Generalized Portfolio Optimization for Efficiently Coordinating Offshore Energy-Harvesting Devices

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Generalized and expanded our portfolio optimization by **generalizing standards for device performance and costs**, **developing a uniform code base** for ease of adding new devices, and **created a user interface** for researchers to use our portfolio optimization tool for their own analysis

Background

- **NC House Bill 951:** 70% reduction in CO2 emissions by 2030 and carbon neutrality by 2050 (GANC, 2021).
- **NC EO 218:** Offshore wind development goals of 2.8 GW by 2030 and 8.0 GW by 2040 (SNC, 2021).
- **Can we coordinate the generation from offshore energy resources to achieve economic benefits?**

- Energy Devices
- Environmental Data
- Domain Selection

Portfolio Optimization → Combination of devices for the domain that maximizes energy to shore for LCOE constraint

Initial Portfolio Optimization [1], [2]

- Uniform standards for performances and costs
- Uniform code base
- **No device optimization**

[1] V. Faria, A. R. Queiroz and J. DeCarolis, "Optimizing offshore renewable portfolios under resource variability," Applied Energy, vol. 326, 2022.
[2] V. Faria, A. R. Queiroz and J. DeCarolis, "Scenario generation and risk-averse stochastic portfolio optimization applied to offshore renewable energy technologies," Energy, vol. 270, 2023.

Fused Portfolio Optimization [3]

- **Device optimization element**
  - Families of designs
- Device performance and costs **specialized,** different code bases for different devices
  - **Difficult to integrate more devices**

[3] M. Maceda, R. Miller, V. A. D. de Faria, M. Bryant, C. Vermillion, and A. R. de Queiroz, "Fused Portfolio Optimization for Harnessing Marine Renewable Energy Resources," Jul. 09, 2025, *under review,* Energy. doi: 10.2139/ssrn.5345338.

Centralized Portfolio Optimization [This Work]

- **Design optimization** element
  - **Generalizes** standards for performance and costs
  - **Uniform code base** for each device
- Integrates **wider array of devices**
- **User Interface**

Software

Input Standardization

Previous Model

Non-uniform & Unknown Binary Files w/ **Inputs**

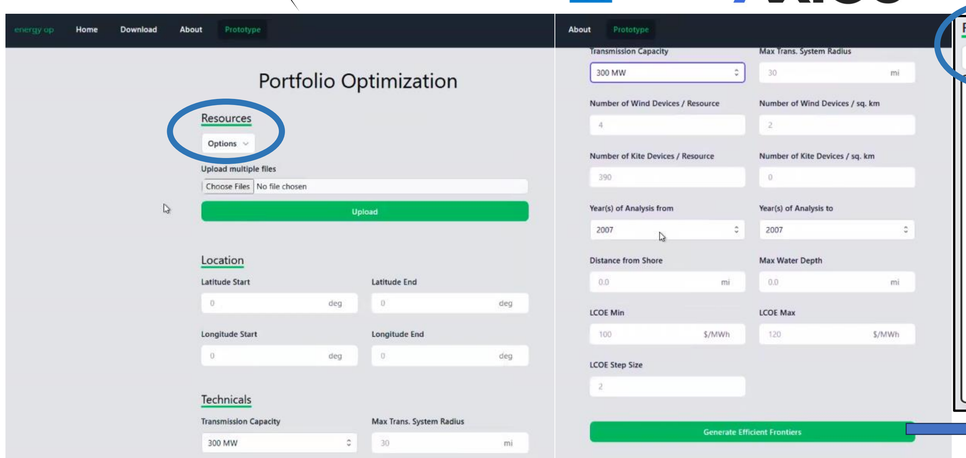
Generalized Model : Modular, easy to add devices

Device Selections From ***User Interface*** → ***Uniformly*** calculate Inputs for each device → Portfolio Optimization

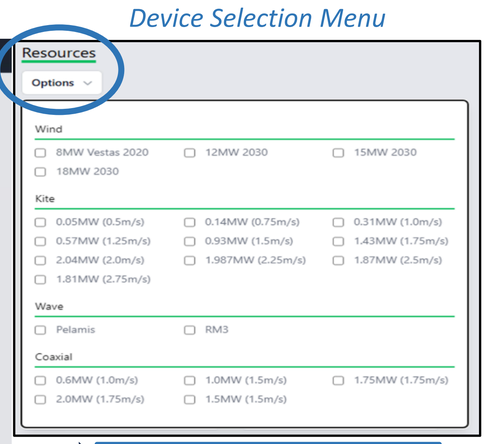
Not Modular, cannot swap out or add device designs to portfolio easily

User Interface

NEXT.js · tailwindcss · TypeScript · AXIOS



Device Selection Menu



As shown in test case!

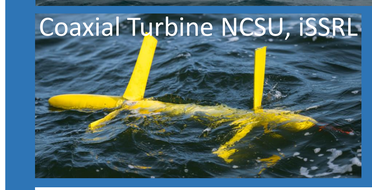
User-specified constraints include:

- Devices
- Domain
- Transmission system capacity
- Transmission system radius
- Maximum depths
- Maximum distance from shore
- LCOE range
- LCOE step size
- Analysis years
- Deploy set number of specific type of device
  - These appear once user has chosen devices
- Device packing densities

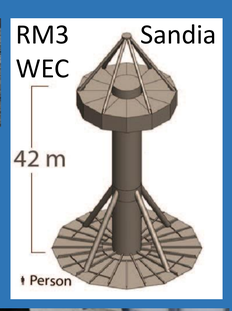
Test Case

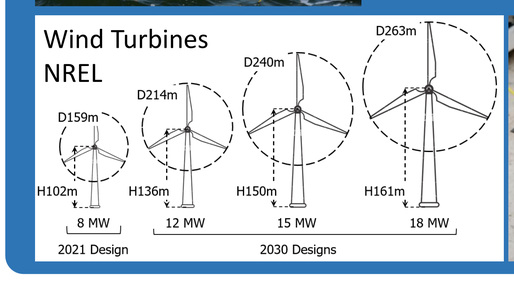
Pelamis Wave Energy Converter (WEC)

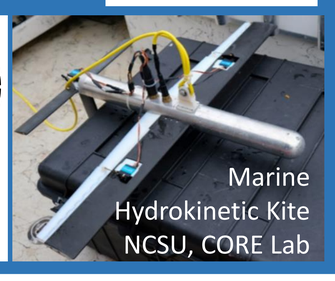
Coaxial Turbine NCSU, iSSRL



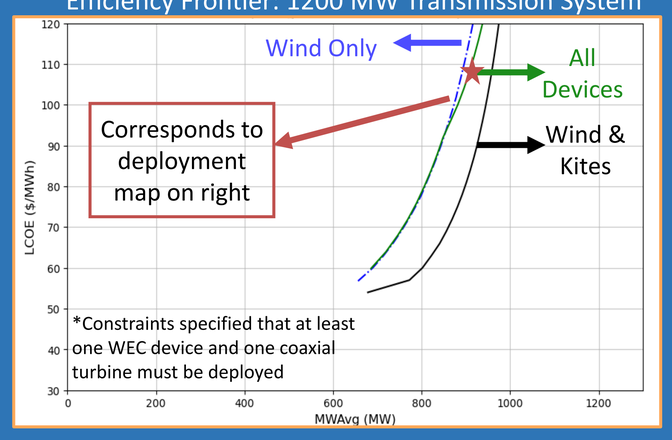
Input Devices

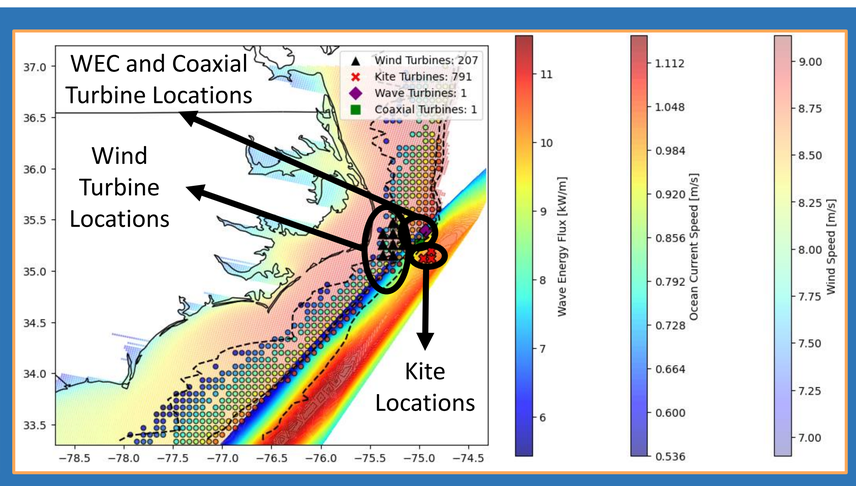






Efficiency Frontier: 1200 MW Transmission System





Conclusions and Future Work

Not all devices are competitive in terms of LCOE

- Technology Readiness
- Additional Domains

- Include readiness levels in user interface
- Expand the domains the portfolio can operate in
- Incorporate uncertainty in device design and cost models
- Full-grid analysis

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