WORLD ECONOMIC FORUM

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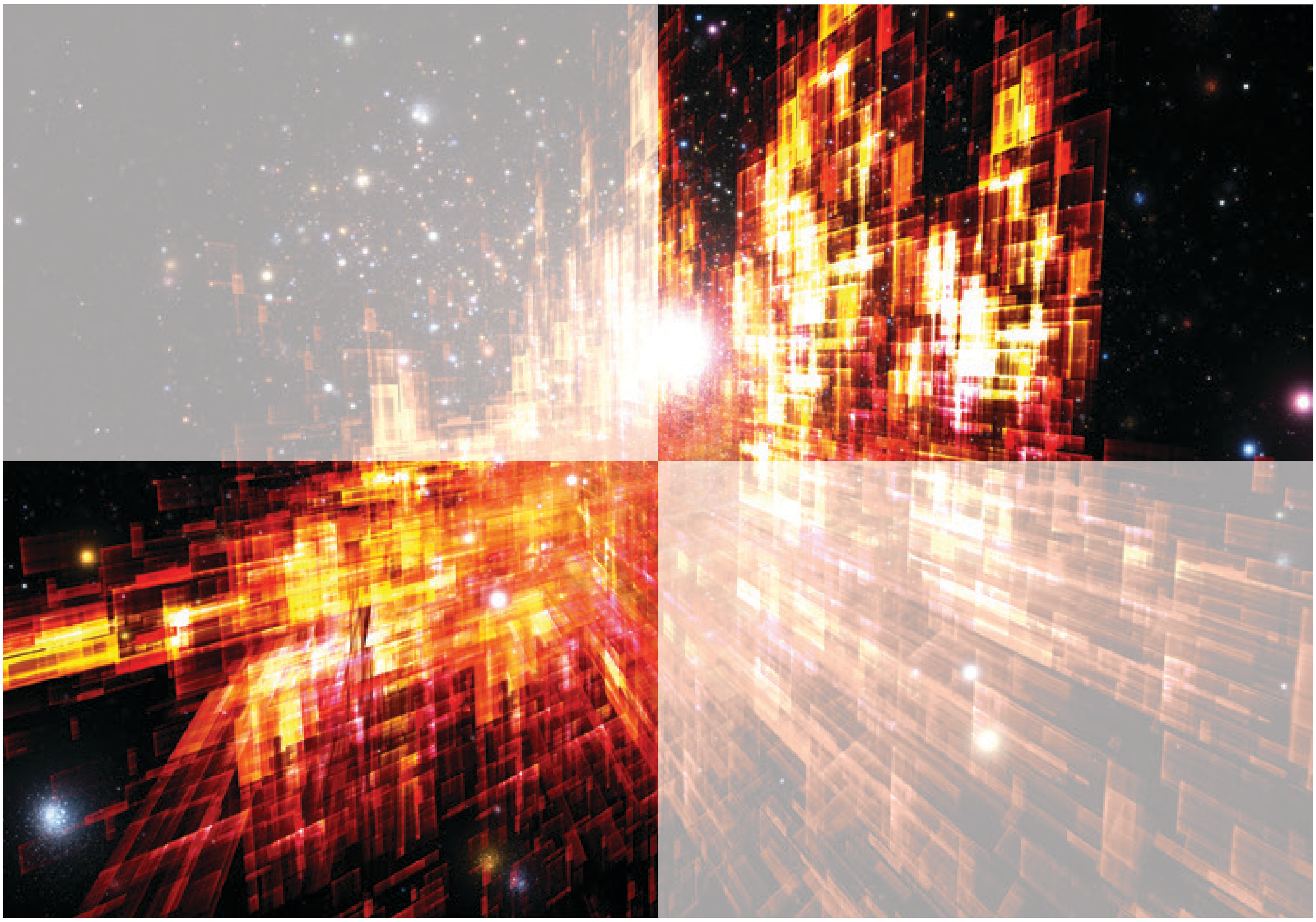
Industry Agenda

The Global Energy Architecture Performance Index Report 2013

Executive Summary

Prepared in collaboration with Accenture

December 2012



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Preface

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Over the past century, affordable energy has been a significant component of global economic growth and development. Now a transition is occurring across the global energy system to a degree and order of magnitude seen only a few times in human history and under completely distinct conditions on both the supply and demand sides.

The transition pathway from the current energy architecture to the new will look different for each country, with energy system objectives planned according to the trade-offs and complementarities surrounding the core imperatives of every energy system: managing energy supply risks while ensuring a country's economic, social and environmental well-being.

The World Economic Forum is pleased to present this executive summary of its Global Energy Architecture Performance Index Report 2013, examining the factors for effective global transition to a new energy architecture, framed through the outputs of the Energy Architecture Performance Index (EAPI) a tool designed to help countries monitor and benchmark the progress of their transition against a series of indicators. This summary considers what the new energy architecture might look like and how best-in-class enabling environments have already helped some high-ranking countries begin their transition to better performing energy systems. The varying demands of each country's energy architecture – the sometimes competing goals of economic growth and development, environmental sustainability, and energy access and security – form the crux of the index and this analysis.

The EAPI 2013 will prove a useful addition to the global dialogue around the transition to a new energy architecture and a practical tool for energy decision-makers. This version is an initial effort, and the EAPI team will look to expand it over future iterations to include better data, where available, and other relevant indicators.

Please go to The Global Energy Architecture Performance Index Report 2013 to view the full report and detailed analysis and to explore the accompanying data platform to understand the data driving country performance.

The Energy Architecture Performance Index 2013 in Numbers

105
countries' energy systems assessed

16
indicators used

64
countries assessed with a fossil-fuel subsidy in place

0.75 / 1
highest score achieved on the EAPI 2013 compared with a 0.55 / 1 EAPI 2013 sample average

36%
the average total primary energy supply from alternative or renewable energy sources (including biomass and large-scale hydropower) of the top 10 performers compared with a 29% Energy Architecture Performance Index (EAPI) 2013 sample average

89
countries in the EAPI sample have renewable energy support policies in place, in the form of regulation, fiscal incentives or public financing

66%
of countries assessed are net energy importers

US$ 46,000
the average GDP per capita of the top 10 EAPI 2013 performers, bar Latvia. An average GDP per capita of US$46,000 puts these countries within the top 25 countries globally on this metric

12%
the average nuclear total primary energy supply of the top 10 performers compared with a 6% EAPI 2013 sample average

US$ 7.14
the average EAPI 2013 sample score for energy intensity (GDP per unit of energy use) compared with an EU15 average score of US$ 9.77

9%
the average total primary energy supply from hydropower of the top 10 performers compared with a 5% EAPI 2013 sample average

The Expert Panel's View: The Use Case for the Energy Architecture Performance Index

The transition to a new energy paradigm will not be feasible without a suite of strategic tools that help the understanding of different pathways to the future. This is the primary motivation for working with the World Economic Forum to develop an innovative new tool – the Energy Architecture Performance Index (EAPI).

The EAPI is a global initiative with the aim of creating a set of indicators that help to highlight the performance of various countries across each facet of their energy systems. In doing so, it attempts to meet two interlinked goals. First, it aims to assess energy systems across their three primary objectives: delivering economic growth, doing so in an environmentally sustainable manner, and ensuring security of supply and access for all. Second, it aims to create a "one-stop shop" for stakeholders where they can easily access transparent and robust datasets and the resulting analysis. The EAPI thus combines an innovative blend of indicators to this end. Of course, the EAPI is highly abstracted and not meant as a comprehensive treatment or classification of an energy system. Rather, it is one way to present and consider the complex information and the highly interdependent issues that prevail in the energy sector.

The Expert Panel advising this project brings together senior representatives from various sectors across the energy value chain. The panel is acutely aware of the importance of the provision of quality data in supporting informed decision-making. Governments, industry and civil society cannot hope to fully understand the functions and idiosyncrasies of their energy systems without it. Across some metrics, there are excellent data resources available. But data paucity means that several aspects of the global energy system cannot be adequately evaluated. Nevertheless, the EAPI will be a useful tool for policy-makers, investors and other stakeholders as they assess energy systems and as they consider the design and implementation of strategies to improve them.

The Expert Panel has contributed to and stress-tested the methodology. It has done its utmost to ensure that the team leading the exercise has been rigorous, and that the EAPI is firmly grounded in "reality on the ground". The product is thus strong and credible, and can be further augmented and refined in subsequent years. The online data platform provides an intuitive user interface that allows for many types of custom research, including "deep-dives" in specific areas of interest.

But the finish line remains distant. Next year, the panel will work closely with the Forum team to address some of the critical data sets that are still missing from the EAPI. It will also drive further dialogue with key institutions connected to the energy sector to ensure that the work remains vibrant and continues to evolve.

Morgan Bazilian, Deputy Director, Joint Institute for Strategic Energy Analysis, US National Renewable Energy Laboratory, on behalf of the Energy Architecture Performance Index 2013 Expert Panel

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We are sure that the EAPI will be an invaluable tool for policy-makers and researchers alike. With this tool we hope that policy-makers can benchmark their policies with the end objective of achieving a transition to the new energy architecture.

"

Ishwar V. Hegde, Chief Economist, Suzlon Energy

1. Defining Energy Architecture and the Energy Triangle

The world's global energy system is in a period of transition. Now more than ever, decision-makers must understand the core objectives of energy architecture – generating economic growth and development in an environmentally sustainable way while providing energy access and security for all – and how they are being impacted by changing dynamics. Responding to these often competing objectives is challenging, as actions to tackle issues such as resource scarcity and climate change must be delivered against the background of difficult economic conditions following the global financial crisis. Difficult trade-offs need to be made, but sometimes complementarities between the imperatives of the energy triangle can be realized. Overall, flux in the system is generating uncertainty for industry and investors.

The Energy Triangle

The energy triangle frames the inherent objectives central to every energy system: the ability to provide a secure, affordable and environmentally sustainable supply of energy. The energy architecture concept can be visualized in figure 1. While this is a greatly simplified view, it highlights the complex interactions and systems that will need to be factored into the transition process.

Energy architecture should:

1. **Promote economic growth and development…**

   Reliable energy promotes economic and social development by boosting productivity and facilitating income generation. Price signals must reflect the true associated costs of energy production to ensure consumption is economically viable and producers remain lean and responsive to an undistorted market.

2. **…in an environmentally sustainable way…**

   The production, transformation and consumption of energy are associated with significant negative environmental externalities. Energy architecture remains the main contributor to global warming.[1] Environmental degradation (for instance particulate matter pollution and land-use impact) and the energy sector's reliance on other constrained resources water and metals to name but two – highlight sustainability as a critical energy architecture priority.

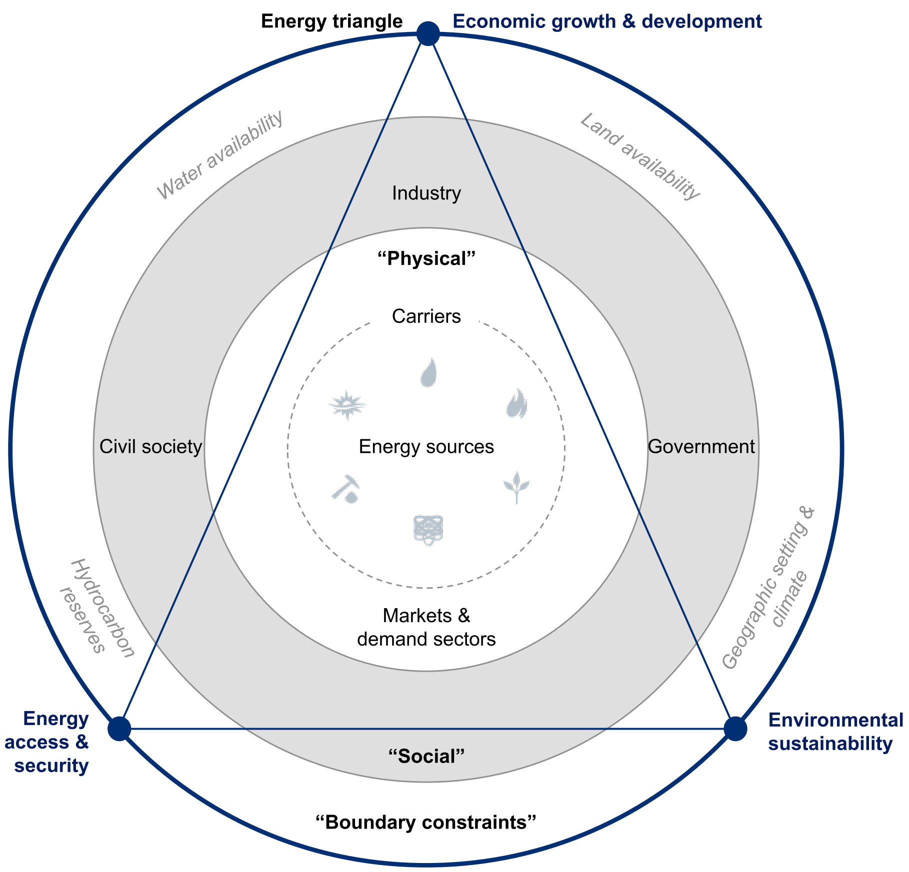
3. **…while providing universal energy access and security.**

   Physical supply of energy is subject to a number of risks and disruptions. But energy security is also about relations among nations. Security of supply from trade partners, the risks of energy autarky (prompting disintegration of energy markets) and uncertainty over prices – creating volatility – are critical concerns that must be managed.

   Universal energy access is vital to fostering lasting social and economic development and to achieving the United Nations Millennium Development Goals.[2] In low-income economies, energy is responsible for a larger portion of monthly household income, and the use of basic cooking and heating equipment often means fuels such as kerosene and charcoal are burned inside houses, impacting human health and contributing to disease through air pollution.

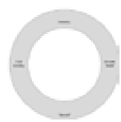
[1] International Energy Agency (IEA), Topic: Climate Change; available at www.iea.org/topics/climatechange.
[2] UN Secretary-General's Advisory Group on Energy and Climate Change, Energy for a Sustainable Future, 2010.

Figure 1: Energy architecture conceptual framework

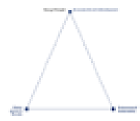


Definitions

Physical elements: includes energy sources, their carriers and end markets



Social elements: includes political institutions, industry and civil society, which shape the physical elements



Energy triangle: ultimate objectives that the energy architecture is designed to support

Boundary constraints: factors limiting performance against the energy triangle, both physical and social

The Challenges Associated with the Transition to a New Energy Architecture

Achieving the imperatives of the energy triangle has become particularly challenging as security and environmental pressures – including tackling resource scarcity and climate change – must be delivered against the background of difficult economic conditions following the global financial crisis.

In this context, countries are changing legislation and exercising caution around the deployment of new energy projects with large upfront capital costs. Some countries have been reconsidering their renewables obligations and CO_2 targets[3] while others have been reaffirming them. Consumers, concerned by bills, are less willing to carry the cost of greener technologies as part of their utilities spend. With the recovery of coal and oil prices since 2008,[4] a squeeze on OECD industrial production can be felt, with energy costs absorbing an increasing slice of revenue.

This is a time of change for the global energy architecture.

2. A Tool for Transition – The Energy Architecture Performance Index

The Energy Architecture Performance Index (EAPI) is a tool that can help decision-makers manage and monitor the challenges associated with the transition to a new energy architecture.

The EAPI measures an energy system's specific contribution to the three imperatives of the energy triangle: economic growth and development, environmental sustainability, and access and security of supply. It comprises 16 indicators aggregated into three baskets relating to these three imperatives. It both scores and ranks the performance of each country's energy architecture (see figure 2).

By measuring and reporting on various sets of indicators, the EAPI provides a transparent and holistic set of insights into energy architecture successes and challenges, acting as a base from which to make policy and investment decisions, and prioritize opportunities for improvement across the energy value chain.

Indicators were selected against the following criteria:

- **Output data only**: The measurement of output-oriented observational data (with a specific, definable relationship to the sub-index in question) or a best available proxy, rather than estimates
- **Reliability**: The use of reliable source data from renowned institutions
- **Reusability**: Data sourced from providers that the EAPI team can work with on an annual basis and that can therefore be updated with ease
- **Quality**: The data selected represents the best measure available given constraints; with this in mind, the Expert Panel reviewed all potential datasets for quality and verifiability and those that did not meet these basic quality standards were discarded[5]
- **Completeness**: Data is of adequate global and temporal coverage; it has been consistently treated and checked for periodicity to ensure the EAPI's future sustainability.

Figure 2: Structure of the Energy Architecture Performance Index 2013

Energy Architecture Performance Index

Key question

How successfully does [the] country's energy system perform in terms of promoting economic growth and development while being environmentally sustainable, secure and allowing universal access to consumers?

Economic growth and development

Objectives	Key performance indicators
Efficiency	• Energy intensity (GDP per unit of energy use in PPP US$ per kg of oil equivalent)
Lack of distortion/ affordability	• Degree of artificial distortion to gasoline pricing (index) • Degree of artificial distortion to diesel pricing (index) • Electricity prices for industry (US $ per kilowatt-hour)
Supportive/ detracts from growth	• Cost of energy imports (% GDP) • Value of energy exports (% GDP)

Environmental sustainability

Objectives	Key performance indicators
Emissions impact	• CO_2 emissions from electricity and heat production (total, thou. metric tonnes)/total population • PM10 (particulate emissions), country level (microgram per m^3) • Nitrous oxide emissions in energy sector (thou. metric tonnes of CO_2 equivalent)/total population • Average fuel economy for passenger vehicle fleet (l/100 km)
Ratio of low-carbon fuels in the energy mix	• Alternative and nuclear energy as share of total consumption (%)

Energy access and security

Objectives	Key performance indicators
Diversity of supply	• Diversity of total primary energy supply (Herfindahl index)
Level and quality of access	• Electrification (% of population) • Quality of electricity supply (survey score between 1-7) • Percentage of population using solid fuels for cooking (%)
Self-sufficiency	• Import dependence (energy imports, net % energy use)

[3] Germany has instigated solar tariff cuts, India has removed a fiscal support structure for the wind sector, and Italy has issued more cuts to the preferential rates awarded to renewables projects. *Source: Ernst & Young, Renewable energy country attractiveness indices, 2012.*

[4] The price of the front-month futures contract for Brent crude oil averaged US$ 114.77 in August 2012. Source: US Energy Information Administration (EIA), *The Availability and Price of Petroleum and Petroleum Products Produced in Countries other than Iran, August 2012.*

[5] Please see the "Data Paucity and Country Exclusions" section of the Methodological Addendum in the full report for further details around these criteria.

3. The Energy Architecture Performance Index 2013 Rankings

This table shows the rankings for each of the separate components of the energy triangle (economic growth and development, environmental sustainability, and energy access and security) and the EAPI 2013 overall ranking. All scores are between 0 and 1.

No country achieves top scores against any basket. This reflects the fact that, although some countries score relatively high and balance the requirements of the energy triangle well in comparison to other countries, not one has managed to do all that can be done. This is especially true of the scores in the environmental sustainability basket. Here, country results are often compared with targets or policy directives. For example, particulate matter (PM10) country-level emissions are assessed against compliance with the 20 microgram per cubic metre (µg/m3) annual mean that the World Health Organization stipulates in its air quality guidelines, while the target value of 5.2 l/100 kilometres for average fuel economy for passenger cars represents the European Union objective. This sets a higher threshold for performance in this basket and reflects how much work is still to be done to address the global challenges associated with sustainable energy production and consumption.

Table: EAPI 2013 rankings

All scores rounded to two decimal places

				EAPI 2013	
Country/ economy	**Economic growth and development**	**Environmental sustainability**	**Energy access and security**	**Overall rank**	**Overall score**
Norway	0.67	0.63	0.95	1	0.75
Sweden	0.58	0.76	0.80	2	0.71
France	0.58	0.75	0.78	3	0.70
Switzerland	0.73	0.58	0.79	4	0.70
New Zealand	0.63	0.69	0.77	5	0.70
Colombia	0.76	0.54	0.78	6	0.69
Latvia	0.62	0.74	0.71	7	0.69
Denmark	0.64	0.56	0.82	8	0.67
Spain	0.71	0.55	0.75	9	0.67
United Kingdom	0.59	0.63	0.78	10	0.67
Romania	0.65	0.63	0.73	11	0.67
Uruguay	0.69	0.58	0.72	12	0.67
Ireland	0.61	0.63	0.74	13	0.66
Germany	0.60	0.58	0.79	14	0.66
Peru	0.78	0.55	0.63	15	0.65
Hungary	0.53	0.67	0.76	16	0.65
Slovak Republic	0.48	0.69	0.78	17	0.65
Portugal	0.64	0.56	0.75	18	0.65
Costa Rica	0.62	0.61	0.72	19	0.65
Austria	0.61	0.52	0.79	20	0.64
Brazil	0.59	0.60	0.73	21	0.64
Lithuania	0.53	0.64	0.73	22	0.63
Canada	0.61	0.47	0.82	23	0.63
Slovenia	0.55	0.56	0.77	24	0.63
Japan	0.60	0.48	0.77	25	0.61
Croatia	0.66	0.47	0.71	26	0.61
Russian Federation	0.58	0.54	0.71	27	0.61
Australia	0.66	0.36	0.81	28	0.61
Belgium	0.51	0.55	0.77	29	0.61
Estonia	0.56	0.59	0.67	30	0.61
Chile	0.57	0.51	0.73	31	0.61
Finland	0.53	0.47	0.81	32	0.60
Greece	0.63	0.48	0.70	33	0.60
Israel	0.61	0.47	0.73	34	0.60
Paraguay	0.60	0.66	0.54	35	0.60
Argentina	0.65	0.48	0.66	36	0.60
Poland	0.60	0.48	0.71	37	0.60
Korea, Rep.	0.59	0.43	0.76	38	0.59
Mexico	0.61	0.50	0.67	39	0.59
Singapore	0.70	0.41	0.67	40	0.59
Netherlands	0.50	0.50	0.77	41	0.59
Azerbaijan	0.47	0.51	0.78	42	0.59
Iceland	0.30	0.70	0.75	43	0.58
Turkey	0.51	0.53	0.70	44	0.58
Thailand	0.54	0.49	0.70	45	0.58
Italy	0.48	0.53	0.72	46	0.58
Panama	0.60	0.54	0.58	47	0.57
Bulgaria	0.56	0.55	0.62	48	0.57
El Salvador	0.48	0.60	0.64	49	0.57
Tunisia	0.43	0.54	0.73	50	0.57
Kazakhstan	0.55	0.45	0.70	51	0.57
Dominican Republic	0.53	0.61	0.55	52	0.56
Czech Republic	0.50	0.40	0.78	53	0.56
Ecuador	0.56	0.52	0.59	54	0.56
United States	0.56	0.34	0.77	55	0.56
Cyprus	0.57	0.51	0.57	56	0.55
Georgia	0.37	0.61	0.66	57	0.55
Algeria	0.37	0.52	0.75	58	0.54
South Africa	0.60	0.49	0.54	59	0.54
Armenia	0.36	0.61	0.64	60	0.54
Philippines	0.41	0.62	0.58	61	0.53
India	0.54	0.59	0.47	62	0.53
Indonesia	0.48	0.56	0.53	63	0.52
Morocco	0.41	0.54	0.61	64	0.52
Malaysia	0.30	0.48	0.77	65	0.52
Libya	0.35	0.47	0.73	66	0.52
Bolivia	0.37	0.55	0.62	67	0.51
Brunei Darussalam	0.40	0.35	0.79	68	0.51
Sri Lanka	0.43	0.63	0.48	69	0.51
Tajikistan	0.29	0.66	0.58	70	0.51
Botswana	0.48	0.57	0.45	71	0.50
Ukraine	0.22	0.56	0.70	72	0.49
Egypt, Arab Rep.	0.27	0.52	0.68	73	0.49
China, People's Rep.	0.34	0.53	0.60	74	0.49
Trinidad and Tobago	0.46	0.37	0.62	75	0.48
Oman	0.34	0.29	0.80	76	0.48
Nicaragua	0.37	0.60	0.45	77	0.48
Vietnam	0.29	0.55	0.57	78	0.47
Namibia	0.43	0.57	0.39	79	0.47
Cameroon	0.40	0.66	0.33	80	0.46
Senegal	0.42	0.63	0.33	81	0.46
Saudi Arabia	0.30	0.28	0.78	82	0.46
Kyrgyz Republic	0.20	0.58	0.58	83	0.45
Cote d'Ivoire	0.36	0.68	0.31	84	0.45
Ghana	0.34	0.66	0.34	85	0.45
Jamaica	0.32	0.50	0.52	86	0.45
United Arab Emirates	0.38	0.22	0.73	87	0.44
Pakistan	0.31	0.59	0.42	88	0.44
Nigeria	0.36	0.70	0.25	89	0.44
Syrian Arab Republic	0.31	0.38	0.62	90	0.44
Jordan	0.25	0.38	0.66	91	0.43
Qatar	0.35	0.15	0.78	92	0.43
Kenya	0.34	0.69	0.26	93	0.43
Haiti	0.44	0.64	0.20	94	0.43
Kuwait	0.35	0.16	0.76	95	0.42
Iran, Islamic Rep.	0.22	0.36	0.68	96	0.42
Zambia	0.33	0.71	0.22	97	0.42
Cambodia	0.37	0.64	0.22	98	0.41
Bahrain	0.29	0.23	0.68	99	0.40
Mongolia	0.29	0.48	0.41	100	0.39
Nepal	0.31	0.69	0.18	101	0.39
Mozambique	0.27	0.71	0.19	102	0.39
Lebanon	0.35	0.37	0.44	103	0.39
Tanzania	0.30	0.72	0.11	104	0.37
Ethiopia	0.25	0.72	0.11	105	0.36

4. Key Findings and Focus Areas for Selected Regional and Economic Clusters

While accepting that each and every country has a distinct set of energy priorities and opportunities, Energy Architecture Performance Index (EAPI) analysis has shown some common themes developing across the various regions and economic clusters studied.

1. **Rich, high GDP per capita countries are more likely to be able to score well against one or more objectives of the energy triangle.** Such countries have the economic flexibility and clout to engage in concerted action on environmental sustainability and the adoption of more efficient, cleaner technologies, involving legacy infrastructure upgrading across the energy system and incorporation of renewables into the energy mix (see figure 3).

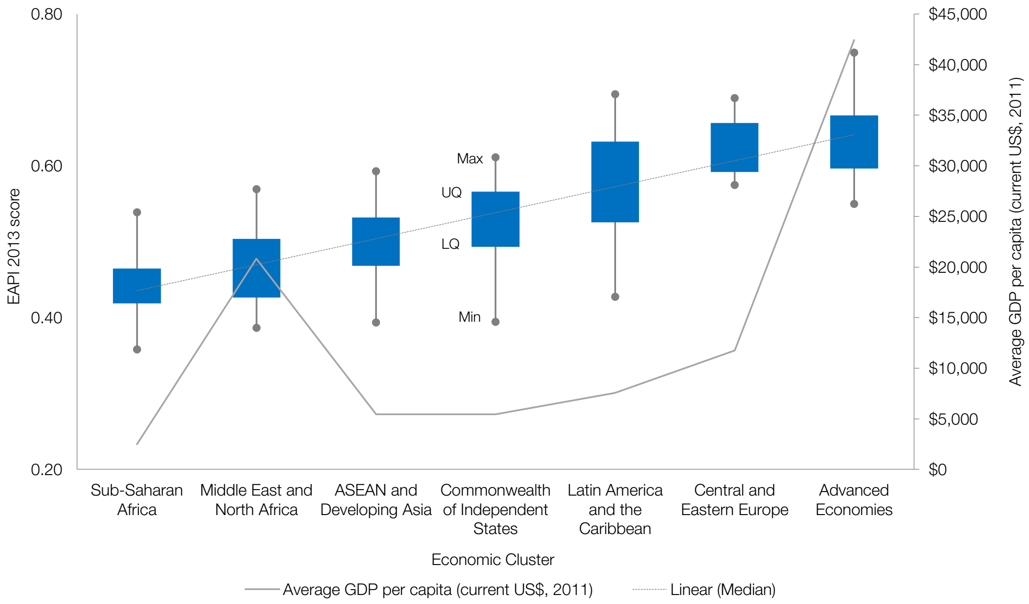
The top ten EAPI 2013 performers enjoy an average GDP per capita of over US$ 46,000 and all except Latvia are within the top 25 countries globally on this metric. With diversified or large service-based economies and a deindustrialized GDP base, energy efficiency is easier to achieve. Geology also plays a part in performance. In the case of many of the advanced economies, natural resources such as hydro, geothermal and oil and gas resources are blended into their energy systems and economies to enable strong performance across each aspect of the energy triangle.

Performance among the Advanced Economies is lower than might be expected proportional to the level of GDP per capita due to low environmental sustainability scores. If the lowest ranked of the advanced economies were to improve performance against the environmental sustainability metrics, the group would see a large overall improvement in the spread of scores.

The Middle East and North Africa's performance bucks the trend towards higher GDP levels and higher EAPI performance. Resource wealth in this area has translated into enormous sovereign wealth for many of the (mainly) Middle Eastern economies, but these countries' energy systems often struggle to maximize performance against all three objectives of the triangle. Fossil fuel products are heavily subsidized, creating economic drag. Cheap and plentiful energy has disincentivized the adoption of efficiency measures, impacting on both economic and sustainability metrics; and access rates and quality of energy supply are below the leader board's standards as grids have sagged under pressure to meet rising demand.[7]

2. **Having a low-carbon fuel mix is a key performance factor.** The top ten performers (see figure 4) source on average 36% of their total primary energy supply (TPES) from alternative or renewable energy sources, including biomass and nuclear.[8] Sweden, France and Switzerland all source over 26% of their TPES from nuclear (France 42%), with an average nuclear TPES of 12% for the top ten compared to 4% for the EAPI 2013 sample. The use of large-scale hydro power also drives performance, with an average hydro TPES of 9% for the top 10 scorers, 5% for the rest of the EAPI 2013 sample.[9]

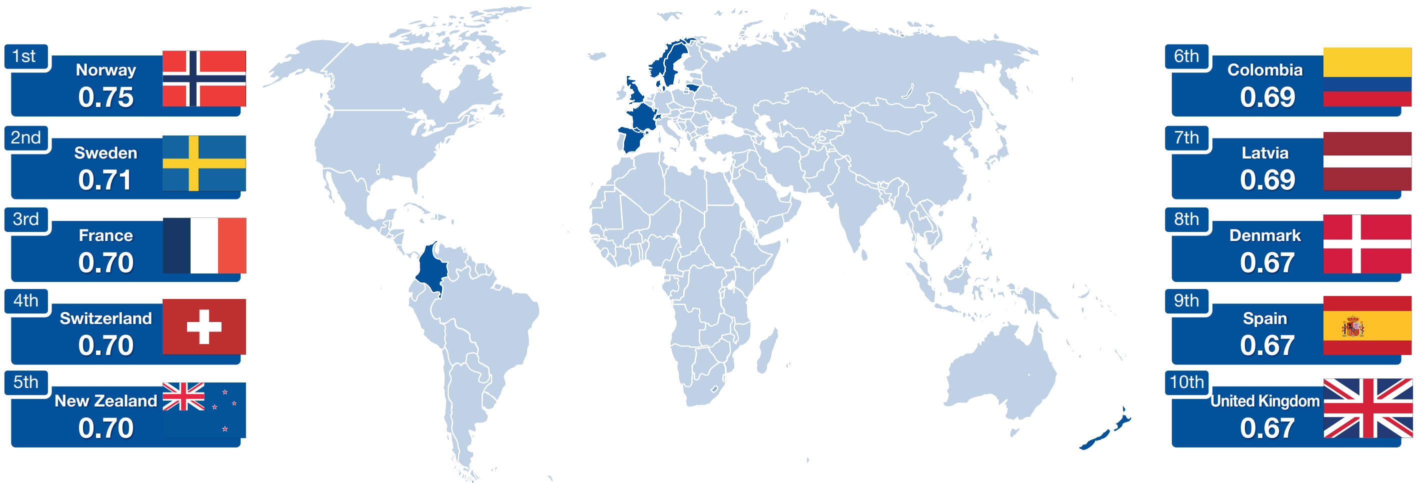
Figure 3: Regional Clusters – Comparison of 2013 EAPI score by average GDP per capita[6]



- Figure 10 is a 'box' or 'spread' chart
- Spread charts show the distribution of a dataset – in this case the different economic / regional clusters' average Energy Architecture Performance scores
- The silver bars are the spread of data from minimum, median to the maximum value
- The blue boxes show the quartiles
- Quartiles are a set of values that divide the data set into four equal groups, each representing a fourth of the sample
- The upper quartile represents the split of the highest 25% of data – the top performers
- The lower quartile represents the split of the lowest 25% of data – the bottom performers
- These spreads are charted against average GDP per capita for the cluster

[6] See Definitions section for explanation of the graph structure and economic/regional clusters.
[7] Up to 2020, electricity demand will rise by 7% to 8% per year on average in Gulf Cooperation Council member countries. Source: Economist Intelligence Unit, The GCC in 2020: Resources for the future, 2010.
[8] This definition is consistent with the International Energy Agency (IEA) Energy Technology Perspectives 2010 BLUE Map scenario, which describes how annual CO2 emissions can be reduced by 50% from 2005 levels, with nuclear power providing 24% of global electricity production.
[9] All figures International Energy Agency (IEA), World Energy Outlook, 2011.

Figure 4: Map of top performers overall



3. **In some regions, there's much basic work still to do to improve performance on the EAPI.** The lowest scorers, as might be expected, face challenges around energy access, efficiency and sustainability, and tend to be located in Sub-Saharan Africa, developing Asia or the highly resource-endowed countries of the Middle East.

   The small, resource-strapped economies of Sub-Saharan Africa exhibit low electrification rates, intermittent supply of electricity and often have limited diversity of fuel sources. The high sustainability scores that these countries sometimes exhibit an overwhelming dependence on biomass energy consisting of wood, charcoal and agricultural residues.

   Many resource-rich Middle Eastern fuel exporters score poorly due to high energy intensity and low fuel mix diversity. With a dominance of hydrocarbons in the energy supply, and the attendant negative environmental impact, these countries also score poorly against environmental sustainability metrics, especially CO2 and nitrous oxide (NOx) emissions relating to energy.

4. **No country achieves top scores against any dimension of the energy triangle.** This reflects the fact that, although some countries score relatively highly and balance the requirements of the energy triangle well, not one has managed to do all that can be done. This is especially true of the scores in the environmental sustainability basket of indicators.

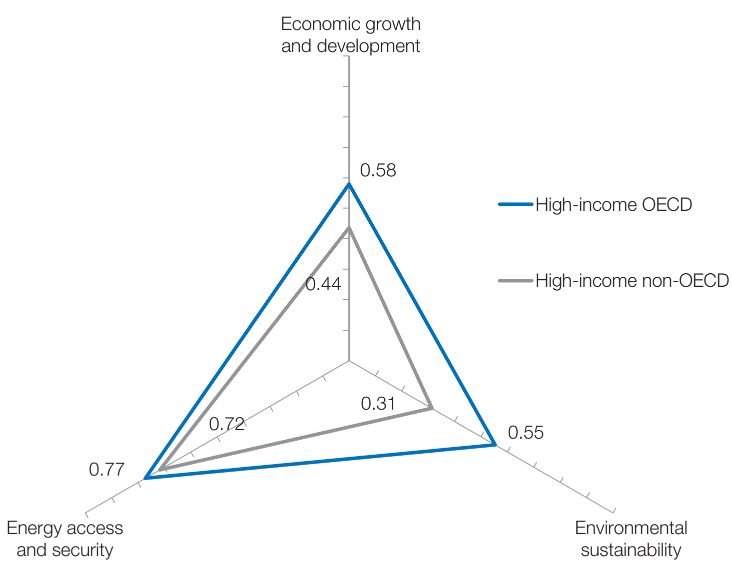
Considerations for the Management of an Effective Transition

1. **Improvements in environmental sustainability should be a priority for high-income and rapidly growing economies.**

   That no country scores perfectly on the EAPI 2013 is reflective of the core message behind the index – global energy architecture still has a long way to go before it can contribute optimally to the three imperatives of the energy triangle. Environmental sustainability is an area that needs significant attention. For advanced and high-income economies – with the highest impact energy sectors performance against this imperative is lower than the other two (see figure 5). This low performance is a function of three factors:
   - The economic cost of building a truly sustainable energy system
   - The high performance targets (based predominantly on existing legislation or official recommendations) used to assess performance
   - The fact that environmental sustainability was not a priority component of the energy discourse until recently, meaning countries are naturally further behind on environmental sustainability metrics than against the other aspects of the triangle (which have been the historic concern of global energy systems).

A tough assessment is critical here. Targets considered and set by experts in the field of pollution mitigation and climate policy need to be met. Given the extent of underperformance, it will be especially interesting to see how high-income and rapidly growing economies progress in this area.

Figure 5: High-income OECD and non-OECD cluster performance on the EAPI 2013



2. **A large natural energy resource endowment is not a critical performance factor.**

Having a large provision of exploitable natural resources has enabled high performance for many of the countries under analysis. But the prevalence of countries without large endowments in the upper quartile of results indicates the importance of efficiency and sustainability measures, largely linked to the efficacy of a country's energy policy. Hence countries like Switzerland, Latvia and France join the top ten performers overall.

Many hydrocarbon-rich nations with high to median GDP levels also score poorly within the index. This reinforces how resource wealth needs to be managed effectively to drive economic growth as well as development, and to mitigate negative environmental externalities due to reliance on hydrocarbons in total primary energy supplies. Resources, particularly hydrocarbons, can be a boon or a burden depending on the policies employed to manage their development; while helping on some security metrics, they may impact especially badly on the economic growth and development and environmental sustainability performance of an energy system if exploited without due consideration.

3. **Globally, some big issues around fossil-fuel subsidies, water use for energy production and effective resource wealth management need addressing.**

A concerted global effort is needed to gather more data around the application of fossil-fuel subsidies, water use per type of energy generation and extraction technology (and the impact this has on a country's overall water resources), and the best models for the development of energy resources. Against each of these energy priorities, a paucity of detailed global data is limiting action. Neither the EAPI nor any index can paint the full picture of a country's energy situation and priorities without a more detailed view of these factors and their impact on a country's energy architecture.

4. **Managing the trade-offs and complementarities is critical.**

Managing the transition to a new energy architecture is not easy. The imperatives of the energy triangle may reinforce or act in tension with one another, forcing difficult trade-offs to be made, and meaning that decisions can have unintended consequences in certain cases. Efforts to bolster energy security through diversification may, for example, have negative implications for environmental sustainability. Policies that support diversification may also come at a considerable cost, with the expansion of technologies not yet at grid parity requiring continued financial support from feed-in tariffs and other financial mechanisms.

In some instances, there are "silver bullets". An example is Iceland's development of profitable and clean data centres using electricity supplied by 100% renewable energy sources. There is no easy formula for managing these trade-offs and complementarities. Decision-makers must ensure that they carefully weigh their choices, designing a portfolio of policies to create an energy mix that best balances the challenges and opportunities of the energy triangle.

Figure 6: Focus areas for selected regional and economic clusters

EU 27

+ Selected data	Average Score (0-1)
EAPI 2013	**0.63**
Economic Growth and Development	**0.57**
Environmental Sustainability	**0.58**
Energy Access and Security	**0.74**

+ Further work to do on sustainability

Environmental Sustainability: EU27 scores above EAPI average on environmental sustainability - 0.58 - but score lags far behind comparably developed Nordic economies with 0.62

CO2 prices: Have decreased with economic slowdown dis-incentivising low carbon energy project development

Defining roadmap and regulations for regional interconnection: A priority, to minimise reliance on imports external to the EU zone (predominantly from Norway and Russia).

North America

+ Selected data	Average Score (0-1)
EAPI 2013	**0.60**
Economic Growth and Development	**0.58**
Environmental Sustainability	**0.40**
Energy Access and Security	**0.80**

+ Focus on energy intensity and emissions

Energy Intensity: Critical measure for both U.S ($6.53 GDP per unit) and Canada ($5.22). Improving industrial / residential building stock performance and average fuel economy for passenger cars (regional average of just 9.26 l/100km) could help

CO2 emissions: Critical focus (U.S. ranks 96th for CO2 from electricity and heat production / total population, Canada 88th). Reduced demand for gasoline due to economic crisis and drops in coal-fired electricity generation, but U.S. supplies just 16% of TPES from low carbon technologies (Canada 26% - could be better given low carbon opportunities). Problem needs attention with shale gas' role in power mix moving forwards (global production likely to reach 30% by 2030 - 70% of this from North America).

Latin America and the Caribbean

+ Selected data	Average Score (0-1)
EAPI 2013	**0.57**
Economic Growth and Development	**0.56**
Environmental Sustainability	**0.55**
Energy Access and Security	**0.61**

+ Each of the sub-indices offer focus areas for LAC

Economic Growth and development: Subsidies across all fuel types often used by LAC governments to try and improve social equity - could lead to deteriorating price distortion score (current score for this indicator aligns with EAPI sample)

Environmental Sustainability: LAC score (0.55) aligns with EAPI average (0.54). Alternative energy sources relatively well utilised, 33% of LAC's total primary energy supply, but PM10 performance poor – could potentially improve vehicle efficiency (LAC scores 0.55 for the Average Fuel Economy for passenger cars (l/100km) indicator, below EAPI average of 0.61

Energy Access: Priority to improve quality of electricity supply. New energy wealth pouring into different parts of region could be managed to translate into social development and prevent indirect de-industrialisation

ASEAN & Developing Asia (DA)

✚ Selected data	Average Score (0-1)
EAPI 2013	**0.50**
Economic Growth and Development	**0.41**
Environmental Sustainability	**0.54**
Energy Access and Security	**0.56**

✚ Each of the sub-indices offer focus areas for Asia

Energy Intensity: $5.78 per unit for DA countries and $6.79 for ASEAN, compared with $7.14 for EAPI sample. Better efficiency can mitigate increasing energy demands from predominantly coal and nuclear sources

Environmental Sustainability: Average regional score of 0.54, comes in far below top performers' average of 0.72. Increased use of alternative fuel sources would reduce emissions impact, improving scores

Energy Access: DA countries need to focus on lack of energy access impeding economic growth and development. DA countries score only 0.47 across access metrics, ASEAN averages at 0.63.

Middle East and North Africa

✚ Selected data	Average Score (0-1)
EAPI 2013	**0.46**
Economic Growth and Development	**0.33**
Environmental Sustainability	**0.36**
Energy Access and Security	**0.70**

✚ Better energy efficiency / fewer emissions

High energy-related emissions: Net exporters often perform poorly on the environmental sustainability sub-index due to high emissions from hydrocarbon use / extraction. Fuel exports as % of GDP exhibits strong negative correlation with sustainability score

Negative economic impacts: Energy intensity is $5.88 per unit of energy, compared to $7.14 for EAPI overall sample.

Brazil, Russia, India and China (BRICs)

✚ Selected data	Average Score (0-1)
EAPI 2013	**0.57**
Economic Growth and Development	**0.51**
Environmental Sustainability	**0.57**
Energy Access and Security	**0.63**

✚ Each of the sub-indices offer focus areas for BRICs

Energy Efficiency: Critical factor, for different reasons: Russian energy sector = quarter of GDP through energy / export earnings (Chatham House) but efficiency half as good as the US. Efficiency savings could be recognised, reducing CO2 p.c. (12mt - one of the highest in the world). Brazil's good intensity score ($8.40GDP / per unit) indicates transition stage of economy – improved living standards and GDP growth may reduce score. India and China relatively energy inefficient, but China building strong clean energy sector and demand management solutions due to relatively modern grid.

CO2 emissions: Critical focus for Russia and China –rank 93rd & 63rd respectively) due to reliance on carbon intensive fossil fuels in TPES (in China coal = 66% of TPES, in Russia 16% from coal, 20% from oil) and large demand (China uses most energy in world – 2438 mtoe - Russia 3rd most (after U.S.) with a 703 mtoe TPES)

Energy Access: Economies a blend of energy 'haves' and 'have nots' – India scores poorly on access metrics (0.45 compared to EAPI average of 0.73). Russia, Brazil and China highly electrified but suffer from quality of supply issues, scoring an average 0.64 / 1 for this metric.

Sub-Saharan Africa

✚ Selected data	Average Score (0-1)
EAPI 2013	**0.44**
Economic Growth and Development	**0.38**
Environmental Sustainability	**0.65**
Energy Access and Security	**0.29**

✚ Improving Energy Access

Access: Struggle to supply citizens with basic energy services. In 15+ countries over 50% of population uses solid fuels for cooking

Quality of supply: 25 countries, mainly from SSA, receive a score < 3.5 / 7 for quality of electricity supply, indicating unreliable and insufficient supply

5. Definitions

Economic/Regional Clusters

In the context of this report, the designations only cover the countries available within the EAPI 2013 sample.

Advanced Economies – A term used by the International Monetary Fund to describe the following developed countries: Australia, Austria, Belgium, Canada, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Japan, Republic of Korea, Netherlands, New Zealand, Norway, Portugal, Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom and United States.

ASEAN – The Association of Southeast Asian Nations, or ASEAN, was established on 8 August 1967 in Bangkok, Thailand, and is made up of: Brunei Darussalam, Cambodia, Indonesia, Malaysia, Philippines, Thailand and Vietnam. Singapore is included in the Advanced Economies regional grouping. This report excludes data for Laos and Myanmar, which should be discounted from the grouping.

Central and Eastern Europe – This grouping comprises Bulgaria, Croatia, Hungary, Latvia, Lithuania, Poland, Romania and Turkey.

Commonwealth of Independent States – This grouping is made up of Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyz Republic, Mongolia, Russian Federation, Tajikistan and Ukraine.

Developing Asia – Developing Asia is an International Monetary Fund definition for countries in the Asia region that are less developed than neighbouring counterparts. These include Cambodia, India, Indonesia, Malaysia, Nepal, Pakistan, People's Republic of China, Philippines, Sri Lanka, Thailand and Vietnam.

EU15 – Fifteen was the number of Member Countries in the European Union prior to the accession of ten candidate countries on 1 May 2004. The EU15 comprised the following 15 countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom. This report excludes data for Luxembourg, which should be discounted from the grouping.

High-income (OECD) – A World Bank classification encompassing: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Republic of Korea, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom and United States.

High-income (non-OECD) – A World Bank classification encompassing: Bahrain, Brunei Darussalam, Croatia, Cyprus, Kuwait, Oman, Qatar, Saudi Arabia, Singapore, Trinidad and Tobago, and United Arab Emirates.

Latin America and the Caribbean – The Latin America and the Caribbean (LAC) region encompasses Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Haiti, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Trinidad and Tobago, and Uruguay.

MENA – The Middle East and North Africa (MENA) is an economically diverse region that includes both the oil-rich economies in the Gulf and countries that are resource-scarce in relation to population. In the context of this report, the MENA designation only covers the countries of MENA within the EAPI 2013 sample: Algeria, Bahrain, Egypt, Iran, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia and United Arab Emirates.

SSA – The designation Sub-Saharan Africa (SSA) is used to indicate all of Africa except northern Africa and excluding Sudan, which is included in Sub-Saharan Africa. SSA comprises: Botswana, Cameroon, Cote d'Ivoire, Ethiopia, Ghana, Kenya, Mozambique, Namibia, Nigeria, Senegal, South Africa, Tanzania and Zambia.

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