Universidad del Valle

Technical-economic assessment for the construction of tidal current turbines in Valle del Cauca, Colombia

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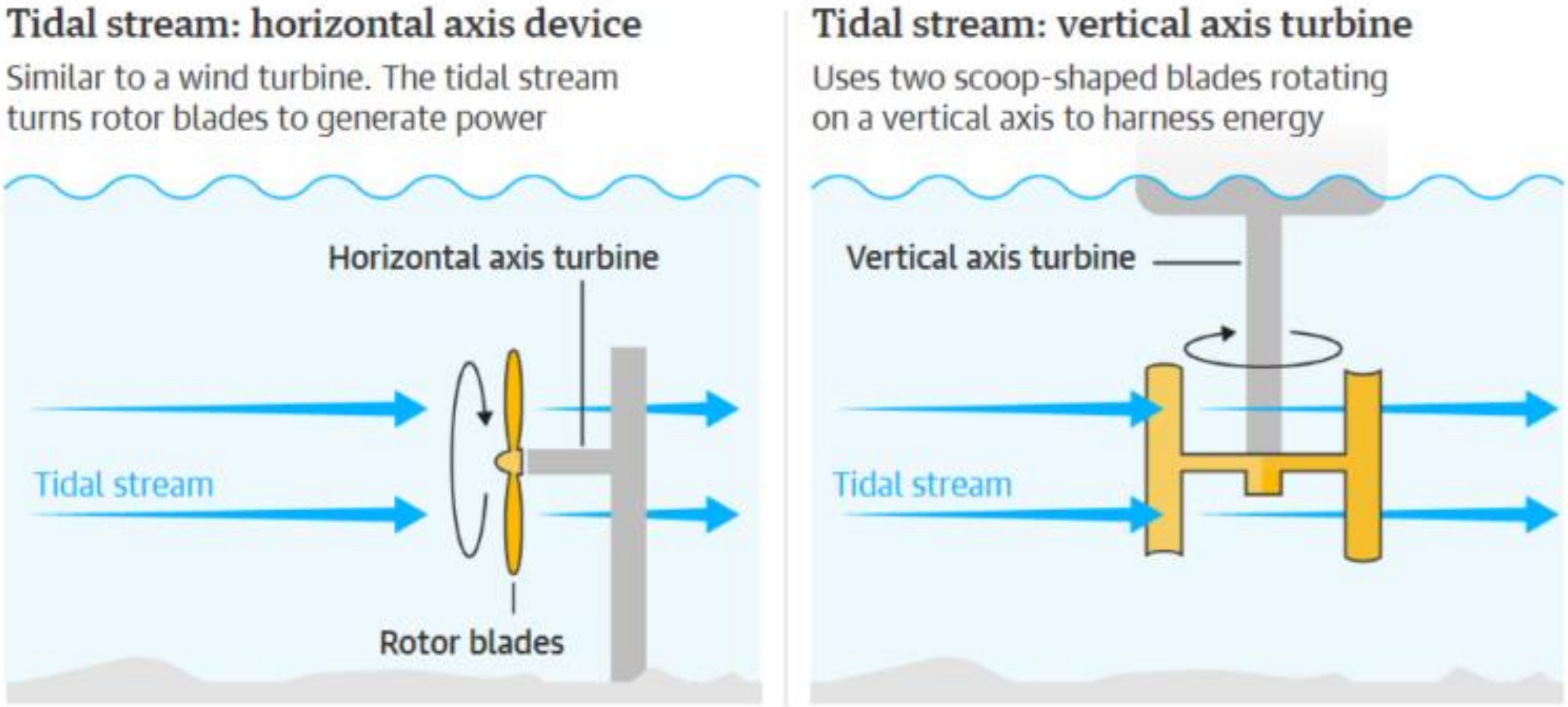
Introduction

Tidal current turbine (TCT).



Source: The European Marine Energy Centre.

The LCOE for tidal energy is estimated from 0.20 USD/kWh to 0.45 USD/kWh, and is expected to reach 0.11 USD/kWh by 2030.

Methodology

1. Location of sites strategic with high potential.

1. Selection of available technologies that could operate in local oceanographic conditions.

1. Calculation of power of each turbine.

$$P = \frac{1}{2}\rho U^3 ACp$$

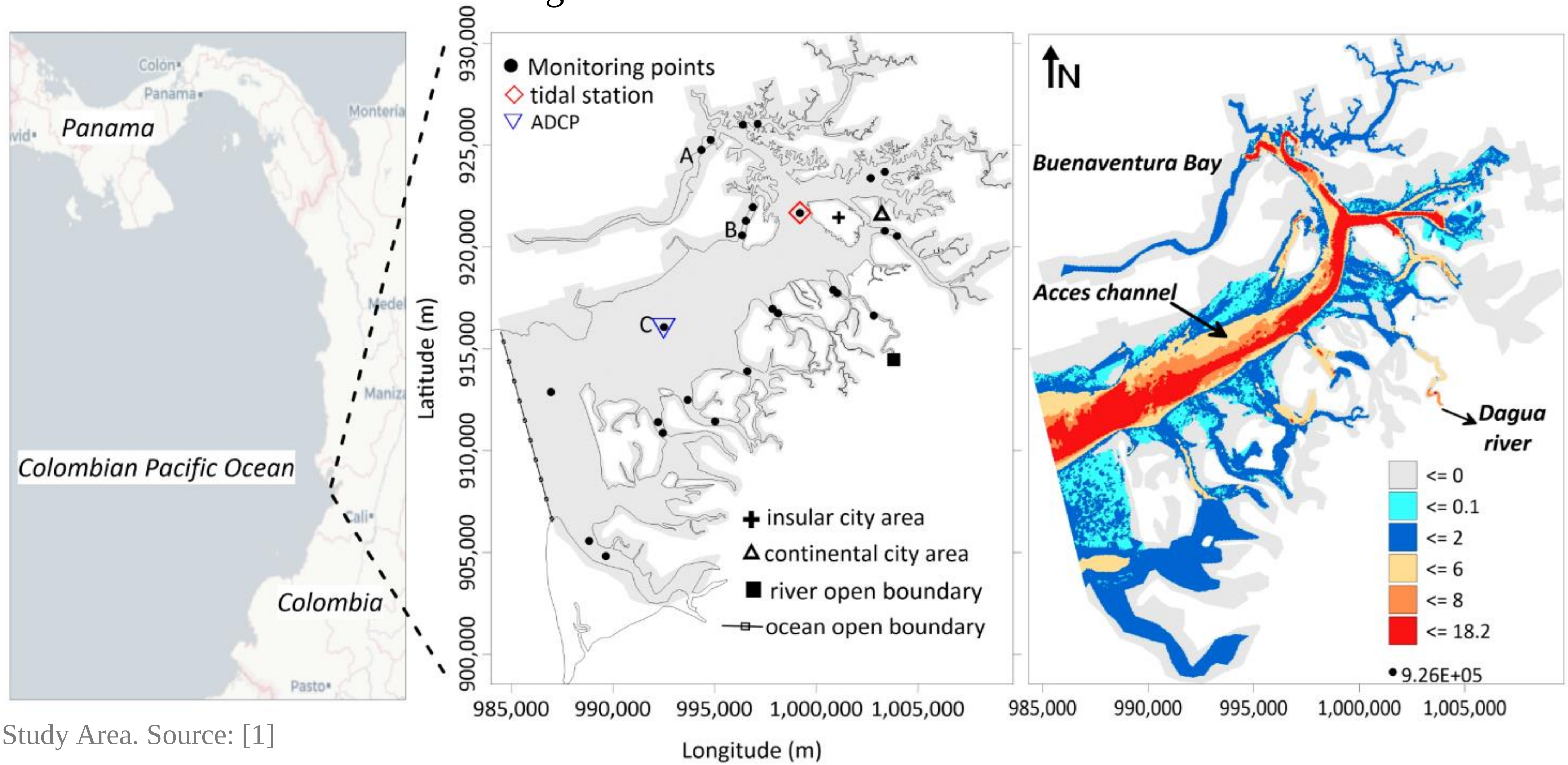
1. Operating expenses estimate.

1. Levelized Cost Of Energy (LCOE) calculation and comparison.

$$LCOE = \frac{TIC \times FCR + OPEX}{AEP}$$

Result 1

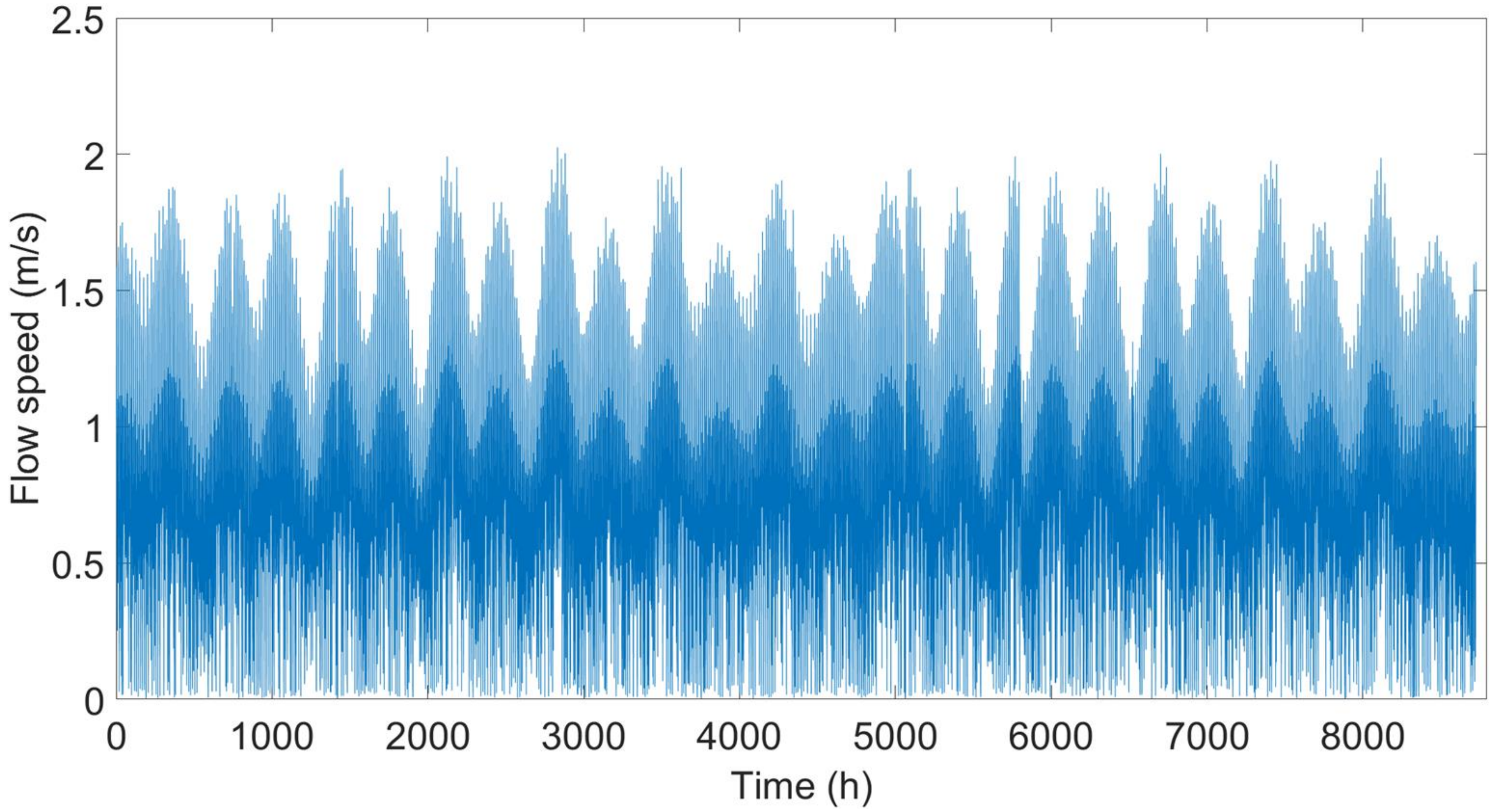
The evaluation was carried out in the Aguadulce creek located in Buenaventura.



Study Area. Source: [1]

Result 1

Velocity currents of point A during 2021 in Buenaventura Bay. [1]



Result 2

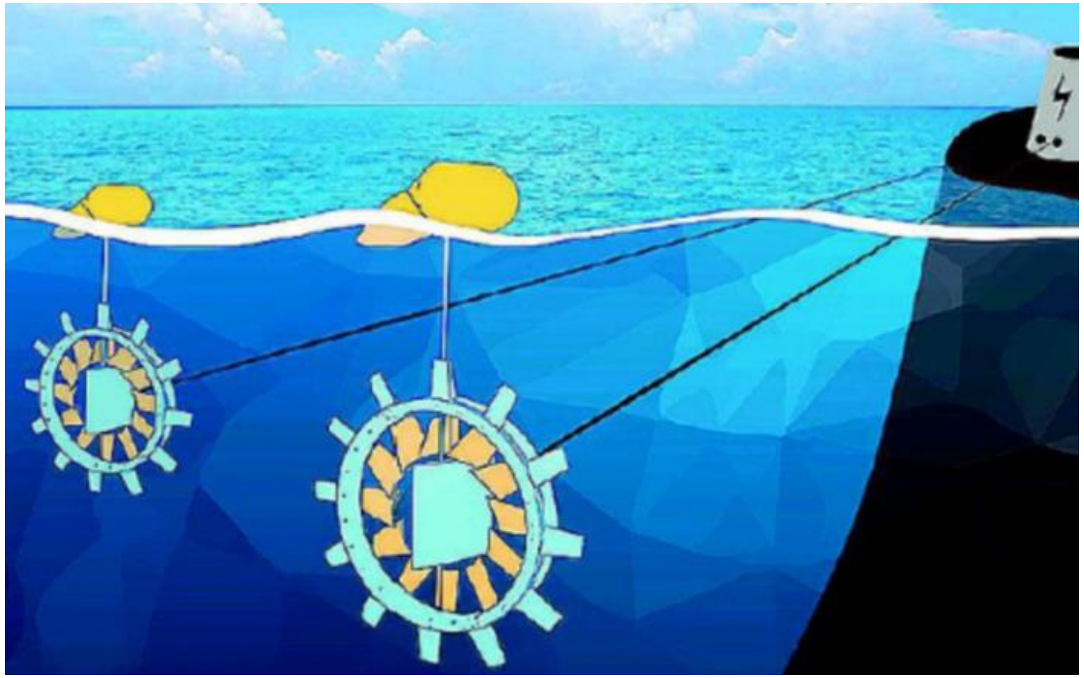
Evopod Turbine

Evopod turbine is in pre-comercial stage, with Cp of 0,4. [2]

IC Description	USD/Turbine
Turbine (floating structure)	65570.04
Moorings	34285.95
Controls/instrumentation	2223.60
Power take-off	56217.84
Power connection	54838.99
Structure installation	39567.00
Mooring installation	18393.75
Grid connection installation	25931.10
Commissioning	5663.64
Project, planning, legal and financial management	17395.31
Contingency	16004.47
Construction insurance	8001.69
Total (USD/Turbine)	**344093.38**

Result 2

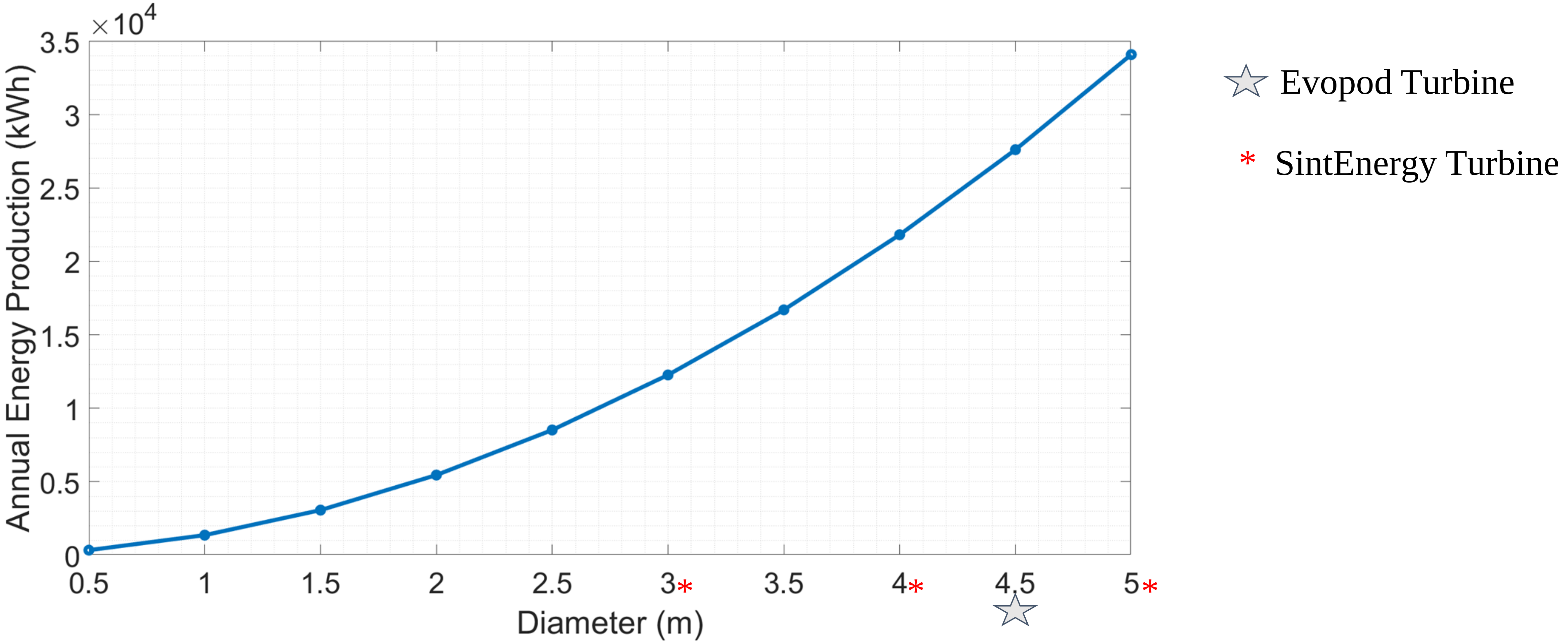
SintEnergy Turbine



	Diameter (m)		
IC Description	3	4	5
Generator and converter, cable	91974.20	114962.30	143705.60
Blades, body, rotor	79286.60	91178.50	104858.00
Mooring	39240.00	62784.00	100454.40
Installation	16840.50	21516.60	27925.80
Design and project management	11172.50	13450.60	15706.90
Site improvement and other issues (network, etc.)	21047.90	26890.30	34901.80
Total (USD/Turbine)	**259561.70**	**330782.30**	**427552.50**

SintEnergy is in development stage, with Cp of 0,4. [3]

Result 3



×10^4
Annual Energy Production (kWh)
3.5
3
2.5
2
1.5
1
0.5
0
0.5
1
1.5
2
2.5
3*
3.5
4*
4.5
5*
Diameter (m)
Evopod Turbine
* SintEnergy Turbine

Result 4

Estimated operating costs Evopod turbine.

CO Description	USD/Turbine
Planned maintenance	1461.04
Mechanical components insurance	4262.73
Total (USD/Turbine)	**5723.77**

Estimated operating costs Sintenergy turbine.

	Diameter (m)		
CO Description	3	4	5
Planned maintenance	3280.40	4443.70	6104.00
Mechanical components insurance	4631.00	5916.30	7678.40
Total (USD/Turbine)	**7911.40**	**10359.90**	**13782.40**

Result 5

ESTIMATED LCOE FOR THE EVALUATED TURBINES.

Turbine	Evopod	SintEnergy		
Diameter	4.5 m	3 m	4 m	5 m
LCOE (USD/KWh)	**1.39**	**2.65**	**1.92**	**1.60**

Conclusion

- The Evopod turbine has the lowest LCOE (1.39 USD/KWh), this is because this technology is more mature, since it is in the pre-commercial stage, while the SintEnergy is still in the development stage.
- The LCOE is high compared to the commercial range currently in the market (0.20 USD/kWh - 0.45 USD/kWh), so it is necessary to reduce these costs through more research and new public policies that encourage technological development and reduce investment risks.
- It is necessary that local industry of Buenaventura, Valle del Cauca department and academy work together to reduce the technological limitations and achieve a reduction in the production costs of the technology.

References

[1] J. G. Rueda-Bayona, J. L. García Vélez, and D. M. Parrado Vallejo, “Effect of Sea Level Rise and Access Channel Deepening on Future Tidal Power Plants in Buenaventura Colombia”, Infrastructures, vol. 8, no. 3, p. 51, Mar. 2023.

[2] González-Gorbeña, Eduardo & Pacheco, André & Plomaritis, Theocharis & Sequeira, Claudia. “Assessing the Effects of Tidal Energy Converter Array Size on Hydrodynamics of Ria Formosa (Portugal)”. 2017.

[3] Silvio Barbarelli, Gaetano Florio, Giacomo Lo Zupone, Nino Michele Scornaienchi, “First techno-economic evaluation of array configuration of self-balancing tidal kinetic turbines”, Renewable Energy, vol 129, Part A, pp 183-200, Dec. 2018.

THANKS!

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