Investigating The Wind Flow Around Urban Residential Buildings.

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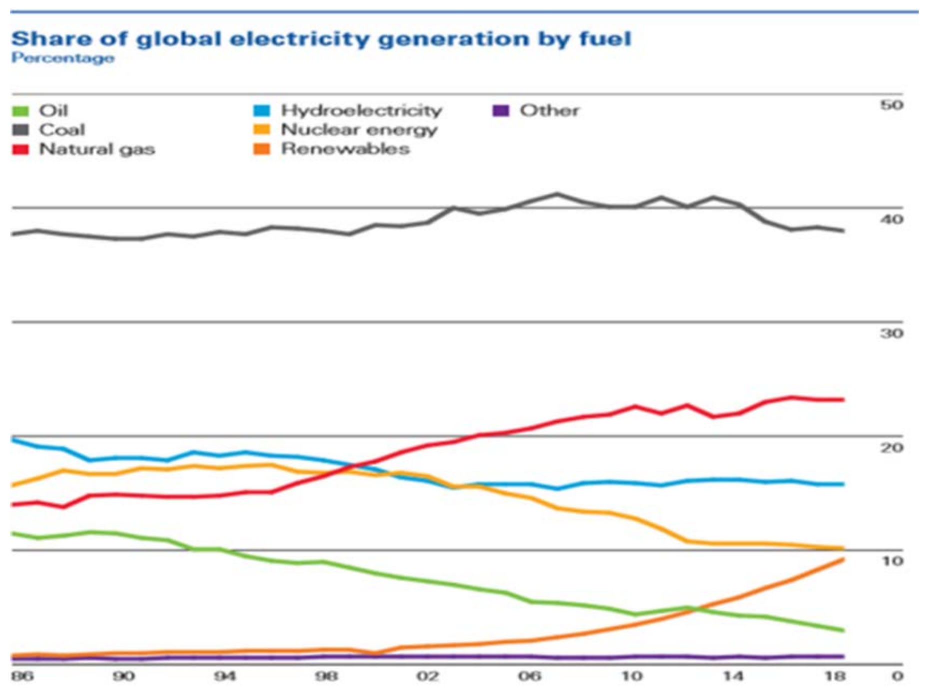
Introduction

As energy demand continues to rise along with the CO2 emissions due to human processes, every possible avenue of energy generation needs to be explored. Producing energy from roof tops at the source is a sustainable and efficient technique providing it is shown to work.



% share of global energy generation from 86-18 (Dudley, 2019)

Project Aims

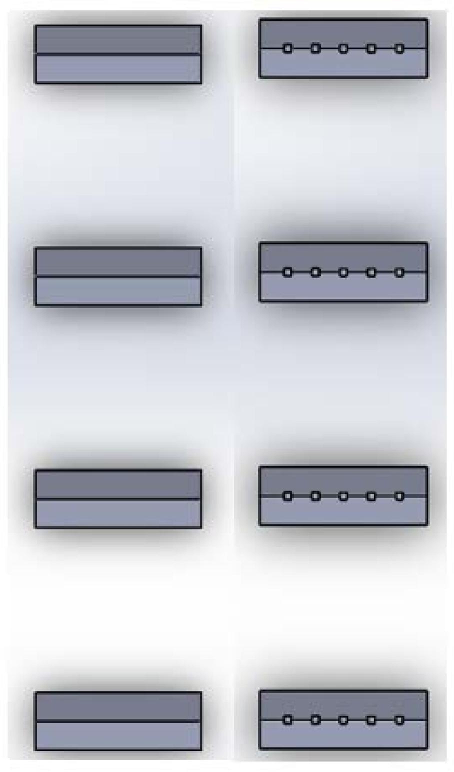
- Determine the best urban wind extraction technology
- Describe the flow patterns in urban Meteorology
- Evaluate the effect of wind direction on the turbine configuration
- Assess the wind resource across Swansea city.
- Determine the feasibility of wide spread roof-mounted turbine installation

Method

A review of the wind estimation tools was undertaken, where CFD was shown to work best. Following this the best practise was researched and applied, later validated against experimental data for reliability.

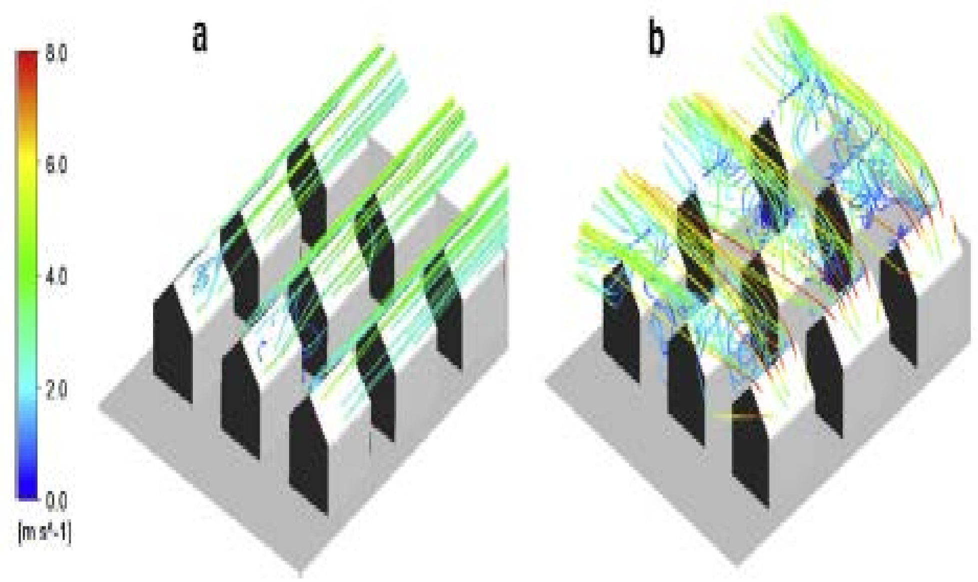
An array of pitched roofs was modelled with an without chimneys. A point midway between two chimneys and through the chimney centre were considered at various heights. The effect on incident wind direction of these points were evaluated.

The idealised array of roofs pitched at 45 with and without chimneys can be seen to the right.

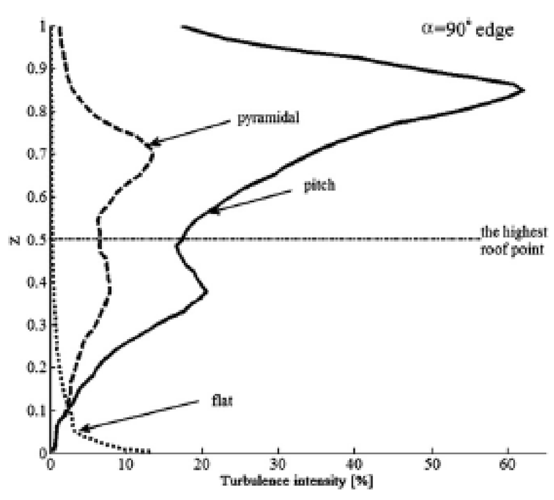


Results.

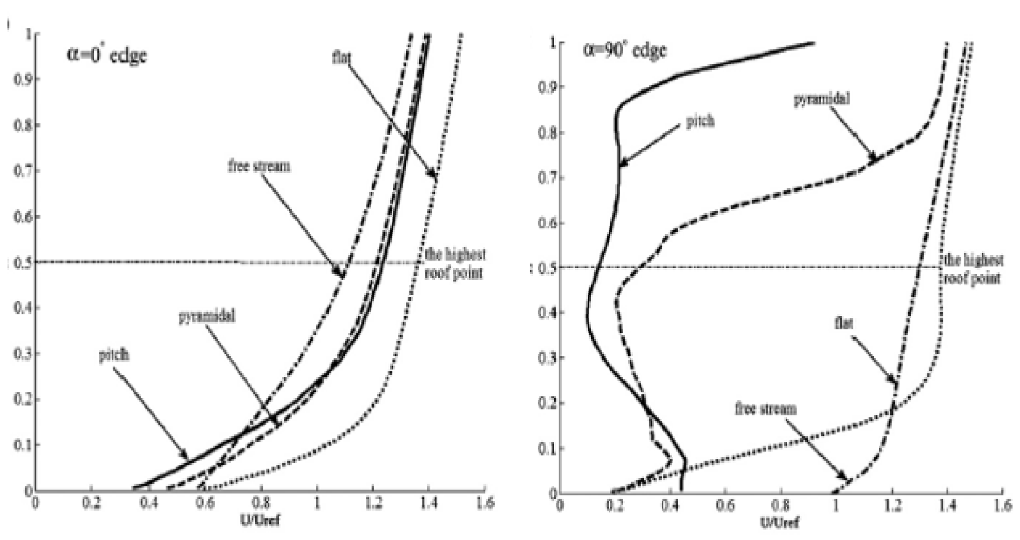
The best extraction device was shown to be a helical Darrieus VAWT that reached a Cp = 0.38 and a cut-in wind speed as low as 1.25 (m/s), shown in the image to the left (Batista, 2015).



The flow patterns were shown the follow the isolated for 0˚ (a) and skimming regime for 90˚ (b) as *described by (Best, 2008). An illustration of this is shown in the above image (Ledo, 2011)*



Ledo, L. (2011) 'Turbulence Intensity vs Height Above the Eve',.



Ledo, L. (2011) 'Streamwise Velocity vs Height Above the Eve'

The results lower turbulence intensity and higher streamwise velocity for incident winds at 0˚ than 90˚

This lead to developing the criteria that only houses situated situated to to be within +/-20˚ of 0˚ incident wind directions are considered good sites. Applying this to the Rensmart wind resource tool and Met Office ind rose Chart, a reduction of up to 80% of potential sited was recorded

Wind rode chart recorded 15m above ground at Mumbles head, Swansea. (Met Office, 2020)

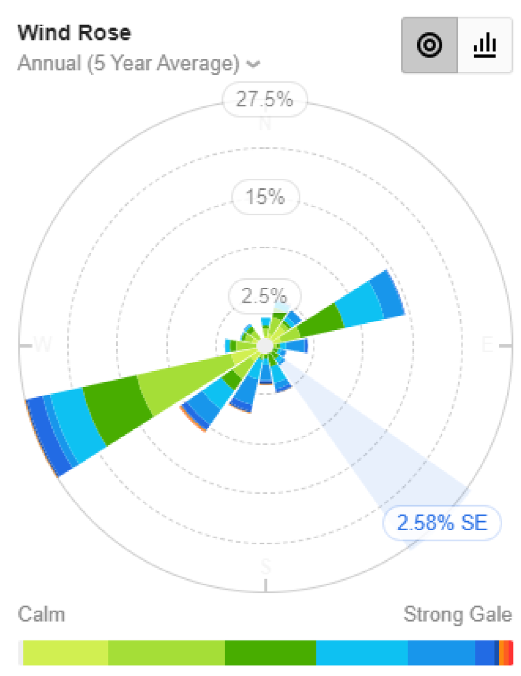


Table of results showing the reduction of potential sites as a result of the wind direction criteria

Grid Region	% of potential sites
5.5	76
5.4	53
6.3	20
6	72

Conclusion

The Darrieus turbine is the best extraction device. Urban wind structure is very complicated and difficult to predict. The large-scale installation of roof-mounted turbines is not feasible as there are a large number or variables each dramatically effected the potential yield.

References

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