Dii Desert Energy

Lessons Learnt: Global Green Hydrogen Cost Optimization VOT-BFT Model™

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Dubai 19th Nov 2023

Document History

DOCUMENT CHANGE HISTORY RECORD SHEET			
Document Title / Number	**Rev.**	**Description Of Change**	**Effective Date**
Lessons Learnt: Global Green Hydrogen Cost Optimization VOT-BFT Model™ Lessons-Learnt-GGHCOVOTBFT-Model-R1-fm230228	1	Initial Release – For Information	28-Feb-2023
Lessons Learnt: Global Green Hydrogen Cost Optimization VOT-BFT Model™ Lessons-Learnt-GGHCOVOTBFT-Model-R1-fm230228	2	Update for Webinar	5-Jun-2023
Lessons Learnt: Global Green Hydrogen Cost Optimization VOT-BFT Model™ Lessons-Learnt-GGHCOVOTBFT-Model-R3-fm231119	3	General Update	19-Nov-2023

Category	**Name**	**Designation**	**Signature**	**Date**
Author	Fadi Maalouf	CTO - Director IPP & EPC	F2M2	5-Jun-2023

Outline

- Introduction
- Toolkit Versions
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- How Does It Work?
- Toolkit Key Objectives
- Toolkit Content
- Toolkit Inputs Form
- Toolkit Pre-COD Finance Cost
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- Takeaways
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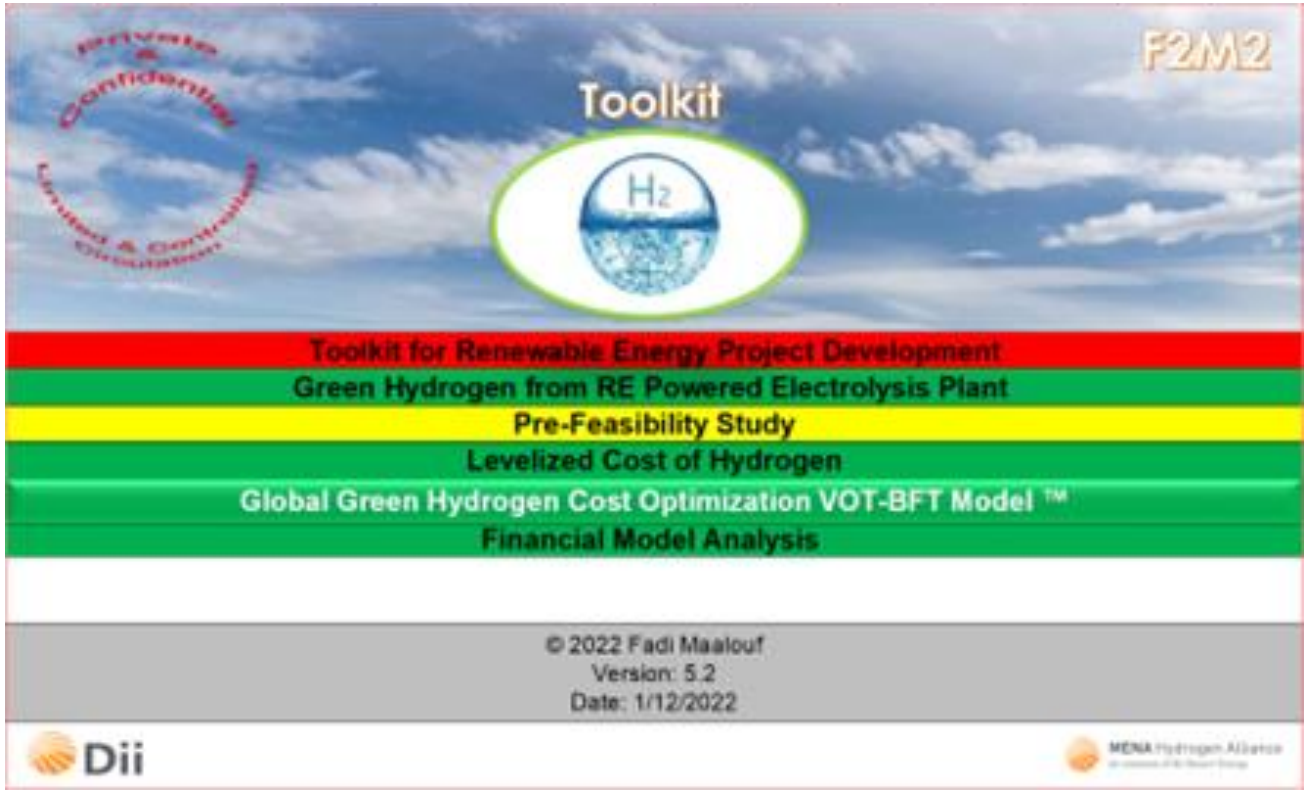


Introduction

- In the Global Energy Transition context and decarbonization, all hands must be on deck!
- There is no magic quick fix or silver bullet solution. It is a collaborative effort across all stakeholders and industries.
- A double win can be achieved: accelerated energy transition driven by sustainable economic recovery.
- An important element of this double win is Green Hydrogen i.e., hydrogen produced from electrolyzers powered by renewable energy resources.
- 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.
- So, 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 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.

Toolkits 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 V7A*
  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

Six versions Modular approach to:

- *Verify costs at each stage of the process*
- *Piecemeal manageable iterative approach*
- *Identify cost optimization priorities & opportunities*

Toolkits Versions

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

General Features:

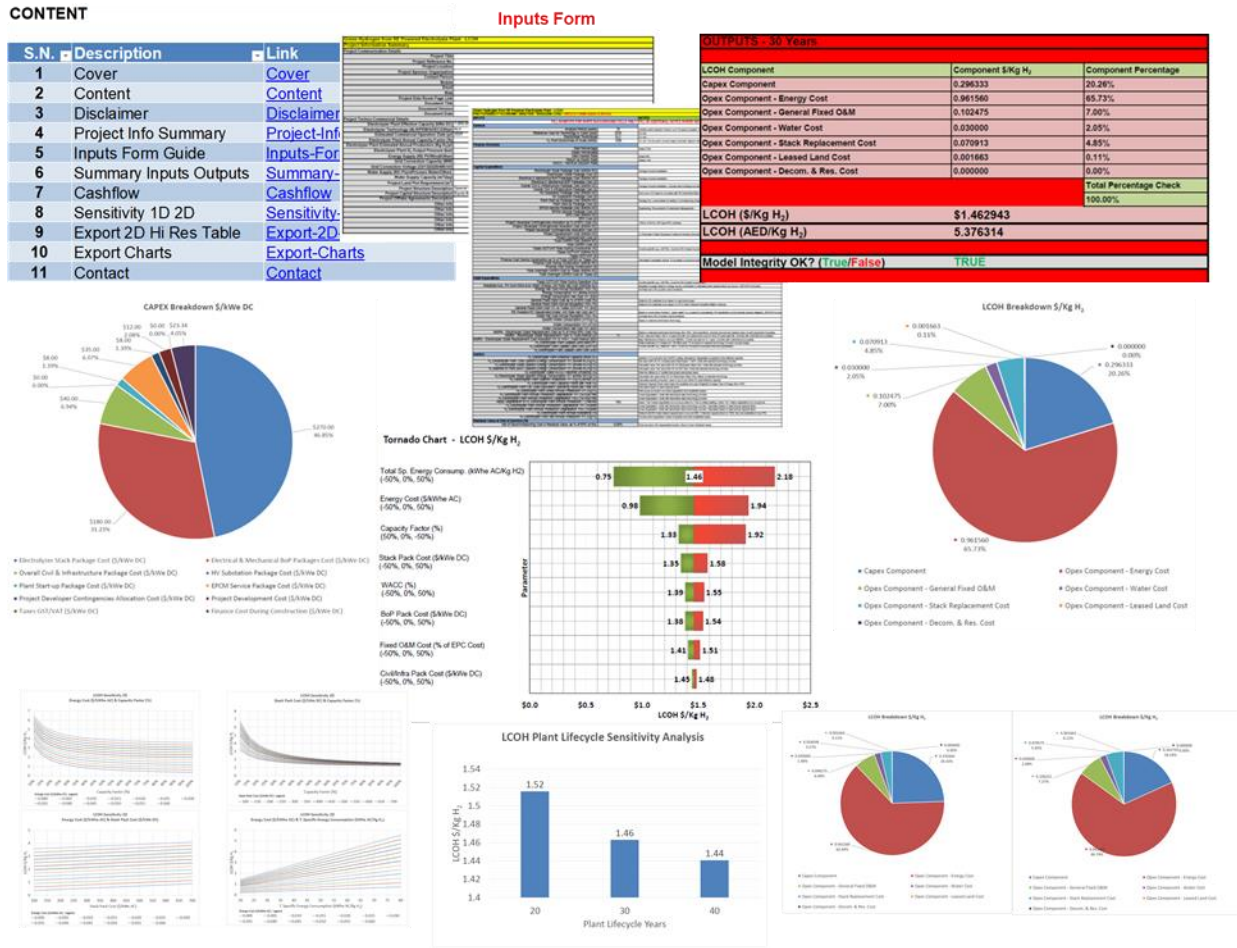
- *Get exclusive market analysis & benchmarking data for Levelized Cost of Green Hydrogen / Green Ammonia / Green e-Methanol Green e-Kerosene*
- *Obtain the best of all worlds assembled from over 50 best in class models for LCOH/LCOA/LCOM/LCOK in the market.*
- *A quick yet very effective holistic approach 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*

Toolkits Versions

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*

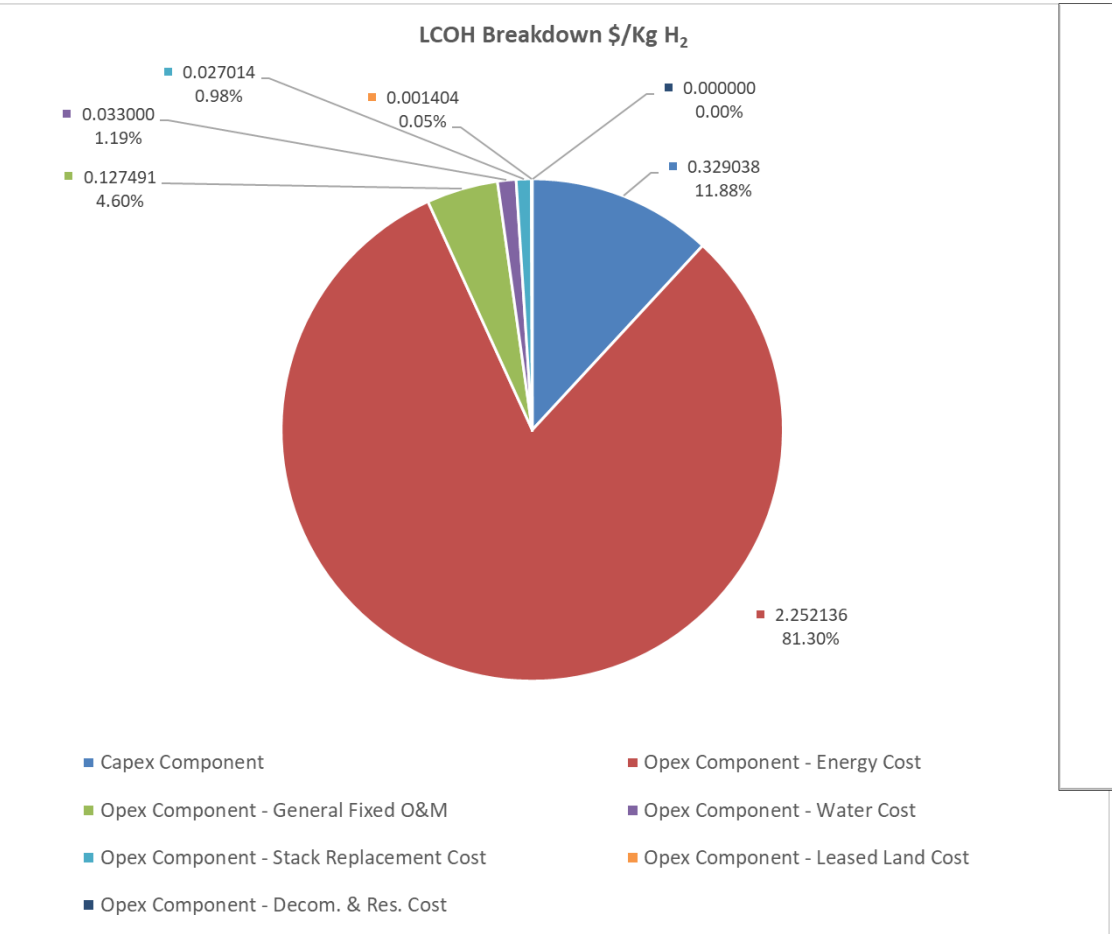


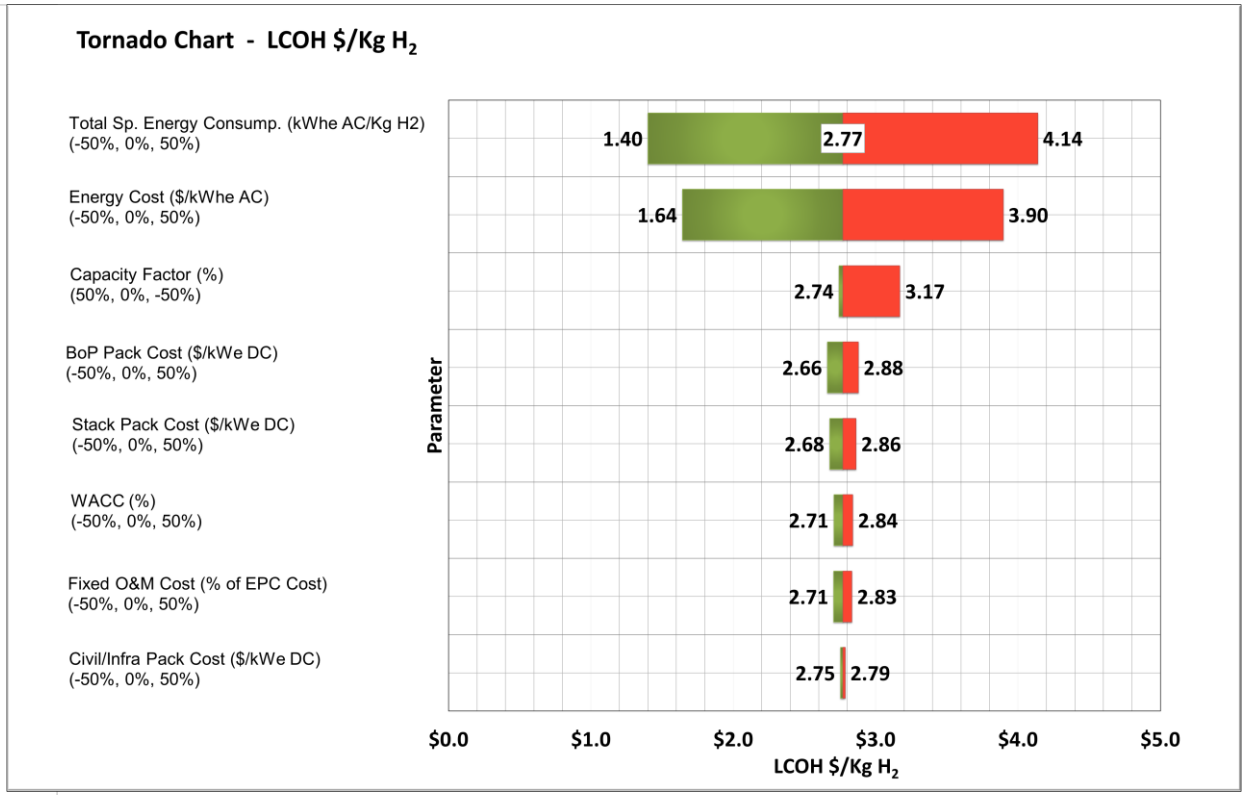
Toolkits Versions

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

Green Hydrogen Toolkit Version 5B

Snapshots



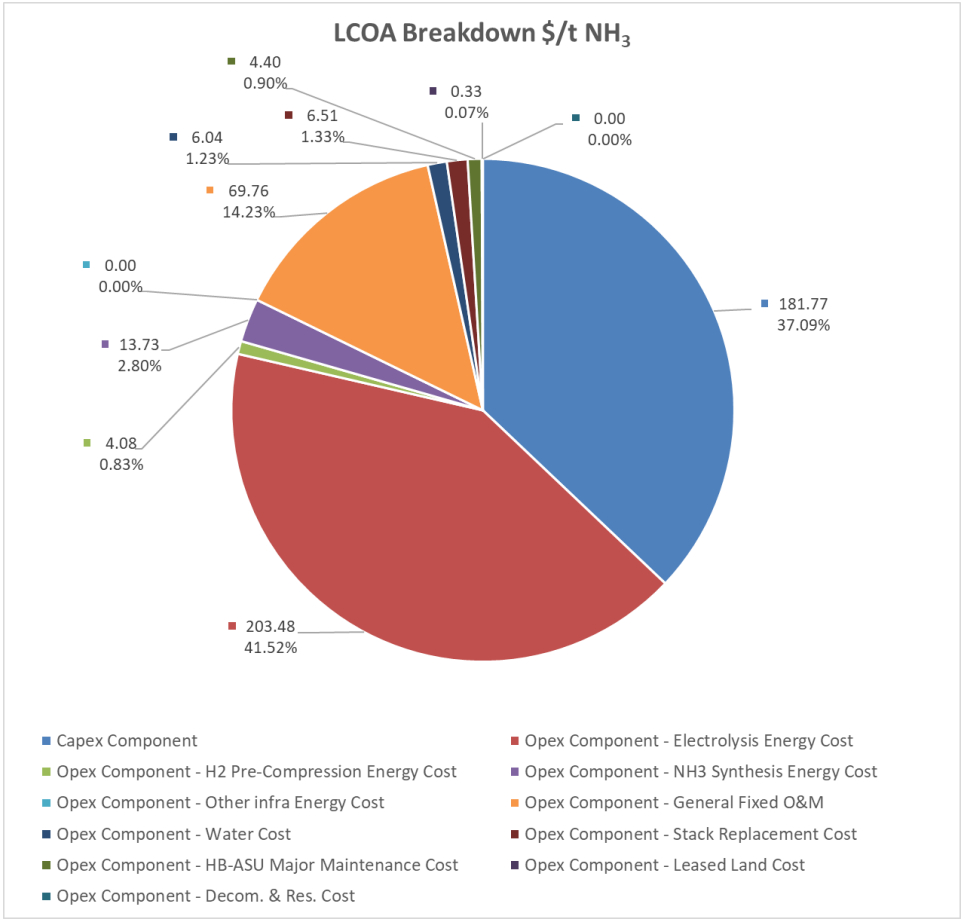


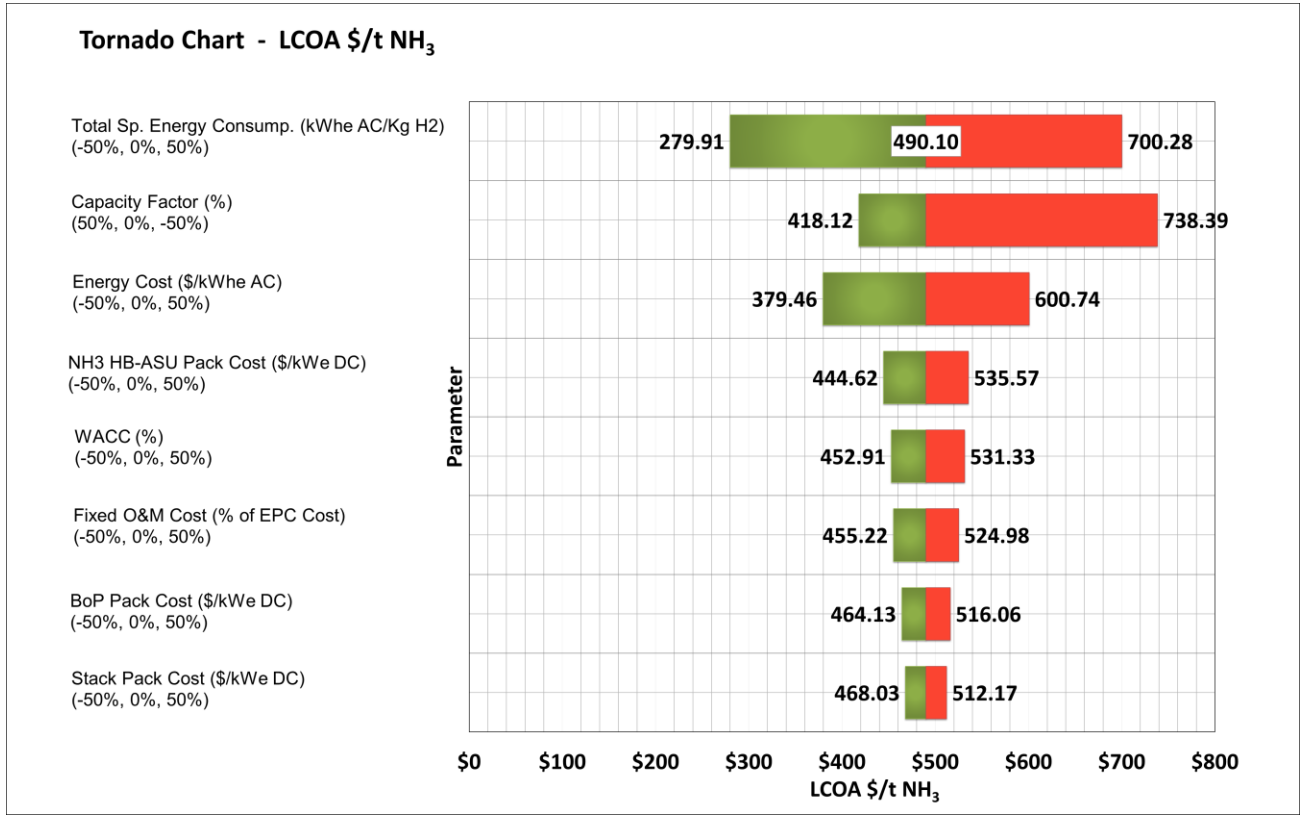
Toolkits Versions

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

Green Ammonia Toolkit Version 7A

Snapshots



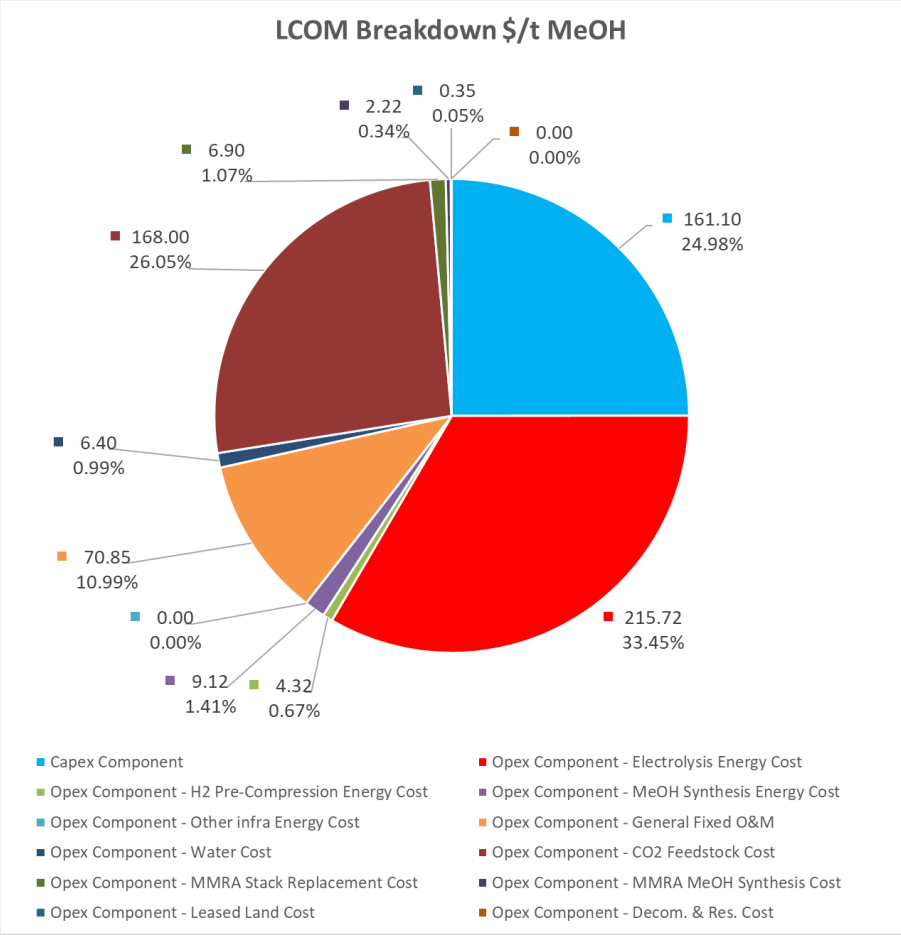


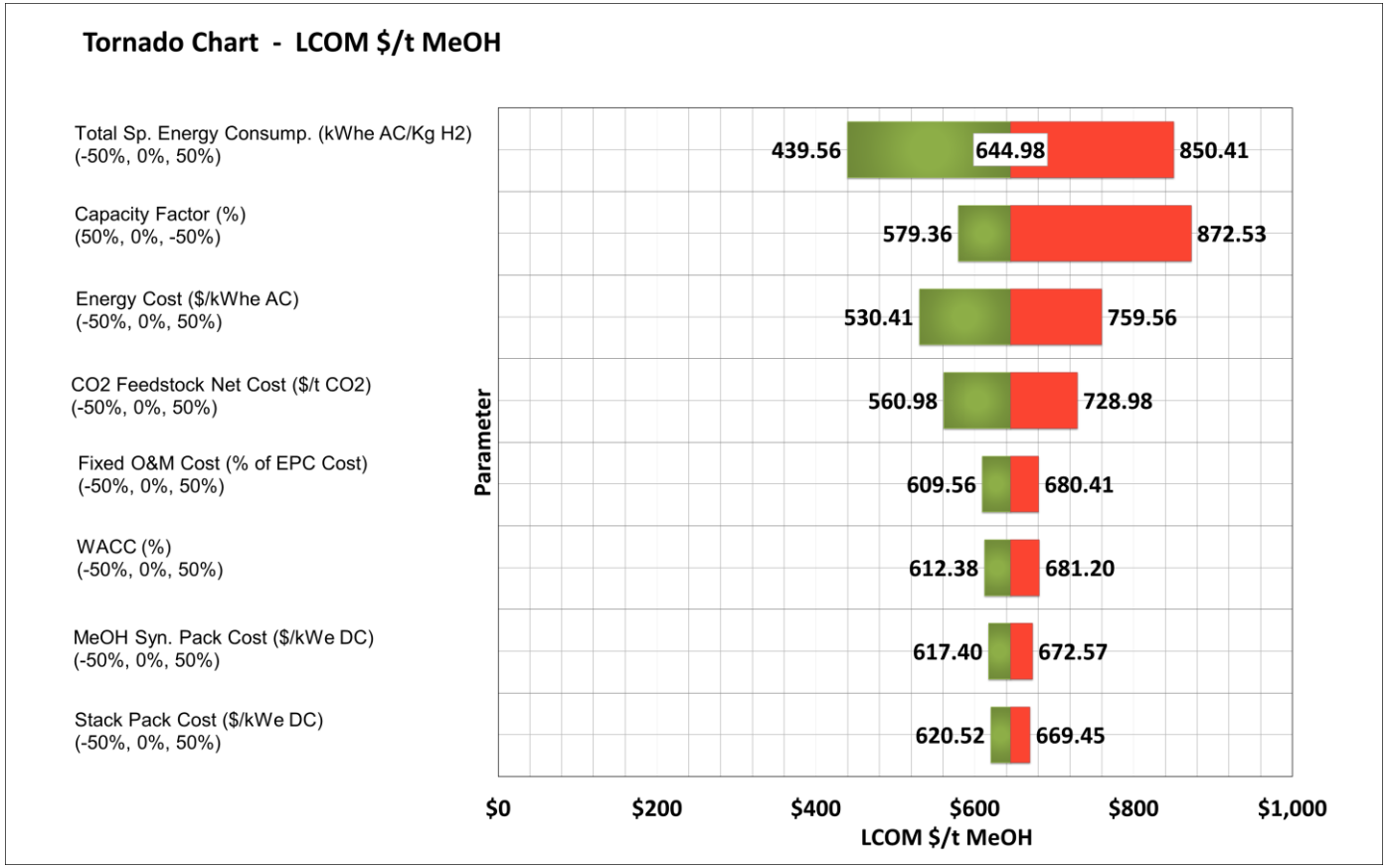
Toolkits Versions

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

Green Methanol Toolkit Version 8A

Snapshots



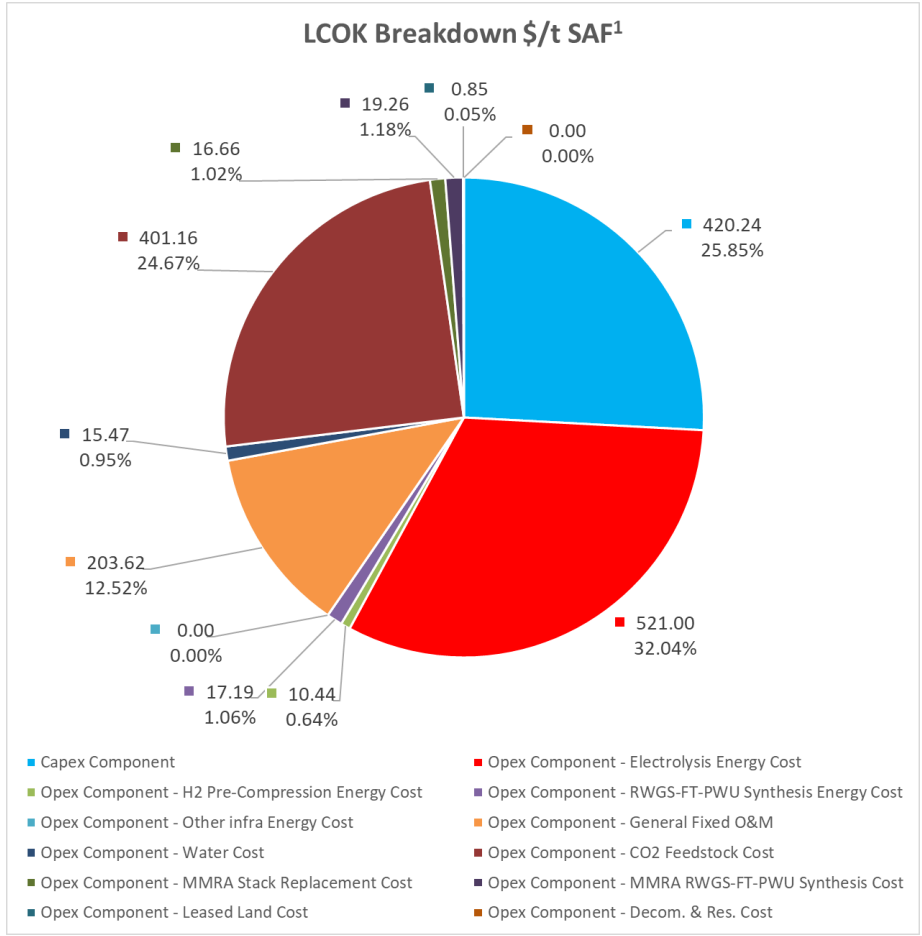


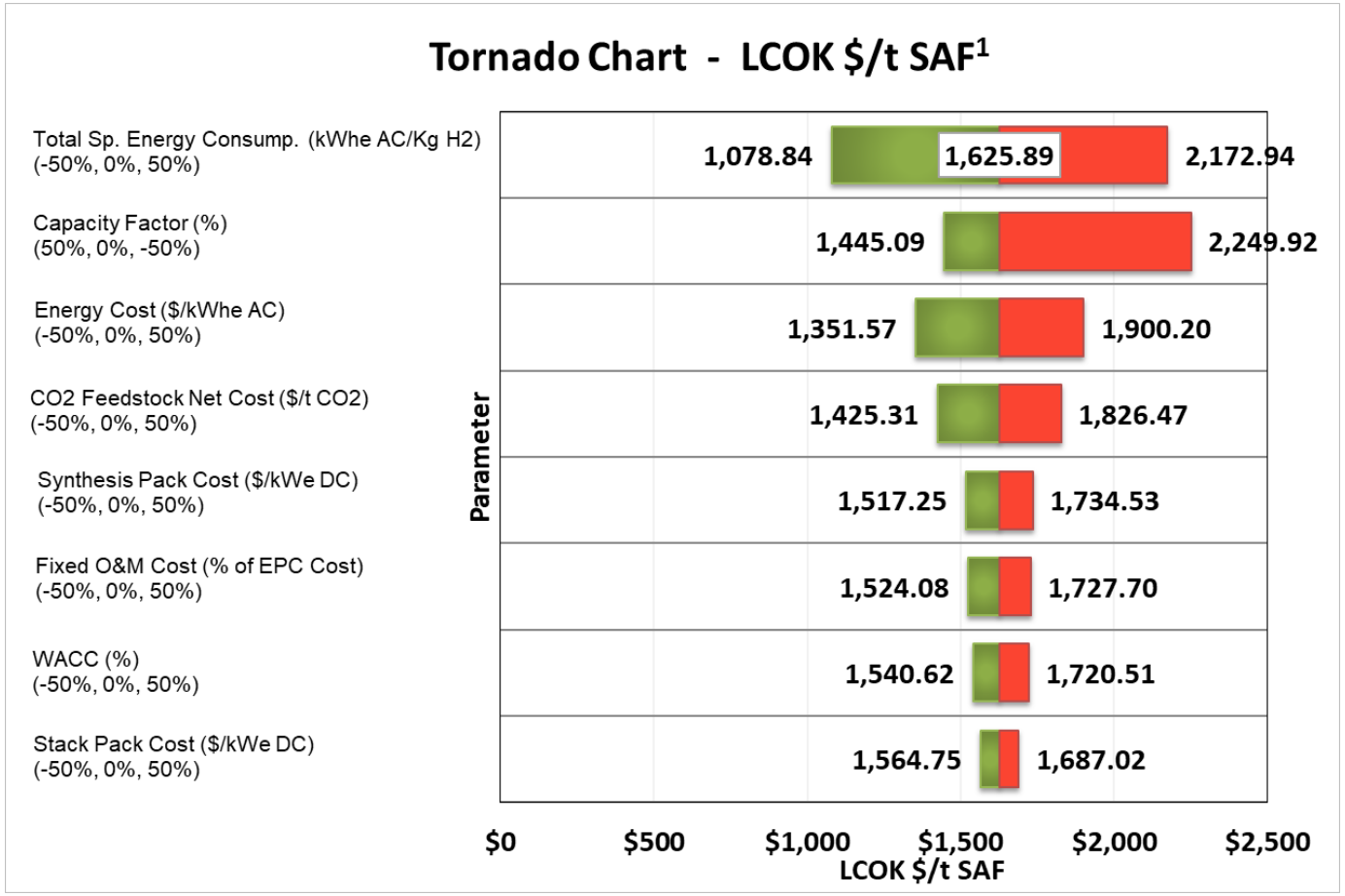
Toolkits Versions

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

Green Kerosene SAF Toolkit Version 9A

Snapshots





How Does It Work?
V5 / V6 / V7 / V8 / V9

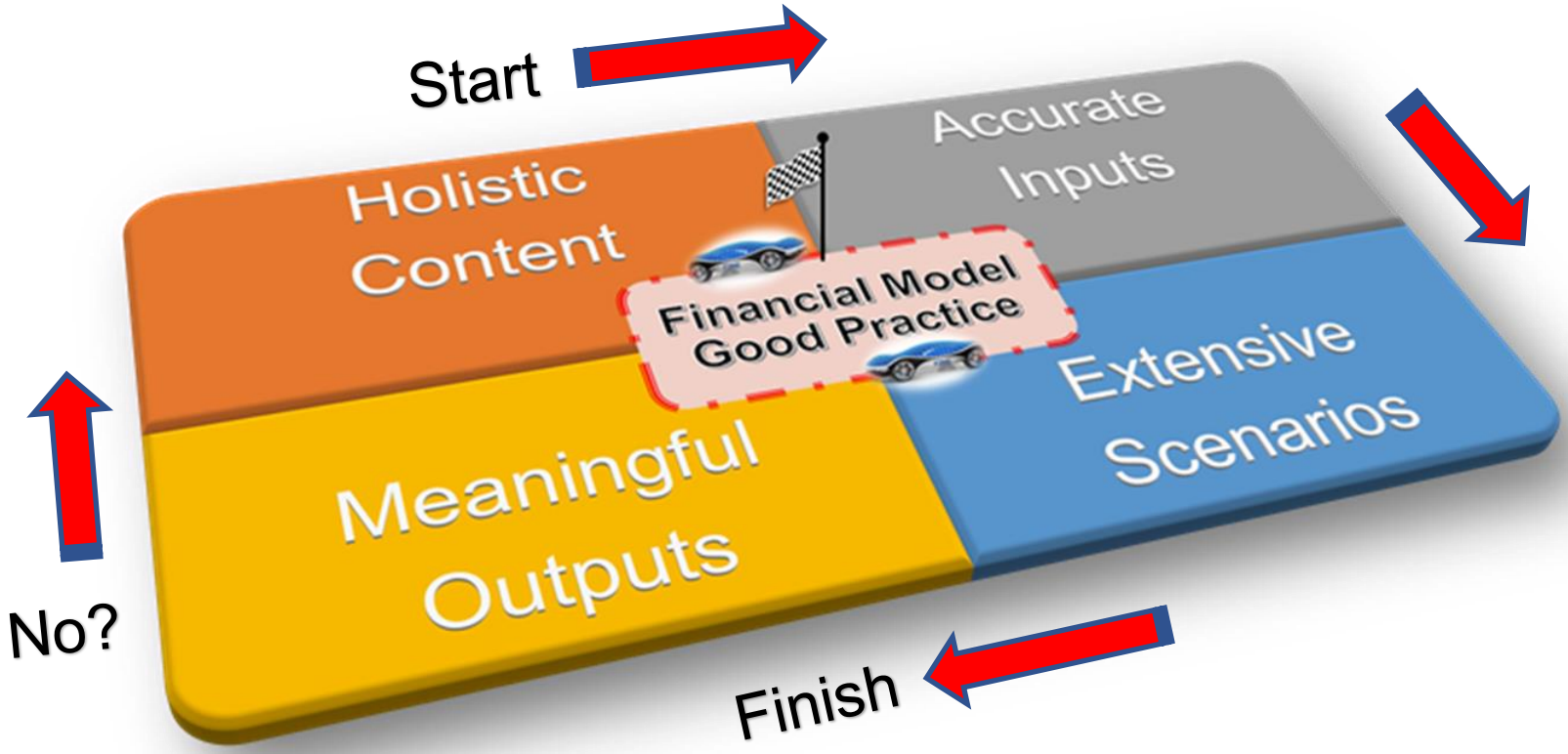
- The financial model toolkit is a discounted cashflow model coupled with visual representation in charts and graphs, and analytical features of one- and two-dimensional sensitivity analysis.

- Basically, the toolkit is a calculation engine that feeds on user supplied input parameters and provides calculated outputs of LCOH in $/Kg H_2 plus plenty of charts for easier analytical what-If-scenarios representation. The same methodologies is applied for Green Ammonia and Green e-Methanol Toolkits.

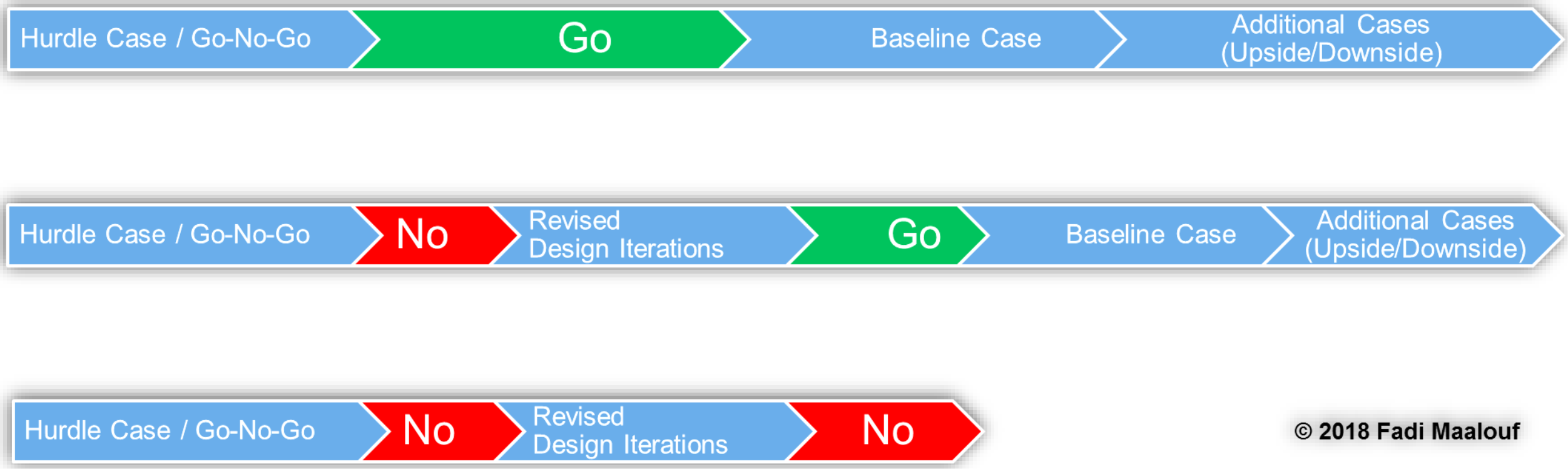
- To run the model and provide a report, the user (desktop researcher) provides Dii with the required “input parameters”.

- This is a two-page Inputs Form that covers the attributes of Green Hydrogen/Ammonia/e-Methanol/e-Kerosene . Dii runs the respective model and provides a report. Service Done!

How Does It Work?
Financial Model Toolkit – Good Practice Principles & Workflow



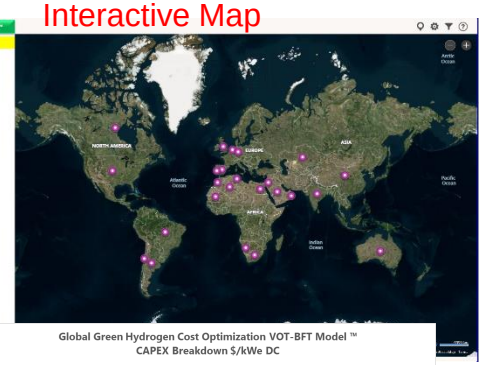
How Does It Work?
Financial Model Toolkit – Capital Budgeting Process Workflow



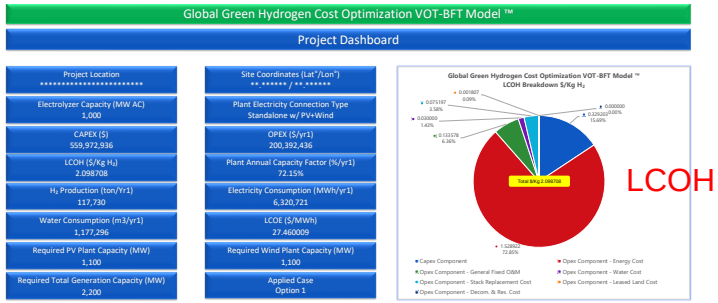
Toolkit Key Objectives
Global Green Hydrogen Cost Optimization VOT-BFT Model™ V5.2

- All-in-one model packed with unique advanced flexible features
- Optimum LCOH anywhere globally, based on site coordinates
- 3 Connection Schemes options
  - Standalone PV+Wind w/ hourly temporal correlation
  - Grid connected PV+Wind w/ hourly temporal correlation
  - Grid connected PPA w/o hourly temporal correlation
- 2 Options for PV+Wind hourly generation data profile
  - Model generated PV+Wind hourly profiles via API
  - User imported custom PV+Wind hourly profile
- Model is Excel based, no additional specialty software
- Macro based functions, eliminate manual tasks
- Model run on laptop, no high performance computing servers

Interactive Map

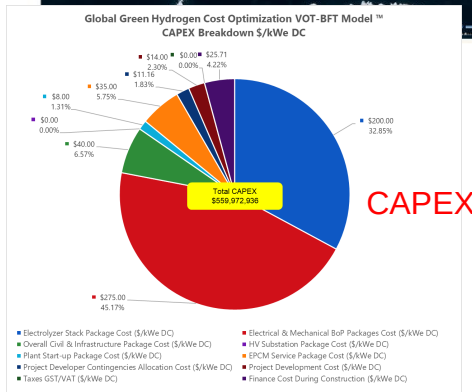


Project Dashboard

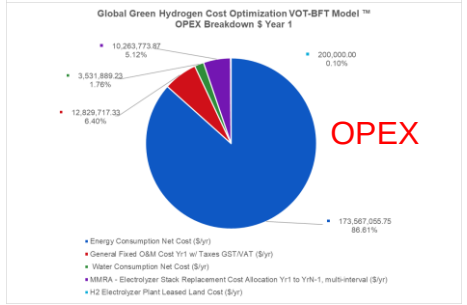


LCOH

Production



CAPEX

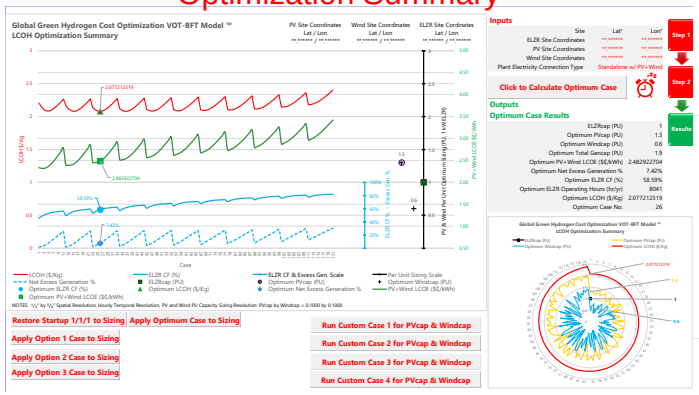


OPEX

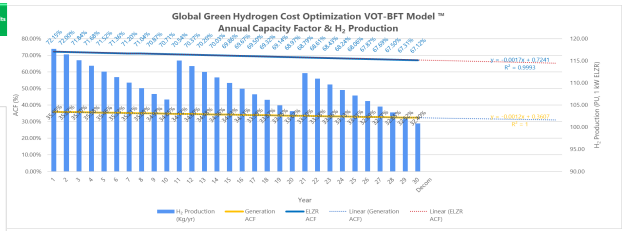
Toolkit Key Objectives
Global Green Hydrogen Cost Optimization VOT-BFT Model™ V5.2

- Per Unit (PU) optimization methodology design
- Optimization process workflow is similar to Genetic Algorithm
- Optimum PV+Wind capacity sizing for optimum LCOH case
- Set electrolyzer operating window & track operating & FLEH hours
- 3 User defined alternative constrained optimum cases
- 8 User defined custom cases for comparison & analysis
- Detailed CAPEX/OPEX/System parameters settings
- Extensive Charts & Visuals for Analysis
- Available on SaaS basis for a nominal fee per project report

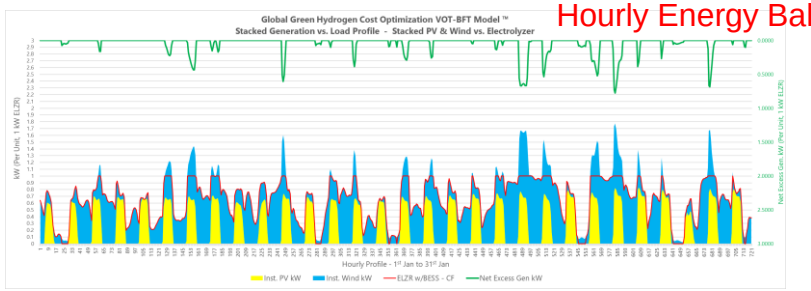
Optimization Summary



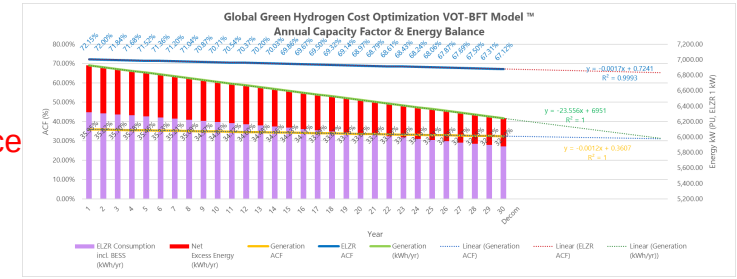
Annual Capacity Factor & H_2 Production



Hourly Energy Balance PV/Wind/ELZR



Annual Capacity Factor & Energy Balance



Toolkit Content
Global Green Hydrogen Cost Optimization VOT-BFT Model™ V5.2

- The model toolkit is an XLS file with 26 sheets.
- The integrity of the toolkit structure and calculation engine is secured and protected against unintended formulae edits.
- A content sheet provides quick navigation hyperlinks to all sheets.
- By providing a list of input parameters, a model run will generate a 17-page pdf report.

Global Green Hydrogen Cost Optimization VOT-BFT Model ™

CONTENT

S.N.	Description	Link
1	Cover Page	Cover
2	Project Dashboard	Dashboard
3	Content	Content
4	Disclaimer	Disclaimer
5	Site Location Interactive Map	Site-Map
6	Project Info Summary	Project-Info-Summary
7	Inputs Form Guide	Inputs-Form-Guide
8	Pre-COD Finance Cost	Pre-COD-Finance-Cost
9	Summary Inputs & Outputs	Summary-Inputs-Outputs
10	Cashflow	Cashflow
11	PV Hourly Generation Dataset API	PV_Hourly
12	Wind Hourly Generation Dataset API	Wind_Hourly
13	PV LCOE Calculations	PV-LCOE
14	Wind LCOE Calculations	Wind-LCOE
15	PV+Wind+BESS LCOE Dynamic Calculations	PV+Wind-LCOE
16	PV+Wind+BESS Hourly Energy Balance & Sizing Calculations	PV+Wind_Hr_AnnualCalc
17	PV+Wind+BESS Annual Energy Balance & Sizing Calculations	AnnualCalc
18	Optimization Data Processing & Analysis	Data-Analysis-AnnualCalc
19	Optimization Data Processing & Analysis - Previous Run Dataset Backup	Data-Analysis-AnnualCalc-PR
20	Optimization Data Processing & Analysis - Previous Run 2 Dataset Backup	Data-Analysis-AnnualCalc-PR2
21	Optimization Results & Charts	Optimization-Results-AnnualCalc
22	Optimization Calculations	Optimization-AnnualCalc
23	LCOH Sensitivity 1D & 2D	Sensitivity-1D-2D
24	Export LCOH 2D Hi Res Table for GIS Interface	Export-2D-HiRes
25	Export Model Charts	Export-Charts
26	Contact	Contact

Toolkit Inputs Form
Global Green Hydrogen Cost Optimization VOT-BFT Model™ V5.2

- The Inputs Form (xls file) data set is in six categories:
  1. General (Lifecycle Selection up to 40 years, economies of scale, technology & costs ref. years, Site Coordinates, Plant Connection Scheme Selection, PV+Wind Hourly Generation Profile Data Source Selection)
  2. Finance Structure (gearing, equity & debt rates, construction period finance)
  3. CAPEX (breakdown required)
  4. OPEX (fixed & variable, energy & water, land lease, escalation rates, stack replacement intervals)
  5. System (capacity, efficiency, degradation, capacity factor, system background settings, optimization cases selection)
  6. Decommissioning & Residual Value
- For each input parameter, notes and remarks are provided. The user can also add his/her special notes as well.

Inputs Form

Global Green Hydrogen Cost Optimization VOT-BFT Model™ - Green Hydrogen from RE Powered Electrolysis Plant - LCOH	
Project Information Summary	
Project Communication Details	
Project Title	Green Hydrogen Plant
Project Reference No.	
Project Location	
Project Sponsor Organization	
Electrolyzer Plant Site Coordinates (Lat°)	**.*******
Electrolyzer Plant Site Coordinates (Lon°)	**.*******
PV Plant Site Coordinates (Lat°)	**.*******
PV Plant Site Coordinates (Lon°)	**.*******
Wind Plant Site Coordinates (Lat°)	**.*******
Wind Plant Site Coordinates (Lon°)	**.*******
Contact Person	
Mobile	
Email	
Web	
Project Data Room Page Link	
Document Title	
Document Version	
Document Date	6-Dec-2022
Project Techno-Commercial Details	
Electrolyzer Plant Effective Capacity (MWe AC)	1,000
Electrolyzer Technology (ALK/PEM/SOEC/Other)	ALK
Estimated Commercial Operation Date (yr)	2025
Electrolyzer Plant Annual Capacity Factor (%)	
Electrolyzer Plant Estimated Annual Production (Kg H_2/yr)	
Electrolyzer Plant H_2 Output Pressure (bar)	
Energy Supply (RE PV/Wind/Other)	
Grid Connection Capacity (MW)	
Grid Connection Voltage (33/132/220/400 kV)	
Water Supply (RO Plant/Process Water/Other)	
Water Supply Capacity (m^3/day)	
Project Land Plot Requirement (m^2)	
Project Structure Description	Special Purpose Vehicle (SPV)
Project Offtake Agreements Description	
Project Supply Agreements Description	
Project EPC/EPCM Agreements Description	
Project Energy Supply Agreements Description	
Project O&M Agreements Description	
Project Finance Term Sheet Agreements Description	
Project Capital Structure Description	Equity Bridge Loan, Equity and Sr.
Pre-COD Finance Cost	
Construction Period (Months)	18.0
CAPEX Credit Period (Months)	0.0
Equity Bridge Loan Interest Rate (p.a.)	4.00%
Debt Interest Rate During Construction (p.a.)	4.00%
EBL Commitment Fee as % of Debt (%)	0.30%
EBL Upfront Fee as % of Debt (%)	1.20%
Sr. Debt Commitment Fee as % of Debt (%)	0.30%
Sr. Debt Upfront Fee as % of Debt (%)	1.20%
Drawdown Selection: Uniform or Custom?	Custom
Custom Drawdown Month 1 (%)	10.00%
Equity Percentage	25.00%
Debt Percentage	75.00%
Other Info	
Other Info	
Other Info	
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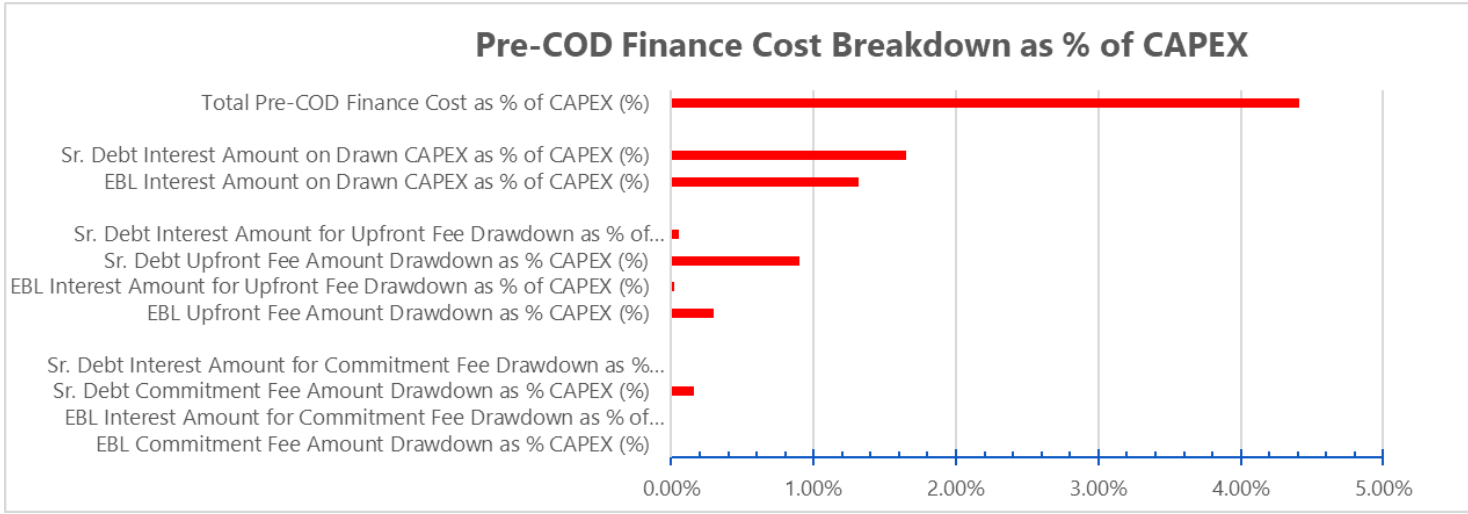
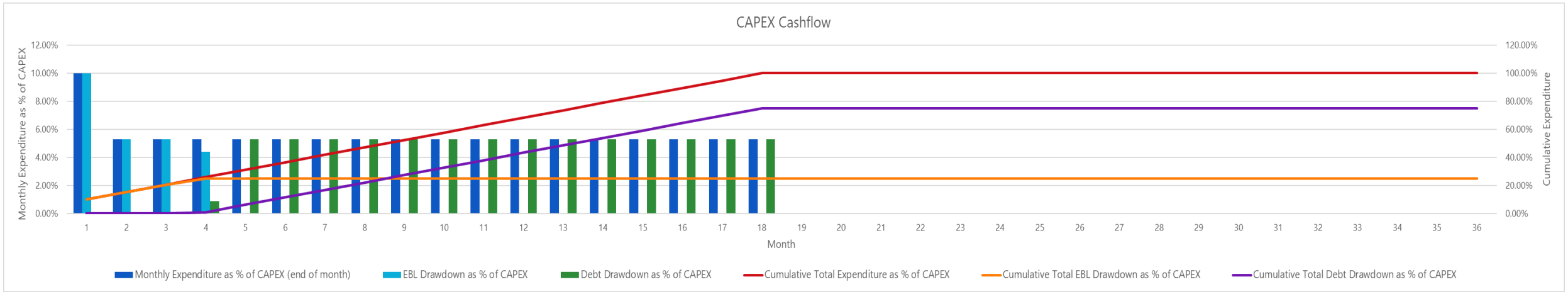
Toolkit Pre-COD Finance Cost

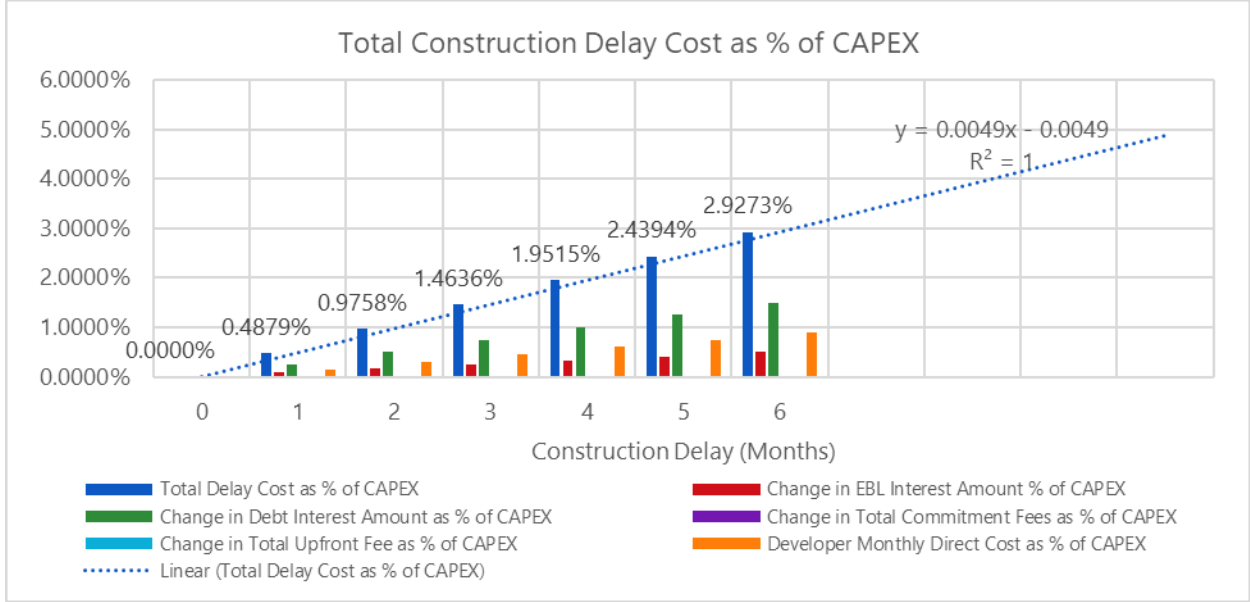
- Pre-COD Finance Analysis:
  1. CAPEX drawdown profile
  2. Construction period finance cost breakdown

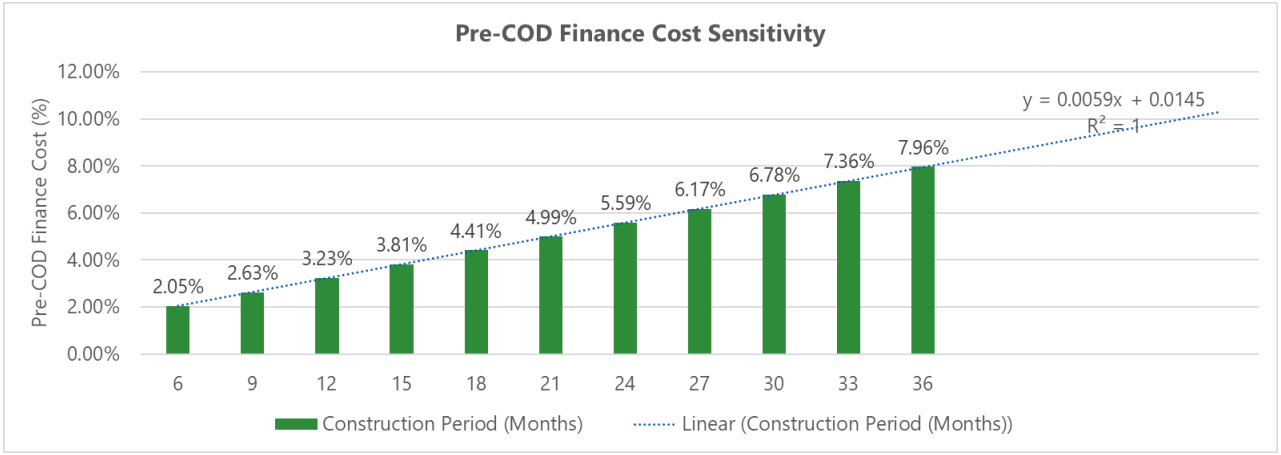




Toolkit Pre-COD Finance Cost

- Pre-COD Finance Analysis:
  1. Construction delay cost analysis
  2. Construction period sensitivity analysis



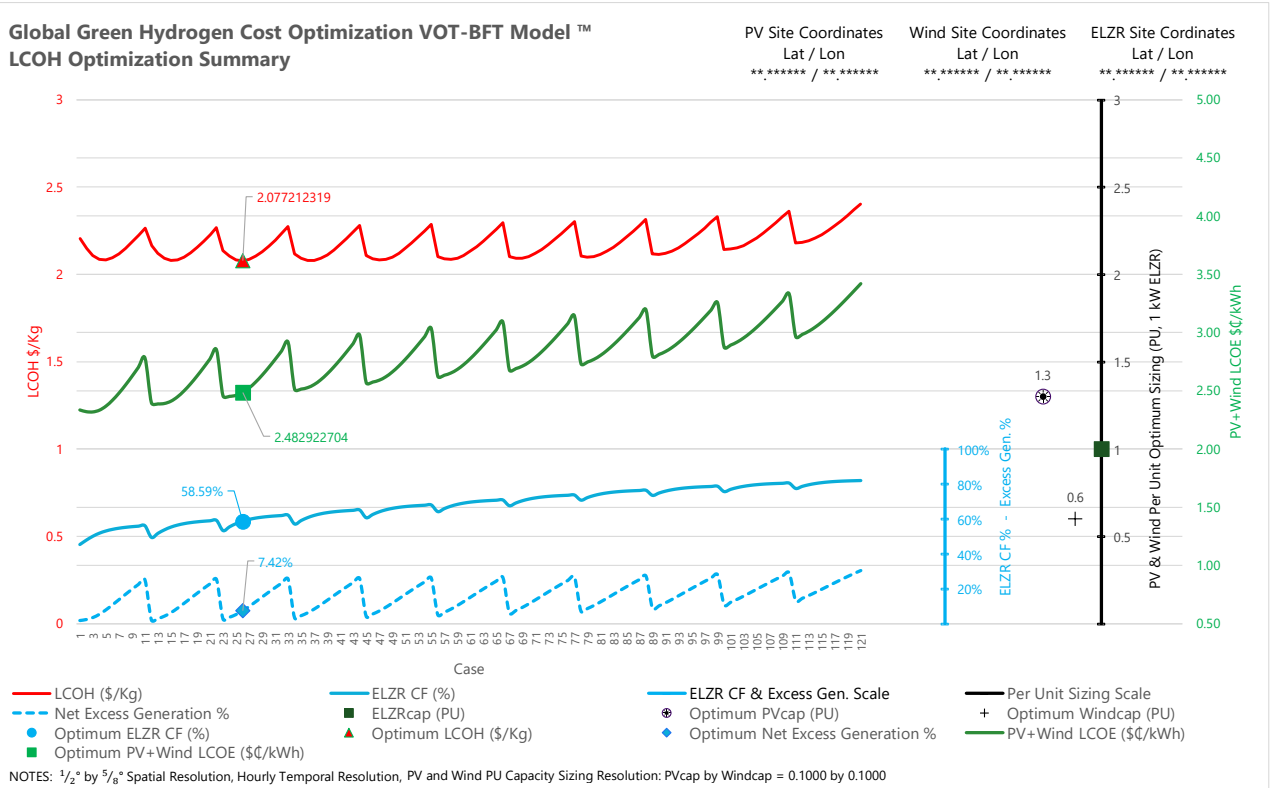


Optimization Process & Results
Global Green Hydrogen Cost Optimization VOT-BFT Model™ V5.2

Optimization Summary

Optimum Case Sizing

One Click Process !



Inputs

Site	Lat°	Lon°
ELZR Site Coordinates	**.******	**.******
PV Site Coordinates	**.******	**.******
Wind Site Coordinates	**.******	**.******
Plant Electricity Connection Type	Standalone w/ PV+Wind	

Step 1

Step 2

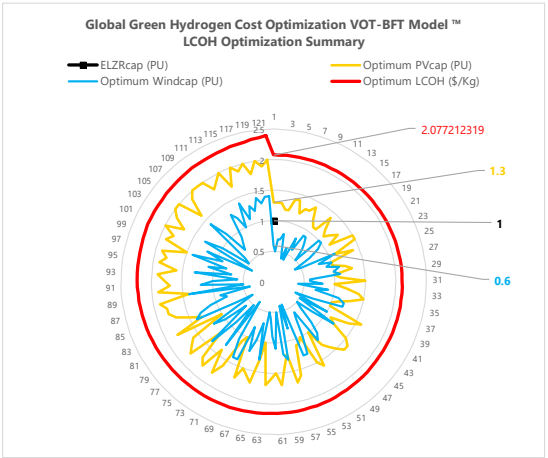
Click to Calculate Optimum Case

Results

Outputs

Optimum Case Results

ELZRcap (PU)	1
Optimum PVcap (PU)	1.3
Optimum Windcap (PU)	0.6
Optimum Total Gencap (PU)	1.9
Optimum PV+Wind LCOE ($¢/kWh)	2.482922704
Optimum Net Excess Generation %	7.42%
Optimum ELZR CF (%)	58.59%
Optimum ELZR Operating Hours (hr/yr)	8041
Optimum LCOH ($/Kg)	2.077212319
Optimum Case No.	26



Restore Startup 1/1/1 to Sizing | Apply Optimum Case to Sizing

Apply Option 1 Case to Sizing

Apply Option 2 Case to Sizing

Apply Option 3 Case to Sizing

Run Custom Case 1 for PVcap & Windcap

Run Custom Case 2 for PVcap & Windcap

Run Custom Case 3 for PVcap & Windcap

Run Custom Case 4 for PVcap & Windcap

Optimization Process & Results
Global Green Hydrogen Cost Optimization VOT-BFT Model™ V5.2

Optimization Process Summary - User Defined Alternative Optimum Cases Solver

Inputs

	Lat°	Lon°
Site		
ELZR Site Coordinates	**.******	**.******
PV Site Coordinates	**.******	**.******
Wind Site Coordinates	**.******	**.******
Plant Electricity Connection Type	Standalone w/ PV+Wind	

Step 1

Step 2

Click to Calculate Optimum Case

Outputs

Apply selected case as baseline case via macro

Restore Startup 1/1/1 to Sizing

Apply Optimum Case to Sizing

Apply Option 1 Case to Sizing

Apply Option 2 Case to Sizing

Apply Option 3 Case to Sizing

Outputs
Optimum Case Results

ELZRcap (PU)	1
Optimum PVcap (PU)	1.3
Optimum Windcap (PU)	0.6
Optimum Total Gencap (PU)	1.9
Optimum PV+Wind LCOE ($¢/kWh)	2.482922704
Optimum Net Excess Generation %	7.42%
Optimum ELZR CF (%)	58.59%
Optimum ELZR Operating Hours (hr/yr)	8041
Optimum LCOH ($/Kg)	2.077212319
Optimum Case No.	26

Option 1
Alternative Optimum Case Results

With Applied Filter - Minimum Required ELZR CF	72%
ELZRcap (PU)	1
PVcap (PU)	1.1
Windcap (PU)	1.1
Total Gencap (PU)	2.2
PV+Wind LCOE ($¢/kWh)	2.746001
Net Excess Generation %	8.76%
ELZR CF (%)	72.15%
ELZR Operating Hours (hr/yr)	8428
LCOH ($/Kg)	2.098708
Case No.	79

Option 2
Alternative Optimum Case Results

With Applied Filter - Total Gencap Limit	1.60
ELZRcap (PU)	1
PVcap (PU)	1.2
Windcap (PU)	0.4
Total Gencap (PU)	1.6
PV+Wind LCOE ($¢/kWh)	2.316968
Net Excess Generation %	3.62%
ELZR CF (%)	49.91%
ELZR Operating Hours (hr/yr)	7677
LCOH ($/Kg)	2.106898
Case No.	3

Option 3
Alternative Custom Case Results

With Applied Filter - PVcap Value	1.20
With Applied Filter - Windcap Value	1.30
ELZRcap (PU)	1
PVcap (PU)	1.2
Windcap (PU)	1.3
Total Gencap (PU)	2.5
PV+Wind LCOE ($¢/kWh)	2.918049
Net Excess Generation %	14.02%
ELZR CF (%)	77.88%
ELZR Operating Hours (hr/yr)	8499
LCOH ($/Kg)	2.15103
Case No.	102

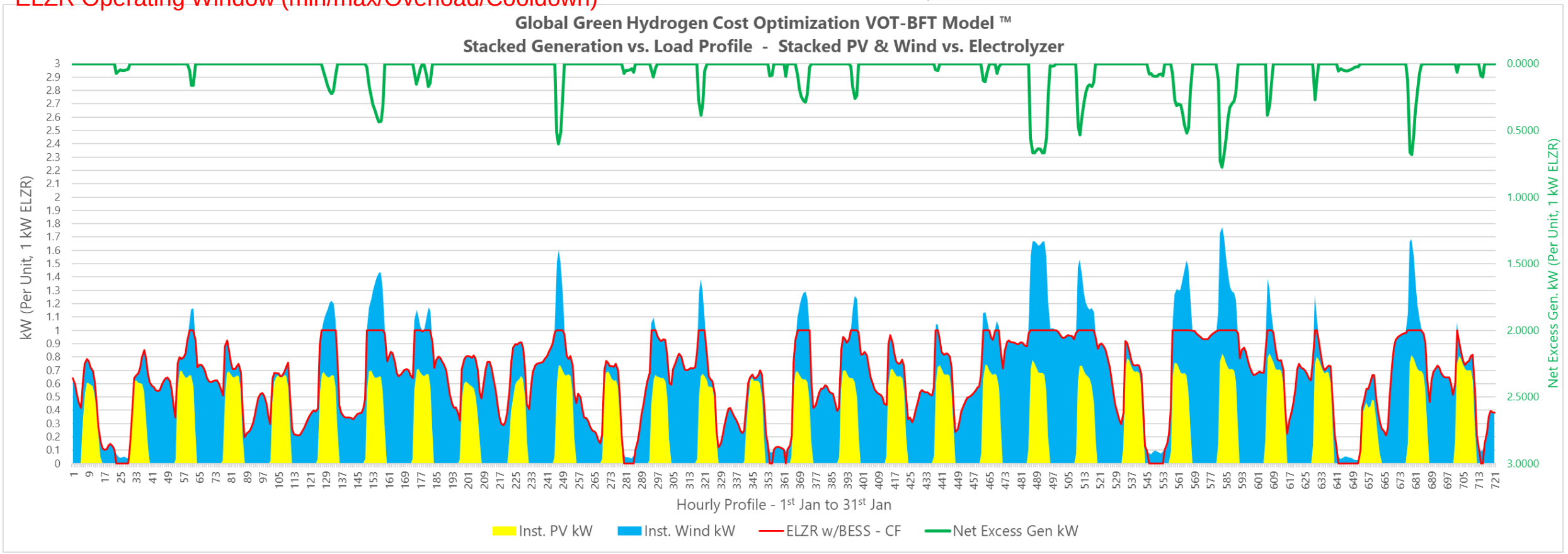
Optimization Process & Results
Global Green Hydrogen Cost Optimization VOT-BFT Model™ V5.2

Optimization Process Summary - User Applied Case

Hourly Energy Balance PV/Wind/ELZR

ELZR Operating Window (min/max/Overload/Cooldown)

Current Status: Plant Electricity Connection Type	Standalone w/ PV+Wind
Current Status: PVcap (PU)	1.10
Current Status: Windcap (PU)	1.10

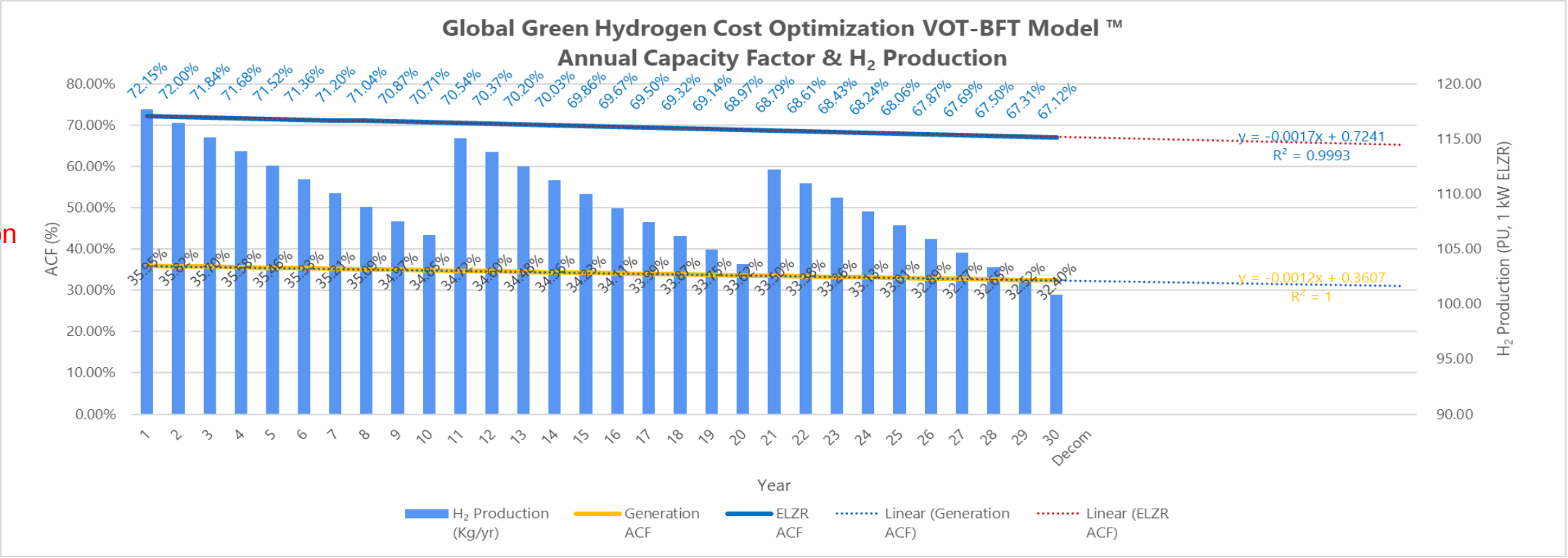


Optimization Process & Results
Global Green Hydrogen Cost Optimization VOT-BFT Model™ V5.2

Optimization Process Summary - User Applied Case
Annual Capacity Factor & H_2 Production
PV & Wind & Electrolyzer Degradation Impact

Current Status: Plant Electricity Connection Type	Standalone w/ PV+Wind
Current Status: PVcap (PU)	1.10
Current Status: Windcap (PU)	1.10

Annual Capacity Factor & H_2 Production



Optimization Process & Results
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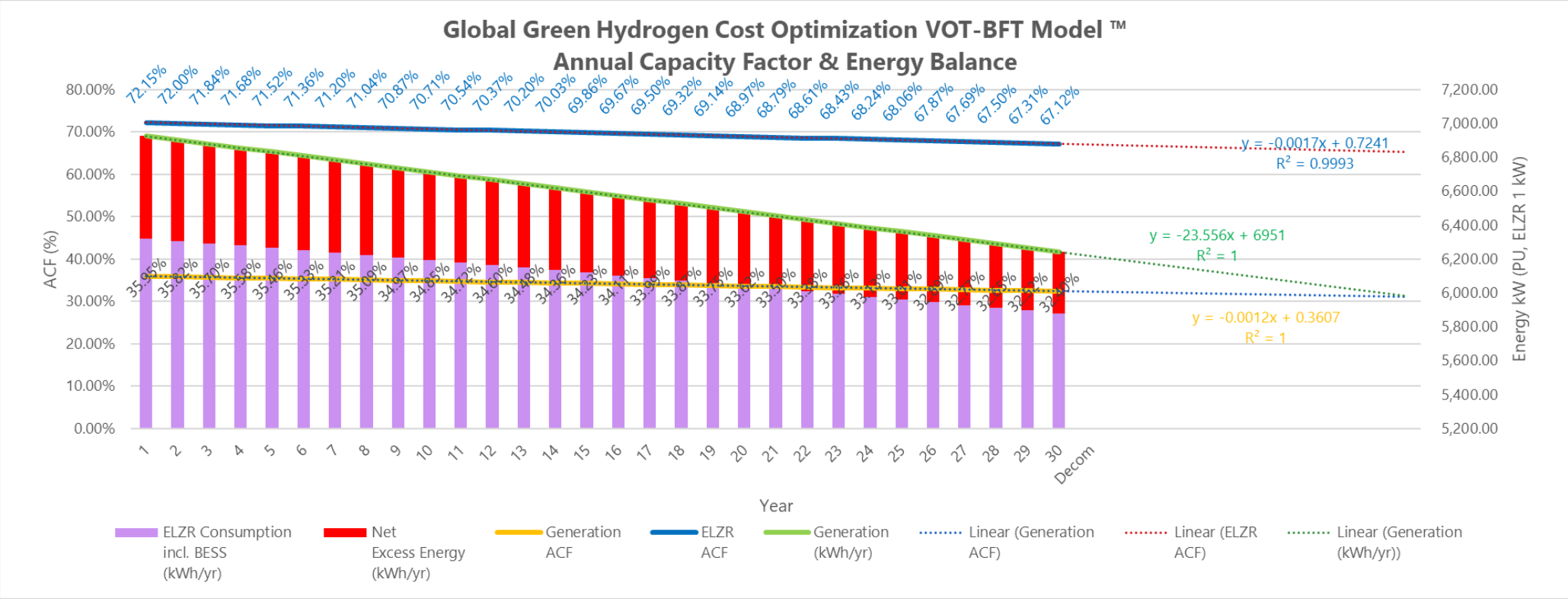
Optimization Process Summary - User Applied Case
Annual Capacity Factor Energy Balance
PV & Wind & Electrolyzer Degradation Impact

Current Status: Plant Electricity Connection Type	Standalone w/ PV+Wind
Current Status: PVcap (PU)	1.10
Current Status: Windcap (PU)	1.10

Annual Capacity Factor & Energy Balance



Optimization Process & Results
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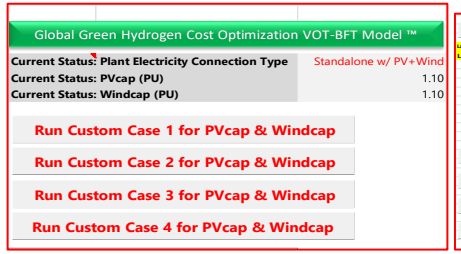
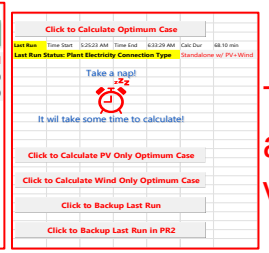
Deep Dive – Advanced Optimization Process Summary
Up to 8 User Defined Custom Cases Analysis

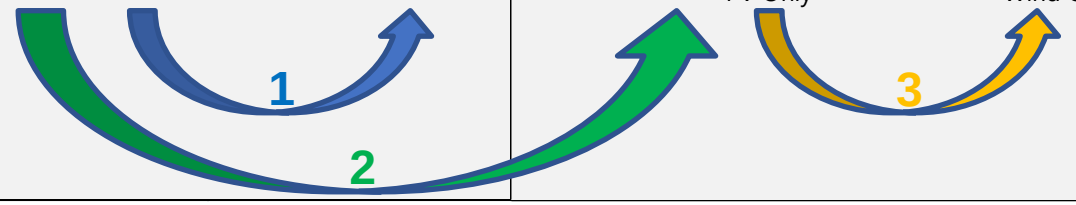




Task automation via macros

Run Custom Case Results

Plant Electricity Connection Type	Standalone w/ PV+Wind	Grid w/ PV+Wind	Standalone w/ PV+Wind	Grid w/ PV+Wind	Standalone w/ PV+Wind	Standalone w/ PV+Wind
ELZRcap (PU)	1	1	1	1	1	1
PVcap (PU)	1.20	1.20	1.30	1.30	1.50	0.00
Windcap (PU)	1.00	1.00	0.60	0.60	0.00	1.30
Total Gencap (PU)	2.20	2.20	1.90	1.90	1.50	1.30
PV+Wind LCOE ($¢/kWh)	2.710930	2.485506	2.482923	2.328625	1.961987	3.071111
Net Excess Generation %	9.42%	9.42%	7.42%	7.42%	5.40%	4.39%
ELZR CF (%)	70.33%	70.33%	58.59%	58.59%	40.85%	53.58%
ELZR Operating Hours (hr/yr)	8,380	8,380	8,041	8,041	4,257	7,950
LCOH ($/Kg)	2.092682	1.967170	2.077212	1.991302	2.075847	2.466210
Case No.	Custom 1	Custom 2	Custom 3	Custom 4	Custom 5	Custom 6
Calc Dur	28.00 sec	30.00 sec	35.00 sec	33.00 sec	33.00 sec	31.00 sec
Note 1					PV Only	Wind Only
Note 2						
Note 3						
Note 4						
Note 5						
Note 6						



Optimization Process & Results
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Optimization Process Final Step

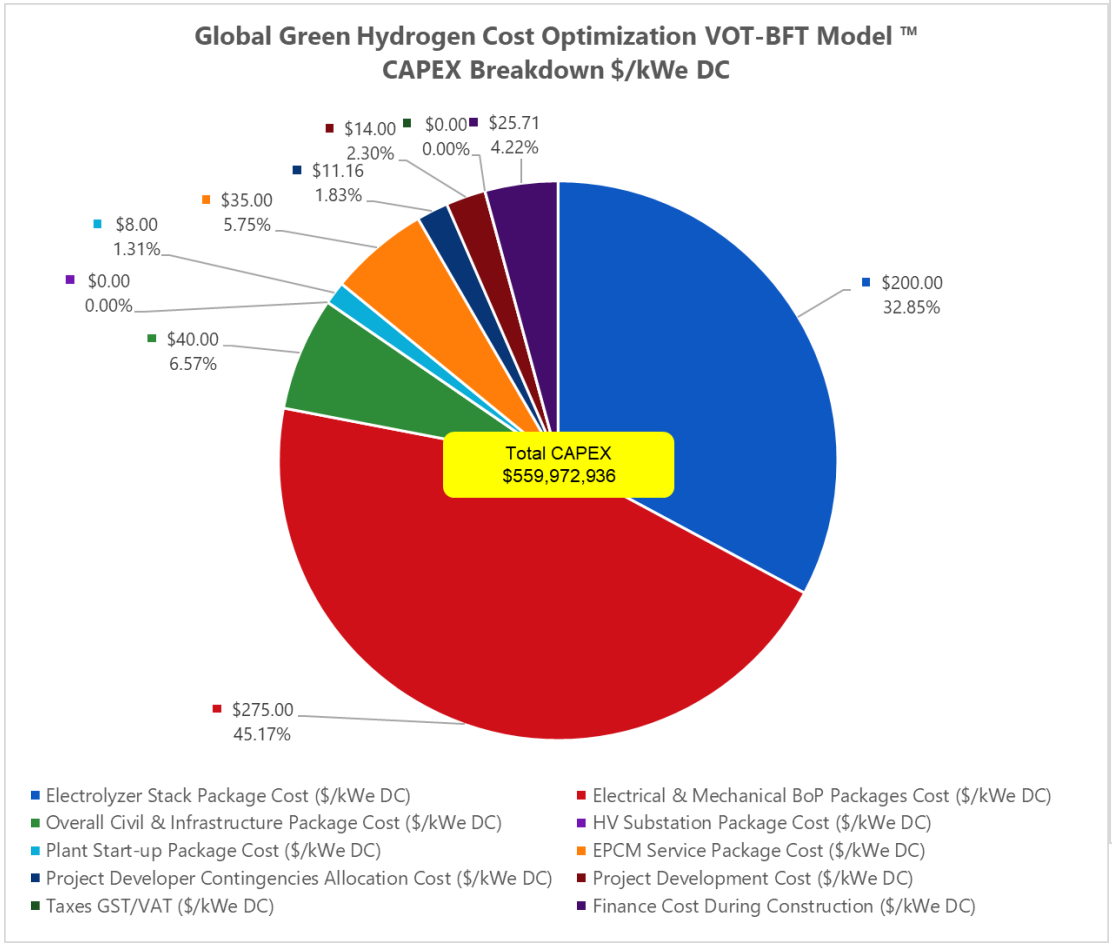
- Apply a user selected case as baseline case (dropdown list)
- Print the complete 17-page report with all data and cases

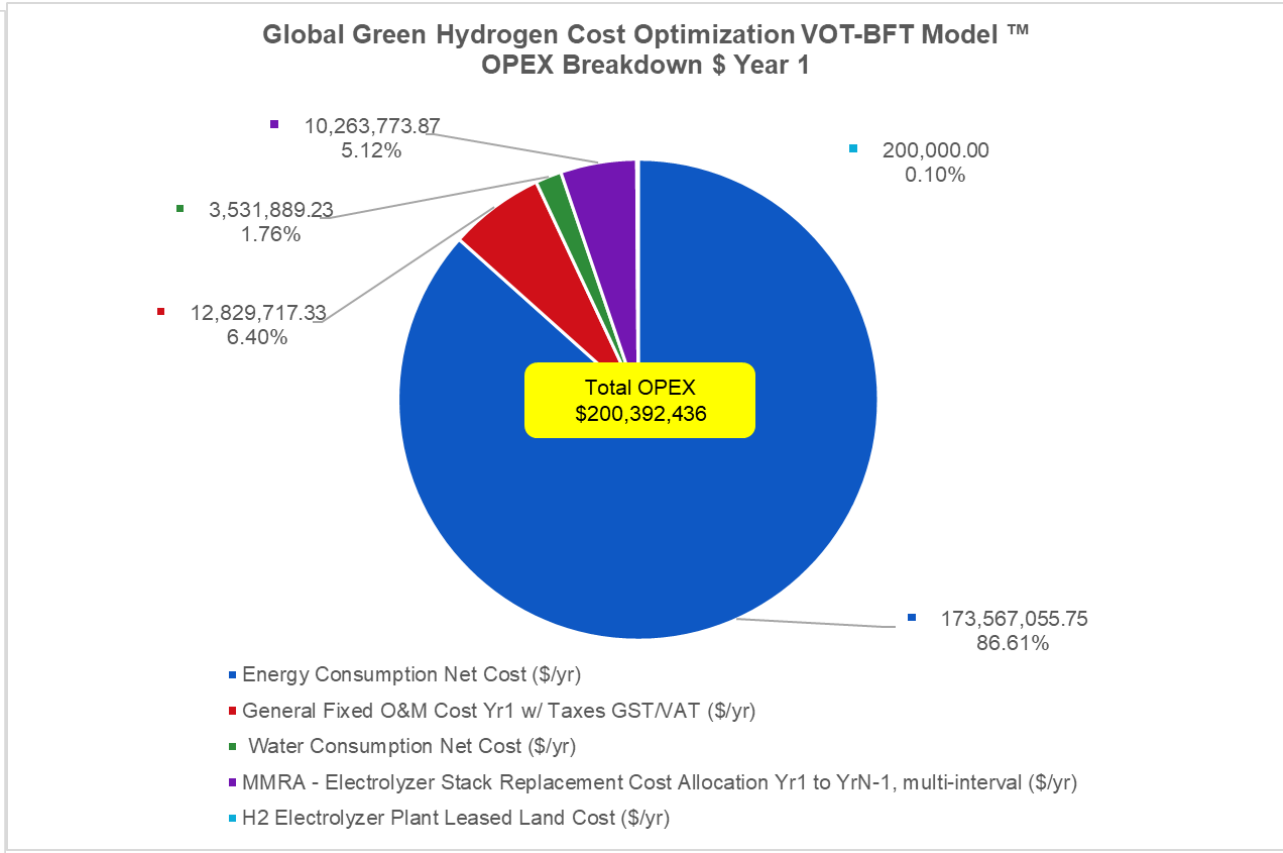
Task automation via macros

PV+Wind Sizing Summary	
Plant Electricity Connection Type (Grid Connected or Standalone)	Standalone w/ PV+Wind
PV+Wind+BESS Optimization Case Selection (Optimum, Options 1/2/3, Custom 1/2/3/4)	Option 1
PV Plant Capacity (kW)	1,100,000
Wind Plant Capacity (kW)	1,100,000
Total Generation Capacity (kW)	2,200,000
BESS Power Capacity (kW)	NA
BESS Energy Capacity (kWh)	NA
PV LCOE $/kWh	0.01888427
PV Plant Annual Capacity Factor (%)	28.78%
Wind LCOE $/kWh	0.02959250
Wind Plant Annual Capacity Factor (%)	43.11%
PV+Wind LCOE $/kWh	0.02746001
Plant Annual Capacity Factor (%)	72.15%
Plant Annual Operating Hours (hr/yr)	8,428

Optimization Process & Results
Global Green Hydrogen Cost Optimization VOT-BFT Model™ V5.2

Optimization Process Results - CAPEX & OPEX Breakdown





Optimization Process & Results
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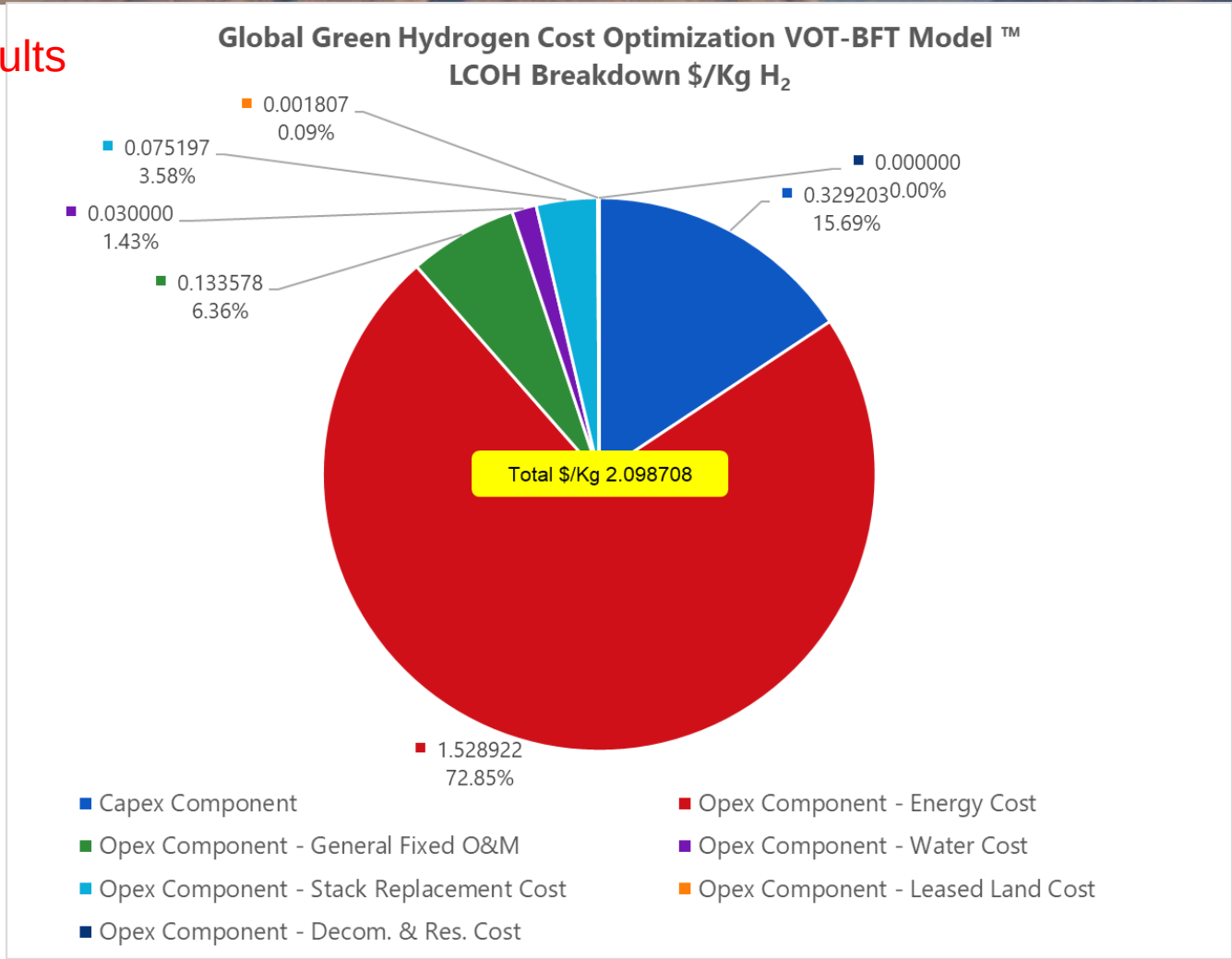
Optimization Process Results
LCOH Breakdown



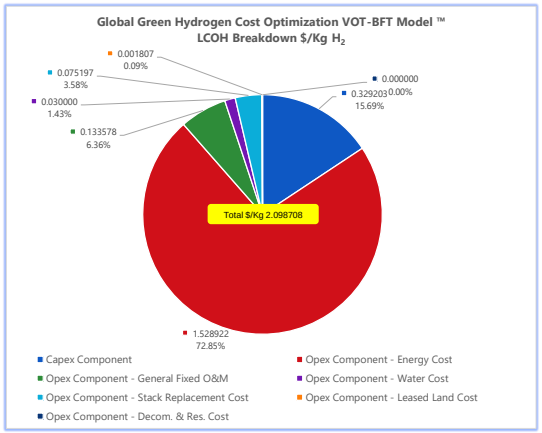
Optimization Process & Results
Global Green Hydrogen Cost Optimization VOT-BFT Model™ V5.2

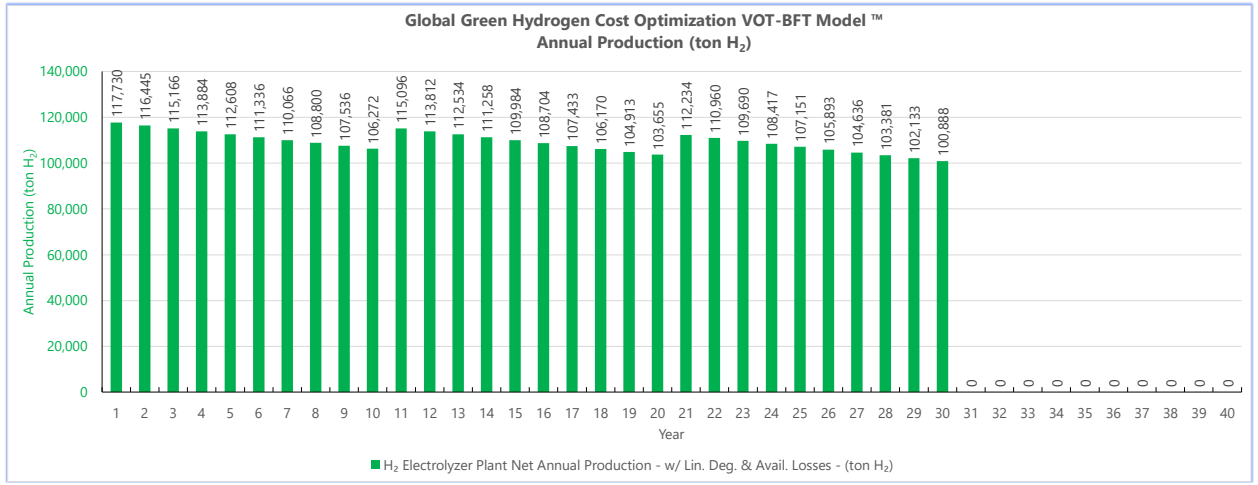
Optimization
Process Results
1-Page
Project Dashboard

Global Green Hydrogen Cost Optimization VOT-BFT Model ™

Project Dashboard

Project Location **********	Site Coordinates (Lat°/Lon°) **.****** / **.******
Electrolyzer Capacity (MW AC) 1,000	Plant Electricity Connection Type Standalone w/ PV+Wind
CAPEX ($) 559,972,936	OPEX ($/yr1) 200,392,436
LCOH ($/Kg H_2) 2.098708	Plant Annual Capacity Factor (%/yr1) 72.15%
H_2 Production (ton/Yr1) 117,730	Electricity Consumption (MWh/yr1) 6,320,721
Water Consumption (m3/yr1) 1,177,296	LCOE ($/MWh) 27.460009
Required PV Plant Capacity (MW) 1,100	Required Wind Plant Capacity (MW) 1,100
Required Total Generation Capacity (MW) 2,200	Applied Case Option 1





Toolkit Sample Report:
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SCAN ME

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Lessons Learnt: Global Green Hydrogen Cost Optimization VOT-BFT Model™

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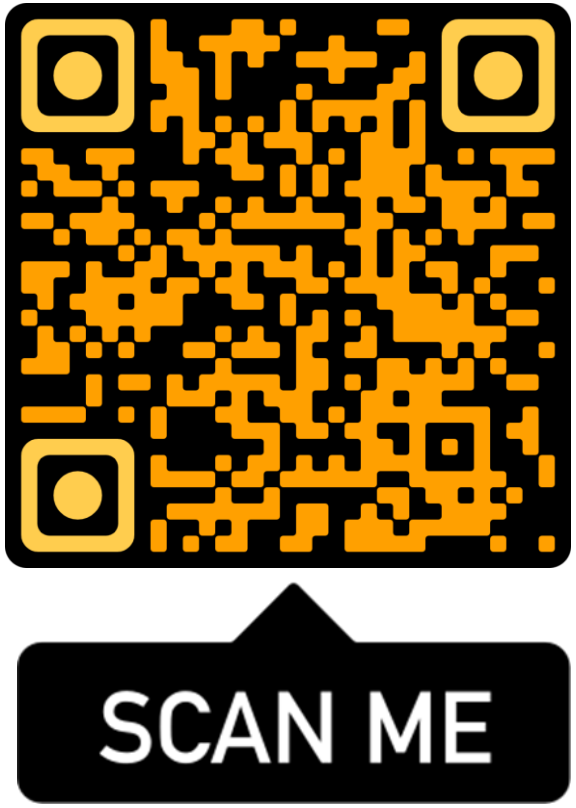

Takeaways

- The green molecules era has arrived.
- Their contribution to the energy transition will rise and accelerate.
- Balancing technical solutions with sound economics will be critical to the success.
- Challenges ahead that are vital for bankable projects development:
  - Clear long-term guarantees of origin / standards / policy / regulatory environments
  - Risk-balanced long-term offtake agreements
  - Overall plant performance guarantees
- Again, all hands must be on deck!

Thank You For Your Attention!

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