世界水电发展的未来展望

美国能源信息部门（EIA）发布

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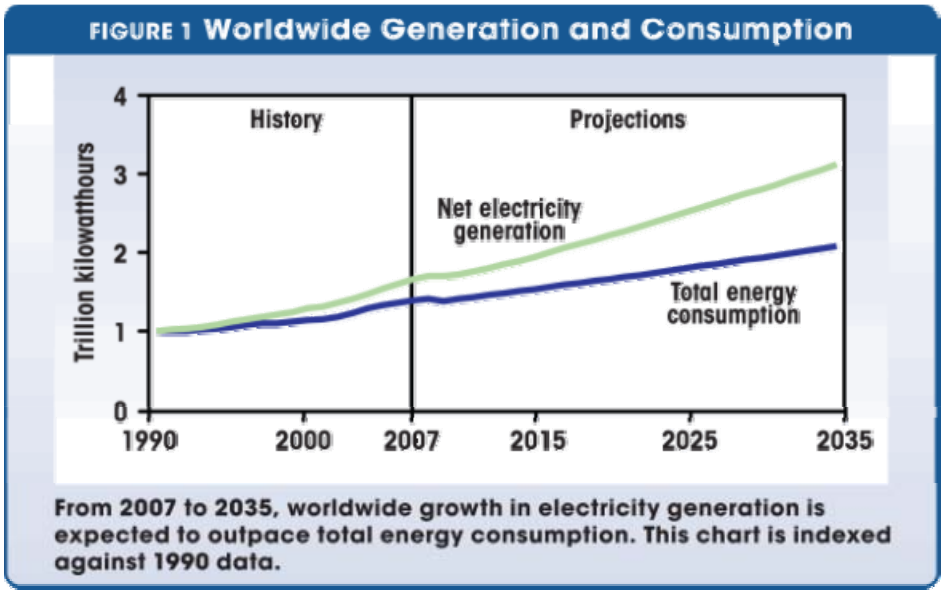
本文经美国能源信息部门同意，摘自《国际能源前景 2010 报告》

关于水电开发，不同的国家有不同的政策，但是水电开发及利用对于满足全球的能源需求是至关重要的。

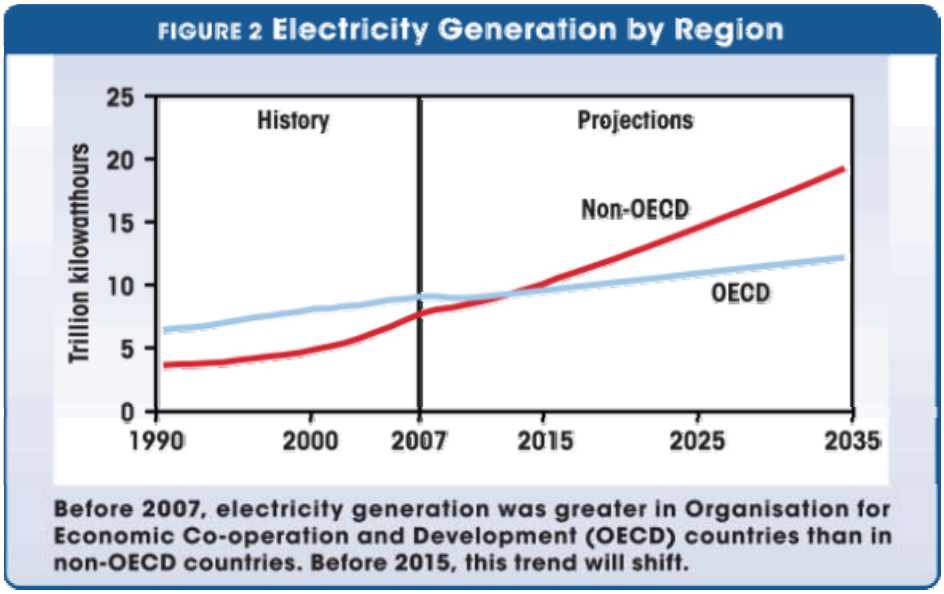
每年，美国能源信息部门（EIA）都会发布一份国际能源市场展望报告，其中也包括电力能源。2010 年发布的《国际能源前景 2010 报告》中对 2035 年之前的发展进行了展望。作为国际能源市场评估的一部分，EIA 分析了政策、激励机制等因素，并支持发展包括水电在内的可再生能源。本文将向读者提供对于世界水电未来发展潜力的分析，并阐述了现行的能源政策将如何影响对这种宝贵能源的利用。

概述

IEO2010 预测，2007—2035 年世界净发电量将年平均增长 2.3%（见下图）。相比而言，1990--2007 世界净发电量平均年增长为 1.9%。



一般而言，被预测的世界经济合作与发展组织成员国家（下称 OECD 成员国家）和发达国家，建立了完善的电力市场和成熟的消费模式，发电量增长低于非世界经济合作与发展组织成员国家（下称非 OECD 成员国家），需求明显未达满足（见下图）。无电网区域的电气化在预测增长趋势上起到了重要的作用。事实上，经过国际能源机构（IEA）估算，2008 年 22%的世界人口没有机会使用电力。



非 OECD 成员国家 2007 年消耗电力占世界总电力的 46%。至 2035 年将达到 61%。因此 2007--2035 非 OECD 成员国家净发电量年平均增长 4.1%，相比之下，OECD 成员国家年增长仅为 1.1%。

对 2030 年总发电量的预测将比 2009 年预测值少 0.3%，这主要是由于经济衰退的影响比以前预测的更为严重。与 IEO2009 比较，IEO2010 关于 2030 年电力组成预测也发生了改变。例如，液体燃料发电低了 11%，天然气和燃煤发电增加 5%，核电增加 9%，可再生能源发电增加 10%。

在 IEO2010 的参考事例中，可再生能源是增长最快的发电能源。世界可再生能源发电量将由 2007 年的 18%增加到 2035 年的 23%，水能发电占居第一。规划期间新的可再生能源发电量将增加 45000 亿 kwh，其中 24000 亿 kwh 来自水电。

除水电外，在规划期大多数的可再生能源技术在经济上还不能与化石能源竞争。政府政策或激励将为可再生能源设施的建设提供最重要的经济促进作用。

可再生燃料组成的变化，在 OECD 成员国家和非 OECD 成员国家是不同的。在前者中，大多数经济可开发水力资源已经开发；除加拿大和土耳其外，很少有大型水电工程的规划。这些国家的大多数可再生能源增长来自非水力资源。许多 OECD 国家，特别是欧洲，政府有许多政策——包括退关税（FIT），税收激励，市场分担份额——用来鼓励建设可再生能源设施。FIT 要求用户以高于批发价的价格购买可再生能源电力。尽管可再生能源的成本较高，但这些政策使可再生能源的发电商实现投资回报。

在非 OECD 成员国家，水电期待成为可再生能源增长的主要来源。水力发电强劲增长的国家有中国、印度、巴西、和包括马来西亚和越南的许多东南亚国家。

北美

北美作为最大的区域，2007 年占世界发电量的 27%。由于非 OECD 成员国家的需求快速增长，它的份额将减少。2035 年，北美占世界发电量仅为 19%。

美国是北美最大的电力消耗国。2007—2035 发电量将年均增加 0.8%。加拿大也有巨大的电力市场，在同一时期，发电量将年均增加 1.2%。墨西哥发电量将较快增长——2035 年前年均增加 3.2%，反映出其电力基础设施巨大的发展潜力。

美国的可再生能源的发电量将增加，用以满足 50 个州中超过一半的区域。在参考事例中可再生能源的发电大量大高于目前的预测，可再生能源的发电比例将从 2007 年的 8.5%增加到 2035 年的 17%。2009 年美国恢复通过与再投资行动，将 168 亿美元投向了能源效率和可再生能源，另外 40 亿美元信贷投向了可再生能源。

在加拿大，水力发电量将年增 0.9%。在安大略州，政府计划 2014 年 12 月前关闭 4 个燃煤电厂，并用天然气、核、水力、风力发电替代。煤电提供安大略 19%的电力。随着退役计划实施，加拿大的煤电从 2007 年 11500 亿 kwh 减少到 9700 亿 kwh。

加拿大可再生能源的发电比例在规划期基本保持不变。水电将为最主要的电力来源。2007 年，水电占总发电量的 59%，2035 年将下降到 54%。

加拿大有许多在建或计划的水电设施，魁北克水电公司在 Eastmain 附近建设装机为 768 MW 水电，在 Sarcelle 建设装机为 150 MW 水电，全部预计 2012 年投产。其它在建的包括魁北克 Romaine 河的装机为 1,550 MW 的 Manitoba 以及 Wuskwatim 装机为 200 MW 的水电站。因此，2007—2035 加拿大将增加 22,910 MW 水电装机容量。

2007 — 2035 年，墨西哥发电量将年增 3.2%，政府意识到国家电力设施要跟上电力需求的增加。2007 年 7 月，政府推出了 2007—2012 国家基础设施计划，它包括了一个投资 253 亿美元的改善和扩大电力基础设施的计划。作为计划的一部分，政府确立了 2006—2012 装机 860 万 kw 的目标。国家正在向实现这一目标迈进。

可再生资源是在墨西哥在规划期内，继天然气发电之后，第二快增长的电力。2007—2035 年，墨西哥可再生能源发电将年增 2.9%。该国目前可再生能源发电主要是依赖水电(73%)和地热(19%)。

墨西哥进行的主要水电工程：装机容量为 750 MW 的 La Yesca，计划 2012 年完成，计划的装机容量为 900 MW La Parota 工程，可能到 2018 年才能完成。在 IEO2010 的参考事例中，墨西哥的水电将年增 2.3%。2035 年，水电将占全部可再生能源发电的 60%以上。

欧洲的 OECD 成员国家

在 IEO2010 参考事例中，OECD-欧洲成员国的发电量年均增长 1.1%，从 2007 年的 340 万 GWh 到 2035 年的 460 万 GWh。大多数电力需求增长来源于人口增长强劲的国家（包括土耳其、爱尔兰和西班牙）和最新的 OECD 成员国（包括捷克、匈牙利和波兰）。

可再生能源是 OECD-欧洲成员国增长最快的电力资源，2035 年前年增 2.6%。但是，这些增长完全来自非水力资源，因为受世界上可再生能源优惠政策的鼓励。2001 年欧盟制定了有法律约束力的战略，2010 年可再生能源电力要达到 21%。在 2008 年 12 月“气候和能源政策”中重申增加可再生能源的目标，2020 年总能源的 20% 必须来自可再生能源。2007 年欧盟电力的约 21%来自可再生能源。

在 IEO2010 的参考事例中，并没有预测全部欧盟的可再生能源战略将按时实现。然而，现行法律期待建设更多的可再生能源而不是他们的缺乏。另外，一些国家提供经济激励促进可再生能源电力的发展，德国、西班牙、丹麦制定免关税政策，在工程完成后免税 20 年。欧洲政府对可再生能源电力的价格补贴继续，可再生能源电力的巨大增长趋势可以继续。

亚洲的 OECD 成员国家

OECD-亚洲成员国发电量年均增长 1%，从 2007 年的 170 万 GWh 到 2035 年的 230 万 GWh。日本发电量在现在和规划中期都占据亚洲区域的大部分份额，尽管它的电力增长在该区域和所有 OECD 成员国家是最慢的，年均仅有 0.5%。

在 OECD 亚洲国的三个经济体（日本、韩国、澳大利亚/新西兰）之间，发电燃料很不一样。在日本，天然气、煤、核是发电主体，其他是可再生能源电力和石油。水力发电到 2035 年预测占电力的 8%。

欧洲和欧亚的非 OECD 成员国

在 IEO2010 参考事例中，非 OECD-欧洲和欧亚成员国发电量年均增长 1.6%，从 2007 年的 16000 亿 kwh 到 2035 年的 25000 亿 kwh。俄罗斯是该区域最大的经济体，2007 年其发电量占该区域的 60%，预计可在规划期继续保持这一比例。

非 OECD-欧洲和欧亚成员国可再生能源发电量几乎全部来自水电，年均将增长 1.3%。这主要是维修和扩大现有电站的结果，例如于 2009 年 8 月中发生事故被损坏的俄罗斯的装机容量为 6,400 MW Sayano-Shushenskaya 水电站水轮机的重建。维修完成预计不会早于 2012 年。

新开发的工程包括俄罗斯的装机容量为 3,000 MW 的 Boguchanskaya 水电站和塔吉克斯坦装机容量为 3,600 MW Rogun 水电站。Boguchanskaya 水电站始建于 1980 年， Rogun 水电站始建于 1976 年，在上世纪 80 年代前苏联经济困难时停建。尽管近期的经济萎缩，Boguchanskaya 水电站的施工仍继续，计划 2012 年完成。2008 年 5 月，塔吉克斯坦总统宣布 Rogun 水电站重新开始建设，虽然如何投资尚未明确。

亚洲的非 OECD 成员国家

在亚洲，由中国和印度领头的非OECD是全世界预测发电量增长最快的区域，2007年—2035年年均增长4.1%。虽然经济萎缩会影响该区域短期的经济增长，但从长期来讲，他们的经济预期会强劲增长，相应电力需求也会增加。预计发电量从2007到2015年将增长42%，从48000亿kwh到68000亿kwh.2015—2025电力需求将增加56%，2025—2035将增加40%。到2035年，发电量将达到148000亿kwh。

可再生能源发电量年均增加5%，占总发电量的比例从2007年的15%到2035年的20%。各种规模的水电开发均会增长。在亚洲，许多国家都有水电站在建项目和规划，包括越南、马来西亚、巴基斯坦和缅甸。总装机容量为3,398 MW的越南Son La省水电建设规划包括了50个电站建设项目，包括装机容量为2,400 MW的 Son La工程和装机容量为520 MW Houi Quang工程，它们计划2015年前完成。马来西亚计划2011年将完成装机容量为2,400 MW 的Bakun 水电站。

在IEO2010的参考事例中，巴基斯坦和缅甸的巨大水电发展计划已被打了折扣，因为这两个国家历史上的原因，要求外国直接投资基础设施项目。

印度计划到2030年水电装机增加一倍以上。在从2007到2017的第十一五、十二五计划中，印度中央电力部门确定装机容量为40,900 MW的水电站将开始建设。虽然在IEO2010参考事例中，报告并不认为全部计划能够完成，但其中仍然有多于三分之一的计划工程在建，预期2020年前完成。

印度联邦政府力图对水电开发提供鼓励。法律已提出给私人发展商超过5年的免税政策，使其能获得固定的投资回报，并允许发电商在市场出售其40%的电力。联邦的意图已得到各邦政府的支持。Himachal Pradesh邦政府计划将其所有的21,000 MW水电资源的大部分进行商业开发，2015年之前增加5,700 MW装机容量，这将使现有的装机容量翻番。到2009年底，在Himachal Pradesh邦有11个工程，总计4,400 MW装机容量已经开发。

与印度类似，中国有许多大型水电工程在建。总装机为容量18,200 MW的三峡电站2008年10月并网，三峡工程开发公司计划到2012年将容量增加到22,400 MW。金沙江溪洛渡工程装机容量为12,600 MW，计划2015年完成。中国有世界第二高坝（近985英尺）的正在建设中的装机容量为3,600 MW的锦屏

一级电站，它位于雅砻江，计划 2014 年完成。它是二滩水电开发公司开发 21 个总装机共为 34,600 MW 的水电开发工程的一部分。

中国政府已制定了 2020 年水电装机容量 300 GW 的战略。这个国家有足够的在建和拟建工程来实现这一战略。中国规模巨大的水电开发计划预计使水力发电量年增 3.9%，到 2035 年水力发电量达到现在的三倍。

中东

中东发电量将年增 2.5%，从 2007 年的 7000 亿 kwh 增加到到 2035 年的 13000kwh。该区域经济和人口规模增长都很迅速，随国民收入的强劲增长，预计导致电力需求的快速增长。伊朗、沙特阿拉伯、阿拉伯联合酋长国(UAE)占据该区域电力需求的三分之二，这些国家的需求在过去几年已快速增长。从 2000 到 2007 年，伊朗净发电量年增 7.9%，沙特阿拉伯年增 6.1%、阿拉伯联合酋长国年增 9.6%。

中东国家很少鼓励使用可再生能源。可再生能源电力的比例在该区域将从 2007 年的 3%增加到 2035 年的 5%。尽管如此，该区域还是有某些新的发展，2009 年伊朗发电量的 10%来自水电，它正在开发 94 个新的水电站。

非洲

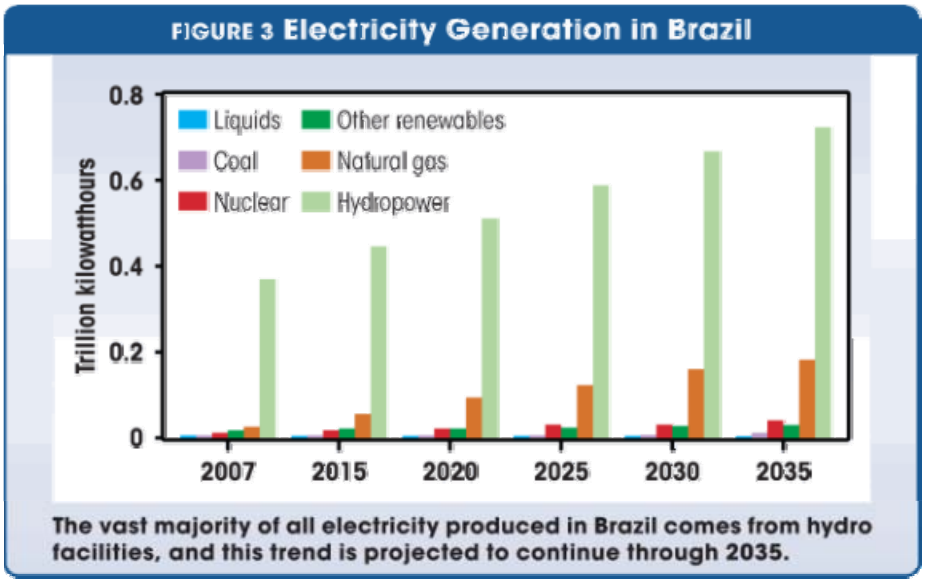
在 IEO2010 参考事例中，非洲电力需求年增 2.6%。2007 年化石燃料发电占区域电力的 81%，对化石燃料的依赖预计继续到 2035 年。

水电和其他市场化的可再生能源预计缓慢增长。和过去一样，非市场化的可再生能源将继续为非洲农村地区提供能源。但是，非洲国家经常难以获得投资和大型商业项目的国际支持。在该区域的若干水电工程的规划取得进展，已宣布的一些工程预计 2035 年前完成，使得该区域的市场化的可再生能源消费，将从 2007 到 2035 年均增长 2.2%。例如，埃塞俄比亚在 2009 年完成 2 个水电项目—装机容量为 300 MW 的 Tekeze 工程和装机容量为 420 MW Gilgel Gibe II 工程。而装机容量为 460 MW 的 Tana Beles 工程已于 2010 年开始运行。

中南美洲

在 IEO2010 参考事例中，中南美洲的发电量将年增 2.1%，从 2007 年的 10000 亿 kwh 到 2035 年的 18000 亿 kwh。最近的经济危机减低了电力需求，特别是在工业部门。长期讲，随着经济困难的远去，该区域的电力市场将重返增长趋势。

中南美洲的发电以水电为主，2007 年几乎占总发电量的三分之二。在最大的 7 个电力生产国中，巴西、委内瑞拉、巴拉圭、哥伦比亚、秘鲁，水电占总电量的 65%以上。



巴西是该区域最大的经济体，2007 年水电提供了几乎 85%的电力（见下图）。在巴西 2008-2017 国家能源规划中，政府推出了建设 54 GW 电力装机的目标。但是，增加的大部分是非水电项目，这是为了调整电力结构，避免干旱季节电力短缺的风险。

尽管如此，在预测期，巴西会继续开发水电，包括在在 Rondonia 的 Rio Madeira 河建设 2 个电站，装机容量为 3,200 MW 的 Santo Antonio 工程 和 装机容量为 3,300 MW 的 Jirau 工程。这 2 个工程计划在 2012-2015 完成。 长期来讲，电力需求将由规划中的的装机容量为 11,200 MW 的 Belo Monte 工程来部分满足。

Outlook on the Future of Hydro Development Worldwide

By U.S. Energy Information Administration

Policies related to development of hydropower facilities vary by country and, in some cases, have a significant effect on these plants' contributions in meeting needs for electricity.

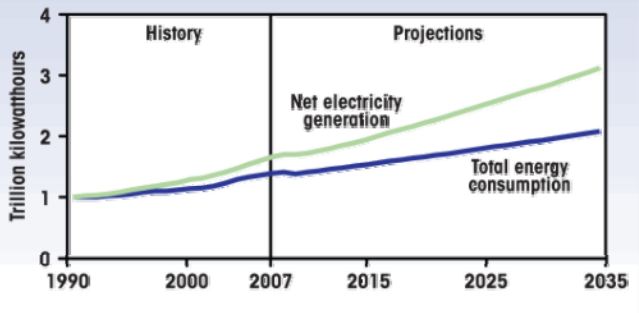
This article is excerpted with permission from the U.S. Energy Information Administration's International Energy Outlook 2010 report.

Each year, the U.S. Energy Information Administration (EIA) develops an outlook for the international energy markets, including electricity. The *International Energy Outlook 2010* projects markets through 2035. As part of its assessment of these markets, EIA analyzes policies and incentives intended to support generation sources, including hydropower. This article will provide an understanding of the potential future of hydro generation worldwide and how current policies can affect utilization of this valuable resource.

World overview

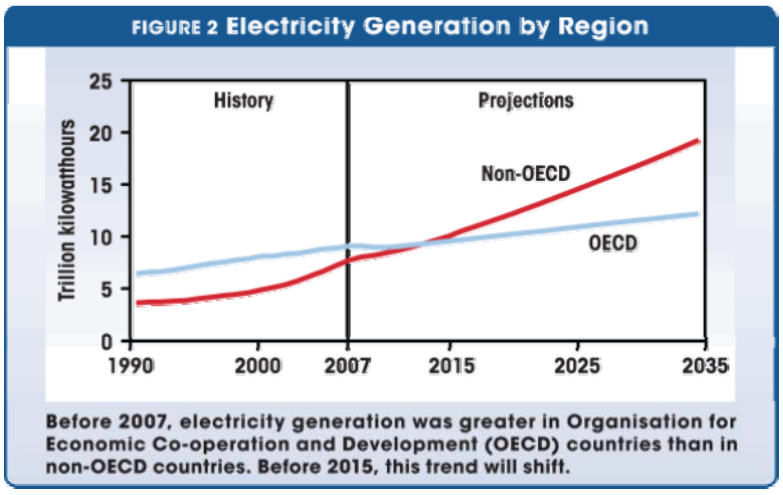
IEO2010 predicts that world net electricity generation will increase by an average of 2.3% per year from 2007 to 2035 (see Figure 1 on page 18). By comparison, net electricity generation grew 1.9% per year from 1990 to 2007.

FIGURE 1 Worldwide Generation and Consumption



From 2007 to 2035, worldwide growth in electricity generation is expected to outpace total energy consumption. This chart is indexed against 1990 data.

In general, projected generation growth in Organisation for Economic Co-operation and Development countries, with well-established electricity markets and mature consumption patterns, is slower than in non-OECD countries, where significant demand is unmet (see Figure 2 on page 18). Electrification of off-grid areas plays a strong role in projected growth trends. In fact, the International Energy Agency estimates that 22% of the world's population did not have access to electricity in 2008.[1]



Non-OECD nations consumed 46% of the world's total electricity supply in 2007. In 2035, non-OECD nations will account for 61% of world electricity use. Net electricity generation in non-OECD countries will increase by an average of 4.1% from 2007 to 2035, compared with only 1.1% per year among OECD nations.

The projection for total electricity generation in 2030 is 0.3% lower than it was in the 2009 outlook, largely because the impact of the recession was more severe than previously anticipated. Compared with IEO2009, the generation mix in 2030 in IEO2010 also changes. For example, liquids-fired generation is 11% lower than in IEO2009, natural gas and coal-fired generation are about 5% higher, nuclear generation is 9% higher, and renewable generation is 10% higher.

Renewable generation

Renewable energy is the fastest-growing source of electricity in the IEO2010 reference case. Total generation from renewable resources will increase by 3% annually, and the renewable share of world electricity generation will grow from 18% in 2007 to 23% in 2035. Hydroelectricity leads the field. Of the 4.5 million GWh of new renewables added over the projection period, 2.4 million GWh is attributed to hydroelectric power.

Aside from hydro, most renewable technologies will not able to compete economically with fossil fuels during the projection period. Government policies or incentives often provide the primary economic motivation for construction of renewable facilities.

Changes in the mix of renewable fuels used differ between the OECD and non-OECD regions. In OECD nations, most economically exploitable hydro resources have been captured; with the exceptions of Canada and Turkey, there are few large hydro projects planned. Most renewable growth in OECD countries comes from non-hydro sources. Many OECD countries, particularly those in Europe, have government policies — including feed-in tariffs (FIT), tax incentives, and market share quotas — that encourage the construction of renewable facilities. A FIT requires utilities to purchase renewable electricity at a price higher than wholesale. This allows the

renewable generator to achieve a positive return on investment despite the higher costs associated with these resources.

In non-OECD countries, hydropower is expected to be the predominant source of renewable electricity growth. Strong growth in hydro generation is expected in China, India, Brazil, and many nations in Southeast Asia, including Malaysia and Vietnam.

North America

North America accounts for the largest regional share of world electricity generation, with 27% in 2007. That share will decline as non-OECD nations experience fast-paced growth in demand. In 2035, North America will account for only 19% of the world's net electric generation.

The USA is the largest consumer of electricity in North America. Generation will increase at an average annual rate of 0.8% from 2007 to 2035. Canada also has a mature electricity market, and its generation will increase by 1.2% per year over the same period. Mexico's electricity generation will grow faster — averaging 3.2% per year through 2035 — reflecting the greater potential for expansion of the electric power infrastructure.

Generation from renewable sources in the USA will increase in response to requirements in more than half of the 50 states for minimum renewable generation or capacity shares. Renewable generation in the reference case is substantially higher than in recent projections, as the share of generation coming from renewable sources will grow from 8.5% in 2007 to 17% in 2035. The American Recovery and Reinvestment Act of 2009 directed $16.8 billion into energy efficiency and renewable energy and another $4 billion into loan guarantees for renewable energy. Federal subsidies for renewable generation are assumed to expire as enacted.

In Canada, generation from hydroelectricity will increase by 0.9% per year. In Ontario, the government plans to close its four coal-fired plants by December 31, 2014, and replace coal-fired generation with natural gas, nuclear, hydro, and wind. Coal provides about 19% of Ontario's electric power. With the retirements, Canada's coal generation declines from about 115 million GWh in 2007 to 97 million GWh in 2035.

The renewable share of Canada's overall generation will remain roughly constant throughout the projection. Hydropower is expected to remain the primary source of electricity in Canada. In 2007, hydroelectric generation provided 59% of the country's total generation; it falls to 54% in 2035.

Canada has several facilities planned or under construction. Hydro-Quebec is continuing construction of a 768 MW facility near Eastmain and a 150 MW facility at Sarcelle, both of which are expected to be fully commissioned by 2012. Others under construction include 1,550 MW Romaine River in Quebec and 200 MW Wuskwatim in Manitoba. Given Canada's past experience and the commitments for construction, new hydro will add 22,910 MW of capacity in Canada between 2007 and 2035.

Mexico's electricity generation will increase by an average of 3.2% annually from 2007 to 2035. The government recognizes the need for the country's electricity infrastructure to keep pace with the anticipated fast-paced growth in demand. In July 2007, the government unveiled its 2007-2012 National Infrastructure Program, which included plans to invest $25.3 billion to improve and expand electricity infrastructure. As part of the program, the government set a goal to increase installed capacity by 8.6 GW from 2006 to 2012. The country is well on its way to meeting this target.

Renewable resources are the second fastest-growing source of generation in the projection, after natural-gas-fired generation. Mexico's renewable generation will increase by 2.9% per year from 2007 to 2035. The country's current renewable mix is split largely between hydro (73%) and geothermal (19%).

Two major hydro projects are under way: 750 MW La Yesca, scheduled for completion by 2012, and the planned 900 MW La Parota project, which may not be completed until 2018. In the IEO2010 reference case, hydropower will increase by 2.3% per year and account for more than 60% of Mexico's total net generation from renewable energy sources in 2035.

OECD Europe

Electricity generation in OECD Europe will increase by an average of 1.1% per year in the IEO2010 reference case, from 3.4 million GWh in 2007 to 4.6 million GWh in 2035. Most growth in electricity demand is expected to come from those nations with more robust population growth (including Turkey, Ireland, and Spain) and from the newest OECD members (including the Czech Republic, Hungary, and Poland).

Renewable energy is OECD Europe's fastest-growing source of electricity generation, anticipated to grow by 2.6% per year through 2035. However, the increase is almost entirely from non-hydropower sources, encouraged by some of the world's most favorable renewable energy policies. In 2001, the EU set a binding target to produce 21% of electricity generation from renewable sources by 2010 and reaffirmed the goal of increasing renewable energy use with its December 2008 "climate and energy policy," which mandates that 20% of total energy production must come from renewables by 2020. About 21% of the EU's electricity came from renewable sources in 2007.

The IEO2010 reference case does not anticipate that all EU renewable energy targets will be met on time. Nevertheless, current laws are expected to lead to the construction of more renewable capacity than would have occurred in their absence. In addition, some countries provide economic incentives to promote the expansion of renewable electricity. Germany, Spain and Denmark have enacted FITs that last for 20 years after a project's completion. As long as European governments support such price premiums for renewable electricity, robust growth in renewable generation is likely to continue.

OECD Asia

Total electricity generation in OECD Asia will increase by an average of 1% per year, from 1.7 million GWh in 2007 to 2.3 million GWh in 2035. Japan accounts for the largest share of electricity generation in the region today and continues to do so in the mid-term projection, despite having the slowest-growing electricity market in the region and the slowest among all OECD countries, averaging 0.5% a year.

The fuel mix for electricity generation varies widely among the three economies that make up OECD Asia (Japan, South Korea, and Australia/New Zealand). In Japan, natural gas, coal, and nuclear power make up the bulk of the electric power mix. The remaining portion is split between renewables and petroleum-based liquid fuels. Hydropower is projected to supply about 8% of total generation in 2035.

Non-OECD Europe and Eurasia

Total electricity generation in non-OECD Europe and Eurasia will grow at an average rate of 1.6% per year in the IEO2010 reference case, from 1.6 million GWh in 2007 to 2.5 million GWh in 2035. Russia, the largest economy in the region, accounted for about 60% of its total generation in 2007 and is expected to retain about that share throughout the period.

Renewable generation in non-OECD Europe and Eurasia, almost entirely from hydro facilities, will increase by an average of 1.3% per year. This is largely a result of repairs and expansions at existing sites, such as reconstruction of turbines in the 6,400 MW Sayano-Shushenskaya plant, which was damaged in an August 2009 accident. Repairs are expected to be completed no earlier than 2012.

New projects include the 3,000 MW Boguchanskaya station in Russia and the 3,600 MW Rogun Dam in Tajikistan. Construction began on Boguchanskaya in 1980 and on Rogun in 1976, but work ceased when the former Soviet Union experienced economic difficulties in the 1980s. Despite the recent recession, construction continues on Boguchanskaya, which is on track for completion by 2012. In May 2008, Tajikistan's president announced construction had resumed on Rogun Dam, although it is still uncertain how the project will be financed.

Non-OECD Asia

Non-OECD Asia — led by China and India — has the fastest projected regional growth in electric generation worldwide, averaging 4.1% a year from 2007 to 2035. Although the recession will affect the region's short-term economic growth, in the long term the economies of non-OECD Asia are expected to expand strongly, with corresponding increases in electricity demand. Total electricity generation in non-OECD Asia will rise by 42% from 2007 to 2015, from 4.8 million GWh to 6.8 million GWh. Electricity demand will increase by 56% between 2015 and 2025 and another 40% between 2025 and 2035. In 2035, net generation in non-OECD Asia will total 14.8 million GWh.

Electricity generation from renewable sources will grow at an average annual rate of 5%, increasing the renewable share of the region's total generation from 15% in 2007 to 20% in 2035.

Hydro facilities of all sizes contribute to the projected growth. Several countries have facilities planned or under construction, including Vietnam, Malaysia, Pakistan, and Myanmar. Almost 50 plants, with a combined 3,398 MW of capacity, are under construction in Vietnam's Son La province, including the 2,400 MW Son La and 520 NW Houi Quang projects, both of which are scheduled for completion before 2015. Malaysia expects to complete its 2,400 MW Bakun Dam by 2011.

Substantial hydro development plans for Pakistan and Myanmar have been discounted in the IEO2010 reference case to reflect the two countries' historical difficulties in acquiring foreign direct investment for infrastructure projects.

India plans to more than double its installed hydropower capacity by 2030. In its Eleventh and Twelfth Five-Year Plans, which span 2007 through 2017, India's Central Electricity Authority has identified 40,900 MW of capacity that it intends to build. Although the IEO2010 reference case does not assume that all the planned capacity will be completed, more than one-third of the announced projects are under construction and are expected to be completed by 2020.

India's federal government is attempting to provide incentives for hydro development. Legislation has been proposed to make private developers eligible over a five-year period for a tariff that would guarantee a fixed return on investment and allow generators to sell up to 40% of their electricity on the spot market. These federal intentions are being supported by state authorities. The government in Himachal Pradesh plans to commercialize a substantial portion of the state's reported 21,000 MW of hydro potential, adding 5,700 MW of capacity before 2015, which would nearly double the existing capacity. At the end of 2009, 11 projects with a combined installed capacity of 4,400 MW were in development in Himachal Pradesh.

Similar to India, China also has many large hydro projects under construction. The final generator at 18,200 MW Three Gorges Dam went on line in October 2008, and Three Gorges Project Development Corp. plans to increase the project's capacity to 22,400 MW by 2012. And work continues on 12,600 MW Xiluodu on the Jinsha River, which is scheduled for completion in 2015. China also has the world's second tallest dam (at nearly 985 feet) under construction, as part of the 3,600 MW Jinping I project on the Yalong River. It is scheduled for completion in 2014 as part of a plan by Ertan Hydropower Development Co. to construct 21 facilities with 34,600 MW of capacity on the Yalong.

The Chinese government has set a 300 GW target for hydro capacity in 2020. The country has sufficient projects under construction or in development to meet the target. China's aggressive hydro development plan is expected to increase hydroelectric generation by 3.9% per year, almost tripling the country's total hydro generation by 2035.

Middle East

Electricity generation in the Middle East will grow by 2.5% per year, from 700,000 GWh in 2007 to 1.3 million GWh in 2035. The region's young and growing population, along with a strong increase in national income, is expected to result in rapid growth in demand. Iran, Saudi Arabia,

and the United Arab Emirates (UAE) account for two-thirds of the regional demand for electricity, and demand in these countries has increased sharply over the past several years. From 2000 to 2007, Iran's net generation increased by 7.9% per year, Saudi Arabia's by 6.1%, and UAE's by 9.6%.

There is little economic incentive for countries in the Middle East to increase their use of renewable energy sources. The renewable share of the region's total electricity generation will increase from 3% in 2007 to 5% in 2035 in the reference case. Despite this, there have been some recent developments in the region. Iran, which generated 10% of its electricity from hydro in 2009, is developing 94 new plants.

Africa

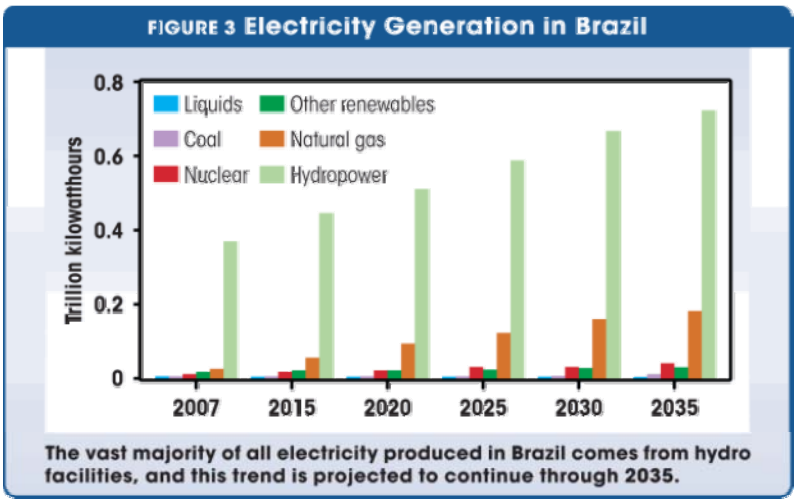
Demand for electricity in Africa will grow at an average annual rate of 2.6% in the IEO2010 reference case. Fossil-fuel-fired generation supplied 81% of the region's electricity in 2007, and reliance on fossil fuels is expected to continue through 2035.

Generation from hydropower and other marketed renewable sources is expected to grow slowly. As they have in the past, non-marketed renewables are expected to continue providing energy to Africa's rural areas; however, it is often difficult for African nations to find funding or international support for larger commercial projects. Plans for several hydro projects in the region have been advanced. Several of the announced projects are expected to be completed by 2035, allowing the region's consumption of marketed renewable energy to grow by 2.2% per year from 2007 to 2035. For example, Ethiopia finished work on two hydroelectric facilities in 2009 — 300 MW Tekeze and 420 MW Gilgel Gibe II — and 460 MW Tana Beles began operating in 2010.

Central and South America

Electricity generation in Central and South America will increase by 2.1% per year in the IEO2010 reference case, from 1 million GWh in 2007 to 1.8 million GWh in 2035. The recent economic crisis lowered demand for electricity, especially in the industrial sector. In the longer term, however, the region's electricity markets are expected to return to trend growth as economic difficulties recede.

The fuel mix for electricity generation in Central and South America is dominated by hydro, which accounted for nearly two-thirds of the total net electricity generation in 2007. Of the top seven electricity-generating countries, five — Brazil, Venezuela, Paraguay, Colombia, and Peru — generate more than 65% of their total electricity from hydropower.



In Brazil, the region's largest economy, hydropower provided almost 85% of electricity generation in 2007 (see Figure 3). In the Brazilian National Energy Plan for 2008-2017, the government set a goal to build 54 GW. However, most of these additions will be non-hydro capacity to diversify the country's electricity generation fuel mix because of the risk of power shortages during times of drought.

Despite this, Brazil does plan to continue expanding its hydro generation over the projection period, including the construction of two plants on the Rio Madeira in Rondonia — 3,200 MW Santo Antonio and 3,300 MW Jirau. The two plants are scheduled for completion in 2012-2015. In the long term, electricity demand could be met in part by the proposed 11,200 MW Belo Monte project.