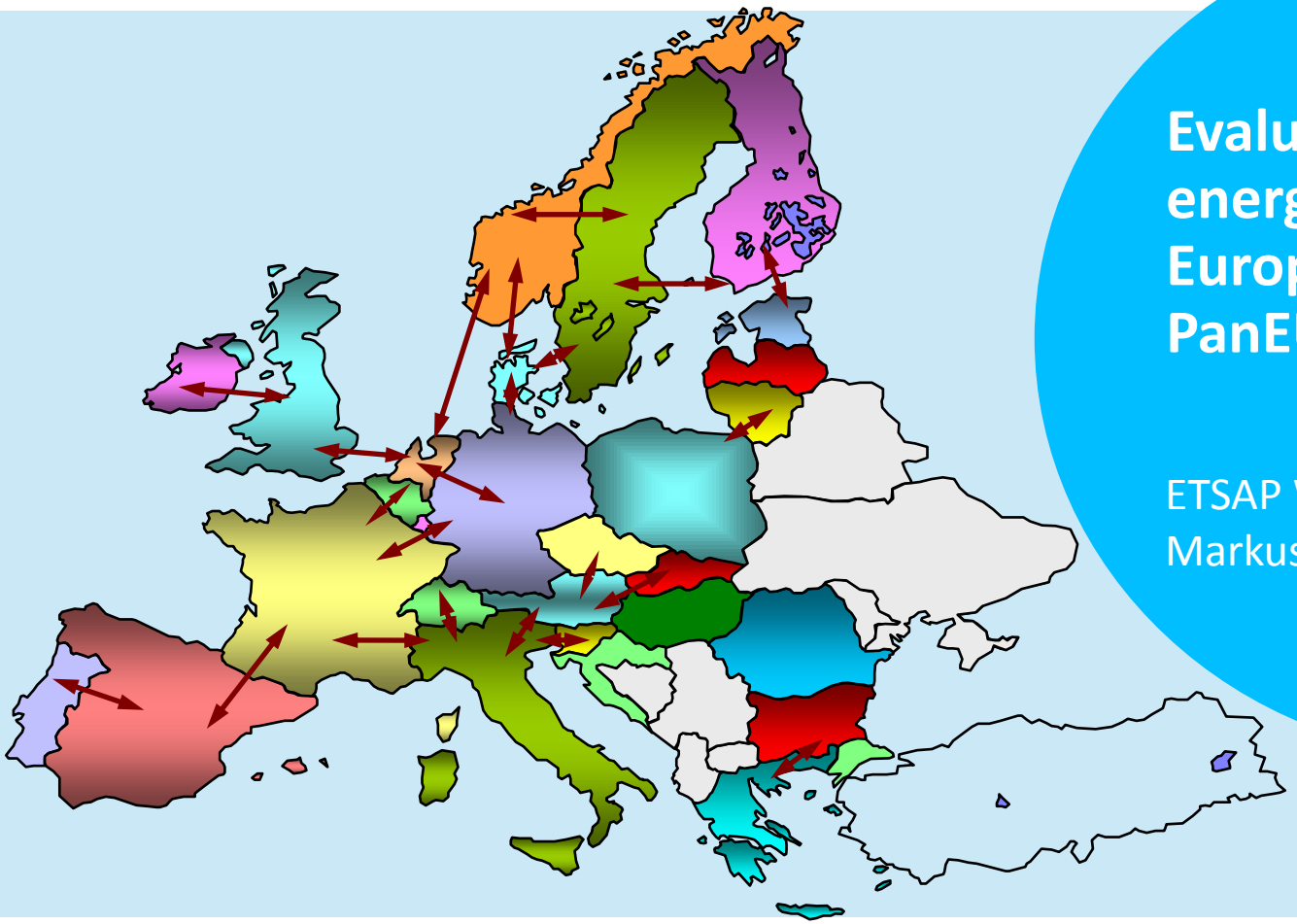
Universität Stuttgart
IER Institut für Energiewirtschaft
und Rationelle Energieanwendung



Evaluation of the role of energy storages in Europe with TIMES PanEU

ETSAP Workshop Madrid
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IER

Outline

1 Introduction

2 ESTMAP storage database – potentials

3 Scenario analysis

4 Conclusions and outlook

Introduction

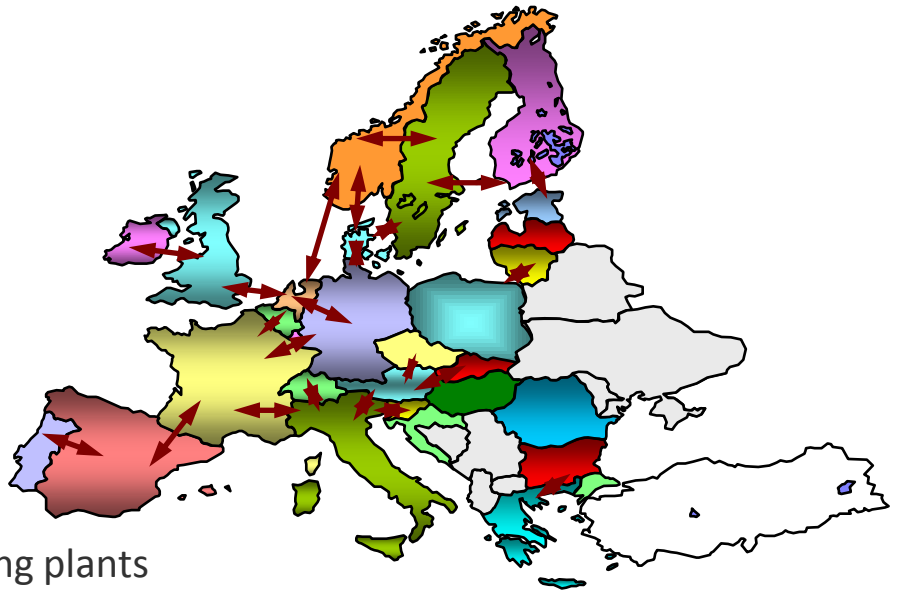
Motivation:

- Political induced increase of share of renewables in the EU-28
- Increasingly feed in of electricity from variable renewables (wind and pv)
- Flexible options and especially Storages are needed

ESTMAP:

- Including ESTMAP storage database in TIMES models
- Scenario analysis

Energy system model TIMES PanEU



- Technology oriented bottom-up partial equilibrium model
- 30 region model (EU 28, No, CH, IS)
- Energy system model
  - SUPPLY: reserves, resources, exploration and conversion
  - Country specific renewable potential and availability
  - Electricity: public electricity plants, CHP plants and heating plants
  - Residential and Commercial: End use technologies (space and water heating, space cooling and others)
  - Industry: Energy intensive industry (Iron and steel, aluminum copper ammonia and chlorine, cement, glass, lime, pulp and paper), food, other industries, autoproducer and boilers
  - Transport: Different transport modes (cars, buses, motorcycles, trucks, passenger trains, freight trains), aviation and navigation
- Country specific differences for characterization of new conversion and end-use technologies
- Time horizon 2010 - 2050
- GHG: CO2, CH4, N2O, SF6 /Others pollutants: SO2, NOx, CO, NMVOC, PM2.5, PM10

Storage potential for Europe

ESTMAP database

One existing reservoir

Country	Potential [GWh]	Connecting Cost $\left[\frac{€}{kW}\right]$	Country	Potential [GWh]	Connecting Cost $\left[\frac{€}{kW}\right]$
AT	409	6,2	IE	30	5,9
UK	1.702	8,4	IT	1.626	6,7
BG	378	6,9	NO	6.616	23,5
CY	51	5,7	PL	47	5
CZ	183	6,5	PT	1.229	4,4
DE	297	6	SE	1.098	11,6
FI	104	8	SI	18	5,6
FR	1.913	5,2	HR	291	7,5
GR	288	11,6	HU	3	5,5

Two existing reservoirs

Country	Potential [GWh]	Connecting Cost $\left[\frac{€}{kW}\right]$	Country	Potential [GWh]	Connecting Cost $\left[\frac{€}{kW}\right]$
AT	16	6,2	UK	85	4
FR	49	2,9	IT	86	7,7
CZ	3	6	NO	212	11,7
DE	5	15,2	PT	28	5,6

Scenario analysis from the ESTMAP project

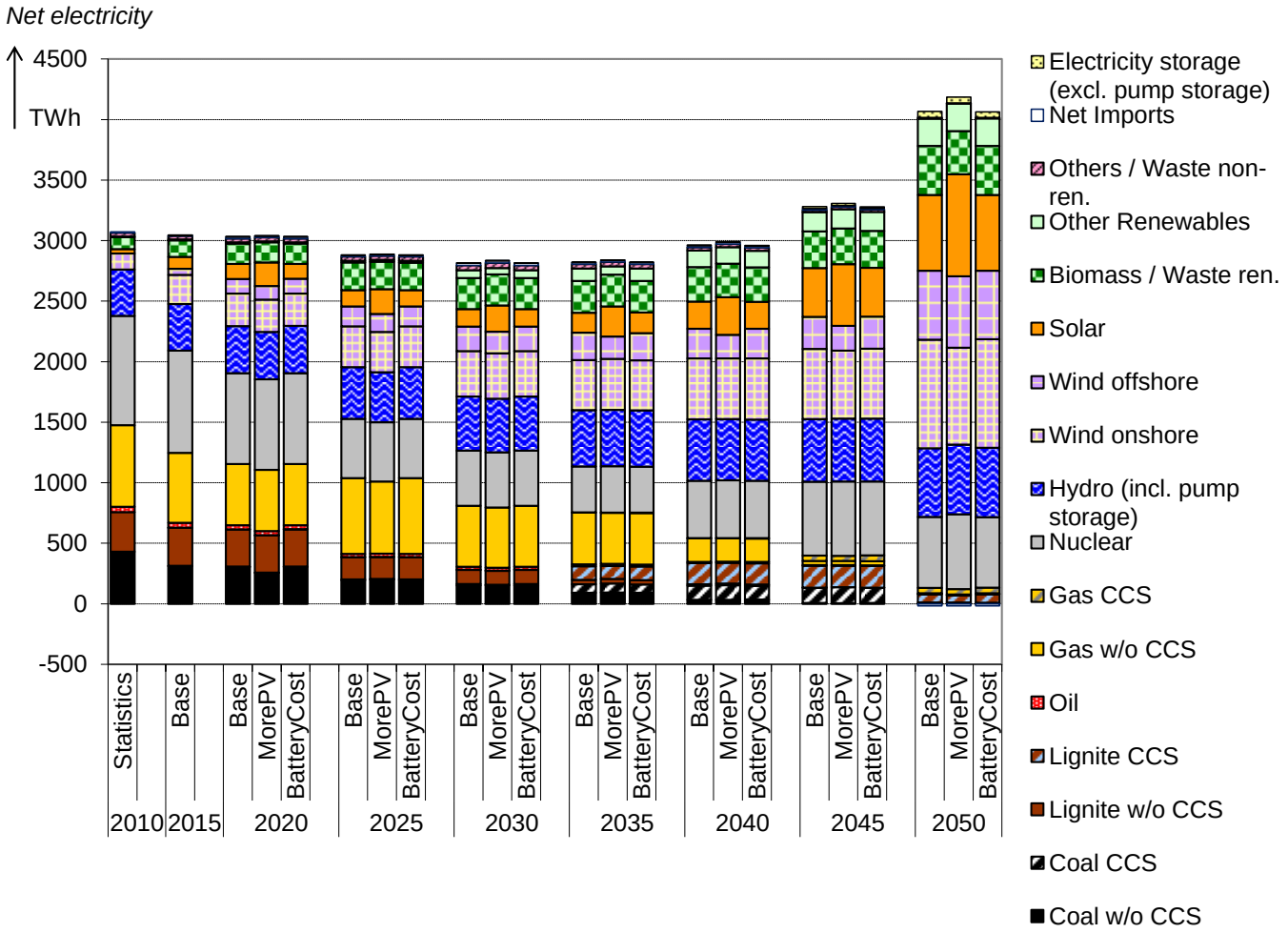
Scenario definition

Scenario assumptions	2030			2050		
	Base	MorePV	Battery Cost	Base	MorePV	Battery Cost
GHG reduction in the EU-28 (vs. 1990)	40 %			90 %		
Share of renewables at electricity consumption in the EU-28	30 %			80 %		
Share of renewables at gross final energy consumption in the EU-28	27 %			75 %		
PV Capacity in Europe	120 GW	180 GW	120 GW	364 GW	546 GW	364 GW

Scenario analysis from the ESTMAP project

Electricity production by energy carrier in Europe

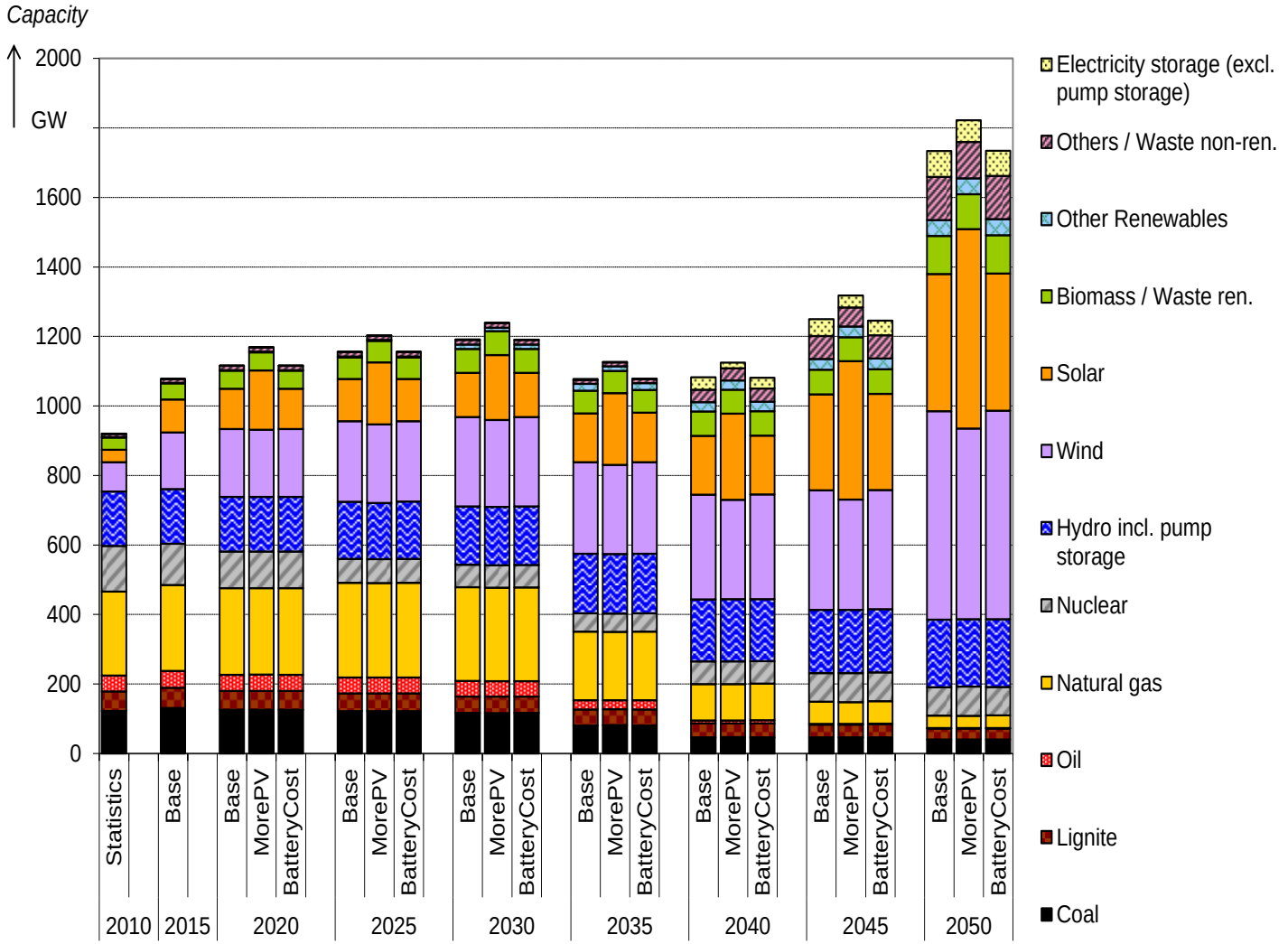
- Increased electricity demand in the EU-28 until the year 2050
- Electrification of the energy system until the year 2050 (achieve GHG emission targets)
- Electrification enables integration of fluctuating renewable energies
- Decrease in fossil fuel based power production and an increase in renewable energy generation



Scenario analysis from the ESTMAP project

Capacities in Europe

- Increase of capacities corresponding to the generation in all 3 scenarios

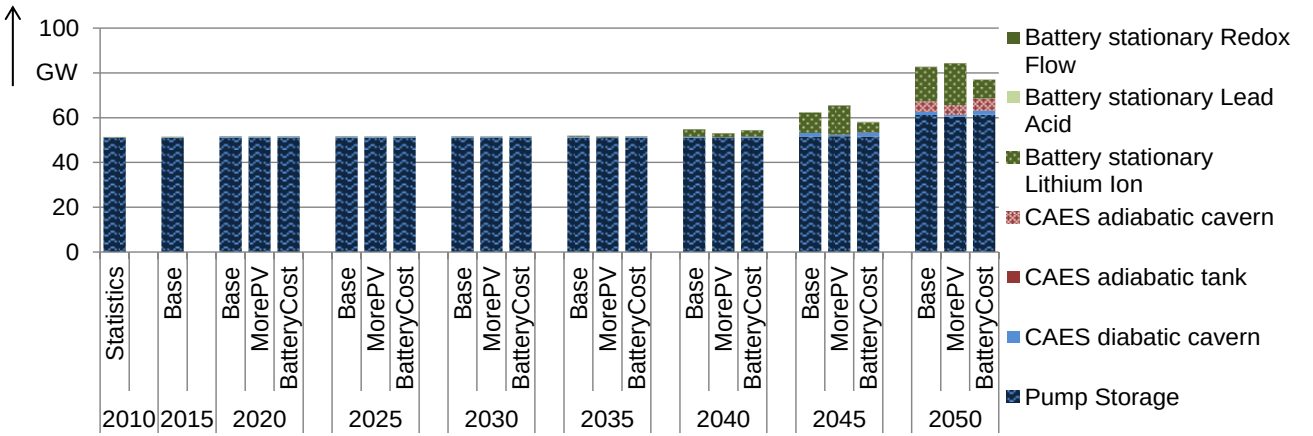


Scenario analysis from the ESTMAP project

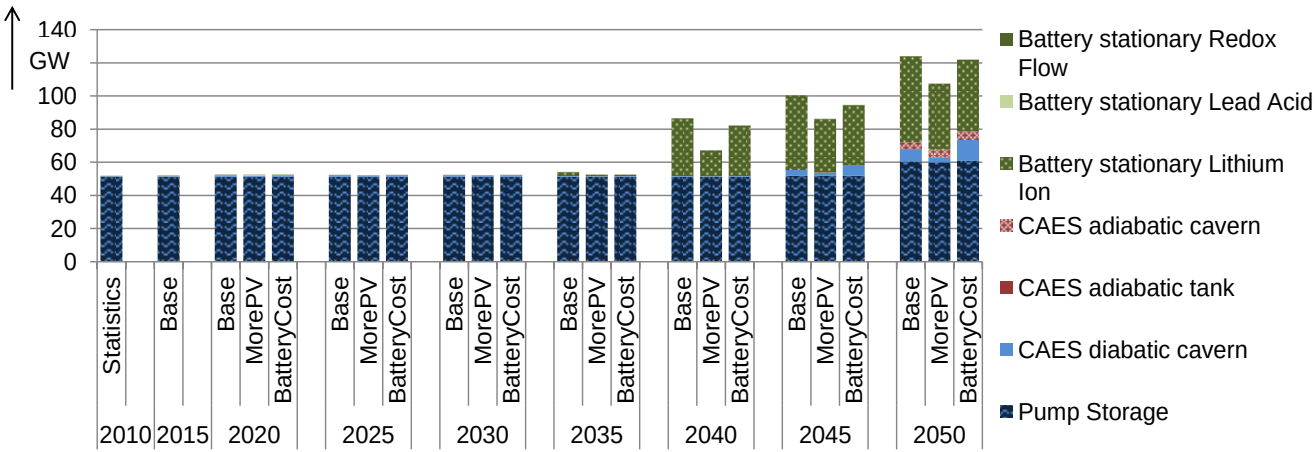
Electricity storages in Europe

- Investment in additional electricity storage capacities from the year 2030 onwards

Storage input capacity

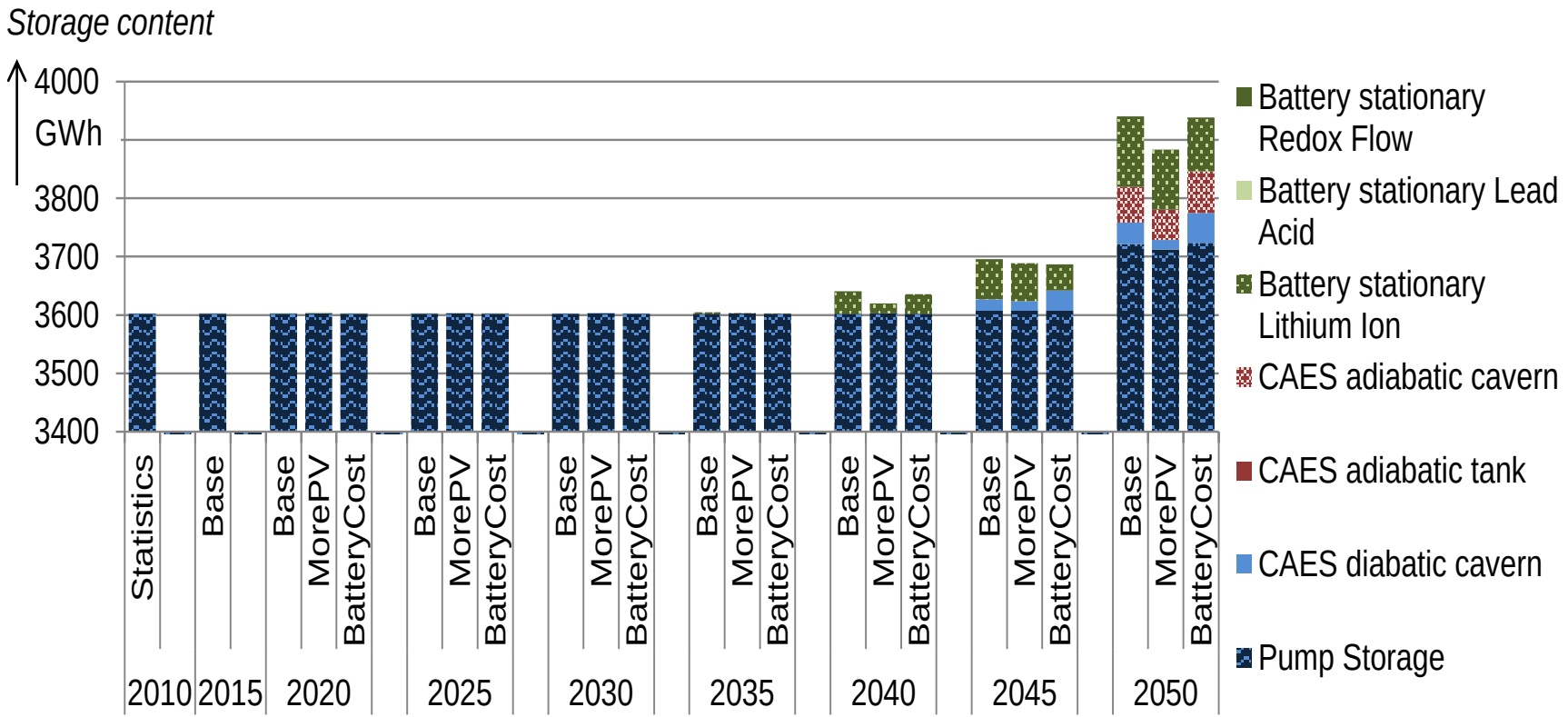


Storage output capacity



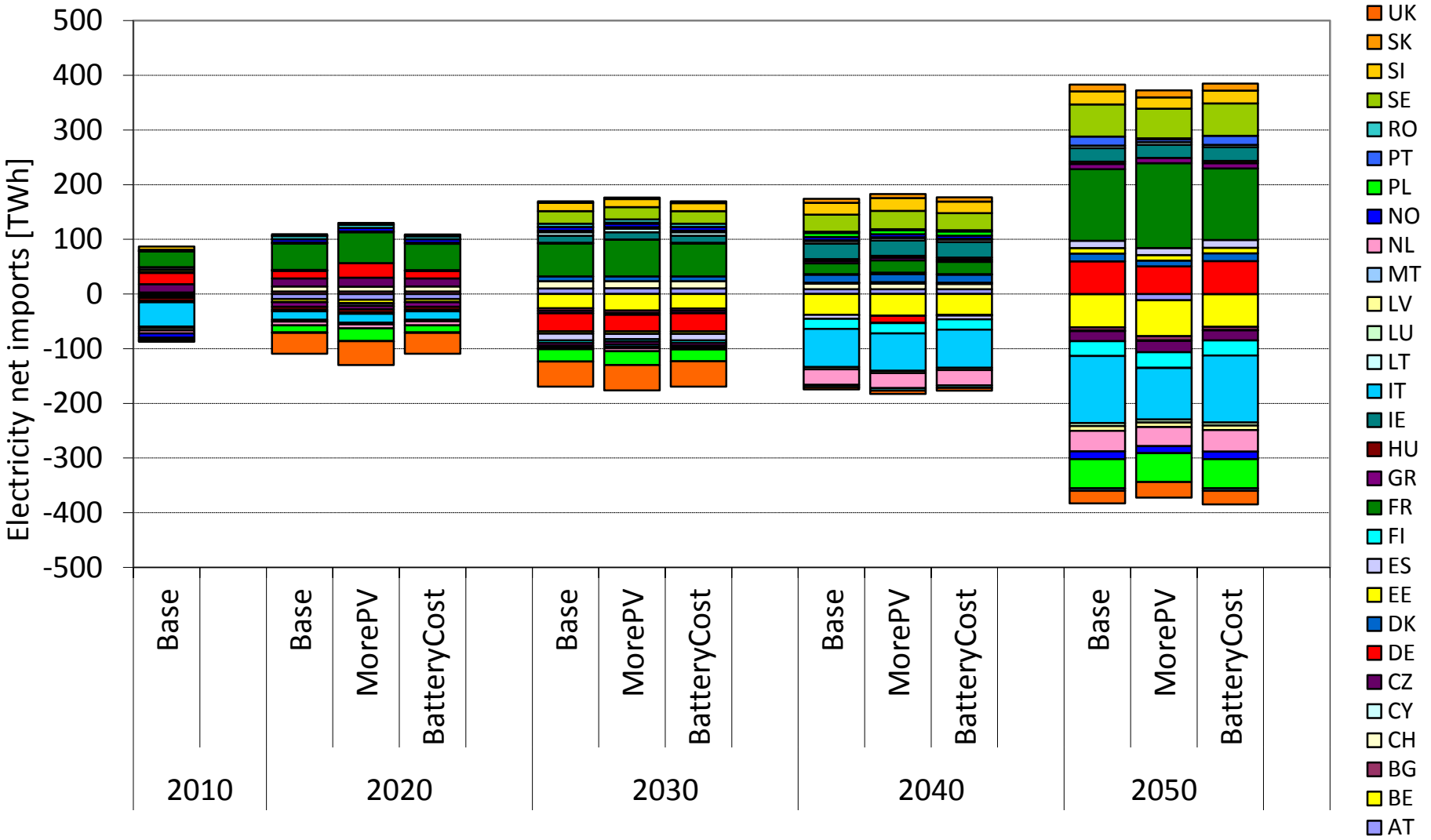
Scenario analysis from the ESTMAP project

Electricity storages in Europe



Scenario analysis from the ESTMAP project

Electricity trade in Europe



Conclusions and outlook

- For all three scenarios an increased electricity demand in the EU-28 until the year 2050 can be observed
- This electrification of the overall energy system contributes to achieving the GHG emission targets as set in the EU roadmaps and reflects the increasing share of fluctuating renewable energy sources (wind and PV) in the energy system
- Investment in additional electricity storage capacities from the year 2030 onwards are needed beside of the use of other flexibility options in the energy system.
- First investments in the European model are in diabatic CAES and battery storages and in the subsequent periods in pump storage und adiabatic CAES
- The cost reduction of adiabatic CAES until the year 2050 leads to an economic advantage of this storage technology towards the end of the model horizon
- The adiabatic CAES contributes to the reduction of the GHG emissions in Europe compared to the diabetic storage, which requires natural gas as an input to store electricity
- But the additional flexibility options might change the picture.

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Thank you for your attention !

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