Integration of CCS systems with gas turbines

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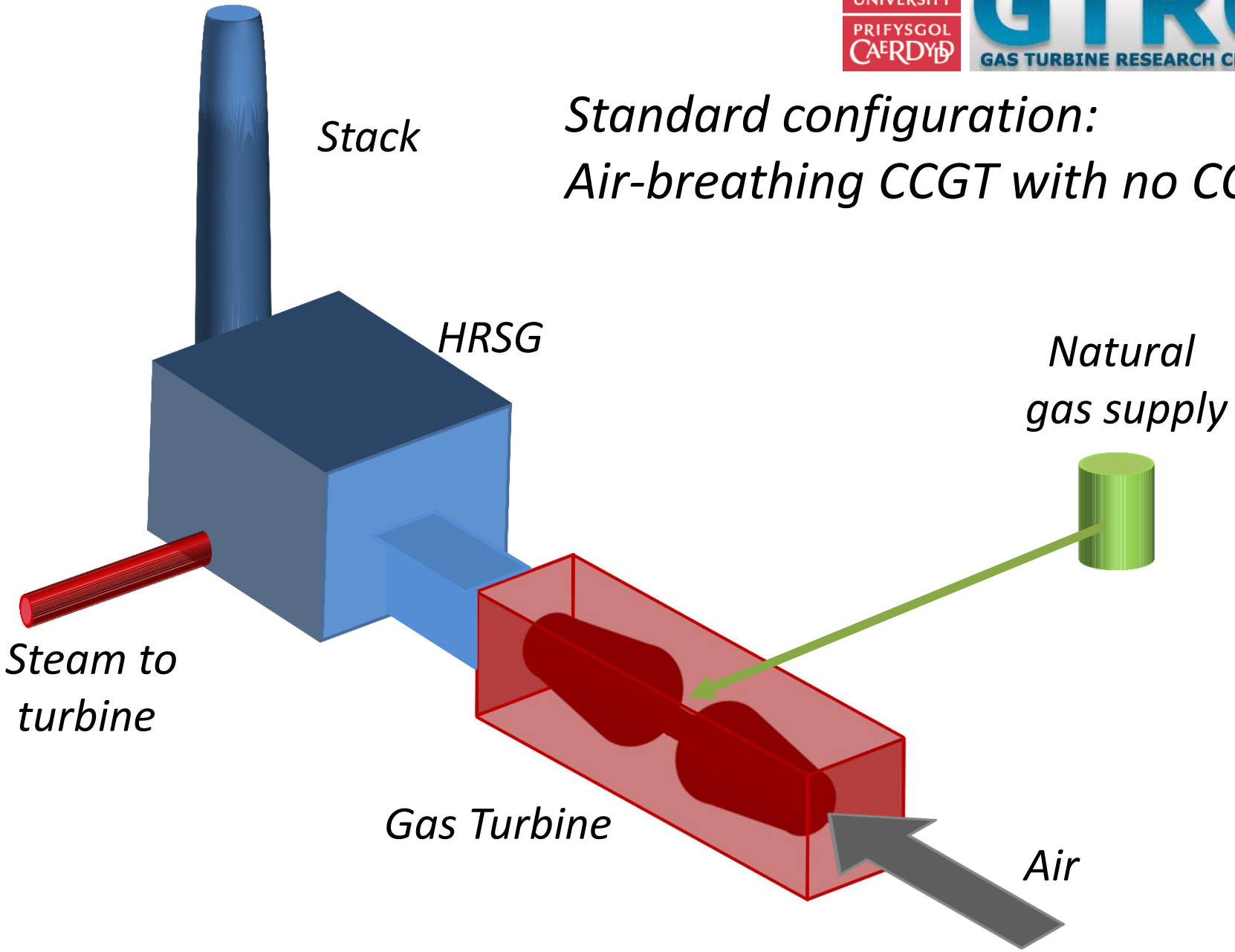
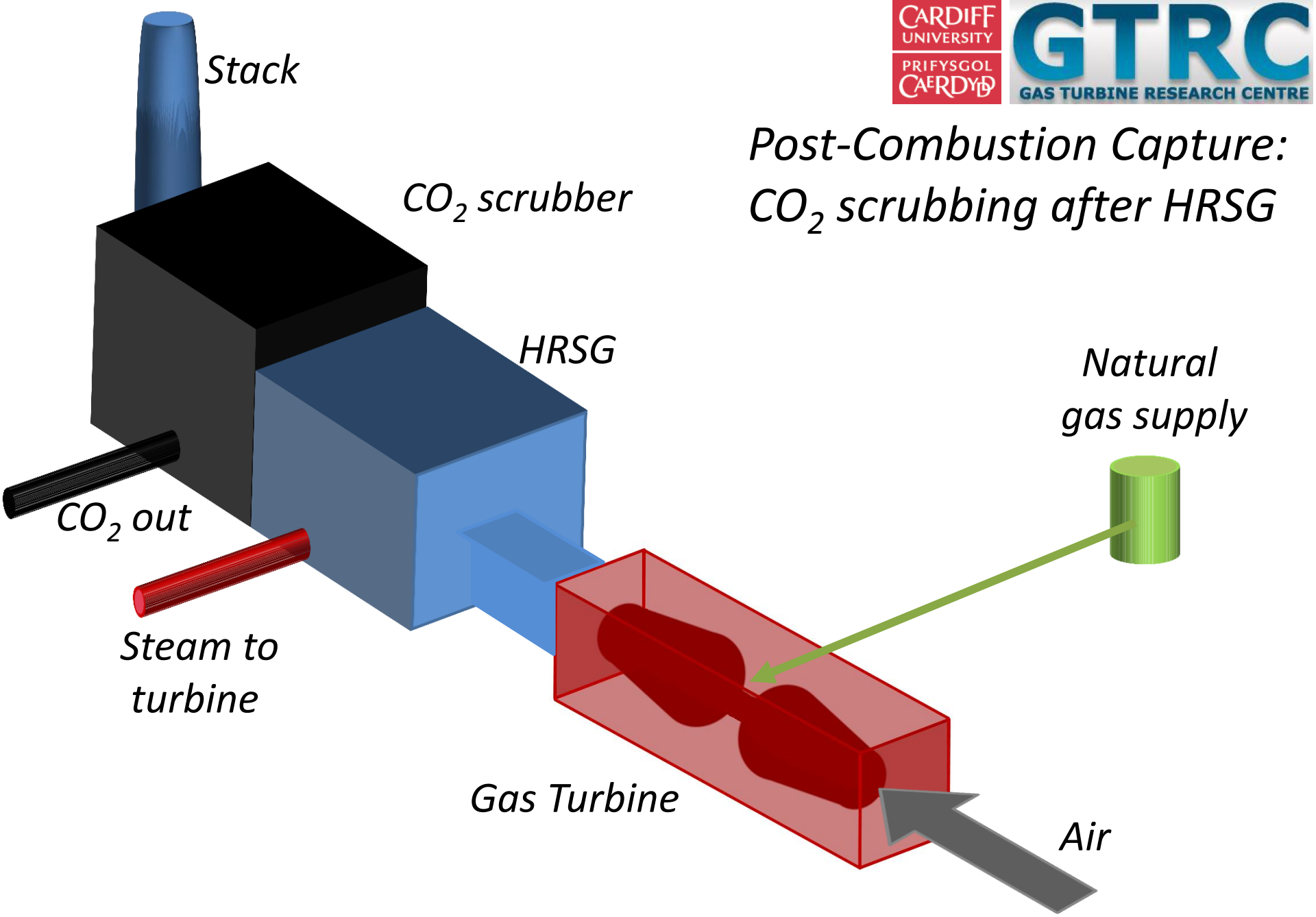
Introduction

- Combined Cycle Gas Turbines (CCGTs) account for 40% of UK's generation potential.
- Likely that this figure will grow, plus gas turbines will be used as stand-by cover for renewables.
- Power generation GTs are sensitive to changes in air momentum and fuel composition, thus major configuration changes associated with CCS must be carefully planned.

Standard configuration: Air-breathing CCGT with no CCS





Post-Combustion Capture: CO_2 scrubbing after HRSG

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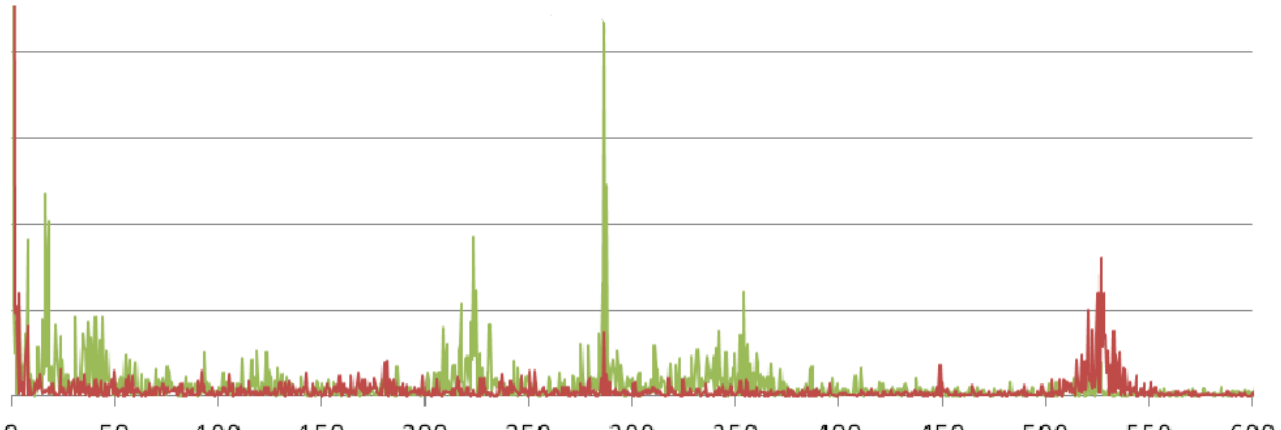
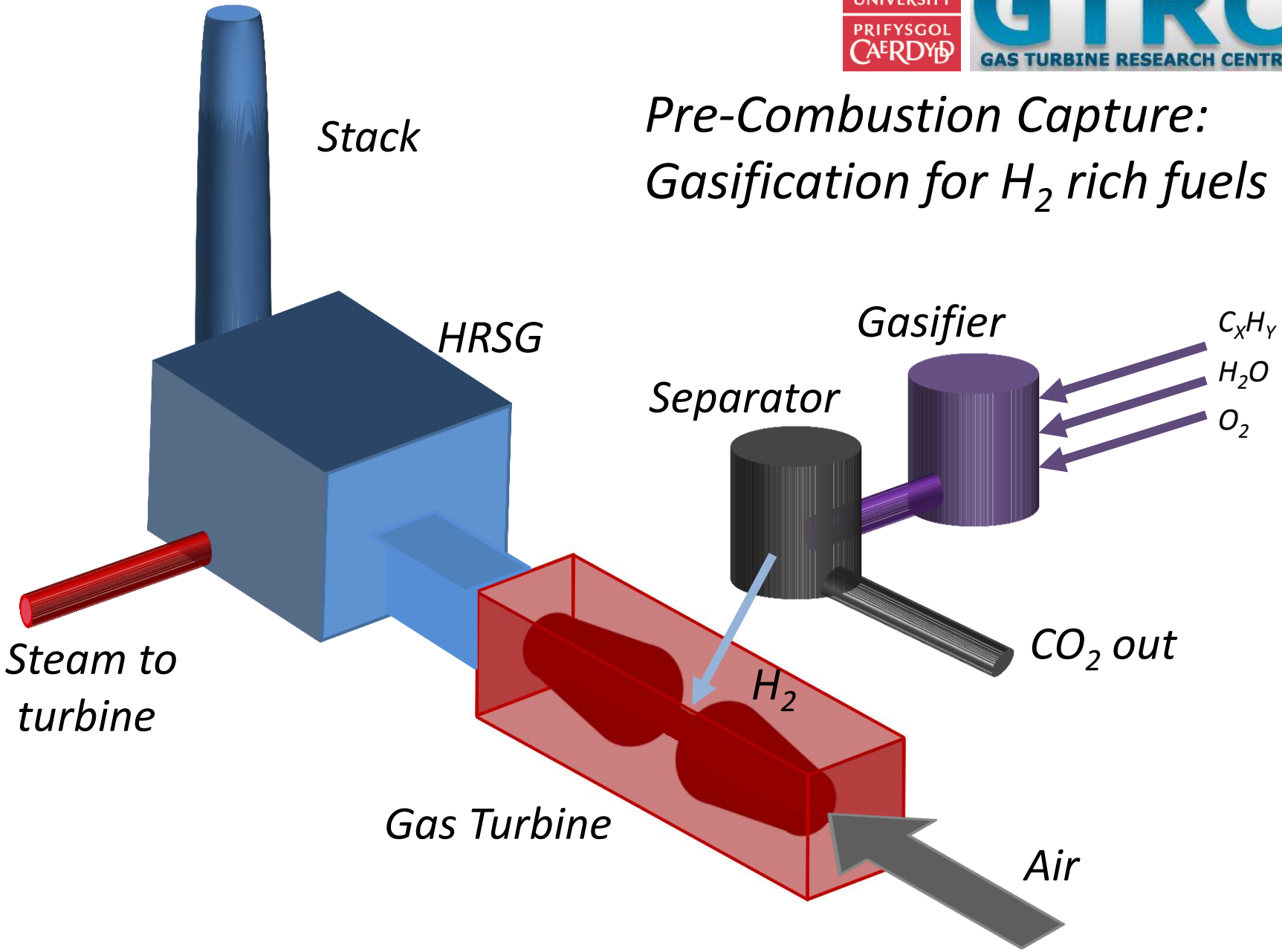
- The CCGT-CCS plant exhaust is likely to be comparatively low in CO_2 concentration, increasing size and complexity of scrubbers.
- There will be some dynamic effects on the G-T's operation:
  - Steam will not always be available to the CO_2 scrubber during GT start up.
  - For the CO_2 scrubber to function optimally, the GT will have to reach operating levels very quickly.
  - Likely that these plants will be used for peaking applications, adding more focus on condition changes.
- Hence there will be challenges with **operational flexibility** and **system stability**.



Power Spectrum. Exhaust in Green and Combustor in Red.

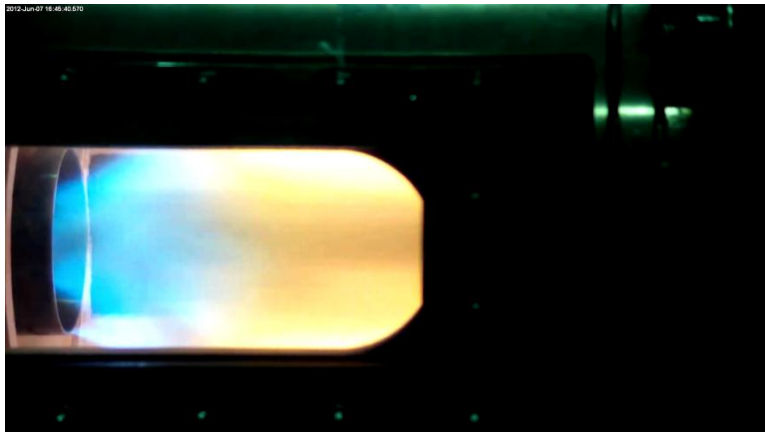
EPSRC
Engineering and Physical Sciences Research Council

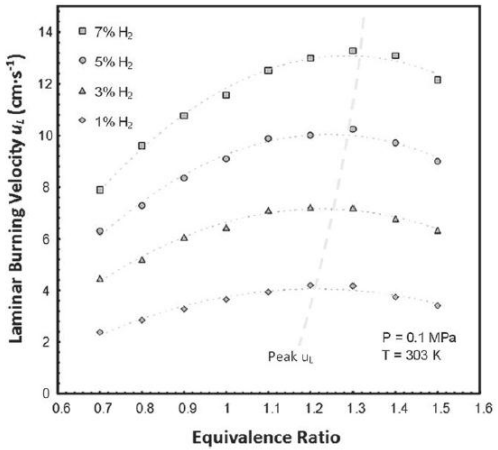
Pre-Combustion Capture: Gasification for H_2 rich fuels

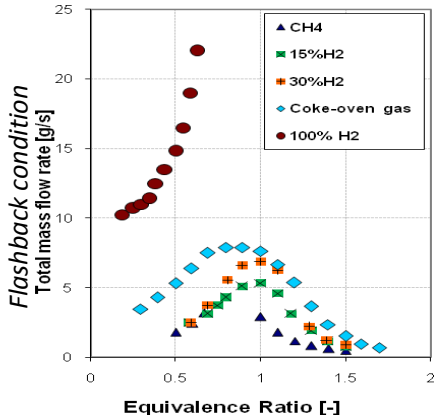


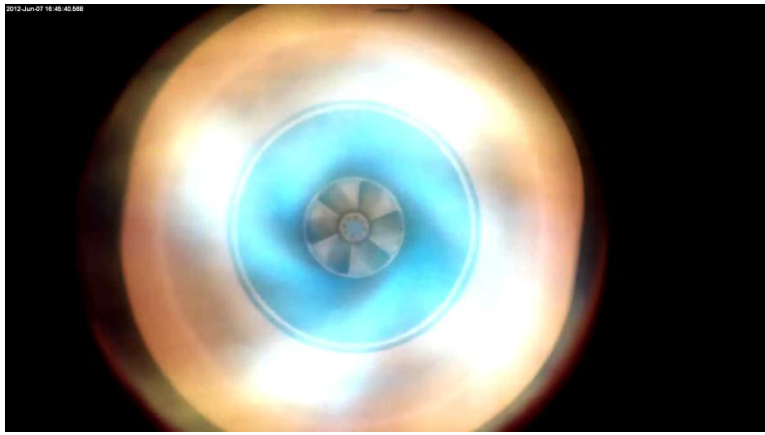
Pre-Combustion Capture: Gasification for H_2 rich fuels FP7

- *The fuel will have a different heating value : density ratio than that of nat. gas. Thus the G-T will need to take account of the momentum differences between different fuels.*
- *The burning velocity of hydrogen is much higher than nat. gas, which is likely to cause flashback. Thus fuel composition is crucial.*

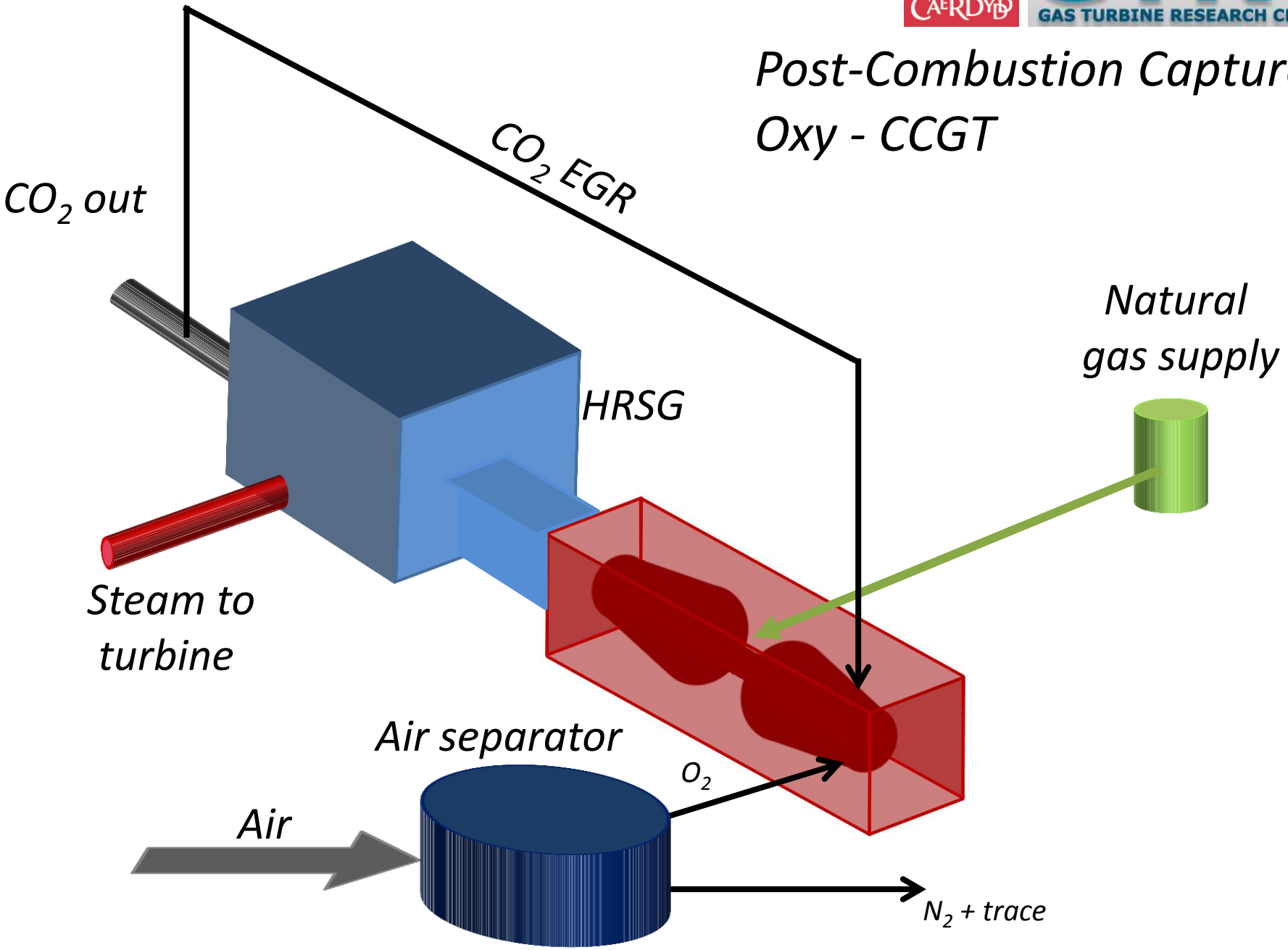






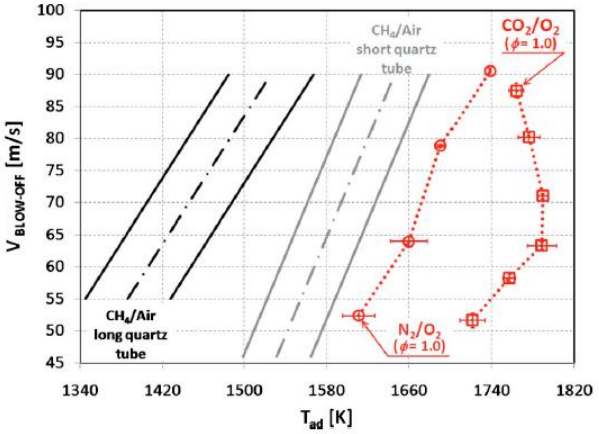


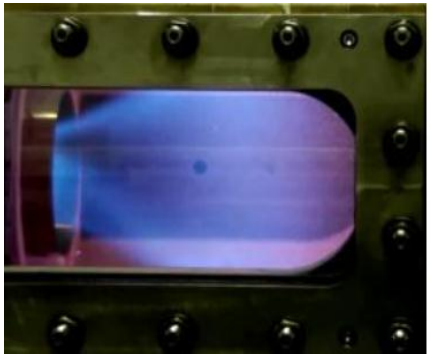
Post-Combustion Capture: Oxy - CCGT

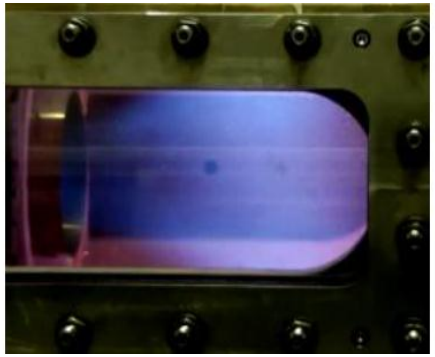


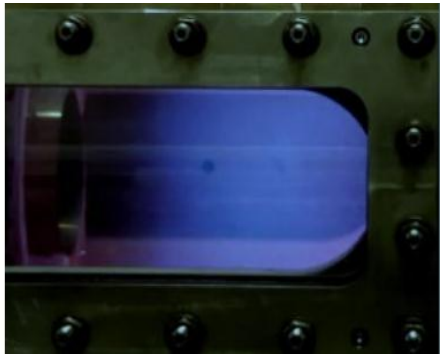
Post-Combustion Capture: Oxy – CCGT UKCCSRC Project.

- The flame temperature is controlled by diluting the oxygen with either steam or CO_2.
- The key challenges are:
  - The aerodynamic design of the gas turbine, which must be modified because of the difference in working fluid properties from that of air.
  - The modification of the combustion process, particularly peak temperatures in the combustion chamber and downstream.









Summary

- Research is therefore needed as follows:
  - Operational flexibility and stability of gas turbines when integrating with post-CCS systems, especially during sudden start-up / shut-down.
  - Stability of operation with high H_2 fuels, plus flexibility to employ a variety of H_2 / CH_4 blends.
  - Sustained operation with oxyfuel systems and recycled CO_2 for thermal moderation.