

An aerial photograph of a multi-lane highway at sunset. A large truck is carrying a long, white wind turbine blade on its trailer. The sun is low on the horizon, casting a warm orange glow over the scene. In the background, there are green fields and a small town with buildings and a church spire. Other vehicles are visible on the highway in the distance.

**THE POWER
TO DELIVER**

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A NEW REVOLUTIONARY CARBON HYBRID TECHNOLOGY WITHIN THE SAME GLOBAL SUPPLY CHAIN

By Martin Molzen, Sr. Director, Business,
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World's largest supplier of rotor blades to the wind industry, leveraging ~ 9GW of global capacity

LM Wind Power designs, tests, certifies, manufacturers and service blades globally

Firm leadership position across the most technological advanced segment of long onshore blades

More than 5,300 equivalent blade-years of offshore operational experience and More than 50% of operational turbines of 6 mw and larger are flying LM blades



Headquarters
Kolding, Denmark

Factories and service locations
Brazil, Canada, China, Denmark, India, Poland, Spain, USA

- » **Global manufacturing footprint and in-house R&D**
- » **More than 185,000 blades installed world-wide**
- » **13 production and assembly facilities on four continents**
- » **Approx. 6,300 professionals**

Blade supply chain requirements and challenges in onshore/offshore markets to secure lowest LCoE

Market requirement		LCoE lever	
Lighter & Longer:	80-90m+ offshore 60-70m+ onshore	Power Production (AEP)	Cost (materials & weight)

Challenges

- Blade lengths exceed physical limitations of existing footprint
- Carbon hybrid requires different resin and typically heated molds
- Logistics challenges (e.g. paint)
- Limited offshore supply chain and support infrastructure



1. Enhanced performance: Tailored Design **LM** WIND POWER

Tailored design

Applying proven building blocks

Aero: slender, wider, C_l/C_d , add-on's

Structure: glass, carbon hybrid

Build: root diameter, sectioned



Increased AEP



Lower LCoE

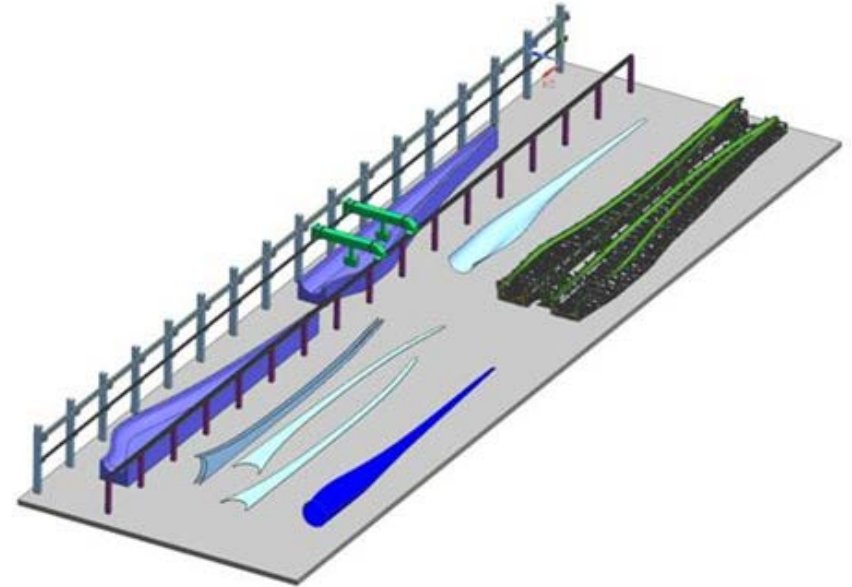
2. Re-use of footprint: Same process

Manufacturing Innovation

Facility design & layout

Same resin technology in spite of carbon hybrid

Same molds, equipment and same production processes



Reduced CapEx



Higher throughput

3. Global supply chain: Materials 1/2

Material Innovation

- Lighter-longer blades resulting in increased AEP
- Lower CapEx as existing mold set-up can be used
- Use of existing resin technology ensuring re-use of supply chain, HSE approach, tooling etc.
- Manufacturing flexibility, training
- Reduced material costs relative to full carbon

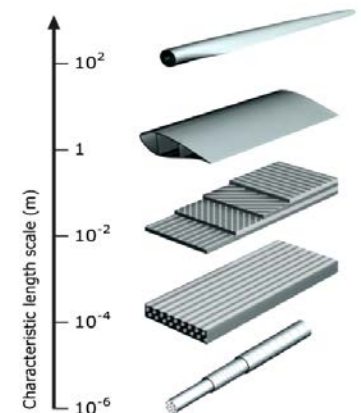
Test blade at full static load



Reduced CapEx



Higher throughput

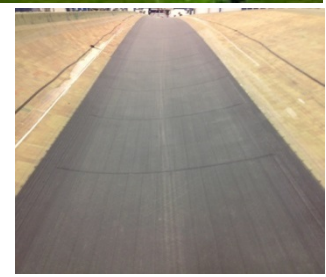
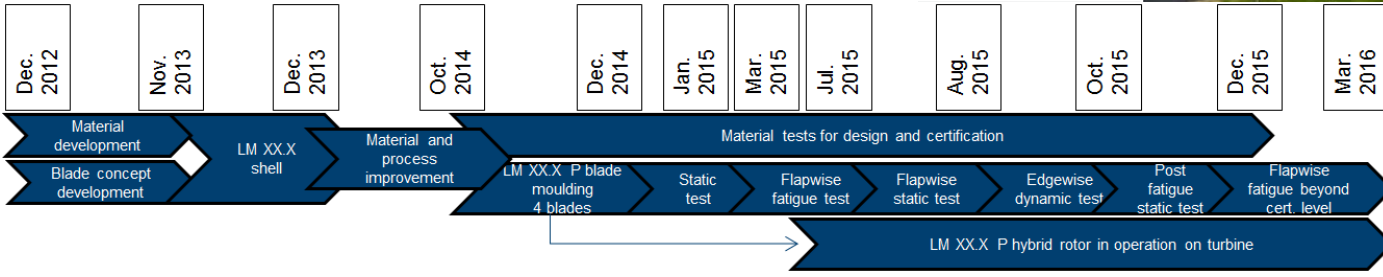


3. Global supply chain: Materials 2/2

Material Innovation

- Leveraging existing global supplier base in spite of introducing a new carbon hybrid “building block”
- High quality infusion of the main laminate in 2 step process
- Main laminate resin system cured at room temperature
- Keep in-mold gel-coating; avoid painting

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Reduced logistic cost



Intact global supply chain

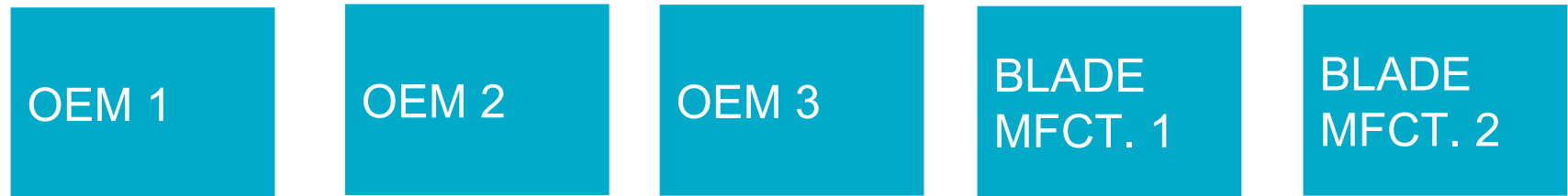


Reliability



Quality

4. Customer & Product: Consolidate



Consolidation of demand from the start through industrialized manufacturing hubs to avoid underutilization



De-risked supply chain



Scale effects



CapEx reductions

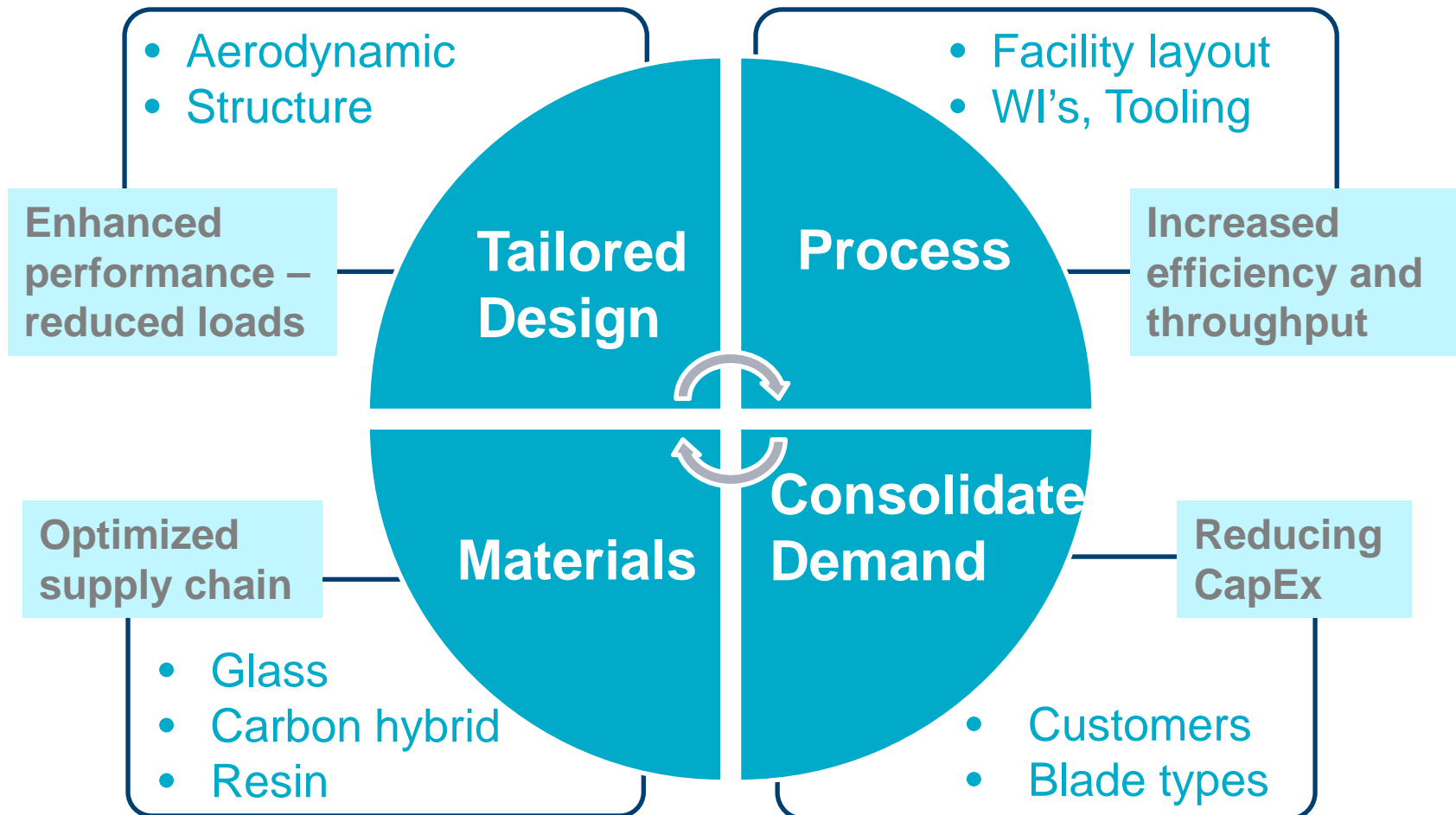


Labor efficiencies

- » Shared administration, building & general project costs

Cost effective supply chain ramp-up opportunities

Overview - LCoE reducing levers



It's not "either or.." - You can have it all !

Closing remarks

- » Design diversity using both traditional glass as well as carbon hybrid, size, scale, and efficient industrialization are key
- » Avoidance of under utilization, material & process complexity and CAPEX redundancies by demand consolidation
- » Offshore supply chain deployments are in a unique position to do this right from the start
- » Onshore supply chain can fully benefit from this in new markets / manufacturing hubs

Learnings / reflections:

- » *The Wind Industry is at a crossroads where capabilities, consolidation and economies of scale is key when choosing your blade supplier !*
- » *As a key supplier you need to focus on the "full package" of LCoE levers and not only innovative materials/processes !*

Questions?

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