Requirements Alternative Proposal

ELECTRIC HYDROGEN

33 Jackson Greenhouse Gas Mitigation

Devens Enterprise Commission Proposal – August 2024

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Alternative Proposal

Overview

Electric Hydrogen (EH2) has been directed by the Devens Enterprise Commission (DEC) to comply with Industrial Performance Requirements Section 974 CMR 4.11.2(C) – Greenhouse Gas Mitigation, which requires those in possession of a MassDEP Air Quality Permit to have at least 30% of the facility's roof footprint accommodated with a vegetated roof system built in accordance with the DEC's Policy for Construction of Vegetated Roofs.

EH2 understands the DEC's specific mission as the regulatory and permitting authority within the Devens Enterprise Zone (DEZ) of protecting the health, safety and welfare of the public, as well as other occupants and users within the DEZ, from nuisance conditions.

As stewards of both the global environment and the local community in Devens, **EH2 seeks the consideration of a renewable electricity procurement alternative in lieu of the vegetated roof requirement** that upholds the spirit of the DEC's bylaws in support of greenhouse gas emissions mitigation. For as long as EH2 requires a MassDEP Air Quality Permit, **the proposed solution will meet or exceed the performance of a vegetated roof with respect to avoided greenhouse gas emissions** at a significantly lower abatement cost per metric ton of carbon dioxide.

Vegetated Roof – Summary of Hardships

Financial and Operational Hardships

Financial

A vegetated roof system, as outlined in the Industrial Performance Standards and Policy for Construction of Vegetated Roofs, has been estimated in amounts above **$9.5M** for installation alone and will also generate additional operational expenses.

Further, Electric Hydrogen is required per the terms of their lease agreement with King Street Properties to restore the facility to its original condition upon lease expiry for systems such as this. The resulting asset lifecycle costs exceed **$14M.**

The potential financial impact from this requirement is significant and would render Electric Hydrogen less competitive in the market.

Operational

The installation and maintenance of a vegetated roof system will impact Electric Hydrogen in various ways operationally, including, but not limited to the following:

- Manufacturing constraint due to lack of rooftop area for future equipment modifications
- Increased risk of roof leaks generates significant safety hazards above high voltage equipment
- Risk to the purity of production parts impacting product quality and performance
- Fatigue of rooftop HVAC and reduction in indoor air quality for occupants due to increased pollen and organic materials adjacent to air intake points
- Impact on Facilities operations with added preventative and corrective maintenance

Vegetated Roof – Summary of Hardships Cont'd

Regulatory and Real Estate Hardships

Regulatory

The Industrial Performance Standards are broadly written and require any entity obtaining a MassDEP Air Quality Permit to install a vegetated roof system. As currently drafted, the policy is binary and overly restrictive of entities that may require a MassDEP AQP for reasons unrelated to greenhouse gas emitting sources.

Electric Hydrogen's air permit applies almost entirely to solvent vapors and is not driven by substantial greenhouse gas emitting processes nor equipment.

Real Estate

Physical greenhouse gas mitigation alternatives present site development challenges for Electric Hydrogen and others.

The speculative development approach to the building prior to understanding the tenant's manufacturing process made it impractical to incorporate a vegetated roof during development of the building core and shell.

As grade level space is considered, there are other tradeoffs that would need to be made to accommodate the requirement (e.g., permeable paving displacement and parking reductions).

Asset Lifecycle Cost

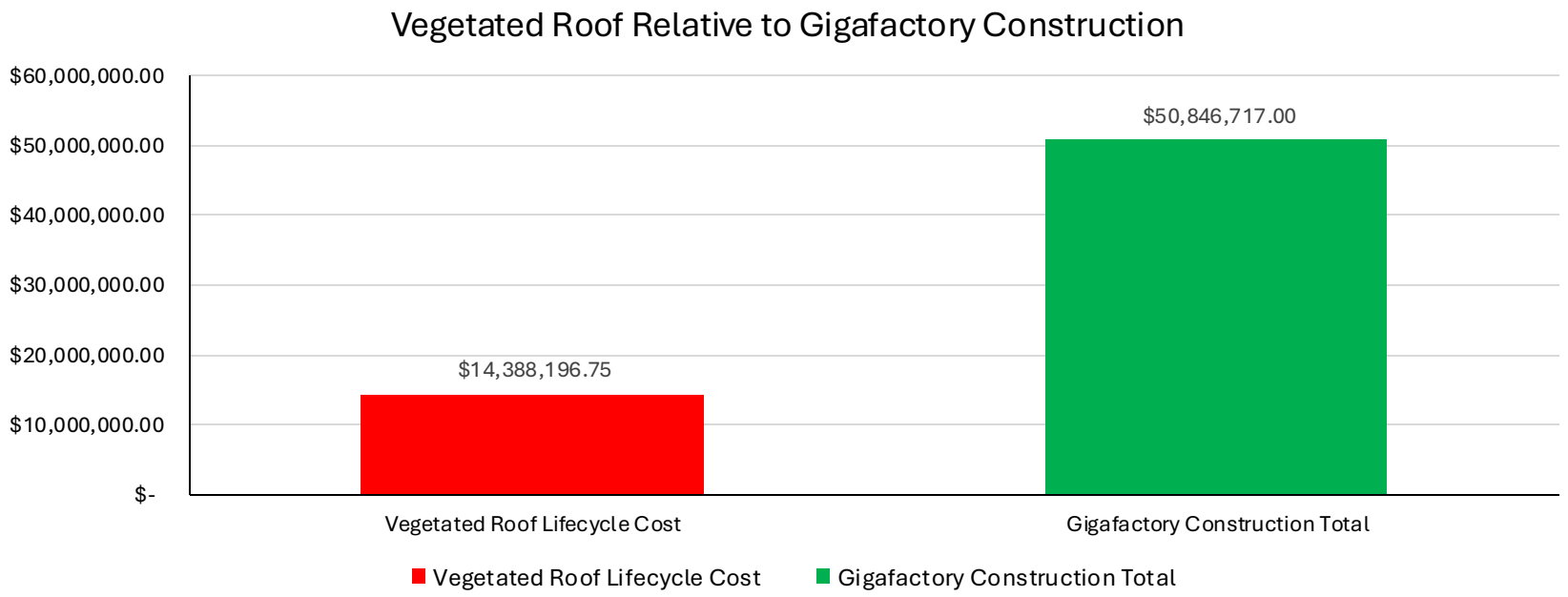
In addition to the burden of an expensive installation cost, EH2 is required to restore the facility to its original condition upon lease expiry resulting in deconstruction costs associated with the vegetated roof concept as a physical asset

This asset lifecycle estimate includes allowances for engineering, design, permitting, equipment relocation, interior logistics for structural upgrades and return of the roof structure to its original condition

~$14.4M estimated lifecycle cost

~28% of factory construction

Vegetated Roof System				
Description	**Amount**	**%**	**$/SF**	**Comments**
Engineering and Design	$347,205.52	2.41%	$9.24	2.5% of direct costs (historic cost index)
Permitting	$152,770.43	1.06%	$4.06	$11/$1000 of direct costs per DEC
Vegetated Roof Installation	$9,490,184.00	65.96%	$252.51	Conceptual estimate from BW Kennedy
Rooftop Equipment Relocation	$1,000,000.00	6.95%	$26.61	Allowance for relocation of existing rooftop equipment
Interior Logistics and Rework	$1,500,000.00	10.43%	$39.91	Allowance for rework of existing interior facilities
Restoration at Lease Expiration	$1,898,036.80	13.19%	$50.50	Estimate for restoration upon lease expiry
Vegetated Roof Lifecycle Cost	**$14,388,196.75**	**100.00%**	**$382.83**	**-**



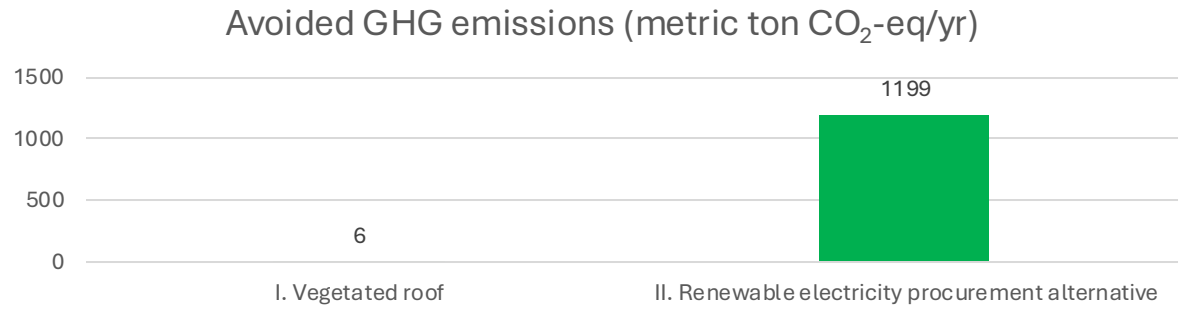
Proposed Renewable Electricity PPA Solution

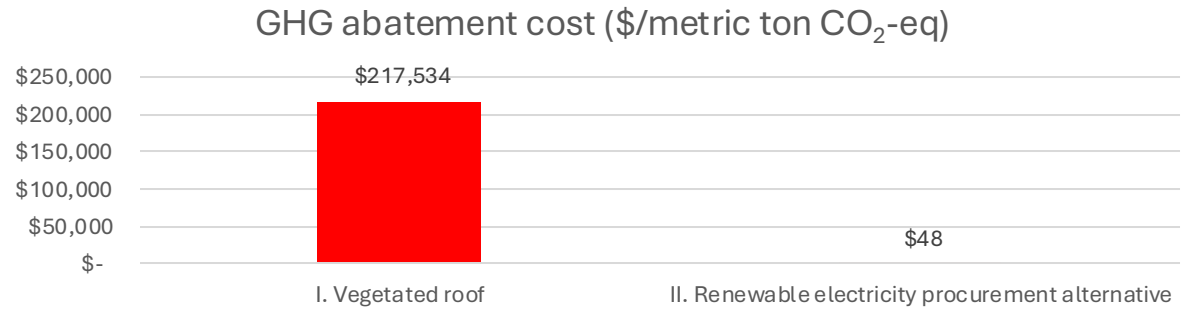
Renewable electricity is a cost and environmentally effective alternative to a vegetated roof

The vegetated roof can mitigate 6 metric tons of greenhouse gas (GHG) emissions per year from reduced heating/cooling demand and carbon sequestration but has a lifetime project cost >$10 million.

100% renewable electricity from New England hydroelectric and wind resources can mitigate ~1200 metric tons of GHG emissions per year at <$100K per year incremental cost.

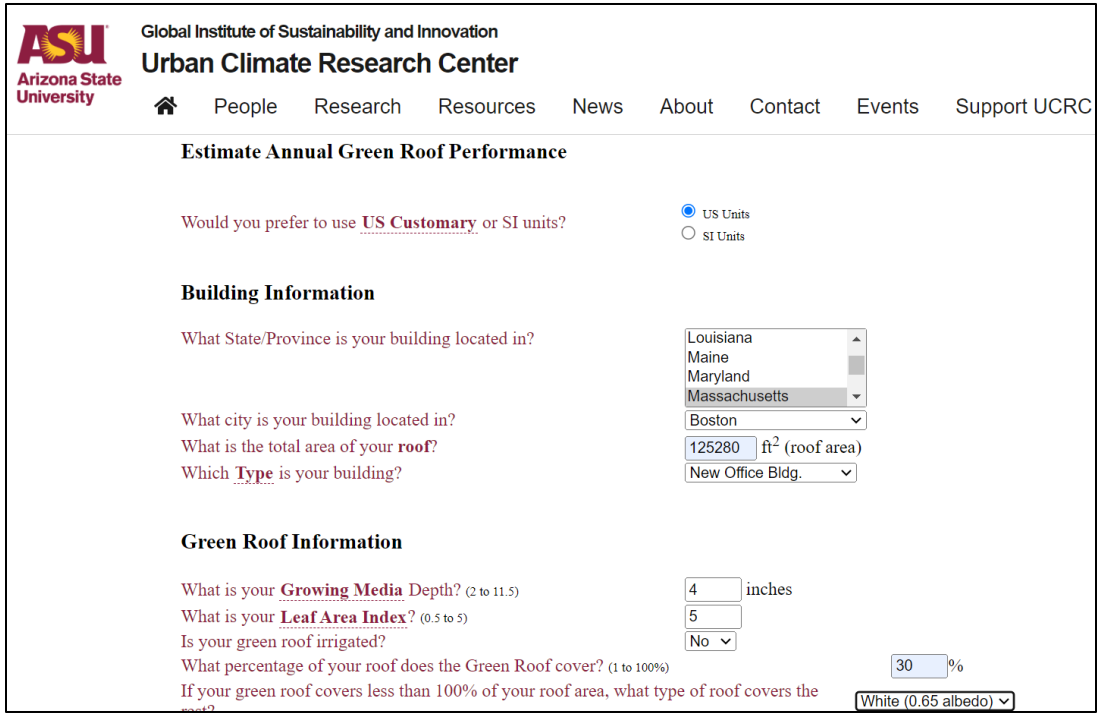
>100x	<0.1%
GHG Abatement	GHG Abatement Unit Cost





125,280 ft^2 white roof with 30% vegetative cover
Heating/cooling benefits: ASU Green Roof Calculator and USEPA 2018
Carbon sequestration: Getter et al. 2009
Grid carbon intensity: USEPA eGRID2022 - NPCC New England
Project lifetime: 12 years; Lifetime cost: $14,388,197

Vegetated Roof GHG Modeling



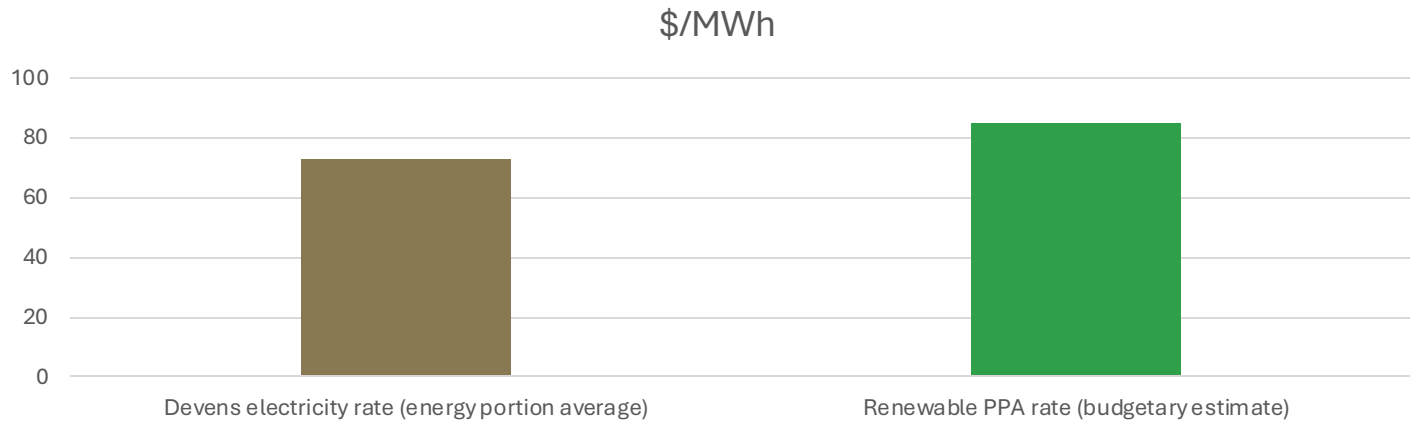
Reduced Heating and Cooling Demand

Model inputs (left)
Model outputs:
•Annual electricity savings: 7157 kWh
•Annual natural gas savings: 229 Therms
Emissions factors:
•Electricity GHG emissions factor: 0.245 kg CO2-eq/kWh (USEPA eGRID202 - NPCC New England)
•Natural gas GHG emissions factor: 5.925 kg CO2-eq/Therm (WRI GHG protocol – Stationary Combustion Tool V. 4.1)
GHG emissions mitigation:
•Electricity savings: 1.8 metric ton CO_2-eq/yr
•Natural gas savings: 1.4 metric ton CO_2-eq/yr
GHG emissions abatement cost:
•Lifetime project cost: $14,388,197 | 12 year project lifetime
•Lifetime GHG emissions abatement: 66 metric ton CO_2-eq (heating+cooling+sequestration)
•Unit abatement cost: $217,534/metric ton CO_2-eq
Uncertainty: model assumes annual electricity and gas usage of 4892500 kWh and 15432 Therms, respectively, which is a factor of ~2x lower than 2024 forecast usage.
Sources: ASU Green Roof Calculator (left) and USEPA 2018 for extensive green roof modeling assumptions

Carbon Sequestration

Inputs:
•125,280 ft² roof with 30% vegetative cover (total vegetated roof area: 3492 m²)
•Carbon sequestration factor:
•375 g C/m² over 2 yr study in Maryland and Michigan (0.688 kg CO_2/m² per yr)
•Carbon sequestration: 2.4 metric tons CO_2/yr
•Sources: Getter et al. 2009 (left)

Renewable Electricity GHG Modeling



Renewable Electricity Procurement

Inputs:
•Annual electricity usage: 4892500 kWh (from vegetated roof modeling)
•Incremental renewable energy procurement cost: $11.9/MWh ($0.0119/kWh) (above)
•New England wind and hydroelectric resources
Emissions factors:
•Electricity GHG emissions factor: 0.245 kg CO2-eq/kWh (USEPA eGRID202 - NPCC New England)
GHG emissions mitigation:
•Electricity emissions avoided (100% renewable electricity): 1199 metric ton CO_2-eq/yr
GHG emissions abatement cost:
•Annual renewable energy procurement cost (100% renewable electricity): $58,074
•Annual GHG emissions abatement: 1199 metric ton CO_2-eq
•Unit abatement cost: $48/metric ton CO_2-eq
Uncertainty: Green roof model assumes annual electricity and gas usage of 4892500 kWh and 15432 Therms, respectively, which is a factor of ~2x lower than 2024 forecast usage.

Alternative Proposal

Proposal: For as long as a MassDEP Air Quality Permit is required, Electric Hydrogen will procure enough renewable electricity to meet or exceed the performance of a vegetated roof with respect to avoided greenhouse gas emissions

Community commitment

- Electric Hydrogen will procure ≥23 MWh per year of Class I Massachusetts renewable energy certificates for retirement by the Devens Enterprise Commission for as long as a MassDEP Air Quality Permit is required

Notes: 23MWh/yr × 1000 kWh/MWh * 0.245 kg CO_2-eq/kWh (USEPA eGRID202 - NPCC New England) ÷ 1000 kg/metric ton = 5.6 metric tons CO_2-eq/yr avoided which is ≥ the GHG emissions avoidance with vegetated roof (5.6 metric tons CO_2-eq/yr).

Corporate commitment

- Electric Hydrogen is committed to mitigating GHG emissions from its Devens manufacturing facility through procurement of 100% renewable electricity in coordination with the Massachusetts Development Finance Authority
  - 2024: planning
  - 2025: procurement strategy
  - 2026: implementation

Appendix

Proposal Summary

For as long as a MassDEP Air Quality Permit is required, EH2 will procure enough renewable electricity to meet or exceed the performance of a vegetated roof with respect to avoided greenhouse gas emissions.

Policy References

- 974 CMR 1.00 Administration
- 974 CMR 4.00 Industrial Performance Standards
- Policy for Construction of Vegetated Roofs

Financial References

- BW Kennedy vegetated roof rough order of magnitude conceptual estimate

Emissions References

- Devens GHG Abatement Alternatives (Calculations)
  - Model files and references for GHG abatement alternatives analysis available

Limited Plan Approval for Process Emission Unit(s) Application, 24-AQ01P-0005-APP

- EH2_Devens_LPA_TechNarrative_CBI_03-05-2024[62].docx

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