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100% Renewables – The importance of System Design for System Integration

REFLECTIONS ON PLANNING A 75% RES SYSTEM IN GERMANY

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Company

AT THE HEART OF THE EUROPEAN TRANSMISSION GRID

- Headcount 600 (2018)
- Revenues 6,1 billion EUR (fiscal 2016)
- Certified Independent Transmission Operator (ITO)
- Area served: 34,600km²
- Total line length: 3,200 km (220 and 380kV)
- 50 substations
- Peak load in Baden-Wuerttemberg: 11 GW
  in Germany: rd. 89 GW
- Annual gross electricity consumption in Baden-Wuerttemberg: 74 TWh
  in Germany: rd. 570 TWh

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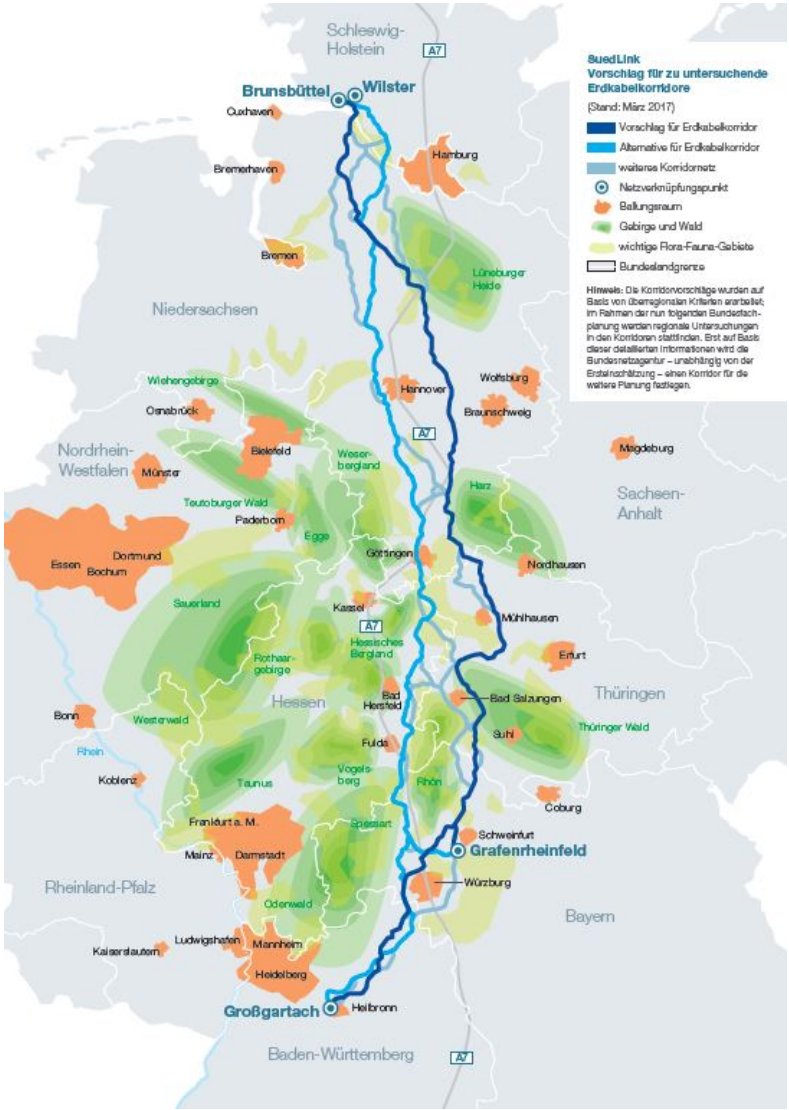
Energy transition and grid expansion

OUR CONTRIBUTION: SUEDLINK

- Joint project TransnetBW/Tennet
- Line corridor: from Brunsbuettel and Wilster to Grafenrheinfeld and Grossgartach
- Provision by law: priority for underground cable
- Length: will be determined when the final route is planned in detail
- Nominal power: 2x2 GW
- Voltage level: ±320 kV DC / ±525 kV DC
- Route corridor: proposed corridor was published on 7 March, application was submitted on 17 March
- One converter in Baden-Wuerttemberg, Grossgartach/Leingarten



100% Renewables – The importance of System Design for System Integration

IT TAKES ABOUT 30 YEARS TO TRANSFORM A POLITICAL IDEA INTO POLITICAL MAINSTREAM…

1980

German Green Party Foundation-Program

/ Renewable sources must provide **100%** of energy supply **in the long run**

2018

Revised European RES Directive

/ Renewables must make up **32%** of energy consumed **by 2030**

Agreement of the German Grand Coaltion

/ We aim for a share of **65%** renewables **by 2030**

…but how long does it take to transform the existing Energy System Design ?

SYSTEM DESIGNS GENERALLY DEPEND ON VERY SIMPLE GUIDING IDEAS OR MAIN MESSAGES

EURATOM TREATY 1957

„To contribute to the raising of the standard of living

by

creating the conditions necessary for a speedy growth of nuclear industries“

System design, infrastructure feature:

Large (Nuclear) Power Plants
+
Weakly interconnected European electrical system

MAASTRICHT TREATY 1993

“To promote a harmonious and balanced development of economic activities

by

establishing a common market and implementing the common policies”

System design, responsibility feature:

Power Exchanges to maximize competition
+
unbundled grid operators

„ICESI TREATY“ 2019

Target

Tool

System design:
infrastructure feature
responsibility feature

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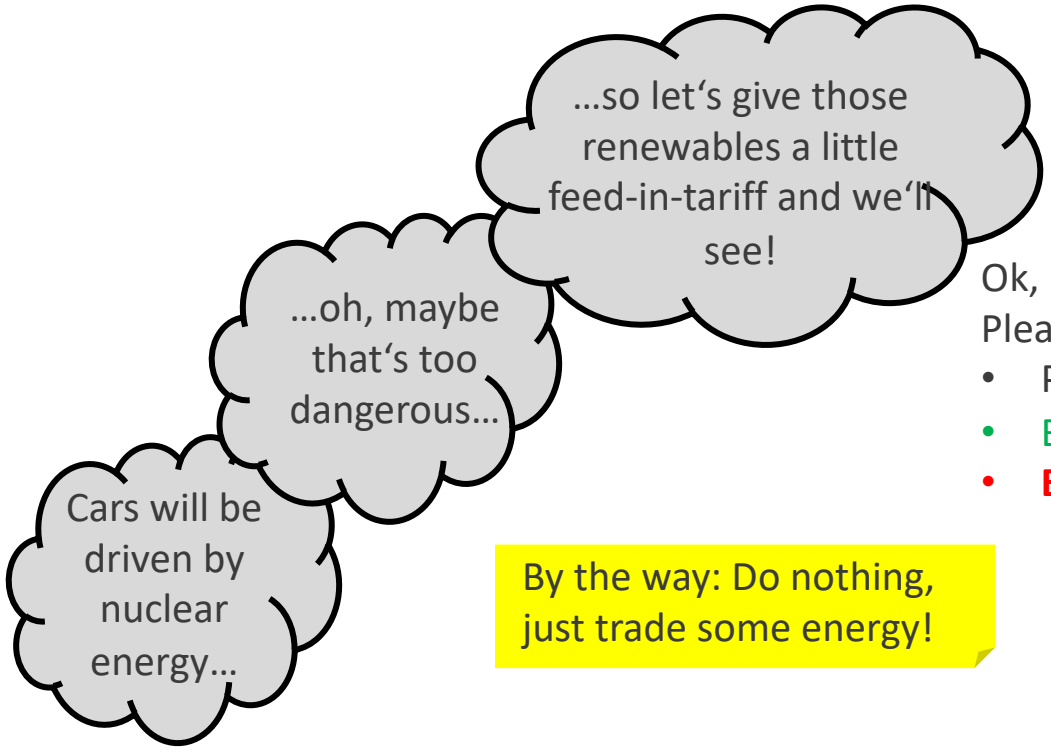
THE STORY OF INNOVATION IS DRIVEN BY THE LACK OF ACCEPTANCE FOR GRID EXTENSION



By the way: Do nothing, just trade some energy!

Ok, Fukushima… end of story.
Please,

- Phase out Nuclear
- Build those Renewables instead
- **Extend the Grid, but not in my backyard!**

Ok, Climate Change is bad.
Please,

- Phase out Coal
- **Step up those RES targets, NOW!**
- **We need more innovation, NOW!**

1970	1980	1990	2000	2010	2020	2030	2040

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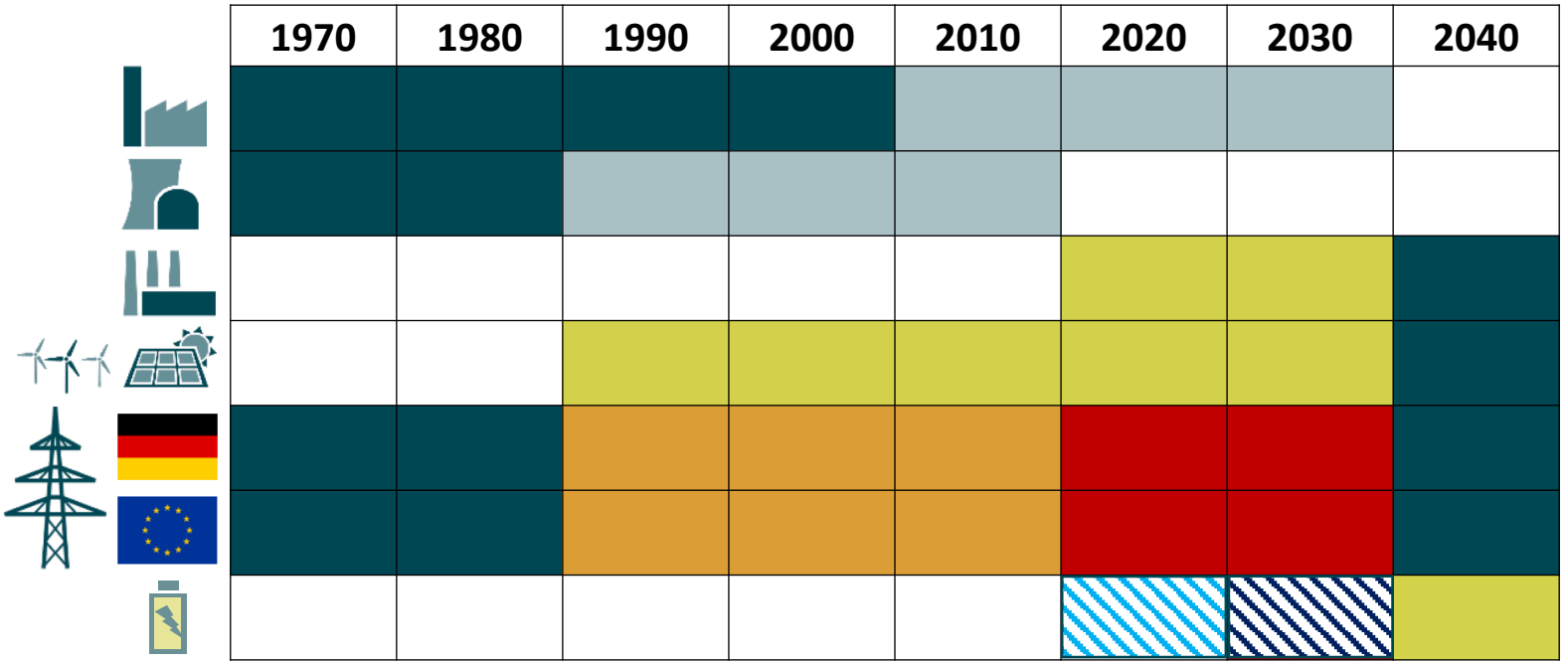
EXISTING SYTEMS CONSIST OF MULTIPLE, SOMETIMES CONFLICTING DESIGN FEATURES



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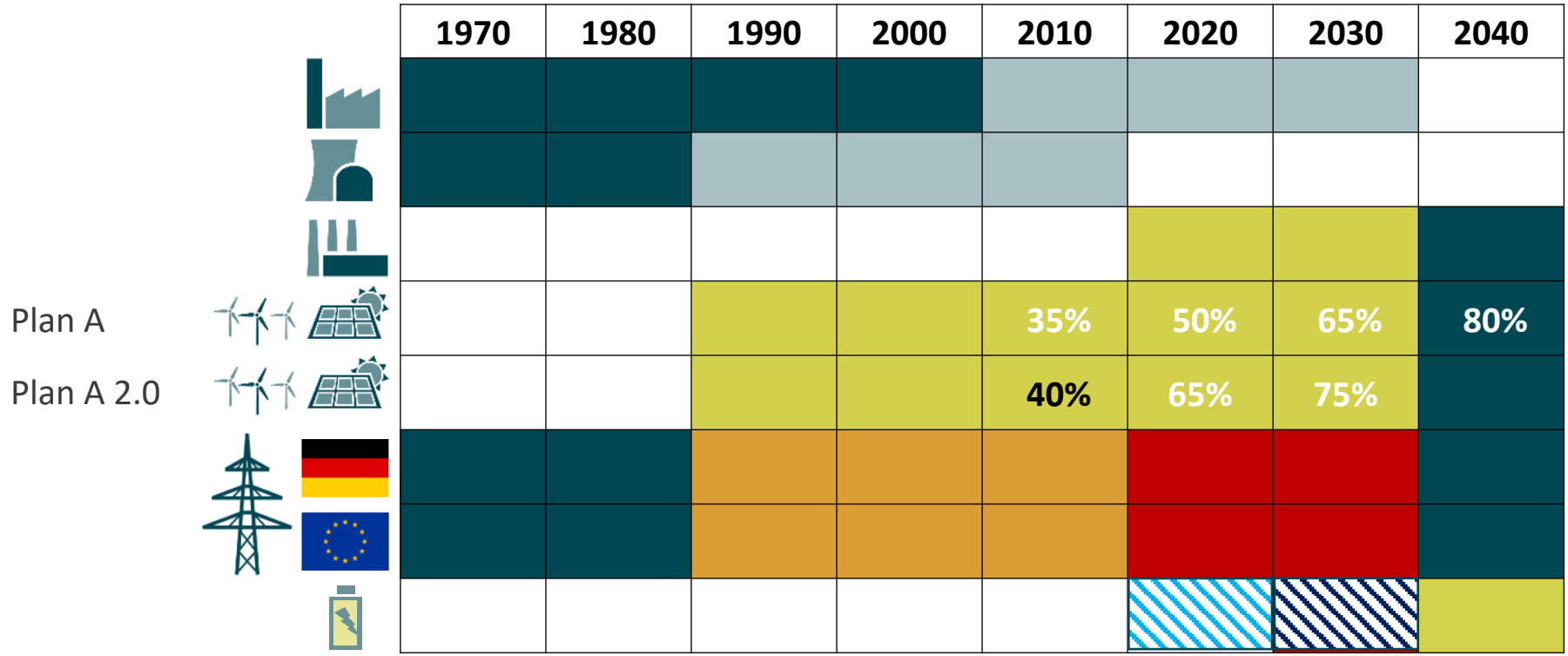
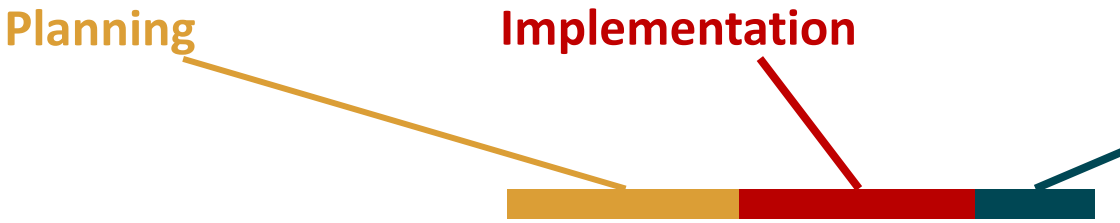
THE EARLIER YOU WANT TO ACHIEVE YOUR TARGET, THE HIGHER THE STRAIN IS FOR THE REST OF THE SYSTEM



EVEN PLANNING A SYSTEM BASED ON 75% RES IS HARD WORK AND TAKES A LONG TIME!



	1970	1980	1990	2000	2010	2020	2030	2040	2050	2060	2070	2080
								0				
								0				
								backup				0
								75%				100%
								100%				100%
								100%				100%
								?	?	?	?	100%

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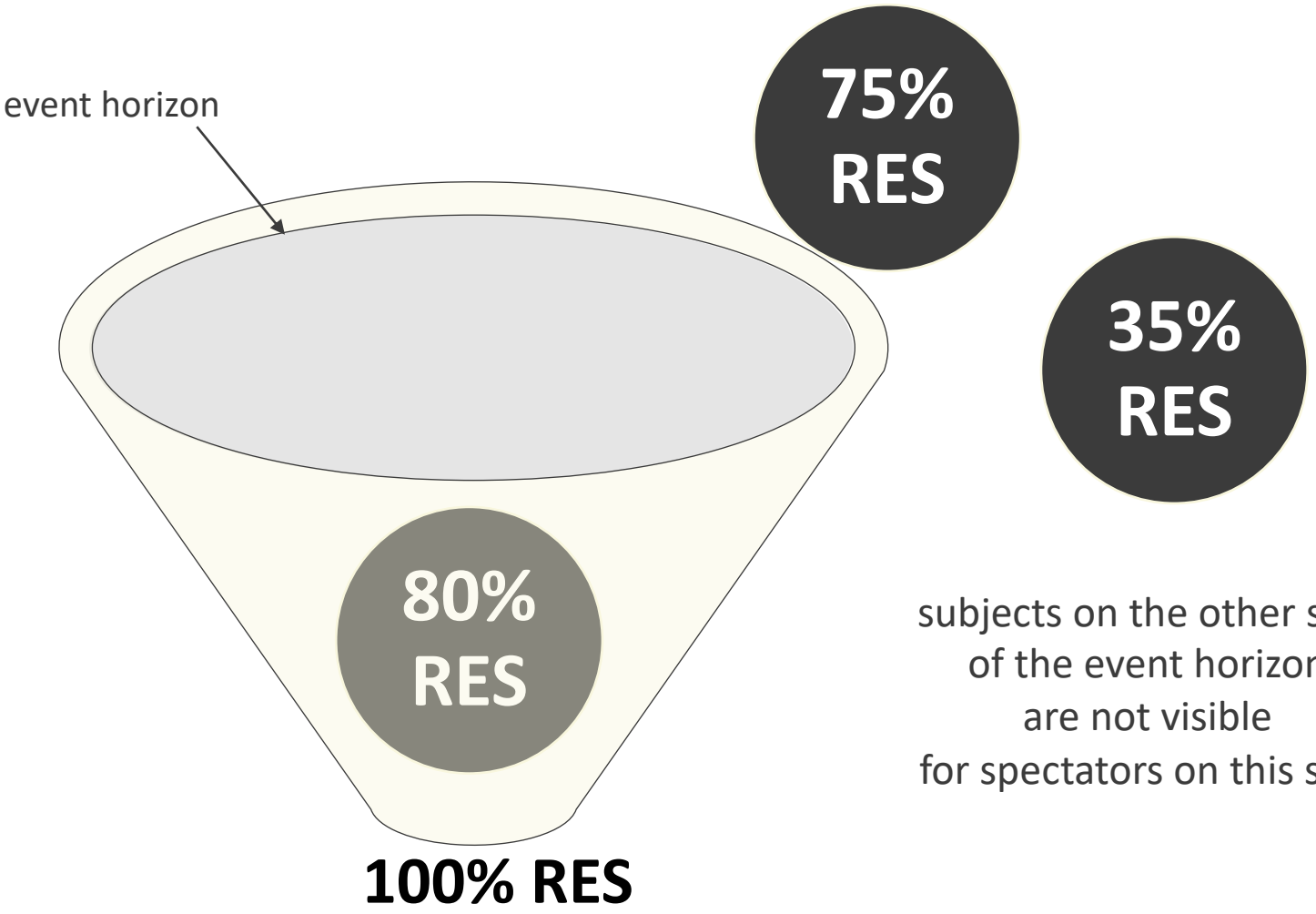
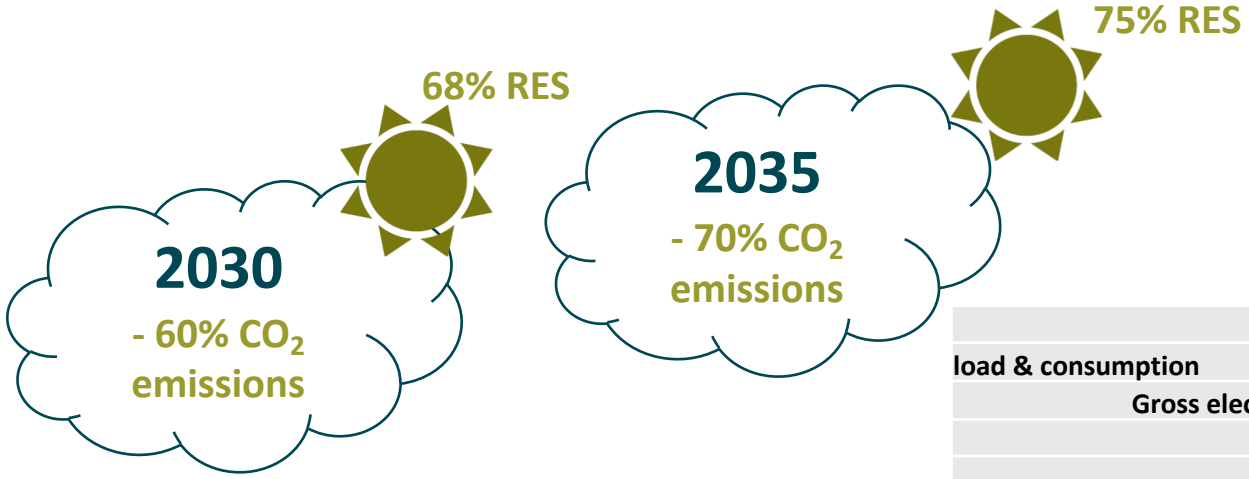
YOU CAN‘T „PLAN“ INNOVATION



subjects on the other side
of the event horizon
are not visible
for spectators on this side

KPIS OF THE GERMAN GRID DEV. PLAN 2019



grid extension*	**11.560 km**
new DC lines	3.780 km
new AC lines	1.030 km
strengthening of existing lines	6.750 km
costs	52 bn €

* according Scen. B2030

Scenario C 2030

„revolutionary technologies“

„quick transition path“

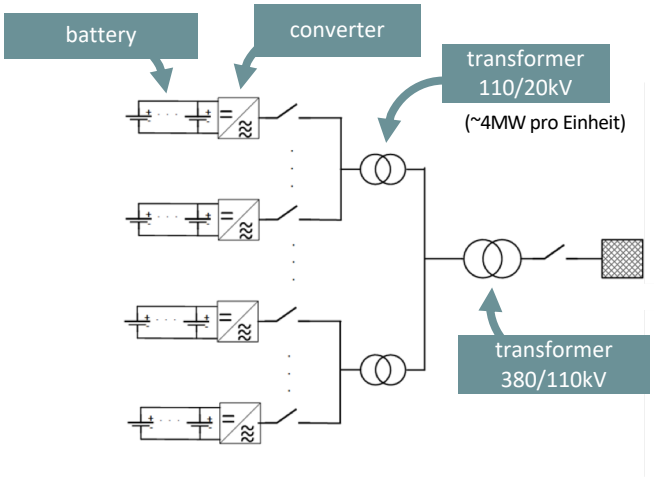
installed capacity conv.	**70 GW**
natural gas	34 GW
coal	17 GW
pump storage	12 GW

installed capacity RES	**220 GW**
wind	103 GW
photovoltaics	105 GW
biomass	5 GW
water	6 GW

	power	energy
load & consumption		
Gross electricity consumption		**616 TWh**
Max Load	100 GW	
Max Residual Load	80 GW	
Max DSM potential (industry, housing)	6 GW	
new flexibility options	**21,4 GW**	**28 TWh**
power to Methane (price-driven)	3,0 GW	1,2 TWh
power to Hydrogen (RES-supply-driven)	2,4 GW	7,8 TWh
power to Heat	16 GW	19 TWh
coupling of energy sectors	**58 GW**	**54 TWh**
heat pumps (4 Mio.)	21 GW	29 TWh
electric vehicles (10 Mio.)	37 GW	25 TWh
batteries	**12,4 GW**	**0,016 TWh**
<150kW (household)	10 GW	10 GWh
>150kW (balancing)	2,4 GW	6 GWh

PILOT: „NETZBOOSTER“

Capacity	500 MW
Operation	Reactive: After contingency (half-automated)
Technology (as of now)	Li-Ionen battery, modular construction
Outllook	Additional benefits for example for reactive power supply



SUMMING UP

- It takes around 40 years to transform simple political ideas into mainstrem
- Energy system designs
  - are based on very simple ideas (as politics)
  - consist of two major design features: infrastructure and responsibility
- A 100% RES system design needs to be developed
  - without crashing the existing system
  - without knowing the right technology mix
- So you plan a 75% RES system and let some space for innovation…
  - …and you realize the 75% RES system until 2050!

Best gues:
The transformation of the energy system into 100% RES
takes a 100 years after the first ideas of 1980!

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