



Achieving flexible and sustainable energy systems

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Achieving flexible and sustainable energy systems



Flex4RES

Flexible Nordic Energy Systems

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DTU Management Engineering
Institut for Systemer, Produktion og Ledelse

- **Energy Systems Analysis (ESY)**

- Global and regional energy system optimisation models (all sectors)
- Integration of intermittent renewables in energy systems
- GIS preprocessing tools
- Quantitative scenario analysis

- **Energy Economics and Regulation (EER)**

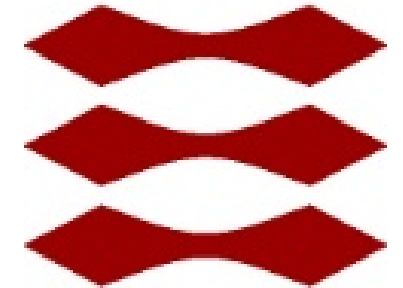
- Analyses of regulatory frameworks and market designs that facilitate the transition towards larger share of renewable energy in the energy system, energy savings, and climate change
- Policy analysis and economic assessment
- Economic and social aspects of wind integration, coupling of markets, and flexibility options
- Demand behaviour based on technical/economic or econometric models

- **Climate Change and Sustainable Development**

- Modelling of climate Change mitigation, renewable energy, and smart cities;
- Decision making tools for climate change impacts and adaptation

- **Transport Economics**

DTU



Sister departments

DTU Wind Energy
Department of Wind Energy

DTU Energy
Department of Energy Conversion and Storage

DTU Elektro
Institut for Elektroteknologi

REPLI - DTU Renewable Energy Policy, Planning and Integration Advice

Scientific advice within energy



Scientific advice

An integral part of Danish universities' portfolio of activities

1/5 of DTU's staff are involved with scientific advice

DTU is #2 in the world and #1 among the European universities in the category Energy Science and Engineering on the Academic Ranking of World Universities 2016 (Shanghai Jiao University)

We have the expertise and the infrastructure.

Goal

The Sustainable Development Goal nr. 7.



Means

Collaboration between universities, companies, authorities and international organizations
→
better technology and analysis methods within the energy sector.

Why advice on sustainable energy from DTU?

REPLI provides research based advisory services and capacity building within integration of intermittent renewable energy sources.

Our advisory services range from technology choices to policy advice and implementation.



Technical University of Denmark Departments and Cent

REPLI

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[Energy Policy & Planning](#) [Renewable Energy Integration](#) [Variable Renewables](#)

ADVISORY SERVICES FROM TECHNICAL... [Advisory Services](#) SHARE



No one-size-fits-all solutions

REPLI offers no one-size-fits-all solutions. The challenges in growing cities, rural areas and isolated islands are extremely diverse when it comes to securing clean and cheap energy without affecting our climate system.

In each case REPLI takes the actual local situation, available resources, existing infrastructure and local competencies as a starting point for utilisation and integration of clean energy sources such as solar, wind and thermal energy.

Among our clients are

- Nordic Energy Research
- DANIDA
- gef GLOBAL ENVIRONMENT FACILITY
- entsoe
- ENERGINET/DK

Advisory Services

We offer international advisory services and capacity building, covering the entire value chain, from mapping of energy resources, technology solutions and systems integration to policy advice and implementation. We bring together the relevant expert and specialist competencies necessary to provide reliable, affordable and sustainable solutions to our clients.

Our clients include governments, development banks and international organisations, and we often work in collaboration and in consortia with private sector firms and organisations.

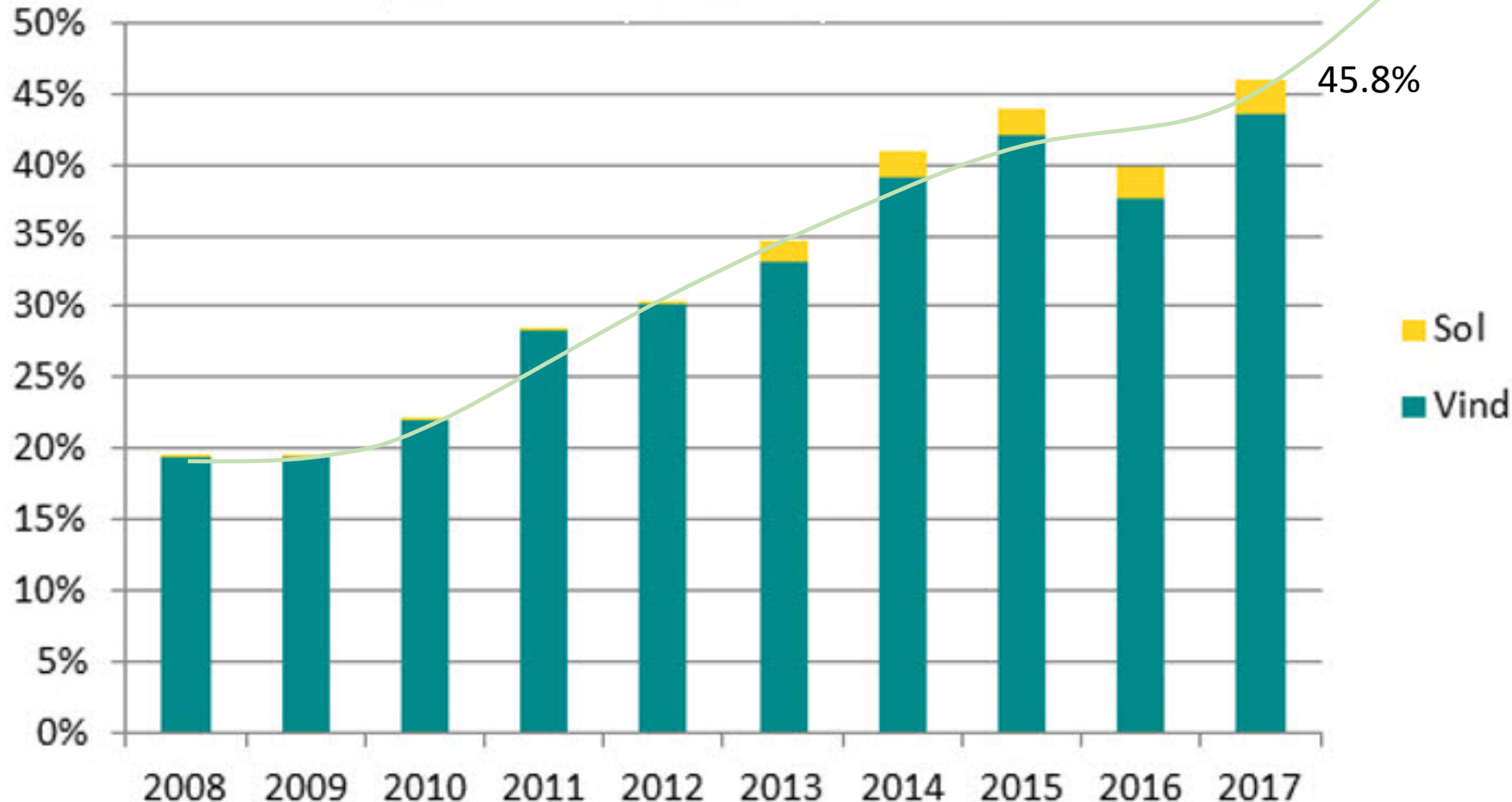
About 20% of DTU's 5,800 employees work with research-based advisory services, directed towards public organisations and the activity generates an annual turnover of approximately DKK 1 billion (USD 150 million).

DTU's research-based advisory services also include close collaboration with industrial stakeholders, such as providing advice related to front-end innovation, deployment of new technologies and test and demonstration facilities.

Updated by [Leif Senderberg Petersen](#)

The Kingdom of the Winds

Wind share in Danish annual electricity consumption



23 December 2017:
1 hour with 139%

25 December 2017:
1 day with average of 109%

Political target 2050:

The total energy supply based on renewable energy incl. heat, gas, transport, industry, etc.

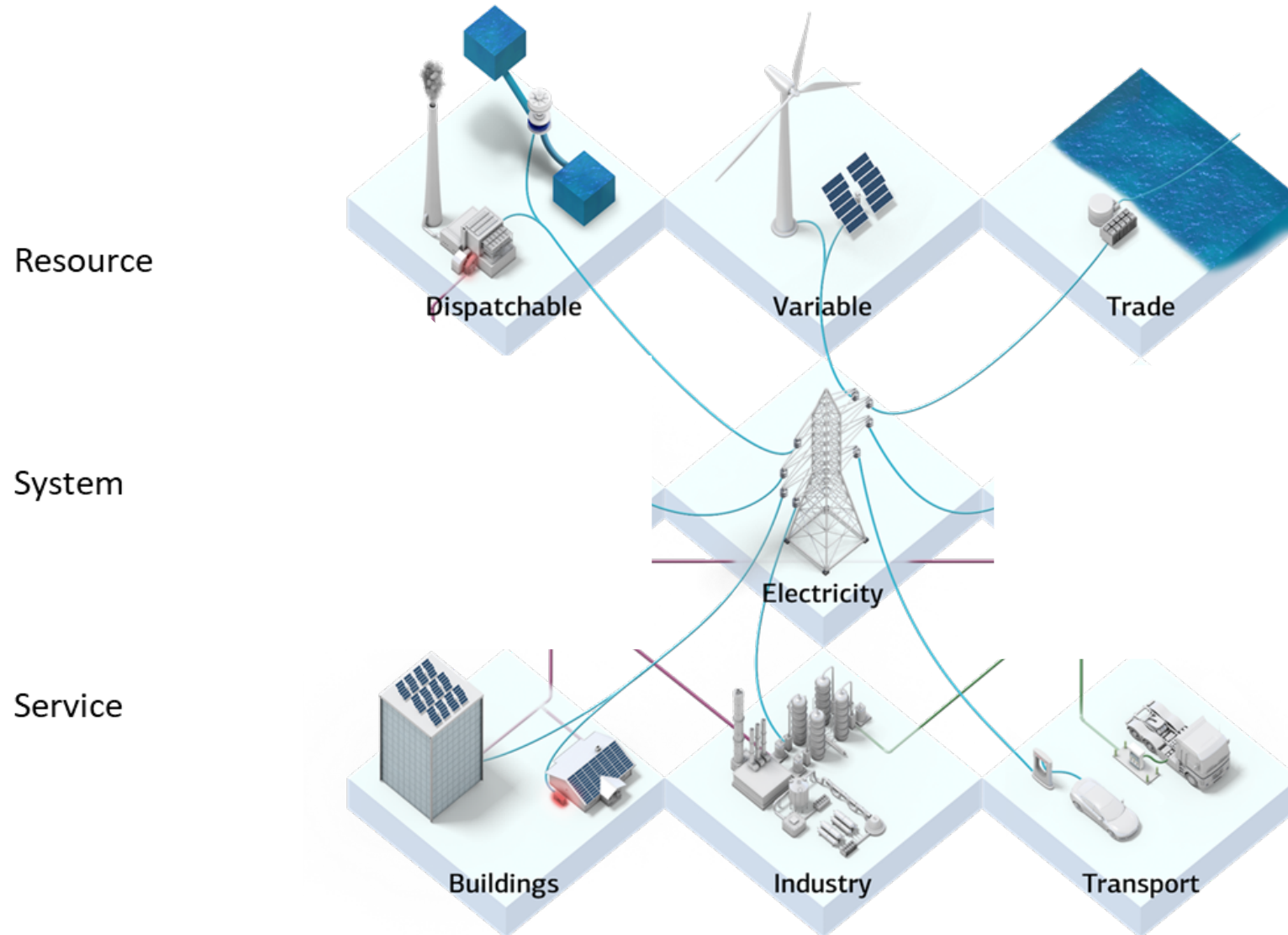
District heating:

50% share of total heat supply, with 69% CHP and <1% P2H



Flexibility Resources

Finding ramping capabilities

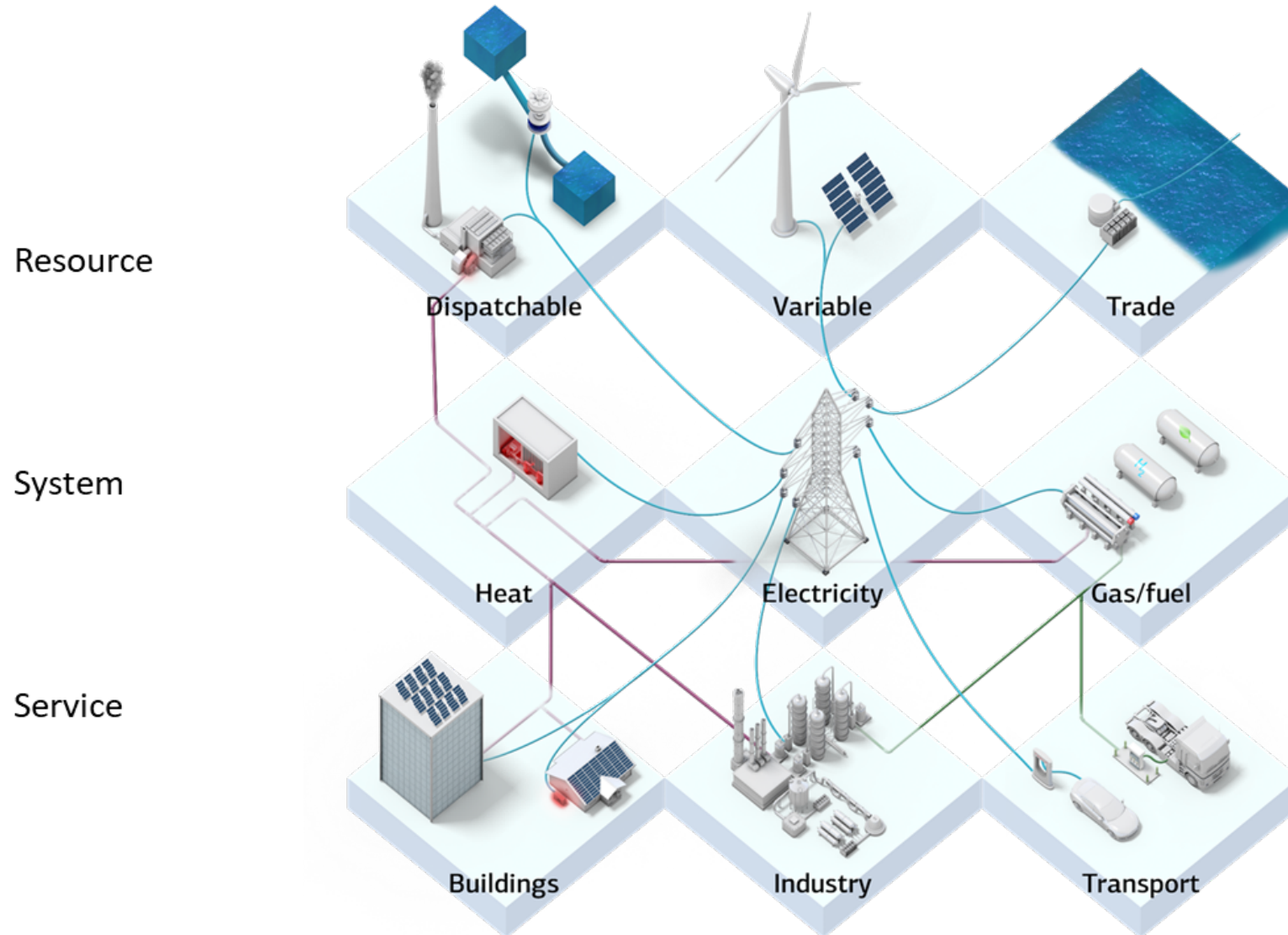


Supply flexibility

Demand responds

Flexibility Resources

Finding ramping capabilities



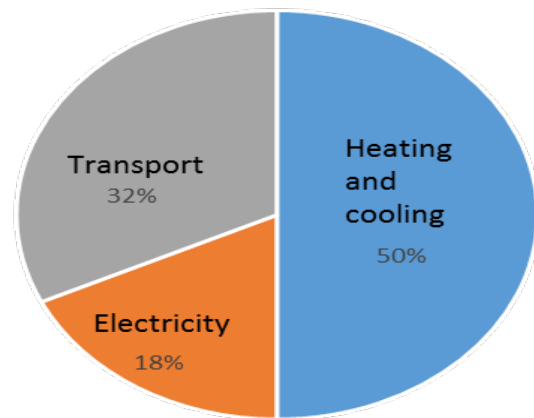
Supply flexibility

Sector coupling/
Electrification

Demand responds

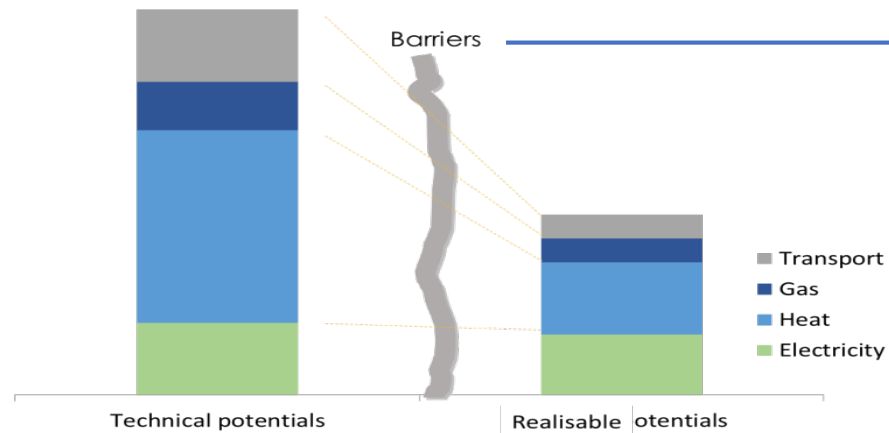
Sector coupling

Electrification as source of flexibility



Distribution of EU energy consumption
(Source: EU Heating and Cooling strategy)

From technical to realisable potentials



Framework conditions

- Market design
- Direct regulation
- Fiscal policies
- Support schemes
- Grid regulation

Large flexibility potentials in electrification of the energy sectors

Hindered by regulatory barriers

Remove barriers

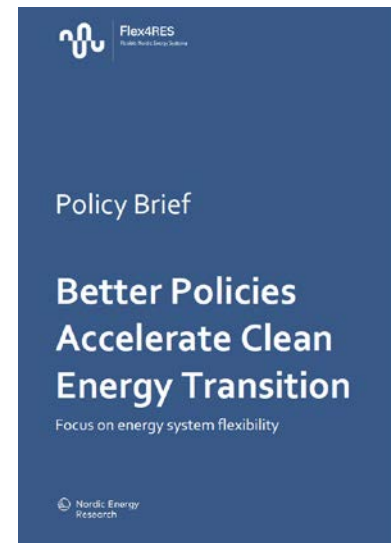
Better Policies Accelerate Clean Energy Transition

Insufficient market signals and uneven frameworks for different renewable energy resources limit flexibility

Revise tariffs, taxation, and subsidies in Nordic-Baltic countries to increase flexibility

Seven policy recommendations:

- R1: Create a level playing field for all RES across sectors through consistent fiscal policies;**
- R2: Implement electricity grid tariffs which allow market signals for flexibility to reach the end-users;**
- R3: Dynamic taxation of electricity (e.g. restructuring levies and taxes);**
- R4: Encourage VRE operators to act flexibly using short-term market-based incentives;**
- R5: Abolish RES support during negative price periods;**
- R6: Enhance electrification by removing the limitations on using electricity for heating;**
- R7: Tackle investment risks in flexible individual heating through new financing and private ownership models.**





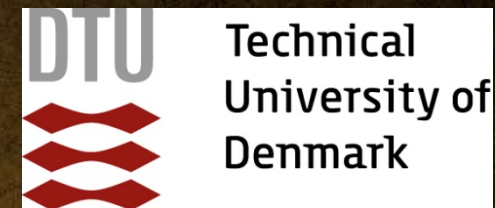
Unlocking flexible and sustainable energy systems

Both technology deployment and regulatory changes

Coherent changes in market designs, regulatory framework condition, and coupling of markets

Make the sector coupling/electrification as flexible as possible

- Remove barriers
- Improve the business case for flexible power-to-heat/gas technologies
- Increase market integration and the value of VRE



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www.Flex4RES.org

www.repli.dtu.dk

www.sys.man.dtu.dk