Power Generation Italy
O&M Hydro Italy – Northern Western Area

Proposta progetto innovazione
Turbine idrocinetiche installate in canali

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Green Power

Oggetto del documento

Green Power

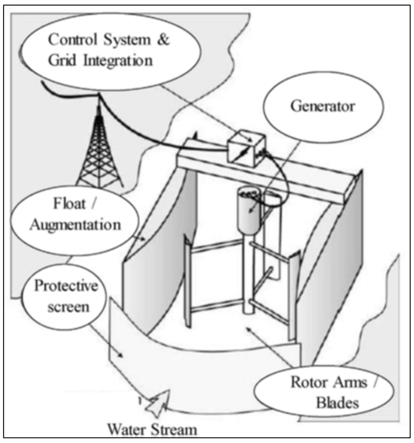
Il presente documento viene redatto allo scopo di presentare un progetto di turbine innovative, possibilmente a basso costo, installate ed utilizzate all'interno di canali.

Tale soluzione permette di ricavare energia rinnovabile da fonte idroelettrica, con i seguenti principali vantaggi:

- Possibilità di realizzazione senza costruzione di opere strutturali massive (es. dighe, traverse).
- Soluzione altamente ecosostenibile.
- Bassi costi di progettazione ed installazione, se realizzata "in house".

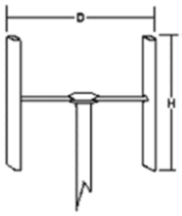
Fonte ppt: C.M. Niebuhra, M. van Dijka, V.S. Nearyb, J.N. Bhagwanc: *A review of hydrokinetic turbines and enhancement techniques for canal installations: Technology, applicability and potential*

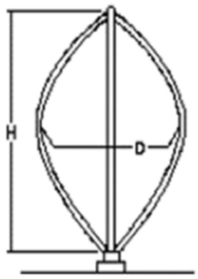
Turbine idrocinetiche - Tecnologia



$$P = \frac{\rho}{2} \times A \times V^3 \times C_p$$

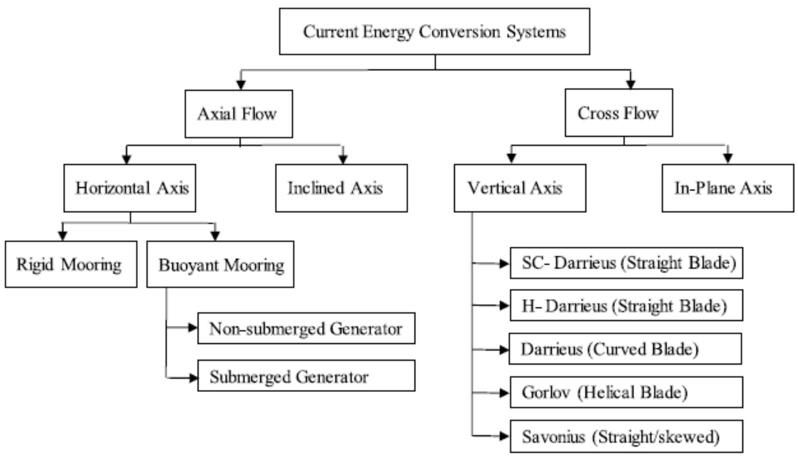
$$C_P = \frac{\tau \times \omega}{P_{HK}}$$





P = Potenza
A = Sezione
V = Velocità
Cp = coefficiente
τ = torcente
Ω = velocità angolare

Turbine idrocinetiche - Tecnologia



Turbine idrocinetiche - Tecnologia

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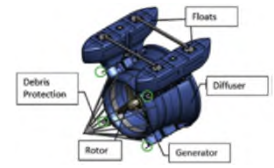
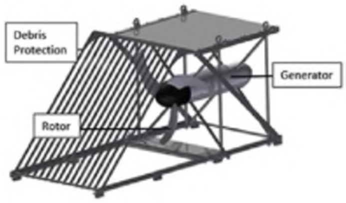
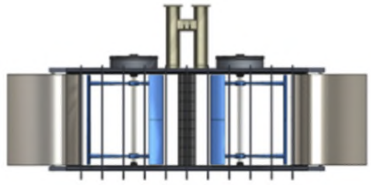


1) Smart Duofloat
Axial flow- Submerged generator
At V=2.8 m/s P=5 kW (1m diam)

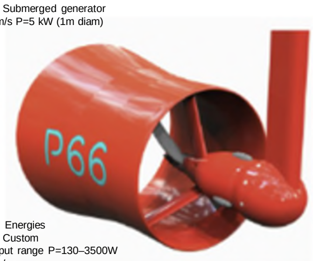


2) Smart Freestream
Axial flow- Submerged generator
At V=3.1 m/s P=5 kW (1m diam)

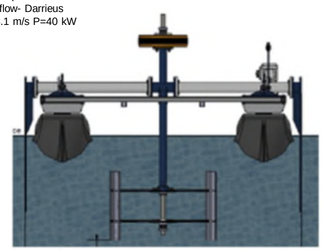


3) Hydroquest River 1.4
Cross flow- Darrieus
At V=3.1 m/s P=40 kW

4) Waterotor Energy Tech
Cross flow- Savonius
At V=0.89 m/s P=1.1 kW



5) Guinard Energies
Axial flow- Custom
Power output range P=130–3500W
Min V=1 m/s



6) EnviroGen Series
Cross flow- H-Darrieus
At V=3 m/s P=5 kW

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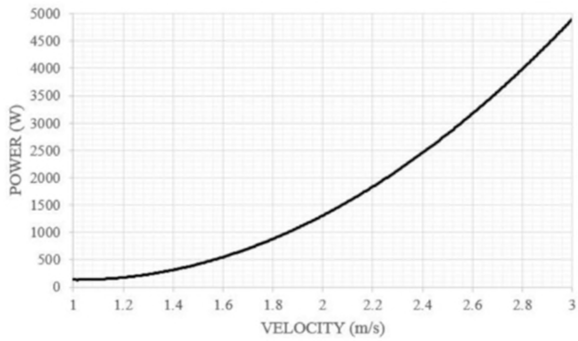
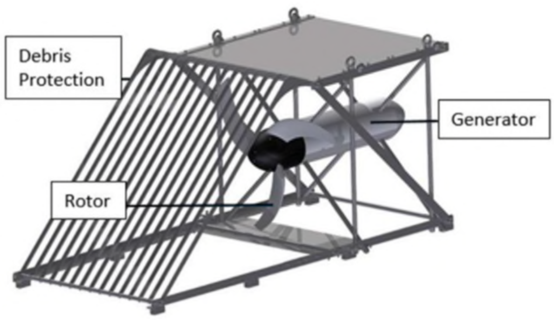
7) ORPC RivGen
Cross flow- Custom
AT V=2.3 m/s P=15 kW

8) HeliosAltas
Cross flow- Custom
Power output range P=100–500W
Min V=1.8 m/s

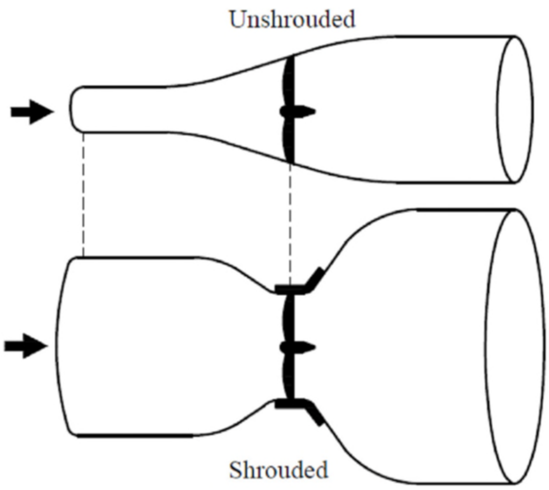
9) Instream energy system
Cross flow- H-Darrieus
At V=3 m/s P=25 kW

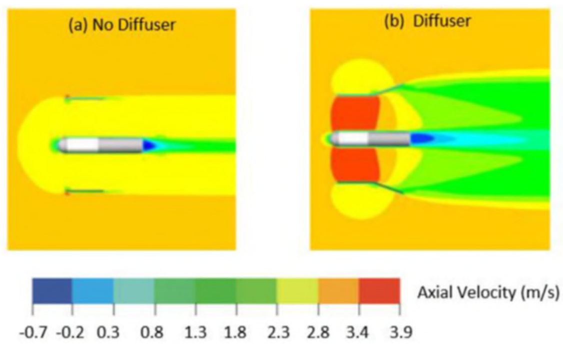
Turbine idrocinetiche - Tecnologia





Turbine idrocinetiche - Tecnologia





Turbine idrocinetiche - Tecnologia

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Enhancement measure	Advantages	Disadvantages	Preferred use
Confinement (diffuser/ shroud)	i. Cost-effective. ii. Shroud may be used as a safety mechanism. iii. Technique may result in faster flow recovery downstream of the turbine (turbulence is contained). iv. Rotor size may be reduced with the use of confinement.	i. Significantly increase the modular turbine unit size. ii. May increase the blockage thus increasing upstream damming effect. iii. May not function adequately over all flow velocities.	Use in higher velocity applications (> 2 m/s)
Channel modification	i. Allows a greater scope of site selection possibilities (lower velocities). ii. Flow direction may be controlled. iii. Allows drastic flow velocity change.	i. Drastic changes may cause non-uniform swirling flow, affecting turbine functioning. ii. May result in high cost civil works. iii. Additional approvals may be required (infrastructure alteration). iv. Can only be applied over a short section before flow stabilizes to a higher flow depth.	Use in lower velocity applications (< 2 m/s)
Multiple turbine application	i. Greater output obtainable per section. ii. Wake effects may be used to place turbines in preferable sections.	i. Clogging effect may be significantly worse (greater blocked area) ii. Inter-turbine effects must be considered which may be difficult to predict.	Areas with a large cross-sectional area.

Turbine idrocinetiche - Fasi

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DESIGN PHASE

- Blade geometry
- Blade size/ number
- Turbine configuration
- Flow characteristics

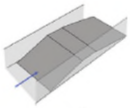
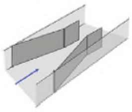
INSTALLATION PHASE

- Turbine placement
- Site selection
- Confinement/shroud
- Multiple turbine application
- Channel modification

OPERATION PHASE

- Cleaning & Maintenance
- Testing
- Monitoring
- Problem mitigation

Turbine idrocinetiche – Soluzione di installazione

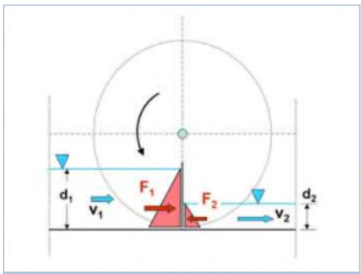
Augmentation forms	Picture	Design theory
Lifting canal bed		The flow exhibits a subcritical regime therefore this theory applies where the bed level is raised causing the venturi phenomenon.
Narrowing canal sides		By narrowing the canal sides the flow area is reduced over a short distance thus increasing the flow velocity.

Installation locations		
	Steep sections	Steeper canal sections result in accelerated flow velocities and therefore higher outputs from the HK device examples include canal outlets to balancing dams, or sections with higher gradients
	Flume sections	Where a narrowing in the canal occurs, higher velocities may be present.
	Siphon/ Pipe exits	Where siphons are used between canal sections narrowed section at exits may be considered as potential sites.
	Robust canal sections	Wide sections of canal with operational flexibility. Examples include high canal walls (room for damming); recovery zones available upstream and downstream

BACK UP

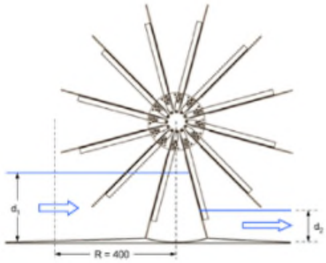
Hydrostatic Pressure Machine

http://www.hylow.eu/



HPW principle

L'HPC utilizza le differenze di pressione idrostatica tra monte e valle della macchina. Ciò consente efficienze elevate con differenze di carico molto basse.
L'HPC più semplice, la ruota a pressione idrostatica, è costituita da una ruota con pale radiali che fungono da sbarramento e che si muovono con la velocità del flusso.



La differenza di forza idrostatica F1 - F2, proporzionale alla velocità v1 e genera la potenza P. L'efficienza diventa una funzione del rapporto d_2 / d_1. Questo principio è piuttosto insolito, ma gli esperimenti hanno mostrato un buon accordo con la teoria.