Zero Emissions for Sustainable Blue Economy

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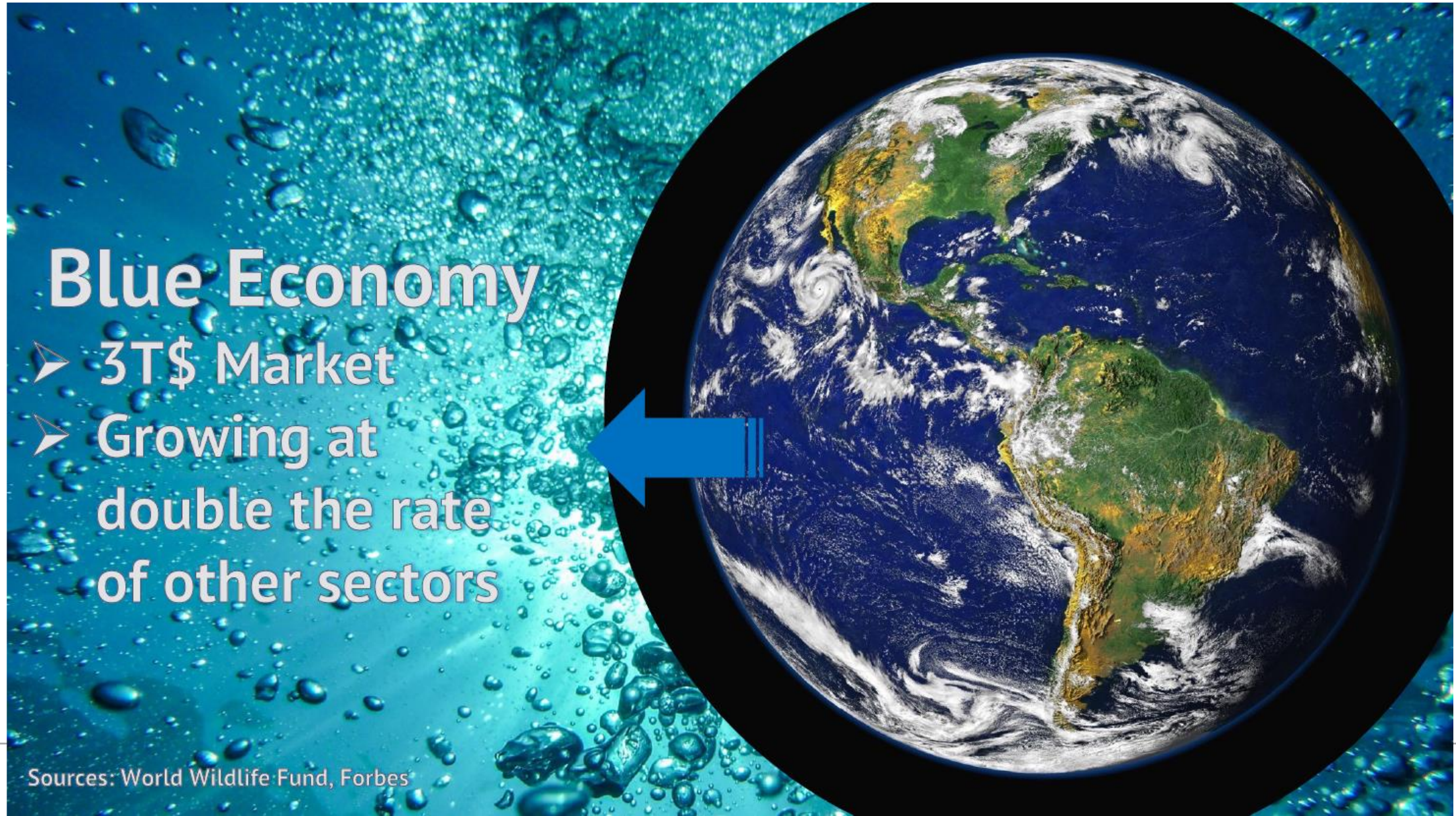
The global challenges

- Access to food (especially proteins) will be difficult by 2050.
  - Increasing world population 34% than today.
  - Decreasing amount of arable land.
- Climate challenges → green economy is required.
- Environmental challenges on health and wildlife → Waste management and **sustainability**.
- Energy demand → clean (renewable) energy.

Opportunities in the Ocean



DNV

TECHNOLOGY OUTLOOK 2030

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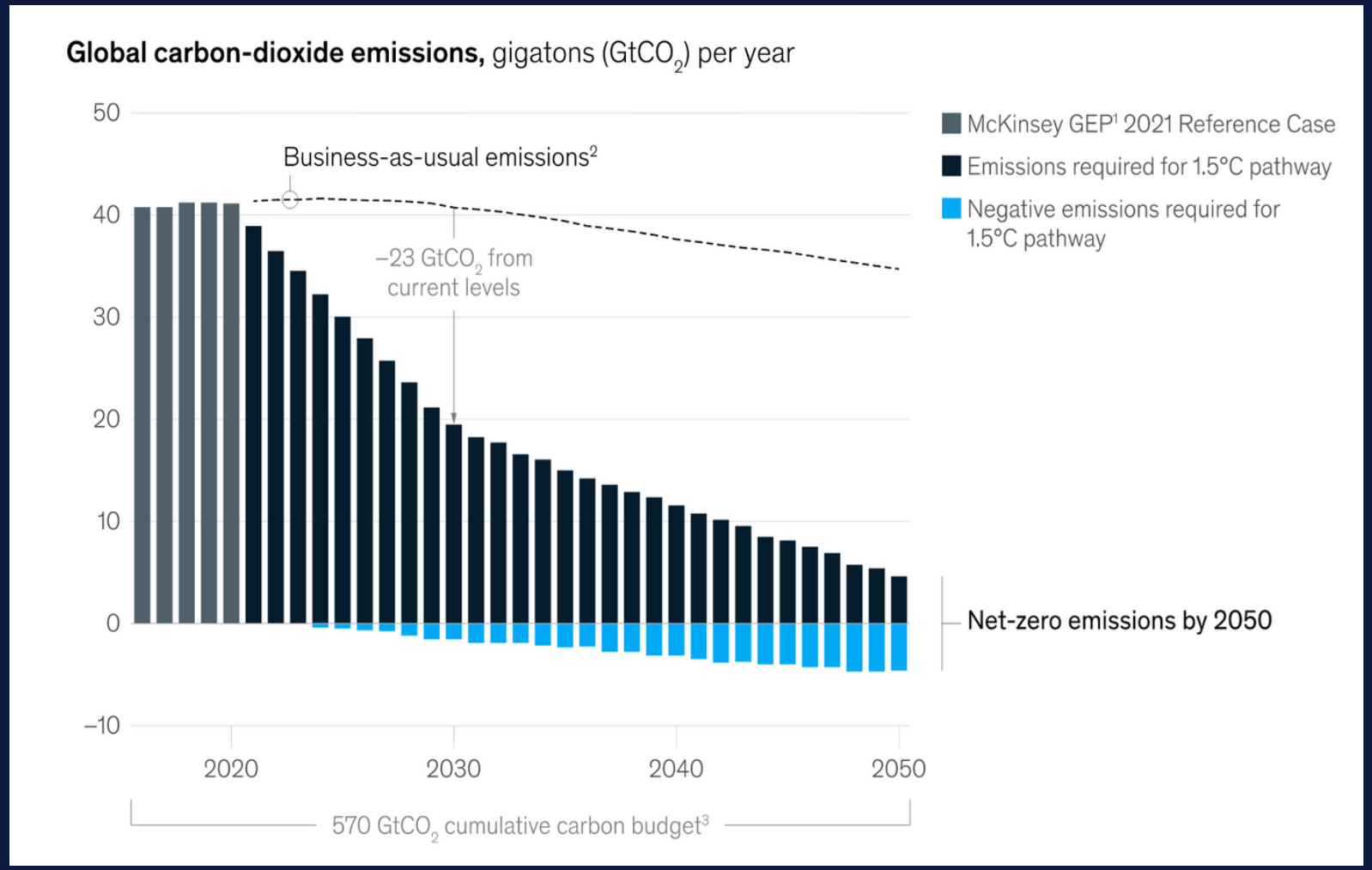
AI, Data and Robotics for autonomous O&M

2030 Vision on Blue Economy (DNV GL): Energy, Aquaculture, Transport

Multipurpose offshore platforms

Ocean is a sensitive fundament for Sustainabilty



Ocean is the world's greatest ally against climate change.

It generates 50 % of the oxygen and absorbs 25 % of all CO2 emissions.

It also captures 90% of excess heat from these emissions

Goals of IPCC report can be met by ocean to remove more billion tons CO2 annualy to reach 1.5°C

Ocean to increase Food production vs.
Ocean to remove more CO2 emissions

The role of AI, Data and Robotics is essential

Aquaculture

Entire value chain

Broodstock	Eggs	Feed	Fish Biology	Production Systems	Environment Impacts	Energy/ Transport	Circularity	Product	Stakeholder Engagement
Monitoring	Early development	Production sustainable feed ingredients	Development	Semi-closed containment RAS Open-cages IMTA	Ecotoxicology	Optimization	Circular economy	Block-chain	Consumer confidence
Biological traits	CRISPR	Fish nutrition/ physiology	Physiology	Biological & Environmental assessments	Climate predictions	Green Energy Systems	Waste to value	Traceability	Policy
Climate predictions	Environment requirement	Functional feeds	Neuroscience	Autonomous operations & control	Wild fish assessments	Green transportation	LCA	Consumer confidence	Regional planning
		Feed evaluation	Stress	Sensors, IoT	Location impacts	Logistics	Regional impacts	Health	Consumer engagement
		Feeding	Welfare	AI, Analytics	Climate footprint		Socio-economic impacts		Regulations
			Health	Drones	Sea lice				
			Disease	Location assessments	Disease				
			Nutrition	Coastal zone planning	Plastic				
			Microbiome		Sea floor				
			Behaviour		Microbiome				
			Environment						
			Production Biology						
			Digitalization						
			Telemetry						

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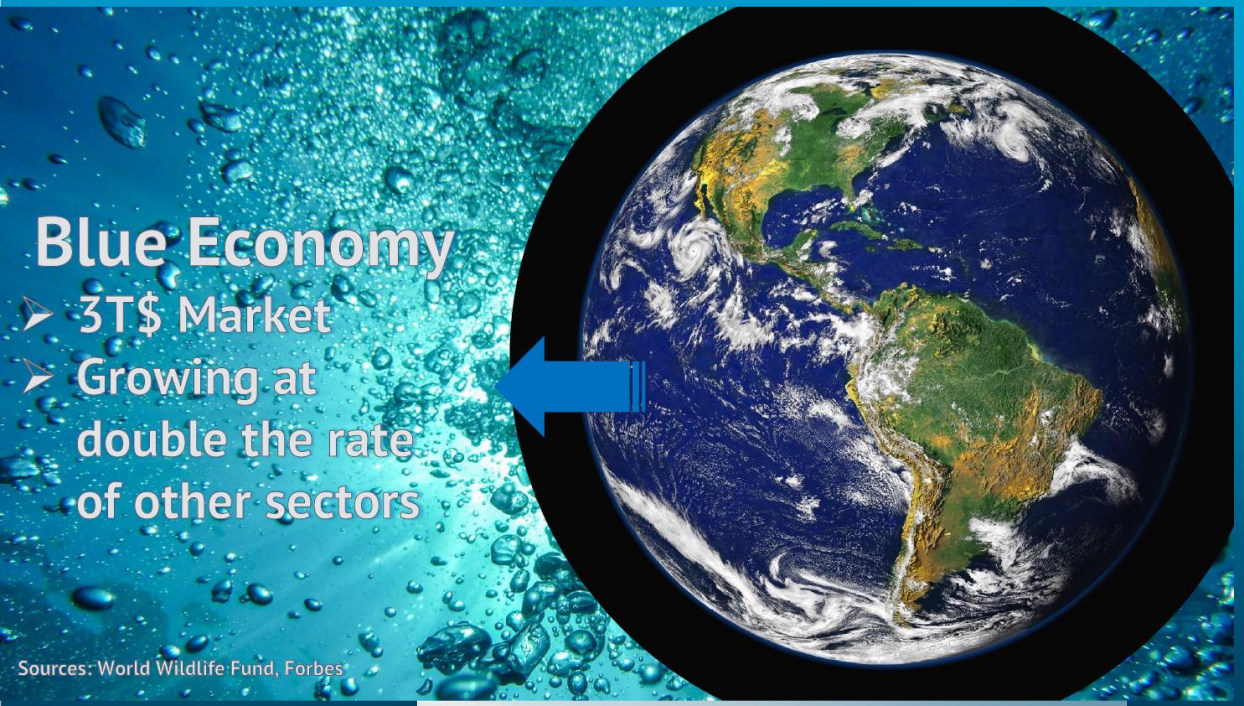
Fish Aquaculture Sector Challenges

Expectations to produce 6 times more food from the ocean by 2050



- **Environmental limitations**
  - Marine licenses and common space use
  - Waste from aquaculture
  - Genetic interactions with wild populations
- **Feed sustainability**
  - 3% uneaten feed in the cages
  - Alternative feed ingredients
- **Disease and parasite problems**
  - Emerging new diseases especially viruses
  - Outbreaks of existing diseases
- **Impacts of climate change on aquaculture**
  - Regional changes and food security

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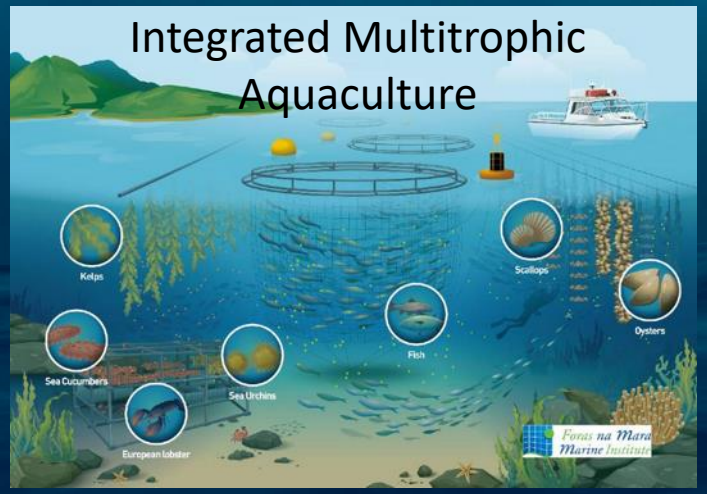
Aquaculture Sector Responses

Closed & Integrated Production Systems



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One Health approach and assess

Organism

- Healthy stock
- Minimal chemical hazards
- Bio-secure farms
- Safe farms
- Optimized farm systems

Environment

- Optimal water quality and usage
- Circularity and waste to value
- Protect biodiversity and natural capital
- Low and renewable-energy use
- Low-spatial footprint

People

- Knowledge and skill generation
- Nutritious & safe food
- Equitable income generation
- Gender equalization
- Quality employment

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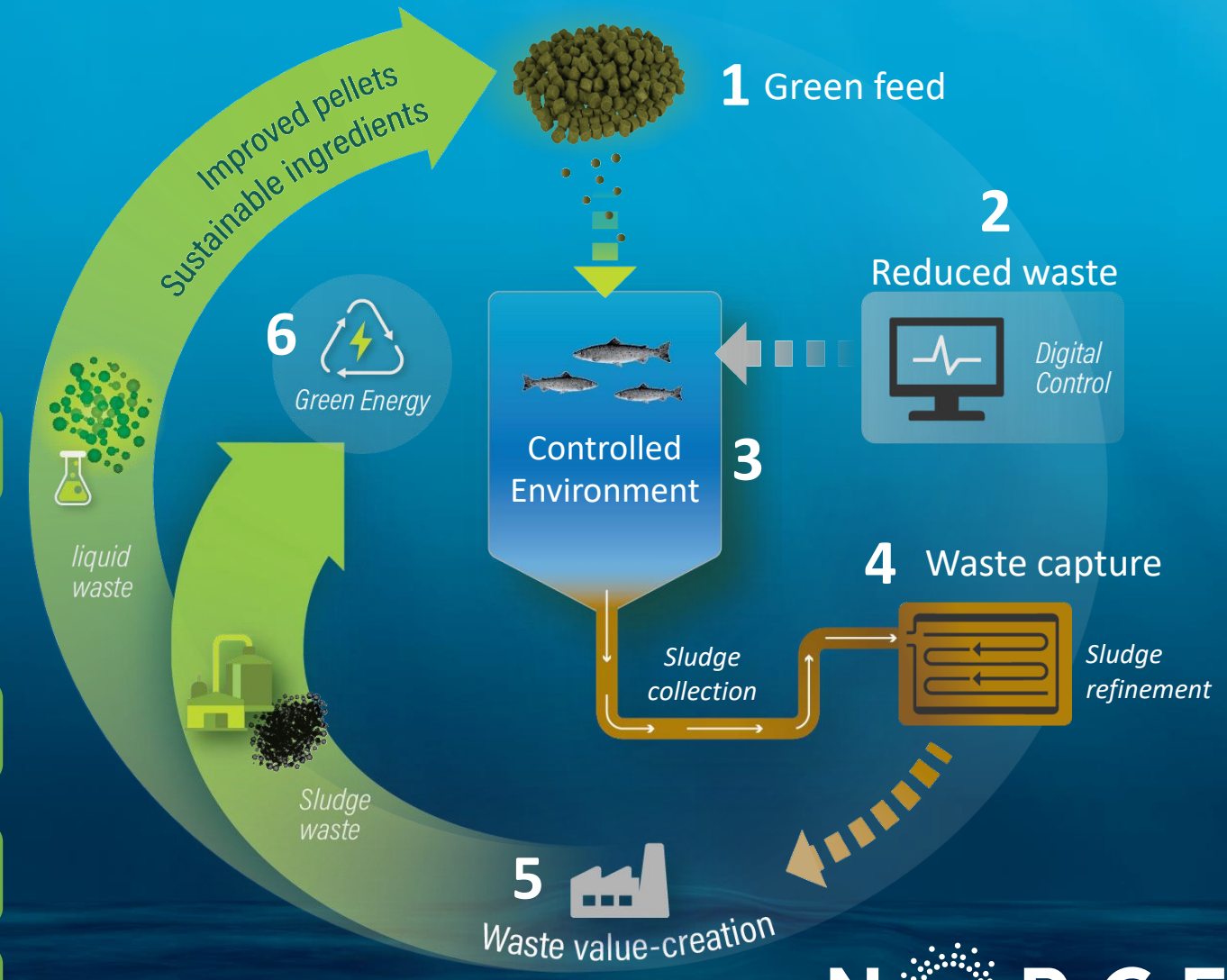
NORCE Aquaculture

Emerging technologies and Circularity

- 1: Sustainable feed ingredients
- 2: AI, Digital control, robotics, & automation
- 3: Fish biology and environment security
- 4: Waste capture and secondary production
- 5: Waste to value and circularity
- 6: Renewable energy solutions



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Aquaculture Sector Responses

Integration of green energy and development of waste value streams

NBioC: National Fermentation and Bioprocessing Centre (Stavanger)

NAM: National algae pilot Mongstad (Bergen)

Synergistic lower trophic production

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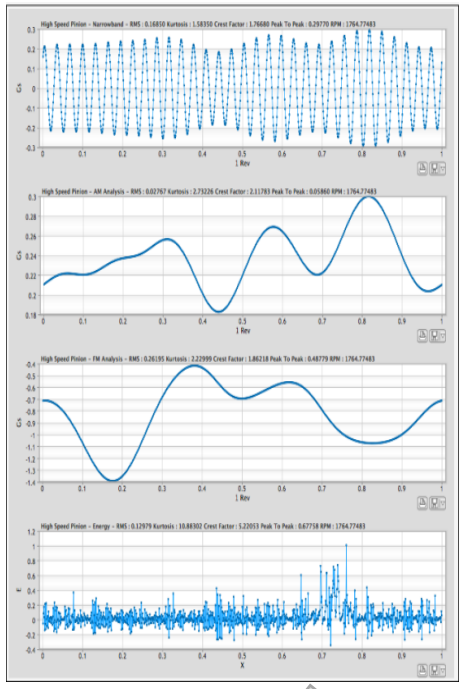
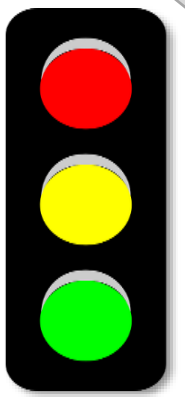
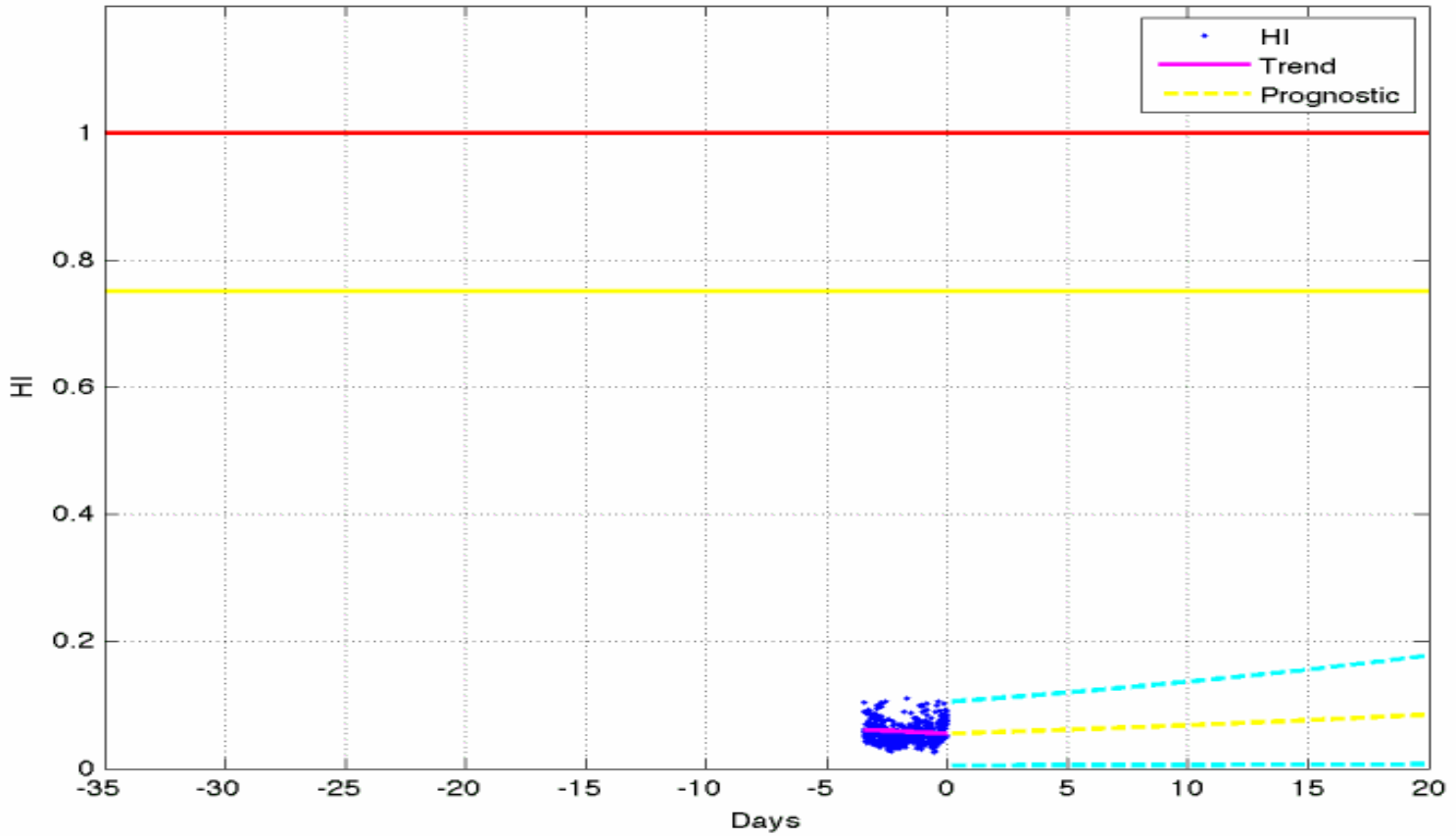
AI, Data and Robotics: Monitoring, prognosis for asset management



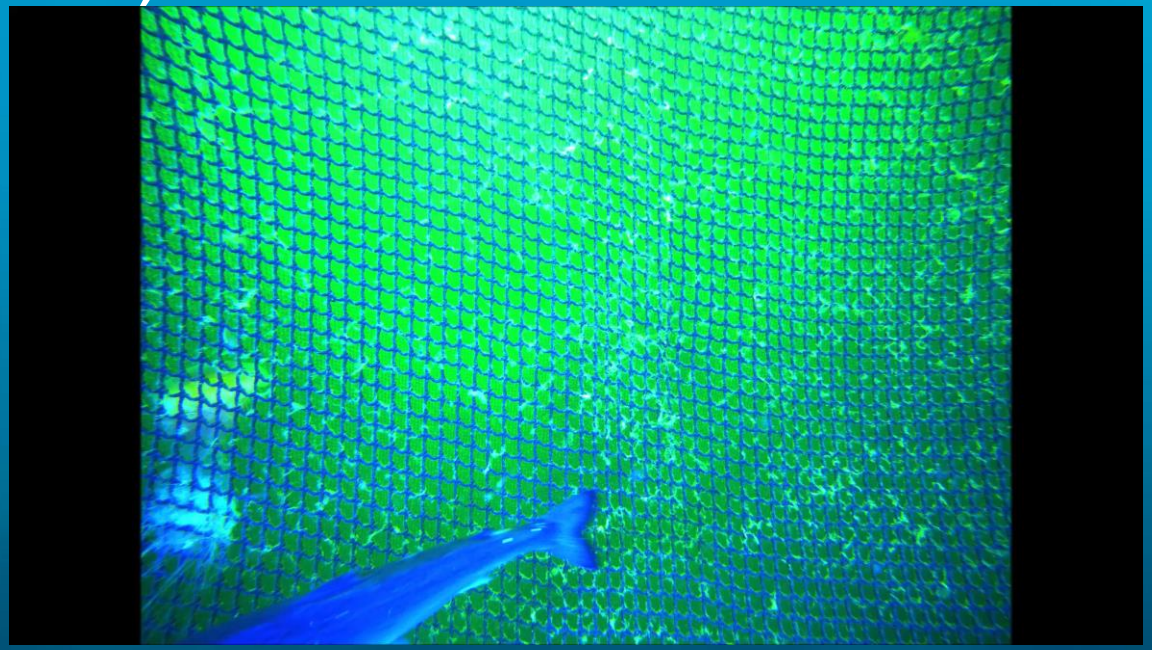
Creating stoplight simplicity out of complex data

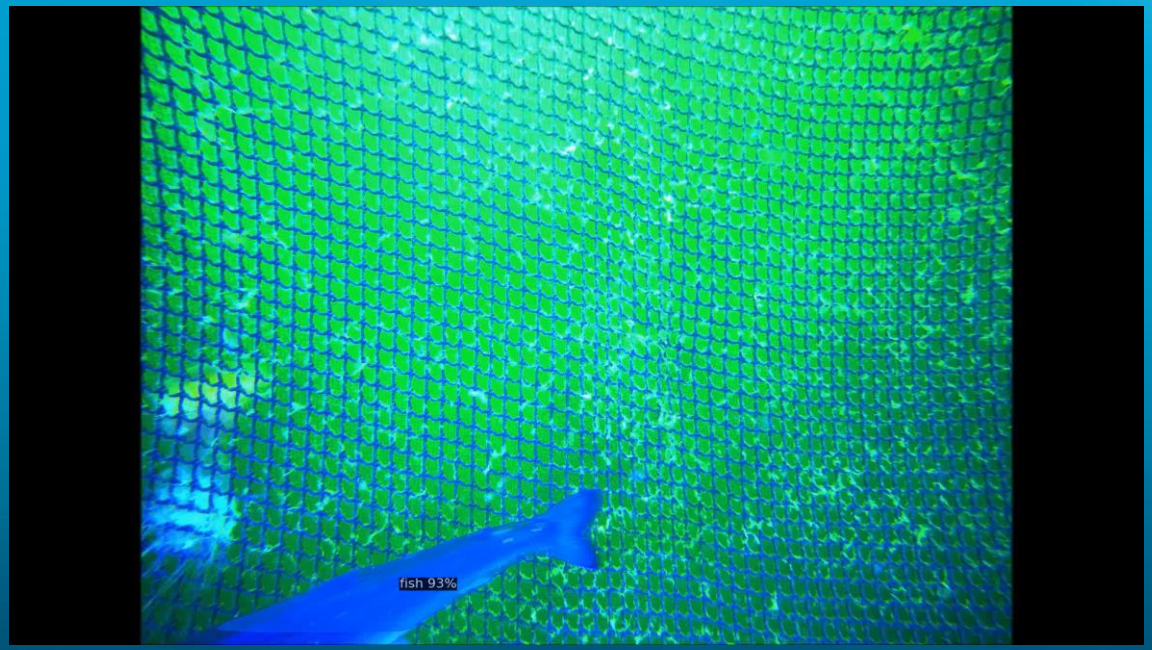




We compute the time to maintenance.

AI, Data and Robotics for Automated Biomass Control





Real-time

- Fish counting
- Fish biomass estimation
- Cage density analysis

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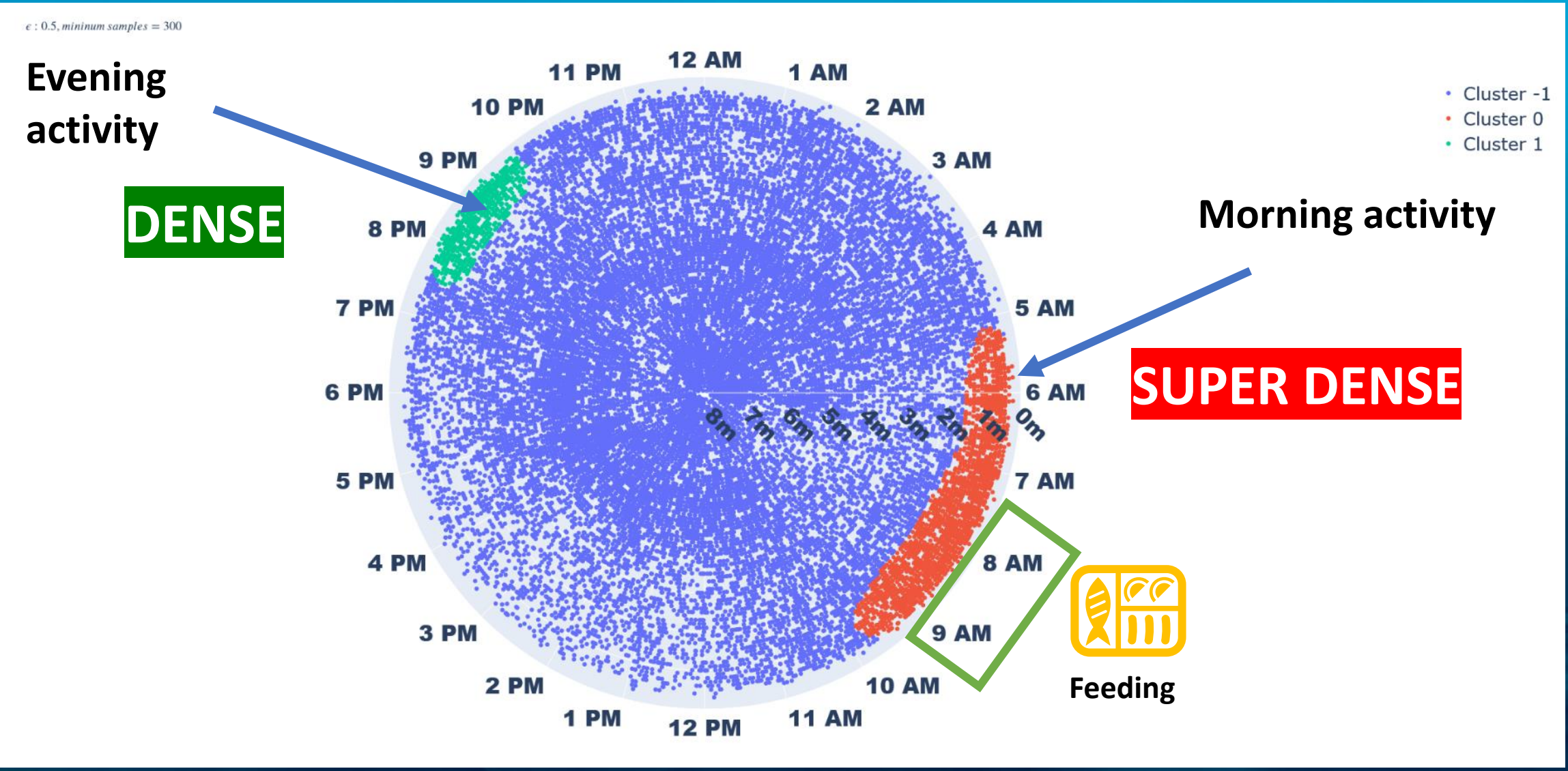
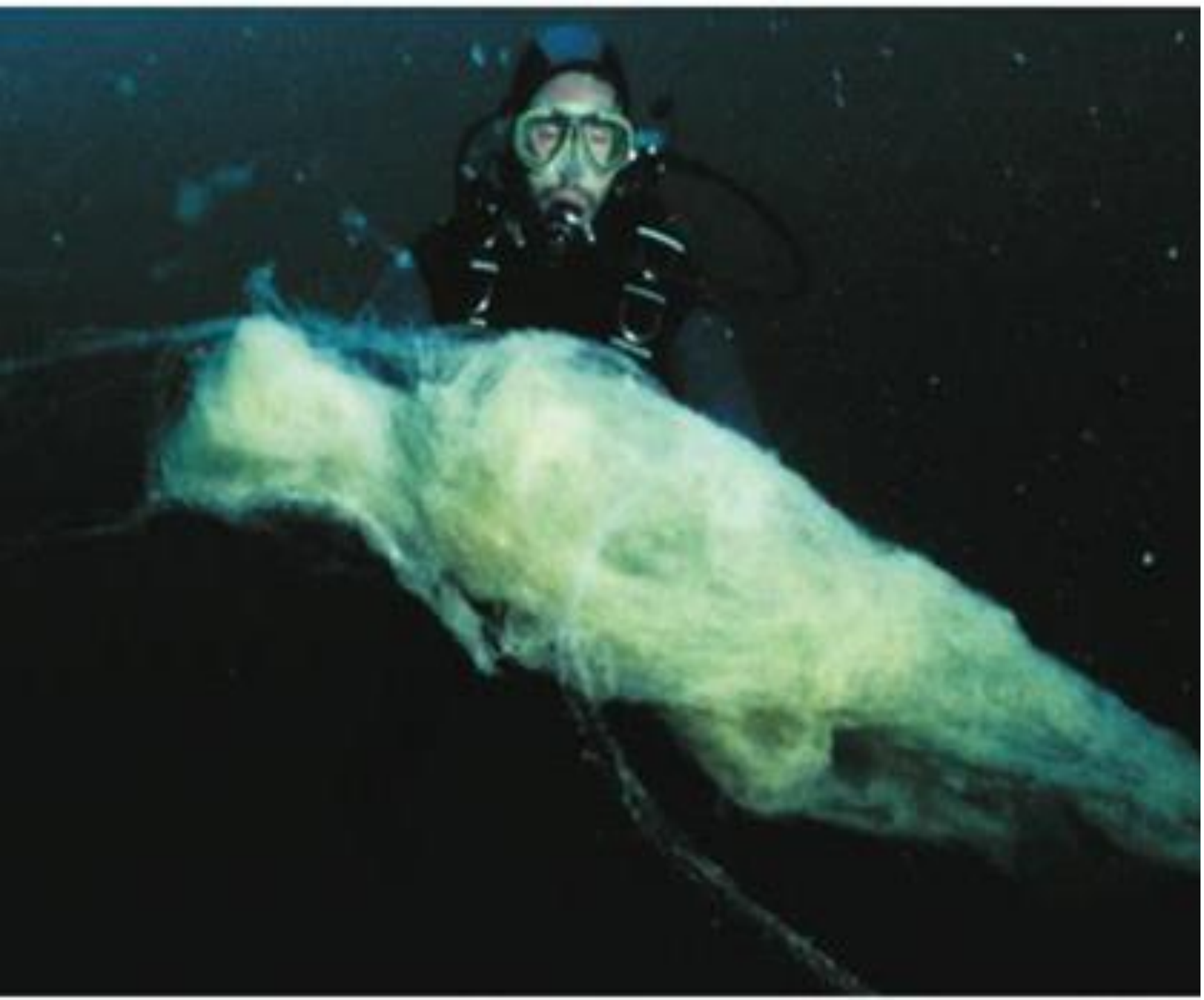
AI, Data and Robotics: Smart Feeding





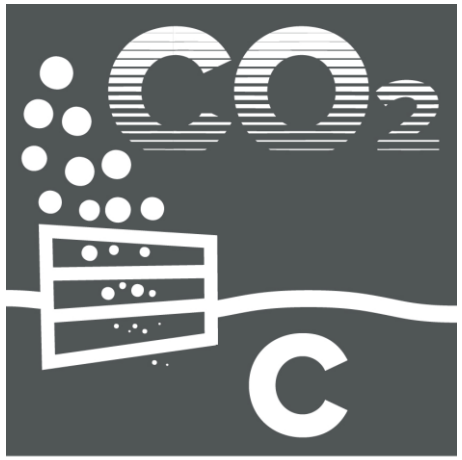
Growing from Phytoplankton micro-organisms

Marine snow

To remove

1 billion ton of atmospheric CO2 annually

Courtesy www.gea275.com
The Gea@275 project

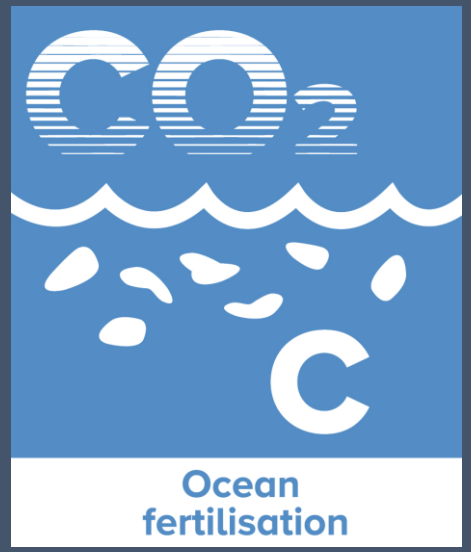


Direct air capture and storage

8-14 GJ

€ 200 per ton

Actual Land-based efforts



Ocean fertilisation

Marine snow

0,00024 GJ

€ 0,1 per ton

The role of AI, Data and Robotics is essential for Marine Snow control

Data: We need to collect large data

Robotics: Use sea drones to scan a large sea areas

AI: elaborate on marine snow condition, prediction and action for healthy growth

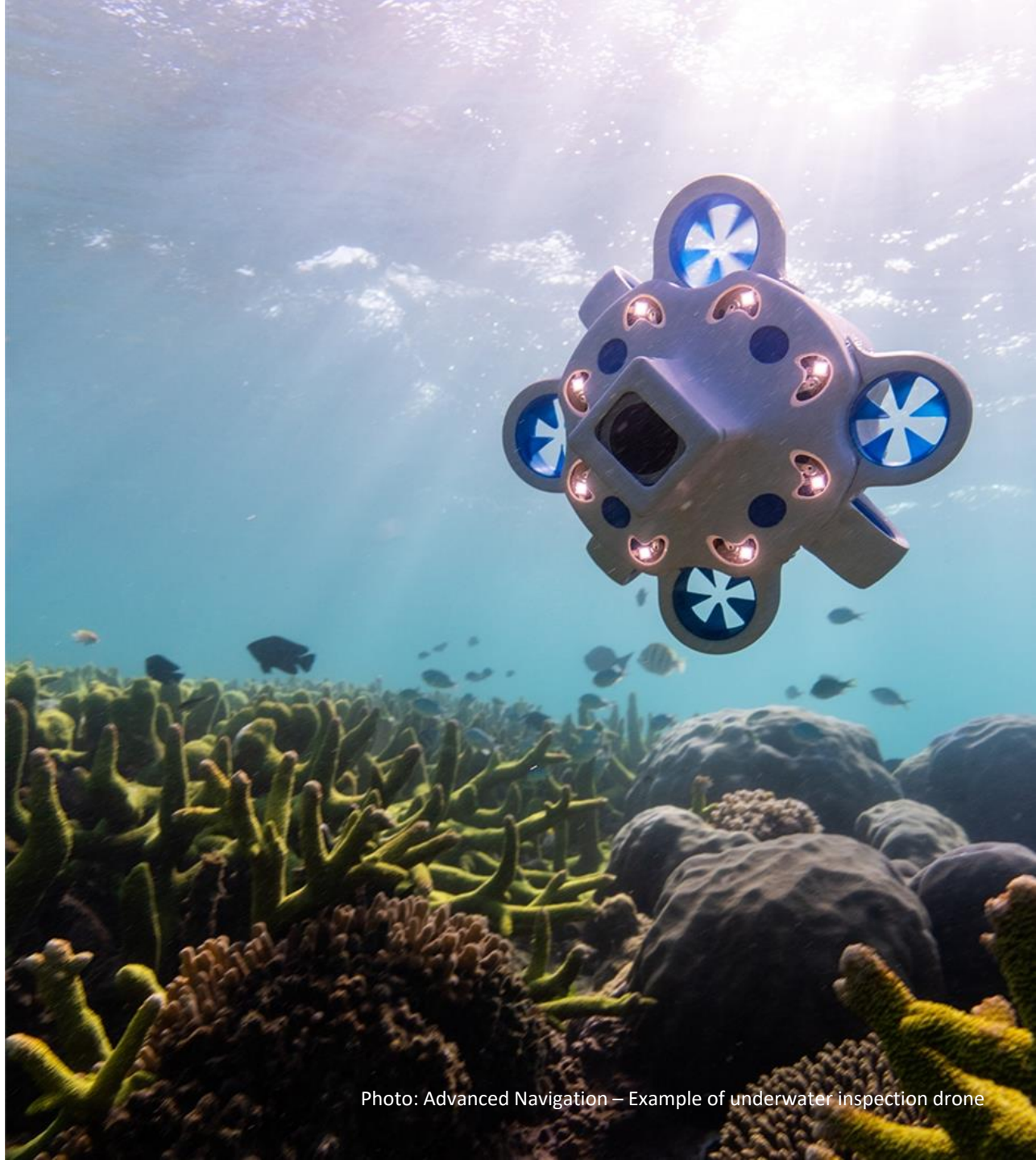


Photo: Advanced Navigation – Example of underwater inspection drone

I have a DREAM

Ocean for food security
@zero CO2 emissions

Scientific Excellence

Local fish feed production
Automated biomass control
Automated waste control
Automated security control
Automated O&M

Business opportunities

Sustainable Aquafood

Food for everyone
Together for sustainability

Zero Hunger, zero emissions

AI, Data & Robotics for clean food production without experts

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Food for everyone

Tomato greenhouse at home

Today (March 2023)
tomatoes are between 6 – 12 Euro / Kilo

AI, Data & Robotics for clean food production without experts

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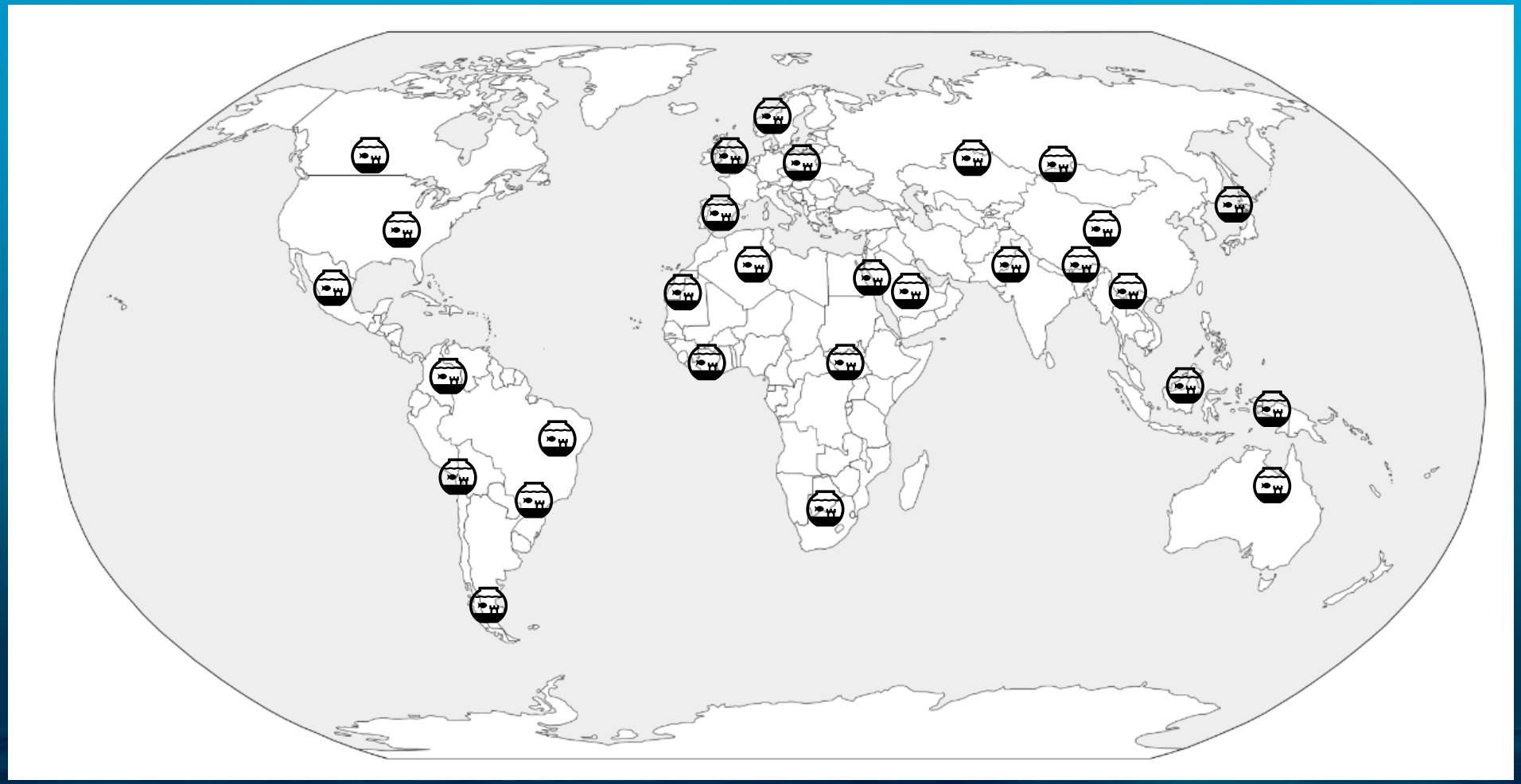
Aquafood: Food for everyone

AI, Data & Robotics enabling



Zero Hunger, zero emissions and together for sustainability

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Thanks. Danke Takk. Kiitos.

Merci. Gracias. Grazie. Obrigado.

ありがとうございました.謝謝你. धन्यवाद. شكرًا

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