ROICE

Repurposing Offshore Infrastructure for Continued Energy

An academia-industry-government effort
to extend energy-life and maximize commercial value of
abandoned/aging offshore infrastructure

ROICE : A Framework for Repurposing Offshore Infrastructure

April 2025

SPONSORS

Endeavor

RODI systems

promethean energy

ELENA KEEN CONSULTING, LLC
COASTAL ZONE MANAGEMENT

University of Houston ROICE Program

The ROICE Program at UH and its advisory group, the ROICE Program Collaborative (RPC), form an **academia-industry-government effort to extend energy-life and maximize commercial value of abandoned/aging offshore infrastructure** facing billions of dollars in decommissioning costs

ROICE-TE

Techno-Economic Analysis of ROICE Installations

ROICE-PIF

Project Implementation Framework for ROICE Installations

- Funded by research grants from state and federal agencies
- Advised by ROICE Project Collaborative (RPC) – industry & academic experts & business leaders
- Phase Gate approach to implementing and operating a demonstration project

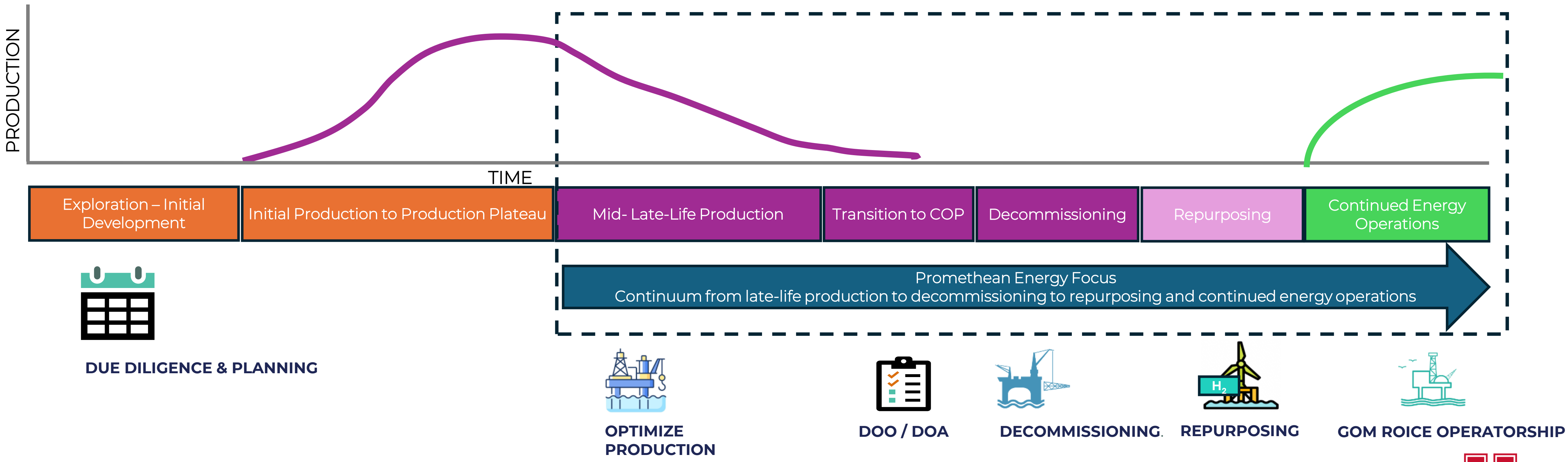
ROICE Vision

*To implement a **ROICE H2 Pilot Project** - a wind to H2 project on a repurposed oil & gas facility*

The ROICE Phase of Asset Life

ROICE focuses on maximizing value across late-life and decommissioned assets by repurposing infrastructure

*Offshore Asset Lifecycle**



* Courtesy: Promethean Energy

ROICE As An Alternative to Decommissioning

Multiple options are being explored for repurposing offshore infrastructure

Low-carbon & Sub-surface
- Stranded Gas Monetization
- CO_2 Sequestration
- CO_2 EOR
- Geothermal
- Gas Hydrates

Alternate Energy
- Wind Power
- Wind to Hydrogen
- Wind to Hydrogen to X (e.g., methanol, ammonia)
- Wave Energy
- Tidal Energy
- Ocean Thermal

Other Options
- Offshore Data Centers
- Sport Fishing / Diving
- Aquaculture
- Desalination

The ROICE Roadmap

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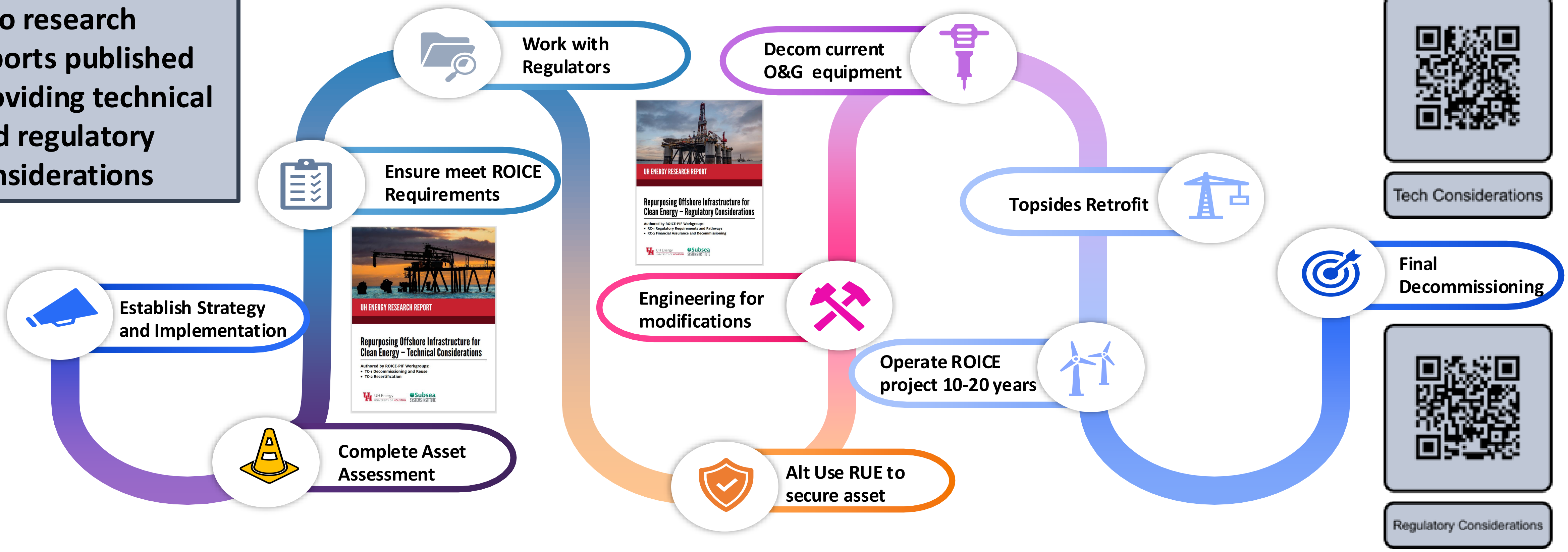
Repurposing Offshore Infrastructure for Continued Energy

ROICE and the RPC are developing a structured roadmap & commercial templates to accelerate the developments

THE ROICE ROADMAP

Two research reports published providing technical and regulatory considerations

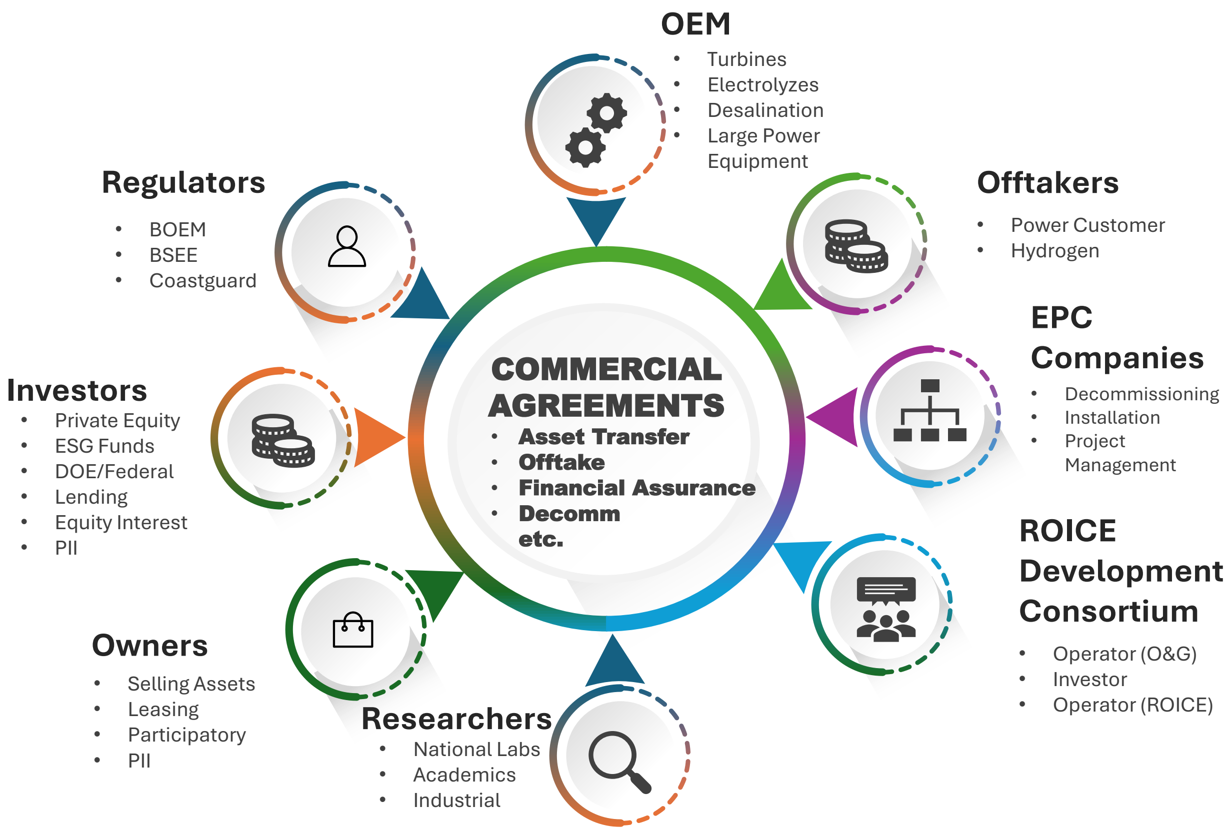


ROICE Stakeholders

ROICE

Repurposing Offshore Infrastructure for Continued Energy

Multiple stakeholder groups are involved across the ROICE lifecycle …



Requires coordinated efforts across:

- ✓ Regulatory Environment
- ✓ Technology Innovation
- ✓ Investments/Financing
- ✓ Engineering & Construction
- ✓ Operations

ROICE Stakeholders

ROICE
Repurposing Offshore Infrastructure for Continued Energy

…with different roles and commercial interests

ROICE Phase

Current Owner
- Major Oil Company
- Mid Sized
- Independent
- Federal Govt
- State Govt

Owner
- Current Asset Owner
- Operator
- Investor (VC, PE, Other)
- Developer

Investor
- O&G Owner
- O&G Partner
- Investment Firm
- Philanthropic
- CE Developer
- Third party interested in CE Projects
- O&G Predecessors of Interest

Developer
- O&G Owner
- O&G Partner
- Wind Partner
- Construction firm
- DOA / DOO

Operator
- O&G Owner
- O&G Partner
- Wind Partner
- Third Party Operator
- DOA / DOO

Notes:

VC:	*Venture Capitalist*
PE:	*Private Equity*
O&G:	*Oil and Gas*
CE:	*Clean Energy*
DOA:	*Designated Operator A*
DOO:	*Designated Operator O*

ROICE Program Collaborative (RPC)

- The ROICE Program is advised by the RPC made up of experts from over 40 organizations – engineering and OEM companies, operators, national labs, associations
- Three categories of RPC members with increasing influence on project direction
  - Participant – All are welcome
    - Invitation to monthly RPC meetings
  - Associate Members
    - Sign an Association Agreement
    - Agree to provide experts' time and data as needed
    - Invited to join select funding opportunities and collaboration with UH faculty
  - Sponsors
    - Sign an MOU; serve on the planning group influencing direction of the project
    - Agree to devote self-funded staff to carry out work scope
    - First right of refusal on funding opportunities, collaboration and demonstration project
- No funding expectation currently – but reserve the right to ask in the future; program funded through research grants

Sample of Current RPC Members

OEM Companies

NEL, IMI, **Rodi Systems**, Hatenboer Water, Power2Hydrogen, GE, GTA H2

Operators & O&G Service Companies

Promethean Energy, Technip FMC, Subsea 7, Noble Corp, Technip Energies, *Baker Hughes*, Neuman-Esser, Siemens
Hess, Talos, BP, Shell, Walter Oil

National Labs

Argonne, NREL

Advisory and Consulting Companies

Endeavor Management, **Elena Keen Consulting**, Grid Advisors, WSP, ABS, *DNV, Gulf Offshore Research Institute*, Centre for Houston's Future, XODUS Group, AquaTerra

Sponsors
Associate Members
Participants

UH ROICE Program Focus

Phased Stage-Gate Approach to Demonstration Project

- ❑ Phase 1 – Screening Studies (complete)
  - ✓ Levelized Cost (LC) Model and LC Heat Maps developed for Wind and Hydrogen ROICE projects in the GOM
  - ✓ Chartered Regulatory and Technical workgroups to develop project implementation framework
- ❑ Phase 2 – Feasibility Studies – by 2Q24
  - ✓ Screened offshore GOM assets for ROICE potential; refined ROICE designs
  - ✓ Defined path to profitability of ROICE projects
  - ✓ Develop ROICE Project Implementation Framework – Regulatory and Technical
- ❑ Phase 3 – Demonstration Project Design – by YE25
- ❑ Future Phases (Demonstration Project)
  - ❑ '26 – '29: Detailed design and execution
  - ❑ '30 – '32: Start up Window

ROICE Phase 3 Scope Elements

1. Develop ROICE Potential Evaluation Workflow for Wind and Wind to Hydrogen
   - Establish the evaluation of ROICE potential prior to decommissioning structures as industry best practice
2. Additional details for ROICE design
   - Floating Structures
   - Pipeline Solutions
   - Safety Considerations
   - Decommissioning and Installation Strategies
3. Assemble stakeholder group and proceed with plans for a demonstration project
4. Expand offshore clean energy (OCE) Options
   - CO2 Sequestration
   - Wave Energy
   - Subsea Hydrogen Generation
   - OTEC
   - Offshore Data Centers
5. Evaluate ROICE for other regions - North Sea; Brazil
6. Establish a network and provide a demonstration platform for OCE technologies

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Framework for Evaluating ROICE Potential in the Gulf of Mexico

**An academia-industry-government effort
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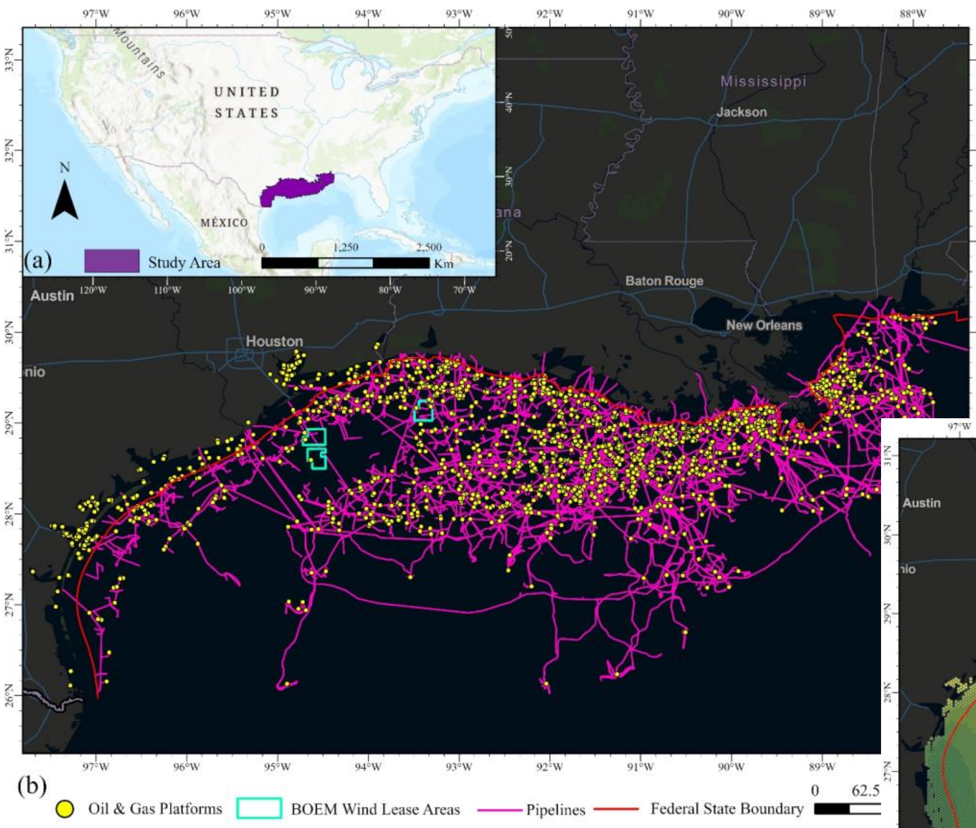
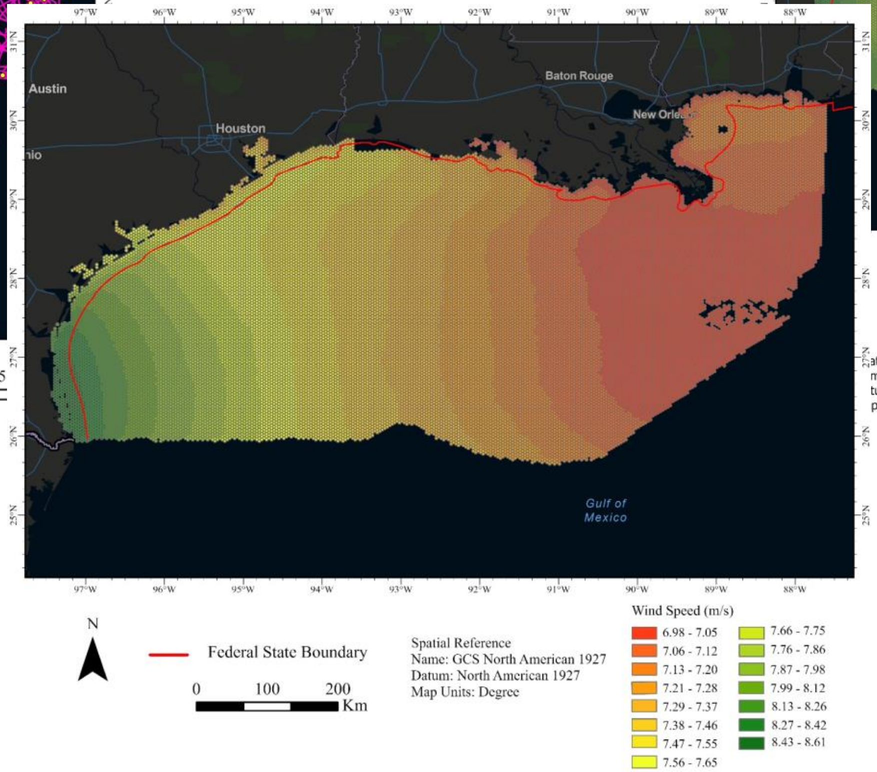
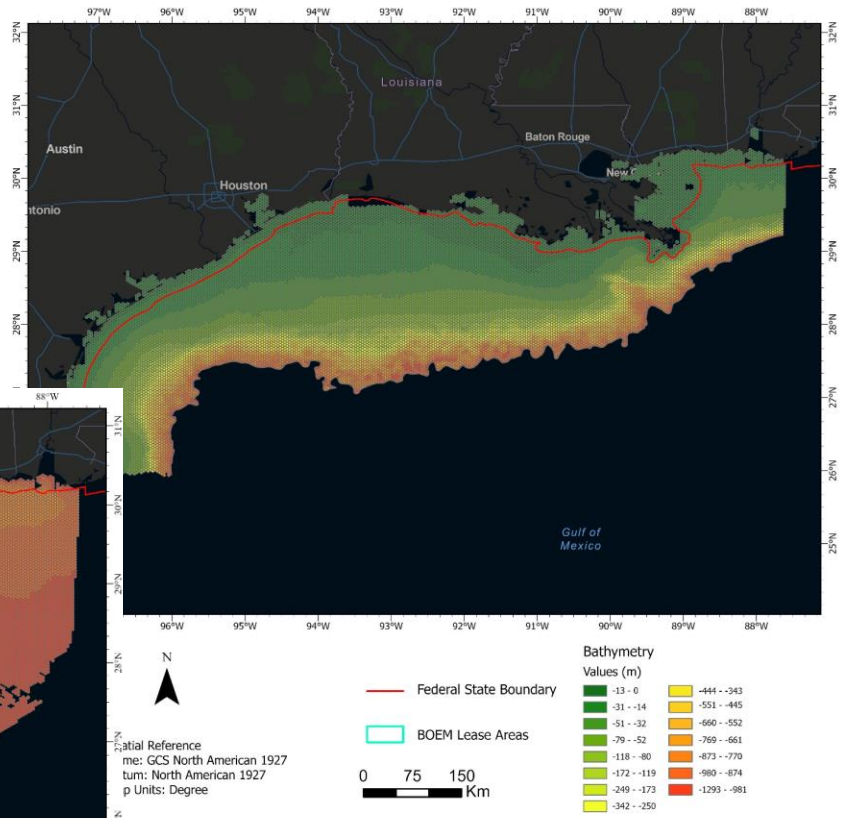
ROICE Potential in the Gulf of Mexico



Large inventory of assets to explore potential to repurpose

Favorable wind speed patterns

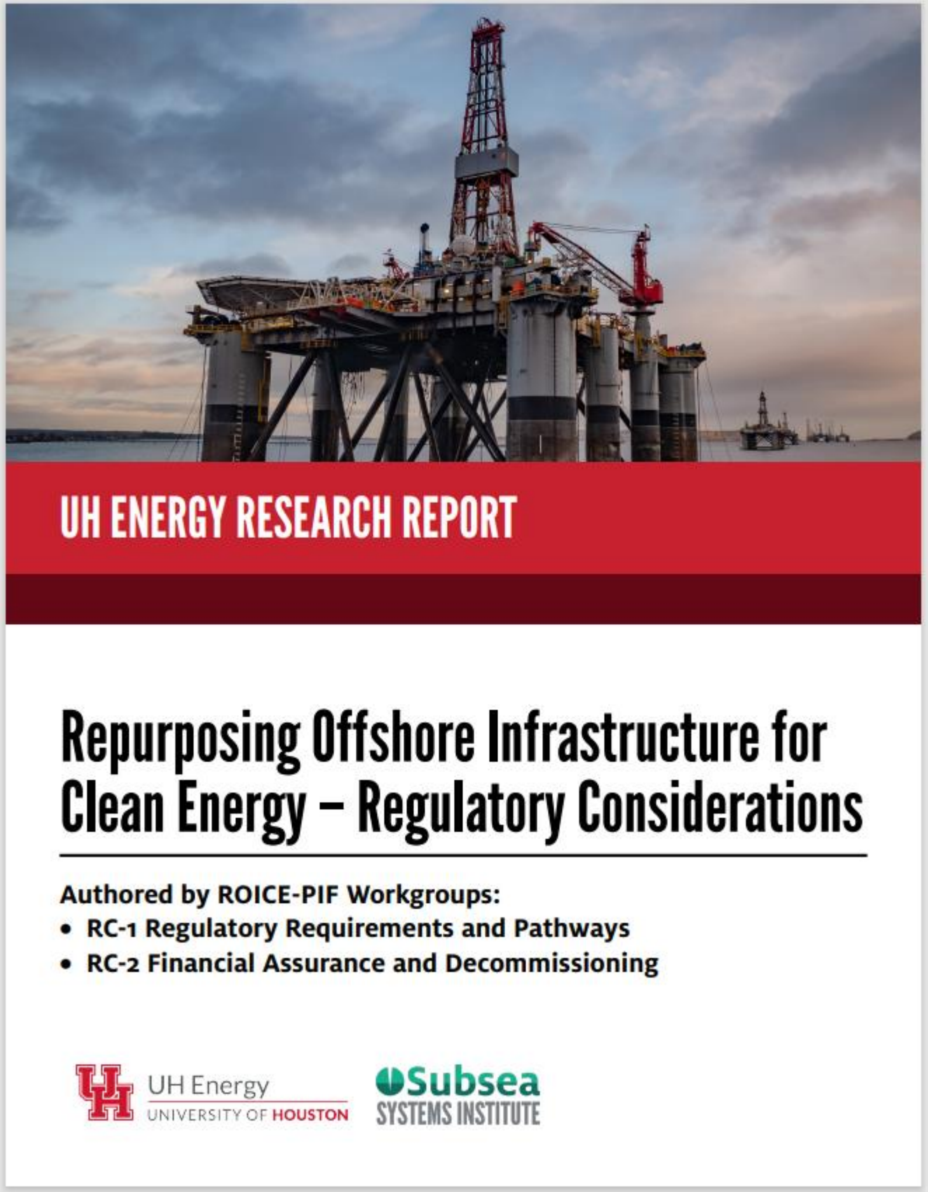




Favorable bathymetry

… and well-established infrastructure and workforce to leverage

ROICE-PIF – Regulatory Considerations Report


UH ENERGY RESEARCH REPORT

Repurposing Offshore Infrastructure for Clean Energy – Regulatory Considerations

Authored by ROICE-PIF Workgroups:
- RC-1 Regulatory Requirements and Pathways
- RC-2 Financial Assurance and Decommissioning

UH Energy UNIVERSITY OF HOUSTON

Subsea SYSTEMS INSTITUTE

ROICE-PIF Workgroups made up of RPC Members develop detailed guidance for stakeholders of ROICE projects in the GOM:

- Regulatory compliance requirements
- Liability transfer pathways
- Financial assurance mechanisms
- Commercial and operational frameworks
- Technical certification of structures
- Pre- and post-ROICE decommissioning requirements

The **Regulatory Considerations Research Report** guides stakeholders in a ROICE project to focus on the following pillars of success:

1. **Communication:** Being transparent and holding proactive discussions with all regulators, agencies, communities and investors
2. **Regulatory Compliance:** Consider using 30 CFR Part 285 to obtain permits; stay up to date with regulatory changes from BOEM and BSEE
3. **Financial Assurance:** Straightforward and comprehensive transition of decommissioning and regulatory liability and responsibilities from current oil and gas operator to ROICE operator

ROICE-PIF – Technical Considerations Report


UH ENERGY RESEARCH REPORT

Repurposing Offshore Infrastructure for Clean Energy – Technical Considerations

Authored by ROICE-PIF Workgroups:
- TC-1 Decommissioning and Reuse
- TC-2 Recertification

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The **Technical Considerations Research Report** guides stakeholders in a ROICE project in the GOM to focus on the following key elements to ensure the structure is suitable for repurposing:

Risk Assessments

Assessments should be performed to help determine an existing asset's suitability. Consequence scenarios(life safety, environment, business disruption) are identified

Decommissioning

Required decommissioning must be completed; existing wells must be plugged and abandoned; oil and gas processing equipment and risers and conductors removed prior to commencing a ROICE project

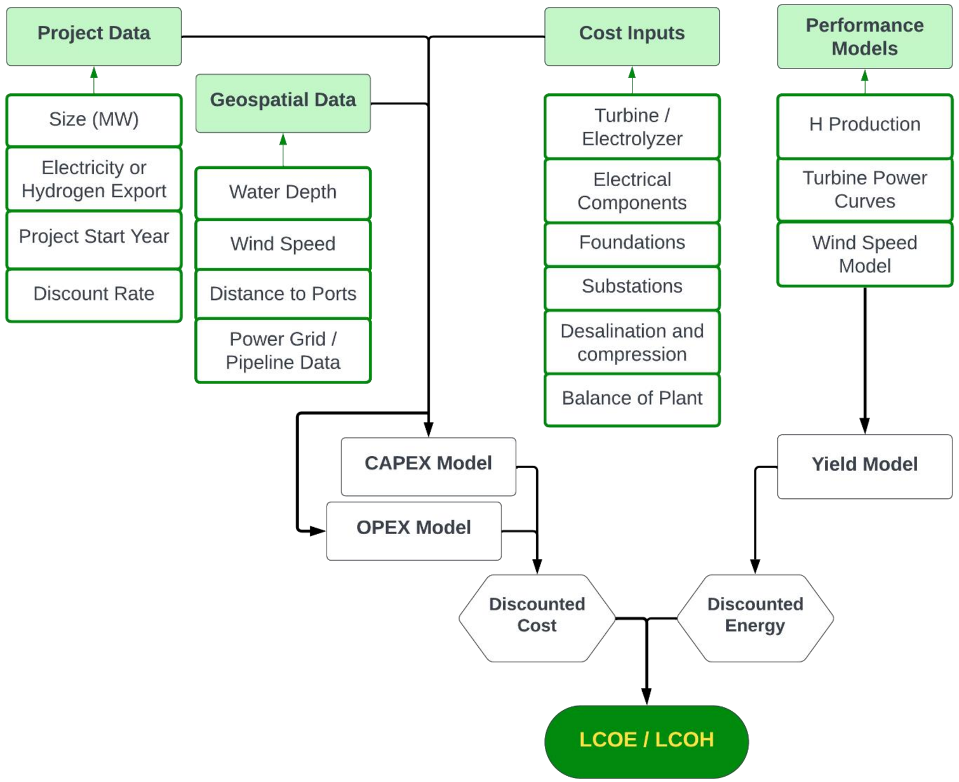
Platform Recertification

Structural inspections, a life extension study, and a structural integrity management plan to validate the existing condition

Regulatory Compliance

Ensure compliance with BOEM and BSEE mandates – engage early.

ROICE Levelized Cost Model



Workflow of our Model

Renewable and Sustainable Energy Reviews 209 (2025) 115115

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

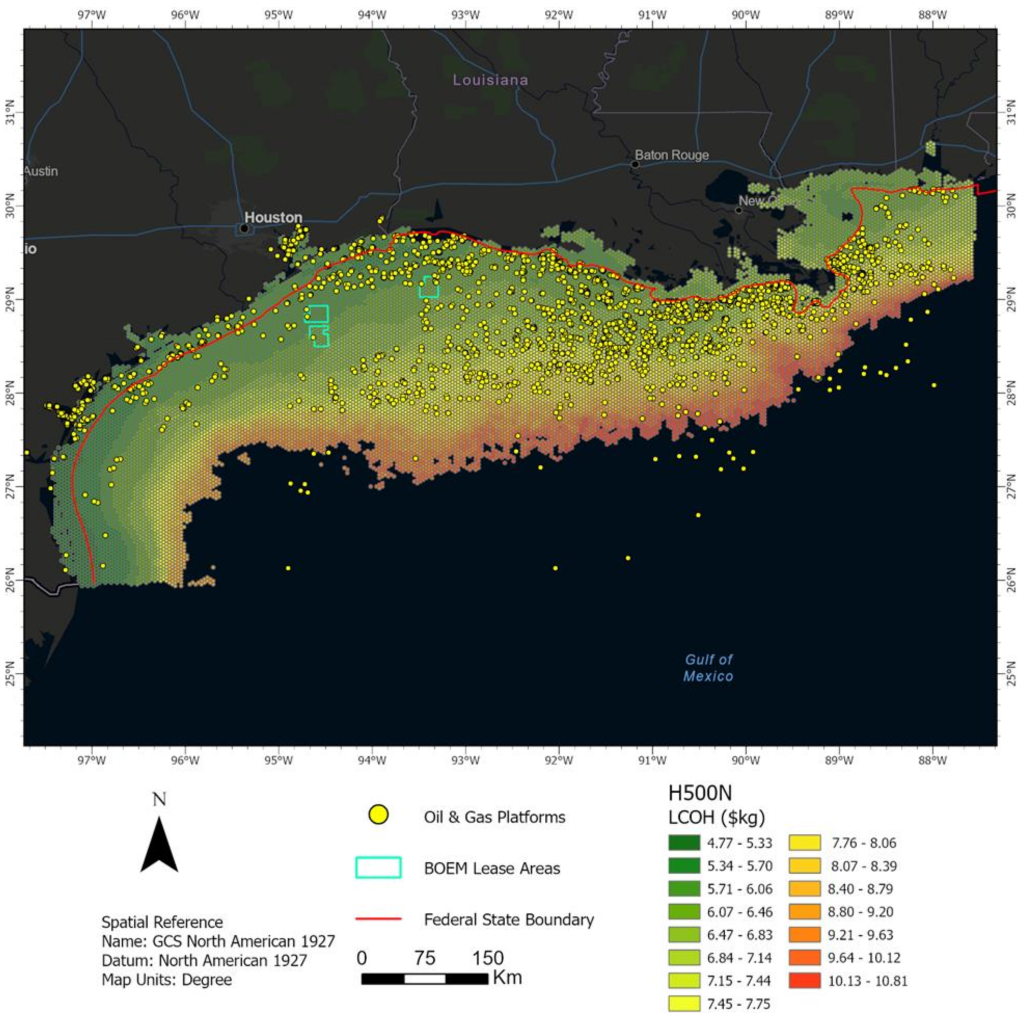
ELSEVIER

Levelized cost of repurposing oil and gas infrastructure for clean energy in the Gulf of Mexico

Yugbhai Patel, Muhammad Younas, Paulo Liu, Ram Seetharam *

- ROICE projects (Repurposing Offshore Infrastructure for Clean Energy) have the potential to transition significant fraction of offshore infrastructure in the GOM and other areas into clean energy projects
- ROICE Levelized Cost (LC) model built for wind or wind to hydrogen projects; LC values estimated for all locations in the GOM
- Levelized costs for ROICE projects are a complex function of various variables – wind speed, water depth, distance to shore, project size, new build vs. repurposed

Levelized Cost Maps



Geospatial LC Map for 435 MW New Build Hydrogen Export Project

Challenges and opportunities for repurposing oil and gas infrastructure for clean energy in the Gulf of Mexico

Muhammad Younas, Yugbhai Patel, Paulo Liu, Ram Seetharam

Submitted to *Journal of Cleaner Production* for review

Ratios of Repurposed CAPEX to New Build CAPEX

Power	Shallow	Deep
435 MW	99%	93%
105 MW	98%	81%

Hydrogen	Shallow	Deep
435 MW	97%	85%
105 MW	88%	61%

Capex Reduction from repurposing existing structures

- 1 to 12% for shallow water locations
- 7 to 39% for deeper water locations

Economic Challenges

Challenges remain:

Levelized Costs (LC) range is higher than equivalent low-carbon renewables-based onshore projects, and even more challenged versus high-carbon alternatives.

Even where the impact of repurposing is high, The overall cost remains a challenge

However:

Capex reductions and technology improvements can make these competitive. 10% improvement in costs and performance can reduce LC's by 15%

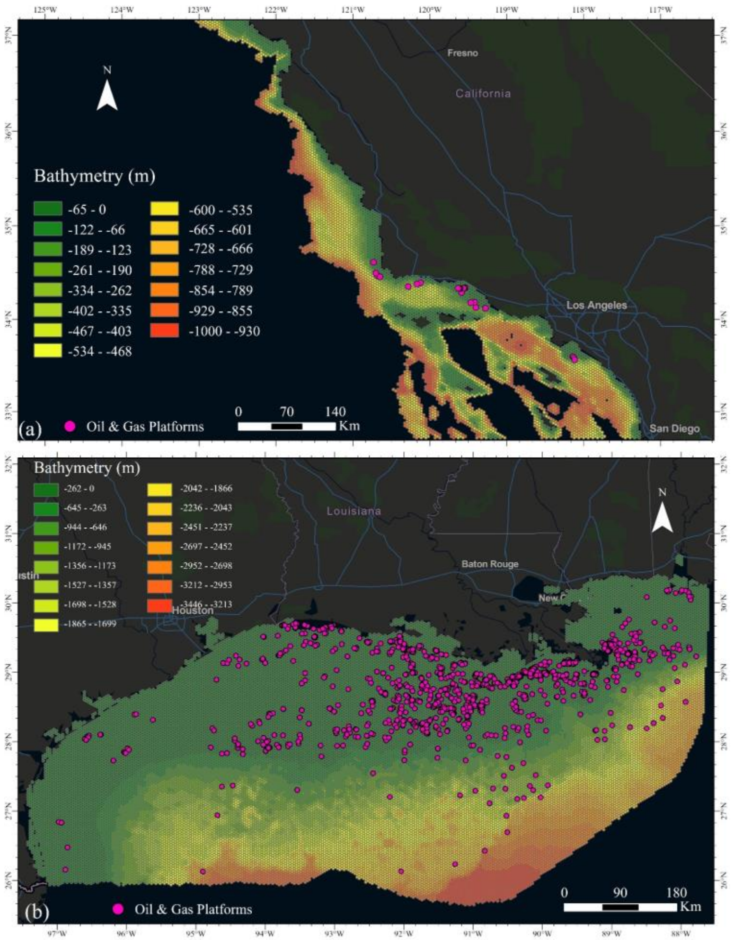
Federal and state incentives (up to $3 / kg of hydrogen; Up to 50% Wind Capex write-off) could make projects at the lower end of LC range competitive

LC Ranges (2023 Capex, No Government Incentives)

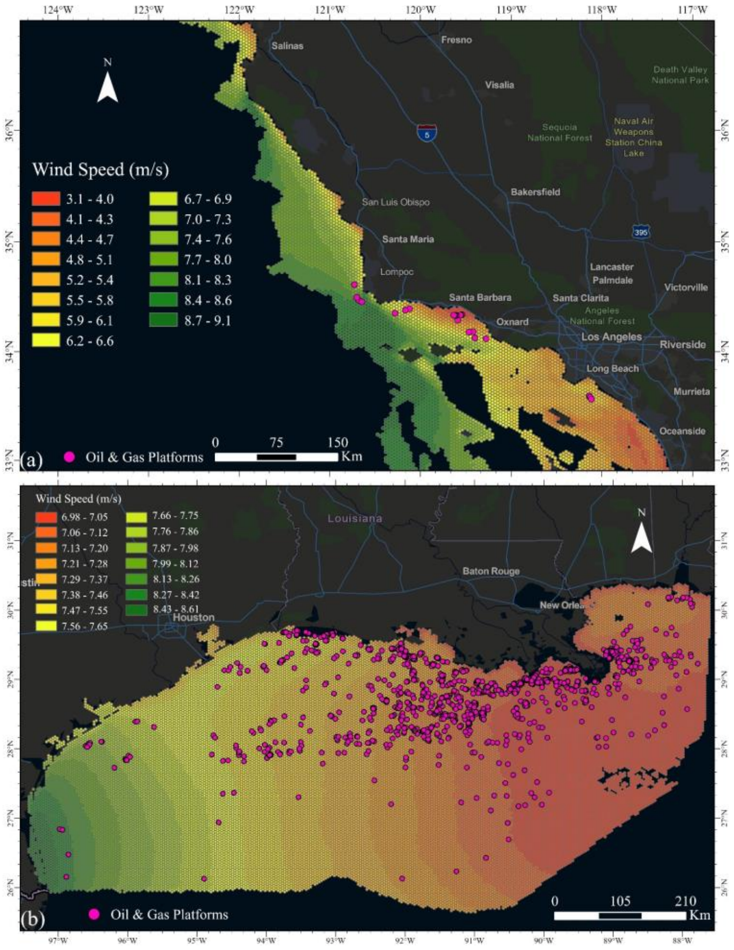
Repurposed wind projects in the GOM: $82 to $231 per MWh. Equivalent new build projects: $82 to $437.

Repurposed hydrogen projects in the GOM: $4.76 to $8.44 per kg of hydrogen. Equivalent new build projects: $4.77 to $19.64.

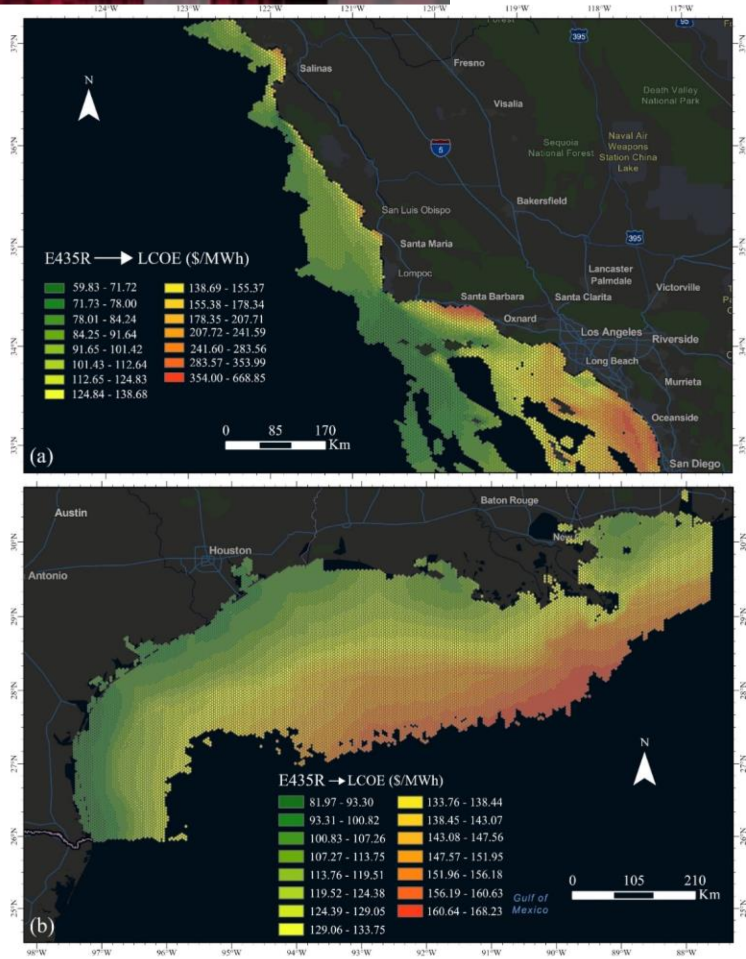
ROICE LC Methodology Applied to California



Water Depth



Wind Speed



Levelized Cost 435 MW ROICE Wind Project

Comparison of levelized costs for repurposing offshore infrastructure for clean energy - Offshore California vs. Gulf of Mexico

Authors: Muhammad Younas, Yugbhai Patel, Paulo Liu, Ram Seetharam

Submitted to *Renewable Energy* for review

The ROICE Workflow

ROICE
Repurposing Offshore Infrastructure for Continued Energy

Obtain Asset Data

Roll-Frame : T002-006

Overall view of ST-311-A, Row A, Leg A3 at right.

Input Asset Location Data into ROICE LC Model

ROICE LC Model

System Parameters

Project Timeline	
End of construction (end of year)	2027
Project life (years)	20
Beginning of Development	2024
CPI of Base NPV Year	304.3
Development duration (years)	4
End year of operation (end of year)	2047
Start of decommissioning (start of year)	2048

Project Capacity	
Initial Project Capcity (MW)	45
Turbine Capacity (MW)	10
# of Turbines	5
Actual Project Capacity (MW)	50
Actual Hydrogen Project Capacity (MW)	50

GIS Inputs	
Latitude	28.12
Longitude	-90.53
Platform Size	1.01
Wave Mean Hs (m)	122.56
Bathy Mean (m)	212243.28
Distance to grid connection point (m)	167465.39
Distance to install port (m)	120616.61
Distance to O&M port (m)	120616.61

Primary Export	Hydrogen
Include P&A Wells	No
Repurposed?	Yes
Jacket Repurposing % of New Build	25%
Pipeline Repurposing % of New Build	35%
Discount Rate	0%

Extract GIS data – water depth, wind speeds

Get GIS Data

	Electricity (MWh)	Hydrogen (Kg)
Discounted Yeild	3181182.058	62132462.06
Discounted CAPEX ($)	$ 493,822,211.41	$419,315,459
Discounted OPEX ($)	$ 94,350,000.00	$212,259,101

Levelized Cost	$184.89 $/MWh	$10.16 $/Kg

Calculate Levelized Cost

Generate LC Values for a given set of ROICE Project parameters

Generate Capex, Opex and Production Profiles

https://www.fcc.gov/media/radio/dms-decimal
Add it to the

Cost Breakdwon

Year	NPV year	Power CAPEX	Hydrogen CAPEX	P&A Well	Pre-ROICE Decom	OPEX	Production (kg)
-4	2024	$ 60,467,930.39	$ 31,667,593.27	$ -	$ 3,345,000.00	$ -	0
-3	2025	$ 79,438,261.49	$ 41,602,524.50	$ -	$ 7,805,000.00	$ -	0
-2	2026	$ 38,533,485.05	$ 20,180,329.05	$ -	$ -	$ -	0
-1	2027	$ 19,167,938.72	$ 10,038,420.09	$ -	$ -	$ -	0
1	2028	$ -	$ -	$ -	$ -	$ 11,712,955.03	3290178.354
2	2029	$ -	$ -	$ -	$ -	$ 11,712,955.03	3290178.354
3	2030	$ -	$ -	$ -	$ -	$ 11,712,955.03	3290178.354
4	2031	$ -	$ -	$ -	$ -	$ 11,712,955.03	3290178.354
5	2032	$ -	$ -	$ -	$ -	$ 11,712,955.03	3290178.354
6	2033	$ -	$ -	$ -	$ -	$ 11,712,955.03	3290178.354
7	2034	$ -	$ -	$ -	$ -	$ 11,712,955.03	3290178.354
8	2035	$ -	$ -	$ -	$ -	$ 11,712,955.03	3290178.354
9	2036	$ -	$ -	$ -	$ -	$ 11,712,955.03	3290178.354
10	2037	$ -	$ -	$ -	$ -	$ 11,712,955.03	3290178.354
11	2038	$ -	$ -	$ -	$ -	$ 11,712,955.03	3290178.354
12	2039	$ -	$ -	$ -	$ -	$ 11,712,955.03	3290178.354
13	2040	$ -	$ -	$ -	$ -	$ 11,712,955.03	3290178.354
14	2041	$ -	$ -	$ -	$ -	$ 11.712.955.03	3290178.354

ROICE Cost Estimator

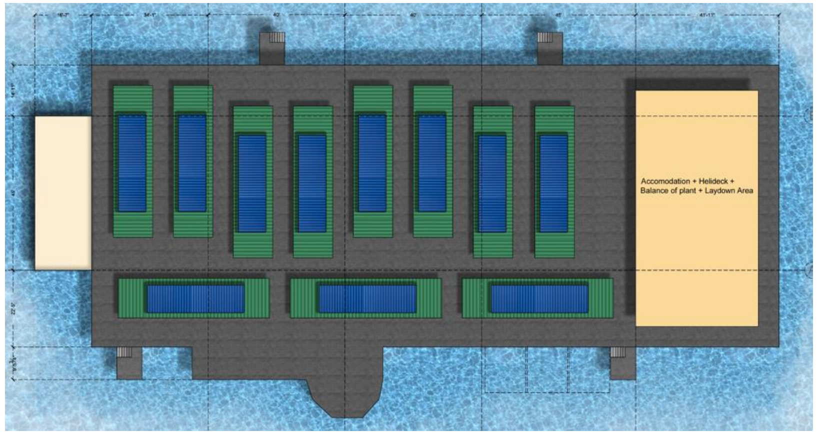
Generate economic metrics (AVP, NPV, IRR) for a range of wind and hydrogen project sizes

ROICE Economics Cases Results

#	P/H	MW	Borrow	Offtake	CpxRed	AVP	IRR	C
1	P	10	N	8	0%	57.50574	0.1972	
2	P	10	N	8	30%	57.50574	0.1972	
3	P	10	N	8	50%	57.50574	0.1972	11.2
4	P	10	N	10	0%	79.2655	0.2419	11.2
5	P	10	N	10	30%	79.2655	0.2419	11.2
6	P	10	N	10	50%	79.2655	0.2419	11.2
7	P	10	N	15	0%	133.6649	0.3319	11.2
8	P	10	N	15	30%	133.6649	0.3319	11.2
9	P	10	N	15	50%	133.6649	0.3319	11.2
10	P	10	Y	8	0%	55.0834	0.1857	11.2
11	P	10	Y	10	0%	76.84316	0.2311	11.2
12	P	10	Y	15	0%	131.2426	0.3226	11.2
13	P	10	Y	8	30%	55.0834	0.1857	11.2
14	P	10	Y	10	30%	76.84316	0.2311	11.2
15	P	10	Y	15	30%	131.2426	0.3226	11.2
16	P	10	Y	8	50%	55.0834	0.1857	11.2
17	P	10	Y	10	50%	76.84316	0.2311	11.2
18	P	10	Y	15	50%	131.2426	0.3226	11.2
19	P	45	N	8	0%	332.1287	0.5499	11.2
20	P	45	N	8	30%	332.1287	0.5499	11.2
21	P	45	N	8	50%	332.1287	0.5499	11.2

ROICE Economic Model

Identify minimum size for a profitable project for given asset
Use placement workflow to see if asset can accommodate



ROICE Placement Workflow

Optimum Project Size for H2 and Wind Projects

ROICE Workflow Case Study - ST-311-A

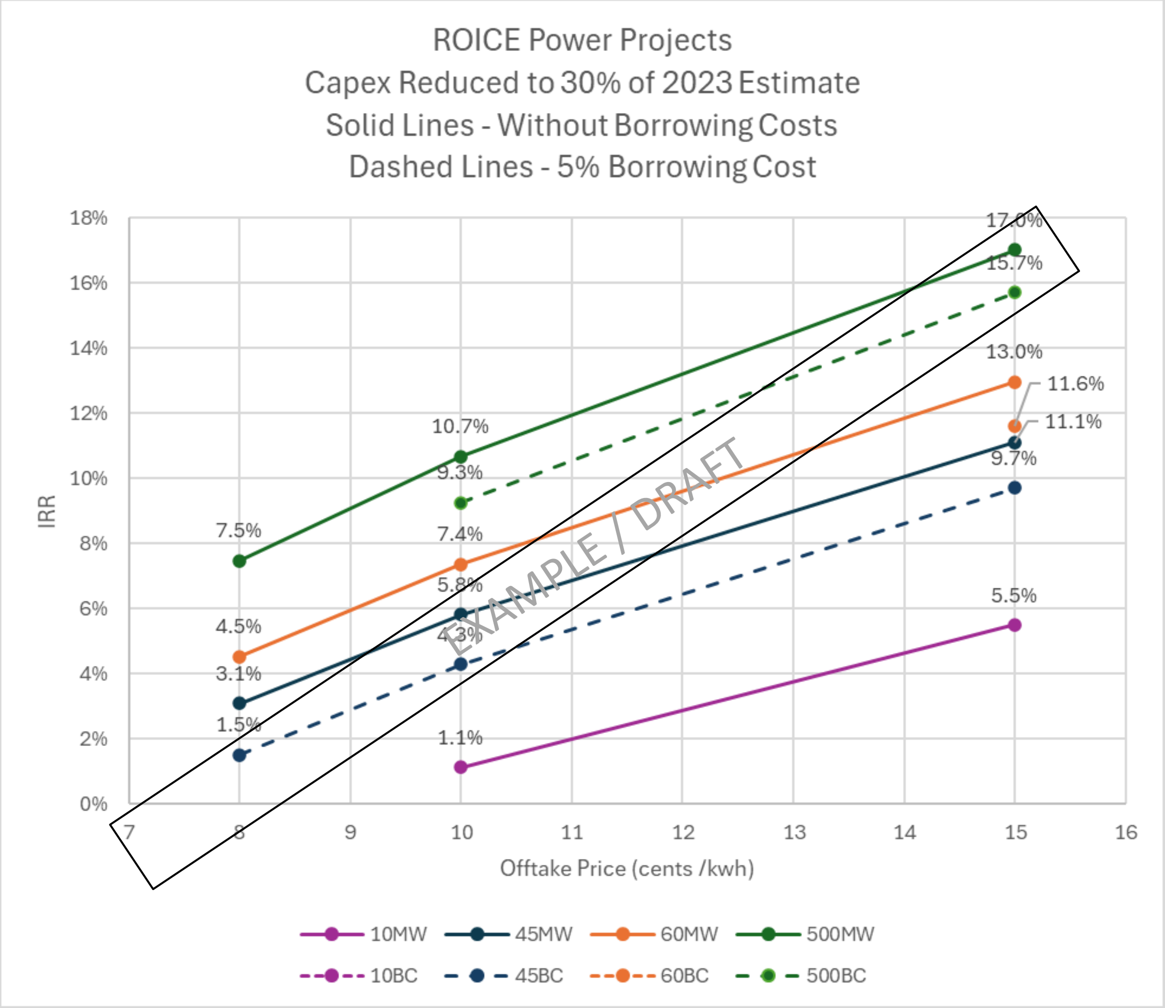
- Walter Oil and Gas Asset is an operating oil and gas fixed platform installed in the year 2015.
- 400 ft of water; 6-leg platform; 100 miles offshore

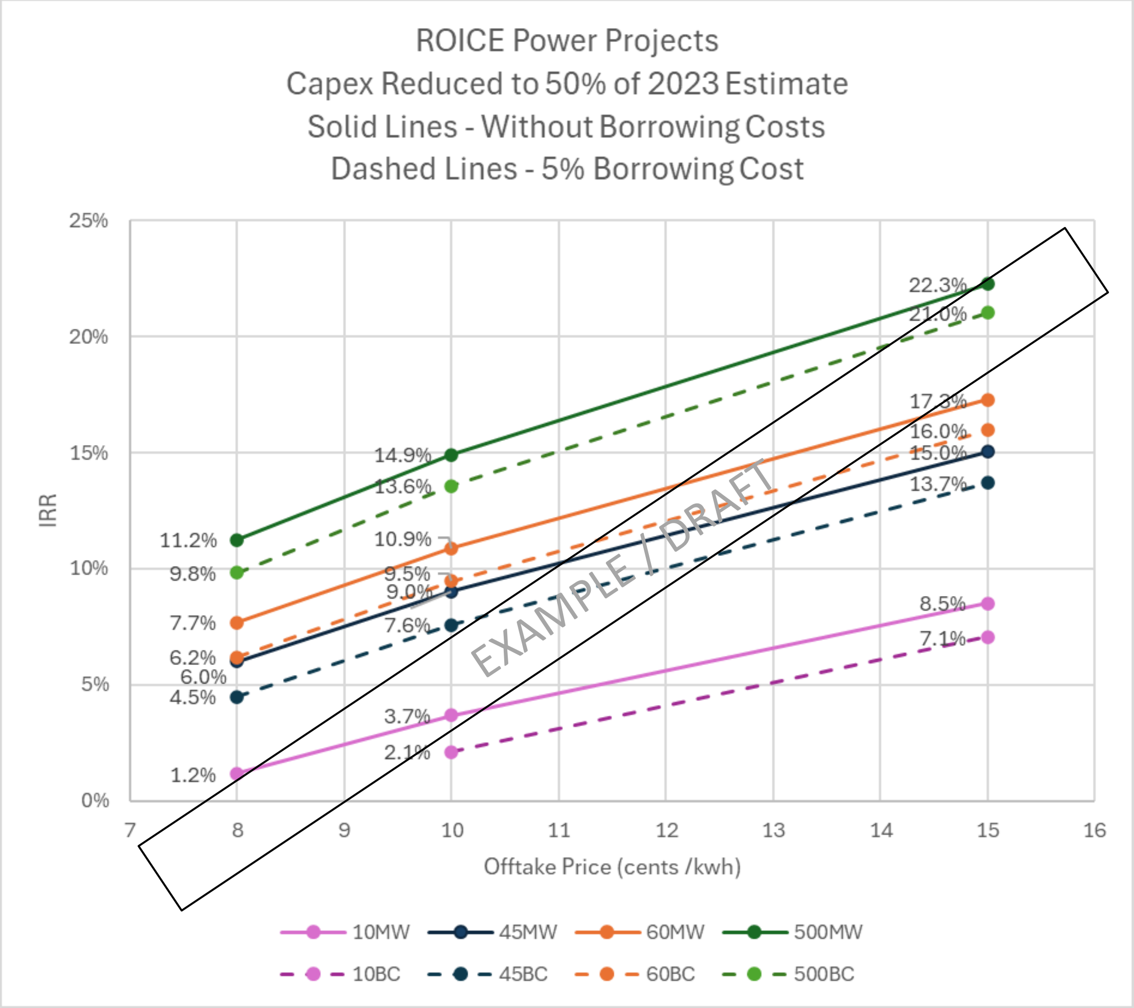
Production Equipment Distribution

- **Drilling Deck (El. +99’ 9”)**
  - 11 x 5MW Process Containers
  - 11 X Dry Cooler Assemblies (stacked)
- **Production Deck (El. +70’ 6”)**
  - 11 x Transformers
  - 11 x Rectifiers
- **Cellar Deck (+57’ 0”)**
  - 6 x Seawater Desal Modules
  - [?] x Seawater Lift Pumps

- *ST-311 data sets received with thanks from Walter Oil*
- *To be used purely for research purposes*
- *Electrolyzer designs received with thanks from IMI*
- *Desalination designs received with thanks from RODI Systems*

ST-311-A: Wind Power Project Economics



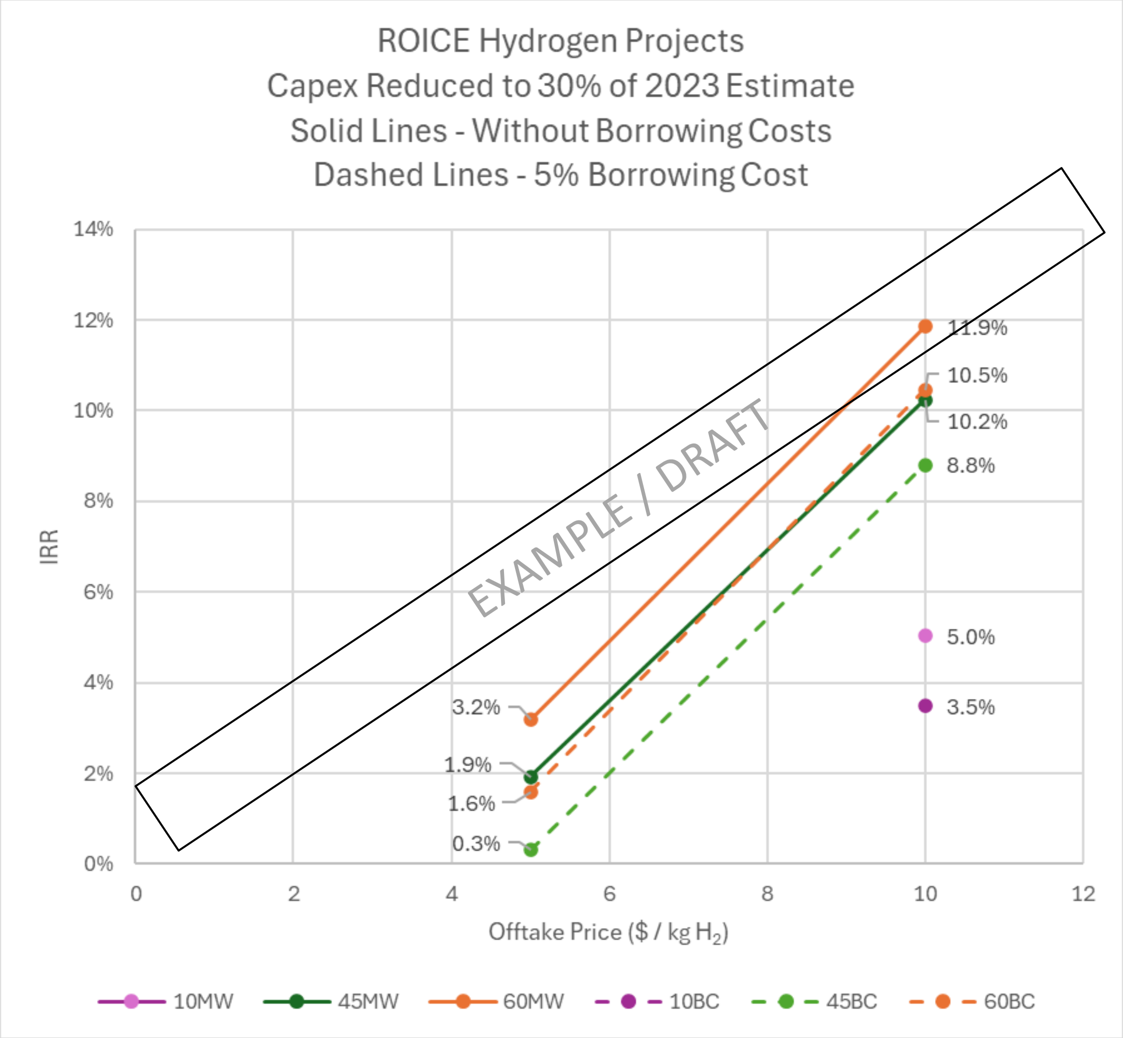


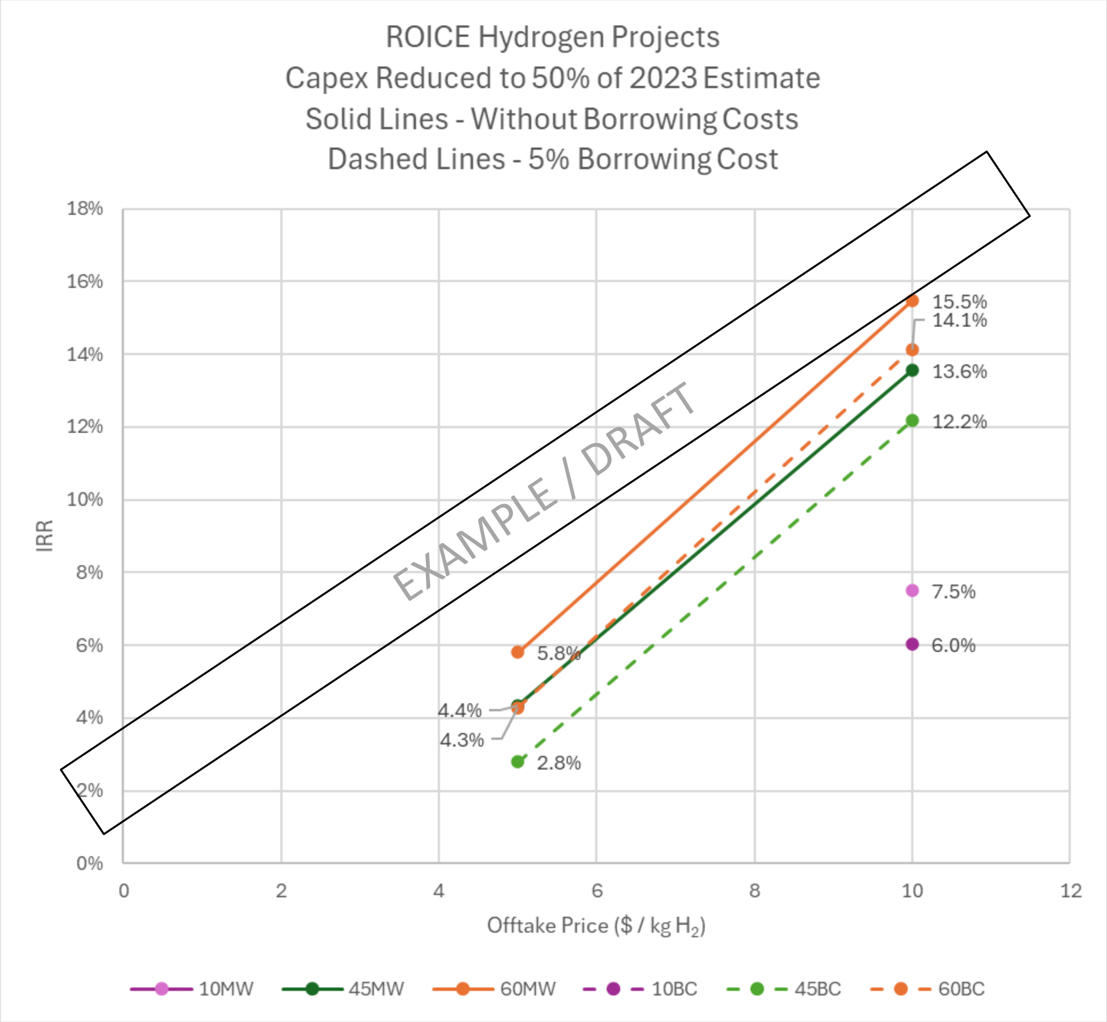
Offshore Technology Conference 2025
OTC-35964-MS

Repurposing Typical GOM Platforms for Wind Power and Hydrogen Generation - Design and Economics

Paulo Liu[1], Yugbhai Patel[1], Muhammad Younas[1], and Ram Seetharam[1]*

ST-311-A: Hydrogen Project Economics





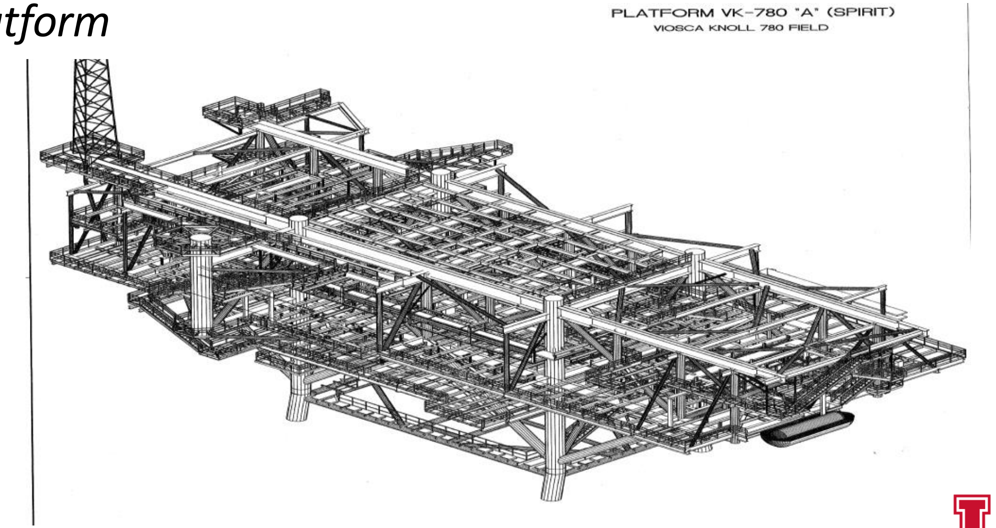
Topsides Changeout

Proton Exchange Membrane (PEM) Electrolyser

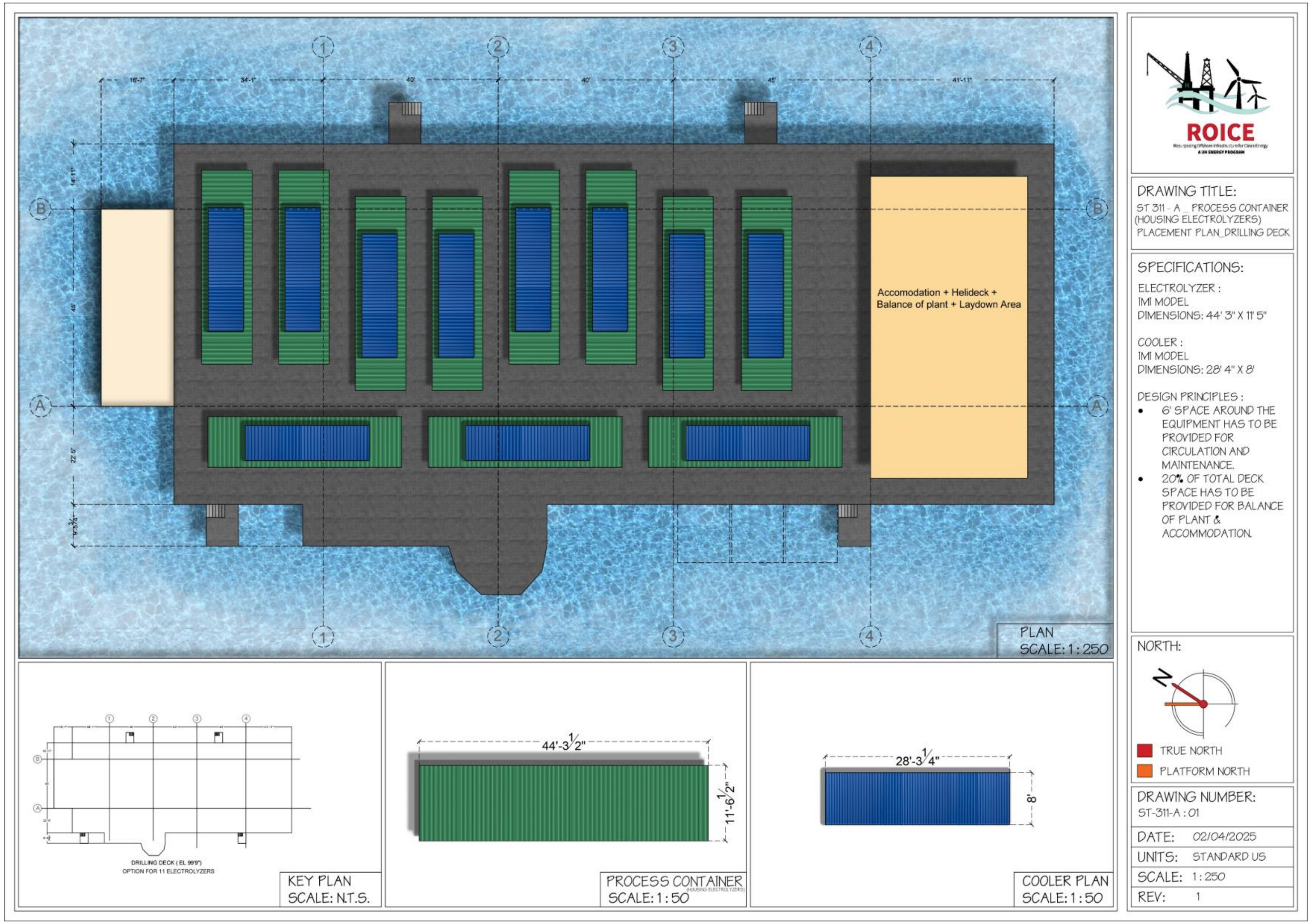
IMI Critical Engineering

Breakthrough Engineering

Wind Turbines installed around the platform – not on the platform



ST-311-A: Drilling Deck H2 Production Layout



Total: 11 x 5 MW Process Containers on drilling deck

Requires 1 Cooling unit to 1 Process Container

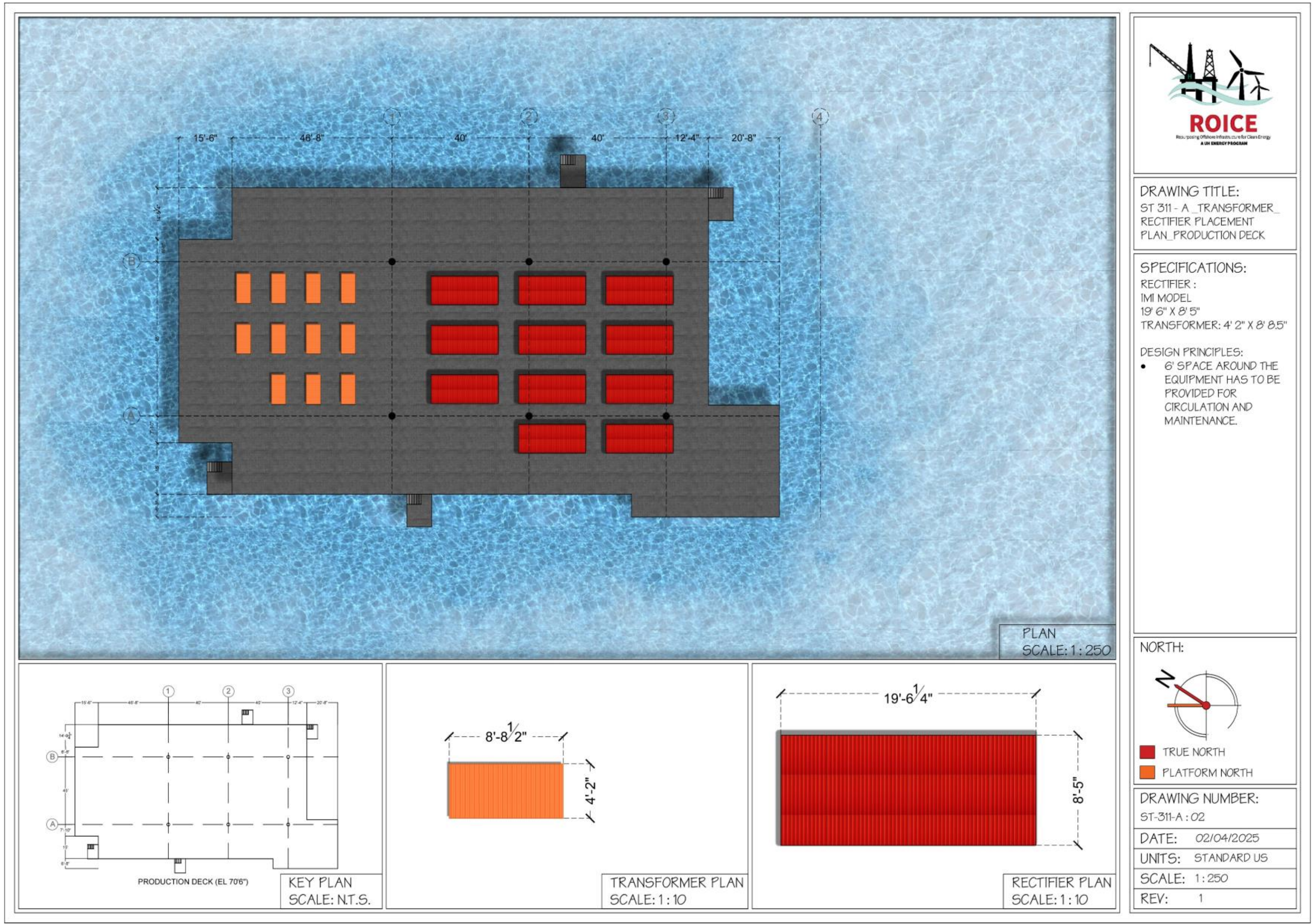
Project Size: 55 MW

Proton Exchange Membrane (PEM) Electrolyser

IMI Critical Engineering

Breakthrough Engineering

ST-311-A: Production Deck Power Supply Layout



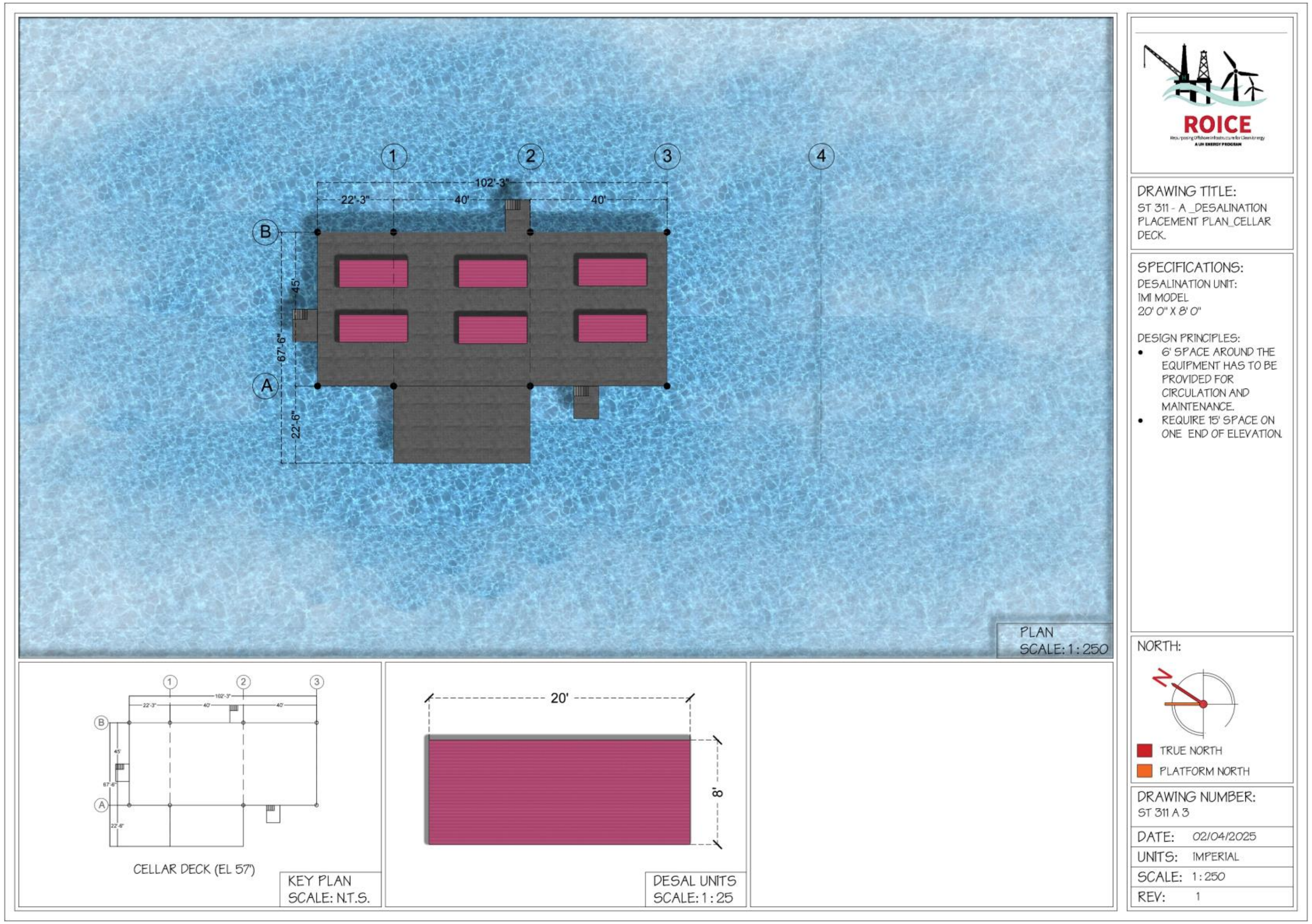
Total:

- 11 X Transformers
- 11 X Rectifiers
- (1:1 ratio with Process Containers)

Note: Power supply for utilities not included

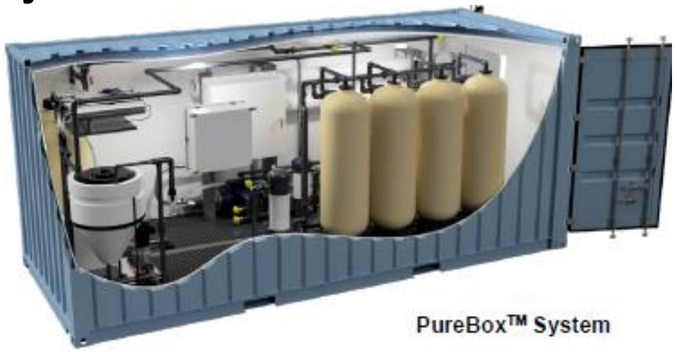
Project Size: 55 MW

ST-311-A: Cellar Seawater Desalination Layout



- 6 x 2,500 L/H desal units
  - 5 provide 100% water demand
  - 1 on rotation for maintenance
- Total working capacity = 12,500 L/Hr
- For maintenance, need to allow 15 ft access space on one end of the container

Project Size: 55 MW

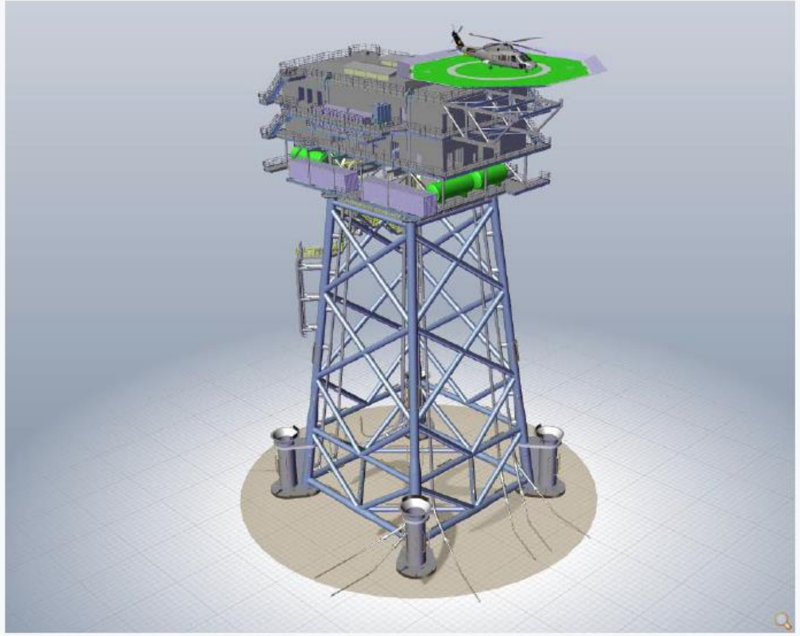


Wind Power Export Projects

- ❑ Power Export projects will require significantly lower footprint than equivalent MW hydrogen export projects
- ➢ Repurposed decks can house larger power projects than hydrogen projects
- ❑ Offshore Power Export Project examples from literature:
  - ❑ 332 MW uses three decks 32 x 16 m (~15 K Sq Ft)*
  - ❑ 400 MW uses three decks 20 x 20 m (~13 K Sq Ft)**
- ➢ Based on size of current power export projects, a 500MW power export project could potentially fit on a West Delta 16 Leg Platform
- ❑ Caveat: Offshore support components may need to be divided into smaller modules for placement on ROICE repurposed platforms

Dimensions:

Topside (L x W x H):	32 x 16 x 18 Meter
Jacket (H):	51 Meter
Water Depths:	28 Meter
Topside Weight:	2,293 tons full operational
Jacket Weight:	1,683 tons excl. piles
Topside Decks:	4 incl. Roof Deck with helicopter landing deck



Courtesy: Nordsee One GmbH

*https://www.nordseeone.com/engineering-construction/offshore-substation.html

**https://www.windpowerengineering.com/making-modern-offshore-substation/

ROICE

Repurposing Offshore Infrastructure for Continued Energy

An academia-industry-government effort
to extend energy-life and maximize commercial value of
abandoned/aging offshore infrastructure

Backup Slides

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Levelized Cost Results

Shallow Water / Near shore locations appear to have the lowest LC for all cases

- New Build or Repurposed, Power or Hydrogen

Repurposing improves the LC by 1 to 10%

In deeper waters (Further away from shore), repurposing can reduce the LC by

- up to 15% for larger scale projects
- up to 40% for smaller scale projects.

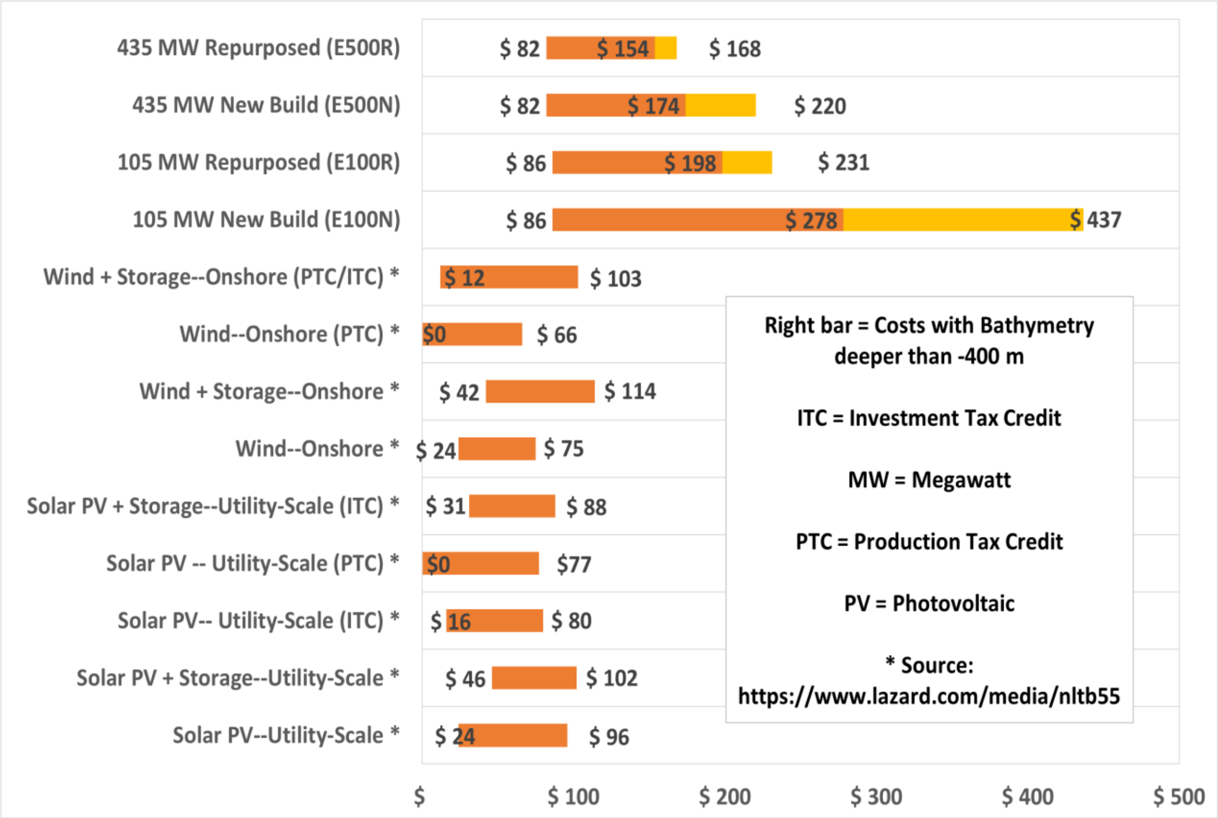
Incremental economics on additional CAPEX for hydrogen generation is likely to be promising, with healthier federal incentives for hydrogen production.*

Unlike power projects, hydrogen projects maintain their economic feasibility in deeper waters and over a range of project sizes.*

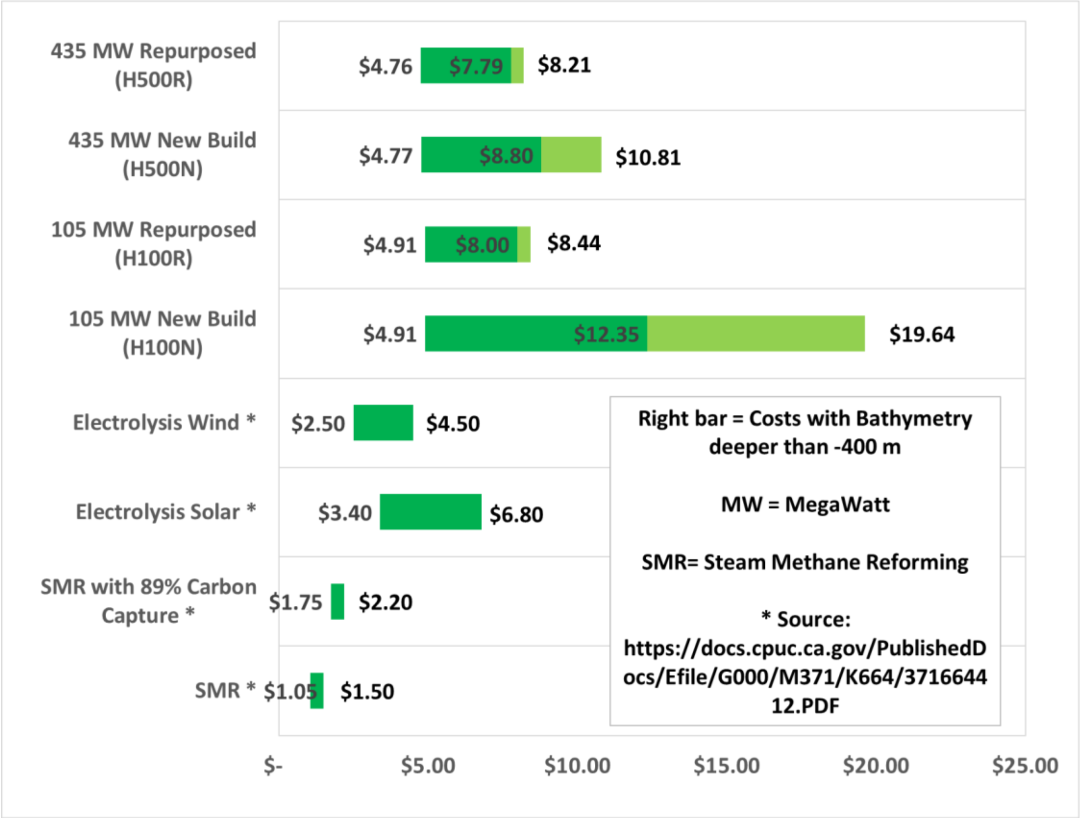
** Later proved to be challenging after more detailed work in Phase 2*

As-Is Case - Economic Challenges

NOTE:
- LC's based on 2023 CAPEX – no cost reduction trends assumed
- No incentive credits applied



LC Comparison for Power Projects



LC Comparison for Hydrogen Projects

Wind Power to Hydrogen Projects

ROICE
Repurposing Offshore Infrastructure for Clean Energy
A UH ENERGY PROGRAM

Project Sizes for Typical Structures from a West Delta Complex

- *5MW IMI Design and 10 MW NEL Design used to estimate footprint*

16 Leg Platform	3300 tons; 90 ft water depth; Main Deck ~ 150 x 130 ft	60 MW (5MW units) – 100 MW (10 MW Units)
12 Leg Platform	3600 tons; 102 ft water depth; Main Deck ~ 135 x 120 ft	60 MW (5MW units) – 100 MW (10 MW Units)
8 Leg Platform A	3000 tons; 143 ft water depth; Main Deck ~ 155 x 65 ft	30 MW (5MW units) – 70 MW (10 MW Units)
8 Leg Platform B	2650 tons; 143 ft water depth; Main Deck ~ 170 x 70 ft	30 MW (5) – 50 MW (10)
8 Leg Platform C	2500 tons; 154 ft water depth; Main Deck ~ 170 x 70 ft	30 MW (5) – 50 MW (10)

Pathways to larger H2 Projects
- Subsea hydrogen gen
- Adding decks and footprint
- Efficient footprint designs
- Stick build design

- *Hydrogen projects likely limited to max 100 MW per platform; multiple platforms needed for larger projects*

ROICE Phase 2 – CAPEX Refinement

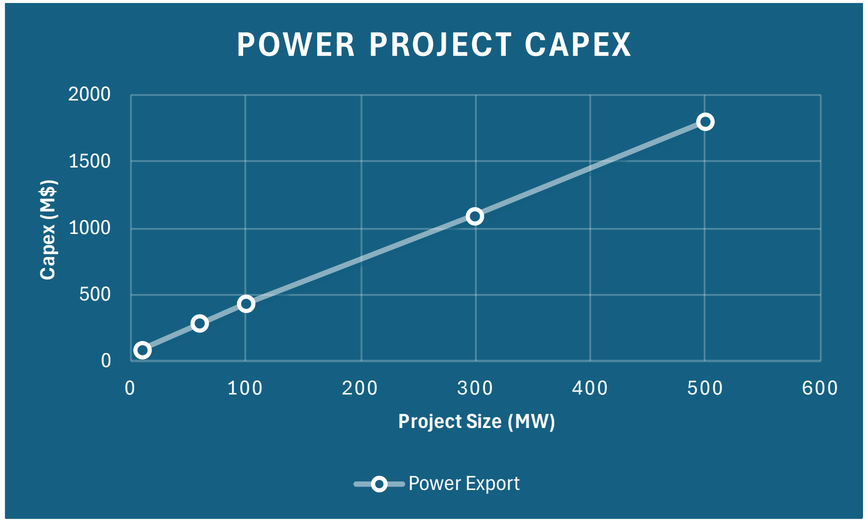
ROICE Cost Estimator

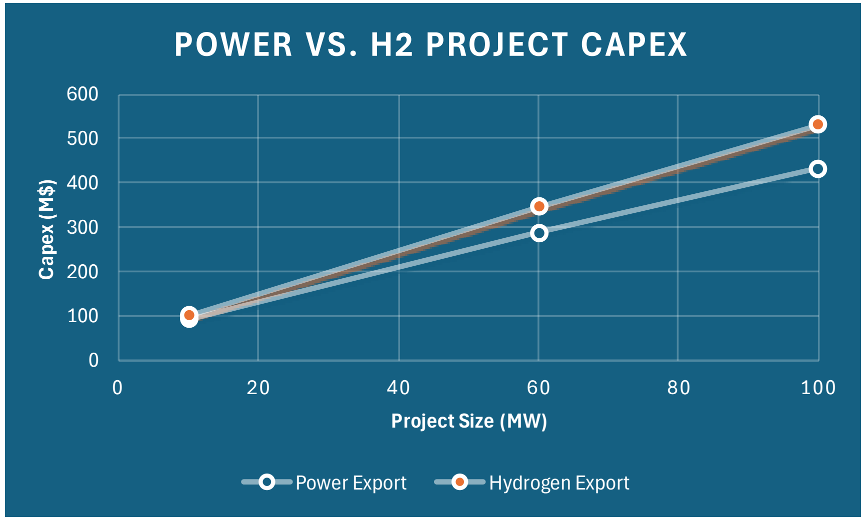
- CAPEX estimates refinements built into ROICE Cost Estimator; also models power and hydrogen generation
- Major CAPEX components for key project cases shown below
- Existing pipelines assumed to be repurposed for low pressure (<30 bar) hydrogen transport to shore; onshore compression costs included
- Pre-ROICE Decommissioning costs ~10% of ROICE project capex for small projects and 1 to 3% for larger projects

CAPEX PARAMETERS $K	10 MW H	60 MW H	10 MW E	60 MW E	500 MW E
Fixed Project Development Cost	$ 8,640	$ 51,840	$ 8,640	$ 51,840	$ 432,000
WTG Costs	$ 31,401	$ 160,624	$ 31,401	$ 160,624	$ 1,125,900
Foundations & Installation	$ 9,146	$ 15,097	$ 10,721	$ 15,860	$ 67,457
Cable Cost	$ 220	$ 786	$ 28,670	$ 29,243	$ 35,382
Onshore Substation	$ -	$ -	$ 1,430	$ 6,073	$ 46,929
Offshore Substation Topside	$ -	$ -	$ 2,861	$ 12,146	$ 93,857
Hydrogen Production	$ 16,079	$ 80,872	$ -	$ -	$ -
Repousrposing Pipelines for H2	$ 26,194	$ 26,194	$ -	$ -	$ -
Pre-ROICE Decommissioning	$ 7,625	$ 11,150	$ 7,625	$ 11,150	$ 11,150
Total	$ 99,306	$ 346,563	$ 91,349	$ 286,937	$ 1,812,676
OPEX PARAMETERS					
Power OPEX ($/year)	$ 1,164	$ 6,981	$ 1,164	$ 6,981	$ 58,175
H2 OPEX ($/year)	$ 1,152	$ 6,864	$ -	$ -	$ -

Nomenclature: [Project Capacity] MW [Primary Export]
*Only array cable cost included for Hydrogen projects

ROICE Project Capex Estimation





Hydrogen projects only require 10 to 20% additional CAPEX over equivalent power export projects

- Projects further from shore may even see capex reductions

AVP from ROICE projects more than sufficient to cover pre- and post-ROICE decommissioning

- Example: For a 60 MW Project with Incentive Offtake Pricing, AVP is 2 to 30 times decommissioning costs

ST-311-A: Deck Loading Calculations

Drilling Deck:

- **20% of area and capacity** set aside for accommodation, stores, balance of plant
- Additional deck above drilling deck: Install a lightweight deck to accommodate an additional 11 process containers
- Redesign process container cooling system – 1 cooler per 1 upper and 1 lower deck

Production Deck

- Revise transformer & rectifier designs to be more space efficient – we may be space (not weight) constrained if doubling H_2 production capacity

Cellar Deck

- Would may to keep conductor bay area clear if this space is used by seawater lift pumps

Deck Capacity Summary (US Tons)			
Deck	**Allowable**	**Calculated**	**Percent**
Drilling	2,431	454	19%
Production	1,416	170	12%
Cellar	500	24	5%
TOTAL	**4,347**	**648**	**15%**