



Improve Your Turbines

Wind Operations Europe 2020 – March 6th





Since 1933
Privately owned



Skive, Denmark
Group headquarters



19
Global offices



+600
Employees

Wind power

**Marine &
offshore**

Land power

OEM: Controller, Converters, Electronics

5% global market share – China, Europe, Brasilia, India

Leading in Retrofit of Control System

>2000 Wind Turbines retrofitted, offerings for
Repower Design (Senvion*, Dong Fang*), Vestas*, Suzlon*,
Enercon, Nordex, ...

Retrofit Focus: Wind Park Owner

Maximal benefit for IPP

- 1) Flexible service & maintenance – stay free
- 2) Full access to all data – you are the owner
- 3) Site Specific Optimizations – gain the maximum

“After DEIF retrofit the errors reduced, the turbine runs more optimal and we had the best energy production month ever!” – S64 owner in USA



The Difference of DEIF in Wind Power



Full Re-engineering of the Wind Turbine!

- Load Calculations,
- Aero-elastic Modelling,
- Control Engineering,
- Data Analysis,
- Lifetime Optimizations,
- Electrical Design,
- Turbine Optimizations & New Functions like De-icing,
- etc. ...

Technology Support Organization – replace OEM



More than 30 engineers, experience in turbine engineering of...

Vestas **SENVION**
wind energy solutions

SIEMENS Gamesa
RENEWABLE ENERGY



SUZLON
POWERING A GREENER TOMORROW

HYUNDAI
HEAVY INDUSTRIES CO.,LTD.

ENERCON
ENERGIE FÜR DIE WELT

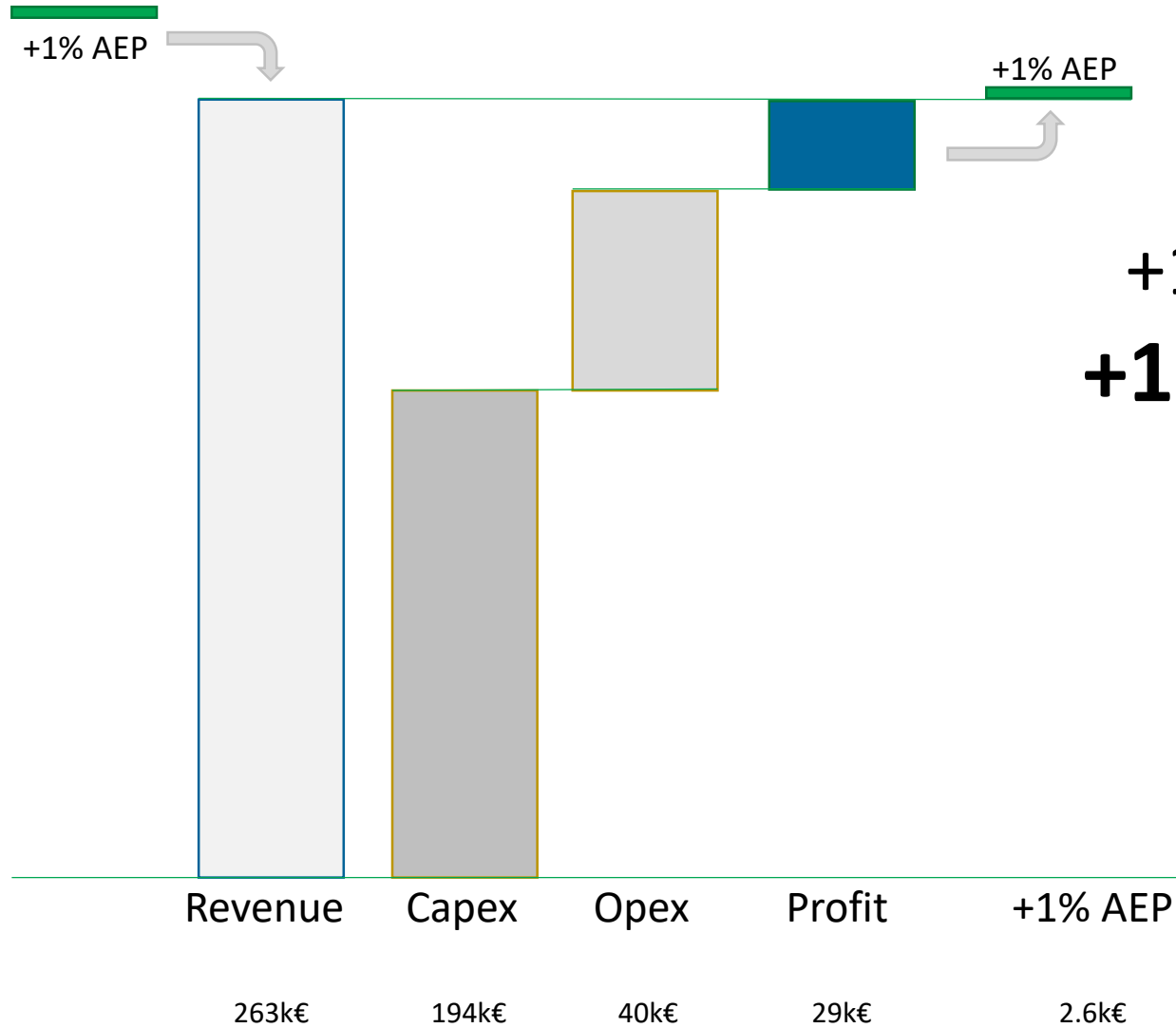
Fuhrländer

DOOSAN

INOX WIND
Energizing INDIA

SINOVEL
华锐风电

What means +1% AEP?

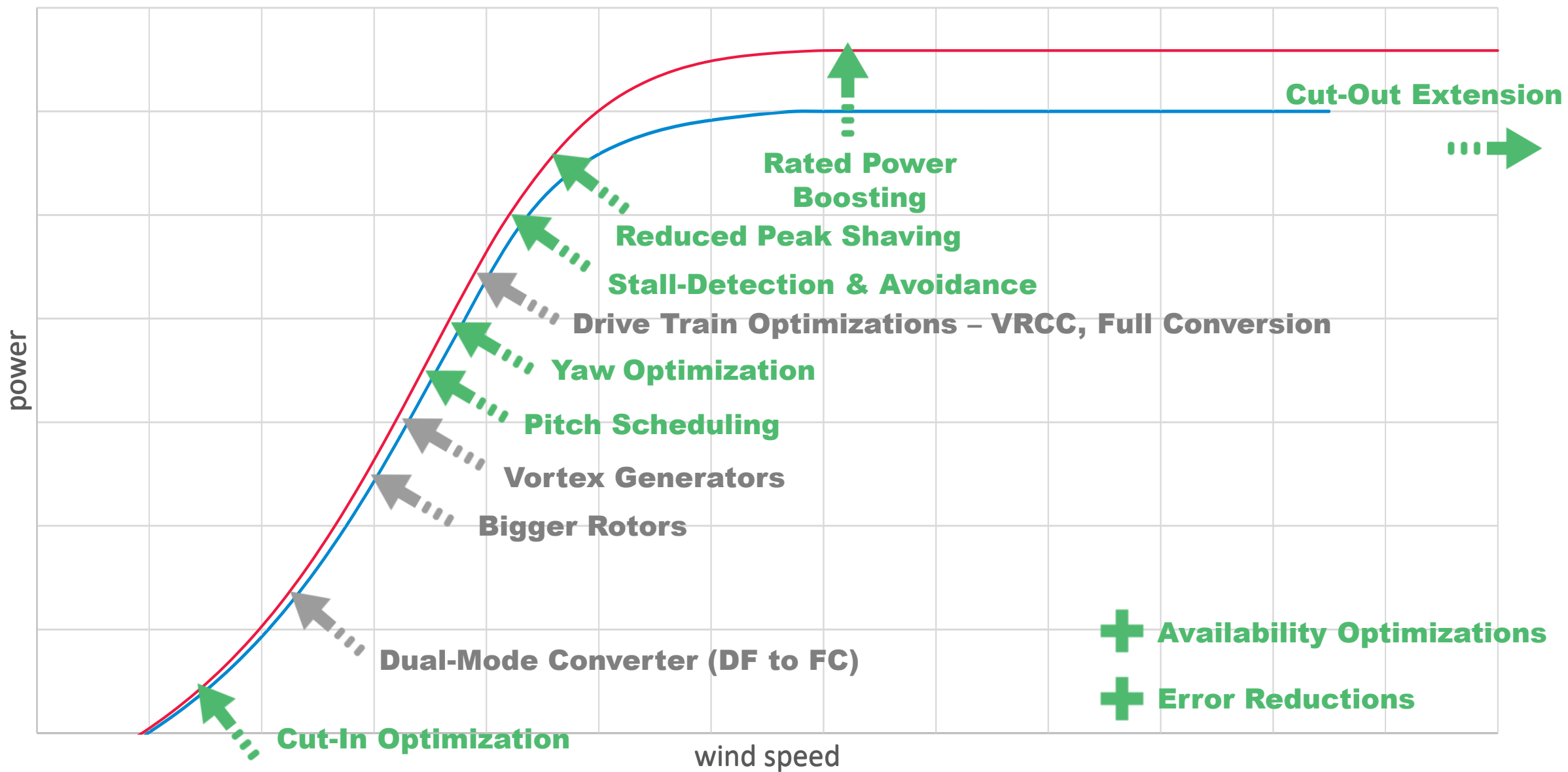


+1% AEP can add
+10% more profit























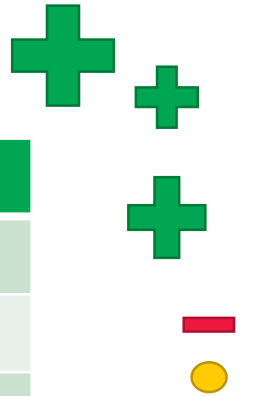
Assumptions:
WTG - 2MW
Capacity Factor - 30%
Market price - 50€/MWh
Initial Investment - 2M€
Return Period - 13 years

Various Methods to Improve The Power Curve



Overview – Various Options

	Method	AEP Potential	Effort	Life Time Effect	Cost Efficiency (1-10)
Software only	Yaw Calibration	0.5-2% 	Low, SW/Parameter	Increased 	10
	Rated Power Boost	0.5-3% 	Medium, Load Calc.	Reduced or Similar 	8
	Cut-Out Extension	0.1-2% 	Medium, Load Calc., SW	Reduced or Similar  	5
	Pitch Scheduling	0.2-1% 	Medium, Load Calc., SW	Similar	3
	Stall Detection	0-20% (recovery) 	Low, SW	Increased 	8
	Reduced Peak Shaving	0.5-2% 	Medium, SW, Load Calc.	Almost similar  	7
	Cut-In Optimization	0.1-1% 	Low, SW/Parameter	Similar	4
SW & HW	Dual Mode Conv.	0.5%-1% 	Medium, HW, SW	Increased 	2
	Fix to Variable Speed	5-20% 	High, HW, Load, SW	Significantly Increased 	7
	Bigger Rotor	Up to 20% 	High, HW, Load, SW	Design dependent	5
	Vortex Generators	0.5%-2%, up to 10% recovery 	Medium, HW, Parameter	Similar	6





Terra-Gen LCC

Increases overall revenue with DEIF control retrofit solution

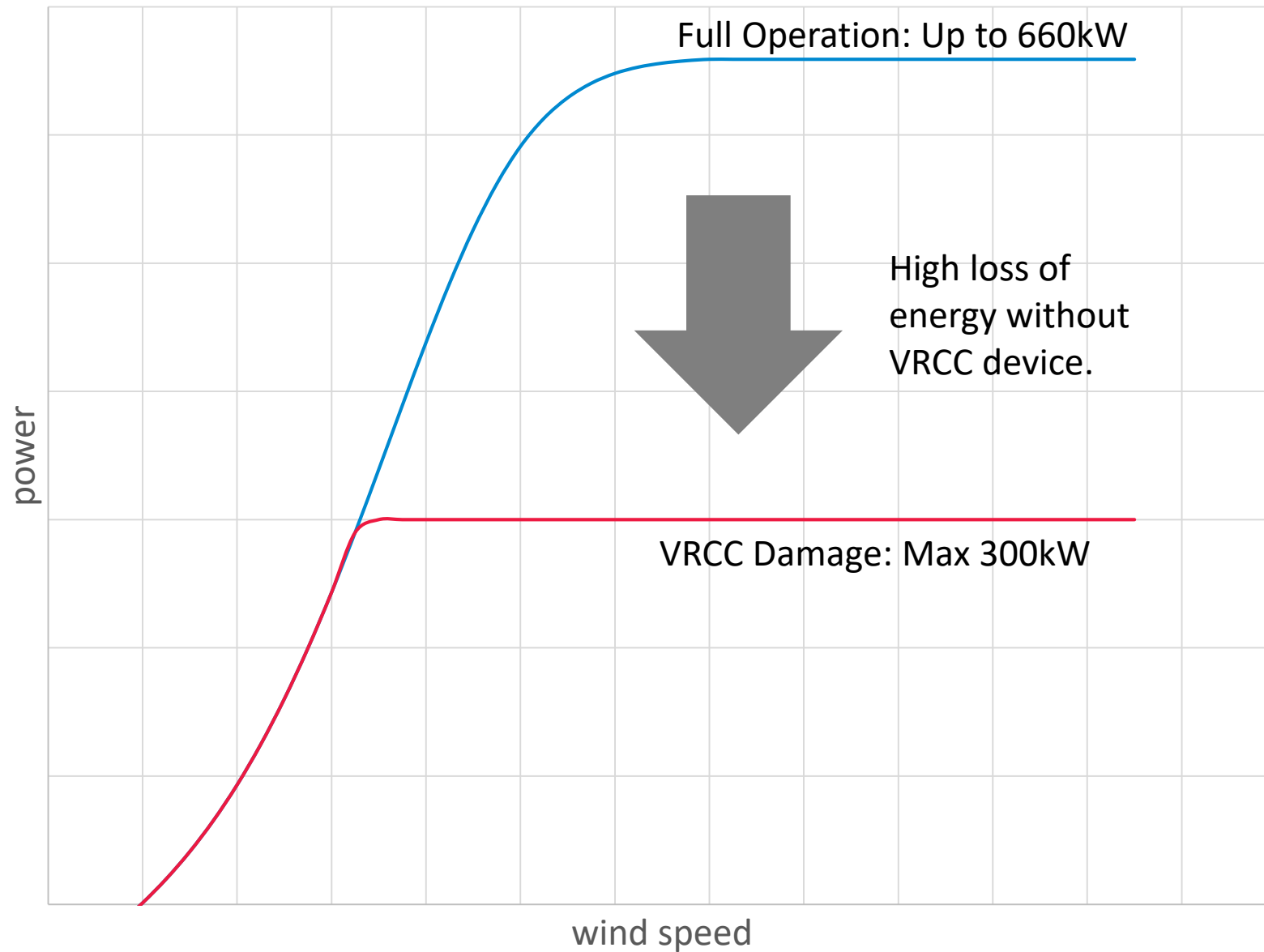
The Challenge

70 V47 wind turbines in California

- Many VRCC* failures
- Expensive repairs
- Removal of VRCC* results in reduced rated power

**How to run a V47*
without VRCC*
and still have same AEP?**

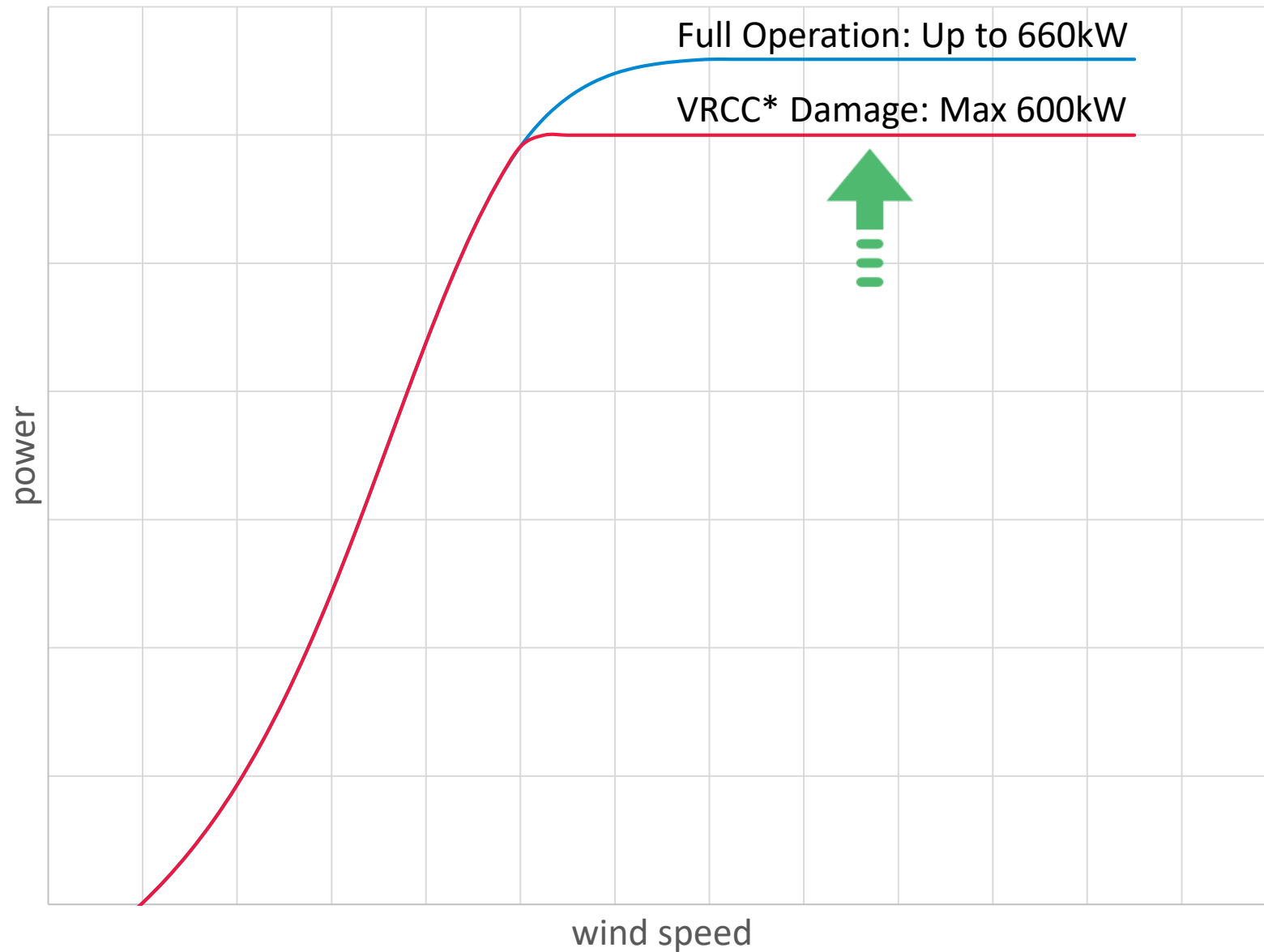
OEM version: Two Operation Modes



In original OEM configuration, a damaged VRCC has to be replaced*

Expensive repairs & huge loss of energy until repair (up to 2 months)

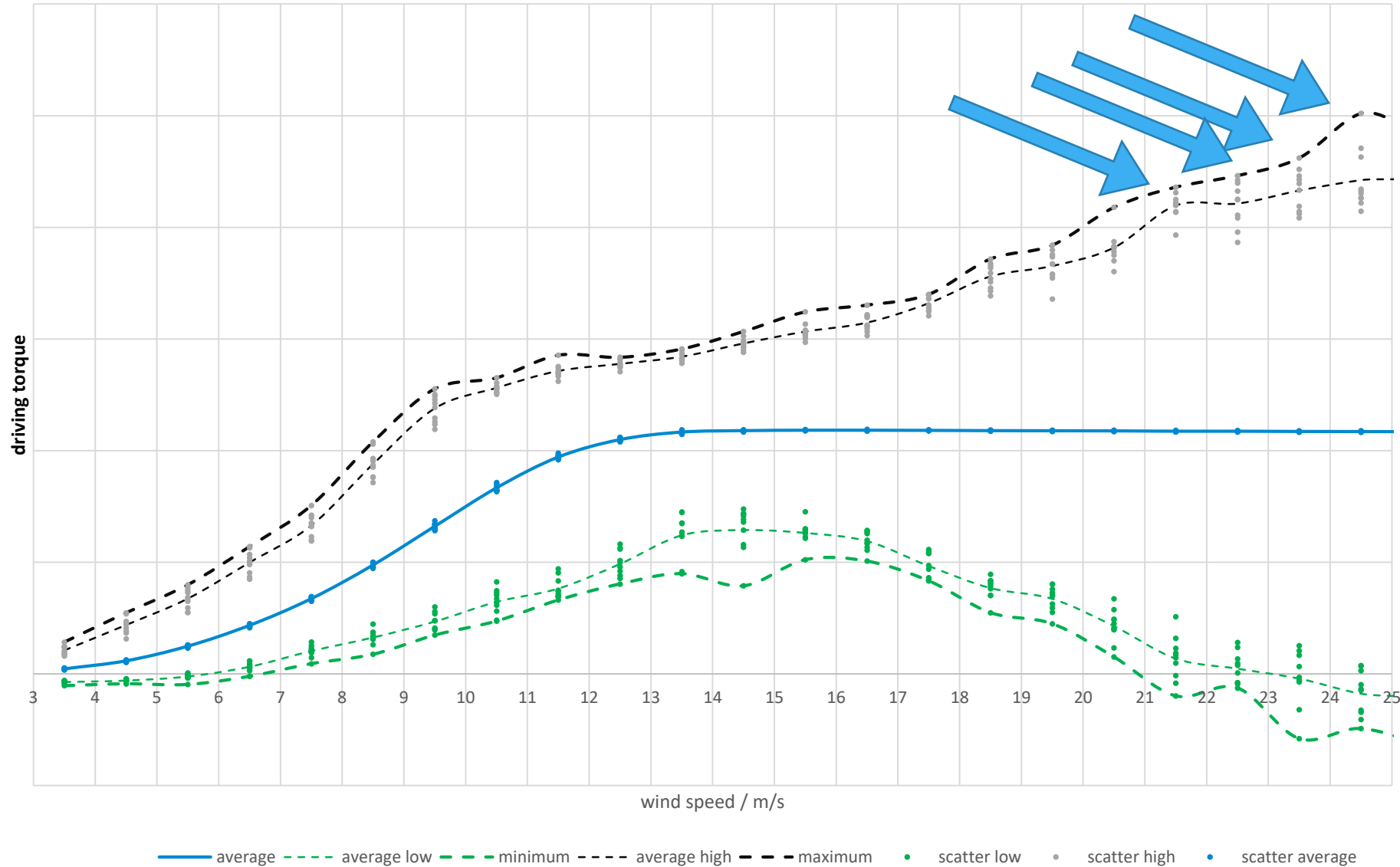
Step 1: Replace Controller



Analysis of Aeroelastic Models showed that same lifetime can be achieved without VRCC and up to 600kW.*

Still loss of -5% AEP at given site compared to VRCC mode

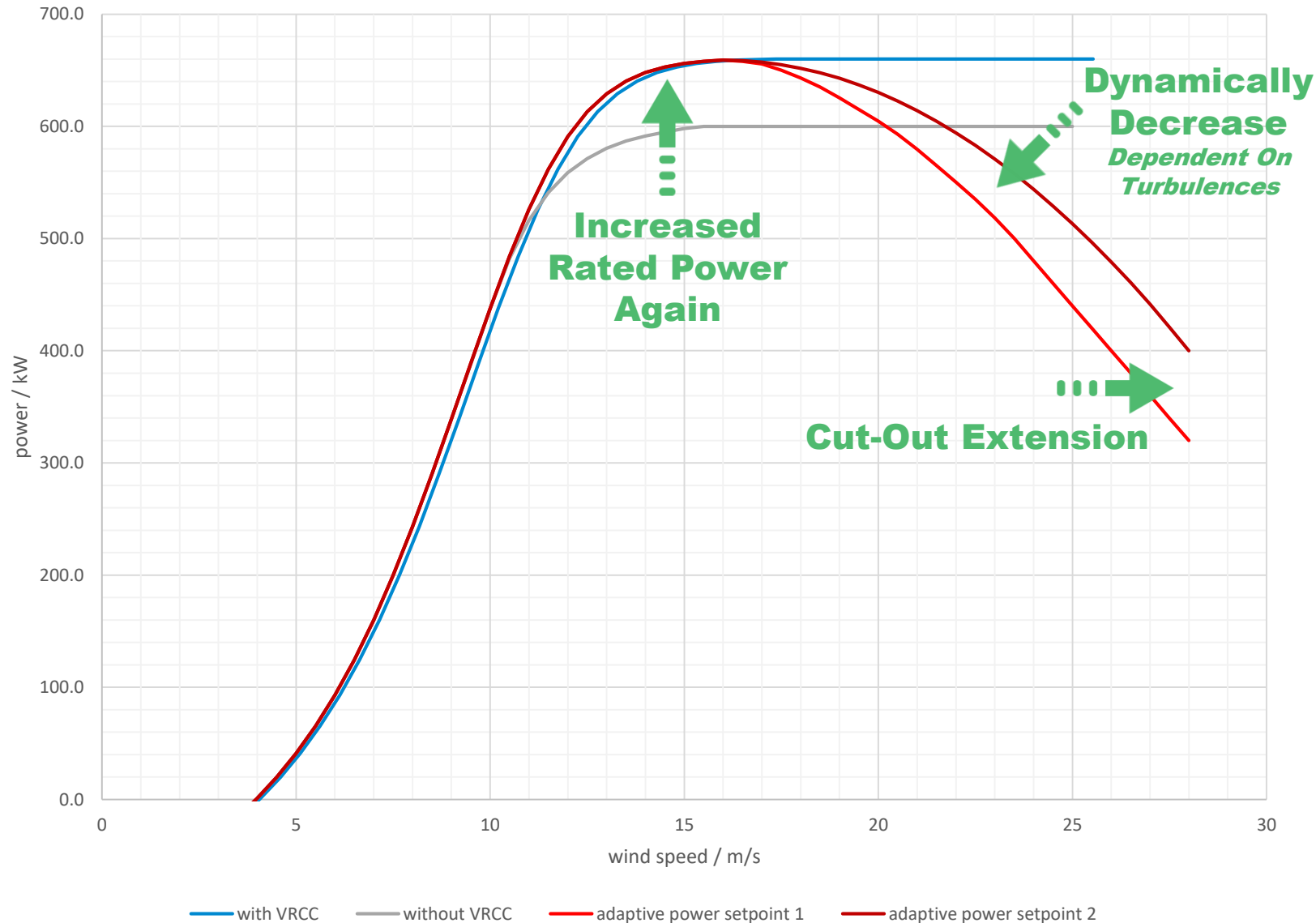
Analysis: Critical Torque Peaks



DEIF identified the main cases responsible for life time reduction by use of an aeroelastic model and enhanced site turbine data collection.

Most „expensive“ operation modes at high wind speeds.

Step 3: Adaptive Power Setpoint



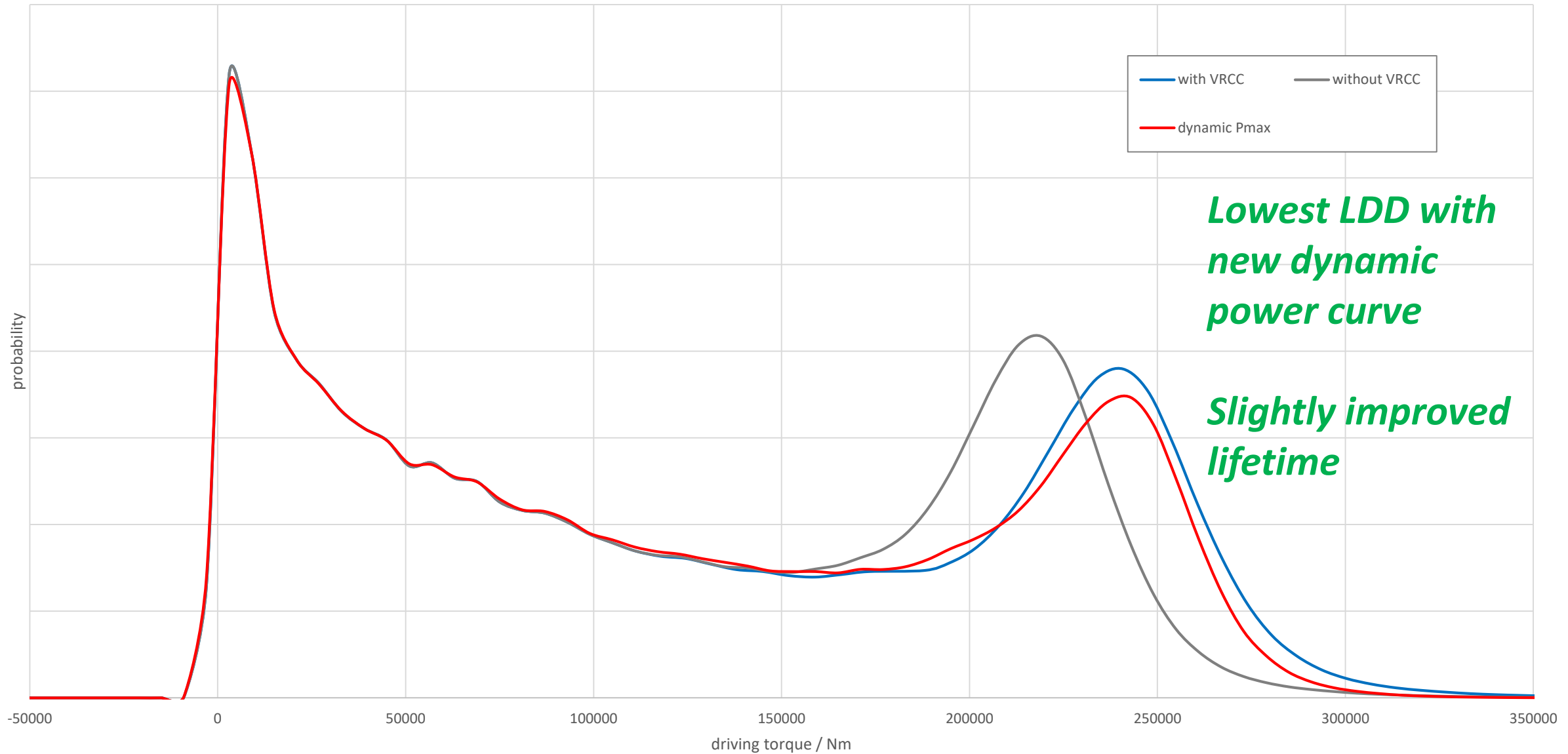
DEIF's stronger controller enabled a more sophisticated turbine operation based on turbulence data analysis

Total gain of 4% AEP by these actions

Finally a total gain of +2% AEP compared to OEM

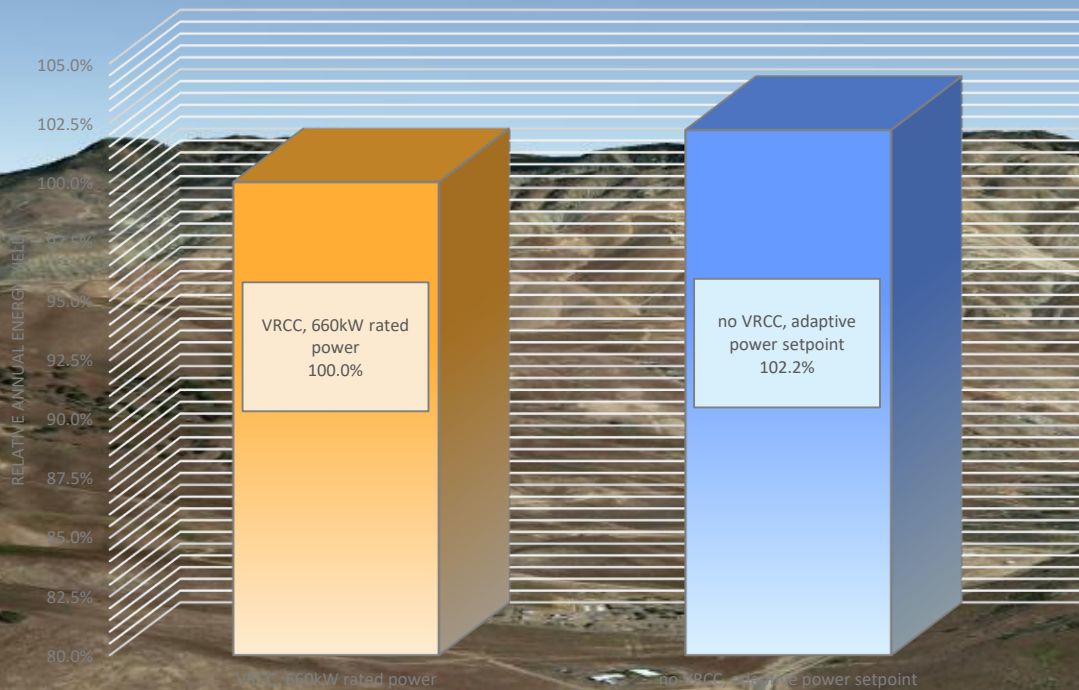
No VRCC anymore

Load Comparison and Life Time



Results

20 turbines original vs. 20 turbines DEIF
6 months duration in 2019



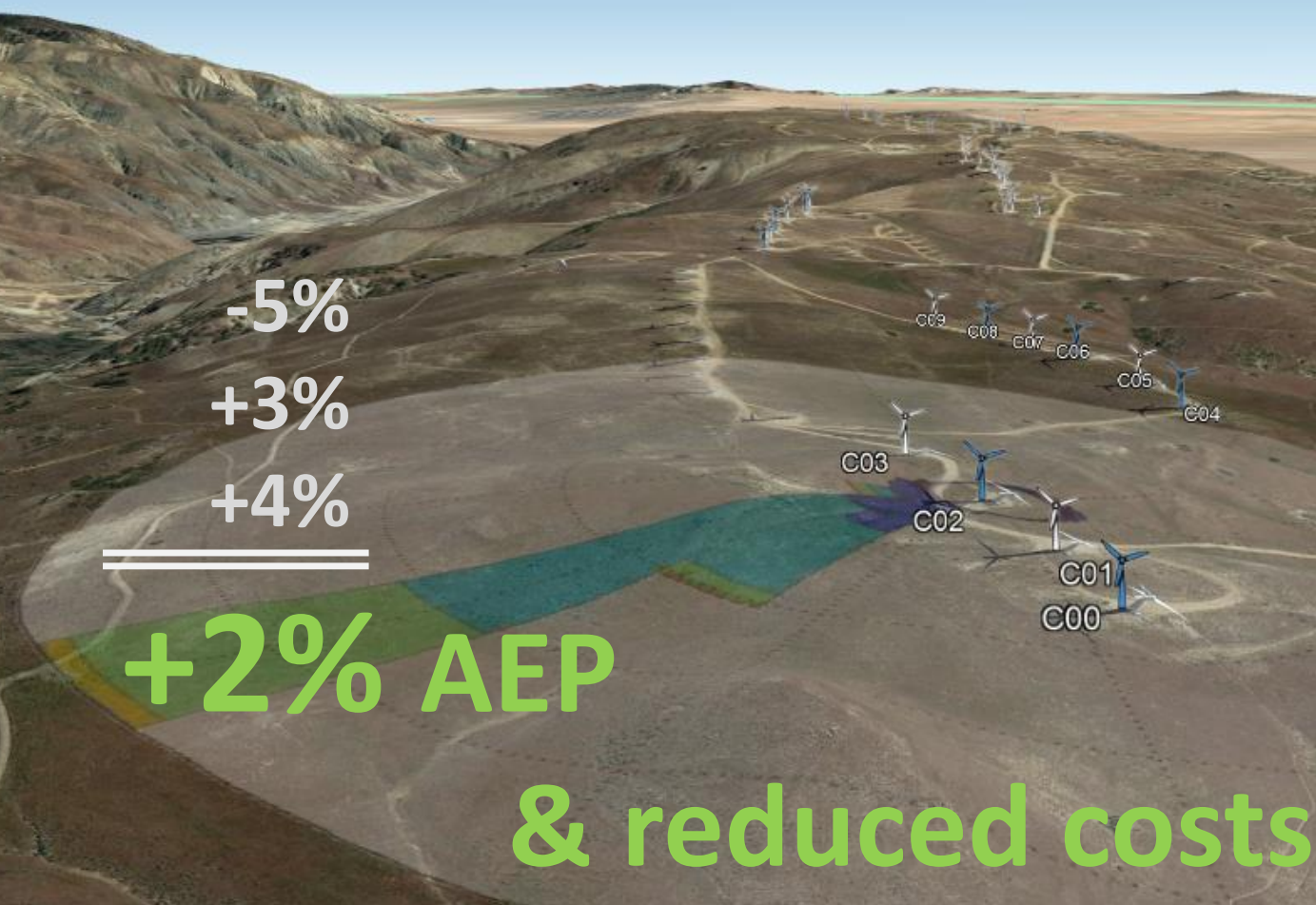
-5%

+3%

+4%

+2% AEP

& reduced costs



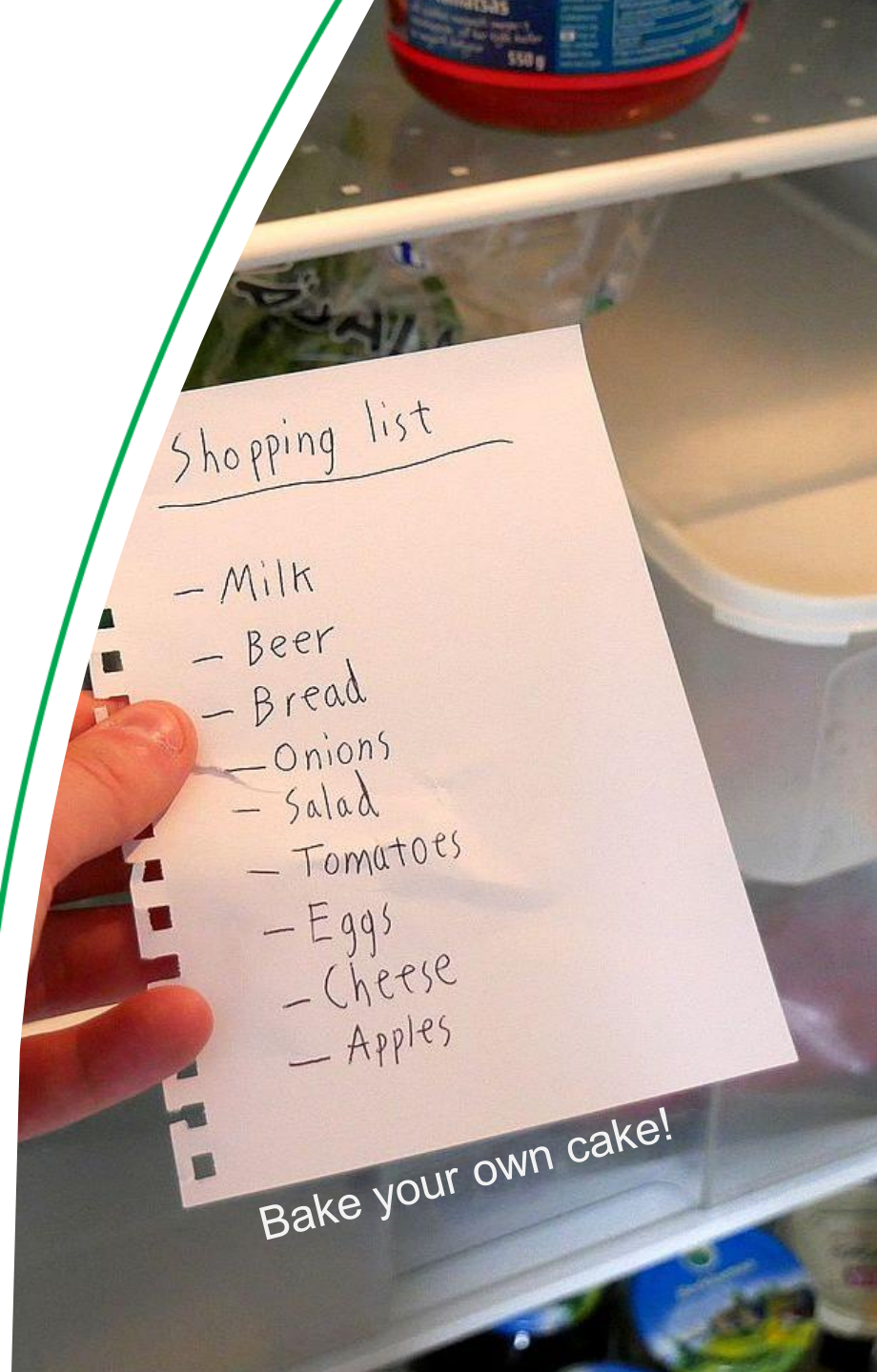
Your Shopping List

- Access to Turbine Controller (or a cooperative OEM)
- Aeroelastic Model
- Engineering Team or Partner
- Test Turbine

... so you can cook your own

+ Higher AEP

+ Higher Profits



Bake your own cake!



DEIF Wind Power



Thank you for your attention



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