# IEC 61850
# ENGINEERING PROCESS
# IN
# OFFSHORE WIND FARMS

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IEC 61850

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# About Dong Energy

- Main Business Units
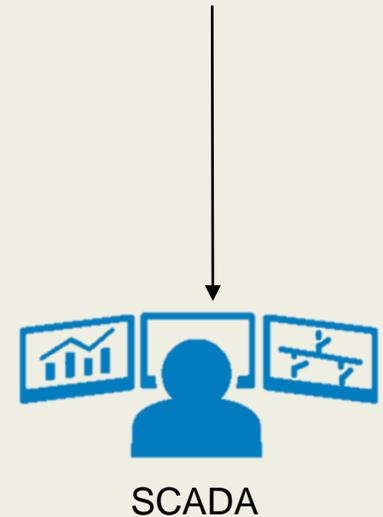
Bioenergy & Thermal Power

Distribution & Customer Solutions

Wind Power

SCADA

- Headquartered in Denmark
- Market Leader in Offshore Wind Power
  - 3.8 GW in operation
  - 3.6 GW under construction

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# DONG Energy activities

**Sweden**

Anholt

**Denmark**

1)

Copenhagen
Middelgrunden
Malmö
Avedøre
**

Esbjerg
Fredericia
Horns Rev 1&2

Nysted

Gode Wind 3&4

Isle of Man
Walney 1&2
Walney Extension**
Barrow
West of Duddon Sands
Burbo Bank
Burbo Bank Extension
Northwich*

Hornsea 2&3&4
Hornsea 1****
Westermost Rough
Race Bank**
Lincs

Gode Wind 1&2
Borkum Riffgrund 1&2***
BKR West 1&2
OWP West

Hamburg
Norddeich

**UK**

Gunfleet Sands 1&2
Gunfleet Sands Demo

London
London Array 1

Brossele**** 1&2
Enecogen

Den Haag
's-Hertogenbosch

**Netherlands**

**Germany**

| | Wind in operation |
| --- | --- |
| | Wind project under construction |
| | Wind project under development |
| | Heat and electricity generation |
| | Electricity generation, gas-fired power station |
| | Sale of power and/or gas |
| | Electricity distribution |
| | Inbicon bioethanol plant |
| | REnescience bio plant under construction |
| | Biogas plant under construction |
| ● | DONG Energy office |
| * | Expected on stream in 2017 |
| ** | Expected on stream in 2018 |
| *** | Expected on stream in 2019 |
| **** | Expected on stream in 2020 |
| 1) | Nine central power stations in Denmark |

**United States**

Boston
Bay State Wind
Ocean Wind

**Taiwan**

Formosa
Fase 2
Fase 1
Taipei
Greater Changhua 1&2&3&4

June 2017

# Offshore Wind Farm



Wind Turbines      Offshore Substation      Onshore Substation      Grid

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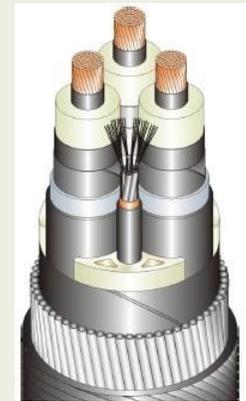
# IEC61850 in Dong Energy Offshore Wind Farms – Part 1

- Different components: Bay Controller Units, Protection Relays, RTUs, SCADA Servers
- Multi Vendor Multi Edition
- Between Substations: Onshore Substation and Offshore Substation(s)
- Between different entities: Generating System Owner and Offshore Transmission System Owner

- Foundation of Communication: Optical Fibres in Export cables and Line of Sight (as backup)



*Ref.: ABB.com*

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# IEC61850 in Dong Energy Offshore Wind Farms – Part 2

- GOOSE applications
  - Only for Non-critical processes e.g.
    - Circuit Breaker Failure Protection
    - Cascade Tripping
    - Operational Tripping System
    - Fault Recorder Initiation
    - CB Close Lockout

- WHY only non-critical?
  - Proven reliability by hardwire signals
  - Less dependent on O&M skills/knowledge

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# Design Issues – Two Entities in One Substation

- Two entities: Generating System Owner (GEN) and Offshore Transmission System Owner (OFTO)

- Requires two separate Substation Automation Systems (SAS) and two separate networks

- Means no GOOSE between OFTO and GEN      or
  Using special switches/gateways to communicate ONLY GOOSE

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# Design Issues – One system covering several Substations

– Two or more substations in each wind farm

– Requires two or more SAS because
  · Independency between substations
  · Possibility for different divestment scenarios in future

– Results in two or more separate networks between substations

– Means no GOOSE between substations or using Routable GOOSE



Wind Turbines    Offshore Substation    Onshore Substation    Grid

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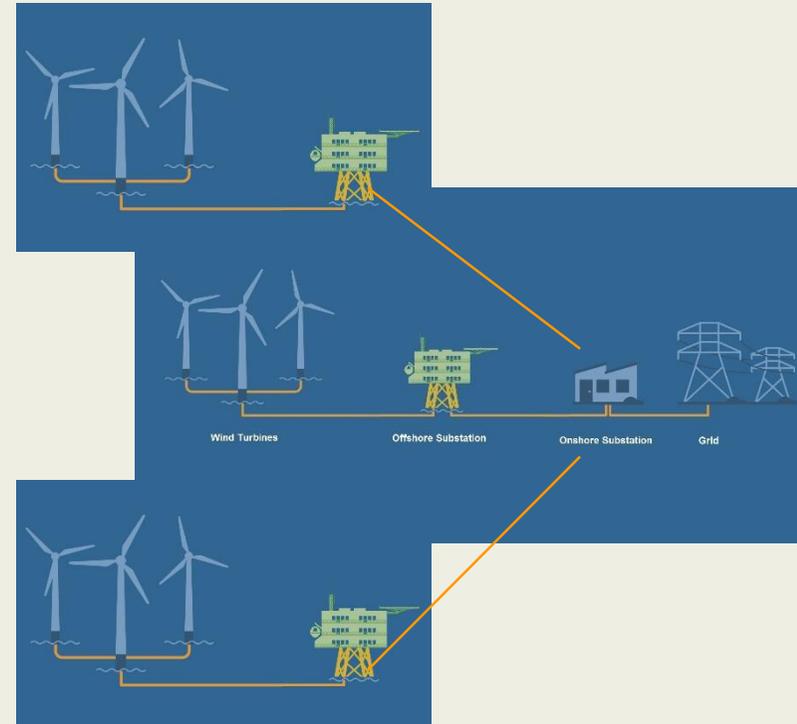
# Design Issues – Network Architecture: RSTP, HSR or PRP

- Preferred architecture is the combination of all
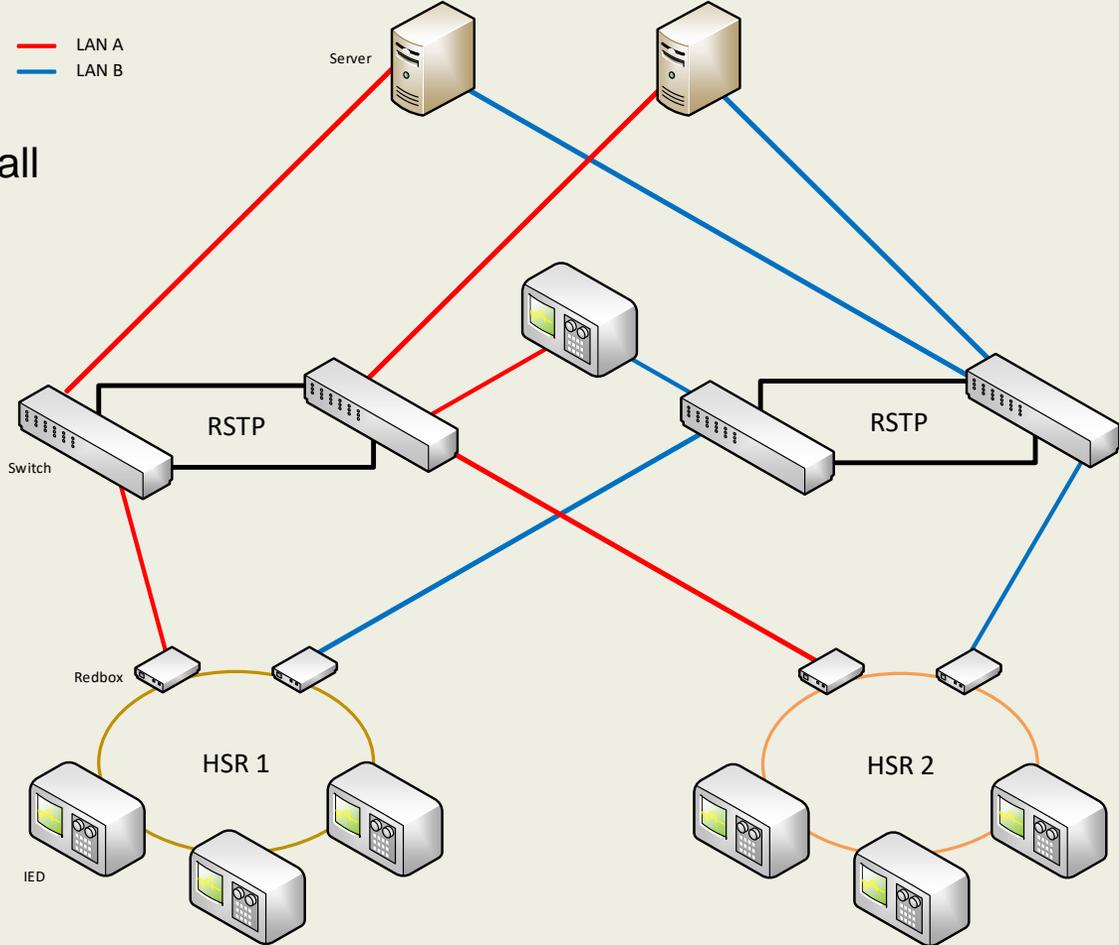
# Design Issues – Remote Monitoring

- Remote connection or Web client

- Cyber security requirements
  - DMZ
  - Jump Host
  - VPN
  - User Management
  - …

# Design Issues – Engineering Process

- Making a System Specification (=.SSD file) in text format

- Procurement

- Detail design in IED level and producing .IID files

- Integrating the IEDs in SAS using .IID files and a signal list

- Integration tests at one of the suppliers' factory

- Modifications based on .IID files
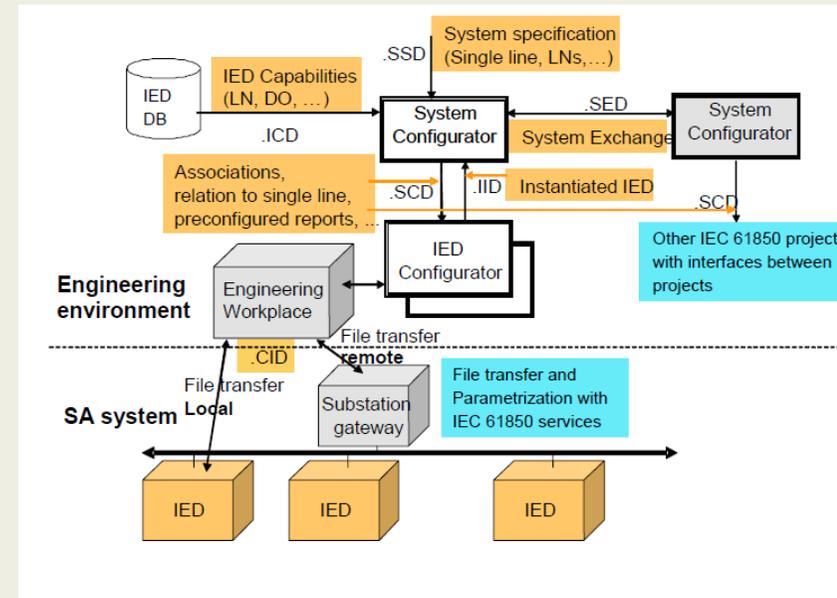


*Ref.: IEC 61850 - 6*

# Design Issues – Engineering Process (Bottom-Up Approach)

- Advantage
  - Possibility of late design freeze
  - More flexibility to work in parallel
  - No need for deep in-house knowledge
  - best practice (so far)

- Disadvantage
  - Higher probability for Interoperability problems
  - Specification in high level and not deep in details,
  - more dependency on vendors engineering knowledge,
  - more efforts in the interface management

- More freedom for Vendors!

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# Design Issues – Engineering Process (Top-Down Approach)

- Advantage
  - Lower probability for Interoperability problems
  - Specification in details,
  - Vendor independent engineering
  - Easier interface management
  - Easier information exchange between projects

- Disadvantage
  - Lack of knowledge in vendors execution team
  - Deeper in-house knowledge is required (both in execution team and O&M team)
  - Immaturity in the market to understand the standard

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# The Way Forward…

- More training for vendors project teams
  - To understand the standard
  - To use the standard properly (e.g. right LNs instead of GGIO)
  - To accept .SCD file as input

- More training for O&M teams
  - To understand the standard
  - To understand the alarms
  - To be able to conduct a proper service and maintenance

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