

The spoken word counts.

## Key Note Speech Feike Sijbesma - CEO Royal DSM

World Congress Industrial Biotechnology (& Bioprocessing) in Toronto (Canada) -  
May 9, 2011 - George Washington Carver Award Acceptance Speech

- I am very honored to be among the recipients of the George Washington Carver Award for my vision and contribution regarding the development and innovation in Industrial Biotechnology, by Royal DSM's efforts in this field, as well as my former Board Membership of BIO (US) and Chairmanship of EuropaBio,
- The GW Carver award recognizes the impact industrial biotechnology is having and further will have on society. Carver was (a century ago) the founder of the so called "chemurgy", the first description of industrial applications of biotechnology. Carver's vision is put into everyday's practice! Products made from renewable agricultural feedstock, impacting economics and sustainability at the same moment: the start of the bio-based-economy.  
Using biotechnology not only for making new biopharmaceuticals ("red biotech") and new genetically modified crops ("green biotech") but also for industrial applications (*sometimes called "white biotech", introduced by FS when he was Chairman of EuropaBio, red.*) like: developing new food-ingredients, new health solutions, cosmetics, new bio-materials/chemicals and alternative energy sources like bio-fuels, all out of renewable feed-stocks.
- As Brent Erickson of BIO mentioned, the list of previous winners is a prestigious one, esteemed colleagues I feel honored to be amongst, like:
  - Patrick Gruber, CEO Gevo (former CTO Dow-Cargill Nature Works), a pioneer
  - Charles Holliday, former CEO and Chairman of the board of DuPont and:  
Gregory Stephanopoulos, Willard Henry Dow Prof of Chemical Engineering at MIT and the father of metabolic (pathway) engineering

Also I feel honored by the scholarship given in name of the recipient!  
It is important to having the next generation further building on this exciting future.

- I see it as recognition of the transformation that DSM has gone through and the contribution that all DSM employees have made to this transformation.
- As you may know DSM began as a coal mining company over a century ago and since then transformed itself to a predominantly 'bulk-chemicals' company and from there to the company we are today: a global Life Sciences and Materials



Sciences-based company, active in Health, Nutrition and Materials, whose purpose is to create brighter lives for people today and generations to come.

- Using Biotechnology in combining Life Sciences & Materials Sciences and driving advances in sustainability and innovation. We are now a key enabler of what many refer to as the bio-based economy.

The shift from the fossil-age to the bio-based-economy

A lot has changed since I began my study molecular biology in 1977 and the start of my career with Gist-brocades in 1987, every time I thought: now a new era starts: and this is even more true today, since I am convinced it did!

I believe we are approaching the peak of what I call the fossil carbon civilization, the fossil-age if you will.

- Around 1850 (on real industrial scale since 1900) the world started to change; we began digging for coal (like DSM: 1902), oil and later on gas. All of this “out of the ground” and that built the fossil based economy, step by step, but fast too. For almost all our energy and electricity, transportation, heating, and artificial and processed materials we are today dependent on coal, oil and gas (estimations indicate over 80%). Alternative energy sources (like wind, water, solar and bio) supply in most western countries for around 5% of the total energy need.
- *This era has been characterized by unprecedented economic, technological, scientific and societal advances. But it is slowly coming to an end, or better: a new era has started*
- We are now facing a number of fundamental global challenges forcing us to shift to a new era:

- Increased consumption by more people:

The world population has reached 7 bn people recently it will grow to 9 billion by 2050 (even 10 billion by 2100). They all need energy, transportation, heating and materials, so the demand will grow in the coming decades, with Asia taking about 75% of that growth

- Increased consumption per capita

Living standards will increase, especially due to the global economic shifts: China, India, Brazil, etc: they all will increase the energy consumption per capita too (next to the increase in population). The key driver behind this economic growth is the rapid increase of a middle class (China and India each over 500 million people in 2025) and the speed of urbanization (already today over 50% of all people worldwide live in cities).

- Climate change forces a shift

We are facing the issue of climate change, a lot is being said about (the root causes of) the heating of our planet, rain and droughts, but a fact is that the level of CO<sub>2</sub> in the atmosphere increased substantially. And sad enough, already today the poorest countries in the world like Bangladesh and Ethiopia suffer the most from the climate change they didn't cause. Combating climate change is estimated to cost hundreds of billions of dollars.

- Fossil-sources will become more expensive

The increase of the demand for fossil resources will (is already) driving up prices; predicted is that long term oil prices above 100\$ per barrel will be the future scenario's. Events with oil drilling in the Mexican Gulf, the problems with the Nuclear Power plant in Japan and expensive new oil winnings (eg in Canada) will make fossil sources not really cheaper the coming decades. On top of this alternative biotech routes will become more competitive with classical fossil production methods (like already demonstrated a decade ago by the German Oko Institute and McKinsey: 50% of the variable costs, or sometimes even 50% of the total costs can be reduced by switching to new biotech routes)

- Availability will (once) become limited

And last but not least: one day the fossil sources will be exhausted, estimations are in 30 years from now we will reach a peak in oil drilling and we might still have 100 (to perhaps 150) years to go (but at much higher costs). Coal and gas reserves will last much longer, though the arguments of conserving the environment and cost will drive us to us more renewable materials. Just like the stone-age or the bronze-age: they ended not because there were no stones or bronze anymore...but because of better alternatives.

- With all this in mind I believe that we are at a turning point. In 2 or 3 centuries to come, people will look back on the fossil carbon age as merely brief moment in history. Because when the fossil carbon is gone, what do we do then?
- We will look back at a period of about 250 years in which we shifted our total economy becoming coal, oil and gas (fossil) source based
- And of course: we won't wait with the shift until we reach the end of the period. We won't wait another 100 years. NO: since we are *now* just reaching the top of the hill, now the shift will start, in fact has started. And we still have a limited period to go for this enormous shift
- And then: then people will say: for thousands (many ten thousands) of years mankind used materials *from* the LAND for building, heating, transportation, etc, and that will be again the case in the thousands of years to come!



- So we will go back to doing what we did before the fossil carbon age. Humans have to go back to living with, and especially off, nature. That means the land, the sun, the sea and the wind. Just as our ancestors did before the fossil carbon age.
- Ignoring this reality is not an option. We do not have a choice. We need to leave to our children a more sustainable society, balancing the needs of people, planet and profit. The bio-based-economy can contribute to this.

*Crucial for the further development will be: the awareness of the above, developing the technology, and setting the right regulatory and public support for it, I don't talk about subsidies here, I talk also about systems in which pollution and carbon has a clear price!*

Bio-materials and Bio-fuels: two growth areas

Let me give two examples: Bio-materials and Bio-fuels

#### Bio-materials

- Since almost all our artificial materials (like plastics) are oil/gas-based, we need to develop the materials of the future (also) with the help of biotechnology from clean renewable sources
- That is why DSM started (having knowledge about Life Sciences/Biotechnology and Materials Sciences) to work in this field too. Several food ingredients (like Vitamin B2 and several pharmaceuticals and some plastics and chemical building blocks) are already made using biotechnology in stead of the classical way: from oil based derivatives. Cleaner and even often cheaper too.
- Today DSM announced together with its partner Roquette to open a large scale commercial plant for bio-based succinic acid, replacing the classical fossil feedstock derived chemical route. This is a BIOBASED process, absorbing CO<sub>2</sub> and replacing the chemical process that is emitting CO<sub>2</sub>. It will allow for the lowest possible cost and therefore expand the market by at least an order of magnitude, creating opportunities into large existing markets as polyurethanes and emerging markets as PBS.
- We will see many more of these projects in the future. By DSM and others
- Crucial is that we develop a global standard for assessing the environmental impact (LCA: total life cycle analysis): DSM advocates and works on such standards together with other industry players. Only then we can objectively compare the environmental footprint of bio- routes with classical fossil routes

#### Bio-fuels



- Next to Bio-materials (having a minor impact on the use of crops, perhaps less than a few percent), we have the area of Bio-fuels, having a much bigger impact on the use of crops (in the US now about one third of corn is used for bio-fuels)
- A real controversy here, which we are all aware of. Reduced to its most basic, it is the “food versus fuel” controversy. This issue dominates the public debate particularly about bio-fuels and bio-energy.
- It is completely understandable. It is founded on the belief that there is an irreconcilable conflict between the objectives of producing food and producing fuel from biomass. We know world population is growing and we know that there is already huge pressure to feed these people (also providing water). Good agricultural land is being reduced by urban spread and erosion and with more people living in cities, it leaves less farmers. With increasing wealth it is also leading to more meat eating, which needs more land, - and so on, and so on.
- We know all these arguments because they are very real. We need a Third Green Revolution, a Third Industrial (!) Green Revolution. The question is how the bio-tech industry can be a stronger partner of the solution (and not the problem)!
- Let me talk about what DSM is doing for a moment, because I think we have identified three ways in which we can absolutely demonstrate that we can deliver ‘Brighter Living’ with biotechnology, and show we are playing our part in solving the problem
- The first you all know about: the so called second generation bio-fuels on which DSM is focussing at. Using only those materials from the crops that are not deemed fit for consumption (the merely non-sugar, but cellulose rich parts, like roots, leaves, etc, or even better: corn-stover, bagasse, etc)
- Last year, we announced a major breakthrough enabling second generation bio-fuels to become commercially viable through the creation of a new enzyme and yeast “cocktail”. This provides the broad spectrum capability to break down and ferment almost all (C5/6) sugars from these non-edible (cellulose rich) materials that we need in order to create commercial efficiency of second generation bio-fuels. We have recently completed a series of larger tests with this technology in cooperation with Abengoa and we are very happy with these results, as shared during this BIO conference.
- We now have a system that actually has shown its efficacy under industrial scale conditions. There are still many more advances needed, expansion to other feed stocks, different pre-treatments but we are confident that we can do this. But we know now that such technology will allow us to use crops that grow on marginal land as well as residuals of food crops; therefore the pressure on land use will decrease. But, of course, only to some extent.

Fact is that we have now proven that with our technology we can *convert over 90%* of the so called C5 and C6 sugars into ethanol under industrial scale conditions, not just in a laboratory.

- Secondly, in order to feed and fuel the future, the plant “capabilities” and the quality of our soil is extremely important and is an area that does not receive much attention. Partly because the agricultural sector in certain countries has made enormous gains over the past 60 years to dramatically increase crop yields. In order to feed and fuel the future, the quality of our soil is extremely important and is an area that should receive more attention.
- Currently, the agricultural sector in most parts of the world, rely heavily on fertilisers to improve soil quality, and herbicides and other aids to help crop growth control.  
Here we believe *Green and White biotech can complement each other*: genetically modified crops, growing in areas where normal crops wouldn't grow, not for food but for fuel purposes...  
But we can go further, for example, better use of microbial populations and enzymes to make more nutrients available for crops and soil organisms, which will help increase yields and improve the nutritional value of plants above and beyond their current levels.
- And this leads me to the third solution. It is absolutely essential that we maximize the use of the biomass value chain, and every element has to be used in the most efficient and sustainable manner possible.
- In terms of food, let's return to the challenge of feeding 9 billion people and their future (increased) consumption and needs. Clearly, this will all drive up the demand for food and so the demand for animal derived protein. Demand for meat alone is expected to increase by 40% in developed economies and 70% in low-income countries by 2050. To address this problem we will need to find alternative, high-quality proteins that can be used to substitute or complement animal proteins.
- Current technology allows the industry to extract proteins for animal feed at the end of the bio-refining process. The main issue is that the proteins have a rather low quality after processing and as a consequence they are not considered fit for direct human consumption.
- At this moment we do not upgrade a substantial part of such plant derived proteins for human consumption. We are, understandable, concerned about the food-fuel debate, *but we are leaving also huge human food opportunities underutilized, at this moment we still don't extract all value out of biomass I believe that at some point in the future it will be possible to produce high quality proteins suitable for human consumption by extracting them before*



*further processing of the plant-materials into ethanol or other bio-based chemicals;*

- Our company, DSM, is at this moment looking for ways to upgrade such proteins from plant residuals (e.g. from the rice production) into human edible proteins. And I am sure there will be more plant (residual) materials found to be a good source for protein for human consumption.
- *So the biotechnology of the future can possibly allow us to produce from plant-material, both, human food, by extracting nutritional high quality human food proteins, as well as bio-chemicals and bio-energy (fuels). So in potential that could mean Food and Fuels!*
- Biotechnology can provide it all, and it does not have to compete with each other. Therefore it is critical that we further develop the technology. Even the sometimes critiqued first generation ethanol production can be further upgraded and contribute to the above pictured vision
- When we begin to fit all the pieces (of the puzzle) together, we can begin to see the creation of a blue print for the future - a truly sustainable, bio-based economy. In essence, we could be in a position to combine two of the greatest economic and societal changes --- the green and industrial revolutions---to create a Green Industrial Revolution that is holistic in nature and value.

The Bio-based-economy: we need to shape it ourselves

- Ultimately the bio-based economy is needs also the support of the public opinion, so the right attention for advocacy and communications is needed.
- Explaining the reason why we have to change is not easy. We will not run out of oil tomorrow. Our environment will not change overnight. These changes will be gradual and we have to communicate and convince a population that typically, and understandably so, confront life day by day; week by week; not decade by decade or generation by generation.
- And what the change factually means is even more complicated to explain, since we talk about technological solutions for issues we don't see daily yet. This makes it all the more difficult to set the change process in motion, because change involves abandoning old certainties, taking risks and even pains.
- We must also recognize that this transformation takes time and we must be in it for the long run.



- To be successful, however, requires adaptation. Like we learned from Darwin: we need to keep adapting to a changing situation. Only then we will survive. And such complicated transformation process asks for communication and consistency. This is the challenge of our industry, even our society.

#### Conclusion

- Delighted to receive this GW Carver award on behalf of all DSM employees, even on behalf of the industry I represent, as well as the society at large, since the impact of biotechnology on the world will be huge
- The fossil based industry will last perhaps 250 or 300 years, we are half way: the turning point to the bio-based economy is now
- Facing major challenges as an industry as we work to build the bio-based economy, but confident and excited about our capacity to successfully navigate this transformation, this process of change
- Biotechnology can bring us new health solutions, a more sustainable environment, but as indicated above, also new materials and even a new source of energy that does not have to compete with food. Even stronger: the new biotech solutions can contribute to Food and Fuel solutions.
- Industry and science must support, together with governments and NGO's building awareness and shape the terms of the public discussion around the bio-based economy

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