Development Policy and Analysis Division
Department of Economic and Social Affairs

Global Policy Model

A low-carbon, high growth policy scenario for the world economy

United Nations
New York, 2009

Extract from *World Economic and Social Survey 2009,* Chapter I, pp. 23-28; 31-34, available at: http://www.un.org/esa/policy/wess/index.html

Is low-emissions, high-growth feasible?

A low-emissions, high-growth scenario

To assess various scenarios for the implications of an investment push given to address the combined challenges of catch-up growth and climate change, an experimental simulation was run with the Global Policy Model (GPM) developed in the Department of Economic and Social Affairs of the United Nations Secretariat. The Global Policy Model was developed to investigate the spillover effects of macroeconomic policy scenarios in an interdependent world economy. The model is centred around standard macroeconomic relations, including complete specifications and econometric estimations of the stock-flow adjustment of real and financial assets and liabilities. An important long-run characteristic is the assumption of endogenous productivity growth generated by economies of scale. Under this assumption, Government policies affecting aggregate demand and market size will have long-term growth effects. When the model hits on supply constraints, it adjusts prices and exchange rates, along with endogenous macroeconomic policy responses (based on past policy behaviour) and adjustments in financial markets. Supply constraints arising from pressure exerted on natural resources and energy will trigger higher world market prices for commodities and fuels, affecting production and consumption throughout the system. The basic version of the model distinguishes 16 countries and country groups.[1]

While mainly macroeconomic in nature, the model does spell out simultaneously energy production and demand for country groups and an international market (a pool) which sets the equilibrium price. Energy demand is estimated based on historical observations, tracing changes in relation to output (income), population and the state of technology measured in the form of relative income per capita, as well as the international price. Energy production is assumed to be determined by domestic energy resource endowments, technology and demand dynamics linked to change in the production structure, consumption patterns and relative prices of energy. The model does not specify carbon emissions linked to economic activity; therefore, inferences regarding climate change scenarios are drawn from trends in energy efficiency and energy use.

The business-as-usual (BAU) scenario used as the basis for the present analysis assumes that the world economy will recover from the financial crisis in 2010. The return to the past pattern of growth, moreover, will lead to a continuation of the current trends in (high-emissions) energy intensity and the economic inequality of past decades. The implication is that, in the business-as-usual scenario, the world would resume growth on a path deemed unsustainable from both a development and an environment perspective.

The alternative, low-emissions, high-growth (LEHG) scenario, having been constructed as a policy-driven departure from the business-as-usual scenario, requires international policy coordination. Three types of policy adjustment are considered as follows:

- Countries worldwide are assumed to increase public spending levels by between 1 and 5 per cent of GDP, with developed countries in the lower end of the range and developing countries in the upper end. The investment push is

1 These include the United States of America, Western and Eastern Europe, Japan, other developed countries, East Asian newly industrialized economies, the Commonwealth of Independent States (CIS) (here incorporating all countries of the former USSR for reasons of historical data consistency), China, Western Asia (excluding Israel which is grouped under "other developed" countries), India, other South Asia (Afghanistan, Bangladesh, Sri Lanka, Nepal and Pakistan), East Asian middle-income countries (excluding the newly industrialized countries), other East Asian low-income countries, Central America (including Mexico and the Caribbean), South America, African middle-income countries and African low-income countries.

expected to trigger faster economic growth and will embrace efforts towards energy efficiency, as well as help increase the supply of primary commodities and food at a rate that is consistent with the growth of world income;

- The investment push and international agreements should contribute to reducing high-emissions energy demand (reflecting, for instance, a cap-and-trade mechanism) to yield lower emissions and greater energy efficiency. Such improvements in energy efficiency are consistent with the investment patterns discussed below;
- Economic resilience of developing countries is strengthened by providing those countries, especially the poorest among them, with full and duty-free market access to developed-country markets, leading to greater economic diversification.

Energy efficiency and energy diversification

To assess the implications of changing course, levels of public investments in infrastructure, diversification of economic activity and energy provision are raised by Governments in all country groups. As discussed further in chapter IV, after possible financial 'crowding-out' mechanisms are accounted for, such public spending is found on balance to "crowd in" private investment. The assumption that public sector injections have the potential to boost energy efficiency was based on empirical evidence for a number of countries that have made important shifts in the recent past (see table 1). Energy efficiency is measured here as the rate of increment in kilograms of oil equivalent per dollar unit of output in real terms. The numbers reflect 20-year averages for 1970-1990, a period in which these countries pushed for greater energy efficiency in response to various oil price shocks. Investment in energy-saving led to reductions in the use of energy per unit of output of 50–200 per cent.

The first main element of the low-emissions, high-growth strategy simulated with the global policy model is therefore injections of public investment which, for developing countries, would be at least as decisive as for the cases presented in table 2. Such positive shocks yield different results according to the inherited economic structure and institutional patterns captured in the econometric specifications. The table summarizes the outcomes as 20-year averages at the end of the simulation period in 2030.

Such results, even if challenging at first sight, are nevertheless reasonable in the context of acknowledged success stories. Developed countries would be achieving very high efficiency improvements, almost as high as in the best of the cases presented above, albeit with slightly higher investment support. Meanwhile, the improvements expected for

Table 1
Energy use and total investment, selected country cases: 20-year averages taken in 1990

	Efficiency: change in energy use per unit of output (percentage)	*Stimulus: rate of growth of total investment in real terms (percentage)*	*Elasticity: ratio of impact of investment to efficiency*
Switzerland	-1.18	2.10	0.6
Finland	-2.03	4.31	0.5
France	-3.21	3.30	1.0
Sweden	-5.79	2.59	2.2
Japan	-1.98	4.15	0.5
United States	-2.94	3.02	1.0

Sources: United Nations, *Energy Statistics Yearbook*, various years; and *National Accounts Statistics*, various years.

developing countries would be considerably higher compared with their past performance, but the impulse from investment is also significantly higher and is sustained over the long term. Hence, the elasticities (ratio of change in investment to energy efficiency) would be in these cases half of those in the developed world. This is a reasonable pattern. The catch-up process in technology improvements cannot be expected to yield immediate results. In addition, not all investments are supposed to be allocated to the energy sector and some growth-enhancing might even require greater energy use.

With the world economy growing at about 5 per cent during 2010-2030, the effective reduction in global energy use per unit of world output will be about 6 per cent

To what extent these improvements in energy efficiency result in effective reductions of fossil fuel production and therefore CO_2 emissions cannot be established with exact precision by the Model in its current state of development. Given the Model's assumptions, the coordinated policy scenario would reduce the global use of energy, measured in millions of tons of oil equivalent, at an annual rate of about 1 per cent between 2010 and 2030.[2] As noted in figure 1 below, with the world economy growing at about 5 per cent during this period, the effective reduction per unit of world output will be about 6 per cent, broadly consistent with the numbers obtained for energy demand given above (see table 2).

Improving energy efficiency is not enough: it will need to be complemented by massive investments in renewable low-emissions energy sources, leading over time to a drastic change in the composition of energy sources

The scenario presented here would lead to a cumulative reduction in the use of oil and coal of about 50 billion of tons of oil equivalent between 2010 and 2030. This reduction is about three times the level of world consumption of fossil fuels in 2008. Clearly, this is not sufficient to achieve the required 50-80 per cent reduction by 2050 or a commensurate reduction of 25-40 per cent by 2030, as required. In other words, improving energy efficiency is not enough: it will need to be complemented by massive investments in renewable low-emissions energy sources, as assumed in the model simulations, leading over time to a drastic change in the composition of energy sources.

Admittedly, this is an optimistic scenario and the impact of the investment push on energy efficiency may not be as successful as the model outcome signals. Suppose, for example, that the improvements in energy use per unit of output are in the order of 4 per cent per annum instead of 6 per cent. Still, it would be possible to reach the same target for reduction of fossil fuel production (and thus of environmental contamination) if, alternatively, the investment strategies were geared towards the production of non-fossil

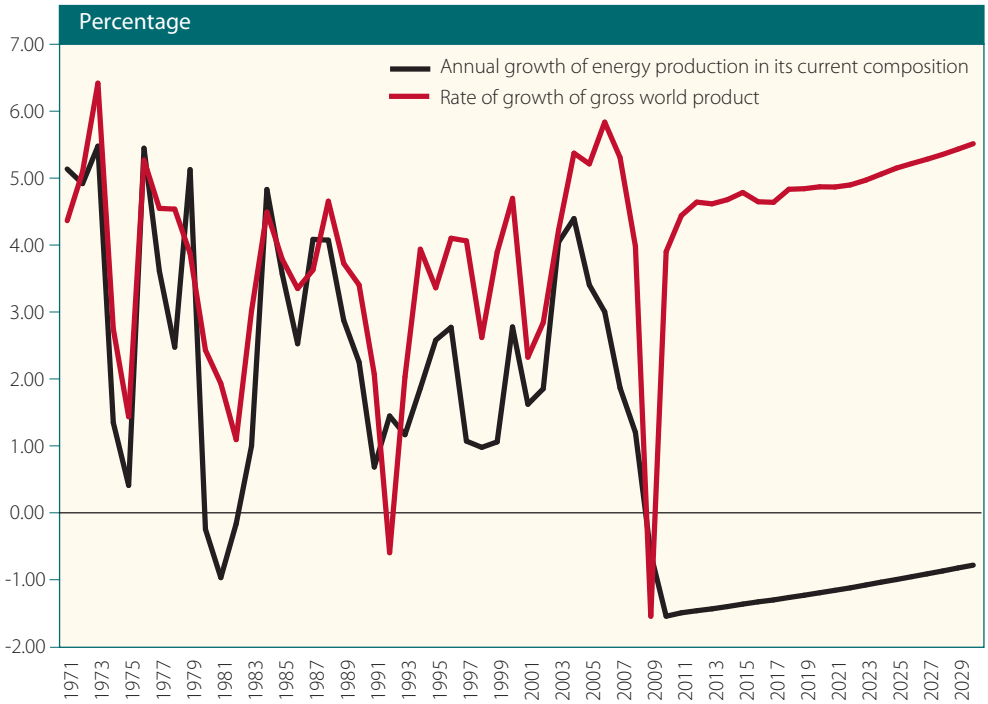
Table 2
Energy use and total investment (model output: 20-year averages taken in 2030)

	Efficiency: change in energy use per unit of output (percentage)	*Stimulus: rate of growth of total investment in real terms (percentage)*	*Elasticity: ratio of impact of investment to efficiency*
Developed countries	-5.20	2.90	1.80
Japan	-5.00	3.75	1.30
Europe	-4.80	2.92	1.60
United States	-5.40	2.54	2.10
Developing countries	-5.80	6.80	0.90
China	-6.40	6.45	1.00
Least developed countries	-6.65	9.90	0.70

Source: United Nations, Department of Economic and Social Affairs, Global Policy Model.

2 The aggregation into tons of oil equivalent assumes the evolution over time of the current composition of energy production.

Figure 1
Growth of world income and of energy use



fuels. This case will require annual increments of low emitting energy of the order of 2 per cent sustained over the long term—a requirement that is not impossible to fulfil. In a study of various country experiences, the Department of Economic and Social Affairs of the United Nations Secretariat and the International Atomic Energy Agency (2007) note that, between 1980 and 2000, Brazil increased the production of biofuels and hydroelectricity (covering about 40 per cent of the total demand for energy) at the rate of 2.25 per cent per annum. Significantly better records have been obtained in France through its shift to nuclear energy.[3] The biofuel or nuclear alternatives are not, of course, free of causes for concern. However, other sources, like wind, solar and hydroelectric, are valid options and are likely to become far more efficient as technologies advance.

Financing or access to markets?

There is no doubt that the low-emissions, high-growth strategy will carry high initial costs for both developed and developing economies. The former, however, are in a better position to advance on this path because they have the financial and technological resources; but even if they do achieve the kind of targets proposed above, this will certainly not be sufficient in terms of meeting global climate goals.

The success of a truly sustainable development strategy requires that developing countries take significant steps towards attaining diversification into industry and services

It will therefore be necessary to devise financing schemes through which the resources needed by the developing world to start out on this path are supplied by the developed world. It seems unlikely that developed countries would continue to finance such an investment push for too long. To highlight this difficulty, the global policy model produced

3 United Nations, Department of Economic and Social Affairs, and International Atomic Energy Agency, Energy indicators for sustainable development: country studies on Brazil, Cuba, Lithuania, Mexico, Russian Federation, Slovakia and Thailand (New York, Department of Economic and Social Affairs of the United Nations Secretariat, 2007).

an alternative low-emissions, high-growth simulation, fully dependent on external borrowing or aid, which is discussed in greater detail in chapter VI. Worthy of note, however, is the fact that such an outcome might very well leave developing countries still dependent on commodity exports and exposed to sharp price volatility, in addition to being saddled with the accumulation of external debt problems. The scenario also highlights how critical it is for the success of a truly sustainable development strategy that developing countries take significant steps towards attaining diversification into industry and services.

The scenario presented here assumes concerted action by policymakers, particularly in industrialized economies, that strongly encourages improved access of developing countries to the markets of those economies for manufactures and services. If this is accompanied by an international accord that encourages steady-state growth of production of food and primary materials and thus stable terms of trade (as is the case for agricultural prices in the European Union (EU) and elsewhere), their rapid expansion will benefit not just developing countries themselves but developed countries as well.

As soon as there is a plan in place to increase the market share of developing countries in manufactures and services, the need for external resources will diminish sharply

However, as indicated in chapter VI, the initial investment push will inevitably require financial support extended from developed to developing countries and, most particularly, to the least developed among them. As soon as there is a plan in place to increase the market share of developing countries in manufactures and services, the need for external resources will diminish sharply. Furthermore, in the absence of an external debt burden, a combination of stable prices of commodities and a sustained growth of income in both the developing and the developed world will contribute to a significantly less dramatic set of fluctuations in domestic prices, interest rates, exchange rates, etc., thus helping to avert sequences of stop-go adjustment-stabilization processes which have been so damaging for long-term development over the last decades.

Assessing the simulation results

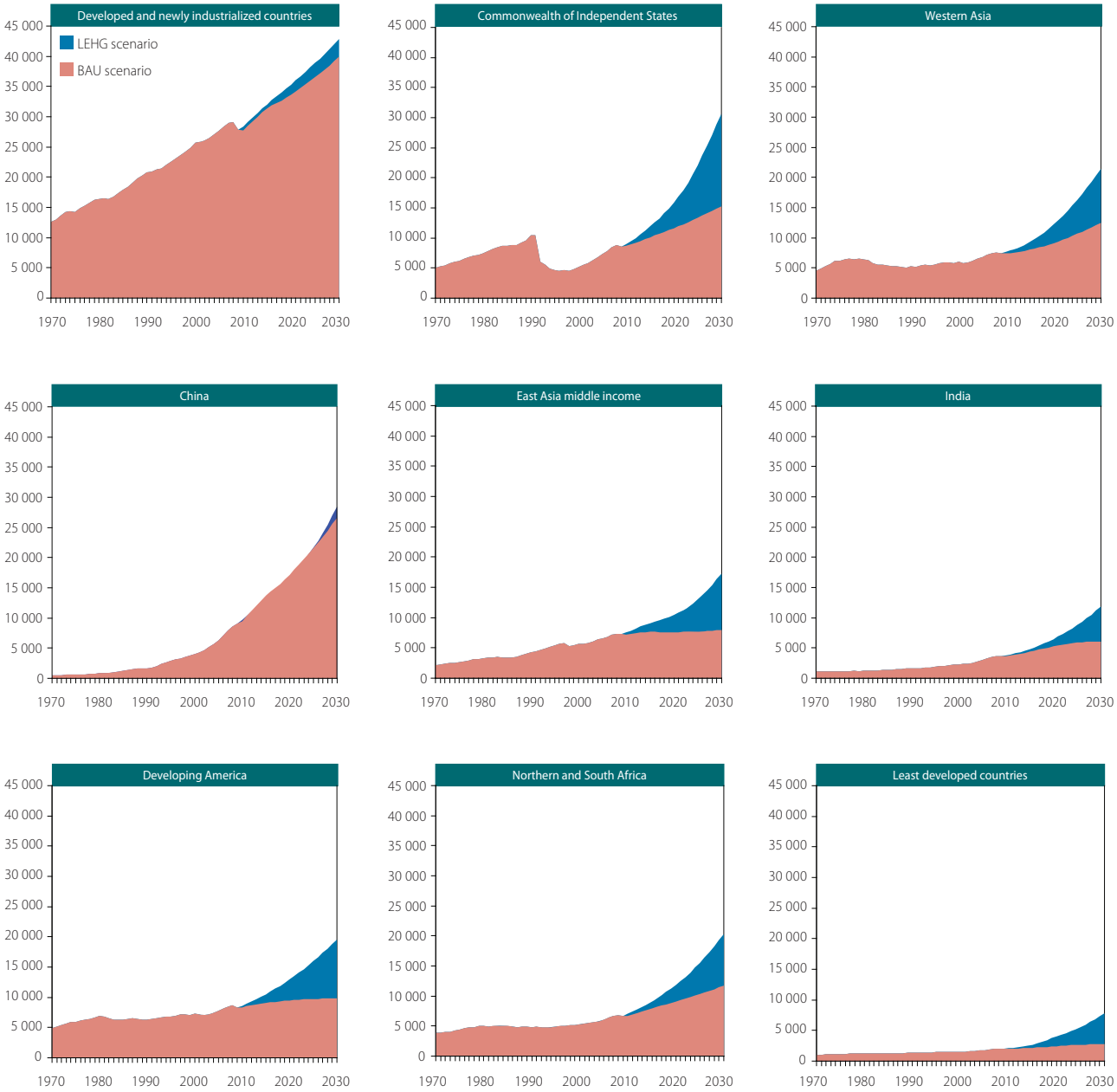
This empirical exercise aimed at assessing whether the low-emissions, high-growth path postulated is a feasible one from an economic point of view. It clearly is. It succeeds in achieving perceptible improvements in reducing absolute energy consumption despite sustained rates of global economic growth, as discussed above. It also yields significantly higher rates of growth in the developing world and it also allows the developed countries to grow at a faster pace than under the business-as-usual scenario. The critical factor driving these patterns is public investment-led expansion. This is on a significant scale, though not extraordinary compared with some instances and the experience of some countries in the past. In terms of income per capita, this scenario yields an improvement for all blocs and, in particular, it significantly raises poorer countries to a level from which they can proceed in the direction of a smooth and unimpeded convergence. Finally, it contributes to export diversification, stable terms of trade and a smooth reduction of the external imbalances that have proved to be unsustainable. The plots in the annex to this chapter summarize these findings for the above-mentioned variables.

The potential shortcomings of the scenario presented here are not to be attributed to the underlying economic principles but rather to the political processes that are required in order for a big push to take place

It is critical, however, to stress that the potential shortcomings of this scenario are not to be attributed to the underlying economic principles of the model simulation but rather to the political processes that are required in order for such a big push to take place. Without serious international policy coordination, this scenario cannot work. It is to be hoped that the gravity of the crisis in which the global economy is actually immersed owing to the lack of proactive policy intervention, and the seriousness of the environmental challenge, would be sufficiently powerful to impel policymakers to commit to achieving such a common goal as is exemplified by the low-emissions, high-growth strategy.

Annex

Figure A.I.1
Low-emissions, high-growth global scenario: trends in income per capita, by country groups, 1970–2030
(2005 United States dollars purchasing power parity)



Source: UN/DESA, simulations with UN Global Policy Model (see text for model assumptions).

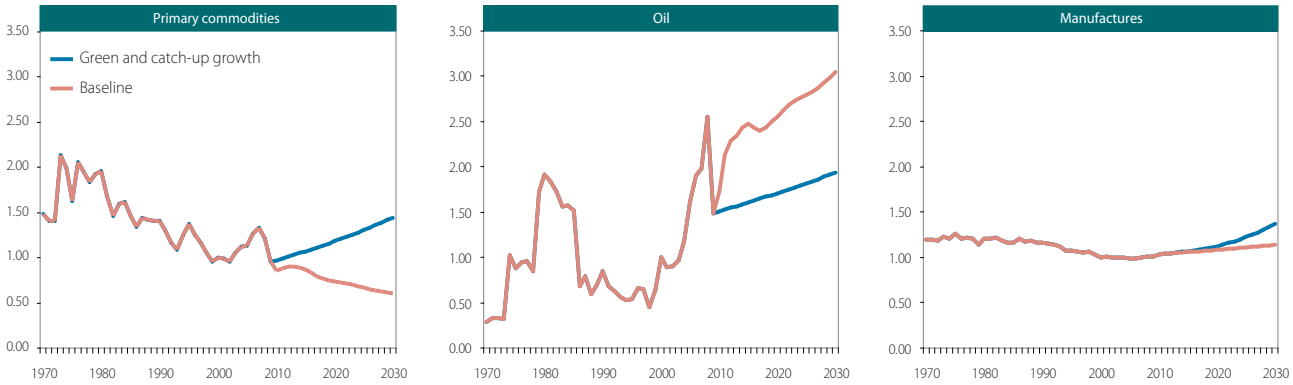
Figure A.I.2
Low-emissions, high-growth global scenario: GDP growth by country groups, 1970-2030
(long-term income growth, 20 years moving average (percentage))

Source: UN/DESA, simulations with UN Global Policy Model (see text for model assumptions).

Figure A.I.3
Low-emissions, high-growth global scenario: growth of real public spending, 1970-2030
(long-term income growth, 20 years moving average (percentage))

Source: UN/DESA, simulations with UN Global Policy Model (see text for model assumptions).

Figure A.I.4
Low-emissions, high-growth global scenario: world market prices of oil, primary commodities and manufactures, 1970-2030
(relative price indices, 200 = 100)



Source: UN/DESA, simulations with UN Global Policy Model (see text for model assumptions).
Note: Commodity price indices were deflated by implicit price deflator of world gross product.