



Wind Propulsion for Offshore Wind Construction Vessels

Satchel Douglas

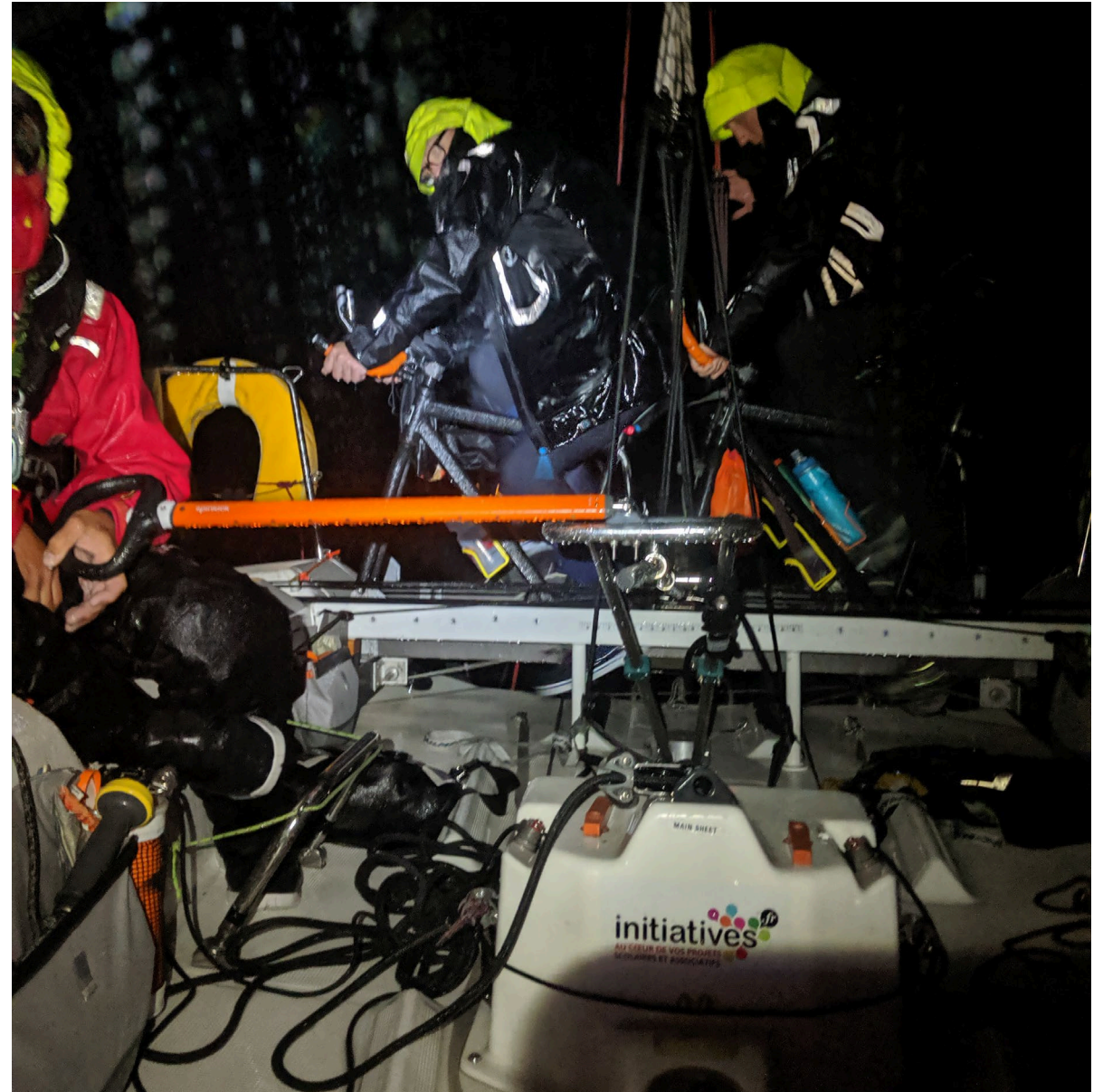
Head of Engineering
Aloft Systems

Agenda

- Jones Act Fleet
- Offshore Wind Construction
- Vessel Types
- Operational Profiles
- Ports and Wind Farm Locations
- Types of Wind Propulsion
- Blue Route Tool
- Analysis and Results
- Life Advice









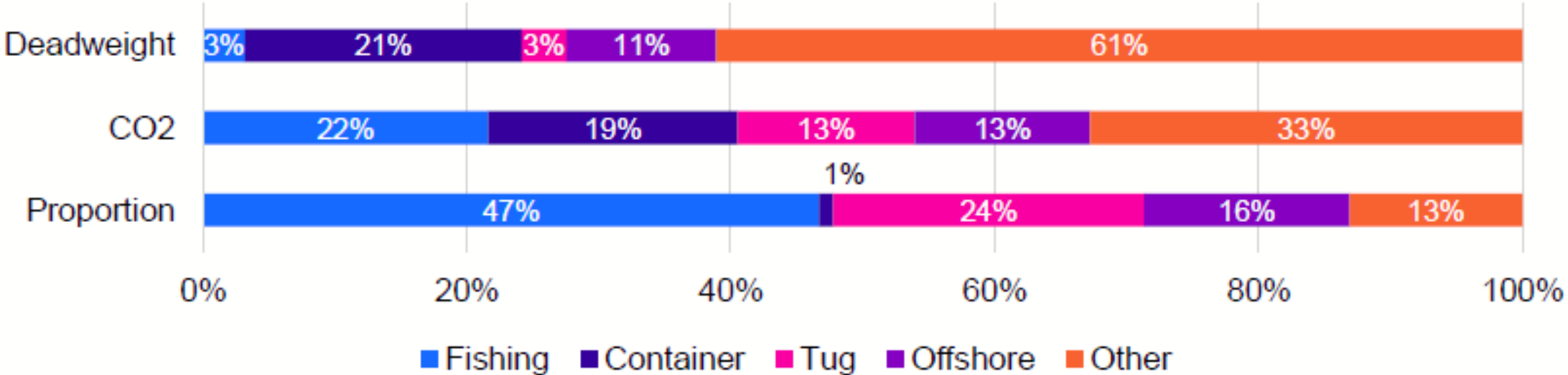
A Second Wind: Zero-Emissions
Propulsion Technology for Existing
Vessels



Jones Act Fleet

Vessel type	No. vessels
Nonselved-propelled vessels	33,266
Dry cargo barges	27,947
Tankers	5,181
Uncategorised	138
Self-propelled vessels	9,904
Dry cargo/passenger	2,919
Ferries, railroad car	569
Tankers	79
Towboats/tugs	5,844
Uncategorised	493
Ocean-going self-propelled vessels (1,000GT and above)	182
Tankers, total	65
Tankers, privately owned	60
Tankers	5
General cargo, privately owned	21
Container, privately owned	62
Ro-Ro, privately owned	29
Dry bulk, privately owned	5
Recreational boats	11,878,542

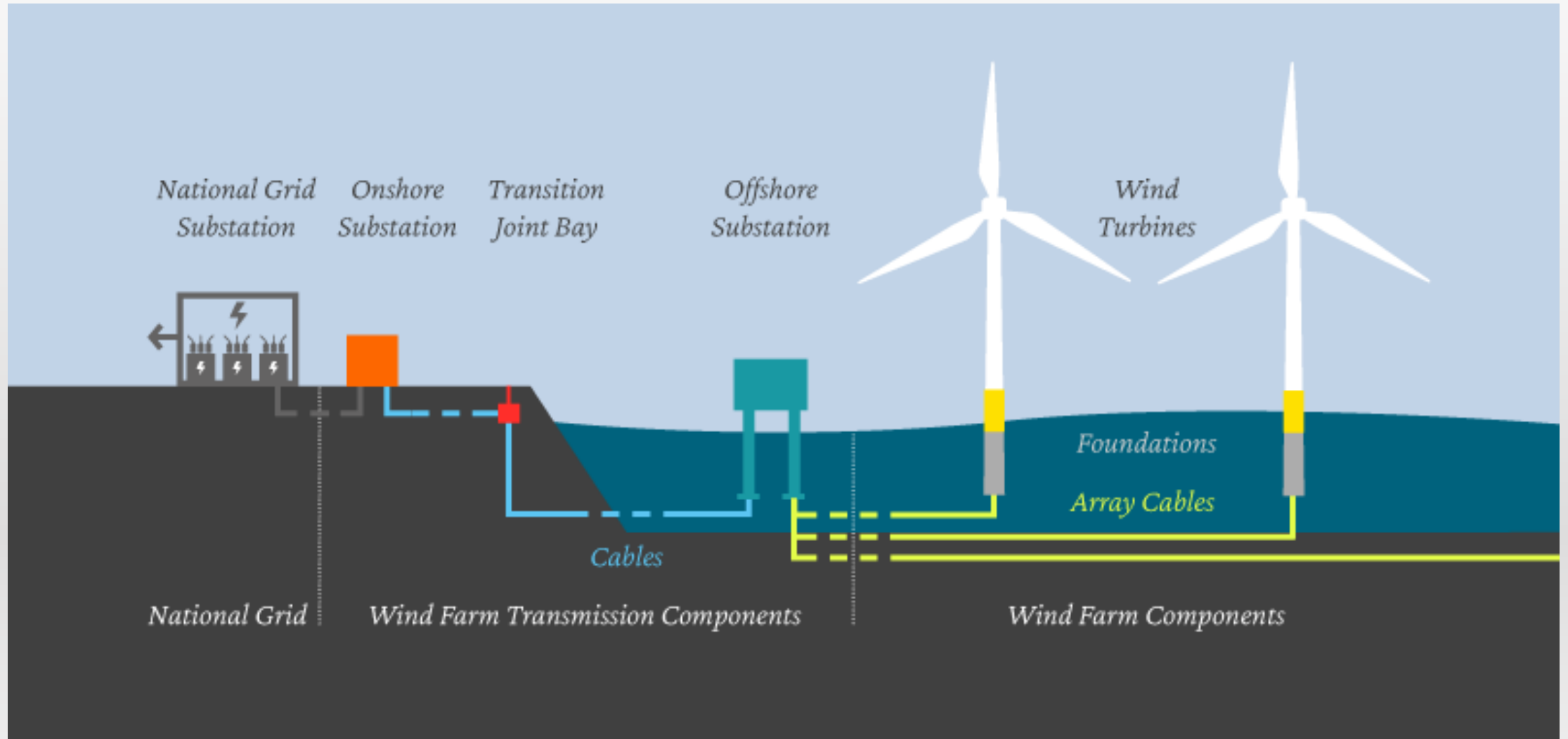
Jones Act Fleet



Source: UMAS report

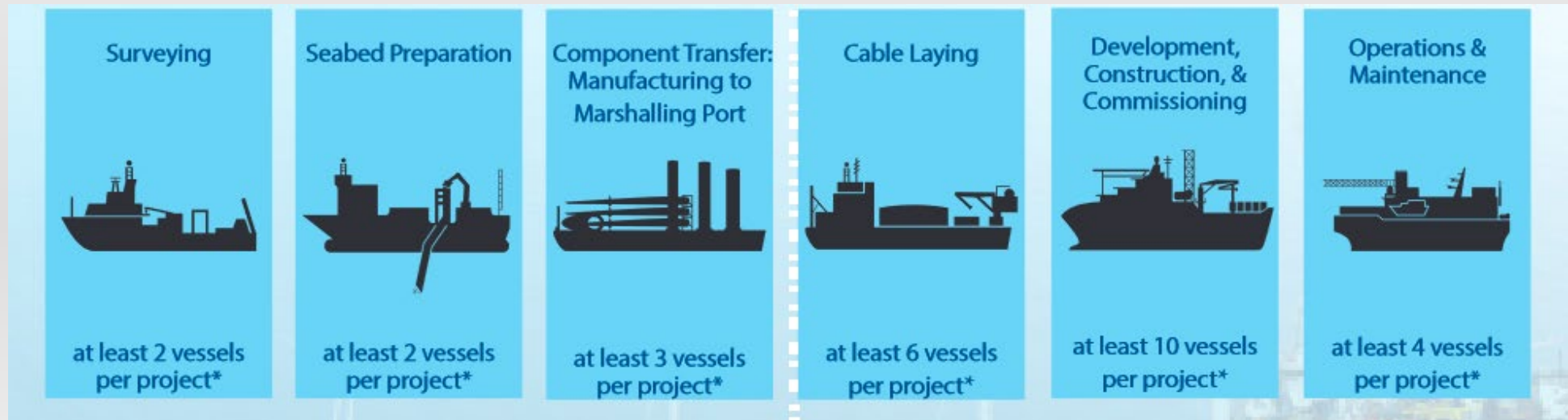


How Offshore Wind is Built



Vessel types used – Offshore Wind

- Crew Transfer Vessel (CTV)
- Survey
- Offshore Supply Vessel (OSV)
- Service Operating Vessel (SOV)
- Cable Lay Vessel
- Guard/Safety Vessels
- Seabed/rock dump
- Feeder vessel/barge
- Foundation Installation Vessel
- Wind Turbine Installation (WTIV)



Crew Transfer (CTV)



<https://www.marinelink.com/news/pioneer-crew-transfer-vessels-designing-481560>

Survey



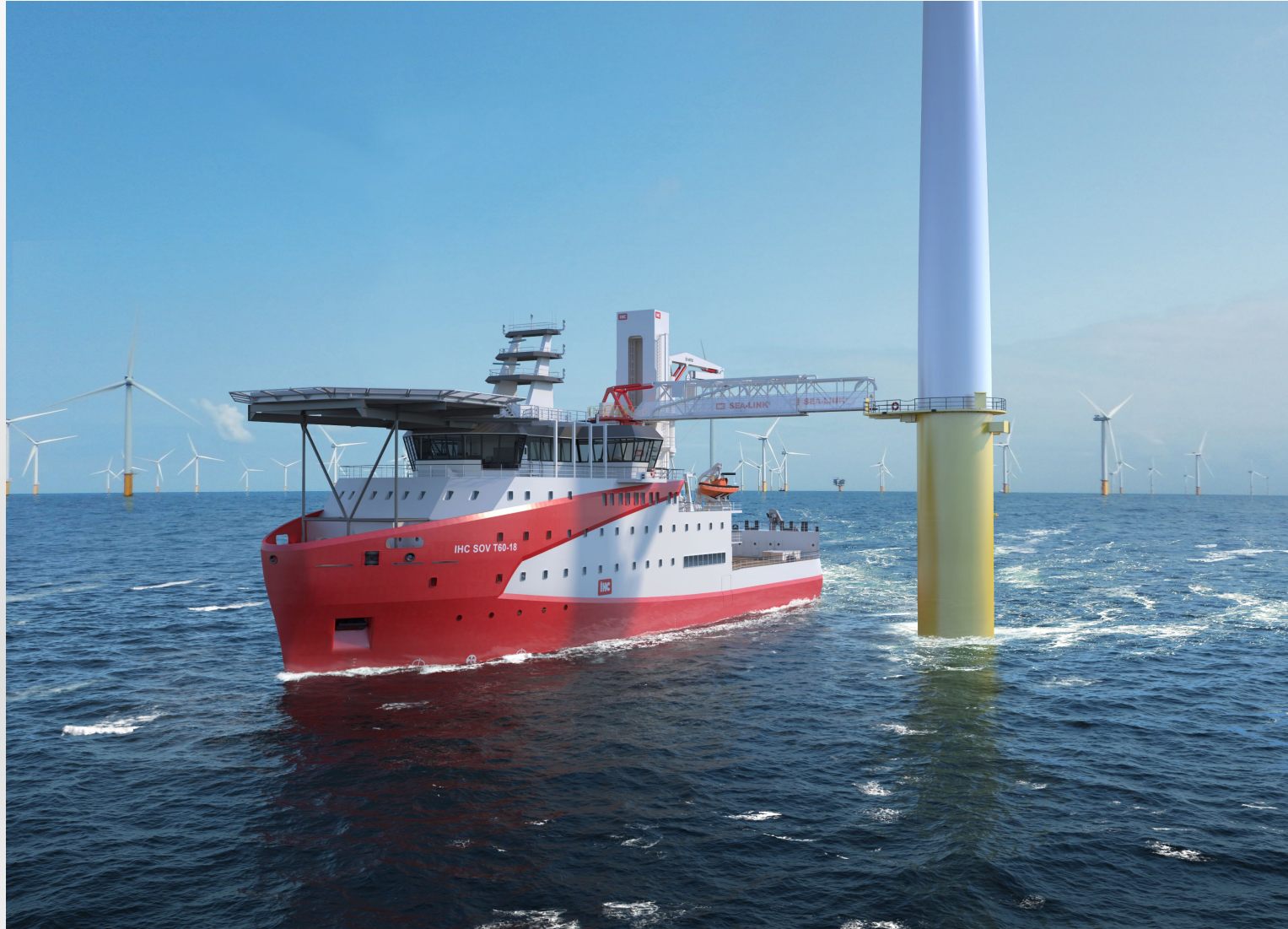
© Richard Byno
MarineTraffic.com

OSV



Guice Offshore

SOV



Royal IHC

Cable Lay



Guard Vessel



Vineyard Wind

Rock Dump Vessel



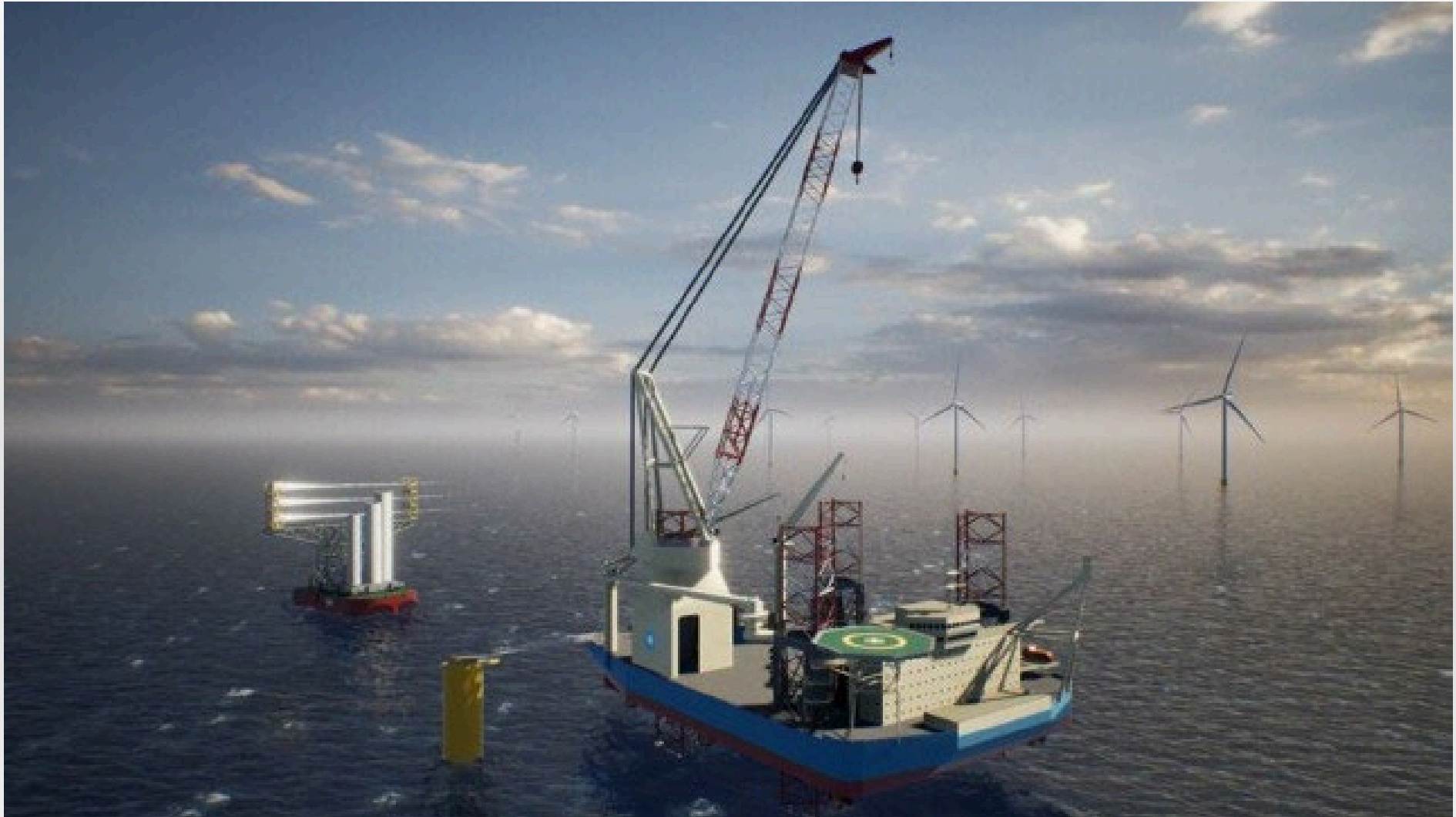
Great Lakes Dredge and Drydock

Foundation installation vessels



Seaway 7

Why Feederling?



Source: Maersk Supply Service

Feeder Barge



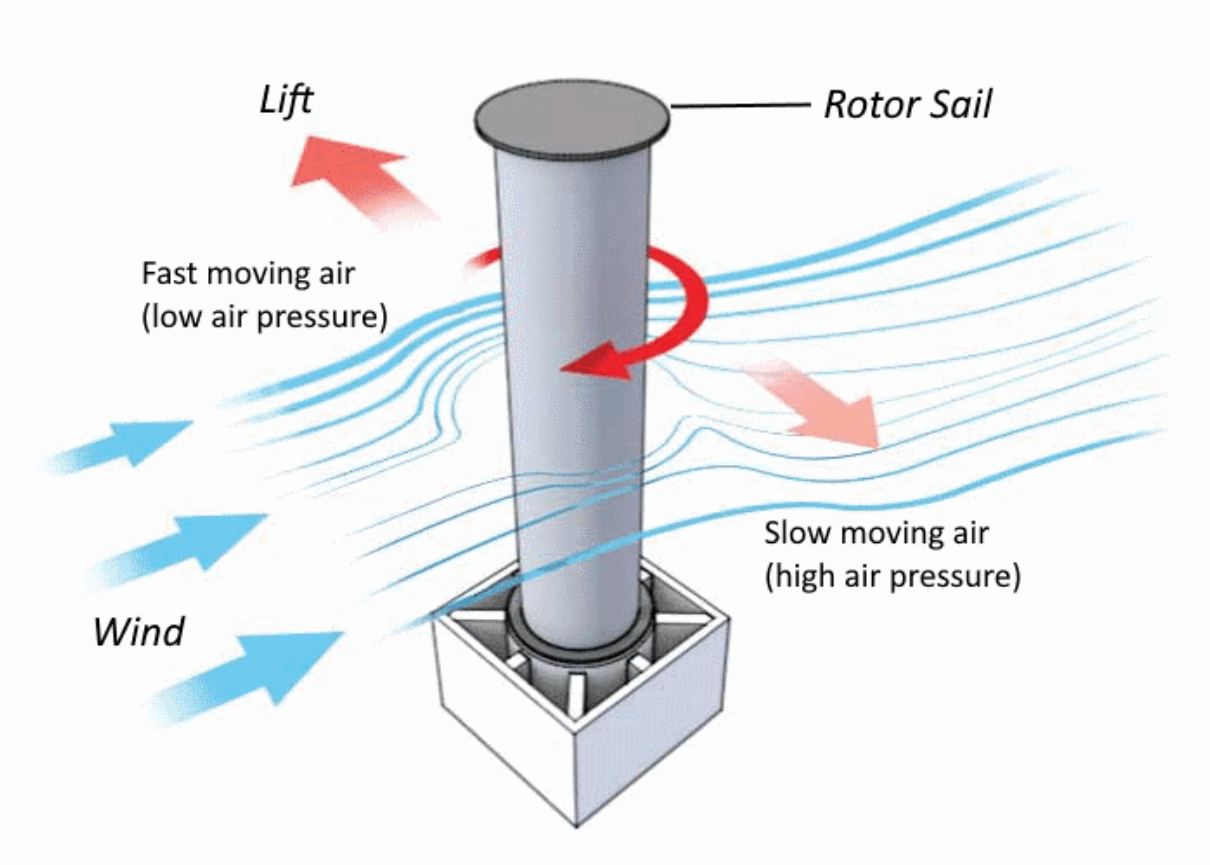
Foss – DEME - Bargemaster

Wind Turbine Installation Vessels

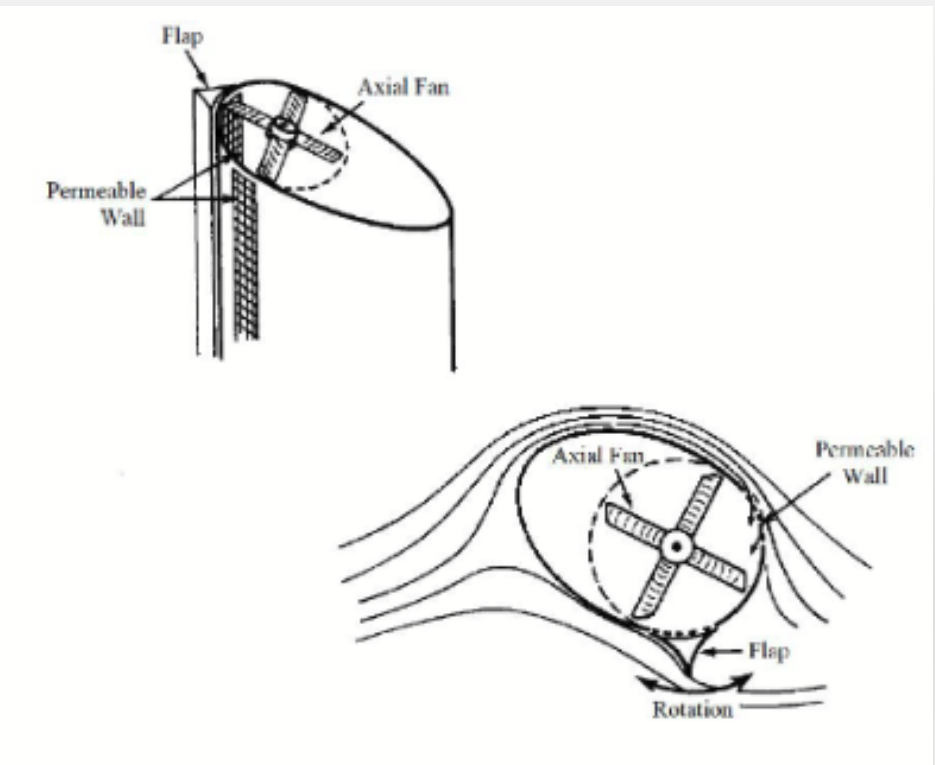


Dominion WTIV

Types of Wind Propulsion



<https://www.amusingplanet.com/2021/02/flettner-rotor-sailing-ships-without.html>



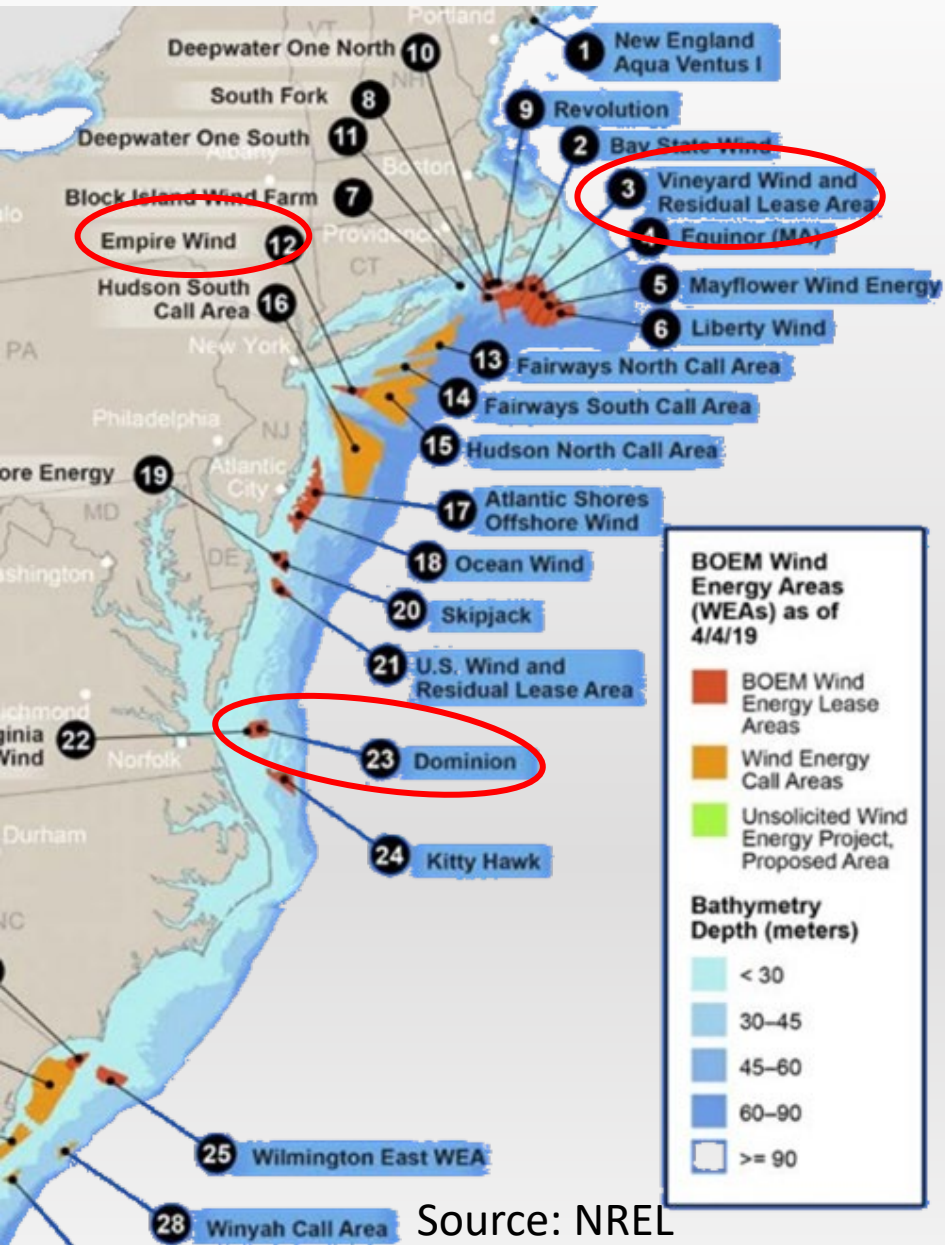
Boonstra Thesis, TUDELFT

Types of Wind Propulsion



Source: Gilles Martin-Raget /
www.americascup.com

Port and Wind Farm Locations



Source: NREL

For this analysis:

- New Bedford to Vineyard Wind
 - 62 Turbines
- South Brooklyn to Empire Wind
 - 160 Turbines
- Norfolk to CVOW (Dominion)
 - 200 Turbines

Operational Profiles

Mostly Stationary

- WTIV
- Foundation Vessel
- Cable Lay
- SOV

Fixed Route

- Crew Transfer
- OSV
- Feeder Barge
- Rock Dump

Flexible Route

- Survey
- Guard

Operational Profiles

Mostly Stationary

- ~~WTIV~~
- ~~Foundation Vessel~~
- ~~Cable Lay~~
- ~~SOV~~

Fixed Route - Shuttle

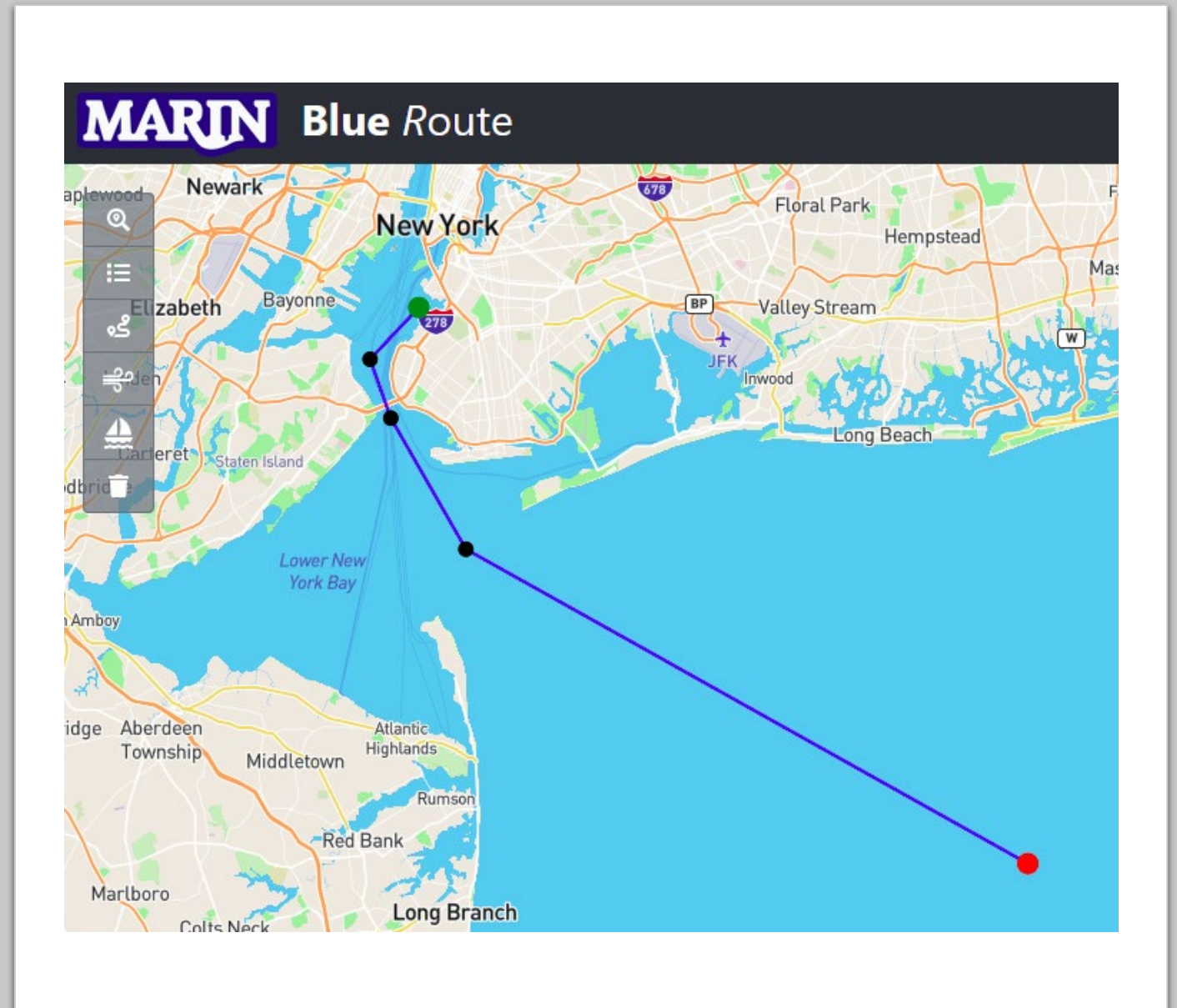
- **Crew Transfer**
- **OSV**
- **Feeder Barge**
- ~~Rock Dump~~

Flexible Route

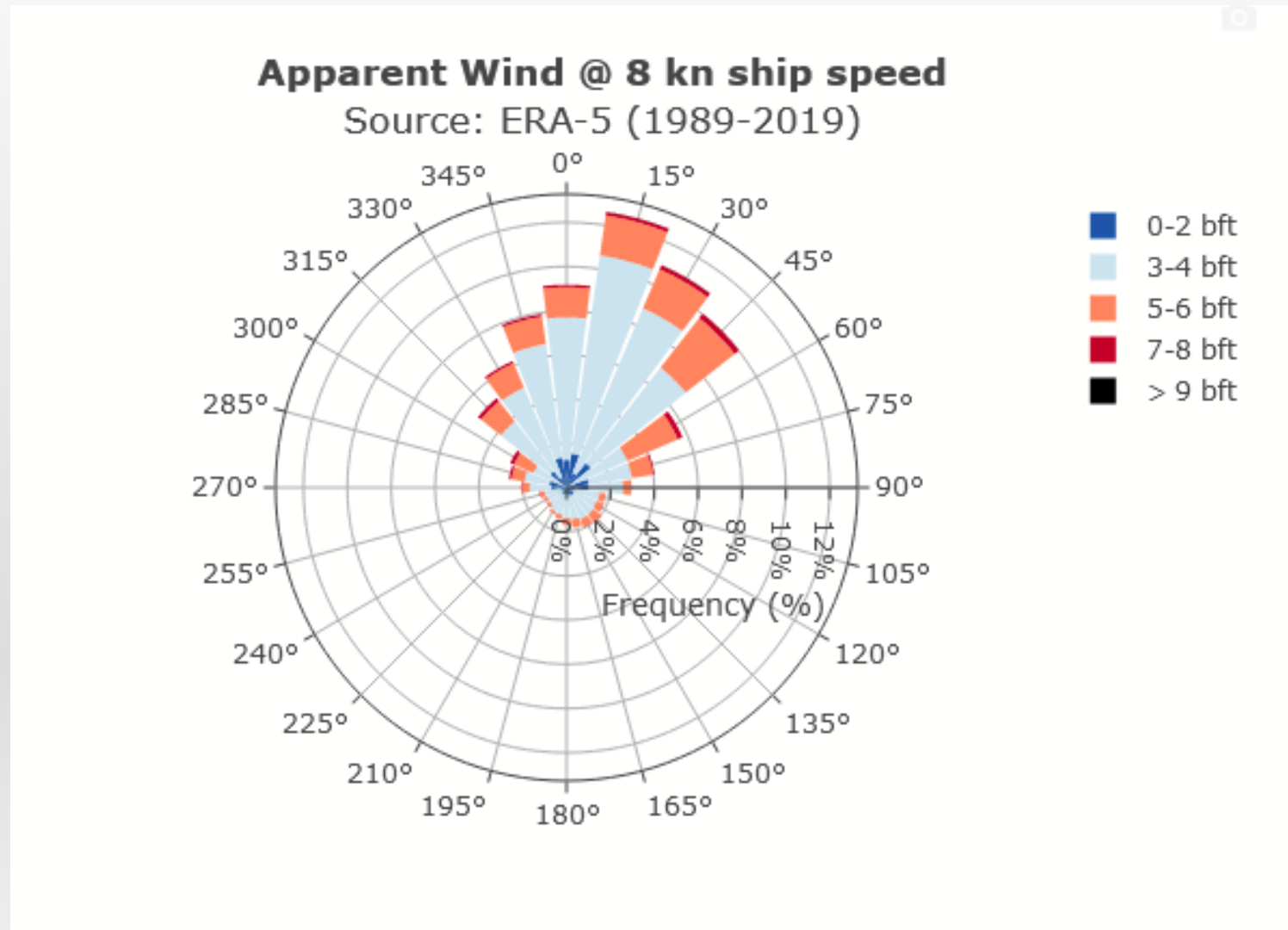
- **Survey**
- ~~Guard~~

Using Blue Routes (Marin)

- ERA5 Reanalysis Wind Data – 30km grid
- Plot vessel route
- Generates statistical wind data

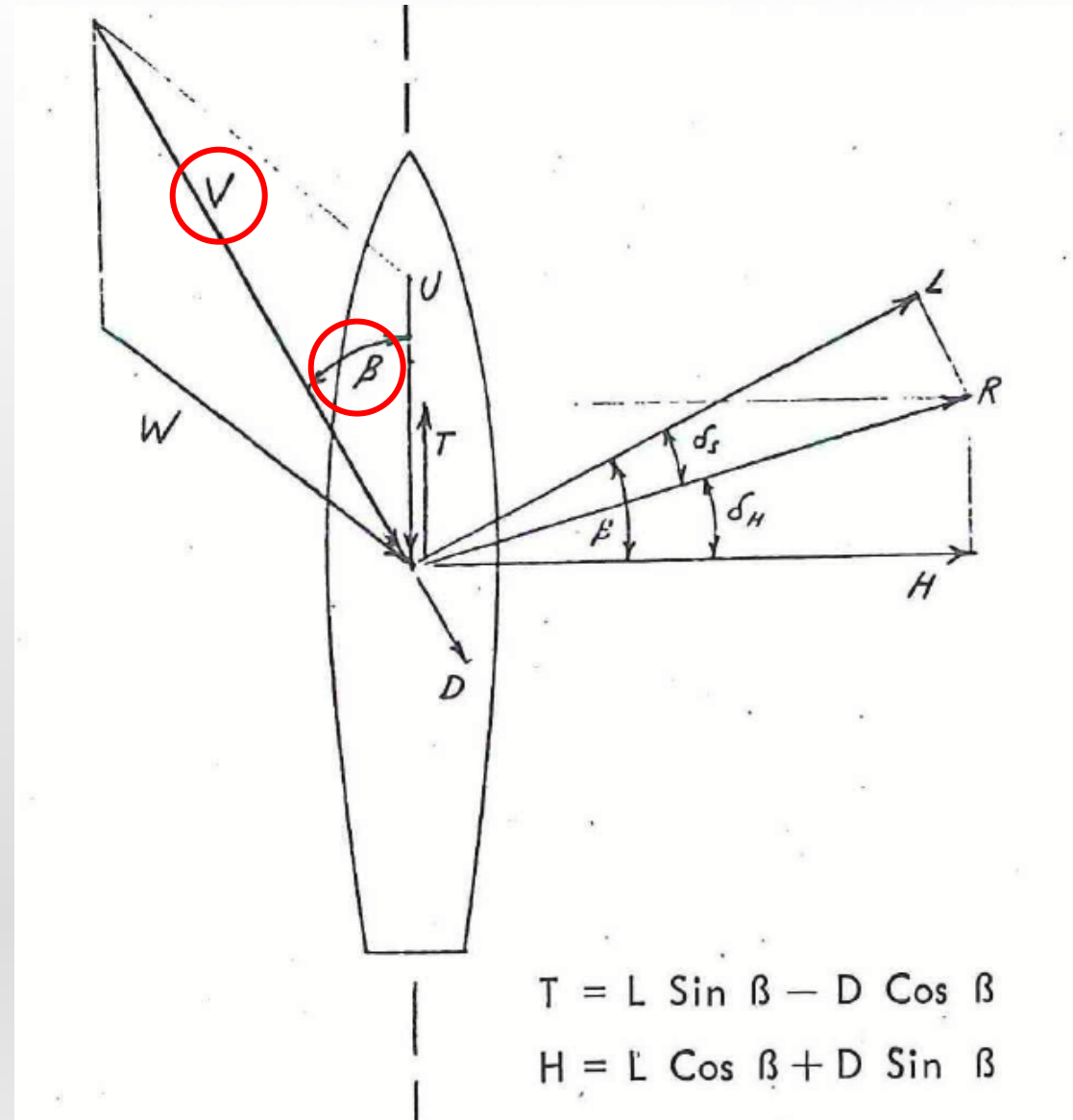


Using Blue Routes (Marin)



Analysis Step 1

- Inputs
 - Wind speed/direction probability matrix
 - Vessel Speed
- Calculate
 - Apparent wind angle (V)
 - Apparent wind speed (β)



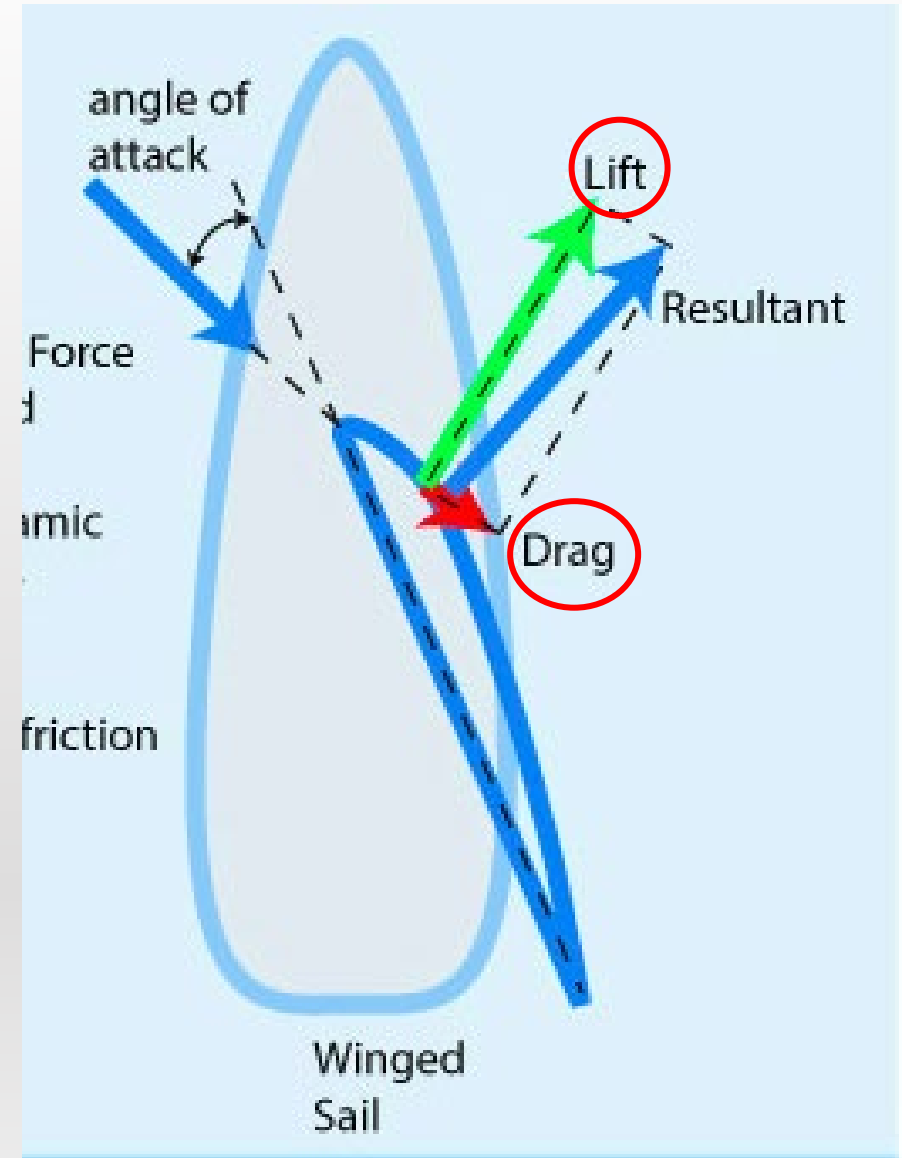
Analysis Step 2

- Inputs

- Apparent wind angle (V)
- Apparent wind speed (β)
- Sail Angle of Attack (α)
- Sail Lift and Drag – C_L and C_D

- Outputs

- Lift and Drag forces



Source:

<https://www.nauticed.org/freesailingcourse-m5>

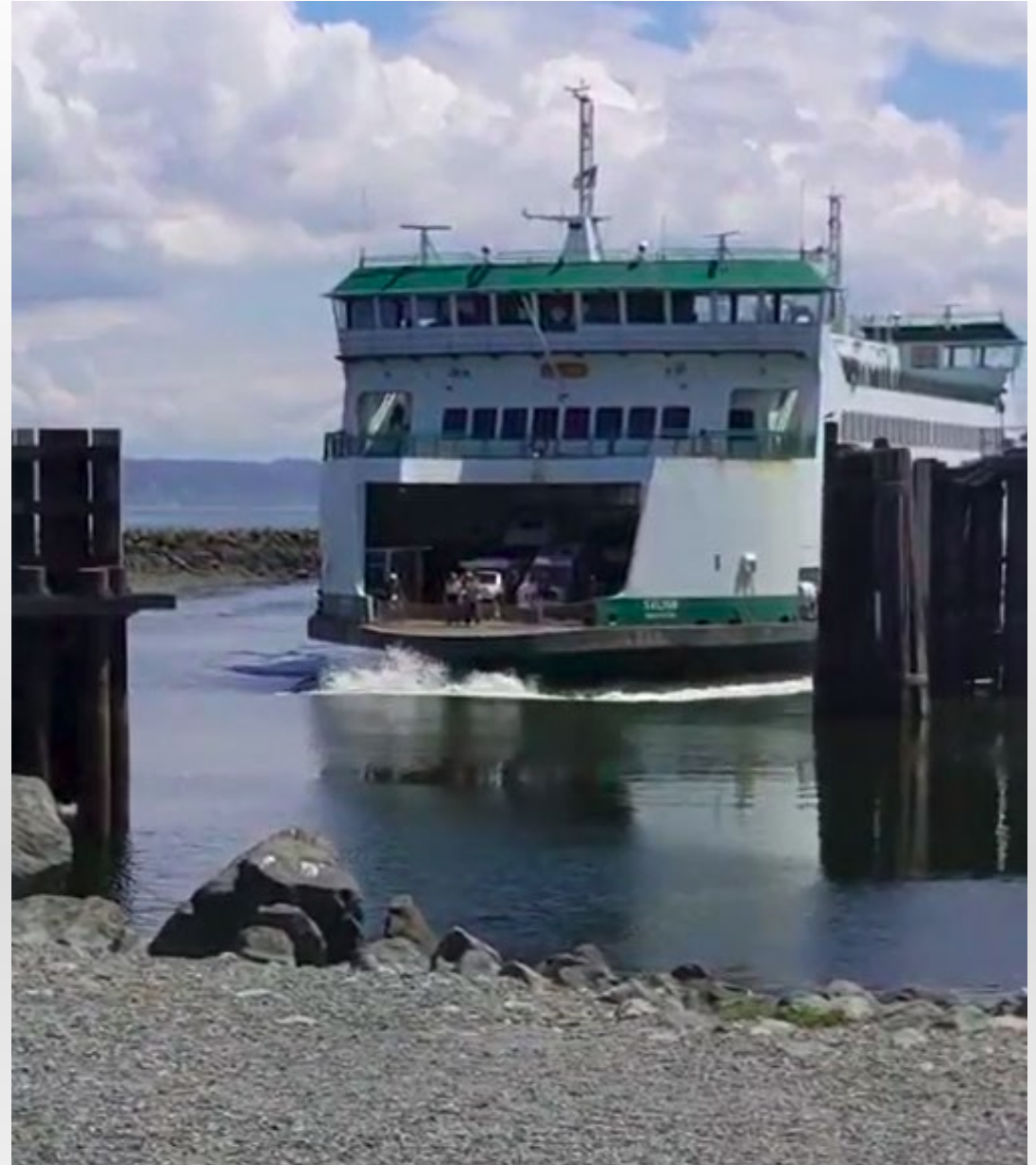
Analysis Step 3

- Resolve lift and drag forces into thrust and heel forces (aligned with vessel axis)
- Assumption: No leeway. Valid for low % wind assistance



Analysis Step 4

- Calculate average thrust
 - KN/m^2
 - Assume 200m^2 sail area
- Convert thrust to power
 - $1\text{kN} \sim 10 \text{ kW}$
- Convert power to fuel
 - 200 g/kWh MGO
- Convert fuel to \$
 - $\$1300/\text{mt}$



Operational Profiles

Vessel	Speed (kts)	Route	Route Frequency	Yearly Operations
Crew Transfer	24	Shuttle	Daily	12 months
Survey	8	Transects	Four weeks on, one week off	12 months
OSV	12	Shuttle	Every two days	8 months
Feeder Barge	8	Shuttle	Every two days	8 months

Operational Profiles

Route	Round Trip Distance (nm)
New Bedford-Vineyard	105
Brooklyn to Empire	78
Norfolk to CVOW	86

Vessel	Route	Speed (kts)	Operation time (hrs/year)	Thrust (kN/m2)	Fuel Savings (\$)	Emissions Savings (mt CO2e)
CTV	New Bedford/Vineyard	24	1597	0.0202	\$16,774	50.3
CTV	Brooklyn/Empire	24	1186	0.0168	\$10,363	31.1
CTV	Norfolk/CVOW	24	1308	0.0281	\$19,111	57.3
Survey	Vineyard	8	6989	0.0346	\$125,742	377.2
Survey	Empire	8	6989	0.0311	\$113,023	339.1
Survey	CVOW	8	6989	0.0323	\$117,384	352.2
OSV	New Bedford/Vineyard	12	1278	0.0199	\$13,220	39.7
OSV	Brooklyn/Empire	12	949	0.0168	\$8,290	24.9
OSV	Norfolk/CVOW	12	1046	0.0271	\$14,745	44.2
Feeder Barge	New Bedford/Vineyard	8	1916	0.0207	\$20,627	61.9
Feeder Barge	Brooklyn/Empire	8	1424	0.0176	\$13,028	39.1
Feeder Barge	Norfolk/CVOW	8	1570	0.0281	\$22,934	68.8



Advice to Students

- Set a life goal, work towards that. It can change, but will help you make decisions.
- Find a friend and do something challenging together, outside your comfort zone. The further from comfort, the more you will grow.

Advice to Students

- Advocate for yourself and your work. Consistency is often taken for granted.
- Ask for help, for connections, for introductions, or just to learn what a job/pathway is like. You won't believe how many people will have call to share their experience, even if you have never met.
- Spend time outside



THANK YOU



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