

**Address of Nicolas G. Hayek, Chairman of the Board of Directors of Swatch Group and of Belenos Clean Power Holding at PSI Colloquium on March 5, 2010 at the PSI Paul Scherrer Institut in Villigen (Switzerland).**

**On the eve of the renewable energy age – how important is the contribution and role that Switzerland could and should play in this explosive time of radical change ?**

Ladies and Gentlemen,  
Dear Colleagues,

In 1948, after the end of one of the most devastating wars that shattered our planet, I was a young student just finishing my 'études supérieures' in mathematics, physics and chemistry. And as most young scientists-to-be in those days, we all believed that nuclear energy – despite the immense and appalling destruction caused by the first atomic bomb attack about 3 years before – would provide all the energy needed for the future at very low cost and all over the world. Nobody really considered civilization's ever-increasing CO<sub>2</sub>-emissions or their impact on the environment, because these were just not significant issues at that time.

However, what we did already know was that the only energy sources, readily available in huge quantities and at relatively low cost, but certainly not renewable, were oil, gas and coal. And we expected that all these oil, gas and coal reserves (fossil fuels) would be consumed within a few decades, and because these reserves were all situated in faraway countries, we believed they would become more expensive and more difficult to distribute.

Nuclear energy was the future, it seemed clean, relatively safe and could be used and produced locally in all countries without long distribution distances, despite the fact that the atom bomb had dampened our enthusiasm and somewhat reduced our confidence in this energy source. Based on the same thinking, the ETHZ, the Swiss government and Swiss industry created around 1970 here in Villigen, the Swiss Institute for Nuclear Research (SIN), a few years after the creation of the Swiss federal institute for reactor research (EIR), located just on the other side of the river in Würenlingen.

Both institutes had specific nuclear research missions:

- the EIR to develop all the expertise and industrialisation of reactor development and its various components;
- and the SIN to develop nuclear research for civil use in all fields in Switzerland.

Today in 2010, 62 years later (in 1948 I was just 20 years old), if we make an analysis of how we stand in this regard, we will find a dramatic change of thinking about this issue.

First of all, during the last 60 years, humanity has evolved and experienced enormous changes in the quality of our atmosphere and environment. Our planet Earth has seen radical deterioration in this area and after a long period of ignorance, disbelief and lack of concern, all the major governments of the world finally recognised that the overheating of our atmosphere was directly related to the emission of CO<sub>2</sub> gases, caused not only by the huge increase in the number of cars, trucks and other vehicles ensuring our full mobility every day, but also due to the CO<sub>2</sub> produced by the fossil fuels from our homes and factories – these emissions are seriously endangering the survival of planet Earth and pose a considerable threat to our climate security.

The second very important and immediate environmental problem was historical and concerned the disaster of April 1986, when one of the nuclear reactors exploded at a power plant in Chernobyl in the Ukraine. This monumental catastrophe, together with a few other less fatal incidents (Harrisburg in 1979 and others) added to the unresolved problems of end-storage, created a very strong popular movement against the increased use of nuclear plants, and forced many major governments in Europe and other countries to prohibit the construction of new nuclear plants for energy production. In the US no construction permits have been issued for the last 20 years, although Barack Obama is currently in the process of re-introducing these permits. A nuclear fusion solution that could ensure clean and less dangerous energy production involving enormous investments – currently being researched by the international industrial community in countries such as France (for Europe) and the United States – is

still a long way from becoming reality, as well as being far too expensive, at least for the moment. Maybe in the future it will become a clean and lower cost source of energy, but the significant issues regarding energy storage, individual transportation and handling for the mobile sector can't be solved by nuclear fusion either.

For all these reasons the Swiss Federal Government and the Federal Institute of Technology in Zurich and naturally also the nuclear industry itself, had to totally rethink the strategy, utility and missions of the EIR and SIN institutes. This was around the beginning of 1985. Many industrialists, politicians and others in Switzerland voiced their opinions about closing at least one of the two institutes, many were even thinking of closing both. At that time, I was asked to study this problem and provide a recommendation on the strategy to be followed in this field. This was in 1985, beginning 1986 at a time when I was already analyzing the strategy and management of both ETHs and their affiliated institutes with Hayek Engineering.

To assist us in this analysis in order to define a strategy for the future of EIR and SIN, we engaged the consultancy services of 4 internationally-renowned and respected scientists, experts in the domain of nuclear research and nuclear energy production:

- Professor W Häfele, Chairman of the Nuclear Research Institut Jülich, Germany
- Professor J Teillac, President of the High Commission for Atomic Energy in France
- Professor P Aigrain, scientific consultant to the Board of the Thomson-Brandt-Group in France, and formerly a member of the French government
- Dr G Manning, executive of the Rutherford-Appleton Laboratory, England

Ladies and Gentlemen, it was a fantastic pleasure for me to go through our archives and review the enormously heavy and voluminous documents that we prepared at the time.

Our 1986 recommendations, a merger between the EIR and SIN, were approved by the ETH, the Swiss government, the Swiss parliament and by the industry itself and the result was the PSI. And I wouldn't have mentioned it today, were it not a milestone in our thinking about renewable energy of the future.

Today I am extremely proud to see how the PSI has evolved, its industry reputation for research and development and its achievements are invaluable. I was reminded of the press conference which we conducted in the PSI lab about one and a half years ago (30 May 2008) when we announced the start of our fuel cell programme. Whilst visiting the same laboratory area last week; the lab was full of the latest, high-tech, state-of-the-art testing equipment and several fuel cell prototypes. Fuel cell tests were being carried out in several of these testing units, and as I looked across the lab a few meters further away, other young scientists were conducting important work for the CERN. This is precisely the large scope and depth of work we dreamed of achieving when the merger was decided in 1986/87, and the PSI has by far exceeded our expectations. The PSI is proving daily how important and essential its work is for all of us.

The phenomenal industrial growth, development and population expansion in emerging countries including the Far East, Australia, South America, the Middle East and Africa, not forgetting Europe itself, as well as the Russian Federation and the United States of America – has led to an enormous increase in the energy requirements of each individual, and all these factors require more and more energy to maintain a better standard of living.

Today fossil energy sources still account for by far the largest proportion of energy used. However, the problems that they create have increased enormously – the CO<sub>2</sub> emissions alone, which have an extremely detrimental impact on the environment, provide a valid enough argument to stop using them; on the other hand the price increase of oil and gas over the last 40 years shows a very strong dynamic to continue, coupled with the fact that certain countries (predominantly major oil and gas producers) could potentially blackmail politically other countries which do not possess these fossil energies on their territories.

And last but not least, the costs together with the health and safety risks associated with the transportation of these fossil energies are enormous. The price of oil and gas is currently stable after several periods of price increases, and we now know that all our reserves will be exhausted in the not

too distant future. This is a very dangerous development for our spaceship earth. For practically all the five following reasons, I repeat:

- Protection of the environment
- acceptable prices
- limited reserves
- political blackmailing
- transportation costs and transportation risks

It requires us to find very, very, very, quickly and I must reiterate, very, very quickly alternative clean, renewable energy solutions to satisfy our ever-growing demand for energy.

Naturally, most countries do indeed plan to reduce their respective energy consumption and technically there are many ways to save energy, for example better insulation of our buildings, or by improving the performance of car engines. These measures could generate anything from between 25% up to even 50% energy saving. It is precisely for this reason that politicians from all over the world congregated recently in Copenhagen to discuss the ways in which to achieve improvement in this field and lower the CO2 emissions in the atmosphere.

Ladies and Gentlemen, we all know that in this regard politicians do indeed have very good intentions, but they are not going to be able to solve these problems efficiently for many reasons. First of all, the world population is increasing constantly, and second the standard of living of all the Earth's inhabitants is also increasing at a very rapid rate. Consequently, the vast majority of consumers is purchasing new cars, trucks, machinery, household appliances, they need heating in their new homes, etc. Society cannot be legally forced to reduce its total energy consumption or emissions, even if billions are paid in compensation to poor developing countries or to our own people. Furthermore, any government, democratic or otherwise, which even attempted to force reduction in energy consumption, would be completely destroyed by public pressure.

Efforts to reduce emissions will be invalidated by the population growth and substantial increase in its energy requirements. Only scientists and researchers together with entrepreneurs 'movers and shakers' will be able to resolve all the afore-mentioned energy problems. The sun is an enormous fusion star which has kept this planet alive for billions of years (since the beginning of life and creation itself) by producing and sending huge amounts of energy to earth every day. This exorbitant quantity of daily energy is reportedly 5 000 times more than the world's current population can use.

In recent times (over the last 4 000-5 000 years) human beings have always actively harnessed the sun's energy. We learned how to capture solar energy with mirrors to create heat, fire and power, and with the recent introduction of photovoltaic cells, we learned how to transform it directly into electricity. And we are rapidly learning how to store it in safely transportable devices. But both processes must be improved, firstly because the current photovoltaic module efficiency at reasonable cost is no more than 10% to 14%, which in the short-term is totally unacceptable, and secondly because the existing electricity storage devices and systems are inefficient and too expensive.

The NASA and other significant developers have indeed achieved a module efficiency rate of 30–40%, which as far as I'm concerned is still not enough for the future. And this rate was attained using highly expensive materials, making this system difficult for widespread general use at the present time. Our efforts must be concentrated on finding ways and means to convert more than 50% of the directly captured solar energy to electricity, with a pricing structure similar to that of the fossil energy in current use and all the benefits for the environment.

Switzerland has very prominent researchers with extensive experience in this field, for example at the IMT in Neuchatel, the EMPA in Zürich, the PSI, the Swiss Federal Institutes of Technology (ETHs) and other research institutes, as well as several internationally-recognized industrial groups, which are able to develop new systems, new ideas and new materials. I am convinced that if research efforts are totally focused, it is viable to achieve significantly better performance within a relatively short period of time, say between 5 maximum 10 years.

Another area of paramount importance is the need to individually transport this energy safely and securely over thousands of kilometers, for example in our vehicles and in transport containers, thus

enabling us to operate our mobile-systems, cars, trucks, trains, airplanes, etc. with exactly the same comfort, range, security and price as with fossil energy today, but in a cleaner and much more readily-available manner.

Newly developed fuel cell systems at acceptable costs operated with decentralized production of hydrogen and oxygen or hydrogen and air, are one of the solutions. Scientists and researchers from the project leader PSI, together with those from Belenos and engineers from the Swatch Group are developing an efficient fuel cell, working with hydrogen and oxygen, and it will be ready this year. Where are we going to get our fuel for this fuel cell – hydrogen and oxygen? Belenos has created a joint venture for this fuel production called Swiss Hydrogen Power – SHP with Groupe E, the electric power company of Fribourg and the Cantonal Bank of Fribourg. We plan to produce this hydrogen and oxygen fuel individually decentralized in private homes, for example with photovoltaic cells, electric power and water electrolysis.

We hope to be able to produce an appliance similar to a medium-sized washing machine, which would produce enough hydrogen and oxygen for a fuel-cell car to cover an average of 13 000 to 15 000 kilometers per year. The fuel tank will have the capacity to cover between 500 and 700 km as is the case with fuels in use today, and the fuel cell could certainly in the short-term solve the car fuel problems facing the automotive industry. It will be available for widespread application relatively quickly, although according to past experience, there is no guarantee that the auto industry will indeed adopt it for use in intensive trials any time soon. However, I must admit that serious approaches have been made by certain important automotive producers, to gauge the possibility of conducting our trials in their cars, but remember these are only discussions even if initiated by the industry itself. We hope that our results will be so conclusive that we will convince them to collaborate with us to speed up the industrialization process and subsequent market deployment.

A completely different system for vehicles is also being developed with a high-volume capacity safety container to store electric power, also enabling long range distances of at least 500 and 700 kilometers to be travelled, very rapid recharging and all this at a reasonable cost. I know that most of you will immediately tell me that this is an impossible dream to fulfill, but I will explain to you later why we believe that such possibilities exist, but will indeed require a hell of a lot of work, innovation capacities and time to achieve the expected, wonderful results for humanity.

We know that in addition to Belenos, many other institutes, researchers and companies in several countries are working in this field, both in fuel cell development and electric containers. It's imperative that we get ground-breaking results very soon. The environmental damage, coupled with the enormous increase of the population and the corresponding increase in their energy requirements, do not give us limitless time to solve these problems. My own personal experience in research, innovation and production has convinced me that only a strong alliance between real innovative entrepreneurs 'movers and shakers' and flexible, highly-gifted creative researchers, such as physicists who are confronted every day, on the one hand with the vast infinity of the universe and on the other with absolutely minute particles of matter, which both still hold the many unsolved secrets of our existence – it is precisely for this reason that they still believe in, or at least do not exclude miracles and can accelerate the resolution of these problems and the production of such renewable energies.

This is why I created Belenos Clean Power Holding Incorporated, a blend of highly dedicated and financially strong, innovative and experienced entrepreneurs, with highly committed researchers, able to think 'out of the box' and find ways to develop new renewable energy systems. Such a dynamic combination should be able to achieve results considered impossible today. But Belenos is only one of many working groups that should be established in Switzerland. This our country has an extraordinary concentration of talent, a wealth of expertise and immensely skilled individuals working in all scientific fields. All these experts should be brought together to be the driving force in pioneering renewable energy systems for the future.

I cannot emphasize enough that Switzerland can and should play a major role in finding these solutions in the coming years. We have, as mentioned a large number of researchers and expertise and many highly educated entrepreneurs, who are 'movers and shakers' with substantial financial resources. Let's mobilize all of them without relying on government or taxpayer's money. If we can unite and coordinate all these experts and talent, in 5 to 7 years all our main energy problems will be solved.

Switzerland has many advantages that will allow us to make a significant contribution to finding innovative solutions to the energy problems. As I already mentioned there are a substantial number of scientists throughout the country specializing in practically all the relevant areas. Switzerland is also one of the few highly industrialized nations which does not have any national oil or gas producing companies or lobbies; nor does it possess an established automotive industry manufacturing vehicles or engines, with major investments to amortize quickly when they become obsolete as a result of new energy systems. All efforts can thus be wholly concentrated on the creation of renewable energy systems.

Many of our scientists have studied and lectured at overseas universities, and have worked closely with research institutes or industrial companies in the US, Japan, other European countries, Australia and South Africa. They continue to maintain very good relationships with the international scientific and industrial community and exchange experiences – all these factors together with our cross-cultural diversity and understanding of other foreign languages are also a huge advantage. As I have already mentioned, Switzerland also has a large number of industrial companies with relatively important financial capabilities, which means that there are enough financial resources to meet all requirements in terms of research, development, manufacturing and distribution. And last but not least, any new product developed with renewable energy will certainly provide a strong return on our investments. Because in our society any new product that helps to improve the quality of life at a reasonable cost, and which is used on a daily basis, is guaranteed a positive return on any investment. Within these parameters new products create new wealth and new jobs and attract all the prerequisite talent, equipment and intelligence.

When such an investment is rewarded by such encouraging results substantial financial resources will automatically be forthcoming. In this regard I myself receive many requests from companies offering to invest in the projects of Belenos. These are the foundations on which we created Belenos just over two years ago (18 December 2007). Some of you may not know that for over twenty years I have been actively involved in trying to create new clean energy systems, especially for cars. As stipulated in the contract the Swatchmobil, subsequently a hybrid vehicle, should have been manufactured with Volkswagen and then with Mercedes when we created the Smart factory; unfortunately, this project was terminated because of lack of confidence and understanding of product strategy by the then management of our partner Mercedes.

This experience proved to me that success in such endeavours can only be achieved if separated from the top management of the automotive industry, in fact from the automotive industry itself for many, many reasons.

First of all, the undisputed and essential requirements of total and absolute security for cars is, for many top car executives, the deadly enemy of substantial innovation. They are ready to innovate in certain clearly defined and limited areas, but they will only make a complete revolution if forced to do so.

Secondly, the best car engineers and developers and the most brilliant ones in the current automotive industry are highly trained mechanical engineers. These experts have vast knowledge of millions and billions of precise, technical details, every nut and bolt in a car; however, they don't possess much knowledge or confidence in electronics, physics, chemistry and other technical fields required to make a complete revolution in the energy systems of cars. I lived and worked with many of them for years, and besides the fact that they don't know very much about other technical fields, they actually have very little confidence in the scientists specialising in those fields, so that trying to convince them to push new systems intensively has been a very hard and disappointing task over the last few years.

Thirdly, billions of dollars have been invested in equipment, logistics and systems for engines and parts of the car based on existing fuel sources; therefore, automotive manufacturers must target and ensure profit and amortise these investments, before jumping too quickly to new systems.

And to conclude, even the smallest car manufacturers are huge companies, their top management being comprised of very highly-paid executives, and the motivation to push dynamically and strongly into new fields, with the potential danger of failure, is practically non-existent. If you make and launch a new car with completely new energy systems and it does not perform perfectly within the first year, you will be fired.



That's why Belenos is going to create new systems and when they are completed and technologically proven, we will deliver them to the industry or to the general public. For example, we are going to conduct trials on cars with our fuel cell and our hydrogen/oxygen production at the end of this year, beginning of next year. Belenos is a holding company using its own capital and financial resources, which does not depend in any way on financial contribution from the government or the taxpayer. This holding company is owned, operated and financed by a select number of shareholders, only efficient, realistic scientists and entrepreneurs who are 'movers and shakers'.

This holding company is ready and willing to create joint ventures for individual renewable energy projects with any third parties in industry, research institutes, power companies, even with governments and other entities. Belenos is a company with the mission to research, develop and produce new innovative energy products/systems. The number of joint ventures that Belenos is ready to enter into and finance (51% and more) is theoretically unlimited. We can create 10 to 20 or more projects in the field of renewable energy, if they are realistic and with solid potential. Every viable endeavour is given careful consideration and in-depth analysis, and naturally we are looking for additional scientists and entrepreneurs to become partners in these joint ventures.

Four joint ventures already exist and two more are currently under development:

- i) Fuel cell with PSI → practically all known fuel cell developments use hydrogen and air, whereas the PSI/Belenos fuel cell technology project is probably unique in using hydrogen and oxygen on a real industrial scale.

This fuel cell has been developed over the last two years by a highly dedicated and efficient team of scientists from the PSI, together with Swatch Group electronic engineers and other scientists from Belenos and Swatch Group who have all given an outstanding performance.

A 10kW prototype has been successfully developed.

Encouraging results with respect to lifetime and cost have also been achieved. Furthermore, a 25kW stack and system are being developed to be also specifically industrially produced.

- ii) with Groupe E and the BCF (Banque Cantonale Fribourg) → Swiss Hydrogen Power (SHP) is evaluating different scenarios for the flow of electricity between photovoltaic cells, the electric grid and the electrolyser to generate the two gases, hydrogen and oxygen. In addition we are also developing the gas containers and the filling stations which will facilitate the transfer of these gases from the containers situated in the home, to the containers in the car.
- iii) a renewable energy planning and consulting Engineering company with Swatch Group and Hayek Engineering → this joint venture will conceive, plan and supervise the use of renewable energy in:
  - the homes of private individuals
  - industrial buildings
  - other areas to be explored

This company will be driven by market demand and will determine the most optimal solution on a case-by-case basis.

- iv) and a classified project called NGH Containers
- v) A joint venture to create a campus for research and production of high-efficiency, low cost photovoltaic cells

and last but not least

- vi) a further classified project for a container for the storage and individual transportation of power. I wish to emphasize yet again that Belenos is an institute focusing on developing renewable, energy sources and not a financial institution providing capital for such projects. We wish to work with, control and manage all the research development and production programs through our own scientists, or partner scientists of the joint ventures and our entrepreneurs. In our future joint ventures not only scientists, research institutes and entrepreneurs will be welcome, but

also large international companies such as Nestle, BBC, Schindler, Novartis, Hofmann La Roche, etc. to name but a few and naturally also entities from the international community outside Switzerland.

This kind of organization has proved to be much more efficient and flexible and costs much less than a disorganized, chaotic and decentralized approach with hundreds of inventors and institutions running around trying to obtain financing from governments banks or industry, with many of them working on the same research element.

Private initiative can also, ladies and gentlemen, in a highly democratic and freethinking, independent and individual-oriented country like ours, be coordinated or concentrated in such a way that research efficiency is strengthened. We tried to find a way to carry out this coordination ourselves as entrepreneurs and scientists – if we create a core with powerful, magnetic appeal we can attract most of the highly-gifted people and accelerate the process in such a way that it will be beneficial for all concerned.

I admit it's difficult, but in the interests of all concerned we will keep trying to do it.