

# **Wind Turbines for Low Cost Power Generation**

**Patented and  
Patent Pending Solutions**

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# Wind Turbines for Low Cost Power Generation

- **There are multiple ways to tap the energy of the wind. Off shore winds appears to be the most competitive solutions. But for on shore distributed power generation new invented jet augmented wind generators are the best economical feasible solution of both stand alone and grid tied applications.**
- **The final aim of the presented here new developments of wind turbines are to decrease both initial investments and maintained costs by environment friendly technical solutions.**
- **For every economical feasible offshore / onshore wind farm is important the initial investment. Low initial investment means competitive cost of power generated by wind farms.**

# Wind Turbines for Low Cost Power Generation

## Best types of wind turbines

A wide variety of types and sizes of wind machines exist today.

We are using here a classification by the overall degree of load (capacity factor) of the different types of wind turbines during an yearly cycle.

The top position of the classification shows both minimal investment and maintenance cost - the best economical feasible solution.

# Wind Turbines for Low Cost Power Generation

## **Drag or lift mode of operation divided basic types of wind turbines**

**On a drag device the wind pushes the blade forcing the rotor to turn about its axis; the most common example of a drag device is the horizontal axis wind turbines (HAWT) for water pumping in farms and vertical axis (VA) drag turbines. Drag devices characteristically produce high starting torque, but they are limited in the amount of energy they can extract from the wind. Drag devices both horizontal and vertical axis of rotation operate at low velocity flow and high speed flow, as well.**

# Wind Turbines for Low Cost Power Generation

## Lift Type of Wind Turbines

Lift HAWT have only a few (two, three) blades in contrast to the multiple blades of a HA drag devices. One blade rotating very fast can extract as much energy as many blades rotating slower. Lift devices use slender airfoils for blades, whose shape is the same as an airplane wing. Lift devices are more efficient than the drag devices, thus the blade area can be reduced considerably. But lift devices not operate in low velocity wind. Lift devices are the best efficient solution of both offshore and onshore applications but they are expensive and complicated machines with high initial investment and high operation costs. They are noisily and killing birds.

# Wind Turbines for Low Cost Power Generation

## JET Mode of Wind Turbine Operation

It is a radical new solution. All my inventions relate to the hydro and wind JET turbine applications take advantages of an additional JET force augmented blade rotation.

Thanks to it the turbine efficiency is increased up to 2 times for both lift and drag devices on the vertical, inclined and horizontal axis hydro / wind rotors of axial and cross flow rotors.

All JET augmented turbines are self starting machines at very low flow stream.

# Wind Turbines for Low Cost Power Generation

Some Relative Advantages and Disadvantages:

## **Drag turbines:**

**High start torque and low blade tip speed. Good performing at low wind speed. Low efficiency at high winds.**

## **Lift turbines:**

**Low start torque and high blade tip speed. Good performing at high wind speed. Not operated at low and very high winds. Extra loading at turbulent winds.**

## **Lift / Jet propeller ROTOJET™ turbines:**

**Good start torque. Best performing at moderate and high wind speed. Operated at both low and high winds.**

## **Lift / Drag / Jet ROTOJET™ vertical axis turbines:**

**Very good start torque. Best performing at low and moderate wind speed. Operated at both low and very high winds.**

# Wind Turbines for Low Cost Power Generation

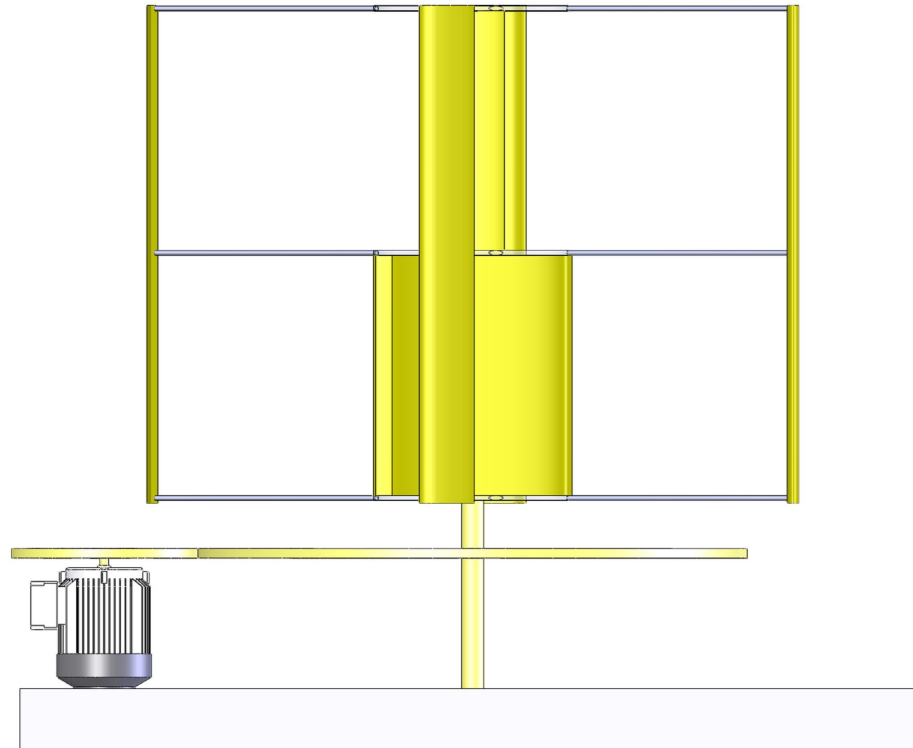
## **ROTOJET™ universal turbines**

**are based on a revolutionary concept, the result of many years of patent's development.**

**It was the world's first low noise and nature friendly commercial scale turbines to generate electricity from low velocity turbulent wind and the first to be used in wind farm projects, hybrid PV-wind farm and systems and for small scale power generation, as well.**

**ROTOJET™ system is applicable of both vertical and horizontal axis direct drive or geared turbine generators.**

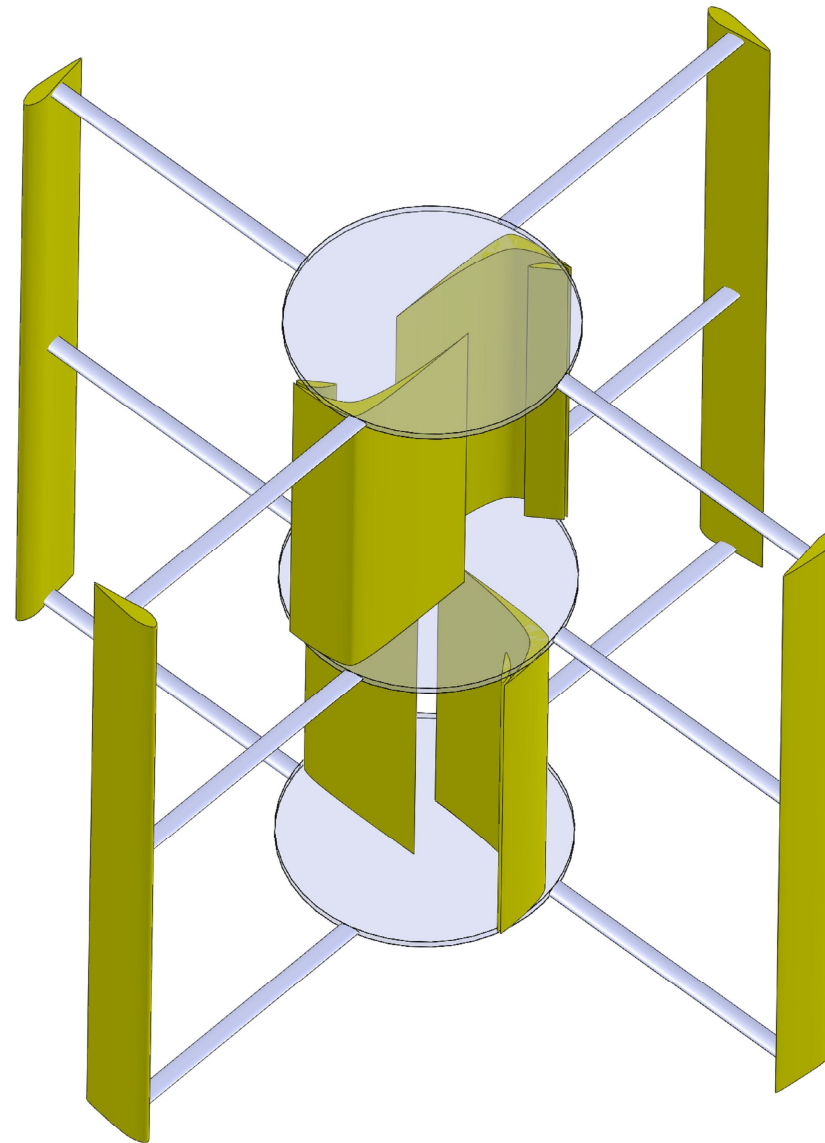
# Wind Turbines for Low Cost Generation



**Vertical axis ROTOJET™ turbine-generator**

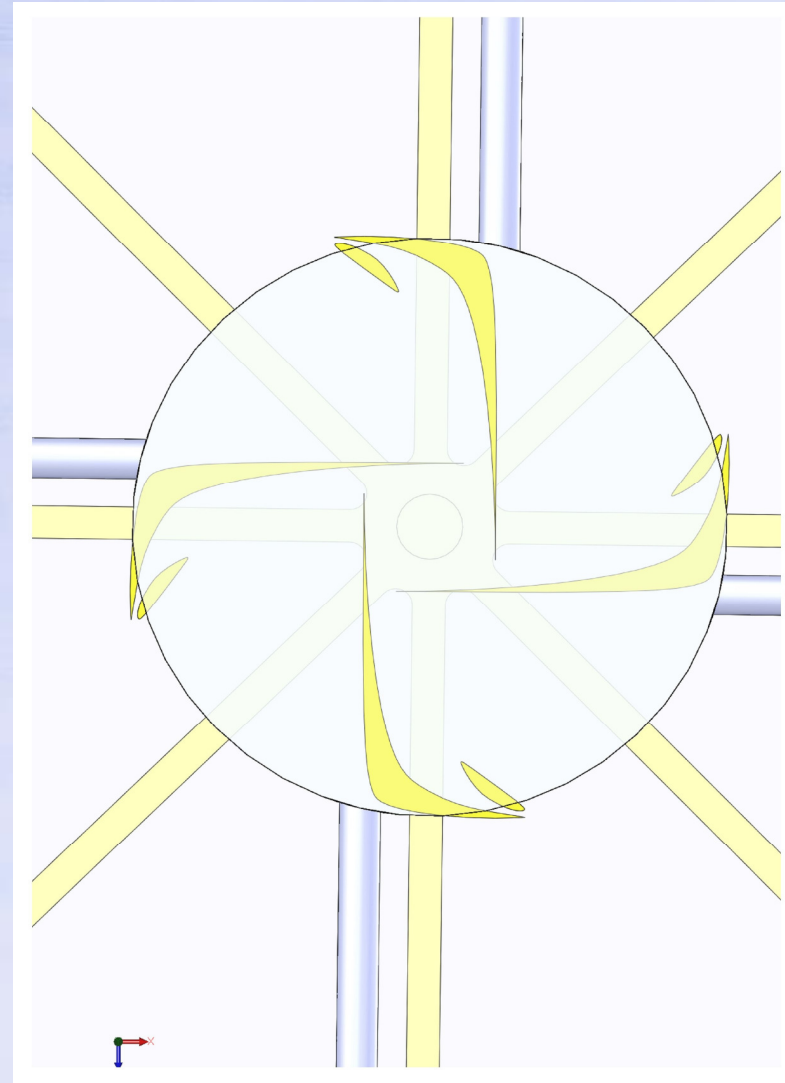


**Inner low blade  
speed rotor  
and outer  
high blade  
speed rotor of  
vertical  
co-axial wind  
turbine**



**Vertical Co-Axial ROTOJET™ turbine**

**Starter / low blade speed rotor of the newly Invented Lift / Drag / Jet Co-axial wind turbine**



**Vertical axis ROTOJET™ turbine**



# Wind Turbines for Low Cost Power Generation

## Jet Tip Propeller Blade Upgrades

It has for a number of years been common practice in air craft wing design to arrange different types of winglets or other means at the wing tip for reducing or preventing the spanwise flow of air from the pressure (upwind) side of the wing profile to the suction (downwind) side of the profile around the tip, which results in the creation of the tip vortex and a decreased lift coefficient at the tip section of the blade/wing, mainly due to the reduced suction at the suction side. Wind turbine rotors having lift blades equipped with winglets are also known in the art, mainly for the purpose of reducing noise emission from the wind turbine due to the presence of the tip vortices but also to improve the overall performance of the wind turbine.

# Wind Turbines for Low Cost Power Generation

## Jet Tip Propeller Blade Upgrades

A curved endplate winglet at the tip of a finite blade/wing can reduce the spanwise flow and thereby reduce the induced drag. Unfortunately, to be effective, the endplate must be so large that the increase in wetted area drag far outweighs any induced drag reduction.

That is why we are developing a radical new tip blade solution simultaneously reducing the induced tip drag and increasing rotational torque of blade tip. We upgrade blade tip by jet channels formed at the pressure (upwind) side of the tip wing profile.

# Wind Turbines for Low Cost Power Generation

## Jet Tip Propeller Blade Upgrades

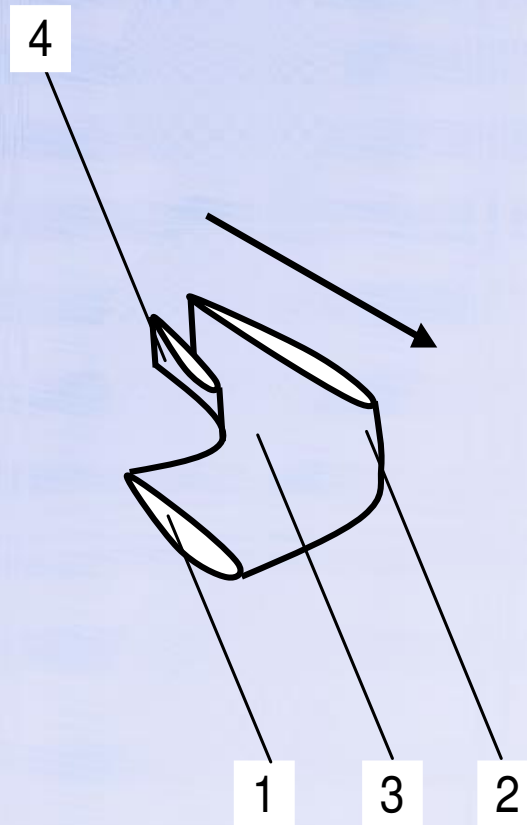
The jet channels form a jet stream. The jet stream creates a tip jet force  $F_{tjet}$ . The additional jet torque equal

$R \times F_{tjet}$  , when  $R$  is the rotor radius.

The additional jet torque increased overall turbine efficiency. The blade tip with jet channels we named JET TIP.

The JET TIP is a successfully applicable upgrade of both drag and lift propeller turbine. It is an universal solution for wind and water stream applications.

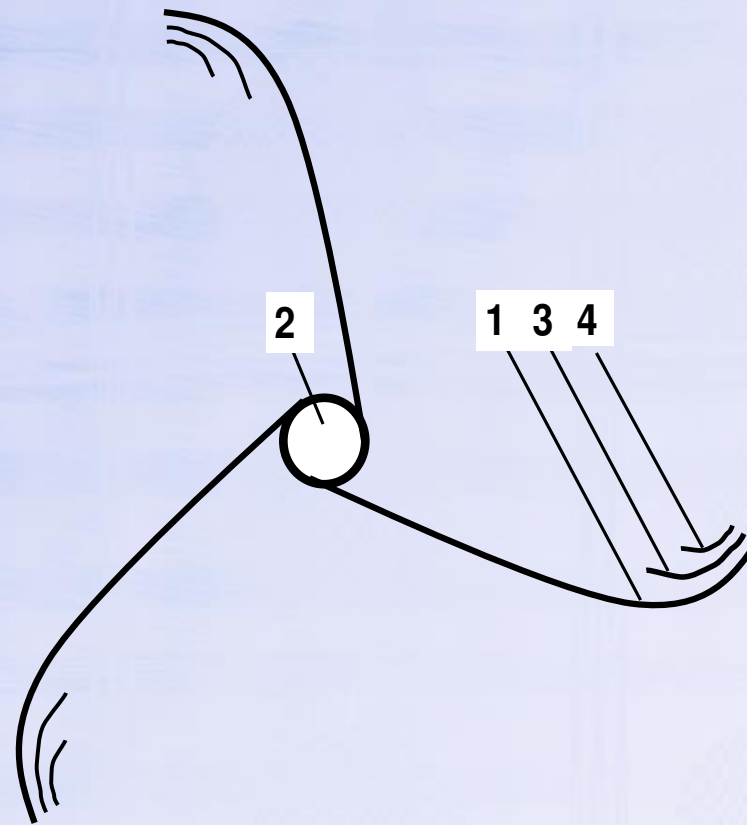
## A Jet Tip of the Propeller Blade



Фиг. 1

# Jet Tips of Cross Flow Rotor Blades

Two JET TIP channels of every blade



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## Jet Tip Propeller Blade Upgrades

In essence, the JET TIP diffuses or spreads out the influence of the wing tip vortex such that the downwash and, in turn the induced drag, are reduced. In this way, the JET TIP acts like an endplate in reducing the spanwise flow but, creating a tip jet force, it accomplishes this with much less wetted area.

Another benefit of JET TIPs, which is not achieved by a simple span extension, is the effect on the more uniformly spanwise pressure distribution, particularly in the region of the lift blade tip. The influence of the JET TIP effectively creating the local rotational force.

# Wind Turbines for Low Cost Power Generation

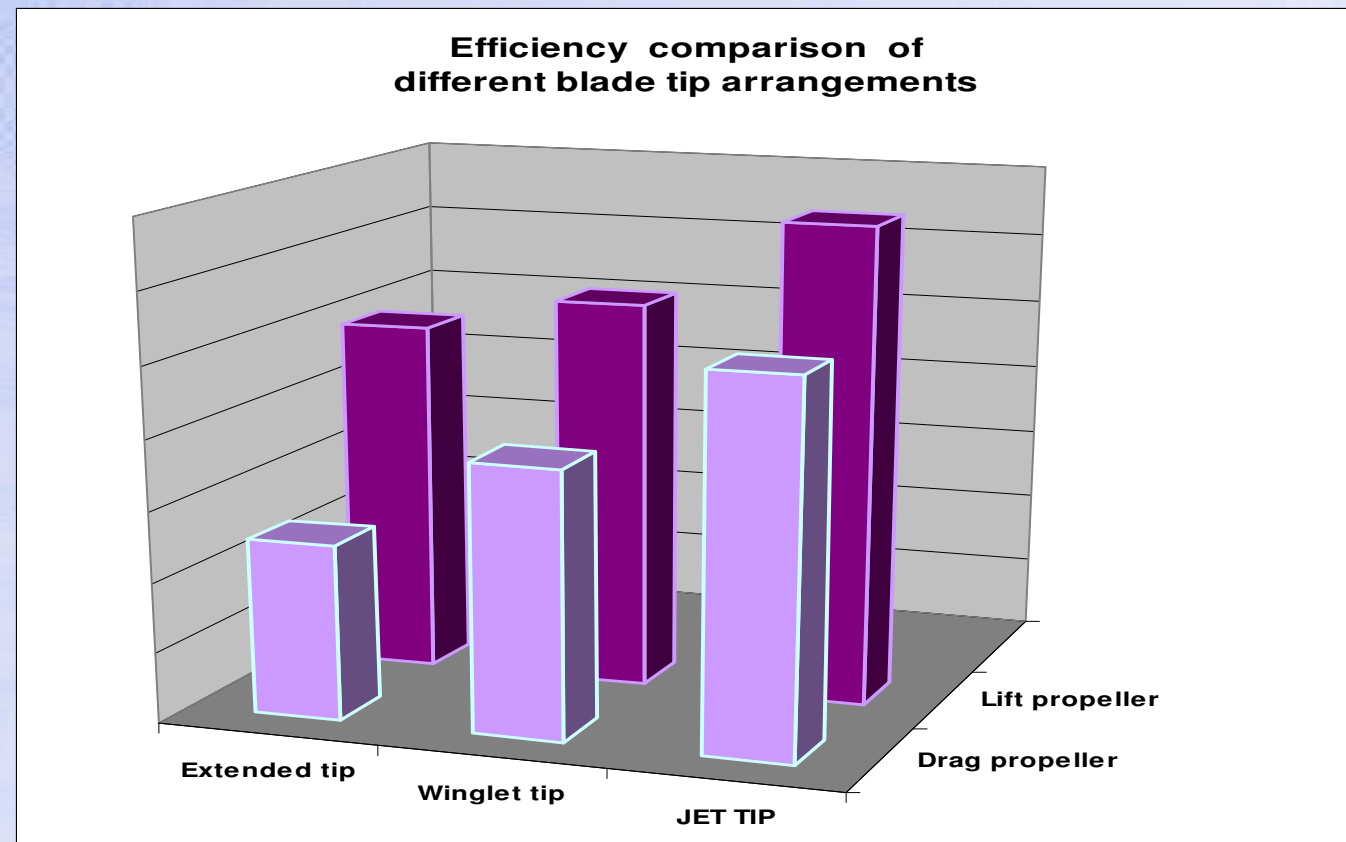
## Jet Tip Propeller Blade Upgrades

Summing up the overall benefits of JET TIP vs. blade tip extension is:

1. Installation of JET TIP upgrade is found to cause a larger increase in the power coefficient and a smaller increase in the flap bending moment than radially extended rotor blades
2. Significantly decrease noise from tip vortices.
3. The smaller turbine diameter for the same tip velocity results in smaller gear ratio or direct drive generators for urban applications.
4. On some sites the local regulations dictates maximum wind turbine height (tower + blade tip in highest position).

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## Jet Tip Propeller Blade Upgrades



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You can see a video of a co-axial vertical axis  
Lift / Drag / jet ROTOJET™ turbine generator  
at [www.tonchev.org/va.avi](http://www.tonchev.org/va.avi)

**Thank you for your attention**  
George Tonchev