

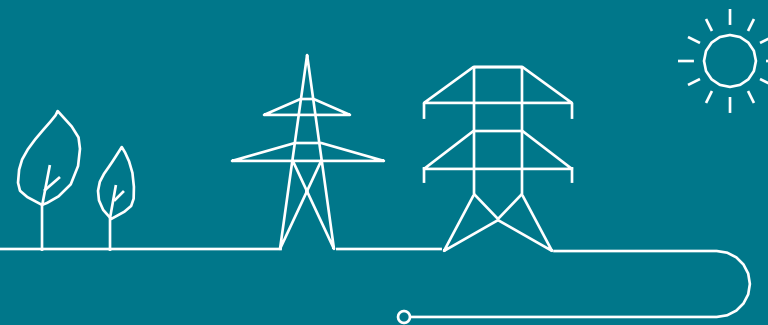
Resilience of energy infrastructure to climate extremes

European Climate-Resilient Energy System – Enhancing adaptation and resilience indicators in the ENTSO-E TYNDP CBA framework – Part 2

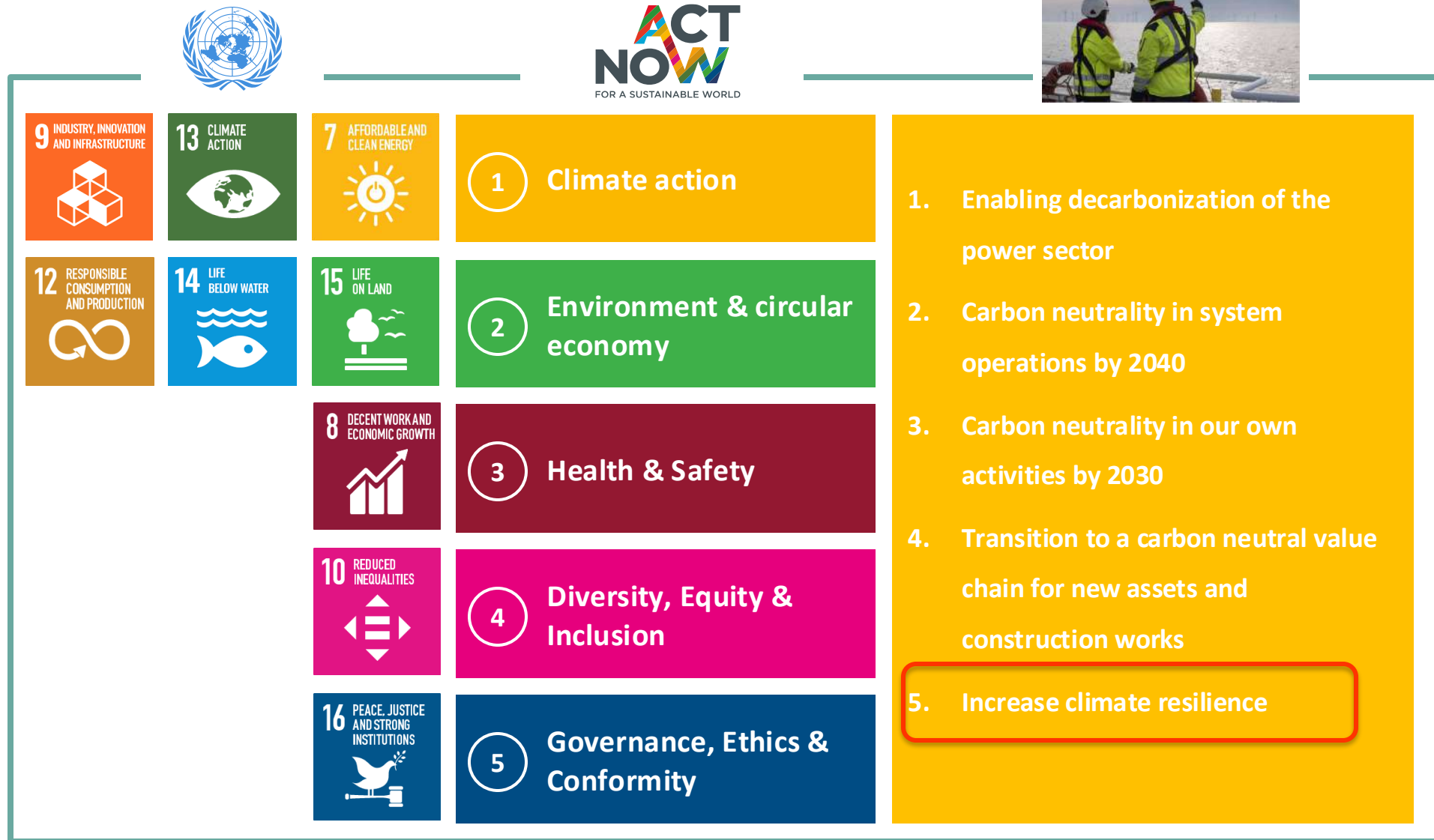
20250320 | Elia Group | Pieter.Smet@elia.be | Asset Management



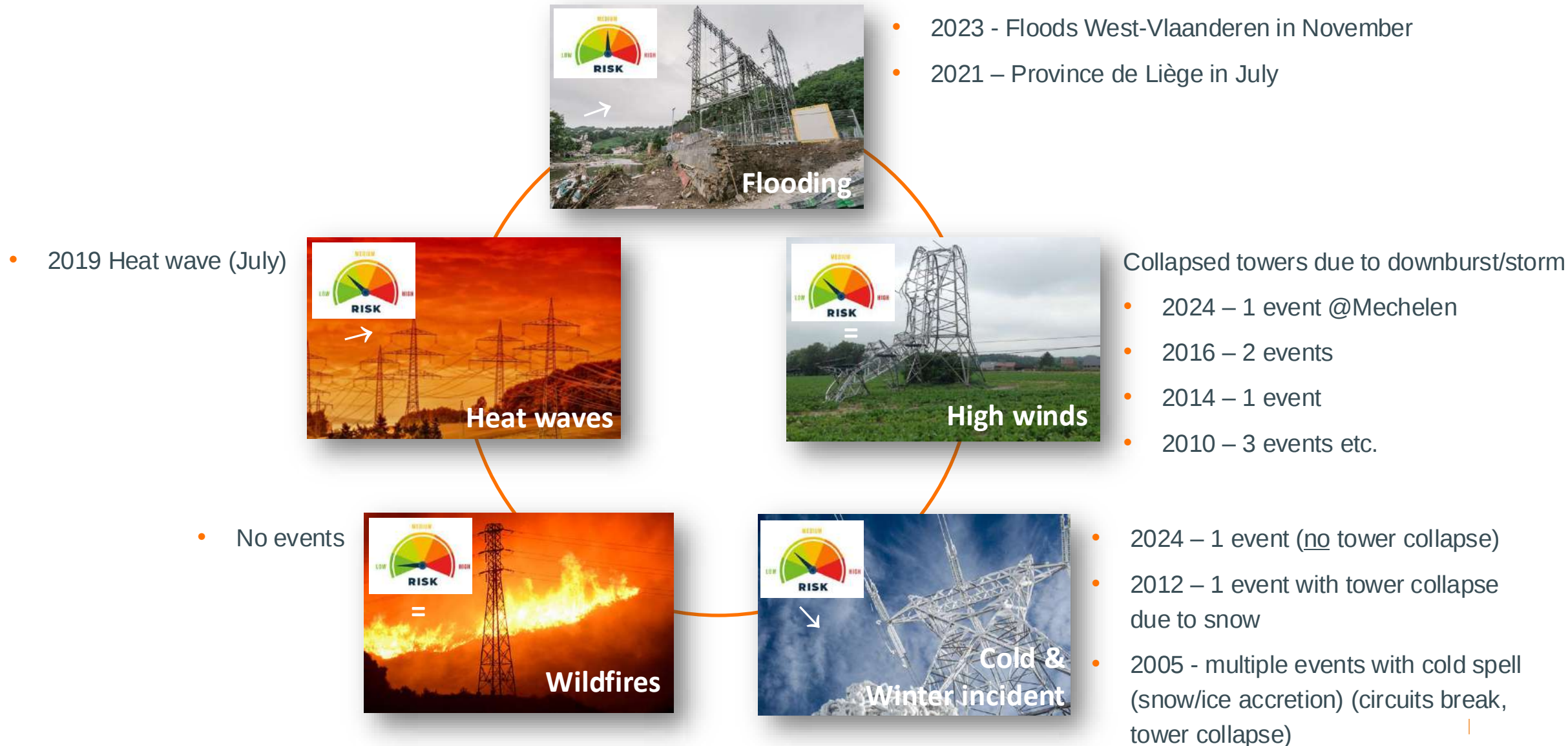
Climate risks regarding Elia's assets



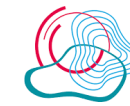
Setting our sustainability ambitions along five dimensions



5 dangers, bearing potential risks to our assets that may evolve with climate change



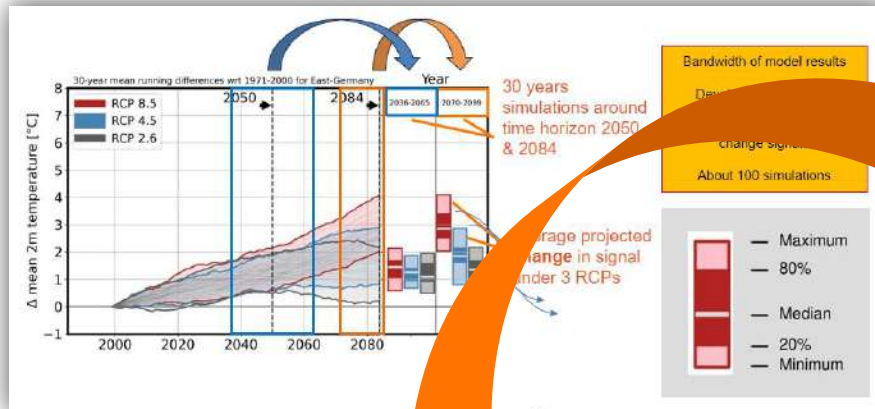
How did we proceed in 2023?



hereon



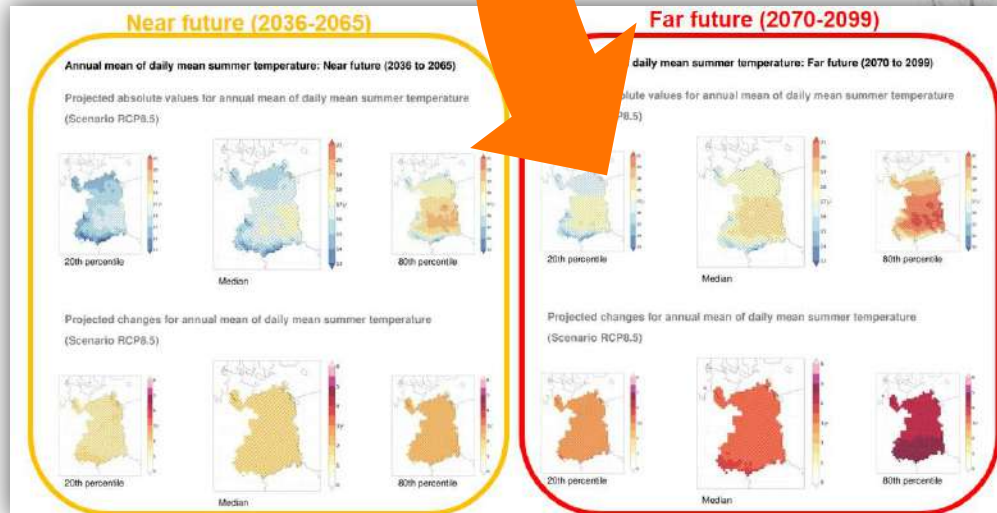
Elia Group



- mean daily temperature
- mean daily minimum temperature, Winter (djf)
- minimum daily minimum temperature, Winter (djf)
- mean daily max. temperature, summer (jja)
- maximum daily max. temperature, summer (jja)
- heat wave frequency ($T \geq 40^\circ\text{C}$), year
- heat wave frequency ($T \geq 35^\circ\text{C}$), year
- Cold spell frequency ($T \leq -10^\circ\text{C}$), year
- days with temperature $\leq -10^\circ\text{C}$, year
- days with temperature $\leq -20^\circ\text{C}$, year
- days with temperature $\leq -25^\circ\text{C}$, year
- days with temperature $\leq -30^\circ\text{C}$, year
- Snowfall Intensity, Snow Frequency & Snow Cover Days
- 10m Wind Speed

Considering scenario RCP2.6 and 8.5

EURO-CORDEX



1. Choosing appropriate climate signals & extreme climate change scenarios
2. State of the art information assembled by experts on climate change (Hereon)
3. 2-time horizons: 2050 & 2085
4. Risk assessment in **workshop** with asset managers & technical experts



Insights from the 2023 study on Elia's Asset Management

- No urgent additional actions but some **attention points** (e.g. derating) as **design criteria** are most often based on high values of maximum wind and ambient temperature
 - E.g. Max temperature thresholds may be exceeded, however in **average**, not for a significantly higher number of days (per year) than what we already experience today
- Elia's **current mitigation policies suffice** momentarily & contribute to climate adaptation:
 - ✓ *Flooding risk* analysis and mitigation for some substations
 - ✓ *Temperature monitoring* in all buildings with equipment like protections, datacom, switchgear
 - ✓ *Heatpumps* for heating of new buildings also useable for cooling
 - ✓ *Gradually reinforcing the 380kV grid* to a higher wind standard.

General insights & recommendations



- **Understanding** climate change is **not a takeaway**: interpretation, explaining,...
- **Data are not a weather prediction**: some extreme events happen through a **combination of climate signals with moderate values** (e.g. snow/ice accretion): how to evaluate?
- **Unobservable local effects** like heat-island effect of cities.
- **Missing data** on likeliness of occurrence and characteristics of **atypical extreme events** like tornado's, downbursts,...



- **Effort** on research of climate signals should be **coordinated** (inter)nationally to gain societal efficiency.
- Design of new assets are based on **(inter)national standards** for the many type of asset owners who may need to **evolve**.

Flooding experience

70kV substation Pepinster - july 2021



Concept

The risk on outages at water levels upto 50cm is covered by Elia's standards.

- But excludes:
 - Substation access
 - Water in the cellars
 - Covers of cable ducts
 - Dirt
 - Measures to avoid contamination (oil-propagation from transformer's oil drip trays)

+ Resilience measures such as water level above 50 cm

- Included:
 - Avoiding long-term (days, weeks) ENS or ENI (Energy Not Supplied/Injected)
 - Avoid or go through long repair periods due to devastating floods
 - Maintain remote control and visibility by dispatching (as physical access may no longer be possible)
- Not included:
 - Avoid ENS or ENI (limited - hours)

Returnperiod

- Normal, sensitive & strategic substations: 100 ans
- Critical substations: 1000 ans (extrem scenario)

Resilience: “Power system resilience is the ability to limit the extent, severity, and duration of system degradation following an extreme event” (CIGRE WG C4.47, October 2019).

Risk matrix

Only for critical sites

Resilience measures trough infrastructure
(substation localisation, raise installations, support walls, by passes, mobile substation control rooms,...)

Resilience measures not trough infrastructure
(waterlevel-monitoring)

Standard measures

> 50 cm	1 site	3 sites		5 sites	2 sites
Indéterminé		24 sites	1 site	4 sites	
0-50 cm	1 site	3 sites			4 sites
Water level/ Returnperiod	extrême 1000 ans	100 ans	50 ans	25 ans	10 ans

48 out of +/-450
sites with flooding-
risk (11%)

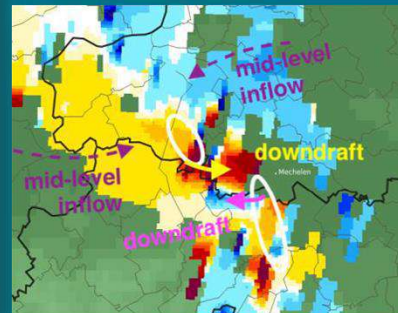
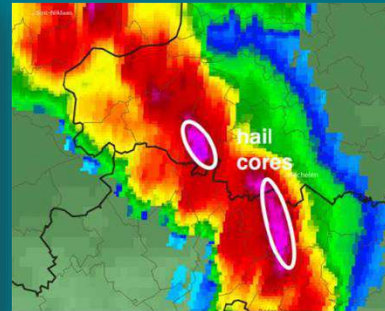
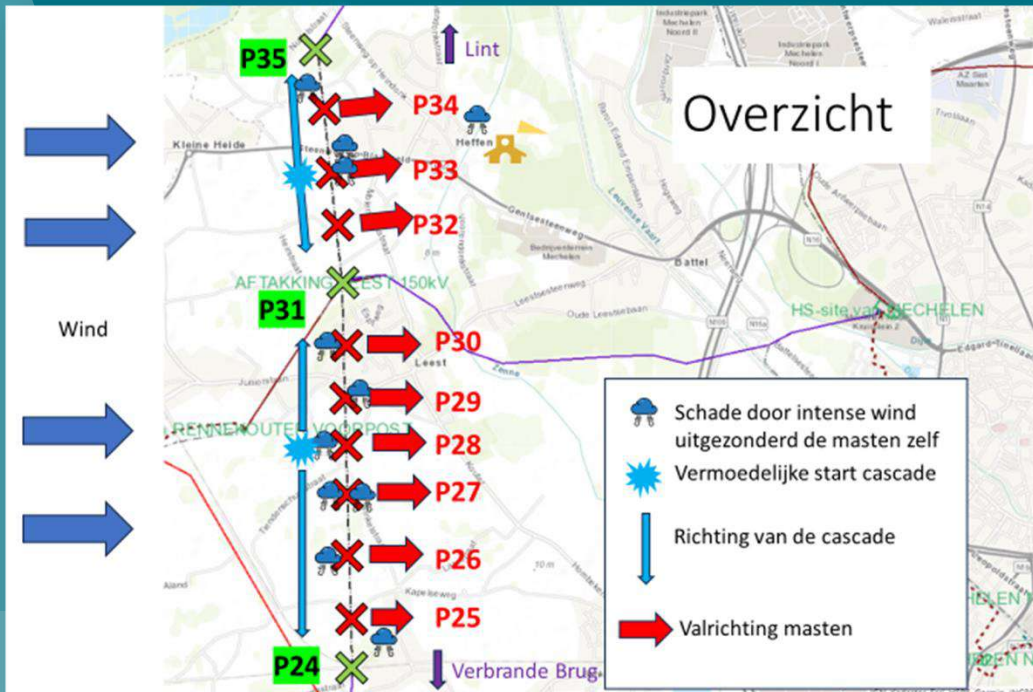
Detailed analysis at the
occasion of an Infrastructure
project

Detailed
analysis to
determine
adaptive
measures

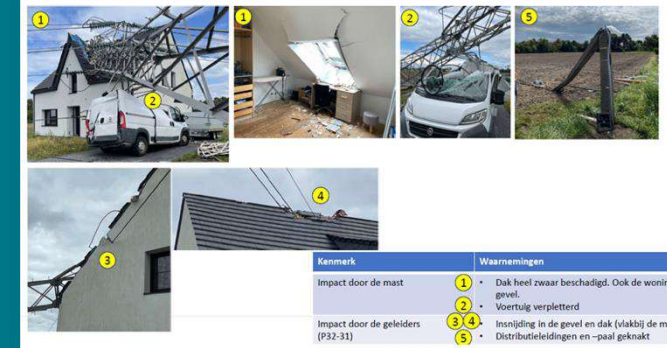
High intensity Wind experience

Mechelen, July 2024

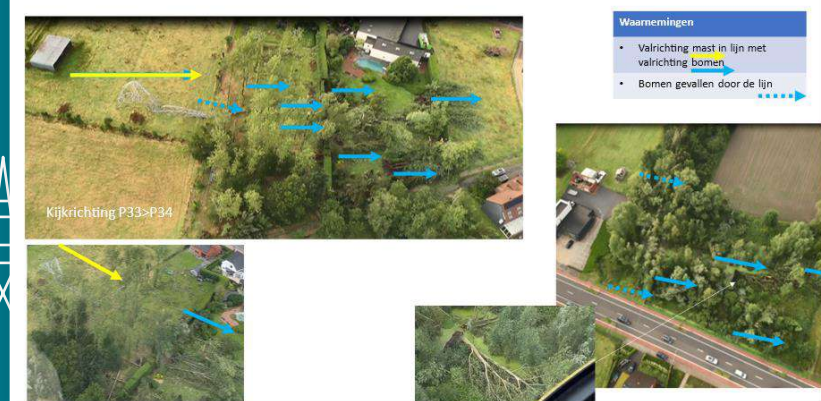
[see more on Elia - YouTube](#) "Guardians of the Grid", episode 1-5)



P32 - Impact schade



P33 - Drone View



Current insights on change of risk related to “high intensity winds”

- Elia conducts studies & exchanges with

- Climate change experts like Hereon
- Weather & climate change experts at RMI of Belgium & KNMI Netherland,
- Other TSO's like TenneT (NL,GE), 50Hz (GE)
- Overheadline experts like DNV

- Some observations:

- **No indication of an increase in extreme wind** speeds in Belgium in the period till 2100 compared to the past: average wind speed remains comparable to the existing ones
- **no higher wind-speeds during synoptic storms** (with low-pressure area's) are to expect but more high intensity rainfall.
- **Possible increase in downbursts** over the last 60 years but very poor statistics. No design rules available (high variation in nature of phenomena, low occurrence, low international knowledge)
- **No knowledge on change of risk on downbursts nor tornados** nor storms with high intensity winds. Downbursts are also a phenomena that can occur at the occasion of thunderstorms and could maybe happen more as also more intense rain is being expected...
- *Quote “More damages that we can allocate to downbursts (and often wrongly to tornados) as a cause due to higher exposure (building intensity increase) and higher detectability (reporting trough use of smartphones, socials, news, lack of historical logging of events) over time. That does not mean that there is a higher risk.”*

Uncertain if the risk on high intensity winds due to convective storms, downbursts etc. is going to change this century with climate change



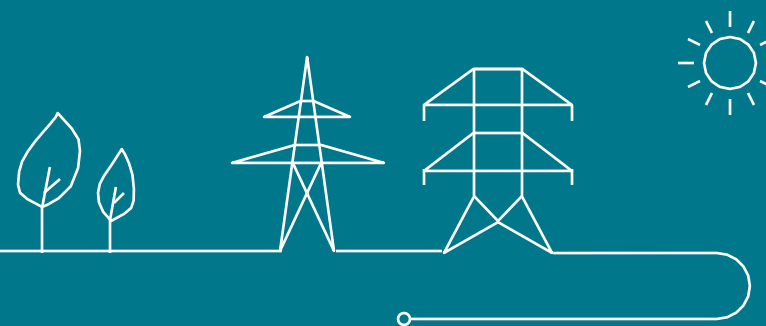
Concept for new towers & Policy for existing lines

- Aligned with Elia's **Risk Appetite**
- New towers are built according to the **latest European norms** with high theoretical wind return-periods from 150 up to 500 years. But, nevertheless, they are not built to withstand specific phenomena as tornados nor downbursts.
- **Anti-cascade towers** are added if necessary in new (part of) lines and for upgrading projects existing lines in projects to increase safety at critical crossings & to limit the extent of a possible cascade.
- As most critical, **380kV towers are reinforced to a higher wind-withstand** at the occasion of upgrading projects to enhance overall reliability and thus to be more climate change resistant

Elia has standards & policies in place to have a reliable OHL-grid.



Preparedness measures from System Operation



Risk preparedness in Belgium and European Union for climate related power supply failure scenarios



Each EU member state has designed a **Risk Preparedness Plan** according to the EU Risk Preparedness Regulation (EU) 2019/941.

Measures for risk prevention, preparedness and planning were identified for national and regional (BeNeLux + D A CH + FR) electricity crisis scenarios.

Identified climate related scenario's: heatwave, cold spell / winter incident, drought, storm, floods



Belgian National Risk Assessment

The National Crisis Center (NCCN) undertook a large-scale risk assessment for Belgium for the period 2024-2030. The greatest risks scenarios for Belgium were evaluated in a structured and scientifically correct manner.

Elia, Creg and FPS Economy were closely involved to determine the scenario's that could lead to large power supply failure



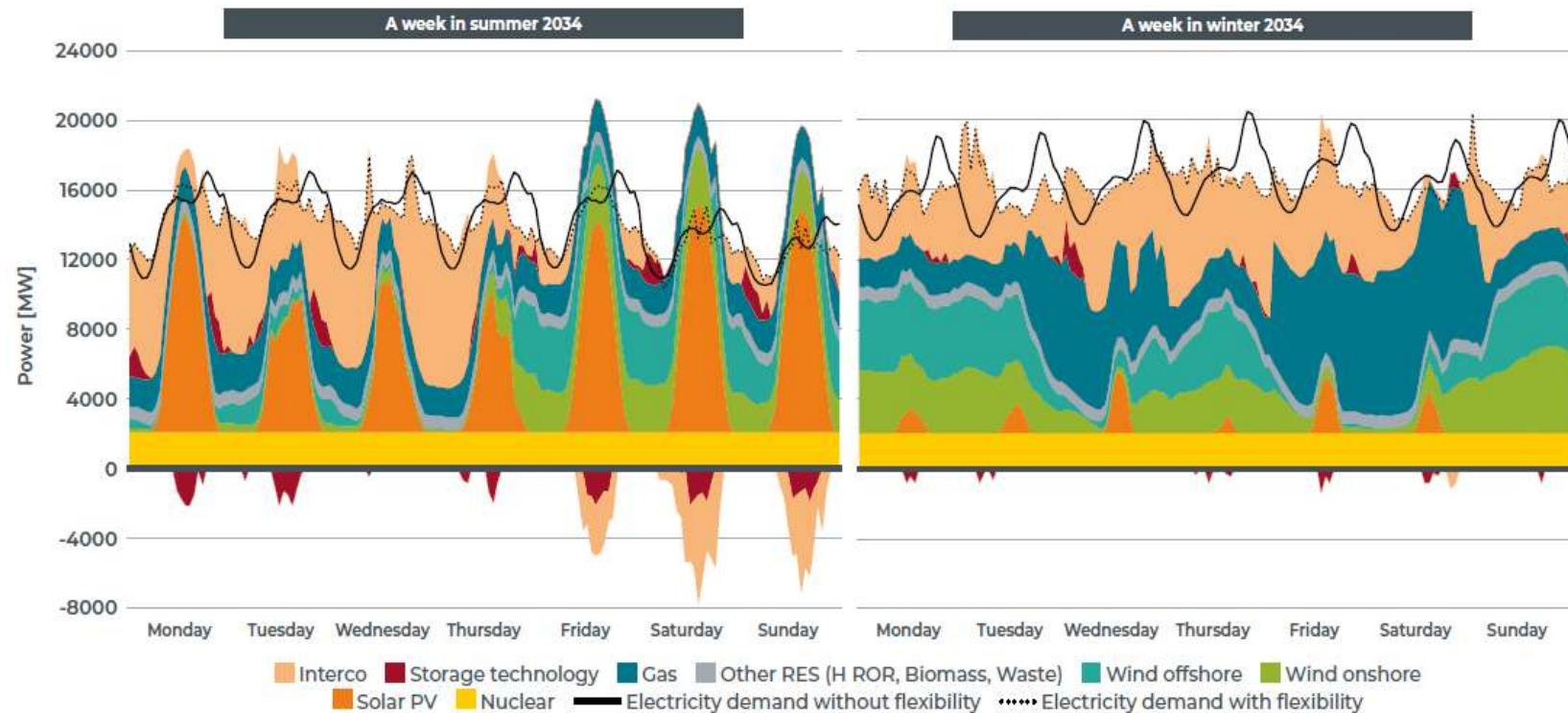
Resilience in operation & design of the network in the context of wind-related events

- Impact of synchronized disconnection of wind production
 - Impact on zone imbalance and reserve in case too much wind (storm) can lead to a more massive disruption (stop) of wind turbines leads mitigation measures for storm and ramping events
 - Efforce "High Wind Speed capabilities" & "Ramping limitations" for design of wind turbine (Network Code requirement)
 - Storm Procedure of application within NCC operational planning (incl. preventive curtailment)
- Impact of tower collapse and subsequent loss of more than 1 circuit
 - Resilient design of the infrastructure:
 - Grid Design: A tower incident is a design-criterium for exceptional contingency that does not lead today to structural investments (except Stevin & Ventilux) but only to operational mitigation measures.
 - Defense plans design (UFLS plan) and Network Code requirements for generating units (LFSM-O (reducing production), RoCoF withstand capability, etc)
 - AM resilient design: Resilience scenario preparation, spare parts management in the "operation & maintenance phase" e.g., Elia's emergency restoration line, strategic stock
 - Operational mitigation measure:
 - Preventive measures by integrating exceptional contingencies within the NCC security analysis when extreme winds above design are announced by the RMI. This can possibly lead to preventive redispatching or restitution of planned outaged grid elements
 - Curative measure within NCC: network reconfiguration, redispatching, ..
 - Curative measure within AM: small repairs, mitigation measures, ...

The design, management & operation of the network is organized to cope with extreme wind-related tower-events in all steps of the lifecycle. 16

Highly diversified production through massive integration of renewable energy sources

FIGURE 7-8 — ILLUSTRATION OF ELECTRICITY DISPATCH FOR BELGIUM IN A WEEK IN SUMMER AND IN WINTER 2034



- **Flexibility** measures are needed to balance the grid with huge amounts of PV
- Load should follow production
- **Fast and flexible storage**, EVs, heat pumps, power to gas
- Especially in case of unpredicted weather events such as thunderstorms, solar variations, snow or sand deposit on PV, ...



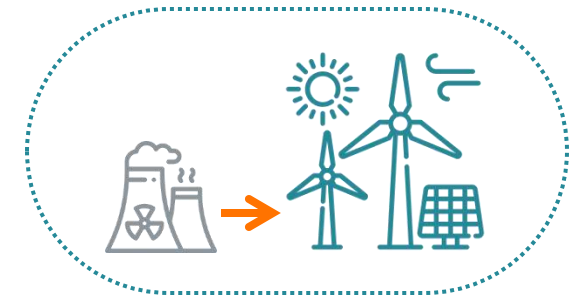
Impact on Defense and Restoration plans

Traditional Defense measures must be reviewed.

- **Distribution systems** that are part of the actual load shedding plan behave more as “injectors” and less as “offtake”
- **New technologies** such as battery storage, electric vehicles, power to gas and heat pumps will have to play a more active role to support the grid.

Restoration plans after black-out under review;

- Keeping the **balance** between production and offtake in a weak grid under restoration becomes more challenging
- Rely more on **inverter-based** resources with “grid forming” capabilities



Crisis teams trained and ready



- **1 major exercise per year**
 - Full mobilisation
 - Preferably with other companies & Belgian authorities
 - On international scale: each 2-3 years
 - Practice delicate decision making for complex events and Crisis communication
- **Several small exercises**
 - Tabletop-style (e.g. out of design scenarios)
 - Linked to an improvement plan from exercise above
- **Ad hoc**
 - Trainings for new people or event based
 - Collaboration for exercise(s) of other utility companies





Thank you.

