A comparison between carbon footprint of water production facilities in the Canary Islands

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ABSTRACT

The Canary Islands have a water culture tied to the exploitation of their groundwater by means of wells and water galleries. However, the growth of tourism, the increase in the local population and the development of agriculture have led to the emergence of new ways of obtaining water, such as the desalination of seawater. The presence of these desalination plants covers the entire archipelago, and sometimes they function as a complement to water needs, while in other cases they are the only source of drinking water available. The result has shown that seawater installations have the largest carbon footprint, mainly due to the electricity mix of the archipelago which, as it does not rely entirely on renewable energy sources, increases CO_2 emissions.

MATERIALS AND METHODS

The carbon footprint makes it possible to identify the sources of GHG emissions in the manufacture of a product, the provision of a service and/or the development of an activity or event [1]. To differentiate between the sources, the GHG Protocol [2] was used as a widely accepted standard to assess direct GHG emissions related to the use of fossil fuels directly by the company (scope 1), emissions related to the electricity consumption (scope 2) and indirect emissions corresponding to fossil fuels (scope 3). The sources were defined, the emissions were counted and transformed into tons of carbon dioxide equivalent, using emission factors published by official agencies.

RESULTS

The facilities studied in the islands (Figure 1) were: three desalination plants in El Hierro, one desalination plant in Gran Canaria, one in Fuerteventura and one in Tenerife. With regard to groundwater, two wells were studied in El Hierro, one well in Gran Canaria, one well in Tenerife, a water gallery in Tenerife and another water gallery in Gran Canaria. The carbon footprint has been calculated for the years 2019 and 2020.

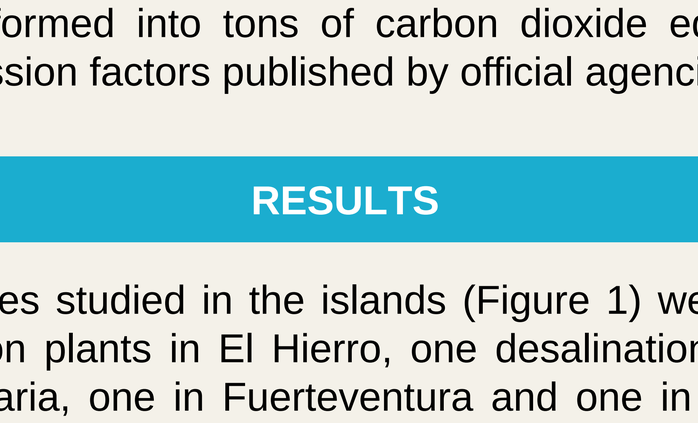

Figure 1. *Geographical location of the Canary Islands. WGS 1989 Complex UTM Zone 28N*

The normalized carbon footprint by volume of water captured is shown in Table 1. Normalized carbon footprints from desalination 4 and well 1 are outliers from the tendency observed in the rest of the facilities. Desalination plant 4 show one of the best normalized carbon footprints of 0.5 $kgCO_2eq \cdot m^{-3}$ by far capturing more volume of water than the rest of the investigated facilities together. On the other hand, well 4 present the highest carbon footprint with 77.5 $kgCO_2eq \cdot m^{-3}$, in this case with the lowest captured volume in all investigated facilities. However, the change of normalized carbon footprint values with the extracted volumes (Figure 2) for the rest of facilities show different tendencies for the different production systems investigated.

Table 1. *Calculated carbon footprint for desalination plants and groundwater production facilities in $kgCO_2eq \cdot m^{-3}$ (years 2019 and 2020)*

	Volume captured		Carbon footprint		Volume normalized carbon footprint			
Units	Hm^3		tCO_2eq		$tCO_2eq \cdot Hm^{-3}$		$kgCO_2eq \cdot m^{-3}$	
year	2019	2020	2019	2020	2019	2020	2019	2020
Desalination plant 1	2.364	2.364	2,522.9	2,443.1	1,067.2	1,033.5	1.1	1.0
Desalination plant 2	0.748	0.748	1,998.6	1,984.9	2,672.0	2,653.6	2.7	2.7
Desalination plant 3	0.820	0.820	2,284.2	2,265.7	2,785.6	2,763.1	2.8	2.8
Desalination plant 4	12.767	13.580	8,153.9	6,563.8	638.7	483.3	0.6	0.5
Desalination plant 5	3.117	2.314	3,164.3	2,575.6	1,015.2	1,113.0	1.0	1.1
Desalination plant 6	3.548	3.631	1,791.1	1,771.7	504.8	487.9	0.5	0.5
Well 1	0.084	0.021	1,829.2	1,627.8	21,776.3	77,516.2	21.8	77.5
Well 2	1.180	1.280	2,847.2	2,667.3	2,412.8	2,083.8	2.4	2.1
Well 3	0.198	0.177	58.1	35.8	293.3	202.2	0.3	0.2
Well 4	0.645	0.623	510.3	460.8	791.1	739.6	0.8	0.7

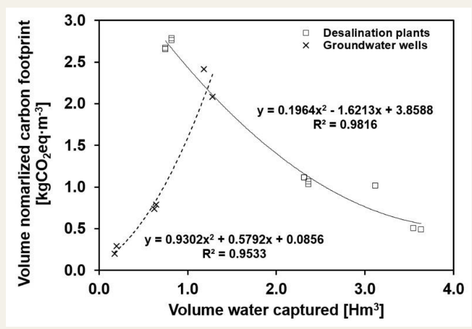

Figure 2. *Volume normalized carbon footprint as a function of volume water captured by the different water production facilities.*

CONCLUSIONS

One of the conclusions drawn from the study is that the carbon footprint of desalination plants is higher than that of wells and water galleries. However, it is considered that measures related to the integral water cycle in the archipelago should be taken, which would reduce emissions from all installations: Use of wells to artificially recharge the aquifer; Use of solar panels to increase the energy self-sufficiency of treatment plants, desalination plants and reservoirs; Contracting electricity entirely from renewable sources, which would result in Scope 2 being offset; Use of high efficiency pumps.

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Ninth International Conference on Environmental Management, Engineering, Planning and Economics (CEMEPE 2022) and SECOTOX Conference

Mykonos Island, Greece, from June 3 to 9, 2022