Optimizing multi-modal project transport in volatile US-market

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DHL Energy conference, Houston, October 13th 2015
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Vestas in brief

The only global wind energy company

19,700
We employ around 19,700 people worldwide and have more than 30 years of experience with wind energy

27,000
We monitor over 25,000 turbines, or 50,000 MW, day and night and the data is used for efficient service planning and pre-emptive maintenance

54,000
We have more than 54,000 turbines in 74 countries worldwide spanning six continents

€ 6.9b
Vestas revenue at the end of 2014 was EUR 6.9 billion
Characteristics of Cargo

Weight and dimension are at the lower end of project cargo, no. of shipment is high

**Towers**
- 30-80 tons
- 2.5-4.5 m diam. (8.25-14.9ft)
- 10-30m long (32-98.5ft)

**Nacelle**
- 60-80 tons
- 3.4-4.2 m high (11.2-13.9ft)
- 10-14m long (32-45.1ft)

**Blades**
- 6-12 tons
- 3.5-4.2 m high (11.6-13.9ft)
- 44-67 m long (144-220ft)

**Hub**
- 20-40 tons
- 3.4-4.2 m high (11.2-13.9ft)
- 3.5 m diameter (11.6ft)

- **Project Transport:** ~ 2,800 WTG / 29,000 main components
- **Vessel Operation:** ~ 350 vessels journeys – mostly sole cargo
- **Transport Equipment:** Book value of 60 Mio. EUR
  Investments of 30 Mio. EUR in 2015
Across the regions we see strong volatility in terms of transport volumes which need to be adapted on a yearly basis.
Alternatives to unload nacelles

Business case needed to evaluate best fit solution

Each solution can be best-fit. It depends in infrastructure, available equipment, equipment cost per market, number of uses, schedule & logistics cost of equipment.
Competition between concepts
Several surprises by challenging ‘golden rules’

Rail is always cheaper than truck > 300 miles
A port can’t be a railhead

Truck is better than vessel on ~420 miles Matane-Searsport

Rules known to ‘everybody’ for many years

Truck out of factory with rail connection to an external shortline can’t make sense

All these rules have proven wrong in 2015

=> it is worth to calculate scenarios
### One fits all – example tower sections on rail

Moving from dimension specific setup to generic solution

<table>
<thead>
<tr>
<th>AS IS</th>
<th>TO BE</th>
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<tbody>
<tr>
<td><img src="image" alt="Railcar with fixtures for one type of Bottom-section" /></td>
<td><img src="image" alt="Railcar with fixtures for all type of towers-sections" /></td>
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<td><img src="image" alt="Railcar with fixtures for one type of middle-section" /></td>
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<td><strong>Cost of fixtures</strong></td>
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<td>very high</td>
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<td><strong>Total cost:</strong></td>
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<tr>
<td><strong>high</strong></td>
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Wind. It means the world to us.”
### Design change vs. superload

Example: Design change of tower increases product cost less than extra cost for superload

<table>
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<th>Superload</th>
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<tr>
<td><img src="image1.png" alt="Superload Image" /></td>
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<table>
<thead>
<tr>
<th>‘Normal‘ load</th>
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<td><img src="image2.png" alt="Normal Load Image" /></td>
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**Total landed cost (tlc) optimization:** Evaluate all cost parameters for relevant alternatives
Ongoing trend of growth of wtgs
2010 vs. 2015 standard in Europe

2010 - V90 2,0 MW 105m

2015 - V126 3,3 MW 137m
Live Voting - result

Which trend has biggest impact to transport cost?

A. wtg 2MW => 3MW   + > 50% weight
   (Hint – complete nacelle becomes superload)

B. Tower 260ft => 390ft   + 50% weight/length
   (Hint – bigger diameter needed)

C. Blade 114ft => 220ft   + > 40% length
   (Hint – > 114ft blade has 'banana-shape')
Solution nacelle: Design allows configuration

Extra cost of modular-design far below gap between normal- and superload

3 transports

4 transports

- transport roof

5 transports

- Dedicated trafo transport

4 transports

Only 2 oversized transports

+ a number of std. containers

Modular design

- Allows adaptation to transport-restrictions in various countries
- Allows optimization of transport costs in various countries
- Modular design needs to be defined in early phase of product development

Low bed transport

Flat bed transport

Low bed transport

Low bed transport

Low bed transport
Solution tower: Design to transport restrictions

Extra cost of shell-design far below gap between normal- and superload

- TLC optimization as option & challenge.
- Impact to transport, manufacturing and construction
- How to find the best global or regional average (different parameters for different projects)
- 'Classical' design optimized in last years with new trailer types
- Limit between 4,42m and 5,5m diameter (depending on country)
Solution blades: Advanced transport solution to prevent split

Extra cost of split blade ~ 50,000 USD per blade

Great technology has been developed – it is just very expensive

- Mob/Demob of equipment
- Reloading of blade
- Work at walking speed with only 1 blade
- High daily rate
- Huge impact to whole project plan and working capital
Another way to create space for a blade transport

No joke – already been done for several projects

- Extra costs for transport are 'budget' for route works
- E.g. 300 blades with 5,000 USD extra cost create 'budget' of 1.5 Mio USD
Summary & Outlook

- Wind transport at lower end of oversized, but high number and multimodule shipments
- Demand is very volatile and needs huge flexibility
- Evaluations of alternatives is worth the effort
- Total Landed Cost as main driver of optimization
- Blades will be the huge challenge going forward