

## An overview of the digitalisation potential for wind energy

A new wind is blowing through the energy system – digitalisation. Over the past decade, most mature heavy industries have experienced a digital revolution, and the wind energy sector is no exception.

Enhanced sensor data collection and high quality data exchanges between wind operators and the surrounding energy ecosystem are growing significantly. Making use of this data will unlock new horizons of productivity and allow the industry to fully realise its enormous potential.

Digitalisation will create new economic opportunities for wind operators, increasing the value of every single MWh produced. Innovative digital technologies will also improve turbine yields and

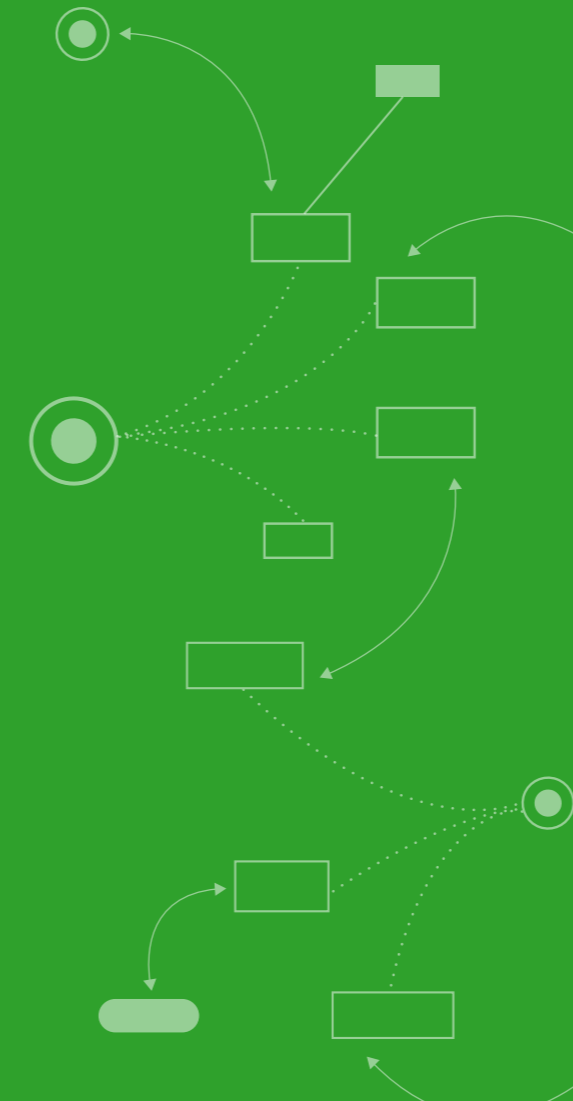
productivity while driving down costs in design, operations and maintenance, thereby reducing the cost of energy.

Digitalisation is primed to make a valuable contribution to wind energy at a crucial time for renewables. As the ongoing energy transition triggers an increase in distributed power generation, new data-related challenges are emerging. Constructed around renewables, and with a higher penetration rate of variable power generators, this new distribution-based energy system will rely heavily on innovative digital solutions for increased connectivity and interactivity between the various actors. Integrating variable renewable energy is critical to ensuring a stable system abundant with clean and affordable energy, and digitalisation is essential to this process.

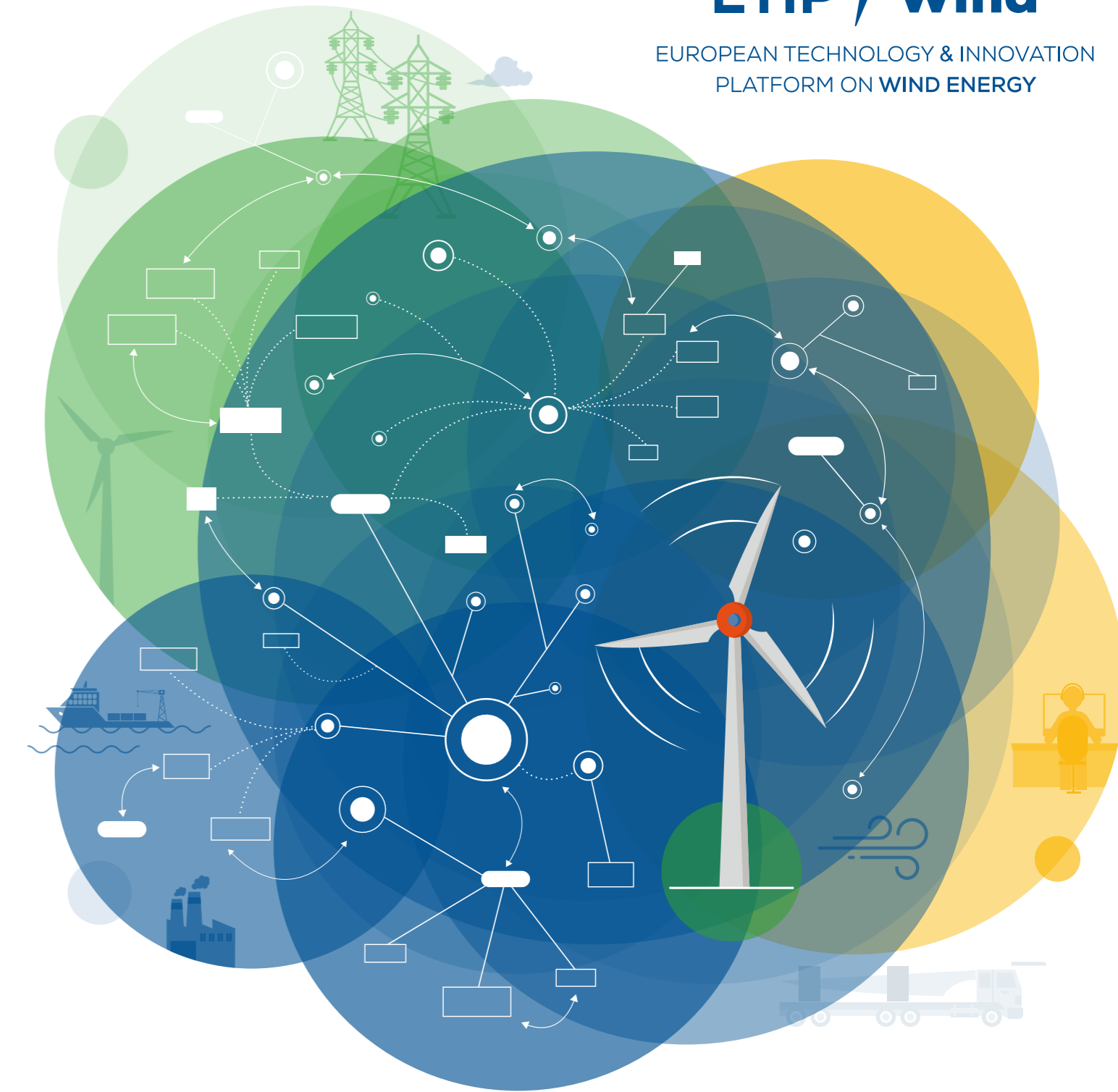
ETIPWind®, the European Technology and Innovation Platform on wind energy, connects Europe's wind energy community. Key stakeholders involved in the platform include the wind energy industry, political stakeholders and research institutions.

The goal of ETIPWind is to create a virtual and physical platform via which the wind energy community can communicate, coordinate and collaborate its work and activities related to research, innovation and technology. The ambition is to define and agree on concrete Research and Innovation (R&I) priorities and communicate these to the European Institutions and other decision-making bodies in order to support the ambition of reaching RES targets for 2020 and beyond.

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EUROPEAN TECHNOLOGY & INNOVATION PLATFORM ON WIND ENERGY



## Objectives for digitalisation

### System integration

UNLEASHING THE FULL POTENTIAL OF WIND ENERGY

Variable renewable energy and distributed generation will be key aspects of the future energy system. New data-based tools to increase the connectivity and interactivity between wind farms and the other actors are needed. Cross-sectoral synergies will facilitate the integration of wind in the electricity system.

**TSO-DSO**  
 More and higher quality data exchanges between system operators and wind power generators will improve the transmission and distribution of clean energy throughout the grid.

**Real-time grid support capabilities**  
 Enhanced digitalisation will enable wind farms to provide more grid services faster and more efficiently.

**Synergies with other power generation**  
 Digital solutions connect wind power plants with other power generators, facilitating system-level energy management.

**Consumer synergies**  
 Digitising electricity consumption and demand-side management will improve consumers' connectivity and interactivity with power generators.

**Sector coupling**  
 Increased digitalisation offers opportunities to strengthen and develop synergies between the electricity sector and other energy carriers.

**Storage**  
 Innovative systems coupling wind power and storage will enhance wind's ability to become a crucial part of the energy system.

### Reducing Costs

PRODUCING CHEAPER AND AFFORDABLE CLEAN ENERGY

Wind is increasingly competitive with conventional energy sources but needs innovative digital solutions to continue its growth. New data-driven designs and strategies will bring the cost of wind energy further down and, at the same time, improve the value of wind power.

**Improving productivity**  
 Enhanced forecasting and smarter control through digitalisation will enable turbines to create more energy.


**Decreasing O&M cost (OPEX)**  
 Improved decision making based on data analytics will enhance daily operations and maintenance, decreasing the MWh production cost.

**Decreasing investment cost (CAPEX)**  
 Data-driven design of wind turbines and new construction and manufacturing techniques will decrease investments cost and avoid over-engineering.

**Lifetime extension**  
 Digitalisation help develop smart materials and tailor-made operation and maintenance strategies that extend turbines' lifetime.

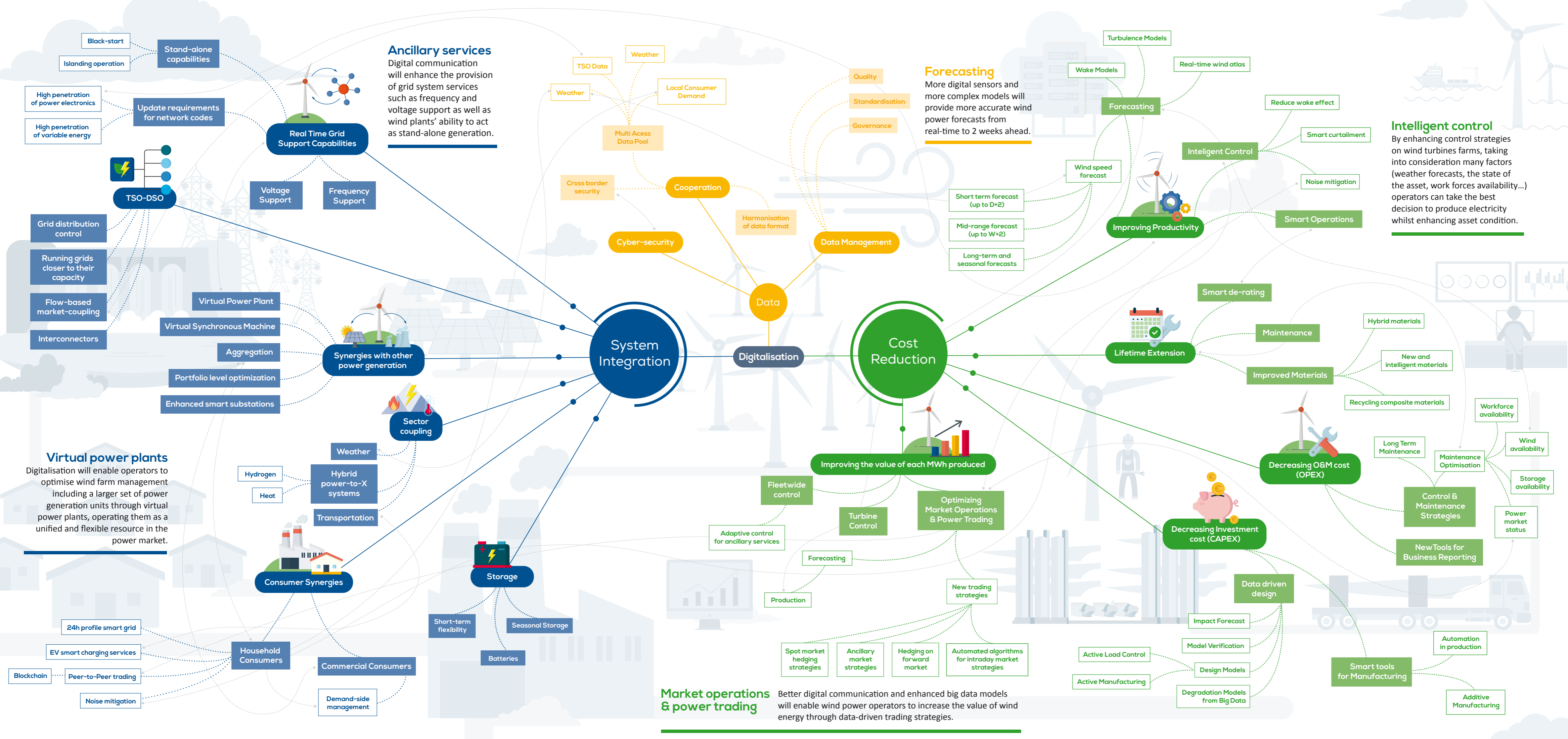
**Improving the value of each MWh produced**  
 Better operations and trading through data-driven analyses of the power markets will boost the value of wind power production.




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# When wind GOES DIGITAL

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**Ancillary services**  
 Digital communication will enhance the provision of grid system services such as frequency and voltage support as well as wind plants' ability to act as stand-alone generation.

**Forecasting**  
 More digital sensors and more complex models will provide more accurate wind power forecasts from real-time to 2 weeks ahead.

**Intelligent control**  
 By enhancing control strategies on wind turbine farms, taking into consideration many factors (weather forecasts, the state of the asset, work forces availability...) operators can take the best decision to produce electricity whilst enhancing asset condition.

**System Integration**

**TSO-DSO**

- Black-start
- Stand-alone capabilities
- Islanding operation
- High penetration of power electronics
- High penetration of variable energy
- Update requirements for network codes
- Real Time Grid Support Capabilities
  - Voltage Support
  - Frequency Support
- Grid distribution control
- Running grids closer to their capacity
- Flow-based market-coupling
- Interconnectors
- Virtual Power Plant
- Virtual Synchronous Machine
- Aggregation
- Portfolio level optimization
- Enhanced smart substations
- Synergies with other power generation
- Sector coupling
  - Weather
  - Hybrid power-to-X systems
  - Transportation
  - Hydrogen
  - Heat
- Consumer Synergies
  - Household Consumers
    - 24h profile smart grid
    - EV smart charging services
    - Blockchain
    - Peer-to-Peer trading
    - Noise mitigation
  - Commercial Consumers
    - Demand-side management
- Storage
  - Short-term flexibility
  - Seasonal Storage
  - Batteries

**Data**

- TSO Data
- Weather
- Local Consumer Demand
- Multi Access Data Pool
- Quality
- Standardisation
- Governance
- Cooperation
  - Cross border security
  - Harmonisation of data format
- Cyber-security
- Data Management

**Cost Reduction**

- Forecasting
  - Turbulence Models
  - Wake Models
  - Real-time wind atlas
  - Reduce wake effect
  - Smart curtailment
  - Noise mitigation
  - Smart Operations
- Improving Productivity
  - Wind speed forecast
  - Short term forecast (up to D+2)
  - Mid-range forecast (up to W+2)
  - Long-term and seasonal forecasts
- Intelligent Control
- Lifetime Extension
  - Smart de-rating
  - Maintenance
  - Improved Materials
    - Hybrid materials
    - New and intelligent materials
    - Recycling composite materials
  - Workforce availability
  - Wind availability
  - Storage availability
  - Power market status
- Decreasing O&M cost (OPEX)
  - Long Term Maintenance
  - Maintenance Optimisation
  - Control & Maintenance Strategies
  - New Tools for Business Reporting
- Decreasing Investment cost (CAPEX)
  - Smart tools for Manufacturing
    - Automation in production
    - Additive Manufacturing
  - Data driven design
    - Impact Forecast
    - Model Verification
    - Design Models
    - Degradation Models from Big Data
  - Active Load Control
  - Active Manufacturing
- Improving the value of each MWh produced
  - Fleetwide control
  - Turbine Control
  - Optimizing Market Operations & Power Trading
    - New trading strategies
    - Automated algorithms for intraday market strategies
    - Hedging on forward market
    - Spot market hedging strategies
    - Ancillary market strategies
  - Adaptive control for ancillary services
  - Production

**Market operations & power trading**  
 Better digital communication and enhanced big data models will enable wind power operators to increase the value of wind energy through data-driven trading strategies.