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Table of contents

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JUST-GREEN AFRH2ICA

EXECUTIVE SUMMARY

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Clean Hydrogen Partnership

This document is the deliverable "D5.4 - Final Positioning Paper" developed within WP5 of the JUST GREEN-AFRH2ICA project.

The aim of this report is to highlight the main themes and findings of the various assessments carried out within the project along the different WPs in order to provide a comprehensive and succinct understanding of Africa's potential in the transition to green hydrogen, and to emphasize how a balanced cooperation between Africa and Europe can contribute to the development of a sustainable hydrogen economy that supports energy independence, economic growth and social well-being on both continents. Africa's renewable energy potential positions it as a leader in green hydrogen production, while Europe's expertise in hydrogen technologies and market frameworks facilitates capacity building and technology transfer.

One of the most important legacies of the project is the Final Strategic Roadmap, which brings together the results of the social, economic and technical analyses addressing Africa's specific challenges.

On the other hand, the human-centered approach underpins the project's activities, with an emphasis on education, training and public engagement.

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1.Introduction

The transition to green hydrogen represents a transformative opportunity to address the interconnected challenges of climate change, energy security, and economic development. By recognizing Africa's vast renewable energy resources and the European Union's leadership in hydrogen technologies, the JUST-GREEN AFRH2ICA project is fostering a collaborative and equitable transition to green hydrogen economies. This collaboration seeks not only to create a sustainable hydrogen market but also to ensure that its development supports energy independence, economic growth, and social well-being across both continents.

A vision of just collaboration between Europe and Africa

At the core of JUST-GREEN AFRH2ICA lies the principle of just collaboration, a balanced partnership where Africa and Europe work together as equals to achieve shared goals. This approach acknowledges Africa's unparalleled potential in renewable energy - particularly solar and wind - as a cornerstone for green hydrogen production, while emphasizing that this potential must benefit African nations by promoting local energy independence, job creation, and economic resilience.

The European Union, with its advanced expertise in hydrogen technologies, policy frameworks, and market development, plays a pivotal role in supporting Africa's renewable energy transformation. However, this collaboration goes beyond technology transfer. It seeks to establish mutual learning opportunities where both regions exchange knowledge, co-develop solutions, and shape the future of the global hydrogen economy in a way that reflects the aspirations and needs of African and European societies alike.

Through active engagement with stakeholders at the African Union (AU) and European Union (EU) levels, the project aims to harmonize strategies for green hydrogen development. This alignment ensures that green hydrogen production in Africa not only meets international demand but also empowers African countries to build sustainable, locally rooted economies. By prioritizing equitable resource management, ethical investment practices, and capacity building, the project ensures that Africa's renewable energy resources become a driver of prosperity for its own people.

The Green Hydrogen Just Transition Roadmap

Central to the project's mission is the development of the **Green Hydrogen Just Transition Roadmap**, a comprehensive guide that integrates social, economic, and technical analyses of

green hydrogen scenarios across Africa. The roadmap draws lessons from Europe's experience in catalyzing investments, establishing policies, and creating a thriving hydrogen market. It also emphasizes Africa-specific challenges and opportunities, proposing solutions that balance the development of export-driven hydrogen projects with the growth of local energy infrastructure.

This roadmap envisions a hydrogen future where African countries can harness their renewable resources not only to meet global demand but also to enhance domestic energy access, reduce reliance on fossil fuels, and stimulate economic diversification.

A human-centered approach is essential to achieving a just transition. JUST-GREEN AFRH2ICA placed significant emphasis on **education and training initiatives** to develop local expertise and empower communities. By engaging young PhD students, local researchers, and the general public, the project promoted widespread awareness of green hydrogen technologies and their potential benefits. These activities were designed to cultivate a new generation of energy leaders and entrepreneurs who can drive the growth of a hydrogen economy tailored to local contexts.

The project actively involves a diverse range of stakeholders, including governments, industries, research institutions, and civil society organizations from both continents. Through stakeholder engagement, the project ensures that decision-making processes are inclusive and reflect the perspectives of all parties involved. This collaborative approach fosters trust, transparency, and shared accountability, laying the foundation for long-term partnerships.

Towards a Sustainable and Independent Hydrogen Economy

By uniting the strengths of Africa and Europe, JUST-GREEN AFRH2ICA aspires to build a green hydrogen economy that is not only innovative and sustainable but also equitable. This vision aligns with global efforts to combat climate change while addressing regional priorities such as energy independence, economic diversification, and job creation.

JUST-GREEN AFRH2ICA was more than a technical project — it was a movement toward a future where the hydrogen economy becomes a tool for shared progress, bridging continents and empowering communities to thrive in the green energy transition.

The Hydrogen Hub Approach

In order to kick-off African Hydrogen Economy and guarantee bankable and reliable green hydrogen projects, JUST GREEN AFRH2ICA (also following suggestions coming from project stakeholders) is promoting the concept of **Hydrogen Hubs,** being inspired (as well as a little bit "in contrast" with) by the EU concept of Hydrogen Valleys. Considering the different background situation (with a weaker electric grid and electrification, an absence of incentives and grid stability needs to be performed by electrolysers, a less organized/structured public

transport system), it is indeed complicated to imagine to setup in Africa one of the Hydrogen Valley archetypes currently promoted in Europe.
However, Africa has different large scale industrial sites that are already today large scale hydrogen off-takers in different sectors (refineries, chemicals, metallurgic...)
Starting from these “Hydrogen Industrial Hubs”, it will be possible to develop scalable and bankable green hydrogen production projects relying on a certain hydrogen demand for industrial purposes. Around such “hydrogen hubs” (that will be investigated in the project in the different African representative countries where consortium partners are active - e.g. Morocco, Kenya, South Africa, Togo/Ghana) that guarantees further than a certain off-taking also proper know-how for managing the electrolysis plant, it will be then possible to create a local hydrogen demand also for other type of business (like transport, production of fertilizers for local agriculture etc.) also targeting a scale up of the first “Lighthouse” project to be installed.

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2.Context analysis

Africa's abundant renewable energy potential, particularly in solar and wind, positions the continent as a key player with the potential to produce green hydrogen at competitive costs. Simultaneously, the European Union has established itself as a global leader in hydrogen technologies, policies, and market frameworks. This dynamic presents an opportunity for AU-EU collaboration to address shared energy and climate goals. However, the historical context of resource exploitation and unequal partnerships necessitates a new approach that avoids perpetuating patterns of dependency or neo-colonial dynamics. The JUST-GREEN AFRH2ICA project emphasizes the importance of mutual benefit, aiming to empower African nations to develop independent hydrogen value chains while fostering collaborative research and development ecosystems with the EU.

The EU's hydrogen target to import 10 Mtpa from non-EU countries by 2030 (RePowerEU plan[1]) could be satisfied thanks to African imports, leveraging existing cross-Mediterranean natural gas pipelines and ship transportation of liquefied hydrogen or ammonia. Meanwhile, many African countries lack well-defined hydrogen strategies despite significant renewable energy potential: most projects, often supported by external investments or political backing, remain in their early stages and focus more on export markets rather than developing local hydrogen demand or markets. More in detail, according to the results of the assessments carried out in the deliverable 1.2, North Africa emerges as an ideal location for hydrogen export to the EU and for use in local refineries and hard-to-abate industries. East Africa, on the other hand, offers potential for green fertilizers and hydrogen production for domestic and Asian markets, while South Africa is well-positioned for green product manufacturing and global export. West Africa presents opportunities for local refineries and markets, with a potential transfer of hydrogen to Northern Africa for EU export.

In terms of resource management, **water considerations are a cornerstone** of hydrogen production, particularly in Africa, where water availability and quality can vary widely across regions. The production of green hydrogen- using electrolysis powered by renewable energy - relies on access to water as a feedstock, making the efficient and sustainable management of this resource a critical factor in the development of the hydrogen economy.

The amount of water required throughout the hydrogen value chain can differ significantly depending on the **source and quality of the water** as well as the **treatment technologies employed**. In areas where water scarcity is a pressing issue, careful planning and innovation are required to ensure that hydrogen production does not exacerbate existing water

[1] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en

challenges or compete with essential needs such as agriculture, drinking water, and sanitation (Deliverable 2.1).

To address these challenges, a holistic and integrated approach to water supply, usage, and disposal is essential. This includes:

- Assessing local water resources: Conducting comprehensive evaluations of local water availability and quality to identify suitable sites for hydrogen production. This ensures that operations are established in regions where water use for hydrogen production will not undermine other vital water needs.
- Innovative water-saving technologies: Adopting advanced water treatment and recycling technologies to minimize the overall water footprint. For example, utilizing desalination to convert seawater into fresh water in coastal regions, or deploying closed-loop systems that reuse water within the production cycle.
- Optimizing site-specific water requirements: Tailoring water management strategies to the unique conditions of each production site, including climate, hydrology, and proximity to water sources. This ensures that water use is both efficient and sustainable.
- Addressing water security risks: Managing risks related to water scarcity, droughts, and competing demands by integrating water considerations into the planning and operation of hydrogen facilities. This includes collaboration with local governments, communities, and industries to align water use with broader regional priorities.
- Balancing water needs and socio-economic benefits: The development of Africa's hydrogen market must carefully balance the water requirements of hydrogen production with the socio-economic benefits it can bring. A well-planned hydrogen economy has the potential to drive economic growth, create jobs, and enhance energy independence, but this must not come at the cost of water access for vulnerable populations. By prioritizing equitable water resource management, hydrogen production can support local development while preserving critical ecosystems.

What is relevant to highlight is that, at the end of the day, green hydrogen promotion is more an opportunity than a threat to facilitate of water access to African economy at 360°, supporting desalination project realization and other water purification interventions.

Representative use cases

The **JUST-GREEN AFRH2ICA** project identified four strategic use cases - **Morocco**, **Kenya**, **Ghana/Togo area**, and **South Africa** - as representative regions to explore the feasibility and scalability of green hydrogen initiatives across Africa. These regions were chosen based on the availability of data, significant renewable energy potential, and the feasibility of leveraging existing infrastructure. By examining these diverse contexts, the project provided

a comprehensive view of the opportunities and challenges associated with green hydrogen development across the continent.

Renewable Energy Resources and Regional Strengths

Africa's renewable energy landscape is diverse, and each use case highlights unique strengths and resource opportunities (Deliverable 2.2) for green hydrogen production:

- **Morocco:** With its abundant **solar and wind resources**, Morocco is well-positioned as a leading green hydrogen producer and an export hub to Europe, also exploiting the Natural Gas pipeline already existing and the relevant industries (e..g of phosphate, refineries, chemicals...) present in the countries. The combination of high-quality renewable resources, high internal demand and established infrastructure provides a strong foundation for green hydrogen initiatives.
- **Kenya** : Unlike most regions where solar and wind are considered as only RES sources , Kenya's Rift Valley relies heavily on **geothermal energy**, providing a unique advantage. Geothermal energy offers (already today) a consistent, year-round energy source for green hydrogen production, reducing dependency on variable renewable energy sources.
- **Ghana and Togo :**This region benefits from abundant **solar energy**, which enhances its capacity for green hydrogen production. Collaboration between Ghana and Togo offers opportunities to develop shared infrastructure and optimize regional potential.
- **South Africa :**South Africa's production potential is bolstered by **solar and wind resources**. Its critical raw material availability, its local industrial industry (steel, chemical etc.) and its proximity to **Namibia** (another country with a great RES potential, a good electrification rate and large scale space availability), which opens opportunities for cross-border collaboration. Namibia's complementary resources further enhance the region's ability to scale hydrogen initiatives.

Applications and Economic Impact

The demand for green hydrogen in these regions is driven by diverse industrial applications, including **fertilizers, steel, and chemicals**, as well as **transportation**. These industries represent significant opportunities for decarbonization and economic growth, positioning green hydrogen as a transformative energy vector (Deliverable 2.2). Further to this, the consortium studied the possibility not only to produce and export green hydrogen (evaluating LCOH in the different use cases analysed in the project), but also to produce "Green products" and export them via existing value chain (Deliverable 2.3). This assessment of "Green products" to be produced via local green hydrogen can facilitate the setup of the concept of "HYDROGEN HUBS" proposed in the project as well as to attract investments from EU

manufacturers already active in Africa in sectors like refineries, chemicals, concrete, steel making... if proper supporting schemes could be implemented.

Employment Potential of Green Hydrogen

The development of green hydrogen has substantial employment implications across Africa (Deliverable 2.2), varying by energy source and region:

- **Solar Energy**: Solar energy projects demonstrate the highest job creation potential, particularly for **PV-based production**, which consistently generates significant employment opportunities throughout project lifecycles. This is especially relevant in regions like Ghana, Togo, and Morocco, where solar resources are abundant.
- **Wind Energy**: While wind projects are less labor-intensive than solar ones, they still offer considerable employment potential, contributing up to **2 million direct jobs** across the continent. South Africa, with its strong wind energy infrastructure, exemplifies this potential.
- **Geothermal and Hydro Energy**: These resources, particularly in **Kenya and Ghana**, provide substantial employment opportunities, supporting local economies and fostering regional expertise.

Scientific publication

The JUST-GREEN AFRH2ICA project promoted an innovative vision and stimulated intense interdisciplinary research activity. Through the analysis of technical, socio-economic and local scenarios, the project generated a solid knowledge base that has been expressed in several scientific articles:

- Green hydrogen landscape in North African countries: Strengths, challenges, and future prospects[2]: This paper explores the diverse strengths and weaknesses of North African countries (Morocco, Algeria, Tunisia, Egypt, and Mauritania) in exploiting their renewable energy potential and adopting green hydrogen initiatives The study highlights the respective countries' contributions and challenges in the context of renewable energy and green hydrogen production.
- Assessing the feasibility of a green hydrogen economy in selected African regions with composite indicators[3]: the study offers a comprehensive analysis of the feasibility of green hydrogen economies in Western and Southern African regions, focusing on the ECOWAS and SADC countries using a novel approach based on composite indicators.

[2] Green hydrogen landscape in North African countries: Strengths, challenges, and future prospects - ScienceDirect (Bayssi et al., 2024) https://doi.org/10.1016/j.ijhydene.2024.08.277

[3] Assessing the feasibility of a green hydrogen economy in selected African regions with composite indicators - ScienceDirect (Lahnaoui et al., 2025) https://doi.org/10.1016/j.ijhydene.2024.12.233

- Evaluation of water/energy intensity of green hydrogen production plants in Africa scenario[4]: the study shows the limited impact in terms of CAPEX and OPEX of water supply in Green Hydrogen production plants in Africa as well as the limited impact from a WEF (Water Energy Food) nexus point of view on local African countries.

Lessons Learned and Broader Implications

The use cases underscore the importance of tailoring hydrogen strategies to the unique characteristics of each region, balancing resource availability, water management needs, and industrial demand. Coastal areas demonstrate the potential of desalination technologies, while landlocked regions highlight the importance of integrating groundwater into hydrogen production strategies. These insights are critical for shaping sustainable hydrogen economies that address local and global challenges.
Additionally, the project highlights the transformative economic impact of green hydrogen. Beyond its potential to decarbonize industries and drive energy independence, the hydrogen economy offers a pathway to significant job creation and skills development, particularly in regions with high renewable energy potential.

Education and Capacity Building

One of the key lessons learned from the JUST-GREEN AFRH2ICA project is the critical role of education and capacity building in fostering a sustainable and inclusive green hydrogen economy. The project emphasized that the success of hydrogen initiatives depends not only on technological and industrial advancements but also on the development of a skilled workforce (at R&D, academic and pre-academic level) and informed communities.

Leveraging African Expertise

An important realization during the project was the underutilization of African expertise for training and education. Africa has a wealth of knowledge and experience, particularly in renewable energy sectors, which can be directly applied to the hydrogen transition. Involving African trainers alongside European experts ensures that education initiatives are rooted in local contexts, reflecting regional realities and challenges. This approach not only enhances the relevance of the training but also fosters ownership and long-term sustainability of the hydrogen economy. Valorizing African expertise also strengthens collaboration between continents, creating a more balanced exchange of knowledge and resources. By integrating local trainers and experts, the project has demonstrated the potential for Africa to lead its own hydrogen transition, supported by international partnerships.

[4] - "Evaluation of water/energy intensity of green hydrogen production plants in Africa scenario", Massimo Rivarolo et al., https://doi.org/10.1088/1742-6596/2893/1/012074

The Need for Infrastructure and Facilities

Despite the fact that some African countries have remarkable academic backgrounds, there is generally a significant gap in the availability of research laboratories and dissemination spaces. For example, the development of hands-on zones where people can go through the theory they are learning would be of paramount importance in order to experience first-hand what they are studying and to further stimulate interest in green hydrogen. These facilities are essential for:

- Advanced research: Laboratories equipped with state-of-the-art technology are crucial for conducting cutting-edge hydrogen research and innovation.
- Public engagement and dissemination: Spaces dedicated to showcasing research results and hosting public engagement events are needed to involve stakeholders, decision-makers, and the general public in the hydrogen transition.

To address this gap, potential interventions should focus on funding the construction and modernization of laboratories. These facilities should serve both academic research purposes and as hubs for stakeholder engagement and public awareness campaigns.

Learning from the Renewable Energy Sector

The renewable energy sector offers a valuable precedent for building training and dissemination infrastructure. In the past, Africa has successfully developed training centers and educational programs focused on solar and wind energy, which have significantly contributed to local capacity building and public awareness. A similar approach could be replicated for hydrogen, ensuring that the continent is prepared to lead in this emerging sector.

Addressing the Public Engagement Gap

Africa currently faces a shortage of spaces and organizational frameworks for end-stage activities aimed at involving the general public. Public engagement is vital for building social acceptance of hydrogen technologies and fostering a sense of community ownership. Dedicated spaces for demonstrations, workshops, and interactive exhibits can help bridge the gap between research and societal impact, ensuring that the hydrogen economy benefits all layers of society.

To capitalize on these lessons, the following actions are recommended:

- Prioritize local trainers: Invest in programs that train African educators and technical experts to lead hydrogen-related education and training initiatives.
- Develop and fund laboratories: Allocate resources to build and upgrade research and dissemination facilities, enabling hands-on training and stakeholder engagement.

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- Foster public awareness: Establish spaces and programs for end-zone activities that connect hydrogen research with the general public, drawing inspiration from successful models in the renewable energy sector.
- Promote international collaboration: Strengthen partnerships between African and European institutions to ensure mutual learning and resource sharing.

Building Momentum for a Green Hydrogen Economy

By focusing on Morocco, Kenya, Ghana/Togo, and South Africa, the JUST-GREEN AFRH2ICA project demonstrated how Africa's diverse resources can be leveraged to establish a **sustainable and inclusive hydrogen economy**. The findings from these use cases provide a scalable framework for expanding hydrogen initiatives across the continent, ensuring that future development is equitable, resource-efficient, and economically beneficial.

The sustainability assessments (Deliverable 2.5) have revealed that the carbon footprint of green hydrogen production in Africa ranges between 1.4 and 2.3 kg CO_2 equivalent per kilogram of hydrogen produced, while electricity consumption and electrolyzer manufacturing emerge as key environmental hotspots.

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3.Consortium position

Wrapping up the whole project activities, the following challenges were identified as the most burning ones to promote a real JUST hydrogen transition in Africa:

- less availability of electrification integration and lack of a robust electric grid can hinder the integration of electrolysers/dedicated RES Plants in Africa, but this can become an opportunity to promote the hydrogen hub concept, composed by off-grid RES+Electrolyser plants with consolidated and relevant hydrogen demand in
- there is a lack of skilled workforce not only to develop African own green hydrogen plants, but even the first plants to be realized by foreign investors: this gap must be covered at academic/pre-academic level but also via "knowledge transfer" from similar sectors (this is an approach to be considered also for manufacturing value chain)
- Few hydrogen strategies are so far present in AU countries and lack of coordination among them: AU recently published the first continental H2 plan, but such strategies has to be jointly monitored and tracked
- African countries won't be able anymore soon to access to subsidized fertilizers and an internal value chain of "self-produced fertilizers" should be developed
- Few projects in Africa achieve FEED+ status: this is related not only to workforce gap, but also due to the fact that Africa has a High cost of capital and high risk of investments related to CAPEX intensive projects as green hydrogen ones are

At this purpose, the following actions were suggested in order to facilitate the setup of a real African hydrogen value chain

- Support as first lighthouse green hydrogen projects the creation of off-grid "Hydrogen Hubs" (at 1-5 MW Electrolyser scale) in hard to abate industries to develop a domestic demand at local level starting from their surrounding and guaranteeing bankable projects with clear and robust H2 demand, attracting also intentions of investment from EU Manufacturers producing specific products (like those ones analysed in D2.3) that already have a logistic value chain in Africa
- Develop local skills (also together with RES ones) at academic/pre-academic level
- Promote water desalination coupled with Green hydrogen hub also to facilitate water access at local level
- Transfer know-how and manufacturing capabilities from some sectors (e.g. power converters, chlorine etc.) to FCH one
- Create a Public Private Partnership that also dialoguing with donors active in Africa, can facilitate the financing of green hydrogen plants
- Create a regulatory framework that imposes to RES investors to couple setup or retrofitting of large RES Plants (e.g. Hydro) with Electrolysers in Africa

While the following actions were proposed to foster cooperation between Africa and Europe in the field of green hydrogen

- Facilitate access to EU Instruments like Innovation Fund, IPCEI, CEF etc. to African partners for green Hydrogen in Africa production projects

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- Define not only MoU , but real and precise off-taking contracts between countries in order to make bankable green hydrogen projects also for what it concerns export projects
- Enable EU products manufacturers to receive ETS savings for green hydrogen projects realized in Africa to produce “green goods” then traded to EU and facilitate the setup of “Green Hydrogen Hubs” in Africa with a double benefit (ETS saving – higher value proposition products) also for EU investors
- Setup real “green hydrogen corridors” (thanks to proper pipeline upgrade but also thanks to robust agreement among EU gas TSOs and creation of free trade zones) between North Africa and Europe via existing Natural gas pipeline

For all these actions and objectives, JUST GREEN AFRH2ICA Consortium identified specific targets and plans up to 2030-2040-2050: all of them pass through two key paradigms

1. Create a real sustainable and just transition, that involves the local communities in the design of green hydrogen projects as well as in their management, drawing them considering benefits for the whole local ecosystem and avoiding any risk of “colonialism”
2. Promote Renewables widespread in Africa as key asset to not only setup a green hydrogen economy, but also to take advantage of electrolysis plants to facilitate water access and electrification at local level

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JUST-GREEN AFRH2ICA

CONCLUSION

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Clean Hydrogen Partnership

In this final positioning paper, the main outcomes of JUST GREEN AFRH2ICA project activities are reported.

Further then the main results of project modelling and roadmapping activities as well as key actions needed to support African Green Hydrogen transition and to setup a mutual benefit cooperation with Europe, this report would like to stress the unique potential of Africa to become a global hydrogen leader, not only for its vast renewable energy potential, but also for other reasons that can make Africa a real global hydrogen transition protagonist such as:

- Presence of raw and precious materials availability for the manufacturing of electrolysers (alkaline, PEM)
- Presence of relevant O&G Know how and infrastructure (pipelines, LNG terminal etc.) that could be easily reconverted to hydrogen
- Presence of hard-to-abate industries in the continent that have to be the first off-takers of locally produced products (already traded all around the world and that can increase their value proposition)

Africa can be therefore already today a Hydrogen Leader, however to do so it has to unlock this potential thanks to the support of foreign investors and foreign competences: Europe has to be the first interlocutors in this sense, creating a bridge across the Mediterranean sea for a mutual benefit collaboration.

Such bridge is already existing both in a figurative and in an actual sense: JUST GREEN AFRH2ICA identified some actions that could be put in place in this direction to boost African economic development and increase European energy security and making both continents frontrunners in a new global hydrogen economy.

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