

Scanning Converging Beam LIDAR (Laser Wind Measurement)

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Team & Collaboration



Founder – Dr Theodore Holtom

Technical collaborators –
Fraunhofer UK Research Centre
for Applied Photonics; Renewable
Advice Ltd blade specialists

Academic collaborator – Dr
Anthony Brooms (Birkbeck, Univ
London): maths, data science, AI



David McCabe – shareholder, advisor:
project management, systems improvement

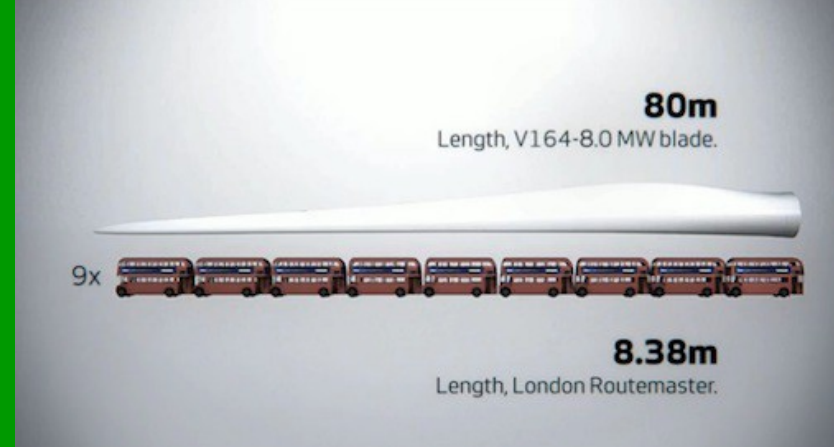
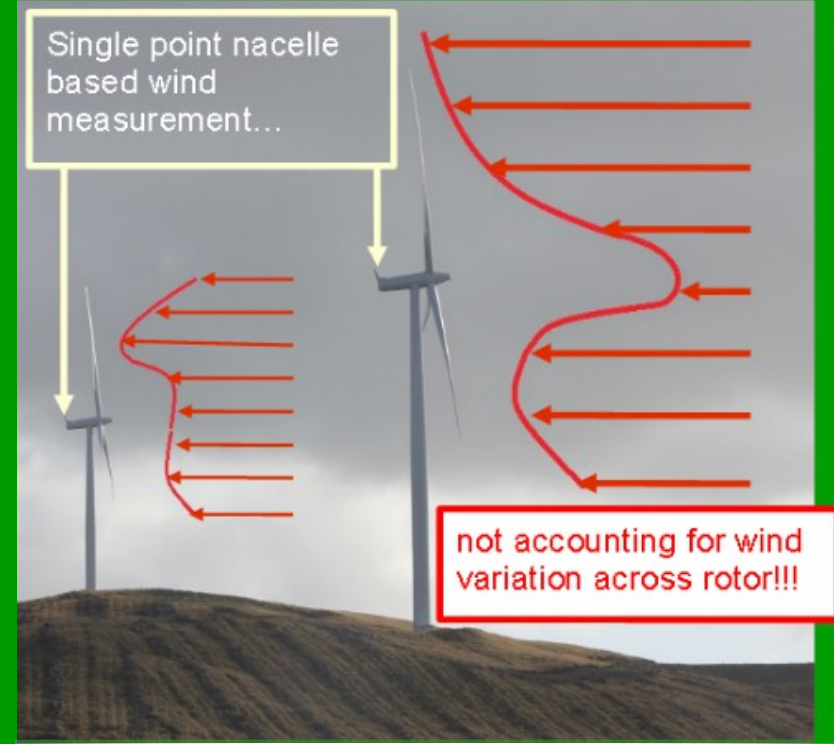


Catherine Dunbar – shareholder, advisor: scientific communications strategy



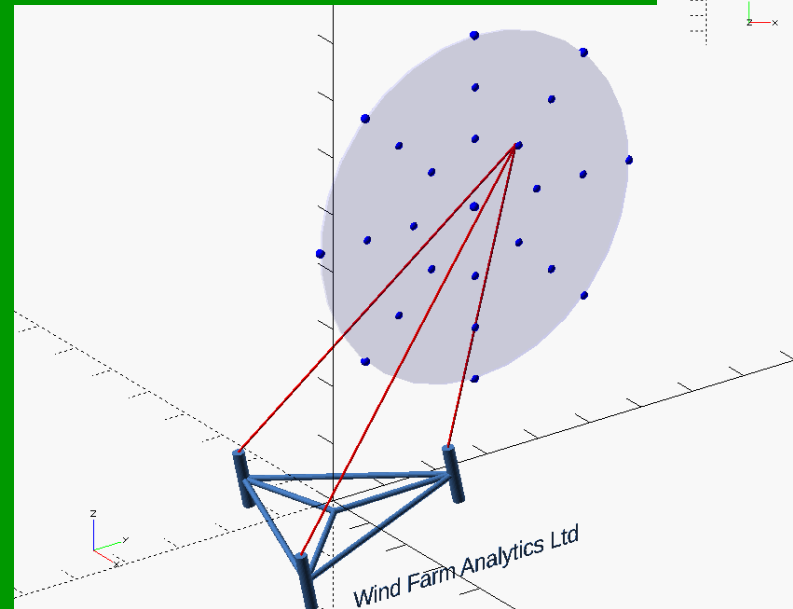
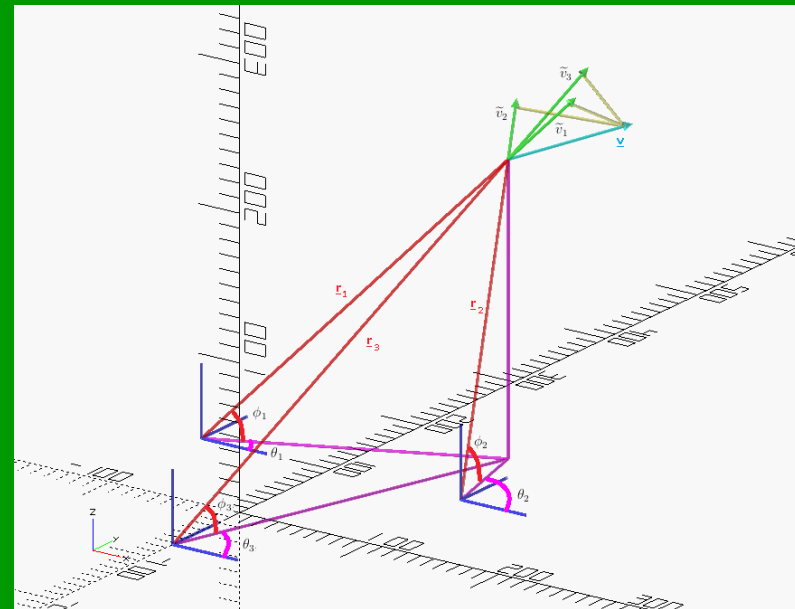
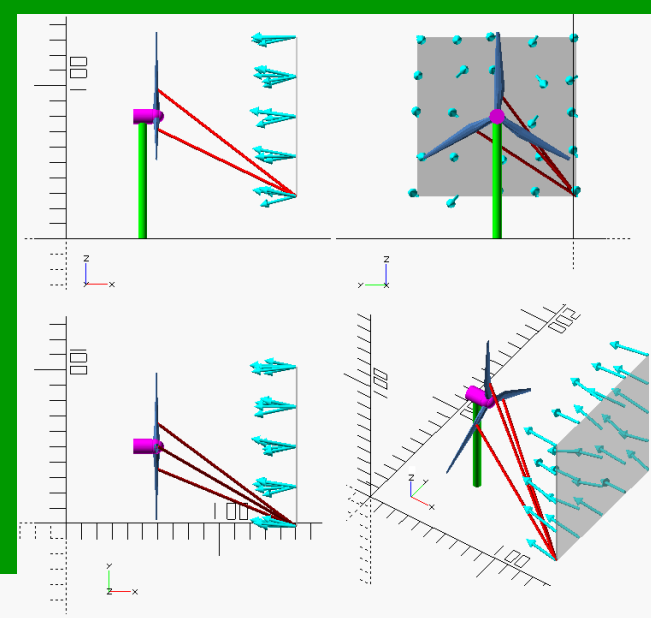
Why?

- Why do we need new laser wind measurement products?
 - Enormous rotors continue to grow (eg 220m diameter);
 - Energy output and fatigue loading depends on wind across whole rotor;
 - But wind turbines (costing ~£10 million each) only have rudimentary single point wind measurement systems on-board
 - While site assessment energy yield suffers from outdated wind measurement methods or diverging beam LIDAR uncertainties
- Converging beam LIDAR technology enables:
 - increased green energy production (more revenue)
 - as well as increasing asset lifetime
 - reduction of operational costs
 - onshore/offshore development project risk reduction



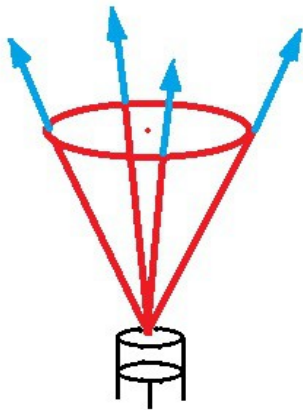
One production line - three LIDAR products

- 1) Ground-based triple LIDAR for measurements feeding into onshore wind farm energy yield assessment
- 2) Floating triple LIDAR for offshore wind farm energy yield assessment
- 3) Rotor-mapping blade-embedded triple LIDAR for operational turbines



Diverging beam design weaknesses of competitor wind LIDARs

Ground-mounted or floating wind LIDAR



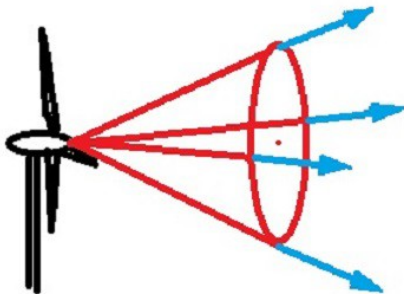
Combines velocity components from far apart in space;

Assumes uniform flow;

Floating system suffers from sea motion;

Fails in complex flow due to complex weather, complex terrain or wakes;

Turbine mounted forward looking wind LIDAR



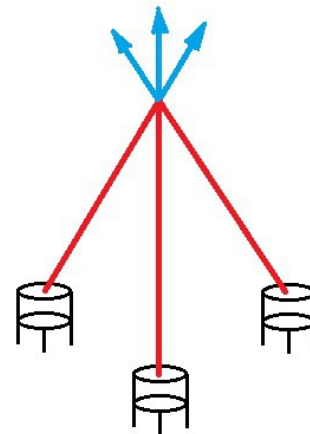
Cannot measure point turbulence intensity;

Assumes horizontal flow;

Cannot map wind in 3d;

Competitor LIDARs are good but we can do better!

Converging beam design advantages and **unique selling point (USP)**

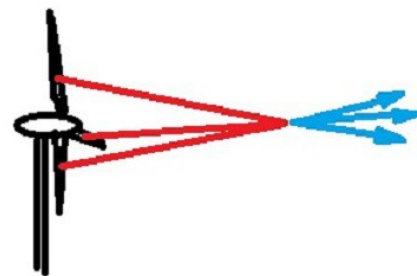


Combines velocity components from intended point;

No assumption of uniform flow;

Floating system uses sensor data to adjust beam steering and cancel sea motion;

Succeeds in complex flow due to complex weather, complex terrain or wakes;



Can measure point turbulence intensity;

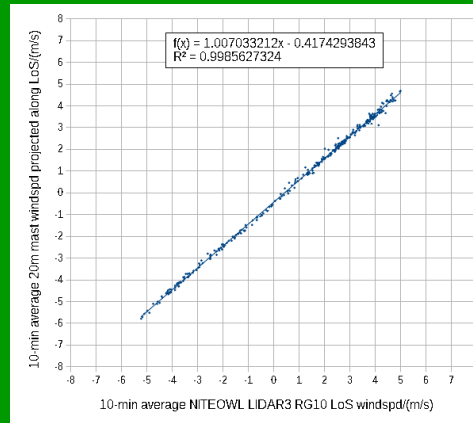
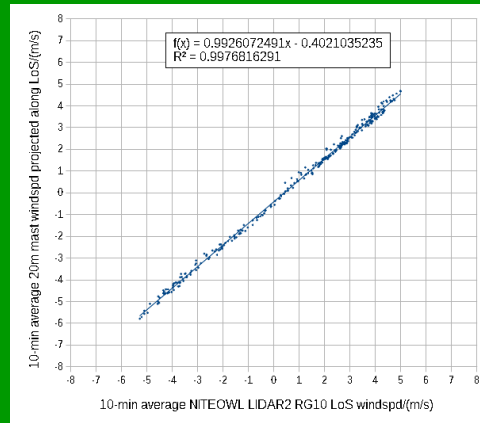
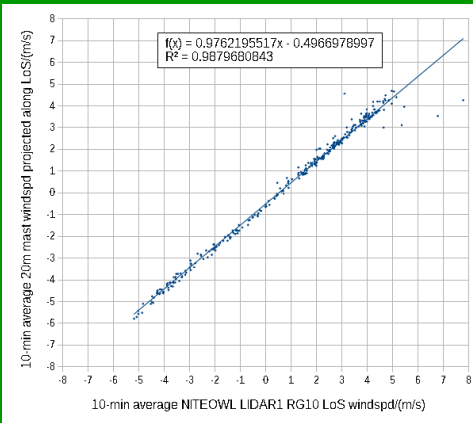
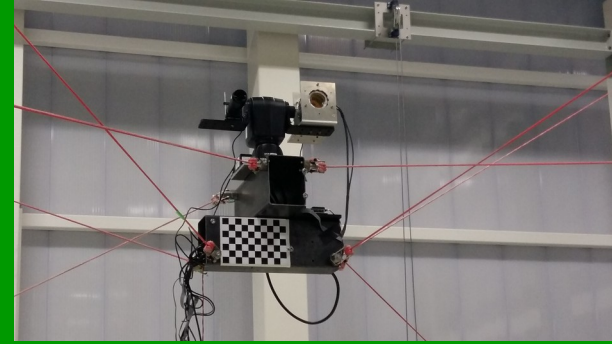
No assumption of horizontal flow;

Can map wind in 3d;

The USP is 3d wind mapping which increases energy yield and wind farm lifetime, reduces O&M costs and investor risk!

Product development to date

- Converging beam steerable LIDARs have been feasibility-studied, designed, prototyped, refined, tested in the laboratory and in the field
- Computer simulations and CAD geometries confirm applicability
- Industry engagement confirms need and validity
- Prototypes demonstrated:
 - Deployed successfully for a number of weeks on Scottish wind farm including excellent agreement with independent meteorological mast
 - Motion correction tested on cable robot for sea motion testing
 - Beam steering LIDAR embedded within blade section



Innovative Aspect, and IP Ownership

- Wind Farm Analytics Ltd has 3 patents granted including:
 - converging beam LIDAR mounted on a wind turbine
 - converging beam LIDAR on a floating platform for offshore wind farm planning and operations
- These have also been filed worldwide and Wind Farm Analytics Ltd has further patents pending
- Innovations:
 - application of three converging beams to provide proper 3-dimensional wind measurement from wind turbine
 - look-ahead full rotor 3-dimensional wind velocity mapping capability by use of three scanning beams
 - positioning the LIDARs inside the blades of large wind turbines including optical windows embedded in blade
 - floating converging beam LIDAR for offshore



Many Benefits

gains scale: per turbine, with higher energy prices, with higher capacity factor with bigger turbines

new big data AI opportunities for wind industry "4.0" - self-learning turbines

better data for researchers

look ahead alarms for protective control eliminate fatigue, decrease O&M costs, increase asset lifetime

decreasing human greenhouse gas emissions and pollution

manufacture wind turbines cheaper

harvest more green energy

advance warning of damaging wind attributes such as extreme wind shear, turbulence, imbalance

increase wind farm revenue by 5-10%

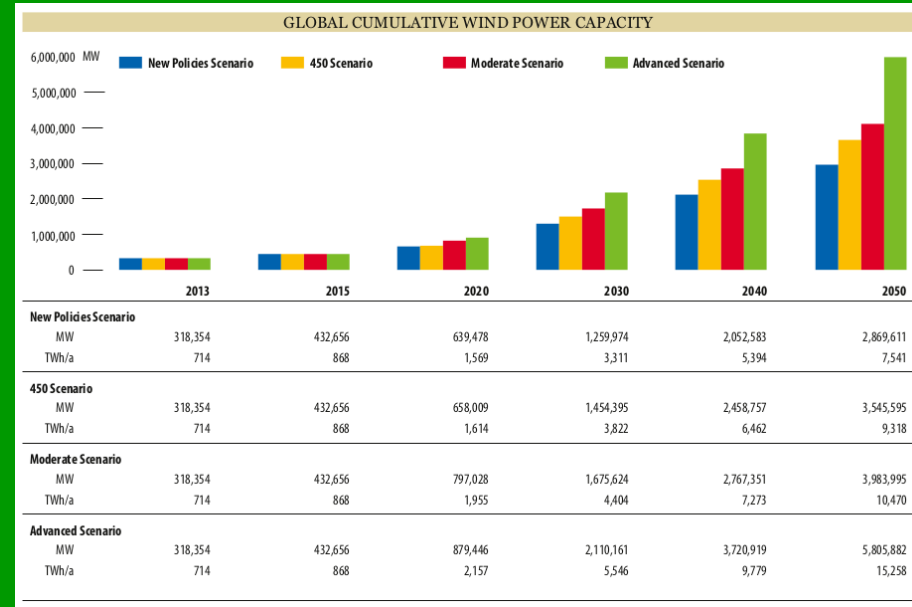
improved wind turbine classification matching site conditions

improved wind turbine warranties; ensuring turbines operate within specification

lifetime data logging on a per turbine basis enables efficient O&M and predictive maintenance by assessing which turbines had a hard or easy life

Do good and make money too!

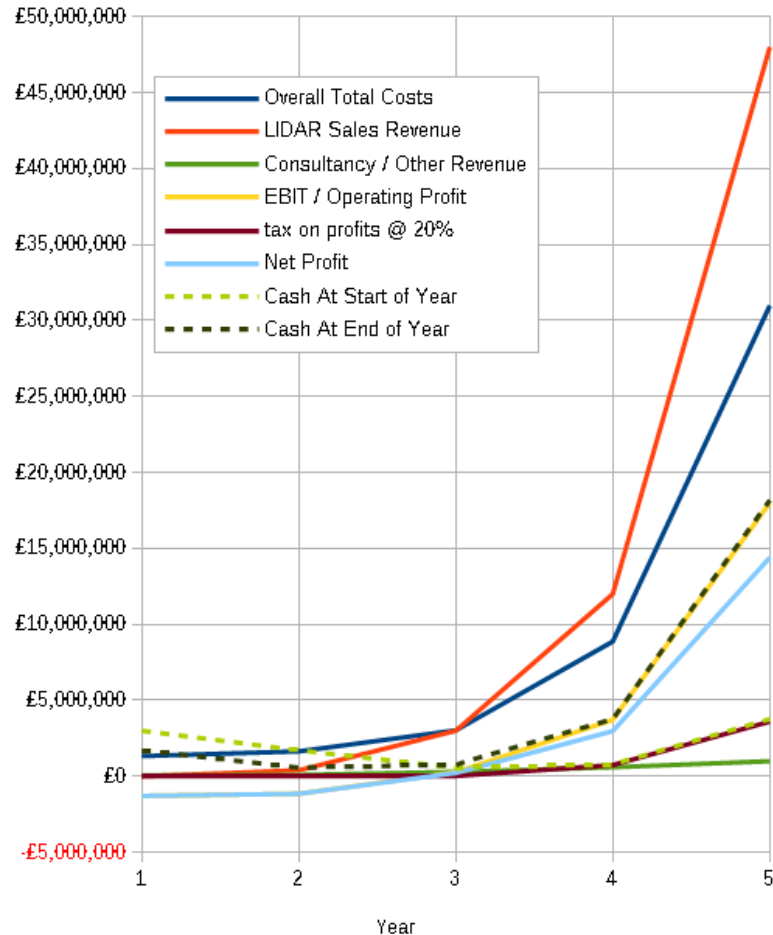
- United Nations sustainable development goals
- Paris objectives
- UK/BEIS Clean Growth strategy
- Wind energy is now cheaper than fossil fuel
- Strong wind industry growth for decades to come
- Sir David Attenborough: “we are facing a man-made disaster”, “decision-makers must act now!”



- Quote attributed to Mahatma Ghandi: “the earth, the air, the land and the water are not an inheritance from our forefathers but a loan from our children. So we have to handover to the next generation at least as it was handed over to us”
- Re-prioritise clean tech over mass consumerism!

Conclusion

Financial Graphs



Overall Total Costs	1,335,120	1,646,600	3,023,415	8,875,494	30,991,309
LIDAR Sales Revenue	0	400,000	3,000,000	12,000,000	48,000,000
Consultancy / Other Revenue	50,000	100,000	300,000	600,000	1,000,000
EBIT / Operating Profit	-1,285,120	-1,146,600	276,585	3,724,506	18,008,691
tax on profits @ 20%	0	0	55,317	744,901	3,601,738
Net Profit	-1,285,120	-1,146,600	221,268	2,979,605	14,406,953
Net Profit Margin	n/a	n/a	6.7%	23.6%	29.4%
Cash At Start of Year	3,000,000	1,714,880	568,280	789,549	3,769,154
Cash At End of Year	1,714,880	568,280	789,549	3,769,154	18,176,106
Headcount	12	14	14	17	21
Triple LIDAR units produced	4	8	30	120	480

- Wind Farm Analytics Ltd is now seeking investment of £3 million with a five year plan to reap benefits quickest
- But for some investors feedback was this is too much for pre-sales – asked for staged plan, delayed recruitment and premises, initial focus on one product to avoid sales, less up front risk
- Wind Farm Analytics has listened to investors and a £500k alternative plan B is now available (a bit slower to scale)
- Enterprise Investment Scheme (EIS) – advance assurance has been obtained from HMRC
- Wind industry continues growing until 2050; addressable market > £1 billion annually!