AMMONIA ENERGY ASSOCIATION

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Who we are

The **Ammonia Energy Association** (AEA) is a global industry association that promotes the responsible use of ammonia in a sustainable energy economy.

Members: 185+ global and cross-sectoral

Our mission

Supply: decarbonize ammonia production

Demand: adopt ammonia in energy markets

How we do it

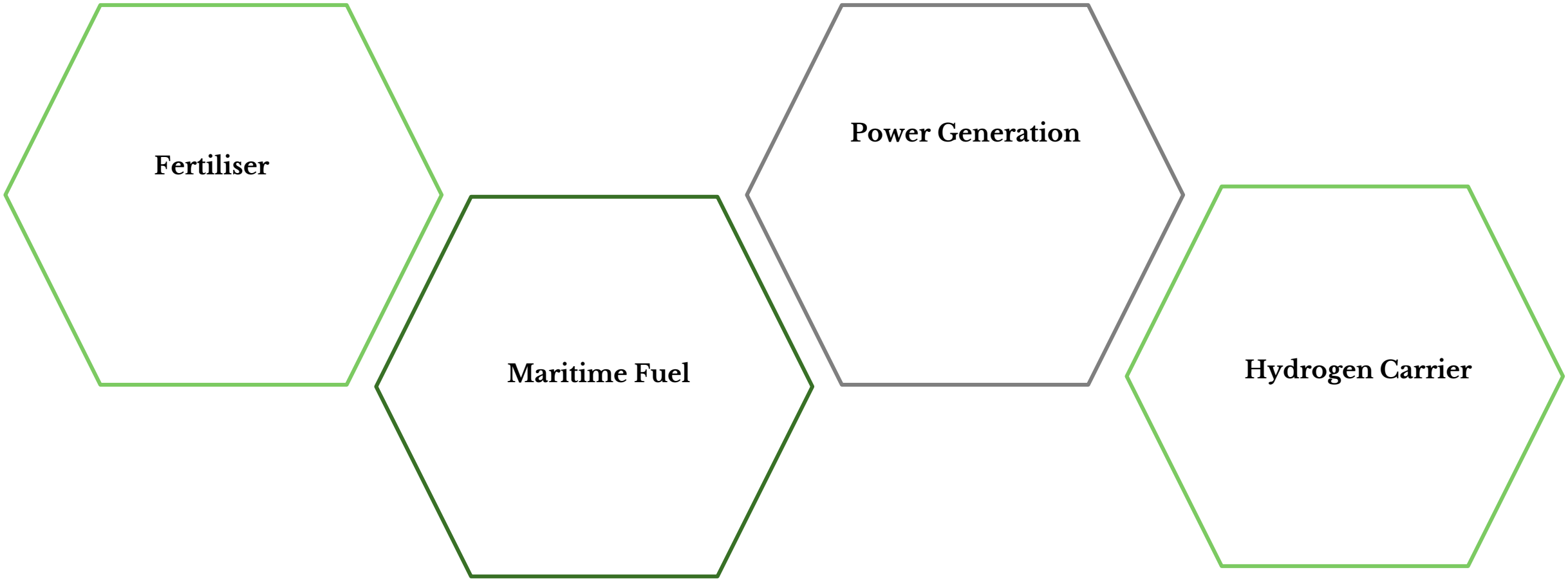
We achieve this by taking collective action on behalf of our Members and by facilitating cross-sector and international collaboration among our membership

Member List (October 2022)

PLATINUM: bp, CF Industries*, CWP Global*, Denbury, The Hydrogen Utility*, Hy Stor Energy, InterContinental Energy*, KBR*, LSB Industries*, Mitsui & Co., Monolith Materials*, Nutrien*, OCI*, Reliance Industries, Starfire Energy*, Yara*. **GOLD**: ACME Group, AFC Energy, Airgas, Aker Clean Hydrogen, Casale*, Enaex, Engie, Equinor, Fortescue Future Industries, FuelPositive, Hamilton Locke, Horisont Energi*, Maersk*, Marnco*, Mitsubishi Heavy Industries, Origin Energy*, Proton Ventures*, ReNew Power, S&P Global, Syzygy Plasmonics, thyssenkrupp Industrial Solutions*, Topsoe*, Trammo, Trigon, Tri-State Generation & Transmission. **SILVER**: AES, Air Products, Ambient Fuels, Ammonigy, AmmPower, Amogy, Argus Media, BASF, Black & Veatch, Bureau Veritas, Burns & McDonnell, Casa dos Ventos, Christof Group, Consorcio Eólico, ControlRooms.ai*, Copenhagen Atomics*, Copernic Catalysts, CRU Group, CS Combustion Solutions, Cummins, Eastman Chemical, European Institute for Energy Research (EIFER), Enterprize Energy, Envision Group, Fertiberia, First Ammonia, Fujitsu Research of America, GenCell Energy, GTI Energy, Gunvor Group*, H2Site, Heraeus, Humble Midstream, HyFuels Holdings, IHI Americas, Inherent Solutions Consult, inodú, Intecsa Industrial, JGC Corporation, Johnson Matthey, Koch Fertilizer, Linde, Lotte Fine Chemical, Mabanaft, Mercuria, MineARC Systems, Mitsui OSK Lines, Nel Hydrogen*, Oldendorff Carriers, Pacific Green Technologies*, SagaPure*, Shell, Skeiron, Stamicarbon, Starbulk Carriers, Sunborne Systems, SwitchH2, Talos Energy, Technip Energies, Técnicas Reunidas, Terrestrial Energy, Thorium Energy Alliance*, TotalEnergies*, TritenIAG, Tsubame BHB, Universal H2, Vesta Terminals B.V., Wonik Materials, Woodside Energy. **MEMBERS**: 8 Rivers Capital, AB Achema, ACEN Australia, Advanced Ionics, Advanced Thermal Devices, AHMON, Air Liquide, alfanar, Apex Clean Energy, Arizona Public Service, Ark Energy, AustriaEnergy, Avaada Energy, Axetris, Borden Ladner Gervais (BLG), Brittany Ferries, C-Job Naval Architects, Carbon-Neutral Consulting*, CHZ Technology, Cozairo, Cura IT, CyaNH3, Danaos Shipping, DBI Fire and Security, Duiker Combustion Engineers, EDF Renewables, EIH2, Energy Estate, Eneus Energy, Evergy, EVOS, Greenfield Nitrogen, GTT North America, Idemitsu Kosan, Incitec Pivot, Ingenostrum, Inpex Corporation, Interlock Energy, Intersect Energy, IT Power Australia, John Cockerill, Jupiter Ionics, Karachaganak Green Energy Corporation, Keppel Infrastructure*, Koole Terminals, Mainspring Energy, MAN Energy Solutions, MicroEra Power*, Moda, Nebraska Public Power District, Neology, Netsco, New Energy Technology, Next Hydrogen, NGLStrategy, Nikki-Universal, Nordex, Northern Nitrogen, NovoHy, NYK Energy Transport (USA), Oceanic Vessels, Oiltanking, Osaka Gas USA, Radia, Renewable Hydrogen Corporation Canada, RES, SBM Schiedam, Scatec, Shrieve Chemical Company, Suzlon Australia, TasRex, Tokyo Gas, Umicore, Unconventional Gas Solutions, Vahterus, Varo Energy, Vopak.

AMMONIA ENERGY ASSOCIATION

Demand for Clean Ammonia



Ammonia Project Features

(Wednesday 23 November, 3PM CEST, online via Zoom Webinar)

Renewable ammonia projects in Sub-Saharan Africa

Ralph Koekkoek
Project Development Manager, MET Development

Marcel Jacobs
Representative African Hydrogen Partnership, owner Jacob Lawren Ltd.

In conversation with:

Kevin Rouwenhorst (Technology Manager, AEA)

Maire Tecnimont

ahp African Hydrogen Partnership

AMMONIA ENERGY ASSOCIATION

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Ammonia Energy Conference 2022

Phoenix

19th Annual Ammonia Energy Conference

Tuesday to Thursday,
November 15-17, 2022

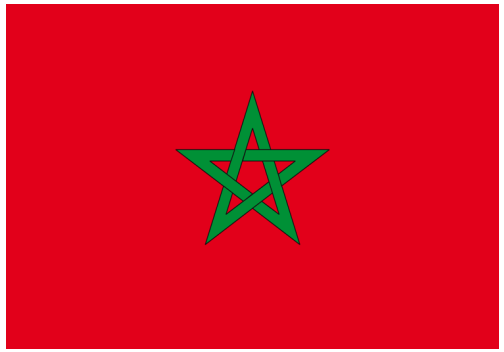
Phoenix Convention Center, Arizona

Schedule and registration details are available at the AEA website

CWP

AMUN & AMAN Projects

AMUN




TANGER
Ceuta
M'diq
Tétouan
Mer Méditerranée
Chefchaouen
Ouezzane
Ketama
Al Hoceima
Oujda
Sour el Arba du Rharb
Moulay Idriss
Kenitra
Volubilis
Khemisset
Taza
RABAT
FÈS
CASABLANCA
Mohammedia
MEKNÈS
Ben Slimane
Romani
Azrou
Jdida
Berrechid
Settat
Khouribga
Midelt
Safi
Fkih Ben Salah
Kasba Tadla
El Kelaa des Sraghna
Beni Mellal
Errachidia
MARRAKECH
Chichaoua
Talouet
Tinejdad
Essaouira
Tinghir
Erfoud
Asni
Taddert
Ait Benhaddou
Rissani
Ouksimeden
Boumalne Dadès
Merzouga
Tifeltout
Skoura
Alnif
Ouarzazate
Tazzarine
AGADIR
Taroudant
Agdz
Tansikht
Inezgane
Zagora
Tamegroute
Taliouine
Foum
M'hamide
Tiznit
Tafraoute
Sidi Ifni
Océan Atlantique
Col de Kerdouse
Goulimine
Tan-Tan
AMUN
Tarfaya
Laayoun
Smara
Bir Anzaran
Dakhla

AMUN in Numbers

- Phase I : 200,000 Ha
  - Wind power generation : ~3.0 GW
  - Solar power generation : ~3.0 GW
  - Green ammonia production : 2.0-2.5 mil. tons
- Phase II : 300,000 Ha
  - Wind power generation : ~3.0 GW
  - Solar power generation : ~3.0 GW
  - Green ammonia production : 2.0-2.5 mil. tons
- Phase III : 70,000 Ha – 320,000 Ha
  - Wind power generation : 1.0 – 5.0 GW
  - Solar power generation : 1.0 – 5.0 GW
  - Green ammonia production : 0.75 – 4.0 mil. tons

AMAN

CWP

AMAN in numbers

- CAPEX : $40+ bil.
- Project footprint : 850+,000+ Ha
- Installed power generation : 30 GW
- Power production : ~110 TWh
- Green hydrogen production : 1.7 mil. tons
- Green ammonia production : 10 mil. tons
- Green ammonia exports : $4-$10 bil.
- HBI production : 2.5 mil. tons
- Desalinated water to the country : 50 - 150 mil. m^3

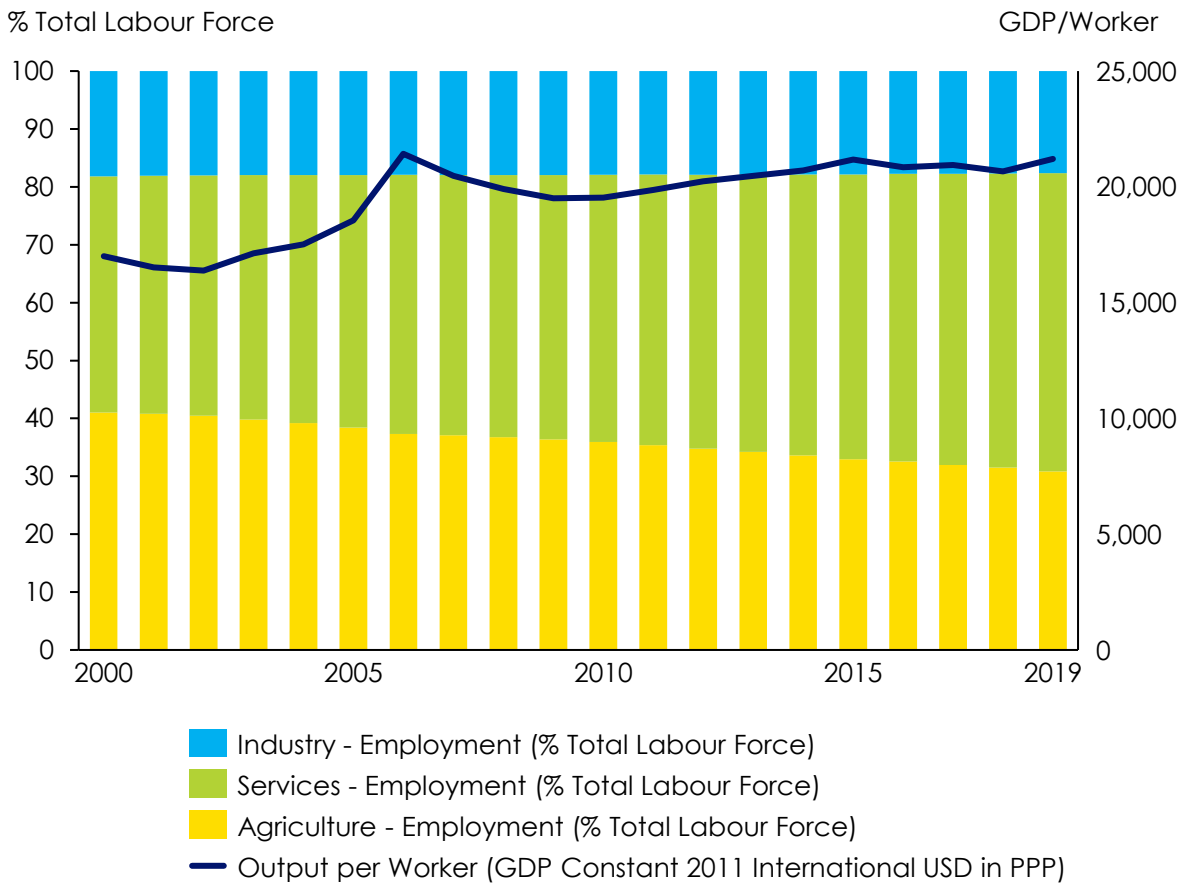
October 2022

AEA WEBINAR: MACRO-ECONOMIC IMPACT ASSESSMENT OF PROJECT AMAN IN MAURITANIA

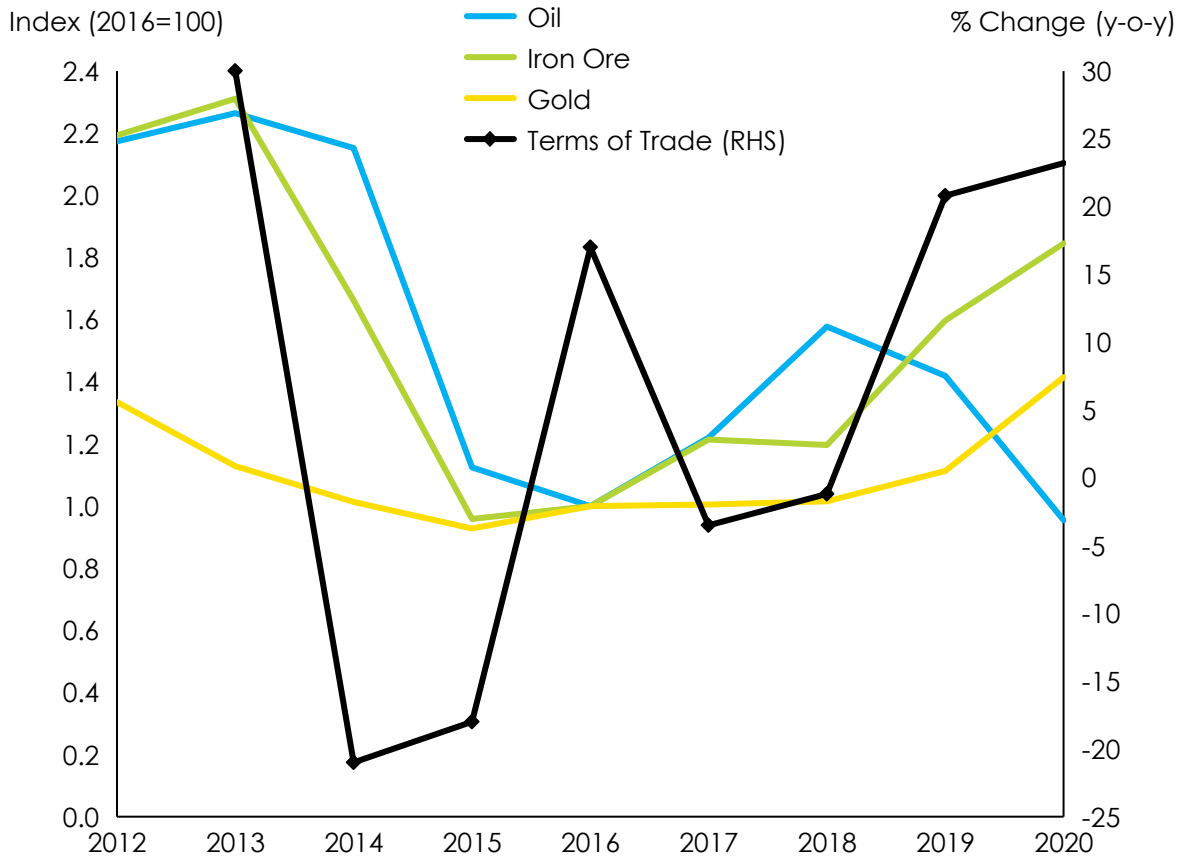
SYSTEMIQ

THE CHALLENGE: LOW PRODUCTIVITY AND EXPOSURE TO COMMODITY PRICE VOLATILITY

Mauritania Sectoral Employment Shares and Productivity



Mauritania Export Commodity Prices and Terms of Trade

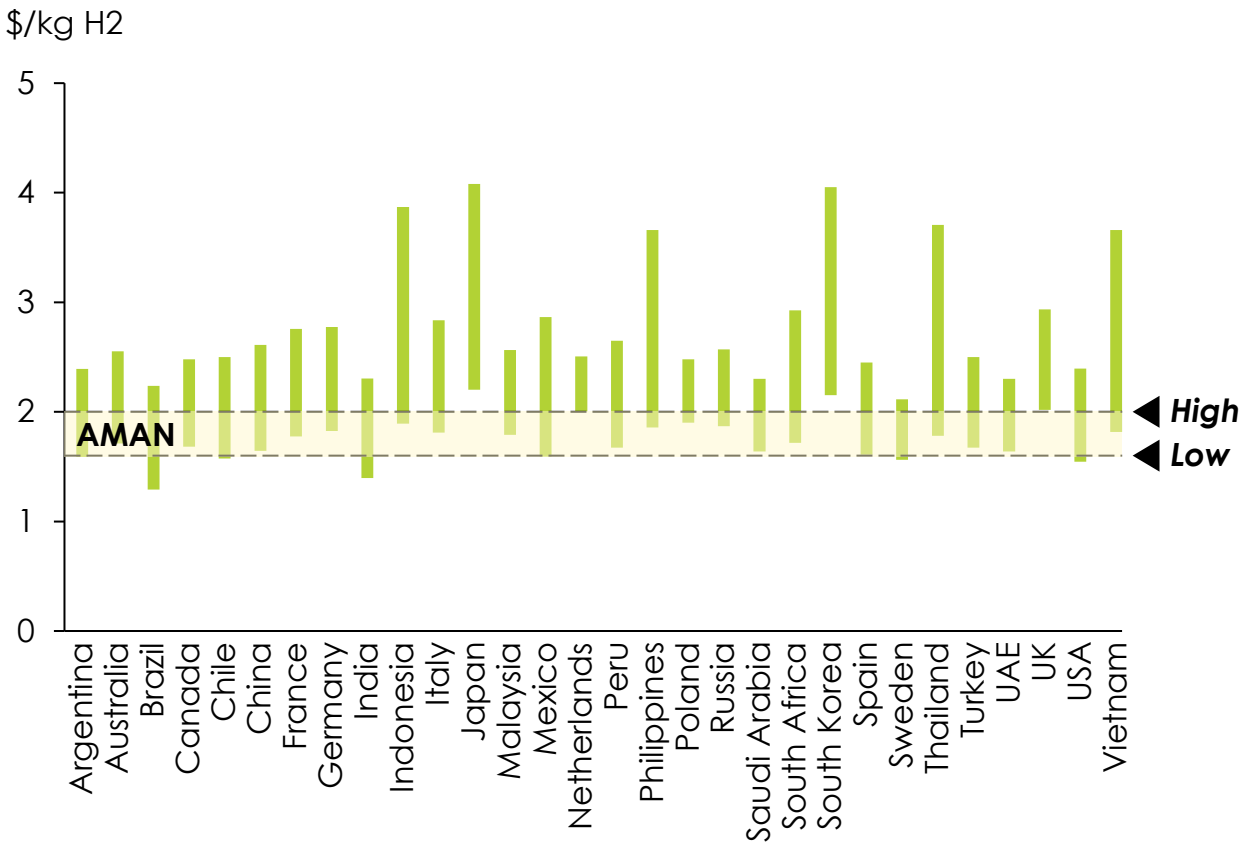


Source: World Bank WDI, ILO, IMF, US Federal Reserve Data.

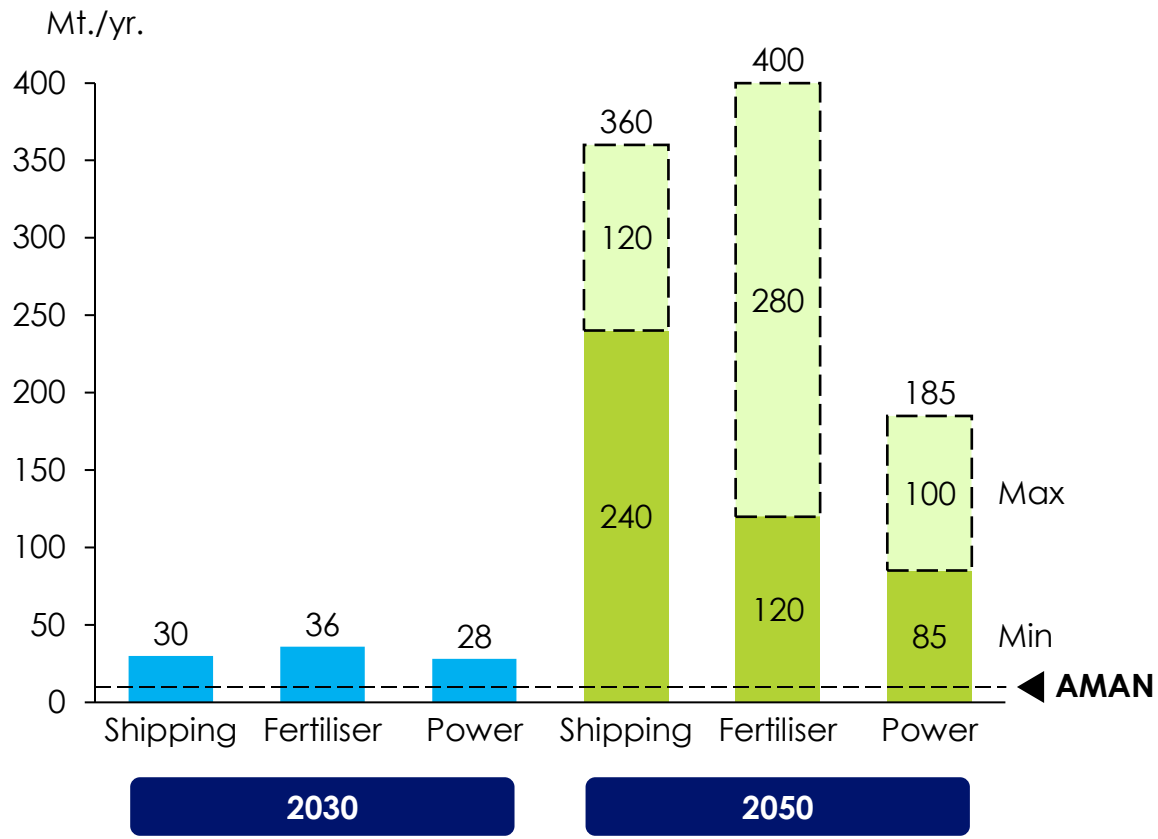
SYSTEMIQ

THE OPPORTUNITY: MAURITANIA FORECAST TO PRODUCE GREEN H2 AT GLOBALLY COMPETITIVE PRICES ALLOWING FOR GLOBAL AMMONIA EXPORTS

Forecast Production Cost of Green Hydrogen Production in 2035



Forecast Sectoral Demand for Green Ammonia vs. AMAN Output



Notes: (1) Electrolyser CAPEX $350/kW, 45 kWh/kg energy consumption. (2) Note: Assumptions for 2030, green ammonia replaces – i) 5% total heavy fuel oil for shipping, ii) 20% of total ammonia fertiliser production, iii) 20% coal firing capacity in South Korea and Japan. Assumptions for 2050, green ammonia replaces – i) between 25-80% of total shipping fuel consumption, ii) 100% of ammonia fertiliser production and other traditional uses, iii) 100% of coal firing capacity in Japan only.
Source: (1) SYSTEMIQ calculations based on ETC (2021), BloombergNEF, 2H2020 LCOE Data Viewer, (2), IEA – the Future of Petrochemicals (2018), S&P (2020), The Institute of Energy Economics of Japan (2018).

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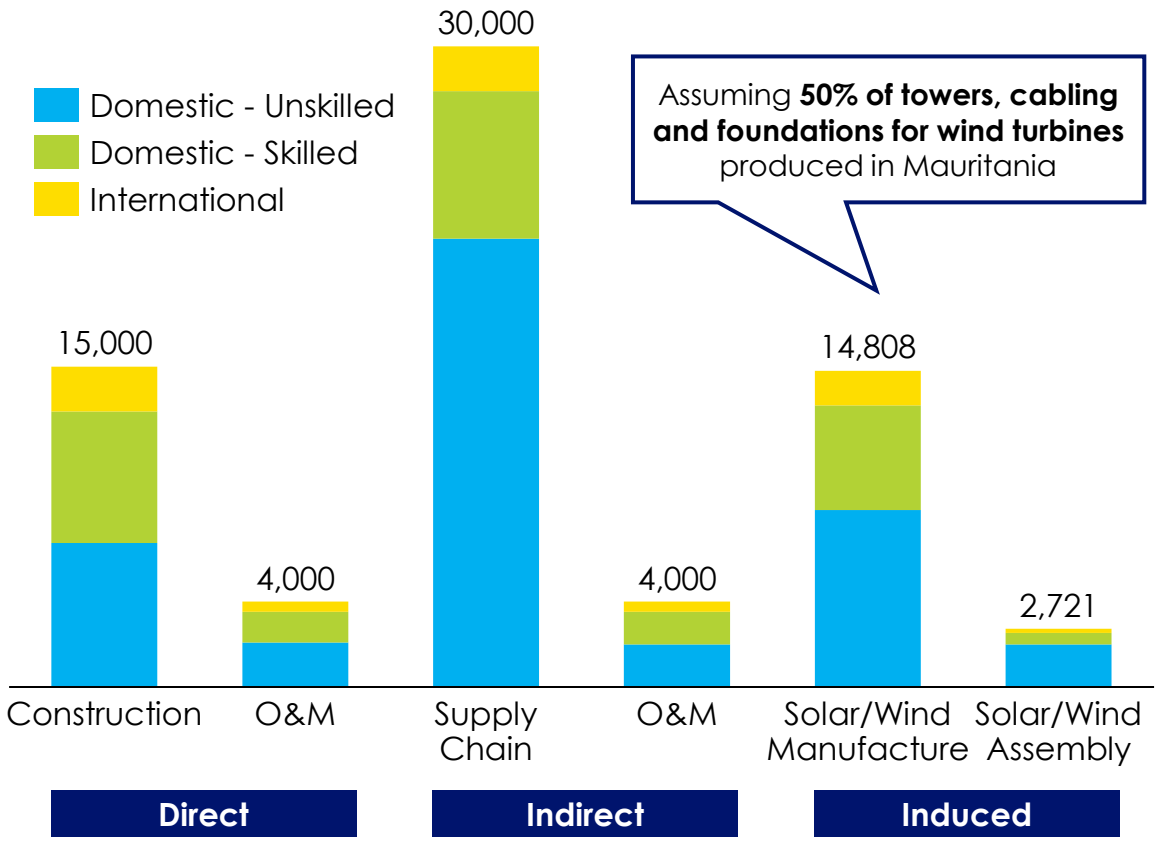
PROJECT AMAN OVERVIEW OF VALUE CHAIN COMPONENTS

	Induced	Indirect	Direct		
Upstream	**Manufacturing & Assembly** • Solar Panels/Modules • Balance of System • Steel Frameworks & Piles • Wind Turbines & Blades • Foundations & Steel Towers • Power System	**Supply Chain** • Raw Materials • Component Parts • Tools & Equipment • Electric Cabling and Switchgears • Prefab Housing • Transport & Logistics • Training & Development	**Operations & Maintenance** • Engineering Support • Technical Support • Security • Administration • Accountancy • Finance • Management • Legal	**Construction** • Wind & Solar Installation • Grid Connection • Land Remediation & Dredging • Production Sites • Storage Facilities • Electricity Transmission • Telecoms & Lighting Infrastructure • Water Pipelines • Buildings (Commercial, Industrial, Personnel)	
Downstream	**Manufacturing & Assembly** • Electrolysers • Desalination Equipment (Tanks and Filters, Reverse Osmosis Banks) • Ammonia Synthesis Equipment (Compressors, Scrubbers, Reactors)				

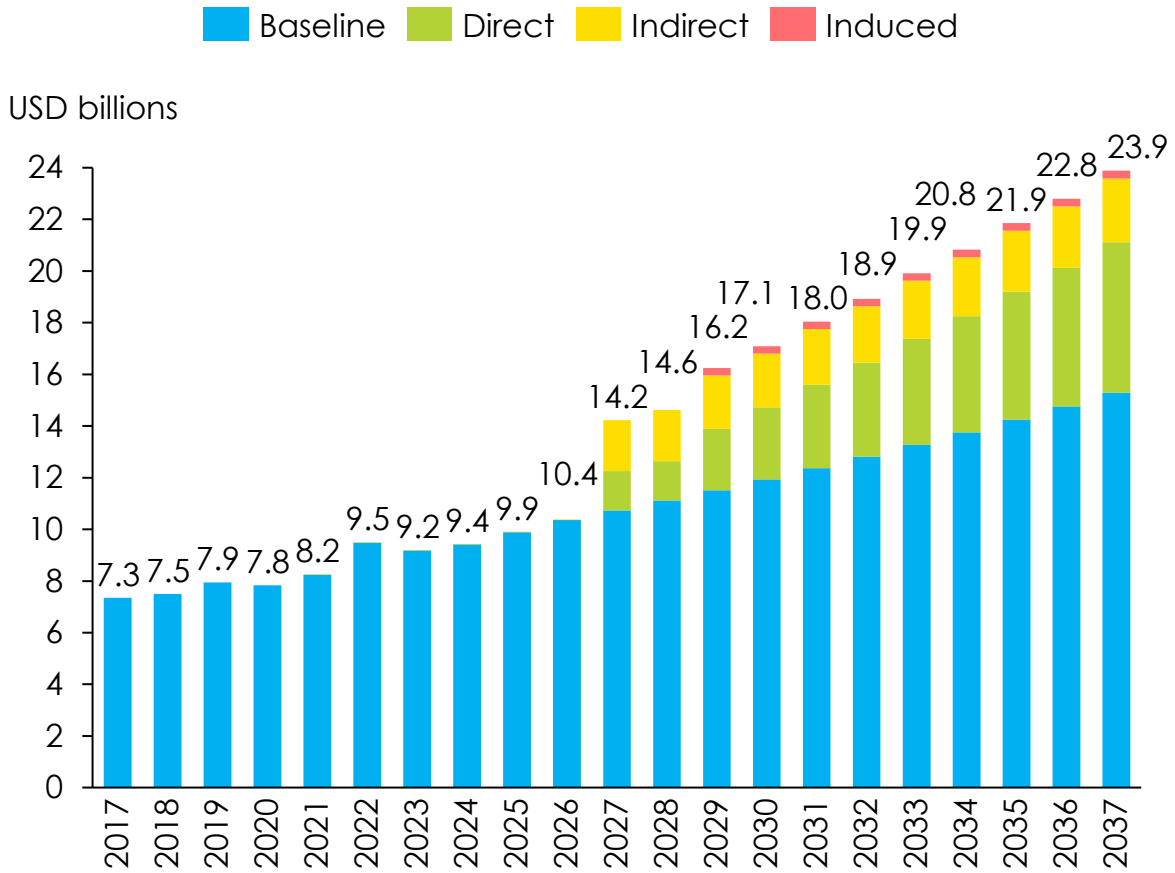
Source: SYSTEMIQ analysis based on H1 Energy, IRENA.

PROJECT AMAN EXPECTED TO CREATE LARGE NUMBER OF SKILLED AND UNSKILLED JOBS, MORE THAN DOUBLING GDP OVERALL BY PROJECT COMPLETION

Breakdown of Jobs from by Project AMAN



Mauritanian Annual GDP with Project AMAN



Note: Figures refer to central case modelling scenarios.
Source: SYSTEMIQ calculations based on H1 Energy, IRENA, World Bank, IMF.

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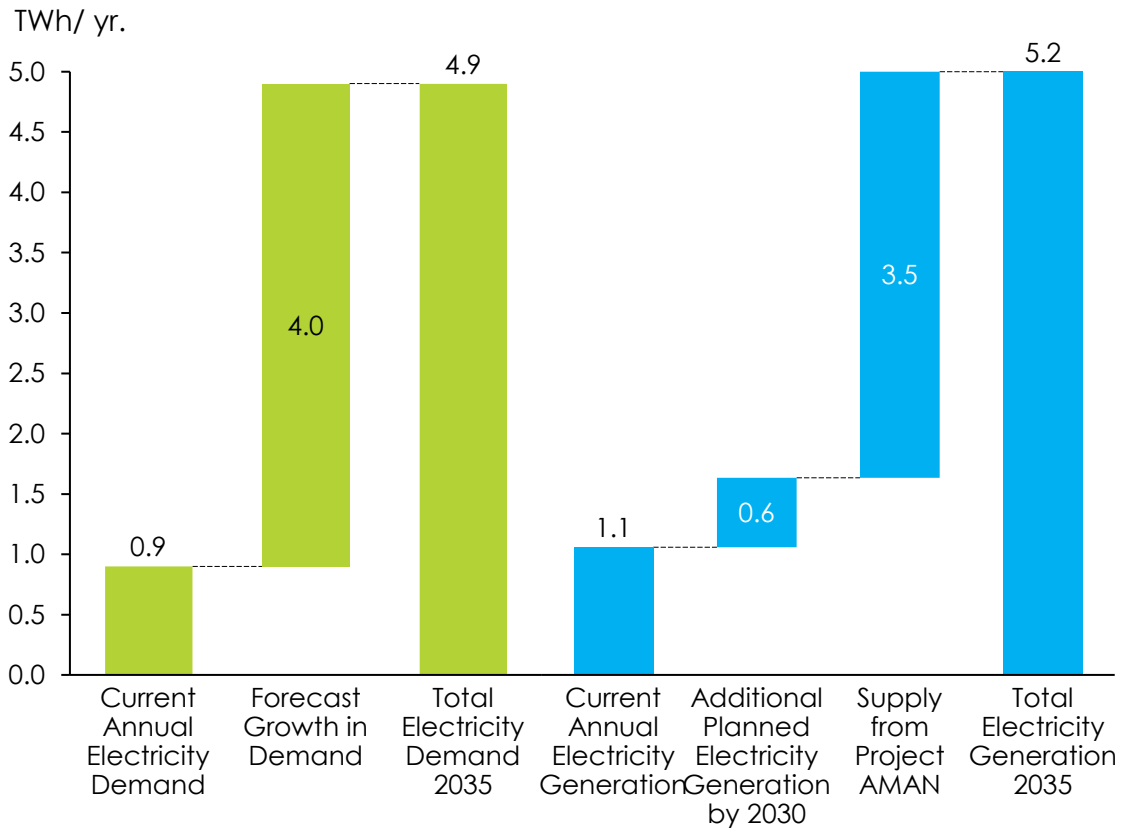
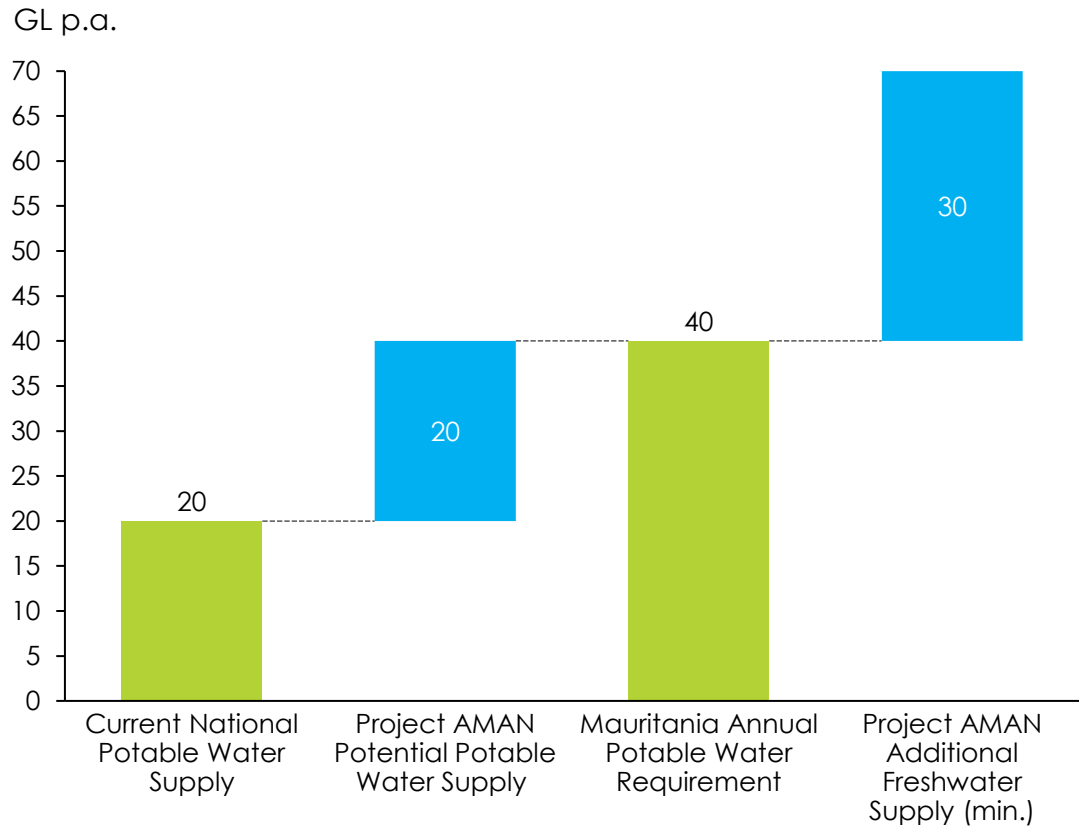
NEW SUPPLY COULD BRIDGE SHORTFALL TO DEMAND IN ELECTRICITY GENERATION AND WATER SUPPLY BY 2030

Mauritania Current and Future Electricity Demand vs. Supply



Mauritania Estimated Potable Water Demand vs. Supply



Note: (1) Future demand growth based on latest available annual consumption of 0.86 TwH per year in 2019, assuming the same rate of growth from 2013-2025 expected by MPEM under strong-growth scenarios continues until 2035. (2) Theoretical water supply not considering cost and feasibility of transporting water to areas of demand.
Source: SYSTEMIQ calculations based on H1 Energy, AFDB, Our World in Data, IRENA, World Bank, Ministry of Petroleum, Energy and Mines (MPEM).

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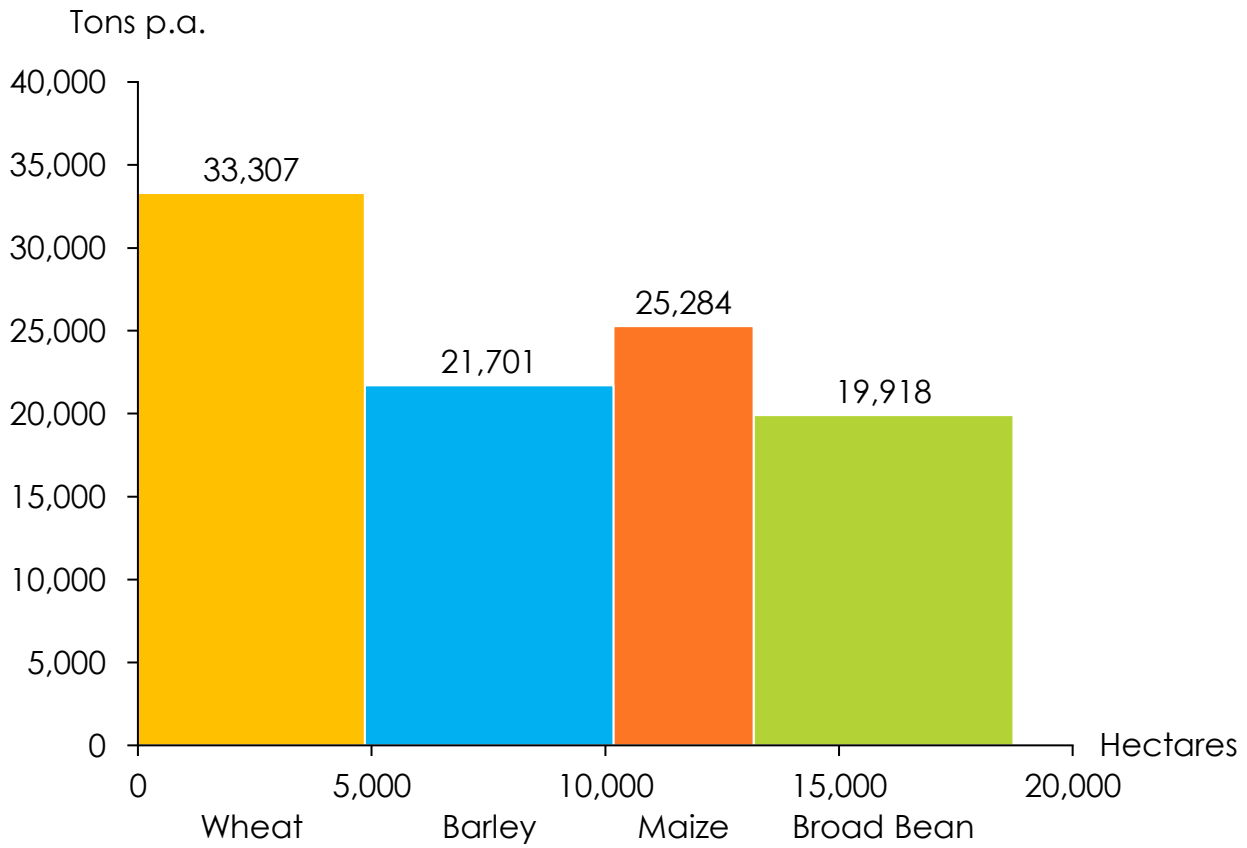
DESALINATED WATER SUPPLY CAN BE UTILISED FOR DESERT AGRICULTURE TO IMPROVE FOOD SECURITY

- Focussing on agriculture in the neighbouring region to the project is possible and could considerably increase **crop production**, reducing reliance on imports and securing greater **food security**.
- Using 30GL of surplus water from project AMAN could help to increase **domestic cereal production** by almost 10% overall, assuming it is used for growing wheat
- There are 3 key **potential methods** for desert agriculture: open field centre-pivot irrigation, drip irrigation, and protected environment (i.e. using greenhouses) agriculture.
- **Trade-offs** exist across different potential production methods between capital costs, water efficiency and crop yields.
- The **appropriate** choice for Mauritania will ultimately depend on a range of factors, including available capital to invest, economic considerations (e.g., transport infrastructure, labour costs) and geographical factors (e.g., weather conditions, soil salinity), which requires detailed local examination.

Potential Cereal Production and Land Area in Arid Locations in Mauritania using 30GL Desalinated Water from Project AMAN



Notes: Estimates derived from a case study on crop production using drip irrigation in Egypt's Western Desert using local aquifers. Output quantities and land area usage in Mauritania by vary depending on local climactic and soil conditions amongst other variable and should figures should be considered as directional.
Source: Moghazy and Kaluarachchi (2020).

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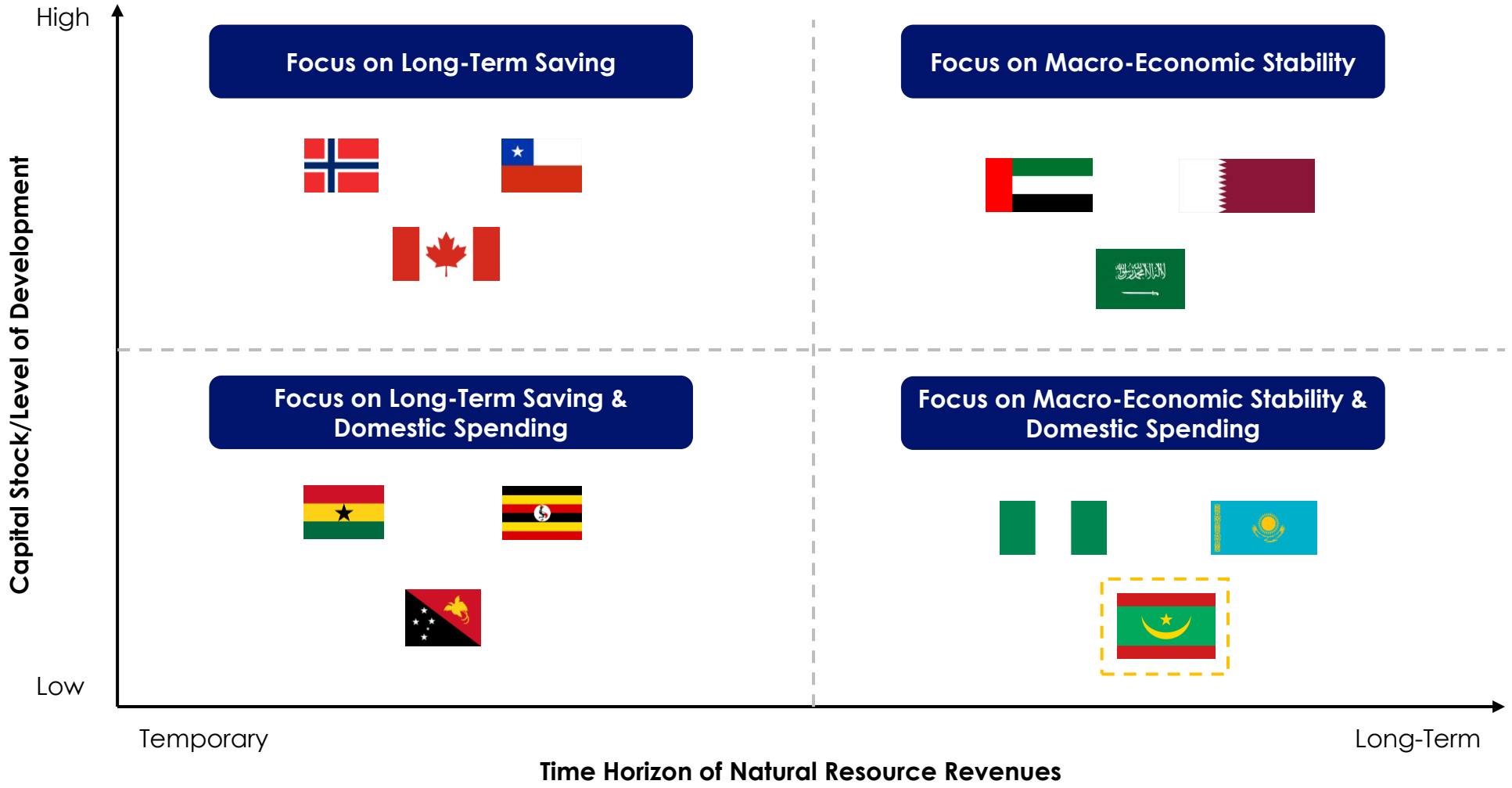
REVENUE MANAGEMENT: OPTIMAL STRATEGY FOR MAURITANIA IS TO FOCUS RESOURCE REVENUES ON DOMESTIC SPENDING AND COUNTER-CYCLICAL SPENDING



Source: SYSTEMIQ based on OECD, IMF, Baunsgaard et al (2018).

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RESOURCE REVENUE MANAGEMENT OPTIONS FOR MAURITANIA

	Direct Dividend Payments	National Budget Allocation	National Resource Fund
Description	Share revenue benefits directly with citizens via cash transfers	Invest revenues in local development through public spending via the annual budget process or multi-year development plans	Establish extra-budgetary fund with macro-economic objectives, investing in both domestic and foreign assets. Operates within fiscal rules determined by multi-year constraints on government finances
Examples	• Alaska Permanent Fund Dividend Scheme • Mongolia Cash Transfer Program	• Indonesia Sekolah Dasar Programme • Botswana Sustainable Budget Index • Nigeria Excess Crude Account	• Norwegian Oil Fund • Chile's Pension Reserve Fund • Abu Dhabi Investment Authority
Advantages	• Direct poverty alleviation, especially if targeted to poorest households • Ensures broad-based public support and ensures accountability • Limits risk of political instability and conflict if implemented equitably	• Supports strategic spending programmes, e.g. on education and infrastructure, boosting productivity • Improves civil service salaries, improving ability to attract and retain talent	• Limits risk of domestic economic overheating and Dutch disease • Secures long-term revenue continuity for future generations • Provides higher returns on and diversifies against risk • Allows for counter-cyclical fiscal spending
Disadvantages	• Increases household consumption at expense of long-term investment, • Limited domestic absorptive capacity can lead to inflationary pressure & exchange rate appreciation	• Limited domestic absorptive capacity can lead to inflationary pressure & exchange rate appreciation • Risks causing Dutch disease, potentially undermining other sectors (especially industry/manufacturing)	• Risk of mismanagement if fiscal rules not consistently followed • Lack of direct benefits for population can lead to public disenfranchisement

Source: SYSTEMIQ analysis based on OECD, IMF, NRGI.