Offshore Wind & Transmission Infrastructure in NW CA

American Association of University Women (AAUW) Meeting

Presented by: Arne Jacobson
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Cal Poly Humboldt

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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 state and local 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

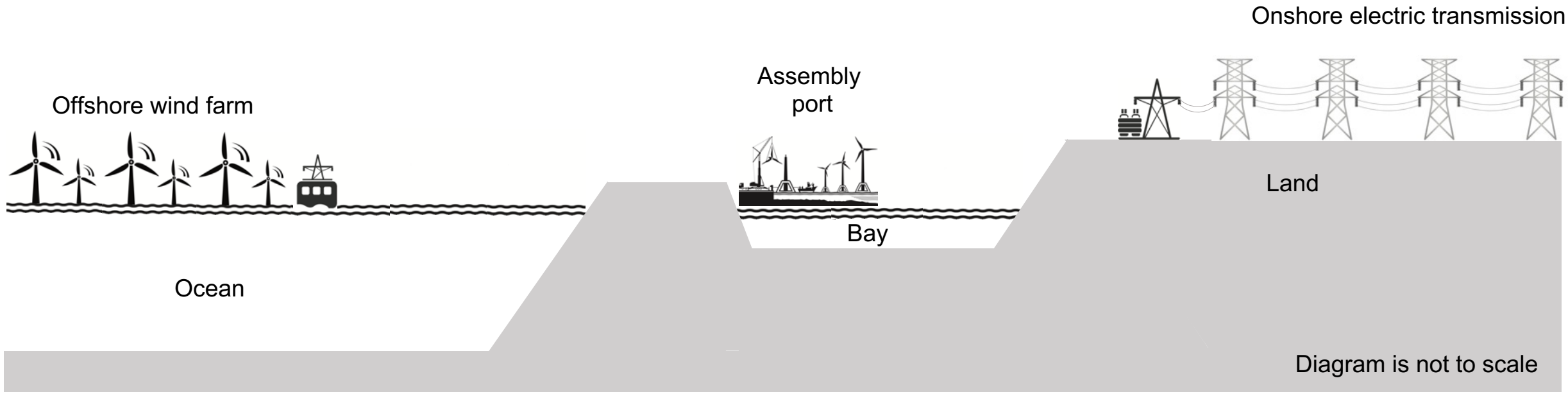
- The winds offshore from NW California are consistently strong, and wind farms in the region could contribute substantially to state and local climate and clean energy goals.
- Significant investments in electric transmission infrastructure are a pre-requisite for development of offshore wind (OSW) at scale in NW California.
- Transmission upgrades can enable regional benefits, including better electricity reliability, but many communities would not benefit without deliberate steps to ensure inclusive outcomes.
- Humboldt County's existing electrical system was established in the post-WWII period, and its geographic extend and capacity have not changed substantially since the mid 1960s.
- Offshore wind provides a generational opportunity for new infrastructure investment.

Offshore Wind Development is Complex and Multifaceted

- Offshore wind development requires multiple types of new infrastructure.
- Transmission is one of four major types of infrastructure that must be developed.

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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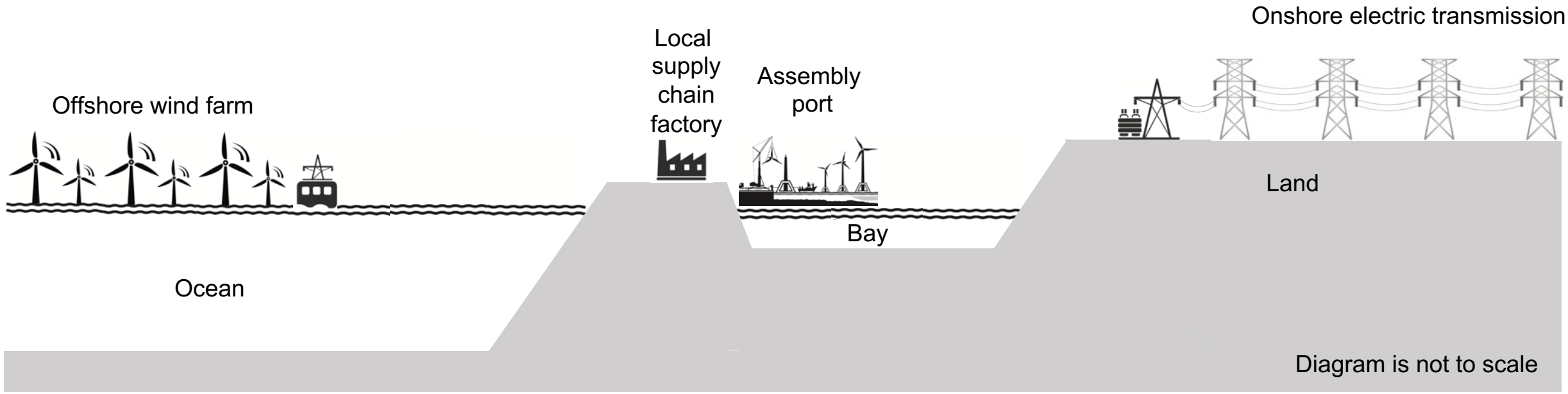

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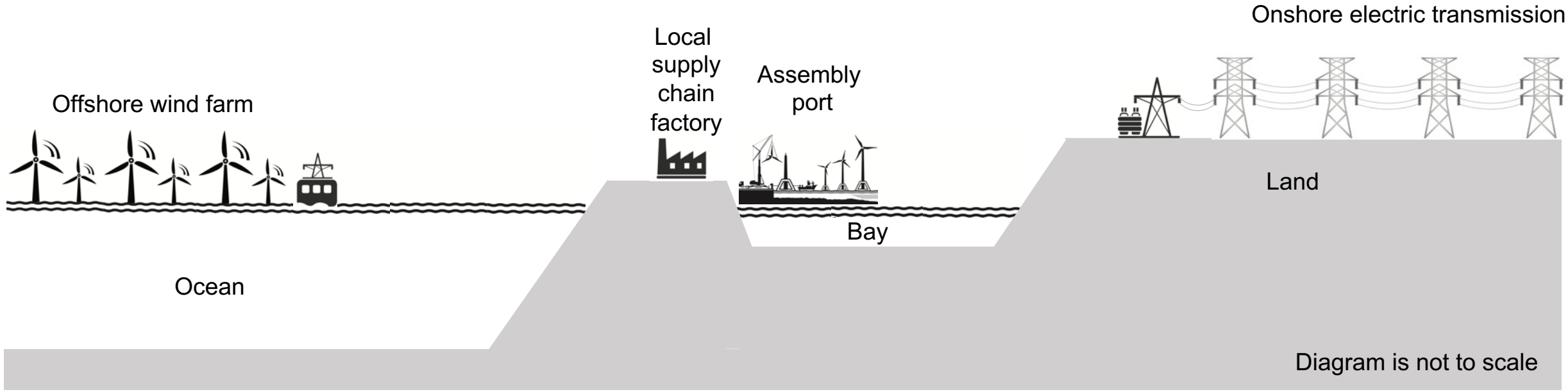
Each of these four types of infrastructure involves its own set of developers and its own regulatory/permitting processes.



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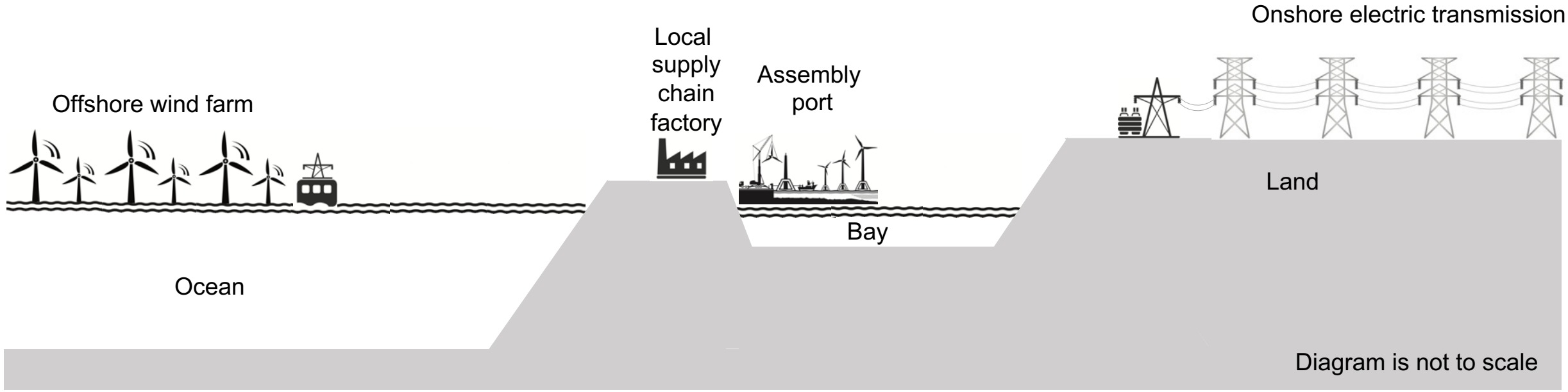
Each infrastructure type requires study to understand issues related to environmental, socio-economic, and cultural resource effects.



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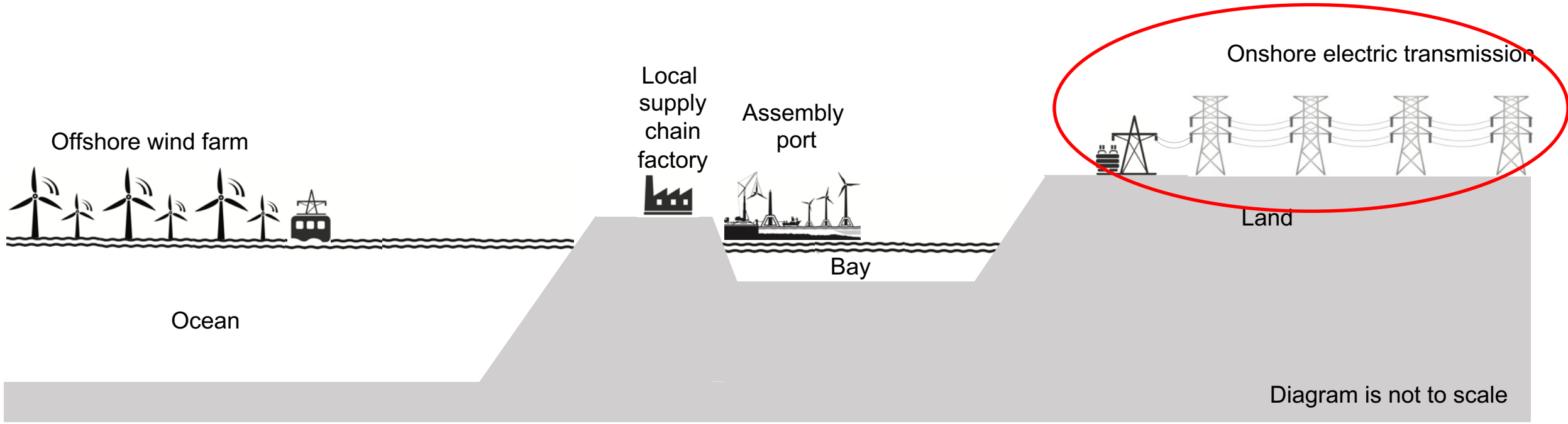
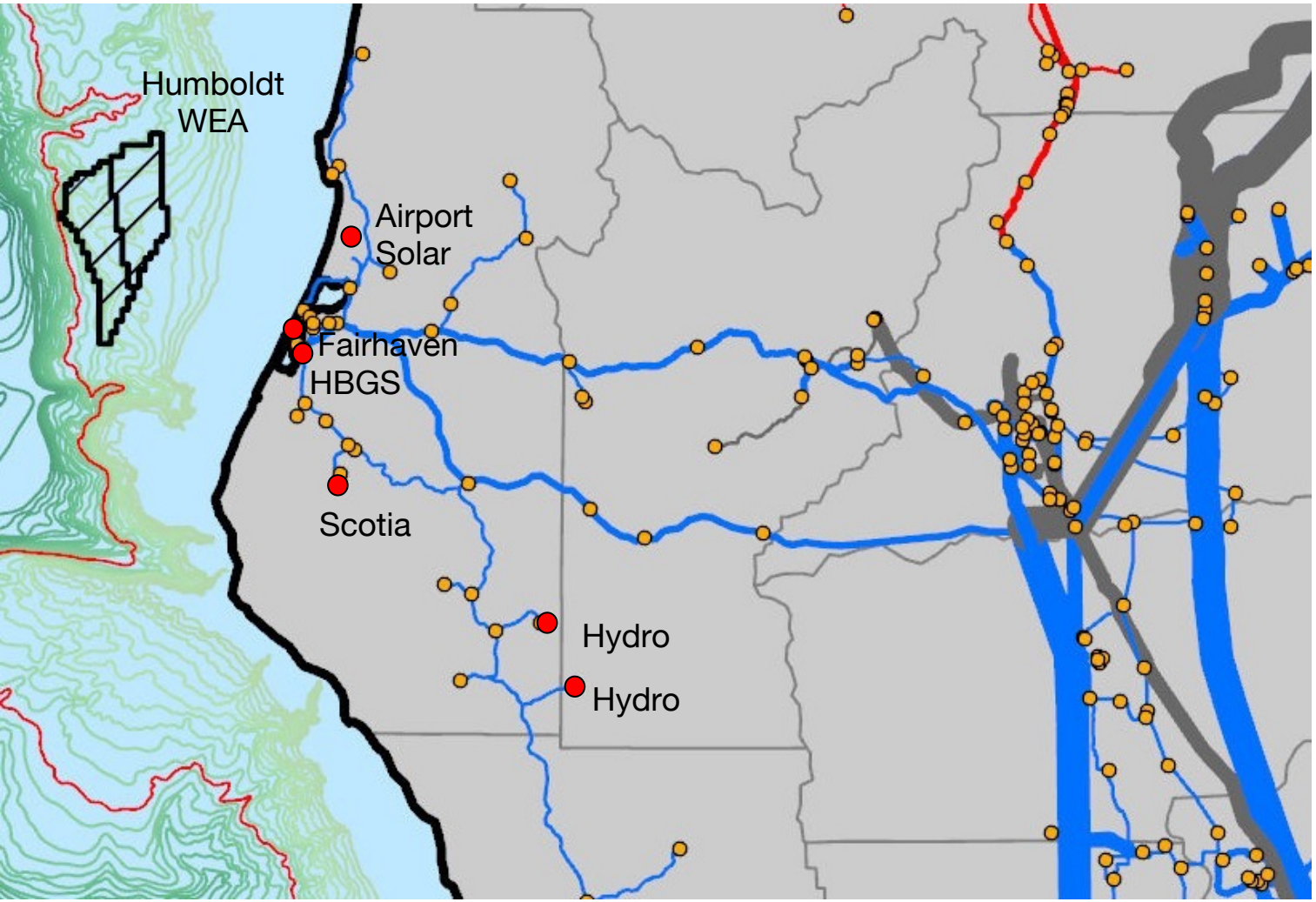


Humboldt County Electricity System (Circa 2024)



- 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

Expansion of Energy Infrastructure After WWII

- PG&E made major investments to expand the electrical and gas infrastructure in the region during the post-WWII period.
- The installed electricity generation capacity serving the region expanded dramatically in the two decades following WWII. As of 2024, the installed capacity was only moderately higher than in 1965.
- The geographic extent and capacity of transmission lines and substations expanded significantly between 1946 and 1965, and it has not changed substantially since then (though there have been upgrades and replacements).
- Natural gas infrastructure also expanded in the 1950s and 60s, with the fossil-fuel based power plants and timber mills being a major consumers of gas.

Maple Creek Substation (2022)

Substation Name	Year Est.
Arcata	1946
Big Lagoon	1954
Blue Lake	1949
Bridgeville	1954
Carlotta	1952
Eel River	1956
Eureka A	1959
Eureka E	1953
Fairhaven	1965
Fort Seward	1948
Fruitland	1952
Garberville	1947
Harris (Eureka)	1960

Est. btw 1945 and 1959

Est. in 1960s

Substation Name	Year Est.
Hoopa	1958
Humboldt (Eureka)	1950
Humboldt Bay	1956
Janes Creek	1957
Maple Creek	c1948
Newburg (Fortuna)	1955
Orick	1952
Rio Dell	1952
Rio Dell Tap	1952
Russ Ranch (Redwood Creek)	1952
Trinidad	Before 1954
Ultra Power (Blue Lake)	1985
Willow Creek	1949

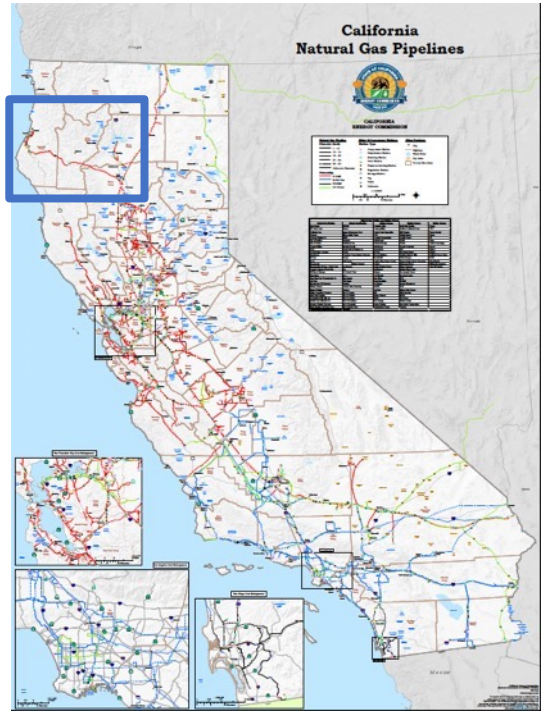
Est. in 1980s

All substations in the table had 60 kV or 110 kV ratings as of the listed dates

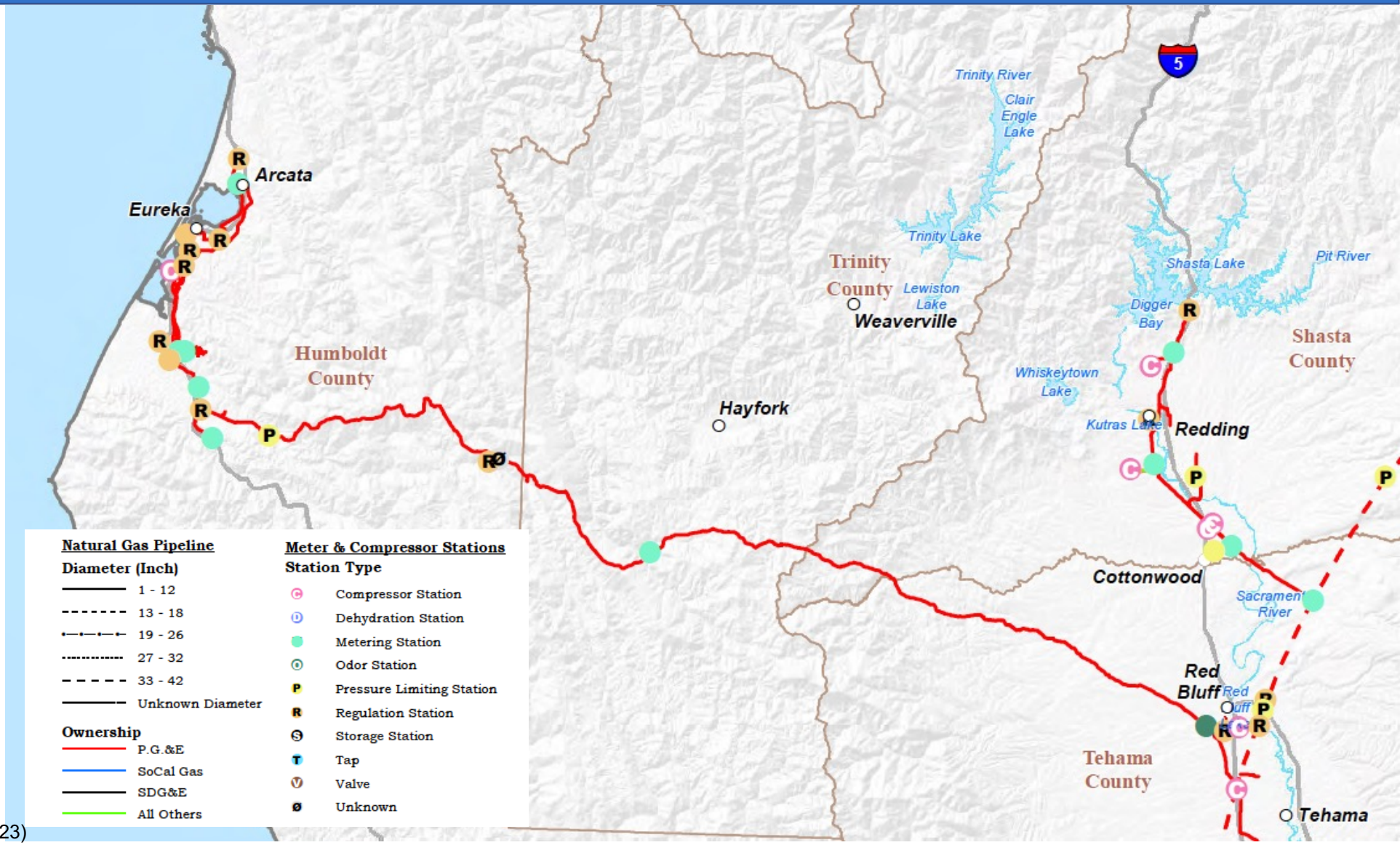
Sources included at end

Humboldt County Natural Gas Infrastructure

- Natural gas pipeline infrastructure serving Humboldt County



Source: California Energy Commission (2023)



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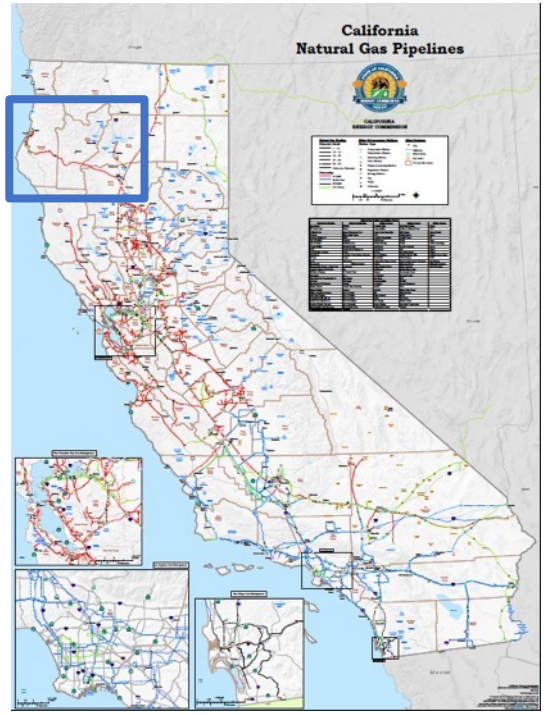
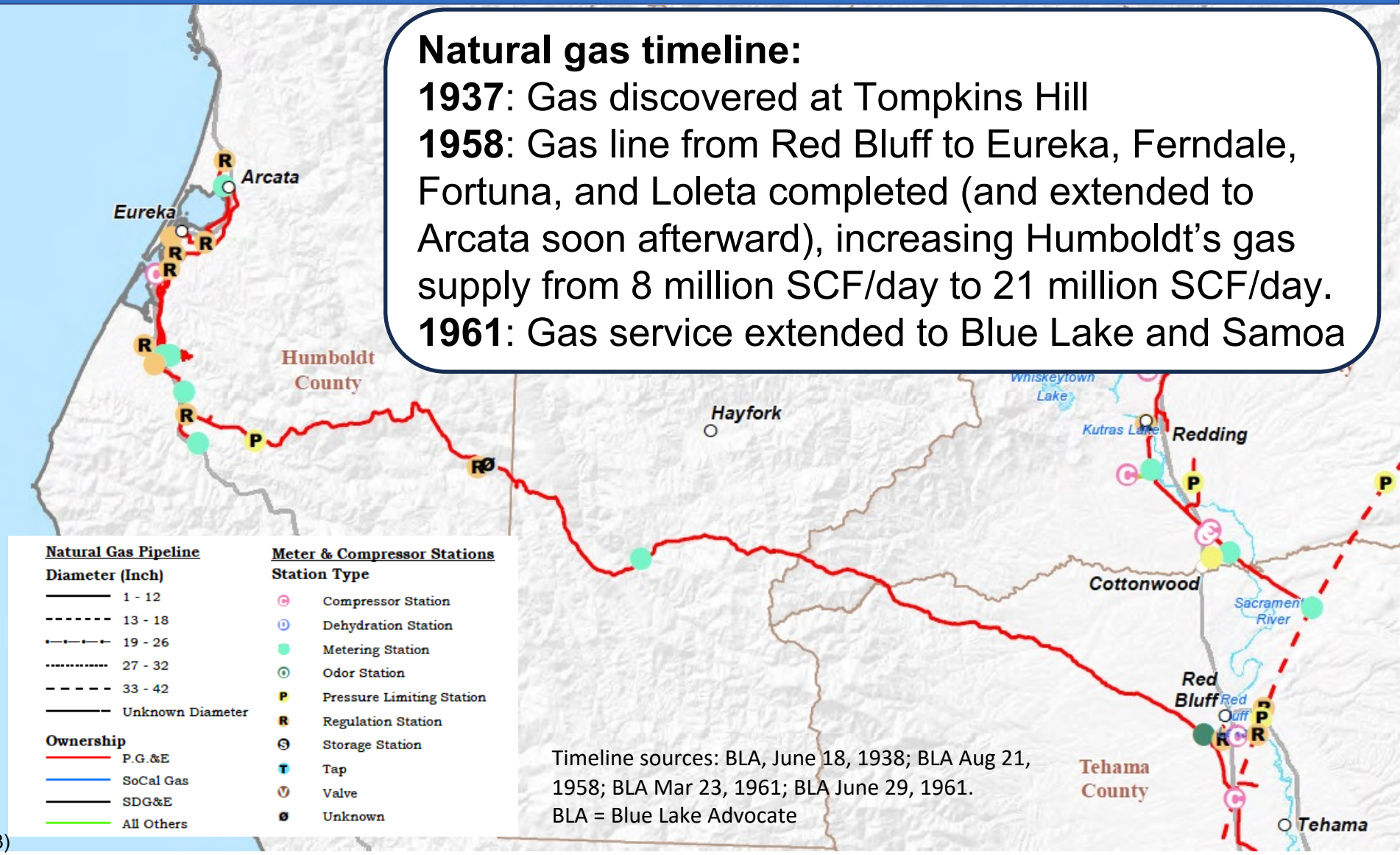


Source: California Energy Commission (2023)

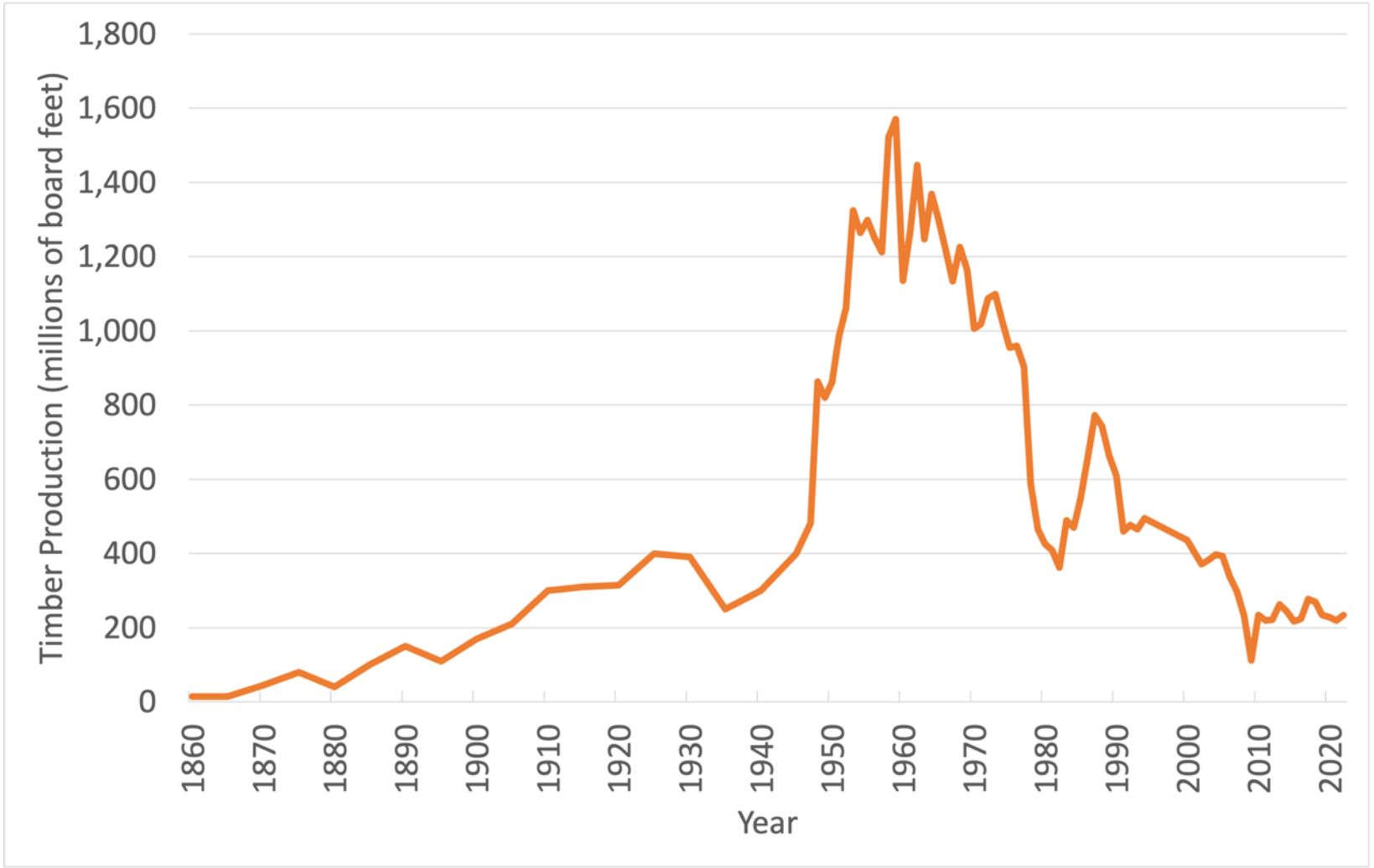
Natural gas timeline:
1937: Gas discovered at Tompkins Hill
1958: Gas line from Red Bluff to Eureka, Ferndale, Fortuna, and Loleta completed (and extended to Arcata soon afterward), increasing Humboldt's gas supply from 8 million SCF/day to 21 million SCF/day.
1961: Gas service extended to Blue Lake and Samoa



Timeline sources: BLA, June 18, 1938; BLA Aug 21, 1958; BLA Mar 23, 1961; BLA June 29, 1961.
BLA = Blue Lake Advocate

Humboldt County Timber Production, 1860-2022

(millions of board feet per year)



Data sources: Vaux, 1955; Waddell and Bassett, 1996; Morgan, et al., 2004; BBER, 2023 (data from 1860 to 1945 are estimated from a graph in Vaux, 1955).

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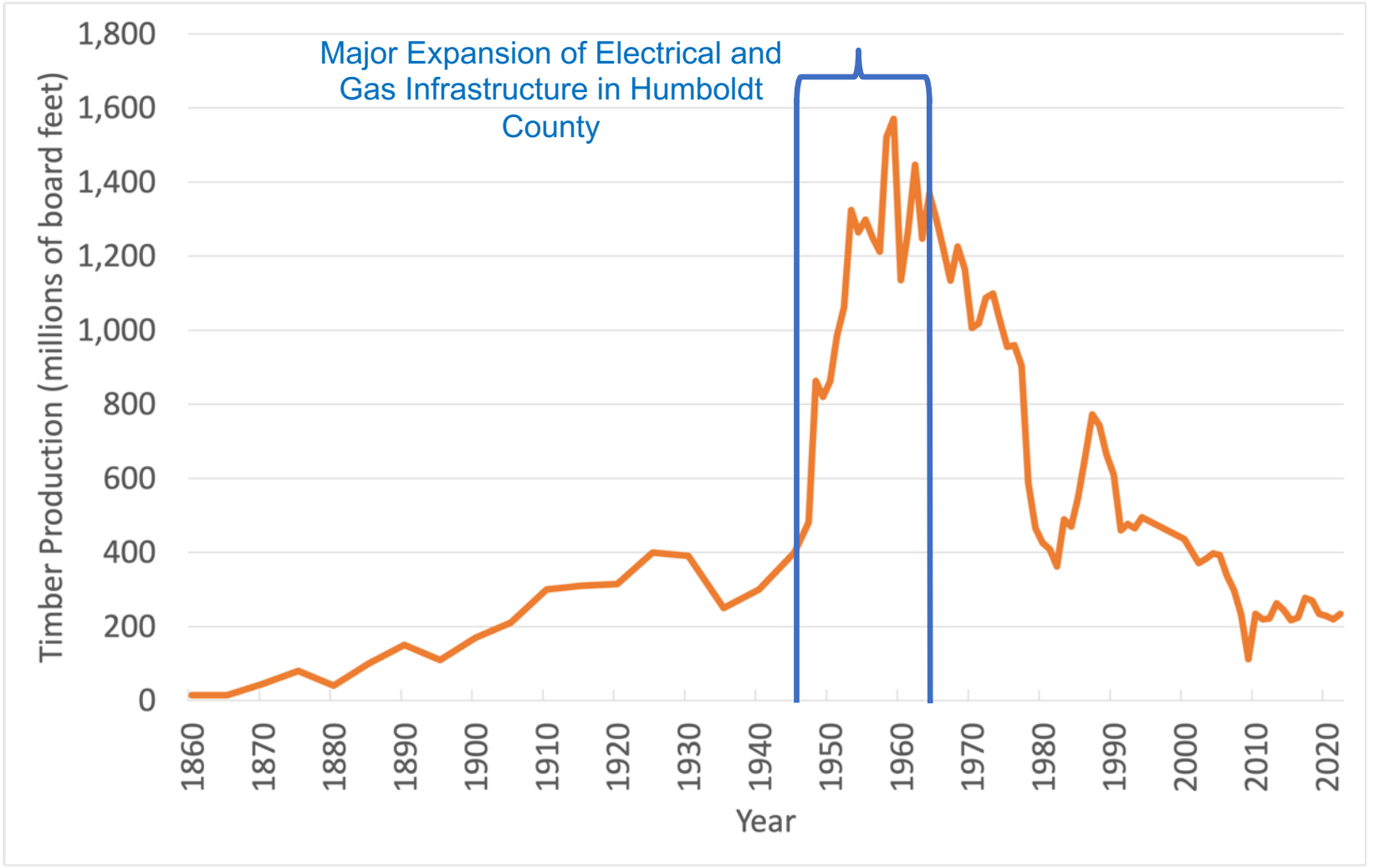


Data sources: Vaux, 1955; Waddell and Bassett, 1996; Morgan, et al., 2004; BBER, 2023 (data from 1860 to 1945 are estimated from a graph in Vaux, 1955).

Implications of Humboldt County's Energy Infrastructure History

- Significant investments in electrical and natural gas infrastructure in Humboldt County occurred during the post-WWII economic boom, a time when the region's timber resources were in high demand to support economic development across California and beyond.
- Investments in new infrastructure since then have been comparatively modest.
- Offshore wind represents a potential opportunity for investment in new infrastructure, including investments that can bring benefits (reliability, capacity, jobs) to the region.

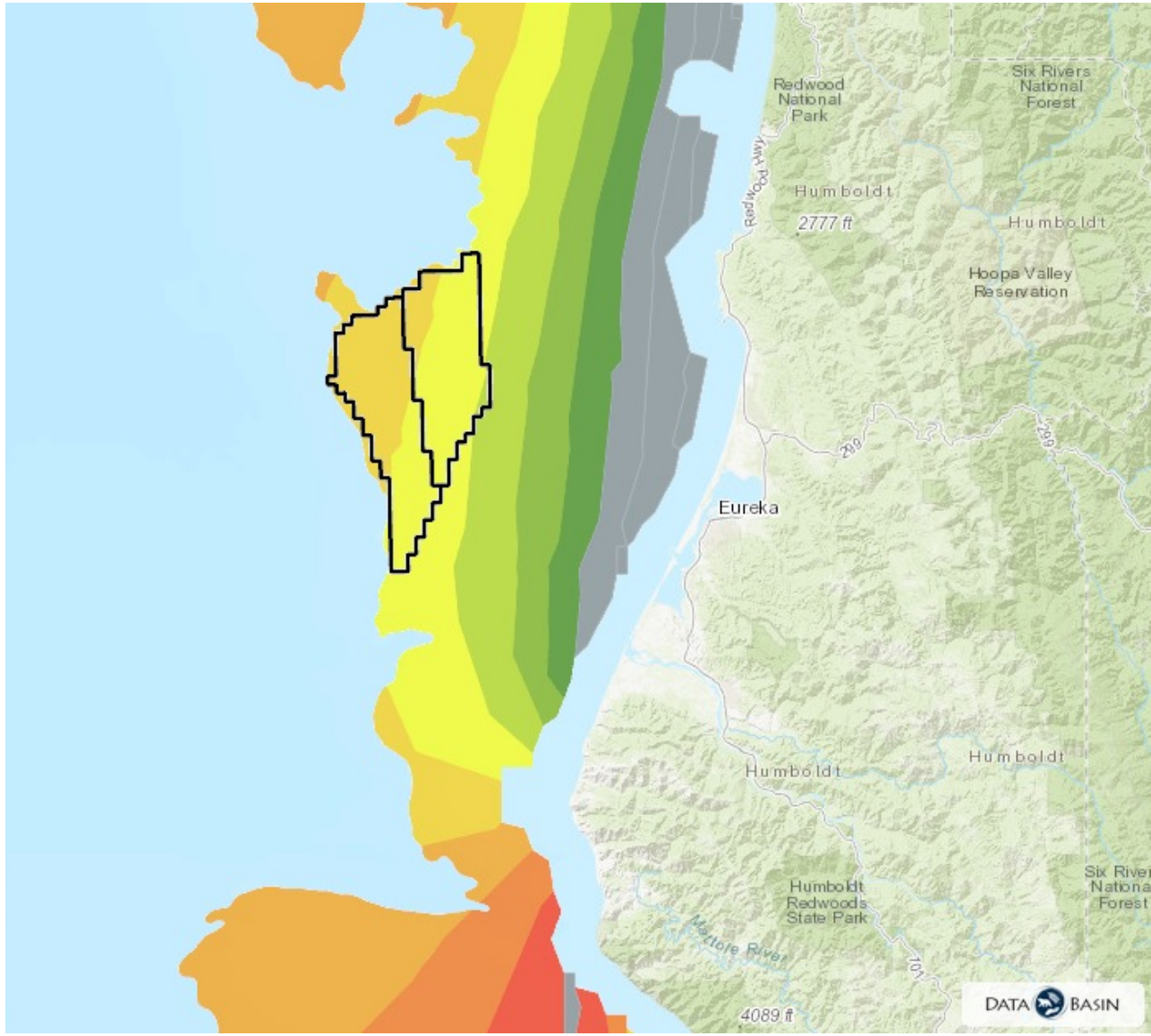
Schatz Center Analysis of Transmission for OSW

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

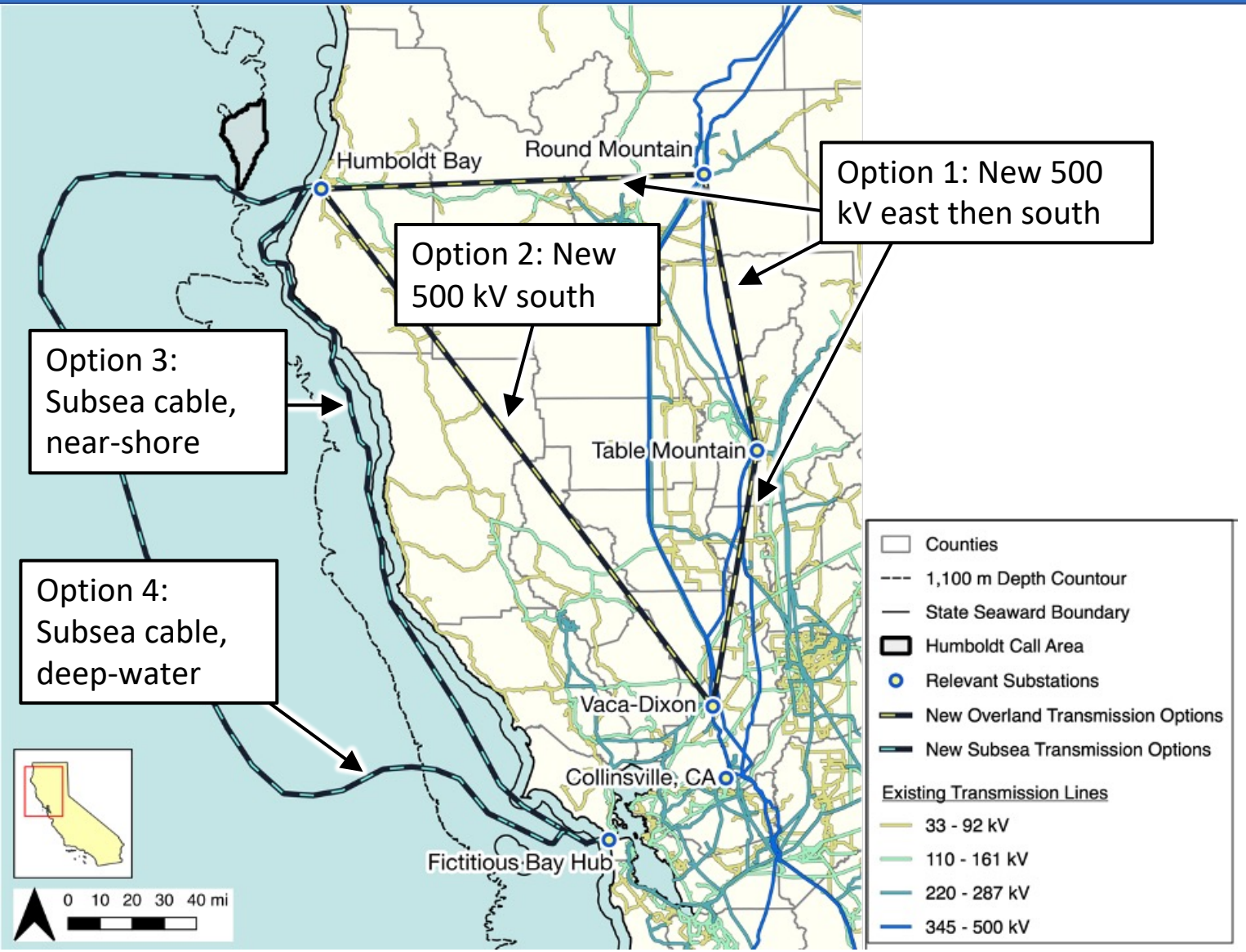


OSW at scale in the Humboldt WEA will require transmission expansion

- 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

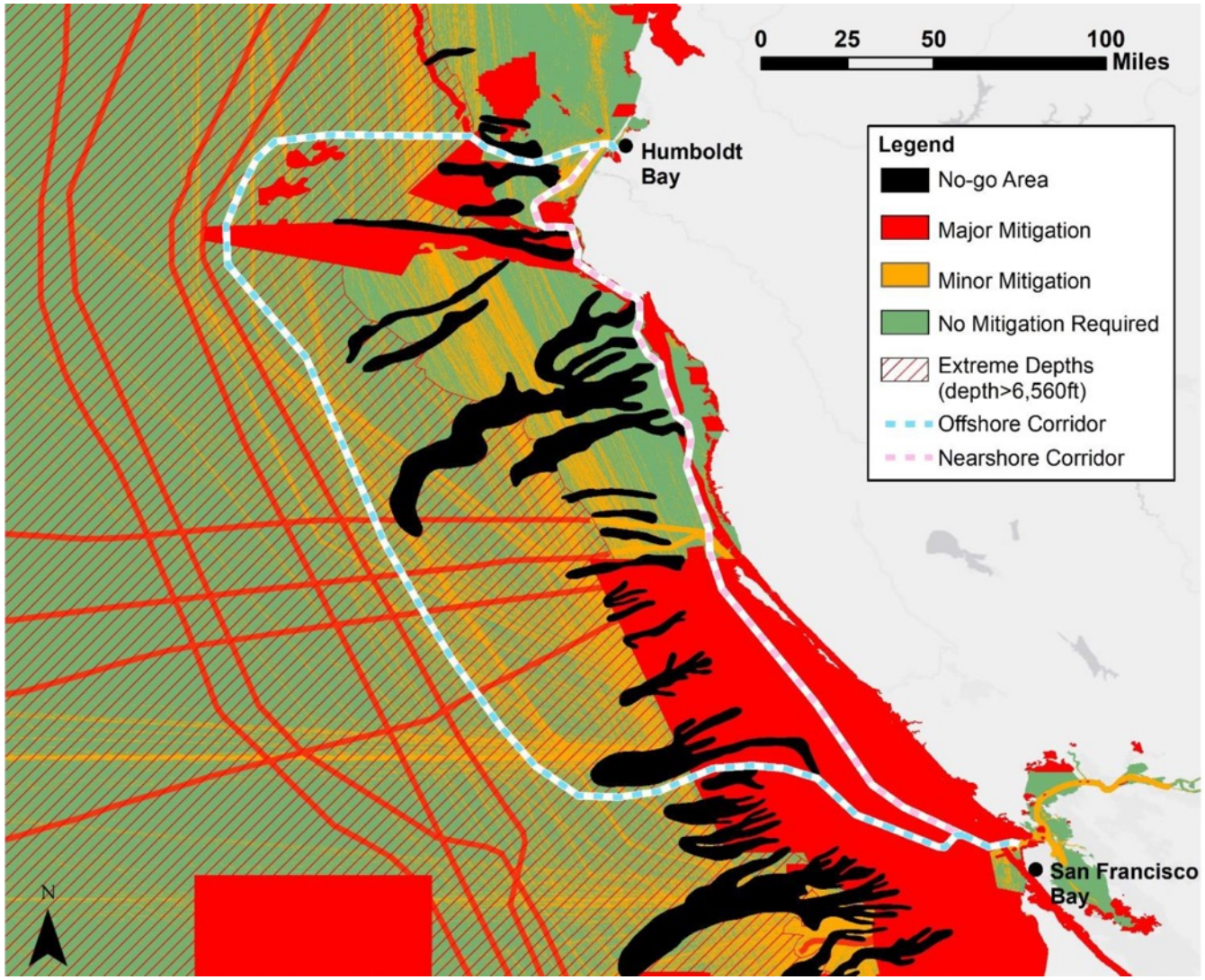
PG&E / Schatz Center Analysis of Transmission Alternatives (1.8 GW)



- 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)

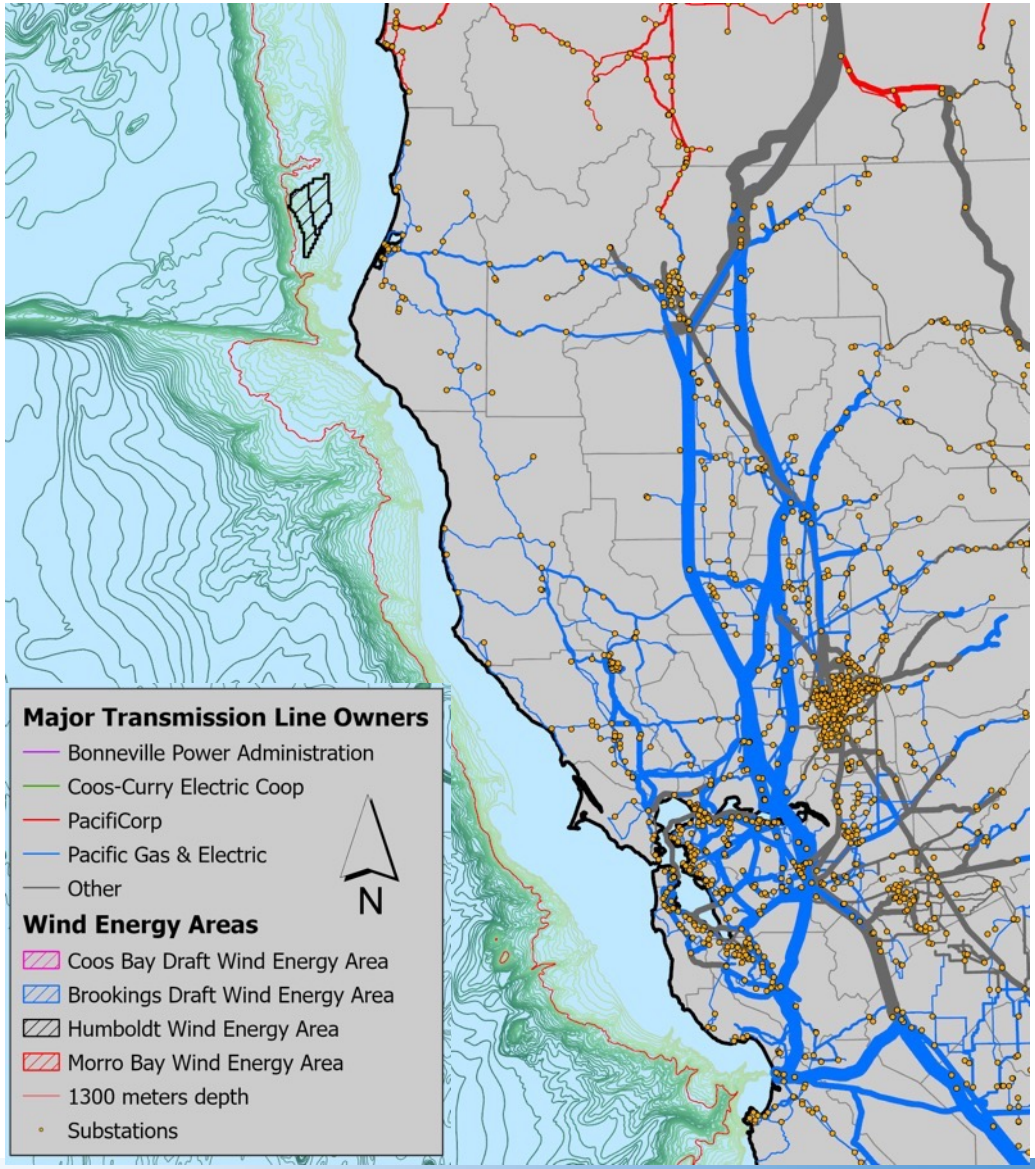


- Undersea transmission routes from Humboldt to the Bay Area may be more challenging due to deep waters, undersea canyons, ecological considerations, and marine protected areas.

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

Overland Transmission Route Options

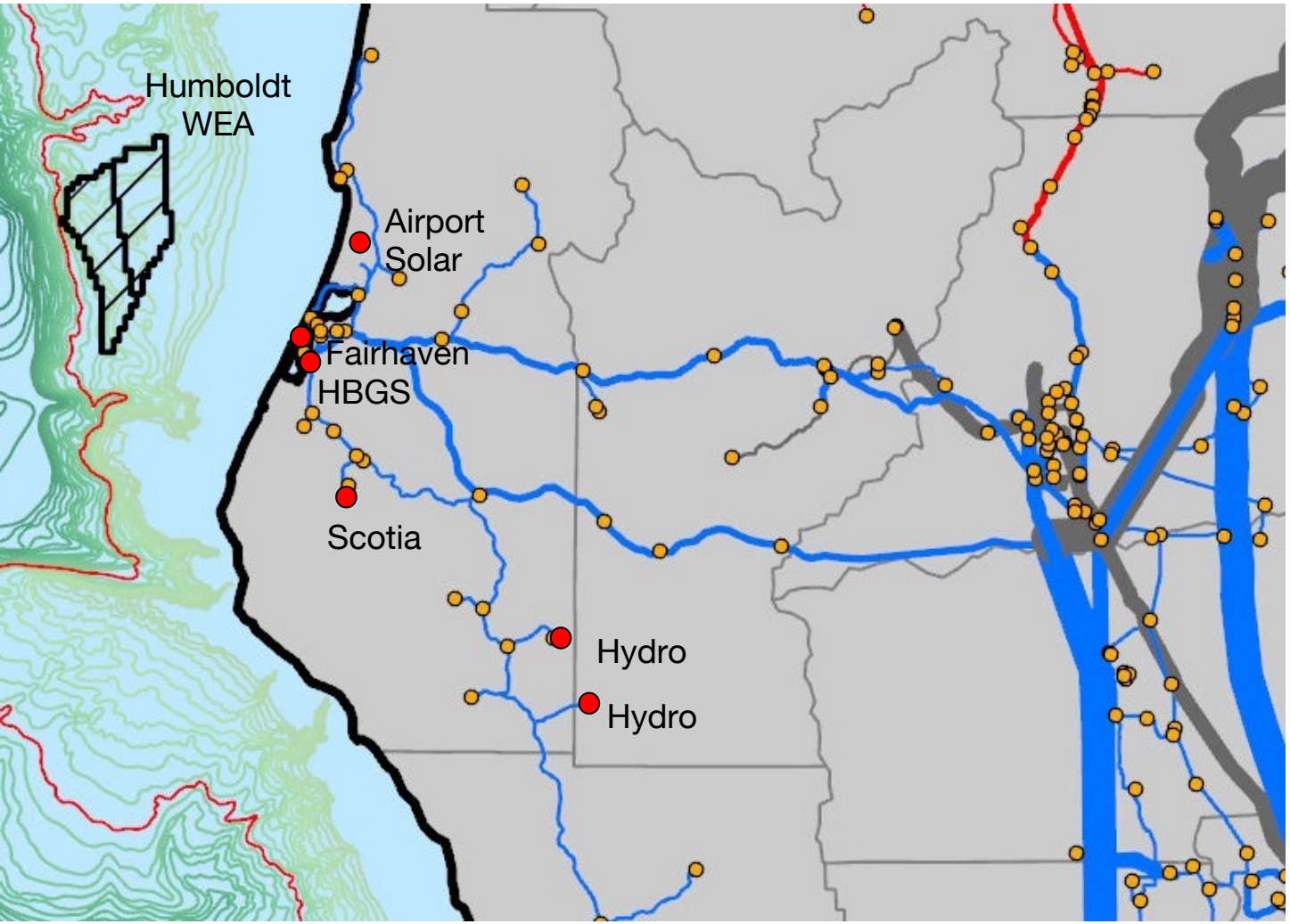
- Specific routes for overland transmission lines have not yet been identified.
- The most likely possibility may be to follow existing transmission line rights-of-way (but these rights-of-way would need to be widened).
- Environmental permitting, land ownership, cultural resources, military-mission 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 and routes influence geographic distribution of benefits, but a well-designed package can benefit multiple areas.

Contact Information

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www.schatzcenter.org/wind

Photo credit: Maia Cheli

Substation timeline sources

Substation Name	Year Est.	Source
Arcata	1946	BLA, 7/27/1946
Big Lagoon	1954	BLA, 12/2/1954
Blue Lake	1949	BLA, 5/7/1949
Bridgeville	1954	BLA, 10/28/1954
Carlotta	1952	BLA, 12/31/1952
Eel River	1956	TS, 7/11/1956
Eureka A	1959	TS, 12/18/1959
Eureka E	1953	TS, 8/6/1953
Fairhaven	1965	BLA, 10/21/1965
Fort Seward*	1948	BLA, 7/31/1948
Fruitland	1952	BLA, 12/31/1952
Garberville	1947	ST, 12/19/47
Harris (Eureka)	1960	TS, 11/10/1960
Hoopa	1958	BLA, 9/18/1958
Humboldt (Eureka)	1950	TS, 8/6/1953
Humboldt Bay	1956	BLA, 10/18/1956
Janes Creek	1957	BLA, 9/12/1957
Maple Creek	c1948	BLA, 7/31/1948
Newburg (Fortuna)	1955	TS, 8/18/1955
Orick	1952	BLA, 3/27/1952
Rio Dell	1952	BLA, 12/31/1952
Rio Dell Tap*	1952	BLA, 12/31/1952
Russ Ranch (Redwood Creek)	1952	BLA, 12/31/1952
Trinidad*	Before 1954	BLA, 12/2/1954
Ultra Power (Blue Lake)	1985	LCT, 1984 and Zoellick, 2005
Willow Creek	1949	BLA, 7/9/1949

BLA = Blue Lake Advocate; TS = Times Standard; HT = Humboldt Times; ST = Sebastopol Times; LCT = Lassen County Times

* Notes: Fort Seward received electricity in 1948, but the substation may have been installed at a later date. The Rio Dell Tap was not mentioned explicitly in the cited article; this listing assumes it was installed at the same time as the Rio Dell substation. The Trinidad substation was installed at some point before 12/2/1954. Based on its relationship to other regional electricity infrastructure, it is very likely that it was built in the late 1940s or early 1950s.