1. PUBLISHABLE SUMMARY

Summary of the context and overall objectives of the project (For the final period, include the conclusions of the action)

The world is suffering from the double impact of a climate crisis and an energy crisis. With the intensity and frequency of climate events rising, Governments around the world are setting up net zero goals and policies to decarbonise their economies and mitigate the risks posed by climate change.

The Russian invasion of Ukraine in 2022 has caused devastation in the region and an energy crisis. In response, Governments and businesses are urgently trying to diversify away from fossil fuels to protect their security of energy supply.

Day and night, the tide carries huge volumes of water across our seas and oceans. This tremendous source of clean energy has long been admired, but the ability to harness this immense power has been challenging – until now. Nova's tidal turbines have been generating electricity from the tide for more than seven years. With the tidal turbines sitting underwater on the seabed, the beauty of the landscape is preserved. There are no dams or barriers and the turbines work in harmony with marine wildlife.

Unlike wind and solar, the tide's predictability days, months and years ahead, enables it to deliver many energy system benefits. Tidal energy can play a key role in helping us to combat climate change, achieve our net zero targets, improve our security of energy supply, and create a new industry delivering many economic benefits.

Marine energy could contribute billions to the European economy by 2050, offering strong business growth and job creation opportunities. The ability to generate electricity from our tides is now proven; the challenge faced by the sector is to lower the cost of tidal energy.

Since developing the world's first offshore tidal array in 2016, Nova doubled the number of turbines at the site and worked with Tesla to add energy storage and create baseload renewable power. With the strong parallels between wind and tidal, there is a huge potential to transfer learnings to lower the cost of tidal energy. Many of the operational principles used in the software for optimising the performance of wind turbines are directly transferable to tidal turbines.

The ELEMENT project focussed on developing an innovative and intelligent tidal turbine control system, using the tidal turbine itself as a sensor, to deliver a step change improvement in performance and lower the cost of tidal energy.

The project partnership of eleven European organisations, led by Scottish tidal energy developer Nova Innovation, has demonstrated:
- A 17.7% reduction in the cost of tidal energy
- More efficient turbine performance with higher yields
- Extended operational life of tidal turbines through intelligent controls
- The positive socio-economic impact that tidal energy has on coastal communities

Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far (For the final period please include an overview of the results and their exploitation and dissemination)

ELEMENT has been a very successful project.

The ELEMENT intelligent control system has been extensively tested in multiple scenarios onshore, in an estuary and offshore, at the Shetland Tidal Array. Throughout the testing, the control system was continually refined and optimised for maximum performance. Financial modelling utilising the test results has demonstrated that the impact of the ELEMENT control system on LCOE for tidal stream energy is a 17.7% reduction – achieving the overarching project objective. This is a major accomplishment that will allow tidal energy to scale up quicker.

The key achievements that have enabled this to happen include:

Design and Verification
A novel control system was designed as part of the project. A team of engineers from the different project partners worked together to incorporate transferable learnings from the wind sector and create a new intelligent control system specifically for tidal energy. This included software design for the control operations and hardware design to enable the new control system to be added to the turbines. Once the design was finalised, it was independently verified by a third party.

Turbine Upgrades
The design of the new control system required some upgrades to be made to Nova's turbines for the various test phases. These works were undertaken at Nova's Manufacturing Facility in Edinburgh at different occasions throughout the project to the RE50, M100 and M100D turbine models.

Onshore Testing
Onshore testing of the upgraded RE50 with the novel control system was completed at OREC's National Renewable Energy Centre in Blyth. Having the ability to use purpose-built facilities for onshore testing significantly lowers the cost of testing and allows the performance of the system to be easily observed and refinements to the design to be made. This advanced learning associated with the novel control systems and significantly de-risked the project. The results demonstrated that the controllers both increased yield and reduced fatigue.

Estuary Deployment and Testing
The RE50 turbine was successfully deployed and operated at the Ételestuary in France, enabling the performance of the turbine control system to be assessed in a real world estuary environment. This built upon the earlier onshore testing and provided vital data and experience operating in estuaries and rivers. This opens up a whole new market with the potential to supply towns, cities and coastal communities near rivers with clean, predictable electricity.

Offshore Deployment and Testing
The ELEMENT control system was successfully implemented and operated on turbine T4 at the Shetland Tidal Array for the offshore testing phase of the project. Upgrades were carried out to T4, including hardware modifications to enable two Acoustic Doppler Current Profilers (ADCP) to be connected to the turbine. The results showed that the control system successfully achieved the primary objectives of the project – to increase yield and reduce fatigue of a turbine in a real-world environment to achieve the overarching aim of lowering the cost of tidal energy.

Project Video
The Element Project video provides a clear visualisation of the technology, the different phases of the project and the various locations used for testing and deployment in France and the UK - https://www.youtube.com/watch?v=KPs-U5pzHcs

Progress beyond the state of the art, expected results until the end of the project and potential impacts (including the socio-economic impact and the wider societal implications of the project so far)

The ELEMENT control system has been extensively tested in multiple scenarios onshore, in an estuary and offshore, at the Shetland Tidal Array. Throughout the testing, the control system was continually refined and optimised for maximum performance.

Financial modelling utilising the test results has demonstrated that the impact of the ELEMENT control system on LCOE for tidal stream energy is a 17.7% reduction – achieving the overarching project objective.

This significant reduction in LCOE demonstrates the impact ELEMENT has had on the future of the industry, moving the European tidal stream sector towards sustainable and commercial multi-turbine arrays.

Address (URL) of the project's public website

element-project.eu

The RE50 turbine undergoing onshore testing at OREC's National Renewable Energy Centre

T4 turbine prior to offshore deployment in Shetland, Scotland

The RE50 turbine prior to Estuary deployment at Étel, France.