would be the nutrients required for secondary fermentation at a regional hub.

AGRICULTURAL SUSTAINABILITY

Though straw is of secondary importance to grain, it still has a great value to agronomy and some of its carbon and nutrient value needs to be retained on the farm. In effect, crop utilisation in countries like the UK is already very efficient and diverting biomass for industrial processing would need some careful environmental evaluation.

BIOREFINED PRODUCTS

The outputs of biorefining need to be compatible with the needs of the chemical industries which have been built up around oil refining for decades. This is where the ability to engineer metabolic pathways in microbes to produce chemicals which are entry points into existing chemical processes is vital.

By identifying these challenges we can immediately see that the science of biorefining requires inputs from the public and private sectors at levels ranging from the international to regional. At the higher level, biorefining needs concerted science and technology programmes integrating the disciplines of plant breeding, microbiology, enzymology and chemical engineering. In the UK this level of organisation is provided through the BBSRC's 'Integrated Biorefining Research and Technology Club' (IBTI), in a partnership with UK-based industries. At the regional level, biorefining has the capability of addressing the local needs of farmers and food processors with the ability to fine tune the processes to the needs of the available biomass or waste stream.

Working at both the national and regional level, the Food and Environment Research Agency (Fera) has identified biorefining as a key area for development in partnership with public and private sectors and one which complements its existing science capability. For example, its work with seed breeders could be usefully developed to look at new traits for feed-stock use in biorefining, while its analytical services would help develop efficient processing technologies for the wide diversity of plant materials used by the food industry. The agency would also be able to provide expertise in environmental impacts of this new industry. Whatever the inputs, importantly in a rapidly changing world organisations such as Fera need to be able to flexibly partner with Universities and industry to develop new technologies such as biorefining which address national needs in food security and environmental sustainability as we draw closer to the storm ahead.

RUSSIA: MODERNISATION THROUGH SCIENCE AND INNOVATION

Dr. Julia Knights, First Secretary, Science and Innovation (S&I), British Embassy, Moscow

Russia is taking many positive steps towards modernising its innovation infrastructure and strong opportunities for UK industry, consultancy and research collaborations exist.

This year the UK Science and Innovation Network (SIN), funded jointly by FCO and BIS with a remit to cover international science and innovation, set up a new section within the British Embassy in Moscow to capitalise on recent opportunities for the UK in research and industry collaboration with Russia.

President Medvedev's Commission of "Modernisation and Technological Development of Russia's Economy" set up in May provides one of the major opportunities for the UK. £211 million is available this year for technological breakthroughs in five themes: energy efficiency, nuclear, space and communications, energy efficiency, medical and information technology (including supercomputers).

A £3.23 billion energy efficient innovation city named "Skolkovo" dubbed "Russia's Silicon Valley" by the Russian media, will act as a testing ground for new economic policies to stimulate commercialisation of scientific research through the Commission's five themes. International architects have been invited to design for the masterplan project worth over £90 million covering 380 ha of

greenfield on the outskirts of Moscow.. And up to three major international partners for each of the five themes are being invited to set up joint R&D programmes with Skolkovo's university partners as well as business incubation and innovation ecosystem support. MIT, Boeing, Google, Microsoft and Intel have all shown interest. Both S&I and UKTi have made UK business aware of these opportunities and the first energy efficiency project under negotiation is between the Moscow Institute of Steel and Alloys (MISA) and the UK's Cambridge University.

Investment in National applied science projects offers another opportunity for the UK. Up to seven designated National Research Centres are being created of which the Kurchatov Institute (KI), on the outskirts of Moscow, famous as the brainchild of the Tokomak, is one. Boasting a new state of the art "Nano Bio Info Cognitive" Centre, a new synchrotron radiation centre with over 30 beamlines, a neutron research reactor for nuclear and solid state physics research and a 600 TB supercomputer, its director Professor Kovalchuk welcomes further collaboration with UK researchers.

Opportunities for collaboration in applied Nanotechnology also exist through £1.41 billion dedicated for applied nanotechnology over 5 years and a "National Nanotechnology Network" (NNN) encompassing leading Russian universities and research centres. The KI will co-ordinate their scientific research and Rusnano (the Russian Nanotechnology Corporation) will take the nano products to market.

Space industry opportunities exist too. £520 million will be spent over the next three years on the new Vostochny Cosmodrome in the Amur Region, to take on some satellite launch duties from the existing Baikonur Cosmodrome in Kazakstan. £370 million will be spent over nine years on developing a nuclear-powered spaceship that will fly to Mars. A new generation Angara rocket is due to be tested in 2013. And "Glonass" a navigation system to rival the US's GPS is being developed as one of four space projects funded under President Medvedev's Commission.

UK researchers also have much to gain from Russia's increasing international engagement. This summer for example, Russia's Ministry of Education and Science (MES) announced a call for £254 million open to the international science community for joint research projects lasting three years with Russian science groups. Involvement in international large science facilities is also a reason for UK researchers to have an interest in Russia. The largest financial contributor (£210 million) to the International Thermonuclear Experimental Reactor (ITER) in Hungary, Russia is also a strong contributor to the European ExFel project in Hamburg. Whilst around 700 Russian engineers and researchers work on the Large Hadron Collider at CERN in Geneva, Russia also participates in The European Synchrotron Radiation Facility (ESRF) and the Facility for Antiproton and Ion Research (FAIR). MES has requested to become an Associate Member of EU Framework Programme 7 which if successful would also involve a substantial financial contribution from Russia.

Challenges for any UK business or researcher do of course exist, not least red tape, poor IP protection, weak law enforcement and trained expertise. Most of the civilian R&D research budget is spent on applied research and links between research and industry need to be strengthened.

President Medvedev aims to tackle all these challenges through his Modernisation Commission and in his landmark "Forward Russia" article in September 2009 he instilled some confidence in businesses with his words "We have to create a modern efficient judiciary, acting in accordance with new legislation on the judicial system and based on contemporary legal principles".

Although the volume of research publications has weakened considerably in recent years (29,000 papers in 1994 vs 27,600 in 2008)*, Russia certainly has no shortage of intellect, remaining notable in Nuclear Physics, Particle and Fields and Multidisciplinary Physics representing 10.2%, 9.9% and 8.0% of World output. Further opportunities for UK researchers to collaborate in joint research can also be found in areas where Russia maintains its strength including in Petroleum Engineering (8.9%) and Geochemistry and Geophysics (7.9%)*. Key growth areas between 2004-2008 which reflect opportunities for UK researchers include Neuroscience and Behaviour, Environment Ecology, Clinical Medical and Geosciences*.

The UK is in a strong position to forge new and enhance existing collaborations and industry links in all of President Medvedev's five Modernisation Commission themes. With that in mind our Science and Innovation (S&I) section in Moscow is working to identify such opportunities within Russia's key science cities. We are doing this through a raft of activities including science missions, innovation round tables, Science Cafes and business breakfasts throughout Russia showcasing the UK's expertise of research to commercialisation.

The first business breakfast will focus on energy efficiency to coincide with the Nano Knowledge Transfer Network delegation of clean tech companies attending the Rusnano Forum in Moscow in November. The first Science Cafe will be held during Moscow Science Festival this October on the UK's and Russia's joint contributions to the Linear Collider.

The S&I section is also working to highlight the UK's science offer through bilateral agreements including a "Year of Space Science" in 2011 as a follow up to the UK Russia MOU on Space Science which was signed in July between the UK Space Agency and the Russian Federal Space Agency, Roscosmos. This will also coincide with the celebrations of the 50th anniversary of Gagarin's heroic space flight.

* Thomson Reuters. (2010). Global Research Report – Russia – Research and collaboration in the new geography of science

To find out more about the work of the S&I section in Moscow, please visit us at http://ukinrussia.fco.gov.uk/en/about-us/working-with-russia/004-embassy-departments/science-technology