Key Findings
California has a long track record of leadership in combating climate change and achieving strong renewable energy goals. Floating offshore wind projects are being evaluated as a means of reaching the state’s RPS and emission reduction targets. This report represents the first analysis of the impacts of floating offshore wind projects on GHG emissions in offshore waters along the California coast.

The result of this study confirms that floating offshore wind is a potential solution for California to significantly decrease GHG emissions associated with electricity production. This study identified key life cycle stages, components, and materials that have the strongest contribution to GHG emissions and includes recommendations to mitigate their emissions.

Life Cycle Analysis
Characterizing Emissions
- Maximum GHG Emissions: 92% less than natural gas.
- GHG Emission Range: Comparable to nuclear & hydro.

Reducing Emissions
- Greater Capacity Factor: More electricity production, thus less Life Cycle GHG Impact.
- Longer Operational Life: More electricity produced in windfarm’s life, thus less Life Cycle GHG Impact.

Key Stages
- Manufacturing: Generates the vast majority of GHG emissions.
- Recycling: Potential to significantly decrease emissions.

Key Components
- Substructure & Turbine: 41% and 36% of emissions.
- Steel & Fossil Fuels: 49% and 27% of emissions.

Recommendations
- Utilize floating offshore wind energy in California to:
  - Achieve emission reduction targets and energy production goals.
  - Improve air quality by reducing emissions associated with natural gas.

- Focus on manufacturing and recycling phases.
- Prioritize factors influencing capacity factor and operational lifetime of the wind farm.

Future Studies
- Evaluate impacts of floating offshore wind projects on California’s electricity gridmix.
- Expand LCA scope to other environmental impacts of floating offshore wind projects.

Environmental and Regulatory Benefits
- Utilize floating offshore wind energy in California to:
  - Achieve emission reduction targets and energy production goals.
  - Improve air quality by reducing emissions associated with natural gas.

Mitigation Efforts
- Focus on manufacturing and recycling phases.
- Prioritize factors influencing capacity factor and operational lifetime of the wind farm.

Background
In California, Senate Bill 100 (est. 2018) requires 100% zero-carbon generated electricity throughout California by 2045. However, natural gas still represents the largest source of non-renewable electricity in the state, accounting for 43% of the total in-state power and 93% of the GHGs emitted from electricity generation in California.

Although California has one of the country’s most aggressive Renewable Portfolio Standards (RPS), the growth of land-based wind power has stagnated over the last several years because of the land-use restrictions and limited in-land wind resources.

Floating offshore wind farms represent a renewable energy resource that can reduce natural gas consumption and help California meet its RPS target, complements solar power production. Due to California’s deep offshore continental shelf, floating offshore wind platforms represent the most practical technology for offshore deployment.

Objectives
To inform the development of floating offshore wind projects in federal waters off California, BOEM Pacific Region has tasked the Bren School with characterizing and assessing the GHG emissions associated with floating offshore wind energy.

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Further Information
For more on our project, accessing presentation material, and for further correspondence, please visit us at: https://www.oceanwindproject.com or feel free to contact us at: gp-windfalllca@bren.ucsb.edu
Major Parameters
- Project Size: 600MW (75 x 8MW turbines with spar-buoy substructure)
- Turbine Size: 164 m rotor diameter, 105 m hub height
- Location: 35 km from electricity grid, 450 m water depth
- 50% capacity factor, 25 year operational life

Unit of Measurement
Environmental impact in this LCA is measured by lifetime kilograms of CO\textsubscript{2}-equivalent emissions per lifetime electricity generation in megawatt hours (kg CO\textsubscript{2}-eq/MWh).

System Boundary
Life Cycle Assessment (LCA) quantifies flows of resources and energy, as well as environmental impacts of a system (ISO 14044 Standards). LCA informs stakeholders of the implications of their choices for environmental quality and sustainability.

Floating Offshore Wind Project

Results Overview
The sensitivity analysis shows the influence that each of the nine analyzed parameters has on GHG emissions. These results indicate that the following mitigation measures could reduce emissions:
- Achieving a high capacity factor
- Prioritizing quality to extend life
- Reducing turbine failure
- Installing turbines during optimal conditions
- Limiting water depth and distance to shore

Minimum estimates for Natural Gas emissions are higher than Maximum estimates for Floating Offshore by a factor of 10. These values demonstrate a significant opportunity for California to reduce its GHG emissions and help satisfy their energy production goals.

Compared to natural gas, a single 600 MW floating wind farm can potentially reduce emissions by 934 - 2,598 million kg of CO\textsubscript{2} equivalent/year. This is equal to at least:
- 15 million of tree seedlings grown for 10 years
- 198 thousand of vehicles driven for 1 year
- 105 million of gallons of gasoline consumed