

## Introduction

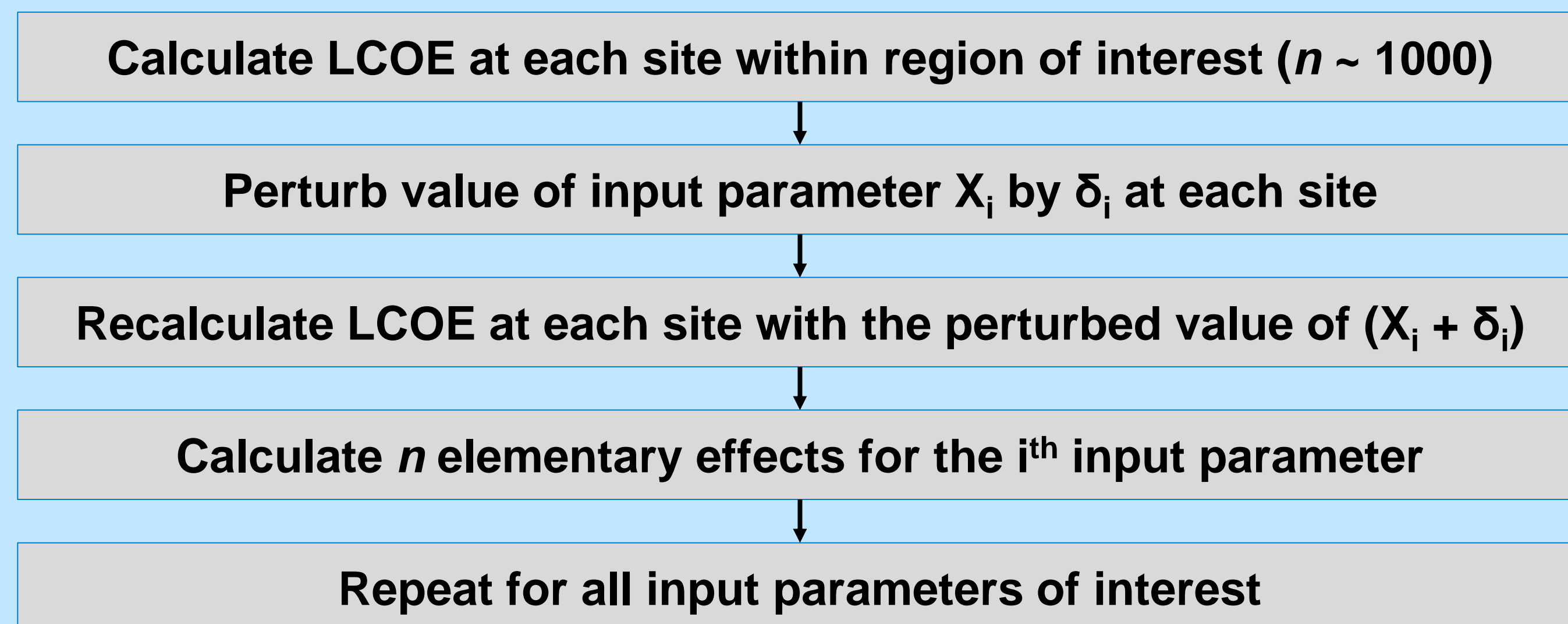
Sensitivity analyses of deterministic offshore wind cost models can be used to understand how uncertainty or changes to input parameters impact the levelized cost of energy (LCOE). Typically, this involves perturbing independent variables for a reference wind plant and reporting the change in LCOE; however, this does not describe how sensitivity indices can vary over a region. This study uses a global one-at-a-time sensitivity analysis to evaluate the range of outcomes and relative impact that changes to component cost categories or geospatial conditions can cause for the LCOE of offshore wind throughout major coastal regions of the United States.

## Methodology

The sensitivity analysis is conducted using Morris factor screening [1] on the outputs of the Offshore Regional Cost Analyzer (ORCA) model [2]. Sensitivities are expressed as *elementary effects* ( $\Delta\text{LCOE}$ ):

$$\Delta\text{LCOE}_i = \frac{\text{LCOE}(X_1, X_2, \dots, X_i + \delta_i, \dots, X_k) - \text{LCOE}(X)}{\text{LCOE}(X)}$$

The sensitivity to the  $i^{\text{th}}$  input parameter,  $X_i$ , is obtained by the following process:

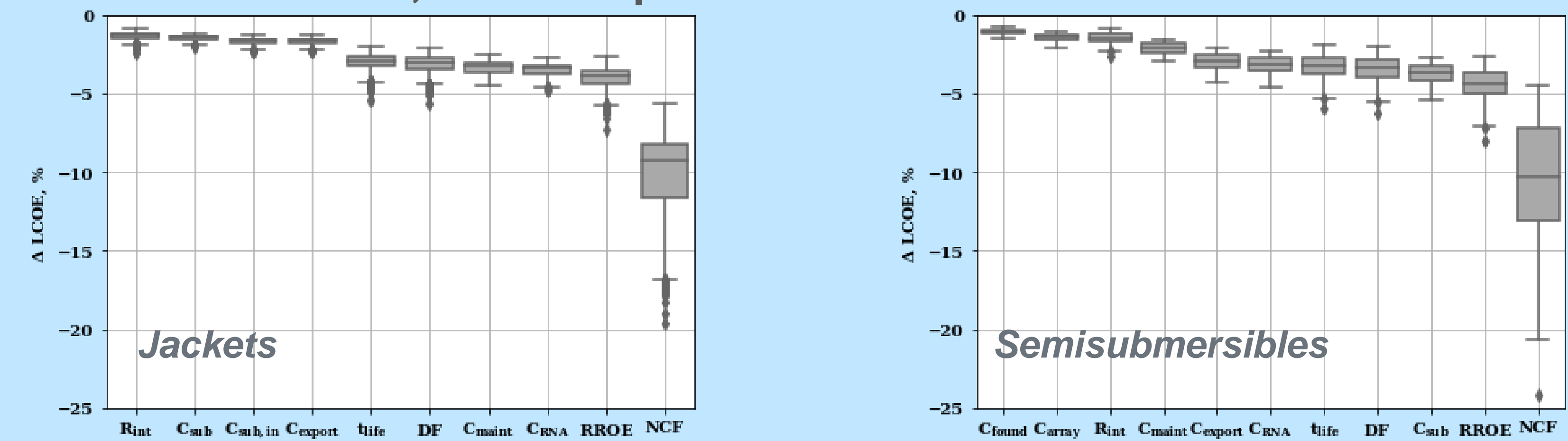


Interpretation of  $\Delta\text{LCOE}$  [4]:

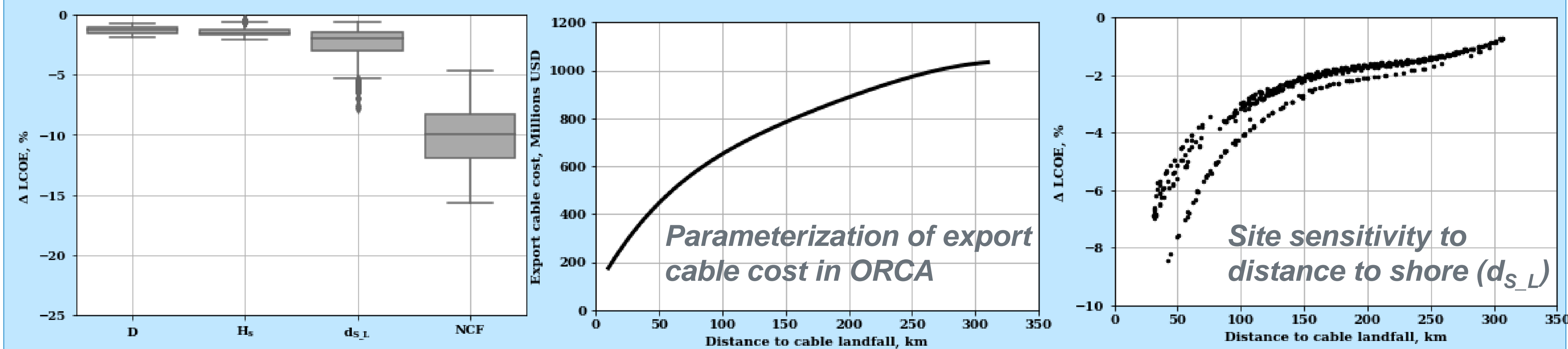
- $\delta_i$  represents anticipated short-term cost reductions for each variable [3], so  $\Delta\text{LCOE}$  is the achievable decrease in LCOE attributed to innovations in that cost category.
- Interactions and nonlinearities between variables are captured by the variance in  $\Delta\text{LCOE}$ . This represents the range of outcomes per input variable from site to site.

## Results

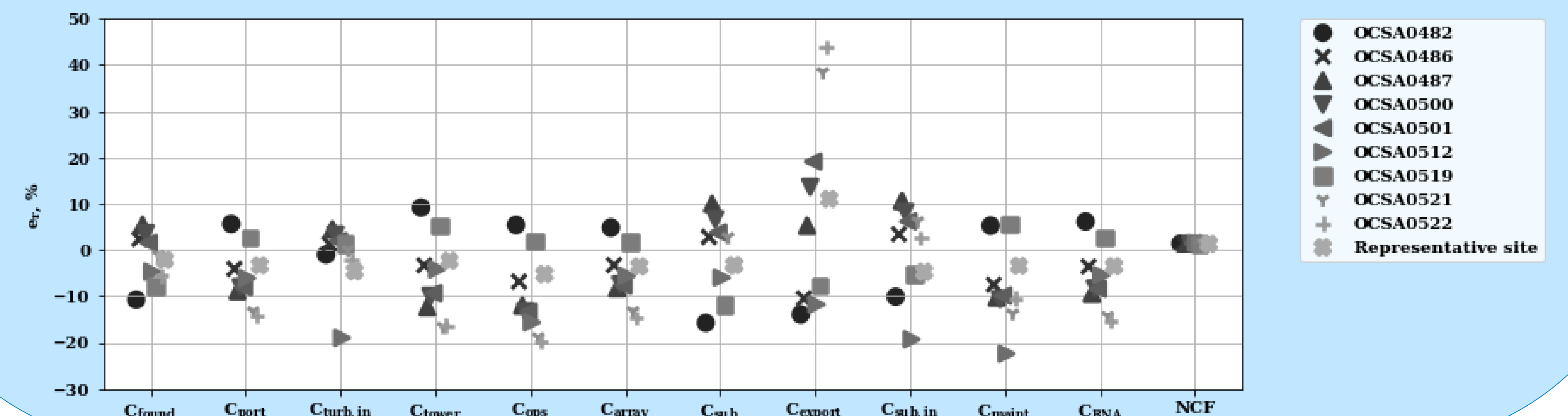
LCOE sensitivities to cost, financial parameters for all U.S. sites:



LCOE sensitivities to geospatial inputs for semisubmersibles in the Atlantic:



Relative error ( $e_r$ ) between individual and aggregated site sensitivities:



## Discussion

- The relative importance of input parameters and component cost categories for LCOE is ranked but a range of sensitivities exist due to nonlinear dependence on geospatial conditions.
- A given reduction in component costs will impact each project in different ways. As a result, representative site sensitivity analyses may not scale regionally.
- This range of outcomes should be considered by developers, OEMs, and policy makers at the early planning stages of a project to appropriately manage risk and uncertainty.

## References

1. Morris (1991), "Factorial Sampling Plans for Preliminary Computational Experiments". *Technometrics*, 33:161-174.
2. Beiter, et al (2016), "A Spatial-Economic Cost Reduction Pathway Analysis for U.S. Offshore Wind Development from 2015 -2030". NREL/TP-6A20-66579.
3. Valpy and English (2014), "Future renewable energy costs: Offshore wind". Technical report, BVG Associates.
4. Shields, Beiter, and Kleiber, "Regional Sensitivities of the Levelized Cost of Energy for Offshore Wind Plants in the United States". Submitted to *Renewable Energy*.