Unlocking the green chemical value chain

Renewable energy based hydrogen and Power-to-X applications
We are project developers and plant operators

- Madoqua Ventures Limited was established in 2016 and operates in Kenya, Portugal and the Netherlands. We work regionally with significant EMEA experience.
- We are owners and developers of projects that harness renewable energy and produce green feedstock such as ammonia and methanol in Portugal and the Netherlands.
- We manage the full project life cycle i.e. feasibility, funding, FEED, detail design, procurement, project / construction management and (start-up) operations.
- We work across projects as interim managers with clear milestones and deliverables. We co-invest on an opportunistic basis.
- Currently, our projects are in incubation stage being prepped for EU grants and national subsidy schemes.
- The project prep process involves identifying strategic partners in the sphere of raw material availability, location selection, engineering as well as development stage funding.
- In addition to the above, we are currently aligning strategic project partners and end users for commodity offtake to ensure early stage commercial viability.
We undertake project advisory, development and operations

- We develop project strategies and concepts, support fund raising or utilize existing funding, setup structures and develop and manage operations and teams.
- We are leveraging on Power-to-X solutions to achieve sector coupling and utilising grid flexibility to develop green hydrogen production facilities.
- We are focused on achieving cost competitive green hydrogen by 2030 followed by cost efficient ammonia and methanol production by 2050.
- We start-up and oversee operations and manage greenfield businesses operations and develop and reinforce business operations processes.

**Concept & Feasibility**
- Concept development, location, commercial off-taker identification.
- Pre – feasibility analysis and partnership development.
- Detailed feasibility study and environmental impact assessment.

**FEED & FID**
- Feasibility analysis, project planning and project approval / licensing.
- Investment structuring, fundraising and decision making.
- Business review, project planning and operational strategy.

**Execution & Operations**
- Detailed engineering, procurement and project management.
- Infrastructure construction, installation, testing and commissioning.
- Plant and commercial operations management.

- **Primary location**
- **Alternate location**
Integrated green chemicals value chain

- We focus on developing and delivering renewable energy projects that produce green chemicals to ensure sustainable economic development and job creation.
- The current project focuses on Portugal’s southern regional industrial zones located in Alentejo along the southern International rail corridor and Northern Netherlands.
- We pilot and develop modular Green Hydrogen production units with integrated Green Ammonia and/or Green Methanol production units.
- We are focused on achieving cost competitive production of Green Hydrogen, Green Ammonia and Green Methanol.
- We start-up, oversee and manage greenfield businesses operations and continue to participate in the operating business as strategic partners.

Source: Thyssenkrupp, 2020
Our focus - Green hydrogen industrial applications

- Green energy
- Grid / Electricity
- H2 production
- H2 gas turbines
- H2 storage
- Grid / Electricity

- CO₂ + H₂ → Hydrocarbon synthesis
- CO₂ + H₂ → Methanol synthesis
- N₂ + H₂ → Haber – Bosch process

- Synthetic fuels
- Methanol
- Ammonia
Green ammonia and green methanol project development strategy (1/3)

<table>
<thead>
<tr>
<th>Green Ammonia modular approach</th>
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<tbody>
<tr>
<td>• 20 MW modular skid amounted alkaline water electrolyser units to produce 3,000 tons of Green Hydrogen per year.</td>
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<tr>
<td>• Integration – 50 MTPD Green Ammonia plant producing 17,000 tons of Green Ammonia per year.</td>
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<tr>
<td>• Transportation – 20 ft / 40 ft leased storage tanks deployed on flat bed rail carriages, truck trailers or freighter barrages.</td>
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Electricity based Green Ammonia production process

- Hydrogen generation
  - Deoxygenation
- Nitrogen separation
  - Air separation
- Haber-Bosch process
  - N2
  - H2
  - NH3

Integrated plant illustration

20 MW electrolyser module

50 MTPS ammonia module
Green Ammonia and Green Methanol project development strategy (2/3)

Green Methanol modular approach

- 20 MW modular skid amounted alkaline water electrolyser units to produce 3000 tons of Green Hydrogen per year.
- Integration – 50 MTPD Green Methanol plant producing 20,000 tons of Green Methanol per year (assuming CH3OH density = 792 kg / m³)
- Transportation – 20 ft / 40 ft leased storage tanks deployed on flat bed rail carriages, truck trailers or freighter barrages.

Electricity based Green Methanol production process

Integrated plant illustration

3rd party CO2 source

Methanol synthesis

Hydrogen generation

CO2 capture / separation

- Solvents
- Sorbents
- Membrane
- Cryogenic System
- Direct capture
- Oxy-combustion
- CO2
Green Ammonia and Green Methanol project development strategy (3/3)

### Areas of detailed investigation
- Operating characteristics of large scale electrolysers and optimal hydrogen storage requirements
- Capital and operating costs.
- Procurement of renewable electricity and grid interconnection.
- Optimal electrolyser load factor (this question is interesting since higher load factors incur higher power prices, but lower capital cost and vice versa)
- Vendor readiness, new market access, commodity pricing and commercial path way development

### Financial optimisation
- Identifying funding assistance by way of grants and concessional loans and developing institutional relationships.
- Pre-feasibility analysis indicates the margin between the cost of inputs (primarily energy) and the value of the output (ammonia and methanol, a commodity with pricing linked to global benchmarks) is insufficient to support Green H2 based Power-to-X projects on a standalone basis.
- Using an expansion strategy after developing the pilot plant to drive down capital and operating costs by increasing production capacity to achieve economies of scale both at the capital acquisition level as well as production output.

### Resource identification
- Pilot plant will require 0.5 hectares of land and potential for future expansion of up to 15 hectares.
- Access to water approximately 55,000 M3 / Year for pilot plant and potential for future expansion of up to 825,000 M3 / Year.
- Pilot plant will require 140 GWh / Year of renewable energy and 2.2 TWh / Year renewable energy for expansion.
- Transportation hub – either port access or freight train access.
- Power transmission infrastructure – access to 66 KV or 132 KV interconnect points.

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**20 MW H2 / 50 MTPD Ammonia or Methanol Pilot**

**360 MW H2 / 900 MTPD Ammonia or Methanol plant**

**PATH FROM PILOT PLANT TO FULL EXPANSION**
### CAPEX (Install Cost) | Amounts’ 000 (€)
---|---
Permits, Engineering and EPCM cost etc | € 9.4 to € 12.6 M
30 MW Electrolyser module (Alkaline) | € 19.7 to € 26.4 M
Storage and compression (Hydrogen & Ammonia) | € 9.4 to € 12.6 M
Ammonia Plant | € 24.4 to € 32.7 M
Balance of Plant | € 7.5 to € 10.1 M
Contingency (12%) | € 11.2 to € 15.1 M
Civil and structural costs | € 4.7 to € 6.3 M
**Total Project Cost** | **€ 88.4 to € 116 M**
*Power Transmission Infra @ 132 KV (up to 5 kms)** | € 7.5 to € 10.8 M
**Total Project Cost (Including HV infra)** | **€ 94 to € 126 M**

### O&M Costs | Amounts ‘000 (€)
---|---
Fixed demand charge (power) | € 0.32 to € 0.47 M
Variable power costs | € 3.8 to € 5.7 M
Water | € 0.06 to € 0.09 M
Operating costs | € 1.2 to € 1.8 M
**Total OPEX (per annum)** | **€ 5.5 to € 8.6 M**
*Transmission charges (incase of HV power infra)* | € 0.88 to € 1.3 M
**Overall OPEX (per annum)** | **€ 6.3 to € 9.4 M**

*Transmission costs o be validated during detailed feasibility study*
CAPEX and OPEX benchmarking based on QNP Power to Ammonia case study (2/2)

Levers to improve the economic viability of project

- Increased grant and concessional debt terms – up to 17% positive impact on NPV
- Carbon credits - up to 17% positive impact on NPV
- Renewable energy bulk transmission charges - up to 14% positive impact on NPV
- Capex optimisation (value engineering) - up to 8% positive impact on NPV
- Subsidy based commodity bulk purchase price - up to 9% positive impact on NPV
- Longer project life - up to 8% positive impact on NPV
- Opex optimisation - up to 7% positive impact on NPV
- Incentives and tax breaks - up to 7% positive impact on NPV.

Areas of focus based on lessons learnt

- Technical feasibility – early engagement with engineering houses, technology suppliers, EU institutions, local government authorities and industrial zones.
- Commercial feasibility – potential for subsidized hydrogen / ammonia and a hydrogen / methanol plant for pilot phase followed by large scale expansion.
- Financial feasibility – Sourcing of grants and concessional loans for pilot phase and equity / long-term concessional debt for project expansion.
- Incentive based location selection, market access, tax breaks and carbon credit swaps to be utilized to develop a path to commercial viability.
Generic layout for a pilot 20 MW H2 Plant and 20,000 MTPA plant NH3 / CH3OH plant

Source: QNP 2020 feasibility study
Overview plant schematic for 20 MW H2 / 50 MTPD Ammonia production
Reach out to us to learn more!

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We look forward to staying in touch!
We have ample infrastructure management, energy investment and regulatory experience

- Most recently, Roger was instrumental in founding and licensing Tatu Integrated Utilities Services all of which are dedicated service organizations and registered as Special Economic Enterprises in Kenya licensed by the Special Economic Zones Authority under the Special Economic Zones Act, 2015.
- Marloes gained her energy experience at Berkeley Energy ($200m Africa Renewable Energy Fund) and infrastructure and development experience from Tatu City.
- David gained his process engineering and project management experience at Schneider Electric and Dow Corning on global projects across Europe, China and Africa.

<table>
<thead>
<tr>
<th>Power</th>
<th>Petrochemicals</th>
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<tr>
<td>Schneider Electric - Hybrid modular power generation and distribution projects.</td>
<td>• Qatar Fuel’s Ras Laffan Fuel Bunkering Facility – EPC contract management with a value of $42m.</td>
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<tr>
<td>Tatu Power – setup foundations for 135 MW infrastructure and utility business and seeking regulator’s approvals from the energy regulatory authority in Kenya.</td>
<td>• GASCO Abu Dhabi’s Habshan Gas Complex Expansion – ICSS, FGS &amp; HIPPS for 2 800 TPD sulfur recovery and a acid gas enrichment unit.</td>
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<td>60 MW biomass project in Ghana – from initial analysis through DD.</td>
<td>• Restructuring of SAG Sohar aluminum smelter and extruder project in Oman.</td>
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<td>Commercial and industrial solar in Ghana and Kenya – investment analysis.</td>
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<td>Integrated Control and Safety System for Shaybah Power Plant $32m.</td>
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<th>Water</th>
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<td>Honeywell – Critical infrastructure security, structured cabling, networking and extra low voltage systems project in Angola.</td>
<td>• Tatu Water is regulated by the Water Services Regulatory Board (WASREB) in Kenya under the Water Act 2016. The team has delivered the financial model for water tariff submission.</td>
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<tr>
<td>Dubai, Jebel Ali and Delhi Airport airfield lights, GTMS and terminal BMS systems and Dubai Metro and Dubai Mall ELV systems.</td>
<td>• Together, the team developed the water strategy for Tatu City, including demand forecast, technical analysis of bulk supply options, investment and returns analysis. Project size of circa $32m; approved by shareholders.</td>
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<tr>
<td>Tatu City Telecom – City wide ICT strategy, design, engineering and deployment including seeking regulatory approvals from the communications authority.</td>
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<td>Schneider Electric – Development of Nigeria LNG Wireless IOT project concept.</td>
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We have project development and investment experience, from concept to delivery

- Madoqua combines over 20 years of infrastructure, project development and investment related project experience across CIS, Middle East and Africa.
- We put together concepts, strategies, project and investment programs to deliver a wide range of projects from bulk infrastructure to enabling technology projects.

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<th>Utilities and Urban Development</th>
<th>Industrial Parks</th>
<th>Chemical Process Plant</th>
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<tr>
<td>• Composite urban realm development by setting up, operating and managing the centralised urban and municipal services.</td>
<td>• Tatu Industrial Park II – financial review of the business model including pricing strategy, infrastructure roll-out budgeting of circa $40m and valuation resulting in external investment.</td>
<td>• 250,000 MTPA Urea Formaldehyde Pre-Condensate 85 plant in Sur, Oman.</td>
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<tr>
<td>• Setting up, operating and managing an integrated utility services operator.</td>
<td>• Kijani Ridge – financial review and pricing of premium residential annex of circa 650 plots. Infrastructure roll-out budgeting of $40m.</td>
<td>• Full Project Cycle Management - FEED, detailed engineering, construction, commissioning and handover of plant circa $20m.</td>
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<tr>
<td>• Setting up and operationalizing the precinct level estate management organs for a self-governing city.</td>
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<td>• Project promoter representative responsible for end to end management of the project from inception to close out.</td>
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<th>Residential Real-estate</th>
<th>Logistics and Warehouse Development</th>
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<td>• Negotiated/arranged $122m debt financing from international lenders for the leveraged buyout of a Singapore based Offshore Fuel Bunkering business for refuelling of ULCC ships in the Gulf of Oman.</td>
<td>• Oaklands - full financial review of circa 1,250 acres of land divided in to commercial, industrial and residential projects including cash flow forecasting and 10-year budget.</td>
<td>• Development management - including sourcing design/structural support, licensing, tendering, procurement and project management)</td>
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<td>• Reorganised agency arrangement with Hempel Denmark to a 5 million litres growth business and setup a coating JV in Oman.</td>
<td>• Taratibu - $30m mid-market land investment product, with 800 plots. Developed from concept to launch including financial and pricing strategy.</td>
<td>• Financial forecasting and market positioning advisory, deal structuring.</td>
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<td>• The team has structured a packaged opportunity ready for external investment.</td>
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