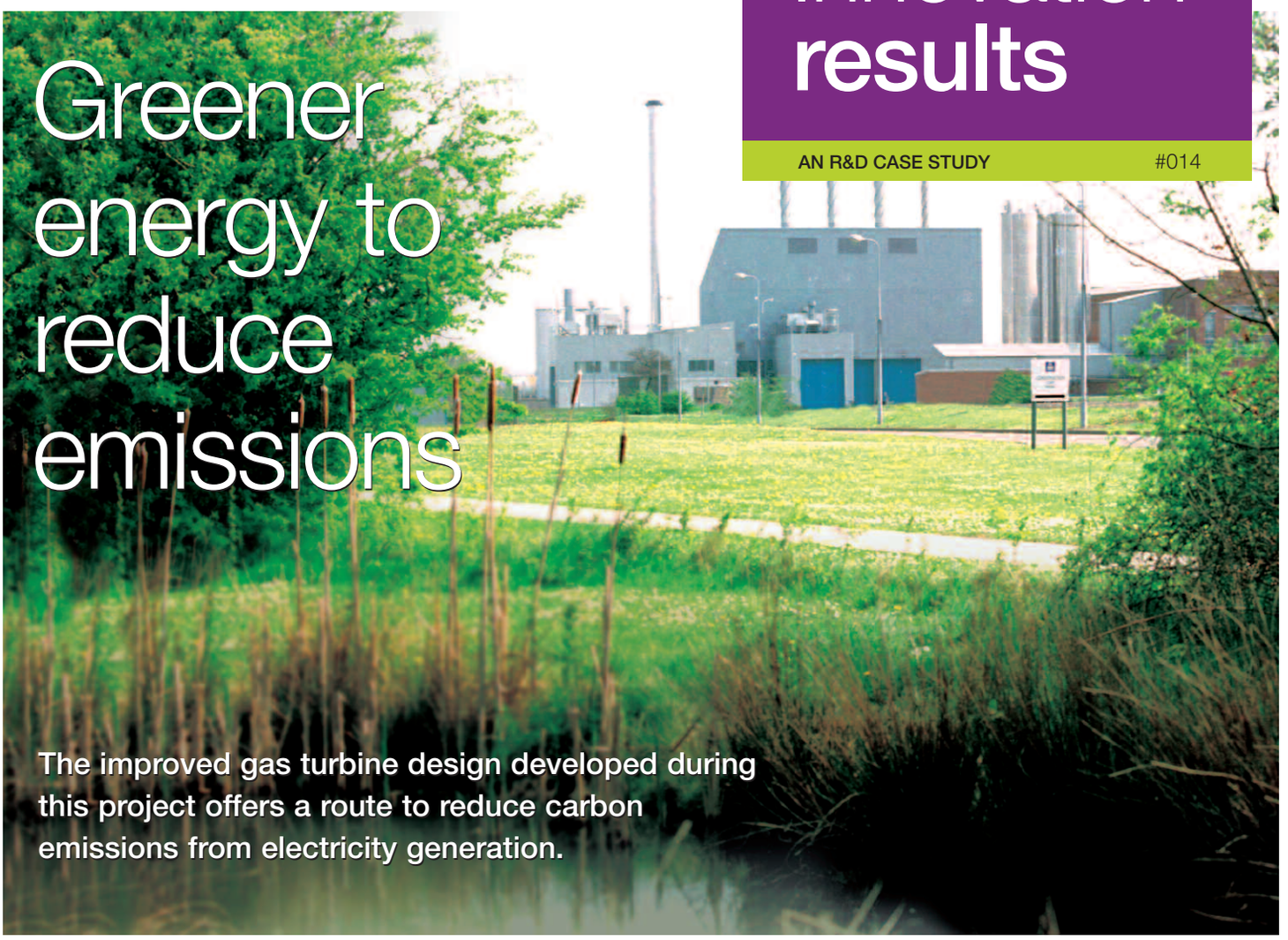
Technology Strategy Board
Driving Innovation

Innovation **results**

AN R&D CASE STUDY #014

Greener energy to reduce emissions



The improved gas turbine design developed during this project offers a route to reduce carbon emissions from electricity generation.

The need

The Government has committed to provide 15% of the UK's energy needs from renewable sources by 2020 to help meet targets of reducing carbon emissions by at least 26% by 2020. Using biomass (plant and animal matter), considered to be carbon neutral when derived from sustainable sources, is one option. The challenge was to show that gas produced from biomass (syngas) through a gasification process can be used to drive standard gas turbines and, hence, generate electricity cost-effectively.

The results

This R&D project used industrial collaboration and innovative design to showcase the potential of the Siemens high efficiency SGT-400 gas turbine to burn the low and medium heating value syngas. As part of the work, the partners had to:

- change the turbine combustion and fuel handling system
- carry out extensive development work on the turbine compressor to accommodate the increased fuel flow required to achieve the same overall energy input as natural gas.

Successful use of the SGT-400 gas turbine depended on the design and manufacture of a scaled-up fuel nozzle that would be suitable for use with the syngas. The partners also created a new compressor, capable of delivering the required flow/pressure characteristics, using advanced design and manufacturing methods. Siemens worked with researchers at Cambridge University to design a high flow, high performance final stage and exhaust system that would allow the turbine to cope with the increased flow rates.

The collaborative work resulted in a design that was suitable for applications using syngas. Performance calculations suggest the design is capable of achieving a net electrical efficiency of 36.25% with such fuels – an increase of over 2% compared with the production model at that time. Any gain in turbine efficiency reduces the amount of fuel used to achieve the same output and thus reduces operating costs.

Biomass

Biomass is obtained from organic matter, either directly from plants or indirectly from waste. The term covers materials such as specially grown willow and farm waste. Biomass can be converted to useful energy through processes such as combustion, anaerobic digestion and gasification.

Comparison of energy content for different fuel types

Future prospects

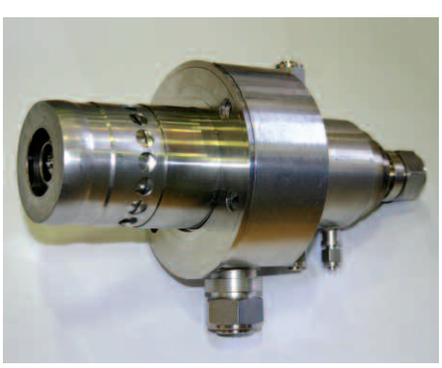
Biomass has the potential to make a significant contribution to the UK's energy supply. In 2008, renewable energy technologies accounted for just 5% of electricity generation in the UK, of which biomass contributed almost half.

Gasification is just one option for the greater use of biomass but, as yet, there are few plants using syngas worldwide. A recent market study estimated that by 2020 biomass gasification could be used to generate 133 TWh/year of electricity and reduce carbon dioxide (CO_2) emissions by over 106 million tonnes (based on 800g CO_2/kW.hr grid generation).

Despite the efficiency gains demonstrated on the SGT-400, the commercial viability of a syngas-fuelled, gas-turbine-based power plant is still questionable, due to the high capital investments required and the need to compress the relatively large volumes of syngas. This situation may change if the conversion technologies associated with syngas move into maturity (ie providing cheaper plant and pressurised syngas).

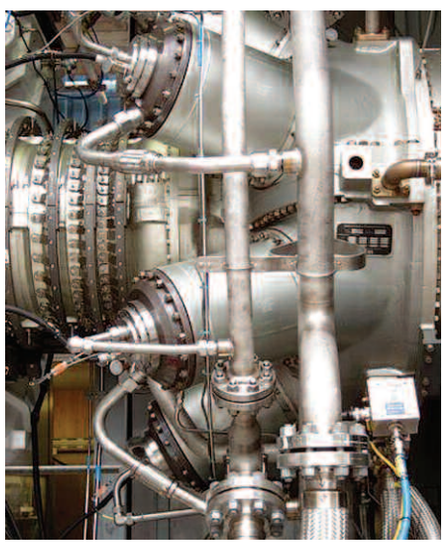
Improvements, such as the compressor design, have already been applied to two turbines produced by Siemens, with predicted improvement in compressor efficiency realised, allowing reduced fuel consumption with associated saving in CO_2 production.

Using syngas to fuel the proliferation of highly efficient gas-turbine-powered combined heat and power plants could contribute significantly to the Government's CO_2 reduction target.



New fuel nozzle for gas turbine

'We have developed gas turbine products to meet future market requirements.'



Gas turbine

Project B_00742

Project partners
Siemens Industrial Turbomachinery Ltd, First Renewables Ltd and Cambridge University

Technology Strategy Board investment
£1.5m

Total project investment
£3.6m

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Technology Strategy Board
Driving Innovation

Collaborative research and development projects are one of the tools that the Technology Strategy Board uses to drive innovation in the UK. The Technology Strategy Board is a business-led executive non-departmental public body, established by the Government. Its role is to promote and support research into, and development and exploitation of, technology and innovation for the benefit of UK business, in order to increase economic growth and improve the quality of life. It is sponsored by the Department for Business, Innovation and Skills (BIS).

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