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### Facilitating energy storage to allow high penetration of intermittent renewable energy



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### **Project Summary & Objectives**

**stoRE** aims to facilitate the high penetration of variable renewable energies in the European grid by unblocking the potential for energy storage infrastructure, through:

- Analysis of the energy storage status and potential
- Assessment of the environmental considerations for the development and operation of energy storage facilities
- Identification, assessment and reviewing together with key stakeholders of the regulatory and market framework conditions
  - at European level
  - in the 6 target countries
- Dissemination activities for improving the understanding of the benefits of energy storage for the energy systems of Europe.





### Results (1)

- □ Current Status, Role and Costs of Energy Storage Technologies
- □ The Role of Bulk Energy Storage in Facilitating Renewable Energy Expansion
- Environmental Performance of Existing Energy Storage Installations
- Recommendations for furthering the Sustainable Development of Bulk Energy Storage Facilities – consultation process closed









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### Results (2)

- Guidelines for the development of PHES in environmentally sensitive sites –
  ongoing consultation process
- European Regulatory & Market Framework for Electricity Storage Infrastructure consultation process closed
- □ Energy Storage Needs in Austria, Denmark, Germany, Greece, Ireland and Spain
- Regulatory & Market Framework for Electricity Storage Infrastructure ongoing consultation process









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### What are the requirements for energy storage in Europe?





Calculation of

total energy

storage needs

#### Development of renewable energy sources Calculation of residual load

Seperation of long and short term energy storage needs

















100% 90% 80% 70% 60% **RES-E share** 50% 40% 30% 20% 10% 0% 2010 2020 2030 2040 2050 Year

DG Energy Roadmap - Current Policy DG Energy Roadmap - Delayed CCS DG Energy Roadmap - Energy efficiency DG Energy Roadmap - High RES DG Energy Roadmap - Low Nuclear DG Energy Roadmap - Reference DG Energy Roadmap - Diversified Supply ECF Roadmap 2050 - 40% RES ECF Roadmap 2050 - 60% RES ECF Roadmap 2050 - 80% RES ECF Roadmap 2050 - Baseline Eurelectric - Power choices - Baseline Eurelectric - Power choices - Power choices Greenpeace - Energy [R]evolution - Advanced Energy [R]evolution -Greenpeace - Energy [R]evolution - Energy [R]evolution Greenpeace - Energy [R]evolution - Reference EEG - stoRE - Green EEG - stoRE - BAU











#### stoRE Target Countries





#### Development scenarios in stoRE

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Target country	40% RE	80% RE	Import/Export	Heating sector
Austria	Already more than 40% RE →2020 scenarios A,B,C	2050 scenarios GREEN, BAU	Yes, combined system Germany - Austria	No
Denmark	Scenarios 2020 A,B,C Different wind development	One scenario	Yes, import/export via AC to Germany	Yes, for 80% RE
Germany	3 scenarios A,B,C Different RE development	3 scenarios A,B,C Different RE development	No	No
Greece	2 Scenarios A,B Strong PV, strong Wind	3 scenarios A,B,C Different RE development	No	No
Ireland	Scenarios 2020 A,B,C Different wind development	One scenario	Yes, import/export via HVDC to GB	No
Spain	2 Scenarios A,B Strong PV, strong Wind	2 Scenarios A,B Strong PV, strong Wind	No	No





#### Calculation of total energy storage needs

Calculation of residual load

Development of renewable energies





### Calculation of residual load

Calculation of residual load in Greece – 80% RES scenario







### Calculation of residual load

Calculation of residual load in Greece – 80% RES scenario









Calculation of

total energy

storage needs

#### Seperation of long and short term energy storage needs

Calculation of residual load

Development of renewable energies



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#### Storage needs for 80% RES Zero curtailment & Unlimited Transmission

Countries	Additional Neo [G\	eded Capacity <b>W</b> ]	Additional Needed Stored Energy			
	Charging	Discharging	[GWh]			
Austria	0 - 2,98	0	0			
Germany	31,85 - 55,16	25,17 - 29,04	950 - 1.534			
Denmark	4,85	3,25	660,75			
Ireland	6.8	4.3	2.700			
Spain	34,2 - 46,8	30,4 - 36,8	640 - 6.340			
Greece	10,6 - 15,1	8 - 8,3	340 - 1.550			

#### Storage needs for 80% RES Zero curtailment & Unlimited Transmission

Countries	Additior	Additional Needed Capacity [GW]			Additional Needed Stored Energy		
	Chargi	Charging		harging		[GWh]	
Austria	0 - 2,98			0		0	
Germany	31,85 - 55,16		25,1	7 - 29,04		950 - 1.534	
Denmark	Scenario 80% RE	Additionally Needed Capa (GW)		acity	, Additionally Needed Stored Energy (GWh)		
Ireland		Chai	rging	Discharging			
Spain	Equal	38.79		25.17		1,308	
	Wind	31.85		25.74		1,534	
Greece	PV	55	.16	29.04		950	

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#### Storage needs for 80% RES Zero curtailment & Unlimited Transmission

Countries	Additio	Additional Needed Capacity [GW]				Additional Needed Stored Energy	
	Scenario	Additionally Needed Capacity (GW)			ity	Additionally Needed	
Austria	80% KE	Charg	ging	Discharging		Stored Energy (GWh)	
	Equal	35.	3	36.5		2240	
Germany	Wind	34.2		36.8		1290	
Germany	PV		36.8			640	
Donmark		Nuclear scenarios					
Definitark	Equal-n	45.	45.3 33.6			6340	
Iroland	Wind-n	44.2		33.6		5000	
Ireland	PV-n	46.	8	34.9		4300	
Spain	34,2 -	34,2 - 46,8		30,4 - 36,8		640 - 6.340	
<b>Greece</b> 10,6 - 15,1		8 - 8,3			340 - 1.550		

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### Regulatory & Market Framework

What is the effect of the regulatory and market framework conditions on the development of new and operation of existing energy storage facilities?

#### Aim: Identify possible barriers

Wide consultation process + Questionnaire + Workshop

#### **Recommendations for improvements**





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