

IGCW CONFERENCE

## 'Most assumptions about chemistry, chemicals, fuels and green chemistry will be proven wrong in the next 20 years'

Today, we have about 500-mn people in this planet who have an energy-rich lifestyle and most of them are located in the western world. And there are 5-bn people elsewhere who want this energy-rich and resource-rich lifestyle.

This will need a lot of resource multiplication. This resource issue can be met only through technology and these new technologies should multiply resources so that 5-bn people can have the same resources that 500-mn people in the west have. The resources and technology are the same, but the issue is one of access.

I am passionate about green chemistry. I would like to talk about all the possibilities and may be some examples of exciting companies and products that are coming out.

First, we must talk about what not to think about. I do not believe in most of the experts and their forecasts. These experts project what the world will be and what the market size will be. They are often wrong about the future.

Many things have changed in the last ten years. Mobiles in India are an example. If the future is going to be like yesterday, these experts can be right. We can extrapolate the past, but it very difficult to predict the future. I believe that to predict the future you have to invent the future.

One of my favourite quotes is from George Bernard Shaw, who said, "All human progress depends on the unreasonable man."

I am submitting that similar changes are happening every single day in the green chemistry space.

One of my other favourite examples is very relevant to India. Ten years ago nobody imagined the role of mobile

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phones, i.e. by 2010, 600-mn people here will have access mobile phones. Only 300-350 mn of these people have access to toilets. Hence, 300-mn people in India decided that it pays to have a mobile phone than have access to toilets. This is hard for experts to predict – that twice as many people that have access to toilets will have access to mobile phones.

My submission to you is that many such assumptions will be proven wrong in the next ten years. Most will be proven wrong in the next 20 years. This is so true for any assumptions about chemistry, chemicals, fuels and also green chemistry.

**VINOD KHOSLA**  
Khosla Ventures

### Role of innovation

In all these cases, innovation comes from unlikely places. My favourite example is of a well-grounded company with lot of research, GE. Their logo is a light bulb. Yet, it was a small company, which has done more in innovating the light bulb than GE has.

Google, Facebook, and Twitter have done more in innovating media than any of the large media conglomerates. Amazon has

done more in innovating retail than WalMart.

In almost every area change – radical and catastrophic change – comes from the fringes and then starts to grow exponentially. I suspect that the same thing will happen in green chemistry.



### Green chemistry and economics

Green chemistry is not just about chemistry, but is about chemistry and economics. The reason I say that is because many people who focus on green do not focus on economics.

My first rule in defining technologies in green chemistry is that they do not defy the laws of economic gravity. This says that the cheapest thing always works. So 'green' is a feature of the most economic way to produce a product. It is not a product by itself. This is what we should aim for. This means not accepting the *status quo* of what you read in the press of new inventions in green. It is about inventing the future we want.

Green products are those that are cheaper and better than their fossil-based competitors and could broadly be used in places like India and China. Unless the green product meets the 'India price', i.e. the price it could be bought in India, and is cheaper than its fossil competitor, it will not have large markets.

### Innovation and failure

The way to get there is through technical innovation. Innovation always in-

volves risk. Risk always involves failure. So, one of my other key urgings to you is being willing to take risks and willing to fail. I always say that it is my willingness to fail that gives me the ability to succeed.

This absolutely is the key to innovation – the willingness to take risk that might not work and that might cause failure.

What we try to do is that when we fail we ensure that the failure is small. We quickly correct ourselves and fix the

*“It is my willingness to fail that gives me the ability to succeed”*

problem or abandon the technology. If the project is a success then it is important that the success is launched.

Most people reduce risk to a point where technology jumps are inconsequential and impacts are marginal. What is really important is that we take large technology jumps. A failure is a small failure and a win is huge win. We take risk and accept failure.

### Portfolio of Khosla Ventures

I will talk about a few things we

have done in the last 4-5 years, in our portfolio at Khosla Ventures.

From Sep 2010 to Sep 2011, we had roughly three ideas accounting for over US\$2-bn in value – all of which were just ideas in somebody's head just five years ago.

### Amyris

Amyris is the in the business of isoprenoids. They are making lubricants, diesels, alkanes and polyisoprene rubber substitutes all from renewable sources, i.e. sugars.

When we first met them they were doing a pharmaceutical product, farnesene, an anti-malarial drug. We asked them that if you have these genetic pathways into organisms, could you produce other isoprenoids? Could you produce alkanes or fuels or specialty chemicals? Their answer was most likely and they went back and tried making it in their lab. Six months later they were producing fuels.

That is how these ideas get started – small, simple and short. Then we embark on the long path, i.e. improve yields, improve products, increase resistance and develop the chemical processes to go with these microbes. Another company was making C18 fatty acids, alcohols etc. We asked them if they could engineer a cell to excrete the product it makes. From that small idea a private commercial company with number of arrangements was born.

### LanzaTech

LanzaTech is one of my favourite companies. They use exhaust gases from steel mills, refineries or chemical plants, which are partially combusted to carbon monoxide. They turned that carbon monoxide and the energy in it into alcohols. They started with ethanol produced from exhaust gases of steel



works. Now, they can not only make ethanol and acetic acid, but also propanol, butanediol, isoprene, succinic acid and wide range of products by genetically engineering the process. They have formed an association with Posco Steel and others and have a relationship with Indian Oil Corporation.

### **Segetis**

Segetis is another example, where levelunic acid is used as a platform chemical and levelunic acid ketals are made. They are making renewable solvents used to make products that are replacements for phthalates which are hazardous.

Another small company is making SAP not from green products, but making them biodegradable. They will be making these from renewable ethanol.

### **KiOR**

One of the most exciting companies is KiOR. They use wood chips and turn it into crude oil for blending into gasoline.

They took a very simple idea: Biomass is mostly hydrogen, carbon and oxygen and nature takes 1000 years to deoxygenate biomass and make it into hydrocarbons. They could deoxygenate the biomass catalytically and they used a chemical process very much like an FCC process. They call it DCC.

KiOR is a public company. They are using wood chips and producing pyrolysis oil and their first commercial facility will be online next year.

The Department of Energy in the US has defined 12 platform chemicals. I believe each of these will become a platform for a new class of chemistry – not only green, but also cheaper than fossil-based products.

### **Focus on IP**

My urging to you is to focus on creating intellectual property (IP).

All it means is risk reduction. Most people think it is spending, but to me it is risk reduction. You could do what

China does to your products or do R&D and create proprietary knowledge. If you take risk of working with these start-ups and leverage the new ideas you could minimize your unmanaged risks.

It is highly possible that in five years we might see oil at \$200 per barrel. How are you going to manage that risk? I believe partnerships with more innovative companies will minimize your long-term risks even though you feel you are increasing costs.

The world has changed. Pharma, biotechnology, media and software have all changed. I believe that it will change in chemistry, chemicals, specialty chemicals and in the large-scale fuels business. People with the most breakthrough technologies will be successful.

The winner will take all.

[Text of address made by video conference at the IGCW Conference in Mumbai on 4 December, 2011].