SCHOTTEL TIDAL GENERATOR

SCALABLE POWER FROM CURRENTS

STG – SCHOTTEL
Tidal Generator

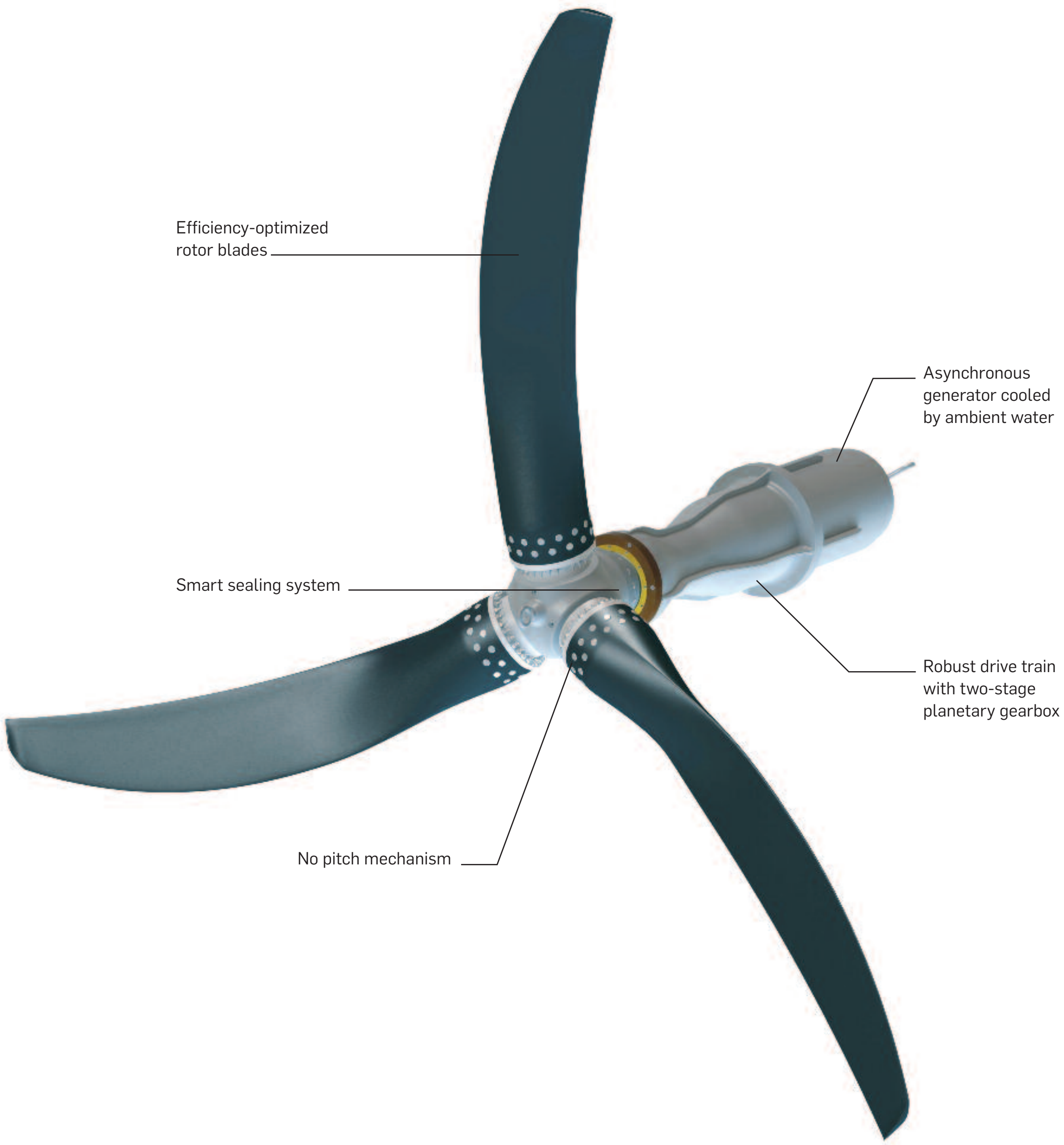
CHALLENGING ENVIRONMENT

Harvesting tidal energy means being exposed to harsh conditions offshore.

WE KNOW WHAT'S REQUIRED

SCHOTTEL has more than sixty years of experience in marine propulsion. We know what's required offshore: robustness, high availability and experienced engineers.

STG 50 – INTELLIGENT POWER GENERATION



STG 50 DESIGN PARAMETERS

- Horizontal free flow turbine
- Rotor diameter: 4.0 to 4.5 m
- Rated flow speed approx. 2.5 m/s
- Maximum flow speed 5.0 m/s
- Rated power 45 to 50 kW (Grid-ready)
- Drive train and generator water cooled

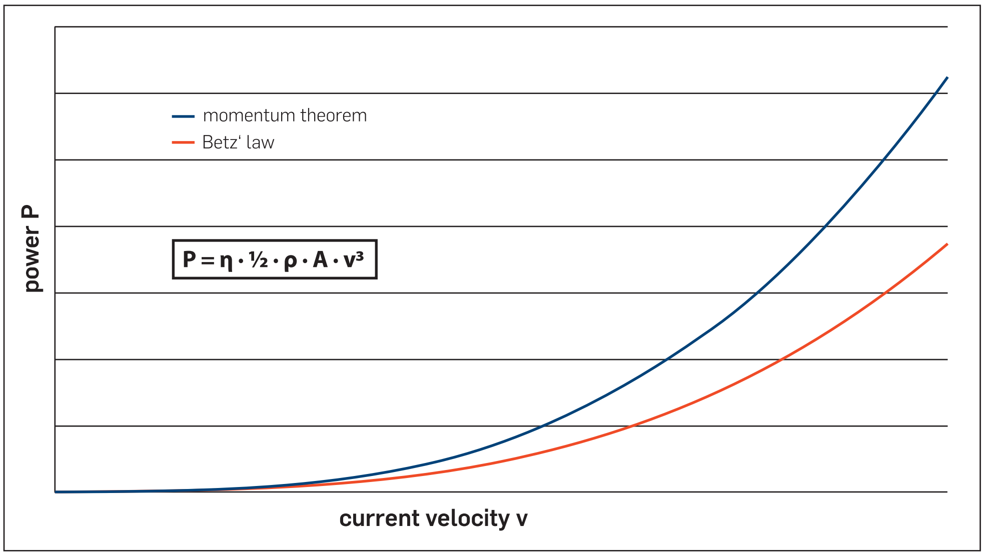
ADVANTAGES

- Robust, simple and light-weight
- Low investment cost
- Low maintenance cost
- High availability
- Flexible, modular approach
- Scalable in terms of quantity
- Compatible with various support structures
- High efficiency & low thrust

TIDAL & CURRENT ENERGY –

INEXHAUSTABLE ENERGY FROM NATURE

Ocean energy from tidal and river currents is an attractive part of the future energy mix. SCHOTTEL aims to make tidal and current energy economically competetive with well established energy sources.

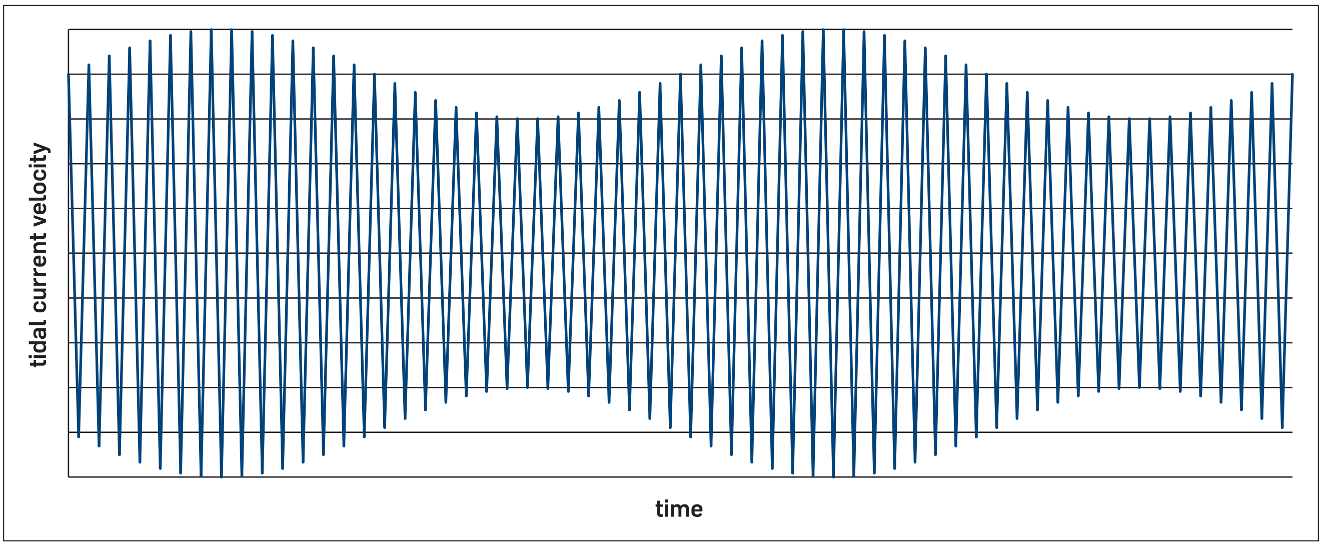


TIDAL & RIVER CURRENT POWER IS...

- a renewable energy source
- inexhaustible
- more reliable than wind, solar and wave energy
- very attractive for grid management, no backup power from other sources of energy required

THE CHALLENGE IS...

- to install a device with low CAPEX in terms of foundation, grid connection and material cost
- to maximize availability
- to withstand in the harsh environment
- to minimize maintenance costs (OPEX)
- to understand stakeholders' considerations



ECONOMY OF SCALE – IS BIGGER ALWAYS BETTER?

SCALING OF CRUCIAL PARAMETERS

Design flow velocity is independent of diameter
- Power ~ Rotor Disc Area • Velocity^3 ~ Diameter^2 • Velocity^3
  => Diameter ~ Power$^{(1/2)}$

Tip speed is limited due to cavitation, indipendend of diameter
- Tip Speed ~ Revolutions • Diameter = constant
  => Revolutions ~ 1 / Power$^{(1/2)}$
- Power ~ Torque • Revolutions
  => Torque ~ Power$^{(3/2)}$

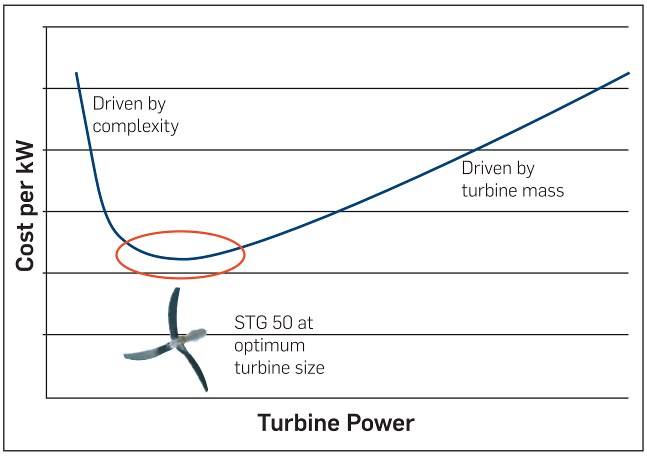
Limiting stress in major component is independent of size (same material)
- Torsional Stress ~ Torque / Shaft-Diameter^3 = constant
  => Shaft-Diameter ~ Power$^{(1/2)}$
- Material Mass ~ Volume ~ Shaft-Diameter^3
  => Material Mass ~ Power$^{(3/2)}$

KEY FACTORS

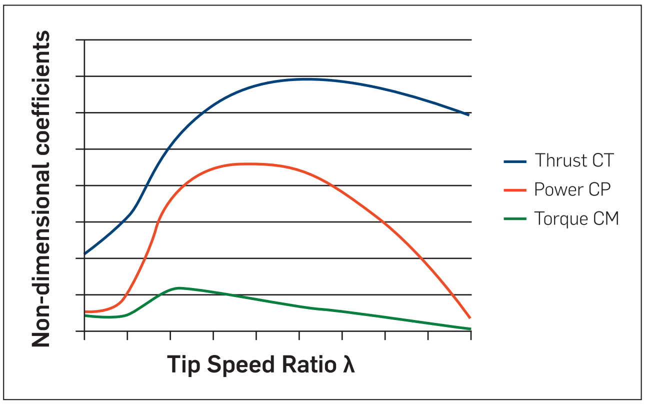
- Reducing the turbine size leads to a better ratio of power and material use.
- High overall power can be reached with higher number of smaller turbines. But:
- Increasing the number of units leads to higher complexity of the system. For extreme cases (very larger numbers of turbines at very small power) this increases costs resulting from cabeling on the platform and assembly effort.

STG 50: THE OPTIMUM IN BETWEEN THE EXTREMES

In between the two extremes of excessive platform complexity and excessive turbine mass an optimum turbine size with respect to the cost per unit of generated power can be found. This is where the STG 50 is positioned!
The STG is the result of thorough research in tidal energy with the focus on low acquisition and maintenance costs. Unlike conventional solutions, STG 50 has a high power output despite the small size and the low weight.
The STG 50 can easily be composed in arrays of various types and sizes depending on the available space and the output expectations.

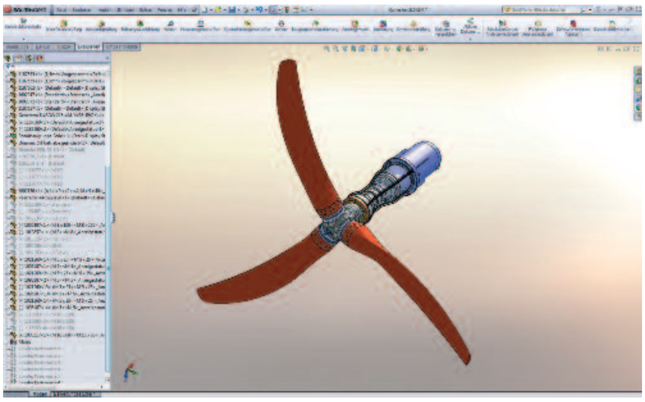


RESEARCH AND DEVELOPMENT



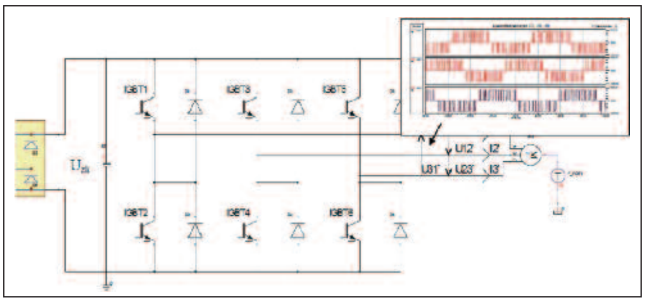
TURBINE DESIGN

The STG turbine was designed with a focus on high efficiency with respect of both hydrodynamics and the electrical components. This ensures optimum power generation.



POWER TRAIN ENGINEERING

Calculation of shafts, gears, bearings, fatigue strength of structural parts, knowledge of sealing technology, material choice, corrosion prevention...
Decades of experience with offshore propulsion systems combined with the latest design and simulation tools allow SCHOTTEL to develop a high quality tidal turbine which is made for its job in salt water.

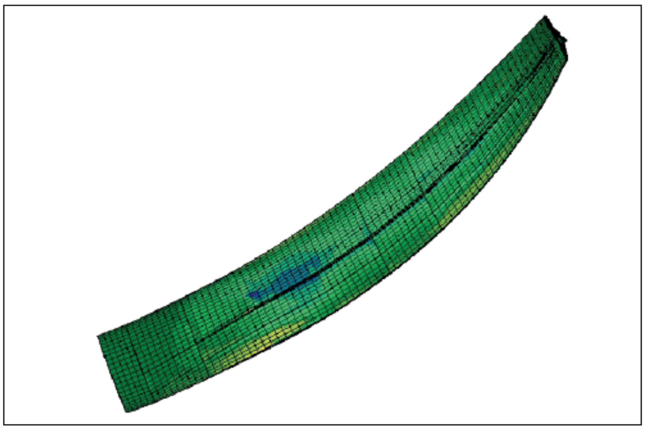


ELECTRICAL SYSTEM

The electrical system of the STG 50 has been optimised using state-of-the-art simulation tools. This comprises the global electrical system of a platform carrying a large number of turbines.

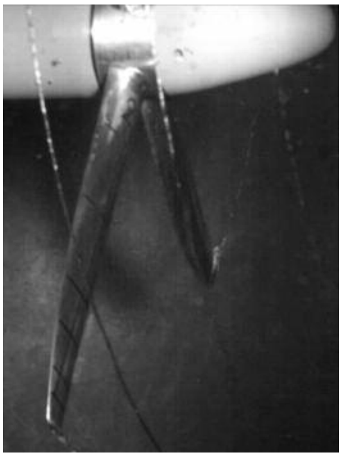
OPTIMUM POWER – LOW THRUST

The hydrodynamic blade design not only features a high power coefficient but at the same time minimizes the thrust forces in order to reduce the loads on the support structure as far as possible.



INTEGRATED TOOL CHAIN

Blade element methods, model tests and RANS-CFD simulation methods have been used to design and optimize the rotor blade shape.
To solve the coupled fluid-structure interaction problem, an integrated tool chain has been established comprising blade element, non-linear beam theory and finite element methods. This enabled the interaction of hydrodynamic forces and structural loads and deformations to be handled.



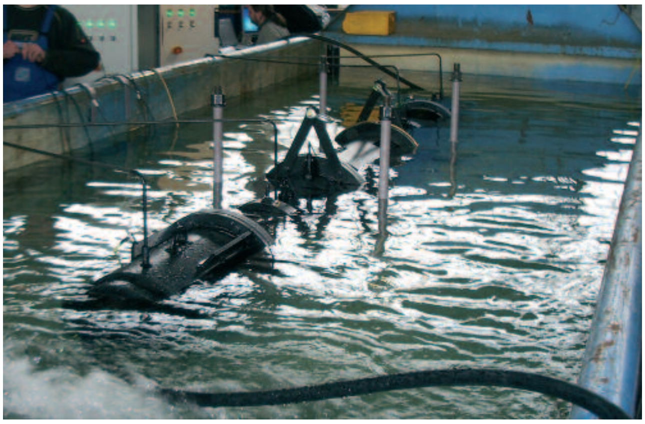
CAVITATION PREVENTION

Model tests as well as RANS-CFD simulations have been employed to prevent the rotor from erosive cavitation.

FULL-SCALE TESTING

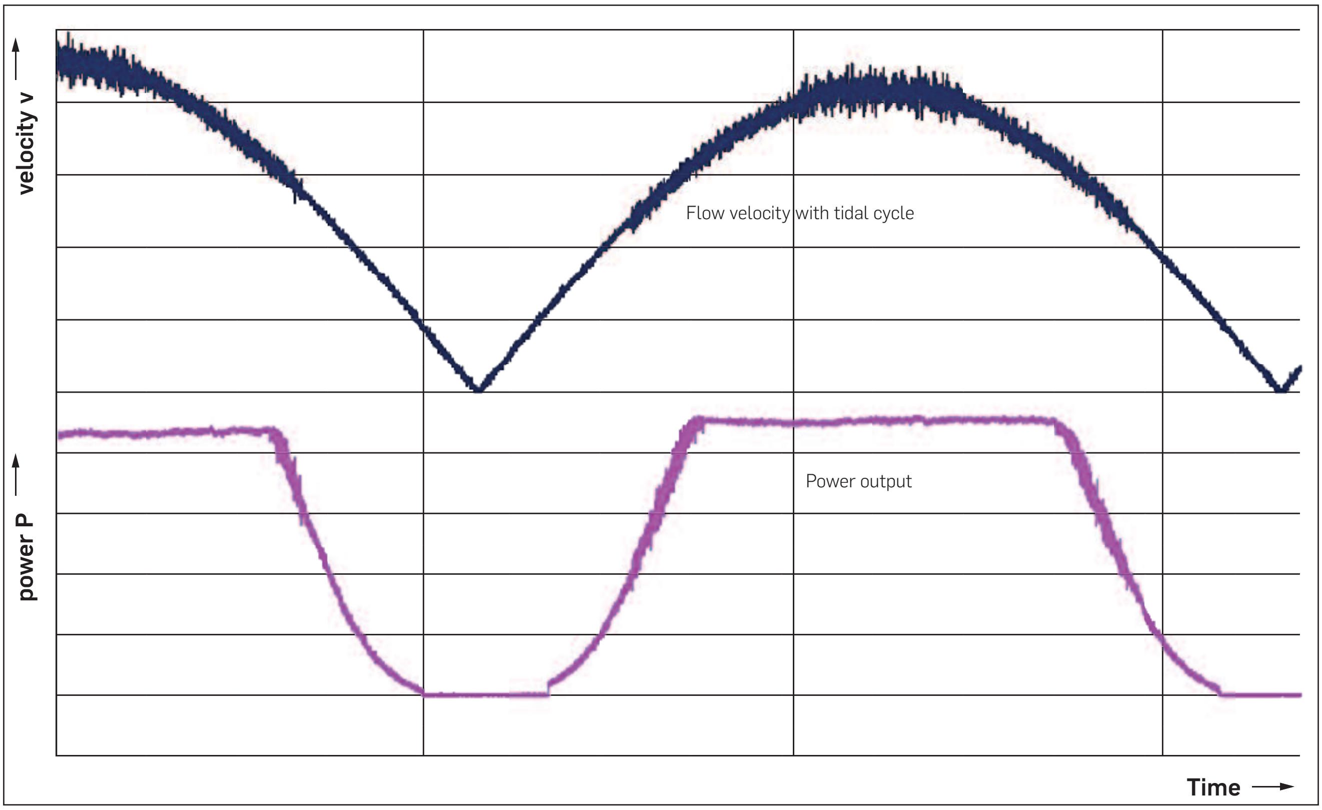
Full-scale tests have been performed with both the drive train and the entire converter including the rotor.

DRIVE TRAIN TESTING



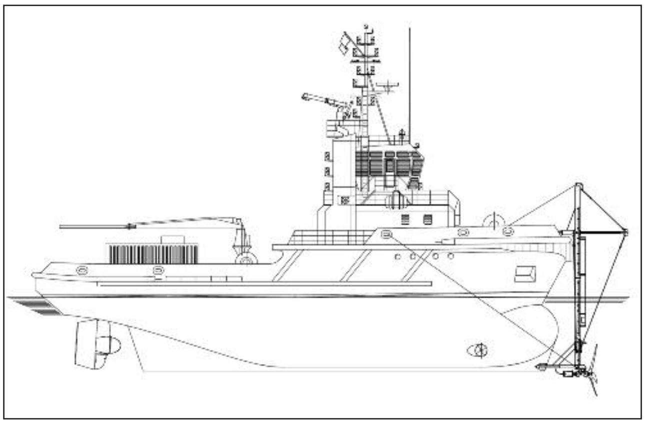
Based on a step-by-step approach, the drive train was subjected to extensive laboratory tests before being tested in the sea. Two complete STG drive trains were installed in a submerged back-to-back configuration: One was used as a motor driving the second, which acted as a power generator in accordance with its final purpose.

The aim of the test was to develop an optimum power control configuration as well as to test the drive train under nominal and overload conditions.
The setup was subjected to a representative load profile including tidal currents, wave and turbulence influence during a long-term test. By this means, the sustainability of the drive train under realistic conditions has been proven.



SEA TESTS

After intensive research, simulations and laboratory tests, first sea trials were performed using a harbour tug.
The STG unit was mounted on a rig at the bow.
For the tests, the rig was lowered into the sea.
Over a period of two weeks the behaviour of an STG 50 turbine was tested and recorded under numerous conditions.
By varying the speed of the tug, diverse flow conditions were simulated, measured and monitored aboard the tug.



Focal points of testing:

- Rotor characteristics with three different rotor configurations
- Function of control system
- Overall efficiency
- Behaviour at overspeed >5m/s
- Cavitation
- Wave influence

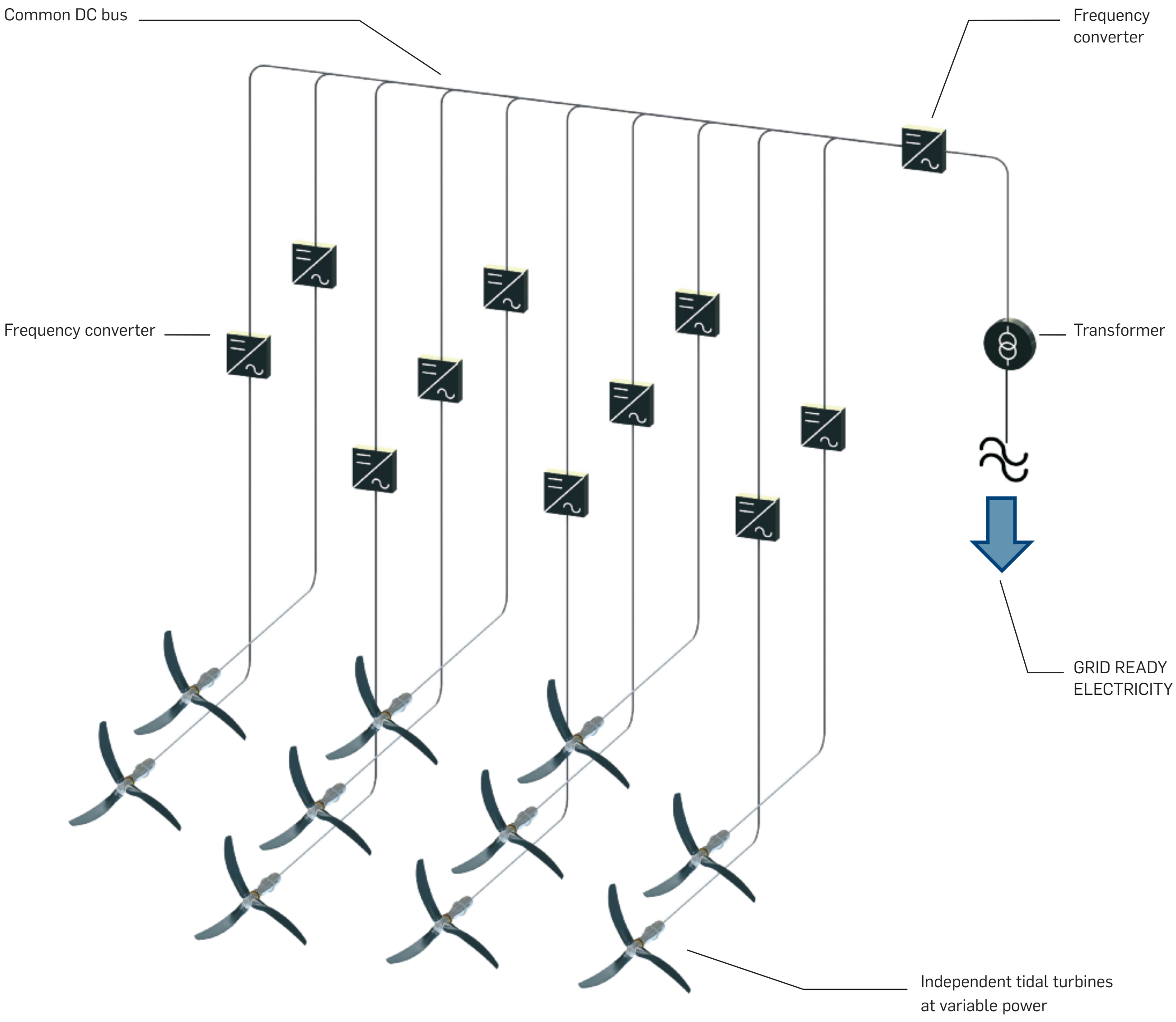
Recorded data:

- Velocity through the water
- Turbine rotational speed
- Power output
- Thrust
- Vibrations
- Temperatures
- Blade strain
- Noise
- Cavitation survey

Major outcomes of testing campaign:

- Entire systems works as expected
- Rated power is delivered as predicted
- No cavitation erosion at overspeeds

ARRAY:
ELECTRICAL ARCHITECTURE



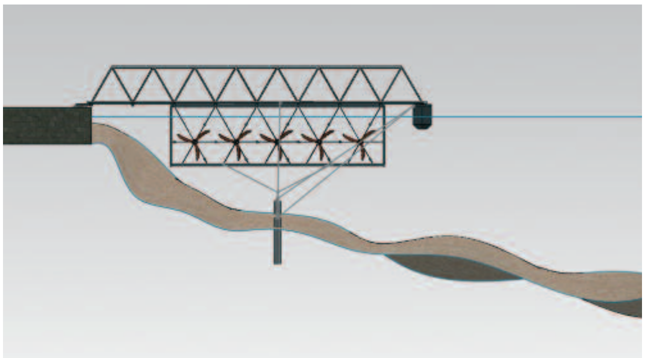
GRID READY POWER

The turbine is equipped with an asynchronous generator converting the variable rotation into electric power.
Each of the turbines is connected to a frequency converter feeding into a common DC bus installed on a tidal platform. Finally, a common frequency converter together with a large transformer are used to produce grid-ready electricity. Hence, no further reconditioning is required onshore.

APPLICATIONS

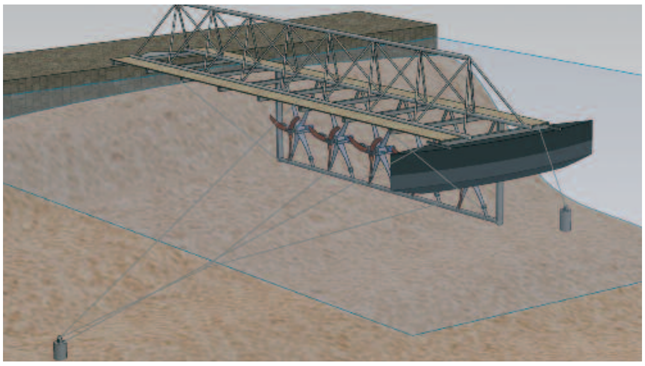
TAILORED INSTALLATIONS

The modular approach of STG turbines allows for an optimum installation customized to the specific sites and to the customer's needs.



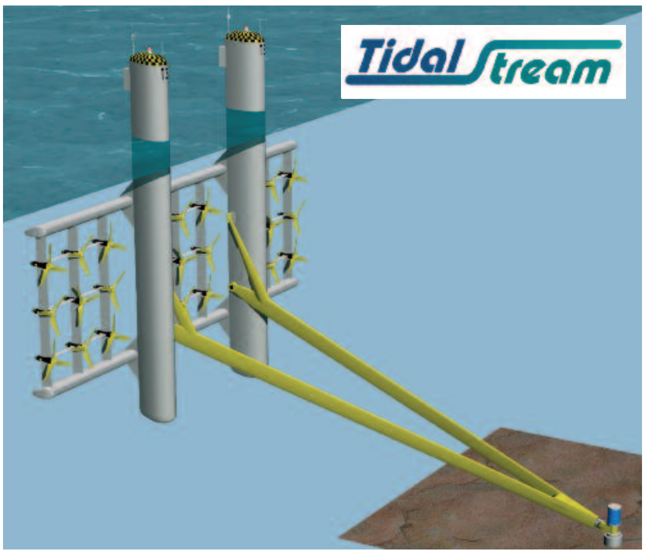
APPLICATION IN RIVERS AND SEA STRAITS

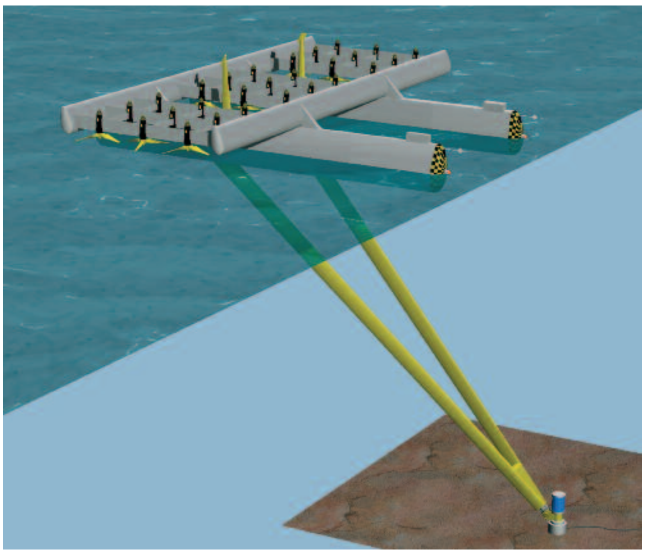
Installation at sites with restricted water depth is easy due to the small size of the turbines. Both jetty and floating platform installations are possible.



OFFSHORE APPLICATION

The STG 50 is compatible to TidalStream Ltd. Triton platforms featuring a low CAPEX related to installed power. Easy on-board access allows for cost-effective maintenance. This results in a low levelized cost of energy (price per kWh).





NEW IDEAS BASED ON EXPERIENCE

The name of SCHOTTEL traditionally stands for qualitiy engineering in the maritime sector with over 90 years in design and precision workmanship.

The SCHOTTEL group is an innovative group of companies specialising in the development, design, production and servicing of azimuthing propulsion and manoeuvring systems as well as complete mechanical and electrical propulsion systems for vessels of all sizes and types.

SCHOTTEL Tidal generators (STG) are the result of the long experience in maritime applications and concepts for renewable energy supply.

YOU CAN FIND US HERE

SCHOTTEL GmbH
Mainzer Str. 99
56322 Spay / Rhein
Germany

Martin Baldus
Product Manager
Renewable Energy
Tel.: +49(2628) 61 299
Fax: +49(2628) 615 299
mbaldus@schottel.de

For further information:
www.schottel.de