

Transition - Innovation - Security

The power system perspective

European Forum Alpbach

Breakout session

“Free play of innovative forces or systematic restructuring?”

23.8.2019

Bernd Klöckl

Stay tuned. Safety first!



For your safety as well as our own we would like to draw your attention to the following safety measures.

In case of an emergency, the following instructions also apply:

- Follow the escape route as indicated.
- Use the stairs instead of the lift.
- Go the assembly point.
- Follow the instructions of the in-company emergency worker who is present at that moment.



Agenda

- Security principles in the EU electricity system
- What happens in Marc Elsberg's „Blackout“?
- Consequences of the energy transition
- Role of innovation and digitalisation

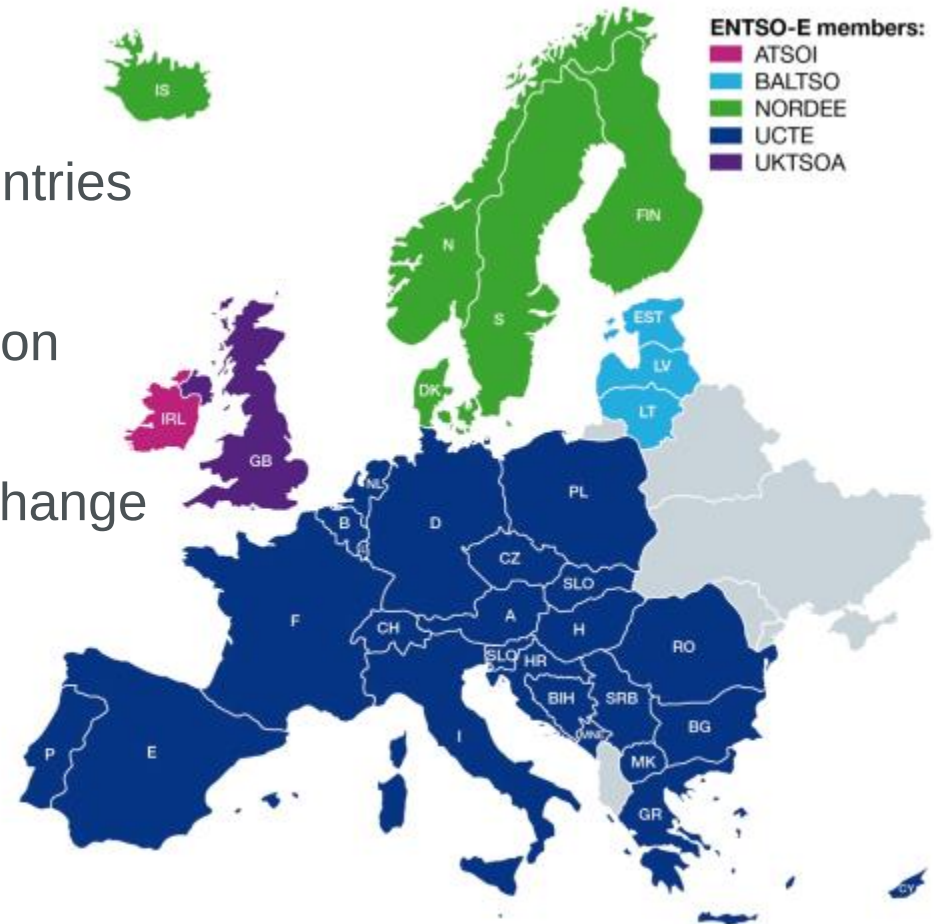
Basics



The EU Power System is the world's largest machine

- 41 TSOs from 34 European countries
- ca. 550 million system users
- ca. 1 bn kW connected generation
- ca. 3000 TWh/a load
- ca. 450 TWh/a international exchange
- ca. 300.000 km lines ($\geq 200\text{kV}$)

Source: ENTSO-E





Security principles

(strongly simplified)

1st Principle: what goes in goes out at all times – and if not, the system counteracts (frequency)

- *No failure of a single power generation unit must lead to a balance problem of the entire system*

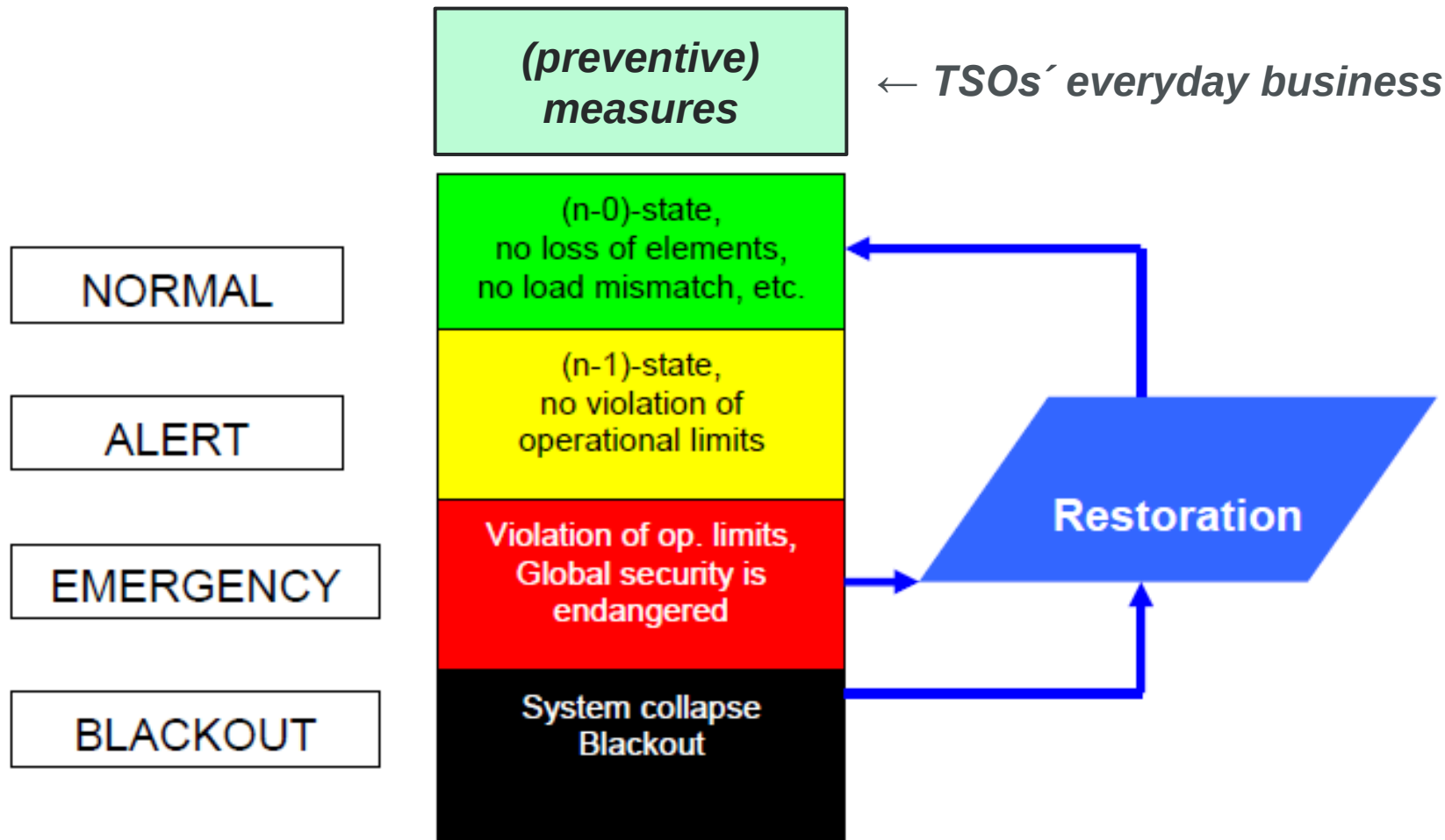
2nd Principle: the load is being served, also in case of the failure of one network element

- *No failure of a single power transmission unit can lead to a supply problem of parts of the system*

3rd Principle: failures of transmission elements lead to a stable post-failure system state

- *failures must not lead to cascading further failures*

Back to normal – how to?



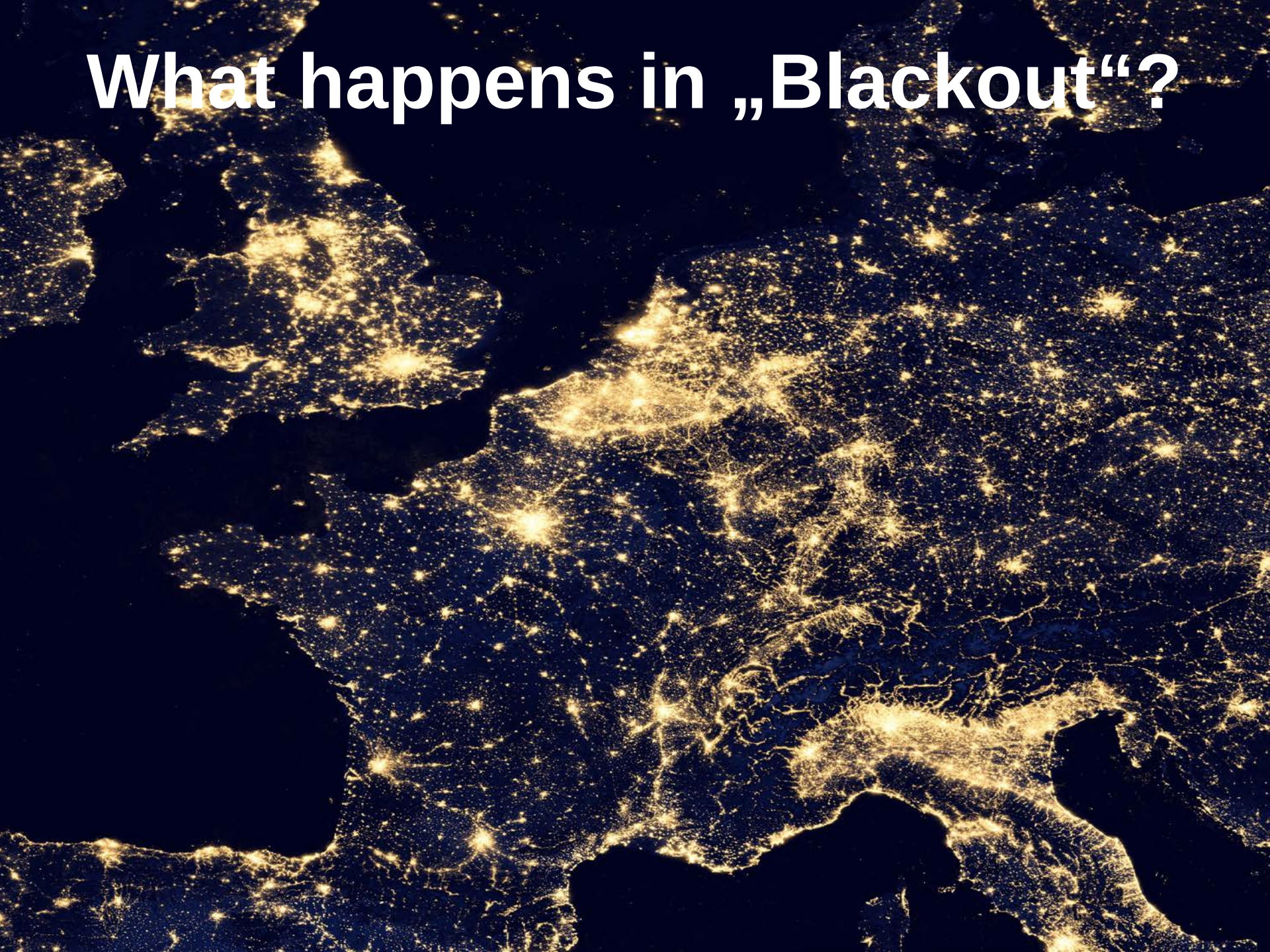
n-2 in action



Backflashover on a 500-kV line in a thunderstorm in Japan

source: <https://dbnst.nii.ac.jp/>

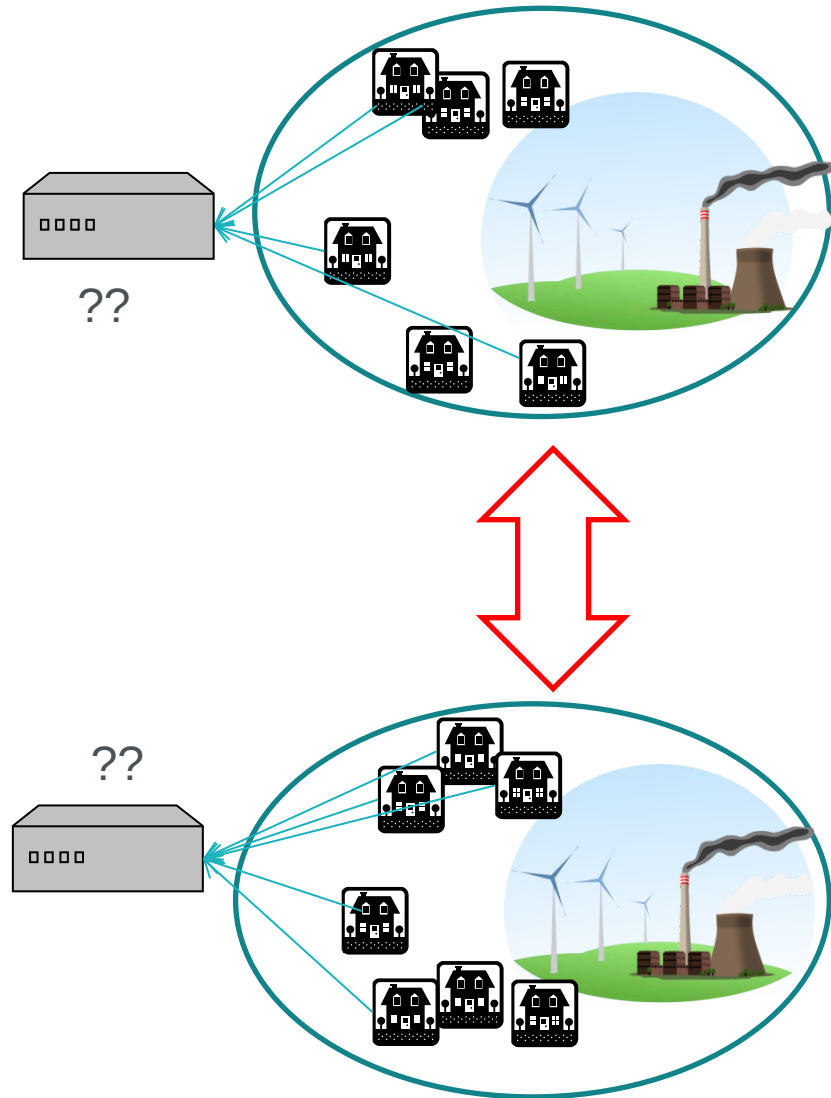
What happens in „Blackout“?



What happens in „Blackout“



- the system control units get wrong information on the actual state of the system
→ attack on principle 1
- a cross-continental power swing ends up in a full EU blackout
→ attack on principles 2 & 3

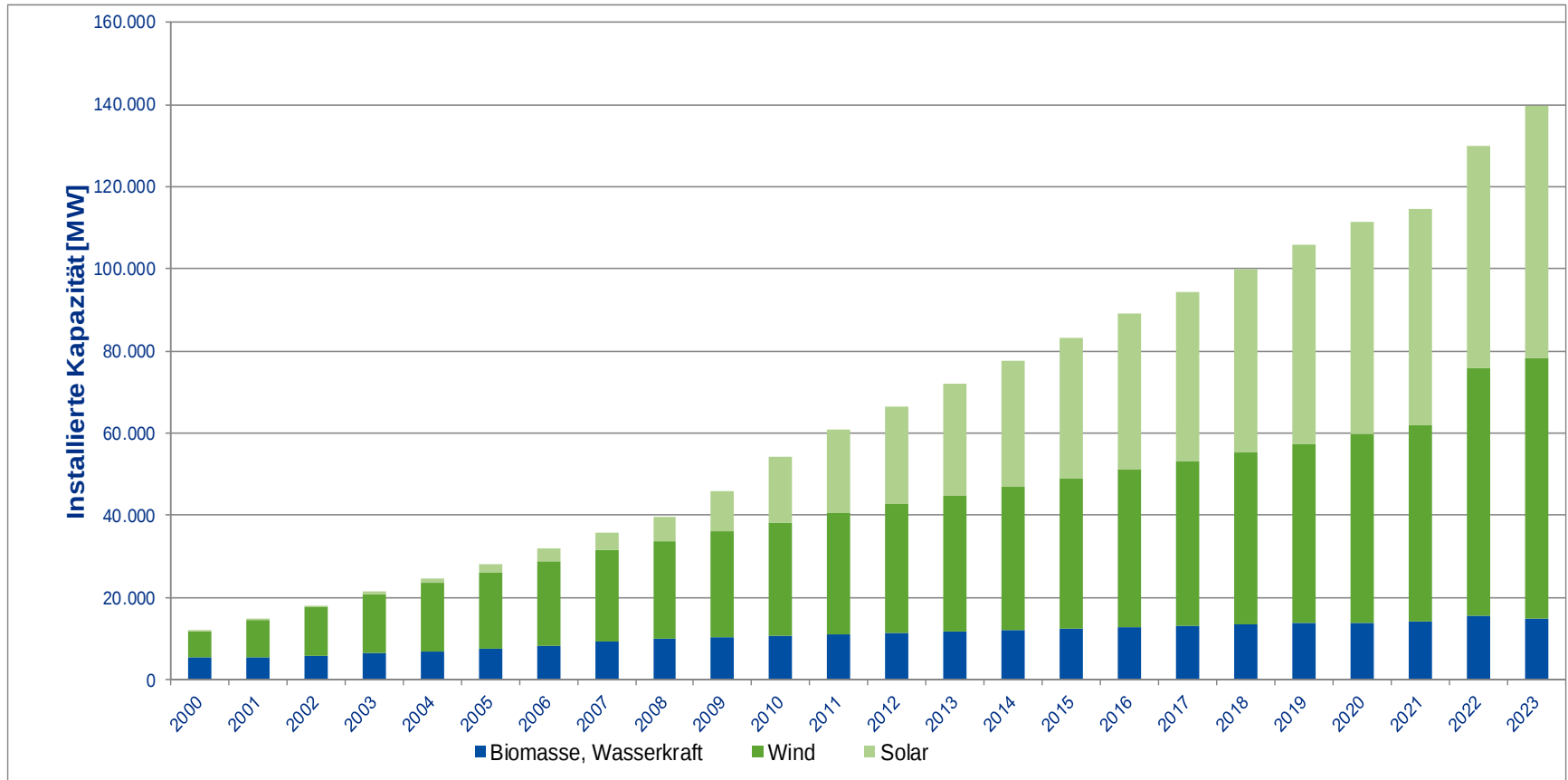


Consequences of the energy transition

*There is no energy turnaround and no disruption –
the system evolves within
very long time periods*



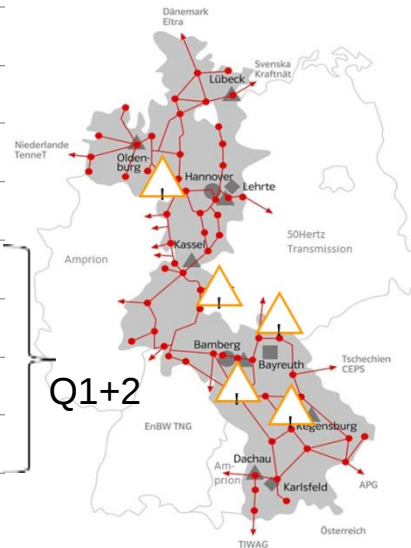
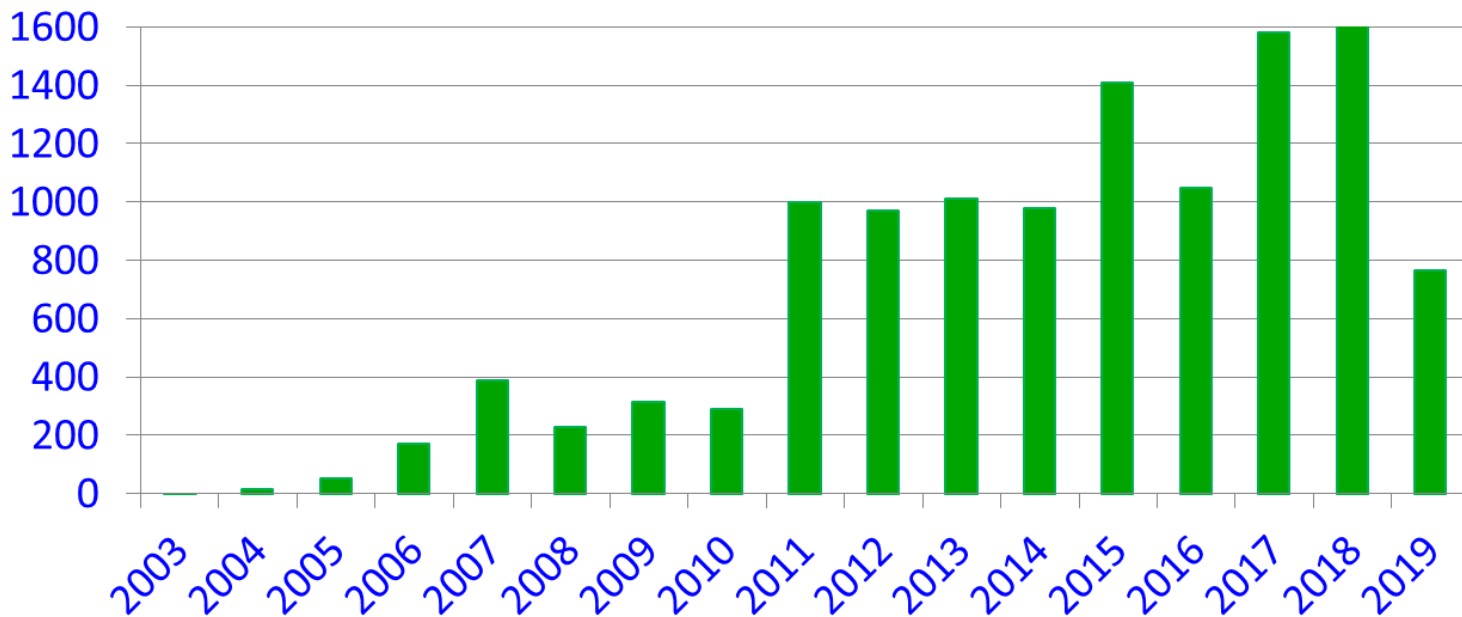
Energy transition in Germany



Effects of the energy transition

Year	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16	'17	'18	'19 Q1+2
measures*	2	15	51	172	387	228	312	290	998	970	1009	977	1407	1049	1579	1638	765
days	2	14	51	105	185	144	156	161	308	344	356	361	349	340	356	360	174

no. of preventive measures



* Ereignisse, in deren Folge Maßnahmen nach § 13 EnWG und § 14 EEG ergriffen wurden



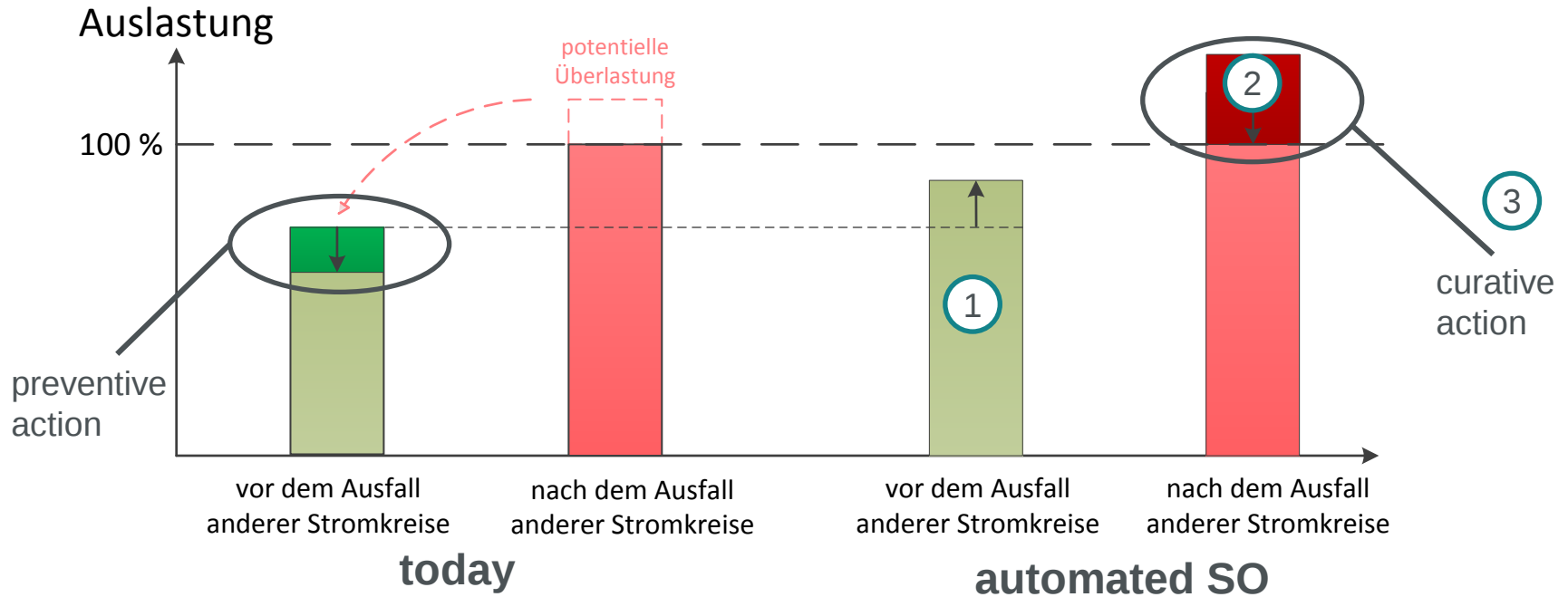
Role of innovation and digitalisation

Big data for (automated) system operation

Additional load

Changed end customer behaviour

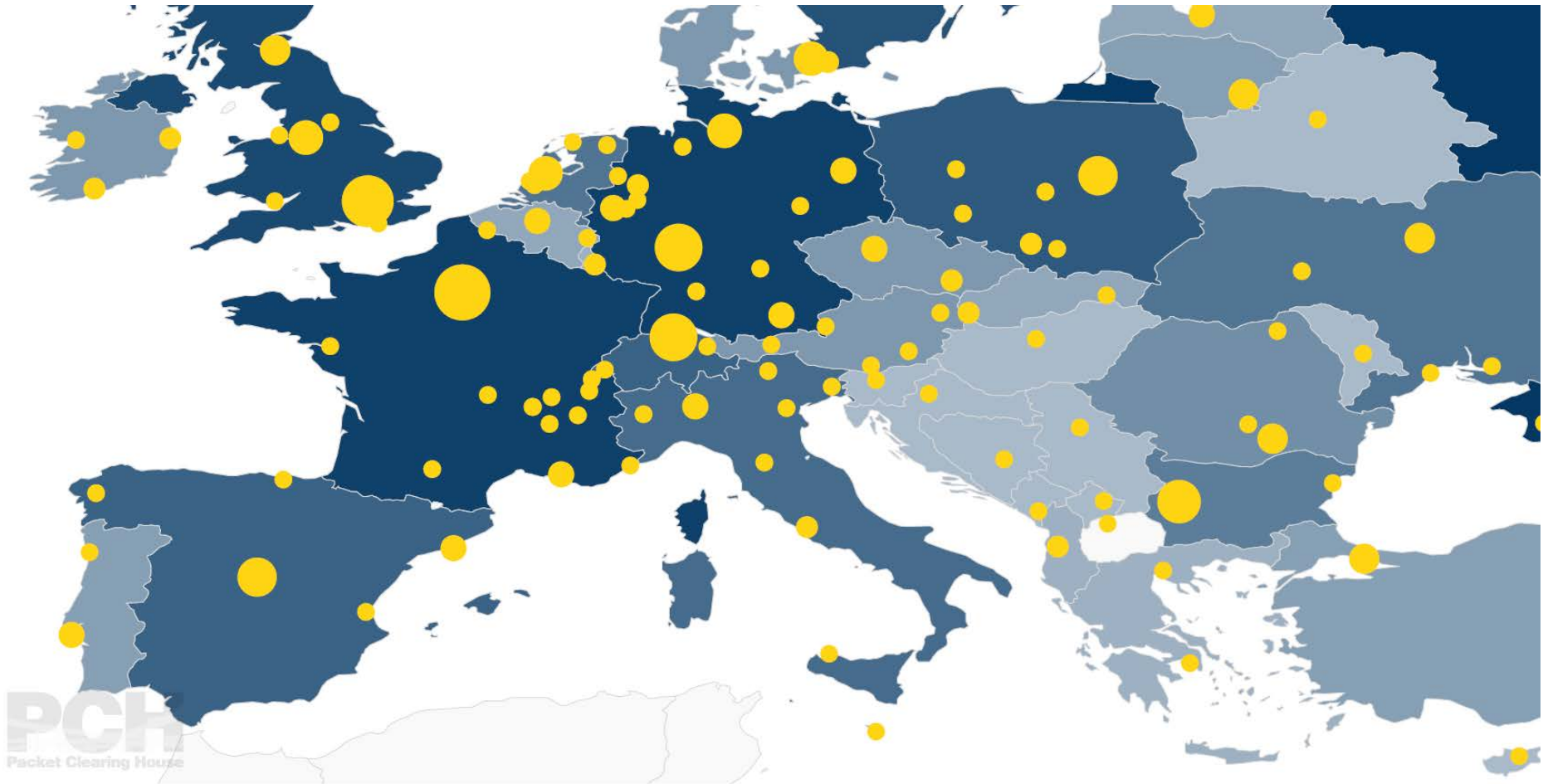
e.g.: Automated system operation



- ①. higher loading of existing assets by big data harvesting
- ②. dynamic loading of overloaded assets by big data harvesting
- ③. usage of fast, flexible end digitalised end customers for post-fault operation



e.g.: Additional load



Showing 329 IXPs from 965 — Region is Europe - Number of IXPs by Country

Source: pch.net

e.g.: Blockchain technology

In two pilot projects with Sonnen and Vandebron, TenneT is using a private blockchain to balance the grid.



- Sonnen pools household batteries to provide redispatch services
- Vandebron provides automated secondary control reserve from a pool of charging stations for electric vehicles
- The flexibility is managed by TenneT via an IBM blockchain solution and used to balance the grid
- Once the concept has been proven, the use of the blockchain solution will be made available to further flexibility providers
- The potential of battery storage for Germany lies between 15-60 GW by 2030

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www.tennet.eu

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