International Conference

Energy & Security

Prague, Czech Republic, October 19–21, 2004

Conference Proceedings

PASS

Program of Atlantic Security Studies

International Conference

Energy & Security

October 19–21, 2004, Prague, Czech Republic

Conference Report

Energy and Security: Global Challenges – Regional Perspectives
Conference Report

Program of Atlantic Security Studies (PASS)
Prague Security Studies Institute
Pohořelec 6, 118 00 Prague 1, Czech Republic
www.pass-prague.cz
pass@pssi.cz

Edited by: Devon Branch-Elliman, Petr Mareš, Oldřich Černý, Jan Havránek
Designed by: Diverzity
Printed by: Tercie Praha

Editors' Note:

The second annual Program of Atlantic Security Studies (PASS) conference, entitled "Energy and Security: Global Challenges – Regional Perspectives", convened between October 19–21, 2004 in Prague. PASS is a joint project of the Prague Security Studies Institute and the Association for International Affairs.

When debating how to present the results and conclusions of the conference both to our esteemed participants and interested public, we decided not to transcribe the proceedings of the conference with all of the comments and interjections made. Instead, we selected some of the most interesting contributions that represented a wide range of opinions on energy and security and compiled them in book form. In doing so, we made a concerted effort to limit the number of changes we made and to maintain the original intent of the speaker. The changes, therefore, are minimal and serve only to clarify the point. Any remaining errors are our own.

We hope that you find the content of the book as interesting as we did and would greatly appreciate any feedback via e-mail to *pass@pssi.cz*

We would like to thank all who made the conference and this book possible.

Devon Branch-Elliman ▪ Petr Mareš ▪ Oldřich Černý ▪ Jan Havránek

Contents

Introduction

Alexandr Vondra
Conference Chairman and Fmr. PASS Coordinator

William M. Martin
Fmr. U.S. Deputy Secretary of Energy

Prague, June 1, 2005

Two of the key strategic decisions of the Czech government in the 1990s were to diversify its energy supply and to decrease its almost total dependency on Russian gas and oil. Since 2000, conversely, Europe has decided to base its energy policy mainly on using Russian supplies. On the other side of the globe, growing Chinese and Indian economies have boosted overall global demand for energy.

Organizing our second annual conference on energy and security interdependence thus appeared natural. There were two events in paricular that made this topic very timely.

The first issue we looked at was the constant fluctuation in oil prices in 2003, which raised many questions about the impact of oil markets on regional and world security in the future. One of the most significant themes of this debate was the question of the "oil motivation" for the campaign in Iraq.

Another concern was caused by some disconcerting developments in the business and political culture in Russia. In October 2003, a Russian security force

arrested Mikhail Khodorkovsky, head of the largest Russian oil producer, Yukos. Earlier in 2003, when discussing the topic of this conference, Khodorkovsky appeared to be a potentially excellent speaker for such an event.

When we were opening our conference on "Energy and Security: Global Challenges – Regional Perspectives", the situation still had not changed significantly. On the contrary, the world had experienced a shock in form of record high oil prices, and many of our concerns seemed to be fulfilled. Similarly, the personal endeavor of Mr. Khodorkovsky to lead Russian business out of the shadow of the state economy was buried, as he was still sitting in jail, waiting for judgment.

At a time of rising global demand for oil, the world was looking to Russia to be a dependable supplier of both oil and gas. But recent developments have raised serious doubts about Russia's ability to be a significant alternative to Middle Eastern oil. Thus, the world faces uncertainty in both the Middle East and Russia.

The Yukos affair and overall development in Russia might have been the main reasons that led the Energy and Security conference participants, without representatives from Russia, to express, their concern "over growing reliance of Central and Eastern Europe on gas supplies from Russia" in the adopted.

By the time that these proceedings are published, it seems that all arguments, concerns and conclusions expressed during the conference will be, unfortunately, vindicated. The former chief of Yukos has been sentenced to nine years, prices of oil and gas have sky-rocketed, the war on terror with all its threats implications is far from over, and consumption will certainly not abate. Therefore, the need for a discussion about the diversification of energy resources, has only intensified.

We believe that our publication can serve as a useful guide to this continuing and important debate. Indeed as the Principles note, alternative sources of energy, such as nuclear power, clean coal, biomass, and other renewables—coupled with energy efficiency—will all be essential. Also, the world should continue efforts to diversify its oil and gas supplies, including using greater quantities from African, Latin American, and North Sea reserves.

Security and Energy

William Martin
Fmr. U.S. Deputy Secretary of Energy

This conference is about energy and security, but I am going to take a different stance on these sensitive issues. I am going to use four specific examples of areas where I am relatively optimistic that the type of challenges that we confront will be resolved.

I would like to start with the U.S. Our energy policy consists of three issues: resources, technology, and defense. In regard to resources, we need to expand our oil and gas deposits, especially in Alaska; we need to build an Alaskan gas pipeline to the lower forty-eight states, and we need to drill for oil in the Arctic National Wildlife Refuge. We also need to increase our nuclear power; I chair the U.S. committee on this issue, and I am optimistic. I will talk about why that is in a moment. Some of you may not know, but the Department of Energy has employed 40,000 scientists in our national labs, and I am very encouraged by the recent work of the Department of Energy on hybrid cars and hydrogen economy. But let us talk about the real U.S. energy policy. I call it, "import and defend."

When I say defend, I mean the Iraq war – not the most popular war around. The Gulf War of 1991 was not popular either, but let us face the facts: we need stability in the Middle East, and the American presence there is going to guarantee long-term security and send a signal to countries like Iran that they should abide by International Atomic Energy Agency edicts, or there will be consequences. While people may be upset about Iraq, let me say that, having struggled with this myself and having served in the Department of Defense last year for Paul Wolfowitz, I think it was the right decision.

Enough of Iraq: let me go on to Europe. Roger Robinson, Richard Perle, and I worked 22 years ago to encourage Europeans to diversify their natural gas sector. In fact, while working in the International Energy Agency (IEA), we agreed that Europeans should be no more than 30% dependent on Soviet gas. The reason for this amount was that we wanted to give an opportunity to the Norwegians and others in Africa to develop gas for Europe, so that Russia, then the Soviet Union, would not have Europe in its grip through natural gas. In fact, today I noticed that almost 50% of Europe's natural gas imports are now likely to come from Russia. Obviously, the Soviet Union is no more and Russia has made tremendous strides, but it is not a good economic principle to be more than 50% dependent on one source. And I think that Europe should consider a greater balance in its sources of gas.

The third issue is atoms for peace. Conventional thinking about nuclear energy is as follows: it is a worthy option, but many people are skeptical of it. Indeed, I think I would have put myself in that category for a long time, until I chaired the U.S. Nuclear Energy Committee. I am not a nuclear energy expert, and that is why Secretary Abraham probably appointed me to that position. But I am an energy expert, and I am an environmentalist. I do support making progress towards issues like the ones in the Kyoto Protocol, and I do not see how we achieve energy security and Kyoto objectives without nuclear power. Nuclear energy is very interesting. For example, let's look at the deal between Russia and the United States to burn highly-enriched uranium. Is it not a wonderful idea to takine weapons, convert them into nuclear energy, and solve the global warming problem at the same time? It almost sounds too good to be true, and there is a challenge here: non-proliferation.

Recently, I have had the opportunity to visit both the Rokkasho-Mura reprocessing plant in Japan and the La Hague reprocessing plant in France. I think these sophisticated technologies offer hope for the long-term use of uranium, as well as better capabilities to store nuclear waste. Right now in the United States, we will need two Yucca Mountains to store the waste from our reactors. Reprocessing, done correctly and at the highest non-proliferation standards, as required by the IAEA, is the way to go. Reprocessing and enrichment in the wrong hands

is a threat, represented by Iran and North Korea today with their enrichment programs. But we should have enough safeguards, especially with modern technology, to assure the safe use of nuclear power.

My fourth point is about North Korea. I have had the honor in the last few months of being a facilitator for the United Nations on the matter of North Korea. This came about because the six parties that are currently working on the issue are Russia, China, the U.S., Japan, and North and South Korea. Sometimes the talks go on, and sometimes the talks stop, depending on who North Korea thinks will win the U.S. election. I can say right now that if they are waiting for Kerry, they are probably going to be waiting for a long time. The fundamental issue is that North Korea must give up its nuclear weapons program. This is something the Chinese agree with. I have had talks in Beijing: the Chinese do not want nuclear weapons on the Korean peninsula, and the Chinese do not want an unstable North Korea because that would invite the U.S. and South Korea right up to the Chinese border. Japan certainly does not want nuclear weapons in North Korea. Nobody does. But at the moment, as John Kerry says, Kim Jong-Il has seven to nine nuclear weapons. I do not know that number, but that is what Kerry said. They also have a submarine fleet, so you have to worry not only about air-borne missile delivery of a possible weapon, but also underwater delivery from a submarine. This is an enormous problem.

I think that the one thing that would help North Korea, if it were to dismantle their weapons, is energy. The Chinese have told me that the entire situation is all about energy. I would not, as the Clinton administration did, provide two nuclear reactors to North Korea. That, to me, does not make a lot of sense, since North Korea does not have an electricity grid. There are plentiful resources in Asia: abundant gas reserves that presently have no market, including the Sakhalin Island. That gas could be piped from the Sakhalin Islands through North Korea to South Korea. It would be something like a "peace pipeline" that would integrate North and South Korea economically.

There are also abundant resources in Siberia that could come through China, then go to South Korea, and maybe up to North Korea. There is a lot of coal in North Korea, but clean coal technology would be an important improvement. Some day, if it wishes to have a nuclear reactor, and if it has shown that it is a responsible nation, and if the International Atomic Energy Agency (IAEA) can assure us that it follow safeguards, then fine, let North Korea have a nuclear reactor. The point I want to make is that if North Korea were to turn and say that it is giving up its weapons, then there could be tremendous economic expansion and integration of the entire northeastern Asian peninsula. And it would be connected through energy.

By the way, just to make a small point here, most of the Middle Eastern oil is not going to the U.S.: it is going to Europe and Asia. Therefore, the greater the extent to which Asia itself, including China, can rely on resources from its own region, the greater the benefit for everybody. This is not to say that I am optimistic about North Korea. I think we are dealing with a stubborn dictator, and if he keeps his nuclear weapons, he will not have economic prosperity in the future for his nation. I think he will remain a threat to the region.

Let me conclude by speaking about Prague a little bit. The Czech Republic sees energy as a possible constraint on its economic growth. We know that central Europe is going to grow rapidly because of its wonderful people, the high-quality of the technology, and the deep culture, represented especially here by Prague. But how does a nation like the Czech Republic develop energy security? How can it diversify its energy resources? How can it work within the EU system? How can it work within the International Atomic Energy Agency to provide energy security for its people? At this conference, we have scientists, foreign policy specialists, economists, and politicians, and, more than that, we have an extraordinary opportunity to share perspectives on energy and security topics with each other, so that we can see the whole picture. I think that is the challenge of this meeting, and I hope that from this historic city will come some historic principles that we can provide to the world.

Business As Usual

Hisham Khatib
Honorary Vice Chairman, World Energy Council

We always try to define energy security as being the continuous availability of energy in the right forms, in sufficient quantities and at reasonable prices. This definition contains, unfortunately, contradictory aspects. It requires the existence of "the right forms,"although the only forms of energy available now, and likely to continue to be available in the future, are fossil fuels. It says "sufficient quantities" and "at reasonable prices," yet abundant, sufficient quantities and cheap, reasonable prices do not tally. In other words, therefore, we have a problem, which we are just now experiencing.

Fossil fuels are the only source of fuels that are reasonably abundant worldwide. In its three forms, oil, gas, and coal, there are sufficient quantities to keep the world economy going for decades to come, probably until the end of the century. We talk about one trillion barrels of proven oil reserves, but, quite honestly, when we look into proven and unproven and unconfirmed sources of oil there are something like 8 trillion barrels of oil that can be produced toward the end of

the century. The alternatives to fossil fuels are new and renewable energy. These have an uncertain future to say the least because they are dispersed, intermittent, inefficient, and not tradable. They will remain part of the global energy mix, but not in very sufficient quantities.

When I look at the conferences, the huge gatherings, the ministerial meetings, and all of this propaganda about new and renewable energy, I, as an energy engineer and energy economist, feel a little bit dismayed. Somebody is trying to mislead the world. There is no future, no immediate future, for renewable energy. The only viable source of energy for the universe for decades to come is fossil fuels. This is the fact that we have to understand, and we have to live with its implications.

The other alternative is nuclear energy. This can offer major energy contributions. Its well-tried technologies can provide abundant sources of energy at reasonable, or slightly expensive, prices. But this is sort of energy is not accepted by the public in most OECD countries. And the contribution of nuclear energy, percentage wise, is likely to continue to decrease slowly over the next few years. For the foreseeable future, oil is and will continue to be the major energy source. The production today of 83 million barrels per day (bpd) in 2004 will grow to something like 116 bpd by the year 2030, an average growth of 1.4-1.7% annually. That has been the trend during the past 30 years and is likely to continue to be the trend during the next 30 years.

Oil, which is now supplying around 36% of global energy requirements, will continue to do the same in the year 2030. When the oil crisis erupted in 1973, a lot of people felt that it was the end of the oil era; they felt that we were then moving to use new energy sources. At that time, oil supplied 37-38% of the global energy demand. Today, oil is still supplying about the same percentage. In 30 years, it is going to continue to supply 37-38% of the energy demand. These are the realities of the market: we have to understand them and live with them and try to make the best out of them. There has not been a crisis in oil supply since those in 1973 and 1979. And as for the prices – yes, they are high today. But when you compare them with the prices in 1973, they are only ″ the prices they were then in real terms.

OPEC will be supplying more than one-half the world's oil in 2030. Now, they are supplying thirty-million barrels per day of oil, and they will be doubling this over the next twenty-five years. What is going to happen, really, is that slowly but surely, significant quantities of non-conventional oil, tar sand heavy oils, will figure increasingly in the oil supply equation. There are 8 trillion barrels of oil in conventional and unconventional forms, proven and unproven, and all of this has to be utilized in the foreseeable future.

High global economic growth, 4.5-5% in this year, is fueling the growth of the demand for oil. In the 1970s, we spoke about the decoupling of energy from the economy, and that happened for only a few years. Now energy and economy are directly related. Economic growth will lead to higher energy growth. The only difference is in energy efficiency.

I propose this equation:

Energy annual growth = economic growth - efficiency improvements

Efficiency improvements are now 1.5-2% annually, so there is going to be a growth in demand for energy which will exceed 3% in this year. Efficiency increases can only spell changes through dramatic increases in the prices of oil products in the U.S. and China, and also by changing transport tastes.

I would like to highlight the differences in how oil is being utilized in different parts of the world, comparing North America with Western Europe. The price per gallon of gasoline in the U.S. is two dollars. In Western Europe, it is five dollars per gallon. Taxes in North America are 41%, in Europe 300%. Oil consumption in America has gone up by something like 16% in the last thirty years. In Western Europe it has gone down by 21%. Average miles per gallon per car in America are only twenty-four, in Europe thirty-six. Diesel engines constitute two-thirds of the cars in Western Europe, but less than one percent of cars in North America. Diesel engines are 30% more efficient than petrol engines.

With such a wasteful approach to oil and such disregard for its scarcity, there is a price to be paid, and that is what is happening today. I am saying that all supply security problems, like 1973 and 1979, are now behind us. Oil exporters are anxious to supply as much as users are anxious to import. There has not been a

OIL CONSUMPTION PATTERNS NORTH AMERICA VS EUROPE

	North America	West Europe
Prices of Gasoline/Gallon	$ 1.9	$ 5
—Of which taxes	41 %	300 %
Oil consumtion 2003–1973	$ 1.9	- 21 %
Miles/Gallon	24	36
Diesel Engine Cars (30% more efficient)	0.5 %	66 %

supply security problem in what is considered to be an unstable part of the world. But prices now are no longer controlled by exporters. They are raised by speculators, strict regulators, strategists' fears, refining limitations, rapid economic growth, and limited investments. As long as we have rapid economic growth, as we have had this year and last year, prices are going to be a problem. Ultimately, these price problems will limit economic growth. Waste and cheap gasoline in the U.S. are major causes of the crisis we are now facing.

I have not spoken about the environment. I am not saying that it is not important, but Kyoto 135 is likely to be ratified any day now, but it contains such flexible terms that it is rendered less effective. We cannot expect miracles from Kyoto. Developing countries—including China, of course—where most of the world's growth is happening, are concerned with the local rather than the global environment, and they are outside Kyoto. The inertia of the energy system is huge. It will take decades to change facilities, technologies and behavior; this is a fact that we have to understand about the energy industry. This is not the telecommunications industry, where consumer behavior and technology change the facts of the day every other year. This is different. Change in the energy business is slow, and its investments are very large. Once you build a coal power station, you have to live with it for thirty or forty years, whether you like it or not. If you build a pipeline, you have to use it, and it goes on like this. Investments in the energy system have an awful lot of inertia that will keep the business going, as it is, for many decades to come.

Unfortunately for many of us, and fortunately for some of us, the near and mid-term energy future is, in my humble view, business as usual.

Is the Canary Nodding Off?

Robert Skinner
Director, Oxford Institute for Energy Studies

I was asked to provide an update on the oil market and to give background as to why oil and gas prices are what they are today. I shall use the current market situation as a basis for questions and propositions that I believe fringe on the core subject of the conference, namely security of energy supply.

The world price of oil is exploring new territory in current dollar terms. Since most of us do not buy crude oil, the distinction between the real and the nominal price of crude is not very relevant. $55 for West Texas Intermediate (WTI) crude oil last Friday seems a sufficiently new high, even though it is really only about two-thirds of the price reached in 1980. This new oil price is a consequence of a set of factors and events that have converged and compounded to put the oil market into a very tight condition. Some analysts believe prices could go higher as we go into the high demand period of the northern hemisphere winter. Without digging deeply into the whole compost heap of economic history and the evolution of oil supply and demand, I will attempt to summarize how we got here.

Throughout the nineties, world oil demand increased by a little less than a million barrels per day per year. During the early nineties, China's demand sailed along at the modest but steady pace of a little over 200,000 barrels per day per year. Our attention then was on the rest of Asia, which together had annual demand increments averaging 520,000 barrels per day (b/d). The region then disappeared into the economic fog bank of the Asian Crisis and the post 9/11 recession. Since 1999, having emerged from the fog, China and the rest of Asia have almost exactly reversed their weights in oil demand growth—the rest of the region's growth is less than half of what it was, and China's annual growth has averaged 520,000 b/d. In retrospect, therefore, we should not have been surprised that this region has had for some time the potential to increase oil demand by over three-quarters of one million b/d per year—and thereby constitute a major driver of world oil demand.

On top of this Asian demand, the Middle East and North America together have added over 3 million barrels per day (MMb/d) since 1999, and that just about finishes the demand story. The OECD European countries have not been a factor, with less than 100,000 b/d of net growth between 1999 and 2003. The International Energy Agency (IEA) in its latest report expects world demand this year to increase by 2.7 million b/d, an increment not seen for nearly three decades, and at a rate more than twice any since 1985. This increase in oil demand reflects the steep jump in the world's GDP, which grew 5% over the last year, the greatest increase for the last 20 years, pulled by the North American and Chinese locomotives.

In very simple terms, America's consumption-driven economy is in part pulling China's production-based economy. But China is also a major consumer of commodities, which it transforms and partly exports. It is now the second largest oil consumer after the U.S., importing nearly 3 million b/d mostly for petrochemicals and for diesel to generate power and to move coal in trucks to power stations because of the shortage of rolling stock and rails.

Perhaps this will be a bit too much like a cartoon, but what has been driving the world oil market might be characterized as follows. If a boat carrying any convertible commodity floats out onto the Pacific ocean, it gets sucked into a Chinese port, offloaded and, with services and equipment imported from neighbouring Asian countries, converted into stuff that is exported to America, where it is moved about the continent on trains and trucks to Big Box stores where consumers go 24/7 in their SUVs to buy it.

Is this a sustainable condition? Americans are consuming as much as ever and not saving, having received a boost from generous election-year monetary and fiscal policy tonics. Some commentators believe this is feel-good based consumption

and is therefore illusory and can not last. America is in its first ever jobless recovery, which prompts many to suspect its consumption rate will recede. While the American consumption boom might be temporary, China's is not necessarily so. There are some huge underpinning structural reasons why China's demand will continue to grow robustly. But those are the economies and governments to watch closely in the months ahead.

With world oil demand rising over the past three years or so, we encountered problems with supply. The following are just a few examples of factors that whittled away surplus capacity:

- Unrest in Venezuela and Nigeria reduced oil output;
- The continued disappointment in Iraq's exports;
- Declines in oil production from the North Sea, the U.S.A. and in Oman and Indonesia;
- Extra calls on oil for power generation in Japan, to replace shut-down nuclear reactors of TEPCO (although strictly speaking, not a 'supply' issue);
- The Yukos affair and cuts in its output, and threats to close it down;
- An ill-timed strike by Norway's offshore workers;
- Four recent hurricanes in the US Gulf, which have disrupted production and crude imports.

Fortunately OPEC, under Saudi leadership, drew on surplus capacity to supplement the million barrels/day of incremental non-OPEC supply, which came mostly from the former Soviet Union with contributions from the deep marine margin plays off West Africa, Brazil and the U.S. Gulf Coast, as well as unconventional oil from Canada and Venezuela.

Of critical importance have been the rapid and serious erosion of spare productive capacity and the market's perception of just what capacity remains.

Through this period at least three myths have fed the media:

1. **OPEC sets the price:** OPEC does not set the price of oil. Like other market players, it examines the flood of imprecise information about demand and supply and tries to adjust its volume of supply to keep prices within its target price range believed to assure its members of adequate revenues for their economies. Its record has not been stellar in this regard. It has attempted to send signals to the market players, not always successfully, by announcing cuts and increases in quota when it felt these were needed. Therefore, politicians can not blame their economic problems on OPEC.
2. **It is all the fault of the 'speculators':** The hedge funds or 'non-commercial commodity traders' (whom the popular press refer to as ‚speculators') have

not set the price. They correctly anticipated the counter seasonal growth in demand in the first quarter of 2004 and increased their positions accordingly. But when they subsequently off-loaded, the price continued to rise. The increase was not due to speculators. Some believed that the 'reading of political factors', including the attacks on foreigners in Saudi Arabia and the on-and-off threat to pull the plug on Yukos, generated a 'Fear Premium,' which leads to a third myth.

3. **The oil price does not reflect the fundamentals:** While many oil analysts are fond of showing a graph of the historical relationship between inventories and price to show that the price should be lower than it is, the critical issue when determining price is spare capacity along the production, transportation and processing chain. How market players view this spare capacity influences what they are willing to pay for oil, especially as we go into the northern hemisphere's winter. Spare capacity trumps inventories every time, and the current absence of spare refining capacity of the right kind even trumps vague assurances that heavier (and therefore undesirable) grades of crude might be available in 40 days. Not being sure you can meet customers' needs drives the market and is, at the end of the day, a critically important fundamental.

This leads to the following question: is this just another cyclical up-tick in prices juiced up into a 'Perfect Storm' by a convergence of accidents and political events? In other words, as these prices begin to bite, demand will shrink, new supply will surge and prices will collapse. Or, is there a major structural shift underway in the industry and, are these prices, then, like a canary in the coal mine, alerting us to a deep-seated problem?

It is well known that oil is less important today in OECD economies than 25 years ago; that taxes on oil products dampen the effect of crude price increases; that central banks are better at shifting monetary levers to influence macroeconomic responses, and that non-dollar economies feel the price effect less. While not a price forecast, the NYMEX forward curve indicates that buyers of oil for delivery in 2010 are prepared to pay $15 to 20 more today than they were willing to pay last year for 2010 deliveries. So, crude buyers believe oil has jumped into a new domain. I would add the following: Over the last year or so almost every major fuel sector has experienced some form of crisis that has put them back onto the public policy agenda:

- oil we have talked about;
- natural gas supply tightened in North America, and, in the UK, the media and some politicians are anguishing about becoming a net gas importer;

- the electricity sector experienced major supply interruptions in North America and Europe and saw the shutdown of nuclear power reactors in Japan, with knock-on effects in the oil and LNG markets.

Energy supply investments are large, fixed and long-term. Notwithstanding all the efforts at market reform and liberalization (often given the misnomer, "deregulation", which connotes the absence of government), these capital investments take place very much within policy and regulatory frameworks set by governments. Over the past two decades, many governments attempted to reform their investment frameworks from ones of state ownership or direction of investments to ones that rely on competition among private investors. The reform efforts seemed vindicated as long as capacity surpluses in most sectors lasted. (No sane government would liberalize a market without first being satisfied that a supply surplus existed.) Some of the early cohorts in the liberalization adventure, such as Canada, the US and the UK, are now experiencing tight supply and higher or volatile prices. Free markets are symmetrical when it comes to prices: they give us both low and high prices. But consumers and, therefore, politicians are very asymmetrical in their expectations of markets: whether fettered or free, they only want low prices.

On the other side, since the 1985-86 oil-price collapse, private oil companies have found it hard to get the kinds of returns and value they want for their shareholders. They have cut costs, merged and acquired, and fiddled around, and not actually found great assets to invest in, to generate the kinds of returns that their shareholders had been accustomed to. And they went for the pretty girl down the street called the "dot-coms" and so things kind of went dead for a while. Many state owned producing companies were not left with sufficient capital to expand capacity adequately. Indeed, with 5 to 7 million b/d of spare capacity in OPEC just a few years ago, what sense would it have made for its members to spend limited capital on more idle capacity?

There has been much discussion about the subject of spare oil production capacity, which developed accidentally as 'fall-out' from the demand crash of the eighties. There are some rather abstract notions floating about, appropriating Kyoto jargon such as 'burden sharing' and 'fairness,' implying that surplus capacity somehow should and can be developed under the aegis of governments, perhaps under the umbrella of the 'producer/consumer dialogue.' In effect, through international discussions, consumer governments would somehow agree to assist in the cost of developing spare capacity in producing countries. This would be fair, it is argued, since it is consumers who benefit most from the availability of spare capacity and it would begin to address the producer side of the security-of-supply coin, namely 'security of demand.'

Frankly, this reminds me of the dashed dreams of State-to-State Oil Deals of the seventies and early eighties; it derives from either an accountant's mindset or from people too accustomed to the state making all the decisions. It certainly reflects an over-developed faith in governments and an under-developed confidence in the power of markets, technology and private capital. The 'producer/consumer dialogue' at government level has a lot of merit and much to do. This important dialogue would be going down the wrong track if the goal is intergovernmental underwriting of spare capacity.

This issue is linked to the question of 'access' to resources. There are many facets to the 'access' issue: environmental restrictions preventing exploration (mostly North America), access by new entrants to a region and the incumbents' control of infrastructure—recently addressed in the UK continental shelf. Recently we have seen the call from some major oil companies for access to the oil resources of OPEC and of the Middle East countries in particular. First of all, there is only one country in the region whose upstream oil sector is not open, Saudi Arabia, and it does not need to be. ARAMCO is demonstrably quite capable of developing Saudi oil.

Other countries are open, but the terms are evidently not sufficiently attractive to the international oil companies to take up the invitation; at what price they will change their minds remains to be seen. Some suggest that private firms could not accept having their production cut back as part of OPEC's volumetric adjustments. Is this a negotiating position? IOCs accept and manage all kinds of risks: I am sure they would figure out how to factor in and manage the risk that their share of production from a project might be reduced under OPEC's pro rationing of volume. Pro rationing is not new: it was invented and practised for decades by governments in North America. Meanwhile, OPEC has much work to do on its whole system of volume management.

I should not leave the subject of the oil producing perspective without adding that oil producers would say: 'if you consumers are so worried about high prices, why don't you reduce your taxes on oil? You make much more revenue on our oil than we do as producers.' While this is complex, any energy minister of a consuming country should squirm uncomfortably before calling on OPEC, as they always do when the price goes up, 'to do something'.

I mentioned the gas supply situations in the U.S. and in the UK, the two countries that have dashed for gas in power generation. The UK does not, in our view, face a serious supply concern. Ample supply projects are contemplated that could, if anything, lead to a gas bubble in the UK. North America is different. I believe it faces serious natural gas supply constraints, but they are not without

solution. Many observers of North America believe the current crisis in its gas and power sectors is due to policy failure rather than a case of resource depletion. Indeed, North America is the only gas market in the world that needs gas, has gas resources yet is not developing them. The industry is lobbying hard to get exploration access to offshore areas, currently off limits, expedited approvals for LNG terminals, fiscal and loan assistance for the Alaskan gas pipeline (recently tacked onto a military appropriations bill), and a host of other actions including greater regulatory flexibility on emissions.

Before Europeans jump to the conclusion that the Anglo-Saxon experience confirms why we must not liberalize and integrate markets in Europe, North America's experience merely confirms that you must take a comprehensive policy approach that does not prevent access to gas resources, that does not foreclose on electricity generation options and that sets in place a regulatory institution which facilitates interstate wheeling of electricity and stimulates investment to make it happen.

Europe is blessed by being surrounded by gas-rich countries. Had we been honoured by having the Chairman of Gazprom speak on this panel, rather than me, I am sure he would remind us that Gazprom has been, is and will continue to be a reliable supplier. He might also say that they will make the necessary investments to meet future requirements. He might not add, however, that you Europeans do not make his task very easy because what you are doing or may be doing with gas and power sector reform and environmental regulations creates uncertainty, making it very hard to ascertain just how much gas you will need and when. In this regard, consultation is needed because complicating the downstream end of the gas supply chain has implications for the upstream.

Market reform or liberalization presents challenges for gas security, but they are not insurmountable. Large, multi-billion dollar investments in gas infrastructure are made more complex by competition in that a rate of return might not be guaranteed, but large supply systems are not impossible (the $3.5 billion Alliance Pipeline in Canada built into the most competitive gas market in the world in 2000). However, it remains to be seen whether competitive markets will induce investments in double-digit billion dollar projects like the Alaskan pipeline and some of the immense schemes proposed out of Russia, both to Europe and to the East.

Gas infrastructure is capital-intensive and needs gas flowing through it to pay for it. This, along with the mutual co-dependence of the parties at either end of a gas pipe, enhances its security of supply. Producer dependence on the revenues compounds the security just as competition can increase suppliers' interest in

making sure gas is flowing to customers when they need it. The security of supply concern largely comes down to the low probability of short term, high impact interruptions. History confirms that most interruptions are either self-imposed or due to operational failures or accidents. Transit country interruption is a concern and is being addressed, but Europe has continued to be supplied. Moreover, downstream companies have a variety of contractual and technical measures to manage the load in the event of an interruption of supply. LNG adds to diversity and will reduce ‚dependency' on single sources, but not likely for this region of Central Europe. LNG does have, however, the potential to catch the Chernobyl Syndrome—an accident anywhere means an accident everywhere.

The organizers asked if I would talk about coal. I would only offer the following observations, recalling from 1991/92 when I led the first IEA review of the then CSFR Energy Sector, that central European countries were and are very coal-intensive.

- With energy security back on the agenda, so is energy diversity – the key means of enhancing security of supply.
- Coal is an essential part of Central Europe's energy system.
- This region would have an impossible diversity and security challenge if it were to close its coal and nuclear plants. They provide half of total energy supply and 80% of electricity in the accession countries, with coal alone providing nearly two thirds of electricity.
- The environment need not suffer from continued coal use. The Commission estimates that over 60% of coal capacity in the enlarged EU is more than 30 years old. Average thermal efficiency in Central Europe is less than 33% (cf 38% in the EU 15). Replacing old coal plants with modern equipment would reduce CO_2 emissions by 30% much more cost-effectively than getting the same reduction via renewables.
- After adjustment and rationalisation following EU membership, consumption is likely to stabilise in Central Europe as it has over the past 10 years in the EU 15, while production is likely to decline.
- Central Europe will continue to need coal for security and can use it without harming the environment.

I want to close by recalling some of the paradoxes of energy security.

- **Paradox 1: 'Middle East oil is insecure'**. While the Middle East without doubt appears politically unstable and has had numerous wars over the past four decades that have affected the price of oil, the world's oil demand has been met and since the first and only time a few producers used the so-called 'Oil Weapon,' the region's producers have made up for interruptions in oil

supply from other countries. This was demonstrated last year when Saudi Arabia increased production in the face of the invasion of Iraq while supplies were reduced from Venezuela and Nigeria.

- **Paradox 2: The 'Oil weapon'**. Since 1973, the so-called oil weapon has been used mostly by consuming countries against producing countries in the form of sanctions (Libya, Iran, Iraq, Syria, now perhaps Sudan, and there have even been threats against the Chavez government of Venezuela); by consuming countries against consuming countries (South Africa), and by producers against producers (against Russia in the late eighties and against Venezuela in the late nineties.)
- **Paradox 3: 'Energy independence is the key to energy security.**' While energy security is often couched in concerns about external threats, many interdictions of supply originate internally (UK Coal Miners' strike in 1984 and Fuel Protests and blockades in Europe in 2000; Alberta cut off crude to eastern Canada in 1981; numerous union actions in France including in June this year when the union cut over 13 GWs of power during an anti-privatization strike, including specific, commando style targeted cuts of power to homes of political leaders).
- **Paradox 4: 'Government intervention can assure security of supply:'** Government policies to enhance security of supply sometimes lead to inverse results. The off-oil policy of Japan, expressed partly in terms of building nuclear plants, led to Japan having to increase oil imports in 2003 because of the generic problems in TEPCO's nuclear plants. Nuclear is a technology with many merits, but it is exposed to the risk of 'problem somewhere/problem everywhere.' If a design flaw is generic, several or all reactors in a system may have to be shut down. This dependence on a single technology owing to government's 'picking winners' can compound rather than reduce energy insecurity.

While based on the empirical evidence, I believe our pre-occupation with energy supply is misplaced or overblown, and, in any event, too focused on the political rather than the real technical/strategic aspects. I have spent enough of my career dealing with energy policy, both nationally and internationally, to be sensitive to the realpolitik of energy and the asymmetrical expectations of consumers and politicians regarding markets.

Price volatility has recently increased and higher prices always get the attention of politicians. It is simply inconceivable that a politician could waive off a significant rise in energy prices. I believe volatility and a sustained higher price is like the canary in the coal mine: it is an important signal for action, action that

is conducive to sound policies that stimulate investment in both supply and in end-use efficiency.

Governments of consumer countries and exporters must work together to understand the real issues in supply security, and politicians need to focus on where their policies or their lack of policies prevent timely investment in energy supply. It takes a very, very long time from when a policy is changed to when new energy supply happens, and the canary is already nodding off.

The U.S. Energy Plan and the Challenges of Oil Market

Giulia Bisconti
Senior Policy Advisor to the U.S. Under Secretary for Energy

In this presentation, I would like to focus on the world energy outlook, with an emphasis on the oil market. The current conditions in the world oil market highlight our common challenges to acquire secure energy supplies and bring stability to energy prices, so that we can continue sustainable economic growth. I want to then share with you a picture of what our broad energy strategy is in the U.S. to meet our energy challenges both today and in the future.

I think the Bush administration deserves a tremendous amount of credit for its methodology of the blueprint established in the National Energy Plan, and I think that I can say that as a career non-political appointee to the Department of Energy. We are investing, and I think that Research and Development is part of the answer. I will describe some of the important areas of R & D in which the U.S. Department of Energy (DOE) is investing. We are investing in energy technologies of the future, in partnership with other countries, with a hope that our future discoveries will support economic growth, protect the environment, reduce poverty, and strengthen our energy security.

The world oil market has experienced wide swings over the past three decades, reflecting in part events like the Arab oil embargo, the Iranian Revolution, the Iran-Iraq War, the Iraqi invasion of Kuwait, the Asian financial crisis, and more recent events such as unrest in Venezuela, the ongoing conflict in Iraq, and tight markets in the face of strong growth in world demand.

Oil prices in nominal terms reached a new record on the NYMEX recently, closing at $52.10 per barrel. Prices began rising in February 2002 and peaked during the Venezuelan strike in advance of the Iraq war. Since then, prices have remained well above the so-called OPEC price ban, and they have been rising steadily since January. There are several reasons why prices have been high. OPEC repeatedly reduced production quotas in 2003 and 2004 in response to their expectation of a possible weakening in price. OPEC has reversed itself beginning last April, but they have lost control of the market. OPEC (OPEC 11, including Iraq) is currently producing at its highest level since 1979, 30.2 mmbd in September, but prices remain high. World surplus capacity, at 0.5-1.0 mmbd, is currently near its lowest point of the past 30 years, leaving little to cushion any potential supply disruption. As a result, perceived risks to supply are magnified by the market, and inventories remain at historically low levels for both crude oil and products.

In October 2004, the IMF and World Bank raised their forecasts of global GDP growth to 5.0 percent for 2004, the highest growth rate in 30 years. Some slowdown is expected in 2005; an even greater slowdown is expected if oil prices remain around $50 per barrel. World economic growth continues, oil demand growth stays strong, and supply remains tight.

Annual world oil demand growth averaged just over one million barrels per day in the 1990s, but fell sharply in 2002. Demand regained strength last year, rising by over 1.2 million barrels per day, and is projected to rise by 2.5 million barrels per day in 2004 to 84.2 million barrels per day, and almost another two million barrels per day in 2005. In particular, Chinese demand growth has shown remarkable strength, where demand is now projected to grow by one million barrels per day in 2004, before slowing to half that rate in 2005 as a result of the efforts by the Chinese government to slow demand growth. U.S. demand is forecast to grow around 390,000 barrels per day in 2004, and 360,000 barrels per day in 2005.

A major concern for the world oil market has been the steady erosion of excess production capacity as demand has surged. IEA currently estimates global excess production capacity at approximately one million barrels per day. Some analysts have lower estimates. Suffice it to say that producers' ability to respond to a disruption in the oil supply is very limited.

With little spare production capacity and low inventories, any supply disruption would be expected to push prices up even higher. In the U.S., inventories of crude oil and all major petroleum products are well below five-year averages. Distillate heating stocks are extremely precarious as we head into winter. Given the small amount of excess capacity, the market has intensified its focus in regions where disruptions could occur. As you know, Iraq has seen periods of disruption due to sabotage; there has been ethnic labor unrest in Nigeria, and terrorists have struck in Saudi Arabia.

High oil prices will not go away. For many different reasons, we are in a period of relatively high prices that are expected to continue to remain high for the next year, and that is without a major supply disruption. Oil continues to be the dominant energy source. Oil's share of world energy is currently projected to remain unchanged at 39% through 2015. Use of natural gas and renewable energy is expected to grow a bit faster than coal and nuclear over the projected period. Much of the expansion in renewable energy is expected to result from large-scale hydroelectric power projects in Asia.

I am not going to go into detail, but let me just note that we have a concern about natural gas prices as well in the U.S. Gas prices have tripled over the past few years, and consumption has greatly increased.

I would now like to talk about the U.S. strategy for addressing our energy challenges, including meeting dramatic energy demand growth that is projected over the next two decades in the U.S. First, we view energy security as a key requirement for sustainable development. Energy supports economic health, which in turn funds conservation, efficiency, and environmental improvements for sustainable development. Countries with strong economies are in a much better position to take advantage of opportunities to have a clean environment. Energy provides a basis for increasing the world's health, environment, and standard of living. We all recognize that energy needs will grow much faster in developing countries.

U.S. energy policies are laid out primarily in the National Energy Plan issued in May 2001. This is basically our key blueprint of what we are trying to do to move our energy plan forward. It has been very impressive for me to watch how methodically the recommendations laid out in the Energy Plan have been followed through. Almost all of the recommendations that could be implemented by executive order have already been acted on. There are only a few areas that are still under consideration or debate, but it has really been impressive how methodically our government has been able to move forward on those recommendations.

I would like to address several elements of the U.S. Energy Action Plan for Energy Security and a Sustainable Future. The National Energy Plan is aimed at developing a reliable, affordable, and environmentally friendly energy mix. In the short term, the United States is moving to complete the filling of our strategic petroleum reserves for the first time in history to 700 million barrels. We have had about 670 million barrels in the reserve and our fill-rate is determined by our need to avoid creating adverse price impacts on the market. Some people wonder why we are filling it even when the price is so high, and the answer is that we are trying to create a stable effect on the world oil market.

We are also working with the IEA to strengthen the reserve policies in other countries, particularly in major consumers such as China and India. Our policy is to use the reserve only in the case of a severe disruption in world oil supply. On a case-by-case basis, we have also used oil from the reserve to ensure continued supply to domestic refiners who have had their supply interrupted by storms or accidents. Most recently, we loaned oil from the reserves to refiners who suffered supply losses due to Hurricane Ivan. One of our key midterm strategies is to improve the ability of the economy to grow while using less energy. One strategy for accomplishing this is working to improve the efficiency of power production.

Another strategy that we have is to improve our fuel and source diversity. We want to grow our renewable energy capabilities. The DOE spends more research dollars on renewable energy and energy efficiency than on any other sources. We want to expand nuclear power. We want to shore up domestic supply through developing more of our reserves; we want to improve the transmission and transportation infrastructure for our energy. We want to integrate the North American supply with Canada and Mexico and to diversify our international supply.

The U.S. did not join the Kyoto protocol, but we are committed to reducing our greenhouse gas emissions in ways that do not harm our economy. Much of our effort is focused on technological solutions. To this end, the DOE has made increasingly larger investments in science and technology research and development to meet our energy challenges for the 21st century. We have a major research commitment to carbon sequestration and emissions reduction to enable the clean use of fossil energy. We are predicting a 50% increase in the use of carbon based fuels over the next twenty years. If that increase is going to occur, a robust sequestration program is vitally important for reducing greenhouse gas emissions.

A tangible measure of our commitment to carbon sequestration is our FutureGen project. This is a ten-year, one-billion-dollar program to create the world's first zero-emissions fossil fueled power plant. When operational, it will be the

cleanest fossil power plant in the world. Virtually every aspect of the plant will be based on cutting-edge technology; rather than using traditional coal combustion technology, it will rely on coal gasification. It will be a living prototype, testing the latest technologies to generate electricity, produce hydrogen, and sequester greenhouse gas emissions from coal. FutureGen will help lead the development of clean fossil-fuel power plants across the world. Because of the obvious international application of FutureGen, we are opening the project to global participation.

We are going to expand the use of emission-free energy sources, including the advanced design nuclear power plants and renewables. The U.S. government and private sector are working together in initiatives that should result in new nuclear power plants in the 2010 timeframe. In the meantime, our 103 nuclear power plants have become extremely efficient and productive. Since 1990, our nuclear power plants have increased their electricity output equal to 26 new power plants, enough to power 26 cities the size of Boston or Seattle.

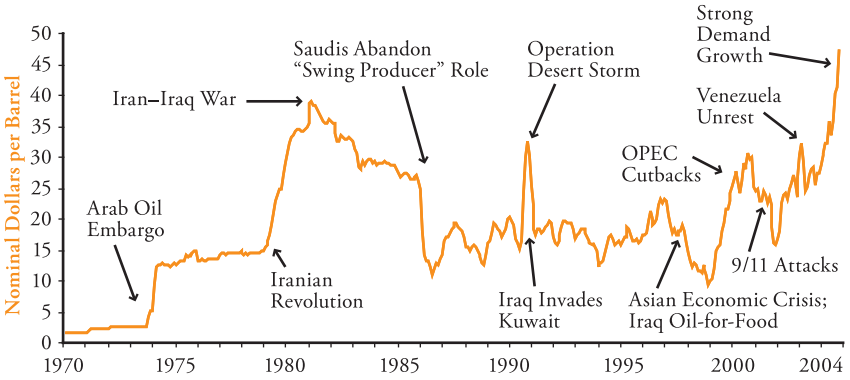
Our long-term strategy is tied up in hydrogen, fusion, the emissions trapped fossil I was just discussing, and future nuclear resources. Hydrogen could become the clean transportation fuel of the future. However, hydrogen is not a source of energy, but a carrier of energy: it must be produced by something. We are looking at nuclear and emissions trapped fossil as the most likely large energy sources to produce hydrogen, with renewables also as an important component.

The U.S. is committed to spending 1.7 billion dollars in the first years to fund the ambitious Freedom Car Hydrogen Fuel Initiative, which will develop emissions free automotive operating systems that will run on hydrogen. If our plans are successful, by 2040 hydrogen could replace more than eleven million barrels per day of oil in America alone, which would, besides lessening our energy dependence, have a tremendous impact on lowering the levels of carbon emissions into the atmosphere.

In regard to fusion, the U.S. is one of the world's largest supporters of fusion research. We are hopeful that ITER parties will conclude successful negotiations of the ITER project, which will be the next stage in fusion development. As for Generation Four nuclear energy, great strides are being made to reduce costs and improve safety, reduce waste amounts and toxicity, and improve the non-proliferation attributes of this important energy source.

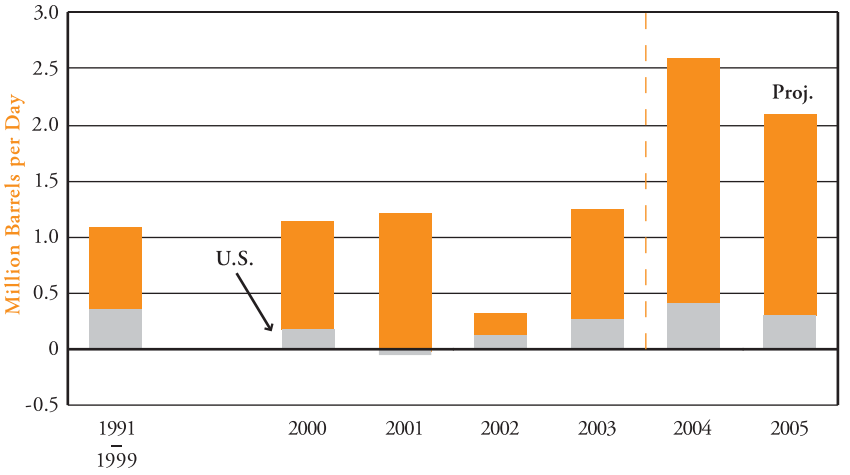
Lastly, I want to conclude with our international energy strategy. We want to strengthen bilateral and multilateral relationships. We want to prevent and effectively respond to supply disruptions. We want to integrate and improve the connectivity of regional energy systems, both in North America and with other countries and their neighbors. We also want to improve the producing and

I. Major Events and World Oil Prices 1970–2004

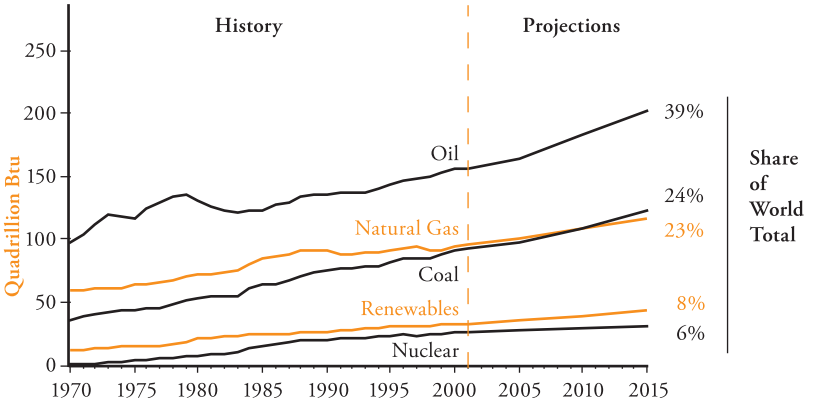


Refiner Acquisition Cost of Imported Crude Oil (Saudi Light Official Price for 1970–73)

II. Annual U.S. and World Oil Demand Growth

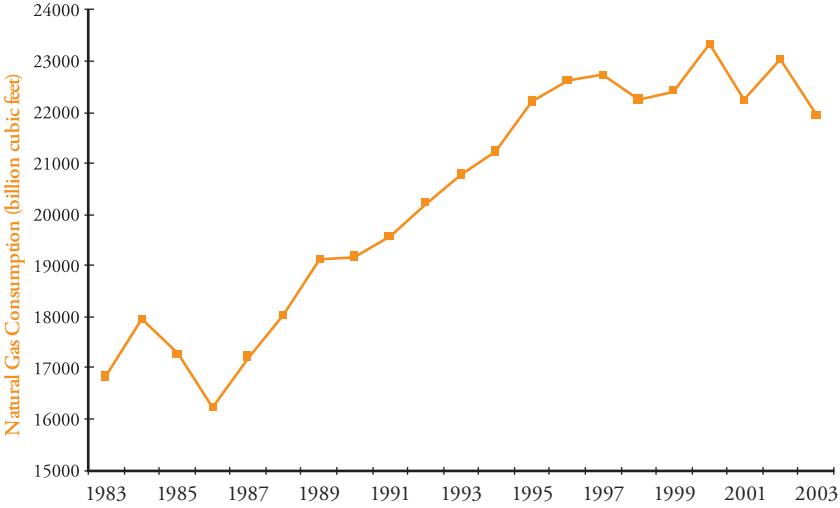


III. World Primary Energy Consumption by Fuel Type, 1970–2015



Source: EIA, International Energy Outlook 2004

IV. U.S. Natural Gas Consumption 1983–2003



consuming countries' relationships. We want to support the development of transparent, open, fair, and competitive markets. We want to engage other countries facing similar energy challenges so that we might tackle those challenges together.

One way we are doing this is by developing and leading new international initiatives to collaborate with other countries on large scale projects. The carbon sequestration leadership forum brought thirteen countries together last year to begin working on ways to sequester greenhouse gas emissions from fossil fuels. In a similar fashion, we launched the International Partnership for the Hydrogen Economy with fifteen countries and the EU to work together on hydrogen. By pooling our technological expertise, by establishing a common set of workable codes and standards, and by setting realistic goals and timetables, we will speed the coming of the hydrogen revolution in a way that would never be possible independent of other nations. We must work together on these goals.

The last area that I will mention is international cooperation and the new Methane to Markets International Partnership. The initiative is designed to promote cost effective near-term methane recovery by targeting three methane sources for action: landfills, underground coal mines, and natural gas and oil systems.

Risks of Import Dependency

John Mitchell
Associate Fellow, Chatham House, The Royal Institute of International Affairs

What do consumers want? Above all, consumers want a good life. They want mobility, they want heat, they want power to work their computers and their factories, and they really do not care how that happens. They are prepared to sing folk songs or do country dancing or deep breathing if that would deliver the result. The question of whether it comes by one form of energy or another is a secondary question.

I suggest that there are really three headings. One is the traditional energy policy area: consumers want reliable supplies at reasonable prices, and that is a contradiction. Somebody has to trade off reliability against price; the question is: does that trade-off get made by governments or get made in the marketplace? And even there, the answer is slightly different for different conditions. Secondly, consumers are also citizens, and therefore they are concerned about national security and foreign policy and the defense and independence and freedom of their country. Thirdly, and this is what I will concentrate on most, consumers are also

humans; they have consciences, and they want to know that what they do is supplied by energy which is derived in a way which is acceptable from an environmental point of view, from a social point of view, from an ethical point of view. That is something that nobody has mentioned so far.

Let me say a word about the traditional energy issues. Much has been said, but there are some things that deserve to be said again because it is so seldom realized how important they are. We have to start with physical facts. The physical facts are that resources of energy, whether coal, oil, or gas are where geology has put them over millions of years. They are there, but the demand for energy is elsewhere. The demand for energy is where history and development have put it, so we have 60% of the oil reserves in the Middle East and 27% of the gas reserves in Russia, but half of the energy demand for oil and gas is in North America and Europe.

In the future, this balance will shift. Half of the increase in energy demand, we are told, will be in Asia. The point is that trade is inevitable, and the phrase that talks about energy dependence, meaning import dependence, is actually a great direction post in the wrong direction. Dependence is good, trade is good; we all learn as economists that trade is beneficial because it enables things to be delivered at the cheapest possible cost. There may be some problems, and we have to deal with them, but trade is inevitable, and that is important because when consumers want reliable supplies, and they want cheap supplies, trade is the way to deliver the lowest cost solution to the world's energy problems.

Not surprisingly, when we look at the figures, there is indeed very substantial trade; something like 20% of the world's energy is traded. Of that 20%, there are three main movements: the movement from Russia to Europe, which accounts for about a third of it; the movement from the Middle East to Asia, which accounts for another third; and the movement from a variety of sources into the United States, into North America, which accounts for about a quarter.

The numbers are much larger if you look at oil alone. Something like 60% of world oil supplies are traded, and to bring that to an end would be impossible in all sorts of ways. The only two countries that are not deeply involved in energy exports and imports, and they are in fact marginal exporters, are Canada and the United Kingdom. They are not necessarily models that anybody else can follow because they happen to have a coincidence of demand and resources.

If we look ahead, to where the expansion of oil supply is going to come from for the next ten years or so, more than half of it will come from outside the Middle East. Of that, much of it is being developed by the private sector. We have a kind of energy policy formula which says, "yes, there is trade in fact," though

that is not often admitted. But in the internal markets, security and the lowest cost are provided by liberal markets, competition, and all of those things that you are very well aware of in the European Union and the Czech Republic, and the construction of those markets is a subject in itself.

Let me move to the question of the future supplies of energy for international trade. There are two quite different problems. One is the investment by Middle Eastern countries, where the oil and gas resources are a state monopoly; are they going to invest? When are they going to invest? The other is the investment by mainly private sector companies in the rest of the world, especially outside the United States, which has rather limited energy resources, and in Russia, which is very different from the rest of the world. The interesting thing, I think, is that this investment is very concentrated. Outside North America, something like 63 billion dollars are spent every year on oil and gas exploration and development. Half of that money is spent by six companies: it is a very concentrated business. You could also say that half is spent by 50 or 100 companies, but nevertheless, a very small number of companies make a very large part of this investment.

The IEA has indicated that, as it looks forward, very large amounts of investment are required in developing countries to provide energy for export. A large part of that is going to be either in OPEC by the state monopolies, or it is going to be by this rather small number of private companies. Now, the thing about the small number of private companies is that they are very exposed to a lot of things. They are exposed to political pressures; they are exposed to national pressures, and to social and ethical pressures.

Before I get to the ethical question, let me just say what the international agendas affecting this investment appear to be. First, the OECD governments are promoting a whole series of wishes about how foreign investment should be treated. They are expressed in different ways; they are expressed in the NG Charter Treaty; they are expressed in the General Agreement on Trade in Services; they are expressed in the General Agreement on Trade Related Investment Measures, the so-called Singapore principles. All of these things are laid down by developed countries to encourage and develop investment of all kinds, but certainly including energy investment, primarily in developing countries.

The NG Charter Treaty is particularly targeted at Russia. The companies, of course, generally prefer what are called "production sharing agreements," which are common in Latin American and African countries, which create a kind of legal enclave for the foreign company to operate independently of local taxes and laws. This is the case with the Baku Pipeline, which has a little agreement that

does just that. There are one or two agreements in Russia which do this also, but it is evident that this is not the way they are going in general.

There is a set of initiatives to bring foreign developing countries which have the resources into line with what you might loosely call OECD principles, and these have to do with what you would expect: stability of laws, stability of contracts, controlling corruption, transparency in where the revenues go, accounting standards, a general minimizing of the state role, and mixed-up objectives of privatization, with the objective of promoting opportunities for companies from the developed world to invest in developing countries.

There is an international agenda which is chugging through a number of channels, where the World Bank and the international financial institutions also participate. This is sometimes called the Washington Consensus because it is part of a general mode to create in developing countries a kind of functioning market economy. And more and more emphasis is given, particularly in World Bank activities, on realizing that you cannot have stable functioning market economies without having good governance. And good governance also means democracy and electoral processes. It means building the capacity of the governments concerned by various kinds of aid programs.

That is the kind of conventional set of pressures, and to that we have now added what I would call the missionary agenda. The missionary agenda comes from human rights groups; it comes from NGOs; it comes from all of those people who appeal to the consciences of consumers. Some of this agenda is the same as what I would call the OECD agenda, but it goes further because it puts much more emphasis on human rights and the social impact of energy investment projects which bear on exports. One of the reasons that these movements have leverage is because, for the private sector, so much of the investment is carried out by a small number of large companies, based in Europe or North America, which are vulnerable to these pressures, not just from public opinion, but also from their investors, from fund managers, increasingly from ethical investment funds, from pension funds or share holders in these things, who now want to say that they do not want their investments to be in companies that are going to have continual conflict on their hands. It is altering behavior: the Burma gas pipeline, the Aceh field in Indonesia, the problems of the people in the delta in Nigeria, the use of oil revenues in Angola and Sudan, the gas pipeline route in Bolivia, which brought down a government, the pipeline through Turkey from the Caucasus, the Three Gorges Dam in China, the whole series of human rights issues in Colombia. There is a very active agenda, which the big companies, because of their exposure to it, are trying to address, but they all add up to companies, governments, and

international institutions taking on a reforming, missionary role in many of the developing countries from which these resources and exports will come in the future (more difficult to do in the case of the Middle Eastern countries because they are quite strong countries, really).

To sum up, I think that consumers are looking for a lot of very difficult objectives to coincide. In the short term, they are looking to avoid nasty surprises, crisis management, and the use of oil stocks. Shocks and surprises will be with us. In the medium term, there is a more complicated agenda. We have to take the political risks on a case by case basis. Mere fact of dependence on imports, apart from being inevitable, does not necessarily create a political problem. If you are totally dependent on Norway for gas imports, I do not think that anyone would say that there was a security problem. If we were totally dependent on Trinidad for gas imports, I do not think that people would say that there was a security problem from the point of view of the government of Trinidad trying to influence the policies of Europe. There may be an explosion in Trinidad, but that is a different problem, which is not going to be used to influence the policies inside Europe. We have to be certain that there is a coincidence of import dependence and political power, which matters and which could, under certain circumstances, be a threat.

I think that if we take that test, we are left with two situations. One is Europe and Russia, and the other is the possibility of combined Islamic action against people whom they regard as a threat to their interests inside the Middle East. Otherwise, dependence is something which is part of life. In the medium term, I think we have to look at some type of dialogue with the OPEC producers. They have interests and concerns about the instability of the market, about differential taxation, and so on. Dialogue in the International Energy Forum Administers has been friendly, and it has become friendlier, but there is no substance to it. Lastly, we have to look at the acceptability from the ethical and social points of view of these missionary attempts to change the rest of the world.

The Risk Assessment Methodology

Robert Eagan
Vice-President, Emeritus, Sandia National Laboratories

I am going to talk about risks, the risk associated with operating nuclear reactors and the risk associated with the electrical distribution network. I am going to do that in terms of something called a "risk equation." For some of you that is old hat; you have seen it a lot. For others, it may be a new concept, so I would like to introduce it in terms we can all identify with: flying on an airplane. I will go through the terminology and then go through that equation, talking about the reactors and talking about the distribution system.

The first thing to recognize is that the risk is never zero. No matter what we do, or where we go, or what kind of system we design, there is always a finite chance that if we fail in any way, it could be catastrophic. The risk equation is pretty simple in concept; it is the consequence of failure. That is, what will happen if the airplane crashes—you will die. Now, that can be expressed in probability terms, it turns out, but it is difficult to analyze because it requires looking at, for example, the threat, the capability of the agent implementing the threat

(let us say, terrorists from Al-Qaeda), and their technical capabilities, as well as their desire to do something to a particular system. So, let us do it in terms of an airplane. We all made the decision to come here, even though we know that the consequence of that airplane you were on crashing would almost certainly have been death. But, when we look at the next term in the equation, the ability of the terrorist to bring down the plane, we know they have the technical capability. They demonstrated it through explosions in Pan Am, through carrying a shoe bomb on board in the case of Richard Reed, who was only defeated because the passengers attacked him, and by missiles, which have also been used in the past. The fact that it is not happening all the time means that terrorists have chosen not to put the resources there, so the probability of that attack occurring on the plane that you or I happen to be on is less than one, substantially less than one, in fact, because of the number of aircraft flying.

The next is the vulnerability or, rather, the reduction in vulnerability to attack. And that can occur in a number of ways. In baggage handling, for example, it could be addressed by using containers that are explosion-proof. Another alternative is to keep the explosives off the plane; that is what we are doing now in the U.S. by detection in airports to keep people from carrying explosives onto the plane.

We are all too familiar with the delays of going through airports, getting on the aircraft, going through the inspections. So the risk in the decision we made to fly here, we determined, was very, very small because we hardly ever think about it, about getting on a plane. To look at risks that have a much larger potential impact, such as the risk of a failure of a nuclear reactor, there is an organized methodology that can be applied. At Sandia, we call that methodology a "risk assessment methodology" or RAM, and it has been applied to reactors and water systems and many other things. I would like to walk you through that kind of approach now and talk about reactors and why I am, in fact, very comfortable in extolling the virtues of nuclear power because the risk is so small, even though the consequences are great.

The first thing to do in making that assessment is to look at the assets and characterize them. What is it about reactors that could cause a problem, and what is it that is inherently safe in them? Determine the consequences of failure. In terms of reactors, that means the consequences of the reactor vessel being breached and the core melting to release radioactive materials into the environment, which could ultimately kill somebody. Defining the threats looks at the desire of terrorists, in this case, to attack a reactor, and also at their capabilities. Now unfortunately, they have proven that they know how to get their hands on

large missiles and aircraft, so that there is a demonstrated capability to do that. Now hitting a reactor, as opposed to the Trade Center Building, is a much more difficult thing to do because it presents a smaller target. And, in fact, getting the aircraft is much more difficult now because of the examples I cited earlier: the inspection of people and locking the doors to the cockpit. Also, safeguards are built into reactor systems. The reactor containment vessel is a meter or more of concrete, highly reinforced, and there are redundant safety systems as well. So containment and the safety and security associated with the act of operations is very good. Although not intended to protect against the attacks, particularly, when they were designed, they serve that purpose admirably.

By going through this process and employing a model, and the model's complexity depends on how serious the issue is, we can come up with a reasonably good number for a risk in analyzing a given system, and then policymakers can make the determination: is this risk acceptable or is it not? And if it is not, then you can go back through that cycle again and seek opportunities to reduce the risk still further.

In my opinion, reactors are very safe; the risk number is extremely low for this kind of attack. Sometimes when I am asked, I say that I would rather live next to a reactor than live in downtown Washington, D.C., where I see the probability of an attack as being somewhat higher.

Let us go through that same cycle again, looking at power systems, but this time, not thinking about it in terms of the immediate deaths which would come from a reactor attack, but rather the impact on economics. (Once again characterizing these assets as relatively complex because they are very broadly distributed, but the consequences of their failures can be extremely negative.) In the report that was handed out for this meeting (which I found fascinating, by the way, and I enjoyed reading it), the consequences of failure of electrical grid systems was considered to be not terribly disruptive over a short period of time.

In fact, the right kind of attack on a grid system can cause it to fail for a very long period of time because there are critical nodes in grid systems that use, for example, very large transformers of which, the last time I looked, there was one spare in the U.S. They are all built outside the United States, and the lead time is around a year, and so an appropriately planned attack could disable the power grid for a long period of time with very severe consequences. The threats, again, are desires on the part of terrorists to attack economic targets, as opposed to ones associated with the death of the people who are near them. The safeguards in the past were relatively modest. Now, over the last several years, they have increased dramatically, particularly when it comes to protecting against software-related

attacks, where one could go in with computers, causing the grid to crash in an unacceptable way and damage the equipment. Nevertheless, they are vulnerable simply by the fact that they are spread out, and watching the oil pipeline destruction going on in Iraq is a very good example that we see everyday.

Again, analyzing these systems for risks suggests to me that, in fact, they are at a much higher risk of disruption and are a much higher risk of causing grave economic damage to a country or region than is an attack on reactor, for example. And so, as we look at that from an economist's point of view, the grid is, in fact, remarkably vulnerable. We have made a lot of progress on addressing the vulnerability. There is, in my view, a long way to go. It is the heart and soul of protecting our economies. And it is because it is not just the grid: it is the things associated with the grid, the so-called interdependencies. When the power grid goes down, the ability to pump water goes away, the telecommunications will fail in a couple of days when the batteries go dead and they are not going to charge the generators anymore with diesel fuel, and so they will die, and emergency services follow there after. And this cascading effect of long-term outages (long-term being more than a few days) is very serious.

Protection of Key Energy Infrastructure

Anne Korin
Editor, Energy Security, Institute for the Analysis of Global Security

I want you to remember that we cannot continue with business as usual, that we have to be very sensitive to how much time it's going to take us to change the situation, that we don't have a lot of time, and that there are things that we can do to change the situation. I will briefly go over each of these issues. I am going to focus on the oil sector and specifically on oil terrorism. The reason we need to care about oil terrorism is because we have almost zero wiggle room in the oil market right now. With growing demand from the developing world—China and India together are a third of humanity, and China's oil consumption grew thirty percent last year, largely driven by the transportation sector—spare capacity has eroded severely. Any severe act of terrorism can really affect the oil market. While it is true that we no longer need to be concerned about oil shocks of the type we saw during the Arab Oil Embargo, we are now looking at a very different kind of oil shock, a next-generation oil shock. That is, an oil shock that is carried out by non-state actors, by terrorists, and these terrorists have clearly

put oil in their crosshairs. I am just going to cite for you an Al-Qaeda statement made after the attack on the French oil tanker, the Lindberg, off the coast of Yemen in 2002. That statement said, "by hitting the oil tanker in Yemen, the Mujahedden have hit the feeding line in the provision to the artery of the life of the crusader nation." I do not think one can get a more clear statement of how well people understand that oil is an Achilles' heal of the West; it is really the lifeblood of the West, and our societies would grind to a screeching halt if it were severely interrupted.

Let us go into specifics. First of all, two thirds of the world's oil reserves are located in the Middle East. If we expand beyond the Middle East, we see that three quarters of oil reserves are located in countries in which Islamic fundamentalism, and the terrorism that goes with it, is on the rise. What that means is that there is ample opportunity and motive to attack oil targets.

What kind of targets are we talking about? First of all, pipelines are extremely vulnerable, with Iraq providing an example. Iraq has over four thousand miles of pipeline, much of it above ground, and we have seen a sustained campaign of sabotage against these pipelines, and these are not random attacks. We track the attacks on Iraqi pipelines, and there have been over one hundred fifty attacks since the official end of hostilities. They fall into two categories. They are attacking with clear strategic intent, number one, to disrupt the ability of Iraq to export oil and thus make the effort of the coalition much more expensive by putting that cost on coalition taxpayers, and number two, to disrupt the ability to provide electricity to Iraqis and thus create resentment against the coalition. They attack at critical points; they attack parts that are more difficult to replace than spare, off-the-shelf parts, and they attack when a pipeline goes back up. They do not bother attacking if it is not a really important pipeline or if it has been damaged. They wait until it has been repaired, and then they just go at it.

It is very concerning that we see these types of attacks occurring in other parts of the world—India and Russia have seen these types of pipeline attacks, certainly not on the scale of Iraq's, but it is just a matter of time. I want to remind you that this type of attack is not a new thing. If you look at Colombia, for instance, the major pipeline in Colombia has been attacked so many times that it is known as "the flute."

Pipelines are really of big concern if you look at one of Iraq's neighbors, Saudi Arabia, which has over twice the pipeline mileage that Iraq has. So if we see these types of attacks spreading there, it would really be very disturbing, especially since Saudi Arabia is essentially the only holder of spare capacity in the oil market, which is why it is the most important country in the world oil market.

Notwithstanding the fact that it has 25% of world oil reserves, it is really the spare capacity that makes it critical.

Next, it is important to mention chokepoints briefly. Oil, because it is located so far away from the consuming countries, has to travel by sea. Unfortunately, the sea is just not a very safe place. Some of the chokepoints are Malaka, Hormuz, and there are several others, but they all are located in areas in which terrorism, again, is on the rise, and more than terrorism, if we just focus in on the Strait of Malaka between Indonesia and Malaysia, what we see is that piracy is really a big problem. Piracy there is at the worst level that it has been over the past twenty years. There has been a slight improvement over the past four months because of coordinated patrols by the littoral states, but it is still a very big problem, and there is a huge concern about collusion between pirates and terrorists. Communications indicated that they considered attacks on shipping in the area in intelligence intercepts of Jemaah Islamia and also in confessions of Jemaah Islamia terrorists in Indonesian custody. The Free Aceh Movement, an Islamist separatist movement in Indonesia, also has a practice of highjacking vessels.

Now when we look at what we have seen in terms of oil terrorism on tankers, first of all, we see that it is not just the Lindberg. In October of 2001, there was a coordinated suicide attack on a tanker off the coast of Sri Lanka. Of course, we had the same kind of attack on the U.S.S. Cole; if they can attack a ship like that, they can attack a tanker. Tankers are very difficult to protect. Of course, the crew is not armed; you cannot put electric fencing up on them, so you cannot really prevent hijacking, and you certainly cannot prevent a suicide boat from coming at them.

The other thing you should remember is the attempted attack on the Basra terminal off the southern coast of Iraq: a suicide boat coordinated attack which fortunately failed because of the soldiers patrolling in the area, but if it had succeeded, a significant amount of Iraq's ability to export would have been curtailed on that day.

Oil facilities are of particular concern. Notice that I am focusing on all the upstream issues here because, while the impact when you attack downstream is significant to the particular consuming country that you are attacking, it is obviously much, much more damaging if you are attacking upstream. If you want to affect the world oil supply, you attack in the generating countries and at the transportation points. The issue of most concern, really, is a successful attack on Saudi oil facilities in particular because of the spare capacity issue. Unfortunately, you are talking about a system design that has very few critical points that each process enormous amounts of oil, and again, when we talk about attacks

(airplanes and so forth), your ability to damage these facilities is there. There was a plot to attack the control systems in the Ras Tanura terminal in Saudi Arabia, and that was thwarted because of good intelligence, but this remains a concern.

There have also been attacks on oil personnel. We have seen those in Nigeria, and certainly in Saudi Arabia, Kolbar, and Yanbu Al Bahr, and again if we listen to the statements after these attacks, we see a clear understanding of the correlation between the jump in oil price and the attack: it is a clear statement of intent.

Nigeria is a good example of a country that is outside of the Middle East, and yet we see all the same problems that we see in the Middle East in terms of vulnerability of the oil supply. Nigeria is half under Asari, the major warlord, who is fighting a pipeline war against the government right now, is waging his own mini-Jihad, and is responsible for many, many supply disruptions in Nigeria.

So what can we do about all of this? What can we do about all of this given that the world is not likely to become a more peaceful place any time soon? These countries are not likely to become any more peaceful in the amount of time it takes for technology to diffuse through the market. If we look at cell phones or the internet, it took a long time, and if we look at the types of technologies that I am going to talk about, we are looking at fifteen or twenty years of effort to really get things out there.

When we look at oil, we need to focus on the transportation sector. In the U.S. the transportation sector accounts for two-thirds of oil consumption; electricity accounts for less than 2%. So displacing oil into electricity generation does not improve your oil issue. The growth in oil consumption in the developing world is driven in large part by the transportation sector.

What can we do in the transportation sector? We cannot focus on technologies that are just in the R&D stage right now. Hydrogen is all well and good, but even the experts in the hydrogen industry themselves say we are not going to make a dent until the mid-2030s, and we do not have that kind of time.

I am going to highlight two types of technologies that are available today. First of all, we need to focus on electrifying transportation. Electricity does not have to be generated from oil. Coal, nuclear energy, renewables, gas, and electricity can be used to power our vehicles. If we look at the new cars that DaimlerChrysler is coming out with, they represent the next step after hybrid vehicles. They are cars that can be fueled by a combination of liquid fuel and electricity. You charge the car by plugging it into an outlet, but you also have a liquid fuel tank, so you do not face the range-limitation of all-electric vehicles. What that means is that 85% of your driving is done on electricity. You get one hundred miles per gallon on a plug-in hybrid vehicle; I think that is forty kilometers per liter, if my quick

calculation is correct, a very significant improvement, and in a technology that we can move toward right now. It is wrong for us to wait for fuel cells; this is something we can do now.

The next thing we need to look at is flexible fuel vehicles. In the U.S. we have three million flexible fuel vehicles on the road. These are cars that can run on any combination of gasoline and alcohol fuel, alcohol being ethanol and methanol. They are standard cars, costing an auto manufacturer less than one hundred dollars per car to make a flexible fuel vehicle as opposed to a standard vehicle. These alcohols can be made from coal; methanol can be made from coal at less than fifty cents per gallon, and the U.S. Department of Energy spent a lot of money developing this technology. There is a commercial-scale plant in Tennessee that does this. Ethanol can be made from biomass. Ethanol can, of course, also be made from natural gas. Combining flexible fuel vehicles and plug-in hybrid vehicles, we get cars that have five hundred miles per gallon of gasoline.

I am going to close my comments with this. We have to do something, and there are things that we can do. We should not wait for the perfect technology to come along and then implement it because the enemy of the very good is the excellent, and we are in a very vulnerable situation right now in the world, and we need to act. If we do not change our course, we are going to end up exactly where we are going.

The Nature of Terrorism ... And How to Cope with It

Richard Perle
Resident Fellow, American Enterprise Institute

What is the nature of an extensive terrorist threat? It is not going to go away any time soon. It is deeply, intensely ideological in nature. It is rather like Nazism or Communism. The terrorists about whom we have every reason to be most concerned are driven by vision rather like the vision of the Nazis and the Communists, in which they seek to bring about what they regard as a "proper" order for the rest of us, the rest of us being infidels who are not ready to embrace an Islamist state. They will not give up easily. And unlike most of the terrorists of the past, they are motivated in significant numbers to sacrifice their own lives to achieve their vision.

Unhappily, almost all our systems of security, developed over many years, depended on confronting enemies who were neither suicidal nor so fanatic. Moreover, the enemies of the recent past were responsible for territory, and that territory could be threatened with retaliation, which gave us in the West a major deterrent capability. But you cannot deter a threat that cannot be properly identified,

and you cannot deter a threat that has no property to protect. And of course, it hardly needs saying that you cannot discourage action by threatening death to people who desire to die as martyrs.

So, for all of those reasons, we are left with a very new challenge, a security challenge of unprecedented nature and dimensions. And as we look at some specific elements of that threat, at the relative robustness of nuclear facilities, and the relative vulnerability of critical infrastructure nodes with respect to fossil fuels, we see that virtually none of our installations were designed against the threat of suicide fanatics. A chain-link fence is perfectly adequate (was thought to be perfectly adequate) to protect power plants, chemical facilities, port facilities, and the like. And chain-link fences are fine until you encounter someone who is prepared to drive a vehicle laden with explosives right through that chain-link fence, and then suddenly you discover that the task of protection of critical infrastructure, including plants producing lethal products, for example, is enormously overwhelming. This drives me to the conclusion that the key challenge for us is less the protection of individual vulnerable installations and rather more the importance of defeating this terrorist movement.

Now, that is not easy. And we certainly will not succeed in doing it if we do not understand its nature. We have thought in the past, in my country, and I dare say that it is continued to be believed in most countries, that terrorism can be dealt with by police forces, by a criminal justice system, by identifying and bringing terrorists to trial and, in the process, by the way, according them Constitutional protections of a very high order. But I do not believe we can defeat the terrorists in this manner. They are too driven. They are too extreme. And finding them one at a time, two at a time, is not going to protect us from the next catastrophe. Let me just say parenthetically that the next catastrophe will be rather like some previous catastrophe, but this time with the potential addition of weapons of mass destruction—chemical weapons, biological weapons, nuclear material, radiological weapons. So the challenge is assuring that the combination of weapons of mass destruction in the hands of terrorists is not permitted to emerge.

This is the essential motivation for the policies of the Bush administration. You know, after September 11, the President asked himself, "What might happen tomorrow or the day after? How many other attacks were in the planning stages on the 11th of September? How many might emerge in the future? What is likely to be their nature? What is likely to be the consequence if they are successful?" And he came to the commonsense conclusion that preventing the acquisition of weapons of mass murder by terrorist organizations was the single greatest challenge we faced.

How to cope with that? Well, one part of the answer was to deal first with the Taliban to demonstrate that governments were no longer immune from retribution. It is an extraordinary thing to realize that on the 10th of September 2001, the Taliban regime in Afghanistan received more humanitarian assistance from the United States than from any other country. And substantial humanitarian aide: we were feeding the people of Afghanistan to a significant degree. And yet, that government invited a terrorist organization to locate on its territory and supported it in its plans to deliver destructive acts against the United States.

Now you have to ask yourself, "Why would the Taliban have done that?" The answer, in part, is that they seemed not unreasonably confident that no action would be taken against them as a result of their hospitality toward terrorists out to destroy the United States and, more broadly, Western civilization. The reason is that we had never before said that we would hold responsible countries that offered sanctuary to terrorists. It was not said in the administration that preceded September 11th or the one before that. It was never said. I recall debating this very issue with Stansfield Turner, former head of the CIA, in 1997. The topic of the debate was whether "we should use military forces in the fight against terrorism." He was dead set against it, and no American administration had embraced the policy of holding states responsible. The American administration under Bush did embrace this policy and changed fundamentally our approach to dealing with terror. The Bush administration did this because it realized that we must deprive terrorists of the sanctuary they need, of the infrastructure they need, of the laboratories, of the ability to bring people and recruit, and train, and identify talent, and plot and dispatch people to the places from which they will operate. If we take that away from them (their ability to do all the things we have been talking about: to attack tankers on the high seas, or do damage at the chokepoints like the Straits of Malaka, or get at a nuclear facility), we can significantly diminish the scale of the threat that we face, so that is what we must do.

When you take actions to manage risk, and it turns out that you learn subsequently that some of the information upon which you took that action was wrong, you do not go back and reassess the risk as though you could have acted on your reassessment at that time. Nobody does that. Has anyone here canceled their insurance when you have not had an accident for a year? Of course not. It looked very much to President Bush, to French Intelligence, to German Intelligence, I dare say to Czech Intelligence, to the United Nations—remember Butler—it looked to the world as if Saddam Hussein was hiding an inventory of weapons of mass destruction because we had documented their construction, and he had refused to document their destruction. He was invited to do so. In

the famous report that was delivered on the 6th or 7th of December to the Blix commission, there were 16,000 pages and no new information about what had happened to the stockpiles of nerve agent and biological weapons, which had been identified as having been produced.

So what conclusion could one draw? You had a regime that had a history of weapons of mass destruction that refused to account for what had happened to them. This regime had a history of hiding and deception. Anyone managing that risk seriously would have concluded exactly what President Bush concluded, which was that leaving Saddam Hussein in place entailed a significant risk. The lesson of September 11th for Americans was that it is possible to wait too long before confronting a known risk. We waited too long before dealing with Al-Qaeda in Afghanistan. We observed what they were doing; we saw the training; we knew about the previous acts of terror, but we waited, and we will not again wait too long. And if you are looking for an explanation for why we went into Iraq, that is a big part of it.

We have other places in the world to worry about, obviously. We have to worry about Iran. Iran is clearly moving in the direction of a nuclear weapon, and, with all the help from the IAEA, Iran will not be sufficiently pressed until the choice is a far more dramatic one than it is today because they are highly manipulative, and they are buying time; it is clear that they are buying time. At some point we have to bring that to a conclusion, not necessarily by military action. My preference, for what it is worth, is to do something that we have done in the past and for which we should be grateful: to align ourselves with the forces of freedom that exist in Iran today, as they existed in Czechoslovakia under the communists. There are tens of millions of Iranians who want to free themselves from the rule of these mullahs, and we are doing virtually nothing to help them. We ought to reconsider that, not just because it is the right thing to do, but because it may be a better waz to change the policies of the Iranian government than some diplomatic process, in which they buy time, and we give them time.

Let me conclude with a couple of bullet points about my own country's contribution to energy and security. We have, and it is an accident of history, the burden of the capability to back up any international regime because it is not coming from the European Union, and it is not coming from individual countries that one might identify. At the end of the day, if the international community is going to seek to impose norms that involve our protection, it is my country that provides the bulk of the energy and the bulk of the force. I am sorry about that; I wish the burden were more evenly distributed. Even when it comes to something that is manifestly non-violent like the maintenance of a petroleum

reserve, the U.S. supplies half of the petroleum reserve of the world. If there were a catastrophic disruption of energy supplies, our petroleum reserve would serve not simply the United States, but the world as a whole. And where is the rest of the world in sharing the burden of maintaining an adequate strategic petroleum reserve? I think it is a scandal that we should bear so much of the burden. Even though we admittedly use more energy than other countries, our contribution to the reserve is double our consumption. We maintain the sea lines of communication, without which energy could not move from its source to its place of consumption, and we do that almost single-handedly. What do we do for the future? Well, let us all hope that the U.S. continues to play this role. There are some, particularly in Europe, who hope that we will cease to play this role, that we will be diminished in our effectiveness, or marginalized, or balanced, or countered by others, who really ought to be on the same side.

Two very small points. It is a scandal that we do not have more stand-by capability to intervene after a catastrophe. We should have not one standby infrastructure, but we should have an array of standby infrastructure, and it should be done on an international cooperative basis: we all have an interest in keeping the system going if it fails, and to be without these large infrastructure elements that take a year or more to build and cost quite a lot of money is not a good position. We have got our heads in the sand if, in the current threatening environment, we cannot do better than that, so we ought to invest in our infrastructure, and we ought to do it on an international basis. We have to promote the technologies, particularly the coal conversion technologies, and we must not shy away from nuclear power, particularly if we move to the electrification of transportation as we should. We must not shy away from it on the theory that it is too unsafe; we have allowed too many luddites to stand in the way of good science. We can do a decent job of protecting what we need to protect, but to rule out an instrument as important as nuclear power for the future would be very foolish indeed.

And finally, we have to make inroads in this war on terrorism. We have to reduce this number of people who are out there determined to deliver a blow against the lifeline, and it is the lifeline. They are smart, and they understand our vulnerability. They can look at a terminal, at a major terminal, and it is stars in their eyes. It is a question of time; they will attempt these attacks, they have already done so in Iraq, and one of these days they are going to succeed. The race is between our ability to diminish their ranks and provide hedges, and provide some protection against their unrelenting effort to impose their vision on all of us.

The Pillars of the EU Energy Future

Jerzy Buzek
Member of the European Parliament, Fmr. Prime Minister of Poland

From the perspective of Brussels, from the perspective of members of European Parliament, we have three or four crucial issues or problems that we should solve during the near future. First are the structure and format of European Commission hearings. Second is the 2007-2013 budget, and we know how important it is. We also have quite a peculiar field of interest. It is a new legislation procedure for chemicals, which for our chemical industry could be dangerous, but could be very helpful from the point of view of environmental protection, and we are discussing it almost every week in the European Parliament. But the most crucial and important problems we have now in the Parliament and the Commission are the energy supply and an energy crisis. Every week, every day, you have at least one or two events on this topic in Brussels about these important issues.

Politically, I think, energy is probably the most important issue on the agenda. Your conference is just in time, especially because it concerns Eastern

Europe. It is, in my opinion, a key region for European security of energy supply. It is a key region for political and geopolitical security in general.

If we answered the main Prague conference questions, there would not be any work in energy for the European Union in general because everything would be solved. Unfortunately, it is impossible to answer such important questions during one conference. We clearly have a long way to go, and so I would like to ask, "Why is energy so important?" The question is very simple, and so is the answer. Everything in our civilization, everything, depends on energy supply. Our civilization, as a matter of fact, in this industrial age, began together with the discovery of coal instead of wood and other renewables as an energy source two or three hundred years ago. So now everything depends on that energy supply. And another question: is it the first time during the last decades that we are in such a situation? Of course not. Since the 1960s, every ten, fifteen years something like an energy crisis occurs. It means, quite simply, political crisis in the world. And it happened twice, thrice, or four times during the second half of the 20th century.

The main assumption is also very, very simple and very obvious. Energy demands and necessity of supply of energy are out of discussion. We do not want to stop economic growth, and we do not want to stop our civilization, so energy supply and energy demands are out of discussion. I do not think we should discuss this problem, except for the figures. As for figures, we are probably talking about no less than twice as much of an energy demand in thirty or forty years as compared to today. Due to China and India's consumption, by 2040, the global energy demand will have doubled. A doubling of demand represents enormous growth.

There are three pillars on which we are building our energy future as a means of building our civilization's future. These three pillars are reserves, environmental protection, and politics. I will say a few words about each of them.

In terms of reserves, the first source of energy is renewables. Even if we do our best in this area, it is not possible to have more than twenty-five percent of our global reserves from this source. In fact, even this much is probably impossible, but let us say twenty-five percent. Therefore, one-fourth of our supply comes from renewable sources. We have renewable sources almost everywhere, much more in the Sahara Desert or in Norway, and much less in the Czech Republic or in Poland because we do not have as many mountains or as much sun, but still, we have some.

I am just talking about primary sources. I am not going to speak about hydrogen because it is, in any case, not a primary source. We must say very, very strongly that it is only an energy carrier, quite similar to electricity. It is not an energy source, of course, because we need coal or oil to produce electricity, so

it is not a primary source. The second primary source, historically speaking, is coal, both hard and lignite. As the name implies, we will have renewable energy sources forever. Coal supplies should last for quite a long time: two-hundred to two-hundred-fifty years.

Then we have oil and natural gas. We must say quite simply: our children will live in a world without petrol, and our grandchildren in a world without natural gas. It is our perspective that, in the future, we should not speak about energy supply and strategic decisions without taking into mind today our children without petrol, our grandchildren without natural gas; it is not a fantastic perspective for our civilization. The fifth source is nuclear energy, of course, and we can also say that, as with renewables, we have a lot of it.

What is our problem in the second pillar—the environment? Taking into account the second pillar, why do we have this problem with energy? The answer is that we cannot use such a source like coal in large amounts today. From the point of view of the second pillar—environmental protection—we have a problem with coal as a matter of fact. We can not avoid this problem. What does it mean? It means that if we could overcome this problem, especially CO_2 capture, which is very costly, we could use coal in much greater quantities. Bearing in mind our children and grandchildren, this would be great. We should speak and think about that.

So what is the problem with CO_2? We know the Kyoto Protocol and all the achievements in this field. It is very costly. If we take sulfur dioxide, we do not have any serious problem with sulfur dioxide, and electricity prices will increase by 7%, 8%, 9%, not more than 10 %. We are capturing all the SO2; the emitted sulfur dioxide is relatively insignificant. Also, nitrogen oxides are not a big problem. We have fluoride burning, and it is not a problem in general, scientifically speaking, or in research. Also with dust, we had this problem forty years ago, but not today. The problem we do have is CO_2. If we want to capture it, it will probably result in energy, electricity, for example, costs rising more or less 50-60%. That is a big difference, and it is very difficult to go through that, but we need to capture the CO_2.

Disposal is also very important, and it is a major problem. If we can overcome this problem from an environmental point of view, we will be in quite a different situation. For countries such as Germany and Great Britain, but especially the Czech Republic and Poland, it is crucial that we should also take into account lignite, not only, of course, hard coal. We have big reserves. From the point of view of coal reserves in the EU, ten new countries change the situation completely. Such countries as the United States and Australia have developed special programs, clean coal technology programs, for billions of dollars every year. Yet we do not have anything like that in the EU.

Of course, in every case we must take into account the efficiency of using energy and also of producing energy. When I graduated from the Energy Department of the Silesian Technical University in Gliwice, the whole coal power plant had an efficiency rating of not more than 30%. Now the average in Europe is 38%. And some coal power plants are above 40%. That is big progress, and we must go in this direction from many different directions.

Let me say a few words concerning environmental protection and nuclear energy. The waste disposal, which is very costly and very dangerous, must be mentioned as well. It is, for example, a very, very clear problem for the Czech Republic, as you are all well aware. In trying to build new nuclear power station you must always think about this problem.

The third pillar is politics. What do I mean by "politics?" I mean the location of the reserves and the means of transport. Why do we have crises? We have them because the location of the reserves and the means of transporting them exist in the countries and regions of the world with great political tension: the Middle East, the Caspian Sea, and the Caucasus area. We have some trouble thinking about Russia as well because we know it is not going in the direction of democracy. We feel it. Russia is always dangerous, from our point of view, from the point of view of democratic, free-market economies and human rights-respecting countries. Transport roads are another problem. For example, we have some problems with Turkey in the Black Sea region.

Central Europe, our countries, are now geographically a key point of our continent and the European Union because we are just between two parts of Europe—East and West—on the best lines of oil and gas transport. I am just speaking about oil and gas because all the last crises are about of oil and gas, not about coal, not about nuclear energy, generally speaking. I am not speaking about tension on the border because Austria and the Czech Republic are quite different. I am just speaking about tension in the whole world. It is our point, and it is because political tension is influencing energy supply. We cannot stop energy demands, and we cannot change from oil and gas to coal and nuclear energy and renewables so easily. We must do it; we must go in this direction. We are thinking about our children, especially, but also about security of supply. We need to research renewable nuclear waste, CO_2 capture, and efficiency. We need big, extremely big research in the European Union in all these fields.

It is time to build the vision of a common European energy market, a true common market. It is an essential moment for the countries of our region, and we should play a crucial role in it. We are facing a great challenge to make the most of our natural trumps, which have been our weak points so far.

As noted above, we are strategically located between the natural resources of Eastern Europe and the market of the highly developed countries of Western Europe. Each of our countries has its own business, of course, sometimes creating contradictions. We compete over electrical energy; we argue about environmental pollution, but, in my opinion, now is the moment to work out a common strategy of middle-European countries, first of all, the Visegrad group, and some other countries which are around us. We already have a tradition of cooperation, and it should be continued within the confines of the EU. Our transit location is our chance, both economical and political. Because of the political balance, we must remember Ukraine and Belarus; we should not avoid thinking about them. The economic independence of these countries also means our safety; it is not only about the power industry. There is also a quite different future for Russia. We want Russia to be a rich, strong, well-organized country. This much is obvious. But it also should be a democratic country.

As I said earlier, because of the diminished resources of crude oil and gas, it is coal, which should be favored again, and the European Union has already taken this position. We are just now working on it in the European Parliament. Lately, we have had three or four events about clean coal technology, together with the Czech members of European Parliament. First of all, it is a great opportunity for the minds of the Czech Republic, Poland, and East Germany, but also Hungary and even Romania. I am talking about lignite, not only hard coal. Our region is, for now, politically stable and free from natural calamities, so the coal supplies are, generally speaking, more reliable and less sensitive to disturbances than oil or gas, but they demand creating the technology of clean coal. Here is a chance for the research institutes in the whole of Europe.

One of the advisors of the British Prime Minister Tony Blair recently said that the warming of our climate is more dangerous than terrorism. We are fully aware that they are both big problems that we must cope with. I know that in our countries we possess scientific potential, which, supported financially by the EU, can fight carbon dioxide and, for many centuries, place it at the bottom of fjords, oceans, and mines which are not used anymore. We are not able to estimate how much intellectual and financial potential must be invested in this second problem—I mean terrorism. I hope that people's positive creative abilities prove stronger than their destructive possibilities.

Energy and Security: The IAEA Mission

David Waller
Deputy Director General, International Atomic Energy Agency

Energy and Security–both of these key words are anxiety-provoking. They conjure up images of withdrawing inside a fortress, and building up supplies, and increasing vigilance. In my remarks, however, I am going to urge that, for purposes of energy security, a much more open approach is needed to ensure energy resiliency. It is essential, in particular, to retain the nuclear power option as an important component of the world's energy mix. However, that option (the nuclear power option) is simply not possible without proper control over (here again, without proper world-wide security of) nuclear material. We must guard against both the threat of the misuse of it for military and weapons purposes and the threat of nuclear terrorism. As one minister put it in Vienna a few weeks ago, we must keep nuclear materials away from madmen and murderers.

So allow me first to discuss what I call this overarching question of the security of nuclear material since it, in my opinion, is a prerequisite for international security, in general, and for the continued use of any nuclear technology includ-

ing nuclear power. For it is clear that the diversion of material from the civilian nuclear fuel cycle to produce a weapon or the use of radiological material in what we have all come to know as a "dirty bomb" could have a devastating effect worldwide. It could suppress international cooperation in the use of nuclear technology and inflict serious damages on national nuclear power programs. In this regard, you may have noticed the front page, above the fold article in the International Herald Tribune on just Monday of this week entitled "Nuclear Comeback Stokes Terror Fears."

This is an area where the IAEA is recognized as playing a rather central role in the international effort to, in fact, strengthen barriers and increase vigilance. There are two interdependent, interrelated components to this, dealing respectively with state and non-state actors. First, it is verification through the IAEA system of inspecting states' undertakings not to pursue nuclear weapons, and this is commonly referred to as "safeguards." Second, it is security against nuclear terrorism which, of course, has received far greater attention since 9/11.

Let me begin with verification. Safeguards, as originally conceived, were largely a matter of simply verifying that nuclear material and activities that were declared to the IAEA by a state remained in peaceful use. Over the years, repeated efforts had been made to make this system more rigorous and to give the inspectors more authority, but frankly, it took the discovery of a clandestine nuclear weapons program in Iraq in the wake of the first Gulf War to generate the necessary political will, and, after extensive deliberations in 1997, what was called the "additional protocol to safeguards agreements" was approved. So now, for countries that have an additional protocol in force, far more information has to be provided by the state to the IAEA and our inspectors on the ground have far greater physical access. Significantly, the protocol now gives us the capability to verify the absence of undeclared material, that would be clandestine activities, in addition to what we had under the lighter regime, which was simply the ability to verify the non-diversion of what had been declared to us. To date, to give you a status report, sixty countries have an additional protocol in force, and we have extensive efforts underway in the diplomatic community to increase that number. The Iraq experience, although unique in some ways, demonstrated that inspections, while requiring time and patience, can indeed be effective, particularly when backed by international pressure. This is true even when a country under inspection, like Iraq, was providing far less than cooperation. All evidence to date indicates that Iraq's nuclear weapons program had been effectively dismantled in the 1990s through IAEA inspections, as we had all but concluded in the run up to the second Gulf War. As the recent Iraq survey group, or the Duflo Report indicates, there is little doubt.

More recent inspections in Iran and Libya took advantage of our experience in Iraq and have also proven effective in revealing in great detail these countries' nuclear programs. But, they have brought to life two disturbing facts. First is the existence of an extensive illicit market for the supply of nuclear weapons, and it is clearly driven by demand. The relative ease with which AQ Khan and associates were able to operate an extensive sub-national illicit network demonstrates, clearly, the inadequacy of the present system for controlling the export of sensitive materials. It has, to date, relied on mere informal arrangements among a limited partnership, called the Nuclear Suppliers Group, and the information it requires is not even systematically shared with the IAEA.

Second is the fact that the technological barriers to mastering the essential steps of uranium enrichment, and, for that matter, to designing weapons, have eroded over time, and they no longer, of themselves, provide protection against proliferation. Indeed, by some estimates, today, perhaps forty or more countries have the know-how to produce nuclear weapons. This means that if any of these countries have acquired the necessary highly-enriched uranium or plutonium, we are basically counting on their continuing good will.

The North Korean situation also carries a disturbing lesson. For over a decade, this country has been in non-compliance with its international obligations under the NPT. In January 2003, it capped its non-compliance by withdrawing, as you will recall, from the NPT, the only country ever to do so. I will call IAEA "the agency." The agency's Board of Governors promptly referred this matter to the UN Security Council, but now, more than a year and a half later, the Council has done nothing. They have sub-contracted the matter out to the six-party talks that are going on now. This creates a very dangerous possibility: namely, that a country could, while adhering to the Treaty on the Non-proliferation of Nuclear Weapons (NPT) and while reporting dutifully to us at the IAEA, acquire nuclear power technology, including uranium-enriched technology, ostensibly for peaceful purposes. It could then withdraw from the NPT at a point where it was well-advanced toward developing a nuclear weapon, perhaps as short as months away from doing so. And, of course, a further problem has arisen in recent years with regard to simply the large amount of poorly-secured, largely military nuclear and radiological material, particularly in countries of the former Soviet Union. And this poses an obvious threat in terms of access to terrorists.

Given these growing vulnerabilities, the agency's Director General, Mohamed El-Baradei has been publicly warning that "the events of the past few years have placed the NPT and the regimes supporting it under unprecedented stress, exposing some of its limitations and pointing to areas that need to be strengthened."

A year ago, in an invited article that he wrote for The Economist, and again, in June of this year in a speech at Carnegie at a non-proliferation conference held at Washington, he laid out a series of proposals. These included tightening export controls over sensitive nuclear materials and technologies, helping countries to stop using weapons-usable materials in civilian nuclear programs, increasing the physical security of such materials, and eventually, eliminating stocks of plutonium and highly-enriched Uranium. The proposals also included placing limitations on the production of new nuclear material, possibly by agreeing to restrict this exclusively to facilities under multinational controls, while providing at the same time international guarantees of supply of nuclear fuel to the legitimate would-be users. Dr. El-Baradei's proposals also called for reinforcing the integrity of the NPT by eliminating the provision that allows a state to withdraw by simply giving three months notice. In light of recent events, I think it is clear that such a period is now viewed as nothing short of cavalier in the context of a treaty that is the cornerstone of the non-proliferation regime. Finally, Dr. ElBaradei urged that the additional protocol become the universally accepted norm.

Earlier this year, the Director General and I met in Washington with President Bush on this subject. The discussion took place not long after the President, in a February address to the National War College, pointed out his proposals for strengthening the non-proliferation regime, and that discussion very encouragingly confirmed that there was a significant commonality of focus and interests of these two men in improving the situation. Since that time, the Director General has established a group of eminent experts from around the world to identify the issues and the multilateral approaches to strengthening controls over sensitive aspects of the nuclear fuel cycle. It is a major challenge to find combinations of the necessary political and economic incentives that promise real non-proliferation benefits and that facilitate, or at least do not obstruct, the spread of the benefits of nuclear power to those who want them. It is a talented group, and we look forward to their report, which is scheduled to come in early next year.

On a parallel track, in May, the U.S.-Russian Global Threat Reduction Initiative, the so-called GTRI, was inaugurated in Vienna. This initiative seeks to eliminate the use of weapons-usable material in civil research reactors by converting those reactors, so that they can use low-enriched uranium and recover and secure vulnerable nuclear material and abandoned radioactive sources. In terms of threats from the non-state players, also known as terrorists, there has also been renewed international commitment to security against nuclear terrorism in the form of strengthening the physical protection of nuclear and radiological material.

The IAEA has a comprehensive program in this regard, helping countries to assess the risk, to increase their border controls, and so forth. Thus, the clear message regarding the security of nuclear material is that the events of the past few years have been a very loud wake-up call regarding the inadequacy of the current international regime. But I think it is particularly encouraging to note the interest and activism of world leaders on these topics. In fact, I found it most interesting that the one key point on which the U.S. presidential candidates did agree in the recent debates was that nuclear proliferation and the acquisition of nuclear weapons by terrorists were the single greatest threats to global security. The good news is that a serious dialogue has begun focusing on reinforcing this system to face the challenges of the twenty-first century.

Having discussed the theme of security of nuclear material as, what I call, a prerequisite to international security, I will now turn briefly to energy security more specifically. Here, as I said a moment ago, it is our essential point that the nuclear power option must remain open, and I will look briefly at energy security more generally and then come back to nuclear to close out.

In a 2002 European Commission Green Paper on the security of energy supply, one of the most widely-quoted conclusions was that Europe's energy-import dependency would likely rise from 50% where it was at that time, 2002, to about 70% in the year 2030. Forecasts of this kind often stimulate talk of building up domestic strategic petroleum reserves and enhancing self-sufficiency. Indeed, I think, we all remember that at the time of the oil shocks in the '70s, there was frequent mention of energy independence as an appropriate goal, and you still hear echoes of this in the post-9/11 world. In the second presidential debate, one of the candidates stated that he had "a plan for energy independence within ten years." In fact, even where that might be attainable, energy self-sufficiency is not necessarily synonymous with security. Just to cite one example, Brazil got 87% of its electricity from domestic hydro in the year 2000, which is admirable self-sufficiency, at least until the failure of the rains among other factors led to rationing in the next two years.

What matters then is supply resiliency. Where strong domestic energy supplies contribute to resiliency, that is most fortunate. Where building up domestic reserves to cushion supply shortfalls can enhance resiliency, that is useful. But building up a country's network of alternative suppliers, raising the reliability of those suppliers, and broadening the portfolio of energy options are also important parts of increasing resiliency, and we all know they offer options beyond a country's border, limited only by human will, not by geological endowment.

Turning now to the nuclear power option, one essential aspect of the IAEA statutory mandate is keeping that option open for those countries that may wish to take advantage of it for a variety of reasons and, indeed, also contributing to nuclear power's continuous improvement in terms of economics, safety, proliferation resistance, and environmental impact. Nuclear power, like any other energy resource, is not a one-size-fits-all solution. Right now, new construction and nuclear expansion are centered in Asia, but nuclear power is also expanding in Eastern Europe. Of the twenty-six units now under construction, fifteen are in India, China, South Korea, and Japan, but remember that seven of them are in Romania, the Russian federation, and the Ukraine. Moreover, Finland will start construction of a new unit next year, and France is expected to pick a site to begin its program of replacing its old reactors with new ones.

The real attractiveness of nuclear power in any given country depends on several things. First, obviously, what are the alternatives that are available? If you are in North America, where there is abundant coal and gas, it is not so attractive, but if you are in Japan or South Korea, it is a different story. Second, the attractiveness of nuclear power depends partly on how fast a country's economy and energy needs are growing. In the large, rapidly expanding economy, China and India's the obvious examples, nuclear makes particular sense. Third, it depends on whether there is an investment environment that encourages long-term thinking. Nuclear plants are expensive to build, but they are cheap to run, so an investor that is looking for a quick return does not like them, but, if an investor or a country can take a longer view, these plants can prove most advantageous and profitable.

Two developments that push in that direction at present are, as noted today, the rise in natural gas prices and the latest impetus given to the Kyoto protocol by President Putin's decision to refer it to the Duma for ratification.

So while it is true that nuclear power does not fit the needs and situations of all countries, it is equally true that it provides a valuable option for many. Assuring its availability for countries that can benefit from it and keeping that option open (indeed, continuously improving it) are essential parts of energy supply resiliency and, thus, very important parts of energy security.

In the intervening years, I have learned a good deal about what it is that the IAEA does to contribute to the maintenance of nuclear power, and I will just quickly go through these. It is safety, of course, safety, and safety, for another Chernobyl would be disastrous. But we also work on capacity building, life-cycle optimization, decommissioning, and so forth. Particularly important is support for innovation in terms of reactor and fuel-cycle technologies.

Very important is nuclear power's contribution to avoiding greenhouse gas emissions. The complete nuclear power chain, and this is often not appreciated—we are talking about from resource extraction to waste disposal and including the construction of the facilities, the reactor, and so forth—emits only two to six grams of carbon per kilowatt hour, about the same as wind and solar, and well below the fossil fuels. Put another way, worldwide, if all existing nuclear power plants were replaced with a representative mix of the non-nuclear sources, the result would be an increase of six-hundred million tons of carbon per year which, by the way, is approximately twice the amount targeted for avoidance by the Kyoto protocol in 2010.

At the global level, the resolution of differences about nuclear power has boiled down to a fundamental understanding, and it was reached after extensive debate, but it is very simple, and that is that the countries agree to disagree, recognizing that some consider nuclear power an important part of their sustainable development, whereas others consider nuclear power and sustainable development fundamentally incompatible.

So to sum up, the word "nuclear" does carry with it threats, but also wonderful opportunities. The threats to international security from the malevolent use of nuclear and radiological material are real, but, as I indicated, the first steps are being taken in the process of raising barriers by strengthening the non-proliferation regime and reinforcing physical security. This, in turn, will enable us to preserve the nuclear power option, which is essential for energy security and for protecting the environment.

World Energy Outlook and Challenges for Europe

Fatih Birol
Chief Economist, International Energy Agency

First, perhaps a word about the International Energy Agency; some of you may not know what it is. We are the energy arm of the OECD. We have a twenty-six member government: U.S., Canada, Mexico and the Americas, all European countries, Japan, Australia, New Zealand, and Korea. We provide energy advice to our member countries and elsewhere. I am going to share with you the results of our publication, "World Energy Outlook 2004." What I am going to cover is that, on the basis of our projections up to 2030, half the world energy system will develop, and what do we see? What are the major challenges for the world and for Europe, in particular? I would like to discuss them, and, unless I specify otherwise, I assume that the major policies of the world governments do not change after mid-2004. That means, on the basis of current policies, what picture will we end up with, and what challenges does this picture show?

First of all, let me tell you at the outset what we see as the four major challenges and what we think we have to face in the next twenty or twenty-five years to come. We call them the Strategic Challenges.

The first one is the security of energy supply. It is at the top of the agenda because we believe that if we do not change our policies, almost 99% of the world's nations will be relying on a very small number of countries' supplies of oil and gas for their economic survival. If I can name them, on the oil side, we have Saudi Arabia, Iran, Iraq, Kuwait, and UAE, and on the gas side, we have Russia. So, leaving aside the political stability in those countries, we think that any system when the large number of the elements' survival depends on the behavior of very few elements, we cannot call this a sustainable energy system, so this is the first challenge we think we are going to face.

The second one is environmental damage, i.e. the implications of the current energy trends on the environment. We do take them seriously, both on the global warming level, as well as the local pollution in the developing countries.

The third challenge which I take very seriously is an uneven access of the world's population to modern energy. Today, according to our analysis, 1.6 billion people, one fourth of the world population, has no access to electricity. In Europe in the past year, we have experienced blackouts for about twenty-four or twenty-six hours in some countries. It even happened in the U.S. This was a major problem for the governments and for the public. However, I would like to remind you that today, 1.6 billion people in the world, mainly in Sub-Saharan Africa and South Asia, live in a permanent blackout. We think this is an important issue, not only economically, but also ethically, and in terms of long-term security concerns of the rich countries.

The fourth challenge is the issue of investments in energy-supply infrastructure. Whether or not the energy investments will be coming in a timely manner is a key issue, and I believe (if I can make a footnote here) the high oil prices we are experiencing today are not only, and even, perhaps, not mainly, a result of high oil demand, but mainly because the supply could not meet that demand. We do not have the supply coming at the right time in the right place, and, as a result of that, we have high oil prices. We were surprised with the high oil demand. However, in the past, we have had higher oil demand growth, and we did not have such high prices, as the supply was there.

So these are my four major challenges, and now let me tell you how we think that the world energy mix, the world energy fuels, can develop in the next two or three years if we do not change our policies.

Hydropower will grow very slowly in the future, mainly in the developing countries and also in countries in which we have already exploited our hydro-power resources.

Nuclear production is a very critical point here, and I will come back to that later. According to our analysis, the nuclear production today will be equal to 2030, more or less, but in many OECD countries, nuclear power plants are going to retire, and in some of them (for example, in Germany) are going to be phased out. In Asia, however, in developing countries and in Japan and Korea, we expect new capacity to come under stream, and, more or less, nuclear production is going to be equal to what it is today. However, this is important, in a growing energy-demand context, nuclear is going to lose market share.

Renewables. I am not a renewable fan, but I do believe that renewables can make, at marginal levels, some contribution to the world energy mix, especially wind and biomass can be good contributors to the diversification of the energy mix, and we do expect that the wind, for example, in Europe will be an important source of power in the future, with some limitations.

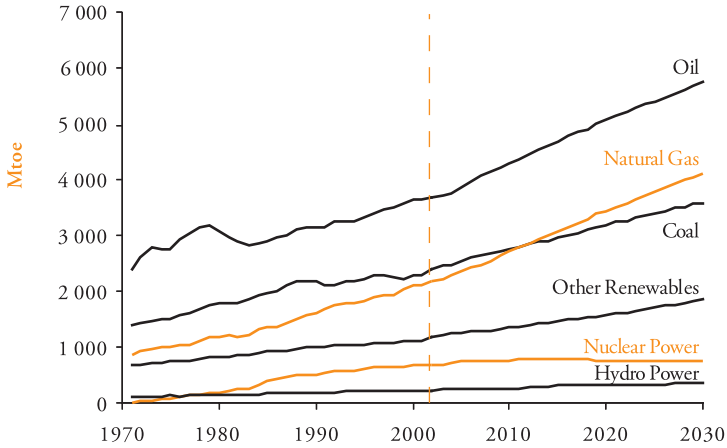
Coal. Nobody likes coal. It is dirty, but it is in the OECD. They do not like it. In China and India (as two major users, we have to look at those countries even if we are thinking about our own energy supply), the electricity demand growth is very high. Let me give you an example. The Chinese electricity power plant system grows every year by as much as one Switzerland and every two years as one UK. And, of course, China goes for coal, which is a domestic resource that is cheap and dirty. We cannot accuse China for using dirty coal which brings a lot of CO_2 emissions into the atmosphere, as it is not their current man occupation, which is understandable, because, as we all know, the climate change issue is a historical issue. And it was the OECD countries which have emitted carbon into the atmosphere since the Industrial Revolution, and we cannot now ask developing countries to use more expensive resources during their developmental phase, which is an important aspect of their economic growth.

The fourth one is gas. It is very important; it is the favorite choice of fuel for many countries, especially for power plants. I can tell you that in Europe,of all ten of the power plants scheduled to be built or purchased between now and 2015, seven are gas-fired power plants. Gas use is expected to surpass that of coal, of course with serious implications for security of supply.

Finally, oil may be the single most important fuel and is mainly driven by the transportation sector.

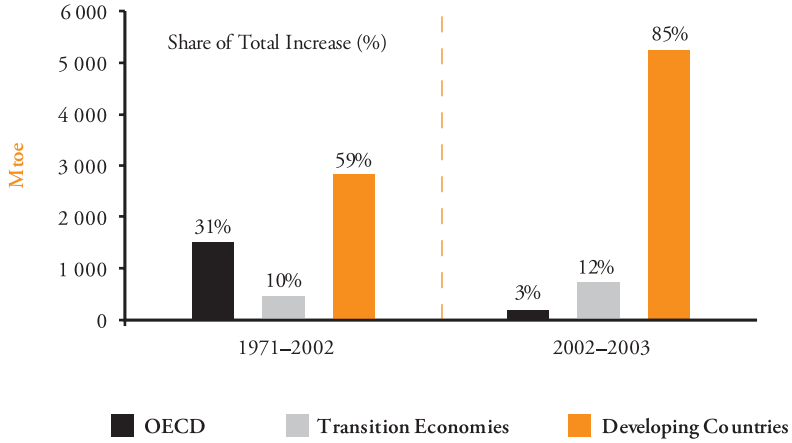
The previous chart showed how the demands will develop. Now the question is, "Who will produce this energy demand? Where will the energy supply come from?" If you look at the past thirty years, you see that OECD countries with

1. World Primary Energy Demand



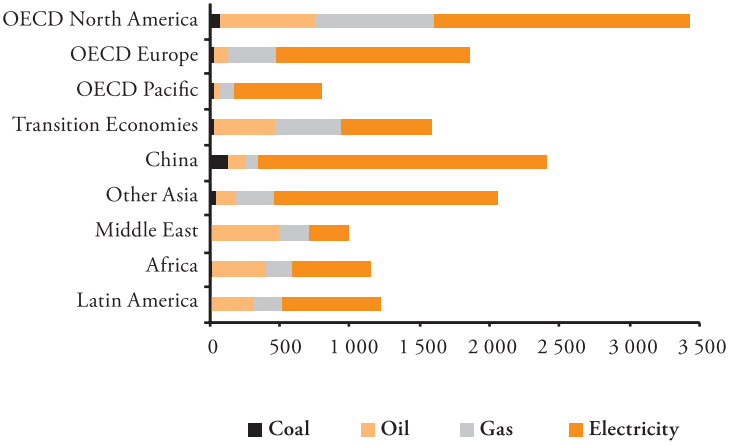
Fossil fuels account for almost 90% of the growth in energy demand between now and 2030.

2. Increase in World Primary Energy Production by Region



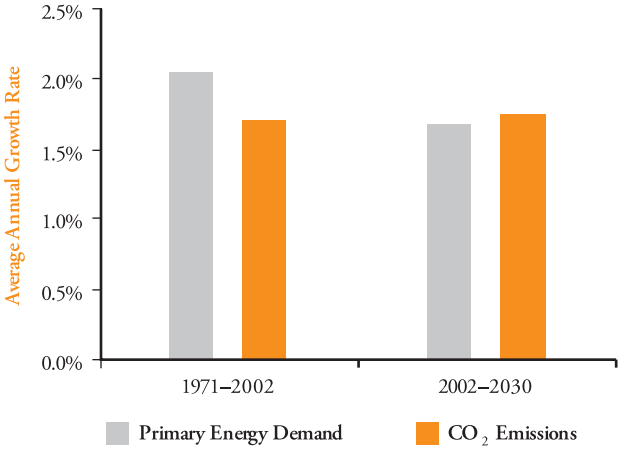
Almost all the increase in production to 2030 occurs outside the OECD.

3. Energy Investment Requirements 2003–2030



Power sector absorbs 62% of global energy investment in the period 2003–2030.

4. Growth in World Energy Demand and CO_2 Emissions



Average carbon content of primary energy increases slightly through 2030 – in contrast to past trends.

a stable economic and political framework contributed about one third of the growth in the energy production-oil, gas, coal, and so on. If you look at the next thirty years, we expect that almost all the growth in the world energy production will come from none of the OECD countries. The geology/geography of course has some geopolitical implications from investment to the trade, from trade to the security of supply, from security of supply to the foreign policy dimensions. So we think this is an important change in terms of the world international energy politics in the future as a result of this.

I wanted to bring to your attention one more issue: energy investments. We did calculate that to finance this world energy system, all the production, transportation of energy, refineries, power plants, distribution networks, and so on, we need sixteen trillion dollars worldwide. It is a huge amount of money between now and 2030. If I say it on a yearly basis, it is perhaps more understandable. It is about five-hundred-fifty million dollars, which is about equal to the current budget deficit of the US, every year that we have to find in order to keep our energy system up and running.

I want to mention two things here, however. One is that I mentioned that most of the demands and production will come from developing countries, but North America, and Europe, and the Pacific still need a lot of investment even though the demand is not growing. What is the reason? The reason is the following: investments have two major drivers. One is to meet the increase in the demand. Second, perhaps more importantly for the OECD countries, especially for Europe and North America, our energy system is aging. It is getting old. In North America, in the US, about 60% of the investments will go to replace the existing infrastructure in the next fifteen years or so. These are the power plants. Power plants, like people, have a life span; it's about sixty years. You have the refineries. You have the oil fields that are declining. We need to understand that, in addition to the amount of money, which is a challenge, we need to see that this is another driver of the energy system.

Energy investments have a lot of challenges, and I will cover only one of them specifically in the context of security of supply in a minute. However, let me mention another challenge that we think is crucial: the increase in CO_2 emissions worldwide. We expect that between now and 2030, world CO_2 emissions will increase about 60% with the current policies in place, and I wanted to bring a very important factor to your attention: a contrast between the past and the future in terms of CO_2 emissions.

In the past thirty years, the world energy demand has increased by about 2%. In the light blue on the Chart 4 you can see that the CO_2 emissions in the past

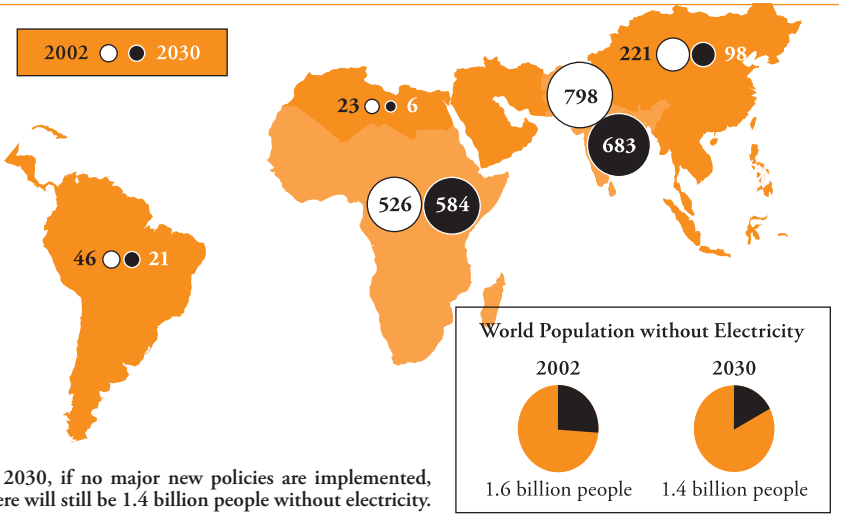
thirty years increased less than the energy demand, but if you look at the future, when we compare the energy demand and the CO_2 growth, CO_2 will grow higher than the energy. This is a contrast to the past. This means that any energy we use in the world will have more carbon content in the future compared to what it had in the past, despite the efficiency improvements and despite the technology. What is the reason here? The reason is what I mentioned in the beginning. It is the negative consequence of nuclear declining share in the world energy mix. Nuclear is replaced by gas or coal and by other fuels, which have CO_2 emissions, which is a very important point to highlight. This is another point in terms of highlighting nuclear's possible role in fighting climate change.

The fifth chart ilustrates an energy poverty issue. This is the world energy power depiction. Today 1.6 billion people have no access to electricity. This is a shame, if I may say so. If we do not change our policies, and if we do not intervene in the subject, despite the technological growth, worldwide innovation, economic growth, and the slowdown of population growth, by 2030, there will still be 1.4 billion people without access to electricity. This is not acceptable both morally and economically, and I do believe that we have to convince the OECD governments to intervene here. One reason for this, for the sake of simplicity, if we leave the ethical arguments aside, is for the long-term security interests. It is important to eradicate poverty in the developing countries, and one of the points here is that energy can increase economic growth.

Let me tell you a couple of things about oil. There is an issue about whether we are running out of oil. People who say nowadays that we are running out of oil make a statement. They say that, in the last ten years, the amount of oil that we have found (new discoveries) is about half of what we used. That means we used more oil than we have found. First of all, is that true? The answer is yes. We found less oil than we used; this is true. But why is this the case? Is it because of a lack of reserves? Are they running out of oil? No. Chart number six has the answer.

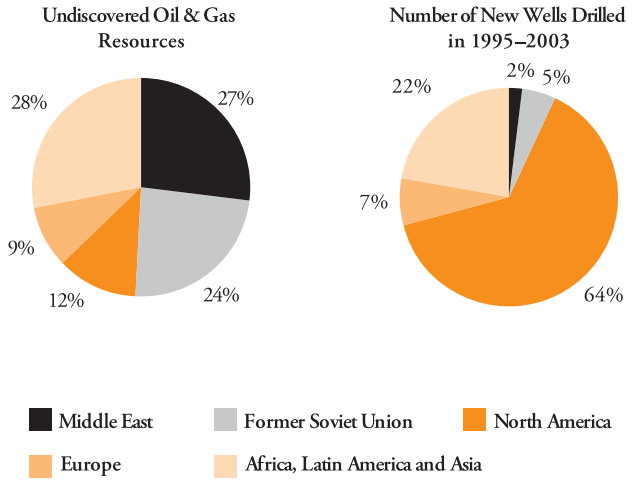
If you can concentrate on the left side, you see the undiscovered oil and gas resources in the world, and if you just concentrate on the dark and light blue ones, they are the OECD North America (the US and Canada) and Europe. In terms of the world oil resources, about 20% of the resources are there. But on the right hand side, you see the number of wells drilled worldwide in the last ten years, world activities, where the investment went in order to find oil, and it is mainly in those two regions-OECD North America and OECD Europe. In fact, normally, the exploration activities investment needs to go to the Middle East where the oil is and where the oil is cheap, but it did not go there. The very reason

5. Electricity Deprivation



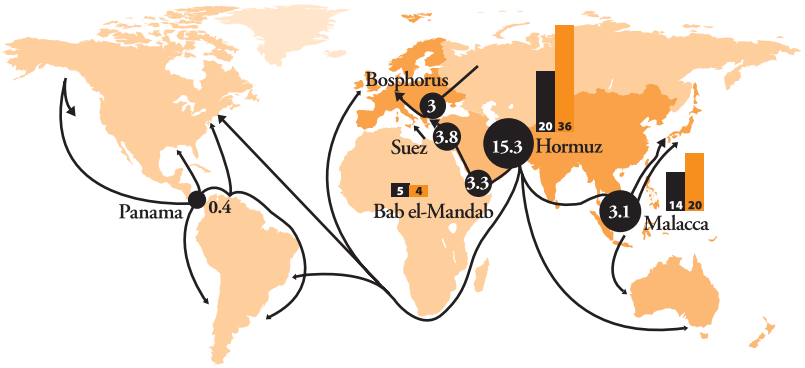
In 2030, if no major new policies are implemented, there will still be 1.4 billion people without electricity.

6. Undiscovered Oil & Gas Resources & Expolaration Wells Drilled, 1995–2003



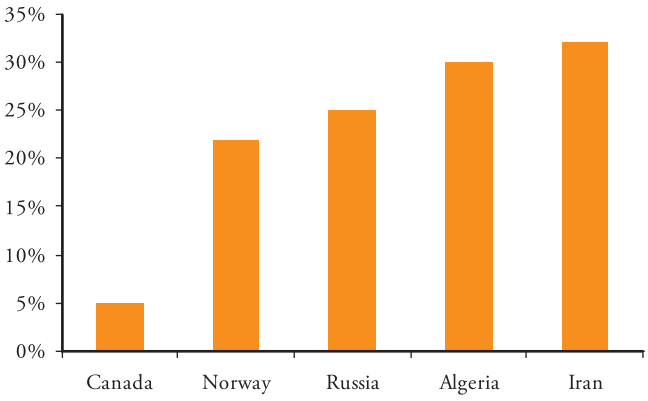
Discoveries have fallen in recent year, mainly because exploration has shifted to less prospective regions.

7. Oil Flows & Major Chokepoints: The "Dire Straits"



The risk of an oil-supply disruption will grow as trade & flows through key maritime & pipeline chokepoints expand.

8. Contribution of Oil & Gas Sectors to GDP, 2002



Importance of oil & gas sector in the Russian economy has grown sharply in recent years, approaching that of some OPEC countries.

why we could not find more oil is not lack of oil, but lack of investment going to the areas where the oil is located.

This brings me to the issue of access to oil reserves worldwide. Today, about two thirds of the world's oil reserves are closed to foreign direct investment in terms of the upstream sector. The key examples are Saudi Arabia, Mexico, and some other Middle East countries. From our point of view, the major question is not availability of oil, but whether oil and global capital can meet and produce oil at an affordable price for the rest of the world. This is a key question, and we will push this throughout our meetings.

However, I want to bring to your attention another issue that the International Energy Agency, with the publication of the new "World Energy Outlook," is going to push: the reserves data transparency. You may have heard that some major international oil companies have downgraded their reserves estimates significantly. You may have also heard that there are some doubts about the level of oil reserves in some key oil-producing countries. What we want to do is start a new international oil initiative, together with the major international organizations and our own governments. We need a new reserves data reporting system which uses common and comprehensive definitions, in terms of reserves, since we believe that oil is a very important strategic good for every world citizen, and it is our right to know how much oil is where and the level of that oil.

We live in a dangerous world, and energy is not immune to this danger. After the 11th of September, we felt it even more strongly. One of the issues, as I mentioned at the beginning, is that oil will be traded more and more. That means the so-called chokepoints will be of more importance. We call them "dire straits" in our book. There are five major dire straits on the chart number 7, and I would like to highlight two of them for the sake of example here. One of them is the Malaka straight which is important for Southeast Asia, and the other is the Hormuz in the Middle East.

Today, we have about twenty-six million barrels of oil passing through these two major checkpoints everyday. As a result of increasing trade (Asia is growing; the domestic production in the major consumer countries is declining), we expect that this trade will be more than doubled to more than fifty million barrels per day in 2030. This again highlights the fact that, in the case of a supply disruption in one of these two checkpoints (it may be as a result of an accident, or of a terrorist attack, or of piracy), the implications for the world economy and especially the surrounding countries will be substantial.

Finally, in terms of oil, I want to address high oil prices. Are they good or bad, and if they are bad, how bad are they? In the year 2004, we are experiencing

very high oil prices of about thirty-eight dollars, on average. If the price stays at this level for the next twenty-five years to come, what are the implications for the oil markets? First of all, oil demand will go down substantially, more than fifty million barrels per day compared to the reference scenario. The reference scenario shows predictions if the process were –normal—normal prices verus high prices—normal means about twenty-five dollars, on average. Second, the OPEC production will be much less because the OPEC production will shift to those areas which are profitable at higher prices and because, since the world demand will be much less, OPEC will have to produce less oil. Third, which is a surprising result, OPEC revenues in cumulative terms will be less in a high-price environment compared to a medium-price environment. That means that if the OPEC governments had a long-term view of their economic development process, they should have gone for a medium-price trajectory, rather than pushing for the high prices because, in the long term, they will lose money.

This brings me to a couple of remarks on Europe. When I talk about Europe, I mean the European Union with twenty-five member countries, including the Czech Republic. We expect that Europe will have to import more and more energy from other countries—oil, gas, and coal. Just a remark on gas and a wake-up call for the governments here. About 80% of the European gas by 2030 will come from outside of Europe, increasingly from Russia. We think that this is not good news because of the security of supply concerns. There are two reasons why gas imports are going to increase. One is that their own production in Europe is going to decrease in the UK, in Denmark, in the Netherlands, and so on. Second, the demand is increasing because of normal gas demand, but also because, by 2015, about half of the coal power plants in Europe are going to retire, and the choice of fuel in most countries is gas.

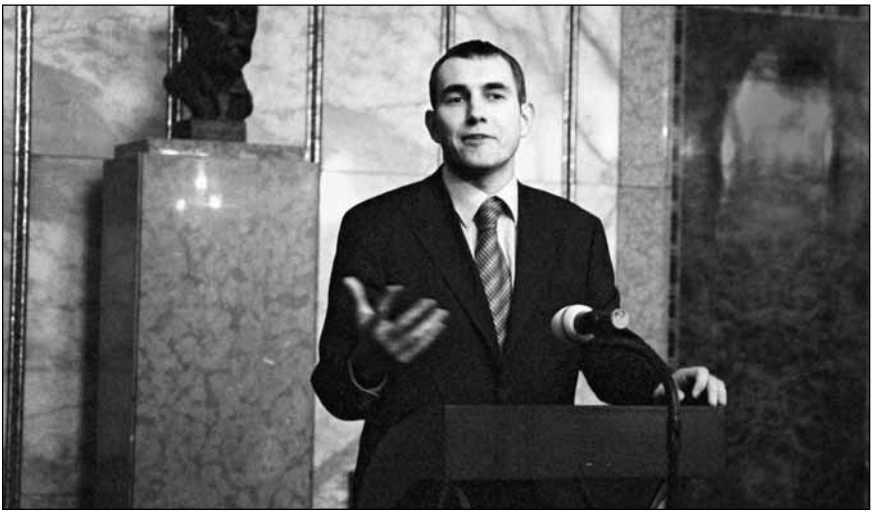
We think that this is an important point, and Germany's policy on the phase-out of nuclear contributes to this picture. We think that this is not good news, and I do not agree that Russia has never failed to deliver. First of all, they did fail to deliver. It is an empirical fact. They did fail to deliver to some countries, and that is an important point to register. The second point is that it is not important if they failed to deliver or not; that is not the main point. The fact that they have the power to not deliver is an important point in terms of the international diplomacy and international negotiations context.

Third is the issue of prices. The chart number 8 shows that the Russian economy is increasingly reliant on oil and gas exports and their revenues. Their reliance on the energy revenues is increasing in such a way that is it approaching that of some OPEC member countries such as Algeria and Iran shown here. Why is this

important? It is important because when we look at the Middle East countries, when they push the prices up, they are not doing it because they have bad intentions or are bad people, but because their economies are relying on the prices of oil and gas. This picture, the increasing reliance of Russia on oil and gas prices, may in the future turn into a threat, and the Russian government may want to keep the prices up.

I will not go to this point, but just to mention it, up to now, what I have told you has been under the current policies, but many governments have policies that are not legally enacted, but are only under consideration, such as the efficiency policies in the European context or the one in the US, where there is a discussion on the strengthening and prolonging of the Coffee/Kaufi standards, also some renewable energy policies within the EU, or in Japan, there are some discussions on the efficiency policies. If these policies were to be introduced tomorrow, how would they change the pictures that I described to you in terms of energy mix, in terms of CO_2 emissions, and how much they would cost? I will only tell you that the trends that I showed you which end up with unsustainable and alarming messages can be changed if the governments were to push some alternative policies. These trends are not unalterable; they can be changed, and our world alternative policies interview can show you those figures.

The projected trends describe a scenario if no policy changes occur, a reference scenario. It lays out some major global concerns, not only for energy and environment, but also in terms of general security concerns, namely in terms of the increasing vulnerability to supply disruptions in oil and gas. The second concern is the CO_2 emissions, increasing in huge amounts worldwide. The third is that we need huge energy investments. We have the capital worldwide, but the question is whether we will be able to get this worldwide capital to the energy industry. This is a major question; there are many barriers there. The fourth major challenge is the energy poverty. We have to take this into account seriously if we want to give global answers to these global problems. We believe that if the governments were to take these challenges seriously, they really can change them, and the major policies in that context will be the policies that rely on increasing the efficiency of energy use, both in the OECD and the developing countries. We do believe that, in addition to those policies, there are countries, like the US and like the EU members, pushing the alternative technologies, such as the carbon sequestration and the advanced nuclear technologies, that can also help to change this picture. Finally, we tell all of our member governments that this picture that I have shown is not a sustainable one, both from an energy and from a social perspective, and they have to act quickly.



Martin Jahn, Deputy Prime Minister of the Czech Republic

Paula J. Dobriansky, U.S. Under Secretary of State for Global Affairs

Pavel Bém, Lord Mayor of the City of Prague

Opening Reception in the Lord Mayor's Residence

Václav Havel, Former President of the Czech Republic

Ichiro Maeda and William Martin

Conference Opening by PASS Coordinator Alexandr Vondra

Jan Ruml, Vice President of the Czech Senate, and Roger Robinson, PSSI Co-Founder

David Waller, IAEA Deputy Director General

Plenary Hall of the Senate of the Czech Republic, Wallenstein Pallace

Panel C: Anne Korin, David Waller, Kevin Rosner, Richard Perle and Robert Eagan

Gala Dinner at the Kampa Museum

Jerzy Buzek, MEP, Former Prime Minister of Poland

Keynote Speech by Jerzy Buzek

Press Conference with William Martin, Alexandr Vondra and Jan Ruml

Václav Havel in interview with Judy Dempsey, IHT

Security of Energy Supplies – Policy Paper

Some Thoughts on the Concept and Key Related Issues

Jan Vaňous
Managing Director of EuroEcon Consulting, Inc., Chevy Chase, MD, USA

September 2004

1. Introduction: Paper Focus and Dimensions of Security of Energy Supplies

Of the four main types of energy, which include:
(I) solid fuels (hard and soft coal, coal products, wood, biomass)
(II) crude oil and refined oil products
(III) natural gas
(IV) electricity
our focus will be on the last three. Although solid fuels are of overwhelming importance (e.g., for countries such as Poland, the Czech Republic, or the US), they occupy a minor role in international trade, which is decidedly dominated by oil

and gas. In addition, coal supplies are generally more reliable and significantly less vulnerable to potential supply disruptions than oil, natural gas, or electricity.
Security of energy supplies has several dimensions, including:

1. availability of "adequate" supplies of different types of energy at a "reasonable" (economically affordable) price
2. Pricing of energy at its full economic cost (or as close to it as possible) along with active government policies to discourage energy waste and encourage energy conservation
3. Ability and adequate capacity to deliver required amounts of different types of energy to the point of demand / consumption at the exact time required by consumers
4. Adequate diversification of energy supplies by type of energy and geographic source and avoidance of excessive reliance on certain types of energy, the supplies of which are inherently unreliable
5. Certainty that supplies of different types of energy will not be interrupted to an unacceptable degree by extraordinary events, including those due to
   (a) technical/equipment failure of transport/transmission system
   (b) weather/climate related developments
   (c) political or organized labor decisions
   (d) terrorist attacks
6. Assurance that different types of energy delivered to consumers are reasonably environmentally sound and safe (both in the physical/biological as well as in the visual sense), including
   (a) extraction, processing, and generation
   (b) transport and transmission
   (c) consumption

2. Key Aspects of Energy Supply Security

2.1 Availability of "adequate" supplies of different types of energy at a "reasonable" price

2.1.1 Price of energy and its availability

With the recent significant upturn in economic activity in China and India, along with other dynamic Third World economies, the demand for energy has significantly

increased, putting an upward price pressure on all major types of fuels (crude oil, natural gas, hard coal, and even nuclear fuel). Once again, concern is mounting about whether or not we are entering a prolonged period—or even a permanent state—of relatively high energy prices, as well as about the adequacy of long-term energy supplies.

The first concern may well be correct, as the growth of demand is likely to outstrip the growth of supply for traditional fuels, particularly in the case of crude oil and hard coal, and, to a considerably lesser degree, for natural gas. We may be entering a period of relatively high real energy prices, albeit at a level at which energy is still affordable to most consumers.

The related concern about the adequacy of long-term energy supplies is most likely unwarranted, provided that mankind is reasonably flexible with respect to the mix of energy we choose to consume, substituting more affordable types of energy for those which are becoming more expensive either because of their declining physical availability or rising cost of production.

2.1.2 Adequacy of long-term energy supplies

Several points should be made with respect to this issue. First, there is nuclear power, the potential of which we are currently utilizing only to a very limited degree. Second, renewable sources of energy will play a much larger role in the coming decades, including wind power, solar power, and hydropower, generated from movement of sea currents and by differences in sea temperature, etc. Third, nuclear power and renewables will permit the price of electricity to remain at a reasonable level. Electricity offers an increasingly promising substitute for liquid fuels used in transportation (the energy mix in transportation can be dramatically shifted toward electricity and away from gasoline and diesel fuel). Fourth, there is also the huge potential of hydrogen as a fuel in transportation, if and when we are able to produce it at an attractive price (not to mention other alternatives such as LNG, alcohol/biomass, etc.).

But the fifth and most important point that politicians and even economists frequently fail to understand is that the demand for energy can dramatically change if the price of energy rises over a critical level: energy is consumed only as an intermediate good, and what consumers ultimately care about is the consumption of the final good or service. For example, in the case of heat, the consumers' objective is to be comfortably warm at home and at work. The production of heat is very complex, involving the consumption of fuel/energy (such as a hard fuel,

natural gas, or electricity), use of different types of heating systems (with varying installation and operating costs, depending on their efficiency of conversion of fuel/energy into heat) and potentially also different mixes of energy (e.g., in the case of some systems, which use both natural gas and electricity). In addition, one of the most important factors in heating is the design of houses and buildings and the amount and type of insulation used in them. Today's houses are already much more energy efficient than their predecessors thanks to better design and more insulation. Still, undoubtedly, a great deal of further progress would rapidly occur in these two areas were energy prices to rise sufficiently to justify additional investments in house/building design and insulation.

Similarly, in the case of automobiles, the consumers' objective is to get comfortably and fast enough from one place to another (the primary objective), perhaps with a demonstration of some flair (a possible secondary objective). Sufficiently high gasoline prices (the question is how high they have to be) will undoubtedly stimulate the downsizing of cars, a reduction in their weight (with more plastics and aluminum alloys used instead of steel), the installation of more efficient engines, and the substitution of alternative for traditional fuels (e.g. electricity/hybrids, LPG, LNG, hydrogen, and alcohol for gasoline and diesel fuel). Finally, since all technologies have their limits, were energy prices to rise significantly in relative terms, we would also have to alter our energy-hungry behavior and lifestyles. This may well mean greater emphasis on public transportation, more car-pooling, a massive shift from road to rail transport, in the case of freight (piggybacking, which is a major issue in Europe with its highly fragmented and comparatively inefficient rail systems).

2.1.3 Are we running out of oil?

The high priest of this theory is Dr. Colin Campbell, a retired oil industry geologist from Ireland. According to his view, the sharp decline in new oil discoveries during the last 20-25 years signifies the beginning of the end of an era when oil was the dominant fuel for the global economy. He reckons that mankind has already consumed about 900 billion barrels of oil over the past 150 years and that we can reasonably extract and consume about the same amount in the future. However, since the current rate of annual oil consumption is already around 30 billion barrels and likely to rise to around 44 billion barrels within the next twenty-five years or so, Campbell thinks that we already have a major oil shortage crisis in the making. Using bell curves to project where we stand now and

where we are headed, Campbell predicts that oil production will reach a historical peak as early as in 2005 and then start falling, never to rise again. His doomsday scenario is that the global economy will be unable to respond fast enough to this development or shift to alternative forms of energy, bringing the economy to a screeching halt. At the extreme, he argues that an oil-induced global financial crash is coming and we should be preparing for it.

The bulk of the oil industry establishment views Campbell as incorrect and sees a number of flaws in his theory. There are widespread disagreements about the level of global oil reserves, with some "mainstream" estimates, such as those by the Exxon Mobil Corp., putting them at 14 trillion barrels—way above Campbell's implied number. The high estimates count all forms of oil in the ground, including tar-soaked sands, oil shale, etc. The prevailing industry view is also that, at the right price, a large portion of such oil is recoverable. Campbell's credibility has been damaged by his repeated shifts and revisions of his theory, such as moving the projected peak of global oil production from 1995 to 2005. However, his credibility got a significant boost recently when the Washington-based energy consultancy, PFC Energy, essentially endorsed his view, with one notable exception—PFC Energy puts the oil production peak at somewhere between 2010 and 2015.

Some critics of Campbell's work, such as energy consultant Michael Lynch from the US, see a number of flaws in his work and argue that the decline in oil discoveries during the last 20-25 years is not an inexorable trend, but a consequence of market forces. Lynch expects the pace of new discoveries to revive and dramatically increase when the oil industry has enough of a financial incentive to figure out how to extract more oil from the ground. Lynch also points out that geopolitical constraints have prevented exploration of many oil-rich regions of the world, including Iraq and Russia, and that high oil prices will provide incentives for these countries to open up their oil fields. Lynch, as well as the bulk of the oil industry establishment, is also generally more optimistic about the future availability of superior technologies, making it possible to extract or recover oil, which cannot be done with current technologies.

What should we make out of this debate? Here are some observations and an assessment by an economist with no specific oil industry agenda:

(I) Campbell has a valid, albeit quite obvious point—at some point oil production will reach a peak and then start declining, following the shape of a bell curve

(II) in an industry, which has yet to achieve a definite consensus as to whether all hydrocarbons are of organic origin or if a significant portion is not, any

definitive claim with respect to the level of global hydrocarbon reserves must be viewed with considerable skepticism (whether on the low or the high side)

(III) the pace of discovery of new hydrocarbon reserves depends on their physical distribution (mainly location, accessibility, and depth)—uneven geographic and geological distribution undoubtedly means an uneven pace of discovery; financial incentives for the oil industry (price of oil, profitability of the industry)— with the exception of the most recent developments, the real price of oil since the mid-1970s has not exactly moved in the desirable direction from the viewpoint of industry; developments in oil extraction and recovery technologies—which occurs in spurts; and the global political climate—which has gradually improved only in the last 10-15 years

(IV) global oil production may well start declining, but it is unlikely to occur in the reasonably near future (e.g. within a decade), and the decline is likely (but not guaranteed) to be relatively slow and gradual

(V) the most troubling issue is what will happen to global oil demand during this period, particularly in light of significant long-term acceleration of economic growth in countries such as China and India with voracious appetites for energy consumption (following the classic economic take-off pattern observed in most developed market economies)—such development could make things significantly worse, even if oil production is declining only slowly

(VI) on the positive side, oil demand will drop as higher future real oil prices will undoubtedly curtail oil consumption and lead to the use of more efficient combustion engines and lighter, less oil-consuming vehicles

(VII) high oil price will stimulate the use of other liquid substitutes for gasoline and diesel fuel, including synthetic gasoline/diesel fuel made from natural gas and coal, as well as alcohol and other liquid fuels made from biomass

(VIII) a most profound impact on oil consumption will come from the availability of alternative forms of energy to power transport vehicles, including electricity, hydrogen, LNG, LPG, etc.

(IX) finally, oil consumption will also be affected by improvements in the efficiency of the transport sector (in terms of unit fuel requirements per ton-km of transported freight or per person-km in the case of passenger transport), heat and cooling production, and electricity generation.

The bottom line: rather than worrying too much about how much oil is still left in the ground and how quickly we may run out of it, we need to concern ourselves with the adequate availability of substitutes and taking measures to stimu-

late energy conservation and efficient use of energy. Even though the market can be reasonably relied on to send adequate price signals and encourage correct oil substitution and conservation trends, it would be wise that mankind buy itself an insurance policy just in case the drop in oil production were to be relatively sudden and quite rapid. The insurance policy we have in mind is an ongoing government-subsidized development of alternative fuels to those based on crude oil, alternative combustion engine technologies, alternative transport means and technologies, etc. The cost of the insurance policy (the subsidy) should be covered by additional taxes on the consumption of oil products (in addition to those taxes which are used to finance the building of transport infrastructure or "abused" to finance the government spending not related to the transport sector or to the protection of the environment).

2.2 Pricing of energy at its full economic cost and active government policies to discourage energy waste and encourage energy conservation

In many countries, energy is not priced at anywhere near its opportunity cost/potential export price (Russia and most oil producing countries outside of the developed West are good examples), while other countries effectively encourage excessive consumption of oil products by a policy of traditionally low taxation of motor fuels (the US is a prime example of this). If all forms of energy were realistically priced on a global basis, and a greater consensus were achieved with respect to the optimal level of taxation (combination of excise and sales/VAT taxes) of different types of energy, above all in the developed West, this would provide an additional important incentive to discourage energy waste and would encourage energy conservation on a global basis. Such steps would at least temporarily reduce the level of global energy consumption (mostly by reducing unit energy/GDP consumption requirements) and certainly lessen its future growth.

2.3 Ability and adequate capacity to deliver required amounts of different types energy to the point of demand/consumption at the exact time required by consumers

In general, transport and transmission capacities for all types of fuels/energy have kept pace with the growth of demand, and it has been relatively rare, up until

now, to encounter transport bottlenecks, with the notable exception of electricity in some countries/regions. With adequate financial incentives, energy companies and governments are likely to continue adding to these capacities in order to assure that the transport infrastructure required to supply energy to consumers is in place. One way of assuring that the cost of this effort not get out of hand and make it necessary to build transport or transmission capacity only for peak demand periods is to increase the emphasis on stockpiling and demand management. The stockpiling of crude oil and refined oil products is not an overly costly or complex matter if it does not involve product price risk—rather, it is a matter of simple economics. (Holding an equivalent of, say, three months' demand equivalent for a readily saleable commodity incurs the annual cost of depreciation of the storage facility plus carrying costs, which is the value of annual consumption divided by four and multiplied by the combined per unit interest cost and storage service profit margin for the stockpiler). Gas storage capacities have been increasing throughout Europe, but the problem remains with their composition—not enough of that storage is of the fast recovery type (salt caverns, old underground mines) because of the cost of securing or constructing the storage which would allow maximum flexibility.

At present, electricity cannot be stored except by means of pumped storage hydropower generation plants, which are typically extremely expensive to build. Consequently, the bulk of generation capacities must operate in line with daily load curves, which, in most countries, show large daily swings in demand, with the peak load from 7 a.m. to 3 p.m., medium load from 3 p.m. to 11 p.m., and low load from 11 p.m. through 7 a.m. This pattern of demand drives up the cost of generating electricity dramatically as a substantial portion of generation capacities operate only 8 to 16 hours a day, instead of the ideal target of 24 hours (in a pure baseload fashion). The problem is further compounded by the seasonality of demand, particularly in countries with a single seasonal peak in winter (as opposed to double seasonal peak—heating peak in winter and air-conditioning peak in summer, characteristic, e.g., for most of the US and increasingly the Mediterranean region).

To a limited degree, it is possible to store products or services produced by means of electricity (primarily hot water, potentially heat stored by means other than hot water, cooling capacity stored by means of ice, etc.) and thus effectively to store electricity in a transformed form. However, it is likely that large-scale higher-voltage battery technology will prove technically feasible and economically viable in a horizon of around 20-25 years (e.g., Britain is currently at the forefront of development of this technology). Such technology would make it

possible for a battery the size of an average family house to store enough electricity to supply a town of about 40 thousand inhabitants for around 6 hours or so. If proven technically viable and cost-efficient, the giant battery technology would revolutionize power generation, as it would largely eliminate the need for peak load generation, allow virtually all electricity to be produced in a base-load fashion (with a portion of it stored for peak demand periods), significantly improve the rates of utilization of generation equipment, and consequently sharply cut non-fuel generation costs. The additional positive impact of the possibility to store electricity, at least on a short-term basis, on improving the security of its supply is obvious.

2.4 Adequate diversification of energy supplies by type of energy and geographic source and avoidance of excessive reliance on the types of energy, the supplies of which are inherently unreliable

Adequate diversification of energy supplies by type—particularly for countries dependent mostly on imported energy—is something that makes obvious sense. The proposition is less obvious for countries which are largely self-sufficient in energy or have a large indigenous supply of a specific type of fuel/energy. While, in the case of Norway, it has recently proven rather problematic to be almost totally dependent on hydropower (when a major drought occurred in 2003), the heavy dependence of a country like Poland on its hard coal does not necessarily entail an added risk in its energy supplies.

Turning next to geographic diversification of energy supplies, in the case of crude oil, it is not that critical whether all of a country's supply essentially comes from a single source (such as in the case of the Czech Republic) because of a significant degree of substitutability of different types of crude oil. The more critical issue is whether there are alternative routes to deliver the oil (particularly in countries which rely mostly or totally on pipeline transport) in the event of a breakdown/blockage of a particular pipeline route. It is also important that the country's refinery capacity be configured in a reasonably flexible manner and not depend solely on a very specific type of crude oil for which substitutes are scarce and difficult to procure.

Much emphasis has been made in the past about the danger of reliance on a single source of natural gas and the need for the diversification of supply. Never mind that the former USSR and nowadays Russia (Gazprom) have never failed to deliver the gas they were contractually obligated to deliver, with the exception of

a few relatively minor supply interruptions/shortcomings caused by unauthorized withdrawal of gas intended for other customers by the Ukraine. In practical terms, a number of EU countries—notably the Czech Republic, Hungary, Poland, and Slovakia—totally rely on physical deliveries of Russian gas, a portion of which is swapped for Norwegian gas in order to cut transport costs. It has proven sufficient to show that, if need be, the Norwegians will be able to deliver their gas physically, or that there will be other suppliers who will make alternative gas available, in the case of a Russian gas supply interruption/shortfall.

Nevertheless, given that natural gas is not supplied on nearly as competitive a basis as crude oil, whenever economically feasible, it makes sense for most countries to seek multiple competing supply sources of natural gas. Securing additional supplies of natural gas from Central Asia through a new pipeline transiting Turkey and the Balkan region (thus totally avoiding transit through Russia), in addition to core supplies coming from Russia and Norway, makes a lot of sense for those countries which would be within the reach of the new pipeline (the Balkan region including Greece, the rest of Central and Eastern Europe, Austria, Italy, and even Germany).

Heavy reliance on unpredictable sources of energy, which are inherently unreliable, is an irresponsible energy strategy for any country. Unreliable sources of energy include hydropower (given the risk of drought), windpower (possible lack of wind), and solar (possible lack of sunshine). But the risk is very different depending on the geographic location and climatic/weather history at the specific location. As we have regularly seen in continental Europe, periodic dramatic shortfalls in snowfall and precipitation imply a much higher risk for hydropower dependence within the Alpine region than, say, in a country such as Norway. Similarly, windpower generation on the Baltic coast is much less vulnerable to climatic and weather shifts than inland windpower generation. But the general point to be made is that electricity generation based on most renewable energy sources entails a considerably higher risk in terms of reliability and predictability. Thus excessive reliance on this type of generation can potentially backfire and dramatically increase the risk of a major shortfall in electricity supplies.

2.5 Certainty that supplies of different types of energy will not be interrupted to an unacceptable degree by extraordinary events of any type

Such interruptions could arise because of technical/equipment breakdown of the transport/transmission system, weather/climate related developments, political

or organized labor decisions, or terrorist attacks. The avoidance of energy supply disruptions due to technical/equipment breakdown of transport/transmission system can be assured by regular monitoring of the technical state of such systems and performing proper and timely repair and maintenance work. This generally appears to be the case, and it would be difficult, e.g., to identify major problem areas of technical nature in the energy transports system within the EU region. However, one can readily find problems in other parts of the world, such in as the US (with electricity transmission and distribution networks), Russia (e.g., with oil pipelines), and most developing countries (across the board). In addition to diversification of energy supplies (by type of fuel/energy and in a geographical sense) and diversification of supply routes (alternative pipeline use, multiple power transmission lines, etc.), diversification of modes of transport (if viable technically and economically) also makes sense.

Weather and climate-related developments can also disrupt energy supplies and are difficult to anticipate and plan for. But it is obvious that careful planning and situating of energy transport infrastructure can limit such disruptions by avoiding locating pipelines and power transmission lines in flood-prone areas, mud/rockslide and avalanche-prone areas, and by taking special care in construction of energy transport networks in earthquake-prone regions or those with difficult geology (such as shifting sands). While numerous errors have been made (such as in the Russian case, when many oil pipelines in the south were buried in shifting sands), more recently we have seen that people have learned from past errors.

Political and organized labor decisions could potentially threaten the security of energy supplies, although such threats are generally heavily discounted. The much touted threat in the Soviet era (at one point) that the communist political leadership could use an energy supply weapon (such as denial of oil or gas deliveries at a critical time) to extract political and other concessions from some of its customers has never visibly materialized. Even the Soviet communist leaders realized the foolishness and the extremely high long-term economic cost of using the denial of energy supplies as a political weapon in relations with countries significantly dependent on Russian oil and gas. Any supplier country resorting to such a step as blackmailing would lose its credibility as a reliable supplier and would never again be trusted by its customers. Not only would it be foolish to use such a weapon, but, in the absence of an exclusive or near-exclusive monopoly supply position, and, given a variety of measures implemented by oil and gas consuming countries to prevent the exercise of such a weapon against a specifically targeted country, the energy supply weapon would have been an ineffective tool for political blackmail.

It is also expected that governments would not tolerate the disruptions of energy supplies by organized labor; nor has the quite disciplined organized labor force shown an inclination up to now to explore its use for obvious reasons.

In light of recent global political developments and the emergence of large-scale global terrorism by extremists on the fringes of Muslim society, the threat of terrorist attacks aiming to disrupt energy supplies is an issue which deserves a great deal more attention than in the past. This topic is covered extensively in Section 3 below, dealing with the upcoming emergence of rational calculating terrorists. This section focuses primarily on potential threats to the security of high-voltage electricity transmission networks, which we identify as most vulnerable and prone to attack by the new breed of rational calculating terrorists, whom we expect to emerge in the coming years.

2.6 Assurance that different types of energy delivered to consumers are reasonably environmentally sound and safe

This is probably something that is either not taken into account in typical reviews of security of energy supplies or typically considered of distinctly secondary importance. The focus should not be just on the physical/biological impact, but on the visual impact as well. We should also be looking at all stages of the process of energy supply and consumption—fuel extraction/processing and electricity generation, fuel transport/power transmission, and fuel consumption itself. We can hardly consider a particular supply of energy as secure—at least on a longer term basis—if it involves an environmentally reckless method of fuel production, leaking pipelines, polluting refineries, health hazards from power generation (nuclear generation, air pollution from coal-fired plants) or from transmission lines, or similar situations.

Pro-environment political movements and populations at large are showing a declining tolerance of such practices and an increased willingness to abandon particular types of energy supplied at a cost of major risk to the environment and/or human life (such as nuclear generation, environmentally-damaging hydropower generation, oil and gas extraction in environmentally sensitive areas, construction of new pipelines with potential adverse environmental impact, etc.). What may have been tolerable in the past is unlikely to be tolerable in the future; hence, marginal sources of energy supplies and modes of transportation/transmission (in terms of economic benefit relative to potential environmental and human health cost) are vulnerable to political actions to shut them down and, thus, should be viewed as unreliable.

Even if safe and sound in the physical and biological sense, populations in most countries are also increasingly sensitive to the visual impact of energy installations and energy transport networks. For example, despite significant domestic power shortages, the population of Croatia sensibly blocked the government plans for the construction of state-of-the-art coal-fired power generation facilities in coastal areas (in order to utilize imported coal), as this would have significantly impaired the visual enjoyment of the Mediterranean coast by tourists and devalued the most valuable national asset and resource which Croatia has. The limitations imposed on wind-power generation in the immediate vicinity of the Baltic coast and throughout the Alpine region, or on the construction of high-voltage transmission lines through the Alps, also make a lot of sense. Even in the US, the large-scale visual blight of Third-World-like power distribution system, based on wooden poles and above-ground hanging cables both in urban and rural neighborhoods, is increasingly questioned (also on safety and reliability grounds). The US offers a prime example of a country with massive hidden underinvestment debt in its power transmission and distribution network, which it will have to start repaying in the not too distant future.

3. Upcoming Emergence of Rational Calculating Terrorists

3.1 Potential terrorist targets

The global political consensus is that terrorist activity worldwide is likely to remain at least at the current level and quite possibly increase significantly. Aside from pure civilian targets and national symbols (World Trade Towers, Eiffel Tower, etc.), the four main targets for terrorists are likely to be:

(I) financial institutions (to exact maximum economic damage from the disruption of financial markets by creating distrust/uncertainty in the banking sector and cause equity values to drop as stock markets decline)
(II) energy and water supplies (to maximize potential economic disruption and disrupt as many lives as possible)
(III) key symbols of political power (parliaments, presidential/prime minister palaces and residences, key government and high court buildings, etc.)
(IV) key symbols of military power (defense and interior ministries, military bases).

Our expectation is that the new generation of terrorists will be increasingly sophisticated and calculating and will opt for new forms of terror selected on the

basis of cost-benefit analysis from the terrorists' viewpoint. It is highly likely that, over time, blind, pure-hate terrorism (e.g. the recent terrorist attack on the Beslan School in North Ossetia) will decline. Such terror creates few friends—even within the Muslim world—and generates no sympathies for terrorist causes. Instead, terrorists are increasingly likely to opt for attacks which create massive economic pain and disrupt human life at a critical time, while hoping to create enough political pressure for policy changes favorable to their causes. The recent terrorist attack in Spain proved that, with the right timing, you can even influence the outcome of national elections.

Focusing on item (ii) and the region of Europe, terrorists would, in principle, attack the following facilities:

(a) trunk oil pipelines and refineries/storage capacities
(b) trunk gas pipelines
(c) LNG ships and LNG storage capacities
(d) individual oil and gas production facilities (sea-based production platforms)
(e) high-voltage transmission lines, dispatch centers, and critical substations
(f) nuclear power plants
(g) hydropower plants
(h) thermal power plants
(i) potable water reservoirs.

3.2 Classic targets for "old-fashioned/emotional" terrorists

Out of the above nine categories, the "old-fashioned/emotional" terrorists, who are primarily interested in substantial loss of life and the "classic" form of terror, would be most inclined to attack the four targets listed below. However, the potential targets in this category are relatively well protected (except for the potable water supply), difficult to attack, and unlikely to result in huge economic cost even if successfully attacked, thus making them unattractive to rational calculating terrorists.

3.2.1 Nuclear power plants

Because of the extent of existing security measures and safety designs (typically involving protective concrete domes over nuclear reactors), these are very difficult to attack and damage extensively without insider co-operation (which, in turn, is extremely difficult to secure). A terrorist attack on a nuclear power plant would have a profound economic and social impact only if it were to lead to the

spread of nuclear material (even of relatively low radioactivity) outside of the plant facility. The loss of power generation capacity would not be significant enough to have a major economic impact. The cost-benefit analysis would suggest that nuclear power plants are not an attractive target for a rational calculating terrorist given that too much effort would be required, the attack would be unlikely to result in enough of an economic impact, and that the potential population health threat is unlikely to generate sympathy for a terrorist cause.

3.2.2 Hydropower plants

These are also subject to a fair amount of security monitoring, very difficult to attack and damage extensively without insider co-operation. The loss of generating capacity would also have very limited impact in most cases. The attack would have a major economic and social impact only if it resulted in the destruction of or major damage to the body of the dam (difficult to achieve) and caused consequent large-scale damage to the region below the dam. The cost-benefit analysis indicates that hydropower plants are also not attractive targets for a rational calculating terrorist—the potential massive loss of life and destruction of property would hardly generate sympathy for terrorists.

3.2.3 LNG ships and storage facilities

This is another category of tightly guarded energy facilities, relatively difficult to attack. The loss of a LNG ship or specific LNG storage facility is unlikely to have a profound economic and social impact. As in the case of hydropower plants or potable water reservoirs, these facilities would attract "old-fashioned" terrorists probably mostly interested in maximum collateral damage (particularly in the case of storage capacities located near population centers). Based on cost-benefit analysis, they are unattractive targets as well, for the same reasons as in the previous two cases.

3.2.4 Drinkable water reservoirs

The poisoning of the municipal water supply is something that is technically not that difficult to do (at least in theory). However, this type of terrorism is in line with the use of a radiological device or biological/chemical weapons and would

have no appeal to a rational calculating terrorist because of the negative population response which would be expected.

3.3 Unattractive terrorist targets

Two other types of potential terrorist targets are unattractive because of the limited economic impact their complete destruction or substantial damage would have. Thus we view them as relatively unattractive to either type of terrorist.

3.3.1 Individual oil and gas production facilities

Practically, it is impossible to blow up an entire oil or gas field; terrorist attacks against individual oil or gas wells would not have the desired effect. In particular, they would typically have only a negligible effect on the overall supply of a specific type of fuel (not only on a global scale, but even on regional scales). Some attacks could obviously be more worrisome—e.g., against natural gas wells producing large quantities of sour gas, but in this case it would be a type of terrorism more in line with what "old fashioned' terrorists are aiming to do and more properly belong to the group listed in Section 3.2.

3.3.2 Thermal power plants

These are also unattractive targets, given the difficulty of causing serious damage to this type of generation facility. Even the full destruction of a couple of blocks in a major power plant (which is rather difficult to achieve) would have very limited economic and social impact.

3.4 Rational calculating terrorist and his/her likely targets

A rational calculating terrorist strives to inflict maximum economic damage (so that as many people as possible feel the economic impact and experience a significant disruption in their lifestyle), tries to limit the loss of life (such loss typically creates an anti-terrorist backlash, and it substantially increases the risk for the terrorist to be hunted down and caught), and tries to convey a clear political

message to achieve his/her goals (hopefully changing voter attitudes, outcomes of elections, foreign policies of individual governments, etc.). In the case of energy supplies, he/she will be increasingly focusing terrorist activities on energy transport/transmission infrastructure, given the relative ease with which it can be attacked, the much decreased likelihood of his/her being detected and caught in the act or afterwards, and the effectiveness of "energy supply denial" as an economic and political weapon.

The three key types of terrorist targets in this case would be:

(I) trunk oil pipelines and refineries/storage capacities
(II) trunk gas pipelines
(III) high-voltage electricity transmission lines, national electricity dispatch centers, and critical power substations.

3.4.1 Trunk oil pipelines and refineries/storage capacities

The act of destroying a portion of a critical oil pipeline or an entire refinery/storage capacity could have a significant short-term, and possibly even longer-term, economic impact (in the case of a refinery or storage capacities). The resulting temporary shortages of refined oil products—particularly at critical times of the year when demand is high—and sharply increased prices could have a significant adverse local or regional economic impact. However, the use of such a terrorist weapon would have its limitations. One can blow up at most a portion of a pipeline (possibly up to several hundred meters in length), and this can probably be repaired fairly quickly. Since crude oil and oil products can be stored, and if stocks in storage are adequate, the economic impact of this type of terrorist attack may not be that significant. The destruction of a refinery (particularly in countries with a single national refinery) would undoubtedly be more painful, but refined products can be transported by road, rail, and product pipelines, which would reduce the economic impact of the damage to the assets in question.

3.4.2 Trunk gas pipelines

Natural gas can be transported in significant quantities only by means of pipelines (excluding the case of LNG, which requires the presence of a seaside LNG terminal and a storage facility). It can be stored in underground storage facilities,

but most of them are not of the fast recovery type (such as salt caverns or former underground mines). It would thus appear that an attack against a major trunk gas pipeline or a set of pipelines (e.g., either in Russia, Ukraine, or in key transit countries) could potentially inflict even more damage, particularly if the terrorists choose the right time—such as the peak of the winter heating season during a spell of unusually cold weather. However, once again, it is possible to blow up only a portion of a gas pipeline, and its repair could probably proceed at an even greater speed than in the case of a comparable oil pipeline attack. If gas storage capacities are adequate, a country or region may be able to survive the incident without profound economic impact. Naturally, potential terrorists could focus their attack on a major compressor station or a critical border transfer station, causing longer-term damage, as compressors are not as easily replaceable as gas pipe.

3.4.3 High-voltage electricity transmission lines, national electricity dispatch centers, and critical power substations

In our assessment, this will be a top priority target for rational calculating terrorists in the future for a host of reasons. First, the denial of electricity has a massive disruptive economic impact, and it will be felt by the population of an entire region or a country. The complete loss of power supply means there would be no light when it is dark (not only during the night!); computers would stop functioning (except for those with a back-up power supply)–nowadays almost everything is dependent on computers—the public transport system would largely shut down (including rail lines, with the exception of those relying on diesel-electric engines, subways, most airlines), and there would be no heat (most individual gas or oil-based systems would not function, as they have electrical components) or air conditioning, no refrigeration, problems with the water supply (most pumps are electrical), etc. If a terrorist attack were to be timed at the seasonal peak of electricity demand—such as during the peak of the winter heating season or during a spell of extremely hot weather during the summer—the economic and broad social impact would be that much more profound.

Second, due to the high density of power transmission lines and the virtual impossibility of monitoring all major power lines (even limiting our focus on 400 kV lines or higher voltage in a few countries) and the ease with which a supporting pylon can be brought down, the risk to a terrorist of being detected or caught is very low. Compared to alternative terrorist targets in the

energy sector—be they oil or gas pipelines or energy production/generation capacities—bringing down a 400 kV power transmission line is an easy task which does not require a great deal of skill or experience. Obviously, attacking a national power dispatch center or a major substation—critical for a national/regional power supply system—would be considerably more ambitious, technically demanding, and risky (particularly as the national dispatch systems tend to be well-guarded nowadays). The general vulnerability of these systems to a terrorist attack has already been exposed by the activities of the "darkers" (vandals who enjoy the visual thrill of shorting a high-voltage line) or by the recent (late summer 2003) Italian blackout experience, presumably as a consequence of the fall of a single tree in the Italian Alps.

While in principle it would be relatively difficult to cause a multi-day collapse of a power supply system in countries with extensive circularity of their power transmission networks (i.e., countries in which most key points of large-scale power consumption can be supplied from two or more directions), a well-coordinated simultaneous attack of a group of terrorists on several critical transmission lines could indeed plunge an entire country into darkness for several days. Typically, the countries most vulnerable to such an attack are those which are relatively isolated and with difficult geography (e.g., Croatia, Greece, Italy, Spain, Portugal), those that are significantly dependent on imported electricity (e.g., the Netherlands and Italy again), and those with inadequate cross-border transmission capacity relative to the overall size of their domestic electricity markets (surprisingly, Poland falls into this category).

The above problem can be seriously compounded when a country ignores its potential transmission system vulnerability on a long-term basis (there are quite a few countries in Europe which fall into this category), lacks adequate economic incentives to make investment into high-voltage transmission which would mostly or heavily benefit its neighbors (Hungary, Croatia, Slovenia, and Bulgaria fit into this category), or engages in "obstructionist" behavior with respect to construction of an adequate pan-European transmission network for "environmental" or other reasons (e.g., Austria). The potential for more vulnerability is also created when some of the major European power generators try to slow down the construction of a pan-European electricity transmission network (something along the lines of pan-European gas supply network) in order to prevent large-scale cross-border electricity exchanges so that they can preserve the value of their less competitive generation assets (elements of such behavior are visible particularly in Germany, France, Spain, and more recently also in Italy).

The ultimate nightmare scenario we envision in the coming years is that sophisticated rational calculating terrorists will simultaneously blow up segments of the 400 kV transmission network at several critical locations in a country such as Italy so as to achieve a maximum multi-day disruption in power supplies or a complete blackout on a national basis. In order to maximize the economic impact of such a terrorist attack, and, given the speed with which such an attack could probably be implemented (obviously with some advance planning), terrorists could time the attack to occur during the period of peak winter demand (during an unusually cold spell) or peak summer demand (during an extreme heat wave). While the population could reasonably handle a one-day total power supply interruption, if such an interruption were to last for several days (say 3-7), we would not be surprised if it brought about massive population protests in the streets all over the country. Such protests could, in turn, trigger cabinet resignations, possibly the fall of an entire government, and a call for early general elections. Undoubtedly, some opposition politicians would seize the opportunity and advocate changes in policy, which would address at least some terrorist grievances—particularly if these have at least some degree of legitimacy (such as a call for an independent Palestinian state, for no limitations on religious expression in public, etc.).

3.4.4 Proper response to potential attacks on power transmission infrastructure

In our assessment, in the coming years, more rational and calculating terrorists will emerge, particularly in Europe, who will primarily focus their activities on causing massive economic damage with widespread impact by attacking financial institutions and energy transport and transmission infrastructure. Within the latter category, we definitely see the power transmission sector as the most likely target of coordinated and well-planned attacks. As such attacks will be extremely difficult to prevent for the reasons already outlined, the proper response of European countries should be to:

(I) significantly improve the monitoring and security of high-voltage transmission network (particularly the 400 kV lines and those of even higher voltage, particularly in Russia and Ukraine)

(II) dramatically step up the construction of cross-border interconnectors in order to improve the potential for cross-border power supply assistance in the event of a domestic power supply disruption

(III) encourage countries to strengthen the security of their power supply by in-

creasing the circularity of their power supply system, even if this means relying on a neighboring country (example: the construction of an undersea cable interconnector between Croatia and central Italy)

(IV) increase co-operation between countries more vulnerable to the disruption in power supply (such as Italy and most of the Balkan area) and those with more secure power supply system and short-term stand-by generation capacity (such as the Czech Republic or Slovakia), or those with long-term large-scale excess generating capacity and the potential ability to contribute in a major way during a power supply crisis (potentially Ukraine and Russia).

4. Creating Our Own Vulnerability in Power Supplies

It is important to note that when it comes to vulnerabilities in power supplies, a great deal of that vulnerability is self-generated by irresponsible behavior, sometimes on a national scale. Here are a few worrisome recent examples from Europe:

1. Excessive reliance on a single type of generation
2. Excessive reliance on relatively unreliable sources of electricity and deceptive practices to justify their use
3. Obsession with the low cost of power at the risk of declining security of supply
4. Absence of a pan-European electricity transmission network (unlike in the case of natural gas)
5. Irrationality of design of transmission and distribution networks
6. Giving priority to protectionism over the security of the power supply.

4.1 Excessive reliance on a single type of generation

A good example of such behavior is Norway, which relies almost exclusively on hydropower to generate all of its electricity. Although Norway produces vast amounts of natural gas, its own gas-fired generation capacity is negligible, and, unlike neighboring Sweden, it does not have any nuclear power plants. When Norway experienced extreme periods of drought (such as in 2003), its power supply situation reached a critical stage. Moreover, because of its relative physical isolation, it was unable to secure sufficient assistance from its Nordic neighbors.

4.2 Excessive reliance on relatively unreliable sources of electricity and deceptive practices to justify their use

While many of the arguments in favor of renewables are certainly legitimate, some renewables—notably windpower and solar power—are inherently unreliable sources of electricity at most locations. Windpower definitely works in the right locations—such as directly on the Baltic Sea or on the Atlantic coast—or if installed on sea platforms (but these are expensive to build). The effectiveness of windpower goes down significantly if located inland (in order not to ruin the visual appearance of lands immediately adjacent to the sea and thus of significant recreational value). Seduced by the high and heavily subsidized prices offered for electricity generated from wind, many generators have gone overboard with the construction of windpower generators all over the countryside; Germany is a good illustration of this extreme. Marginal windpower generation capacities have very low effectiveness, and the resultant visual blight, noise, and other adverse environmental side effects have been given little weight in cost-benefit calculations. Unreliable historical data on wind occurrence and speed have been used to justify the rather extreme growth of this segment of generation at locations in which it does not make long-term economic sense.

What the public has not been told is that wind generation in most locations is rather unreliable, that recent weather and climatic changes make economic calculations even more difficult, and that for every MW of windpower generating capacity, there has to be adequate back-up power, typically in the form of rather expensive gas-fired generation. (What drives up the cost of the back-up gas-fired generation capacity is the fact that its utilization rate will be relatively low—implying high unit capital cost, and the cost of the fuel will be high because of the unpredictable pattern of gas offtake—natural gas suppliers do not exactly welcome customers who cannot say when and how much gas they are likely to consume.) Since the assurance of adequate back-up generation capacity is not the responsibility of windpower generators and, given the persistent mis-pricing of this standby capacity (the price offered is typically too low), we have recently witnessed occasional major power shortages in countries such as Germany and Austria, which can be squarely attributed to the failure of windpower generation capacities to deliver the expected amount of electricity. With inadequate back-up generation capacities, both countries have attempted to alleviate the shortages through short-term electricity imports from neighboring countries, and, in

order to secure adequate transmission capacities for crisis situations, they significantly curtailed cross-border transmission capacities available for all-time use for the purpose of transmission of baseload electricity. Not only is such a practice uncompetitive, as it unilaterally restricts cross-border baseload electricity trade, but, in essence, it exports the German and Austrian problem into neighboring countries such as the Czech Republic. In effect, instead of penalizing the reckless behavior caused by domestic windpower generation, it actually rewards it and imposes a significant portion of the economic cost on neighboring countries.

4.3 Obsession with low cost of power at the risk of declining security of supply

This is perceived to be a particularly American phenomenon—as the American consumption culture is based on the obsession with low gasoline prices (resulting in low mileage performance of automobiles and widespread use of gas-guzzling SUVs), it is equally obsessed with the low cost of electricity. Americans take the low cost of electricity for granted, and US generators have largely given up on trying to charge the consumer the true cost of electricity at the time of peak demand, making the entire US electricity system increasingly vulnerable, particularly during the summer electricity demand peak due to air conditioning. The American obsession with the low cost of electricity is also illustrated by the country's essentially Third World-like system of electricity distribution, relying mostly on wooden poles and multiple layers of hanging cables that are vulnerable to breakdowns, not to mention a significant visual blight even in very expensive residential neighborhoods (including what is being done to the trees located below power lines).

While Europe (including Eastern Europe) is generally inclined to bury its power lines in cables underground whenever practical, it too is increasingly obsessed with the idea of cheap electricity (the UK and Scandinavia being good examples), even with the rising risk of generation capacity failures and inadequate back-up at a time of potential crisis. The pressure for cheap electricity, the seeming willingness to tolerate a greater degree of risk to power supplies, and the growing interdependence of European economies—even in the area of electricity supplies—as integration advances, suggest the increasing likelihood of major power supply failures and blackouts, possibly affecting more than one country and lasting more than a few hours or a day.

4.4 Absence of pan-European electricity transmission network

High-voltage transmission lines throughout most of Europe have been mostly built for the needs of each country and not in response to market incentives (potential transmission fees collectable), in order to make it possible to transmit electricity throughout Europe from regions of potential surplus to regions of potential deficit. In fact, in many countries, there is significant opposition to the construction of transmission lines, which would mostly serve for transit purposes (even if such a service were fairly financially compensated and profitable for the transit country). For environmental reasons and because of political opposition, it is impossible to build any transmission lines exceeding the current 400 kV standard. Hence, larger amounts of electricity can only be moved by doubling the lines, increasing the number of strands carried (and the height of pylons), and increasing the diameter of the strands (hence also their weight). There are serious limits to transmission capacity increases if we rely only on these options.

Ironically, the only region of Europe where transmission is more efficient and the transmission network has been laid out in preparation of a pan-European transmission network is Russia, Ukraine, and portions Poland, Hungary, Romania (transit only) and Bulgaria, which have segments of 750 kV lines, originally built in the communist era as a part of single common CMEA transmission network and power supply system. What this means is that with relatively modest additional investments in transmission, in the case of any power supply crisis or emergency, significant portions of Central and Eastern Europe could be potentially aided by electricity supplies from Ukraine and ultimately Russia as well. Using their own transmission networks, these countries can, in turn, also offer potential help to countries farther west or south such as Germany, Austria, and ultimately Italy as well. Regrettably, the EU has yet to show any interest in taking advantage of this potential—one of the few areas where accession countries in co-operation with Ukraine and Russia could actually assist the core EU region in case of an electricity supply crisis.

4.5 Irrationality of design of transmission and distribution networks

To elaborate on the above point, it is sufficient to look at the map of European electricity transmission and distribution networks. They were designed for the needs of individual countries and as yet are showing little response to European economic

integration. The cases where one system/network actually supplies power in a different country are incredibly rare and of minor importance. This will have to gradually change—both in order to cut costs and improve the security of electricity supply. Over time, borders should become irrelevant and electricity should be transmitted and distributed in a fashion which minimizes transmission and distribution losses and improves the security of supply whenever possible.

4.6 Protectionism given priority over security of power supply

The main agenda of major power generators in Europe are both to maximize profits and protect asset values (which is much more problematic)—particularly in the case of generators with significant holdings of marginal/high-cost generation assets, which are vulnerable to competition from cheap electricity. Those generators, which are particularly vulnerable to competition from cheaper imported electricity, have strong incentives either to use their own power or business and political clout to delay the construction of transmission lines which would potentially increase electricity supplies from other lower-cost generators or, at least, to try to influence the process with the same aim. Additional cross-border interconnectors and new transmission lines bring unwelcome competition, reduce electricity prices (undesirable from their viewpoint), and improve the security of supply (desirable, but not enough to compensate for the potential loss from more supply competition). The latest trick employed by the vulnerable generators is to increase reliance on expensive and unreliable windpower (under the cloak of doing something that is environmentally friendly) and then increase their demand for standby transmission capacity at cross-border points because of increased risk of unpredictable fluctuations in local production and the need to offset it by increased electricity imports. This works wonderfully to effectively reduce the cross-border transmission capacity normally used for imports of baseload electricity; it reduces effective electricity supplies in the home market, stifles competition, and drives up electricity prices, but preserves asset values and protects profitability of these generators.

5. Conclusions and Policy Recommendations

These are not meant to be exhaustive or all-encompassing, as the scope of this paper and the absence of a larger team of energy experts contributing to it do not

permit it to go into as much depth as the topic would probably warrant. Here are some of the author's thoughts on policy implications:

5.1 For Europe at large

The main point we would like to make is that much greater energy co-operation and integration should take place within the EU, particularly now with the addition of eight accession countries from Central/Eastern Europe. It is worth noting that throughout the core EU region and in Brussels, these countries are generally considered an additional burden on the core EU region in the sense that they will consume more resources allocated through Brussels than they will contribute to it. This is a correct view on the whole, but ironically, in the energy sector, the core EU region stands to gain more from pan-European energy co-operation and integration than do the accession countries. This is a simple reflection of geography and the location of the energy sources supplying Europe. With the exception of Norwegian and British oil and gas from the North Sea and relatively limited indigenous energy production (Dutch gas; German, Polish, and Czech coal; Romanian oil) or primary electricity (hydro or nuclear), most of the energy consumed in Europe is imported from the East (Russia), the Southeast (middle East, Australia), and, to a lesser degree, the South (North Africa, Central Africa, and South Africa). And, with the exception of Norwegian gas (in the case of the Czech Republic and Poland), accession countries do not get any of their energy supplies through the core EU region plus Norway.

On the other hand, the core EU region receives all of its natural gas supplies from Russia through EU accession countries (Slovakia, the Czech Republic, Poland and through Balkan countries in the case of Greece) and Ukraine. Before their delivery in Western Europe, Russian crude oil and refined oil products flow through pipelines, oil terminals, and refineries in the Baltic Republics, Belarus and Ukraine (outside of EU), Poland (supplies for the former East Germany), and Slovakia (a portion of supplies for Austria). In the case of electricity, significant flows go from the Czech Republic, Poland, Slovakia and Bulgaria to the markets in Germany, Austria, Greece, and indirectly also to Italy. In the future, once Ukraine and Russia are synchronously connected to the UCTE transmission network (probably sometimes around 2010-12), the flow of electricity from the East to the West is likely to become much more dramatic, and this region could play an even a greater role than that played by France—currently the largest net exporter of electricity in Europe by a wide margin.

We see the entire enlarged EU region as being, so to speak, "in the same boat"—highly dependent on imported energy, vulnerable to high energy prices (due to a combination of relatively slow increase in supplies and sustained rapidly rising demand in China and the rest of Asia), and vulnerable to potential supply disruptions due to a combination of the slow pace of the development of alternative energy transport routes and networks and due to the dramatically increased likelihood of terrorist attacks aimed at temporarily crippling critical transport routes/networks and at inflicting the maximum economic damage on a given country or a group of countries targeted by the terrorists for political reasons. Among the policy recommendations to counter these likely developments, we would list in particular:

(I) energy consumption in general: while Europe in general is already far more conscientious than the US in terms of energy conservation (facing high gasoline prices, the Europeans drive smaller and more economical cars, rely more on public transportation, live in smaller and better insulated houses and generally work in more energy efficient buildings), there are areas of significant potential energy consumption improvement in Europe through:
  (a) massive switch from truck transport back to rail transport using the piggybacking technology widely in use in the US (but that will require the unification of individual national rail networks and the creation of a pan-European rail freight network system)
  (b) improved highway networks and a system of circular by-passes of major municipal areas (the energy efficiency of automobiles sharply drops, and emissions soar with chronic congestion and stop-and-go traffic)

(II) electricity transmission: while Europe has a highly competitive oil market with very similar refined product prices throughout Europe and a relatively competitive gas market, where price differentials are largely explainable by additional transport cost or price-discriminating behavior of the price-setting semi-monopolies (Russia's Gazprom), the electricity sector is highly fragmented, characterized by major transport barriers, and, hence, is the least competitive of the three; since we can never equalize fuel costs throughout Europe, the only way toward a single European electricity market, toward persistent pressure for absolute electricity price equalization, and toward general enhancement of safety and reliability of European electricity supplies is through massive additional investment in the high-voltage (400 kV) transmission system, with particular focus on cross-border transmission links and an aim to:

(a) increase the security of power supply in relatively isolated countries with difficult geography (e.g. Croatia, Greece, Italy, Portugal, Spain)
(b) enhance the circularity of the national power supply systems and reduce the likelihood of a power supply failure by external loops whenever practical (e.g., through undersea cable links such as that between Southern Italy and Greece and potentially between Central Italy and Croatia)
(c) improve the security of the power supply in countries vulnerable to terrorist attacks
(d) take full advantage of excess power supplies and generation capacities (as well as the relatively high standard of reliability and ample transmission capacity) available in some new EU members countries, notably the Czech Republic, Poland, and Slovakia
(e) connect Ukraine and Russia to the UCTE transmission network in a synchronous fashion (so that electricity can flow to EU countries without having to go through relatively expensive HVDC back-to-back station interfaces) at the earliest possible time and thus enhance EU energy supply co-operation with these two countries in a significant way and secure potential additional electricity supplies to the EU region at a time of potential crisis (this added potential baseload electricity flow could also be used to stimulate electricity supply competition and put some limits on expected major electricity price increases facing EU consumers during the next 6-8 years)

(III) electricity generation: plenty of problems exists in this sector, which need to be corrected in the longer run, including:
(a) lack/slow progress in creating a single electricity market to make it possible to generate electricity at widely different costs throughout Europe (which immediately implies waste in the absence of major transmission cost barriers)
(b) plant location is not rational in relation to the pan-European market
(c) some countries are embarking on a risky policy of excessive reliance on renewables (particularly in the case of relatively unreliable windpower), with unrealistic cost calculations and deliberate understatements of the indirect costs of such strategies (including the back-up generation capacity cost, environmental cost, and potential export of domestic generation problems to neighboring countries, etc.)
(d) some generators deliberately aim at or engage in curtailing cross-border

electricity exchanges by a variety of means (such as by demanding certifications that imported power is produced in a "clean" fashion), solely in an effort to protect values of their marginal (i.e., high-cost) generation assets

(e) Europe lacks a clear common position on nuclear power, leading to strange inconsistencies (such as when the brand new and relatively safe Temelin nuclear power plant in the Czech Republic gets incredible scrutiny, while some rather aged and truly accident-prone German nuclear power plants conveniently fall under the radar screen of the critics, or when some Austrians usurp the right to dictate what generation technology and mix neighboring countries should use, without being willing to compensate the neighbors in any way for the added cost of electricity generation, etc.)

(IV) natural gas transport and storage: this sector in general is in relatively good shape, but the persistent high price of natural gas (due to its linkage to fuel oil prices) puts some limits on its utility as a fuel in electricity generation and potentially (in a liquefied form) as a substitute for gasoline and diesel fuel; in order to make natural gas more competitive, European countries should strive to increase the number of alternative suppliers and hence gas-on-gas price competition, including:

(a) additional gas supplies from Russia secured through gas savings in domestic Russian use (due to more realistic pricing of gas to Russian consumers and the curtailment of the huge waste of gas by the Russian electricity sector, which currently burns massive amounts of it inefficiently under boilers)

(b) gas from Turkmenistan and Central Asia via a new pipeline through Turkey and the Balkan region

(c) a pipeline from the Middle East (potentially from Qatar) through Turkey (this one coming further down the road)

(d) additional undersea pipelines from Libya and Algeria to Italy and Spain

(e) new LNG projects (in Northern Russia, the Middle East, Africa, etc.)

(V) oil transport: oil pipelines are, in general, a more economical and ecologically sounder mode of transportation of crude oil (and refined oil products) than sea or rail transport, and the following steps should be taken:

(a) the existing Russian/Ukrainian oil pipeline network into Europe

(mainly Druzhba) should be utilized to its maximum potential to export Russian crude oil to European markets and be connected to refineries in Western Europe whenever possible (aside from Leuna, connection to the Swechat, and potentially also Ingolstadt, refineries is only the beginning)

(b) Europe should take a greater role in helping to bring Russian and Caspian oil to European markets through new pipelines going through the Ukraine (Odessa-Brody), Romania, and/or Bulgaria, which will either boost the capacity for crude oil delivery to final European refinery destinations or at least help to avoid the Bosporus oil transport bottleneck

5.2 For the Czech Republic and Slovakia

The Czech Republic and Slovakia are not major energy producers—neither country produces crude oil or natural gas in amounts worth mentioning, the Czechs mine a good deal of soft coal (some of which is effectively transported in a transformed form as electricity), and both countries have sizeable generation of nuclear power. The Czech Republic is the second largest net exporter of electricity in Europe after France, but, in absolute terms, the 15 TWh or so exported annually on net basis does not make that much of a difference in the framework of the entire European electricity market. Slovakia is at least temporarily also a net exporter of electricity, but to a much smaller degree (under 5 TWh annually on net basis).

Nevertheless, the two countries play a major role in European natural gas supplies and security by being key transit countries for key natural gas flows. The bulk of Russian natural gas exports currently goes through Slovakia, with the notable exception of the flows through the new pipeline crossing Poland. The Czech Republic serves as a transit route for roughly one half of the Russian gas going through Slovakia and destined for markets west of the Czech Republic; the other half of gas transiting Slovakia is destined for markets south and southwest of Slovakia/Czech Republic.

Oil pipelines going through the two countries currently serve exclusively local markets, but a change can be expected in the not too distant future. By the end of 2005, the Slovak oil pipeline company, Transpetrol, (with Russian Yukos as a strategic investor) will start delivering crude oil from the Druzhba pipeline to the OMV refinery at Swechat (initially at a pace of around 2 mmt annually, but ultimately at as much as 5 mmt annually). The logical step for the Czech government,

which owns 100% of the Czech oil pipeline company MERO, would be to follow the Slovak example and explore the potential of reversing the IKL pipeline from Kralupy to Ingolstadt in Bavaria and use the unutilized excess transport capacity of the Druzhba oil pipeline (well in excess of 5 mmt annually) to transport additional Russian, or even Caspian, crude oil to the German market. Both countries have already concluded that the planned reversal of the Adria pipeline (another former alternative to get crude oil from the Mediterranean to Hungary, Slovakia, and the Czech Republic) to become a pipeline for exports of Russian crude oil will have no impact on oil supply security, as it has not been used at all for well over a decade. With the likelihood that the planned Odessa-Brody pipeline in Ukraine, which connects with the southern branch of Druzhba pipeline, will make it possible for the Visegrad countries to gain access to supplies of Caspian oil in the not too distant future, the strategic value of the IKL pipeline as an oil supply route alternative for the Czech Republic will further decline.

In the case of electric power, the Czech Republic and Slovakia can be expected to play a growing role in the pan-European electricity market. The Czech Republic is likely to remain a longer-term structural net electricity exporter (as would Slovakia if the two remaining blocs at the Mochovce nuclear power plant are completed). The two countries have a unique geographic position in Europe, similar to that of Austria and Switzerland, and a highly developed electricity transmission network including cross-border transmission capacities (compared to, say, Poland). Aside from exporting their own electricity, the two countries can also play a role as potential transit routes for electricity from Poland (and ultimately even Scandinavia) and Ukraine/Russia. Given that virtually all countries south of the Czech Republic and Slovakia are power deficient or generate electricity at relatively high cost (given the absence of an indigenous fuel base), these are attractive markets characterized by high prices relative to most of Europe.

Among energy policy recommendations for the two countries, we would list the following:

(I) electricity transmission: in order to enhance its role as an important region for electricity supplies to the south and west in general as well a source of significant generation reserve for the rest of EU in the event of a supply disruption/crisis, both national transmission system operators (CEPS and SEPS) should further develop cross-border transmission capacities and connections with 400 kV transmission networks of neighboring countries, notably:

(a) between Slovakia and Hungary (where demand for capacity already exceeds supply by a wide margin)
(b) between Slovakia and Austria (a project blocked by the anti-nuclear lobby in Austria, but strongly supported by the EU as part of the pan-European electricity transmission grid integration)
(c) between the Czech Republic and Austria (at the end of this decade, the transmission situation between Austria and Italy will dramatically improve, but the Czechs will not be able to take full advantage of the potential of supplying electricity to Italy without connecting either Southern or Western Bohemia with the Austrian high voltage grid)
(d) between the Czech Republic and Poland (by connecting the huge Turow power plant on the Polish-Czech border to the Czech grid)

(II) electricity generation: nothing particularly dramatic needs to be done in this area:
(e) ČEZ and SE companies made sensible long-term decisions to complete the Temelin nuclear power plant (in the Czech Republic) and build the Mochovce plant (in Slovakia), and it would make sense to complete the two remaining blocs at Mochovce, given the prospect of a significant increase in European electricity prices during the remainder of this decade
(f) the Czechs should not fall for the windpower generation alternative (currently in vogue in Germany and Austria), given its lack of reliability, adverse environmental and visual impact, and dubious economics, and the Czechs should fulfill their commitment to renewables mostly by focusing on the use of biomass (wood, suitable agricultural crops, agricultural waste, etc.)
(g) the Czechs should also proceed cautiously with the construction of the next generation of coal-fired plants, utilize the existing resources more efficiently (including huge amounts of hard coal processing sludge available in the Ostrava-Karvina region), and build new plants dimensioned for the European and not just the local market (based on blocs of at least 350 MW each to achieve maximum operating efficiency)

(III) natural gas transport and storage: SPP and Transgas (E.ON/Ruhrgas and RWE) should:
(h) actively support the long-term development of the gas pipeline from Turkmenistan through Turkey to the Balkan region and its connection to the existing Slovak and Czech gas pipeline network, in the interest of greater gas supply competition and diversification

(i) further develop economically viable gas storage capacities on the territories of the two countries in order to increase security of gas (and indirectly also electricity) supplies both within the region and for neighboring countries

(j) oil transport: the Czech government should negotiate with the government of Bavaria to reverse the IKL pipeline and permit its use for export of Russian/Caspian crude oil to the Ingolstadt refinery (the Czechs sunk a great deal of money into this project and they are getting minimal return on it; the pipeline is rapidly deteriorating as it is sitting full of stagnant crude oil with a fairly high content of corrosive saline water, and its strategic value will be impaired significantly further if the Odessa-Brody pipeline is built and the Caspian crude oil starts flowing through the Druzhba pipeline).

Prague Principles for Energy Security

Prague, October 21, 2004

- World energy demand is growing at a rapid rate, and international cooperation to find economic, secure and sustainable energy sources is of vital importance for both industrial and developing nations. Energy demand will likely double within the next twenty years. All energy resources are important. Oil, coal, natural gas, nuclear power and renewable resources are required; but each poses a different set of challenges.

- The Czech Republic, EU, Japan, the United States and other nations can best achieve energy and security objectives through diversification of energy fuels and the sources of those fuels. Particular attention should be given to the rising dependency of EU countries on imports.

- Oil demand is rising rapidly, especially in China and other industrializing countries. Current challenges confronting the oil market are manageable, but

concerted efforts are required to expand world oil production and protect against the growing threat of terrorism. The importance of political and economic stability in key producer countries is noted and encouraged.

- Nuclear power is an important source of energy and could contribute further to alleviating energy security and environmental problems. New technology, especially recycling nuclear fuels, can help extend uranium reserves and provide solutions to long-term storage. Nuclear energy can only be successful within a framework of robust controls to enhance non-proliferation objectives. Concern is expressed over the nuclear weapons potential of North Korea and Iran. In this regard, the growing importance of the International Atomic Energy Agency is noted.

- Europe, especially Central and Eastern Europe, has abundant coal resources. Development of new technologies to burn coal more cleanly and to sequester CO_2 is essential to expand coal use which can be an indigenous resource of vital importance to diversification of the world's energy base.

- Natural gas is a clean fuel and is gaining increasing prominence, especially in Europe. Care must be given, however, not to become overly dependent on any one source of supply. Concern was especially expressed over growing reliance of Central and Eastern Europe on gas supplies from Russia. Diversification of sources is required to eliminate the possibility of undue political leverage being exercised.

- An unprecedented effort is required to ensure adequate transparency of investment in producer countries and the protection of infrastructure and transportation corridors. A key challenge is the need for energy capital acquisition, which requires long-term energy markets and deregulation of the markets.

- Leadership at the highest level of government is required to ensure that energy security is achieved at reasonable economic cost. A high priority is that emerging energy strategies be sustainable and compatible with environmental and global security objectives. Energy conservation and efficiency shall be an integral component of these strategies. International cooperation on this matter is of highest importance.

Alexandr Vondra, Conference Chairman and PASS Coordinator
William Martin, Fmr. U.S. Deputy Secretary of Energy

Executive Summary

The Conference was commenced by Pavel Bém. Following the introductory remarks of Oldřich Černý, Martin Jahn greeted Conference participants by providing a vivid account of geopolitical and energy security concerns of the Czech Republic.

Opening Remarks ➡ Alexandr Vondra

In his opening remarks, Alexandr Vondra highlighted three issues the Conference might focus on in its deliberations. He first underscored the question of affordability of energy from political, economic and environmental points of view: taking into account instability in some energy exporting states, the effect of high energy prices on economic growth, and the increasing environmental pollution

due to rising energy demand; all of which has placed us in a dilemma of choosing between boosting supply or controlling demand to meet our ever increasing energy needs. As a second theme, he listed the integration and consolidation of the EU's energy market and the challenge this process poses to national energy producers and suppliers in Central and Eastern Europe, many of which have ambitions to become regional players in the market, including ČEZ-the dominant Czech electricity company. Finally, he emphasized the question of security of energy supply, especially in the context of the possible political and economic leverages key energy suppliers like Russia and some Middle East countries might have over their customers, identifying diversification of energy supply and transparency in oil revenues as the main issues in this regard.

Panel A

Producers' Perspectives
Chair ▪ Heinz Rothermund

Heinz Rothermund opened the Panel's discussions with a series of fundamental questions. Referring to the example of South Korea, which in 30 years increased its oil consumption from two barrels per year per person to 17, he expressed concern about China following the same pattern of consumption in the future. He stressed that China had already doubled its oil consumption in ten years and has become the second largest consumer of oil following the United States - totaling nine percent of the world oil demand. With this as a backdrop, he raised two questions of whether the world would be able to achieve a soft landing in such circumstances, and whether energy market liberalization would create investment incentives for the long-term energy projects that are required to meet the challenges of ever increasing energy demands.

In addressing some of these challenges, Hisham Khatib underscored that fossil fuels-oil, natural gas and coal-were the only source of energy which were sufficiently abundant to sustain the world economy growth for decades to come, adding that renewables had an uncertain future since there were disbursed, intermittent, inefficient, and not tradable. In this regard, he suggested nuclear power as an alternative to fossil fuels. He further pointed out that the 37 percent share of oil in total world energy consumption would remain the same in the year 2030, and that OPEC would supply more that half of the world's oil production at that

time. Regarding the question of the environmental sustainability of energy use, he emphasized that there would be no substantial improvement in the foreseeable future because of the inertia in the energy sectors of most developing countries not party to the Kyoto Protocol, which produce the bulk of greenhouse gases emissions.

William Martin expressed optimism about meeting many energy challenges, providing four specific examples. He first referred to the United States, which would seek to expand development of their oil and natural gas resources; increasing the use of nuclear power; advancing new technologies, including hydrogen; and defending its energy interests by all means, including military ones, in what he defined as the core of the US energy policy: 'import and defend'. Regarding the second example – Europe, he underscored the need for diversification of natural gas supplies, saying that the 50 percent dependency on Russia for natural gas supplies should be reduced by providing more opportunities for other natural gas producing counties like Norway. Listing the Atoms for Peace concept as the third example, he pointed out that meeting the requirements of the Kyoto Protocol was hardly possible without nuclear power, noting that the reprocessing of nuclear waste might provide a solution for the long-term use of nuclear energy. For part of the fourth example, he refereed to North Korea, underscoring that if energy was really the issue at stake for continuing its nuclear program, then the country's waste coal resources and abundant natural gas reserves in Sakhalin Island could be exploited and piped through the Korean Peninsula and well beyond. He states that such a solution could provide for political stability of the entire Peninsula and encourage regional economic integration through energy systems as well as securing an important regional energy source for Asia, especially China.

Examining underlining reasons for the current high prices of oil, Robert Skinner noted that the world demand for oil would increase by about 2.7 million b/d this year according to the IEA latest estimate, an increment not seen for nearly three decades. He pointed out that the increase in oil demand reflected the five percent jump in the world's GDP, the greatest growth for the last 20 years, pulled especially by China and the United States. With oil demand rising, the world encountered problems with supply caused by a number of factors, he provided: the continued disappointment with Iraq's oil exports, unrest in Venezuela, and Nigeria's reducing their oil outputs, declines in the oil production in the North Sea, the United States, Oman, and Indonesia; all of which resulted in a rapid and serious erosion of spare capacity and market's perception of what capacity remained, pushing oil prices up. Against this background, he rejected claims that 'OPEC sets the price', that 'it's the entire fault of the speculators',

and that 'the oil price does not reflect the fundamentals', as complete nonsense. Regarding the issue of Europe's dependency on Russia for natural gas imports, he said that it was in mutual interest to keep natural gas flowing, encouraging Europeans to continue importing natural gas from Russia. In this context, he rejected \ arguments that there was something like an 'oil weapon', that 'energy independence is the key to energy security', and that 'government intervention can assure security of supply', pointing out that our preoccupation with energy supply was misplaced and too focused on the political rather than the real technical and strategic aspects.

Discussion

Responding to a question from the audience of whether the United States had a global energy policy, as their energy behavior might affect the rest of the world, William Martin said that the US energy policy was domestically oriented, but included many international elements such as a project on clean coal technology. He then considered the issue of high energy consumption in the United States, underscoring the importance of having such a pricing system that would account for all externalities of energy use, whether they would be environmental damage or the military costs of protecting the Middle East, to be truly reflective in the price of oil or natural gas. In this regard, Robert Skinner suggested imposing an environmental tax on gasoline as a solution, but William Martin opposed that as not politically feasible. One participant raised a question about the prospect of energy consumption in 2030, noting the unevenness of energy consumption when 30 percent of the world's population, predominantly from developed countries, consumed 90 percent of world energy. In addressing that question, Hisham Khatib stated that there was a rapid growth of energy consumption in the developing countries amounting to almost a five percent increase every year, while the energy consumption in the developed world rose only about one percent a year. As a result, the share of energy consumption would be almost equal at that time, he said. Robert Skinner, addressing a question of whether it was time to follow the US policy of building strategic petroleum reserves (SPR) and to use them during a temporary shortage of petrol to stabilize the market, said that it would be very dangerous to allow politicians to fiddle with the market on the price side using SPRs, as the value of SPRs would certainly decrease. In his opinion, SPRs should be left for a strategic disruption of gasoline supply and not as an instrument of stabilizing the market in a temporary gasoline shortage.

Panel B

Consumers' Perspectives
Chair ▪ Magdaléna Vášáryová

Going back to the question of high oil prices, Giulia Bisconti underscored that the period of relatively high prices would continue for the next year. Given the rapid global economic growth, with spare capacity near the lowest point in the last 30 years and historically low inventories of both crude oil and oil products, she underscored that any supply disruption could push prices even higher. She went on to describe key elements of the US energy action plan for the next two decades, providing for the short term strategy with the objective to maximize US strategic reserves up to 700 million barrels; the midterm strategy determined by improving energy efficiency of power production and transportation infrastructure, diversifying energy sources and supply by expanding nuclear power, developing more domestic resources, using renewables, and integrating the North American supply system with Canada and Mexico; and the medium/long term strategy based on the reduction of greenhouse gas emissions through technological solutions, encompassing the employment of carbon sequestration, nuclear fusion, hydrogen as an energy carrier, and renewables. Describing also the US international energy strategy, she emphasized the need for cooperation with other countries facing similar energy challenges on large-scale projects such as carbon sequestration or the hydrogen economy, and the necessity of preventing supply disruption by integrating and improving the connectivity of regional energy systems.

Against the background of growing global energy demand and rising oil prices, Hiroshi Morimoto described the evolution of Japanese energy policy after the oil shocks in the 1970s. He provided for two major strategies pursued by the Japanese Government for the last 30 years: employing energy-saving technologies to improve energy efficiency and introducing alternative sources of energy to reduce dependency on oil. As a result of vigorous promotion of those goals, Japan became one of the world's most energy-efficient countries and their dependency on oil has decreased about 27 percent. Considering the need for reducing Japan's dependency on oil even further while also mitigating global warming, he pledged for the continuing expansion of nuclear power and renewables, especially solar and wind power. As an additional countermeasure against global warning, he emphasized the importance of developing clean coal technology.

Patrick Hardouin, speaking about NATO's role in energy and security, said that energy security posed a serious challenge for NATO and its members, especially with regard to stability of energy supply and protection of energy related infrastructure against terrorist attacks. He emphasized, however, that NATO, as collective defense organization, had no institutionalized energy security policy per se, except for the framework of economic cooperation, within which collaboration could take place in the form of information sharing, expression of concerns, and discussion on energy security relevant matters.

Adopting a consumers' perspective on energy security, John Mitchell suggested that consumers were looking for very difficult objectives to coincide: they wanted reliable supplies at reasonable prices, which would not threaten the political independence of their countries, and they wanted to know that the supply of energy was acceptable from environmental, social, and ethical points of view. However, this could be sometimes contradictory, he said. There was always a trade-off, he emphasized, as someone had to trade off reliability against price, for instance. Describing the geography of energy resources and energy demand, he underscored that trade was inevitable and that the notion of energy dependence meaning import dependence was wrong. Trade was beneficial, and when consumers wanted reliable and cheap supplies, then trade delivered lowest cost solutions to the world's energy problems, he said, adding that import dependency was just part of life. Looking ahead at the expansion of energy supply, he pointed out that huge investments would be required in developing countries to provide for energy exports, but that there were only a few large private companies, mostly from Europe and North America, which could actually make such an investment. He noted that these companies were, however, under growing political, national, social, and ethical pressures by the OECD, the World Bank, human rights groups, and others, who either formed regulations about how foreign investments should be treated, or appealed to the consciousness of the consumers by stressing human rights and the social impact that energy investments projects bore on exports. Given the energy trends, he encouraged review of the acceptability from the ethical and social points of view of these missionary attempts to change the rest of the world.

Discussion

During the subsequent discussion one participant raised the question of whether the protection of key energy infrastructure could become a new NATO agenda. Patrick Hardouin pointed out that there was a need for protecting specific

energy installations, but it was the primarily responsibility of governments to provide such protection rather than that of a collective defense organization like NATO. Responding to another question concerning possible mechanisms the US Department of Energy (DOE) might have developed to prevent energy supply disruption brought about by a terrorist attack, Giulia Bisconti said that the DOE collaborated very closely with all sectors of the US industry, especially in the area of intelligence sharing between the DOE and concerned companies.

Welcoming Remarks ▪ Václav Havel

In his welcoming remarks, Václav Havel warned of the dictatorship of energy, a situation under which now ever centralizing energy corporations would fall altogether in the hands of one person, who could then efficiently manipulate everything behind the scene. He proposed the mobilization of human energy and responsibility as a solution thereof.

Keynote Speech:
The World Energy Outlook and Challenges of Europe ▪ Fatih Birol

Fatih Birol presented the IEA world energy outlook for the year 2030, projecting the expansion of world energy demand about 60 percent in 25 years with 1.6 billion people still without access to electricity. He argued that oil would remain the single most important energy source in the world energy mix of the year 2030, natural gas the second, and coal the third, leaving behind renewables, nuclear, and hydro power. In this respect, he noted that 99 percent of countries in the world would be dependent on a small number of states for oil and natural gas supplies, namely Saudi Arabia, Iran, Iraq, Kuwait, UAE, and Russia; referring to security of energy supply as a major challenge in the years to come. Regarding the projected increase of the world energy demand, he underscored the need for securing supply routes, and the necessity for investment in energy supply infrastructure, claiming that the global energy system would require investments worth $16 trillion worldwide. He further underscored that about 85 percent of energy production would come from non-OECD countries, and that CO_2 emissions would increase about 60 percent due to the declining share of nuclear power in the world energy mix. Given the projected trends, he called

for increasing the efficiency of energy use in both OECD and in developing countries and pledged for the employment of advanced nuclear and coal sequestration technologies.

Panel C

Energy Security: Assessment of Threats
Chair ■ Kevin Rosner

Providing for the threat assessment of key energy installations, Robert Eagan talked about risks associated with operating a nuclear reactor and electrical distribution network in terms of risk equation, which he defined as a consequence of failure in terms of threat and vulnerability of the system. Applying risk assessment methodology (RAM) on nuclear installations for the case of a terrorist attack resulting in deaths of people around the reactor, he said that nuclear reactors were very safe and the risk number was very low, indeed. However, he indicated that in the case of an electrical distribution network which was well spread out and where the safeguards were relatively modest in comparison to nuclear reactors, there was much higher risk of disruption and much higher risk of causing grave economic damage,. From an economic point of view, he pointed out that the electrical distribution network was remarkably vulnerable against a terrorist attack; as such an attack could effectively disable the electrical power grid for a long period of time with serious consequences on the population's well-being.

David Waller then presented a vivid description of the IAEA work related to the security of nuclear material, including the question of safeguards and measures against nuclear terrorism. Referring to the unprecedented pressure under which the non-proliferation regime was placed by the revelation of secret nuclear programs in Iraq, Libya, and North Korea; he said that the major challenge the IAEA was facing was to find combinations of necessary political and economic incentives to promise real non-proliferation benefits that facilitate the spread of nuclear power to those who wanted it. He stressed that nuclear power was essential for energy security and that it was the primary objective of the IAEA to keep the nuclear power option open and to assure its availability for countries that might wish to take advantage of it. He also underlined the contribution of nuclear power to environmental protection in avoiding greenhouse gas emissions, which are roughly equivalent to those produced by wind and solar power and well bellow the level produced by the fossil fuels.

Addressing the protection of key energy infrastructure, Anne Korin warned about new generation of oil shocks brought about by attacks on oil infrastructure and means of transportation by non-state actors, especially terrorists from Al-Qaeda. Enumerating a number of past terrorist attacks on tankers in the Middle East and pipelines in Iraq, Russia, and Columbia, she warned about the spread of such attacks to Saudi Arabia, which would have severe consequences on the security of oil supply, as Saudi Arabia is essentially the only country with sufficient spare capacity. As a solution to cope with such a situation, she proposed to decrease swiftly our dependency on oil for transportation by using electricity, generated from sources other than oil to power vehicles and preferring flexible fuel vehicles that could run on the combination of gasoline and alcohol fuel produced from coal and biomass.

In considering the question of terrorism vis-à-vis the protection of key energy installations, Richard Perle said that we could not be successful in deterring the threat of a terrorist attack against energy infrastructure, as such a threat could not be properly identified, there was no territory to protect which could be threatened by retaliation, and we could not discourage action by threatening death to people who desired to die as martyrs. Instead of protecting individual vulnerable installations, which was, in effect, an impossible task, he suggested that we should rather concentrate our efforts on defeating terrorism as a movement, especially by fighting against governments supporting terrorism to deprive terrorists of the sanctuary they need to operate. Addressing also the issue of the US contribution to energy and security, he emphasized that the role the United States played in carrying the burden of backing any international regime by providing the bulk of force and energy was absolutely essential and should not be diminished. In this regard, he considered scandalous that the United States alone maintained half of the world's petroleum reserves and all sea lines of communication, calling for sharing the burden the United States bore more evenly.

Discussion

Responding to a question about how to strengthen the non-proliferation regime vis-à-vis Israel, not party to the Non-proliferation Treaty (NPT), David Waller proposed two possible ways: one through the creation of a nuclear free zone in the Middle East, another through the realignment whereby Israel, India and Pakistan (also not parties to the NPT) would declare themselves as nuclear weapon states and accede to the NPT. With regard to the creation of the nuclear free

Middle East, Richard Perle said that it would be unrealistic to expect that Israel would give up its nuclear weapons, and that lending legitimacy to such a concept would only become an excuse for Israel's adversaries to justify their efforts to acquire their nuclear weapons. In that sense, he insisted that it would make the situations worse rather than better, making clear that regarding nuclear weapons, it made an enormous difference who possessed them and why. Regarding the question of securing sea lines of communication, Anne Korin noted that the United States offered to provide assistance in patrolling waters around the straits of Malacca to prevent piracy but the assistance was rejected as an infringement of sovereignty by Malaysia and Indonesia, for that the US presence would be the flashpoint for terrorists there. She also pointed out that one of the implications of the growing dependency of China on the Middle East for oil imports could be the fostering of political, economic, and military ties between China and Middle East countries, adding that one day the United States and China might clash in the Middle East, competing over the same pool of resources. In this regard, one participant noted that China might also consider building a blue water navy to maintain sea lines of communication. Kevin Rosner then addressed the question of the growing monopolization of Russian natural gas exports from Central Asia, explaining that Russia imported cheap natural gas from Turkmenistan and re-exported it with a 300 percent charge to Europe, saying that Russia was also buying upstream capacities along its borders from the Baltic States to Romania which had an effect on downstream capacities and supply markets in terms of supply direction and price control. Referring then to the issue of protecting key energy installations after Anne Korin had stated that NATO had certainly a role to play in this regard; he raised the question about how to be more efficient in preventing terrorist actions in general. Anne Korin said that it was crucial to deprive terrorists of the money they need to survive, and one way to do it would be to reduce our oil consumption, in order to decrease revenues some of the oil rich countries used to support them. One participant responded that money was not an issue, as terrorism was a cheap business, although he admitted that it was important to follow the money to reveal terrorist networks. Richard Perle noted that to get a handle on the money was important, as the governmental money had fuelled an extremist outlook in a number of places, including madrassas in Pakistan, underscoring that the level of support that came from some governments was unacceptable. He reiterated that we had to focus on governments that offered sanctuary for terrorists. If governments could not prevent their territories from being used by terrorists, we should cooperate with allies to replace those governments, he said. Another participant then emphasized that the war

on terrorism could not be won only by military means and that we had to try to win the hearts and souls of the people in the Islamic world and to distinguish between extremist and moderate Muslims. Richard Perle responded by underscoring that there was a lot we could do with open minds but very little with people with whom there could be no dialogue. He said that we had to encourage the battle within the Muslim world between the people who represented decent and humane values and the relatively small, but unfortunately influential, number of fanatics for whom the establishment of a different kind of order was an imperative. He concluded by saying that the most troubling part of the terrorist threat allied with people not open to any dialogue.

Panel D

Integration and Consolidation: Resources and Infrastructure
Chair ➡ Judy Dempsey

In her opening remarks, Judy Dempsey referred to an increasing share of gas imports from Russia to the EU and claimed that the European Commission had done little to promote open energy markets and diversification of energy supply, especially in Eastern Europe. She stressed that there was still no energy charter between the European Commission and Russian, a circumstance that had an adverse effect on energy markets and investment confidence in Russian. Underlining the fact that 30 percent of Gazprom's natural gas production exported to Europe brought 70 percent of Gazprom's revenues, she argued that the European Commission had failed to be consistent.

Enumerating the unique features of electricity-instantaneousness, low elasticity, and the need for balance between production and consumption, Nobuya Minami outlined the basic requirements for generation and transmission systems to secure reliability of energy supply. He said that electricity did not necessarily follow traditional market beliefs such as that higher prices in the spot market during a tight supply-demand situation would prompt necessary investments. Due to the specific characteristics of electricity, he argued, an imbalance between supply and demand could lead to extensive blackouts in a short period of time and, therefore well-balanced investments in generation and transmission facilities were required to secure reliability of electricity supply in the mid-term. Concerning liberation of electricity markets, he claimed that the separation of generation

facilities and transmission networks prevented a stable electricity supply in both the short and long terms, underscoring the need for a system composed of responsible vertically-integrated utilities that were directly connected to consumers. In this regard, he noted the Japanese Government's commitment to maintain the scheme of responsible suppliers in vertical integration beyond the liberalization of the Japanese energy market. Finally, he underlined the need for nuclear energy to ensure a stable electricity supply in an environmentally compatible manner and called for creating such a system that would encourage the expansion of nuclear energy in liberalized markets.

Vladimír Schmalz then described the structure of ČEZ and portrayed ČEZ's transformation vision, encompassing the integration of ČEZ's distribution companies and subsequent division of ČEZ into power generation and power distribution utilities. Beyond the consolidation, he said, ČEZ sought to play an important role in the both regional and European markets, referring to the recent acquisition of power distribution companies in Bulgaria and ČEZ's participation in various power generation and distribution related tenders in Slovakia, Poland, and Romania.

Referring to an estimate of the European Commission that EU dependence on external energy sources would increase to 70 percent in the year 2030, Ivan Pilip warned about the EU's decreasing self-sufficiency in energy supply. He stressed the importance of diversification of energy supply within the EU to reduce overdependence on external energy sources. In doing so, he underscored the need for substantial investments in new supply routes. He noted that the European Investment Bank (EIB) was active both inside and outside the EU in the Balkans, the Mediterranean, Ukraine, Belarus; and financed a number of energy infrastructure projects from 1993 to 2000, including the gas pipelines between Norway and the European Union, and Tunisia, Algeria, and Italy, providing for €2.5 billon to these and other related projects.

Discussion

In the following discussion, one participant voiced concerns about Russia's imposing limitations on foreign investment to its energy sector and Gazprom's using the liberalization of the EU energy market as a vehicle to further increase its share in the market. Given the close relations of the EU with most Middle East countries, reference was also made to the possibility of decreasing the EU's dependency on Russia for natural gas and oil imports by investing in the Middle East energy

sector, especially in Libya, Saudi Arabia, and Iran. Ivan Pilip underscored that the EIB was involved in a number of energy related projects in the Mediterranean, especially in Algeria and Tunisia, referring to Libya as a possible partner in the future.

Keynote Speech:
Energy Security: Global Challenges - Regional Perspectives ➡ Jerzy Buzek

Jerzy Buzek outlined three pillars of the EU energy future all of which were aimed to reduce the EU dependency on imported sources of energy in an environmentally sustainable way: first, building strategic reserves of key energy sources; secondly, providing for environmental protection, in particular through the reduction of CO_2 emissions by increasing efficiency of both energy production and consumption and encouraging new technologies, especially clean coal technology; and finally, promoting research in renewables, nuclear energy, and in the reduction of CO_2 emissions. Concerning the diversification of energy sources, he pointed out that the EU should prefer coal to oil and natural gas and take advantage of waste coal resources in the new EU member countries, and, in doing so, it should realize its tremendous research potential and develop a clean coal technology that would allow exploiting fully these resources. In this regard, he called on Central European countries, especially the Visegrad Group, to develop a common energy policy based on the promotion of coal as a fuel and research in clean coal technology.

Panel E

Environment and Sustainable Development
Chair ➡ Karel Schwarzenberg

Addressing the question of environmental sustainability of the energy use, Jacques Bouchard stated that due to the population growth and increasing energy demand in developing countries the world energy consumption would double in the next 50 years and greenhouse gas emissions would rise accordingly. He emphasized that the expansion of nuclear energy offered a solution to produce more energy with zero CO_2 emissions, while keeping energy production costs

at an acceptable level for consumers. Taking into account the increasing safety and steadily decreasing cost of nuclear energy production, he further said that nuclear power might be a promising energy source for the production of hydrogen as a main fuel for transport. With regard to current high costs of building nuclear power generating assets, he highlighted the importance of designing the next generation of nuclear power plants with lower construction and production costs that would become competitive in liberalized markets. Addressing environmental and public concerns about nuclear waste, he also explained benefits of spent fuel management, saying that the reprocessing of nuclear waste could eliminate proliferation risks and decrease uranium consumption as well as the quantity of the final waste and its lifetime. In this regard, he underscored that the spent fuel management amounted only to less than six percent of the total electricity production costs.

Subsequently, Kunihide Kobayashi provided background for the extensive use of nuclear energy in Japan, listing the scarcity of domestic energy resources, the reduction of greenhouse gas emissions, and the abundance of uranium, as the main reasons. In suggesting solutions to meet Japan's increasing energy needs, he stressed the importance of the reprocessing of nuclear waste to enhance security of energy supply by re-using uranium and plutonium recovered from spent fuel, noting that the construction of a Japanese reprocessing plant and mixed-oxide (MOX) fuel fabrication plant was planned. In this context, he underscored the necessity to gain public support for further expansion of nuclear power, to develop high-level human resources in the nuclear industry, to promote nuclear power in liberalized markets, and to improve nuclear power related information sharing world-wide.

From an environmental perspective, Bedřich Moldan pointed out that three things have to be taken into account in sustainable energy policy: efficiency of energy use, renewable energy resources, and the appropriate timing of employing and using these resources. As a major problem in current energy policies, he identified the excessive use of fossil fuels producing greenhouse gas emissions. In this regard, he argued that solar power and hydrogen as an energy carrier were the most promising energy sources in the long run. He said that technology in general offered a number of environmentally sustainable solutions, listing technological maturity, information sharing, and functional regulatory and economic frameworks as perquisites for their effective use. He called for internationalization of negative externalities of both energy production and consumption and stressed that tradable permits should be used as market based instruments. He also pledged for the removal of environmentally harmful subsidies.

Alvin Trivelpiece then called for a more efficient use of energy by not supporting energy projects that do not adhere to the simple rule of making net energy infinity. He underscored that before using any energy source, we should always count the amount of energy (KW/h of electricity) we produced with that source and weight it against the amount of energy (all joules of energy) that had been used to make this source a working reality and, in doing so, to find out whether that source was economically justified. He also highlighted the role nuclear power could play in making hydrogen, fertilizers, or possibly water in a more efficient way than producing them separately.

Panel F

Producers, Consumers, Transit Countries and Geopolitics
Chair ▬ Michael Žantovský

Susan Eisenhower drew the participants' attention to the importance of nuclear power for world's economic well-being and security. She underscored that the world's future energy demands could not be met without the use of nuclear power. She regretted that nuclear energy would lose its share in global energy mix in the years of come, despite enormous technological strides to improve that technology. In this regard, she called for institutional reform by continuing work in banning fissile material and securing nuclear materials related to nuclear weapons and nuclear power plants, long-term disposal of nuclear waste, international standards for power plants and cross-national licensing. She also stressed the need for international partnerships, especially in developing new technologies in areas such as proliferation resistance, the nuclear fuel cycle and waste management. Finally, she emphasized the necessity of political will and international leadership in securing continuous support for nuclear power, saying that nuclear energy was an essential perquisite for security. She pointed out that nuclear power was critical for meeting our nuclear disarmament objectives, as without nuclear power neither could we recycle nuclear warhead material to nuclear fuel, nor could nuclear weapon scientists be converted to nuclear energy researchers.

Given the rising demand for oil in China and India, Joseph Gilben provided a comprehensive assessment of the role the Israeli pipeline could play in the transportation of crude oil from the Mediterranean to Asia. He said that there would

be 4 million b/d of Russian and Caspian oil reaching the Mediterranean from the Black Sea after the completion of the Baku-Tbilisi-Ceyhan (BTC) pipeline in 2010, but only three ways to deliver them to Asia: around the Cape of Good Hope in South Africa, through the Suez Canal and through the Israeli pipeline from Ashqelon in the Mediterranean to Elat in the gulf of Aqaba. Comparing these three options, he argued that the Israeli pipeline was more economical than the remaining two because of high transportation costs and draft limitations respectively.

Petr Nečas argued that Europe's reliance on Russian natural gas and Russia's need for European investments in the energy sector would inevitably foster mutual economic and political ties. Noting concerns about political leverage stemming from undue dependence on Russia for natural gas and oil imports, he pushed for the diversification of supply in Central and East European countries. He further referred to Central Asia and the Caucasus as regions of enormous energy potential but lacking in political stability, underlining the strategic role Turkey might play in this regard, he proposed this as a reason to have Turkey as a member of the EU.

Jan Nehoda concluded the Panel by providing a comprehensive assessment of the natural gas industry in the Czech Republic, underscoring low pollution emissions, reliability of supply, and competitive price among the greatest benefits of the use of natural gas. He also described the evolution of the European transmission network, noting that it would be difficult to liberalize the natural gas market inside the EU because the sources of natural gas were located outside it, especially in Russia and Norway. Regarding further supply diversification, he said that liquid natural gas (LNG) imported at competitive prices from other gas producing countries might become an important additional source of energy in the EU. For the part of the security of supply, he claimed that the EU did not have to worry about dependency on imported natural gas, provided it had reliable partners, stressing the importance of long-term contracts of natural gas supply. In this regard, he also encouraged building strategic reserves of natural gas in the EU.

Discussion

Addressing the question of stability in the Middle East, one participant noted that the Middle East was politically stable and the region had been a reliable supplier of oil for more than thirty years, so there was no reason for concern. As

a response to inquiry about cooperation in natural gas in the Middle East, Joseph Gilben then described the recent involvement of Israel in the natural gas industry, saying that small natural gas reserves had been found in Gaza and off coast of Ashqelon and that there was an agreement in principle between Egypt and Israel according to which Egypt would provide for transport of natural gas to Israel by pipeline for 20 years. Responding to a question about how to strengthen the role of the IAEA when there were widespread public doubts about the effectiveness of international organizations, especially in the United States, Susan Eisenhower underlined the need for providing resources and reviewing charters of the IAEA as well as other international organizations in order to increase their efficiency and effectiveness needed to carry out their mandates. She also addressed the issue of nuclear safety against the backdrop of recent accidents in nuclear facilities in Japan and the United States, stressing the importance to develop the next generation of nuclear power plants, which are safer, more reliable and proliferation resistant, as well as cheaper to build and run; noting that the cost of doing it were actually equal to the cost of sustaining the US troops in Iraq for one week. Referring to the increasing state control over Gazprom and Transneft, one participant raised the question whether we should start worrying about the reliability of the natural gas supply in the Czech Republic. As a response, Petr Nečas voiced concerns about energy supply being used as political leverage by Russia, outlining, therefore, three pillars on which Czech energy policy should be based: diversification of energy sources, free European energy market, and the reduction of dependence on imported fossil fuels, all of which should allow utilizing domestic energy sources up to 65 percent. Jan Nehoda said that the Czech Republic might consider acquiring additional-the third-source of natural gas to sustain a possible supply disruption as a result of state intervention in the natural gas supply.

Closing Remarks — Jan Ruml

In his closing remarks, Jan Ruml underscored the significance of the Conference by bringing together professionals from public, private, and non-profit sectors to address the questions of affordability, accessibility, and sustainability of energy and its use. He said that the Conference had raised public awareness about the energy-security nexus and challenged our views on the importance of energy for our security.

Conference Program

TUESDAY — OCTOBER 19

The Residence of the Lord Mayor of the City of Prague,
Mariánské nám. 1, Prague 1

19:30 **Opening Reception**

Welcome Remarks:
Oldřich Černý, Director, Prague Security Studies Institute
Pavel Bém, Lord Mayor of the City of Prague

Opening Remarks:
"Geopolitical and Security Energy Concerns
– Czech Perspective"
Martin Jahn, Deputy Prime Minister of the Czech Republic
for Economics

WEDNESDAY — OCTOBER 20

The Senate of the Czech Republic, Wallenstein Palace,
Valdštejnské nám. 4, Prague 1

19:00 **Welcome:**
Alexandr Vondra, PASS Coordinator

Panel A: "Producers' Perspectives"
Security of supply and investment climates: Russia, Middle East, Central Asia. Relations between producers and producing countries – privatization, subsidies, public support. Development of international energy markets – new resources, investments, production and technologies.

Chair:
Heinz Rothermund, Fmr. Managing Director of Shell Exploration & Production International

Panelists:
Hisham Khatib, Honorary Vice Chairman, World Energy Council
William Martin, Fmr. U.S. Deputy Secretary of Energy
Robert Skinner, Director, Oxford Institute for Energy Studies

10:30 **Coffee Break**

11:00 **Panel B: "Consumers' Perspectives"**
Is the West going to experience a new oil shock? Oil, gas, coal, or what? What is the relation between the price of energy and economic growth? Diversification and liberalization of the EU energy market: what are the real benefits for consumers?

Chair:
Magdaléna Vášáryová, Slovak Ambassador to Poland

Panelists:
Giulia Bisconti, Senior Policy Advisor to the U.S. Under Secretary for Energy

Hiroshi Morimoto, Executive Vice-President,
The Kansai Electric Power Co., Inc
Patrick Hardouin, Dep. Assistant Secretary General
for Regional, Economic & Security Affairs, NATO
John Mitchell, Associate Fellow, Chatham House,
The Royal Institute of International Affairs

12:30 **LUNCHEON IN THE SENATE DINING HALL**

REMARKS:
Václav Havel, Fmr. President of the Czech Republic

INTRODUCTION:
William Martin, Fmr. U.S. Deputy Secretary of Energy

KEYNOTE SPEECH:
"The World Energy Outlook and Challenges of Europe"
Fatih Birol, Chief Economist and Head, Economic Analysis Division, International Energy Agency

14:15 **PANEL C: "ENERGY SECURITY: ASSESSMENT OF THREATS"**
Nuclear energy – challenge or menace? Security of resources, transit routes and distribution networks. How to avoid black-outs and possible terrorist attacks? Sustainability through demand management or through boosting supply.

CHAIR:
Kevin Rosner, Security Advisor, BTC Pipeline Company

PANELISTS:
Robert Eagan, Vice-President, Emeritus,
Sandia National Laboratories
Anne Korin, Editor, Energy Security,
Institute for the Analysis of Global Security
Richard Perle, Resident Fellow, American Enterprise Institute
David Waller, Deputy Director General,
International Atomic Energy Agency

16:15 **Coffee Break**

16:45 **Panel D: "Integration and Consolidation: Resources & Infrastructure"**

Gradual consolidation and integration of energy markets: growing competition or cartel behavior? EU regulations and national energy policies. Investment in and financing of the infrastructure – national grids and pipelines. Who will finance new exploitation and energy research projects?

Chair:
Judy Dempsey, Senior Correspondent, Europe, International Herald Tribune

Panelists:
Nobuya Minami, Fmr. President, Tokyo Electric Power Company
Ivan Pilip, Vice-President, European Investment Bank
Vladimír Schmalz, Director for Mergers and Acquisitions, ČEZ, a.s.

18:15 **Adjourn**

19:30 **Gala Dinner at the Kampa Museum**

Kampa Museum, The Jan and Meda Mládek Foundation, U Sovových mlýnů 2, Prague 1

Introduction:
Alexandr Vondra, PASS Coordinator

Keynote Speech:
"The Energy Challenge: Working in partnership..."
Paula Dobriansky, Under Secretary of State for Global Affairs, U.S. Department of State

THURSDAY, OCTOBER 21

The Senate of the Czech Republic, Wallenstein Palace,
Valdštejnské nám. 4, Prague 1

9:00 **KEYNOTE SPEECH:**
Jerzy Buzek, MEP, Fmr. Prime Minister of Poland

9:30 **PANEL E: "ENVIRONMENT AND SUSTAINABLE DEVELOPMENT"**

Kyoto: international commitments versus national interests. International emissions trading: fiction or real business? Subsidizing of renewable resources or market choice? Green taxation: are the customers willing to pay for green energy? What are the real costs of nuclear energy?

CHAIR:
Karel Schwarzenberg, Fmr. Chancellor of the President of the Czech Republic

PANELISTS:
Jacques Bouchard, Director, Nuclear Energy Division, Atomic Energy Commission
Kunihide Kobayashi, Managing Director, Tohoku Electric Power Co., Inc.
Bedřich Moldan, Director, Environment Center, Charles University
Alvin Trivelpiece, Emeritus Director of Oak Ridge National Laboratory

10:30 **COFFEE BREAK**

11:00 **PANEL F: "PRODUCERS, CONSUMERS, TRANSIT COUNTRIES & GEOPOLITICS"**

Diversification: a competitive or common interest? Challenges of trans-border supply: investment in transit infrastructure and its security. Long-term or short-term contracts? How is the energy security of Europe, Asia and the US related to Russia and the Middle East?

Chair:
Michael Žantovský, Czech Ambassador to Israel

Panelists:
Susan Eisenhower, Chairman of the Board of Directors, The Eisenhower Institute
Joseph Gilben, International Energy Consultant & Director of Bellbank Ltd.
Petr Nečas, MP, Vice-Chairman, Committee for European Affairs, Czech Parliament
Jan Nehoda, Member of the Board and COO, Transgas, a.s.

12:30 Closing Luncheon in the Senate Dining Hall

Luncheon Remarks:
Jan Ruml, Vice-President of the Senate of the Czech Republic

Closing Remarks:
Alexandr Vondra, PASS Coordinator

Participants

Fawzi Al-Quraishi
Economic Analyst
Royal Embassy of Saudi Arabia
Prague

Regina Axelrod
Chair, Political Science
Adelphi University
Garden City, NY

Gawdat Bahgat
Director
Center of Middle Eastern Studies
Indiana, PA

Margarita M. Balmaceda
Associate
Davis Center for Russian and Eurasian Studies
Harvard University
Cambridge, MA

Pavel Bém
Lord Mayor of the City of Prague
Prague

Antonín Berdych
President
Association for International Affairs
Prague

Václav Binar
Managing Partner
PROS & CONS EUROPE, s.r.o.
Prague

Fatih Birol
Chief Economist, Head of the
Economic Analysis Division
International Energy Agency
Paris

Giulia R. Bisconti
Senior Policy Advisor to the U.S.
Under Secretary for Energy
U.S. Department of Energy
Washington, DC

Mariusz Bocian
Researcher
Centre for Eastern Studies
Warsaw

Jacques Bouchard
Director General
Nuclear Energy Division,
Atomic Energy Commission
Paris

Pavel Bratinka
CEO
Eurooffice Praha-Brusel a.s.
Prague

Jan Bubeník
Managing Partner
Bubenik Partners
Prague

Viliam Buchert
Senior Editor
MF Dnes Daily
Prague

Jerzy Buzek, MEP
Member of the
European Parliament
Fmr. Prime Minister of Poland
Warsaw

William J. Cabaniss
Ambassador of the United States
of America to the Czech Republic
Embassy of the United States
of America
Prague

Oldřich Černý
Director
Prague Security Studies Institute
Prague

Erika Csekes*
Attorney at Law
Csekes, Vilagi, Drgonec & Partners
Bratislava

Mazin Dabbagh
Crude Oil Marketing Manager
Saudi Petroleum Overseas Ltd.
London

Patrick Hardouin
Deputy Assistant Secretary General for Regional Economy & Security Affairs
NATO Headquarters
Brussels

Václav Havel***
Former President of the Czech Republic
Prague

Charles B. Heck
Fmr. Director for Norht America
The Trilateral Commission
Washington, DC

Kenneth M. Hillas
Deputy Chief of Mission
U.S. Embassy
Prague

Martin Jahn
Deputy Prime Minister of the Czech Republic for Economics
Prague

Josef Jařab
Member of the Senate of the Czech Republic,
Chairman, Senate Committee on Foreign Affairs, Defense and Security
Prague

Tomáš Kadlec
Director General
and Chairman of the Board
ČEPRO, a.s.
Prague

Hisham Khatib
Honorary Vice Chairman
World Energy Council
Amman

Kunihide Kobayashi
Managing Director
Tohoku Electric Power Co., Inc.
Sendia Miyagi

Anne Korin
Editor, Energy Security
Institute for the Analysis of Global Security
Washington, DC

Daniel Koštoval
Deputy Secretary
Embassy of the Czech Republic
Moscow

Andrzej Krawczyk
Ambassador Extraordinary and Plenipotentiary
Embassy of the Republic of Poland
Prague

Daniel Kaiser
Editor
BBC Czech Republic
Prague

Bedřich Moldan
Director
Charles University
Environment Center
Prague

Athur de Montalembert
Vice President,
International & Marketing
AREVA
Paris

Hiroshi Morimoto
Executive Vice President
The Kansai Electric Power Co., Inc.
Osaka

Petr Nečas, MP
Vice-Chairman
Committee for European Affairs
Chamber of the Deputies
of the Czech Parliament
Prague

Jan Nehoda
Member of the Board & COO
Transgas, a.s.
Prague

Tomas Němeček
Chief Columnist
Respekt Weekly
Prague

Maciej Nowakowski
Researcher
Centre for Eastern Studies
Warsaw

František Pazdera
Director General
Nuclear Research Institute Rez plc
Husinec-Řež

Richard Perle
Resident Fellow
American Enterprise Institute
Washington, DC

Ivan Pilip
Vice-President
European Investment Bank (EIB)
Luxembourg

Roger W. Robinson, Jr.*
Co-Founder
Prague Security Studies Institute
Prague

Kevin Rosner
Security Advisor
BPC Pipeline Company
Baku

Heinz Rothermund
Fmr. Managing Director of SHELL
EP International BV
Mannedorf

Jan Ruml
Vice President of the Senate
of the Czech Republic
The Senate of the Czech Republic
Prague

Jan Vacík
Appian Group a.s.
Chairman of the Board of Directors and CEO
Prague

Peter Valert
Partner
CMS Cameron McKenna
Prague

Petr Vančura
Executive Director
The Bell Association
Prague

Jan Vaňous
Managing Director
EuroEcon, a.s.
Prague

Magdaléna Vášáryová
Ambassador Extraordinary & Plenipotentiary
The Embassy of the Slovak Republic in Poland
Warsaw

Luboš Veselý
Chairman of the Research Center Council
Association for International Affairs
Prague

Alexandr Vondra
PASS Coordinator
Program of Atlantic Security Studies
Prague

David Waller
Deputy Director General
International Atomic Energy Agency
Vienna

Michael Žantovský
Czech Ambassador to Israel, Fmr.
PASS Coordinator
Embassy of the Czech Republic
Tel Aviv

Pavol Zatlkaj
First Secretary
Embassy of the Slovak Republic
Prague

Jan Žižka
Editor
Euro Weekly
Prague

*) PASS Advisory Board member
**) PSSI International Advisory Board member
***) PASS Advisory Board & PSSI International Advisory Board member

Acknowledgements

Gratitude is owed to the following people and institutions for their support of the conference:

Pavel Bém
Lord Mayor of the City of Prague

William J. Cabaniss
U.S. Ambassador to the Czech Republic

Josef Jařab
Chairman of the Senate Committee on Foreign Affairs, Defense and Security

Meda Mladek
President, The Museum Kampa – Jan and Meda Mladek Foundation

Jan Ruml
Vice-President of the Senate of the Czech Republic

General Partners:

RWE Transgas, a. s.
ČEZ, a. s.

Partners:

OMV Aktiengesellschaft
Central European Foundation (CEF)
Appian Group a. s.
Unipetrol, a. s.
MARSH, s. r. o.
U.S. Embassy in Prague
ČSA, a. s.
Mercedes-Benz
The Museum Kampa – Jan and Meda Mladek Foundation
Hotel Savoy in Prague
Hotel InterContinental Praha

Staff and Organizers

PASS
Antonín Berdych, Oldřich Černý, Jiří Schneider, Luboš Veselý, Alexandr Vondra (Coordinator), Michael Žantovský

PASS Executive Secretary
Jan Havránek

Press Secretary
Jan Marian

Logistics & Transportation Management
Vlastislav Vilímek

Arrivals Manager
Jan Černý

Drivers
Jaroslav Bican, Roman Brandejský, Luděk Kočvara, Michal Růžek, Stanislav Petera

Volunteers
Marek Dvořák, Jan Gallas, Tereza Grunwaldová, Radko Hokovský, Vilém Kolín, Jakub Kulhánek, Kateřina Křížová, Petr Lang, Romana Lantorová, Jan Lipavský, Iva Neumannová, Alice Savovová, Petra Strejčková, Jan Škoda, Dalibor Tomko, Pavel Zástěra, Veronika Zdeňková

Senate Staff
Lenka Ningerová

Lord Mayor's Office Liaison
Jana Vávrová

Special Thanks
Audrey Chriqui, Corbin Miller, Elsa Palanza, Peter Roady, Isamu Seto, Konosuke Sugiura


RWE
Transgas


ČEZ


OMV


STREDOEURÓPSKA NADÁCIA
CENTRAL EUROPEAN FOUNDATION


APPIAN GROUP


MARSH


Unipetrol


CSA
CZECH AIRLINES