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PML ASSESSMENT FOR OPERATIONAL POWER

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LIMA Programme 2020

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This webinar presents the principles of determining Probable Maximum Loss (PML) in different types of energy sources. PML is an important factor In engineering insurance due to very large Sums Insured involved and setting of treaty capacity.

PML ASSESSMENT FOR OPERATIONAL POWER

Presenters: Schwätter Falko and Thomas Kibet

September 2020

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Agenda

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1. Introduction
2. Wind Power PML Assessment
3. Thermal Power Plant
4. Discussions and Questions

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Probable Maximum Loss: Introduction

Definitions, Importance and Factors

September 2020
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Probable Maximum Loss

Probable Maximum Loss is **a loss which occurs under unfavourable (but not extreme) circumstances at the time of peak exposure.**

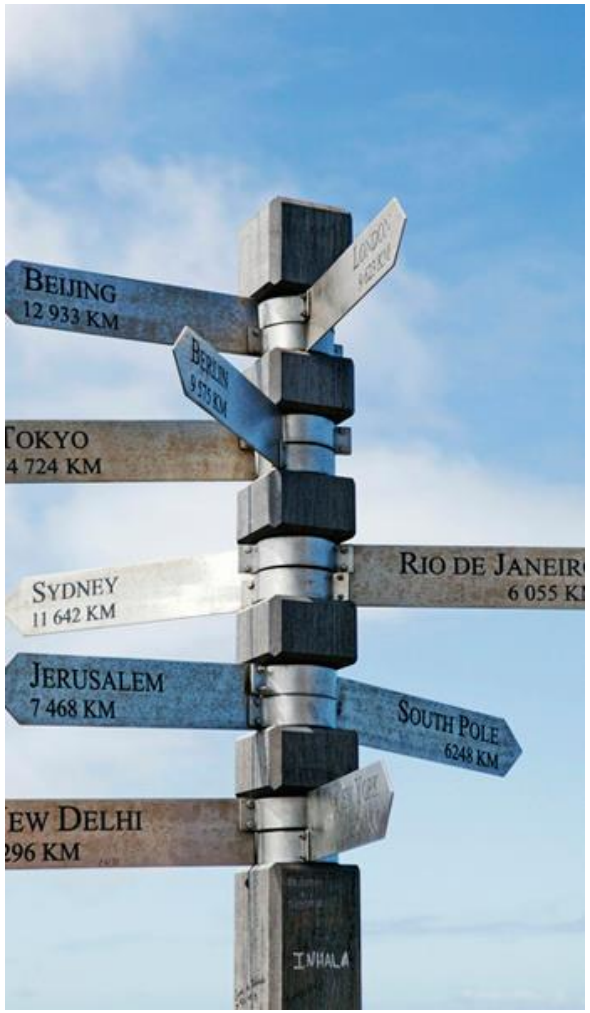
Consider “Murphys Law“

“If there's more than one possible outcome of a job or task, and one of those outcomes will result in disaster or an undesirable consequence, then somebody will do it that way.“

Edward Aloysius Murphy Jr.

Source: Munich RE

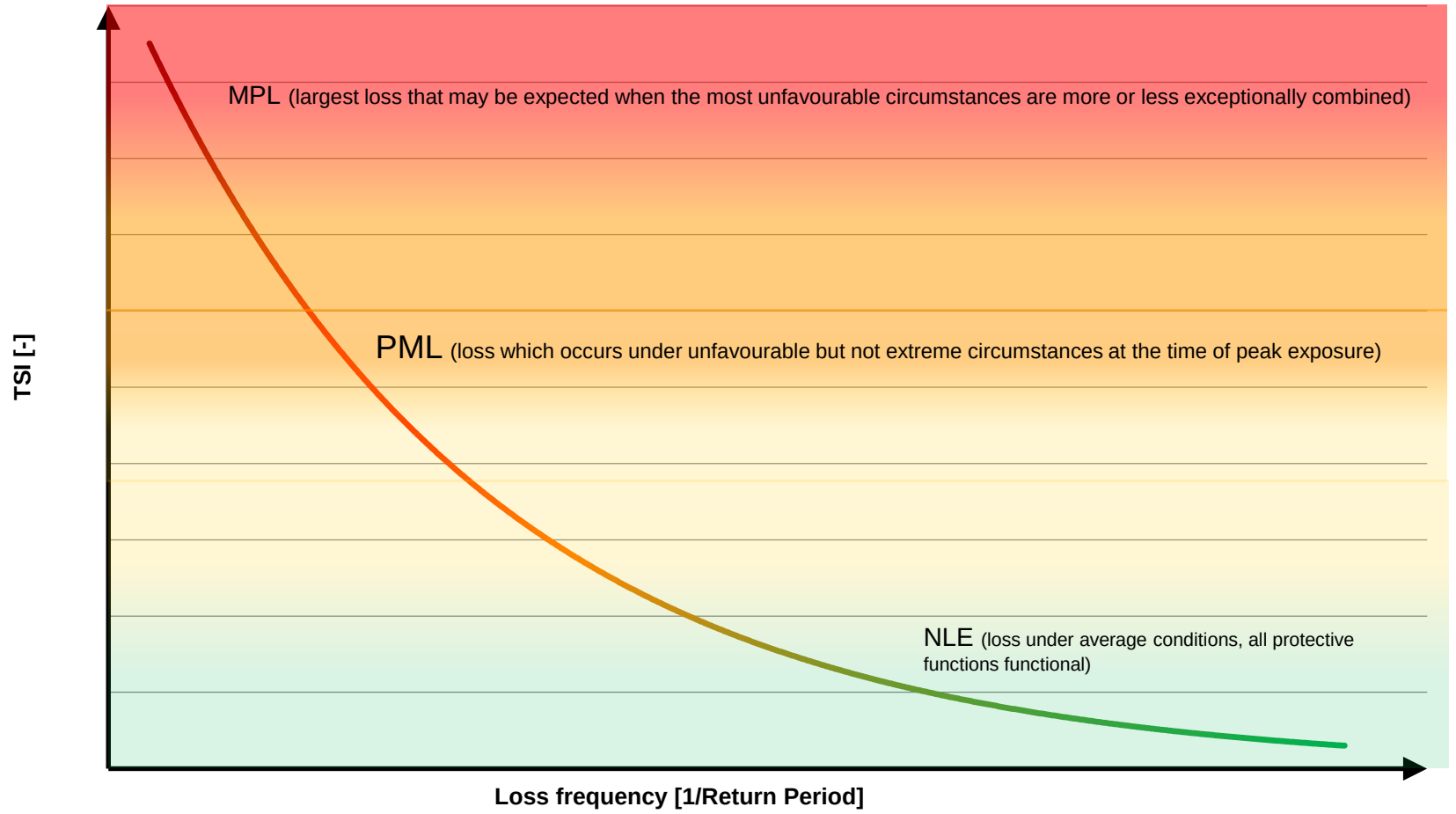
PML - Definition



PML – Probable Maximum Loss

- Loss is based on **a single event** and not in the combination of independent events.
- But the single event to include all consequential losses arising under **unfavourable** but not improbable circumstances in an unbroken chain of causes, e.g. property damage caused by an earthquake and increased by a following fire.
- The insured risk is in its **most vulnerable** condition
- **Most** of the values are at risk
- Active automatic protection systems are rendered **inoperative**
- Manual loss mitigation measures by operators, personnel, fire fighters**, should not be considered**
- Passive protections are effective
- Gross negligence of human beings should be assumed

PML - Definition



In summary, the PML is the loss which occurs under unfavourable but not extreme circumstances at the time of peak exposure.

PML
Purpose & Importance

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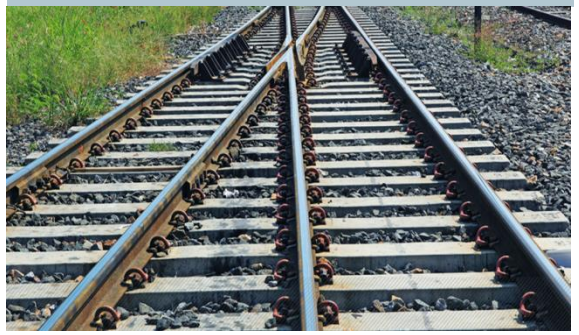
PML considerations are part of company internal processes and individually regulated, some reasons for the implementations of a PML assessment process as follows:

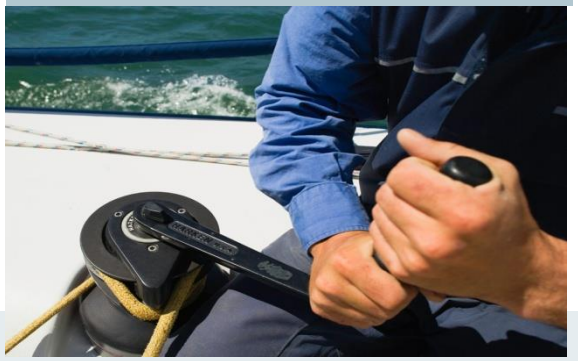
Optimizing capacity deployment
Net retention / Reinsurance capacity



Regulating underwriting limit and authority

Control of exposure and limiting net retentions

Portfolio steering – Diversification - Strategy



Important Pricing purposes

Source: Munich RE

PML - Factors

Fire Scenario

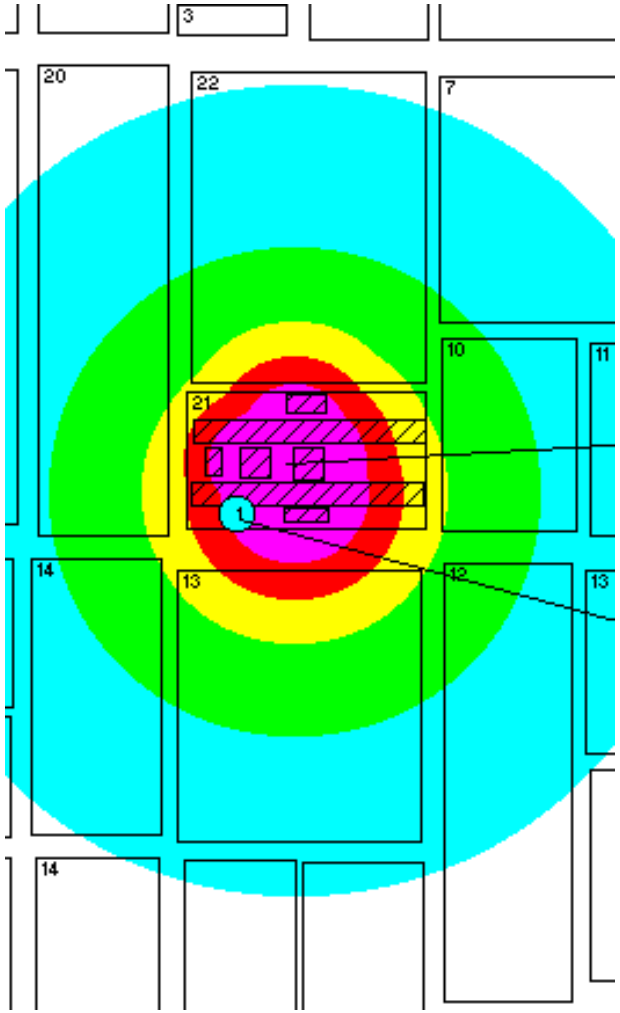
- For some engineering risks the calculation basis is 100% loss (total loss) of the insured values of a defined fire area.
- Reductions can only be granted with intimate knowledge of the technical facts and conditions. The justification for a PML lower than 100% is an **adequate fire area separation** or use of **inflammable parts or construction materials**.

PML - Factors

Dust Explosion

Dust explosions are a familiar hazard in the woodworking, metalworking, plastics processing, chemicals, paper, agricultural food and related industries. In a dust explosion, a mixture of dust particles ignites in the air. For this to happen, the particles must consist of combustible material, be smaller than about 500 µm, and their individual concentration in the air be between the lower explosion limit (LEL) and the upper explosion limit (UEL). The smaller the particles and the finer they are distributed in the air, the greater the risk of explosion. Dust explosions can cause a chain reaction that could lead to a total loss.

PML - Factors



Vapour Cloud Explosion

Oil and gas industry plants handle large quantities of combustible and explosive materials at elevated temperature and pressure levels. A vapour cloud explosion (VCE) is the worst-case scenario that must be taken into consideration in calculating the PML. Particularly during the hot test phase, i.e. as soon as oil or gas is fed into the plant, there is a risk of VCE.

Other further PML scenarios include **boiling-liquid expanding-vapour explosions (BLEVE)** in liquefied petroleum gas tank farms and pool fires in liquid tank farms. The blast effect of VCE depends particularly on the amount of hydrocarbons released. There are several methods to calculate the blast effect of VCE.

PML - Factors

Earthquake/Earth Movement (incl. Subsidence, Landslides, etc.)

Munich Re “World Map of Natural Hazards should be used to determine earthquake intensities and the resulting PML. For objects located in MR Zone 3 or higher, additional information, such as a soil investigation report or other risk influencing factors should be obtained in order to derive a realistic PML.

PML - Factors

Water Damage (Flood/Inundation/Tsunami)

Flooding should always be assessed individually. If the initial location survey reveals a potentially high flood PML, further information, such as return periods of flood levels and flood protection measures are to be requested and compared to building and construction standards. The flood level return period for the estimation of flood PMLs should be not lower than 100 years for objects exposed to flood due to the failure of flood protection measures.

PML - Factors

Windstorm

Munich Re “World Map of Natural Hazards” should be used to determine windstorm intensities and the resulting PML. Objects located in zones with peak wind velocities higher than approx. 200 km/h (tropical cyclone Zone 3, extra tropical storm zone 4) should be assessed on an individualbasis.

The PML exposure during erection/construction is often higher than during the following operational phase. Particularly exposed are structures with large “sail” areas such as hangars, tanks or tall steel structures, etc. erected on site. Damage to and caused by construction equipment (e.g. cranes) should also be considered. The construction schedule should be carefully evaluated in terms of progress at times of local windstorm seasons.

PML - Factors

Machinery Breakdown Scenario

Machinery breakdown (MB) losses occur more frequently, but trigger a smaller loss on average. In most cases, the damaged machine can be repaired. Risks with a large portion of the TSI in a single piece of equipment (e.g. gas turbines, large transformers, compressor trains, etc.) are prone to high PMLs.

PML - Factors

Defects / Faulty Design Scenario

Defects and faulty design are usually taken care of by special clauses and should be taken into consideration subject to the type of design cover (e.g. DE 1-5 or LEG 1-3) or any sublimit where applicable (e.g. construction of roads, tunnels, pipelines often have a section limit applied to PD).

PML - Factors

Strike, Riot and Civil Commotion Scenario

Covers for strike, riot and civil commotion (SRCC) should always be sublimited and are thus normally not relevant for PML considerations.

PML - Factors

Terror Scenario

Terrorism is normally excluded from coverage. If terrorism coverage is granted, it should strictly be sub-limited and thus not subject to a PML scenario.

PML - Factors

PML Component “Loss of Profit”

As a rule, the calculation basis **is 100% loss of the total sum insured minus time excess for loss of profit**. Exceptions should be assessed individually and deviations from this Best Practice documented.

PML - Factors

PML Component “Third-party Liability”

The cover for third-party liability in engineering risks should always be limited. The PML calculation should assume a **100% loss of the TPL limit.**

PML ASSESSMENT FOR WIND PLANTS

September 2020

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Wind Power

Factors to consider for PML assessment

iStock-840166882

PML Assessment
Factors to consider

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1. Number, Layout and Distribution of turbines
2. Number of (sub)stations and transformers
3. Transmission line connection alternatives
4. Location Natcat hazard exposures scores
5. Location and ease of access to wind park
6. Availability of repair facilities and equipment – cranes, overhaul workshop
7. Spare parts

PML Assessment

Number of turbines, layout and distribution

Image: used under license from shutterstock.com

PML Assessment
Number of substations and transformers

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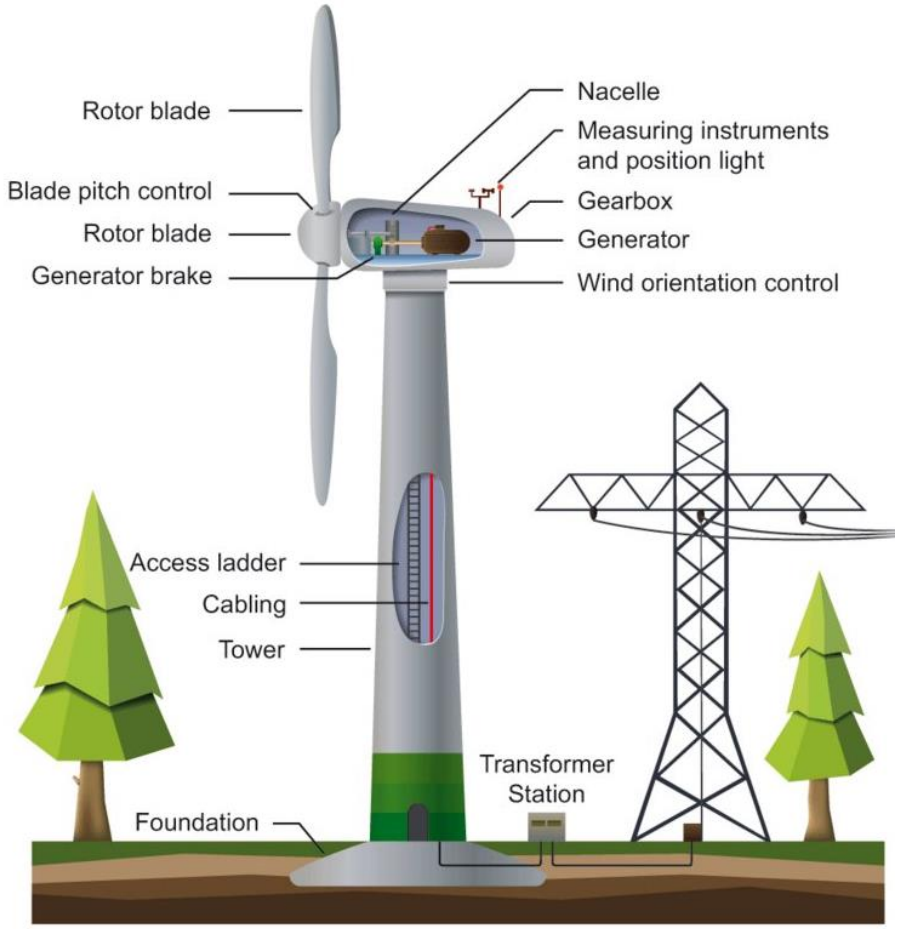
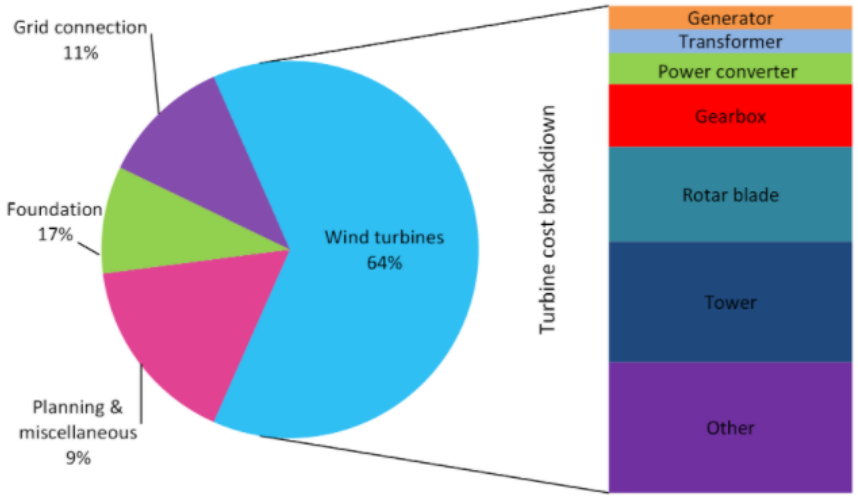
Turbine Components



Cost Split



How many transformers?

Any spare capacity?

What redundancy measures are in place?

Source: UKA, IRENA

PML Assessment
Natcat Hazards

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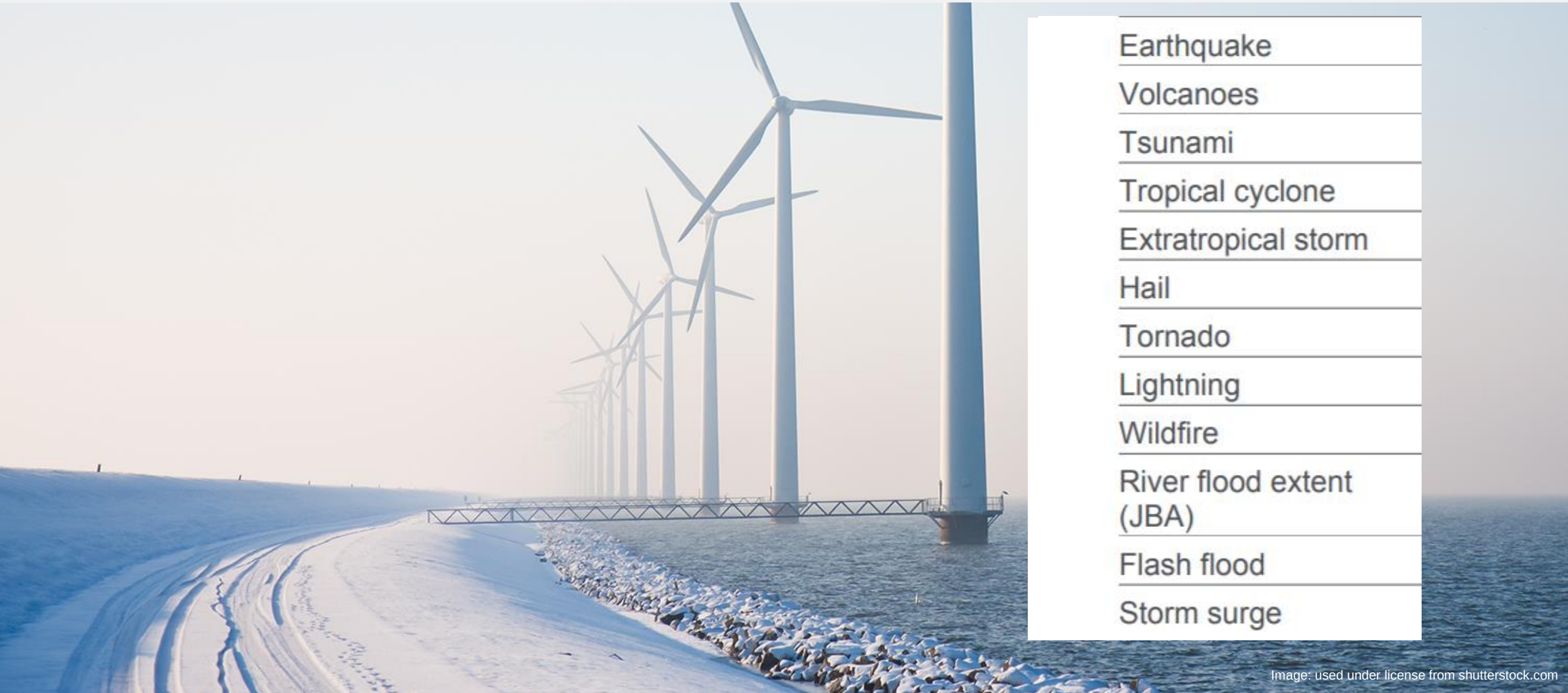
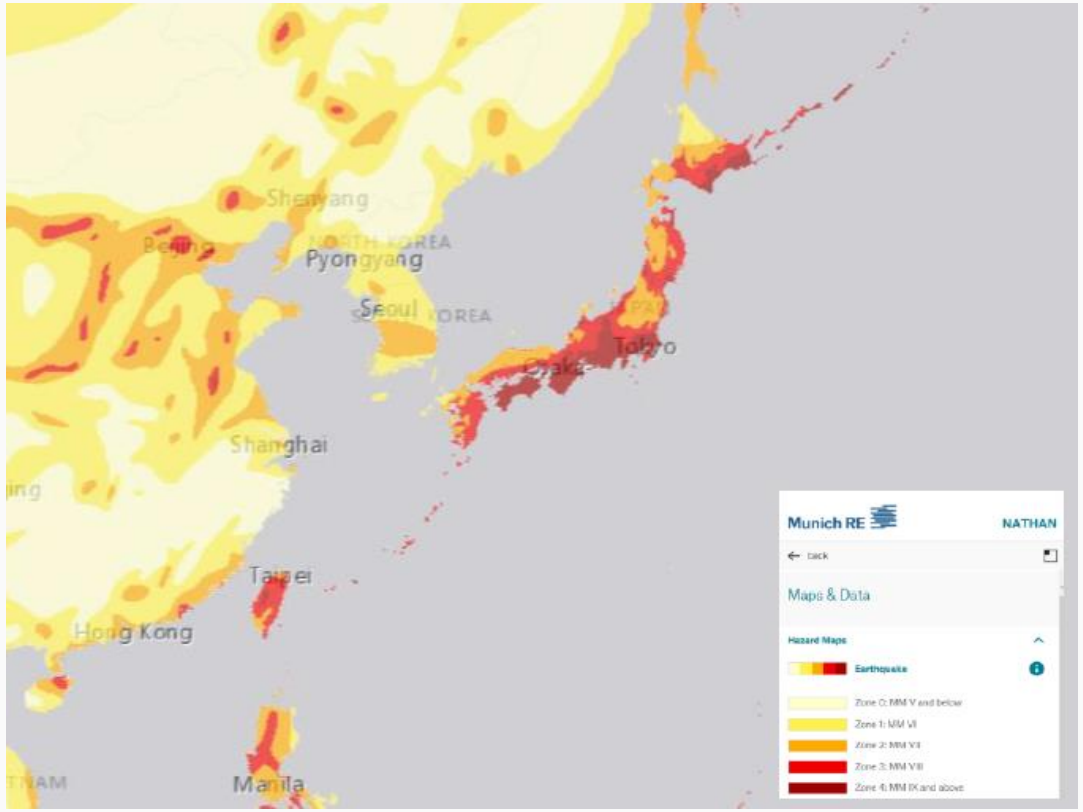


- Earthquake
- Volcanoes
- Tsunami
- Tropical cyclone
- Extratropical storm
- Hail
- Tornado
- Lightning
- Wildfire
- River flood extent (JBA)
- Flash flood
- Storm surge

PML Assessment

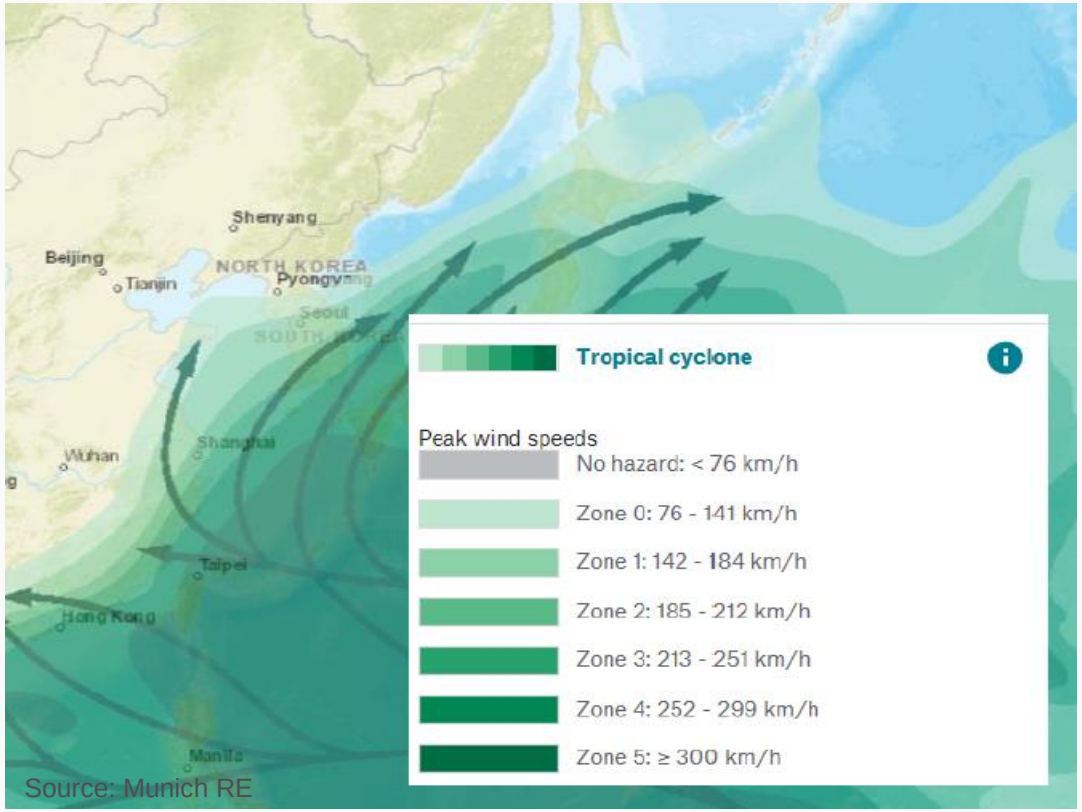
Natcat Hazard Score Rating

Earthquake



Tropical cyclone

Consider windstorm zone and class of turbines



PML Assessment
Other factors

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1. Location Access, road conditions
2. Availability of repair equipment – cranes, overhauling workshops
3. Spare parts
4. LTSA/SLAs

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PML Assessment

Example

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PML Assessment
Example – values insured

365 Wind Turbines complete @approx 1.1m	400,000,000.00
Transformers and other station installations	75,000,000.00
Buildings	20,000,000.00
Other civil works and infrastructure	35,000,000.00
PD Total	**530,000,000.00**
BI 12 months	150,000,000.00
TOTAL	**680,000,000.00**

PML Assessment
Example – Risk info

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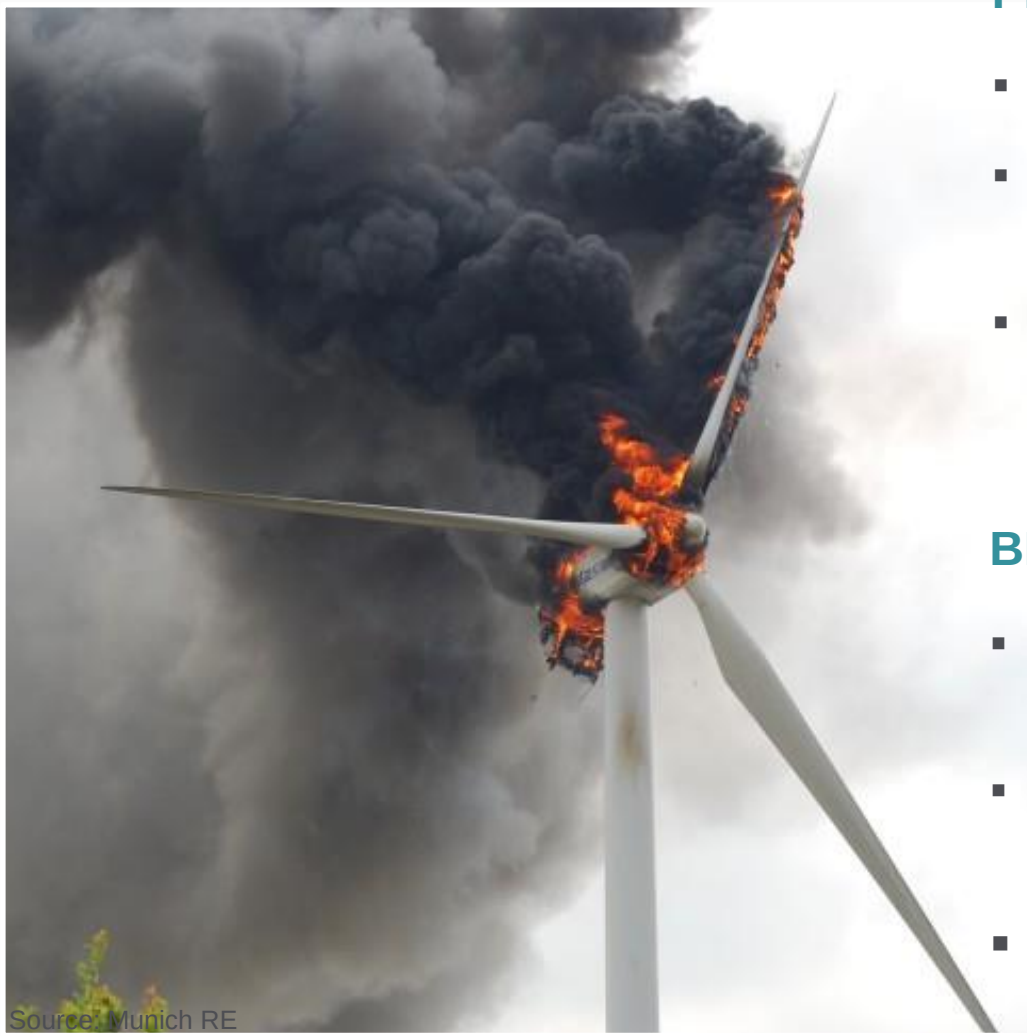
1. Windfarm is onshore
2. 365 turbines each 850kW
3. All turbines in one park spread over approx. 50,000 acres
4. Windstorm zone – Plant located in Tropical Storm Zone 3
5. Turbines grouped in 18 transmission feeder lines feeding the station
6. One substation with nine (9) transformers in groups of 3. Each group of 3 transformers separated by strongly fireproof bays. One spare transformer on site

PML Assessment
Fire Scenarios

Fire, lightning and explosion



Source: Munich RE

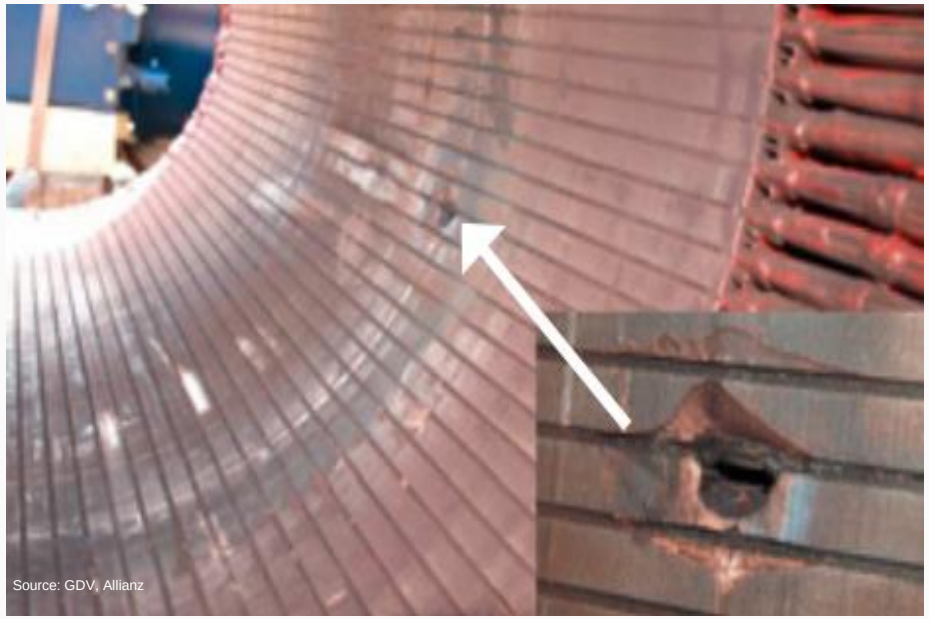
PD Loss/Damage

- **Fire** affecting **one complete WTG** – PML is SI of Full unit **EUR1,100,000**
- **Fire** of a **main transformer (or group of transformers)** – Loss affecting one (1) of the 3 bays i.e. 33% loss. PML Approx **EUR 25,000,000**
- **Fire** spreading **to all transformers** (unlikely) and entire **Station** facilities damaged – Need to reconstruct entire station. PML Approx **EUR 75,000,000**

BI/LOP Loss

- **PML 100 %** of affected unit(s) or BI due to failure of transformer. BI period 3 - 6 months depending on spare parts situation and location.
- BI PML **EUR37,500,000** (3mths) **to 75,000,000** (6mths) (arising from scenario 3 above)
- **Overall PD+BI PML = EUR 150,000,000** (NB add extensions, additional cover)

PML Assessment
MB Scenarios



PD Loss/Damage

- Breakdown/ damage to **Gearbox** or Serial Loss to Gearboxes. PML loss will be between 10 – 50% of WTG value of EUR1.1mio. Approx. **EUR100,000** to **550,000.** NB, care to be taken on seral loss clause in use!
- Failure of largest **Transformer.** PD PML is **1 unit of the 9 units** i.e 1/9 x 75,000,000 = **8.3mio EUR.**

BI/LOP Loss

- Single failure of gearboxes or transformers may take 3 – 6 months depending on spare parts situation and location.
- Serial loss: 6 to 12 months depending on turbine type
- **PML 100 %** of affected unit(s). For example one transformer out for 6 months i.e. 1/9 transformers x 6/12 months x EUR150m = BI PML **EUR8.3mio**

Overall PD+BI PML = EUR 16,600,000 (NB add extensions, additional cover)

PML Assessment
Natcat Scenario

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Storm Zone	Estimated PML
1	15%
2	30%
3	50%-75%
4	75%-90%
5	90%-100%

PD Loss/Damage

- Natural events as a trigger.
- Windstorm event damaging several units of one wind park is a common cause for losses.
- Potential loss depends on the zone. For example, if this **EUR 530million** plant is in **zone 3,** PD PML loss will be approx. **50-75%** i.e **265.5m – 397.5m EUR**.

BI/LOP Loss

- PML 100 % of **affected units** or BI due to failure of largest **transformer(s)**
- BI period 6 up to 12 months, or longer depending on location and availability. **Caution** on longer IPs e.g. 18 – 24months
- For example above, BI PML 75% x BI SI of EUR150m= **EUR112,500,000**

Overall PD+BI PML = EUR 510,000,000 (NB add extensions, additional cover)

PML
Thermal Power Plant

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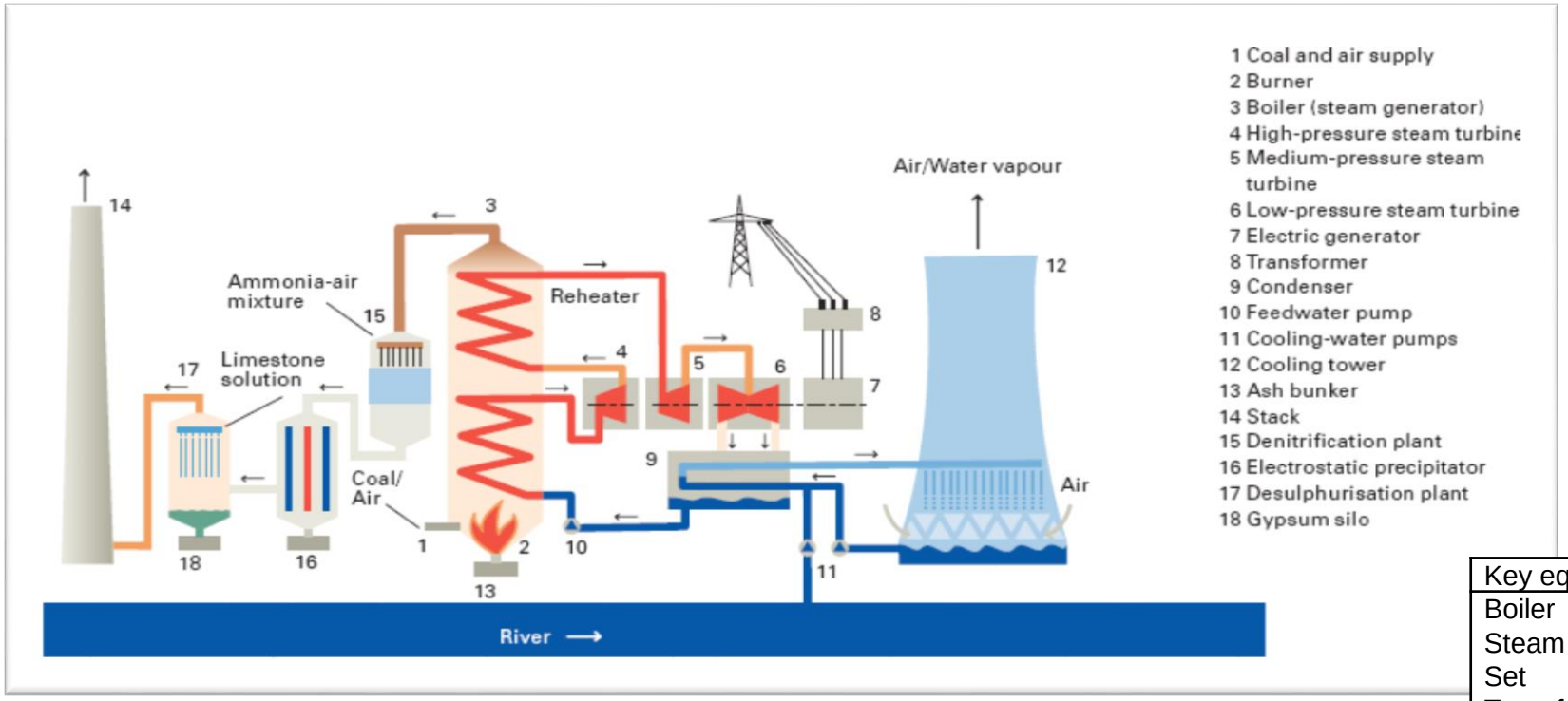
PML Thermal Power Plant

- Object: Steam Power Plant 1 x 300 MW_{el}, Coal Fired



Source: Munich RE

Key equipment	Insured value
Boiler	80,000,000 €
Steam Turbine Generator Set	40,000,000 €
Transformer	10,000,000 €
Auxiliary equipment	110,000,000 €
Civil works	60,000,000 €
Flue Gas Cleaning Part	75,000,000 €
TSI:	375,000,000 €

PML Thermal Power Plant

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Possible PML Scenarios:

- Fire in Machine Hall
- Boiler Explosion
- Machinery breakdown
- NatCat

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10. Conditions for loss settlement

10.1. In the event of any loss or damage the basis of loss settlement under this *section* shall be as follows:

10.1.1. for stock, goods in process, finished goods, raw materials and supplies the costs required to replace the damaged material at the same *premises* by material of a similar kind and quality to that immediately before the loss;

10.1.2. for plans, drawings, records, data and programs for electronic and electromechanical data-processing equipment the cost of reproducing the same from duplicates or from originals;

10.1.3. for mechanical, electrical and electronic equipment older than 5 years to be calculated from the date of manufacture and for mobile equipment of any age:

10.1.3.1. for damage which can be repaired the costs necessarily incurred to restore the damaged item to its former state of serviceability plus the cost of dismantling and re-erection incurred for the purpose of effecting the repairs as well as ordinary freight to and from a repair shop, customs duties and dues, if any, to the extent that such expenses have been included in the *sum insured*. If the repairs are carried out at a workshop owned by the *insured*, the *insurer* shall pay the cost of materials and wages incurred for the purpose of the repairs plus a reasonable percentage to cover overhead charges.
No deduction shall be made for depreciation in respect of parts replaced.

10.1.3.2. If the cost of repairs equals or exceeds the *actual value* of the damaged property immediately before the occurrence of loss or damage, that property shall be regarded as a total loss.

10.1.3.3. In the event of a total loss the *insurer* shall pay the *actual value* of the *property insured* immediately before the occurrence, including charges for ordinary freight, cost of erection and customs duties, if any, provided such expenses have

Munich Re CMI Wording

Munich RE

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.....

10.1.4. for all other property the *new replacement value* or the cost of restoring the property to a condition equal to but no better or more extensive than its condition when new, whichever is the lower.

PML Thermal Power Plant
2 years old

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- Object: Steam Power Plant 1 x 300 MW_{el}, Coal Fired

1. Boiler

1.1 Size: 300 MW_{el} ➡ 900 t/h Steam
Specific Value: 85,000 EUR/(t/h)

1.2 NRV: 900 t/h x 85,000 EUR/(t/h) = EUR 76,500,000.-

1.3 PML: Scenario: Boiler explosion
120% NRV
EUR 76,500,000 x 1.2 = EUR 91,800,000

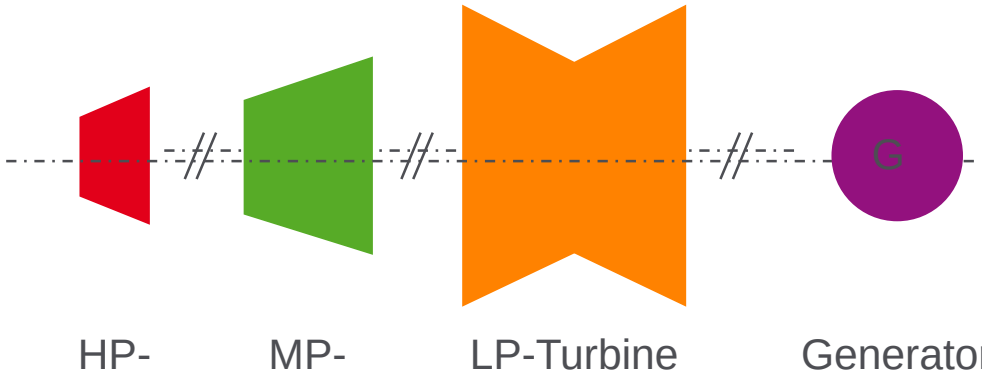
Source: Munich RE

PML Thermal Power Plant
2 years old

Munich RE

- Object: Steam Power Plant 1 x 300 MW_{el}, Coal Fired

2. Turbogeneratorset (STG)



Source: Munich RE

2.1	Size:	300 MW_{el} ➡ Specific Value: 130 EUR/kW
2.2	NRV:	300.000 kW x 130 EUR/kW = EUR 39,000,000.-
2.3	PML:	Scenario: Breakdown of Steam Turbine Generator Set 100 % of NRV EUR 39,000,000 x 1 = EUR 39,000,000

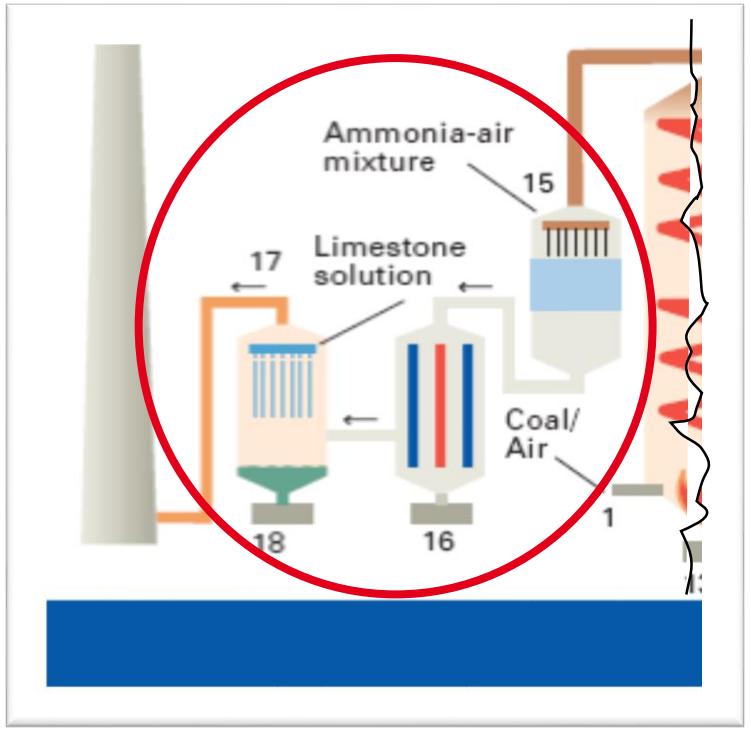
PML Thermal Power Plant
2 years old

Munich RE

- Object: Steam Power Plant 1 x 300 MW_{el}, Coal Fired

3. Total Power Station

3.1	Size:	300 MW_{el}
3.1.1	Without:	Desulphurization FGD (SO_2) Denitrification DeNOx (NO_x)
	Specific Value:	1000 EUR/kW
	NRV 300 MW:	~ EUR 300,000,000
3.1.2	Including:	Desulphurization FGD (SO_2) Denitrification DeNOx (NO_x)
	Specific Value:	1250 EUR/kW
	NRV 300 MW	~ EUR 375,000,000



Flue Gas Cleaning – Source Munich RE

PML Thermal Power Plant
2 years old

Munich RE

- Object: Steam Power Plant 1 x 300 MW_{el}, Coal Fired

3. Total Power Station

3.2 NRV: 300,000 kW_{el} * 1250 EUR/kW = EUR 375,000,000

3.3 PML: Compare PML-scenarios and choose the worst case PML-scenario:

PML_{Boiler} = EUR 91,800,000

PML_{STG} = EUR 39,000,000

PML Total Power Station: $PML[\%] = \frac{91.8m\ €}{375\ m\ €} = 24\%$

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10.1.3.2. If the cost of repairs equals or exceeds the *actual value* of the damaged property immediately before the occurrence of loss or damage, that property shall be regarded as a total loss.

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.....

10.1.4. for all other property the *new replacement value* or the cost of restoring the property to a condition equal to but no better or more extensive than its condition when new, whichever is the lower.

PML – MB Insurance
10 years old

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- Object: Steam Power Plant 1 x 300 MW_{el}, Coal Fired

MB coverage only

Please consider ⇨ ***Limit of Indemnity: Actual cash value***

1.	**Boiler:**	Scenario: Breakdown of boiler (e.g. Pipe burst)
1.1	NRV:	EUR 76,500,000,- [85,000 EUR/(t/h)]
1.2	Depreciation:	5% on NRV per annum
1.3	Actual Value:	EUR 76,500,000 – EUR 76,500,000* 5 %* 10 a = EUR 76,500,000 – EUR 38,250,000 = EUR 38,250,000
1.2	PML:	EUR 30 % of NRV EUR 76,500,000 x 0.3 = EUR 22,950,000

PML – MB Insurance
10 years old

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- Object: Steam Power Plant 1 x 300 MW_{el}, Coal Fired

MB coverage only

1.5 Compare $PML_{,new}$ to Actual Cash Value

If the *Actual Cash Value* is **lower** than the $PML_{,new}$ you could consider the *Actual Cash Value* being the PML.

$PML_{,new}$ EUR 22,950,000 **<** Actual Cash Value EUR 38,250,000

PML_{Boiler} = EUR 22,950,000

PML – MB Insurance
10 years old

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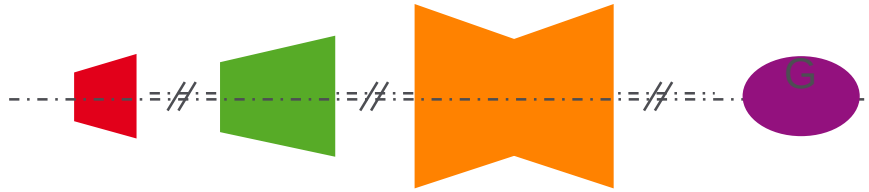
- Object: Steam Power Plant 1 x 300 MW_{el}, Coal Fired



MB coverage only

2.	**TG-Set:**	Scenario: Breakdown of STG
2.1	NRV:	EUR 39,000,000-, [130 EUR/kW]
2.2	Depreciation:	5% on NRV per annum
2.3	Actual Value:	EUR 39,000,000 – EUR 39,000,000* 5 %* 10 a = EUR 39,000,000 – EUR19,500,000 = EUR 19,500,000
2.4	PML_{new}:	100 % of NRV EUR 39,000,000 x 1.0 = EUR 39,000,000

PML – MB Insurance
10 years old

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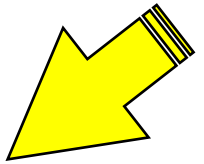
- Object: Steam Power Plant 1 x 300 MW_{el}, Coal Fired

MB coverage only

2.5 Compare $PML_{,new}$ to Actual Cash Value

If the *Actual Cash Value* is **lower** than the $PML_{,new}$ you could consider the *Actual Cash Value* being the PML.

$PML_{,new}$ EUR 39,000,000 **>** Actual Cash Value EUR 19,500,000



PML_{STG} = EUR 19,500,000

PML – MB Insurance
10 years old

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- Object: Steam Power Plant 1 x 300 MW_{el}, Coal Fired

MB coverage only

3. Total Power Station 10 years old

3.1 NRV: EUR 375,000,000 x 0.8 = EUR 300,000,000
[1250 EUR/kW] [without buildings]

3.2 PML: Compare PML Scenarios and choose the worst case PML-Scenario:

PML_{Boiler} = EUR 22,950,000
PML_{STG} = EUR 19,500,000

PML MB without chemical explosion coverage

$$PML\,[\%] = \frac{22{,}95\,\text{m}\,€}{300\ \text{m}\,€} = 7{,}7\,\%$$

Thank you for your attention

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Q & A Session

4

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Feedback Form - PML Assessment for Operational Power

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