Photo Credit: NREL

PROJECT BRIEF
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Project Members:
Luke Feinberg
Zach Jylkka
Mengya Tao
Ben White
Yingda Xu
Project Advisor:
Bruce Kendall, Ph.D

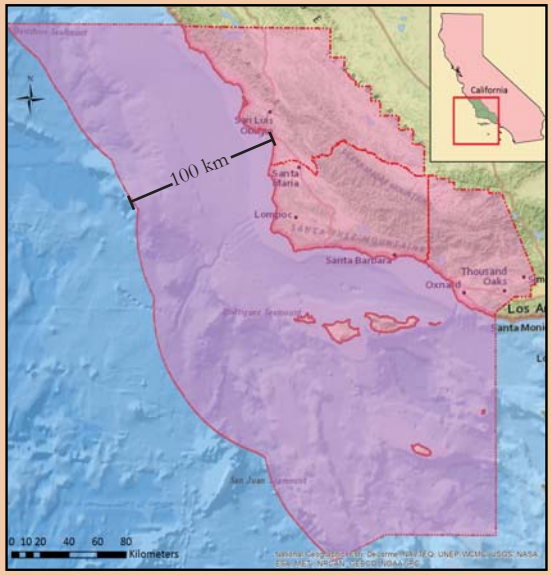
Evaluating Offshore Wind Energy Feasibility off the California Central Coast

PROJECT INTRODUCTION

At the end of 2012, California ranked second among all states in installed wind power capacity with 5.549 Gigawatts (GW).[1] However, none of that wind power is being generated offshore.

Different obstacles exist off the California coast, where the Pacific Outer Continental Shelf (OCS) quickly drops off to waters deeper (greater than 50m) than conventional offshore platforms (e.g., monopile, jacket) can support wind turbines with economic efficiency. Therefore, floating turbine platforms will likely be necessary in the majority of potential offshore wind (OSW) farm locations.

Our project explores the feasibility of OSW energy generation in central California. The region of interest (ROI) was limited to Ventura, Santa Barbara, and San Luis Obispo Counties.



Region of interest map: the shaded area represents our ROI from onshore to 100 km offshore.

PROJECT OBJECTIVES

- Research stakeholder perceptions of offshore wind;
- Identify federal, state, and local permitting pathways;
- Conduct spatial analysis of conflicting uses of the marine environment.

Photo Credit: Principle Power

KEY CONCLUSIONS

Based on the parameters examined in this project, OSW development is feasible off California's central coast; however, development barriers exist:

1. Some stakeholders oppose OSW development. Major concerns expressed include impacts to marine life and viewsheds.
2. State and federal permitting paths lack integration and need coordinated effort.
3. Environmental baseline data are incomplete and/or outdated.

<u>Our research indicates that these barriers may be overcome:</u>

1. Survey respondents indicate support and increased willingness to pay for OSW. Environmental and viewshed impacts should be considered in site selection studies.
2. Effective methods of streamlining the regulatory process exist on the East Coast and could be implemented in the ROI.
3. Once better baseline data are gathered, a framework exists for identifying areas of least conflict for OSW.

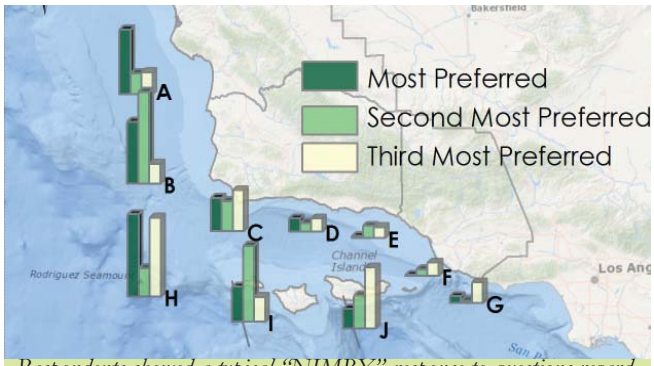
STAKEHOLDER ANALYSIS

We approached this objective by identifying key stakeholder groups that may be interested in and/or affected by OSW development in the ROI. Engagement with the Channel Islands National Marine Sanctuary Advisory Council (SAC) greatly facilitated this identification process.

A diverse array of findings from 15 interviews with SAC representatives and other stakeholders were used to summarize opinions on OSW, enhance the accuracy of the permitting analysis, and to incorporate stakeholder concerns into the spatial analysis.

Stakeholder Interview List	
Federal Government	Recreational Groups
State Government	Conservation Organizations
Local Government	Education Institutions
Tribal Office	Commercial Fishing
Department of Defense	Energy Sector

To gauge broader public attitudes towards OSW, we ran an online survey from September 16 to November 30, 2013. It was publicized through community listservs, an article in the *Santa Barbara Independent,* and targeted outreach to disproportionately represented stakeholder groups.



Respondents showed a typical "NIMBY" response to questions regarding preferred locations of OSW developments.

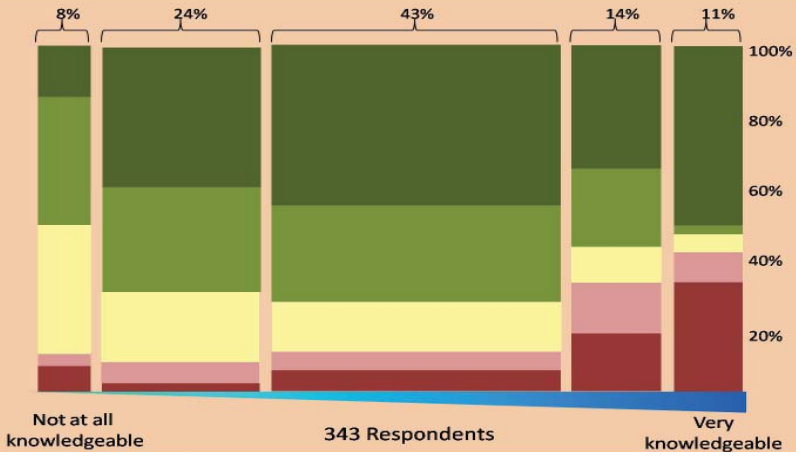
We collected 351 survey responses from individuals residing in our ROI. The targeted nature of the sample means that it is not representative of the general population in the study area. Compared to census data, a disproportionate number of participants were: white, highly educated, indicated a high-income, and individuals living in Santa Barbara County.

To interpret our data, we employed descriptive survey statistics (e.g., frequency distribution) and statistical analysis (logistic regression). A majority of respondents (67%) support OSW development. One question, which asked people to rank their knowledge of the offshore wind industry, revealed that increased perceived knowledge led to polarized positions of support (i.e., as individuals' self-professed knowledge increased, their opinions on offshore wind, positive or negative, grew more pronounced). Top development concerns focused on impacts to seabirds, marine mammals, and viewshed impacts. Respondents also overwhelmingly relayed a 'not in my back yard' (NIMBY) reaction to possible wind farm locations.

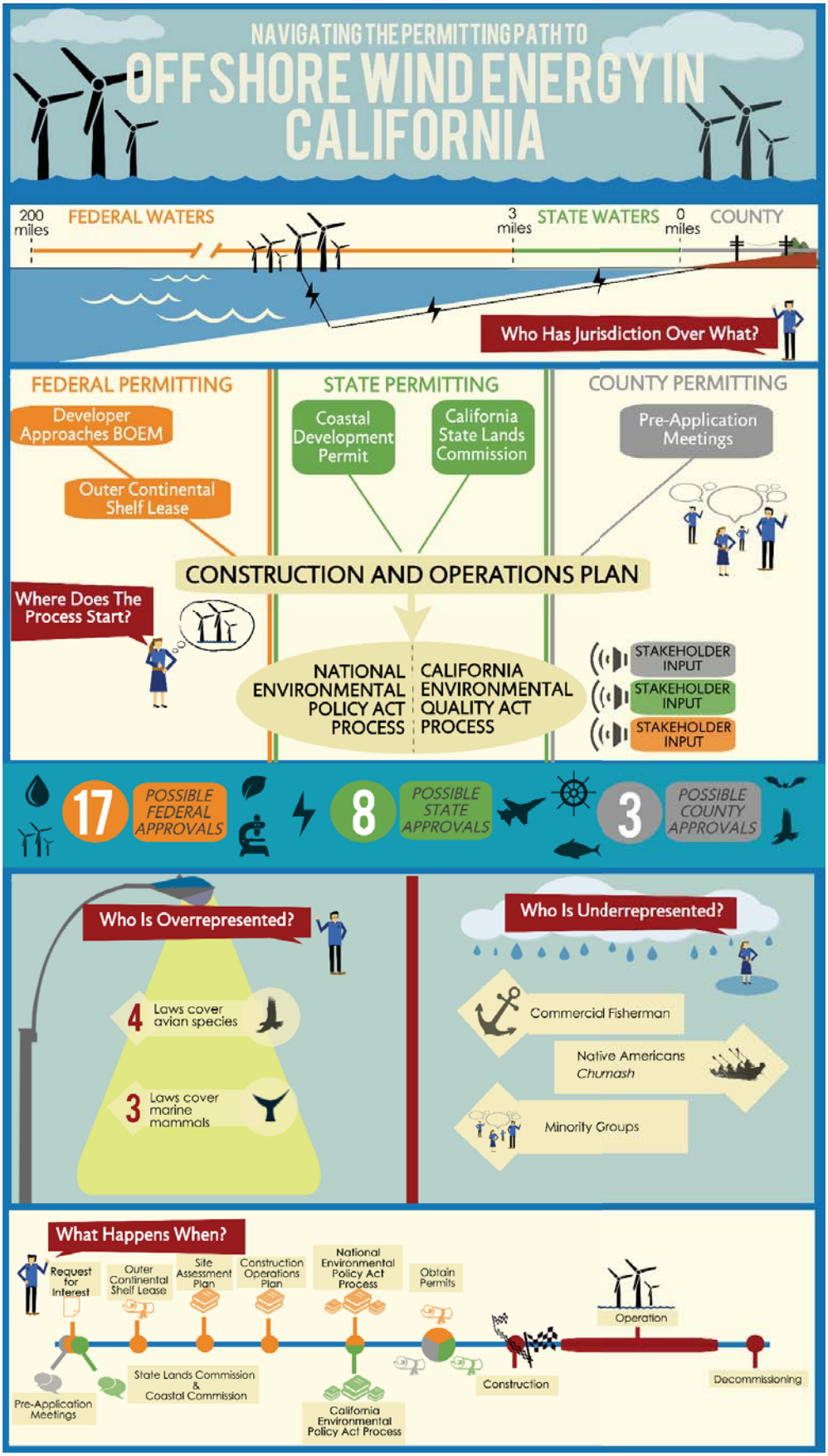
Factors Predicting Support of OSW

Factor Influencing Support	Effect
Location of residence	Santa Barbara County residents more likely to support
Sex of respondent	Females more supportive
Respondent's level of knowledge of OSW	Intermediate level of knowledge of OSW most supportive
Respondent's work Industry	Works in environmental or energy industry most supportive

Based on logistic regression of respondents indicating "strong" or "somewhat" support vs. those indicating "strong" or "somewhat" opposition (n=226). All variables were significant with P<0.05.



This mosaic plot compares survey respondents' attitudes toward offshore wind (support or oppose) with their self-professed knowledge of offshore wind. The width of the x-axis represents the percentage of respondents in different knowledge levels; the width on y-axis represents the distribution of attitudes within each knowledge level.



Permitting pathways were identified by systematically reviewing relevant legislation, agencies, and permits associated with OSW development. Although few relevant case studies of OSW development in the United States exist, interviews with agency and industry representatives allowed the team to identify salient points and gain a practitioner's perspective of environmental regulations.

Analysis of the permitting pathway revealed several issues that impact the development of OSW in the ROI. Up to 28 separate approvals may be required prior to wind farm construction. Patterns of disproportionate representation emerged; some avian species have as many as four federal statutes and associated permits. By contrast, important stakeholder groups, such as First Nation tribes and commercial fishermen, are largely absent from regulatory requirements.

Furthermore, the Department of Defense (DoD) Sea Range is a unique area used as a laboratory setting for testing military equipment and is located in the ROI. DoD concerns over the effect of wind turbines on military radar systems may limit a developer's ability to obtain Federal Aviation Administration approval for projects off the central coast.

Regulatory burdens on OSW could be substantially reduced if the State requested the creation of a (Bureau of Ocean Energy Management) BOEM Task Force to coordinate data collection, streamline the permitting process, and coordinate stakeholder communication.

The infographic is a graphic depiction of the major elements in the permitting process. We developed this infographic to communicate the broad outlines of the permitting process to the general public.

SPATIAL ANALYSIS

CalWind gathered available spatial data to map existing ocean uses as related to sites with the highest wind speeds. Spatially explicit data do not exist (or is not publicly available) to represent all stakeholder priorities and environmental variables, so the team focused on a subset of considerations. We employed a GIS-based multi-criteria decision analysis (MCDA) framework and supplementary Marxan analysis to simulate the siting of wind energy farm(s) in the ROI.

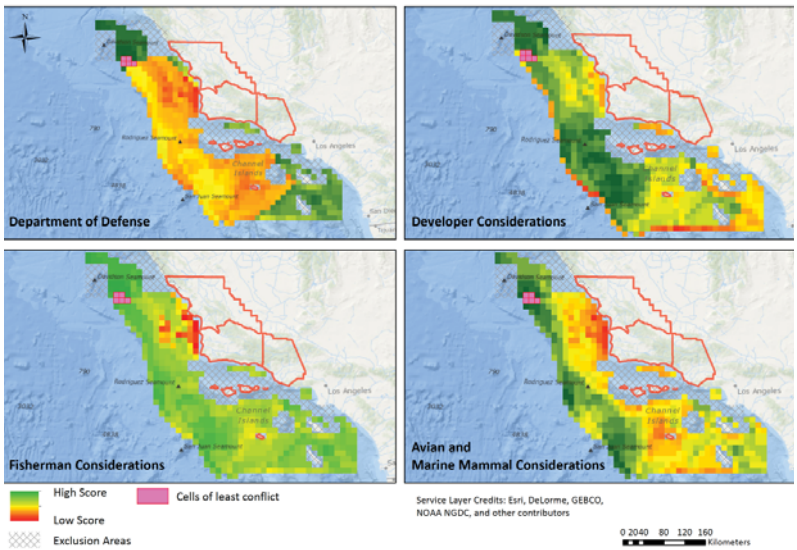
To approximate developable areas, we converted the ROI into 100km^2 'developable' grid cells, and calculated scores for a series of variables within each cell. Cells that intersected or were within shipping lanes and National Marine Sanctuaries were excluded.

Spatial Analysis Variables	
Benthic substrate	Marine bird biodiversity
Salmon and dragging fishing grounds	Marine mammal presence
Department of Defense Sea Range	Wind speed and distance to onshore interconnection

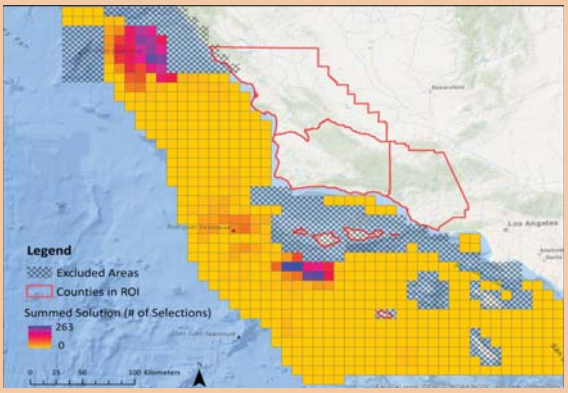
For the MCDA analysis, individual variable scores were weighted to calculate an overall cell score. Each scenario was designed to represent the prioritization of different stakeholder variables. For example, in the DoD perspective map, the MCDA model places a higher penalty on cells within the Sea Range to avoid wind farm placement within areas used for Air Force and Navy exercises.

Cells in the northwestern portion of the ROI scored high consistently because the area has high wind, is outside of the DoD's Sea Range, has soft substrate, low scores of marine bird biodiversity and mammal presence, and is outside of important dragging and salmon fishery areas.

The area west of Santa Barbara County consistently received low scores. This is likely because of the region's biological importance as an 'upwelling' zone, which supports higher fish, bird, and marine mammal populations.[2]



GIS-MCDA output for four hypothetical weighting scenarios. Dark green cells indicate high development potential and red cells indicate areas with low development potential (combination of wind speeds, distance to shore, and degree of spatial conflict). Pink cells were the highest scoring in all four scenarios.



Marxan summed solutions (frequency of cell selection over 1000 runs) with a wind generation target of 200MW and a weighted sum cost inclusive of all variables considered in the MCDA analysis, as well as distance to a grid interconnection point. Here, cells selected with the highest frequency to achieve the target at the lowest cost appear in red, pink, purple, and blue (highest). Similar to the MCDA analysis, the northwestern region again emerged as an area with high development potential, along with the area south of San Miguel and Santa Rosa islands.

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For more information, please visit our website:
http://www.calwindproject.com/

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1. Wind Powering America: U.S. Installed Wind Capacity. US DOE at <http://www.windpoweringamerica.gov/wi.asp>
2. NASA: Earth Observatory, "California's Channel Islands: From Shore to Sea (Jason Project)."