Catalyzing the Journey

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

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

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Unlocking Capital Flows

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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.

2018 carbon emission volume (MtCO$_2$e)

<table>
<thead>
<tr>
<th>Region</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global</td>
<td>47,261</td>
</tr>
<tr>
<td>SEA</td>
<td>3,545</td>
</tr>
</tbody>
</table>

- **Energy**: 46%
- **Land use change and forestry**: 27%
- **Waste**: 15%
- **Industrial processes**: 14%
- **Other**: 15%

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

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>SEA total primary energy supply (Million tons of oil equivalent)</th>
<th>SEA total installed power capacity (Gigawatts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Biomass</td>
<td>625</td>
<td>234</td>
</tr>
<tr>
<td>Renewable Energy</td>
<td>+108%</td>
<td>+157%</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>1,298</td>
<td>601</td>
</tr>
<tr>
<td>Coal</td>
<td>83%</td>
<td>75%</td>
</tr>
<tr>
<td>Oil</td>
<td>77%</td>
<td>64%</td>
</tr>
<tr>
<td>OIL</td>
<td>+108%</td>
<td>+157%</td>
</tr>
</tbody>
</table>

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

- **To stop loans for coal-fired power generation in 2020**
- **To phase out coal from its portfolio by 2040**
- **To exit financing coal, oil, and natural gas exploration and extraction activities (May 2021)**

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
2. 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.
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

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**Energy Transition Index¹ (2021)**

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>RANKING</th>
<th>Top performer</th>
<th>Bottom performer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweden</td>
<td>1</td>
<td>79</td>
<td>115</td>
</tr>
<tr>
<td>Singapore</td>
<td>21</td>
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<td>Malaysia</td>
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<tr>
<td>Brunei</td>
<td>82</td>
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<tr>
<td>Cambodia</td>
<td>93</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>115</td>
<td>39</td>
<td></td>
</tr>
</tbody>
</table>

Global average: **59**

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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

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“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 potential² relative to conventional energy industry
Priority imperatives for SEA to transition toward a cleaner energy system

**Reduce**
- **Efficient production and design**
  - Minimize emissions through more efficient design and use of energy and materials

**Substitute**
- **Renewable energy generation**
  - Transition toward cleaner sources of energy
- **Alternative fuels**
  - Adopt alternative, low-carbon fuels

**Scale**
- **Grid modernization**
  - Upgrade grid infrastructure for renewables
- **Electrification**
  - Replace fossil fuel technology with substitutes that use electricity

**Remove**
- **Carbon capture, utilization, and storage**
  - Leverage technology to remove CO$_2$ from concentrated sources/atmosphere

**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

**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

**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

**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 infrastructure 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

**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

**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)

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

**ENERGY TRANSITION**

**DECARBONIZE**

**ENERGY JOURNEY**

02
Numerous technologies and innovations enabling the transition

- **Reduce**: Efficient production and design, Renewable energy generation, Alternative fuels
  - Minimize emissions through more efficient design and use of energy and materials
  - Transition toward cleaner sources of energy
  - Adopt alternative, low-carbon fuels

- **Substitute**: Renewable energy generation, Alternative fuels
  - Sustainable biogas/biomass/biofuel
  - Wind
  - Solar photovoltaic (PV)
  - Solar thermal (electricity and heating)

- **Scale**: Grid modernization, Electrification
  - Upgrade grid infrastructure for renewables
  - Replace fossil fuel technology with substitutes that use electricity

- **Remove**: Carbon capture, utilization, and storage
  - Leverage technology to remove CO₂ from concentrated sources/atmosphere

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
- Nuclear
- Geothermal (electricity and heating)
- Hydropower
- Marine energy
- Low/no-carbon hydrogen production, storage, transportation and use
- Next-generation battery and energy storage
- Electrification in buildings and industry
- Ultra-high voltage direct current transmission
- Smart grid and energy management
- Direct air capture
- Carbon capture and storage
- Carbon transport

Sources: IEA; IRENA

High relevance to SEA
Digital/data innovations

Technology readiness (global)
- HIGH
- LOW

4th generation nuclear

Digital/data innovations
Businesses are innovating across levers

Reduce

Start-ups

- **TURNTIDE**
  Energy-efficient electric motor system
- **enVerid**
  Energy-efficient HVAC systems for buildings
- **waycare**
  Cloud-based platform for proactive traffic management

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
- **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

Substitute

- **Insolight**
  High-efficiency solar panel with optical layer to concentrate light
- **KRAFT**
  Low-cost flying wind turbine solutions
- **Fervo Energy**
  Enhanced geothermal systems enabling significant cost reduction

Scale

- **envelio**
  Intelligent grid platform supporting integration of distributed generators
- **point**
  Hydrogen fuel cell for air transport and urban air mobility
- **Biofuel Evolution**
  Low-carbon bioethanol from households, agriculture, and food waste
- **H2 PRO**
  Electrolyzers for green hydrogen production at scale
- **Dynamic Line Rating tech**
  Dynamic Line Rating tech with noncontact sensors and analytics
- **QuantumScape**
  Solid state batteries capable of faster charge times and longer range for EVs
- **instagrid**
  Portable battery for applications with high energy density demand
- **Power Ledger**
  Blockchain-enabled P2P energy trading platform
- **LINEVISION**
  Hardware-agnostic, off-the-shelf EV charging SaaS solution
- **Blockchain**
  Blockchain-enabled P2P energy trading platform

Remove

- **climeworks**
  Active commercially viable direct air capture technology
- **neustark**
  Recycled and CO₂-enriched concrete
- **Carbon utilization to produce chemical products and polymers**
- **ExxonMobil**
  Low Carbon Solutions – new business focusing on carbon capture and storage technologies
- **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

Non-exhaustive
Data and digitalization have begun to play a key role in decarbonization efforts.

### Reduce

**Schneider Electric**
- **Appliance and equipment/process efficiency**
- **Smart energy-management system**
- **Intelligent traffic system**

**Vasakronan**
- **Smart energy-management system**

Utilizes AI/ML and IoT 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.

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**

**VATTENFALL**
- **Electric vehicle and charging infrastructure**
- **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.

Leverages AI 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.

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Notes: 1. Artificial intelligence, machine learning, and internet of things
2. Sources: Microsoft; Business Times; Industry interviews; Smart Energy; Vattenfall
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.

**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.

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**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

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Sources: Company website; Company interviews

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**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.
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.

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**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

★ Digital/data innovations

**Reduce**

*SENSOR FLOW*

**Technologies:**

- Smart energy-management system

**Overview:**

Monitor analytics and control automation to reduce hotel energy usage

- Potential savings in energy bill and carbon footprint
  - ~30%
  - Hospitality group clients (e.g., Marriott, Hyatt, Accor)

**Substitute**

*SUNSEAP*

**Installation and management of solar PV**

- Solar PV

**Scale**

*CANOPY POWER*

**End-to-end microgrid systems and project financing**

- Solar PV
- Battery
- Smart grid and energy management

Since founding in 2016:

- >30 KtCO₂ avoided from building clients
- >25 KtCO₂ avoided from retail clients
- >10 Projects
- >6 Countries

**Remove**

*PETRONAS*

**First CCS project underway – target completion in 2025**

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

- Offshore CCS project in Sarawak to capture and convert CO₂ 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

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

   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.

   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.

   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.
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

Main drivers:\(^2\)
- Commodity-driven: Mainly palm oil and rubber - 73%
- Logging: 19%
- Shifting agriculture: 8%

SEA contribution to global emissions (2018):

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>LUCF</td>
<td>70%</td>
</tr>
<tr>
<td>Overall</td>
<td>7%</td>
</tr>
</tbody>
</table>

But time is limited; potentially

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss in peatlands by 2030</td>
<td>100%</td>
</tr>
<tr>
<td>Loss of forest cover by 2050</td>
<td>50%</td>
</tr>
</tbody>
</table>

SEA has enormous potential for climate mitigation

- **560 MtCO\(_2\)e**
  - 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

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

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

**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

**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

**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**

**Manage**

**Natural forest management**
Monitor and sustain forest health

**Working land management**
Reduce emissions from working land practices

- **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**

- **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

### 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

### Technologies and innovations
- Satellite imagery and monitoring
- High-yield oil palms using genetic testing
- Improved water and sediment management
- Biochar production
- Drone-based real-time and participatory monitoring
- Terrestrial ecosystem monitoring with visual or acoustic sensors

### 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

### Notes:
1. Light detection and ranging

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

### Technology readiness (global)
- HIGH
- LOW

### Digital/data innovations
- Cloud-seeding to induce rainfall
- Aerial yarding in logging
- Drone-based thermal imaging
- IoT smart sensors for forest management
- Robotics in fire detection
- Robotics in firefighting
- Genetically engineered trees
- Advanced mangrove restoration
- Drone-based automated seed gathering
- Drone-based automated reforestation/afforestation
## Businesses are innovating across levers

### Conserve
- **Orbital Insight**
  - ML-enabled monitoring
- **Rainforest Connection**
  - Acoustic forest monitoring
- **planet**
  - Satellite imagery data
- **STARLING**
  - Satellite monitoring for palm oil-driven deforestation

### Restore
- **dendra systems**
  - Drone-based reforestation
- **Land Life Company**
  - Smart reforestation on degraded land
- **Living Carbon**
  - Genetically engineered trees

### Manage
- **TIMBETER**
  - Smarter logging
- **Treevia**
  - IoT forest management
- **Pachama**
  - AI tracking of forest activity
- **L’Oréal**
  - Dedicated nature restoration fund through the L’Oréal Fund for Nature Regeneration

### Non-exhaustive

Sources: Company websites; CrunchBase
Promising early activity in SEA

- **Conserve**
  - 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]

- **Restore**
  - Drone-based reforestation
  - Actively experimenting with and researching automated forest restoration

- **Manage**
  - IoT forest management
  - Leverages satellites to remotely detect hotspots as an early warning system

### Numbers

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

- **3 km**
  - Listening radius of each device

- **>9**
  - Forest restoration projects across SEA

- **>200**
  - Publications on forest and biodiversity restoration

- **150,000 ha**
  - Forest area monitored

- **7.5 million**
  - Triple-gold-certified carbon credits annually

---

[^1]: According to forest patroller report that “logging has totally stopped”
[^2]: Rainforest Connection’s first project was in Indonesia in 2013 and piloted a project in the Philippines in 2021.
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

**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.

**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** 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

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

“**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**"
WHAT’S NEXT

Expansion into new markets

Establishment of Indonesia’s first carbon offset marketplace

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.

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 permanence1 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.

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

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

**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**
- **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
- **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
- **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

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)

<table>
<thead>
<tr>
<th>Country</th>
<th>Estimated</th>
<th>Percentage of 2020 GDP(^2)</th>
<th>Percentage of employment(^3)</th>
<th>Percentage of SEA agriculture emission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myanmar</td>
<td>~23</td>
<td>~49</td>
<td>~15</td>
<td></td>
</tr>
<tr>
<td>Vietnam</td>
<td>~15</td>
<td>~37</td>
<td>~14</td>
<td></td>
</tr>
<tr>
<td>Indonesia</td>
<td>~14</td>
<td>~29</td>
<td>~38</td>
<td></td>
</tr>
<tr>
<td>Philippines</td>
<td>~10</td>
<td>~23</td>
<td>~12</td>
<td></td>
</tr>
<tr>
<td>Thailand</td>
<td>~9</td>
<td>~31</td>
<td>~13</td>
<td></td>
</tr>
<tr>
<td>SEA overall</td>
<td>~10</td>
<td>–</td>
<td>–</td>
<td></td>
</tr>
</tbody>
</table>

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

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

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)

<table>
<thead>
<tr>
<th>Year</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>525</td>
</tr>
<tr>
<td>2029F</td>
<td>613</td>
</tr>
</tbody>
</table>

\(+17\%\)
Along with direct emissions, agriculture also **drives other negative environmental impacts**

<table>
<thead>
<tr>
<th><strong>Direct emissions</strong></th>
<th><strong>Deforestation</strong></th>
<th><strong>Water security and pollution</strong></th>
<th><strong>Energy consumption</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct emissions of GHG from agriculture activities</td>
<td>Loss of forest cover through conversion of land for agricultural use</td>
<td>Impact on water resulting from irrigation as well as polluted agriculture drainage</td>
<td>GHG emissions from energy consumption to power agriculture activities</td>
</tr>
<tr>
<td>Rice contributes to ~80% of the region’s cereal production and is &gt;5x more emission-intensive relative to an average cereal crop</td>
<td>~45% of sampled oil palm plantations are converted from forest areas. Palm is a significant regional industry</td>
<td>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</td>
<td>Increasing production levels and adoption of new agricultural technologies lead to higher energy requirements</td>
</tr>
</tbody>
</table>

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

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

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

**SEA imperatives (key actions)**

**Sustainable production**
- 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

**Optimized protein mix and production**
- 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

**End-to-end traceability**
- 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

**Minimal food loss and waste**
- Universal standards
  - Food waste likely to increase from growing population
  - Invest in development and adoption of sustainable food upcycling/recycling

**Dietary shift**
- 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)

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

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

**Agri-food imperatives**

**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 smallholders’ 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 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 for alternative-protein and promote region’s traditional protein sources (e.g., tofu)

**Upcycle/recycle**
- Food waste likely to increase from growing population
- Invest in development and adoption of sustainable food upcycling/recycling

**Universal standards**
- Global food standards are becoming increasingly advanced (e.g., EU Green Deal), though the World Health Organization identified significant gaps in SEA
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**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
Multiple levers and innovations available to support transition

**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

---

**Technologies and innovations**

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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Organic/sustainable fertilizer and pesticide</td>
<td>Whey protein</td>
<td>Barcode and RFID</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Modem drip irrigation</td>
<td>Plant-based protein</td>
<td>Smart warehouse/inventory management system</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Genome editing</td>
<td>Insect protein</td>
<td>Retail/consumer food waste management platform</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IoT, monitoring, and analytics to support production</td>
<td>Low-emission cattle feed</td>
<td>IoT and process/tracking digitalization</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Automation and robotics to support production</td>
<td>Algae protein</td>
<td>Food sensing/biosensing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Advanced controlled environment cultivation system (e.g., vertical farming)</td>
<td>Fermentation-based protein</td>
<td>Sustainable treatment, preservative, and storage</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sustainable upcycling/recycling (e.g., compost, anaerobic digestion, dehydration)</td>
<td></td>
</tr>
</tbody>
</table>

**Technology readiness (global)**

- **HIGH**
  - Digital/data innovations
  - Blockchain-based traceability and transparency
  - IoT and process/tracking digitalization
  - Smart warehouse/inventory management system
  - Retail/consumer food waste management platform
  - Barcode and RFID

- **LOW**
  - Advanced controlled environment cultivation system (e.g., vertical farming)
  - Automation and robotics to support production
  - IoT, monitoring, and analytics to support production
  - Genome editing
  - Modern drip irrigation
  - Organic/sustainable fertilizer and pesticide

**Non-exhaustive**

Sources: Eden Green; EU Commission; FAO; Food Navigator; Food Packaging Forum; Good Food Institute; INSEAD; Labiotech; Lux Research; Market Watch; MHI, Natiune; Silicon Republic; ASEAN Post; Tony Blair, Warp News; Waste2; Wipo Green; World Resources Institute
### Businesses are innovating across levers

#### Sustainable production
- **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

#### Optimized protein mix and production
- **VOLTA GREENTECH**: Feed supplement to reduce methane emissions from cows
- **PRECISION PROTEIN**: Sensor-based technology and software to optimize animal production operations
- **Perfect Day**: Fermentation-based technology creating animal-free dairy protein

#### End-to-end traceability
- **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

#### Minimal food loss and waste
- **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

#### Dietary shift
- **crisp**: App-only supermarket for locally sourced seasonal products
- **ODDBOX**: ‘Wonky’ and surplus vegetable/fruit box delivery scheme
- **RecycleFood**: Mobile app tracking food shopping’s carbon footprint

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**Start-ups**
- **Corporations**
- **Initiative to support farmers in adopting regenerative agriculture practices on 10 million acres of cropland in US by 2030**
- **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
- **Walmart**: ‘Eden’ – a machine learning algorithm that scans produce to assess quality and freshness
- **Infarm**: 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

Sustainable production

Sources: Microsoft

<table>
<thead>
<tr>
<th>Technology:</th>
<th>Overview:</th>
<th>Highlights:</th>
</tr>
</thead>
<tbody>
<tr>
<td>IoT, monitoring, and analytics to support production</td>
<td>Digital solution using IoT, machine learning, and cloud technologies to provide data-driven insights that help farmers increase their agriculture productivity sustainably</td>
<td>Cloud-based IoT hub supports data collection from millions of sensors in real time, &gt;10x increase in rate of data collection</td>
</tr>
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<td>IoT, monitoring, and analytics to support production</td>
<td>Digital solution using IoT, AI, and cloud technologies to deliver real-time weather and moisture data to farmers to support their decision making</td>
<td>IoT-enabled boxes containing sensors gather data on temperature, light, moisture, wind, etc. and upload to cloud every 15 minutes</td>
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<td>IoT, monitoring, and analytics to support production</td>
<td>Integrated data platform for crop management, regenerative agriculture, and carbon MRV and monitoring</td>
<td>MRV software leveraging satellite data, remote sensing, and soil modeling to help farmers accurately quantify soil carbon sequestration</td>
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Cloud-based crop management and analytics platform allows farmers to monitor crop performance and stress to optimize profitable and sustainable agricultural practices

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

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

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

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

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

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

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

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

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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

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

Digital/data innovations

Sustainable production

- 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

- 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
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.

Feeder 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 eFishery Feeder 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.

>15,000 farmers have purchased feeders

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

Up to ~35% reduction in feed waste

Up to ~2x increase in farmer annual net profit

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

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.

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

Sources: Company website; Company interviews
HOW IT WORKS

eFishery platform

**eFisheryFund**
Provides farmers increased financing access through BNPL loans underwritten by smart-feeder data

**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

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

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.”

Gibran Huzaifah, CEO & Co-founder, eFishery

“**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.**”
Many other SEA firms are making significant progress across levers

★ Digital/data innovations

**Optimized protein mix and production**

**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

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

**End-to-end traceability**

**Technology:**
- Blockchain-based application

**Overview:**
Utilizes biotechnology to develop (the world’s first) cell-based milk

> >90%
Carbon footprint reduction

> >30 million
Pieces of fruit tagged and tracked to date

**Dietary shift**

**Technology:**
- Conscious-consumption platform

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

> >50,000
Product brands and restaurants reviewed

> >100 million
Equivalent transaction value

Notes: 1. When production facility is at scale
Sources: Company websites; Green Queen; KrASIA

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

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

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

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

Sources: Bain analysis

Non-exhaustive

ESTIMATED TIME HORIZON

Here and now opportunities

Over the horizon opportunities

0-5 years

5-10 years
Priority imperatives for SEA to address in waste and industrial sectors

<table>
<thead>
<tr>
<th>Waste management and circularity</th>
<th>Industrial and construction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Optimized production and consumption</strong></td>
<td><strong>Improved waste management</strong></td>
</tr>
<tr>
<td>Reduce the amount of nonrecyclable and hazardous waste generated</td>
<td>Improve management, recycling and upcycling of waste</td>
</tr>
<tr>
<td><strong>SEA imperatives</strong> (key actions)</td>
<td></td>
</tr>
<tr>
<td>Sustainable production</td>
<td>Cleaner waste-to-energy and industrial symbiosis</td>
</tr>
<tr>
<td>Overproduction in SEA contributes toward ~150 Mt of municipal solid waste (MSW) annually (~8% of global)</td>
<td>Significant value creation opportunities in treating waste as a resource</td>
</tr>
<tr>
<td>Optimize efficiency in production using big data and predictive analytics to reduce waste</td>
<td>Adopt efficient segregation and sorting solutions, advanced waste-to-energy methodologies, and greener composting</td>
</tr>
<tr>
<td>Advanced sustainable materials</td>
<td>Increase rate of recycling</td>
</tr>
<tr>
<td>&gt;30 Mt of plastic waste generated each year form SEA, with countries having the highest share of plastic waste deemed mismanaged</td>
<td>Open dumping and burning of MSW is prevalent in many SEA countries, while the overall recycling rate is only ~9%</td>
</tr>
<tr>
<td>Develop and adopt more sustainable materials to substitute single-use plastics and other nonrecyclable materials</td>
<td>Design for circularity and implement traceability solutions, policies, and financial mechanisms to incentivize recycling</td>
</tr>
<tr>
<td>Sustainable consumption</td>
<td>Better management of hazardous waste and e-waste</td>
</tr>
<tr>
<td>SEA’s fast-growing economy (forecasted ~4% annually) and rising affluence leads to increased consumption and waste</td>
<td>&gt;7 Mt of hazardous waste and ~2 Mt of e-waste annually reported from SEA</td>
</tr>
<tr>
<td>Shift to sharing economy platforms, rental models, resale markets</td>
<td>Establish legal framework, collection, and processing infra. for hazardous/e-waste</td>
</tr>
</tbody>
</table>

**Reduced embodied carbon in construction**

- Minimize carbon released from life-cycle production, transportation and use of construction materials
  - 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
    - Mitigate and capture emissions released from non-energy-related chemical processes
    - Mitigate 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

**Reduced process-related emissions**

Sources: ASEAN Today; Eco-Business; UNEP; Borgen Project
Multiple levers and innovations available to support transition

### Waste management and circularity

<table>
<thead>
<tr>
<th>Technologies and innovations</th>
<th>Optimized production and consumption</th>
<th>Improved waste management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compostable bioplastics and other recyclable plastic alternatives</td>
<td>Reduce the amount of nonrecyclable and hazardous waste generated</td>
<td>Improve management, recycling and upcycling of waste</td>
</tr>
<tr>
<td>Digitalized sharing economy platforms to facilitate sustainable consumption</td>
<td><strong>Digital/data innovations</strong></td>
<td></td>
</tr>
<tr>
<td>Big data analytics to optimize production and reduce wastage</td>
<td><strong>Note:</strong> 1. Recycled polyethylene terephylate</td>
<td></td>
</tr>
</tbody>
</table>

### Industrial and construction

<table>
<thead>
<tr>
<th>Reduced embodied carbon in construction</th>
<th>Reduced process-related emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimize carbon released from life-cycle production, transportation and use of construction materials</td>
<td>Mitigate and capture emissions released from non-energy-related chemical processes</td>
</tr>
</tbody>
</table>

#### Embodied carbon assessment tools and project footprint calculators

- Big-data precision calculation and benchmarking to optimize material use
- Low embodied-carbon materials and design
- Circular, future-proof architecture with disassembly and recycling functionality

#### Carbon capture and storage for industrial process emissions

- Plasma arc gasification to generate green hydrogen from waste
- Compostable bioplastics and other recyclable plastic alternatives
- Digitalized sharing economy platforms to facilitate sustainable consumption
- Big data analytics to optimize production and reduce wastage

#### Waste and Industry

**Digital/data innovations**

- rPET1 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

---

**Sources:** Bain analysis; UNEP; IPCC; PreScouter

Note: 1. Recycled polyethylene terephylate
Businesses are innovating across levers

**Waste management and circularity**

<table>
<thead>
<tr>
<th>Start-ups</th>
<th>Corporations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SECURITY MATTERS</strong></td>
<td><strong>INEOS</strong></td>
</tr>
<tr>
<td>Blockchain-enabled traceability with chemical markers for recycling</td>
<td>Recycled polyethylene using depolymerization</td>
</tr>
<tr>
<td><strong>CIRCULARISE</strong></td>
<td><strong>BIOMASS INNOVATIONS</strong></td>
</tr>
<tr>
<td>Blockchain-enabled traceability with digital twin</td>
<td>Bionanocellulose-based plastic alternatives</td>
</tr>
<tr>
<td><strong>REDWOOD MATERIALS</strong></td>
<td><strong>RECYCLEYE</strong></td>
</tr>
<tr>
<td>Recycled essential metals from battery cell production and consumer electronics</td>
<td>AI-enabled computer vision algorithm to identify and sort through waste streams</td>
</tr>
</tbody>
</table>

**Industrial and construction**

| **BETOLAR** | **3D PRINTING SOLUTIONS** | **ONE CLICK CA** |
| Next-generation low-carbon alternative to cement | CO₂ mineralization in concrete to reduce need for cement | Automated life-cycle assessment and embodied carbon calculator |
| **LENDAGROUP** | **THOMAS RAU** | **CIRCULAR ARCHITECTURE** |
| 3D-printed buildings for Net Zero homes | Recyclable building architecture that can be fully disassembled | Circular architecture using upcycled and recycled building materials |

**Start-ups**

- **INNOVATION AWARD**: Award for ‘most sustainable office’ at its European headquarters

Sources: Company websites
## Promising activity emerging in SEA

### Waste management and circularity

**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
- 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)

<table>
<thead>
<tr>
<th>Metric</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>+35%</td>
<td>Recycling rates in pilot villages</td>
</tr>
<tr>
<td>+30%</td>
<td>Monthly income for informal waste collectors using the app</td>
</tr>
<tr>
<td>~30%</td>
<td>High overall plant efficiency due to optimised designs and technology</td>
</tr>
<tr>
<td>&gt;30 years</td>
<td>Plant life span due to modular, future-proof design with easy dismantling</td>
</tr>
</tbody>
</table>

### Industrial and construction

**SCG**

- 3D-printed prefabrication construction
- Low-embodied-carbon materials and design
- 102 sqm 3D printed co-working space in Saraburi, Thailand
- Construction waste as a result of 3D printing

**Integrated Waste Management Facility (IWMF); Singapore Government**

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

**Digital/data innovations**

- Non-exhaustive
SEA’s Net Zero roadmap can be phased based on the technological readiness and abatement potential of levers.

**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

**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.

**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.
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 SEAs 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**

<table>
<thead>
<tr>
<th>Year</th>
<th>Total projects</th>
<th>Nature-based solutions (NBS) - forestry: 84%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>649</td>
<td>25%</td>
</tr>
<tr>
<td>2020</td>
<td>1259</td>
<td>35%</td>
</tr>
</tbody>
</table>

**SEA contribution to global:***

- Voluntary offsets transactions: 9% of ~$300 million global market
- Annual investible carbon potential: 25% of ~1.8 billion MtCO₂e global carbon credit potential in pantropic forests

**By 2030**

- Debt financing: ~$600M
- Project development: ~$4B
- Audit and MRV: ~$50M
- Registries (nonprofits): ~$40M
- Assurance: ~$500M
- Trading: >$10B
- Purchasing: ~$5B
- Consulting (across value chain): ~$40M

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

- **Innovative financing models**
  - Long lead times (3- to 7-year development cycle) and uncertainty in conflict with traditional funders’ demand for quick returns
  - Adopt new funding models (PPPs, blended financing, smallholder models) to de-risk projects and increase private capital flow

#### 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 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/region level interfere with a functioning voluntary carbon market (e.g., carbon taxes, ETS, 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

**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

### Technologies and innovations

#### Unlock supply
- **Quality project development and pipeline visibility**
  - Increase supply of high-quality carbon reduction projects

#### Lowered barriers to project development
- Incentivize funding and reduce set-up costs and inefficiencies

#### Improve integrity
- **Assurance and transparency in projects**
  - Ensure integrity and accuracy of carbon avoidance/removal

#### 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

<table>
<thead>
<tr>
<th>Technology readiness (global)</th>
<th>HIGH</th>
<th>LOW</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Soil carbon crediting methods in agriculture</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Carbon crediting methods for blue carbon in mangroves</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Carbon crediting methods for blue carbon in seagrass meadows</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Carbon crediting methods for ocean carbon sequestration</strong></td>
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</tr>
<tr>
<td><strong>Science-based modeling and mapping of co-benefit value</strong></td>
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<tr>
<td><strong>Project fundraising using cryptocurrency tokenization</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>AI/ML-enabled remote monitoring to ensure additionality, permanence and no leakage of credited offsets</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Digital twin technology for enhanced visibility and transparency over natural capital</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Digitalized due diligence and KYC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Integrated carbon exchange and marketplaces</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Advanced data infrastructure for transparency of market data</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Blockchain tokenization for transparency and traceability in transactions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Carbon footprint calculators</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Sources: Allied Offsets; Industry interviews; Bain analysis
Businesses are innovating across levers

Unlock supply

Start-ups

- New methodologies in blue carbon sequestration measurements
- Coastal carbon capture methodologies through enhanced weathering
- Smallholder financing models

Corporations

- Private sector-led initiative working across the value chain to scale voluntary markets, with >250 member institutions
- Integrated carbon marketplace prioritizing transparency and credibility with strict due diligence and quality assurance
- Blockchain-enabled voluntary carbon marketplace called Project Carbon to support clients on their Net Zero journey

Improve integrity

- Tech-enabled monitoring for offset quality rating
- Digitalized due diligence and KYC
- Tech-enabled monitoring for offset quality rating
- Digital twin technology and tokenization for forestry

Establish fundamentals

- Blockchain tokenization of REDD+ credits
- Blockchain tokenization of amazon forest credits
- Agri-centric, blockchain-enabled offsetting
- Simplified footprinting and offsetting
- Carbon offset contract exchange
- Integrated carbon trading exchange

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

Unlock supply

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

GrabForGood

- AI/ML-enabled remote monitoring

Establish fundamentals

- 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

Digital/data innovations

- Unlock supply: Philippines Palawan Protection Project
- Improve integrity: GrabForGood
- Establish fundamentals: Carbon credits exchange and marketplace

Notes: 1. Business-to-consumer
Sources: Green Biz, Earth Ledger, Its Our Home, Company websites

Non-exhaustive
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.

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.

<table>
<thead>
<tr>
<th>LEVERAGE ENABLERS</th>
<th>GREEN DATA REVOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Instrumentation for de-averaged data</strong></td>
<td><strong>Accuracy and granularity</strong></td>
</tr>
<tr>
<td>IoT sensors, precision monitoring equipment, etc. at the base of data source</td>
<td></td>
</tr>
<tr>
<td><strong>Democratization of data</strong></td>
<td><strong>Interoperability across data sources</strong></td>
</tr>
<tr>
<td>Ubiquitous data collection</td>
<td><strong>Standardized definitions methods</strong></td>
</tr>
<tr>
<td>Telemetry through satellite imaging, drones, LiDAR, smart sensors, camera traps</td>
<td>SpatioTemporal Asset Catalog for standardized spatial data mapping</td>
</tr>
<tr>
<td><strong>Complete supply chain data visibility</strong></td>
<td><strong>Powerful computing innovations</strong></td>
</tr>
<tr>
<td>Materials to products, factories to stores</td>
<td>Advanced processors, quantum computing, AI/ML, real-time data testing, etc.</td>
</tr>
<tr>
<td><strong>Private-public good datasets, data crowdsourcing</strong></td>
<td><strong>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</strong></td>
</tr>
<tr>
<td>Emergence of global environmental datasets and meta-registries</td>
<td><strong>Large-scale cloud computing</strong></td>
</tr>
<tr>
<td><strong>Co-innovation</strong></td>
<td><strong>Optimize/innovate</strong></td>
</tr>
<tr>
<td>Increasing collaboration</td>
<td>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</td>
</tr>
</tbody>
</table>

Notes: 1. Application programming interface
Sources: Datacenter News; Datacenter Knowledge; Bain experience; Industry interviews; Company websites

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

## Use case

<table>
<thead>
<tr>
<th>Description</th>
<th>Features</th>
<th>Users/Partners</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy</strong></td>
<td>Open platform digital twin technologies to optimize urban planning, energy efficiency, and disaster planning.</td>
<td><strong>Nature</strong></td>
</tr>
<tr>
<td><strong>Agri-food</strong></td>
<td>Integrated data on environment, buildings, transport, drainage, traffic, etc. Simulations and scenario analysis</td>
<td><strong>Nature</strong></td>
</tr>
<tr>
<td><strong>Energy</strong></td>
<td>Open-source platform to aggregate data, modeling and computing for climate-integrated investing.</td>
<td><strong>Nature</strong></td>
</tr>
<tr>
<td><strong>Agri-food</strong></td>
<td>Physical-economic models Global data compendium Scenario-based predictive analysis</td>
<td><strong>Nature</strong></td>
</tr>
<tr>
<td><strong>Energy</strong></td>
<td>Harmonized data from multiple sources using APIs Statistical and analytical packages</td>
<td><strong>Nature</strong></td>
</tr>
<tr>
<td><strong>Agri-food</strong></td>
<td>AI for Earth multi-petabyte planetary computer Hyperscale cloud, AI, and IoT digital twins</td>
<td><strong>Nature</strong></td>
</tr>
<tr>
<td><strong>Energy</strong></td>
<td>Datasets, industry-leading AI, and cloud computing tools to solve environmental problems</td>
<td><strong>Nature</strong></td>
</tr>
<tr>
<td><strong>Agri-food</strong></td>
<td>Real-time satellite imaging Analytics on changes in forest cover, land use, climate, and biodiversity</td>
<td><strong>Nature</strong></td>
</tr>
<tr>
<td><strong>Nature</strong></td>
<td>Largest open-source satellite imaging and spatial mapping platform for management of natural assets</td>
<td><strong>Nature</strong></td>
</tr>
<tr>
<td><strong>Nature</strong></td>
<td>Provider of ready-to-use, future climate data for impact studies and risk assessment</td>
<td><strong>Nature</strong></td>
</tr>
<tr>
<td><strong>Nature</strong></td>
<td>Projections of rainfall, wind speeds, temperatures, and solar radiation using advanced statistical processing</td>
<td><strong>Nature</strong></td>
</tr>
</tbody>
</table>

**Sources:** Microsoft; Geoportal: CrunchBase; S1World; OS-C: 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

Note: 1. Singapore accounts for 60% of SEA’s data center supply

Sources: Unreal Engine, NRF, Global Forest Watch, STWorld; Datacenter News; Datacenter Knowledge

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 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

**Singapore’s Digital Twin**

by STWorld

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

**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:**

- Monitor building characteristics and sunlight to plan for **solar**
- Simulate floods and other climate events for **disaster planning**
- Alert on **illegal deforestation activities** at project sites
- Monitor and ensure **deforestation-free supply chains**
- Monitor building characteristics and sunlight to plan for **solar**
- Simulate floods and other climate events for **disaster planning**
- Alert on **illegal deforestation activities** at project sites
- Monitor and ensure **deforestation-free supply chains**

Image credits: STWorld, YouTube

Image credits: Global Forest Watch

Image credits: 51World, YouTube

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

Sources: Unreal Engine; NRF; Global Forest Watch; STWorld; 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

<table>
<thead>
<tr>
<th>SBTi signatories as of end July 2021</th>
<th>SEA companies with Net Zero commitments (non-SBTi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,699 Global¹ 25 SEA (21 since 2020)</td>
<td>Net Zero by:</td>
</tr>
<tr>
<td>- MEA</td>
<td>- 2030</td>
</tr>
<tr>
<td>- LATAM</td>
<td>- 2050</td>
</tr>
<tr>
<td>- UK</td>
<td>- 2060</td>
</tr>
<tr>
<td>- NA</td>
<td>-</td>
</tr>
<tr>
<td>- REST OF APAC</td>
<td>-</td>
</tr>
<tr>
<td>- EU</td>
<td>-</td>
</tr>
</tbody>
</table>

11 with targets set²

Market cap of SBTi signatories³ as percentage of total market cap in:

<table>
<thead>
<tr>
<th>SEA</th>
<th>Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>4%</td>
<td>27%</td>
</tr>
</tbody>
</table>

Average annual emissions reductions⁴ since SBTi start year:

<table>
<thead>
<tr>
<th>SEA</th>
<th>Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>4%</td>
<td>6%</td>
</tr>
</tbody>
</table>

4.2% Required by SBTi for 1.5°C target

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

Non-exhaustive
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

<table>
<thead>
<tr>
<th>Efficiencies and savings</th>
<th>New growth areas</th>
</tr>
</thead>
</table>

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

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

>$460 billion potential economic opportunities

>$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

1. Measure baseline and set ambition
   - Measure and establish **baseline emissions** and potential impact on P&L
     (e.g., due to carbon taxes)
   - Define **Net Zero ambition** aligned to business strategy

2. 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

3. 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 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:

<table>
<thead>
<tr>
<th>Emission scope</th>
<th>Emission source examples (software co)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scope 1:</strong> Direct Emissions</td>
<td>Back-up power generation</td>
</tr>
<tr>
<td></td>
<td>Data center operations</td>
</tr>
<tr>
<td></td>
<td>...</td>
</tr>
<tr>
<td><strong>Scope 2:</strong> Electricity, Cooling, and Heating</td>
<td>Electricity</td>
</tr>
<tr>
<td></td>
<td>Heating</td>
</tr>
<tr>
<td></td>
<td>...</td>
</tr>
<tr>
<td><strong>Scope 3:</strong> Other Indirect Emissions</td>
<td>Company travel</td>
</tr>
<tr>
<td></td>
<td>Waste</td>
</tr>
<tr>
<td></td>
<td>...</td>
</tr>
</tbody>
</table>

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

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

Source of value
- Value preservation through efficiencies and savings
- ... ...

Ambition archetype
- 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
- 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

<table>
<thead>
<tr>
<th>Maintenance optimization</th>
<th>LED and smart lighting</th>
<th>On-site renewable energy installation</th>
<th>...</th>
</tr>
</thead>
</table>

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

<table>
<thead>
<tr>
<th>Carbon-free product design</th>
<th>Supply network optimization</th>
<th>Low-carbon business models</th>
<th>...</th>
</tr>
</thead>
</table>

#### 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

<table>
<thead>
<tr>
<th>Insetting</th>
<th>Offset credits</th>
<th>...</th>
</tr>
</thead>
</table>

**Examples**

- **Bosch** focused on reduction of operational emissions as part of its climate strategy
- **Orsted** 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.

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

Sources: Bain experience

---

**Levers**

- Process optimization
- LED lighting
- Smart ventilation
- Process rebuild
- Energy recovery
- Maintenance optimization
- Efficient generation and heat exchange
- Optimized plant layout
- Refurbish, retrofit, replace machines
- Process automation
- Redesign products
- On-site solar
- Wind
- Green energy power purchase agreement (PPA)
- Harmonized pressure/ temperature

**Emissions (Scopes 1 & 2) of Global Auto Supplier Co (in tCO\(_2\)e)**

- Green energy utilities
- Biomass
- Energy efficiency
- Renewables
- Forestry and land
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

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

- **Point of departure** (total carbon from current portfolio)
- **Exit part of portfolio** unwilling to reduce carbon footprint
- **Reduce carbon footprint** by supporting clients’ transition
- **Offset remaining carbon** via nature-based solutions

**Carbon emission abatement from portfolio (tCO₂e)**

- **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

**Sustainable loan**

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

**Case study**

**Projected**

**RMI**

**The Japan Times**

**European Investment Bank Group**
The right enablers will help an organization to sustain and scale its Net Zero results.

## Elements of a green organization

<table>
<thead>
<tr>
<th>Leadership and culture</th>
<th>Structure and accountabilities</th>
<th>Objectives and incentives</th>
<th>Talent and capabilities</th>
<th>Business and mgmt. processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Leadership focus</td>
<td>• Line accountabilities and operations</td>
<td>• Targets and cascading</td>
<td>• New capabilities</td>
<td>• Key metrics</td>
</tr>
<tr>
<td>• Culture and mindset</td>
<td>• Dedicated team</td>
<td>• Integrated budget</td>
<td>• Climate literacy training</td>
<td></td>
</tr>
<tr>
<td>• Impact stories</td>
<td>• Formal governance</td>
<td>• Decarbonization-linked incentives</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• New ways of working</td>
<td>• Executive objectives</td>
<td>• Subject matter expertise</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Decision tools</td>
<td></td>
</tr>
</tbody>
</table>

### 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:**

<table>
<thead>
<tr>
<th>price of carbon ($/tCO₂e)</th>
<th>yearly funding for environmental initiatives ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>projected annual carbon emissions in boundary (tCO₂e)</td>
<td></td>
</tr>
</tbody>
</table>

**Potential use cases**

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

### 4. Engage and inspire stakeholders to ensure results delivery

<table>
<thead>
<tr>
<th>External/customer brand positioning</th>
<th>Employee communication</th>
<th>Shareholders/investors value alignment</th>
<th>Supplier support</th>
<th>Ecosystem partnerships</th>
</tr>
</thead>
</table>

**Notes:**
- 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
Microsoft has defined a net-negative carbon ambition and is establishing a green organization to realize its goals.

**ENABLERS**

1. **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

2. **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

3. **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.

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 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 ($/tCO₂e) = yearly funding for environmental initiatives ($) / projected annual GHG emissions in boundary (tCO₂e);
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

## Decarbonization efforts by leading SEA players

<table>
<thead>
<tr>
<th>Baseline and ambition</th>
<th>SBTi target set (&lt;2°C)</th>
<th>SBTi committed</th>
<th>Electric and hybrid fleet</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SBTi target set (&lt;2°C)</strong></td>
<td>Reduce scope 1 and 2 emissions by 28% and scope 3 from capital goods by 22% (per m²) by 2030, vs. 2019 baseline</td>
<td>28% emissions reduction by 2030, vs. 2007 baseline</td>
<td><strong>Full fleet running on clean energy by 2030; Net Zero targets and roadmap to be announced next year</strong></td>
</tr>
<tr>
<td><strong>Lever</strong></td>
<td><strong>Sustainability council</strong> established, reporting to board of directors and supported by group Chief Sustainability Officer</td>
<td><strong>Increasing use of biomass and renewables with multiple solar PV projects/pilots</strong></td>
<td><strong>Partnerships with governments to develop and grow infrastructure for electric vehicles</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Systematic KPIs</strong> tied to renumeration</td>
<td><strong>AI solutions to manage energy in production units, reducing emissions by 1,600 tons of CO₂/year</strong></td>
<td><strong>Pilot feature for users to choose EV rides and offset carbon emissions on app</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Internal carbon price</strong> across global portfolio in progress</td>
<td><strong>Roll-out of low-carbon cement and greening of supply chain</strong></td>
<td><strong>Investments in carbon offset and solarization projects</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Sustainability X Challenge</strong> set up</td>
<td><strong>Investments in forest rehabilitation</strong></td>
<td><strong>New EV business models piloted</strong></td>
</tr>
</tbody>
</table>

### Sources
- CapitaLand Sustainability Report (2020)
- SCG Sustainability Report (2020)
- Grab ESG Report (2020)
- Nikkei Company website
- Bain interviews

**SBTi committed**

- **SBTi committed**
- **SBTi committed**
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

<table>
<thead>
<tr>
<th>Consumers</th>
<th>Investors</th>
<th>Regulators</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rewards</strong></td>
<td><strong>Risks</strong></td>
<td></td>
</tr>
<tr>
<td>As The North Face battles Patagonia in outdoors market, it bets tackling climate change will pay off</td>
<td>Ayala unit secures $67 million funding for solar farm in India</td>
<td>Sunseap signs 20-year agreements to supply energy to Vietnam’s national grid</td>
</tr>
<tr>
<td>“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”</td>
<td>“Sitara Solar project... has secured a 20-year loan from the US International Development Finance Corporation (DFC)”</td>
<td>“(Sunseap) has signed 20-year power purchase agreements with state-owned utility Vietnam Electricity to supply clean energy to the country’s national grid”</td>
</tr>
<tr>
<td><strong>Great demand for carbon-neutral products</strong></td>
<td><strong>Climate Activist Investors Pressure Big Oil: What’s Next?</strong></td>
<td><strong>Regulate business to tackle climate crisis, urges Mark Carney</strong></td>
</tr>
<tr>
<td>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</td>
<td>“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”</td>
<td>“...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...”</td>
</tr>
</tbody>
</table>

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.

### Example

<table>
<thead>
<tr>
<th><strong>Workers</strong></th>
<th><strong>Communities</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Smallholder farmers</td>
<td>Prohibitive costs for smallholder farmers who typically have poor access to capital to invest in sustainability</td>
</tr>
<tr>
<td>MSME¹ suppliers</td>
<td>Increasingly stringent sustainability standards and requirements may act as barriers for MSMEs to access global value chains</td>
</tr>
<tr>
<td>Workers reliant on resource extraction</td>
<td>Serious threat of job displacement as the region shifts away from coal and fossil fuels toward renewable energy</td>
</tr>
<tr>
<td>Green economy workers</td>
<td>An overfocus on building green infrastructure could lead to oversights in human and labor rights</td>
</tr>
<tr>
<td>Coastal, rural, and Indigenous</td>
<td>Green developments could damage sources of livelihoods, displace communities, and result in land rights inequality</td>
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</tbody>
</table>

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.

| 16-39% of a farmer’s annual income needed to obtain a sustainable palm oil certification in Indonesia |
| 78% of MNCs will remove suppliers that endanger their Net Zero transition by 2025² |
| ~20 million workers employed by oil and gas in Indonesia alone |
| 197 allegations of human rights abuse related to renewable energy projects globally |
| 39 dead, up to 100 missing, and thousands homeless due to a collapsed hydropower dam in Laos |
Small steps are being taken to **address transition risks on SEA workers and communities**

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

- 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 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
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

>5 million jobs
related to Net Zero potentially created in SEA by 2030

- Energy transition
- Valuing nature
- Agri-food system transformation
- Waste and industry emissions management

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