

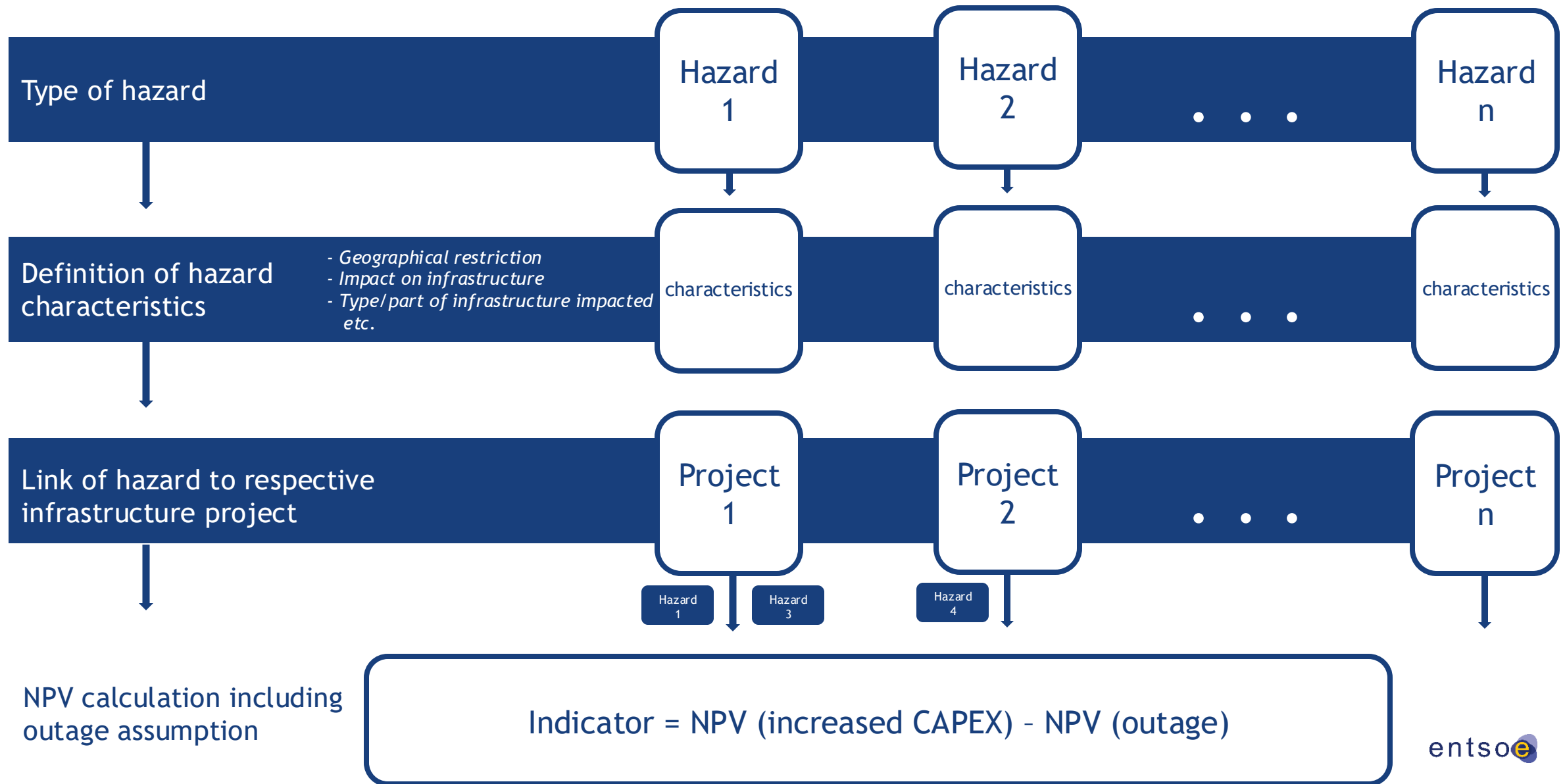
Working Group Analysis of Costs and Benefits

20 March 2025, Nils Schindzielorz (TenneT)



A new indicator of climate adaptation and resilience measures:
Development status and potential usability

General overview



Type of Hazards

Relevant hazards proposal:

Floods

Slow soil erosion (?)

- Pluvial
- Fluvial
- Coastal

Fast loss of stable land (?)

Wildfires

- Soil erosion

Heatwaves

Storms / Wind bursts

- Strong winds / gusts wind

Extreme temperatures

Heat

- Punctual
- Heatwaves

Cold

- Punctual
- Cold period

Indirect hazards

- Changing oceans pH levels
- Dust storms
- Droughts

Definition of Hazards characteristics

Relevant characteristics

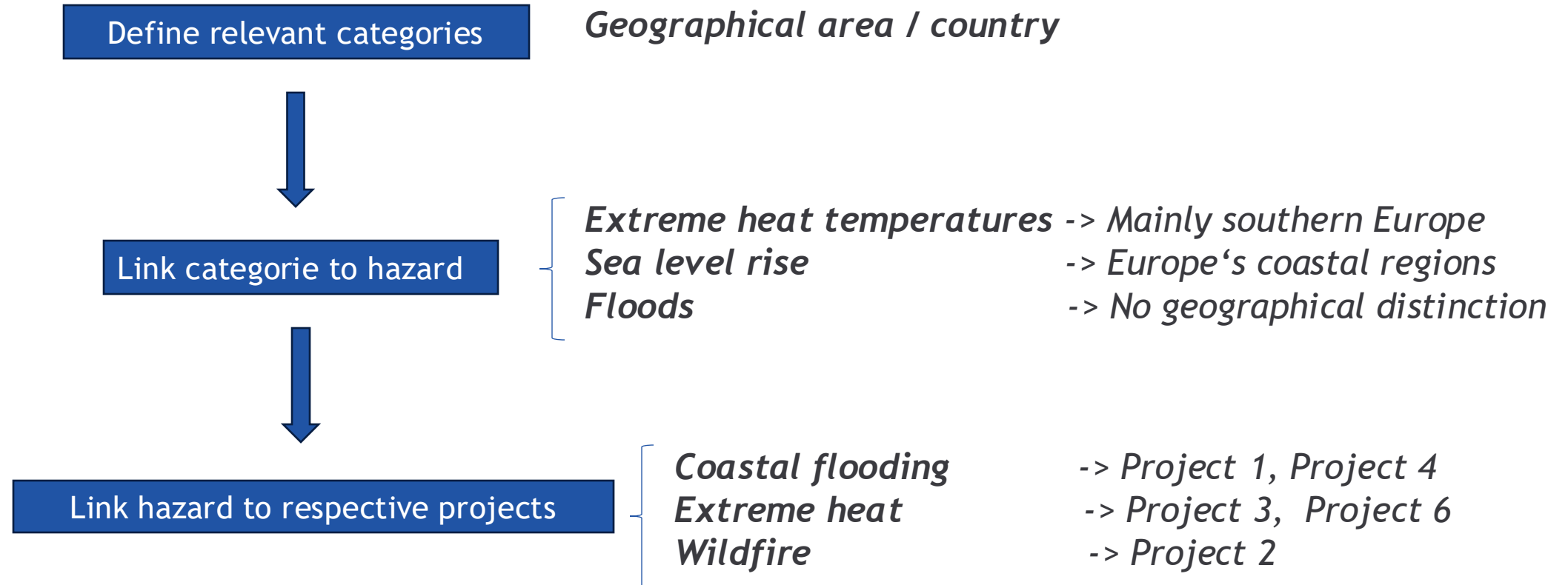
- Geographical area /country
- Duration of damage/outage (might be linked to duration of hazard)
 - Case: hazard has destroyed the asset: outage lasting until rebuild
 - Case: operational outage due to safety reasons: lasting only as long as the hazard
- etc

Factors relevant for the NPV-approach

- Duration
- Rebuild costs
- Probability
- Adaptation measures (?)

Link of hazard to respective infrastructure project

- Approach



- See example at the end

NPV calculation including outage assumption

$$NPV_{adapted} = \sum_{t=t_0}^T \frac{Benefit_t - Cost_t^A}{(1+r)^t}$$

$$NPV(N)_{outage} = \sum_{t=t_0}^T \frac{Benefit_t \cdot d_t - Cost_t^B - Cost_t^R \cdot f_t}{(1+r)^t}$$

d : duration of outage [0;1]

t : year of NPV approach

T : maximum year of NPV approach (25 years)

Cost:

- A: adapted CAPEX+OPEX
- B: not adapted CAPEX+OPEX
- R: rebuild CAPEX

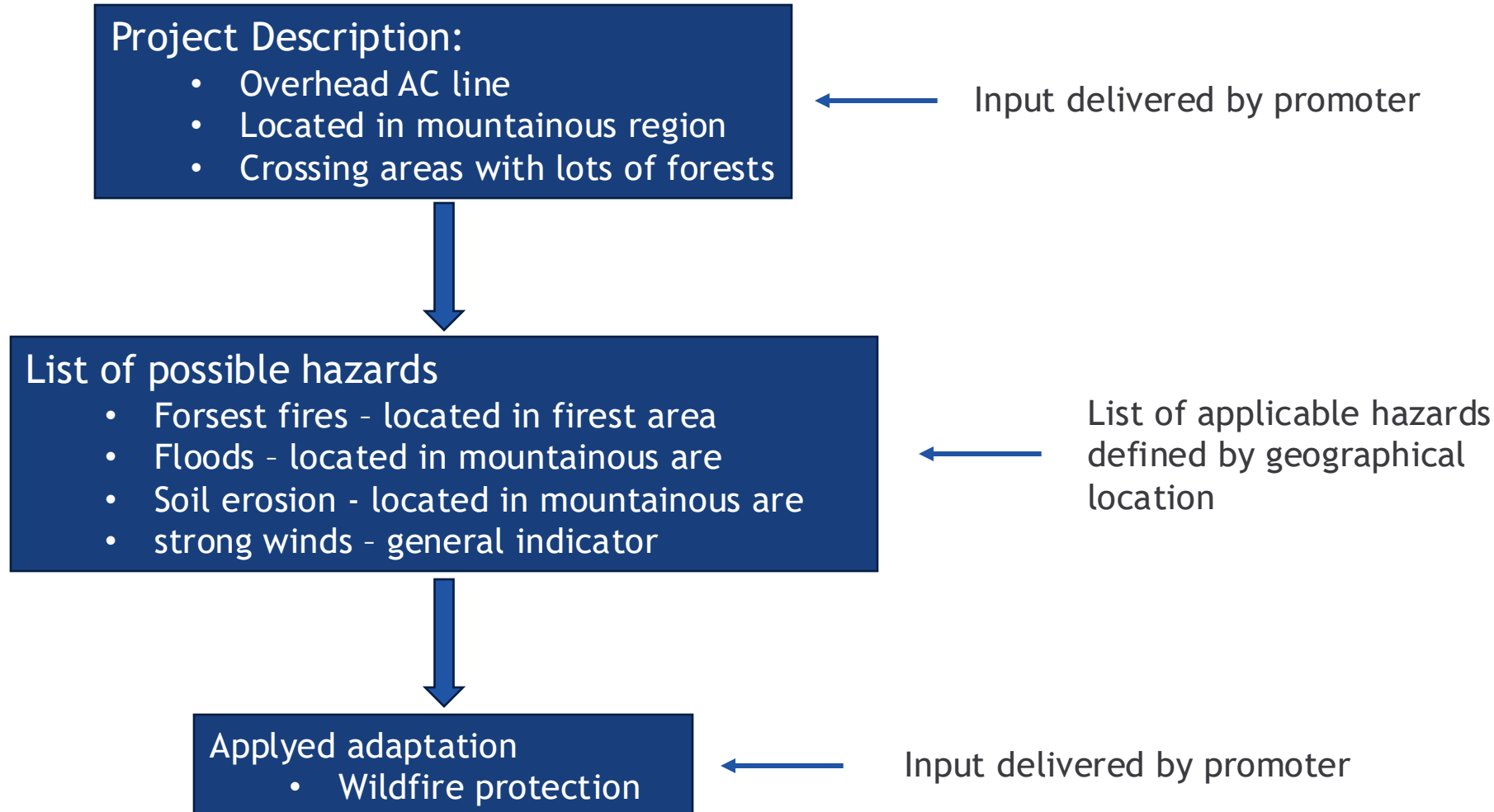
$$Cost_t^{A,B} = \begin{cases} CAPEX + OPEX, & t = 1 \\ OPEX, & \text{else} \end{cases}$$

$$d_t = \begin{cases} d, & t = N \\ 1, & \text{else} \end{cases}$$

$$f_t = \begin{cases} 1, & t = N \\ 0, & \text{else} \end{cases}$$

$$NPV_{outage} = \frac{1}{T} [NPV(1) + NPV(2) + \dots + NPV(T)]$$

Full example for fictive project



Full example for fictive project

Applied adaptation
• Wildfire protection

← Input delivered by promoter



Definition of relevant costs

← Input delivered by promoter

- | | | |
|------------------|-------------------|------------------------|
| • Project CAPEX: | adapted: 100 M€ | not adapted: 80 M€ |
| • Project OPEX: | adapted: 0.8 M€/y | not adapted: 0.64 M€/y |
| • Rebuild costs: | adapted: - | not adapted: 10 M€ |

Relevant parameter

← Input delivered by ENTSO-E

- | | |
|-----------------------------------|-----------------------|
| • Assumption: duration of outage: | 1 year ($d = 1$) |
| • Assessment period: | 25 years ($T = 25$) |
| • Discount rate: | 4%/y ($r = 0.04$) |
| • Benefit of Project: | 30 M€/y |

Full example for fictive project

$$\begin{aligned} NPV_{adapted} &= \sum_{t=t_0}^T \frac{Benefit_t - Cost_t^A}{(1+r)^t} \\ &= \frac{30M\text{€} - 100M\text{€}}{(1+0.04)^1} + \sum_{t=2}^{25} \frac{30M\text{€}}{(1+0.04)^t} = 372.51M\text{€} \end{aligned}$$

$$\begin{aligned} NPV(1)_{outage} &= \sum_{t=t_0}^T \frac{Benefit_t \cdot d_t - Cost_t^B - Cost_t^R \cdot f_t}{(1+r)^t} \\ &= \frac{30M\text{€} \cdot 0 - 80M\text{€} - 10M\text{€} \cdot 1}{(1+0.04)^1} + \sum_{t=2}^{25} \frac{30M\text{€} \cdot 1}{(1+0.04)^t} = 353.28M\text{€} \end{aligned}$$

Full example for fictive project

$$NPV(1)_{outage} = 353.28M\text{€}$$

$$NPV(2)_{outage} = 354.76M\text{€}$$

$$NPV(3)_{outage} = 356.18M\text{€}$$

...

$$NPV(25)_{outage} = 376.73M\text{€}$$

$$NPV_{outage} = \frac{1}{T} [NPV(1) + NPV(2) + \dots + NPV(T)] = 366,74M\text{€}$$

$$\text{Climate Adaptation Benefit} = 372.51M\text{€} - 366.74M\text{€} = 5.76M\text{€}$$

Open questions for discussion

- **How to define the re-build costs?**
 - Consider general assumptions
 - Link them to the hazard
 - Extend of assumed damage (just one part, or whole line etc.)
- **Assumption of duration of non-availability of the benefit, based on:**
 - Probability of the hazard
 - Extend of assumed damage (just one part, or whole line etc.)
 - Duration of re-build works

Note: we need to make simplifications

Our values define who we are, what we stand for and how we behave.
We all play a part in bringing them to life.



EXCELLENCE

We deliver to the highest standards.
We provide an environment in which people can develop to their full potential.



TRUST

We trust each other, we are transparent and we empower people.
We respect diversity.



INTEGRITY

We act in the interest of
ENTSO-E



TEAM

We care about people. We work transversal and we support each other.
We celebrate success.



FUTURE THINKING

We are a learning organisation.
We explore new paths and solutions.

We are ENTSO-E