Journal of Physics Special Topics
An undergraduate physics journal

A1_7 Tea at Lake Windermere

Z. Syed, S. Farr, L. Weightman, H.Dankin

Department of Physics and Astronomy, University of Leicester, Leicester, LE1 7RH

December 17, 2021

Abstract

In this article, we discuss the feasibility, most efficient and, cheapest method to make tea in lake Windermere, the largest lake in the UK. Although a very unrealistic scenario, it would be possible to brew tea in the lake but at great expense. The electricity and tea prices combined would cost about 14-34 billion pounds, depending on which teas are chosen and the method used. This leads to the conclusion that although theoretically possible, practically turning lake Windermere into a lake of tea is not feasible. It would be more realistic to pick a smaller lake in the peak district for this topic.

Introduction

Lake Windermere is the largest lake in the U.K., located in the Lake district; it stretches to a length of just over 18 kilometers and has a volume of 314.3x10^6m^3 [1]. Lake Windermere is one of the most beautiful sights in the U.K. and what is better than to enjoy a cuppa by its side.

Boiling the water

To boil water in Lake Windermere we will need to turn it into a kettle, to ensure uniform heating of water heat rods would be placed under the lake. The expenses for heating the water to a suitable temperature for brewing tea will be calculated. Assuming negligible impurities in the water, water density in the lake is 1kgm^3, using the equation

$$m = \rho V \tag{1}$$

We can determine the mass of water in the lake, m = 314.3x10^6kg. Assuming the water starting temperature to be $T_1 = 15^o$C= 288K and final temperature $T_2 = 100^o$C= 378K, and specific heat capacity, c = 4200Jkg^{-1}. We can use the following equation,

$$Q = mc\Delta T \tag{2}$$

to calculate the energy required to heat the water to required temperature, Q = 1.12x10^{14}J= 3.11x10^5MWh.

Source	Price per MWh(£)	Total Cost(million£)
Natural Gas	135	42
Wind	82	25.5
Coal	148	46
Nuclear	93	28.9
Solar	80	24.9

Table 1: Cost of heating the lake per different sources of electricity[2].

Brewing the Tea

For simplicity we will compare between two types of tea, loose-leaf, and tea bags. To calculate amount of tea required we will use a cup of tea as our base measure and scale it up to the lake proportionally. We can take the average

Tea type	Loose-leaf	Teabag
Amount p cup(x$10^{-3}kg$)	5	2
Total Amount(10^9kg)	4.76	1.9
Price per cup(£)	0.036	0.021
Price per kg(£)	7.17	10
Total Price(billion £)	34	19

Table 2: Comparison between loose-leaf and tea bag, amount and price

Lake Name	Blea Water	Blelhan Tarn	Overwater
Volume(10^5m^3)	5	7	4.5
Q ($10^{11}J$)	1.79	2.50	1.61
Energy Cost (£)	40,000	55,555	35,778
No. of cups (x10^9)	1.52	2.12	1.36
Tea Amount(x10^6)	3.04	4.24	2.72
Tea Cost(million£)	21.79	30.40	9.75
Total (million£)	21.84	30.45	9.79

Table 3: Amount of energy, tea and money required to brew tea in the smaller lakes, at lake district[1].

cup volume to be 330ml which is 3.3x10 $- 4m^3$, that means the lake would make up to 9.52x10^{11} cups assuming no water loss through evaporation. Based on the required amount of tea to be used for loose leaf tea, the sum ends to be higher but if we compare the values of two teas based on price per kg, the loose-leaf tea comes as the cheaper option at £13.6 billion. Meaning if we use same amount of loose leaf, it would allow for a cheaper brew, and since loose leaf tea can be brewed multiple times, a smaller amount can be used for one time brew.

Analysis

After analysing the data from table1 and 2, we can pick electricity produced by solar power and loose-leaf tea to be the cheapest options to brew a lake of tea. Although even on the cheaper side of the spectrum the price to make tea, comparing the cost of electricity with the price of tea that comes at an astonishing £13.6billion the electric cost is negligible, at £24.9 million. In comparison the amount of tea required to make this is 65 percent of the annual tea production of the world (2.9 billion kg)[3]. Although due to obvious reasons the act won't be possible in practicality. Speaking in hypothetical with no issues such as the lake ecosystem and the finances required to create a system that would boil water in the lake uniformly, we would face a problem financially and in materials.

Other Options?

With these circumstances would it be possible in a hypothetical scenario to turn a lake into a large cup of tea. To answer the question, we can take smaller lakes into consideration and calculate the required cost. After analysing the data from table 3, in future work, smaller lakes could be considered which would be less expensive.

Conclusion

In the world of theory, with a few assumptions, it is possible to brew tea in Lake Windermere. However, it is not practical considering the amount of energy and tea leaves required. Even with certain assumption, with a minimum budget of £13.6 billion and requiring 65 percent of annual tea production, to brew tea in the lake are not feasible in practicality. But under same assumptions if the idea is moved to smaller lakes in the Lake district, the idea is feasible based on finances and materials required.

References

[1] `https://webarchive.nationalarchives.gov.uk/ukgwa/20060223173113/http://www.environment-agency.gov.uk/commondata/103196/1118608?referrer=/regions/northwest/346910/347005/1110630/1110650/`[Acessed:25 Nov 2021]

[2] `https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/566567/BEIS_Electricity_Generation_Cost_Report.pdf#page=59`[Acessed:25 Nov 2021]

[3] `https://www.o-cha.net/english/cup/pdf/6.pdf`[Acessed:25 Nov 2021]