Investigating Rotor Area Considerations in the IEC Wind Turbine Safety Standards

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The Case for an IEC Mid-Size Wind Turbine Safety Standard?

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Overview

- Current wind turbine safety standards
- Evolution of wind turbine size
- Survey of certified wind turbines
- Compare small and large turbine standards
- Suggestion for a “mid-size” turbine standard
- Recommendations on how to proceed

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Current Standards

- IEC 61400-1: Wind Turbine Design Requirements
  - Ed. 1: 1994; Ed. 2: 1999; Ed. 3: 2005
  - Applicable to all wind turbine sizes and designs
- IEC 61400-2: Small Turbines
  - Ed. 1: 1996
    - Applicable to rotor sizes up to 40 m^2
  - Ed. 2: 2003
    - Extended to rotor sizes up to 200m^2
  - Ed. 3 pending
- National Standards
  - AWEA, BWEA, CanWEA…

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Motivation for 61400-2

- 61400-1 requirements deemed too onerous for small wind turbines
  - Cost of compliance prohibitive for small turbines
  - Historically, small turbines proven safe
- Size limit set by experience
  - Originally 40m^2
  - Increased to 200m^2 based on engineering study
- Mid-size wind turbines are now in a similar predicament

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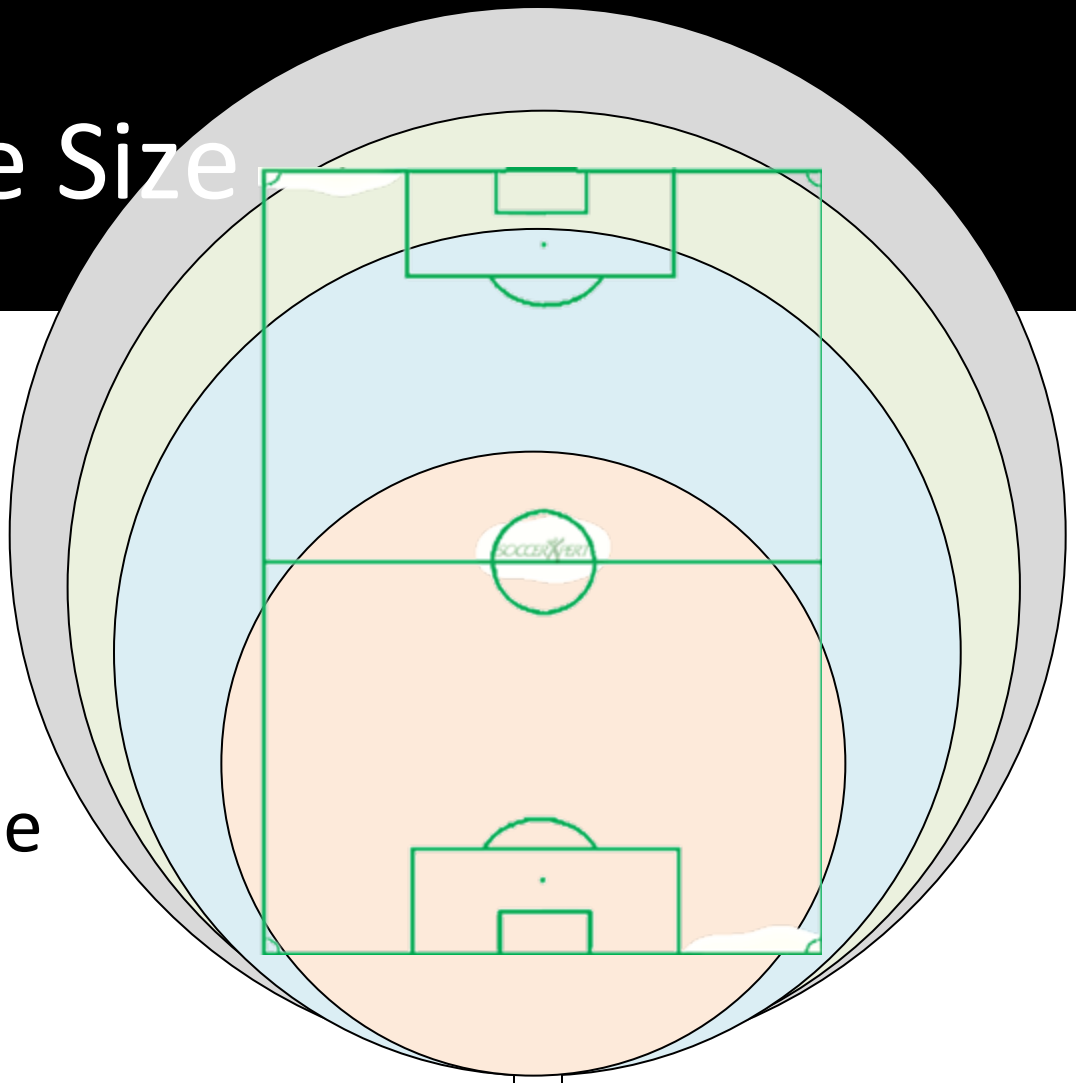
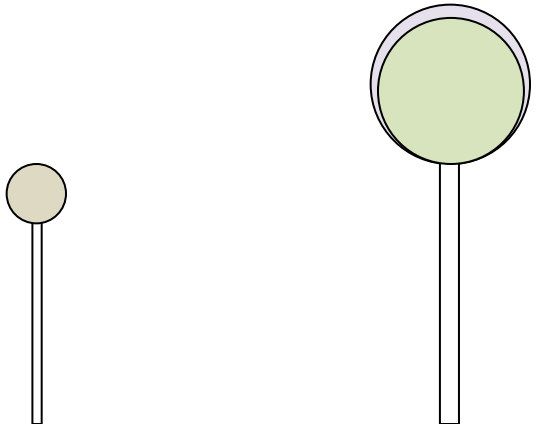
Wind Turbine Size

- 61400-2 size limit
- Utility-scale
  - On-shore
  - Off-shore
- Mid-size
- Pending utility-scale designs





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Certified Wind Turbines

- Survey of GL certified turbines in last 10 years
  - IEC 61400-2 (small turbines)
    - Only one certified turbine
    - Five others listed as having applied
  - IEC 61400-1
    - Smallest certified turbines: ~1500 m^2 (~600kW)
    - Smallest applicant: 855 m^2

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Mid-size Turbines

- Why are mid-size turbines not IEC certified?
  - Lack of need
    - Few regulatory agencies require certification
    - Growing need being driven by incentive requirements
  - Expense
    - Cost of certification testing does not scale with rotor size
      - Testing costs become a larger percentage of development for smaller wind turbines

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Standards Comparison

Requirement	SWT	LWT
Design Load Cases & Inflow Conditions	-1 or -2	-1
Type Testing		
Full-System Load Measurements	no	yes
Duration Test*	yes	no
Blade Test		
Static	yes	yes
Fatigue	no	yes

*Duration Test:

- 6 months of operation
- 2500hrs of power production
  - 25hrs @ 1.2 V_{ave}
  - 25hrs @ 1.8 V_{ave}
- Pass/Fail Criteria:
  - 90% availability
  - Post-test inspection
  - No power production degradation

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Mid-Size Standard "Compromise"

Requirement	SWT	MWT	LWT
Design Load Cases & Inflow Conditions	-1 or -2	-1	-1
Type Testing			
Full-System Load Measurements	no	no	yes
Duration Test	yes	yes	no
Blade Test			
Static	yes	yes	yes
Fatigue	no	no	yes
Validation Test Measurements*	no	yes	no

*Validation Test:

- Collection of data including one or more of:
  - Power performance data
  - Dynamic responses (e.g. yaw motions)
  - Loads (tower or blade moments)

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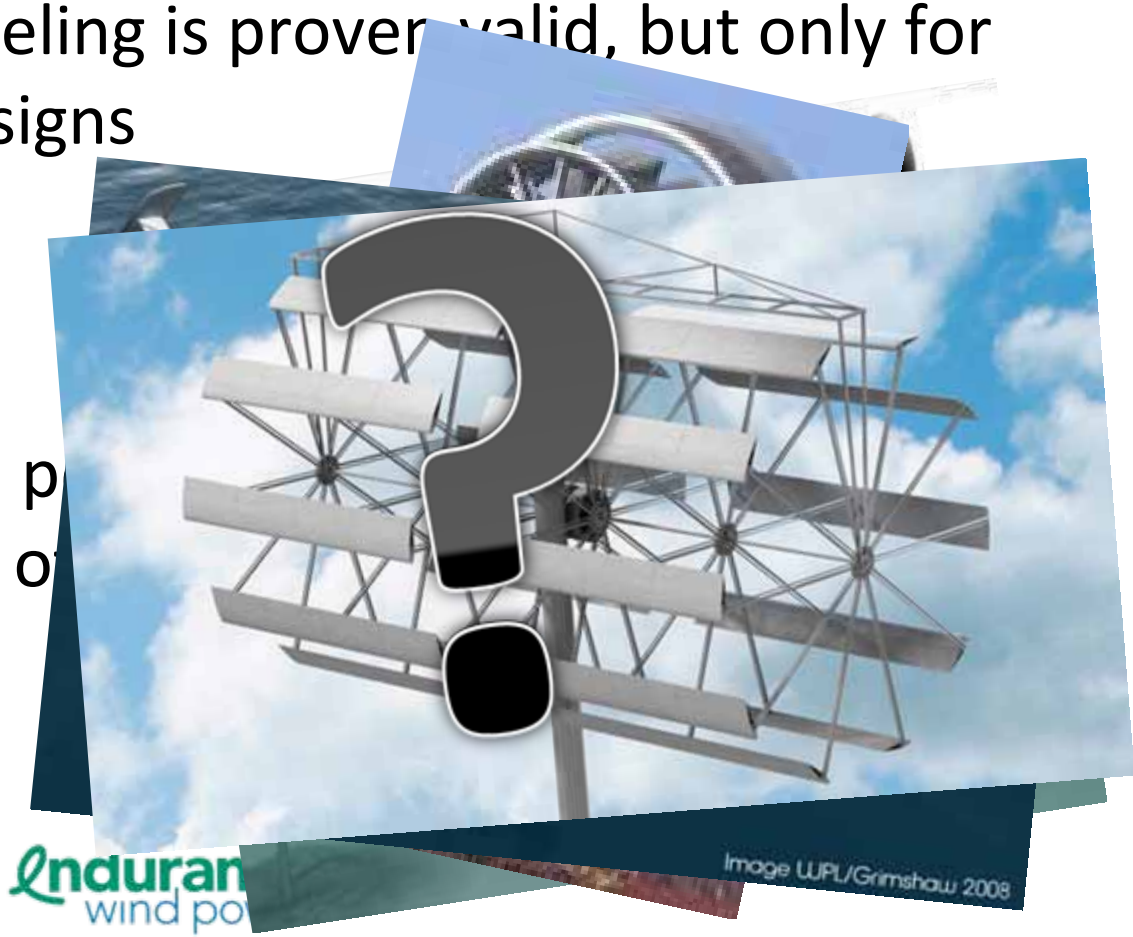
MWT Standard Scope

- Limited to specific HAWT architectures?
  - Aero-elastic modeling is proven valid, but only for typical HAWT designs
- Size limit?
  - Needs definition, p
    ascertain validity o



Conclusions

- Need for certification is growing
  - Demands from incentive agencies
- Cost of 61400-1 certification prohibitive for MWT
  - Likely to worsen as standard evolves with growth in turbine size
- Large differences between -1 and -2 requirements presents opportunity for “middle ground”
- Development of an MWT standard needs to be tackled by industry participants
- These recommendations are a starting point for the discussion – we hope it continues…

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