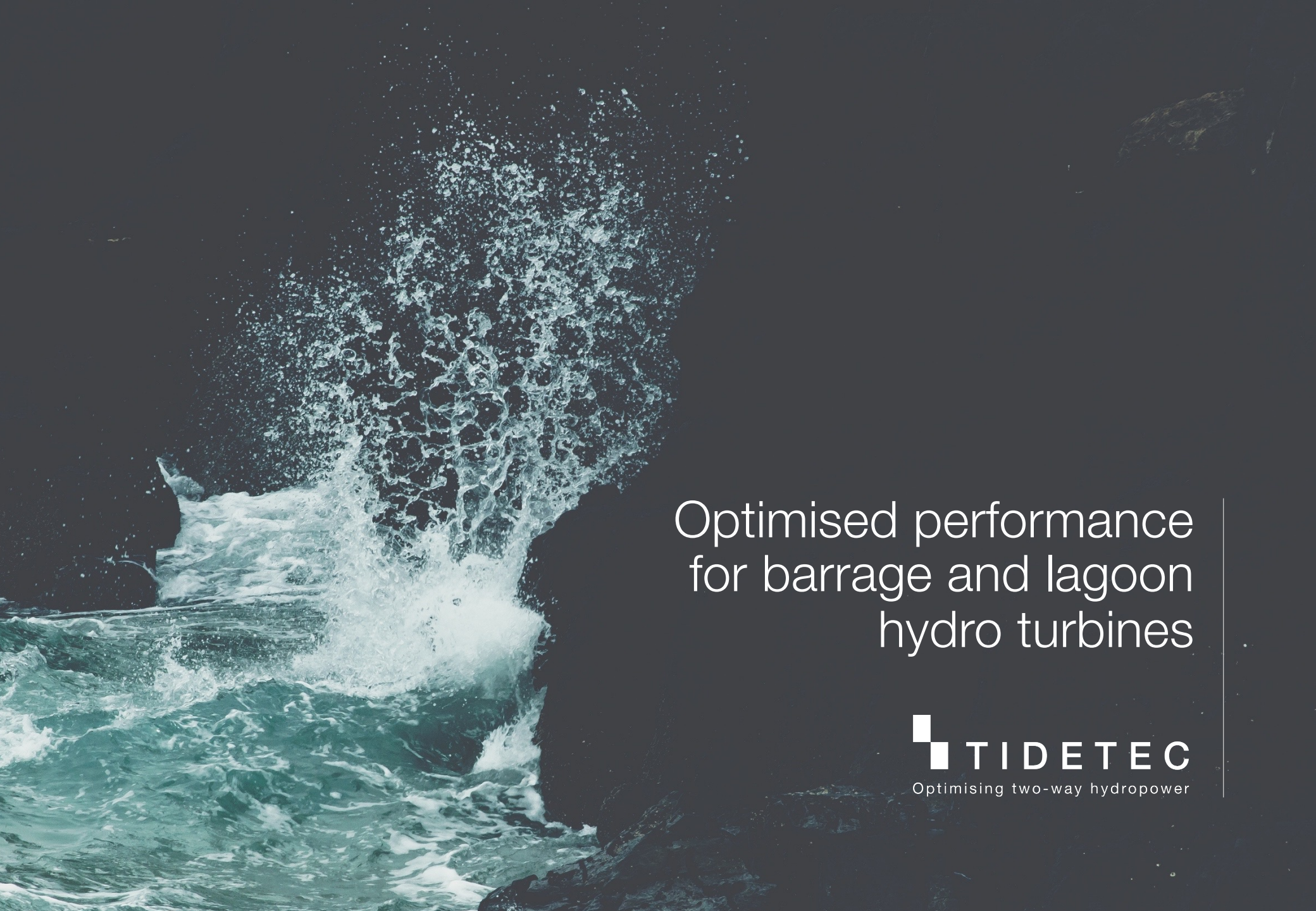

Optimised performance for barrage and lagoon hydro turbines

TIDETEC

Optimising two-way hydropower

Optimised performance for barrage and lagoon hydro turbines

CONTENT

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TIDAL RANGE POWER..

LAGOONS, BARRIERS, BASINS & DOCKS

- Energy Transition

- Intermittent supply (wind, solar) calls for predictable **base load and energy storage**

- Investments directed to adaption for climate change (coastal infrastructure and flood protection)

... PREDICTABLE, AFFORDABLE AND CLEAN ENERGY

Tidetec improves the most effective tidal turbine technology by integrating the turbine into a rotating turret, enabling optimal efficiency in both directions

SUMMARY OF TECHNOLOGY

Most tidal power plants today generate power only in one direction. Projected, next-generation tidal plants with two-way production have sub-optimal production. Tidetec's innovative solution improves the efficiency of the most cost-effective tidal turbines available enabling optimal efficiency both ways. This is simply done by integrating the turbine into a rotating turret.

The technology enables optimal turbine function (generation and pumping) with bi-directional flow. Tidetec's technology consists of three main technology components; The turret with a turning mechanism, turbine and caisson. Tidetec's core competence lies in the integration of these components.

TURRET WITH A TURNING MECHANISM

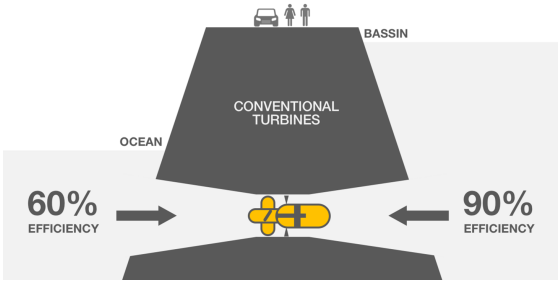
At the core of Tidetec's concept is the rotating turret. Its main function is to allow turning the turbine, enabling optimal bi-directional functionality. Tidetec has a portfolio of turning mechanisms suited to different turbines.

TURBINE

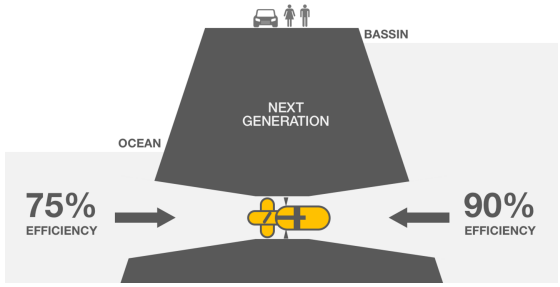
In principle, any turbine can be applied in the Tidetec solution, however some designs fit better than others. Tidetec, in collaboration with TUM, have developed a low head turbine that is capableof generating energy in both flow directions, "basin to sea" and "sea to basin" and also effectively pumping in both directions. The increased discharge characteristics of the turbine is also important in tidal barrage configurations.

CAISSON

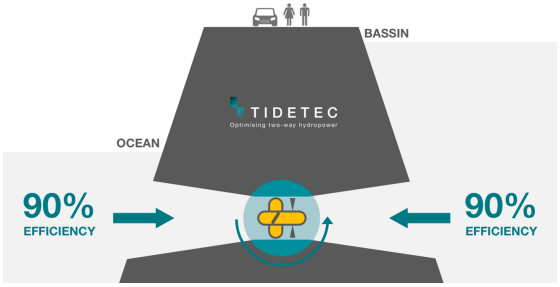
The Tidetec turbine solution is intended to fit into a concrete caisson that will form part of a dam/barrage/lagoon. The construction will likely consist of three elements; sluices, caisson for turbine placement in addition to a passive breakwater.



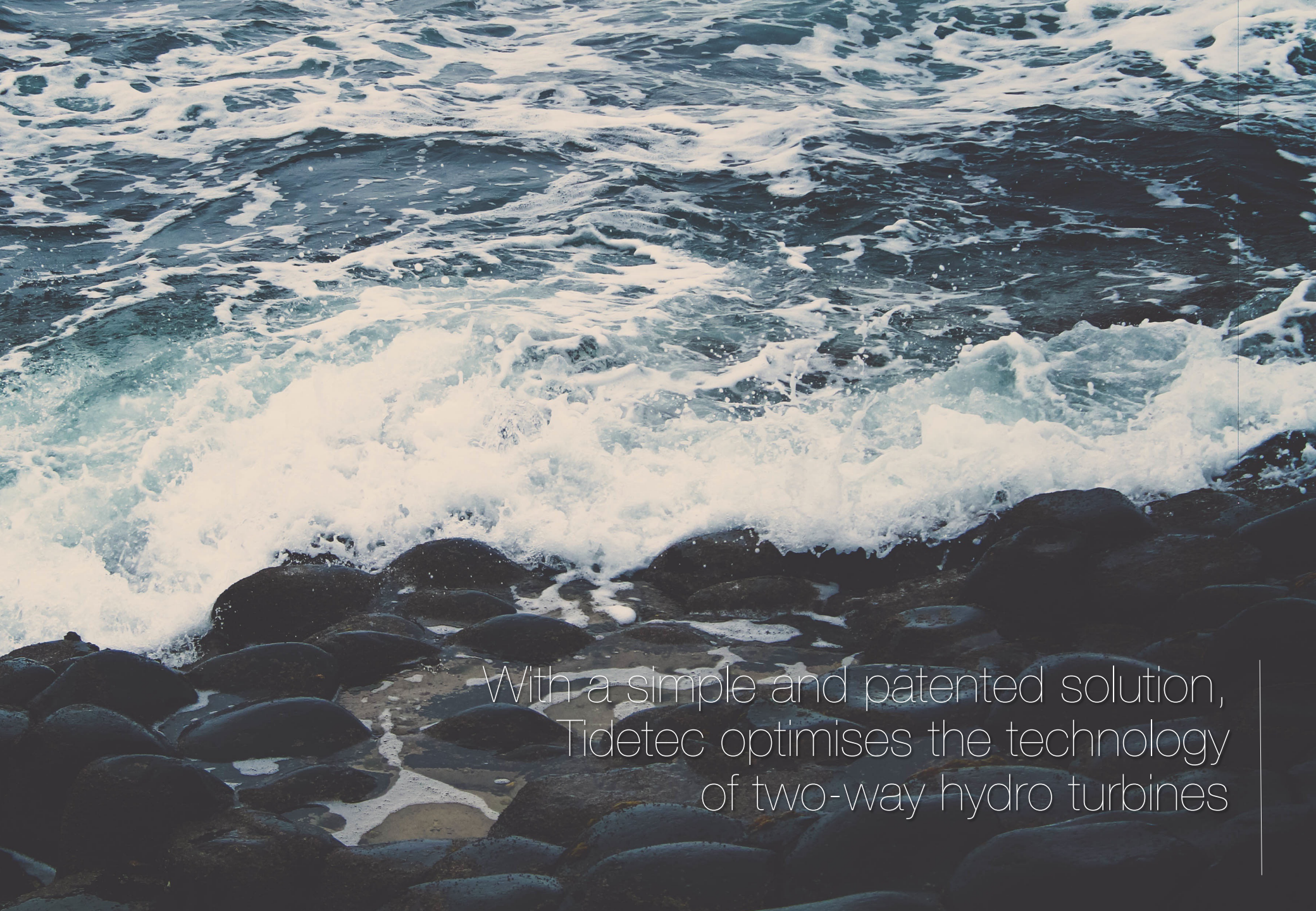
CONVENTIONAL TURBINES: Current technology only utilizes 60% of streams flowing back into the basin



NEXT GENERATION: Turbine manufactures strive to improve bidirectional efficiencies, but potential efficiency gains are limited



TIDETEC has patented a solution that enables maximal efficiency both ways

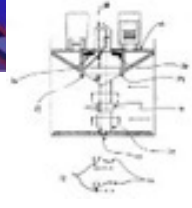


With a simple and patented solution,
Tidetec optimises the technology
of two-way hydro turbines

FROM PATENTS TO COMMERCIALIZATION

2003
Tidetec founded
by Per Kollandsrud

Per Kollandsrud
Founder files 3 patents

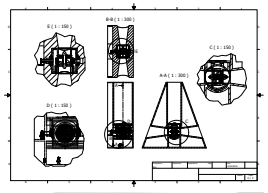


2013
Arne Kollandsrud
hired as MD

2014-2017
MEUR 1.9 Eurostars project
3 employees

2015
Nomination at
Tidal Energy Summit 2015

2016
New patent Rolling turret filed

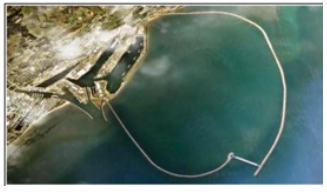


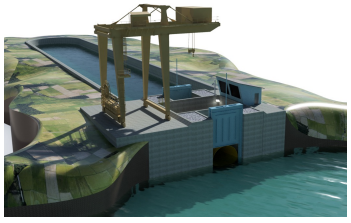
2016
Functional scale model turning
mechanism tested in sea water

2017
Tidetec featured as promising
technology in Hendry review
All-Energy prize
Model turbine tested

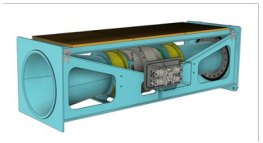
2017/18
MoU Atlantis Wyre
Patent granted

2019
Collaboration Mersey Tidal
Project ++
Europe patent granted
2021 Conceptual design and
Pilot/Demonstrator

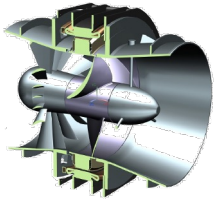




2021
Increasing to 6 employees
Pilot project design basis and
upscaling of model turbine + EU
project Fibregy
Fundraising and softfunding
secure runway until 2023



2022
Finished detail engineering
of small scale pilot
Building consortium
Pre-feed for new markets
within hydropower.



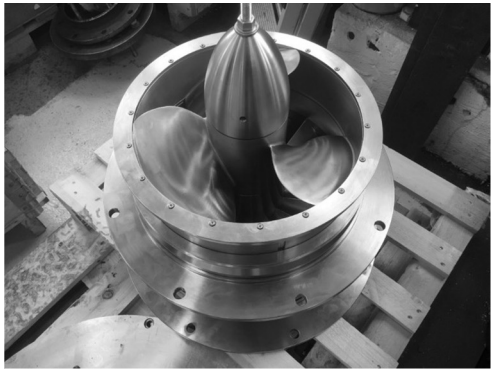
TIDETEC
Optimising two-way hydropower

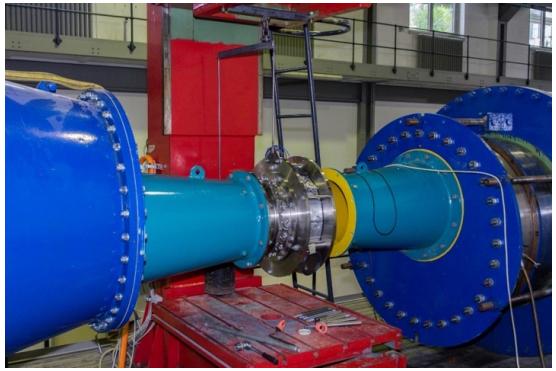
PROOF OF CONCEPT

Model turbine and prototype tested and patented Eurostar project 1.9MEUR

The Tidetec prototype for the turret and turning mechanism was tested in the Svelvik tidal stream during September to October 2016. The main purpose was to showcase and prove the concept, to show the robustness of the turning mechanism, the ability to keep the intended areas dry and operational in harsh sea water conditions.

The prototype consists of a polymer caisson, a steel turret with a turbine and a rotating drive and CPU to control the timing and set points of the rotation. The prototype is instrumented to make sure that all activity is logged, and to secure that the system is working as intended. Test data and additional documentation can be acquired on request.





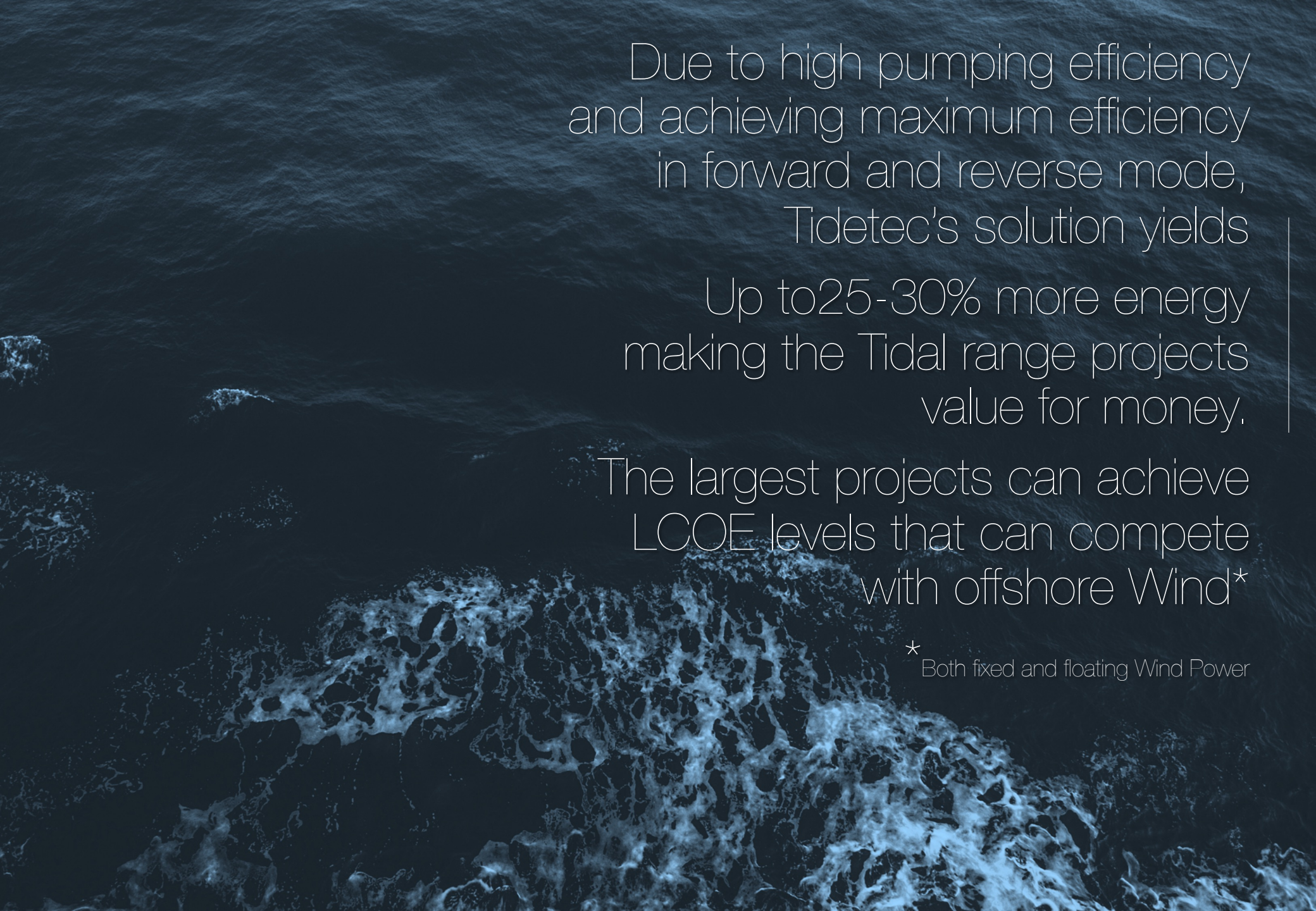
MAIN DIMENSIONS
Size: 1000 x 1000 x 1200 mm (without lifting frame)
2200 x 3500 x 2000 mm (with lifting frame)
Weight: 3,5 tonnes
Designed for easy placing and retrieval

PURPOSE OF TESTING
Small scale sea water testing of Tidetec turning mechanism with turbine

LOCATION SPECIFICATIONS
Two-way flow
Sediments in the water
The depth at the location is about 4,5 meters
Close to power supply and grid
Possibility to use crane
Workshop for assembly
Proximity to airport to display turbine to potential clients

LOCATION
Svelvik - one hour drive from Oslo

TESTING SCHEDULE
The prototype was operational from mid September to end October 2016.



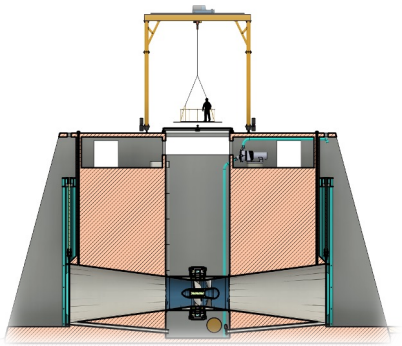
Due to high pumping efficiency and achieving maximum efficiency in forward and reverse mode, Tidetec's solution yields

Up to25-30% more energy making the Tidal range projects value for money.

The largest projects can achieve LCOE levels that can compete with offshore Wind*

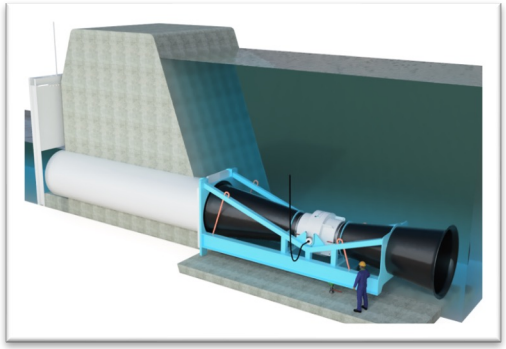
* Both fixed and floating Wind Power

1. Tidetec product range:



Integrated solutions:
Lagoons, Barriers, Tidal basins

- Built into a dam / concrete structure
- Turbine sizes from Ø2m to Ø8m
- Tidal Lagoons and –barriers
- Two-way pumping and generation with rotating turret
- Large potential UK market -



«Tidal in a box» solutions:
Integrated in existing infrastructure

- Connected to a gate or through a wall
- Turbine sizes from Ø0,5m to Ø2,0m
- Redundant dry-docks or water basins
- Two-way pumping and generation with rotating turret
- Pathfinder projects

Pumped storage «drydock» solutions:

- Sold as pumps for drydocks
- Power generation when flooding dock through turbine/pump
- For locations with no tidal head, or as tidal enhanced low head pumped storage
- One-way system / no turning turret

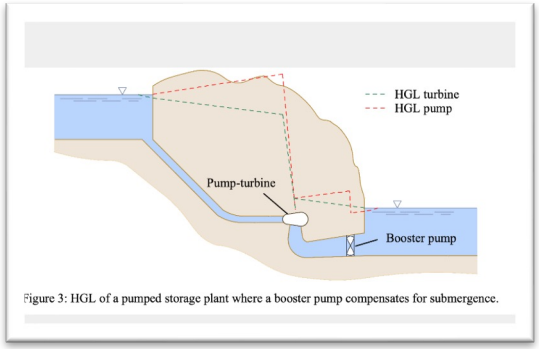


Figure 3: HGL of a pumped storage plant where a booster pump compensates for submergence.

Pumped storage «booster» solutions:

- Booster pump for existing power stations
- One-way system / no turning turret?
- Turbine integrated in gate shaft

Complete system

Tidetec's technology consists of three main technology components; the Turret with turning mechanism, the turbine and the caisson. Our core competence lies in the turning mechanism and the integration of all components.

Turret with turning mechanism

A COST EFFECTIVE AND FEASIBLE WAY TO TURN A TURBINE

The rotating turret is the core of the Tidetec concept. The main intention of the turret is to turn the turbine, to enable optimal bi-directional functionality. Tidetec have a portfolio of patented turning mechanisms suited to different turbines.

Our engineering of the turret has shown that it is feasible and economical to apply this to a two-way working turbine. The cost of a complete 20 MW turbine system be more or less equal to the cost of the systems planned today. This is due to an increase in cost because of the turret (10%), and a decrease of turbine cost due to simpler turbine design. Feed engineering has been conducted for the complete turning system, to have a reliable cost estimate.

TURNING MECHANISM

The rolling turret, is based on a cylinder rotating around a horizontal axis. It has bearings on each side of the cylinder, avoiding the need for a thrust bearing. A hollow axle (shaft) is mounted on one side of the cylinder, where all cables and cable management evacuates into a dry room in the caisson. This axle is also where the rotating movement of the turret is actuated.

DIMENSIONING

Dimensioning and stress tests have been conducted on a 6 meter diameter turret. The turret has more than sufficient capacity to withstand the hydrostatic pressure and the axial force of the turbine during operation.

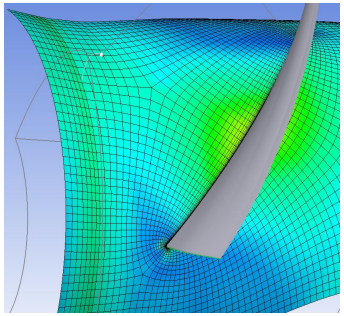
Turbine

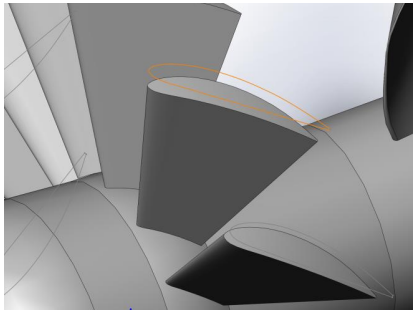
As the Tidetec solution is a new conceptual way of using a low-head hydro turbine, in principle any low-head hydro turbine can be applied, however some turbines are better than others, due to their size. Tidetec in collaboration with TUM have developed a low head turbine that is capable of generating energy in both flow directions, “basin to sea” and “sea to basin” and also of high efficiency pumping in those directions. This means the turbine can operate in all four quadrants of a head discharge-diagram.

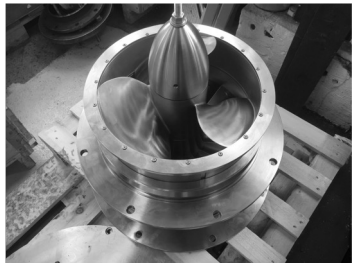
A variable speed tubular Straflo turbine is used in the design of the Tidetec turbine.

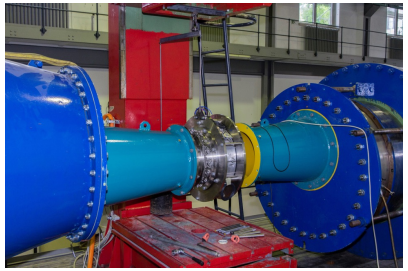
The variable speed turbine will be equipped with adjustable guide vanes, fixed runner blades and a turning mechanism. This design permits an optimal four-quadrant-operation. Turbine efficiency in turbining mode is simulated to be above 90%. The turbine runner and guide vanes have been optimised for 2 to 8 meter head using ANSYS and Solidworks.

The Straflo turbine is a well known turbine with almost 100 existing installations. It has also been used in tidal barrage application at Annapolis Tidal power plant.



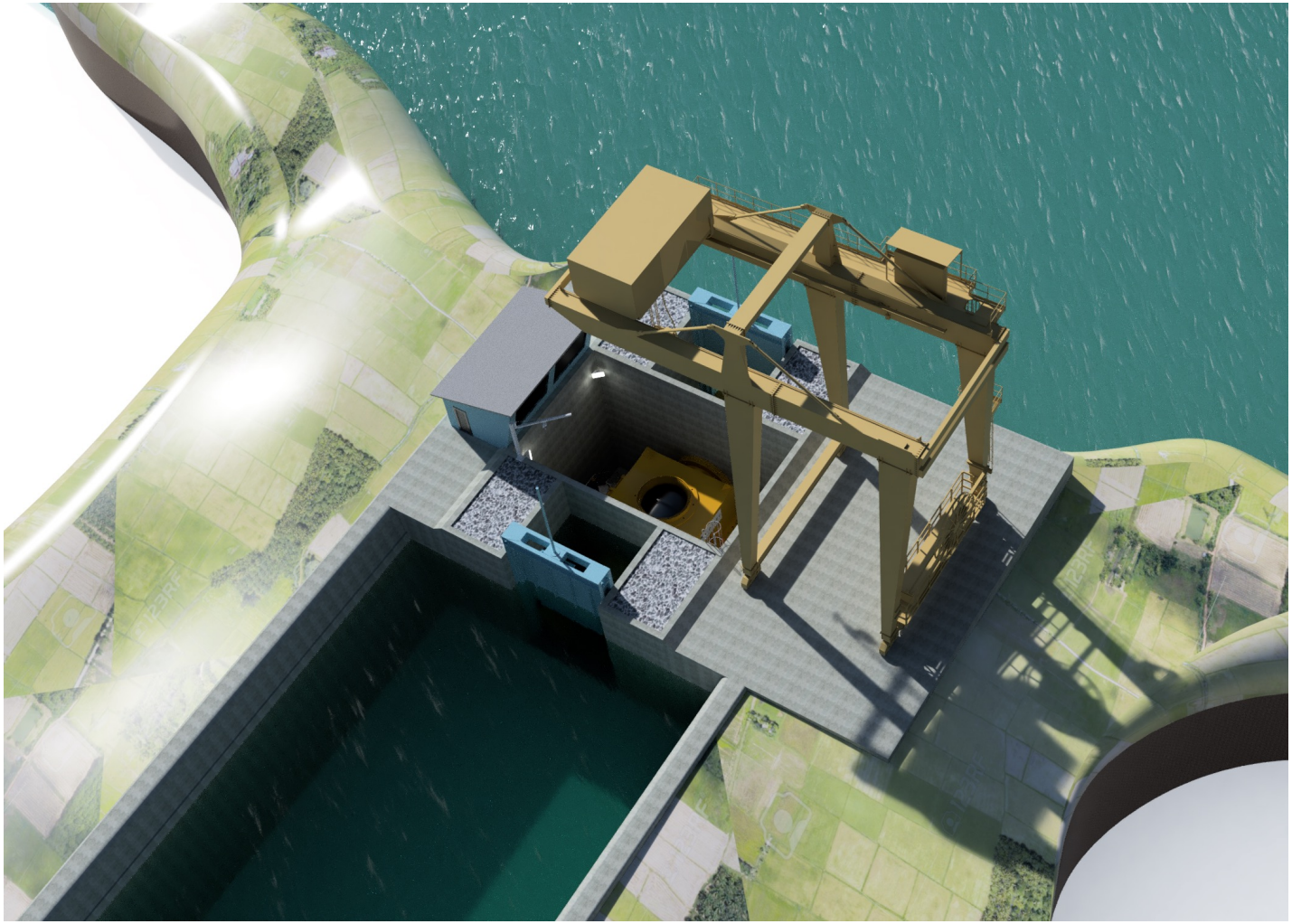






design and simulation work at TUM.

Caisson



Tidetec's turbine solution is intended to fit into a concrete structure (caisson), which is part of a dam/barrage/lagoon. The purpose of this construction is to separate two water masses, as well as housing the turbine. The construction will consist of three elements; sluices, caisson for turbine placement in addition to a passive breakwater.

The caisson is constructed with ease of maintenance in mind, so all critical areas are easily accessible.

A conceptual design has been evaluated regarding cost, installation method and strength.

Tidal energy has a huge worldwide potential, pioneered by UK, South Korea and Canada

Market potential

Academic studies have identified over 300GW of potential tidal range capacity globally.

UK

Project name	Total MW
Swansa Bay	320
Cardiff	3000
Wyre	120
Newport	1600
Churchill Barriers	26
Colywn Bay	1600
Picardy coastline 1	2000
Picardy coastline 2	2000
Scots bay	1100
North Wales	2000
Bridgwater	1600
West Cumbria	1600

NETHERLANDS

Project name	Total MW
Grevelingendam	80

CANADA

Project name	Total MW
Pennamaquan Project	25.6
Bay of fundy 1	1000
Bay of fundy 2	1000
Bay of fundy 3	1000
Bay of fundy 4	1000
Bay of fundy 5	1000

SOUTH KOREA

Project name	Total MW
Garolim	520
Incheon	1440
Ganghwa	838
Sihwa	254

MEXICO

Project name	Total MW
Baja California, Mexico	3000

FRANCE

Project name	Total MW
Cotentin Peninsula 1	2000
Cotentin Peninsula 2	2000
Cotentin Peninsula 3	2000

INDIA

Project name	Total MW
The Gulf of Khambhat 1	5500
The Gulf of Khambhat 2	5500

Areas eligible for tidal energy generation

TIDETEC TEAM

CORE TEAM

Arne H. Kollandsrud
CEO Tidetec, Co-founder and share holder

Arne has been working as the CEO since 2013 and is a co-owner of Tidetec. He has been Member of the Board in Tidetec since his father Per Kollandsrud founded the company in 2000.
Arne is Char Leader in Kollan AS, Tidetec's main shareholder

Ilias Zilakos
Senior Engineer, PhD, Tidetec AS

Ilias has 10 years of experience from R&D projects in marine technology. He has been involved in structural analysis of marine and offshore structures, material modelling of composite systems, prototype engineering and large-scale testing. His experience in mathematical modelling and numerical methods, helped Tidetec in optimizing the operational path of its turbine solution.

Alexander Kornilov
Lead Designer in Tidetec

Alexander has more than 30 years of experience in mechanical engineering in multidiscipline roles but predominantly in design. Through his career, he has been involved in almost every step of product development, from conceptualization to manufacturing processes. He has served in several positions within the Oil & Gas industry, Automotive and Heavy industry. His main role in Tidetec is the design of the prototype turnable turbine housing.

Bert Pasop
Technical Lead in Tidetec

Bert is highly skilled and respected Project Lead Engineer with comprehensive experience within mechanical and structural engineering as well as in both the design and analysis of structures. Experience includes both off-shore and on-land projects, in varying areas of these industries. He has a long track record in leading successfully the technical aspects of start-up companies. His role in Tidetec is to lead the technical aspects of the pilot project.

Rachel Zeringue
Project Engineer in Tidetec

Rachel has a MSc in Mechanical and Structural Engineering with a specialization in Renewable Energy. She has a diverse engineering background with experience in CAD. She has been involved in several engineering volunteer projects involving engineering design, building, and education.

Jim Dåtland
Advisor to the Board

Jim Dåtland is an executive with more than 25 years of corporate- and capital markets experience from various positions in stock exchange listed offshore drilling companies as well as from wealth management at the family office of T.D. Veen AS . Mr. Dåtland holds a master's degree in finance from Norwegian School of Economics (NHH) and is a Norwegian citizen based in Stavanger, Norway.

Heidi Fuglum
Commercial Advisor

Enthusiastic and market oriented senior manager with more than 20 years of experience. Background covers business development, strategy, personal administration, product development and product management.
The Research Council of Norway where she is both in Skattefunns complain selection (tax release for R&D projects) and in the jury of BIA (Brukerstyrt Innovasjonsarena) where we nominate application for R&D funding.

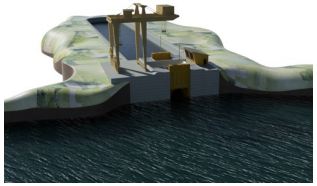
Mads Sørsdal
Visual designer, concept engineer

Mads has more than 15 years of conceptual design experience in subsea and marine industry. In Tidetec , he is working on the concept design, visualization and marketing material.

TIDETEC
Optimising two-way hydropower

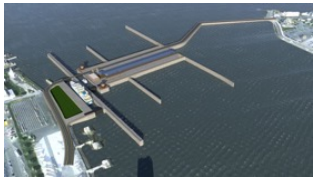
Examples of Ongoing Projects

Ultra Small lagoon
AEP: ~100-250 MWh
Capex: ~4-8 m£ needed



Large Dry-dock (Commercial) Scotland area,
Commercial demonstrator - High level estimate
AEP estimation 308 MWh
Capex 2-4 M£

Small Barrier,
AEP estimation 125-150 GWh
Capex 2-300 m£



Small lagoon Project
AEP estimation 300 GWh
Capex: 600m£

Large Lagoon
AEP: 6563 Gwh
Capex: 7.57 Bn£

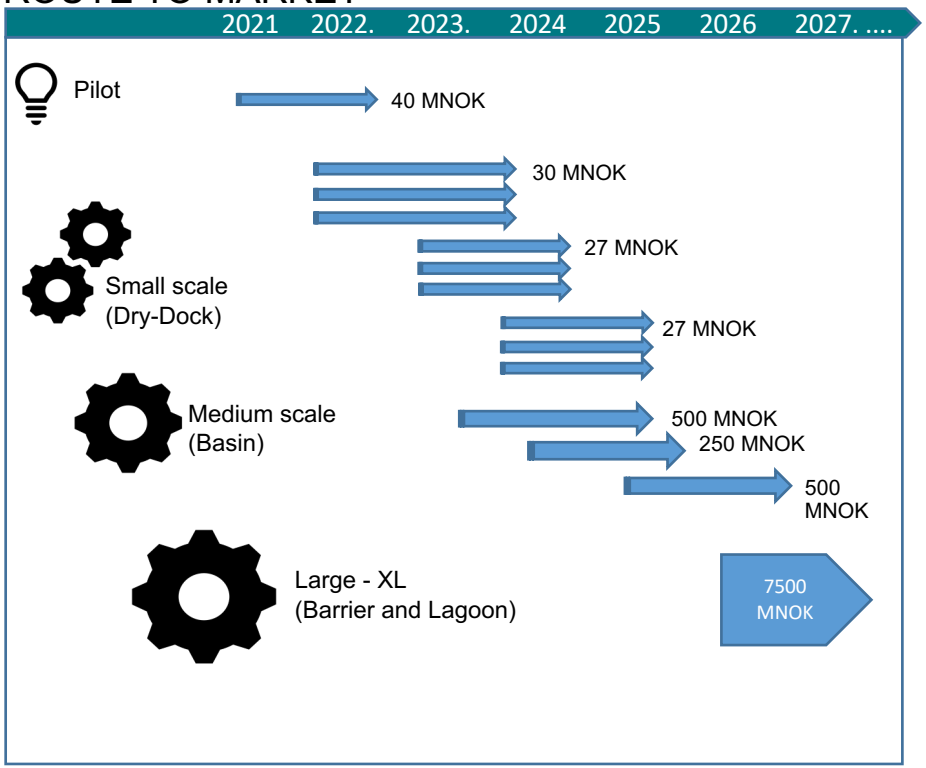
Large Barrier
AEP: 2090 GWh
Capex: 3Bn£

0. SUMMARY

TIDETEC at a glance

- Opens tidal range power market through new patented technology
- Disrupts energy cost producing both at ebb and flow directions – with high pumping efficiency
- Provides stable base load when needed through storage and delayed production
- Has already earned the position as reference for key UK tidal range projects
- Pilot project soft-funded (by EU/H2020, UK/OceanDemo & Enova/IN)

ROUTE TO MARKET



2021: Secured runway until 2023 through fundraising and soft funded projects

Est. 300 MNOK annual revenues by 2025 - with significant step-up into 2026

TIDETEC
Optimising two-way hydropower

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