ASEAN DATA SCIENCE EXPLORERS

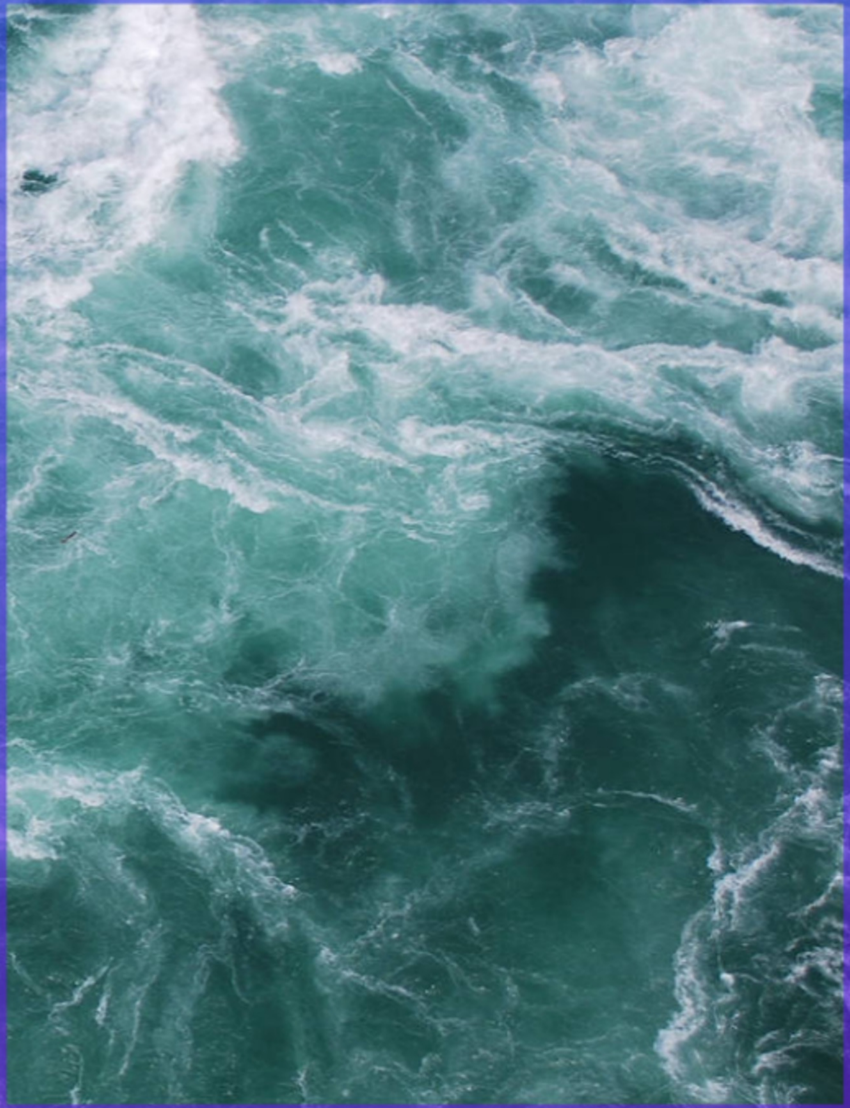
Carbonwave

Leveraging the Interplay between Ocean Acidification and Energy Insecurity for Sustainable Blue Economy Development

Team: aSAP

Country: Vietnam
Institution: VinUniversity
Members:
Le Trung Kien
Cao Van Truong

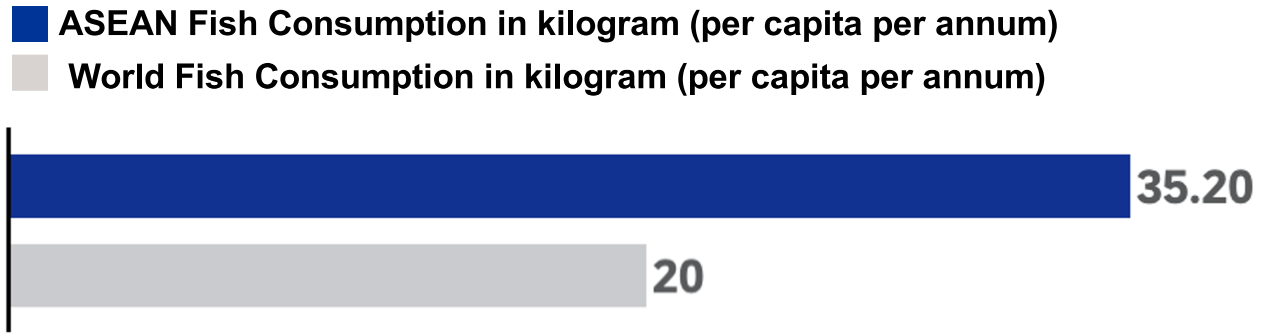
3 GOOD HEALTH AND WELL-BEING
11 SUSTAINABLE CITIES AND COMMUNITIES
13 CLIMATE ACTION



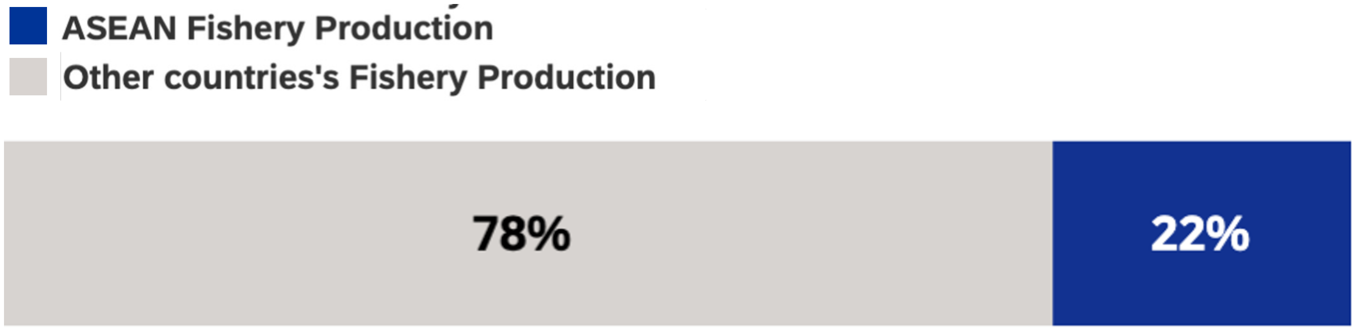
Do you like fish?

Do you like fish?

BLUE ECONOMY AS A KEY PILLAR IN ASEAN ECONOMY



ASEAN fish consumption almost doubles the world's fish consumption per capita.



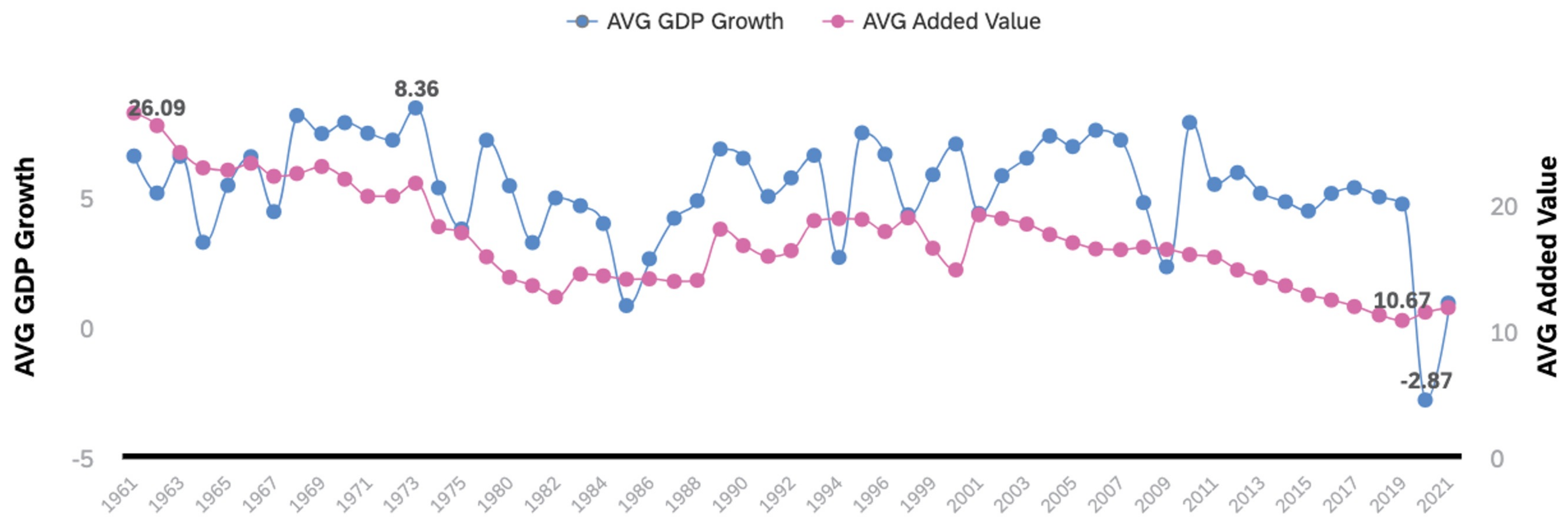
ASEAN Member States accounted for nearly **22% of the global fishery production**

Source: Randhawa (2024), ASEAN (2023), Chan et al. (2017), and Setiawan et al. (2022)

Do you like fish?

BLUE ECONOMY AS A KEY PILLAR IN ASEAN ECONOMY

Aquaculture and Fishery Added-Value correlates with the GDP Growth of ASEAN countries



ASEAN Blue Economy

accounts for approx.

30%

of the **ASEAN** GDP

Source: Randhawa (2024), ASEAN (2023), Chan et al. (2017), and Setiawan et al. (2022)

Southeast Asia Holds 34% of the World's Coral Reef Ecosystem

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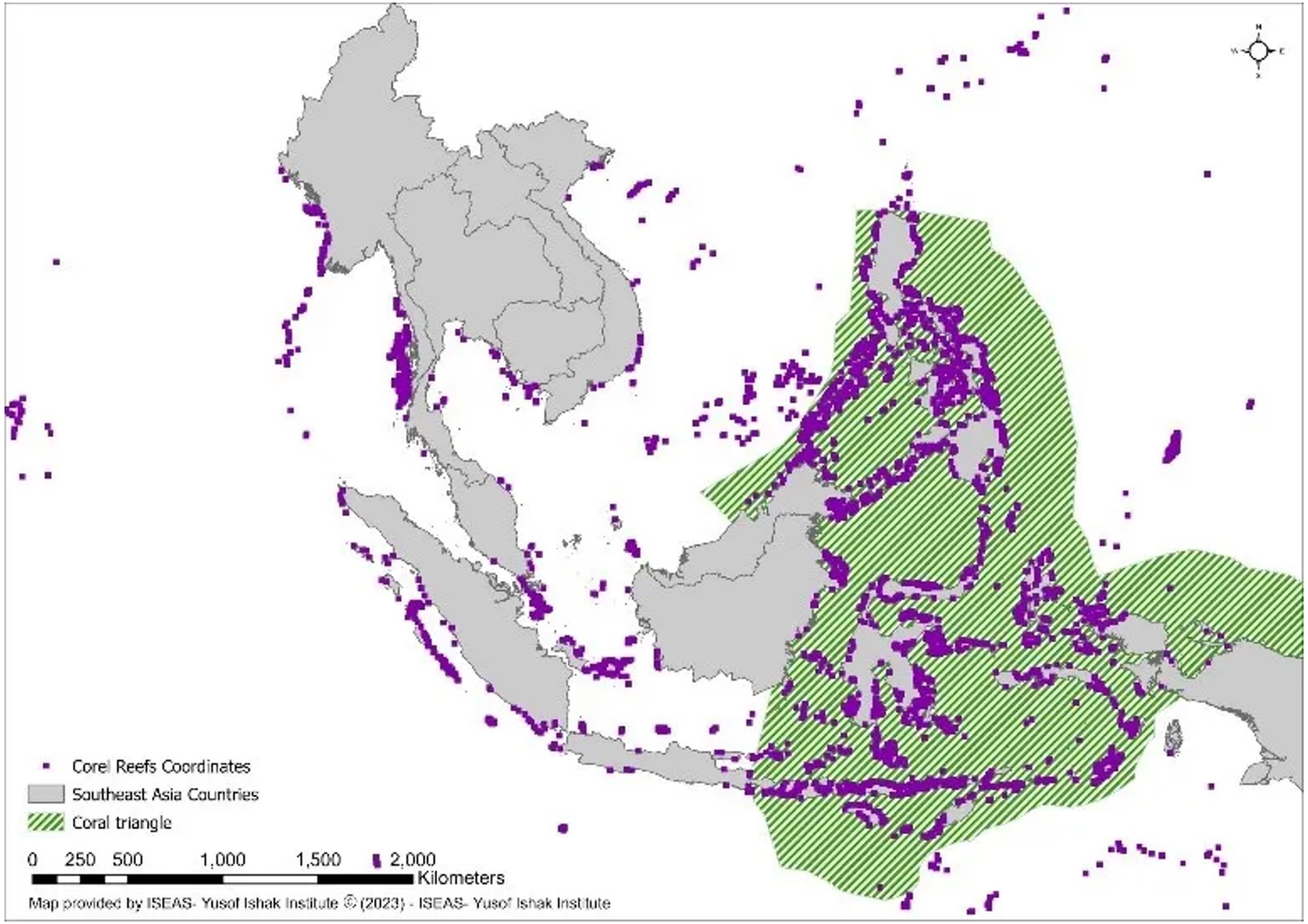


accounts for approx.

76%

of the world's coral species

6 AMS

houses **the coral triangle**,

which **has more coral reef biodiversity than anywhere else in the world.**

Source: WWF (n.d.)

However, things are getting worse.

Ticking-Time Bomb

OCEAN ACIDIFICATION POSING THREATS TO MARINE BIODIVERSITY

Ocean absorbs about 30 percent of the CO2 that is released in the atmosphere

Air

CO_2 CO_2

CO2 absorbed from the atmosphere

Sea Water

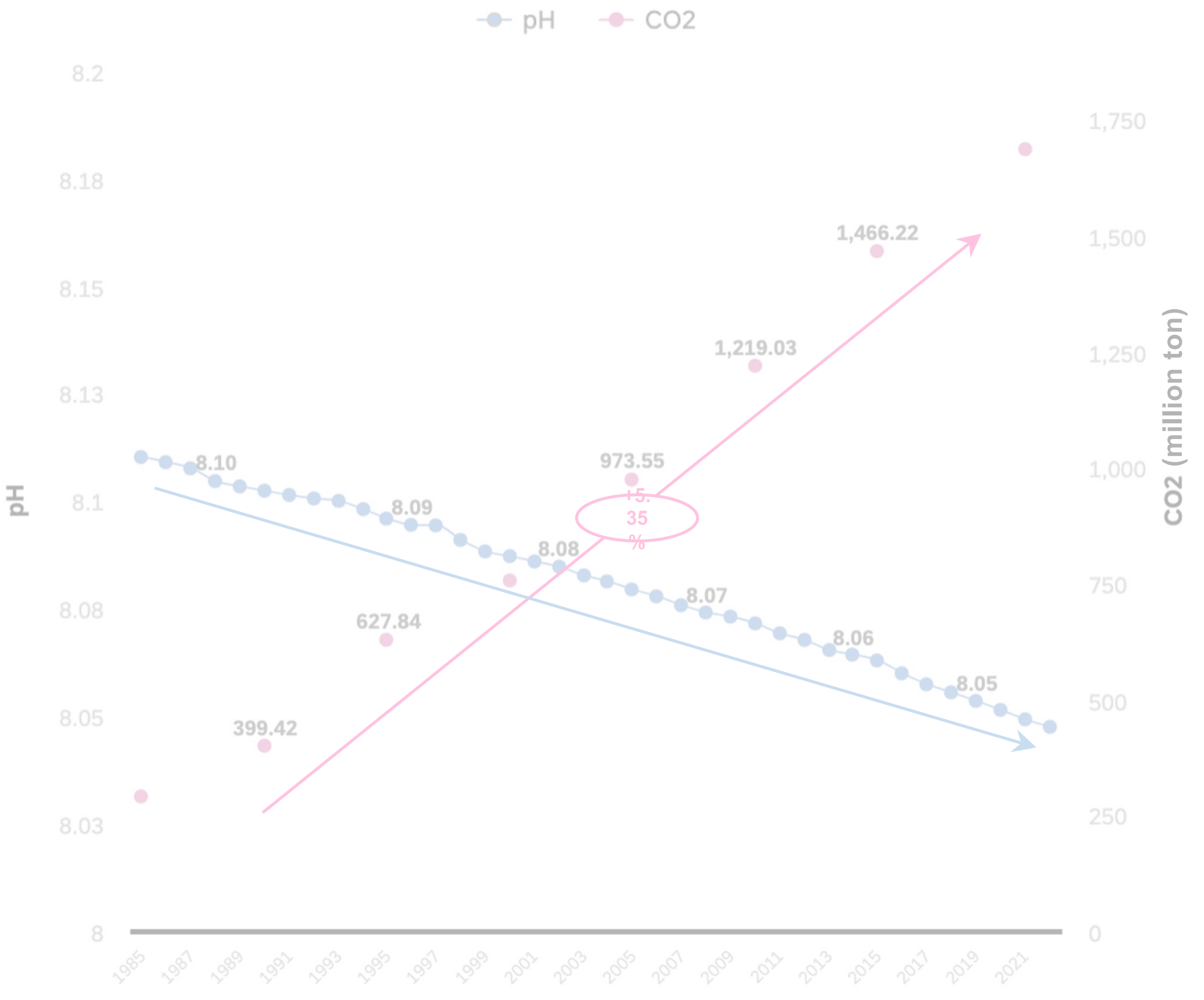
$CO_2 + H_2O + CO_3^{2-} \rightarrow 2HCO_3^-$

By 2100, ocean pH could decline to **7.6 - 7.7**
which equals to **30% increase in acidity**

Biodiversity Loss due to Ocean Acidification

Coral Reefs Dying	Molluscs	Echinoderms
-32% calcification -47% abundance	-40% calcification -34% survival	-10% growth -11% development

As of 2024, CO2 emitted in atmosphere has increased fivefold, causing the ocean to become more significantly acidic.



Source: Thomas & Davis (2021), CoastalAdapt (2017), NOAA (n.d.), NOAA (2024), and Setiawan et al. (2022)

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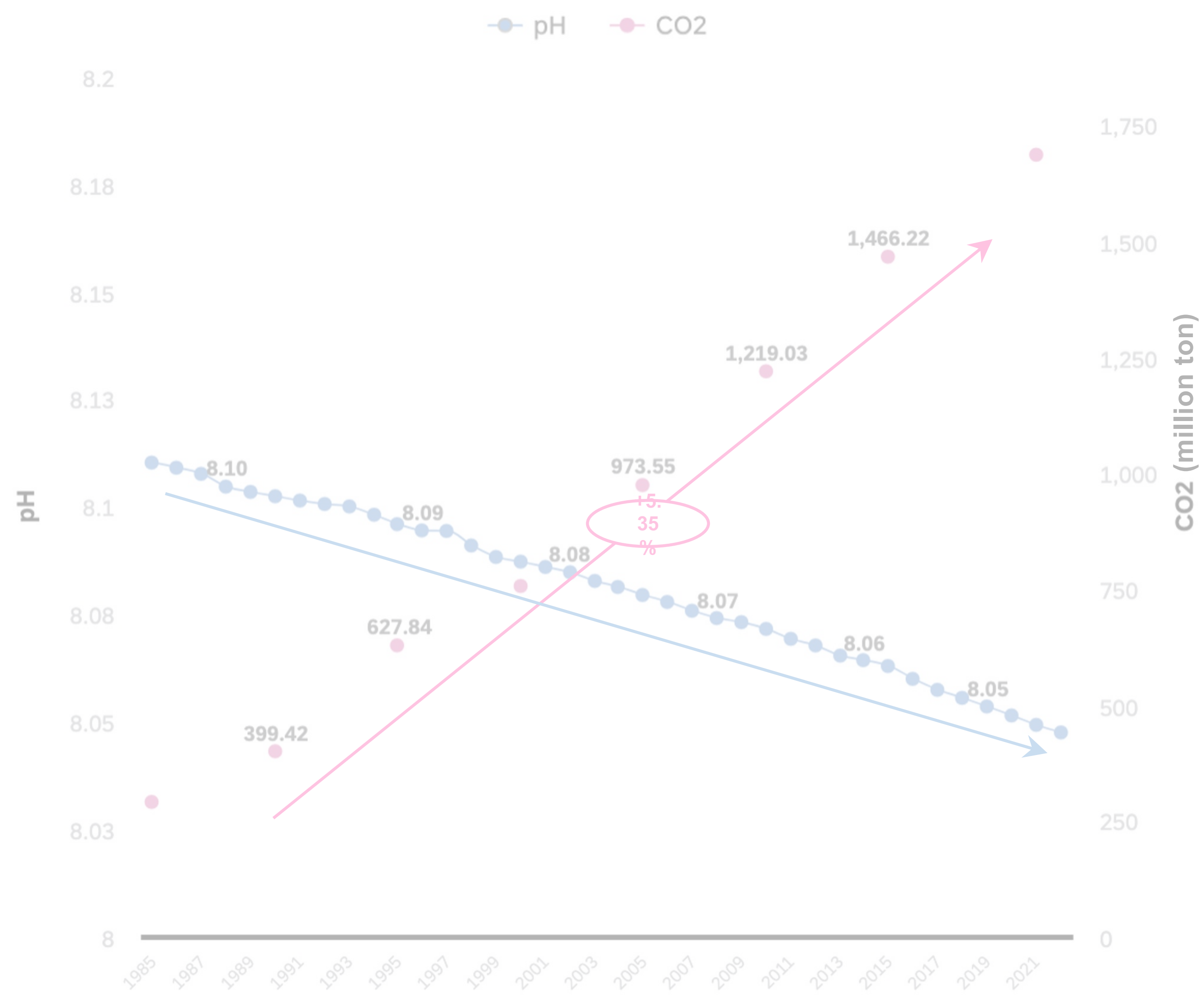

Source: *Thomas & Davis (2021), CoastalAdapt (2017), NOAA (n.d.), NOAA (2024), and Setiawan et al. (2022)*

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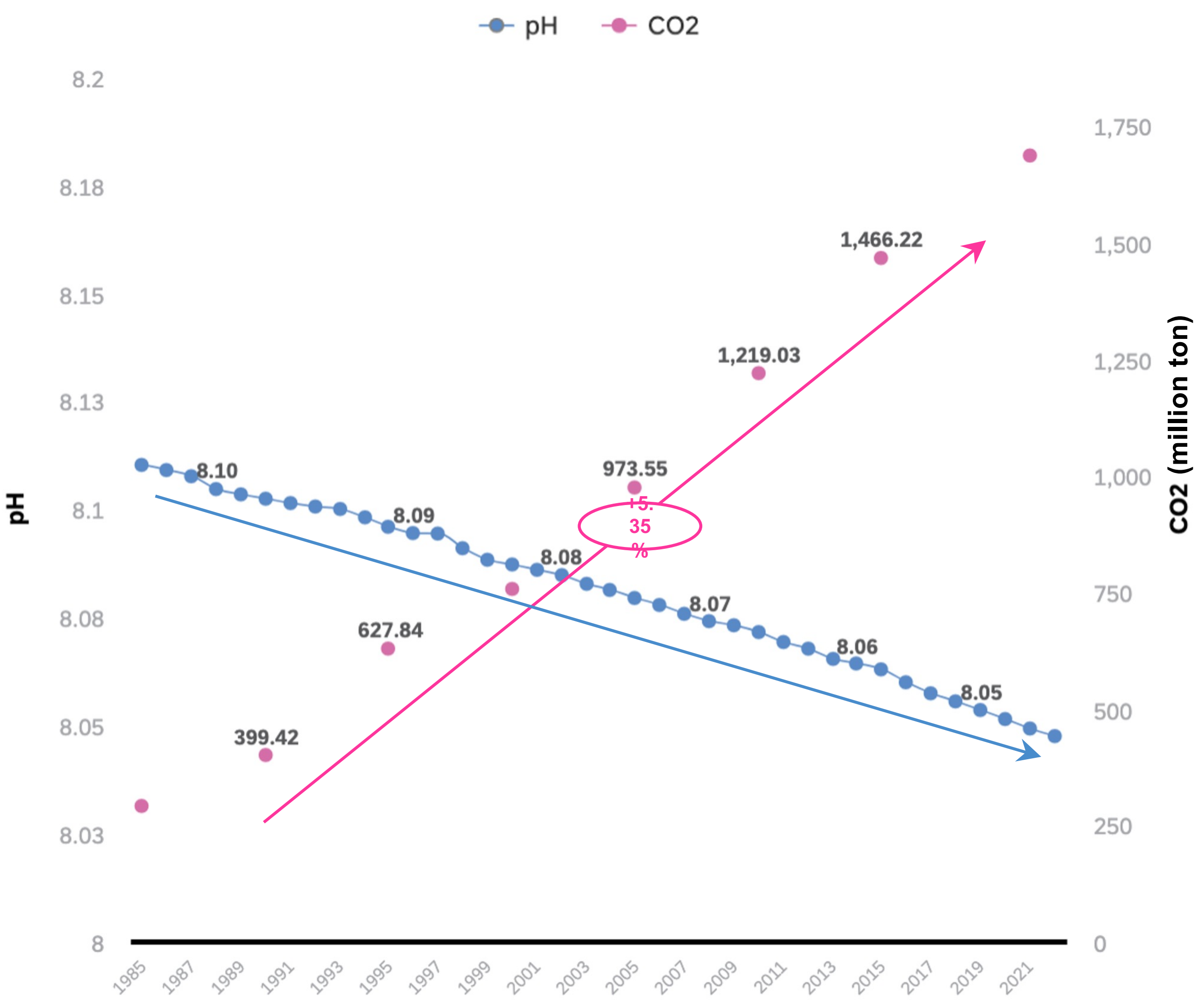

Source: Thomas & Davis (2021), CoastalAdapt (2017), NOAA (n.d.), NOAA (2024), and Setiawan et al. (2022)

That's not all.

An Under-the-Radar Threat

A CLOSER LOOK AT OCEAN ACIDIFICATION IN ASEAN

The US

NOAA OCEAN ACIDIFICATION PROGRAM

A Complete Dataset
Ocean Carbon and Acidification Data System (OCADS)

European

Copernicus Europe's eyes on Earth

Copernicus Marine Service

European Commission

246 Dataset
European Marine Observation and Data Network (EMODnet)

An Under-the-Radar Threat

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ASEAN

?

An Under-the-Radar Threat

IN NEED OF PUBLIC & TRACEABLE REGIONAL DATASET

The US

NOAA OCEAN ACIDIFICATION PROGRAM

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ASEAN

0 dataset

If the problem is just CO_2, let's CAPTURE it!

Current Response

AMS STARTED PAYING ATTENTION TO CARBON CAPTURE TECHNOLOGY

From **National** to **Regional Commitment**

	Indonesia	Malaysia	Thailand	Vietnam
International Climate Change Commitment	√	√	√	√
Net Zero Target	√	√	√	√
Party to the London Protocol	×	×	×	×
CCS-specific domestic policies or incentives	√	√	√	×
CCS project(s) proposed/in development	√	√	√	×
CCS specific legal and regulatory framework	√	√ (one state)	×	×
Existing legislation applicable to CCS operations	√	√	√	√

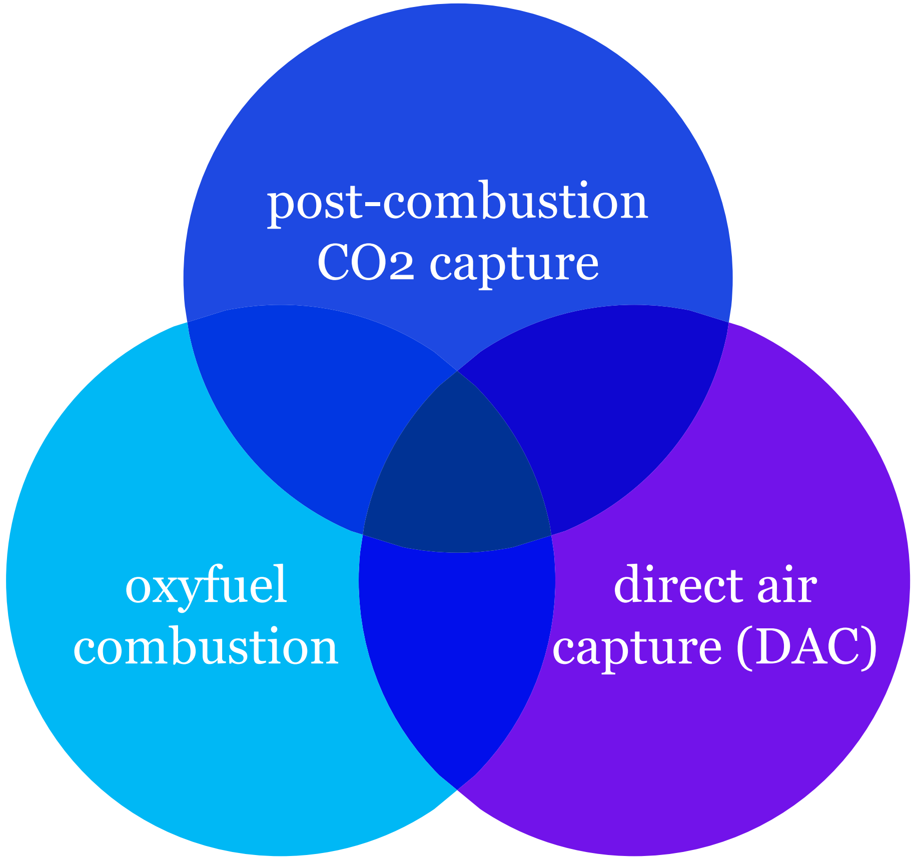
With established **policies** and **facilities**

ASEAN is ready for Carbon Capture & Storage Technology (CCS)

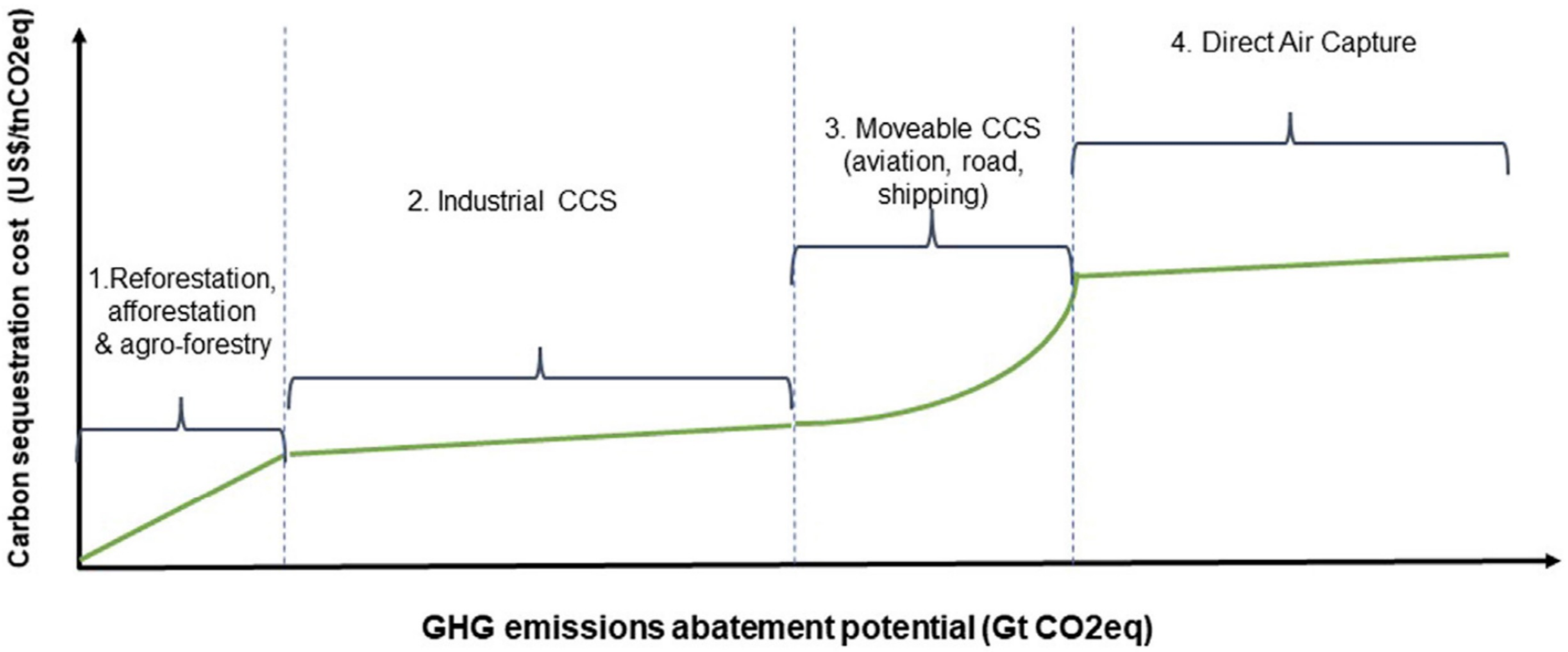
Source: ASEAN Centre for Energy (2024)

First Step of Bomb Defuse

CARBON CAPTURE SOLUTION REVIEW



key technologies
to reduce CO2 emissions



Source: Wu et al., 2024

First Step of Bomb Defuse

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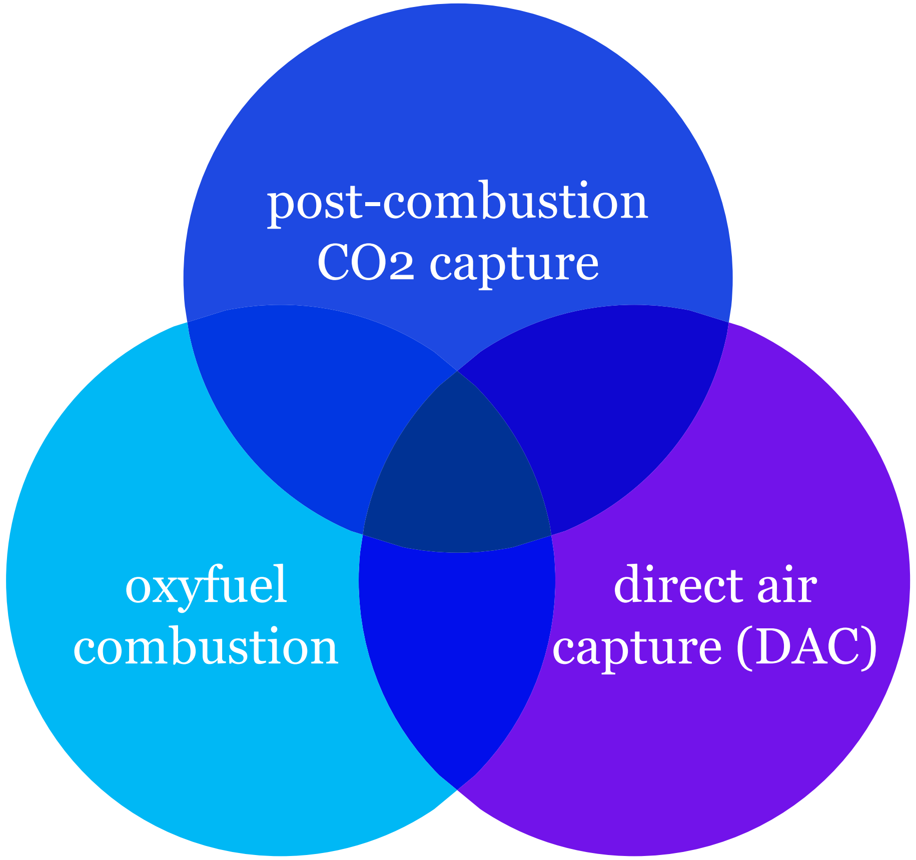

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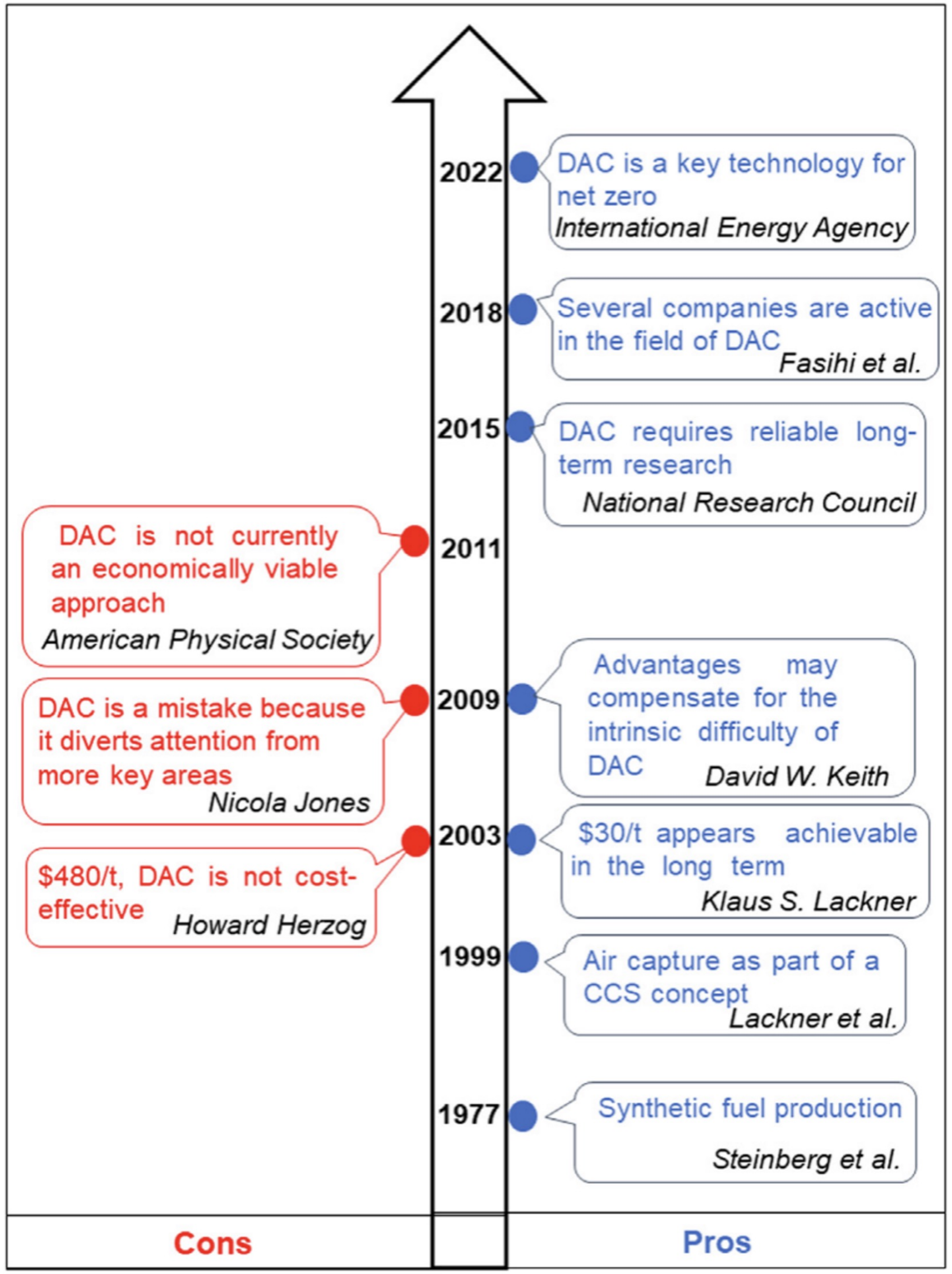
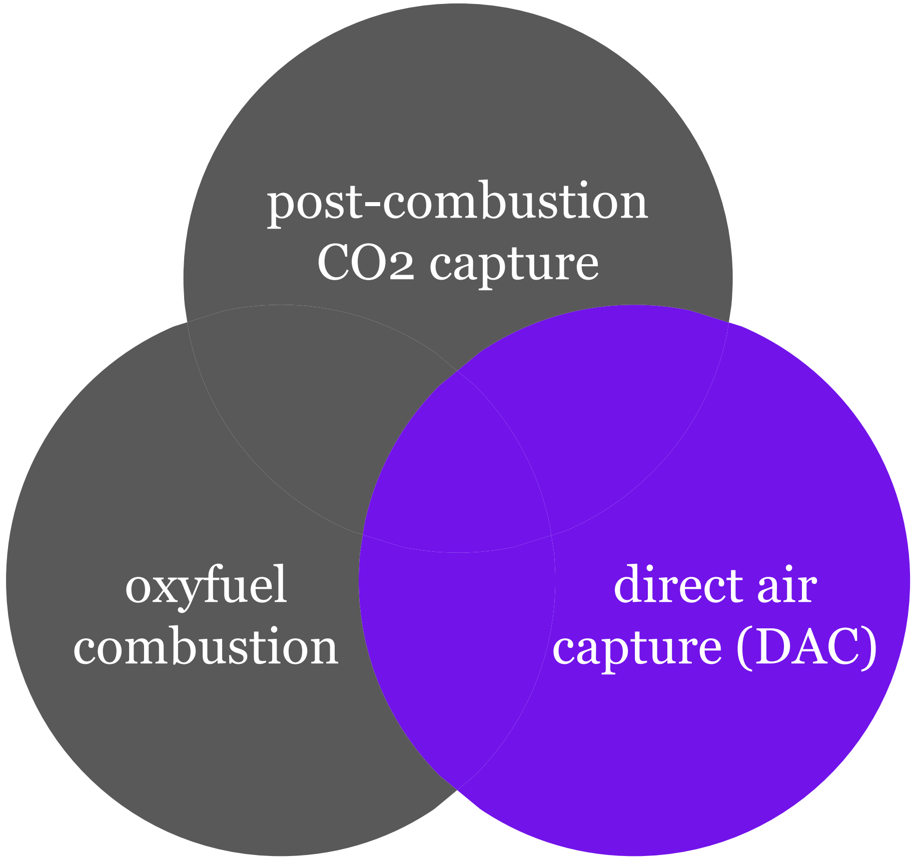


Controversy
of DAC development

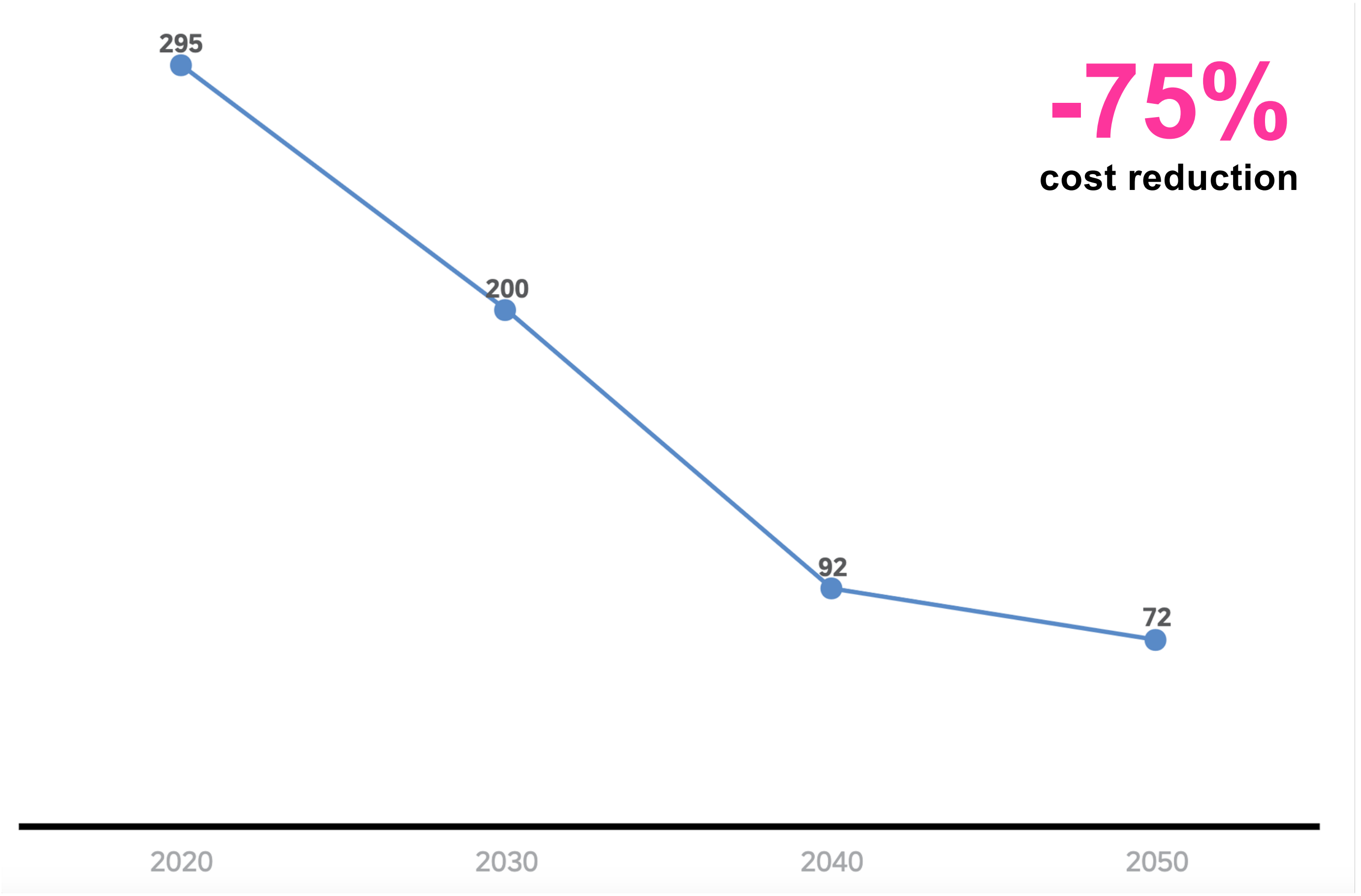
Source: Wu et al., 2024

First Step of Bomb Defuse

CARBON CAPTURE SOLUTION REVIEW



DAC as
the highest potential solution



The DAC CO2 capture costs
is expected to reduced significantly

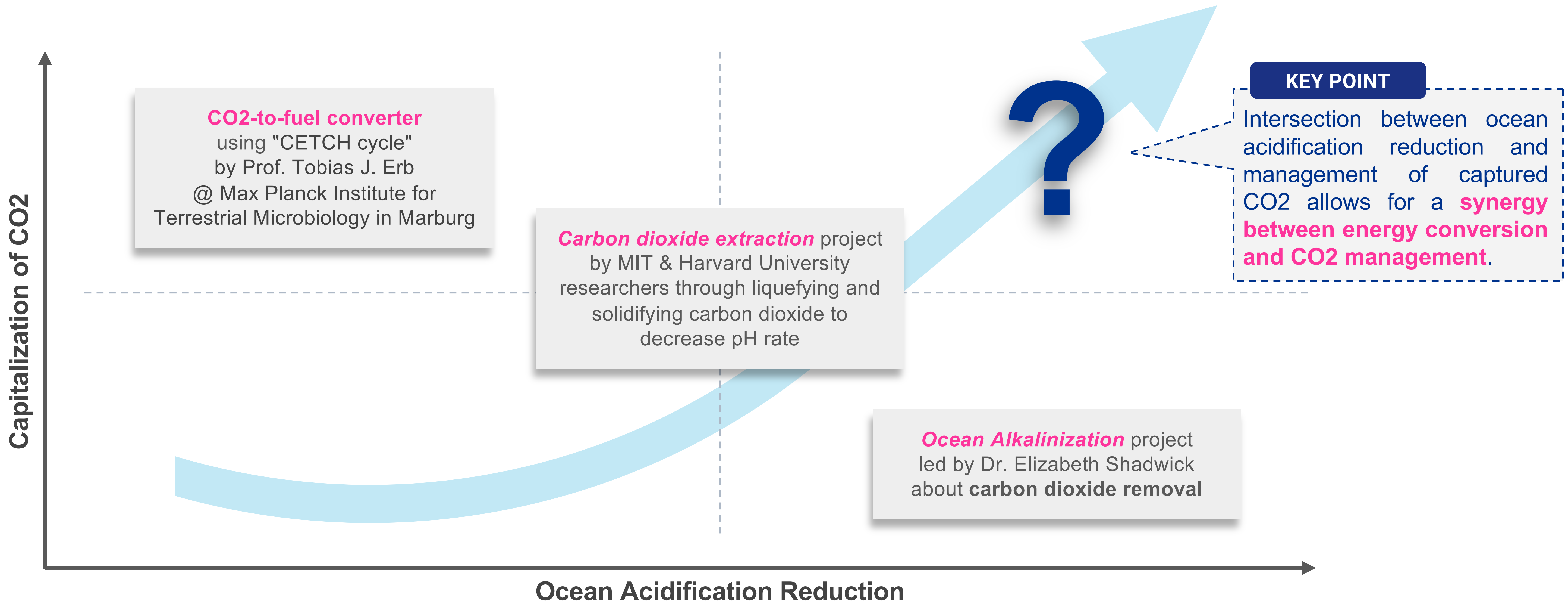
Source: Wu et al., 2024

After being captured and stored, what's next?

Setting the Stepping Stones

CURRENT ADAPTIVE MEASURES FOR CO2 MANAGEMENT

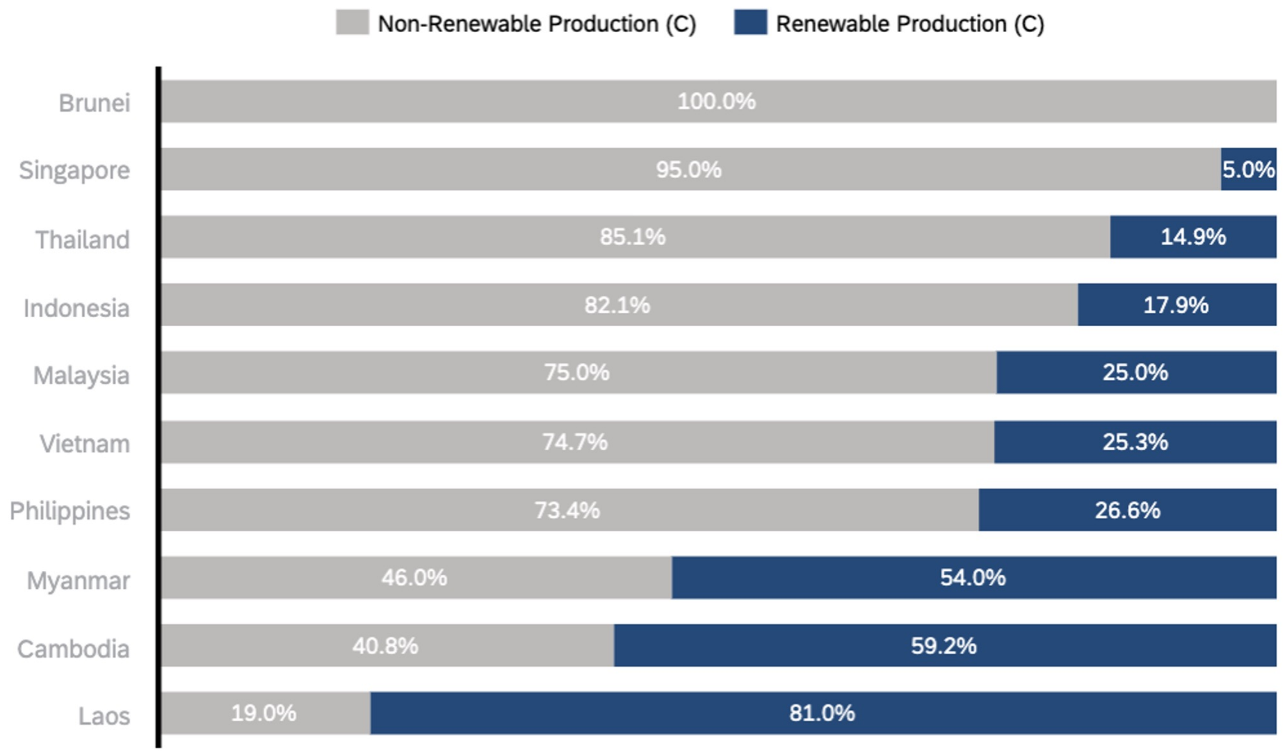
There are many existing practices with a mission to tackle the root cause of ocean acidification through capturing CO_2. However, efficient management of captured CO_2 remains a significant challenge.

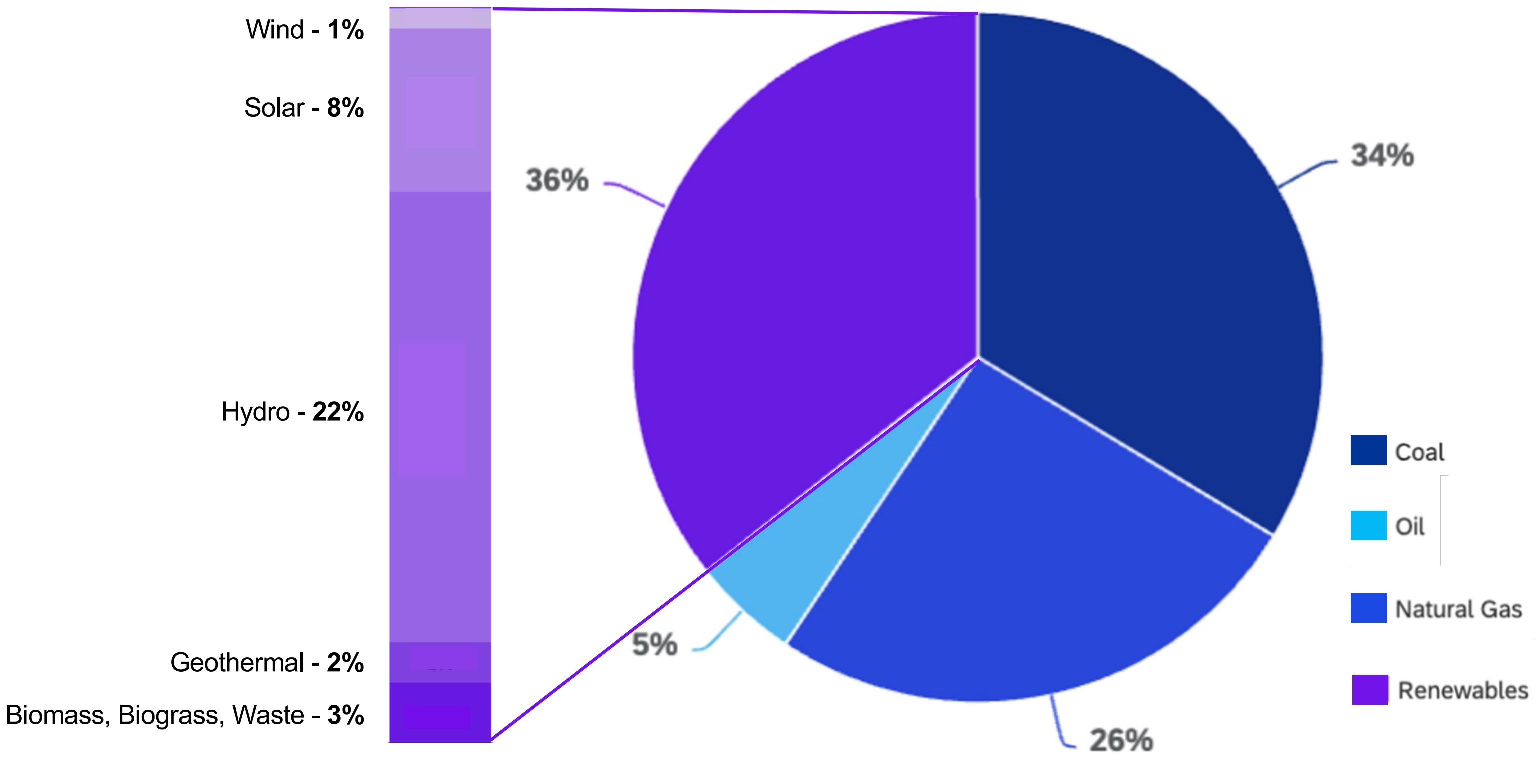


Source: Merck Group (2022), MIT News (2023), and Schmidt (2023)

Double-Impact Initiatives

PROMISES TO MITIGATE THE OVER-RELIANCE ON NON-RENEWABLES OF ASEAN





7/10 AMS are still overly dependent on non-renewable energy

By 2050, **coal and natural gas** is predicted to account for **60%** of total energy production.

Source: ASEAN (2022)

After having renewable energy,
we care for the underserved community.

ASEAN Energy Landscape on Islands

ENERGY INDEPENDENCE ON ISLAND: A SUSTAINABLE FUTURE

Current electricity insecurity on islands requires alternatives to reduce reliance on diesel fuel and mitigate strain on vulnerable connections to national grids.

THE NUMBERS THAT SPEAK

SABAH ISLAND

85,200 rural people are without grid electricity in Sabah

PANAY ISLAND

P1.5$ billion in economic losses on the third day of electricity blackout due to power crisis

CON DAO ISLAND

Only 9 diesel generators serves as major energy source, costing **174 billion VND** per year (2022)

BEST PRACTICES

1. **Renewable Energy for Self-Sustainable Island Communities (REACT)**
   - Achievements: (1) Energy Independence & (2) Energy Transition
   - Methods: Utilizing local renewable energy sources
2. **H2RES Model, tested in Porto Santo island**
   - Achievements: Fuel Cell from 35% - 55% efficiency
   - Methods: Construct an energy storage system by optimizing renewable resources structure and planning

KEY POINT

To resolve electricity insecurity, ASEAN islands require a structured energy strategy focused on achieving both energy independence and transitioning to sustainable sources.

Source: Kinabalu (2022), GMA Regional TV News (2024), Huong (2023), Marins et al. (2009), and Barney (2024)

Our Answer

HOW CAN ENERGY SUPPLEMENT OCEAN ACIDIFICATION?

Situation

Blue economy contributes to **30%** of ASEAN economic development, while the worsening of **ocean acidification** is threatening the **livelihood of marine species and coastline residents**.

Complication

Challenge

- Threats to marine ecosystems posed by ocean acidification
- Lack of effective carbon dioxide control

+

Opportunity

Room for **energy innovation** due to energy insecurity in coastline areas

Question

How can we effectively **manage ocean acidification** by capitalizing on **energy security** in coastal areas?

Answer

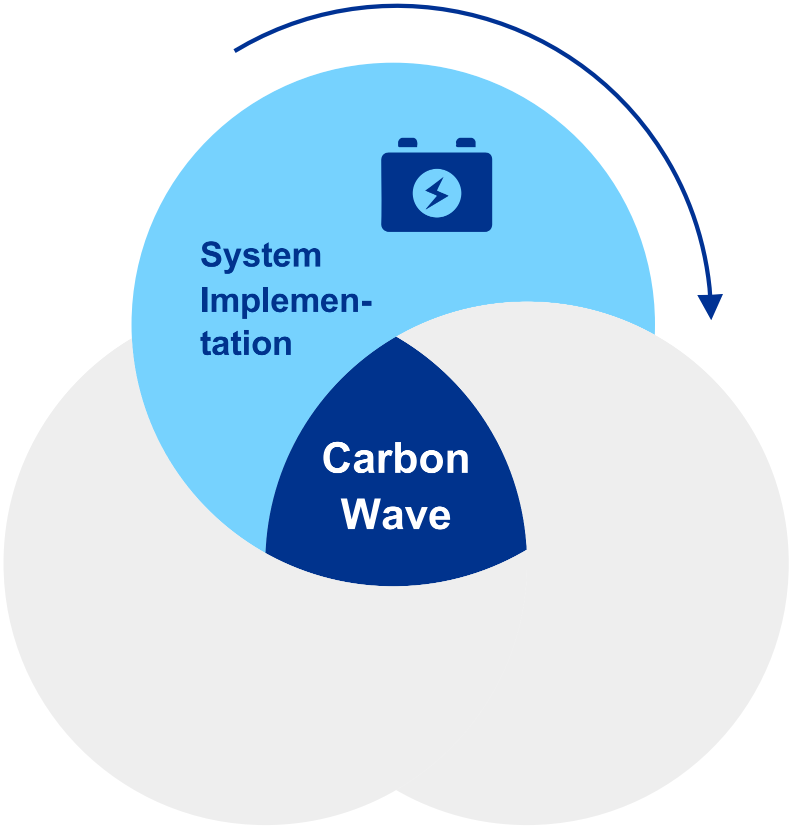
Integrate Carbon Capture System with Coastal Energy Infrastructure to:

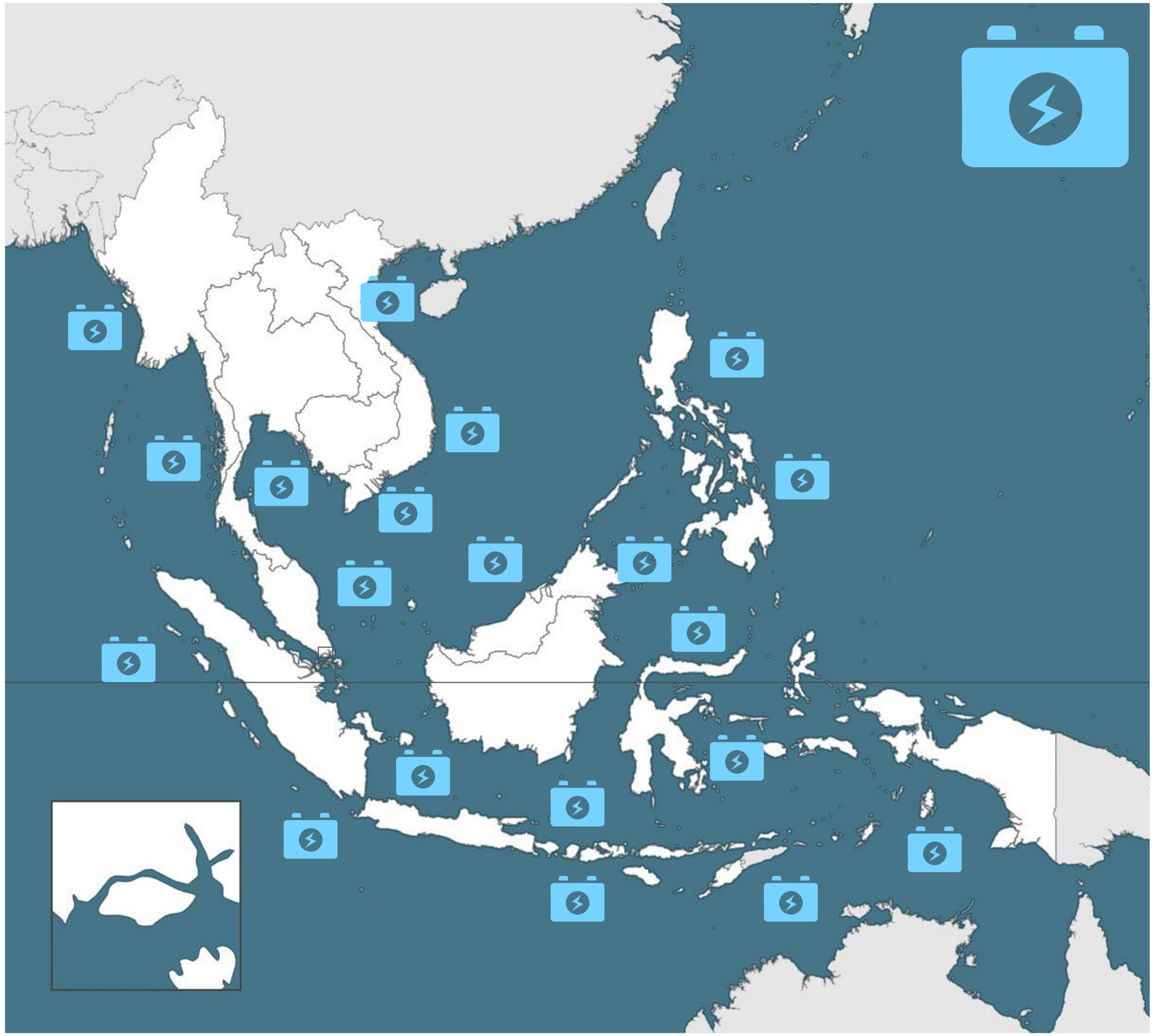
(1)Mitigate ocean acidification and its threats to marine ecosystems

(2)Solve the energy insecurity without the exorbitant cost of transmission

Our Answer

DOUBLE IMPACT - TRIPLE SOLUTIONS



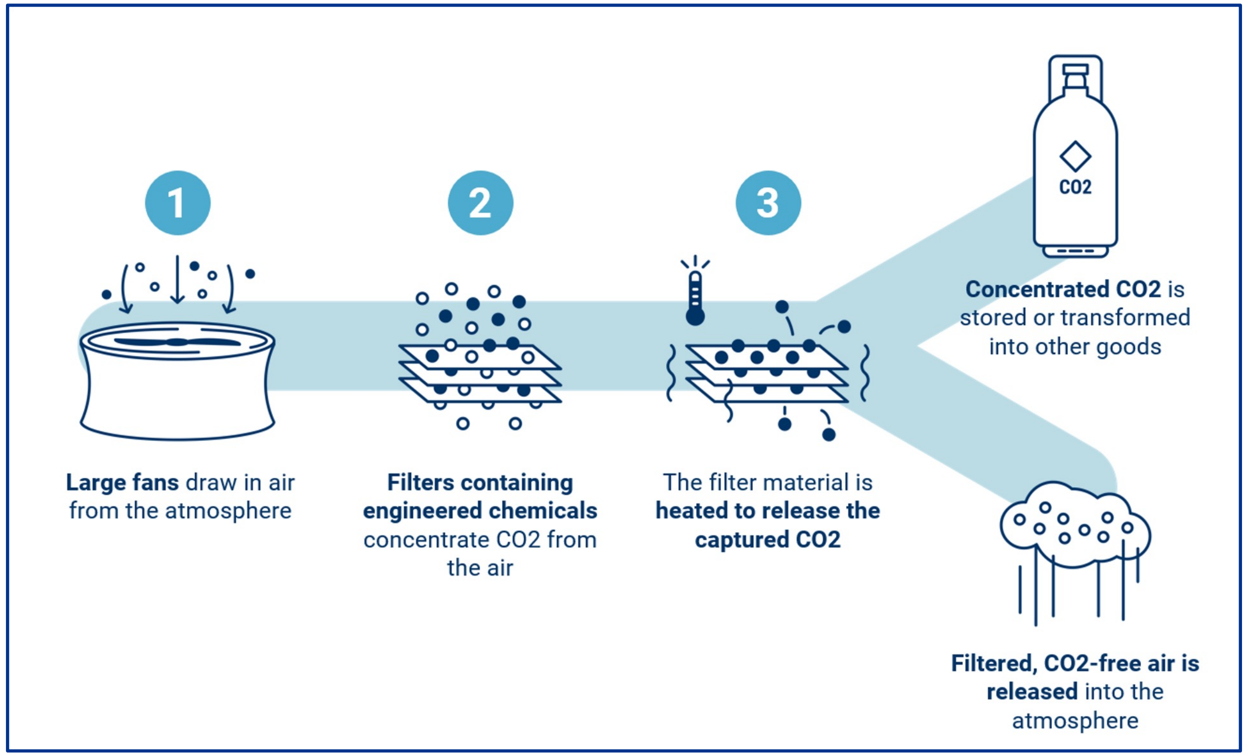


Our Answer

DOUBLE IMPACT - TRIPLE SOLUTIONS

HIF

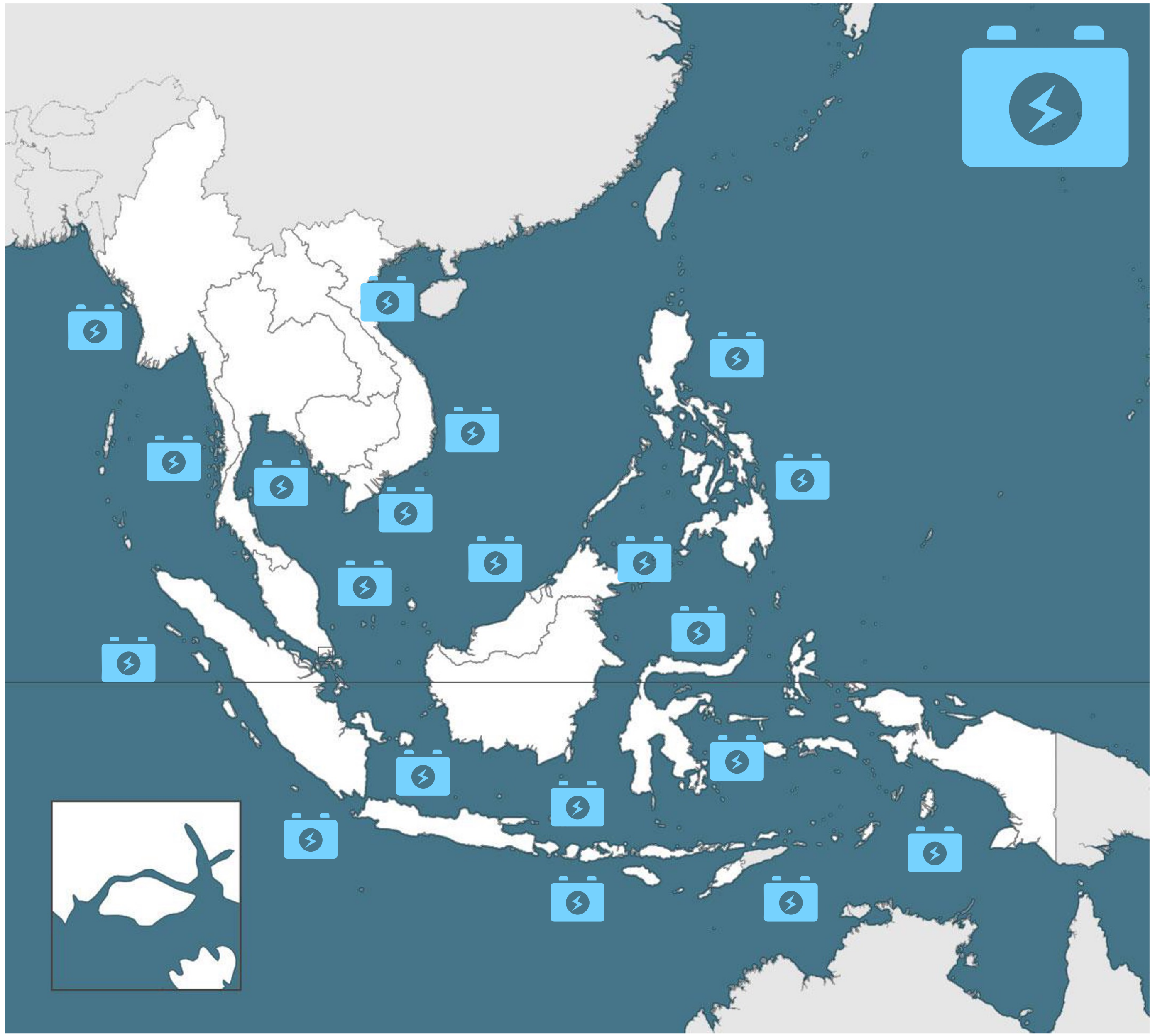
Great Carbon Valley



1POINTFIVE

CAPTUREPOINT

CARBONVERT



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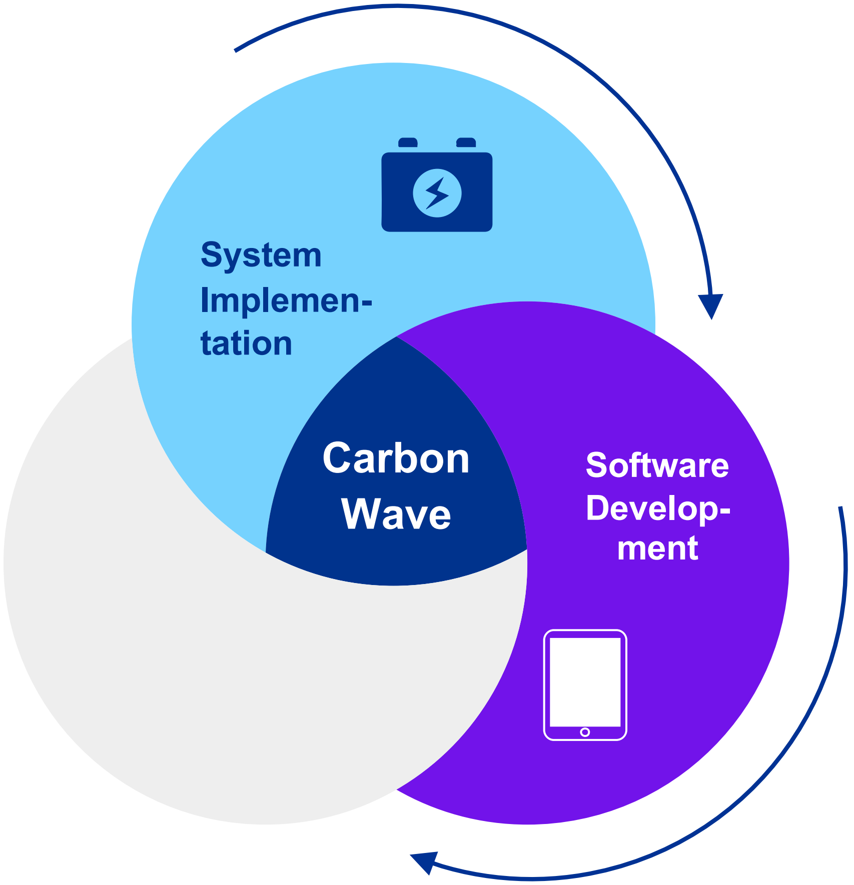

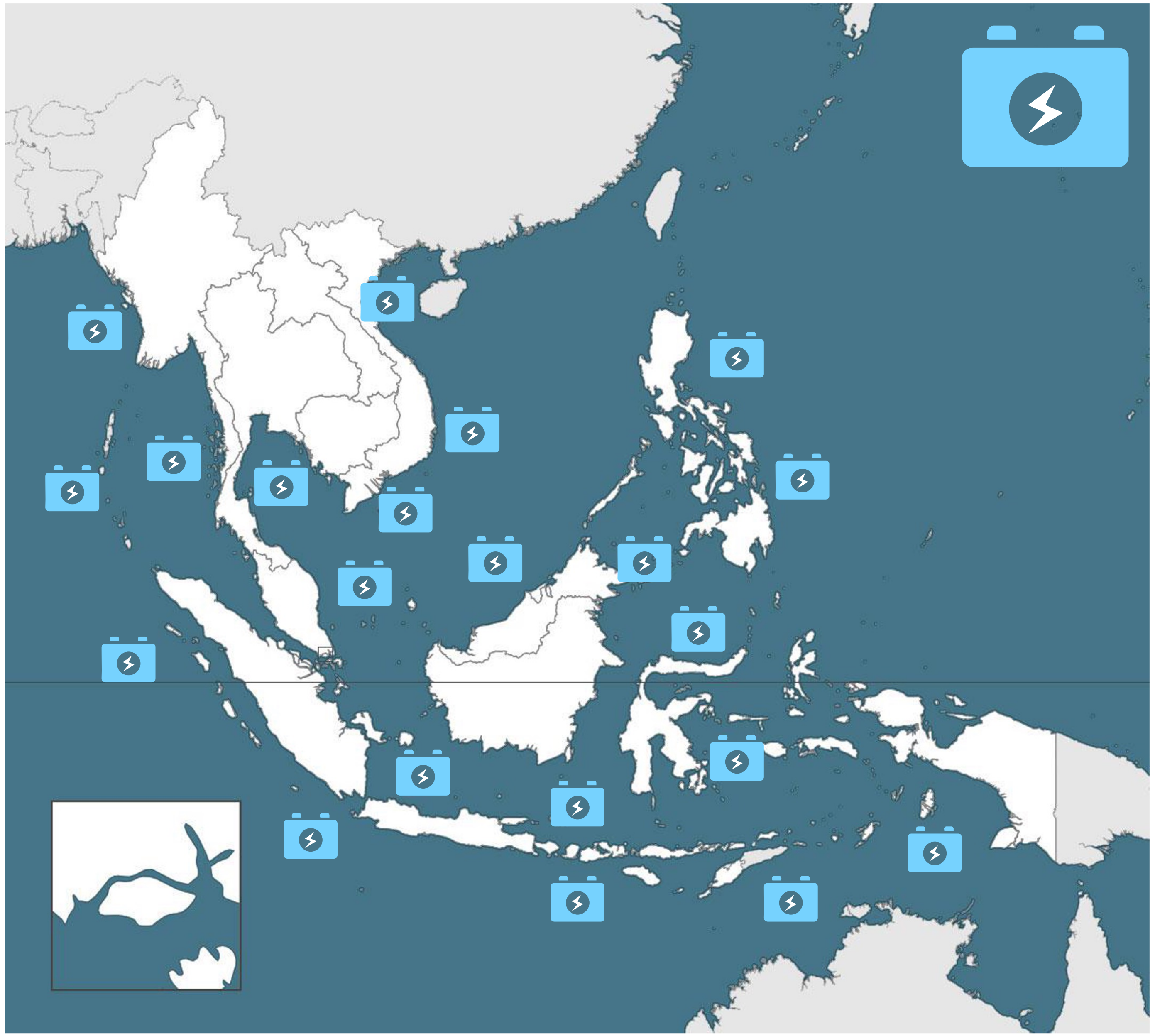

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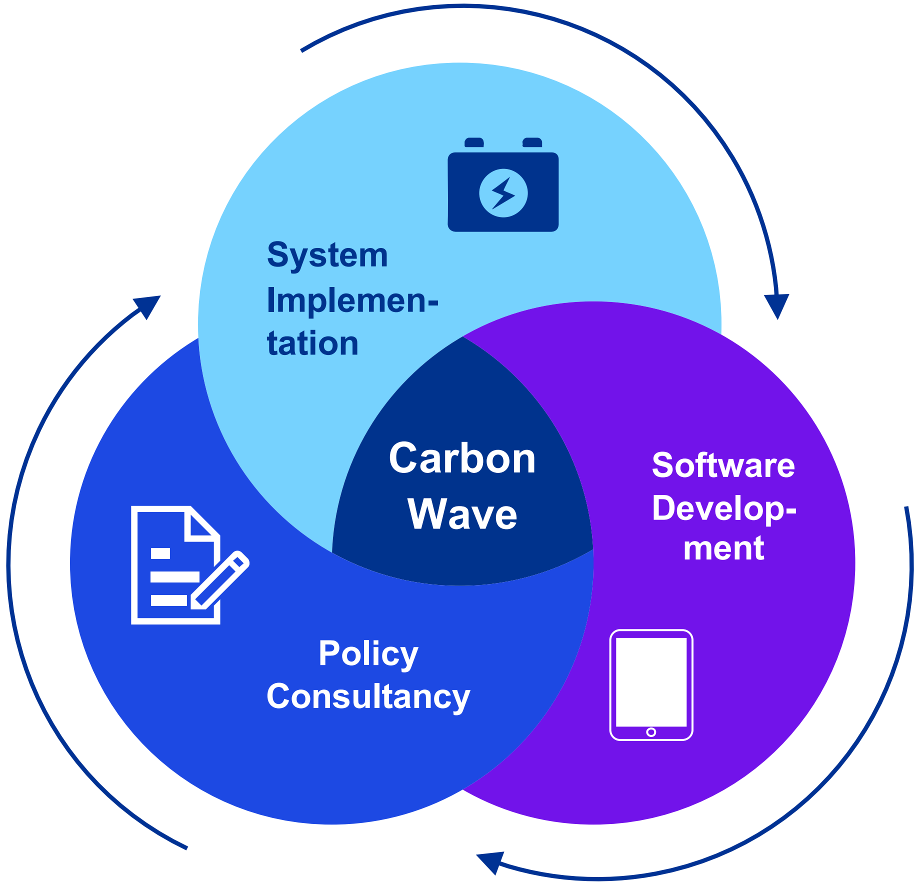
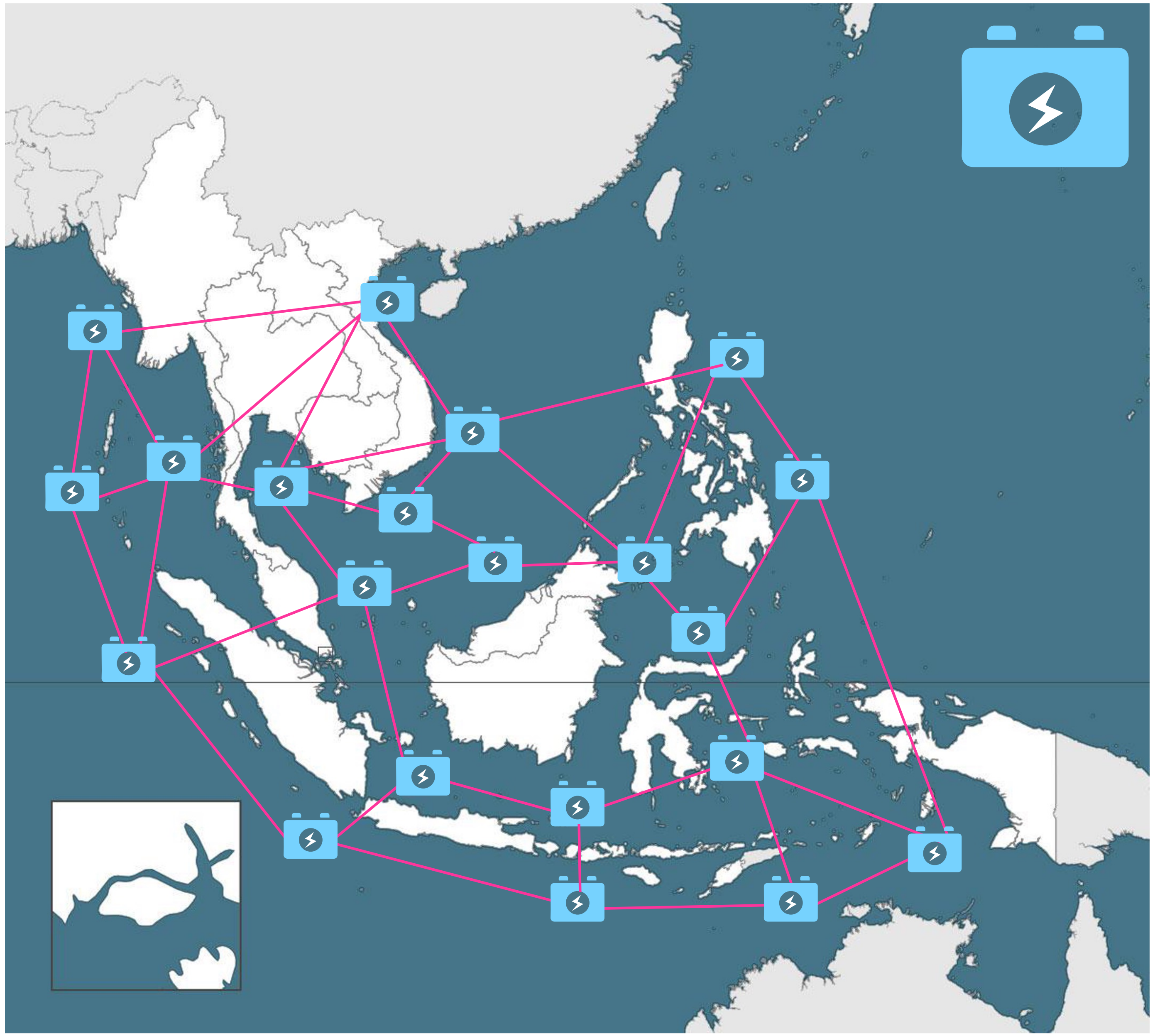


Transboundary Energy Trading *

Carbon Energy Consumption



*: See Appendix 6

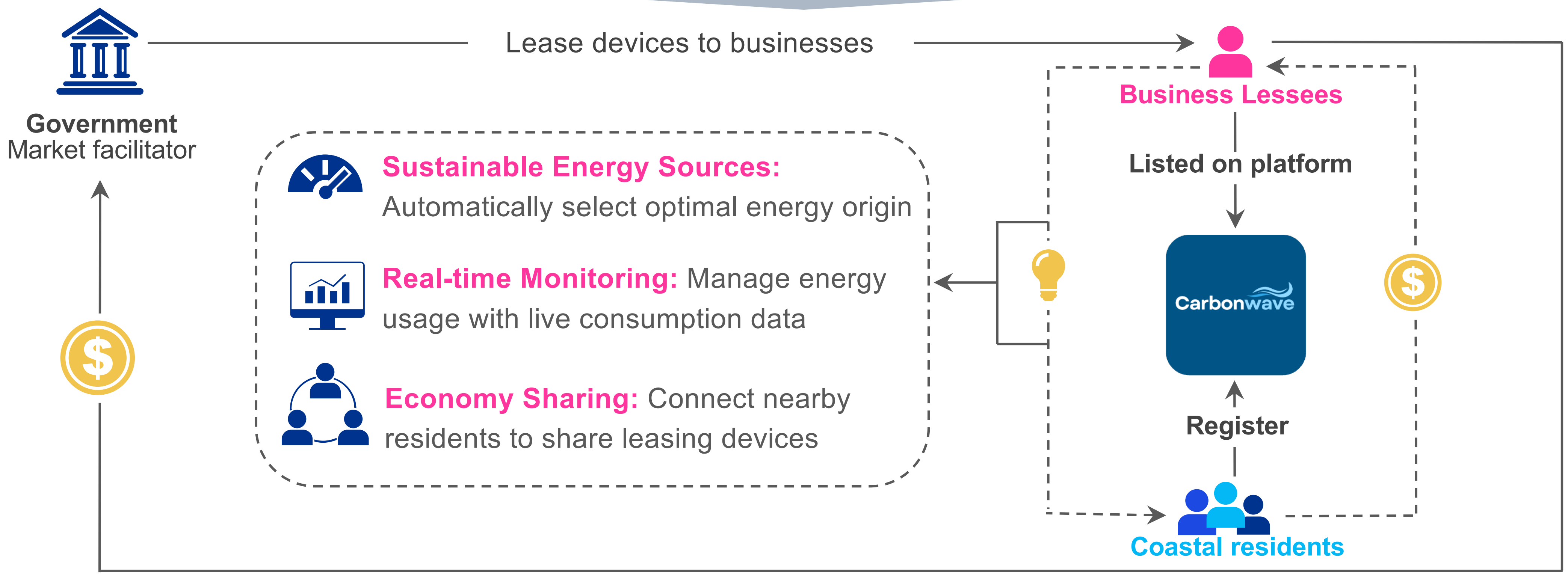
Carbonwave

PPP* CARBON CAPTURE SYSTEM FOR ENERGY CONVERSION

Energy Conversion Process

Carbon Capture	Energy Conversion	Energy Storage & Distribution
Place carbon capture devices along coastlines	Filter CO_2 from atmosphere to harvest electricity	Warehouse energy for saving and distribution

CarbonWave **Sharing Blue Economy Platform**



**PPP: Public-Private Partnership*

Carbonwave

ZOOMING OUT THE ENERGY CONVERSION PROCESS

Energy Conversion Process

Carbon Capture	Energy Conversion	Energy Storage & Distribution
Place carbon capture devices along coastlines	Filter CO2 from atmosphere to harvest electricity	Warehouse energy for saving and distribution

CarbonWave Sharing Blue Economy Platform

Government
Market facilitator

Lease devices to businesses

Business Lessees

Listed on platform

Carbonwave

Register

Coastal residents

Sustainable Energy Sources: Automatically select optimal energy origin

Real-time Monitoring: Manage energy usage with live consumption data

Economy Sharing: Connect nearby residents to share leasing devices

ZOOMING OUT THE ENERGY CONVERSION PROCESS

Energy Conversion Process

Carbon Capture	Energy Conversion	Energy Storage & Distribution
Place carbon capture devices along coastlines	Filter CO2 from atmosphere to harvest electricity	Warehouse energy for saving and distribution

- **Objective:** Address Ocean Acidification
- **Solution:** Captures carbon, preventing CO2 from reaction with H2O
- **Impact:** Directly reduce the acidification process

Carbonwave

ZOOMING OUT THE ENERGY CONVERSION PROCESS

Energy Conversion Process

Carbon Capture	Energy Conversion	Energy Storage & Distribution
Place carbon capture devices along coastlines	Filter CO_2 from atmosphere to harvest electricity	Warehouse energy for saving and distribution

Ocean Acidification: **Solved** ✓

- **Objective:** Benefit coastal populations (over 60% of ASEAN population)
- **Solution:** Provide sustainable energy converted from CO_2 captured
- **Impact:** Addresses energy insecurity and reduces ocean acidification as people have more access to sustainable energy

Carbonwave

ZOOMING OUT THE ENERGY CONVERSION PROCESS

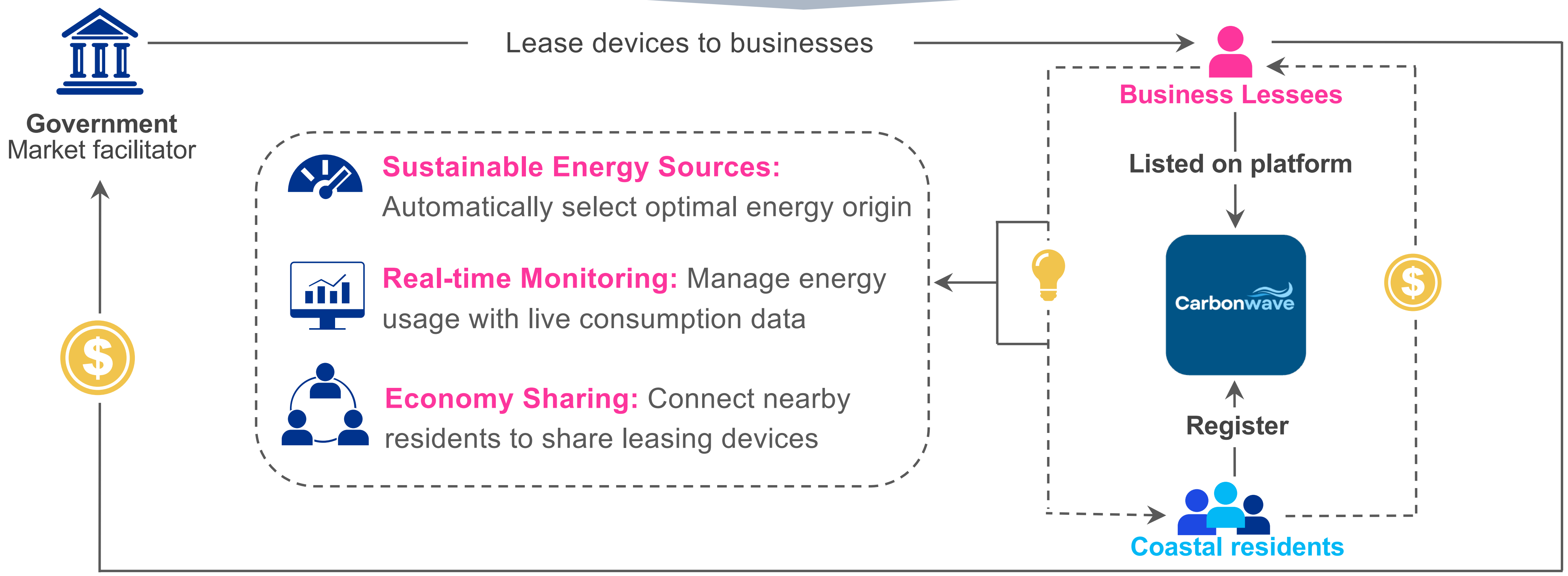
Energy Conversion Process

Carbon Capture	Energy Conversion	Energy Storage & Distribution
Place carbon capture devices along coastlines	Filter CO2 from atmosphere to harvest electricity	Warehouse energy for saving and distribution

Ocean Acidification: **Solved ✓**

Energy Insecurity: **Solved ✓**

CarbonWave **Sharing Blue Economy Platform**



Carbonwave Operating Mechanism

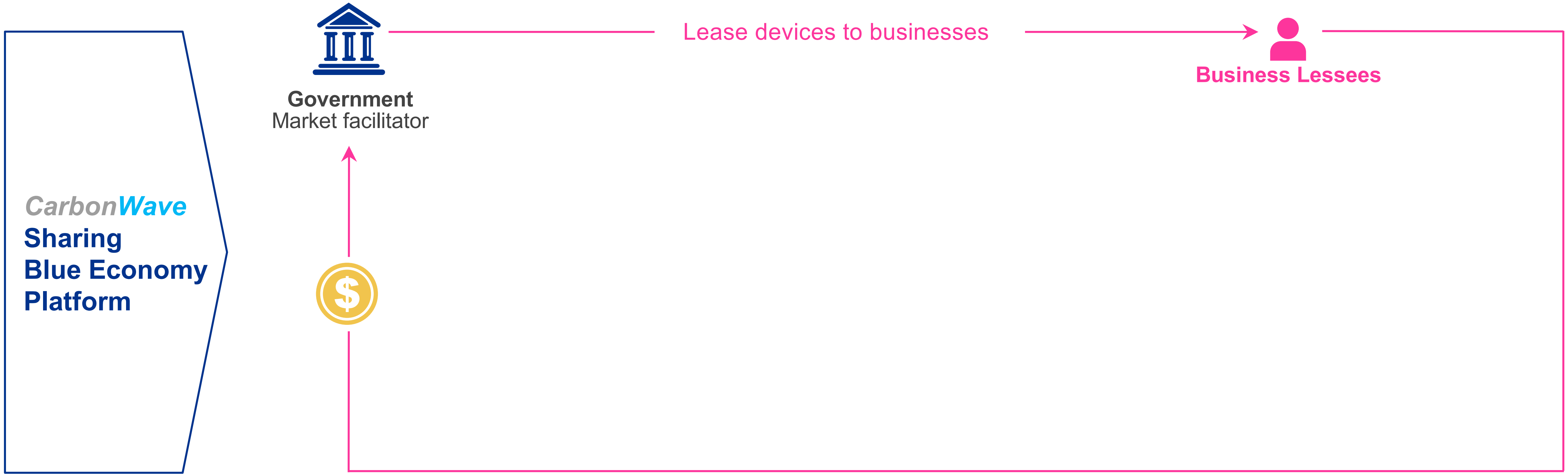
GOVERNMENT ACTS AS A MARKET FACILITATOR

Government
Market facilitator

CarbonWave
Sharing Blue Economy Platform

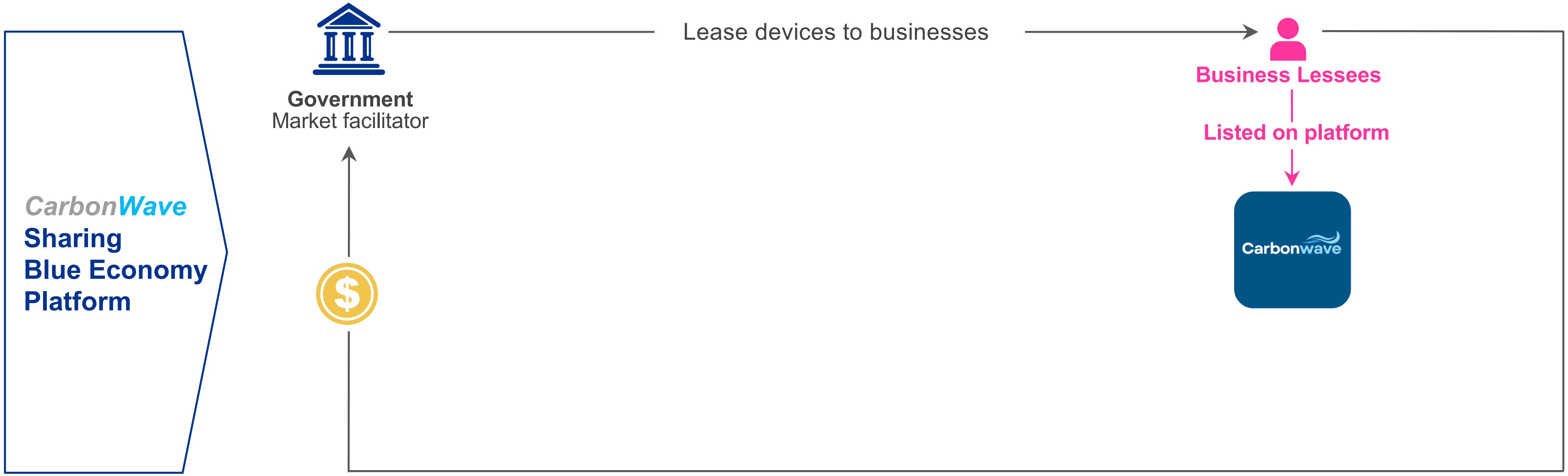
Carbonwave Operating Mechanism

GOVERNMENT LEASES CARBON CAPTURE DEVICES TO BUSINESSES



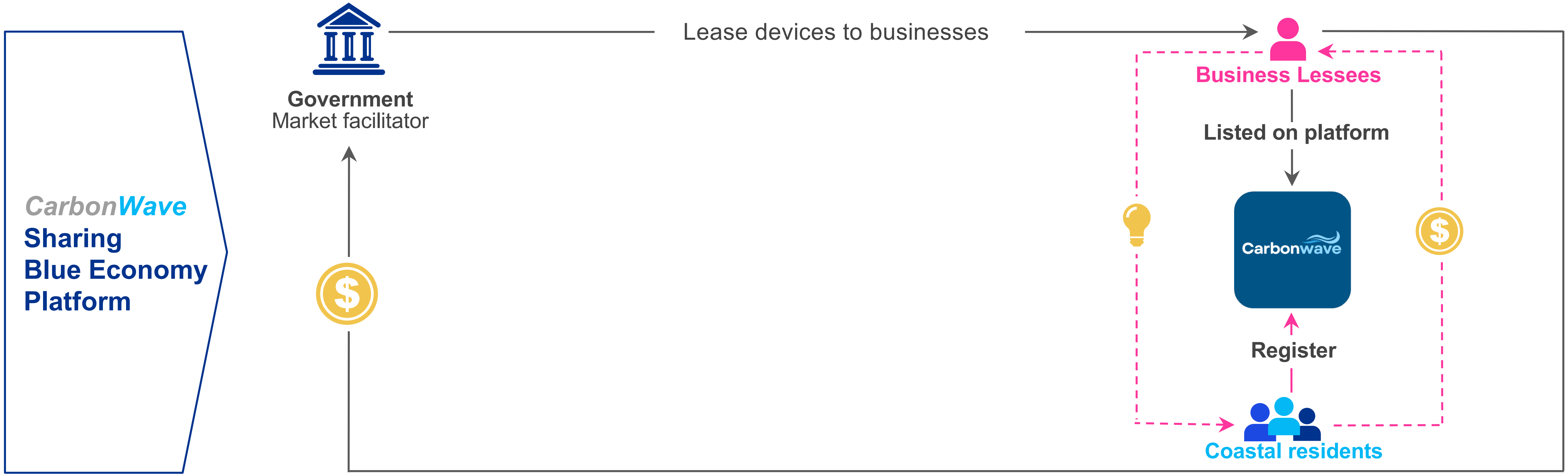
Carbonwave Operating Mechanism

LISTED BUSINESSES ON MOBILE APP



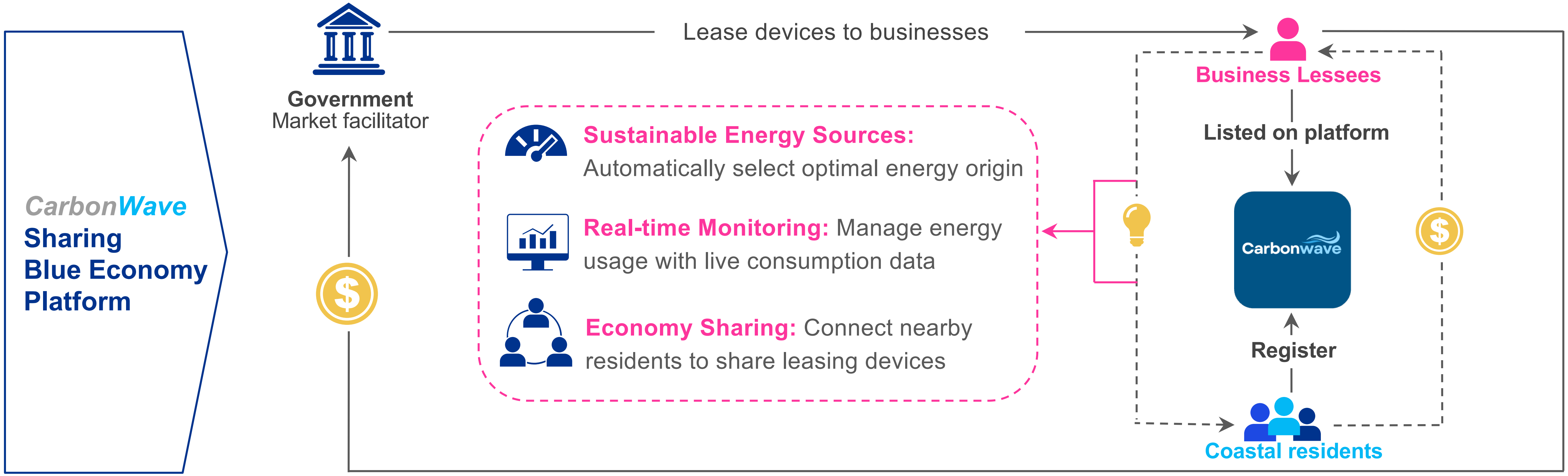
Carbonwave Operating Mechanism

BUSINESSES GAIN REVENUE FROM DISTRIBUTION OF ENERGY TO RESIDENTS



Carbonwave Operating Mechanism

PRODUCT OFFERINGS FOR USERS



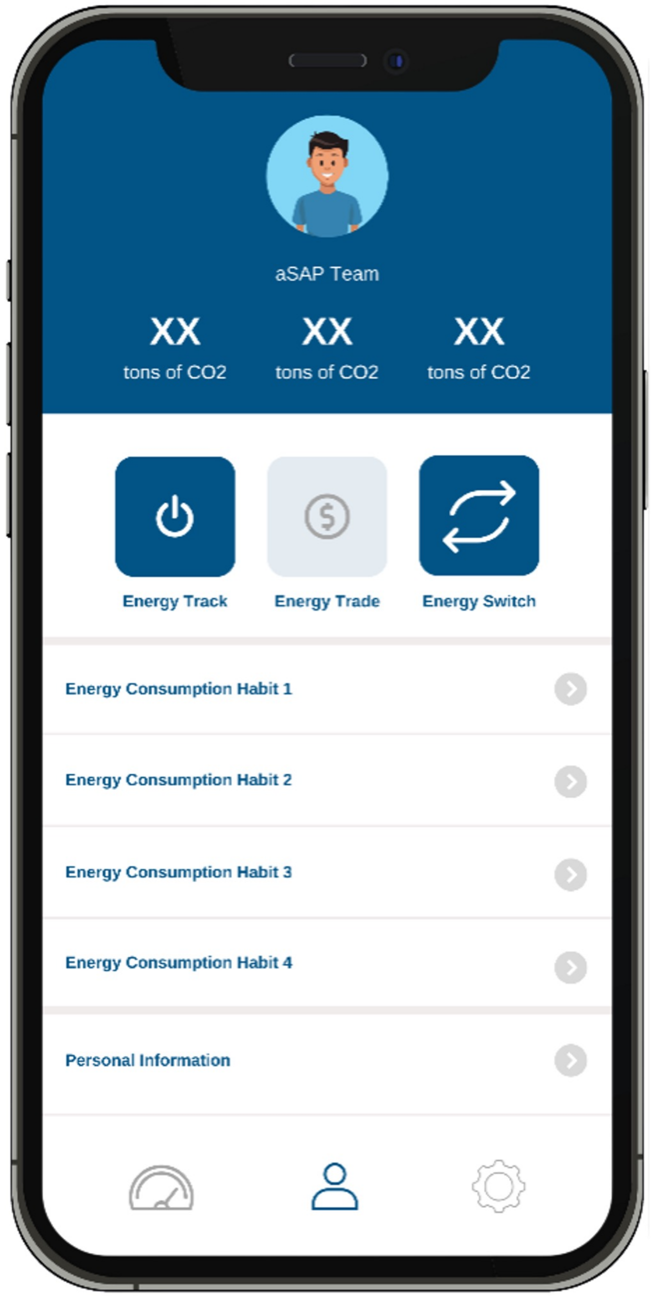
Carbonwave Offers Customized Functions based on Preferences and Habits of Users

User Ownership

Customized Functions

User can provide their **energy consuming habits** to receive customized recommendations and analysis.

User Engagement



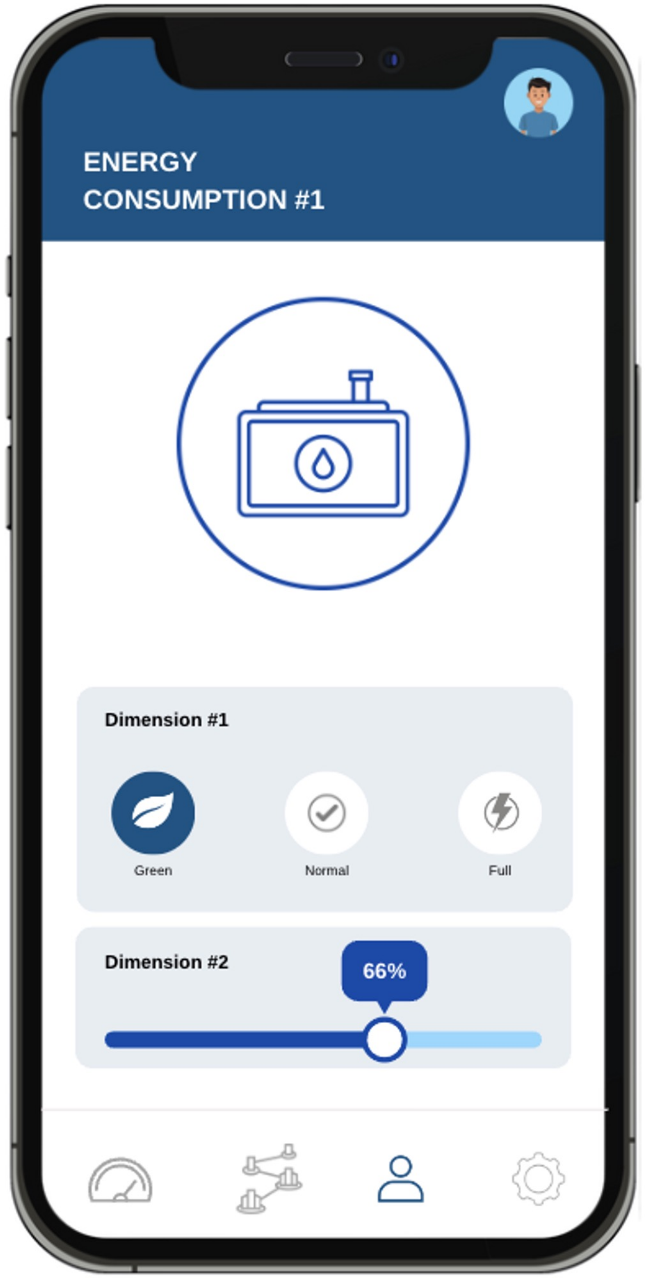
Carbonwave Gives Users the Ownership to Control their Energy Consumption and Modes of Consumption

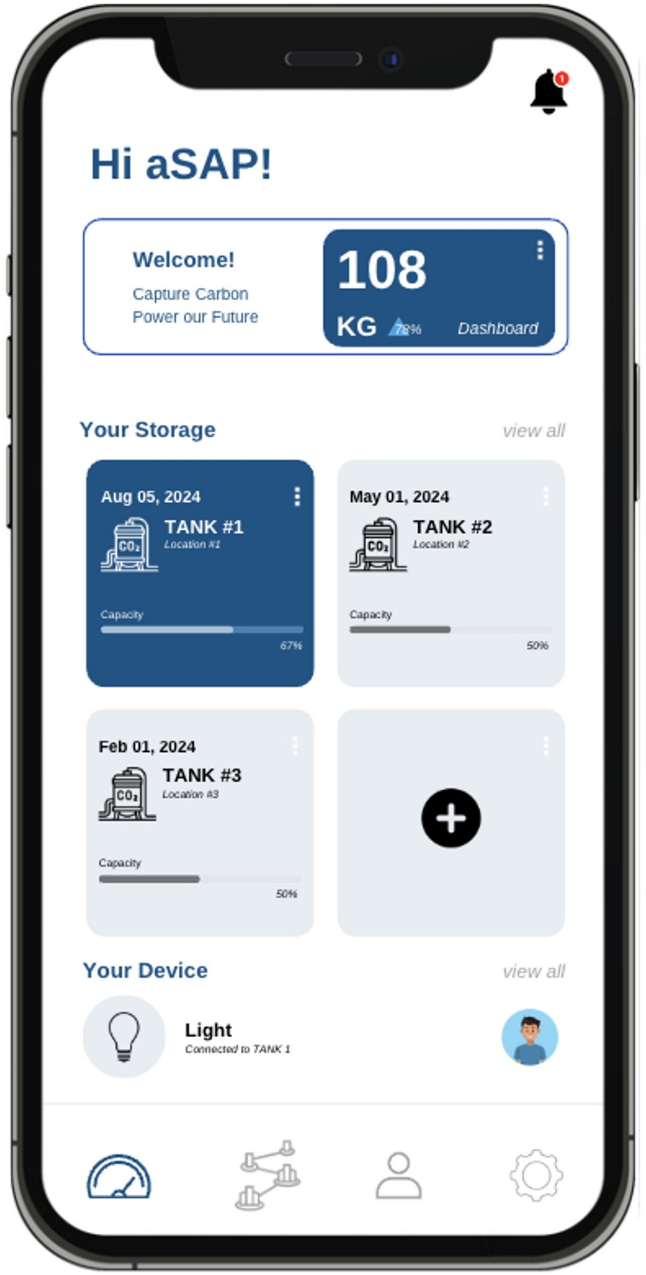
User Engagement

User Ownership

Users can choose the modes for **electrification, control their energy consumption, and choose their suppliers** accordingly.

Customized Functions





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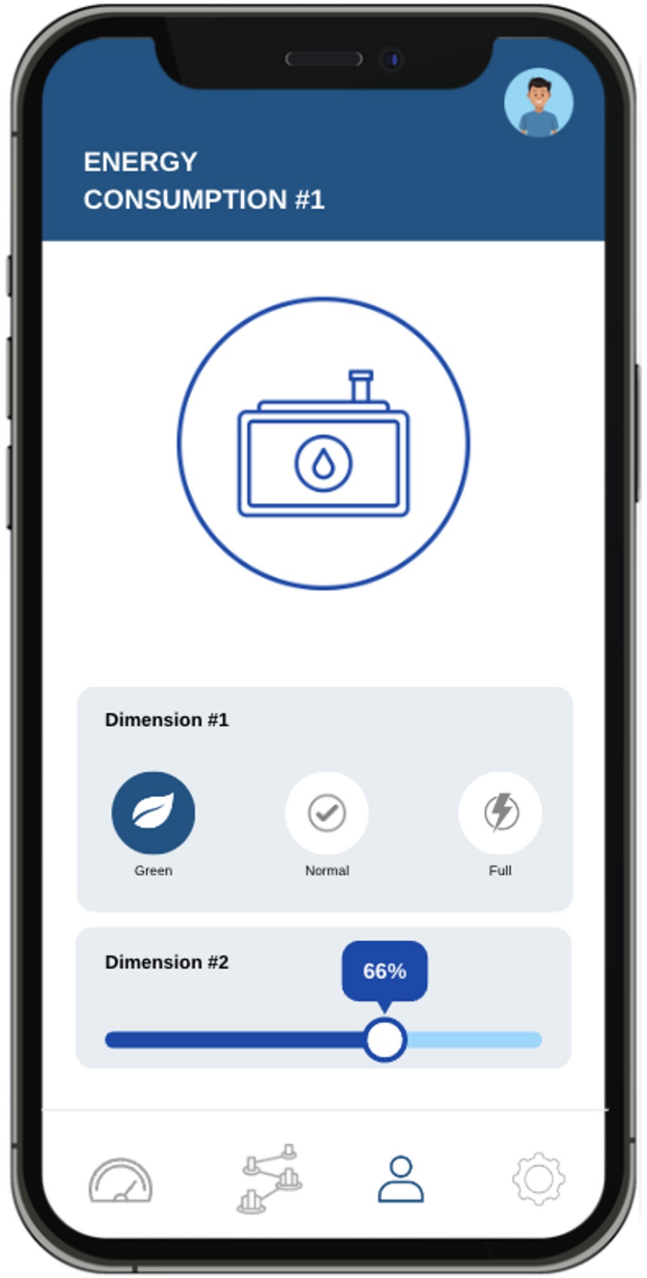
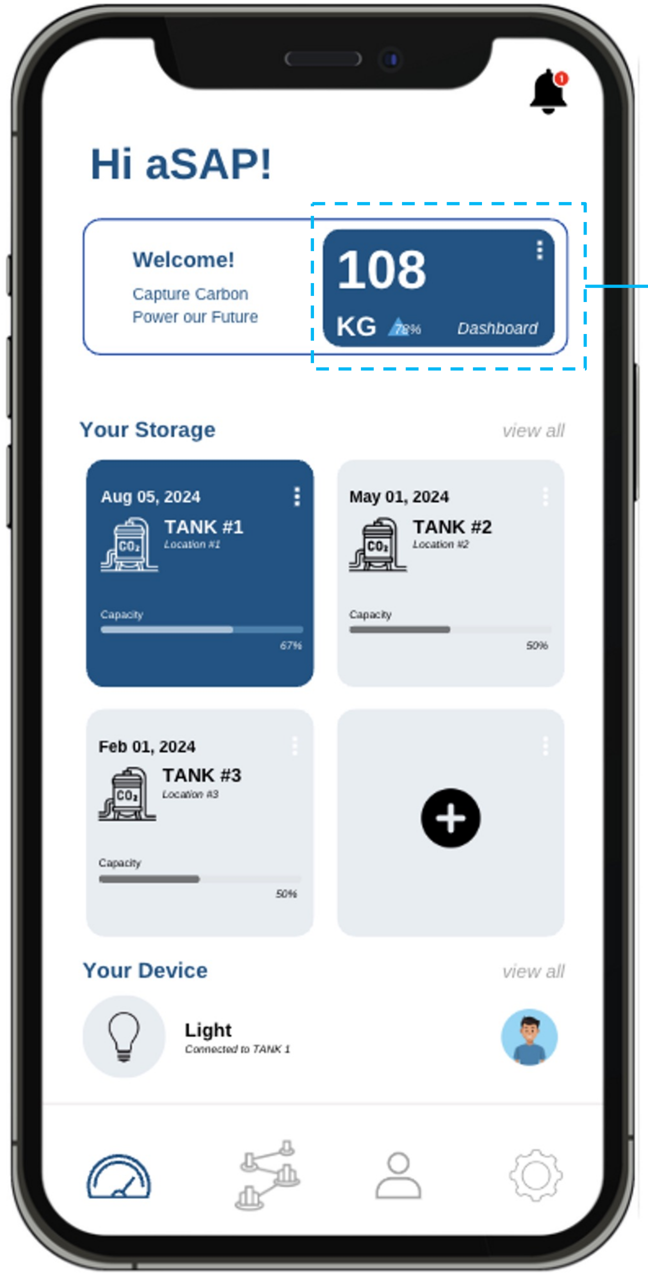




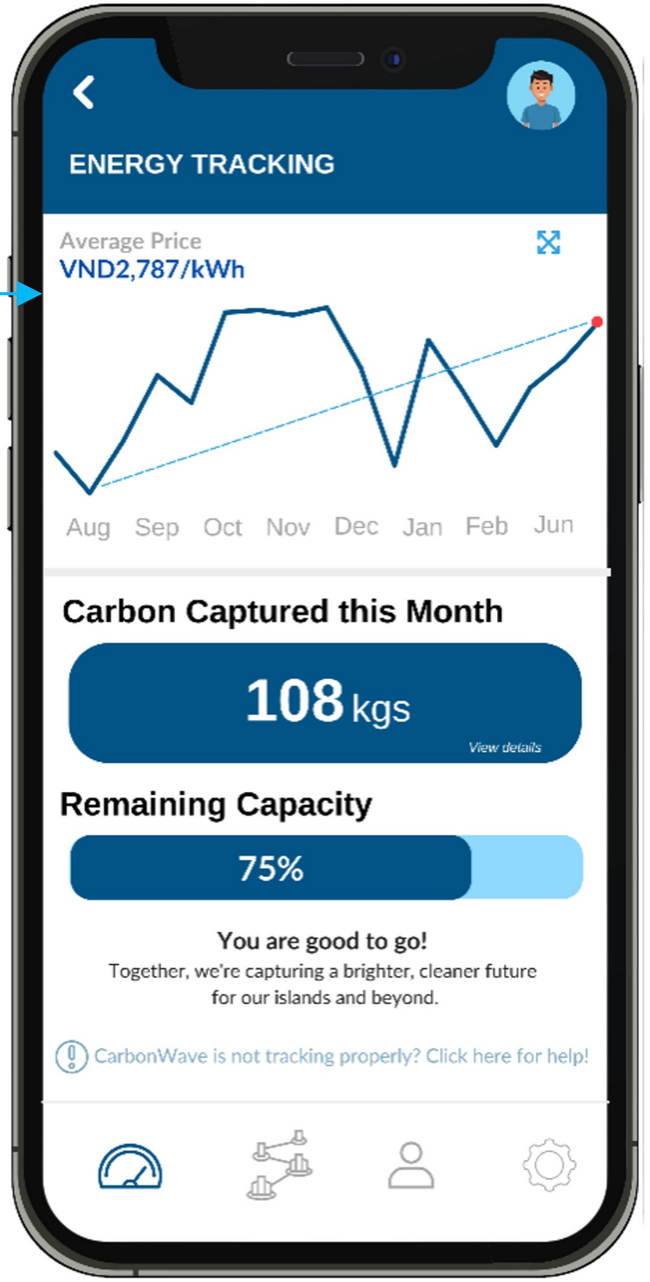
Carbonwave Empowers User Engagement to Control Their Energy Consumption and Foster Sustainable Practices

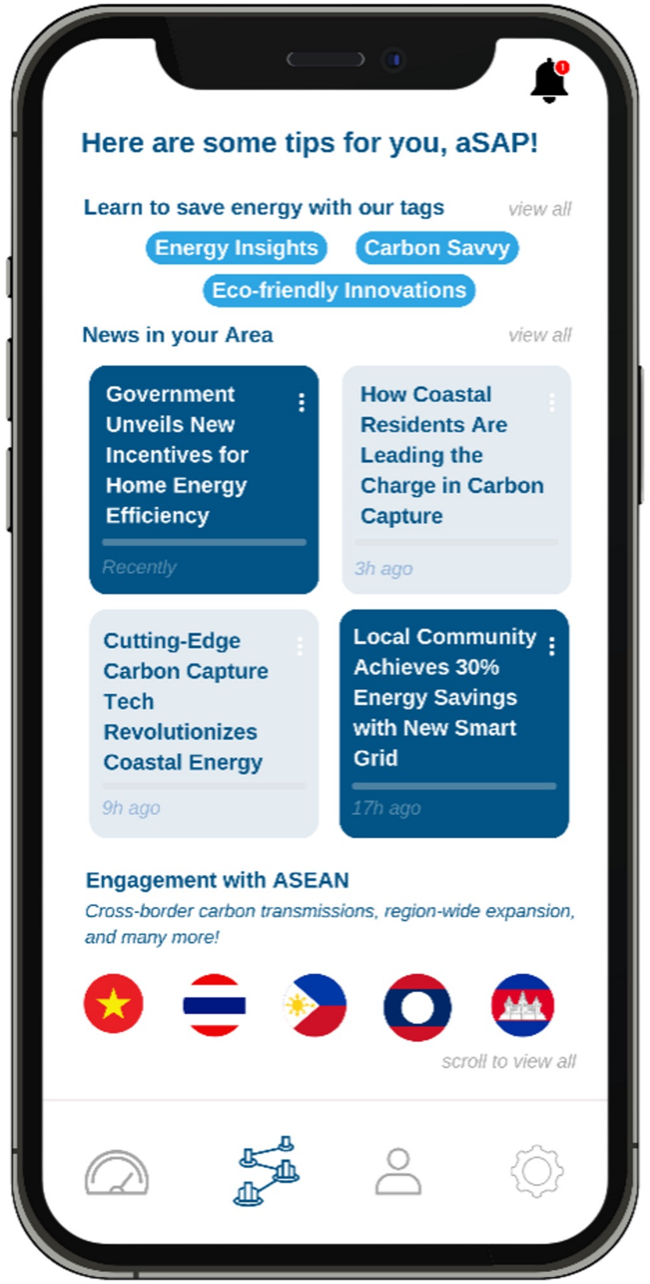
Customized Functions

User Engagement

User can track their own **energy price**, **consumption behavior**, **receive tips & news**, and participate in **cross-border activities** to foster a common ground favoring sustainable energy among AMS.

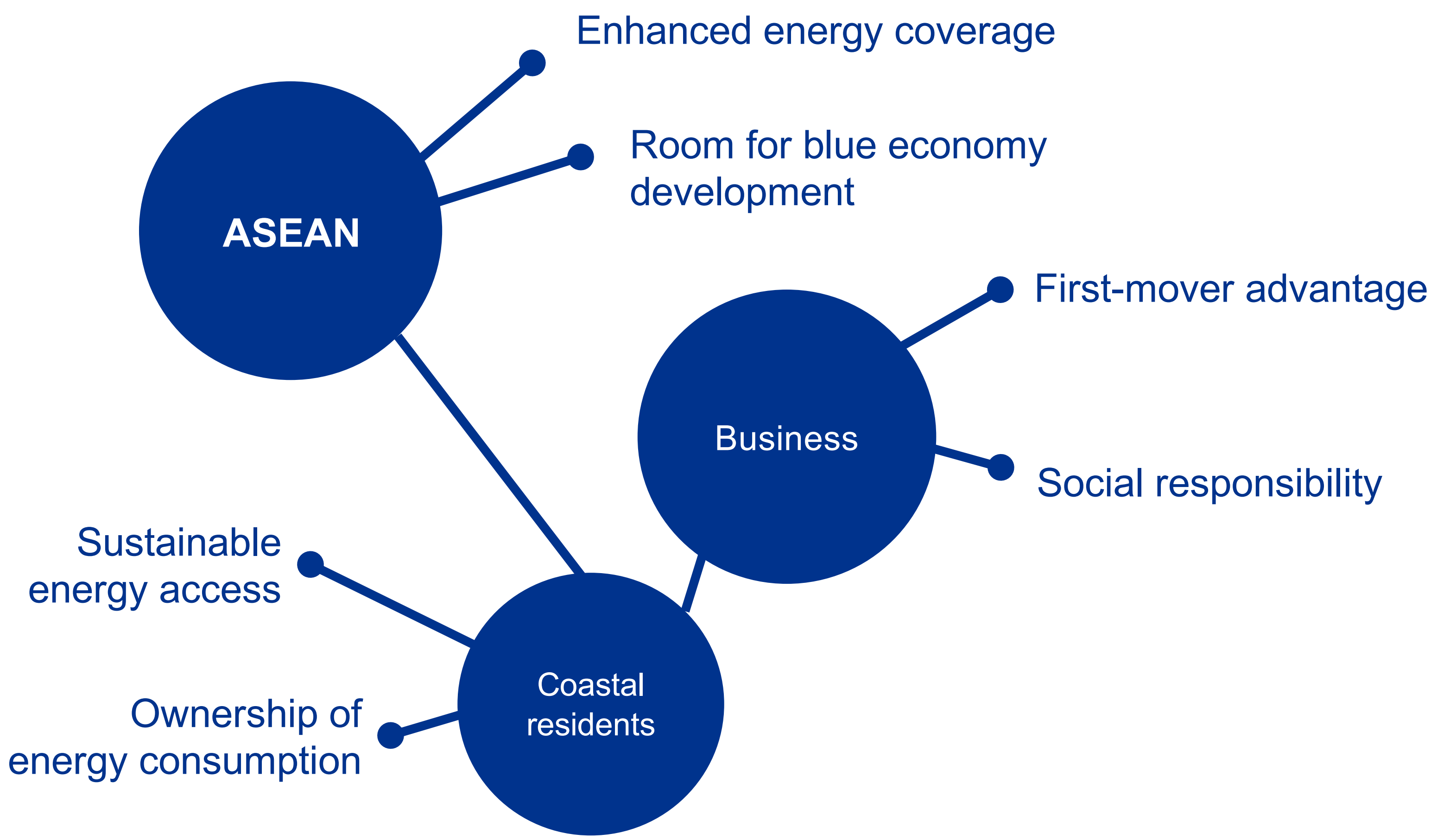
User Engagement





Qualitatively and Quantitatively, Carbonwave is Going to Change the Lives of Millions of Coastline Residents

Value Proposition



Feasible

1,743.21MMT CO2
yet to be captured in ASEAN

Proven technology and necessary legal frameworks* have already existed in some countries in ASEAN

Scalable

Pilot testing in
Vietnam and Indonesia
before scaling up to the whole ASEAN region

Scalable funding models (public-private partnerships) to support expansion

Sustainable

DAC model is expected to reduce to
less than $100/t**
(one-third of current cost)
under large-scale implementation

Impactful

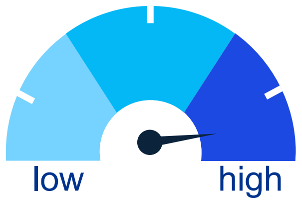
Help
60% ASEAN population
living in coastal areas from energy insecurity

*: Appendix 1 **: Appendix 2a

Pathway to Energy Independence

FROM SHORT-TERM SECURITY TO LONG-TERM SUSTAINABILITY

Ocean Acidification



Short-term vision

- **Main focus:** Coastline residents living with **uninformed electricity cut-offs** due to unsustainable transmission from national grid
- **Transmission technique:** Charge energy directly into the regional electricity station

Continuity of electricity and residents' ownership on their consumption

Energy Sufficiency

Impact of Project

Need of Legislative Framework

Pathway to Energy Independence

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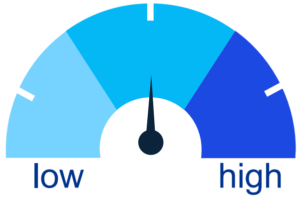

Energy Sufficiency

Energy Security

Long-term vision

- **Main focus:** Expand to reach out to **residents in isolated areas** without energy
- **Transmission technique:** Establish an ecosystem focused on generating energy from captured carbon

Impact of Project

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FROM SHORT-TERM SECURITY TO LONG-TERM SUSTAINABILITY

Impact of Project (vertical axis) / **Need of Legislative Framework** (horizontal axis)

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Energy Sufficiency

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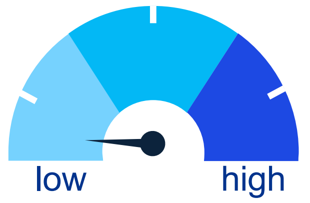

Energy Security

Long-term vision

- **Main focus:** Expand to reach out to **residents in isolated areas** without energy
- **Transmission technique:** Establish an ecosystem focused on generating energy from captured carbon

Energy Independence

Legal Framework for Decentralized Energy Production

Need of Legislative Framework

Implementation Overview: 10-Year Plan

INCREMENTAL STEPS BEFORE REGION-WIDE EXPANSION

2025 ››› 2028 ››› 2031 ››› 2034 - 2035

Pilot Testing
- Establish regulatory frameworks and partnerships
- Conduct feasibility studies and initial technology testing

Scale Up
- Expand carbon capture infrastructure
- Increase public awareness and community engagement

Optimization
- Integrate system with national electricity network

Long-term Goals
- Explore international partnerships
- Commit to long-term sustainability goals

Research and develop carbon capture for energy conversion systems

Pilot testing along the coastline of Vietnam and Indonesia, Phu Quoc and Sumatra islands

Implement along the Gulf of Thailand, Manila Bay, and Cebu of Philippines

Accelerate Net Zero target

Expand to other coastal areas within ASEAN region

Integrate and optimize energy production and distribution

Review and upgrade technology

Seeking partnerships

In Near Future

WHAT TO EXECUTE IMMEDIATELY?

2025 ››› 2028 ››› 2031 ››› 2034 - 2035

Pilot Testing
- Establish regulatory frameworks and partnerships
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Expand to other coastal areas within ASEAN region

Integrate and optimize energy production and distribution

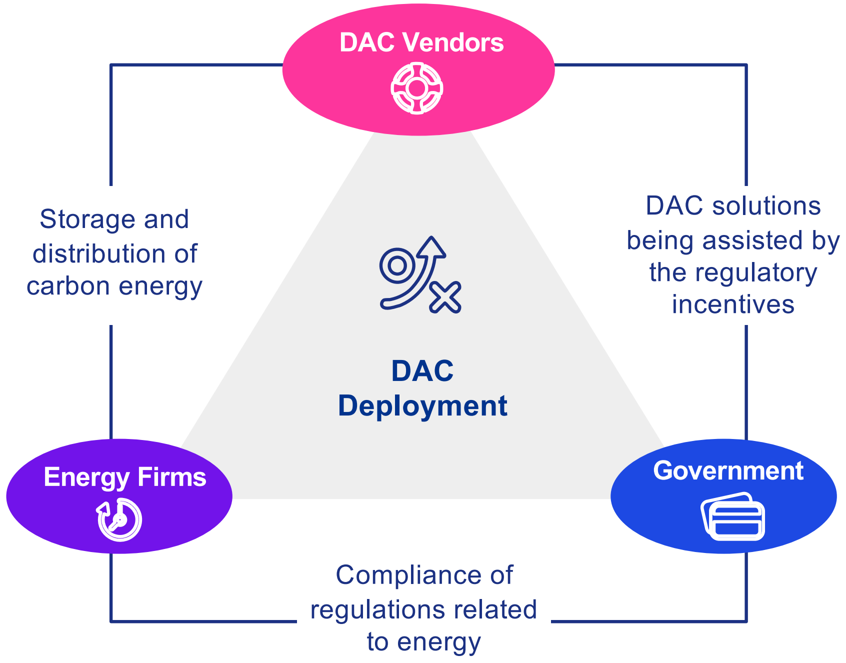
Review and upgrade technology

Seeking partnerships

What to Immediately Execute?

FIRST PILOT INITIATIVE

Research & Vendors Contact



Deliverable

DAC technology being ready for pilot phase

SAP Assistance

SAP Analytics Cloud
Carbonwave
SAP CRM
ERP

Deliverable

SAP support in terms of building application, data management, and best practices of carbon management

Pilot Project in Bich Dam

Bich Dam Island
Farthest island in Nha Trang, 174 households living **without energy**

Green Transformation Project

VINUNIVERSITY
NHA TRANG

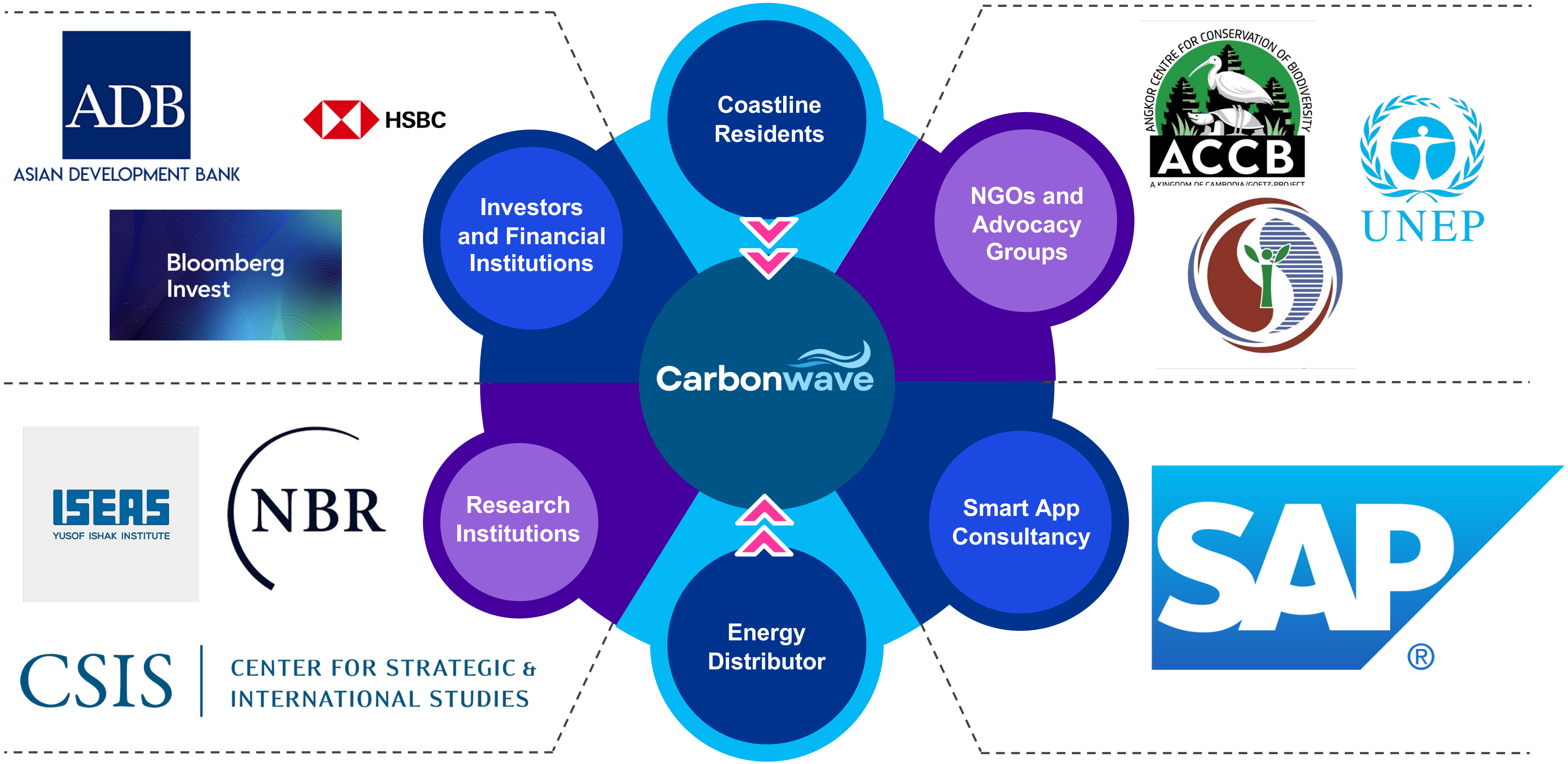
Deliverable

Sustainable source of energy for Bich Dam - the cornerstone for pilot phase of project by 2027

Stakeholder Ecosystem

CLEAR ROLES, SHARED GOALS

Government serves as a market facilitator to incentivize the lease of carbon conversion system from energy distributor.



Amplifying Impacts of Carbonwave

ORIENTATION FROM UN SDGs, ASEAN BLUE ECONOMY FRAMEWORK* & ASEAN BLUEPRINT 2025

Proposition

CarbonWave

- CO2 Capturing
- Renewable Energy Transition
- Island Energy Independence

Status Quo

- Ocean Acidification
- Black-out & Pressure on national grid

Expected Impact

Primary Impact

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

"12.2. By 2030, achieve the sustainable management and efficient use of natural resources."

"12a. Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production"

50% renewable energy production

11 SUSTAINABLE CITIES AND COMMUNITIES

"11.3. [...] enhance inclusive and sustainable urbanization and capacity for participatory, [...]"

"11.6. [...] paying special attention to air quality and municipal and other waste management"

75% islands adopting carbon capture system

Secondary Impact

3 GOOD HEALTH AND WELL-BEING

*"3.9. By 2030, substantially reduce the number of deaths and illnesses [...] and **air, water** and soil **pollution** and **contamination.**"*

8.2pH in 80% area of sea water

13 CLIMATE ACTION

*"13.b. Raising capacity for effective climate change-related planning and management in [...] **small island** developing States."*

75% islands with sustainable electricity

ASEAN ECONOMIC COMMUNITY BLUEPRINT 2025

one vision, one identity, one community

Strategic Theme:

"Enhancing energy connectivity and market integration in ASEAN to achieve energy security, accessibility, affordability and sustainability for all"

AEC 2025 is envisioned to:
- Create a more **dynamic and resilient** ASEAN, capable of responding [...] energy security issues
- Promote a **science-based** use of, and support for, **green technology and energy**

Foundational Framework

ASEAN CENTRE FOR ENERGY • ACE •

*"In this evolving landscape, **CCS has become indispensable for achieving net zero**. The urgency of its implementation has shifted from a distant future objective to the immediate present."*

Source: United Nations (2024) and ASEAN (2024)

VINUNIVERSITY

ASEAN DATA SCIENCE EXPLORERS

Carbonwave

Leveraging the Interplay between
Ocean Acidification and Energy Insecurity

THANK YOU

Team [illegible]aSAP

Country: Vietnam
Institution: VinUniversity
Members:
Le Trung Kien
Cao Van Truong

3 GOOD HEALTH AND WELL-BEING
11 SUSTAINABLE CITIES AND COMMUNITIES
13 CLIMATE ACTION

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Appendix 1. Key Regulatory Framework for CCS

CCS-RELATED REGULATIONS IN INDONESIA

Regulatory Framework	Overview
CCS-related Regulations	
Ministry of Energy & Mineral Resources Regulation 2/2023	• Regulates CCS and CCUS implementation in upstream oil and gas activities, including the enforcement, implementation, monitoring, Measurement, Reporting & Verification (MRV), and economic provisions.
Presidential Regulation 14/2024	• Provides a broad national framework of CCS in Indonesia, establishing general legal, environmental and operational guidelines. • It also sets out the overarching policy and incentives for CCS, including cross-border cooperation.
Technical Standards for CCS Operation	• Published of technical standards adopting ISO/TC 265: (focusing on geological storage) ✓SNI ISO 27914:2017 Carbon dioxide capture, transportation and geological storage. ✓SNI ISO/TR 27915:2017 Carbon dioxide capture, transportation and geological storage Quantification and verification. ✓SNI ISO/TR 27923:2022 Carbon capture, transportation and geological storage – Injection operations, infrastructure and monitoring. ✓SNI ISO/TR 27918:2018 Lifecycle risk management for integrated CCS projects.
SKK Migas Working Guideline No. PTK-070/SKKIA0000/2024/S9	• Guideline on CCS/CCUS for oil and gas upstream activities in alignment with other regulations such as MEMR regulation, carbon economic value, MRV, etc. • Working Procedural Guideline of CCS/CCUS on Working Areas of Cooperation Contract Contractors in oil and gas upstream activities in alignment with MEMR regulation.

Source: ASEAN Centre for Energy (2024)

Appendix 2a. A Future of DAC Application Cost

PROFITABILITY IS IN THE NEAR FUTURE

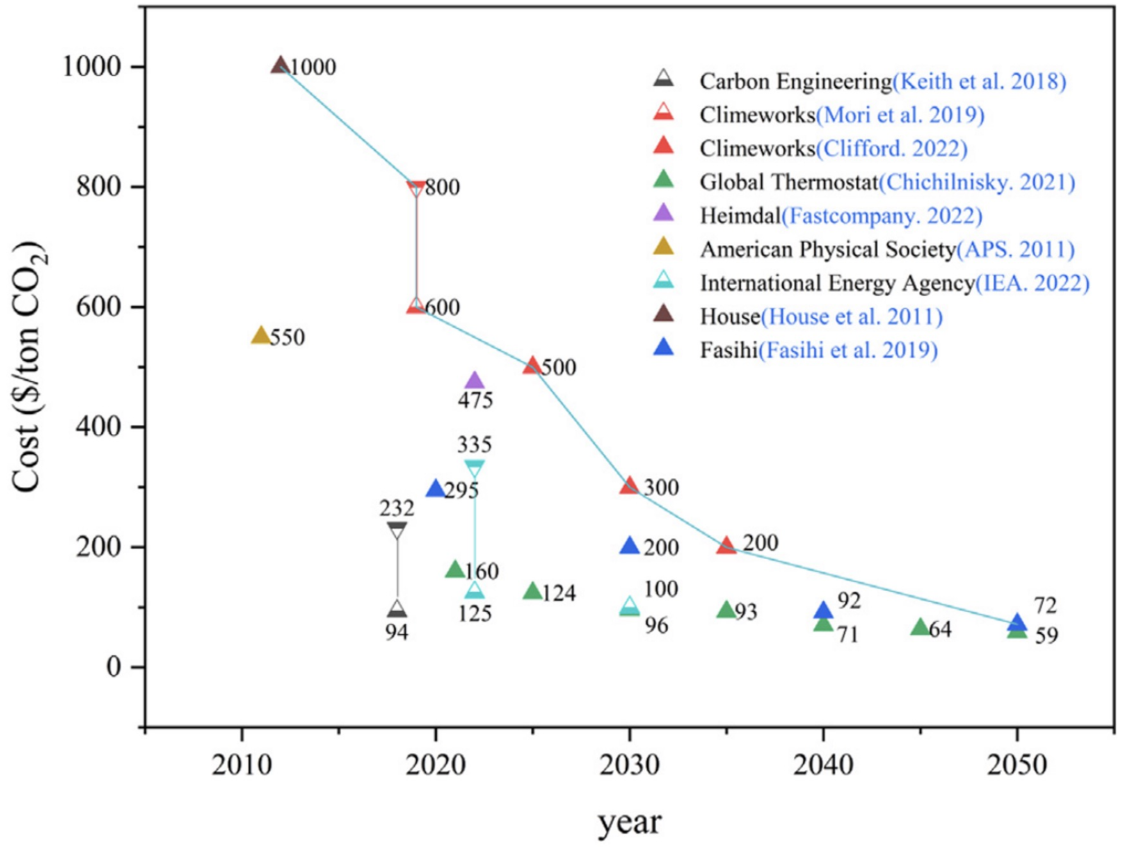


Fig. 2.9. The cost summary of DAC. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Significant drop in DAC price

"According to IEA, **the cost of DAC under large-scale application conditions (1 Mt CO2/year) is between $125–335/t**. Low heat and electricity prices could reduce the projected cost to just above the industry target of $100/t (Baylin-Stern et al., 2022). If the captured carbon could be monetised using some form of carbon pricing scheme, the levelized cost of DAC would be well below $100/t.

Furthermore, a carbon price above $160/t could make DAC-based capture profitable.

Due to the **high flexibility** of DAC technology in terms of plant site selection, the best power generation and heating technology could be used in areas with high renewable energy potentials. By **2030**, the cost of DAC could be reduced to **less than $100/t**. In addition to strong policy and financial support, technological research and development may also cause industrial upgrades. Therefore, cost reduction could be achieved through technological research and development, learning-bydoing, and large-scale implementation (Fasihi et al., 2019)."

Source: Wu et al., 2024

Appendix 2b. DAC Provider List

HIF

1POINTFIVE

Great Carbon Valley

CARBONVERT

CAPTUREPOINT

Source: Wu et al., 2024

Appendix 3. Synergy Towards Common Goals

ALIGNMENT WITH BLUE ECONOMY FRAMEWORK

1

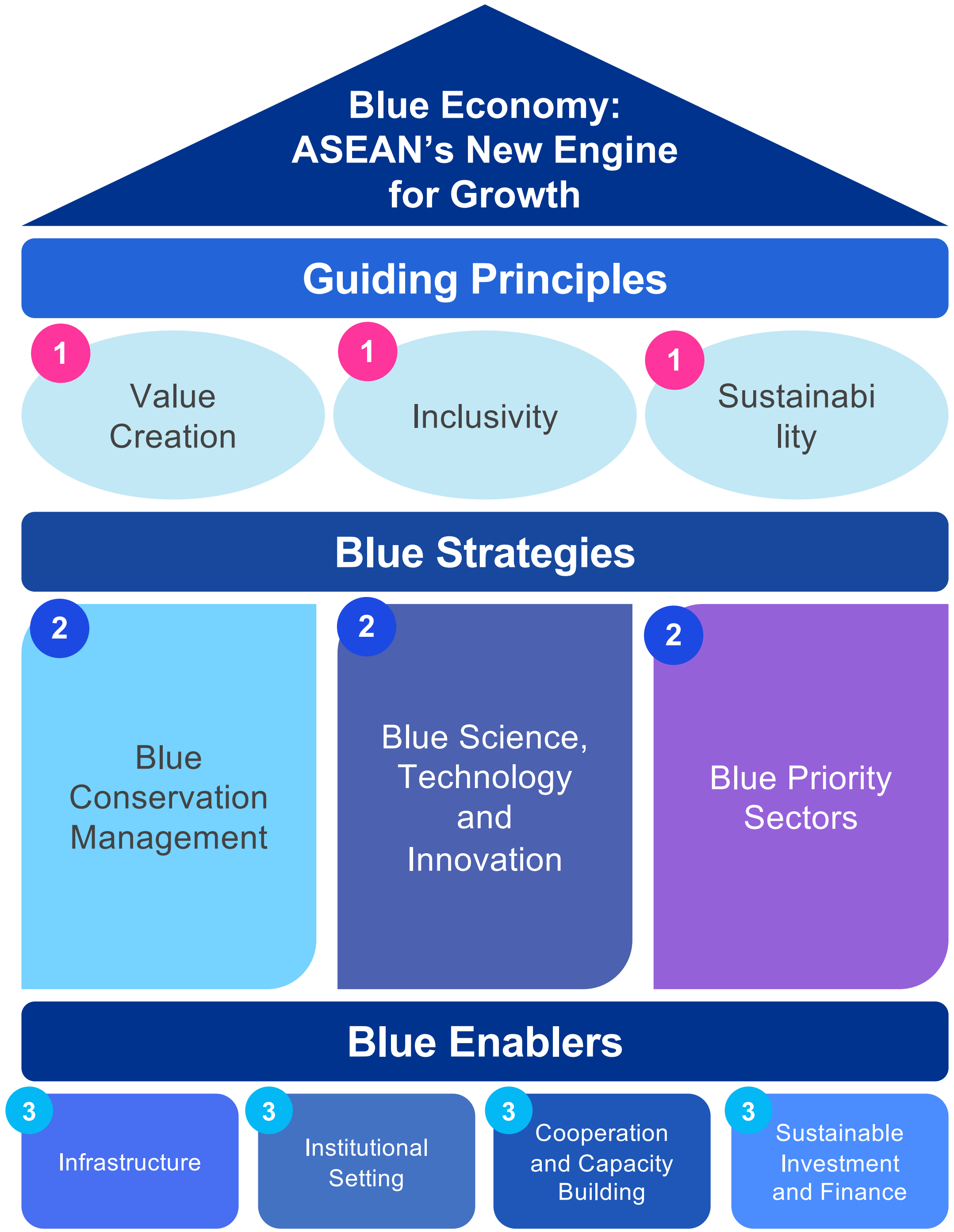
- Generate sustainable energy for growth of blue economy
- Ensure the participation of stakeholders from ASEAN and state as market facilitators, businesses, and coastline residents
- Protect marine environment from ocean acidification threats

2

- Ensure a neutral carbon balance by capturing and converting into energy
- Harness technological innovations and think tanks among AMS to bring equitable access to energy for coastline residents
- Facilitate the growth of traditional sectors and pave the way for aa new format of energy purchase

3

- PPP model enables public-private cooperation to incentivize individuals and organizations to fully utilize the new energy conversion network
- Mobilize the skilled workforce in implementing and expanding the system

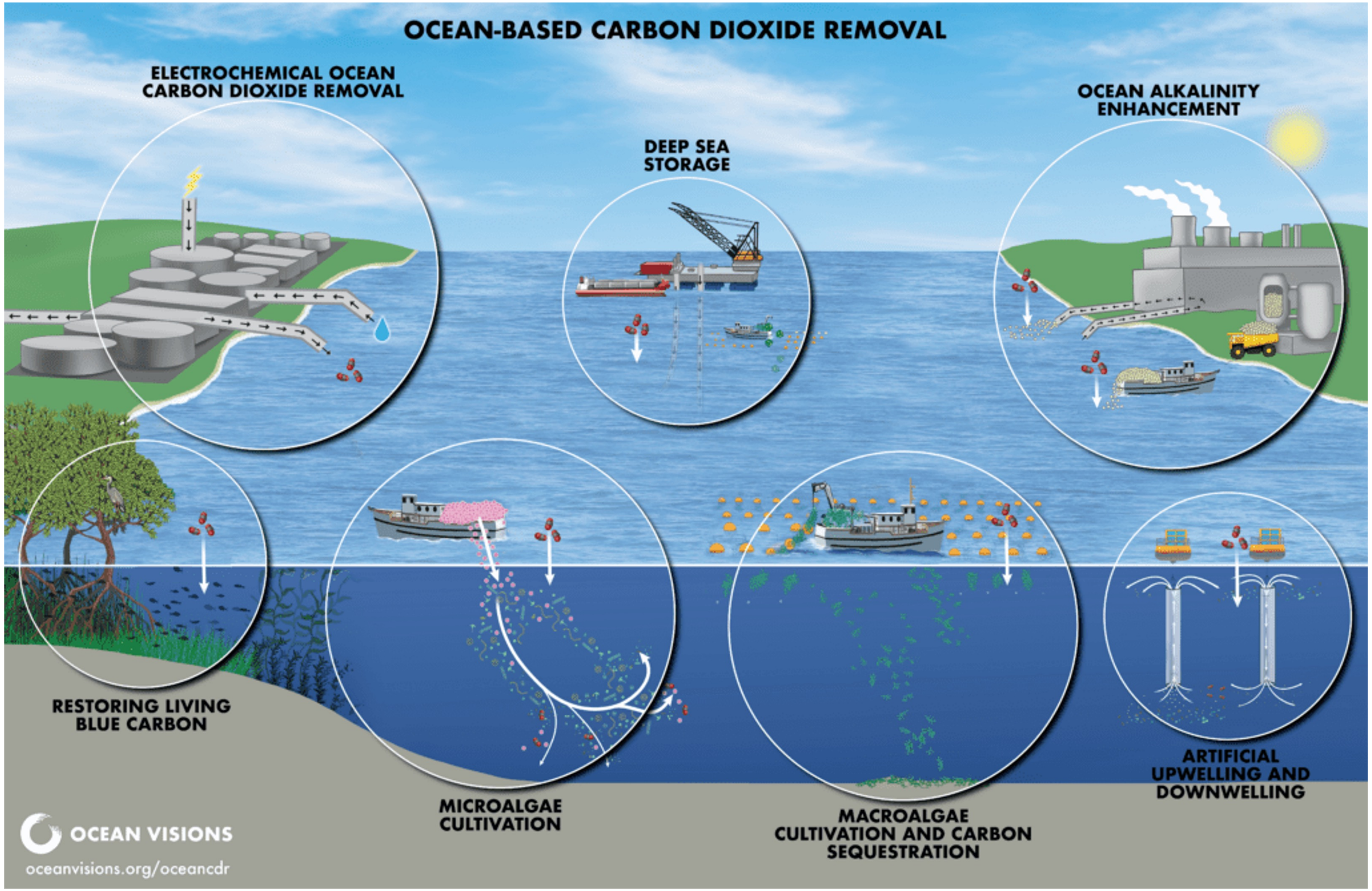


Model adopted from ASEAN Blue Economy Framework 2023

Source: ASEAN (2023)

Appendix 4. A Future of Carbon Capture Ecosystem

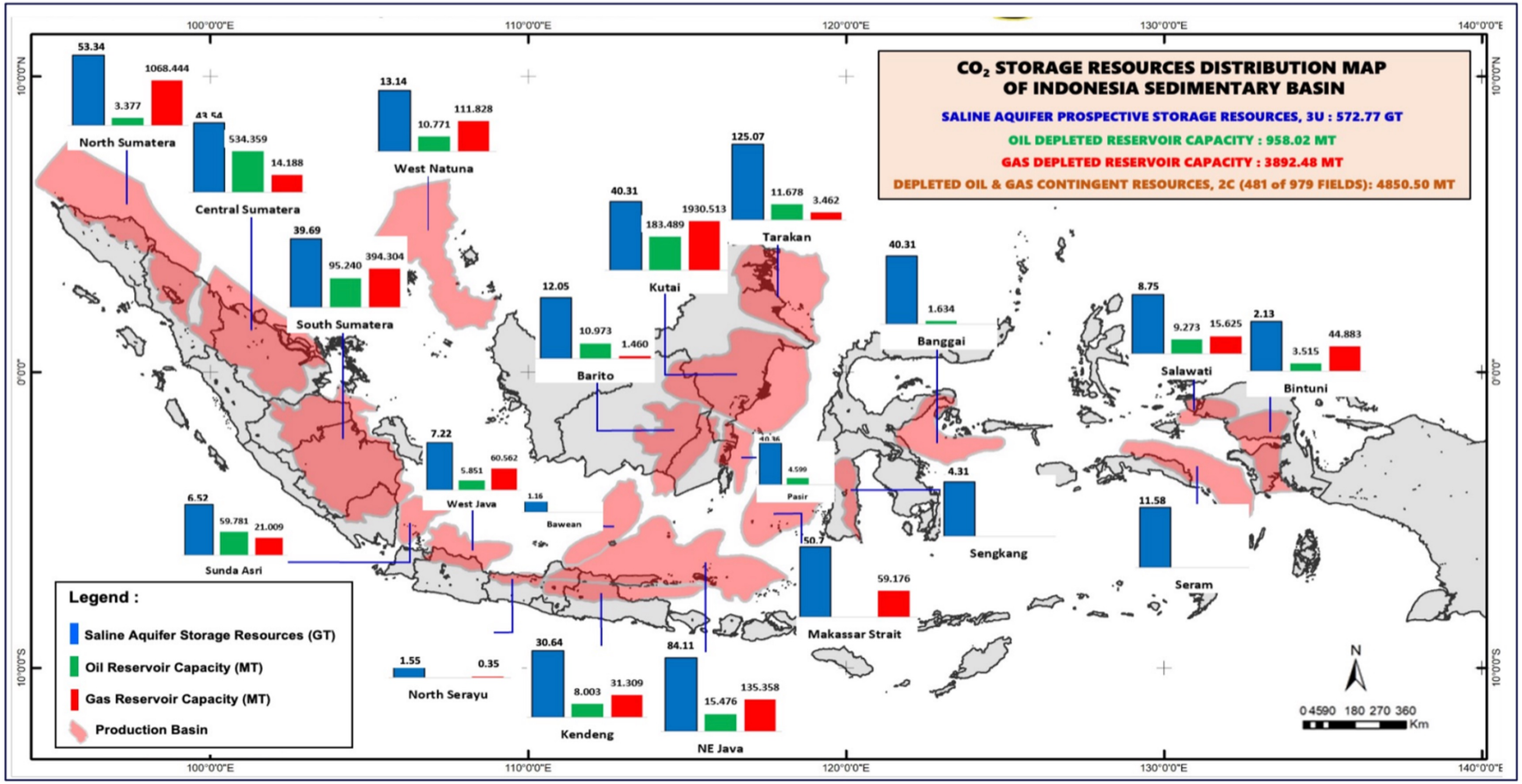
REELING IN RESULTS: CARBON CAPTURE AT EVERY TIDE



Source: Ocean Visions (n.d)

Appendix 5. Potential of CO2 Storage Capacity

- Saline Aquifer Potential: 572 Gt-CO_2 (in 20 production Basins)
- Oil and Gas Reservoir: 4.85 Gt-CO_2 (in 481 Oil and Gas Fields)



Source: ASEAN Centre for Energy (2024)

Appendix 6. ASEAN Transboundary Energy Trading Network

China – SEA	12 connections
Laos – Vietnam	2 connections
Cambodia – Vietnam	1 connection
Laos – Cambodia	1 connection
Thailand – Cambodia	1 connection
Laos – Thailand	17 connections
Thailand – Malaysia	2 connections
Malaysia – Singapore	1 connection
Malaysia – Indonesia	1 connection

Source: PwC (2022)

Appendix 7. Piloting in Bich Dam Island (Vietnam)

Details of Bich Dam

Approval — November 24

Vendor Due Diligence — December 24

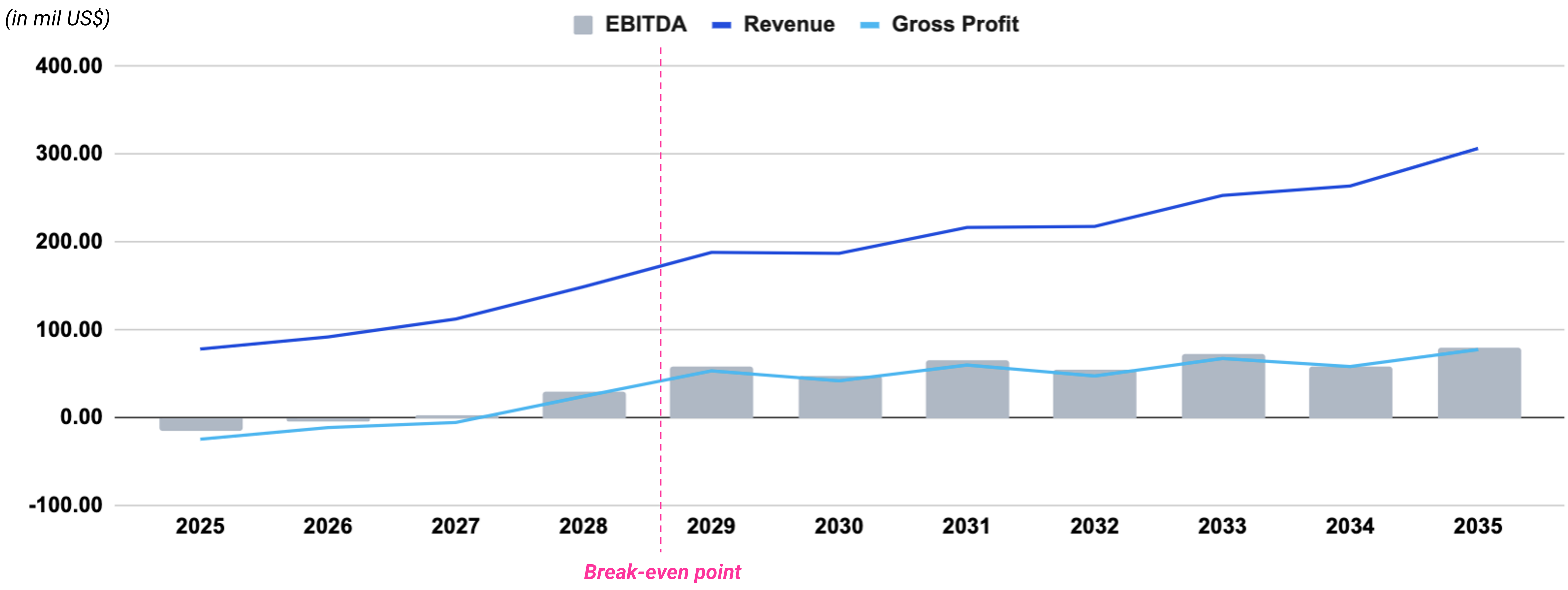
Disbursement (VINUNIVERSITY) — January 25

Implementation — February 25

Appendix 8a. Financial Projection

(in mil US$)	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Revenues											
Leasing carbon capture devices	15.00	18.00	20.00	29.54	40.37	45.21	50.64	57.22	66.95	79.00	93.21
Energy distribution	8.00	9.50	12.00	23.10	37.78	42.70	50.81	58.43	66.03	77.25	89.61
Fundings	50.00	55.50	61.05	71.43	85.00	70.71	84.15	67.89	83.31	64.49	80.81
User investment platform fee	5.00	6.00	13.11	15.73	18.88	22.65	24.92	29.40	32.63	36.22	40.57
Total Revenue	78.00	89.00	106.16	139.80	182.03	181.27	210.51	212.93	248.91	256.96	304.21
Less: Revenue expenses											
Software maintenance	10.35	14.30	17.00	14.93	16.87	20.08	23.89	27.48	31.32	36.02	41.42
Equipment & infrastructure cost	70.00	64.00	72.00	76.58	79.64	80.44	81.24	82.87	85.35	89.62	94.10
Research and development	7.20	8.50	9.69	11.14	13.37	14.84	17.36	19.09	21.39	25.23	28.01
Commission for partners	5.00	5.65	6.33	7.47	8.36	9.37	11.05	12.71	13.98	16.64	19.30
Total revenue expenses	92.55	92.45	105.01	110.11	118.24	124.72	133.54	142.15	152.04	167.51	182.83
Net Revenue	-14.55	-3.45	1.14	29.69	63.79	56.56	76.97	70.79	96.87	89.45	121.37
Less: Cost of goods sold											
Carbon capture devices fees	5.00	5.85	7.02	8.21	9.45	11.15	13.37	15.11	16.78	19.12	21.99
Energy conversion equipment	2.00	2.26	2.64	3.01	3.56	3.95	4.66	5.12	6.15	6.76	7.51
Energy storage and distribution	1.50	1.74	1.95	2.14	2.53	2.93	3.35	3.95	4.62	5.08	6.05
Other expenses	1.40	1.54	1.82	2.02	2.22	2.57	3.09	3.46	4.05	4.61	5.26
Total cost of goods sold	9.90	11.39	13.43	15.39	17.75	20.60	24.47	27.64	31.59	35.58	40.81
Gross profit	-24.45	-14.84	-12.29	14.30	46.04	35.95	52.50	43.14	65.28	53.87	80.56
Add: Revenue from financing activities	6.00	10.80	5.40	10.90	7.40	8.10	10.00	7.50	9.20	7.00	8.70
Less: Financing expenses	0.53	0.81	0.41	0.82	0.56	0.61	0.75	0.56	0.69	0.53	0.65
In that: Interest expenses	0.42	0.65	0.32	0.65	0.44	0.49	0.60	0.45	0.55	0.42	0.52
Less: General and administrative expenses	1.30	1.51	1.72	1.93	2.16	2.54	2.93	3.51	3.86	4.33	5.15
Net operating profit	-20.28	-6.35	-9.01	22.45	50.72	40.90	58.82	46.57	69.93	56.02	83.46
Add: Other income	0.50	0.59	0.68	0.77	0.92	1.01	1.16	1.32	1.51	1.74	2.02
Less: Other expenses	0.30	0.35	0.40	0.45	0.50	0.59	0.69	0.76	0.88	1.03	1.13
EBITDA	-20.08	-6.11	-8.73	22.78	51.14	41.32	59.30	47.13	70.56	56.73	84.35

Appendix 8b. Break-Even Point



Appendix 9. Risk Management

	RISKS	MITIGATION PLAN
Technology	Infrastructure not ready to support advanced energy solutions Dependence on emerging technologies	• **Pilot Testing:** Start small with pilot projects, such as on Bich Dam Island, to test and demonstrate feasibility before scaling up • **Reiteration:** Continuous revampment between R&D and technological provider during pilot phases
People	Resistance from local communities due to social or cultural barriers Low adoption rates due to the population's unfamiliarity with technology	• **Localisation:** Engage locals in the project planning phase to address concerns and build trust through communication • **Leverage Local Authorities:** Develop a structured framework for ongoing communication using local authorities
Policy	Unaligned energy trading regulations across ASEAN member states	• **Regional Cooperation:** Strengthen ties with ASEAN energy forums and participate in transboundary energy discussions
Finance	Insufficient funding or cost overruns in energy infrastructure projects Fluctuating energy market prices and uncertain returns on investment	• **Cost Management Framework:** Establish a clear budgeting and cost control system for each phase • **Hedging and Insurance:** Implement financial instruments such as hedging or insurance to protect against market volatility
Environment	Environmental impacts of new energy projects	• **Environmental Impact Assessments (EIA):** Conduct thorough EIAs for all major energy projects to identify potential risks to ecosystems and implement mitigation measures