

Corkeen Environmental footprint

Amorim Cork Composites, S.A.

Executive summary

(high level disclosure version as requested by the client)

March 2022

Disclaimer

EY environmental footprint analysis follows a life-cycle approach based on ISO Standard 14040 and is based on Amorim Cork Composites data and business assumptions. The results presented are not third-party verified.

Agenda

1. About the study

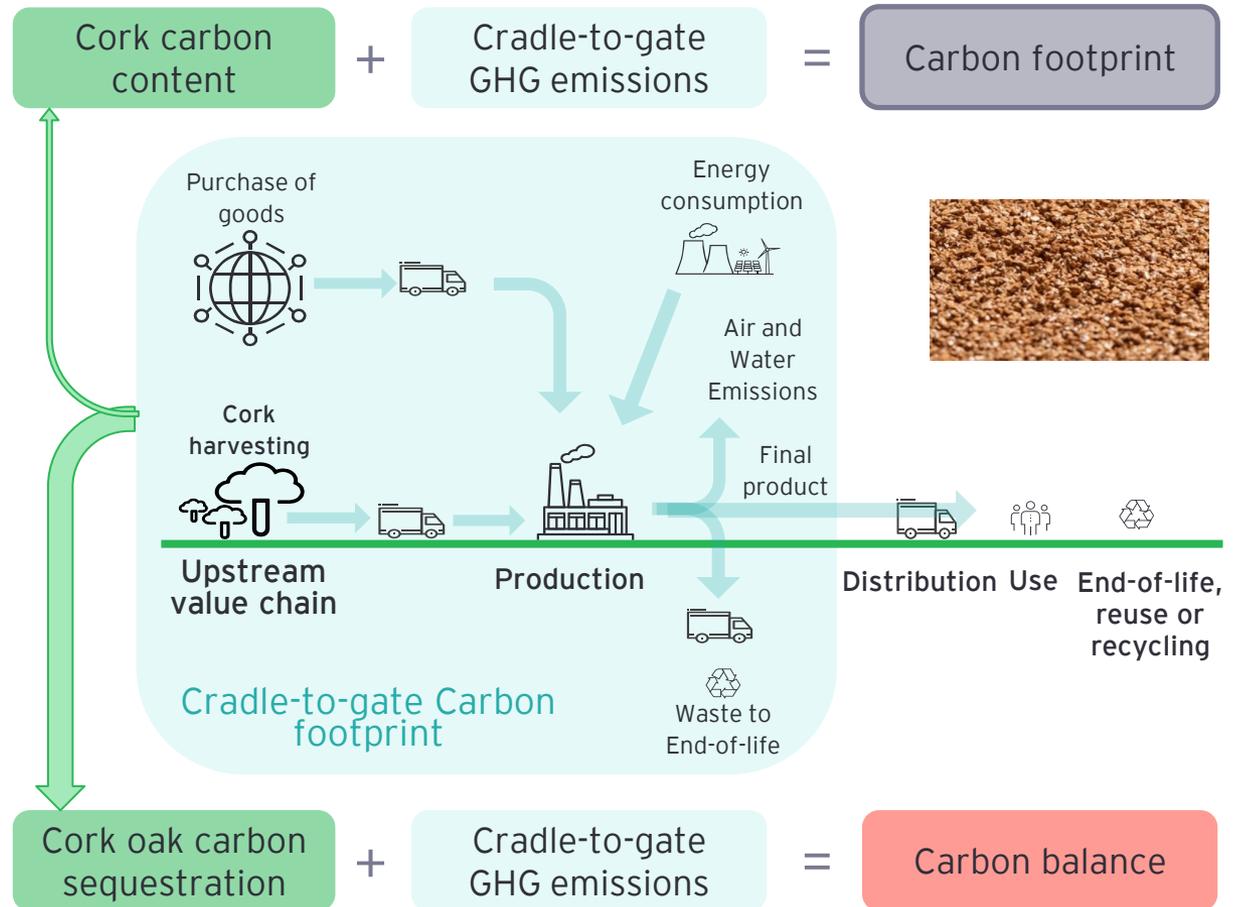
2. Carbon balance

Scenario analysis with carbon sequestration at the forest stage

3. LCA

Lifecycle environmental impacts for cradle-to-gate, expedition and installation scope for main impact categories

4. Conclusions



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About the study

About the study

Context

- ▶ Corticeira Amorim is the largest world producer of cork products, championing the sector since 1870. The company has a portfolio of products with applications in multiple industries, such as wine, construction, flooring, aeronautical, automobile, footwear, among others. The company has implemented an integrated production process that ensures that no cork is wasted.
- ▶ Cork is an ecological and sustainable material 100% natural, renewable, recyclable and reusable.
- ▶ Amorim Cork Composites, a subsidiary of Corticeira Amorim is focused in producing innovative solutions with combinations of cork and other materials, by recycling, reusing and reinventing natural and organic materials. The composite cork industry requires high levels of physical and chemical performance, providing adequate solutions to the needs of several industries such as the automotive, aerospace and aeronautical industries, the construction sector, as well as the shoe and interior design industries.
- ▶ The **main purpose** of this study is to quantify the potential environmental impacts generated by the production of Corkeen by Amorim, through a life cycle approach.
- ▶ Corkeen is a surfacing system for playgrounds made from cork and cork by-products, providing a safe and stable solution for children. Due to cork characteristics, Corkeen has a high impact absorption, high drainage capacity and lower surface temperatures than comparable materials, as it does not incorporate plastic or rubber, thus reducing the spread of microplastics. Moreover, it is fully accessible for wheelchairs and other mobility aid and complies with strict safety standards.

Product characteristics	Corkeen
Size (mm x mm x mm)	1000 mm x 1000 mm x 40 mm
Weight (kg)	6,62

About the study

Methodology

- ▶ The study analyses the environmental footprint of the product Corkeen, through a life cycle analysis (LCA) approach.
- ▶ **Guidelines:** The study was based on ISO 14040/44 series of standards, complemented with the guidelines from the International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance
- ▶ **Approach :** *cradle-to-gate* (from raw material extraction to the finished product at the factory gate), further including the expedition and installation stages due to the products' specifications (layers' are only assembled during installation)
- ▶ **Life cycle stages assessed:** forest management activities, base layer production, top layer granules production, top layer coating and packaging, expedition and installation, as well as transport of raw materials from suppliers
- ▶ **Functional unit :** 1 m² of installed product
- ▶ **Modelling software and database :** SimaPro 9.1 with ecoinvent 3.5 database
- ▶ **Method :** Midpoint characterization factors recommended by the International Reference Life Cycle Data System (ILCD). The potential climate change impacts (**carbon footprint**) of each stage were estimated selecting the impact category Climate Change from the ILCD method.

About the study

Methodology (cont.)

► Impact categories assessed :

Impact category	Unit	Description	Reference
Climate Change (CC)	kg CO ₂ eq	Global Warming Potential calculating the radiative forcing over a time horizon of 100 years.	IPCC 2007
Ozone Depletion (OD)	kg CFC-11 eq	Ozone Depletion Potential (ODP) calculating the destructive effects on the stratospheric ozone layer over a time horizon of 100 years.	World Meteorological Organization (WMO) 1999
Human Toxicity: Cancer Effects (HTC)	CTUh	Comparative Toxic Unit for humans (CTUh) expressing the estimated increase in morbidity in the total human population per unit mass of a chemical emitted (cases per kilogramme). Specific groups of chemicals require further works.	USEtox
Human Toxicity: Non-Cancer Effects (HTCN)	CTUh	Comparative Toxic Unit for humans (CTUh) expressing the estimated increase in morbidity in the total human population per unit mass of a chemical emitted (cases per kilogramme). Specific groups of chemicals require further works.	USEtox
Photochemical Ozone Formation (POF)	kg NMVOC eq	Expression of the potential contribution to photochemical ozone formation. Only for Europe. It includes spatial differentiation.	van Zelm et al. 2008.
Acidification (A)	mole H ⁺ eq	Accumulated Exceedance (AE) characterizing the change in critical load exceedance of the sensitive area in terrestrial and main freshwater ecosystems, to which acidifying substances deposit. European-country dependent.	Seppälä et al. 2006 and Posch et al. 2008.
Terrestrial Eutrophication (TEu)	mole N eq	Accumulated Exceedance (AE) characterizing the change in critical load exceedance of the sensitive area, to which eutrophying substances deposit. European-country dependent.	Seppälä et al. 2006 and Posch et al. 2008.
Freshwater Eutrophication (FEu)	kg P eq	Expression of the degree to which the emitted nutrients reaches the freshwater end compartment (phosphorus considered as limiting factor in freshwater). European validity. Averaged characterization factors from country dependent characterization factors.	ReCiPe version 1.05

About the study

Methodology (cont.)

► Impact categories assessed :

Impact category	Unit	Description	Reference
Marine Eutrophication (ME)	kg N eq	Expression of the degree to which the emitted nutrients reaches the marine end compartment (nitrogen considered as limiting factor in marine water). European validity. Averaged characterization factors from country dependent characterization factors.	ReCiPe version 1.05
Freshwater Ecotoxicity (FEC)	CTUe	Comparative Toxic Unit for ecosystems (CTUe) expressing an estimate of the potentially affected fraction of species (PAF) integrated over time and volume per unit mass of a chemical emitted (PAF m3 year/kg). Specific groups of chemicals require further works	USEtox (recommended + interim)
Mineral and Fossil Resource Depletion (MFRD)	kg Sb eq	Scarcity of mineral resource with the scarcity calculated as 'Reserve base'. It refers to identified resources that meets specified minimum physical and chemical criteria related to current mining practice. The reserve base may encompass those parts of the resources that have a reasonable potential for becoming economically available within planning horizons beyond those that assume proven technology and current economics	van Oers et al. 2002

► To evaluate other relevant potential impacts, water use, and energy consumption were also assessed

Impact	Unit	Description	Reference
Water consumption (AWARE)	m3	AWARE is to be used as a water use midpoint indicator representing the relative Available Water REMaining (AWARE) per area in a watershed after the demand of humans and aquatic ecosystems has been met. It assesses the potential of water deprivation, to either humans or ecosystems, building on the assumption that the less water remaining available per area, the more likely another user will be deprived.	AWARE 2016
Energy consumption	MJ	The Cumulative Energy Demand (LHV) method was created by PRé Consultants team based on data published byecoinvent for raw materials available in the SimaPro database. The method calculates Lower Heating Values (LHV) of fuels used in each process.	Frischknecht, R. et al., 2007. Weidema B, et al 2013

About the study

Methodology (cont.)

▶ Data collection procedure



▶ Biogenic emissions and CO_{2eq} removals due carbon content in the reference flow are also considered, with the following assumptions :

- ▶ All cork raw materials that enter the system were considered to have a similar amount of carbon stored. The calculation of CO₂ uptake is based on the atomic weights of carbon (12) and carbon dioxide (44), as well as the carbon fraction (dry basis) of 55% and a moisture fraction of 6%¹.
- ▶ Given the purpose of the assessment, emissions from biomass energy production are considered neutral, due to the assumption that the CO₂ that is being released in the incineration process (biogenic CO₂) was captured in the previous product stage 1 - forest management and cork harvesting (uptake), as so, it is no more than a short term delayed emission, resulting in a net neutral balance of CO₂ emissions ^{2,3}.

▶ Accounting the use of materials from recycling :

- ▶ By using materials that have been previously discarded by their first owner (cork by-products), not fit to be used in the primary product manufacturing at their source, Amorim Cork Composites becomes the secondary user and needs to account for the use of recycled material (as a flow from technosphere). This implies that from the moment the user of a secondary user pays for the material, this (secondary) product system will also be responsible for the environmental burden from that point on (also known as polluter-pays principle). As so these materials enter the product system as having zero burdens and benefits.

¹Dias, A.C., Arroja, L., 2014. A model for estimating carbon accumulation in cork products. Forest Systems 2014 23(2): 236-246

²Demertzi, M., Paulo, J.A., Arroja, L., Dias, A.C., 2016. A carbon footprint simulation model for the cork oak sector. Science of the Total Environment 566-567 (2016) 499-511

³Rives, J., Fernandez-Rodriguez, I., Rieradevall, J., Gabarrel, X., 2013. Integrated environmental analysis of the main cork products in southern Europe (Catalonia - Spain). Journal of Cleaner Production 51 (2013) 289-298

About the study

Methodology (cont.)

- ▶ **Additional scenario analysis of the potential carbon sequestration at the forest stage**
 - ▶ A scenario analysis was performed, given past studies^{3,4}, where it is assumed that carbon sequestration of the cork oak forest can indirectly be attributed to cork products was simulated, as the cork transformation industry contribute to the exploitation and maintenance of the cork oak forest.
 - ▶ The analysis compares the GHG emissions of the studied cradle-to-gate system (including expeditions and installation)* to the cork oak forest carbon uptake, considering the cork weight in the functional unit. The resulting carbon balance is presented as an additional environmental information, as should not be confused with the carbon footprint analysis, where GHG emissions and biogenic stored carbon by cork are addressed.
 - ▶ Carbon stored in cork, in the product, was excluded for this scenario to avoid double counting. Allocation of CO₂ uptake to the cork extracted from the cork oak stands follows the same premises of allocating environmental impacts in a previous study⁵.
 - ▶ In this study, a **weight-based perspective for carbon sequestration at the forest stage was considered**: All CO₂ uptake by the cork oak forest is allocated to extracted cork, as cork production is the main economic activity of cork oak forest, considering the weight of cork present in the functional unit of the final product.
 - ▶ The analyzed scenarios consider carbon sequestration in well-managed cork oak forests, with a high tree coverage and good soil and climate conditions, to have an average CO₂ uptake of 11 t CO₂/ha⁶, reaching a maximum of 14,7 t CO₂/ha. Translating⁷ these values in function of cork extraction, there is a CO₂ uptake of 55 t CO₂/t of cork extracted, reaching up to 73 t CO₂/t of cork extracted.

*detailed results of carbon footprint not disclosed in this document as requested by the client

⁴EY, 2019. Environmental footprint of natural cork stoppers. Corticeira Amorim, Santa Maria de Lamas.

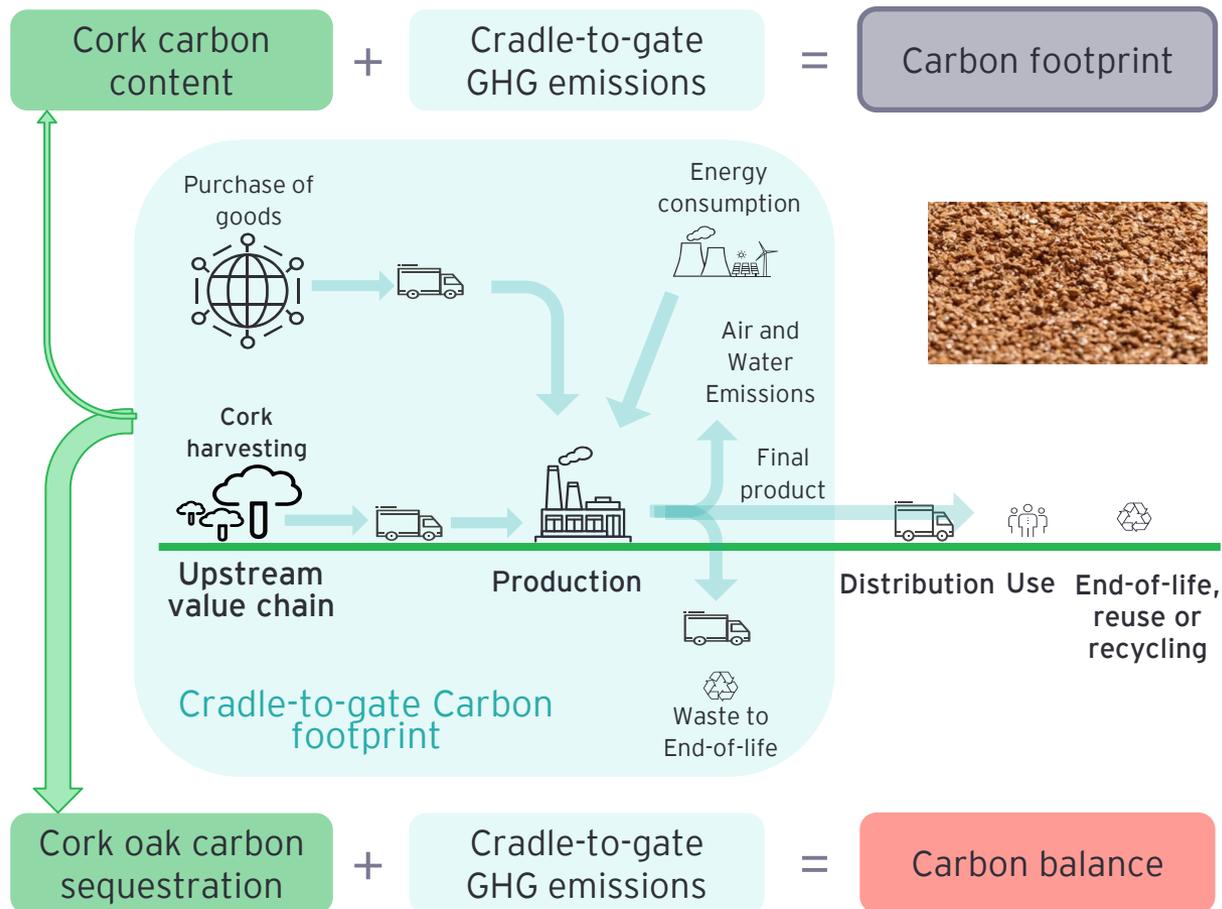
⁵Dias, A.C., Rives, J.S., González-García, S., Demertzi, M., Gabarrel, X., Arroja, L., 2014. Analysis of raw cork production in Portugal and Catalonia using life cycle assessment. International Journal of Life Cycle Assessment (2014) 19:1985-2000

⁶Figures considered in the "The value of cork oak montado ecosystem services" (EY, 2019c). Average ecosystem CO₂ uptake (11 t CO₂/ha) considers wet and dry years in well managed forests, with a maximum of 14,7 t CO₂/ha registered in optimal climatic conditions (Costa-e-Silva et al., 2015).

⁷Conversion of forest ecosystem uptake per tonne of extracted cork considers the total cork oak occupation area in Portugal (7 19 937 ha) (ICNF, 2019) and an average value of cork production (145 000 t cork) based on a nine-year series (2003-2011) (APCOR, 2011).

About the study

Methodology (cont.)



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Carbon balance

Carbon balance: results

Scenario analysis with carbon sequestration in the cork oak montado¹

For the average weight Corkeen when considering carbon sequestration in the cork oak* montado:

There is a forest storage up to:

- **120**

kg CO₂/1 m²

Therefore, the carbon balance reaches up to

- **102**

kg CO_{2eq}/1 m²



scenario analysis based on well-managed cork oak montado

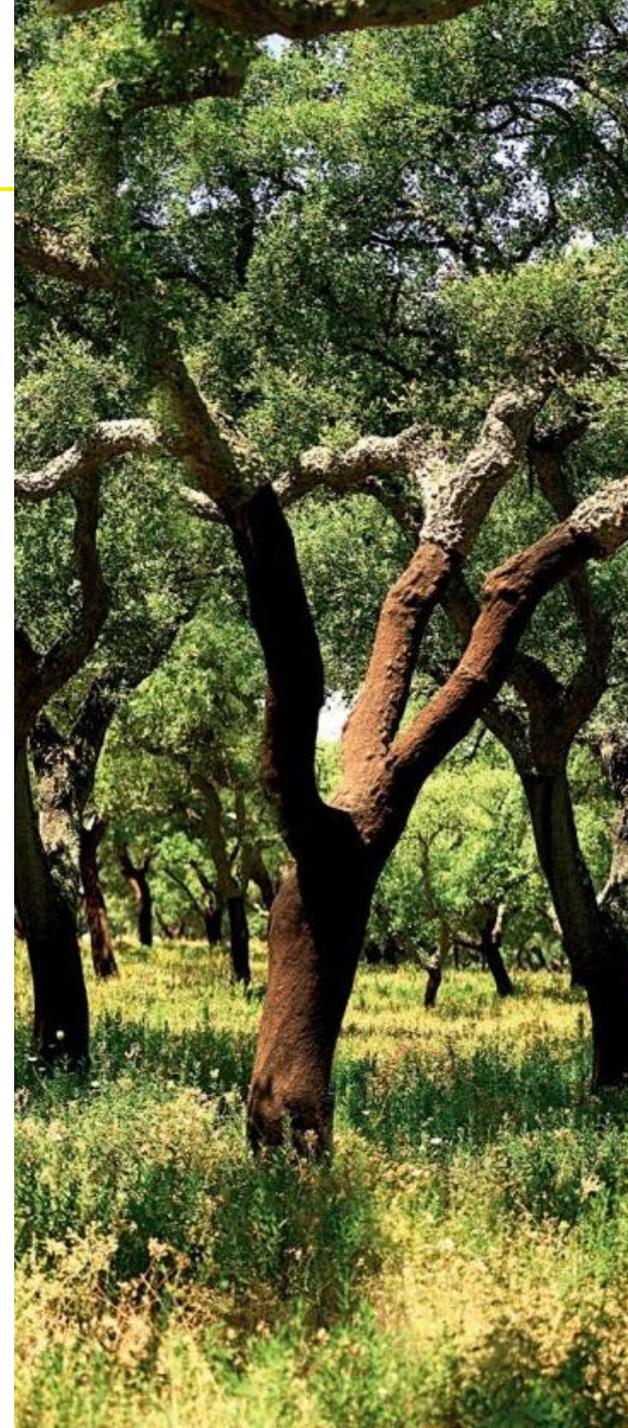
- **73 t CO₂/t cork**

Maximum ecosystem CO₂ uptake registered (14,7 tCO₂/ha) (Costa-e-Silva et al., 2015).

with the average ecosystem CO₂ uptake being - 55 t CO₂/t cork, considering wet and dry years in well managed forests (11 t CO₂/ha).⁹

⁹ figures used in "The value of cork oak montado ecosystem services, EY 2019"

¹ considering a carbon footprint of 18 kg CO_{2e} previously calculated



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LCA environmental footprint

LCA results: 1m² of Corkeen

Environmental footprint for 1 m² of Corkeen



LCA Indicators : CC=Climate Change; OD=Ozone Depletion; HNTC = Human Toxicity: Non-Cancer Effects; HTC=Human Toxicity: Cancer Effects; POF= Photochemical Ozone Formation; A=Acidification; TEu=Terrestrial Eutrophication; FEu=Freshwater Eutrophication; ME=Marine Eutrophication; FEc=Freshwater Ecotoxicity; MFRD=Mineral and Fossil Resource Depletion; WU=Water use; CEDt=Cumulative Energy Demand - Total

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Conclusions

Conclusions

Environmental balance

- ▶ Overall results for year 2020 show that, under a cradle-to-gate approach, further including the expedition and installation of the product, the highest environmental impacts are associated with the processes where customized products and other materials, such as resins and binders, are used. Therefore, the impact of Corkeen Top Layer Coating and Installation stages is significant across all LCA impact categories.
- ▶ The exception to this affirmation is the indicator CEDt (Cumulative Energy Demand) in which a significant contribution of the Base layer production and packaging as well as the Top layer granules production stage is observed. Together these stages account for 90% of direct and indirect energy use, which is concentrated in cork granules production, due to high energy consumption from several sources including electricity, biomass and natural gas, as well as the energy required to support the input of steam.

Carbon sequestration of the cork oak forest

- ▶ Considering a scenario analysis, where the carbon sequestration of the cork oak forest can indirectly be attributed to cork products, based on well-managed cork oak forests, a forest carbon uptake up to -120 kg CO_2 per 1 m^2 can be observed. Considering both the forest carbon uptake and the GHG emissions of maximum weight of Corkeen production ($18,1 \text{ kgCO}_2/ 1 \text{ m}^2$), there is a carbon balance up to $102 \text{ kg CO}_{2\text{eq}}$ per 1 m^2 . This balance illustrates the differentiating factor between cork and other products.
- ▶ As the cork oak tree retains carbon for over 100 years, regardless of cork harvesting, cork exploitation supports the maintenance of the ecosystem, thus having a positive contribution to global climate regulation.

Technical sheet

Technical sheet

Title "Environmental footprint of Corkeen : Executive summary (*high level disclosure version as requested by the client*)"

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