

✈ Upscaling - the game changers (short version)

EnVentus™ wind turbine product solution

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2019 WIND
ENERGY
DENMARK

Trends in a changing renewables industry

**Auctions and
Forward-Selling**

**Value of energy
increasingly
important**

**Faster development
cycles**

**LCOE trend to
continue**

Our Next step: EnVentus™

EnVentus™ is the next generation in wind turbine technology

Designed to encompass a wide range of turbine configurations with the release of new modules over time, EnVentus™ applies advanced modularisation to meet customisation and market demands more efficiently.

Modular architecture in separate platforms

Platform A	Platform B	# variants	Application Space

illustrative



Advanced Modular architecture in single platform

Platform C	# variants	Application Space

illustrative

EnVentus™ | Introduction

First launched variants

WTG
AEP
driven
turbines

V150-5.6 MW™

V162-5.6 MW™

Park
AEP
driven
turbines

V138-3.0 MW™



EnVentus™ | Key technology choices

Architecture introduced in 2019

Based on proven system designs from the 2 MW, 4 MW, and 9 MW platforms

Platform from which future turbine variants will be developed, gradually replacing 2 MW and 4 MW based variants

Applying advanced modular design for flexibility in turbine configurations at low complexity

Let's explore the EnVentus™ modularisation further...

1

• Wind capture

- Structural shell blades with pre-bent design
- Cast hub with single cylinder per blade, hydraulically actuated pitch system

2

• Drivetrain

- Medium-speed geared drive
- 2-stage planetary gearbox with journal bearings
- Permanent magnet generator

3

• Nacelle

- System 8000 Control System
- Full-scale converter
- Liquid-immersed transformer

4

• Transport and Service

- World adaptor transport solution
- Separate drivetrain transport
- Design for Service

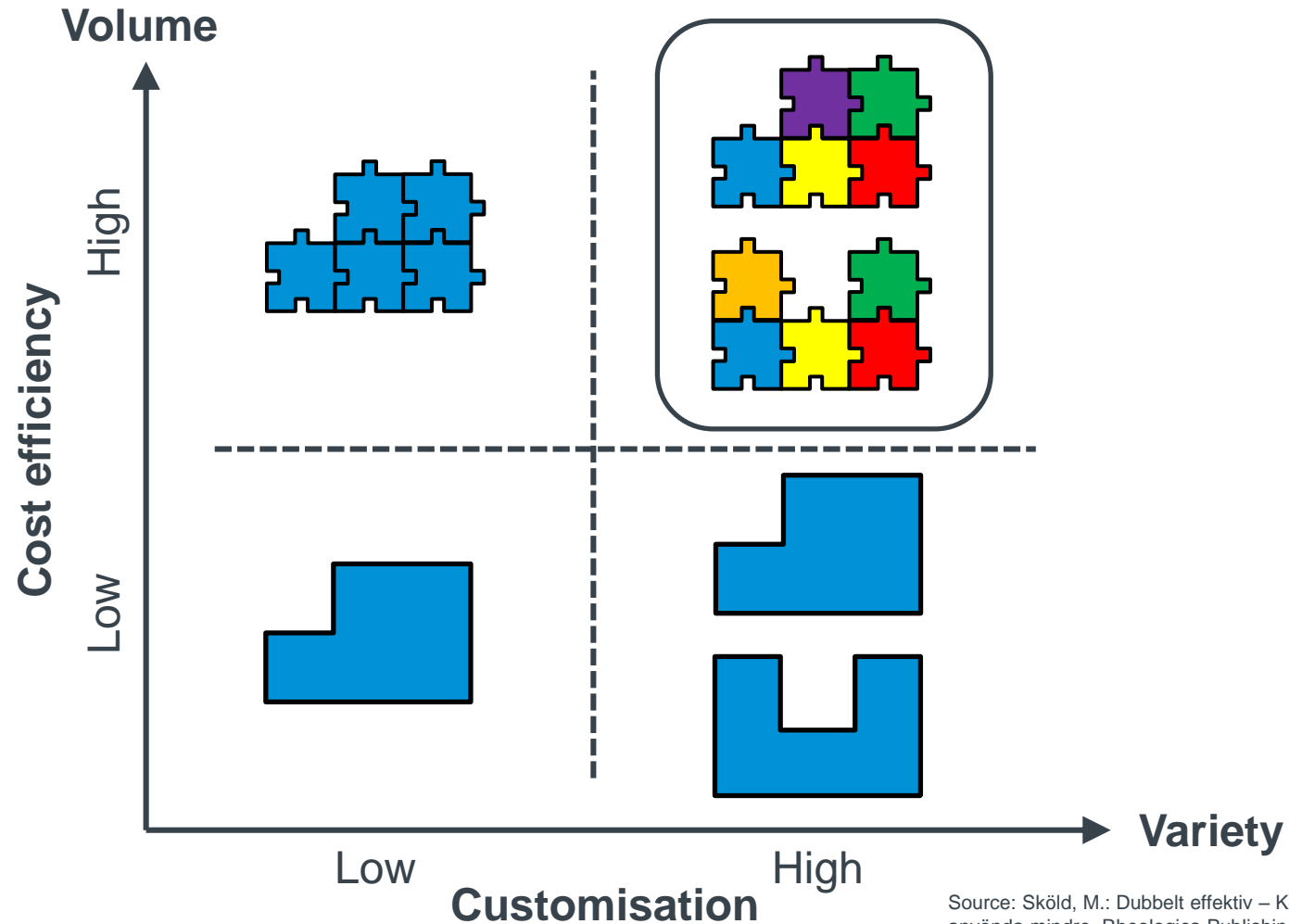
5

• Towers

- New standard towers (TST, LDST, HTST)
- IEC + DIBt

EnVentus™ | What is modularisation?

A process that reduces complexity by deconstructing a product into manageable units



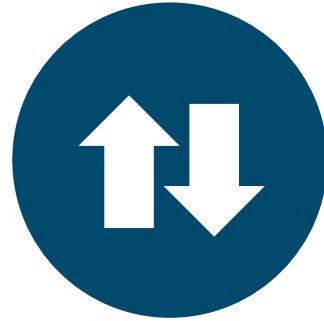
Source: Sköld, M.: Dubbelt effektiv – Konsten att få mycket att bli mer genom att använda mindre, Rheologica Publishing, Stockholm, 2016. Adapted with permission.

EnVentus™ | Benefits of modularisation & Key modularisation principles

Modularisation enhances solution flexibility, while maintaining benefits of scale



Enabling more tailored solutions



Expanding number of variants while Lowering complexity



More standardised components enable efficiency



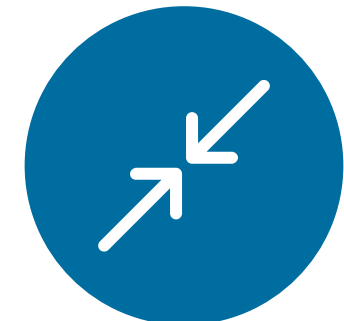
Increased opportunities to build supplier partnerships



One problem – One solution



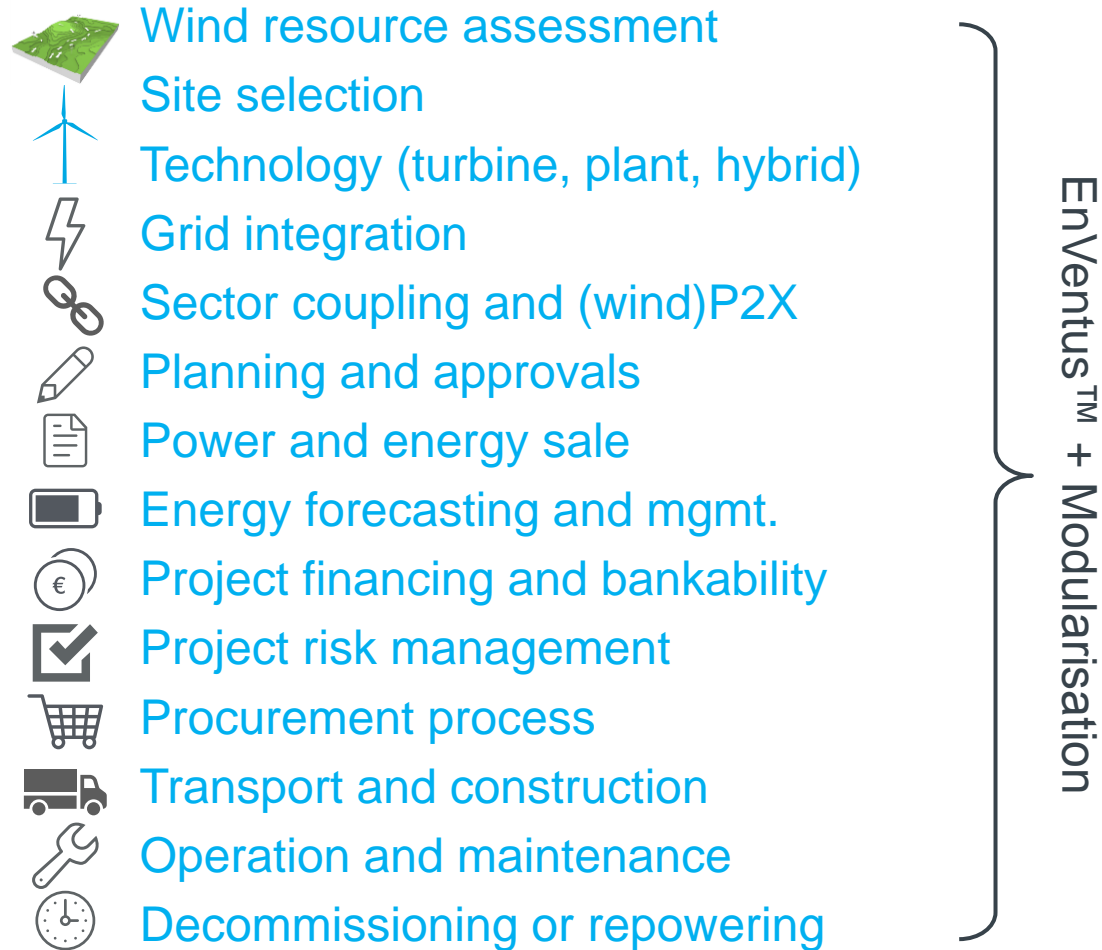
Total value-chain optimal module variance



Protected module interfaces

EnVentus™ | In an upscaling context

In future upscaling scenarios, all **life cycle phases** of wind projects require gamechangers



- EnVentus™ and modularisation form the foundation for Vestas' upscaling game changers
- Modularisation will directly or indirectly affect all wind project life cycle phases

EnVentus™ and upscaling | Key takeaways

1979-2019: Era of **Technology and LCOE parity**

2020-2050: Era of **Industrialisation and Scale (Green Transition)**



EnVentus™ and modularisation form the foundation for Vestas' upscaling game changers



Modularisation will directly or indirectly affect all wind project life cycle phases



Value proposition of large turbines is sensitive to market conditions and small turbines should not be ignored



Onshore turbines will likely continue to grow in size towards 2050 – we know how to upscale technology and volume but...

...political + societal will and action is awaited – Let's go to work!

Thank You



TECHNISCHE UNIVERSITÄT DRESDEN
DMK 2019
Dresdner Maschinenelemente Kolloquium

Balancing incremental development and disruption in the design of a modularized, scalable powertrain windturbine product system EnVentus™.
Jens Demtröder, Dr. Philip Carne Kjær, Anders Reinewald Hansen, Aarhus, DK

Abstract
Increasing worldwide demand for affordable energy and the transformation to sustainable energy sources offer unique growth potentials to the wind industry. Past growth in the wind industry was primarily driven by continuously increasing turbine size. Capturing the future potentials will require additional disruptive steps to industrialize both product and production. A product portfolio which suits varying conditions and requirements around the globe requires many product variants. Managing this variance through global manufacturing footprints and supply chains increases complexity and cost for the windturbine OEM as well as suppliers and operators. Market dynamics asks for agile release of customized variants that optimize cost of energy for each specific project. This paper presents an approach to manage this complexity by transitioning the complete product portfolio into one modular product system. Common tools for the architecting process are discussed, and it is shown on the example of the powertrain how the modularity influences concept choices.

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Exclusive: The inside story of Vestas' groundbreaking new platform

24 January 2019 by Edo de Waard

Vestas' new onshore platform, christened EnVentus, propels medium-speed geared drivetrain technology and modular design into the mainstream market, setting new standards for power rating and rotor size at 5.6MW and 162 metres.

New design... The EnVentus nacelle incorporates a compact medium-speed drivetrain. It is longer because the converter is located behind the generator.

Thank you for your attention

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