

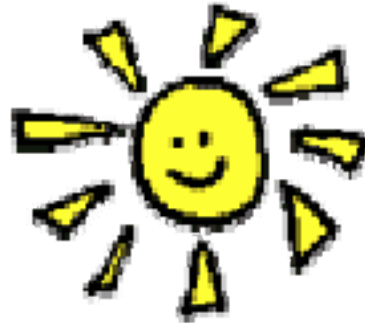
# Alstom GIGATOP Turbogenerators

Willi Rütli

Paris, 2008-08-27

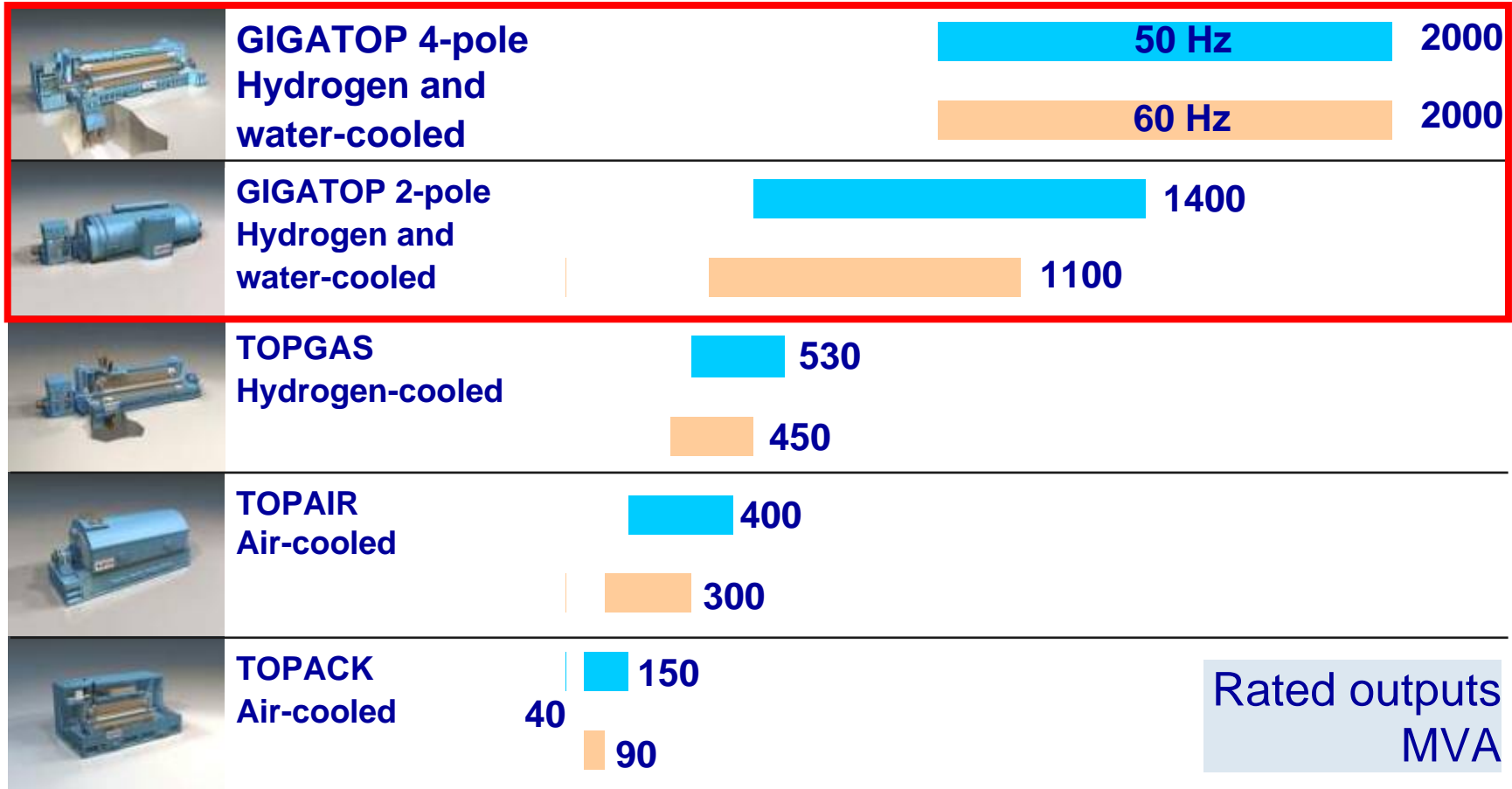
**ALSTOM**

# Power Generation ... a booming market



# Turbogenerators

## Product families



Comprehensive range from 40 to 2000 MVA

# GIGATOP 2-pole

In operation today – for close to 25 years



## Leibstadt, Switzerland

- 1318 MVA
- Commercial operation since 1984

More than 20 years experience with highest ratings

# GIGATOP 2-pole

In operation today – newest technology



## Lippendorf, Germany

- Europe's most modern lignite plant
- 2 x 1166 MVA
- Commercial operation since 1999
- > 99% availability

Newest technology with potential for higher ratings

# GIGATOP 2-pole

Projects in execution – Units delivered



## Neurath, Germany

- World's largest lignite fired plant
- 2 x 1333 MVA
- Commercial operation: 2010

First unit delivered to site

# GIGATOP 2-pole

Projects in execution – Largest unit being built



## Datteln 4, Germany

- World's largest hard coal fired plant
- 2 x 1400 MVA
- Commercial operation: 2011

World's largest 2-pole turbogenerators under construction

# GIGATOP 4-pole

In operation today



## Chooz & Civaux, France

- Largest turbogenerators in operation today
- 4 x 1710 MVA
- Commercial operation since 1996
- 99.97% reliability

Largest 4-pole units in operation with highest reliability



# GIGATOP 4-pole

## Projects in execution



60 Hz recent orders

50 Hz recent orders



18 units (25 GW) ordered since 2005

# GIGATOP

## Unique stator bar design



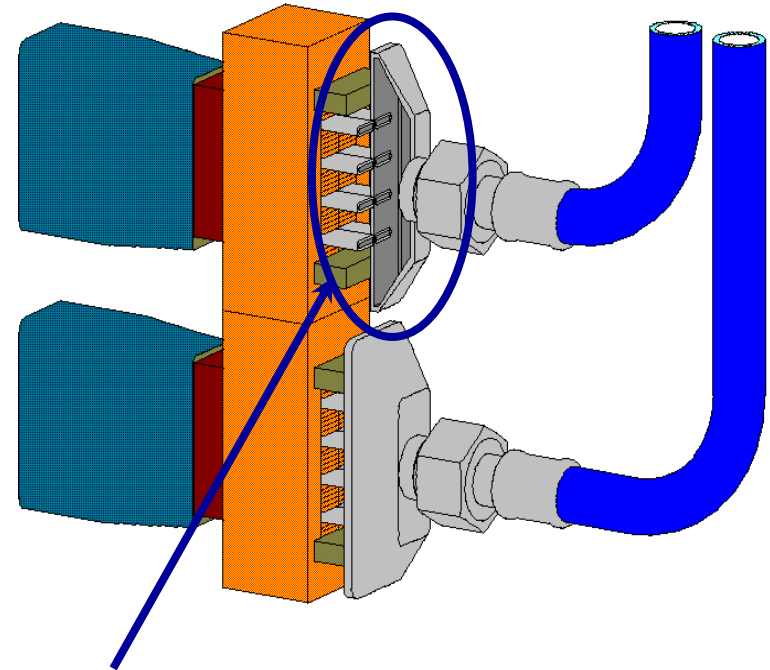
### MICADUR®

- High performance VPI Insulation
- Up to 30 KV



Maintenance free through stainless steel

- No copper oxides
- No clogging

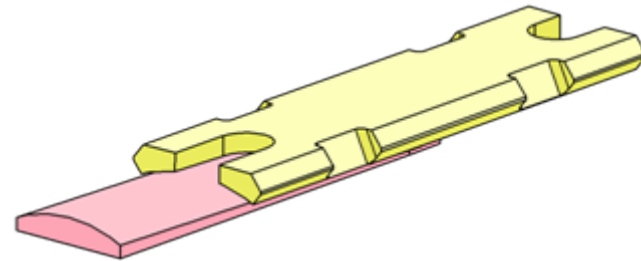
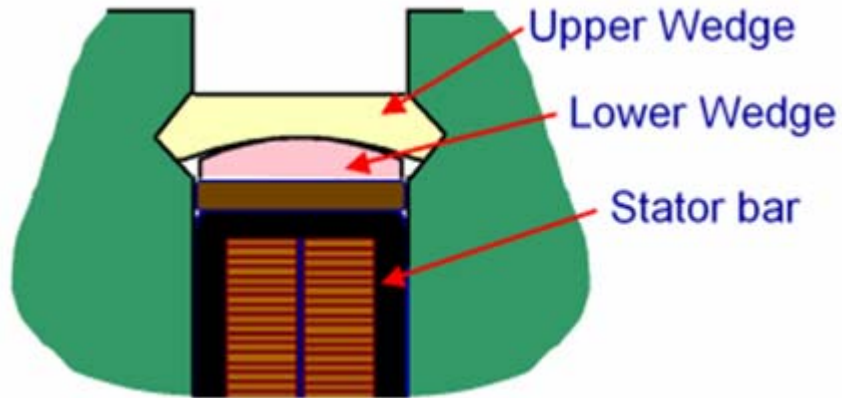


- Welded connections
- Functional separation of electrical and hydraulic connection

VPI insulation and stainless steel tubes for reliable operation

# GIGATOP

Stator wedging designed for ease of maintenance



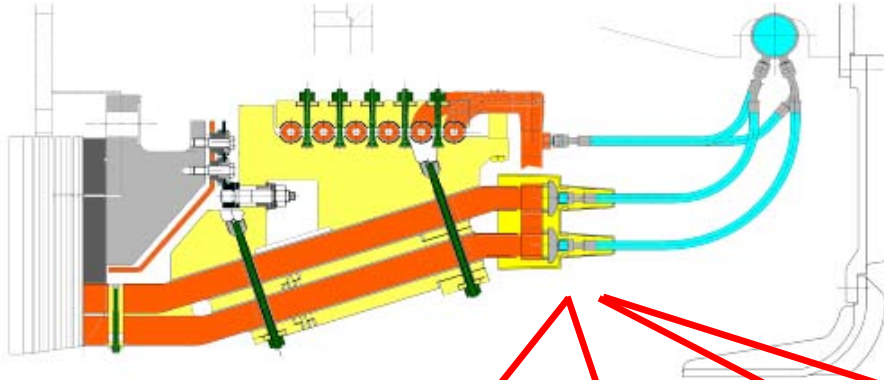
- Constant radial pressure
- Settling effect compensation
- Re-tightening

# GIGATOP

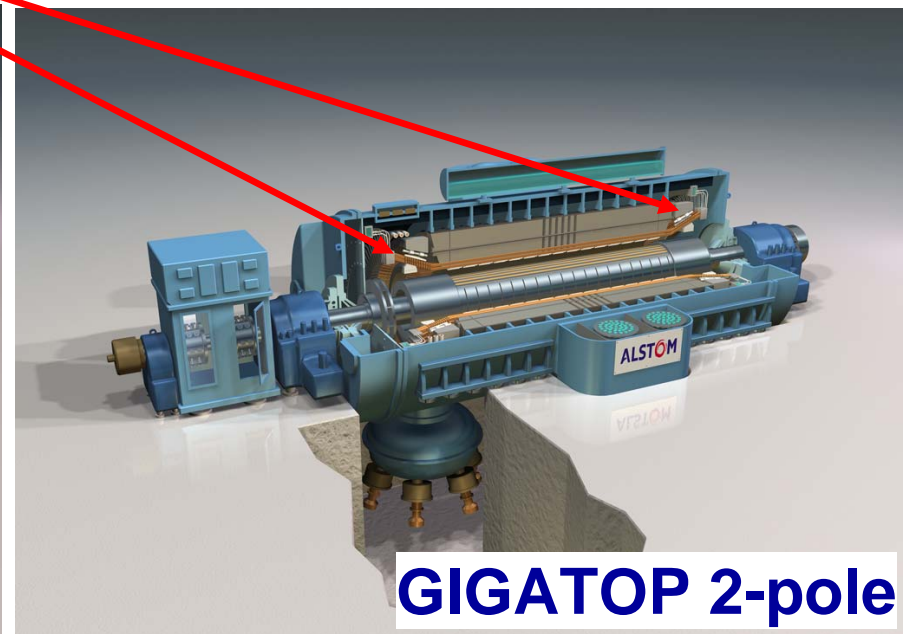
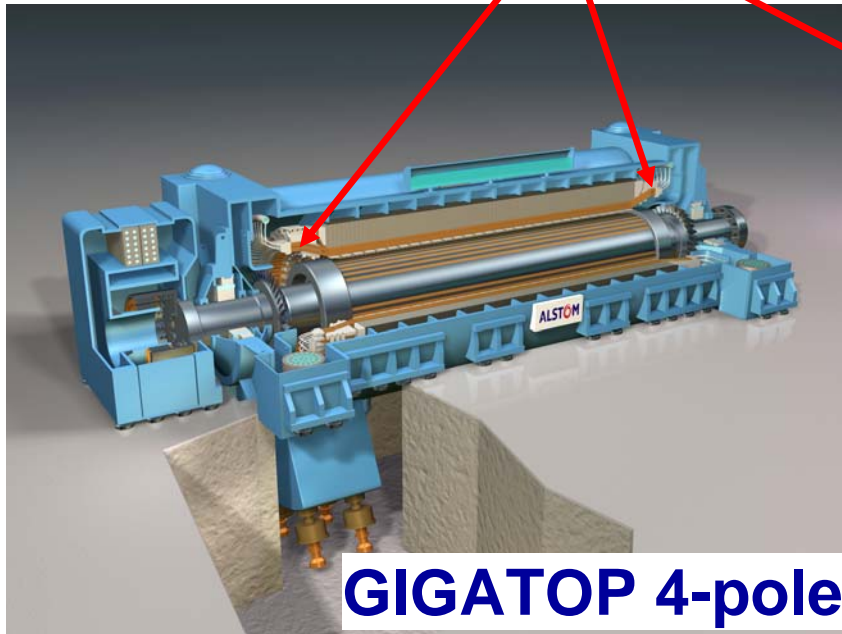
## Retighten able stator end winding support



To allow short maintenance time



- Massive support rings
- Free axial expansion
- No loosening in operation
- Re-tightening possible during regular maintenance



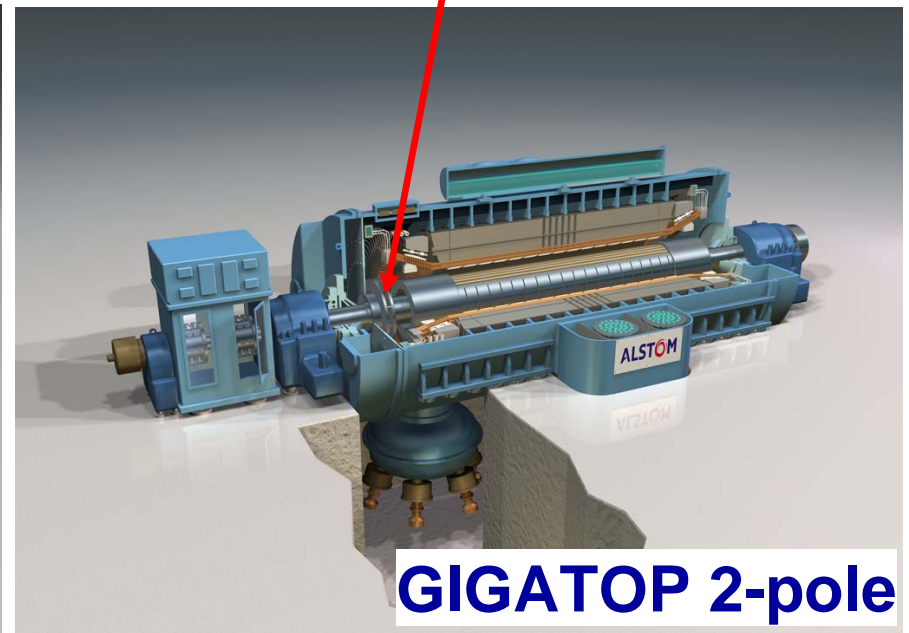
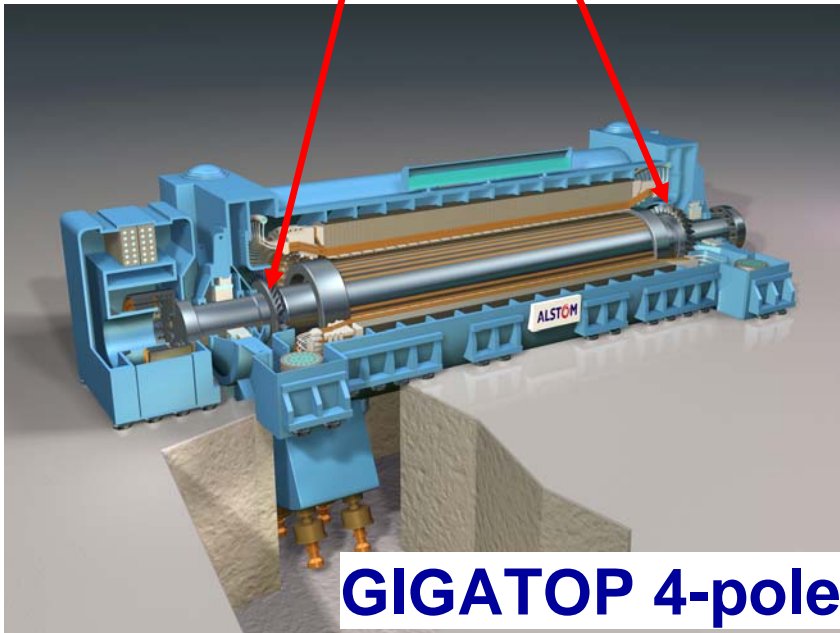
# GIGATOP

Single stage fans for highest efficiency



2 high efficient  
axial fans

1 high efficient  
radial fan



# GIGATOP 4-pole

Compact and high performing brushless exciter



## Reduced shaft line length



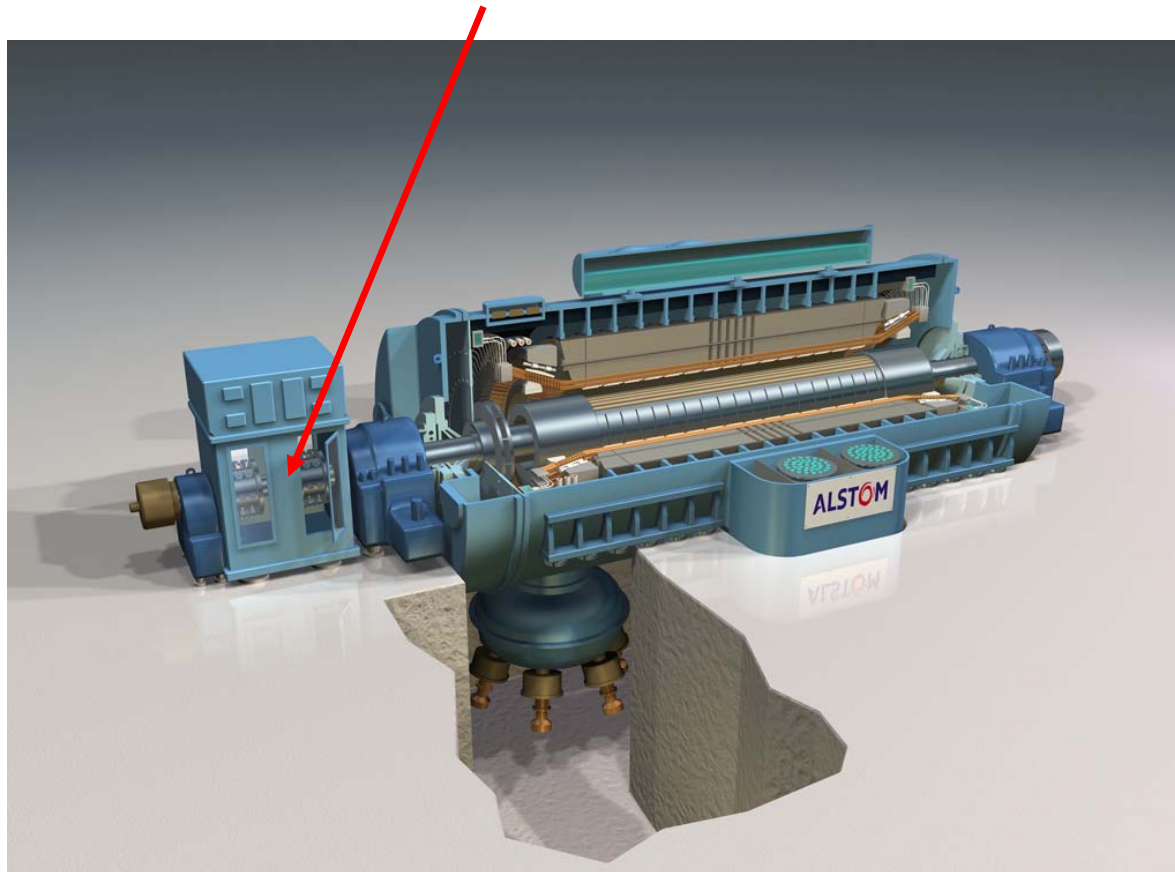
- No slip rings and brush gear
- Excellent dynamic behaviour supporting grid stability
- Extreme compactness
- No need for 3<sup>rd</sup> bearing

# GIGATOP 2-pole

Brush gear designed for ease of maintenance



- Air-cooled
- Brushes online exchangeable

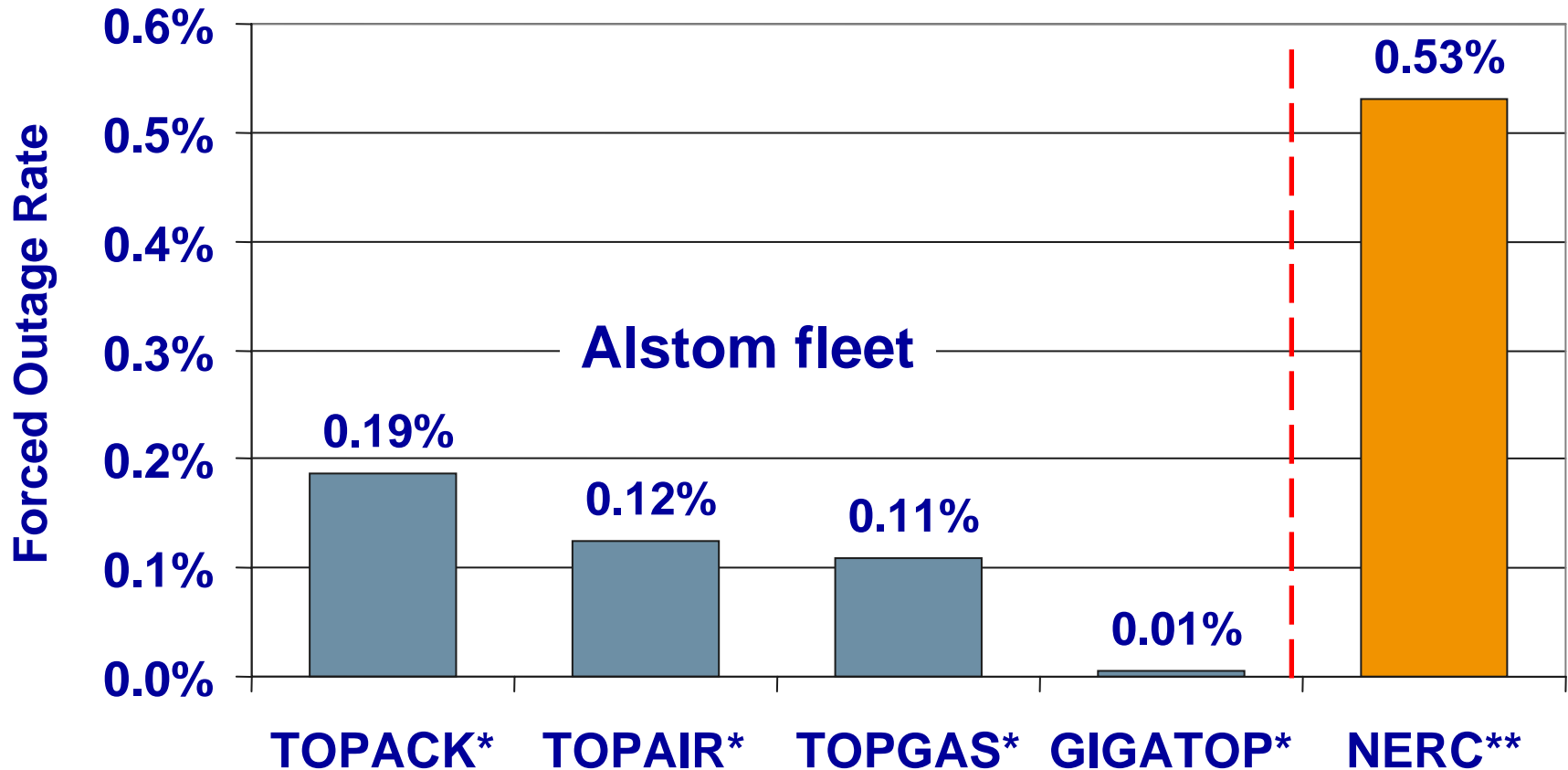


- Easy, short and lowest maintenance
- Reliable operation
- Highest efficiency
- Reduced shaft line length
- Unique brushless exciter



# Turbogenerators

## Reliability



Very high reliability demonstrated

\* Alstom data derived from Strategic Power Systems Inc. (1990-2007)

\*\* North American Electric Reliability Council (NERC), Data cover all fossil steam plants (2002)

# Turbogenerators

Minimize risk for OEM and customers



- Technology Development Quality Process
- Product Development Quality Process
- Type tests
- Modern design/calculation tools
- Systematic operation feedback analysis



**Schnabelcar**

- Railway transportation
  - Frame diameter: 4,15 m
  - Stator frame weight: 450 T
- Alternatives
  - Road transportation
  - Stator stacking/assembly on site

- Grid stability influenced by generator pf and scr
- Use of modern digital AVR
- Stiffening grid by reinforcing lines
- Innovation in plant equipment
- Superconducting technology based on 2<sup>nd</sup> generation HTS

From focus on generator to focus on full system

- Rotor limitations
  - Capability of forging suppliers
  - Material stress limits
  - Rotor dynamics
- Up-rating potentials
  - Cooling system optimization
  - Electrical field strength in HV insulation
  - Higher voltage ratings

Still some room for higher ratings

[www.alstom.com](http://www.alstom.com)

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