An Assessment of Global Ocean Thermal Energy Conversion (OTEC) Resources under Broad Geographical Constraints

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WORLDWIDE OTEC RESOURCE

Temperature difference between 20 m and 1000 m depths
(Nihous, G.C., 2, 043104, JRSE, 2010; from NODC WOA05 database)

$\Delta T > 18$, OTEC RESOURCE

Is Degradation of Resource Possible?

1D studies* indicate Maximum OTEC Power

NUMERICAL MODELING OF OTEC

MITGCM

4 Degree* and 1 Degree ** Grids (Global)

Maximum OTEC Power, Environmental effects: cooling/warming surface layers, warming of deep layers, Increase in THC strength

1) Global 2) EEZ 3) 100km from shoreline 4) Only Atlantic Ocean 5) Only Indian and Pacific Ocean

OTEC MODELING PROTOCOL

Sea level

- Surface water intake (sink) with a flow rate of $1.5Q_{cw}$ (m$^3$/s)
- Mixed effluent (source) with a flow rate of $2.5Q_{cw}$ (m$^3$/s)
- Deep water intake (sink) with a flow rate of $Q_{cw}$ (m$^3$/s)

Water column:
- Sea level approximately 20m
- Approximately 50m to 250m
- Approximately 1000m

$w_{cw} = Q_{cw}/A$ (m/s)
$A =$ Grid cell area
Nominal OTEC Power: $f(Q_{cw}, \Delta T_0)$; $\Delta T_0$ is initial value
Actual OTEC Power: $f(Q_{cw}, \Delta T)$; $\Delta T$ is asymptotic value
ENVIRONMENTAL EFFECTS
Temperature Change in Surface Layers (50m) at Maximum Power

Color axis: 106 km, -4 °C
Green, 0 °C
Red, 6 °C
ENVIRONMENTAL EFFECTS

Strength of THC

Upper Northward Flow @ 26ºN in Atlantic Ocean
CONCLUSIONS

• Large-scale OTEC operations were assessed under broad geographical restrictions with MITgcm. A maximum power of 14TW was predicted for the Global case

• Cold seawater flow intensity at maximum power ≈ 5 Sv/TW (5 m³/s/MW)

• OTEC net power (area) density at maximum power generally scales as inverse of area of implementation.

• Environmental effects: temperature changes in surface layers and in the ocean interior, boost of the THC.

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Thank you, Questions?