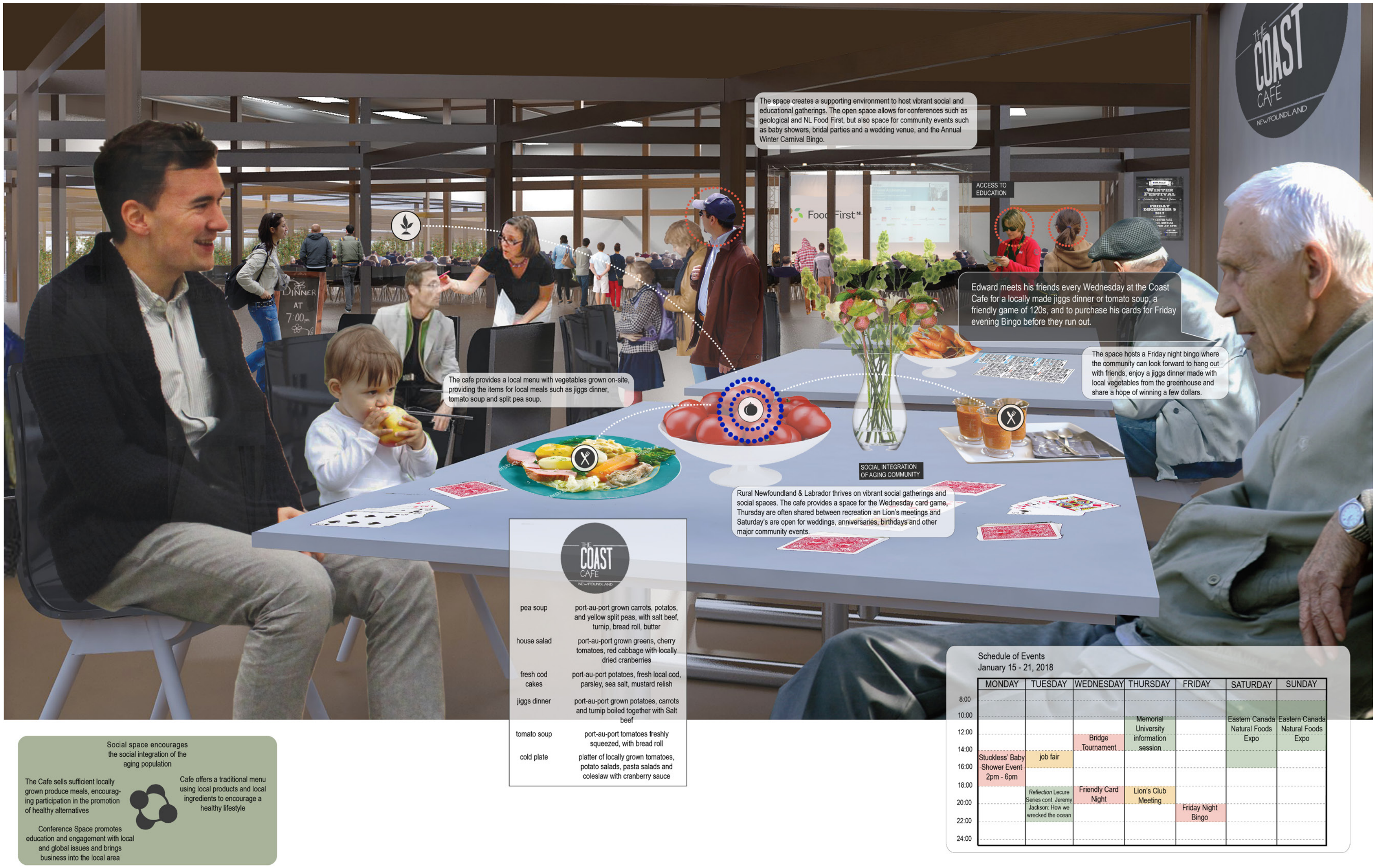


Fig. 4.62 Cafe and Conference Center.

Fig. 4.63 Distribution Market

Fig. 4.64 Sesaonality demonstrating wind speed per month at 50m height


MAR.
APR.
MAY.
JUN.
JUL.
AUG.
SEP.

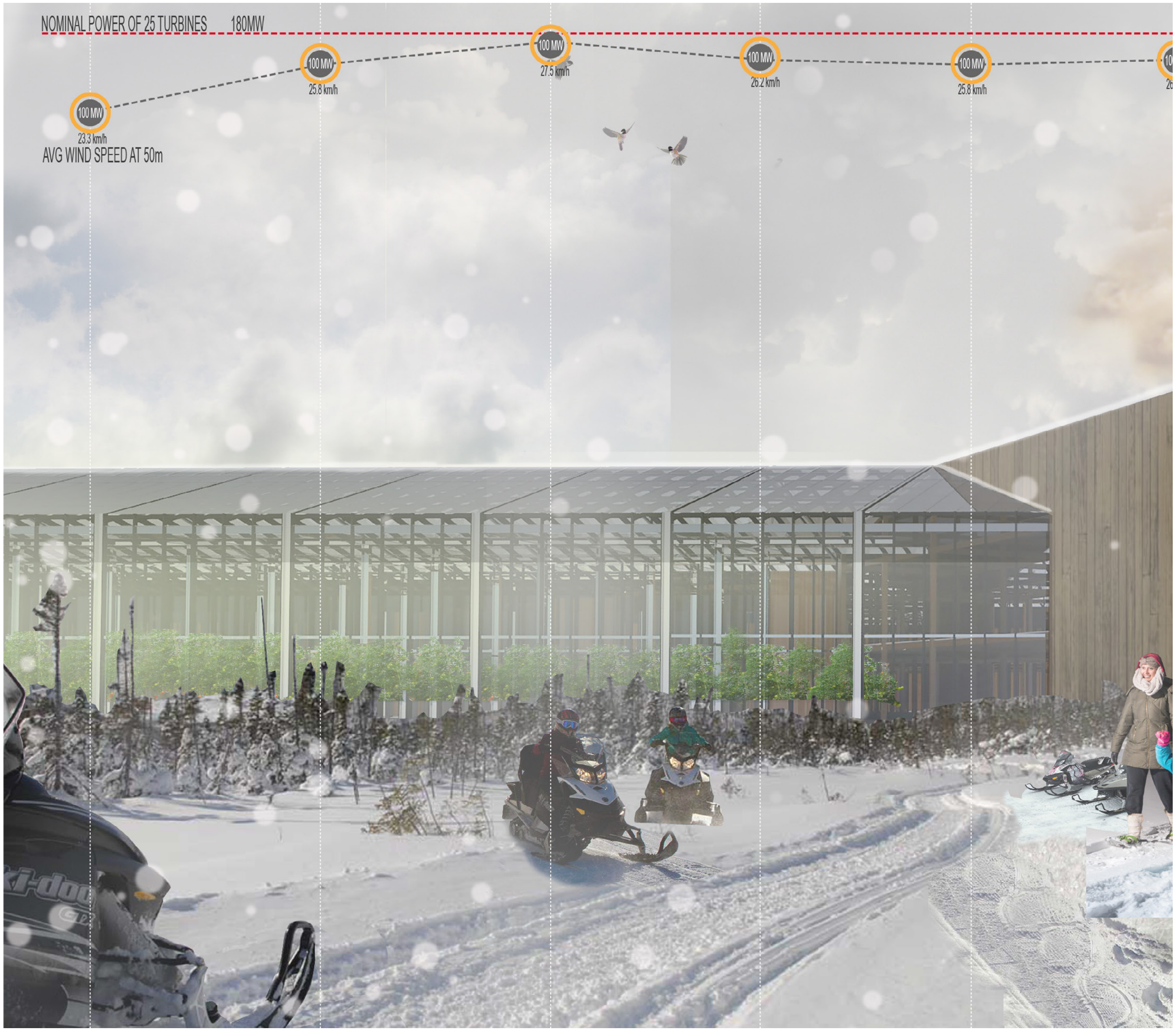
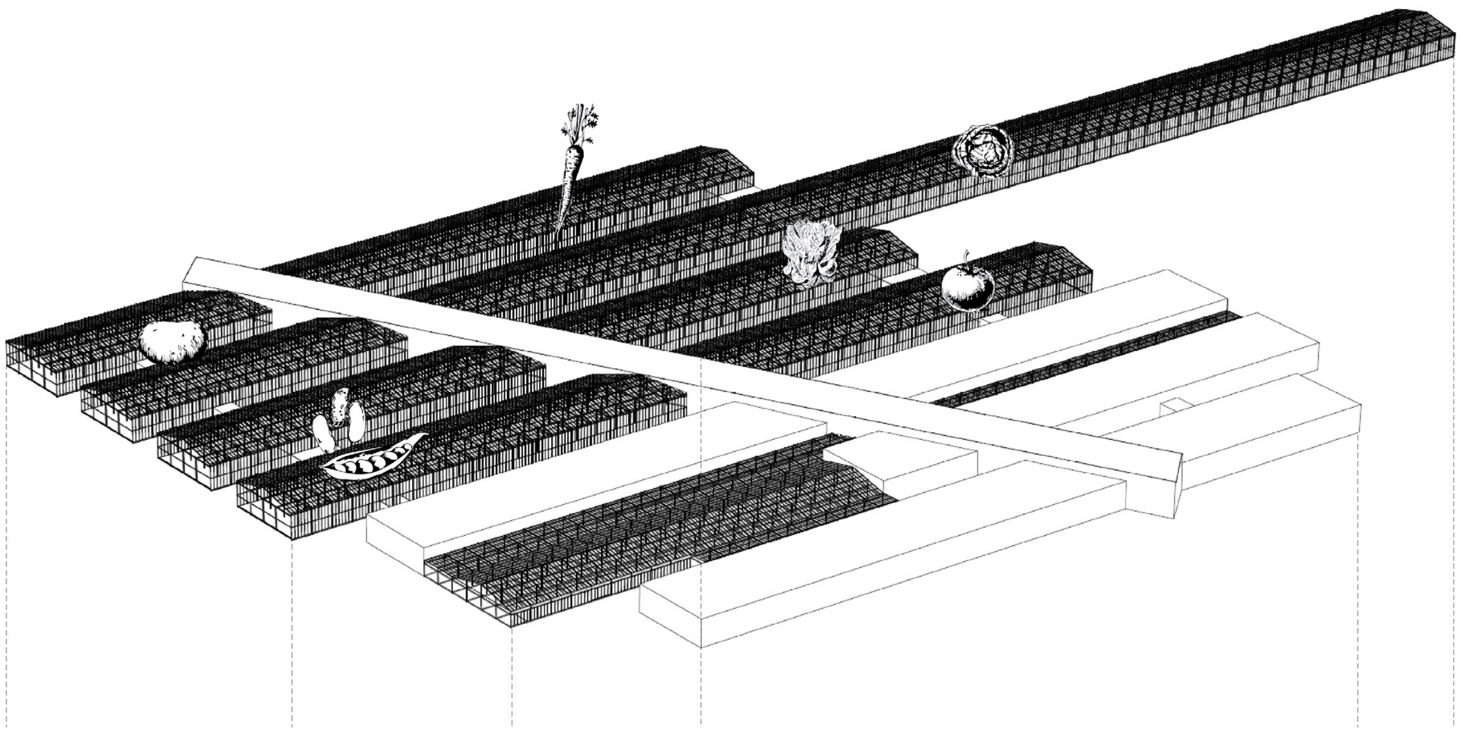


Fig. 4.65 Sesaonality image demonstrating estimate of wind energy extraction, based on interpolation of maximum output of wind turbines and 50m wind speeds.


100 MW
24.4 km/h
100 MW
21.7 km/h
100 MW
21.2 km/h
100 MW
19.5 km/h
100 MW
18.6 km/h
100 MW
20.8 km/h
PORT-AU-PORT
CO-OP

USDA category	example crop	total cups required as per USDA	total number of plants required	total required space (m^2)
green	lettuce	1410630	64412	2576
red/orange	carrots	1187573	477909	1720
red/orange	tomatoes	1187573	10837	3251
starch	potatoes	2799173	27003	4051
other	cabbage	3365180	45185	5648
legumes	peas	614614	2355508	4711

Fig. 4.66 Average vegetable count consumed by Port-au-Port region. The design allows for an increase in greenhouse components to the an influx/reduction of residents and vegetable options.



USDA category	example crop	total cups required as per USDA	total number of plants required	total required space (m^2)
green	lettuce	2622360	119742	4790
red/orange	carrots	2155303	867348	3122
red/orange	tomatoes	2155303	19667	5900
starch	potatoes	4120740	39752	5963
other	cabbage	3370055	45250	5656
legumes	peas	1182233	4530908	9062

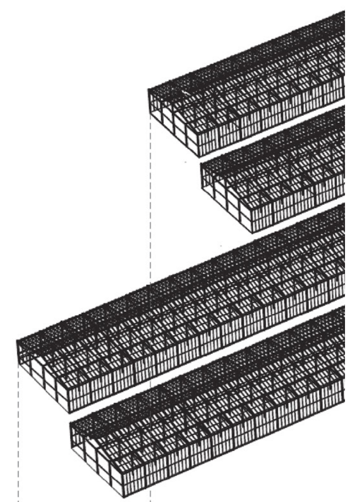
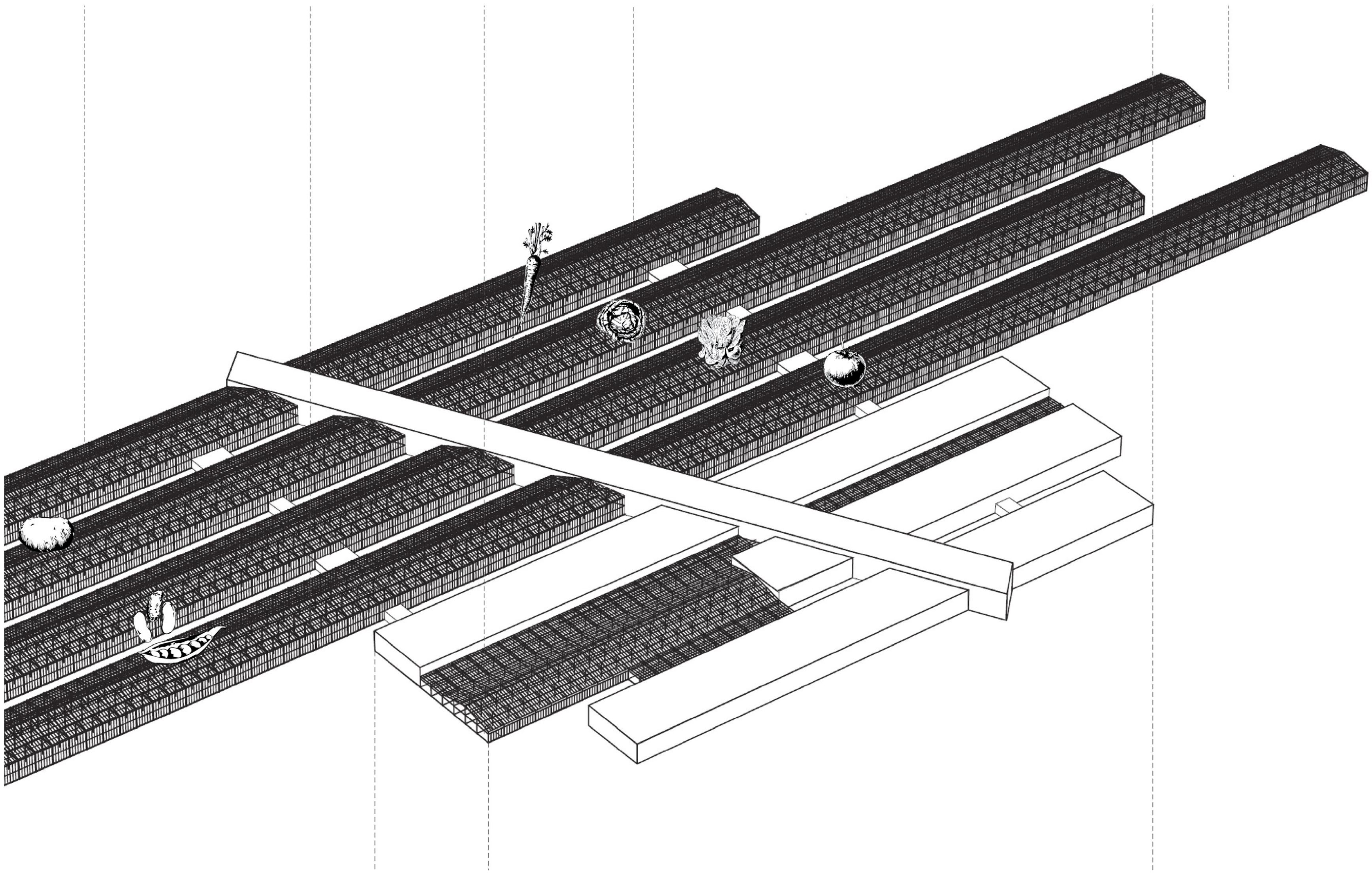


Fig. 4.67 Minimum required vegetable count consumed by Port-au-Port region based on USDA requirements. The design allows for an increase in greenhouse components to adapt to the an influx/reduction of residents and vegetable options.



USDA category	example crop	total cups required as per USDA	total number of plants required	total required space (m^2)
green	lettuce	3802110	173612	6944
red/orange	carrots	2816775	1133542	4081
red/orange	tomatoes	2816775	25703	7711
starch	potatoes	5722990	55209	8281
other	cabbage	4734275	63567	7946
legumes	peas	1976819	7576159	15152

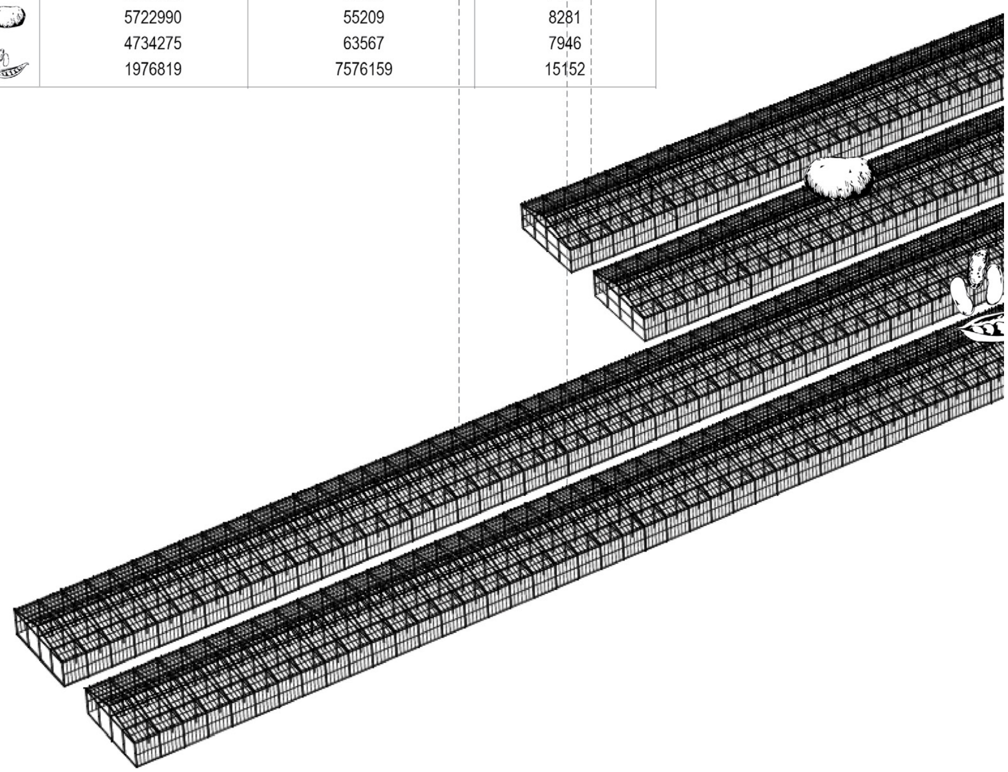
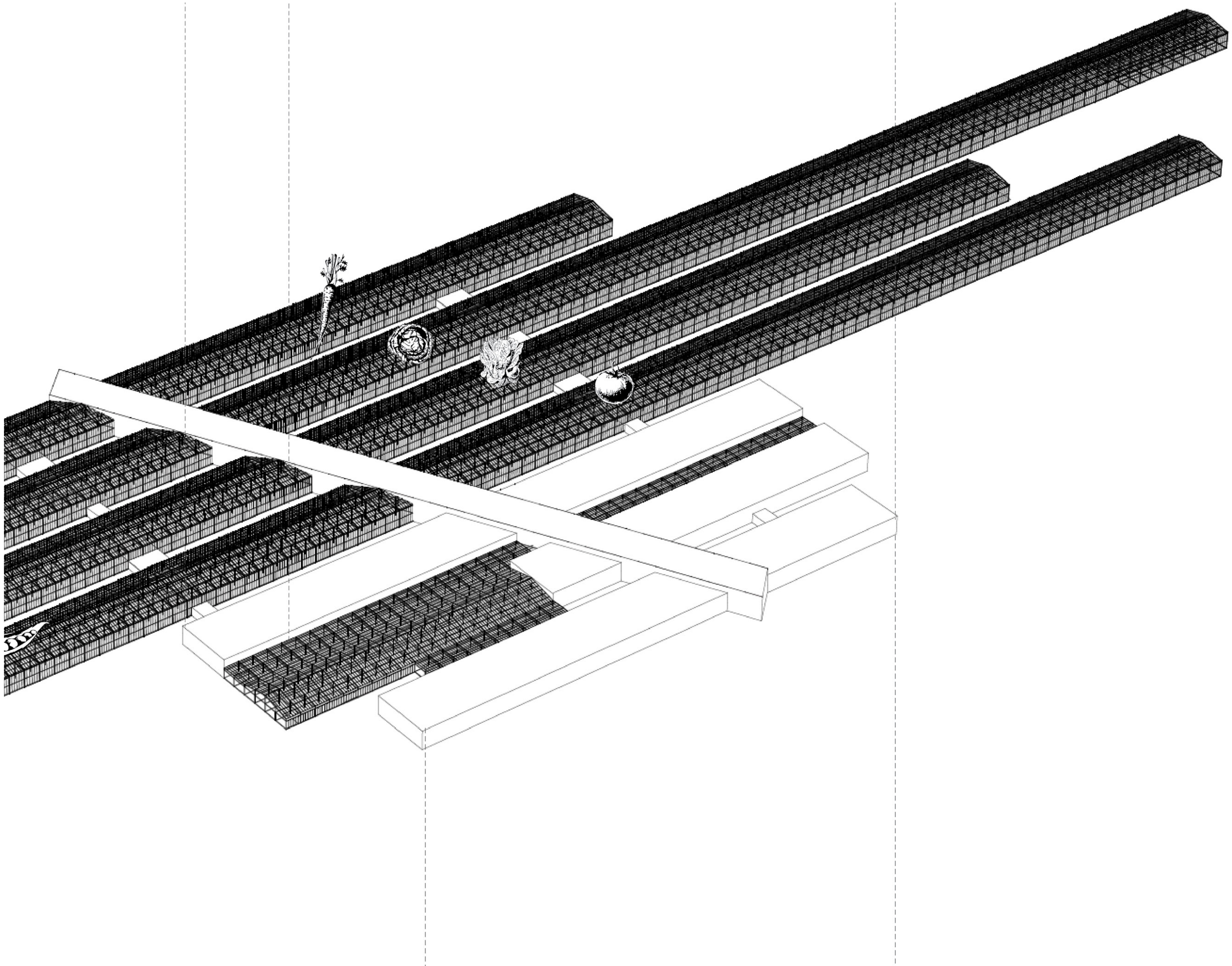


Fig. 4.68 Higher-end required vegetable count consumed by Port-au-Port region based on USDA requirements. The design allows for an increase in greenhouse components to adapt to the an influx/reduction of residents and vegetable options..



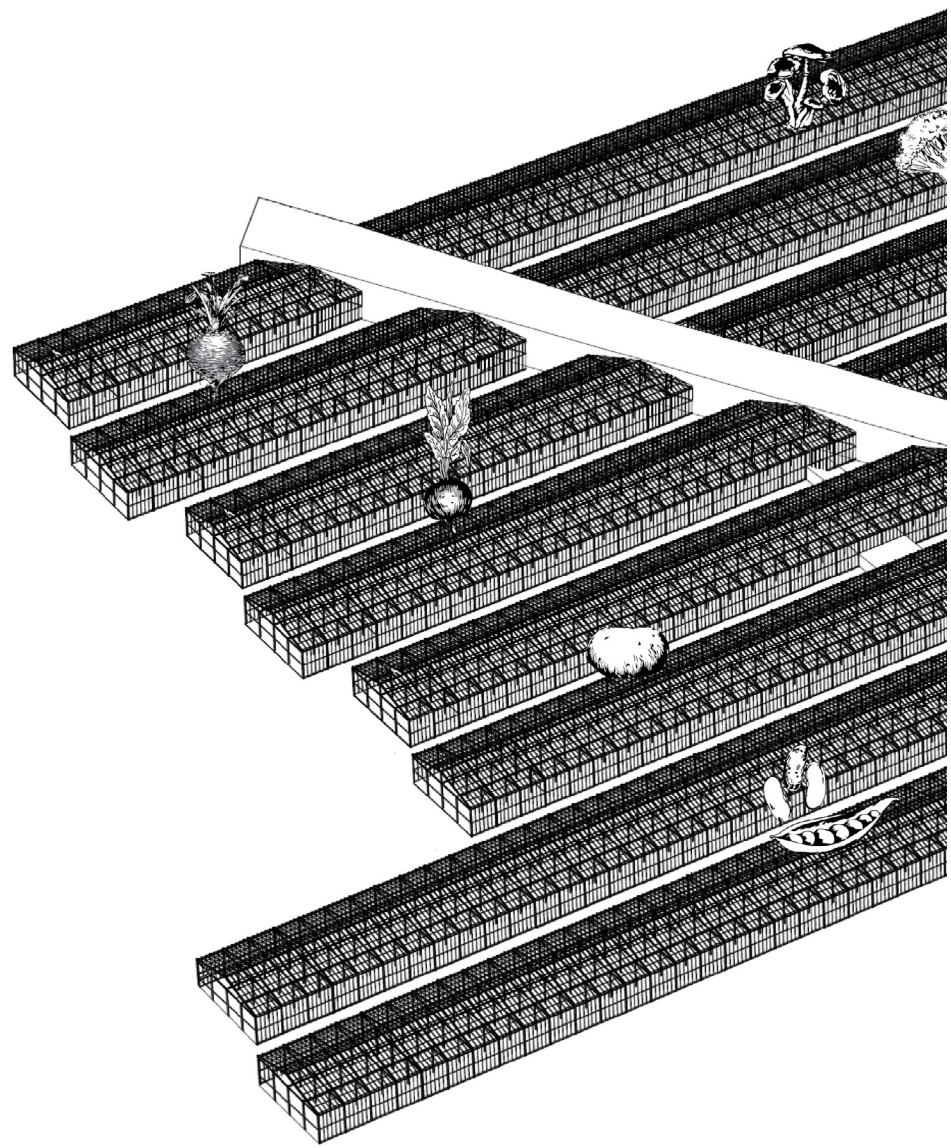
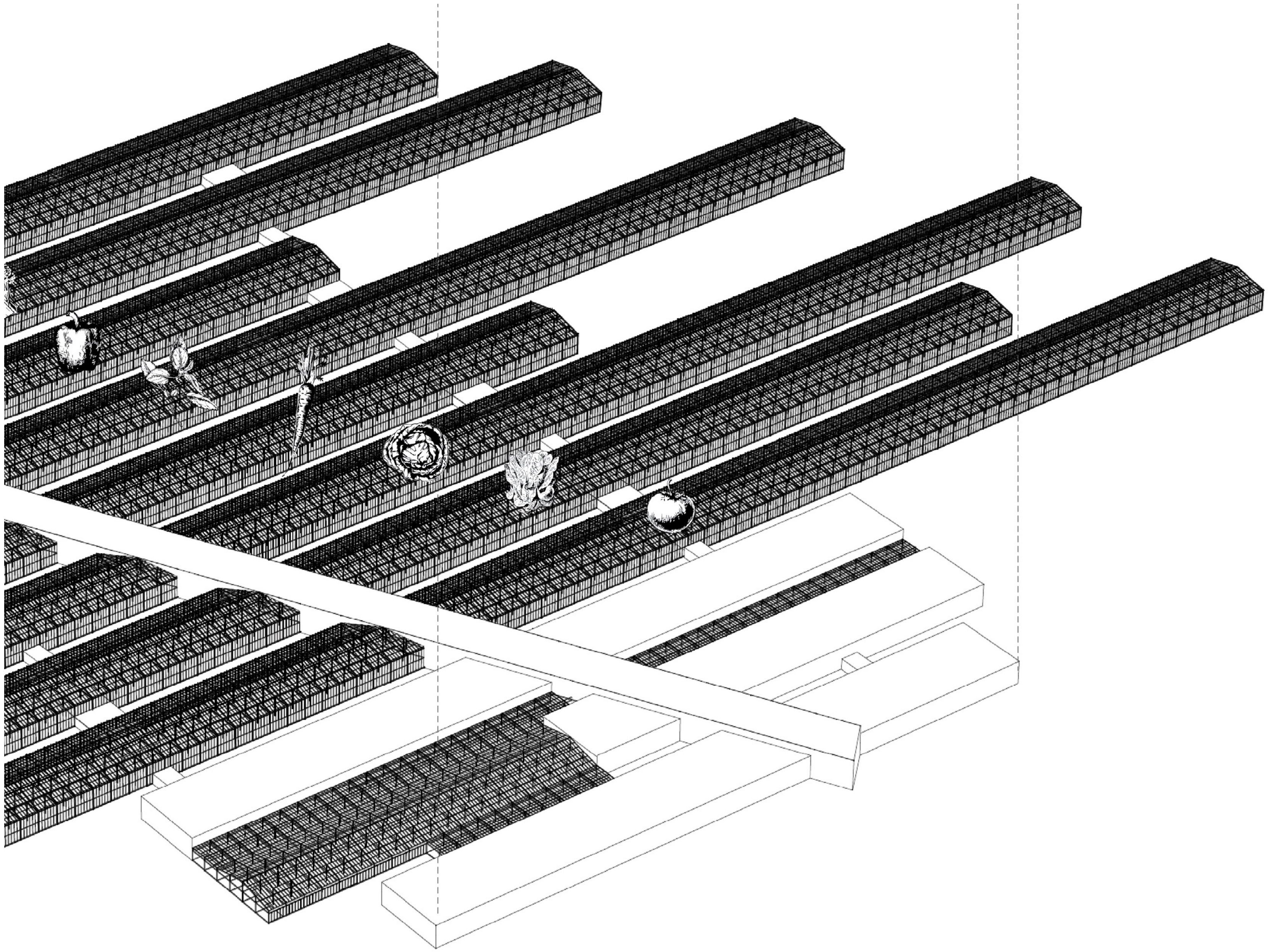


Fig. 4.69 The design allows for an increase in greenhouse components along the pathway to adapt to increasing vegetable options.



Part 5 growth

One of the striking traits of Newfoundlanders is fatalism. It's in our songs and stories and sermons, its resides in our literature and newspapers and broadcasts. It derives from our centuries of dependence on the North Atlantic. He who would survive must learn to be part of the wind and water, rock and soil.

- Cyril Poole, quote within the Sense of Place: Loss and the Newfoundland and Labrador Spirit

Provincial Impact

There is a lack of architecture and design research focused on rural communities, as well as the regional need for a long-term vision of daily life. We must rethink the role of design in relation to regional arrangement – the way in which community systems, residents function with respect to resource base and the form of a village. With an energy farm arriving to the St. Georges Bay area, new facilities and opportunities for employment arise.

Newfoundlanders have managed to use their island resources to allow growth and sustainability of communities. This includes their native diet of fish from the ocean, native cold climate crops such as potatoes and cabbage, and currently the oil that is withdrawn from the sea.

Newfoundlanders have a high appreciation for products and resources made on the island. As resource use is custom on the island, utilizing the wind would be widely accepted. There is much potential in using this wind for energy harvesting throughout the island, providing systems such as those discussed in the case study of Port-au-Port.

Wind speeds across the island are strong. The following diagram of regional connection analysis demonstrate areas of high import-replacement potential and potential future energy farm locations. Network conditions appear throughout the periphery of the island. These networks should be viewed as opportunities to expand the greenhouse wind farm partnerships. With the emerging wind opportunities providing power that lowers greenhouse expenses, fresh fruit and vegetables could be provided to the entire Newfoundland population.


LOCAL FOODS
Growing farms, health, jobs
Turn groceries into Rewards
dressings & dips
fresh cut vegetables
PORT-AU-PORT

Fig. 5.2 Provincial conditions demonstrate potential network connections, where regional stability is promoted.

- 1990 population
- 2010 population
- centers over 2000 people
- current fisheries
- ferry routes
- 30 minute connections

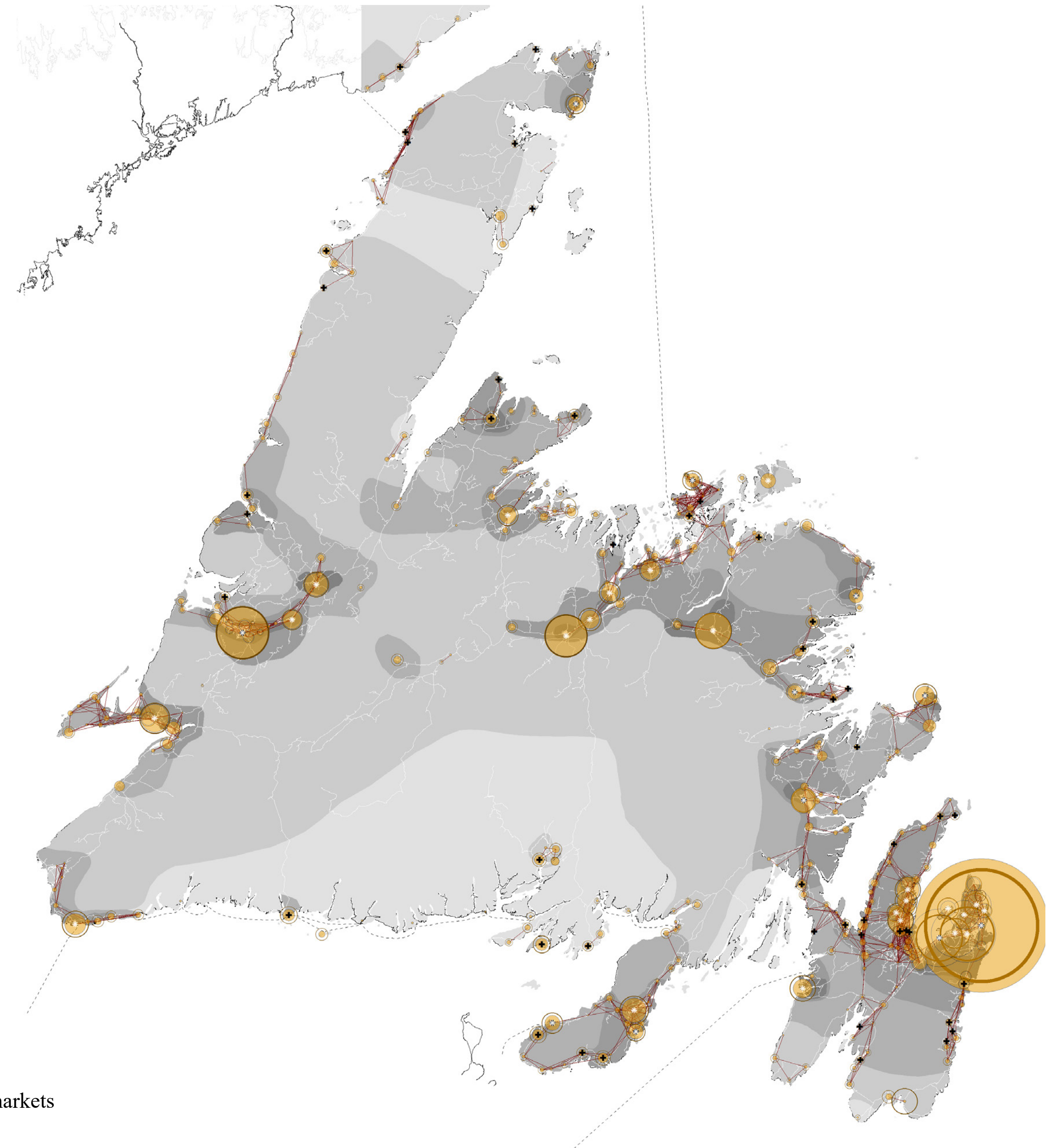


Fig. 5.1 Visualizations of ocal produce sold in grocery markets

Conclusion

A case study greenhouse complex in the Port-au-Port peninsula is designed in order to investigate the future vision of the import-replacement initiative using latent island wind energy at a local scale. A education and research center, community and distribution space, and greenhouse production center are amalgamated into one greenhouse-education facility. The design focuses on education of sustainable practices and transparency of business ethics in areas of greenhouse production in order to make energy infrastructure more legible within an energy conscious community.

Population flows, food flows, energy flows, government structuring, and climatic and geographical analysis is evaluated in order to demonstrate their effect on the island and its ability to be restructured in order to turn current dependency into resiliency.

Precedents of greenhouse environments and energy ownership are analyzed and possible crop choices are studied to suit the potential site.

The greenhouse complex in Port-au-Port addresses only one area of the Island, where the problem of food security spans across the province. The Port-au-Port design hopes to raise awareness and educate communities on a possible future scenario for rural communities.

The architectural intentions set out in the Port-au-Port case study aim to create a diagram of community sufficiency, analyzing the scale that is required to provide the area with sufficient crop to be independent from global dependencies. Across the island the design and scale of greenhouse complexes would vary, depending on the vernacular architectural techniques of the area, the history of fishing ports, the unique history of the area, and would differ based on the architectural intentions of the local community. Every area of Newfoundland reflects their own rich history, and the greenhouse complex would have the opportunity to reflect this uniqueness.

The Port-au-Port region has the unique history of being an Acadian village, with ties not predominantly to a fishing village, but rather to industrialism, which led to a design tied to production. This design is linked to the particular area, and lacks the spectacular approach that could suit other fishing villages on the island, such as Twillingate regions or the St. Anthony region that continue to have strong ties to fishing industries.

To relate more directly to the local culture, a greenhouse complex of this nature would benefit from the involvement of the community in the building process. I do not imply that everyone is involved in the physical construction, but rather community residents could be involved in the process and design, from knowledge of local resource flows, integration of these flows, living

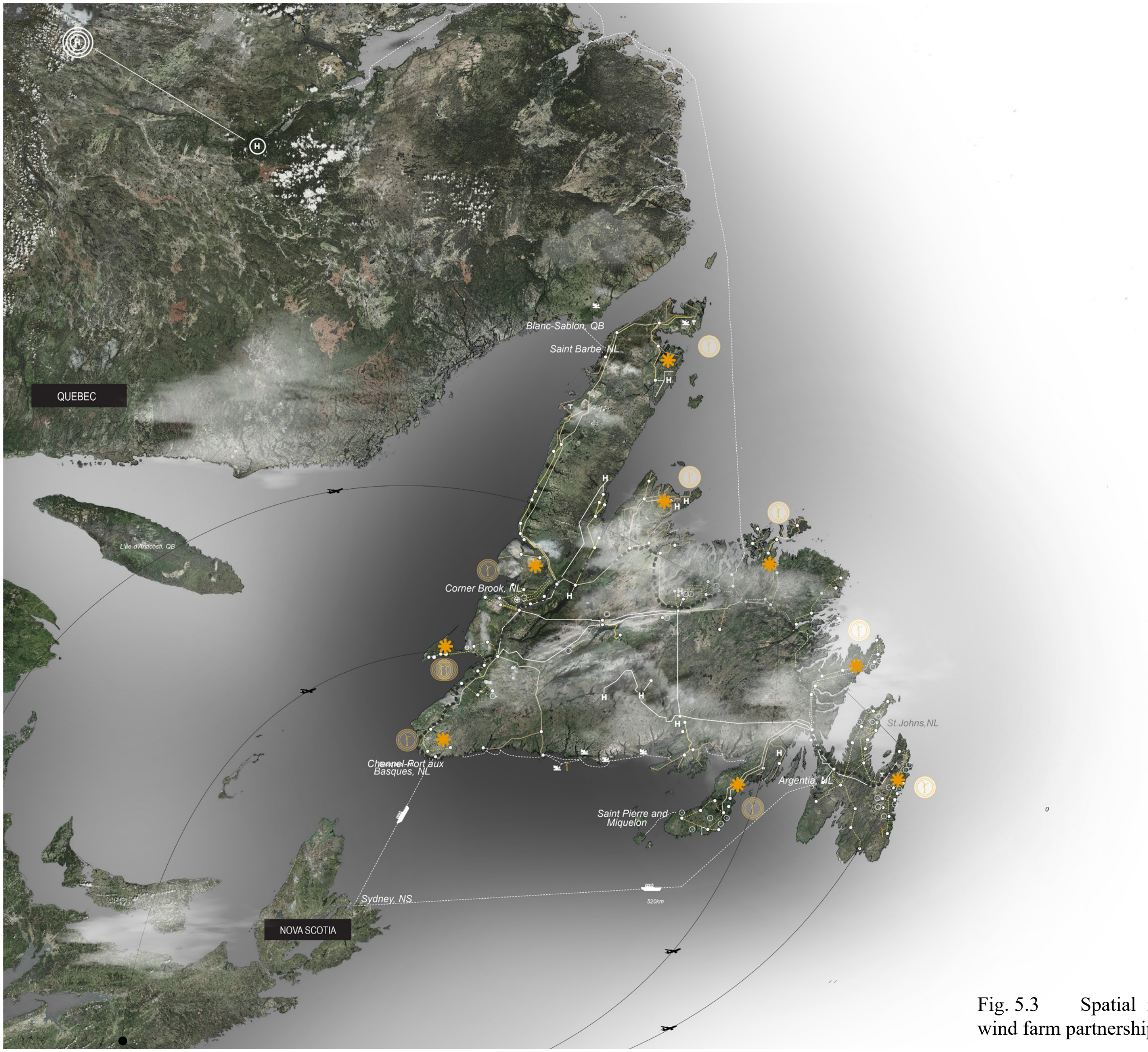


Fig. 5.3 Spatial representation of greenhouse and wind farm partnerships

environments and a daily life that reflects sustainable practices. With community involvement, the complex could be further designed to relate more specifically to the local culture by being linked to the outport shore, intersect with surrounding buildings and support surrounding businesses to create a community hub.

The scale of the greenhouse in the case study reflects USDA requirements and is a very large structure. Other configurations and iterations of the greenhouse complex and a smaller configuration of community parts are worth considering. A large amount of capital would be required to construct the entire complex designed in the Port-au-Port case study. The scale can be substantially reduced and trial sizes would be beneficial to the island as a means to begin thinking in a sustainable and resilient manner.

The design and visualizations aim to attract community citizens who are interested in change, raise awareness through education (as education fosters a shared understanding), and identify a guiding vision, as attractive shared visions are driving forces in change and offer a community-defined vision of the future.

I do not presume to be an expert in the specific fields, but rather, I use this thesis to synthesize a range of specialized fields not normally explored together as a whole. A range of professions and specialized professionals would be beneficial for the future of this project going forward, in order to optimize the expertise required to create a new vision of sustainability. It is my hope that this thesis educates and raises awareness of issues that continue to be ignored in a country that prides themselves on innovation, freedom and equality. The first step to solving an ongoing issue is realizing that there is a problem with the current situation.

bibliography

Anderson, Jeannine. “Boulder moves ahead in bid to create its own public power utility.” *American Public PowerAssociation*, September 30, 2013. https://www.publicpower.org/periodical/article/boulder-moves-ahead-bid-create-its-own-public-power-utility.

“Boulder Energy Future.” Energy Future. Accessed September 13, 2017. https://bouldercolorado.gov/energy-future.

“Beothuk Energy eyes Maritime Link for wind power conduit.” CBCNews, April 18, 2014. Accessed September 24, 2017. http://www.cbc.ca/news/business/beothuk-energy-eyes-maritime-link-for-wind-power-conduit-1.2542080.

Bill 61, 47th General Assembly Cong. (2012) (enacted).

Blackmore, G. C. *Sense of Place: Loss and the Newfoundland and Labrador Spirit*, . St. Johns, N.L.: Royal Commission on Renewing and Strengthening Our Place in Canada, 2003.

Breen, Katie. “Wind power for sale: Energy Company says N.L. should buy, stimulate west coast economy.” *CBC News*, June 13, 2016. Accessed April 1, 2017. http://www.cbc.ca/news/canada/newfoundland-labrador/wind-power-for-sale-energy-company-says-n-l-should-buy-stimulate-west-coast-economy-1.3628097.

Canada. Agriculture and Agri-Food Canada. Newfoundland and Labrador’s Agriculture Industry. Ottawa: Agriculture and Agri-Food Canada, 2013.

Canada. Department of Natural Resources Forestry and Agrifoods Agency. Wholesale and Other Opportunities In the Vegetable Industry of Newfoundland and Labrador. By Blaine Hussey. 2007.

Canada, Government Of Canada Statistics. “Canadian International Merchandise Trade (CIMT): Statistics Canada.” Government of Canada, Statistics Canada. January 02, 2018. Accessed January 02, 2018. http://www5.statcan.gc.ca/cimt-cicm/section-section?lang=eng&dataTransformation=0&refYr=2017&refMonth=7&freq=6&countryId=999&usaState=0&provId=10&retrieve=Retrieve.

Canada. Parliament. Senate. *Understanding freefall the challenge of the rural poor*. Ottawa: Senate, 2006.

Canada. The Way Forward: A vision for sustainability and growth in Newfoundland and Labrador. Government of Newfoundland Labrador.

Civic Center. "Electric Utility 10th Anniversary." News release, June 1, 2015. https://cityofwinterpark.org/docs/departments/electric-utility/10th-anniversary-presentation-2015-06-01.pdf.

Clayton, Anthony M. H., and Nicholas J. Radcliffle. *Sustainability: a systems approach.* London: Earthscan publications, 1997.

Cleo Research Associates. C*ollected research papers of the Royal Commission on Renewing and Strengthening Our Place in Canada*. Power Politics and Questions of Political Will: A History of Hydroelectric Development in Labrador's Churchill River Basin, 1949-2002. St. Johns, N.L.: Royal Commission on Renewing and Strengthening Our Place in Canada, 2003.

Climate Characteristics. 2014. Accessed September 24, 2017. http://www.heritage.nf.ca/articles/environment/seasonal.php.

"Climate Stephenville." Meteoblue. Accessed January 02, 2018. https://www.meteoblue.com/en/weather/forecast/modelclimate/stephenville_canada_6156244.

Cook, Mandy. "Sprung Up." *The Independent News,* November 23, 2007. Accessed September 25, 2017. https://issuu.com/theindependentdotca/docs/2007-11-23.

Control of potato diseases in Newfoundland. Ottawa: Dept. of Agriculture, 1968.

Copes, Parzival. *The Resettlement of Fishing Communities in Newfoundland*. Ottawa, 1972.

Dietary guidelines for Americans, 2015-2020. New York, NY: Skyhorse Publishing, 2017.

"Dietitians of Canada (Newfoundland and Labrador: Pre-Budget Recommendations." February 2016. Dieticians of Canada.

Differences. "Differences Between Publicly and Investor-Owned Utilities." California Energy Commission. Accessed December 23, 2017. http://www.energy.ca.gov/pou_reporting/background/difference_pou_iou.html.

"Dragons Den." In Newfoundland Hydroponic Lettuce Grow-Op. CBC. December 3, 2007.

Eating healthier in Newfoundland and Labrador: provincial food and nutrition framework and action plan (phase 1: 2005-2008). St. Johns, N.L.: Government of Newfoundland and Labrador, 2006.

"Economy." Town of Stephenville, Newfoundland. Accessed December 23, 2017. http://www.townofstephenville.com/visitors/economy/.

"Electricity Rates." NL Hydro | Power Your Knowledge. Accessed September 24, 2017. http://www.poweryourknowledge.com/rates.html.

"Fatter, not fitter, in N.L., study says." CBCNews, March 5, 2014. http://www.cbc.ca/news/canada/newfoundland-labrador/fatter-not-fitter-in-n-l-study-says-1.2560989.

Finnis, Joel. "An Atlas of Climate Change for the Island of Newfoundland." Atlantic Climate Adaptation Solutions Association, March 2012. Memorial University of Newfoundland.

"Fisheries and Land Resources." Soil Survey | Forestry and Agrifoods Agency. Accessed September 25, 2017. http://www.faa.gov.nl.ca/agrifoods/land/soils/soilsurvey.html.

Focusing our energy: Newfoundland Labrador energy plan. St. Johns, NL: Newfoundland and Labrador, 2007.

Food First NL. "Everybody Eats A Discussion Paper on Food Security in Newfoundland & Labrador." November 2015.

"Geoscience Resources of Newfoundland and Labrador." Geoscience Resources of Newfoundland and Labrador. Accessed January 02, 2018. http://gis.geosurv.gov.nl.ca/.

Government of Canada,Canadian Food Inspection Agency. “Greenhouse Vegetable Sector Biosecurity Guide.” Government of Canada,Canadian Food Inspection Agency. March 31, 2017. Accessed January 02, 2018. http://www.inspection.gc.ca/plants/plant-pests-invasive-species/biosecurity/greenhouse-vegetable-sector-biosecurity-guide/eng/1484722296145/1484722331070?chap=6.
Government of Newfoundland and Labrador, “Background on Churchill Falls,” (Churchill Falls Media Briefi ng October 9, 1996,) p.3.

Halseth, Greg. The next rural economies: constructing rural place in global economies. Wallingford: CABI Publ., 2010.

“Healthy Corner Stores NL.” Food First NL. Accessed September 23, 2017. http://www.foodfirstnl.ca/our-projects/healthy-corner-stores-nl.

Hender, F. *Soils of Stephenville: Port aux Basques map sheet, Newfoundland*. Ottawa: Research Branch, Agriculture Canada, 1989.

Heritage Partner Project. “Stephenville the American Influence.” Stephenville Introduction. Accessed December 23, 2017. http://www.heritage.nf.ca/articles/society/stephenville-introduction.php.

Higgins, Jenny. The Sprung Greenhouse. Accessed September 23, 2017. http://www.heritage.nf.ca/articles/politics/sprung-greenhouse.php.

Hough, Michael. *Cities and natural process: a basis for sustainability*. London: Routledge, 2006

House, J. D. *Against the tide: battling for economic renewal in Newfoundland and Labrador.* Toronto: University of Toronto Press, 1999.

Jacobs, J. *Cities and the Wealth of Nations: Principles of Economic Life*. New York: Rondom House, 1984.

James, Sarah, and Torbjörn Lahti. *The natural step for communities: how cities and towns can change to sustainable practices*. Gabriola Island, BC: New Society Publishers, 2008.

Jones, Lawrence E. *Renewable energy integration: practical management of variability, uncertainty, and flexibility in power grids*. London: Academic Press, an imprint of Elsevier, 2017.

Kay, James J., Henry A. Regier, Michelle Boyle, and George Francis. “An Ecosystem Approach for Sustainability: Addressing the Challenge of Complexity.” *Futures* 31, no. 7 (1999): 721-742.

Kean, Gary. “Beothuk Energy says it is ready to spend $1 billion to create new wind farm industry.” The Western Star , July 20, 2017. Accessed September 24, 2017. http://www.thewesternstar.com/news/local/2017/7/20/beothuk-energy-says-it-is-ready-to-spend--1-billion-to-create-ne.html#.
Martin, Melanie . “Resettlement.” Resettlement. July 2007. Accessed September 23, 2017. http://www.heritage.nf.ca/articles/politics/resettlement.php.

Kinsella, Stephanie. “Beothuk Energy lands European backer for wind farm on west coast.” *CBC News*, October 2, 2016.

Knútur Rafn Ármann and Helena Hermundardóttir. *Iceland: A Land of Greenhouses*. Islenskt grænmeti. Poster

“Lettuce, new houses, and the buzz at the corner store.” The Lettuce Farm. April 13, 2013. Accessed September 25, 2017. http://www.thelettucefarm.com/news.html.

Live here, work here, belong here: a communities action plan for Newfoundland and Labrador, 2015-2020. St. Johns, N.L.: Government of Newfoundland and Labrador, Department of Advanced Education and Skills, 2015.

Mannion, John J. *The Peopling of Newfoundland: essays in historical geography*. St. Johns, Nfld.: Institute of Social and Economic Research, Memorial University Newfoundland, 1990.

Maser, Chris. Sustainable community development: principles and concepts. Florida: St. Luice Press, 1997.

McMinn, John, and Marco Polo. *41° to 66°: regional responses to sustainable architecture in Canada*.

Cambridge, Ont.: Cambridge Galleries, Design at Riverside, 2005.

Myrick, Jeff. “Maritime Link Benefits Agreement Creates Local Economic and Employment Opportunities.” Emera Newfoundland & Labrador. November 26, 2014. Accessed December 31, 2017. http://www.emeranl.com/en/home/newsinformation/newsannouncements/Benefits-Agreement.aspx.

Nathan Rice, “Boulder, Colo., votes for energy independence -- from its utility,” *High Country News*, December 28, 2011.

Newfoundland and Labrador Statistics Canada. Annual Estimates of Population for Canada, Provinces and Territories. Sept 27, 2017. Raw data. http://www.stats.gov.nl.ca/statistics/population/

Paxton, Angela. The food miles report: the dangers of long-distance food transport. London: SAFE, 1994.

Pérez, Claudio E. 2002. “Fruit and vegetable consumption.” Health Reports. Vol. 13, no. 3. Statistics Canada. http://www.statcan.gc.ca/studies-etudes/82-003/archive/2002/6103-eng.pdf.

“Piccadilly Central High School - Home of The Pirates.” Accessed December 23, 2017. http://piccadillycentralhigh.weebly.com/about.html.

Place in Canada. A History of Hydroelectric Development in Labrador’s Churchill River Basin. St. Johns, N.L.: Royal Commission on Renewing and Strengthening Our Place in Canada, 2003.

Population projections for the City of St. Johns. St. Johns, NL: Economic Research and Analysis Division, Dept. of Finance, 2014.

Porthönnun. “About Friðheimar.” Friðheimar. June 07, 2013. Accessed September 25, 2017. http://fridheimar.is/en/about-fri%C3%B0heimar.

Power, Lauren. “Overcoming Insecurities: Food Security Network NL and the State of Food in our Province.” The Overcast: Newfoundland’s Alternative Newspaper, June 1, 2015. Accessed May 5, 2017. https://theovercast.ca/overcoming-insecurities-food-security-network-nl-and-the-state-of-food-in-our-province/.

Provincial Wellness Plan Report. Newfoundland and Labrador Centre for Health Information, 2014.

Pun, Ngai. *Social Economy in China and the World*. Abingdon, Oxon: Routledge, 2016.

Quinlan, A. James. *Building agricultural capacity in Newfoundland and Labrador.* St Johns, NL, Canada: The Leslie Harris Centre of Regional Policy and Development, Memorial University, 2012.

Race, Kayla. "What is Community Choice Energy?" Climate Action Campaign. July 19, 2017. Accessed December 23, 2017. https://www.climateactioncampaign.org/2015/07/01/what-is-community-choice-energy/.

Regional Energy Development. EmeraNL. http://www.emeranl.com/site/media/emeranl/Documents/Regional%20Energy%20Development170.pdf

Rennie, Rick. "Iron Ore Mines of Bell Island." Newfoundland Heritage Web Site. 1998. Accessed September 22, 2017. http://www.heritage.nf.ca/.

Resh, Howard M. *Hydroponic food production: a definitive guidebook of soilless food growing methods ; for the professional and commercial grower and the advanced home hydroponics gardener*. Santa Barbara, CA: Woodbridge, 1985.

Ricketts, Randy. *An overview of the Newfoundland and Labrador agrifoods industry: 2004.* Corner Brook, NL: Department of Natural Resources, 2004.

Risdon, James. "Beothuk signs deal with Copenhagen Infrastructure to develop wind farm in Newfoundland." *The Chronicle Herald*, September 28, 2016. Accessed September 22, 2017. http://thechronicleherald.ca/business/1400981-beothuk-signs-deal-with-copenhagen-infrastructure-to-develop-wind-farm-in-newfoundl.

Rural youth study, phase II: rural youth migration: exploring the reality behind the myths: a rural youth *discussion paper*. Ottawa, Ontario: Rural Secretariat, 2002.

Ryan, A. B. "Geology of the West Coast of Newfoundland." *Newfoundland Journal of Geological Education* v7, no. 2 (1983). Accessed September 25, 2017. http://www.nr.gov.nl.ca/nr/mines/outreach/education/westcoast.html.

Sherman, Charles Edward, and Hap Brenizer. *Hydroponic gardening at home*. Berkeley, CA: Nolo Press, 1975.

Skolnik, Michael L. *Viewpoints on communities in crisis*. St. Johns, Nfld: Institute of Social and Economic Research, Memorial University of Newfoundland, 1980.

Smith, Joshua Emerson . "Focus: More cities, counties choosing green energy sources." *The San Diego Union-Tribune*, August 4, 2016. Accessed September 1, 2017. http://www.sandiegouniontribune.com/news/environment/sdut-cca-california-community-choice-aggregation-2016aug14-story.html.

"The Sprung Greenhouse." The Sprung Greenhouse. Accessed December 23, 2017. http://www.heritage.nf.ca/articles/politics/sprung-greenhouse.php.

Stackhouse, Paul W., Jr. Atmospheric Science Data Center, NASA Surface meteorology and Solar Energy: Global Data Sets. Raw data. Newfoundland and Labrador. https://eosweb.larc.nasa.gov/cgi-bin/sse/global.cgi?email=skip@larc.nasa.gov.

Statistics Canada. 2011 and 1991 Population by province and territory (Newfoundland and Labrador). *Census*. February 4, 2011. Raw data.

Statistics Canada. Annual Estimates of Population for Canada, Provinces and Territories. Sept 27, 2017. Raw data. http://www.stats.gov.nl.ca/statistics/population/

Statistics Canada, Census of Agriculture, 2006 and 2011. http://www.statcan.gc.ca/pub/95-640-x/2011001/p1/p1-01-eng.htm. 2016-01-25

Statistics Canada, Estimates of Demographic Components, Newfoundland & Labrador, Demography Division. 1971-72 to 2015-16. Raw Data.

Statistics Canada, Net Interprovincial Migrants by Age Groups and Sex, Demography Division. 1971-72 to 2014-15. Raw Data. http://www.stats.gov.nl.ca/statistics/population/PDF/NetMig_AgeSex_BS.pdf

Statistics Canada. 2011. Population, urban and rural, by province and territory (Newfoundland and Labrador). Table. Statistics Canada 2011 Census of Population. *Census*. Last updated February 4, 2011. Raw data. http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/demo62b-eng.htm

Statistics Canada, Unemployment Rate, Monthly, Canada and Provinces, Labour Force Survey. Dec 1, 2017. Raw Data. http://www.stats.gov.nl.ca/statistics/labour/PDF/UnempRate_Monthly.pdf

"System Information." Newfoundland & Labrador Hydro. Accessed September 24, 2017. https://www.nlhydro.com/system-information/.

Thackara, John. *In the bubble: designing in a complex world*. Cambridge, MA: MIT Press, 2006.

Wadel, Cato. *Marginal adaptations and modernization in Newfoundland: a study of strategies and imlications in the resettlement and redevelopment of outport fishing communities*. St. Johns, NF: Inst. of Social and Economic Research, Memorial Univ., 1980.

Williamson, John. *Proposals for curbing the boom-bust cycle in the supply of capital to emerging markets*. Helsinki: UNU/WIDER, 2002.

"Wind." NL Hydro | Power Your Knowledge. Accessed September 24, 2017. http://www.poweryourknowledge.com/wind.html

Wizelius, Tore. *Windpower ownership in Sweden: business models and motives*. New York, NY: Routledge, 2014.

Woodrow, E. F. *Pedoclimatic zones of the island of Newfoundland.* St. Johns, Nfld.: Dept. of Agriculture, 1987.

Wright, Miriam. *Royal Commission on Renewing and Strengthening Our Place in Canada: consultation document: Newfoundland and Labrador History in Canada, 1949-1972*. St. Johns, NL: The Royal Commission, 2003.

Young, Victor L. *Collected research papers of the Royal Commission on Renewing and Strengthening Our Place in Canada*. St. Johns, N.L.: Royal Commission on Renewing and Strengthening Our Place in Canada, 2003.

appendix

Provincial Mapping

Fig. A.1 Economic Zones, 1 : 10,000,000

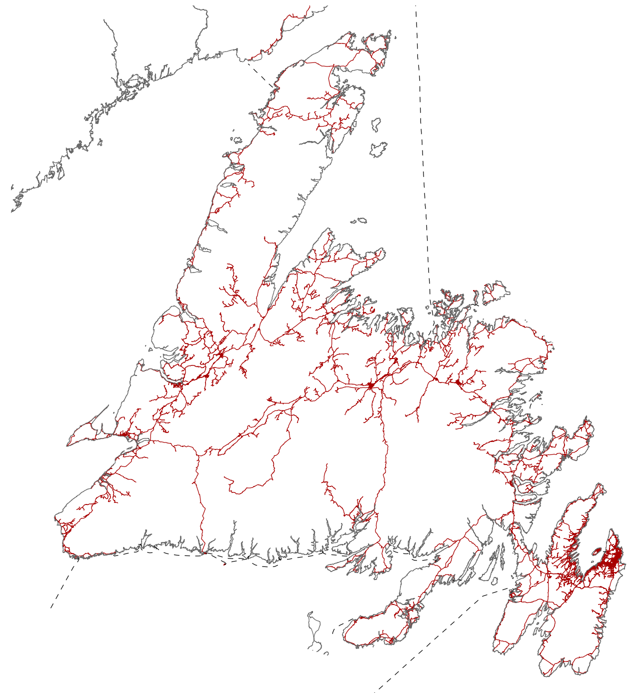


Fig. A.2 Transportation Network, 1 : 10,000,000

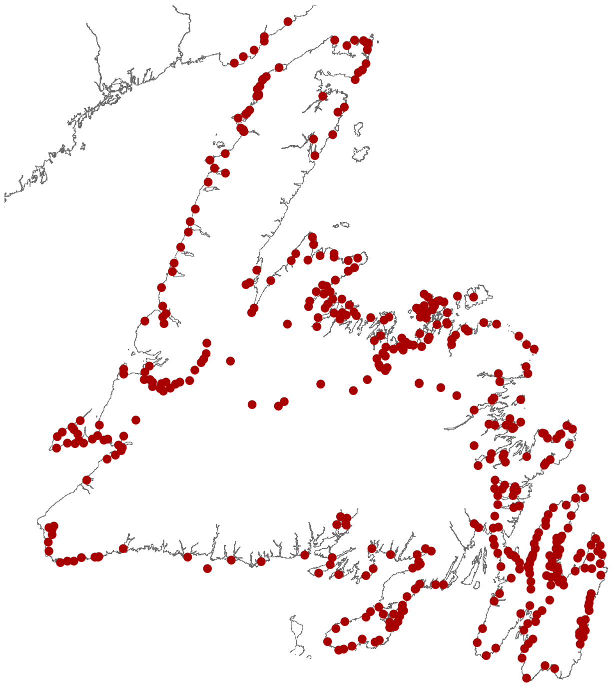


Fig. A.3 Communities, 1 : 10,000,000

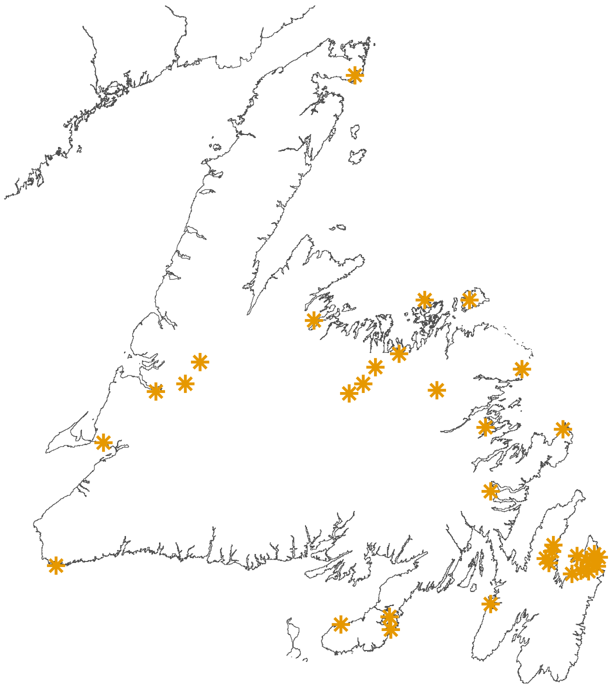


Fig. A.4 Communities over 2000 Population, 1 : 10,000,000

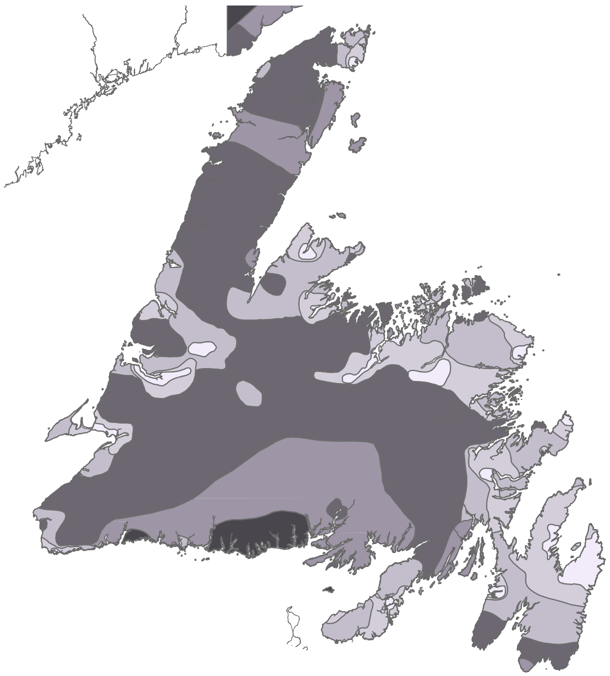


Fig. A.5 Remote Index, 1 : 10,000,000

Fig. A.6 100m Topography, 1 : 10,000,000

Fig. A.7 Hydrology, 1 : 10,000,000

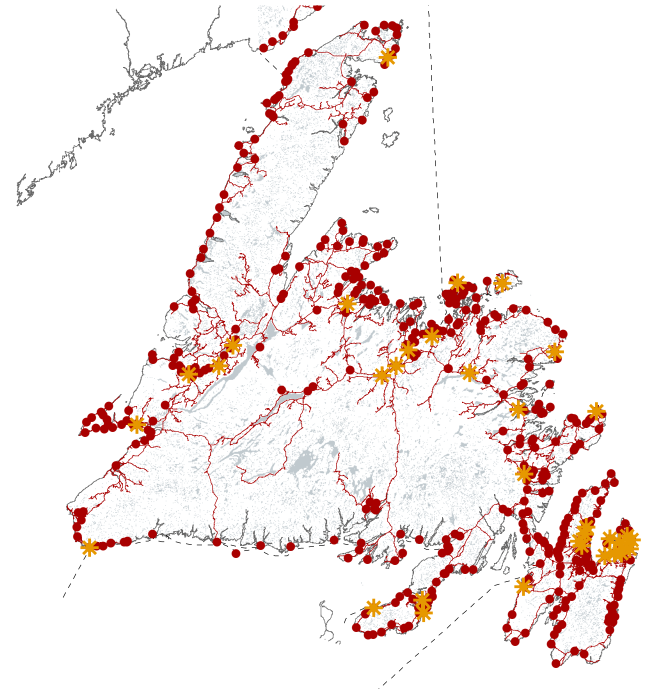


Fig. A.8 Composite, 1 : 10,000,000

Stephenville Network	total population	% population >15	0-3	4-8	9-13	14-18	19-30	31-50	51-70	71+
barachois brook	124	86.1	5	5	5	5	5	20	50	20
black duck	77	92	0	0	5	0	0	15	25	20
black duck brook-winterhouse	96	93.8	0	0	5	5	10	25	35	15
cambells creek	92	81.9	0	5	0	5	0	20	20	15
cape saint george	949	86.1	35	40	55	75	80	250	310	90
flat bay	229	88.1	5	10	10	15	20	65	90	10
fox island river-port au mal	194	86	10	5	15	10	20	50	55	25
gallants	59	93.2	0	5	0	5	0	0	30	5
kippens	1815	84.6	75	100	110	115	130	515	600	175
lourdes	532	85.2	35	25	25	25	60	125	175	65
Mainland	341	84.8	20	15	15	30	35	90	110	30
mattis point	129	82.7	5	10	5	20	15	50	30	5
picadilly head	139	82.7	5	10	10	0	10	40	40	20
piccadilly slant-abrahams cove	428	81.1	25	30	35	45	30	120	115	30
port au port east	598	87	20	25	30	35	50	135	225	85
port au port west-agnathuna-felix cove	447	90.6	10	15	20	30	25	120	180	60
sheaves cove	117	93.6	5	0	5	5	10	30	30	15
ships cove-lower cove-jerrys nose	308	85.4	5	15	30	15	25	90	100	30
st georges bay	1207	87.3	35	50	60	90	115	270	435	150
stephens crossing	1875	86.2	85	85	85	115	175	435	590	305
stephenville	6719	85.7	305	305	350	430	730	1680	2085	850
three rock cove	189	85.2	10	5	15	15	15	55	65	10
west bay	273	81.3	25	10	20	20	30	80	75	25
total in age group	16937	86.5	720	770	910	1110	1590	4280	5470	2055
approx. male			360	385	455	555	795	2140	2735	1027.5
approx. female			360	385	455	555	795	2140	2735	1027.5

Fig. A.9 Vegetable Count

Regional Food Distribution

average consumption

stephenville network	total population	% population >15	0-3	lettuce	tomato	carrot	potato	cabbage	legume	4-8	lettuce	tomato	carrot	potato	cabbage	legume
Barachois Brook	124	86.1	5	65	364	364	390	260	104	5	65	468	468	546	325	104
Black Duck	77	92	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black Duck Brook-Winterhouse	96	93.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Campbells Creek	92	81.9	0	0	0	0	0	0	0	5	65	468	468	546	325	117
Cape St. George	949	86.1	35	455	2548	2548	2730	1820	728	40	520	3744	3744	4368	2600	832
Flat Bay	229	88.1	5	65	364	364	390	260	104	10	130	936	936	1092	650	208
Fox Island River-Point au Mal	194	86	10	130	728	728	780	520	208	5	65	468	468	546	325	104
Gallants	59	93.2	0	0	0	0	0	0	0	5	65	468	468	546	325	104
Kippens	1815	84.6	75	975	5460	5460	5850	3900	1560	100	1300	9360	9360	10920	6500	2080
Lourdes	532	85.2	35	455	2548	2548	2730	1820	728	25	325	2340	2340	2730	1625	520
Mainland	341	84.8	20	260	1456	1456	1560	1040	416	15	195	1404	1404	1638	975	312
Mattis Point	129	82.7	5	65	364	364	390	260	104	10	130	936	936	1092	650	208
Piccadilly Head	139	82.7	5	65	364	364	390	260	104	10	130	936	936	1092	650	208
Piccadilly Slant-Abrahams Cove	428	81.1	25	325	1820	1820	1950	1300	520	30	390	2808	2808	3276	1950	624
Port au Port East	598	87	20	260	1456	1456	1560	1040	416	25	325	2340	2340	2730	1625	585
Port au Port West-Aguathuna-Felix Cove	447	90.6	10	130	728	728	780	520	208	15	195	1404	1404	1638	975	312
Sheaves Cove	117	93.6	5	65	364	364	390	260	104	0	0	0	0	0	0	0
Ship Cove-Lower Cove-Jerry's Nose	308	85.4	5	65	7.5	364	390	260	104	15	195	31.5	1404	1638	975	312
St. George's	1207	87.3	35	455	2548	2548	2730	1820	728	50	650	4680	4680	5460	3250	1040
Stephenville Crossing	1875	86.2	85	1105	6188	6188	6630	4420	1768	85	1105	7956	7956	9282	5525	1768
Stephenville	6719	85.7	305	3965	22204	22204	23790	15860	6344	305	3965	28548	28548	33306	19825	6344
Three Rock Cove	189	85.2	10	130	728	728	780	520	208	5	65	468	468	546	325	104
West Bay	273	81.3	25	325	1820	1820	1950	1300	520	10	130	936	936	1092	650	208

stephenville network	19-30	lettuce	tomato	carrot	potato	cabbage	legume	31-50	lettuce	tomato	carrot	potato	cabbage	legume
Barachois Brook	5	162.5	741	741	767	936	195	20	910	3042	3042	3536	4368	962
Black Duck	0	0	0	0	0	0	0	15	682.5	2281.5	2281.5	2652	3276	721.5
Black Duck Brook-Winterhouse	10	325	1482	1482	1534	1872	676	25	1137.5	3802.5	3802.5	4420	5460	1202.5
Campbells Creek	0	0	0	0	0	0	0	20	910	3042	3042	3536	4368	962
Cape St. George	80	2600	11856	11856	12272	14976	3120	250	11375	38025	38025	44200	54600	12025
Flat Bay	20	650	2964	2964	3068	3744	1352	65	2957.5	9886.5	9886.5	11492	14196	3126.5
Fox Island River-Point au Mal	20	650	2964	2964	3068	3744	780	50	2275	7605	7605	8840	10920	2405
Gallants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kippens	130	4225	19266	19266	19942	24336	5070	515	23432.5	78331.5	78331.5	91052	112476	24771.5
Lourdes	60	1950	8892	8892	9204	11232	2340	125	5687.5	19012.5	19012.5	22100	27300	6012.5
Mainland	35	1137.5	5187	5187	5369	6552	1365	90	4095	13689	13689	15912	19656	4329
Mattis Point	15	487.5	2223	2223	2301	2808	585	50	2275	7605	7605	8840	10920	2405
Piccadilly Head	10	325	1482	1482	1534	1872	390	40	1820	6084	6084	7072	8736	1924
Piccadilly Slant-Abrahams Cove	30	975	4446	4446	4602	5616	1170	120	5460	18252	18252	21216	26208	5772
Port au Port East	50	1625	7410	7410	7670	9360	3380	135	6142.5	20533.5	20533.5	23868	29484	6493.5
Port au Port West-Aguathuna-Felix Cove	25	812.5	3705	3705	3835	4680	975	120	5460	18252	18252	21216	26208	5772
Sheaves Cove	10	325	1482	1482	1534	1872	390	30	1365	4563	4563	5304	6552	1443
Ship Cove-Lower Cove-Jerry's Nose	25	812.5	73.75	3705	3835	4680	975	90	4095	306	13689	15912	19656	4329
St. George's	115	3737.5	17043	17043	17641	21528	4485	270	12285	41067	41067	47736	58968	12987
Stephenville Crossing	175	5687.5	25935	25935	26845	32760	6825	435	19792.5	66163.5	66163.5	76908	95004	20923.5
Stephenville	730	23725	108186	108186	111982	136656	28470	1680	76440	255528	255528	297024	366912	80808
Three Rock Cove	15	487.5	2223	2223	2301	2808	585	55	2502.5	8365.5	8365.5	9724	12012	2645.5
West Bay	30	975	4446	4446	4602	5616	1170	80	3640	12168	12168	14144	17472	3848

9-13	lettuce	tomato	carrot	potato	cabbage	legume
5	97.5	552.5	552.5	728	728	130
5	97.5	552.5	552.5	728	728	130
5	97.5	552.5	552.5	728	728	130
0	0	0	0	0	0	0
55	1072.5	6077.5	6077.5	8008	8008	1430
10	195	1105	1105	1456	1456	260
15	292.5	1657.5	1657.5	2184	2184	390
0	0	0	0	0	0	0
110	2145	12155	12155	16016	16016	2860
25	487.5	2762.5	2762.5	3640	3640	650
15	292.5	1657.5	1657.5	2184	2184	390
5	97.5	552.5	552.5	728	728	130
10	195	1105	1105	1456	1456	260
35	682.5	3867.5	3867.5	5096	5096	910
30	585	3315	3315	4368	4368	780
20	390	2210	2210	2912	2912	520
5	97.5	552.5	552.5	728	728	130
30	585	84	3315	4368	4368	780
60	1170	6630	6630	8736	8736	1560
85	1657.5	9392.5	9392.5	12376	12376	2210
350	6825	38675	38675	50960	50960	9100
15	292.5	1657.5	1657.5	2184	2184	390
20	390	2210	2210	2912	2912	520

14-18	lettuce	tomato	carrot	potato	cabbage	legume
5	97.5	624	624	728	637	130
0	0	0	0	0	0	0
5	97.5	624	624	728	637	130
5	97.5	624	624	728	637	130
75	1462.5	9360	9360	10920	9555	3705
15	292.5	1872	1872	2184	1911	390
10	195	1248	1248	1456	1274	260
5	97.5	624	624	728	637	130
115	2242.5	14352	14352	16744	14651	2990
25	487.5	3120	3120	3640	3185	650
30	585	3744	3744	4368	3822	780
20	390	2496	2496	2912	2548	520
0	0	0	0	0	0	0
45	877.5	5616	5616	6552	5733	1170
35	682.5	4368	4368	5096	4459	910
30	585	3744	3744	4368	3822	780
5	97.5	624	624	728	637	130
15	292.5	42	1872	2184	1911	390
90	1755	11232	11232	13104	11466	2340
115	2242.5	14352	14352	16744	14651	2990
430	8385	53664	53664	62608	54782	11180
15	292.5	1872	1872	2184	1911	390
20	390	2496	2496	2912	2548	520

19-30	lettuce	tomato	carrot	potato	cabbage	legume
5	162.5	741	741	767	936	195
0	0	0	0	0	0	0
10	325	1482	1482	1534	1872	676
0	0	0	0	0	0	0
80	2600	11856	11856	12272	14976	3120
20	650	2964	2964	3068	3744	1352
20	650	2964	2964	3068	3744	780
0	0	0	0	0	0	0
130	4225	19266	19266	19942	24336	5070
60	1950	8892	8892	9204	11232	2340
35	1137.5	5187	5187	5369	6552	1365
15	487.5	2223	2223	2301	2808	585
10	325	1482	1482	1534	1872	390
30	975	4446	4446	4602	5616	1170
50	1625	7410	7410	7670	9360	3380
25	812.5	3705	3705	3835	4680	975
10	325	1482	1482	1534	1872	390
25	812.5	73.75	3705	3835	4680	975
115	3737.5	17043	17043	17641	21528	4485
175	5687.5	25935	25935	26845	32760	6825
730	23725	108186	108186	111982	136656	28470
15	487.5	2223	2223	2301	2808	585
30	975	4446	4446	4602	5616	1170

51-70	lettuce	tomato	carrot	potato	cabbage	legume
50	2925	7670	7670	9100	12480	1820
25	1462.5	3835	3835	4550	6240	910
35	2047.5	5369	5369	6370	8736	1274
20	1170	3068	3068	3640	4992	728
310	18135	47554	47554	56420	77376	11284
90	5265	13806	13806	16380	22464	3276
55	3217.5	8437	8437	10010	13728	2002
30	1755	4602	4602	5460	7488	1092
600	35100	92040	92040	109200	149760	21840
175	10237.5	26845	26845	31850	43680	6370
110	6435	16874	16874	20020	27456	4004
30	1755	4602	4602	5460	7488	1092
40	2340	6136	6136	7280	9984	1456
115	6727.5	17641	17641	20930	28704	4186
225	13162.5	34515	34515	40950	56160	8190
180	10530	27612	27612	32760	44928	6552
30	1755	4602	4602	5460	7488	1092
100	5850	350	15340	18200	24960	3640
435	25447.5	66729	66729	79170	108576	15834
590	34515	90506	90506	107380	147264	21476
2085	121972.5	319839	319839	379470	520416	75894
65	3802.5	9971	9971	11830	16224	2366
75	4387.5	11505	11505	13650	18720	2730

71+	lettuce	tomato	carrot	potato	cabbage	legume
20	780	2782	2782	3588	3952	624
20	780	2782	2782	3588	3952	624
15	585	2086.5	2086.5	2691	2964	468
15	585	2086.5	2086.5	2691	2964	468
90	3510	12519	12519	16146	17784	2808
10	390	1391	1391	1794	1976	312
25	975	3477.5	3477.5	4485	4940	780
5	195	695.5	695.5	897	988	156
175	6825	24342.5	24342.5	31395	34580	5460
65	2535	9041.5	9041.5	11661	12844	2028
30	1170	4173	4173	5382	5928	936
5	195	695.5	695.5	897	988	156
20	780	2782	2782	3588	3952	624
30	1170	4173	4173	5382	5928	936
85	3315	11823.5	11823.5	15249	16796	2652
60	2340	8346	8346	10764	11856	1872
15	585	2086.5	2086.5	2691	2964	468
30	1170	103.5	4173	5382	5928	936
150	5850	20865	20865	26910	29640	4680
305	11895	42425.5	42425.5	54717	60268	9516
850	33150	118235	118235	152490	167960	26520
10	390	1391	1391	1794	1976	312
25	975	3477.5	3477.5	4485	4940	780

total lettuce	total tomato	total carrot	total potato	total cabbage	total legume
5102.5	8121.75	8121.75	19383	23686	4069
3022.5	4725.5	4725.5	11518	14196	2385.5
4290	6958.25	6958.25	16471	20397	3880.5
2827.5	4644.25	4644.25	11141	13286	2405
39130	65841.75	65841.75	155064	186719	35932
9945	16162.25	16162.25	37856	46657	9028.5
7800	13292.5	13292.5	31369	37635	6929
2112.5	3194.75	3194.75	7631	9438	1482
76245	127653.5	127653.5	301119	362219	66631.5
22165	37280.75	37280.75	87555	105326	19298.5
14170	24092.25	24092.25	56433	67613	12532
5395	9737	9737	22620	26390	5200
5655	9444.5	9444.5	22412	26910	4966
16607.5	29311.75	29311.75	69004	80535	15288
26097.5	42880.5	42880.5	101491	123292	23406.5
20442.5	33000.5	33000.5	78273	95901	16991
4290	7137	7137	16835	20501	3757
13065	499.125	21931	51909	62738	11466
51350	85397	85397	201487	243984	43654
78000	131459.3	131459.3	310882	372268	67476.5
278427.5	472439.5	472439.5	1111630	1333371	244660
7962.5	13338	13338	31343	37960	7000.5
11212.5	19529.25	19529.25	45747	54158	10296

Fig. A.10 Food Distribution Average Consumption minimum recommended intake

stephenville network	total population	% population >15	0-3	lettuce	tomato	carrot	potato	cabbage	legume	4-8	lettuce	tomato	carrot	potato	cabbage	legume
barachois brook	124	86.1	5	130	650	650	520	390	117	5	260	780	780	910	650	130
black duck	77	92	0	0	0	0	0	0	0	0	0	0	0	0	0	0
black duck brook-winterhouse	96	93.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
cambells creek	92	81.9	0	0	0	0	0	0	0	5	260	780	780	910	650	260
cape saint george	949	86.1	35	910	4550	4550	3640	2730	819	40	2080	6240	6240	7280	5200	1040
flat bay	229	88.1	5	130	650	650	520	390	117	10	520	1560	1560	1820	1300	260
fox island river-port au mal	194	86	10	260	1300	1300	1040	780	234	5	260	780	780	910	650	130
gallants	59	93.2	0	0	0	0	0	0	0	5	260	780	780	910	650	130
kippens	1815	84.6	75	1950	9750	9750	7800	5850	1755	100	5200	15600	15600	18200	13000	2600
lourdes	532	85.2	35	910	4550	4550	3640	2730	819	25	1300	3900	3900	4550	3250	650
Mainland	341	84.8	20	520	2600	2600	2080	1560	468	15	780	2340	2340	2730	1950	390
mattis point	129	82.7	5	130	650	650	520	390	117	10	520	1560	1560	1820	1300	260
picadilly head	139	82.7	5	130	650	650	520	390	117	10	520	1560	1560	1820	1300	260
piccadilly slant-abrahams cove	428	81.1	25	650	3250	3250	2600	1950	585	30	1560	4680	4680	5460	3900	780
port au port east	598	87	20	520	2600	2600	2080	1560	468	25	1300	3900	3900	4550	3250	1300
port au port west-agnathuna-felix cove	447	90.6	10	260	1300	1300	1040	780	234	15	780	2340	2340	2730	1950	390
sheaves cove	117	93.6	5	130	650	650	520	390	117	0	0	0	0	0	0	0
ships cove-lower cove-jerrys nose	308	85.4	5	130	10	650	520	390	117	15	780	52.5	2340	2730	1950	390
st georges bay	1207	87.3	35	910	4550	4550	3640	2730	819	50	2600	7800	7800	9100	6500	1300
stephens crossing	1875	86.2	85	2210	11050	11050	8840	6630	1989	85	4420	13260	13260	15470	11050	2210
stephenville	6719	85.7	305	7930	39650	39650	31720	23790	7137	305	15860	47580	47580	55510	39650	7930
three rock cove	189	85.2	10	260	1300	1300	1040	780	234	5	260	780	780	910	650	130
west bay	273	81.3	25	650	3250	3250	2600	1950	585	10	520	1560	1560	1820	1300	260

stephenville network	19-30	lettuce	tomato	carrot	potato	cabbage	legume	31-50	lettuce	tomato	carrot	potato	cabbage	legume
Barachois Brook	5	455	1495	1495	1430	1170	455	20	1820	5980	5980	5720	4680	1820
Black Duck	0	0	0	0	0	0	0	15	1365	4485	4485	4290	3510	1365
Black Duck Brook-Winterhouse	10	910	2990	2990	2860	2340	1170	25	2275	7475	7475	7150	5850	2275
Campbells Creek	0	0	0	0	0	0	0	20	1820	5980	5980	5720	4680	1820
Cape St. George	80	7280	23920	23920	22880	18720	7280	250	22750	74750	74750	71500	58500	22750
Flat Bay	20	1820	5980	5980	5720	4680	2340	65	5915	19435	19435	18590	15210	5915
Fox Island River-Point au Mal	20	1820	5980	5980	5720	4680	1820	50	4550	14950	14950	14300	11700	4550
Gallants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kippens	130	11830	38870	38870	37180	30420	11830	515	46865	153985	153985	147290	120510	46865
Lourdes	60	5460	17940	17940	17160	14040	5460	125	11375	37375	37375	35750	29250	11375
Mainland	35	3185	10465	10465	10010	8190	3185	90	8190	26910	26910	25740	21060	8190
Mattis Point	15	1365	4485	4485	4290	3510	1365	50	4550	14950	14950	14300	11700	4550
Piccadilly Head	10	910	2990	2990	2860	2340	910	40	3640	11960	11960	11440	9360	3640
Piccadilly Slant-Abrahams Cove	30	2730	8970	8970	8580	7020	2730	120	10920	35880	35880	34320	28080	10920
Port au Port East	50	4550	14950	14950	14300	11700	5850	135	12285	40365	40365	38610	31590	12285
Port au Port West-Aguathuna-Felix Cove	25	2275	7475	7475	7150	5850	2275	120	10920	35880	35880	34320	28080	10920
Sheaves Cove	10	910	2990	2990	2860	2340	910	30	2730	8970	8970	8580	7020	2730
Ship Cove-Lower Cove-Jerry's Nose	25	2275	137.5	7475	7150	5850	2275	90	8190	495	26910	25740	21060	8190
St. George's	115	10465	34385	34385	32890	26910	10465	270	24570	80730	80730	77220	63180	24570
Stephenville Crossing	175	15925	52325	52325	50050	40950	15925	435	39585	130065	130065	124410	101790	39585
Stephenville	730	66430	218270	218270	208780	170820	66430	1680	152880	502320	502320	480480	393120	152880
Three Rock Cove	15	1365	4485	4485	4290	3510	1365	55	5005	16445	16445	15730	12870	5005
West Bay	30	2730	8970	8970	8580	7020	2730	80	7280	23920	23920	22880	18720	7280

9-13	lettuce	tomato	carrot	potato	cabbage	legume
5	325	910	910	975	780	195
5	325	910	910	975	780	195
5	325	910	910	975	780	195
0	0	0	0	0	0	0
55	3575	10010	10010	10725	8580	2145
10	650	1820	1820	1950	1560	390
15	975	2730	2730	2925	2340	585
0	0	0	0	0	0	0
110	7150	20020	20020	21450	17160	4290
25	1625	4550	4550	4875	3900	975
15	975	2730	2730	2925	2340	585
5	325	910	910	975	780	195
10	650	1820	1820	1950	1560	390
35	2275	6370	6370	6825	5460	1365
30	1950	5460	5460	5850	4680	1170
20	1300	3640	3640	3900	3120	780
5	325	910	910	975	780	195
30	1950	112.5	5460	5850	4680	1170
60	3900	10920	10920	11700	9360	2340
85	5525	15470	15470	16575	13260	3315
350	22750	63700	63700	68250	54600	13650
15	975	2730	2730	2925	2340	585
20	1300	3640	3640	3900	3120	780

14-18	lettuce	tomato	carrot	potato	cabbage	legume
5	325	1430	1430	1300	1040	390
0	0	0	0	0	0	0
5	325	1430	1430	1300	1040	390
5	325	1430	1430	1300	1040	390
75	4875	21450	21450	19500	15600	8775
15	975	4290	4290	3900	3120	1170
10	650	2860	2860	2600	2080	780
5	325	1430	1430	1300	1040	390
115	7475	32890	32890	29900	23920	8970
25	1625	7150	7150	6500	5200	1950
30	1950	8580	8580	7800	6240	2340
20	1300	5720	5720	5200	4160	1560
0	0	0	0	0	0	0
45	2925	12870	12870	11700	9360	3510
35	2275	10010	10010	9100	7280	2730
30	1950	8580	8580	7800	6240	2340
5	325	1430	1430	1300	1040	390
15	975	75	4290	3900	3120	1170
90	5850	25740	25740	23400	18720	7020
115	7475	32890	32890	29900	23920	8970
430	27950	122980	122980	111800	89440	33540
15	975	4290	4290	3900	3120	1170
20	1300	5720	5720	5200	4160	1560

19-30	lettuce	tomato	carrot	potato	cabbage	legume
5	455	1495	1495	1430	1170	455
0	0	0	0	0	0	0
10	910	2990	2990	2860	2340	1170
0	0	0	0	0	0	0
80	7280	23920	23920	22880	18720	7280
20	1820	5980	5980	5720	4680	2340
20	1820	5980	5980	5720	4680	1820
0	0	0	0	0	0	0
130	11830	38870	38870	37180	30420	11830
60	5460	17940	17940	17160	14040	5460
35	3185	10465	10465	10010	8190	3185
15	1365	4485	4485	4290	3510	1365
10	910	2990	2990	2860	2340	910
30	2730	8970	8970	8580	7020	2730
50	4550	14950	14950	14300	11700	5850
25	2275	7475	7475	7150	5850	2275
10	910	2990	2990	2860	2340	910
25	2275	137.5	7475	7150	5850	2275
115	10465	34385	34385	32890	26910	10465
175	15925	52325	52325	50050	40950	15925
730	66430	218270	218270	208780	170820	66430
15	1365	4485	4485	4290	3510	1365
30	2730	8970	8970	8580	7020	2730

51-70	lettuce	tomato	carrot	potato	cabbage	legume
50	3900	12350	12350	11700	9750	3250
25	1950	6175	6175	5850	4875	1625
35	2730	8645	8645	8190	6825	2275
20	1560	4940	4940	4680	3900	1300
310	24180	76570	76570	72540	60450	20150
90	7020	22230	22230	21060	17550	5850
55	4290	13585	13585	12870	10725	3575
30	2340	7410	7410	7020	5850	1950
600	46800	148200	148200	140400	117000	39000
175	13650	43225	43225	40950	34125	11375
110	8580	27170	27170	25740	21450	7150
30	2340	7410	7410	7020	5850	1950
40	3120	9880	9880	9360	7800	2600
115	8970	28405	28405	26910	22425	7475
225	17550	55575	55575	52650	43875	14625
180	14040	44460	44460	42120	35100	11700
30	2340	7410	7410	7020	5850	1950
100	7800	450	24700	23400	19500	6500
435	33930	107445	107445	101790	84825	28275
590	46020	145730	145730	138060	115050	38350
2085	162630	514995	514995	487890	406575	135525
65	5070	16055	16055	15210	12675	4225
75	5850	18525	18525	17550	14625	4875

71+	lettuce	tomato	carrot	potato	cabbage	legume
20	1560	4940	4940	4680	3900	1300
20	1560	4940	4940	4680	3900	1300
15	1170	3705	3705	3510	2925	975
15	1170	3705	3705	3510	2925	975
90	7020	22230	22230	21060	17550	5850
10	780	2470	2470	2340	1950	650
25	1950	6175	6175	5850	4875	1625
5	390	1235	1235	1170	975	325
175	13650	43225	43225	40950	34125	11375
65	5070	16055	16055	15210	12675	4225
30	2340	7410	7410	7020	5850	1950
5	390	1235	1235	1170	975	325
20	1560	4940	4940	4680	3900	1300
30	2340	7410	7410	7020	5850	1950
85	6630	20995	20995	19890	16575	5525
60	4680	14820	14820	14040	11700	3900
15	1170	3705	3705	3510	2925	975
30	2340	135	7410	7020	5850	1950
150	11700	37050	37050	35100	29250	9750
305	23790	75335	75335	71370	59475	19825
850	66300	209950	209950	198900	165750	55250
10	780	2470	2470	2340	1950	650
25	1950	6175	6175	5850	4875	1625

total lettuce	total tomato	total carrot	total potato	total cabbage	total legume
8775	14267.5	14267.5	27235	22360	7657
5200	8255	8255	15795	13065	4485
7735	12577.5	12577.5	23985	19760	7280
5135	8417.5	8417.5	16120	13195	4745
72670	119860	119860	229125	187330	68809
17810	29217.5	29217.5	55900	45760	16692
14755	24180	24180	46215	37830	13299
3315	5427.5	5427.5	10400	8515	2795
140920	231270	231270	443170	361985	126685
41015	67372.5	67372.5	128635	105170	36829
26520	44102.5	44102.5	84045	68640	24258
10920	18460	18460	35295	28665	10322
10530	16900	16900	32630	26650	9217
32370	53917.5	53917.5	103415	84045	29315
47060	76927.5	76927.5	147030	120510	43953
36205	59247.5	59247.5	113100	92820	32539
7930	13032.5	13032.5	24765	20345	7267
24440	733.75	39617.5	76310	62400	21762
93925	154310	154310	294840	241475	84539
144950	238062.5	238062.5	454675	372125	130169
522730	859722.5	859722.5	1643330	1343745	472342
14690	24277.5	24277.5	46345	37895	13364
21580	35880	35880	68380	55770	19695

Fig. A.11 Food Distribution Minimum Required Intake upper range recommended intake

stephenville network	total population	% population >15	0-3	lettuce	tomato	carrot	potato	cabbage	legume	4-8	lettuce	tomato	carrot	potato	cabbage	legume
barachois brook	124	86.1	5	260	780	780	910	650	156	5	390	1430	1430	1300	1040	390
black duck	77	92	0	0	0	0	0	0	0	0	0	0	0	0	0	0
black duck brook-winterhouse	96	93.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
cambells creek	92	81.9	0	0	0	0	0	0	0	5	390	1430	1430	1300	1040	260
cape saint george	949	86.1	35	1820	5460	5460	6370	4550	1092	40	3120	11440	11440	10400	8320	3120
flat bay	229	88.1	5	260	780	780	910	650	156	10	780	2860	2860	2600	2080	780
fox island river-port au mal	194	86	10	520	1560	1560	1820	1300	312	5	390	1430	1430	1300	1040	390
gallants	59	93.2	0	0	0	0	0	0	0	5	390	1430	1430	1300	1040	390
kippens	1815	84.6	75	3900	11700	11700	13650	9750	2340	100	7800	28600	28600	26000	20800	7800
lourdes	532	85.2	35	1820	5460	5460	6370	4550	1092	25	1950	7150	7150	6500	5200	1950
Mainland	341	84.8	20	1040	3120	3120	3640	2600	624	15	1170	4290	4290	3900	3120	1170
mattis point	129	82.7	5	260	780	780	910	650	156	10	780	2860	2860	2600	2080	780
picadilly head	139	82.7	5	260	780	780	910	650	156	10	780	2860	2860	2600	2080	780
piccadilly slant-abrahams cove	428	81.1	25	1300	3900	3900	4550	3250	780	30	2340	8580	8580	7800	6240	2340
port au port east	598	87	20	1040	3120	3120	3640	2600	624	25	1950	7150	7150	6500	5200	1300
port au port west-agnathuna-felix cove	447	90.6	10	520	1560	1560	1820	1300	312	15	1170	4290	4290	3900	3120	1170
sheaves cove	117	93.6	5	260	780	780	910	650	156	0	0	0	0	0	0	0
ships cove-lower cove-jerrys nose	308	85.4	5	260	17.5	780	910	650	156	15	1170	75	4290	3900	3120	1170
st georges bay	1207	87.3	35	1820	5460	5460	6370	4550	1092	50	3900	14300	14300	13000	10400	3900
stephens crossing	1875	86.2	85	4420	13260	13260	15470	11050	2652	85	6630	24310	24310	22100	17680	6630
stephenville	6719	85.7	305	15860	47580	47580	55510	39650	9516	305	23790	87230	87230	79300	63440	23790
three rock cove	189	85.2	10	520	1560	1560	1820	1300	312	5	390	1430	1430	1300	1040	390
west bay	273	81.3	25	1300	3900	3900	4550	3250	780	10	780	2860	2860	2600	2080	780

stephenville network	19-30	lettuce	tomato	carrot	potato	cabbage	legume	31-50	lettuce	tomato	carrot	potato	cabbage	legume
Barachois Brook	5	585	1755	1755	1820	1560	650	20	2340	7020	7020	7280	6240	2600
Black Duck	0	0	0	0	0	0	0	15	1755	5265	5265	5460	4680	1950
Black Duck Brook-Winterhouse	10	1170	3510	3510	3640	3120	806	25	2925	8775	8775	9100	7800	3250
Campbells Creek	0	0	0	0	0	0	0	20	2340	7020	7020	7280	6240	2600
Cape St. George	80	9360	28080	28080	29120	24960	10400	250	29250	87750	87750	91000	78000	32500
Flat Bay	20	2340	7020	7020	7280	6240	1612	65	7605	22815	22815	23660	20280	8450
Fox Island River-Point au Mal	20	2340	7020	7020	7280	6240	2600	50	5850	17550	17550	18200	15600	6500
Gallants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kippens	130	15210	45630	45630	47320	40560	16900	515	60255	180765	180765	187460	160680	66950
Lourdes	60	7020	21060	21060	21840	18720	7800	125	14625	43875	43875	45500	39000	16250
Mainland	35	4095	12285	12285	12740	10920	4550	90	10530	31590	31590	32760	28080	11700
Mattis Point	15	1755	5265	5265	5460	4680	1950	50	5850	17550	17550	18200	15600	6500
Piccadilly Head	10	1170	3510	3510	3640	3120	1300	40	4680	14040	14040	14560	12480	5200
Piccadilly Slant-Abrahams Cove	30	3510	10530	10530	10920	9360	3900	120	14040	42120	42120	43680	37440	15600
Port au Port East	50	5850	17550	17550	18200	15600	4030	135	15795	47385	47385	49140	42120	17550
Port au Port West-Aguathuna-Felix Cove	25	2925	8775	8775	9100	7800	3250	120	14040	42120	42120	43680	37440	15600
Sheaves Cove	10	1170	3510	3510	3640	3120	1300	30	3510	10530	10530	10920	9360	3900
Ship Cove-Lower Cove-Jerry's Nose	25	2925	175	8775	9100	7800	3250	90	10530	630	31590	32760	28080	11700
St. George's	115	13455	40365	40365	41860	35880	14950	270	31590	94770	94770	98280	84240	35100
Stephenville Crossing	175	20475	61425	61425	63700	54600	22750	435	50895	152685	152685	158340	135720	56550
Stephenville	730	85410	256230	256230	265720	227760	94900	1680	196560	589680	589680	611520	524160	218400
Three Rock Cove	15	1755	5265	5265	5460	4680	1950	55	6435	19305	19305	20020	17160	7150
West Bay	30	3510	10530	10530	10920	9360	3900	80	9360	28080	28080	29120	24960	10400

9-13	lettuce	tomato	carrot	potato	cabbage	legume
5	585	1690	1690	1690	1365	585
5	585	1690	1690	1690	1365	585
5	585	1690	1690	1690	1365	585
0	0	0	0	0	0	0
55	6435	18590	18590	18590	15015	6435
10	1170	3380	3380	3380	2730	1170
15	1755	5070	5070	5070	4095	1755
0	0	0	0	0	0	0
110	12870	37180	37180	37180	30030	12870
25	2925	8450	8450	8450	6825	2925
15	1755	5070	5070	5070	4095	1755
5	585	1690	1690	1690	1365	585
10	1170	3380	3380	3380	2730	1170
35	4095	11830	11830	11830	9555	4095
30	3510	10140	10140	10140	8190	3510
20	2340	6760	6760	6760	5460	2340
5	585	1690	1690	1690	1365	585
30	3510	195	10140	10140	8190	3510
60	7020	20280	20280	20280	16380	7020
85	9945	28730	28730	28730	23205	9945
350	40950	118300	118300	118300	95550	40950
15	1755	5070	5070	5070	4095	1755
20	2340	6760	6760	6760	5460	2340

14-18	lettuce	tomato	carrot	potato	cabbage	legume
5	585	1755	1755	1820	1560	650
0	0	0	0	0	0	0
5	585	1755	1755	1820	1560	650
5	585	1755	1755	1820	1560	650
75	8775	26325	26325	27300	23400	5655
15	1755	5265	5265	5460	4680	1950
10	1170	3510	3510	3640	3120	1300
5	585	1755	1755	1820	1560	650
115	13455	40365	40365	41860	35880	14950
25	2925	8775	8775	9100	7800	3250
30	3510	10530	10530	10920	9360	3900
20	2340	7020	7020	7280	6240	2600
0	0	0	0	0	0	0
45	5265	15795	15795	16380	14040	5850
35	4095	12285	12285	12740	10920	4550
30	3510	10530	10530	10920	9360	3900
5	585	1755	1755	1820	1560	650
15	1755	105	5265	5460	4680	1950
90	10530	31590	31590	32760	28080	11700
115	13455	40365	40365	41860	35880	14950
430	50310	150930	150930	156520	134160	55900
15	1755	5265	5265	5460	4680	1950
20	2340	7020	7020	7280	6240	2600

19-30	lettuce	tomato	carrot	potato	cabbage	legume
5	585	1755	1755	1820	1560	650
0	0	0	0	0	0	0
10	1170	3510	3510	3640	3120	806
0	0	0	0	0	0	0
80	9360	28080	28080	29120	24960	10400
20	2340	7020	7020	7280	6240	1612
20	2340	7020	7020	7280	6240	2600
0	0	0	0	0	0	0
130	15210	45630	45630	47320	40560	16900
60	7020	21060	21060	21840	18720	7800
35	4095	12285	12285	12740	10920	4550
15	1755	5265	5265	5460	4680	1950
10	1170	3510	3510	3640	3120	1300
30	3510	10530	10530	10920	9360	3900
50	5850	17550	17550	18200	15600	4030
25	2925	8775	8775	9100	7800	3250
10	1170	3510	3510	3640	3120	1300
25	2925	175	8775	9100	7800	3250
115	13455	40365	40365	41860	35880	14950
175	20475	61425	61425	63700	54600	22750
730	85410	256230	256230	265720	227760	94900
15	1755	5265	5265	5460	4680	1950
30	3510	10530	10530	10920	9360	3900

51-70	lettuce	tomato	carrot	potato	cabbage	legume
50	5850	16900	16900	16900	13650	5850
25	2925	8450	8450	8450	6825	2925
35	4095	11830	11830	11830	9555	4095
20	2340	6760	6760	6760	5460	2340
310	36270	104780	104780	104780	84630	36270
90	10530	30420	30420	30420	24570	10530
55	6435	18590	18590	18590	15015	6435
30	3510	10140	10140	10140	8190	3510
600	70200	202800	202800	202800	163800	70200
175	20475	59150	59150	59150	47775	20475
110	12870	37180	37180	37180	30030	12870
30	3510	10140	10140	10140	8190	3510
40	4680	13520	13520	13520	10920	4680
115	13455	38870	38870	38870	31395	13455
225	26325	76050	76050	76050	61425	26325
180	21060	60840	60840	60840	49140	21060
30	3510	10140	10140	10140	8190	3510
100	11700	650	33800	33800	27300	11700
435	50895	147030	147030	147030	118755	50895
590	69030	199420	199420	199420	161070	69030
2085	243945	704730	704730	704730	569205	243945
65	7605	21970	21970	21970	17745	7605
75	8775	25350	25350	25350	20475	8775

71+	lettuce	tomato	carrot	potato	cabbage	legume
20	2340	6760	6760	6760	5460	2340
20	2340	6760	6760	6760	5460	2340
15	1755	5070	5070	5070	4095	1755
15	1755	5070	5070	5070	4095	1755
90	10530	30420	30420	30420	24570	10530
10	1170	3380	3380	3380	2730	1170
25	2925	8450	8450	8450	6825	2925
5	585	1690	1690	1690	1365	585
175	20475	59150	59150	59150	47775	20475
65	7605	21970	21970	21970	17745	7605
30	3510	10140	10140	10140	8190	3510
5	585	1690	1690	1690	1365	585
20	2340	6760	6760	6760	5460	2340
30	3510	10140	10140	10140	8190	3510
85	9945	28730	28730	28730	23205	9945
60	7020	20280	20280	20280	16380	7020
15	1755	5070	5070	5070	4095	1755
30	3510	195	10140	10140	8190	3510
150	17550	50700	50700	50700	40950	17550
305	35685	103090	103090	103090	83265	35685
850	99450	287300	287300	287300	232050	99450
10	1170	3380	3380	3380	2730	1170
25	2925	8450	8450	8450	6825	2925

total lettuce	total tomato	total carrot	total potato	total cabbage	total legume
12935	19045	19045	38480	31525	13221
7605	11082.5	11082.5	22360	18330	7800
11115	16315	16315	33150	27495	11141
7410	11017.5	11017.5	22230	18395	7605
105560	156422.5	156422.5	317980	263445	106002
25610	37960	37960	77090	63960	25818
21385	31590	31590	64350	53235	22217
5070	7507.5	7507.5	14950	12155	5135
204165	303095	303095	615420	509275	212485
59345	87945	87945	178880	147615	61347
38480	57102.5	57102.5	116350	96395	40079
15665	23497.5	23497.5	47970	40170	16666
15080	22425	22425	45370	37440	15626
47515	70882.5	70882.5	144170	119470	49530
68510	101205	101205	205140	169260	67834
52585	77577.5	77577.5	157300	130000	54652
11375	16737.5	16737.5	34190	28340	11856
35360	1021.25	52390	106210	88010	36946
136760	202247.5	202247.5	410280	339235	142207
210535	311642.5	311642.5	632710	522470	218192
756275	1120990	1120990	2278900	1885975	786851
21385	31622.5	31622.5	64480	53430	22282
31330	46475	46475	95030	78650	32500

Fig. A.12 Food Distribution Upper Range Intake

Vegetable Greenhouse Spacing

min required vegetables

usda category	crop	cups needed for udsa requirements	total amount cups needed	grams per cup of crop	grams per crop (medium)	total amount grams needed	crops required/ year
green	lettuce	2	2622360	50	150	131118000	874120
red/orange	carrots	1	2155302.5	128	61	275878720	4522601.967
red/orange	tomatoes	1	2155302.5	180	62	387954450	6257329.839
starch	potatoes	1	4120740	150	213	618111000	2901929.577
other	cabbage	1	3370055	89	908	299934895	330324.7742
legumes	peas	1	1182233	63	0.35	74480679	212801940

avg required vegetables

green	lettuce	2	1410630	50	150	70531500	470210
red/orange	carrots	1	1187572.75	128	61	152009312	2491955.934
red/orange	tomatoes	1	1187572.75	180	62	213763095	3447791.855
starch	potatoes	1	2799173	150	213	419875950	1971248.592
other	cabbage	1	3365180	89	908	299501020	329846.9383
legumes	peas	1	614614	63	0.35	38720682	110630520

max required vegetables

green	lettuce	2	3802110	50	150	190105500	1267370
red/orange	carrots	1	2816775	128	61	360547200	5910609.836
red/orange	tomatoes	1	2816775	180	62	507019500	8177733.871
starch	potatoes	1	5722990	150	213	858448500	4030274.648
other	cabbage	1	4734275	89	908	421350475	464042.3733
legumes	peas	1	1976819	63	0.35	124539597	355827420

crops required/ day	harvest time (days) / turnover	yield/ plant	space needed for one crop/ plant (cm2)	total plants required	total required space (cm2)	total required space (m2)
2394.849315	50		400	119742.47	47896986.3	4789.69863
12390.69032	70		36	867348.32	31224539.61	3122.453961
17143.36942	120	60000	3000	19667.135	59001405.94	5900.140594
7950.491993	50	10	1500	39752.46	59628689.95	5962.868995
904.9993814	50		2500	45249.969	113124922.7	11312.49227
583019.0137	50	120	20	4530908	90618159.45	9061.815945
1288.246575	50		400	64412.329	25764931.51	2576.493151
6827.276533	70		36	477909.36	17204736.86	1720.473686
9446.005082	120	60000	3000	10836.601	32509804.03	3250.980403
5400.681073	50	10	1500	27003.405	40505108.05	4050.510805
903.690242	50		2500	45184.512	112961280.2	11296.12802
303097.3151	50	120	20	2355508.2	47110163.1	4711.01631
3472.246575	50		400	173612.33	69444931.51	6944.493151
16193.45161	70		36	1133541.6	40807498.05	4080.749805
22404.75033	120	60000	3000	25703.072	77109215.63	7710.921563
11041.84835	50	10	1500	55209.242	82813862.63	8281.386263
1271.348968	50		2500	63567.448	158918621	15891.8621
974869.6438	50	120	20	7576158.8	151523176.4	15152.31764

A.13 Greenhouse Spacing