ASIA CLEAN ENERGY FORUM 2025

Empowering the Future: Clean Energy Innovations, Regional Cooperation and Integration, and Financing Solutions

2–6 June | ADB Headquarters

Norwegian Embassy
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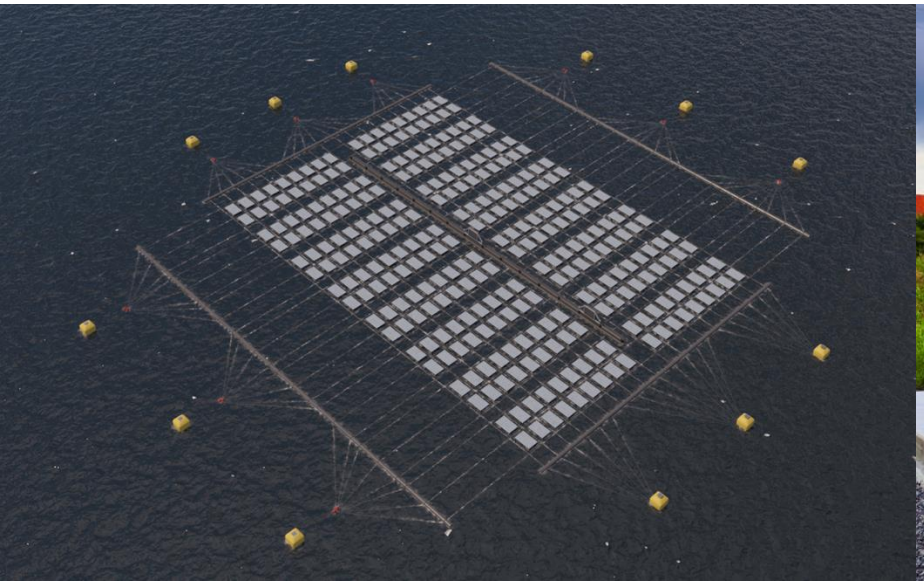
The Future of Floating PV and BESS in Asia

Manila 2 June 2025



EMERGING AREAS | ENERGY SECTOR

ADB

FPV and BESS Initiatives in Asia and the Pacific

Cindy Cisneros Tiangco
Director, Emerging Areas, Energy Sector Office

2 June 2025
Pre-ACEF Event: The Future of Floating PV and BESS in Asia
ADB Headquarters, Metro Manila, Philippines

ADB Strategy 2030, Energy Policy, and Emerging Areas

GUIDING PRINCIPLES AND DIFFERENTIATED APPROACHES

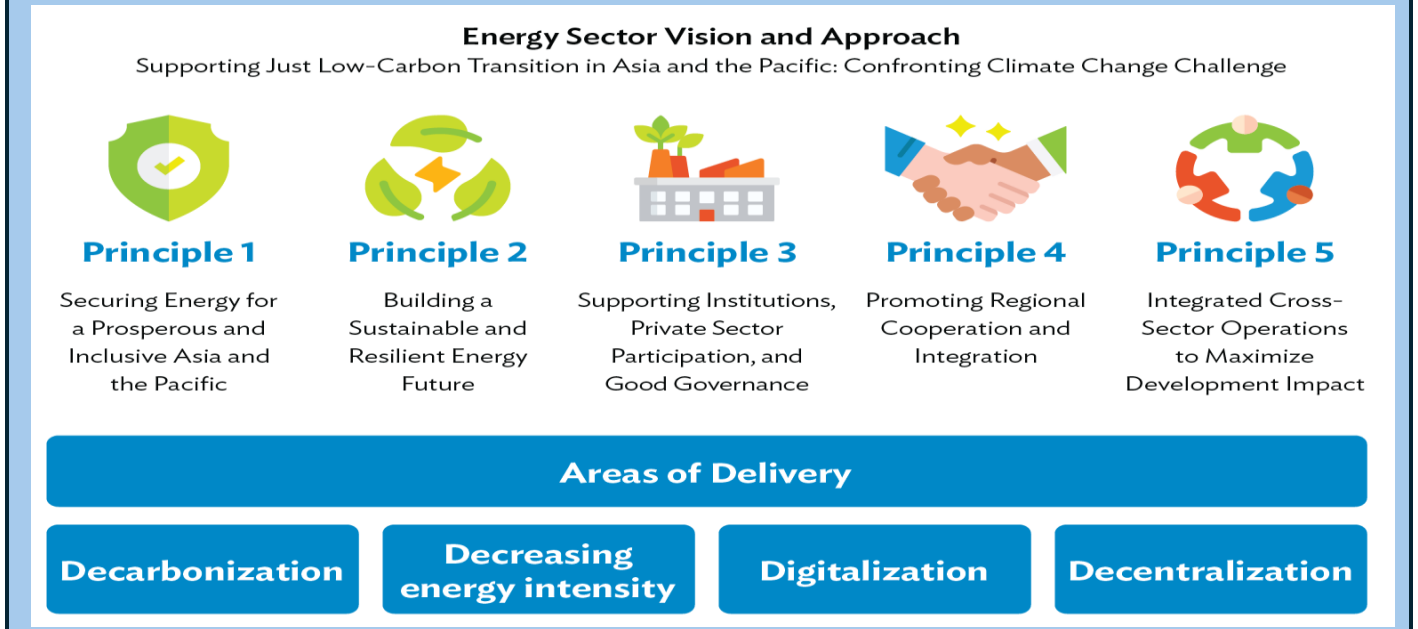
- Country-focused approach
- FCAS and SIDS, pockets of poverty and fragility
- Promoting innovative technology
- Delivering integrated solutions

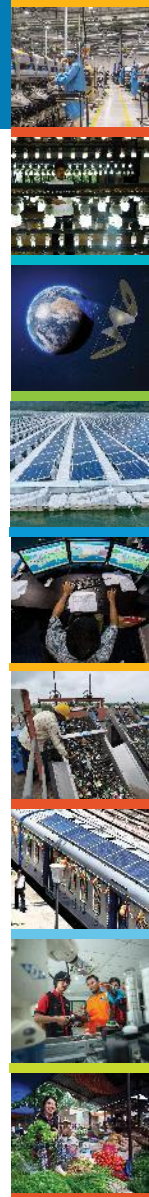
ADB NEW OPERATIONS MODEL (Four shifts)

- Solutions Shift
- Climate Change Shift
- Private Sector Development Shift
- New Ways of Working

Emerging Areas:

- Energy cuts across sectors and plays a key role in confronting the climate change challenge.
- The emerging areas can and should address all the areas of delivery under the five principles of the Energy Policy and accelerate the energy transition
- Significant focus is needed to support principles 2 and 5 in building a sustainable and resilient energy future, through **integrated cross-sector operations to maximize development impact.**
- Emerging areas in all sectors will focus on **innovative approaches and financing, frontier technologies, collaboration and knowledge**





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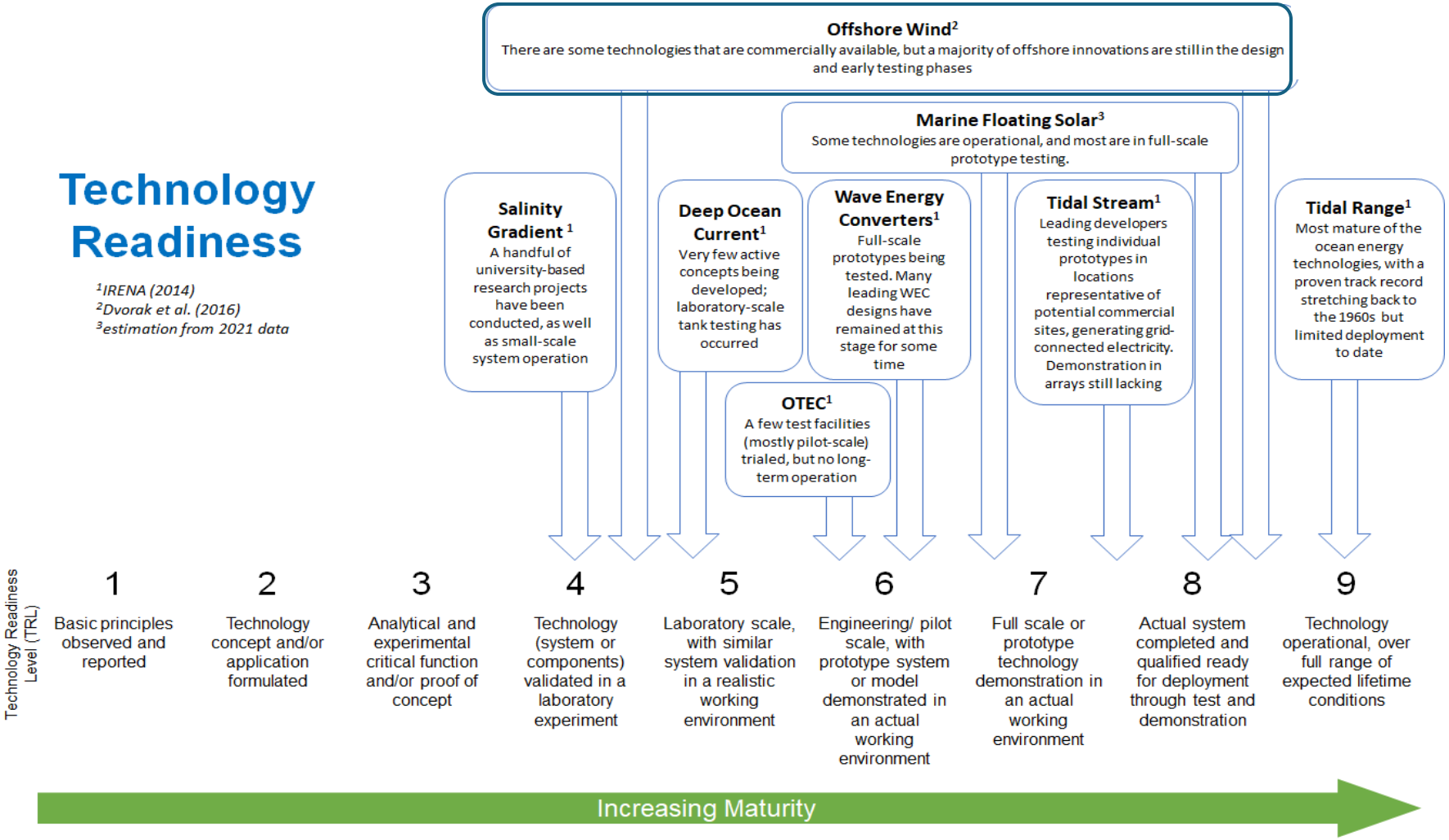
Emerging Ocean and Marine RE Technologies

Technology Readiness

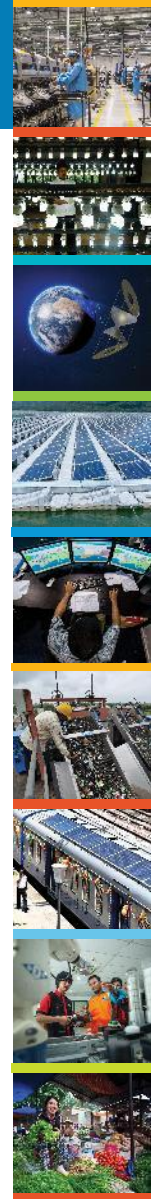
[1]IRENA (2014)
[2]Dvorak et al. (2016)
[3]estimation from 2021 data



https://www.energytransitionpartnership.org/wp-content/uploads/2024/04/Marine-Renewable-Energy-in-the-Philippines-Sustainable-Energy-from-Ocean-Spaces-and-Resources-2022.pdf

Technology	Typical Plant Capacity Factors*
Solar PV	16.1% to 20.8%
Offshore Wind	30% to 50%
Tidal Range (e.g. Barrage)	Typically 25%
Tidal Stream	25% to 40%
Ocean Current (e.g. Gulf Current in Florida Strait)	Up to 70%
Wave	32% to 40%
OTEC	90% to 95%

***Note: these are dependent on other factors such as: site, resource, technology, and other project parameters**



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Challenge: Achieving Climate Change Adaptation and Resilience through *Smart, Low-Carbon Integrated, Multi-Sectoral Solutions and Approaches*

- Challenge: Climate resilience investments are developed within a single sector, hence opportunities for more effective, **multi-sectoral solutions are missed**;

- Solution: This sub-program targets climate vulnerabilities in any or all sectors through the **early identification and provision of appropriate interventions** that are enabled/supported by smart energy services.

- Approach: Rapid analysis of each sector (enabled by data); develop **suitable smart solutions investment that adapts or builds resilience**; ensure total focus on most vulnerable; implement smart solutions(i.e. multi-sector / cross-sector) investments

- Innovations/transformations: **multi-sectoral, collaborative, and cohesive**; e.g. energy sector becomes an enabler, i.e.. service provider (providing adaptation solutions), productive uses of energy (PUE); many new energy and energy-linked technologies; ICT standards across different sectors

- Specific co-benefits:
  - **Contributes to livelihoods, or economic development**, or food/water security, or disaster management, etc;
  - Expanded energy sector and significant mitigation benefits;
  - Demand driven approach increases scope for revenue (e.g. energy, energy-linked (i.e. PUE), energy-enabled, etc) and attracting private investments.

.

* Productive uses of energy are *agricultural, commercial and industrial activities involving energy services as a direct/indirect input to the production of goods or provision of services with increase in income or productivity*

Examples

- Where CC threatens **food security,** the smart energy investment may lead to improved ecosystems (reefs and mangroves), aquaculture, or to food processing and storage facilities;

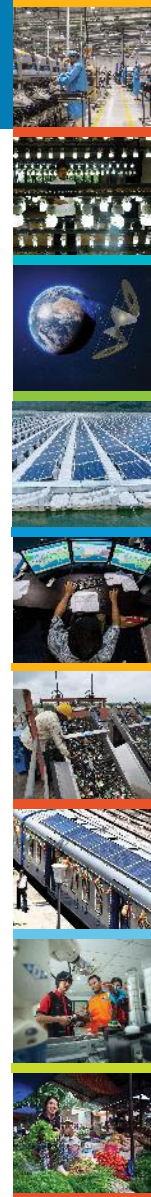
- Where CC threatens **water security**, the smart energy investments may support water supply and distribution, e.g. through desalination, water pumping;

- In areas where **improved connectivity** would lead to improve increased resilience, smart energy investments will lead to internet connectivity;

- Where CC leads to more typhoons (or other **rapid disasters**), the smart energy systems may provide improved warning systems, and decentralized energy production/storage facilities for use in the in early post-disaster period;

- In areas with low **adaptive capacity**, smart energy systems can improve society resilience by providing low-cost, resilient, decentralized transportation – bicycles, cars, small boats, battery storage, etc;

- In **hard-to-reach (e.g. up-hill) areas**, smart energy investments may lead to improved food storage and processing, improved irrigation, independent transport systems, independent EWS and clinics, evacuation centres, etc;



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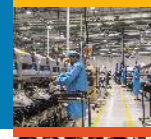
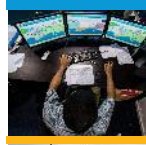
Smart, Low-Carbon Integrated, Multi-Sectoral Solutions and Approaches









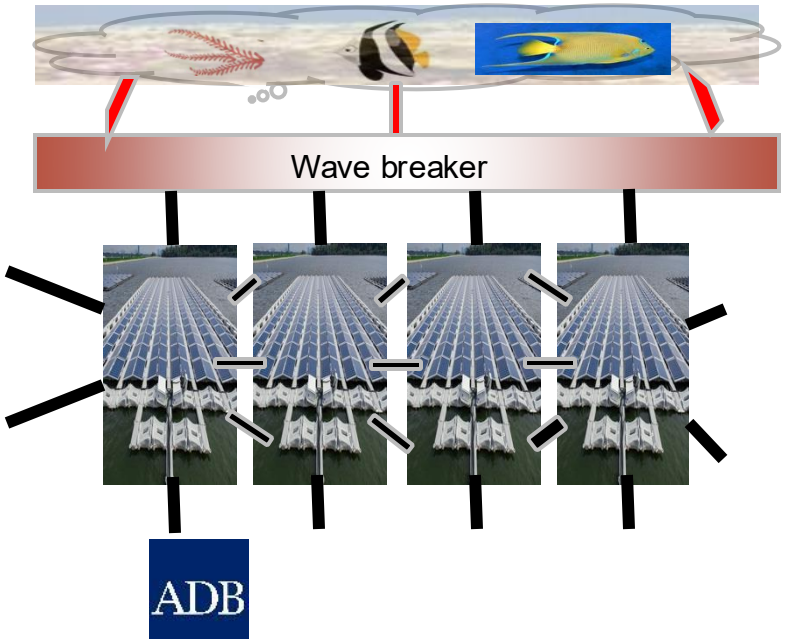
Floating PV and Productive Uses of Energy

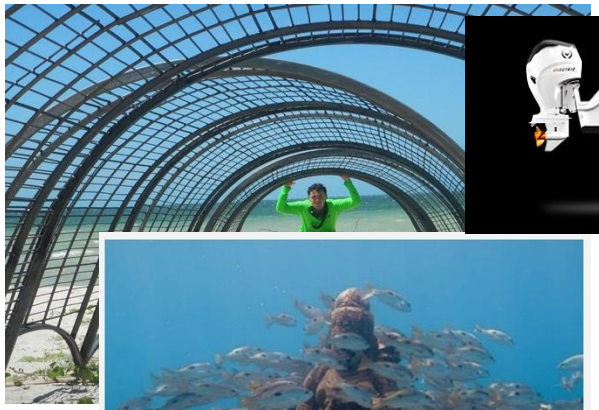
Kiribati and Tuvalu Floating Solar Plus projects features

- Regional procurement
- Design Build Operate (FPV, grid upgrades, PUEs, SBEs)
- 1-year O&M services
- Coastal protection through wave breakers and electric reefs
- Electric boats, EVs and EV charging stations
- Capacity building and awareness raising
- Disaster risk reduction measures
- Early warning systems and disaster preparedness
- Smart energy management systems

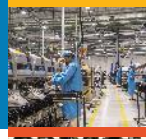
South Tarawa, Kiribati (2024)

Funafuti, Tuvalu (2023)





Dense fish populations around Biorock structure at Karang Lestari project, Pemuteran,Bali. Photo: Rani Morrow-Wuigk





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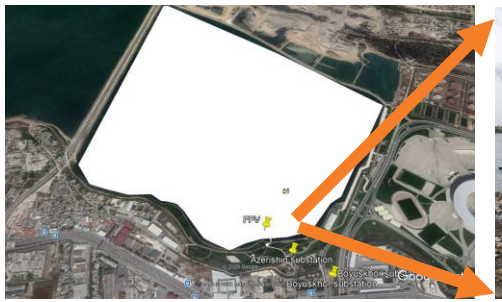
Floating PV initiatives

Program Year	DMC	Project Name/Components (Indicative)	Identified FPV Potential (MW)	Market Potential/ Program (MW)	Scope and Indicative Location	Remarks/Notes
2023	TUV	Increasing Access to Renewable Energy Project (AF) ($5mn)		1	Marine/Lagoon	Approved in 2023 (for regional procurement with KIR STREP 2
2024	KIR	South Tarawa Renewable Energy Project (Phase 2) ($20 mn)		5	Marine/Lagoon	For approval in 2024 (for regional procurement with TUV IAREP AF
2026	TUV	Climate-Resilient Cross-Sector Integrated Project (AF 3)		3	Marine/Lagoon	Included in Country Program MOU
2026	TON	Integrated Sustainable and Resilient Power Sector Program		5	Marine/Lagoon	Included in Country Program MOU
2026	RMI	Energy Transition Project (Marine RE/Wind pilots)		3	Marine/Lagoon	Included in Country Program MOU
2026	KIR	Climate-Resilient Cross-Sector Integrated Project (STREP 3)		5	Marine/Lagoon	Included in Country Program MOU
2026-2028	INO	CIREBON-1 Floating Solar		1	Reservoir	Early-stage concept with fish farming;
2026-2028	INO	Accelerating Indonesia's Clean Energy Transition	1300		Mixed	RBL (FPV, PV and wind), with private sector participation
2026-2028	INO	FPV on Agricultural Dams	14700		Dams/reservoirs	14.7 GW identified by INO MEMR and request to study
2026-2028	IND	West Bengal Floating Solar	250	150	Bakreshwar Dam	Technical assessments and project preparation underway
2026-2028	AZE	AZE Floating Solar Plus Project	4000	50	Lakes/HPP dams	Pilot operational; Boyukshor Lake FS available, 100 MW
2026-2028	KGZ	KGZ Floating Solar Plus Project	15000	544	HPP reservoirs	115 kWp pilot operational; 40 MW pre-FS completed;
2026-2028	MLD	Floating Solar Projects	50	10	Marine/Lagoon	Bid preparation >10MW; 50 MW with private sector participation
2026-2028	REG	PAK, TAJ, UZB AFNR-ENE plus			Mixed	Pre-FS/Concepts developed
2026-2028	PHI	Utility Scale Floating Solar Projects			Reservoirs	Early-Stage discussions
2026-2028	REG	Pacific Floating Solar Plus Projects			Mixed	Early-Stage discussions
		Total	**35300**	**777**		

List is not exhaustive, subject to country programming and due diligence



AZE Lake Boyukshor Pilot

KGZ Bishkek HPP5 Pilot

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Battery Energy Storage Systems initiatives

Table A1: Selective List of ADB-financed BESS Projects Since 2014

Sovereign				Nonsovereign		
Year	Country	Project description		Year	Country	Project description
2014	Cook Islands	Solar PV and BESS (3MW/12MWh)				
2018	Pakistan	Grid-connected BESS (20MW/5MWh)				
2019	Tonga	PV plant (0.3 MW) with BESS (0.9MW/0.45MWh); Grid stability BESS (5.1MW/2.5MWh)				
2020	Mongolia	Grid-connected BESS (80MW/200MWh)		2020	Thailand	Wind power (10MW) and BESS (2MWh)
2020	Cambodia	Pilot BESS (16MWh) to support 100MW PV plant				
2022	Cambodia	49 MW/MWh BESS to support integration of PV plants				
2023	Maldives	BESS (44MWh+) in 18 islands		2023	Uzbekistan	PV plant (250MW) and BESS (63MW/126MWh)
				2024	Thailand	Solar and BESS (multiple plants)
				2024	Cambodia	Signed a transaction advisory services mandate with the Électricité du Cambodge (EDC) to develop 2 GW solar PV project combined with BESS.

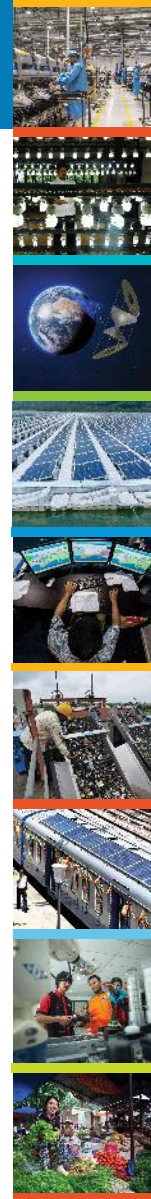
BESS= Battery Energy Storage Systems, MW= megawatt, MWh= megawatt hour, PV= photovoltaic.
Source: Asian Development Bank.

Table A2: Selective List of ADB-financed BESS Project Pipeline for 2024/2025

Region	Country	Pipeline supported by ADB	Sov/NSO
SEAP	Viet Nam	Finalizing the scope of a pilot BESS project (**50MW**/50MWh) for EVN. Having applied for a GEAPP grant for co-financing. The project is a part of the government's JETP scheme (issued in October 2023).	SOV
	Thailand[a]	Gulf Solar and Solar with Battery Energy Storage Systems Project. 640MW PV 249MW solar with **396MW** BESS by the Blended Finance Committee.	NSO
	Kiribati	(49450-030) South Tarawa Renewable Energy Project (Phase 2). 4 MW FPV, **3 MVA** /5 MWh BESS. 2024 Pipeline	SOV
	Solomon Islands	(57006-001) Renewable Energy Development Project. Solar PV arrays and multiple BESS.	SOV
	Palau	(49450-037) Energy Transition Project. **15 MWh** BESS.	SOV
ECWA	Georgia[a]	Proposed loan of (54448-001) Energy Storage and Green Hydrogen Sector Development Program. **150 MW**/90 MWh BESS installation. 2024 pipeline.	SOV
	Uzbekistan	Uzbekistan: Kungrad 1 Wind Power BESS Project. A 500-MW wind power project and a BESS. 2024 pipeline.	NOS
SA	Bangladesh	A combination of gas gensets, BESS and solar PV for power and heating in the industrial sector.	NOS

BESS= Battery Energy Storage System, ECWA= East, Central, and West Asia, GEAPP= Global Energy Alliance for People and Planet, GW= gigawatts, JETP= Just Energy Transition Partnership, MV= millivolt, MVA= megavolt amperes, MW= megawatt, MWh= megawatt hour, NSO= nonsovereign, OMDP= Office of Markets Development and Public–Private Partnerships, PV= photovoltaic, SA= South Asia, SEAP= Southeast Asia and the Pacific, SOV= sovereign.

[a] These countries are not classified as LMIC and low priorities for the BESS Consortium. Still the TA can support the countries.



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Enhancing Access to BESS for Low-carbon Economies (ENABLE)

TA10479-REG: Accelerating Battery Energy Storage System Development in the Asia and Pacific

Objective:	The TA aims to unleash renewable energy potential through scaling up BESS deployment. ENABLE platform provides a space for like-minded international financiers to bring their resources on to the platform and catalyze the BESS market in the region. This international alliance initiative is led by ADB and Global Energy Alliance for People and Planet (GEAPP), and potential partners.
Scope:	**a) Analysis:** Analyze innovative solutions, e.g., AI & digital tools, storage technology options, and more private sector participation. **b) Knowledge sharing:** Workshop, webinar, newsletter. Tailored for DMCs. **c) Projects:** Identify and process innovative BESS projects pipeline.
Outcome:	Prioritized BESS pipeline ($100-200m)
Period:	2025-2028 (Approved in April 2025)
Countries:	Cambodia, Mongolia, Viet Nam (initially).

Source: GEAPP

Recent ADB BESS projects

Sovereign: Apr 2025: Georgia (200MW/200MWh, $104 million.)

Non-Sovereign: Apr 2024: Thailand: (256 MW/396 MWh, $820 million.)

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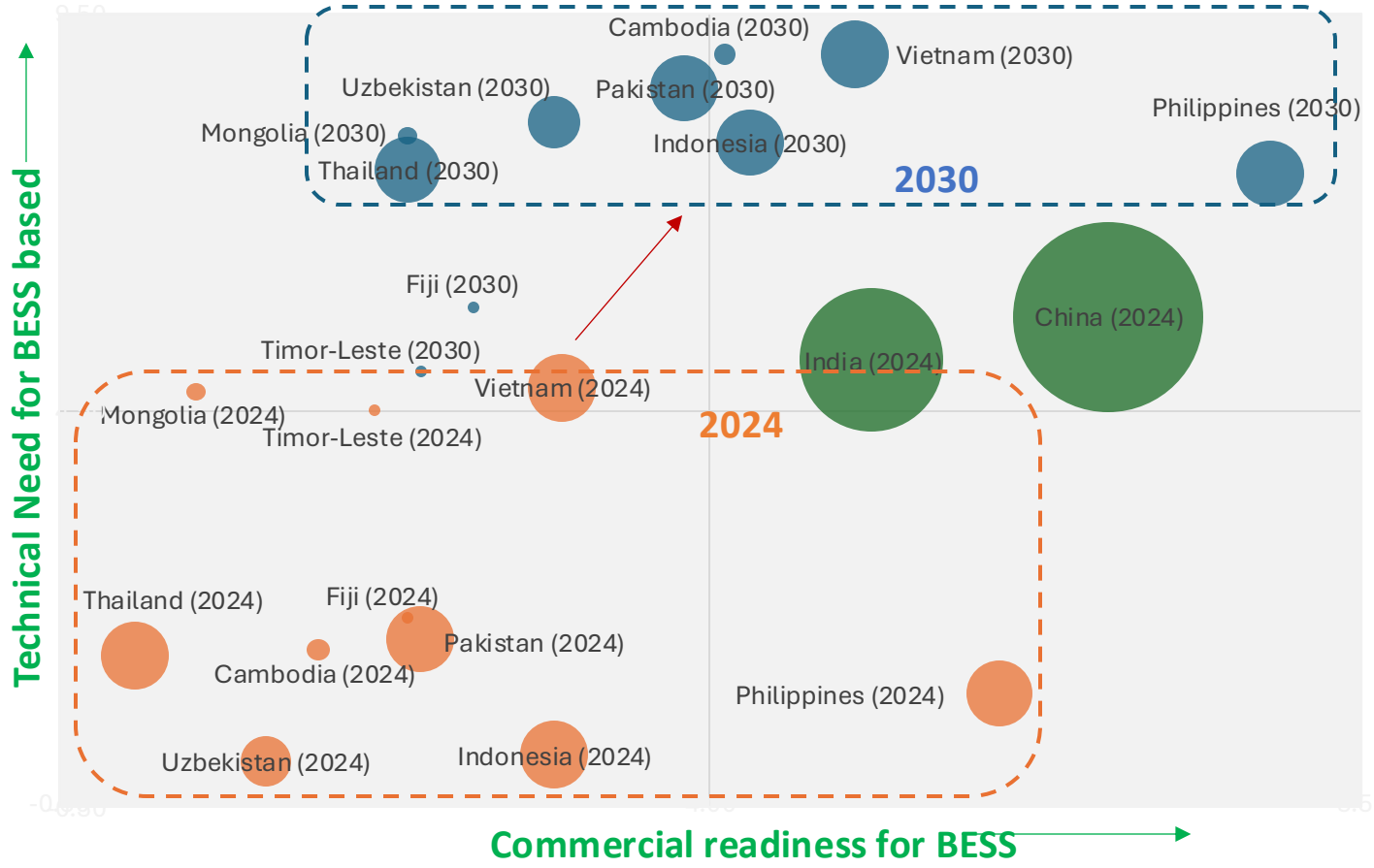
TA10479-REG: Accelerating Battery Energy Storage System Development in the Asia and Pacific

GEAPP BESS Consortium was launched in 2023 by a coalition of like-minded development partners with common goal to seed ~5GW of BESS by 2030 across emerging economies. ENABLE is part of BESS Consortium. The goal of the ENABLE platform is to bring together these efforts on to a single platform and catalyze the BESS market in the region.

- Convene key actors and decision makers in the region to build market momentum and raise ambition for deploying BESS in SEA
- Share BESS investment opportunity in SEA and facilitate a coordinated approach in providing Technical Assistance and Project Financing
- Identify and leverage convening power, expertise and capital of the global BESS Consortium and partners to support projects in Southeast Asia and Mongolia
- Share best practices and facilitate learning with actors in Asia, LAC, and Africa to accelerate BESS deployment

ENABLE aims to improve the commercial viability of BESS in SEA as BESS becomes more critical for large-scale RE integration



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Thank you!

Presented by:
Cindy Cisneros Tiangco
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Sectors Department 1

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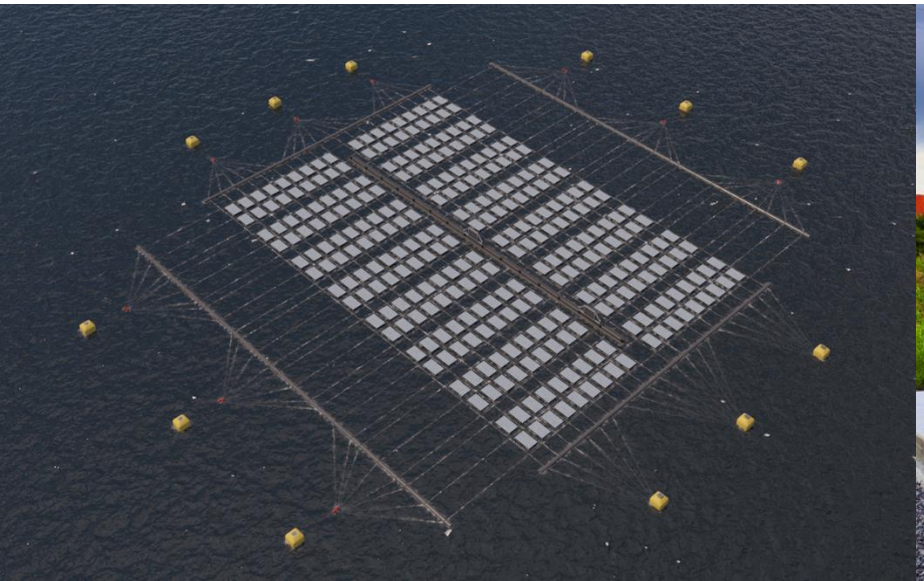
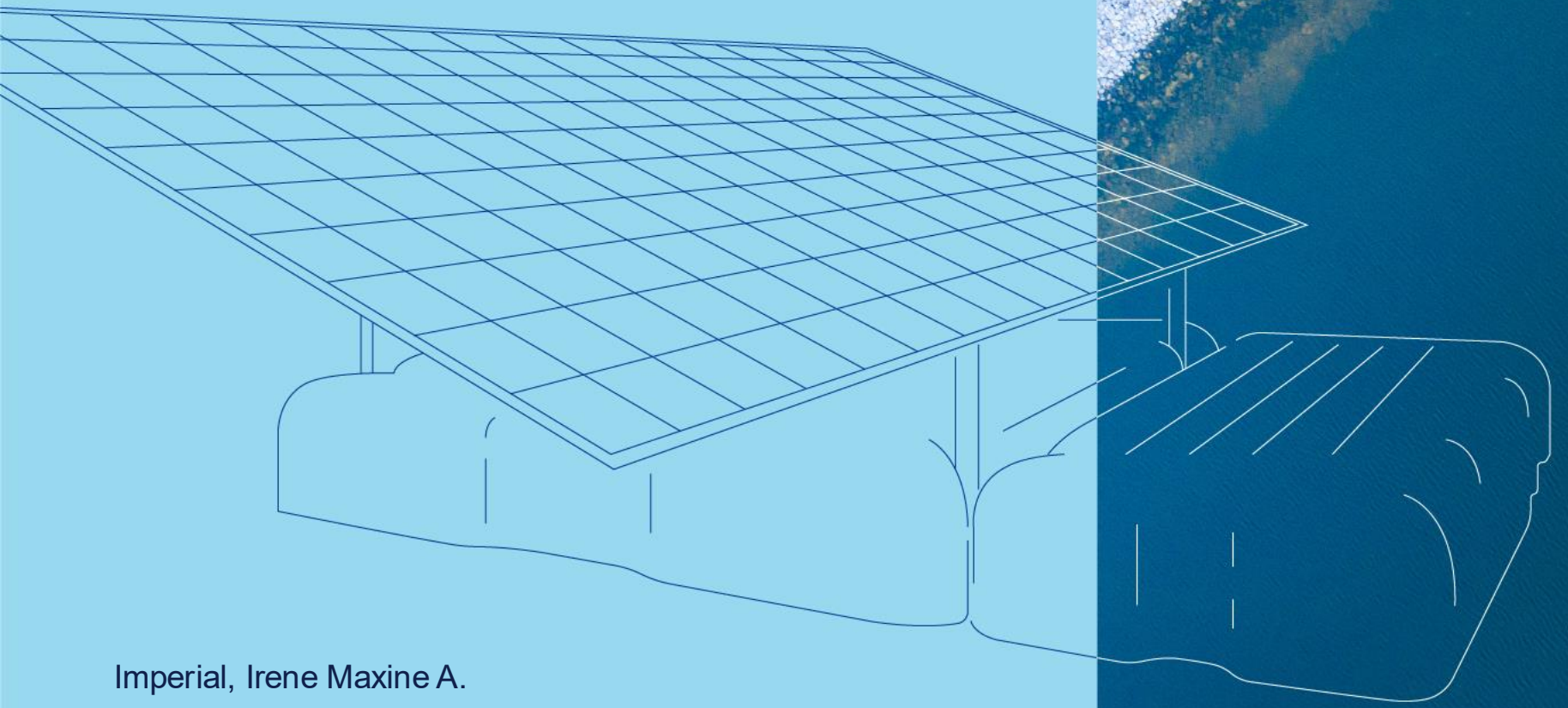
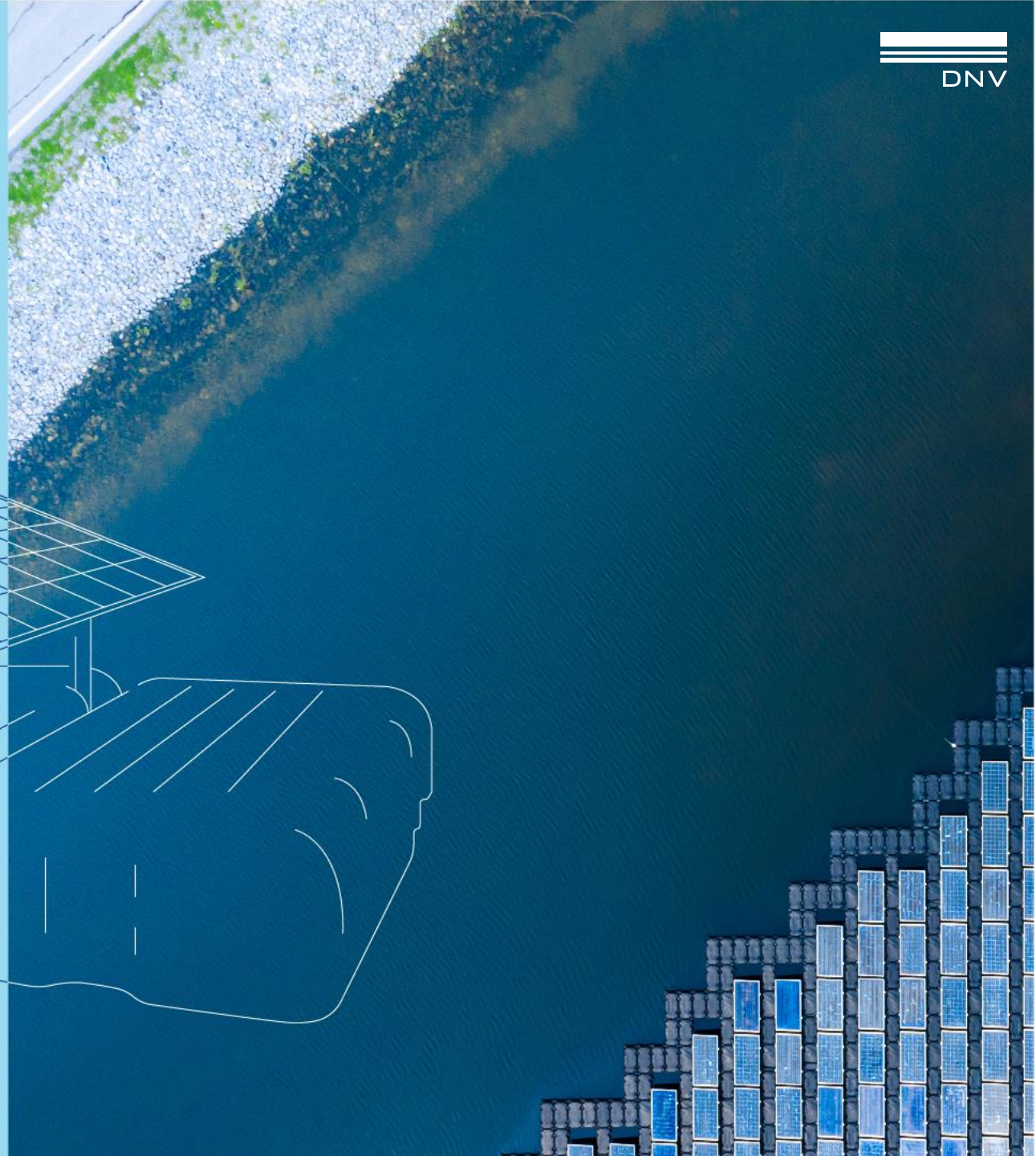


Known Failures and Risk Mitigation in Floating Solar





Imperial, Irene Maxine A.

2 June 2025

Content

- Failures
- Mitigation measures at the design engineering stage

Failures
(And importance of proper design engineering)

SOURCE: Nikkei BP

Floating PV – Failure modes

Design wind speed and load accumulation

Fire on folded-up FPV system

- Actual wind speeds were higher than design wind speeds
- Uneven tension on mooring lines due to uneven shape of FPV islands
- Catastrophic loss of the system

Design wind speed

Folded up-FPV system

- Actual wind speeds were higher than design wind speeds
- Uneven tension on mooring lines due to uneven shape of FPV islands
- Large loss of system

Floating PV – Failure modes

Temporary anchoring

Floats ran aground, in construction

- Temporary anchors used during installation which did not have sufficient design wind speed
- High wind speed even occurred
- Construction delay and potential cost

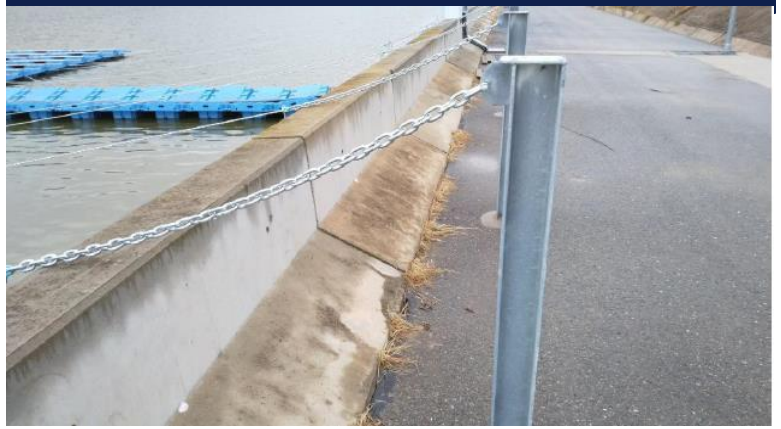
Water level variation

Floats resting on water-bed ground due to water-level variation

- Lacking information on water level variation
- Damage on mooring and anchoring system, floats, PV modules and cables

Floating PV – Failure modes

Water level variation



Wear and tear on mooring lines

- Water level variation greater than design
- Uneven load distribution, abrasions and stress cycles in the mooring lines

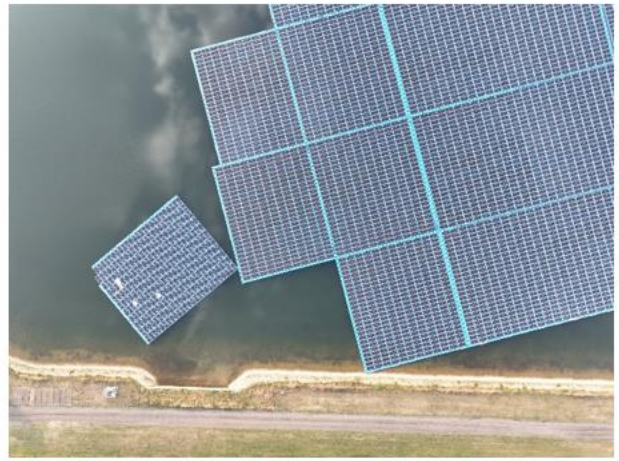
Insulation fault

Damage on overly-tight PV cables

- Movement of floats causing cable stress fatigue and damaged insulation
- Causing insulation fault and fire
- Downtime and damage to the system

DNV







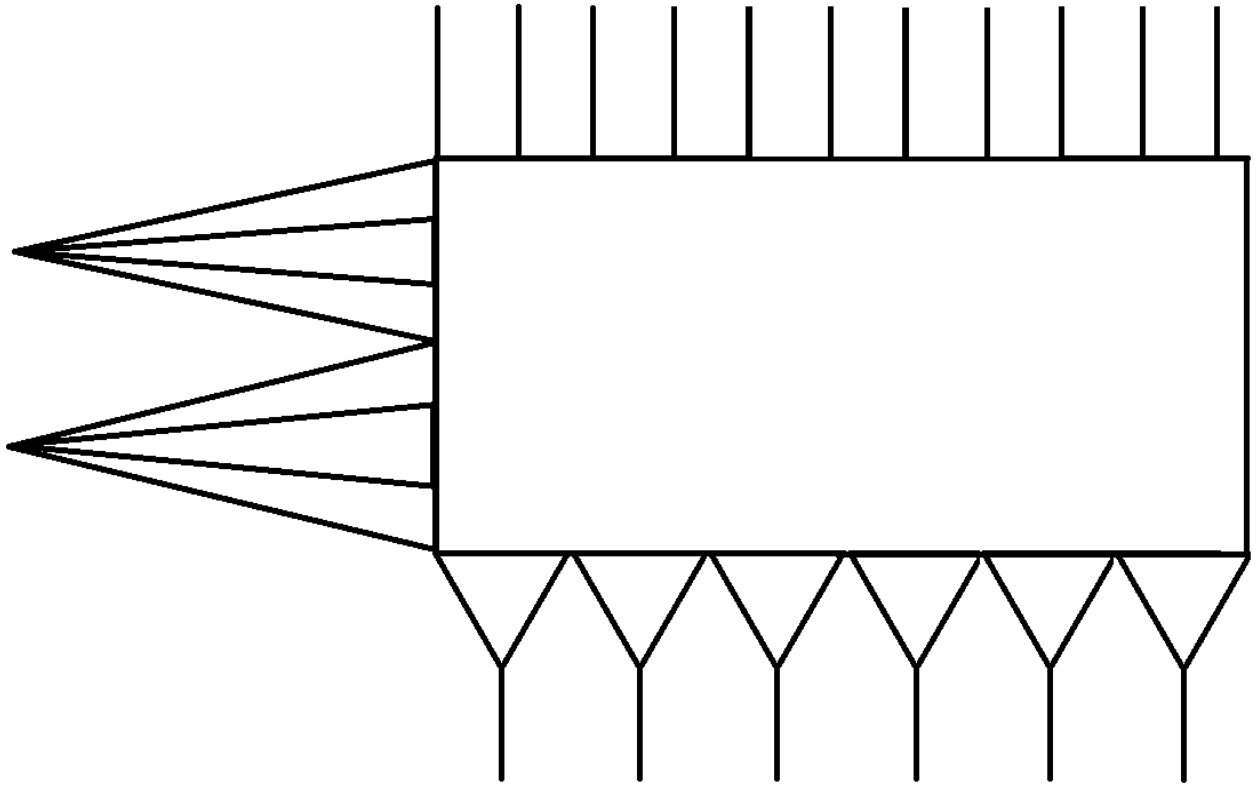





Mitigation measures at design engineering stage

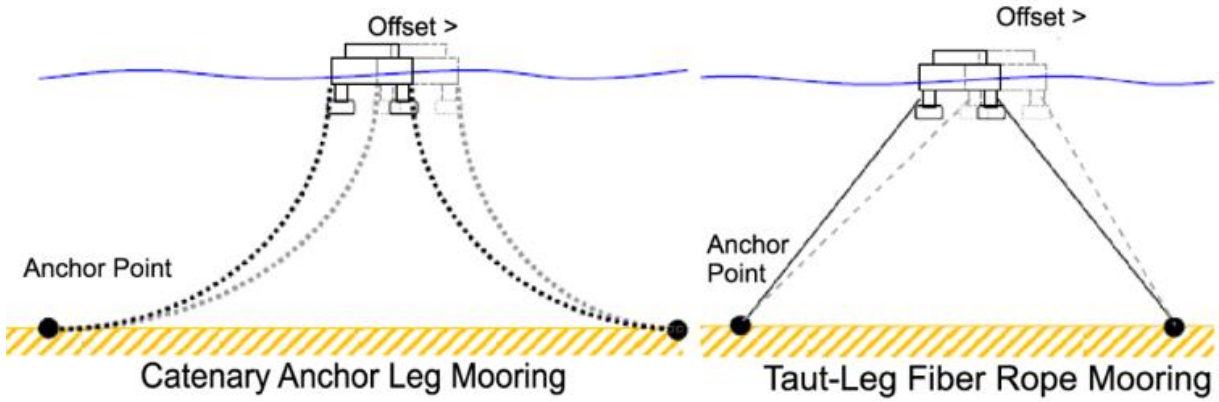
Challenge: Uneven tension distribution in mooring lines

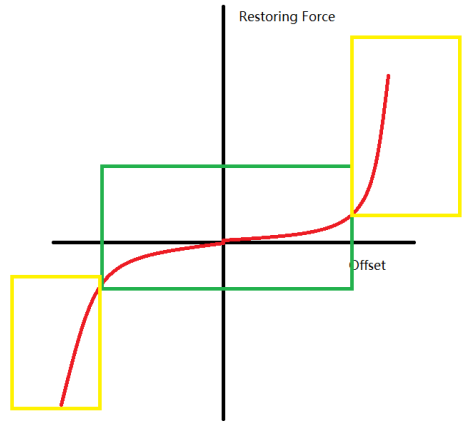
- Large arrays with limited mooring connection capacity
  - Resulting in many lines to distribute loads, often in complex arrangements
- Uneven tension distributions
  - Causing a few lines to take most of the load with risk of overload and progressive failures
- Mitigations
  - Tolerances on line lengths and anchor installation
  - Simplify configuration (e.g. use of parallel lines)
  - Optimize lengths, line material and mooring components
  - Account for change in properties (e.g. creep)
  - Load and response assessment

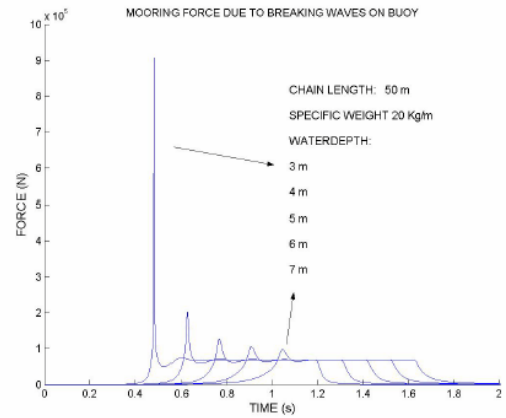


Challenge: Water level variation and shallow water

- Mooring shall keep the floating unit(s) in position and limit horizontal excursions.
  - Works through geometric stiffness (weight of line) or elastic stiffness (flexibility of line)
- What if you have shallow water and large water depth variations?
  - Will make mooring by means of traditional configurations challenging
  - Will have breaking wave impact
- Possible Solutions
  - Alter line geometry - by use of longer lines or buoyancy elements
  - Use of in-line inserts to absorb tension variations
  - Wave breaker







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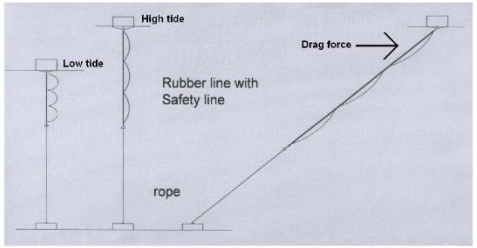

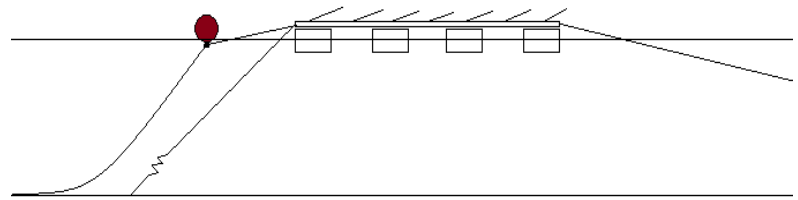

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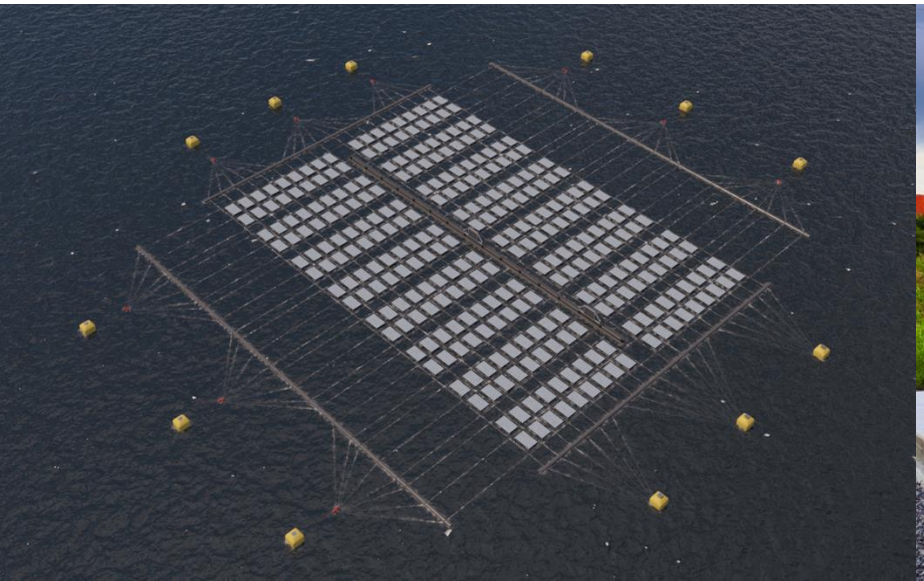
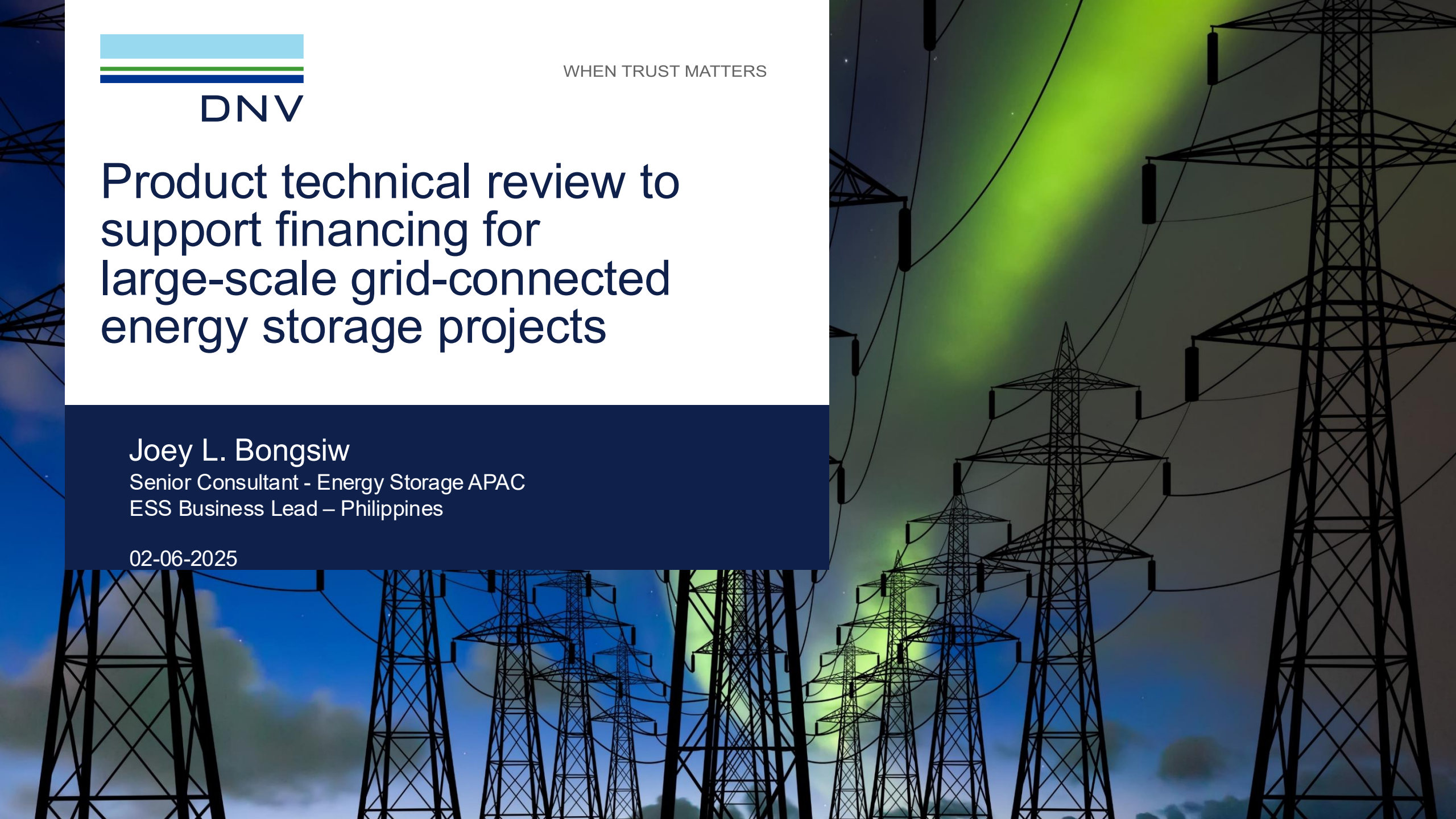


WHEN TRUST MATTERS

Product technical review to support financing for large-scale grid-connected energy storage projects

Joey L. Bongsiw
Senior Consultant - Energy Storage APAC
ESS Business Lead – Philippines

02-06-2025

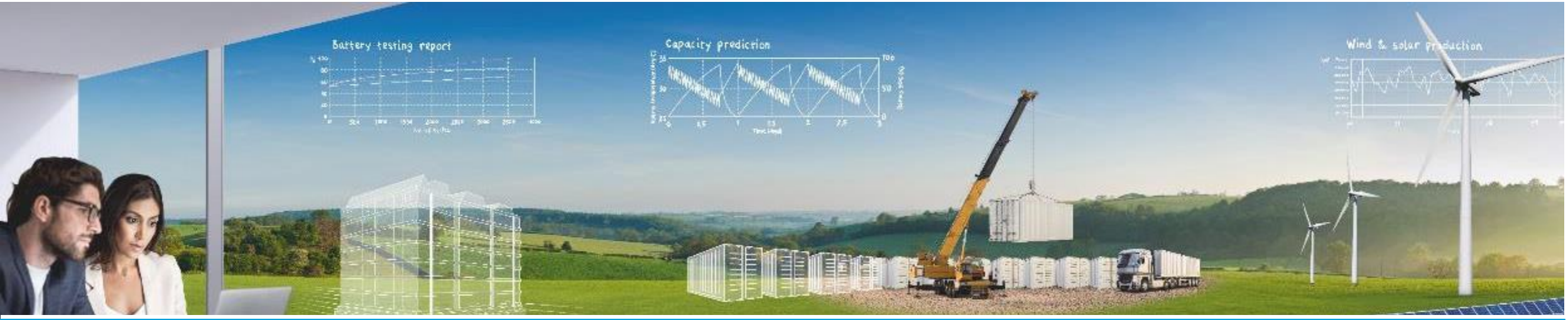


Agenda

- DNV Energy Storage
- BESS product technical bankability review
- Products reviewed by DNV
- Summary

DNV Energy Storage

Broad and deep expertise in energy storage projects



FEASIBILITY

- Market & regulatory intelligence
- Utility grid integration
- Sizing, technology selection and business case modelling
- Technology & controls review & verification
- Technical and commercial training courses
- GRIDSTOR & standards development
- Type- and component certification
- Grid code compliance

TESTING

- Battery cell & module performance testing
- Battery fire safety
- Power electronic converter performance testing
- Battery controls validation testing & development
- Battery life estimation

DEVELOPMENT & ENGINEERING

- Battery degradation assessment & warranty verification
- Resource, energy & financial optimization
- Supplier due diligence
- Project and site safety analysis & code compliance
- Procurement and contracting support
- Technical reviews of civil, electrical, controls and grid interconnection works
- Project certification

CONSTRUCTION

- Certification of equipment
- Owner's engineer
- Bank's engineer
- Factory acceptance tests
- Site acceptance tests

OPERATION

- Inspection, test and assessment of asset condition, performance & remaining lifetime
- Asset monitoring, operation and optimization
- Refinancing, mergers & acquisitions
- Forensics
- Life extension and upgrades

*Our testing, certification and advisory services are independent from each other

Our experts

APAC Energy Storage Section

Singapore

Yongshan Xiao

Kevin Chiu

Xian Liang

Donghan Shi

Luther Tan

China (Shanghai, Guangzhou)

Yifu Wang

Yuan Gemius Liu

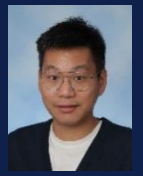
Zhao Jialin Symbol

Chunlong Song

Australia (Sydney / Melbourne)

Rhuraidh Mathieson

Stuart Whiting



Ji Song

Philippines (Manila)

Joey Bongsiw

Korea (Seoul)

Arnold Ilkyoung Kwoun

Shawn Seunghyun Yang

Japan (Yokohama)

Yoshihisa Wakamatsu

Seika Minakoshi

and **50+ Global DNV Energy Storage Experts**

DNV

BESS product technical bankability review

What is technical bankability review?

Product certification	**Ex: DNV, IEC,IEEE, UN, VDE…**
	Compliance to mandatory safety and performance standards is a sign that your product meets the minimum requirements for a certain market.
	Compliance to IEC standards.
Technology bankability assessment	**Independently assessment to the technical claims by the equipment manufacturers.**

What do we primarily look for in a bankability assessment?

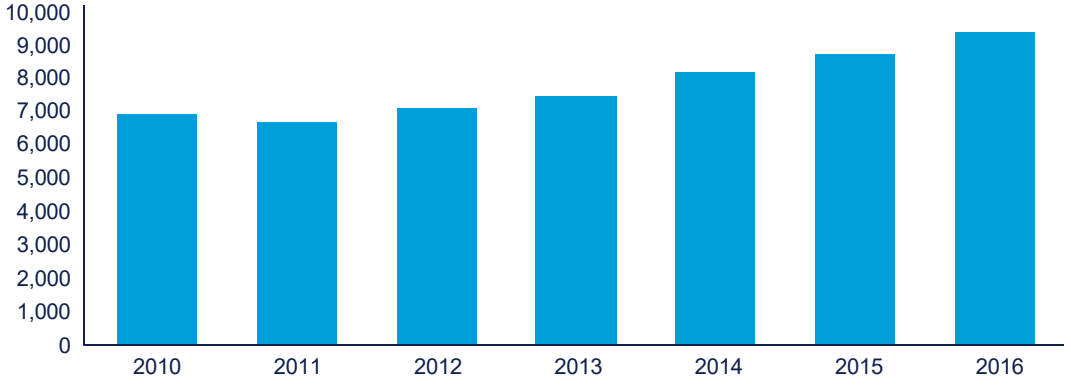
- Company evaluation
- Manufacturing inspection
- Technical evaluation
- Reliability, regulatory compliance and quality
- Warranty and product support
- Example installation and operation

Company evaluation

- Company overview
- Company ESS product history
- High-level financials
- Sales revenues
- Intellectual property review

Global ESS Revenue

Revenues ($m)



Source: IMS Research – now part of IHS Inc.

Manufacturing evaluation

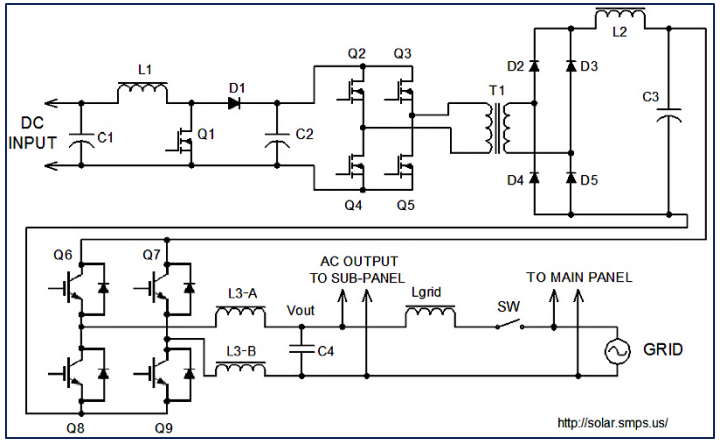
This stage includes an audit of the manufacturing facility and meetings with key staff members to evaluate claims about:

- Supply chain
- Incoming materials inspections
- Product assembly
- System assembly
- Factory system test
- Quality systems
- Packaging and shipping

Technical evaluation

Product evaluation

- Product overview and data sheets
- Architecture/topology/construction
- Environmental characteristics
- Thermal performance
- Power quality
- User interface software and monitoring



Performance evaluation

- Product efficiency / Capacity degradation
- Safety

Manufacturer _____

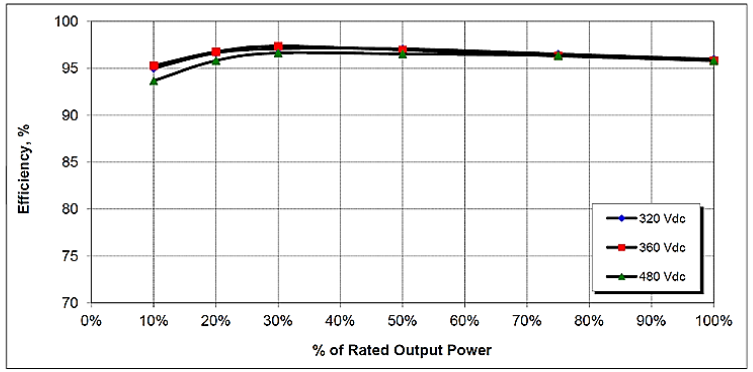
Model #: _____

Rated Maximum Continuous Output Power @25°C: 250 kW Night Tare Loss: 50 W
Rated Maximum Continuous Output Power @40°C: 250 kW Night Tare Loss: 50 W

Vmin: 320 Vdc Vnom: 360 Vdc Vmax: 480 Vdc

		Power Level (%; kW)						
		10%	20%	30%	50%	75%	100%	
Input Voltage (Vdc)		25.00	50.00	75.00	125.00	187.50	250.00	Wtd
Vmin	320	95.0	96.6	97.1	97.1	96.5	96.0	96.6
Vnom	360	95.3	96.8	97.4	96.9	96.3	95.8	96.5
Vmax	480	93.7	95.8	96.6	96.5	96.3	95.8	96.3

CEC Efficiency = 96.5%



Reliability, regulatory and field evaluations

- **Reliability evaluation**
  - Design for reliability
  - Component selection
  - MTBF, FMEA
  - Reliability testing
- **Regulatory and standards evaluation**
  - Applicable standards and codes
  - Regulatory certifications and compliance
- **Field history**
  - Units fielded
  - Failure analysis

DNV·GL

TYPE CERTIFICATE

Certificate No.: TC-GCC-TR8-04006-0 | Issued: 2018-06-25 | Valid until: 2023-05-31

Issued for:

SUN2000 60KTL-HV-D1-001, SUN2000-55KTL-HV-D1, SUN2000-55KTL-HV-D1-001 and SUN2000-55KTL-IN-HV-D1

Specified in Annex 2

Issued to:

Huawei Technologies Co., Ltd.

Bantian, Longgang District
Shenzen, 518129
P.R.China

According to:

VDE-AR-N 4120:2015 TCC High Voltage
BDEW:2008-06 Technical Guideline Generating Plants Connected to the Medium-Voltage Network
FGW TG8:2016-12-MM Technical Guidelines for Power Generating Units and Farms, Part 8

Based on the documents:

CR-GCC-TR8-03592-A065-0	Model Validation GCC
CR-GCC-TR8-03592-A066-0	Low Voltage Ride-Through
CR-GCC-TR8-03592-A067-0	Control behavior and other Grid Code Requirements

The generating unit complies with the requirements of VDE-AR-N 4120 and BDEW medium voltage guideline and the complementary documents stated in Annex 1, provided the conditions of Annex 1 are considered at project level. The simulation model and the measurement reports of the type tests are cited in Annex 3.

Changes of the system design, software or the manufacturer's quality system are to be approved by DNV GL.

Hamburg, 2018-06-25
For DNV GL Renewables Certification
Christer Eriksson
Service Line Leader Type Certification

DAkkS
By DAkkS according DIN EN ISO/IEC 17065 accredited Certification Body for products. The accreditation is valid for the fields of certification listed in the certificate.

Hamburg, 2018-06-25
For DNV GL Renewables Certification
Mirco Scholz
Project Manager

The accredited certification body is Germanischer Lloyd Industrial Services GmbH, Brooktorkai 18, 20457 Hamburg.
DNV GL Renewables Certification is the trading name of DNV GL's certification business in the renewable energy industry.

Warranty and product support

- **Service infrastructure evaluation**
  - Location of service centers
  - Service organization
- **Warranty evaluation**
  - Terms
  - Availability guarantees
  - Optional service
- **Product manuals**
  - Installation
  - Operation and maintenance
  - Technical updates

Products reviewed by DNV

Products reviewed by DNV

- **Selected battery suppliers:**

CATL
BYD
LG Energy Solution
SAMSUNG SDI
HTHIUM
EVE
REPT
Envision AESC
SUNWODA ENERGY
BATTERO TECH
GanfengLiEnergy 赣锋锂电

- **Selected storage integrators:**

TESLA ENERGY
FLUENCE A Siemens and AES Company
SUNGROW
CanadianSolar
HUAWEI
POWIN
Envision
CUBENERGY

- **Selected residential storage products:**

PYLONTECH
solaredge
LG Energy Solution
FRANKLINWH
SUNPOWER
ENPHASE
sonnen
TESLA ENERGY
FOX ESS

DNV

Summary

Whether you are a buyer or supplier, the whole market grows faster with transparency and confidence in the products.

DNV is a trusted voice provider!

Thank you

www.dnv.com

Norwegian Embassy
Manila

Norwegian
Energy Partners

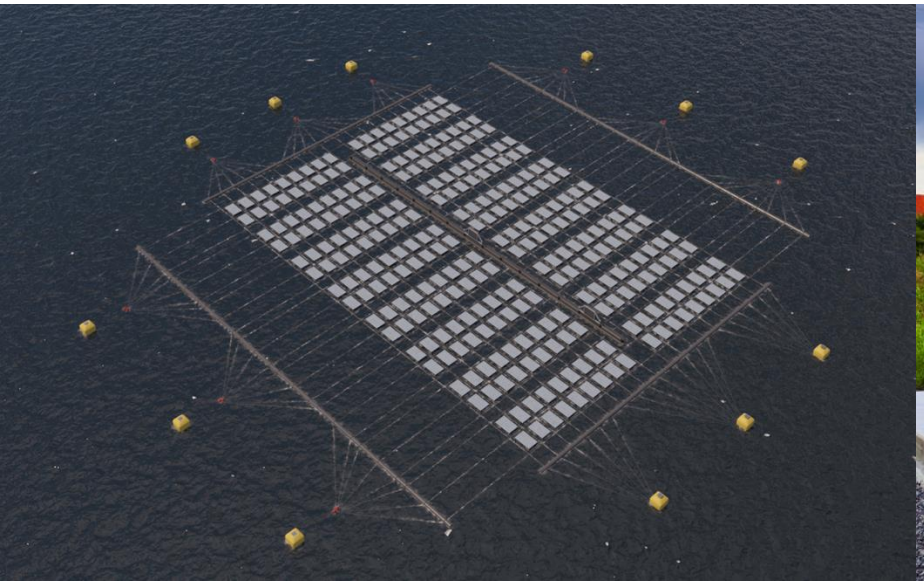
ADB

Embassy of Sweden
Manila

Fornybar
Norge

The Future of Floating PV and BESS in Asia

Manila 2 June 2025



SN|ABOITIZ
POWER GROUP

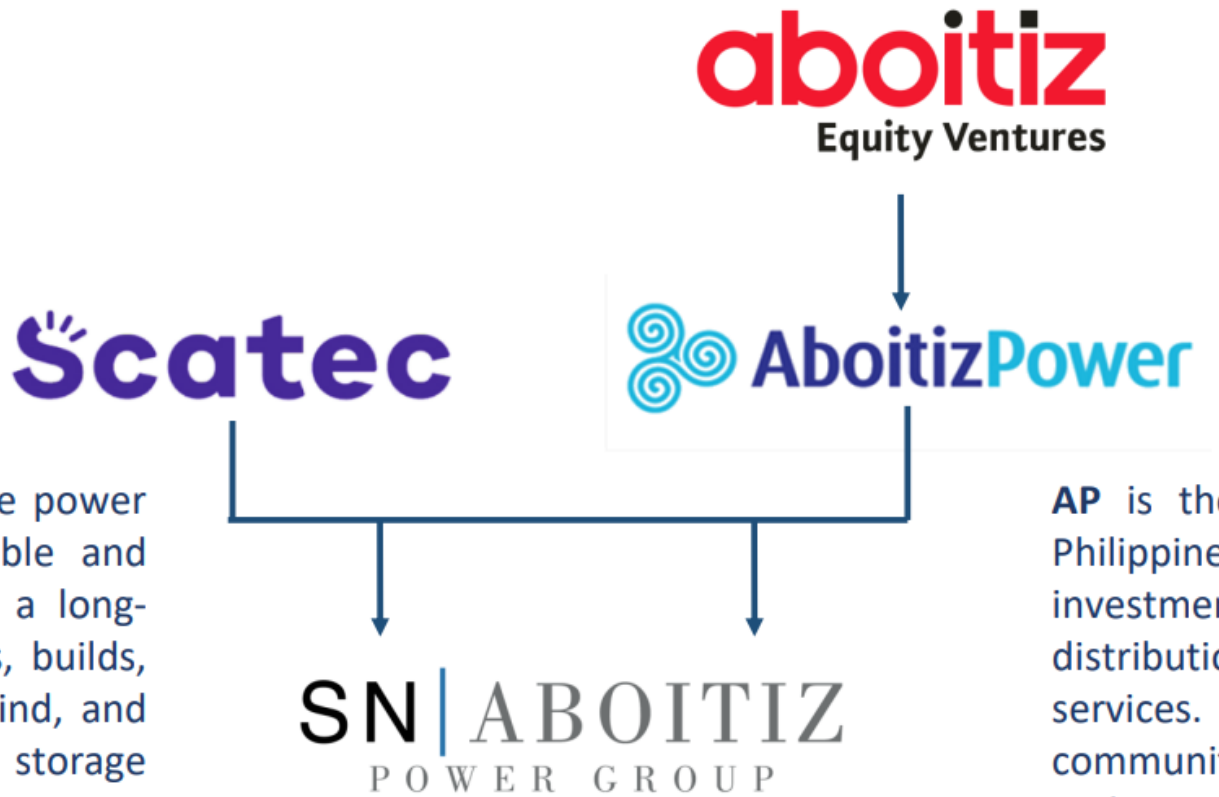
Clean Energy in Action:

The Case of Magat Dam – Hydro + Bess + FPV

Jason D. Soberano | Vice President & Chief Business Development Officer

Asia Clean Energy Forum | June 2, 2025

Joint Venture



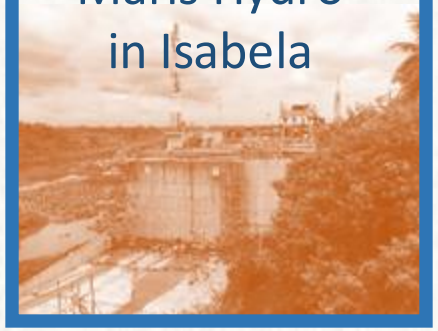
Scatec is a leading renewable power producer, delivering affordable and clean energy worldwide. As a long-term player, Scatec develops, builds, owns, and operates solar, wind, and hydro power plants and storage solutions.

AP is the holding company of the Philippines-based Aboitiz Group's investments in power generation, distribution, and retail electricity services. It advances business and communities by providing reliable and ample power supply at a reasonable and competitive price, and with the least adverse effects on the environment and host communities.

673 MW
of Renewable Energy

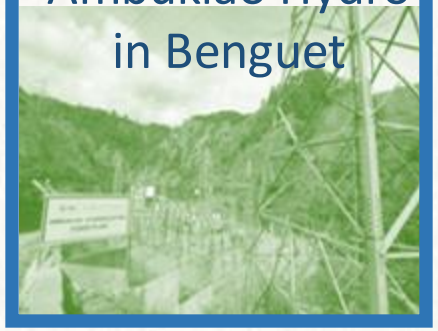
388 MW
Magat Hydro in Isabela and Ifugao

8.5 MW
Maris Hydro in Isabela

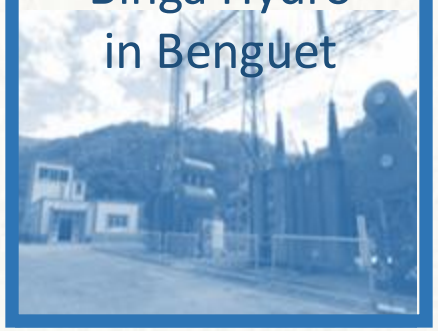


24 MW
Magat BESS in Isabela

112.5 MW
Ambuklao Hydro in Benguet



140 MW
Binga Hydro in Benguet



Magat BESS

Key Role of Storage in the Energy Transition

- Manages intermittency of variable RE
- Enables greater RE penetration without compromising stability
- Supports ancillary services
- Essential part of Philippine Energy Plan goals

24-MW Magat BESS

- Co-located with Magat hydro in Ramon, Isabela
- Delivering ancillary services and energy to the grid since January 2024
- Participating in the reserve market since January 2024
- Enhancing grid reliability, particularly during peak demand

24-MW Magat BESS

Best Practices

•Utilization of liquid cooling lithium iron phosphate batteries (LFP) to achieve higher energy density, long battery life and safety

•Completion of feasibility study to determine optimal sizing of the BESS and its applications for utility scale

•Collaboration with project key stakeholders to establish critical parameters for design and execution

•Stakeholder engagement during permitting and construction

•Compliance with international design and safety standards of energy storage system

Challenges

●Unexpected delays in customs clearance (new technology) and delivery of major equipment to the project site

●Implementation of the Reserve Market for ancillary services

●Grid testing and commissioning (regulatory) timelines

Expansion Plans

Scaling energy storage for grid resilience

- SNAP targets 80 MW of battery energy storage capacity by 2026
- Ongoing construction: Magat BESS Phase 2 16-MW expansion
- Ongoing construction: Binga BESS: 40 MW co-located with Binga hydro in Benguet
- More BESS projects coming in by 2027
- Reinforces SNAP's role in the energy transition
- How will Pumped Storage Hydro affect BESS in the market?

Magat FPV

Magat FPV

Location: Magat Reservoir, Brgy. Aguinaldo, Ramon, Isabela
Start of Operation: July 2019

SNAP's pilot 200-kW Floating Solar Project was inaugurated on June 27, 2019 and is located over the 2,500-square meter Magat Reservoir in Ramon, Isabela. The project is the first non-hydro project of SNAP and was installed over a period of 2 months from March to May 2019. It is currently the largest pilot floating solar in the country.

Its design was inspired by nature. The giant water lily, *Victoria Amazonica*, sits on the water surface just like our floater. The floating solar project is composed of 792 solar panels spread over a diameter of 52 meters secured by 4 pieces of mooring. Its current power output is used to power the company's station service.

Currently, the Magat Floating Solar Project is undergoing its feasibility study phase to confirm the viability of a commercial-scale project.

Milestones

Switch-on: Pilot 200kW

June 2019

Feasibility Study Phase for Commercial Scale

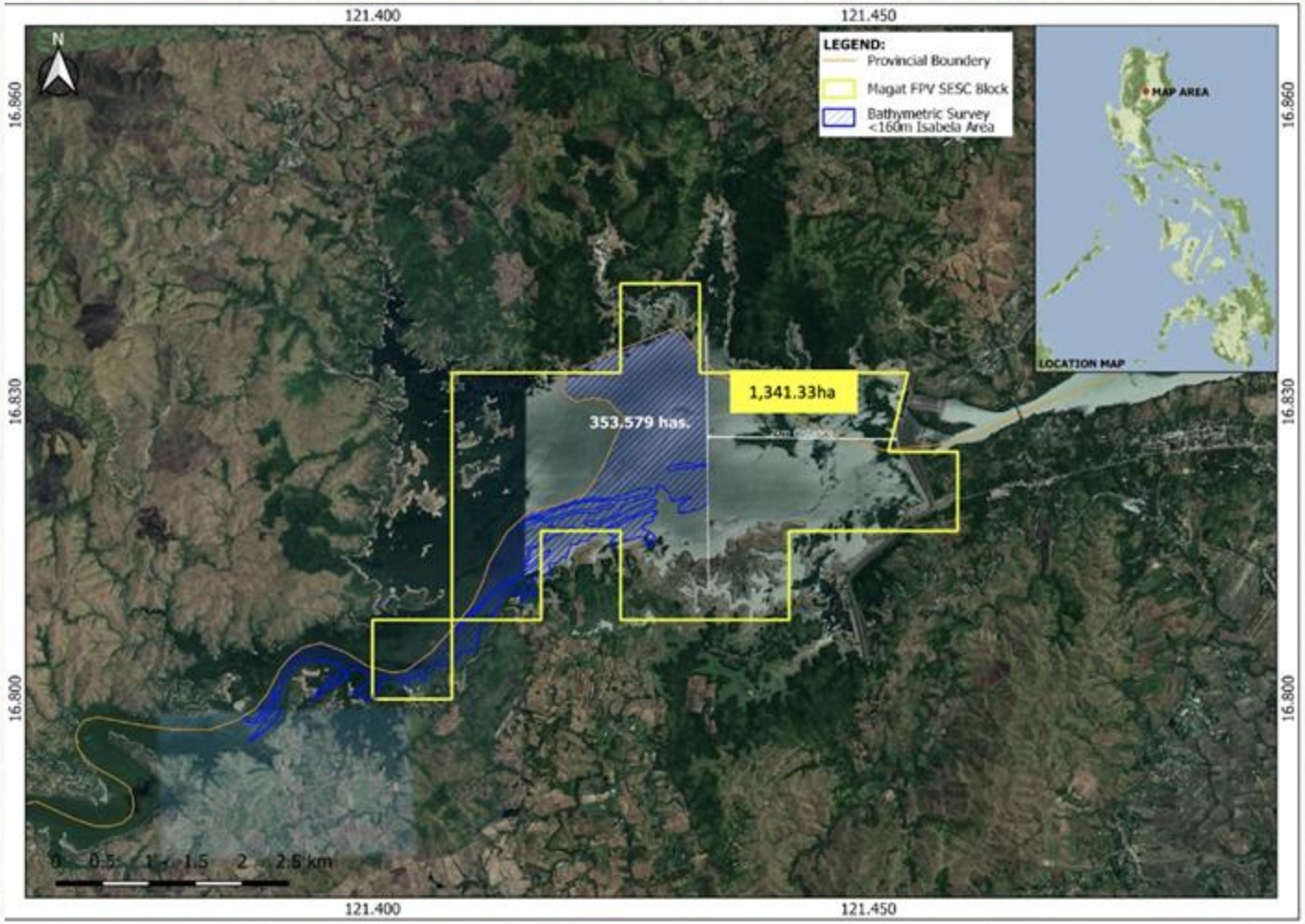
2023

Target Start of Construction - Phase 1

2026

Magat FPV Expansion

- Total of 1,341.33 hectares of water surface area within the solar energy operating contract (SEOC) signed with the DOE.
- Potential 108 MWac of floating solar capacity using pure float technology (considering the deep riverbed, without the 2-km threshold from Magat dam and political boundaries).
- Major project components include PV modules, floats, mooring lines, anchoring, lightning protection, combiner box, inverters and transmission line.



Stakeholder Engagement

Throughout the project development and execution process, we engage with key stakeholders to ensure compliance with regulation and policy, and to mitigate potential risks.

NATIONAL IRRIGATION ADMINISTRATION 1963	Grants possessory rights of the water surface of Magat Reservoir within the identified Contract area of the Project
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES 1987	Grants the Environmental Compliance Certificate (ECC) of the Project.
NATIONAL COMMISSION ON INDIGENOUS PEOPLES 1997	Issues the Certificate of Non-Overlap (CNO) of the Project.

Challenges

- Metocean conditions (wind, wave, current) and marine consideration for FPV installations; Laguna Lake experiences; water level variations; Philippines' weather conditions
- CAPEX cost - differentiated tariff FPV vs ground-mounted (need support on cost side)
- Project insurability and financing. Insurance 2x – 3x cvs ground mounted solar
- Transmission lines and connection point
- Potential (minimal) environmental impact on the water body ecosystem and on surroundings of natural or man-made body of water
- Technology benchmarking suitable for each project site and basis for input to the energy assessment, CAPEX, OPEX and LCOE estimates and risk assessment.
- Technology and testing standards

Moving Forward

Hybrid Solutions for a Resilient Grid

- More BESS projects this 2027
- Scaling up of Magat FPV this 2026
- Creation of new energy solutions: hydro + fpv + storage for mid-merit applications

Real-world learnings shape more effective, scalable clean energy projects


SN|ABOITIZ
POWER GROUP

Norwegian Embassy
Manila

Norwegian
Energy Partners

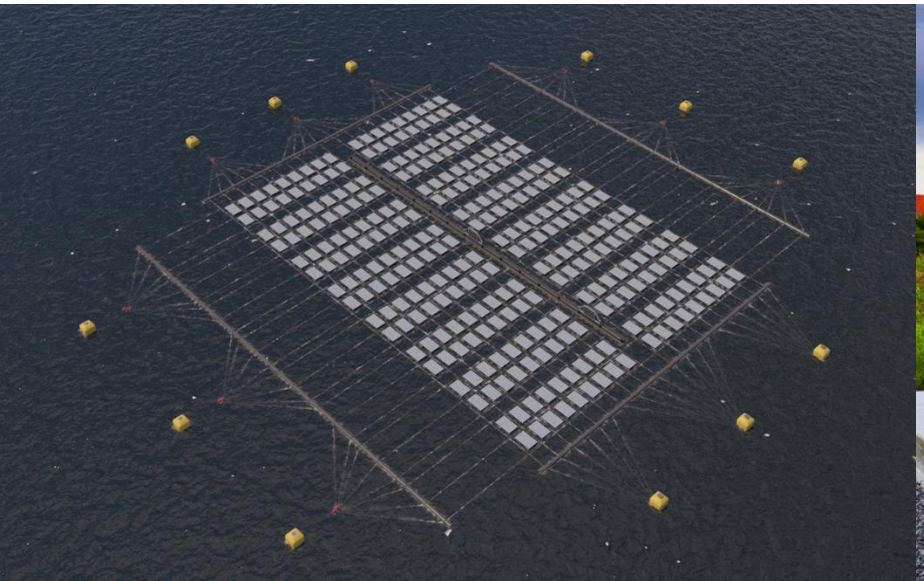
ADB

Embassy of Sweden
Manila

Fornybar
Norge

The Future of Floating PV and BESS in Asia

Manila 2 June 2025



Fred. Olsen 1848

Floating Solar PV in dynamic environments

Martinius Hars, June 2nd, 2025

Topics For Today

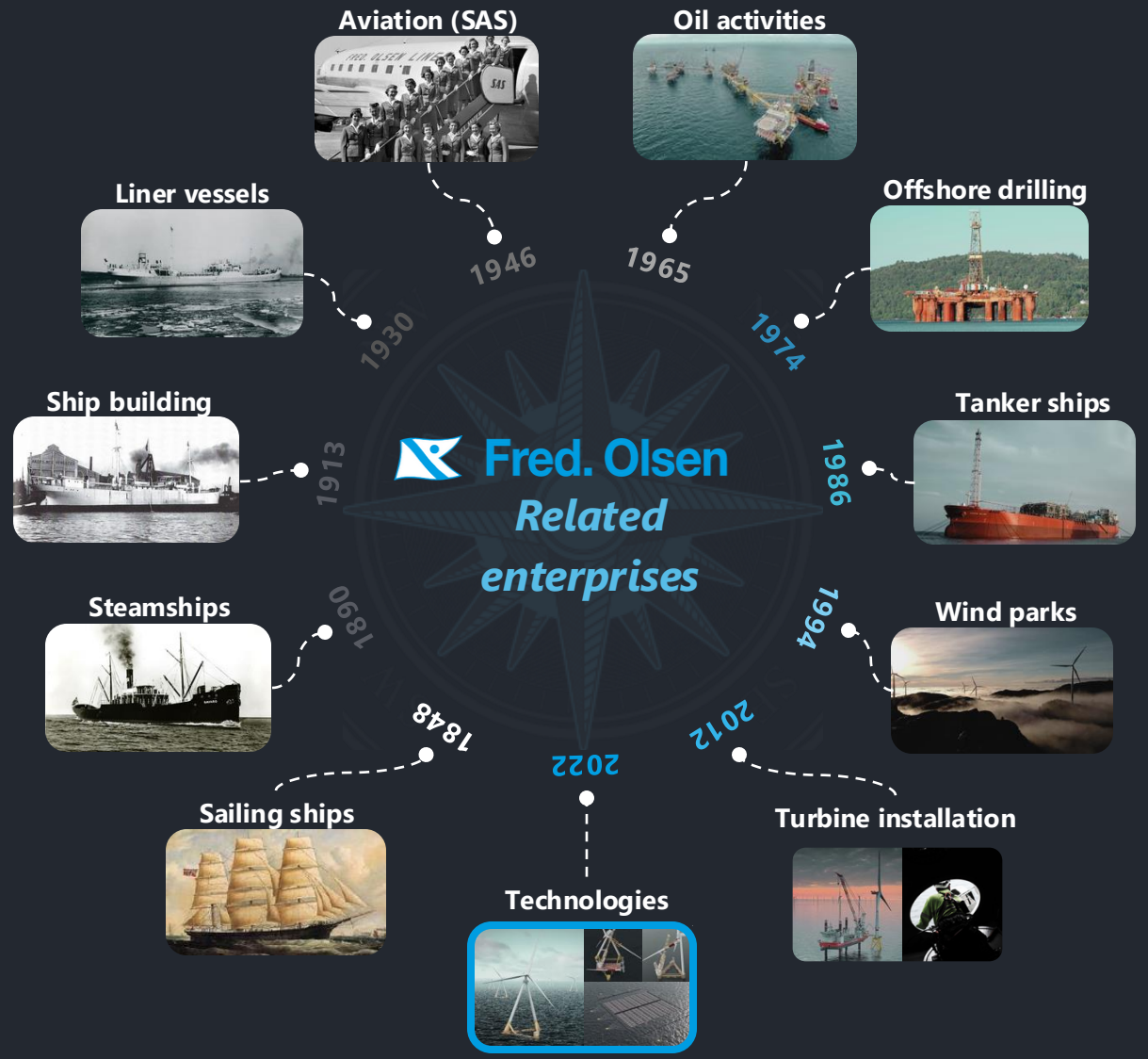
- Fred. Olsen 1848
- Nearshore Floating Solar
- Presentation of Brizo and updates
  - Floating Laboratory / Test site
  - Technical developments
- Anchor & mooring solution for Hydro dams

Fred. Olsen 1848

Pioneering Since 1848

The history of Fred. Olsen shows a profound culture of innovation that is still deeply embedded in the organization today.

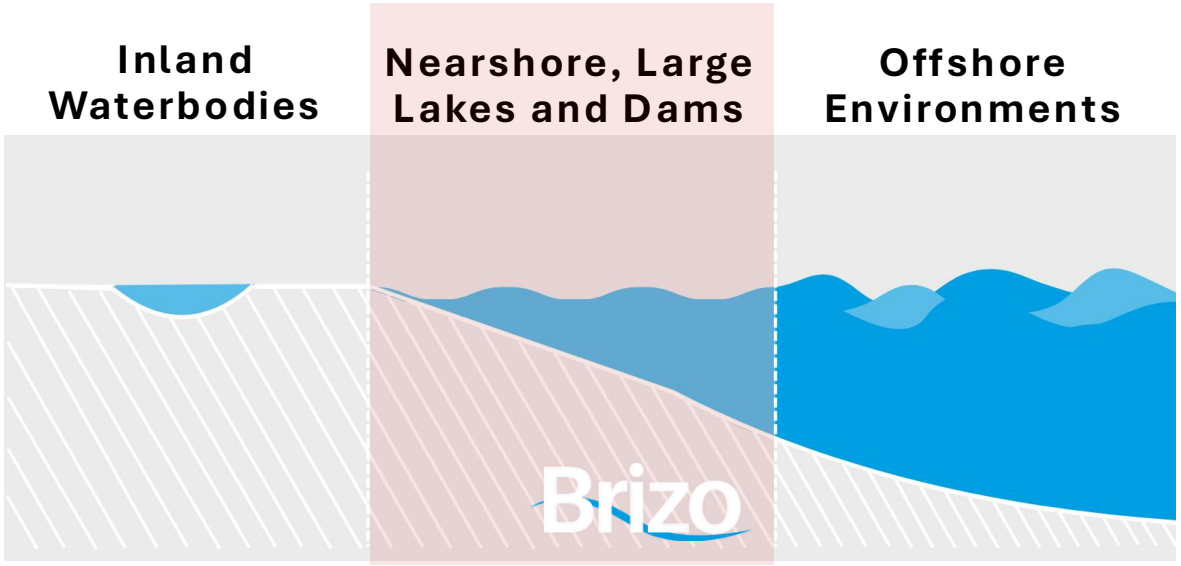
From sail ships and a strong maritime history of exploring new technologies as they arose (steam, diesel machinery) to aviation and a strong participation in the oil arena of Norway, the group has now transformed ***to fully renewable energy exposed investments.***



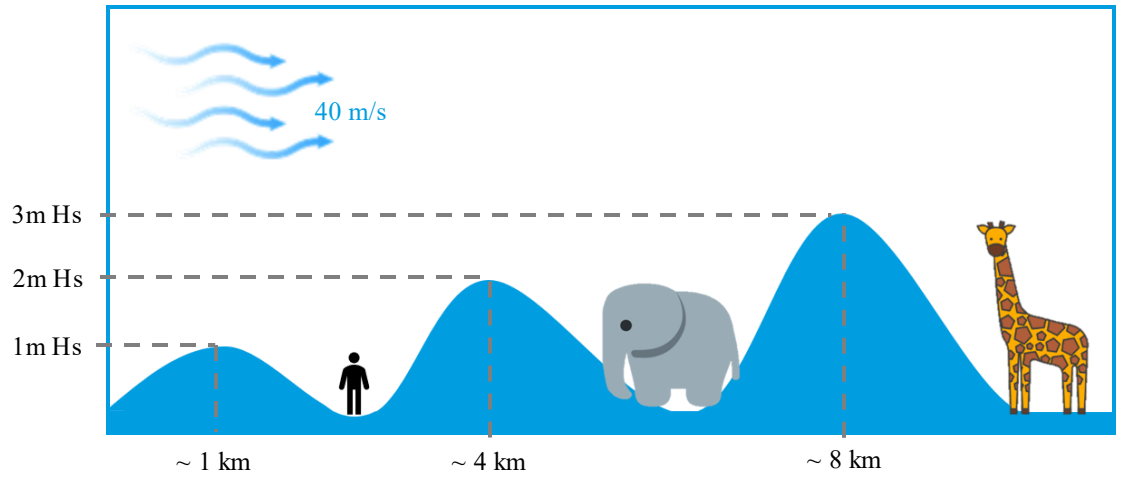
Fred. Olsen 1848

One Type of Technology Doesn't Fit All

Floating Solar Environments



Indicative: Fetch versus wave heights



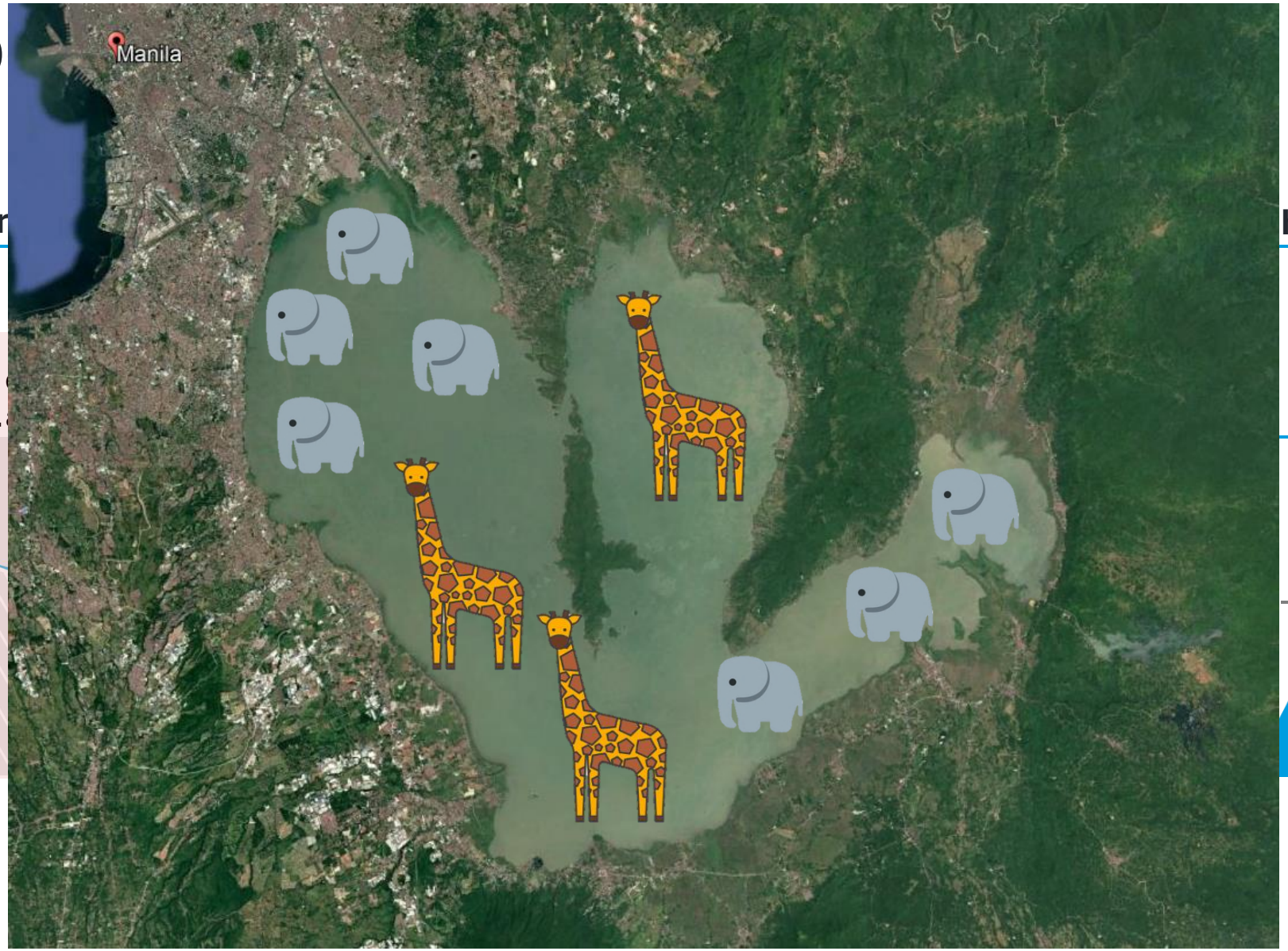
Fred. Olsen 1848

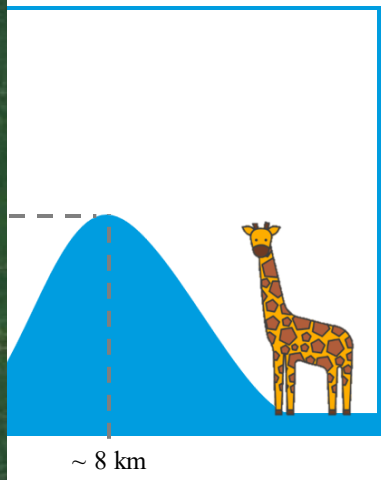
One Typ

Floating Solar Envir

heights

Inland Waterbodies





Fred. Olsen 1848

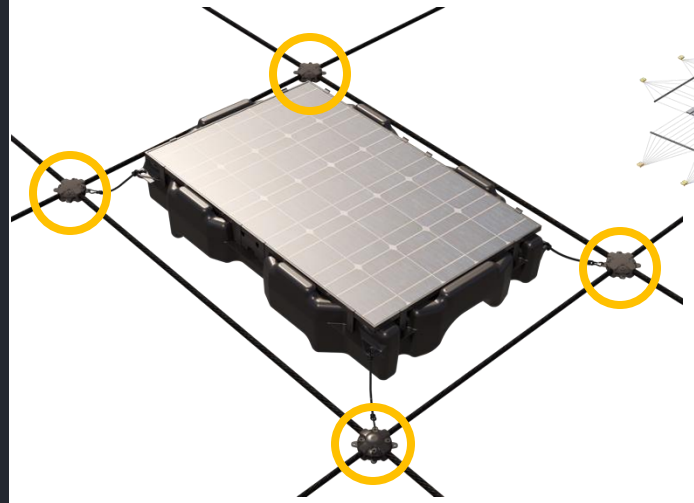
Brizo

Brizo

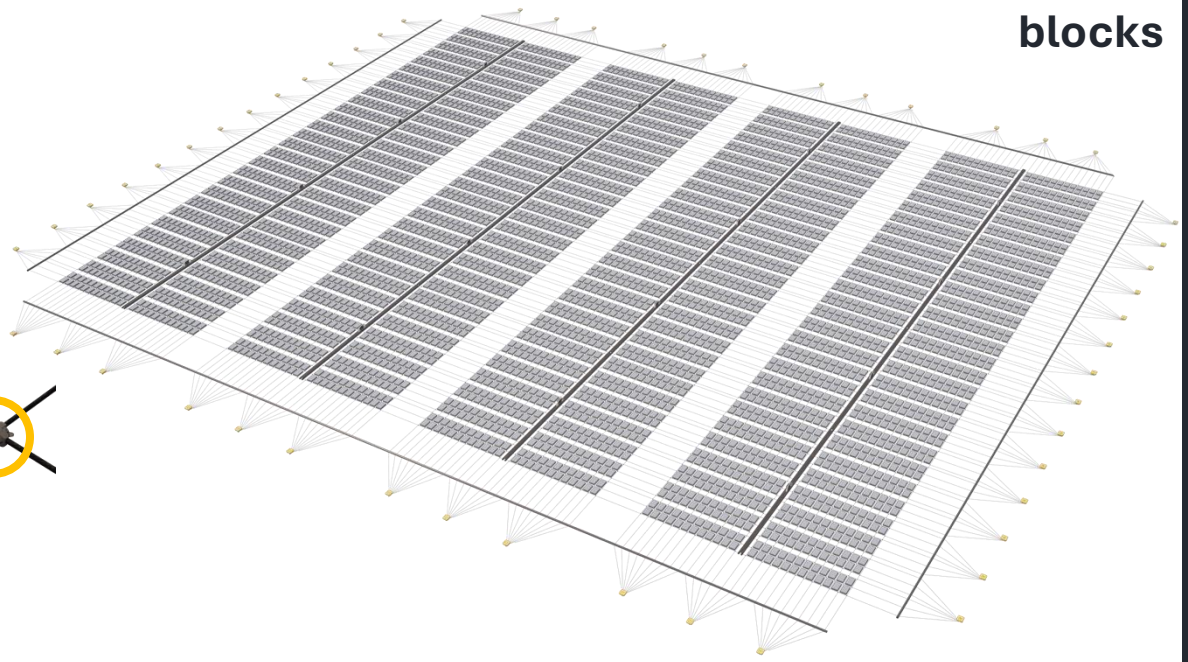
Resilient to wind and waves

- **Designed** up to 3,5m HS (7m peak waves)
- **Easily sourced low-cost components** which can be assembled anywhere
- **Easily scalable** and can be customized to each individual project
- **Integrated maintenance solution** for easy access and cost-efficient upkeep

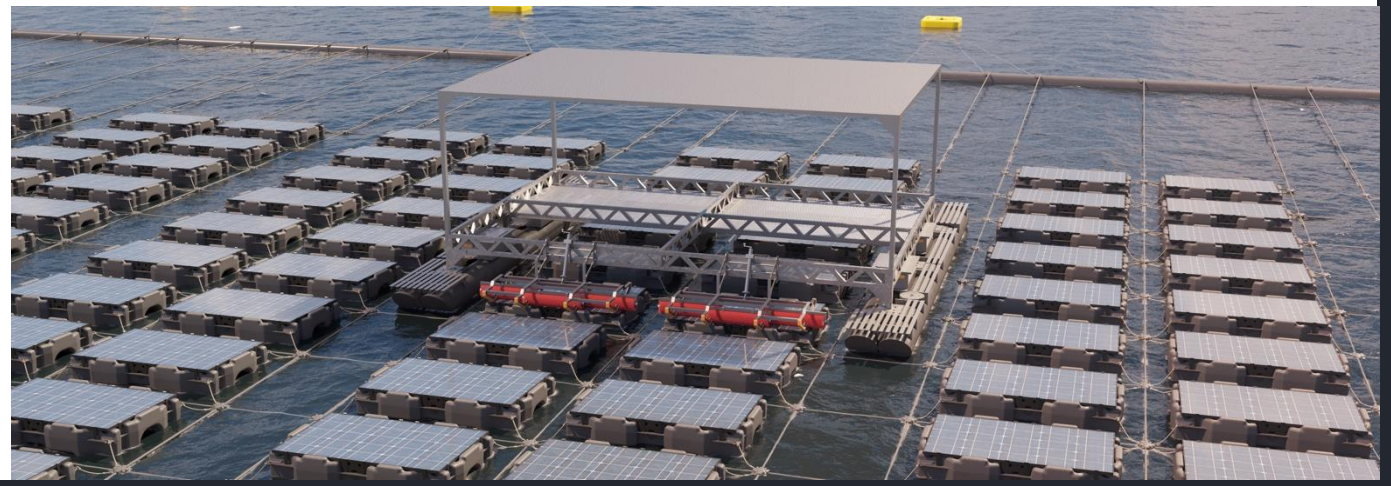
Individual anchoring in the pre-tension rope mesh



3MW building blocks



Integrated O&M



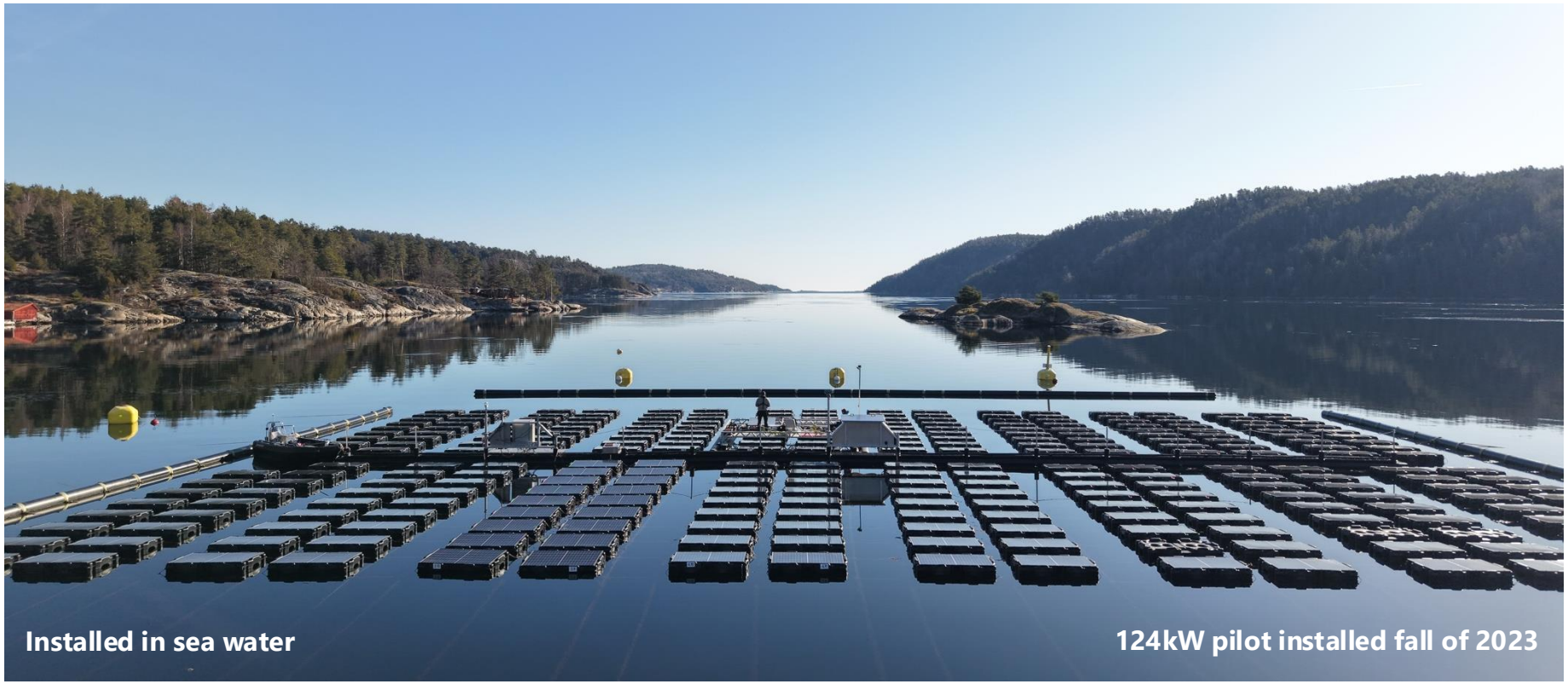
Latest developments

Fred. Olsen 1848

Brizo Floating Laboratory – Norway

Activities in 2024:

- **Floating modules replaced** with a new design
  - *Testing of cable different management solutions*
- **O&M catamaran tested**: Operations & cleaning procedures
- Testing of a **new tensioning buoy design**
- **Instrumentation equipment** installed
- **Connected to the grid**



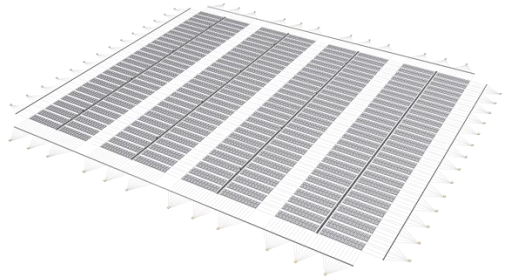
Installed in sea water

124kW pilot installed fall of 2023

FPV Amsterdam 2025

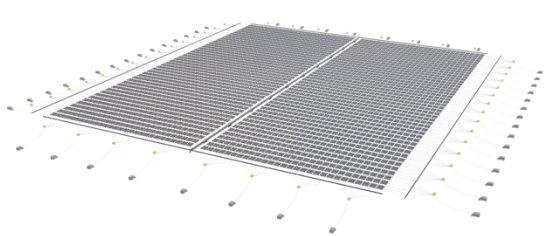
Technical Developments

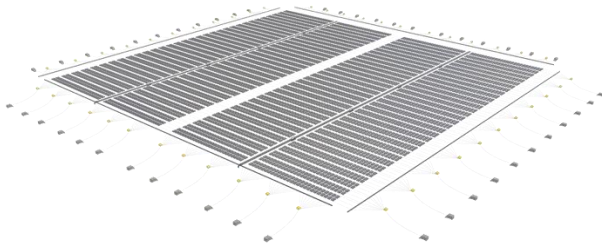
Old site layout



New site layouts:

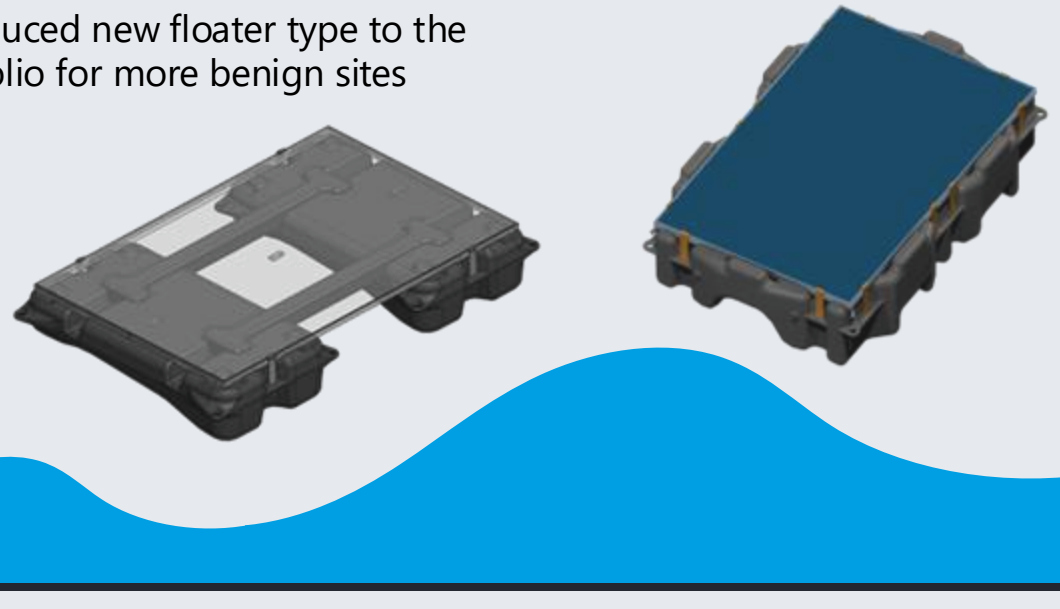
- Improved energy density
- Reducing number of floating walkways



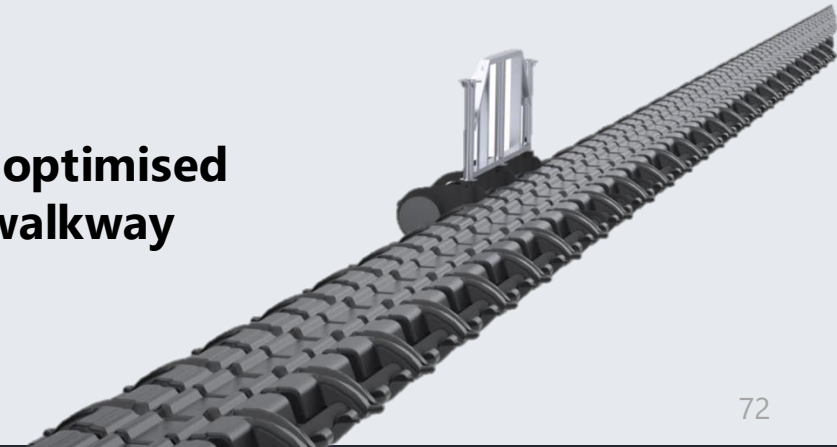


New floater portfolio

- Introduced new floater type to the portfolio for more benign sites



New and optimised floating walkway design



Fred. Olsen 1848

Tank Test at SINTEF Ocean

February 2025 – Trondheim, Norway

Wave type:	Irregular waves
Wave height (Hmax):	3.72m
Wave height (Hs):	2.00m
Peak Period:	6.07 s

Scale: 1:10

Wave heights tested:

1.0m to 3.5m significant wave height (Hs)

Fred. Olsen 1848

Tank Test at SINTEF Ocean

February 2025 – Trondheim, Norway

System integrity

- Remained intact during largest waves

System behaviour

- Floaters and ropes followed wave motions as expected
- Breaking waves observed within the system under short wave conditions

Rope & Floater performance

- No rope breakage occurred
- All floaters stayed in position throughout the tests

Pre-Tension Performance

- Sufficient pre-tensioning identified across different wave conditions
- Ensured no floater collisions

Force Trends

- Forces decrease with increasing wave period
- Highest forces occur during wind waves
- Swell waves exert less impact on the system

Scale: 1:10

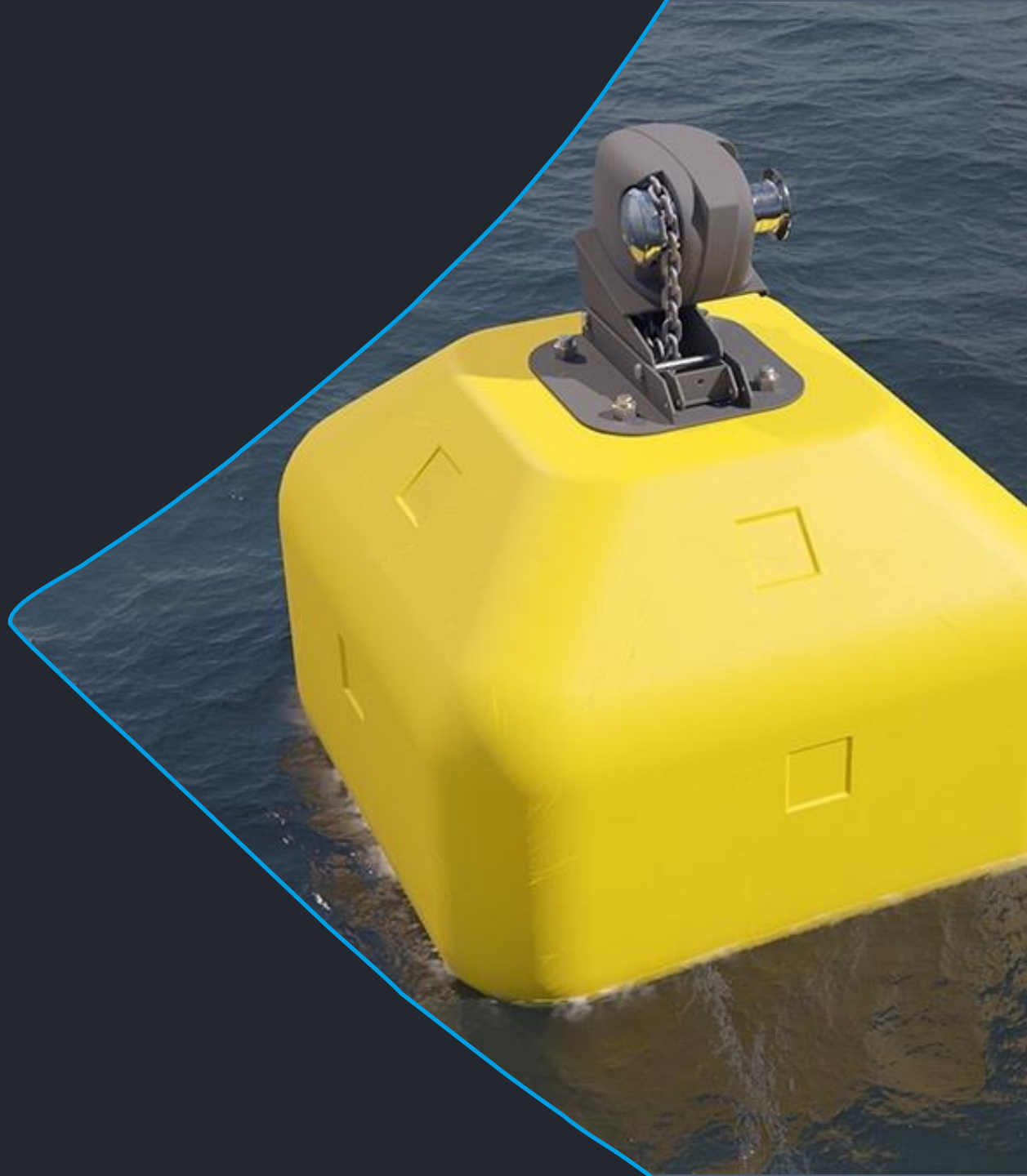
Wave heights tested:

1.0m to 3.5m significant wave height (Hs)

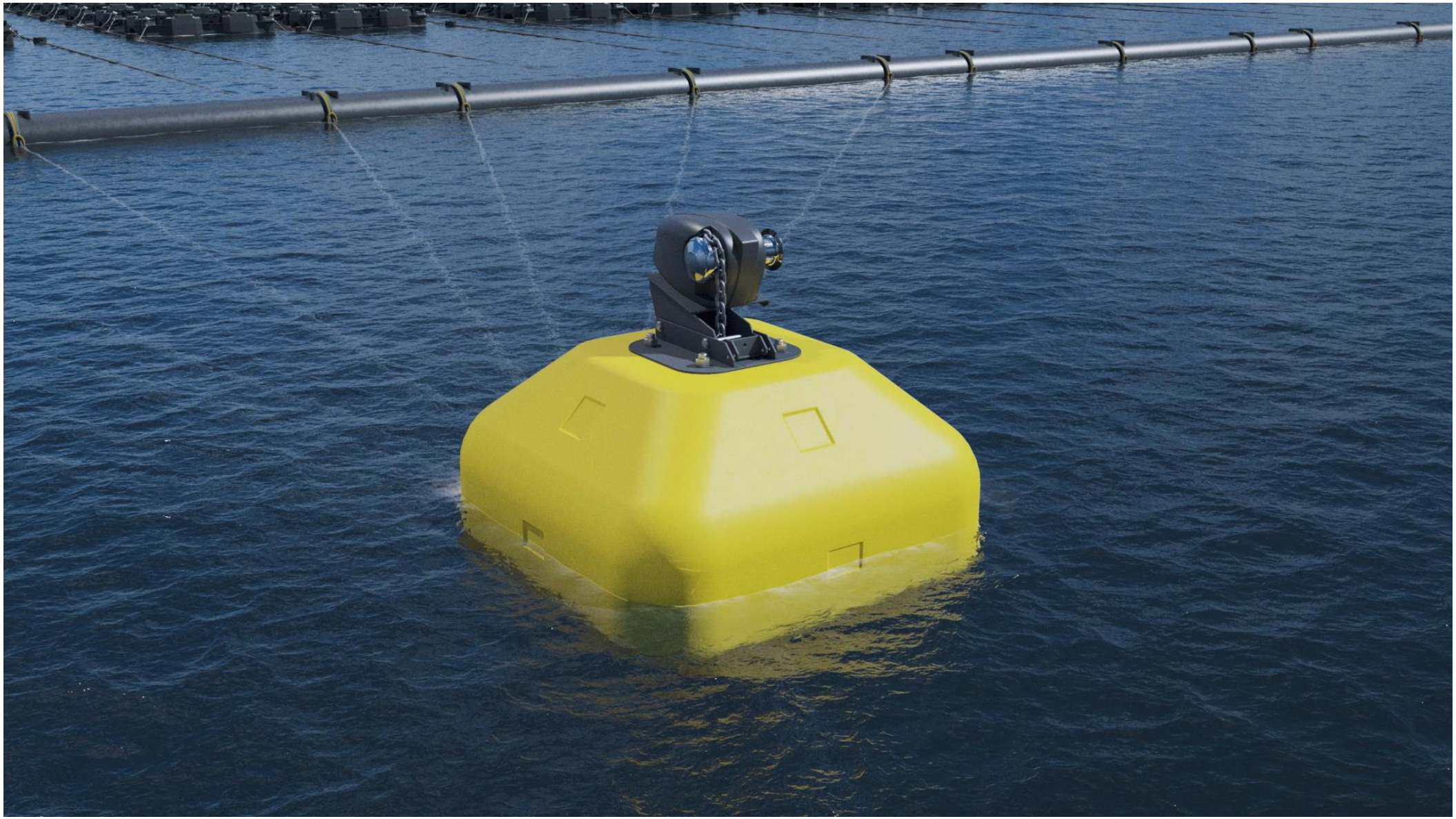
Fred. Olsen 1848

Tension buoy

Hydro Dam application



Patent Pending



Thank you for your attention

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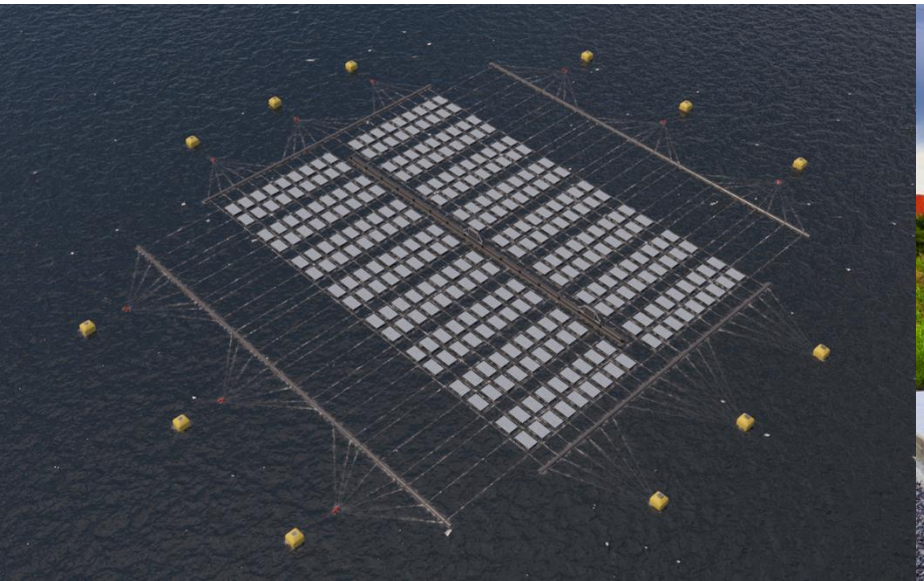
The Future of Floating PV and BESS in Asia

Manila 2 June 2025



UNLOCKING THE FULL POTENTIAL OF ENERY STORAGE SYSTEM

This is Pixii

Speeding up the transition to green energy

Shaping the power of the future

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OUR LEGACY

PART OF ELTEK HOLDING

Enetek Power Group Pte Ltd, an entity owned by Eltek Holding.

Eltek
ELTEK HOLDING

dynea
Specialist manufacturer of wood adhesives

CBK GROUP
Distributes computer and network related products

Heimgard Technologies
Powering brand through IOT for a seamless connected home

enetek
Specialist in AC and DC power solutions

Pixii
Develops smart power technology and storage solutions

PIXOTOPE
A revolution in virtual production systems

NORWEGIAN LAB
Develops eco-friendly healthcare products and cosmetics

Head Office (Singapore)
Eltek & Pixii HQ (Norway)

Global reach

AMERICAS

USA
- Denver, Colorado

EMEA

Norway
- Kristiansand (HQ)
- Oslo
- Drammen

Germany
- Darmstadt

Slovakia
- Liptovský Mikuláš

APAC

India
- New Dehli

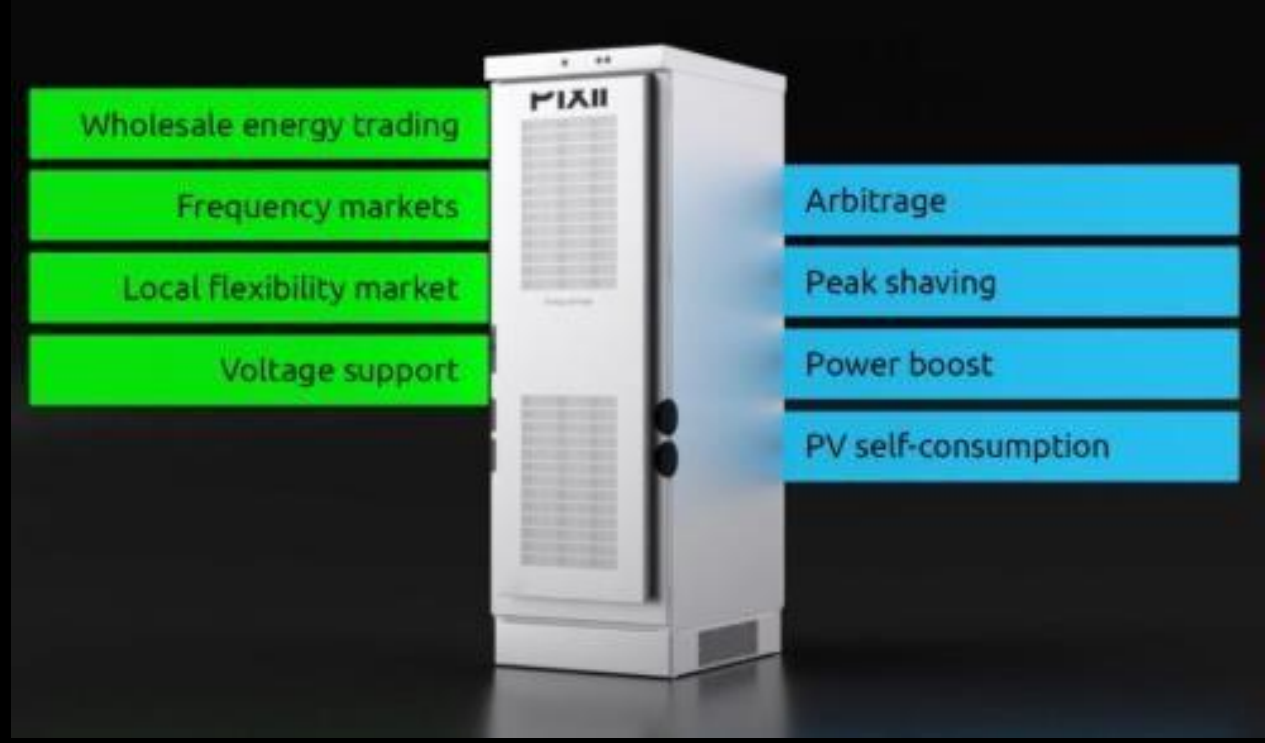
Singapore
- Singapore

Australia
- Sydney
- Brisbane

The Philippine power grid today is under significant strain. Much of its infrastructure is aging, and the country's unique geography — being made up of over 7,000 islands — makes it incredibly difficult to ensure consistent, reliable power distribution nationwide.

On top of that, the Philippines is highly exposed to natural disasters like typhoons and earthquakes, which frequently damage transmission lines and lead to blackouts in both urban and rural communities.

Another critical issue is the country's dependency on imported fossil fuels. Because a large share of its energy mix still comes from thermal power, the Philippines is vulnerable to global fuel price volatility. This dependence not only affects energy prices but also impacts energy security and sustainability goals.



At the same time, there's a strong and commendable push for renewable energy — especially solar. But like many countries, the Philippines faces a common challenge with renewables: intermittency. Solar and wind power are not always available when demand is highest, and without effective storage, much of that clean energy potential is wasted.

This is where BESS steps in.

Introduction to Battery Energy Storage Systems (BESS):

In today's world, electricity is essential for almost everything we do, from powering homes and businesses to keeping industries running. However, electricity generation and consumption don't always happen at the same time. Sometimes, there's too much electricity being produced when demand is low, and other times, there's not enough when demand is high. This is where **Battery Energy Storage Systems (BESS)** come in.

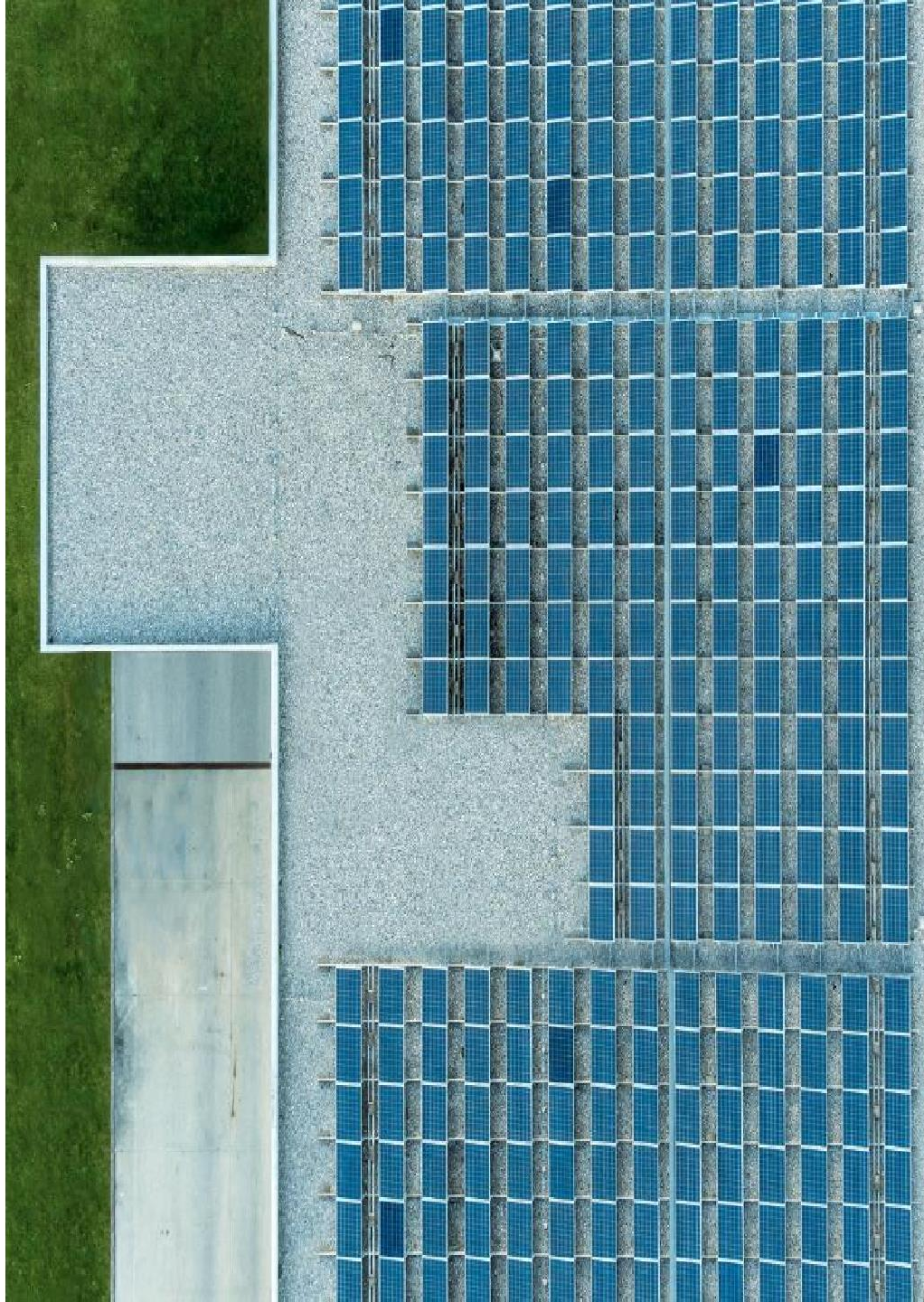
A **BESS is like a giant rechargeable battery** that stores electricity when there is excess supply and releases it when needed. This stored energy can come from various sources, including the power grid or renewable energy systems like solar panels and wind turbines. By acting as a buffer between energy production and consumption, BESS helps ensure a **stable, reliable, and efficient power supply.**

THE CHALLENGE

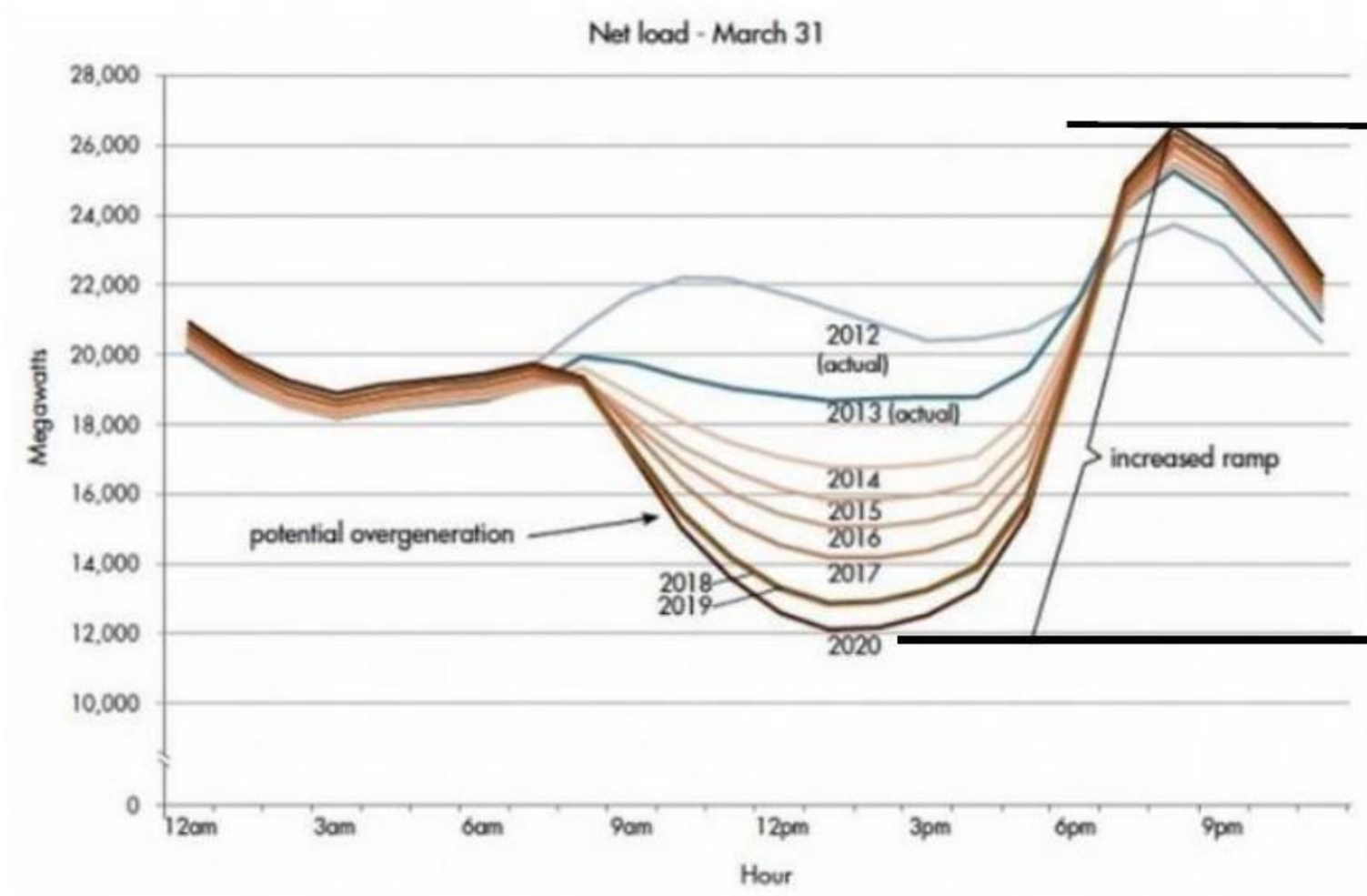
Decarbonisation causing challenges in the grid

Better utilization of resources	Move consumption to hours with high sun and wind production or use energy storage 	Better utilization of energy: Avoiding the loss of renewable energy 
Better utilization of the grid	New and existing customers agree to be flexible in areas with limited grid capacity 	Better utilization of the grid network: More actors can get connected earlier 
Realtime balancing	Regulate consumption and production according to current needs in the power system 	Balance between consumption and production: Secure power supply 24/7 

Optimizing ROI		Solving primary needs		
Save cost	**Generate income**	**Boost power**	**Back-up power**	**Grid support**
Arbitrage	Arbitrage	Peak shaving	Vehicle-to-home	Frequency support
PV self-consumption	Flexibility markets / Balance services	Voltage support	AC back-up	Voltage support
Peak shaving			Gen-set integration	



The «California Duck curve»

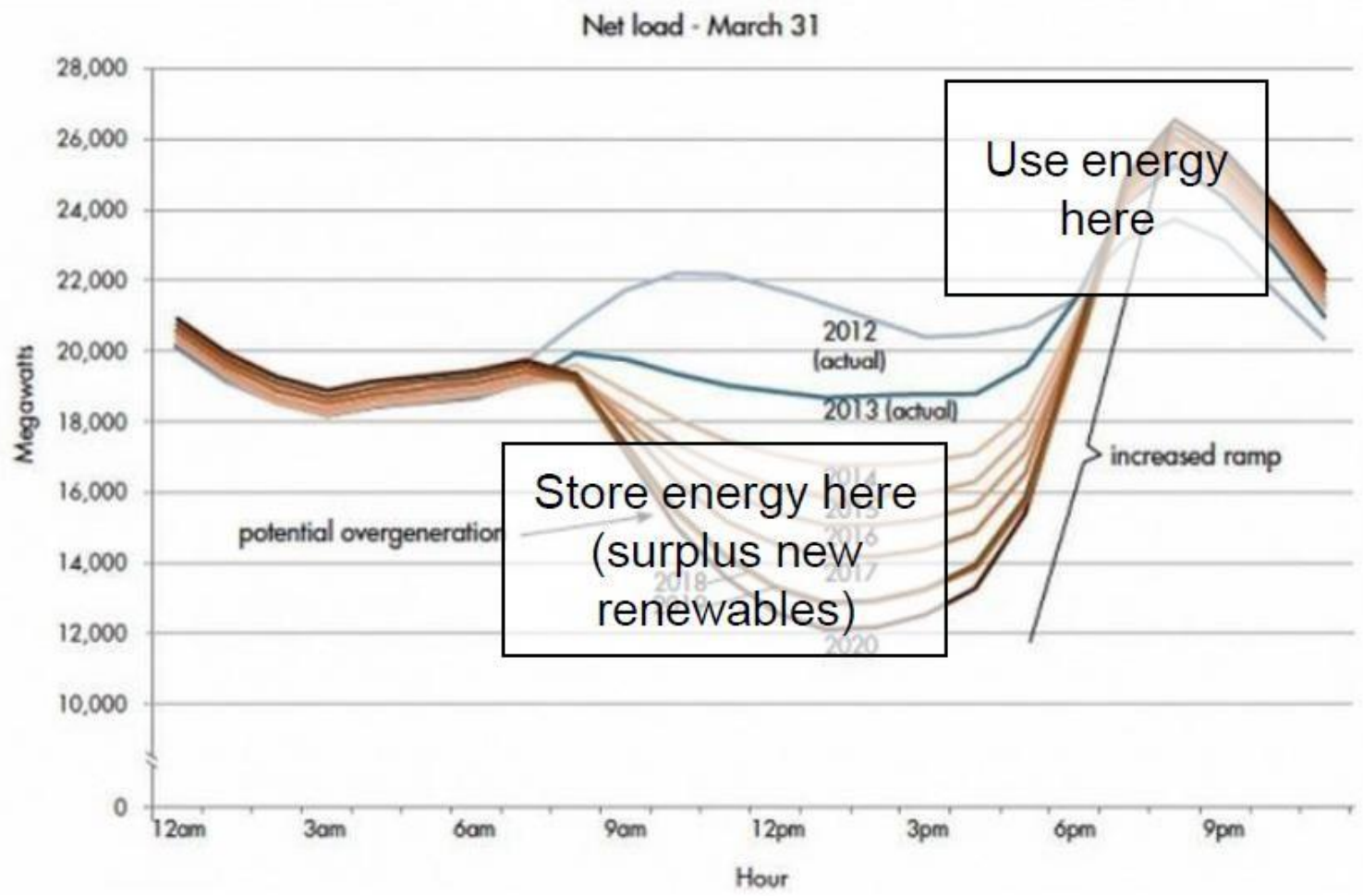


Maximum load on generation, transmission and distribution increases

Risk of overproduction increases

Demand from traditional power generation during the day

The main purpose of energy storage



Demand from traditional power generation during the day

Meeting market needs

DSO/DNSP

Decongest your grid and improve power quality

Flexibility market

Enable power systems to generate new revenue streams from the frequency response market

Telecom

Enable power systems to generate new revenue streams from flexibility markets

Commercial and Industrial

Reduce energy cost and unlock new revenue streams to meet green targets

Micro grid and Off-grid

Green, cost-effective and reliable electrification

EV Charging

Multiply available power for EV fast charging

Residential

Get more out of your solar investment and optimize your energy consumption with our integrated smart home hub

OEM's

Diversify revenue, reduce cost, optimize production and efficiently reach new customer segments and markets.


Our technology enable the
electrification of society
Paving the way for
a sustainable future
Ready for delivery!

Shaping the power of the future

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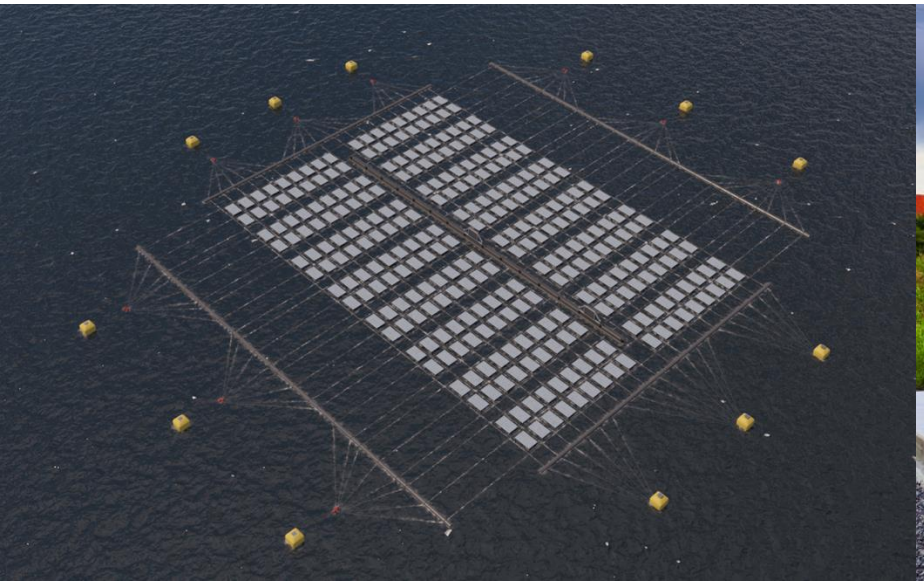

PUBLIC

HITACHI

Hitachi Energy

Battery Energy Storage System

Key to Provide Resilience for Future Grid

Power Conversion Solutions
Regional Sales & Market Manager
PU Jianjiang
2 Jun 2025, Manila, Philippines

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HITACHI

Global trends

“

Each clean GW that we add to the energy system needs to be balanced with an increase in grid capacity and flexibility to meet security, reliability, and resilience.

We are advancing the world’s energy system to be more sustainable, flexible and secure.

Interconnecting regions, countries and continents

Delivering reliable energy to cities and remote communities

Managing energy complexity and enabling smart life through digitalization

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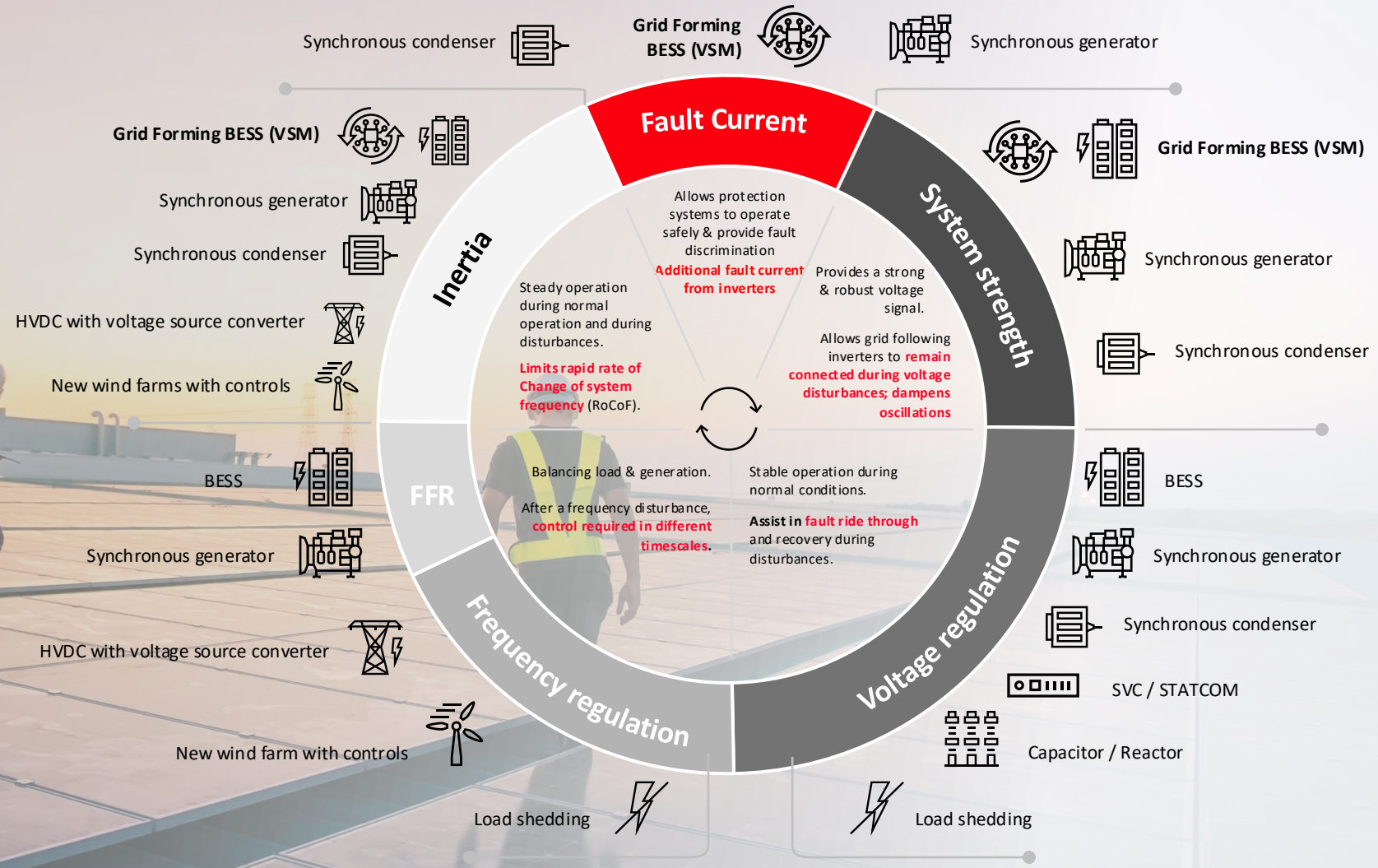
Ensuring network stability and flexibility

HITACHI



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Challenges for Renewables penetration

HITACHI

Scale:

'Small' amounts of renewable generation can cause instability and power quality issues

Power Quality:

Renewables can exacerbate voltage and frequency issues in weaker grids

Instability:

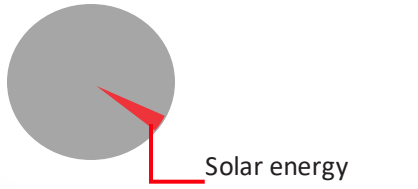
Fluctuating renewables and dynamic loads may cause grid instability

Penetration limits:

Without smart controls and storage, renewable penetrations must be limited to prevent grid problems

BESS with SMART CONTROLS CAN OVERCOME LIMITS

Enables an island to get more energy from solar



Mitigate problems with quality and reliability

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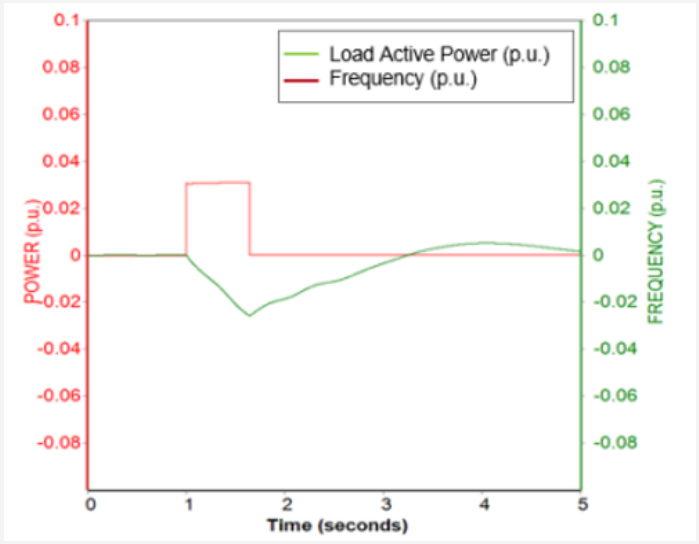
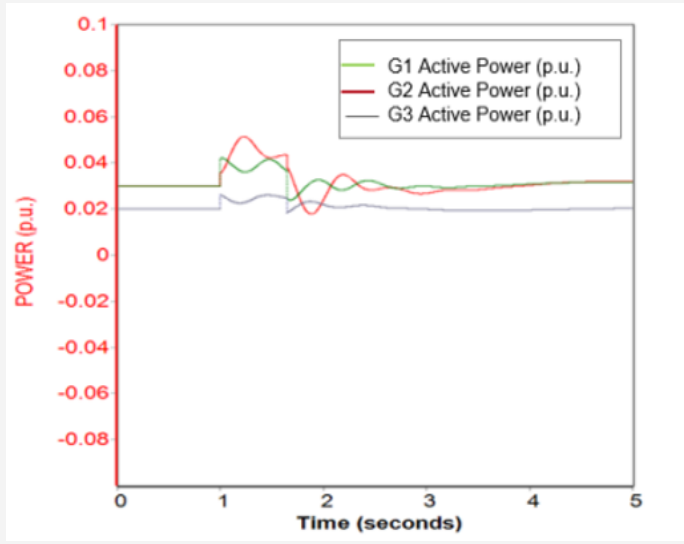
Improve network stability and resilience

HITACHI

Without BESS

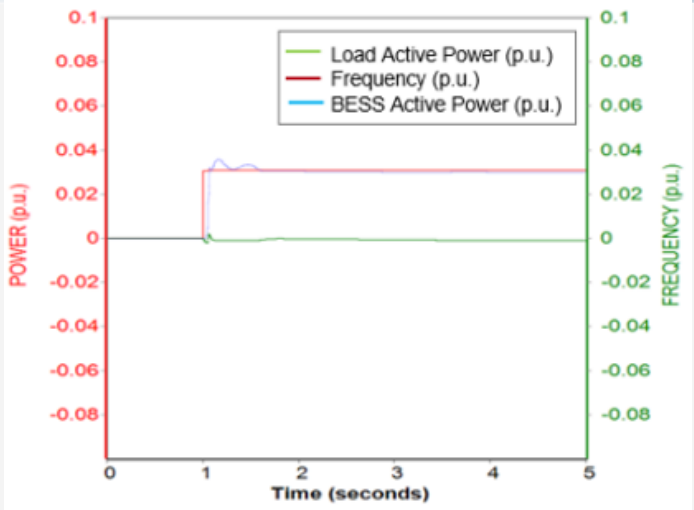
- 0.026 P.U. Max Frequency Deviation
- Load Shedding

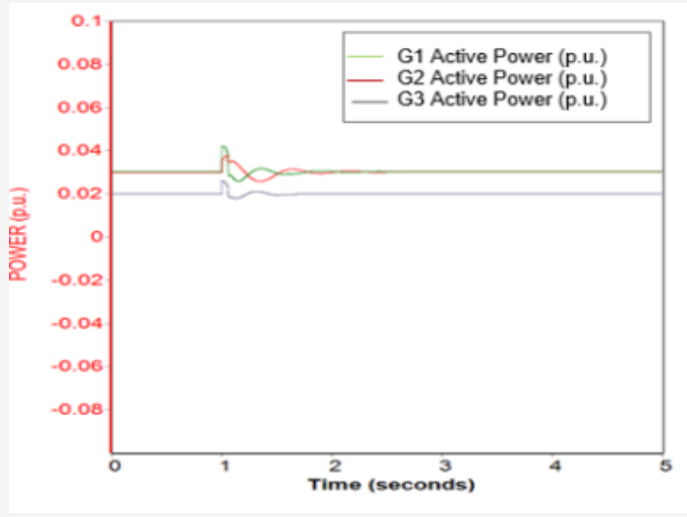




With BESS & Smart Control

- 0.002 P.U. Max Frequency Deviation
- No Load Shedding
- BESS response within 0.06s





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Strong Track Record: Combined 7’000+ MW ESS Solutions Installed

Often co-located with PV, we're a leader in PV-BESS hybrids (AC- and DC-coupled)

HITACHI

Customer Challenges

- PV integration through hybrid BESS
- Grid-forming and seamless switch capabilities in large- and mid-sized BESS applications to support weak- and off-grid applications
- Local content

Customer Outcomes

- Improved reliability and resiliency
- Reducing energy cost and CO2 emissions
- Unlocking new revenue streams
- Maximizing renewable integration

Global Installations (key projects)

Global Footprint

350+
Projects delivered worldwide, +15 PV-BESS DC-coupled

7’000+ MW
ESS capacity delivered worldwide, often PV co-located

30+
Years of experience

90+
Countries supported with Service and Sales organizations

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HITACHI

Success Story
SNAP Magat BESS System

Internal
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HITACHI

Key to provide resilience to future grid

Project information

- Project name: **Magat BESS Project**
- Location: Ramon, Isabela / Philippines.
- Customer: SN Aboitiz Power (SNAP)
- Completion date: April 2023
- Generation portfolio: Hydro and Floating PV

01

Solution

- Hitachi Energy's 24MW/32.5 MWh Battery Energy Storage System with full suit of e-mesh control system
- Long Term Service Agreement

02

Impact

- Expanding Hydro plant capacity and seamless integration into existing hydro plant
- Diversify SNAP's renewables fleet with complimentary technology beside Hydro and floating solar
- Stable source of grid ancillary service

03

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HITACHI

Success Story

Nusa Penida Microgrid System Project

Internal

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HITACHI

Pathway to energy independence and clean energy for islands and remote communities

Project information

- Project name: Nusa Penida Microgrid BESS
- Location: Bali / Indonesia
- Customer: PLN
- Completion date: 2022
- Generation portfolio: PV, Deisel

01

Solution

- Hitachi Energy's 3MW/3 MWh Battery Energy Storage System with full suit of e-mesh control system
- collocated with 40MWp Solar, 3MWp Distributed rooftop solar and Deisel

02

Impact

- Reduce carbon emissions by 3,200 tons of CO2 per year
- Delivers stable, coordinated operation of the BESS and solar PV with an existing diesel power plant.
- Manage consumption surge in peak season (G20 Summit)

03

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Thank you

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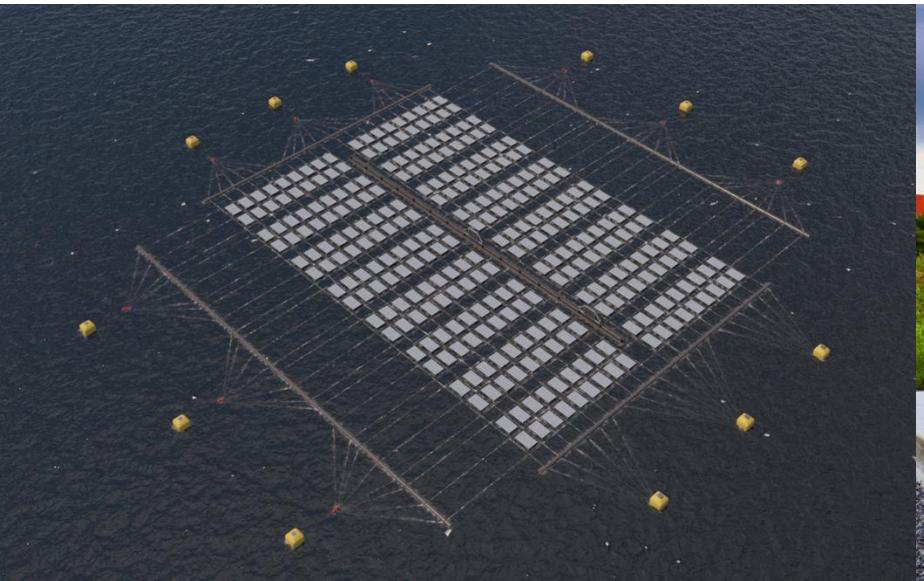


Norfund

The Norwegian Investment Fund for Developing Countries

Investing to create jobs, improve lives and support the transition to net zero

Manila

2 June 2025

MISSION:

Create jobs and improve lives and support the transition to net zero by investing in businesses that drive sustainable development

Norfund

The Norwegian Investment Fund for developing countries

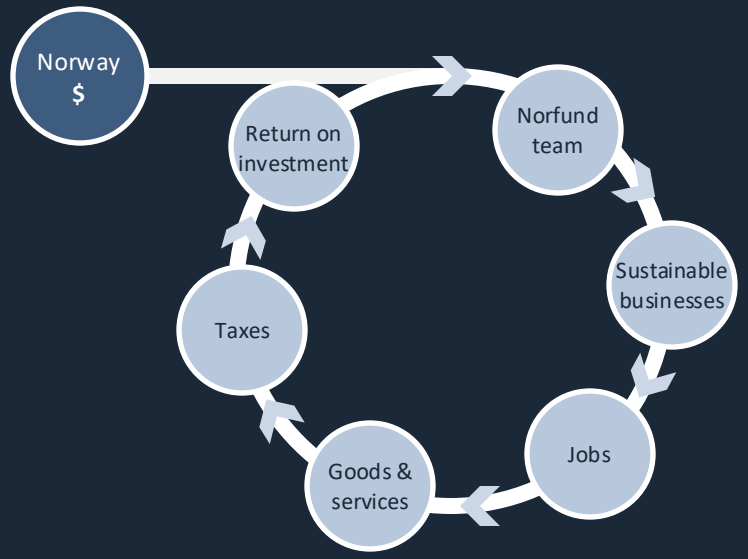
Development Mandate

Create jobs and **improve lives** by investing in businesses that drive sustainable development

Climate Mandate

Invest in the transition to **net zero** in **emerging markets**

Norfund's model

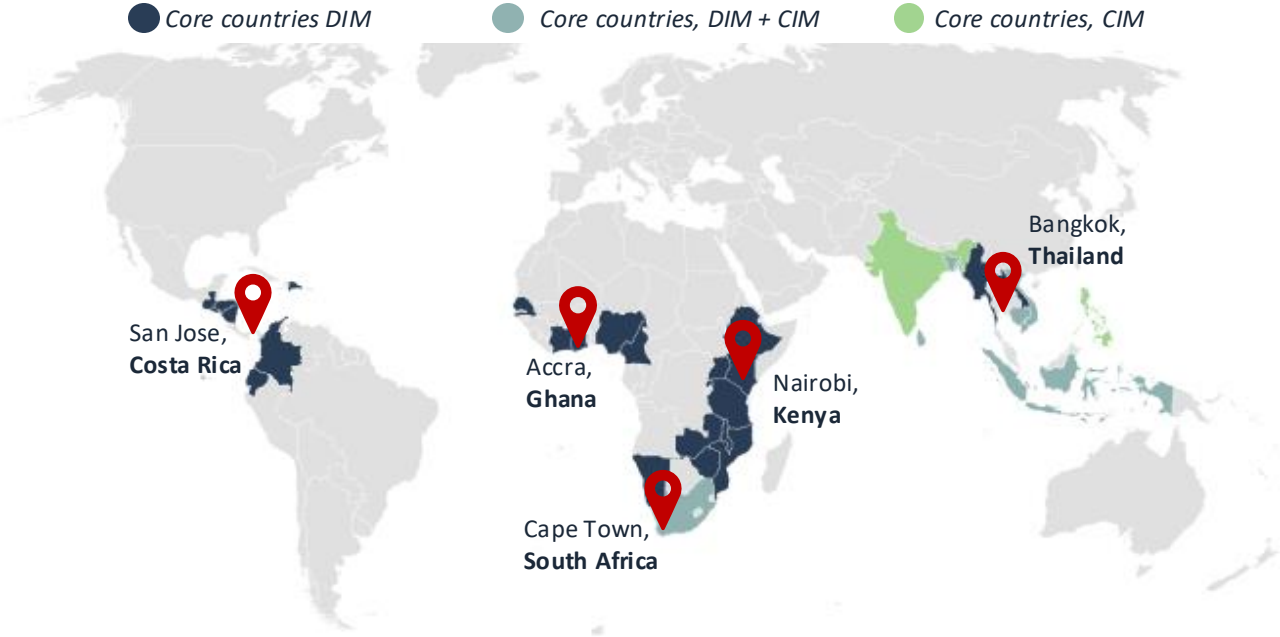


Renewable energy

Financial Inclusion

Scalable Enterprises

Green Infrastructure



41.6
bNOK portfolio

131
Employees (FTE)

25
Nationalities

Note: As of Q1 2025; DIM = Development Investment Mandate; CIM = Climate Investment Mandate

Our investments are concentrated in **four areas** that each contribute to the SDGs

Renewable Energy

Large-scale renewable power generation

Commercial and industrial power solutions

Off-grid energy solutions

Financial Inclusion

Commercial banks

Microfinance institutions

Other financial services, including non-deposit taking lenders, insurance and fintech

Scalable Enterprises

Agribusiness value chain

Manufacturing

Other scalable businesses through funds

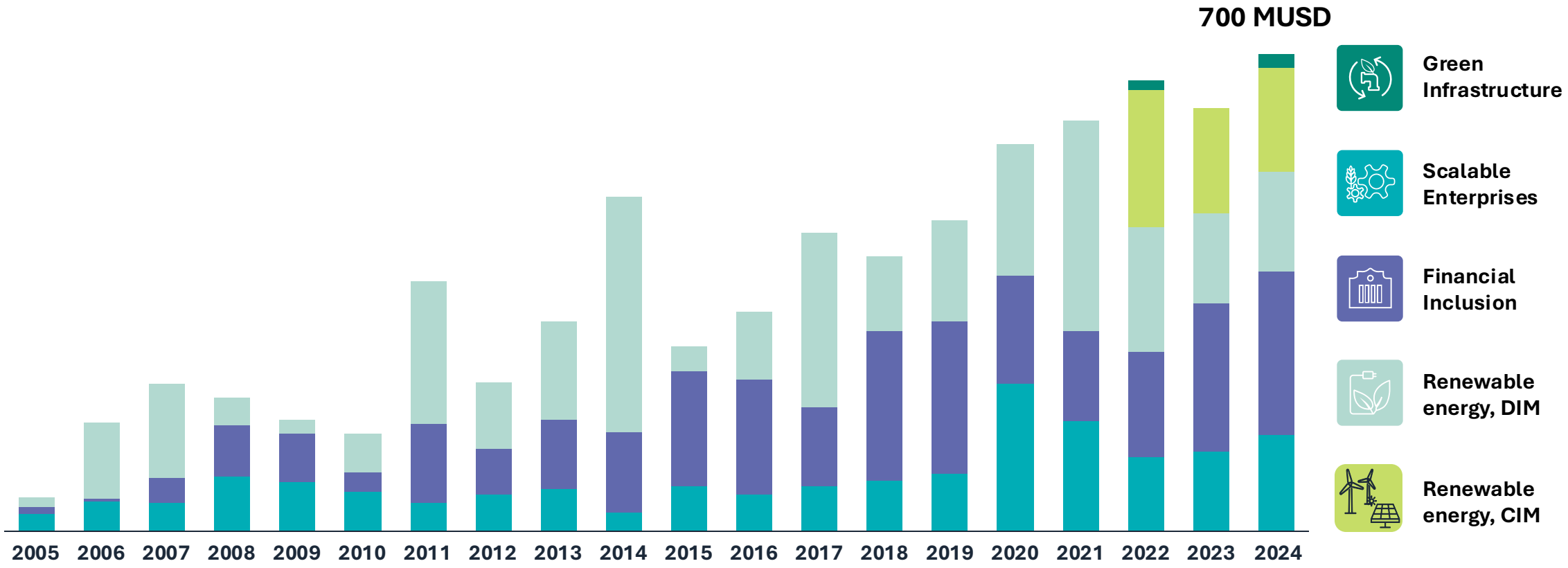
Green Infrastructure

Waste management, including waste-to-energy

Water supply and sanitation, including wastewater treatment

Our investments have grown to c. USD 700 million per year

New committed investments per year, USD million

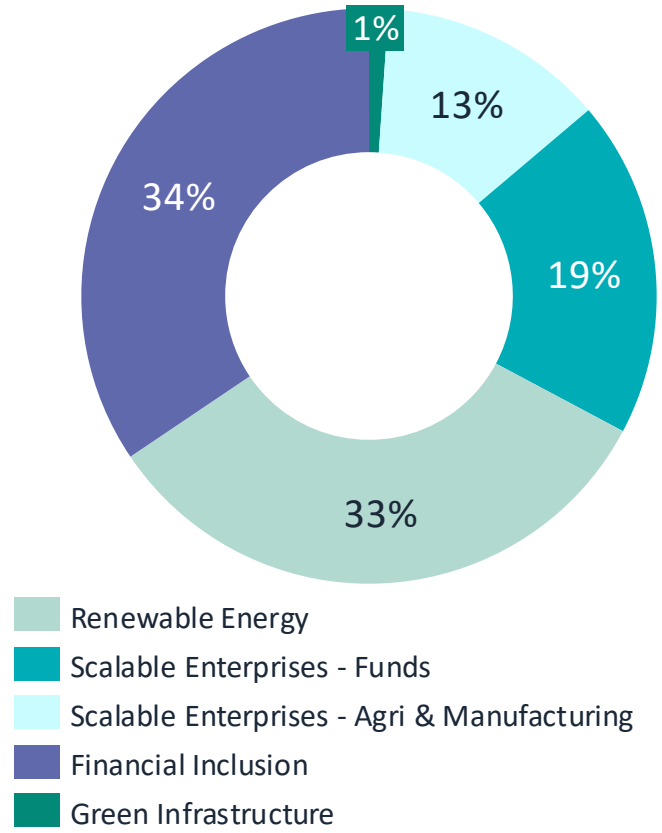


Norfund

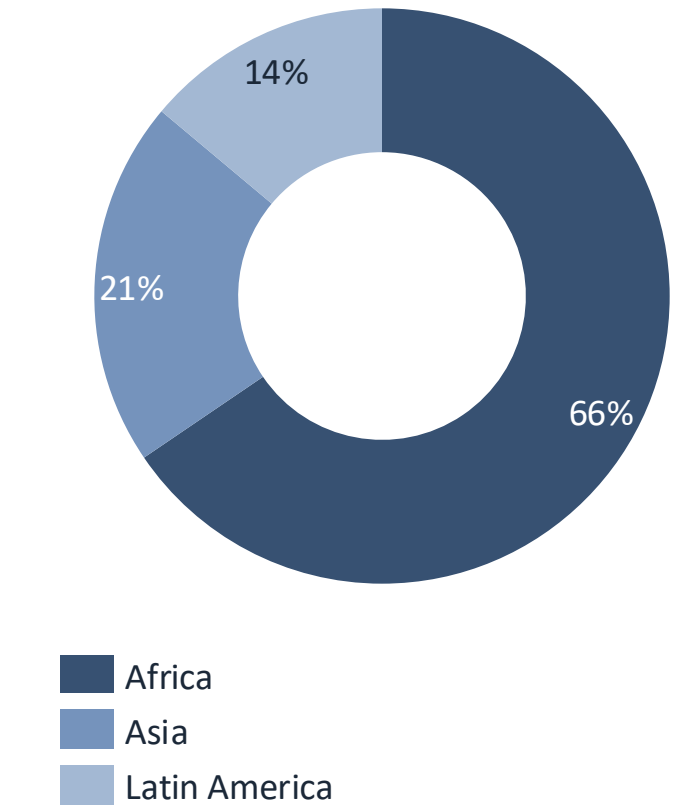
Breakdown of committed portfolio for the **development mandate** Q1 2025

100% = NOK 36.2 billion

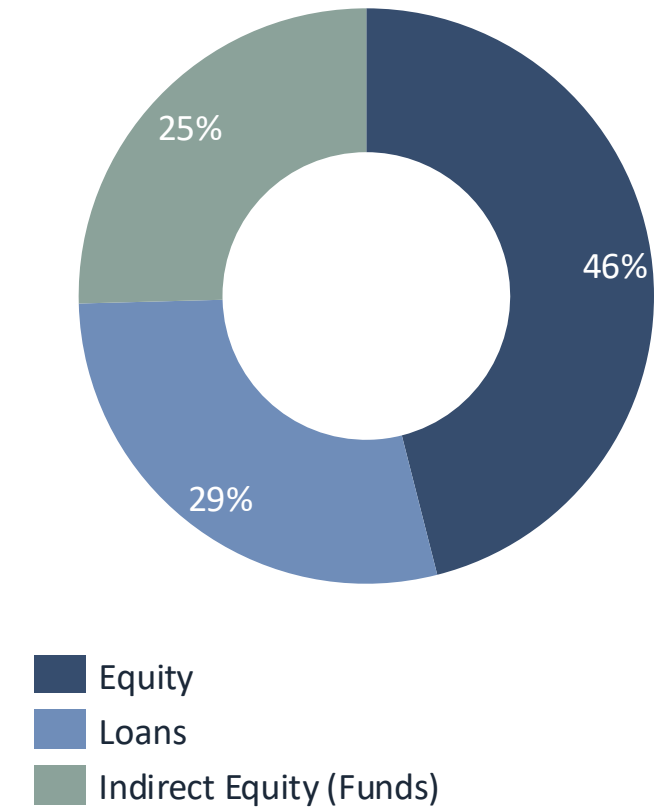
Investment area



Geography



Instrument



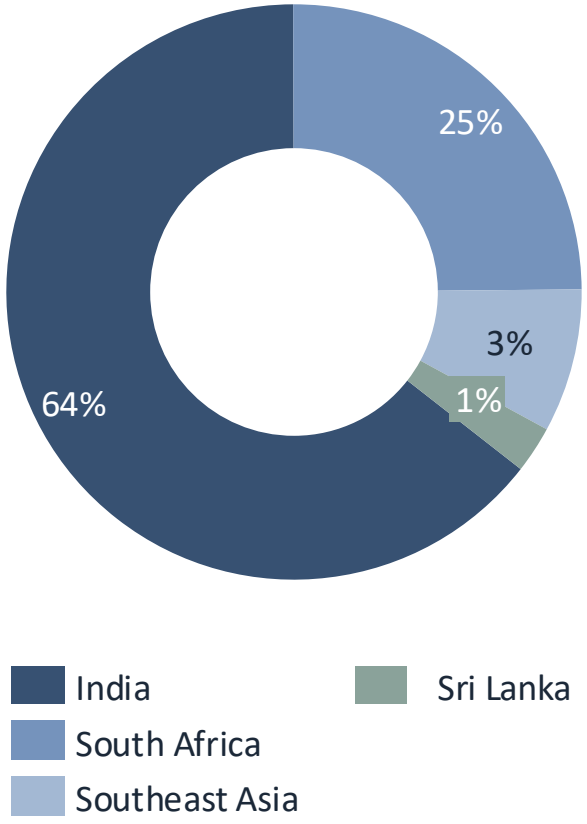
Note: As of Q1 2025

Norfund

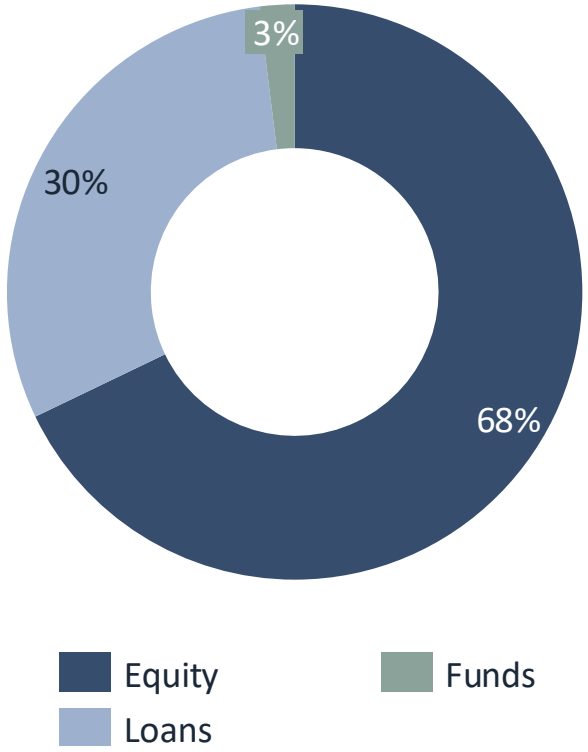
Breakdown of committed portfolio for the **climate mandate** Q1 2025

100% = NOK 5.4 billion

Geography



Instrument



Note: As of Q1 2025

Norfund

Under the climate mandate we will primarily invest in renewable energy, but also associated enabling technologies that can reduce the need for fossil fuels

Our primary focus is on renewable energy… *~90% of portfolio*

Renewable energy production, e.g.,

- Solar (incl. floating)
- Wind (onshore, offshore)
- Hydropower

… as well as enabling technologies *~10% of portfolio*

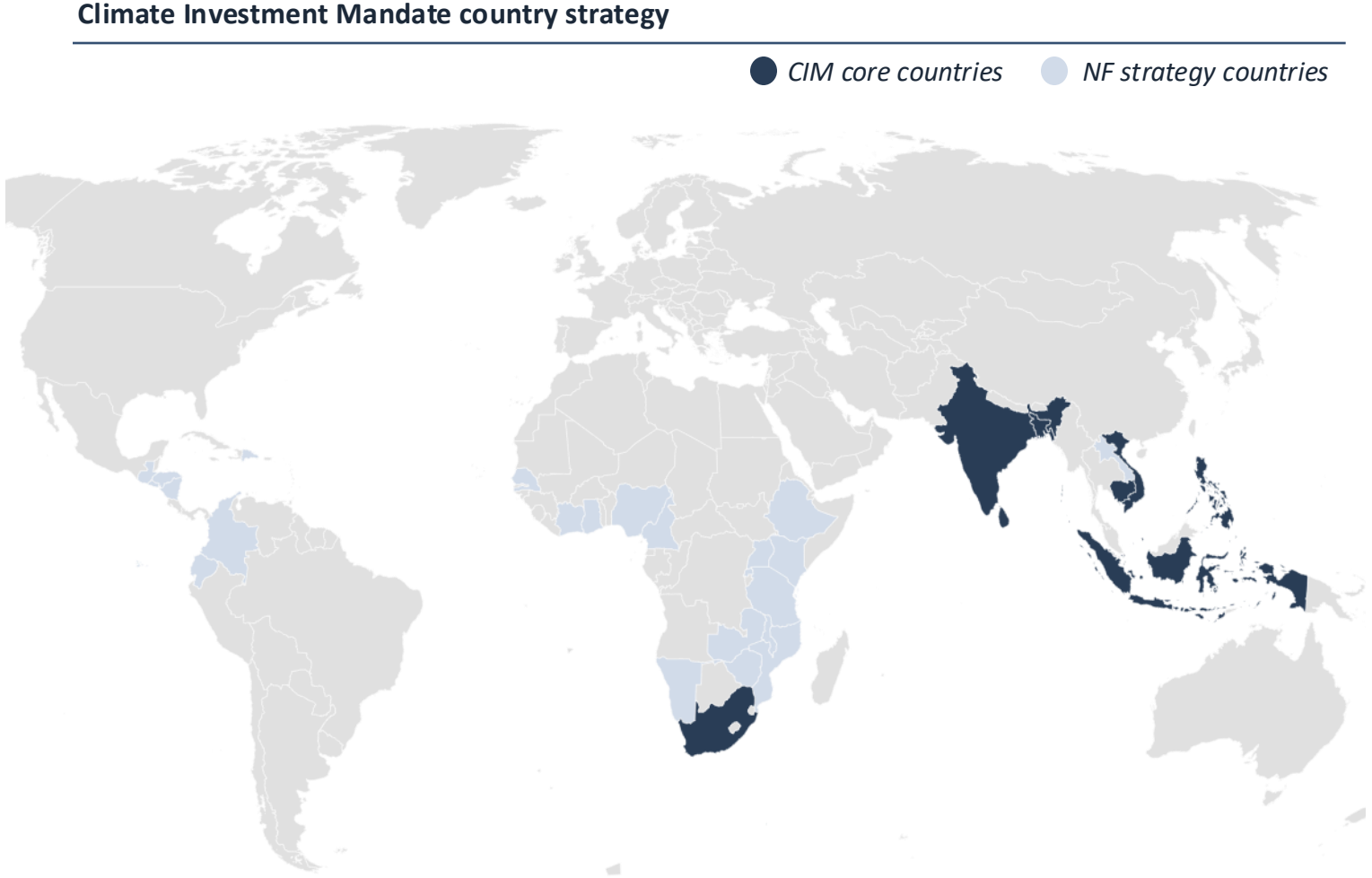
Enabling technologies, e.g.,

- Storage
- Green hydrogen and other power-to-X technologies
- Transmission

Norfund

Core geographies are South Africa and South- and Southeast Asia

Climate Investment Mandate country strategy



The CIM will prioritize existing Norfund strategy countries[1] in order to maintain focus and build on existing capabilities. Countries are selected based on the climate impact, our ability to be additional and feasibility to execute successful investments.

Among existing strategy countries, we will prioritize **8 core countries** based on the selection criteria[2]:

- India
- Vietnam
- **Philippines**
- Cambodia
- Indonesia
- Sri Lanka
- Bangladesh
- South Africa

We may **opportunistically extend our reach to new countries with high climate impact,** together with strong, existing partners

1. Countries prioritized for Norfund in the 2023 strategy – 30 core countries 2. (1) Climate impact (measured by amount of coal in pipeline and grid emission factors), (2) additionality (measured by Norfund's country and sector-specific additionality scores and (3) feasibility (measured by Norfund's capabilities and investability of the country

Norfund

Norfund in the Philippines

NOW EXITED PARTNERSHIP WITH ABOITIZ POWER THROUGH SNAP

- The Philippines used to be one of **Norfund's largest exposures**, with several hundred million USD invested via investee SN Power's partnership with Aboitiz Power in **SNAP**.
- **Exited in 2021** through a sale of SN Power to Scatec
- Norfund now **looking to invest** in the Philippines again
- **USD 200-300m** investment capacity for the right Philippine opportunities during 2025-2027

Examples of our investments – Floating solar in India

FOURTH PARTNER ENERGY – ONSITE FLOATING SOLAR PV FOR C&I CUSTOMERS

- Shyam Metalics & Energy Power Pvt Ltd, **Odisha**
- Capacity: **1.2 MWp**
- 33% cost saving on customer's on electricity bills
- **1694 tons of reduced carbon emissions**, ~40m litres of water conserved, equivalent to planting 80k trees

- Shyam Sel & Power Pvt Ltd, **West Bengal**
- Capacity: **1.095 MWp**
- 36% cost saving on customer's electricity bills
- **1619 tons of reduced carbon emissions**, ~38m litres of water conserved, equivalent to planting 74k trees

Examples of our investments – Solar and storage in South Africa

H1 HOLDINGS – KENHARDT HYBRID SOLAR AND STORAGE PROJECT

- One of the world's largest **solar and battery facilities**, with a total solar capacity of 540 MW and a battery storage capacity of **225 MW/1,140 MWh**, delivering electricity 16 hours a day, located in the Northern Cape
- Developed by Scatec, awarded under the Risk Mitigation Independent Power Producer Procurement Programme. **Norfund's investee H1 Holdings** is an equity investor in the project.
- **Purpose:** Enhance grid stability and provide reliable renewable energy.

Examples of our investments – Storage in South Africa

GLOBELEQ – RED SANDS STORAGE PROJECT

- Will be **largest stand alone storage** system in Africa, with a capacity of **153 MW / 612 MWh**, located in the Northern Cape region.
- Will be developed by **Norfund's investee Globeleq**, awarded under Energy Storage Capacity Independent Power Producer Procurement Programme (ESIPPPP)
- **Purpose:** Contribute to the nation's energy security, Support the transition to a low-carbon economy, and address urgent power infrastructure needs. Achieved by securing flexible, dispatchable generation that can provide energy, capacity, and ancillary services.

OUR MISSION IS NOT POSSIBLE TO SOLVE ON OUR OWN

Norfund is created to take risk to foster development – that is challenging, and we will not always succeed

OUR AMBITION IS TO CREATE JOBS, IMPROVE LIVES AND SUPPORT THE TRANSITION TO NET ZERO…

… AND WE RELY ON COLLABORATION TO DELIVER ON THIS AMBITION

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