Offshore Wind, Infrastructure, and Research

Tribal Offshore Wind Summit 2024

Presented by: Arne Jacobson
Schatz Energy Research Center
Cal Poly Humboldt

January 30, 2024

Schatz Energy Research Center at Cal Poly Humboldt

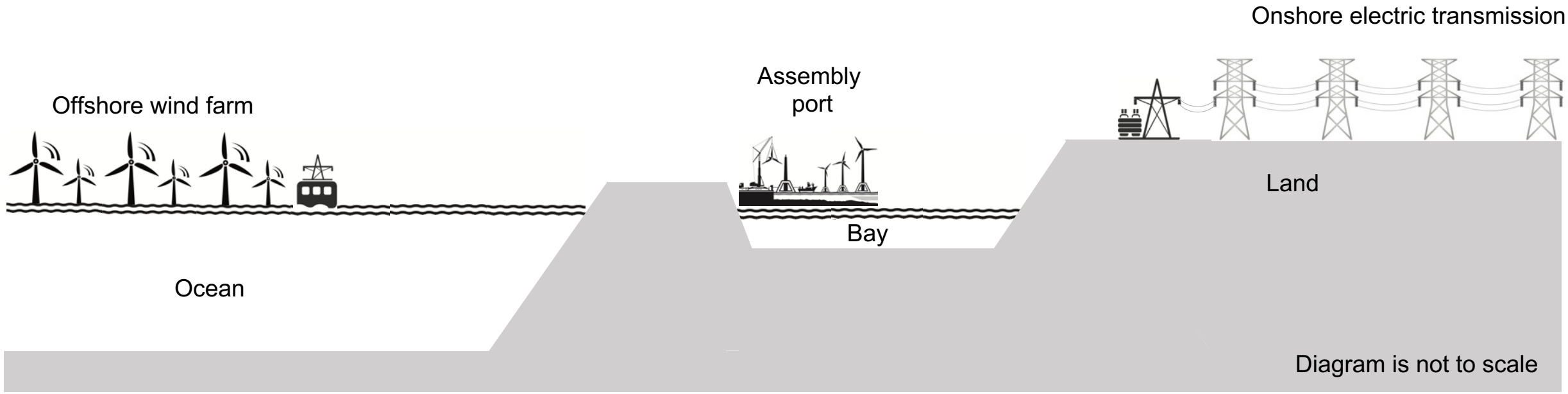
- **The Schatz Energy Research Center** conducts applied research and analysis relevant to offshore wind and other topics related to climate and clean energy.
- We are honored to have had the opportunity to partner with multiple Tribal Nations in the region over the past 25 years, and we are committed to continued collaboration and to sharing what we learn in an honest and respectful manner.

Offshore Wind Development is Complex and Multifaceted

- Offshore wind development requires multiple types of new infrastructure

Infrastructure and Offshore Wind Development

Offshore wind development involves four main types of infrastructure:
(1) offshore wind farms, (2) ports (import/export, assembly, O&M),
(3) electric transmission (and conversion), (4) component supply chains.



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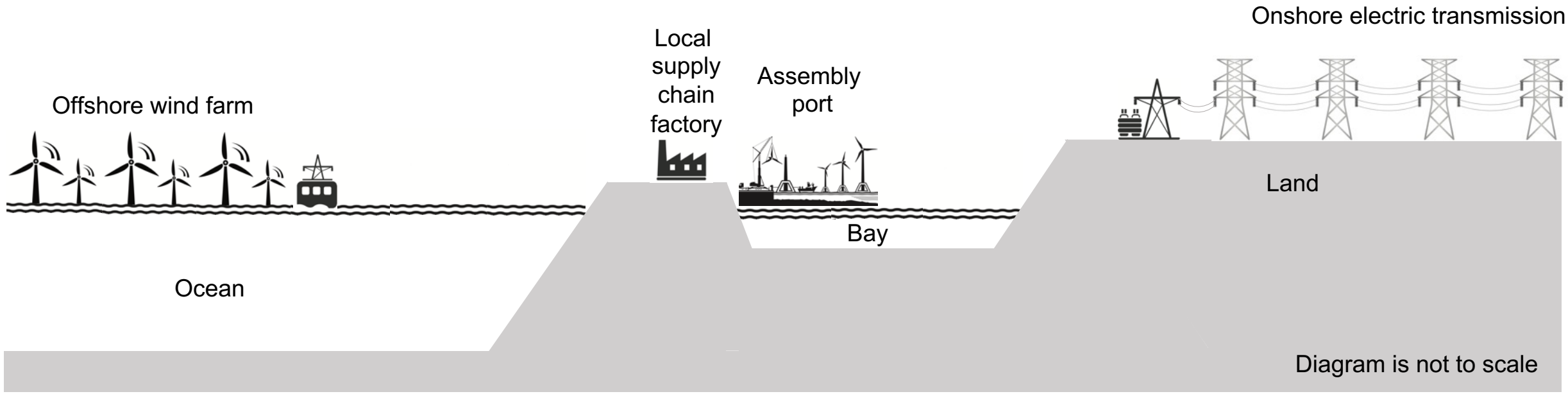

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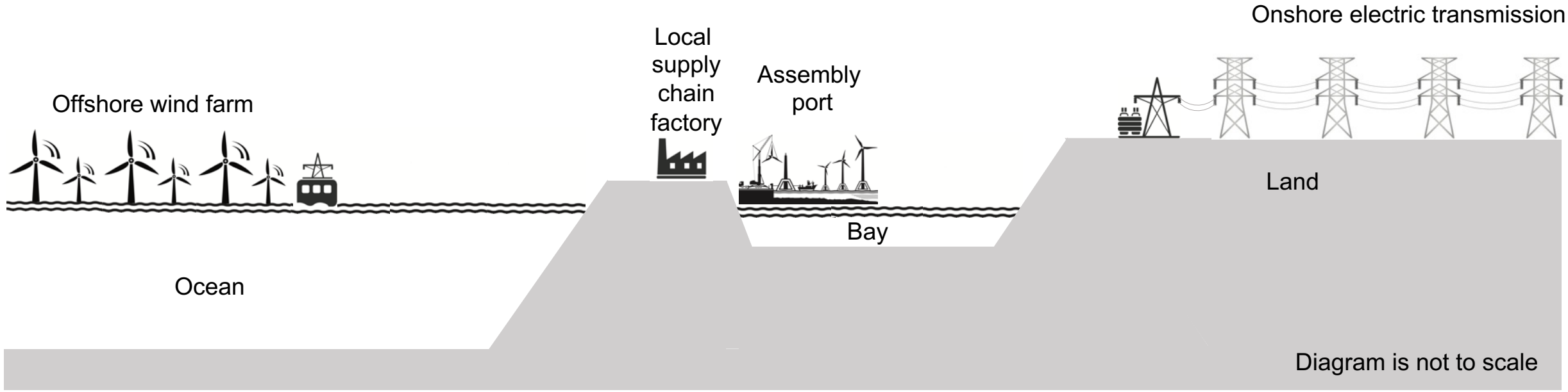
Each of these four types of infrastructure involves its own set of developers and its own regulatory/permitting processes.



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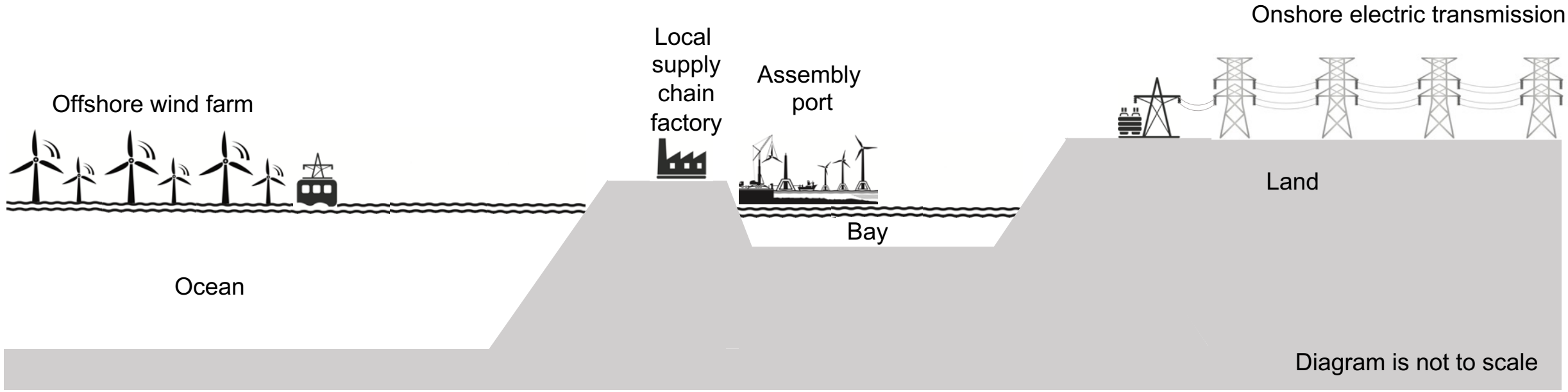
Each infrastructure type requires study to understand issues related to environmental, socio-economic, and cultural resource effects.



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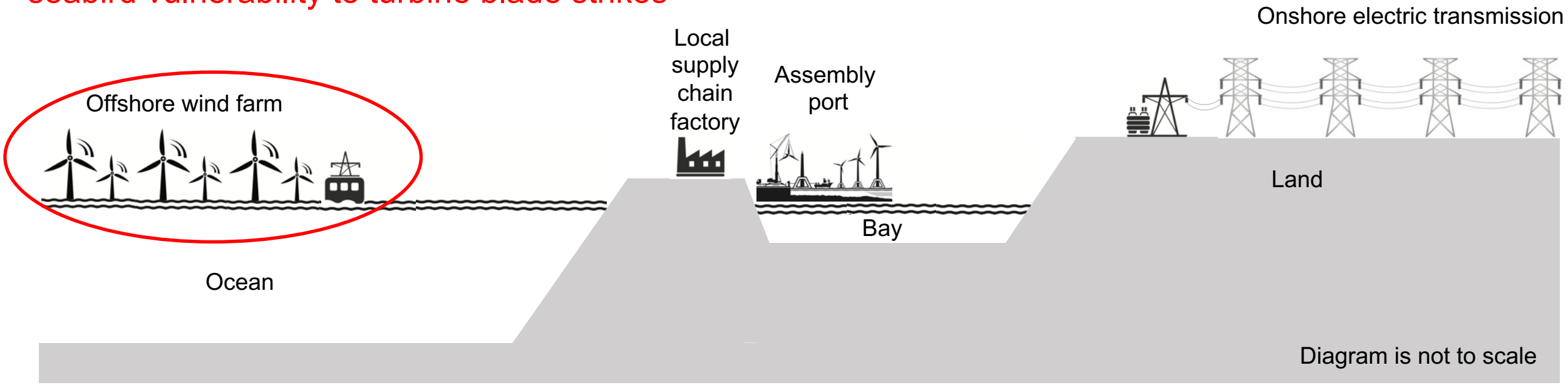
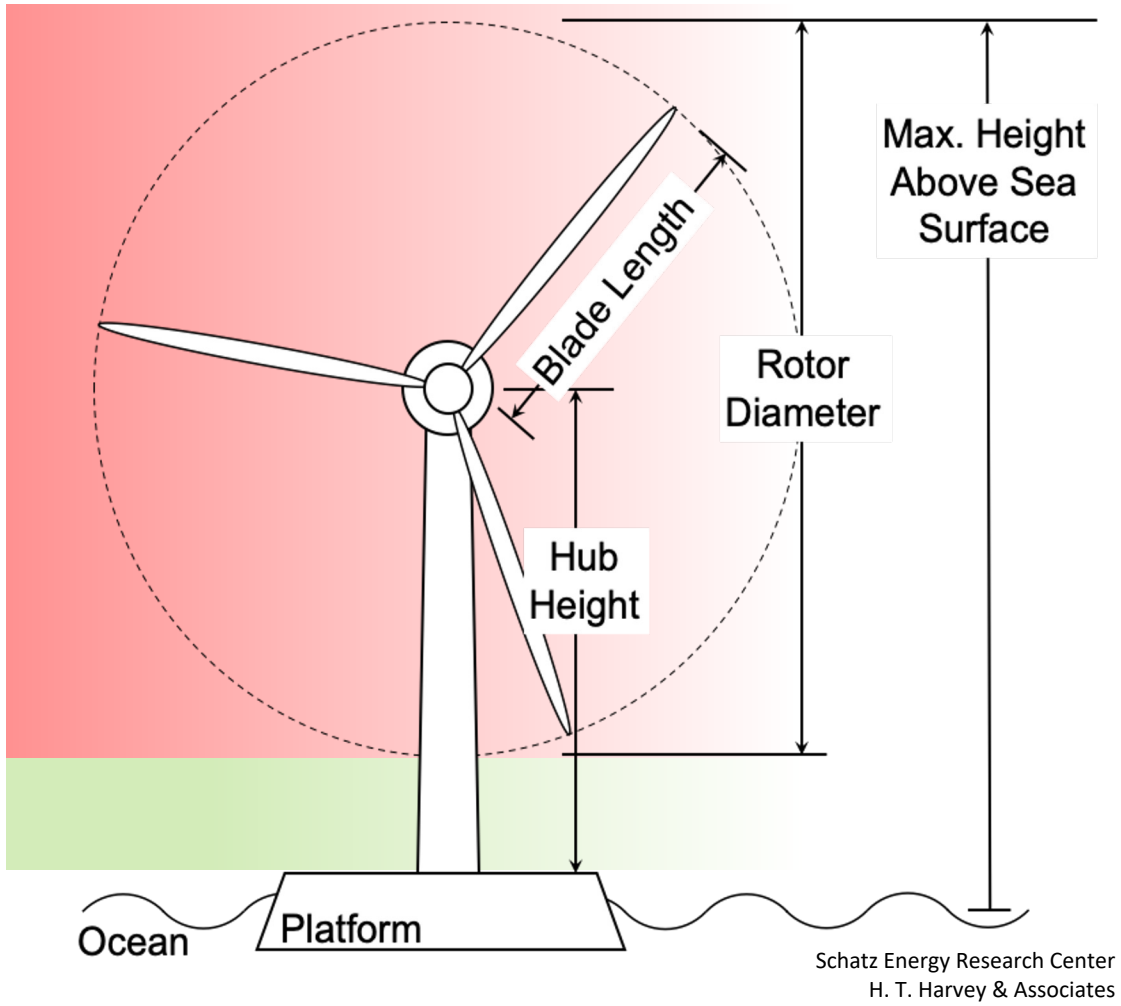
Environmental issue related to wind farms:
seabird vulnerability to turbine blade strikes



Seabird Vulnerability to Wind Turbine Blade Strikes

Example of a study to understand a key environmental dimension of wind farm development:

- Analysis to evaluate seabird vulnerability to turbine blade strikes from offshore wind farms along the California coast by considering seabird presence and flight height as a function of wind speed



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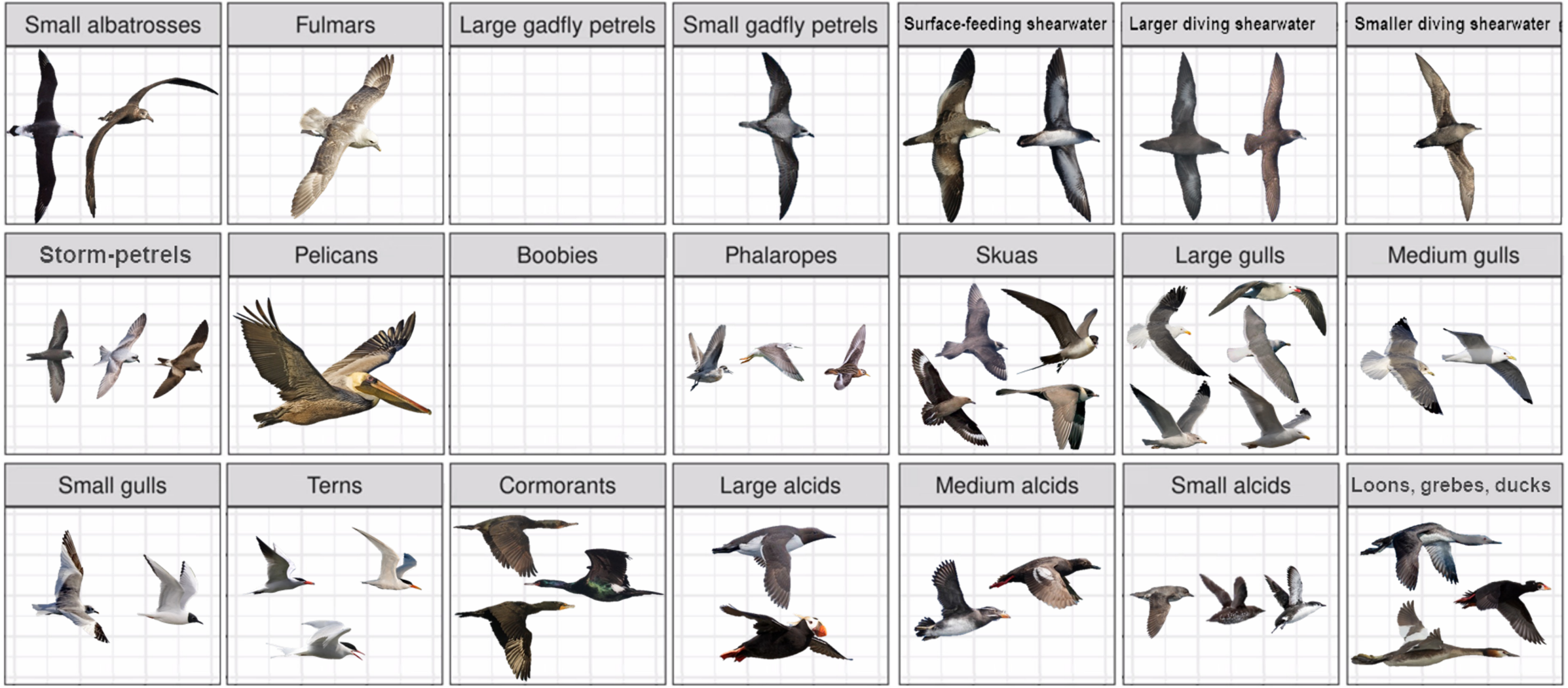
Study Involves 45 Species Present Along California Coast



NOTE: Bird images are not to scale

Seabird Vulnerability to Wind Turbine Blade Strikes

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Some Notes About Seabirds and Offshore Wind

- Seabird communities differ in nearshore versus offshore waters
- Only some seabird species fly high enough to enter the rotor swept zone of wind turbines
- Findings will help identify which seabird species have higher and lower vulnerability and which wind areas are more and less favorable with respect to wind generation potential and seabird vulnerability.

Timeline for Results

- We are in the final stages of the study, and we expect to share results in the next few months

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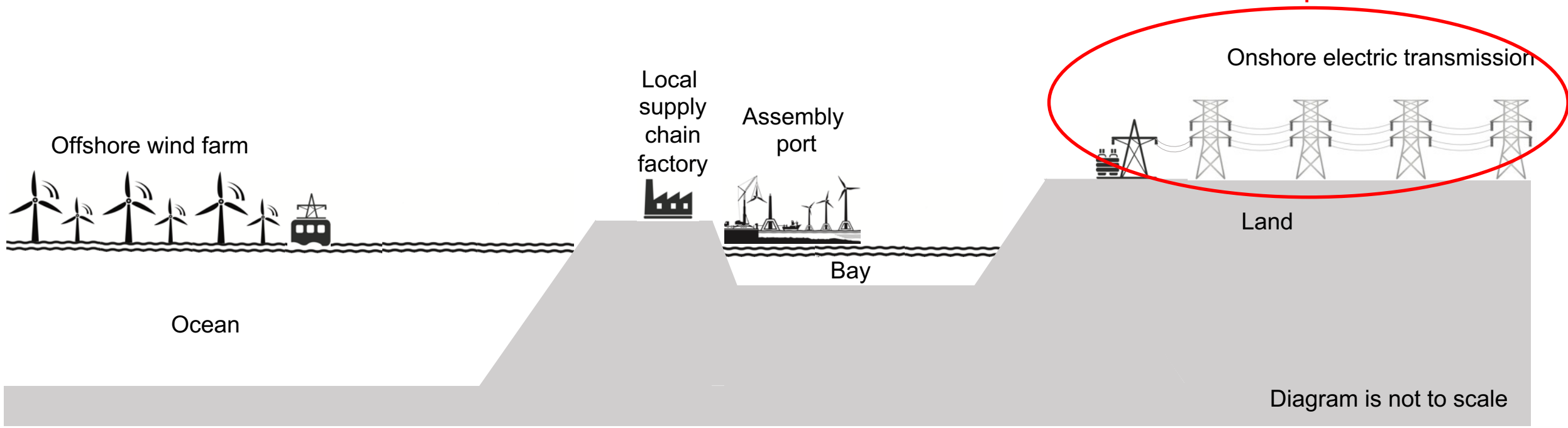
Technical, economic, and community benefits dimensions of transmission development



Transmission Alternatives for OSW in NW CA and SW OR

Project Sponsors and Core Steering Group Members

CALIFORNIA ENERGY COMMISSION

Agreement No. 700-22-002

OREGON DEPARTMENT OF ENERGY

Project Team

Team lead: Arne Jacobson; **Project manager**: Jim Zoellick; **Team members**: Charles Chamberlin, Eli Wallach, Ian Guerrero, Andrew Harris, Greyson Adams, Lorelei Walker*

+ Anton Fund Interns: Claire Ingvoldsen*, Donovan Wakeman*

*Student researchers

Partners

QUANTA TECHNOLOGY

NREL NATIONAL RENEWABLE ENERGY LABORATORY

MOTT MACDONALD

H. T. HARVEY & ASSOCIATES Ecological Consultants

CONAWAY GEOMATICS

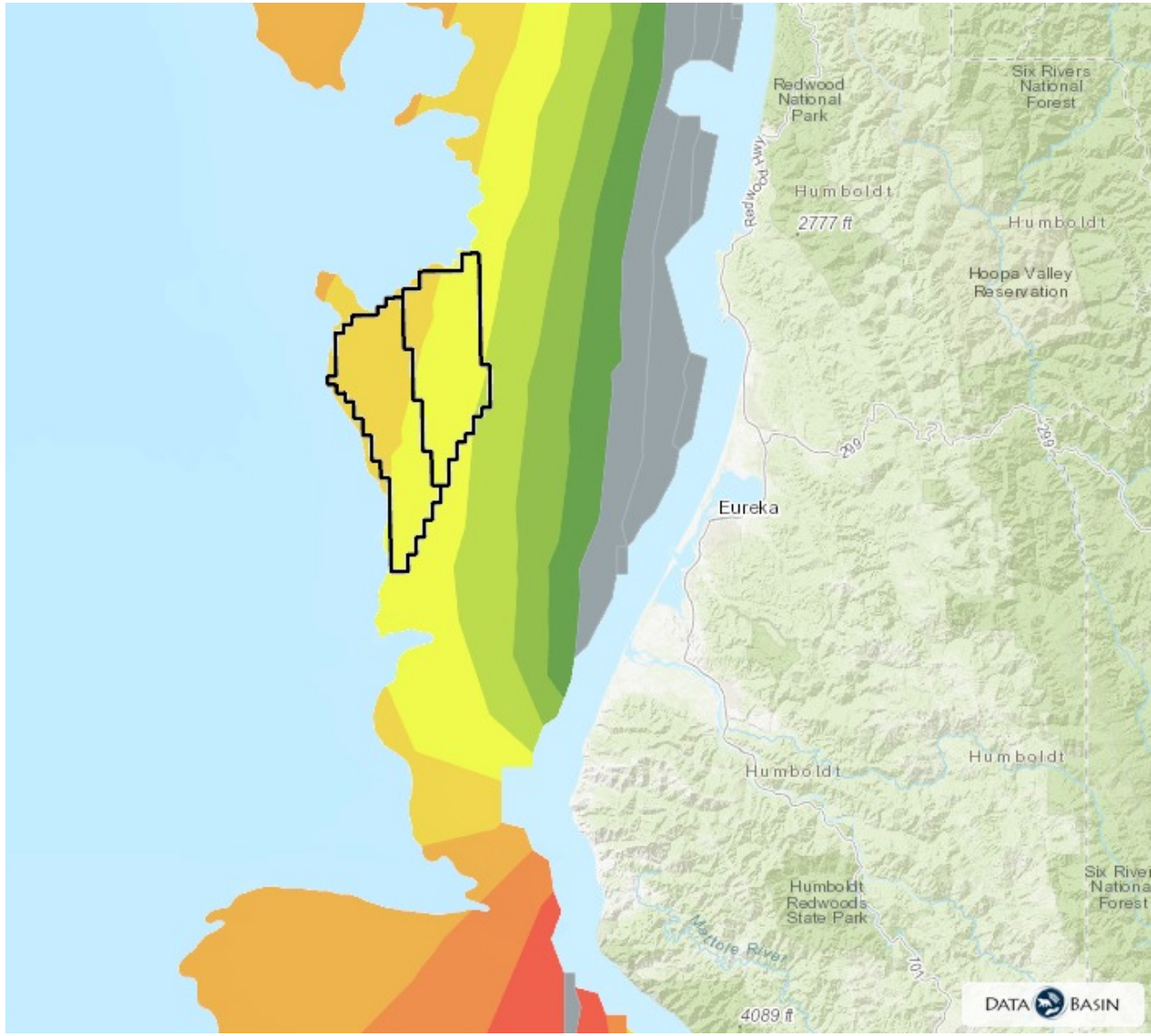
Schatz Center Analysis of Transmission for OSW

Over the past five years, the Schatz Center and partners have engaged in three major studies focused on understanding the transmission infrastructure needs of offshore wind.

Analysis has covered multiple scenarios:

- Large-scale wind farm in Humboldt Wind Energy Area (WEA): 1,836 MW
- Small-scale wind farm in Humboldt WEA: e.g., less than 200 MW
- Large-scale wind farms at multiple sites in NW California and SW Oregon: 7,200 to 25,800 MW

schatzcenter.org/wind
schatzcenter.org/publications



Key points: offshore wind and transmission in NW CA

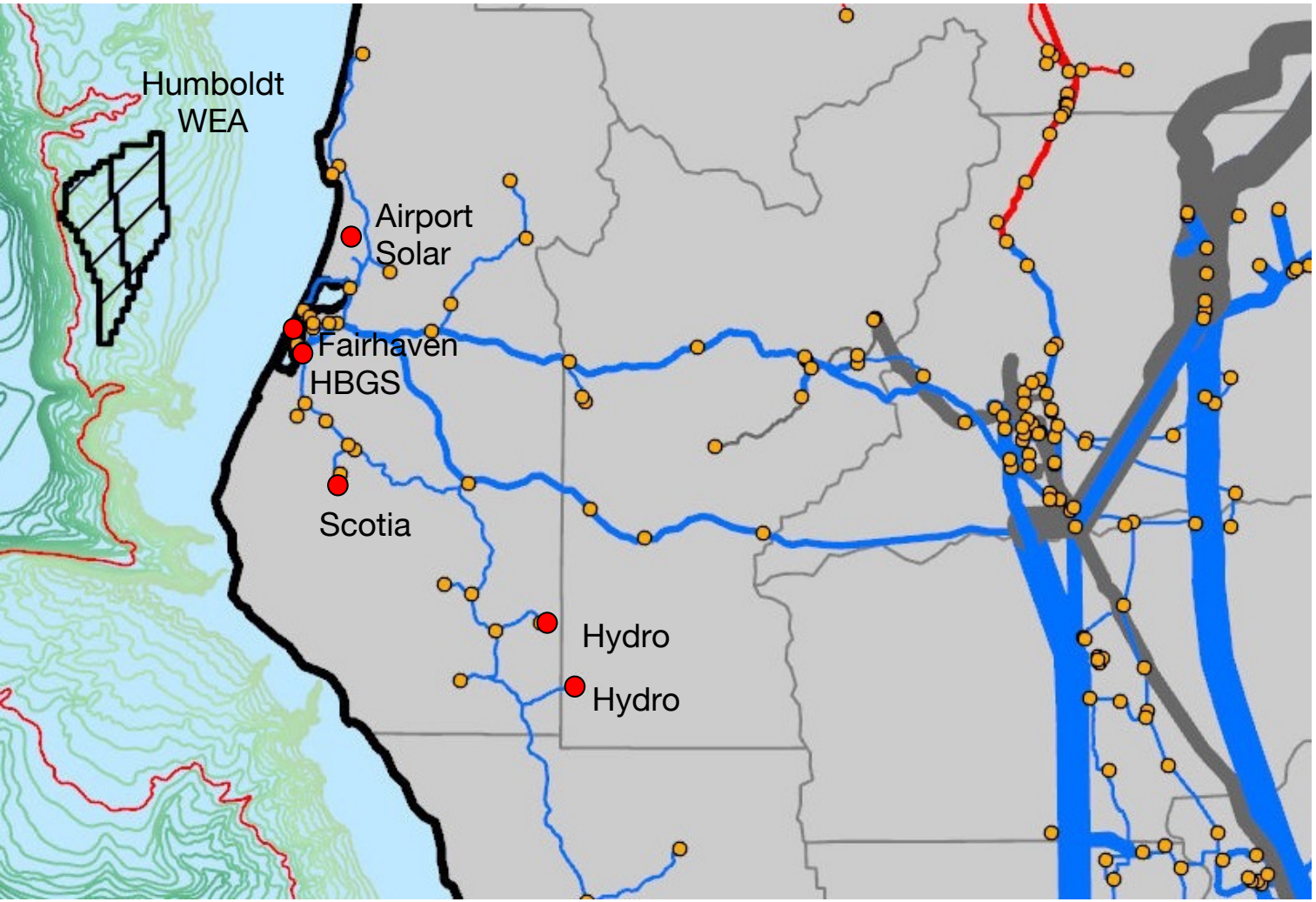
- The winds offshore from NW California are consistently strong, and wind farms in the region could contribute substantially to California's climate and clean energy goals.

Image source: Wikipedia Commons (https://upload.wikimedia.org/wikipedia/commons/7/76/Agucadoura_WindFloat_Prototype.jpg)

Key points: offshore wind and transmission in NW CA

- The winds offshore from NW California are consistently strong, and wind farms in the region could contribute substantially to California's climate and clean energy goals.
- Significant investments in electric transmission infrastructure are a pre-requisite for development of offshore wind (OSW) at scale in NW California.
- Transmission infrastructure to support OSW will involve both offshore and onshore elements. Multiple technologies and routes can be considered.
- Environmental impact, cultural resources, rights-of-way, cost, and other factors must be considered when selecting transmission alternatives.
- Transmission upgrades can enable regional benefits, including better reliability. Technology and route choices affect results.

Humboldt County Electricity System (Circa 2024)



- Humboldt County's electrical system is relatively isolated from the main CA grid.
- The regional load is concentrated in the Humboldt Bay area (avg load ~90 MW).
- Local generation is needed to power the region. The 163-MW natural gas fired Humboldt Bay Generating Station plays this role.
- Major transmission corridors in CA run along the I-5 corridor, linking large generators and load centers.

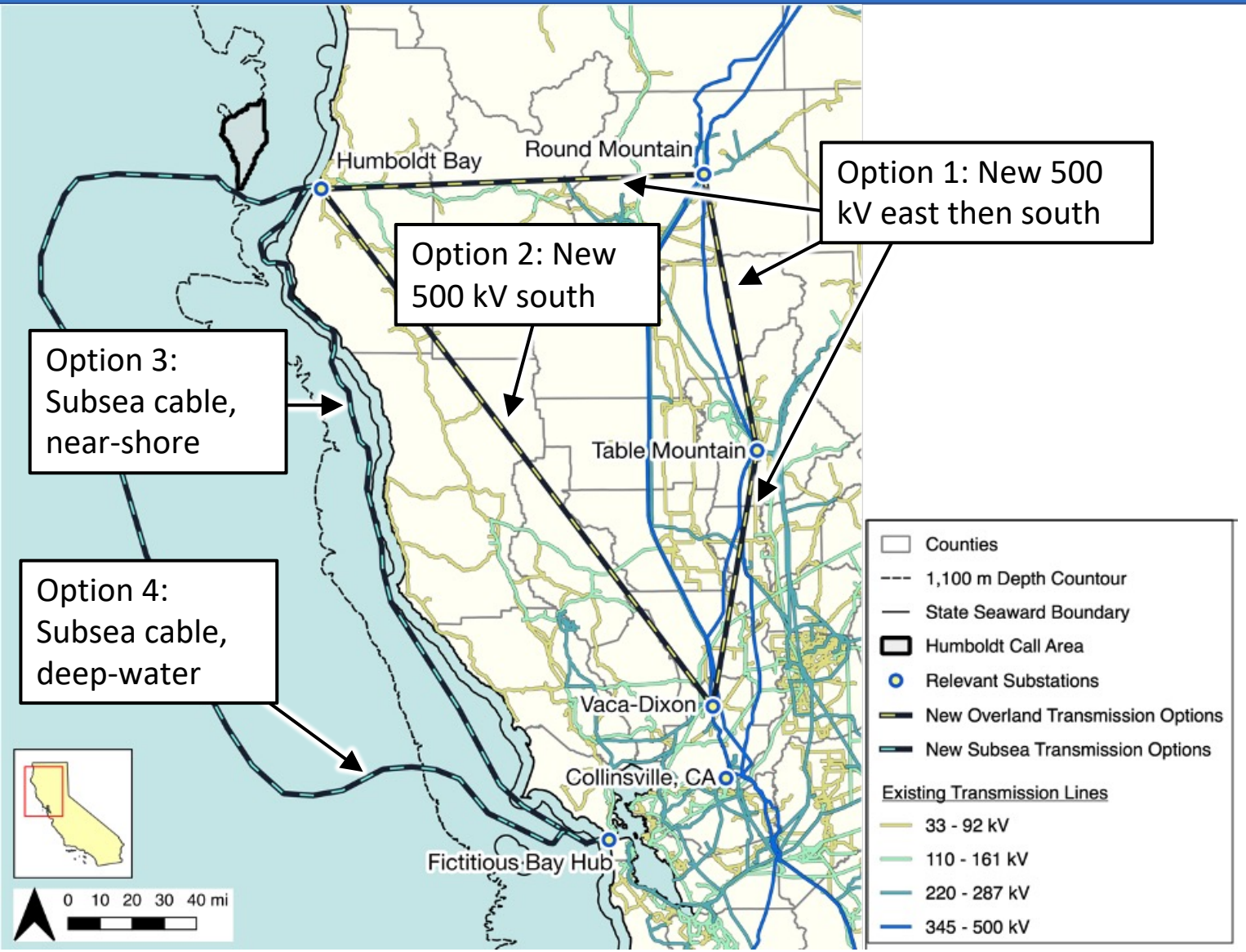
HBGS = Humboldt Bay Generating Station

OSW at scale in the Humboldt WEA will require transmission expansion

- The output of an 1,800 MW wind farm is over 20 times the export capacity of existing lines serving Humboldt County.
- A large-scale expansion of transmission capacity would be needed to deliver OSW to major load centers (estimated cost: $2 to $5 billion, depending on specifics)

115 kV line serving Humboldt County passes under 500 kV lines near Cottonwood, CA

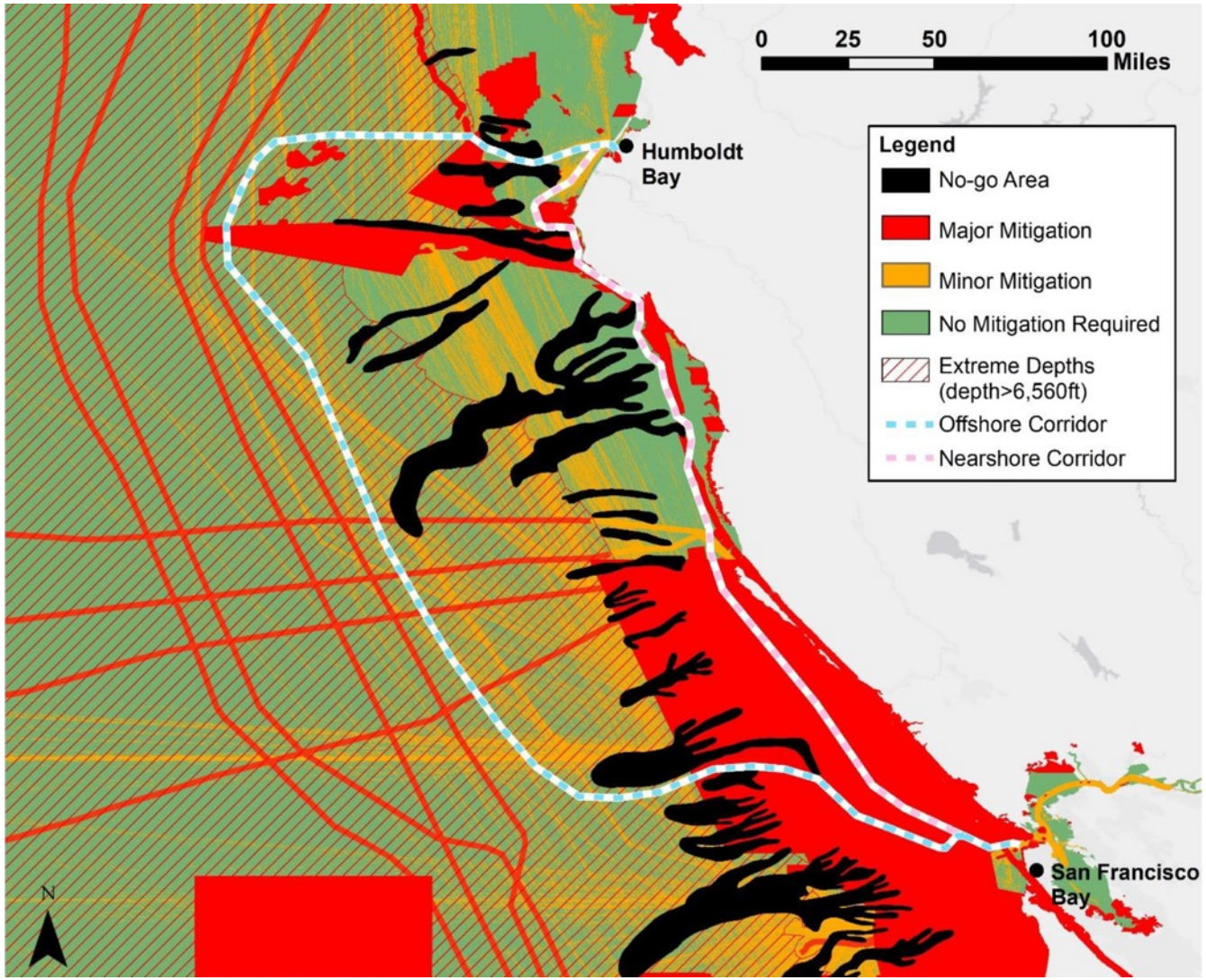
PG&E / Schatz Center Analysis of Transmission Alternatives (1.8 GW)



- Transmission lines to support OSW in the Humboldt WEA could follow overland and/or undersea routes.
- At least two lines are needed to meet redundancy requirements

Source: Severy, et al., 2021: schatzcenter.org/pubs/2020-OSW-R12.pdf

Undersea Cable Corridor Alternatives
(developed by Mott MacDonald)

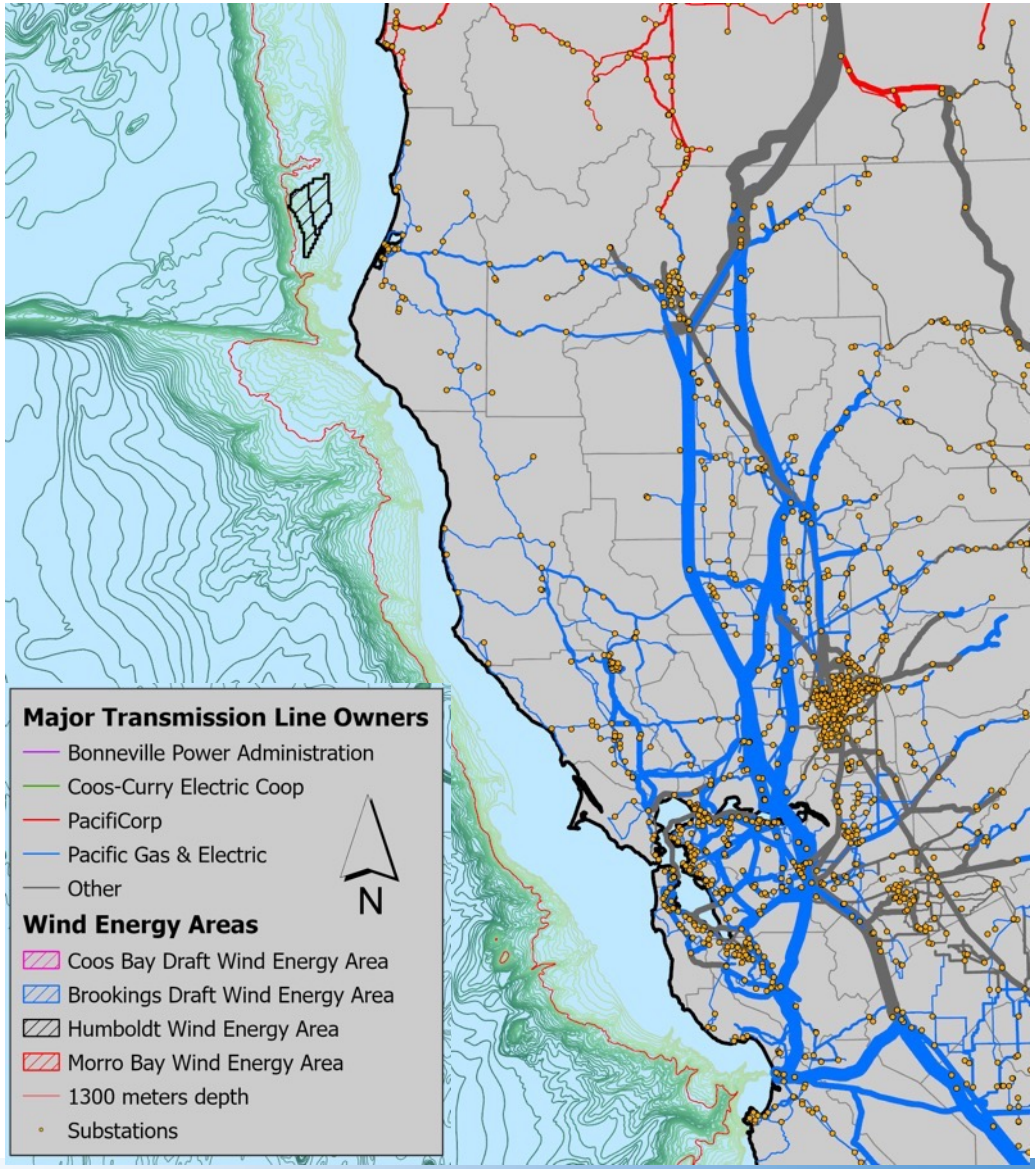


- Undersea transmission routes from Humboldt to the Bay Area may be more challenging due to deep waters, undersea canyons, ecological considerations, and marine protected areas.

See http://schatzcenter.org/pubs/2020-OSW-R5.pdf

Overland Transmission Route Options

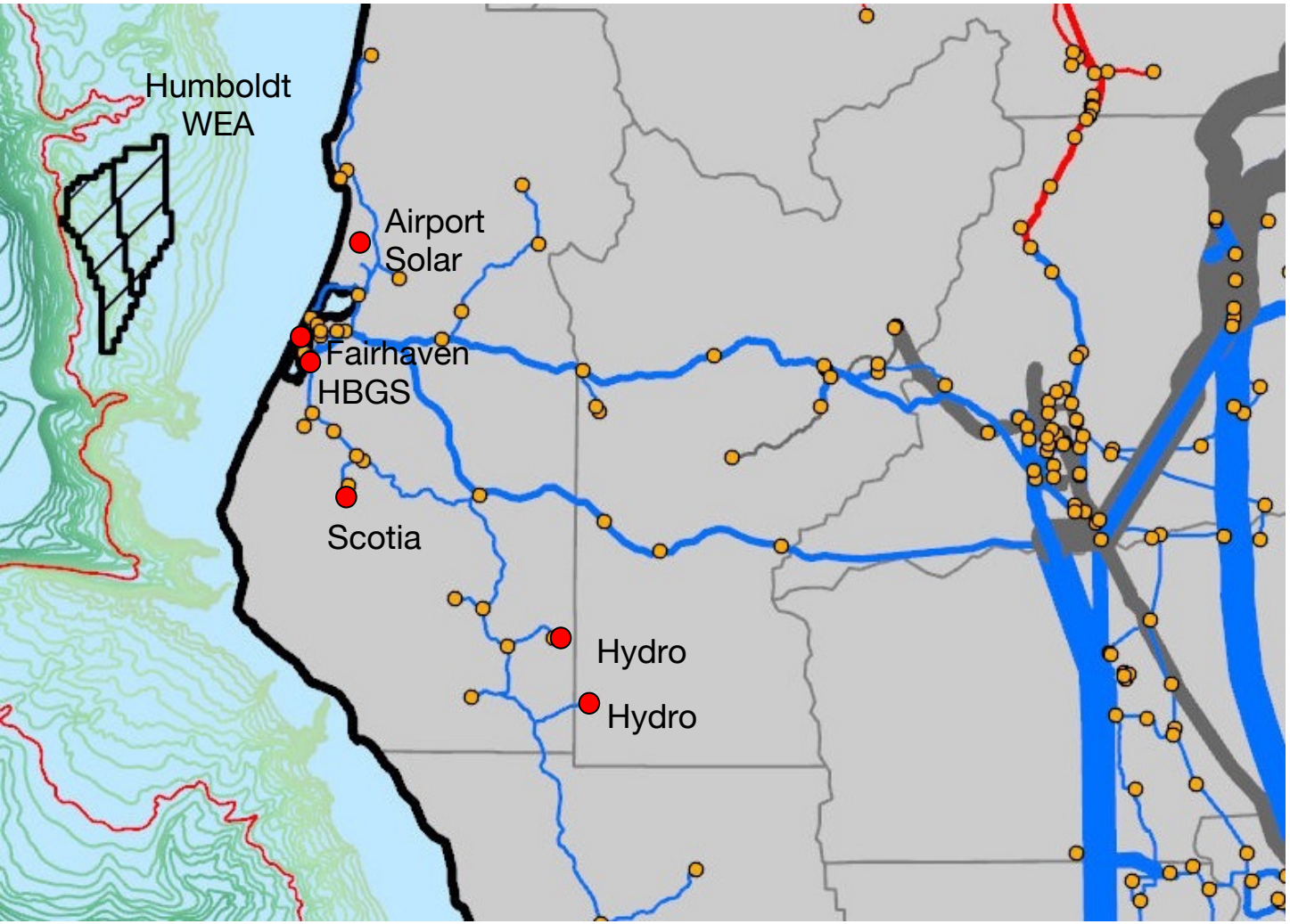
- Specific routes for overland transmission lines have not yet been identified.
- The most likely possibility may be to follow existing transmission line rights-of-way (but these rights-of-way would need to be widened).
- Environmental permitting, land ownership, cultural resources, military-mission compatibility, and cost play key roles in determining eventual routes.
- Large scale transmission projects often take a decade or more, mainly due to route and permitting challenges.



Potential local benefits from transmission to support OSW

- Access to clean energy from offshore wind farms.
- Increased access to transmission capacity, which could allow for regional load growth.
- Improved electricity reliability due to increased transmission capacity and associated redundancy.
- Reduction in local air and water pollution from retirement of combustion-based power plants.
- Regional jobs and economic activity (mostly construction phase).

Regional Benefits Depend on Route and Technology Choices



HBGS = Humboldt Bay Generating Station

- Large-scale transmission lines to Humboldt Bay can increase capacity and improve reliability in that area, assuming a local grid connection (cost to do this is low).
- Communities on radial lines that extend from Humboldt Bay would still be limited by the capacity and reliability of those lines.
- Technology choices (e.g., HVDC vs. HVAC lines) and routes influence geographic distribution of benefits, but a well-designed package can benefit multiple areas.

What are some upcoming studies and activities?

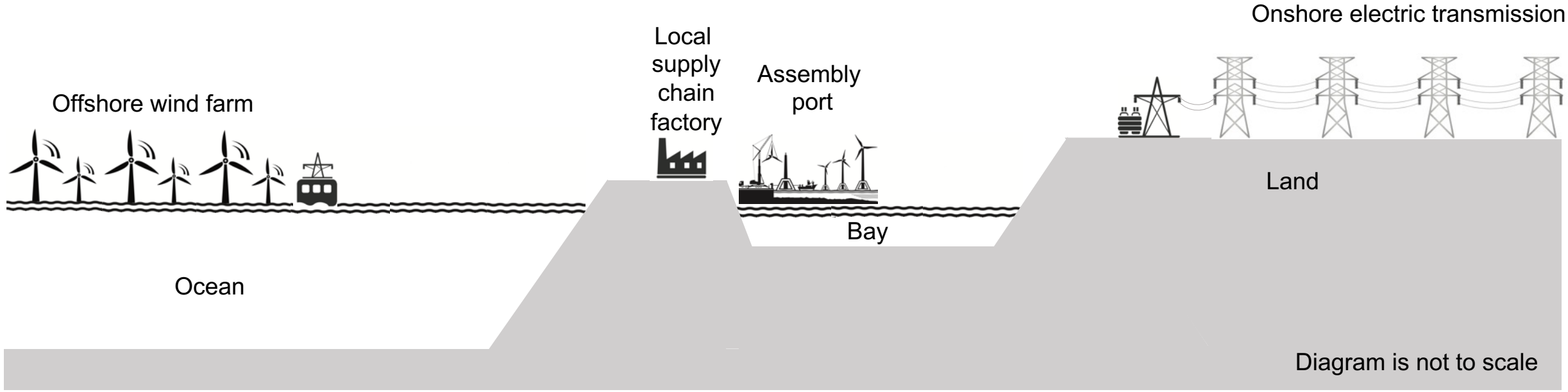
We are at the early stages of several new activities:

- Assessment of the potential to **combine energy storage** (e.g. batteries) with **offshore wind** to improve system economics and provide regional electricity reliability and capacity benefits in NW California.
- Research to develop a system to **detect** when debris (e.g. lost fishing gear) that could be an **entanglement hazard for marine life** gets caught on the mooring lines that hold floating offshore wind systems in place.
- With support from California Sea Grant, we are **hiring** an **economic analyst / offshore wind extension specialist** to support efforts to identify economic and workforce opportunities in NW California.
- In collaboration with the Redwood Region CORE Hub, participating in OSW **knowledge exchange events**.

Scientific Research & Analysis is a Fifth Infrastructure Type

Capacity to engage in scientific analysis, research, and related forms of knowledge generation are a fifth type of infrastructure that is needed to develop a version of offshore wind that addresses environmental concerns, is respectful of indigenous communities and knowledge systems, and provides tangible regional benefits and opportunities on an inclusive basis.

This knowledge generation should be done in a respectful and inclusive manner.
We are interested to collaborate!



Contact Information

Arne Jacobson, Ph.D.
Director, Schatz Energy Research Center
Cal Poly Humboldt
arne.jacobson@humboldt.edu

www.schatzcenter.org/wind

Photo credit: Maia Cheli