



WORLD ENERGY COUNCIL
CONSEIL MONDIAL DE L'ÉNERGIE

Deciding the Future: Energy Policy Scenarios to 2050

Executive Summary

World Energy Council 2007

Promoting the sustainable supply and use
of energy for the greatest benefit of all



Deciding the Future: Energy Policy Scenarios to 2050

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Introduction

To meet the energy demand of all households worldwide, energy supplies must double by 2050. This is the most important finding of WEC's Energy Policy Scenarios to 2050.

This may sound like a tall order, but there are enough energy resources around the world to satisfy the energy demand over the next forty-plus years.

The challenge will be how to get these resources and energy services from where they are produced to the places that have the greatest need for them.

The second most important finding is that while fossil fuels will continue to account for the largest proportion of primary energy requirements through the next four decades, we can not only double world energy supplies and improve access but also effectively manage greenhouse gas emissions and address climate change.

The main driver to address this dual challenge will be higher energy prices. Higher prices will propel the developed world towards greater energy efficiency and attract much higher levels of capital investment in infrastructure. But massive new levels of public and private investment in research, development and deployment of clean and more efficient technologies are also urgently needed.

Governments must do their part by establishing global rules of energy trade and setting a stable price for carbon that is clearly understood by markets and investors. Government engagement in these and other areas must be encouraged while much deeper cooperation and integration within and among regions of the world, and between the public and private sectors is essential. The private sector must be correspondingly engaged.

It is a myth that the task of meeting the world's energy needs while addressing climate change is simply too expensive and too daunting. With greater cooperation, greater investment, and clear rules for energy trade, together we can build a sustainable energy future.

Turning the traditional modelling approach upside down

To provide insight on the rapidly changing environment in which the energy sector operates, beginning with *Energy for Tomorrow's World* published in 1993, WEC has updated or built new energy scenarios. In 1998 *Global Energy Perspectives*, published with the International Institute for Applied Sciences (IIASA) in Vienna, became a reference in the energy sector.

Starting in 2000, WEC went a step beyond, providing a list of actions linked to these scenarios, including three sustainability goals which have now become widely understood within and outside the energy sector, as the 3 A's: to meet global energy demand, future energy supplies must fulfill three criteria: **accessible**, affordable modern energy for all; **available** energy, that is, reliable and secure delivery; and **acceptable** - meeting social and environmental goals.

In this year's *Energy Policy Scenarios to 2050*, we decided to take a new approach to scenarios, moving away from strictly statistical

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modelling to an approach that would take us into the field for a bottom-up regional view of our energy future focusing on policies to ensure energy sustainability.

A series of 20 workshops were conducted from July 2005 to April 2007 in various regions of the world. Over 400 principals from industry, government, academia, NGOs and trade groups gave their views of how to meet the need for energy that is accessible, available, and acceptable by 2020, 2035 and 2050. These experts came from the five global regions, Africa, Asia, Europe, Latin America and the Caribbean and North America, and from all facets of energy planning: energy production, finance, academia, civil society, and government. These qualitative views of how policies can address future challenges to the delivery of clean energy services in all regions of the world were checked for consistency against a mathematical model of the energy sector. In addition, seven specialist groups provided current data on everything from climate change to power generation, energy price drivers and electricity consumption patterns, transport and finance.

Introducing our global policymaking framework

Using the metaphors of four well-known animals, the work of the WEC Scenarios group delineates four possible approaches by decision makers to the challenges of delivering future energy in a sustainable and secure way. These will vary by

degree from country to country and region to region.

These four approaches are represented by:

- ▶ The **lion**, a highly skilled, social animal that launches its forays after careful planning and in a highly cooperative effort, exercising great control and discipline, represents strong government engagement, together with close cooperation and deep integration of the public and private sectors, domestically and internationally.
- ▶ The **giraffe**, a highly adaptable and independent creature that thrives in an unstructured environment and sees opportunity at great distances, describes market-driven actions made with minimal government involvement but a high degree of cooperation and integration of the public and private domains, domestically and cross borders.
- ▶ The **elephant**, a social animal with good memory that relies mostly on its own well-structured family unit with little cooperation between families, characterizes government deeply engaged in policymaking, but with little cooperation between nations or integration of the public and private spheres.
- ▶ The **leopard**, a solitary creature who is swift to act in isolation, and represents energy responses with little government involvement and little cooperation and integration of the public and private sectors.

Toward a new global energy regime

While each region has different priorities for developing its energy supply and services, the achievement of WEC's 3 A's depends in all regions on closer cooperation and integration.

As fresh talks get underway during the UN Framework for Climate Change (UNFCCC) meetings about the post 2012 period, a major finding of the WEC Scenarios should be kept in mind: regions of the world, with their varying rates of economic and social development, do not have the same policy priorities.

Africa, the least developed region, is principally concerned with increasing access to energy. On the other end of the spectrum, Europe, with a mature and well-developed regional economy, places more emphasis on energy acceptability in its policymaking.

For the less developed regions, including Asia, Africa and Latin America, WEC regional findings show that greater cooperation and integration offers the best route to achieving WEC's 3 A's simultaneously. Reliance on international agreements and laws will not be enough to accomplish these objectives. This also means more partnerships with developed countries to transfer technology and expertise will be critical to fulfilling the right balance of these energy priorities.

Greater government involvement will also help develop sustainable energy but will have less impact, and developing countries will get the most benefit from it, since government support is needed in countries with a less developed private sector.

Lion: strong global economy, global pacts on emissions, and on dealing with energy poverty

Overall, the lion scenario, with high levels of government involvement and high levels of cooperation and integration, proved broadly the best strategy for achieving WEC's 3 A's in all regions in the developed and developing world.

Of the four scenarios this approach produces the best estimates for maintaining a strong global economy while reducing energy intensity, tackling climate change, and improving access to modern energy sources and services. Governments and the private sector share their expertise and experience, bolstering regional energy integration. After intense negotiations, international agreements are struck to curb greenhouse gas emissions and eradicate energy poverty, although tensions persist.

Africa – living standards improve, energy access leaps ahead

Strong economic growth leads to higher per capita GDP, and as living standards improve, population growth rates decline after 2020. Better growth rates encourage more financing and technology transfer in the energy sector, and Africa adopts the latest technology. Governments tap the international public and private communities, and in a common goal to eliminate energy poverty develop secure energy supplies and services, and mitigate the effects of climate change.

Access to modern energy is significantly increased, as governments commit to delivering reliable energy to more people, creating incentives to develop energy technologies that suit local conditions, and mitigating the effects of climate change with greater international assistance. Institutional financing and the private sector play a greater role in developing energy infrastructure. A more diverse energy mix is the result, with more biomass for households, more biofuels for transport, and more natural gas for domestic and commercial use.

Asia – economy still on a roll, clean development becomes top priority

Large electricity supply projects dramatically increase the number of people who get access to modern energy, while regional cooperation leads to integration, which increases reliability of the system. Developed countries invest heavily in regional energy infrastructure. Governments adopt policies to improve energy efficiency, curbing energy demand. The latest technology is adopted, thanks to better international cooperation, although the shift to clean energy is held in check to some extent by robust economic growth.

Latin America and the Caribbean – *pressure to protect the environment*

Private sector involvement in the energy sector is damped somewhat by close involvement of national and foreign governments. Population growth recedes starting in 2020 as living standards rise. With greater access to international financing, management and technology, major energy infrastructure projects are undertaken which increases access to reliable energy. Under national and international pressure, local policymakers place protection of the environment high on their agenda.

Europe – *energy gets more affordable, coal use declines*

Greater opening of energy markets to international players leads to more competition and lower energy prices. Consumer countries sit down with producer countries to strike long-term

supply agreements on natural gas, which by 2050 helps the Continent wean itself off coal use by 50%.

Governments cooperate and commit to greater opening of their energy markets, boosting competition and lowering energy prices. Greater energy availability also results from pacts between the consuming countries of Europe with energy-producing countries, so natural gas use rises and coal use drops by half. Governments craft clean energy policies that meet with the approval of business.

North America – *greater assistance abroad, greater green efforts at home*

North America commits to greater efforts to improve access to modern, reliable energy in other regions of the world. International cooperation leads to steady improvements at home in developing an environmentally sustainable energy system.

Giraffe: *freer markets lift global GDP, population growth eases*

With governments only minimally involved and strong cooperation and integration regionally and internationally, efforts are directed at freeing up global markets to boost economic growth, trade and affordable energy. Markets are emphasized, and governments stick to market regulation with little recourse to taxes and subsidies. There is freer movement of goods and services worldwide, and energy sources are more diverse. Population stabilizes and declines in some regions.

Africa – *energy demand slackens, availability improves, energy access for all achieved*

Due to strong involvement of the private sector internationally and continent-wide, innovation in energy technology is enhanced, reducing energy costs and boosting access to modern energy. CO₂ emissions stay high, as government involvement remains low and coal and natural gas use rises, although biofuels are also adopted for transport. Without government

incentives, renewables are adopted late. Energy efficiency and conservation are introduced due to more transfers of know-how and technology.

Asia – *oil and gas use rises, and so do emissions*

Buoyed by strong economic growth, fossil fuel use rises in Asia, also due to better integration of regional energy markets, increased energy trade, major investment and technology cooperation. Electricity supply expands as countries make more power available off-grid from renewable energy.

Europe – *mostly status quo, low carbon technologies emphasized*

Consumers are more prosperous, as market forces are kept in balance. Greater cooperation results in more efforts to deal with the effects of climate change, but progress is limited by the lack of strong government involvement. Europe remains satisfied with its energy system as it is.

Latin America and the Caribbean – *poor infrastructure holds prosperity in check*

Governments do not act to reinvest in energy infrastructure, which damps economic growth. Energy intensity eases later on, due to a long timescale for technology transfers to take effect, thus stabilizing energy demand at the same time. Private sector investments in energy rise, but not necessarily aligned with market needs. Investments in environmental protection lag.

North America – *Clean energy becomes a bigger priority*

International and regional actors pressure North America to devote more attention to dealing with the effects of energy use.

Elephant: *energy supplies more secure and diverse, slight cut in emissions*

In a scenario of strong government involvement in energy planning but minimal cooperation and

integration by the private sector, governments make energy security a top priority by diversifying supplies and suppliers, leading to faster economic growth than under the leopard scenario, but not as fast as with lion or giraffe. Energy intensity eases everywhere for most of the period to 2050. Thanks to government pressure and government requirements to boost energy efficiency, energy demand rises initially and then tapers off. Lack of international cooperation means emissions reductions remain limited.

Africa – *energy access improves, low carbon planning stagnates*

Lack of international cooperation stymies curbs in emissions, which region governments alone do not have the power to rein in, while energy intensity in the long term gets worse amid lack of access to new technologies. Governments increase access to energy and domestic energy production improves, although production capacity is constrained by a lack of technology transfer and less effective international aid programs. Low carbon policies are a low priority.

Asia – *leap forward in power production and clean energy*

Many governments commit to reducing fossil fuels and bringing on-stream large power plants, especially in China and India. Emissions rise until late in the period to 2050 but then start to decline because of more efficient technology. Governments place high on the agenda long-term energy security, promoting cleaner fuels, and renewable energy in rural areas.

Europe – *governments back energy companies, strike big bilateral deals*

Governments support the growth of energy companies and attempt large bilateral agreements in the region. Clean energy gets a modest lift from government intervention. But without greater international cooperation, governments are unable to propel long-term increases in reliable energy access.

Latin America and the Caribbean – energy intensity and energy access worsen

As agricultural and industrial exports rise and thermal energy takes up a larger share of power generation, energy intensity does not improve. Governments succeed in diversifying energy supplies by adding more wind power, solar heating, biofuels and natural gas early on, and generating more power from coal and nuclear fuel later on. Lack of private sector involvement in research and development and lack of investment in mitigating the effects of climate change mean the region makes very little headway in developing technologies locally. It also translates into low involvement by the region in the Clean Development Mechanism, in which industrialized countries help meet commitments to cut emissions under the Kyoto Protocol by investing in emissions reductions projects in developing countries.

North America – energy infrastructure ages, private investment wanes

Deeper government engagement coupled with low cooperation displaces private sector initiatives in developing energy infrastructure. As a result, the energy system goes into decline, and reliability suffers. Without high levels of cooperation, low carbon initiatives lose momentum in the middle of the planning period.

Leopard: slower economic growth, higher emissions, greater uncertainty

In a scenario of light-handed government and little global or regional cooperation, countries are preoccupied with their own security of energy supply. Governments adopt few energy taxes and subsidies. Uncertainty leads to slower economic growth and underinvestment in the energy sector. Energy intensity worsens in the developing world, and declines less rapidly elsewhere. Greenhouse gas emissions rise until later stages, when technology advances eventually kick in. Energy demand continues to rise.

Africa – little progress on increasing energy access

Technology transfer, foreign investment, and access to clean energy are limited due to low government involvement and low regional and international cooperation. Improving access to reliable energy remains difficult, demand for non-commercial energy increases and poverty worsens.

Asia – climate change gets short shrift

The electricity grid is expanded, as slow but steady economic growth helps the region to meet rising energy demand. Lacking strong government commitment, neither nuclear power nor renewable energy are developed to the fullest. Energy security is a high priority and little attention is paid to climate change.

Europe – clean energy develops late

Security of supply is hampered in 2020, as Russia pursues its own agenda and Nordic markets become more insular. National champions develop, blocking access to EU markets for non-EU companies. Close to 2050, European energy companies develop more sustainable practices.

Latin America and the Caribbean – energy rationing, high-energy prices

This scenario is bad for the region's economy, energy consumers and the environment, leading to the formation of cartels, energy rationing, high-energy prices, meager economic growth and inefficient, environmentally damaging energy delivery.

North America – setback in energy security

Without clear lines of accountability to maintain and develop energy infrastructure, North America's energy supply becomes less reliable. With low cooperation, security of supply is less assured than before. Clean energy develops slowly and is not a priority for policymakers.

Dynamics of global energy markets

There was a general convergence of expectations among the WEC experts on the shape of energy markets which lead to these dynamics.

Energy supply and demand

At least by 2050, the world will need to double today's level of energy supply to meet increased demand.

- More primary energy will be needed initially in 2020, although some regions will moderate this need by more energy efficient technologies.
- To double energy supplies, policymakers must keep all energy options on the table.

Supply-demand balance

Oil

- Greater government engagement will help ease tension in global oil markets, coupled with greater private sector cooperation and integration.
- However, more private sector collaboration without greater government commitment may lead to a ratcheting up of oil market tensions, as higher economic growth would lead to increased demand for energy and higher energy prices, rather than more widely available energy.
- A large drop in oil production in the Middle East due to technical constraints or lack of good planning on oil field development

would also raise tensions in energy markets overall.

Gas

- Tensions in the gas market will get worse in most regions, especially early 2020 through to the end of the planning cycle, due to higher demand, as gas becomes an important resource to help reduce global greenhouse gas emissions.
- Russia becomes a gas-based economy, possibly raising tensions in European and Asian markets.
- Gas market tension rises in the Americas from 2020, but eases from 2035 as increased gas exploration brings more new supplies on stream.

Coal

- Coal supplies are adequate to meet short-term demand until late in the planning period, but when demand is high, tensions mount, stemming from environmental pressures exerted by governments.
- Later on, tensions mount as coal-to-liquid technology increases demand.
- If the capture and storage of carbon becomes feasible, demand will rise for coal and supply-demand tensions will result.

Nuclear

- Tensions will grow in nuclear markets, especially in Asia and Africa, as the combined need for more secure carbon-

At least by 2050, the world will need to double today's level of energy supply to meet increased demand.

free energy supplies results in increased demand. Supplies may be limited by slow government action on advanced standardised designs and by the inaction on the part of the international community in dealing with the dual concerns of waste disposition and weapons proliferation. Strong cooperation between international government and industry players is essential for developing a nuclear power sector in the developing world.

Renewables

- Energy from renewable sources will have an important impact on markets during the time period, but will not dominate any market.
- As consumer expectations grow for more renewables, supply-demand tensions rise as demand outstrips supply.

Non-conventional energy

- The use of non-conventional energy decreases in Asia, Latin America and Africa – first in Asia where progress is already underway and later in Africa because of a lack of effective government engagement.

Achieving a sustainable energy future

A doubling of supplies can be achieved by 2050 with cleaner and more efficient technologies, the underpinnings of a low carbon economy.

Fossil fuels should remain a fixture in a low carbon economy, produced more efficiently with more effective management of greenhouse gas emissions.

If there is government commitment and private sector collaboration, energy intensity will continue to decrease.

The energy mix will become more diverse, provided government assumes a strong role in RD&D and the private sector cooperates

Choices of new energy technologies and sources will be driven by higher energy prices, setting a global carbon price high enough to affect choices without crimping economic growth, especially in developing countries, and considerations for higher standards for clean energy production.

The world's energy mix will include more supplies of hydroelectricity, nuclear power with satisfactory planning for spent fuel, biofuels, biomass and other renewables.

A new framework for agreement on setting a value for carbon is critical, since without strong international cooperation and government involvement greenhouse gas emissions will not be managed, stabilised and reduced.

Setting Targets

The WEC study group believes the world can meet its requirements to double energy supply while meeting commitments for creating a low carbon world.

For the first time in the crafting of scenarios, the WEC study group has set targets for improving accessibility, availability and acceptability.

Targets will serve as benchmarks for policymakers to measure progress. These targets are realistic, and provided the political will exists for government and industry to work closely together in drafting the necessary policies and regulations, and make the massive investments required, they can be achieved.

Accessibility

Given that about two billion people have no access to commercial energy and another one billion have only sporadic access:

1. Reduce by half the number of people without access to a minimum level of modern energy services by 2035 to one billion from two billion (WEC defines this minimum as the annual electricity equivalent of 500kWh per person per year).
2. Halve again the number of people without access to energy by 2050 to five hundred million from one billion.

A doubling of supplies can be achieved by 2050 with cleaner and more efficient technologies, the underpinnings of a low carbon economy.

Availability

Given that most of the disruptions in delivering energy from source to end use have been related to underinvestment in energy transport infrastructure, such as pipelines and terminals, or due to market failures or political disagreements, WEC believes it is necessary to achieve the following:

3. Develop commercial and physical energy systems which are 99% reliable in Europe, North America, and parts of Asia by 2035.
4. Develop commercial and physical energy systems, which are 99% reliable in most of Asia, Africa and Latin America by 2050.

Acceptability

Given that environmental concerns will have a major influence on the future shape of the global energy industry:

5. Slow the rate of energy-related emissions growth significantly by 2020.
6. Stabilize CO₂ emissions from energy use by 2035.
7. Reduce anthropogenic emissions to current levels or below by 2050.
8. Decouple emissions from economic growth by 2050.

WEC policy recommendations

Regardless of the scenario in place, to spur greater development of clean and reliable energy in all regions, WEC uncovered seven policy areas that need to be addressed now, to raise investment in clean energy infrastructure. Each region will have its own local conditions to take into consideration when crafting policies:

- ▶ **Promoting energy efficiency** using all available methods along the entire energy chain, from exploration to final energy use, including consumer awareness campaigns, financial incentives, standards and regulations.
 - ▶ **Raising public awareness** of how the transport sector can play an important role in more efficient energy use, through changes in urban planning, energy efficiency measures, and technology development.
 - ▶ **Setting a global price for carbon** high enough to drive prices and motivate behaviour changes, and low enough not to hamper strong economic growth.
 - ▶ **Closer integration of energy markets** regionally and globally for greater economies of scale in energy demand and supply. To achieve this a new set of international trade rules for energy will address concerns over how to reconcile global energy trading and investment with a rising wave of energy company re-nationalizations, the build up of national energy champions, and escalating tensions between producer and consumer countries.
- ▶ **Creating a new international framework for technology transfer** from developed and developing countries that respects intellectual property, helps countries develop technologies meeting their energy priorities, and develops local skills.
 - ▶ **Global dialogue on security of supply and demand.** Energy consuming countries and regions are concerned about the threat to their way of living without secure supplies. Likewise, energy supplying countries are concerned about similar threats from a lack of assured demand. New international models of cooperation that provide for long term security on both sides are in order.
 - ▶ **Taxation, legal and commercial frameworks** that limit investment risk and fostering realistic expectations for risk and return.

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