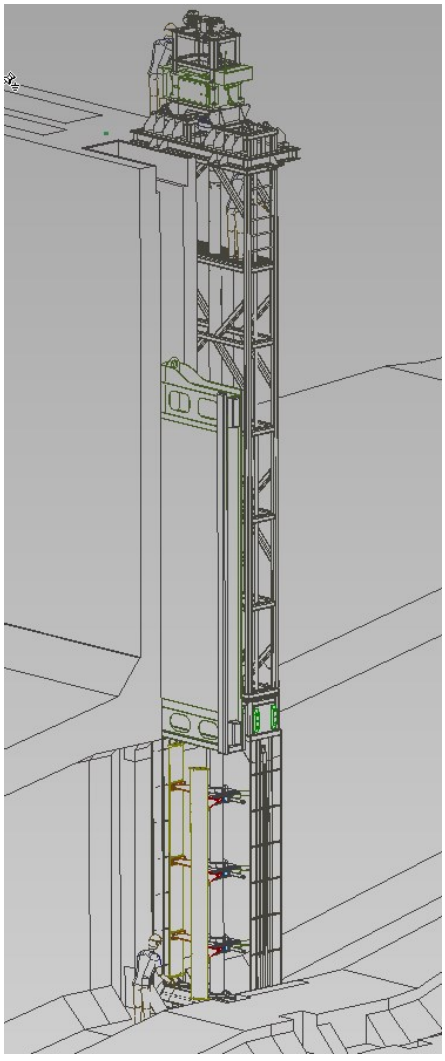
Port of Antwerp
In tune with the world

Abstract of the hydroturbine in Port Of Antwerp



Version	Date	Description	Author	Check	Approval
0.1	2019-01-12	Concept	M. Lootens	PO	X
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Inhoud

1. Introduction

Port Of Antwerp (PoA) has embedded innovation and sustainabiity in its vision and mission: "… *Our main foundations are our great adaptability, our strong focus on innovation and digitisation and on sustainable added value, and our responsibility towards society."*

Innovation is a key enabler in creating new business value and a future-proofed port platform. The Hydropower project is a good example on how PoA adopts its mission in reality.

This abstract contains the main steps from idea to a tested prototype model of a 3 bladed vertical axe waterturbine mounted in existing infrastructure of the lock at the left bank of the harbour of Antwerp.

2. POA driven by 5P, SDG's en innovation

Both on sustainability and innovation the Port of Antwerp is building a leading position and is being recognized as such. Key elements are:

- Sustainable reports POA: in 2017 a third sustainable report (conform GRI reporting standards) covering the complete POA platform has been published. An overview of the projects on the 5 P's are present at the POA website: (https://www.portofantwerp.com/en/sustainability)
- SDG's: on March 22 2018, the World Ports Sustainability Program (WPSP) charter was signed in Antwerp. During a two-day conference, sustainable ports worldwide set out the guidelines for their commitment to contribute to the realization of the 17 Sustainable Development Goals of the United Nations. If organizer of this event, the port of Antwerp is positioning itself as a pioneer of the port as a sustainable link in the global supply chain.
- With a clear vision and strategy on the Port of the Future, POA is a strong innovation community builder by supporting initiatives as NxtPort, The Beacon, PortXL, ChainPort and by setting up innovation platforms on energy transition, smart shipping, air quality, drones (SAFIR project), …
  More information: https://www.portofantwerp.com/en/port-future

3. Project scope

In order to know the power output from tidal waterflow, a prototype is developed and tested so its output can be validated. This output will give insight in further development of tidal power in the port in order to deliver electrical power to the own facilities, and further on, to the local (smart) grid. The tidal of the river Scheldt (from 0 to 6 m) has the advantage of predictability and can contribute towards a more balanced electrical power grid on the left bank.

The integration of these new electrical power sources can than be integrated with the existing alternative power plants (solar panels and wind turbines) to a smart grid on the left bank, as a sustainable energy supply to the shorepower installations on Deurganckdok – having a significant impact in the reduction of moured ship emissions.

4. Project Summary

The idea of hydropower started in 2012 with the target to harvest electrical enegry from intense waterstream (up tot 8m/s) in the existing waterculverts around the locks (#6).

An in-depth study started and 1 of the (6) locks seemed to have the most preferable conditions. In 2016 the management board of Port Of Antwerp decides to heavily invest in sustainability and innovation. In 2017, the construction of a waterturbine was ordered to De Meyer [Belgium] and Water 2 Energy [Netherlands] after a public tender procedure.

By using 3D design, Virtual Reality, Computised Fluid Dynamics and all the knowledge of earlier studies on waterflow in the existing culverts and the beaviour on the water household at the harbour, a prototype was developed, constructed and installed in december 2018.

The video https://www.youtube.com/watch?v=BsmdX6EdD2o shows the project during full development.

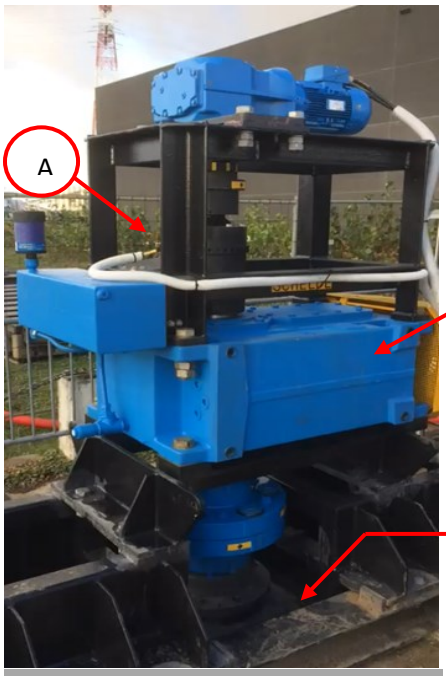
The protoype turbine was then submitted to 2 reference tests combined with a duration test of 235 hours. All the data from these test are a crucial input for a realistic business case.

Most important, this test resulted in the relation between water velocity [m/s] and power [kW] for this type of turbine, subjected to the specific working conditions (-15 metres, sludged water, trash, …).

5. Testing facility

Testsituation

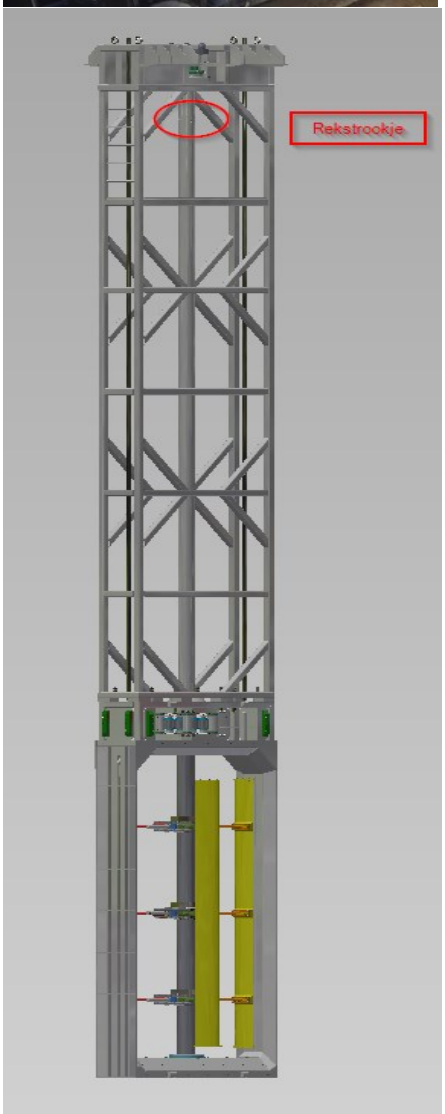
The turbine and its frame is mounted in a rectangular shaft of the lock infrastructure. This shaft has a depth of 15 metres and is perpendicular to a horizontal canal with a cros section of 12m². The frame glides into this shaft and fits perfect due to intensive 3d measurement. The frame is modular and weighs around 12t. At the top, a gear box is mounted which reduces the slow speed/high torque -axe to a high speed/low torque-axe. On the high speed side-axe, a dynamometer (later stadium a generator) is mounted. By measuring the torque and the revolutions per minute, the power [kW] is calculated.



A: Encoder

B: 90° reductor

C: Torque measurement



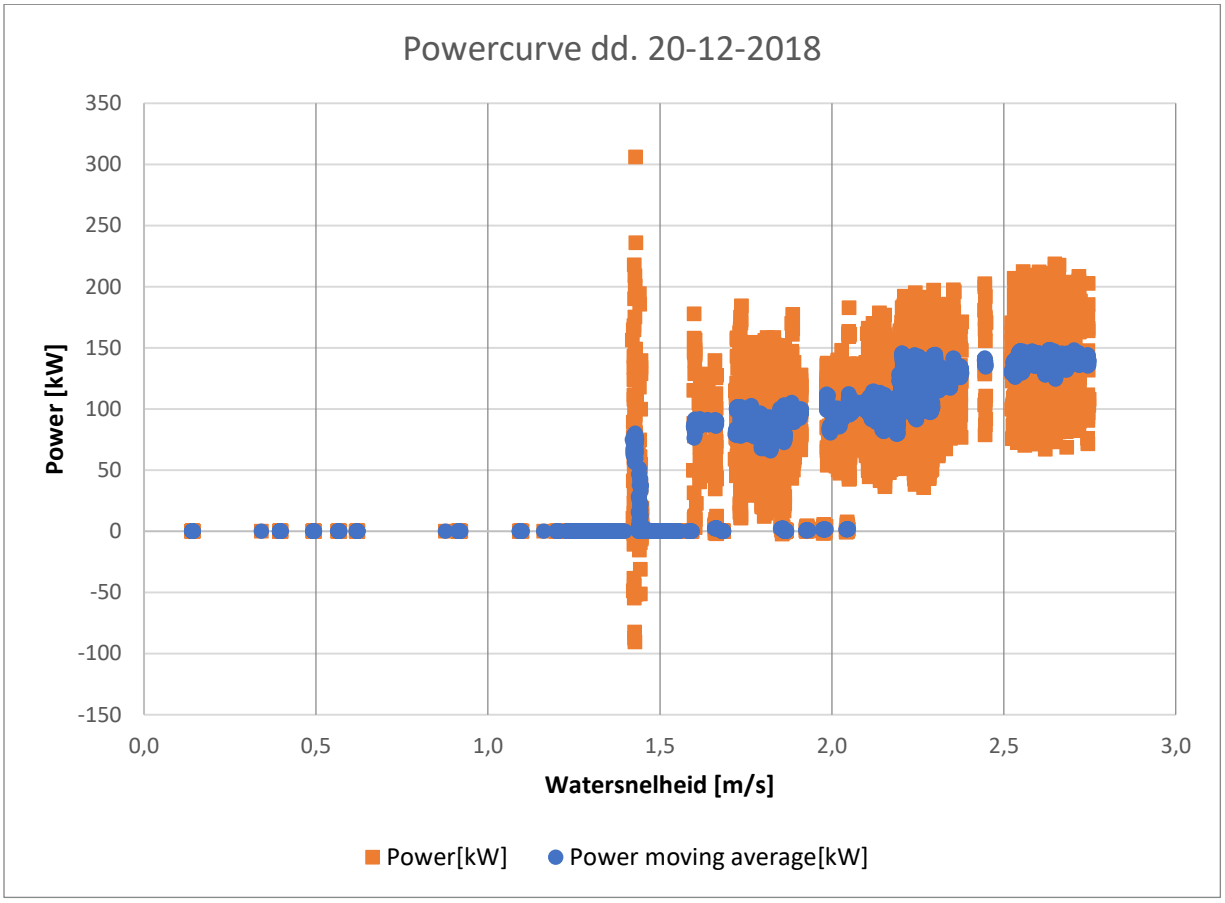
Frame height : 15 metres

Weight : 12 tonnes

3 bladed Turbine

Testresults on power output:

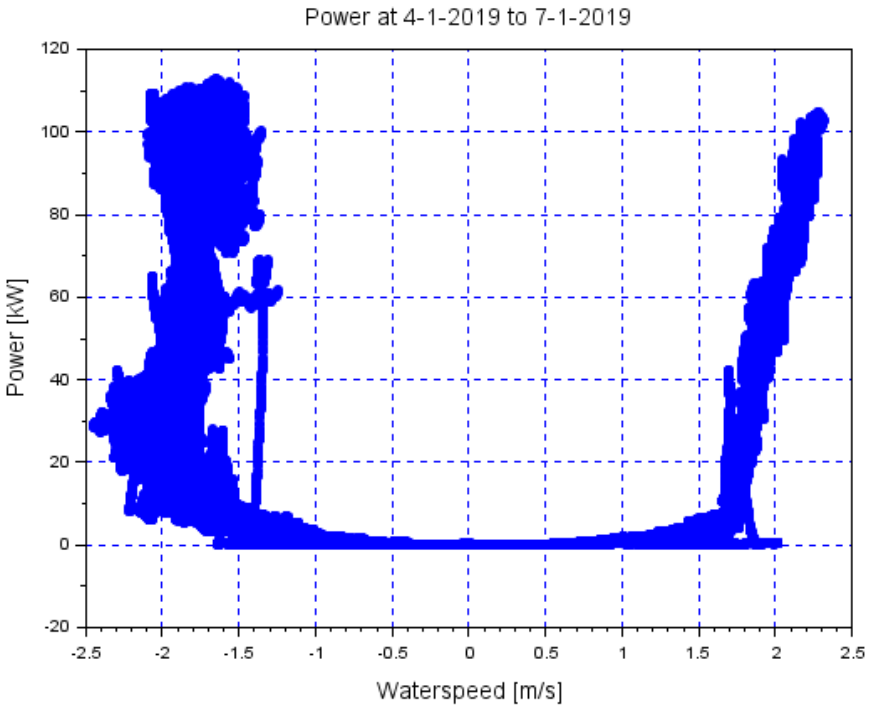
The first reference test, the power curve shows a peak of 150 kW.

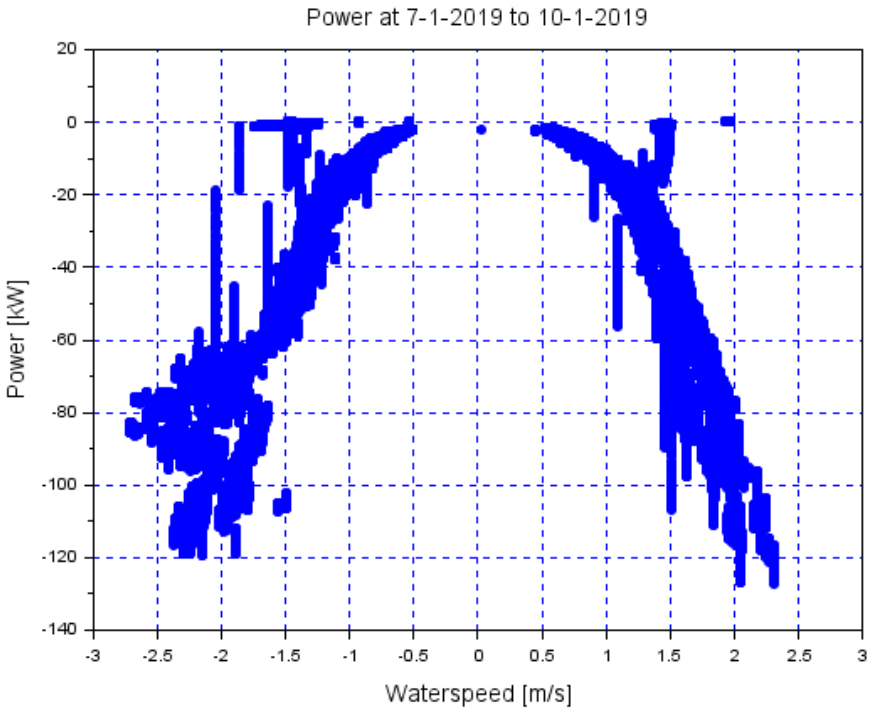


The first part of the endurance tests (4/1/2019 -> 10/01/2019) shows that the turbine at velocities of +- 2m/s, achieves 120 kW.

The total endurance test stretched 235 hours with an uptime of 65%.

The turbine is than submitted to detailled inspection to gather an indication of the lifespan of the structural components.


Power at 4-1-2019 to 7-1-2019
Power [kW]
120
100
80
60
40
20
0
-20
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5
Waterspeed [m/s]


Power at 7-1-2019 to 10-1-2019
Power [kW]
20
0
-20
-40
-60
-80
-100
-120
-140
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5
3
Waterspeed [m/s]

6. Conclusion and next steps:

The initial goal was to reach 100kW but this test proves that the 3-bladed vertical axe turbine has much more potential (150 kW).

A lot of improvements are possible which will have positive impact on the power output, the lifespan and the water management system in the dock.

In a next step the feasibility to roll this out further to 5+ hydroturbines on the Kallo and Kieldrecht locks is in investigation – also linked on setting up a sustainable energy smart grid on the left bank of the port.