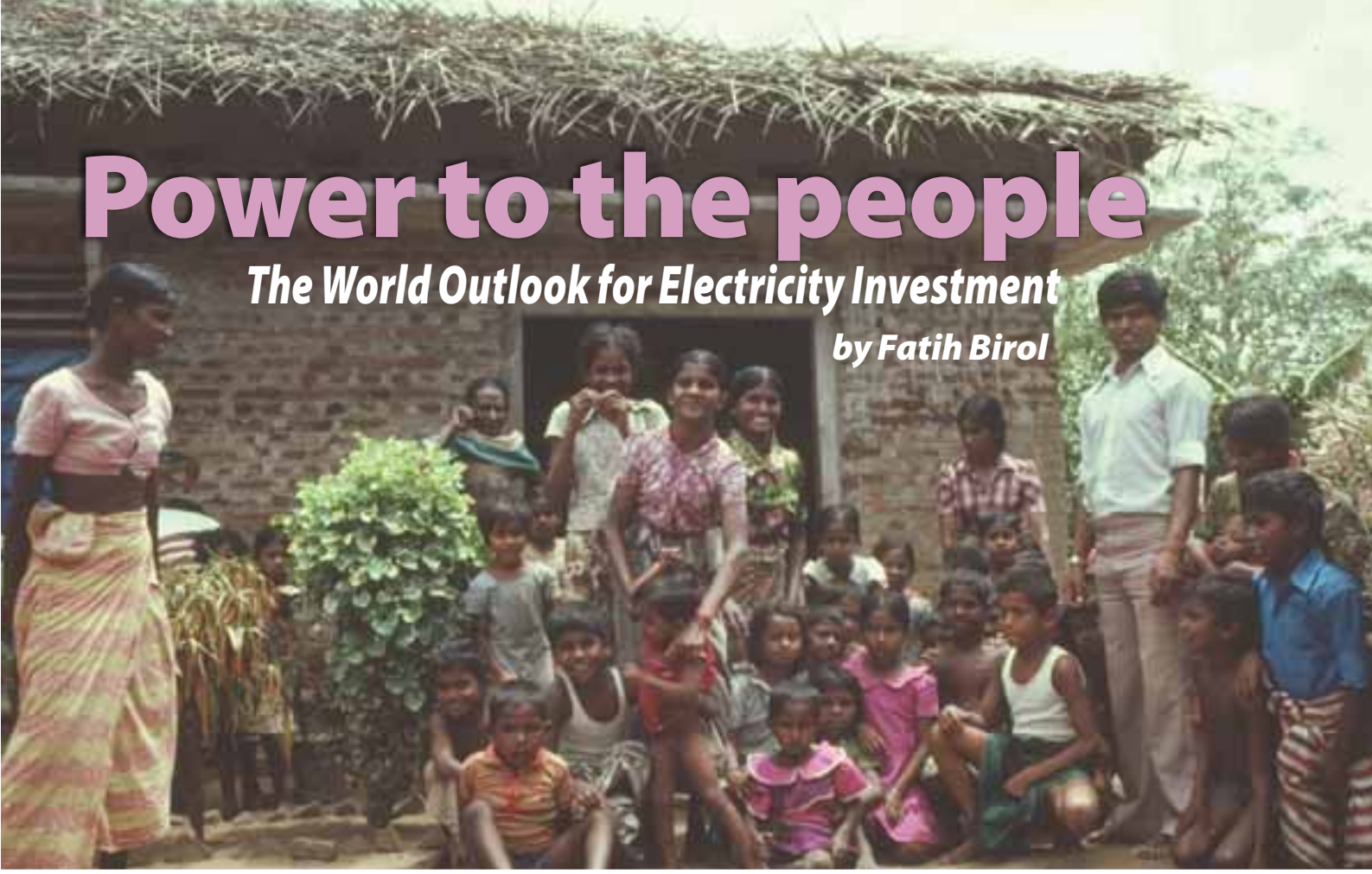


Power to the people

The World Outlook for Electricity Investment

by Fatih Birol

Electricity blackouts made news in Europe and North America not long ago. Behind the headlines, too much of the world lives with blackouts everyday. About one in four people still have no electricity. How much will it cost to bring the needed power to more people?

Energy analysts are looking at the pace and price of progress — at a time when electricity demand is rising ever higher.

Total investment required for the energy-supply infrastructure worldwide over the period 2001-2030 is expected to amount to $16 trillion, or $550 billion a year. This investment is needed to replace existing and future supply facilities that will be exhausted or become obsolete during the projection period, as well as to expand supply capacity to meet projected primary energy demand growth of 1.7% per year.

Capital needs will grow steadily through the projection period. The average annual rate of investment is projected to rise from around $450 billion in the current decade to $630 billion in 2021-2030. This compares with estimated investment of $410 billion in 2000. Actual capital flows will fluctuate around these levels according to project and business cycles. The power sector will account for the bulk of energy-investment needs, and oil and gas in almost equal measure for most of the rest *(see Figure 1)*.

These are some of the key findings of the *World Energy Investment Outlook* of the International Energy Agency (IEA), based in Paris, France. This article focuses on the power sector. The award-winning report, released in late 2003, assesses, fuel by fuel and region by region, the prospects for and possible barriers to investment in the global energy sector to 2030. The core analysis of investment needs is based on the reference scenario projec-

Figure 1: **Cumulative Investment in Energy**
by Fuel, Worldwide, 2001-2030

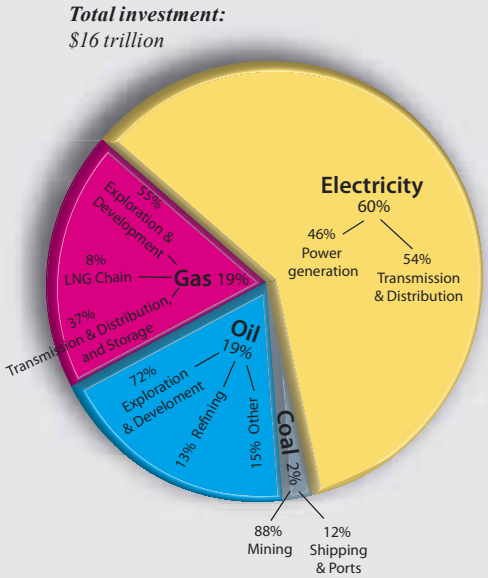
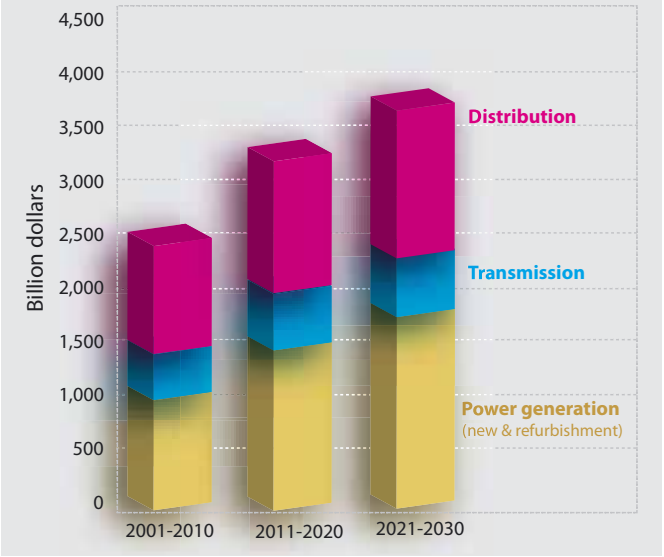


Figure 2: **Investment in Electricity,** Worldwide, 2001-2030



tions of supply and demand contained in the IEA's *World Energy Outlook 2002*.

Although the total sum of investment needs is large in absolute terms, it is modest relative to the size of the world economy, amounting to only about 1% of global GDP on average over the next thirty years.[1] The proportion is expected to fall slightly over the projection period, from 1.1% in the current decade to 0.9% in the decade 2021-2030. But the extent of the challenge differs among regions, ranging from only half a percent in countries of the Organisation for Economic Cooperation and Development (OECD) to 5% in Russia.

Electricity Market Trends

World electricity demand is projected to double between 2000 and 2030, growing at an annual rate of 2.4% *(see Table 1)*. This is faster than any other final energy source. Electricity's share of total final energy consumption rises from 18% in 2000 to 22% in 2030. Electricity demand growth is strongest in developing countries, where demand will climb by over 4% per year over the projection period, more than tripling by 2030. Consequently, the developing countries' share of global electricity demand jumps from 27% in 2000 to 43% in 2030.

The next three decades will see a pronounced shift in the generation-fuel mix in favour of gas and away from coal — the most widely used fuel today worldwide. The role of nuclear power is also expected to decline markedly, because few reactors will be built and some existing ones will be retired. Nuclear production is projected to peak at the end of this decade and then decline gradually. Its share of global power generation will, therefore, drop sharply from around 17% now to 9% in 2030.

Power Sector Investment Needs

To meet the expected growth in electricity demand through 2030, cumulative investment of $10 trillion in power-sector infrastructure will be needed — equivalent to 60% of total energy-sector investment. If the investments in the oil, gas and coal industries that are needed to supply fuel to power stations are included, this share reaches more than 70% and total power-sector investment over $11 trillion. That is nearly three times higher in real terms than during the past thirty years. As demand for electricity increases, investment needs will gradually rise, from $2.6 trillion in the current decade to $3.9 trillion in 2021-2030 *(see Figure 2)*.

The power sector in developing countries will require more than half of the global investment, exceeding $5 trillion. Two-thirds must flow into developing Asia. China's investment needs will be the largest in the world, approaching $2 trillion *(see Table 2)*. India will need investment close to $700 billion, while East Asia and Latin America each will need investments approaching $800 billion. The electricity industry in OECD countries will need investment of around $4 trillion, while that in the transition economies will need $700 billion of investment, more than half of it in Russia.

Generation is the largest single component of total power infrastructure investment. Investment in new plants over the next thirty years will be more than $4 trillion, accounting for 41% of the total. Most of this investment will go into the development of gas and coal-fired power plants.

Refurbishment of existing power plants over the next 30 years will

Table 1: **Electricity Balance,*** Worldwide, 2000-2030

	2000	2010	2020	2030	Average annual growth 2000-2030 (%)
Gross generation (TWh)	**15,391**	**20,037**	**25,578**	**31,524**	**2.4**
Coal	5,989	7,143	9,075	11,590	2.2
Oil	1,241	1,348	1,371	1,326	0.2
Gas	2,676	4,947	7,696	9,923	4.5
Hydrogen-fuel cells	0	0	15	349	n.a.
Nuclear	2,586	2,889	2,758	2,697	0.1
Hydro	2,650	3,188	3,800	4,259	1.6
Other renewables	249	521	863	1,381	5.9
Own use and losses (Mtoe)	**235**	**304**	**388**	**476**	**2.4**

**Includes transport, agriculture and non-specified uses of electricity.*

need investment of $439 billion. Investment in transmission and distribution networks together will take 54% of the total. Network extension, as a component of investment, is more important in developing countries, because of population growth and an increase in the rate of electrification.

In OECD countries, where networks are more developed, most network investment will be needed for refurbishment and replacement of existing equipment. In the European Union, as in the rest of the OECD, investment in new power stations to replace those built in the 1970s and 1980s will need to rise in the coming years *(see Figure 3)*. In developing countries, priority is often given to investment in generation, but a growing share of capital will need to go to transmission and distribution in the future.

Table 2: **Electricity Investment,** Summary for 2001-2030, billion dollars*

	Generation				
	New	Refurbishment	Transmission	Distribution	Total
OECD Europe	645	62	143	501	1,351
OECD North America	717	137	295	728	1,876
OECD Pacific	357	61	131	260	809
Total OECD	**1,719**	**260**	**569**	**1,488**	**4,036**
Russia	157	21	45	154	377
Transition economies	**297**	**41**	**82**	**280**	**700**
China	795	50	345	723	1,913
East Asia	344	22	133	301	799
Indonesia	72	6	33	74	184
South Asia	310	18	142	312	783
India	268	15	119	262	665
Latin America	317	19	128	281	744
Brazil	149	7	54	122	332
Middle East	92	15	47	103	258
Africa	206	13	123	266	609
Total developing countries	**2,064**	**138**	**918**	**1,987**	**5,106**
Total world	**4,080**	**439**	**1,568**	**3,755**	**9,841**

**based on year 2000 US dollars*

Challenges in OECD Countries

Power-sector investment now accounts for less than 0.5% of GDP in most OECD countries, and that figure is expected to drop to an average of 0.3% over the next three decades. Investment has declined somewhat since the mid-1990s for a number of reasons, including high reserve margins in some countries, the lower capital costs of new power plants, low demand growth and uncertainty caused by environmental policies and market liberalisation.

Market liberalisation has created new challenges and uncertainties in OECD countries. There is new concern about the adequacy of investment as markets adapt to the new conditions. Investors in liberalised markets are more exposed to risk than they were in regulated markets and in different ways.

A number of market and regulatory imperfections may lead to under-investment in some electricity markets. Prices may be distorted, for example, by government policies to protect small consumers. And concerns are growing about whether competitive markets adequately remunerate investment in peak capacity. Policymakers in most OECD countries appear to believe that current market designs do not guarantee an adequate level of security of supply, and are considering how to intervene to address this issue.

Environmental regulations, requiring power plants and other industrial facilities to reduce their emissions, are becoming tighter. Uncertainty about future environmental legislation increases investor risk. Existing legislation is directed principally at emissions that have a local or regional impact, such as sulphur dioxide, nitrogen oxides and particulate matter. These emissions depend on the fuel mix used in power generation and tend to be higher in countries where the share of coal in the generation-fuel mix is high. Emission standards for these pol-

Figure 3: **Age of Power Generation Systems in the European Union**

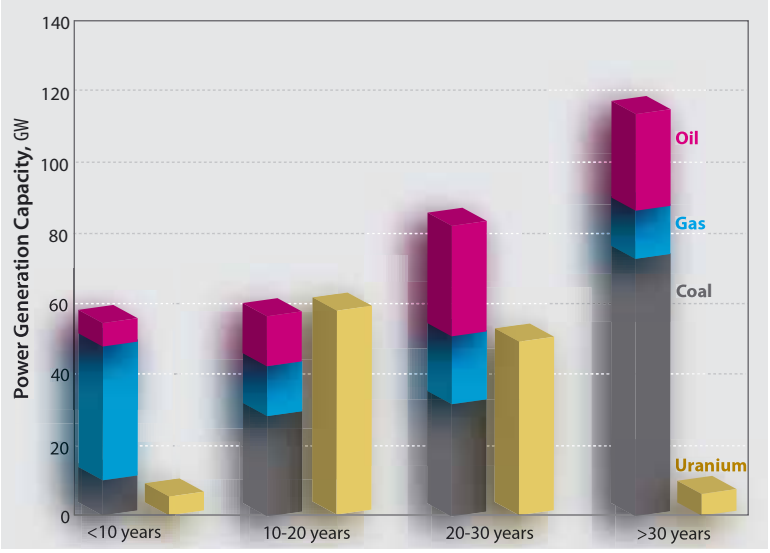
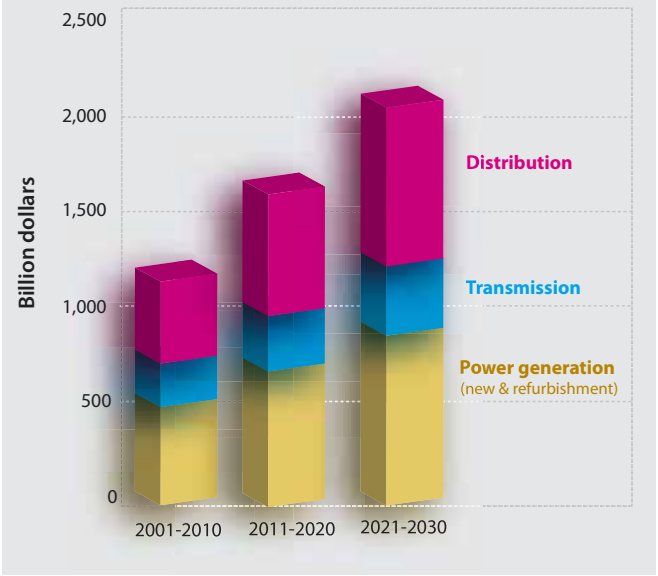


Figure 4: **Investment in Electricity,**
Developing Countries, 2001-2030



lutants are tight and are becoming tighter in many OECD countries, which will significantly increase investment requirements.

Challenges in Developing Countries

Capital flows to the power sector will need to rise substantially over the coming decades to meet rapidly rising demand *(see Figure 4)*. Mobilising the capital to build new power stations and add sufficient transmission and distribution capacity may prove an insurmountable challenge for some developing countries. The risk of underinvestment is perhaps greatest in many African countries and India. Public utilities are often not profitable and are, therefore, not able to finance new projects themselves. The poor financial health of utilities often results from low electricity tariffs or under-collection due to non-payment or theft.

Investment in power sector infrastructure in developing countries has traditionally been the responsibility of governments, though the 1990s saw an increasing number of countries turning to the private sector for part of the investment needed to finance the electricity sector. Direct government-funded investment in the power sector is likely to continue to decline, due to competing demands on government tax revenues and structural reforms aimed at promoting private participation. Government are, in many cases, also seeking to encourage competition.

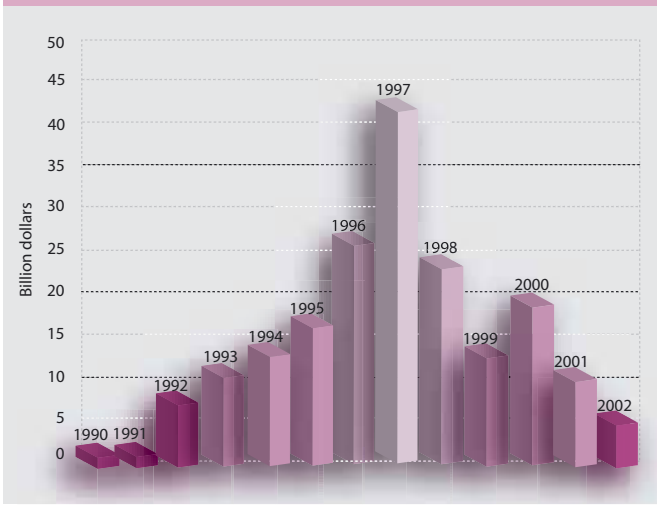
But attracting private capital is enormously challenging. Private investment in the power sector in developing countries has fallen sharply since the late 1990s, due to badly designed market reforms, economic crisis or poor returns on earlier investments *(see Figure 5)*.

Poorly developed domestic financial markets are often a major barrier to domestic investment. Another handicap is growing constraints on their ability to borrow money in international markets. Funds from international lending institutions and export-credit agencies have diminished in recent years. Exchange rate risk can also limit access to international financial markets.

Overcoming these obstacles will not be easy. It will require significant improvements in governance and deeper market reforms. A key challenge will be to reform tariff structures to make prices cost-reflective and improve revenue collection in a way that does not unduly hurt poor consumers who are not able to afford even basic electricity services.

Even if the huge electricity investment needs which arise in developing countries in the IEA's reference scenario are met in a timely fashion, there will still be 1.4 billion people without access to electricity in 2030. It is not that no one is trying. The proportion of the population without electricity will fall by a third in that timescale — but population growth will maintain the absolute numbers very close

Figure 5: **Private Investment in Electricity**
Developing Countries, 1990-2002



to their present level. This is morally and economically unacceptable and signals the need for action by industrialised countries to reduce such extremes of wealth and deprivation.

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[1] Total cumulative investment divided by cumulative world GDP (in year 2000 dollars at market exchange rate) between 2001 and 2030.