Claims experience in thermal generation turbines

The significance of the claims experience for thermal turbines used for electricity generation is well-known; not just for the high repair or reinstatement costs in the event of a claim, but also for the effects of the stoppages.

Whilst the development of the thermal turbines powered by steam has been linked largely to the development of electricity generation with fossil fuels (coal or liquid fuels), its use is linked also to generation with nuclear energy and in recent years has been accompanied various renewable energy sources: solar, biomass and geothermal.

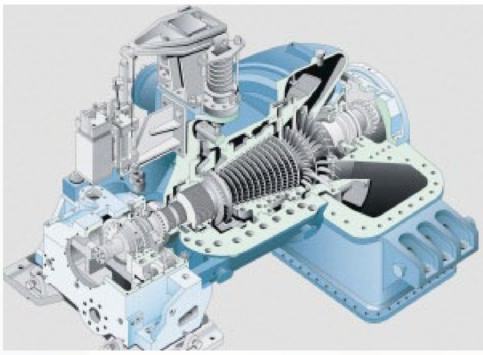
So, approximately 80 % of electricity generation is carried out through the use of this type of turbine and, overall, there are no great changes on the horizon.

Nevertheless, the development of new methods of production or use of energy, the liberalisation of the electricity generation markets, politics in respect of the use of nuclear energy and the development of renewable energy regimes, impose the use of more and more efficient technologies, together with changes in the ways of using turbines.

All of this is taking place in the context of growing demand worldwide, albeit with certain asymmetry in respect of a logically greater growth in the so-called emerging economies and stagnation in the traditionally more developed countries.

WHAT IS A THERMAL TURBINE?

A turbine is a machine that transforms the energy from a gas or steam, pressure and temperature, into mechanical energy on its axis.
Basically, there are two types of thermal turbines:



- **Gas Turbine,** in which gases are expanded as result of the combustion of a liquid or gaseous fuel in previously compressed air.
- **Steam Turbine,** in which the expansion of water steam generated in an external combustion or heat source section and, therefore, enables the use of very diverse primary heat sources (coal, fuel oil, biomass, nuclear reaction, thermal solar energy, geothermal energy, residual heat from the exhaust gases from another gas turbine or industrial process, etc.).

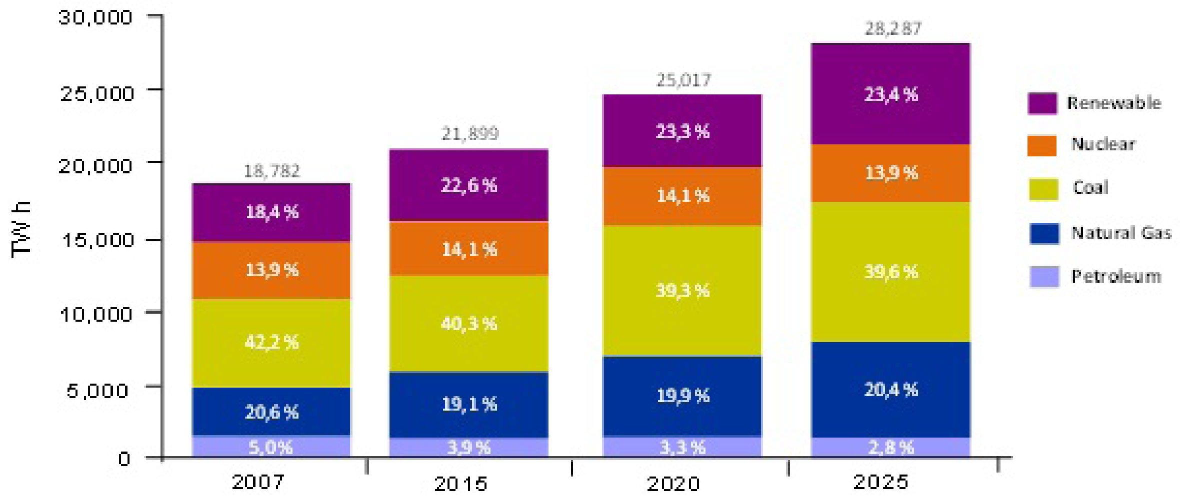
TYPES OF POWER PLANT

- **Steam turbine plants,** which can be classified into nuclear power plants; conventional thermal power stations or renewable energy plants (solar, biomass, etc.).
- **Open cycle gas turbine plants,** with a single gas turbine.
- **Combined cycle gas turbine plants,** in which the residual heat of exhaust gases from a gas turbine is used to generate steam and drive a steam turbine.
- **Cogeneration Plants,** any of the above plants in which residual heat is recovered for use in industrial processes or community heating.

GLOBAL EVOLUTION OF ELECTRICITY GENERATION

In this context, we should take into account that, according to the International Energy Agency´s report, Market Trends in the Medium-Term Renewable Energy Market, within 5 years, generation with renewable energies – wind, solar, hydroelectric and others – will surpass natural gas and will double nuclear power, converting these technologies into the second source for generating electricity worldwide, although oil will continue as the number one resource on a global scale.
Prospectively, we can take the IEA (International Energy Agency) calculations as a reference.

Fuels and other energy sources for the generation of electricity worldwide. 2007-2025 (TWh)



Source: Energy Information Administration e *International Energy Outlook 2010*

METHODOLOGY USED FOR ANALYSIS

This research has been carried out taking some representative samples where factors that affect the claims experience are analysed with regard to electricity generation in power plants and attempts to show segmentation on the basis of type of turbine, type of plant, age, output range, etc.

Turbine samples

We have tried to carry out the distribution of the turbine characteristics based on the information provided by the Insureds at the time of underwriting or renewal.

However, whilst sums insured information for material damage and BI is generally available, this is not the case in respect of more detailed technical information.

Additional relevant information was obtained from an engineering website that provides a large sample of turbines with relevant technical characteristics that, with due caution, has been used to compare indicators from the claims samples with those of the turbines and to reach conclusions.

Claim samples

The choice of samples followed the following criteria:

- A total of 330 claims involving thermal generation turbines were identified.
- Following criteria of economic size, of belonging to power generating groups or sizeable industrial groups, of availability of adjusters´ information and of the location in countries relevant to the MAPFRE Global Risks portfolio, the aforementioned sample was reduced to 78 claims.
- In order to obtain relevant conclusions, the figures considered were always the total 100% amounts for material damage and BI and, for the latter, taking both the economic loss and the days of stoppage, in view of the differences in the daily gross profit per megawatt in the different markets for the same technologies.

PRINCIPAL CONCLUSIONS

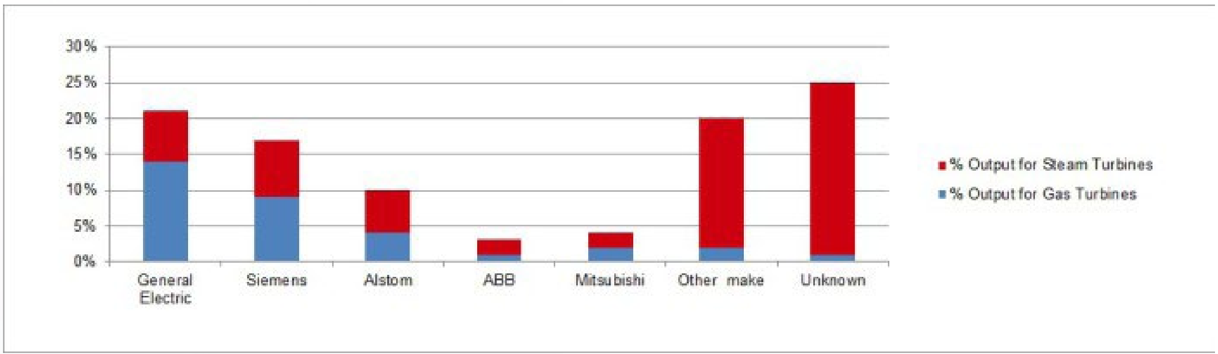
ON TOTAL NUMBER OF TURBINES

Type of turbine

Type of turbine	Number of turbines	% of number	Total output	% of output	Average output
Gas Turbines	478	43%	75,280.9	33%	157
Steam Turbines	631	57%	155,340	67%	246

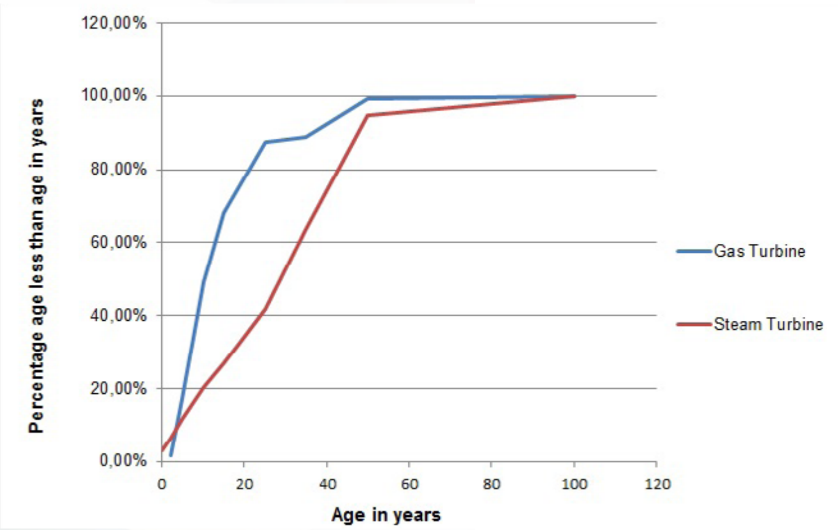
Type of Turbine and Manufacturers.

The turbine manufacturing market is very concentrated, to the extent that 4-5 companies such as General Electric, Alstom, Siemens, Mitsubishi or Westinghouse represent over 90% of the gas turbine market and more than 60% for steam turbines, which are more diverse.



Distribution by age.

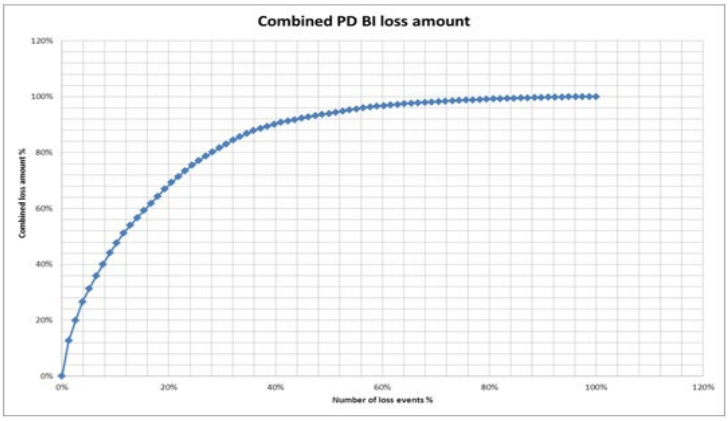
The gas turbine is a more recently developed technology which accounts for practically 2/3rds of all equipment being between 5 and 25 years old, whilst steam turbines are between 10 and 50 years old.



CLAIMS

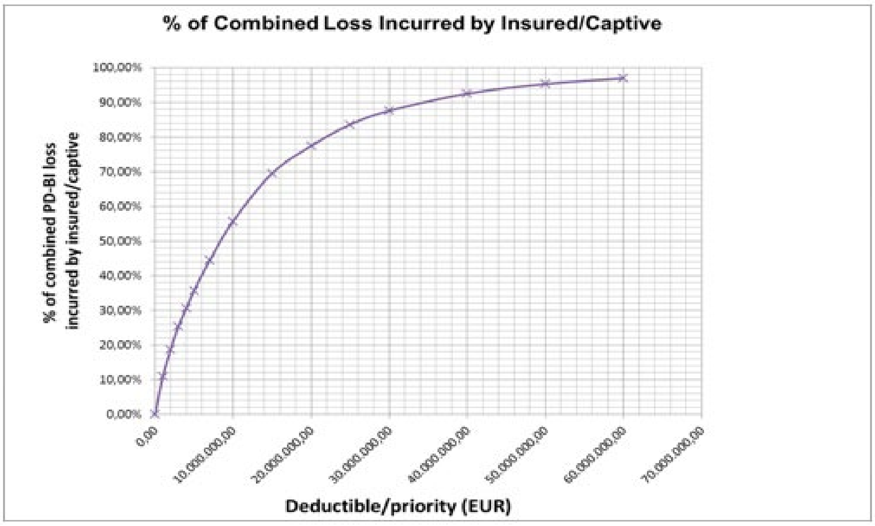
Distribution of claims by amount.

It can be observed that a relatively small percentage of the claims, that is 20%, affect approximately 70% of the total material damage amounts. Moreover, it should be pointed out that the largest claim in the sample represents 13% of the combined losses (MD+BI).



Retention of the Insured as a function of deductibles.

Based on the claims that were analysed, the following distribution of the claims amount was obtained depending on the deductible.



Claims by type of Turbine.

Although the number of gas turbine claims is higher in terms of total and average amounts for material damage, for business interruption, the total and average amount is substantially higher for steam turbines.

This is due to the fact that gas turbines have an average stoppage time of 54 days compared to an average stoppage time of 154 days for steam turbines.
In combined figures, the amounts are comparable, although the steam turbines are slightly higher.

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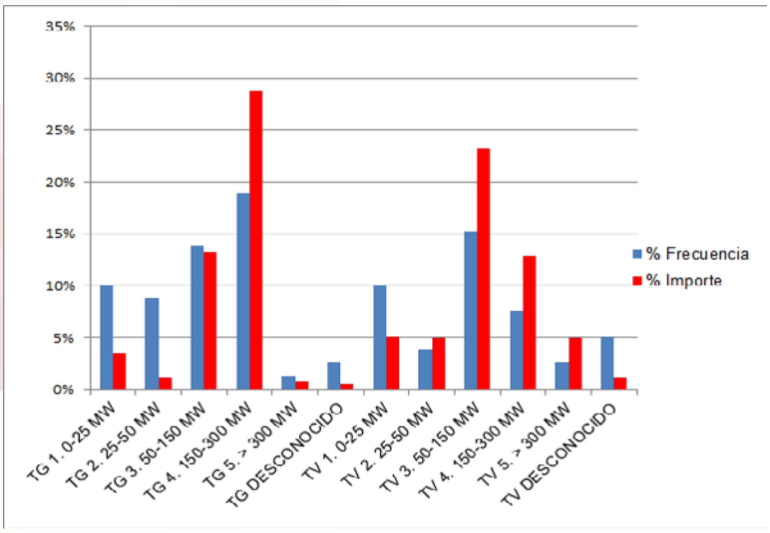
Age.
For gas turbines the period of highest frequency and amount of damage lies between 10 and 15 years and for steam it is between 5 and 10. Between 35 and 50 years of age, the steam turbines show an upturn in claims due to the wear suffered over time.

Fuel.
The economic size of claims is notable in the steam turbine claims where the use of fuel such as biomass, waste, coal or solar energy has higher costs than the average for gas turbines.

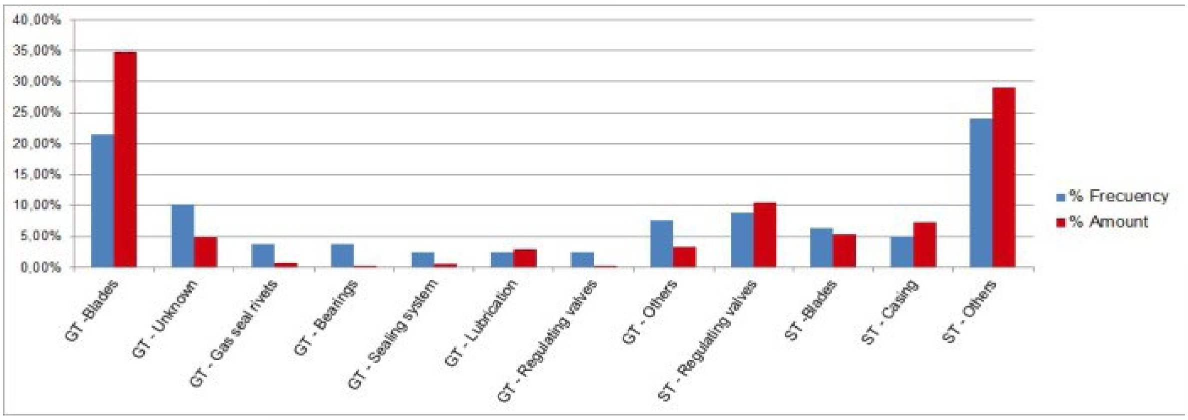
Type of plant and operation.
The highest index effect on the average cost for material damage lies with the combined cycle plant, amounting to a value of 1.8 for steam turbines and 1.3 for gas. The lowest costs are with the cogeneration and open cycle plants when they use a gas turbine, with an index effect of between 0.08 and 0.09 respectively.

Turbine output.
On the other hand, the size or generated output of the plant is another consideration to be taken into account and, following the logic of the greater the size the greater the average cost of repair, those turbines in the 150 to 300 MW range are 35% above the average.



Element causing failure.

The importance of blade failures in gas turbines is notable. These are mainly in the first crown of the blades due to the demanding temperature conditions in this point.

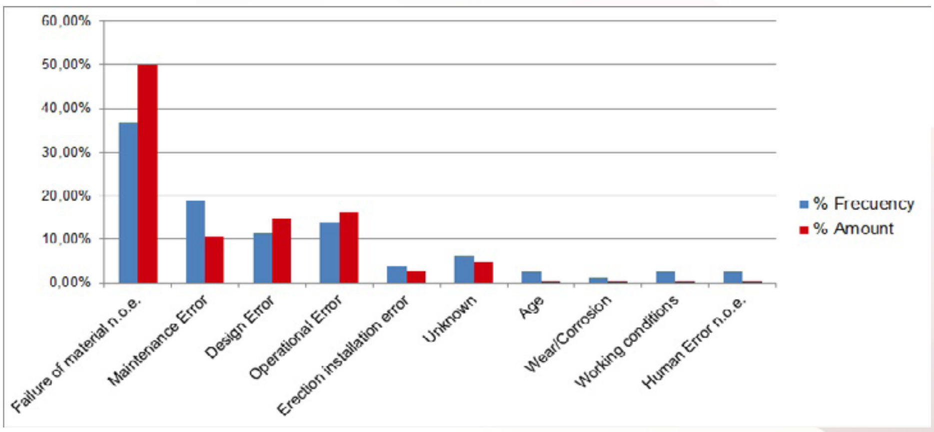


Damaged Element.

Despite the possibility of completely disassembling turbines, the complete replacement of the turbine is the operation that has the greatest effect on the cost of claims with a 37% effect and the blades are the elements where damage is first manifested on 27 % of occasions.

Claim causes.

With regard to groups of causes, there is a clear influence from failures in materials, both in frequency and in amounts as can be seen in the following graph.



Nevertheless, despite attempts to analyze the cause of breakdowns, very often the reason for the failure is not known due to the difficulties in reconstructing the damage and research with the manufacturer who is the guarantor of the correct design of the equipment.

Claim circumstances.

The following significant data has been ascertained with regard to the circumstances under which claims arise.

CIRCUMSTANCES	% Amount	Maximum	Average	Num	TOTAL
Following maintenance	23%	78.648.687	13.132.887	11	144.461.758
Without results after research	18%	27.950.936	6.923.218	16	110.771.494
Discovered during maintenance	10%	25.202.471	4.172.136	15	62.582.044
External causes	7%	41.245.679	41.245.679	1	41.245.679
Under Guarantee	6%	17.313.872	5.230.811	7	36.615.679
Start-up	3%	15.884.000	5.425.995	4	21.703.979
Normal ageing	2%	3.000.000	1.803.305	6	6

FINAL CONCLUSIONS

The following conclusions can be obtained from the claims analysis:

- The importance of the blades is confirmed as a critical and determining element in claims, especially for gas turbines.
- The importance of predictive maintenance is reinforced, including the need for continuous supervision during operating conditions that will enable the detection of breakdowns before serious damage is caused and to limit interventions to a minimum, as this is a circumstance associated with a large number of claims.
- The importance of the claims experience with steam turbines powered by biomass and other non-conventional energy sources, presumably, not only due to less uniform and continuous combustion, but also due to the technological culture of the companies using them.
- In the case of the older plants and, therefore, those with less automatic controls, efforts should be made to invest in instrumentation, control and supervision and continuous training of staff to ensure, as far as possible, the correct operation and solution of incidents that arise.
- Emphasis on protocols, qualification of staff and the supervision of these aspects in the intervention with turbines in order to minimise the consequential damage.
- The importance of certain autonomy on the part of the insured with regard to knowledge of the technology, so that they do not have to rely 100% on the technological supplier who can then become the judge and executioner.
- Lastly, and concerning the adjustment of this type of claim, the importance of cooperation between the adjuster, insured and technological party should be emphasised, including the involvement of specialized companies that will enable an independent and valued opinion for determining the immediate and root causes of the claim.