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# P3_3 You really can't boil the ocean

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**Abstract**

There is a well known phrase, "you can't boil the ocean", to describe an impossible task. This statement is technically a false statement given a large enough source of energy and enough time. However, is it *really* possible? In this paper we discuss if you could feasibly bring an ocean to boil, in a reasonable time-frame, given some assumptions. We discover that the energy required to boil the *"easiest"* ocean is $6 \times 10^{24} J$, equivalent to the annual energy output of $\sim$ 10 million nuclear power plants (Canada's T.C Energy Bruce) [1].

## Introduction

There is a common phrase *"you can't boil the ocean"* denoting something either very difficult or impossible. So we thought could you boil the ocean given enough resources? We defined that the boiling of an ocean would only be successful if achieved well within the lifespan of one person, boiling an ocean within a decade. In this paper we only discuss bringing the oceans to boiling temperature ($102°C$), similar to when you *"boil the kettle"* so we will not discuss boiling the ocean dry. In this calculation we will also only consider electrical sources of energy and the number of stations required.

## Method

Using data taken from National Oceanic and Atmospheric Administration (NOAA) on ocean volumes [2] and taking some absurd assumptions, you can use a simple well known equation Eq.(1) to derive an energy required to boil each ocean. Assumptions: Density of each ocean is the same ($\rho_{sw} \sim 1000kgm^{-3}$), Specific heat capacity $C \sim 4000Jkg^{-1}$, The systems cannot lose energy, All energy transfer is 100% efficient and The ocean's temperature is completely uniform. The energy to boil each ocean can be calculated; first by obtaining a mass of salt water by using volume and density, this can then be compared to the energy output of varying energy sources. Eq.(1) below shows this calculation, where $Q$ - energy, $m$ - mass, $C$ - Specific heat capacity and $\Delta T$ - change in temperature.

$$Q = mC\Delta T \tag{1}$$

## Results & Discussion

Table 1 shows the raw data on each ocean and the energy we have calculated to boil each one.

Using this data we can then compare the energy required to boil the *"easiest"* ocean to the output of varying energy sources. We have chosen multiple types of power producers for comparison, they are as follows: nuclear fission, natural gas, coal, solar power and a nuclear solar hybrid; whereby the exclusion zone of the reactor is filled with solar panels. Converting the required energy into watt-hours ($Wh$) allows for

| Useful Ocean Characteristics | | | |
|---|---|---|---|
| Ocean | Approximate Volume ($10^7 km^3$) | Average Temp ($°C$) | Energy required ($10^{24} J$) |
| Arctic | 2 | -2 | 6 |
| Atlantic | 31 | 13 | 30 |
| Indian | 26 | 25 | 20 |
| Pacific | 66 | 10 | 60 |
| Southern | 7 | 4 | 9 |

Table 1: Known ocean volume and temperature [2][3], and calculated energy required to boil each ocean

easier comparison to readily available information on all energy sources. Unsurprisingly multiple power stations must be used to boil the ocean in less than a decade. Below is a plot (Figure 1) comparing these different sources and showing their relationship between the number of power plants and the time this number will take to bring the arctic to boiling point.

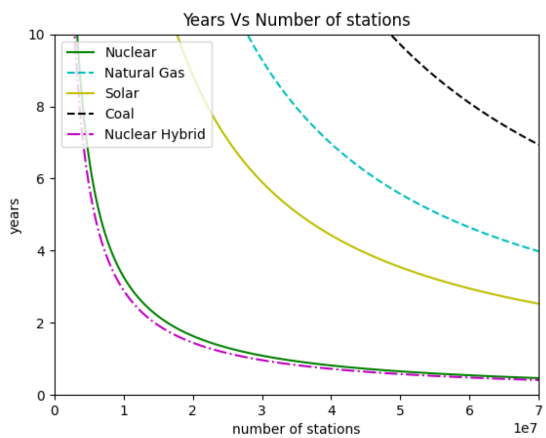


Figure 1: Number of various energy producing options to boil the ocean

To produce this plot, we have taken some figures on the average output of each power producing solution and calculated how much energy they could theoretically produce within a year per station: Nuclear to produce $\sim 50 \times 10^{12} Wh/year$ [1], Natural gas $\sim 6 \times 10^{12} Wh/year$ [4], Coal $\sim 4 \times 10^{12} Wh/year$ [5], Solar to be $\sim 50\%$ efficient on the solar flux from the sun and each "*station*" is taken to be an area of radius $1000m$ generating $\sim 10 \times 10^{12} Wh/year$. It is clear to see, from Figure 1, that we require a minimum of $\sim$ 100 million high-output nuclear power stations to bring the ocean to boiling within a decade, this vast amount of power plants required is completely unrealistic, not to mention prohibitively expensive.

## Conclusion

From this simple calculation we can see that under all circumstances the feasibility of boiling the ocean is remote at best. Realistically this proposal is impossible to any person or nation as of writing this paper. We haven't even taking into consideration whether there is enough mass or supply on the planet to support the building materials and fuelling requirements to run this absurd amount of power stations simultaneously for a whole decade, nor have we considered the surface area of the planet this ordeal would cover. We conclude that although boiling the ocean is mathematically possible we agree that the phrase "You can't boil the ocean" is correct and we do not object to the continued use of the phrase.

## References


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