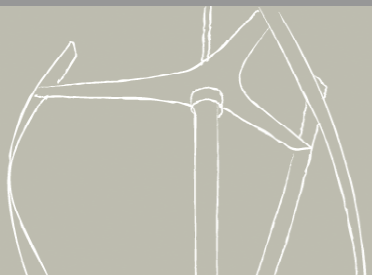


# Airport Safety

quietrevolution VAWT, Impact on Radar &  
other airport safety systems



quietrevolution

# Airport Systems

- Used to safely control the movement, landing and take off of aircraft

Primary Surveillance Radar [PSR]

Instrument Landing Systems [ILS]

Distance Measuring Equipment [DME]

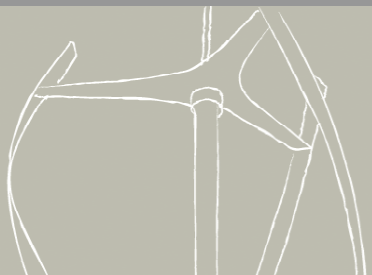
Doppler Radar Direction Finder [DRDF]



# Who are affected

- Airport operators, such as BAA  
Carriers / passengers  
Ministry of Defence  
Civil Aviation Authority

They all have genuine concerns

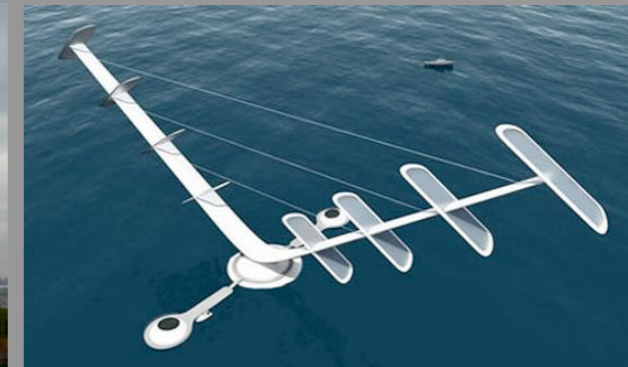


# Potential Impact of turbines

- Will depend on several factors:

## Scale of turbine -

The larger the turbine the greater the potential to affect airport systems

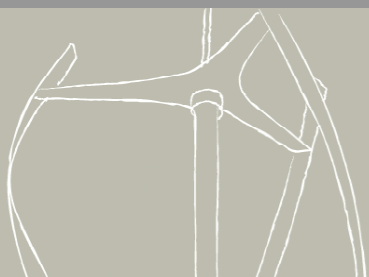
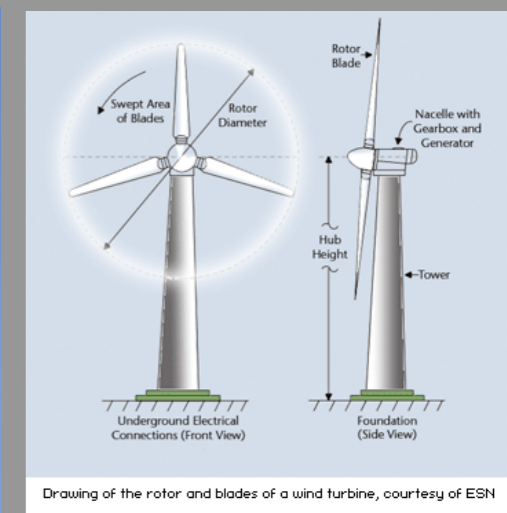


## Materials -

Some materials produce a more visible return than others

## Technology type - VAWTs & HAWTs

VAWTs keep a constant cross section, while HAWTs have a variable cross section



# PSR

## Primary Surveillance Radar [PSR]

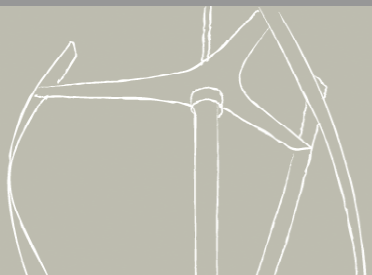
- Long-range, low or high frequency systems
- Typically located on elevated ground
- System incorporates Moving Target Identification [MTI] to discriminate wanted moving targets [aircraft] from static objects and ground clutter.
- Turbines must be in direct line of site of PSR for the radar to be affected.

### POTENTIAL IMPACT FROM WIND TURBINES:

A turbine is a reflector as all other ground clutter  
The 'reflectivity' of a large turbine may be several orders larger than that of an aircraft, there is a risk that the radar receiver could be blind to aircraft in the area beyond the turbines.

The rotating blades are 'seen' by the radar as a moving target, where the profile changes with wind direction.

The profile of a VAWT is constant regardless of wind direction.



# PSR

## Primary Surveillance Radar [PSR]

Impact of qr5 turbine would be similar to a car or truck & 3.6% of the RCS of Enercon E66 turbine

[NOTE: Vehicles operate on the airport aprons of all major airports]

Targets	RCS (m <sup>2</sup> )	RCS (dBsm)	Example Speed (ms <sup>-1</sup> )
Bird	0.01	-20	9-13
Man	1	0	0.8
Micro turbine	3.8	5.8	10-100
Small wind turbine	5	7	40
Cabin cruiser	10	10	8-13
VAWT	72.4	18.6	10-20
Car	100	20	13-30
Truck	200	23	13-26
Enercon E66 wind turbine	1995	33	30-70
Corner reflector	20379	43.1	0

Table 4-1 Comparison of the RCS values and speeds of a VAWT with other real world objects [7]

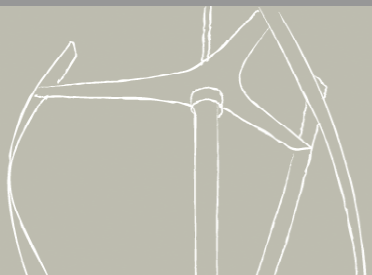
TABLE: TYPICAL RADAR CROSS SECTIONS OF VARIOUS OBJECTS.



# PSR

## Primary Surveillance Radar [PSR]

- **Moving target indicator filters can filter out the static components of the qr5. The static components are the source of the majority of the radar return.**
  - *“Taking into account the use of moving target indicator (MTI) filters in radar, and the likely clutter levels and obscuration associated with the urban environment, it is highly unlikely that a [quietrevolution] VAWT will add any additional clutter levels to that already seen and dealt with by a radar.”*
- QinetiQ report on qr5 VAWT, published Nov 2008
- **Conclusion -  
Even within an airport safeguarded zones a quietrevolution VAWT is unlikely to have any significant effect on the Primary Radar System.**



# ILS

## Instrument Landing Systems [ILS]

- Standard precision approach Landing system in civilian airports.
- Ground based air-interpreted instrument approach system
- Precision guidance using combination of radio signals
- Used in poor weather and reduced visibility conditions

### Two types of ILS

Single and Two frequency systems. Single frequency are more likely to be susceptible to reflections than two frequency types.

### Rotating Parts

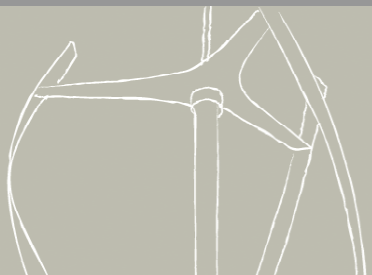
ILS's are not likely to be affected by the central mast or central turbine tube. The only parts of the rotor that could potentially affect an ILS are the rotating parts.

### Tone Frequencies

ILS's tend to operate with tone frequencies of 90Hz or higher, The qr5 turbine's rotational frequency is 5Hz to 15 Hz and the effects from the turbines on an ILS are therefore likely to be un-measurable.

### Disturbance

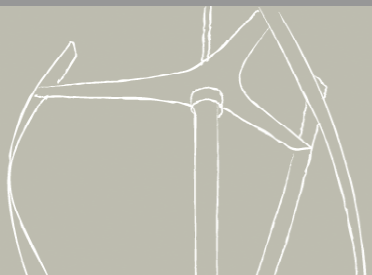
Any disturbance to an ILS is likely to be extremely small [or probably non existent], even when the turbine is located with line of site and within the airport safeguarding zones



# DME

## Distance Measuring Equipment [DME]

- Used to measure aircraft distances as they approach for landing
- Typically considered as a back-up system
- Various types : Omni-directional or multi-path; can have single or bi-directional antenna
- Omni-directional with single antenna will be more susceptible than Multi-path bi-directional versions
- Typically located 3m above ground level
- Typically 1no. or 2no. DME's on each airport runway
- Sensitive to degradation by building development in line or close to line of aircraft approach
- Only susceptible to interference if there is a line of sight between DME and turbine
- The affect of a turbine will depend on the type and location of the DME at an airport



# DRDF

## Doppler Radar Direction Finder [DRDF]

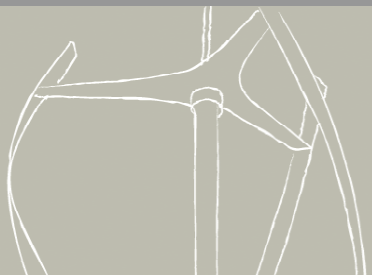
- Received VHF communications from aircraft.

Potential for some interference from turbines if located within airport safeguarded zones

A turbine is unlikely to affect signal strength  
The potential risk is that bearing errors are introduced.

The level of risk is low, depending on the individual airport systems and degraded by existing 'clutter'.

rotor siting to avoid positions between aircraft approach paths [and emergency exit paths] and air traffic communication locations



# Summary

The three key parameters in determining impact on airport navigation and radar equipment are:

1. Whether the turbine(s) are within the airport safeguarding zones
2. Whether the turbine(s) are in direct line of sight of the equipment
3. The quality / age of the airport systems

In most commercial and military airports, with modern sophisticated equipment the installation of qr5 turbines should be possible

Modern airport systems can easily filter out and ignore any effects of the turbines, in exactly the same way that they filter out airport structures and airport ground vehicles



# Summary

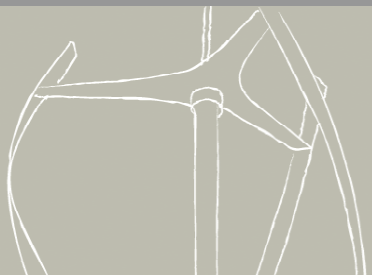
**QinetiQ report on qr5 VAWT, published Nov 2008, summarised the impact of the qr5 turbine on radar as follows:**

*“... urban clutter attributed to cars and trucks, which have a comparable RCS [Radar Cross Section] return, would have already created similar clutter levels. Therefore, the addition of a [quietrevolution] VAWT to this clutter would have limited impact.”*

*“ MTI [moving target indicator] filters are used within the radar. This effectively cancels out the RCS from the static parts of the VAWT, leaving just the RCS of the moving components. Therefore, despite being readily detectable, the RCS due to the static components of the VAWT are unlikely to show up on the radar display.”*

*“Taking into account the use of moving target indicator (MTI) filters in radar, and the likely clutter levels and obscuration associated with the urban environment, it is highly unlikely that a [quietrevolution] VAWT will add any additional clutter levels to that already seen and dealt with by a radar.”*

*“... it should be noted that this RCS [Radar Cross Section] would be no more visible than that of other objects such as houses and telegraph poles or lampposts. The [quietrevolution] VAWT is primarily designed to be placed in urban areas, which will be surrounded by trees, houses and lampposts. So a [quietrevolution] VAWT is unlikely to add any more static clutter to an operators screen than is already present.”*



# Information Sources



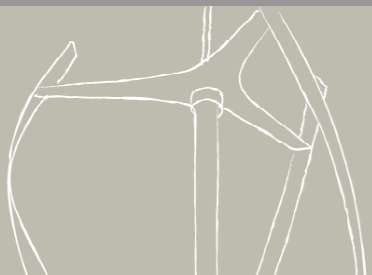
Our current knowledge is primarily based on 2 reports :

**QinetiQ, July 2008 [which included a real test of the visibility of the QR5 turbine to typical radar systems as used by civilian and military airports]**

This report is available on request from quietrevolution

**Cyrrus, 11 April 2008 [An impact study of quietrevolutions turbines on Filton Airport systems]**

This report was commissioned by a client of quietrevolution and can only be released upon receiving their written approval.



# Airport Safety

questions

