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Potential Climate Change Mitigation and Environmental Impacts from the Widespread Implementation of Ocean Thermal Energy Conversion

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Ocean thermal energy conversion (OTEC) is a form of renewable energy that could potentially displace a significant amount of fossil-fuel generated electricity. Many multi-century simulations of the UVic Earth Systems Climate Model (UVic ESCM) are presented to better understand the climate change mitigation potential and the projected magnitude and significance of the impacts of widespread OTEC implementation at varying total power outputs (3, 5, 7, 10, and 15 TW). This study builds on previous research with the inclusion of a fully coupled atmospheric model, sea ice model, and comprehensive carbon cycle model. In high emission scenarios (Representative Concentration Pathway 8.5), OTEC was found to be able to briefly produce over 36 TW of power and power production rates of 6 TW and below were found to be sustainable on multi-millennial timescales. The study also included an emission reduction associated with OTEC that resulted in cumulative emission reductions of 1190-3600 Pg C by 2500 relative to a control scenario without OTEC deployment. Environmental impacts include globally averaged sea surface temperature decreases of 0.8-3ºC relative to control values, increased heat uptake at intermediate depths, and enhanced biological production. The implementation of OTEC was found to induce overturning cells in the North Pacific and cause significant relative increases in strength of the maximum Meridional Overturning Circulation globally with values ranging from 1.6 to 8.2 Sv by 2500, depending on the level of OTEC power generation. While caution is required and the engineering challenges would be large, early indications suggest that the large-scale implementation of OTEC could make a substantial contribution to climate change mitigation.