e-Hydrogen Cost Optimizer

Empowering Smart Investment in Green Hydrogen Projects

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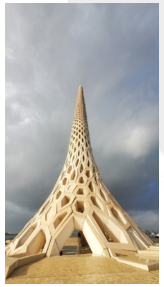
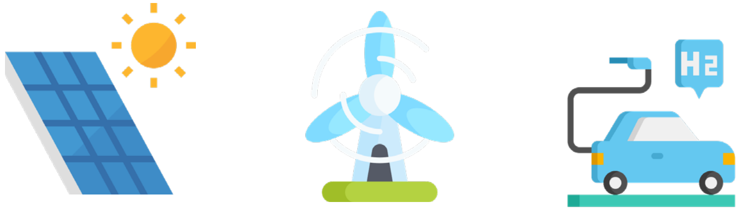
Saudi Arabia



KAUST
(Thuwal)

King Abdullah University
of Science and Technology

KAUST & the Clean Energy Research Platform



Supporting Saudi's transition to clean energy

NEOM & Saudi Green Hydrogen Vision

NEOM نيوم

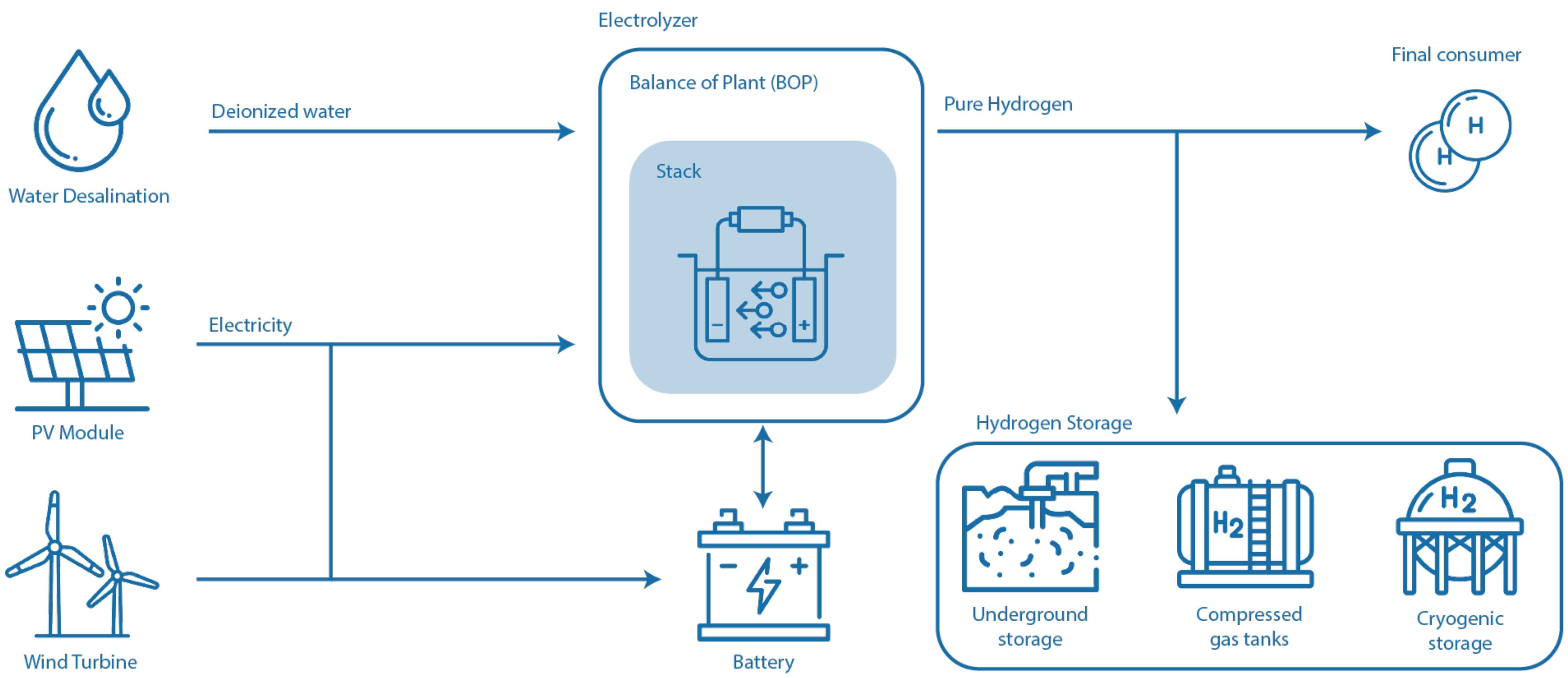
SAUDI GREEN INITIATIVE

THE LINE

NEOM The Line: powered by **100% renewable energy**

Challenge: **no sun at night** → **need for energy storage solutions**

Solution: **green hydrogen**



Electrolyzer
Balance of Plant (BOP)
Stack
Water Desalination
Deionized water
PV Module
Electricity
Wind Turbine
Battery
Pure Hydrogen
Final consumer
H
H
Hydrogen Storage
Underground storage
Compressed gas tanks
Cryogenic storage

The challenge

Affordable and sustainable green hydrogen

Cost Optimization

Produce more hydrogen at the lowest possible cost

Environmental Impact

Decisions affect emissions, water use, sustainability

Hydrogen Demand

Meet future global and national needs

Balance economic efficiency with environmental responsibility

Our solution

e-Hydrogen Cost Optimizer

e-h2.org

Developed in

MILP library:

PYOMO

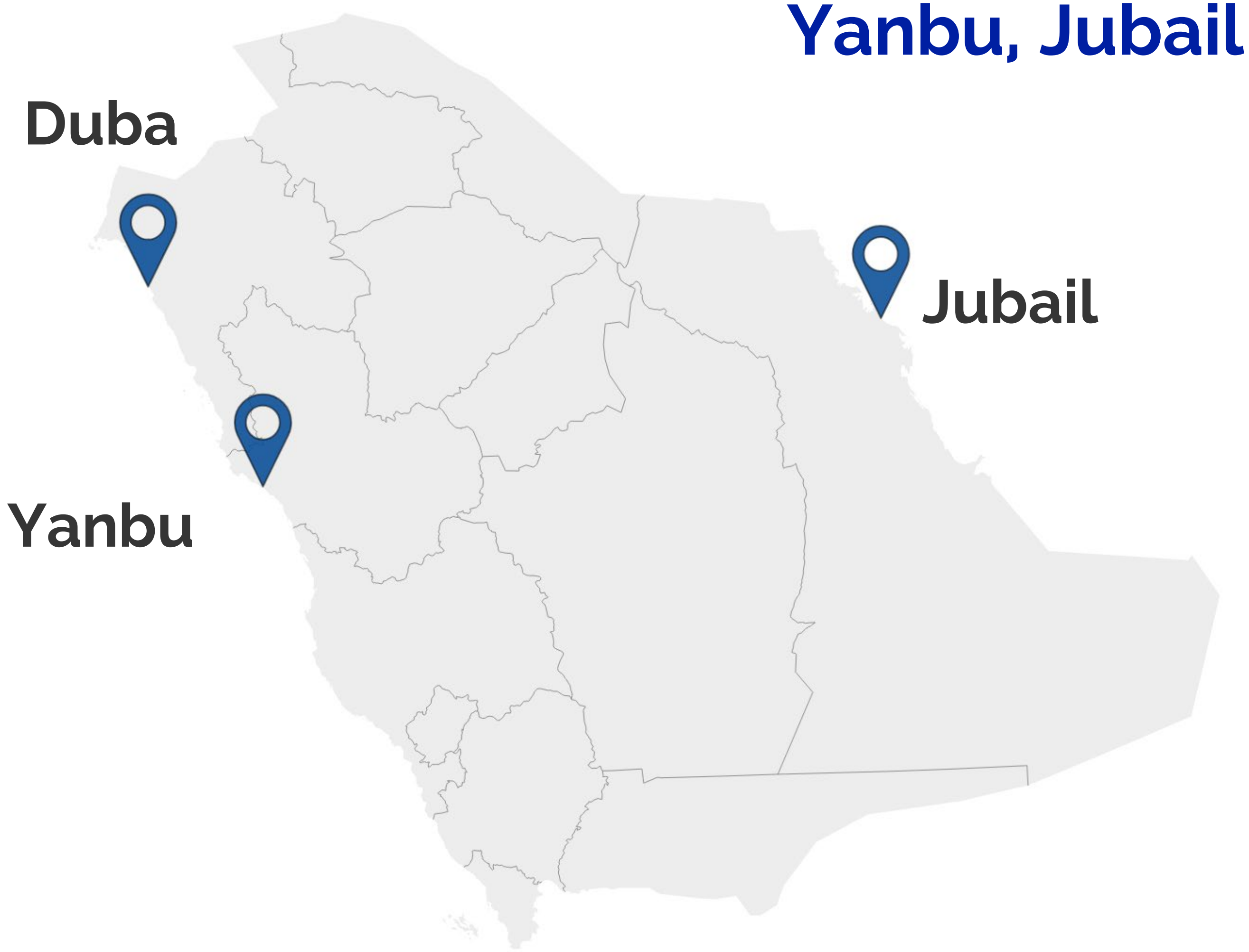
LCA library:

Brightway

Operating System

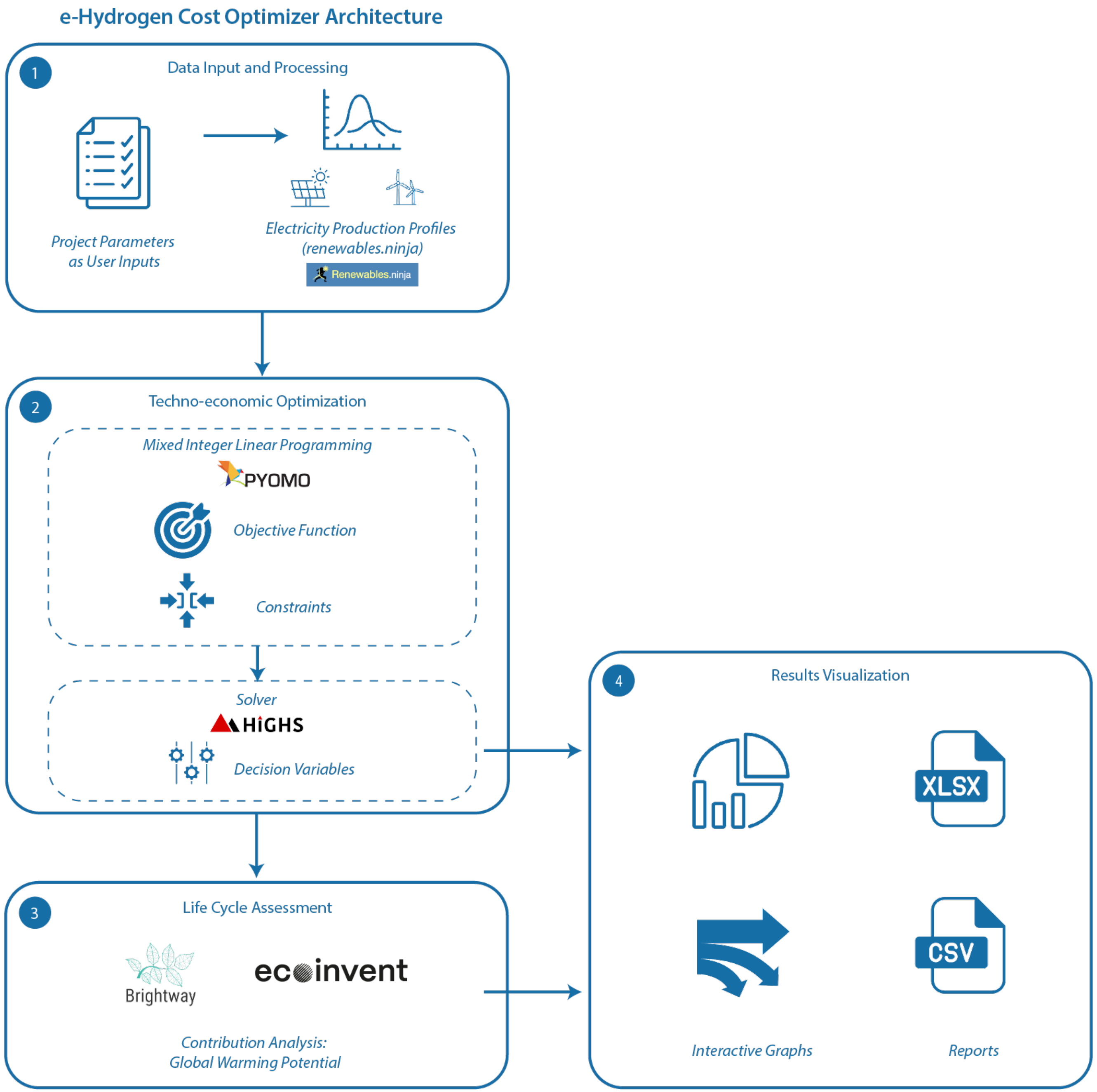
Coastal application

We applied the optimizer in Saudi Arabia's coastal cities: Yanbu, Jubail and Duba

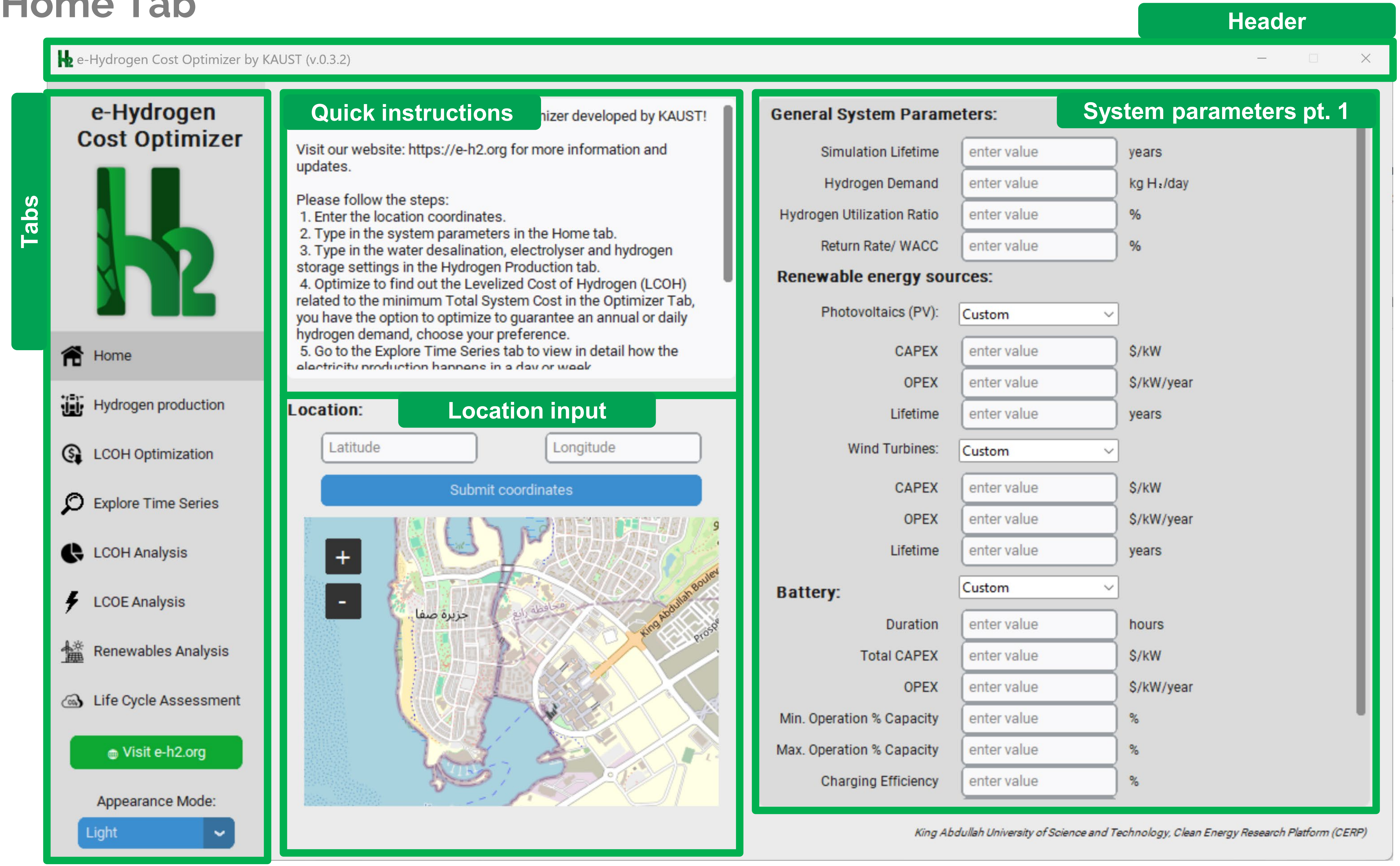


- Hydrogen production relies on desalinated water
- Desalination is already expensive in Saudi Arabia
- The optimizer can be adapted worldwide

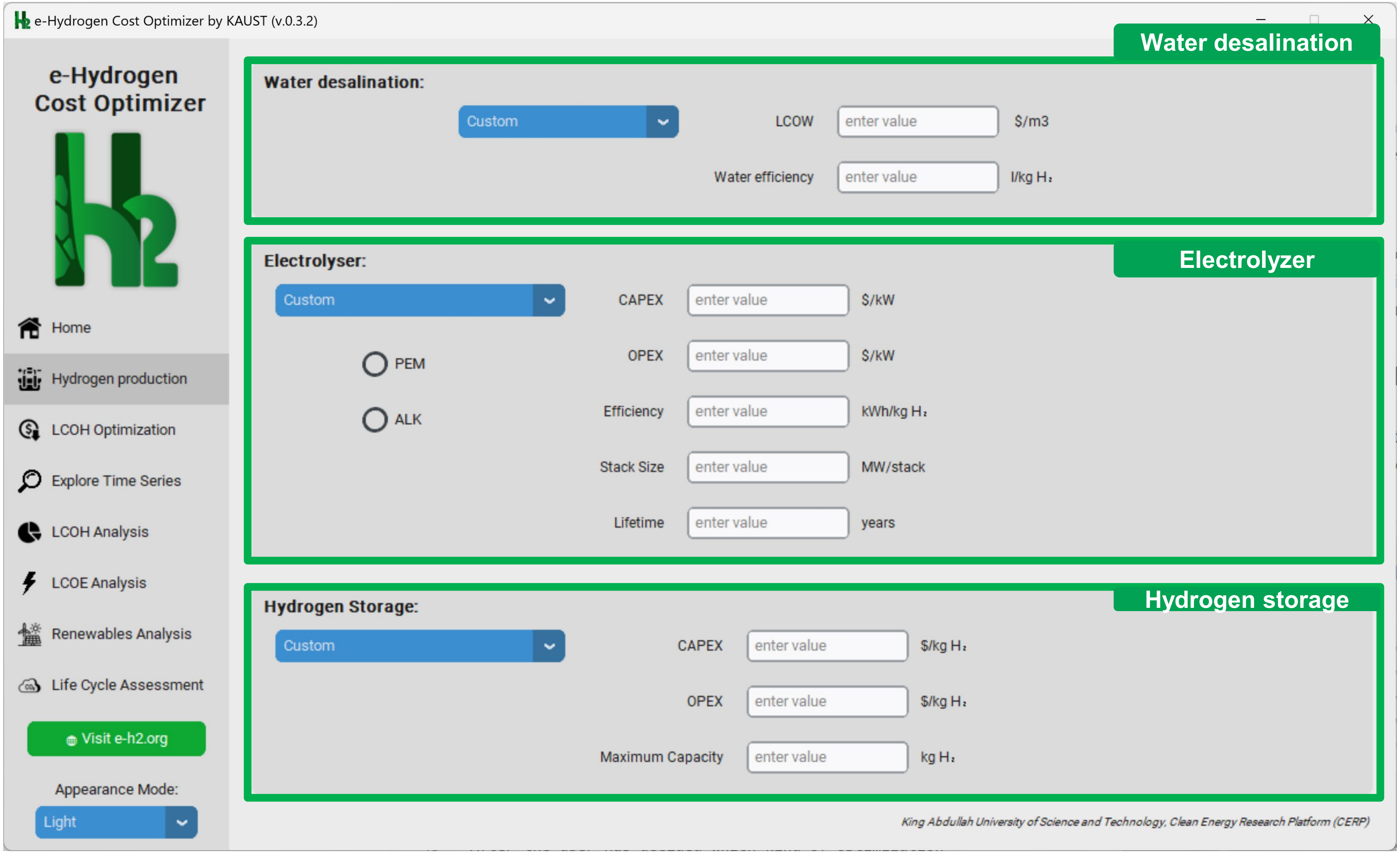
Architecture



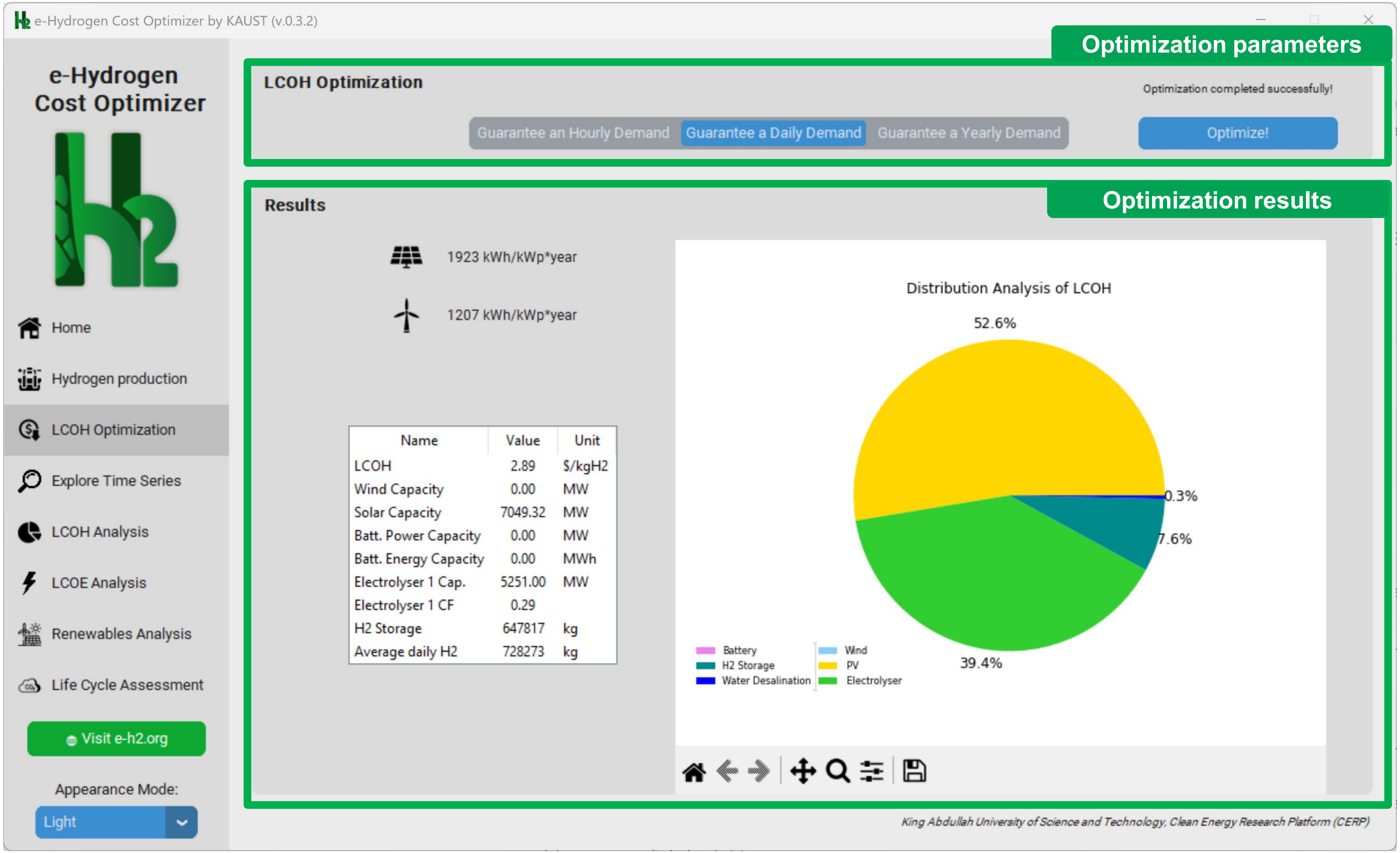
Home Tab


Header
e-Hydrogen Cost Optimizer by KAUST (v.0.3.2)
Tabs
e-Hydrogen
Cost Optimizer
Home
Hydrogen production
LCOH Optimization
Explore Time Series
LCOH Analysis
LCOE Analysis
Renewables Analysis
Life Cycle Assessment
Visit e-h2.org
Appearance Mode:
Light
Quick instructions
izer developed by KAUST!
Visit our website: https://e-h2.org for more information and updates.
Please follow the steps:
1. Enter the location coordinates.
2. Type in the system parameters in the Home tab.
3. Type in the water desalination, electrolyser and hydrogen storage settings in the Hydrogen Production tab.
4. Optimize to find out the Levelized Cost of Hydrogen (LCOH) related to the minimum Total System Cost in the Optimizer Tab, you have the option to optimize to guarantee an annual or daily hydrogen demand, choose your preference.
5. Go to the Explore Time Series tab to view in detail how the
Location:
Location input
Latitude
Longitude
Submit coordinates
جزيرة صفا
King Abdullah Boulev
System parameters pt. 1
General System Parameters:
Simulation Lifetime
enter value
years
Hydrogen Demand
kg H₂/day
Hydrogen Utilization Ratio
%
Return Rate/ WACC
Renewable energy sources:
Photovoltaics (PV):
Custom
CAPEX
$/kW
OPEX
$/kW/year
Lifetime
Wind Turbines:
Battery:
Duration
hours
Total CAPEX
Min. Operation % Capacity
Max. Operation % Capacity
Charging Efficiency
King Abdullah University of Science and Technology, Clean Energy Research Platform (CERP)

Hydrogen Tab

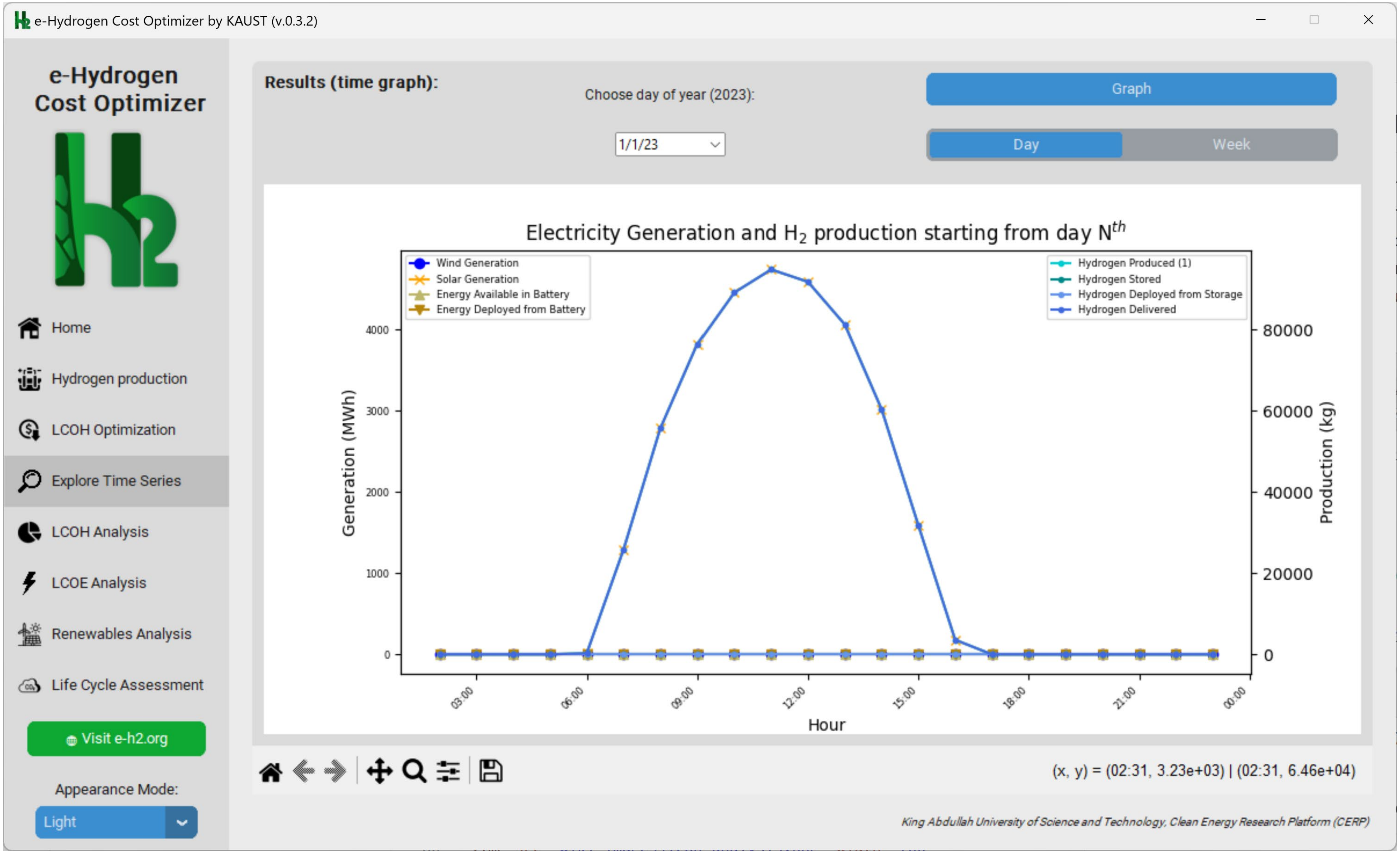


LCOH Optimization Tab



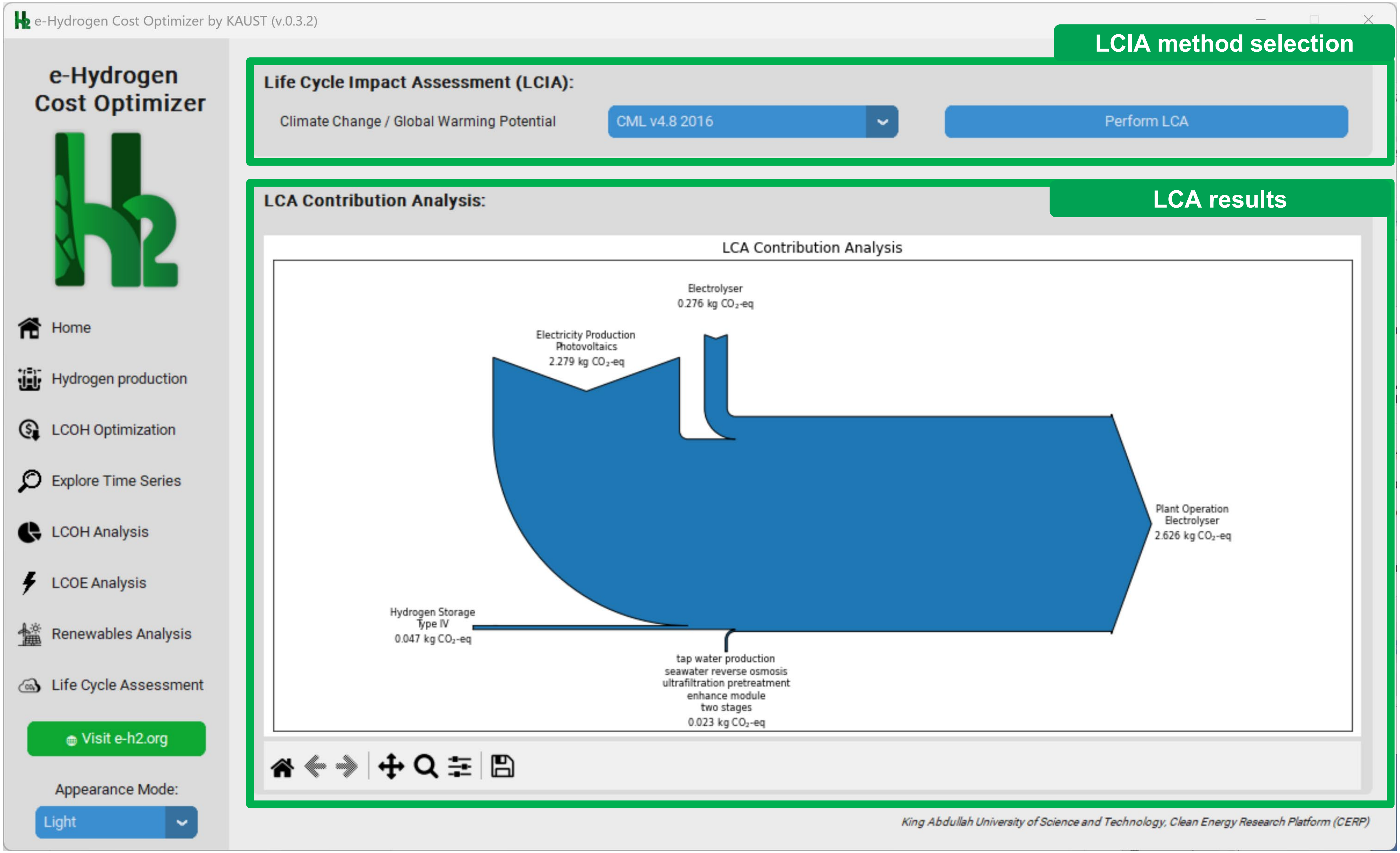
LCOH Analysis

Explore Time Series



Renewable Analysis

Life Cycle Assessment



Electricity Production, Photovoltaics

market for photovoltaic slanted-roof installation, 3kWp, single-Si, panel, mounted, on roof [unit]

1/(lifetime(capacity*1000)*FLH_pv)*

lifetime = PV modules lifetime [years]
capacity = 0.003 [MW]
FLH_pv = local full load hours for PV [h/year]

market for tap water [kg]

*installation*panel_area_scSi*water_pv_panels_cleaning*

installation = market for photovoltaic slanted-roof installation, 3kWp, single-Si, panel, mounted, on roof, amount [unit]
panel_area_scSi = 21.4 [m^2/unit]
water_pv_panels_cleaning = 20 [kg/m^2]

market for wastewater, average [m^3]

-tapwater/1000

tapwater = market for tap water, amount [kg]

→ **Electricity Production, Photovoltaics** → 1 kWh electricity, low voltage

EcoEditor.exe

Plant Operation, Electrolyzer

Electrolyzer [unit]

(electrolyzer_capacity)/(days*lifetime*daily_hydrogen_demmand)

electrolyzer_capacity = electrolyzer capacity from TEA model [MW]
days = 365 [days]
lifetime = electrolyzer lifetime [years]
daily_hydrogen_demmand = average daily H_2 production from TEA model [kg/day]

Electricity Production, Photovoltaics [kWh]

electrolyzer_efficiency*solarCapacity/(solarCapacity+windCapacity)

electrolyzer_efficiency = specific energy consumption [kWh/kg H_2]
solarCapacity = PV modules size from TEA model [MW]
windCapacity = Wint turbines size from TEA model [MW]

Electricity Production, Wind Turbine [kWh]

electrolyzer_efficiency*windCapacity/(solarCapacity+windCapacity)

electrolyzer_efficiency = specific energy consumption [kWh/kg H_2]
solarCapacity = PV modules size from TEA model [MW]
windCapacity = Wint turbines size from TEA model [MW]

Hydrogen Storage [kg]

hydrogen_storage/(days*lifetime*daily_hydrogen_demmand)

hydrogen_storage = H_2 storage from TEA model [kg]
days = 365 [days]
lifetime = electrolyzer lifetime [years]
daily_hydrogen_demmand = average daily H_2 production from TEA model [kg/day]

market for battery, Li-ion, LFP, rechargeable, prismatic [kg]

(battery_energy_capacity*10e6)/battery_density/(days*lifetime*daily_hydrogen_demmand)

battery_energy_capacity = battery energy capacity from TEA model [MWh]
battery_density = 120 [kg/Wh]
days = 365 [days]
lifetime = electrolyzer lifetime [years]
daily_hydrogen_demmand = average daily H_2 production from TEA model [kg/day]

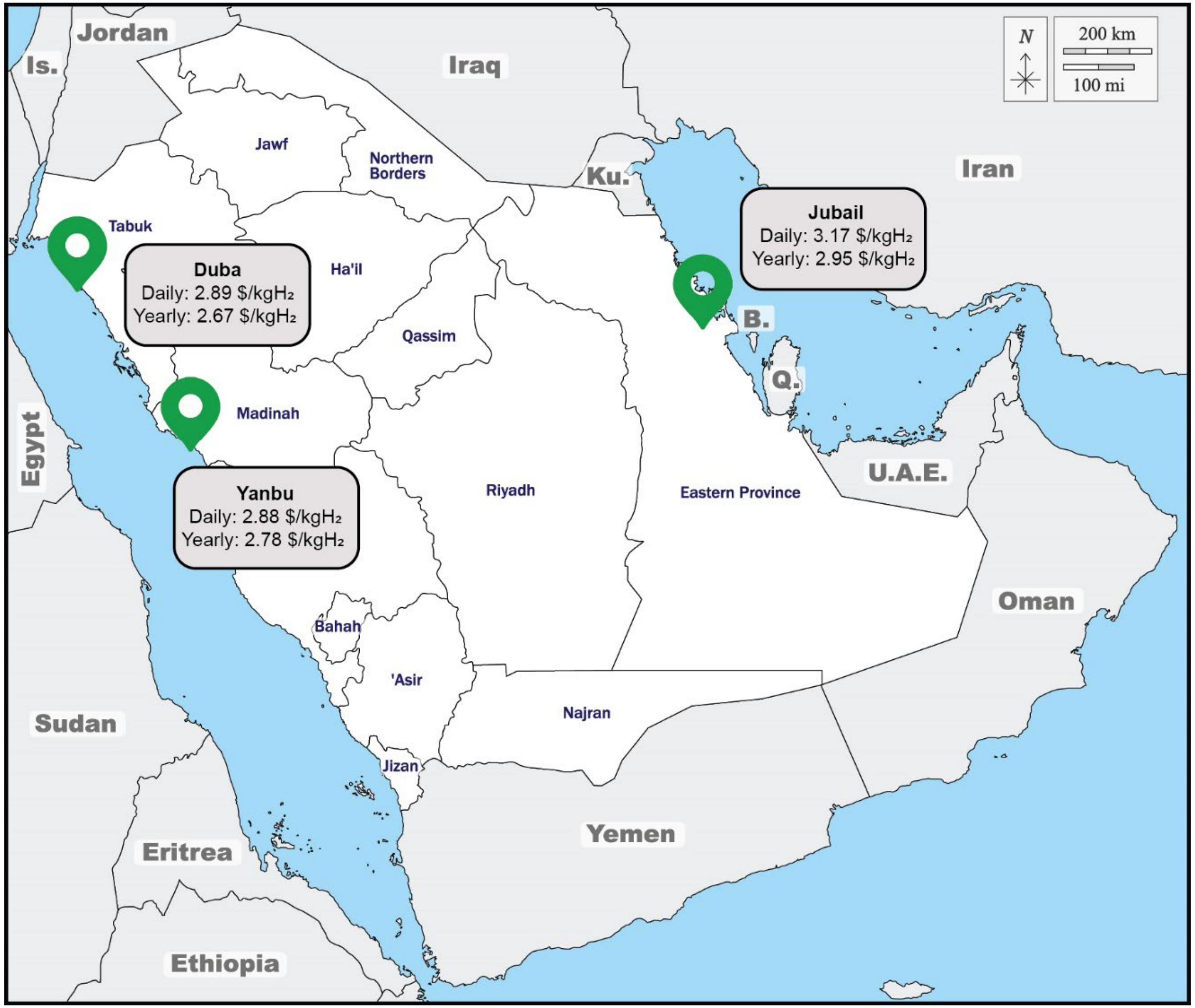
tap water production, seawater reverse osmosis, ultrafiltration pretreatment, enhance module, two stages [kg]

tap_water

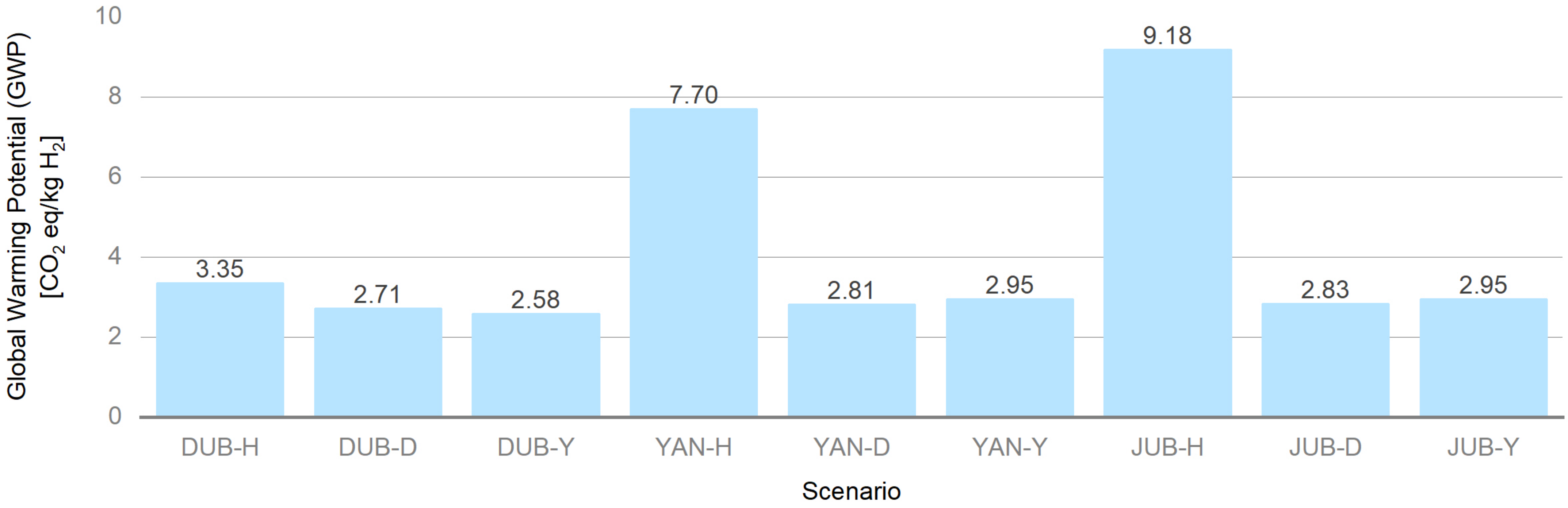
tap_water = 10 [kg/kg H_2]

→ Plant Operation, Electrolyzer → 1 kg H_2

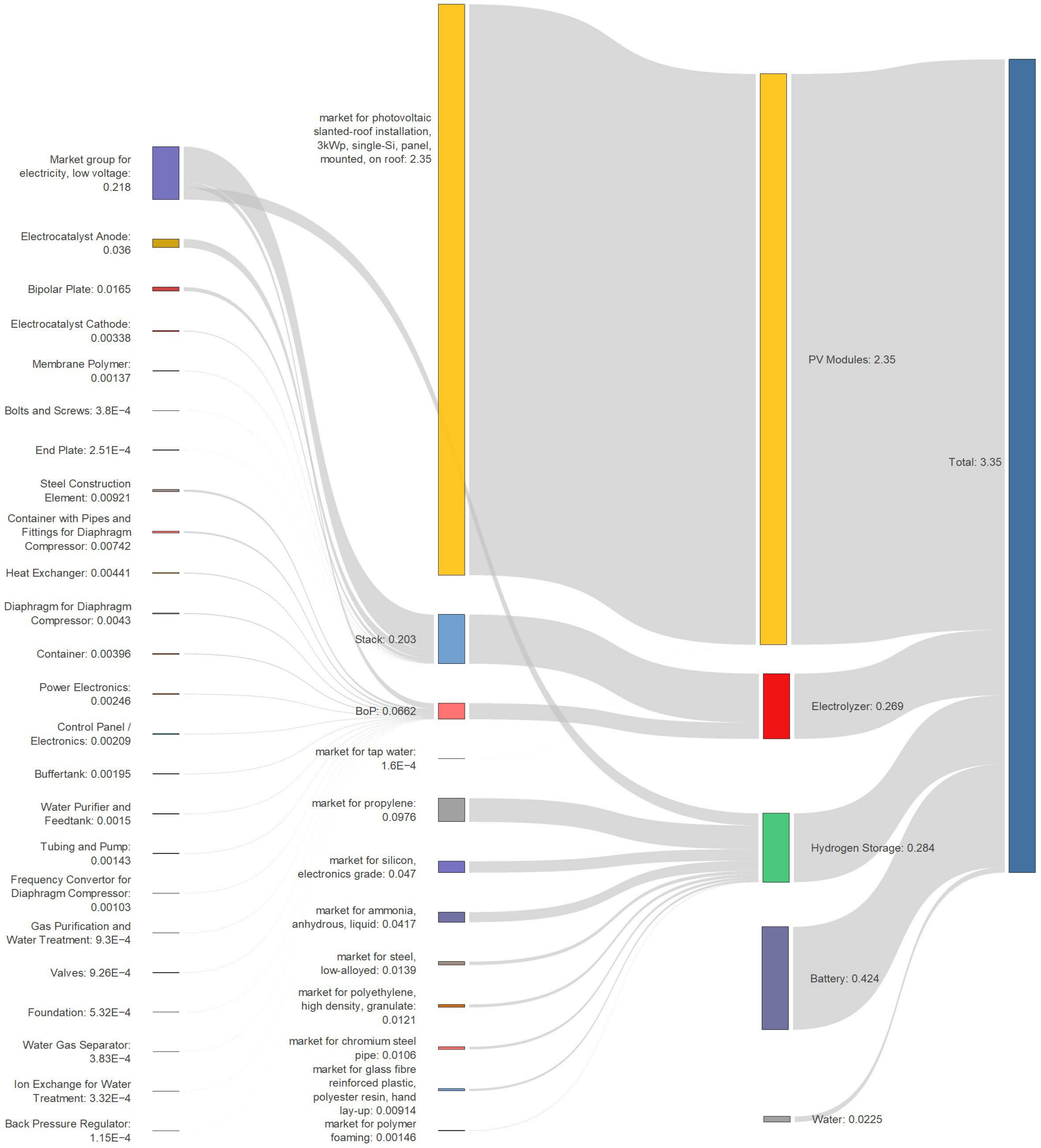
LCOH RESULTS



LCA RESULTS



Global Warming Potential (GWP)
[CO_2 eq/kg H_2]
10
8
6
4
2
0
3.35
2.71
2.58
7.70
2.81
2.95
9.18
2.83
2.95
DUB-H
DUB-D
DUB-Y
YAN-H
YAN-D
YAN-Y
JUB-H
JUB-D
JUB-Y
Scenario



LCA DISTRIBUTION RESULTS

WHAT IS NEXT?

To add different hydrogen electrolysis technologies:

Alkaline
Solid Exchange Oxide Cell

To add hydrogen derivatives :

E-Ammonia
E-Methanol
E-Diesel

QUESTIONS?

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