





### Choice of Flexibility sources towards a 100% renewable based Nordic energy system

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### Towards 100% RES and Carbon Neutrality **100** Flex4RES



### **The Clean Energy Transition**



Goals and RE-thinking of the energy infrastructure





### **Example: Wind share in Denmark**



Wind production share in DK-West

Flex4RES

7-2012

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.

#### **Need for Flexibility**

### **Present Flexibility**

### Adequate Flexibility Indicator AFI = 1/(1+CV[p])

#### where

CV[*p*] = sigma[*p*]/E[*p*] is the coefficient of variation of prices

AFI between 0 and 1

- 0 = no flexibility; infinitely volatile prices
- 1 = perfectly adequate flexibility; constant prices

Nord Pool market prices 2018



### **Flexibility definition**





influence of variable supply

Negative values indicate large influence of variable demand

# Flexibility in electricity infrastructures **U** Flex4RES



## Flexibility in coupled infrastructures



### Flexibility by coupling

Transmission

Electricity/gas/heat Transport/storage

Coupling	Incentives for flexibility	Price variations	Driver	Impact
Geographical coupling	Price differences between regions	$\checkmark + \checkmark \Rightarrow \checkmark$	Different technology mix	Increased imports and exports
Sector coupling	Price differences between energy sources and technologies	$\checkmark \Rightarrow \checkmark$	Increased business opportunities	Increased national demand



Interconnection Common frameworks developed over the last 3 decades



Sector coupling Sector specific frameworks

### Sector coupling

Electrification as source of flexibility





### **Nordic Barriers**

- EU framework (Clean Energy for All Europeans)
- Nordic region greener than EU
- Traditional energy policy framework still dominate

#### Main barriers

#### **B1** Insufficient market signals for some stakeholders;

#### B2 Uneven frameworks for different renewable energy resources.

**Policy recommendations** (Market-based policy framework):

R1 **Create a level playing field** for all RES technologies 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.



**Policy Brief** 

Flex4RES Flexble Nordic Energy System

#### Better Policies Accelerate Clean Energy Transition

Focus on energy system flexibility

Nordic Energy Research

# Nordic commonalities with regional diversity

Recommendations	Related barrier(s)	Denmark	Norway	Sweden	Finland	Estonia	Latvia	Lithuania
Rı	B2							
R2	Bı							
R <sub>3</sub>	B1,B2							
R4	B1,B2							
R <sub>5</sub>	B1,B2							
R6	B2							
R <sub>7</sub>	B2							

B1 = Insufficient market signals for some stakeholders; B2 = Uneven frameworks for different renewable energy resources

#### • All foresee an increase in VRE

- Common barriers, but specific conditions need consideration
- All have information deficit on flexibility and lacking policy awareness



### Summary and next steps



#### Transition to a 100% RES-based Nordic energy system is possible

- Present system already relative flexible
- Policy awareness on flexibility in addition to traditional environmental and cost related issues.
- System instead of individual sector approaches
- Soft infrastructure (Regulation/economics/institutions) as important as hard infrastructure
- Develop adequate incentives

#### **Next steps / research questions**

- Impact assessments/quantification
- Low hanging fruits / socio-economic least-costs solutions
- Technology and climate/environmental impact
- Pathways Regulatory, technical and sustainable
- Policy recommendations



#### **Questions?**



#### www.Flex4RES.org

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### Extra slides



#### Flex4RES **Scenarios** High sector coupling Sector coupling Both transmission FULL ENERGY Electricit (electrifying heat, gas, transport) CO-OPERATION CO-OPERATION and sector coupling **R1: Level playing field** 3 R2/3: Tariffs & taxes No targeted Targeted incentives < ➤ incentives for flexibility for flexibility EXTENDED ELECTRICITY MARKET Interconnection ELECTRICITY MARKET CO-OPERATION CO-OPERATION Investments in Existing transmission transmission capacity capacity 2030 2030 - 205 15 GW Reference scenario 10 GW 5 GW - 1 GW BAU Low sector coupling

### Scenario / model runs





## **District Heating in the Baltics/Nordics Flex4RES**



Source: Euroheat, 2015

District heating is widely used in most Baltic/Nordic countries and thus represents a flexibility source of considerable magnitude which is only partly exploited today by the power market



# **Choice of heat supply -at different electricity prices**

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