*After the RISEnergy Transnational Access, Users are required to submit a User Report. This should be done within 4 weeks after the Access is completed unless otherwise agreed. The User Report will be given to the User(s) by the WP2 leader. The report contains sections related to the work performed, the main results and observations that were achieved.*

*This document should be completed, signed, and sent by e-mail to risenergy@for.kit.edu.*

Summary questionnaire for Users who have been granted Transnational Access (TA) under the RISEnergy project Horizon Europe TA scheme. More information on RISEnergy TA can be found in "General Rules" and in "Access Policy" which can be found on the RISEnergy webpage.

*Please complete, sign, and send this form, together with the Cost claim by e-mail to* risenergy@for.kit.edu *with title: RISEnergy APPXXX - reports.*

| General information about the project | |
|---|---|
| Project title (as used in Application) | Turbine blade pitch optimisation. |
| Project number (APPXXX) and acronym (max 15 characters) | APP146 |
| RISEnergy RI(s) accessed | IFREMER Wave & Current Flume.<br>Boulogne Sur Mer. |
| Keywords (up to five, free text) | Hydrokinetic. Renewable, Electricity. Circular. Recyclable. |
| Arrival date (in town where RI is located) | 9th September 2025 |
| Departure date (from town where RI is located) | 19th September 2025 |
| Starting date of Access (first day at RI) | 10th September 2025 |
| Finishing date of Access (last day at RI) | 19th September 2025 |
| Number of days not using the RI (during the above period) | 4 |
| Reason for not using RI those days (describe) | Arrived at the town at 6 pm on the 10th which was too late for access.<br>The facility was closed over the weekend 13th and 14th of September so access was not possible.<br>The equipment was disassembled and loaded for transport on the 19th. |
| Number of days using the RI | 7 |
| Number of Users granted Access (group size) | 4 |

| | |
|---|---|
| Comments | |
| User | |
| User group leader or sole applicant (user group member 1) | |
| First name | |
| Last name | |
| Affiliation / Employer | |
| Country of Employer | |
| E-mail | |
| User travelling to RI? | |
| Comments | |
| User group member 2 | |
| First name | |
| Last name | |
| Affiliation / Employer | |
| Country of Employer | |
| E-mail | |
| User travelling to RI? | |
| Comments | |
| User group member 3 | |
| First name | |
| Last name | |
| Affiliation / Employer | |
| Country of Employer | |
| E-mail | |
| User travelling to RI? | |
| Comments | |
| User group member 4 | |
| First name | |
| Last name | |
| Affiliation / Employer | |
| Country of Employer | |
| E-mail | |
| User travelling to RI? | |
| Comments | |
| Please insert more fields if your groups had more than four members. | |

## Access Summary Report - work performed and initial results

### Brief description of the objectives of your project (up to 200 words)

The research was focused on the development of a floating hydrokinetic turbine system. The system comprises twin vertical axis turbines that are mounted either side of a bluff body. Previous lab and field tests show that the bluff body creates an upstream pressure field. This pressure distribution across the plane normal to the plane of energy extraction accelerates flow, which significantly increases the Cp of the turbines but also creates a complex flow pattern that is difficult to model using CFD.

The turbines are unique because of a blade pitching system that can maintain the blades angle of attack in optimum lift in the upstream area while creating minimum parasitic drag in the downstream area. The pitching system can be altered to change the angle of attack along the blade track and therefore enable the optimisation of the turbine using the pitching control.

The controlled conditions in the flume at Boulogne enabled experimentation with different stator angles and resistance loading, and identification of the optimal TSR for power extraction while power output was measured and analysed.

The lab equipment provided visualisation of flow patterns around the turbines including turbine inlet flow direction range, the bypass flow relative to the blockage area. Turbine RPM and power outputs were recorded independently by GKinetic equipment.

### Activities performed (up to 600 words)

A 2 kW hydrokinetic turbine system was transported to and installed at the IFREMER flume at Boulogne Sur Mer. The turbine was a floating unit that was held in position with a forward mooring line and lines from both sides.

The turbines run at low speeds and are driving 3 phase permanent magnet generators. Using belts and pulleys the rpm at the generators is increased to provide suitable voltage for measurements. An adjustable analog electrical resistor bank was connected to the generator. Using this resistor bank, we imposed different electrical loads on the generator which controlled the turbine speeds and hence the TSR.

Using a "Fluke" Power Logger we measured the power outputs at different TSRs. The meter measured and recorded the voltage and current on each phase. This data was time stamped for post testing comparative analysis. To expedite on-site decision making, the power generated at each test configuration was estimated through visual observation of the voltage and current displayed on the power logger.

The system was equipped with an adjustable stator. Different combinations of stator angle and turbine blade apparent angle of attack were experimented with to find the optimum TSR.

LDV equipment at the lab allows the mapping of flow around the turbine. The outputs are available as raw data and as visual animations. This data is valuable for the optimisation of the turbine system power output. The LDV system takes significant time to set up and calibrate. LDV data acquisition was started when the optimum TSR had been identified.

Using the LDV equipment available at the lab, the flow pattern was mapped at a range of flow velocities.

Using load cells at the lab, the drag loads imposed by the turbines were measured and recorded.

The following data were recorded throughout the experimental period.

Date

Time
Cam Shape Profile
Power Log Filename
Stator Angle
Flow Speed
Resistive load

Outputs recorded by GKinetic
No load Voltage
Voltage per phase
Amps per phase
Maximum Power Point Voltage
Maximum Power
Turbine RPM
Generator RPM

Parameters generated from test outputs
Turbine Cp
Turbine TSR

Outputs Recorded by IFREMER
Anchor Line Drag Load
LDV Data

A number of mechanical modifications were carried out during the tests. These were as a result of observations and data interpretation One of the modifications was the introduction of a series of openings behind the rotor on the port side. This was carried out following the identification of a suspected high pressure zone behind the stator and between the turbine & bluff body, which could impede the upstream movement of the blade prior to reaching its initial power position . The intention was that these openings would relieve pressure in that region and mitigate against potential power loss. Modifications were also carried out to improve stator stability and angle adjustments.
A critical objective for the tests was to measure the flow angles into the turbine and across the blades. This required that the horizontal flow behaviour was recorded. It was decided the best method to do this was to set up a horizontal LDV. To do this, the IFREMER team set up the LDV camera underneath the floor of the tank that recorded the inflow angles in front of the turbine at 3 levels.

## Scientific results (up to 800 words)

*[Summarise the (initial) outcomes of your study at the RI(s).*
As test results are industry sensitive, they will be presented as non-dimensional.
At the time of writing all data generated has not been processed and LDV or straingauge data has not been received by GKinetic from IFREMER. The results discussed here are preliminary.

The initial testing focused on establishing a baseline of power generation. Data generated was processed using the following formulae.

Electrical Power ($P_e$) generation, measured in Watts (W), recorded on-site was calculated using the formula: -

$$P_e = \sqrt{3} \cdot V_{AVG} \cdot I_{AVG} \cdot pf$$

Where $V_{AVG}$ is the Average Voltage, $I_{AVG}$ is the Average Current and pf is the power factor, in this case we are using a purely resistive load which has a power factor of 1.
As the power logger did not visually display the power being generated in Watts (W) and this parameter was required to inform the direction of testing, the Max and Min values of voltage and amperage across the three phases were recorded and these values averaged.

Theoretical power available ($P_a$), measured in Watts (W), is calculated using the formula for hydrokinetic power: -

$$P_a = \frac{1}{2} \cdot \rho \cdot A \cdot V_T^3$$

Where ρ is the density of water, in this case it is assumed to be 1, $A$ is the swept area of the device which is measured as the vertical height of the turbine multiplied by the distance from the outer rotor edge to the centerline of the bluff body (m$^2$) and $V_T$ is the mean velocity of flow in the tank (m/s).

Coefficient of performance ($C_P$) is calculated by comparing recorded electrical power ($P_e$) with the theoretical power available ($P_a$): -

$$C_P = \frac{P_e}{P_a}$$

Tip Speed Ratio (λ) is calculated using the formula: -

$$\lambda = \frac{\omega \cdot R}{V_T}$$

Where ω is the angular velocity of the rotor (rad/s), $R$ is the radius of the rotor (m) and $V_T$ is the mean velocity of flow in the tank (m/s).

Turbine RPM is measured with a magnetic RPM sensor. This is converted to rad/s using the formula: -

$$rad/s = RPM \cdot (2\pi \div 60)$$

A baseline of energy generation was established with the device in its initial mechanical configuration and resistor banks at a precalculated setting. Previous bench testing of the electrical system in isolation produced a generator efficiency of 0.95.

Incremental adjustments to the resistance value for each generator were made and power generation outputs were recorded at flow speeds of 0.6m/s to 1.5m/s in increments of 0.1m/s or 0.2m/s. Power generation was compared to baseline figures, the optimal generator resistance at each flow speed was noted and the TSR at that point was calculated.
This refinement of resistance values resulted in a CP increase of 10-15% across the range of flow speeds.

Vortex shedding from the turbines was observed alternating sides which resulted in the device swinging back and forth on its mooring line.
The analog resistance bank was then connected to both generators through a DC Bus. This had the effect of stabilising the device in the water as it regulated/equalised the RPM of each turbine which regulated the rate of vortex shedding.

An increase in CP of ~4% was observed across the range of flow speeds.

It was observed that at flow speeds of 1.2m/s and above, the bow of the floating platform was intermittently submerging resulting in instability of the platform. The anchor line was initially angled upwards by 3°- 4° which had minimal effect on the instability. The anchor line attachment was then moved from the bow of the platform to the keel.
This resulted in a reduction of the instability and the bow maintaining its level relative to the waterline.

Once an optimal Cp was reached at each flow velocity and the configuration recorded, the LDV data was captured at flow velocities of 0.8, 1.0 & 1.2 m/s.

LDV data was captured in four vertical planes on the port side of the device.

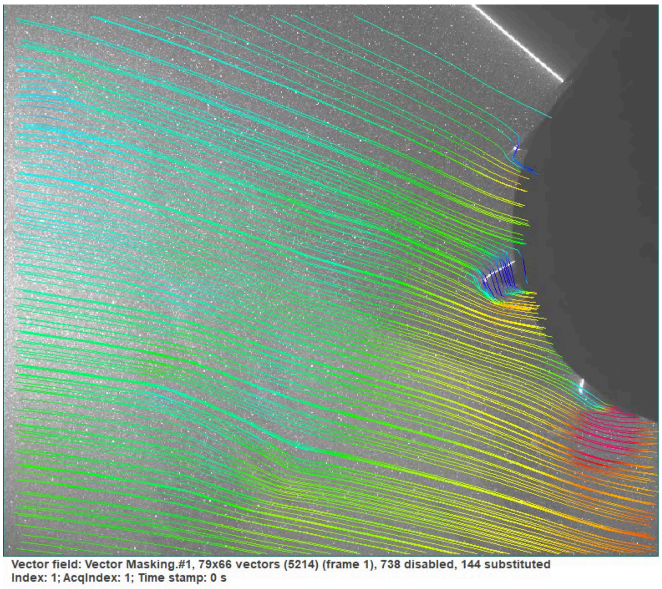
1. 20mm out from the edge of the floating platform
2. In the plane between the stator edge and rotor
3. Along the centerline of the rotor
4. 75mm out from the outside edge of the rotor

LDV data was captured in three Horizontal planes on the port side of the device.

1. 100mm up from the lower edge of the rotor
2. Along the center of the rotor
3. 100mm down from the upper edge of the rotor

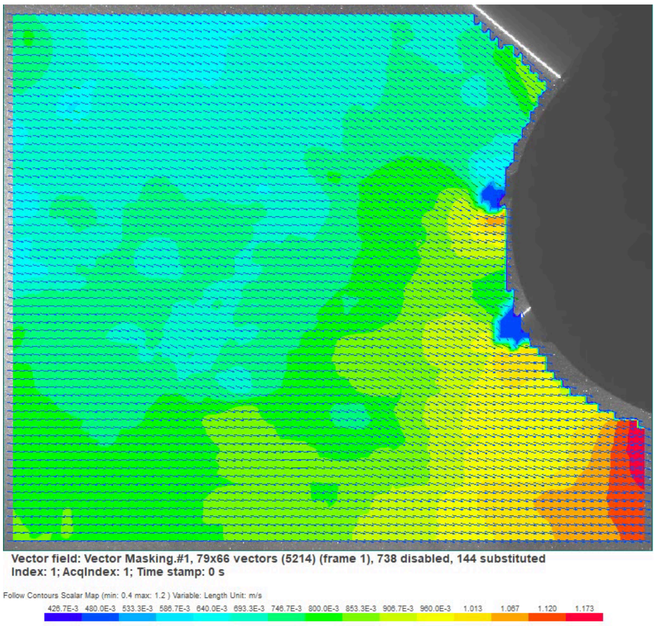
Initial LDV studies in the vertical plane showed the flow trending downwards to the upstream of the turbines.

Initial LDV studies in the horizontal plane showed the direction and magnitude of flow. Of note were low velocity areas on the upper surface of the blades and high velocity areas to the outside of the turbines.



```
Vector field: Vector Masking.#1, 79x66 vectors (5214) (frame 1), 738 disabled, 144 substituted
Index: 1; AcqIndex: 1; Time stamp: 0 s
```

LDV in the horizontal plane with streamlines



Vector field: Vector Masking.#1, 79x66 vectors (5214) (frame 1), 738 disabled, 144 substituted
Index: 1; AcqIndex: 1; Time stamp: 0 s

LDV in the horizontal plane with vectors and velocity shown as colour gradient

## Interpretation of the results (up to 400 words)

The horizontal LDV data has shown that the CFD derived blade angle of attack is not optimum. The low velocity areas on the upper surface of the blades show that the blades are predominantly in stall in this position. This has the effect of increasing the solidity of the turbine and increasing bypass flow. The LDV data clearly defines the flow angle in the region of the blades in the upstream section of rotation where they are designed to generate maximum lift. It is clear from the data that adjustment of the blade angle will improve Cp further. This vector data in the horizontal plane will allow a new geometry to be designed to optimise blade angle of attack.

The use of the lab at IFREMER allows for an iterative process. Throughout this series of tests, Cp was improved by 60% by adjusting the generator resistance and the stator angle. This has allowed us to define the optimal electrical configuration for the current turbine setup.

Connecting both generators to a single resistance bus helped to minimise irregular vortex shedding and the instability which this caused. It is believed that this was due to the turbines having distinct RPM and blades on each side coming into the prime power position at different times. This has led to the conclusion that it would be best to mechanically connect both turbines to synchronise them, with prime power position of the blades occurring on both sides contemporaneously.

The initial horizontal LDV showed significant bypass flow. The bypass flow is believed to be a result of the solidity of the turbine but also the shear effect of the rotating turbine. It is believed that as the blades were not at the optimum angle at the area that is close to the bluff body, this influenced excessive shear to the flow regime. Aside from improving the blade angle of attack, there are a number of parameters that can be altered to correct this. It was noted that the arc of rotation where the turbine blades operate in drag extend into the downstream area. It is theorised that this impacts on the solidity of the turbine. This will be explored further.

The addition of pressure relief apertures behind the stator seemed to increase energy generation by 0.5-1%. This needs to be further explored.

It was noted that during the collection of LDV images on the outer edge of the turbine to describe bypass flow, the efficiency of the turbine at the same flow velocity was increased. This could be explained by interference in the flow from flume boundary layer interaction.

## Main achievements during the TA related work (up to 250 words)

*[Describe the main achievements during your stay at the site(s), Outputs (results, publications, models, etc.), conclusions, next steps, potential impact]*

The main objective was to understand the water inflow angles to the blades. It was important that this data was obtained at the highest possible Cp. Both these objectives were reached and this will enable the further optimisation of the complete hydrokinetic system.

The data shows that further significant improvements are possible. The fact that the blades were not at the optimum angle at the area that is close to the bluff body caused excessive shear to the flow regime.

This was a practical demonstration of the drivetrain and PTO system and it revealed opportunities for improvements to the mechanical drivetrain.

The GKinetic turbine is a low cost RES. It can be mass produced and easily deployed. Higher efficiency will result in lower LCOE. The outputs from this work have allowed us to identify clear pathways to higher performance. Better efficiencies can be achieved by improved blade angles. Lower solidity can be designed into the system. Syncing of the turbines with the use of driveshafts will improve stability.

Using the data from this test could enable better CFD models that will help with hydro dynamic design and scaling.

The development of the turbine system is an iterative process. With the learning from this series of tests we can make mechanical alterations to alter the blade angles to suit the inflow angle. Another test series at IFREMER would be important to validate the improvements..

## Data Management

Power generation data is saved in .fel,.fca2 & .txt files.
All other data generated on-site was recorded in an .xlsx file.
Data from IFREMER has not yet been received.
All data will be stored by GKinetic on both work a laptop and secure online storage.
Data will be managed by Gary Brennan, CTO of GKinetic Energy Ltd.
Data will be used to inform future design and to verify power generation at this stage of development.

## Difficulties during the TA related work (up to 250 words)

A number of difficulties arose during the test series.

The turbine system is built using aluminium. It became apparent that the aluminium reflected the laser and caused anomalies in the data. The equipment had to be painted on site. This used valuable time and could have been done before travelling to the test site.

The turbine used solid aluminium discs on the top and bottom to mount the blades. This prevented the camera from recording inside the turbine. The use of a clear disc on the bottom would have allowed for more data from within the turbine.

The use of belts and pulleys in the power train contributed to an instability of the unit in the tank. This can be improved with shaft drives.
Uncertainty about the flow acceleration existed because of the proximity to the flume walls. This could be addressed in another test series by using a half model.
Some shading occurred during LDV data collection due to the laser being on one side only. This could be improved with the use of a second laser.
The use of a trigger to synchronise turbine rotation to laser firing would have greatly improved the data quality and allowed for better mean flow direction visualisation. This is imperative for subsequent test series.

## Intended publications

It is expected to submit the outcomes of the project work to EWTEC 2026, the Energy Tech Summit 2026 and Energy Ireland's Renewable Energy Magazine 2026.

## Expected impact

Better efficiencies can be achieved by improved blade angles. Lower solidity can be designed into the system. Syncing of the turbines with the use of driveshafts will improve stability.

While exact generation figures will not be published, observations on stability and flow pattern will, which can inform future research into hydrokinetic energy generation systems. It is expected that the high efficiencies shown, along with clear opportunities for improvement, will aid in securing funding for the next phase of development.

Two of the GKinetic team members of the IEC (International Electrotechnical Commission) ad-hoc groups for International Standards Development for Marine and Hydrokinetic Renewable Energy: - TC114/ahG12 - River power performance and TC114/ahG13 - River Energy Resource Assessment as well as the NSAI (National Standards Authority of Ireland) National mirror committee to IEC/TC 114. Observations from this testing will inform contributions to these standards.

The results have already been shared, in a preliminary fashion, to a prospective client and are of great assistance in securing a commercial pilot site to carry out a long term field demonstration of the technology.

The testing and results are contributing to a potential collaboration between an engineering fabrication company, a private client and a renewable energy supply company.

## Conclusions / additional comments

The GKinetic turbine is a low cost RES. It can be mass produced and easily deployed.
Higher efficiency will result in lower LCOE. The outputs from this work have allowed us to identify clear pathways to higher performance.
The use of a flume to study hydrodynamics in parallel with power outputs informed on opportunities to improve turbine efficiencies.

Better efficiencies can be achieved by improved blade angles. Lower solidity can be designed into the system. The pitching system can be altered to change the angle of attack along the blade track and therefore enable the optimisation of the turbine using the pitching control. It is noted that changing the blade pitch will alter the flow direction entering the turbine and that this is an iterative process. Once a new blade pitching geometry is developed based on the results of this project, it would be ideal to return to test the new configuration in the same testing facility.

Syncing of the turbines with the use of driveshafts will improve stability.

The successful development of this turbine system can have a significant impact in solving a critical & growing need for reliable, baseload energy by unlocking 3,000GW from free-flowing inland waterways.

Did you complete the European Commission User questionnaire https://ec.europa.eu/eusurvey/runner/RIsurveyUSERS?

☐ *Yes* ☐ *No*

### Feedback – HSE, Ethics and Satisfaction

Please rate on a scale from 1 (excellent) to 5 (poor). Feel free to provide additional comments

Practical information on how to apply for Transnational Access and the overall application process

| 1 (excellent) | 2 | 3 (neutral) | 4 | 5 (poor) |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

*Comment*

Information provided, once your project was accepted, on how to proceed

| 1 (excellent) | 2 | 3 (neutral) | 4 | 5 (poor) |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

*Comment*

| | |
|---|---|
| Support received at the site(s) regarding technical/scientific matters and logistics | Have you got sufficient support from the RI staff during the project? If not, please, specify the problems. ☐ *Yes* ☐ *No* |

*Please specify any problems*

| | |
|---|---|
| RI extension / upgrades required | In your opinion, is the RI needed to be upgraded? If yes, please give an explanation. |

| | |
|---|---|
| | ☐ *Yes* ☐ *No* |
| *Please specify* | |
| Problems with local regulations | Have you had any problems with regulations of the visited RI owner (HSE, lab working hours, etc.)? If yes, please, specify<br>☐ *Yes* ☐ *No* |
| *Please specify* | |
| Health and safety issues | Did you encounter any health or safety issue during your research? Please provide details.<br>☐ *Yes* ☐ *No* |
| *Please provide details* | |
| Environment & Ethics | Did your research involve the use of elements that may cause harm to the environment, to animals or plants? Please provide details.<br>☐ *Yes* ☐ *No* |
| *Please provide details* | |
| Environment & Ethics | Did your research deal with endangered fauna and/or flora and/or protected areas? Please provide details.<br>☐ *Yes* ☐ *No* |
| *Please provide details* | |
| Environment & Ethics | Did your research involve the use of elements that may cause harm to humans, including research staff? Please provide details.<br>☐ *Yes* ☐ *No* |
| *Please provide details* | |
| Environment & Ethics – Dual use | Does your research have the potential for military applications? Please provide details.<br>☐ *Yes* ☐ *No* |
| *Please provide details* | |
| Environment & Ethics – Misuse | Does your research have the potential for malevolent /criminal/terrorist abuse? Please provide details.<br>☐ *Yes* ☐ *No* |
| *Please provide details* | |

| | |
|---|---|
| Environmental issues | Were any potentially dangerous substances (materials / gases etc.) released into the environment (atmosphere, water, or land)? Please provide details.<br>☐ *Yes* ☐ *No* |
| *Please provide details* | |
| Ethics issues | Are there any other ethics issues that should be taken into consideration? Please specify<br>☐ *Yes* ☐ *No* |
| *Please provide details* | |
| Overall impression of communication and interaction after finishing your TA and related work | 1 (excellent) ☐ · 2 ☐ · 3 (neutral) ☐ · 4 ☐ · 5 (poor) ☐ |
| Comment | |
| Suggestions for facilities not included in RISEnergy which you would use for your research | |
| [Please provide suggestions for specific type of facilities missing (RI gaps) or measurement / experiments you would like to perform which can not be done on current RISEnergy facilities.] | |
| Suggestions how RISEnergy can improve future TA programme, how to make the TA more impactful and how to enable the achievement of high TRL levels | |
| [Your suggestions] | |

| 1 (excellent) | 2 | 3 (neutral) | 4 | 5 (poor) |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

## Feedback – Pro-active Innovation Support

| | |
|---|---|
| Awareness | Did you know about the pro-active innovation support of RISEnergy?<br>☐ Yes ☐ No |
| *[Please specify how you learned about the pro-active innovation support]* | |
| Personal experience | Have you taken advantage of or benefited from the pro-active innovation support?<br>☐ Yes ☐ No |
| [*Please provide details]* | |

| | | | | | |
|---|---|---|---|---|---|
| Information/service provided by the pro-active innovation support? | 1 (excellent) | 2 | 3 (neutral) | 4 | 5 (poor) |
| | ☐ | ☐ | ☐ | ☐ | ☐ |
| [*Please provide details*] | | | | | |

I declare that the above provided information and especially that information on the number of days visited the RI is correct.

☐ *I have read the RISEnergy privacy policy for participation in the RISEnergy TA and consent to participation and the associated data processing.*

Your full name:

Your signature: