CLEAN ENERGY SOLUTIONS CENTER
ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY
An Initiative of the Clean Energy Ministerial

Applying Hydrogen Knowledge

Hydrogen and Analytical Tools Webinar Series

May 29, 2024

Overview of Workshop Series

Title	Description	Proposed Date
#1: Hydrogen 101	- Hydrogen Considerations Tree - US National Hydrogen Strategy and Roadmap - Key considerations and tools used for hydrogen market analysis	7 February
#2: Hydrogen to Support Climate Targets	- Potential for hydrogen, and its derivatives to decarbonize domestic, commercial, and hard-to-decarbonize sectors. - Overview of the “Greenhouse gases, regulated emissions, and energy use in technologies” (**GREET**) Model	21 February
#3: Technical Considerations	- Technical considerations and challenges of hydrogen production, storage, and transport - Application of the Hydrogen Analysis Production (**H2A**) tool: Transparent cost analysis methodology for hydrogen production at centralized and distributed facilities	6 March
#4: Hydrogen Markets	- Techno-economic considerations for near- and long-term hydrogen (+ derivatives) markets - Example analysis and tools for demand projections - Overview and application of the Revenue, Operation, and Device Optimization (**RODeO**) tool: Explores optimal system design and operation	20 March
#5: International Hydrogen Landscapes	- Policy and regulatory enabling conditions (e.g. standards, certifications, incentives) to support hydrogen markets - Overview of International Hydrogen Markets and Standards, and the International Partnership for Hydrogen and fuels cells in the Economy – IPHE - Hydrogen Workforce Development, Energy and Environmental Justice	17 April
#6: Hydrogen in the Transport Sector and Infrastructure Planning	- The capacity for hydrogen to decarbonize the transport sector and ownership costs of different propulsion technologies for medium and heavy-duty vehicles - Overview and application of the Scenario Evaluation and Regionalization Analysis (**SERA**) tool: Provides insights that can guide hydrogen infrastructure development and transportation investment decisions (city to national levels).	1 May
#7: Applying Knowledge	- Integrated exercises to apply acquired knowledge into country-specific structure, roadmap, and prioritization framework - Summary of key takeaways from training program and next steps - Application of the Hydrogen Financial Analysis Scenario Tool (**H2FAST**) tool: Provides a quick and convenient in-depth financial analysis for hydrogen projects	29 May

Housekeeping - Zoom

- This webinar is **being recorded** and will be shared with attendees.
- You will be **automatically muted** upon joining and throughout the webinar.
- Please use the **chat feature** to add comments and share input.
- Please use the **Q&A function** in your toolbar to ask questions.

- If you have **technical issues**, please use the chat feature to message Sophie Schrader or Holly Darrow.
- You can adjust your audio through the **audio settings.** If you are having issues, you can also dial-in and listen by phone. Dial-in information can be found in your registration email.
- We will be launching a **survey** when the event ends. Your feedback is highly valuable to us!

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Webinar & Speaker Introductions

Agenda

Speaker	Topic	Duration
Daniella Rough	Welcome, housekeeping, series intro, agenda, speaker intros, CESC intro	15 mins
Jamie Kee	Overview of the Hydrogen Financial Analysis Scenario Tool (H2FAST)	10 mins
Hussain Almajed	H2FAST Case Study: Wind-Powered Green Ammonia Production in La Guajira, Colombia	30 mins
Daniella, Jamie, Omar, Hussain	Q&A	15 mins
Daniella Rough	Discussion and SWOT analysis	30 mins
Daniella, Jamie, Omar, Hussain	Q&A, wrap up, and closing	20 mins

Webinar Speakers

Daniella Rough

International Project Manager

National Renewable Energy Laboratory

Jamie Kee

Hydrogen Analyst

National Renewable Energy Laboratory

Hussain Almajed

PhD Intern

National Renewable Energy Laboratory

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Overview of the Clean Energy Solutions Center

Presented by Aaron Ng, U.S. Department of Energy

May 29, 2024

The Clean Energy Solutions Center

CLEAN ENERGY SOLUTIONS CENTER
ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

CLEAN ENERGY MINISTERIAL
Advancing Clean Energy Together

OBJECTIVE

To accelerate the transition of clean energy markets and technologies.

RATIONALE

Many developing governments lack capacity to design and adopt policies and programs that support the deployment of clean energy technologies.

AMBITION/TARGET

Support governments in developing nations of the world in strengthening clean energy policies and finance measures

ACTORS

Leads:

Operating Agent:

NREL
Transforming ENERGY

Partners:

More than 40 partners, including UN-Energy, IRENA, IEA, IPEEC, REEEP, REN21, SE4All, IADB, ADB, AfDB, and other workstreams etc.

ACTIONS

- **Deliver** dynamic services that enable *expert assistance*, *learning, and peer-to-peer sharing of experiences.* *Services are offered at no-cost to users.*
- **Foster** dialogue on emerging policy issues and innovation across the globe.
- **Serve** as a first-stop clearinghouse of clean energy policy resources, including policy best practices, data, and analysis tools.

UPDATES

Website:
www.cleanenergyministerial.org/initiatives-campaigns/clean-energy-solutions-center

Factsheet:
www.nrel.gov/docs/fy22osti/83658.pdf

Requests: Now accepting Ask an Expert requests!

The Clean Energy Solutions Center

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ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

CLEAN ENERGY MINISTERIAL
Advancing Clean Energy Together

Ask an Expert Service

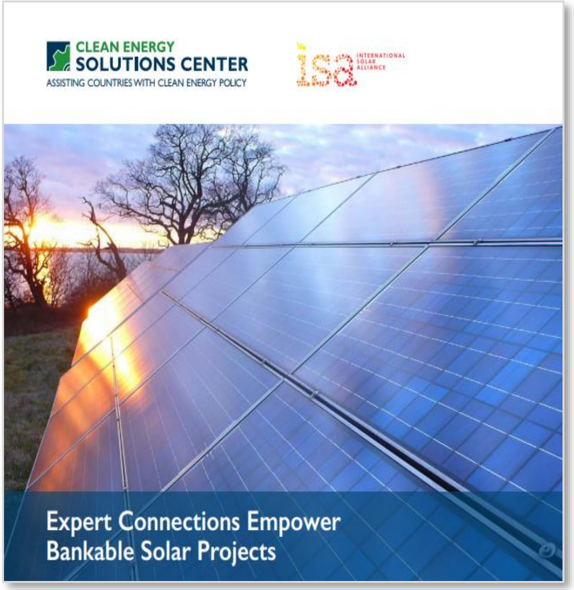
- Ask an Expert is designed to help policymakers in developing countries and emerging economies identify and implement ***clean energy policy*** and finance solutions.
- The Ask an Expert service features a network of more than **50** experts from over **15** countries.
- Responded to **300+** requests submitted by **90+** governments and regional organizations from developing nations since inception

Training and Capacity Building

- Delivered over **300** webinars training more than **20,000** public & private sector stakeholders.

Resource Library

- Over **1,500** curated reports, policy briefs, journal articles, etc.



For additional information and questions, reach out to Jal Desai, NREL, jal.desai@nrel.gov

Guiding Sustainable Hydrogen Integration: Hydrogen Considerations Tree

- **Background:** Growing need from country partners related to hydrogen, and key considerations in costs, benefits and tradeoffs when making strategy, policy and investment decisions.
- **Objective:** Build understanding and capacity of country partners to make informed decisions, as they look to potentially support hydrogen and its derivatives.
- **Format:** Key topics are organized into a “considerations tree” to help stakeholders think through technical, regulatory, economic, environmental, social, and analytical questions.

1. End-Use Application Considerations
   - Energy Generation
   - Industrial and Chemical
   - Transport and Agriculture
2. Production and energy source Considerations
   - Electrolysis Technological Advancements
   - Feedstock
   - Energy Sources: Renewable, Nuclear, Fossil
3. Infrastructure Considerations
   - Production and Conversion
   - Storage and Distribution
   - Clusters or hubs
4. Costs and Economic Viability Considerations
   - Capital Expenditure/ Operating expenditure Viability
   - Markets
   - Technology Availability
5. Environmental Considerations
   - Greenhouse Gases & Life Cycle Assessments
   - Local/Regional/ Country-Level Environmental Impacts
   - Resource competition
6. Social Considerations
   - Stakeholder Engagement
   - Workforce Opportunities
   - Health and Safety
7. Policy and Regulatory Considerations
   - Policy and regulatory framework
   - Incentives and Enabling Conditions
   - Standards and Certifications
8. Considerations Tree Exercises
   - Case Study: Large-scale wind powered hydrogen & ammonia project
   - SWOT Analysis (Strengths, Weaknesses, Opportunities, Threats)

Image Source: Sam Booth, NREL

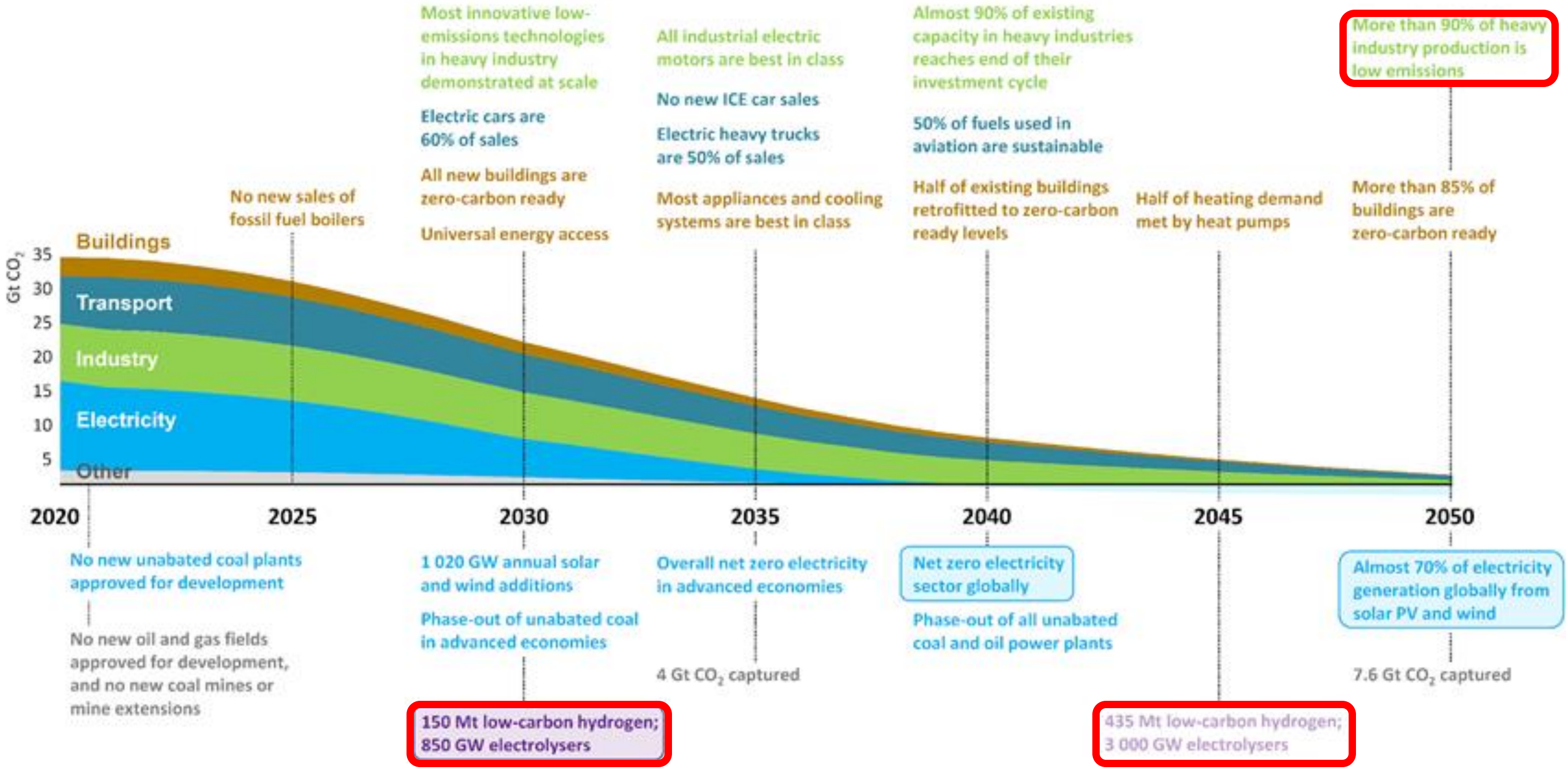
Explore the USAID-NREL Hydrogen Considerations Tree

Executive Deck

Fact Sheet

Image Source: Sam Booth, NREL

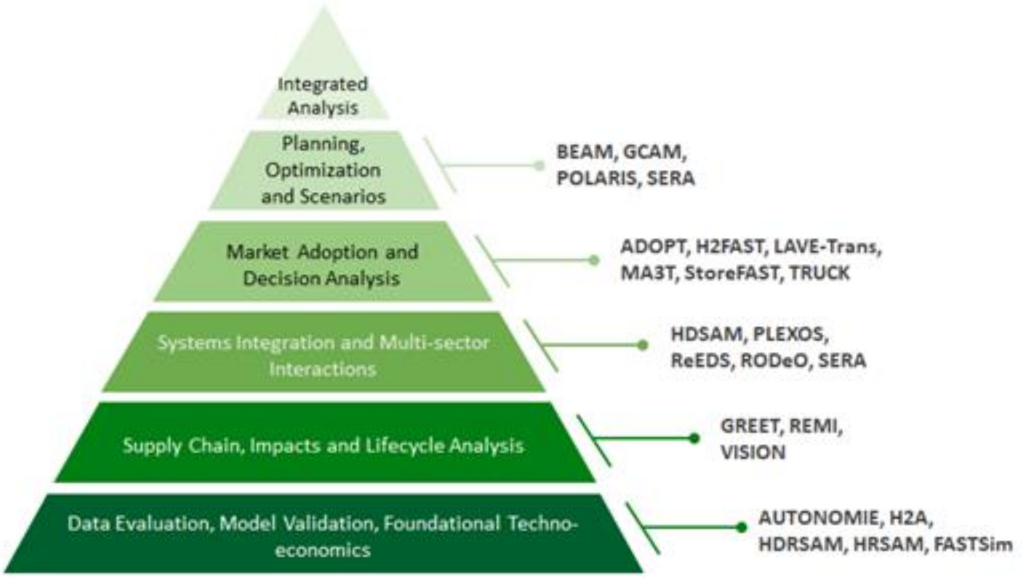
The Path Toward a Net-Zero Emissions Energy Sector by 2050



Ref: https://unfccc.int/sites/default/files/resource/NZE2050_Worsdorfer_IEA.pdf

Tools Spotlight: Supporting decision making

Decision-making workflow for hydrogen deployment



ADOPT: Automotive Deployment Options Projection Tool, Autonomie: (a vehicle system simulation tool), BEAM: Behavior, Energy, Autonomy, and Mobility, FASTSim: Future Automotive Systems Technology Simulator, GCAM: Global Change Assessment Model, GREET: Greenhouse gases, regulated emissions, and energy use in Technologies Model, H2A: The Hydrogen Analysis Project, H2FAST: Hydrogen Financial Analysis Scenario Tool, HDRSAM: Heavy-Duty Refueling Station Analysis Model, HDSAM: Hydrogen Delivery Scenario Analysis Model, HRSAM: Hydrogen Refueling Station Analysis Model, LAVE-Trans: Light-Duty Alternative Vehicle Energy Transitions, PLEXOS: (an integrated energy model), POLARIS: (a predictive transportation system model), ReEDS: Regional Energy Deployment System, REMI: Regional Economic Models, Inc., RODeO: Revenue Operation and Device Optimization Model, SERA: Scenario Evaluation and Regionalization Analysis, StoreFAST: Storage Financial Analysis Scenario Tool, VISION: (a transportation energy use prediction model).

- **Hydrogen Analysis Production (H2A)**: Transparent reporting of process design assumptions and a consistent cost analysis methodology for hydrogen production at central and distributed (forecourt/filling-station) facilities. H2A includes biomass, coal, electrolysis, natural gas, and emerging production pathways.
- **Revenue, Operation, and Device Optimization (RODeO)**: Explores optimal system design and operation considering different levels of grid integration, equipment cost, operating limitations, financing, and credits and incentives.
- **Scenario Evaluation and Regionalization Analysis (SERA)**: Provides insights that can guide hydrogen infrastructure development and transportation investment decisions and accelerate the adoption of hydrogen technologies (city to national levels).
- **Hydrogen Financial Analysis Scenario Tool (H2FAST)**: Provides a quick and convenient in-depth financial analysis for hydrogen fueling stations and hydrogen production facilities.

Source: https://www.hydrogen.energy.gov/pdfs/us-national-clean-hydrogen-strategy-roadmap.pdf

Image Source: Sam Booth, NREL

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Overview of the Hydrogen Financial Analysis Scenario Tool (H2FAST)

Presented by Jamie Kee, National Renewable Energy Laboratory

May 29, 2024

H2FAST – Hydrogen Financial Analysis Scenario Tool

Provide flexible rigorous financial analysis for wide variety of hydrogen and non-hydrogen production and service systems.

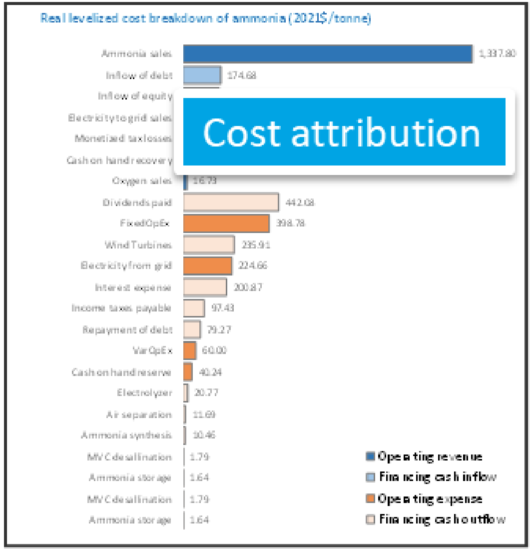
Accommodate diverse systems and services. (example past applications)

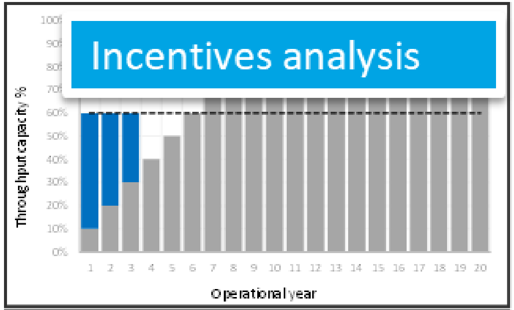
- Retail hydrogen sales
- Hydrogen production (electrolytic, fossil, biomass, others)
- Hydrogen delivery & distribution
- Ammonia production
- Methane pyrolysis
- EV charging
- Seasonal energy storage
- Fleet operations
- Combined heat and power (CHP fuel cells)

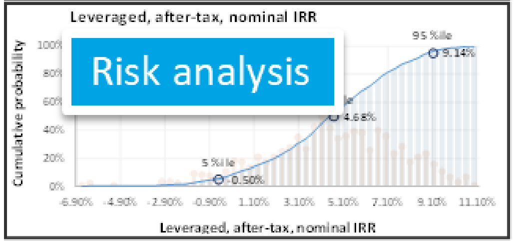
Model users

- System operators
- Government & policy makers
- Equity and debt investors
- Strategic investors (gas suppliers, utilities, car OEMs)
- Equipment manufacturers
- Academic institutions & national laboratories

H2FAST



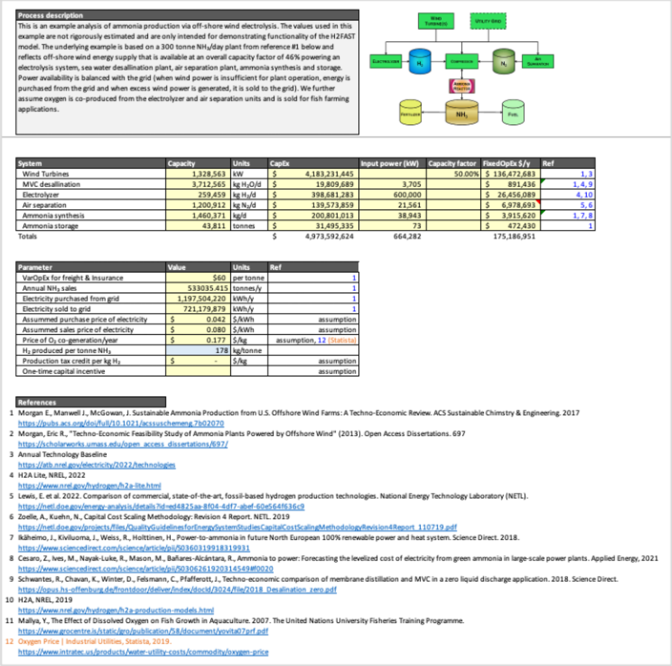




H2FAST – Hydrogen Financial Analysis Scenario Tool

- Financial model built for commodity-based processes, such as hydrogen production
- **Publicly-available** Excel model
  - **Python** version is now available from NREL
- Converts engineering inputs to Generally Accepted Accounting Principles (GAAP)
  - **Income** and **cash flow statements** as well as a **balance sheet** allows auditing of the financial calculations
- **Compatible** with the International Financial Reporting System (IFRS)
- Model modes:
  - **Price-taker:** Set the market price and analyze financial performance
  - **Price-setter:** Set the target financial parameters and calculate price

H2FAST – Excel Sheets Overview



Process description

This is an example analysis of ammonia production via off-shore wind electrolysis. The values used in this example are not rigorously estimated and are only intended for demonstrating functionality of the H2FAST model. The underlying example is based on a 300 tonne NH_3/day plant from reference #1 below and reflects off-shore wind energy supply that is available at an overall capacity factor of 46% powering an electrolysis system, sea water desallination plant, air separation plant, ammonia synthesis and storage. Power availability is balanced with the grid (when wind power is insufficient for plant operation, energy is purchased from the grid and when excess wind power is generated, it is sold to the grid). We further assume oxygen is co-produced from the electrolyzer and air separation units and is sold for fish farming applications.

System	Capacity	Units	CapEx	Input power (kW)	Capacity factor	FixedOpEx $/y	Ref
Wind Turbines	1,328,563	kW	$ 4,183,231,445		50.00%	$ 136,472,683	1, 3
MVC desallination	3,712,565	kg H_2O/d	$ 19,809,689	3,705		$ 891,436	1, 4, 9
Electrolyzer	259,459	kg H_2/d	$ 398,681,283	600,000		$ 26,456,089	4, 10
Air separation	1,200,912	kg N_2/d	$ 139,573,859	21,561		$ 6,978,693	5, 6
Ammonia synthesis	1,460,371	kg/d	$ 200,801,013	38,943		$ 3,915,620	1, 7, 8
Ammonia storage	43,811	tonnes	$ 31,495,335	73		$ 472,430	1
Totals			$ 4,973,592,624	664,282		175,186,951	

Parameter	Value	Units	Ref
VarOpEx for freight & Insurance	$60	per tonne	1
Annual NH_3 sales	533035.415	tonnes/y	1
Electricity purchased from grid	1,197,504,220	kWh/y	1
Electricity sold to grid	721,179,879	kWh/y	1
Assummed purchase price of electricity	$ 0.042	$/kWh	assumption
Assummed sales price of electricity	$ 0.080	$/kWh	assumption
Price of O_2 co-generation/year	$ 0.177	$/kg	assumption, 12 (Statista)
H_2 produced per tonne NH_3	178	kg/tonne	
Production tax credit per kg H_2	$ -	$/kg	assumption
One-time capital incentive			assumption

References

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https://pubs.acs.org/doi/full/10.1021/acssuschemeng.7b02070

2 Morgan, Eric R., "Techno-Economic Feasibility Study of Ammonia Plants Powered by Offshore Wind" (2013). Open Access Dissertations. 697
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3 Annual Technology Baseline
https://atb.nrel.gov/electricity/2022/technologies

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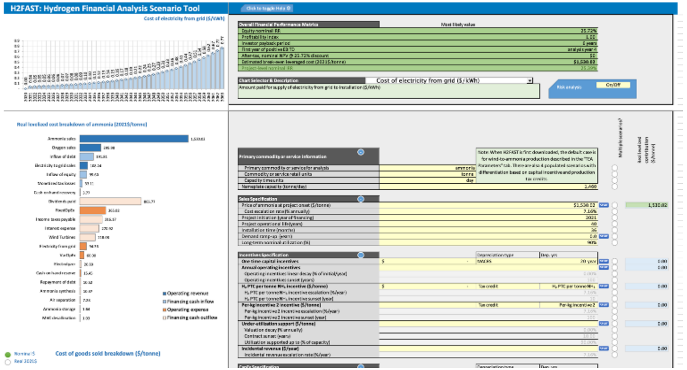
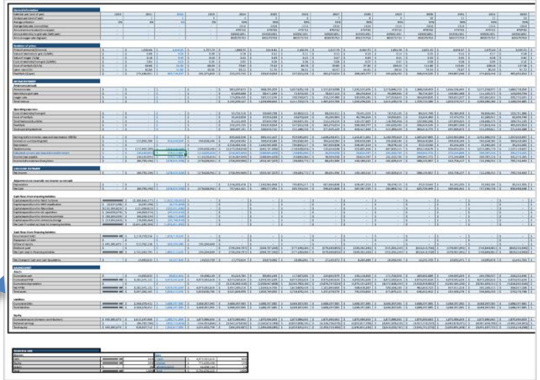
10 H2A, NREL, 2019
https://www.nrel.gov/hydrogen/h2a-production-models.html

11 Mallya, Y., The Effect of Dissolved Oxygen on Fish Growth in Aquaculture. 2007. The United Nations University Fisheries Training Programme.
https://www.grocentre.is/static/gro/publication/58/document/yovita07prf.pdf

12 Oxygen Price | Industrial Utilities, Statista, 2019.
https://www.intratec.us/products/water-utility-costs/commodity/oxygen-price





How Does H2FAST Work?

Inputs:

- TEA Parameters
  - Nameplate capacities
  - Input power
  - Capacity factors
  - Fixed annual OPEX
  - Co-product prices
  - Fixed annual OPEX
  - Electricity price(s)
- Interface
  - Price mode
  - Project initiation year
  - Project lifetime
  - Installation time
  - Tax credits & rates
  - Risk analysis
  - Co-product prices
  - Financing structure
- Overrides
  - Custom pricing data
    - Varying electricity price per year
    - Varying tax incentive per year

H2FAST

Outputs:

- Interface
  - Graphical results
  - Price (if price-setter)
  - Risk analysis results
- Report Tables
  - Income statement
  - Cash flow statement
  - Balance Sheet
  - Annual results

Inputs capture a variety of system parameters to produce accurate output results

Why H2FAST?

- **H2FAST** provides a detailed financial analysis based on simple technical and financial parameters
- **H2FAST** outputs cost breakdown of relevant financial metrics (e.g., co-product sales, taxes, feedstocks, etc.)
- **H2FAST** allows users to perform detailed analyses (e.g., sensitivity analyses, risk analysis, multiple scenarios)
- **H2FAST** helps users understand the economic and financial feasibility of projects and provides a standardized approach for comparing processes

H2FAST

Thank you!

Jamie Kee, Jamie.Kee@NREL.gov

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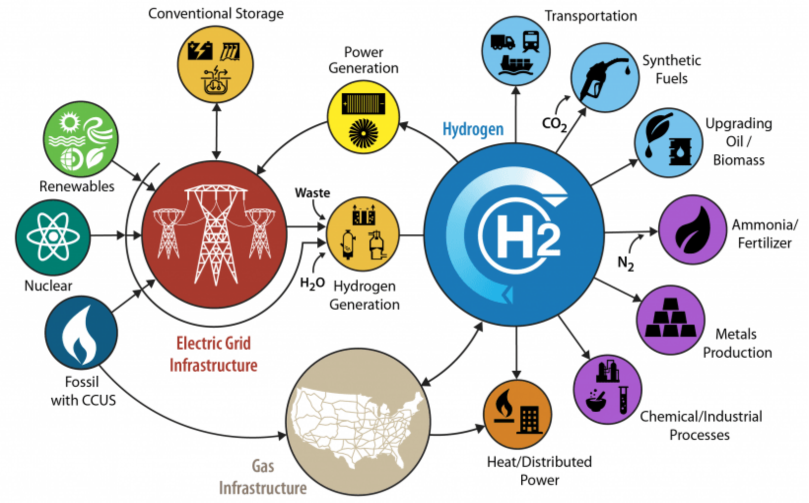
H2FAST Case Study: Wind-Powered Green Ammonia Production in La Guajira, Colombia

Presented by Hussain Almajed, National Renewable Energy Laboratory

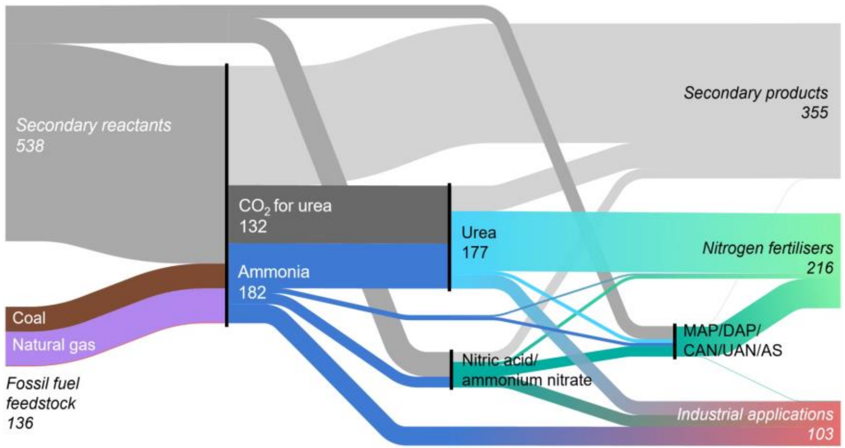
May 29, 2024

Green Ammonia Requires Green Hydrogen

- Renewably-powered H_2 can be used in many industries
- Expected 2030 H_2 global demand from electrolysis = 27 Mt-H_2/yr



- Today, green ammonia requires electrolysis-based H_2
- Ammonia global demand in 2050 is expected to be almost double the demand in 2019



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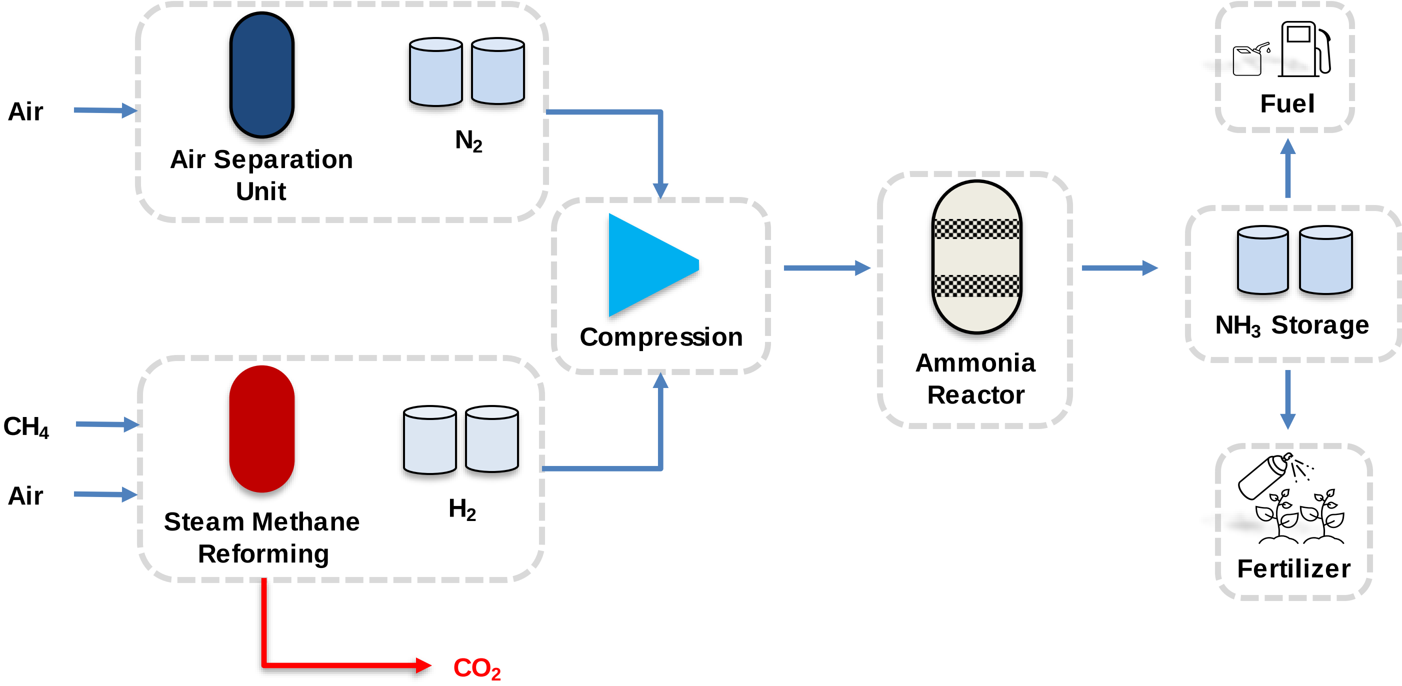
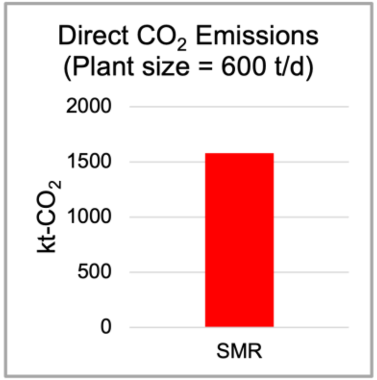
DOE, H2@Scale, 2017. https://www.energy.gov/eere/fuelcells/h2scale
IEA, Global Hydrogen Review 2023, 2023. https://www.iea.org/reports/global-hydrogen-review-2023/executive-summary

Conventional Ammonia Production





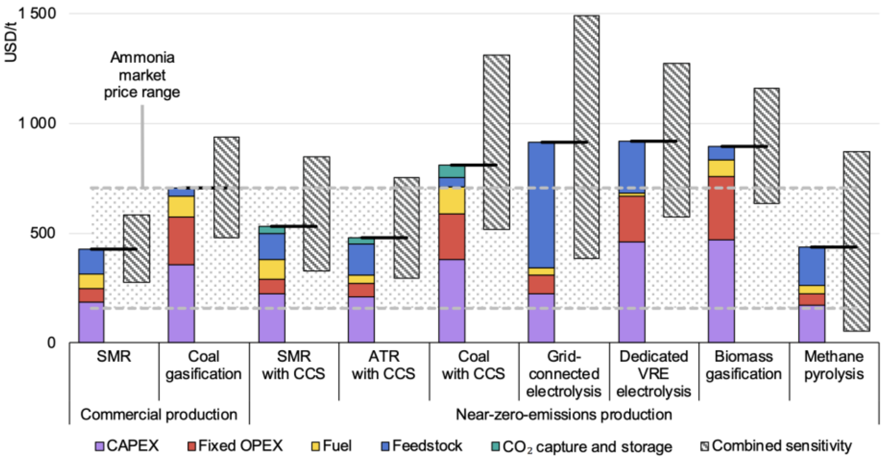
Data from IEA, "Ammonia Technology Roadmap"

**Simplified process flow diagram of the conventional Haber-Bosch process*

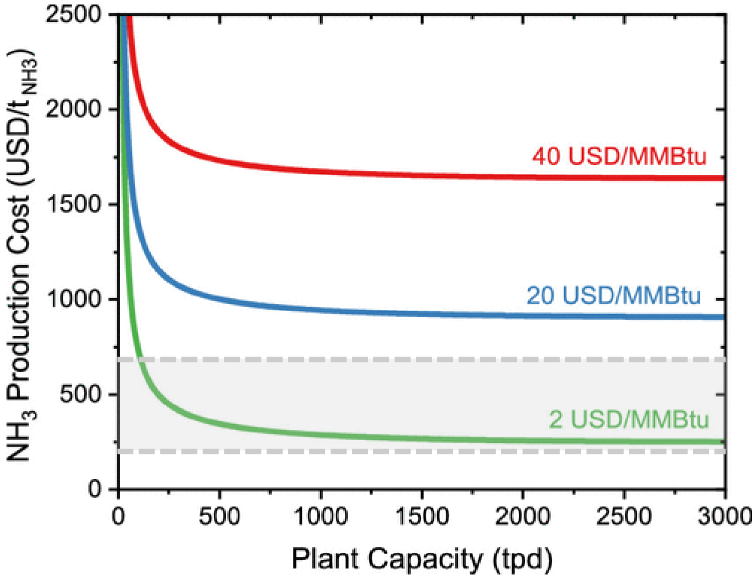
Conventional Ammonia Price Sets the Benchmark Price

- Conventional ammonia price ≈ $220-700 per tonne
  - Heavily depends on the price of natural gas

Figure 1.6 **Simplified levelised cost of ammonia production for commercial and near-zero-emission production routes in 2020**



IEA, 2021.



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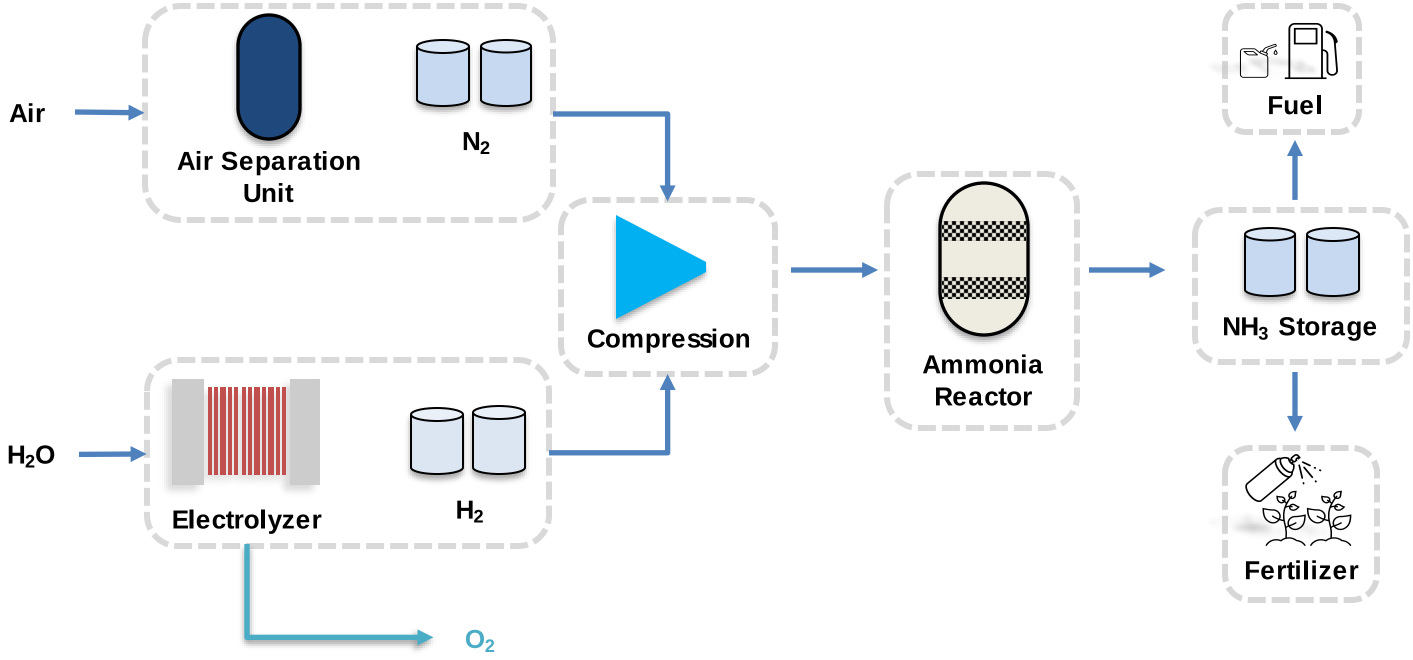
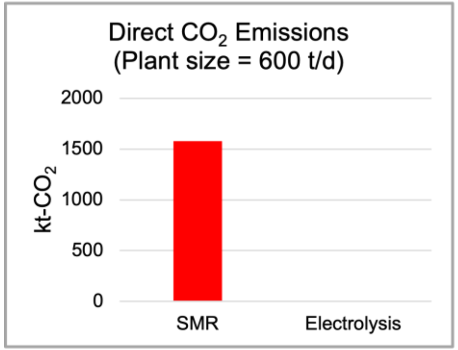
Green Ammonia Production

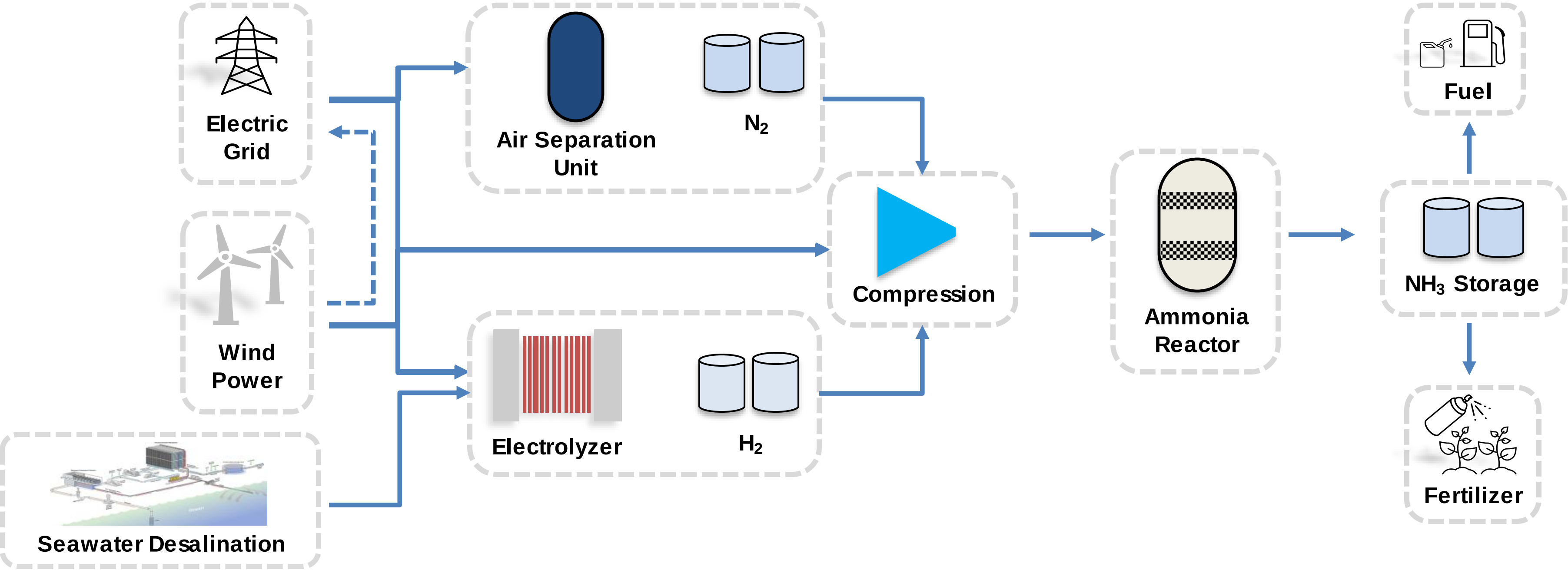




Data from IEA, "Ammonia Technology Roadmap"

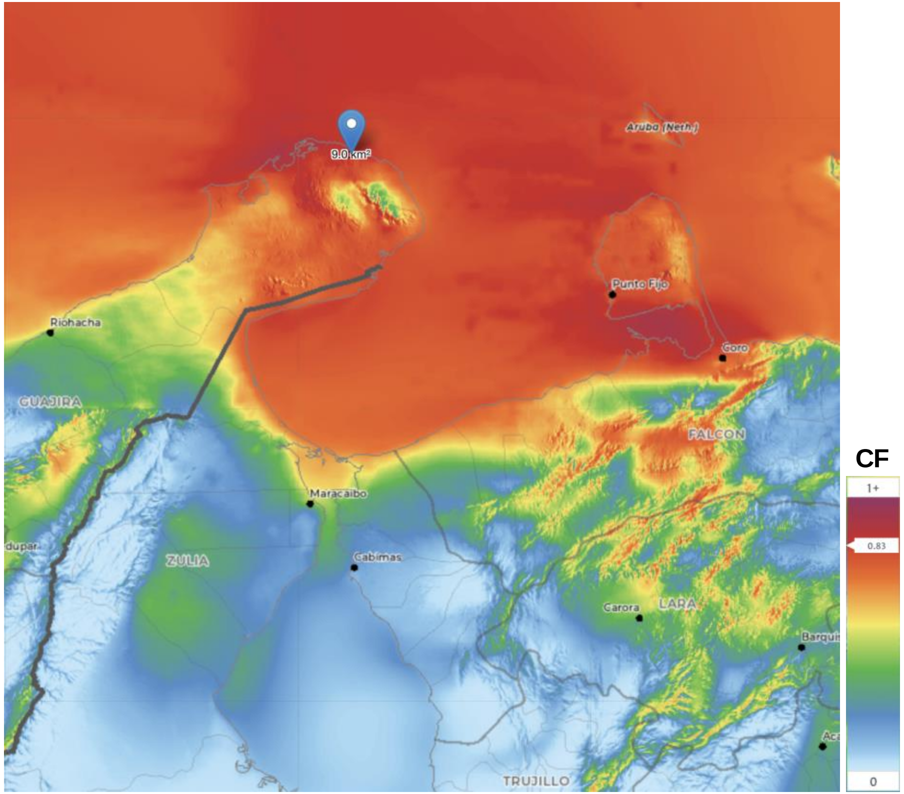
**Simplified process flow diagram of the "green" Haber-Bosch process*

The Case Study: Considered Process Design



*Simplified process flow diagram of the considered ammonia production pathway

The Case Study: Key Assumptions



- **Location:** NE of La Guajira, Colombia (high wind capacity factor)
- **Plant Capacity:** 300 tonnes of ammonia per day
- **Electricity Sold to Grid:** 50.2%
- **Electricity Purchased from Grid:** 49.2%
- **Wind Capacity Factor:** 81.3%
- **Inflation Rate:** 7.16% (Colombia)
- **Depreciation Method:** Straight Line

Global Wind Atlas. URL: https://globalwindatlas.info/en (accessed May 22nd, 2024)
Morgan E., Manwell J., McGowan, J. Sustainable Ammonia Production from U.S. Offshore Wind Farms: A Techno-Economic Review. ACS Sus. Chem. & Eng. 2017. DOI: 10.1021/acssuschemeng.7b02070

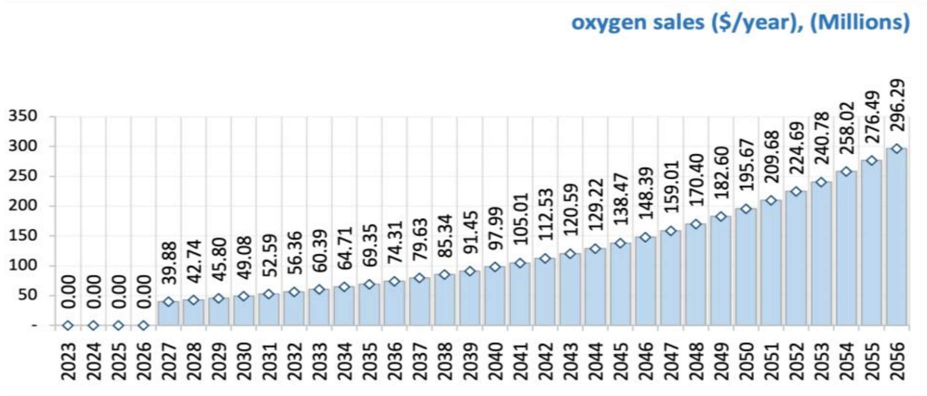
The Case Study: Parameters Input

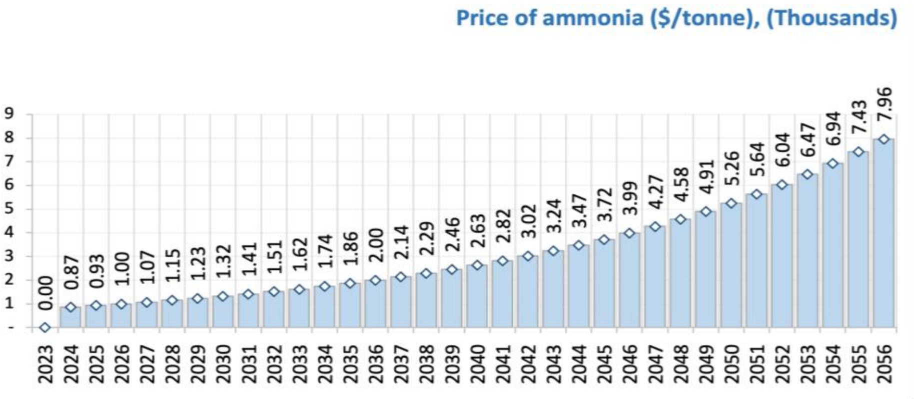
Parameter	Value
Sold grid electricity price ($/MWh)	80
Purchased off-grid electricity price ($/MWh)	42
O_2 price ($/kg-$O_2$)	0.177
Wind power capacity factor	81.33%
Plant capacity factor	90%
Total tax rate	29.4%
General inflation rate	7.16%
Leveraged after-tax nominal discount rate	25.72%
Debt/equity ratio	70/30
Debt interest rate (long-term, bond)	10.7%
Working capital	3-month liquidity

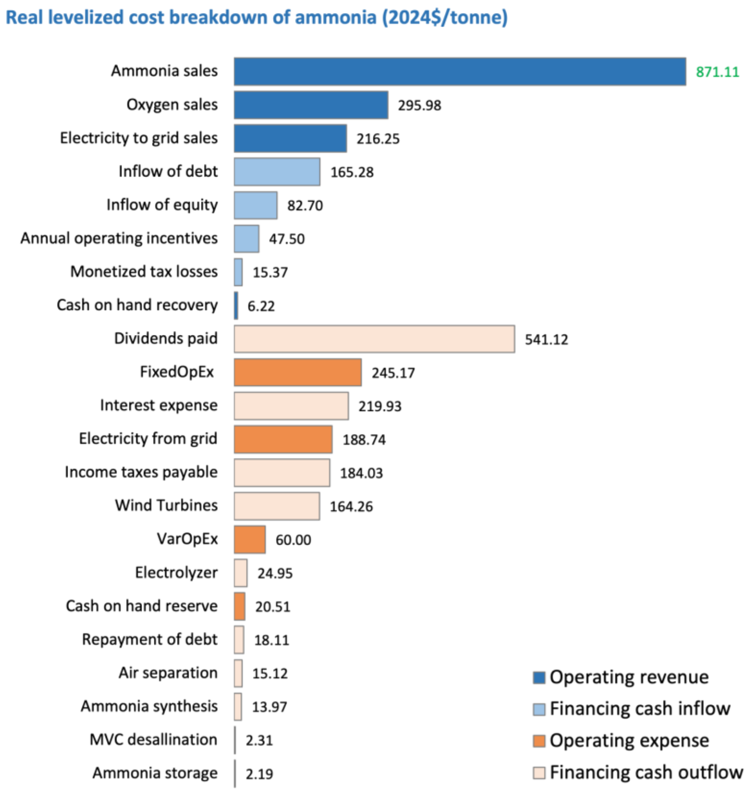
Other inputs to consider:

- Tax incentives
  - One-time payments
  - Annual incentives
- Variable annually-averaged electricity prices (Override)
- Specific CAPEX/OPEX elements
- Taxation of operating incentives
- Depreciation methods and lengths
- Debt type (bond type vs. one-time loan)

The Case Study: Baseline Results from H2FAST

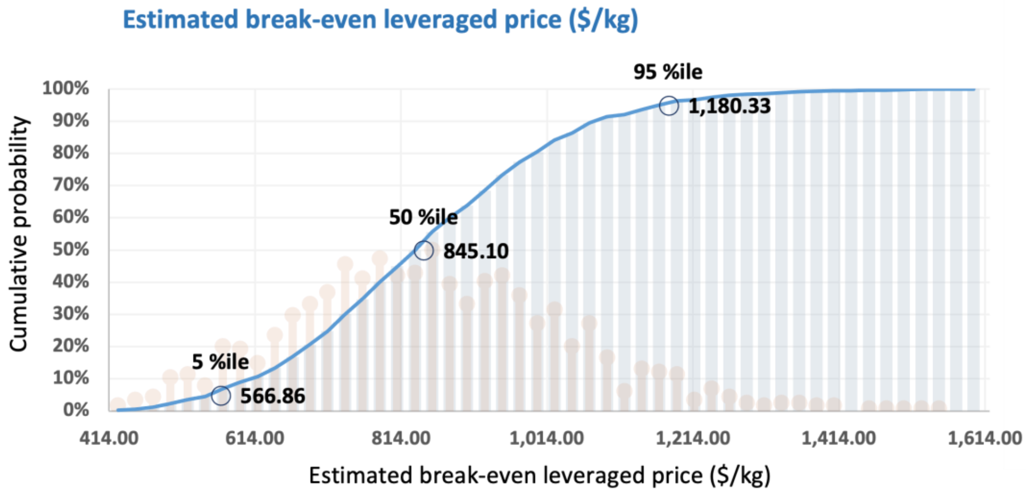


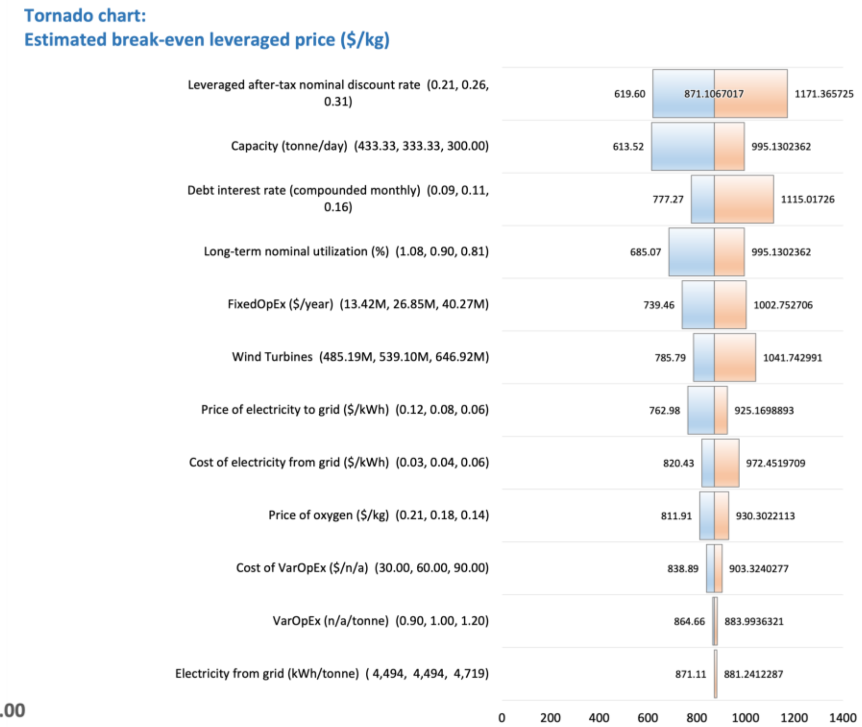




The Case Study: Risk Analysis Results from H2FAST

- Monte Carlo risk analysis results
- Most-probable break-even leveraged price of ammonia



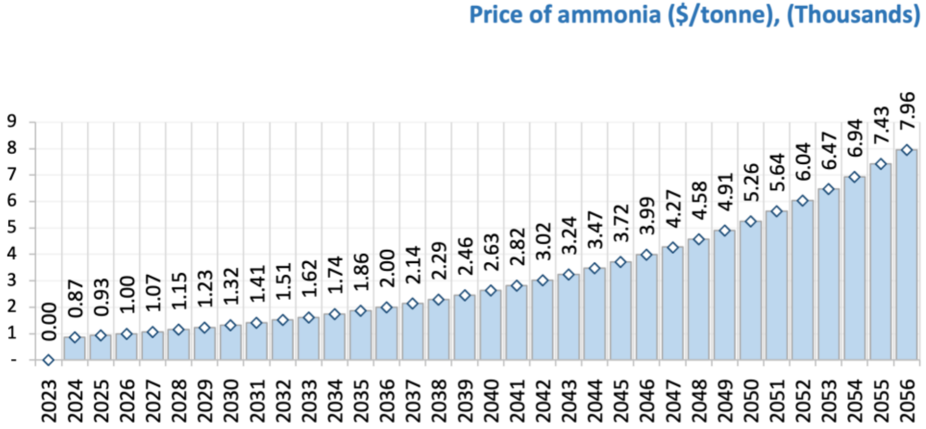


The Case Study: Inflation Rates Effects

- Inflation rates affect the break-even leveraged price of NH_3

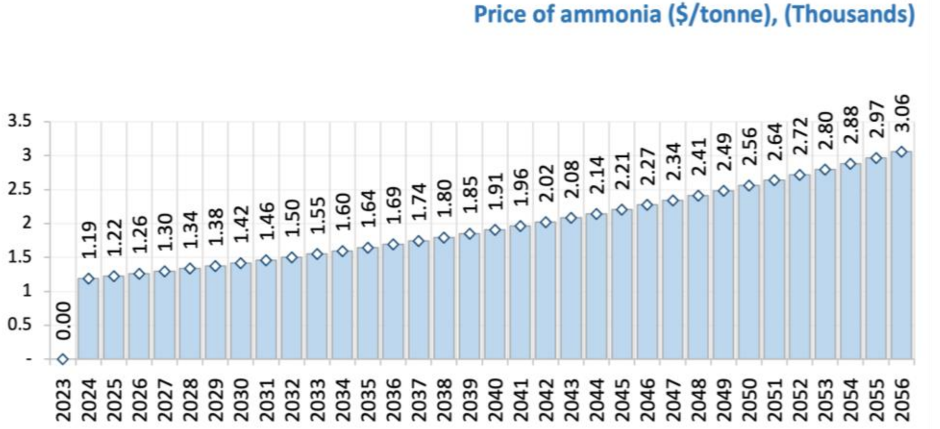
7.16%

Overall Financial Performance Metrics	Most likely value
Equity nominal IRR	25.72%
Profitability index	1.00
Investor payback period	7 years
First year of positive EBITD	analysis year 4
After-tax, nominal NPV @ 25.72% discount	$0
Estimated break-even leveraged cost (2024$/tonne)	**$871.11**



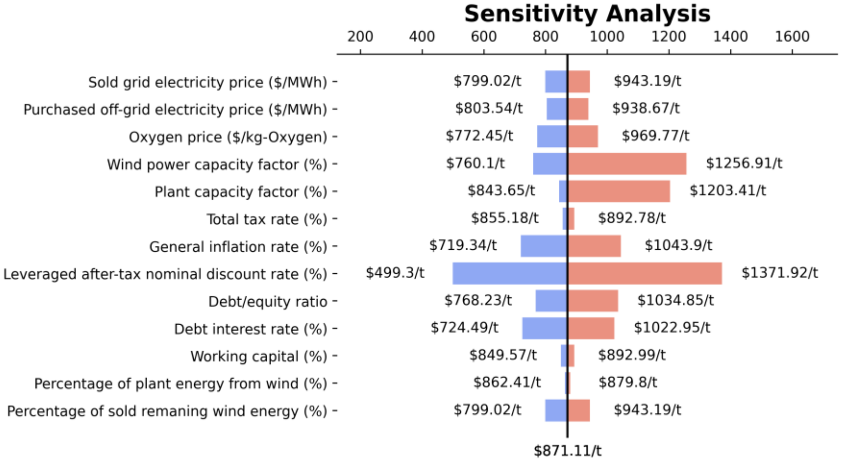
3.00%

Overall Financial Performance Metrics	Most likely value
Equity nominal IRR	25.72%
Profitability index	1.00
Investor payback period	6 years
First year of positive EBITD	analysis year 4
After-tax, nominal NPV @ 25.72% discount	$0
Estimated break-even leveraged cost (2024$/tonne)	**$1,187.22**



The Case Study: Additional Sensitivity Results

Parameter	Optimistic	Base	Pessimistic
Sold grid $P_{electricity}$ ($/MWh)	106.7	80	53.3
Purchased off-grid $P_{electricity}$ ($/MWh)	28	42	56
O_2 price ($/kg-$O_2$)	0.236	0.177	0.118
Wind power capacity factor	95%	81.33%	54.22%
Plant capacity factor	95%	90%	60%
Total tax rate	39.2%	29.4%	19.5%
General inflation rate	9.55%	7.16%	4.77%
Leveraged after-tax nominal discount rate	17.15%	25.72%	34.29%
Debt/equity ratio	76/24	70/30	61/39
Debt interest rate (long-term)	7.13%	10.7%	14.3%
Working capital	2-month liq.	3-month liq.	4-month liq.
% of plant energy from wind	33.47%	50.20%	66.93%
% of sold remaining wind energy	65.57%	49.18%	32.79%



- One-step further can capture extra sensitivity metrics
  - E.g., Wind power capacity factor
  - E.g., % of plant energy from wind
  - E.g., % of sold remaining wind energy

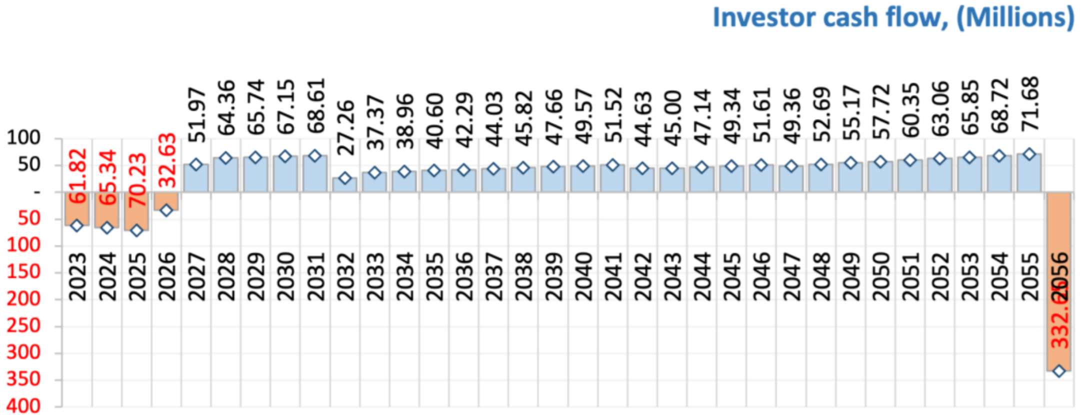
The Case Study: An Optimistic Case

Parameter	Optimistic
Sold grid electricity price ($/MWh)	106.7
Purchased off-grid electricity price ($/MWh)	28
O_2 price ($/kg-$O_2$)	0.236
Wind power capacity factor	95%
Plant capacity factor	95%
Total tax rate	39.2%
General inflation rate	3%
Leveraged after-tax nominal discount rate	17.15%
Debt/equity ratio	70/30
Debt interest rate (long-term)	10.7%
Working capital	3-month liquidity

Bond Debt

Overall Financial Performance Metrics	Most likely value
Equity nominal IRR	17.15%
Profitability index	1.00
Investor payback period	7 years
First year of positive EBITD	analysis year 4
After-tax, nominal NPV @ 17.1466666666667% discount	$0
Estimated break-even leveraged cost (2024$/tonne)	$354.92

Investor Cash Flow = Investor Withdrawals – Investor Contributions



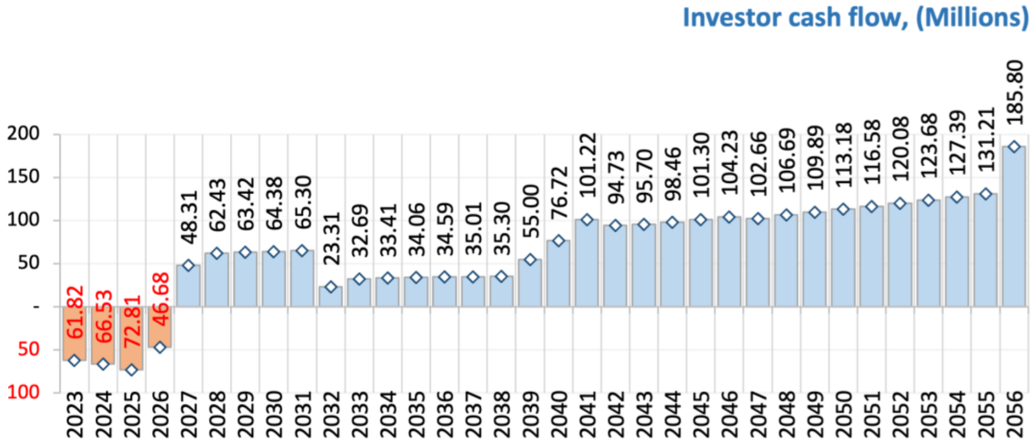
The Case Study: An Optimistic Case

Parameter	Optimistic
Sold grid electricity price ($/MWh)	106.7
Purchased off-grid electricity price ($/MWh)	28
O_2 price ($/kg-$O_2$)	0.236
Wind power capacity factor	95%
Plant capacity factor	95%
Total tax rate	39.2%
General inflation rate	3%
Leveraged after-tax nominal discount rate	17.15%
Debt/equity ratio	70/30
Debt interest rate (long-term)	10.7%
Working capital	3-month liquidity

One-time Loan

Overall Financial Performance Metrics	Most likely value
Equity nominal IRR	17.15%
Profitability index	1.00
Investor payback period	8 years
First year of positive EBITD	analysis year 4
After-tax, nominal NPV @ 17.1466666666667% discount	$0
Estimated break-even leveraged cost (2024$/tonne)	**$533.35**

Investor Cash Flow = Investor Withdrawals – Investor Contributions



Capabilities and Limitations of H2FAST

Main Capabilities:

- Model is used in corporate finance
  - Three-statement model
- Compatible with IFRS and GAAP
- Price-taker or price-setter modes
- Simple process and power input parameters (e.g., plant capacity, electricity prices, etc.)
- Automatic plotting of important results
- Performs Monte-Carlo risk analysis
  - Probability analysis to predict possible outcomes

Main Limitations:

- Does not model the retained earnings or most accounting metrics
- Does not account for annual changes in inflation rates or earnings per share
- Depends on process and power system assumptions (i.e., design-specific)
  - E.g., Does not capture hourly variable electricity
    - Can set constant annual electricity price
  - E.g., Does not capture hourly variable mass flow rates

How To Get H2FAST?

- *https://www.nrel.gov/hydrogen/h2fast.html*

CLEAN ENERGY SOLUTIONS CENTER
ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY
An Initiative of the Clean Energy Ministerial

Thank you!

Hussain Almajed, Hussain.Almajed@NREL.gov

CLEAN ENERGY SOLUTIONS CENTER
ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY
An Initiative of the Clean Energy Ministerial

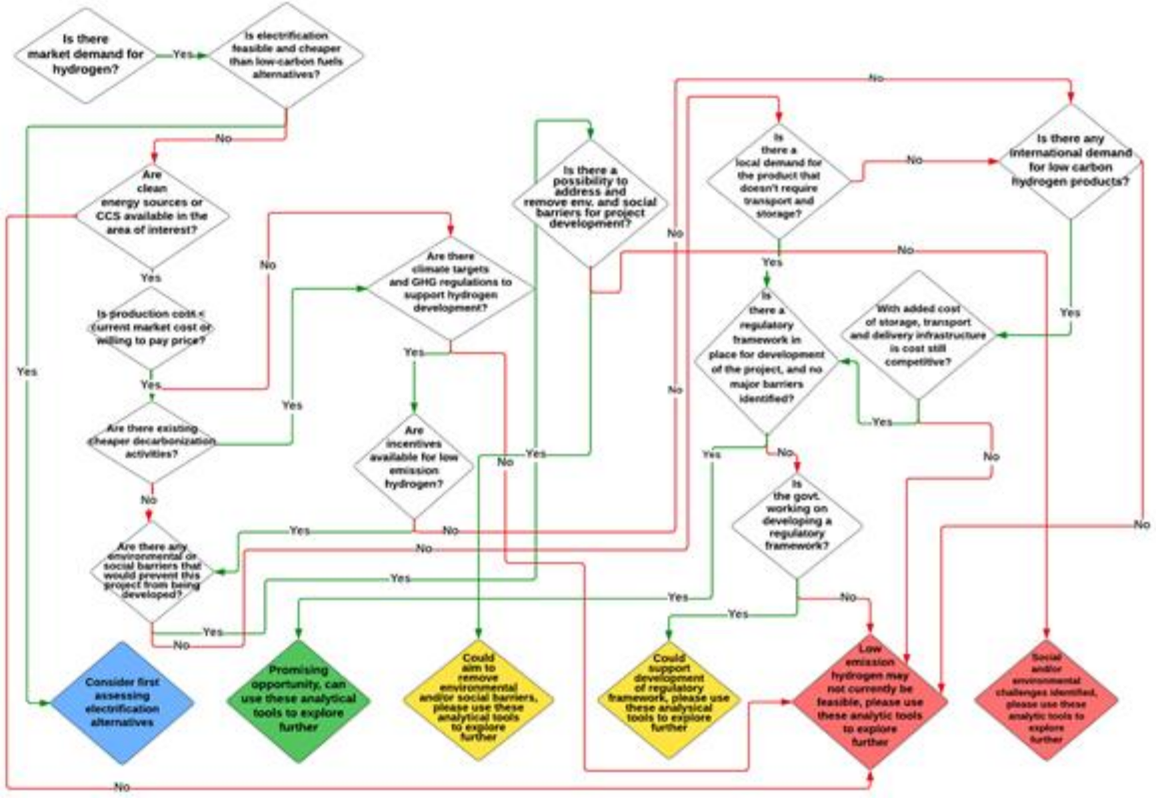
Quick Demonstration of the H2FAST Tool

Presented by Jamie Kee, National Renewable Energy Laboratory

May 29, 2024

Navigating Hydrogen Considerations Tree Flow Chart for Potential Projects

Start Here:



Note: This flow chart is intended to provide a very high-level overview of considerations and questions, to be used for qualitative discussion purposes.

It should not be used to make investment decisions.

Image Source: Sam Booth, NREL

Promising Opportunity to Explore Further

Start here

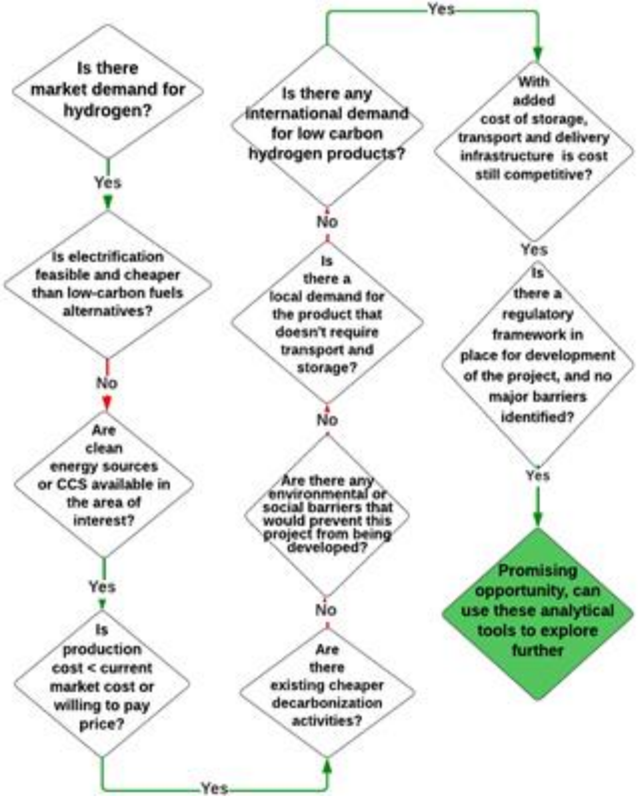


Image Source: Sam Booth, NREL

Significant Barrier(s) Identified

Start here

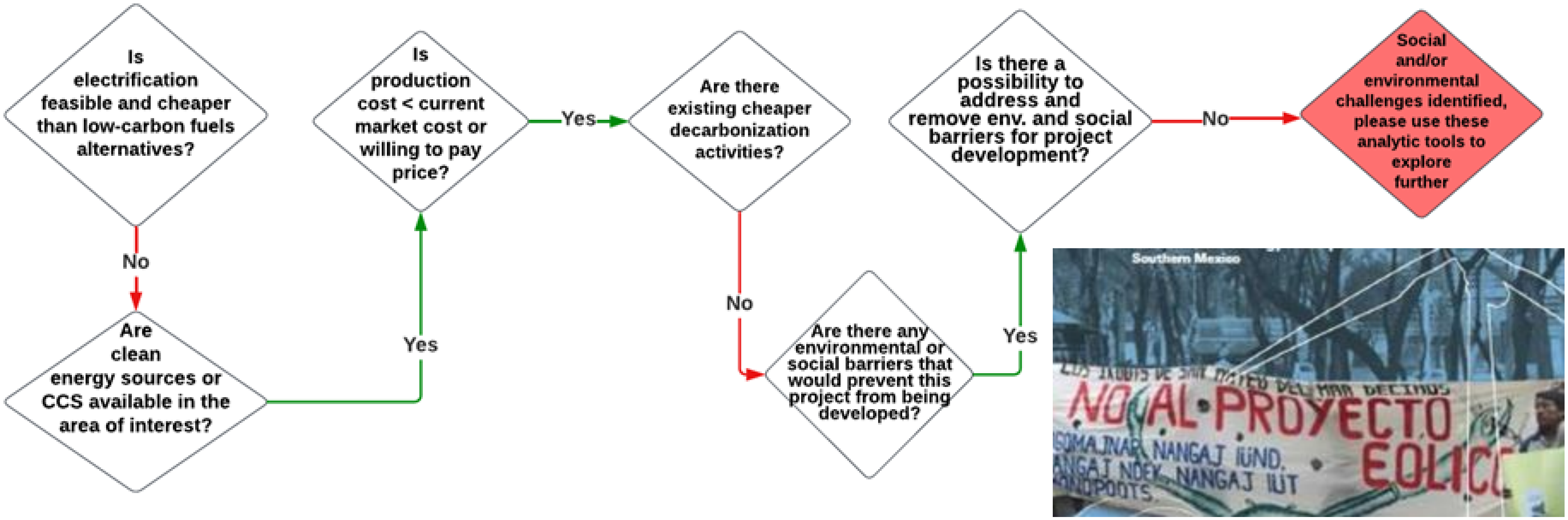


Image Source: Sam Booth, NREL

Integrating Diverse Stakeholders

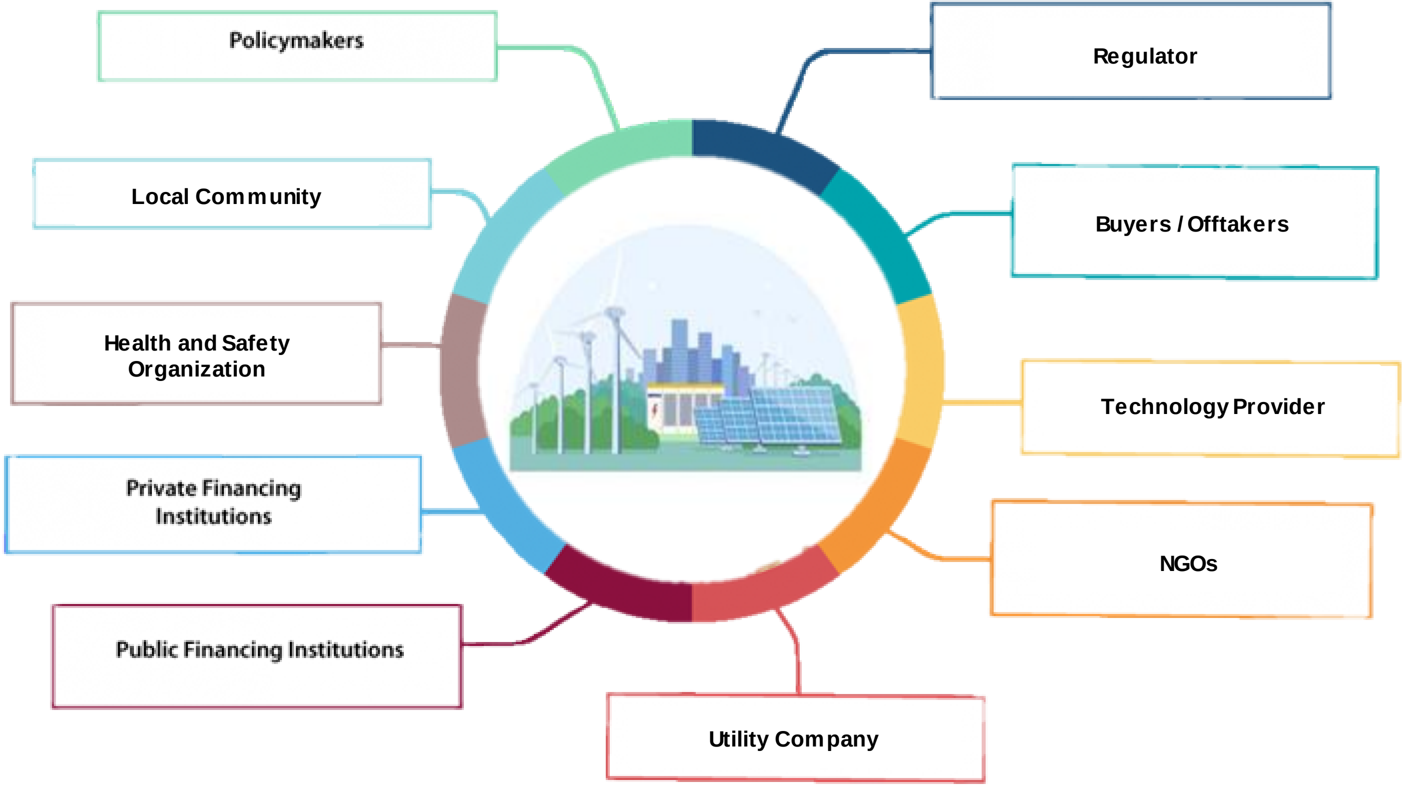
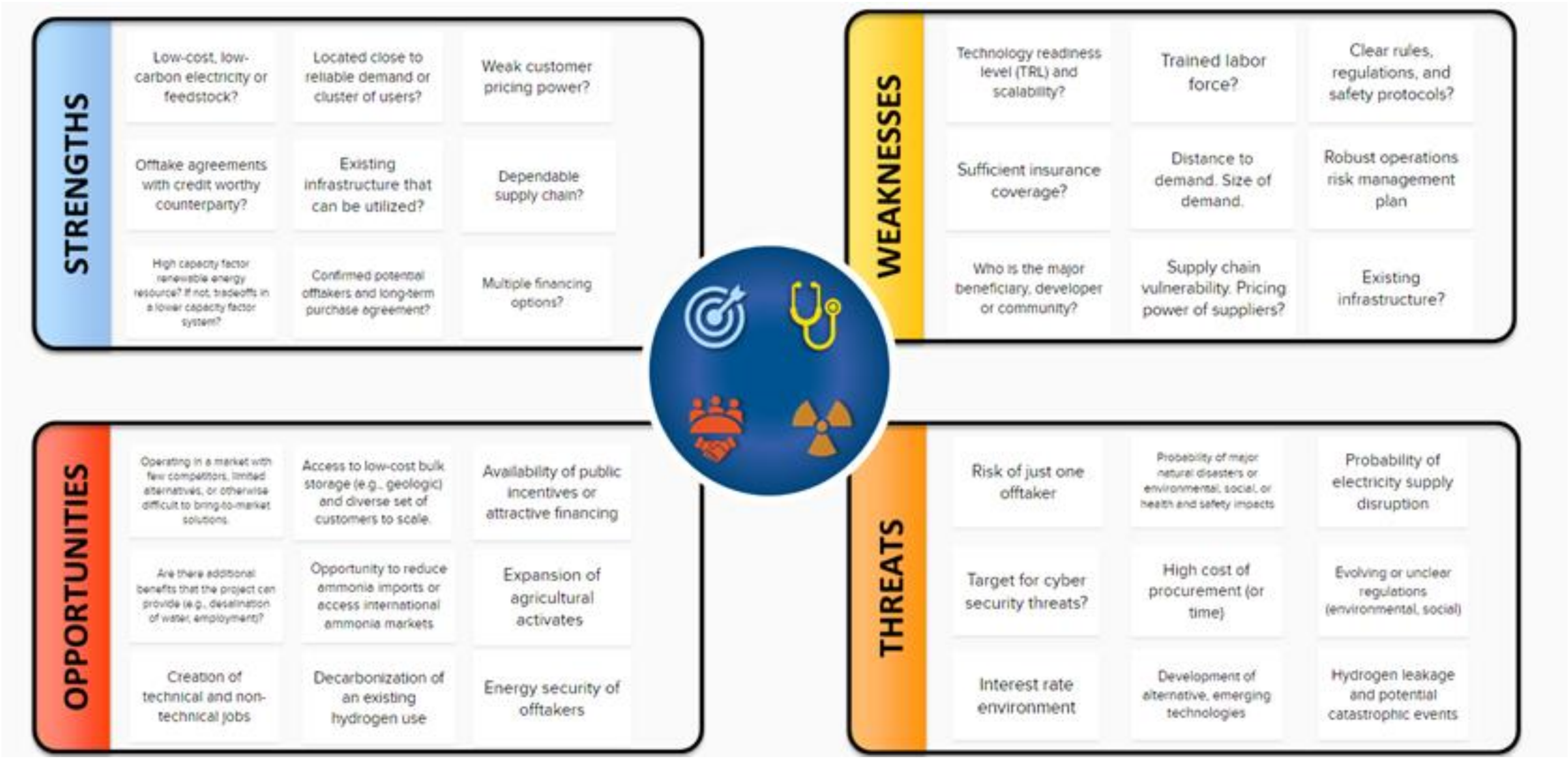


Image Source: Sam Booth, NREL

SWOT Analysis - Guiding Questions



Next Steps

Please take our survey! It will surface as soon as the event ends. Your feedback is highly valued!

Thank you for joining!

Questions? Contact Expert@CleanEnergySolutions.org

https://www.cleanenergyministerial.org/initiatives-campaigns/clean-energy-solutions-center/