02

Catalyzing the Journey

Energy transition, valuing nature, and a sustainable agri-food system

Sources:

Main report

Read the main report

here

SEA's Green Economy 2021 Report: Opportunities on the Road to Net Zero

Deep-dive sections

01

Find out more about SEA's progress on its climate ambitions

here

Defining the Road to Net Zero

02

Catalyzing the Journey

This report

03

Find out more about SEA's green capital flows

here

Unlocking Capital Flows

Country insights

Find perspectives on Indonesia

here

Find perspectives on Malaysia

here

Find perspectives on Singapore

here

Find perspectives on Thailand

here

Find perspectives on the Philippines

here

Find perspectives on Vietnam

here

Find perspectives on Brunei, Cambodia, Laos, and Myanmar

here

Key messages

A

Heavy-emitting sectors and the nascent carbon markets are good places to start our Net Zero journey

- **~90% of emissions are addressable** through 3 broad levers:
  - **Energy transition:** The region must transition from resource extraction to electrification, leveraging opportunities in energy efficiency, renewables, emerging carbon capture and storage (CCS) technologies, and hydrogen
  - **Valuing nature:** Technology and financial innovations will help SEA 'better price' its large, undervalued natural resources, which can be protected to serve as carbon sinks and biodiversity banks
  - **Agri-food system transformation:** Agriculture is a major contributor to income and employment, but also emissions; to decarbonize, SEA must engage and enable smallholder farmers to adopt sustainable practices, but also seek to establish itself as a global leader for food tech

B

Leveraging enablers for scale will be key – voluntary markets and digital innovation are critical

- **Beyond decarbonization**, scaling the region's **voluntary carbon markets** will catalyze SEA's Net Zero transition by pricing carbon while incentivizing protection of our natural capital and contributing socioeconomic benefits to the region
- SEA holds immense potential, particularly in **nature-based solutions**, and innovation is accelerating: by 2030, ~$10 billion revenue opportunities across the value chain may be generated from SEA offsets
- A growing **green data revolution** is increasing the availability of massive amounts of data, intelligent models, and predictive analytics, which are able to scale our ability to monitor and accelerate progress toward sustainability goals
- There are green shoots in **digital innovation taking place in SEA**, with Singapore's digital twin and the geospatial mapping of SEA forests as prime examples

C

Businesses play a significant role in the journey to Net Zero

- **The green economy offers a sizeable opportunity** of ~$1 trillion by 2030, which can be realized through (a) decarbonizing existing business models, and (b) building new, sustainable businesses
- **Southeast Asian (SEA) businesses are mobilizing** (number of SBTi signatories in SEA increased from 4 in 2019 to 25 in 2021) but have room to grow: SBTi-committed businesses represent 4% of market cap in SEA vs. 27% globally
- **Ambitious Net Zero goals need corresponding actions** and commitments. To do this, businesses should establish their baseline and set their ambition, develop a roadmap aligned with business strategy, and set up a green organization to scale successful implementation

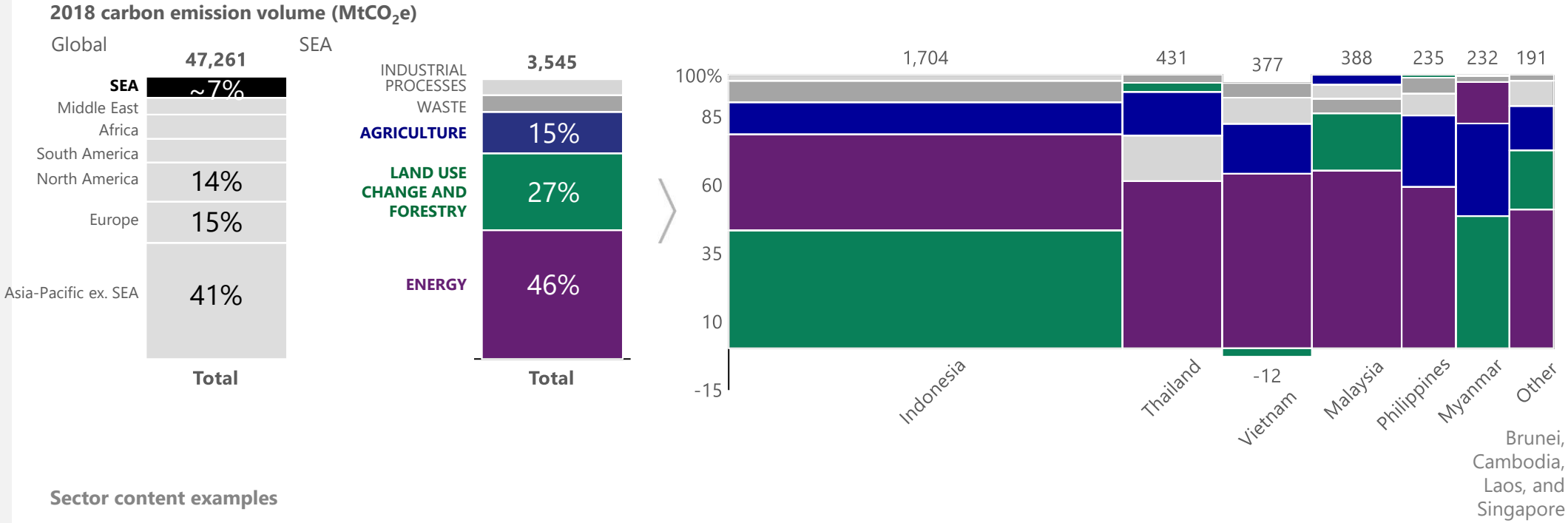
D

At-risk workers and communities need to be supported to ensure a just transition

- **Protecting the jobs and livelihoods** of SEA's at-risk workers and vulnerable communities during the transition is essential for an equitable low-carbon future
- Workers need to be supported through the transition (e.g., through financing and upskilling), social safeguards must be put in place, and communities must be consulted in order to ensure green developments do not endanger coastal, rural, and Indigenous livelihoods
- If done right, the Net Zero transition offers significant opportunities for the region in the form of ~5 million new jobs

Energy, land use change and forestry, and agriculture are the biggest emitting sectors in SEA

Three sectors contribute to ~90% of SEA emissions



Sector content examples

Energy:
Emissions from energy generation and consumption across all industries, e.g., transport and heating in manufacturing/ industrial/agriculture processes

Land use change and forestry:
Emissions and removal of carbon from human-induced land use e.g., urbanization, deforestation

Agriculture:
Emissions from enteric fermentation from livestock, fertilizer application, manure management, etc.

Waste:
Direct emissions from landfills, wastewater treatment, sewage, etc.

Industrial processes:
Non-energy-related emissions such as release of embodied carbon in cement

Notes: Sectors based on Intergovernmental Panel on Climate Change (IPCC) definitions

Sources: Climate Watch

Building blocks on SEA's Net Zero journey

Decarbonize

Energy transition

Address growing energy security and demand through cleaner sources

Valuing nature

Assign value to and protect the region's natural capital as carbon sinks and biodiversity banks

Agri-food system transformation

Empower smallholders to adopt sustainability while building out SEA as the alternative-protein hub

Others: Waste and industry emissions management

Leverage enablers

Voluntary carbon markets

Compensate for hard-to-abate emissions, scale decarbonization solutions by pricing carbon, and protect SEA's natural capital while leveraging its potential to serve global need and contributing to the region's socioeconomic development

Data and digital

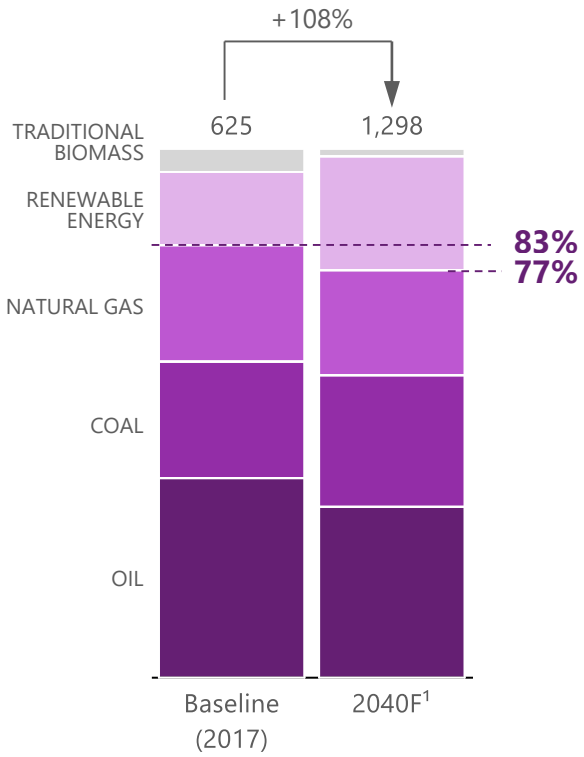
Catalyze innovation and scale sustainability impact through the green data revolution

SEA has set an ambition to transform its energy mix, but more measures are required to decrease the region's reliance on fossil fuels

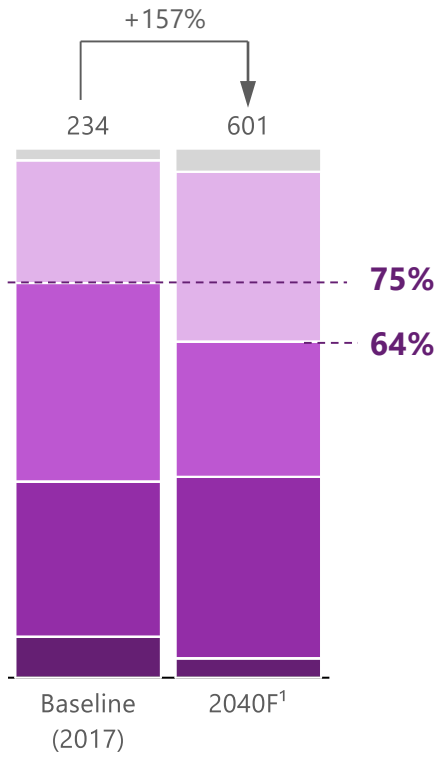
Fossil fuels to remain dominant source for SEA's growing energy demand

% fossil fuels

SEA total primary energy supply (Million tons of oil equivalent)



SEA total installed power capacity (Gigawatts)



Notes: 1. Projection based on ASEAN Centre for Energy's publication in 2020, which considered existing and upcoming policies at both national and regional levels, and corresponds to the ASEAN Phase 2: Plan of Action for Energy Cooperation (APAEC) 2021-2025's target scenario. Even in ASEAN's progressive scenario, total primary energy supply is still expected to increase by 83% between 2017-2040

Sources: ASEAN Centre for Energy; ASEAN Plan of Action for Energy Cooperation (phase II: 2021-2025); Asia Clean Energy Partners; Climate Analytics; Mongabay; the 6th ASEAN Energy Outlook

Momentum is building in the transition away from fossil fuels, though a long way to go

Non-exhaustive

National divestment plans

Coal moratorium (Oct 2020): no longer accepts proposals for new coal-fired power plants

Draft power plan (Feb 2021): no new coal-fired power plants except those under construction/planned for completion by 2025

No new plants (May 2021): to stop building new coal-fired plants after 2023

Corporates and financiers' announcements

SMBC MIZUHO: To **stop loans for coal-fired power** generation in 2020

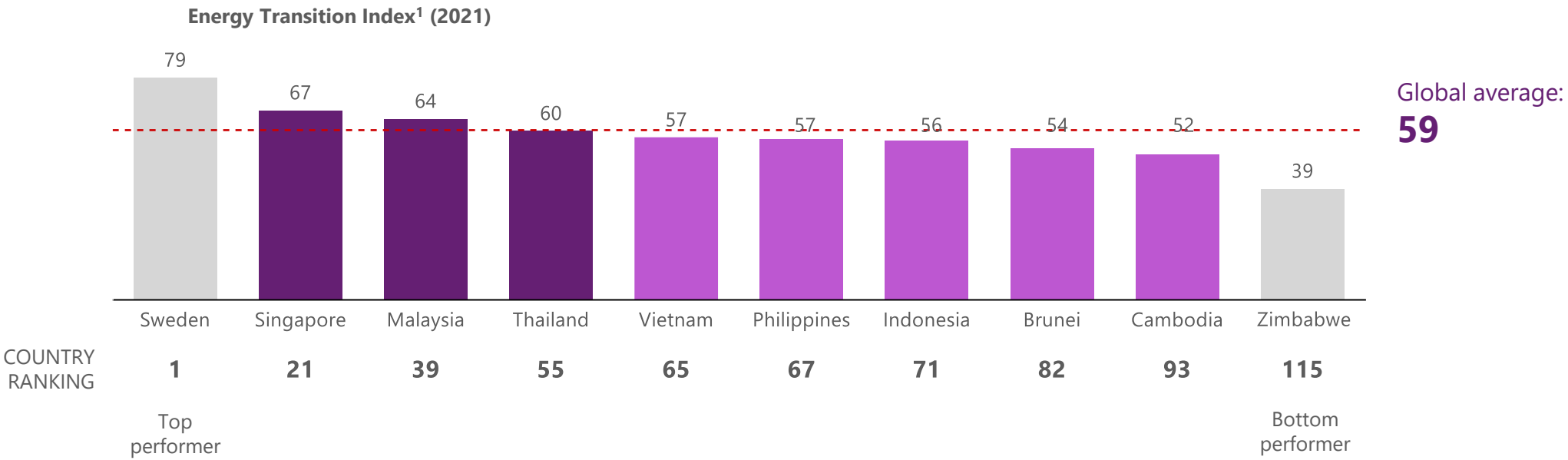
TENAGA NASIONAL: Will **no longer build any new coal-fired power plants** after commissioning the last one in 2019

CIMB: To **phase out coal from its portfolio** by 2040

ADB: To **exit financing coal, oil, and natural gas** exploration and extraction activities (May 2021)

Most SEA countries still lag in transition readiness despite regional targets

Stable government support, sufficient capital deployment, and human capital development essential to enable transition



Notes: 1. Energy Transition Index benchmarks progress on energy transition in 115 countries and is made up of 2 main dimensions: 1) Transition Readiness captures the state of underlying enablers needed for energy transition such as stability of the policy environment and level of political commitment, investment climate and access to capital, human capital and level of consumer engagement, and development and adoption of new technologies and 2) System Performance Score captures the energy system's current ability to deliver its functionality in terms of meeting demand and granting sufficient access in a sustainable manner; 2. For job creation potential, 2.5x more jobs expected to be created for every $10 million investment in renewables and energy efficiency relative to fossil fuels, which will also require different skills/expertise

Sources: World Economic Forum (ETI data not available for Laos and Myanmar); Sustainable Energy for All; UNESCAP

> *"Lack of predictability [of policies] is a big issue in this region"*
>
> SEA Energy Investment Director, Government Investor Co

~$27 billion

Annual investment needed to support renewables, electrification, energy efficiency, etc.

2.5x

Job creation potential[2] relative to conventional energy industry

Priority imperatives for SEA to transition toward a cleaner energy system

A
DECARBONIZE
ENERGY TRANSITION

Reduce

Efficient production and design

Minimize emissions through more efficient design and use of energy and materials

SEA imperatives (key actions)

Efficient consumption

Most SEA countries do not have regulatory requirements for energy and materials efficiency in building design

Implement efficient design standards and regulations with corresponding financial incentives for implementation

Effective urban mobility

Urban congestion contributes to emissions and air pollution (e.g., Manila, Jakarta, and Bangkok are in top 50 of Traffic Index)

Build public transport infrastructure and digitalize urban transport systems and routes to reduce congestion

Substitute

Renewable energy generation

Transition toward cleaner sources of energy

Scaled capacity

SEA has high potential for renewables, but unreliable legal and regulatory frameworks increase risks and costs for private investment in this space, despite low costs

Leverage international support (e.g., multilateral development banks) and introduce reforms to encourage investment

New baseload source

Long-term reliance on fossil fuels for energy security with complex government subsidies and support

Promote policies to disincentivize fossil fuels and explore alternative baseload sources (e.g., geothermal)

Alternative fuels

Adopt alternative, low-carbon fuels

Modern bioenergy

Conversion of abundant biomass feedstocks into biofuels could potentially provide up to two-fifths of the region's projected needs for transport fuel

Develop supply chain to convert feedstocks to fuel and advance the adoption of clean, innovative bioenergy

Low/no-carbon hydrogen

Investments in low-carbon hydrogen production have gained traction globally in past 1-2 years although SEA has yet to pick up the trend

Develop infrastructure needed to support low/no carbon hydrogen economy (e.g., renewable energy sources)

Scale

Grid modernization

Upgrade grid infrastructure for renewables

Electricity access

~45 million people currently lack electricity access, primarily in rural areas; most SEA countries target 100% access by 2030

Deploy microgrid solutions and distributed renewable energy to expand geographical reach

Improved infrastructure

Current electricity infra-structure is not integrated across countries to efficiently distribute variable renewable energy; latest SEA energy plan to drive grid resiliency

Digitalize existing grids with smart technology and expand regional electricity trading

Electrification

Replace fossil fuel technology with substitutes that use electricity

Electric vehicles (EV)

SEA market is nascent with consumer usage pattern yet to be established, but momentum is picking up

Develop charging infrastructure and incentivize EV adoption

Remove

Carbon capture, utilization, and storage

Leverage technology to remove CO_2 from concentrated sources/atmosphere

CCUS[1]

SEA's uptake of CCUS technology still nascent, as costs remain high and few government incentives. Seven identified projects under development by MNCs[2]

Provide support for heavy adoption of CCUS across industries, as well as foster regional cooperation for shared infrastructure

Notes: 1. Carbon capture, utilization, and storage; 2. Multinational corporations

Sources: ASEAN Energy; Black and Veatch; ERCE; ERIA; IEA; IRENA; Nissan; Numbeo; World Bank; World Resources Institute; The Economist

Numerous technologies and innovations enabling the transition

High relevance to SEA

★ Digital/data innovations

Non-exhaustive

Reduce

Efficient production and design

Minimize emissions through more efficient design and use of energy and materials

Substitute

Renewable energy generation

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Alternative fuels

Adopt alternative, low-carbon fuels

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Upgrade grid infrastructure for renewables

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Remove

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Leverage technology to remove CO_2 from concentrated sources/atmosphere

Technology readiness (global): HIGH → LOW

Technologies and innovations

- Alternative refrigerants
- Appliance and equipment/ process efficiency ★
- Design and construction improvement
- Waste heat recovery
- Smart energy-management system ★
- District heating/cooling network
- High-speed public transport
- Intelligent traffic system ★
- Hydropower
- Nuclear
- Geothermal (electricity and heating)
- Solar photovoltaic (PV)
- Solar thermal (electricity and heating)
- Wind
- Marine energy
- 4th generation nuclear
- Sustainable biogas/ biomass/biofuel
- Low/no-carbon hydrogen production, storage, transportation and use
- Electric vehicle and charging infrastructure
- Smart grid and energy management ★
- Ultra-high voltage direct current transmission
- Next-generation battery and energy storage
- Electrification in buildings and industry
- Carbon transport
- Carbon capture and storage
- Direct air capture
- Carbon utilization (e.g., concrete and biomass)

Sources: IEA; IRENA

Businesses are innovating across levers

Non-exhaustive

A DECARBONIZE
ENERGY TRANSITION

Reduce

Start-ups

TURNTIDE
Energy-efficient electric motor system

enVerid
Energy savings. Air quality.
Energy-efficient HVAC[1] systems for buildings

waycare
Cloud-based platform for proactive traffic management

Substitute

insolight
High-efficiency solar panel with optical layer to concentrate light

H2PRO
Electrolyzers for green hydrogen production at scale

KITE//KRAFT
Low-cost flying wind turbine solutions

hypoint
Hydrogen fuel cell for air transport and urban air mobility

FERVO ENERGY
Enhanced geothermal systems enabling significant cost reduction

(Biofuel Evolution)
Low-carbon bioethanol from households, agriculture, and food waste

Scale

envelio
Intelligent grid platform supporting integration of distributed generators

instagrid
Portable battery for applications with high energy density demand

Power Ledger
Blockchain-enabled P2P energy trading platform

QuantumScape
Solid state batteries capable of faster charge times and longer range for EVs

LINEVISION
Dynamic Line Rating tech with noncontact sensors and analytics

CHARGENET
Hardware-agnostic, off-the-shelf EV charging SaaS[2] solution

Remove

climeworks
Active commercially viable direct air capture technology

neustark
Recycled and CO_2-enriched concrete

CEMVITA FACTORY
Carbon utilization to produce chemical products and polymers

Corporations

SIEMENS
Smart building digital twin for efficiency optimization and data gathering for future design

TARGET
Goal to source 100% of electricity from renewable sources by 2030

TOYOTA
Hydrogen engine technologies and partnerships to expand hydrogen refuel infrastructure

General Electric
GridNode Microgrid and Distributed Energy Resources management solutions

TESLA
Million-mile battery lasting an electric car's entire lifetime in development

ExxonMobil
Low Carbon Solutions – new business focusing on carbon capture and storage technologies

DAIKIN
New refrigerant blend for electric vehicle to improve efficiency of HVAC systems

equinor
Major investments in wind and solar; target to grow renewables capacity tenfold by 2026

Microsoft
Experiments on use of hydrogen fuel cells to power data centers

MITSUBISHI ELECTRIC
Joint venture with Siemens Energy to replace GHG[3] with clean air in insulation for high-voltage switching solutions

Shell
2.5 million EV charging-points installation target worldwide by 2030

DOW
Part of cross-border carbon-capture consortium in North Sea Port (Belgian-Dutch area)

Notes: 1. Heating, ventilation, and air-conditioning; 2. Software as a service; 3. Greenhouse gas

Sources: Company website; CrunchBase

Data and digitalization have begun to play a key role in decarbonization efforts

★ Digital/data innovations

Case studies | Non-exhaustive

Reduce

Schneider Electric

- Appliance and equipment/process efficiency ★
- Smart energy-management system ★
- Intelligent traffic system ★

Utilizes AI/ML and IoT[1] to build smart factories, optimize own logistics, and provide customers with smart solutions in energy efficiency

Smart planning and scheduling management reduces machine **downtime by ~44%** at their Batam, Indonesia, Smart Factory

Predictive modeling optimizes transport route to **minimize emissions** (air-sea-road)

Power Advisor (analytics-based service) **optimizes performance** and reliability of **electrical systems** that power large facilities

Vasakronan

- Smart energy-management system ★

Harnesses IoT and digital twin solutions to unlock the potential of connected, intelligent properties to drive efficiencies

Cloud-based IoT solution suite enables **digitalization** of multiple processes, including those concerning **energy efficiency**

Digital twin representations allow for **energy optimization** of operations for buildings and physical assets

Smart IoT application automates analyses and detection of building improvements and repairs required

Substitute/Scale

DOOSAN

- Appliance and equipment/process efficiency ★
- Wind
- Smart grid and energy management ★

Develops digital twins for wind farms to maximize energy production

IoT sensors gather data from thousands of data sources such as wind farms and weather forecasts

Machine learning models predict **optimal production** output of each wind turbine to fine-tune operations

Optimized **energy storage systems** and **microgrid solutions** enhance storage and distribution

VATTENFALL

- Electric vehicle and charging infrastructure ★
- Smart grid and energy management ★

Leverages AI[1] and smart sensors to provide customers with a mobile app to optimize heat consumption while rolling out EV charging infrastructure

Developed a mobile app and installed IoT sensors to remotely control heating to reduce energy consumption and improve customer satisfaction

25,000 EV charging points built since 2016 across Northern Europe

Smart energy management to optimize electricity at EV charging points if other parts of the grid require more electricity

Notes: 1. Artificial intelligence, machine learning, and internet of things

Sources: Microsoft; Business Times; Industry interviews; Smart Energy; Vattenfall

02

CATALYZE THE JOURNEY

Surbana Jurong leverages IoT and data to improve electrical efficiency of buildings and cities while reducing their carbon footprint

Global urban, infrastructure, and managed services consulting firm headquartered in Singapore, with over 70 years of experience delivering projects in more than 30 countries

A

DECARBONIZE

ENERGY TRANSITION

SURBANA JURONG

CASE STUDY

Digital facilities management

Digital platform using IoT sensors to improve building operations efficiency

>32,000

IoT sensors installed and managed across buildings in Singapore since 2000

44% savings

in energy consumption in Surbana Jurong's new campus

Smart city-management service

City management as a service using digital twins and predictive modeling to increase efficiency and climate resilience

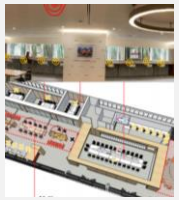
30% reduction

in resident complaints

80% increase

in user feedback through natural language processing algorithms

THE JOURNEY



Launch of 24K integrated platform to operationalize IoT sensor data

Legacy telemonitoring of 24,000 lifts spurred Surbana Jurong's push toward smart buildings and city management. Through the 24K platform, users can visualize real-time monitoring data on an integrated dashboard, enabling better management of energy consumption and indoor air quality

Surbana Jurong's new campus at the core of sustainability ethos

Slated to launch by the end of 2021, the campus embodies sustainable design principles such as use of precast materials, rooftop solar panels, and smart energy-management systems to minimize the building's carbon footprint

LEARNINGS

Demonstration of value critical for adoption of sustainability solutions

Surbana Jurong helps clients quantify the impact of embodied carbon in tangible terms (e.g., equivalent to the number of cars on the road) and provide sustainable alternatives that minimize any potential negative cost impact

> "*__Data and technology underpin our entire sustainability journey__. With our 24K platform, clients can elevate their sustainability journey and achieve their goals through close __energy efficiency monitoring__ and granular __scope 1 and 2 emissions data capture__*

Sources: Company website; Company interviews

HOW IT WORKS

Digital facilities management

IoT sensors collect data from building mechanical and electrical systems

Data (e.g., temperature) is collected and aggregated to generate usage-pattern reports

Building managers use reports to optimize system operations and electricity consumption

Use cases:

- Energy management
- Security and surveillance
- Indoor air-quality monitoring

Smart city-management service

IoT sensors across the city collect data for predictive modeling

A digital twin is created, and its performance is simulated with different scenarios (e.g., day vs. night)

City operators preemptively calibrate city's systems to operate at optimum levels in different scenarios

Use cases:

- Energy management
- Climate and flood modeling
- Traffic monitoring

WHAT'S NEXT

Singapore-wide digital twin operationalized for climate resilience	Create an AI/ML-powered predictive engine that uses real-time data from IoT sensors to create digital twins, better anticipate climate incidents (e.g., floods), and facilitate rapid response to minimize disruptions
Integration of 24K platform to improve access to green financing	Provide banks and insurers more transparency and data on building and operational emissions to better enable green debt and insurance underwriting (i.e., improved financing terms, reduced premiums) while reducing "greenwashing" risk
Affordable, sustainable housing with biomimetic design	Provide affordable and sustainable housing to lower-middle income families in the region that are more energy efficient by leveraging biomimetic designs

> *"We are pushing aggressively to break the norms of design; our ambition is for **all our projects to be sustainable while incorporating more digital innovations***
>
> *Eugene Seah, Managing Director, Smart City Solutions, Surbana Jurong*

Promising early activity in SEA

A DECARBONIZE
ENERGY TRANSITION

★ Digital/data innovations

Case studies | Non-exhaustive

Reduce

SENSOR FLOW

Technologies:

- Smart energy-management system ★

Overview:

Monitor analytics and control automation to reduce hotel energy usage

~30% Potential savings in energy bill and carbon footprint

10 Hospitality group clients (e.g., Marriott, Hyatt, Accor)

Substitute

SUNSEAP

Technologies:

- Solar PV

Installation and management of solar PV

>30 $KtCO_2$ avoided from building clients

>25 $KtCO_2$ avoided from retail clients

Scale

CANOPY POWER

Technologies:

- Solar PV
- Battery
- Smart grid and energy management ★

End-to-end microgrid systems and project financing

Since founding in 2016:

>10 Projects

6 Countries

Remove

PETRONAS

Technologies:

- Carbon capture and storage
- Carbon utilization (e.g., concrete and biomass)

First CCS project underway – target completion in 2025

Offshore CCS project in Sarawak to capture and convert CO_2 into petrochemical products

Conceptual engineering design contract recently awarded to a British firm

Sources: Company websites; The Star

Several high-potential commercial opportunities for businesses to participate in SEA's energy transition

A DECARBONIZE
ENERGY TRANSITION

Non-exhaustive

1 Here and now opportunities

Energy efficiency technologies

As various energy efficiency technologies become **more mature with decreasing cost**, they present **potential 'quick-win' opportunities** with **positive returns on investments (ROI)** for businesses to assess and adopt

Solar energy with battery storage

SEA countries are actively enhancing **national policies** aligned with the regional targets for renewable energy. **Increasingly attractive investment opportunities** will develop in this space given the **scalability** of this solution

Grid infrastructure overhaul

Increasing share of renewables in the region's overall energy supply as well as the region's **efforts to increase grid interconnectedness** will continue to unlock investment opportunities in this area

2 Over the horizon opportunities

ESTIMATED TIME HORIZON

EV ecosystem

As **electric vehicles gain momentum** in the region due to shifting customer demand and increasing tax incentives, **charging infrastructure, engine, battery, etc. will need to be developed** to enable adoption

0-5 years

CCUS

Opportunities today mostly limited by unit economics to MNCs under global decarbonization agenda or **large corporations** with **government backing.** Private investments could be possible with subsidies, especially for use in heavy industries. Direct Air Capture technology could be a game changer but is even further from commercialization

5-10 years

Low/no-carbon hydrogen

Low-carbon hydrogen, which is currently more cost competitive in the US/EU, has the potential to unlock a **multitude of economic opportunities** in energy storage, chemical feedstock, transportation etc. in SEA. However, **innovation and development the region still lags today**. To tap into the **game-changing potential of no-carbon hydrogen** (attainable once prices are ~$2/kg), the region needs **more infrastructure investments** and governmental alignment to **increase the supply of renewable energy**.

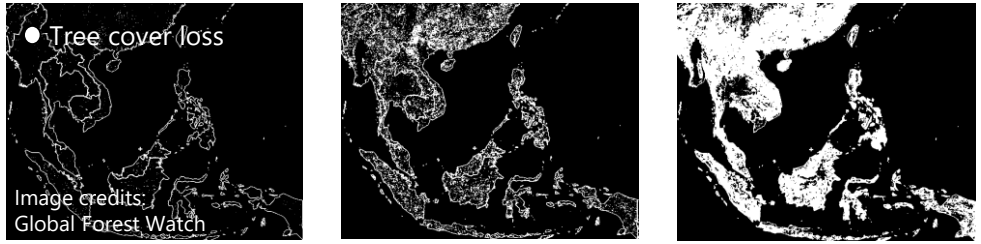
5-10 years

SEA holds one of the most valuable natural capital resources globally

However, high rates of deforestation make the region's LUCF[1] a net emitter

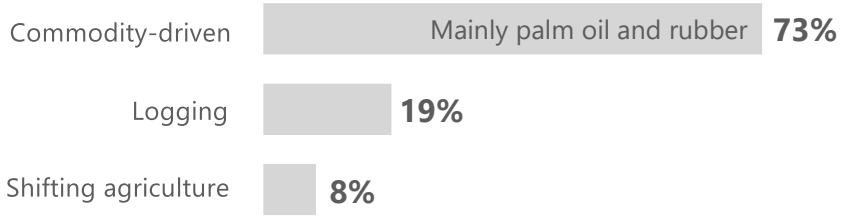
SEA has highest rate of deforestation globally, driving disproportionate contribution to emissions

40 million ha (~17%) of forests lost since 1990



1990 2005 2020

Main drivers:[2]



SEA contribution to global emissions (2018):

SEA has enormous potential for climate mitigation

560 $MtCO_2e$

Annual mitigation potential in standing forests – **largest globally in terms of** financially viable, investible carbon stock

4.8 Gt

Blue carbon storage potential from mangroves and seagrass – **highest globally**

But time is limited; potentially

100% Loss in peatlands by 2030

50% Loss of forest cover by 2050

Notes: 1. Land use change and forestry; 2. Commodity-driven deforestation refers to conversion of forest land for permanent farming (majority) and mining. Shifting agriculture refers to practice of clearing small areas of forest for cultivation and moving on once the soil loses its fertility

Source; NTU; WRI; Climate Watch; Ecosperity; Europa; Earth; Trends in Ecology and Evolution; Nature; Down To Earth; Global Forest Watch

Conservation and restoration of the region's natural resources also has significant co-benefits

		In SEA
Biodiversity protection	Indigenous, endangered vegetation and wildlife can thrive in restored habitats	**20%** of **world's biodiversity** **6** of 25 global **biodiversity hotspots**
Air and water quality improvement	Increased vegetation captures pollutants in ambient air and water	**~2 million** **Premature deaths** from **air pollution** annually, with significant contribution from burning of forests
Disaster and weather event mitigation	Forest ecosystems help stabilize climate and reduce devastation from severe flooding	**4** of 10 SEA countries ranked in top 10 at **risk of extreme climate change** globally **17-37%** Combined **GDP loss** from climate impact by 2050 2°C-3.2°C scenarios
Socio-economic/ cultural value preservation	Preservation of community livelihoods reliant on natural capital	**438 million** Sizeable population (67% of 655 million total population) **dependent on forest** areas for subsistence and income

Sources: The Diplomat; BBC; Eckstein et al., 2017; Poffenberger et al., 2006; CNA; ADB; Swiss Re

Priority imperatives to conserve and restore SEA's natural capital

A
DECARBONIZE
NATURE

Conserve

Avoided forest loss

Reduce emissions from deforestation and land use change

Blue carbon ecosystem protection

Prevent losses of mangroves, seagrasses, salt marshes, etc.

Avoided peat impacts

Reduce biomass and soil carbon emissions due to degradation

Restore

Peat restoration

Restore peat soils for carbon sequestration

Reforestation and afforestation

Plant trees to increase or restore forest cover

Blue carbon ecosystem restoration

Restore mangroves, seagrasses, and marshes

Manage

Natural forest management

Monitor and sustain forest health

Working land management

Reduce emissions from working land practices

SEA imperatives (key actions)

Reduced land used for agriculture

~80% of forest loss in SEA due to commodities (mostly permanent farming of palm and rubber) and shifting agriculture

Minimize unsustainable forest conversion for plantations by employing measures that improve productivity per plot and reduce need for further land use conversion

Elimination of illegal logging

40-60% of timber production in Indonesia is logged illegally

Deploy remote detection technology to monitor and respond to illegal logging activity

Peatland rewetting and maintenance

~97% of global tropical peat carbon sinks are in SEA. Today, ~90% of these are drying up due to degradation

Introduce large-scale measures to rewet peatlands and technologies to monitor and manage peat health

Strategic reforestation

Though SEA has ~120 million ha of land available for reforestation, much less is suitable when direct and opportunity costs and other constraints or risks are factored in

Leverage tech, e.g., geospatial mapping and drones, to identify optimal reforestation sites and enable more efficient forest/mangrove planting

Restoration of blue carbon ecosystems

SEA contains the largest mangroves and seagrass stock globally, which are rapidly being degraded by aquaculture

Research and adopt best blue carbon restoration initiatives

Fire detection and response

>300,000 ha p.a. of forests burnt in Indonesia between 2017-2019

Deploy technology to detect illegal slash-and-burn activity and mitigate fires

Remote monitoring

~200 million ha of forests – too much for SEA to manage manually

Digitalize forest management and utilize telemetry to remotely monitor large areas of trees for health and risks

Reduced forestry impact

Logging, an oft-hidden source of emissions, contributes to ~20% of deforestation in SEA

Adopt sustainable practices and technology to minimize damage from logging activities

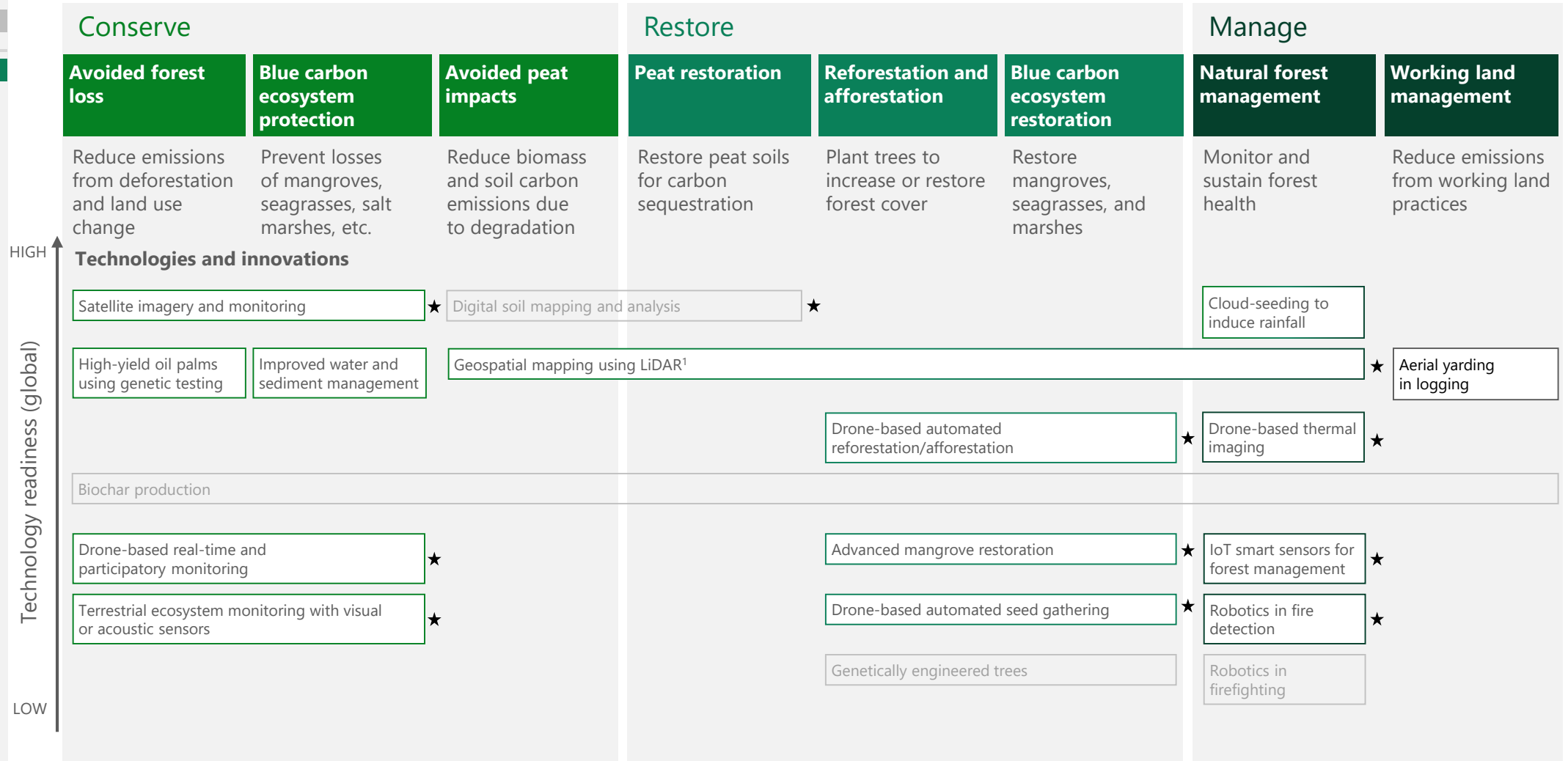
Sources: Royal Society Publishing; Reuters; Europa; NTU; Mishra et. al.; CNA; BBC; The Straits Times; Peatlands; Bain analysis,

Innovations are emerging to scale adoption of levers, many of which are digital

A DECARBONIZE
NATURE

High relevance to SEA
★ Digital/data innovations

Non-exhaustive



Notes: 1. light detection and ranging

Sources: Royal Society Publishing; Good Tech Lab Impact Tech Report 2019; Bain analysis; Eco-Business

Businesses are innovating across levers

CATALYZE THE JOURNEY

A
DECARBONIZE
NATURE

Non-exhaustive

Conserve

Start-ups

- Orbital Insight — ML-enabled monitoring
- SATELLIGENCE — Satellite monitoring of deforestation
- RAINFOREST CONNECTION — Acoustic forest monitoring
- UPSTREAM TECH — ML-enabled remote monitoring software
- planet. — Satellite imagery data
- STARLING — Satellite monitoring for palm oil-driven deforestation

Corporations

- Disney — Forest and wildlife conservation project financing
- Framework development to value blue carbon ecosystems
- Unilever — Incentives to suppliers for forest protection and regeneration
- Walmart — Biodiversity conservation project financing and strict sustainable sourcing

Restore

Start-ups

- dendra SYSTEMS — Drone-based reforestation
- drone seed — Drone-based reforestation
- LAND LIFE COMPANY — Smart reforestation on degraded land
- Terraformation — Scaled forest restoration
- Living Carbon — Genetically engineered trees
- REFORESTUM — Community reforestation platform

Corporations

- DANONE — Regenerative agriculture and soil health research to benefit farms and communities
- Microsoft — AI for Earth platform and data sharing for conservation and restoration
- Nestlé — Reforestation/agroforestry project investments and sustainable sourcing initiatives
- Regenerative grazing project development to address degraded pasture

Manage

Start-ups

- INSIGHT ROBOTICS — Forest fire detection robots
- TIMBETER — Smarter logging
- TREEVIA — IoT forest management
- overstory — AI-optimized forest management
- Pachama — AI tracking of forest activity
- COLLECTIVE CRUNCH — Forest inventory management SaaS

Corporations

- L'ORÉAL — Dedicated nature restoration fund through the L'Oréal Fund for Nature Regeneration
- amazon — Carbon credit market entry grants for small family forest owners

Sources: Company websites; CrunchBase

Promising early activity in SEA

★ Digital/data innovations

Case studies | Non-exhaustive

Conserve

RAINFOREST CONNECTION

Terrestrial ecosystem monitoring with visual or acoustic sensors

AI, cloud-based listening devices monitor rainforests in real time for illegal logging, with high focus on SEA[1]

0
Incidents of logging within monitored area in Sumatra since installation[2]

3 km
Listening radius of each device

Restore

FORRU

Drone-based reforestation ★

Actively experimenting with and researching automated forest restoration

>9
Forest restoration projects across SEA

>200
Publications on forest and biodiversity restoration

Manage

katingan mentaya PROJECT

IoT forest management ★

Leverages satellites to remotely detect hotspots as an early warning system

150,000 ha
Forest area monitored

7.5 million
Triple-gold-certified carbon credits annually

Notes: 1. Rainforest Connection's first project was in Indonesia in 2013 and piloted a project in the Philippines in 2021; 2. According to forest patroller report that "logging has totally stopped"

Sources: Straits Times; Straits Times (2); Nikkei; Washington Post; My Cebu; Company websites,

02

CATALYZE THE JOURNEY

Jejak.in protects Indonesia's forests by using a wide array of technologies to measure, report, and verify (MRV) carbon sequestration

Seed stage start-up focused on carbon measurement in forest areas
Based in Jakarta, launched in 2018 with 1-10 employees to date

A

DECARBONIZE

NATURE

Jejak.in

CASE STUDY

Digital forest monitoring program

Devices developed in-house to monitor forests and collect critical data (e.g., soil and air quality)

10 million
trees are registered under Jejak.in's monitoring program

28,400 ha[1]
of land are registered under Jejak.in's monitoring program

Online carbon offset marketplace

Enables individuals and businesses to purchase carbon credits to offset their carbon footprint

>15,000
tons of carbon sequestered through online marketplace

>3,000
individuals planting trees via online marketplace

20 partners
today supported by more than 1,000 forest caretakers

mrt jakarta

Jejak.in helps passengers calculate their carbon footprint and offers carbon credits for purchase via its online marketplace

Notes: 1. Represents 0.03% of Indonesia's total estimated forest acreage (92.1 million ha)

Sources: Company website; Company interviews

THE JOURNEY

Better impact monitoring for conservation programs

Corporate conservation initiatives have faced challenges from manual monitoring, double counting, and the inability to accurately measure the carbon sequestration potential and impact of projects. Jejak.in's platform enables accurate impact measurement and forest monitoring while augmenting on-the-ground verification personnel (e.g., mobile upload of environmental data, augmented reality tree measurement). Leveraging IoT and LiDAR sensors, drones, and satellites, environmental data (e.g., carbon storage and sequestration, biodiversity) are collected. They are then automatically analyzed with AI/ML models, thereby reducing reliance on manual efforts and increasing the reliability of measured impact

Development of an end-to-end solution to streamline climate action

Leveraging Microsoft's AI for Earth grants and technical resources, Jejak.in has developed a holistic solution that enables businesses to independently calculate emissions, offset carbon via forest conservation programs, and remotely monitor forest conservation efforts

> *"When we started, we realized that corporate forest conservation programs **lacked the ability to accurately monitor and measure their carbon sequestration potential**. With Jejak.in, corporations now have **more visibility on their impact** and consequently a **better way to evaluate their programs***

HOW IT WORKS

Forest conservation monitoring

IoT sensors in the forest, drones, and satellites collect detailed environmental data in forests (e.g., carbon stock, biodiversity) that allows for **accurate carbon stock monitoring** and the **generation of high-quality carbon credits**

Emissions accounting	Online carbon offset marketplace	Forest MRV
		
Measures scope 1, 2 and 3 carbon emissions for companies and individuals	Provides a marketplace to allow the **purchase of forests to offset carbon emissions**	**Carbon impact reports** generated and visualized through interactive MRV dashboards

Notes: 1. Additionality ensures carbon reduction that would not have happened in the absence of offset, no leakage ensures that the offset does not result in redirection of emissions and permanence ensures carbon removed does not re-enter the atmosphere

LEARNINGS

Government engagement critical to establish ecosystem fundamentals

During the development of Jejak.in's platform, engaging with Indonesia's Ministry of Environment and Forestry was critical as they provided large reliable environmental databases while research institutes were crucial in providing the expertise to accurately measure carbon emissions and sequestration potential

High-quality carbon offsets crucial to reduce greenwashing risks

Generating high-quality verifiable carbon offsets through an automated monitoring platform that have additionality, no leakage, and permanence[1] is critical to reduce the risk of "greenwashing." As such, Jejak.in's founder recognized early on the need to hire those with deep sustainability expertise to develop the platform

WHAT'S NEXT

Expansion into new markets

Expand and launch products and services in other countries in SEA, by the end of 2021

Establishment of Indonesia's first carbon offset marketplace

Launch Indonesia's first digital blockchain-based carbon offset marketplace, to more accurately prevent double-counting issues

> *"Access to reliable data was a big challenge for us. By partnering closely with various key stakeholders, we were able to tap into their databases and expertise to **build an accurate and reliable AI/ML model***

> *"The **climate crisis we are facing is real and we need to do something about it.** Indonesia and its natural capital has the potential to play a leading role*
>
> *Arfan Arlanda, CEO & Founder, Jejak.in*

Several high-potential commercial opportunities for businesses to participate in SEA's natural capital conservation and restoration

Non-exhaustive

1 Here and now opportunities

Forest conservation
Scalable conservation projects that protect standing **tropical forest stock and biodiversity hotspots** may command **significant carbon credit premiums due to co-benefits**

Peatland maintenance or rewetting
Huge untapped potential for carbon credit generation from **carbon-dense tropical peatlands**, which can store 10-20x more carbon than a typical mineral forest

Remote monitoring technologies
Automated and digital monitoring and detection systems enable wide-scale, real-time visibility of natural capital "assets," mitigating risks from illegal logging, land use conflicts, and forest fires

Spatial productivity for working lands
Technologies that **enhance yield** per unit area and reduce forest conversion, especially in the palm oil industry, will have outsized impact due to the crop's regional economic significance

2 Over the horizon opportunities

Estimated time horizon

Advanced/automated reforestation
Reforestation in SEA today faces prohibitive costs and lower ROI than avoided deforestation projects. This could change with automated reforestation using drones (from seed gathering to seeding), strategic planting through geospatial analysis, and planting genetically modified trees

0-5 years

Mangrove restoration and conservation
New methodologies to measure wetland carbon make it easier to assign a value to the protection and restoration of SEA's **mangroves.** These ecosystems are better than terrestrial forests at sequestering carbon and offer many socioeconomic benefits (e.g., improved flood and erosion protection, increasing economic resilience) to communities that depend on healthy coastal fisheries

0-5 years

Seagrass restoration and conservation
Seagrass meadows could present an important source of blue carbon credits due to their **high rate of carbon sequestration** and **low risk of land use conflicts**. However, lack of data on seagrass sequestration impedes its viability as an opportunity today

5-10 years

Sources: Bain analysis; Reuters

Agriculture is the third biggest emitting sector – as the region's economic backbone, production is expected to grow with rising food demand

Top 5 SEA countries contributing to agriculture emissions have heavy economic dependency on the sector

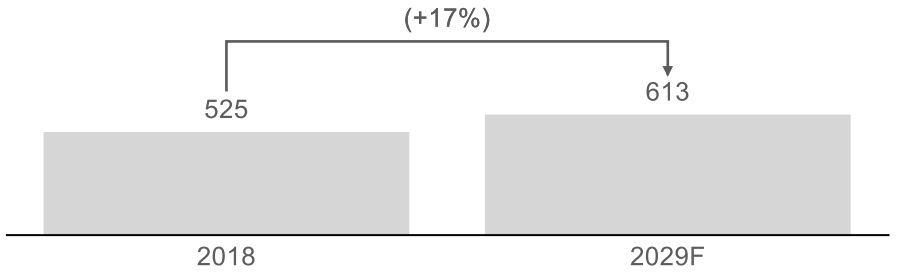
Agriculture sector[1] of SEA countries with highest agriculture emissions (latest data available)

5 counties contribute to ~90% of all SEA agriculture emission

Estimated	Percentage of 2020 GDP[2]	Percentage of employment[3]	Percentage of SEA agriculture emission
Myanmar	~23	~49	~15
Vietnam	~15	~37	~14
Indonesia	~14	~29	~38
Philippines	~10	~23	~12
Thailand	~9	~31	~13
SEA overall	~10	–	–

Continued growth expected as countries ramp up production to meet rising food demand (especially protein consumption) both regionally and globally

Agriculture production for ID, VN, TH, and PH[4] (tons, million)



Notes: 1. Sectors based on IPCC definition; 2. 2020 data inclusive of agriculture, forestry and fishing (based on World Bank definition); 3. 2019 data (latest year available from Food and Agriculture Organization) includes paid employment and self-employment; 4. ID-Indonesia; VN: Vietnam; TH-Thailand; PH-Philippines; Projection by Organization for Economic Co-operation Development (OECD) in 2020; forecast not available for Myanmar – production includes key commodity products: cereals, oilseeds, sugar, meats, dairy, fisheries, cotton, roots and tubers, and pulses

Sources: FAO; OECD; Oxford Economics; World Bank

Along with direct emissions, agriculture also drives other negative environmental impacts

In SEA

Direct emissions	Direct emissions of GHG from agriculture activities	Rice contributes to **~80%** of the region's cereal production and is **>5x** more emission-intensive relative to an average cereal crop
Deforestation	Loss of forest cover through conversion of land for agricultural use	**~45%** of sampled oil palm plantations are converted from forest areas. Palm is a significant regional industry
Water security and pollution	Impact on water resulting from irrigation as well as polluted agriculture drainage	"*Many rivers in the region are highly polluted with domestic, industrial and agricultural waste thus causing the Water Quality Index (WQI) to reach unsafe levels*" — THE ASEAN POST
Energy consumption	GHG emissions from energy consumption to power agriculture activities	Increasing production levels and adoption of new agricultural technologies lead to higher energy requirements

Sources: FAO; Vijay et al, 2016; The ASEAN Post

Priority imperatives in SEA for transition toward sustainable agri-food system

A DECARBONIZE

AGRI-FOOD

Sustainable production

Align current cultivation practices to regenerative principles while maintaining/enhancing productivity

Optimized protein mix and production

Maintain/enhance livestock productivity while scaling alternatives

End-to-end traceability

Create end-to-end traceability to enable efficient and transparent supply chain

Minimal food loss and waste

Reduce food loss/waste to moderate production requirement

Dietary shift

Empower people to become more responsible consumers

SEA imperatives (key actions)

Field testing and knowledge building

60% of SEA agriculture population are smallholders who mostly lack knowledge on climate issues and are largely motivated by financial benefits

Collect data to prove tangible cost and revenue uplift from sustainable practices

Precision farming and other sustainable agriculture practices

Regional staples like rice are particularly water and emissions intensive, and small-holders' traditional practices are typically not sustainable (e.g., flooding fields)

Encourage use of precision farming tools and drip irrigation systems to optimize resource use, and genetic engineering to increase yields and reduce emissions intensity

Financing innovation

Uptake of new technology by smallholder farmers requires significant financial support from public and private sectors, but SEA countries vary in agriculture PPP[1] model maturity – some are still nascent (<3 years)

Use PPPs, asset leasing models, and subsidy conditions to incentivize and scale adoption of advanced inputs and transformative techniques by farmers

Alternative cultivation

Traditional outdoor farming products dominate due to high proportion of smallholders with limited access to capital

Explore alternative cultivation methods (e.g., vertical farming) to boost production

Alternative protein

Meat alternatives are gaining traction among SEA consumers

Invest in R&D[2] for alternative-protein and promote region's traditional protein sources (e.g., tofu)

Advanced digital tools

Rising internet penetration (~60% in SEA) and connectivity enable more sophisticated traceability solutions than radio-frequency identification (RFID)

Incentivize mass adoption of next-gen logistic solutions using IoT, real-time supply chain tracking, and food waste management platforms

Universal standards

Global food standards are becoming increasingly advanced (e.g., EU Green Deal), though the World Health Organization identified significant gaps in SEA

Drive adoption of global/regional standards for data collection, governance, and sharing to streamline food supply chain management

Upcycle/recycle

Food waste likely to increase from growing population

Invest in development and adoption of sustainable food upcycling/ recycling

Dietary education

Meat demand likely to increase by ~5% annually in SEA for next 10 years

Raise consumer awareness on consumption climate impact and encourage shift toward sustainable consumption patterns (e.g., remain poultry- and pork-focused which is less emission intensive than red meat, and buy locally sourced products)

Access to sustainable products

Sustainable, alternative food products remain more expensive

Increase customers' ability to purchase more sustainable food products through subsidy/other policy measures

Notes: 1. Public-private partnerships; 2. Research and development

Sources: ASEAN; CGIR; GSMA; OECD; Research Dive; WHO; WWF; Industry interviews; 2020 SEA e-Conomy report

Multiple levers and innovations available to support transition

A DECARBONIZE
AGRI-FOOD

High relevance to SEA
★ Digital/data innovations

Non-exhaustive

Sustainable production	Optimized protein mix and production	End-to-end traceability	Minimal food loss and waste	Dietary shift
Align current cultivation practices to regenerative principles while maintaining/enhancing productivity	Maintain/enhance livestock productivity while scaling alternatives	Create end-to-end traceability to enable efficient and transparent supply chain	Reduce food loss/waste to moderate production requirement	Empower people to become more responsible consumers

Technologies and innovations

Technology readiness (global): HIGH → LOW

- Organic/sustainable fertilizer and pesticide
- Modern drip irrigation
- Genome editing
- IoT, monitoring, and analytics to support production ★
- Automation and robotics to support production ★
- Advanced controlled environment cultivation system (e.g., vertical farming)
- Whey protein
- Plant-based protein
- Insect protein
- Low-emission cattle feed
- Algae protein
- Fermentation-based protein
- Cell-based protein
- Barcode and RFID ★
- Smart warehouse/inventory management system ★
- IoT and process/tracking digitalization ★
- Food sensing/biosensing
- Blockchain-based traceability and transparency ★
- Retail/consumer food waste management platform ★
- Active packaging
- Sustainable treatment, preservative, and storage
- Sustainable upcycling/recycling (e.g., compost, anaerobic digestion, dehydration)
- Conscious-consumption platform ★

Sources: Eden Green; EU Commission; FAO; Food Navigator; Food Packaging Forum; Good Food Institute; INSEAD; Labiotech; Lux Research; Market Watch; MHandL; Nature; Silicon Republic; ASEAN Post; Tony Blair; Warp News; Waste2; Wipo Green; World Resources Institute

Businesses are innovating across levers

A DECARBONIZE
AGRI-FOOD

	Sustainable production	Optimized protein mix and production	End-to-end traceability	Minimal food loss and waste	Dietary shift
Start-ups	PHOSPHOLUTIONS Sustainable fertilizer delivering nutrients to plants more efficiently Rivulis Satellite data and hyper-local weather info for site-specific irrigation recommendations and crop health monitoring iFarm Software platform and modular components/units to set up vertical farms	VOLTA GREENTECH Feed supplement to reduce methane emissions from cows PRECISION LIVESTOCK TECHNOLOGIES Sensor-based technology and software to optimize animal production operations Perfect Day Fermentation-based technology creating animal-free dairy protein	MarketMan Inventory and payment software for foodservice operators and their suppliers FARM FARE Digital platform and distribution services connecting producers to wholesale channels safetraces On-food traceability solutions using DNA-based tags	mimica Smart packaging label/cap that changes texture when the food has spoiled wasteless AI-powered dynamic pricing engine for markdown optimization to reduce wastes OUTCAST Plant-based supplements from fruit/vegetable waste	crisp App-only supermarket for locally sourced seasonal products ODDBOX 'Wonky' and surplus vegetable/ fruit box delivery scheme evocco Mobile app tracking food shopping's carbon footprint
Corporations	Cargill Initiative to support farmers in adopting regenerative agriculture practices on 10 million acres of cropland in US by 2030 BAYER Joint investment with Temasek to form new company focused on developing breakthroughs in vertical farming	Cargill Cattle wearable neutralizing part of enteric methane as it is exhaled while capturing behavioral/physiological data Tyson New line of plant-based meat products including fresh patties, ground 'beef,' fake bratwurst, and Italian sausage	Mondelēz International Blockchain food traceability program for Triscuit brand, allowing customers to track origin of food through QR scan IBM IBM Food Trust – network of growers, processors, wholesalers, and others on IBM blockchain to share food records	 Substitution of plastic trays with ones made from food waste and other recycled materials Walmart 'Eden' – a machine learning algorithm that scans produce to assess quality and freshness	BURGER KING 'Impossible Whopper' burger made with plant-based, protein-filled patty WHOLE FOODS MARKET Partnership with Infarm to install vertical farming to grow and sell produce in-store

Sources: Company website; CrunchBase

Data and digitalization have begun playing key roles in decarbonization efforts

★ Digital/data innovations

Non-exhaustive

Sustainable production

慧云信息 TALENTCLOUD

Technology:

IoT, monitoring, and analytics to support production ★

Overview:

Digital solution using IoT, machine learning, and cloud technologies to provide data-driven insights that help farmers increase their agriculture productivity sustainably

Highlights:

Cloud-based IoT hub supports data collection from millions of sensors in real time, **>10x increase in rate of data collection**

Machine learning models process data to deliver up-to-date, customized crop management recommendations

Automated machine learning capabilities help to optimize models and allow for ~65% of **reduction in debugging time**

iberCaja

Technology:

IoT, monitoring, and analytics to support production ★

Overview:

Digital solution using IoT, AI, and cloud technologies to deliver real-time weather and moisture data to farmers to support their decision making

Highlights:

IoT-enabled boxes containing sensors gather data on temperature, light, moisture, wind, etc. and upload to cloud **every 15 minutes**

Web platform presents data to farmers in real time to support benchmarking and decisions, resulting in **significant savings** on **water and electricity** and **better crop yields**

Database to be set up to support insight generation about fields (e.g., profitability and crop loss forecast to inform financing decisions)

regrow

Technology:

IoT, monitoring, and analytics to support production ★

Overview:

Integrated data platform for crop management, regenerative agriculture, and carbon MRV and monitoring

Highlights:

MRV software **leveraging satellite data, remote sensing, and soil modeling** to help farmers accurately quantify soil carbon sequestration

Cloud-based crop management and analytics platform allows farmers to monitor crop performance and stress to optimize profitable and sustainable agricultural practices

Integration of publicly available **satellite imagery** used to better understand conservation information and boost yields sustainably

Sources: Microsoft

Leading SEA businesses are also leveraging data to scale impact across levers

★ Digital/data innovations

Non-exhaustive

A
DECARBONIZE
AGRI-FOOD

Sustainable production

VillageLink

IoT, monitoring, and analytics to support production ★

Mobile farming application, digital advisory, and farming intelligence software leveraging satellite data

Access to satellite data allows for **contextualized weather advisory services** based on geolocation and predicted weather conditions

AI and image recognition technologies to detect and provide recommendations for pests and diseases

Mobile platform utilized to conduct detailed assessment at scale, enabling updated crop monitoring and benchmarking

End-to-end traceability; Minimal food loss and waste

Olam AtSource
Re-imagined by Olam

IoT and process/tracking digitalization ★

Centralized digital platform to improve management, efficiency, and visibility of overall trading activities along the agri-food supply chain (contracting, risk management, operations planning, etc.)

Cloud-based infrastructure offered through platform-as-a-service business model enables quick delivery of a scalable solution

Rule-based engine automates creation of contracts, invoices, and shipment documents, **reducing time taken for month-end cycles by ~25%**

AI/ML leveraged for deployment of chatbots at scale to support operations

Sources: Company website

02

CATALYZE THE JOURNEY

eFishery uses data and IoT to improve smallholder fishery productivity and sustainability

Series B agri-tech start-up ($20 million raised) focused on aquaculture intelligence in Indonesia (pilots in Thailand and Vietnam)
Based in Bandung, launched in 2013 and has more than 250 employees

A

DECARBONIZE

AGRI-FOOD

eFishery

CASE STUDY

IoT fish and shrimp feeders

optimize feed quantity and automate feeding time for smallholder farmers

Smallholder fishery services

host an online marketplace to market produce and provide smallholders access to financing

>15,000 farmers
have purchased feeders

Up to **~2x** increase
in farmer annual net profit

>30% reduction
in production lead time by optimizing feeding schedule and frequency

Up to **35%** increase
in production yield by reducing feed waste

Up to **~35%** reduction
in feed waste

Sources: Company website; Company interviews

THE JOURNEY

Feeders as productivity tools to empower underserved smallholders

Few innovations address smallholder farmers' needs due to the perception of unattractive economics. As such, smallholders typically still feed by hand, resulting in sub-optimal feeding, water pollution (nitrogen from excess feed), and wastage. The eFisheryFeeder helps farmers optimize feed costs (~70-90% of all costs) by improving productivity while reducing wastage and water pollution, thereby empowering farmers to be more sustainable while improving their profitability and livelihoods

Smallholder farmers' needs at the core of the innovation process

eFishery's design process focuses on developing products that farmers can afford and understand. For example, eFishery uses vibration-based sensors (fish movement correlates with hunger) over more sophisticated underwater cameras and acoustic sensors because they are more affordable and easier to operate

> *"As a former fish farmer, I knew that if the feeder was too expensive or complex, farmers would not be able to afford or understand it. As such, my biggest aim and challenge was to design **a feeder that kept the complexity and costs as low as possible***

HOW IT WORKS

eFishery platform

eFisheryFund

Provides farmers increased financing access through BNPL[1] loans underwritten by smart-feeder data

eFisheryFresh

Farmers can sell their produce via an online marketplace for more profit enabled by eFisheryFeed's lower cost feed

eFisheryFeeder

The feeder and mobile app collect fish yield and harvest profit data through IoT sensors and farmer inputs, combined with AI/ML, to calibrate feed dosage and underwrite loans to farmers

eFisheryFeed

eFishery's BNPL loans enable farmers to purchase lower cost feed through bulk purchase programs

Notes: 1. Buy-now pay-later

LEARNINGS

Community building and education critical for smallholder adoption

Building a personal relationship and educating farmers to move away from entrenched traditional methods (e.g., hand feeding) were critical for early adoption

Important to ensure fair value distribution across supply chain

Including incumbent distributors into the marketplace allowed eFishery to create a mutually beneficial system that leveraged distributors' supply chain capabilities to expand farmers' reach while creating incremental value for all stakeholders

WHAT'S NEXT

By 2025:

~1 million

farmers with eFisheryFeeders

~10

countries (which hold ~80% of global aquaculture production) with eFishery presence

> *"You **cannot 'hack' smallholder penetration** – it's **all about relationship building**. What mattered to farmers in the early days was not our tech but **the quality of our relationship and trust with them. The positive word of mouth from our first customers** then helped us generate more traction*

> *"Our ambition is **to become the world's largest aquaculture cooperative**, to empower smallholder farmers with sustainable practices and encourage consumers to **transition from higher-emission meats** (e.g., beef and lamb) **to fish, which has a lower carbon impact***

Gibran Huzaifah, CEO & Co-founder, eFishery

Many other SEA firms are making significant progress across levers

★ Digital/data innovations

Non-exhaustive

A DECARBONIZE
AGRI-FOOD

Optimized protein mix and production

NutritionTechnologies
Innovation. Naturally.

Technology:

Insect protein

Organic/sustainable fertilizer and pesticide

Overview:

Manufactures animal feed protein, oil, and organic fertilizer from black soldier fly larvae

>80,000
Tons of waste annually diverted from landfills[1]

>10,000
Fish saved by providing a substitute for fishmeal[1]

TurtleTree

Technology:

Cell-based protein

Overview:

Utilizes biotechnology to develop (the world's first) cell-based milk

>90%
Carbon footprint reduction

Exact
Composition, functionality, and taste compared to traditional dairy milk

End-to-end traceability

DIMUTO

Technology:

Blockchain-based application ★

Overview:

Offers blockchain technology to digitalize food products for end-to-end visibility along supply chain

>30 million
Pieces of fruit tagged and tracked to date

>100 million
Equivalent transaction value

Dietary shift

abillion

Technology:

Conscious-consumption platform ★

Overview:

Provides plant-based reviews and discoveries through mobile application

>250,000
Community members globally

>50,000
Product brands and restaurants reviewed

Notes: 1. When production facility is at scale

Sources: Company websites; Green Queen; KrASIA

Several high-potential commercial opportunities for businesses to participate in SEA's agri-food transformation

A DECARBONIZE
AGRI-FOOD

Non-exhaustive

1 Here and now opportunities

Advanced production tools

Leveraging innovative financing/business models (e.g., asset leasing models) to **drive adoption of more advanced tools/technologies for farmers** to sustainably improve production yield of crops like rice (e.g., automation, monitoring, analytics, etc.)

Digital service platforms for farmers

Growing internet and mobile device usage in the region provides an opportunity to **give smallholder farmers access to sophisticated services** (e.g., analytics/advisory on production, trade and market access, etc.) remotely through a digital platform

Digital supply chain solutions

As various solutions (e.g., real-time tracking, platform to manage food waste, etc.) become **more mature with decreasing cost**, their adoption in SEA will likely accelerate due to the solutions' **potential to demonstrate tangible cost savings**

Plant and fermentation-based alternative-proteins

Provision of alternatives to meat-based protein sources will help SEA to **buffer against the expected overall rise in demand for meat** products as the region develops. Plant-based protein alternatives and traditional proteins (e.g., tofu, tempeh) are ready to scale, while bio-fermentation is a critical lever that can radically reduce land use needs

2 Over the horizon opportunities

ESTIMATED TIME HORIZON

Upcycling technologies

Evolving suite of new technologies can **unlock the significant value of food loss** along value chain which may still retain its nutrients (e.g., surplus, damaged products, processing leftovers, etc.) by **bringing it back into a consumable state**

0-5 years

Cell-based alternative-protein

While not yet commercialized, lab-based protein is capturing interest from a **growing sustainable consumption movement**, fuelled by Covid-19. Further investments will allow SEA to fulfil its potential as a **global food technology hub**

5-10 years

Sources: Bain analysis

Priority imperatives for SEA to address in **waste and industrial sectors**

Waste management and circularity

Optimized production and consumption

Reduce the amount of nonrecyclable and hazardous waste generated

Improved waste management

Improve management, recycling and upcycling of waste

SEA imperatives (key actions)

Sustainable production

Overproduction in SEA contributes toward ~150 Mt of municipal solid waste (MSW) annually (~8% of global)

Optimize efficiency in production using big data and predictive analytics to reduce waste

Cleaner waste-to-energy and industrial symbiosis

Significant value creation opportunities in treating waste as a resource

Adopt efficient segregation and sorting solutions, advanced waste-to-energy methodologies, and greener composting

Advanced sustainable materials

>30 Mt of plastic waste generated each year form SEA, with countries having the highest share of plastic waste deemed mismanaged

Develop and adopt more sustainable materials to substitute single-use plastics and other nonrecyclable materials

Increase rate of recycling

Open dumping and burning of MSW is prevalent in many SEA countries, while the overall recycling rate is only ~9%

Design for circularity and implement traceability solutions, policies, and financial mechanisms to incentivize recycling

Sustainable consumption

SEA's fast-growing economy (forecasted ~4% annually) and rising affluence leads to increased consumption and waste

Shift to sharing economy platforms, rental models, resale markets

Better management of hazardous waste and e-waste

>7 Mt of hazardous waste and ~2 Mt of e-waste annually reported from SEA

Establish legal framework, collection, and processing infra. for hazardous/e-waste

Industrial and construction

Reduced embodied carbon in construction

Minimize carbon released from life-cycle production, transportation and use of construction materials

Reduced process-related emissions

Mitigate and capture emissions released from non-energy-related chemical processes

Management of embodied carbon in construction

Accelerating construction to meet infrastructure gap and shorter life span of buildings due to urban renewals in SEA result in significant embodied carbon emissions from materials and construction processes throughout building life cycles

Maximize use of existing assets, optimize material use and design, employ low-carbon construction technologies, and plan for future use scenarios and end-of-life

Mitigation of process and fugitive emissions in manufacturing and industry

The nature of process and fugitive emissions make them difficult to assess. However, they form a nontrivial source of SEA emissions due to heavy petrochemical production and electronics manufacturing presence

Adopt stricter processes to prevent, manage, detect, and remove fugitive emissions, such as better designed valves, leak detection and repair programs, and technologies to capture emissions before they escape

Sources: ASEAN Today; Eco-Business; UNEP; Borgen Project

Multiple levers and innovations available to support transition

★ Digital/data innovations

Non-exhaustive

A DECARBONIZE

WASTE AND INDUSTRY

Waste management and circularity

Optimized production and consumption

Reduce the amount of nonrecyclable and hazardous waste generated

Improved waste management

Improve management, recycling and upcycling of waste

Technologies and innovations

Technology readiness (global): HIGH → LOW

- Compostable bioplastics and other recyclable plastic alternatives
- Digitalized sharing economy platforms to facilitate sustainable consumption ★
- Big data analytics to optimize production and reduce wastage ★
- rPET[1] facilities for plastic recycling
- Smart sorting using sensors or RFID ★
- Waste-to-energy technologies
- Chemical recycling of plastics with pyrolysis to create liquid fuels/feedstock
- AI-enabled image recognition for sorting ★
- Plastics traceability using blockchain and bio/chemical markers ★
- Plasma arc gasification to generate green hydrogen from waste

Industrial and construction

Reduced embodied carbon in construction

Minimize carbon released from life-cycle production, transportation and use of construction materials

- Embodied carbon assessment tools and project footprint calculators
- Big-data precision calculation and benchmarking to optimize material use ★
- Low embodied-carbon materials and design
- 3D printed pre-fabrication construction
- Circular, future-proof architecture with disassembly and recycling functionality

Reduced process-related emissions

Mitigate and capture emissions released from non-energy-related chemical processes

- Carbon capture and storage for industrial process emissions

Note: 1. Recycled polyethylene tetraphyte

Sources: Bain analysis; UNEP; IPCC; PreScouter

Businesses are innovating across levers

Non-exhaustive

A DECARBONIZE
WASTE AND INDUSTRY

Waste management and circularity

Start-ups

SECURITY MATTERS
Blockchain-enabled traceability with chemical markers for recycling

INEOS
Recycled polyethylene using depolymerization

Enerkem
Manufactures biofuels and renewable chemicals from nonrecyclable waste

CIRCULARISE
Blockchain-enabled traceability with digital twin

CELIUGY
Bionanocellulose-based plastic alternatives

STYLE THEORY
Sharing economy model to enable circularity in fashion

REDWOOD MATERIALS
Recycled essential metals from battery cell production and consumer electronics

RECYCLEYE
AI-enabled computer vision algorithm to identify and sort through waste streams

SG H2 ENERGY
Plasma-enhanced gasification to create green hydrogen from waste

Corporations

IKEA
Circular designs using recycled materials

Apple
Robotics to disassemble and recycle used phones

intel
90% recycling rate, with aims for 100% by 2030

adidas
Shoes made with recycled plastics and fishing nets

Nike
Circular designs and supply chain traceability

ESTĒE LAUDER COMPANIES
Investments in molecular plastic recycling tech

Industrial and construction

Start-ups

BETOLAR
Next-generation low-carbon alternative to cement

MIGHTY BUILDINGS
3D-printed buildings for Net Zero homes

One Click LCA
Automated life-cycle assessment and embodied carbon calculator

CARBON CURE
CO_2 mineralization in concrete to reduce need for cement

ICON
3D printing, robotics, and advanced materials for sustainable homes

tally
Carbon footprint assessment for buildings and architects

CarbiCrete
Cement substitute made from CO_2 and steel waste

THOMAS RAU
Recyclable building architecture that can be fully disassembled

LENDAGER GROUP
Circular architecture using upcycled and recycled building materials

Corporations

Johnson Controls
99% recyclable design for batteries

Turner
Carbon-neutral construction offerings

Worley
Management of carbon savings through sustainable solutions

hp
PCs made with recovered plastic from ecosystems

Bloomberg
Award for 'most sustainable office' at its European headquarters

CLARK CONSTRUCTION
Sustainable materials and life-cycle assessments

Sources: Company websites

Promising activity **emerging in SEA**

★ Digital/data innovations

Non-exhaustive

Waste management and circularity

gringgo

Technology:

- AI-enabled image recognition for sorting ★

Overview:

Addresses waste with AI-enabled image recognition tools that optimize waste sorting and drive the circular economy

+35% Recycling rates in pilot villages

+30% Monthly income for informal waste collectors using the app

Integrated Waste Management Facility (IWMF); Singapore Government

Technology:

- Cleaner combustion of waste
- Smart sensors for waste sorting ★
- Circular, future-proof architecture

Overview:

State-of-the-art facility with cleaner waste-to-energy solutions that adopt advanced boiler designs and emissions treatment systems (to be completed by 2028)

~30% High overall plant efficiency due to optimised designs and technology

>30 years Plant life span due to modular, future-proof design with easy dismantling

Industrial and construction

SCG

Technology:

- 3D-printed prefabrication construction
- Low-embodied-carbon materials and design ★

Overview:

Leverages low-embodied-carbon cement and 3D printing-enabled construction techniques

102 sqm 3D printed co-working space in Saraburi, Thailand

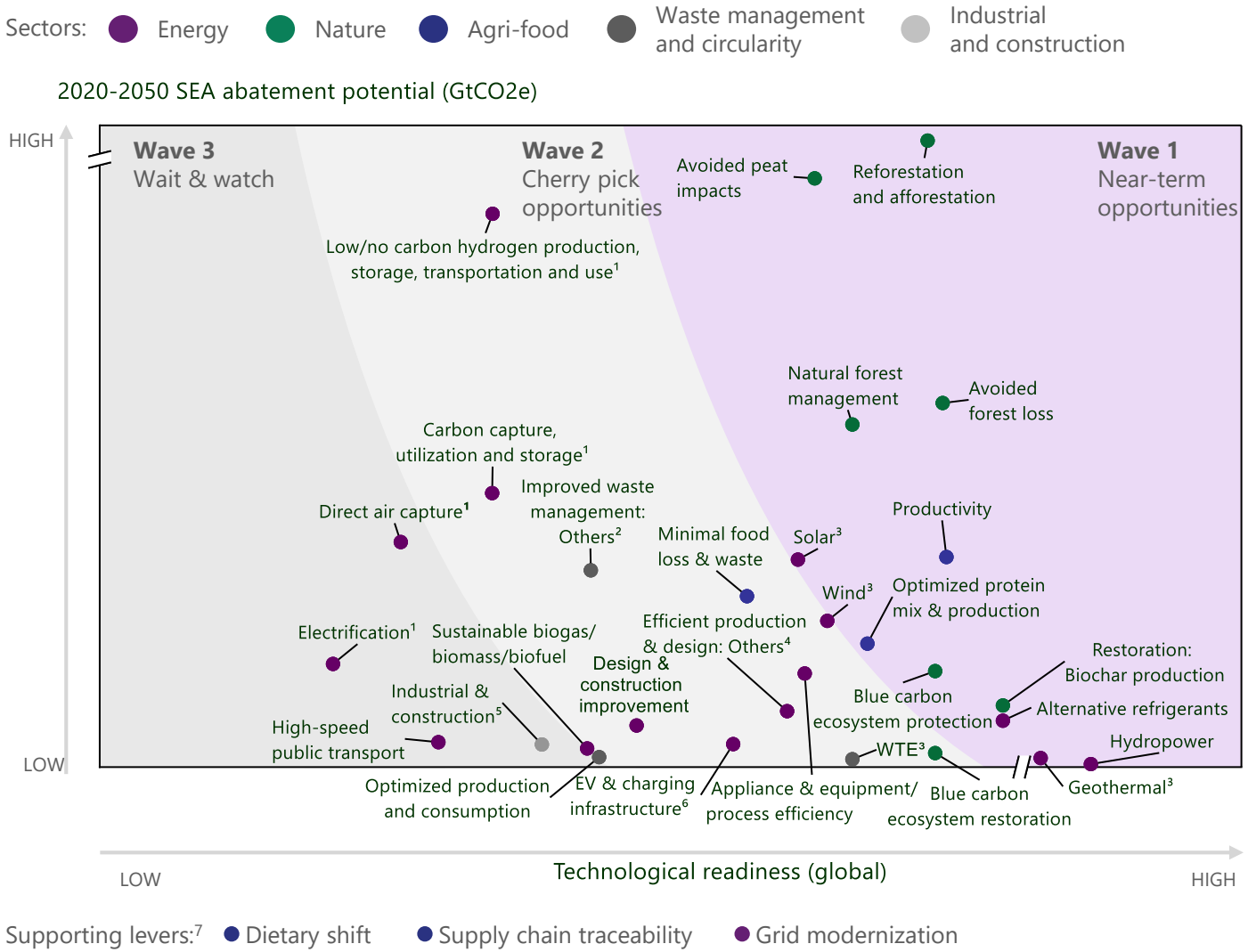
-25% Construction waste as a result of 3D printing

Sources: Company websites; NEA; 3D Printing Industry

SEA's Net Zero roadmap can be phased based on the technological readiness and abatement potential of levers

Directional | Non-exhaustive

A



SEA's natural capital holds the highest abatement potential in the near term

Conservation and restoration of the region's nature is a critical part of the solution, especially given today's state of technological maturity for other levers[8]

Solar and wind are the region's most promising renewables

Solar and wind provide relatively higher abatement potential that also present immediate opportunities due to rapidly declining costs. Grid modernization will be critical to mitigate intermittency of these sources

Hydrogen's abatement potential will be significant once unlocked

Once the technology matures, numerous decarbonization pathways (e.g., steel production, fertilizer feedstock) could benefit from commercialization of low/no-carbon hydrogen

Notes: 1. Hydrogen, CCUS, direct air capture and electrification abatement potential is estimated on a standalone basis and is not additive; 2. Improved waste management such as recycling; 3. Technology readiness assessment for solar, wind, geothermal and Waste-to-Energy (WTE) excludes more nascent technologies (e.g., airborne wind systems); 4. Others: waste heat recovery, district heating/cooling network, smart energy management system, intelligent traffic system, walkable cities, etc.; 5. Includes reduced embodied carbon in construction and process-related emissions; 6. Excludes hybrid or electric airplanes and more nascent charging technologies (e.g., smart charging, dynamic inductive charging); 7. Supporting levers do not have direct abatement potential but are critical enablers of others (e.g., grid modernization required to scale renewables); 8. Breakthroughs in innovations may change relative abatement potential of levers

Sources: IEA 2020 ETP Clean Energy Technology Guide; Project Drawdown; Climate Watch; HSBC; EIU; Bain analysis

Building blocks on SEA's Net Zero journey

Decarbonize

Energy transition

Address growing energy security and demand through cleaner sources

Valuing nature

Assign value to and protect the region's natural capital as carbon sinks and biodiversity banks

Agri-food system transformation

Empower smallholders to adopt sustainability while building out SEA as the alternative-protein hub

Others: Waste and industry emissions management

Leverage enablers

Voluntary carbon markets

Compensate for hard-to-abate emissions, scale decarbonization solutions by pricing carbon, and protect SEA's natural capital while leveraging its potential to serve global need and contributing to the region's socioeconomic development

Data and digital

Catalyze innovation and scale sustainability impact through the green data revolution

Scaling the voluntary carbon markets can accelerate SEA's Net Zero transition

Developing a robust carbon market will allow SEA to:

Enable and scale Net Zero levers

Balance climate targets with economic growth
While emissions reduction should remain the priority, SEA's economic growth and energy needs mean that fossil fuels cannot be cut out overnight. Carbon markets will allow countries to compensate for these hard-to-abate emissions while facilitating the gradual transition to a Net Zero economy

Scale decarbonization by pricing carbon
Voluntary markets can help to establish a carbon price (especially in the absence of compliance schemes or carbon taxes), enabling firms to better internalize the cost of emissions, while revenues from carbon credit generation can encourage smallholders to adopt more sustainable practices

Operationalize mitigation as quickly as possible
Nearer-term solutions to decarbonize will have a more significant climate impact relative to a perfect solution that is still years from deployment - carbon markets can facilitate mitigation while buying time for further technological development

Meet global need while contributing regional socioeconomic benefits

Propel the region on a global stage
SEA's wealth of natural capital makes the region an ideal front-runner to meet the market needs, but supply and infrastructure will need to be developed quickly before the world meets its needs elsewhere

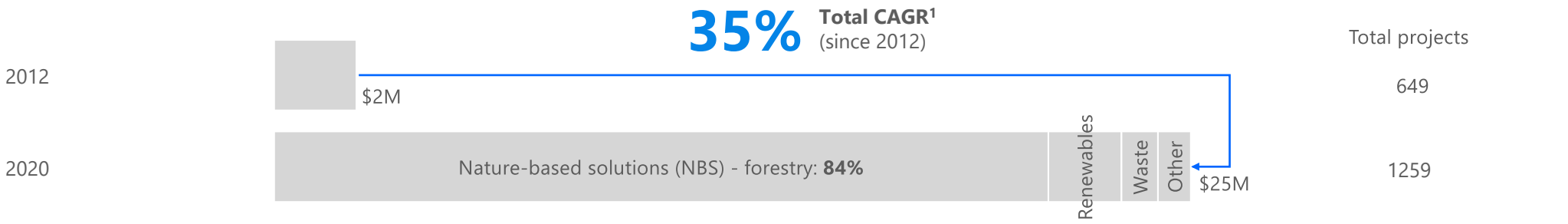
Generate socioeconomic co-benefits
Carbon crediting activities often result in preservation of biodiversity, improvements in ambient air and water quality, and protection of economic sectors such as agriculture, fisheries, forestry, and ecotourism

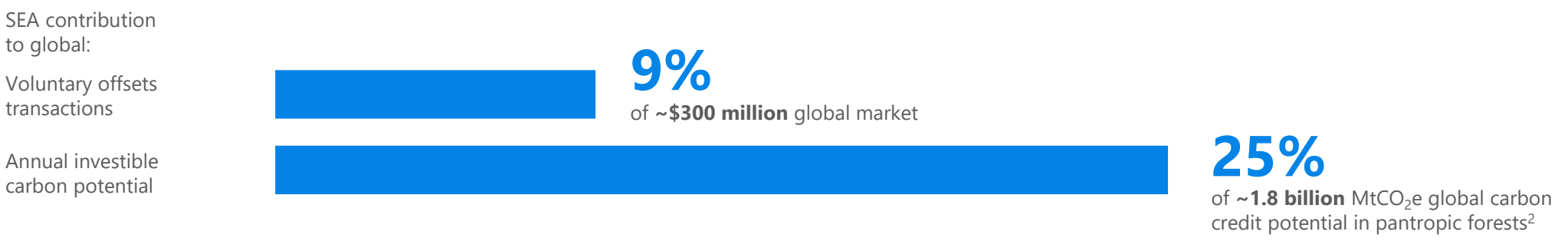
Spur green finance by improving bankability
Carbon credits provide an additional revenue stream to incentivize development of nature-based projects and decarbonization technologies that may be economically unviable today (e.g., direct air capture, etc.)

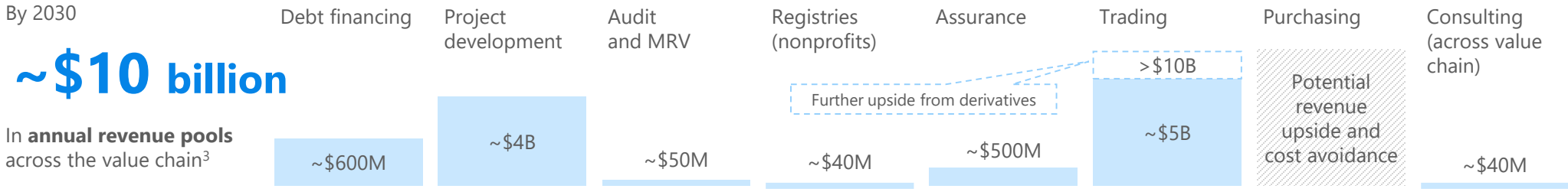
SEA voluntary carbon markets are nascent but growing quickly

Significant headroom for SEA's carbon markets to grow, especially given the region's outsized potential for nature-based solutions

SEA voluntary markets transactions are mainly made of forestry credits today







Notes: 1. Compounded annual growth rates; 2. Based on estimates of investible carbon stock in terrestrial forests in global pantropic regions; 3. Revenues across value chain from interest payments, offset sales, audit and monitoring fees, registry fees, assurance fees, offset resale, and commissions, respectively

Sources: Koh et al.; Allied Offsets; State of Voluntary Carbon Markets; Bain analysis

Priority imperatives for SEA's carbon markets

Unlock supply

Quality project development and pipeline visibility

Increase supply of high-quality carbon reduction projects

SEA imperatives (key actions)

Strengthened pipeline for carbon credit project

Many small, siloed projects in SEA

Aggregate smaller projects for scale benefits, increased visibility, and diffusion of best practices

New carbon crediting/ measurement methods

Untapped potential for carbon sequestration beyond forestry

Adopt new carbon measurement methodologies for sequestration techniques such as blue carbon

Assign value to natural assets

Significant co-benefits in SEA's natural assets for additional revenue

Use biodiversity/stapled credits for more revenues to scale projects

Lowered barriers to project development

Incentivize funding and reduce set-up costs and inefficiencies

Innovative financing models

Long lead times (3- to 7-year development cycle) and uncertainty in conflict with traditional funds' demand for quick returns

Adopt new funding models (PPPs, blended financing, smallholder models) to de-risk projects and increase private capital flow

Accelerate project set-up and verification

Long time to market (>1 year for verification in SEA) due to insufficient verification resources in the region

Digitalize and streamline verification processes by adopting AI/data-driven technologies

Improve integrity

Assurance and transparency in projects

Ensure integrity and accuracy of carbon avoidance/removal

Tech-enhanced assurance

>80% of SEA's offsets projects are in forestry. Impossible to manually monitor vast amounts of forest areas

Leverage technology such as satellites, drones, LiDAR, and machine learning to automate remote monitoring of carbon stock

Due diligence

Lack of governance bodies in SEA today may result in sub-optimal verification, fraud, and money-laundering, decreasing trust

Build expertise and services to enhance due diligence processes such as KYC and AML[1] protocols for carbon crediting projects

Establish fundamentals

Systematic capital allocation frameworks and regulation

Facilitate functioning market-based mechanisms

Consistent country-level regulations and policies

Inconsistent policies and standards at country/regional level interfere with a functioning voluntary carbon market (e.g., carbon taxes, ETS,[2] laws)

Establish consistent set of policies that builds on regional collaboration, and common taxonomy to make credits more uniform

Clear price signals

Widely heterogenous prices of carbon credits

Introduce carbon indices for clearer price signals

Green asset pricing models

Insufficient data and lack of common framework to value carbon projects

Establish meta-registries for data to build carbon pricing models

Infrastructure to facilitate trading and participation

Remove obstacles to adoption and provide liquidity

Trading infrastructure and marketplaces

Majority of SEA offsets are transacted through brokers (~40%), or direct from developers, driving large reseller premiums and variances

Develop centralized exchanges to improve visibility and liquidity and provide standardized price signals

Carbon derivatives market

Huge uncertainty and volatility in carbon prices may discourage participation or investment in project development

Develop and price carbon futures or forward contracts that enable developers or investors to hedge their exposure and lock in prices to reduce volatility

Notes: 1. 'Know your customer' and 'Anti money laundering'; 2. Emissions trading scheme

Sources: Allied Offsets; Industry interviews; Bain analysis

Scientific and technological innovations supporting the rise of carbon markets

High relevance to SEA
★ Digital/data innovations

Unlock supply

Quality project development and pipeline visibility

Increase supply of high-quality carbon reduction projects

Technologies and innovations

Technology readiness (global): HIGH → LOW

- Soil carbon crediting methods in agriculture
- Carbon crediting methods for blue carbon in mangroves
- Carbon crediting methods for blue carbon in seagrass meadows
- Carbon crediting methods for ocean carbon sequestration
- Science-based modeling and mapping of co-benefit value

Lowered barriers to project development

Incentivize funding and reduce set-up costs and inefficiencies

- Project fundraising using cryptocurrency tokenization ★

Improve integrity

Assurance and transparency in projects

Ensure integrity and accuracy of carbon avoidance/removal

- Digitalized due diligence and KYC ★
- AI/ML-enabled remote monitoring to ensure additionality, permanence and no leakage of credited offsets ★
- Digital twin technology for enhanced visibility and transparency over natural capital ★

Establish fundamentals

Systematic capital allocation frameworks and regulation

Facilitate functioning market-based mechanisms

Infrastructure to facilitate trading and participation

Remove obstacles to adoption and provide liquidity

- Carbon footprint calculators ★
- Integrated carbon exchange and marketplaces ★
- Advanced data infrastructure for transparency of market data ★
- Blockchain tokenization for transparency and traceability in transactions ★

Sources: Allied Offsets; Industry interviews; Bain analysis

Businesses are innovating across levers

Non-exhaustive

Unlock supply

Start-ups

The Blue Carbon Initiative
New methodologies in blue carbon sequestration measurements

Project Vesta
Coastal carbon capture methodologies through enhanced weathering

Farmfit Fund
Smallholder financing models

Conservation International
Innovative financing models for REDD+[1] projects through its carbon fund

Improve integrity

Pachama
Tech-enabled monitoring for offset quality rating

climatecare
Digitalized due diligence and KYC

Sylvera
Tech-enabled monitoring for offset quality rating

Single Earth
Digital twin technology and tokenization for forestry

Establish fundamentals

uphold
Blockchain tokenization of REDD+ credits

Moss
Blockchain tokenization of amazon forest credits

Nori
Agri-centric, blockchain-enabled offsetting

Patch
Simplified footprinting and offsetting

XCHG
Carbon offset contract exchange

AirCarbon Exchange
Integrated carbon trading exchange

Corporations

Task Force on Scaling Voluntary Carbon Markets
Private sector-led initiative working across the value chain to scale voluntary markets, with >250 member institutions

BNP Paribas, ClimateSeed, AXA Investment Managers
Integrated carbon marketplace prioritizing transparency and credibility with strict due diligence and quality assurance

CIBC, Itaú, nab, NatWest Group
Blockchain-enabled voluntary carbon marketplace called Project Carbon to support clients on their Net Zero journey

CME Group
World's largest financial derivatives exchange with a newly launched carbon offset futures contract

Note: 1. Reduced emissions from deforestation and forest degradation

Sources: Company websites; TSVCM; Ledger Insights

The seeds are being sown for a bustling carbon market within SEA

★ Digital/data innovations

Non-exhaustive

Unlock supply

2020

CONSERVATION INTERNATIONAL x P&G

Philippines Palawan Protection Project

Technologies:

New scientific methods in blue carbon measurement ★

Overview:

Aims to **protect 31 species of mangroves** in the Philippines and develop the region's **first blue carbon credits**

Highlights:

Utilizes **groundbreaking blue carbon** measurement method that accounts for **carbon stored in sediments** held in place by the **root systems of mangroves**

Improve integrity

2021

Grab x Shell x sembcorp x katingan mentaya PROJECT

GrabForGood

AI/ML-enabled remote monitoring ★

Provides **B2C[1] carbon offsetting** services to customers through the Green Programme – a partnership between **Grab, Shell, Sembcorp, and Katingan Mentaya Project**

Allows users to reduce their carbon footprint **by purchasing carbon credits** through the **Green Programme** feature on the app

Leverages **remote sensing and satellite imagery** to monitor and assess forest integrity and potential forest fires

Establish fundamentals

2021

Climate Impact X

Trusted carbon credits. Real impact

Integrated carbon exchange and marketplaces ★

Launched a **carbon credits exchange and marketplace** in Singapore – a partnership between **DBS, Standard Chartered, SGX, and Temasek**

Utilizes **satellite monitoring and machine learning** to ensure integrity of credits

Employs **blockchain technology** to ensure **transparency in transactions**

Notes: 1. Business-to-consumer

Sources: Green Biz; Earth Ledger; Its Our Home; Company websites

Key enablers to scale the region's carbon markets

Scaled-up supply of high-quality credits with improved transparency and integrity

While SEA holds immense potential for nature-based solutions, the carbon markets are held back today by low trust in the quality of offsets from this region and low liquidity, among other issues. Digitally-enabled technologies such as blockchain tokenization and remote monitoring provide opportunities to improve confidence cost effectively and attract the investors/buyers and capital required to scale. Favorable government policies are also required to incentivize project development

Strong demand signal from governments and plan for voluntary markets to coexist alongside compliance markets or carbon taxes

Carbon pricing mechanisms that factor in the true cost of carbon, combined with the acceptance of (high-quality) offsets by governments, will drive a big shift in capital and demand into the voluntary carbon markets. California, Japan, and China are examples of regions that allow use of offsets (within boundaries) in ETS

Regional framework to establish credible cross-border markets at scale

To truly scale SEA carbon markets on a global level, the region's countries will need to avoid carbon nationalism. Instead, policymakers from each country need to work together to establish a standard set of objectives, rules, and terminology that communicates clearly the role of offsets in the region's overall Net Zero agenda, with regionally-centralized registries and a system for corresponding adjustments[1]

Notes: 1. Corresponding adjustments are a tool designed to promote the integrity of emissions accounting under the Paris Agreement, preventing "double counting" of emissions

Sources: WRI; Brookings

The green data revolution is a major catalyst for innovation and scaling sustainability impact

Thematic developments in data and digital innovations are supporting scale-up of solutions

Instrumentation for de-averaged data

Accuracy and granularity
IoT sensors, precision monitoring equipment, etc at the base of data source

→ De-averaged data improves specificity and root cause analysis capabilities

Democratization of data

Ubiquitous data collection
Telemetry through satellite imaging, drones, LiDAR, smart sensors, camera traps

Complete supply chain data visibility
Materials to products, factories to stores

Private-public good datasets, data crowdsourcing

→ Emergence of global environmental datasets and meta-registries

Interoperability across data sources

Standardized definitions methods
SpatioTemporal Asset Catalog for standardized spatial data mapping

Improved techniques/tools for data harmonization

→ Pre-processed datasets freeing time up for analytics (what used to take months can now be done in hours)

Intelligent data processing and analytics

Powerful computing innovations
Advanced processors, quantum computing, AI/ML, real-time data testing, etc.

→ Exponentially smarter models, with increased training from volume of data processed

Large-scale cloud computing

Improved access and collaboration
Cloud and API[1] integration

→ Integrated data ecosystems allowing concurrent contribution and access, and efficient complex modeling with powerful compute capabilities (AI, ML, etc.) being moved closer to where data is stored

Co-innovation

Increasing collaboration
Expertise sharing between cross-sector and intergovernmental working groups is accelerating the flywheel of data impact in sustainability, from measuring and tracking to optimizing and innovating

Empowering leaders to jointly solve problems at scale with sharpened, data-driven insights and intelligent decision-making models

Notes: 1. Application programming interface

Sources: Datacenter News; Datacenter Knowledge; Bain experience; Industry interviews; Company websites

Large-scale data collaborations are poised to increase adoption of sustainability solutions globally

Data collaborations between global stakeholders such as ecologists, climate scientists, data scientists, and governments are driving game-changing outcomes by democratizing data and insights for businesses and decision makers

Non-exhaustive

	51 WORLD	OS-C	GEO GROUP ON EARTH OBSERVATIONS	Microsoft	GLOBAL FOREST WATCH	the climate data factory
Use case	Energy	Energy Agri-food	Energy Agri-food Nature	Energy Agri-food Nature	Nature	Nature
Description	Open platform **digital twin technologies** to optimize urban planning, energy efficiency, and disaster planning	Open-source platform to aggregate data, modeling and computing for **climate-integrated investing**	Comprehensive **single-access-point ecosystem** for environmental data	**Datasets**, **industry-leading AI, and cloud computing** tools to solve environmental problems	Largest open-source **satellite imaging and spatial mapping** platform for management of natural assets	Provider of **ready-to-use**, **future climate data** for impact studies and risk assessment
Features	Integrated data on environment, buildings, transport, drainage, traffic, etc. Simulations and scenario analysis	Physical-economic models Global data compendium Scenario-based predictive analysis	Harmonized data from multiple sources using APIs Statistical and analytical packages	AI for Earth multi-petabyte planetary computer Hyperscale cloud, AI, and IoT digital twins	Real-time satellite imaging Analytics on changes in forest cover, land use, climate, and biodiversity	Projections of rainfall, wind speeds, temperatures, and solar radiation using advanced statistical processing
Users/ Partners	HUAWEI, Alibaba Group, SJ Surbana Jurong, 中国移动 China Mobile, HYUNDAI, BMW	BNP PARIBAS, Goldman Sachs, amazon, Allianz, S&P Global, Federated Hermes	GEOTERRA, TERRAQUE, esri, EVERSIS, SPACEWILL, Water Youth Network	Jejak.in, NCX, SunCulture, OCEAN MIND, The Nature Conservancy, adaviv	Global Canopy, The Nature Conservancy, THE WORLD BANK, BBVA Banco Continental, NATIONAL GEOGRAPHIC	PARTNERSHIP FOR RESILIENCE & PREPAREDNESS, IISD, BSR, CSIRO, POLITECNICO DI TORINO

Sources: Microsoft; Geoportal; CrunchBase; 51World; OS-Climate; Regrow; Global Forest Watch; The Climate Data Factory

Huge potential for SEA to leverage global data and digital innovations to accelerate the Net Zero journey

While potential is significant, it is critical to scale use of data innovations sustainably

Non-exhaustive

Image credits: 51World, YouTube

Singapore's Digital Twin
by 51World

Enables city operators to monitor various aspects and make better decisions by providing data and scenario modeling

Potential use cases:

Monitor building characteristics and sunlight to plan for **solar**

Simulate floods and other climate events for **disaster planning**

Image credits: 51World, YouTube

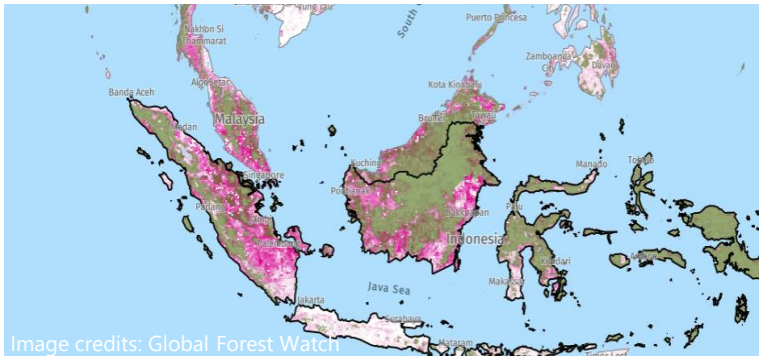


Image credits: Global Forest Watch

Geospatial mapping of forests in SEA
by Global Forest Watch

Enables remote monitoring and management of natural capital by providing real-time geospatial data via satellite imaging

Potential use cases:

Alert on **illegal deforestation activities** at project sites

Monitor and ensure **deforestation-free supply chains**

Image credits: Global Forest Watch

Key watch-out:

Data center (DC) management

As **data/digital penetration** grows, **sustainable management** of DCs will be critical:

>95% of SEA DCs use inefficient air-based cooling systems

12% of Singapore's energy will be consumed by DCs[1] by 2030

Microsoft

Aiming to power all data centers with **100% carbon-free** energy by 2030

- **Liquid cooling** to increase energy efficiency
- **Large batteries** to replace diesel generators as backup energy assets
- **'Temporal Matching'** of clean energy purchases with consumption on hourly basis

Notes: 1. Singapore accounts for 60% of SEA's data center supply

Sources: Unreal Engine; NRF; Global Forest Watch; 51World; Datacenter News; Datacenter Knowledge

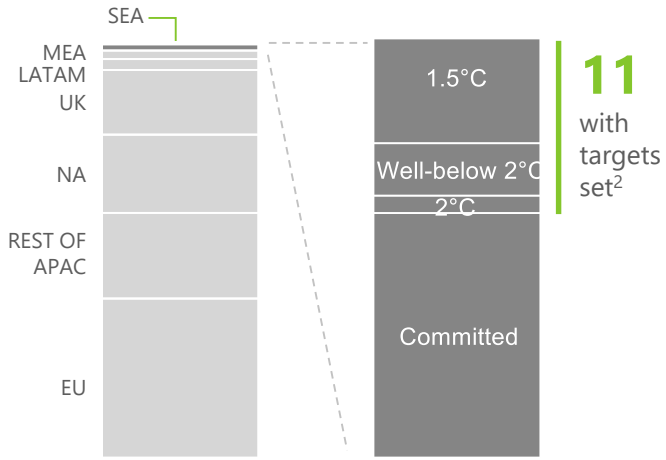
SEA businesses are beginning to mobilize, with room to grow and scale impact

SEA SBTi signatories' average annual emissions reductions are almost in line with 1.5°C targets but below global SBTi average

Non-exhaustive

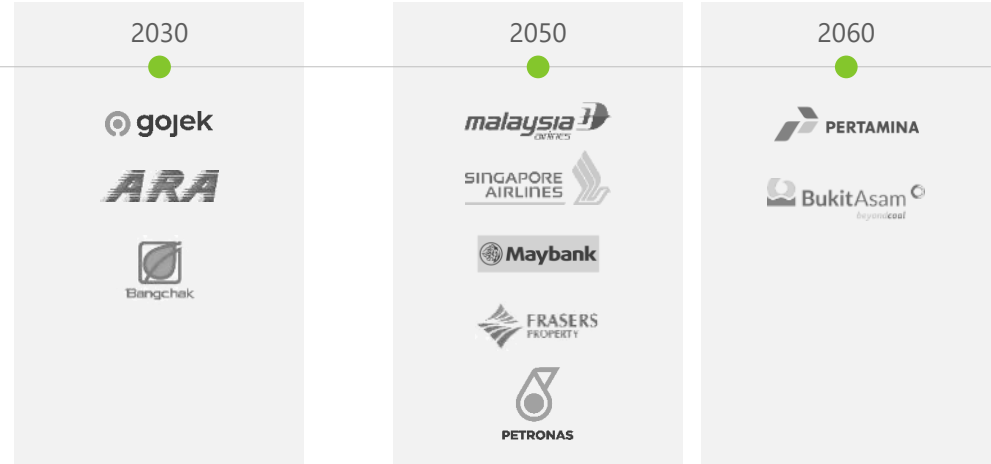
SBTi signatories as of end July 2021

1,699 Global[1] **25** SEA (21 since 2020)

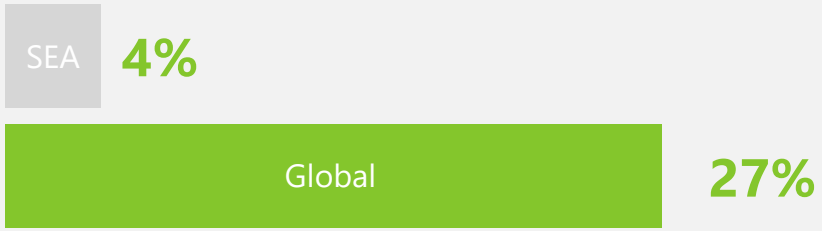


SEA companies with Net Zero commitments (non-SBTi)

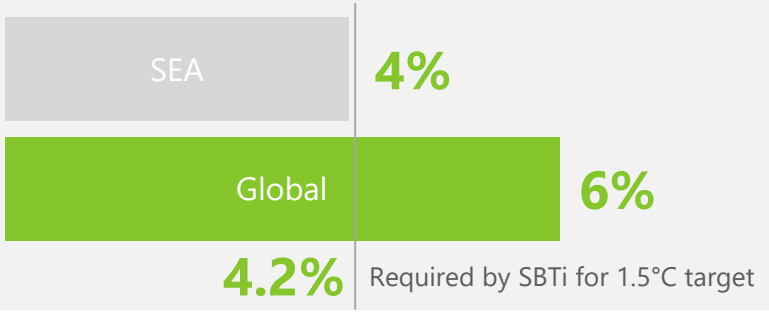
Net Zero by:



Market cap of SBTi signatories[3] as percentage of total market cap in:



Average annual emissions reductions[4] since SBTi start year:



Notes: 1. Middle East and Africa (MEA), Latin America (LATAM), North America (NA), Asia-Pacific (APAC), and European Union (EU); 2. Committed: Have made a commitment to reduce emissions, but without set target with defined timeline. Target set: Numerical emissions target set, with defined timeline; 3. Only 14 SEA companies with SBTi commitments are publicly listed and have their market caps included in the 4% of total SEA market cap; 4. 4% annual emissions reduction by SEA SBTi companies refers to average (linear) rate of reduction, and includes public companies who have published emissions for years after they had set their SBTi target (n=4, others joined SBTi after 2020, and have not published emissions since)

Sources: SBTi; The Jakarta Post; Travel Weekly; Company websites; Argus Media; World Bank; Capital IQ

Leaders stand to capture ~$1 trillion in green economic opportunities in SEA by 2030 through two sources of value

~$1 trillion economic opportunity by 2030 from greening SEA's economy, majority with decarbonization impact

'Getting the house in order' – improve efficiency of existing businesses and generate savings through decarbonization initiatives

>$460 billion potential economic opportunities[1]

Pursue new revenue opportunities built around Net Zero principles while contributing to global decarbonization

>$490 billion potential economic opportunities

Notes: 1. Economic opportunities estimated under new growth areas include size of projected revenue pools along SEA carbon market value chain by 2030 ($10 billion)

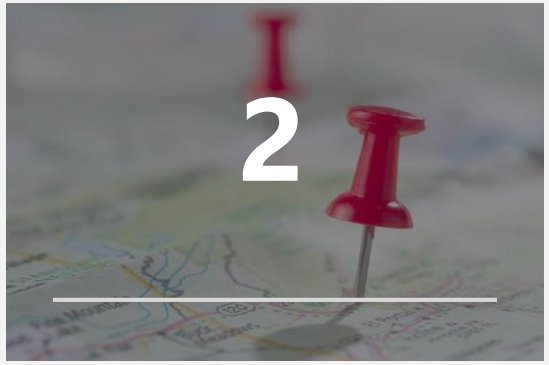
Sources: Bain analysis; Bain SEA Green Economy report 2020

Three steps for organizations on their Net Zero journey

Measure baseline and set ambition

Measure and establish **baseline emissions** and potential **impact on P&L**[1] (e.g., due to carbon taxes)

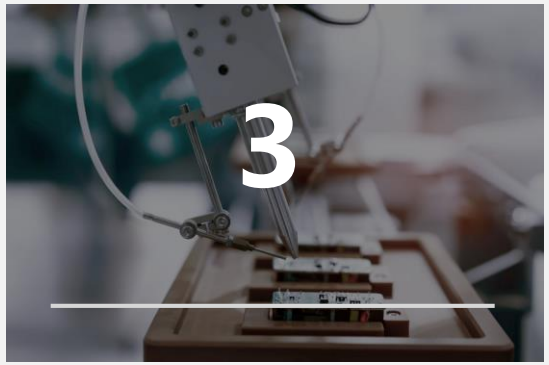
Define **Net Zero ambition** aligned to business strategy



Define decarbonization levers

Define a comprehensive list of **abatement levers** available across three broad types: strategic, operational, and compensatory (offset)

Prioritize levers based on **abatement potential and ROI** to inform implementation roadmap



Enable delivery at scale through a 'green-enabled' organization

Integrate decarbonization principles into all aspects of the **operating model**

Leverage **digital and technology to measure, track, and report against KPIs**[2] at scale

Scale efforts through **internal carbon pricing**

Engage and **inspire stakeholders** to ensure **results delivery**

Notes: 1. Profit and loss; 2. Key performance indices

Sources: Bain experience

The critical first step is to establish a clear starting point and set the Net Zero ambition

Establish emissions baseline and potential impact on P&L

Measure and inventorize scope 1, 2, and 3 emissions across the business, and establish relevant potential carbon costs to define organization's starting point

Inventorize carbon emissions:

Emission scope	Emission source examples (software co)
Scope 1: Direct Emissions	Back-up power generation
	Data center operations
	...
Scope 2: Electricity, Cooling, and Heating	Electricity
	Heating
	...
Scope 3: Other Indirect Emissions	Company travel
	Waste
	...

X

Model **potential cost of carbon on organization's P&L** (today and forecast)

Understand carbon cost implications:
- Industry norms/requirements
- Government/international regulations
- ...

Define Net Zero ambition

Set ambition based on established emissions starting point and desired sources of value from decarbonization

Source of value	Ambition archetype
Value preservation through efficiencies and savings	**Compliance observer** Satisfying key regulatory requirements and delivering to threshold standards
	Proactive participant Managing risks beyond current regulations with long-term investments
	Value leader Directly assessing, investing, and driving value from Net Zero efforts, treating carbon as an emerging asset class
Value creation through new growth areas	**Disruptive innovator** Net Zero as a competitive advantage, embedding efforts to develop new business model and/or products

Sources: Bain experience

A structured, interlinked approach based on three sets of abatement levers guides the path to Net Zero

Three sets of abatement levers

Operational

- Executed at line level and shop floors
- Involves asset upgrades, process adjustments, and supply chain requirements to reduce/eliminate emissions

Maintenance optimization	LED and smart lighting	On-site renewable energy installation	...

Strategic

- Impacts entirety of business
- More transformative in nature and includes significant changes to product/asset portfolio

Carbon-free product design	Supply network optimization	Low-carbon business models	...

Compensatory

- Investments to offset/neutralize (residual) company emissions (e.g., via nature-based solutions projects)
- Companies should differentially focus on eliminating emissions through other levers and only compensate hard-to-abate emissions via offsets

Insetting	Offset credits	...

Examples

BOSCH
focused on reduction of operational emissions as part of its climate strategy

Ørsted
divested oil and gas business to focus on renewables

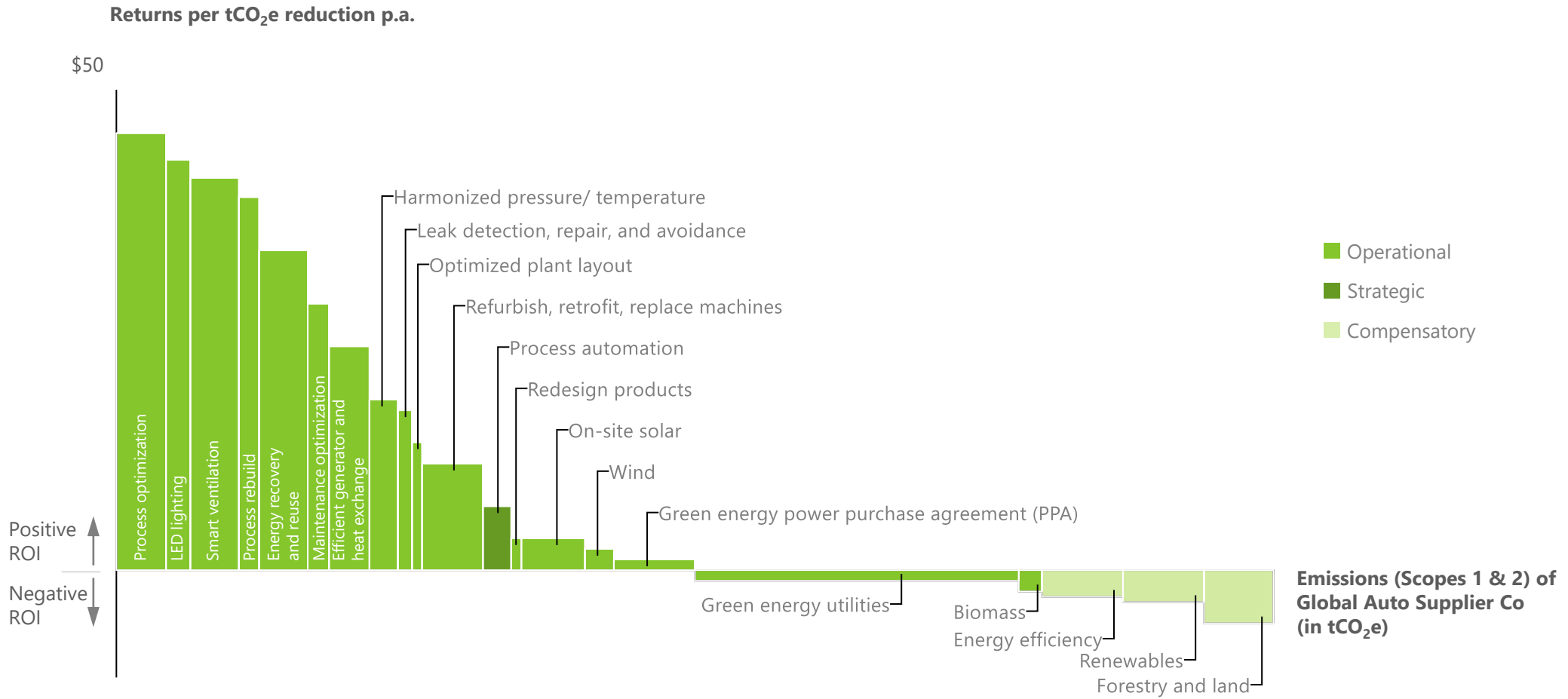
shopify
invested in projects that remove atmospheric carbon

Sources: Bain experience; Company websites

A range of abatement levers are readily deployable for businesses, many with positive returns

Projected | Case study

~50% of emissions for Global Auto Supplier Co can be eliminated with a positive business case



Sources: Bain experience

Financial institutions and investors can go beyond their own operations and drive decarbonization across the portfolio

Financial institutions and investors are seeking to decarbonize their portfolios

> *Leading lenders to the global steel industry… are working together to develop **a climate-aligned finance agreement** to support steel sector decarbonization*

RMI ENERGY. TRANSFORMED.

> *Three major Japanese banks to **support client firms' decarbonization***

the japan times

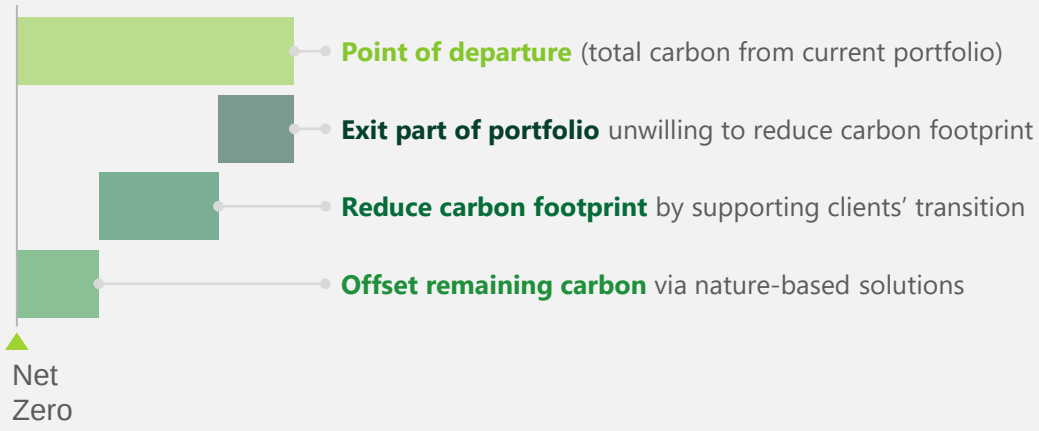
> *EIB will **end financing for fossil fuel energy projects** from the end of 2021*

European Investment Bank Group

Example: Global bank employed a systematic portfolio decarbonization approach to deliver multiple benefits

Projected | Case study

Carbon emission abatement from portfolio (tCO_2e)



15% **Reduction target in emissions** across portfolio of small and medium enterprises (SMEs)

40% **Potential additional loan volume** from financing decarbonization transition

3% pt. **Potential increase in returns** from optimizing portfolio for sustainability

Sources: Company website; Bain analysis

The right enablers will help an organization to sustain and scale its Net Zero results

Elements of a green organization

1 Integrate decarbonization agenda into the operating model

Leadership and culture	Structure and accountabilities	Objectives and incentives	Talent and capabilities	Business and mgmt. processes
• Leadership focus • Culture and mindset • Impact stories	• Line accountabilities and operations • Dedicated team • Formal governance • New ways of working	• Targets and cascading • Integrated budget • Decarbonization-linked incentives • Executive objectives	• New capabilities • Climate literacy training • Subject matter expertise	• Key metrics • Climate risk assessment and continuity planning • Decision tools

2 Leverage technology and data to measure, track, and report results

Materiality assessment and life-cycle analyses	Data collection and measurement	Monitoring and reporting	Processing and analytics	Automation

3 Scale efforts via internal carbon pricing to establish a systemic link between Net Zero and the bottom line

Calculation of carbon price:[1]

price of carbon ($/tCO$_2$e) = yearly funding for environmental initiatives ($) / projected annual carbon emissions in boundary (tCO$_2$e)

Potential use cases

Internal carbon fee	Shadow price	Implicit price
Charge business units a carbon tax for emissions to generate a dedicated revenue stream	Use theoretical price on carbon to support long-term planning and investment strategies	Evaluate cost associated with compliance to regulations or reducing emissions

4 Engage and inspire stakeholders to ensure results delivery

External/customer brand positioning	Employee communication	Shareholders/investors value alignment	Supplier support	Ecosystem partnerships

Notes: 1. Other alternative methods to derive internal carbon price are also available – e.g., targeting price within range of market prices for carbon offsets, evaluating potential cost of regulations on fossil fuel usage and emissions, etc.

Sources: Bain experience

02 Microsoft has defined a net-negative carbon ambition and is establishing a green organization to realize its goals

CATALYZE THE JOURNEY

C ENABLERS

Microsoft

01 Microsoft's decarbonization ambition for 2020 and beyond

- Carbon negative by 2030
- Remove historical carbon emissions by 2050
- Incentivize procurement of renewable energy
- Generate funding to support sustainability programs
- Invest in technology innovation for sustainability
- Prepare for future regulatory risk

02 Integrate decarbonization goals into operating model

Line leaders held accountable
by aligning KPIs and incentives with decarbonization targets

A cross-company council set up
comprised of key business unit executives to provide oversight and governance

Decarbonization integrated into culture
by incentivizing sustainable employee behavior and implementing sustainable policies

03 Leverage technology and data to measure, track, and report results

Cutting-edge digital solutions developed
to measure and track emissions accurately (e.g., emission-tracking software, digital twins)

Emissions reporting made transparent
by democratizing access to employees and subscribing to international reporting bodies (e.g., Carbon Disclosure Project)

Sources: Microsoft

04 Scale decarbonization effort via an internal carbon pricing system

Carbon price established
by determining investment needed to meet carbon emissions reduction targets[1]

Carbon taxes incorporated as an expense
directly affects a business unit's profit and loss

Funds channeled to decarbonization
via investments in internal initiatives, green power purchases, and carbon offset purchases

05 Engage and inspire stakeholders to ensure results delivery

Employees educated and onboarded
via a series of engagements, including personnel from top management to shop floor engineers

Employees inspired and enlisted
to generate fundable decarbonization ideas

Stakeholders beyond Microsoft engaged
by prioritizing suppliers that have aligned decarbonization ambitions

06 Key achievements

1.3 million tons[2] of carbon	removal secured in FY21 via projects (under request for proposal)
21 million tons of carbon	collectively removed from top suppliers in FY20
$129 million invested	to spur innovation in carbon reduction, water management, and circular economy

Notes: 1. Price on carbon ($/$tCO_2e$) = yearly funding for environmental initiatives ($)/projected annual GHG emissions in boundary (tCOe);
2. Represents ~1% of total carbon emissions from Microsoft, of which scope 3 emissions (supplier and customer-based) account for more than 90%

Sources: Microsoft

Emerging Net Zero activity by SEA companies

C

Decarbonization efforts by leading SEA players

	CapitaLand	SCG	Grab
Baseline and ambition	**SBTi target set (<2°C)**	**SBTi committed**	**Electric and hybrid fleet**
	Reduce scope 1 and 2 emissions by 28% and scope 3 from capital goods by 22% (per m^2) by 2030, vs. 2019 baseline	28% emissions reduction by 2030, vs. 2007 baseline	Full fleet running on clean energy by 2030; Net Zero targets and roadmap to be announced next year
Levers	• Higher **energy efficiency** and green building certification • Use of **digital tools** such as Building Information Modeling and Intelligent Building Platform • Use of more **sustainable and locally sourced** materials • Promotion of **water and waste circularity**	• Increasing use of **biomass and renewables** with multiple solar PV projects/pilots • **AI solutions** to manage energy in production units, reducing emissions by 1,600 tons of CO_2/year • Roll-out of **low-carbon cement** and greening of supply chain • Investments in **forest rehabilitation**	• Partnerships with governments to develop and grow **infrastructure for electric vehicles** • Pilot feature for users to **choose EV rides** and **offset carbon emissions** on app • Investments in **carbon offset and solarization projects** • New **EV business models** piloted
Enablers	• **Sustainability council** established, reporting to board of directors and supported by group Chief Sustainability Officer • **Systematic KPIs** tied to renumeration • **Internal carbon price** across global portfolio in progress • **Sustainability X Challenge** set up	• **Sustainable development committee** established, reporting to President and CEO and comprising multiple subcommittees (e.g., circular economy, climate change, etc.) • **Internal carbon price** piloted at rate of $18 per tCO_2 and used for evaluation of rooftop solar project	• **Sustainability Steering Committee** established, reporting to Executive Committee and supported by regional sustainability teams

Sources: CapitaLand Sustainability Report (2020); SCG Sustainability Report (2020); Grab ESG Report (2020); Nikkei; Company website; Bain interviews

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Ultimately, early movers with bold ambitions can reap significant rewards, and late actors face risks to bottom line

Emerging evidence of rewards and risks from key stakeholders in the market today

	Consumers	Investors	Regulators
	THE NORTH FACE	AC Energy An Ayala Company	SUNSEAP
Rewards	**As The North Face battles Patagonia in outdoors market, it bets tackling climate change will pay off** — CNBC	**Ayala unit secures $67 million funding for solar farm in India** — BusinessWorld	**Sunseap signs 20-year agreements to supply energy to Vietnam's national grid** — THE BUSINESS TIMES
	"To gain more market share, The North Face drastically has been scaling sustainability across all its operations… sales did pick up with the brand's new sustainability efforts	*"Sitara Solar project… has secured a 20-year loan from the US International Development Finance Corporation (DFC)*	*"(Sunseap) has signed 20-year power purchase agreements with state-owned utility Vietnam Electricity to supply clean energy to the country's national grid*
Risks	**Great demand for carbon-neutral products** — ClimatePartner	**Climate Activist Investors Pressure Big Oil: What's Next?** — yahoo!finance	**Regulate business to tackle climate crisis, urges Mark Carney** — The Guardian
	"Majority of consumers welcome carbon labels as a decision-making tool when shopping… over 60% buy only environmentally friendly products, or try to do so as much as possible	*"Oil giants… are facing shareholder rebellions led by climate activists over the companies' perceived failures to set a clear business strategy for a low-carbon future*	*"…for the world to meet its climate goals, governments have to force industries to follow clear rules, on everything from energy generation to construction and transport, and set carbon prices that drive investment toward green ends…*

Sources: Business World; CNBC; The Business Times; The Guardian; Yahoo Finance; Climate Partner

Though critical, achieving a Net Zero economy for SEA could have significant impact on the developing region's workers and communities

SEA workers and communities may be at risk in the transition toward a Net Zero economy

D

		Example			
Workers	Smallholder farmers		**Prohibitive costs for smallholder farmers** who typically have poor access to capital to invest in sustainability	**16-39%**	of a farmer's annual income needed to obtain a **sustainable palm oil certification** in Indonesia
Workers	MSME[1] suppliers		**Increasingly stringent sustainability standards and requirements** may act as barriers for MSMEs to access global value chains	**78%**	**of MNCs will remove suppliers** that endanger their Net Zero transition by 2025[2]
Workers	Workers reliant on resource extraction		**Serious threat of job displacement** as the region shifts away from coal and fossil fuels toward renewable energy	**~20 million**	workers **employed by oil and gas** in Indonesia alone
Workers	Green economy workers		An overfocus on building green infrastructure could lead to oversights in **human and labor rights**	**197**	allegations of **human rights abuse related to renewable** energy projects globally
Communities	Coastal, rural, and Indigenous		Green developments could **damage sources of livelihoods, displace communities, and result in land rights inequality**	**39**	**dead, up to 100 missing, and thousands homeless** due to a collapsed hydropower dam in Laos

Notes: 1. Micro, small, and medium enterprises; 2. According to survey with 400 of world's largest MNCs, conducted by Standard Chartered in Mar 2021

Sources: WRI; Wageningen University; ADB; World Bank; SC

Small steps are being taken to address transition risks on SEA workers and communities

D

Empower smallholders and suppliers to embark on their Net Zero journey

Provide supply chain financing, improve access to markets, extend contract terms, shorten payment terms, and build capabilities of smallholders and suppliers

PUMA

IFC International Finance Corporation WORLD BANK GROUP
Creating Markets, Creating Opportunities

Puma is partnering with the International Finance Corporation (IFC) to **provide preferential supply chain financing rates** based on sustainability performance of SEA suppliers

Olam

Olam Direct is **improving farmers' access to market information and financing options** while providing buyers with better traceability and supplier sustainability information

Establish upskilling and retraining programs

SEAS Sustainable Energy Association of Singapore

The Sustainable Energy Association of Singapore has established a **sustainable energy training program** to better equip workers for the transition to renewable energy

Actively support local communities when developing climate action projects

Protect land rights, involve local communities in planning phase, and protect/improve livelihoods of coastal, rural, or Indigenous communities

THE MELOY FUND
FOR SUSTAINABLE COMMUNITY FISHERIES

The Meloy Fund is a $40 million fund that invests in sustainable fishing and seafood enterprises and **creates opportunities for local fishers to secure more sustainable livelihoods** in Indonesia and the Philippines

Sources: Olam; IFC; SEAS; Meloy Fund

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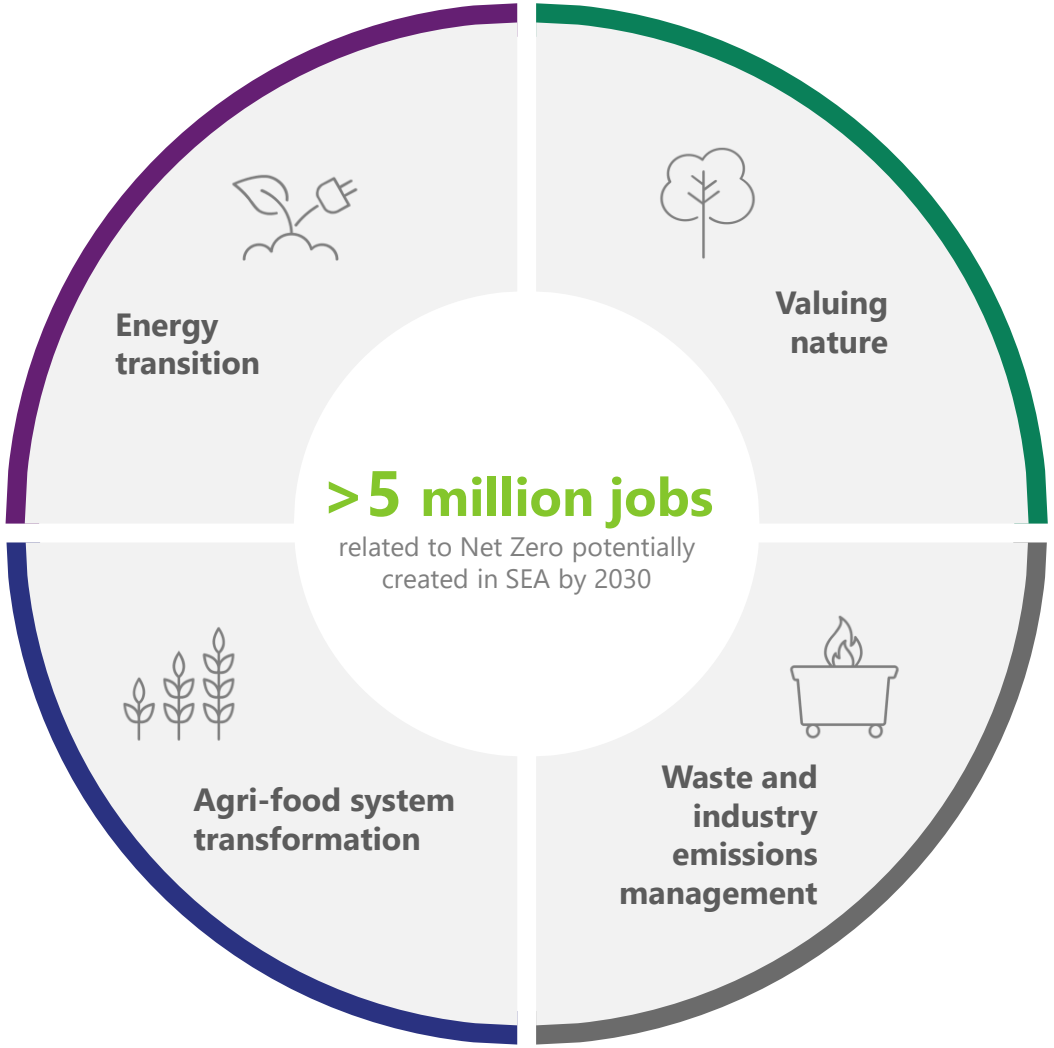
If done right, the transition could offer significant opportunities to the region's populations

2-2.5x

more jobs created per dollar invested in renewables and energy efficiency vs. fossil fuels

>600

jobs may be generated per $1 million invested in reforestation projects



Sources: WWF and ILO (2020); GEF; Conservation International; Sustainable Energy for All

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Businesses can play a powerful role in facilitating a just transition

1 

Lead an equitable transition across the supply chain
by actively supporting suppliers and local communities

2 

Establish new sustainable economies
within area of business operations, which communities can self-sustain long after operations cease

3 

Incorporate net job creation and fair labor metrics
when evaluating sustainability strategies and investments, in addition to financial and emissions metrics

4 

Train the future workforce to match demand for green skills
by working with higher learning institutions

5 

Aim to exceed the minimum standards
for social and environmental safeguards for projects and actively establish dialogue with internal and external stakeholders (especially local communities) for better planning

For any queries, please reach out to:

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