

**The Royal Society of Edinburgh**  
**The Christmas Lecture 2008**  
***Science and Arbroath in the 21<sup>st</sup> Century***

**10 December 2008**

**Professor Anne Glover**

**Chief Scientific Adviser for Scotland**

**Report by Matthew Shelley**

*Scotland has a remarkable legacy as the birthplace of many great scientists. This tradition is alive and well today as the country continues to be a leader in science and technology. These are strengths of which Prof Anne Glover, who spent her early childhood in Arbroath, believes we should all be proud and on which we can build a great future. Yet the future, not just for Scotland, but for all mankind is in dire danger from the effects of man-made climate change. The threat to the planet can only be averted if scientists, politicians and individual citizens act together to bring about real change and create sustainable lifestyles.*

Science is exciting – influencing every aspect of our lives from the moment we are born. But unlike the arts, music and cultural activities it can seem distant and inaccessible. Yet, from life-saving medicines to iPods we are surrounded by the benefits that science, technology and engineering have brought.

Professor Anne Glover, Chief Scientific Advisor for Scotland, said: “Maybe my only disappointment about a life in science is I feel that science isn’t shared enough with all of our community.” She continued that its sophistication has made it seem remote and inaccessible to those without a background in the subject, when it should be something with which we can readily engage and which we celebrate. Nonetheless, independent research shows Scotland is held in higher esteem than any other country in the world for its scientific research. “That’s something I feel we should be proud of. But it will also be our future. Our economy, our prosperity and our wellbeing will depend on our excellence in science, technology and engineering because we don’t need an economy that makes cheap widgets. If you are the cheapest at making something there is always someone out there who can undercut you, but if you are the smartest it’s very hard for others to compete.”

According to Professor Glover the recently launched Large Hadron Collider at CERN, near Geneva, is a prime example of the importance of science. “To me this defines what it is to be a human. It highlights the difference between us and any other species on the planet that we can build this.”

The collider is located in a tunnel 27km in diameter and is used to accelerate sub-atomic particles, heading in opposite directions, to just below the speed of light before allowing them to crash into each other. The results of these collisions can tell us about the fundamental nature of matter. This research could yield immense practical benefits. It may hold the key to advances like nuclear fusion plants which would, unlike the fission ones of today, create energy without radioactive waste. It is helping us learn how to create medical devices that can cure cancers by targeting individual cells in areas of exceptionally sensitive tissue like the brain. Indeed, we already have enormous benefits from the collider project, as its development demanded a whole new approach to the sharing of information across the globe – giving rise to the internet. “The Large Hadron Collider is an amazing achievement. Sadly, there is much human activity about which to be disappointed, but this has to be one of our ultimate achievements.”

Professor Glover looked at the contribution Scots have made to the world through science in the past. This included Nobel laureate Sir Alexander Fleming who gave us penicillin, and with it the cure to many once-fatal illnesses. Then there was Alexander Graham Bell, credited with inventing the telephone, and the founder of the National Geographical Society. Another great Scottish scientist was James Clerk Maxwell, father of modern physics, who Professor Glover said “taught Einstein everything he knew – metaphorically speaking”.

Today we continue to excel, as the home of great scientists such as Sir Ian Wilmut, whose cloning of Dolly the sheep paves the way for cures to devastating illnesses such as Alzheimer's.

At the same time, the software behind famous computer games and the technology that gives us iPods, are all the result of Scottish ingenuity.

Scotland has also developed the world's smallest TV screen. This is expected to lead to the development of one-way glasses that allow wearers to see programmes on the lenses in front of their eyes. Similar imaging technology is also already being used to help blind people see basic shapes and in future may allow some fully to regain their sight.

Science also has a critical role in addressing what Professor Glover described as "one of the biggest challenges we all face; rapid man-made climate change". This is because it allows us to observe change, explain what is happening, reduce uncertainties and identify solutions. In the case of climate change this may include carbon capture technology or the use of renewables.

To do its job, however, scientists must be allowed to carry out pure research and this will sometimes involve decades of study. The weather observations carried out in the Antarctic from the 1950s onwards did not at first sight offer any practical returns on investment. But over 20 years scientists began to see changes taking place and discovered that the CFCs, the chemicals once used in fridges and aerosols, were creating a hole in the ozone layer which protects us against damaging ultraviolet (UV) radiation from outer space. "UV radiation causes cancers, skin cancers for example, so it's very dangerous. Ozone protects us from that and the ozone layer is very fragile. "But the really comforting thing is that the world's population and our political leaders recognised what was happening, they understood the science, and put a ban on CFCs. "The outcome will be that hopefully by the end of this century we will have repaired that hole in the ozone layer. "So that gives us cause for optimism that we can face big problems and do something about them."

The big problem we face now is the greenhouse effect being created as human activity causes the release of more and more greenhouse gasses, particularly carbon dioxide, into the atmosphere. This traps heat rather than allowing it to escape into space. We only know this is happening thanks to rigorous scientific research. By analysing ice core samples from the Antarctic we can look at the amount of carbon dioxide present in the atmosphere in the past which became trapped as ice was laid down. This shows that it fluctuates naturally due to wobbles in the Earth's rotation, meaning the planet shifts between ice ages and warm spells every 120,000 to 130,000 years.

Over the past million years the concentration of CO<sub>2</sub> in the atmosphere has varied between 180 parts per million (ppm) when the world is cold to 280ppm when it is at its warmest. Even though we are just 30,000 years out of the last ice age the current levels of CO<sub>2</sub> have changed dramatically. "I hope it will shock you to learn that the present levels are over 380ppm. Never in history, as far as we have been able to go back through the ice core, has the concentration ever been that high. "And that is because of human activity."

Since the 1950s there has been an enormous increase in population, energy production, air travel, car use and the consumption of goods, especially plastics. "We are responsible for all these extra greenhouse gasses. What it does is acts like a fleece blanket. What we are doing is putting more fleece blankets round the Earth and that's warming up the surface of the planet." This causes the ice at the poles to melt which threatens to raise water levels by six to seven metres – which would leave places like Arbroath submerged. "If you think of much smaller rises, they would leave countries like Bangladesh entirely underwater. That's going to affect all of us because when that happens the people of Bangladesh have to go somewhere. All round the globe people will be fleeing from coastal regions and if you think about where our population is it tends to be in coastal regions."

Current predictions are that the heatwave of 2003, which brought a wave of deaths in Europe, will seem like a cool summer by 2050. At the same time new diseases like Blue Tongue, which is already affecting UK livestock, will arrive as there are fewer cold spells to kill out the carriers of disease in the winter.

Professor Glover showed maps of how the coastline might change if worst fears are realised. Within around 40 years low lying areas of Scotland, like the Old Course at St Andrews, could be swallowed by the sea and by 2100 the British mainland could be a scattered patchwork of islands.

“Why it’s different from in the past is that we fly everywhere and think nothing of it; we think nothing of driving around as a single person in a car; we demand goods and services and foods from overseas; we are not content only to have our raspberries and strawberries at a certain time of year. The only way we will be able to cope with this problem is if all of us change. And actually it is one thing where tiny acts by individuals can make an enormous difference.” This might be directly by walking not driving, or through example by holidaying in this country rather than abroad which encourages others to do the same.

Professor Glover said she is very proud that Scotland has just announced the £10 million Saltire Prize, the biggest ever environmental prize to be awarded for the generation of a threshold amount of power from wave or tidal resource. “Scotland, a very small country, is doing something very big to address a global problem and this is displaying scientific leadership.”

The Professor called on everyone to save energy and reduce consumption. “What’s the reward if we do this? The reward is that we protect the planet on which we live. It is the most awe-inspiring planet, no matter how flashy Saturn is with those rings, there’s nothing quite like this and we need to protect our place on the planet.”

Professor Glover ended with an observation she found optimistic, but said others might find pessimistic. “We are a very young and inexperienced species and it’s very hard for us to cope. We think we are smart, we think we are sophisticated, but we are not and we are making a mess of things at the moment. “It’s possible that we won’t get ourselves out of this hole. But for me the comforting thing is that if we disappear from the planet there will still be microbes, and the thing about them is they grow, they develop, they evolve.

“Maybe next time round there might be the evolution of a species of human that is slightly more considerate about the planet than we are.”

*Following the lecture the Chair of the session, President of the RSE, Lord Wilson of Tillyorn, thanked Professor Glover and led a question and answer session.*

Asked if she believed humans were capable of moving away from the use of fossil fuels and a consumerist society before it’s too late, Professor Glover said the choices are stark. One reason for hope is that research suggests people were happier when life was simpler in the 1950s, so we might discover we prefer another way of life.

The Professor was asked her view on the USA’s decision to invest large sums in propping up a car industry that causes pollution. She responded that we are not always good at swift changes of direction. But we do have a window of about 10 –15 years during which relatively modest changes will be able to mitigate the affects of climate change.

Asked if Scotland can meet its simultaneous targets for economic expansion and major cuts in CO<sub>2</sub> emissions she said both might be possible, in part because the country has 40% of Europe’s renewable energy resources. But the Professor went on to question why we are seeking growth and argued that the emphasis must be on sustainability.

Professor Glover was questioned on whether she thought the increasing inequalities in society fuelled consumerism by encouraging people to desire ever-more products and services. She responded that ordinary citizens have a role in making it easier for politicians to propose measures that will change society to make it more sustainable.

The vote of thanks was given by Dr David Keeble of the Institute of Physics, which was the joint sponsor of the event. He noted that it was the last in a successful year-long series of RSE events in Arbroath for which he also thanked the Society and its staff.