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HYDRO

# Floating Tidal Instream Energy

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Sustainable Marine Energy & SCHOTTEL HYDRO

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# Hydrokinetic Energy



**INTEGRATED TIDAL ENERGY**

# Global Market Opportunity

## NORTH AMERICA

Strong tidal and river resources. Political support on national & regional levels. Grid-tied and off-grid potential



## EUROPE

Traditional leader in Ocean Energy sector. Primary markets for tidal are UK & France.



## ASIA

Most exciting market in global terms. Manifold opportunities to compete directly with fossil-fuels in Philippines & Indonesia



## SOUTH AMERICA

World's strongest river resources. Individual projects 100MW+ . World-class tidal sites in Chile & Argentina



## AFRICA

Limited tidal energy potential. Large but unknown river energy potential. Huge & growing off-grid market.



## AUSTRALIA & NEW ZEALAND

Significant tidal resource in Australia & NZ. Run of River downstream of dams in N.Z.



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# The Philippines

## KEY MARKET FACTS

- 20<sup>th</sup> largest sea area in the world - ~7,100 islands, ~2,000 inhabited
- Ministry of Energy estimates 40GW – 60GW tidal energy potential



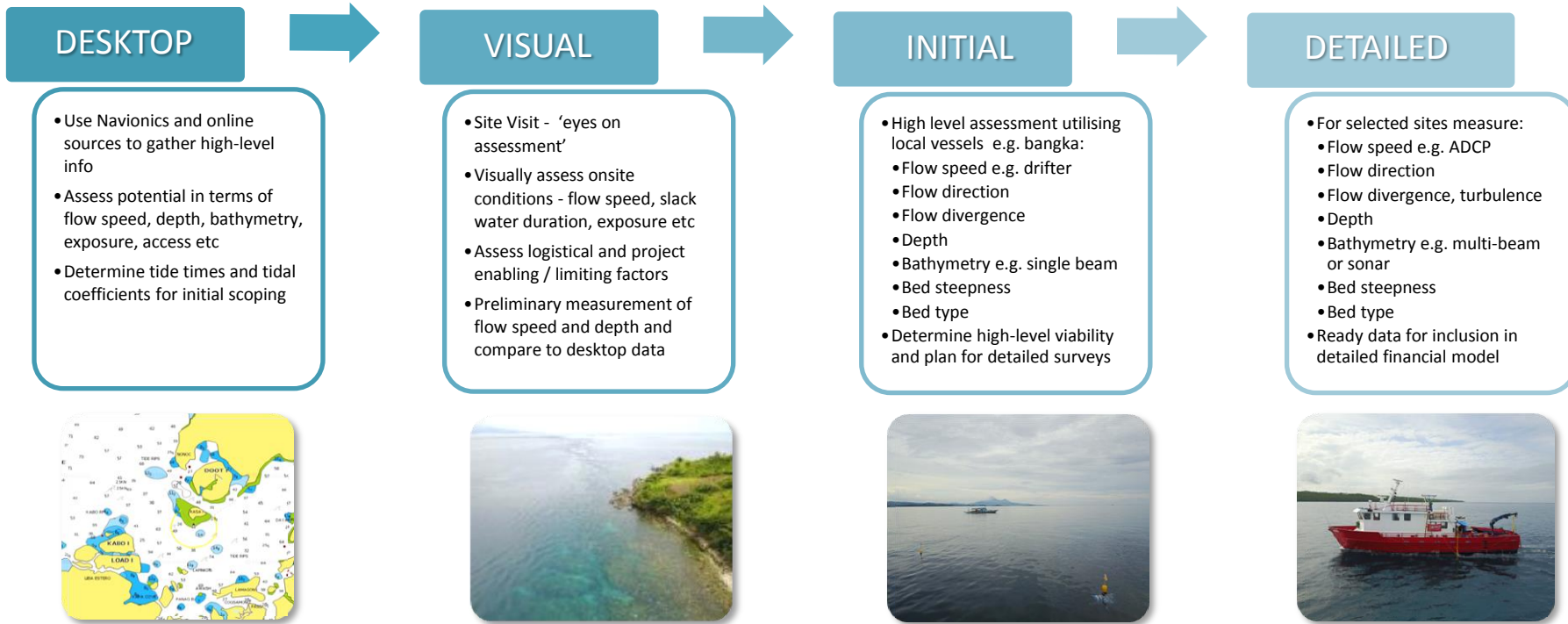
## PROJECT OPPORTUNITIES

- Tidal opportunities between the islands
- First project locations are being actively progressed by project developers
- Scope for follow-on projects <5MW – 100MW+
- **First projects directly competing with diesel for off-grid applications**



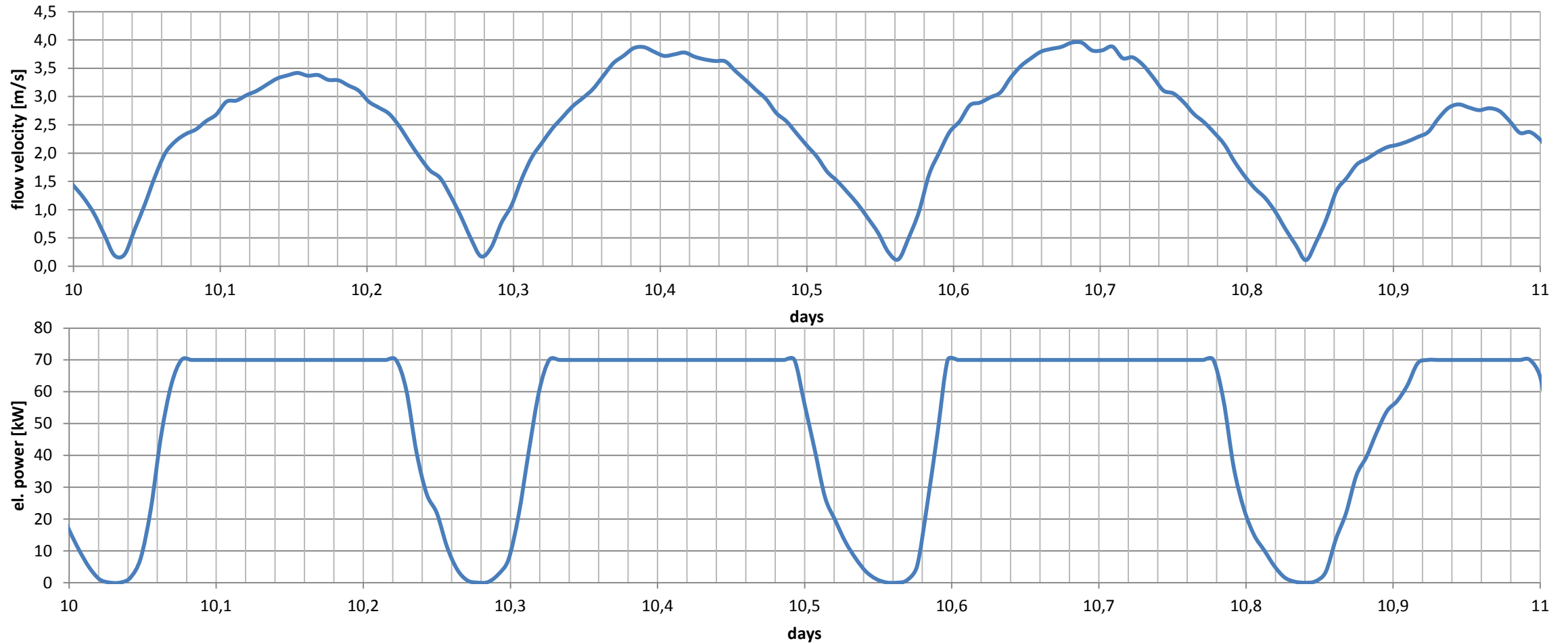
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# Site Assessment



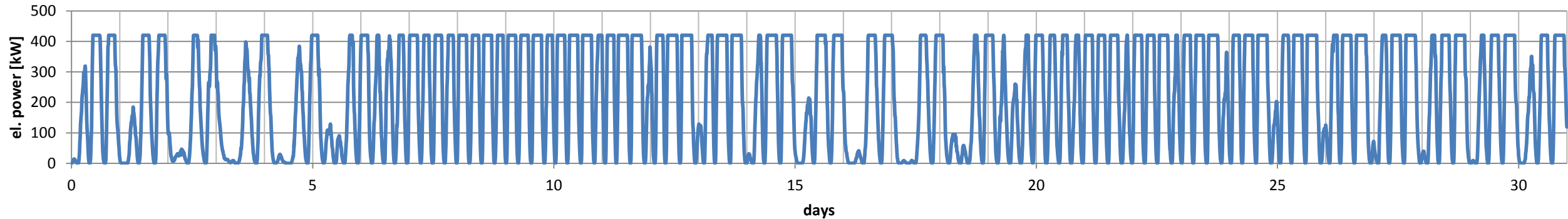
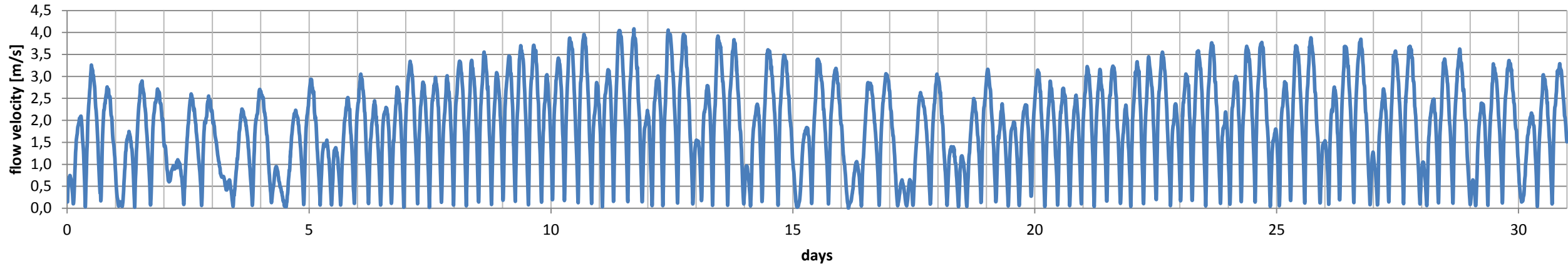
# INTEGRATED TIDAL ENERGY

# A Predictable Resource – One Day Time Series



**INTEGRATED TIDAL ENERGY**

# A Predictable Resource – One Day Time Series

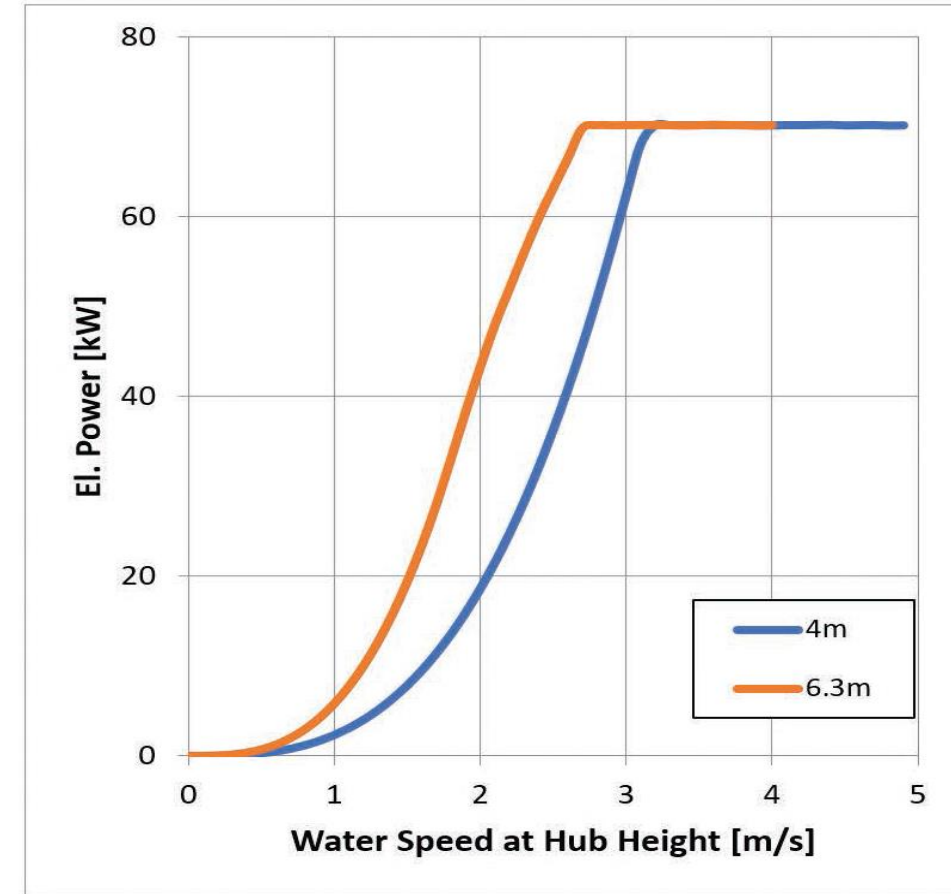


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# SCHOTTEL Instream Turbine



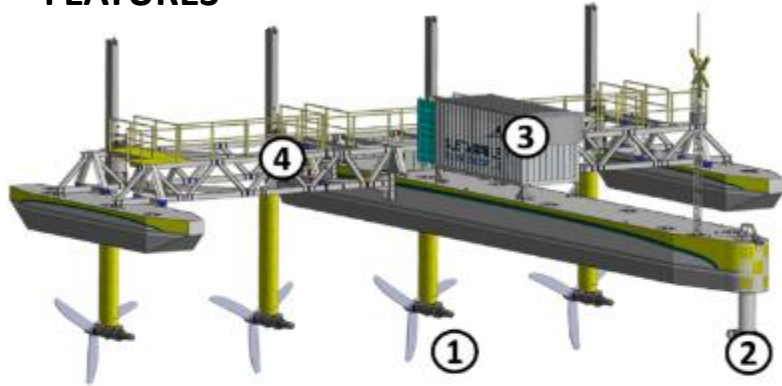
- SHY is a part of the SCHOTTEL Group, a market leader in azimuthing ship propulsion, founded in 1921 with approximately 1200 employees worldwide
- The SIT 250 consists of a fixed pitch horizontal axis turbine with a high power to weight ratio
- SHY has also developed a modular power conversion system which is produced by SCHOTTEL Group company HW Elektrotechnik





# PLAT-I Inshore Tidal Energy Platform

## FEATURES



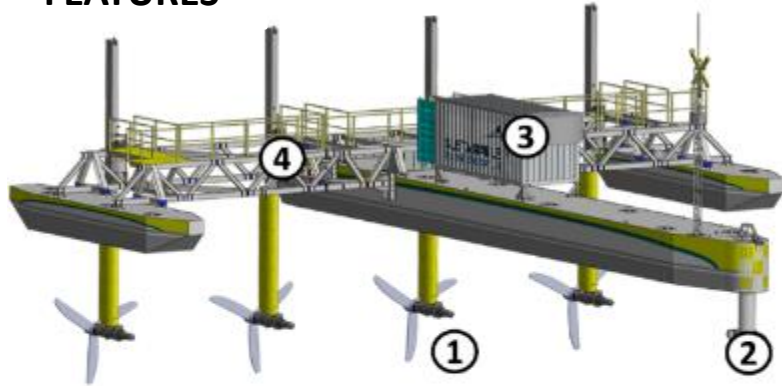
1. SIT 250 tidal turbine generators
2. Turret mooring to allow 360° rotation
3. Containerised control and power conversion system
4. Turbine deployment module for turbine access



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# PLAT-I Inshore Tidal Energy Platform

## FEATURES



1. SIT 250 tidal turbine generators
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# Anchors & Mooring Systems

- SME has developed innovative direct embedment anchoring systems for both rock and soft seabed
- These anchors have advantages over traditional anchoring technologies such as gravity bases or drag embedment anchors. These include:
  - Extremely high holding power on rock seabed
  - Highly accurate placement on rock and soft seabed
  - Far lower material and logistical cost for installation
- In tandem installation tools have been built and demonstrated to install anchors sub-sea and in energetic environments
- SME's innovative mooring technology is also available for other marine solutions



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# PLAT-I Inshore Tidal Energy Platform

## DEVELOPMENT HISTORY

**Q3 2016**

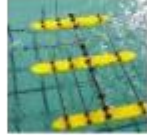
PLAT-I concept process begins

Comprehensive market study performed; establish key design criteria

**Q4 2016**

Concept designs evaluated

Phase 1 tank testing



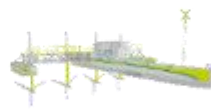
**Q1 2017**

Phase 2 tank testing at FloWave Edinburgh



**Q2 2017**

Design and costings finalised  
Production begins



**Q3 2017**

Fabrication at JBS  
SCHOTTEL delivers SITs

**Q4 2017**

Assembly, commissioning,  
and installation at Connel



Innovate UK

Scottish Enterprise

FloWave

LMC  
LONDON MARINE CONSULTANTS



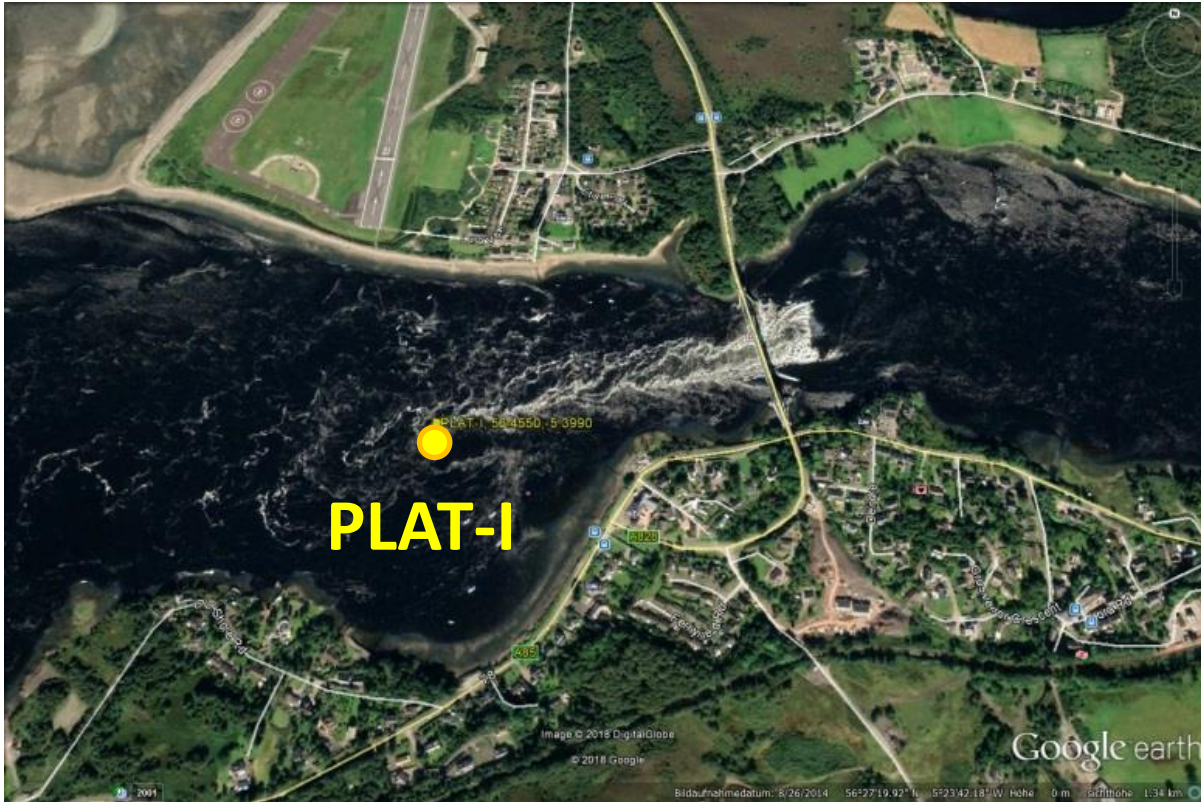
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TIDAL POWER

INTEGRATED TIDAL ENERGY

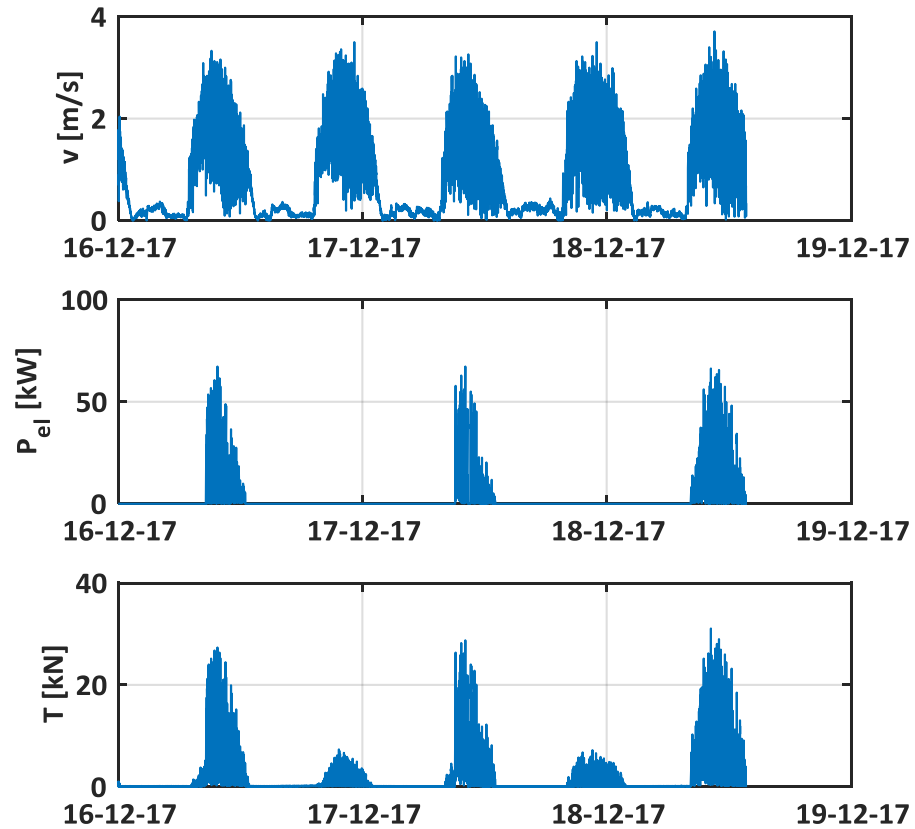
# PLAT-I at Connel, Argyll & Bute, Scotland



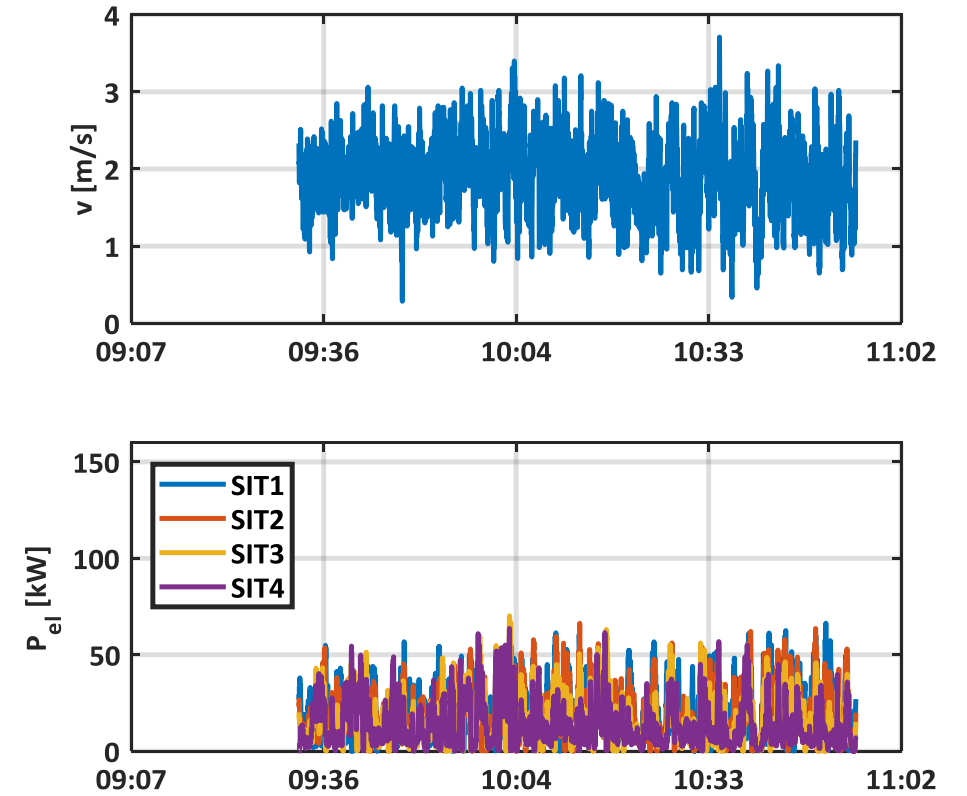
- High spatial variation
- High temporal variation (TI= 40% @ 2m/s)
- Strong ebb – weak flood

# Time Series Data

Raw data (SIT 2 only)

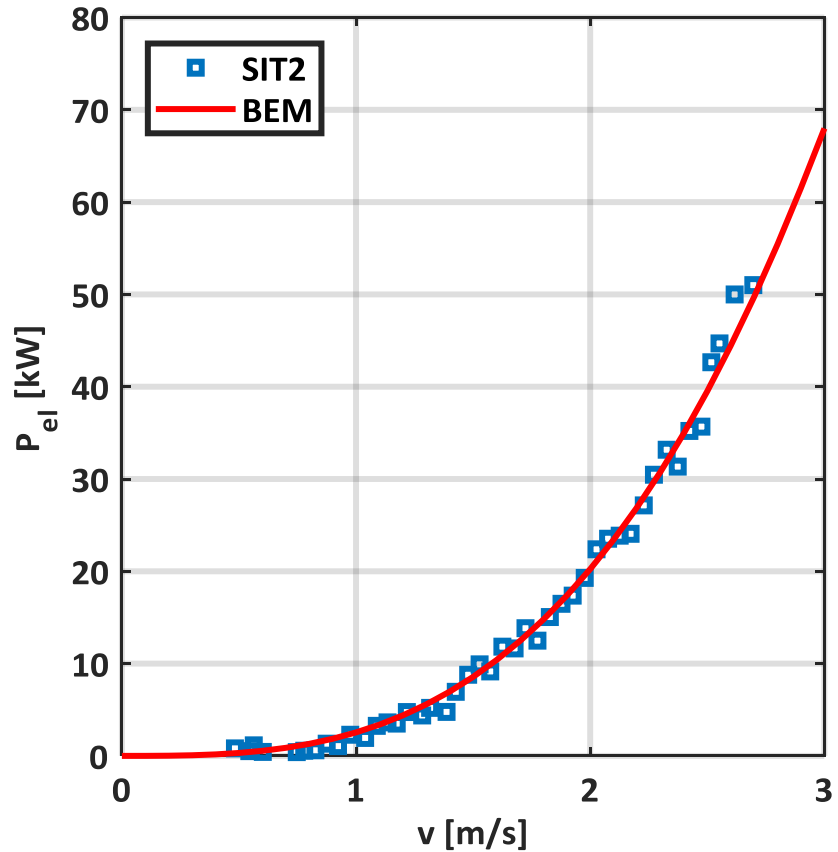


Raw data (all turbines; 19/12/2017)

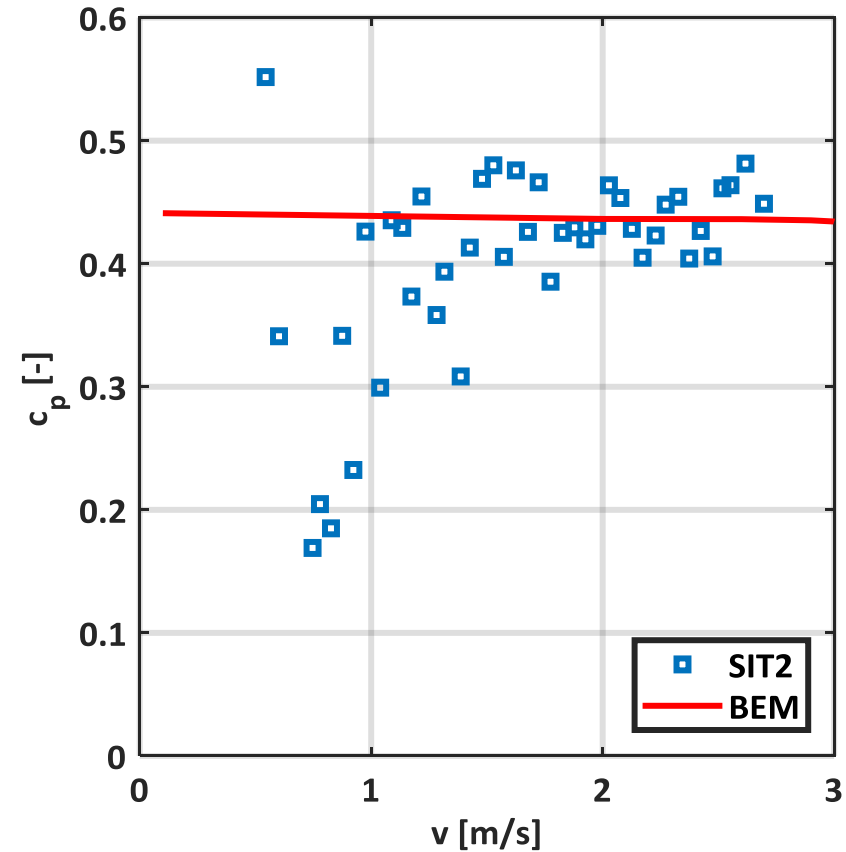


# Performance Assessment – Design Validation

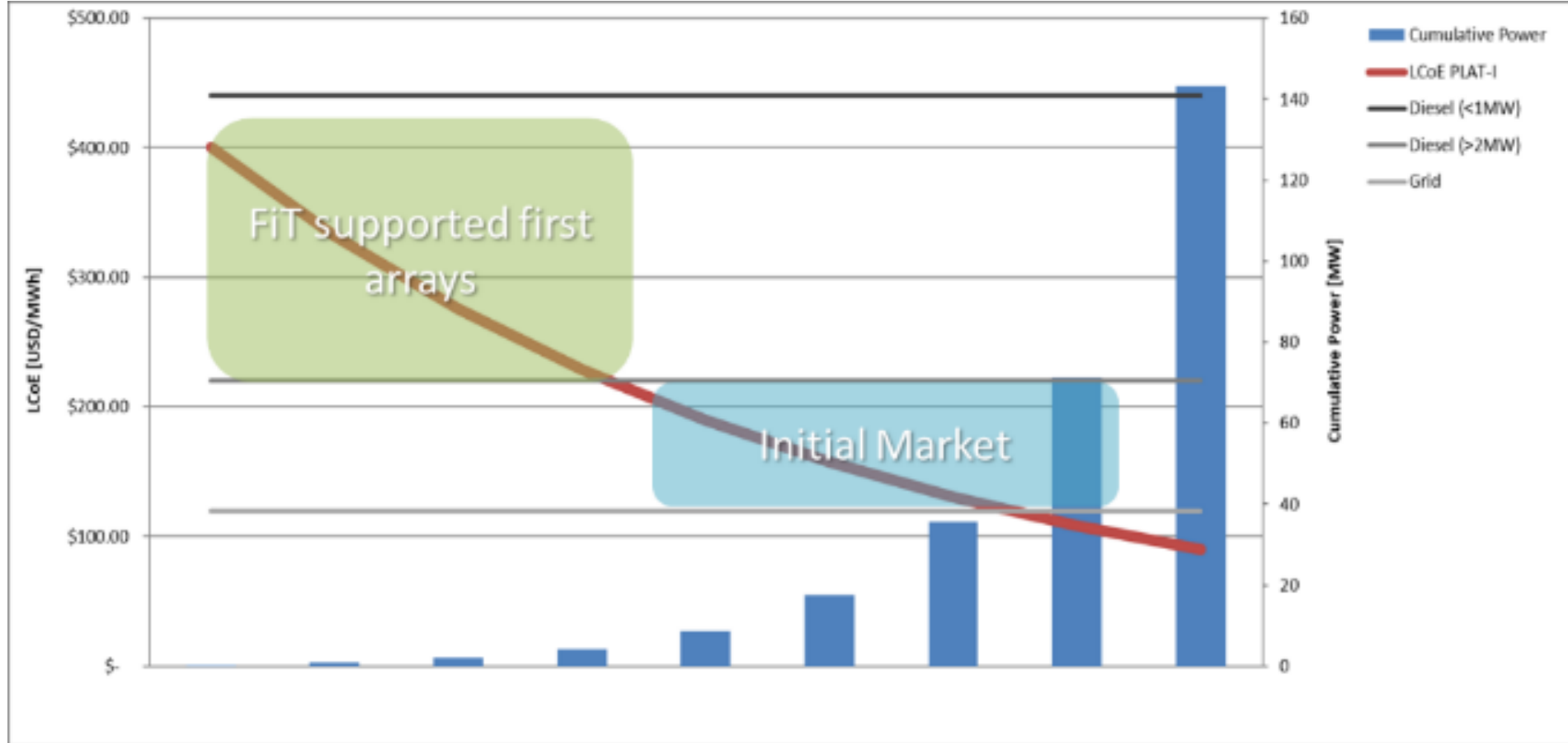
## Power Curve - Comparison with Prediction



## Power Coefficient Rotor



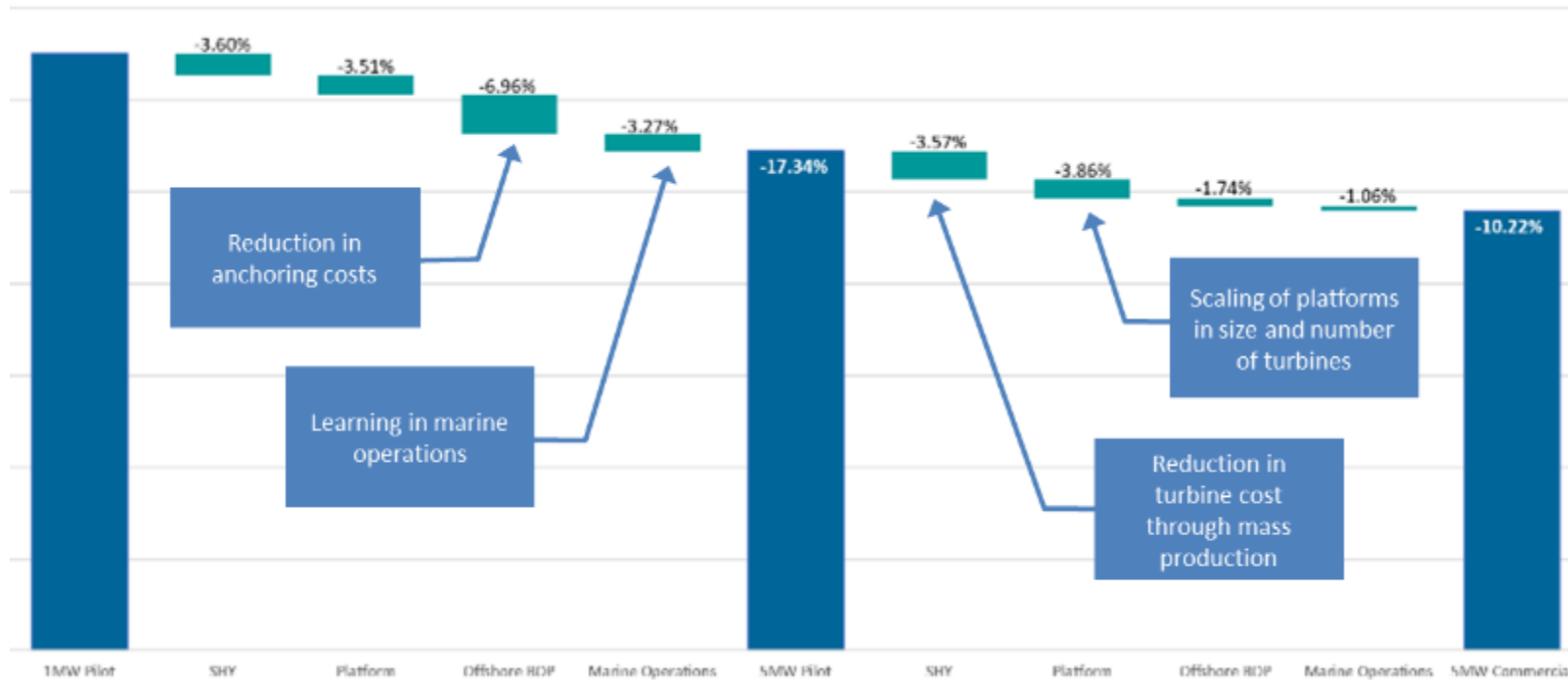
# Driving down costs



- Modular systems
- Stepwise build out
- Start by addressing market for island and coastal communities
- Only incremental reductions assumed here
- Technology can compete in Off-Grid markets (2-10 MW capacity) after 10 MW had been installed



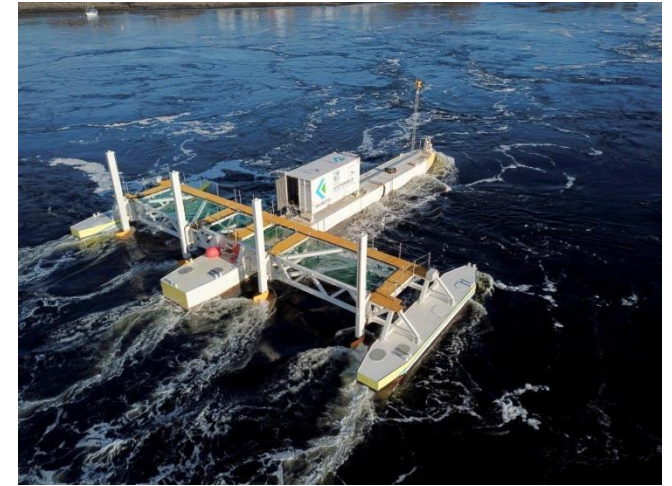
# Incremental Cost Reduction



Cost reductions are incremental and achieved through learning; both in physical technology and processes, and then scaling up; in number of units produced and deployed.

# Summary and Conclusions

- First demonstration projects have been crucial in creating awareness of the potential of tidal energy in the region
- Small scale and modular floating concept ideally suited to address island grid market
- Cost reduction potential while competing with diesel (below 10 MW)
- Yield and reasonable PPA crucial for first projects in SEA (in the 1 MW range)



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