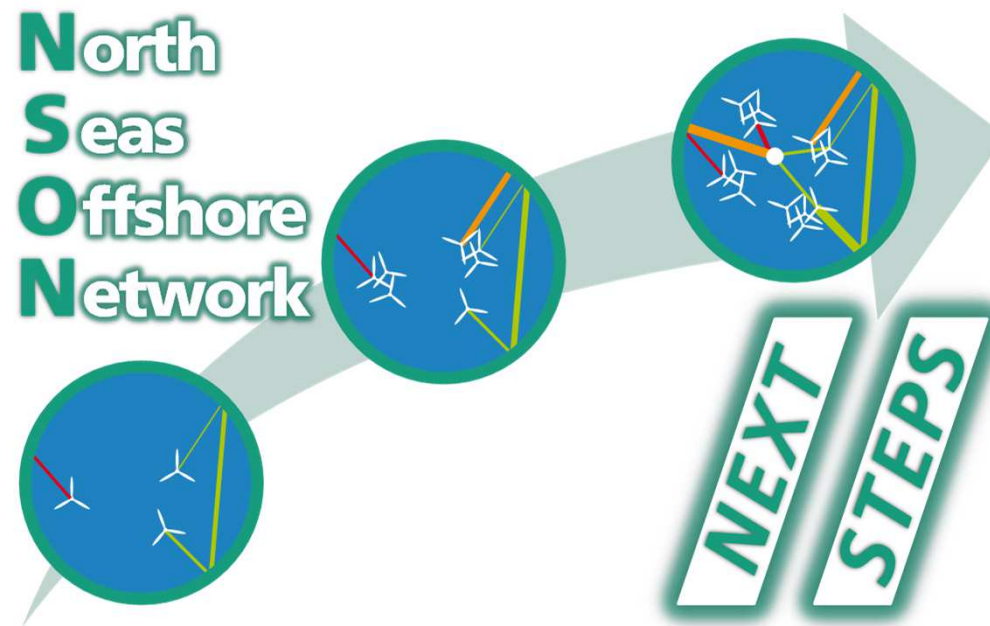


EXPERIENCES AND PROSPECTS OF GERMAN NSON ACTIVITIES TOWARDS COST-EFFICIENT OFFSHORE WIND CONNECTION AND INTERNATIONAL INTEGRATION

North Sea Offshore Network
side event at
Wind Europe Offshore 2019

Copenhagen
November 28, 2019



Joint project: NSON II
Economical Connection and
International Integration of
Offshore Wind Energy in the
North Sea

Denis Mende
Fraunhofer IEE

CONTENTS

- NSON Initiative and German NSON (I)-project
- German NSON (I)-project
 - focus, goals, and main results
- German NSON II-project
 - Partners and project overview
 - Background and motivation
 - Working plan
 - Focus, goals, and expected results
- Further activities in mixed AC/DC-Systems
 - MODULATOR

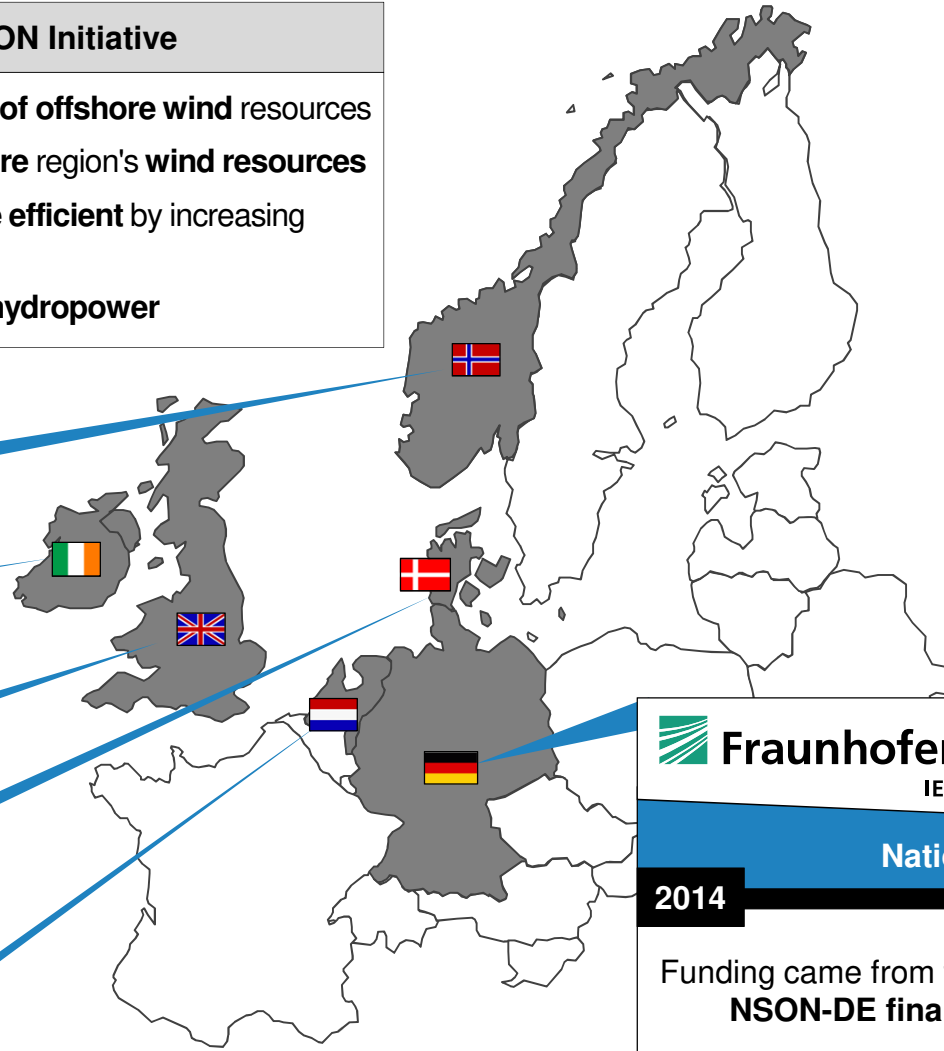
CONTENTS

- **NSON Initiative and German NSON (I)-project**
- German NSON (I)-project
 - focus, goals, and main results
- German NSON II-project
 - Partners and project overview
 - Background and motivation
 - Working plan
 - Focus, goals, and expected results
- Further activities in mixed AC/DC-Systems
 - MODULATOR

NSON Initiative and German NSON (I)-project

Objectives of the NSON Initiative

- **Harnessing, sharing, and trading of offshore wind resources**
- Supporting the **utilization of offshore region's wind resources**
- Making the **national markets more efficient** by increasing connection capacities
- Providing **balancing from Nordic hydropower**



Northern Seas Offshore Network (NSON) Initiative

- Pursuing an **offshore grid in the Northern Seas** region
- **Research, Development & Deployment Program**
- **Following the Berlin Model** for cooperative research activities in Europe: nationally funded projects which are guided by a simple and target-oriented implementation
- Initiative resulted from activities of the **European Energy Research Alliance EERA** in the Joint Programme for Wind Energy



National NSON project in Germany (NSON-DE)

2014

2017

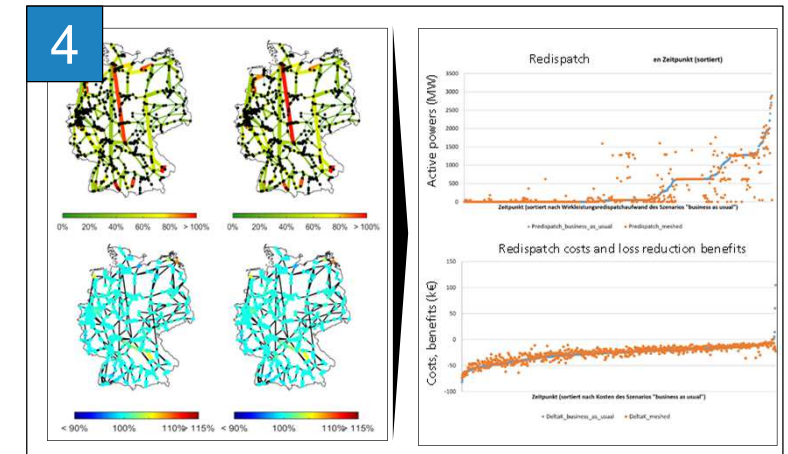
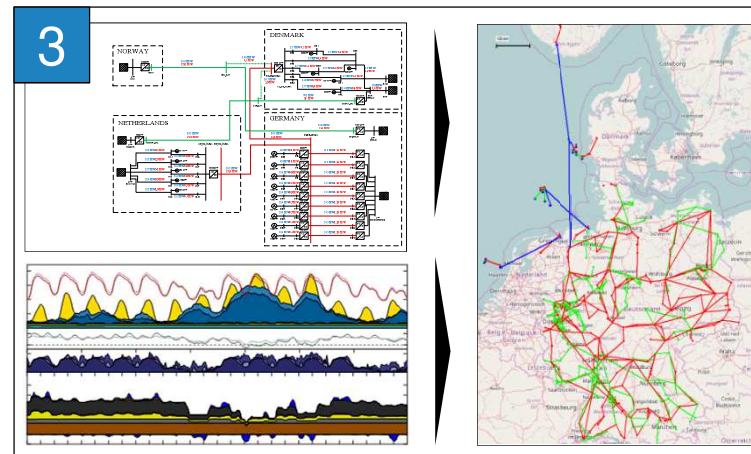
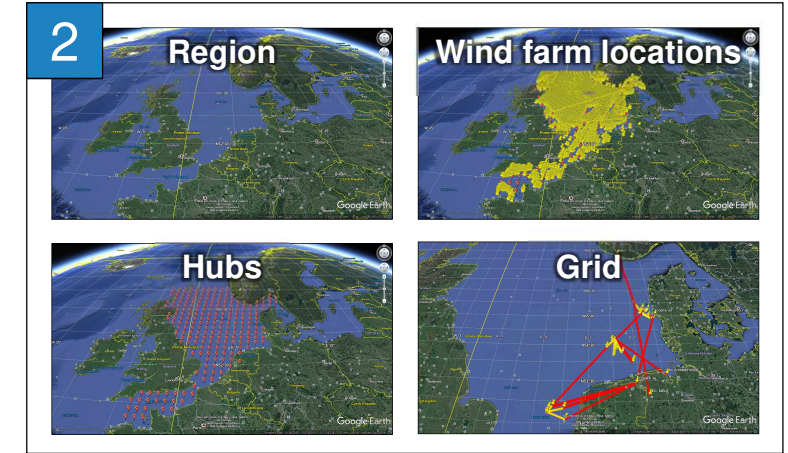
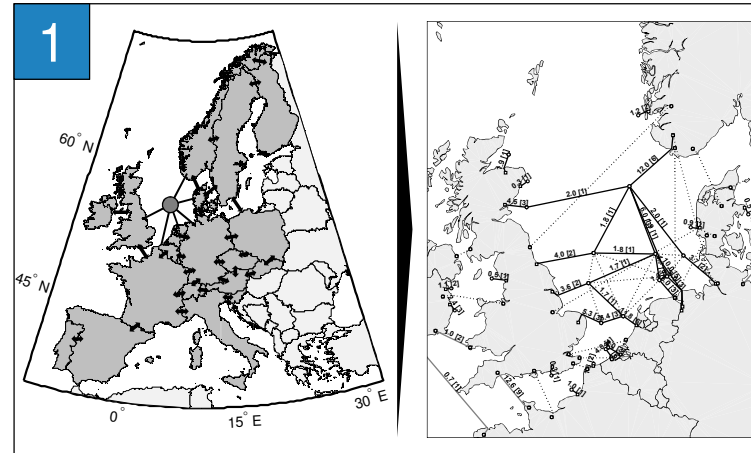
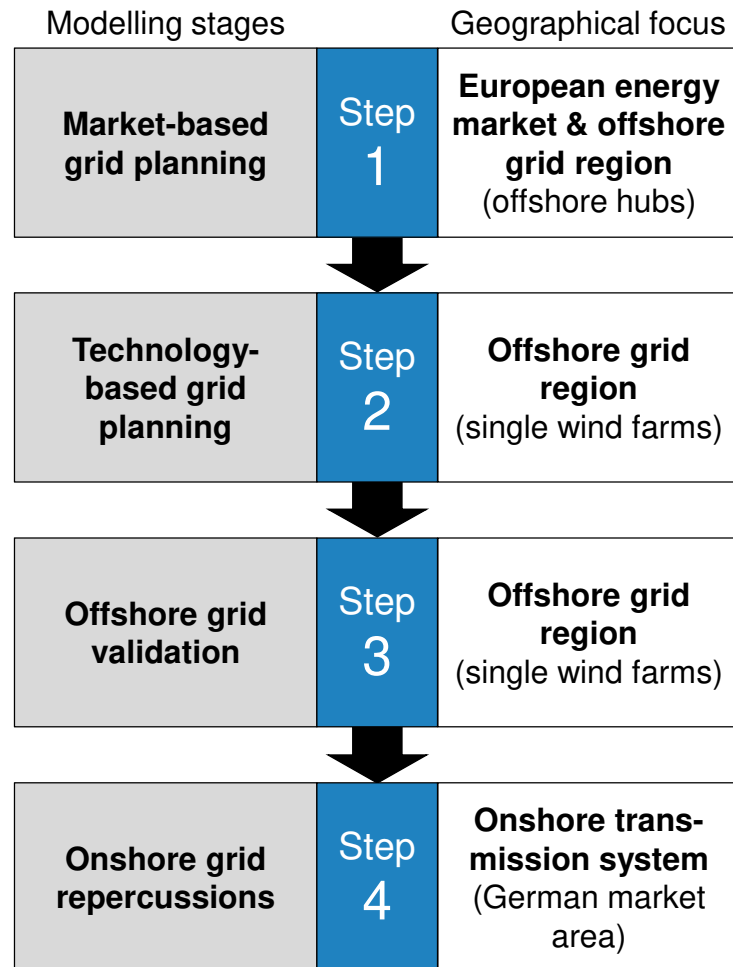
Funding came from the Federal Ministry for Economic Affairs and Energy (BMWi)
NSON-DE finalised end of 2017 – Report published in June 2018

CONTENTS

- NSON Initiative and German NSON (I)-project
- **German NSON (I)-project**
 - **focus, goals, and main results**
- German NSON II-project
 - Partners and project overview
 - Background and motivation
 - Working plan
 - Focus, goals, and expected results
- Further activities in mixed AC/DC-Systems
 - MODULATOR

German NSON (I)-project

Focus, goals, and main results (I/II)



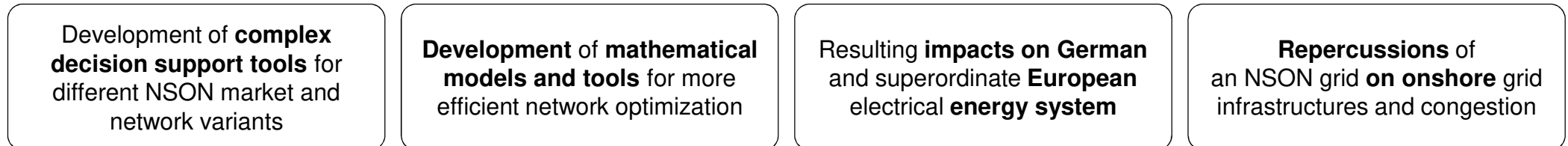
German NSON (I)-project

Focus, goals, and main results (II/II)

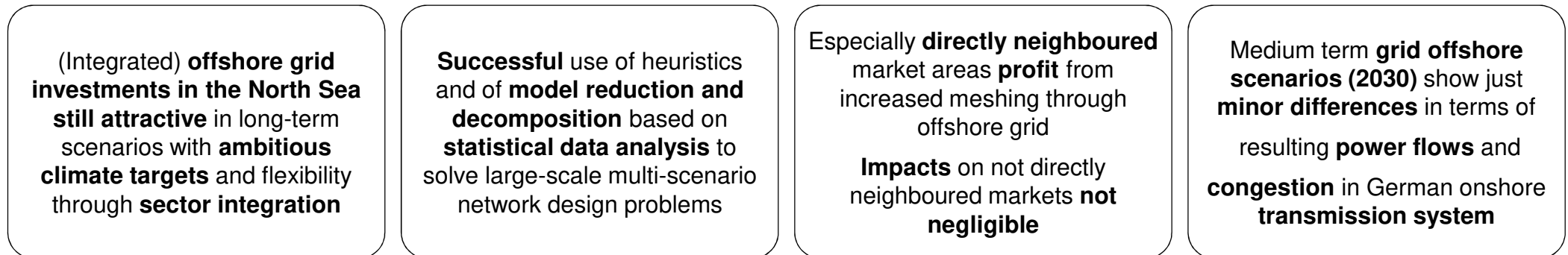
Project



Goals



Main results



CONTENTS

- NSON Initiative and German NSON (I)-project
- German NSON (I)-project
 - focus, goals, and main results
- **German NSON II-project**
 - **Partners and project overview**
 - **Background and motivation**
 - **Working plan**
 - **Focus, goals, and expected results**
- Further activities in mixed AC/DC-Systems
 - MODULATOR

German NSON II-project

Partners and project overview

Project title

- Joint project: NSON II
- Economical Connection and International Integration of Offshore Wind Energy in the North Sea

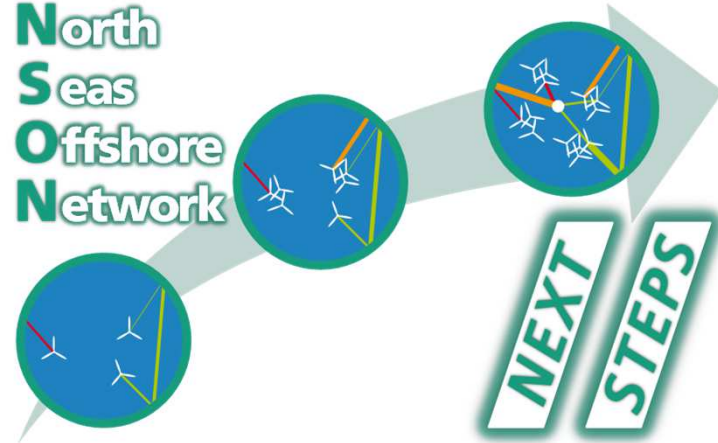
Timeframe

- Project start Jan. 2020
- Duration 3 years

Funding

- Federal Ministry for Economic Affairs and Energy (BMWi)

North
Seas
Offshore
Network



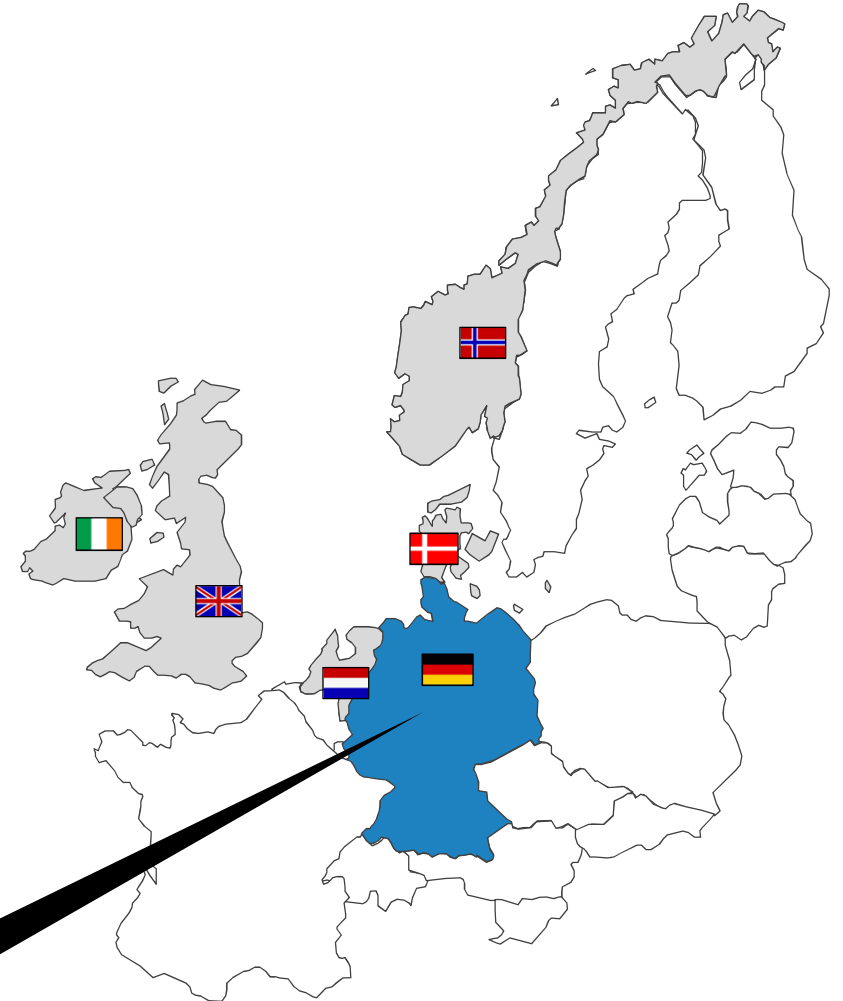
Partners

 **Fraunhofer**
IEE



Leibniz
Universität
Hannover

U N I K A S S E L
V E R S I T Ä T



German NSON II-project

Background and motivation

„SHORT-TERM TASKS“

technical **feasible** and **cost-efficient** connection of wind farms in German **offshore zone 3**

Regulation: **decrease costs AND maintain system reliability**



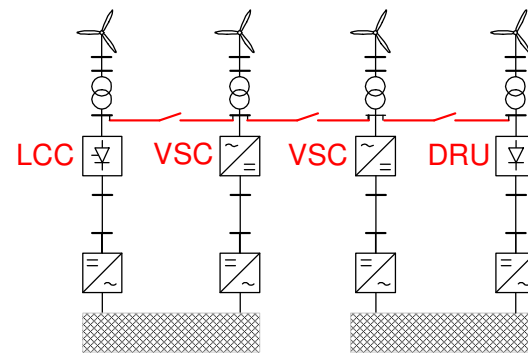
SCIENTIFIC QUESTIONS

Robust market based scenario planning under uncertainty

Plant and system control structures and methods

Optimized grid planning and operation of offshore systems

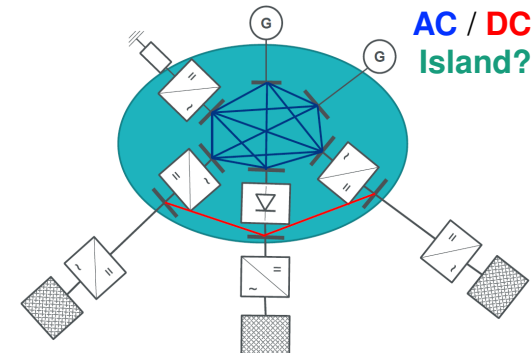
Development of suitable mathematical methods and techniques



„PLANT AND SYSTEM CONTROL“

AC-parallel and meshed operation of different converter technologies

Ratio of **grid forming and following converters** in meshed grid structures



„OPERATIONAL CHALLENGES“

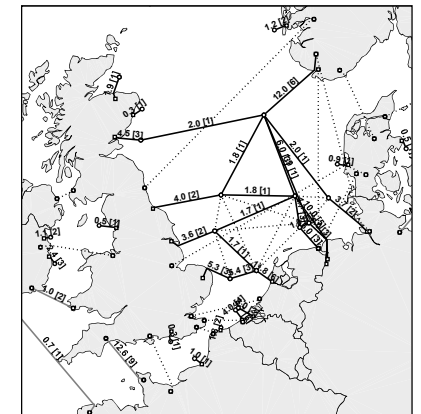
Optimized mixed AC/DC- and converter type-system layout

Identification and optimization of **system control** modes and converter **set points**

„LONG-TERM PROSPECTS“

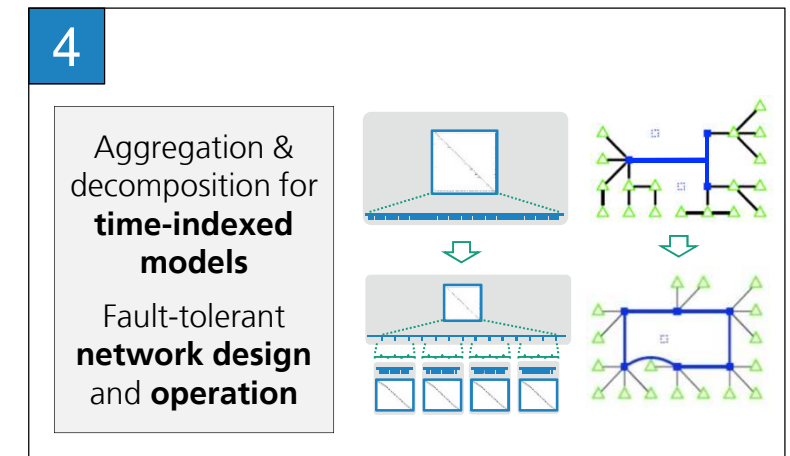
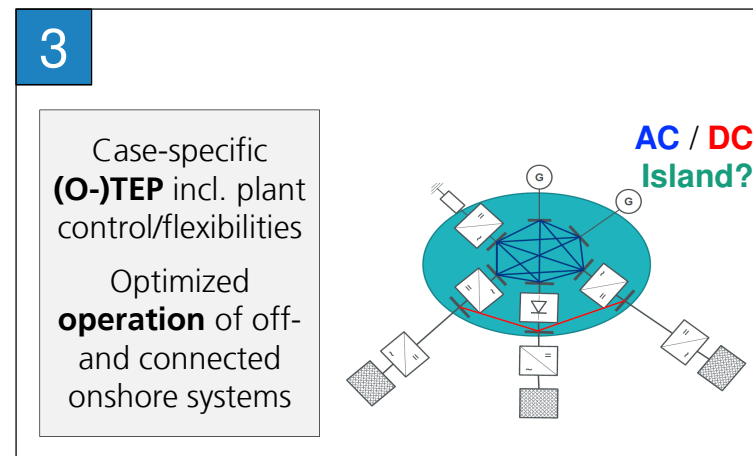
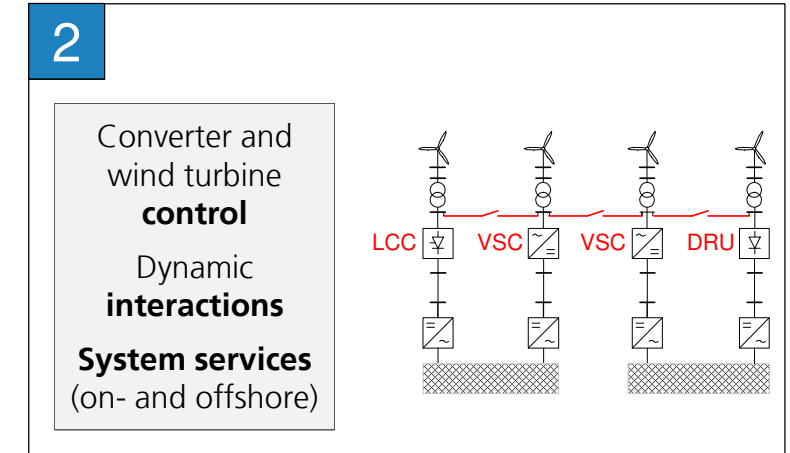
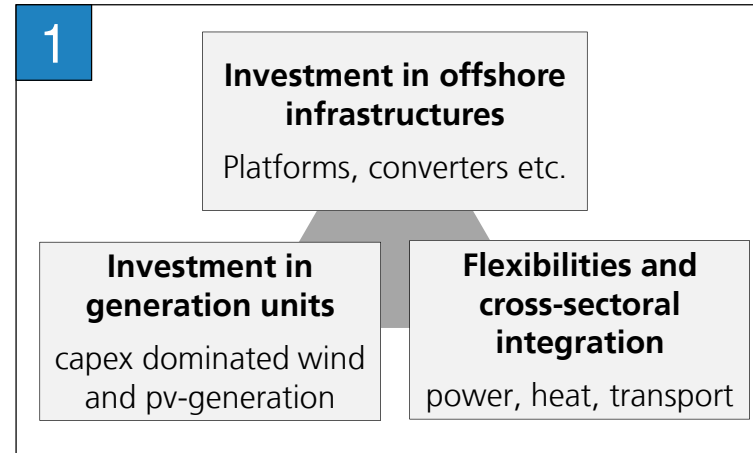
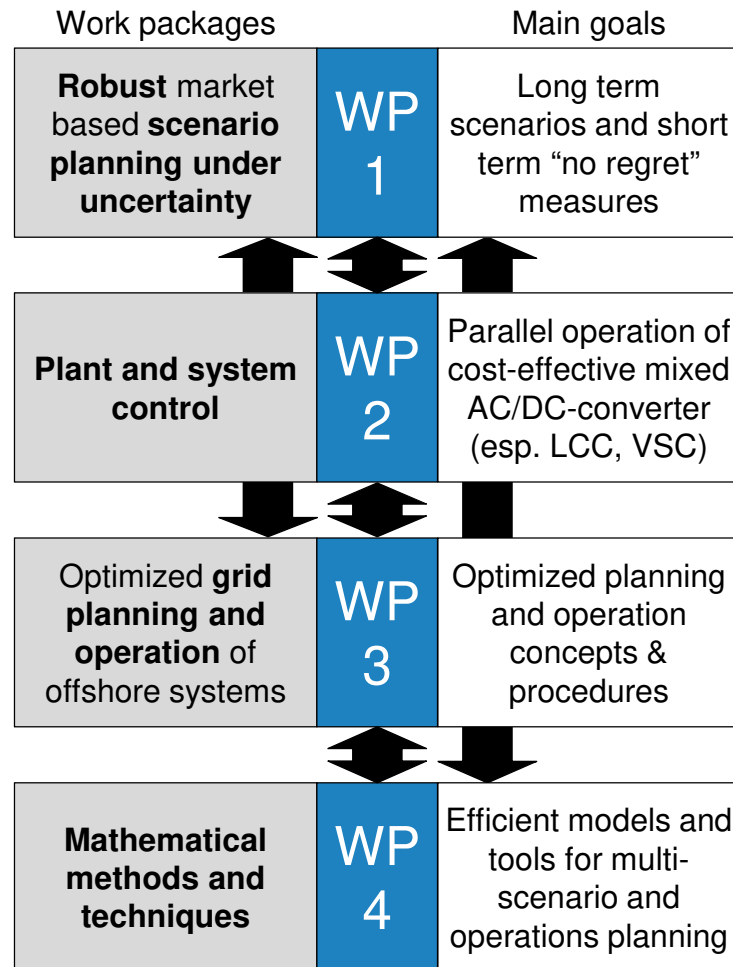
meshed offshore grids and multiple interconnectors in North Seas region

built and established
North Sea Wind Power Hub(s)



German NSON II-project

Working plan



German NSON II-project

Focus, goals, and expected results

Project



Goals

Long term **energy scenarios** and short term **“no regret” measures**

Parallel and meshed operation of **cost-effective mixed AC/DC-converter** (esp. LCC, VSC)

Optimized planning and operation concepts & procedures

Efficient **mathematical representation** in multi-scenario optimization and operations planning models

Expected results

Co-optimisation of **short- and long-term interdependencies** and **uncertainties**:
Offshore **grid investments**
Generation **expansion**
(Onshore) **flexibility from cross-sectoral** integration

Technical requirements for **parallel and meshed operation**
Control concepts for parallel and meshed operation
Feasibility for additional **active power trade** and **operating reserve**

Mathematical models to represent control and operational constraints
Optimized **transmission expansion planning** and **system operation** methods and models including **mixed AC/DC-structures** and restrictions

Better models and **faster solvers**, i.e.
more efficient handling of long **operational planning horizons**
effective integration of **failure resilience** into network design and **power flow computation**

CONTENTS

- NSON Initiative and German NSON (I)-project
- German NSON (I)-project
 - focus, goals, and main results
- German NSON II-project
 - Partners and project overview
 - Background and motivation
 - Working plan
 - Focus, goals, and expected results
- Further activities in mixed AC/DC-Systems
 - MODULATOR

Further activities in mixed AC/DC-Systems

MODULATOR (I/II)

Project title

- MODULATOR
- Module Aware Modelling and Assessment of Performance of Inter-connected AC/MTDC Power Grids

Timeframe

- Project start May 2018
- Duration 3 years

Goal

- Develop a framework of module-aware modelling of interconnected AC/MTDC grids where each subsystem will be treated as a pluggable building block (i.e. “software”)

Partners



SINTEF



Fraunhofer

Outline

STATE OF THE ART

- Commercial SW for analysis of transmission system mostly tailored to conventional AC systems
- Models and methods for DC and hybrid AC/DC transmission systems recently developed



PRESENT DEFICIENCIES

- Time domain analysis is inefficient and time consuming
- SW addressing Hybrid AC/DC based on black boxes and not reflecting last modelling advances
- Models and methods from latest research is not harmonized



OBJECTIVE

- Create framework for new generation of integrated software tools for analysis and optimization of hybrid AC/DC transmission systems

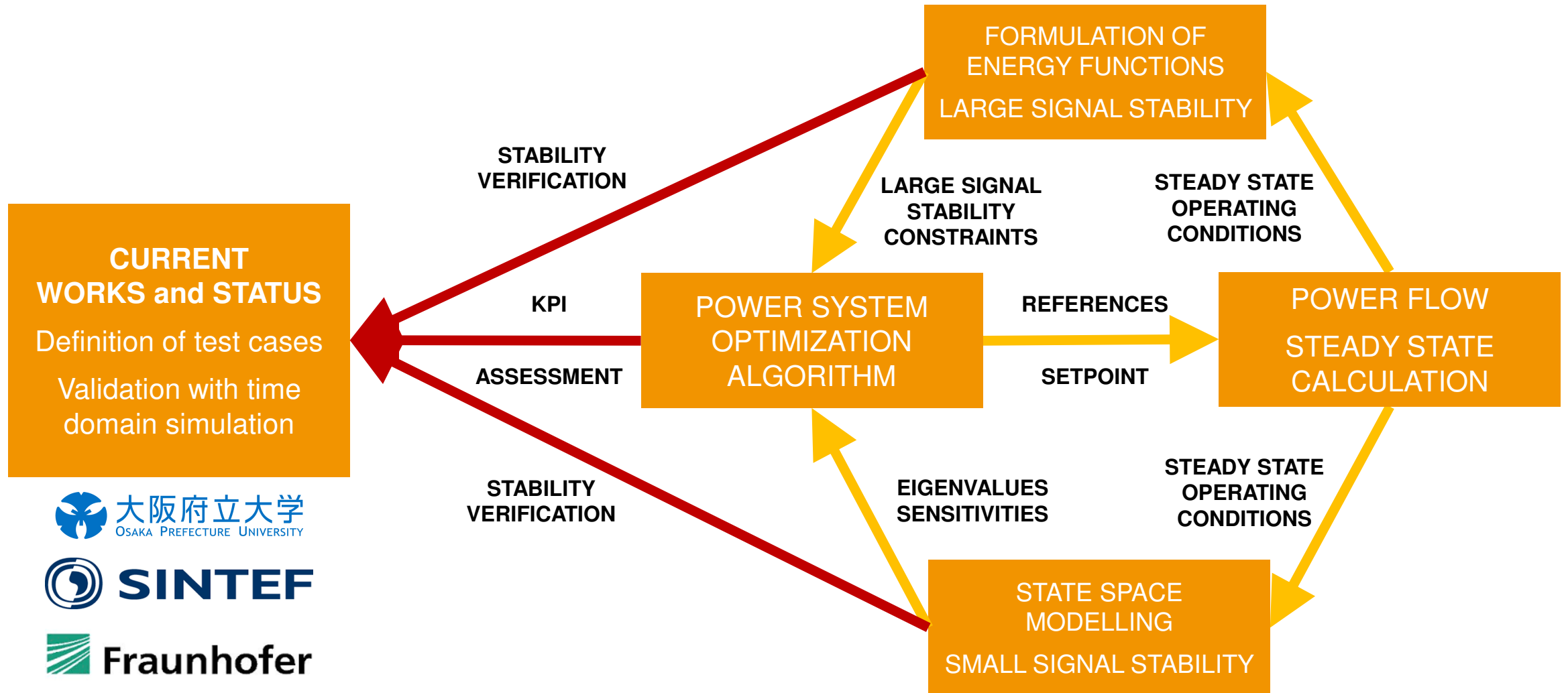


IMPACT

- Lower computational load and faster results
- Optimization of planning and operation of hybrid AC/DC grids accounting stability constraints

Further activities in mixed AC/DC-Systems

MODULATOR (II/II)



EXPERIENCES AND PROSPECTS OF GERMAN NSON ACTIVITIES TOWARDS COST-EFFICIENT OFFSHORE WIND CONNECTION AND INTERNATIONAL INTEGRATION

THANK YOU FOR YOUR ATTENTION! QUESTIONS?



Fraunhofer

IEE

Dipl.-Ing. Denis Mende

Fraunhofer Institute for Energy Economics
and Energy System Technology IEE

Grid Planning and Operation

Königstor 59 | 34119 Kassel / Germany
Phone +49 561 7294-425
denis.mende@iee.fraunhofer.de