Wind Energy - Extreme Blade Transport

WASHTO Fall 2014 Conference

Excellence in Energy Logistics

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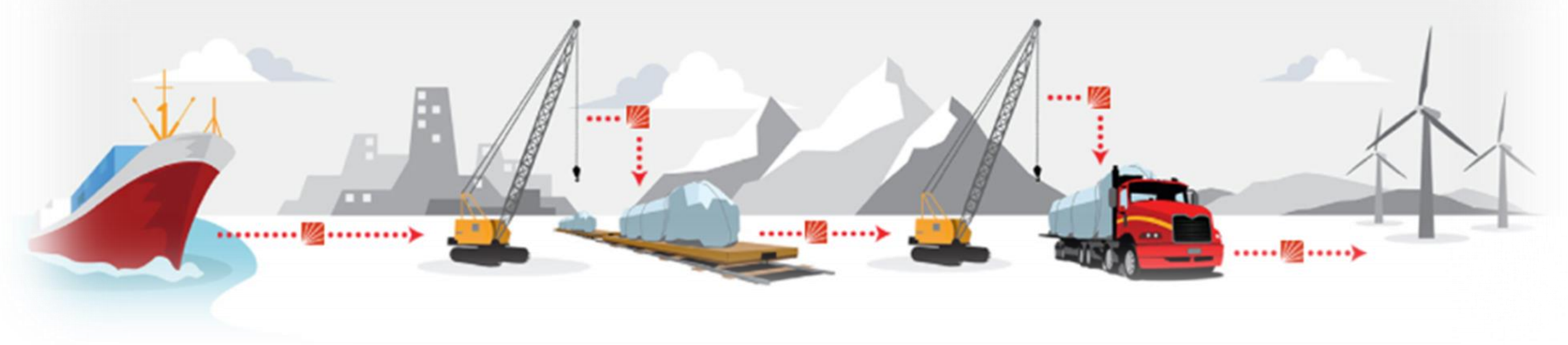

Agenda

- Anatomy of a Wind Turbine
- Overview and Background of the Wind Industry
- Turbine Supplier, Blade Sizes, and Orders
- Equipment Overview
- Multi Mode Transport
- Carrier Overview Breakdown
- Current Largest Blade
- Challenges
- Summary and Closing

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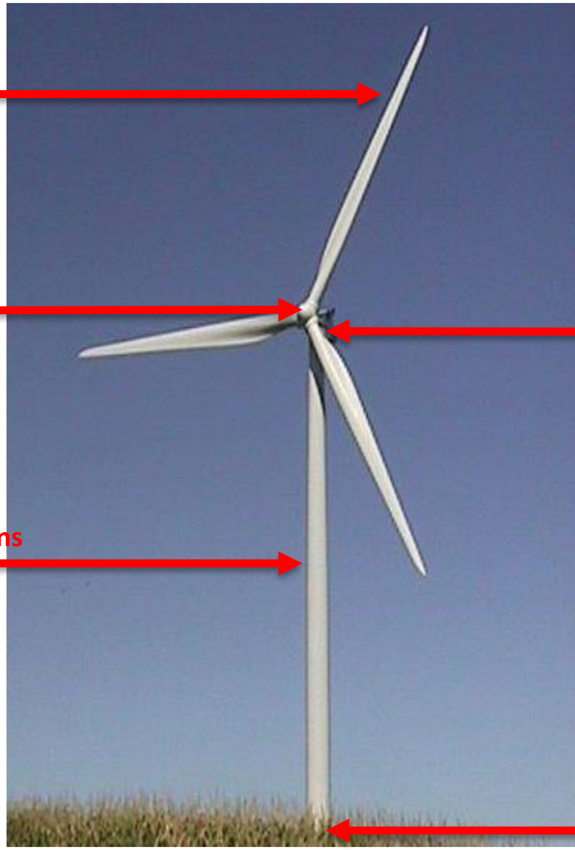
Anatomy of a Wind Turbine



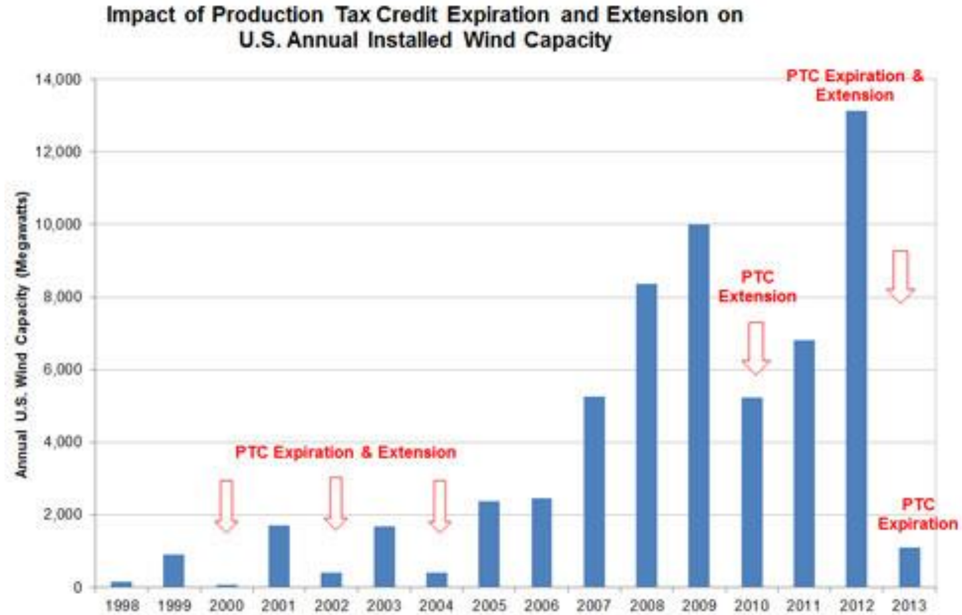
- **2008 Wind Turbine Generator** was a 1mw to 2mw unit with a 80m (3 section) Tower and 40m Blades
- **2012 Wind Turbine Generator** was a 2mw to 3mw unit with a 90m (4 section) Tower and 50m Blades
- **2015 Wind Turbine Generator** most likely will be a 2mw to 3.5mw unit with a 100m (4-5 section) Tower and 55m to 60m Blades

Total Loads = 12 Over Dimensional Loads + 2-3 Legal Load

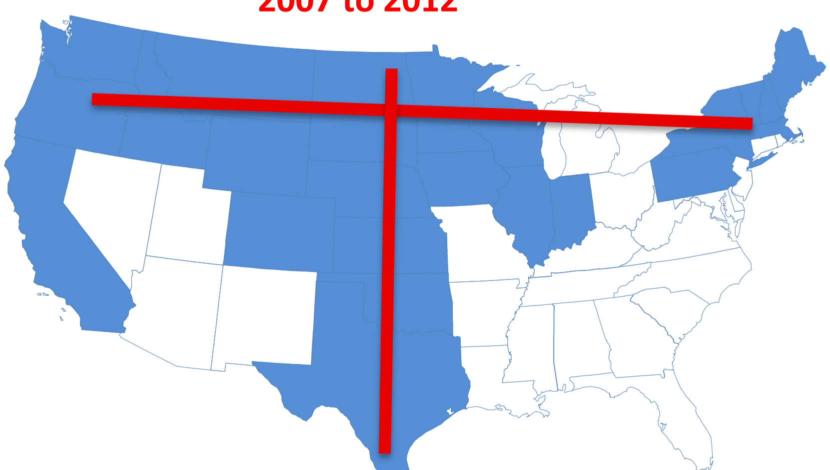
Overview and Background

US Wind Market

- **Production Tax Credit (PTC)** - The Production Tax Credit (PTC) is a federal incentive that provides financial support for the development of renewable energy facilities. Companies that generate electricity from wind and other Renewable Energy are eligible for a federal PTC, which provides a 2.3-cent per kilowatt-hour (kWh) incentive for the first ten years of a renewable energy facility's operation.

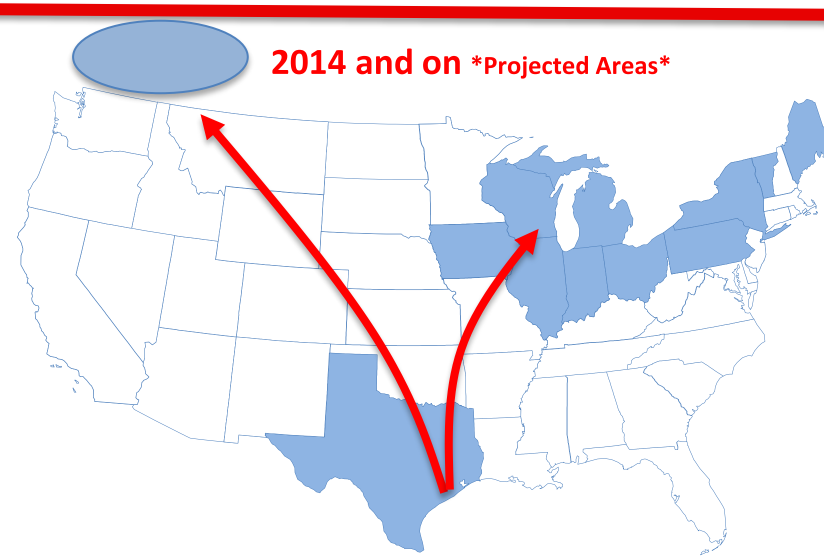


2007 to 2012



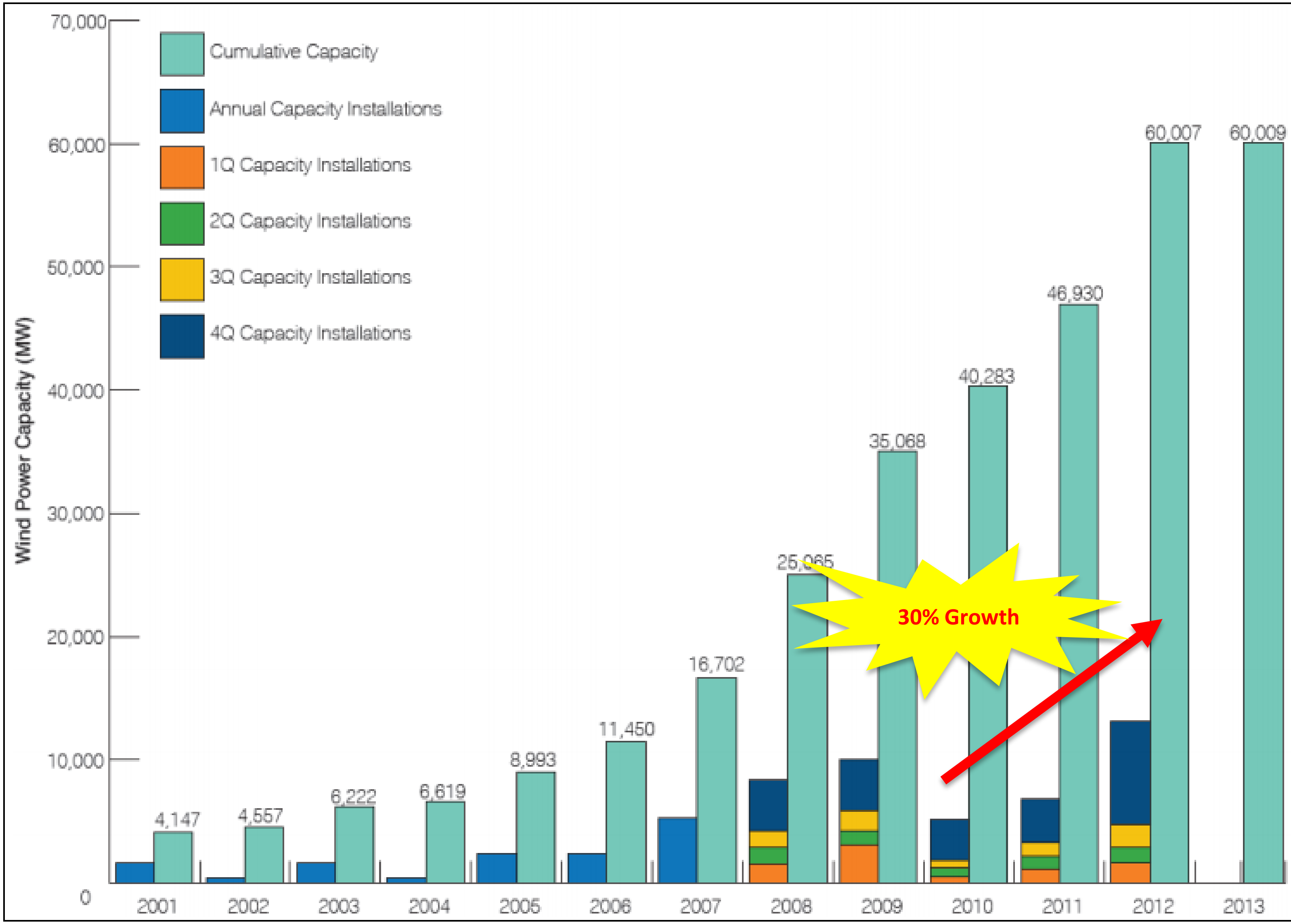
Installations were primarily in the Wind T Corridor

2014 and on ***Projected Areas***



Larger Blades (Sweep Area) will enable more "Lower Wind Speed" Project Sites

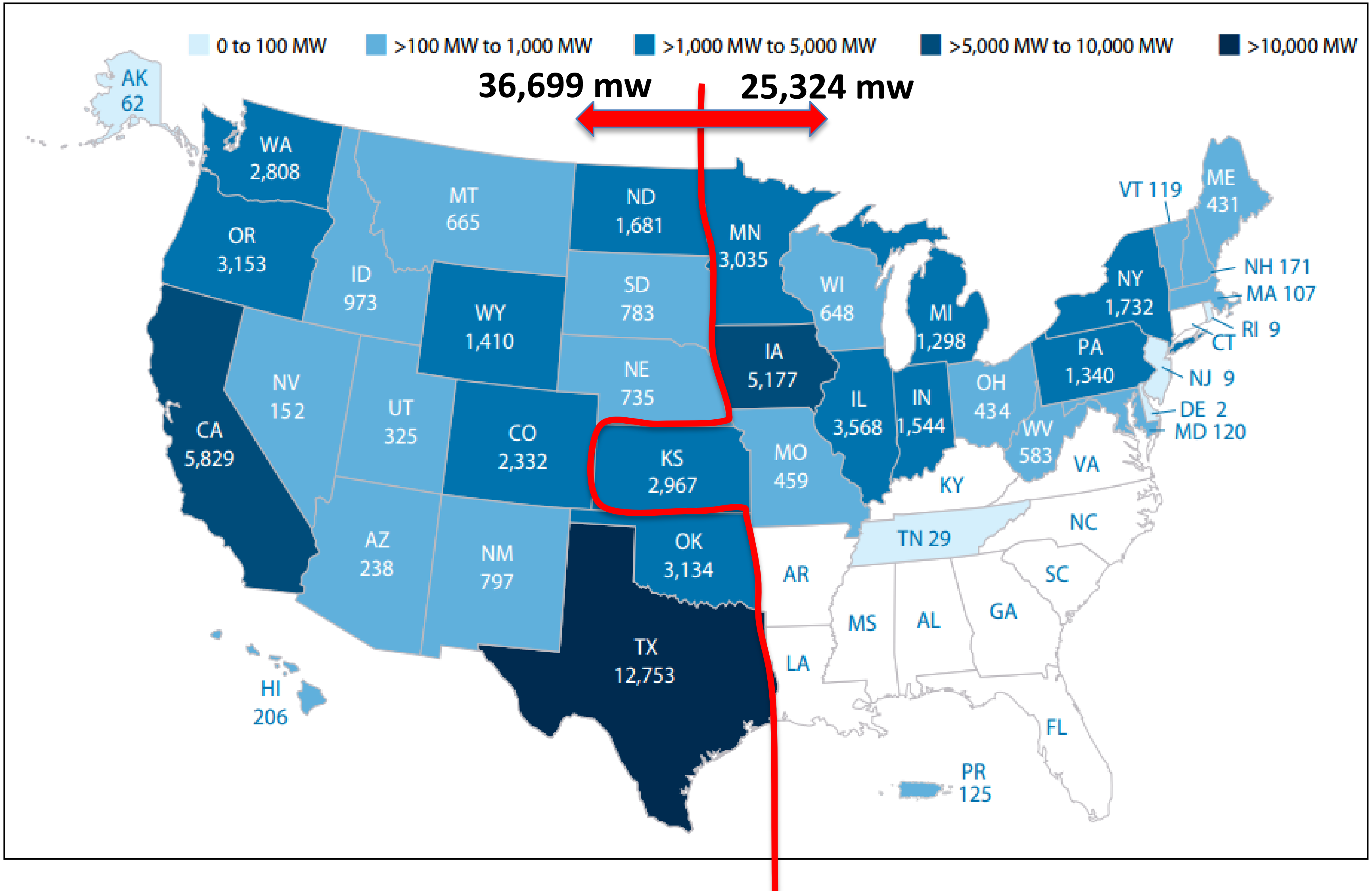
Wind Market Statistics



Total Wind Turbine Generator Deliveries	8,363	10,004	5,216	6,819	13,128	1,086

Source – AWEA

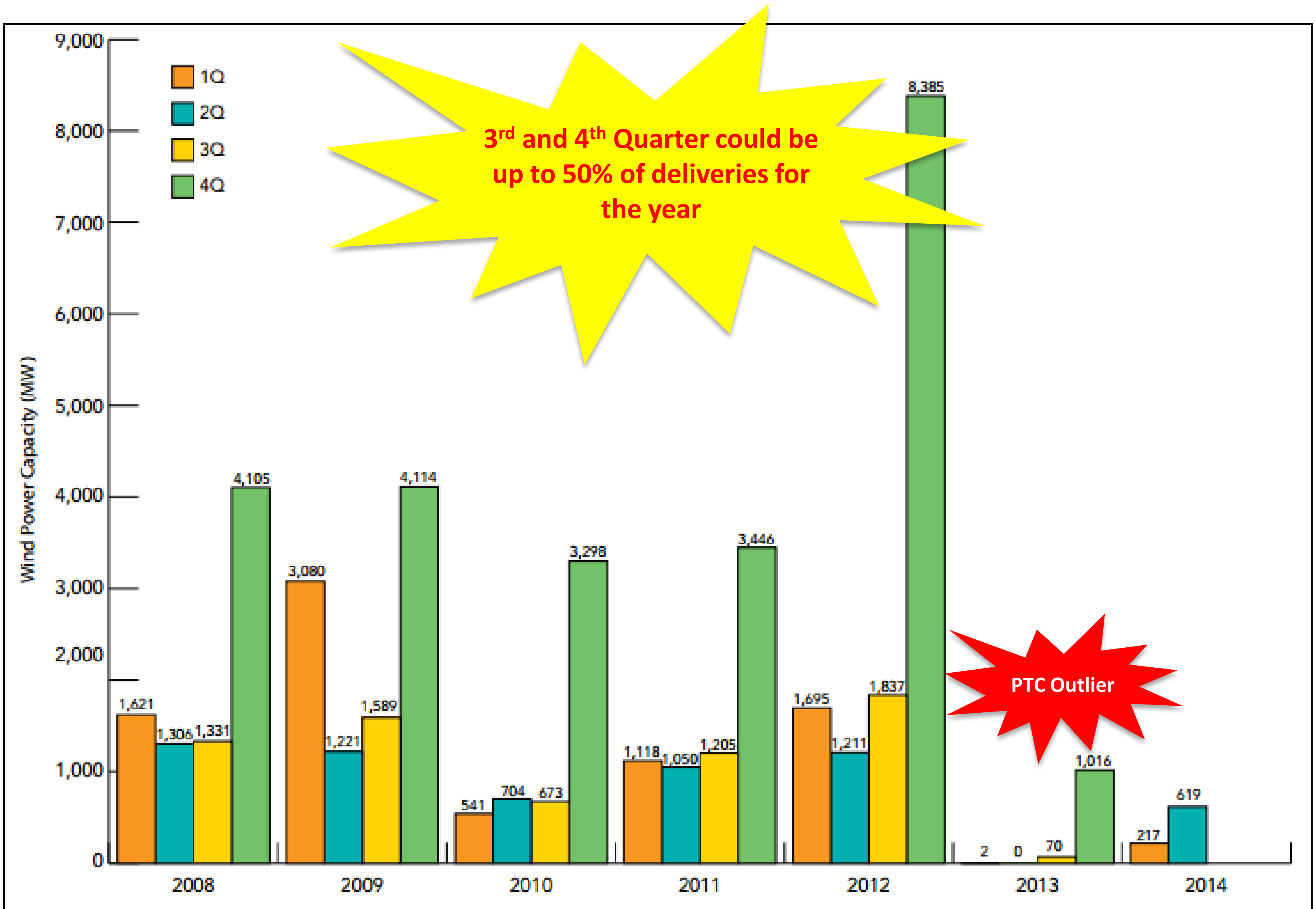
Wind Market by States



More than 60% of installations fall into WASHTO States

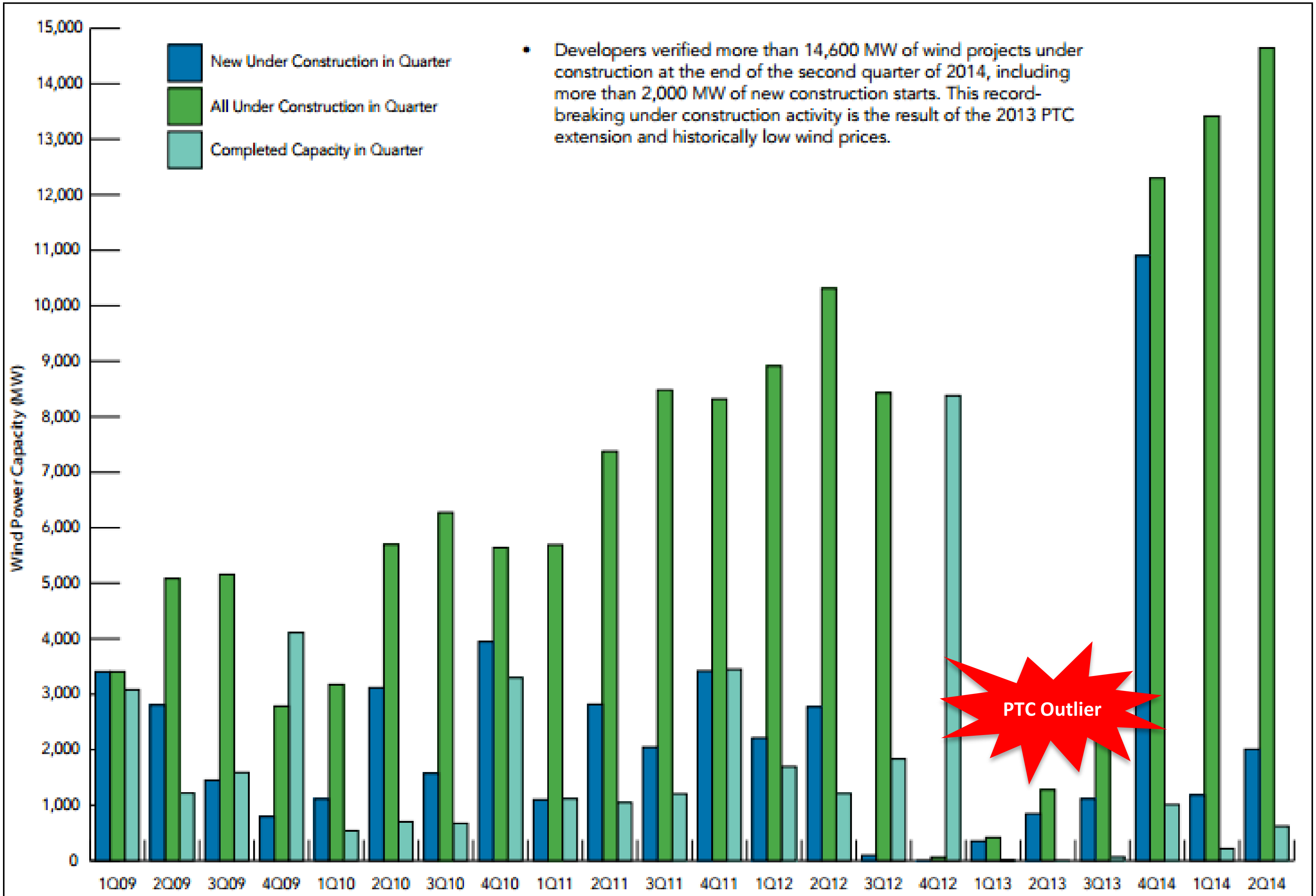
Source – AWEA

US Wind Power Capacity Installations by Quarter



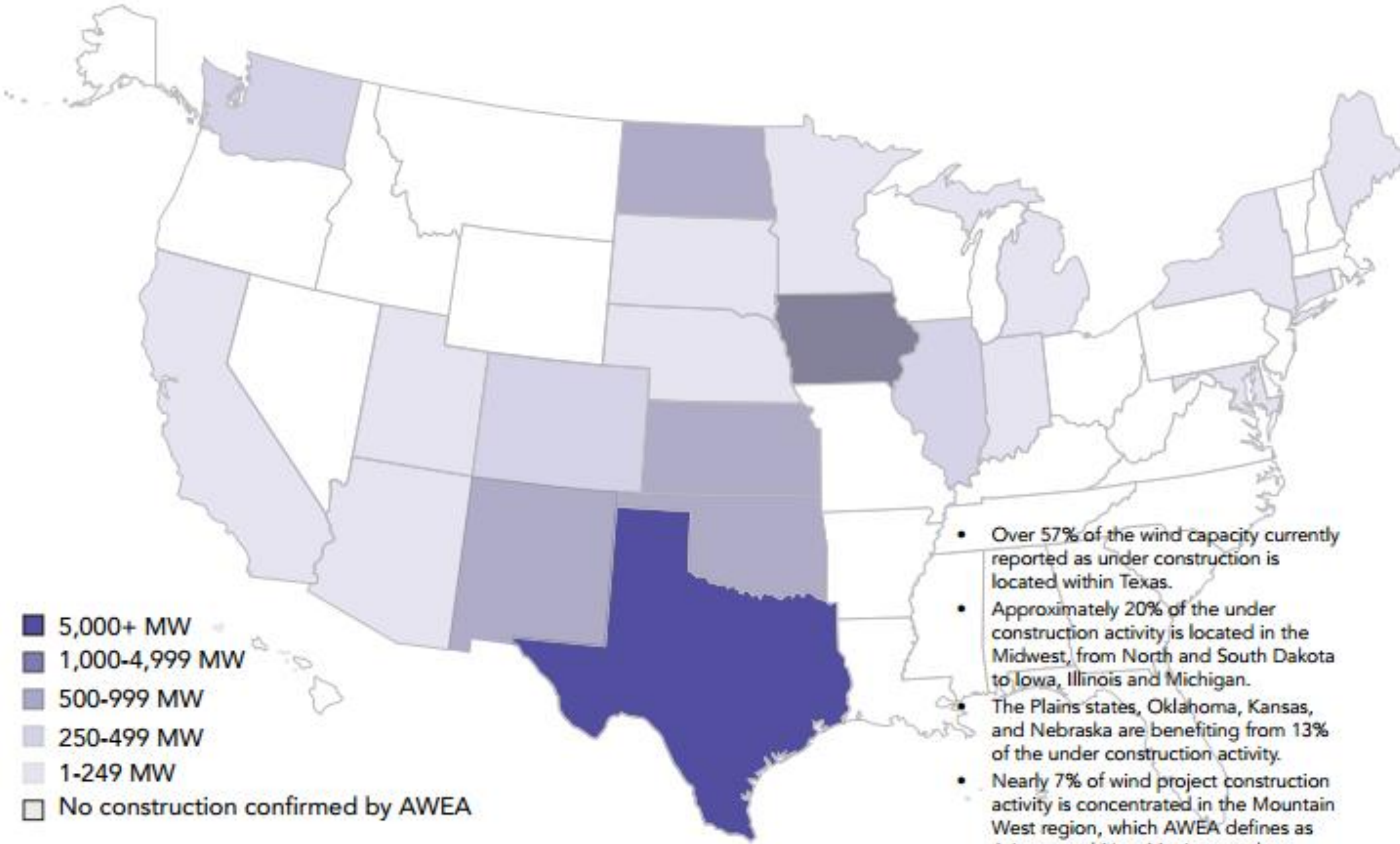
Source – AWEA

Wind Power Capacity Under Construction



Source – AWEA

Wind Power Capacity Under Construction



- Over 57% of the wind capacity currently reported as under construction is located within Texas.
- Approximately 20% of the under construction activity is located in the Midwest, from North and South Dakota to Iowa, Illinois and Michigan.
- The Plains states, Oklahoma, Kansas, and Nebraska are benefiting from 13% of the under construction activity.
- Nearly 7% of wind project construction activity is concentrated in the Mountain West region, which AWEA defines as Arizona and New Mexico, north to Colorado, Utah and Wyoming.

Source – AWEA

US Wind Turbine Supplier Market

GE Energy — 3x Unit has up 53m Blades – **Low Risk for North America**

Vestas — V105 and V126 3mw, 54m and 62m Blades – **High Risk for North America**

SIEMENS energy — D3 3.2mw, 53m and 55m Blades – **Medium Risk for North America**

SENVION wind energy solutions — 3XM 3mw, 55m and 59m Blades – **High Risk for North America**

acciona Energy — AW 3000 3mw, 62m Blade – **High Risk for North America**

SUZLON POWERING A GREENER TOMORROW — S9X Line 2mw, 50m Blade – **Low Risk for North America**

ALSTOM — ECO 122 3mw, 60m Blade – **High Risk for North America**

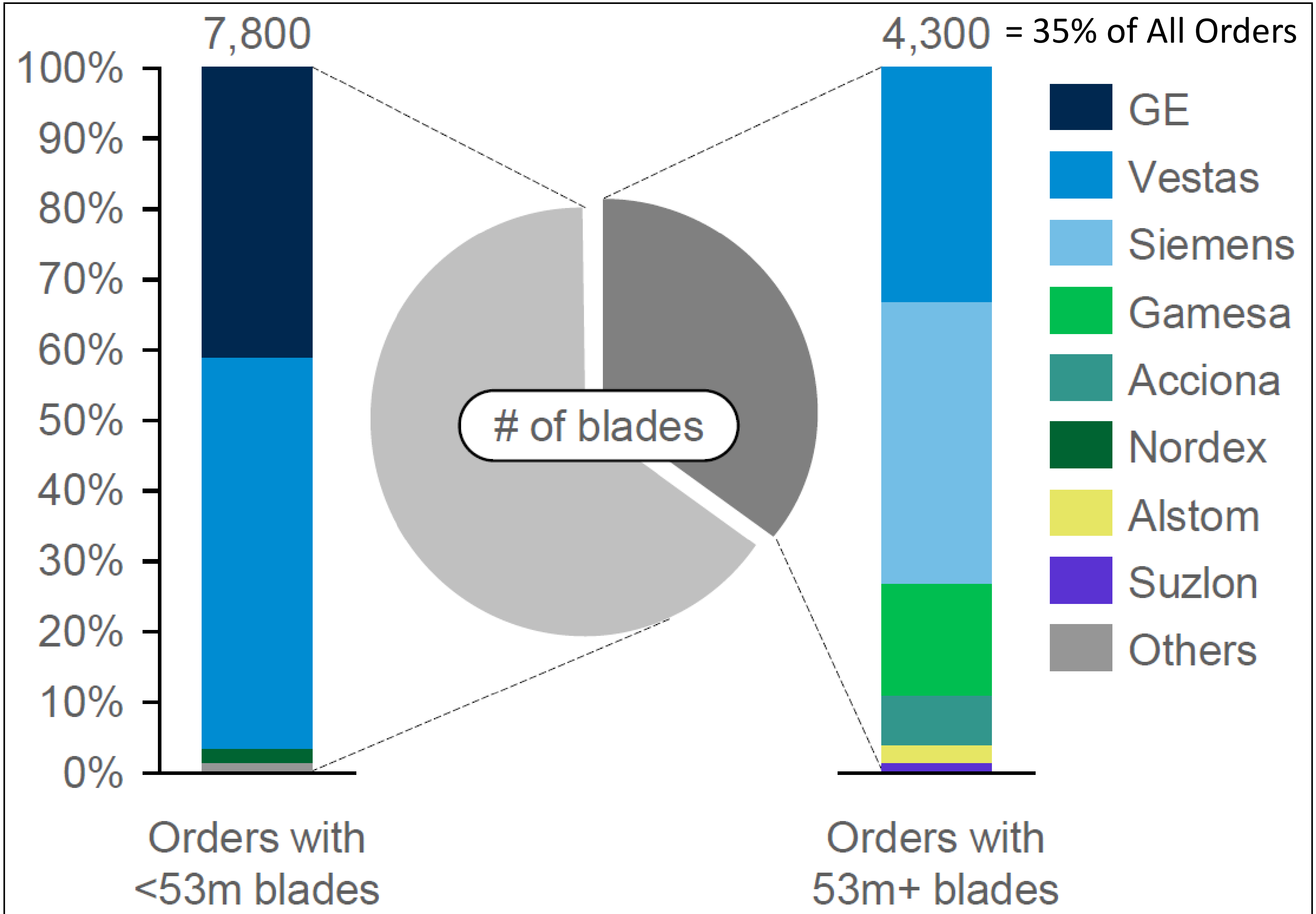
Gamesa — G114 2.5mw, 56m Blade – **Medium Risk for North America**

GOLDWIND — 2.5mw unit, 59m Blade – **High Risk for North America**

NORDEX We've got the power. — Generation Gamma, 55m Blade – **Medium Risk for North America**

Source – LPG

2015 US Wind Turbine Orders



Source – MAKE

Equipment Overview:

Specialized Stretch Blade Trailers are Required to Haul Any Wind Turbine Blades

Major Blade Trailer Manufactures

1. TrailKing (Most predominant in North America)
2. Temikso
3. K Line
4. Cometto (Mostly in South America)
5. Faymoville (Mostly in South America)
6. XL
7. IST Trailers
8. Heil Trailer
9. Goldhofer (Mostly in EU Market)

Other Manufactures are in the Market, list does not take ALL into account

Source – LPG

US Road Network:

Most Source Locations require routing through or around Major City Epicenters

- Routing Challenge minimum of 700 miles to Transit Over the Road to Project Sites
- Most highway intersections have signage and poles that will affect tail swing of Blade Tips
- Once off a major highway the last 10% of the route will have Significant Challenges with Small Rural Networks
- Most Larger Blades will be imported into US Gulf and West Coast Ports, these Ports will create challenges in Routing out of the Location onto the US Oversize Overweight Corridor Network.

Key:
= Port Source Location
= Domestic Source Location

Multi Mode Transport:

Barge -

Ability to Barge up Mississippi River to extend Source Location into the US

- Timing – more time is needed in Supply Chain
  - NOLA to Iowa roughly 3 weeks one way Up River
- Elevated Risk due to more touch points in Supply Chain

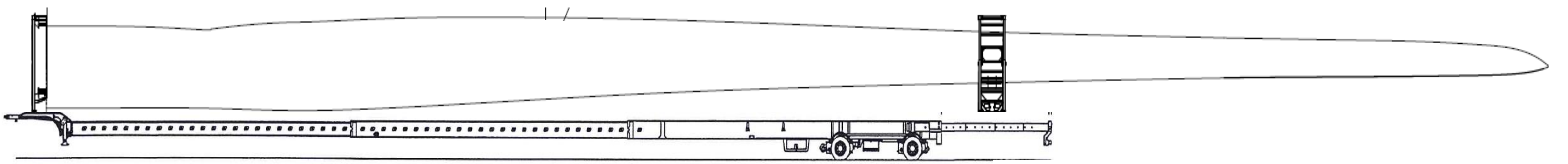
Rail -

Ability to Rail into Inner US to extend Source Location further inland (Closer to Project Sites)

- Routes are limited due to Clearances
- 3 rail cars instead of 2 for 50m Blades
  - *Roughly* - 12 Blades per unit train
  - Unit Train is 6,500 ft long
- No Solution above 55m blades have been tested
  - (55m blades have been moved)

Carrier Overview:

- Most Blade Trailers were purchased and designed for double blade transport of 40m blades (industry standard until 2011)
- Industry has not seen a much investment into New Blade Trailers over the past few years
- Carriers are "Custom Modifying" their current fleet to meet OEM Demands
    - Challenge is all designs are Unique to their own Fleet



*Tip Fixture on Rear Pull Out, Not Rear Deck

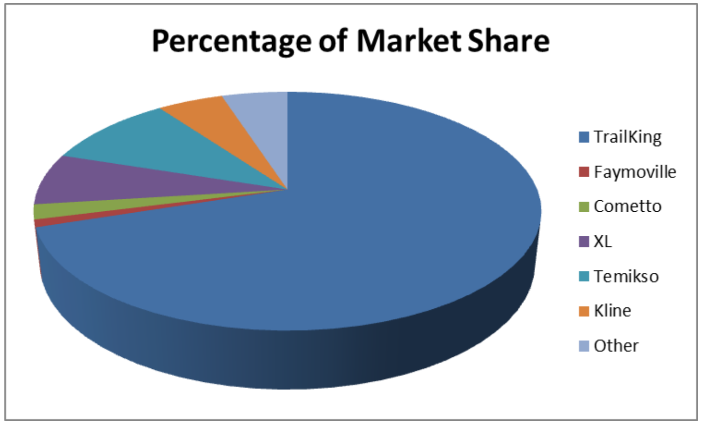
Carriers are Custom Modifying their own Trailer Fleet to accommodate a certain OEM's Blade Configuration

Carrier Solution - This tip fixture is positioned on the rear pull out of the trailer. This is only possible because the rear pull out was modified (with steel beams) by the Carrier, this location is not designed by the manufacture to take ANY weight.

Carrier Overview Breakdown

Carrier	Size of Fleet	Trailer Manufacture	Max Stretch	Beam Inserts
Carrier 1	20	Temisko	45.7	No
Carrier 2	110	TrailKing/Temisko	47.5	Yes
Carrier 3	10	TrailKing/Fayomville	45.7	Unknown
Carrier 4	15	TrailKing	47.5	Yes
Carrier 5	30	Trailking	45	Unknown
Carrier 6	20-30	TrailKing	47.5	Yes (15-20)
Carrier 7	25-35	Trailking	47.5	Unkown
Carrier 8	27	Trailking/Master	40	No
Carrier 9	20	Temisko	45.7	No
Carrier 10	26	Temisko/Trailking	47.5	Yes (15)

Roughly 50% have beam insert capability

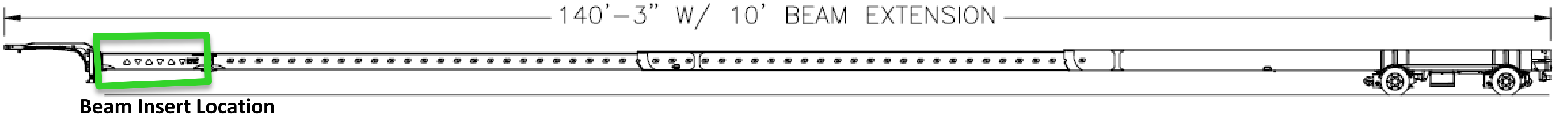


Not all US Carriers were pulsed for this Survey

Source – LPG

Beam Inserts

- Trailking has the largest Market Share, some of these trailers have a pined Gooseneck which allows for Beam Inserts to extend trailer length.
  - Beam Inserts come in 15, 20, and 25 feet increments
  - **Negative Impact is once in place, they can not be collapsed into a "Legal Load" they must permit empty**
- Manufactures are actively creating new trailer designs to meet current industry need for 60+ meter blades, very limited quantity and not a current proven solution (IST is a new company example)
- Manufactures have not seen a great deal of new Blade Trailer orders over the past 2 years.



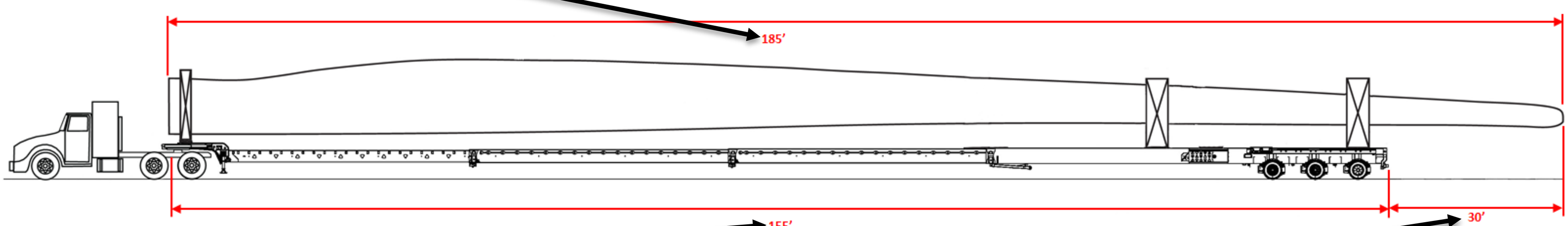
Current Largest Blade

Max Length of Blade 56m

<u>Current Overview:</u>

- Carriers are custom modifying limited equipment to haul specific blades.
- Logisticus feels with Beam Inserts that a Project Solution can be created
    - Beam Inserts come in 15, 20, and 25 feet increments
    - Negative Impact is once in place, they can not be collapsed into a “Legal Load” they must permit empty
- Current Largest Trailers will stretch to 155 feet. Federal law allows up to a 30 feet overhang, total length of the maximum blade that can be hauled on current trailers is 56m in length. **This is without Beam Inserts**

Largest Blade that can be Transported today while maintaining a 30 ft overhang is a 185ft or 56m blade



Largest Trailer – Trailking TX85EFX

Maximum Rear Overhang 30 feet

If Longer then a 56m Blade Then

Solution 1

If Beam Inserts are added to current trailers to increase trailer length which could increase blade length.

Solution 2

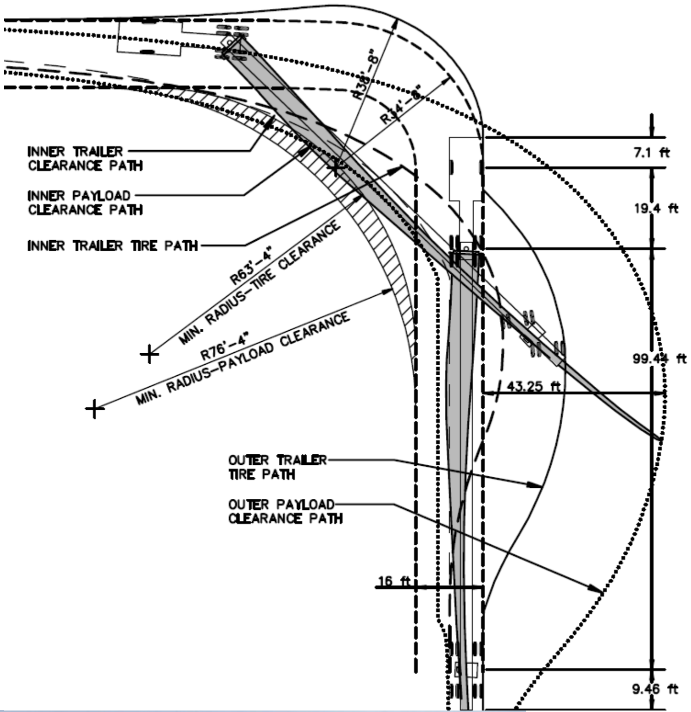
If allowable rear overhang is increased by states then Maximum Blade Length can increase.

Permits/Routing

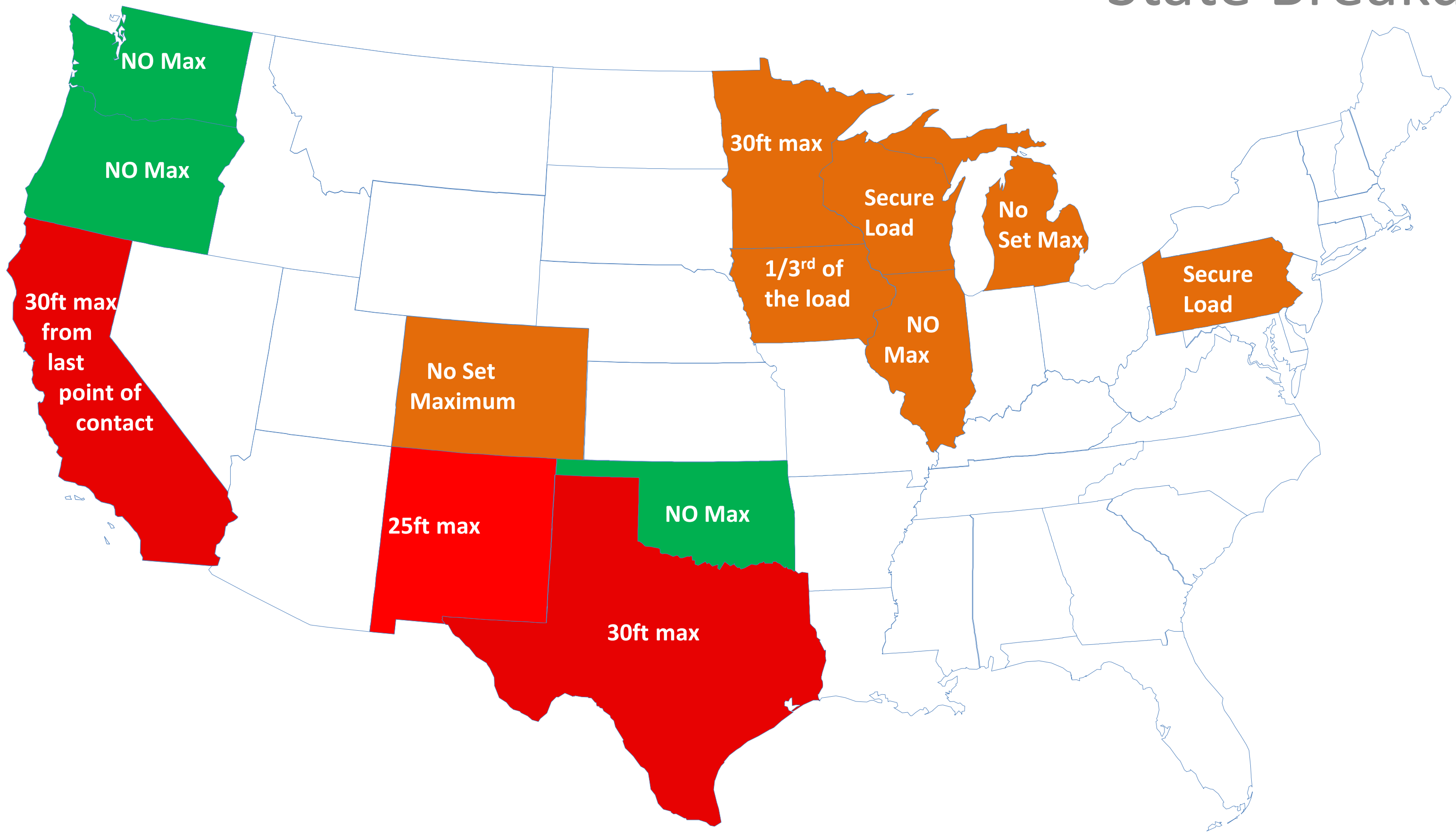
- **Permits and Police** – with an overall length of 200+ feet and an overhang that is over 30 feet; Permits will be difficult to obtain. In addition, the risk of added Police Escorts is Very High which will slow transit times and increase Transport Cost, especially in small cities and towns.
- **Routing** – with overhangs of 30+ feet the tip swing will become the limiting factor on routes, many signs will need to be brought down. On state highways this will add increased lead time on approvals since most will fall into a State ROW which will be a 30 to 60 day permit to obtain.

Rear Overhang

- **Overhang Issue** – with a rear overhang of 30+ feet, some State DOT's will flag the load and want additional verification on the Load. With State DOT's not having one standard rule/law on the overhang transporting, with the normal Turbine Supplier Strategy (Port of Import to Site via Truck) will become a issue. Multi-Mode transport will have to be considered on many projects.



State Breakdown



Summary

- Current Blade Trailers in the Industry were designed and built for Transportation of smaller wind blades
  - Newer Trailer Designs have a upper spec of roughly less than 160 feet of extension (Not Market Proven)
- Blades over 58m will have a rear overhang of over 30 feet
- States and Provinces are flagging all loads which have a rear overhang over 30 feet (9.1m)
- Routing with more than a 9m rear overhang will pose more challenges due to tip swing with signage and poles
- Permits and Police will increase transit times and decrease cycle rotations
- **All of these issues results in No Project Level Solution**

Challenge	Risk Level	Notes
Trailers	**High**	Deck Support Locations
Permits	**High**	Allowable Rear Overhang
Routes	**High**	Tip Swing Signage and Turning Radii's
Blade Damage	**Medium**	Flex Issues and Tip Damage with Accidents
Police Escorts	**Medium**	Added Escorts and Availability

We understand Risk.

Let us help you manage it.

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