



EUROPEAN
TURBINE
NETWORK



Gas Turbines in a Low-Carbon Economy

European Policy and Market Outlook



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Presentation Content

GT in a Low Carbon Economy

1. Background

- Energy policies and EU emission targets
- Fuel and CO₂ prices
- Uncertainties

2. Market/ operational impact

3. GT opportunitites, challenges

4. ETN and ETN's R&D recommendation report

EU Energy Policy and Targets



Philip Low, Director Energy EC

1. 2020 Targets (20/20/20)
2. EU to cut greenhouse gas emissions by 80-95% by 2050

80 % reduction of CO₂ emission



Electricity Generation sector
= **97% reduction**

Europe's Economic
Competitiveness



Sustainability
Climate Change

Security of Supply



I think you
should be more
explicit here in
step 2!

1. Exit nuclear,
coal ...

2. miracle
happens

3. only
renewables



"I think you should be more explicit here in step two."

Future 2030 Energy and Climate Change Package

Currently under preparation



Why?

- ☐ The current 20/20/20 targets expire in 2020
- ☐ Need for intermediate 2030 targets



To show the commitments towards the 2050 GHG Emission Targets



Latest developments:

- ☐ March 2013 “A 2030 Framework for Climate and Energy Policies” as basis for discussion and public consultation
- ☐ Proposal expected at the end of 2013 – **Targets? binding or not?**

The Industrial Emission Directive - LCP Directive

- ❑ The revised Large Combustion Plant Directive (LCP) applies to combustion plants with a **thermal output of 50 MW or more**
- ❑ Requires Member States to reduce emissions of SO₂, NO_x and dust from LCP to protect human health and environment

Many coal plants will need to close down or invest in expensive emission reduction technologies when it comes into play in 2016

Different impact in different countries





European Industrial Emission Directive

Gas Turbines Operating on Liquid Fuels

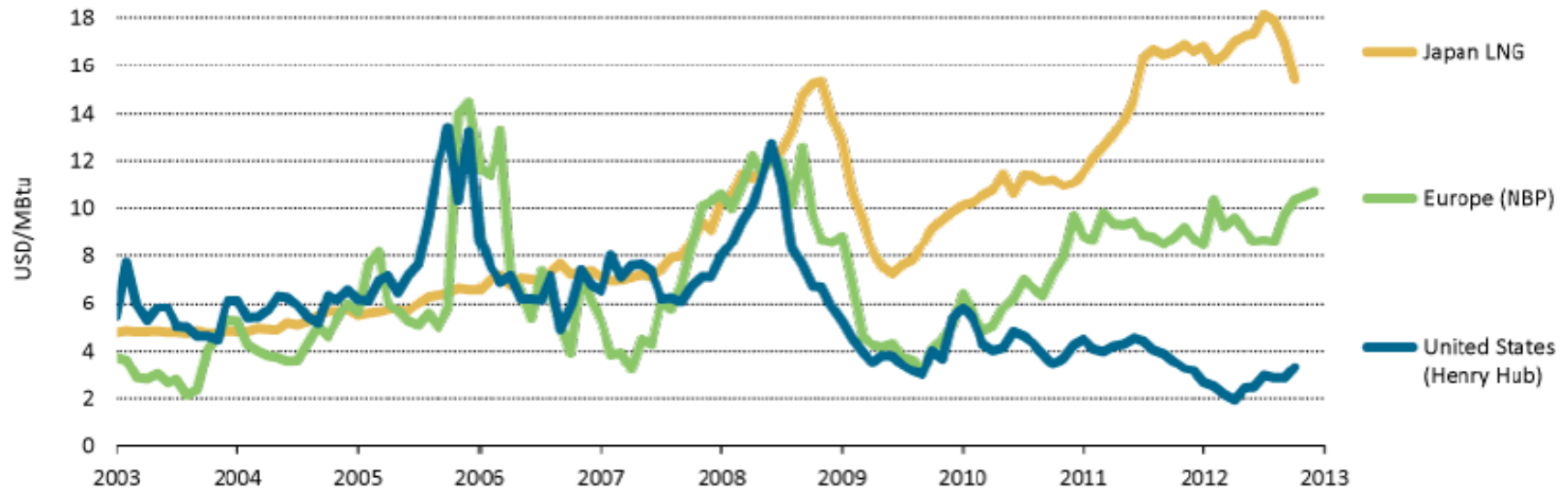
❑ IED LCP Directive:

- GT permitted after 2012 should comply with a NO_x limit of **50 mg/Nm³ (24,36 ppm)** when operating on liquid fuel

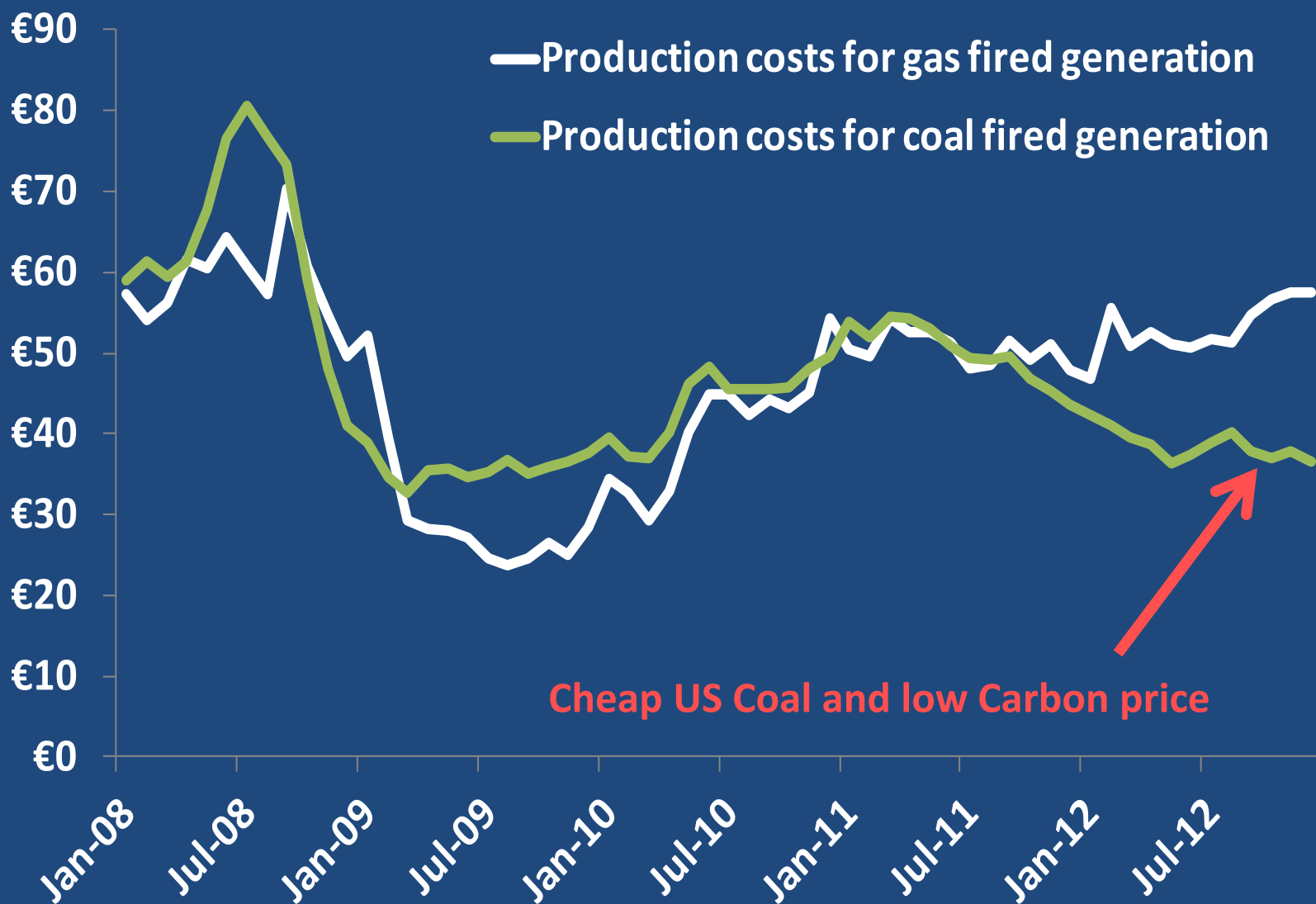
❑ Current Status:

- Liquid Fuelled GT achieve NO_x emissions above **86 mg/Nm³ (41,9 ppm)**
- Alstom upgraded GT13E2 (2012) claim to achieve **50 mg/Nm³ (24,36 ppm)** only above 70% of load
- Siemens' SGT6-5000F (US 60 Hz) claim to achieve **51,3 mg/Nm³ (25 ppm)**

Increasingly Regional Gas Price Spread over last decade



At these prices, gas is not even close to being competitive with coal



Unconventional Resources are no Longer Unconventional



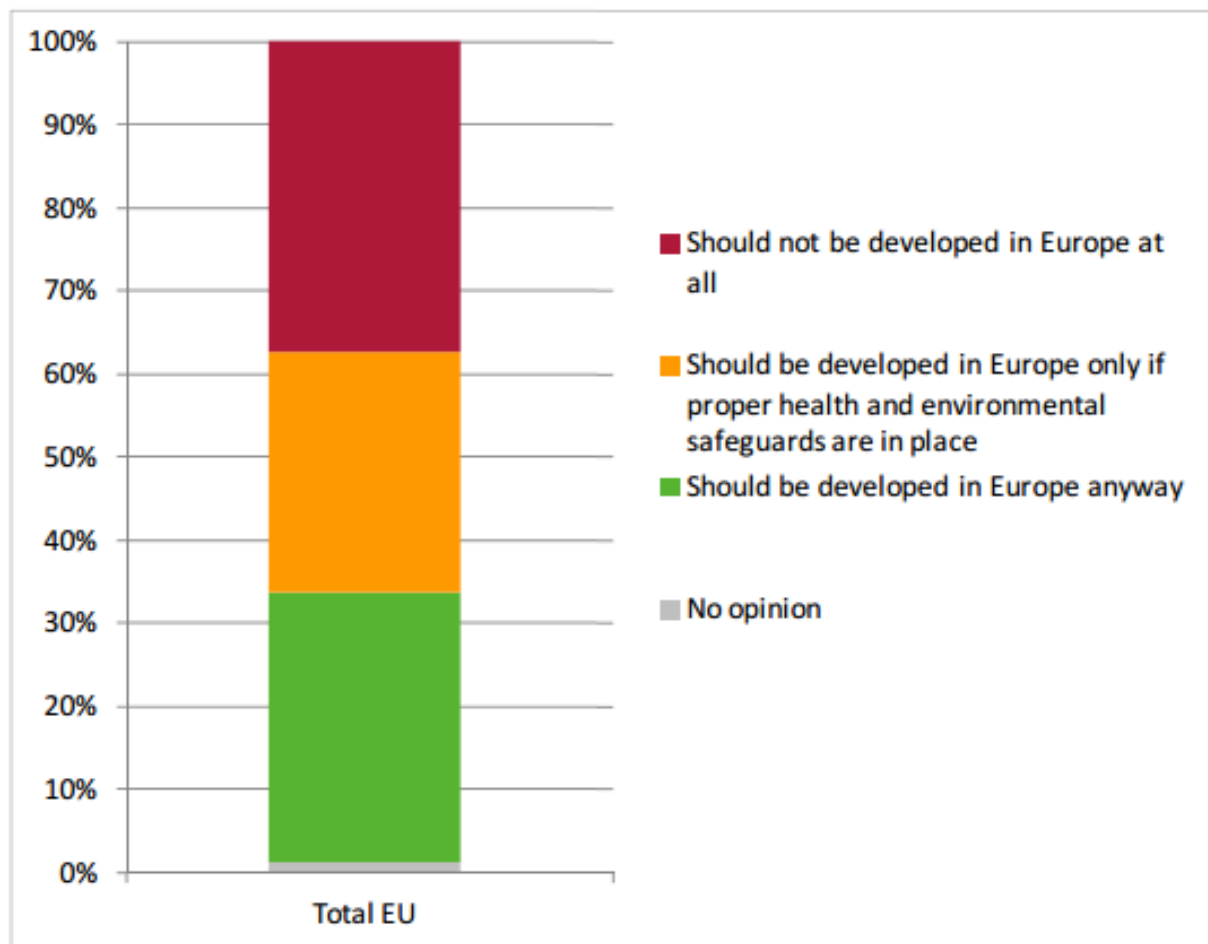
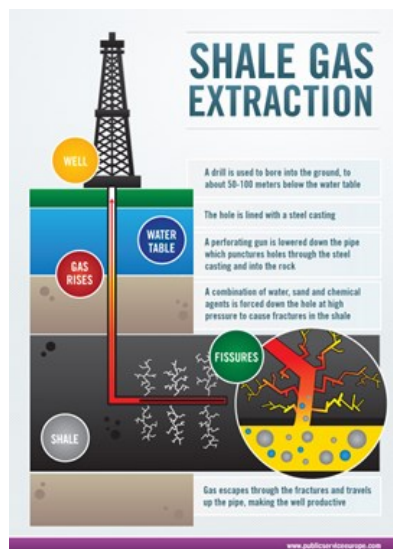
Expected impact on Natural Gas prices?



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Shale Gas Exploration in Europe?

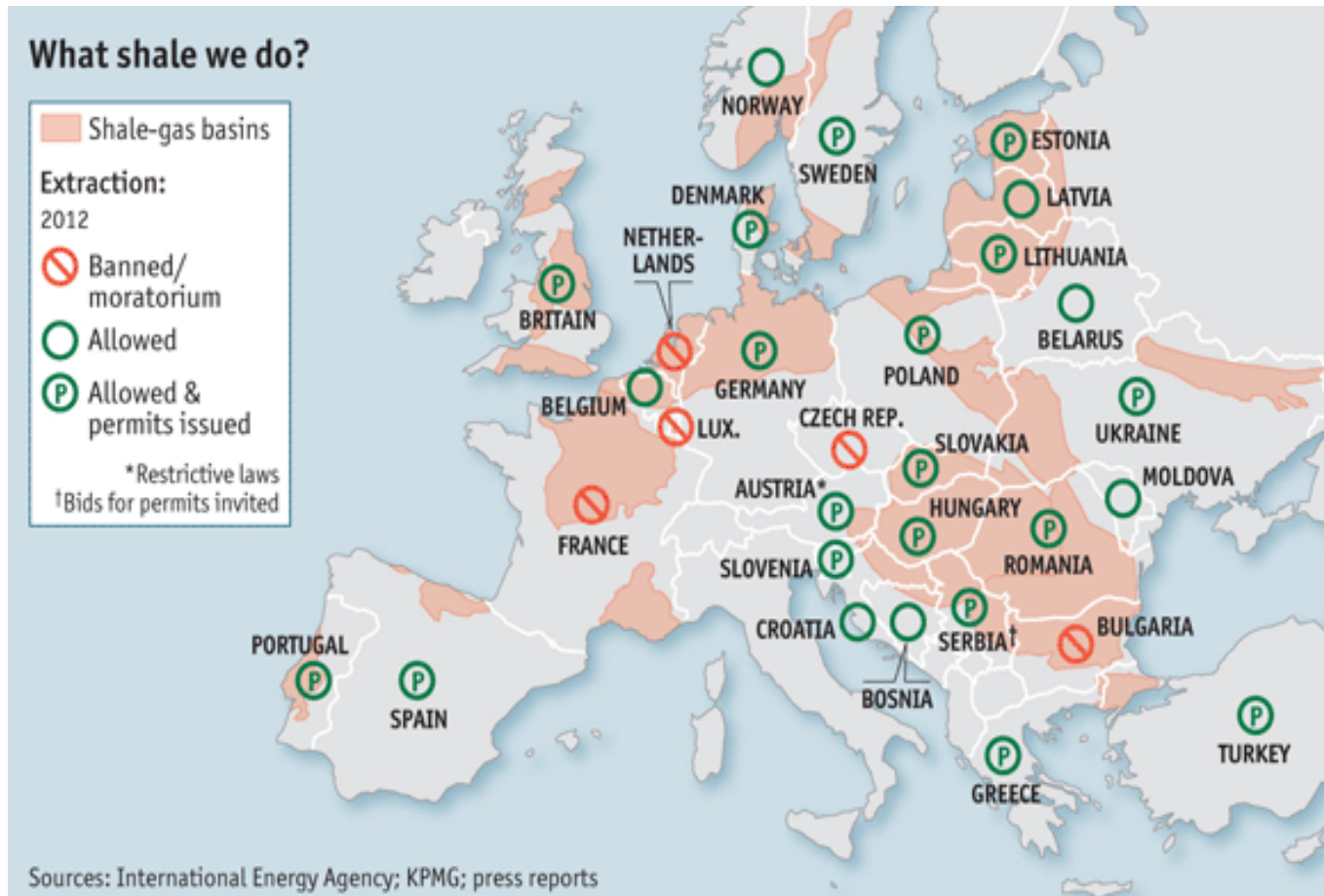
Public Opinion in 2013





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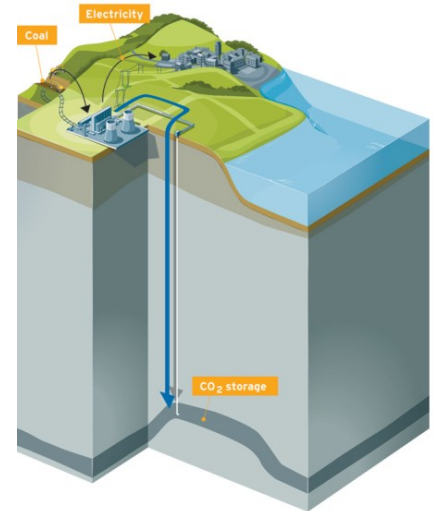
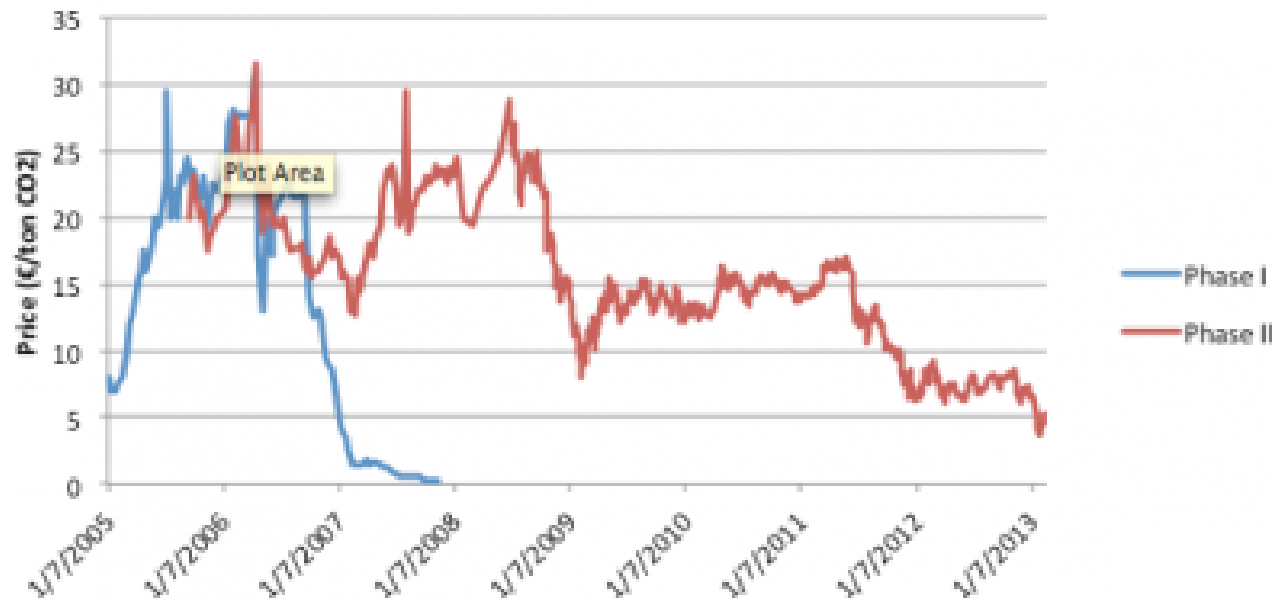
Current European Positions on Shale Gas Exploration



Can Europe afford not to extract these resources?

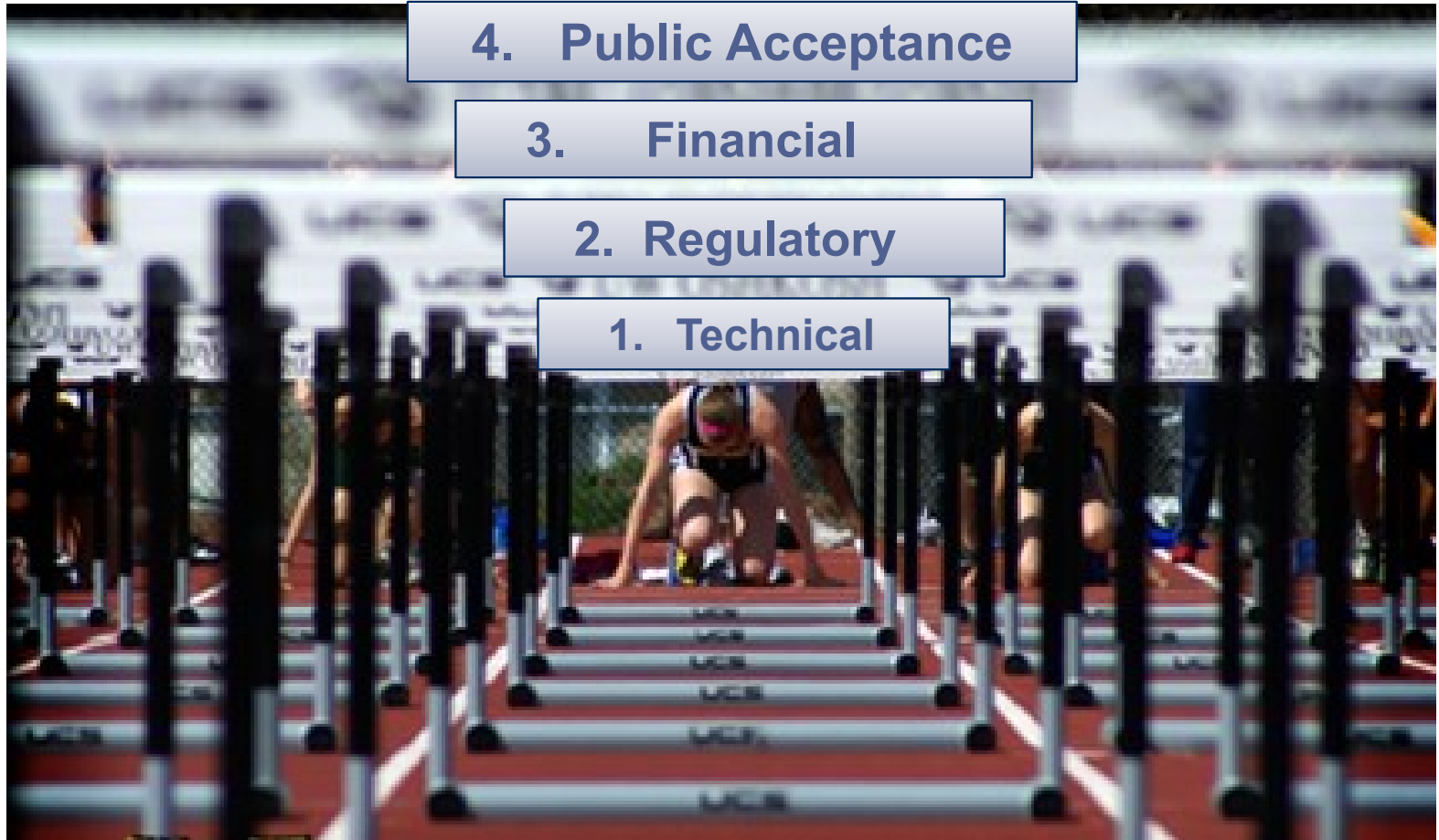
ETS Price and Carbon Capture and Storage (CCS)

Figure 3: EU ETS Allowance Prices



Will CO₂ prices ever reach levels that will make CCS economic feasible?

Many Barriers for the CCS Race



Need a World Championship

Increasing amount of Uncertainties

- ❑ **Policy** - Lack of a long term energy policy with clear milestones
- ❑ **Market** - No clear signs due to policy uncertainties and increasingly different market needs and fuel prices
- ❑ **Financial** – the financial crises leading to reduced demands and an increased global competition



Market Impact

High Level User Meeting, European Parliament Oct 2012
ETN Annual General Meeting April 2013



GDF-Suez, Enel, Endesa, E.ON, Vattenfall, CEZ, EDF, Dong Energy, Contour Global, Shell, Total, Statoil and ExxonMobil

Europe's Competitiveness has taken a hit

Between 2005 and 2012 the electricity price index for the industry in the EU raised with 38% while it was reduced with 4% in the US.

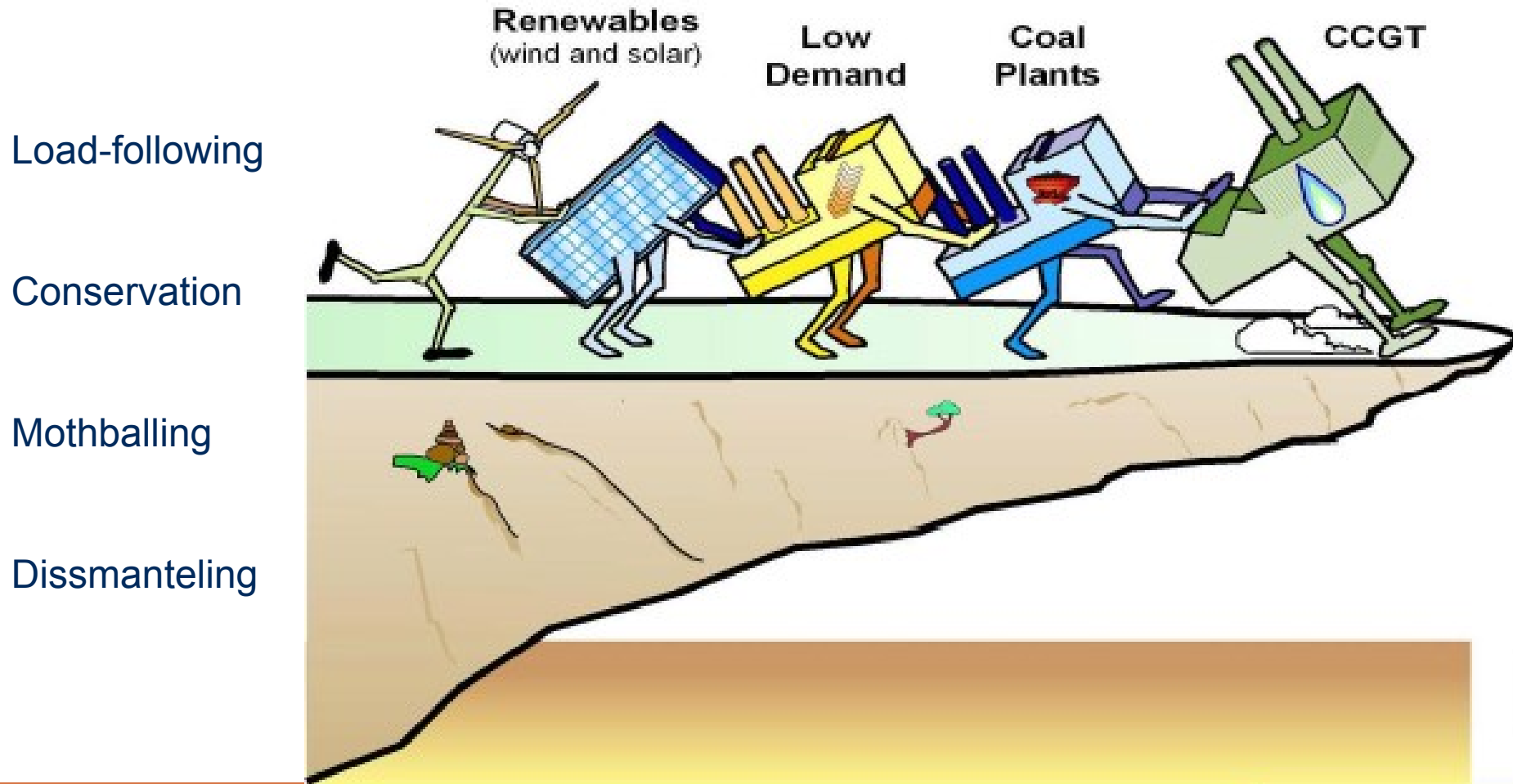
September 29, 2013 2:52 pm

Eon chief warns US energy advantage makes Europe uncompetitive



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CCGT future in Europe

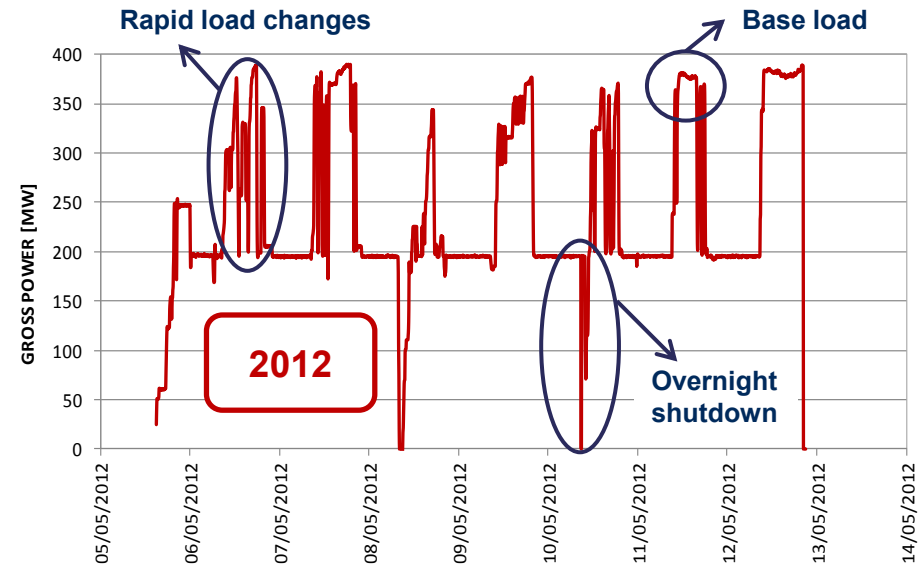
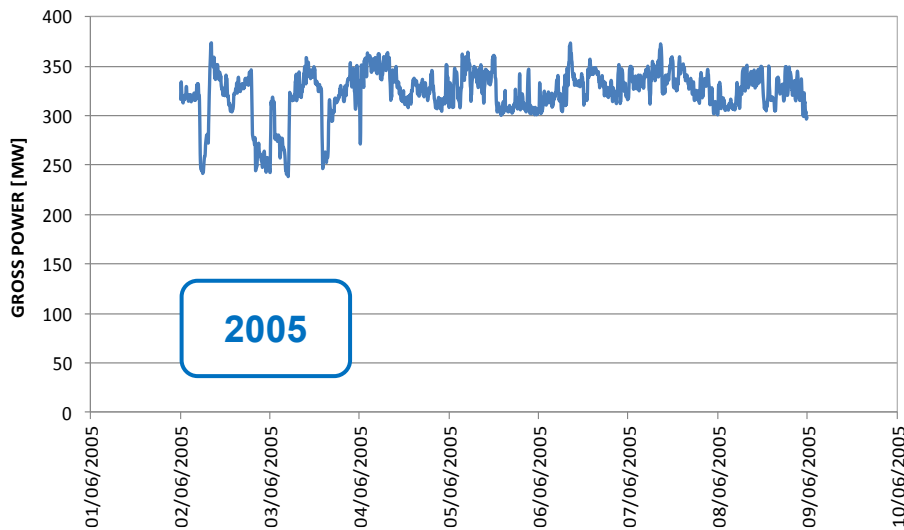




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The new role of GTCCs - Flexibility

Typical weekly trend of a combined cycle power plant



- Increased number of startup / shut down cycles
- Reduced operation at base load
- Operation at minimum environmental load during nights



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Utilities Market Outlook in Europe

- ❑ Strong expansion of renewable generation
- ❑ Overcapacity - no need for new capacity (short term)
- ❑ Renewable generation priority in the grid
- ❑ Shift from base-load to load-following operation due to intermittency of RES
- ❑ New role for gas turbines as capacity back-up
- ❑ CCGT Conservation, mothballing and even dismantling
- ❑ Simple Cycle more interesting due to higher flexibility and lower CAPEX





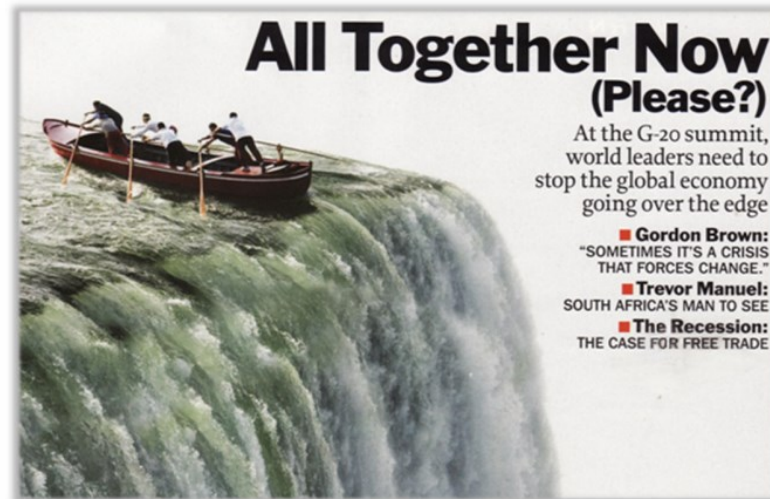
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Oil & Gas Operators Outlook and Needs

- ❑ High power density with respect to weight and footprint
- ❑ High availability and reliability
 - Short down time for planned and unplanned maintenance activities.
 - Long operational hours between (planned) maintenance stops.
- ❑ >60 MW units for mechanical drive
- ❑ Low BTU gas fuel capability (high inert gas (CO₂) content in fuel)



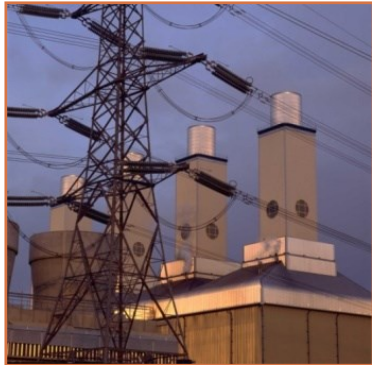
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In Uncertain Times
You Need Cooperation

European Turbine Network

102 Member organisations from 18 countries



Power Generation

**Experiences and Knowledge
from the whole value chain**

■ Users
■ OEM'S

User's experiences/requirements



**Mechanical Drive &
Power Generation**

■ Equipment
Suppliers
■ Service Providers
■ Universities/ R&D
■ Consultancies



Vision

**Environmentally
Sound GT Technology
with Reliable and
Low Cost Operation**

ETN - Platform to Address Member Concerns and to Launch Projects



Committee 1: Cycle Efficiency



Committee 2: Fuel Flexibility and Emissions



Committee 3: Materials Degradation and Repair Technologies



Committee 4: Condition Monitoring, Instrumentation and Control



Committee 5: Asset Management



Example of an ETN
coordinated R&D Project



Low Emission Gas Turbine Technology for Hydrogen-rich Syngas

H₂-IGCC Energy without CO₂

Duration: 2009-2013

Budget: 17.8 M Euro

www.H2-IGCC.EU





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GT Challenges and R&D Needs

ETN's R&D Recommendation Report 2013





ETN's R&D Recommendation Report 2013-14

Chapters:

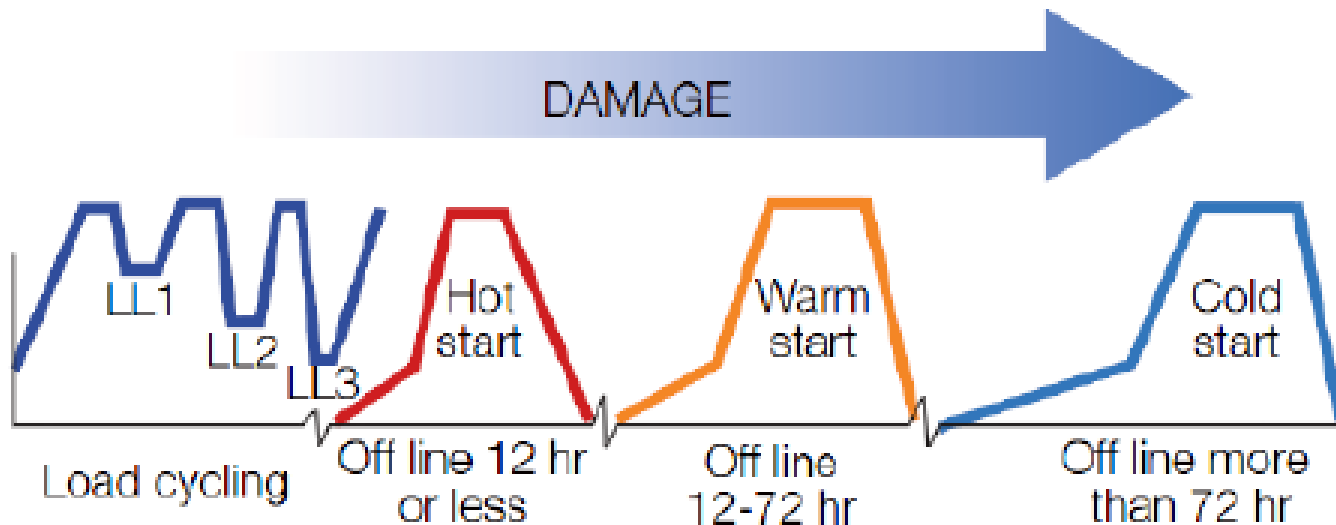
- ☐ Operational Flexibility
- ☐ Efficiency
- ☐ Fuel Flexibility
- ☐ Emissions
- ☐ Carbon Mitigation and CCS
- ☐ Advanced Cycles
- ☐ Materials
- ☐ RAM
- ☐ Condition Monitoring
- ☐ Sensors and Instrumentation

Available on ETN website
in January 2014

Operational Flexibility

Requirements to provide backup for renewables:

- ❑ Fast start ups/shutdowns
- ❑ Fast load changes and load ramps
- ❑ High reliability, long component life under the above
- ❑ High start up operability and load predictability

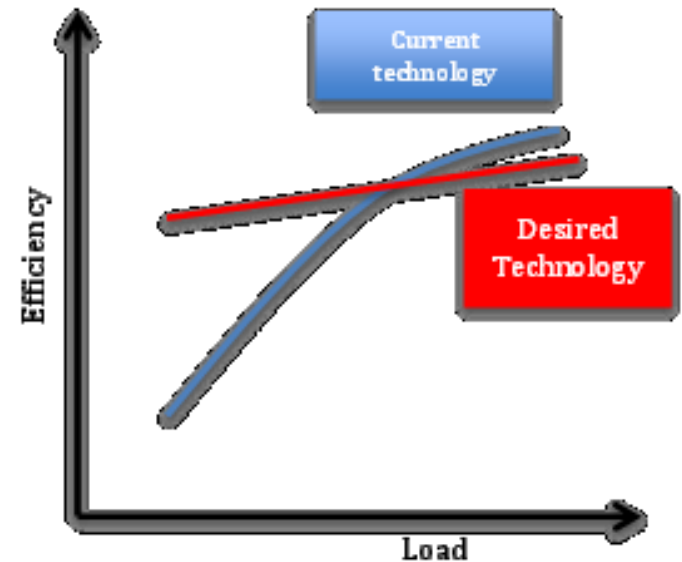




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Efficiency

- ❑ Flexible operation as a base for renewables requires **high efficiency over a wide operating range** achieved mainly through improved part load efficiency
- ❑ **Overall system optimisation** including the bottoming cycle
- ❑ Improved GT efficiency still asks for further **increased TIT and pressure, less cooling air, advanced aero design, improved materials and cycle innovations**





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Fuel Flexibility

Safe operation, with high efficiency and low emissions, on a variety of gaseous & liquid fuels

- ☐ Fast changes in fuel gas composition
- ☐ Flashback / flame blow-out
- ☐ Flame instabilities (causing pressure pulsations)
- ☐ NO_x / CO emission levels

Emissions

Low emission levels of CO, NO_x throughout the load range on a variety of gaseous & liquid fuels

- ☐ Fast load changes
- ☐ High flame temperature / high pressure

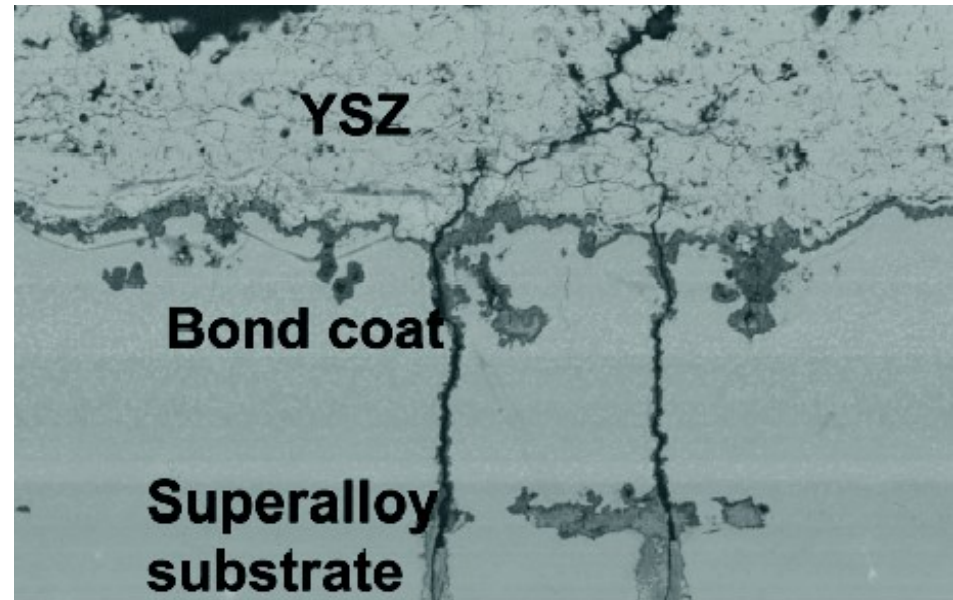


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Materials

Impact from fuel contaminants and flexible operation

- ❑ **TBC spallation and sintering**
– leading to hotspots and blade failures
- ❑ **Excessive bond-coat oxidation/corrosion** leading to premature TBC spallation or damage to substrate materials



Both lead to

- Unforeseen outages
- High repair costs/inability to refurbish blades



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Conclusions

- ❑ EU committed to create a low-carbon economy by 2020 and zero carbon electricity generation by 2050 (97% reduction)
- ❑ Increasing amount of intermittent renewable energy production resulting in new demands on gas turbine operation
- ❑ Gas Turbines Technology main role in the future in Europe will be to stabilise the grid
- ❑ The increasing cost of load following operation and the increasing spread between coal and gas prices squeezes out CCGT in favour of simple cycle GT
- ❑ Many opportunities for GT in a low carbon society with the right R&D investments: energy efficiency (complete operating range); use of low or carbon free fuels; new and hybrid cycles; storage (CAES); CCS



The Future of Gas Turbine Technology

7th International Gas Turbine Conference 2014

14-15 October 2014 in Brussels, Belgium





IGTC-14 Call for Papers

Please submit your abstracts for review papers, case study papers and/or technical papers in the following gas turbine areas and application fields

- **Flexible Operation & Fuel Flexibility**
- **Plant and System Integration**
- **Electricity Operator Issues**
- **Oil & Gas Operator Issues**
- **Manufacturing and Repair**
- **Materials**
- **Turbomachinery**
- **Combustion**

Deadline: 15 November 2013

More information on www.etn-gasturbine.eu

A European Platform for Gas Turbine Technology Development and Cooperation



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