SMART Wind Support Structures Subgroup Meeting
Potential Improvements in Tower Sourcing

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Virtual Meeting

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Potential Improvements in Tower Sourcing

Mid-Size (=>100kw) Towers

Upper Small Size (=>20kw) Towers

- Support structure alternatives
- Importance of in-place cost comparison
- Cost insight
- Local manufacturing
- Potential areas of improvements

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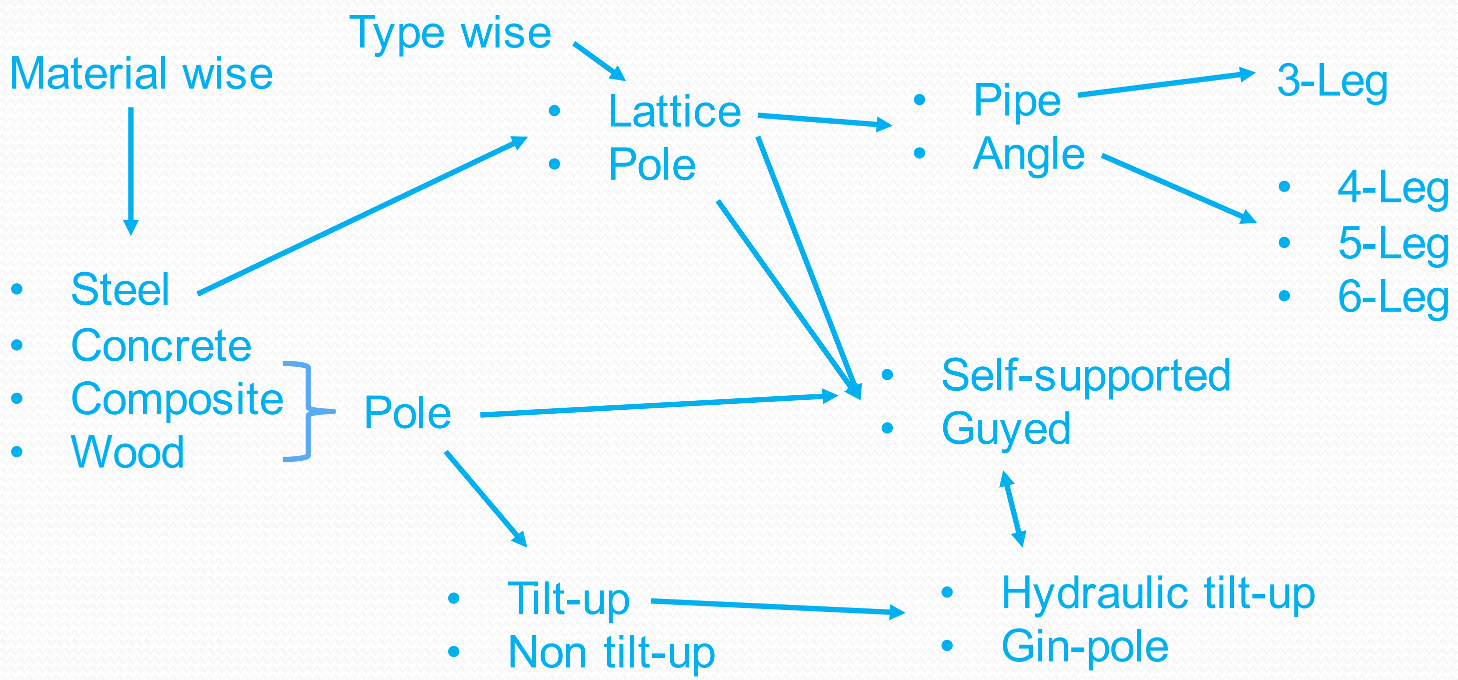
SUPPORT STRUCTURE ALTERNATIVES



In-place cost comparison is crucial at the very beginning of projects!

In-place cost comparison = tower + installation + foundation + O&M + decommissioning

Utility structure:	pole or lattice
	steel or concrete or wood
	self-supported or guyed
Wireless structure:	pole or lattice
	3-leg lattice or 4-leg lattice
	pipe or angle
Large wind:	pole (tubular) or lattice (4-leg or 5-leg or 6-leg)
Small wind:	pole or lattice
	tilt-up or non tilt-up
	gin-pole or hydraulic tilt-up

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Midsize Wind Poles

Tubular:

Round cross section

Formed by roller

Multi-sided:

12-sided, 16-sided, 24-sided, etc. cross section

Formed by brake press

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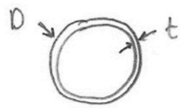
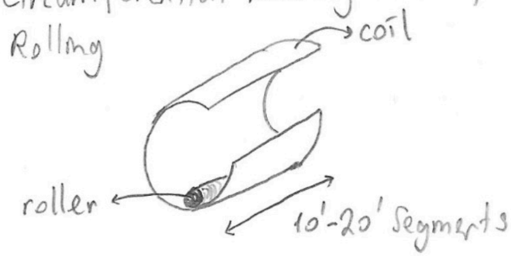
Mid-Scale (100kw - 1MW)

Large Wind Towers

- Used in utility wind (≥ 1MW)
- Round cross-section

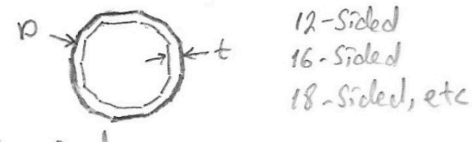


- Painted (no galvanize)
- Flange connection
- Internal climbing
- Circumferential welding on shaft
- Rolling

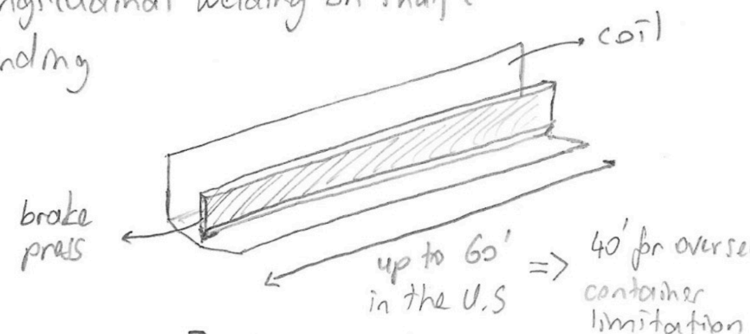


Utility Poles

- Electric transmission line poles
- Multi-sided cross-section



- Galvanized
- Both slip-joint & flange connection
- External climbing
- Longitudinal welding on shaft
- Bending



Two different Assembly Line

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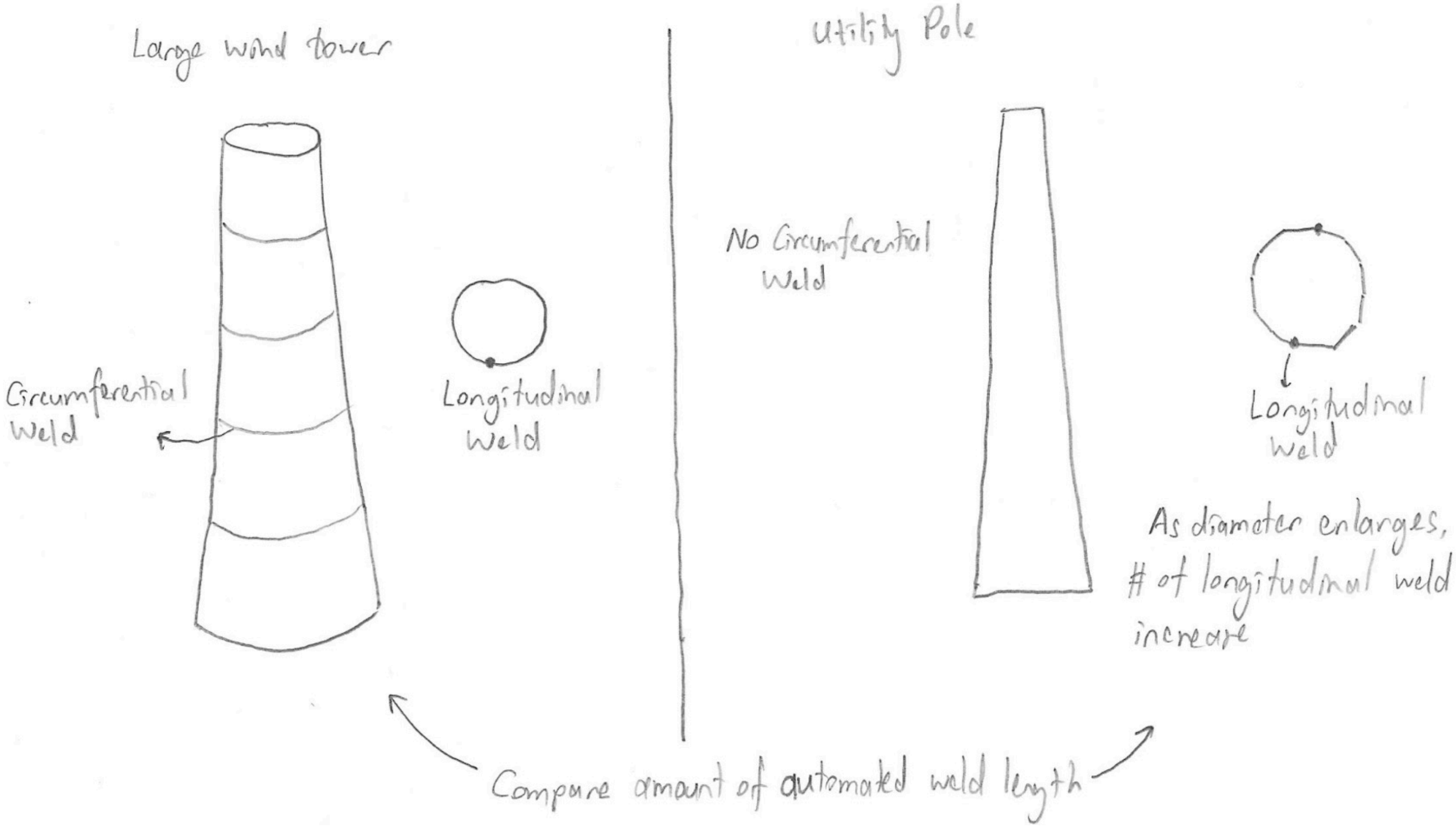
Cost Driver-1: Weld Labor



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Cost Driver 2: Finish

Large Wind: Min of SSPC-SP-6

Commercial sand blast in accordance with paint manufacturer's specs. Paint system to be designed to satisfy at least min requirements of ISO 12944 Corrosivity Category C3 for both tower interior & exterior surfaces

Utility Pole: Hot dip galvanize per ASTM A123

Largest kettle in the US

↳ 55' x 10.5' x 12'

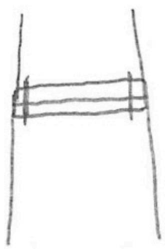
Salina, KS

$$\frac{\text{Diameter}}{\text{Wall Thickness}} < 180$$

Otherwise shape of tower cross-section damages because of heat in kettle

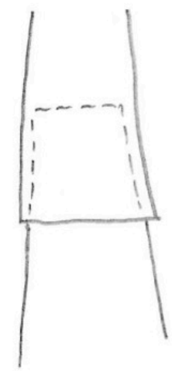
Cost Driver-3 : Shaft Connection Method

Large wind : Flange



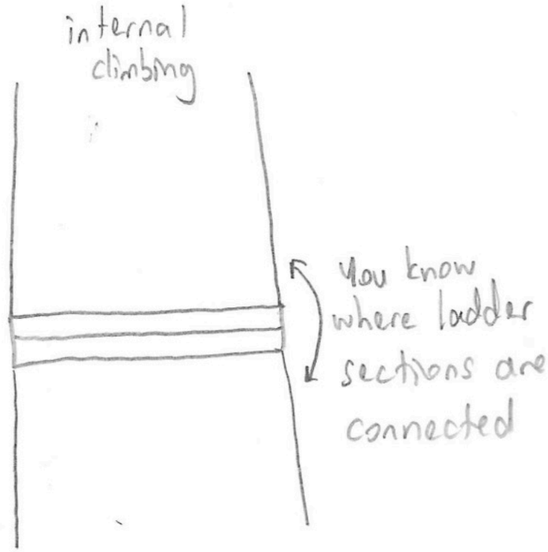
As diameter enlarges (>100")
flange connection becomes more
cost effective in general

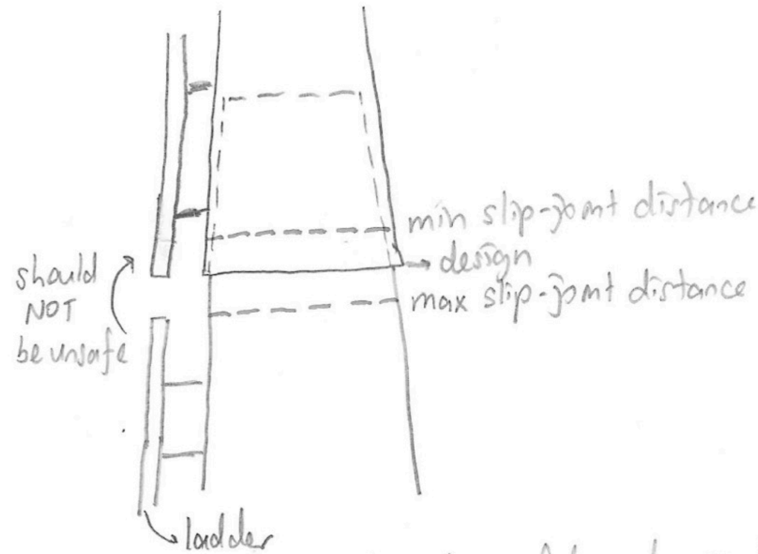
Utility pole : mostly slip-joint



As diameter gets lower than 80"
slip-joint becomes more cost
effective in general

Be careful in designing climbing on slip-joint connections





Min slip-joint distance > 1.5 x diameter of female section

Slip-joint distance tolerance → +/- 10% of design S-J distance

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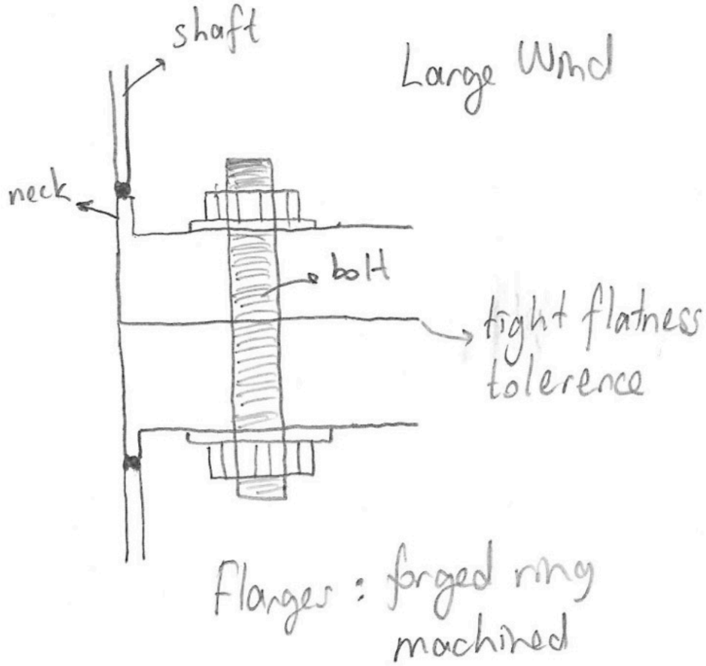
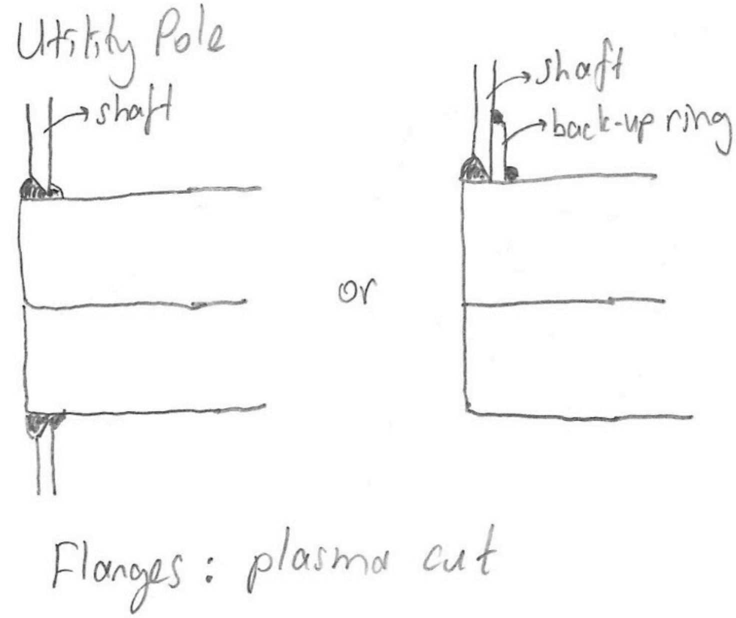
Cost Driver-4: Weld detail on flanges





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If tower base diameter > 100” then tubular section is more cost effective

If tower base diameter is between 100” & 80”, then further analysis suggested

If tower base diameter < 80” then monopole is more cost effective

These are budgetary figures based on experience

Performing tower in-place cost comparison is very important to make decision

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Supply of (30) 100ft / 20kw hydraulic tilt-up structures

Hydraulic-tilt up pole supply cost: $20K
Hydraulic unit cost: $10K

Self-supported pole with climbing supply cost: $15K

1 Year: 30 structures * ($20K - $15K) + $10K = $160K savings a year on tower supply

Crane installation cost = A1
Hydraulic unit installation cost = A2

OEM cost for 20 years on a self-supported structure with climbing system = B1
OEM cost for 20 years on a hydraulic tilt-up structure = B2

Compare A1 + B1 and $160K + A2 + B2 in one year interval to make a decision

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$1.5/lb budgetary supply price of a self-supported pole with climbing

- $0.42/lb : Material cost
- $0.18/lb : Galvanization cost
- $0.60/lb : Labor and overhead (this might go up significantly for special poles)
- $0.30/lb: Profit considering 20% margin

American pole fabricators enjoy manufacturing:

- Self-supported
- Base plate with anchor bolts or embedded
- Step bolts or McGregor ladder for climbing
- Cable safety system
- Work platform on top
- ASTM A572 Grade 65 material for pole shaft
- ASTM A572 Grade 50 material for flanges and base plate
- Galvanize per ASTM A 123, no paint

More than 90% of the poles supplied to the utility and wireless industries are made in the U.S. Why not small wind pole?

- Not enough volume
- Using standardized structures (80ft, 100ft, 120ft; not 90ft or 105ft as an example)
- Using poles that are similar to the utility and wireless poles. Self-supported, galvanized, step bolts for climbing, etc.
- Making strategic alliance agreements with tower manufacturers, committing at least 30 to 50 poles a year in order to have better pricing.

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Adding mandatory requirements to source made in US poles in the federal funded projects.

Adding tower specifications based on manufacturing in the US

- Pole shafts per ASTM A572 Grade 65
- Flanges and plates per ASTM Grade 50
- Anchor bolts per ASTM A615
- Bolts per ASTM A325 or A394

Designing pole shafts longer than 40ft, up to 60ft (will help to reduce the number of connections, i.e. reduced installation cost, for example 1 slip-joint connection in a 100ft pole considering maximum 60ft section length rather than 2 slip-joint connections in a 100ft pole considering maximum 40ft section length)

No gussets in base plate and flange designs

Adding charpy requirements for project sites located in cold climates

Effort to increase the U.S content in the overall project

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Clean Line Energy Partners
Plains & Eastern Transmission line Project
~700 miles of 600kV HVDC

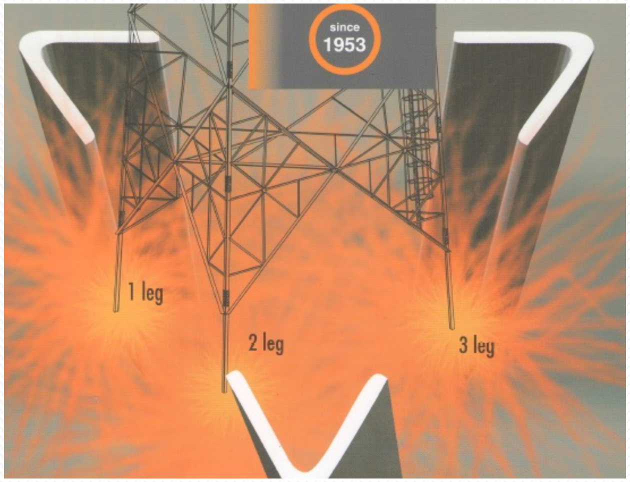
Supporting local businesses

Transmitting clean energy from OK to TN

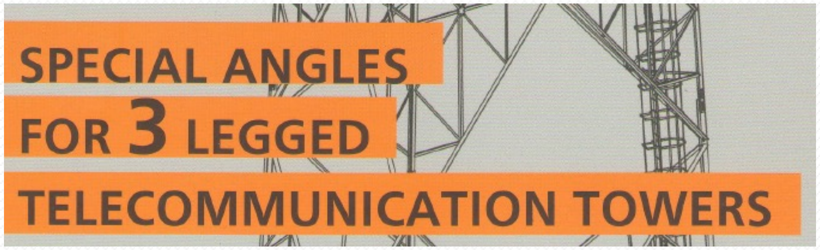
All made in US support structures!

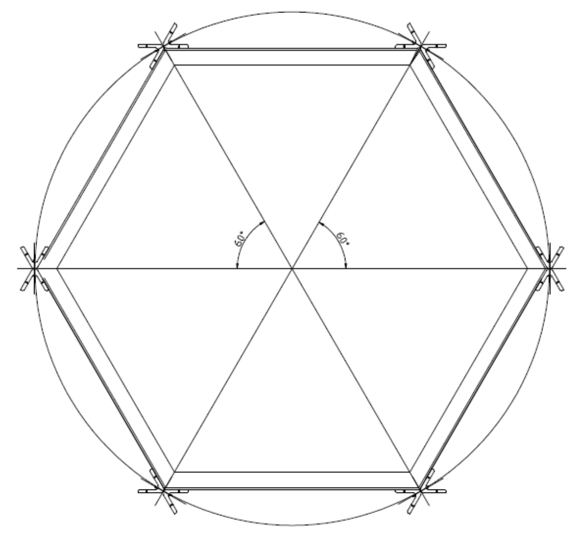
60 Degree Angle - Hot Rolled

- Reducing tower weight 10% - 15%
- Reducing ground area usage
- No welding
- Reducing tower cost 12% - 20%



$2.5M to $3.5M Investment to build a shop to manufacture lattice towers from 60 degree hot rolled angles for the wind energy and wireless industries





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Potential Monopole Cost Improvement in the U.S:

Pole Manufacturer
Brake formed, longitudinally seam welded pole section, base plate welded

→

General Steel Shop
Welding top flange, man & hand hole, platform, climbing, all accessories, etc.

→

Coating Facility
Galvanizing and/or painting

→

CUSTOMER DELIVERY

Manufacturing Inspection

Pre-shipment Inspection

Engineering, procurement & project management services support to the turbine manufacturer by a tower engineering firm

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SUGGESTIONS:

- Specific small wind turbine support structure design standard should be prepared like ASCE 48-05 or ASCE 72 in utility poles, EIA-TIA-222-G in wireless poles, AASHTO in lighting poles, etc.
- Small wind support structures and foundations should be checked, tested and certified by a third party.
- Each new support structure and foundation design and concept should be checked, tested and certified by a third party.
- Towers and foundations should be tested for at least six months period prior to commercialization.
- HS Code: 7308.20 / Custom duty on Chinese poles.

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THANK YOU!

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