$\text{NO}_x$ emissions for European gas turbine line and storage compressors

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Contents of the presentation

- Characterize the machinery
- Investigate how the machines are operated
- Analyze NO$_x$ emissions
- Conclusions and recommendations
The survey – A large amount of data has been collected

- Participation from 11 countries
- A total of 515 turbines in survey
- Total capacity is 18,800 MW
- Operational data from 2008 and 2009
- Average 2008/2009 data:
  69,632 TJ of natural gas, 8837 tons of NOₓ annually
- Quality assurance of data by comparison for identified outliers in dialogue with data providers
Characterization of machinery

RESULTS
Age distribution for capacity

Year

Capacity of installed MW
0 100 200 300 400 500 600 700
93 % of capacity is for transport

Total capacity in MW:

- Line: 17,649
- Storage: 1,157

Turbine
Average size of gas turbines by year of installation

![Graph showing the average size of gas turbines by year of installation. The x-axis represents the year of installation, ranging from 1965 to 2011. The y-axis represents the capacity of installed MW, ranging from 0 to 1400. The graph shows variations in the capacity of installed MW across different years.](image-url)
Size distribution for line and storage turbines
Normal burners on older turbines, low-NO$_x$ on young turbines (some retrofitted)
Characterization of operations

RESULTS
Natural gas consumption varies year/year
Low-NO\textsubscript{x} burners dominate operation 58/42

![Bar chart showing the consumption of natural gas for low NOx burners and normal NOx burners from 2008 to 2009. The chart indicates a significant difference in consumption between the two types of burners.](image-url)
Annual load factor is very low for most turbines
Typical average annual load when rolling is 50-90 % of full load
A large part of the capacity is operated a few hours
Investigation of NO$_x$ emissions

RESULTS
NO$_x$ emission factor has a clear downward trend for turbines

Year installed

EMF NO$_x$ in g/J

Turbines 2008
Turbines 2009
Low-\(\text{NO}_x\) burners do have lower \(\text{NO}_x\) emissions

![Bar chart showing comparison of Total activity EMF NOx g/GJ for Turbines between 2008 and 2009. The chart indicates lower emissions for Low NOx burners compared to Normal NOx burners.]
Comparison by country

Graph showing the emission factor in g NOx/GJ for different countries over two years: Turbines 2008 and Turbines 2009.
Emission factor development

- Target average low NOx burner
- Target Danish CHP turbines
Conclusions I

- A large amount of data on line and storage gas turbine compressors has been collected.

- Annual operational load factor is very low and when rolling, turbines have an average of 50-90% load.

- Large year over year changes in operation due to weather and changes in trade pattern.

- Many turbines in operation were installed in the 1970s and 1980s.
Conclusions II

- Low-NO\textsubscript{x} burners provide lower NO\textsubscript{x} by approximately a factor of two

- Emission factor for NO\textsubscript{x} is steadily decreasing as gas companies choose low-NO\textsubscript{x} technology when they install a new turbine

- Regulators must acknowledge that specific cost for NO\textsubscript{x} reduction could be very high due to high investment costs and a low number of operation hours on many turbines
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