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Arno A. Evers' The Hydrogen Society

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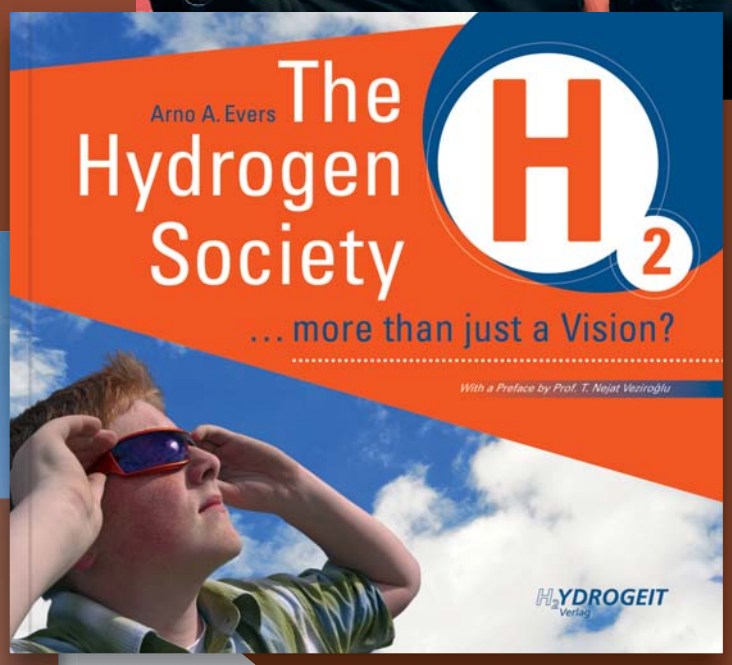

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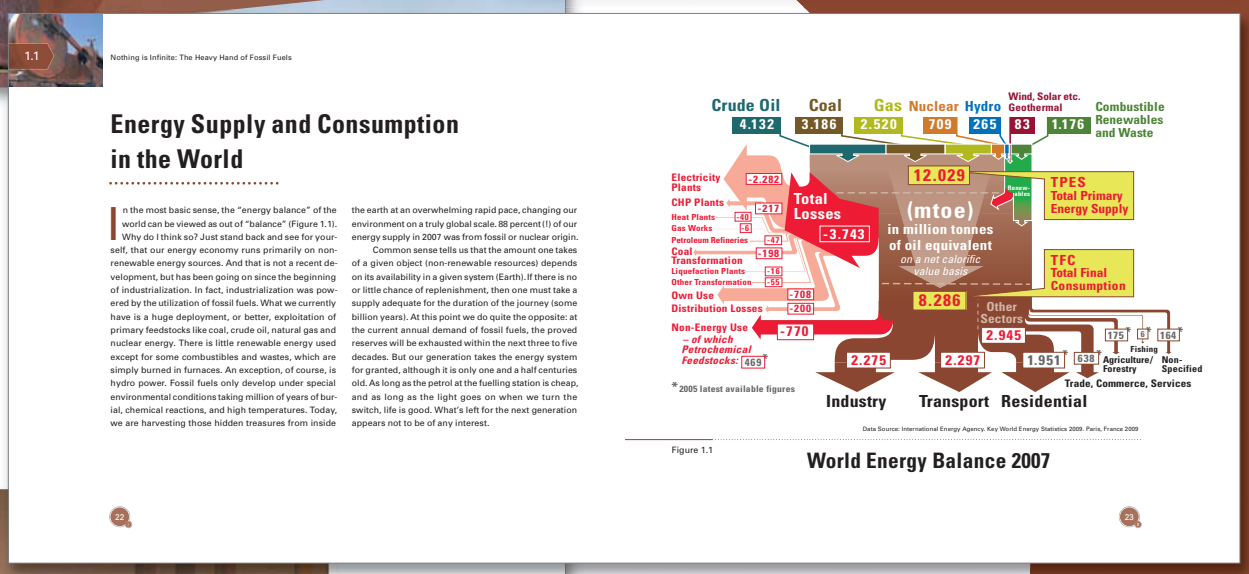
Nothing is Infinite:
The Heavy Hand of Fossil Fuels

When we began to utilize fossil-fuel resources in the mid 1800s, we didn't just increase our standard of living by discovering clever ways to exploit our natural environment. We also began to deplete resources faster than nature can replenish them, and in the process alter whole ecosystems and drive up the natural levels of greenhouse gases (GHGs) in the atmosphere. While we can see and feel our impacts on the Earth's environment already, no one can predict definitely how much global warming will ultimately occur by burning fossil fuels, or what effects this warming may have. Recognizing these problems, let's begin our journey into the realm of energy with the elementary facts of its supply and consumption.

Impressions



1.1 Nothing is Infinite: The Heavy Hand of Fossil Fuels

Energy Supply and Consumption in the World

In the most basic sense, the "energy balance" of the world can be viewed as out of "balance" (Figure 1.1). Why do I think so? Just stand back and see for yourself, that our energy economy runs primarily on non-renewable energy sources. And that is not a recent development, but has been going on since the beginning of industrialization. In fact, industrialization was powered by the utilization of fossil fuels. What we currently have is a huge deployment, or better, exploitation of primary feedstocks like coal, crude oil, natural gas and nuclear energy. There is little renewable energy used except for some combustibles and wastes, which are simply burned in furnaces. An exception, of course, is hydro power. Fossil fuels only develop under special environmental conditions taking million of years of burial, chemical reactions, and high temperatures. Today, we are harvesting those hidden treasures from inside the earth at an overwhelming rapid pace, changing our environment on a truly global scale. 88 percent (!) of our energy supply in 2007 was from fossil or nuclear origin.

Common sense tells us that the amount one takes of a given object (non-renewable resources) depends on its availability in a given system (Earth). If there is no or little chance of replenishment, then one must take a supply adequate for the duration of the journey (some billion years). At this point we do quite the opposite: at the current annual demand of fossil fuels, the proved reserves will be exhausted within the next three to five decades. But our generation takes the energy system for granted, although it is only one and a half centuries old. As long as the petrol at the fuelling station is cheap, and as long as the light goes on when we turn the switch, life is good. What's left for the next generation appears not to be of any interest.

Figure 1.1

World Energy Balance 2007

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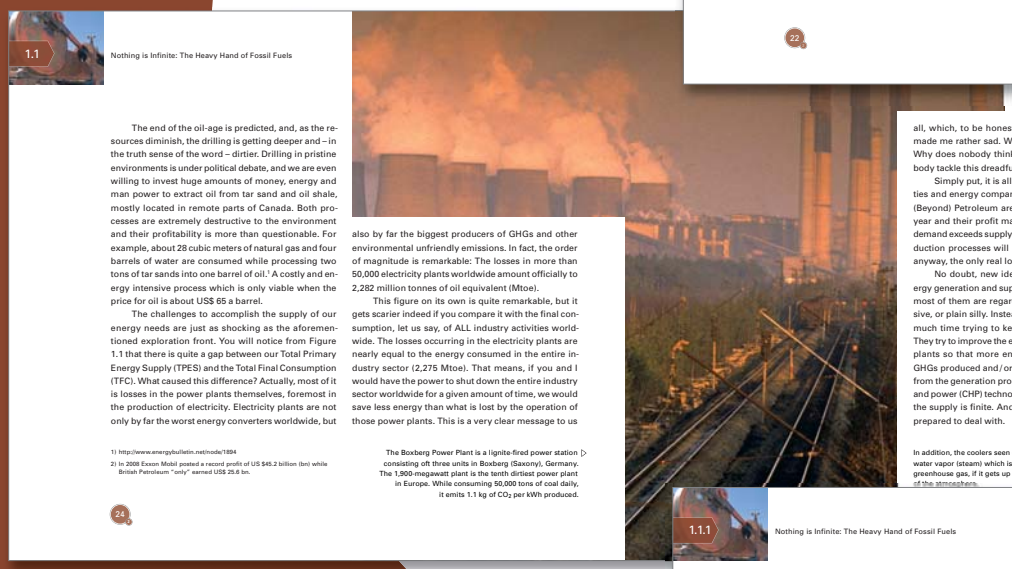
from his book



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The end of the oil-age is predicted, and, as the resources diminish, the drilling is getting deeper and – in the truth sense of the word – dirtier. Drilling in pristine environments is under political debate, and we are even willing to invest huge amounts of money, energy and man power to extract oil from tar sand and oil shale, mostly located in remote parts of Canada. Both processes are extremely destructive to the environment and their profitability is more than questionable. For example, about 28 cubic meters of natural gas and four barrels of water are consumed while processing two tons of tar sands into one barrel of oil.[1] A costly and energy intensive process which is only viable when the price for oil is about US$ 65 a barrel.

The challenges to accomplish the supply of our energy needs are just as shocking as the aforementioned exploration front. You will notice from Figure 1.1 that there is quite a gap between our Total Primary Energy Supply (TPES) and the Total Final Consumption (TFC). What caused this difference? Actually, most of it is losses in the power plants themselves, foremost in the production of electricity. Electricity plants are not only by far the worst energy converters worldwide, but also by far the biggest producers of GHGs and other environmental unfriendly emissions. In fact, the order of magnitude is remarkable: The losses in more than 50,000 electricity plants worldwide amount officially to 2,282 million tonnes of oil equivalent (Mtoe).

This figure on its own is quite remarkable, but it gets scarier indeed if you compare it with the final consumption, let us say, of ALL industry activities worldwide. The losses occurring in the electricity plants are nearly equal to the energy consumed in the entire industry sector (2,275 Mtoe). That means, if you and I would have the power to shut down the entire industry sector worldwide for a given amount of time, we would save less energy than what is lost by the operation of those power plants. This is a very clear message to us all, which, to be honest, first surprised me and then made me rather sad. Why is this not even discussed? Why does nobody think about this and why does nobody tackle this dreadfully inefficient system?

Simply put, it is all about economics. In fact, utilities and energy companies like ExxonMobil or British (Beyond) Petroleum are earning billions of Euros per year and their profit margins will only increase when demand exceeds supply.[2] Exploration, mining, and production processes will be paid for by the consumers anyway, the only real loser is Nature.

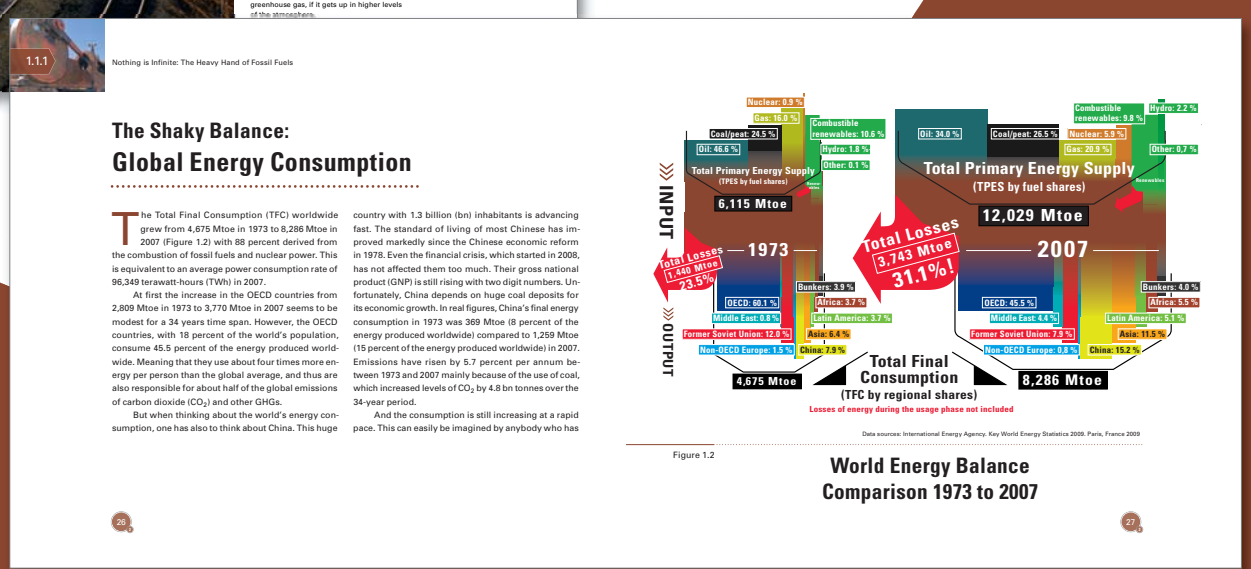
No doubt, new ideas for a more sustainable energy generation and supply chain are already here, but most of them are regarded as impractical, too expensive, or plain silly. Instead too many people spend too much time trying to keep the ailing system running. They try to improve the efficiency of fossil-fuelled power plants so that more energy is generated per unit of GHGs produced and/or more otherwise "waste" heat from the generation process is used via combined heat and power (CHP) technology. But the problem remains: the supply is finite. And this is a fact that we must be prepared to deal with.

1) http://www.energybulletin.net/node/1894
2) In 2008 Exxon Mobil posted a record profit of US $45.2 billion (bn) while British Petroleum "only" earned US$ 25.8 bn.

The Boxberg Power Plant is a lignite-fired power station consisting oft three units in Boxberg (Saxony), Germany. The 1,900-megawatt plant is the tenth dirtiest power plant in Europe. While consuming 50,000 tons of coal daily, it emits 1.1 kg of CO_2 per kWh produced.

In addition, the coolers seen on the left emit water vapor (steam) which is the most abundant greenhouse gas, if it gets up in higher levels of the atmosphere.

24



1.1.1 Nothing is Infinite: The Heavy Hand of Fossil Fuels

The Shaky Balance: Global Energy Consumption

The Total Final Consumption (TFC) worldwide grew from 4,675 Mtoe in 1973 to 8,286 Mtoe in 2007 (Figure 1.2) with 88 percent derived from the combustion of fossil fuels and nuclear power. This is equivalent to an average power consumption rate of 96,349 terawatt-hours (TWh) in 2007.

At first the increase in the OECD countries from 2,809 Mtoe in 1973 to 3,770 Mtoe in 2007 seems to be modest for a 34 years time span. However, the OECD countries, with 18 percent of the world's population, consume 45.5 percent of the energy produced worldwide. Meaning that they use about four times more energy per person than the global average, and thus are also responsible for about half of the global emissions of carbon dioxide (CO_2) and other GHGs.

But when thinking about the world's energy consumption, one has also to think about China. This huge country with 1.3 billion (bn) inhabitants is advancing fast. The standard of living of most Chinese has improved markedly since the Chinese economic reform in 1978. Even the financial crisis, which started in 2008, has not affected them too much. Their gross national product (GNP) is still rising with two digit numbers. Unfortunately, China depends on huge coal deposits for its economic growth. In real figures, China's final energy consumption in 1973 was 369 Mtoe (8 percent of the energy produced worldwide) compared to 1,259 Mtoe (15 percent of the energy produced worldwide) in 2007. Emissions have risen by 5.7 percent per annum between 1973 and 2007 mainly because of the use of coal, which increased levels of CO_2 by 4.8 bn tonnes over the 34-year period.

And the consumption is still increasing at a rapid pace. This can easily be imagined by anybody who has

Figure 1.2

World Energy Balance Comparison 1973 to 2007

28 27

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