



**Big Kinetic**  
*turbines (wind etc)*



# Axis

“Vertical” (Perpendicular to wind)

“Horizontal” (Parallel to wind)

Blade Type

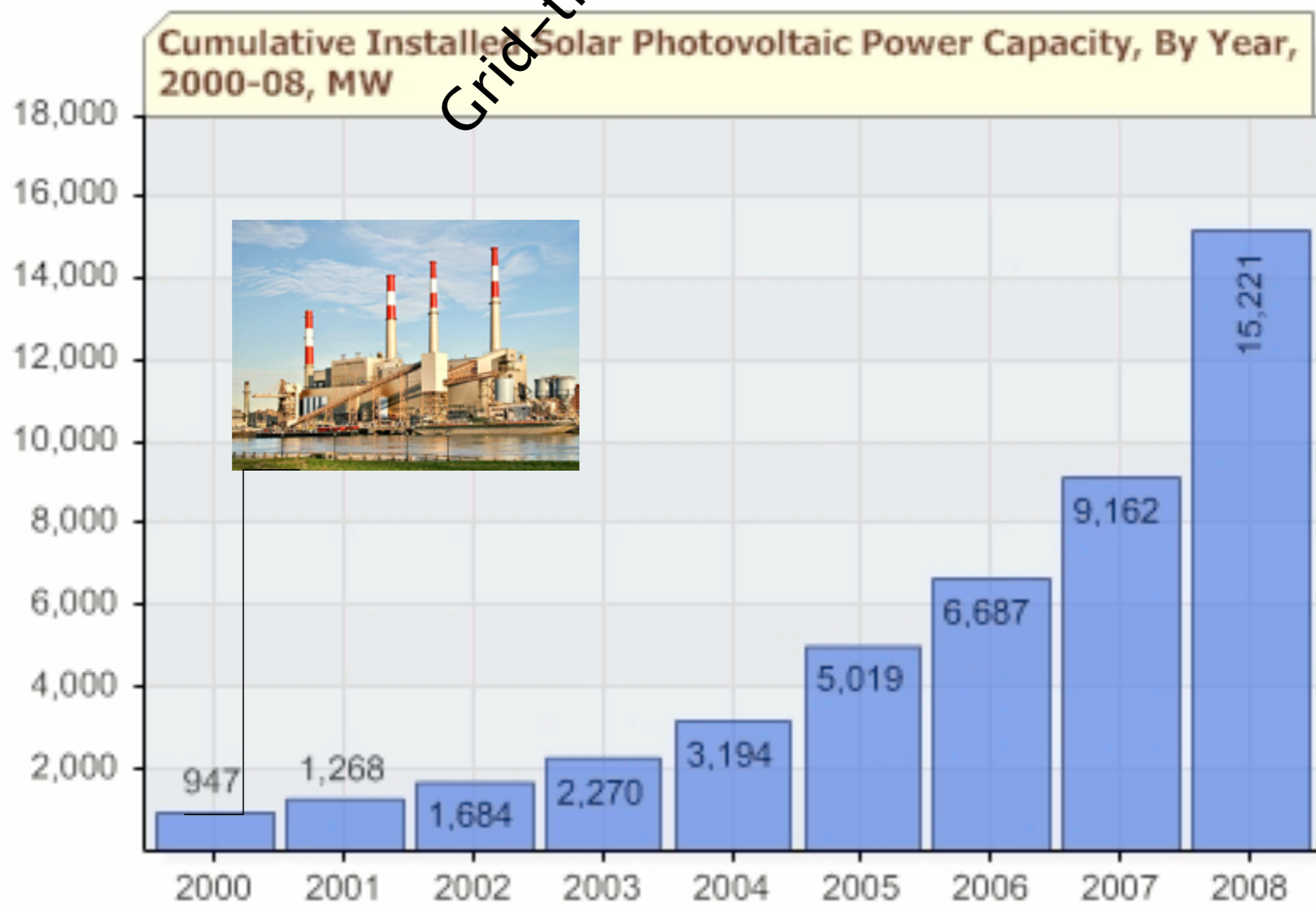
Lift



Drag

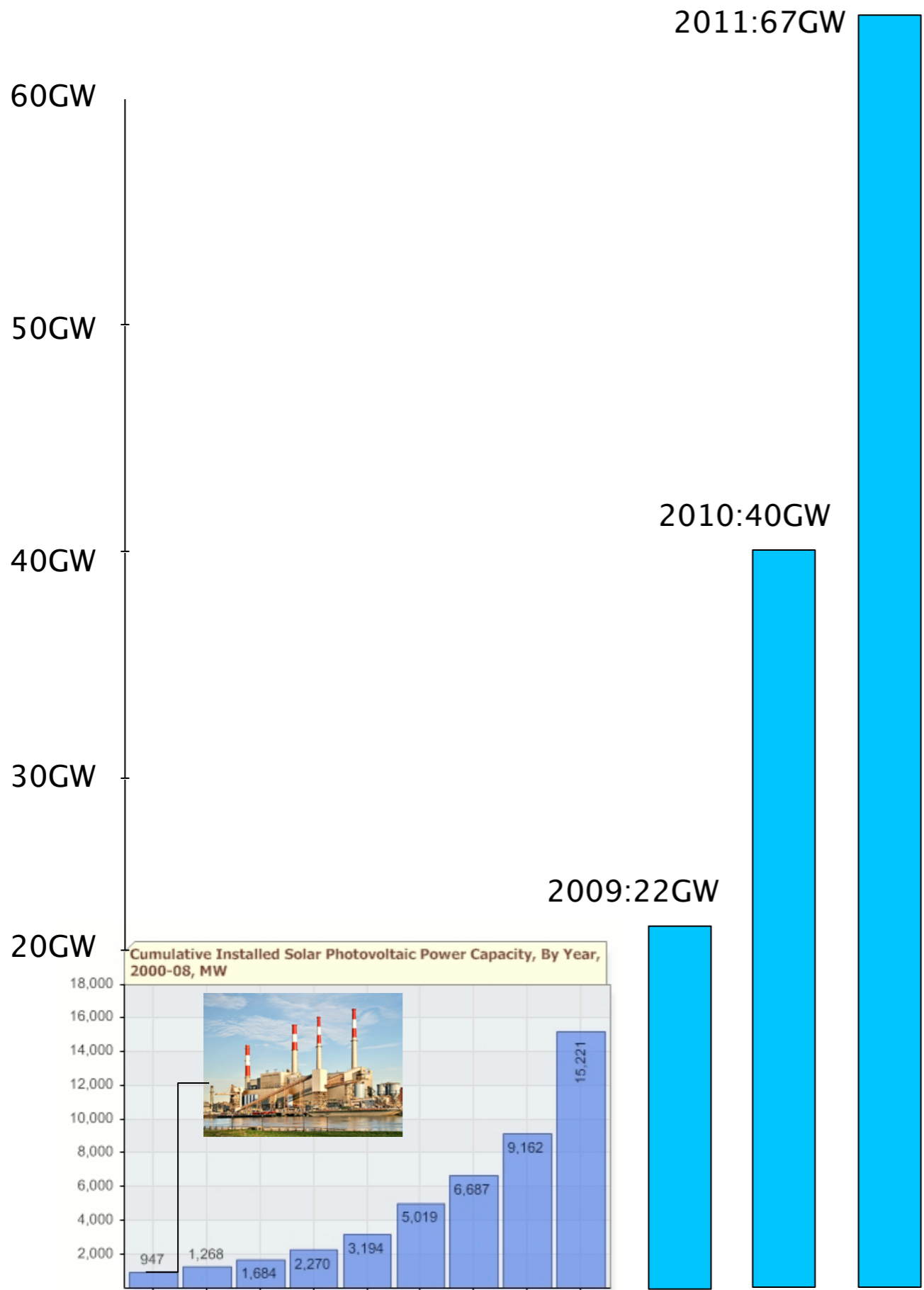


Grid-tied



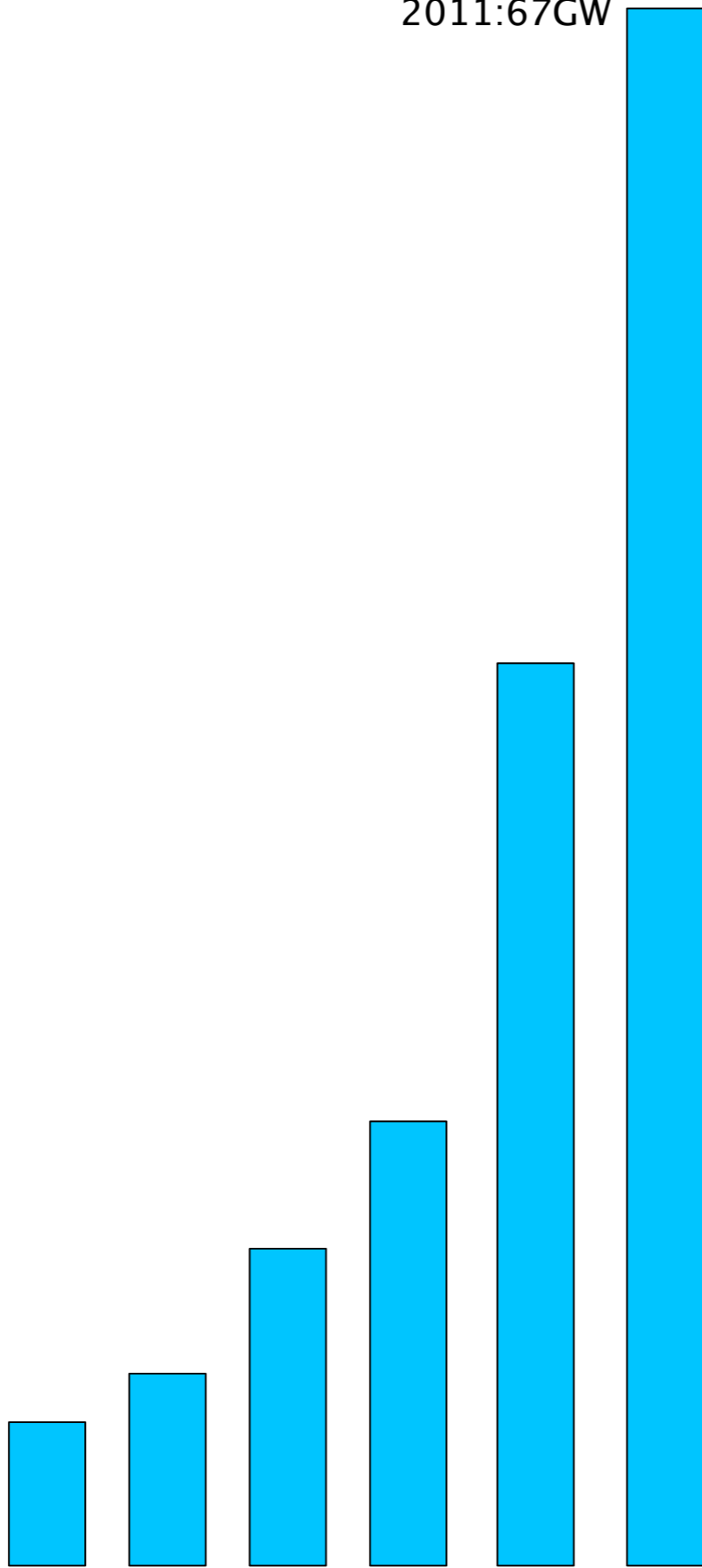
Source: <http://www.energyandcapital.com/>

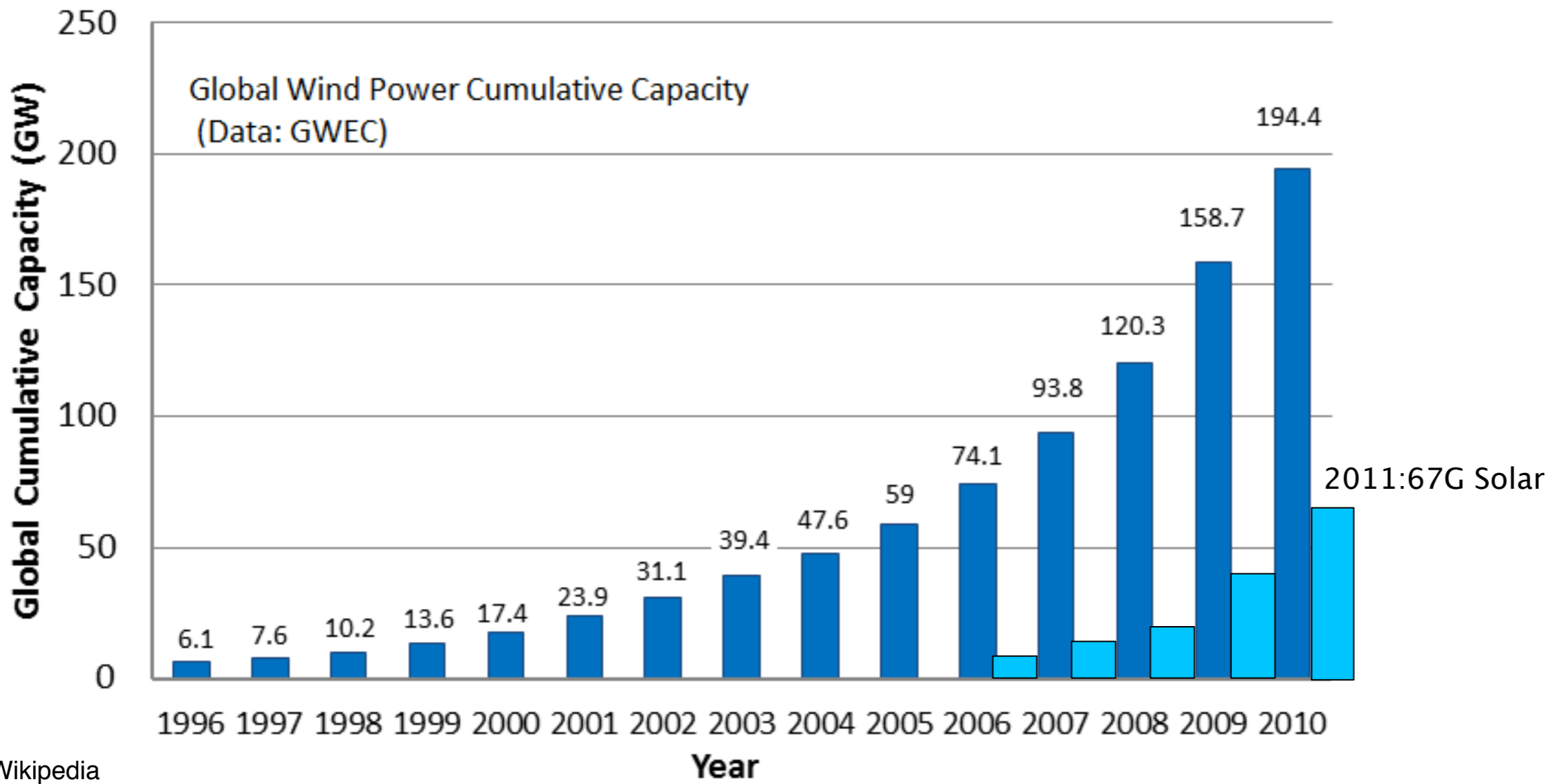
Inset: Big Allis, first 1GW generator, in Queens.



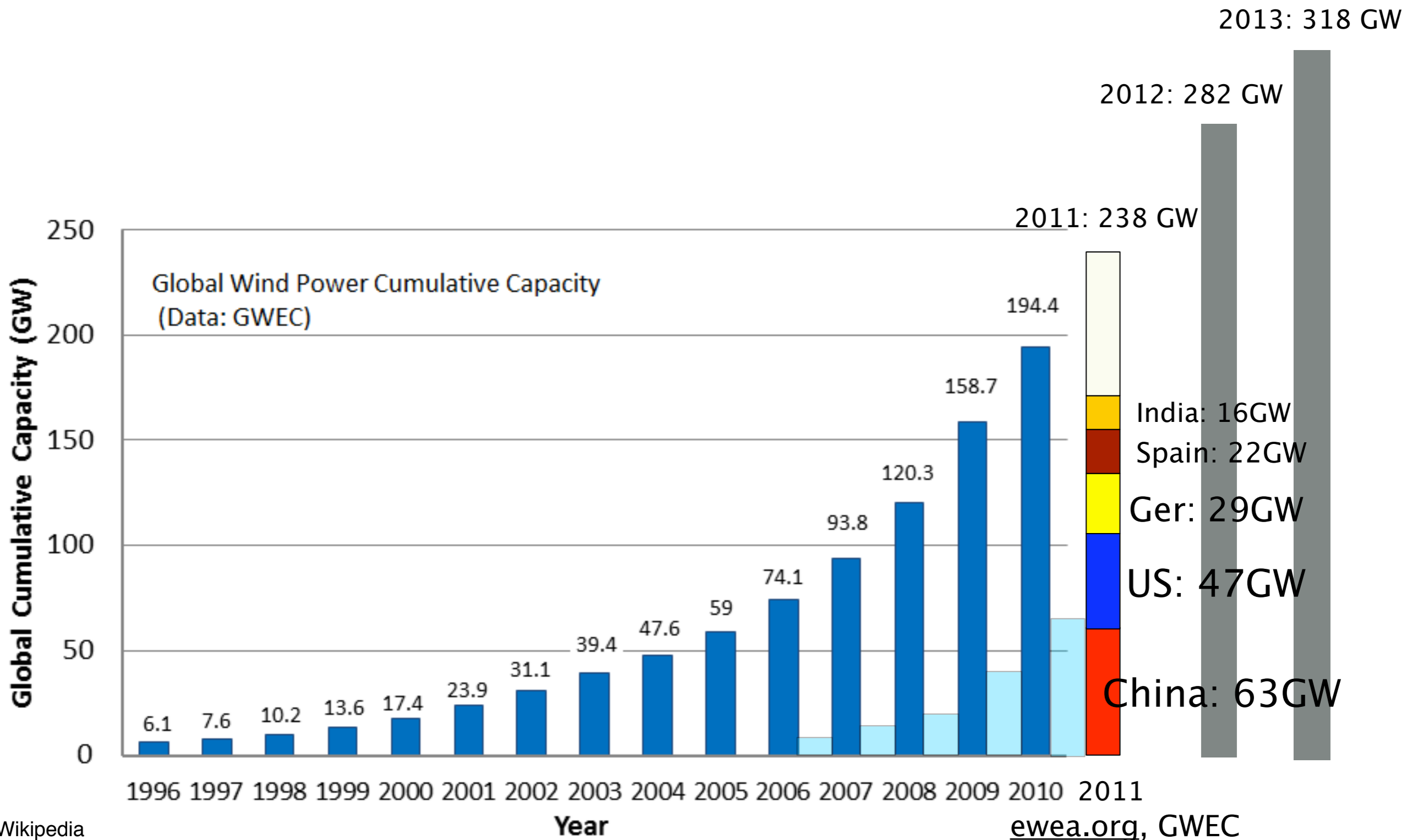


2011:67GW













2.3 MW



~ 2MW typical turbine size



2.3 MW



x 11,500\*

\*200 watt output



2.3 MW



x 22\*



\*140 hp output



2.3 MW



x 435



\*1000 MW



Brooklyn Wind Turbine

Vestas V27  
225 kW

572 m<sup>2</sup>  
swept area

31m tall  
13.5m  
blade length

Project West Wind

Siemens 2.3  
2.3 MW

5,026 m<sup>2</sup>  
swept area

67m tall  
40m blade length

Mahinerangi

Vestas V90  
3 MW

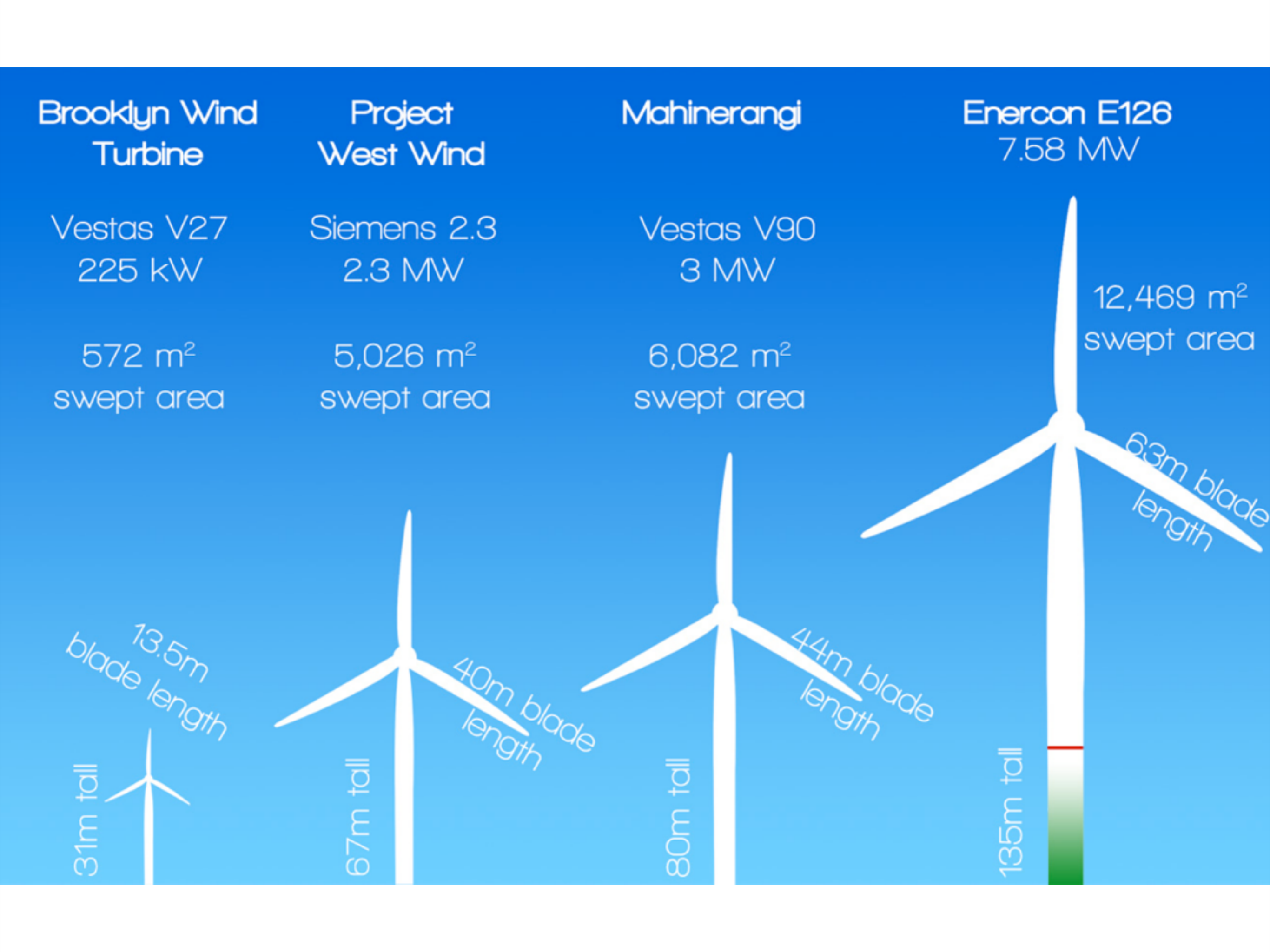
6,082 m<sup>2</sup>  
swept area

80m tall  
44m blade length

Enercon E126  
7.58 MW

12,469 m<sup>2</sup>  
swept area

135m tall  
63m blade length







<http://www.juwisolar.com/>

## 2.2 MW solar installation for Mars Corp, Hackettstown, NJ



Google Earth



Capacity factor: 20 - 40%

$$2.3 \text{ MW} \times 365 \text{ days} \times 30\% = 6 \text{ GWh}$$





**PETZL**



© Jean-Paul Cane / Rope Partner  
[www.petzl.com](http://www.petzl.com)





Offshore wind





Makani M30 30kW  
prototype airborne turbine



# Airborne Wind Turbines

Joby RIP 2012

Joby Energy is developing airborne wind turbines which will operate in the upper boundary layer and the upper troposphere.

While knowledge of the tremendous energy in high-altitude wind is not new, recent advances in power electronics, sensors, and control systems now make our technology practical.

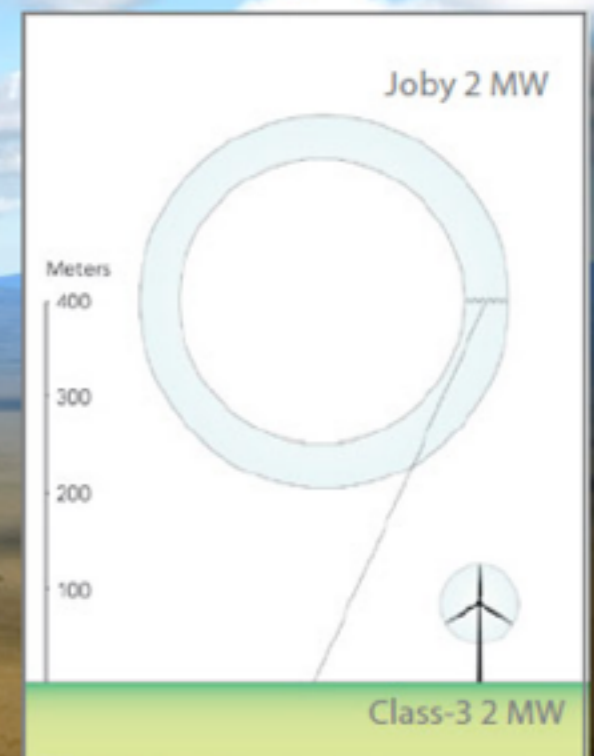
Our multi-wing structure supports an array of turbines. The turbines connect to motor-generators which produce thrust during takeoff and generate power during crosswind flight. Orientation in flight is maintained by an advanced computer system that drives aerodynamic surfaces on the wings and differentially controls rotor speeds. A reinforced composite tether transmits electricity and moors the system to the ground. The high redundancy of the array configuration can handle multiple points of failure and remain airborne.



## How It Operates

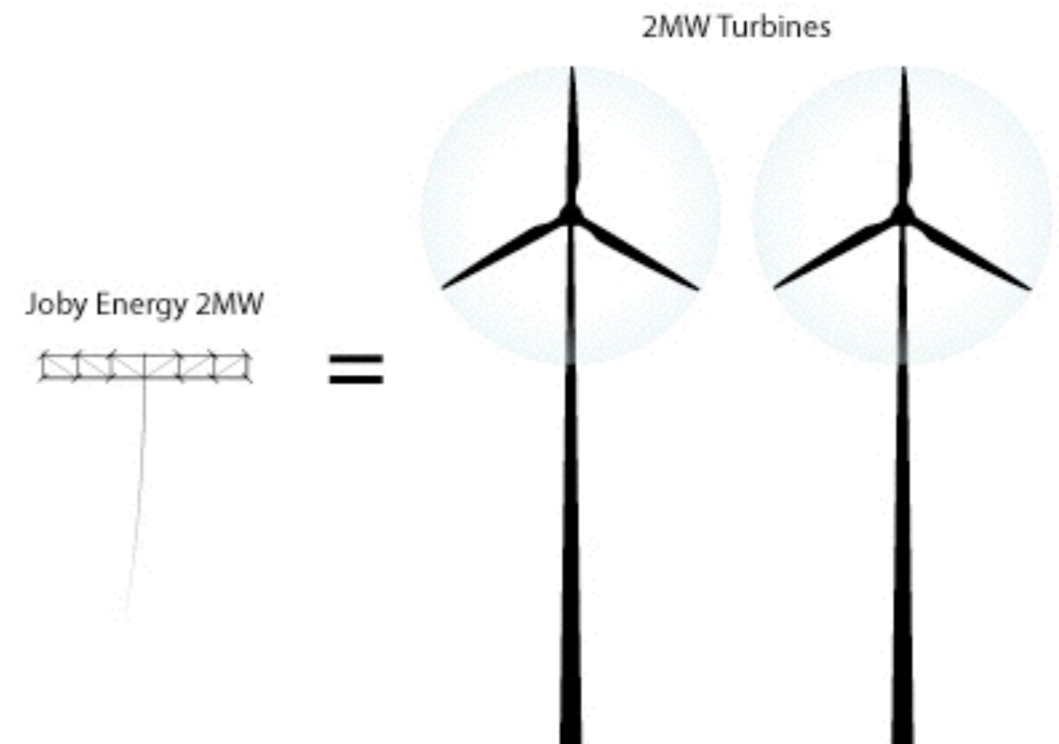
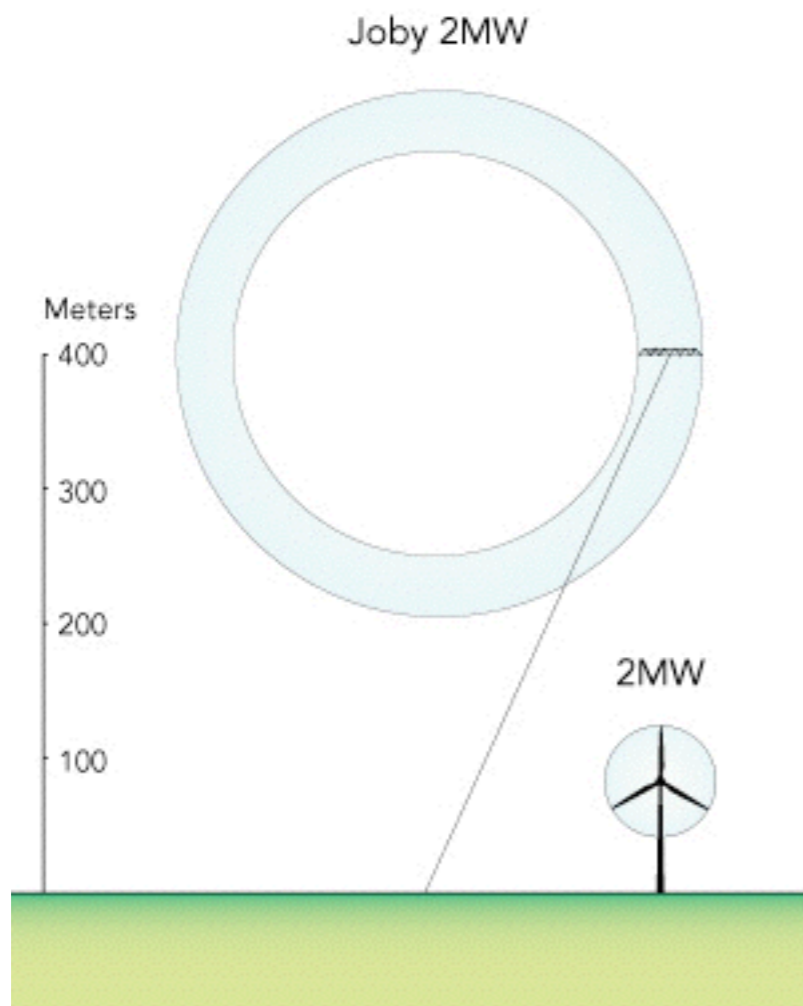
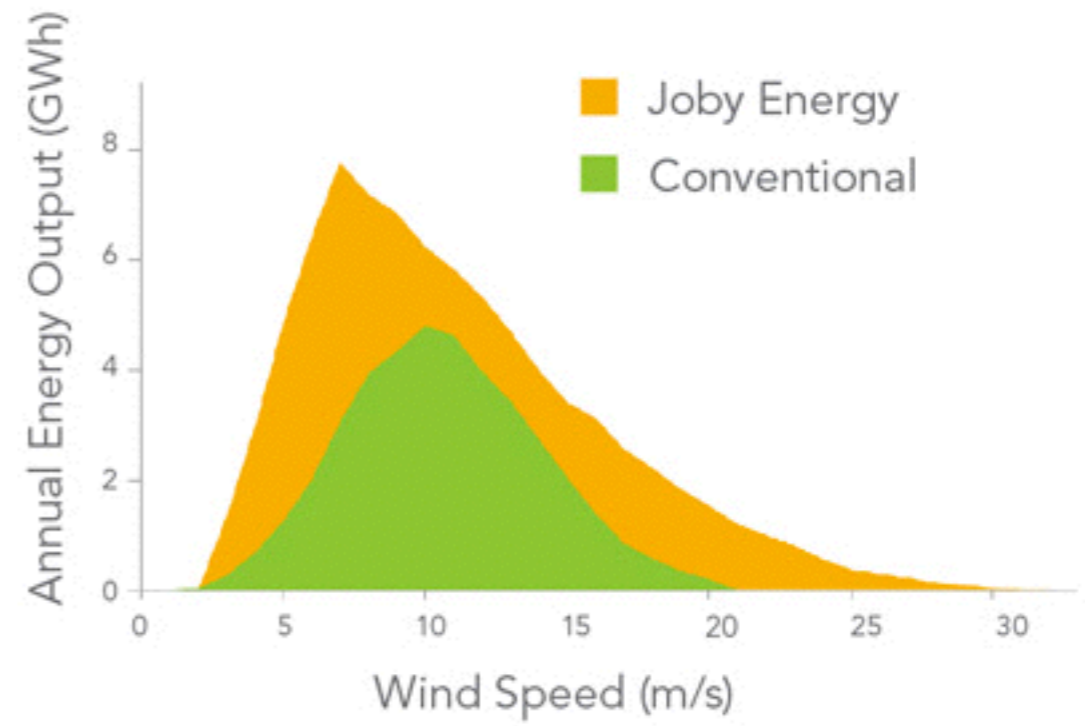
For launch, the turbines are supplied with power to enable vertical take-off. Upon reaching operating altitude, the system uses the power of the wind to fly cross-wind in a circular path. The high cross-wind speeds result in the turbines spinning the generators at high speeds, eliminating the need for gearboxes and increasing efficiency. The energy is transferred to the ground through the electrical tether. During occasional periods of low wind the turbines are powered to land the system safely.

Joby turbine





Joby turbine data  
(predicted)



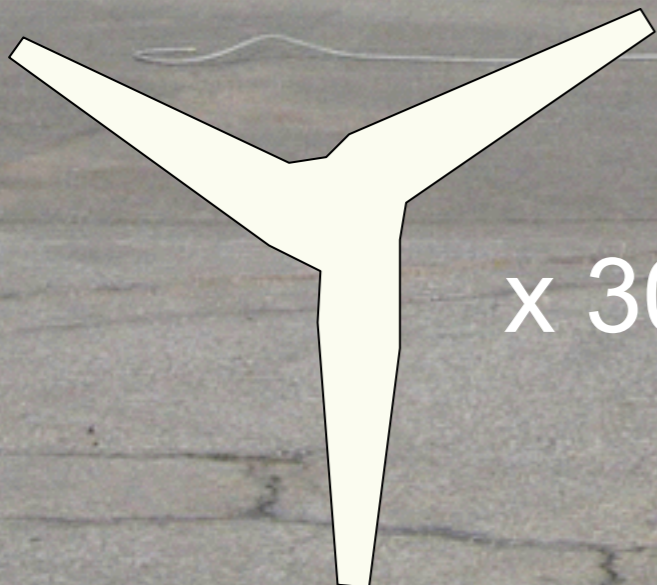




- Phase 1 (2002 – 2006): Prototype Testing
- Phase 2 (2006 – 2009): Demonstration
- Phase 3 (Current): MW-Scale Build-Out

Verdant Power East River turbines





x 30 = 1 MW

Verdant Power East River turbines





Source of wind?





Source of wind?





“Wind Powered Footbridge” [www.michaeljantzen.com](http://www.michaeljantzen.com)

Swept area?