## Monopile and transition piece costs

The monopile cost data are derived from a batch of ORBIT runs (v 1.0.8) using the MonopileDesign module. We define a set of reference wind turbines between 12 MW and 20 MW for a 600 MW fixed-bottom offshore wind project with a mean wind speed of 9 m/s:

|  |  |  |  |
| --- | --- | --- | --- |
| **Turbine rating, MW** | **Rotor diameter, m** | **Hub height, m** | **Load factor** |
| 12 | 215 | 138 | 3.25 |
| 15 | 240 | 150 | 3 |
| 18 | 263 | 161 | 2.75 |
| 20 | 270 | 169 | 2.5 |

The load factor is a scaling parameter used in ORBIT as a safety factor on the 50 year extreme thrust load on the rotor. We adjusted the scaling factor to align the results with a set of higher fidelity WISDEM runs.

We then ran a parametric sweep of MonopileDesign for each turbine rating at water depths of 20, 30, 40, 50, and 60 m and extracted the results of ORBIT for the monopile mass and cost and transition piece mass and cost. ORBIT sizes the mass of the components based on a first-order engineering model and then calculates the cost of these components based on a finished cost rate of $3000/t.

We compared ORBIT runs with a batch of WISDEM runs from a separate study as a cross-validation. ORBIT results are typically within +/- 30% of the WISDEM results, with higher accuracy for 15 MW turbines below 50 m depth (+/- 15%) and 20 MW turbines above 40 m depth (+/- 15%). WISDEM results have periodically been spot checked against industry data, with masses and costs being relatively in line with industry.

Comparing the new data points against the [old ORCA equations](https://github.com/NREL/NRWAL/blob/main/NRWAL/analysis_library/osw_2022/monopile_updates_2022.yaml) (updated in 2022) shows that the new monopile costs are typically 15-30% lower than the old equations indicate and that the new transition piece costs are typically +/-10% of the old costs. Given the more transparent, bottom up, and cross-validated ORBIT results, we have higher confidence in the new data.

The final cost curves represent the finished manufacturing costs (without transportation or installation) for the monopile and the transition piece.

Chart

Description automatically generated

