Dii Desert Energy

E-Fuels Levelized Cost Models & Analysis

Cornelius Matthes

24th May 2024

Outline

- Introduction
- Model Versions
- Model Features
- E-Fuels Cost Models Key Assumptions
- Green E-Ammonia Model
- Green E-Methanol Model
- Green E-Kerosene Model
- Takeaways
- Contact

Introduction

- Hydrogen is a versatile energy carrier with a wide range of uses and unique attributes, especially for energy sectors that are hard to electrify with renewable resources but can be made greener through sector coupling.

- If Green Hydrogen is technically a key enabler of decarbonization, then the next step or barrier to break is economics.

- This translates to: how much does **Green Hydrogen and Derivative E-Fuels** costs to produce and how to calculate that as well as analyze pathways of cost reduction?

- A financial model toolkit for analyzing levelized cost of Green Hydrogen & derivatives becomes necessary.

Model Versions

Levelized Cost of Green Hydrogen LCOH & Ammonia LCOA & e-Methanol LCOM & e-Kerosene LCOK

Six Versions:

- *LCOH Financial Model Toolkit V5A*
  Green H_2 Production
- *LCOH Financial Model Toolkit V5.2*
  Global Green H_2 Cost Optimization VOT-BFT Model ™
- *LCOH Financial Model Toolkit V6A*
  Green H_2 Production & Delivery Infra Pathways
- *LCOA Financial Model Toolkit V7B*
  Green NH_3 Production & Storage
- *LCOM Financial Model Toolkit V8A*
  Green e-Methanol Production & Storage
- *LCOK Financial Model Toolkit V9A*
  Green e-Kerosene Production & Storage

Today

Model Features

Levelized Cost of Green Hydrogen LCOH & Ammonia LCOA & e-Methanol LCOM & e-Kerosene LCOK

General Features:

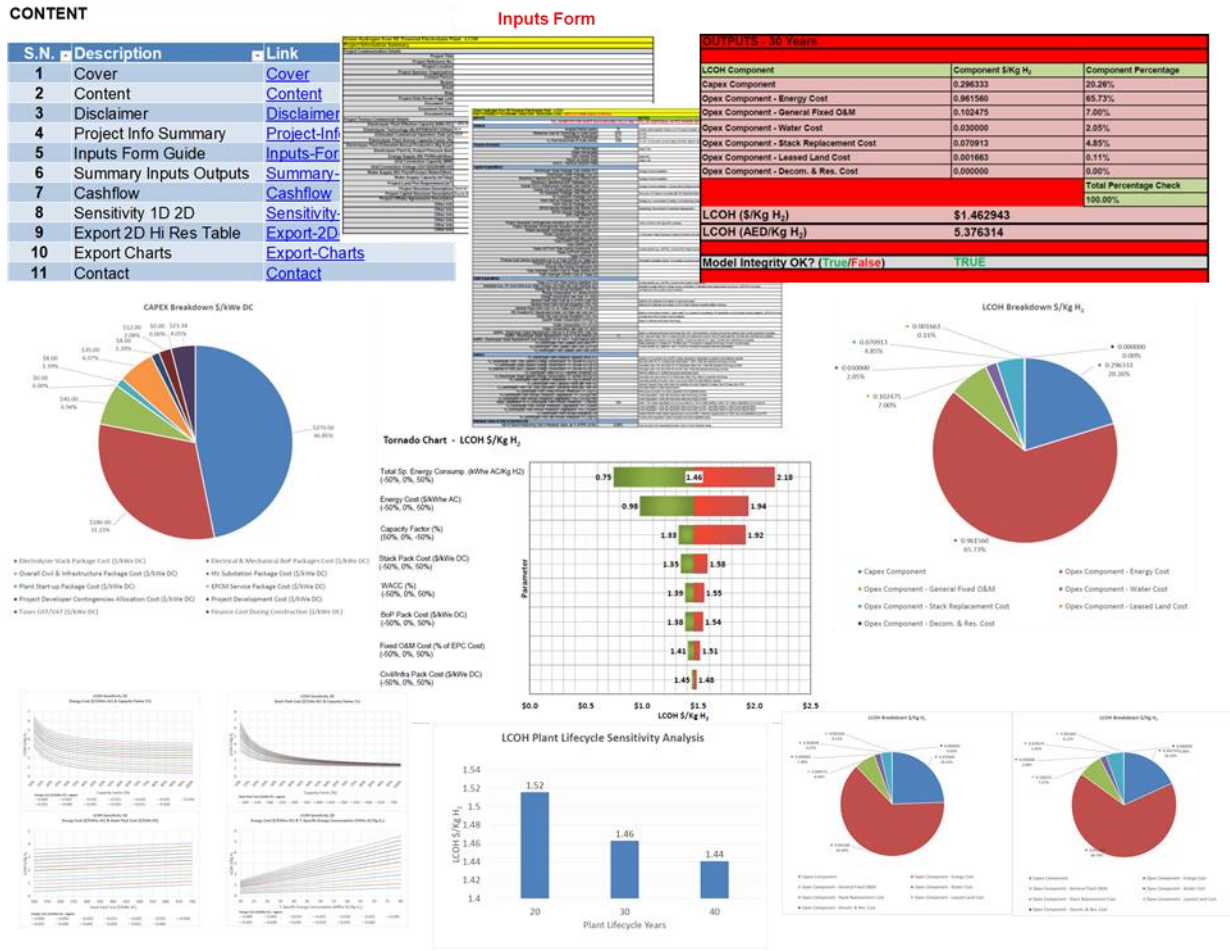
- *Get exclusive market analysis & benchmarking data for Levelized Cost of Green Hydrogen / Green Ammonia / Green e-Methanol Green e-Kerosene*
- *Obtain the best of all worlds assembled from over 50 best in class models for LCOH/LCOA/LCOM/LCOK in the market.*
- *A quick yet very effective holistic approach methodology to determine levelized costs of green molecules.*
- *Capture all life cycle costs and assess project feasibility.*
- *A detailed analytical dive into optimizing costs as well as performance parameters.*
- *Utilize powerful and comprehensive sensitivity analysis scenarios.*
- *User-friendly design with guideline, rich visuals & charts, printable 17-page report.*
- *Toolkits are available on a Software as a Service (SaaS) basis.*
- *Native model toolkits files (xls) are available as commercial product.*
- *Download sample pdf reports at: download link provided upon request*

Model Features

Levelized Cost of Green Hydrogen LCOH & Ammonia LCOA & e-Methanol LCOM & e-Kerosene LCOK

Financial Model Toolkit General Features: Zoom In!

- *Very Well-Structured Content & Workflow*
- *Project Information Data Capturing Full Scope of Work & Limits*
- *Detailed Input Parameters Form with Guideline Notes*
- *Analysis of Pre-COD Finance Cost & Construction Delay Cost*
- *Tabular LCOH/LCOA/LCOM/LCOK Outputs*
- *Breakdown CAPEX & OPEX & LCOH/LCOA/LCOM/LCOK Output Charts*
- *Up to 16 Parameters Sensitivity Tornado Chart*
- *Up to 8 Two-Dimensional Sensitivity Charts*
- *Multi-Lifecycle Analysis Chart*
- *Export Data/Charts Feature*
- *GIS Interface Feature*

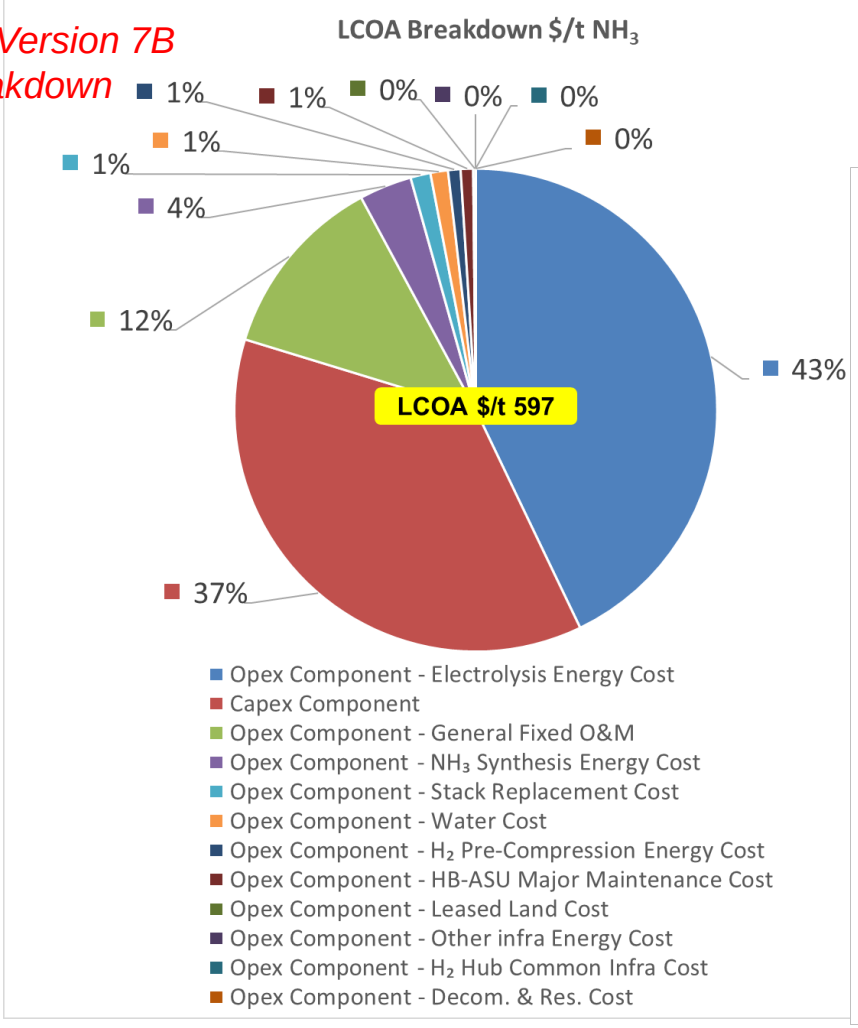


E-Fuels Cost Models Key Assumptions

- Plant Lifecyle: 20 years
- Plant Economies of Scale: 1 GWe Electrolyzer
- WACC: 6.4%
- Renewables Electricity Cost: USD 2.5 cent/kWh
- Electrolyzer Capacity Factor: 70%
- PtL Synthesis Process
  - E-Ammonia: Haber Bosch
  - E-Methanol: H_2+CO_2 Synthesis
  - E-Kerosene: Fischer Tropsch
- Costs Reference Year: 2030
- ALK Electrolyzer Cost (Stack+BoP): $560/kWe
- Plant Total Installed Cost (Electrolysis + Synthesis)
  - E-Ammonia: $1.61B

Green E-Ammonia LCOA Model

Green Ammonia Model Version 7B
Typical LCOA Cost Breakdown

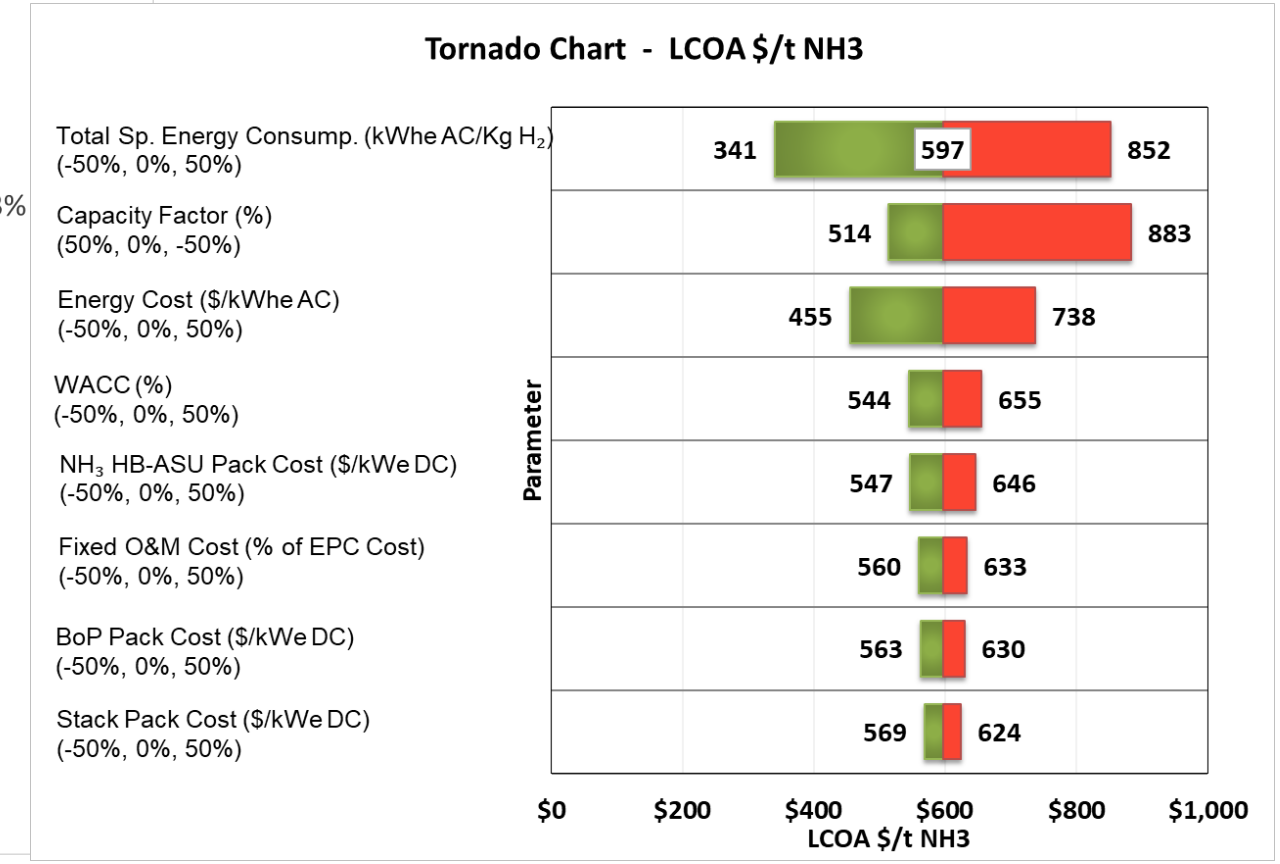


Major Cost Contributors
1. *Energy Cost*
2. *CAPEX*

Green Ammonia Cost Range 550-850 $/ton

Grey Ammonia Cost Range 290-460 $/ton
S&P May 2024

Top 3 Impactful Drivers
1. *Electrolyzer Efficiency*
2. *Capacity Factor*
3. *Energy Cost*



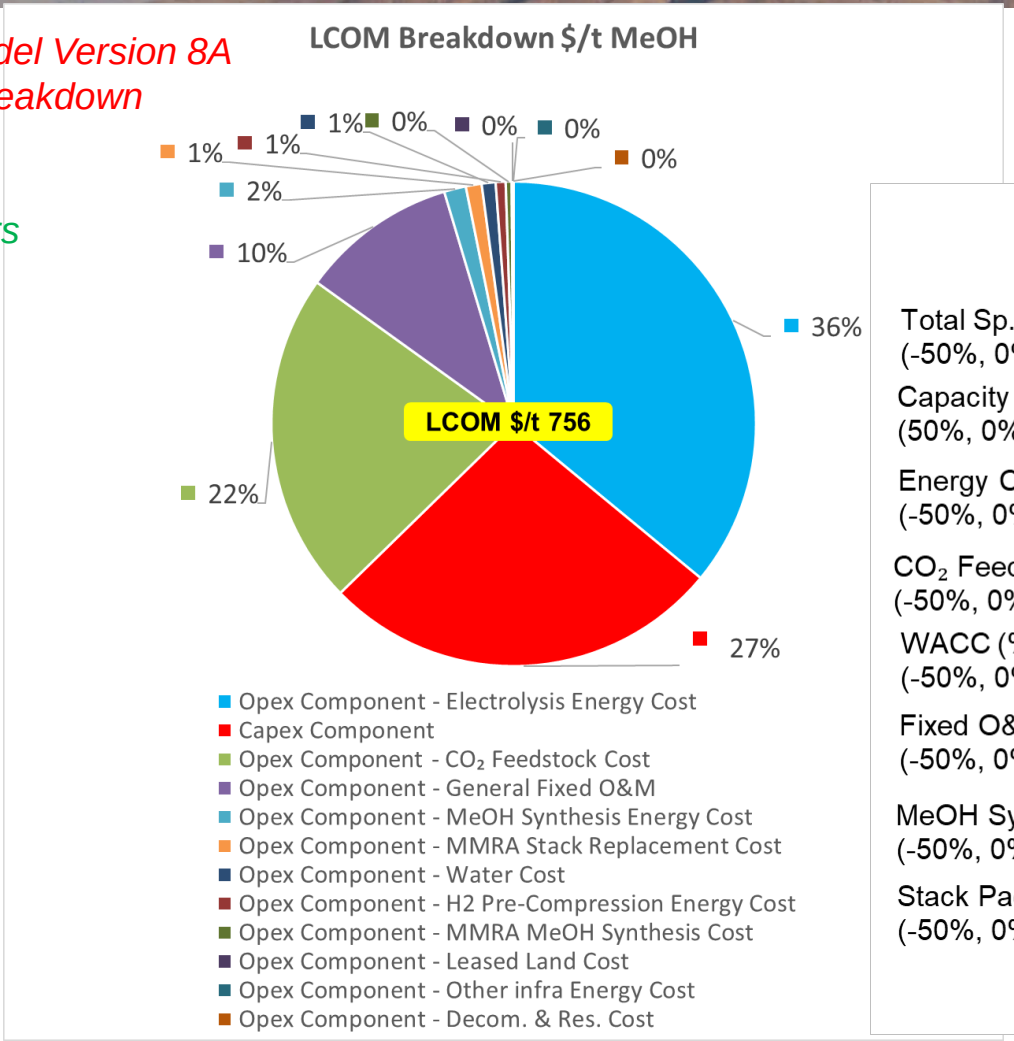
Green E-Methanol LCOM Model

Green E-Methanol Model Version 8A
Typical LCOM Cost Breakdown

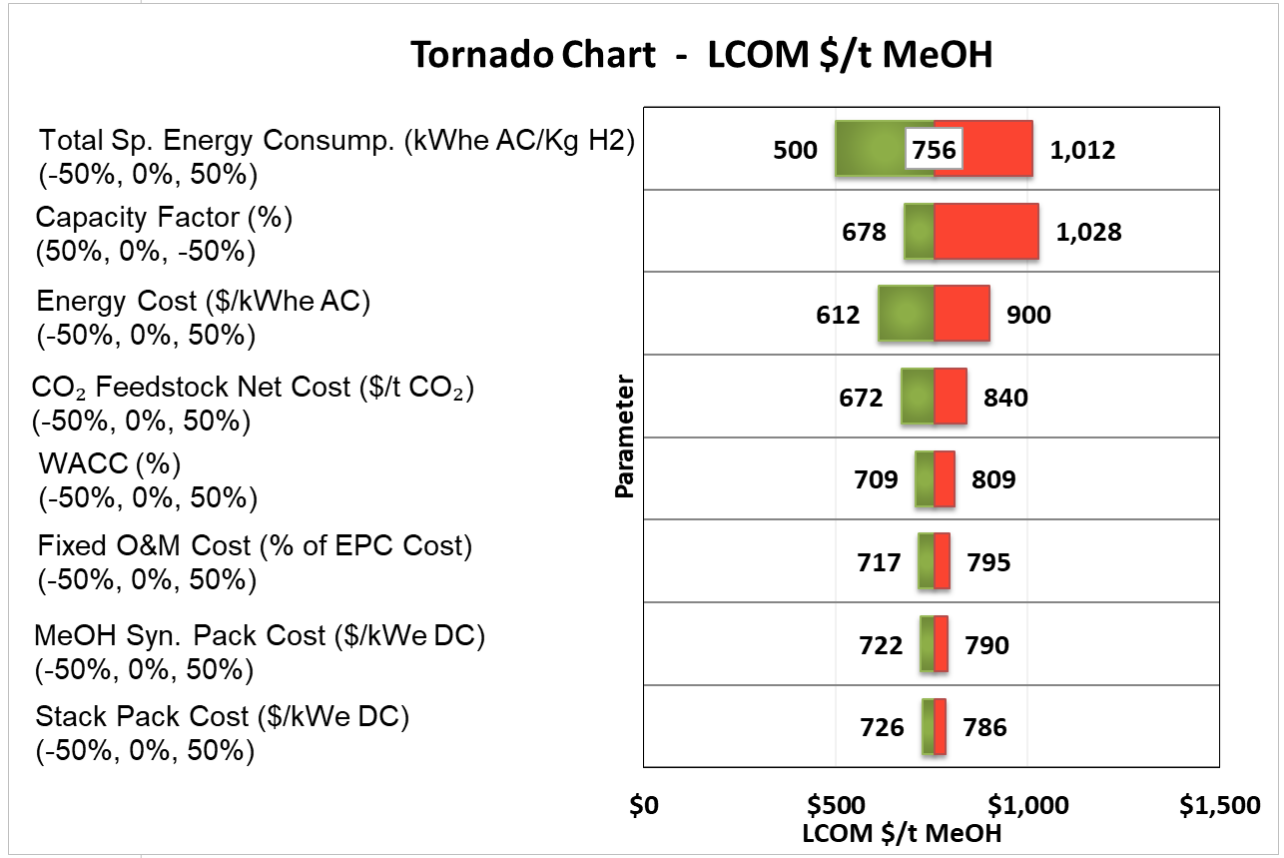
Major Cost Contributors
1. *Energy Cost*
2. *CO_2 Feedstock*
3. *CAPEX*

Green E-Methanol Cost Range 700-950 $/ton

Grey Methanol Cost Range 350-550 $/ton
Methanol Inst. Apr 2024



Top 4 Impactful Drivers
1. *Electrolyzer Efficiency*
2. *Capacity Factor*
3. *Energy Cost*



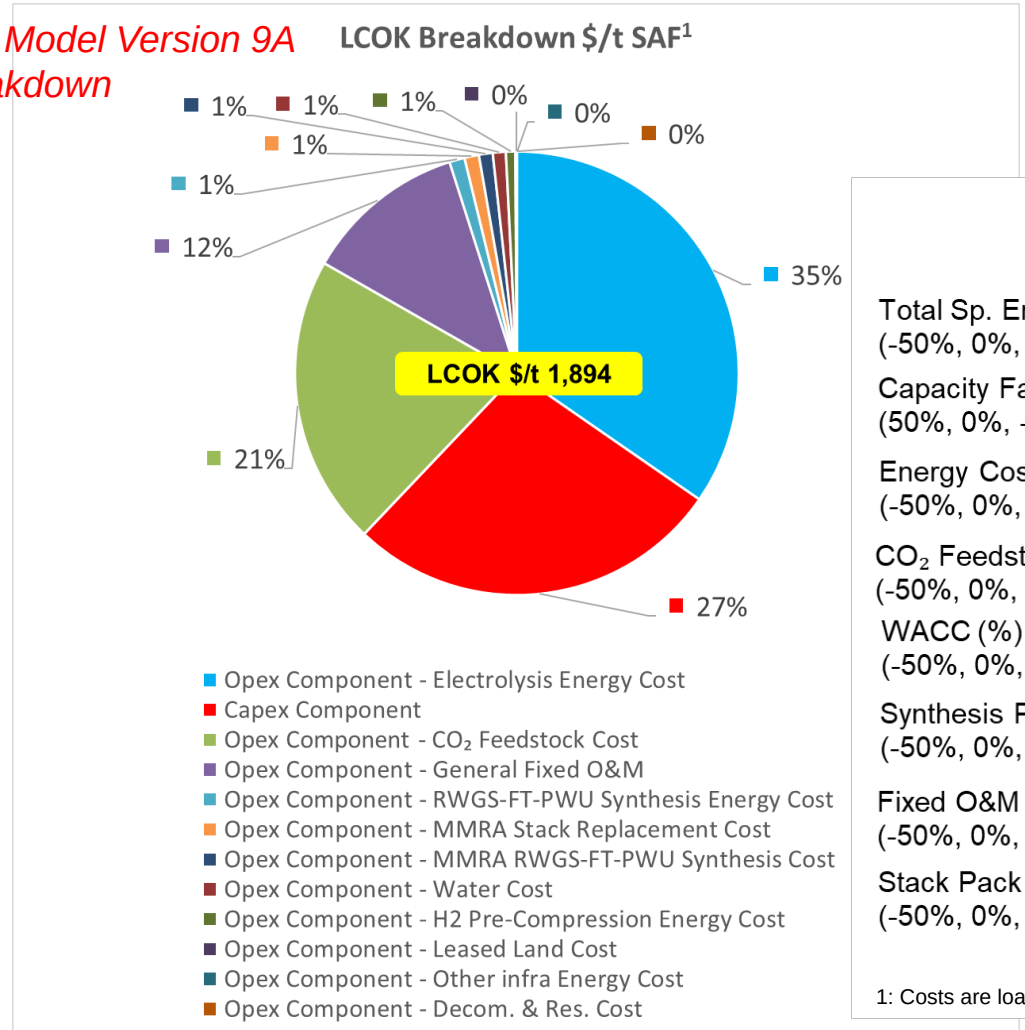
Green E-Kerosene/SAF LCOK Model

Green E-Kerosene/SAF Model Version 9A
Typical LCOK Cost Breakdown

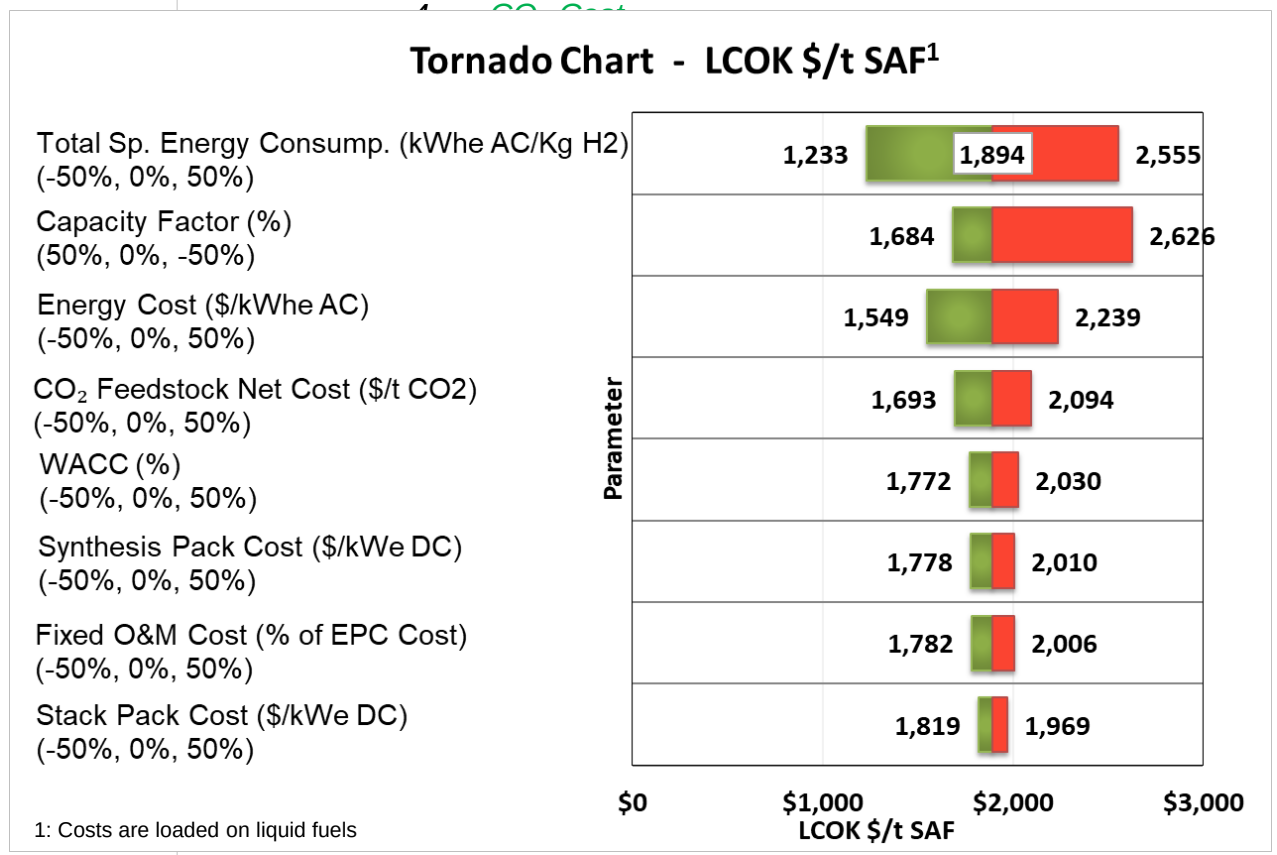
Major Cost Contributors
1. *Energy Cost*
2. *CAPEX*
3. *CO_2 Feedstock*

Green E-Kerosene Cost Range 1700-2400 $/ton

Grey Kerosene Cost Range 760-840 $/ton
IATA. May 2024



Top 4 Impactful Drivers
1. *Electrolyzer Efficiency*
2. *Capacity Factor*
3. *Energy Cost*
4. *CO_2 Cost*



1: Costs are loaded on liquid fuels

Takeaways

- Green E-Fuels are vital for NetZero 2050
- Challenges that are critical for bankable projects development:
  1. Create foreseeable demand via a combination of policy and economic tools
  2. Establish risk-balanced long-term offtake agreements
  3. Bridge the green e-fuel price gap against grey fuel by pricing GHG at true cost of damage potential
  4. Institute clear long-term guarantees of origin / standards / policy / regulatory environments
  5. Form harmonized overall plant performance guarantees
  6. Enhance e-fuels synthesis processes operational flexibility to better couple with renewables generation
- Global warming and climate change are real. The true cost of GHG is steadily rising via “new normal” extreme weather events. GHGs need to be priced based on their irreversible damage potential and threat to humanity well being

Thank You For Your Attention!

Contact:

Cornelius Matthes

CEO

+49 152 3467 4386

cornelius@dii-desertenergy.org

www.dii-desertenergy.org