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TO: Petroleum Sector
Bheki Ntshalintshali
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Martin Jansen
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Dear Comrades,

RE: ICEF ENERGY CONFERENCE NOV. 1989

Herewith extracts from the proceedings of this Conference. There are masses of tables & other information so if you need to know anything just ask. There are also massive organograms for BP & Shell.

Yours Fraternally

Rod Crompton
GENERAL SECRETARY

ICEF WORLD CONFERENCE ON THE ENERGY INDUSTRY

BRUSSELS, 21-23 NOVEMBER 1989

INDUSTRY OVERVIEW

1. DEMAND AND SUPPLY

The decline in world energy consumption caused by the twin oil price hikes of 1973 and 1979 checked development in the major market economies and triggered the process of industrial restructuring that has so profoundly affected all sectors and all regions.

More efficient use of more expensive energy and strategic policy changes have made major contributions to easing the historical reliance upon energy inputs - especially in the case of oil. As a result the ratio between energy consumption and growth of gross world production has diminished by nearly 25 % over the past fifteen years. It has been estimated that full use of available energy-efficient technologies could cut per capita energy use by as much as 50% without impeding economic growth. The extent to which these gains are realized will depend upon a wide variety of economic and developmental factors, among which the price management of fuels is a very important one.

There has also been a change in the industrial mix of the major OECD economies with the decline of old industries using high energy imputs and the rise of high technology sectors with different and lower energy requirements. The shift of much basic manufacturing to new locations in the developing world and to the hitherto centrally planned economies is likely to precipitate a further important change in energy requirements.

Demand for energy is forecast to continue to grow at only about half the rate of general economic growth over the short to medium term. Consumption is very uneven on a world scale, however. In 1988 the world consumed energy equivalent to some 8 billion tonnes of oil (Tonnes Oil Equivalent, or TOE) - an average of 1.3 tonnes for every man, woman and child on Earth. While citizens of the USA will consume an average of 8 TOE per capita, however, the average for both Japan and Western Europe is around 3 TOE, while people in the Third World still rely on fuelwood and dried animal dung as important energy resources, consuming only a small fraction of a TOE each in many cases.

Table 1, which summarizes the development of recent energy consumption by fuel and geographically, also demonstrates a rising proportion of energy being consumed in the developing regions and continuing lower consumption in North America and Western Europe following the recessionary period.

Fuel Choices

Although the world consumed some 21% more energy in total in 1986 than it had done ten years earlier, the total consumption of oil was practically the same as in 1976 at 2,881 million tonnes. This lessening dependency on oil in the overall energy mix was due to the slump in demand for fuel oil (from 28.3% of the market in 1979 to 19.7% in 1986). Demand for both gasoline and middle distillates rose over the period as a whole. The share of the various traded fuels in total world energy consumption at the end of 1986 was: Oil 38%; Coal 30%; Gas 20%; Hydro 7%; Nuclear 2%.

Patterns of fuel choice as between different countries and regions vary considerably, however, depending on indigenous resources, stage of development and policy. Table 2 summarizes these differences on a regional basis.

In broad terms it is clear that the centrally planned economies of Eastern Europe and China depend to a much greater extent upon coal for their primary energy inputs than on oil or gas, whereas the OECD countries as a whole use twice as much oil as either coal or gas.

Overall potential energy reserves are not scarce, despite the rhetoric of the seventies' 'energy crises'. Proven fossil fuel reserves (a figure which has as much to do with economics as with physical availability) are sufficient for at least a century at present rates of consumption and are being added to every year. Two-thirds of these reserves are of coal.

Given that the World Energy Conference of 1980 estimated world recoverable resources of energy to be at least 15 times as large as the figure for 'proven reserves', there is clearly little danger of literally running out of energy even from conventional sources.

2. OIL

The loosening of strict oil dependency noted above may well prove to be a temporary phenomenon in many uses at the lower prices now prevailing. Even at its currently low level, however, the oil price is still an administered price, maintained at well above what it would be in any hypothetical free market. Oil is very cheap to extract in relative terms and found in many different regions of the world. Actual production costs vary greatly, but may range from as low as $1 per barrel in parts of the Middle East fields up to $10 per barrel average in the USA and even double that in some sections of the North Sea. Since 63% of proven oil reserves are in the Middle East (mostly in Saudi Arabia), this combination of advantages makes that region dominant in price-setting.

Until 1973, however, the arbiters of oil supply and price had been the major oil companies, who controlled every stage of production, distribution and marketing from the oil well to the petrol filling station. In that year the producing governments decided to assert sovereignty rights over their own oil resources. While the producer governments controlled the oilfields, the companies had unique access to the technologies of exploration and extraction. These skills they put at the disposal of other countries in return for long term supply arrangements covering output from any new findings as an alternative to their previous suppliers if necessary and a bargaining counter. Since that time the producers and suppliers have been bound in a relationship of mutual need.

Managing the Glut

Since opening up these new resources, it has not been so easy to control the flow of oil onto the world market. Wells drilled during a period of high prices have not all automatically been shut down when the price has dropped, especially where they have come to provide a central source for income for indebted governments or are integral to the growth process, as in Latin America or S.E. Asia.

The task of market control has therefore fallen heavily upon the major Middle Eastern producers of OPEC and upon the oil companies. Table 4 illustrates the cutback in OPEC output in response to the growth of alternative supplies, despite some breaking of ranks within the cartel.

The drastic lowering of prices in 1986 has succeeded in closing off some of the oil spigots, however. The USA is a traditional 'swing producer' like Saudi Arabia, though seldom viewed as such. The rate of its production is still effectively controlled by the oil majors with the many independent producers being manipulated via the price mechanism. Between 1981 and 1988 the number of drilling rigs operating throughout the world dropped from over 6.000 tonnes to under 2.000 with the bulk of that reduction taking place in the USA. The resulting rise of oil imports to the USA is now valued at over $50 billions - about a quarter of the country's huge trading deficit.

Outside of USA, however, the companies have remained available to drill for new oil. Exploration budgets of the oil majors were again up in 1988. The latest licensing rounds for North Sea rights have seen eager bidding, despite declaration of the area as a mature producing region. New fields are being opened up near the vast Middle Eastern reservoirs from fresh wells in North and South Yemen, Jordan and Syria, where wars and political disruption seem to favor oil wealth.

Estimated proven reserves in 1989 are given in table 5.

The shift away from oil in the industrialized economies is likely to continue for strategic and structural reasons, even at lower price levels. Chevron estimates that by 2000 oil will be required for only 40% of primary energy needs outside the centrally planned economies, as against 46% in 1986.

Restructuring

With world oversupply and future market expansion below the rate of general economic growth, oil is a good example of a mature sector at the global level. The longer term expansion prospects of the newly industrializing countries and of Eastern Europe and China are likely to be fueled from indigenous resources until their economies take off sometime in the next century, if present trends hold. While waiting for these scenarios to unfold, however the major oil enterprises are compelled to follow alternative growth strategies common to other mature sectors - namely, expansion by acquiring the market share of others through takeover.

Although low oil prices have caused difficulties for exploration/production activities, the integration of the biggest oil companies through to petrochemical products has enabled them to offset these losses by gains from low input prices for these downstreams operations. With cash flow thus maintained, these market leaders have been enabled to go after the upstream assets or the downstream market shares of smaller, more vulnerable operators. A rash of mergers has announced a full scale shake-out in all sectors of the industry.

Newly-privatised British Petroleum strengthened its position both in the important US market and internationally by buying out the remaining 45% of Standard Oil (Sohio) during 1987. The deal made BP the world's third largest oil company with assets of over $48 billion. This was swiftly followed by takeover of the United Kingdom's biggest remaining independent operator, Britoil, for some $4.5 billion. Amoco paid a similar sum for Dome Petroleum's assets. A promise to invest a further $2.5 billion in exploration and development quieted political qualms at the advance of the US investment into Canadian energy assets. Between the end of 1980 and 1986 cumulative foreign direct investment in the US petroleum industry rose from $12.2 billion to $29.6 billion.

Willing sellers have also been found among those companies which had diversified into oil in the good times and are now ready to cash in their assets to concentrate resources in other sectors. RTZ's sale of its oil and gas properties to Elf Aquitaine is particularly interesting in view of the group's evident decision to concentrate on the alternatives of coal and uranium in the longer term. Dow, PPG Industries and ICI are among the major chemical groups which have divested oil and gas assets during 1987, while BASF recently moved in the opposite direction to acquire offshore wells from US Pennzoil. Tenneco's decision to rid itself of over $5 billion of oil and gas assets attracted a bevy of suitors.

Mobil, on the other hand, closed a 15 year chapter of unsuccessful diversification out of energy by selling its Montgomery Ward chain store holding for $3.8 billion. This helped to redeem most of the group's outstanding debt in respect of its earlier purchase of Superior Oil.

Over the next five years, the top 15 oil companies are likely to accumulate combined cash surpluses of around $75 billions, giving ample funds to continue this restructuring process to its oligopolistic conclusion.

The Push Downstream

The biggest shift of power within the oil industry is undoubtedly the moves by the major OPEC producers to break out of their commodity supply role by diversifying downstream. The potential market power of an entreprise integrated from oil pump to petrol pump has already been shown by the past history of the oil majors. Now the new owners of the world's biggest reserves mean to have their time.

Leaders in downstream diversification outside their borders have been Kuwait and Venezuela. Under the 'Q8' brand name, Kuwait Petroleum International (KPI) has built a substantial marketing network in Italy and Northern Europe by buying out Gulf's European operations based on refineries in Rotterdam and Gulfhaven. The Kuwait Investment Office (KIO) has meanwhile advanced oil and other interests through dynamic portfolio managament. Acquiring US Santa Fe International in 1981, KIO recently emerged from the BP privatization muddle with over 22% of the world's third largest oil company. Now it has entered into active management of its assets in Spain's largest chemical company, ERT, while KPI has announced its intention to expand in France, the Federal Republic of Germany (FRG), USA and the Far East in order to ensure direct market outlets for half its OPEC production quota of 1 billion barrels per day.

Venezuela already refines this amount of oil through its partnership with companies in West Germany, Sweden and the USA. Similar moves are now being made by Nigeria ,which is seeking a stake in the refining and petrol distribution business of Elf-Aquitaine.

The largest potential entrant to integrated production is Saudi Arabia. Having found its internal diversification into petrochemicals slowed by the lowering of oil revenues, the world's biggest resource holder has now turned its attention to exterior investment. After discussions with its ARAMCO partners, the country's oil industry has been thoroughly reorganized and integrated, culminating in the purchase of a half-share in three Texaco refineries and over 11.000 petrol filling stations in the eastern USA. Discussions are continuing concerning a similar holding in the European operations of one of the majors.

Thus, as the existing integrated oil companies are prospecting for alternative resources around the world, their erstwhile producing partners are moving inexorably into a directly competitive position. Whenever the showdown occurs, it is likely to be resolved on the basis of agreed market sharing rather than by all-out price war if the past history of the industry is any guide.

Refining

These moves come at a highly strategic juncture for the industry's refining sector, where market maturity in the industrialized countries and the shift of demand towards lighter products have caused considerable overcapacity for several years. Over 100 US refineries were closed over the period 1981-1985, removing nearly 3.5m barrels/day of capacity. Although 25 of these refineries were owned by the oil majors, there were 85 closures among the smaller refineries owned by independents. Similar pressures have closed a third of Europe's total refining capacity since the start of the decade. Even so, surplus capacity is still being shed as profits falter on low operating rates. The following situation in Singapore is likely to be followed in other S.E. Asian locations.

Singapore's petroleum industry, now the third largest in the world is expanding to meet competition from new refineries coming on stream in neighbouring countries. The seven major refiners have plunged headlong into various upgrading projects, aimed at giving them greater flexibility to produce higher value-added products at lower costs. The industry is pumping more than Sing$1 billion in new investments to upgrade the refineries into sophisticated processing plants such as hydrocrackers and visbreakers. The upgrading will mean the production of more light products from fuel oil and crude. Growth in the demand for fuel oil is likely to fall as rival refineries in neighbouring countries increase their own refining capacity. The products include petrol, naptha, kerosene and jet fuel, which generally command a higher price over such "heavy" products as fuel oil. The new plants are expected to increase Singapore's production of higher valued products by about 20%. Singapore's refining industry can now cater to short-term processing needs, brouhgt about by fluctuations in demand and supply. Within this decade, local refiners have lost traditional customers in Indonesia,India and Iran, but found new ones in Japan, China, Taiwan and Thailand. Recently, four Singapore refiners - British Petroleum, MOBIL Singapore, SHELL Eastern and Singapore Petroleum - renewed their contracts with the China National Chemicals Import and Export Corporation (Sinochem) to process an estimated 60.000 barrels of Chinese crude oil per day. Singapore's refining capacity will be further enchaced by four main projects now under construction - SHELL Eastern Petroleum's long residue catalytic cracker (LRCC) and iso-propyl alcohol plant, MOBIL's medium pressure hydrocracker complex, and Esso's visbreaker plant. When operational, they will strengthen the industry which last year grew by 8.7% to reach Sing$7.8 bn. SHELL's LRCC project will enable the refiner to convert low value fuel oil into more valuable products. The iso-propyl alcohol plant will produce up to 70.000 tonnes per year of the product. MOBIL Singapore's 23.000 barrels per day hydrocracker complex also includes a 12.000 bpd MOBIL isomerisation de-waxer and hydrogen plant. The Sing$200m facility will convert heavy fuel oil to high quality kerosene and diesel oil at a lower cost than conventional hydrocrackers. Esso`s 50.000 bpd visbreaker will be able to produce more value-added petroleum products from fuel oil. This project will come on-stream in early 1990., Singapore Refining Company (SRC), a joint venture between BP Singapore, Singapore Petroleum Company and Caltex, is increasing its capacity by 20.000 bpd to cope with the additional demand as part of a Sing$100m plan.

A major factor is the outdated nature of much of the refining plant in place. Soon after the year 2000, it is estimated, lighter products will account for 80% of each barrel of oil consumed, as against around 60% in 1980. Refiners are also being required to raise octane levels to meet tightening regulations on lead in petrol. To produce this changed mix will require investment in new technology. To repay those investments will require operating rates well in excess of the 70% averages currently being experienced. Only about a third of current world capacity is able to meet the new requirements.

In the longer term also the oil companies will need to consider competition arising from very cheap crude being fed into producer-owned refineries. Tables 6-12 show the existing spread of refining capacity and announced expansion plans in producer countries. Not shown are the inevitable further closure to come among older refining plant.

1989 has seen refining profits rise dramatically. After a decade in which oil companies cumulatively lost hundreds of millions of dollars refining the oil that they very profitably brought up from deep under the earth, this capital-intensive link in the chain between production and sales to the consumer is starting to look like a healthy business. Refining oil into usable products is starting to earn a profit again, and across Europe oil companies are busily investing again to expand capacity. The demand for "whiter", or chemically lighter, petroleum products, which include transportation fuels such as diesel and petrol, has grown while demand for darker, heavy fuels has fallen. White products require intensive refining, in effect reducing capacity, and they command higher margins. The improved outlook results not so much from cuts in gross refining capacity, but from fundamental changes in the pattern of consumption.

See appendix 1 for a full survey of European Refineries in 1988.

Employment Effects

The impact of these major changes in this key sector upon the people who work in it has been severe. Employment in the oil and gas extraction industry fell particularly rapidly in the USA from 708.300 workers in 1982 to 457.400 workers in 1986. Total employment in the US petroleum sector dropped from 1.9 million people to 1.6 million over the same period.

During 1989, oil companies are embarked on the biggest round of retrenchment since oil prices halved in 1986. America's Occidental set the ball rolling in September 1989 when it announced that it was cutting its domestic oil-and-gas operations with the loss of some 900 jobs. Britain's BP followed up by damming its upstream (oil exploration and production) business. One in six jobs in its exploration arm are to be scrapped, and $1.3 billion of oil-and gas reserves sold. Occidental reckons that the changes will save it $100m a year; BP says that it will save $150m a year. More shake-ups can be expected in the coming months, preceded by hot denials. Royal Dutch/SHELL, the world's biggest oil company, looks set to restructure its American upstream business, with perhaps 1,000 jobs going. It may swap some North Sea reserves with Amoco-itself in the process of cutting up to 8,000 staff worldwide. MOBIL, too, seems poised to shake up its upstream business. Others will follow. The upheaval marks a big shift in oil-exploration strategies. After 1986's oil-price collapse, oil companies claimed that they had cut the cost of finding oil by a third. Now upstream costs are rising. In practice, this means that the oil majors will concentrate on looking for new oil in regions like South-East Asia, where exploration is relatively high-risk, but where the chances are that any oil found will be in biggish, low-cost fields. BP reckons its competitive exploration edge is an aeroplane called ALF. The Airborne Laser Fluorosensor spots those offshore oil-seeps which can betray oilfields below. At present there is one in the air, but Asian skies may soon be full of them. Oil companies are also shaking up their managements. Texaco, which had 11 layers of management from petrol pump to chairman's office, now has just five. BP Exploration is trimming seven layers of management down to four; its head office will have just two. Oil-and-gas asset sales and swaps ($20 billion-worth have changed hands so far this year) will continue apace. The reason? Oil companies are keen to attain "critical mass" in the exploration areas they are targeting, shorthand for buying assets that fit their portfolios and selling those that don't. The first company to grab, say, 10% of exploration in a frontier area can gain up to a decade's competitive advantage. This is a costly game, so capital-spending budgets are escaping the axe. BP will continue to invest $3.5 billion a year; cash from its asset sales will help buy a smaller rival in 1990. Some industry pessimists reckon that the number of big integrated oil companies could halve by 2000.

Although petroleum refining employs only some 15% of the overall industry workforce, it is disproportionately important for trade union membership. Because refineries tend to be near other industrial conurbations and are relatively few, as opposed to the widely dispersed nature of marketing outlets and the remoteness of drilling sites, they are more thoroughly organized. The shake-out in this sector has therefore hit membership particularly hard.

The known and documented dangers to workers' health from the many hazardous exposures in this sector make the protection of new oilfield and any refinery workers through union organization a priority in the new regions of development.

3. GAS

Because of the historically dominant role of oil in energy supply, it is inevitable that other fuels should be treated relative to the development of that sector. In the case of gas, its production and distribution as a byproduct of oil and by the same companies, has tended to eclipse its growing importance. Transportation problems have kept natural gas use largely localized until fairly recently, but its future could be bright.

Production and reserves of natural gas increased only modestly in recent years, despite some benefit of the installation of dual or multi-fired equipment. Last year oil recovered much of its lost ground at the expense of gas. Projections for the end of the century, however, show a rising profile for gas as an industrial fuel and as a halfway measure to meet anti-pollution tergets. Plans to use gas for power generation and as an alternative motor car fuel give further expectation of an advance.

Suppliers are relatively aboundant on a world scale, but proven reserves are centered on the USSR's Western Siberian gas fields, which contain some 40% of world reserves and currently supply 15% of Western

Europe's needs. Proposed gas-gathering schemes for the North Sea, bringing supplies by pipeline to the UK are not likely to come to fruition before the end of the century, but the development of Norwegian suppliers is moving ahead. Spain's Enagas signed a 30 year supply deal early in 1988 for 1 billion cubic meters per year of gas from the Troll field, starting in 1996. Pipelines via Zeebrugge and France will need to be extented to fulfil this contract. Spain saw a 27% increase in natural gas sales during 1987, most supplies coming from Algeria and Libya. British Gas is seeking a minority stake is Norway's Saga gas company while increasing its holding in Canada's Bow Valley Industries.

Elsewhere new discoveries are being persued. Brazil has found new gas reserves in the Amazon Basin totaling over 100 billion cubic meters and aims to double its natural gas output by 1991. India is completing construction of an 800 mile pipeline carrying natural gas from the Bombay High field to fertilizer plants across the country. China is mounting a drive to discover and develop its own natural gas resources for selfsuffiency. The ongoing steady development of resources and markets seems likely to produce a more important role for gas by early next century.

4. ELECTRICAL POWER GENERATION

World electricity output amounted to 9.7 million gigawatt hours in 1986 - an increase of 3% on the year, which was higher than the 2.1% average growth in total energy consumption.

Figures for electricity generation in 1987 are given in tables 17-19.

Of a total installed electricity generating capacity of 2,497 GW only 490 GW is in the developing world. According to the most conservative forecast of the International Atomic Energy Authority, generating capacity could grow by about 37% overall in the industrialized countries by 2000, but by some 106% in the developing countries. By that time some 37% of primary energy will go into producing electricity in that year in the industrialized world (as against 33% at present) and 27% in the developing world (currently 19%). Even so, the growth forecast over this period is much slower than that which occured during the last two decades.

Almost two-thirds of electricity generation takes place in plants fueled by one or more of the fossil fuels, mainly coal. Hydro and a little natural geothermal energy supply between them around 22% of the fuel for electricity generation; nuclear just over 15%. Within this overall fuel pattern, however, individual national fuel structures differ enourmously. While fossil fuels fire over 73% of US power stations, for example, with hydro and nuclear plants sharing the remaining capacity in roughly equal proportions, France's generating capacity is now 70% given over to nuclear and still climbing. In the developing world almost all electricity generation is from fossil fuels with no nuclear plants yet commissioned.

What the future pattern of generating plant will be is more a matter of the politics of environmental concern than of economics. While most estimates project an increase for coal up to 40% of total electricity generation by 2000, because of its cheapness and wide availability, real fears of the dangers from atmospheric pollution may intervene to depress this tendency unless cleaner burning technologies can be introduced at reasonable cost and higher efficiencies. The effects of acid precipitation upon forest resources and aquatic life and the more far-reaching consequences of a 2% rise in global temperature as a result of the 'greenhouse' warming effect of carbon dioxide and other waste gases have placed a big question mark over continued expansion of fossil fuel usage and over coal in patricular.

New advanced coal use technologies including fluidized bed combustion and coal gasification are a partial response to this concern, but very considerable expenditures are necessary to raise existing facilities to standards of emission control acceptable within new international accords. The FRG's electricity utilities, for example, increased expenditure on environmental protection by 48% (to DM 4 billions) in 1986 - at least half of this being spent on new plant. Even so, the country's most advanced coal-fired power plant at Petershagen had to be closed down recently after only six months of operation because of exessive nitrogen oxide emissions. A recent study by the US Department of the Environment concluded that it would be cheaper to replace all existing coal burning plants with new 'clean coal' technology than to reduce emissions by installing conventional scrubbers.

If coal does maintain or increase its lead, however, several of the big energy combines are in a position to benefit from this choice also. The world's biggest owners of coal resources are also oil companies, like British Petroleum and Shell.

Natural gas is also being proposed as an alternative generating fuel to either coal or oil. Recent changes in technologies suggest benefits which could double its use for this purpose by the beginning of the next century, according to a recent survey. The commercialization of combined-cycle gas turbines allowes thermal efficiencies of around 50%, as opposed to 40-43% with conventional gas plant and around 38% with coal combustion. Such plants are environmentally more acceptable and cheaper to construct than either coal or nuclear installations. Combined-cycle technology also lends itself to much smaller units, allowing greater flexibility to follow load peaks and construction nearer to urban centers of demand.

Atomic Energy

Cheap, clean and safe electricity was the promise of atomic energy to meet future needs. Recent events have severely damaged that vision and seem likely to restrict and even to reverse expansion in nuclear capacity, except where policy commitments are irreversible.

1979, the year of the second oil shock, was also the year of the first nuclear shock, when the Three Mile Island accident threw doubt in the public mind about the fundamental safety of this wonder energy source. This fear was vastly intensified on a global scale by the disaster of Chernobyl and has since been sustained by revelations of minor accidents over a long period in older UK plants, release of statistics suggesting correlations between nuclear power operations and local cancer and leukemia rates in the USA and UK and by scandalous and inept handling of nuclear wastes. The policy effects of this concern have been to close down the nuclear option in Italy and the Netherlands, reverse Sweden's expansion plans to a phaseout and effectively stop further development in the USA.

A number of developingt countries still maintain nuclear ambitions - among them Argentina, Brazil, Venezuela, India and Indonesia - but these are likely to be realized in the long rather than in the short term and could undergo alteration with the development of alternative indigneous fuel suppliers.

France, Japan and the UK remain committed to a strong nuclear capacity in their future generation plans. France has indeed virtually completed its transformation to a largely nuclear powered industry. Japan published its own plan for future energy supply in 1987, showing a strong expansion for nuclear power from 27% (1986) up to 35% of generating capacity by 1995 with further growth beyond. This decision is heavily influenced by Japan's current complete dependence on external energy supplies. 84% of the country's overall energy needs are met from imported fuels (including all its oil), as against 12% in the USA and 48%in the FRG. Oil fueled 34% of Japan's generators in 1984 as compared with 5% in the USA and just 2% in the FRG.

The experience of France to date has demonstrated more dramatically the investment burden of its nuclear transformation than any actual cost advantages in production. The state electricity utility, EdF, has a cumulative debt of $39 billion with marginal profits on its operations unlikely to repay this indebtedness without imposing a sharp rise in electricity prices. It is not a convincing economic case to place against other safety concerns.

The present nuclear situation is summarized in the following tables 20-26.

Alternative Fuels

The medium term prospects for development of alternative energies from 'soft' sources such as solar, wind and wave power, remain relatively insignificant, at least in part due to low research funding and the continued availability of adequate traditional fuels. Although the drop in oil prices has added no economic incentive, the costs of introducing expensive emission controls for fossil fuels and problems over the nuclear options are forcing reconsideration of long term alternatives.

It is likely to be well into the next century before thermonuclear fusion becomes a reality, if then. But international cooperation is now being stepped up to advance research into this potentially safer nuclear source. The development of new superconductor materials able to operate at around normal room temperatures also offers considerable scope for cheaper electricity generation and savings on transmission losses. These devices are now attracting most of the large equipment manufacturers into important research programs.

The major energy corporations have not abandoned their hold over research and development of the softer energies, continuing to keep options open if environmental controls forces a determined move in that direction. Bio production of methanol as a less polluting motor fuel is successfully proven by Brazil's Proalcohol program

and by its limited use in the USA. The oil price reduction seems likely to confound the economic argument, however, as it has already done in Europe.

The FRG and Japan host the most serious programs of research into photovoltaics and wind energy. A recent joint venture between Siemens and ARCO's Solar Europe aims to produce commercial quantities of solar cells by 1990. Japan's Sunshine Project is the most integrated attempt to develop and assess the whole range of alternative energies.

The impact of any breakthrough achieved in these technologies will not be felt until well past the year 2000, whatever the outcome of present research. Until that time, oil, coal and gas seem likely to retain their central importance as the key to economic growth.

Table 6

World refinery capacity (000 bd)

	1979	1987	1988	% change 88/79	% change 88/87	% of 88 total
USA	17,920	15,665	15,915	-11.1	2.2	21.4
Canada	2,315	1,820	1,890	-18.4	3.8	2.6
Total	20,235	17,385	17,805	-12.0	2.4	24.0
Argentina	660	690	690	4.5	-	0.9
Brazil	1,230	1,395	1,410	14.6	1.1	1.9
Mexico	1,340	1,790	1,790	33.5	-	2.4
N. Antilles	840	320	320	-62.0	-	0.4
Trinidad	465	300	300	-35.5	-	0.4
Venezuela	1,445	1,200	1,200	-17.0	-	1.6
Others	2,645	1,720	1,790	-32.3	4.1	2.4
Total	8,625	7,415	7,500	-13.0	1.1	10.0
Belgium	1,020	705	705	-30.9	-	1.0
France	3,420	1,900	1,810	-47.1	-4.7	2.4
Italy	4,205	2,465	2,345	-44.2	-4.9	3.3
Netherlands	1,815	1,395	1,395	-23.1	-	1.9
Spain	1,475	1,420	1,420	-3.7	-	1.9
UK	2,460	1,820	1,805	-26.6	-0.8	2.4
W. Germany	3,040	1,615	1,645	-43.9	1.9	2.2
Others	2,665	2,630	2,840	6.6	8.0	3.8
Total	20,100	13,950	13,965	-30.5	0.1	18.8
Bahrain	250	250	250	-	-	0.3
Iran	1,045	530	530	-49.3	-	0.7
Iraq	265	320	320	20.8	-	0.4
Kuwait	575	635	745	29.6	18.7	1.0
S. Arabia	635	1,375	1,375	116.5	-	1.9
Others	770	1,095	1,115	44.8	1.8	1.5
Total	3,540	4,205	4,335	22.5	3.1	5.8
Africa	2,000	2,645	2,695	34.8	1.9	3.6
Japan	5,285	4,460	4,325	-18.2	-3.0	5.8
Indonesia	535	780	780	45.8	-	1.1
Singapore	1,040	860	860	-17.3	-	1.2
Australasia	800	730	740	-7.5	1.3	1.0
Others	2,635	3,320	3,320	26.0	-	4.4
Total	10,295	10,150	10,025	-2.6	-1.2	13.5
Total non Cpe	64,795	55,750	56,325	-13.1	1.1	75.7
Cpe	15,225	17,880	17,990	18.2	0.6	24.3
TOTAL	80,020	73,630	74,315	-7.1	0.9	100.0

Source: BP and Oil & Gas Journal

HEALTH AND SAFETY AND THE ENVIRONMENT IN THE ENERGY INDUSTRY

Since the last ICEF World Energy Conference in 1985, there have been several developments in some areas of electrical energy production. For an overall view of the health and environmental hazards associated with the different stages of energy obtained from the four "conventional" primary sources - oil, gas, coal and water - and nuclear, delegates should refer to the 1985 World Conference documentation.

This paper then will restrict itself to some interesting recent trends and developments that were not covered in 1985, and also touch on the hazards that may arise from the alternative, renewable sources of energy, such as solar and geothermal energy.

1. OFFSHORE OIL AND GAS.

A. Production.

After the "Alexander Kielland" and "Ocean Ranger" disasters in the early 1980s, the "Piper Alpha" tragedy in which 167 people died when an Occidental Petroleum platform exploded in the North Sea in July 1988, was yet another reminder that oil and gas extraction for energy is one of the most dangerous industries in the world. Indeed, the potential for a major accident on offshore installations - blow-outs, fires, explosions - is a major area of concern in drilling operations. Most blow-outs and major accidents tend to be attributed to human error, meaning "worker" error. An analysis of offshore accidents, however, shows that the human error can be traced not so much to error on the part of workers as to management malpractice and governmental lack of legislation or enforcement.

As the facts surrounding the Piper Alpha disaster demonstrate, such accidents can be prevented with better management and adequate, enforced legislation. Proper safety regulations and proper union representation in the oil and gas extraction industry are the best means to avoid future oil platform disasters. (For more detailed information on this accident see ICEF Info 7-1988).

While there has been much concern over major accidents, at least 50% of fatalities and the majority of serious injuries sustained during offshore drilling operations can be attributed to "everyday" accidents. The combination of a maritime environment with frequently severe climatic conditions also increases both the incidence and severity of all types of accident.

Occupational health problems associated with welding and maintenance, an often neglected problem, are more common on offshore installations, if only because more welding and maintenance is needed.

Exposure to noise and vibration is also more serious because of the practice of working 12-hour shifts, the confined nature of the worksite, transmission of sound through the framework of the structures themselves, and the difficulty of soundproofing living and sleeping quarters. A relatively high incidence of acute psychological disturbance has also been noted among offshore workers because of the arduous, dangerous work interspersed with periods of acute boredom.

Recent developments by the European oil and gas industry, however, question the need for offshore platforms, and thereby the number of workers exposed to a hazardous environment at sea. Total, the French petroleum company, the French Petroleum Institute, and Statoil, the Norwegian state oil company, have developed equipment that could pump oil straight to shore from wells without the need for offshore production platforms.

Offshore platforms are necessary to separate the oil from unpredictable amounts of water and natural gas, mixtures of which are presently impossible to pump. As stated above, platforms are particularly dangerous, and difficult to build and work on. The alternative of being able to pump the oil mixture directly to land from the well head is an interesting development from the standpoint of working conditions.

The project is not without its problems. The machinery will have to be reliable because the system is planned for use at depths of more than 600 metres, presently beyond the reach of divers (although see below). Another problem in pumping multi-phase mixtures is that of dealing with carbon dioxide, sulphur dioxide and other

corrosives in the water. the mix will also contain very fine particles of sand. The scientific community experimenting with ceramic cladding for pump blades to protect them from pitting and corrosion.

The project is still some 7 to 8 years away from a fully working system, but Canadian companies which ha to deal with particularly hostile conditions in the ice-bound Beaufort sea are already interested.

It must be admitted that any alternative to the need to work in the physically extreme, isolated environme of most offshore rigs should be welcomed, especially when the production work can be carried out onshor

B. Diving.

Any offshore oil production requires the use of divers at all stages. Most activities in support of explorat drilling require brief dives only. A study of over 3000 such dives indicated that 80% were shorter than 30 minut and 99% were completed in less than one hour. The diving activities related to construction and maintenan however, tend to require longer periods on the bottom.

Diving may be divided into two main categories: air diving and mixed gas diving. The former is limited to dept of approximately 60m. because of physiological limits imposed mainly by nitrogen narcosis. The effects on t body are similar to the effects produced by alcohol, and the degree of impairment at 45m. is roughly comparat to the effects of 3 or 4 glasses of brandy. The severity of nitrogen narcosis increases rapidly with depth and m divers are seriously impaired at a depth of 75m.

Work beyond this depth is conducted by using artificial atmospheres in which helium replaces nitrogen. Dive on offshore rigs are presently supplied a mixture of oxygen and helium which allows them to descend to abc 300m. Any deeper than this the pressure build-up affects the central nervous system, causing tremo clumsiness and cramps.

To overcome this barrier, a French team of scientists at the National Marine Research Institute in Marseille has been testing mixtures of hydrogen and oxygen. Divers breathing this mixture apparently "feel normal" simulated depths of 450m. (See ICEF Occupational Health Newsletter 2-1986). Because mixtures of hydrog and oxygen are so dangerous on land, the researchers envisage the use of the gases primarily for prolonged sta underwater.

In industry's terms, dives of longer duration mean that the ratio of usable work time on the bottom to total tir required for the dive, including descent and decompression, decreases rapidly as bottom times are lengthene application of this concept to diving practice has led to the development of saturation diving techniques in whi divers are compressed to working depth pressure and are maintained at that pressure even when not diving. Su operations require an underwater habitat where sleep and work are possible, or a submersible decompressi chamber which functions as a sort of elevator transporting the diver from a worksite to a decompression compl at the surface where he/she can rest until the next work cycle.

Given this tendency to longer periods underwater, the research mentioned above could accelerate the tren even though the health effects of extended periods of compression have not been thoroughly researched. Pa studies have shown that the incidence of osteonecrosis among deep-sea divers increases with depth of dive reaching 20% among those who dive to 300m. Any trend to longer periods at even greater depths should therefo be viewed with great cation. (Further information on damage caused by diving, and latest advances in diagnos of this damage can be seen in ICEF Occupational Health Newsletters 1-1988 and 1-1989.)

C. Transport of oil and gas.

The dangers associated with pipeline transport of gas have been highlighted recently with the leak ar explosion in the USSR in which many people were killed as the trains in which they were travelling were caug in the fireball. Indeed, a large scale escape of liqified petroleum or natural gas accompanied by a massive fireba necessarily entails serious consequences, and steps must be taken to minimise these.

The main problem in this respect in recent years is that regulations have not kept pace with technology - pipe laying standards are rapidly outmoded as techniques have developed. In the USA, for example, the bas standards have not changed in 30 years, so that manual shutoff valves are still widely used when automatic remote-control shutoff valves would appreciably lessen the volume of gas spilled from leaks and ruptures pipelines. Pipelines would be made safer with double walls and spill monitoring systems, according to the U Federal pipeline regulatory program, which also calls for more inspectors, annual inspections and stiffer penalties for non-compliance.

As reported in ICEF Occupational Health Newsletter 1-1986, while pipelines account for only 3.1% of in-transit accidents, they release large volumes of gasesand liquids, accounting for 58.9% of the total quantity released in the study quoted. Such major quantities released and the subsequent loss of life associated with leakages of gas from pipelines in recent years are better qualified as disasters. In addition to the recent Soviet gas line disaster, an explosion of a natural gas pipeline in Gahri Ohada, Pakistan, resulted in 60 deaths in 1984; also in 1984, 508 people died in a pipeline fracture and explosion in Cubatao, Brazil; and in 1978 in Huimanguilla, Mexico, 58 people died after a gas pipeline fracture.

Transport of oil in tankers continues to be a major cause of environmental pollution, especially of coastal areas where the effects are felt most keenly. In the 1970s and 1980s there have been an average of 19 tanker accidents per year involving spills of over 675 tonnes of oil. Since 1974, seven accidents such as the infamous "Amoco Cadiz" have entailed compensation costs of over $20 million at current rates. This is based on compensation awarded, or likely to be awarded when outstanding claims are settled. Real costs of clean-up, economic losses for neighbouring populations, replacement of damaged equipment, compensation for lost oil, etc., are generally much higher than compensation paid.

That the marine and coastal environment suffers considerable damage in the event of a large spill of oil was brought home once again in March this year when the Exxon Valdez ran aground in Alaska, releasing 35,000 tonnes of crude oil. The subsequent failure to contain the oil set the scene for pollution on an enormous scale and questioned the different parties' responsibilities. although the tanker belonged to Exxon Corporation, the Alyeska Pipeline Service Company, a consortium funded and controlled by seven oil companies, and whose job it was to contain any oil spill, failed miserably when the Exxon Valdez ran aground. Half its equipment was out of order, and much of the rest lay under deep snow - in stark contrast to the original plans of the oil companies to provide everything necessary to deal with a spill that was seen to be inevitable in that part of Alaska, the Valdez oil terminal. The crack teams of specialists trained to deal with oil spills, the latest equipment, both ready to respond within 5 hours of an accident, as originally promised and as required by state law, were gradually run down. And here the State of Alaska must also share in the blame. in the face of repeated warnings about Alyeska's slackness, the state made no effort to enforce its own laws.

The need to stipulate responsibilities and be able (and willing) to enforce them is of prime importance in the transport of oil in which the potential for accident and widespread environmental damage is of the highest order.

2. NUCLEAR POWER.

Since the 1985 Energy Conference the nuclear industry has been shaken by the Chernobyl nuclear reactor explosion. Fall-out from this accident has caused many countries to re-evaluate their nuclear energy policy, and some have abandoned plans to continue with nuclear power altogether.

Since the accident the ICEF has been following developments at Chernobyl, and the response by such international agencies as the UN International Atomic Energy Agency and the International Commission on Radiological Protection, etc., as well as related issues connected with the health hazards of nuclear power production. Detailed information, especially concerning the need to lower dose limits to ionising radiation, can be found in ICEF Occupational Health Newsletters Nos. 3-1986, 4-1986, 1-1987, 2-1987, and ICEF Info 3-1988.

One particular problem that the ICEF has not covered before, and that has surfaced because of a rethinking of nuclear policy and the fact that several nuclear reactors are coming to the end of their working lifetimes, is that of decommissioning of nuclear plant. This will inevitably give rise to a whole workforce's potential exposure to the effects of ionising radiation.

The process of decommissioning is conventionally divided into 3 largely self-contained stages:

- Stage 1 involves defuelling and the sealing of mechanical opening systems outside the sheiding.

- Stage 2 involves removing all plant and buildings outside the shielding and reinforcing the shielding, mainly with concrete.

- Stage 3 involves complete removal of all plant and buildings, and returning the site to unrestricted future use (green field conditions).