1. Wireless Power Transmission Charging Rate & AUV Charge Time

Underwater Wireless Power Transmission systems typically provide charging rates between 1–10 kW per docking station, with commercial solutions like **Seatooth** delivering around 3–7 kW. These systems rely on mutual induction, which in seawater faces challenges such as alignment precision and conductivity losses, resulting in overall efficiencies of about 70–90% under ideal conditions. For standard AUV batteries with capacities between **10–40 kWh**, charging times generally range from **1 to 4 hours** depending on factors such as the WPT rate, system efficiency, and the AUV's onboard power management system, which may limit charge rate to prevent overheating. For example, a **20 kWh AUV** battery charged at **5 kW** with 80% efficiency would take approximately **4** hours to fully recharge.

2. Battery type in the station

For an underwater charging station, Lithium Iron Phosphate batteries are recommended due to their high safety, excellent cycle life of 3,000–5,000 cycles, and ability to operate reliably under high-pressure conditions. These batteries also offer over 95% charge/discharge efficiency, making them ideal for demanding marine environments. The station's battery capacity typically ranges from **200 to 500 kWh** to ensure uninterrupted operation. This capacity must support two Wireless Power Transmission docks delivering a combined **10–20 kW,** along with additional onboard systems such as sensors, communications equipment, and winch mechanisms, all running continuously for 24–48 hours even without solar or external power input. For example, a 500 kWh battery can sustain two 10 kW docks for approximately 25 hours at full load.

3. Cost Estimate

A single underwater charging station designed for 500-meter depth using HY-80 steel and the specified systems is estimated to cost between **$6.1 million and $9.7 million**. The pressure hull, built from HY-80 steel and weighing approximately 20,000–30,000 kg, contributes **$2M–$3M** to the total. The Wireless Power Transmission system with two docks, including power electronics, coils, alignment mechanisms, and cooling, adds **$1.5M–$2M**. A winch system and 1 km armored fiber-optic/power umbilical cable costs around **$500K–$1M.** The floating solar platform, rated at 50–100 kW and built for wave resistance, ranges from **$800K–$1.2M.** A 500 kWh Lithium Iron Phosphate battery system, selected for safety and efficiency, adds another **$300K–$500K.** Finally, installation and deployment, which involves specialized vessels and remotely operated vehicles, is estimated at **$1M–$2M.** Together, these components bring the full cost of one complete station to the **$6.1M–$9.7M** range.

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