

Translation of the speech held at the occasion of the

**Celebration of Dr. Ludwig Bölkow's 90th Birthday Anniversary
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Dear Guests, Dear Dr. Bölkow !

Dr. Ludwig Bölkow nowadays is mainly honoured for his achievements as an industrialist. The high time of his entrepreneurial activities took place in Ottobrunn near Munich and extended over exactly two decades from 1958 to 1978.

In the meantime, his 2nd "career" as a founder and as a visionary of a different energy future also lasts for 20 years. This contribution deals with the motivations which guided Dr. Bölkow during the last 20 years, traces the external impulses upon which he reacted and finally tries to point out to what extent he was successful in influencing the course of events.

The result shall be anticipated here: his efforts during the last 20 years were not in vain – many impulses were given. Dr. Bölkow succeeded in acquiring a voice that was noted in the public debate on energy policy matters.

Influences and Motivation

What motivated Bölkow after his involvement at MBB came to an end in the late 1970s and in the beginning of the 1980s? Which were the influences and motives, inducing him to become active himself and finally to donate a foundation?

The oil price crises of the 1970s did shake up the industrialised nations and demonstrated to us our dependence on finite fossil energy sources. Since this time Bölkow's thoughts were determined by the fact that fossil energy carriers such as coal, oil and gas are finite. Certainly at that time the work of the Club of

Rome also exercised an important influence with respect to the perception of the limitations in our world.

The emerging discussion of the threatening climate change represented another important impetus.

Bölkow was very much occupied by the problems linked to the use of nuclear energy. He was especially concerned about the issues of safety and waste disposal. But also the limited uranium resources were seen by him as a problem.

In the 1970s for the first time a broader public became aware of the fact that our energy system is – as we would phrase it today – not sustainable. For Bölkow this constituted a challenge for the profession of “the engineers“. He therefore envisaged as the most important future task for engineers, technicians and scientists, to contribute to the solution of the identified problems: after all it were them who have caused these problems to a substantial part by the technologies they have developed.

Approaches

But where should one look for possible solutions? What kind of approaches - methodical and substantial - were needed?

Bölkow's views were highly influenced by his experiences at MBB in the development of defence technologies and also from the study work carried out in the transportation sector. There were two guiding ideas - on the one hand there was “the thinking in systems”, on the other hand there was “the thinking in long time periods”.

The then newly developed methodology of Operations Research brought a new perception and a new approach into defence technology. It was shown that it is not sufficient to analyse the problems in a one dimensional way. Superior solutions could be obtained by modelling multi-dimensional, complex and inter-related structures with the help of comprehensive mathematical models. This was an important root of what was later called “thinking in systems”.

Bölkow's continuing interest in transport matters was based on the activities at MBB in the sector of rail transport systems and the development of new transport systems (the topics comprising transport system studies, development of automated guideway transit systems, magnetic levitated train systems and traffic control systems). The central idea was always the possible contribution of improved systems and technologies to conceive and build more environmentally friendly and socially compatible transport systems.

Also in this area the thinking in systems and especially the long-term perspective played an important role. In this context the "Hochleistungs-Schnellbahn Studie - HSB-Studie" ("High-Performance High Speed Train Study"), finalised in 1971, was of great importance. This large system study for a redesign of the cargo transport was the most comprehensive transport system study ever carried out in Germany.

The studies by the IIASA in Laxenburg near Vienna exercised a strong influence on the thinking of Bölkow – in particular the study "Energy in a Finite World". The main message of this study was that fundamental changes in the energy system are very slow - like the introduction of a new energy carrier which requires much time before it gains a significant market share. The market penetration follows a logistic curve – for a long period the growth rates are very low, then all of a sudden they rise rapidly and strongly and then after some time diminish again. The restructuring of our energy economy therefore is a task for decades.

Due to his scepticism regarding nuclear energy Bölkow was searching for solutions which for their part would not cause unacceptable risks in other areas and would nevertheless be feasible. In this search he was influenced very much by the works of Justi and Dahlberg, namely the vision of a solar energy supply for industrialised countries via the import of solar energy from the earth's sunbelt.

Bölkow during his time at MBB made many journeys, especially to developing countries. With these countries cooperations existed in the HiTech sectors of

aerospace and defence and support was organized to transfer certain technologies. On the other hand, he learnt that no similar preparedness did exist to tackle energy and environmental problems with a comparable drive - not in the energy sector, nor in the agricultural sector nor in the transport sector. He saw the necessity to do more in these areas.

Foundation of the EAT Systemtechnik and the Ludwig Bölkow Foundation

For all these reasons the big task perceived by Bölkow is the restructuring of the energy supply system of the world: the aim is to supply the world with renewable energy sources, with solar energy, and to do everything necessary to advance this concept.

Bölkow at that time had conversations with many people in order to identify possible ways for the promotion of his ideas. In this period, the idea matured to donate, if necessary, a foundation.

First of all, Bölkow talked about his ideas with Dr. Vogels, his successor at MBB in these times. He did this because he saw several activities at MBB which were matching his ideas (in the fields of biomass gasification, photovoltaics, wind energy and new transport systems). Vogels was open for Bölkow's ideas and used his influence to form a "Working Group Systems Technologies" ("Arbeitsgemeinschaft Systemtechnik") in order to tackle the topics under consideration.

This working group was founded in May 1980, and involved four companies: MBB, Krauss Maffei, Fritz Werner Industrie and Imbert Energietechnik.

As it became foreseeable that the "Working Group Systems Technologies", due to lacking support by the partner companies would not succeed in achieving the postulated goals, Bölkow decided to go ahead alone.

In November 1982 the EAT was founded as a non-profit organisation by Mr. Bölkow personally together with Mr. Striegel. The three letters EAT stood for "Energy", "Agriculture" and "Transport Technology". According to its statutes the

purpose of EAT was the promotion of environmentally friendly and socially compatible technologies.

From the very beginning, when founding the EAT, Bölkow aimed also at donating a foundation. From his experience with the “Working Group Systems Technologies” he had learned that at that time these topics could not be dealt with in a purely commercial context and that politics also had its difficulties with the topic. This in particular is due to the prevailing time scales in companies as well as in politics. The time scales there are determined by 4 and 5 year terms of company leaders, parliaments and governments, whereas the possible solutions of the problems to be addressed require decades. The consequence is that – short of imminent crises - such long-term questions usually are ignored and often negated and in any case are not addressed and solved in due time by those institutions typically responsible for these issues.

In December 1983 Bölkow donated the Ludwig Bölkow Foundation and shortly afterwards the ownership of the EAT was transferred to the foundation. The EAT later was renamed into Ludwig-Bölkow-Systemtechnik. After a modification of the tax laws for non-profit organisations Bölkow founded the commercial L-B-Systemtechnik in 1998 and the activities were transferred into this new company.

Based on the described influences, thoughts and motives the goals of the foundation were formulated. In the statutes it simply reads: “The foundation serves the promotion of research and development in the areas of energy, agriculture and transport technology”.

In the brochure of the Foundation this is detailed as follows: “In the energy sector the Foundation investigates with priority the feasibility of an inexhaustible and environmentally compatible energy system based on solar energy as primary energy source and on hydrogen and electricity as secondary energies.”

First programmatic activities

The initial work done was of a programmatic nature and found its expression in a lecture held at the Peutingen Kollegium. This lecture with the title “Decisions for a long-term energy policy“ shaped the orientation of the foundation for many years and had a determining influence on the perception of Bölkow’s ideas in the public. It was published even before the founding of the EAT in March 1982 as a booklet (always referred to internally as the ‘blue book’ due to the colour of its cover).

The main thoughts of this ‘blue book’ can be outlined as follows:

- The first fundamental thesis is that the structures of the energy system can be changed only within long periods of time. All the changes in the past have taken a long time and the rate of change always was very slow in the beginning (new energy carriers penetrated the market only along the course of the so-called ‘logistic curve’).
- The second observation addresses the great differences in the energy consumption of people in different countries and regions of the world – the difference between poor and rich is especially one of energy consumption.
- Then follows a discussion of how the world energy demand might develop in the next decades in view of an expected growth of the world population to 8-10 billion human beings.

Bölkow takes a clear position in criticising the mainstream projections of ever growing future energy demand in Germany. Already at that time it was obvious to him that the past growth of energy consumption in Germany could be stopped by adopting a more intelligent and efficient utilisation of energy.

- The next question he poses is: how can the world be supplied with sufficient energy while at the same time avoiding the emission problems associated with the burning of fossil fuels and dealing with the problem of limited fossil resources?

At the time the dispute about nuclear power plants was in full progress, especially with respect to the fast breeder reactor and the high temperature pebble bed reactor. Bölkow saw the future of nuclear energy directly linked to the success of the fast breeder reactor. But especially with regard to the safety issues of the breeder reactor he was very sceptical.

However his general attitude towards nuclear energy in Germany in view of its current share of energy supply in these days was somewhat undecided. But he certainly could not envision the extension of nuclear energy as an option for securing the long-term energy supply of the world as a way to substitute fossil energy carriers.

- Then follows a comprehensive coverage of the options for supplying the world with solar energy. In particular the vision of an energy economy is described in which solar hydrogen, produced in the sunbelt of the earth, is an essential part. Bölkow comes to the conclusion that the extensive utilisation of solar energy constitutes the most promising option for the energy supply of the world: because solar energy can be utilised everywhere, it bears the least risks and is best compatible with nature and society.
- Finally Bölkow pleads with insistence that society should adopt the necessary restructuring of our energy system as a great and long-term task and that for this purpose the political course has to be set already today.

The theses of the 'blue book' were very progressive at their time, and what is even more important and remarkable: they have survived the two decades quite well – the essential analyses, the appraisals and conceptions have remained valid.

Due in particular to the theses of the 'blue book', Bölkow's name for a long time has been associated with the scenario of a future energy economy characterised by the generation of renewable electricity and hydrogen in large centralised plants in the sunbelt of the earth and also with the transport of these energy carriers over long distances to the industrialised countries in the north.

This is the time to point at a profound and rarely perceived misunderstanding between Bolkow and his audience:

With these scenarios Bolkow intended to show in principle the feasibility of a purely solar energy supply of the world – he wanted to inspire confidence for such an option in order to get society involved. His intention was not to exclude the multitude of all the other possible and sensible solutions which are of smaller scale and of a local and decentralised nature.

By concentrating on his large scale scenario connecting different parts of the world Bolkow wanted to show that the technological changes are rather small which are necessary to move from today's technology, and in particular from today's infrastructure, towards a sustainable energy system. However the actual transformation of the energy system nevertheless will be time consuming and therefore is an urgent task.

He was however not aware of the fact that most people know only very little about the technologies and the infrastructures of our present energy supply system and that many people therefore were scared by the huge dimensions of the picture outlined.

Most likely it never occurred to Bolkow that there might be people who did not know how our world functions technically.

Project Outlines

Now follows a short description of important project lines.

In the second half of the 1980s one main focus of the work was in the area of transport systems.

Main topics were the problems of alpine transit traffic, intermodal cargo transport and the vision of the "quiet train". The goal of all these studies was to explore possibilities of how to move the transport of cargo from road to rail.

A major activity at that time was work for the Deutsche Bundesbahn (German Federal Railways) in a comprehensive research project named “Strategies for Intermodal Cargo Transport“.

In the early 1990s, based on the work carried out for the Bundesbahn, there was a participation in a large system study on intermodal cargo transport carried out by Daimler. This project was known under the title “Güterverkehr 2000“ (“Cargo Transport 2000“).

Then there were small contributions to the work of the “Enquête-Kommission des Deutschen Bundestages“ (Enquête Commission of the German Federal Parliament) on “Preconditions for and Consequences of Build-up Strategies for a Solar Hydrogen Economy“ with scenarios for the build-up of photovoltaics and wind power.

Another contribution was the analysis of the methane emissions associated with the production of natural gas. Measurements in Siberia in which LBST took part could prove that methane emissions from the natural gas production in Russia were not higher than those of western production areas.

The transport of hydrogen in pipelines over long distances was extensively investigated by LBST and its feasibility in principle could be proved.

Motivated by these findings, a joint study with the Munich Municipal Gas Company was initiated in which the feasibility of the distribution of hydrogen in the existing local natural gas pipeline grid was investigated. One result was that admixtures of up to 15% of hydrogen to natural gas are feasible in the Munich grid without major technical adaptations.

These activities formed the basis for a further investigation by LBST on the use of fuel cells for domestic energy supply. This study was commissioned by the Berlin electricity and gas utilities and the Office of Technology Assessment of the German Federal Parliament. For fuel cells running with natural gas a large market potential could be identified in a liberalised energy market with distributed supply structures.

Electricity generation via photovoltaics was another topic dealt with by the Systemtechnik at the end of the 1980s. This because photovoltaics – the direct conversion of sunlight into electricity – exercised a huge fascination. The first applications were in aerospace and now, so to speak, this technology should be brought down to earth. Were widespread terrestrial applications feasible? How could this highly attractive but at that time unaffordable technology become economically viable? The fundamental idea was to realise the manufacturing processes in an industrial scale – or as it were “the job is to get the manufacturing of photovoltaic devices out of the labs and the garages and transfer it to industrial plants“.

In a study funded by the Federal German Ministry for Research and Technology (BMFT) a manufacturing plant was designed such that its layout and size should allow a cost reduction for the manufacturing of PV-modules by a factor of 5 to 10. The study was never officially publicated since some companies intervened at the ministry and prevented its publication. The finding was not opportune that photovoltaics could be made decisively cheaper if only the necessary investments would take place. The prevailing doctrine at that time was that a lot of research was still required before a market introduction could be envisaged.

Nevertheless among experts the study was widely read and its findings accepted. With its transparent methodology the study has set a standard. After all the study has had a significant influence on the public debate, especially due to a detailed report in the German science magazine “Bild der Wissenschaft“.

Half a decade later, commissioned by Greenpeace, an update of the study under the title “Solarfabrik 2000“ (“Solar Plant 2000”) was published. Based on this study Greenpeace launched a photovoltaics promotion campaign after photovoltaics manufacturers had threatened to leave Germany and actually Greenpeace succeeded in generating a new impetus for the then depressed solar scene in Germany.

In the meantime the photovoltaics business has returned to Germany and due to widespread market introduction programs in Germany and Japan we now at last experience the industrialisation of photovoltaics.

An important project of the Ludwig Bölkow Foundation is SOLUX, a solar lantern for developing countries as a substitute for the kerosene lamps. Up to now, some 20,000 lanterns and solar modules have been mounted in special workshops in developing countries.

How can the pathway be prepared towards an energy system with a continually increasing share of renewable energies? In the late 1980s and early 1990s LBST was involved in some projects which tried to answer this question. I will mention only a few projects here:

“Block 103“. This project in Berlin-Kreuzberg tested the combination of photovoltaics with a CHP-plant and a heating furnace.

The photovoltaics project “Megawatt Project Berlin“. One of the tasks of this pilot project was to identify and quantify the photovoltaic power generation potential on the roofs of an urban structure of buildings.

The photovoltaics and hydrogen project at the agricultural college of Triesdorf. There several pilot installations were erected and tested.

Of high relevance for the further development of our work was the European-Quebecian hydrogen project EQHPP (European Québec Hydro-Hydrogen Pilot-Project).

In the mid-1980s Dr. Joachim Gretz of the Joint Reserach Centre of the European Commission in Ispra approached the public with the idea of an international hydrogen project and initiated the project. Within the framework of a scientific cooperation agreement between the European Commission and the Canadian government the feasibility of a hydro-hydrogen project of large industrial scale was studied.

The feasibility study was jointly coordinated by the Ludwig Bölkow Foundation and the power utility Hydro Quebec. Although the analysed project for the

generation of hydrogen from hydro-electricity never was realised to the originally planned extent, the development and realisation of various application technologies was carried out. In the 1990s, in the following areas demonstration projects were realised in Europe and Québec: urban transit buses, stationary fuel cells, aircraft turbines and hydrogen storage and transport.

Under the umbrella of this project some 80 companies and research institutes from 7 European countries and Canada were active. The project raised awareness world-wide and even served as a model for the Japanese WE-NET.

This project in particular was for LBST the basis for many lasting international contacts and also has led to subsequent project activities. It was the EQHHPP that has brought hydrogen back again on the European agenda with an effect lasting until today.

Since the beginning of the 1990s, LBST became occupied increasingly with questions related to alternative propulsion concepts and alternative fuels.

The results of one of the first systematic studies in the years of 1993-1996 which was performed in cooperation with the automotive industry showed that vehicles with fuel cell propulsion in combination with renewably produced hydrogen have the largest potential for a reduction of local and global emissions. This combination therefore presents a promising option to make road transport more environmentally compatible. At that time, this conclusion did not arouse much enthusiasm neither in the research ministry nor in the automotive industry. The opinion prevailed that both fuel cell propulsion systems and renewably produced fuels could at best be a vision for the transport sector in a very distant future.

Nevertheless, this study then was the reason why some years later (1998) LBST was involved as a consultant in a project initiated by important German automotive and energy companies. In the "Verkehrswirtschaftliche Energiestrategie" ("Transport Energy Strategy") industry tries to identify fuel pathways which in the long term have the potential to reduce emissions arising from the transport sector in order to make it more sustainable.

The work for the “Transport Energy Strategy“ was followed by a contract commissioned by General Motors for an extensive European Well-to-Wheel study which was completed this summer.

A further continuation of these activities on a European level is under way. The results of this study will contribute to the formulation of a long-term fuel strategy for the European Union.

Also the development of the first Bavarian fuel cell bus by the companies MAN, LINDE and Siemens has been initiated to a large extent by LBST. This project has been funded by the Bavarian State Ministry for Economics, Transport and Technology. State Minister Wiesheu personally advocated this project whereas on the federal level in Bonn the opinion prevailed that there was no perspective for fuel cells and hydrogen in transport.

We can see a continuous line and an inner logic in the sequence of these projects in the transport sector: more and more we realise the necessity of a switch to other propulsion systems together with the introduction of fuels produced from renewable energy sources. Increasingly the still remaining question is not “whether” this will happen but only “how” and of course “when”.

There are many other activities which cannot be addressed today due to the lack of time:

- the activities of our branch in Dresden,
- our presentations in the Internet on hydrogen, fuel cells and the future availability of oil and gas,
- our role as coordinators in important EU-projects in the area of hydrogen,

and quite a few other things.

Now I would like to make some remarks on the topic of the future availability of oil and gas resources. Mr. Bölkow intuitively distrusted all statements saying that within the coming decades no shortages of oil and gas are to be expected.

Therefore, he repeatedly urged us to critically investigate the finiteness of fossil energy sources.

As a result of many analyses and based on many personal contacts especially with geologists our views on the matter have fundamentally changed over the last years.

Very briefly, our present appraisal of the situation can be summarised as follows. In contrast to the usual question “For how many years will the known oil reserves last at the present level of production?” the more relevant question is “Up to which level can world oil production grow and when will we experience the unavoidable peak of production?” The question after the “last drop of oil” obscures the view on shortages imminent already in the near future.

We are of the opinion that in the near future the world approaches the peak of crude oil production. This will represent a fundamental turning point.

Then for the first time the finiteness of crude oil will be felt in the markets and this will lead to a worldwide re-orientation of, as it were, the “compass of energy policy” . This is a shock for our conception of the subject which can be described like this: although we accept the finiteness of fossil energy sources in principle we nevertheless think that in practical terms this has nothing to do with our own life.

In the meantime, we have experienced the rise of oil prices by a factor of 3 in the year 2000 and it appears as if this rise is more or less going to stay. Also this development was not expected by most observers. And only very recently we learnt that world oil production in 2001 decreased from levels in 2000, a decline that happened for the first time since many years, and moreover it looks as if oil production this year also will be stagnant.

So we presently experience a three year plateau of oil production – in contrast to all official forecasts – and this is the largest setback since 20 years. Whether this plateau figuratively speaking represents a “base camp“ from where the further ascent to the “summit“ will start or whether we probably already have

reached the peak – we do not know it and the information necessary to decide this question now is not available. Only in retrospective in a few years time will we be able to have a better understanding of the present situation. Even if a further ascent might still be possible, it obviously will be increasingly burdensome.

Impulses

In the course of the years, Ludwig Bölkow, the Foundation and the Systemtechnik have initiated many new projects and also have supported the formation of new institutions aiming at a sustainable energy economy.

The “Solar-Wasserstoff-Bayern” project (Solar Hydrogen Bavaria Project) in Neunburg vorm Wald mainly can be traced back to an initiative of Bölkow. Of course Bölkow had presented his energy visions also to Franz-Josef Strauß, then the leader of the German federal state of Bavaria, and had won his support to enable the realisation of these visions.

The idea fell on fertile grounds with Strauß. Mr. Strauß brought about the participation of the Bavarian power utility Bayernwerk AG. First deliberations on the later project were performed at the EAT Systemtechnik (the predecessor of LBST) and the Bayernwerk identified a suitable location in Neunburg vorm Wald.

In order to realise this project at the end of 1986 the Solarwasserstoff Bayern GmbH (SWB) was founded by the companies Bayernwerk, BMW, Linde, MBB and Siemens. Bölkow was vice-president of the SWB supervisory board during its entire existence.

At the 1995 Climate Summit in Berlin, Ludwig Bölkow and the Systemtechnik were founding members of E⁵, the European Business Council for a Sustainable Energy Future. During the recent years, E⁵ has played an important role as business NGO especially at the climate conferences before and after Kyoto.

In 1996, Ludwig Bölkow and the LBST were founding members of the Deutscher Wasserstoff-Verband (German Hydrogen Association).

Ludwig Bölkow and the LBST have also played an important part in promoting the foundation of the Munich Energy Agency. This was also supported by the Energy Agency of Lower Saxony.

In 1995, the Bavarian Ministry of Economics, Transport and Technology started an initiative to bundle all hydrogen activities in Bavaria. Several working groups installed for this purpose have been coordinated by LBST. These efforts resulted in the founding of the coordinating body “Wasserstoff Initiative Bayern (WIBA)” (“Hydrogen Initiative Bavaria”).

The Profile of the Foundation / Systemtechnik

Why was Bölkow so effective and how did he obtain an own voice in the energy policy debate in Germany? Not only through the ideas for which he stands but also because of his personality. The fact that Dr. Bölkow, bearing in mind that he was a successful and renowned entrepreneur, adopted the topic of a sustainable energy system based on solar energy and committed himself to this cause had by itself a significant effect. At the same time this setting annoyed parts of the establishment as Bölkow forced them to deal with his arguments.

In this way Bölkow played an essential role in making these ideas socially acceptable and furthermore he was successful in reaching a wide audience – also literally through the many lectures which he still held until a few years ago.

Without doubt the particular character of the Foundation and the Systemtechnik has its root in Bölkow’s technology orientation. But unlike the purely technology oriented institutes at universities and elsewhere, we always also tried to integrate economic, societal and political aspects into our work.

Bölkow used to say frankly what he thinks. He used to develop his ideas without considering whether the results would please or not. Of course this independence had its price and economic interests often had to stand back. But Bölkow actually did pay the price for independence.

One of the big strengths of Dr. Bolkow was and still is his capability to fascinate other people. This is also the main reason for the special continuity of his staff. This experienced and motivated staff with its strong international embedding constitutes our main asset.

Closing Remarks

The title of the 'Blue Book' 20 years ago read 'Decisions for a long-term Energy Policy'. Many different pathways into the future are possible and a choice can only be made politically: what do we want, for what goals can we win majorities in society? The recent report of the Enquête Commission of the German Bundestag "Sustainable Energy Supply under the Conditions of Globalisation and Liberalisation" shows how vehemently these questions are still debated and how far away we still are from reaching any consensus. The matter has not lost anything of its topicality during the last 20 year – to the contrary it is more urgent than ever.

One of the scenarios of this commission deals with the goal of a 100 % solar energy supply of Germany by the year 2050 and proves that this is feasible in principle. This shows that ideas which 20 years ago were regarded as being a vision only (i.e. as being completely unrealistic) are on their way to gain respectability.

I want to conclude with a personal remark. All members of the staff who had the luck to work together with Dr. Bolkow during the last 20 years, have experienced an extremely intensive and fulfilling field of work which in this particular form is very rare if not unique. For this, Dr. Bolkow, we would like to thank you sincerely.