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IEA Task 32 Lidar Use Cases

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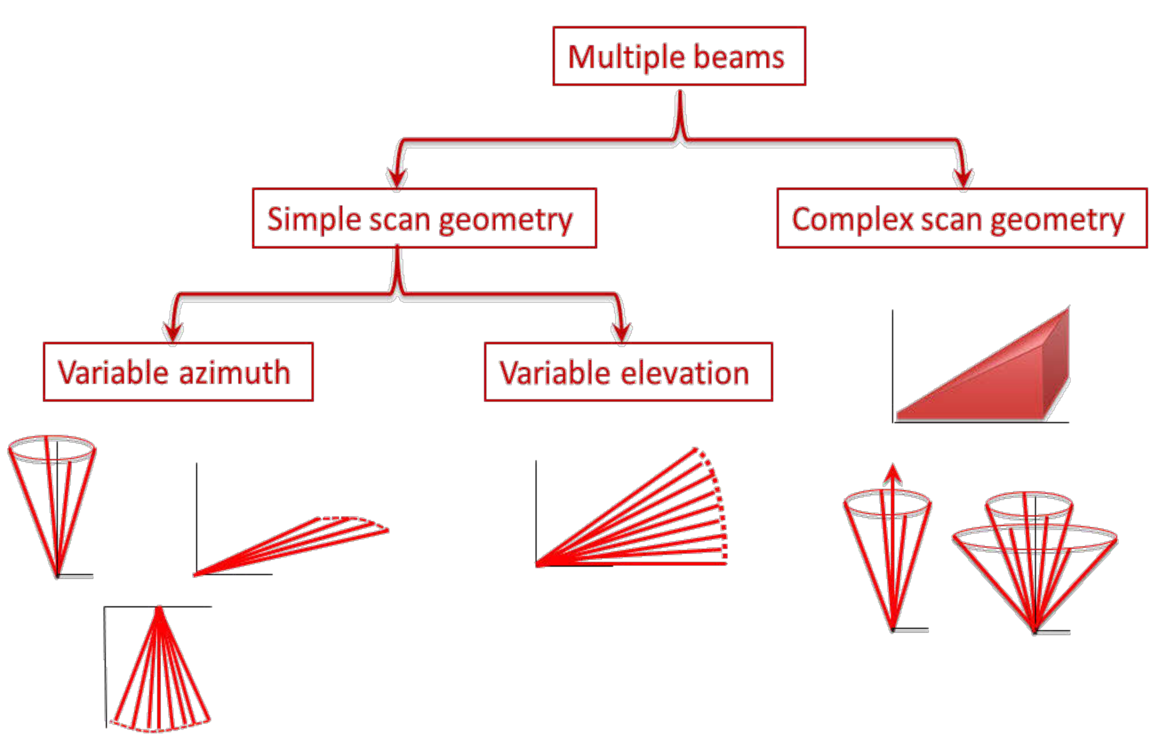
Abstract

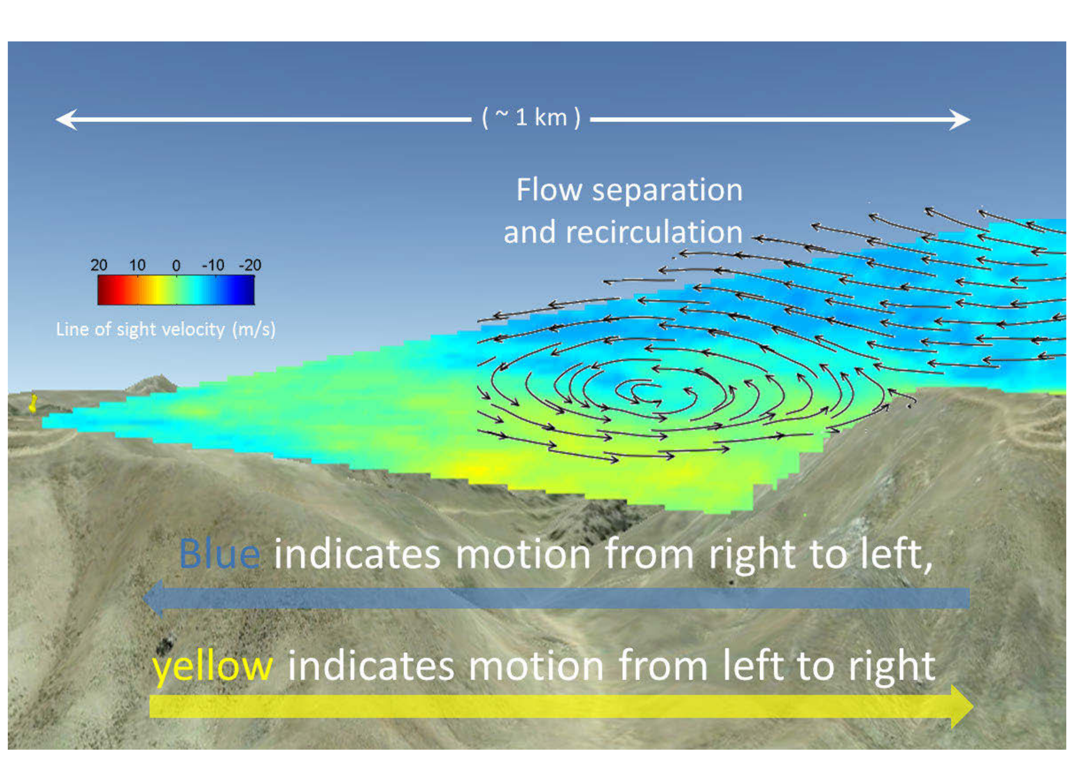
Remote sensing in general and lidar in particular have made available a much more extensive set of measurement techniques than were previously utilised by wind power professionals. These allow wind conditions to be characterized in much more details and with much more accuracy than was previously possible.

Exploiting these new opportunities as effectively as possible requires a structured approach to the design of measurement campaigns involving lidar to ensure high value data are acquired. If lidar is only used to fulfil requirements previously met by more limited instrumentation then the full value offered by lidar will not be realised.

Unnecessary limitations in the value of lidar data can be avoided by considering lidar use cases when designing measurement campaigns.



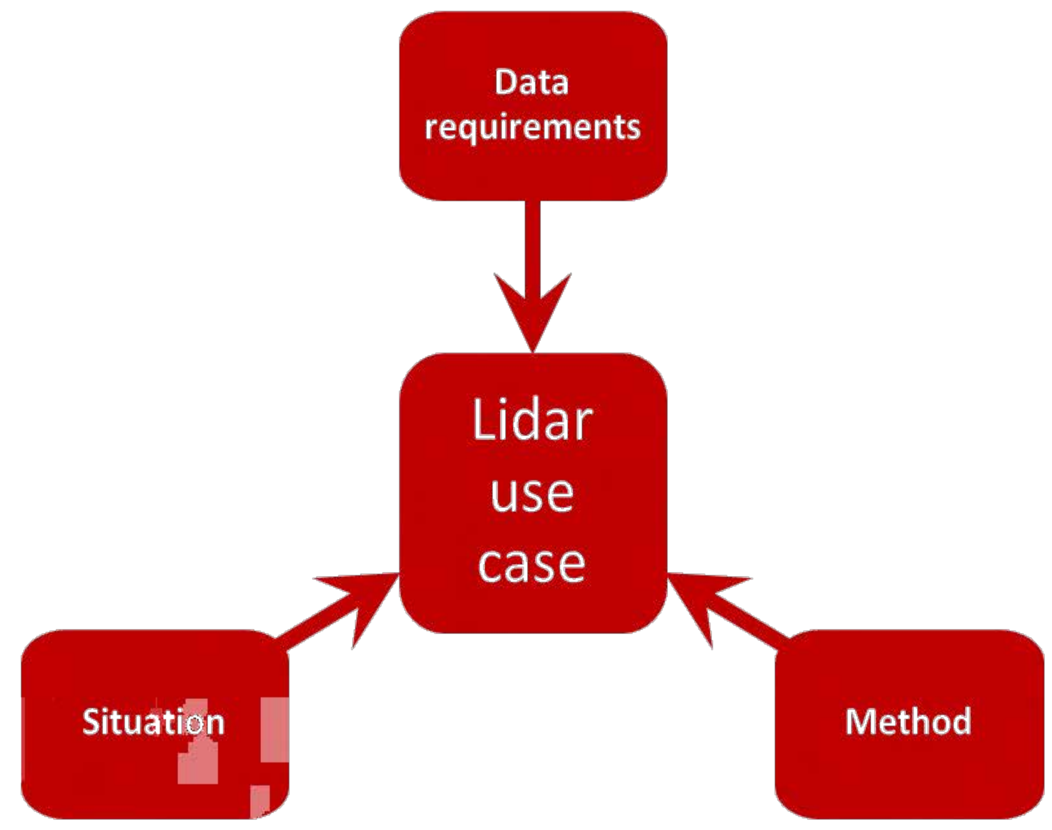
A wide variety of lidar methods can be implemented: it is not sufficient to consider only replication of the capabilities of met masts, as this will unnecessarily limit the ways in which lidar is applied to deliver valuable data. Lidar can be used to visualise wind flow across horizontal or vertical surfaces and within volumes to investigate complex wind characteristics.



An example is shown above. An RHI scan shows in detail how wind shear profiles develop as wind penetrates behind a ridgeline. It is evident that the ridge is causing flow separation and recirculation. Lidar measurements like these often detect detachment that is not predicted by CFD.

A PPI wind farm wakes can show how wake recovery changes within the array: it is clear that wakes in wind farm arrays cannot be understood as a summation of wakes of individual wind turbines, rather, they are an emergent property of the ensemble that cannot be understood in terms of the properties of the wake of an individual wind turbine.

IEA Lidar Use Cases

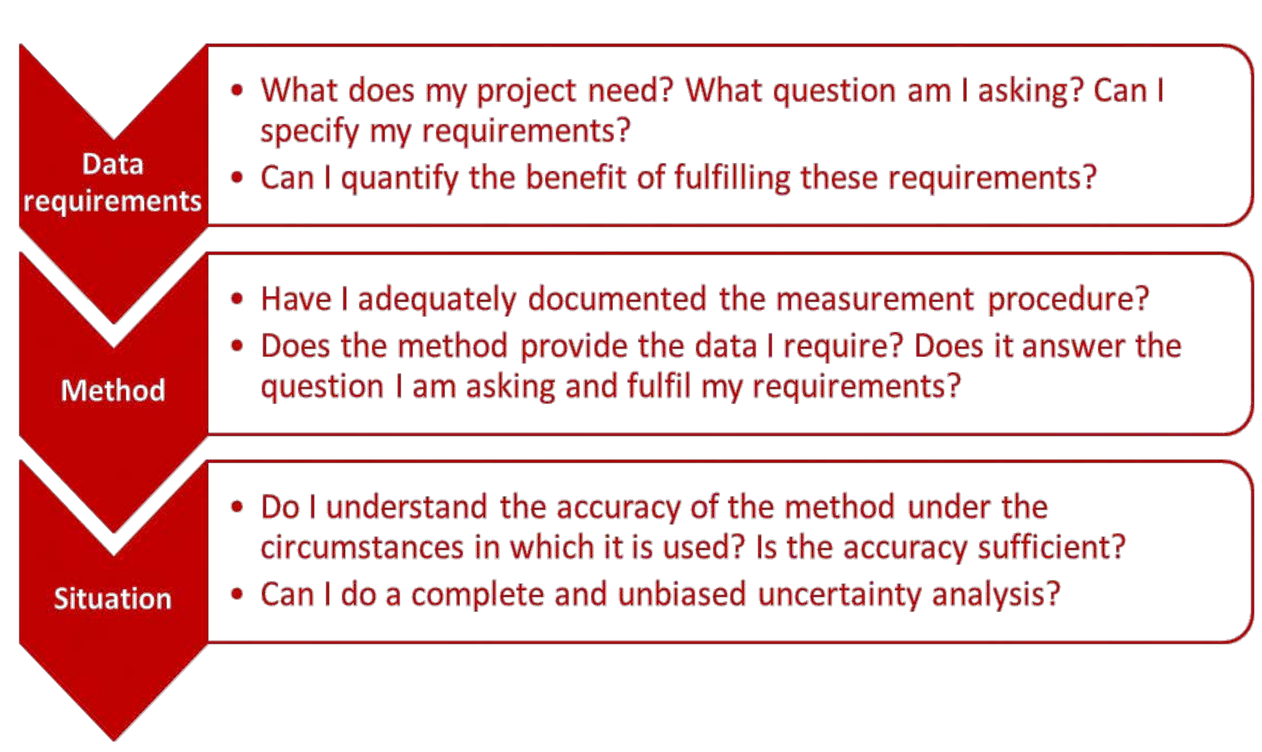


The International Energy Agency (IEA) Wind Energy Task 32 has been set up to capture and codify the wind industry's experience and expertise with respect to the use of lidar in wind power applications. Key work packages within this task have adopted a lidar use case framework as the basis for describing the diversity of lidar techniques available. This framework looks at

- The combination of the lidar methods being employed,
- The data requirements that can be fulfilled using the data sets these methods make available, and
- The situations and sets of circumstances in which the performance of these procedures can be verified in terms of measurement accuracy.

A valid lidar use case entails the implementation of a method where

- The accuracy of the data is understood under the circumstances in which the method is used and
- The data set fulfils a purpose or requirement that arises sensibly in the context of the broader project aims and objectives



IEA lidar use cases provide

- A formalism that has been adopted as a way of aggregating and organising diverse lidar methods by IEA Wind Energy Task 32
- A means to ensure well-documented repeatable methods are applied appropriately with the consistency necessary to ensure investor confidence
- A basis for exploiting the new measurement opportunities scanning lidar represents and the new datasets it provides
- A framework to re-assess established wind industry practices and procedures to integrate effectively new method and datasets

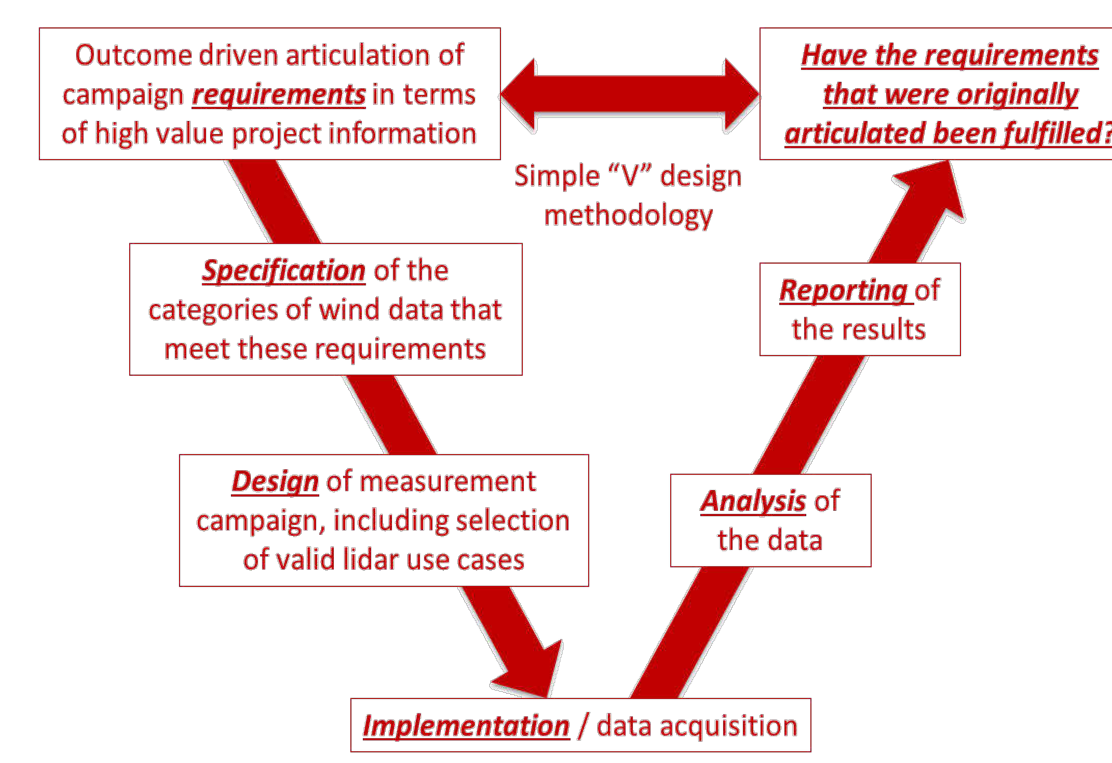
Measurement Campaign Design

As a result of the adoption of the lidar use case description of the application of lidar it should be possible to calculate a quantifiable return on investment and integrate the acquisition of the data into financial models with greater transparency.

1. Select the appropriate lidar measurement methodology for a given project data requirement with reference to the circumstances under which the data are being acquired

2. Define a complete, unbiased, open and transparent approach to measurement uncertainty with respect to lidar measurements such that IEA bankability requirements are met

3. Undertake offshore measurements that enable fuller characterisation of the complex offshore wind conditions that impact the productivity and longevity of offshore wind power assets



Use cases should be considered when designing a measurement campaign using, for example, the V-methodology shown above. Requirements are specified without reference to methods, which are selected only once the requirements they are intended to fulfil have been properly articulated.

Although apparently obvious, the versatility of lidar allows the adoption of this approach for the first time.

An assumption, which is fallacious, but is the basis of many of the data requirements of established wind energy procedures, is "what we can't measure can't have been important in the first place". Consequences of this include:

- The cost of new data is known but the benefit remains obscure, so brutal false economies are inflicted on measurement campaigns
- New measurement opportunities are ignored and unexpected negative project outcomes occur
- Incomplete uncertainty analyses are treated as though complete and new data seems to introduce rather than reduce uncertainty

If lidar is deployed, you can acquire data that allows understanding of wind conditions to be developed during pre-construction phases of delivery which would not normally possible until post-construction performance is observed using data you would not otherwise obtain.

References

1. Clifton, A., et al., IEA Wind Energy Task 32 Remote Sensing of Complex Flows by Doppler Wind Lidar: Issues and Preliminary Recommendations, NREL, 2015