WETA
WATER EMERGENCY TRANSPORTATION AUTHORITY

Presentations for October 7, 2021 Board of Directors Meeting

WETA
WATER EMERGENCY
TRANSPORTATION AUTHORITY

Item 8: WETA Zero Emission Study Update

Zero Emission Fleet Study Update

WETA Board of Directors

October 7, 2021

WETA

ARUP

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Study Goals

"Develop a plan to transition ferry operations on San Francisco Bay to zero-emission vessels"

How much power do we need?

Where will it come from?

When do we need it?

How much will it cost?

How do we pay for it?

Emphasis on the use of electric propulsion systems and resolving the technical and regulatory barriers for the shore side infrastructure

Study Responsibilities

Study Funding

WETA

CALIFORNIA ENERGY COMMISSION

Management

WETA

Maritime

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Vessel Analysis

Route Analysis

Shoreside

ARUP

Infrastructure Analysis/Feasibility

Stakeholder Agreements

Stakeholders Engaged

United States Coast Guard 1790

PG&E

Alameda Municipal Power

Port of San Francisco

State of California Energy Commission

Chevron

CARB

San Francisco County Transportation Authority

City of Berkeley

Lennar

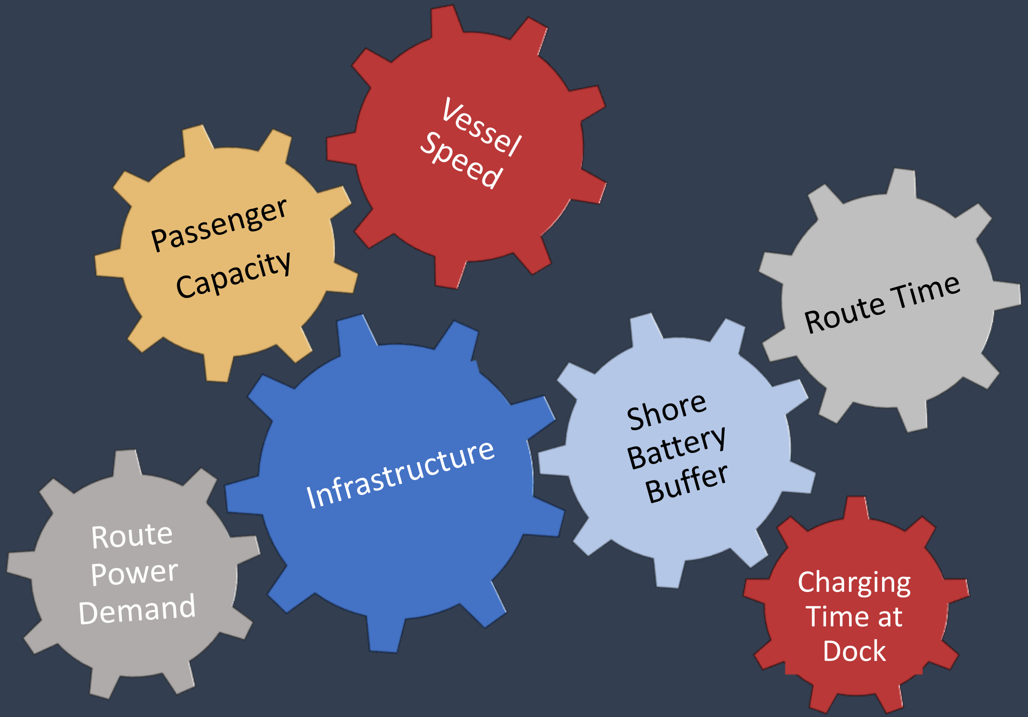
San Francisco Water Power Sewer
Services of the San Francisco Public Utilities Commission

Seal of the City of Alameda
Prosperitas Terra Marique
Incorporated 1854

Workflow

Stage 1
Baselining

Collect and process data on operations, vessels and terminals to define their constraints and opportunities



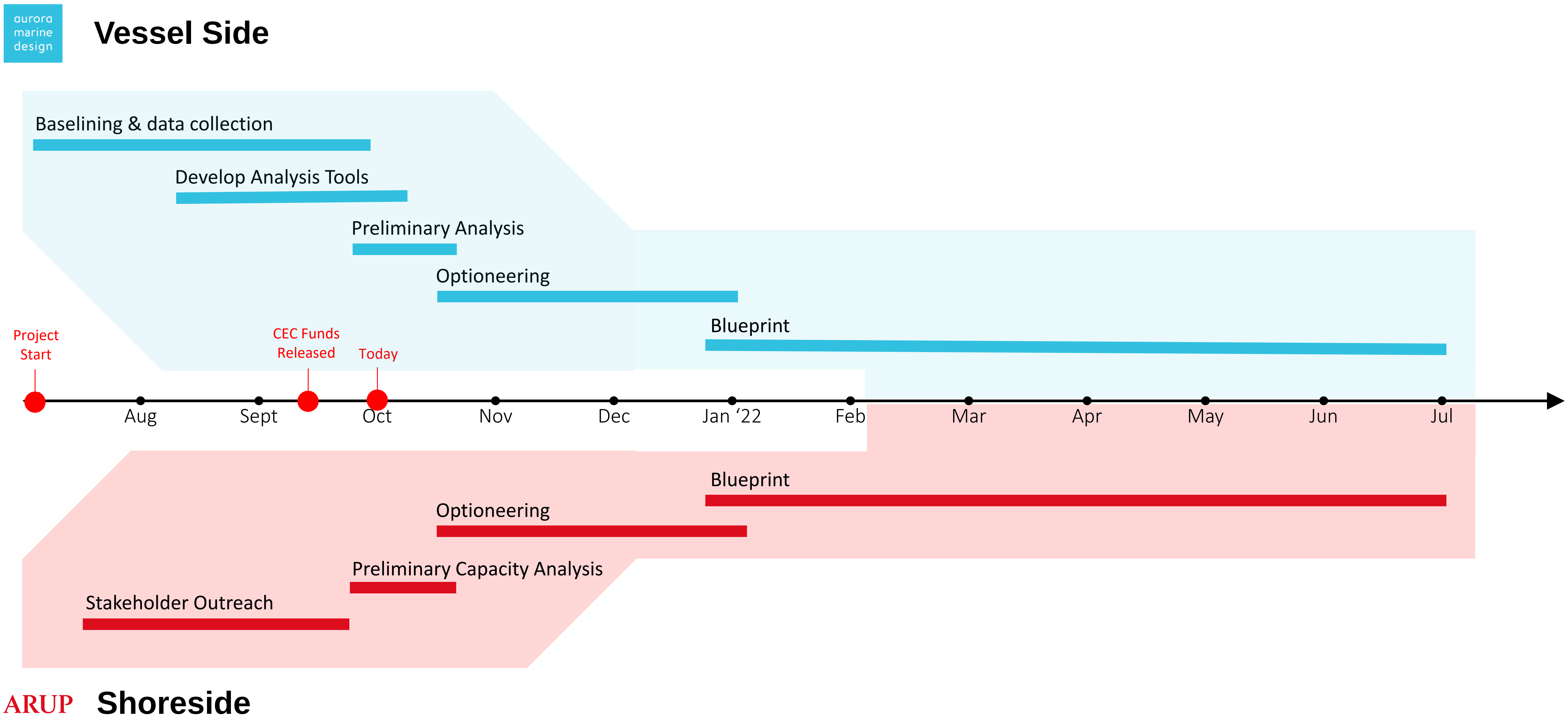
Stage 2
Optioneering

Develop solutions and assess their attributes and drawbacks to select optimal direction

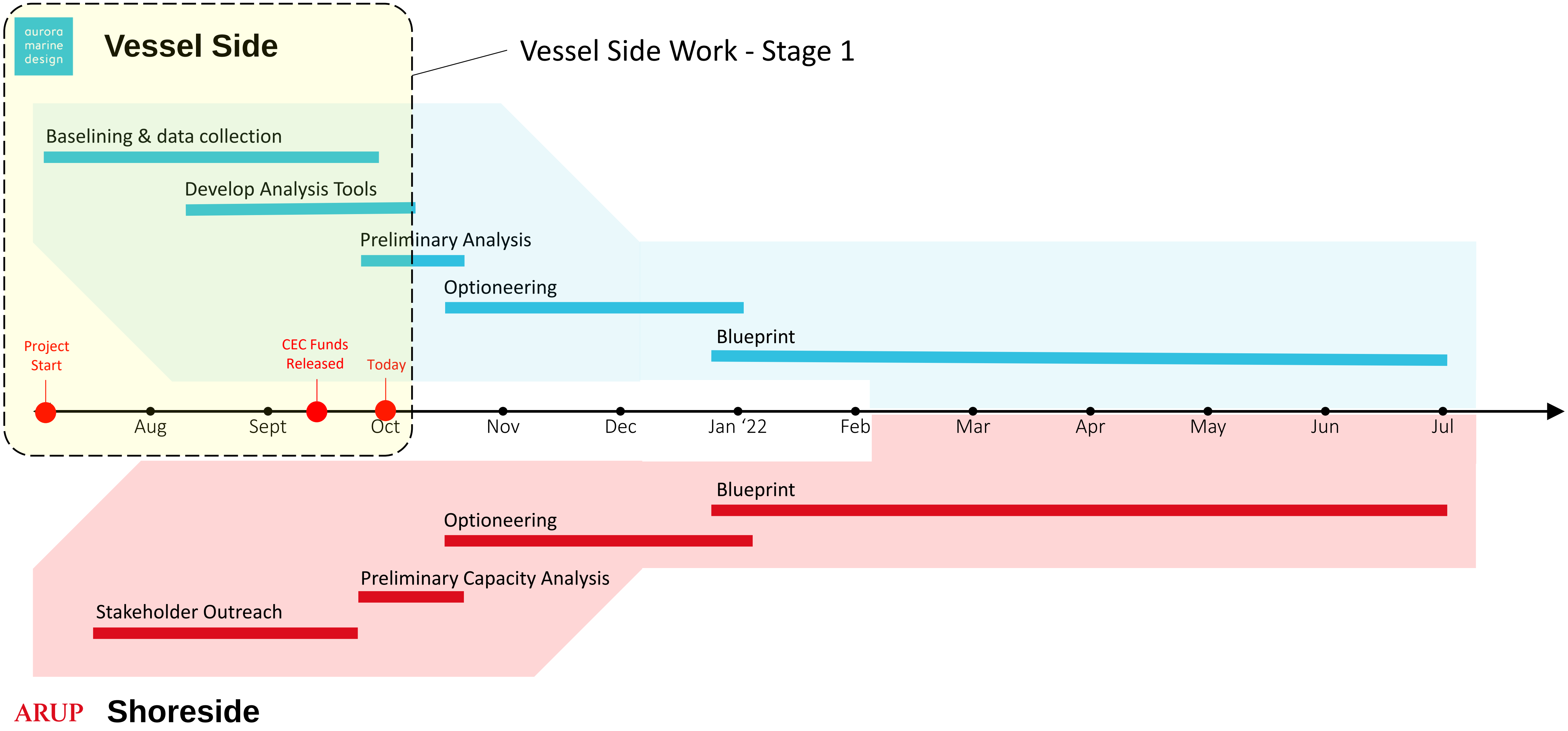
Stage 3
Blueprint & Strategy

Lay out an actionable path to progress to procurement, design and delivery of electrified ferry service

Study Schedule

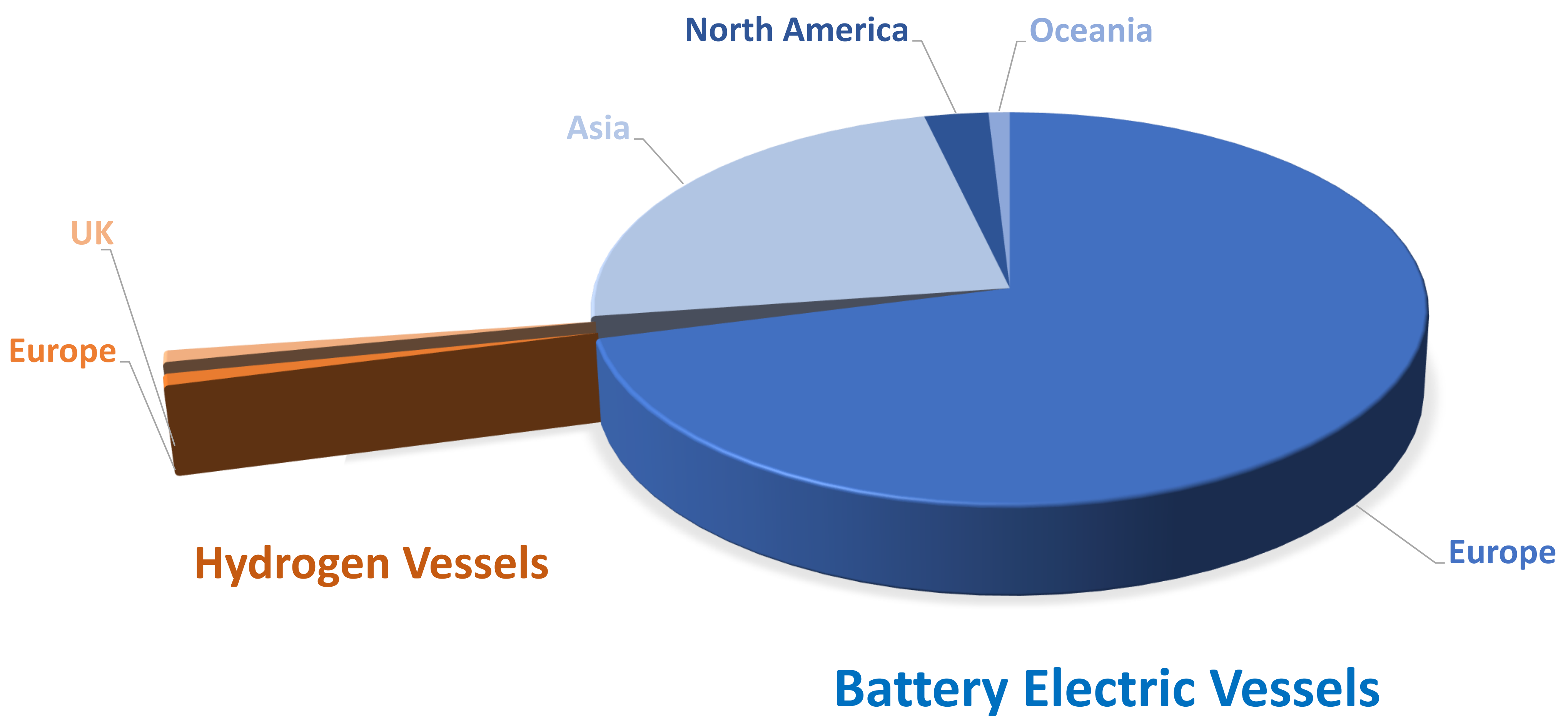


Vessel Side Progress Update



Global Zero Emission Ferry Fleet *

** Vessels currently in service based on readily available information*



Energy Sources**

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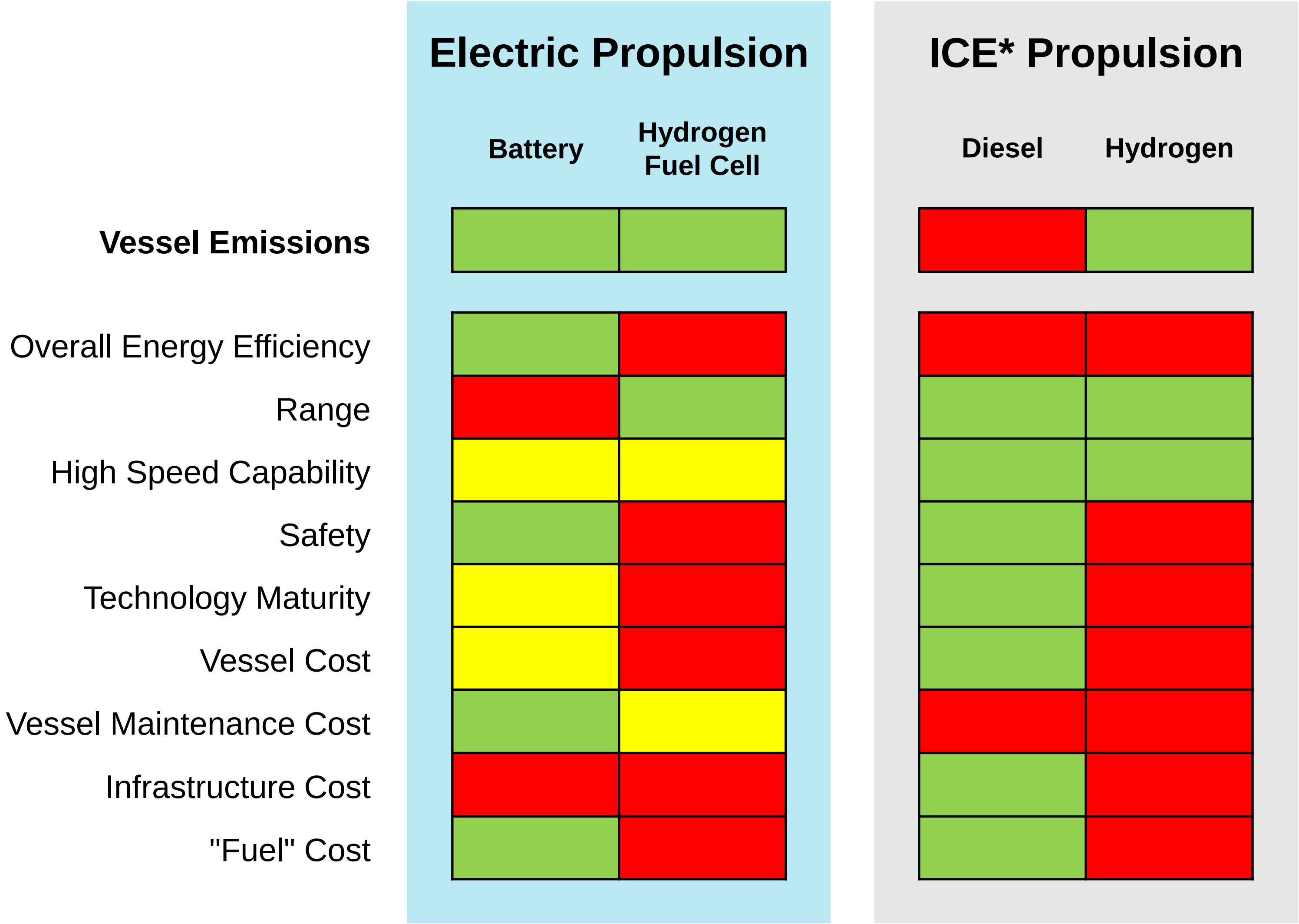
- **All propulsion options have strengths and weaknesses**
- **Careful route definition and analysis is required to determine the best match**
- **Battery Electric is initial focus per the CEC Study**
- **Hydrogen Electric provides a zero emissions “bridging” solution where Battery Electric is impractical**



** Internal Combustion Engine*

*** This chart is a general representation of propulsion tradeoffs which may differ per geographical location*

Data Collection

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Vessel Data Collected

- Detailed Vessel Metrics
- Performance characteristics, speed vs power vs weight vs fuel burn
- Viability of Electric Conversion:
  - Remaining Lifespan
  - Structural Design Limits (How much weight and space margin do we have to install this equipment?)

Route Data Collected

- Develop a database of existing and planned routes. For each route, determine:
  - Load Profile
  - Daily Timetables
  - Route Constraints
  - Expected Growth
- Assess operational profiles for energy usage, speed sensitivity, and timetable sensitivity

WETA Ferry System Analysis

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WETA's complex service involves **A LOT OF VARIABLES!**

- How much energy is currently consumed on each route segment and what is the sweet spot for speed vs. power consumed vs passengers moved?
- What is the impact of extended dockside charging time?
- Is interlining possible or practical during a transition to electric?
- What impact does speed vs passenger capacity have on power consumed?

This required the development of some WETA specific **RAPID ANALYSIS TOOLS**

Route Analyzer Tool

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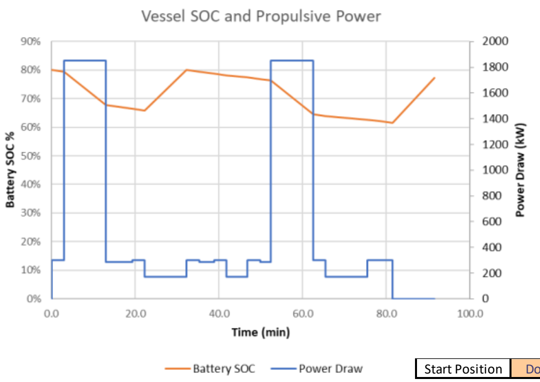

Start Position | Downtown

Leg	Inputs	Route Segment	Length (mi)	Speed (kts)	Time (min)	Propulsive Power Required (kW)	Fuel consumption (gal)	Battery Consumption (Electric) (kwh)	Cumulative Time (min)	Time	SOC
		Outputs									
		-	-	-	-	-	-	-	0.0	14:00	80%
Leg 1 Oakland	*Total Distance: 6.4 mi*	*Leave Downtown*	0.1	3.0	3.0	298	1.1	18.6	3.0	14:03	79%
	Unrestricted Transit Speed 26 kts	Unrestricted Transit	5.0	26.0	10.0	1851	21.1	350.6	13.0	14:13	68%
	Inner Harbor Transit Speed 10 kts	Inner Harbor Transit	1.2	10.0	6.3	285	2.3	37.2	19.3	14:19	66%
	Number of Passengers 250	*Enter Oakland*	0.1	3.0	3.0	298	1.1	18.6	22.3	14:22	66%
		Subtotal	6.4		22.3		25.6	424.9	22.3	14:22	
Docked-Oakland	Time Docked 5 *min* ☐ Charging ☑ Under Power At	Docked	0.0	0.0	5.0	171.5	1.2	19.2	27.3	14:27	
		Docked- Charging						0.0			
		Subtotal	0.0		5.0		1.2	19.2	27.3	14:27	65%
Leg 2 Alameda Main Street	*Total Distance: 0.9 mi*	*Leave Oakland*	0.1	3.0	3.0	298	1.0	18.6	30.3	14:30	65%
	Inner Harbor Transit Speed 10 kts	Inner Harbor Transit	0.7	10.0	3.5	285	1.1	21.1	33.8	14:33	64%
										14:33	64%
	Number of Passengers 250	*Enter Alameda Main Stre*	0.1	3.0	3.0	298	1.0	18.6	36.8	14:36	63%
		Subtotal	0.9		9.5		3.1	58.2	36.8	14:36	
Docked-Alameda Main Street	Time Docked 10 *min* ☑ Charging ☑ Under Power At	Docked	0.0	0.0	10.0	171.5	2.3	38.4	46.8	14:46	
		Docked- Charging						-480.0			
		Subtotal	0.0		10.0		2.3	38.4	46.8	14:46	78%
Leg 3 Downtown	*Total Distance: 5.7 mi*	*Leave*	0.1	3.0	3.0	298	1.0	18.6	49.8	14:49	77%
	Inner Harbor Transit Speed 10 kts	Inner Harbor Transit	0.5	10.0	2.6	285	0.8	15.5	52.5	14:52	77%
	Unrestricted Transit Speed 26 kts	Unrestricted Transit	5.0	26.0	10.0	1851	20.6	350.6	62.5	15:02	65%
	Number of Passengers 250	*Enter Downtown*	0.1	3.0	3.0	298	1.0	18.6	65.5	15:05	65%
		Subtotal	5.7		18.6		23.4	403.2	65.5	15:05	
Docked-Downtown	Time Docked 10 *min* ☑ Charging ☑ Under Power At	Docked	0.0	0.0	10.0	171.5	2.3	38.4	75.5	15:15	
		Docked- Charging						-480.0			
		Subtotal	0.0		10.0		2.3	38.4	75.5	15:15	79%
		Trip Summary:	13.0				58.0	982.4	75.5	15:15	79%

Create a user-friendly tool to rapidly configure and optimize energy used on each route

Enables user to:

- Build a route from a dropdown library of route segments
- Select a vessel (current fleet and user defined)
- Adjust route parameters (speed, dock maneuverability, leg distances)

Output :

- Energy used
- Battery sizing
- Charging power required at each stop
- Transportation Efficiency metrics
- Diesel used *- for calibration*

Fleet Analysis Tool

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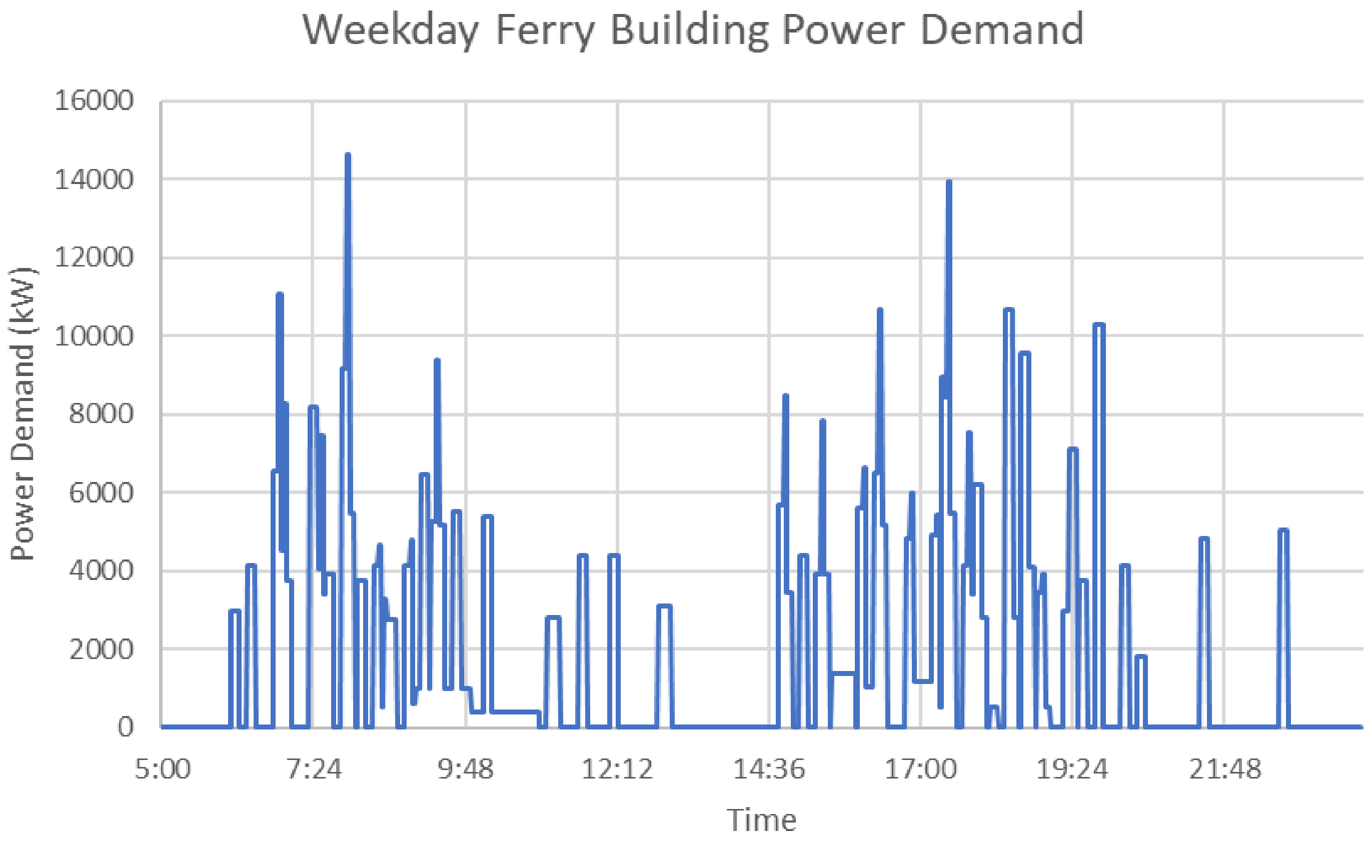
Rapidly determine the power required at each terminal

Receives inputs directly from the Route Analyzer tool

- Contains a graphical schedule builder
- Automatically updates real time systemwide energy demands at any given minute
- Exports an energy demand profile at each terminal to support shoreside infrastructure analysis



Shoreside Progress Update

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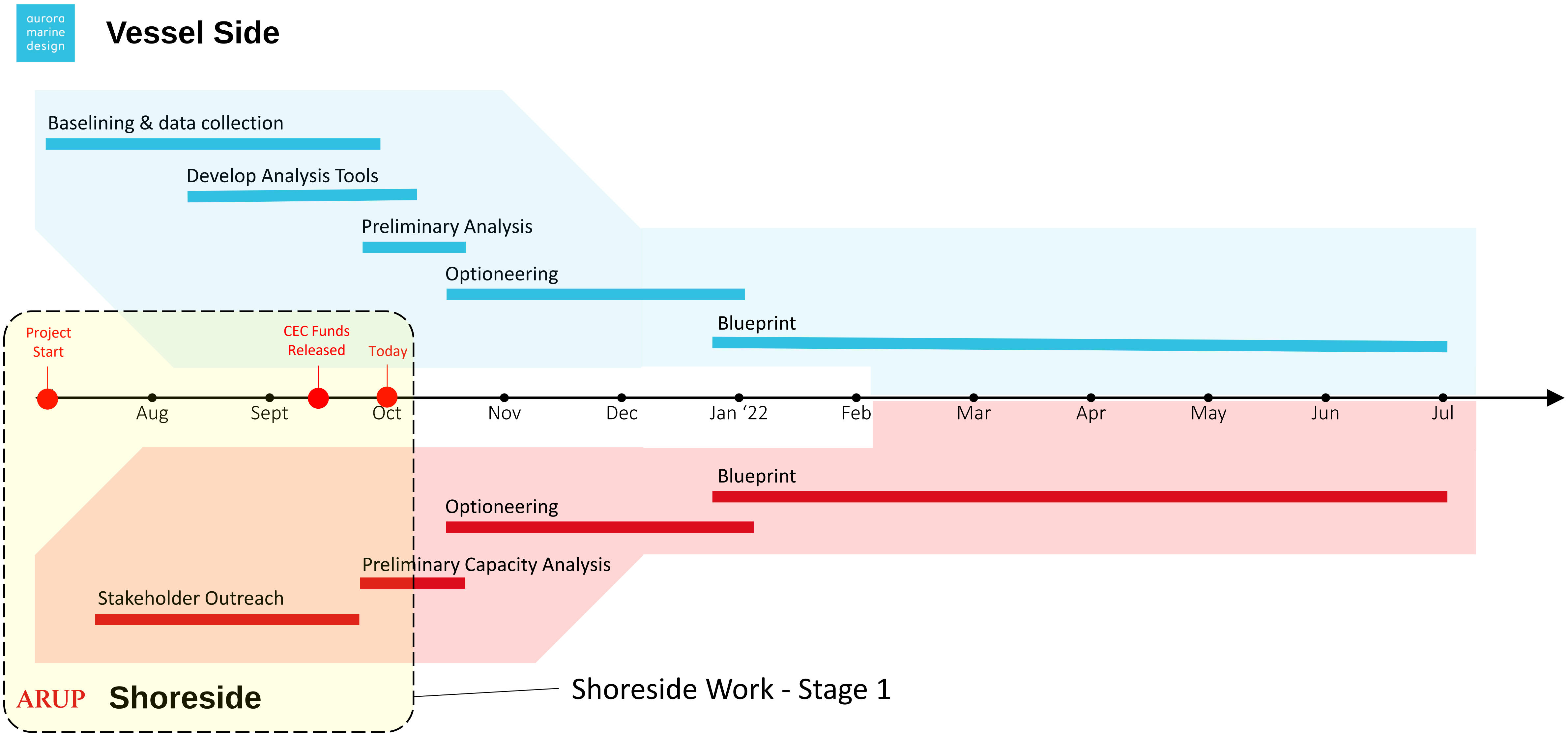

Shoreside Overview

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Stage 1 - Baselining

- Existing Infrastructure
- Local Grid Context
- Space Constraints
- Ferry Requirements (aurora marine design)

Stage 2 - Optioneering & Optimizing

- Design Options
- Phasing Options
- Utility Engagement
- Vessel & Scheduling (aurora marine design)

Optimization Metrics

- Economic Metrics
- Emission Metrics
- Policy Compliance
- Service Provision
- Resilience Tests

Stage 3 - Blueprint

- Transition Roadmap

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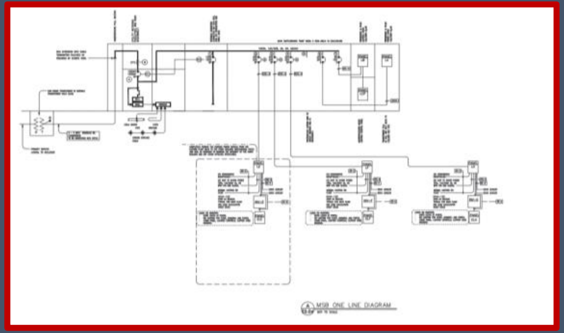
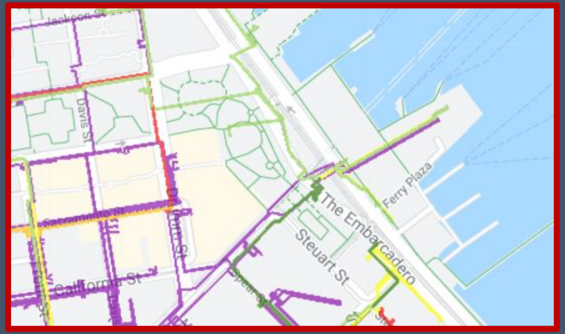
Baselining – Terminal Assessment



Existing Electrical Connections and Design

Excluding central bay all terminals predicted to require substantive grid connection upgrades and the addition of resilience measures for transition. These will be costly



Local Grid Context

High variability in the grid context of the different terminals. In particular Downtown is of high concern.

Space constraints assessment

Opportunities for solar, batteries and back up power reserves are being assessed by evaluating space availability

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Baselining – Terminal Assessment

Highly constrained grid with costly upgrades

Constrained grid with reasonable cost upgrades

Unconstrained grid with opportunities

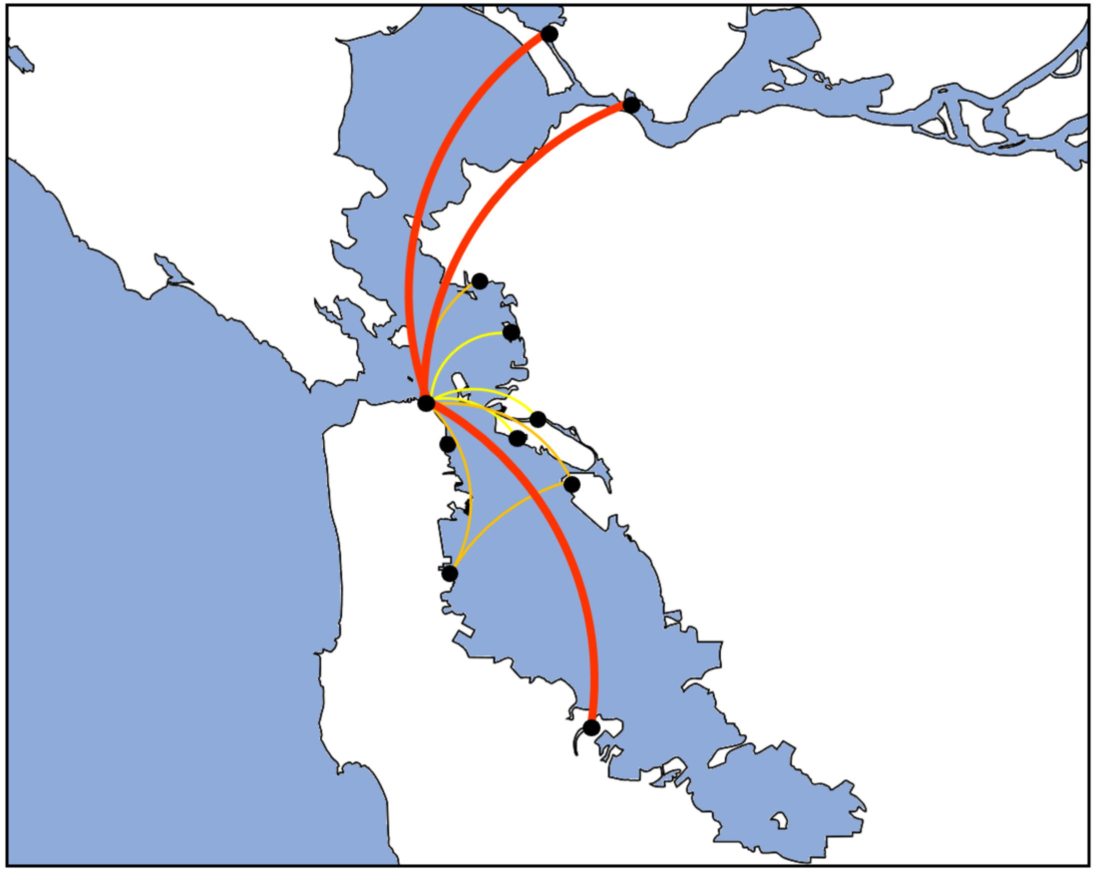
Potential Solar

Uncertain

SF Ferry Building	Richmond	Alameda Seaplane
Oakland	South SF	Central Bay Maintenance
Alameda Main Street	Mission Bay	Berkeley
Harbor Bay	Treasure Island	Redwood City

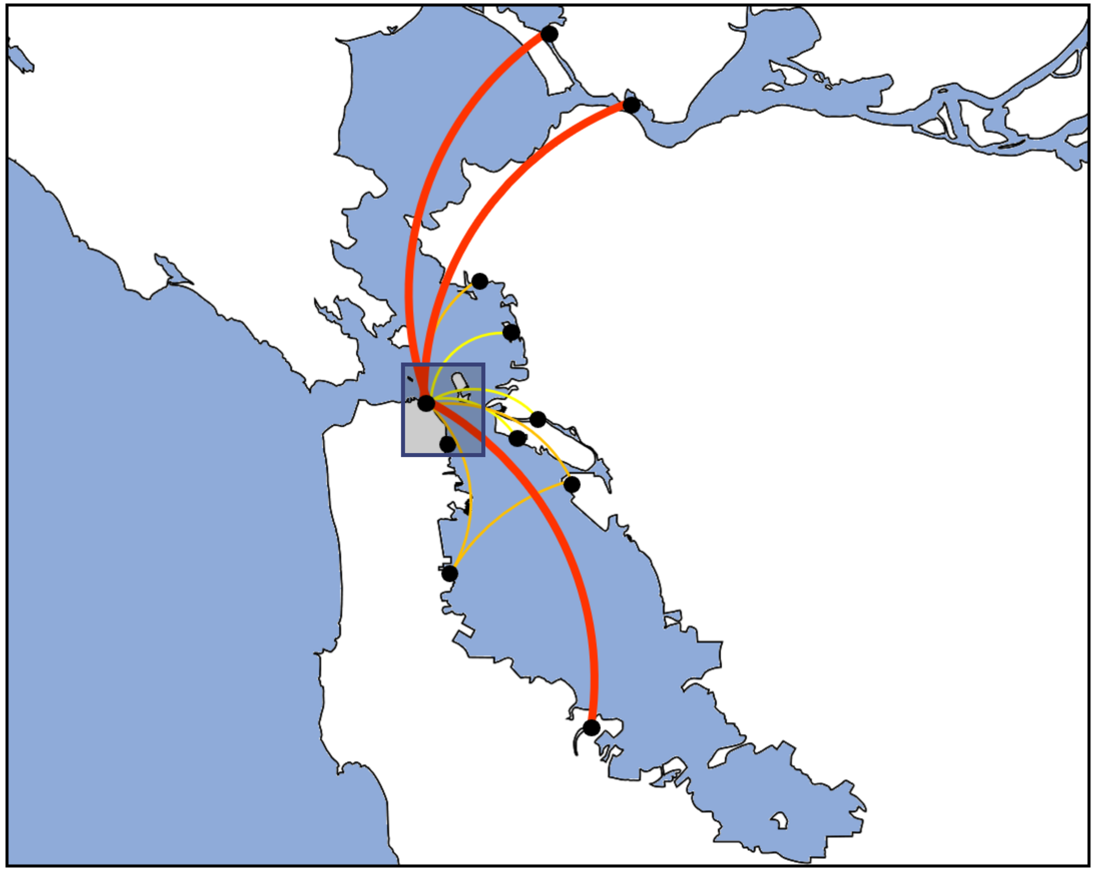
Preliminary Roadmap

Phased Implementation



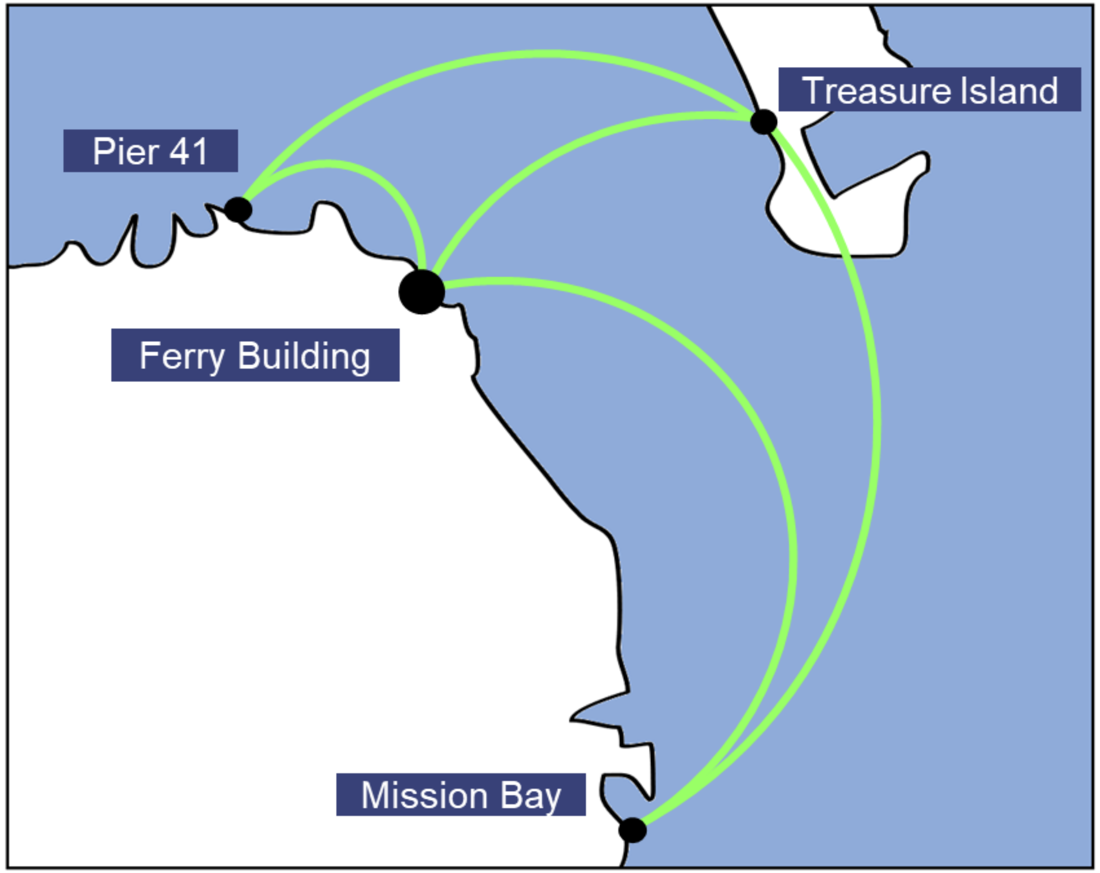
- **Initial analysis points to four phases of implementation**
- **These will be refined during the next stage of the project**

Phased Implementation



Phase 1 - Inner Central Bay

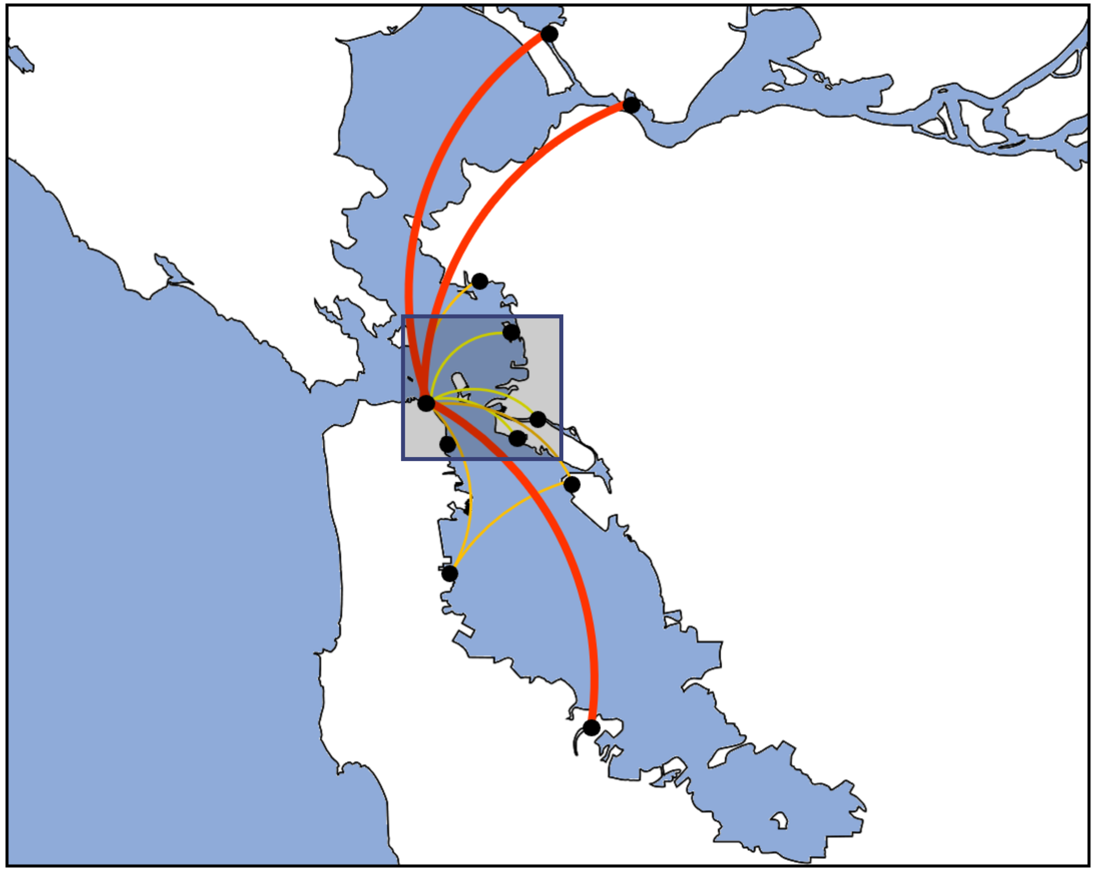
TI, Mission Bay, Pier 41, SFFB

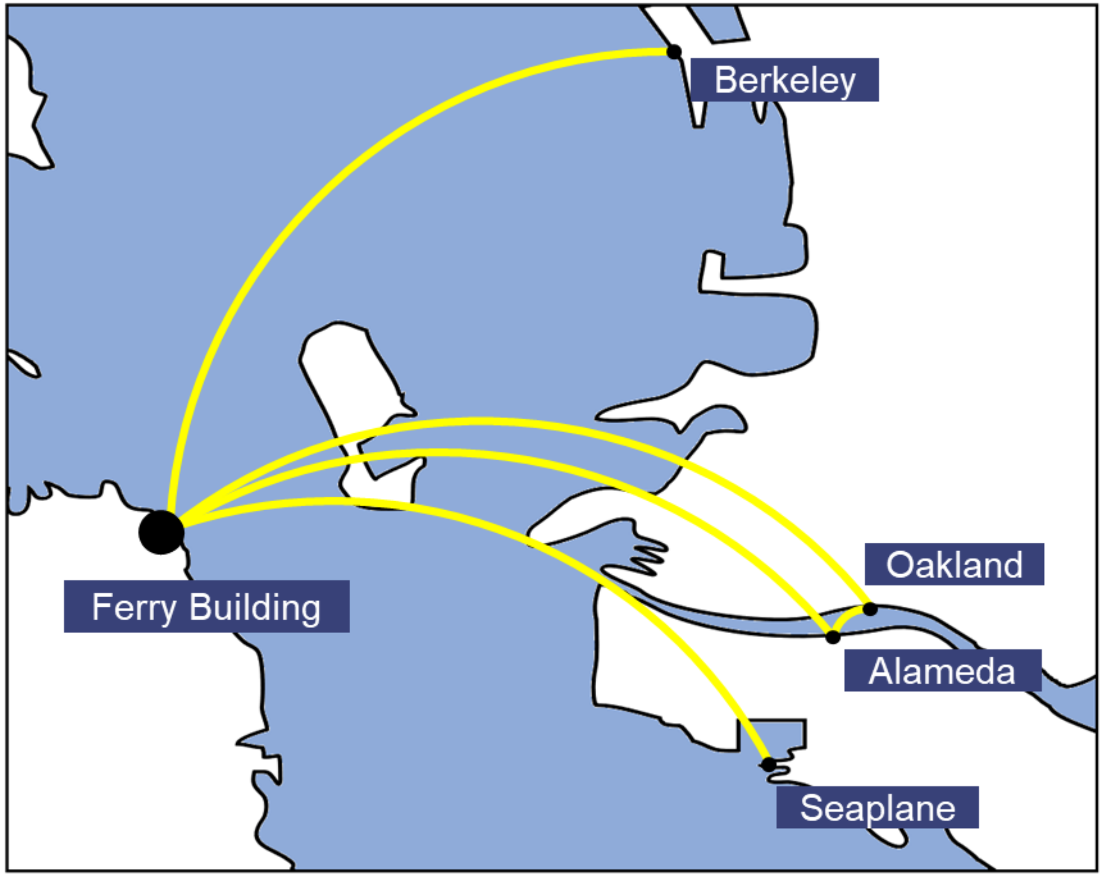


Phased Implementation

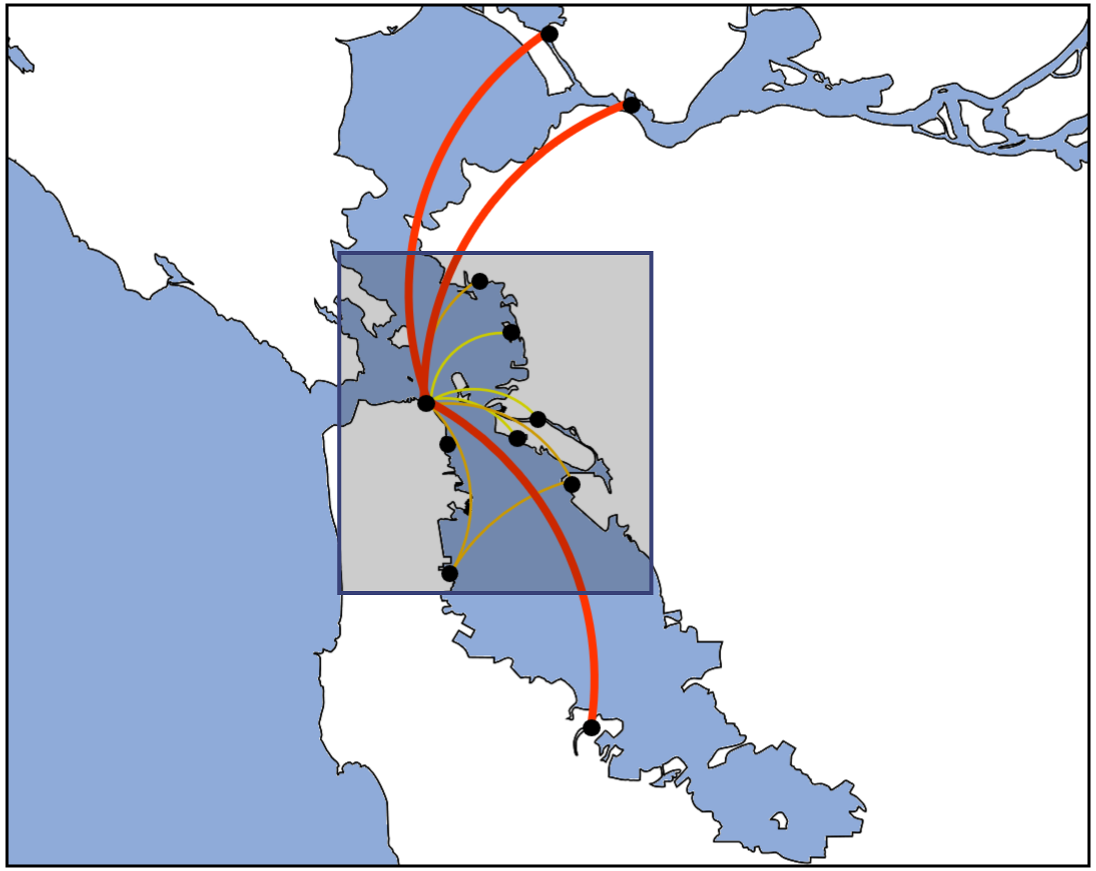
Phase 2 – Central Bay

Oakland, Alameda, Berkeley



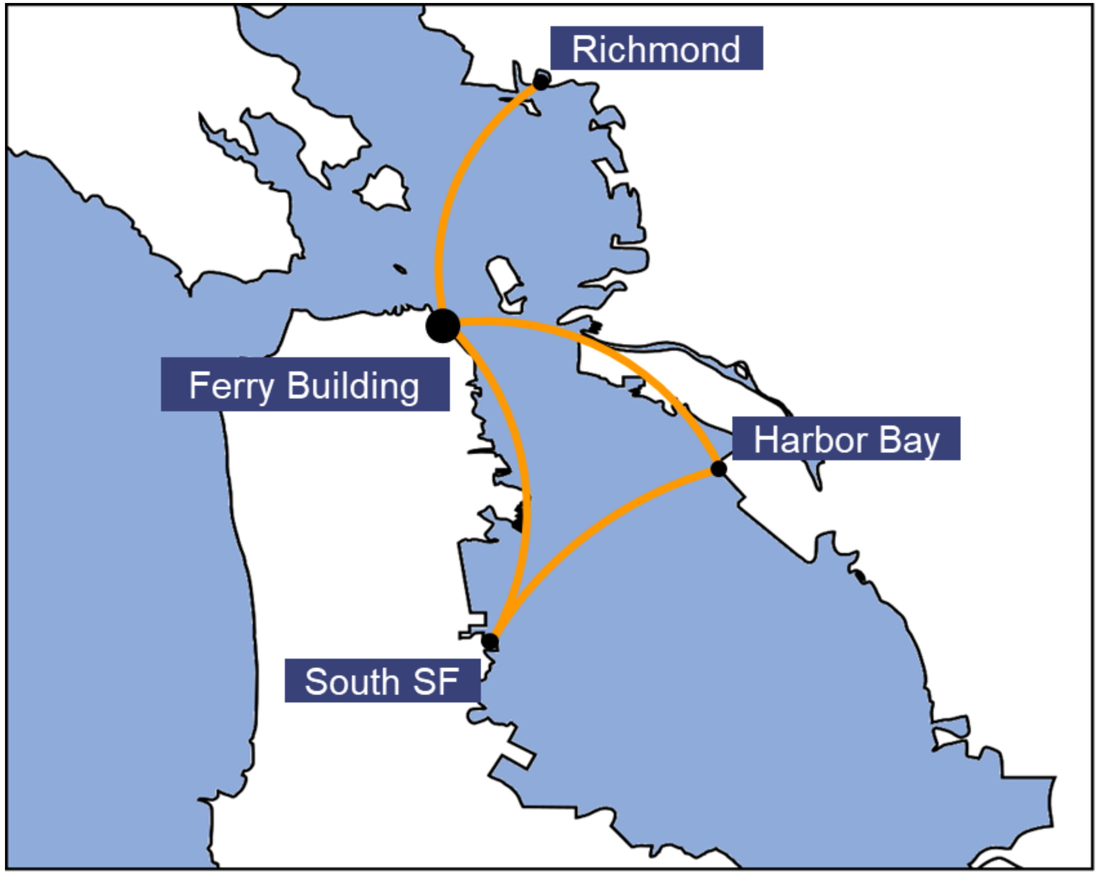


Phased Implementation

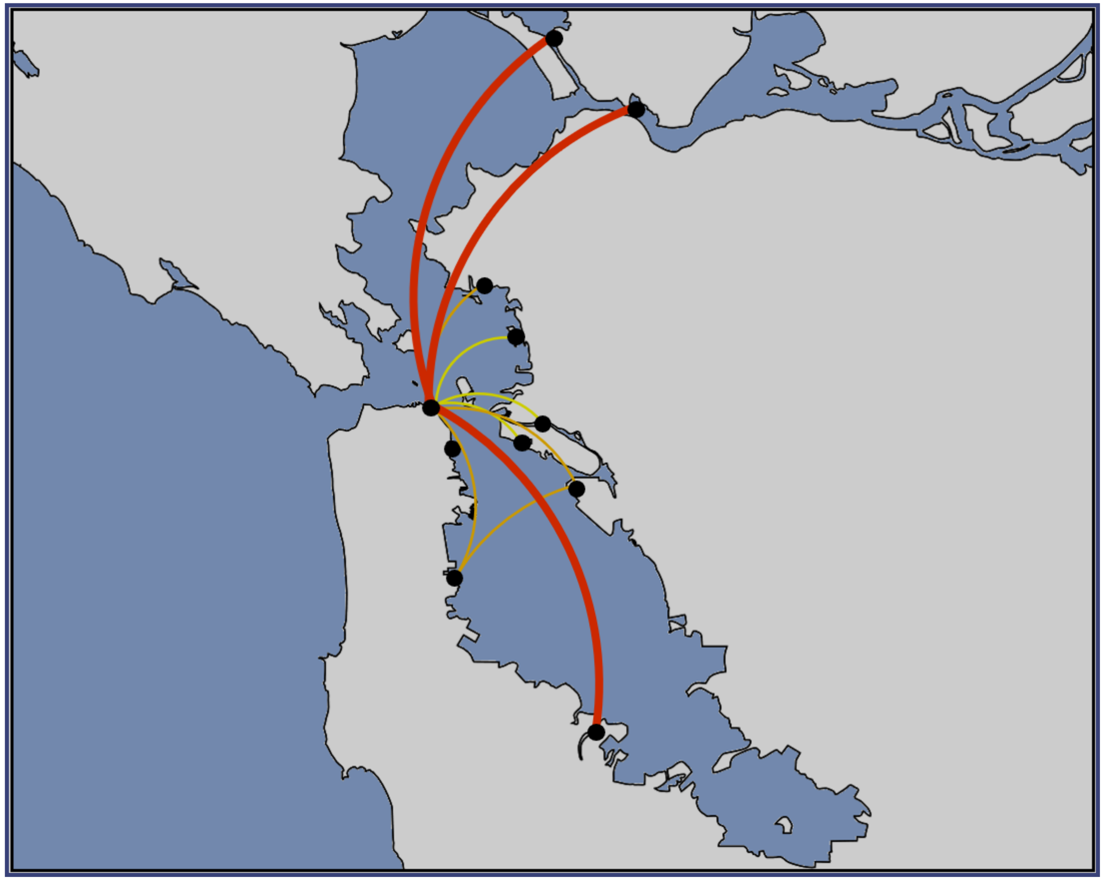


Phase 3 – Long Run Central Bay

Harbor Bay, South SF, Richmond

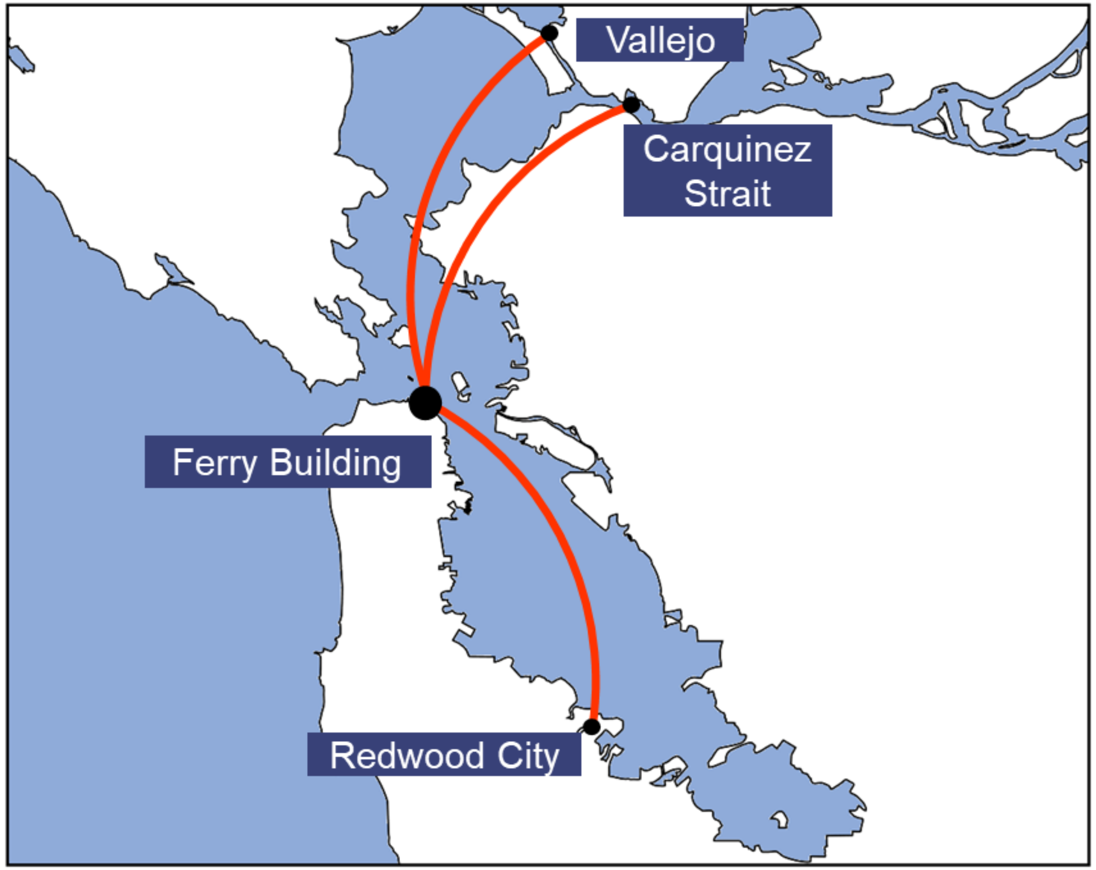


Phased Implementation



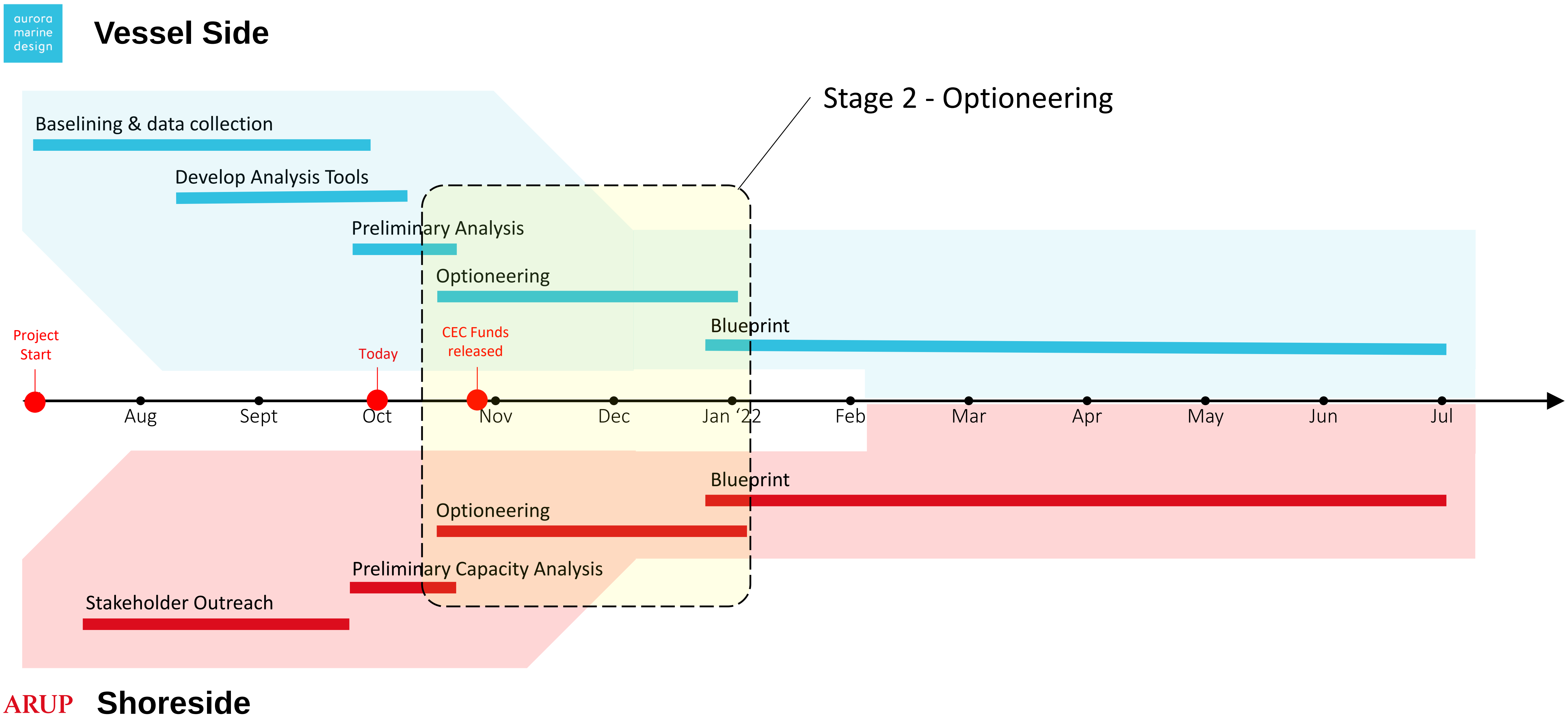
Phase 4 – Long Runs

Vallejo / Carquinez / Redwood City



Next Steps

Next Steps



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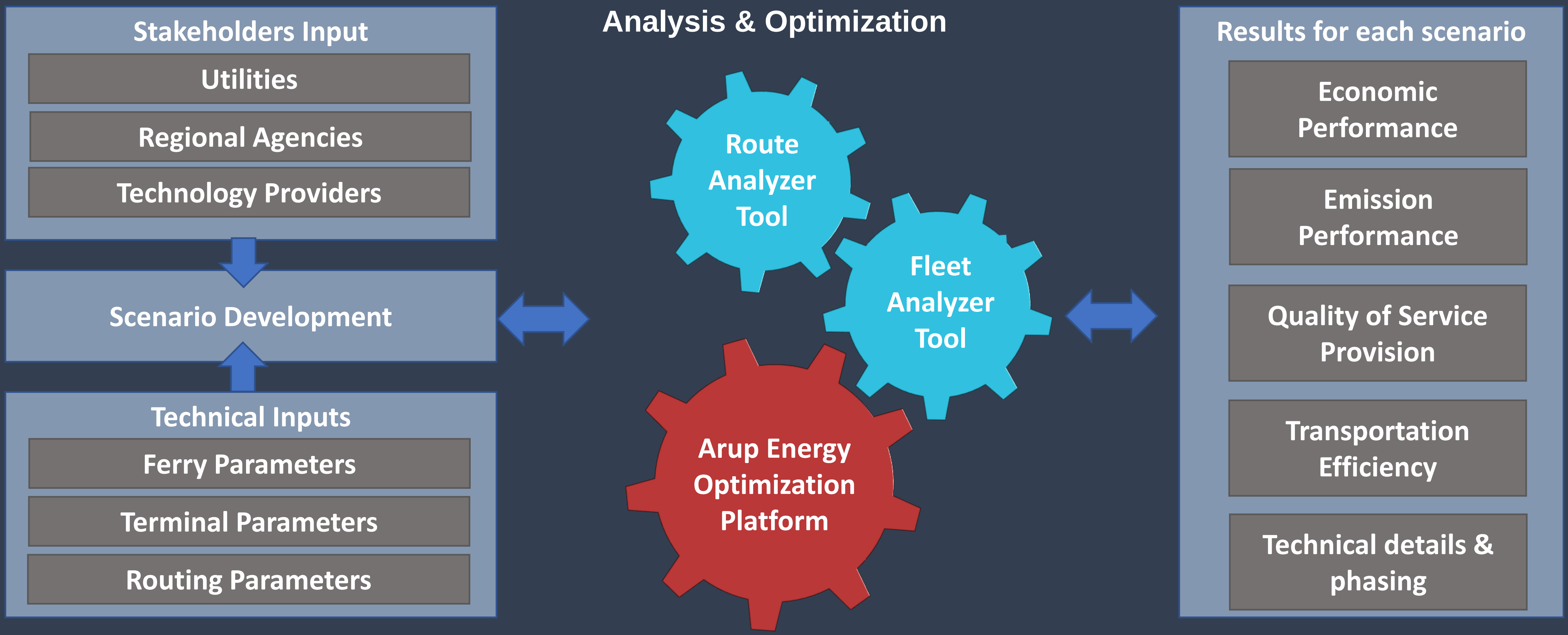
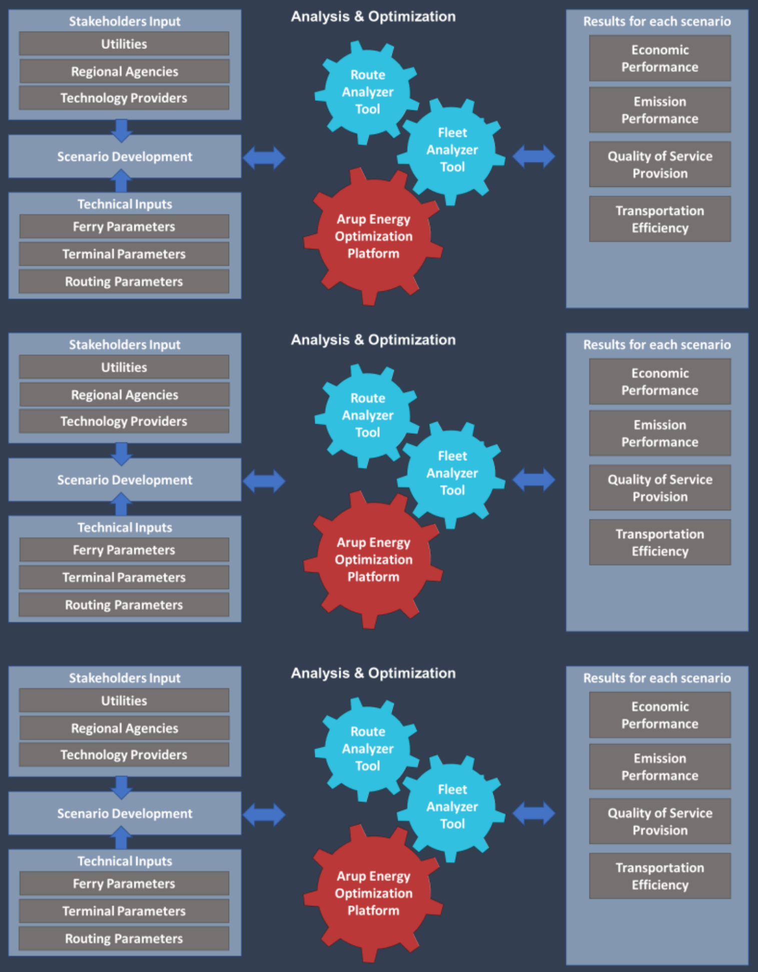
Vessel Side
Stage 2 - Optioneering
Baselining & data collection
Develop Analysis Tools
Preliminary Analysis
Optioneering
Blueprint
Project Start
Today
CEC Funds released
Aug
Sept
Oct
Nov
Dec
Jan '22
Feb
Mar
Apr
May
Jun
Jul
Blueprint
Optioneering
Preliminary Capacity Analysis
Stakeholder Outreach
ARUP
Shoreside

Next Steps – Iterative Optioneering & Optimizing



Next Steps – Iterative Optioneering & Optimizing

Rerun multiple scenarios for each phase



Answers to our study questions

How much power do we need and where?

What is the phasing for implementation?

How much will it cost year by year?

How do we pay for it?

Thank You