Project Title: 'THz nanodevices for energy harvesting'
Principle Investigator: Prof Aimin Song (University of Manchester)
Project duration: 15/11/09 – 15/09/10
Grant Value: £144,168

The urgent need to reduce carbon emissions in order to limit the impacts of global warming necessitates action for us to reduce our dependence on fossil fuels by switching to various carbon-free renewable energy resources. In the UK, the government has set up ambitious targets for the production of electricity from renewable sources, 10% of electricity by 2010 and 15% by 2020. Therefore the development of a new low-cost, efficient and environmentally friendly way to generate electricity would be of enormous benefit to society as a whole. This project outlines a plan for the technical and commercial development of 'rectennas' which can be used to convert heat, and later solar, energy from a variety of sources directly into usable electricity. It will also provide significant business opportunities internationally as countries strive to move towards more sustainable ways of generating electricity. This technology has the potential to overcome the fundamental limits of high cost and low efficiency that have limited the success of conventional thermoelectric and photovoltaic devices as low carbon solutions to the world's energy needs.

Heat energy, in the form of infrared radiation, is emitted from any object above absolute zero temperature; the hotter the object the more energy is released. This project aims to develop technology that can harness this energy by converting it into usable electricity using 'rectennas'. Rectennas consist of an antenna, to capture electromagnetic radiation, and a rectifier (requiring diodes with particular characteristics) to convert the energy into DC current. A square meter of material at 700°C, for example, releases about 50kW of energy as heat which would be enough to power 2,500 energy saving light bulbs. The work extends proven technology, shown to be highly efficient (>80%) in the microwave region (GHz), into higher frequencies (Thz) to harvest heat (infrared) from a variety of sources including waste heat from computer chips, car exhausts and beyond. Further development of this technology offers hope of highly efficient light (solar) energy capture. Despite the great potential benefits the device could deliver, the technology is relatively simple and requires only two main components making them cheap to produce and reliable to operate. Antennas that operate at frequencies (infra-red) which allow them to capture heat energy frequencies have very recently been developed, tested and manufactured at low cost however work is required to get rectifiers to operate at this range. Developing recitifiers which are capable this is the main objective of the project and Prof. Song is a world leading expert in the high speed diodes which make up rectifiers, diodes are semiconductor devices which only allows current to flow through it in one direction.

There are numerous possible applications of the technology to harvest energy from a range of heat sources. A system to translate vehicle exhaust heat into electricity could reduce fuel consumption and carbon emission from hybrid vehicles. Converting waste heat from computer chips would reduce carbon requirement for powering and cooling and prolonged battery life of mobile devices. In the short term, the North West, the Joule Centre and the University of Manchester will all benefit from being associated with this high impact, clean tech project that should attract significant media and investor interest. This project also received 99.5k from the University of Manchester Intellectual Property (UMIP) premiere fund.