CONFERENCE ON SMALL SCALE INLAND & COASTAL SAIL FREIGHT

HUDSON RIVER MARITIME MUSEUM
KINGSTON, NY
5 NOVEMBER 2022

HUDSON RIVER MARITIME MUSEUM

HUDSON SAIL FREIGHT 2016 HUDSON, NEW YORK

Apollonia

The Center for Post Carbon Logistics

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Hudson River Maritime Museum
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Post Carbon Logistics

Cover Photo: Schooner *Apollonia* under sail off Port Ewen Bay, 24 July 2021.

Sponsored in part by the Maurice D. Hinchey Hudson River Valley National Heritage Area.

International Windship Association

Hudson River Maritime Museum
50 Rondout Landing
Kingston, NY 12401
N: 41° 55' 9" W: 73° 58' 47"
WWW.HRMM.ORG

CONFERENCE SCHEDULE

09:30
Welcome Address. Gavin Allwright.
10:00
Finding Cargo For Sail Freight. Brad Vogel
10:30
Zero Carbon First & Last Mile Transportation. Steven Woods.
11:00
Docking, Cargo Handling & Engine Use: Practical Challenges for the small Sail Freighter. Sam Merrett.
11:30
Rondout Riverport 2040: A Small Ports Toolkit For A Carbon Constrained Future. Andrew Willner.

12:00-1:30 PANEL DISCUSSION: Practicalities.

BREAK FOR LUNCH

2:00
Ship Shares, Patient Venture Capital Investment, and Community Supported Shipping (CSS).
Geoff Uttmark & Andrew Willner.
2:30
Diversity, Equity & Inclusion: Opportunities Within A Reemerging Industry. Tanya Van Renesse.
3:00
Scaling Sail Freight: An Open Access Model For Climate Crisis Response. Steven Woods.

3:30-5:00 PANEL DISCUSSION: Next Steps.

Presentations are scheduled for 20 minutes with 10 minutes for questions.
A 10 minute break is provided between each session.

PRESENTERS

GAVIN ALLWRIGHT
Gavin Allwright is the Secretary-General of the International Windship Association. The IWSA is a recognized IMO Consultative body on wind propulsion, and engaged in worldwide advocacy, planning, and implementation of maritime wind propulsion.

BRAD VOGEL
Brad Vogel has helped develop sail freight cargoes since 2019 and he has served as schooner *Apollonia*'s supercargo since June of 2021, handling cargo, logistics, docking, insurance, events, press, social media, sponsorships, partnerships, business development, strategy, and more with the ship's team. Initially inspired by Vermont Sail Freight, he met the *Apollonia* crew on the Hudson River in 2015 and gradually moved from diehard fan to part of the core leadership. He previously served briefly as a sail freight agent for *Grain de Sail*.

Vogel attended the University of Wisconsin at Madison for undergraduate and earned his law degree at Tulane University in New Orleans, where he served as Editor in Chief of the Tulane Maritime Law Journal. He currently runs a non-profit in New York City and recently retired as captain of the Gowanus Dredgers Canoe Club. A poet, he founded and runs the annual NYC Poets Afloats residencies and reading series aboard ships in New York Harbor, as well as the annual Gowanus Dawn Reading in canoes. He lives in Gowanus, Brooklyn at the bottom of the *Apollonia*'s run.

STEVEN WOODS
Steven Woods is the HRMM *Solaris* & Education Coordinator. He has worked in museums for over 20 years, & holds a Master of Science Degree in Resilient & Sustainable Communities. His Master's Thesis was on sail freight fleet strength requirements for supplying the New York Metro Area's minimum food needs by sail, and played a major part in the HRMM exhibit on Sail Freight. He was the lead author of a case study of the *Apollonia*'s climate impacts published in the *Journal Of Merchant Ship Wind Energy* in March of 2022.

CAPTAIN SAM MERRETT
Sam Merrett is the Captain of Schooner *Apollonia,* the only Sail Freighter currently operating in the US. USCG 100 Ton Master Mariner, Ship Owner, and Operator, Sam has a background in alternative energy conversions for diesel engines, and also works for the HRMM as *Solaris*' Managing Captain.

ANDREW WILLNER
Andrew Willner has been a leader, organizer, and advocate for the New York/New Jersey Bioregion for almost 40 years. He was an early proponent of the Waterkeeper model of water and habitat protection as the founder of NY/NJ Baykeeper. Andrew is The Executive Director of the Center for Post Carbon Logistics, and from 2008 to 2014 was the Principal Professional Consultant for energy, transportation, and the environment to the Hugo Neu Corporation.

Andrew is a sought-after speaker on a wide variety of subjects including climate, post carbon logistics, environmental advocacy, sustainability, permaculture and transition, and is often asked to read from his fiction and non-fiction writing.

PRESENTERS

GEOFF UTTMARK
Geoff Uttmark is founder and managing director of TransTech Marine Co. / ShipShares LLC, sister companies that work together to create a catalytic force for design and development of marine shipping projects and technologies that are green, empowering and sustainable. TransTech is the R&D side of the house, ShipShares builds investor support communities for transformative projects and disruptive technologies that often fall outside the purview of established venture capitalists.

The mantra of TT/SS is to first make a difference in the marine shipping industry and if this is done effectively and profitably, investor support will be found. Marine shipping is more than safe, efficient transport of cargoes; it is vital connectivity for continents, coasts, countries, companies and communities. To us, that's personal. So our business model is to design, build, operate smaller, greener ships that will call smaller ports (as well as large ones). Such ships must of course be competitive and profitable to attract investors. But dividends will go to all of society in the form of reduced carbon emissions, revitalized waterways, repurposed ports and renewed connectivity to the seas.

Geoff holds a USCG Master Mariner's License (200 GRT, ret.). He received MSC in Shipping, Trade & Finance (Honors thesis) from Bayes Business School, The City University, London, and BSc Marine Engineering/Economics from the University of Michigan.

In addition to operating TransTech/ShipShares LLC, Geoff has taught courses in all aspects of marine shipping technical design, economics and finance at the US Merchant Marine Academy, Columbia University, Stevens Institute of Technology and the University of Washington (Seattle).

CAPTAIN TANYA VAN RENESSE
Capt. Tanya van Renesse is a sailor and planning team member aboard sail freight Schooner *Apollonia*. When she is not on a cargo run, she is a captain aboard the Hudson River Maritime Museum's solar tour boat *Solaris* and a head sailing instructor for the museum's sailing school. Her loves of sailing and sustainable transportation started while pursuing her undergraduate degree in Environmental Policy and Economics at the University of California, Santa Cruz, where she served as the Student Environmental Center's Sustainable Transportation Campaign Coordinator and sailed on the school's varsity sailing team. She has been thrilled to watch as sail freight creeps its way into public consciousness and is grateful for the opportunity to speak about her passions at this conference!

PANELISTS

DAVID BORTON, Ph.D.
Dr Borton is the CEO and founder of Solar Sal Boats, which produces 100% Solar-Powered electric vessels for passenger and cargo use. The Solar Sal 27 successfully made the Inside Passage to Alaska in 2020, and the Solar Sal 24 was victorious in the Micro Category of the 2022 Northeast Grain Race. Earlier prototypes moved a significant amount of cargo on the New York State Canal system, and the Solar Sal design is in routine use with the HRMM's tour boat *Solaris*. Dr Borton is also a professor at Rensselaer Polytechnic Institute in Troy, NY.

CAPT. ROBERT KUNKEL
Captain Kunkel operates Harbor Harvest and their hybrid-electric cargo catamaran, the *Captain Ben Moore*. Harbor Harvest operates markets supplied across the Long Island Sound by local farmers, fishermen, and other food producers. He has a long history of advisory and governmental positions relating to coastal cargo and wind power work.

RIK VAN HEMMEN
Rik van Hemmen is president and senior partner of Martin, Ottoway, van Hemmen, and Dolan, INC. He has considerable experience in the maritime field, with significant interest in wind propulsion and coastal trade. He is a Fellow of the Society of Naval Architects and Marine Engineers, and the National Academy of Forensic Engineers.

TIANNA KENNEDY
Tianna Kennedy is a long time supporter of sail freight, including involvement with both the Vermont Sail Freight Project in 2013-2014, and Schooner *Apollonia*. She is a farmer in the Northern Catskills, has significant experience in Community Supported Organic Agriculture, and agricultural and environmentally related social justice initiatives.

VISITING VESSELS:

Schooner *Apollonia*
The Only Sail Freighter operating in the US. 64 foot LOA, 10 CDWT Capacity.
Bald-headed, 2-masted Schooner, home port Hudson, NY.
J. Murray Watts design, built at Baltimore in 1946.

M/V *Captain Ben Moore*
An Electric-Hybrid 64 Foot Catamaran with 10 CDWT Capacity.
Home Port of Norwalk, CT.

Solar Vessel *Solaris*
The Only 100% Solar Powered Coast Guard Inspected Passenger Vessel.
The tour boat of the Hudson River Maritime Museum, at her home port.

ABSTRACTS

Finding Cargo For Sail Freight
Finding cargo for sail freighters is a process which requires considerable work and coordination. Historically, this was undertaken by professional brokers, but this portion of the infrastructure of small scale coastal trade disappeared over a century ago. Looking at the modern situation, there is also the problem of motivating shippers to choose a slower and possibly more expensive mode of transport. The challenges of finding and securing cargo at economically viable volumes will be reviewed and methods of addressing these in the absence of a formal brokerage will be examined.

Zero Carbon First & Last Mile Transportation
Moving cargo by sail is a low-to-no carbon endeavor, but the carbon impact of transport between origin or destination and the docks is frequently not. In light of this concern, several opportunities present themselves for reducing or eliminating the carbon impact of first and last mile transport on land. These options are different based on the ranges and environments involved, and can use either Organic or Contract transport depending on local circumstances.

Docking, Cargo Handling & Engine Use: Practical Challenges for the small Sail Freighter.
Between docks, other than monitoring cargo, there's little to differentiate a sail freighter from any other sailboat. However, finding workable docks, handling occasionally awkward cargoes, and keeping engine use to a safe minimum are all significant challenges for sail freighters. This is especially true on inland waterways with strong currents and inconsistent winds. Picking weather windows and anchoring are important tools. Cargo handling at public parks, without shore gear or even purpose-built ship's gear add another challenge once a dock is reached. Circumstances on different routes will vary significantly, but we will address some common challenges.

Rondout Riverport 2040, a small ports toolkit for a carbon constrained future
Rondout Riverport 2040, a small ports toolkit for a carbon constrained future, proposes a pragmatic and prosperous vision for the near future with transformed Hudson River small ports, boasting shores lined with leading-edge and heritage maritime commerce that profit and engage while allowing for an equitable transition beyond fossil fuels.

Rondout Riverport will offer increased capacity, be significantly more compact, and more resilient than the current patchwork of land uses found on today's waterfronts. The mission of tomorrow's ports is the post-carbon maritime transport of goods and people up and down the Hudson River and beyond. They are designed to attract shipping, distribution, commerce, food processing, and craft businesses. The result: regenerative working waterfronts — gateways to the Hudson Valley and the world.

The ports' versatility will depend on the linking of their economic opportunities with environmental restoration, sustainable commerce, and training centers. This multi-generational project will also be a source of inspiration for broader long-term action on climate change. The path to a regenerative future starts with community engagement and data collection, planning, and implementation of an actionable vision, one that incorporates a sense of community and place, local stewardship, and widely shared economic opportunity.

ABSTRACTS

Ship Shares, Patient Venture Capital Investment, & Community Supported Shipping (CSS)
Ocean shipping is one of the first industries where ship finance became a comparative advantage. The practice of dividing ownership of a ship into sixty-four shares originated in medieval Italy, stemming from unique risks and rewards in maritime ventures that required community investment. From Italy the practice spread across Europe where share offerings launched some of the most successful maritime ventures in history, including the Dutch East India Company and the Hudson Bay Company.

Whaling ships were built and outfitted by selling shares, and Maine coal schooners were financed by shares. Typically, a share was 1/64 the cost of building, but as the size of ships and costs grew, shares were 1/256 in some cases. Some portions of the shares were given to "widows and orphans" of mariners as charity. Crowdfunding is the contemporary version of selling shares in a ship.

What if instead of the usual "venture capital" model the ship, its managing company, and in some cases the cargo was owned by the community in which it operates? The contemporary method of the community having a share in a ship, or a shipping venture is through Community Supported Shipbuilding (CSS). This consists of a community of individuals who pledge to support the building of a ship which becomes, either legally or spiritually, the community's ship, with the builders, and shippers providing mutual support and sharing the risks and benefits of shipping goods by water.

Like Community Supported Agriculture (CSA)s, CSSs create direct connections between producers and consumers and the members and owners share the risk of shipbuilding and shipping. The goals model is to have the producer and consumer to come into the market as equals and make an exchange with fair prices and fair wages.

The vision is for the Hudson Valley to become the leader in impact investing in the marine shipping space. We can do this by leading or joining maritime transport initiatives that have strong social and environmental merit in addition to positive traditional financial metrics, and by research, design, and identification of potential "game-changer" technologies. The emphasis in all endeavors is to advance local or regional social benefit projects or disruptive maritime technologies with local, investment expertise and local capital to maximize the impact of investment.

Financing for vessel construction and re-purposing could come from a variety of sources:

- Federal Ship Financing Program (Title XI)
- community support
- crowd funding (ship shares)
- public agencies and entities
- and private start up investment.

ABSTRACTS

Diversity, Equity, and Inclusion: Opportunities Within a Reemerging Industry.
Anyone who spends time on the water in most places in this country will quickly notice a theme among seafarers: They are predominately wealthy, cis white men. In the past century, aligning almost exactly with the decline of traditional sail freight, the sailing industry has transitioned from a haven for diversity to a white dominated space in this country. Women, on the other hand, have never truly been included in maritime trade. Though the present state of inclusion in the maritime industry may seem grim, the reemergence of sail freight has presented a tremendous opportunity; a clean slate.

In her short talk, Tanya van Renesse will analyze the current state of the maritime trade and sailing industries in terms of diversity, equity, and inclusion, and present some strategies for moving mindfully ahead.

Scaling Sail Freight: An Open Access Model For Climate Crisis Response.
Sail Freight is only a meaningful change in economic or carbon emissions terms if it achieves statistical significance in trade volume. The key to expanding a coastal and inland "Mosquito Fleet" is spreading knowledge, building infrastructure, and inspiring people to simply do something. This can be facilitated and encouraged through engagement with a wide variety of citizens with a wide variety of motivations; ecological, political, financial, or otherwise. Creating the resources and removing barriers to starting a sail freight business and make small ports better suited to sail freight operations can be organized and accelerated using Anarcho-Communist methods such as open-source plans, open access publishing, affinity activism, mutual aid, and the creative commons.

PAPERS INCLUDED

The papers contained in the following section were submitted by the Authors for inclusion in these proceedings. Any previously published paper will have all pertinent information included here. Not all papers, slides, and presentations from the Conference are included in this volume.

CONTENTS:

Citation: Author, "Title." *Proceedings Of The Conference On Small Scale Inland And Coastal Sail Freight.* Kingston: Hudson River Maritime Museum, 2022.

Danube Clean Cargo: Prefigurative Experiments and Arts-based Research

Time's Up

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Abstract

In 2020 we, the arts-collective Time's Up, commenced a small pilot program for food deliveries on the Danube river in Austria. While the pilot had to be suspended for various reasons, we find it valuable to talk about our results; what we learnt, what we experienced, the images that arose. The pilot does not exist in isolation, but is part of a larger imagination and development of clean transport. By clean we mean free of fossil fuel usage.

The Danube is one of the living connections of central and eastern Europe, and has been a cargo carrying avenue for centuries. Ocean going vessels were able to reach Belgrade from the Black Sea. The Danube upriver of Belgrade is classed as "mountainous" due to its flow speed, traditionally only paddled or poled vessels could stem the flow; most vessels were one way downstream deliveries of wood, salt and other basics.

Since the regulation of the Danube and the creation of multiple dams and locks, the river is, to a certain degree, "tamed." In the slow flowing sections behind dams, there are even some recreational sailors. Transport is nevertheless almost entirely in the hands of large motorised barges.

The river is also blessed with an extensive floodplain, filled with vibrant farms. Close to Linz, there is a local organic food supplier who uses, for the last mile deliveries, cargo bikes. As an experiment, we looked at what it would mean to replace the road section from the upriver floodplains into the urban area of Linz with small sail cargo deliveries.

We invested time and effort in collaboration with various partners to develop the logistics of deliveries, ordering and sorting, cooling, movement, loading and unloading. In the end, the lack of a verifiable refrigeration system was deemed an insurmountable challenge for food safety. We were left with plans and analyses, experiments and test runs but no actual data. The project was, to use Foucault's term, somewhat too *Heterotopic* to be realisable, but remained a sort of parallel or post-neoliberal economic order along the lines of J.K Gibson-Graham, a prefiguration of a possible, low carbon future, an example of less efficiency effectiveness.

In this report we would like to share the insights and experiences, and contextualise the project in terms of futures thinking, heterodox economics, arts practices and the sail cargo community.

Keywords: Danube, Inland Cargo, Clean Cargo, Sail-Electric Transport, Arts-based research, Futuring, Scenarios, Experiential Futures

Introduction

In 2020, confronted by a lack of other public avenues to explore our work on experiential speculative futuring, we as Time's Up decided to undertake an experiment. What if, we wondered, we wanted to use the Danube as a conduit for clean transport? Echoing the work of the trans-Atlantic efforts of Tres Hombres, Gallant, Avontuur and the brand new Grain de Sail (amongst others), was there an inland waters approach to clean cargo that made any sense? What sort of sense-making could we derive from such thoughts and experiments? What are the hurdles, what are the benefits, does it make a difference, can it even be done safely?

The project was not developed as a pilot for some investment. We were not in a position to be able to carry on the project in some ever expanding way and that was not our objective. However the project was meant to be seriously undertaken, to place some stakes in the sand to say what was possible, to explore options, to see what happens if, to act as if this was an actual thing.

The planned project was to temporarily replace part of the existing logistics system bringing locally grown organic food to the city of Linz and its surrounding towns and suburbs. The diesel powered trucks would be replaced by a sail and electric powered small vessel. Through a series of these replacement actions, each carefully delineated, a framework for this kind of transport could be envisioned, experienced, reflected upon and imagined.

We sat with the food companies leader and discussed the ideas and the possibilities, the histories in the area and how this should work. We developed collaborations with partners at the Frauenhofer Institute in German with an interest in sail cargo and clean transport, and with Lorenz Köll of the Green Energy Center Europe, who was already working with the food supply company. We worked together with the zero emission last mile service provider Gerald Dehmer who had been working with the company for years. With these partners we were able to discuss the ideas of clean transport in quite some detail, where clean is principally to do with fossil fuels, but extends into other ideas of clean.

In spite of careful planning, the project collapsed for a very simple reason. The cold chain. In order to deliver food supplies, there needs to be a reliable, documented cold chain so that all foodstuffs arrive in a safe state. In the pandemic year of 2020, when home deliveries of household goods were exploding and the logistics system with which we were working was under duress, it was not the time to undertake any experiments that might interfere and cause any further disruption.

In this report, we would like to share some of the insights from the project. On one hand there is the pilot project, the elements of "can this work" as a technical feasibility study. There are the implied and possible extensions and further developments that are indicated by the investigations. There are the drab aspects of limits to feasibility. As the project emerged as a result of our investigation of a swathe of developments in a context of futures speculation, we would like to share some of the ideas and tools from that area of activity. This project was a deep dive into the possibilities of river based freight, what it means, what it implies, where it comes from and where it is going.

There are many ways to read this report. The linear way will take you from a short look into the past and present of transport on the Danube, the river in a larger context and what has happened to it. You will then be taken through the project itself and our investigations, the results we had, and then the emerging visions that remain in spite of the failure of the project itself. Placing the project in its arts-based research context, we outline several arts projects on the Danube, and a look back to the arts-based research project *Control of the Commons*, which foreshadows this project in many ways.

There is probably no correct order to read this report in. It is clearly not the case that the vision preceded the experience, nor did the vision emerge from the experience / experiment like an egg from a chicken. Rather the two co-evolved into a form that begins to make sense.

Future is a Verb

In this section, we would like to share with you some of the ideas around futuring, forecasting and futures literacy.

When people hear about The Future, too often their imaginations are filled with science fiction ideas, apocalypse, paradise or some strange mixture of these standard tropes. The role of the futurist is taken to be the role of the oracle, the soothsayer, who can determine what the future will look like. This is unfortunately untrue. The futures expert Jim Dator at the University of Hawaii likes to say that "The future cannot be predicted because the future does not exist" (Dator 2019).There are multiple ways to think about this. One is that the few predictions that we can make are to do with the times of sunrises and phases of the moon; the motion of celestial bodies is perhaps the one core predictable part of the universe. Anything more complex, from weather to fruit pickings, fashion, technology or sports events, cannot be reliably predicted. In almost all human endeavours there are multiple ways that the developments can play out. This interpretation, saying that there are more than one futures available, is perhaps the most useful.

The strength of Dator's work, and the work of many other futures practitioners, is to enable us to find ways to think about possible futures, in the plural. Or better: to think out loud, together, in exchange, about possible futures. There are many processes to assist in this thinking (Smith and Ashby 2020; Schwartz 1998) and many resources (FoAM 2015). Futures are by necessity fundamentally interdisciplinary and thus require multiple inputs, points of view and understandings in order to be developed. Group work and thinking out loud is vital. Because no one can be right (although sometimes futures practitioners find older work that is remarkable, but coincidentally, prescient) there is no point arguing, the process is not about honing in on a correct prediction, but rather developing understandings of the possibilities that can emerge in the future. Thus we often speak about future as a verb, something that ones does, that one practices; we undertake futuring exercises. We speak also of futures literacy, an ability to think out loud, coherently and together, about possible futures, preferred and feared futures, to imagine, speculate, contemplate and reason about possible futures (Miller 2018)**.**

It can be claimed that seamanship is a form of futuring. On a non trivial journey, the actual conditions that will be encountered cannot be known in advance. Good seamanship is about having imagined many scenarios, developed possible reactions to them and gone about making sure that the vessel and crew are prepared. While one would not want to belabour this analogy, it might be said that a fossil fuel driven vessel requires less futuring, less seamanship, because one can point the vessel where you want to go and ignore many of the capricious nature of the weather. One might even think of McWhirr (Conrad 1902) and his rejection of anything but that which he sees and experiences.

One of the interim results of a futuring process can be a scenario. A scenario is roughly an imagination of a possible future state of the world, or the part of the world that we are interested in. For instance a town in an industrial area might lose its employment base through technological revolutions and then company closure, the ensuing improvement in air and water quality leads to an emergent tourism industry and a scenario of ecotourism for the town. Another scenario has all young people leaving the town, a slow death of the community as human resources dwindle, infrastructure collapses and the town shrivels. Such bullet-point scenarios can be useful for short imaginations or developing policy, but are hard to communicate and to understand, with little investigation of the implications for everyday life or the actual processes of the scenario. Some ways to go on are to develop visualisations of the scenarios, which in the example above might include dive boats operating on the regenerated reef off the coast, wineries on the bank of the formerly polluted river and lush forests. Another approach is to create narratives of the possible future, whether narrative fragments, short stories or entire novels. *The Ministry for the*

Future (Robinson 2020) is a recent example, with the speculations of a possible future brought close by emotionally laden storytelling and narration, even from the point of view of non-human "characters" in order to broaden the perspectives.

Deriving from the age old claim, well known from apprenticeships and other action oriented learning approaches, we like to say that when it comes to possible futures:

"I hear futures and I forget; I see futures and I remember; I do futures and I understand."

The field of *Experiential Futures* aims to bridge the "gap between the ground of present sensation and islands of abstract possibility"(Candy and Dunagan 2016) in order to better understand possible futures. The expression *experiential futures* was coined by Stuart Candy (Candy 2010) and includes a range of activities that help us use our bodies and sensations to better understand possible futures (Candy et al. 2019). Artefacts such as those from Extrapolation Factory and the Near Future Laboratory, newspapers (Near Future Laboratory and Scott Smith 2014), design objects (Dunne and Raby 2013), and experiences such as meals (Fruhstorfer 2017), smells (Ginsberg 2019) (Ginsberg, Alexandra Daisy 2019), apartments (Superflux 2017), museums (Time's Up 2021) or towns (Time's Up 2017). When the future is present and we are embedded (Kuzmanovic et al. 2019) then many of the scepticisms are turned off and the ability to think further about the scenario is enhanced.

At Time's Up our work has always been about experiences and embeddings, inviting and encouraging audiences to become visitors and explore, even participate in the environments we create. Thus the field of experiential futures was a natural area of investigation for us. The Turnton world was developed in an extensive futuring process, deriving from an assumption that the ecological destruction that is currently ongoing will not be stopped soon, but that once the damage became clear (too late for many) that society would respond with significant sociopolitical changes to mitigate the effects and adapt to the changes. In some sense, we assumed a dystopia and embraced it with a utopia, using futuring processes to develop understandings of how these two classes of developments could intertwine.

Turnton started as a process of futures exploration, using the Causal Layered Analysis techniques of Sohail Inayatullah (2004) to investigate questions around luxury. This was developed in contexts of oceans, travel, maritime ecosystems, clean cargo, migration, regenerative agriculture and many other fields to end up with a scenario that utilised a plethora of factors. Creating the organisations, social structures, characters, interactions and history that portrayed the storyworld of Turnton was a next level of development, before we begun imaging experiences as situations that would exist in Turnton and then created the experiences by building the stuff that the exhibitions are made up of. This process of creating an experience of a possible future is based upon Stuart Candy and Jake Dunagan's Experiential Futures Ladder (Candy and Dunagan 2016) with the explicit added step of creating a storyworld, a fictionalised understanding of the dynamics of the world. The process is of course not that linear, with the development of scenarios and stuff necessitating further development of the storyworld and the scenario, which effect other situations, etc.

Exhibitions of fragments of Turnton have included the docks and an Ocean Recovery Farm, cargo areas and detoxification stations for seafarers exposed to the off-gassing of algal blooms, the Medusa Bar (all good harbours have a bar and that is where the best stories emerge), a pod hotel, train station and an art gallery. Turnton exhibitions portray everyday life in this possible future (Foster 2013), as we understand that the high level implications of futures thinking are interesting, but the effects that developments might have on our actual, lived lives are much more important and vital.

Within the development of Turnton, we investigated many elements of trade and transport; from these emerged an interest to further investigate the possible futures of transport on inland waters.

Traditional and modern transport on the river Danube

The Danube is the longest river in central Europe. It was the northern border of the Roman empire. It flows sometimes along what used to be the coastline of the Tethys sea, the vast ocean that was bordered by the granite of the Bohemian mound and whose calciferous deposits form the Alps, the islands of the Mediterranean and the coast of northern Africa. The Danube is classed as “mountainous” from the origins until it reaches Belgrade, due to the slope of the river as it flows towards the Black Sea. The Danube encounters ten countries, acting as a border on occasion. The Danube is growing from the 55 million tonnes of sediment carried to the mouth every year. The headwaters of the Danube are a spring in the Black Forest of Germany, where the Rhein also emerges.

The Danube joins and separates, it gives and it receives, it has a catchment of just over 800,000 square kilometers and transport 200 cubic kilometers of water per year into the Black Sea, or 2000 cubic meters per second as it leaves Austria.

The tradition of transporting heavy things on the water goes back millenia. It is unknown how long people have been transporting things on the Danube, but there is a long history. One example is the *Ulmer Schachtel*, the “Ulm Box”, which was a vessel built in Ulm in what is now Bavaria, was used to transport wares to Vienna for sale, where the ships would be broken up after the journey and sold for wood. There was no need or desire to bring the vessels back up river. Similar stories exist around wood transport, with rafts being used to transport logs downriver to sawmills. Salt was similarly transported downriver on rafts from mines in the Alps. The power of the water flow itself was the source of motion, steering was by two large oars, one at the bow and one at the stern, to guide the rafts around wildwater and whirlpools, to bring the raft into a beach for unloading or just to rest for the night. A *Zille* is an Austrian style of boat common on the lakes and rivers: a long, thin, flat-bottomed boats still used with paddles and by poling, with the modern version cut off at the stern for an outboard motor. A boat builder in Upper Austria would sell a dozen or more of their Zille downriver, with one layer of Zille lashed in top of one below, perhaps three tiers high, for delivery by a couple of apprentices. They would walk back to the boatbuilder after delivering the wares.

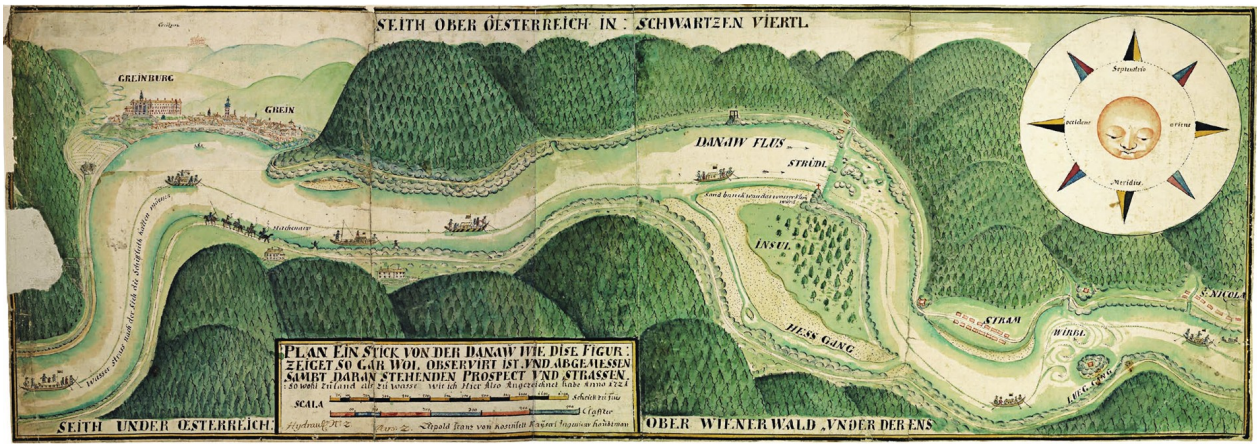

Figure 1: The area around Grein, showing the Strüdl, the rocky, dangerous passage. Note also a boat being towed upriver by horses on the Treppelweg.

That is not to say that no vessels were ever taken upriver. A vessel like a Zille, lightweight and with minimal draft, could be paddled or poled along the shallows at the edge of the river. Taking advantage of the eddy currents, which often flow against the main stream of the river, these small vessels could make upriver journeys. The Treppelwege (tow paths) along the edge of the Danube still exist and have special rights attached to them, even though they are hardly used any more. Traditionally horses, workers or slaves would be used to tow a boat upriver against the flow of

the river. There is documentation of vessels making an upriver sailing journey from the Black Sea to Belgrade; it was not possible, in general, to get any further by sail alone.

The Danube was, at this time, a wild river. Transporting gravel and grit from the glaciers of the Alps, the river was and is powerful. The bed of the river was strewn with boulders, the chaotic river bed forming whirlpools that would suck unsuspecting objects on the river down. Even in the mid 20th century, children who grew up swimming in the Danube learnt how to escape a "Strudel" should they be caught up in the whirling waters. The process of regulating the river has been and is ongoing. Removing these boulders and other dangers to navigation has been a process over centuries. The last major danger to shipping was removed from the Danube near Grein in the mid 19th century, but the river was still very dangerous until the hydroelectric dam downstream was completed in 1959. This stretch of the river is still dangerous and requires special training for ships' captains to bring their vessels through.

Maps of Austrian cities show the shapes of the river as a network of meanders until the 19th century. These were slowly structured, the river banks reinforced with stone and safe anchorages created to escape the ravaging floods. The first dam on the Danube was built in Jochenstein on the border to Germany in 1956, the last Austrian dam was built at Freudenau near Vienna in 1998. Now around 60% of the electrical energy in Austria comes from hydropower (Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie (BMK) 2022). The planned dam at Hainburg on the Slovakian border was defeated in 1985 after a year of protest and occupation, sometimes in the freezing water in winter, by ecologists and supporters wanting to save the last freely flowing, wild section of the Danube in central Europe. This work is still reverberating (Mohl 2022).

Figure 2: Vienna around 1830, showing the meanders that the Danube took to the northeast of the city.

Watching a cargo vessel pass by Hainburg today is like watching something that is almost but not entirely futile. The massive diesel motors running at nigh upon top speed, the roaring sound and the churning wake push the 100m long vessel upriver at less than walking pace. This is the river at its most natural, a formidable force of nature, that can only just be beaten by the power of fossil fuels and heavy machinery.

The Danube is used today as a regular supply route. There are two main groups of commercial vessels on the Danube; the White Fleet of passenger vessels and the Black Fleet of transporters. Vessel size is limited by the locks; with 240m length and 24 meters width the locks give a natural maximum size for vessels and vessel groups. A standard transport vessel is around 76m long and 11m wide, painted black, steel, a massive motor in the stern with the pilot house, a minimal crew who will drive it day and night. Some vessels are just barges and require a pusher, essentially a tug designed to push barges. A pusher will often push two barges, either side by side or one in front of the other. It is easier to push a long skinny double barge up river and it is more manoeuvrable to push a double width barge downstream. Freighters coming downstream have right of way, as it is harder to control a vessel with the river racing you on. For instance a downriver ("valley-headed") vessel can request that the general navigational principle of ships passing port-to-port (that is, keeping to the right) be suspended for them to better take a bend in the river. Traditionally by showing a flashing light against a blue board on the starboard side, this request is now usually made by radio. But they all still have the blue board and the flashing light mounted and ready for use (ViaDonau 2019).

As with all COLREGS[1], commercial vessels have right of way. Even a single hulled 100m long vessel is hard to steer and seeing over the bow to a small vessel, whether recreational or working, is impossible. The constant flow of the Danube is a hazard: even a moored barge is moving relative to the water at a speed of a few knots: if you lose control of your row boat, you will be dragged under the hull and often enough never seen again. The murky, muddy, ever moving Danube does not give up her secrets easily. For instance in spite of the general depth of the navigable sections of the river being around four meters, a recent survey found an unexplained 13m deep depression in the river bed in a bend close to Linz.

In the quieter section of the Danube, upriver of the dams and locks and hydro-electric power stations, the power of the Danube is all but invisible. The river depth is up to 15m more, the flooding area widens the river as well, so the flow is but a fraction of the free flowing sections. In this section recreational boaters paddle and row, motor around, even wakeboarding and water skiing are undertaken. There are some sailing clubs, with trailer sailers and smaller dinghies, even some foiling Moths and other such boats are to be seen. In the areas where the floodplain is wide, the winds can come at various angles, the interplay of the current and the wind, the other boats, the freighters and the passenger ships makes for a pleasurable day on the water.

The Danube has a long history and a long future. It is tamed and wild. It floods and it gets sluggish in the summer. One could talk for hours and write for pages about it. It is the backdrop for this story.

What we did

As we discussed above, the idea that the Danube be used as an avenue for transporting goods is not new. Sailing on the Danube, especially over longer distances, makes little sense. The Danube does have its uses for long distance transport, for instance wind turbine parts and other massive pieces, where one ship or pushed convoy replaces 70 or more transporters on the autobahn (ViaDonau 2019). However the train transport network is more closely allied with the industrial and urban concentrations, and as we see from the flow of the Danube, moving large vessels upstream is a massive and energy intensive undertaking. At the moment, there does not seem to be a place for clean cargo for long distance transport on the Danube.

The idea of doing local, small transport raises itself. Over the years, there have been discussions with a number of producers to even think about what commodities could successfully be transported along the Danube. Following the lead of *Tres Hombres*, *Avontuur* and *Gallant*, high value commodities that do not require huge transport volumes offer themselves. Several discussions with breweries and distilleries never got much further than initial excited imaginations.

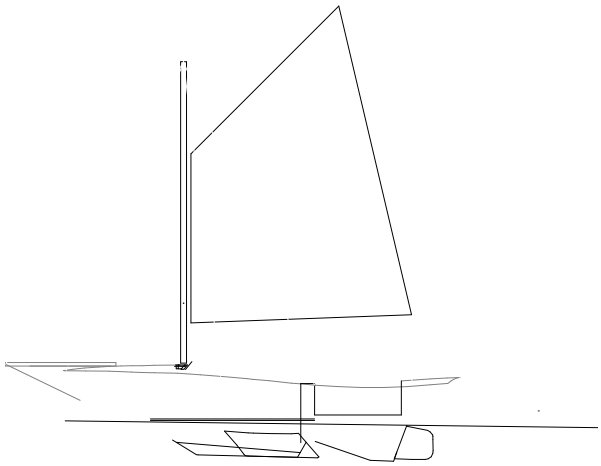

Figure 3: Schematic Diagram of the The Runcible Spoon.

The vessel we have is a small open boat. The hull is a 5.4 meter Silhouette II designed by Robert Tucker and built in plywood in 1962. Purchased with damaged deck and cabin, the boat had these removed, we installed stronger sole beams and soles, a deck mounted gaff rig with the mast in a tabernacle for easy access below bridges. A 4 kW Torqeedo Cruise electric outboard is mounted on a lifting support on the stern. Four deep cycle batteries give 200Ah of 48V power, stored beneath the sole to improve righting moment. The vessel is painted green and named *The*

1 COLREGS, the International Regulations for Preventing Collisions at Sea.

Runcible Spoon in reference to Edward Lear's "*The Owl and the Pussycat.*" It is a commercially registered cargo vessel.

Figure 4: The Runcible Spoon at anchor, with a barge passing.

In 2020 a local group *Gmias* (Austrian dialect for Gemüse, i.e. vegetables) set up a Community Supported Agriculture (CSA) project on the outskirts of Linz (Gmias 2020). It was clear that around half the portions from the market garden would be needed in Linz, where a distribution point was developed. We looked at the quantities involved and the location of the farm, loading possibilities and other details. With the distance from the farm to the distribution point being 8 kilometers, while the distance to the river was 4.5 kilometers over a hill and along bicycle-unfriendly roads, it was clear that there was no advantage to adding a leg of the transport journey by ship with two processes of transshipping from bike to boat and then boat to bike.

One of the local organic food success stories is the Achleitner Biokiste ("Organic Box"). In 1990 the farmer family Achleitner went organic and began direct marketing of their produce (Biohof Achleitner n.d.). In the intervening years they have begun to act as a distributor for many regional organic producers and have expanded their network of deliveries to cover the entire state of Upper Austria and into the neighbouring states Salzburg and Lower Austria. They are constantly looking to improve their services, with ongoing investigations into various electric trucks and a long term collaboration with the city based bicycle delivery service and cargo bike supplier *GerRad* run by Gerhard Dehmer (Dehmer n.d.).

The Biokiste are a standardised box with a 30cm x40cm footprint, either 20 or 30cm high. These are a European standard, 8 boxes having the same footprint (80 x 120 cm) as a Europallet, the standard pallet used in the EU and worldwide.

The first conversations with Gerhard were sobering but inspiring. Finding co-workers for bicycle deliveries is hard. Changing a punctured tyre in sleet by the side of a major road is nobody's idea of fun. Doing it close to dawn less so. The logistics of transporting a load of Biokisten around a route in the city, delivering each one correctly and taking the empty previous boxes (when present) away, being able to get to the right box inside a transport container that is trying to keep the heat, rain, snow and other negative influences away from the Biokiste; it's a challenge.

The logistics chain

While the immediate idea is that a collection of boxes are packed, kept stable and cool, transported, then unpacked, the realities of logistics are more complex. In many senses the entire problem of this industry is logistics. It is even arguable that logistics is the core industry of contemporary society. Delivery companies are often only able to maintain themselves by their sheer size, with margins at each delivery tiny. Nevertheless smaller logistics processes continue to be viable; perhaps we can integrate ourselves into this one. The current chain for the Biokisten is as follows.

Individual boxes are packed and numbered at the Biokiste main warehouse. Each box is unique with extra wares for certain households. Each stack is in sequence for delivery, so that the delivery driver need only take the top box at each stop. The stacks are then transferred to a delivery van. Many Biokisten are delivered straight from the van, especially in the more distributed sections of the city and the suburbs. Those that will be delivered by cargo bike for the last section are then unloaded at a holding space near the centre of the city for last-mile transport (Woods 2022, p 41). The bike deliveries use a custom trike with an insulated carrying box. Eight stacks of Biokisten fit in the box.

Figure 5: Cargo trike and delivery van at the inner city transshipment station.

The transshipment is the most problematic part of the process. It takes time, effort and concentration. As the stacks leave the van to the holding space and are then re-stacked in the cargo trike container, mis-ordering can easily occur.

One of the planned improvements in the logistics chain for the bike deliveries is to pre-pack groups of Biokisten stacks in an insulated box that is then transported by truck to the holding space, and from there is mounted straight onto the cargo trike. Each of these minicontainers would have the correct internal dimensions for the stacks, plus cooling, and would be attached to the trike for one delivery round. Using butterfly latches, these could be held solidly in place and then easily removed, lessening the transshipment issue.

Our experiment was to add an extra step in the logistics chain. From the warehouse, stacks of Biokisten would be delivered to the waterfront, loaded onto the vessel, transported towards Linz and then unpacked to the cargo trike. The vessel would replace the holding space in the city, delivering stacks to the trike for local distribution at the closest point to the distribution area.

We used our digital plan of the vessel in order to estimate how many Biokisten could be transported. Without becoming unwieldy, 70 Biokisten could be transported. With each trike load being around 35 Biokisten, this meant that two trike rounds could be implemented per vessel loading, which is one days deliveries for one trike. If a third trike round should be transported, then an extra layer of Biokisten would need to be added and the loading would need to reach out towards the cockpit area, making the load somewhat unwieldy, but still within bounds of reasonableness.

The stack of Biokisten would be covered in order to be sun protected. In order to maintain cool, we anticipated a layer of insulation over the top of the stacks, with one Biokiste being replaced with ice blocks, possibly with an integrated battery powered fan to move the cool air around the transport area.

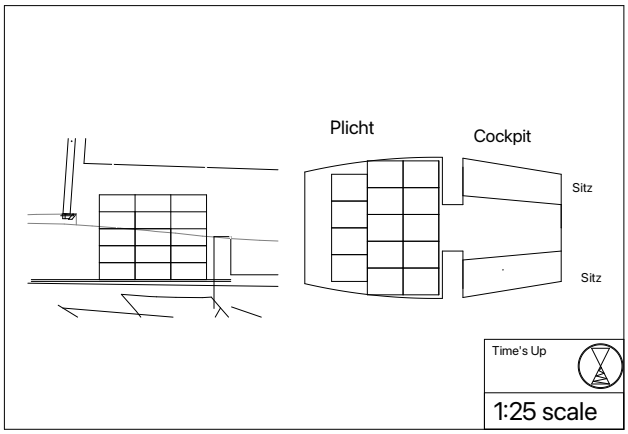

Figure 6: Packing diagram for 70 Biokisten.

Given that we could be confronted with contrary winds, or none at all, one of the borderlines was to know the energy requirements of the journey along the river.

We undertook several journeys between the loading point at Eferding and Linz. We investigated accessibility for bicycles, looked at loading points, planned how a temporary crane could be installed in order to make loading and unloading simpler. Getting to know the bends of the river, finding places where eddies were present, learning to recognise signs of rocks on the riverbed. We took extensive notes on throttle levels, battery status, speed and position. For these explorations journeys we used only the electric motor.

Kühlkette

With the initial work done, we began to get ready for actual delivery runs, starting small and developing from there. One trike load for a few days, then two, noticing the details, looking for conveniences, learning to manoeuvre around problems. Here the realities of the Covid-19 lockdowns and logistics raised their heads. With the explosion in home delivery demand as a result of the lockdowns, the logistics system of the company was permanently at breaking point. In addition, the final straw appeared: as it was summer, there was a necessity to have a documented *Kühlkette*, the cold-chain, from warehouse to the customer’s doorway. The measurement of temperatures in various Biokisten was part of the planning and analysis, in order to find and react to issues, and to make estimates of what sort of cooling would be most appropriate.

However the logistics team at the Biokisten delivery group decided to cancel the pilot. They did not have spare capacity for experiments at this time. As this was designed as a pilot and an experiment, not as something that we had already invested in with the aim to create a replacement for a section of the delivery chain, it was outside their realm of possibility.

And thus the prefiguration stalled.

Energy Analysis

We were nevertheless able to make some analysis based on our preparations.

We journeyed from the harbour in Linz to the loading pontoon in near Eferding at Brandtstatt. That return journey required 7.3 kilowatt-hours (kWh) of energy, measured by the amount of electricity consumed to recharge the batteries. Note that this was a worse (but not worst) case scenario in many ways: the river was slightly above average depth and thus flowing strongly. This is the equivalent of 26.3 megajoules (MJ). The road delivery to Linz and back from the same place is a roundtrip of 53km. The best case road version of this journey would be done with a high efficiency “Neighbourhood Electric vehicle” (NEV) which can transport up to a tonne effectively. Based upon

standard figures taken from Wikipedia this would require 20 MJ, so it would be slightly more efficient in terms of energy than the boat. However these vehicles are quite likely not road legal outside the city.

Based upon numbers supplied by Jonathan Köhler at the Frauenhofer Institute an electric delivery van consumes around 0.26 kWh per kilometer, thus 13.8 kWh for this journey. This is around double the consumption that the boat needs.

Comparing it to contemporary systems: a delivery van would need about (8.1*0.53=4.3 liters of diesel fuel for the journey, emitting 11.4kg of CO2. So over a year 11.4*5*52=2.9 tonnes, the CO2 footprint of about 0.6 people as a global average (4.8 tonnes per capita, in 2017(Ritchie, Roser, and Rosado 2020)). Given that overnight charging would use hydroelectric power from the turbines on the Danube, thus with zero CO2 emissions, this is a significant but not huge change from this perspective.

Note that emissions are not the only consideration. While less relevant in a small city like Linz, larger cities such as London, Amsterdam and Berlin are dealing with congestion issues by introducing ship and bicycle combined logistics for the last and second-last mile (holz 2022) .

The times required begin to play a role here too. The van would be finished with this journey in a bit more than 45 minutes each way, more during the morning traffic jams. The NEV has a much lower speed and would require (if legally possible) about an hour each way. The boat requires around 4.5 hours upstream, 1.5 hours downstream. Plus the time to get through the lock at Ottensheim, which can be (and has been) anywhere from 15 minutes to over 2 hours. In terms of paying an employee to drive the boat, this probably makes a significant difference.

There are also questions of scale. What if this was a real thing? Someone would be having to deliver this every weekday, leaving at dawn to get the freight to Linz for delivery in the colder hours of the morning. The romance of boat living raises its head – is this attractive? The boat we are using would not be appropriate or particularly effective, as it is neither rain proof nor has it proper sun cover. However in order to deliver the approximately 300 Biokisten that would be the daily deliveries to Linz, a speculative small boat using the minicontainer system described above would not need to be significantly longer or larger and could be designed to have a much better underwater shape for efficient movement. The Biokisten have an average weight of 3.5kg. It is arguable that a vessel for the 1050kg transport would have a similar wetted surface as the test boat and would thus require essentially the same energy. The weight of the batteries acts as ballast in order to balance the small but helpful sail plan.

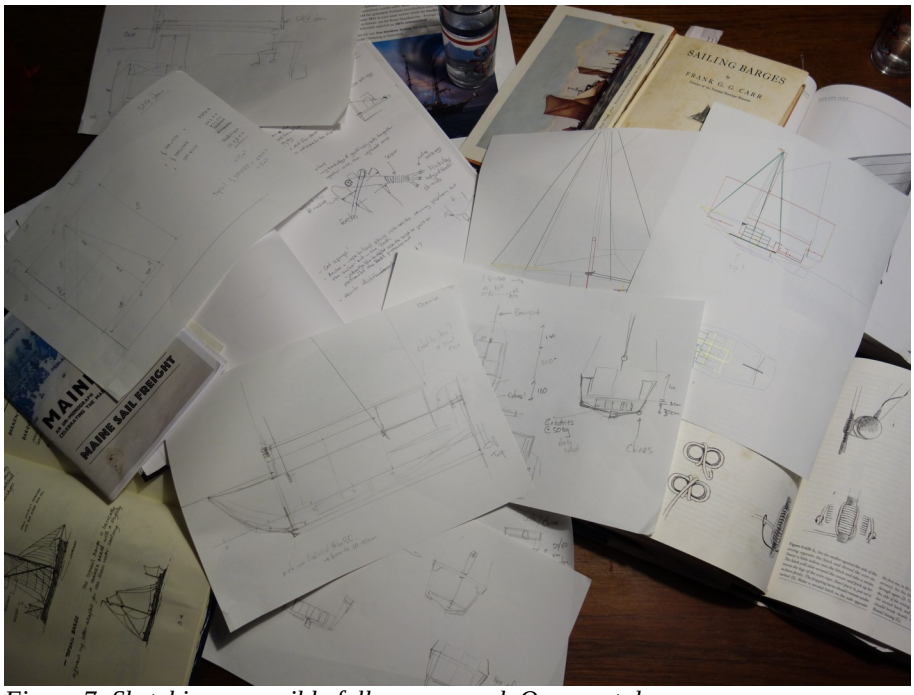

Figure 7: Sketching a possible follow up vessel. One must dream.

Visions, Futuring

The project was not aimed at test driving a prototype system and becoming a part of the logistics network for the company. Perhaps this lack of commitment was a contributing factor to the premature demise of the project. If we had been more adamant that this project must succeed and that we were undertaking development for the ongoing commercial development of this service, perhaps it might have happened. We will never know.

The process of developing such a pilot, this prefiguration of a process, is not necessarily about solving the problem. Rather it is about developing a better understanding of the problem that we might be trying to solve. Or realising that it is not a problem. As futurists know, Futuring is not Planning. Planning is working out the details of how something will happen, to ensure that it does. Planning is about control, measurement, certainty. Futuring is a collection of processes of imagination, of investigating options. Futuring is about things that are beyond our control, but might be under our influence. Futuring is about living with uncertainty. Only in the later stages does one begin to decide on futures that are more desirable, or interesting, or relevant, and start looking at ways to plan for them, to create them, to prepare for them.

So what sorts of images arise?

The first is the use of electricity. With a decline in fossil fuels, shipping, like other transport methods, will have to become carbon neutral. The Danube has a wealth of hydroelectric power. As hydroelectricity production does not decline over night, whilst demand does, charging ship's batteries overnight makes sense. While the Danube has no restrictions on shipping movements, many other inland waterways (such as the Belgian) restrict movement to daylight hours by way of restricted lock operating times. This plays well with wind assisted movement. The Danube and most inland waterways are rather restricted, so sailing through the night is often a bad idea.

Battery systems are improving by leaps and bounds. As electric bikes and cars have become commonplace, trucks are now become electrified. At the other end of the spectrum, utility scale battery systems are coming into their own (Neoen 2019). For smaller vessels, systems like those for cars and trucks will likely find use. For larger vessels the use of battery charging will lead to long downtimes, so battery exchange systems are in development. The *Alphenaar* (Butler 2021) in the Netherlands is implementing the Zero Emission Services system of *ZESpacks* container battery systems as we speak (ZES n.d.). *Fleetzero* (Fleetzero n.d.) and other providers are looking to use container based battery systems for open ocean transport in the near future. In these models, standard shipping containers are fitted with battery systems, charged on land and loaded onto vessels. The empty batteries are simply swapped out in port using standard container loading equipment, so there is minimal delay in shipping onwards. This system favours smaller vessels (around 1000 TEU) using shorter routes (Schumacher 1993) but are also feasible for transoceanic routes (Valentine 2021).

Thus we expect battery systems to be important for larger vessels on inland waters. We do not have suitable insight as to the applicability of wind propulsion for larger vessels on inland waters. So in general we will continue to think about smaller wind powered and wind assisted vessels.

River valleys shape the wind. So the wind tends to follow the rivers, either opposing the movement of vessels or supporting them. There is little need for ships that can point well, as there is no point trying to tack upriver against the current and the current will help downriver travel. In the areas that are not embedded in valleys, it is arguable that winds across the river can be used. This would indicate that powerful sail plans that capture a lot of wind would be optimal, for instance gaff or sprit rigged fore-and-aft sail plans or square sails. Some evidence suggests that the sprit rig is the most effective sailing rig (Palmer 2012; 1984) and has the added benefit of supplying a crane arm as part of the standing rigging. A square rig would take best advantage of the following winds to push the vessels against the current. Arguably a *Dynarig* style assembly would be worthwhile in order to maximise pointing ability for those

cases where reaches would be helpful. We have heard reports of a *Dynarig* being implemented on a dinghy, it might be feasible to use this for small river cargo.

The river has the added problem of bridges. While longer section are bridge free, there are still many sections with bridges. While the height below the bridges varies, a height from the waterline on 7m is the limit for passing safely without issues (downstream from Passau with 4.61m, Linz has 7.4m, Krems has 7.85m and Novi Sad has 6.82m). As the river depth and thus the height of the water surface is always changing, the reference value that is given is the height to Highest Shippable Water (HSW) level. This is the level at which the Danube is closed to shipping, because the amount of water and the speed of flow is no longer safe even for large powered vessels. It is feasible that design considerations for sail powered vessels could be adapted for taking advantage of the actual heights under bridges that will be encountered up to whatever safe level of water the shipping organisation offers; this might be anything up to a meter or more lower than the HSW level.

The maximal height of rigging leads to several possible solutions. One is for a vessel to use square sails that are wide and low. This might be combined with a wider hull or even catamaran style hulls, although these are generally not deemed practicable for freight operations. Twin masts in parallel might also be an option with sprit or gaff rigged sails. Another technique would be quickly removable topmasts and sails. Being able to roller furl a topsail then drop it under a bridge to be re-deployed on the other side, echoing the running mast dropping under bridges practiced by the UK and Dutch sailing barge crews, would be a dynamic and hopefully elegant way to deal with bridges. This would nevertheless require well trained and coordinated crews, or good automation. Projects such as the hard wing sails from Aloft Shipping with their automated systems might be excellent for this. The Aloft sails are designed to be folded flat, again emulating the "bridge shooting" actions of traditional sailing barge skippers. Another possibility is that the top section of the sail could be "reefed" while the lower sections keep working, allowing a vessel to carry on under sail power while passing low bridges.

As we noted above, rivers have varying currents. Larger vessels are constrained by draft to remain in the channels, where the current is usually strong. Smaller vessels have a number of benefits, the ability to avoid the strong contrary currents being just one. The ability to set up regular liner services with smaller vessels, whether daily fresh food deliveries or other delivery processes that are not based on massive, bulk commodities, is an advantage. This has been suggested and is being implemented by Fleetzero. For longer distances, small boat shipping is not practical. The speed of trains combined with the relative efficiency and ability to access city centres is of great benefit. Shipping wins out for the very large deliveries and those that can use the proximity of the rivers and canals to certain resources such as food shipping (Woods 2021).

Our experiences have little bearing on the possibilities for larger inland shipping processes. However we are aware of many systems that are being developed that are probably useful for inland shipping. We might speculate that there some kind of exploration of the optimal vessel size possible here.

Visions, Hopes, Dreams, Utopias and the rest

The process of futuring is about being able to think out loud about possible futures. The most common form of that out loud thinking is the development of a scenario, in some level of detail and fidelity, with some level of robustness. When we say that a scenario is robust, we see the scenario as able to adapt to many variations in the preconditions. A fragile scenario needs everything to come together just right, any change will break it. Scenarios can be thought to have scales: a small scenario might just describe a family, an organisation or a street, while larger scenarios take in suburbs, regions, international networks, or even the entire globe as their area of interest.

We also often speak of the likelihood of scenarios or future developments, with the Voros Cone (Voros 2017) being a common and often easily understood method to visualise this. Starting on the left with now, where we imagine there

is a single point "describing" the way of the world, there are various ways that the world can develop. This is represented by the cone expanding to the right, expanding with possibility as time marches onwards. The center of the cone is the predicted future, the thing that, at least in the discourse we are presently involved in, is regarded as the standard way forward. Around this exists a cloud of probable futures, things that do not vary too much from the predicted future. Moving further out, less likely things might happen and we get possible futures, things that are not likely but at least not unreasonable, preposterous futures that are quite outrageous but still, just, physically possible, whereas outside the cone are the impossible futures; scenarios that break our understanding of how the world works (aliens, antigravity).

Scattered amongst these possibilities we find the preferred futures. Subjectively these are the scenarios that are, for whatever reason, better for the communities, groups, organisations or individuals involved. Activist groups will decide upon the preferred futures that they are fighting for, businesses will find preferred futures that match their mission, whether maximal profit or maximal customer satisfaction, community organisations have a preferred future for their environment and living spaces. Some preferred futures are visions, grand and epic, while others are small, perhaps dreams of a family looking to escape a war zone or crushing poverty. The Sustainable Development Goals are 17 aspects of a preferred future, very specific, high level future developments, while a regenerative farm has specific, concrete details, for instance a Holistic Context (Savory and Butterfield 2016), that make up its preferred future.

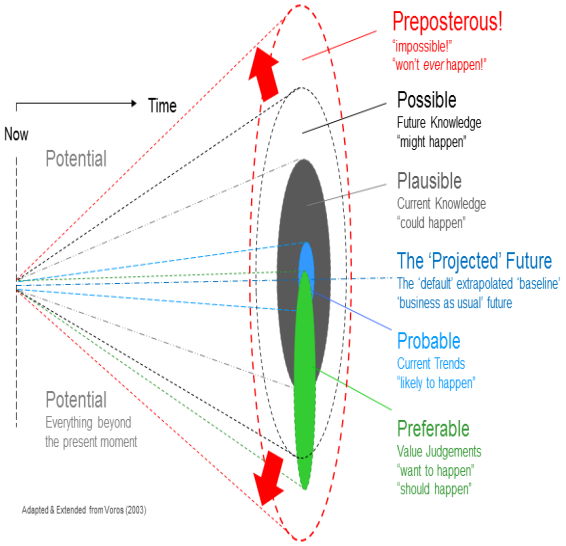

Figure 8: The Voros cone, as used in (Voros 2017).

The ability to speak about, write about, discuss, debate and develop these scenarios is vital. Dator says that the future cannot be predicted, and no scenario actually happens. Scenarios are tools for strategy, sharing imaginations of what could be as a way to then plan what should be and then decide what we will do about it. Scott Smith says that we do not visit the future to stay there, but to come back and apply what we have learnt to today. The ability to think out loud about futures is vital. Participation and dialogue, involvement and discussion, are paramount in the effective use of scenarios.

The Rondout Riverport 2040 (Willner 2021) vision is an example that pertains to the area of the northeast USA. The details in Steven Woods' thesis (Woods 2021) look into various scenarios and develop implications from them. The first is more visionary, the second more numerically based and both give us tools to think about possible futures. In order to further this work, a group of interested persons would need to come together and be facilitated to develop a number of scenarios about how these processes could continue to play out. What are the various possibilities for the clean cargo development of the Hudson River and the surrounding bioregion? The papers from Willner and Woods would offer a great starting point for these discussions. A well facilitated process of developing multiple scenarios could be of great value here.

One might ask what outputs of futuring processes exist? One direction is forecasts or predictions, where more specific claims are made about what will happen. Forecasts are like the IPCC reports, which state developments with certain degrees of certainty. Predictions are claims about what will happen, varying from the timing of a sunrise

(very predictable) to the movement of weather patterns (less so). Techniques such as Causal Layered Analysis (Inayatullah 2004) do not provide so much a scenario as they provide a whole new way of thinking about a given context and situation, with language, metaphors, worldviews changed in important ways.

Figure 9: I see and I remember: London future Cityscape, as seen in Superflux' Mitigation of Shock (Superflux 2017).

What one does with a collection of scenarios is also unclear (Chermack 2022). The most common application is as a collection of worlds with which one can think through implications. In this scenario, how would we be acting? How would we sense this scenario in advance and work to prevent it or compensate for it, accelerate it or support it? Scenarios are often brought to life with visualisations, whether computer generated or more subjective, such as the London as Venice images. Developing narrative probes, small story fragments, is another useful technique, leveraging the human capacity to understand the world through story. The broad range of Experiential Futures (Candy 2010, Candy& Potter 2019) includes two important elements. One is the creation of artefacts from a possible future; objects, rooms, plaques that belong to that future and convey strong haptic and somatic information for the audience. The other are acted out experiences, called prehearsals by FoAM (Kuzmanovic et al 2019) or more generally prefigurations.

Our work, as we outlined above, prefers to use scenarios to develop experiences of those possible futures and thus to enable and support discussions of those and similar possible futures. We do this in a cultural context, because we think that culture is the place to explore and discuss the ways that possible futures will impact upon the ways in which we live. The world in which we want to live is the most fundamental of all questions. Culture subsumes economics and politics, technology and the sciences inasmuch as all these areas act as inputs and inspirations for the scenarios and reflections upon them. By doing experiential futures, participants begin to understand and thus to develop their dreams and visions in more detail. The next section outlines a further visioning that has emerged from this process.

A dream on the Danube

A vision that then arises is one of river shipping with a wide variety of small to medium sized freighters loading and unloading some kind of standardised mini containers that are suitable for foodstuffs and other regional deliveries, second last mile or distribution from ocean going clean cargo vessels, so-called feeder routes such as the *Apollonia* in the US or *Raybel* in the UK.

Small vessels, manned by one or two persons, wake up just before dawn and take on deliveries from small cargo transports; electric vans and cargo bikes. Hitching these cooled containers to the onboard reefer systems, the vessels detach their charging cables and set sail. With wind heading upriver, two vessels unfurl rectangular sails to push them across the slow current in the zone above the dam, conserving battery power for later in the day when they need to power against the fast current before the next dam.

Another vessel heads downstream, 8 mini reefers with fresh supplies for the city. Passing through the lock, they leave sails furled as they use minimal power to steer through the strong currents downstream. As the landscape opens up they set sail on a broad reach to accelerate downstream, then furl and pull into the first stop on their way. A container is hoisted on the board crane and swung to the trike on the shoreline. The delivery trike takes the container, clips it down and heads off. The vessel pulls to the other side of the river and repeats the action with a small electric delivery van serving a town at the top of the river side hills. 80 minutes later the vessel meets the first trike again downriver, hoists the container of empty delivery boxes onboard and unloads the next container. The next 5 hours continue this way until the bike and van return the last of the empty containers to the vessel. Unloading is made difficult by the passing of several large freighters, running on ZESpacks which delays the trike side of the river twice. With the river water level low due to yet another dry period, the crew have to be more precautious around riverbed rocks that are closer to the surface. They join the trike rider for an end of the day drink and meal at their standard restaurant bar, then the vessel heads upstream again. Sailing against the current is slow but stable, with tactical shore changes important. Along one section of the river they can use an old barge technique, pushing a wave of water against the vertical river shoreline bulkhead, cushioning themselves from the bulkhead and letting them stay out of the main current and maintain speed (Carr 1951). For the kilometer before the dam and the lock, the motor is turned on and runs hard to push the vessel up the last section against the current. Upriver from the dam, it is an easy calm sail for three kilometers before the vessel pulls into the shore, ties up and reconnects to the power charging system. Going over the logs for the day, the skipper notes that the bulkhead surfing section is showing signs of better consumption, so she send off a short message to her co-owner who will be running the vessel for the next few days, sharing an idea that she tried out and seems to help.

Ahead, a larger freighter pulls in for the night. The fixed batteries are charged by cable, and the battery container is exchanged for deep charging, the fully charged replacement clicking in.

Since the discontinuation of night time travel on the river, sleeping on board smaller vessels has become comfortable again. The skipper decides that it is a good night not to be indoors and calls her partner to come down for a night on the boat rather than riding home to the stuffy air of their house. They can ride home together in the morning when her co-owner arrives for the next day's deliveries.

Arts-based research approach and insights

When we pass our attention away from the practical aspects of the project, we find that the cultural and artistic parts of the project are also complex and interesting.

The most similar project that we are aware of is the Mains Sail Freight project undertaken in 2015 by a group of artists and seafarers allied with the Greenhorns group. Greenhorns is a grassroots farming activist group based in Maine (Greenhorns n.d.). The schooner *Adventure* delivered 3 tonnes of produce to Boston Harbour from Portland, Maine in August 2015, presenting the produce and the project at the dockside as well as at farmer's markets and other places. While around 30% of the shipment was pre-sold, as with many other sail freight projects such as New Dawn Traders, the portion that was sold at markets was a way to talk about the project to a wider audience directly. While perhaps most clearly a historical re-enactment for the external observer, the creators of the action saw it more as a way to make a point about food systems and regional economics, to raise questions around economic models for the 21st century.

The project grew in some way from the Vermont Sail Freight project (Andrus 2012) in 2012, which took 15 tons of produce down the Hudson river on the custom built sailing barge *Ceres*. Also organised by the Greenhorns, the project took a different axis through the north eastern states of the USA.

Severine von Tscharner Fleming referred to the project as a type of pageant; a parade of otherness, demonstrating possibility, opening up our mental models, celebrating alterity and full of questions (Fleming et al. 2015). These projects are short term, bounded in space and time and have as one of their goals the creation of valid and vital discussions, awareness raising and community building. One of the ways in which we can think about this otherness is using the idea of a *heterotopia*. Foucault indicated that all ships are, to some degree, heterotopias, places that are other (Foucault 1986). The Greek root hetero means difference or other. The rules of engagement, the social contract, societal and other norms fade or even disappear when as sea as others emerge. This is apparent in the ways that ship workers are treated, the difficulties of policing acts of piracy, the complexities of ownership of ships. However we are more interested in the aspects of shipping that are positively other, traditions of mutualism and aid, solidarity and respect. A pageant is something that attracts attention and is a celebration, a temporary rupture in the social fabric that is welcomed and special. A sailing vessel upon the Danube is exactly that, as is a sailing vessel being used to transport produce in Maine in the 21st century.

Figure 10: The Iceberg of Economics, used by Gibson-Graham as an explanatory tool over many iterations.
(Credit: James Langdon)

Otherness or alterity is a vital category. Social and economic constructs lead us to believe that there is one right way of doing things, fitting in with what is normal, the baselines that we know through our childhood, socialisation, education and media. J.K. Gibson-Graham have brought our attention to the fact that, in spite of claims of the end of history and the attempts to economise all of our lives, there is a vast iceberg of non-market exchange based work, exchange, trade, reciprocity and other forms of economics that the dismal science as it is practiced today cannot, or does not, deal with (Gibson-Graham 1996; Tsing 2021). These are sometimes referred to as heterodox economics. Moments when the structures of late phase consumer neoliberalism are laid bare are unusual. The container vessel *Ever Given* reminded many of us that there are transport and trade routes that effect our supply chains; the invisibility of logistics networks behind the delivery vans that provide 24 hour service was momentarily broached. We cannot change something that is invisible until it becomes visible. Misquoting Wittgenstein, it is hard to discuss those things for which I do not know the words.

There is a piece of advice often shared with young practitioners, something like "good artists borrow, great artists steal" often overlaid with the statement that "emulation is the sincerest form of flattery." When we find someone "stealing" our idea, it can and probably should be taken as a form of admiration. Most businesses in (late) capitalist society grow and expand as a fundamental aspect of their shareholder value maximisation orthodoxy. Occasionally organisations fall away from the perceived necessity to grow through expansion. The standard process of business development is more income, more people, more projects, more size. Talking with various sail cargo practitioners it was pleasant to hear them not talking about this sort of growth, but rather the idea of development by emulation. Every enterprise, every organisation, is unique in its location and routes, its characteristics and the characters who make it happen, its challenges and the competencies it has or it develops in order to deal with them. A community of experimentation, like the restaurant world, takes on structural anti-fragility (Taleb 2012).The community is filled with emulations and borrowings, ideas that sort of work in one place being replicated elsewhere

and working there better; so much so that the original idea has been lost; the idea has been *stolen*, in that the copier is perceived at the originator. It might even be possible to think of the sail cargo community as a form of open source community: regular meetings such as the Sail Cargo Alliance (SCA n.d.) meetups have been places for communal sharing of ideas and approaches, plans and schemes. Ideas are thrown around, taken further, re-interpreted, translated into new contexts. We have and will continue to argue, that this form of sharing, inadvertent and conscious, perhaps even malicious, is one of the identifying marks of a healthy ecosystem of ideas (Time's Up 2021). Claiming ownership of an idea is hard and reeks of petty mentalities. Radical generosity is a hallmark of enabling and powerful communities. The process of taking those rough ideas and turning them into a functioning organisation and enterprise, is an act of ownership that is valuable. This is the sort of work that Gibson-Graham's economic reflections contemplate.

Some other River Art Projects

There are many other arts-based projects on rivers, with which it is perhaps interesting to compare the work presented here. Three relevant project on the Danube are Marie Polakova's *DownRiver* project, Rainer Prohaska's *MS Fusion* project series and the *flagship europe* expedition from the Art University of Linz. Polakova undertook her investigations of the cultural life of people and groups operating on the Danube in 2016, travelling on the 5.4 meter sailboat *Sarcelle* with its mast removed, a small outboard motor, an umbrella and a vulnerability that worked to enhance her acceptance and integration into Danube culture. Rainer Prohaska's projects were decidedly more architectural, constructing a mobile platform from two (and occasionally three) Zille boats and aluminium scaffolding. The vessel was designed to be reconfigured by any of the artists in residence that accompanied him on the journey, and was designed to work as a mobile platform for arts experiments while underway. The *flagship europe* journey undertaken by the Space and Design class at the Linz Arts University in 2005 re-purposed the 66 meter barge *Negrelli* into a mobile home, studio and performance space for 30-60 students and staff from the university. Many projects were undertaken en route, exhibitions were arranged with groups and institutions along the Danube.

Figure 11: Three distinct arts based journey projects on the Danube.

Each of these projects had distinct attributes. Polakova was alone, Prohaska had a series of guests, *flagship* was a large social group that journeyed the whole route together. Polakova was investigating the social and cultural aspects of life along the river, Prohaska enabling artists in residence to explore water based themes, *flagship* was about undertaking long term projects and creating cultural experiences along the river as they travelled. Polakova undertook one journey and then left the arts world to become a deck crew on river freighters; Prohaska has

undertaken a series of these journeys, with the fourth starting in 2022; the *Negrelli* was subsequently used for a Danube concert series by the musician Herbert von Goisern.

Many similarities between these projects and Swoon's *Swimming Cities of Serenissima* series are obvious. The practices of arts on the water are varied and subtle (Grover 2016) and not without danger. The recurring theme in many of these works is that the water is a simple yet infinitely complex place to be operating, and that the experience of being there is fundamentally different from the documentation and reporting of being there.

The project *Control of the Commons* was undertaken in 2011 and 2012, an investigation of the waterways of Europe and Australia, looking at environmental, climate and ecological considerations from small vessels built from scrap and powered by hand and wind. Interviews, videos, photo documentation and log books nevertheless fail to convey the experience of being on the river and the awe which the experience brings. Like Polakova's *Downriver* project, the results of the process was perhaps a better but nevertheless inexplicable understanding of what living on, by and with a water way can be like. Emerging from this, Pippa Buchanan developed the *Boss of the River* interactive work, a photo booth that placed you into the position of being the waterway manager, the "Boss of the River" for one day. The big question: what would you do? One of the most clearly recurring themes was the re-wilding of the waterways: removing the dams, the locks, the hydroelectric systems and letting the river be the river it needed to be.

Figure 12: Subak 2 on the Murray River, Australia. A blending of Taiwanese PVC pipe fishing boats and a Dhow rig.

Conclusion

"Predictions are hard, especially about the future" is a well-worn phrase, often attributed to a physicist. In order to avoid the futility of prediction, futuring imagines ways in which the future might be. A sense of possibilities. Experiential Futures are designed to allow us to get a more in depth idea of how a possible future might actually look and feel, how the somatic reality of it might be. Prefigurations are an enacted form of experiential future.

We are reminded that the word *crisis* has its origins in the Greek word for turn, decide or choice – a decision making leading to change. Similarly the German word for neccesary, *notwendig*, is built up from the word not, meaning emergency, and wend, meaning turn. Many of the possibilities that are being explored are seen as not necessary, as there is no emergency to turn from. The emerging crisis, whether environmental, ecologucal, economic or political, may indicate that the change is necessary, and we can hope that, as with Shell in the 1970s oil crisis (Schwartz 1998), our capacities to have thought about these things in advance will allow us to make better decisions.

The prefiguration described here looks at the possibility of running a small, clean freight service on the Danube. Some practical insights were obtained in spite of the discontinuation of the project. The implications helped inspire imaginations of possible futures for clean cargo on the Danube and other inland waters. For one of the things that might be most valuable about many of these speculations is the development of what Robert Musil calls the *Möglichkeitssinn*, a sense of possibilities (Musil 1930). Developing a sense of what could be, even though it is not, is perhaps one of the more fundamental qualities that we can develop today. Being able to talk about possible futures,

to be open to speculations and their implications, developing futures literacy and an appreciation of that which seems, initially, to be ridiculous, is a role that many can take on, but is often left to the arts and cultural practitioners.

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Scaling Sail Freight: An Open Access Model For Climate Crisis Response

Steven Woods

Abstract: Sail Freight is only a meaningful change in economic or carbon emissions terms if it achieves statistical significance in trade volume. The key to expanding a coastal and inland "Mosquito Fleet" is spreading knowledge, building infrastructure, and inspiring people to simply do something. This can be facilitated and encouraged through engagement with a wide variety of citizens with a wide variety of motivations; ecological, political, financial, or otherwise. Creating the resources and removing barriers to starting a sail freight business and make small ports better suited to sail freight operations can be organized and accelerated using Anarcho-Communist methods such as open- source plans, open access publishing, affinity activism, mutual aid, and the creative commons.

Keywords: Sail Freight, Anarchy, Scale, Coastal Trade, Open Source.

This conference has discussed a number of the practicalities and challenges of Sail Freight, but the real question to address in the long term is how to expand the impact of the technology. This cannot really be done by the study of wind propulsion technologies, weather routing, feasibility studies, and other academic work: At some point, ships have to be built, crews must be trained, and cargoes arranged. As we've discussed, there are significant challenges to all of these elements of the sail freight revival. However, there's a clear precedent of how such a movement can be built, literally, and moved forward: Anarcho-Communist methods such as Open Access, Open Source, and Creative Commons.

Before we progress any further, a short note about definitions in the sail freight movement: There are several competing definitions and similarly perceived movements which must be differentiated if we are to avoid falling into a Wittgensteinian Hell of mutual incomprehensibility. The principal things to differentiate between are "Windship," "Wind Propulsion," "Wind Assisted Propulsion," and "Sail Freight."

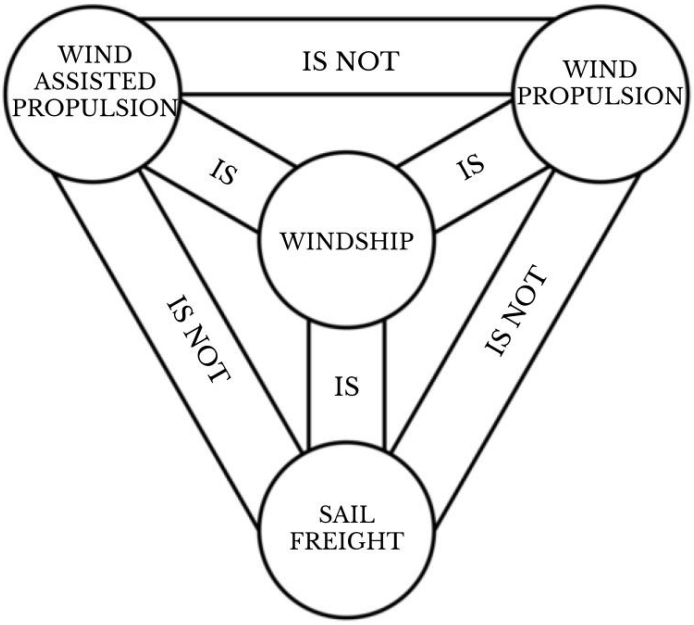

Image Based on: "Trinity Shield Template" AnonMoos, CC BY-SA 4.0 via Wikimedia Commons. [1]

[1] Image taken from: Woods, Steven *Sail Freighter Handbook*. Kingston: Center For Post Carbon Logistics, 2022.

Any vessel capable of using the wind for propulsion is a Windship. Wind Propulsion is the use of the wind for any propulsive force by any means, while wind assisted propulsion is the use of wind propulsion as a fuel-saving device on otherwise conventional motor vessels. Sail Freight, however, is defined as "The ecologically motivated maritime movement of cargo by primarily wind power with little, if any, engine use."[2] This movement is likely to be primarily among small general cargo vessels in coastal or inland trade, displacing the use of trucks and trains, as well as a small number of larger vessels moving containerized cargo.

Sail Freight involves far less capital and investment per vessel, requires fewer licenses and a lesser degree of regulatory oversight. Thus, it can be far more democratic, diverse, and decentralized than a larger cargo fleet. The number of possible vessels involved, as well as the number of ports which can be used for small vessels is very large. Training requirements are relatively minimal as well, with recreational infrastructure generally able to form the backbone of a labor force training system. This marks a significant departure from the general rule in the maritime field worldwide.

As a result of these characteristics, the use of Anarcho-Communist methods is practicable, where they would not be for a large vessel movement involved in international trade. The use of Open Source, Open Access, and Creative Commons for a sail freight movement is already underway to some degree, but not exactly in a way which will allow the sail freight movement to scale into a statistically significant part of the transportation system in the next few years.

Open Source is already in use in the form of a few boat plans, such as the Greenheart Project's design from 2014, and the recently released plans of *Ceres*, the spritsail yawl rigged, lee board sailing barge of the Vermont Sail Freight Project. The TransTech River Sea Ship 80 foot design is also effectively open source.[3] These form the backbone of a possible set of fleet designs which can be drawn upon without needing to retrofit or restore an existing vessel, as the supply of historic sail freighters which can be put back to use will eventually be exhausted. However, there needs to be a concerted movement to create or acquire designs for useful vessels and release them as Open Source plans.

A proposed model for these plans is to make effectively the same boat with a simple schooner rig in three sizes: A 39 foot, 14.9 GRT Uninspected Cargo Vessel, along with 24.9 and 49.9 GRT versions. These will fit the three smaller licensure categories for captains: No license, 25 GRT, and 50 GRT. Where possible these should be kept below 65 feet to simplify Coast Guard inspection requirements. All plans should be spec'd for construction in steel and plywood, to allow for different levels of available capital. There will have to be several designs created and scaled for different environments, and to allow for a diversity of levels of skill and resources.

Creative Commons is also in use to forward the Sail Freight Movement, specifically in the creation of handbooks, academic papers, and case studies. By publishing with the Creative Commons license, the proliferation of information is aided, allowing for historic pre-patent, pre-copyright style cultural and technological diffusion at a high pace. These manuals and handbooks can be especially useful by providing a digest of the pertinent information for those just starting in the movement, and should be created for as many auxiliary aspects of sail freight as possible. Open Access is a fundamental adjunct to the other two methods of scaling sail freight: These materials all need to be freely available to anyone and everyone to use. Without this essential element, the other resources become immediately less effective, and the movement becomes less democratic.

There are a few things which should happen if a sail freight movement based on democracy, diversity, and decentralization is to be successful. A short outline of such a program shows there is a lot of work to do, but luckily all of the work involved is eminently achievable. Anything on the table below

[2] Woods, *Sail Freighter Handbook*. Pp 3
[3] Woods, *Sail Freighter Handbook.*

lined through has already been created, and several others are in the process of development. In some cases, there are designs and materials which could be bought out and made open source to accelerate the completion of these objectives.

PRINCIPAL WORK TO BE DONE:

TECHNICAL	WRITING	OPERATIONAL
1. 39 Ft 15 GRT Schooner/Ketch	~~1. Sail Freighter Handbook~~	1. Sail Freight Cargo Board
2. ? Ft 25 GRT Schooner/Ketch	2. Sail Port Handbook	2. Sail Freight Brokerage
3. 64 Ft 50 GRT Schooner/Ketch	3. Broker's Handbook	3. Create Funding Pool
4. 39 Ft 15 GRT Shoal Draft sch	4. Cargo Sailor's Handbook	4. Build Ships
5. ? Ft 25 GRT Shoal Draft sch	5. Feasibility Studies	5. Develop Port Support
6. 64 Ft 50 GRT Shoal Draft sch	~~6. Carbon Intensity Studies~~	6. Train Crew
7. 100 GRT Sch/Barkentine	7. Economic Studies	~~7. Create Promotional Events~~
~~8. 80 Ft Inland Waters Schooner~~	8. Policy Studies	8. Interlocking Regional Fleets
~~9. 39 Ft Plywood Sailing Barge~~	~~9. Sail Freighter Case Studies~~	9. Integration Of Canalways
~~10. Greenheart Ship Design~~	~~10. Educational Writing~~	10. Create Small Shipyards

Technical progress has already been made, but could be accelerated significantly through the purchase or creation of several ship designs, such as those by Tad Roberts and Derek Ellard. Other designs developed during the 1970s Oil Crisis can be hunted down and possibly revived for open-sourcing and publication. These can be augmented through the breakdown of smaller systems such as winches, donkey and electric engines, and other equipment through a model similar to that of Open Source Ecology, if not in direct cooperation with them.[4]

Writing can be accomplished with almost no capital, but publication can be a significant barrier. Academic journals do not seem to be overtly interested in non-technical writing outside the realms of wind propulsion and wind assisted propulsion, or weather routing. Only a few journals cover sail propulsion or sail freight, and most of these are not open access. Academic gatekeeping behaviors further complicate the publication of many studies, but there are other outlets for handbooks, manuals, and practical notifications, such as the Center For Post Carbon Logistics. The establishment of an annual "Green Book Of Windjammers" with a directory of sail freighters and notices of practical interest to the sail freight movement. This will likely be a worthwhile investment in time and resources, as it could create a central clearing house for new manuals, practical advice, notes on ports and support services, or other news which might make everyone's lives easier. The compilation of public domain resources useful for Sail Freight should also be prioritized and encouraged through this publication.

Operational work needs to be done soon, and in some depth. The creation of a cargo board in the manner of FeralTrade.Org[5] would be a good first start, and an encouragement to see where people are

[4] See https://www.opensourceecology.org/ for more information on this organization.
[5] See Feraltrade.org for more information on this organization.

interested in shipping goods by sail. This should be built as part of a professional brokerage, which can employ someone to match cargos with potential couriers, at least part time. This can be funded through a non-profit initially, and could be one of the biggest advantages we can give to current sail freighters, as they need to fill their holds to be economically viable.

Other operational work also depends on funding. Building even very simple ships will require funds and resources which are not currently available. This is the most fundamental element of scaling sail freight, in that without ships the movement doesn't exist and cargo cannot be moved. As the movement grows, other concerns can be taken into account, and the resources spread a bit further.

Operational concerns also extend to funding and ownership models of individual ships. At the same time, Anarcho-Communist and communalist ideas of ship ownership should be embraced, such as the Farmer's Ships of the Aland Islands, Community Supported Shipping (similar to Community Supported Agriculture), cooperative ownership models, and other options which will make ownership more democratic. This not only lets financial risk and benefit be spread across a wider number of people, but can draw interest from a much larger number of people. This will also prevent concentration of ownership and monopolization in the sail freight industry as it grows. Further, many alternative models such as the above allow for predictable amounts of annual funding for crews, increasing economic viability over the long term.

The last element which will be important to Sail Freight is getting a wide range of people involved and interested. This can't be a movement of rich old white men if it is to succeed. Everyone needs to be actively invited and welcomed into the movement, doing whatever they're capable of, looking at Sail Freight as part of an integrated transportation system working for mutual benefit, not strictly for profit. If someone's talent is working a cargo bicycle, they should be invited to work with the sail freighter at their local port; if their talent is in logistics, they need to be invited as a broker. Some people can simply be invited as dockers and longshore workers. Sailors and those just interested in sailing, especially outside the generally wealthy recreational sailing demographic need to be invited and instructed in sailing. Small businesses and small farmers need to be invited and connected to all sorts of groups through the medium of sail freight. Most of all, it is important that everyone be invited to cooperate with the fleet in taking action for a Just energy transition, and the creation of an economy which is centered around serving people, not the mathematical abstraction of power which is money and profit.

Leaning on Mutual Aid across a highly diverse, democratic, and decentralized movement can create a viable sail freight sector by simply making things freely available. While purpose-built ships and boats may be difficult to get hold of without significant capital, refitting recreational vessels and growing a wildcat fleet will move the idea forward. With a bit of time to grow the idea and get more resources into the hands of those interested, the movement will be able to grow rapidly once conditions are fully amenable to the adoption of Sail Freight. Prudence, vigilance, and forethought can make this movement resilient and ready to surge on relatively short notice as conditions become ever more favorable for alternative forms of transportation.

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Zero Carbon First And Last Mile Transportation

Steven Woods

Abstract: Moving cargo by sail is a low-to-no carbon endeavor, but the carbon impact of transport between origin or destination and the docks is frequently not. In light of this concern, several opportunities present themselves for reducing or eliminating the carbon impact of first and last mile transport on land. These options are different based on the ranges and environments involved, and can use either Organic or Contract transport depending on local circumstances.

Keywords: Sail Freight, Open Source Hardware, Cargo Bike, Human Power, Post-Carbon Transport.

Sail Freight is a low-to-no carbon means of transportation, so it makes little sense for sail freighters involved in the inland and coastal trade to rely on conventional fossil fueled transport for first and last mile hauling, especially when distances involved are generally under 3 miles. The challenge facing sail freighters in the Northeast US is the lack of existing low carbon transportation facilities in the region outside the major cities (New York, Boston, Providence), nd , potentially, the volume of load and distances involved in rural areas.

There is a trade off to be made when looking at first-and-last-mile land transport based on what is available and what is being transported, but ensuring the maximal use of low carbon options are available and employed is a worthwhile exercise in planning for an integrated, polytechnic,[1] sustainable transportation network. Directly implementing such a plan may be beyond the capabilities of most small vessels, but they will play a role in supporting the plan's development alongside their own.

TECHNICAL OPTIONS

There are many technical options for low to no carbon land transportation, but as this paper encompasses only terminal transportation of cargo, the scope of discussion is limited. This bars consideration of large trucks and rail, for example. As we are not dealing with sail freight between fixed terminals, static systems such as ariel tramways and conveyor belts will also be excluded. Technically speaking, there are several main types of transport vehicles which can be considered for the target terminal logistics use, which can be categorized by their source of power: Human, Animal, Internal Combustion, and Electric.

Internal combustion systems using carbon neutral fuels such as hydrogen, biodiesel, ethanol, or methane could be plausibly employed for landside delivery, but this is less than practical over the long term for a number of reasons: Fuel competition, fuel availability,[2] and other pollution concerns (noise, particulate matter, heat, etc) all present barriers to use for these vehicles in large numbers during a longer term energy transition. Animal traction, whether through draft or pack applications can be useful in some environments where there is sufficient feedstock for these animals. Animal powered farms will likely use

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[1] The term "Polytechnic" is used in this paper in the meaning ascribed to it by Lewis Mumford. This encompasses the idea of many technologies (some of which may be many thousands of years old) working together, as opposed to using only the latest and (supposedly) greatest technologies. This is opposed to Monotechnical world, which we currently inhabit, relying near exclusively on trucks and cars. A relatively recent example of a polytechnic environment in the US would be the first decade of the 20th century, where working sail, railroads, bicycles, pack animals, steam vessels, motor trucks, and other technology all worked together in their most applicable roles to achieve the necessary tasks of the economy. See: Mumford, Lewis. *The Pentagon Of Power: The Myth Of The Machine Vol II.* New York: Harcourt Brace Jovanovich, 1974.

[2] Hirsch, Robert, Roger Bezdek, Robert Misi, Wendling, and Misi Manyanga. *Peaking of World Oil Production: Impacts, Mitigation, and Risk Management.* Washington DC: US Department of Energy, 2005.

this option as they will need the animals for other tasks on farms, but there's little to recommend their use in an urban environment.[3] Electric vehicles are a good option where the surplus power is available. Human power as a prime mover is available anywhere that sail freighters are likely to go, but will need tools to increase individual carrying capacity to a reasonable level.[4]

Technical options may be very wide ranging, but there are only a few technical options which fit well with the mission at hand. Discerning those, with the further requirement that they be currently available as Commercial Off-The-Shelf (COTS) solutions with spare parts and support availability narrows the options considerably. The best powerplants for these operations is likely to be human and electric power across a number of environments.

PROBABLE OPTIONS

Sorting between these options can be brought down to just those probable and immediately implementable solutions to the problem presented to sail freight operations: Short Range Delivery in rural and urban environments. Not all possible options are practicable in all environments, and some which would be viable in one environment are completely ruled out in others. For sail freighters, there are two main environments which will be encountered: Rural and Urban.

Urban environments add a set of limiting factors: narrow, crowded streets, high density settlement, and the need to avoid congestion recommends a small, light vehicle which requires little in the way of fuel inputs. Road surfaces are likely to be relatively uniformly asphalt or concrete, with few problematic obstacles. Ranges will be short, maneuverability will be just as important as carrying capacity, and human power will be plentiful (though not necessarily cheap). Depending on range, a number of tools can be employed, including wheelbarrows, bicycles, carts, and light duty electric trucks.

Rural environments are normally faced with longer distance transport, over a variety of types of road surface. Bicycles are light duty electric vehicles are most likely to be successful here. In some limited cases animal power might be employed, but this is unlikely in the Northeast US due to a lack of mules and donkeys or working horses. Further, animal power has few COTS applications.

The two options which stand out as good options on both environments, which also have COTS solutions are electric vehicles and bicycles. Of these two, the electric assist cargo bicycle is most likely to be the best option in most cases. When paired with a trailer, the load capacity of such bikes can be well over 500 pounds, they are capable of dealing with variable surfaces, and longer ranges when required. Cargo bicycles are already making significant inroads in urban delivery and have a proven track record of reducing emissions, roadway congestion, and improving delivery times over short distances. They have generally been more successful where bicycle infrastructure is present, but can also share the road with cars where needed.[5,6]

The determining factor for most operations will be the choice between Organic and Inorganic transport, as discussed below. This will dictate the constraints which shoreside transport will have to work within, and in turn be dictated by local cargo volumes and distances.

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[3] Henry W. Daly, *Manual of Pack Transportation* (Washington DC: Government Printing Office, 1917). https://books.google.com/books?id=_9M3Yjvkba8C

[4] Hathway, Gordon. *Low-Cost Vehicles: Options for Moving People and Goods* (London, UK: Intermediate Technology Publications, 1985).

[5] J. Alexander Page, "Role of Cargo Bicycles in Disaster Planning and Emergency Management." Master's Thesis. University of Oregon, 2014.

[6] Vasiutina, Hanna, Andrzej Szarata, and Stanisław Rybicki. 2021. "Evaluating the Environmental Impact of Using Cargo Bikes in Cities: A Comprehensive Review of Existing Approaches" *Energies* 14, no. 20: 6462. https://doi.org/10.3390/en14206462

ORGANIC TRANSPORT

Organic Transport in this context simply borrows the military definition: Transport which is built into the Unit, not assigned from elsewhere. The cargo bike and trailer used by schooner *Apollonia* is a good example of Organic Transport, as the system is carried aboard and deployed whenever needed in support of the Schooner's operations.[7] The options for Organic Transport are essentially limited to Long-tail cargo bikes and trailers due to space constraints. Tricycles, box-type cargo bikes, and most electric vehicles will be too bulky and heavy to handle constantly, and will have a negative effect on cargo space. This options has proven quite effective for *Apollonia* and promises similar success for other sail freighters looking to incorporate an organic transport element into their operations.

INORGANIC TRANSPORT

Organic Transport is normally resorted to when no support is available. This is the case for *Apollonia* at the majority of their ports, for example. In this case, where only conventional fossil fueled option are available, organic transport is the best option, but where there are other options, inorganic transport is a valuable form of logistics support. There are few practical restrictions faced by inorganic transport for sail freighters, and will really be dictated by the local environment and supply situation.

Inorganic transport can be any type imaginable, as long as it is local to the port involved. *Apollonia* has used bike courier services in New York City, electric cars, and biodiesel-fueled trucks as the situation has presented. In some cases, this transport is Organic to those shipping with *Apollonia*, and thus require few additional arrangements and planning to secure the vehicle and cargo movement. Where possible this second-party transport is to be preferred to other arrangements due to the simplicity and low capital requirements involved.

Third-Party Inorganic low-carbon transport is available mostly in major cities, in the form of bike courier services. These can be arranged through their retail arrangements, or accounts created to formalize the relationships between the water and land transport, but this may not be advantageous in all cases. Where possible, though, cooperation between low carbon transport options should be encouraged to build solidarity and supporting links.

The main disadvantage to third party inorganic transportation for most sail freighters will be the addition of another layer of cost. In an industry already more expensive than its competition, this could be economically problematic until fuel prices rise to a reasonable level.

DEVELOPING SHORESIDE SUPPORT

Shoreside Logistics can be best served in many future cases through third-party inorganic transport companies working at each port. From the sail freighter's perspective, this allows for a more intensive use of the vessel, as time in port can be reduced to only cargo handling time, instead of handling and delivery time. Similarly, this is also the best case for the employment of landside equipment, as it can be involved in carrying more than simply the windjammer's cargo in a low-carbon In these cases, warehousing or some sort of supporting port infrastructure will be desirable to deal with any asynchronous deliveries, most importantly warehousing.

This is most easily done in larger population centers where low-carbon courier services will have plenty of other business. Third Party Inorganic Transport elements of the transport system will need to have sufficient trade volume to stay in business, and this is likely not possible in rural environments. However, deliveries in urban areas are frequently within a 3 mile route, making most low- or no-carbon vehicles more than viable for these deliveries. Further, urban roadway congestion has already proven the

[7] Woods, Steven, and Sam Merrett. "Operation of a sail freighter on the Hudson River: Schooner Apollonia in 2021" *Journal of Merchant Ship Wind Energy* 2 March 2022. JWME.org/articles

value of small agile vehicles for short range, low-mass deliveries.[8] These concerns are especially important in the Hudson Valley, where there are a limited number of urban centers large enough to support such a courier service at current conventional transport prices, essentially only the New York Metro Area, Newburgh, and the Albany-Rensselaer-Troy areas are dense enough to support independent delivery services which could link to sail freighters. This will be a significant challenge to overcome in the coming years.

Rural areas will have the greatest number of challenges for developing third party inorganic transport assets due to population dispersal and local challenges such as volume of business. In this case the development of Second-Party Organic transport is the more important resource to develop. The changeover of supplier equipment to low- or no-carbon alternatives will have the same multiplier effects as with developing the third party systems in urban environments: More than just the windjammer's cargo will be moved with these assets, leading to larger overall carbon and economic gains.

This is not to say that Organic Transport is not important to keep aboard most sail freighters for the foreseeable future. The use of Organic Transport will be important in smaller towns and cities too small to support third party delivery services. In many cases, capacity for other options may well be too small for demand, meaning there may be delays and timing mismatches which organic transport can overcome. In rural areas, the same can be the case, and the use of bikes will be a simple way to take care of these concerns.

CONCLUSION

The way forward for maximizing low-carbon land-side transport for sail freighters is threefold: First, organic transport methods should be further developed as the opportunity presents. Second, in rural areas, the logistical equipment of suppliers should be emphasized, to reduce general carbon emissions in partner's operations. In urban areas the creation and expansion of third-party low-carbon delivery services should be encouraged.

As this last option of creating and expanding low-carbon transport options in urban areas is likely the lowest capital investment available for landside transport outside organic transport assets, it should be emphasized where possible. This can be linked to the general desirability of these services, and considered as an early-adoption element of port infrastructure when talking with investors and entrepreneurs. With a delivery business using a single cargo bike and trailer requiring about $7,500 of capital, there are opportunities for establishing at least part-time delivery services at strategic points, with a reasonable time to break-even.

No part of a sustainable transportation system should be viewed in isolation, as multi-modal, polytechnic transportation will be the rule in a zero-carbon economy. Until then, we will need to consciously build a network of supporting businesses and systems to maximize carbon displacement gains and prove the economic viability of these low-carbon transportation techniques. As the price of trucking and conventional last mile transport climbs, this will become easier due to economic and environmental pressures converging, but without the work of building systems before this crisis it will be impossible to make a sufficient transition when the opportunity presents. Some of the sail freight efforts of the next five years will need to be focused on building these complimentary services and movements to ensure everyone's success.

[8] Vasiutina, et al. 2021. "Evaluating the Environmental Impact of Using Cargo Bikes in Cities"

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Rondout Riverport 2040
A Comprehensive Plan for a Working Waterfront and the Transportation of Goods and People in a Carbon Constrained Future

A. Willner, The Center for Post Carbon Logistics, USA

Summary:

Rondout Riverport 2040 proposes a pragmatic, positive, and prosperous vision for the near future in which the communities of Kingston and Esopus, New York, are enriched by a transformed port, boasting a shoreline brimming with heritage and leading-edge maritime commerce and working waterfront technologies that profit and engage individuals, businesses and communities, allowing for an equitable transition beyond fossil fuels, where all work as together to forge a vital and vibrant economic bond with the greater Hudson Valley Bioregion.

1. INTRODUCTION

Rondout Riverport 2040 offers the communities of Kingston and Esopus, New York, a visionary template and extraordinary opportunity for remaking and transforming the Rondout Creek and Hudson River Working Waterfront over the next 20 years.

Rondout Riverport 2040 provides a trailblazing and sustainable development guidelines for our community, harnessing and enhancing our region's widely shared prosperity, even as we enter an economically demanding carbon-constrained future.

The Riverport, in 2040, as envisioned here, will offer far more capacity, while being significantly more compact in land area, more robust, and resilient than the current patchwork of diffuse land uses found on today's waterfront. The core mission of tomorrow's port is the post carbon maritime transport of goods and people up and down the Hudson River and beyond.

The Riverport is designed to attract shipping, distribution, commerce, hospitality, and craft businesses, creating a dynamic collaboration and nexus for optimized local and regional market productivity. The result: an economically, culturally, and environmentally resilient post carbon working waterfront – a gateway to the Hudson Valley and world.

Rondout Riverport 2040 is a signature project benefiting from the creative contributions of its founding partners, The Hudson River Maritime Museum [1], The Schooner Apollonia [2], Sustainable Hudson Valley [3], The Center for Post Carbon Logistics [4], and many additional partner organizations, local governments, and institutions to address and transcend the near future threats of sea level rise; increasingly turbulent and extreme weather events; and unexpected global, national and regional economic shocks. Rondout Riverport's versatility will depend on the linking of its economic opportunities with environmental restoration and sustainable commerce. Embracing this multi-generational project will also be a source of inspiration for broader long-term action on climate change.

We can best accomplish these visionary waterfront goals via an integrated "placemaking" approach.

Placemaking provides a method for answering critical questions: What are the best ways to mobilize and coordinate our many community assets? How do we effectively draw on public and private partnerships to creatively identify opportunities? How can we successfully coordinate our implementation efforts? And where do we find the resources needed to accomplish our vision for a transformed riverport?

We do not have to wait until 2040 to start benefiting. Communities can begin now, as they participate in a vigorous planning process, while taking key steps for future proofing our shoreline against the harms threatened by a more politically, economically, and environmentally chaotic planet in a post-carbon future. The path to a bright, sustainable future starts with community engagement and data collection to build an actionable vision for the Rondout Riverport, a vision that incorporates a proud sense of community and place, local stewardship, and widely shared economic opportunity. The choice is ours.

2. A VISION FOR RONDOUT RIVERPORT WORKING WATERFRONT, CIRCA 2040

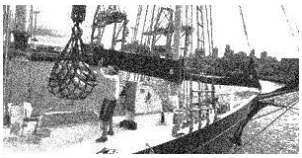
Imagine: It is a hot, late autumn day along the Hudson. From the rooftop of a trading house[1] in Kingston, a ship spotter sees the topmast of a large sloop. The sloop signals a waiting solar electric steam tug, the *Augustin Mouchot* [5], which tows the engineless sailing ship toward a berth in the newly completed Rondout Inner Harbor.

The sloop, the *Pete Seeger*[6], is loaded with high-value cargo from abroad, transferred in New York Harbor from the oceangoing post carbon Eco-Clipper [7] *Jorne Langelaan*.[8] The mixed freight consists of Caribbean fair-trade coffee and cocoa beans bound for the Hudson Valley's roasters and chocolatiers, along with preserved

[1] A trading house is an exporter, importer and a trader that purchases and sells products for other businesses. Trading houses provide a service for businesses that want international trade experts to receive or deliver goods or services.

tropical fruits and rum destined for local Kingston storehouses.

The *Seeger's* crew put a harbor furl on the hemp cloth sails, even as other crew members ready the on-board cargo gear. The sailors open hatches and set up the cargo boom which will do most of the heavy lifting. The crew can also access the harbor's floating cargo cranes for heavier or bulkier freight.



Unloading Black Seal in Brooklyn

These locally trained young seafarers are in good spirits, looking forward to spending some time ashore, and to a few drinks of locally made brew, cider, and spirits. Like any sailors, they are also hungry and ready for a good meal at a tavern – the local fare includes dishes harvested from the Hudson's new artisan fishery and from oyster beds seeded in shallows created by former piers and abandoned roads, submerged downriver over the last 20 years due to climate change's rising seas and increasing river levels. After dinner, the sailors walk along the sea-life-encrusted seawall, built from repurposed concrete and stone from former waterfront byways, buildings, and piers inundated by the Hudson's rising waters.

A longshore crew, warehouse workers, drovers, and their electric-assist people-powered tricycles and wagons, converge at the waterfront's new storm-proofed floating dock – which rises and falls with surging tides. Cargo surveyors assist with the unloading of the coastal Schooner, *Sam Merrett* [9] down from Nova Scotia with a load of lobsters and oysters. The square foremast tops'le Schooner *Kevin Kerr Jones* [10] is unloading citrus from Savannah. Other stevedores are loading the solar electric Feeny [11] shipyard-built canal barge *David Borton* [12], bound for ports up the Hudson River and through the Erie Canal with a destination at Buffalo. Some smaller solar barges are loading for Port Jervis, on to the newly opened Delaware and Hudson Canal [13].

The (s)low tech Rondout Riverport is modern and efficient. The port is no longer dependent on prohibitively expensive fossil fuels, nor the notoriously unreliable overseas energy supply chain. Instead, Rondout makes the best use of old and new – tried and true 19th century technology blended seamlessly with 21st century solar and battery electric gear and vehicles. More people are at work today on the waterfront than at any time since the 1920s; there are more warehouses and trading houses, shipbuilding, repair facilities, and docking facilities than at any time in the Rondout's nautical history.

Just behind the waterfront are coopers [14], using sustainably harvested local oak; sail and ropemakers, utilizing New York hemp; forges and foundries using concentrated solar [15] to form bronze fittings. Riggers are hard at work in ropewalks [16] making running rigging and dock lines to equip the numerous commercial and recreational sailing ships and boats.

Rope Walk

Dry docks and shipyards look out on bikeways and walkways circumscribing the tidal flats, from which hundreds of locals and tourists observe the port activity, safe in the knowledge that food and goods continue to pour into a port that – thanks to good planning 20 years ago – is admirably adapted to keep pace with a changing climate and evolving post carbon economy. All of this could be, if only we take a can-do proactive approach toward tomorrow.

Solar Electric Canal Barge

3. REINVIGORATED WATERWAYS: THE FOUNDATION OF A RESILIENCE STRATEGY

"Contrary to the techno-paradise that some expect, my belief is that our future will likely resemble our past, and that we may fall back on proven, low energy approaches to supporting human life that have been historically proven to work. "Isn't that pessimistic?" asked the interviewer. I replied that I don't think so. It is in my view even more pessimistic to imagine a world continuing on the current path, becoming a place in which there is no place for human labor or creativity, where rather than doing things with our backs and hands and minds, we must instead wait passively for conveniences and solutions to be marketed to us. That, to me, is the most depressing future imaginable." – Erik Andrus [17] Founder the Vermont Sail Freight Project [18]

Not so long ago, in the 19th and early 20th centuries, the Hudson River bustled with commerce and lay at the heart of a thriving network of marine highways linking the largest cities and smallest communities to a web of regularly scheduled transportation routes – waterways stretching from the Atlantic west to the Great Lakes.

Boats of all sizes served local cargo and passenger needs. Schooners, sloops, barges, and steamboats connected river town inhabitants. Farmers, merchants, and oystermen relied on this vibrant and diverse fleet to deliver goods to market and to bring back supplies.

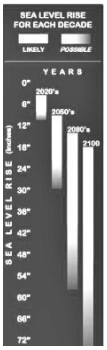
The Hudson River – and the ships and boats sailing her – were vital and integral to those who worked, lived, and thrived along our inland waters, putting places like Kingston and Esopus on the map.

Historically, thousands of vessels plied these marine highways, sailing up and down the Hudson Valley, delivering fresh local farm produce ranging from apples to applejack, fish, and shellfish, and carrying passengers to ports along the way.

View near Anthony's Nose [19]

The Kingston and Esopus' Rondout Creek and Hudson River Working Waterfront has long been a key contributor to our region's financial wellbeing – though it could be so much more. Now, as we enter a carbon constrained future our Riverport is poised for rebirth, to again become a key regional hub for the transport of goods and people.

As we move into a world facing increasingly tough political, economic, and environmental challenges, we must ask ourselves: How shall we, living beside the Hudson River, meet the looming threats of climate change, rising sea level, aging infrastructure, changes to global shipping patterns, threats to food security, upheavals in energy production and distribution, and the risks all these disruptions could bring? As in the 19th and 20th centuries, the answer to those questions, and the solutions to our problems lie only as far away as the lapping waters of our home river.



Scenic Hudson Sea Level Rise by Decade

Rondout Riverport 2040; A Comprehensive Waterfront Plan for a Working Waterfront and Transportation of Goods and People, offers a pragmatic look forward to what – with proper preparation, cooperation, and investment – could result in a revitalized and highly profitable Rondout Riverport at mid-century. This plan provides a practical salient vision of resilient shorelines [20] and a working waterfront [21], redesigned to protect our community from sea level rise and storm surges [22], built to accommodate a wide spectrum of business, cultural and social uses that will benefit our communities and the Hudson Valley Bioregion. This, to put it simply, is a waterfront proposal that "floats all boats," promising equity and prosperity for our citizens, large and small industries, impact investors [23], entrepreneurs, craftspeople, environmentalists, boatmen and women, dreamers, and doers.

But here is a warning: An optimistic future depends on our will to make it so. If we pursue politics and policy as usual, we could face a grim tomorrow as our region is hobbled by climate change: Abandoned, flooded, mouldering shoreside buildings and piers; low-lying and failing sewage treatment plants and electric utilities; eco-refugees crowding our upstate communities seeking limited food and shelter; and a polluted, dead estuary as oil and chemical plants are inundated. Despite sincere efforts at incremental change and adaptation planning, without visionary action right now, our region could face a dire tomorrow marked by rising water and plummeting economic fortunes. The choice remains ours.

The reality of escalating climate change makes clear that we must redesign our economies if we are to maintain quality of life in a carbon constrained future. A major opportunity offers itself: to take advantage of our wealth in waterways and return to our bioregion's nautical roots and pioneer a new industry grounded in tried-and-true technology that once drove our economy: low/no carbon shipping, and post carbon transportation businesses, and organizations [24].

In the New York City metropolitan area today, 80% of freight transport is carried by truck [25], a mode of transportation that is congesting our highways, increasing air pollution, and entirely dependent on fossil fuels. In a carbon constrained future, sustainable water transport (an

innovative mix of sailing vessels, hybrid/fossil fuel-free electric ships, and people/electric powered transport) will almost certainly be a necessity.

As the climate crisis deepens, water-based transportation routes can link communities and promote resilience throughout the Hudson Valley – doing so without congestion, without pollution, while being energy efficient, non-dependent on increasingly expensive fossil fuels, and potentially very profitable.

Water-based transportation, once ubiquitous on the Hudson, is just about the only form of transportation, other than the bicycle, that requires little or no roadway maintenance. Navigation channels are less costly than roads to keep up; they do not require a large industrial base and are far less energy-intensive than alternatives.

We need not look far for proof: The 363-mile-long Erie Canal system [26] linking the Atlantic Ocean with the Great Lakes, has been continuously operational since 1825. The cost of keeping it running is tiny compared to that of equivalent highway mileage. The Hudson and its linked waterways comprise the greatest set of transportation assets in the world – assets greatly underutilized today. Those "blue highways" will see their status grow in a post carbon world, and communities along them will prosper as a result.

Kingston and Esopus are two such communities. The Rondout Riverport is strategically located to be part of this great renaissance: located just ninety miles from one of the greatest ice-free harbors on earth; and sixty miles from the entrance to the Erie Canal.

But to make this opportunity a reality, Riverport infrastructure must be created to increase capacity, while being nimble enough to respond to rising sea and river levels and worsening storm surges, as well as shifting economic tides. The port will also need to be made accessible to smaller, more numerous vessels on a protected and restored working waterfront [27]. To thrive as a maritime and commercial center in a carbon constrained era, Rondout Riverport's infrastructure must include:

- Charging stations for electric and electric hybrid vessels, flood-proof storage and production facilities for biofuels [28] like methane (produced by sewage treatment plants), biodiesel (from restaurant used fryer fat) [29], and hydrogen [30] (created from seawater while sailing vessels are underway); A flood-proofed waterfront and flood-proofed [31] warehouses and trading houses;

- Local ship and boatbuilding and repair facilities to support our local commercial fleet [32].

- More traditional break bulk [33] cranes for transfer of palletized, and bagged cargo [34]

- Across-docking facilities for transfer of goods from ship-to-ship and from ship-to- first-and-last-mile providers (i.e. small sailing, rowing, hybrid vessels as well as people/electric powered commercial trikes [35], and wagons);

- Access to innovative training facilities [36] to provide a labor force: the new traders, river rovers, seafarers, and port workers. This labor force will need training based on models for "preserving the tools and skills of the past to serve the future."

Rondout Riverport will not stand alone, but will be integrated into the greater Hudson Valley Bioregion, along with the wider Northeast and U.S. transportation and distribution system, with which it will engage collectively and creatively to unleash an extraordinary historic transition to a future beyond fossil fuels [37]; a future that is vibrant, abundant, resilient, and ultimately preferable, more equitable, and more economically viable than the current model.

Rondout Riverport 2040 will serve as an empowering example to our bioregion and our country – demonstrating the viability of ethical livelihoods and teaching beneficial sustainable technologies that do minimal socio-environmental harm; methodologies that foster self-reliance and promote Slow Tech hands-on work practices.

Caulking Seams

The result: entrepreneurs, professionals, technicians, craftspeople, academics, and students from across our bioregion, and across the United States, will be drawn to our state-of-the-art waterfront – gathering here to learn from each other. Our waterfront will be like no other in our region, or maybe in the nation: Becoming a *living laboratory,* cultivating not only practical and sustainable energy, commerce, and transportation solutions, but generating a flow of fresh, pathfinding ideas.

To bring these advanced infrastructure changes about – working with partners throughout the region – we will need to establish: a new binding agreement with the region's farmers and farm advocacy organizations in our "foodshed" that offers subsidized support of infrastructure including, but not limited to:

- Full employment in year-round growing season zero carbon greenhouses [38].

- First and last mile transportation of agricultural products to processors and the waterfront (using existing and new rail-trails as bike/trike corridors);

○ Solar powered cold storage at critical locations.

○ Year-round indoor farm markets.

○ An inter-port agreement with small and mid-sized ports along the Hudson River, the Erie and Champlain Canals, and New York Harbor:

○ This agreement would include the sharing of information on resilience and "future proofing" of all waterfronts.

○ Establish a *Sustainable Working Waterfront Toolkit* – making available the historical and current uses and economics of New York's waterfronts as a resource. The toolkit must include legal, policy, and financing tools that river ports and waterfront communities can tap into so as to preserve and enhance local and regional port facilities.

● Small ship access to flood proofed regional produce and fish markets [39].

○ The Hunts Point Market and Fish Market must be made accessible to small ships, delivering farm goods from upstate and returning with seafood from the Market.

● A new agreement with transport and longshore unions that allows ships to load and unload with their own equipment. Local industry will need to work in close conjunction with the unions to hire and train more people for post carbon longshore work.

● A partnership with the region's Maritime Academies, the Hudson River Maritime Museum's Wood Boat School [40], and a new maritime trades high school based on the New York Harbor School [41] to train mariners, and to teach the logistics careers required to serve the new post carbon working waterfront; with the ultimate goal being the creation of a Training Center [36] in the mid-Hudson Valley where professional practitioners and apprentices can participate in practical workshops to relearn maritime and other heritage skills and old/new technology to serve present and future needs;

● An endowment for the preservation and utilization of traditional maritime skills and tools, the establishment of a traditional knowledge database/Wiki; library; and pre/post carbon tool, technology, and machinery collection. This innovative interactive educational resource serves to preserve, restore, and promote the re-use of traditional skills, integrating those skills and methods with modern know-how and appropriate post carbon technologies.

● Create maritime mixed-use zones where public parks, walkways and bikeways are built in flood zones and are adjacent to and part of the working waterfront – acting as a source of recreation and as a vital part of flood control.

● Establish a strong working relationship with NOAA's National Sea Grant Program for working waterfronts [42].

● Advocate for a reduced, less intrusive regulatory role for the US Army Corps of Engineers. Instead, encourage Corps funding be channelled into partnerships with other agencies, local non-profit organizations, and an engaged public to develop, and redevelop climate change-resistant and resilient Hudson River ports, and to create living shorelines, restored wetlands, and estuarine habitats resulting from the removal of bulkheads and restoration of intertidal habitats [43].

Through this diversity and combined effect of uses, Rondout Riverport's working waterfront will also:

● Create jobs in sailing, logistics, shipbuilding, harbor maintenance, craft, food production and more.

● Revitalize the waterfront community via economic development combined with better public access and recreation.

● Improve regional food production and distribution, linking producers to markets in the Hudson Valley and beyond.

● Design and build a maritime commerce micro-hub for aggregation, warehousing, co- packing, and marketing.

Rondout Riverport will be the homeport for future-proof sailing, alternative fuel, and solar electric ships. It will provide training in maritime skills, shipbuilding, and longshore trades, while also educating crews in "earth care, people care, and fair share" principles [44]. These future-proof[2] ships and their locally trained crews will carry *people, goods, and knowledge* to and from towns along the Hudson and on the region's canals.

As Rondout Riverport becomes the working waterfront of tomorrow, the constraints, and advantages of smaller and (s)lower tech modes of transport must be considered in every aspect of the port's design [45]. Historic and modern technologies must meld seamlessly to offer approaches that are more self-sufficient and sustainable. Just one example: ships of all sorts, meeting a variety of needs, will have to be built (and rebuilt) locally, from locally sourced or recycled materials, and be crewed by locally trained seafarers. These new vessels will likely be different than the ones we build today; smaller, more versatile, adaptable, energy-smart, and affordable.

As fossil fuels become more expensive or less available, replaced by alternative sources, and are restricted by

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[2] The term "future-proof" refers to the ability of something to continue to be of value into the distant future – that the item does not become obsolete.

climate change policy – port infrastructure will need to be part of a carbon neutral trading network for "short sea shipping [46]" that links us to the region and the world, serving the Hudson Valley, the New York/New Jersey Harbor, Coastal waterways, and transfer points for goods from overseas.

Moreover, the Rondout Riverport will be well positioned to become a laboratory for carrying cargo under sail [47] as public agencies [48], and private companies [49] accelerate their investigations of the potential economic and environmental benefits of transferring more cargo from roadways to waterways.

4. IMAGINE THE FUTURE, REALIZE THE VISION

Life at the water's edge is rapidly changing. The impacts of new technology, patterns of urban development, and globalization are redefining global logistics, and while some waterfront cities will thrive as ports and grow under these new conditions, others will need to evolve to survive and succeed….

The Rondout Creek today, lapping at the shores of Kingston, and of the Sleightsburg and Connelly hamlets in the town of Esopus, is in the flux of significant change. The waterfront as it is, represents an amalgam of positives and negatives. At its best, it boasts commercial shipyards, marinas, marine services businesses; institutions including the Hudson River Maritime Museum (and its Wooden Boat School, and Shipyard [32]); along with wetlands, open space, promenades, magnificent scenery [50] and recreational possibilities. But at its worst, it is marred by brownfields [51], combined sewer overflows [52], and a variety of non-water dependent [53] uses that make poor use of water accessibility, marine transportation, and port possibilities.

Most unfortunate of all: existing development plans lack a sweeping vision and often fail to take a future into account dominated by climate impacts, including severe storm surges, along with a steady sea and river level rise that will soon inundate portions of the currently existing Rondout and Hudson shoreline [54]. Plans that fail to take climate change into account will drown in insolvency.

Over the past few years, a variety of plans and proposals have been put forward, each with particularly good elements, but also with gaps and flaws:

- The City of Kingston and town Esopus are working with stakeholders and partners on The Rondout Waterfront to improve the resiliency and sustainability of the shoreline, implement an economic development strategy, and cultivate better access to the river via waterfront parks and open space for people on foot, on bicycle, and launching boats.

- Kingston's Weaving the Waterfront [55] planning process has many elements including: the Waterfront Resiliency Project, Rondout Riverport Shoreline Stabilization and Public Access Project [56], Kingston Point Park Improvements Project [57], Kingston Point Climate Adaptive Design [58], Kingston Point Rail Trail Phase 2 [59] and trail and public access improvements.

- The Town of Esopus, is also working on a comprehensive plan that contains waterfront [60] goals for the Wallkill, Hudson, and Rondout Creek Waterfront access and usage. These plans include development policies to restore, revitalize, and redevelop deteriorated and underutilized waterfront areas for commercial, industrial, cultural, recreational, and other uses.

- Significant work has also been done to address storms and sea level rise: Preparing Hudson River Waterfronts for an Era of Rapid Sea Level Rise [61], The City of Kingston Grant-Funded Waterfront Projects [62], Scenic Hudson's report on Sea Level Rise [63], and Hudson River Sea Level Rise City of Kingston [63]. New York is also starting to pay attention to the climate issue through The Climate Leadership and Community Protection Act (CLCPA) [64].

However, importantly, very few if any of these proposals are in the implementation phase. And little of the available climate and sea level change studies and data are included in the port and waterfront redevelopment plans as presently formulated.

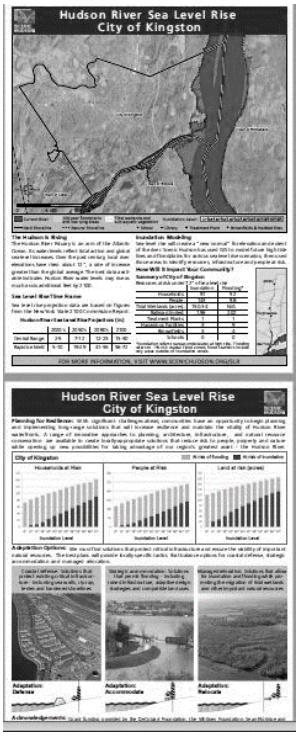
Rondout Riverport 2040 is unique in that it takes likely forecasts of the near future fully into account; it is a proposal that offers a hard, sober look at the realities of our climate change, alternative energy, and global supply chain future.

But for this plan to be realized, stakeholders, partners, and existing maritime institutions will need to buy-in now and participate actively in the planning and implementation process. Those institutions include, but are not limited to the Center for Post Carbon Logistics [4], the Schooner Apollonia [2], the Hudson River Maritime Museum's solar electric passenger vessel Solaris, [1] the Hudson River Sloop Clearwater [65], Sustainable Hudson Valley's Regional Hudson Valley Climate Action Plan [66], The Riverport Coalition [67], Riverkeeper [68], and the Beacon Sloop Club's Woody Guthrie [69]. This diverse partnership must also be inclusive of public and private landowners, as well as land conservation organizations, including but not limited to the Kingston Land Trust [70], Scenic Hudson, and the hundreds of Hudson Valley organizations and individuals working for a more resilient and sustainable future.

4.1 Threat Assessment, a first step.

The Rondout communities must start by objectively assessing near future threats and evaluating our greatest points of weakness – assessing local infrastructure, and economic, political, social, and environmental structures. Rondout Riverport communities will especially need to

fortify against the economic and environmental storms to come by doing work to enrich our towns and neighborhoods today, reducing risk and enhancing resilience for the future, by:



Threat Assessment

- Implementing community flood-proofing [71] and simultaneously introducing drought-resistant landscaping [72], in preparation for extreme weather patterns;

- institutionalizing green building practices [73];

- zoning against development in climate disaster-prone floodplains [74];

- installing redundant communication and storm-proof energy systems [75];

- establishing systems for community-wide food security [76];

- creating "resiliency hubs," [77] equipped to deal with sudden health, environmental, or weather / climate disasters, and develop strategies for proactive risk minimization and management;

- using the tools of community "placemaking" [78] to include the broadest possible participation in planning for, and developing, a working and recreational Rondout Waterfront and Port that will be operational and adaptable for the first half of the 21st century and beyond;

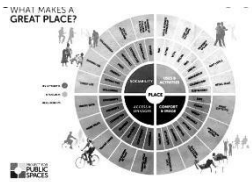
- develop an education and training center [36] for rapid proliferation of all these practices and trades in and beyond the Rondout Riverport.

5. PLACEMAKING - A PATHWAY TO THE FUTURE

Rondout Riverport 2040 will engender the Hudson Valley's can-do spirit, harness our region's inventiveness and our love of innovation, allowing our region and its people to not merely survive in the Post Carbon era, but thrive. And why not? After all, our region gave the world the steamboat, the telegraph, the submarine, FM radio, the first interactive software systems vital to today's computers, and even potato chips. We seem born to invent the future!

Rondout Riverport 2040, by cooperating fully with all partners, will incorporate the best elements of existing planning documents; undertake a thorough land use, flood plain, and sea level rise analysis; examine current trends in shipping, energy, food security and port management; assess the best climate change and economic forecasts; and create an adaptive re-use Waterfront plan that incorporates the best of 19th, 20th, and 21st century technologies.

But this process will do far more than construct a vision. It must ensure that this vision is aligned with community values and sensibilities. To achieve this goal, we will use a placemaking approach as the structure for addressing critical questions about how best to mobilize the many assets of the Rondout Riverport in a coordinated fashion to meet community needs and attract diverse resources.



What Makes a Great Place?

Placemaking is a holistic approach for considering the possibilities inherent in a locality by identifying a unifying purpose or theme – the essence of the place – and then identifying multiple strategies, at multiple scales, that relate to this theme, providing direction for achieving unified objectives and goals.

The foundation of placemaking is a focus on the many natural benefits of public space to achieve the most comprehensive multiple uses, aesthetic benefits, connectivity, and social interaction. This process will generate key insights into how state, municipal, and county government agencies can best coordinate implementation efforts and find the resources to address problems and opportunities.

The placemaking approach will catalyze the integration of the many layers of conceptual planning already underway by various entities, aiding in the development of collaborative strategies for redeveloping the Port so that it serves multiple river uses and users.

The partners will work with, and gain consensus from, other Hudson Valley organizations to begin realizing the *Rondout Riverport 2040* vision. A network of groups, including the Lifeboats HV, Sustainable Hudson Valley Senior Fellows [79], Good Work Institute Fellows Network [80], C4PCL's advisory committee [81], plus staff and contractors, will provide intensive inputs and garner resources to translate the partners' vision into robust planning and implementation during 2021.

It is now past time to implement the many excellent ideas generated by our communities and their planners. It is time to bring the planning process forward into those communities. The path to a bright, sustainable future starts with research and engagement, and placemaking in Kingston and Esopus and on the Rondout Waterfront.

The source of our inspiration and empowerment will be our region's shorefront and its waters, its hands, and minds. Here the best and brightest, urban and rural, "Slow" technologists, craftspeople, educators, planners, artists, schoolchildren, and seniors, can come together to remake our post-modern world. Here we will find new, efficient, green ways to produce energy; revolutionize agriculture to assure food security; reinvent transportation on land and water to move goods up and down our Hudson and to prosper in the challenging times ahead. Here we'll help birth a new, inclusive regional economy that rewards all citizens, while celebrating democracy, cooperation, and public service.

Picture a Rondout Port in which every day, diverse participants – Transition and Permaculture practitioners, boat and ship builders, coopers, riggers, longshore workers, managers, carpenters, commercial fishermen, millwrights, engineers, potters, community development financial institutions, weavers, woodworkers, planners, architects, writers, historians, archivists, computer and IT experts, and people from wildly diverse vocations – will all merge and meld their talents to realize the vision of *Rondout Riverport 2040*.

In implementing the Rondout Riverport vision, we will move via hands-on experiences beyond spin and abstract buzzwords – past "environmental", or "sustainable", or "eco" this or that. Here, our work will focus on a single place and on a Just Transition away from fossil fuels. The times ahead will give new meaning to the word deckhand, as all join to create the naturally viable means for living and being in community in the 21st Century – as we prosper economically, emotionally, and spiritually, beyond the realm of coal and oil.

The next step will be one of the most critical: to gather all our research and data, analyze it, and commit to honestly confronting challenges, while also boldly embracing opportunities and possibilities. We must move forward quickly and vigorously; climate change and economic change are moving ahead swiftly. We must inspire individuals, communities, local leaders, and City, County, and State officials to commit to the creation of a thriving, innovative Rondout Riverport and Working Waterfront, as a gateway to a vast system of sustainable waterways that together will enable a Post Carbon Future full of hope and opportunity.

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Mr. Wilner has been a leader, organizer, and advocate for the New York/New Jersey Bioregion for more than thirty years. He was an early proponent of the Waterkeeper model of water and habitat protection as the founder of NY/NJ Baykeeper.

Mr. Willner has experience as a city planner, wood worker, boat builder, photographer, Permaculture and Transition practitioner, storyteller, and author.

Mr. Willner is a sought-after speaker on a wide variety of subjects including post carbon logistics, environmental advocacy, habitat restoration, and regenerative communities.

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Getting to Marine Highways via Marine Byways

Marine Highways

- The United States has a remarkable, but severely underdeveloped resource that can reduce pollution, increase transportation efficiencies and advance sustainable transportation
- This concept has been named Marine Highways and has been supported at the Federal level since 2007
- It envisions increased movement of cargo (and passengers) on the nations' waterways and various experiments have been funded over the years, particularly with regard to break bulk cargo and ferries
- These experiments have shown that the concepts are workable, but have often failed to break through at a commercial level (achieve critical mass)

Marine Highway examples

- Hudson river barge container trade
- NYC cross harbor trade
- Short Sea Shipping
- James River Container project
- Port improvements at the ISO container level to improve regional short shipping trade
- Ferry improvement projects

Marine Highways Obstacles

- Fuel price variations very seriously affect competition with road and rail
- Shippers and the public at large are the customers and they are used to interacting with road and rail and therefore have a hard time integrating another transport mode into their personal optimization routines.
- Marine highways require Marine Highway entries and exits and many of those have disappeared and fallen into disrepair
- Marine Highways strongly engage with intermodal (ISO containers), but maritime trade needed to walk before it could run with containers
- Quite possibly the development of Marine Highways with containers is one bridge too far and customers need to reconnect with the Marine Highway in smaller steps to become more familiar with the concept. Maybe re-focus on growth of the concept from a smaller starting point, instead of large scale insertion.

Before Highways there were Byways

- Before we had interstate highways there were byways where trade was developed on a smaller scale.
- Not until the public started to shift away from rail and small scale maritime to trucks and buses did the efficiency of an interstate highway system become useful.
- In other words, customers had to become familiar with trucks and buses on a local (less efficient) level before the present massive road transportation system could be implemented.
- That familiarity relates to the customers learning to drive trucks, the establishment of local truck depots, the establishment of local truck garages, the establishment of local trucking companies and customers thinking of trucking as their prime transportation mode
- Once these concepts were established the interstate highway system destroyed the byway system and resources and also destroyed the local marine resources (the marine byways).

Marine and Road, there is a difference

- Highways and byways can be built, but our navigable waterways are fixed.
- Our waterways are relatively inexpensive to maintain (as compared to roads), have massive unused capacity, massive potential for reduced emissions and can be brought back on line in our transportation infrastructure at low cost
- However, we have lost our entrance and exit ramps to our waterways.
- Road highways and byways are inherently separated, while waterways are a much more complex (and interesting) combined resource. You cannot walk on a highway, but you can still do a Tom Sawyer on a waterway and we need to take advantage of that.

Marine Byways

- Our waterways are both Marine Highways and Marine Byways and we need to take advantage of that in reviving waterway transportation.
- To get Marine Highways to work maybe we first need to develop Marine Byways
- Marine Byways is the development sandbox for Marine Highways the same way that byways on land were the development sandbox for the interstate highway system
- Let's build Marine Byways, get customers to understand there are Marine Byways, and let the Marine Byway industry develop the Marine Highway system

Marine Byway Aims

- It all relates to awareness; get customers to see and believe in the attractiveness of marine transportation.
- Don't think large, think easy (and fun) to engage.
- Many exit and entrance ramps, initially on a small scale, with the potential to increase scale. (Build town docks and piers that can simultaneously handle recreational activities, aquaculture, passengers and light freight)
- Water access to as many stake holders as possible
- Maritime pays well and has always been the path to the middle class. Provide those who want to enter the middle class with a path to the marine byway and eventually the marine highway.
- Make it easy for young people to engage with Marine Byways
- Champion system wide reduced emissions and environmental impact.
- Support small freight and passenger operations to allow growth to larger freight and passenger operations.
- Provide seed money and then allow organic growth. Maritime allows us to start small; take advantage of it.
- Plan for sea level rise in building marine byways

Enabling Marine Byways

- Build many modest sized Marine Byway entrance and exit ramps
- Allow the public to experience Marine Byways operations as part of their daily life
- Entrance and exit ramps with charge points and sustainable fueling
- Entrance and exit ramps that allow cargo handling (initially pallet size, with containers as a future growth goal)
- Provide the public with a path to the middle class through marine training opportunities associated with entrance and exit ramps
- Recreation that provides education that enables participation in maritime commerce
- Allow all types of small Marine Byway experimentation that meets the aims

Typical Marine Byways projects

- System wide analysis.
- Local action that enhances the system
- Basic entrance/exit ramp installation along marine byways
- Develop micro cargo movement and deliveries near Marine Byways
- Erie Canal passenger and freight development
- Develop longer distance passenger cruise/ferry/excursion trade
- Provide byways transshipment opportunities at major container hubs with customs clearance
- Increase maritime education at marine byway entrance/exit ramps

Specific Marine Byways projects

- Built specific systemwide tool kits
- Schooner Apollonia
- Kingston/Ronduit Creek entrance/exit ramp optimization
- Marine high schools with school research/training vessels
- Erie canal passenger/freight development
- Enhancement of existing excursion/ferry trade to new Marine Byway entrance and exit ramps
- Support for emerging low emission ferry/ freight technologies
- Marketing to upstream producers and shippers
- Develop small intermodal (efficient and secure movement of pallet size cargo)

Schooner Apollonia

- This is happening. It may not be the most efficient, but there is a market.
- The market is driven by specialty products and motivations
- Wine, malt, coffee. Products that benefit from an image
- Niche markets are testbeds
- Build a little, test a little, learn a lot

http://www.schoonerapollonia.com/

"Apollonia by Apollon" - Schooner Apollonia sailing down the East River into New York Harbor following its first-ever sail freight delivery of Hudson Valley Malt to three breweries in Long Island City, Queens in August of 2021. Apollonia's visit to New York City, part of the vessel's fourth round trip from Hudson, NY to NYC and back, also included deliveries to Red Hook, Brooklyn and Manhattan. Credit: Laurent Apollon/WindSupport NYC

The Hudson River NY canal system. A Case Study

- About 1000 miles of underdeveloped marine byway level waterways
- A remarkable localvore food market with a massive consumer market hub (NY/NJ)
- Underdeveloped employment opportunities along the Hudson river and canal system
- Decimated entrance and exit ramps along the system and very few remaining ramps
- Kingston as a testbed for refinement of existing assets
- An astonishing amount of underdeveloped byway assets with regard to manufacturing, tourist assets and undervalued real estate.
- The ability to grow organically along Long Island Sound, New England, Raritan Bay, Delaware Bay and Chesapeake Bay.
- The ability to export pallet size cargo to containerized cargo nationwide and overseas by consolidation in the port of NY/NJ.

Operation of a sail freighter on the Hudson River: Schooner Apollonia in 2021

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Sam Merrett, Master of Schooner *Apollonia*

Abstract: In the discussion of sail freight worldwide, little analysis exists to illuminate the effects of sail freight vessels engaged in shipping along rivers. Even less of the literature provides meaningful, in-depth insight into the operations of such vessels. The 64-ft (19.5 m) schooner *Apollonia*, a small general cargo vessel and the only active, operational sail freighter in the United States, operates on the Hudson River and in New York Harbor. The ship's logs and other data from 2021, the *Apollonia's* first sail freight season, are examined here to gauge the performance of small sail freighters on river trade routes. The available data shows sail freight has a strong advantage over comparable trucking in fuel use per Ton-Mile.

INTRODUCTION

In the last half century, Wind Propulsion has been widely acknowledged since the Oil Crisis of the 1970s as a means of reducing fuel use in maritime transportation, and research started in that era has been resumed as climate and economic concerns force change in the maritime industry. Small sail freighters engaged in coastal or inland waterway trading with break bulk general cargo have been ignored in this discussion of working sail's revival, however. These vessels are neither bulkers carrying loose cargo such as iron ore or grain, nor do they use intermodal shipping containers. The cargo is instead loaded directly into the hold in smaller packaging, such as sacks, crates, boxes, coolers, and barrels. Analysis of logs, cargo, and fuel-use data from the schooner *Apollonia* operating on the Hudson River and New York Harbor allows for a comparison of these vessels to other methods of cargo transportation.

Sail freight is defined as "The maritime movement of cargo under primarily wind power."[1] As can be seen in the figure below, this includes sail and motor-sailing vessels which rely on their engines for less than half of their propulsive power.[2] Sail-Assist and conventional motor ships are excluded from this definition, but are by far the most-discussed in journals at this time.

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[1] Woods, Steven. "Sail Freight Revival: Methods of calculating fleet, labor, and cargo needs for supplying cities by sail." Master's Thesis. Prescott College, 2021. Pp 6. www.Researchgate.net

[2] Wind Ship Development Corporation, *Wind Propulsion For Ships Of The American Merchant Marine* Norwell, MA: WSDC, 1981. Pp II-5

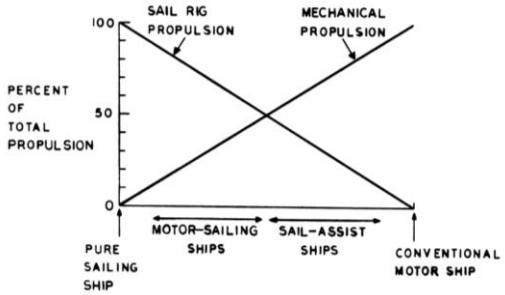

Figure 1: "Motor Sailing Propulsion Spectrum" in: Wind Ship Development Corporation, *Wind Propulsion For Ships Of The American Merchant Marine* Norwell, MA: WSDC, 1981. Pp II-5.

While there is considerable space within the sail freight continuum for high levels of engine use, the majority of coastal and inland trading under sail at this time is in small general cargo vessels which are either engineless, as with the ketch *Nordlys*,[3] or use engines only when docking or for safety reasons in crowded harbors, like the schooner *Apollonia*.

The tonnages involved in most studies of wind-assisted ship propulsion allow for comparison with conventional merchant ships. There are multiple studies which show the fuel saved from sail retrofits to existing vessels, compared to the ship's previous performance.[4] However, these are based on places where maritime shipping is the rule, such as small island states and archipelagoes, or transoceanic shipping. This is not the case when looking at inland and coastal vessels which displace rail and road transport instead of other ships.

Another element worth noting in this study is the *Apollonia*'s goals. The ship and her crew are not looking solely to reduce carbon emissions, though this is a significant part of their mission. Their goal overall is to have an environmental, economic, and social impact, the "Triple Bottom Line." This entails an extra educational bottom line, changing the way people think about the Hudson River, waterways, transportation, and supply chains. The economic mission involves paying more in labor than on fossil fuels. There is significant interaction between goals: Ecological improvements have a social impact by reducing pollution, while economic changes have social impacts on jobs and livelihoods. This multifaceted impact is outside the scope of this paper, which will be limited to assessing the comparative CO2 intensity of sail freight vessels and fossil fueled trucks.

THE SCHOONER *APOLLONIA*

The *Apollonia* is a steel J Murray Watts design from 1946, built in Baltimore, MD. Acquired in 2016, she spent 4 years in repair and retrofit before launching for a first season of relationship building and experimentation in 2020, including one circuit from Hudson, New York to New York City with a small number of cargos. 2021 was the first season of regular operations. *Apollonia* has a sail area of 122 square meters, and is equipped with a Detroit diesel engine of approximately 125 Horsepower.

[3] "Nordlys" https://fairtransport.eu/nordlys/ Accessed 27 November 2021.

[4] R.G. MacAlister "The retrofitting of sail to two existing motor ships of the Fiji Government fleet." *Proceedings of Regional Conference on Sail-Motor Propulsion* (Manila: Asian Development Bank, 1985)

Schooner *Apollonia* Critical Data:
Length: 64 ft/19.5m Beam: 15 ft/4.5m
Rig: 2 Masted Bald-Headed Gaff Schooner.
Sail Area: 122 sq m/1320 sq ft.
Cargo Deadweight: 10 Short Tons/9.07 tonnes.
Cargo Volume: 600 Cu ft/17 Cu M/½ TEU.
Displacement: 36 tons. Draft: 7 ft
Engine: 125 HP/92 KW Detroit Diesel.
Fuel Capacity: 250 Gal/946 Liters.
Crew: 4

Fig 1: Schooner *Apollonia* under sail off Rondout Lighthouse, 24 July 2022. Courtesy, Steven Woods.

APOLLONIA'S 2021 OPERATIONS

The *Apollonia* made five circuits from Hudson, NY to New York City on the Hudson River: one per month from May through October, excepting June. Cargo was generally transported first- and last-mile by means of an electric-assist cargo bike and trailer powered by solar panels mounted on the wheelhouse of the vessel, minimizing the emissions of first- and last-mile transportation. This use of low energy intensity land transportation proves the viability of a sustainable cargo system, as well as allowing the ship to carry her own shoreside delivery capabilities. In addition, the use of a cargo bike avoids heavily congested roads. Handling of all break bulk cargo was by the "Armstrong Method" aided by ship's gear such as block and tackle.

The typical crew of four consisted of Master, Mate, Bosun, and Deckhand. All crew served as dockers as no longshore or stevedore crews were available or hired. Sailing was by both night and day depending on wind, tide, and current conditions, which dictated the watch rotation. Due to the small crew size, there was little real differentiation of roles.

Figure 2: Map of *Apollonia*'s Port Calls.[5]

APOLLONIA'S CARGO

The *Apollonia*'s main cargo was Malted Grains moving from the Germantown, NY area to several breweries down the Hudson River and around New York Harbor. These were exclusively embarked at Hudson, NY, packed in 50 pound sacks. Many other cargos were included in the season, including solar panels, a printing press, coffee, beer, tea, mead wine, salt, a cargo of wine and chocolate cross-loaded from the French Sail Freighter *Grain de Sail* in New York Harbor, 1 ton of peppers from Milton to Hudson, hot sauce, maple syrup, yarn, honey, jam, condiments, rope, CBD, pepper flakes, soap, skincare products, and other goods. A barrel of Rye Whiskey, aging on the ship since 2020, was carried until the October run. Another cargo was 11,500 pounds of Red Oak logs from Kingston to Brooklyn for an urban mushroom farm.

TABLE 1: MALT CARGO DATA			
DESTINATION	**DIST from Hudson NY**	**WEIGHT (Lb)**	**TON-MILES**
Poughkeepsie	41.4	2,505	51.85
Beacon	56.35	3,900	109.88
Peekskill	73.6	3,600	132.48
Ossining	85.1	6,550	278.7
Yonkers	98.9	2,950	145.88
LIC, Queens	130	4,750	308.75
GBX	138	9,700	669.3
	TOTALS:	33,955lb/16.98 tons	1,696.84 ton-miles

[5] Esri *Light Gray Canvas Reference* [Basemap] Scale Not Given. February 2022. https://basemaps.arcgis.com/arcgis/rest/services/World_Basemap_v2/VectorTileServer (Accessed 1 March 2022)

TABLE 2: ADDITIONAL CARGO DATA					
Origin	**Destination**	**Cargo**	**Weight (Lb)**	**Distance**	**Ton-Miles**
Milton	Hudson	Peppers	2,000	78.2	78.2
Poughkeepsie	South St	Flour	1,500	91.1	68.32
Kingston	GBX	Mushroom Logs	11,500	97.75	562
GBX	Ossining	Coffee	440	55.2	12.15
GBX	Kingston	Coffee	120	97.75	5.87
Hudson	Newburgh	Whiskey, Barrel	150 (est)	56.35	4.23
GBX	Kingston	Whiskey, 2 cases	50 (est)	97.75	2.44
Milton	South Street	Pumpkins	2,900	85.35	123.76
Milton	GBX	Pumpkins	500	87.4	21.85
Milton	Ossining	Pumpkins	100	39.1	1.96
Milton	South Street	Apples, 8 boxes	160(est)	85.35	6.83
Milton	South Street	Squash, Assorted	200	85.35	8.54
Milton	South Street	Grapes, 3 flats	30 (est)	85.35	1.28
Milton	South Street	Cider, 2 cases	30 (est)	85.35	1.28
GBX	Kingston	Printing Press	500 (est)	97.75	24.44
				Additional Ton Miles:	923.15
				TOTAL TON MILES:	2,619.99

ABBREVIATIONS: GBX=Gowanus Bay Terminal. **South St**= South Street Seaport Museum, Manhattan. All locations are in New York State. All distances in Statute Miles for comparison to trucking.

Small cargos included ceramic plates, books, apparel, and postcards. The ship also carried what were essentially classical "Tramping" cargos, purchased by the ship and sold on her own account.[6] This makes tracking the ton-miles involved with these cargos difficult, and these small and tramping goods have been excluded from the study. We will focus only on major cargos here, understanding the figures produced are a minimum impact.

The principal cargos and destinations for malt remained the same over the course of the season, and have been consolidated in Table 1 above. Other cargos are given in more detail in Table 2. Official river miles between ports, converted to statute miles, are used to give a uniform comparison, but the total miles covered by *Apollonia* were much greater due to tacking, jybing, and other maneuvers.[7]

FUEL USE DATA

Fuel Use for *Apollonia* over the season is estimated at 37 gallons over 38 hours of engine use.[8] Not all engine hours were recorded prior to July 2021 due to recordkeeping changes aboard ship, and

[6] Thomas F. Tartaron, *Maritime Networks in the Mycenaean World* (New York: Cambridge University Press, 2013). Pp 30-32

[7] United States Department of Commerce, *Distances between United States Ports,* 13th ed. (Washington DC: US Department of Commerce, 2019).

[8] The *Apollonia*'s fuel tank was not full at the season's start, and fuel purchase records from 2020 have been lost. The tank does not have a gauge, and was not "sticked" before the season began. About 40 gallons were added in 2021 and visual inspection at the end of the season shows the fuel level slightly above where it was in May. There was no plan of making these studies when the 2021 season began.

engine hours are only noted in full hours, limiting the precision of these figures. Approximately 18 hours of engine time was spent on educational programming out of Hudson, NY separate from the vessel's cargo runs. This gives an average rate of about 0.97 gallons per hour, which is reasonable for rarely exceeding clutch speed on the engine. Fuel use per voyage was calculated by the total hours of engine operation noted in the log for each voyage; total fuel used for cargo transport was about 19.47 gallons for the season.

Without the installation of costly and complicated differential fuel gauges on the ship the collection of more precise fuel use data is impossible. Such approximations are generally in line with methods used in other studies where this equipment was not available, and the data is considered sufficient for the purpose of this paper.[9] The Schooner *Apollonia* has an estimated efficiency of 134.6 Ton-Miles per gallon of diesel fuel.

Examining a single voyage with better records shows the October run moved 397.37 ton-miles with three engine hours, giving 136.55 ton-miles per gallon, or 51.77 tonne-kilometers per liter. Other voyages at higher percentages of the schooner's maximum load, or lower engine use will score differently, but are less well documented.

ENGINE USE STRATEGY

Apollonia's engine use strategy is quite simple: The engine is only used for safety purposes and docking where necessary. If the tide is against the vessel's course, she drops anchor or ties up in port, instead of employing the engines. If there was no wind, she would occasionally use only the tide for propulsion. This is substantially the same engine use strategy as 17th and 18th century Hudson River sloop masters,[10] and was adopted due to ecological as opposed to economic imperatives. This leads to a very low engine use figure, averaging less than 4.5% of hours under way over the season. 60% of voyages show less than 3.75% of hours underway involved engine use. As previously mentioned, the engine was rarely, if ever, brought above idle RPMs.

TABLE 3: *Apollonia* Engine Use and Sailing Data

Month	Sailing Days	Hours Sailing	Hours at Anchor	Hours at Port	Average VMC	Engine Hours	% Engine Hours
May	11	89.25	67.5	113.75	2.48	4 (est)	4.48
July	14	108.25	58.25	139.5	2.13	4	3.70
August	13	95	77.75	85.25	2.74	6	6.32
September	12	86.5	48.75	100	2.83	3	3.47
October	10	80	48.1	102.95	2.85	3	3.75

[9] R.G. MacAlister "The retrofitting of sail to two existing motor ships of the Fiji Government fleet."
[10] Paul E Fontenoy. *The Sloops of the Hudson River: A Historical and Design Survey* (Mystic: Mystic Seaport Museum, 1994)

Apollonia used her engine less than 4.5% of the time, making her a near-pure-sail vessel. The hope for future seasons is to reduce this engine use intensity as much as possible, though with the docks available it is likely that some level of engine use will be unavoidable.

Speed and distance actually traveled by *Apollonia* is a complex calculation. Due to the inland and tidal nature of the Hudson River, it is frequently necessary to drop anchor when the tide or current is against the intended course when sailing. Due to a longer ebb than flood tide, it is easier to go South. The winds on the Hudson do not lend themselves to consistent sailing, which requires frequent tacking and gybing. There were a total of 62 days of operations over the season, with 459 hours sailing and 300.35 at Anchor. *Apollonia* made an average Velocity Made good on Course (VMC) ranging from 2.35 to 2.85 Knots while under way, with speed being higher, but unrecorded. A trend of increasing VMC through the season is noted in the logs, likely reflecting increased crew skill. Overall VMC once hours at anchor are included amounts to a seasonal average of 1.578 knots.

While the tide cycle on the Hudson River is approximately 6 hours, favorable winds cannot be scheduled so regularly. Whether the vessel's next stop would be at anchor or at dock depended on a multitude of factors and could not be reliably predicted far in advance.

When examining coastal Sail Freight, there will be different sailing characteristics in open waters, which may impact average VMC. *Apollonia* makes frequent stops, using her engine when docking frequently in comparison to a longer coastal route. As was found by Perez *et al* studying large ships, the advantages of Sail Freight are greatest on long routes with low engine use.[11] This confirms historic trends noted by Riesenberg[12] and Erikson.[13] The fewer stops or maneuvers a motor-sailer makes on their route the better expected fuel efficiency will be.

COMPARISONS TO TERRESTRIAL TRANSPORTATION

Apollonia is involved in inland waterway trading, which means she should not be compared to oceangoing cargo vessels due to the tonnages, cargos, and routes involved. The average freight-ton efficiency in the US for trucking is not a good comparison as this average is skewed by the relatively high efficiency of very large trucks moving cargo very long distances.[14]

A few other concerns arise for making a valid comparison: *Apollonia* is not capable of moving containerized cargo, making her a general cargo ship. As rail lines are not generally loaded with break bulk cargo, this means rail should also be excluded. In the case of other sail freighter designs using containerized cargo, such as those by Derek Ellard, the comparison would rightly be with large trucks or rail. In the case of his Electric Clipper 180, carrying 36 TEUs, the appropriate comparison would be rail.

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[11] Perez, S; Guan, C; Mesaros, A; Talay, A, "Economic Viability of bulk cargo merchant sailing vessels", *Journal of Merchant Ship Wind Energy*, 17 August 2021. (Accessed 3 December 2021) https://www.jmwe.org/uploads/1/0/6/4/106473271/jmwe_17_august_2021.pdf

[12] Felix Riesenberg, *Standard Seamanship For The Merchant Service* 2nd ed. (New York: D. Van Norstrand, 1936) pp 11.

[13] See: Georg Kahre, *The Last Tall Ships: Gustaf Erikson and the Aland Island Sailing Fleets, 1872-1947* Basil Greenhill, Ed. (London: Conway Maritime Press, 1990)

[14] In 2018 trucks moved 2,033,921 million ton-miles, using 28,987 million gallons of fuel, averaging 70 ton-miles per gallon. SEE: Bureau of Transportation Statistics *National Transportation Statistics* www.bts.gov/us-tonne-kilometers-freight AND www.bts.gov/content/combination-truck-fuel-consumption-and-travel (Accessed 15 Nov 2021)

Something like the Electric Clipper 100 carrying 4 TEUs would be more accurately compared to a class 8 truck.[15]

As with the 1920s when Walter Hedden studied *How Great Cities Are Fed*, it is small trucks which move most food and goods within 100 miles of major cities.[16] The cargo taken on *Apollonia* moved to its destination principally in 2½ ton box trucks before transitioning to Sail Freight in 2021. Apollonia has a similar cubic capacity to a 12 foot box truck, at about 600 cubic feet, which would be in the same class as a 2½ to three ton truck. A 2½ ton truck at 12 miles per gallon gives a maximal theoretical efficiency of 30 ton-miles per gallon, which is similar to figures given by the National Highway Safety Administration in 2006.[17] This holds for essentially all the cargos involved with *Apollonia*, excepting those likely moved by less efficient pickup trucks, and is the appropriate comparison.

COMPARISON TO BOX TRUCKS

Apollonia's Ton Miles of transport avoided the use of around 67.9 Gallons of fuel, and she has an advantage of 104.6 ton-miles per gallon against the theoretical optimum for 2½ ton trucks.[18] The *Apollonia* requires only 22.3% of comparable ideal trucking fuel use values. If account is taken of empty miles back to the malthouse or point of origin for these trucks, the advantage is immediately doubled. In this case, fuel use is less than 12% of trucking.

It should be noted this comparison contrasts real-world results aboard *Apollonia* with theoretical best-case conditions for the trucks. If the trucks are less than fully loaded, the ton-mile efficiency of the truck declines. Further, the New York Metro Area is a maze of congested roads with dozens of over-capacity *Passages Obligés* such as bridges and major intersections, leading to 335.9 million gallons of wasted fuel[19] and an economic cost of 18.26 billion dollars in 2019.[20] These figures alone bring the 30 ton mile per gallon figure for trucks into question when looking at the New York Metro Area, giving *Apollonia* a further advantage, though the effects of road congestion on truck fuel efficiency are not considered here. If there are any other disadvantages for the truck, such as steep climbs or sub-optimal maintenance, its efficiency declines. In terms of carbon impacts, the consumption of tires, lubricants, spare parts, and road wear should be included in the calculation for trucks,[21] while *Apollonia*'s inputs are essentially fuel, one tenth of a set of sails annually, and a small amount of paint.

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[15] Derek Ellard "The Electric Clippers" gosailcargo.com (accessed 1 December 2021)

[16] Walter P Hedden, *How Great Cities are Fed* (New York: D.C. Heath, 1929).

[17] NHTSA *Factors and Considerations for Establishing a Fuel Efficiency Regulatory Program for Commercial Medium- and Heavy-Duty Vehicles* (Washington, DC: NHTSA, 2010) https://www.nhtsa.gov/sites/nhtsa.gov/files/nhtsa_study_trucks.pdf (Accessed 28 November 2021) Pp 12-13. The figure given for typical ton-miles for vehicles in this study is quite clearly a multiplication of the load capacity by the average miles per gallon, not accounting for deadheading or partial loads.

[18] It is worth noting that even when compared to the optimal efficiency of 10 ton trucks, *Apollonia* retains an advantage of 22.6 tm/gal using her observed real-world efficiency. When comparing her maximum efficiency to the same 10 ton trucks, she is over 5.5 times more efficient.

[19] Bureau of Transportation Statistics "Annual Wasted Fuel Due To Congestion" *National Transportation Statistics* https://www.bts.gov/content/annual-wasted-fuel-due-congestion (Accessed 18 January 2022)

[20] Bureau of Transportation Statistics "Annual Highway Congestion Cost" *National Transportation Statistics* https://www.bts.gov/content/annual-highway-congestion-cost (Accessed 18 January 2022)

[21] David Austin, *Pricing Freight Transport to Account for External Costs* (Washington DC: Congressional Budget Office, 2015). https://www.cbo.gov/sites/default/files/114th-congress-2015-2016/workingpaper/50049-Freight_Transport_Working_Paper-2.pdf. Pp 2 Summary.

Given better freight ton efficiency data for small trucks and historical data for the same cargo movements, a more accurate calculation of *Apollonia*'s impact could be made. This data is not readily available, and the above are the likely floor for efficiency gains from small Sail Freighters on inland routes using an auxiliary diesel engine.

Intensity as a percentage of maximum load weight for *Apollonia* is worth considering. The maximum a 10 CDWT capacity could have carried per circuit would be 2,346 ton miles. This assumes a two-way voyage from Hudson to New York City, each leg of which is 117.3 miles long, with a full hold. For five trips, this would be a maximum of 11,730 ton-miles. *Apollonia* only moved slightly over 21.5% of this maximum in 2021, as some runs were not made with a completely full hold, while others, such as a 2,000 load of peppers from Milton to Hudson, were affected by cargo density. *Apollonia*'s maximum theoretical fuel efficiency would be some 626 ton-miles per gallon of fuel (266 tkm/l), at the crew's current skill level and engine use patterns.

This maximum figure is over twenty times that of comparable trucking, nearly 9 times the average for trucking in the US, and 25% better than rail figures of around 500 ton-miles per gallon. With the time allowed by the season on the Hudson, a total of 12 voyages could be undertaken, which may result in higher realized efficiency through higher average cargo intensity or less engine use per ton-mile across the season.

The issue of cargo density as mentioned above is important for both trucks and sail freighters: It would be impossible to fit 10 tons of fresh peppers into the hold of the ship or onto most trucks, and cubic space should play into this calculation. As Malt is generally between .3-.7 tons per cubic meter in density (load factor), this is a serious concern for *Apollonia*'s main trade reaching full tonnage loads due to cargo density and the limits of storage space, meaning neither will likely reach their theoretical efficiencies in service. If fuel were allocated to vehicles based solely on their maximum theoretical fuel efficiency, no cargo moved by fossil fuels or electrified transport would ever arrive on target. This lack of clear information on average or real-world relative energy and carbon intensity for various vehicle types is a significant problem for sustainable transportation planning and research. By contrast, over 5,000 years of precedent has shown a lack of fuel does not fundamentally affect sail freighters' ability to reach their destination, though it may affect port-to-port time and scheduling.

Turning to Carbon Emissions, at 22.48 pounds of CO2 per gallon of diesel[22] *Apollonia* emitted about 437.68 pounds of CO2 in the course of her operations. A 2.5 ton truck would emit 1,963.25 pounds (890.5 kg) of CO2, assuming no deadheading and maximum efficiency loads. In the worst-case scenario, *Apollonia* avoided over 1,530 pounds (694 kg) of carbon emissions in 2021. Her impacts on particulates, SOx, NOx, and other pollutants will be proportionate, and the issue of noise pollution is not covered here.

IMPLICATIONS FOR INLAND AND COASTAL SAIL FREIGHT EFFICIENCY

There are lessons to be learned from the *Apollonia* for inland and coastal Sail Freight in small vessels. Internal Combustion Engine propulsion experiences economies of scale, and becomes more efficient the larger a vessel becomes.[23] As sail freight vessels grow in CDWT terms both important

[22] Energy Information Administration. *Carbon Dioxide Emissions Coefficients* https://www.eia.gov/environment/emissions/co2_vol_mass.php (Accessed 8 February 2022)

[23] WSDC, *Wind Propulsion For Ships Of The American Merchant Marine* Pp X-6

efficiency metrics, Ton-Mile Fuel Efficiency and Tons Per Sailor, increase so long as engine use patterns remain the same. The application of electric engines with underway battery recharging will give further advantages against all forms of terrestrial transport. Engineless coastal vessels will have a much higher fuel efficiency in the middle legs of their voyages, but must use tugs when entering certain ports, inducing some fuel use on the terminal ends of the voyage which will be difficult to measure accurately. This will give a significant incentive in climate adaptation planning to shift cargo to coastal and inland sail-motor freighters where possible, but will need to be tested once such vessels are in service and can give real-world comparisons.

How the overall distance traveled by *Apollonia* compares to trucking routes for the same cargo has not been examined, but may conceal other difficulties in measuring efficiency by changing the relative ton miles by river or road. From Hudson Valley Malt to Sing Sing Kill brewery is 78.2 miles by truck, but 85.1 river miles from Hudson to Ossining. This makes comprehensive comparison complex, but does not affect relative fuel efficiency.

OPPORTUNITIES FOR FURTHER RESEARCH

The *Apollonia* refined her routing over the course of 2021 to optimize her circuit. This involved stopping at ports only while headed in one direction, for example. This reduces the total number of dockings per circuit, which can have a significant effect on the amount of engine time used per voyage. Less engine use translates directly to less fuel use for the same number of ton-miles. The skill of the crew and their familiarity with both the ship and the waters they sail will only grow as the operation continues, which will be worth examining when data becomes available.

No economic analysis of the *Apollonia* has been undertaken, and is outside the scope of this study. Examining the economics of coastal and inland sail freighters will have to be made based on a vessel and route pairing to make the appropriate comparison. Fuel cost and trucking rates will also play a role in making such a comparison, both of which are quite volatile at this time.

Research with small sail freighters equipped with other engine types, such as electric motors powered by batteries, propeller regeneration, and solar charging systems is worth funding once such vessels are available for study. Their ecological footprint will be significantly different than *Apollonia*'s, and their engine use strategy could be far more intensive without increasing carbon emissions or other pollution. Vessel design is outside the scope of this paper, and these vessels have yet to be commissioned, making a comparison impossible at this time.

The complete effects of *Apollonia*'s operations are difficult to quantify, such as social impact. This could be measured in the lives prolonged by a lack of pollutants released in New York City, traditional skills learned, and educational moments which changed how people think of transportation, consumption, and waterways like the Hudson River and New York Harbor. These topics are outside the scope of this study.

CONCLUSION

Schooner *Apollonia*'s cargo and fuel use records from 2021 show that the ton-mile fuel efficiency of even a very small sail freighter is far higher than comparable trucking. Operational results show a fuel efficiency of 134.6 ton-miles per gallon of diesel fuel while operating at 21.5% tonnage intensity, as compared to an average of 70 tm/gal for US trucking overall. When compared to the 2½ ton box trucks

she replaces, she has an advantage of 104.6 tm/gal at the same intensity against the truck at 100% intensity. If *Apollonia* were used at full CDWT capacity with current engine use patterns, she would give 626 tm/gal, 25% better than rail, nearly 21 times better than 2½ ton trucks, and just under 9 times more efficient than the US trucking average.

Due to the engine use strategy of the ship, considerable time was spent at anchor. Over 62 days of operations, 459 hours were spent underway, with 300.35 at anchor. Velocity Made good on Course (VMC) while under way ranged from 2.35-2.85 knots, while overall VMC including time at anchor was 1.578 knots.

The nature of navigation and winds on the Hudson River make these results applicable principally to this route and engine use pattern. Predominant winds force frequent tacking and jybing, and the slightly longer ebb tide makes southbound travel easier than northbound. It is clear that larger vessels will be more efficient, and other routes which require less docking and maneuvering under power will increase efficiency, making these figures a likely floor of fuel efficiency for inland and coastal sail freighters.

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Energy Security Scenarios

Steven Woods, Tim Boykett

Abstract: Sail Freight has a distinct role to play in any Energy Security or Energy Independence consideration as fossil fuels become scarcer and geopolitical tensions further increase energy prices. The following scenarios are designed as thought experiments for the conference's participants along with those engaged in other coastal transport not involving wind propulsion. Other sail freight projects would do well to answer the same questions early and often for use in their own marketing and strategic planning efforts.

Keywords: Energy Crisis; Sail Freight; Energy Independence; Energy Security; Energy Sufficiency.

Introduction

Futures thinking is a selection of tools, methods and approaches with which we can help ourselves be less surprised, and even prepared for, various future developments (Schwartz 1998; Smith and Ashby 2020). The Sail Freight movement can possibly apply these tools to its own work. This article looks at a number of scenario developments and raises some of the questions that these developments might entail for sail freight practitioners.

There are a number of predictable changes to the world energy situation which will result from the current geopolitical and geological realities humanity now faces. With Russian energy production embargoed by Europe and NATO countries, and the decline of accessible oil reserves even for oil shales (partly due to natural depletion and partly to underinvestment and lack of necessary equipment) mean a large-scale shortage of fossil fuels is likely to occur in the next few years. This seems to involve both fossil oil and gas, and will cause a price spike for all energy sources, including electric power generated through fossil fuels. Biofuels, whether liquid, solid, or gaseous, are not in a position to take up a significant amount of the slack produced by this crisis.

With this looming crisis in mind, it is worth noting that Sail Freight is in a unique position to take advantage of the likely results of such a crisis: with little reliance on fuels of any sort, and an extremely high energy efficiency, sailing vessels can move critical goods at competitive costs during such an event. Taking maximum advantage of such a crisis for the sail freight industry would require some foresight and preparation for each individual operation. Understanding current spare capacity with current capabilities is critical, alongside knowing what capability is available to intensify operations. This would require crew availability, brokers, reserve fuel for maintaining an "Emergency and Docking" engine use pattern, and more direct support from partners at the docks.

The following scenarios were developed as a guide to thinking about what is likely to happen, and how to adapt to it in a way which gets sail freight economic advantages which can be carried forward into the climate crisis campaigns.

The article is structured as follows. We start with a collection of single factor scenarios and the ensuing questions that, we imagine, could arise for a sail freight enterprise. We then introduce several combined scenarios and discuss them. After that we introduce some of our methods about how we derived these factors and their possible changes.

Individual Scenarios

1. Diesel Prices rise by 300% within the next 12 months. This price spike is likely to be maintained by geopolitical forces for the next 12 months.

- ☛ How would such an event change your marketing approach?
- ☛ How would this development impact your operations?
- ☛ How could your operation be scaled up to meet this challenge?
- ☛ How might this effect your first/last mile delivery systems?
- ☛ How might this effect your ability to hire crew?
- ☛ What resources would you need to stockpile to weather these conditions?

2. Diesel shortages result in rationing, with non-transferable allowances for all non-fishing vessels or critical passenger ferries under 500 tons of 30 gallons of diesel fuel per month. Prices double from current levels, but stabilize quickly. Rationing for non-strategic/ non-essential uses (including your own) is expected to continue for 12 months.

- ☛ How would such an event change your marketing approach?
- ☛ How would your operations be effected by this lack of fuel?
- ☛ How can this fuels crisis be converted into more business for sail freighters?
- ☛ Do you have, or could you create, the capacity to move fuel without burning it?
- ☛ What challenges do your foresee with establishing a small collier-type fleet?
- ☛ What resources would you need to stockpile to weather these conditions?

3. Carbon Levies are instituted at the rate of $100 per ton of CO2e emitted.

- ☛ How does this effect your (planned) operations?

☛ What equipment changes would need to be made to keep your operation going?

☛ How does this effect your first and last mile transportation options?

☛ What resources would you need to stockpile to weather these conditions?

4. Due to power shortages based on critically low natural gas stocks, power to all nonessential services is cut at grid level. All maritime vessels and marinas are included in this shutdown, as are electric cars and trucks outside a designated 2 hour charging window. Most electric vehicles only gain 25% charge per day, as fast charging is disabled in all locations to reduce peak power demand.

☛ How does this effect your direct operations?

☛ How does this effect your first and last mile logistics?

☛ How can your operation be intensified to meet this crisis, and in what ways?

☛ How can this be used to increase low-to-no-carbon first and last mile logistics providers outside of major cities, and how can your operation support this?

☛ Internal Combustion Engines are unaffected by this crisis. Does this effect your operations as a result?

☛ What resources would you need to stockpile to weather these conditions?

5. Carbon Credits are initiated at 10¢ per kilogram of CO2e emitted. Your operation is given credits based on tonne-kilometers at average Trucking values of 107.5 g CO2/tkm. How would the ability to trade these carbon allowances or cash in on the difference between your actual (observed) values and trucking average values effect your business model?

☛ What resources will be needed to calculate your carbon levy and payment?

☛ What would you change about your operations to document the necessary information for this additional revenue?

☛ Will this change in regulations change your first and last mile logistics arrangements or record-keeping?

☛ Would this regulatory change materially effect the availability of inorganic land transport in your area of operations?

☛ At what financial threshold would a carbon levy be able to pay for your operation's current expenses?

☛ Would such a regulatory change encourage you to shift to alternative or lower-carbon fuels if the opportunity presented?

☛ What resources would you need to take advantage of this regulatory change?

6. Shipping rates across the transportation sector climb rapidly due to fuel cost spikes, creating a viable maritime market for containerized cargo movement between large and intermediate hubs along maritime highways.

☛ Can your vessel be modified to take advantage of this development?

☛ What role does containerization potentially play in your operation, if any?

☛ What idea do you have to replace the one-container truck with sail freight?

7. $10,000,000 funding is announced for making small port maritime shipping hubs, which will contain warehouses, refrigeration facilities, staffing, sailor's hostels, and cargo bike delivery services. 20 of these locations will be created along the East Coast.

☛ What small port hubs would you identify as the most critical to develop?

☛ What other facilities would you request as integrated supports at these hubs?

☛ What shore gear would you request be installed at these hubs?

☛ What resources would you need to stockpile to weather these conditions?

8. As part of a green jobs campaign, funding is made available in order to train crew and to supplement wages. As a result, training is more widespread and graduates are enthusiastic to work in the sail freight field. Wage supplements means that the wage cost to your organization is less.

☛ What training would you find most valuable for your existing crew?

☛ In what ways would cheaper crew change the way that you run your enterprise?

☛ To what extent would such changes enable/encourage expansion of your fleet?

☛ How would you take on and integrate training work in your business?

9. In a surprise move, the tax codes in your jurisdiction are changed to allow a 150% expenses write off for green investments, in line with the Australian Film Industry boost that occurred in the early 1980s (Screen Australia n.d.).

☛ What investment plans do you have should an investor with $10k, $100k or $1 million come you you?

☛ What expansions in your planned activities would emerge if you were able to access significant new investment funding?

☛ What ongoing return on investment would such an investor be able to expect from you?

10. The technologies of weather forecasting improve quickly. Long term weather forecasts become more reliable, allowing better passage planning, while *nowcasting*, very specific localised weather forecasting (Wikipedia 2022), becomes cheap and reliable.

☛ How would your planning react to long term weather forecasts of increased accuracy?

☛ Being able to predict the movement of storm cells and other specific weather in the vicinity, would your operations be able to use this information?

☛ To what extent can you replace crew understanding and experience with technological support?

Combined Scenarios

The value in scenario thinking is not primarily in imagining reactions to and implications of possible single developments, but in imaging the non-linear effects of multiple developments that cascade one upon another. The following combined scenarios offer themselves to us, but you will probably find value in imagining responses to many other combinations.

A. Combining scenarios 2 and 4. In addition to the conditions in Scenario 4, other fuels are rationed at the rate given in Scenario 2 for all vehicles aside from designated exempt equipment, such as farm machinery, designated shipments of food, and emergency response vehicles.

☛ How does this effect your first and last mile logistics?

☛ How long can your operations be carried on in these circumstances?

☛ How would this change your cargo prioritization with higher demand?

☛ How can your operation assist in building an emergency fleet to meet the crisis?

☛ What resources would you need to stockpile to weather these conditions?

B. Combining the scenarios 1 & 8, when not only fossil fuel prices increase massively, but crew costs decrease significantly.

☛ Which tasks done now with cheap energy would make sense to be done manually?

☛ How long can your operations be carried on in these circumstances?

☛ What would a new ratio of crew to fuel costs mean for your enterprise?

☛ What skills would become less relevant in maritime training?

☛ What capacity for training additional crew would be available on your vessel?

C. Combining scenarios 7, 8, and 1, where conventional shipping costs become significantly higher for all other means, and the rising support of green maritime hubs is linked to a reduced crew cost.

☛ With additional support and increased economic competitiveness, how much more intensively could your operation be run?

☛ How will costs for your operation change RELATIVE TO CONVENTIONAL SHIPPING?

☛ How would the increase in fuel costs and additional support effect your regular packet routes?

☛ Would the addition of sailor's hostels, warehousing, and inorganic transport be economically beneficial if there was a small monthly subscription cost to use them?

Methodology

The development of strategic foresight is a complex process. However some of the important aspects are:

- Find a good question, which inspires imaginations and generative answers.
- Analyse possible developments, using e.g. STEEP or other criteria, to ensure that you are imagining widely.
- Develop enough detail in scenarios without going too far.
- Imagine possibilities for your reactions to or exploitation of, the developments that arise.

As we started these reflections, we thought that an appropriate question might be "How to set up and run a shipping / transport business in contrast to existing truck based transport?" However that felt a bit direct and perhaps banal. For a number of reasons for this exercise we then took as a central question "How will you take up the strain when the status quo starts to give way? What do you need to make sure you can?" The reasons for these

questions are the open question of "How" inviting exploration of multiple strategies to respond to changes. The second part of the question revolves around resources, and in particular resources that partner organizations will be in a position to supply.

We take some inspiration from the Futures Ladder developed by Stuart Candy and Jake Dunagan (2016). The top level is the question as to setting, the general idea of time and space in which we will be developing imaginations of possible futures. The next level is the scenario itself: developing imaginations of what might happen.

Our setting is that the Status Quo Energy Situation breaks fundamentally, causing a serious vacuum in the economy which can be filled to some degree by working sail. We assume that the work that practitioners here are involved with will become more fundamentally relevant and of wider value.

Part of the energy status quo which effects the world of Sail Freight is foreign and domestic policy seemingly unrelated to transport. As has been seen very clearly, the War in Ukraine has had a very large effect on the oil industry, and has led to dangerously low energy stockpiles in Europe and very low storage levels in the US. Domestic labor policy and labor action may drive up the cost of trucking through pay increases for truckers as a wave of retirements hits the industry, and rail capacity cannot be easily increased after the disinvestment in rail over the last 40 years. If current trends continue, diesel prices will likely climb to a point which makes sail freight economically competitive with trucking, and incurs lower infrastructure support costs than expanding the existing rail network. It is critical that Sail Freight and other coastal trade systems be available to take advantage of these changes when they happen, and this cannot be the case without early and thorough preparation.

For this exercise, we are interested in specific adaptations for one bioregion, specifically the North Eastern United States, which is the area in which this event is taking place. When looking to adapt the rules, maxims, and wider principles of sail freight to any specific bioregion, a deep delve into local history, conditions, materials, infrastructure, and abilities will need to be undertaken. Each bioregion has distinct opportunities and strengths, resources and historical detail. We only ask questions, and recommend that readers who are interested can delve into specific developments of scenario reactions for details (Willner 2021) (Woods 2021).

Conclusion

The development of sail freight is unpredictable. There are a number of interested organisations, from distinct fields, who are currently implementing sail freight processes. This paper is intended as a way for those involved, and those imagining being involved, to have some kind of futures awareness for possibilities that may arise in the area.

Imagining possible futures creates memories of those futures, so that people who have undertaken these exercises can be better prepared for changes that arise, possibly very suddenly. Not only changes similar to those that have been imagined, but evidence suggests

that by having exercised the ability to imagine responses to significant change, people and organizations are better prepared to deal with novel developments.

We hope that this modest introduction can help you prepare for the changes that might arise for us all.

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