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Industry Agenda

The Global Energy Architecture Performance Index Report 2014

Prepared in collaboration with Accenture

December 2013

REF 031213

Contents

Preface

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Effectively balancing the demands of providing an affordable, sustainable and secure energy supply continues to play a key role in the development of countries. Driven by the boundary constraints of economic development, geography and prosperity, countries are striving to find new and innovative ways to meet the demands of their energy system.

During the past three years, the World Economic Forum has been working on the New Energy Architecture initiative to better understand the changes underway in the global energy system, and how they can be managed to enable an effective transition. A core pillar of this work has been the development of the Global Energy Architecture Performance Index.

The key message of the first edition of the Energy Architecture Performance Index report, which is reiterated and further supported by the findings of this year's report, is that transition pathways look different in each country. Setting the course for transition to a new energy architecture means developing a long-term strategy which takes into account the trade-offs and complementarities surrounding the core imperatives of every energy system: managing risks to energy supplies while ensuring a country's economic, social and environmental well-being.

The World Economic Forum and Accenture are pleased to present the second edition of this report examining the factors for an effective global transition to a new energy architecture. The transition debate is framed through the results 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 report, similarly to its earlier edition, looks at what a new energy architecture might look like and how best-in-class enabling environments have already helped some high-ranking countries begin their transitions to more efficient energy architectures. The different demands of countries' individual energy architectures – 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.

This year's report also looks at transition pathways and challenges faced by regions and economic clusters, underlining the effect of cross-national factors such as geographic location, regional geology and stage of economic development on a country's energy system.

The New Energy Architecture project is conducted under the Forum's Energy Industry Partnership, with support from the World Economic Forum team responsible for The Global Competitiveness Report and key business, government and civil society constituents from the energy sector. We would like to thank the Expert Panel, which has supported the dialogue and research behind this report, the International Energy Agency (IEA) as the main data contributor, and the external perspective contributors.

We believe the EAPI 2014 will prove a useful addition to the global dialogue on the transition to a new energy architecture and a practical tool for energy decision-makers. This version of the EAPI already represents an evolution from last year's edition. We continue to welcome feedback and constructive debate on how to further improve the quality of the index and ensure it tracks the relevant metrics of the energy system as it evolves.

EAPI 2014 in Numbers

124

countries' energy systems assessed

18

indicators utilized

0.75/1

highest score achieved on the EAPI 2014, compared with 0.52/1 EAPI 2014 sample average

41%

average total primary energy supply from alternative or renewable energy sources (including biomass and large scale hydropower) of the top 10 performers, compared with 28% EAPI 2014 sample average

33%

of countries assessed are net-energy exporters

US$ 5.4

average GDP per unit of energy use extracted in BRICS economies, compared with US$ 10 average in the EU28

0.80/1

average score for the EU28 cluster for diversification of total primary energy supply, compared to the 0.65/1 EAPI average, and 0.40/1 of the MENA cluster

36%

average contribution of fuel exports to GDP in assessed net-energy exporters in the MENA region, compared with 17% average contribution across the ASEAN sample

0.32/1

average score for CO_2 emissions per kWh generated in the ASEAN country sample against 0.81/1 average score for Nordic economies

39%

average electrification rate for assessed countries in sub-Saharan Africa, compared with 100% average in OECD economies

Executive Summary

Fundamental transitions across global energy systems are underway, characterized by unprecedented complexity – technology advances and discoveries have opened the doors to a range of energy sources and are changing the way energy is consumed. Markets are increasingly affected by shifts in global demand and supply patterns; all the while energy decisions are being underlined by the urgency of addressing the climate debate. As demand for energy is surging worldwide, the requirement to adopt new approaches and strategies to fundamentally change the energy architecture is a top global priority. The importance of securing a sustainable future is clear, and this goal has to be set against the more than one billion people around the world who have no reliable access to power, and the continued growth and industrialization of economies transforming global energy markets and creating new challenges for supply and demand management.

In this dynamic global context, the challenges of developing an energy architecture that delivers a secure, affordable and environmentally sustainable energy supply are many and complex. In assessing the performance of countries across a number of key indicators, this study confirms just how various and sizeable those challenges are: no country achieves the full score of 1/1 overall, and no country achieves top performance on each measure. While there is considerable variation in performance between different countries, all face obstacles on the way to achieving lasting balance in their management of the three sides of the energy triangle: economic growth and development; environmental sustainability; and energy access and security.

Diverse Challenges, Unique Contexts

This study highlights the complex trade-offs and dependencies that beset attempts to secure an energy system that performs well across all key objectives. Different countries are of course variously endowed with natural resources and are pursuing economic development from very different starting places. Balance is hard to achieve in the face of directly competing claims and policies. For example, an emphasis on securing economic growth often means that environmental considerations receive less attention. The push to secure environmental sustainability in developed countries is now experiencing something of a backlash as consumers baulk at the additional costs and demand lower energy prices. Plentiful natural resources in net-exporting countries often mean that fossil fuel costs for domestic consumption are subsidized, thereby reducing incentives to pursue energy efficiency measures and invest in renewables.

The top performers for the Energy Architecture Performance Index highlight that there is no single pathway to achieving a balanced energy system; the results do, however, underline the bearing economic development has over performance. Norway tops the rankings for the EAPI 2014, followed by France and Sweden. All of the top 10 performing countries are European Union (EU) and/or Organisation for Economic Co-operation and Development (OECD) economies, with the exception of Costa Rica and Colombia.

Table 1: Top 10 EAPI 2014 Rankings

Country / Economy	Energy Architecture Performance Index (EAPI) 2014		*Economic Growth & Development Basket*		*Environmental Sustainability Basket*		*Energy Access & Security Basket*	
	Score	Rank	*Score*	*Rank*	*Score*	*Rank*	*Score*	*Rank*
Norway	0.75	1	0.69	5	0.60	21	0.96	1
New Zealand	0.73	2	0.63	18	0.70	7	0.85	5
France	0.72	3	0.63	19	0.73	1	0.81	18
Sweden	0.72	4	0.59	30	0.73	2	0.85	6
Switzerland	0.72	5	0.73	3	0.59	23	0.82	14
Denmark	0.71	6	0.71	4	0.54	39	0.88	3
Colombia	0.70	7	0.74	2	0.50	51	0.84	7
Spain	0.67	8	0.69	6	0.55	38	0.78	30
Costa Rica	0.67	9	0.68	7	0.56	31	0.77	35
Latvia	0.66	10	0.58	35	0.65	12	0.77	36

A Strategic Tool

To move beyond the tensions inherent in pursuing these and other competing aims, governments need a new set of strategic tools to help them map out their journeys to a new energy architecture consistent with the overriding goals of security, affordability and sustainability. These tools should be expressly designed to provide information and analysis that will support a greater balance between policy objectives. The creation of the Energy Architecture Performance Index is one such response to that requirement. The EAPI employs a set of indicators to assess and rank the energy architectures of 124 countries. The indicators highlight the performance of each country across the key dimensions of the energy triangle, measuring the extent to which a country's energy architecture adds or detracts from the economy; the environmental impact of energy supply and consumption; and how secure, accessible and diversified the energy supply is.

Using the EAPI can help governments and others along the energy value chain to identify and prioritize areas for improvement. By using consistent data from reliable sources, the EAPI provides a transparent and easily compared set of measures that can help track progress and open new perspectives on the specific challenges faced by every country in each region.

A Regional Approach

This year's report uses the EAPI research findings to highlight some of the specific challenges that individual countries and regions face in developing their responses to creating successful new energy architectures. By describing the best performing countries overall, the report aims to shed some light on the policy decisions and frameworks that have helped to secure their progress.

The structure of this year's report explores the results of the index at a regional/economic cluster level as well as at a national level, drawing out some of the main challenges that groups of countries face. Deeper analysis of the common challenges often highlights the importance of cooperation and knowledge sharing in addressing them. The key highlights from the regions analysed in this report underscore the following:

– EU28, OECD and Nordic economies are the top performing regions/economic clusters across the index, with average scores of 0.62/1, 0.63/1 and 0.68/1 respectively. This result underlines the bearing that economic development has on the performance of an energy system. Scores in EU28 bring to bear the focus on transitioning towards a low-carbon economy as set out by the European Union's 20/20/20 Strategy. Carbon-abatement measures, renewable energy deployment and efficiency measures have, in part, contributed to lowering the overall contribution of the region to greenhouse gas (GHG) emissions, and are improving energy security in the region. However, further analysis highlights the extent to which Eastern European member states continue to struggle with fossil fuel and import dependence.

– Industrializing clusters such as BRICS, ASEAN and Developing Asia are, for the most part, characterized by more energy- and emission-intensive economies, as highlighted by the lower average scores for these regions in the relative indicators. The overall average scores of these clusters are 0.55/1, 0.48/1 and 0.45/1 respectively – highlighting the performance gap with the top performing clusters. The performance of BRICS, ASEAN and Developing Asia clusters across the energy triangle dimension underline the different priorities of these emerging and industrializing economies.

– Performances across the North American continent vary widely, highlighting the difference stages of economic development and resource wealth between the US and Canada and the Central and Caribbean states. While the resource wealth and investments in renewables are driving high scores for Canada and the United States in energy security, low performance in environmental indicators of both countries remains a key challenge. The North American continent also includes high performers such as Costa Rica – one of the top 10 performers globally – and Haiti, which in 116th place is ranked one of the lowest. Overall, this variance highlights the disparity beween import- dependent countries of the Caribbean and Central American countries, and the Canada, U.S and Mexico.

– The relationship between performance on the EAPI and GDP is reversed in the case of the Middle East and North Africa (MENA) region. MENA achieves the lowest average performance at 0.42/1 across all the regions/economic clusters, although the average GDP per capita of US$ 15,000[1] is significantly higher than the next best performer, sub-Saharan Africa. As the region with the world's greatest endowment of natural resources, MENA performs significantly above average for net energy exports; however, the overall score is impacted by lower performance in environmental sustainability and economic growth and development, driven by the pervasiveness of fossil fuel subsidies which weighs on the regions' economy, brings about inefficient energy use and hinders investment in renewable energy sources.

The report explores regional performances in more detail, drawing key insights from the EAPI results, and displaying external perspectives on key topics from relevant industry stakeholders.

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Understanding how countries’ energy systems perform against each other can send a powerful message to policy-makers, industry stakeholders and NGOs. Thanks to its transparency and granularity, the Energy Architecture Performance Index is a valuable tool in creating a common framework for debate, and draws out opportunities for improvement.

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Jeroen van der Veer Executive Member, Governing Board, European Institute of Innovation and Technology; Chair, Global Agenda Council on Energy Security

Section 1: The New Energy Architecture Challenge – Balancing the Energy Triangle

Defining Energy Architecture and the Energy Triangle

Energy architecture is defined as the integrated physical system of energy sources, carriers and demand sectors that are shaped by government, industry and civil society.

The “energy triangle” frames the objectives central to energy architecture: the ability to provide a secure, affordable and environmentally sustainable energy supply. More specifically, energy architecture should:

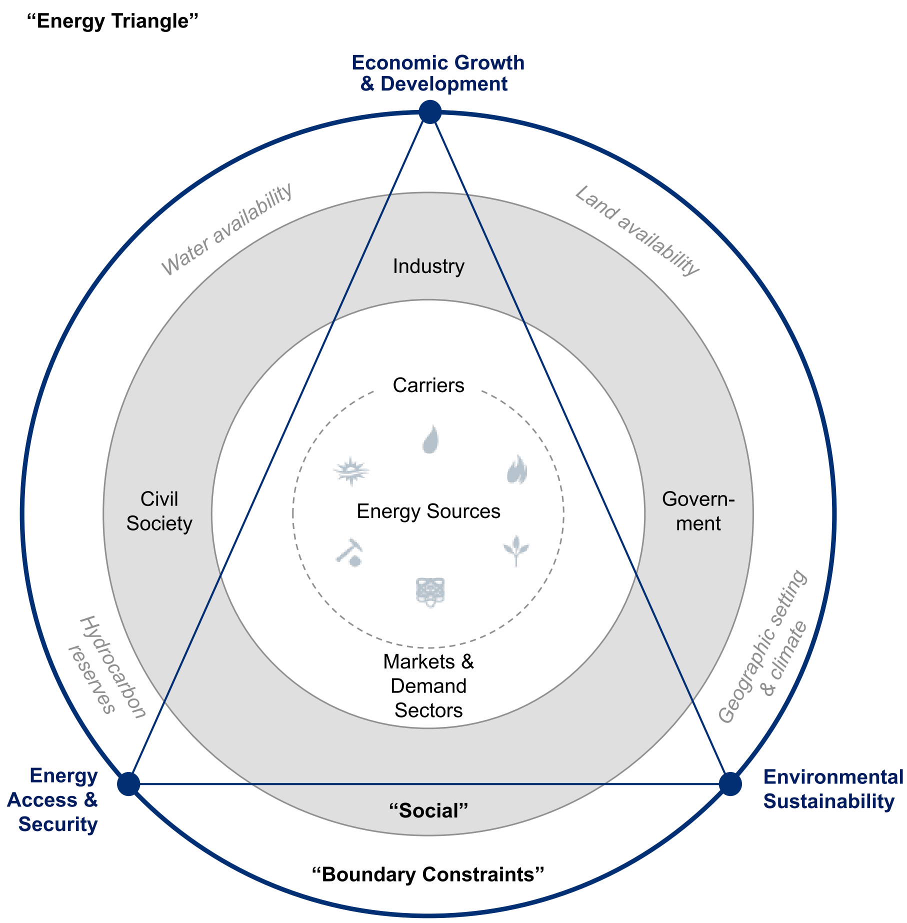
1. Promote economic growth and development…
Reliable energy promotes economic and social development by boosting productivity and facilitating income generation. Price signals must reflect the true associated costs of energy production to ensure consumption is economically viable and producers remain 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.[2] Environmental degradation (for instance, particulate matter pollution and land-use impact) and the energy sector’s reliance on other constrained resources (e.g. water and metals) highlight sustainability as a critical energy architecture priority.

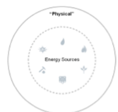
3. …while providing universal energy access and security
The supply of energy is subject to a number of risks and disruptions. But energy security is also about relations among nations. Security of supply from trade partners, the risks of energy autarchy and uncertainty over prices – all creating volatility – 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.[3] 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.

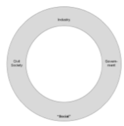
Figure 1: Energy Architecture Conceptual Framework



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.

The 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 – Charting a Course for Transition

The requirement to deliver on the energy triangle is driving fundamental change in the way in which energy is sourced, transformed and consumed at national, regional and global levels. This is resulting in the transition to a "New Energy Architecture".

In the past five years alone, the emergence of new technologies and legislation and the impact of unforeseen events have transformed the energy sector. The shale gas "revolution" has redrawn the US energy landscape, and kick-started a reindustrialization of its economy. *Energiewende* (energy transition) has put Germany on a radical footing as it looks to decarbonize its economy and lead the race for green growth, inter alia by installing the equivalent of seven and a half nuclear power stations-worth of solar peak generation per year for the last three years.[4] And the legacy of Fukushima has resulted in the introduction of one of the world's most aggressive solar schemes.

The work of this report has underlined the complexity of the transition. There is no single way forward; rather, each country and region must work with its own resources and constraints. While individual nations have taken significant steps forward, progress at the global level has been slow, and mistakes and miscalculations have been made along the way. Most significantly, nations have struggled to maintain balance in their energy systems, and have been forced to make difficult choices and trade-offs.

In the developing world, the on-going strong pace of economic growth, which has continued apace despite the impact of the global financial crisis, has put pressure on both environmental sustainability and security. This has been most apparent in China, which recently took on the mantle of the world's number one importer of petroleum products from the US, and is also the world's number one emitter of greenhouse gases.

In a number of developed countries, a strong push for environmental sustainability has raised questions over the implications for economic growth and development. The IEA estimates the total integration costs of increasing the supply of renewable energy sources to be ~5-25/MWh, due to additional capacity costs (to manage intermittency), balancing costs (to maintain grid stability), and transmission and distribution costs (to integrate renewables located far from demand centres).[5] These costs have typically been passed on to both residential and commercial energy users, resulting in significant price hikes and concerns over industrial competitiveness. As a consequence, a number of OECD nations, including the United Kingdom, Canada and Australia, are now considering repealing legislation designed to reduce the environmental impact of their energy sectors in favour of a regulatory environment more amenable to low prices. However, these measures have also been behind the increase in share of renewable energy in a number of countries, progressing the transition of these towards more environmentally sustainable energy architectures. A perspective from the chairman and chief executive officer of Acciona makes the case for the role of renewables in the transitioning to an energy system fit for the 21st century (see page 24).

A Tool for Transition – The Energy Architecture Performance Index

As governments the world over continue to grapple with the challenge of the energy trilemma, it is vital that they build deeper understanding of the implications of their decision-making for energy system performance. The transition to a new energy architecture will not be feasible without a suite of strategic tools that support the understanding of different pathways to the future. The creation of the Energy Architecture Performance Index is a response to this need.

The EAPI uses a set of indicators to highlight the performance of various countries across each facet of their energy architecture, determining to what extent nations have been able to create affordable, sustainable and secure energy systems. The EAPI therefore helps stakeholders as they look for performance areas to improve and to prioritize opportunities for improvement across the energy value chain. In creating a one-stop shop for stakeholders to easily access transparent and robust datasets and the resulting analysis, the EAPI aims to promote a dialogue about the steps that can be taken to enable an effective transition to a new energy architecture.

The realities of energy transitions are multifaceted and complex. The purpose of the EAPI is to provide a framework for debate and common grounds for comparison across the core dimensions identified by the principles of the energy triangle. The EAPI is therefore structured on the principles of the energy triangle, assessing the performance of countries based on how they respond to the challenge of delivering affordable, environmentally sustainable and secure energy supply. A number of indicators inform the score across the individual corners of the triangle; these are ultimately aggregated to provide an overview of the overall state of a country's energy system, as well as an overarching score and rank. Figure 1 shows the conceptual framework behind the indicators, while Figure 2 details the indicators which underlie each dimension of the energy triangle.

The tool was developed in collaboration with a group of energy experts from across the value chain. The Expert Panel[6] has provided input and guidance into the methodology of the index. The tool presented in this report builds on the first edition of the index, published in the *Global Energy Architecture Performance Report 2013*. Following the publication of the first edition, relevant feedback and areas for improvement were identified and the methodology updated to reflect them.

The coverage of the index has also increased this year, from 105 to 124 countries. This was due to the release of more extensive data sets for a number of the indicators.

A detailed overview of the methodology is provided in the methodological addendum.

Figure 2: Energy Architecture Performance Index (EAPI) Indicators

ENERGY ARCHITECTURE PERFORMANCE INDEX

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

QUANTITATIVE

ECONOMIC GROWTH & DEVELOPMENT

OBJECTIVES	KPIS
Efficiency	• Energy Intensity (GDP per unit of energy use (PPP $ per kg of oil equivalent))
Affordability	• Degree of artificial distortion to gasoline pricing (index) • Degree of artificial distortion to diesel pricing (index) • Electricity Prices for Industry (U.S. Dollars per Kilowatt hour)
Supportive / detracts from growth	• Cost of energy imports (% GDP) • Value of energy exports (% GDP)

ENVIRONMENTAL SUSTAINABILITY

OBJECTIVES	KPIS
Emissions impact	• Efficiency of electricity production – CO2 from electricity generation/ kWh • Nitrous oxide emissions in energy sector (thou. metric tons of CO2 equivalent)/Total Population • Methane emissions in energy sector (thou. metric tons of CO2 equivalent)/Total Population • Emissions intensity – PM10, country level (mg per m3) • Average Fuel Economy for Passenger vehicle fleet (l/100km)
Ratio of low carbon fuels in the energy mix	• Alternative and Nuclear energy as share of total consumption (%)

ENERGY ACCESS & SECURITY

OBJECTIVES	KPIS
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) • Diversification of net import counterparts by country (Herfindahl index)

A Perspective from the Expert Panel

Morgan Bazilian, Deputy Executive Director, Joint Institute for Strategic Energy Analysis, US National Renewable Energy Laboratory (NREL), and Adjunct Professor, Columbia University, USA, on behalf of the EAPI Expert Panel

The unprecedented and rapid transformation of the energy sector globally continues to create a challenging landscape for policy and investment decision-making. These changes range from technical and system development to economic and risk-related innovation, shifting geopolitical concerns, and the international focus on ensuring universal access to energy services. Identifying relative strengths and weaknesses in various approaches helps us better adapt and create vibrant energy systems at the local, national and regional level – thus, the impetus for our continued effort on developing the Energy Architecture Performance Index. The EAPI developed by the World Economic Forum has already shown great promise in helping bring important insights.

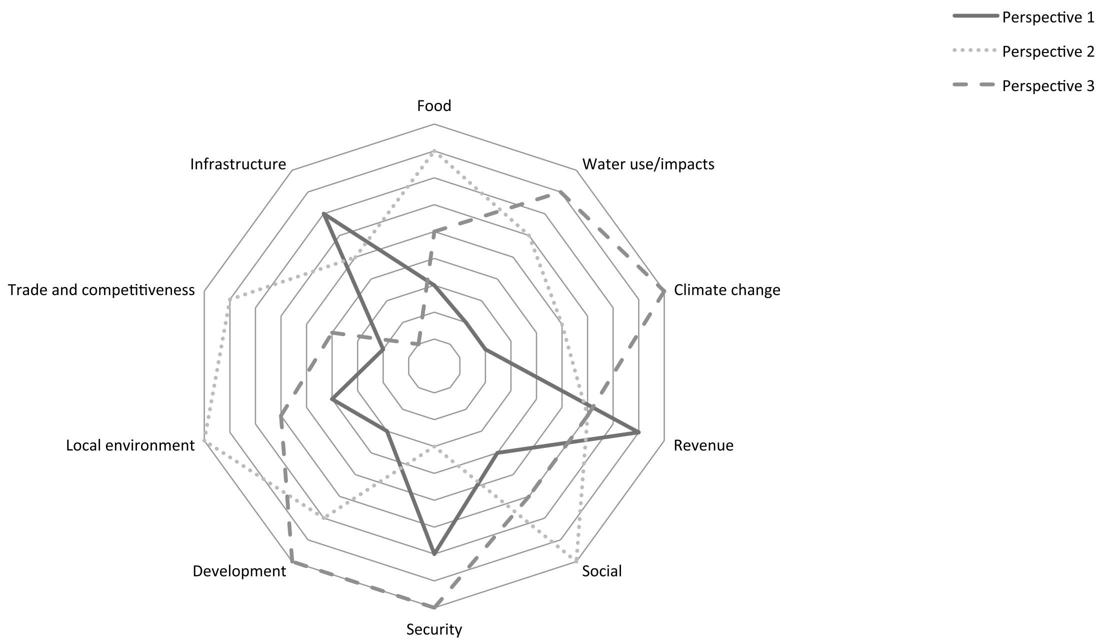
The EAPI is a global initiative with the aim to create a set of indicators that highlights various countries' performance across each principal facet of their energy systems. In doing so, it attempts to meet two interlinked goals. The first is to assess energy systems across three primary objectives: to deliver economic growth, to do so in an environmentally sustainable manner, and to ensure security of supply and access for all. Secondly, it provides a one-stop shop where stakeholders can easily access transparent and robust datasets and the resultant analysis. The first iteration of the index, launched last year, proved to be both an excellent conduit for the work of several World Economic Forum Global Agenda Councils and a way to focus attention on places where the Forum can make specific and useful contributions in a complex terrain.

While focus is on the core aspects of security, environment and economics, the index recognizes the realities of energy policy as containing "more sides than a triangle". The figure below depicts a schematic of these wider concerns, and how different national or regional priorities exist within them.

Since the launch of the first Energy Architecture Performance Index in December 2012 (EAPI 2013), the Expert Panel has been engaged in a review process to identify opportunities to improve the methodology. While key methodological principles from EAPI 2013 remain unchanged, the Expert Panel that advises on the index design and development decided to pursue several refinements in the EAPI 2014. We believe they make the index more reflective of how energy systems function and interact with the wider economy. These refinements include both new indicators and replacement of existing ones, and address gaps in accounting for all GHG emissions from the energy sector, the carbon-intensity of power generation and the complexity of trade in defining the energy security of countries. Further details of these changes are described in the methodological addendum of this report.

We will continue to track global energy transitions through the index and will now produce time-series data, which is essential for clearly showing such change. The other members of the Expert Panel and I remain committed to providing support and to continuing the valuable work of the Energy Architecture Performance Index.

Moving Beyond the Policy Energy Triangle



Section 2: Global Energy Performance Index

Global Rankings

The rankings for this year's Energy Architecture Performance Index are shown in Table 2.[7]

The following sections discuss the findings of the EAPI for the top 10 performers globally, as well as the comparative performance of countries within key regions.

Top Performers

The top 10 performers across the index are mostly European and/or OECD nations – Norway, New Zealand, France, Sweden, Switzerland, Denmark, Spain and Latvia – with the exception of Colombia (7th) and Costa Rica (9th).

Although these countries share the highest performances globally, the top 10 shows that there is no single transition pathway. Each country's performance is shaped by its specific natural resource endowment, boundary constraints and political decisions. While these countries achieve the highest scores of those studied, no single country achieves a top score of 1/1 for the index overall, and no country achieves top performance in any of the three dimensions.

The section below provides an overview of the top performers and the key drivers behind their success.

1. Norway – 0.75
With a score of 0.75 over 1, Norway is the top performer across the index. The country's success arises mainly from two factors: its vast natural resource endowment and its focus on developing renewable, sustainable energy. These strengths contribute to delivering the highest performance in energy security and access (0.96) and high scores across the other dimensions of the energy triangle. Norway's considerable North Sea offshore assets make it the third largest exporter of energy in the world, after Russia and Saudi Arabia. At the same time, Norway has placed great emphasis on furthering its environmental sustainability, setting itself the ambitious target of reducing its 1990 levels of global greenhouse gas emissions by 30% by 2020, and to becoming carbon neutral by 2050. Through the roll-out of a number of sound policies, Norway has made great strides towards a low-carbon economy with virtually all its electricity supply coming from hydro, and efficiency measures in public and private buildings. The wealth accumulated from its petroleum revenue positions Norway well to invest in developing new solutions for a low carbon future.

2. New Zealand – 0.73
New Zealand's energy system is characterized by the diversity of its total primary energy supply (TPES), the development of renewable energy sources and a liberalized energy market that has delivered a relatively high level of energy security alongside economic prosperity for consumers. These factors combine to afford New Zealand high scores across the energy triangle. The New Zealand Energy Strategy, published following a government review in 2010, set the path towards improving the energy system by establishing clear long-term policy priorities and energy-savings goals for the country. Among them is the ambition to increase the contribution of renewables to electricity generation from the current 70% of output to 90% by 2025. Although hydro contributes the largest share of installed renewable capacity, New Zealand seeks a wider portfolio of renewables with greater capacity in geothermal and, increasingly, in wind. As the country strives to achieve its ambition in the power-generating sector, it may face challenges of integrating these sources into the national grid.

3. France – 0.72
Energy policy in France has focused on balancing environmentally sustainable energy production, affordability of energy and the competitiveness of its industry. To achieve this balance, France has had a long-standing commitment to establishing and developing its nuclear generating capacity. Currently, nuclear contributes to over 45% of France's TPES, and 75% of total power-generating capacity.[8] While nuclear power is virtually emissions free, nuclear waste and radioactive materials create significant environmental challenges. France has been at the forefront of addressing these concerns through an independent Nuclear Safety Authority and by creating a comprehensive framework for managing radioactive waste and materials. However, the energy transition debate in France is shifting towards reducing the contribution of nuclear to 50% of power generation by 2025, with plans to diversify into renewable energy sources. Additionally, France has indicated additional focus on energy efficiency improvements and increased investment in this space through fiscal disincentives for fossil fuel consumption as part of its energy strategy from 2014.[9]

4. Sweden – 0.72
Sweden is the fourth highest performer across the EAPI, receiving its best score in the environmental sustainability dimension, ranking in second place after France. Sweden's energy sector is defined by its nuclear generating capacity, and a policy and investment focus on renewable energy sources, both in power generation and in the transportation sector. In the 1980s, the Swedish government stated its intent to decommission existing nuclear capacity. However, this policy was repealed in 2010, and there are now life-extension and reactor expansions underway. Nevertheless, Sweden imposes high taxes on nuclear power. In 2009, Sweden's Climate and Energy Policy outlined the goals of a fossil-fuel independent vehicle fleet by 2030, and net zero GHG emissions by 2050. The policy framework to support the realization of these targets is in part driven by overarching EU energy policies, and partly specific to Sweden's goals. For example, Sweden leads the way in transport, with a blend of fiscal incentives for the purchase of flexible fuel vehicles and congestion charge systems in urban centres.

5. Switzerland – 0.72
As is the case for France and Sweden, Switzerland's performance across the energy triangle is largely a result of the prevalence of nuclear generating capacity which contributes to low-carbon, affordable energy. However, in 2011, Switzerland's Federal Council launched its Energy 2050 strategy that involves both the gradual phasing out of nuclear power and the aggressive target of reducing greenhouse gas emissions by one-fifth by 2020.[10] Although hydropower is the largest contributor to the country's electricity output, in the absence of nuclear power Switzerland is likely to

Table 2: EAPI Global Rankings

Country / Economy	Energy Architecture Performance Index (EAPI 2014)		*Economic Growth & Development Basket*	*Environmental Sustainability Basket*	*Energy Access & Security Basket*
	Score	Rank	*Score*	*Score*	*Score*
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Switzerland	0.72	5	0.73	0.59	0.82
Denmark	0.71	6	0.71	0.54	0.88
Colombia	0.70	7	0.74	0.50	0.84
Spain	0.67	8	0.69	0.55	0.78
Costa Rica	0.67	9	0.68	0.56	0.77
Latvia	0.66	10	0.58	0.65	0.77
United Kingdom	0.66	11	0.60	0.56	0.83
Romania	0.66	12	0.63	0.60	0.75
Austria	0.66	13	0.62	0.55	0.82
Canada	0.66	14	0.60	0.48	0.88
Germany	0.65	15	0.64	0.52	0.80
Portugal	0.65	16	0.62	0.57	0.77
Ireland	0.65	17	0.64	0.56	0.75
Peru	0.65	18	0.78	0.46	0.70
Finland	0.65	19	0.54	0.55	0.84
Slovak Republic	0.64	20	0.46	0.66	0.81
Hungary	0.64	21	0.53	0.61	0.78
Brazil	0.64	22	0.54	0.57	0.79
Uruguay	0.64	23	0.65	0.53	0.73
Paraguay	0.63	24	0.66	0.62	0.61
Slovenia	0.63	25	0.53	0.53	0.82
Australia	0.63	26	0.67	0.35	0.87
Luxembourg	0.63	27	0.66	0.52	0.69
Russian Federation	0.62	28	0.59	0.49	0.79
Czech Republic	0.60	29	0.50	0.48	0.84
Belgium	0.60	30	0.47	0.56	0.79
Iceland	0.60	31	0.28	0.72	0.79
Chile	0.60	32	0.61	0.44	0.74
Netherlands	0.60	33	0.49	0.47	0.83
Lithuania	0.60	34	0.56	0.53	0.69
Estonia	0.59	35	0.54	0.50	0.72
Mexico	0.59	36	0.60	0.41	0.75
United States	0.59	37	0.57	0.34	0.84
Japan	0.58	38	0.58	0.43	0.74
Kazakhstan	0.58	39	0.56	0.40	0.79
Poland	0.58	40	0.61	0.36	0.77
Israel	0.58	41	0.61	0.40	0.73
Greece	0.58	42	0.59	0.41	0.74
Croatia	0.58	43	0.63	0.34	0.75
El Salvador	0.57	44	0.52	0.53	0.67
Bulgaria	0.57	45	0.53	0.46	0.73
Argentina	0.57	46	0.64	0.40	0.68
Turkey	0.57	47	0.53	0.45	0.73
Panama	0.56	48	0.64	0.45	0.60
Italy	0.56	49	0.46	0.48	0.75
Ecuador	0.56	50	0.56	0.43	0.68
Korea, Rep.	0.55	51	0.55	0.38	0.74
Azerbaijan	0.55	52	0.44	0.43	0.79
Congo, Rep.	0.55	53	0.53	0.58	0.55
South Africa	0.54	54	0.59	0.38	0.64
Thailand	0.53	55	0.49	0.39	0.73
Albania	0.53	56	0.52	0.45	0.63
Dominican Republic	0.53	57	0.58	0.45	0.56
Georgia	0.53	58	0.37	0.57	0.66
Armenia	0.53	59	0.33	0.57	0.69
Tunisia	0.53	60	0.36	0.45	0.77
Tajikistan	0.52	61	0.32	0.65	0.60
Singapore	0.52	62	0.58	0.37	0.61
Indonesia	0.52	63	0.45	0.41	0.69
Philippines	0.51	64	0.41	0.51	0.62
Venezuela	0.51	65	0.25	0.57	0.70
Algeria	0.50	66	0.34	0.40	0.76
Cyprus	0.49	67	0.55	0.39	0.54
Guatemala	0.49	68	0.35	0.54	0.58

Country / Economy	Energy Architecture Performance Index (EAPI 2014)		*Economic Growth & Development Basket*	*Environmental Sustainability Basket*	*Energy Access & Security Basket*
	Score	Rank	*Score*	*Score*	*Score*
India	0.48	69	*0.49*	*0.41*	*0.54*
Sri Lanka	0.48	70	*0.43*	*0.48*	*0.53*
Malaysia	0.48	71	*0.26*	*0.34*	*0.83*
Bolivia	0.48	72	*0.33*	*0.42*	*0.68*
Kyrgyz Republic	0.47	73	*0.20*	*0.60*	*0.62*
Belarus	0.47	74	*0.26*	*0.48*	*0.67*
Vietnam	0.47	75	*0.30*	*0.43*	*0.66*
Nicaragua	0.46	76	*0.40*	*0.48*	*0.51*
Ukraine	0.46	77	*0.23*	*0.39*	*0.77*
Malta	0.46	78	*0.48*	*0.36*	*0.54*
Morocco	0.46	79	*0.36*	*0.38*	*0.64*
Cameroon	0.46	80	*0.35*	*0.63*	*0.40*
Egypt, Arab Rep.	0.46	81	*0.24*	*0.43*	*0.71*
Namibia	0.46	82	*0.45*	*0.51*	*0.41*
Ghana	0.45	83	*0.34*	*0.59*	*0.42*
Uzbekistan	0.45	84	*0.28*	*0.41*	*0.66*
China	0.45	85	*0.35*	*0.35*	*0.65*
Libya	0.45	86	*0.33*	*0.29*	*0.72*
Macedonia, FYR	0.45	87	*0.37*	*0.31*	*0.66*
United Arab Emirates	0.44	88	*0.35*	*0.21*	*0.77*
Honduras	0.44	89	*0.31*	*0.50*	*0.51*
Qatar	0.44	90	*0.35*	*0.17*	*0.80*
Saudi Arabia	0.44	91	*0.32*	*0.19*	*0.81*
Zambia	0.44	92	*0.35*	*0.71*	*0.27*
Nigeria	0.44	93	*0.38*	*0.61*	*0.33*
Trinidad and Tobago	0.44	94	*0.42*	*0.22*	*0.68*
Botswana	0.44	95	*0.48*	*0.37*	*0.46*
Pakistan	0.43	96	*0.33*	*0.44*	*0.54*
Cote d'Ivoire	0.43	97	*0.29*	*0.59*	*0.41*
Iraq	0.42	98	*0.37*	*0.19*	*0.72*
Senegal	0.42	99	*0.37*	*0.49*	*0.42*
Turkmenistan	0.42	100	*0.25*	*0.27*	*0.75*
Brunei Darussalam	0.42	101	*0.36*	*0.21*	*0.70*
Iran, Islamic Rep.	0.42	102	*0.25*	*0.25*	*0.76*
Nepal	0.42	103	*0.31*	*0.63*	*0.33*
Bosnia and Herzegovina	0.42	104	*0.34*	*0.24*	*0.68*
Kuwait	0.42	105	*0.33*	*0.12*	*0.80*
Mozambique	0.42	106	*0.29*	*0.71*	*0.26*
Eritrea	0.41	107	*0.35*	*0.55*	*0.33*
Syrian Arab Republic	0.41	108	*0.27*	*0.27*	*0.69*
Kenya	0.41	109	*0.28*	*0.63*	*0.31*
Republic of Moldova	0.40	110	*0.31*	*0.28*	*0.60*
Oman	0.39	111	*0.28*	*0.12*	*0.79*
Jamaica	0.39	112	*0.25*	*0.36*	*0.56*
Ethiopia	0.39	113	*0.26*	*0.71*	*0.19*
Bangladesh	0.38	114	*0.39*	*0.39*	*0.37*
Jordan	0.38	115	*0.25*	*0.28*	*0.60*
Haiti	0.38	116	*0.37*	*0.52*	*0.23*
Mongolia	0.37	117	*0.29*	*0.24*	*0.58*
Bahrain	0.37	118	*0.18*	*0.21*	*0.72*
Togo	0.37	119	*0.25*	*0.65*	*0.20*
Cambodia	0.36	120	*0.36*	*0.45*	*0.28*
Tanzania	0.36	121	*0.26*	*0.65*	*0.17*
Benin	0.35	122	*0.32*	*0.49*	*0.25*
Lebanon	0.33	123	*0.33*	*0.25*	*0.41*
Yemen, Rep.	0.32	124	*0.33*	*0.26*	*0.38*

face challenges in maintaining electricity capacity. The interconnectedness of the Swiss energy market with EU markets will be a powerful tool in addressing these capacity challenges. Moreover, policies outlined in the 2050 strategy document focus on energy efficiency and further deployment of renewable energy. The next years will be important for Switzerland's transition, as the country drives to replace its nuclear base while balancing the imperatives of the energy triangle. Switzerland is driving efficiency and financing further decarbonization efforts through a CO_2 tax on space heating.

6. Denmark – 0.71
Ranking sixth on the overall index, Denmark is the best EU performer in the economic growth and development and energy security dimensions. In recent years, Denmark has rolled out a number of policies for renewable energy, energy efficiency and climate change with the long-term energy objective of becoming completely independent of fossil fuel consumption by 2050. In its Energy Strategy 2050, the government published this long-term vision, as well as set out a series of energy-policy initiatives addressing renewables, efficiency and climate change. The key goal of the strategy is to transform Denmark into a low-carbon society with a stable and affordable energy supply, independent of both its own declining fossil fuel reserves and fossil fuel imports. The first phase of the strategy will focus on policy initiatives and investment frameworks to improve energy efficiency and to increase installed renewable energy capacity. In its later phases, the strategy will seek to reduce fossil-fuel dependence further and improve the integration of renewables in the energy grid through the promotion of smart grid solutions and the development of a low-carbon transportation sector.

7. Colombia – 0.70
Colombia's position on the index is largely driven by the transformation of its oil and gas sector over recent years. Following steady decline in hydrocarbon production to 2008, Colombia has seen a dramatic increase in production as a result of successful policy reform promoting new investment in exploration and development of its fields. This affects the country's performance on energy security and on economic growth and development, with production making Colombia self-sufficient in natural gas and generating revenue from exporting gas to neighbouring Venezuela. However, this surge in hydrocarbon output also has a negative impact on the country's environmental sustainability score, with Colombia achieving the lowest score in this dimension compared to the other top 10 performers in the index – 0.50 compared to the average of 0.63 for the other top 10 countries. Additionally, Colombia performs worse among its top 10 peers for access to modern electricity and percentage of population using solid fuels for cooking, with a 97% access rate and 14% of the population relying on solid cooking fuels. In view of its increased revenues and availability of natural resources, Colombia needs to develop its electricity grid to bring access to rural populations that are the most affected by these indicators.

8. Spain – 0.67
Spain is the fifth largest energy consumer in Europe and, thanks to recent investment in wind and solar power, one of the region's largest producers of electricity from renewables. Despite its drive for renewables, Spain remains a large consumer of fossil fuels, with virtually no domestic resources. However, government regulation that limits the percentage of total oil and gas imports any single country may sell to Spain ensures its diversity of supply. This diversification policy is aided by the country's large liquefied natural gas (LNG) regasification capacity and Spain's location close to North African exporters such as Algeria, which provides natural gas to the country through the undersea Maghreb-Europe Gas Pipeline. Alongside the diversity of its import base, Spain has pursued policies to increase power generation from renewables, generating a significant amount of power from wind energy, the second most in Europe behind Germany. The sizeable investment and incentive framework for renewables, coupled with the economic downturn of 2008-2010, is increasing the challenge of maintaining the competitiveness of Spain's power-generating sector and the affordability of energy for consumers. Addressing the impact of changes in the regulatory framework for subsidies and investment into renewable energy are key areas for the country to address.

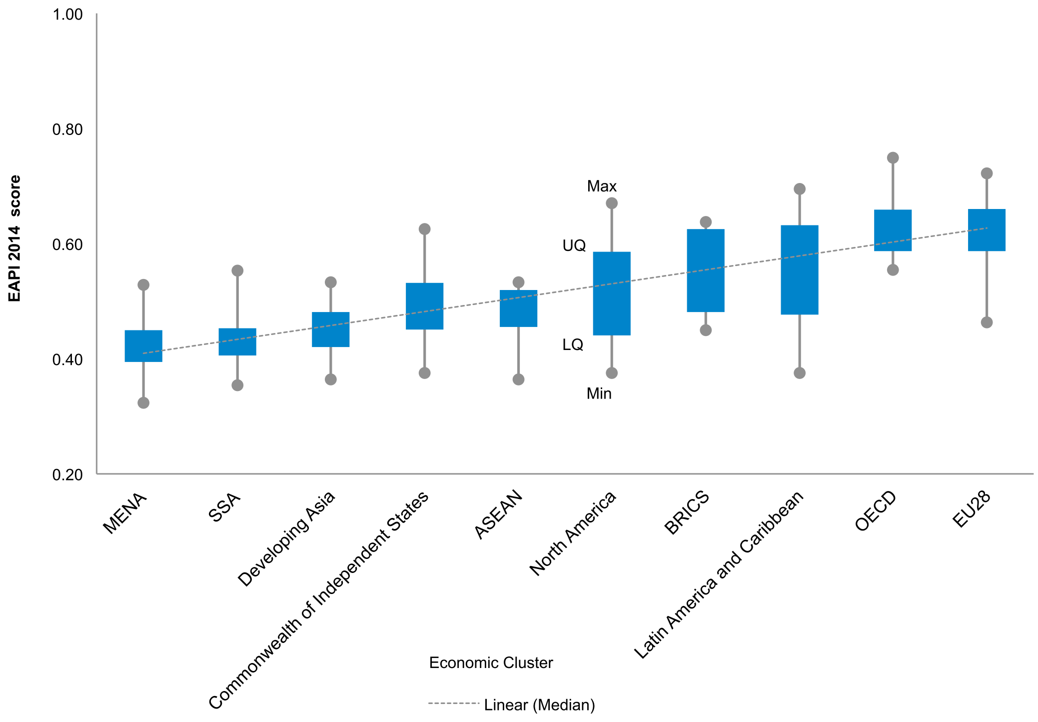
9. Costa Rica – 0.67
Costa Rica, ranked in 9th place, is along with Colombia one of only two upper middle-income countries[11] to rank within the top 10 in the EAPI. Costa Rica has established itself as a world leader in renewable energy, with considerable investment in developing and expanding renewable energy capacity, especially wind power. Costa Rica achieves 52% of its TPES from renewables, with over 99% of electricity output produced by renewable energy sources, predominantly hydro. In recent years, Costa Rica has sought to diversify across renewable technologies in a bid to mitigate the risks of energy security challenges in years with reduced rainfall. The overarching government strategy driving the transformation of Costa Rica's energy system has the goal of making Costa Rica the world's first carbon neutral country. As policies continue to focus on expanding installed power-generating capacity from renewables, Costa Rica has the potential to progress towards its goal by addressing fossil fuel consumption and emissions in its transportation sector as the country is, together with Colombia, the lowest performer across the top 10 in fuel economy of passenger vehicles, with a score of 0.4 against the top 10 average (excluding Costa Rica and Colombia) of 0.7.

10. Latvia – 0.66
Latvia is the only EU11 country – an EU grouping consisting of Eastern European countries – to rank within the top 10. The success of the country's energy system is largely driven by the decline in the overall energy intensity of the economy, having fallen from US$ 5/kgoe in 2001 to just under US$ 9 in 2011. This has been driven by reforms such as liberalization of the energy sector and targeted initiatives for improvements in energy efficiency. Affordability of energy relative to the low taxation benchmark of the index[12] is also a key high performance indicator for Latvia, affording the country an average score of 0.91 for fuel pricing in line with minimal taxation. In terms of energy security, like most Eastern European countries, Latvia is almost entirely dependent on Russia for its fossil fuel supply. To mitigate the risks of over-dependence on a single supplier, Latvia has diversified its electricity sector to derive 54% of power from hydro and another 3% from wind and biomass. To further reduce its dependency, Latvia is also participating in the Baltic Energy Market Interconnection Plan (BEMIP), to increase and improve inter-country connections in the Baltic region.

Regional Insights

The following sections explore and compare regional performance: first, by comparing the average performance of regions/economic clusters to identify the key challenges each faces, and second, by comparing the scores of individual countries within each region/economic cluster. This aims to highlight performance and challenges across the dimensions of the energy triangle, identify successful transitions and provide best practices.

Figure 3: Average EAPI 2014 Score by Region/Cluster



- Figure 3 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

See Definitions section for further explanation of the graph structure and economic/regional clusters

EU28, OECD and Nordic economies are the top performing regions/economic clusters across the index, with average scores of 0.62, 0.63 and 0.68 respectively. This result underlines the bearing that economic wealth has on the performance of an energy system. In 2012, the average GDP per capita across OECD economies was nearly US$ 40,000,[13] against the average in sub-Saharan Africa of just over US$ 2,000, one of the lowest-performing regions with an overall score of 0.43. Higher-income economies, with GDP largely dominated by the service sector, have been more successful in focusing on the environmental performance of their energy systems. They have adopted efficiency measures, invested in renewable technologies and put in place incentives for their adoption.

Industrializing economies and clusters such as BRICS, ASEAN and Developing Asia are characterized by more energy-intensive economies – as highlighted by the lower average scores for these regions in the energy intensity indicator (Table 3). Table 3 also draws attention to the low performance of these industrializing clusters in the carbon-intensity of the power-generating sector – averaging 0.36 against the 0.68 average of EU28, OCED and Nordic economies. Although BRICS, ASEAN and Developing Asia clusters fall within the same score range as OECD, EU28 and Nordic economies in the economic growth and development dimension, their scores diverge more widely in environmental sustainability and energy security and access dimensions, highlighting the different priorities of these economies.

Table 3: Average regional/cluster ranking per individual indicator, energy triangle dimension and overall EAPI. Ranking from 1 (best) to 124 (worst)

Indicator/Dimension	ASEAN	BRICS	Central and Eastern Europe	Commonwealth of Independent States	Developing Asia	European Union (EU28)	Middle East & North Africa	Nordic Countries	North America	OECD	Latin America and Caribbean	Sub-Saharan Africa
GDP per unit of energy use	70	84	42	94	75	36	79	54	56	39	46	88
Fuel Imports (%GDP)	75	44	82	70	67	75	44	42	67	60	58	60
Super Gasoline - Level of Price Distortion through subsidy or tax	66	53	28	73	64	44	101	73	65	54	59	60
Diesel - Level of Price Distortion through subsidy or tax	83	66	21	76	83	29	109	58	69	42	69	52
Electricity Prices for Industry	21	19	64	4	14	38	n/a	20	35	33	32	1
Fuel Exports (% GDP)	50	68	38	46	71	61	35	57	81	68	72	75
Economic Growth & Development	**73**	**47**	**44**	**90**	**79**	**33**	**96**	**38**	**53**	**32**	**47**	**84**
Alternative and nuclear energy (% of total energy use, incl. Biomass)	65	64	72	80	55	63	110	28	51	61	52	20
Nitrous oxide emissions in energy sector / per capita	50	80	72	45	52	96	50	111	57	102	49	37
Methane Emissions from Energy sector / per capita	70	78	77	82	56	61	84	51	42	62	49	49
CO2 emissions from electricity production / per kWh	89	83	63	57	87	57	95	20	60	54	48	52
PM10, country level	71	55	43	61	87	32	90	18	61	35	70	75
Average Fuel Economy for passenger cars (l/km)	75	40	20	34	78	16	87	38	81	27	81	46
Environmental Sustainability	**85**	**70**	**71**	**66**	**80**	**46**	**107**	**20**	**66**	**48**	**59**	**31**
Electrification rate	86	64	14	25	87	1	69	1	73	7	78	114
Quality of Electricity Supply	61	77	51	76	78	31	56	8	65	26	75	95
Percentage of population using solid fuels for cooking	62	67	51	56	87	14	6	1	65	7	63	108
Energy imports, net (% of energy use)	57	44	82	58	49	87	38	48	72	78	60	52
Diversity of TPES (Herfindahl index)	50	55	44	67	57	36	96	26	67	30	65	92
Diversification of Import Counterparts (Herfindahl Index)	25	5	50	57	31	40	30	55	54	33	48	54
Energy Security & Access	**70**	**63**	**55**	**63**	**82**	**35**	**54**	**8**	**72**	**27**	**70**	**111**
Energy Architecture Performance Index	**76**	**52**	**49**	**72**	**85**	**27**	**97**	**12**	**62**	**24**	**53**	**96**

The relationship between performance on the energy triangle and per capita GDP is reversed in the case of the Middle East and North Africa region. MENA achieves the lowest average performance at 0.42 across all the regions/economic clusters although average GDP per capita of US$ 15,000 is significantly higher than the next best performer, sub-Saharan Africa. As the region with the world's greatest endowment of natural resources, MENA performs significantly above average for net energy exports at 0.54 and for contribution of fuel exports to GDP at 0.51 against the regional averages of 0.39 and 0.14 respectively. The significant contribution of fuel exports to the economy illustrates the over-dependence of the region on the hydrocarbon industry. The high performance in energy security and export-related indicators is negatively impacted by the region's scores in economic growth and development and environmental sustainability. These are the lowest across all regions at 0.21 and 0.26 respectively – well below the average of 0.47 and 0.49. The key driving factor is the pervasiveness of fossil fuel subsidies, which weighs on the regions' economy, brings about inefficient energy use and hinders investment into renewable energy sources.

Although some regions/clusters are defined by similar challenges, average regional scores show varied performance of individual countries. The largest variations are in North America and the EU28, highlighting the divergence of energy systems within these regions. For example, the North American continent includes high performers such as Costa Rica – one of the top 10 performers globally – and Haiti, which in 116th place is one of the lowest ranking. This variance highlights the regional disparity between import-dependent countries of the Caribbean and Central America – which receive lower scores in energy security and economic growth and development – and countries such as Costa Rica, the US and Canada which are tackling energy security through aggressive deployment of renewable technologies, and increased focus on developing domestic natural resources in the case of Canada and the US. Mexico's energy reform is also expected to play a key role in the economic and energy security landscape of the country and region.

Among the lowest-performing regions of the Middle East and North Africa and sub-Saharan Africa, the spread of scores underlines the potential for improvements for low-performing countries in the regions. High performers within these clusters can provide valuable transition models for their peers, by bringing to bear successful policies and investment frameworks. Key examples are renewable energy and efficiency strategies in Tunisia for the Middle East, and the drive for improved energy access rates in South Africa among sub-Saharan African countries.

The following sections explore a number of individual regions in more detail, providing analysis on top performers within each region and drawing attention to the key challenges each region is experiencing.

Table 4: Overview of high/low performers per region or economic cluster

ASEAN

Country	Score	Rank
Thailand	0.53	55
Singapore	0.52	62
Indonesia	0.52	63
...	...	...
Vietnam	0.47	75
Brunei Darussalam	0.42	101
Cambodia	0.36	120

BRICS

Country	Score	Rank
Brazil	0.64	22
Russian Federation	0.62	28
...	...	...
...	...	...
South Africa	0.54	54
India	0.48	69
China	0.45	85

Central and Eastern Europe

Country	Score	Rank
Romania	0.66	12
Hungary	0.64	21
Lithuania	0.60	34
...	...	...
Albania	0.53	56
Macedonia, FYR	0.45	87
Bosnia&Herzegovina	0.42	104

Commonwealth of Independent States

Country	Score	Rank
Russian Federation	0.62	28
Kazakhstan	0.58	39
Azerbaijan	0.55	52
...	...	...
Turkmenistan	0.42	100
Republic of Moldova	0.4	110
Mongolia	0.37	117

Developing Asia

Country	Score	Rank
Thailand	0.53	55
Indonesia	0.52	63
Philippines	0.51	64
...	...	...
Bangladesh	0.38	114
Mongolia	0.37	117
Cambodia	0.36	120

EU28

Country	Score	Rank
France	0.72	3
Sweden	0.72	4
Denmark	0.71	6
...	...	...
Italy	0.56	49
Cyprus	0.49	67
Malta	0.46	78

Middle East & North Africa

Country	Score	Rank
Tunisia	0.53	60
Algeria	0.5	66
Morocco	0.46	79
...	...	...
Bahrain	0.37	118
Lebanon	0.33	123
Yemen	0.32	124

Nordic Countries

Country	Score	Rank
Norway	0.75	1
Sweden	0.72	4
Denmark	0.71	6
...	...	...
...	...	...
Finland	0.65	19
Iceland	0.60	31

North America

Country	Score	Rank
Costa Rica	0.67	9
Canada	0.66	14
Mexico	0.59	36
...	...	...
Trinidad and Tobago	0.44	94
Jamaica	0.39	112
Haiti	0.38	116

OECD

Country	Score	Rank
Norway	0.75	1
New Zealand	0.73	2
France	0.72	3
...	...	...
Turkey	0.57	47
Italy	0.56	49
Korea, Rep.	0.55	51

Latin America and Caribbean

Country	Score	Rank
Colombia	0.70	7
Costa Rica	0.67	9
Peru	0.65	18
...	...	...
Trinidad and Tobago	0.44	94
Jamaica	0.39	112
Haiti	0.38	116

Sub-Saharan Africa

Country	Score	Rank
Congo, Rep.	0.55	53
South Africa	0.54	54
Cameroon	0.46	80
...	...	...
Togo	0.37	119
Tanzania	0.36	121
Benin	0.35	122

Two Simple Rules to Build a Global Energy Architecture for the 21st Century

José Manuel Entrecanales, Chairman and Chief Executive Officer, Acciona, Spain

There is by now an unequivocal body of evidence that has elevated the issue of how we manage and consume the world's energy resources to the top of the global agenda.

Although the issues are well defined, formidable challenges remain. Even when the best minds are engaged in drafting clear roadmaps – for example, in the Forum's New Energy Architecture: Enabling an Effective Transition – governments must still define priorities and juggle conflicting interests to ensure that their energy models achieve economic growth, environmental sustainability and energy security for all.

It is clear that there is no single solution to this equation. But it is equally obvious to me that renewable energy is a vital and indispensable part of the answer. I believe that renewables are uniquely positioned to respond to some of these new challenges. Here are a few reasons why.

The first and most widely known aspect of renewable energy is its infinite and non-GHG emitting nature. For this reason alone, we should increase the share of renewable and non-polluting energies in our energy mix.

Second, and no less important, as local and geographically well distributed sources of energy, renewables increase a country's energy independence and security in two important ways. By replacing fossil fuel imports, renewables strengthen a country's balance of payments. They also bring price stability to electricity markets by making power generation less dependent on the volatile prices of fossil fuels, over which importing countries have no control. I believe that energy security and price stability will become increasingly important considerations for policy-makers in a world still riven by geopolitical tensions over access to the finite reserves of fossil fuel resources.

Third, we know that renewables generate economic wealth and regional development. A European study by Ernst & Young showed that in countries with no fossil resources, investing in a wind farm had an impact on GDP 3.5 times greater than a similar investment in a combined cycle gas turbine plant, while the wind farm created 1.6 times more jobs in the EU27.

Furthermore, the development of renewables brings with it an opportunity to create a new industrial cluster defined by its high technological content, skilled jobs, significant export opportunities and a long and promising future.

In addition, renewables are economically efficient and are becoming increasingly competitive compared with traditional power sources. The cost of renewable energy has plummeted in recent years. Wind turbine prices, for example, have dropped 30% in the past four years and PV solar power has reduced its installation costs by 50% in the past five years. In many parts of the world, renewable energy is expected to compete head-to-head with fossil fuel-based energies. According to McKinsey (Global Solar Initiative), on-shore wind will become competitive with gas and coal in 2015. And this does not take into account negative externalities, which make renewables compare even more favourably to conventional sources.

Renewables are also the logical choice for fast-growing, energy-hungry economies because they are quick to assemble, highly predictable, easy to integrate and have no adverse impact on the environment. Furthermore, they are an efficient solution for countries whose priority is to extend energy access and security, and to increase their energy independence. This is because renewable energy power plants can be built in a short time and can become operational in less than two years. Compare this to an average of almost five years for the development of a conventional fossil fuel power plant.

Renewable energy plants have the added advantage of being scalable: they can be configured in different sizes without necessarily requiring a minimum size to make a project profitable. Given that 19% of the world's population does not have access to electricity, wind and solar represent an important solution to this pressing need. This is particularly true for rural communities that are not connected to an electricity grid.

Finally, renewable energy plants are "reversible". If, in a few decades, new, more efficient, more competitive or more manageable energy technologies were to be developed, removing renewable energy plants throughout the world, changing their location or even transforming them into alternative uses, is a perfectly possible scenario with little or no long-term negative consequences. Unfortunately, we cannot say the same about most other conventional energy sources and their associated generation technologies.

However, structural change in a country's energy system is not easy to bring about. Energy policy requires long-term political commitment and also the strength to resist the enormous economic and social pressures of the entrenched interests of incumbents. The introduction of new technologies, such as renewables, has a disruptive effect on the energy industry status quo, where it is not unusual to find direct public intervention or integrated monopolies.

This is one reason why any society wanting to build its energy architecture for the 21st century needs to follow some very basic rules before starting on the road to a cleaner and more sustainable energy model.

The first rule is the simplest but also the most difficult to accomplish: the necessary changes to a country's energy model must be a common goal that enjoys multiparty support and the approval of a majority of the population. It is also necessary to explain how the change will happen and be very transparent on the costs and benefits of the new policy.

The second rule is as challenging as the first one: governments must develop a long-term strategy accompanied by a clear set of policies and instruments. This policy has to be flexible enough to adapt to short-term economic changes (such as the current economic crisis) without sacrificing its long-term objectives.

There are, of course, many more rules and much more advice on how to proceed. Very recently, the IEA listed many of them in great detail in its report Tracking Clean Energy Progress 2013. All of them are logical and build on lessons learned from past errors. No doubt, we will avoid repeating many of them and this will clear the way for swifter and cheaper ways of adopting a cleaner energy system.

But all of these efforts will be in vain unless the two important rules that I have just mentioned are followed very strictly. It is to be expected that entrenched interests will do their utmost to maintain the status quo and prioritize short-term private gain over longer-term social and economic benefits.

That is why, as with the introduction of many other disruptive technologies, the key resides in winning political and social support for change.

European Union (EU28)

EU28 - Analysis of EAPI Performance

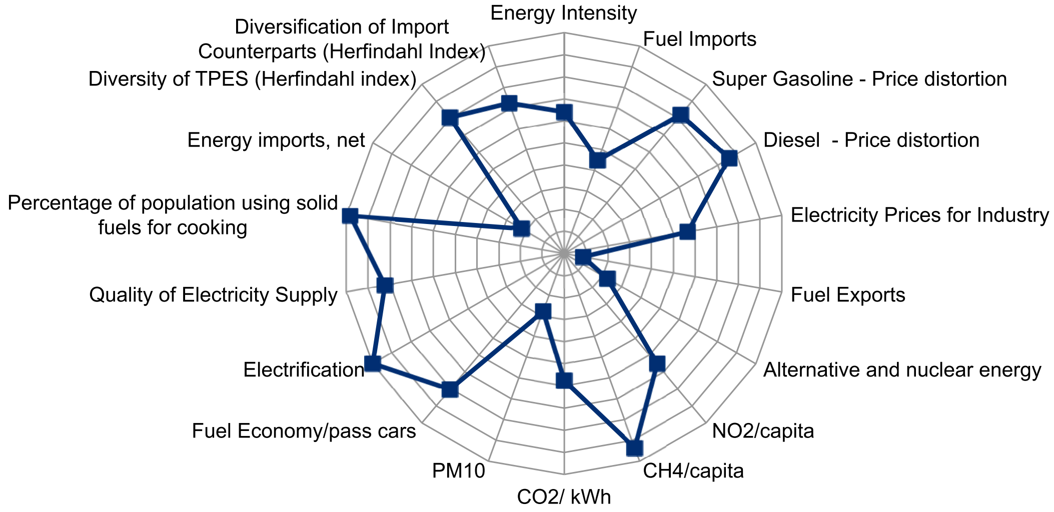
Table 5: EU 28 EAPI Performance

EU28	EAPI 2014		Economic Growth & Development		Environmental Sustainability		Energy Security & Access	
Country Name	**Score**	**Rank**	Score	Rank	Score	Rank	Score	Rank
France	**0.72**	**3**	0.63	19	0.73	1	0.81	18
Sweden	**0.72**	**4**	0.59	30	0.73	2	0.85	6
Denmark	**0.71**	**6**	0.71	4	0.54	39	0.88	3
Spain	**0.67**	**8**	0.69	6	0.55	38	0.78	30
Latvia	**0.66**	**10**	0.58	35	0.65	12	0.77	36
United Kingdom	**0.66**	**11**	0.60	27	0.56	32	0.83	13
Romania	**0.66**	**12**	0.63	17	0.60	19	0.75	41
Austria	**0.66**	**13**	0.62	20	0.55	37	0.82	16
Germany	**0.65**	**15**	0.64	15	0.52	46	0.80	21
Portugal	**0.65**	**16**	0.62	21	0.57	29	0.77	33
Ireland	**0.65**	**17**	0.64	12	0.56	33	0.75	45
Finland	**0.65**	**19**	0.54	44	0.55	35	0.84	9
Slovak Republic	**0.64**	**20**	0.46	59	0.66	8	0.81	19
Hungary	**0.64**	**21**	0.53	49	0.61	17	0.78	31
Slovenia	**0.63**	**25**	0.53	48	0.53	41	0.82	15
Luxembourg	**0.63**	**27**	0.66	10	0.52	45	0.69	64
Czech Republic	**0.60**	**29**	0.50	52	0.48	60	0.84	10
Belgium	**0.60**	**30**	0.47	58	0.56	34	0.79	27
Netherlands	**0.60**	**33**	0.49	53	0.47	62	0.83	11
Lithuania	**0.60**	**34**	0.56	38	0.53	43	0.69	65
Estonia	**0.59**	**35**	0.54	43	0.50	52	0.72	56
Poland	**0.58**	**40**	0.61	22	0.36	98	0.77	32
Greece	**0.58**	**42**	0.59	31	0.41	82	0.74	47
Croatia	**0.58**	**43**	0.63	16	0.34	103	0.75	43
Bulgaria	**0.57**	**45**	0.53	47	0.46	63	0.73	54
Italy	**0.56**	**49**	0.46	60	0.48	59	0.75	46
Cyprus	**0.49**	**67**	0.55	40	0.39	89	0.54	97
Malta	**0.46**	**78**	0.48	56	0.36	97	0.54	99
EU28 Average	0.62		0.57		0.53		0.77	

Overview

In 2011, the European Union unveiled its energy strategy to 2050, outlining the vision for transforming Europe into a competitive, low-carbon economy. The strategy calls for greater deployment of renewable energy, improved energy efficiency and reduction of GHG emissions. Within this framework, the EU seeks 20% efficiency improvement and emission reduction on 1990 levels, and a 20% share of renewables in the energy mix across member states by 2020. Policies among EU members have largely reflected this mandate and the latest European Commission report suggests members are generally in line to achieve at least one target.[15] In 2011, the EU achieved a 17% reduction in GHG emissions on 1990 levels,[16] showing progress is being made towards targets. However, the negative growth rates caused by the economic contraction of recent years have also played a role in reducing emissions through lower industrial activity. Additionally, the economic situation has led to policy reversal in EU member states (e.g. the United Kingdom, Spain and Italy) that faced challenges in sustaining high subsidies and investment frameworks for renewables.

Figure 4: EU28 – Average Performance per Indicator



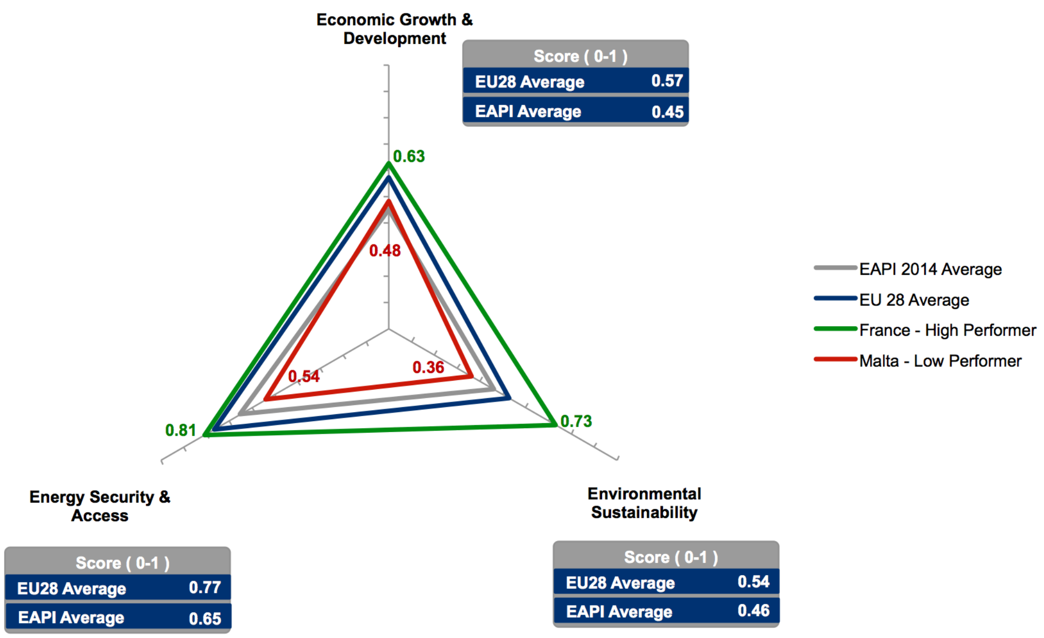
*Spider chart represents average performance of region/cluster for individual EAPI indicators. Low scores close to the centre of the chart; high scores close to the outer circle

The spider chart in Figure 4 provides an overview of the average EU28 performance across the core indicators of the EAPI, highlighting the challenges of the EU28 energy architecture:

– Overall, the scores of EU28 countries reflect the region's strategic emphasis on emission reduction and renewable energy targets – half of the EU28 countries score in the upper quartile for their energy security and access, and over 60% score among the top 50 for performance in environmental sustainability.
– Performance continues to be hindered by reliance on energy imports, with the EU28 average score of 0.22/1 for the relative indicator in line with the global lower quartile threshold of 0.21/1. The energy security challenge of import dependence is further compounded in EU11[17] countries whose average expenditure for fuels relative to GDP affords them an average 0.35/1 against the EU15[18] average of 0.56/1.
– The best performer in the EU28 cluster is France with a score of 0.72/1, compared to the lowest performer, Malta, scoring 0.46/1 and ranking 78th globally. Scores across the cluster are highly dispersed, drawing attention to the different levels of economic development of EU member states. With the exception of Italy and Latvia, the spread of rankings shows a split between EU15 Central and Western European largely deindustrialized economies sitting in the top half of the regional rankings, and EU11 Eastern European industrializing economies occupying the lower half.

The next section of the report compares the performance of EU28 member states against each other by identifying and analysing the key challenges and success stories of the economic cluster across each dimension of the energy triangle.

Figure 5: EU 28 – Energy Triangle Performance: Average against High/Low Performer



Economic Growth and Development

In general, EU28 countries perform well in the economic growth and development dimension of the energy triangle. This is due in part to the combination of low intensity service-led economies and EU-wide efficiency targets mandated under the Energy Efficiency Directive.[19] The lower half of the rankings for this dimension are occupied by EU11 countries (except Italy), which have more energy-intensive economies driven by growth in industrial activities, and high import costs relative to GDP.

High performer – Denmark
Denmark is the best performing EU28 member state across this dimension, and ranks 4th globally. With a service-led economy (the service sector accounts for 76% of its GDP[20]), the country has one of the most energy efficient GDPs globally. Additionally, Denmark achieves the lowest spending on fuel imports relative to GDP across EU28 members. Denmark's long-term energy strategy, set out in the "Roadmap to 2050", is to become a fossil-fuel free country by 2050. The short-term implementation of the strategy involves efficiency and renewable targets to 2020 which aim to further reduce fuel import costs as well as provide the basis for the development of a renewable sector in the economy.

Trading economic growth for environmental sustainability
Ranking 60th, Italy is the lowest EU28 performer for this dimension of the energy triangle. Although the country's economy has an energy intensity of over US$ 12 GDP/unit of energy (comparable to the United Kingdom and Spain), it also imposes some of the highest taxes on gasoline and diesel globally and its electricity prices are among the highest in the EU.[21] Like other EU countries, Italy made significant investments in the development of renewables, setting up incentive schemes such as the *Tariffa Omnicomprensiva*, a feed-in tariff for all power generation up to 1 MW, and the *Conto Energia* which covers photovoltaic plants and solar heat installations.[22] But while this large-scale investment has been instrumental in increasing renewable capacity in Italy, it has provoked questions on the long-term economic sustainability of the measures and the cost to consumers – especially during the period of recession. The cost of the incentive schemes in Italy totalled an estimated € 3.4 billion in 2010, with over 80% of the costs passed on to consumers[23]. This example highlights how the affordability challenge has impacted the competitiveness of EU industries against other economies with lower cost bases for energy.

Environmental Sustainability

Performance across the environmental sustainability indicators is overall high among EU28 member countries. The top performers in Europe and globally are France and Sweden, whose nuclear capacity, accounted for as low-carbon energy sources in the index, affords them the top two rankings. The performance of other countries is more varied, with a number of EU15 economies making significant investments in low carbon through increased deployment of renewables and GHG reduction policies. The low performers across these indicators are EU11 economies whose scores are impacted by higher industrial activity relative to their EU15 counterparts, as well as by the low diversification of sources in the energy mix.

Nuclear capacity as a low-carbon energy source
The environmental performance of France and Sweden is underpinned by the extensive nuclear capacity in the power-generating sector in both countries and the contribution of this capacity to total primary energy supply of 45% and 32%, respectively. This nuclear strategy has led France to have a low-carbon emission power-generating sector compared to EU counterparts. However, France has indicated it may seek to reduce reliance on nuclear from the current 75% of power-generating capacity to 50% by 2025 and diversify into renewable power.[24] Similarly, Sweden's policy landscape for nuclear has been unstable since the decision in 1980 to gradually phase out nuclear capacity, when Sweden started imposing mounting taxes on nuclear power. In 2010, this policy was reversed with life extended in existing power plants and a number of planned additions. Nevertheless, the government does not intend to incentivize nuclear, and no public financing is involved in upgrading existing plants and developing new ones. Investment will be directed instead at renewables and hydro projects.

Within the EAPI, nuclear energy is accounted for as a low-emission energy source. However, the negative externalities of nuclear, such as the disposal of radioactive waste, and the potential risks such as accidents and leaks have not been accounted for.

Environmental sustainability through renewables
EU countries such as Denmark, Germany and Spain have set out their transition pathways through investments and policies to drive expansion of renewable capacity. Spain has increased the contribution of solar and wind energy to TPES from 1% in 2005 to 4% in 2011; similarly, in Denmark the contribution of solar and wind energy grew from 3% to 5% over the same period. Germany, the largest energy consumer in Europe,[25] was in 2011 the largest producer of non-hydro renewable energy in Europe. In its *Energiewende* "Energy Transition" strategy, Germany set out the ambitious goal to phase out its nuclear capacity (following safety concerns due to the Fukushima Daiichi incident), reduce reliance on fossil fuels and improve its environmental performance by investing – and promoting investment – in the renewables market. Current policies include upfront investment support and provisions to allow the resale of surplus renewable energy back to the grid with a feed-in tariff guaranteed for up to 20 years. Through such incentives, renewables grew 10 times faster than the OECD average from 1990 to 2010 and now account for 20% of electricity generation. The closing article of this section provides an industry perspective on the progress of the *Energiewende* in achieving its goals.

The cost challenge of renewable energy, coupled with the availability and comparative low cost of coal over natural gas in the EU – driven by the shale 'revolution' in the US – has triggered a return to coal over natural gas in power generation. The EU increased coal imports by 2.8% in 2012, compared to the average 1.3% decline trend of the past decade.[26] Because coal generates, on average, twice the amount of GHG emissions as natural gas,[27] this trend is having the opposite effect to that targeted by EU renewable policy directives. This highlights the pricing challenge of renewables, as well as the need to build more resilience against price fluctuations in fossil fuels.

The environmental challenge of EU11 industrializing economies

The lower rankings in environmental sustainability are occupied by EU11 countries – Croatia, the latest country to join the EU in 2013, ranks 103rd and Poland 98th. Although some EU11 countries perform well due to hydro and nuclear capacity (e.g. Latvia and Slovakia), the energy mix of Eastern European countries is dominated by fossil fuels. This is due, in part, to the availability of coal from countries like Poland and Germany, the proximity to Russia as a resource hub and the role of these countries as transit routes for Russian pipelines to Europe.

Estonia has one of the most carbon-intensive power-generating sectors globally, placing the country on a global ranking of 123rd; in 2012, CO_2 emissions per kWh were comparable to those of Iraq and Mongolia. The country's power-generating mix is dominated by oil shale, from which the country derives 90% of its electricity production.[28] While Estonia's National Energy Action Plan 2007-2013 set out measures to improve energy efficiency in the power and residential sectors, addressing the diversification of the electricity fuel mix will be instrumental in lowering the country's energy intensity.

Energy Security and Access

EU28 member states, with the exception of Malta and Cyprus, perform well in the energy security and access indicators. Even with the low performers included, the average EU28 score of 0.77/1 sits only marginally below the global upper quartile performance threshold of 0.78/1. Although scores are overall uniform, analysis of the indicators and of individual policy directions shows the discrepancy between high performers such as Denmark that aspire to energy independence and the risks facing import-dependent countries from Eastern Europe.

Energy independence by 2050

With the exception of Denmark, all EU28 member states are net-energy importers. This, alongside diversity in the source of primary energy supply, contributed to Denmark achieving the top performance across EU28 member states for energy security and access. Aside from production from its North Sea fields which contributes to the country exporting 17% of net energy consumption, energy security in Denmark is also underpinned by the high diversity of TPES created by large-scale developments in renewables, especially wind and biogas, in recent years. With declining oil and gas production, Denmark's long-term energy strategy is to become energy independent and carbon-neutral by 2050, with all its energy supply for electricity, heating, industry and transport coming from renewable sources. Denmark has approved aggressive targets for renewables, especially wind energy, which currently provides 30% of electricity production, and is expected to reach 50% by 2020. A number of policies such as tax rebates, subsidies, direct contributions and investments in R&D are driving the transition through continued private sector investment.

The next step for Denmark is the integration of renewables in the power grid through smart grid solutions to maximize the efficient use of intermittent renewable energy sources. In April 2013, the Danish government launched its Smart Grid Strategy to provide the framework for the development of a smart grid which can combine smart meters read on an hourly basis with variable tariffs and a data hub. The aim is to make it possible for consumers to use power when it is least expensive.

EU11 energy security and import dependence

For the net-importing countries, scores across the energy security indicators vary widely, with Mediterranean-facing countries overall receiving higher scores than the EU11 countries. Countries such as Lithuania, Poland and Bulgaria face significant energy security challenges due to the low diversification of total primary energy supply, import dependence and low diversification of import partners. Almost entirely reliant on Russia for their supply of energy, these countries face significant energy security challenges. In 2009, a dispute over pricing with Russia caused a severe energy shortage in Ukraine, and highlighted the dangers of over-dependence on a single supplier. To mitigate energy security risks, Poland is building an LNG terminal to enable the import of natural gas from Qatar, starting in 2015. The pricing under the long-term contract with Qatar is expected to be higher than purchasing natural gas from Russia,[29] but Poland has decided to trade off affordability in favour of a more secure supply base. To mitigate energy security risks, more gas grid connections between EU11 countries are expected in the future. There are plans for a Poland-Slovakia link, as well as for links from Hungary, Croatia and the Czech Republic to the Polish LNG terminal.

Though still heavily dependent on fuel imports, Mediterranean-facing EU28 countries have successfully diversified their fossil fuel supply – primarily because of their geographic location. Spain – which relies on imports for 75% of its net energy consumption – is the best performer in the indicator on diversification of import counterparts, ranking third globally. This is the result of government policy limiting import quantities per source to ensure security of supply. Italy, France and Portugal are also high performers across this indicator, in part because their geographic location on the Mediterranean facilitates access to supplies from North African countries such as Algeria and Libya.

EU28: Achieving the 20/20/20 Targets in EU15 and EU11 Member States

The disparity in the performance of EU28 countries is marked by the visible split between EU15 countries, which lead with top performance across most indicators, and the EU11 countries occupying the latter half. In light of the overarching EU energy strategy to 2050, and the more immediate targets to 2020, EU15 countries such as Germany and Denmark have put in place a range of policies and investment frameworks while there is still progress to be made for EU11 countries.

The EU Low Carbon Roadmap for 2050 provides a strong statement on the EU's commitment to transition to a cleaner, more sustainable energy system. As part of the roadmap, the 20/20/20 strategy outlines the three core targets to be achieved across the European Union by 2020: 20% share of renewables in final energy consumption; 20% reduction in CO2 emissions compared to 1990 levels; and 20% efficiency improvements from 1990. These targets have set the pace for transition and are complemented by a range of directives which provide a sense of policy direction across energy end-use sectors, energy mix, renewable energy sources, etc.

EU15 member states, benefitting from generally deindustrialized, service-led economies, have been better placed to make the low-carbon development a key priority. Countries such as Germany, Denmark, Sweden and Spain have made significant investments in energy efficiency, renewable energy sources and carbon-abatement programmes – sometimes in excess of the EU 20/20/20 targets. Denmark's Energy Strategy 2050 is targeting 100% energy supply for electricity, heating, industry and transport to come from renewable energy.

Although bound by the EU climate targets, the policy priorities of EU11 countries[30] – consisting predominantly of Eastern European nations – are different from those of EU15 countries. EU11 countries are broadly defined by the development stage with more energy-intensive economies from nascent industries. The economic burden of investment and policy shifts necessary to meet the EU 20/20/20 targets is a key concern for EU11 countries, which fear this will impact economic development and the competitiveness of their industries. Poland, whose power-generating sector is dominated by coal, vetoed the proposal of 2011 for more aggressive EU targets to 2020 over concerns the impact these would have on industrial growth. According to a World Bank report, implementing the package of EU climate policies could cost Poland 1.5% to 2.2% of real GDP to 2015 – with the figure nearly doubling by 2030.[31]

Figure 6: GDP per unit of energy use (PPP $ per kg of oil equivalent), 2012

Source: World Bank

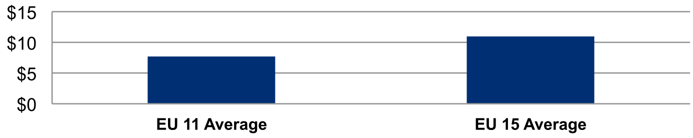
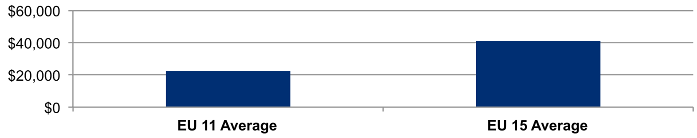


Figure 7: GDP per capita, PPP (current international $), 2012

Source: World Bank



Although the priorities of EU15 and EU11 member states are somewhat divergent, the EU Energy Efficiency Directive – which sets out numerous standards and regulations on achieving the energy efficiency targets – provides a sense of policy direction which can have key benefits such as energy savings, increased energy security as a result of lower consumption, reduced emissions and the development of new energy-efficiency related markets. These benefits are largely in line with the priorities of EU11 countries which are burdened by import dependence and growing energy costs. According to analysis from the European Union,[32] the Energy Efficiency Directive could deliver up to € 220 billion in net savings – with € 60 billion coming from savings in power generation, and cumulative € 380 billion from reduction in fuel expenditure and imports over the period 2011-2020. To deliver these savings, however, the same analysis estimates an average € 24 billion will need to be invested annually into energy efficiency measures such as building insulation and energy management technologies.

Attracting this scale of investment and sustainably developing the energy efficiency market will mean the less wealthy EU11 countries need to identify opportunities and best practices in financing frameworks and market mechanisms. The European Investment Bank and the European Bank for Regional Development (EBRD) have mobilized significant funding in support of EU11 countries' energy efficiency programmes. The EBRD, which provides funding for development projects in Eastern European countries, including EU11, has set energy efficiency as a cornerstone of its Energy Operations Policy, setting aside over € 1.5 billion of investment for energy efficiency initiatives and small distributed renewables projects since 2006.[33] Through the Sustainable Energy Efficiency Initiative, the EBRD provides project finance, as well as technical assistance and policy dialogue – the latter two support mechanisms are in place to assist investments with activities such as market analysis, and to identify the necessary regulatory frameworks to ensure the success and long-term sustainability of projects. For example, in Bulgaria, the EBRD financed a € 180,000 project to install more efficient steam boilers in a pharmaceuticals company – resulting in a 20.7% reduction in annual energy costs (equal to € 72,000/year savings).[34]

To date, a number of efficiency-related investment funds and financing models have emerged across the EU in support of the Energy Efficiency Directive. Project financing models can, however, still be onerous and have a slow rate of return. When looking at implementing energy efficiency in the residential sector or in non-industrial end use sectors such as schools, this challenge is even more apparent. To address the barrier of upfront costs, a number of Energy Service Companies are taking on the performance risk by funding the improvements from energy savings delivered. In the Czech Republic, the introduction of these contracts have seen an increase in the number of efficiency projects realized, totalling over 150 in 2011.[35]

External Perspective: Update on Germany – Towards a Sustainable Energiewende

Peter Terium, Chief Executive Officer, RWE, Germany

Germany has voted. After September's elections, politicians are now expected to provide guidance on how the *Energiewende* (the transformation of the [German] energy market) is to proceed. There is consensus that the momentum on climate issues and renewable energy must be maintained – this is good news, as the *Energiewende* is the right path to take. The aim of creating a more sustainable, resource-efficient energy sector deserves full support. Nevertheless, the *Energiewende* will only be successful if underlying policies are firmly based on a competitive and European mindset.

Acceptance of the Energiewende
Public acceptance may otherwise become an issue, as it is strongly affected by the costs of the *Energiewende* to society and concerns about security of supply. Excessive cost, deindustrialization and lower levels of system adequacy will not be accepted by the broader public, despite an otherwise strong preference for sustainability and renewables.

Competition and a Pan-European Approach Are Key to the Success of the Energiewende
Cost efficiency and security of supply can be maintained if policies underlying the *Energiewende* reflect the spirit of fair competition and the idea of the European Energy Market. The *Energiewende* is too ambitious to see it as a purely German undertaking. And it is essential to integrate both entrepreneurial initiative as well as administrative planning into the process.

The European Energy Market opens up a level playing field large enough to accommodate a project as extensive as the *Energiewende*. The European Commission is justified in its determination to do all in its power to promote and broaden the common Energy Market.

However, it must be recognized that there are also very promising German initiatives to align the *Energiewende* with the European Energy Market. The two leading energy industry associations – the German Association of Energy and Water Industries and the Association of Municipal Utilities – have made good proposals on the market integration of renewables and on security of supply.

A Structural Crisis in the Energy Industry
These proposals are based on the fact that European power generation is in a massive structural crisis. Subsidized renewable energy from Germany is ruining the business case for many thermal power plants. Renewable generators, however, are not able to replace coal- and gas-fired power plants since their output depends on fluctuating weather conditions.

There is a risk that the commercial meltdown of thermal power generation goes too far and may cause supply issues. The German government has already introduced provisional regulation which prevents selected power plants from going off the grid – despite the fact that they are no longer profitable. This will work in the short run, but will not be sustainable. Constantly falling prices on European power exchanges indicate that the situation will get worse if no sustainable policy action is taken.

The Case for Doing Something about Security of Supply
Sustainable policy action would design a mechanism that remunerates any power generator's contribution to security of supply. There is a consensus within the German energy industry that such a mechanism should not take the form of subsidization to keep commercially non-performing power plants alive. Rather, the idea is to provide the European Energy Market with a security mechanism that will not distort competition in wholesale power trading and be as lean as possible.

Other European countries have also addressed the security of supply issue, e.g. the United Kingdom and Italy. France will implement a capacity market in 2016. It would be fatal if a patchwork of unilateral capacity mechanisms were to distort the European Energy Market. Nevertheless, the French approach is a good one in terms of market design and it takes a similar approach to the German energy industry's proposal. This paves the way for a blueprint for the future European market.

The EU-ETS Needs Structural Reform
Finally, the European Union Emissions Trading System (EU-ETS) is under discussion. The EU-ETS is the instrument of choice for cost-efficient climate action. It must maintain this role beyond 2020. Because carbon trading works. Beyond 2020, however, its future is uncertain – which is detrimental for energy sector investment. Energy infrastructure investment entails distant time horizons. Hence, there is an urgent need for credible post-2020 climate targets and undistorted carbon trading.

Energy Policies High on the Agenda
Germany has every reason to put energy policies high on its agenda. The new legislative period offers much opportunity to kick-start with a new policy approach – towards more competition and a more European approach.

North America

North America - Analysis of EAPI Performance

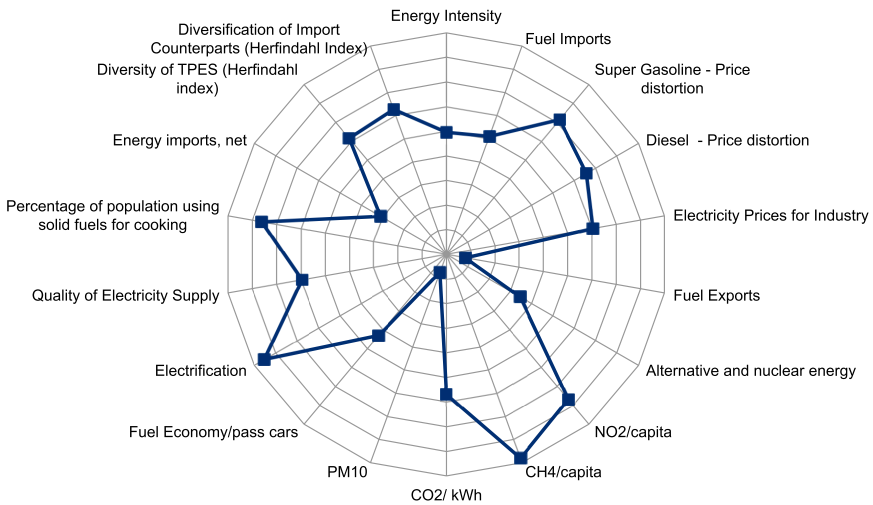
Table 6: North America EAPI Performance

North America	EAPI 2014		Economic Growth & Development		Environmental Sustainability		Energy Security & Access	
Country Name	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Costa Rica	0.67	9	0.68	7	0.56	31	0.77	35
Canada	0.66	14	0.60	25	0.48	56	0.88	2
Mexico	0.59	36	0.60	26	0.41	83	0.75	44
United States	0.59	37	0.57	36	0.34	104	0.84	8
El Salvador	0.57	44	0.52	51	0.53	42	0.67	74
Panama	0.56	48	0.64	14	0.45	68	0.60	90
Dominican Republic	0.53	57	0.58	34	0.45	65	0.56	94
Guatemala	0.49	68	0.35	82	0.54	40	0.58	93
Nicaragua	0.46	76	0.40	67	0.48	61	0.51	102
Honduras	0.44	89	0.31	99	0.50	50	0.51	103
Trinidad and Tobago	0.44	94	0.42	65	0.22	116	0.68	73
Jamaica	0.39	112	0.25	115	0.36	99	0.56	95
Haiti	0.38	116	0.37	70	0.52	47	0.23	121
North America Average	0.52		0.48		0.45		0.63	

Overview

The North American continent includes two of the largest economies globally, Canada and the United States, where the average per capita GDP in 2012 was US$ 51,000. It also includes Central American and Caribbean nations, where the average per capita GDP stood at just over US$ 10,000.[36] The region's energy landscape also shows great variation. While Canada, Trinidad and Tobago, Mexico and the US hold vast domestic natural resources, the rest of the continent is highly dependent on imports to meet energy demands. The energy landscape is expected to undergo a transformation in the future, with US shale development set to make the country self-sufficient in net terms by 2035,[37] and the Mexican energy reform process of 2013 potentially creating investment opportunities for further development of the country's resources. A perspective from the chief executive officer of *Petróleos Mexicanos (Pemex)* on the Mexican reform process is included later in this section.

Figure 8: North America Overview of Average Performance per Indicator



*Spider chart represents average performance of region/cluster for individual EAPI indicators. Low scores close to the centre of the chart; high scores close to the outer circ

Although scores across the North American continent vary significantly – especially between the economies of Canada and the United States and the Caribbean and Central American states – Figure 8 provides an overview of some of the key performance challenges faced by the region:

– Scores across the North American continent vary widely. The US, Canada, Mexico and Costa Rica appear in the upper quartile, evidencing the impact of natural resource endowment, economic development and strong energy policy on the scores. The wide variance in scores highlights the diverse nature of the challenges North American countries face in their transitions.

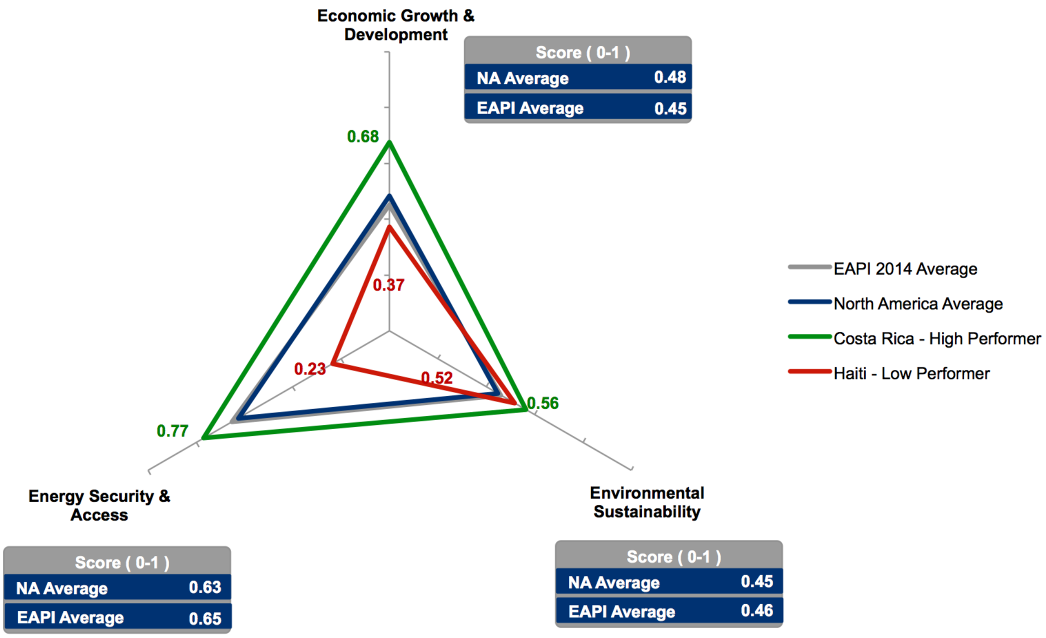
– Costa Rica is the continent's top performer and the only North American country to rank, at 9th place, among the global top 10. Costa's Rica's success is driven by its ambition to achieve 100% renewable energy for electricity production by 2021, maximizing the environmental sustainability of its energy system and reducing energy security challenges by limiting import-dependence expenditure and risk.

– The region's lowest performer is Haiti, which ranks in the lower quartile of the index with a score of 0.38/1, narrowly preceded by Jamaica, the only other Caribbean nation included in the index.[38] For both countries, their geography and lack of economic development create significant challenges – challenges that in Haiti's case were further compounded by the 2010 earthquake that destroyed the already limited existing power infrastructure.

– While the economically developed and resource-rich United States and Canada perform well across indicators for energy security, they face increasing pressure to improve the environmental sustainability of their energy systems. This issue is explored in greater depth in the article on North America, which looks at the environmental impact of unconventional developments in the US and Canada.

The following sections explore in more detail the core challenges confronting the North American continent across each dimension of the energy triangle.

Figure 9: North America – Energy Triangle Performance: Average against High/Low Performer



Economic Growth and Development

North America's average score across economic growth and development indicators is above the global average of 0.45/1. However, the disparity in scores across this dimension draws attention to the level of import dependence of the lowest performers, compared with the ambitious energy policies that have been implemented by Costa Rica, the highest performer. Classified as a middle-income country by the IMF,[39] Costa Rica achieves a score of 0.68/1, the highest in the region. This is comparable to the scores achieved by high-income OECD economies such as Australia, Norway and Spain. Although Costa Rica's economy expanded by an average annual 4% between 2000 and 2012,[40] the economy remains relatively low in energy intensity, with US$ 12 GDP per unit of energy use compared with the regional average of US$ 7.6.

The economic impact of import dependence
Honduras and Jamaica are the lowest performers in North America for the economic growth and development dimension, largely due to the economic impact of import dependence and the lack of domestic energy supply – the countries spent, respectively, 12% and 16% on imports relative to GDP in 2012. While relative import expenditure has remained largely stable in Honduras since 2008, Jamaica's has decreased from 25% to 16% over the same period. Initiatives such as the World Watch Institute's for sustainable development are supporting the implementation of energy efficiency and renewable capacity in energy-dependent Caribbean states, with the long-term goal of achieving sustainability targets while reducing import costs and improving the affordability of energy. Jamaica has pursued policies to improve the affordability of solar technologies and is piloting net metering to allow independent power producers to sell excess electricity production back to the grid. However, the scalability of these initiatives is one of a number of challenges that need to be overcome before further reduction of import dependence is achieved.

Environmental Sustainability

Environmental sustainability receives the lowest average score for North America across the three dimensions of the energy triangle. Notwithstanding the success story of Costa Rica's transition to renewables, countries across North America face a range of environmental challenges, including low diversification of the fuel mix across the Caribbean and Central America (which occupy the lower quartile of the indicator), the emission intensity of Canada, and the high level of emissions from the transportation and power generation sectors in most countries in the continent.

Costa Rica's energy system is defined by the large contribution of renewables – mainly hydro, geothermal and wind – to its power generation mix. Renewables contributed over 90% of total electricity production in 2012,[41] and the government is targeting 100% renewable power generation by 2021. Costa Rica has implemented policies such as feed-in-tariffs and a number of investment incentives for sustainable development projects across all sectors, including energy. Over 70% of Costa Rica's renewable capacity is locked in hydro-power generation, sparking concerns over the dependence of this source on annual rainfall. To address this risk, the country has launched, among other renewable energy initiatives, a net metering pilot to test the effect of distributed generation on the grid and promote diversification of renewable technologies beyond hydro.

Transportation sector
Canada, the United States and Mexico are the highest performers for fuel economy of passenger vehicles. The disparity reflects the improved living standards and access to better vehicle fuel technologies in the larger economies of these countries. Nevertheless, the environmental sustainability of transportation remains a key issue, especially in the United States where the sector contributed 28% of GHG emissions in 2011.[42] The US is the lowest OECD performer for this indicator. Although the index only accounts for passenger cars, roads continue to be the primary mode of transport for goods in the US, further compounding the emissions challenge. While a number of states, such as California, are rolling out infrastructure for the electrification of passenger vehicles, the transition to improved fuel economies in the medium- and heavy-duty sectors is more challenging and slower to implement.

Environmental sustainability of the high-income OECD North American countries
The US and Canada receive their lowest scores across the energy triangle in environmental sustainability. The low performance of both countries is dictated by different drivers. Although the US is undergoing a shift from coal to gas in power generation, the score is still negatively impacted by the predominance of coal in power generation and emissions from the transportation sector; conversely, Canada's score is impacted by the high per capita emission intensity.

Notwithstanding the boom in gas supply, the US is still dominated by coal, which contributed to 42% of power generation in 2011.[43] As a result, the US performs in the lower quartile for CO_2 emissions from power generation, scoring 0.45/1 compared to the regional average of 0.57/1. The US is aggressively pursuing wind power, with an expected 19% increase in capacity in 2013 (representing 4% of total installed capacity). The game changer in the US is the increasing availability and price competitiveness of natural gas over coal, which is shifting reliance away from coal and onto natural gas. This trend contributed to the US lowering its contribution to GHG emissions by -3.8% in 2012, half of which the IEA attributes to the coal-to-gas switch. However, without effective regulation in this sector, a reversal of the trend is possible if there were to be a shift in the current coal/gas price differential.

Conversely, Canada scores in the top quartile for the carbon-intensity of its power generation, receiving the best score in the region after Costa Rica. The country's power sector is dominated by hydro, which contributes over 60% of electricity, and due in part to supportive policies, Canada is also a large and growing producer of wind energy. However, performance on methane and nitrous oxide emissions are among the lowest in the region, and sit within the lower quartile of global scores – bringing into focus the environmental impact of Canada's upstream operations. A perspective from Alison Redford, Premier of Alberta, closes the section on North America. The article highlights the policy measures which are set to drive improvements on environmental performance and reduce energy intensity.

Energy Security and Access

Scores on energy access and security vary widely across the continent; the US and Canada, with abundant natural resources and 100% electrification rates, score within the top 10 globally for this indicator, while the Caribbean islands and some Central American countries are highly dependent on imports of fossil fuels.

Top performers – US and Canada

Canada is one of the world's five largest energy producers, ranking second after Norway across the energy security and access indicator, and ranking 28th globally for net energy exports. The country exports over 60% of its domestic energy consumption. Oil sands developments, as well as recent discoveries of unconventional gas resources, have extended the country's export potential. Canada's extensive hydroelectric capacity also drives its high performance, providing a 0.91/1 score for diversification of total primary energy supply, against the regional average of 0.59/1.

The US is the second highest-ranking North American country in this dimension. This results from the high electrification rates and a diversified fuel mix, as well as low import dependence compared with other net importers on the continent (the US scores 0.42/1 for this indicator, against an average of 0.21/1 for other net importers in North America). Recent developments in unconventionals in the US, and the expected increased production from these plays, are projected to transform the US to energy independence in net terms by 2035.[45]

Energy security and access in the Caribbean and Central America

Energy security is a key challenge for countries in the Caribbean and Central America. Jamaica and the Dominican Republic are the lowest performers in the indicator for net energy imports, with an average score of 0.06/1, compared with the average of 0.21/1 for other net importers in the region. Reducing import dependence and exposure to fluctuating fossil fuel prices is an important issue for these countries, which should look to the example of Costa Rica's long-term strategy to mitigate the risks of energy dependence.

Haiti is the lowest performer in the energy security and access dimension, as well as being the only country in the region facing significant energy access challenges. In 2010, only 34% of the population had access to electricity and over 90% relied on solid cooking fuels. Before the earthquake of 2010, the country's power, transmission and distribution infrastructure was already inadequate to meet demand. And with almost half the population illegally connected to the power grid,[46] utilities faced additional challenges from power theft. The earthquake further exacerbated the situation by causing significant damage to the existing infrastructure. USAID is currently supporting a number of initiatives to redevelop and extend the power infrastructure, including feasibility studies for wind energy to supplement oil generation, which has to date dominated the country's power mix.

External Perspective: Update on the Mexican Energy Reform

Emilio Lozoya Austin, Chief Executive Officer, Petróleos Mexicanos, Mexico

The main factor behind Mexico's disappointing economic growth record over the past 30 years is stagnant productivity. Hence, the new administration is emphasizing reforms that will, directly or indirectly, have a positive impact on productivity growth. This is the case in labour market reform, the reform of competition legislation, reform in the telecoms industry and recent constitutional changes in education.

Mexico's energy sector faces a big challenge: while the country has vast hydrocarbon resources, the cost of energy to the economy is relatively high, affecting investment opportunities and productivity growth. Energy reform can, and I am sure will, play a major role in creating the conditions for sustained economic growth.

Over the past decade, North America's oil and gas industry has experienced a veritable revolution. Deep-water production and shale gas and oil have drastically reduced US dependence on imported oil, and we have witnessed the decoupling of the price of gas in the region from that of oil. With prices for natural gas at a fraction of what they are in other regions, and given Mexico's resources, joining North America's energy revolution is an opportunity the country cannot afford to miss.

Access to cheap gas would allow Mexico to lower energy costs for industry and for power generation, with the additional benefit of increasing energy efficiency and reducing emissions of CO_2 and other greenhouse gases.

To make the most of this opportunity, both Petróleos Mexicanos (Pemex) and the oil industry must ramp up investment to increase production of oil and gas, and to improve productivity throughout the industry's value chain, from exploration and production to refining, petrochemicals and distribution and logistics. This is what the constitutional changes proposed by President Enrique Peña Nieto, currently being discussed by Congress, seek to accomplish.

While ownership of resources will remain in the hands of the nation and Pemex will remain a public sector enterprise, the reforms will allow Pemex and the Mexican State to share risks with private firms and tap their investment resources and technology.

In the new scenario, Pemex will have to transform itself substantially. Corporate governance, corporate structure, internal control, management practices and human capital policies will have to be brought in line with best practice if Pemex is to compete successfully.

Competition is good news for Pemex. Given a standard fiscal regime and the freedom to make strategic alliances and to define our policies, we have the potential to become an even more relevant international player in oil and gas. Yet, our largest opportunity remains at home: we estimate that Mexico's oil and gas industry has a US$ 60 billion a year potential for profitable investment.

Technological development, Mexico's natural resource endowment and a growing consciousness of the need to harness these resources towards the goal of generating sustainable economic growth have converged to create a unique opportunity in Mexico. I am confident that energy reform will effectively turn Mexico into one of the most promising and exciting areas for expansion in the oil and gas industry worldwide.

North America: The Environmental Sustainability of the North American Resource Revolution

The US and Canada are among the top ranking countries in North America; although their performance is strong in the energy security and economic growth and development indicators, both countries receive their lowest performance in the environmental sustainability dimension of the energy triangle. In regards to their unconventional resource wealth, both countries face increasing pressure to address and mitigate the environmental impact of these.

Recent years have witnessed an upsurge in the volume of recoverable hydrocarbon resources across North America. The combination of technical advances and high oil prices has supported the economic viability of developing oil sands, which has significantly increased estimated reserves and production in Canada. In 2013, established oil sands reserves, meaning total economically and technically recoverable resources independent of development projects, amounted to an estimated 168 billion barrels of reserves and, according to the IEA, oil sands output is expected to nearly triple to 4.3 million barrels a day by 2035. Canada also has an estimated 573tcf of recoverable shale gas resources and 8.8 billion barrels of shale oil, although low natural gas prices in the US are holding back investments in the development of these.

In the US, technical advances in horizontal drilling and hydraulic fracturing have made it economically viable to develop natural gas from shale formations throughout the country. The EIA estimates that the lower 48 states have a combined total of 482 tcf of technically recoverable shale gas resources;[47] between 2000 and 2010, production of natural gas in the US increased from 0.4 tcf to 5 tcf.[48]

In the US, the revival of domestic production and the low price of natural gas have had an important economic impact. Between 2006 and 2010, the price of natural gas in the US declined by 36%, lowering the cost base for industry and thus reviving energy-intensive industries such as manufacturing, especially in industries like rubber and plastics. Similarly, in the Province of Alberta – which holds 98% of Canadian oil sands reserves – the energy sector contributed over 22% of GDP.[49]

Developments in Canada and the US have also had a significant impact on the region's energy security. Although Canada held conventional reserves prior to the development of oil sands, its production was in slight decline by 2002[50]. The impact of shale discoveries in the US has been even greater, with the IEA estimating that continued production from both natural gas and light tight oil could make North America energy independent by 2020. The IEA also expects that the US will be a net exporter of natural gas by 2035[51], with 28 applications to export LNG from the US at various stages within the approval process.

The significant reserves of the US and Canada have positively impacted the economic and energy security landscape of the two countries; however, oil sands and shale gas developments are highly controversial due to the environmental impact of the production processes involved. These challenges include impacts on air quality, water and land.

– *Air*: Large amounts of energy are used to produce the steam required for in-situ production or the hot water for bitumen and sand separation in oil sands mining operations. The energy intensive process contributes to Canada's national air emissions portfolio. According to Environment Canada's Facility Greenhouse Gas Emissions Reporting Program (GHGRP) in 2011 greenhouse gas emissions from unconventional oil extraction totalled 49Mt CO2 –eq. While this represents a significant increase from emissions reported by the sector over the past decade, highlighting the growth of unconventional developments in Canada, the carbon intensity of the sector (emissions per barrel of oil) has decreased 26% since 1990 levels as a result of industry action[52].

– *Water* is a key environmental factor in the development of both shale and oil sands. In hydraulic fracturing, millions of gallons of water and chemicals are injected into the shale formation at high pressures. The management of flow-back water (which returns from the well mixed with chemicals, sand and fossil fuel products) and concerns over the contamination of water supplies are critical issues for the industry. Significant amounts of water are also used in the extraction and processing of oil sands, with mining having significantly higher water requirements than in-situ extraction. According to IEA production estimates, and accounting for the shift in favour of in-situ extraction over mining, water withdrawal for oil sands developments will grow from about 220 million cubic metres (mcm) in 2010 to about 520 mcm in 2035. However, water requirements are increasingly sourced from saline aquifers, rather than freshwater sources, reducing the impact of oil sands on the fresh water reserves of the region. Furthermore, an estimated 80%-95% of water used by oil sands developers is recycled. Nonetheless, according to Natural Resources Canada contaminated water resulting from oil sands mining extraction is often stored in tailing ponds, raising concerns over leakages into the region's freshwater reserves. Industry is working to develop effective solutions to manage these tailing ponds. One such solution is the concept of dry stackable tails which offers great advantages to current technologies as it can reduce the amount of water required by half and allows for quick reclamation of disturbed land.

– In terms of *land use*, oil sands reserves cover an area of approximately 142,000km2 and their development has, to some extent, impacted land and forestry – most notably through mining extraction methods. However, 80% of oil sands reserves are estimated to be recoverable through in-situ extraction, which uses considerably less land than mining extraction[53]. In the US, land use for shale development is driven by the significantly higher number of wells required for production compared to conventional developments.

With the expected increase in production from unconventional sources, Canada and the US face challenges in ensuring the sustainability of their energy sectors. In response, various industry and government-led initiatives are identifying new ways to drive environmental performance through technology and regulation.

Policy regulation in the US: Since the rapid development of shale gas began in the US, federal, state and local regulations have emerged to help manage the environmental impact of production (especially of water consumption in hydraulic fracturing). Although US federal regulation does not specifically cover hydraulic fracturing, broader oil and gas regulation (e.g. the Clean Water Act and the Pollutant Discharge Elimination System permit programme) covers water disposal. State-level policies play a more significant role in managing the local environmental challenges of hydraulic fracturing. Most shale gas-producing states have implemented regulation (of varying stringency), especially regarding disclosure of fracking fluids, proper casing of wells and management of wastewater. Carbon legislation is less widespread, limited to Clean Air Act enforcement and green completion (restrictions on methane venting during well completion) regulations in some locations, although this is becoming best practice without regulation.

Canadian joint government and industry-led initiatives: A priority for the Canadian federal government is the development of carbon capture and storage (CCS) technology to mitigate the impact of emissions from its oil sands industry. The Province of Alberta has committed CAD$ 170 million for 2013 and 2014 – and a total of CAD$ 1.3 billion over 15 years – to fund two large-scale CCS projects that will help reduce CO_2 emissions from oil sands refining.[54] The two projects, Shell Quest and the Alberta Carbon Trunk line, are expected to reduce Alberta's GHG emissions by 2.76 million tonnes annually from 2016.[55] A further element of the government's strategy is the roll-out of policies to drive the largest oil sands operators to seek efficiency and emission-abatement programmes as conditions of their permits.

In Canada, operators representing 90% of oil sands production formed the industry group COSIA[56]. Its mission is to accelerate improvements in oil sands operations' environmental performance by exchanging best practices and technologies for emission abatement and land and water use. To date, COSIA members have shared 446 distinct technologies and innovations, demonstrating how industry can cooperate in the pre-competitive space – environment in this case – to tackle common goals.

Technology and innovation: The invention and deployment of new technology plays an instrumental role in the sustainable development of unconventionals. Regardless of regulatory pressure, there are economic benefits to reducing the water intensity of shale operations due to the rising cost of water sourcing, transportation and disposal. In US shale operations, a range of low-water fracking and water-recycling technologies are being developed and deployed in the field and offer the potential to significantly reduce water intensity in hydraulic fracturing. The reduced water transport activity will also have a positive impact on carbon intensity.

In oil sands, in-situ recovery technologies such as steam-assisted gravity drainage (SAGD) and cyclic steam simulation (CCS) – have delivered step changes in water, energy and emission intensity of oil sands recovery over mining; the Canadian Energy Research Institute estimates in-situ technologies have delivered efficiencies and cost savings reducing production costs from $68/barrel to $48/barrel. A number of other advancements such as improvements in well design, solvent injection, air injection, dynamic thermal stripping, and non-aqueous extraction are continuing to be developed to bring about further improvements in the fields of energy, emission and water intensity in oil sands production. The trialling of a number of technologies are a positive indicator demonstrating the market pressure for alternatives.

Although unconventionals have some inherent environmental intensity disadvantages compared to traditional upstream activities, environmental regulation and new technologies are already being rolled out to mitigate the environmental impact of unconventional oil and gas production in the US and Canada. As North American unconventional production continues its unprecedented growth, the ability to reduce their intensity will be critical to managing their negative environmental impact on the energy landscape.

External Perspective: Stewardship and Resource Development Fit Together

By Honourable Alison Redford, Premier of Alberta, Canada

"You can't have it both ways" – Albertans often hear this rhetoric when resource development and the environment are discussed. The myth is that resource development and environmental protection are mutually exclusive and incompatible.

We believe we can have it both ways. The reality is that resource development and environmental protection are inseparable, not incompatible, and we have built Alberta's entire system around that premise.

Developing Alberta's vast natural resources is essential to the province's economy and its residents' well-being: resource development creates jobs and generates the government revenues needed to pay for important public services such as health and education, not only in Alberta but across Canada. Plus, Alberta has established itself on the world market, supplying energy and resource-based products.

We realize development is about more than economics. Alberta is a land of great natural beauty, and Albertans cares for its environment. That is why we take a holistic approach to our land and resources that includes the creation of seven comprehensive regional land-use plans that aim to balance the competing demands on our landscape. These plans are a blueprint for long-term responsible growth to balance our economic, environmental and social needs. The first plan is already in place and covers the oil sands-producing region in the north-eastern part of the province.

To achieve our environmental goals, we need to know what the specific effects of development are. We need the facts so that we can take the right steps to minimize adverse effects and undertake future improvements. An independent, arms-length environmental monitoring agency will provide those facts through a comprehensive and credible science-based monitoring system.

The agency's work will be open and transparent as its activities and data will be shared publicly through an open data portal – in fact, oil sands environmental data is already being shared today. The sharing of open and transparent data helps steer the discussion about oil sands towards science and facts.

The facts show that we are doing well. Air in the oil sands region is rated at the highest air quality level 97% of the time. Oil sands facilities adhere to some of the most restrictive water use rules in the world as all existing and approved oil sands projects withdraw less than 1% of the average annual flow of the Athabasca River. Land is reclaimed throughout a mine's life cycle. By the end of 2012, more than 77 square kilometres of previously disturbed lands were either permanently or temporarily reclaimed.

However, Alberta still has challenges that need to be met by investment in technology and through on-going innovations from researchers, engineers and scientists.

Investment in technology is a key commitment under Alberta's Climate Change Strategy – and that investment has achieved real results. Alberta was the first North American jurisdiction to put in mandatory reduction targets for large emitters and a price on carbon. Those who fail to reduce must purchase offset credits or pay CAD$ 15/tonne over the limit. Revenues collected through this are deposited into a clean energy technology fund that has already collected CAD$ 398 million, of which CAD$ 212 million has been invested into 51 clean energy projects. Since 2007, greenhouse gas emissions have been reduced by 40 million tonnes from business-as-usual.

Innovation, technology and research are at the forefront of Alberta's environment story. We also see in our advancements the opportunity to share best practice and knowledge with the world.

Alberta will continue to produce the energy the world needs while Albertans continue to enjoy this province's abundant natural beauty, clean air and clean water.

Middle East and North Africa (MENA)

MENA - Analysis of EAPI Performance

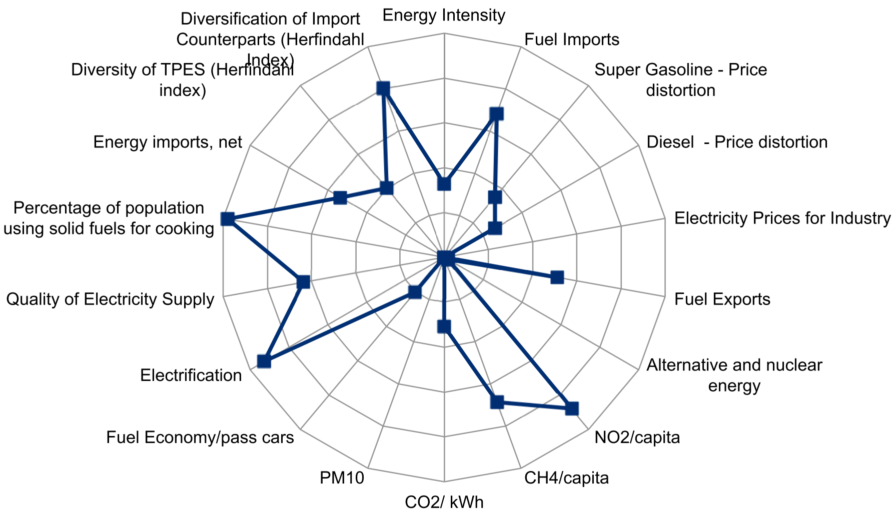
Table 7: MENA EAPI Performance

Middle East & North Africa (MENA)	EAPI 2014		Economic Growth & Development		Environmental Sustainability		Energy Security & Access	
Country Name	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Tunisia	0.53	60	0.36	75	0.45	66	0.77	37
Algeria	0.50	66	0.34	88	0.40	85	0.76	40
Morocco	0.46	79	0.36	78	0.38	92	0.64	82
Egypt, Arab Rep.	0.46	81	0.24	121	0.43	73	0.71	60
Libya	0.45	86	0.33	90	0.29	106	0.72	57
United Arab Emirates	0.44	88	0.35	79	0.21	118	0.77	34
Qatar	0.44	90	0.35	81	0.17	122	0.80	22
Saudi Arabia	0.44	91	0.32	97	0.19	120	0.81	17
Iraq	0.42	98	0.37	74	0.19	121	0.72	59
Iran, Islamic Rep.	0.42	102	0.25	120	0.25	112	0.76	39
Kuwait	0.42	105	0.33	91	0.12	123	0.80	20
Syrian Arab Republic	0.41	108	0.27	110	0.27	109	0.69	67
Oman	0.39	111	0.28	108	0.12	124	0.79	26
Jordan	0.38	115	0.25	116	0.28	108	0.60	88
Bahrain	0.37	118	0.18	124	0.21	119	0.72	58
Lebanon	0.33	123	0.33	93	0.25	113	0.41	108
Yemen, Rep.	0.32	124	0.33	92	0.26	111	0.38	111
MENA Average	0.42		0.31		0.26		0.70	

Overview

The EIA estimates that the MENA region collectively holds 800 billion barrels of proven oil reserves and 2,800 tcf of natural gas. In recent years, focus in the region has been on addressing key challenges such as the environmental impact of the production, refining and domestic consumption of resources, as well as the economic impact of subsidies. As MENA countries strive to address these challenges, the region is also expected to be one of the largest contributors to the global increase in energy demand, placing additional pressure on consumption patterns and placing the spotlight on the power-generating sector's efficiency.

Figure 10: MENA Overview of Average Performance per Indicator



*Spider chart represents average performance of region/cluster for individual EAPI indicators. Low scores close to the centre of the chart; high scores close to t

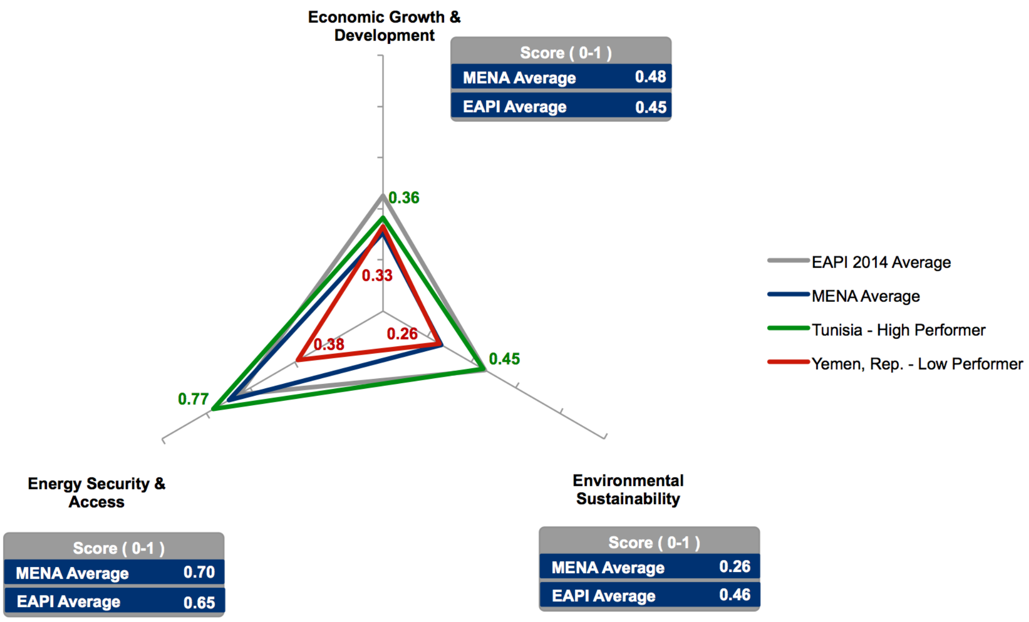
– The top performer in the MENA region is Tunisia with a score of 0.53/1 compared to the regional average of 0.42/1. Tunisia's performance relative to other countries in the region is driven by the country achieving the highest regional performance in environmental sustainability and upper quartile scores for the other two dimensions of the energy triangle.

– The low performers in the MENA region are also the lowest performers globally: Lebanon and Yemen occupy, respectively, the 123rd and 124th ranking across the index. Yemen's low ranking performance arises from a combination of fuel subsidies, reliance on fossil fuels for primary energy supply, and low electrification rates.

– The disparity in scores across the region is driven by a number of factors. Most notable perhaps is the regional co-existence of some of the largest net exporters in the world, such as Qatar and Kuwait, alongside the high import-dependence of countries like Morocco, Jordan and Lebanon, who rely on imports to meet over 90% of their energy demand.

– Despite the high performance of net-exporting countries in the energy security dimension, their performance in the other dimensions of the energy triangle is low. Results are impacted by the prevalence of high fuel subsidies in the region that create inefficient use of resources along with high cost, and the dominance of fossil fuels in the energy mix that result in high CO_2 emissions and reduce the use of low-carbon energy sources.

Figure 11: MENA – Energy Triangle Performance: Average against High/Low Performer



Economic Growth and Development

The average performance of MENA countries in economic growth and development of 0.31/1 places the region below the lower quartile threshold for this dimension globally – Iraq, the top performer in the region, achieves a score of 0.37/1, placing it just over the lower quartile performance of 0.33/1. Although MENA countries receive some of the highest scores globally in export contribution to GDP, the score is negatively impacted by fossil fuel subsidies in exporting nations and the energy intensity of the hydrocarbon production and refining industries prevalent in these.

Disparity in the region

MENA countries dominate the top 10 ranking globally for economic contribution of fuel exports to GDP. For major net exporters such as Qatar, Libya, Bahrain, Saudi Arabia and Kuwait, the contribution of fuel exceeded 50% of GDP in 2012. Conversely, the economic impact of the energy system on net importers like Morocco, Lebanon, Jordan and Tunisia is severe. The lowest performer, Jordan, for example, spends nearly 20% of GDP to import 96% of its energy needs. As explored in the environmental sustainability section below, net importers such as Morocco and Tunisia are rolling out renewable energy capacity in a bid to reduce the economic impact of imports and mitigate against fluctuating fossil fuel pricing.

The cost of energy subsidies

As a result of the highly subsidized prices at which fuels are sold domestically compared to international market prices, countries throughout the MENA region perform poorly on the price distortion of liquid fuels indicator. Libya and Saudi Arabia are the lowest ranking in the region and among the lowest ranking globally for this indicator, with prices for super gasoline at US$ 0.12 c/l and US$ 0.16 c/l respectively – significantly lower than the benchmark US price of US$ 0.97.[57] The IMF estimates that 8.5% of regional GDP was spent by MENA countries on subsidies in 2011, highlighting the significant economic impact of subsidies on government budgets. Although countries like Saudi Arabia and Iraq have indicated their intent to address the subsidy issue in the face of rising energy demand, only limited action has been taken to date. IEA analysis suggests that the subsidies in resource-rich countries such as those in the MENA region will be the hardest to eradicate.[58]

Energy intensity

Energy intensity scores for the MENA region vary significantly, with Tunisia, Morocco and Lebanon receiving an average score of 0.64/1 against the regional average of 0.13/1 of the lowest four performers – Iran, Bahrain, Oman and Iraq – who extract US$ 3-US$ 4 of GDP per kgoe. The low performers' score is a result of the energy intensity of economies centred on the production, refining and petrochemical industries. In addition, a number of MENA countries rely on desalination plants to generate most of their freshwater – this process is energy intensive, consuming up to an estimated 3.6 kWh/litre of freshwater produced.[59] Energy efficiency measures in industry and the deployment of advanced technologies such as reverse osmosis in desalination plants – which use the hydraulic pressure created in the process as a power source – are starting to be rolled out in the region.

Environmental Sustainability

MENA countries achieve their lowest average performance across the three dimensions of the energy triangle in the environmental sustainability dimension, with an average score of 0.26/1 against the global average of 0.46/1. MENA's top performer is Tunisia, one of the few net-importing countries in the region. Conversely, large exporting MENA countries occupy the seven lowest rankings globally for this dimension of the energy triangle. This illustrates the significant challenge faced by the region in balancing the development and availability of hydrocarbons with an environmentally sustainable energy system.

Environmental solutions to import dependence

Tunisia's performance in the environmental sustainability dimension is largely due to the 15% contribution of renewables to the country's total primary energy supply, compared to the average 1% in net exporters of the region. In 2012, Tunisia's total installed capacity from renewables was 220 MW, with 154 GW delivered by wind, and 4 GW from solar PVs. Along with other MENA countries, Tunisia has set targets to grow the share of renewables to 2030. Tunisia aims to increase renewables to 25% electricity generation and 40% installed capacity over this time period.[60] A number of policy initiatives have been enacted to support this goal. These include net metering pilots and financial and fiscal incentives, as well as public investment and the provision of loans to renewable projects. Furthermore, Tunisia, together with Morocco, is piloting solar water heating systems through schemes such as the PROSOL in Tunisia and the PROMASOL in Morocco. For net importers in the region, expanding domestic energy supply and reduce import dependence through the deployment of renewable energy is increasingly important.

Environmental impact of energy production

Net-exporting MENA countries feature among the lowest performers on the environmental sustainability dimension of the energy triangle, occupying the lowest eight ranks globally. Fossil fuels dominate the total primary energy supply, with net exporters in the region receiving an average 1% contribution from alternative and nuclear energy. The dominance of fossil fuels also impacts CO2 emissions from the power-generating sector – over 50% of MENA countries score in the lower quartile for this indicator, with the highest CO_2/kWh emitters being Saudi Arabia, Iraq, Oman, Libya and Kuwait, also being some of the largest net exporters in the region.

The abundance of natural resources and the persistence of fuel subsidies mean the diversification of energy sources remains a key challenge for the region. Nevertheless, an increasing number of petroleum-exporting countries are setting out plans to deploy renewables in their energy mix. According to a recent report[61] from the Renewable Energy Policy Network for the 21st Century (REN21), a leading research centre on renewables, as of May 2013, all MENA countries have renewable energy targets, up from just five countries in 2007. These include renewable capacity additions of 6 GW in Oman, and 55 GW in Saudi Arabia by 2020.

Emission intensity of hydrocarbon recovery

The greenhouse gas emissions associated with upstream and refining industries play a role in performance across emission-related indicators. While Qatar is the third largest natural gas producer and largest LNG exporter in the world, it is also the largest per capita emitter of methane from energy globally at 0.02 metric tons of methane (CO_2-eq) – almost double the share of the next worse performer, Brunei Darussalam, at 0.01. However, according to the World Bank, over the period 2000-2008, flaring of methane was reduced in Qatar from 9 m3 per boe to 11 m3 boe, while production of gas increased nearly four-fold.[62] The Qatari government is investing in flaring reduction measures as a key part of addressing environmental impact and the efficiency of its hydrocarbon industry. The Qatar National Development Strategy 2011-2016 sets the key objective of halving flaring between 2008 and 2016. Part of the strategy includes developing a flaring monitoring tool as one of the 10 environmental strategy priorities for 2016.

The region has high potential for, and would benefit from, the deployment of carbon capture and storage technology to reduce its overall carbon footprint. To date, a number of countries including Algeria, Bahrain and the United Arab Emirates (UAE) are developing and exploring technologies to capture and store CO_2. For example, Algeria has been operating the In Salah CCS project since 2004, capturing and storing 1 metric tonne per annum of CO_2. In the UAE, the Abu Dhabi Future Energy Company (Masdar) is exploring the potential to deploy a network of carbon capture and storage projects to capture CO_2 and use it to fuel enhanced oil recovery technology.[63]

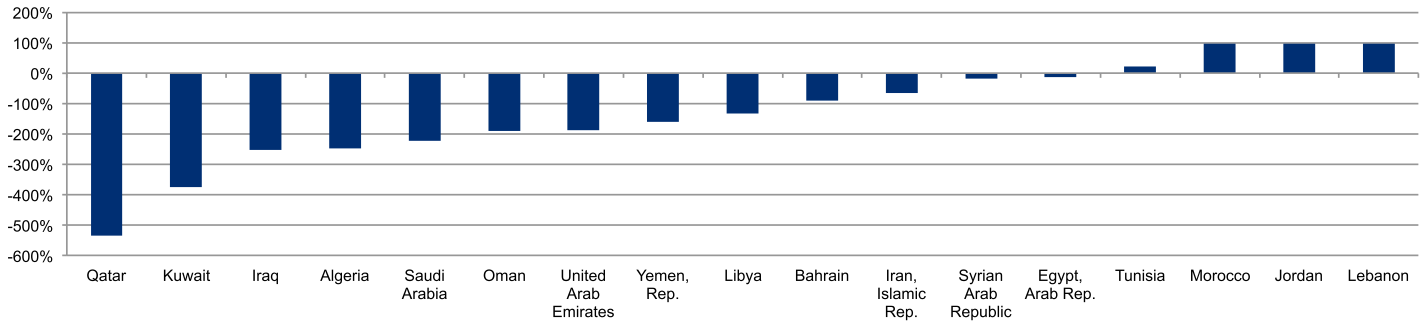
Energy Security and Access

The MENA region achieves its best performance in the energy security and access dimension of the energy triangle, with an average dimension score of 0.70/1 and Saudi Arabia scoring 0.81/1. The region's resource richness means that more than half of the global top 20 performers in the energy imports indicator are MENA countries. However, a number of MENA countries lack sufficient domestic resources and depend heavily on imports from neighbouring countries for their energy supply.

Energy security versus import dependence in the region
The MENA region holds over 50% of the world's proven oil reserves and 40% of natural gas reserves.[64] Nevertheless, the scores of MENA countries are widely dispersed within the energy security dimension of the triangle. Qatar and Libya export over 200% of net energy consumption; on the other hand, Morocco, Jordan and Lebanon are almost entirely reliant on energy imports, at over 95% net imports. For import-dependent countries in the region, progress in diversifying the energy mix is a key long-term objective, as rising oil prices and increasing energy demand impact their energy security landscape.

Figure 13: MENA – Energy Imports, Net (% of Energy Use)

Source: World Bank, 2012



The energy access challenge
Overall electrification rates in the region are high, with an average 0.96/1 score for the corresponding indicator. Yet, according to the IEA, 9% of the population in the Middle East lacks access to modern energy. In Yemen, the lowest performer for the indicator, only 45% of the population has access to modern energy. Similarly, 33% of the country's population relies on solid fuels for cooking, a figure significantly higher than the 5% regional average. The World Bank has committed funds to improve energy access in rural areas of Yemen, with the largest portion of the projected spending focused on developing on-grid connections and exploring the potential of off-grid solar solutions.

Middle East and North Africa: The Energy Security Paradox

While MENA's average score for energy security indicators of 0.70/1 sets the region above the global average of 0.65/1, MENA countries face increasing challenges in responding to growing domestic energy demand. Improving efficiency, diversifying the energy mix and addressing the subsidy challenge are all factors that can support MENA countries' transition to affordable, sustainable and secure energy systems.

The MENA region has the largest proven natural resources globally, with 57% of the world's oil and 41% of its natural gas.[65] In recent years, improved living standards and the region's expanding petrochemical industry have increased regional energy demand, with total primary energy supply rising by over 800 million boe (14%) from 2007 levels. In line with this figure, energy consumption is expected to grow 1.9% per year between 2012 and 2035.[66]

Population growth and economic expansion have increased energy demand significantly over the past decade; between 2000 and 2011, domestic consumption almost doubled in Oman[67] and tripled in Qatar.[68] Growth in energy demand is driven across the end-use sectors: in the residential sector through increased use of air conditioning and cooling units; in the transportation sector through rising vehicle ownership; and in the industrial sector from greater industrial activity, hydrocarbon production and refining, and energy-intensive desalination plants.

Growing demand, coupled with limited development in the power generation sector, has led to inefficient use of resources, load management issues and blackouts in peak demand times in countries like Oman and Saudi Arabia. In 2012, Saudi Arabia used nearly 1 million boe of crude per day for power generation to meet increased demand[69] during the summer months.

The MENA region is paradoxically experiencing energy security challenges as countries struggle to balance export revenues, domestic consumption and power sector development. To address the challenges, demand- and supply-side resource management will be increasingly important. Implementing energy efficiency measures and removing fossil fuel subsidies could curb demand, manage expected increases in expenditure on imports (for net importers) and free up resources to continue securing revenue from exports, as well as achieve environmental goals. Improved supply-side management, including additional capacity, development of upstream gas for domestic power production and the potential for an integrated supply network across Gulf Cooperation Council countries, is also all likely to be critical.

Demand Side

Improving efficiency standards can play a key role in managing demand growth. In recognition of this, MENA countries are looking at addressing this challenge; both the UAE and Saudi Arabia have created national energy efficiency plans that include a number of measures to address the efficiency of end-use sectors.

Efficiency-related programmes, however, are likely to face incentive and implementation challenges without accompanying reform of energy subsidies – fossil fuel subsidies are a key barrier to the region's energy efficiency plans as the provision of energy below market prices encourages inefficient energy use. According to IEA estimates, the MENA region accounted for 40% of the US$ 523 billion spent on subsidies globally in 2011.[70] Although high-subsidy MENA countries are showing interest in scaling back subsidies, both the IMF and the IEA see a number of obstacles to achieving the goal. Attempts to review subsidies globally have been met with both government and public opinion opposition. Improved communication of the benefits of a subsidy phase-out, accompanied by long-term plans for a gradual phase-out, could be useful tools to support the measure.

Supply Side

Regardless of the success of demand-side management, developing effective supply remains a vital area of focus for the region. Power-generating capacity in net-exporting countries is dominated by thermal – both natural gas and oil. In Oman, gas accounts for 80% of power generation, while Saudi Arabia's power generation is dominated by crude and fuel oil, with current domestic natural gas production insufficient to meet demand.[71]

While countries throughout the region are struggling to keep pace with the increase in power demand, progress is underway to install both conventional thermal and renewable energy capacity. Saudi Arabia has launched the largest generation expansion plan in the Middle East with plans to increase capacity from 55 GW to 120 GW by 2020, with further increases planned by 2032; 55 GW of the expansion is expected to come from renewables, 41GW of which from solar. In 2012, Oman presented its plan to develop five renewable energy projects expected to add 6 MW of capacity.

Developing upstream gas potential in oil-producing MENA countries also offers an opportunity to improve energy supply. Despite holding the world's fifth-largest proven natural gas reserves, Saudi Arabia has only partly developed its gas potential to date. Similarly, Kuwait is increasingly reliant on natural gas imports to reduce the amount of fuel oil used to meet peak demand. In Saudi Arabia, domestic natural gas production is directed internally, but further production will be necessary to meet growing energy demand and minimize direct crude burn for power generation. Natural gas demand is expected to double by 2030 from 2011 levels; to meet growing domestic needs, the Petroleum Ministry and Saudi Aramco announced a US$ 9 billion strategy to add 50 tcf of non-associated reserves by 2016 through new discoveries.[72]

The region's supply infrastructure could also benefit from wider integration of power markets. Since 2010, the Gulf Cooperation Council – Oman, Kuwait, Saudi Arabia, Qatar, Bahrain and the UAE – has started realizing plans to integrate member countries' power sectors with the goal of helping with load management and peak demand. The 400 kV interconnection will help stabilize power supply in peak demand periods, but faces the key challenge that all countries across the region are subject to similar demand patterns – such as increased use of cooling units in summer. To address this, Saudi Arabia has also discussed a 3 GW link with Egypt, whose peak hours vary from Saudi Arabia's, and is considering a connection to European power grids.

The production and export of the MENA region's huge assets in oil and gas, coupled with rising oil prices over the past decade, have improved living standards and promoted industrial expansion, thus driving an increase in energy demand. Growth is expected to extend further, putting pressure on MENA countries to improve their energy systems' performance by managing both supply and demand. The combination of energy efficiency measures in end-use sectors, reducing fuel subsidies, expanding and diversifying generating capacity and better deployment of natural resources could help address the energy security challenge as well as tackle environmental challenges.

External Perspective: Energy Efficiency in Saudi Arabia

Khalid Al-Falih, President and Chief Executive Officer, Saudi Aramco, Saudi Arabia

At the outset, it is important for me to emphasize that energy efficiency and diversity of fuel mix are rational choices; and there are countless examples and good practices that can be found around the globe. With that in mind, efficiency and diversity become key aspects of energy policy in many countries around the world, irrespective of their resource endowment.

Looking at Norway as an example of a major oil and gas producer – the third largest exporter of energy after Russia and Saudi Arabia – the country has actively promoted investment in renewable energy and energy efficiency through a dedicated government agency. Similarly in Australia, another resource-rich country endowed with coal and natural gas, support for the development of renewables and energy efficiency has been enhanced through mandatory renewables targets, feed-in tariffs and energy efficiency regulations. Looking closer to home in the Arabian Gulf region, the United Arab Emirates imposed a mandatory rating system for construction of energy efficient buildings in Abu Dhabi, and created a free zone dedicated to the development of green technologies and energy conservation in Dubai.

Like those examples, and many more, the Kingdom of Saudi Arabia recognizes the importance of energy efficiency and ensuring a sustainable and diversified energy mix. This becomes of higher importance to us with the high pace of growth we are experiencing. Saudi Arabia has been able to sustain high economic growth rates over the past decade, which contributed to an unprecedented increase in demand for energy. Saudi Arabia registered higher economic growth in 2011 and 2012 than any other member of the G20 with the exception of China. Robust growth is forecast to continue as our country pursues an ambitious agenda of raising living standards for its citizens, diversifying the economic base, creating sustainable jobs and enhancing the competitiveness of the economy while sustaining our natural resources. However, diversifying our economic base from a dependence on crude oil exports should not be construed as turning away from leveraging the Kingdom's "energy advantage". In fact, manufacturing investments that add value and create jobs will continue to be a main pillar in the Kingdom's economic development.

Delivering safe, secure and environmentally sustainable energy to foster this growth is of paramount importance. Saudi Arabia is pursuing a diverse set of demand-side and supply-side options to meet this challenge. On the demand side, a Saudi Energy Efficiency Center (SEEC) was established to roll out energy efficiency measures in industry, transport and buildings. In particular, SEEC has already established minimum standards for air conditioning units in a bid to reduce the growth of peak energy demand. On the supply side, the National Power and Water efficiency programme is driving efficiency improvements in existing plants and developing a long-term plan based on an optimum fuel mix consisting of conventional natural gas, liquid hydrocarbons and renewables. Currently, natural gas accounts for almost 50% of power generation, which is higher than figures observed in developed nations such as the United Kingdom and the United States. Moreover, promising unconventional gas discoveries in Saudi Arabia will further increase the percentage of gas in power generation, thus further improving generation efficiency while meeting our future energy demands.

Saudi Aramco, as a major contributor to the economy and a major energy user in its own right, is a leader in efforts to improve energy efficiency. This is demonstrated through the significant actions undertaken in all its operations. On average, since the year 2000, the company has been able to achieve 2% annual reduction in energy intensity in industrial facilities, which resulted in savings of around 130 thousand barrels per day of oil equivalent. This was realized through various initiatives such as cogeneration, retrofitting industrial equipment and process enhancements. Furthermore, our cogeneration facilities provide an additional layer of reliability to our critical infrastructure, while complementing the overall efficiency improvement of the country's power system.

In addition, the company recently launched its own "lead-by-example" programme to improve energy efficiency in its non-industrial facilities, targeting a minimum of 35% improvement by 2020. The programme will involve massive replacement of inefficient lighting, air conditioning and low-efficiency appliances. Further savings will be achieved through improving water heating systems and enhancing building insulation. One of our landmark projects, Al-Midra office tower, received the Leadership in Energy and Environmental Design (LEED) Platinum Certification accreditation, which is the Green Building Certification institute's highest recognition. The Al-Midra office tower combines an array of energy efficient measures in cooling and lighting, together with a passive design for the main building and supporting facilities which include the largest solar photovoltaic shaded car-park in the world, covering an area of 4,500 parking spaces and producing 10.5 MW of clean energy.

As highlighted earlier, good practices in energy efficiency and diversity can be found in many countries around the world, irrespective of their resource richness. Therefore, from Saudi Arabia's perspective, as we progress in the development of our energy policy, we will continue to draw upon lessons learned from our own experience as well as from the international community, in order to drive a continuously competitive and prosperous economy. Saudi Aramco will continue to play a key role in these endeavours.

Brazil, Russia, India, China, South Africa (BRICS)

BRICS - Analysis of EAPI Performance

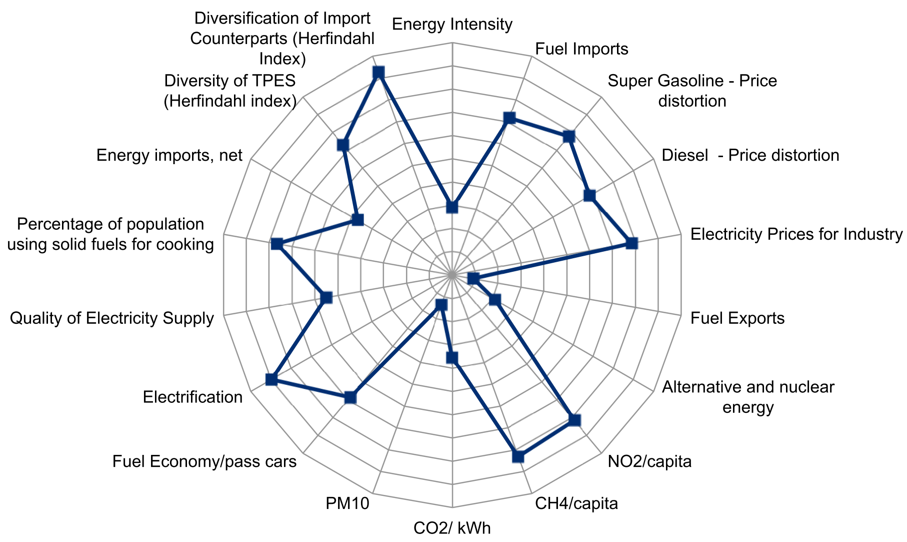
Table 8: BRICS EAPI Performance

BRICS	EAPI 2014		Economic Growth & Development		Environmental Sustainability		Energy Security & Access	
Country Name	**Score**	**Rank**	Score	Rank	Score	Rank	Score	Rank
Brazil	**0.64**	**22**	0.54	42	0.57	26	0.79	25
Russian Federation	**0.62**	**28**	0.59	28	0.49	53	0.79	29
South Africa	**0.54**	**54**	0.59	29	0.38	94	0.64	81
India	**0.48**	**69**	0.49	54	0.41	79	0.54	98
China	**0.45**	**85**	0.35	84	0.35	100	0.65	80
BRICS Average	0.55		0.51		0.44		0.68	

Overview

BRICS countries have experienced, to some extent, constant economic growth and industrialization over the past two decades. During the financial crisis of 2009, the Indian and Chinese economies continued to achieve close to double-digit growth; while the other BRICS economies faced significantly lower or negative growth values for that year, most of them are expected to continue on a growth trajectory. For South Africa, India, China and Brazil, growth has come from expansion in heavy industries, manufacturing, mining and construction, while Russia has pursued the expansion of production and export of oil and gas. In recent years, BRICS economies have increasingly come under the spotlight for the contribution to climate change of their energy- and carbon-intensive economies (with the exception of Brazil, whose energy mix is dominated by hydropower). However, some key changes to the energy systems across BRICS are underway: China and India have both set targets to reduce the energy intensity of their economies, and all the BRICS economies are aiming to increase the share of renewables in the energy mix. In Brazil, discoveries in pre-salt offshore fields are expected to improve the country's energy security.

Figure 13: BRICS Overview of Average Performance per Indicator



*Spider chart represents average performance of region/cluster for individual EAPI indicators. Low scores close to the centre of the chart; high scores close to

Figure 13 shows average scores across individual indicators for the BRICS cluster, highlighting some key messages for the region:

- As evidenced by the industrialization of the BRICS economies, energy intensity is a key challenge for the economic cluster, which receives one of the lowest average performances globally for this indicator, achieving an average score of 0.29/1 against the global average of 0.45/1.

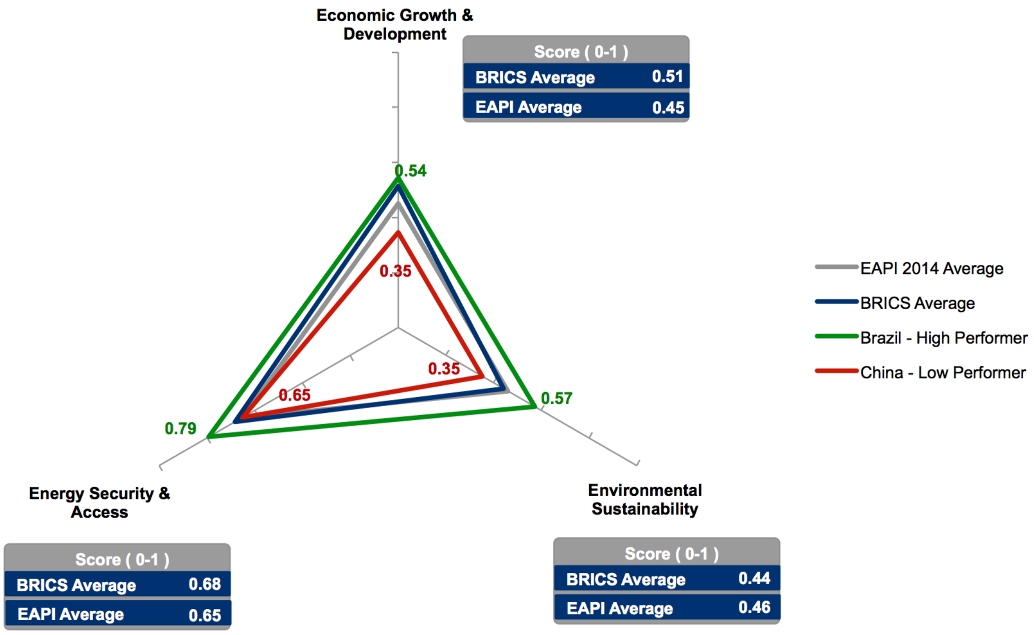
- With the exception of Brazil, whose power-generating sector is dominated by hydro, BRICS economies are heavily dependent on fossil fuel sources for power generation – thus impacting the environmental and emission score indicators.

- Within the BRICS cluster, Brazil achieves the highest score of 0.64/1, while the lowest performer, China, ranks below the EAPI average with a score of 0.45/1. The different requirements of the energy systems of these economies are highlighted in the wide disparity of scores across the EAPI and within each dimension of the energy triangle.

- China and India receive their lowest scores in the energy security and environmental sustainability dimensions, underlining the challenges these countries face in diversifying their energy mix beyond fossil fuels and their increasing reliance on imports.

- Russia's extensive oil and gas reserves mean the country performs better than its peers across the energy security indicators; however, the environmental consequences of its resource wealth impact scores in the environmental sustainability dimension.

Figure 14: BRICS – Energy Triangle Performance: Average against High/Low Performer



Economic Growth and Development

Russia is the best performer across the economic growth and development dimension for the BRICS cluster. Although the country achieves the lowest performance across the cluster for liquid fuel subsidies, it achieves a score of 0.33/1 for the contribution to GDP of fuel exports, compared with the 0.03/1 average for the rest of the cluster. This highlights the country's extensive natural resource wealth and export activities, with exports contributing to over 18% of GDP in 2012. Energy intensity is a key challenge for all BRICS economies, which – apart from Brazil scoring 0.53/1 for this indicator – score within the lower quartile globally with an average of 0.23/1. This highlights the high industrialization level of BRICS economies and, to some extent, the inefficient use of energy brought about by continuing energy subsidies in Russia, India and South Africa.

Energy intensity
Energy intensity is a key challenge for all BRICS economies. China, Russia and South Africa have the most energy-intensive economies in this cluster, averaging US$ 4.6 GDP per unit of energy use, highlighting the reliance of these countries on energy-intensive industries such as petrochemicals in the case of Russia and heavy industry, mining and manufacturing in the others. This level of performance highlights opportunities for improvement through the roll-out of energy efficiency measures, as well as seeking to diversify the economy beyond industrial activities. Improving on energy intensity continues to be a key focus area for China, whose latest Five-Year Plan includes a target for reducing energy use per unit of GDP by 16% on 2010 levels by 2015. Among a range of efficiency initiatives, the plan envisages a refocus of the economy towards growth in

the service sector.

Brazil has the least energy-intensive economy of all the BRICS countries, with US$ 8.20 GDP/unit of energy in 2011 – a 26% improvement on 2000 levels. Energy efficiency in Brazil can in part be attributed to the high price of energy compared to global and BRICS pricing. While Brazil ranks 51st for this indicator globally, other BRICS countries sit within the top 20. Higher electricity prices have, to some extent, driven more efficient use of energy and investment into more efficient technologies. However, in an effort to boost growth and improve competitiveness, the Brazilian government recently announced plans to reduce the cost of electricity to industry by up to 32%.[73] It is unclear to what extent this will impact further dissemination and deployment of efficient technologies in the long term.

Subsidies
Russia and India share the lowest performance for the indicator on liquid fuel subsidies; Russia achieves a score of 0.60/1 against the regional average of 0.82/1 for subsidies in the price of super gasoline, while India's subsidies for diesel put it in the lower quartile globally for this indicator. Although subsidies are more common in resource-rich countries such as Russia, they are employed by developing economies such as India and South Africa to improve energy affordability and access for lower-income groups.

To date, limited action has been taken to eradicate subsidies and international calls for a phase-out have encountered widespread public opposition in countries where subsidies are in use. Although the phasing-out of subsidies is one of Russia's energy sustainability priorities during its G20 leadership in 2013, no detailed long-term strategy has been set. Meanwhile, in India, the poorest districts in the country are piloting a scheme to improve subsidy administration for LPG to target only the lowest-income group. Known as the Direct Benefit Transfer scheme (a poverty alleviation programme which targets those living below the poverty line[74]), this will see the difference between the market and subsidy price of LPG being paid directly to participants (to a maximum of nine cylinders a year).

Environmental Sustainability

The lowest average score for BRICS countries across the three dimensions of the energy triangle is for environmental sustainability. With the exception of Brazil, where hydropower is a significant component of the country's energy mix, the other BRICS economies are more significantly reliant on coal and other fossil fuels for power. Industrial and petrochemical activity means that emission intensity in PM10, nitrous oxide and methane is also a major issue for these countries.

Limiting the environmental impact of energy production and consumption, while continuing to foster economic growth, is a key focus for countries in the BRICS cluster. Some elements of the challenges that this creates are covered in the sections below, with further analysis of the issue provided in the final section of this chapter.

High performer – Brazil
Brazil achieves the highest score of 0.57/1, compared with the average of 0.41/1 for the rest of the BRICS cluster. This performance is largely driven by the 45% contribution of alternative and nuclear power to the total primary energy supply of the country. In 2011, 80% of the electricity produced in Brazil[75] came from hydro, affording Brazil a significantly higher score for the carbon efficiency of its power-generating sector; Brazil's 0.91/1 score is in stark contrast to India, China and South Africa's average of 0.09/1. Brazil is planning the further expansion of hydro capacity, as well as growing the share of modern renewables in the energy mix to limit dependence on annual rainfall to feed hydro power.

Emissions intensity
The predominance of coal in the energy mix of India, China and South Africa defines the scores of these countries across emission-related indicators. The three countries rank among the lowest globally for CO2 emissions from the power-generating sector, with average performance of 0.09/1 against the global average of 0.54/1. A number of policies have already been rolled out in some of the BRICS cluster nations to address the carbon intensity of power generation – including emission-trading schemes and fiscal disincentives for coal – and further policies are planned. China has started piloting carbon-trading schemes in some of its more emission-intensive regions, with plans for countrywide roll-out by 2020. India has imposed a tax on coal production and importation since 2010; South Africa has indicated it will introduce a carbon tax starting in 2015 and China has suggested that resource tax reform may include a coal tax.

The performance of India and China is also marked by high PM10 emissions of an average 54 mg/m^3 against the lower than 20 mg/m3 annual mean stipulated by World Health Organization air quality guidelines. Local pollution in China gained significant media attention in January 2013, when protests erupted in major Chinese cities that pressured the government to address emissions abatement. Later that year, China unveiled its 10-Point Plan including key measures such as stricter controls on coal-burning emissions and road traffic, which seek to push energy consumers to use cleaner energy sources and use public transport.[76] Furthermore, China announced a potential ban on new coal-fired power plants in parts of Beijing, Shanghai and Guangzhou.

Energy Security and Access

The energy security landscape is quite varied within the BRICS cluster. Brazil and Russia achieve largely similar scores (averaging 0.79/1), while India, the lowest performer, scores 0.54/1, putting the country in the lower quartile globally for this dimension. The drivers behind the performance of BRICS economies vary, ranging from issues of import dependence and low electrification rates in India, to lack of diversity in primary energy sources in Russia, China and South Africa.

High performers – resource availability versus diversification of fuel sources
Although Brazil and Russia both perform within the upper quartile globally for the energy access and security dimension, this is determined by different factors: Brazil achieves a higher score for diversification of total primary energy supply compared to its BRICS peers, scoring 0.89/1, compared

with the average of 0.69/1 for the remaining countries in this group. Brazil relies heavily on hydro for power generation, but the country also has some nuclear capacity, and is targeting an increased share for renewables as part of diversification policies set in place after reduced rainfall in 2000-2001 caused power shortages in the country. The pre-salt offshore discoveries are expected to alter the country's energy security landscape, as the 10-year energy plan released in 2013 aims to expand oil production to over 5 million barrels per day by 2021, and has set targets for oil exports of over 2.25 million barrels per day by 2021.[77]

Although Russia's energy sector is not as diversified as Brazil's, its vast oil and natural gas resources afford it a higher than average performance in the BRICS cluster. In 2012, Russia exported over 80% of domestic consumption, compared to the only other net exporter in the cluster, South Africa, which exported just 18%. Activities geared to increasing Russia's production of both oil and natural gas are on-going, including Arctic exploration.

Growing import dependence

China and India import, respectively, 11% and 28% of net energy consumption. This makes them the most energy-dependent of the BRICS economies. With growing energy demand largely outstripping internal resources, India and China's dependence on energy imports is expected to continue. That said, China ranks in first place globally for the diversification of its import counterparts, up from its 4th place ranking in 2008. This underscores China's success in establishing strategic partnerships with, and investing in, major oil and gas producers such as Iraq, Russia and more recently Canada.

Beyond assuring import supply for net importers with growing energy demand such as India and China, mitigation of energy security challenges can be supported by implementation of efficiency improvements to curb demand and through diversification of energy sources. China's Five-Year Plan includes aggressive targets to increase the share of renewables in the energy mix – with the bulk of installed capacity additions of 2012 coming from hydro and nuclear. Similarly, India is rolling out low-carbon power generation through plans to increase nuclear capacity from the current 4.4 GW to 5.3 GW by 2016.[78] Further, India's Ministry of New and Renewable Energy set out a strategy for 2011-2017 which targets installed capacity from new renewables to reach 21,700 MW during the six-year period, supported by national and state-led policies including feed-in tariffs and renewable purchase obligations.

Energy access in India

Energy access across BRICS is high, with the exception of India and South Africa which continue to face lower rates for rural and low-income groups. India is the lowest performer within the BRICS cluster, with only 75% access to modern energy. This equates to 293 million people lacking access to modern energy, compared to 4 million in China.[79] Alongside a number of national and international initiatives to improve energy access, India has launched a Remote Village Electrification programme that includes targets for deploying off-grid renewables to rural communities.

Brazil, China and South Africa have been successful in addressing access to energy during the period of economic growth. During this decade, policies for delivering rapid on-grid and off-grid expansion have meant access in rural settings grew from 80% to 94% in Brazil, and from 37% to 64% in South Africa. Brazil's *Luz Para Todos* programme, coordinated by the Ministry of Mines and Energy, was instrumental in delivering access to energy by supporting rural communities in purchasing and installing distributed renewable energy.

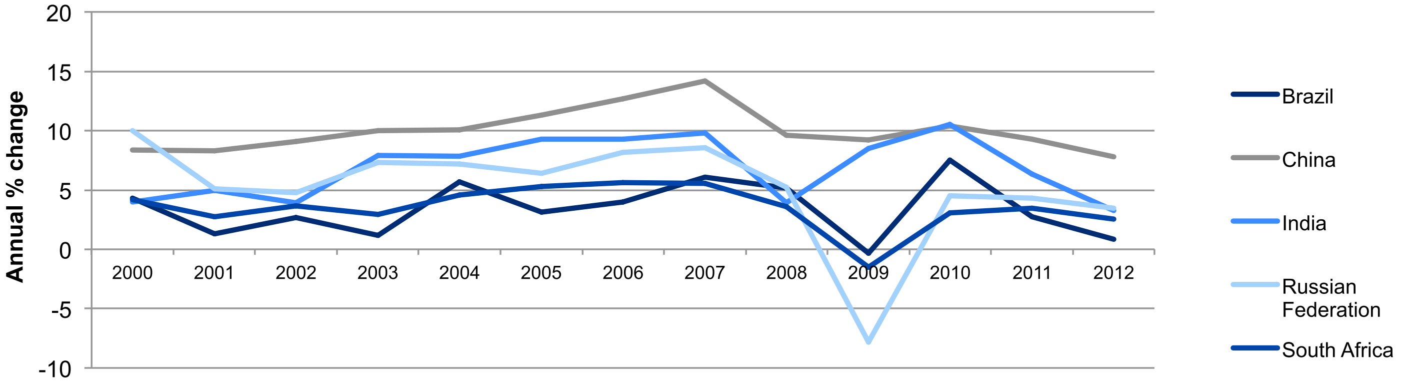
BRICS: Balancing Economic Growth and Environmental Sustainability

Economic expansion in the BRICS cluster – Brazil, Russia, India, China and South Africa – has been, potentially with the exception of Brazil, fuelled by policies which traded off environmental objectives in favour of economic expansion. After over two decades of growth, this trade-off is increasingly coming under the spotlight; China continues to be the largest GHG emitter globally, and both India and the Russian Federation are within the top 10 global emitters.[80] For the majority of economies in this cluster, achieving greater balance between economic growth and environmental sustainability is a key priority.

Over the past decade, BRICS countries have experienced rapid industrialization, economic growth and increases in GDP per capita. On average, the GDP of Brazil, China, India, Russia and South Africa grew by 7% annually between 2002 and 2012.[81] Despite negative growth years for some BRICS during the economic recession in 2009, and recent IMF estimates projecting the slowdown of growth in BRICS – with growth for South Africa, China, Russia and India projected to be 1½ to 4¼ percentage points lower in 2013 than it was in 2011[82] – the economies of BRICS countries are still expected to remain in positive growth figures.

Figure 15: BRICS – GDP Growth (Annual %)

Source: World Bank, 2012



This economic growth has also been met by increased demand and consumption of energy. Energy consumption in China more than doubled in the period 2000-2010, reaching 2.4 million KTOE in 2010; in Brazil and India, the growth was between 40-50% over the same period. In terms of future projections, China and India are expected to provide the bulk of the global increase in energy demand to 2035.[83]

Throughout this growth period, BRICS countries have largely upheld policies to ensure affordability of energy to drive competitiveness in industry. Industry growth has been the primary driver of energy demand in countries like China, where industry accounted for nearly 50% of final energy consumption in 2012.[84] These policies have, to some extent, been to the detriment of the environmental sustainability of the energy systems that developed as a consequence.

In response to growing environmental concerns, both China and India have set a range of targets to reduce the energy intensity of their economies and improve their climate metrics. China's current Five-Year Plan has among its targets the reduction of energy intensity of its industry by 16% by 2015 from 2010 levels – this is further complemented by the 10-Point Plan adopted by the Chinese government in 2013 to tackle urban pollution. Similarly, India has plans to reduce carbon-intensity by 20-25% by 2020. To achieve these targets without hindering growth, BRICS countries need to realize opportunities to balance the imperatives of the energy triangle.

To achieve a 2 °C increase scenario – to limit global warming to a 2 °C increase to 2035 – the IEA suggests four key GDP-neutral emissions abatement measures: adopting energy efficiency measures; limiting use and further deployment of low-efficiency coal-based power plants; phasing out fossil fuel subsidies; and minimizing methane emissions from upstream oil and gas.

Given the diversity of energy systems within the BRICS countries, each measure is likely to have a varying degree of impact by country.

Adopting Energy Efficiency Measures

Energy efficiency measures in the industrial, residential and transportation sectors can make a strong contribution to reducing GHG emission globally.[85] Potential efficiency measures in these sectors include the implementation of minimum energy performance standards (MEPS) in cooling/heating products, residential appliances and industrial equipment.

Addressing energy consumption of industry in economies such as China and India is key to achieving efficiency improvements. Aside from the roll-out of MEPS for industrial motors, China is increasing standards and regulation for its largest industrial energy consumers through a range of measures including the Top 10,000 Programme, which sets energy savings targets to 2015 for the largest industrial consumers accounting for 85% of energy demand in industry.[86] According to the Chinese State Council, the programme could save an estimated 250 million tonnes of coal equivalent and 610 million tonnes of CO_2 from 2011 to 2015. Similarly, in India, the "Perform, Achieve and Trade" initiative was set up as a mandatory trading system for energy efficiency obligations in some of the most energy-intensive industry industries.

In the Russian Federation, improvements in the residential and heating sector could be instrumental in addressing energy efficiency – 26% of total final energy consumption of the country in 2012 came from the residential sector, compared to less than 10% in Brazil. A recent study on the potential of energy efficiency in Russia estimates that efficiency measures in insulation, heating and appliances could account for over 60% of efficiency-related savings in a 2030 scenario.[87]

Limiting Use of Low-Efficiency Coal-Based Power Plants and Finding Alternative Lower-Carbon Sources

Coal-powered generation is predominantly a concern in China, India and South Africa. China accounted for 46% and India 9% of global coal consumption in 2011, while coal contributed to 70% of total primary energy supply in South Africa the same year. Most forecasts believe coal will continue to play a key role in meeting the increased energy demand in these countries. However, environmental pressures are driving these countries to identify measures to limit the use of low-efficiency coal power generation, in favour of more efficient fossil fuel technologies, or through investment in renewable energy capacity.

China is exploring a range of fiscal and financial disincentives and is currently piloting emission trading in its most emission-intensive districts – however, carbon trading schemes such as the EU ETS have had limited success to date. In addition, China has indicated the potential roll-out of a resource tax on coal, and the country's 10-Point Plan to tackle pollution aims to reduce the proportion of coal in total energy consumption to 65% by 2017.[88] A perspective from Lin Boqiang, Director at the China Centre for Energy Economics Research of Xiamen University, further expands on the transition pathway of China towards improving its energy-environmental performance. India and South Africa are also exploring a range of measures to reduce coal consumption and replace it with alternative, lower-carbon options.

Disincentives for coal consumption can contribute to creating an enabling environment for the deployment of low-carbon power generation. BRICS countries all have in place targets to increase their share of energy from renewable and low-carbon energy sources. Aside from having targets for renewable energy, India is continuing its long-term drive to increase the share of nuclear capacity from 4% in 2011 to 25%.[89] Although installed renewable capacity has grown significantly over the past decade, cost competitiveness with fossil fuels, reliance on subsidies and incentives remain a challenge, underlining that more needs to be done to address cost and market structures for renewables.

Renewable energy is, however, unlikely to fill the base-load gap if coal capacity in these coal-dependent countries is significantly scaled back; instead, natural gas has a key role to play in filling the gap. Beyond the strategies to secure gas supplies from international markets, South Africa and China, which hold some of the largest recoverable shale gas reserves[90] globally, can aspire to replicate the shale gas revolution in the US, which is seeing coal displaced by the cheaper and widely available natural gas. However, IEA estimates suggest that resource, technical and infrastructure requirements of shale recovery and the gas/coal price differential will mean development to scale will not occur before 2020.[91]

Phasing out Fossil-Fuel Subsidies

Phasing out fossil-fuel subsidies has a key role in improving the environmental performance in those BRICS countries where energy subsidies persist. Subsidies promote the inefficient use of energy, weigh on the economy and create market distortions which, among other things, impact the competitiveness of investing in renewable energy sources. In the BRICS cluster, Russia, India and South Africa have the highest fossil fuel subsidies, with an average 18% subsidization rate in India and Russia, and a 4% rate in South Africa.[92]

Subsidy reform globally has been challenging and a politically sensitive topic in a number of countries. Best practice in addressing subsidy reform emphasizes the importance of clearly communicating the objectives with stakeholders and consumers, planning a long-term, gradual phase-out, and monitoring the progress and impact of the policies.[93] In Nigeria (2012) and Bolivia (2010), overnight significant reductions on subsidies were met with public protests and civil unrest – drawing attention to the need for long-term planning and information campaigns to support any such measures.

Minimizing Methane Emissions

The energy sector is responsible for 40% of global methane emissions, a greenhouse gas with a global warming potential 21 times higher than CO_2.[94] In the energy sector, the vast majority of methane emissions occur when natural gas is released in oil production operations ("associated petroleum gas"), as part of safety venting operations or due to leaks during transmission and distribution.

With extensive oil and gas production and pipeline infrastructure, methane emissions are a key challenge for Russia – the country was responsible for 40%[95] of global energy-related methane emissions in 2012. In 2009, Russia aimed to reach a 95% utilization rate of "associated gas" by 2012; however, estimates from 2012 point at a 76% utilization rate achieved to date.[96] Although a number of measures are being implemented, the cost of retrofitting extensive infrastructure and limited success in enforcing standards is impacting progress. In the absence of stringent regulation and incentive mechanisms, it is unclear to what extent capture and reuse technologies will be implemented.

As evidenced above and in the performance of the BRICS cluster in the EAPI, these economies face a number of challenges in balancing the energy requirements of their growing economies with the concerns over the long-term environmental sustainability of their energy systems. The IEA recommendations for GDP-neutral carbon abatement solutions identify the key opportunities for developing long-term strategies to address the environmental challenge.

External Perspective: Balancing Economic Growth and Development with the Challenge of Environmental Sustainability – China's Perspective

Lin Boqiang, Director, China Centre for Energy Economics Research, Xiamen University, People's Republic of China

China has achieved impressive economic growth over the past three decades. However, the recent environmental pollution (haze) in major Chinese cities has greatly attracted the public's attention to the seriousness of environmental pollution. It clearly indicates how much China has paid environmentally for its economic growth. China's State Council issued an action plan of air pollution control on 12 September 2013. The plan expresses China's effort in the next five years to improve overall air quality and drastically reduce air pollution, especially in areas near Beijing, the Yangtze River Delta, and the Pearl River Delta.

There are many factors contributing to air pollution in China. However, controlling energy consumption, changing the energy structure and increasing the supply of clean energy are likely to be the main factors in reducing air pollution in these regions.

The plan focuses on reducing coal consumption in Eastern China, which is still in a development stage of relatively high economic growth and represents a major portion of projected increases in energy demand. If renewable or cleaner-burning energy sources cannot meet the growing energy demand in the eastern regions, energy resources, especially coal from the western regions, will be required to supplement electricity – compounding the pollution problems in the western regions.

Coal currently provides 69% of primary energy and close to 80% of electricity in China. Hydropower development is restricted by its potential, and other renewable energy, such as wind and solar, are too small to make a meaningful contribution at this point. Nuclear energy could substitute coal substantially, but it requires a long-term development plan. Natural gas with less emission could possibly substitute not more than 5% of coal in the primary energy mix in next few years.

Air pollution control in the eastern regions will result in more pollution in the western regions in two ways: one is the migration of high energy-intensive industries from the eastern to the western regions, and the other is more coal-fired power generation in the western regions that could be transmitted to the eastern regions. Therefore, the trend of accelerated pollution in the western regions seems inevitable.

What happened in the eastern regions should be an important lesson for China. How to balance economic growth and development with the challenge of environmental sustainability is critically important today, as China has been forced to clean up the eastern regions that could lead to high possibilities of polluting the western regions.

The government needs to establish two mechanisms to avoid the pollution pattern in the eastern regions. First, the terms of trade for energy transfer should be in favour of the western regions so that an effective ecological compensation mechanism could be established to minimize the environmental impact. The central government needs to coordinate and ensure reasonable energy prices, which can support economic development in the western regions and curb energy consumption in the eastern regions. Secondly, the government should ensure ordinary people in the western regions benefit from the energy resource transfer. With higher incomes, the people in the western regions could gain access to commercial energy, change their energy consumption patterns, afford cleaner energy and reduce coal consumption.

Association of Southeast Asian Nations (ASEAN)

ASEAN - Analysis of EAPI Performance

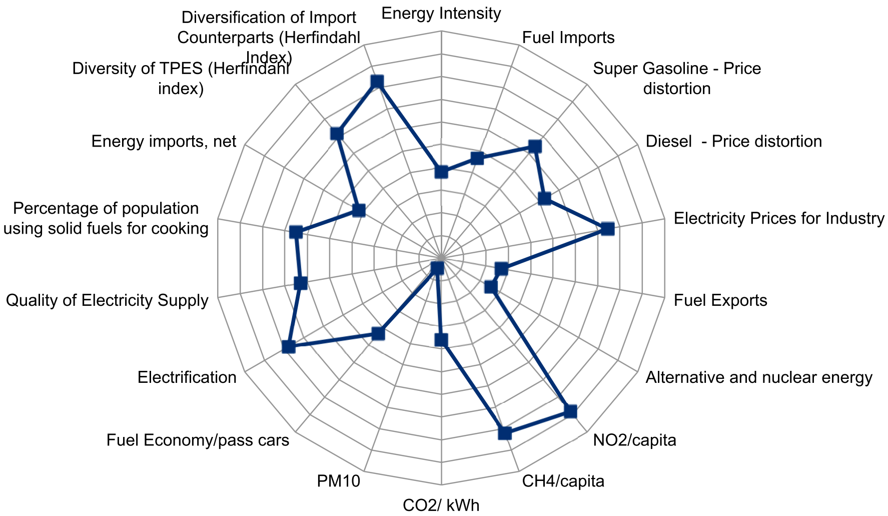
Table 9: ASEAN EAPI Performance

ASEAN	EAPI 2014		Economic Growth & Development		Environmental Sustainability		Energy Security & Access	
Country Name	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Thailand	0.53	55	0.49	55	0.39	91	0.73	53
Singapore	0.52	62	0.58	32	0.37	95	0.61	86
Indonesia	0.52	63	0.45	61	0.41	81	0.69	66
Philippines	0.51	64	0.41	66	0.51	49	0.62	85
Malaysia	0.48	71	0.26	111	0.34	102	0.83	12
Vietnam	0.47	75	0.30	102	0.43	74	0.66	77
Brunei Darussalam	0.42	101	0.36	77	0.21	117	0.70	63
Cambodia	0.36	120	0.36	76	0.45	67	0.28	117
ASEAN Average	0.48		0.40		0.39		0.64	

Overview

The Association of Southeast Asian Nations (ASEAN), comprising 10 nations in South-East Asia, includes the large economies of Thailand, Singapore, Indonesia, the Philippines and Malaysia and the smaller, generally less developed economies of Vietnam, Cambodia, Laos, Myanmar and Brunei Darussalam.[97] ASEAN aims to reach economic integration by 2015; from an energy perspective, the integration plan includes the roll-out of the integrated ASEAN Power Grid and the development of the Trans-ASEAN Gas Pipeline – initiatives that would greatly benefit the energy security of the region. Over the past two decades, the ASEAN region has experienced vast energy demand growth, and this trend is expected to increase by an additional 80% between 2013 and 2035.[98] Given the uneven spread of natural resources across the South-East Asia region, integration of energy systems could be instrumental in balancing supply and demand.

Figure 17: ASEAN Overview of Average Performance per Indicator



*Spider chart represents average performance of region/cluster for individual EAPI indicators. Low scores close to the centre of the chart; high scores close to the o

The disparate sizes of ASEAN economies are reflected in the dispersion of scores across the energy triangle. However, Figure 16 highlights some common key challenge areas for ASEAN countries that are likely to be exacerbated by the expected increase in energy demand in the region.

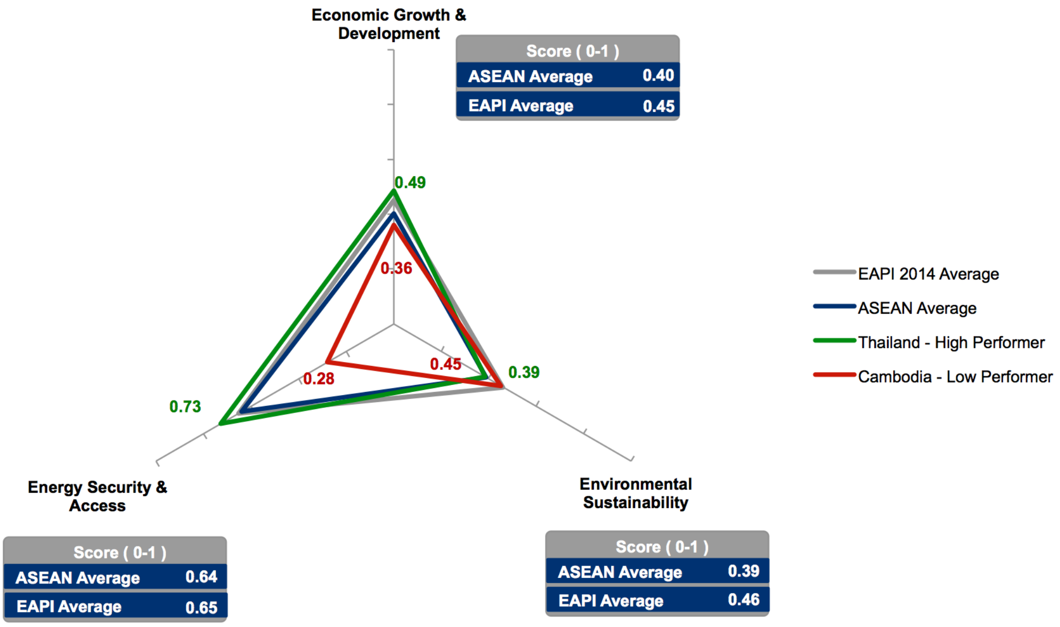
– The ASEAN region faces a number of challenges including energy intensity, import dependence and fossil fuel dependency. In terms of energy intensity, ASEAN countries receive an average score of 0.38/1 against the global average of 0.48/1. Vietnam, Thailand, Brunei Darussalam and Indonesia have the most energy-intensive economies, all scoring below 0.30/1.

– The larger ASEAN economies – Indonesia, Malaysia, the Philippines, Singapore and Thailand – achieve the highest scores for the region, with performances ranging from 0.53/1 for Thailand to 0.51/1 for the Philippines. These countries perform better than other ASEAN countries for a number of reasons including higher electrification rates, higher GPD and, compared to Brunei Darussalam, lower energy intensity.

– Singapore, Brunei Darussalam and Malaysia all receive less than 10% of total primary energy supply from alternative and nuclear sources, drawing attention to the key challenge in the region of over-dependence on fossil fuels – and in the case of Brunei Darussalam and Malaysia, the persistence of fossil fuel subsidies impacting investment in alternative low-carbon technologies. The performance of Vietnam, Cambodia, Indonesia and the Philippines, compared to the other ASEAN countries, is largely due to the continued use of solid fuels for cooking – all above 50% of the population.

– Cambodia, the least developed ASEAN economy represented in the index, achieves the lowest performance of 0.36/1 and is one of the lowest performers in the index globally, ranking 120th among the 124 countries included.[99] Low electrification rates and over-dependence on imports of fossil fuels affect scores across the environmental, economic and energy security dimensions of the energy triangle.

Figure 17: ASEAN – Energy Triangle Performance: Average against High/Low Performer



Economic Growth and Development

Singapore's score of 0.58/1 for the economic growth and development dimension makes it the highest ranking in the region, and places Singapore within the upper quartile of performance globally. Singapore benefits from high per capita GDP, driven in part by the service sector, which affords the country lower energy intensity than other ASEAN countries. The performance of other ASEAN countries averages 0.38/1, with key performance challenge areas in fuel subsidies and energy intensity.

Subsidies in ASEAN
Brunei Darussalam, Malaysia, Thailand, Indonesia and Vietnam receive the lowest regional scores in price distortion of super gasoline and diesel; the IEA estimates that in 2012, subsidies in the ASEAN region amounted to US$ 51 billion.[100] Malaysia, Indonesia and Brunei Darussalam are the lowest performers, receiving average scores of 0.28/1. The phase-out of fossil-fuels is being widely advocated, and some ASEAN countries are starting to address the challenge. In June 2013, Indonesia continued its subsidy reform process by increasing gasoline and diesel prices. Brunei Darussalam, Malaysia, Myanmar, Thailand and Vietnam are also implementing policies to improve the alignment of domestic pricing for fuels and energy with global markets.

Energy intensity
Two significant market distortions arising from energy subsidies are the inefficient use of energy and the reduced

incentives for investment in energy efficient technologies and renewable energy sources. ASEAN countries with some of the highest subsidy levels also achieve the worst performance across the energy intensity indicator – namely Brunei Darussalam, Indonesia, Vietnam and Thailand. The average GDP per unit of energy use in these countries is comparable to some of the lowest global scores for large net-energy exporters such as Venezuela and Libya. Countries like Indonesia and Malaysia are implementing energy efficiency targets and policies to drive down energy intensity; however, energy subsidies pose a barrier to the success of energy efficiency policies.

Environmental Sustainability

ASEAN countries' average performance across environmental sustainability is overall low at 0.39/1 compared to the global average of 0.46/1. Fossil fuels, especially coal, dominate the power mix of ASEAN economies and this affects performance across the emissions indicators and on the share of low-carbon energy. The top performer for the region is the Philippines, which achieves the best scores compared to ASEAN peers across most of the emissions indicators – especially per capita nitrous oxide emissions. Brunei Darussalam, the region's largest net exporter, is also the worst performer across this indicator – evidencing the relationship between hydrocarbon production, subsidies and emissions.

Renewables
Brunei Darussalam, Malaysia and Singapore obtain less than 5% of their TPES from non-fossil fuels, setting these countries within the lower quartile performance of the index. Conversely, Cambodia and the Philippines receive the highest contribution in the region, primarily driven by the continued use of traditional biomass for energy. Although renewable capacity in ASEAN has expanded in recent years, progress to establish and develop a renewables market has been slow. However, all ASEAN countries have set renewable energy targets, albeit with varying aspirations and levels of commitment. The Philippines has set itself the aggressive target of tripling installed renewable capacity by 2030. In Indonesia, the target of receiving 25% of its energy consumption from renewables by 2025 is backed by feed-in tariffs for all renewables, including biogas.

Emissions intensity
Indonesia, Brunei Darussalam and Cambodia all rank within the lower quartile of the index for the CO_2 intensity of their power-generating sector. This largely reflects the dominance of fossil fuels in the sector, and the inefficiency of power-generating technology. According to IEA analysis, improvements in the efficiency of coal-fired generating plants to beyond the current 34% could have a significant impact on reducing CO_2 emissions and local pollution.[101]

Indonesia has among the highest PM10 concentrations across the index globally at 60 micrograms – 10 micrograms above the health levels recommended by the EPA.[102] Urban pollution, such as particulate matter, is generally due to inefficient fossil fuel combustion in power generation. In urban settings, proximity of industry and power generation to cities compounds the issue. Some cities in Asia are trialling a "green belt" to move polluting industries further from urban centres. However, these types of solutions only relocate emissions instead of reducing them. The concluding article of the ASEAN section looks further in detail at solutions for addressing energy consumption and pollution in urban environments.

Energy Security and Access

With the region's energy demand expected to grow by 80% to 2035, energy security is a key challenge for ASEAN countries.[103] Although ASEAN has extensive natural resource endowments – notably in Indonesia, Brunei Darussalam and Malaysia – the region's supply infrastructure is a growing challenge. The IEA estimates that US$ 1.7 trillion of cumulative investment in energy supply infrastructure is needed to 2035; nearly 60% of this investment is required for the power sector.[104]

Balancing supply and demand
On the whole, the ASEAN region is endowed with significant natural resources. However, as indicated by the disparity in scores for the net export indicator, these resources are not equally divided across the region. The ASEAN region includes four net-energy exporters – Brunei Darussalam, Indonesia, Malaysia and Vietnam – with the remaining four ASEAN countries covered by the index relying on an average of 50% net imports. Brunei Darussalam, given the size of the country relative to its extensive natural resources, is one of the highest performers globally, ranking in 5th place.

A solution to addressing the region's supply and demand imbalances is in part expected to come through the planned integration of ASEAN countries' energy systems. One of the key elements of the ASEAN Economic Community is the development of the integrated ASEAN Power Grid and the Trans-ASEAN Gas Pipeline. If successful, the implementation of the ASEAN energy integration plan could have a significant impact on both the quality of energy supply and the region's energy security. However, a number of challenges are likely to hinder integration plans, including the cost of addressing differences in the power and gas infrastructure. In view of the upcoming ASEAN chairmanship in Myanmar, the country's minister of energy provides his perspective on the energy integration plan in the perspective which concludes the ASEAN section.

The energy access challenge
The region's lowest-performing country across energy access-related indicators is Cambodia. It achieves the lowest access to electricity relative to population (at 31%), and nearly 90% using solid cooking fuels. In terms of real numbers, Indonesia has the largest population lacking energy access at 66 million. The challenge in Indonesia is compounded by its complex geography and the related difficulties of delivering access across the world's largest archipelago. However, progress has been made across ASEAN, generally by government and donor-led initiatives to bring distributed power-generating capacity to rural populations, where energy access challenges are localized. For example, Indonesia has allocated a US$ 1 billion annual budget to bring distributed energy solutions to rural and isolated communities.[105]

ASEAN: Urbanization and Energy

As evidenced by the performance of ASEAN countries within the EAPI, emission and energy intensity are two key challenges faced by the region. The projected increase in energy demand in the region is compounded by the urbanization trend which is bringing higher energy demand and more intensive consumption to urban areas.

Over the past two decades, the ASEAN region has experienced rapid and uncontrolled urbanization – with the five largest ASEAN economies – Indonesia, Thailand, Malaysia, Singapore and the Philippines – reaching an urbanization level of 46% in 2012 and expecting to see a further 25% growth by 2050.[106]

Alongside increased urbanization and population growth, the region has seen a 2.5% increase in energy demand by since 1990. This trend is expected to continue, with the IEA projecting a further increase of 80% up to 2035.[107] Increases in urbanization can present a number of challenges across the energy system with higher, concentrated energy demand adding stress to the supply infrastructure, and emissions from increased vehicle ownership and traffic congestion. Motor vehicles in Bangkok, Thailand, increased from 600,000 in 1980 to 6.8 million in 2013,[108] largely due to inadequate public transport and under-regulated vehicle standards.

These challenges are putting pressure on ASEAN cities to address urban pollution and congestion, and to find new solutions to manage energy supply and demand. A number of technology and policy solutions are available to mitigate these challenges – four potential solutions are explored below.

1. Smart grid: Smart metering enables the transfer of information in two-way communication between consumers and the grid; implementing this type of technology can help energy providers understand demand patterns and become more efficient in balancing supply and demand, and can empower users to be more efficient with their energy consumption. A number of smart grid implementations are using variable pricing rates based on the load of the grid, offering consumers lower rates for energy used at times when there is more capacity in the grid. In 2009, the Singapore Energy Market Authority launched a smart metering pilot which provided users with information on variable electricity tariffs; in a previous Singapore pilot, this resulted in a 10% reduction in consumption at peak times, and an overall 2% reduction in energy consumption.[109]

   An interesting technology in smart metering is vehicle-to-grid (V2G) technology which allows the bi-directional transfer of power between plug-in electric vehicles and buildings. A fully electric car can draw or produce up to 19 kW, the average power need for 13 US houses.[110] The technology was initially developed in the aftermath of the March 2011 tsunami in Japan which caused power shortages and rolling blackouts in the country. When combined to smart metering technology and varying electricity pricing based on load capacity of the grid, the technology has the broader application of helping consumers reduce energy costs.

2. Maximize economies of scale: Urban environments can offer energy saving opportunities enabled by the higher population density and economies of scale. A clear example of this is that urban environments can take advantage of public transportation to replace personal vehicles. The development of effective public

transport can support cities in reducing congestion by providing a common transportation mode – for this to be effective, public transport must extend to reach outer-city populations, as well as be exempt from congestion to offer a valid alternative to private transportation. Cities such as Bangkok have developed above-ground metro transportation. The City of Shanghai invested nearly 3% of its GDP between 1999-2009 to develop a transportation infrastructure; over 40% was dedicated to the development of the Shanghai Metro, which now carries 8 million passengers a day, spans 420 km and covers over 80% of the city's built-up area.[111] As demonstrated by the Shanghai Metro, developing a transportation network which extends to provide service to the wider urban settlement can be capital intensive, and therefore challenging to implement.

3. Smart traffic control: Data from in-vehicle telematics or road sensors can help cities understand and manage the flow of traffic in real time, providing opportunities to reduce emissions and fuel consumption by redirecting traffic through less congested routes. Although a number of pilots using smart traffic technologies are underway, no widespread implementation of the technology exists to date. However, other measures to reduce congestion from private vehicles exist in the form of financial disincentives for vehicle ownership use and incentives for investment into cleaner transportation. For example, Singapore has established a congestion charge scheme which uses variable real time pricing to charge road users at peak congestion times. Additionally, Singapore has imposed quotas for new vehicles, and high vehicle registration rates to mitigate the rise in the number of vehicles on the road. Incentives and emission standards to promote new, more efficient vehicle technologies can also play a role in reducing urban pollution. In Sweden, fiscal and financial incentives for the purchase of flexible fuel vehicles, as well as regulation to impose the sale of biofuels for larger fuel retailers, have led to a 12% reduction in city pollution.[112]

4. Big data: Collecting relevant information on urban activity from, for example, mobile devices, smart grid infrastructure and in-vehicle telematics can support governments and service providers to better understand patterns of behaviour and consumption, including understanding the expansion of the urban environment and provide opportunities to make long-term informed plans for public services.

The development of ASEAN economies and the rapid urbanization trend witnessed over the past years have brought to head a number of energy challenges – especially increased, concentrated energy demand, road congestion and higher emissions. Urban environments have the potential to enhance their environmental and energy performance by adopting efficiency measures and emissions standards and by leveraging opportunities for economies of scale in sectors like public transportation. If supplemented by the right policy environment – especially with regards to the phase-out of fuel subsidies – these offer high opportunities for ASEAN cities in addressing energy demand and the environmental sustainability of their urban environments.

External Perspective: Pathway to an ASEAN Integrated Energy System

Union Minister U Zay Yar Aung, Minister of Energy, Myanmar

ASEAN is one of the fastest growing economic regions in the world and has a fast rising energy demand driven by economic and demographic growth. Furthermore, ASEAN has been demonstrating a sharp rebound from the global economic crisis.

In 2010, the region's real GDP grew above the world average, with some countries even recording two-digit economic growth. Total GDP of the region in 2010 was US$ 1,850 (at current prices), having grown by 7.4% from the previous year, and the total population of ASEAN reached 598.5 million in 2010, 1.3% more than the previous year.

The region's economic and population growth have resulted in a consequential increase in final energy consumption. With the assumed GDP growth rate of 5.2% per annum from 2007 to 2030,[113] this growth is significantly higher than the world's average growth rate of 1.4% per year in primary energy demand over 2008-2035.[114]

In view of the high economic growth and need of energy supply, the challenge to ensure a secure supply of energy is an overriding concern for ASEAN. Energy is crucial to the transformation of ASEAN into a stable, secure, prosperous, competitive and resilient ASEAN Economic Community in 2015.

In this regard, ASEAN developed *The ASEAN Plan of Action for Energy Cooperation (APAEC) 2010-2015* under the theme "Bringing Policies to Actions: Towards a Cleaner, More Efficient and Sustainable ASEAN Energy Community".

It covers the energy component of the ASEAN Economic Community Blueprint 2015, to ensure a secure and reliable energy supply for the region through, among others, collaborative partnerships in the ASEAN Power Grid (APG) and Trans-ASEAN Gas Pipeline (TAGP), the promotion of cleaner coal use, energy efficiency and conservation, renewable energy and nuclear energy. APG and TAGP are regional strategies for energy security aimed at establishing cooperation to connect electricity and natural gas within and throughout ASEAN.

The establishment of the ASEAN power grids and gas pipelines would be necessary to minimize the unnecessary cost for the energy infrastructure, and to collaborate in addressing regulatory issues within the governments and regulators. Additionally, frameworks, government support and business models need to be aligned when the time comes to transport electricity and gas in the most economical and efficient manner. Being proactive in this space is of great importance for the region to understand the key success factors required for market readiness.

Coordinated by the ASEAN Council on Petroleum, or ASCOPE, TAGP aims to develop a regional Trans-ASEAN Gas Pipeline grid by 2020, by linking the existing and planned gas pipeline networks of the ASEAN member states.

ASEAN implement to conduct of EE&C competition of buildings, capacity building activities, Renewable Energy development, Regional Energy Policy and Planning and Civilian Nuclear Energy development.

The region is heading towards ASEAN connectivity by 2015, with continuous strong commitment from ASEAN member countries to cooperate and collectively pursue initiatives towards realizing the ASEAN Economic Community in 2015.

Myanmar has returned to the global stage with a series of political reforms after years of economic sanctions. With better international relations, the country has seen emerging economic opportunities, and a greater number of social, cultural and economic exchanges are the profits.

Myanmar's government is working to change the face of the country, and internal peace is a necessity. Stability is the dignity of the nation and boosts the country's reputation. With closer ties with world powers, the entire population should respect laws and help ensure the stability.

Myanmar will assume the ASEAN chairmanship in 2014, which creates a great environment to develop closer connectivity, especially economic and trade opportunities. The country will also see a larger amount of foreign investments.

Myanmar will take concrete steps to carry out the remaining tasks of the ASEAN Community Roadmap together with ASEAN member countries, while striving to further strengthen the ASEAN Community.

During its ASEAN chairmanship, Myanmar will try to continue and maintain the traditions and unity of the association. The motto for 2014 is "*Moving Forward in Unity, to a Peaceful and Prosperous Community*". Myanmar is attaching great importance to the chairmanship, as it is the first time the country holds the position since becoming an ASEAN member, and has pledged to successfully perform the duty.

Myanmar will also try to maintain the ASEAN centrality. Myanmar will be working hard as a responsible member nation, and while chairing the ASEAN in 2014, Myanmar will be able to successfully take on the duties with the help of member and dialogue partner countries.

Sub-Saharan Africa (SSA)

SSA - Analysis of EAPI Performance

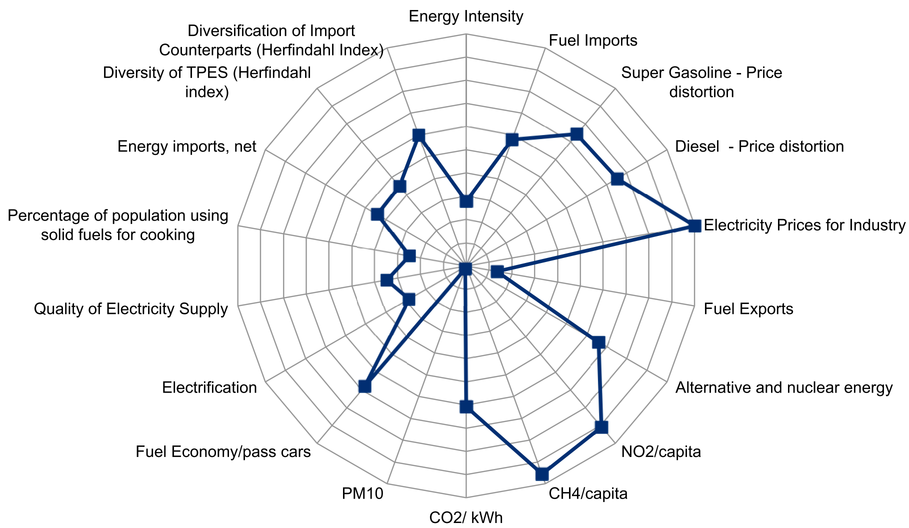
Table 10: SSA EAPI Performance

Sub-Saharan Africa SSA	EAPI 2014		Economic Growth & Development		Environmental Sustainability		Energy Security & Access	
Country Name	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Congo, Rep.	0.55	53	0.53	46	0.58	25	0.55	96
South Africa	0.54	54	0.59	29	0.38	94	0.64	81
Cameroon	0.46	80	0.35	85	0.63	13	0.40	110
Namibia	0.46	82	0.45	62	0.51	48	0.41	107
Ghana	0.45	83	0.34	87	0.59	22	0.42	105
Zambia	0.44	92	0.35	83	0.71	6	0.27	118
Nigeria	0.44	93	0.38	69	0.61	18	0.33	114
Botswana	0.44	95	0.48	57	0.37	96	0.46	104
Cote d'Ivoire	0.43	97	0.29	104	0.59	24	0.41	109
Senegal	0.42	99	0.37	71	0.49	55	0.42	106
Mozambique	0.42	106	0.29	105	0.71	5	0.26	119
Eritrea	0.41	107	0.35	80	0.55	36	0.33	113
Kenya	0.41	109	0.28	109	0.63	14	0.31	116
Ethiopia	0.39	113	0.26	113	0.71	4	0.19	123
Togo	0.37	119	0.25	119	0.65	11	0.20	122
Tanzania	0.36	121	0.26	112	0.65	10	0.17	124
Benin	0.35	122	0.32	96	0.49	54	0.25	120
SSA Average	0.43		0.36		0.58		0.35	

Overview

Although sub-Saharan Africa achieves one of the lowest average scores compared to other analysed regions, the region has a number of resource-rich countries such as Nigeria, the Republic of Congo and Angola, along with extensive coal reserves in South Africa. Recent discoveries of large natural gas fields off the coast of Mozambique and Tanzania are expected to become commercially operational by 2016, further increasing the region's resource wealth.[115] However, the region also faces critical challenges of low electrification rates – 590 million people lack access to a modern energy supply and 700 million use traditional biomass for cooking.[116]

Figure 19: Sub-Saharan Africa Overview of Average Performance per Indicator



*Spider chart represents average performance of region/cluster for individual EAPI indicators. Low scores close to the centre of the chart; high scores close to the o

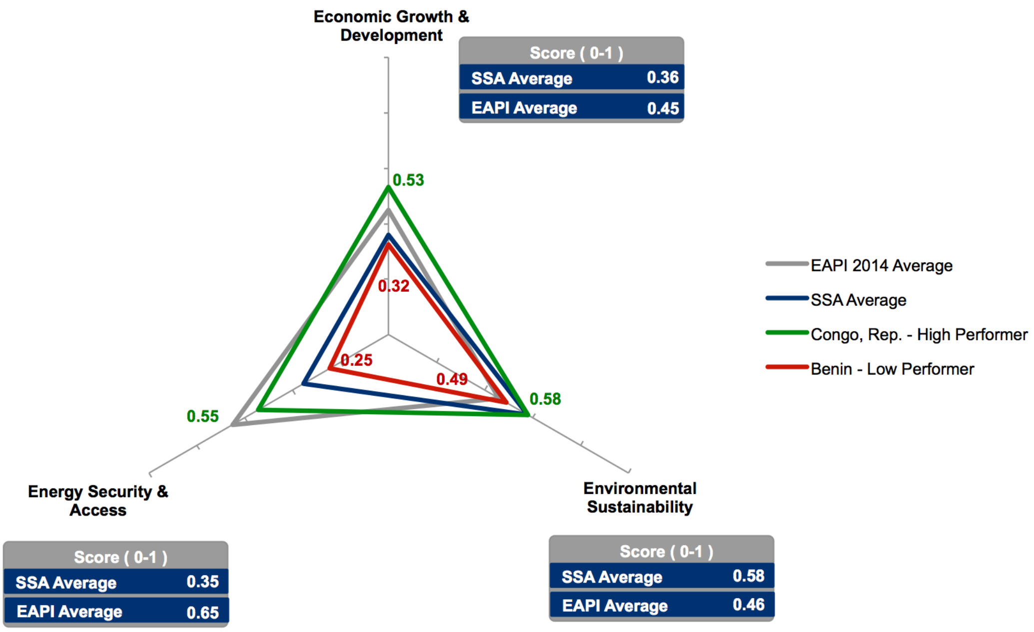
Figure 18 provides an overview of average performance of sub-Saharan Africa for individual indicators of the EAPI; the spider chart highlights the key challenges faced by the region.

- The average score of sub-Saharan Africa is 0.43/1, which places the region in the index's lower quartile of overall performance. The Republic of Congo is the best performer in the index, ranking 53rd globally with a score of 0.55/1, followed closely by South Africa (54th). The lowest performer in the region is Benin with an EAPI score of 0.35/1. Benin, along with 12 others of the 17 sub-Saharan African countries ranked in the index, ranks in the lower quartile of the overall index.

- Low energy access rates across sub-Saharan Africa affect the performance of all countries, highlighting access to energy as the region's key challenge of the region. Compared with the global average of 0.83/1 in this indicator, the sub-Saharan Africa region achieves an average score of 0.28/1.

- While low access rates adversely impact the energy security dimension, the prevalence of traditional biomass in the total primary energy supply of the region, and generally low industrial activity, mean sub-Saharan African countries on average achieve higher scores in the environmental sustainability indicators. As countries in sub-Saharan Africa strive to improve access rates and grow their economies, they will need to focus on measures to ensure that these do not come at the cost of environmental performance.

Figure 19: Sub-Saharan Africa – Energy Triangle Performance: Average against High/Low Performer



The key factors affecting performance across the energy triangle are detailed in the sections below and additional analysis of the energy access challenge is further explored in the concluding section of the sub-Saharan Africa chapter.

Unfortunately, due to availability of data for the region, only 17 out of 46 sub-Saharan African countries are included in this study.

Economic Growth and Development

Scores across the economic growth and development dimension are influenced by the disparity in distribution of natural resources and varying export capacities. Fossil fuel exporting countries tend to have more energy-intensive industries owing to the industrial activity of the sector. In addition, the extended mining activities of the region contribute to the high intensity scores. In efforts to improve access rates, a number of sub-Saharan African countries have instituted fuel subsidies, which negatively impact access scores and, according to the IMF,[117] have had limited success in reaching their target group.

High performer – South Africa
South Africa is the highest-performing country across this dimension for the sub-Saharan region and ranks in 29th place globally. Over the past decade, South Africa has undergone economic development which has set it apart from other countries in the region, and warranted the country's inclusion among the BRICS economies. Although South Africa has an energy-intensive economy as a result of its industrial activity, the country's higher GDP relative to other sub-Saharan Africa countries mitigates the impact of import expenditure relative to GDP.

Subsidies
The persistence of fuel subsidies affects scores across the region, with higher prevalence of these in the resource-rich countries; Nigeria and Angola have the highest subsidies in the region for super gasoline and diesel respectively. Addressing subsidies remains a key challenge for both Nigeria and the Republic of Congo in terms of improving the affordability of the overall energy system. The UN estimates that Nigeria spent US$ 7.6 billion, or 2.6% of GDP,[118] on subsidies in 2012. Attempts by the government to remove subsidies in 2012 were met with public opposition, which ultimately led to the policy being reversed. The case of Nigeria, along with other countries struggling with entrenched fuel subsidies, highlights the necessity for long-term planning and graduated approach to a subsidy phase-out.

Energy intensity
Overall, sub-Saharan African countries occupy the lowest rankings globally for the energy intensity of the economy. This is largely driven by low GDP and the prevalence of energy-intensive industries such as mining and fossil fuel production. In 2012, the energy intensity of Mozambique and Togo was around US$ 2 GDP per kg of oil equivalent, making them among the most energy-intensive economies globally.

Botswana's economic dependence on diamond exports makes it one of the exceptions in the region. Diamonds contribute over one-third to the country's GDP.[119] Although mining is in general an energy-intensive industry, the high value of exports compared to the energy needed to extract them and the overall lack of other industrial development make the country's economy one of the least energy-intensive economies globally and the best performer in the region for this indicator.

With economies in sub-Saharan Africa expected to grow, and industry, mining and fossil fuel production likely to contribute to this growth, these countries will face increasing challenges in managing their future energy intensity. This will be particularly relevant for the region's resource-poor countries. Rapidly developing countries like China and India have also significantly increased their energy demand and the energy intensity of their economies, with GDP and CO_2 emissions growing at the same rate.[120]

Environmental Sustainability

Sub-Saharan African countries receive their highest scores in the environmental sustainability dimension of the index. The use of traditional biomass for energy along with the small power-generating capacity tied to low electrification rates contribute to this high performance, affecting scores on low-carbon fuels in the energy mix and other emission-related indicators. However, the resource-rich countries face increasing challenges in the environmental sustainability from their production and refining activities.

Biomass and electrification
Due to low access to modern energy, traditional biomass continues to play a dominant role in the energy mix of sub-Saharan Africa, thus affecting scores for countries across the environmental sustainability dimension. The best performing countries in environmental sustainability – Ethiopia, Mozambique and Zambia – receive over 90% of total primary energy supply from non-fossil fuels supplies, predominantly traditional biomass; 12 out of the 16 countries scored for the region rely on traditional biomass for over 50% of their primary energy demand.

The transition to higher electrification rates brings its own challenges. South Africa, which has the highest electrification rate in the region, also receives the lowest performance rating across environmental sustainability indicators. The country's TPES is dominated by 70% coal. Policies and investments to improve access to energy and to develop industry, combined with the country's large recoverable coal reserves, have forced a trade-off between environmental sustainability in favour of affordability of energy. However, the government has set out aggressive targets to expand its renewable capacity across multiple renewable technologies. Through the government-led Renewable Energy Independent Power Producer Procurement Programme (REIPPP), South Africa aims to stimulate independent power producers into the renewable energy market and work towards achieving the target of 3,725 MW of renewable capacity between 2010 and 2030.[121]

Although installed renewable capacity is insufficient to meet growing domestic demand, the efficiency of the power-generating sector in Mozambique, Zambia and Ethiopia reflects the dominance of hydro capacity in the existing power infrastructure – these three countries rank within the top 10 globally for the carbon efficiency of the power-generating sector. In Zambia, over 95% of installed capacity in 2013 came from hydro, although total installed capacity was just below 2,000 MW[122] against 26,000 MW in the Netherlands, a country with similar size population.[123]

The inability to split out tradition and modern biomass poses two challenges for countries in the region: first, it limits the ability to track progress on transitions from traditional to modern, more sustainable biomass in the future; and secondly, it fails to account for the environmental impact of deforestation and the health issues related with the use of solid cooking fuels.

Environmental sustainability of upstream oil and gas
Performance on the energy-related methane emissions indicator singles out fossil fuel-producing countries in the region such as the Republic of Congo, South Africa and Nigeria,[124] which score the lowest in the region. In 2011, Nigeria contributed to over 11% of global methane emissions from the energy sector.[125] Although the technology to reduce and capture fugitive emissions exists, lack of stringent regulation and incentives to industry has led to insufficient investment in their implementation. The World Bank Gas Global Reduction Partnership – a public-private partnership led by the World Bank – brings together governments of oil-producing countries and oil companies to extend the use of best practice and implement country-specific programmes. In Nigeria, Shell is rolling out associated gas gathering facilities to its flow stations, with the target of reducing methane emissions by 90%.[126]

Energy Security and Access

Sub-Saharan African countries are among the world's lowest performers in the energy security and access dimension of the triangle. Although resource-rich countries such as Nigeria and the Republic of Congo receive high scores for the net energy export indicator, energy access, poor quality of the electricity supply and the continued use of solid fuels for cooking negatively impact scores across this dimension.

Energy security
The energy security landscape varies greatly throughout sub-Saharan Africa. The Republic of Congo, Angola[127] and Nigeria export over 100% of domestic consumption. If and when they are commercially developed, the recent large gas discoveries in East Africa and the shale gas potential of South Africa are expected to further increase the region's production capacity. Conversely, countries like Botswana and Senegal imported over 50% of their energy needs in 2012. The diverse spread of resources affects the energy security landscape for these countries, as well as import/export balance-sheets for sub-Saharan Africa countries.

Energy access
Despite the large natural resource endowments of a number of countries in the region, energy poverty, an inadequate electricity supply network and the use of solid cooking fuels continue to be key challenges throughout sub-Saharan Africa. Mozambique and Tanzania have the lowest scores globally and within the region, with an average 15% electrification rate. Similarly, in Mozambique, over 90% of the population still relies on solid fuels for cooking.

The success story from the region is South Africa. Its aggressive government policies, private investment and the increasing economic development that has set GDP per capita in South Africa at over US$ 7,000 in 2012 – compared to the average US$ 1,800 of other sub-Saharan Africa countries[128] – have supported the steady increase from 66% access rates in 2000 to 83% in 2010. The improvement has been even more significant in rural areas, where rates almost doubled over the same period.[129] However, as electricity demand continues to increase, South Africa faces challenges in growing supply at the same rate. In 2010 the country suffered rolling blackouts as demand outstripped the available supply infrastructure. While the power sector in South Africa is dominated by centralized coal generation plants, the electricity strategy of 2010 has drawn greater focus on developing and diversifying the power infrastructure through renewable targets, incentives to fast-track electricity projects by independent power producers and investment into natural gas pipeline connections to Mozambique.

An insight piece and an industry perspective from Gib Bulloch, global lead for the Accenture Partnership Development Programme (ADP), concludes the section on sub-Saharan Africa by providing further insight on the current scale and state of the energy access challenge in the region, and the role of business in achieving energy access targets.

Sub-Saharan Africa: Meeting the Energy Access Challenge

Energy poverty is a key challenge for a significant number of countries across sub-Saharan Africa. The region achieves an average score of 0.28/1 for the indicator, against the global average of 0.84/1. Identifying opportunities to deliver on energy access is a key priority for the evolution of the energy system in sub-Saharan Africa.

Energy access continues to be the key energy system challenge facing sub-Saharan Africa. Globally, an estimated 1.3 billion people lack access to modern energy – 590 million of them are in sub-Saharan Africa.[130] Electrification rates across the region are among the lowest globally, with an average 15% in Tanzania and Mozambique; the figure for the latter dropping to 1.7% in rural areas.

Reducing energy poverty is a key development enabler but, overall, governments have been unsuccessful in securing investment for grid development. A number of local and international initiatives have dotted the region with off-grid projects involving renewables and diesel generators, with both government- and donor-led initiatives struggling to achieve economic sustainability and scale.

Diesel generators remain one of the region's key sources of electricity, especially so in resource-rich countries where fuel subsidies make fossil-fuel options more affordable and attractive than alternative grid development or renewable options. According to estimates from one African research and advocacy organization, Nigeria's installed power-generating capacity in 2010 was just over 6,000 MW, with estimates for power from distributed private diesel generators reaching 28,000 MW.[131] Aside from the inefficiency and environmental impact of directly burning liquid fuels, the stability of power supply from diesel generators in rural areas is entirely dependent on the consistency of fuel supplies. The lack of effective transport infrastructure and fuel theft are some of the larger issues affecting energy supply from distributed diesel generation.

A number of donor-led initiatives have focused on deploying small-scale renewable capacity to isolated communities, a less capital-intensive solution than main grid development. Most of these initiatives have struggled to achieve scale and become self-sustaining. In common, to an extent, with the global picture, there are significant barriers to investment in and deployment and uptake of renewable energy. Cost is particularly relevant, with poverty in the region combined with high fuel subsidization rates, posing a barrier to commercial investment in renewable capacity. Furthermore, to ensure the long-term sustainability of renewables, technology must be matched to local requirements and build local maintenance capacity. A number of business models are emerging which address some of the challenges, especially around affordability. An example is Simpa Networks in India. It sells distributed solar PV systems through "progressive purchase" contracts, through which customers make a small initial down payment for the product and top up their payments in small user-¬defined increments using a mobile phone. The payments add towards the final purchase price, which, once fully paid, unlocks the system permanently with no further costs.[132]

Institutional barriers also limit the success of energy access initiatives and the development of national power sectors. In resource-rich countries such as Nigeria and the Republic of Congo, policies and government strategy have focused on securing revenue from upstream oil and gas production and growth of associated industries while failing to redirect revenues, create the necessary investment frameworks or prioritize energy access targets. In Nigeria, the privatization of the power sector currently underway seeks to rectify this investment challenge. Moreover, several nations are tackling this challenge by setting up government bodies with the express mandate to focus on addressing rural electrification challenges. In Mozambique, the FUNEA (Fundo de Energia), brings together the ministry of energy with the ministries of finance, agriculture and industry and commerce to develop off-grid and mini-grid solutions that address the energy access issue but also draw economic development into the equation.

Within the region, South Africa has been most successful in improving access rates, increasing access in rural areas from 37% to 64% over the period 2000-2010. The country set ambitious targets and channelled significant investment into developing power-generating capacity and a distribution infrastructure. Although this did not keep pace with increased power consumption (leading to rolling blackouts in 2008), a number of electricity-specific investment frameworks and policies are addressing the challenge. The escalating costs for the electricity sector of infrastructure development are likely to impact further achievement of energy access targets. To finance its growth plans, Eskom – responsible for generating 95% of electricity in South Africa – has had to seek government approval to increase pricing by 20-25% over the 2010-2013 period.

Providing affordable and environmentally sustainable access to energy to 590 million people in sub-Saharan Africa represents a huge challenge. The World Bank estimates that since the mid-1990s, external finance to Africa's power sector has averaged around US$ 600 million per year of public assistance, plus a similar volume of private finance.[133] To achieve the goal of universal energy access, the IEA estimates that cumulative investments of US$ 1 trillion will be needed through to 2030.[134]

A number of initiatives have been borne from the urgent need to provide access to modern energy. The Sustainable Energy for All (SE4All) initiative, created in connection with the Rio+20 Human Development Goals, seeks to achieve universal access to energy by 2050. Additionally, Power Africa, a US-led initiative, has formed partnerships with several countries in the region to support investment in power infrastructure development and deployment of renewables.

SE4All has made an initial commitment of US$ 32 million in direct investment to support universal energy access. Power Africa has committed over US$ 7 billion over the next five years to add 10,000 megawatts of more efficient electricity generation capacity, as well as attracting private sector investment of US$ 9 billion to develop 8,000 MW of generating capacity – 5,000 MW of which will be added by GE in Tanzania and Ghana.

Given the scale of the challenge, current levels of donor and direct investment cannot achieve universal access to energy. Initiatives such as SE4All and Power Africa can be instrumental in attracting direct and foreign investment, but donor-led activities are unlikely to be sustainable if the implemented business models are not accompanied by the necessary investment frameworks and support structures.

The high investment requirements of infrastructure development, especially in rural areas – for both grid expansion and capacity increase – mean the energy access challenge will most likely be addressed through a combination of on-grid, off-grid and micro-grid solutions. Off-grid solutions include the provision of home plug-and-play solar kits including batteries and Pico (low consumption) LED lights. The Lighting Africa initiative has to date provided access to modern energy through off-grid solar solutions to 6.9 million people in Africa[135] by focusing on improved cross-stakeholder collaboration, standardization of technologies and products and information sharing, and in supporting the development of micro-finance funds. As part of Power Africa, the US African Development Foundation is launching a US$ 2 million "Off-Grid Energy Challenge" to provide grants of up to US$ 100,000 to African-owned and operated enterprises to develop or expand the use of proven technologies for off-grid electricity benefitting rural and marginal populations.[136] However, this level of investment is small compared to the scale of the challenge. Signs of progress in on-grid solutions are also emerging, with the first commercial wind farm in the region adding 52 MW[137] to capacity in Ethiopia in 2012.[138]

In face of the energy access challenge, a positive market indicator is that financing is shifting away from the traditional grant model and moving towards finding sustainable market solutions, providing implementation support and identifying best practice examples with scale potential. Donors and initiatives such as SE4All are starting to focus on "bridge financing" or catalyst funding to scale up existing, tested technologies and solutions.

External Perspective: The Role of the Private Sector in Providing Energy Access across Sub-Saharan Africa

Gib Bulloch, Global Managing Director, Accenture Development Partnerships

The UN's year of "Sustainable Energy for All" (SE4All) in 2012 has played a fundamental role in raising awareness of the 1.3 billion people without access to modern energy and the 2.6 billion people reliant on traditional sources of energy such as biomass.[139] A situation which is particularly severe in sub-Saharan Africa, where four out of five families lack access to electricity and nearly 70% of the population still relies on biomass for cooking,[140] the initiative has signed up 26 countries in the region. Many of these have made specific commitments towards universal access to energy, with some developing supporting action plans. Ghana, for example, has committed to universal access to electricity by 2020 and is implementing a National Electrification Scheme to achieve this.[141]

The real challenge, however, comes now. To maintain momentum, the UN declared 2014 to 2024 to be the decade for action. Indeed, despite a slew of funding commitments, pilots and entrepreneurial activity, efforts remain largely fragmented and opportunity capture at scale limited.

So, what can be done to achieve scale? An integral part of the solution lies in greater involvement of the private sector. Well placed to create sustainable and replicable business models, its access to capital outshines that of many governments in the region. With an estimated US$ 50 billion a year required to support universal access to energy from now until 2030,[142] its role should not be underplayed. This role entails making use of and channelling existing capabilities to solve this global crisis. Five key actions are recommended:

- Target efforts where there is likely to be greatest impact.
- Create demand-side driven offerings.
- Be innovative in developing sustainable business models.
- Embed solutions into local communities while retaining the ability to scale.
- Make use of existing technologies to increase efficiency, scalability and impact.

Firstly, the sector should target efforts where there is likely to be greatest impact – both where the need and the political support is greatest. While government support for energy access has been pledged, this in itself is insufficient, and needs to be underpinned by an enabling policy environment. The importance of this was highlighted in Vietnam, where strong political support in addition to policy incentives that maximized the country's natural resources helped achieve an electrification rate of 98% in 2010.[143] The private sector must work with governments across sub-Saharan Africa to define policy frameworks that most effectively create sustainable markets. President Obama's recent announcement of "Power Africa", aiming to establish a partnership between governments and the private sector, is a step in the right direction.

Secondly, the private sector should take a demand-driven approach and use its understanding of consumers to develop sustainable offerings. Too often, efforts aimed at increasing access to energy attempt to provide energy as an end in and of itself. However, energy is a commodity and thus to create demand it is important to consider the services that consumers want and are willing to pay for – and how these might differ by country and culture. For example, efforts made over the past decade to increase access to cleaner cooking facilities often paid too little attention to cultural traditions and instead focused on mass production of products which did not meet the requirements of local demand – resulting in a plethora of discarded cook stoves across the region. While initiatives such as the Global Alliance for Clean Cook Stoves are currently working to define more holistic and collaborative approaches, it is important to keep the early lessons learned in mind.

Furthermore, for these offerings to be sustainable, the private sector will need to use its capacity to innovate to develop viable business cases. Energy demand in rural parts of sub-Saharan Africa is currently low, often rendering the business case for many services challenging to establish. The private sector will therefore need to be creative in making the business case work. One solution being trialled by the Rockefeller Foundation's Smart Power for Environmentally-Sound Economic Development (SPEED) initiative is the concept of a micro-grid anchor tenant. SPEED aims to use the power needs of cellular towers as an anchor load to support the return on investment and overall project economics of a cleaner power infrastructure that would serve the larger needs of the local community. Still in the early stages, efforts such as these should be monitored and, if successful, mirrored.

These solutions further need to balance local community buy-in with the ability to scale. Although many entrepreneurs have experienced substantial success in expanding energy access across sub-Saharan Africa, these efforts have often relied on intangible factors such as community support or local personalities, making them challenging to scale or replicate. Thus, the private sector should use its understanding of how to scale a business to carefully balance these two factors.

Finally, the private sector should use existing technology at its disposal to help develop more efficient, sustainable and scalable solutions. As a starting point, the high penetration of mobile phones in sub-Saharan Africa provides companies with the opportunity to more quickly reach rural communities, to facilitate and simplify payment schemes and to maintain customer contact – helping to increase local buy-in. Mobisol, SharedSolar and M-KOPA are among those using mobile technology to improve their offerings.[144] Companies can also harness technology to increase efficiency and cut costs in supply chains – whether spare parts management or the provision of maintenance.

The private sector has many existing capabilities, and should begin channelling these to scale access to energy in sub-Saharan Africa. Through the Energy Access for Development Impact, Accenture is actively exploring ways in which it can use its wide breadth of capabilities, assets and networks to create greater and deeper impact. Indeed, while the social and economic development impacts of energy access are well understood, use of these capabilities will help to prove the business case for the private sector and, in turn, further accelerate progress. Paired with multistakeholder collaboration, we have the chance to make the UN's decade for action count and help to propel overall economic development and prosperity across the region.

Appendix

Definitions

Statistical

Spread charts
Spread charts show the distribution of a data set. The bar equals the spread of data from the minimum value through the median and to the maximum value of the data set. The quartiles are sets of values that divide the data set into four equal groups, each representing a quarter of the population being sampled. The upper quartile represents the split of the highest 25% of data or the top performers, whereas the lower quartile represents the split of the lowest 25% of data or the bottom performers.

Herfindahl index
A normalized Herfindahl index is used here as a measure of the size of fuel-type consumption in relation to a country's total energy industry. The score represents the sum of the squares of the total primary energy supply types of the different countries being analysed within the energy industry, where the energy shares are expressed as fractions. The result can range from 0 to 1.0; in this case, a low score indicates a large number of individual energy sources and greater diversity, and an increasing score reflects a decrease in diversity towards a single-sourced supply. The Herfindahl index is also used to measure the diversification of import trade partners in relation to the amount imported from individual partners.

The formula is as follows:

$$H = N \sum s_i^{\,2}$$

where si is the fuel-mix share of the fuel i in the overall mix, and N is the number of fuels. Then, to normalize:

$$H = (H-1/N) / (1-1/N)$$

The normalized result can range from 0 to 1.0.

Economic/Regional Clusters

In the context of this report, the below designations only cover the countries available within the EAPI 2014 sample.

ASEAN – The Association of Southeast Asian Nations was established on 8 August 1967 in Bangkok, Thailand and includes: Brunei Darussalam, Cambodia, Indonesia, Malaysia, Philippines, Thailand and Vietnam. Singapore is included in the High Income (non-OECD) grouping.

BRICS – This designation comprises five economies: Brazil, Russia, India, People's Republic of China, and South Africa.

CIS – The Commonwealth of Independent States includes Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyz Republic, Republic of Moldova, Russian Federation, Tajikistan, Turkmenistan, Ukraine and Uzbekistan.

Developing Asia – Defined by the IMF as less developed than their neighbouring counterparts, the countries in this group include Brunei Darussalam, Cambodia, People's Republic of China, India, Indonesia, Malaysia, Mongolia, Nepal, Philippines, Sri Lanka, Thailand and Vietnam.

EU28 – The designation for the European Union's (EU) 28 member countries as of September 2013, it comprises: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden and United Kingdom.

EU15 – The designation for the 15 EU member countries prior to the accession of 10 additional countries on 1 May 2004, it comprised: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom. This report excludes data for Luxembourg.

EU11 – This group of the EU's Central and Eastern European member countries includes: Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Republic and Slovenia.

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

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

Latin America and the Caribbean – This area includes: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Trinidad and Tobago, Uruguay and Venezuela.

MENA – The Middle East and North Africa is an economically diverse region including both the oil-rich economies of 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 2014 sample: Algeria, Bahrain, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia, United Arab Emirates and Yemen.

Sub-Saharan Africa – This region covers all of Africa except northern Africa, and includes: Benin, Botswana, Cameroon, Republic of the Congo, Côte d'Ivoire, Eritrea, Ethiopia, Ghana, Kenya, Mozambique, Namibia, Nigeria, Senegal, South Africa, Sudan, Tanzania, Togo and Zambia.

Weights, Measures and Abbreviations

BCF	billion cubic feet
BD	barrels per day
Bbd	billion barrels per day
BOE	barrel of oil equivalent
CO2	carbon dioxide
GW	gigawatt
GWh	gigawatt-hour
Ha	hectare
Hz	hertz
kgoe	kilogram of oil equivalent
km	kilometre
km2	square kilometre
KTOE	kilotonne of oil equivalent
kV	kilovolt
kVA	kilovolt ampere
kW	kilowatt
kWh	kilowatt-hour
MCF	thousand cubic feet
MMbbl	million barrels
MMCFD	million cubic feet per day
MTOE	million tonnes of oil equivalent
MW	megawatt
MWh	megawatt-hour
MVA	million volt-amperes
PM10	particulate matter (</= 10 mcg)
TCF	trillion cubic feet
TWh	terawatt-hour

Methodological Addendum

This section describes the methodology behind the Energy Architecture Performance Index (EAPI) 2014 (updated from the 2013 index). EAPI is a composite index that measures the performance of global energy systems across three areas: economic growth and development, environmental sustainability, and energy access and security.

Methodology

The EAPI focuses on tracking specific and output-oriented indicators to measure the energy system performance of different countries. In order to score and rank the performance of countries' energy architectures, 18 indicators are aggregated into three baskets related to the three imperatives of the energy triangle: economic growth and development; environmental sustainability; and energy access and security of supply.

Ultimately, the EAPI is split into three subindices:

1. *Economic growth and development:* measures the extent to which energy architecture supports, rather than detracts from, economic growth and development

2. *Environmental sustainability:* measures the extent to which energy architecture has been constructed to minimize the negative impact of external environmental factors

3. *Energy access and security:* measures the extent to which energy architecture is at risk of a security disruption, and whether adequate access to energy is provided to all parts of the population

The score attained on each subindex is averaged to generate an overall score.

How the EAPI Functions

An index is a statistical measure of the changes across a set of indicators reflective of an entity – in this case, energy systems. Indices reduce complexity by tracking specific indicators so that, ideally, a change in the index reflects a proportional change in the real world. In this context, the term "indicator" provides empirical evidence of whether a certain desired outcome has been achieved, and energy system decision-makers can use this evidence to assess progress towards their objectives. The distinction between "input" and "output" indicators is critical. Input indicators measure human or financial resources specifically deployed for a particular energy project or programme, whereas output indicators measure the quantity of energy-related goods or services produced and the efficiency of energy production.

Reality and the statistics that represent it cannot be assumed to converge in perfect harmony, and the statistical results of the analysis need to be set in context for understanding the real-world situation. Furthermore, as an initial effort, the set of indicators measured by the EAPI are by no means definitive. Some data, either originally intended for inclusion or not available in suitable quality or coverage, had to be excluded, and certain assumptions had to be made as to how indicators should be measured to reflect a high or low score within the EAPI.

To ensure the index produces policy-relevant insights and rankings, any targets used are derived from accepted policy documentation or expert judgements.

EAPI 2014 Indicators: Selection Criteria, Methodology Updates to 2013 and Profiles

Specific feedback and recommendations from the Expert Panel concerning data sourcing and the data selection criteria were very helpful. Where possible, the intent was to select indicators against the following criteria:

- *Use of only output data* – measuring either output-oriented observational data (with a specific, definable relationship to the subindex in question) or a best available proxy, rather than estimates

- *Reliability* – utilizing reliable source data from renowned institutions

- *Reuse of data* – sourcing data from the same suppliers on an annual basis, thus facilitating updates of the data

- *Quality* – selecting data that represent the best measure available, given constraints (all potential data sets were reviewed by the Expert Panel for quality and verifiability, and those data sets not meeting basic quality standards were discarded)

- *Completeness* – using data of adequate global and historical coverage; data has been consistently treated and checked for periodicity to ensure the EAPI's future sustainability

When an indicator was missing data for a particular year, the latest available data point was used to avoid extrapolation.

2013-2014 Methodology Review

Following the launch of the EAPI 2013, a review process was activated on how to further improve the index methodology and identify new, pertinent data sets. Interviews with members of the Expert Panel and other relevant stakeholders highlighted the following areas:

- *Adjustment to the indicator for monitoring CO_2 emissions:* In the first edition of the EAPI, the CO_2 emissions indicator used total CO_2 emissions from electricity and heat production to derive a per-capita measure. Using a per-capita denominator for emissions, however, could distort a country's emissions data by basing it on population size. The new indicator for CO_2 emissions calculates a score based on the total CO_2 emissions from electricity generated per kWh produced. This alternative indicator is reflective of a country's power-generation mix and contribution to GHG emissions, and supports the debate on the climatic implications of a transition to cleaner and more efficient power-generation sources.

- *Inclusion of a new indicator monitoring methane emissions:* According to the IEA analysis *Redrawing the Energy-Climate Map*, energy was responsible for 3.1 gigatons (Gt) of carbon-dioxide-equivalent methane emissions, making it the second-largest contributing sector. Energy-sector methane emissions are primarily due to inefficiencies in the upstream practices of flaring and venting. Industry regulation and policies to lower methane emissions could significantly contribute to reaching the climate goal of limiting global temperature increase to 2°C through 2020.

- *Inclusion of a new indicator to monitor diversity in trade counterparts:* A country's energy security can be defined by its supply of natural resources. However, some importing countries have been able to establish themselves to some degree within the global or regional energy trade market, affecting the security of their energy supply. Their security may be comparatively at risk depending on the number of trade partners they rely on and how their energy demands are spread among the partners. Using the Herfindahl index methodology, the model assigns a score based on the number of trade partners of each importing country, and the spread of import quantities across these partners.

No changes were made to the overall aggregation methodology for the index.

Indicator Profiles

Table 11 provides details for each of the selected indicators; the weight attributed to an indicator within its basket (or subindex); what it measures; and the energy system objective it contributes to, either positively or negatively.

Table 11: Indicator Profiles

Energy system objective	Measure (of)	Indicator name	Indicator weight
Economic growth and development	Efficiency	Energy intensity (GDP per unit of energy use (PPP US$ per kg of oil equivalent))	0.25
	Lack of distortion/affordability	Degree of artificial distortion to gasoline pricing (index)	0.125
		Degree of artificial distortion to diesel pricing (index)	0.125
		Electricity prices for industry (US$ per kilowatt-hour)	0.25
	Supportive/detracts from growth	Cost of energy imports (% GDP)	0.125
		Value of energy exports (% GDP)	0.125
Environmental sustainability	Share of low-carbon fuel sources in the energy mix	Alternative and nuclear energy (% of total energy use, incl. biomass)	0.2
	Emissions impact	CO2 emissions from electricity production, total/kWh	0.2
		Methane emissions in energy sector (thousand metric tonnes of CO_2 equivalent)/total population	0.125
		Nitrous oxide emissions in energy sector (thousand metric tonnes of CO_2 equivalent)/total population	0.125
		PM10, country level (micrograms per cubic metre)	0.2
		Average fuel economy for passenger cars (l/100 km)	0.2
Energy access and security	Level and quality of access	Electrification rate (% of population)	0.2
		Quality of electricity supply (1-7)	0.2
		Percentage of population using solid fuels for cooking (%)	0.2
	Self-sufficiency/ multi-lateral markets	Import dependence (energy imports, net % energy use)	0.2 / 0.125
		Diversification of import counterparts (Herfindahl index)	0 / 0.125
	Diversity of supply	Diversity of total primary energy supply (Herfindahl index)	0.2

Weighting: Approach and Rationale

Within the aggregate score, each of the three baskets receives equal priority and weighting. Fundamentally, the World Economic Forum believes that the imperatives of the energy triangle are of mutual importance and interlinked. To bring greater balance to the energy triangle and enable an effective transition to a new energy architecture, it is important that policy-makers look to the long term, providing a more stable policy environment based on an in-depth understanding of the trade-offs they make. Where possible, decision-makers should aim to take action resulting in positive net benefits for all three of the energy triangle's imperatives.

With a few exceptions in all three baskets, each indicator is equally weighted within them. Indicators that correlate closely, do not apply to certain countries or run orthogonally to each other, are diluted to prevent double-counting of scores.

Economic growth and development: The super gasoline and diesel indicators combine to form a mini-index within the economic growth and development basket; this mini-index is allocated equal weighting with the other indicators. Within the same basket, the indicators for fuel imports and exports as a share of GDP are combined to form a mini-index, which is also allocated equal weighting with the other indicators.

Environmental sustainability: The nitrous-oxide emissions and methane emissions indicators are combined to form a mini-index within the environmental sustainability basket; this mini-index is allocated equal weighting with the other indicators.

Energy security and access: The score for the energy imports indicator (for countries that are net importers) is combined with the score for the diversification of import counterparts indicator to form a mini-index, which is allocated equal weighting with the other indicators.

Indicator Metadata

Table 13 provides the metadata for each of the selected indicators, including: the title; the rationale for each indicator's inclusion in the EAPI; the year for which the latest data is available; the source of the data; the time series it covers; any technical notes related to the construction of the indicator including nominators, denominators and unit; and the URL for the source data (if available).

Table 12: Raw scores per indicator*

* "C" in this column designates confidential information sourced from the International Energy Agency (IEA) that cannot be distributed publically.

Country / Economy	GDP per unit of energy use (PPP $ per kg of oil equivalent)	Fuel Imports (% GDP)	Fuel Exports (% GDP)	Super Gasoline - Level of Price Distortion through subsidy or tax (Index 0 -1)	Diesel - Level of Price Distortion through subsidy or tax (Index 0 -1)	Electricity Prices for Industry (U.S. Dollars per Kilowatthour)	**Economic Growth and Development Basket**	Alternative and nuclear energy (% of total energy use, incl. Biomass)	Nitrous oxide emissions in energy sector (metric tons of CO_2 equivalent per capita)	CO_2 emissions from electricity production, per kWh	Methane Emissions in energy sector (metric tons of CO_2 equivalent)/ Total Population)	PM10, country level (micrograms per cubic meter)	Average Fuel Economy for passenger cars (l/100km)*	**Environmental Sustainability Basket**	Electrification rate (%)	Quality of Electricity Supply (1-7)	Percentage of population using solid fuels for cooking	Energy imports, net (% of energy use)	Diversity of TPES (Herfindahl index)	Diversification of Import Counterparts (Herfindahl Index)	**Energy Access and Security Basket**	**Energy Architecture Performance Index**
Albania	$ 13.12	7%	4%	0.89	0.90	n/a	0.52	31%	0.02	2	0.25	38	c	0.45	100%	4.5	39%	32%	0.40	0.29	0.63	**0.53**
Algeria	$ 7.46	1%	34%	0.17	0.10	n/a	0.34	0.1%	0.01	548	1.01	69	c	0.40	99%	4.2	5%	-248%	0.44	n/a	0.76	**0.50**
Argentina	$ 6.42	2%	1%	0.89	0.81	$ 0.05	0.64	9%	0.04	367	0.39	57	c	0.40	88%	3.1	5%	4%	0.32	0.12	0.68	**0.57**
Armenia	$ 6.62	9%	1%	0.76	0.70	n/a	0.33	31%	0.01	92	0.67	45	c	0.57	100%	5.2	19%	67%	0.30	0.29	0.69	**0.53**
Australia	$ 7.57	3%	5%	0.85	0.96	$ 0.06	0.67	5%	0.17	841	2.00	13	c	0.35	100%	6.2	5%	-135%	0.22	n/a	0.87	**0.63**
Austria	$ 11.37	6%	1%	0.89	0.89	$ 0.15	0.62	30%	0.09	188	0.26	27	c	0.55	100%	6.7	5%	62%	0.13	0.16	0.82	**0.66**
Azerbaijan	$ 7.35	0%	46%	0.46	0.34	n/a	0.44	3%	0.01	439	1.21	27	c	0.43	99%	4.8	7%	-377%	0.47	n/a	0.79	**0.55**
Bahrain	$ 3.27	20%	50%	0.15	0.10	n/a	0.18	0.0%	0.03	640	2.43	44	c	0.21	94%	6.3	5%	-90%	0.70	n/a	0.72	**0.37**
Bangladesh	$ 8.55	2%	0%	0.70	0.46	n/a	0.39	28%	0.01	593	0.08	115	c	0.39	55%	2.2	91%	17%	0.30	0.22	0.37	**0.38**
Belarus	$ 4.81	28%	26%	0.53	0.55	n/a	0.26	6%	0.08	449	0.11	6	c	0.48	100%	n/a	5%	85%	0.39	0.93	0.67	**0.47**
Belgium	$ 7.74	16%	11%	0.72	0.79	$ 0.14	0.47	31%	0.07	220	0.14	21	c	0.56	100%	6.4	5%	71%	0.17	0.35	0.79	**0.60**
Benin	$ 3.92	4%	0%	0.75	0.77	n/a	0.32	57%	0.01	720	0.11	48	c	0.49	28%	2.2	91%	44%	0.44	0.09	0.25	**0.35**
Bolivia	$ 6.68	5%	22%	0.42	0.33	n/a	0.33	27%	0.02	423	1.01	57	c	0.42	80%	3.8	29%	-134%	0.23	n/a	0.68	**0.48**
Bosnia and Herzegovina	$ 4.84	12%	3%	0.97	0.99	n/a	0.34	8%	0.03	723	0.38	21	c	0.24	100%	6.5	45%	35%	0.42	0.26	0.68	**0.42**

Energy Architecture Performance Index	**0.44**	**0.64**	**0.42**	**0.57**	**0.36**	**0.46**	**0.66**	**0.60**	**0.45**	**0.70**	**0.55**	**0.67**	**0.43**	**0.58**	**0.49**	**0.60**
Energy Access and Security Basket	0.46	0.79	0.70	0.73	0.28	0.40	0.88	0.74	0.65	0.84	0.55	0.77	0.41	0.75	0.54	0.84
Diversification of Import Counterparts (Herfindahl Index)	0.67	0.09	n/a	0.57	0.37	n/a	n/a	0.15	0.05	n/a	n/a	0.55	n/a	0.19	0.19	0.20
Diversity of TPES (Herfindahl index)	0.28	0.18	0.68	0.16	0.55	0.45	0.14	0.20	0.43	0.16	0.31	0.21	0.57	0.25	0.88	0.16
Energy imports, net (% of energy use)	56%	8%	-388%	36%	29%	-22%	-66%	70%	11%	-281%	-905%	48%	-6%	55%	96%	25%
Percentage of population using solid fuels for cooking	37%	6%	5%	14%	89%	75%	5%	6%	46%	14%	77%	6%	78%	8%	5%	5%
Quality of Electricity Supply (1-7)	3.1	4.8	5.2	4.0	3.2	2.6	6.5	5.2	5.1	5.2	n/a	5.6	3.6	5.6	5.2	6.4
Electrification rate (%)	43%	99%	73%	100%	31%	54%	100%	100%	100%	97%	37%	99%	59%	100%	100%	100%
Environmental Sustainability Basket	0.37	0.57	0.21	0.46	0.45	0.63	0.48	0.44	0.35	0.50	0.58	0.56	0.59	0.34	0.39	0.48
Average Fuel Economy for passenger cars (l/100km)*	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
PM10, country level (micrograms per cubic meter)	64	18	44	40	42	59	15	46	59	19	57	27	30	22	27	16
Methane Emissions in energy sector (metric tons of CO_2 equivalent)/ Total Population)	0.25	0.22	10.81	0.21	0.10	0.13	1.27	0.25	0.61	0.29	0.95	0.06	0.19	0.54	0.01	0.50
CO_2 emissions from electricity production, per kWh	2517	87	717	535	804	207	186	410	766	176	142	56	445	236	697	589
Nitrous oxide emissions in energy sector (metric tons of CO_2 equivalent per capita)	0.03	0.04	0.04	0.04	0.02	0.01	0.19	0.03	0.04	0.01	0.02	0.02	0.01	0.04	0.03	0.14
Alternative and nuclear energy (% of total energy use, incl. Biomass)	25%	45%	0.0%	28%	73%	73%	27%	23%	12%	25%	51%	52%	79%	11%	5%	24%
Economic Growth and Development Basket	0.48	0.54	0.36	0.53	0.36	0.35	0.60	0.61	0.35	0.74	0.53	0.68	0.29	0.63	0.55	0.50
Electricity Prices for Industry (U.S. Dollars per Kilowatthour)	n/a	$ 0.16	n/a	$ 0.08	n/a	n/a	$ 0.06	$ 0.15	n/a	$ 0.10	n/a	$ 0.11	n/a	$ 0.10	$ 0.19	$ 0.15
Diesel - Level of Price Distortion through subsidy or tax (Index 0 -1)	0.76	0.62	0.15	0.97	0.78	0.62	0.75	0.76	0.78	0.72	0.56	0.83	0.73	0.96	0.91	0.86
Super Gasoline - Level of Price Distortion through subsidy or tax (Index 0 -1)	0.75	0.85	0.25	0.97	0.82	0.67	0.80	0.95	0.84	0.78	0.70	0.96	0.92	0.92	0.92	0.82
Fuel Exports (% GDP)	0%	1%	73%	9%	0%	9%	6%	0%	0%	11%	39%	0%	13%	3%	1%	3%
Fuel Imports (% GDP)	9%	2%	2%	16%	7%	8%	3%	7%	4%	2%	2%	5%	12%	8%	10%	8%
GDP per unit of energy use (PPP $ per kg of oil equivalent)	$ 13.91	$ 8.48	$ 5.49	$ 5.77	$ 6.33	$ 7.06	$ 5.87	$ 11.93	$ 4.14	$ 15.01	$ 10.89	$ 12.42	$ 3.21	$ 10.05	$ 11.10	$ 6.53
Country / Economy	Botswana	Brazil	Brunei Darussalam	Bulgaria	Cambodia	Cameroon	Canada	Chile	China	Colombia	Congo, Rep.	Costa Rica	Cote d'Ivoire	Croatia	Cyprus	Czech Republic

Country / Economy	Denmark	Dominican Republic	Ecuador	Egypt, Arab Rep.	El Salvador	Eritrea	Estonia	Ethiopia	Finland	France	Georgia	Germany	Ghana	Greece	Guatemala	Haiti
Energy Architecture Performance Index	**0.71**	**0.53**	**0.56**	**0.46**	**0.57**	**0.41**	**0.59**	**0.39**	**0.65**	**0.72**	**0.53**	**0.65**	**0.45**	**0.58**	**0.49**	**0.38**
Energy Access and Security Basket	0.88	0.56	0.68	0.71	0.67	0.33	0.72	0.19	0.84	0.81	0.66	0.80	0.42	0.74	0.58	0.23
Diversification of Import Counterparts (Herfindahl Index)	n/a	0.18	n/a	n/a	0.22	0.83	0.29	0.61	0.48	0.08	0.22	0.13	0.58	0.16	0.43	0.64
Diversity of TPES (Herfindahl index)	0.14	0.40	0.68	0.38	0.26	0.61	0.44	0.85	0.09	0.21	0.20	0.12	0.34	0.24	0.41	0.60
Energy imports, net (% of energy use)	-17%	89%	-119%	-14%	48%	22%	12%	6%	49%	47%	68%	60%	4%	61%	28%	22%
Percentage of population using solid fuels for cooking	5%	7%	5%	5%	22%	60%	11%	95%	5%	5%	46%	5%	84%	5%	57%	91%
Quality of Electricity Supply (1-7)	6.7	2.1	4.5	3.4	4.7	n/a	5.1	3.1	6.7	6.6	5.3	6.1	2.7	5.3	5.3	2.0
Electrification rate (%)	100%	98%	97%	100%	92%	33%	100%	23%	100%	100%	100%	100%	61%	100%	82%	34%
Environmental Sustainability Basket	0.54	0.45	0.43	0.43	0.53	0.55	0.50	0.71	0.55	0.73	0.57	0.52	0.59	0.41	0.54	0.52
Average Fuel Economy for passenger cars (l/100km)*	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
PM10, country level (micrograms per cubic meter)	15	14	19	78	28	61	9	47	15	12	49	16	22	27	51	35
Methane Emissions in energy sector (metric tons of CO_2 equivalent)/ Total Population)	0.22	0.08	0.23	0.38	0.06	0.10	0.74	0.12	0.17	0.56	0.45	0.18	0.13	0.15	0.12	0.09
CO_2 emissions from electricity production, per kWh	360	589	389	450	223	646	1014	7	229	79	69	461	259	718	286	538
Nitrous oxide emissions in energy sector (metric tons of CO_2 equivalent per capita)	0.10	0.02	0.01	0.02	0.02	0.01	0.10	0.02	0.45	0.05	0.02	0.07	0.02	0.06	0.03	0.01
Alternative and nuclear energy (% of total energy use, incl. Biomass)	25%	10%	13%	4%	52%	78%	14%	94%	46%	52%	28%	20%	63%	8%	66%	78%
Economic Growth and Development Basket	0.71	0.58	0.56	0.24	0.52	0.35	0.54	0.26	0.54	0.63	0.37	0.64	0.34	0.59	0.35	0.37
Electricity Prices for Industry (U.S. Dollars per Kilowatthour)	$ 0.11	$ 0.21	$ 0.06	n/a	$ 0.16	n/a	$ 0.08	n/a	$ 0.10	$ 0.11	n/a	$ 0.11	n/a	$ 0.11	n/a	$ 0.17
Diesel - Level of Price Distortion through subsidy or tax (Index 0 -1)	0.84	0.82	0.17	0.10	0.71	0.95	0.92	0.57	0.81	0.91	0.84	0.85	0.58	0.73	0.63	0.63
Super Gasoline - Level of Price Distortion through subsidy or tax (Index 0 -1)	0.76	0.97	0.35	0.26	0.77	0.47	0.92	0.64	0.72	0.83	0.82	0.80	0.56	0.74	0.69	0.76
Fuel Exports (% GDP)	3%	1%	16%	3%	1%	0%	11%	0%	3%	1%	0%	1%	11%	5%	1%	n/a
Fuel Imports (% GDP)	3%	8%	7%	5%	8%	0%	12%	5%	6%	4%	8%	5%	1%	9%	7%	8%
GDP per unit of energy use (PPP $ per kg of oil equivalent)	$ 13.81	$ 13.36	$ 10.90	$ 6.68	$ 9.93	$ 4.14	$ 5.40	$ 2.76	$ 6.25	$ 9.42	$ 6.93	$ 10.90	$ 4.46	$ 10.99	$ 7.18	$ 3.70

Country / Economy	Honduras	Hungary	Iceland	India	Indonesia	Iran, Islamic Rep.	Iraq	Ireland	Israel	Italy	Jamaica	Japan	Jordan	Kazakhstan	Kenya	Korea, Rep.
Energy Architecture Performance Index	**0.44**	**0.64**	**0.60**	**0.48**	**0.52**	**0.42**	**0.42**	**0.65**	**0.58**	**0.56**	**0.39**	**0.58**	**0.38**	**0.58**	**0.41**	**0.55**
Energy Access and Security Basket	0.51	0.78	0.79	0.54	0.69	0.76	0.72	0.75	0.73	0.75	0.56	0.74	0.60	0.79	0.31	0.74
Diversification of Import Counterparts (Herfindahl Index)	0.42	0.39	0.51	0.07	n/a	n/a	n/a	0.40	0.17	0.07	0.33	0.09	0.42	n/a	0.17	0.09
Diversity of TPES (Herfindahl index)	0.34	0.15	0.41	0.20	0.13	0.44	0.73	0.25	0.25	0.22	0.64	0.21	0.71	0.28	0.50	0.17
Energy imports, net (% of energy use)	51%	55%	15%	28%	-89%	-67%	-253%	90%	86%	79%	82%	94%	96%	-105%	20%	82%
Percentage of population using solid fuels for cooking	51%	5%	5%	58%	55%	5%	5%	5%	5%	5%	11%	5%	5%	9%	80%	5%
Quality of Electricity Supply (1-7)	3.2	5.6	6.7	3.2	4.3	5.3	n/a	6.5	5.6	5.8	4.4	6.0	5.8	4.8	3.8	5.7
Electrification rate (%)	81%	100%	100%	75%	94%	98%	98%	100%	100%	100%	92%	100%	99%	100%	19%	93%
Environmental Sustainability Basket	0.50	0.61	0.72	0.41	0.41	0.25	0.19	0.56	0.40	0.48	0.36	0.43	0.28	0.40	0.63	0.38
Average Fuel Economy for passenger cars (l/100km)*	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
PM10, country level (micrograms per cubic meter)	34	15	18	52	60	56	88	13	21	21	27	24	30	18	30	30
Methane Emissions in energy sector (metric tons of CO_2 equivalent)/ Total Population)	0.06	0.22	0.01	0.10	0.28	1.07	0.54	0.46	0.14	0.11	0.05	0.03	0.13	2.80	0.20	0.15
CO_2 emissions from electricity production, per kWh	332	317	0	912	709	565	1003	458	689	406	711	416	566	403	274	533
Nitrous oxide emissions in energy sector (metric tons of CO_2 equivalent per capita)	0.02	0.03	0.04	0.02	0.02	0.03	0.02	0.06	0.04	0.05	0.03	0.06	0.01	0.08	0.02	0.08
Alternative and nuclear energy (% of total energy use, incl. Biomass)	49%	25%	84%	28%	34%	1%	1%	6%	5%	13%	18%	10%	2%	1%	80%	17%
Economic Growth and Development Basket	0.31	0.53	0.28	0.49	0.45	0.25	0.37	0.64	0.61	0.46	0.25	0.58	0.25	0.56	0.28	0.55
Electricity Prices for Industry (U.S. Dollars per Kilowatthour)	n/a	$ 0.16	n/a	$ 0.08	$ 0.06	n/a	n/a	$ 0.17	$ 0.10	$ 0.28	n/a	$ 0.16	n/a	$ 0.04	n/a	$ 0.06
Diesel - Level of Price Distortion through subsidy or tax (Index 0 -1)	0.70	0.83	0.74	0.52	0.28	0.07	0.41	0.79	0.70	0.66	0.73	0.98	0.59	0.41	0.77	1.00
Super Gasoline - Level of Price Distortion through subsidy or tax (Index 0 -1)	0.76	0.87	0.78	0.76	0.28	0.19	0.53	0.76	0.77	0.60	0.73	0.77	0.88	0.61	0.84	0.90
Fuel Exports (% GDP)	1%	3%	1%	3%	7%	21%	45%	1%	0%	1%	3%	0%	0%	32%	1%	5%
Fuel Imports (% GDP)	12%	10%	5%	10%	5%	0%	1%	4%	6%	5%	16%	5%	19%	2%	11%	16%
GDP per unit of energy use (PPP $ per kg of oil equivalent)	$ 6.68	$ 9.36	$ 2.01	$ 6.05	$ 5.38	$ 3.93	$ 3.10	$ 14.98	$ 10.47	$ 12.72	$ 5.05	$ 9.94	$ 5.22	$ 2.78	$ 3.53	$ 5.86

Country / Economy	Kuwait	Kyrgyz Republic	Latvia	Lebanon	Libya	Lithuania	Luxembourg	Macedonia, FYR	Malaysia	Malta	Mexico	Mongolia	Morocco	Mozambique	Namibia	Nepal
Energy Architecture Performance Index	**0.42**	**0.47**	**0.66**	**0.33**	**0.45**	**0.60**	**0.63**	**0.45**	**0.48**	**0.46**	**0.59**	**0.37**	**0.46**	**0.42**	**0.46**	**0.42**
Energy Access and Security Basket	0.80	0.62	0.77	0.41	0.72	0.69	0.69	0.66	0.83	0.54	0.75	0.58	0.64	0.26	0.41	0.33
Diversification of Import Counterparts (Herfindahl Index)	n/a	0.67	0.26	0.12	n/a	0.75	0.53	0.23	n/a	0.19	n/a	n/a	0.10	n/a	0.29	0.93
Diversity of TPES (Herfindahl index)	0.44	0.20	0.18	0.87	0.47	0.25	0.46	0.30	0.22	0.88	0.30	0.47	0.52	0.56	0.54	0.69
Energy imports, net (% of energy use)	-375%	48%	53%	97%	-132%	79%	97%	43%	-11%	94%	-17%	-435%	96%	-25%	79%	13%
Percentage of population using solid fuels for cooking	5%	34%	5%	5%	5%	21%	5%	n/a	5%	5%	14%	72%	5%	95%	55%	82%
Quality of Electricity Supply (1-7)	5.2	2.7	5.3	1.3	3.9	5.5	6.6	4.9	5.8	5.1	4.7	3.6	5.5	3.2	5.5	1.6
Electrification rate (%)	94%	100%	100%	100%	100%	100%	100%	99%	99%	100%	99%	86%	99%	15%	44%	76%
Environmental Sustainability Basket	0.12	0.60	0.65	0.25	0.29	0.53	0.52	0.31	0.34	0.36	0.41	0.24	0.38	0.71	0.51	0.63
Average Fuel Economy for passenger cars (l/100km)*	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
PM10, country level (micrograms per cubic meter)	91	35	12	25	65	16	12	17	18	n/a	30	96	23	22	42	27
Methane Emissions in energy sector (metric tons of CO_2 equivalent)/ Total Population)	3.81	0.05	0.83	0.03	2.66	0.54	0.28	0.22	0.77	0.00	0.34	0.37	0.05	0.21	0.06	0.06
CO_2 emissions from electricity production, per kWh	842	59	120	709	885	337	410	685	727	872	455	949	718	1	197	1
Nitrous oxide emissions in energy sector (metric tons of CO_2 equivalent per capita)	0.07	0.00	0.07	0.02	0.03	0.03	0.16	0.02	0.03	0.01	0.03	0.04	0.02	0.01	0.06	0.02
Alternative and nuclear energy (% of total energy use, incl. Biomass)	0.0%	37%	35%	3%	1%	16%	4%	11%	5%	5%	11%	4%	4%	91%	24%	87%
Economic Growth and Development Basket	0.33	0.20	0.58	0.33	0.33	0.56	0.66	0.37	0.26	0.48	0.60	0.29	0.36	0.29	0.45	0.31
Electricity Prices for Industry (U.S. Dollars per Kilowatthour)	n/a	n/a	$ 0.12	n/a	n/a	$ 0.12	$ 0.14	n/a	n/a	n/a	$ 0.09	n/a	n/a	n/a	n/a	n/a
Diesel - Level of Price Distortion through subsidy or tax (Index 0 -1)	0.12	0.58	0.92	0.57	0.05	0.96	1.00	0.95	0.36	0.93	0.52	0.74	0.58	0.75	0.80	0.66
Super Gasoline - Level of Price Distortion through subsidy or tax (Index 0 -1)	0.13	0.54	0.90	0.67	0.06	0.88	1.00	0.93	0.37	0.82	0.52	0.79	0.87	0.97	0.75	0.88
Fuel Exports (% GDP)	55%	3%	4%	0%	56%	17%	0%	3%	15%	14%	4%	21%	1%	7%	1%	0%
Fuel Imports (% GDP)	0%	18%	10%	14%	0%	26%	6%	14%	9%	27%	3%	14%	13%	10%	5%	6%
GDP per unit of energy use (PPP $ per kg of oil equivalent)	$ 4.37	$ 4.28	$ 8.98	$ 9.81	$ 5.19	$ 8.97	$ 11.90	$ 7.61	$ 6.11	$ 13.73	$ 10.53	$ 3.68	$ 9.45	$ 2.30	$ 10.01	$ 3.66

Country / Economy	Netherlands	New Zealand	Nicaragua	Nigeria	Norway	Oman	Pakistan	Panama	Paraguay	Peru	Philippines	Poland	Portugal	Qatar	Republic of Moldova	Romania
Energy Architecture Performance Index	**0.60**	**0.73**	**0.46**	**0.44**	**0.75**	**0.39**	**0.43**	**0.56**	**0.63**	**0.65**	**0.51**	**0.58**	**0.65**	**0.44**	**0.40**	**0.66**
Energy Access and Security Basket	0.83	0.85	0.51	0.33	0.96	0.79	0.54	0.60	0.61	0.70	0.62	0.77	0.77	0.80	0.60	0.75
Diversification of Import Counterparts (Herfindahl Index)	0.09	0.10	0.61	n/a	n/a	n/a	0.26	0.25	n/a	n/a	0.12	0.62	0.08	n/a	0.24	0.22
Diversity of TPES (Herfindahl index)	0.27	0.10	0.34	0.65	0.20	0.53	0.18	0.52	0.33	0.20	0.11	0.28	0.20	0.74	0.47	0.11
Energy imports, net (% of energy use)	17%	14%	50%	-117%	-577%	-191%	23%	80%	-51%	-14%	41%	26%	78%	-535%	96%	23%
Percentage of population using solid fuels for cooking	5%	5%	54%	74%	5%	5%	64%	18%	49%	36%	50%	5%	5%	5%	11%	17%
Quality of Electricity Supply (1-7)	6.7	6.1	3.9	1.8	6.6	6.4	2.0	5.4	3.0	4.9	4.0	5.5	6.4	6.6	4.3	4.3
Electrification rate (%)	100%	100%	74%	48%	100%	94%	91%	88%	97%	85%	83%	100%	100%	94%	99%	100%
Environmental Sustainability Basket	0.47	0.70	0.48	0.61	0.60	0.12	0.44	0.45	0.62	0.46	0.51	0.36	0.57	0.17	0.28	0.60
Average Fuel Economy for passenger cars (l/100km)*	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
PM10, country level (micrograms per cubic meter)	30	11	21	38	16	95	91	45	64	42	17	33	18	20	36	11
Methane Emissions in energy sector (metric tons of CO_2 equivalent)/ Total Population)	0.34	0.34	0.07	0.23	2.68	5.48	0.23	0.03	0.21	0.13	0.07	1.09	0.14	22.63	0.52	0.57
CO_2 emissions from electricity production, per kWh	415	150	460	405	17	794	425	298	0	289	481	781	255	494	517	413
Nitrous oxide emissions in energy sector (metric tons of CO_2 equivalent per capita)	0.05	0.07	0.02	0.01	0.07	0.04	0.02	0.02	0.03	0.01	0.01	0.10	0.05	0.05	0.02	0.02
Alternative and nuclear energy (% of total energy use, incl. Biomass)	7%	40%	50%	83%	43%	0%	39%	20%	81%	24%	40%	9%	23%	0%	3%	23%
Economic Growth and Development Basket	0.49	0.63	0.40	0.38	0.69	0.28	0.33	0.64	0.66	0.78	0.41	0.61	0.62	0.35	0.31	0.63
Electricity Prices for Industry (U.S. Dollars per Kilowatthour)	$ 0.14	$ 0.07	$ 0.19	n/a	$ 0.06	n/a	n/a	$ 0.14	$ 0.05	$ 0.08	n/a	$ 0.12	$ 0.13	n/a	n/a	$ 0.12
Diesel - Level of Price Distortion through subsidy or tax (Index 0 -1)	0.81	0.76	0.73	0.66	0.56	0.23	0.73	0.62	0.80	0.86	0.62	0.94	0.84	0.16	0.86	0.94
Super Gasoline - Level of Price Distortion through subsidy or tax (Index 0 -1)	0.57	0.92	0.75	0.37	0.44	0.18	0.69	0.64	0.93	1.00	0.76	0.93	0.68	0.15	0.87	0.96
Fuel Exports (% GDP)	17%	1%	0%	39%	22%	45%	0%	0%	9%	3%	1%	2%	2%	57%	0%	2%
Fuel Imports (% GDP)	20%	3%	13%	0%	1%	4%	7%	1%	7%	3%	6%	5%	7%	0%	10%	5%
GDP per unit of energy use (PPP $ per kg of oil equivalent)	$ 9.26	$ 7.69	$ 7.46	$ 3.48	$ 11.05	$ 3.12	$ 5.72	$ 13.73	$ 8.36	$ 14.64	$ 9.64	$ 8.85	$ 12.19	$ 4.73	$ 4.10	$ 9.18

Country / Economy	Russian Federation	Saudi Arabia	Senegal	Singapore	Slovak Republic	Slovenia	South Africa	Spain	Sri Lanka	Sweden	Switzerland	Syrian Arab Republic	Tajikistan	Tanzania	Thailand	Togo
Energy Architecture Performance Index	**0.62**	**0.44**	**0.42**	**0.52**	**0.64**	**0.63**	**0.54**	**0.67**	**0.48**	**0.72**	**0.72**	**0.41**	**0.52**	**0.36**	**0.53**	**0.37**
Energy Access and Security Basket	0.79	0.81	0.42	0.61	0.81	0.82	0.64	0.78	0.53	0.85	0.82	0.69	0.60	0.17	0.73	0.20
Diversification of Import Counterparts (Herfindahl Index)	n/a	n/a	0.22	0.06	0.52	0.16	n/a	0.06	0.15	0.17	0.27	n/a	0.18	0.25	0.14	0.24
Diversity of TPES (Herfindahl index)	0.27	0.46	0.37	0.54	0.11	0.12	0.45	0.17	0.35	0.13	0.16	0.47	0.32	0.75	0.18	0.69
Energy imports, net (% of energy use)	-80%	-222%	53%	97%	61%	50%	-15%	74%	49%	29%	50%	-18%	36%	7%	42%	18%
Percentage of population using solid fuels for cooking	5%	5%	51%	5%	5%	5%	15%	5%	75%	5%	5%	5%	34%	94%	26%	94%
Quality of Electricity Supply (1-7)	4.5	6.4	2.3	6.7	6.2	6.4	3.8	6.4	5.0	6.5	6.8	3.9	2.7	2.3	5.2	n/a
Electrification rate (%)	100%	94%	57%	73%	100%	100%	83%	100%	85%	100%	100%	93%	100%	15%	100%	28%
Environmental Sustainability Basket	0.49	0.19	0.49	0.37	0.66	0.53	0.38	0.55	0.48	0.73	0.59	0.27	0.65	0.65	0.39	0.65
Average Fuel Economy for passenger cars (l/100km)*	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
PM10, country level (micrograms per cubic meter)	15	96	77	23	13	26	18	24	65	10	20	54	29	19	53	27
Methane Emissions in energy sector (metric tons of CO_2 equivalent)/ Total Population)	2.99	1.90	0.14	0.26	0.17	0.60	0.60	0.07	0.03	0.14	0.15	0.29	0.07	0.16	0.35	0.27
CO_2 emissions from electricity production, per kWh	384	737	637	499	197	325	927	238	379	30	27	594	14	329	513	195
Nitrous oxide emissions in energy sector (metric tons of CO_2 equivalent per capita)	0.05	0.04	0.01	0.02	0.08	0.07	0.04	0.05	0.01	0.13	0.05	0.01	0.00	0.02	0.05	0.02
Alternative and nuclear energy (% of total energy use, incl. Biomass)	9%	0%	47%	3%	31%	35%	13%	24%	51%	65%	49%	1%	57%	89%	19%	84%
Economic Growth and Development Basket	0.59	0.32	0.37	0.58	0.46	0.53	0.59	0.69	0.43	0.59	0.73	0.27	0.32	0.26	0.49	0.25
Electricity Prices for Industry (U.S. Dollars per Kilowatthour)	$ 0.05	n/a	n/a	$ 0.12	$ 0.20	$ 0.13	$ 0.02	$ 0.10	n/a	$ 0.08	$ 0.09	n/a	n/a	n/a	$ 0.08	n/a
Diesel - Level of Price Distortion through subsidy or tax (Index 0 -1)	0.61	0.03	0.94	0.77	0.87	0.92	0.87	0.93	0.57	0.68	0.74	0.21	0.67	0.78	0.59	0.74
Super Gasoline - Level of Price Distortion through subsidy or tax (Index 0 -1)	0.60	0.08	0.95	0.97	0.79	0.86	0.84	0.93	0.79	0.71	0.85	0.48	0.89	0.80	0.95	0.71
Fuel Exports (% GDP)	18%	55%	3%	28%	5%	4%	3%	2%	0%	3%	1%	3%	11%	0%	4%	2%
Fuel Imports (% GDP)	0%	0%	13%	45%	11%	11%	6%	6%	6%	5%	3%	2%	28%	12%	13%	10%
GDP per unit of energy use (PPP $ per kg of oil equivalent)	$ 4.38	$ 4.46	$ 7.15	$ 9.46	$ 8.21	$ 7.92	$ 3.95	$ 12.11	$ 11.19	$ 8.41	$ 16.74	$ 4.97	$ 6.80	$ 3.27	$ 5.05	$ 2.34

Country / Economy	Trinidad and Tobago	Tunisia	Turkey	Turkmenistan	Ukraine	United Arab Emirates	United Kingdom	United States	Uruguay	Uzbekistan	Venezuela	Vietnam	Yemen, Rep.	Zambia
Energy Architecture Performance Index	**0.44**	**0.53**	**0.57**	**0.42**	**0.46**	**0.44**	**0.66**	**0.59**	**0.64**	**0.45**	**0.51**	**0.47**	**0.32**	**0.44**
Energy Access and Security Basket	0.68	0.77	0.73	0.75	0.77	0.77	0.83	0.84	0.73	0.66	0.70	0.66	0.38	0.27
Diversification of Import Counterparts (Herfindahl Index)	n/a	0.15	0.10	n/a	0.49	n/a	0.13	0.10	0.23	n/a	n/a	n/a	n/a	0.45
Diversity of TPES (Herfindahl index)	0.83	0.30	0.17	0.59	0.19	0.60	0.18	0.15	0.33	0.74	0.33	0.15	0.75	0.61
Energy imports, net (% of energy use)	-102%	21%	73%	-164%	32%	-188%	39%	15%	58%	-20%	-186%	-9%	-161%	8%
Percentage of population using solid fuels for cooking	5%	5%	5%	5%	5%	5%	5%	5%	5%	11%	5%	56%	33%	83%
Quality of Electricity Supply (1-7)	5.4	5.3	4.8	n/a	4.7	6.5	6.7	6.2	5.6	n/a	1.8	4.0	1.5	3.1
Electrification rate (%)	99%	100%	100%	100%	100%	94%	100%	100%	99%	100%	100%	96%	45%	19%
Environmental Sustainability Basket	0.22	0.45	0.45	0.27	0.39	0.21	0.56	0.34	0.53	0.41	0.57	0.43	0.26	0.71
Average Fuel Economy for passenger cars (l/100km)*	c	c	c	c	c	c	c	c	c	c	c	c	c	c
PM10, country level (micrograms per cubic meter)	97	23	35	36	15	89	13	18	112	31	10	54	34	27
Methane Emissions in energy sector (metric tons of CO_2 equivalent)/ Total Population)	9.46	0.43	0.21	3.86	1.05	2.81	0.21	0.68	0.20	0.90	0.82	0.47	0.10	0.19
CO_2 emissions from electricity production, per kWh	700	463	460	954	392	598	457	522	81	550	264	432	655	3
Nitrous oxide emissions in energy sector (metric tons of CO_2 equivalent per capita)	0.03	0.02	0.04	0.02	0.03	0.02	0.04	0.20	0.04	0.01	0.03	0.02	0.02	0.02
Alternative and nuclear energy (% of total energy use, incl. Biomass)	0%	15%	10%	0%	21%	0%	14%	16%	42%	2%	11%	28%	1%	91%
Economic Growth and Development Basket	0.42	0.36	0.53	0.25	0.23	0.35	0.60	0.57	0.65	0.28	0.25	0.30	0.33	0.35
Electricity Prices for Industry (U.S. Dollars per Kilowatthour)	$ 0.02	n/a	$ 0.14	n/a	n/a	n/a	$ 0.14	$ 0.07	$ 0.10	n/a	n/a	n/a	n/a	n/a
Diesel - Level of Price Distortion through subsidy or tax (Index 0 -1)	0.20	0.42	0.57	0.12	0.76	0.39	0.61	0.64	0.85	0.53	0.00	0.65	0.28	0.90
Super Gasoline - Level of Price Distortion through subsidy or tax (Index 0 -1)	0.34	0.56	0.44	0.12	0.82	0.28	0.67	0.59	0.79	0.62	0.00	0.70	0.35	0.90
Fuel Exports (% GDP)	33%	5%	1%	43%	2%	32%	3%	1%	0%	10%	24%	8%	17%	0%
Fuel Imports (% GDP)	13%	8%	6%	1%	15%	1%	4%	3%	6%	2%	0%	9%	4%	3%
GDP per unit of energy use (PPP $ per kg of oil equivalent)	$ 1.64	$ 10.47	$ 11.73	$ 1.95	$ 2.61	$ 5.48	$ 12.13	$ 7.36	$ 11.55	$ 2.02	$ 5.32	$ 4.90	$ 7.98	$ 2.59

Table 13: Indicator Metadata

Title	Rationale	Latest data	Sources	Time Series	Full description	URL	Tech Notes
GDP per unit of energy use (PPP $ per kg of oil equivalent)	Provides an indication of the efficiency of energy use, and whether there is an opportunity to improve energy availability by reducing energy intensity.	2011/ 2012	World Bank and International Energy Agency	1980 - 2011/2012	Energy use per PPP GDP is the kilogram of oil equivalent of energy use per constant PPP GDP. Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport. PPP GDP is gross domestic product converted to 2005 constant international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as a US dollar has in the United States	http://data.worldbank.org/indicator/EG.GDP.PUSE.KO.PP.KD	No specific target for energy intensity. The Kyoto Protocol sets targets for total greenhouse gas emissions for annex I (developed) countries. European Council for an Energy Efficient Economy recommends 20% reductions by 2020 in energy intensity across many different Eurozone countries, but not universally. Low threshold - lowest performance HIgh threshold - excludes 2.5 percentile
Fuel Imports (% GDP, adjusted for LCU)	Provides an indication of the extent to which the energy sector has a negative impact on growth. Import bill is calculated based on the import of fuels (mineral fuels, lubricants and related materials) as classified under the Standard International Trade Classification, Revision 3, Eurostat.	2012	World Trade Organisation and World Bank	1980 - 2012	Fuel Imports, US$ at current prices. Fuel imports include mineral fuels, lubricants and related materials as classified under the Standard International Trade Classification, Revision 3, Eurostat. GDP is the total market value of all final goods and services produced in a country in a given year, equal to total consumer, investment and government spending, plus the value of exports, minus the value of imports, calculated using today's dollar value.	http://data.orldbank.org/indicator/NY.GDP.MKTP.CD http://stat.wto.org/StatisticalProgram/WSDBStatProgramTechNotes.aspx?Language=E#Def_Meth_Com	No data available for target setting. The low performance distribution threshold is based on the lowest performance value for 2012. The target value excludes 2.5% percentile.
Super Gasoline - Level of Price Distortion through subsidy or tax (Index 0 -1)	Fuel subsidies are a burden on country economies and encourage wasteful fuel use. Aligning fossil fuel pricing with world market price would clearly foster greater economic and energy efficiency, reducing the burden on country finances. Fossil fuel taxation is powerful a revenue tool for, most notably, the transport sector. But too high taxation burdens the consumer and drives inflation as costs rise for transporting goods around a country, and revenue generated from taxation may be elastic over the long-term as consumers adjust their consumption in light of higher prices. We therefore propose that a high tax rate (within the 4th quartile) is the optimal pricing mechanism for driving economic growth, on a global basis and excluding consideration of other externalities associated to fossil fuel consumption.	2012	GIZ (Gesellschaft für Internationale Zusammenarbeit), the German development agency	2004 - 2012	Price per litre of super gasoline in US cents. All prices relate to November 2012 data. Prices reflect Brent crude price of US$ 110 per barrel (reference day 16 to 18 November 2012). All pricing data related to GIZ database. Score derived from the level of a country's deviation from a threshold price, set as the threshold point between high taxation and very high taxation per fossil fuel, per year. These boundaries are defined by GIZ in their International Fuel Prices report. A very high subsidy equates with a retail price of gasoline and diesel below price of crude oil on world market. A subsidy is indicated by a price of gasoline and diesel above the price of crude oil on the world market and below the price level of the United States. Cost-covering retail prices incl. industry margin, VAT and incl. approx. US$ 0.10. This fuel price without other specific fuel taxes may be considered as the international minimum benchmark for a non-subsidized fuel. Taxation is indicated by a price of gasoline and diesel above price level of the United States and below price level of Spain/Luxembourg (in November 2012fuel prices were the lowest in EU15). Prices in EU countries are subject to VAT, specific fuel taxes as well as other country-specific duties and taxes. Very high taxation is indicated by a retail price of gasoline and diesel above the price level of Spain/Luxembourg. At these levels, countries are effectively using taxes to generate revenues and to encourage energy efficiency in the transport sector.	http://www.giz.de/Themen/en/dokumente/giz-en-IFP2010.pdf	The low performance distribution threshold is based on the lowest performance value for 2012: 0. The target value is 1.
Diesel - Level of Price Distortion through subsidy or tax (Index 0 -1)	As above	2012	GIZ (Gesellschaft für Internationale Zusammenarbeit), the German development agency	2004 - 2012	Price per litre of diesel in US cents. All prices relate to Nov. 2012 data. Prices reflect Brent crude price of US$ 110 per barrel. All pricing data related to GIZ database. Score derived from level of a country's deviation from a threshold price, set as the median point in the very high taxation boundary per fossil fuel, per year. For more information regarding thresholds and median point calculations, see above.	http://www.giz.de/Themen/en/dokumente/giz-en-IFP2010.pdf	The low performance distribution threshold is based on the lowest performance value for 2012: 0. The target value is 1.

Title	Rationale	Latest data	Sources	Time Series	Full description	URL	Tech Notes
Electricity Prices for Industry (U.S. Dollars per Kilowatthour)	Energy consumption is strongly correlated to GDP, and lower energy prices are key drivers of economic growth, with electrical generation and other energy efficiencies good proxies for the Solow residual, describing technological progress. We therefore utilise this data as an indicator of low energy prices having a positive impact on growth. Subsidy data is unavailable across this data point, meaning that electricity prices must be assumed to be the product of a liberal energy market pricing mechanism at an aggregate level though, in reality, a larger portion of some countries' bills may be determined by political or regulatory decisions warranting subsidy, and a smaller share depending on the actual supply and demand conditions	2009	Energy Information Administration, Monthly Energy Review, May 2010, Table 9.9. Other Countries -- International Energy Agency, Energy Prices & Taxes - Quarterly Statistics, Fourth Quarter 2009, Part II, Section D, Table 22, and Part III, Section B, Table 19, 2008.	2001 - 2009	Energy end-use prices including taxes, converted using exchange rates. Price includes State and local taxes, energy or demand charges, customer service charges, environmental surcharges, franchise fees, fuel adjustments, and other miscellaneous charges applied to end-use customers during normal billing operations. Prices do not include deferred charges, credits, or other adjustments, such as fuel or revenue from purchased power, from previous reporting periods. NA = Not available Nota: The Paris-based International Energy Agency (IEA) maintains annual and quarterly time series of this price data that begin with the year 1978 and that also include the most recent quarterly prices. Information on purchasing this data online from the IEA is available at: http://data.iea.org/ieastore/default.asp.	http://www.eia.gov/countries/prices/electricity_industry.cfm	No specific targets available. The low performance distribution threshold is based on the lowest performance value for 2010. The target value is based on the highest performance value for 2010, with the spread adjusted for Italy's high and outlying result.
Fuel Exports (% GDP)	Provides an indication of the extent to which the energy sector has a positive impact on growth. Export bill is calculated based on the export of fuels (mineral fuels, lubricants and related materials) as classified under the Standard International Trade Classification, Revision 3, Eurostat.	2012	World Trade Organisation and World Bank	1980 - 2012	Fuel exports, US$ at current prices. Fuel exports include (mineral fuels, lubricants and related materials) as classified under the Standard International Trade Classification, Revision 3, Eurostat. GDP is the total market value of all final goods and services produced in a country in a given year, equal to total consumer, investment and government spending, plus the value of exports, minus the value of imports, calculated using today's dollar value.	http://data.worldbank.org/indicator/NY.GDP.MKTP.CD http://stat.wto.org/StatisticalProgram/WSDBStatProgramTechNotes.aspx?Language=E#Def_Meth_Com	No data available for target setting. The low performance distribution threshold is based on the lowest performance value for 2012. The target value is fixed at the highest value for the 2012 dataset,, excluding a 2.5 percentile to remove outliers. The inclusion of this indicator was frequently debated by the team, given the well understood effects of indirect-deindustrialization, the symptoms of which include the decline in productivity of national manufacturing sectors due to the currency strengthening effect of natural resource endowment and exploitation, and the following shift of labour resources away from the non-tradable goods sectors. However, given the EAPI's strict focus on country energy architecture and, within this basket, the contribution of energy to GDP, it was felt that on an overall global basis, revenues from fossil fuel endowments contributed to country GDP, especially when successful boom minimization structures (e.g. investment into sovereign wealth funds, stabilizing the powerful revenue stream) were used to reduce the risk of Dutch disease and drive competitiveness through investment in education and infrastructure programmes.

Title	Rationale	Latest data	Sources	Time Series	Full description	URL	Tech Notes
Alternative and nuclear energy (% of total energy use, incl. Biomass)	Alternative and nuclear energy production reduces reliance on fossil fuels, which produce greenhouse gases and pollute the atmosphere. Inclusion of this indicator supposes that nuclear energy is also environmentally preferable to fossil fuel usage given the higher volume of negative environmental externalities associated with fossil fuel mining, power production and emissions.	2010/11	International Energy Agency	1980 - 2012	Alternative energy includes hydropower and nuclear, geothermal, biomass and solar power, among others.	www.worldenergyoutlook.org/	The low performance distribution threshold is based on the lowest performance value for 2010. The target value is based on expert opinion, stipulating that an energy system 100% reliant on alternative and nuclear energy represents the ideal.
Nitrous oxide emissions in energy sector (thousand metric tons of CO2 equivalent) / Total Population	Nitrous oxide is both an ozone-depleting compound and greenhouse gas, and is now the largest ozone-depleting substance emitted through human activities. It is one of a group of highly reactive nitrogen oxides (NOx). NO2 forms quickly from emissions from cars, trucks and buses, power plants, and off-road equipment. In addition to contributing to the formation of ground-level ozone, and fine particle pollution, NO2 is linked with a number of adverse effects on the respiratory system.	2010	International Energy Agency, World Bank	1990 - 2010	Energy processes produce nitrous oxide emissions through the combustion of fossil fuels and biofuels.	http://data.worldbank.org/indicator/EN.ATM.NOXE.EI.ZS	No universal targets applicable. The low performance distribution threshold is based on the lowest performance value for 2010. The target value is 0% of total emissions.
CO2 emissions from electricity production, total / kWh	Carbon dioxide emissions from electricity and energy production contribute to climate change and ensuing environmental degradation.	2010	International Energy Agency	2000 - 2010	CO2 emissions from electricity and heat production is the sum of three IEA categories of CO2 emissions: (1) Main Activity Producer Electricity and Heat which contains the sum of emissions from main activity producer electricity generation, combined heat and power generation and heat plants. Main activity producers (formerly known as public utilities) are defined as those undertakings whose primary activity is to supply the public. They may be publicly or privately owned. This corresponds to IPCC Source/Sink Category 1 A 1 a. For the CO2 emissions from fuel combustion (summary) file, emissions from own on-site use of fuel in power plants (EPOWERPLT) are also included. (2) Unallocated Autoproducers which contains the emissions from the generation of electricity and/or heat by autoproducers. Autoproducers are defined as undertakings that generate electricity and/or heat, wholly or partly for their own use as an activity which supports their primary activity. They may be privately or publicly owned. In the 1996 IPCC Guidelines, these emissions would normally be distributed between industry, transport and “other” sectors. (3) Other Energy Industries contains emissions from fuel combusted in petroleum refineries, for the manufacture of solid fuels, coal mining, oil and gas extraction and other energy-producing industries. This corresponds to the IPCC Source/Sink Categories 1 A 1 b and 1 A 1 c. According to the 1996 IPCC Guidelines, emissions from coke inputs to blast furnaces can either be counted here or in the Industrial Processes source/sink category. Within detailed sectoral calculations, certain non-energy processes can be distinguished. In the reduction of iron in a blast furnace through the combustion of coke, the primary purpose of the coke oxidation is to produce pig iron and the emissions can be considered as an industrial process.	http://www.iea.org/publications/freepublications/publication/name,32870,en.html	The target value of 0 represents the ideal state of CO2 emissions from electricity . The low performance distribution excludes 2.5 percentile.

Title	Rationale	Latest data	Sources	Time Series	Full description	URL	Tech Notes
Methane Emissions from Energy sector (thousand metric tons of CO2 equivalent)/ Total Population)	The energy sector contributes to 40% of global methane emissions.	2010	International Energy Agency, World Bank	1990-2010	Methane emissions from energy processes are emissions from the production, handling, transmission, and combustion of fossil fuels and biofuels.	http://data.worldbank.org/indicator/EN.ATM.METH.EG.KT.CE	No universal targets applicable. The low performance distribution threshold is based on the lowest performance value for 2010. The target value is 0% of total emissions.
PM10, country level (micrograms per cubic meter)	Suspended particulates contribute to acute lower respiratory infections and other diseases such as cancer. Finer particulates lodge deep in lung tissue, causing greater damage than coarser particulates. Annual average concentrations of greater than 10 micro-- grams per cubic meter are known to be injurious to human health.	2010	World Bank*	1990 - 2010	Particulate matter concentrations refer to fine suspended particulates less than 10 microns in diameter (PM10) that are capable of penetrating deep into the respiratory tract and causing significant health damage. Data for countries and aggregates for regions and income groups are urban-population weighted PM10 levels in residential areas of cities with more than 100,000 residents. The estimates represent the average annual exposure level of the average urban resident to outdoor particulate matter. The state of a country's technology and pollution controls is an important determinant of particulate matter concentrations.	http://data.worldbank.org/indicator/EN.ATM.PM10.MC.M3	The target value of 0 represents the ideal state of PM10 country-level particulate emissions. The low performance distribution threshold is based on the 20 µg/m3 annual mean stipulated by the World Health Organization's recommendations – scores over this threshold score 0. *(Kiran Dev Pandey, David Wheeler, Bart Ostro, Uwe Deichmann, Kirk Hamilton, and Katherine Bolt. "Ambient Particulate Matter Concentrations in Residential and Pollution Hotspot Areas of World Cities: New Estimates Based on the Global Model of Ambient Particulates (GMAPS)," World Bank, Development Research Group and Environment Department (2006))
Average Fuel Economy for passenger cars (l/100km)	The transport sector is one of the most important areas requiring attention in improving environmental sustainability. Over 50% of oil use around the world is for transport, and nearly all the recent and future expected growth in that use comes from increased transport activity (IEA). Fuel efficiency directly affects emissions causing pollution by affecting the amount of fuel used, Measuring the average litres of gasoline equivalent used per hundred km driven indicates the efficiency of a country's transport system. Passenger cars in this instance stand as proxy for the transport sector.	2011	International Energy Agency	1990 - 2011	Measure of the average litres of gasoline equivalent used per hundred kilometres driven, indicating the efficiency of a country's transport system. Passenger cars in this instance need to stand as proxy for the entire transport sector, given the paucity of global data across this indicator for both light-duty and heavy-duty vehicle fleets.	www.worldenergyoutlook.org/	In its 2007 review of the EU CO_2 and cars strategy, the European Commission announced that the EU objective of 120 g CO_2/km (5.2 l/100 km or 45.6 mpg) by 2012 must be met. A resolution was formally adopted to enforce mandatory fuel efficiency standards of 120 g/km (5.2 l/100 km or 45.6 mpg), with carmakers achieving 130 g/km (5.6 l/100 km or 42 mpg) through technical improvements and the remaining 10 g/km coming from complementary measures (e.g. efficient tires and air conditioners, tire pressure monitoring systems, gear shift indicators, improvements in light-duty vehicles, and increased use of biofuels). Thus, the target value of 5.2 l/100 km represents the EU target. The low performance distribution threshold is based on the lowest performance values from the 2010 data range.

Title	Rationale	Latest data	Sources	Time Series	Full description	URL	Tech Notes
Electrification rate (%)	Over the last few years, there has been international focus on the issue of access to energy. High global energy and food prices have shown the impact on both the global economy and the world's poor. In addition to the UN General Assembly adopting 'Sustainable Energy for All' as an annual theme, the UN Advisory Group on Energy and Climate Change has called for the adoption of a goal of universal access to modern energy services by 2030.	2010	World Bank Global Electrification Database 2012	2000-2010	Data for access to electricity are collected among different sources: mostly data from nationally representative household surveys (including national censuses) were used. Survey sources include Demographic and Health Surveys (DHS) and Living Standards Measurement Surveys (LSMS), Multi-Indicator Cluster Surveys (MICS), the World Health Survey (WHS), other nationally developed and implemented surveys, and various government agencies (for example, ministries of energy and utilities). Given the low frequency and the regional distribution of some surveys, a number of countries have gaps in available data. To develop the historical evolution and starting point of electrification rates, a simple modeling approach was adopted to fill in the missing data points - around 1990, around 2000, and around 2010. Therefore, a country can have a continuum of zero to three data points. There are 42 countries with zero data point and the weighted regional average was used as an estimate for electrification in each of the data periods. 170 countries have between one and three data points and missing data are estimated by using a model with region, country, and time variables. The model keeps the original observation if data is available for any of the time periods. This modeling approach allowed the estimation of electrification rates for 212 countries over these three time periods (Indicated as "Estimate"). Notation "Assumption" refers to the assumption of universal access in countries classified as developed by the United Nations.	http://databank.worldbank.org/data/views/variableselection/selectvariables.aspx?source=sustainable-energy-for-all	United Nations Secretary-General Ban Ki-moon's Advisory Group on Energy and Climate Change stipulated a target to achieve universal access to modern energy services by 2030. The EAPI has therefore set a target of 100% for this indicator. The target value represents the ideal state of country-level electrification rates. The low performance distribution threshold is based on the lowest performance values from the 2010 data range.
Quality of Electricity Supply (1-7)	Survey repsonse to: "How would you assess the quality of the electricity supply in your country (lack of interruptions and lack of voltage fluctuations)?" [1 = insufficient and suffers frequent interruptions; 7 = sufficient and reliable] | 2009–10 weighted average	2012	World Economic Forum, Global Competitiveness Index	2005-2012	Survey repsonse to: "How would you assess the quality of the electricity supply in your country (lack of interruptions and lack of voltage fluctuations)?" [1 = insufficient and suffers frequent interruptions; 7 = sufficient and reliable] | 2009–10 weighted average	www.weforum.org/issues/global-competitiveness	No specific targets available due to qualitative nature of data range. The low performance distribution threshold is based on the lowest performance value for 2012. The target value is based on the highest performance value for 2012.
Percentage of population using solid fuels for cooking	The number of people who use traditional biomass, such as wood and manure, is projected to rise from 2.7 billion today, to 2.8 billion in 2030. According to estimates from the World Health Organization (WHO) and IEA it is estimated that household air pollution from the use of these traditional sources of biomass in stoves with inadequate ventilation would lead to over 1.5 million premature deaths per year in 2030. Combatting this problem will mean universal access to clean cooking facilities for 2.8 billion people,with additional cumulative investment of some USD 56 billion required in the next 20 years, or USD 2.6 billion every year (IEA).	2010	Millennium Development Goals Database Source: United Nations Statistics Division The Millennium Development Goals Database presents official data for more than 60 indicators to measure progress towards the Millennium Development Goals.	1990 - 2010	Solid fuel information is either extrapolated (single year data point), averaged (two or more years that are spaced four or fewer years apart) or a linear regression is performed when solid fuel use information is available for two or more years that are spaced at least five years apart. All countries with a gross national income (GNI) per capita above US$ 10,500 and for which no survey data is available are assumed to have made a complete transition to using non-solid fuels as the primary source of domestic energy for cooking and heating.	http://mdgs.un.org/unsd/mdg/	This indicator correlates highly with GDP levels. For literature relating to targets, the EAPI focussed its analysis on developing country policy targets in order to reflect the status quo. The Forum of Energy Ministers of Africa has committed to providing access to modern cooking energy to 50% of the rural poor. In 2005, the Economic Community of West African States (ECOWAS) committed to providing modern cooking energy to 100% of the rural population (corresponding to more than 300 million people). The UN pledge is "sustainable energy for all". The EAPI has therefore set a target of less than 5% for this indicator. The target value represents the ideal state of country level electrification rates (a score of <5% being the highest score historically). The low performance distribution threshold is based on the lowest performance values from the 2010 data range.

Title	Rationale	Latest data	Sources	Time Series	Full description	URL	Tech Notes
Energy imports, net (% of energy use)	The security of a country's primary energy supplies may be threatened if it is reliant on a high proportion of imports (especially if these are concentrated among relatively few trade partners). A high import ratio within a country's total percentage of energy used indicates an exposure to supply shocks and price spikes in commodities, and risks stemming from political decisions that might restrict trade with energy suppliers.	2010/11	World Bank (International Energy Agency and United Nations, Energy Statistics Yearbook.)	1980 - 2010/11	Net energy imports are estimated as energy use less production, both measured in oil equivalents. A negative value indicates that the country is a net exporter. Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport.	http://data.worldbank.org/indicator/EG.IMP.CONS.ZS/countries	No specific targets available. The low performance distribution threshold is based on the lowest performance value for 2012. The target value is based on the highest performance value for 2012.
Diversity of TPES (Herfindahl index)	Energy resilience rather than indepence is more aligned with energy security. 'The foundation of a secure energy system is to need less energy in the first place, then to get it from sources that are inherently invulnerable because they're diverse [and] dispersed... Any highly centralised energy system -- pipelines, nuclear plants, refineries -- invite devastating attack. But invulnerable alternatives don't, and can't, fail on a large scale.' [Amory B. Lovins and L. Hunter Lovins. "Terrorism and Brittle Technology" in Technology and the Future by Albert H. Teich, Ninth edition, Thomson, 2003, p. 169.]	2011	International Energy Agency	1980 - 2011	Total primary energy supply represents domestic supply only and is broken down into energy type. It represents inland demand only and, except for world energy supply, excludes international marine and aviation bunkers. The Herfindahl index is used here as a measure of the size of fuel-type consumption in relation to a country's total energy industry. The score represents the sum of the squares of the total primary energy supply types of the different country's being analysed within the energy industry, where the energy shares are expressed as fractions. The result can range from 0 to 1.0, moving from a large number of individual energy sources to a single-source supply. In this case, increases in the score indicate a decrease in diversity and vice versa. The formula is as follows: H = N ∑ si 2 where si is the fuel mix share of the fuel i in the overall mix and N is the number of fuels. Then, to normalize: H = (H-1/N)/(1-1/N) The normalized result can range from 0 to 1.0	www.worldenergyoutlook.org/	No target data available. The low performance distribution threshold is based on the lowest performance value for 2012. The target value is based on the highest performance value for 2012. NB: The diversity score was worked out using a wide array of countries, not all of which could be included in the final version of the EAPI due to data paucity. This means the target and threshold scores do not equate to 0 and 1 respectively, but 0.09 and 0.88, in line with the performance of the various countries included in the Index relative to all countries analysed (217 in total).
Diversification of Import Counterparts (Herfindahl Index)	Having a variety of import counterparts means market risk diversification including exposure to supply shocks, tariffs and price spikes in commodities, and risk stemming from political decisions that might restrict trade with energy suppliers. A diverse import portfolio can mitigate these potential risks.	2012	United Nations Conference on Trade and Development (UNCTAD)	1995-2012	Data presents merchandise trade by trading partner and product based on SITC, Rev.3 commodity classification (the most detailed level is two digit), expressed in thousands of dollars. Herfindahl Indexation scores countries based on number of trade partners and distribution of trade ($ value) across trade partners. Herfindahl Index methodology as above. Indicator applied only to net importing countries as defined by the data in the indicator for Energy imports, net (% of energy use).	http://unctadstat.unctad.org/ReportFolders/reportFolders.aspx?sCS_referer=&sCS_ChosenLang=en	No specific targets available. The low performance distribution threshold is based on the lowest performance value for 2012. The target value is based on the highest performance value for 2012.

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The World Economic Forum's Energy Industries Team is pleased to acknowledge and thank its valued Data Partner, without whom the realization of the Energy Architecture Performance Index 2014 would not have been feasible:

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Endnotes

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[123] Population in 2012 of Zambia: ~14 million; of the Netherlands: ~16 million.

[124] The score for Nigeria is offset by the use of population as the denominator for methane emissions from the energy sector. Nigeria is the most populous country in Africa, distorting the country's actual contribution to methane emissions.

[125] *Redrawing the Energy-Climate Map*, June 2013. Paris, France: IEA.

[126] Global Gas Flaring Reduction partnership (GGFR).

[127] Angola is not included in the Global Energy Performance Index 2014 due to insufficient data.

[128] GDP per capita, PPP (current international $). World Bank, http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD. The average includes only SSA countries from the index.

[129] For the rural population, an increase in electrification rates from 37% to 64% in the period 2000-2012.

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