

NV·GL



ENERGY

## Flex Power Grid Lab

An overview

**Erik de Jong**  
25 April 2017

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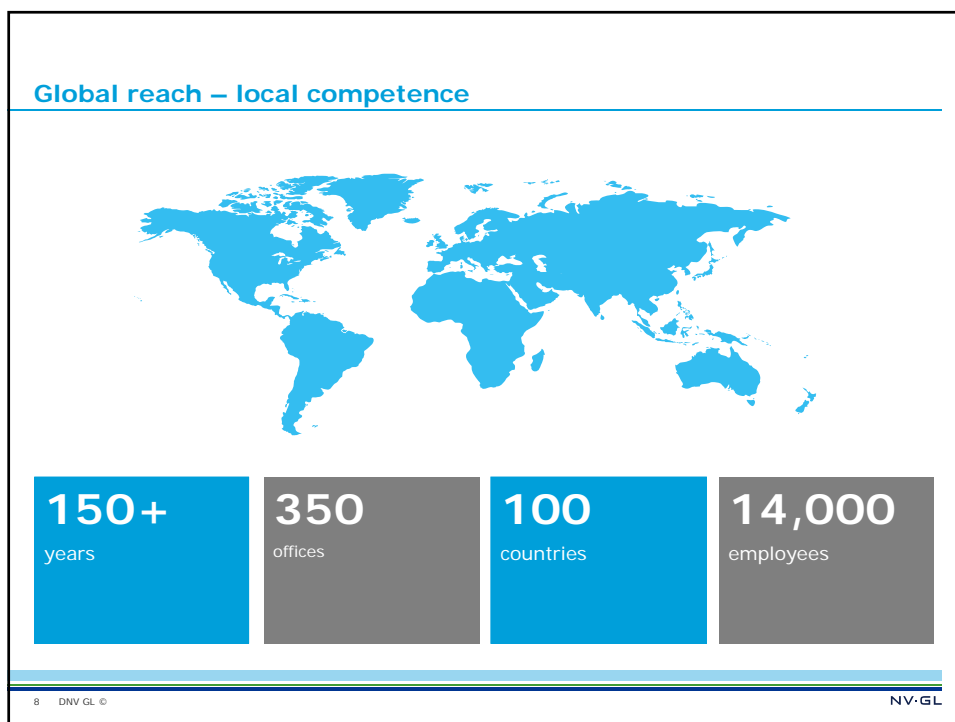
SAFER, SMARTER, GREENER

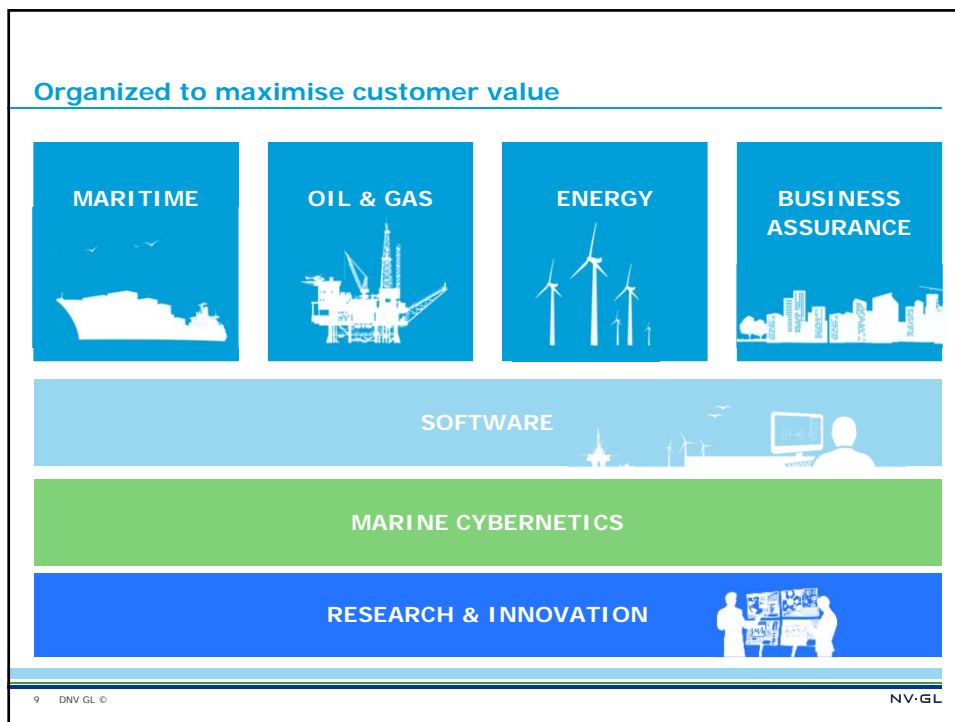
## Content

- Introduction
- Flex Power Grid Lab
- Power Cybernetics
- Broader HIL activities within DNVGL
- Project highlights (FPGLab & Power Cybernetics related)
- Questions

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## Assisting companies in solving the energy trilemma



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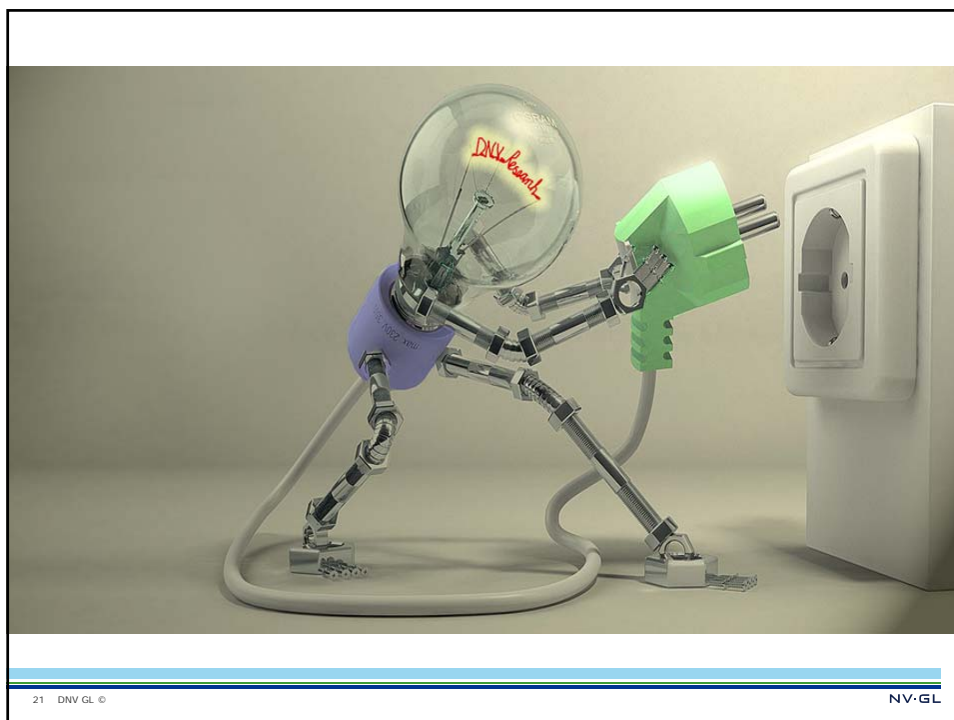
## Global service portfolio



- Power testing, inspections and certification
- Renewables advisory services
- Renewables certification
- Electricity transmission and distribution
- Smart grids and smart cities
- Energy market and policy design
- Energy management and operations services
- Energy efficiency services
- Software

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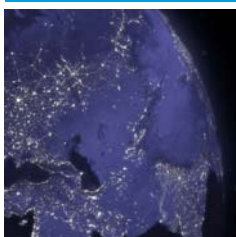
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## Power Systems and Electrification

Build competence, methods and tools to achieve competitive advantage and prepare DNV-GL for the future of the rapid changing power industry.

### Super grids



Help to position DNV GL as strong player in the Super grid arena

### Smart grids



Innovate and enhance services within Smart and Micro grids

### Energy Storage



Prepare DNV GL for the growth market of Energy Storage

### Renewables

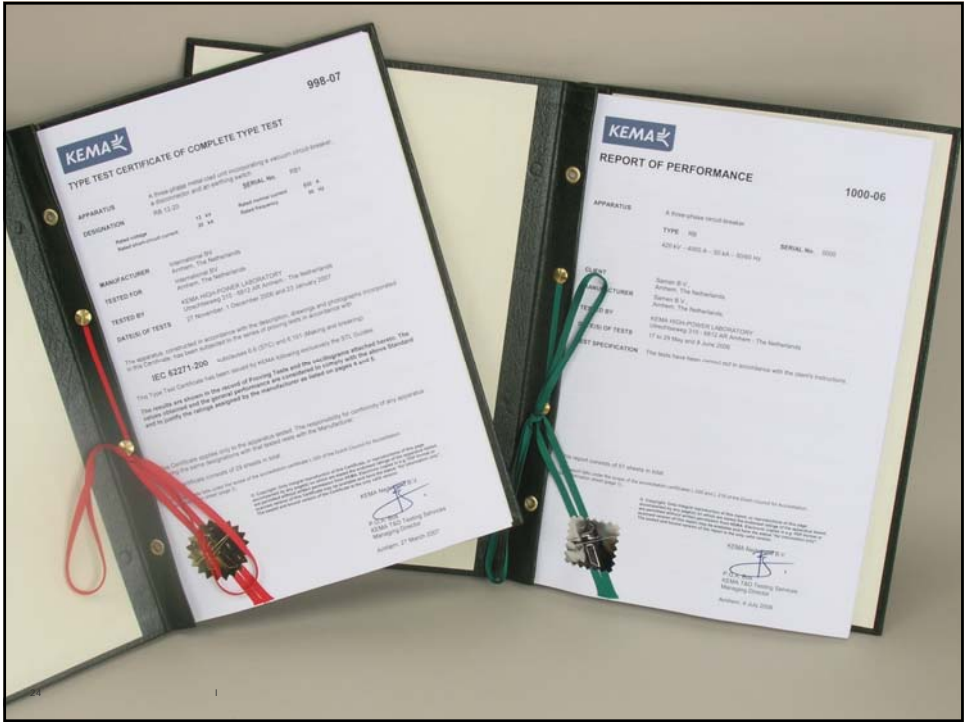


Prepare DNV GL for the shift of renewables towards the free market

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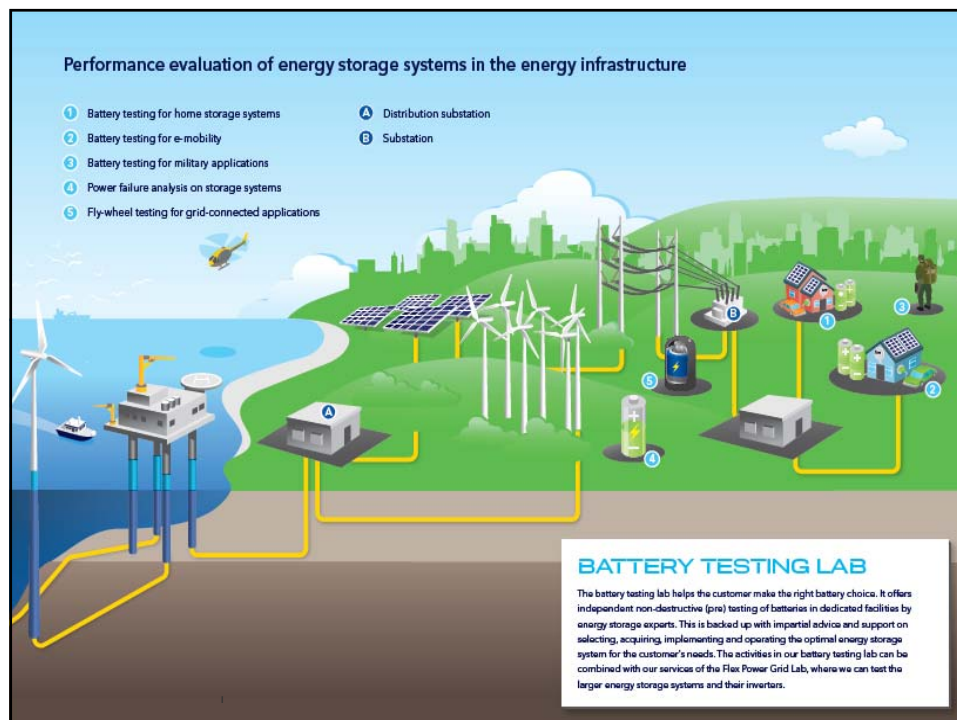


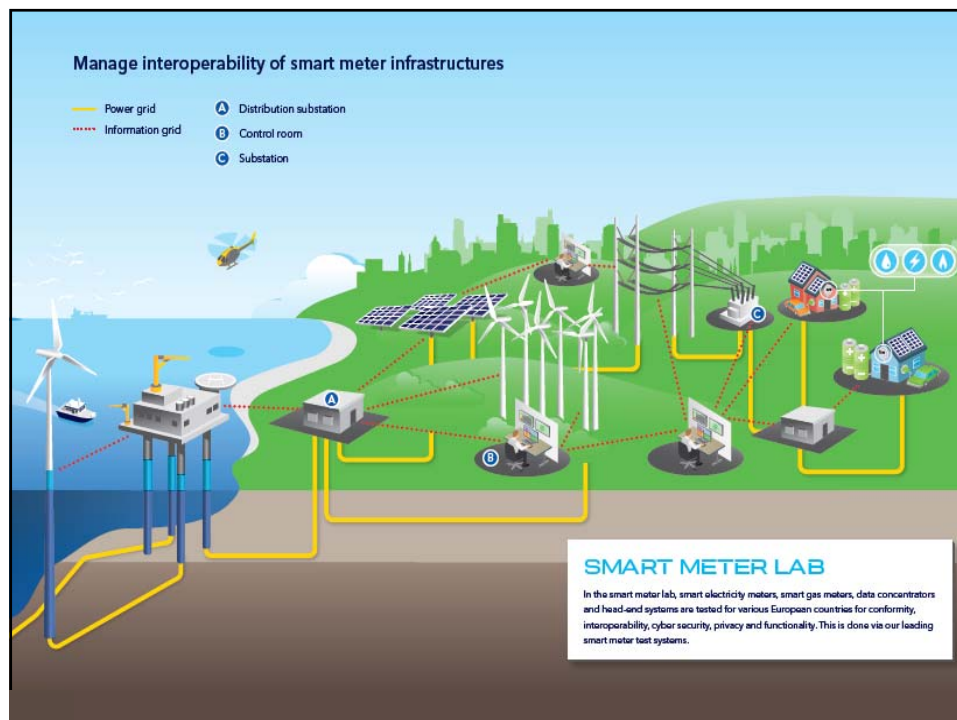
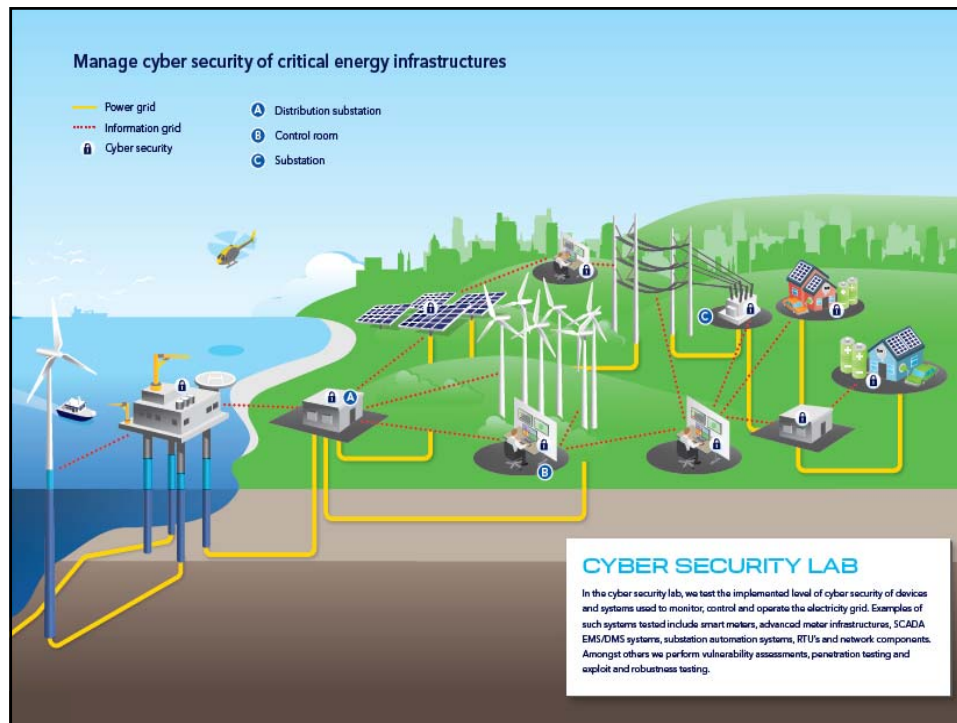


## +7 more (smaller) Arnhem laboratories

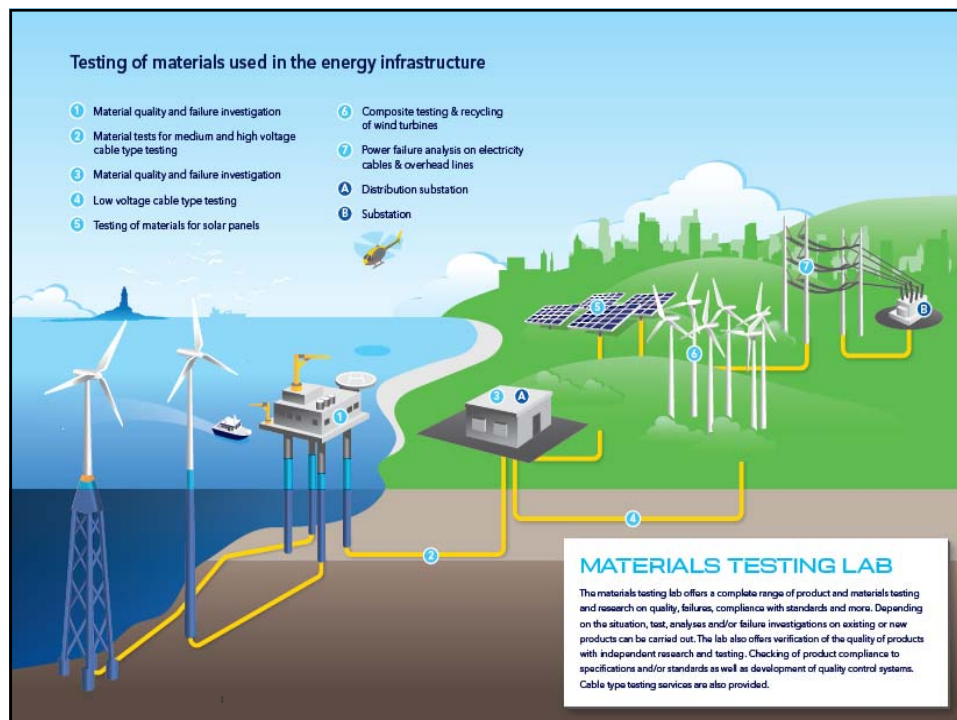
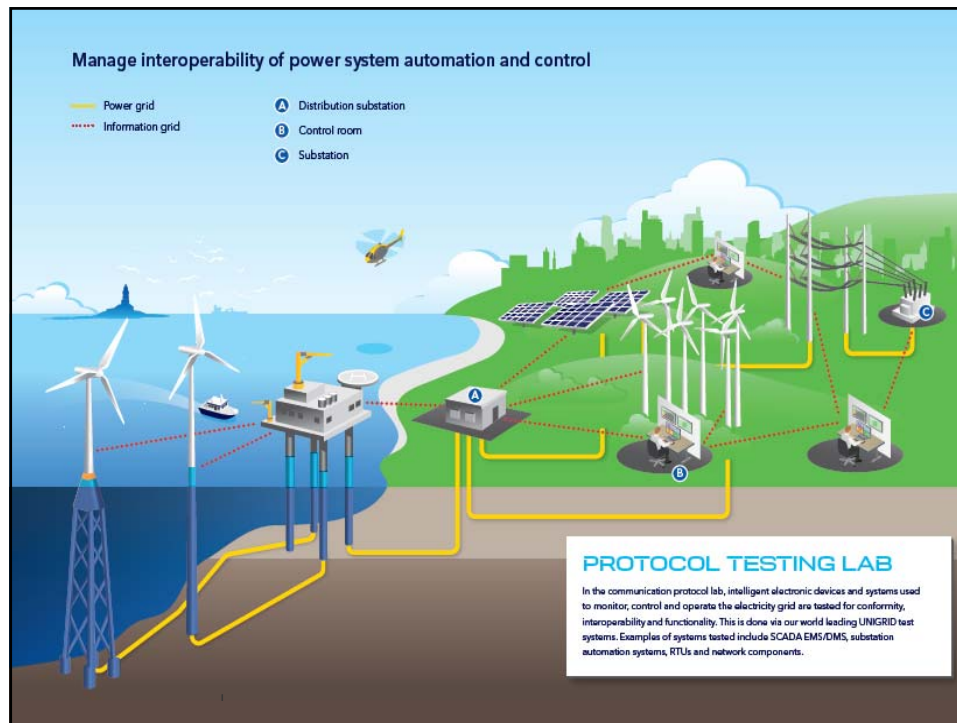
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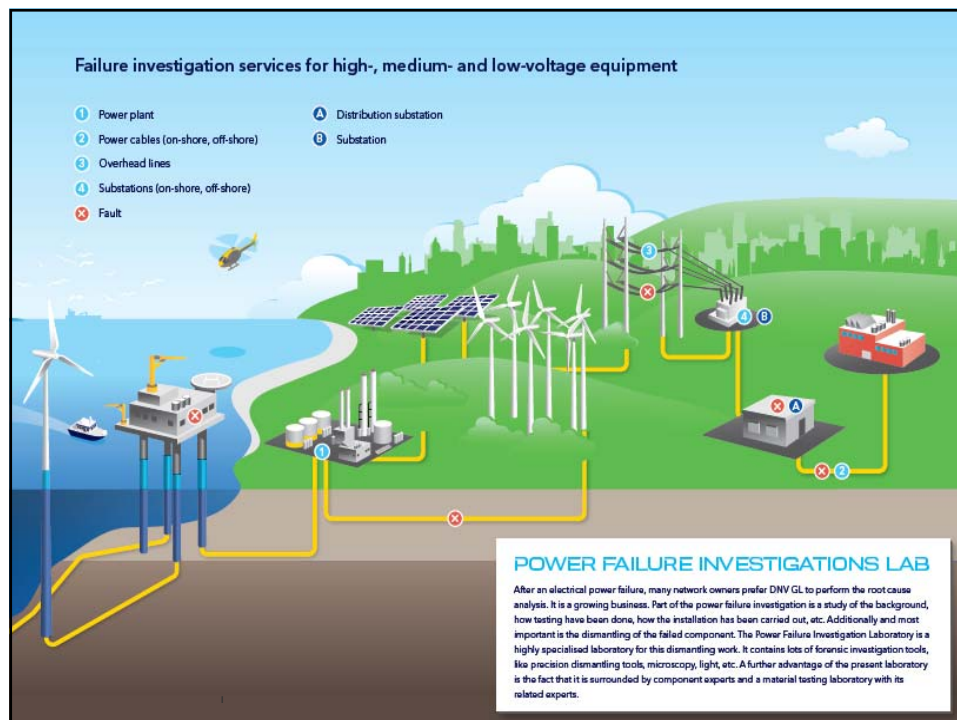
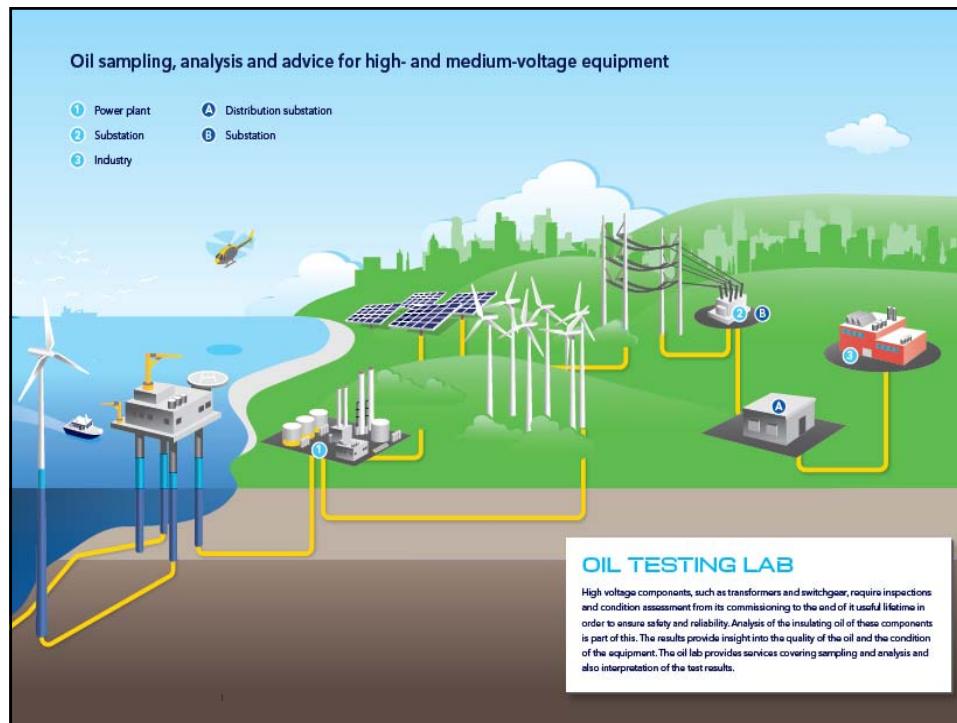
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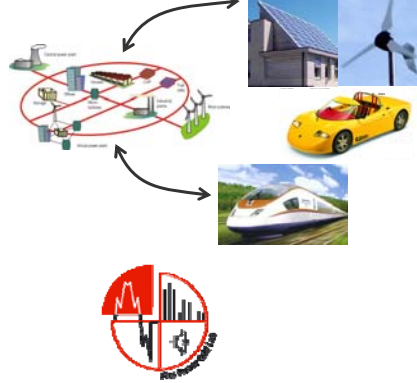




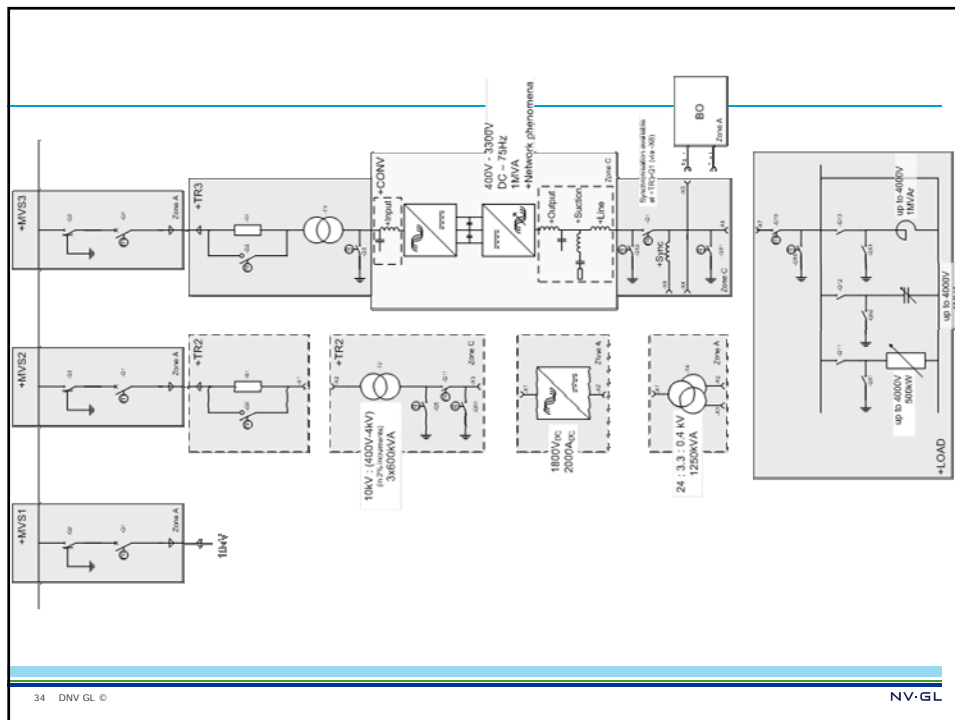
## Flex Power Grid Lab (FPGLab)

The Flex Power Grid Lab (FPGLab) offers unique services, as an independent laboratory, related to Distributed Energy Resources (DER) and Renewable Energy Systems (RES) integration for SmartGrids and power electronics development and testing for industrial high voltage (24kV) and power up to 1MVA, by offering a predefined "bad" grid or load.

### Applications

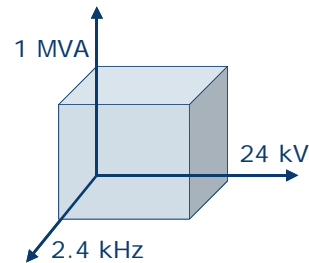


[www.FlexPowerGridLab.com](http://www.FlexPowerGridLab.com)




### Key figures make test facility unique

- Voltage level up to **24 kV**
- **DC to 75 Hz** frequency range
- Continuous power up to **1 MVA**
- Up to **>25<sup>th</sup>** harmonics
- **4 Quadrant** operation
- Synchronization with other source
- Controllable power exchange
- Adjustable loads (0.5MW, 1MVar)



A free programmable “nightmare” grid



Single AC2660

#### High-Power Laboratory Supplies

2013 Anderson Electric Controls AC2660P 1.32MW Master/Slave Dual Power Supply.

- Solar Simulator Equipped – most powerful available
- Active Rectifier Front End – best grid performance
- Bidirectional Power – Ideal for battery operations
- DC/DC Back-End – Full Control Range from Zero Current and Voltage to 2500 Amps and 1000 Volts
- Low Hours, Perfect Operational History
- Configured for Dual Unit Series Operation – 2000Vdc


#### Specifications

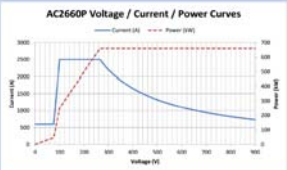
**Single Unit**  
DC Side: 2500A, 1000V, 660kW  
AC Side: 480Vac, 860A, 0.99 pf nominal


**Dual Units – Series**  
DC Side: 2500A, 2000V, 1320kW  
AC Side: 480Vac, 860A (each), 0.99 pf nominal


**Dual Units – Parallel**  
DC Side: 5000A, 1000V, 1320kW  
AC Side: 480Vac, 860A (each), 0.99 pf nominal

Liquid Cooled – Dual Units include liquid/liquid chiller









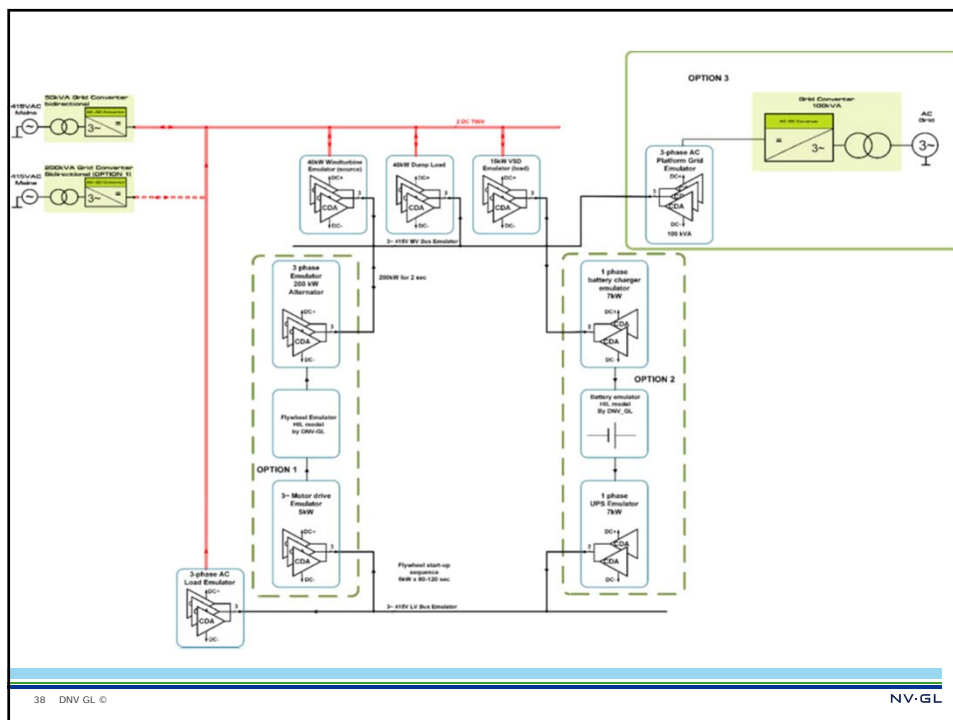
## OPAL RT as Real Time Digital Simulator

- OP5600 system
- HIL box
- RT-Lab



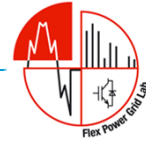
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### Flex Power Grid Lab (FPGLab)



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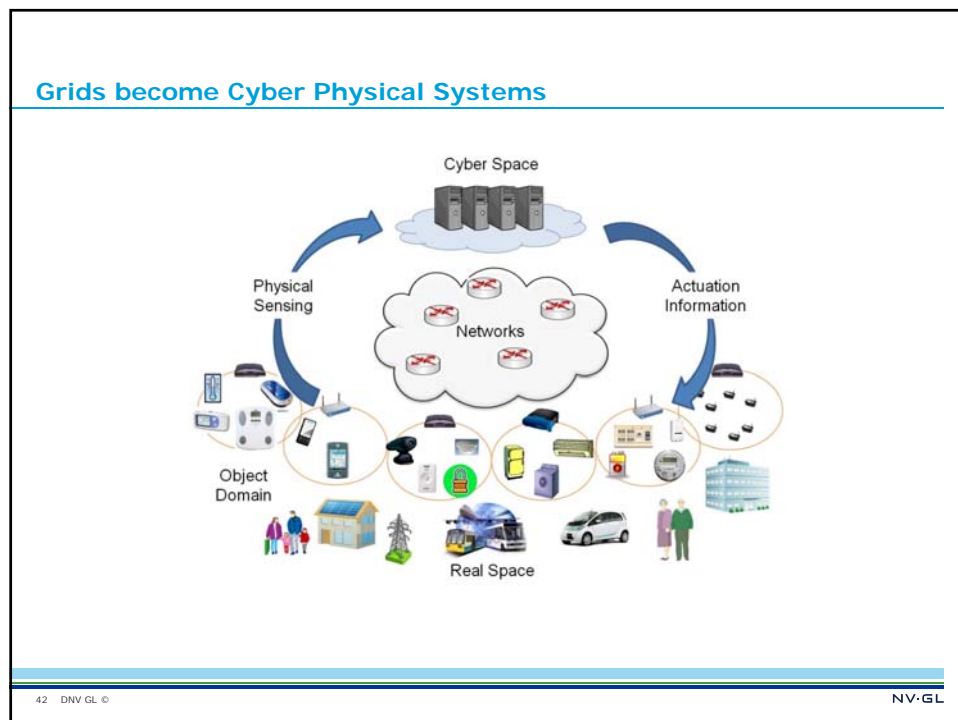
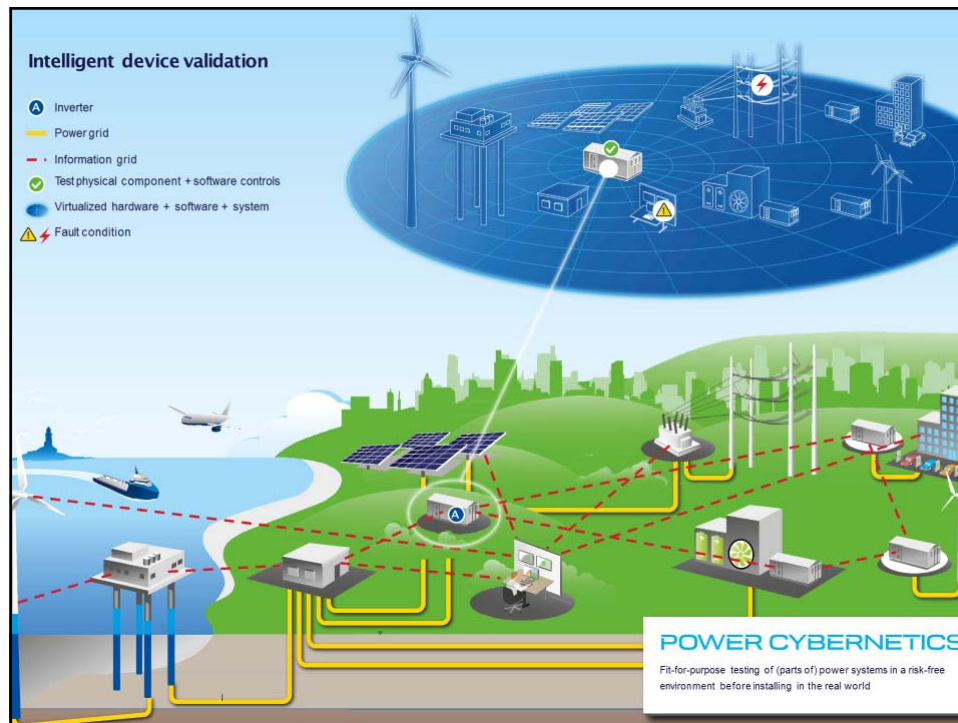
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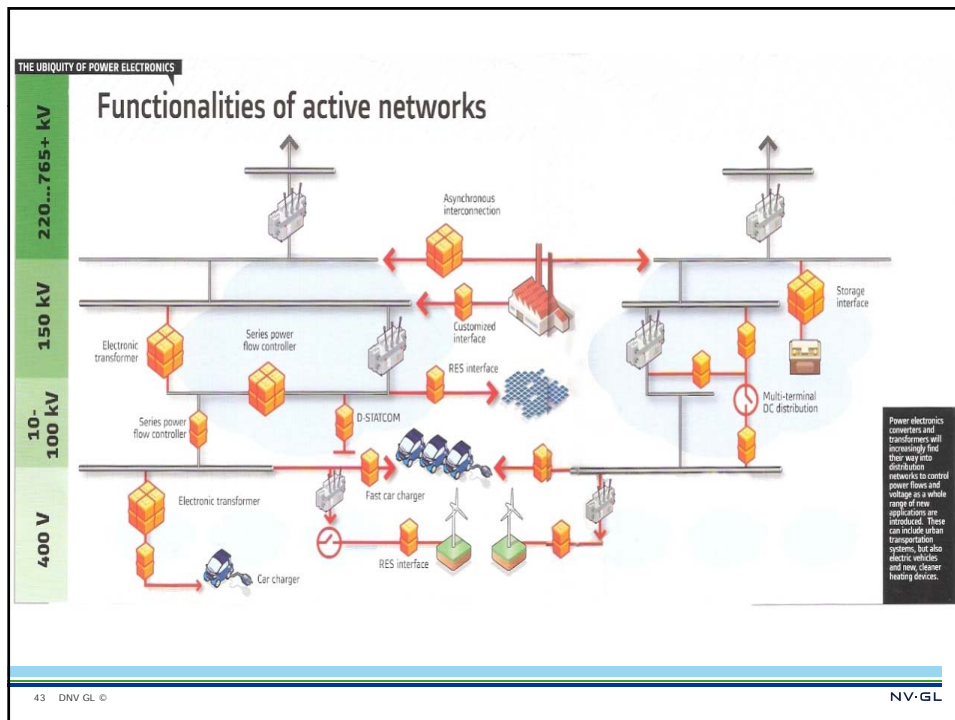
### Platform for Power Cybernetics (using HIL)



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### Power Cybernetics

- Component testing:
  - Individual performance validation
  - Certification on component level
  - General application information
  - = 'complies to standard'

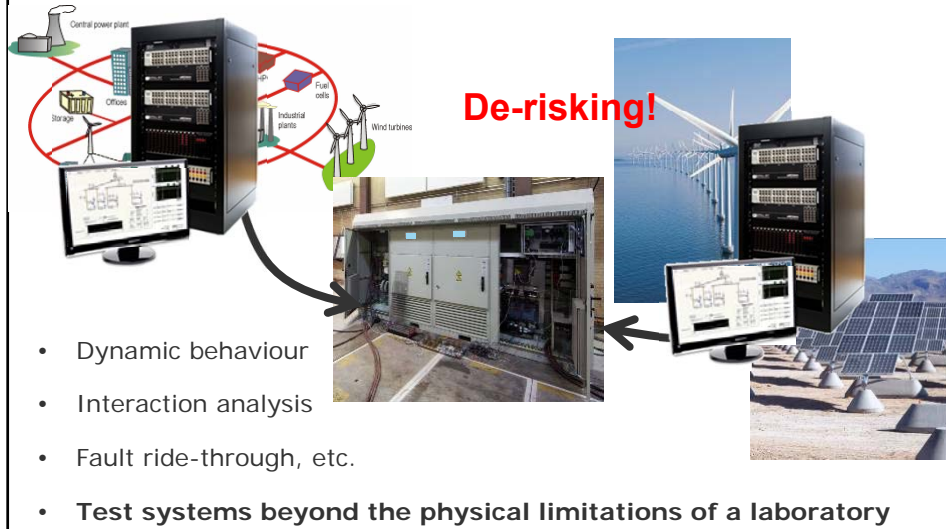
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- System testing:
  - System performance validation
  - Validation on system level (>1 component)
  - Specific application information
  - Interaction verification
  - Dynamic behavior
  - = 'Fit for purpose'

**Hardware in the loop testing promises to do this**

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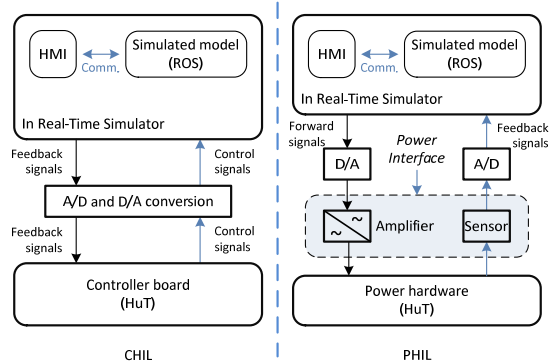
## What is hardware-in-the-loop testing?



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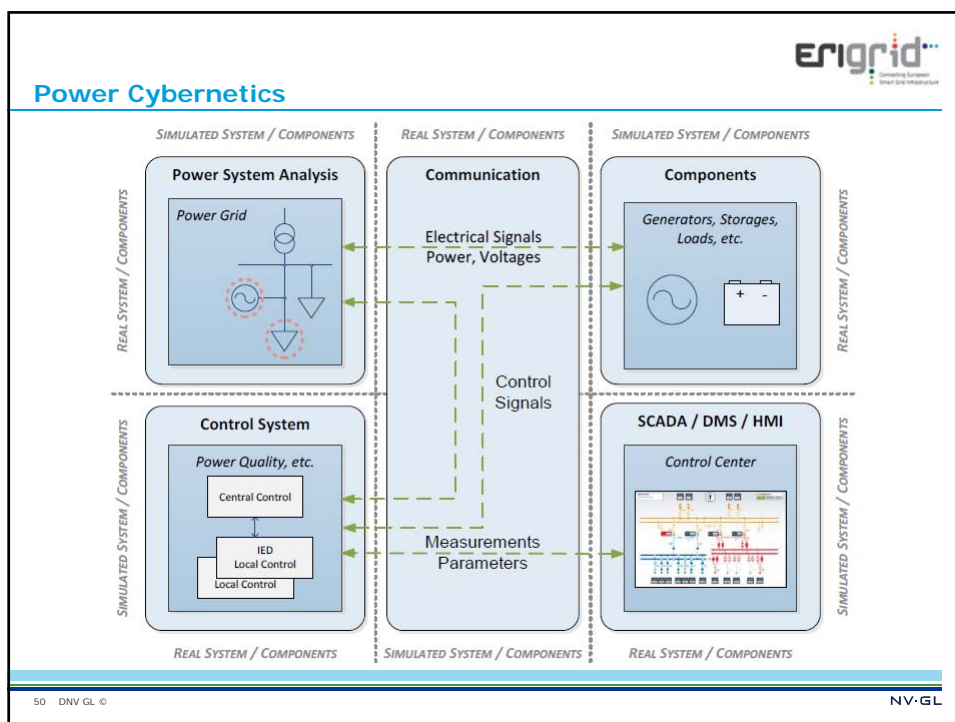
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## Power Cybernetics



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## Position paper Power Cybernetics – available now!

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**POSITION PAPER 2016**  
**POWER CYBERNETICS**  
The future of validation

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**DNV-GL Energy**  
DNV-GL Energy is a leading provider of safety and security services for the energy sector. We provide a wide range of services, including safety and security assessments, risk management, and incident investigation. Our services are designed to help our clients reduce risk and improve the safety and security of their operations.

**DNV-GL**  
DNV-GL is a leading provider of safety and security services for the energy sector. We provide a wide range of services, including safety and security assessments, risk management, and incident investigation. Our services are designed to help our clients reduce risk and improve the safety and security of their operations.

**DNV-GL Energy Research & Innovation**  
DNV-GL Energy Research & Innovation is a leading provider of safety and security services for the energy sector. We provide a wide range of services, including safety and security assessments, risk management, and incident investigation. Our services are designed to help our clients reduce risk and improve the safety and security of their operations.

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### HIL activities within DNVGL

#### Maritime applications

- Service offering: Marine Cybernetics
  - CHIL testing of vessel systems (a.o. Dynamic Positioning Systems)
- Competence centre: Trondheim, Norway



## HIL activities within DNVGL

### Maritime applications

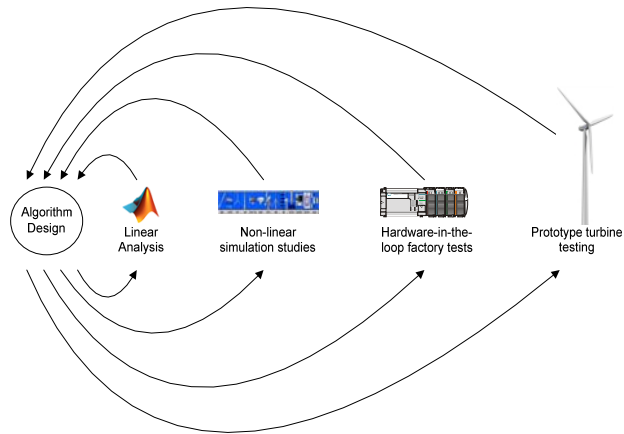
- Service offering: Marine Cybernetics
  - CHIL testing of vessel systems (a.o. Dynamic Positioning Systems)
- Competence centre: Trondheim, Norway

### Wind applications

- Service offering: BLADED
  - HIL test module for turbine control development and validation
- Competence centre: Bristol, United Kingdom

## Control algorithm design process using BLADED

1. Steady-state design
2. Linear modelling, design & analysis
3. Full nonlinear model simulations
4. Implementation, real time testing
5. Commissioning, system ID, prototype testing



Private and confidential

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## HIL activities within DNVGL

### Maritime applications

- Service offering: Marine Cybernetics
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### Wind applications

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### Power system applications

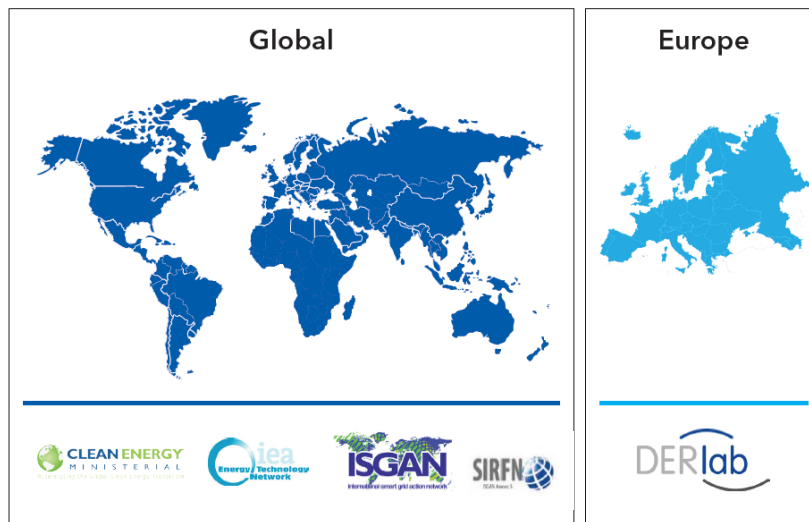
- Service offering: Power Cybernetics
  - P/HIL using a.o. the FPGLab for system level validation
- Competence centre: Arnhem, the Netherlands



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## International cooperation on Power Cybernetics



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## Distributed Energy Resources Laboratories A Network Excellence for Smarter Grids



as of March 2016

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Program R&I-P&E	Project ERIGRID	
<ul style="list-style-type: none"> <li>▪ Full project name: European Research Infrastructure supporting Smart Grid Systems Technology Development, Validation and Roll Out</li> <li>▪ Objectives:               <ul style="list-style-type: none"> <li>– To jointly develop common methods, concepts and procedures for a holistic system validation approach for smart grids, with special attention towards cyber-physical systems (Power Cybernetics).</li> <li>– To provide a single entry point to the research infrastructure to offer a broad spectrum of services to researchers active in Smart Grids.</li> <li>– To integrate and enhance the necessary research services for analyzing, validating and testing Smart Grid configurations.</li> <li>– Provide system level support and education for industrial and academic researchers to foster future innovation.</li> <li>– Expected outcome:                   <ul style="list-style-type: none"> <li>– Develop and enhance common system validation approaches (HIL)</li> <li>– Strengthen the technical leadership of DNVGL in power cybernetics.</li> </ul> </li> </ul> </li> <li>▪ Role of DNV GL: Project member, Provide Trans-National access</li> <li>▪ Partners:               <ul style="list-style-type: none"> <li>– 18 European laboratories (AIT, CEA, CRES, DERlab, <b>FPGL</b>, DTU, ENEL, GINP, ICCS, IWES, OCT, OFF, RSE, SIN, TEC, TUD, UST, VTT)</li> </ul> </li> </ul>		
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Opportunity – Don't miss it!
<ul style="list-style-type: none"> <li>▪ Trans-national access to any of the 18 DER laboratories</li> <li>▪ Projects awarded based on quality, relevance and compatibility               <ul style="list-style-type: none"> <li>– Proposals submitted to project</li> <li>– Committee with independent members reviews proposals</li> </ul> </li> <li>▪ Free of charge:               <ul style="list-style-type: none"> <li>– Including lab usage</li> <li>– Including travel &amp; accommodation (also from the U.S.A.!) )</li> </ul> </li> <li>▪ Must publish results at conference or in journal</li> <li>▪ 2<sup>nd</sup> call now OPEN, closes 15 June 2017 ( <a href="http://erigrid.eu">erigrid.eu</a> )</li> </ul>
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## Questions?



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## Thank you for your Attention

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