How Shell Lubricants solutions deliver value to wind turbine manufacturers and operators by reducing total cost of ownership and increasing equipment efficiency and reliability.

**Boosting efficient and reliable wind power**

**SHELL LUBRICANTS**
TOGETHER ANYTHING IS POSSIBLE

Cezar Galate Cerbam
Technical Manager
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About Shell in 2018

- **92,000**
  - Average number of people we employed

- **$21 billion**
  - Cash flow from operating activities

- **30 million customers**
  - Served every day through 43,000 Shell-branded retail stations

- **30.9 million tonnes per annum**
  - Liquefied natural gas liquefaction volumes

- **50%**
  - Share of our production that was natural gas

- **1%**
  - Our share of the global supply of energy

- **3.7 million**
  - Our production of crude oil and natural gas in barrels of oil equivalent a day

- **57.1 million**
  - Tonnes of liquefied natural gas we sold

- **70+**
  - Number of countries in which we operated

- **2%**
  - Our share of the world’s oil production

- **$1 billion**
  - Spent on research and development

- **$102 million**
  - Spent on voluntary social investment worldwide

- **2016**
  - Amount of carbon dioxide captured by the Quest CCS facility in 2016

About lubricants within our business

01 Exploration
- Exploring for oil and gas: offshore
- Exploring for oil and gas: onshore

02 Development and extraction
- Developing fields
- Producing oil and gas
- Extracting bitumen

03 Manufacturing and energy production
- Upgrading bitumen
- Refining oil into fuels and lubricants
- Converting gas into liquid products (GTL)
- Producing petrochemicals
- Producing biofuels
- Generating power

04 Transport and trading
- Liquefying gas by cooling (LNG)
- Shipping and trading
- Regasifying (LNG)
- Supply and distribution

05 Sales and marketing
- Retail
- Lubricants
- B2B
- Chemicals

About Shell Lubricants

The global number-one lubricants supplier

11 YEARS No.1
GLOBAL LUBRICANTS SUPPLIER

Supports customers in more than 90 countries

Shell lubricants are recommended or approved by over 3,000 equipment manufacturers.

More than 150 patents for lubricants, base oils and greases

Employs over 10,500 people

Research and development centres on four continents

More than 700 technical staff among Shell Lubricants and its distributors

7 base oil plants, 15 grease plants and 44 blending plants

More than 150 patents for lubricants, base oils and greases

Source: Kline & Company, Competitive Intelligence for the Global Lubricants Industry, 2008–2018
About investment in lubricants technology

Shell delivers value by investing in new lubricants:
- We continually invest in research and development.
- We have pioneering research centres around the world.
- We have more than 150 lubricant, base oil and grease patent series.

We support customers with on-the-ground experts to help solve lubrication problems.

260 Shell Lubricants technical specialists help customers reduce the TCO through effective lubrication.
Shell investing in New Energies

- **Focus areas:**
  - New Fuels
    - Biofuels
    - Hydrogen
    - Electric Mobility
    - Gas for Transport
    - Shell GTL (Gas to Liquids) Technology
  - Power
    - Wind
    - Solar
    - Energy Access
    - Trading and Marketing

- Selective and opportunity driven investment
- Capital investment $1-2 billion per annum average
Shell operations in Wind Power

- Wind is an increasingly prominent part of the evolving energy system
- Shell has more than 15 years’ experience
- Onshore and offshore projects operational in the USA & Europe (50:50 Joint Ventures)
- Working to develop a diverse portfolio in offshore wind
Challenges
The needs of wind power operators

- Machine reliability
- High productivity
- Reliable supply
- Low total cost of ownership (TCO)
- On-site technical support
- Excellent safety and environmental conditions

We understand that enabling your equipment to work reliably for longer is essential to meeting your customers’ demands. Our offer is designed to help you address the challenges facing your business.
Wind turbines technology evolution

- Turbines are becoming larger: the average output capacity has increased to 1.96 MW (3.6 MW offshore).
- Gearboxes are heavily loaded; in 2014, there were about 900 gearbox bearing failures that resulted in insurance claims.
- Wind turbines, especially for offshore environments, are moving towards direct drive (no gearbox) owing to reliability issues.
Wind turbine lubrication challenges

Wind turbines are often remotely located, which makes accessing them for maintenance expensive. They are subjected to variable loads including gust loads.

- Longer turbine blades lead to more extreme loads and vibration on the bearings, which can accelerate wear.
- Lubricants must be able to perform efficiently despite extreme low or high ambient temperatures and sandstorms.
- The lubricant must resist the formation of deposits and retain its wear protection properties when contaminated with water.
- Gear oils need a low foaming tendency to cope with the high flow rates in wind turbine gearboxes, which give little time in the sump to release entrained air.
Lubricants can make a significant difference

Competitiveness is critical to power companies facing new competition from alternative and distributed energy providers. Cutting the costs of producing and delivering energy is a priority.

Not all companies are aware that the choice of lubricant can make a significant difference to the TCO of generation, transmission and distribution equipment.

Whether you operate gas or combined-cycle turbines, stationary engines, wind turbines or transformers, lubricants can make a significant difference to your equipment’s TCO.
TCO: Understanding lubricants’ impact on business costs

**TOTAL OPERATING COSTS**

**Lubricant Selection**

**Lubricant Products**

**Leaks**

**Handling & Dispensing**

**Disposal**

**Oil Analysis**

**Product Inventory**

**Admin & Management**

**Training**

**FURTHER IMPACT OF LUBRICANTS ON COSTS**

**Downtime and loss of production**

**Decreased component life**

**Increased cost of maintenance**

**Maintenance and business processes**

**Lubricants and greases**

- Effective efforts here can lead to significant savings and efficiency improvements.
Unlocking savings and productivity in the power industry

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<th>COMPANIES RECOGNIZE, BUT UNDERVERE, POTENTIAL COST SAVINGS FROM EFFECTIVE LUBRICATION</th>
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<td><strong>56%</strong> of companies believe they can reduce costs by <strong>&gt;5%</strong> through lubricant selection and/or management.</td>
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<td>But only <strong>1 in 4</strong> think savings could exceed <strong>10%</strong>.</td>
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<td>In reality lubricants can impact up to <strong>20% to 30%</strong> of total maintenance expenditure.</td>
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1 Potential effect calculated based on Shell Lubricants site surveys with customers.
Unlocking savings and productivity in the power industry

| Lack of Lubricants Expertise and Process are Barriers to Total Cost of Ownership¹ Savings |
|---|---|
| The benefits of higher quality lubricants are not fully understood |
| **60%** | **49%** |
| do not expect it will help reduce unplanned downtime | do not expect it will help reduce maintenance costs |
| **59%** | Only **48%** |
| think they do not conduct staff training on lubricants as regularly as they should | think lubricant product performance should be an important purchase consideration |
| Only **43%** | have all the correct lubrication management procedures in place² |

¹TCO is defined by Shell Lubricants as the total amount spent on industrial equipment, including cost of acquisition and operation over its entire working life, including costs of lost production during equipment downtime.
²Shell recommended procedures are delivery and storage, oil change, oil dispensing systems, efficiency of grease lubrication systems, oil analysis and training employees in lubricant selection or management.
Unlocking savings and productivity in the power industry

**THIS IS HAVING A FINANCIAL IMPACT**

- **62%** admit their incorrect lubricant selection has caused unplanned downtime.
- **1 in 4** companies believe costs exceeded $500,000.
- **1 in 5** companies state costs exceeded $1 million.

**EFFECTIVE LUBRICANT SELECTION AND MANAGEMENT CAN HELP COMPANIES LOWER **TOTAL COST OF OWNERSHIP (TCO)** THROUGH REDUCED UNPLANNED DOWNTIME AND LOWER MAINTENANCE COSTS**

*Potential effect calculated based on Shell Lubricants site surveys with customers*
Shell Lubricants for Wind Turbines

**Generator Bearing**
- Shell Gadus S5 V100 2

**Hydraulic Brake**
- Shell Tellus S2 V 32
- Shell Tellus S4 VX 32

**Yaw Gear**
- Shell Gadus S4 WE 320
- Shell Gadus S4 OGT

**Yaw Bearings**
- Shell Gadus S5 T460 1.5
- Shell Gadus S5 V460 KP

**Yaw Drive**
- Shell Omala S4 WE 150
- Shell Omala S4 GX 220
- Shell Gadus S5 T 460 1.5

**Main Gearbox**
- Omala S5 Wind 320
- Omala S4 GX 320

**Pitch Drive**
- Shell Omala S4 GX 220

**Pitch/Blade Bearing**
- Shell Rhodina BBZ
- Shell Gadus S5 V110 KP

**Main Shaft Bearing**
- Shell Gadus S5 T460 1.5
- Shell Gadus S5 V460 KP
Shell lubricants with OEM in wind power

Shell Lubricants has long-standing relationships with many of the sector’s leading equipment manufacturers. It has more than 3,000 equipment manufacturers’ recommendations or approvals across its product range, including approvals from:

- Gamesa
- Siemens
- Dongfang
- Suzlon
- NGC
- General Electric
- Nordex-Acciona
- Windey
- Moventas
- Winergy
- Envision
- Suzlon
- Bosch Rexroth
- Vestas
Shell Omala S5 Wind 320: Key features and benefits

Superior oxidation and thermal degradation resistance promotes extended oil-drain intervals.

Robust wear and corrosion protection can help to extend equipment life.

Advanced foam control and superior filterability contribute to less gear and bearing failure.

Enhanced low-temperature flow can lead to improved speed to grid and improve system efficiency in cold climates.

Over one million cumulative run-hours have been accrued in turbines located in Spain, China, United States, India and Denmark.

Oil changing without flushing.
Shell Omala S5 Wind 320: 10 years warranty

**TRUST**
Purchasing the most advanced technology in the market through a trusted partner with technical expertise

**FINANCIAL**
Removes one oil change in the lifetime of the wind turbine, thereby saving costs for oil and for maintenance for an oil change

**SAFETY**
Reduced risk exposure with less up-tower work

Offshore, this can amount to a US$30,000 saving per asset.
Shell Lubricants Services

Shell LubeAdvisor
Shell LubeAnalyst
Shell LubeCoach
Shell LubeMatch
Shell HSSE Culture & Commitment

12 Live Saving Rules

1. Permit
2. Personal Protective Equipment
3. Electrical Safety
4. Fall Protection
5. System Override
6. First Aid
7. No Smoking
8. No Littering
9. No Distracted Driving
10. No Phone Use
11. No Loitering
12. Safe Lifting

Road Safety Campaign
Industrial Safety Program
Unlocking savings and productivity in the power industry

SHELL LUBRICANTS HAS UNLOCKED OVER US$139 MILLION IN SAVINGS FOR POWER SECTOR CUSTOMERS.*

*Based on documented savings delivered to Shell Lubricants customers from 2011 to 2016
Chinese wind farm enhances turbine performance with Shell Omala S5 Wind 320

Background
The Guohua wind farm in Dailiji, Inner Mongolia, China, operates 33 1.5-MW turbines from Dongfang Electric New Energy Equipment that began productive operation in late 2009. The wind farm is in an area that experiences a yearly temperature range of –30.5 to +38.9°C.

Challenge
The wind farm operator, Guohua (Tongliao) Wind Power Co., Ltd, wanted to ensure maximum uptime and availability for the turbines by using a high-performance lubricant. Although the turbines’ gearboxes are not prone to frequent faults, a failure would result in a long period of downtime for the affected turbine.

Outcome
The management team enlisted the help of the Shell technical team and the equipment manufacturer, who recommended that the wind farm should trial Shell Omala S5 Wind 320, Shell’s next-generation gear oil for wind applications, in two of its turbines.

Benefits
Guohua wind farm tracked the operation of the two turbines and the properties of the oil during the two-year trial and found that
- The runtime of the turbines was significantly longer
- A foaming problem in the gearboxes had been alleviated
- The cold start-up time of the turbines was shorter
- The additive content of the oil remained stable
- The amount of wear metals in the oil was much lower than the industry standard limit.
Questions and answers