WORLD ENERGY COUNCIL

World Energy Trilemma Index | 2019

In Partnership with Oliver Wyman

ABOUT THE WORLD ENERGY COUNCIL

The World Energy Council is the principal impartial network of energy leaders and practitioners promoting an affordable, stable and environmentally sensitive energy system for the greatest benefit of all.

Formed in 1923, the Council is the UN accredited global energy body, representing the entire energy spectrum, with over 3,000 member organisations in over 90 countries, drawn from governments, private and state corporations, academia, NGOs and energy stakeholders. We inform global, regional and national energy strategies by hosting high-level events, including the World Energy Congress and publishing authoritative studies, and work through our extensive member network to facilitate the world's energy policy dialogue.

Further details at www.worldenergy.org
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Published by the World Energy Council 2019

World Energy Council
Registered in England and Wales
No. 4184478

VAT Reg. No. GB 123 3802 48

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ABOUT THE WORLD ENERGY TRILEMMA INDEX

The World Energy Council's definition of energy sustainability is based on three core dimensions: Energy Security, Energy Equity, and Environmental Sustainability of Energy Systems. Balancing these three goals constitutes a 'Trilemma' and balanced systems enable prosperity and competitiveness of individual countries.

The World Energy Trilemma Index has been prepared annually since 2010 by the World Energy Council in partnership with global consultancy Oliver Wyman, along with Marsh & McLennan Insights of its parent Marsh & McLennan Companies. It presents a comparative ranking of 128 countries' energy systems. It provides an assessment of a country's energy system performance, reflecting balance and robustness in the three Trilemma dimensions.

Access the complete Index results, national Trilemma profiles and the interactive Trilemma Index tool to find out more about countries' Trilemma performance and what it takes to build a sustainable energy system:

https://trilemma.worldenergy.org

World Energy Trilemma Index 2019, published by the World Energy Council 2019 in partnership with OLIVER WYMAN.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Monitoring the sustainability of national energy systems

The world is undergoing an unprecedented energy transition, from a system based on carbon-intensive fossil fuels to a system based on low carbon, renewable energy, driven by the twin imperatives of mitigating climate change and generating economic prosperity. The speed of change and the effectiveness of individual governments to develop and implement policies to deliver energy sustainability varies across countries and geographies. The World Energy Council recognises the value of adopting a whole energy systems approach in providing the benefits of sustainable energy to all. This energy transition is a connected policy challenge – success involves managing the three core dimensions; Energy Security, Energy Equity and the Environmental Sustainability of Energy Systems throughout the transition process.

The Council's World Energy Trilemma Index, developed in partnership with Oliver Wyman, provides an objective rating of national energy system performance across these three Trilemma dimensions. We have created the Trilemma to support an informed dialogue about improving energy policy to achieve energy sustainability, by providing decision-makers with information on countries' relative performance. Objectively comparing the success of energy systems around the globe is challenging, but a high-level ranking of performance against a set of benchmark indicators helps start a conversation about policy coherence and effectiveness. Deeper analysis at regional and national levels can give policy makers real insights on trajectories and outlooks, informing future priorities.

To provide greater insight, we have evolved the methodology for the 2019 Trilemma and, for the first time, introduced visualisation of historical trends to enable the Trilemma performance of individual countries to be tracked back two decades to 2000. The new time-series analysis provides insights into a country's historical trends, challenges and opportunities for improvements in meeting energy goals now and in the future. The Index demonstrates the impact of varying policy pathways countries have taken in each of the dimensions over the past 20 years. Looking at these trends can inform a dialogue on national energy policy to promote coherence and integration to enable better calibrated energy systems in the context of the global energy transition challenge.

Ten countries achieve the top AAA balance grade in the 2019 World Energy Trilemma Index, representing top quartile performance in every dimension. Since 2000, no countries have consistently improved in each dimension every year; instead most show historical trends with a variety of peaks and troughs in a general upward direction. Overall Trilemma performance for 119 countries over the 20-year period has improved, with only 9 countries seeing their overall performance declining. The rate of improvement in overall Trilemma performance also increases as the transition progresses and encourages countries to improve their energy policies.

The overall top three countries across all three Trilemma dimensions are Switzerland, Sweden and Denmark. These countries have balanced policies for the three dimensions to provide a high baseline in each indicator of the Trilemma and have maintained consistent performance coupled with steady economic growth. Cambodia, Myanmar and the Dominican Republic have shown the biggest improvements in balancing the Trilemma, with a 30-40% improvement in the overall Trilemma Index

from the 2000 baseline. Their rapidly improving energy systems are the result of a focus on electrification, energy generation diversity, and infrastructure investment, pushing up performance from a low baseline. The ability to differentiate between top performers and top improvers is an important new feature of the enhanced Trilemma tool.

For the Energy Security dimension, the top performing countries in 2019 are Sweden, Denmark, and Finland. These countries have the most robust and secure energy systems that manage supply and demand effectively. The countries displaying the greatest advances in Energy Security since 2000 are Malta, Jordan and the Dominican Republic. These countries have all implemented small but significant changes with big impacts, such as increasing supplier diversity or stock levels, as well as investment in enhancing grid stability.

The top of the Energy Equity dimension traditionally ranks well-endowed or well-connected countries and geographically concentrated populations with access to abundant and affordable energy: Luxembourg, Bahrain and Qatar are the top performers in 2019. The historical improvement story is very different however, and the countries with the greatest Equity successes are those focused on advancing UN Sustainable Development Goal 7, achieving universal access to basic energy needs. Cambodia, Nepal, and Myanmar have made substantial access improvements, more than doubling levels of energy access above their 2000 baseline.

The leaders of the 2019 ranking for the Environmental Sustainability of Energy Systems are countries making steady gains on the pathway to decarbonisation and pollution control, in the context of sustainable economic growth. The top performers in this dimension are also the overall Trilemma leaders – Switzerland, Denmark and Sweden. Significant improvers over time, showing progress against lower baselines, are countries like China and Poland; tangibly decarbonising compared to their 2000 baseline performance.

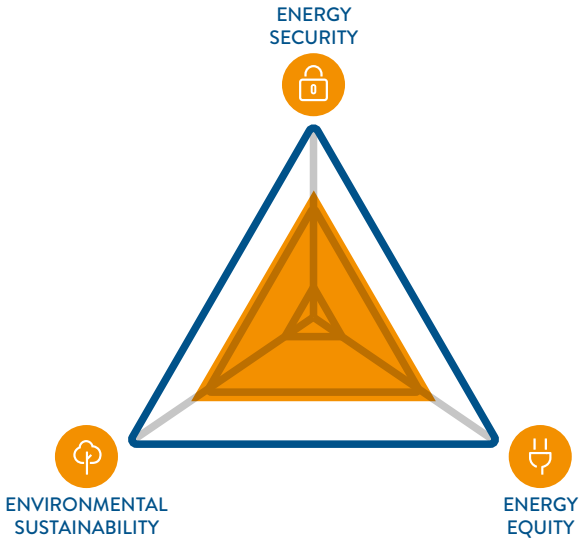
Across the different regions of the world, pathways through the transition are different, and leading countries in each region represent this diversity. The top 10 2019 Trilemma ranking is dominated by European countries, with Switzerland as the top performer in Europe both due to robust baseline systems and coherent policies improving upon these. Uruguay ranks highest of all Latin American and Caribbean countries, with high scores in the Security and Sustainability dimensions. In the Middle East and Gulf region, Israel ranks highest due to its performance in Sustainability compared to the regional average. New Zealand, with a placing in the global top 10, heads up the Asia-Pacific region with an AAA grade. Mauritius is ahead of other countries in Africa, balancing both Equity and Sustainability performance. Canada represents the best overall performance in the North American region due to strong Energy Security and a commitment to balanced and integrated energy policy.

Readers are encouraged to use the Trilemma framework with its three dimensions of Security, Equity and Sustainability to inform an engaged dialogue with policy makers and energy communities about navigating the energy transition effectively and building prosperity for a nation's citizens.

Figure 1: 2019 World Energy Trilemma top 10 performers and improvers

TOP 10
OVERALL RESULTS

1. Switzerland
2. Sweden
3. Denmark
4. United Kingdom
5. Finland
6. France
7. Austria
8. Luxembourg
9. Germany
10. New Zealand



TOP 10
ENERGY SECURITY

1. Sweden
2. Denmark
3. Finland
4. Latvia
5. Canada
6. Angola
7. Ukraine
8. Romania
9. Slovenia
10. Czech Republic

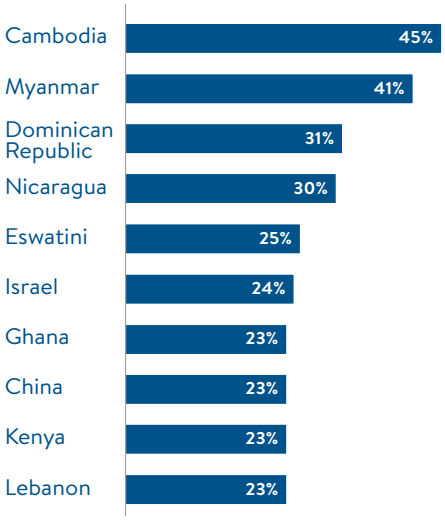
TOP 10
ENERGY EQUITY

1. Luxembourg
2. Bahrain
3. Qatar
4. Kuwait
5. United Arab Emirates
6. Oman
7. Saudi Arabia
8. Netherlands
9. Iceland
10. Singapore

TOP 10
ENVIRONMENTAL SUSTAINABILITY

1. Switzerland
2. Denmark
3. Sweden
4. France
5. Norway
6. United Kingdom
7. Costa Rica
8. Luxembourg
9. Namibia
10. Slovakia

TOP 10
OVERALL INDEX SCORE IMPROVERS
2000 – 2019

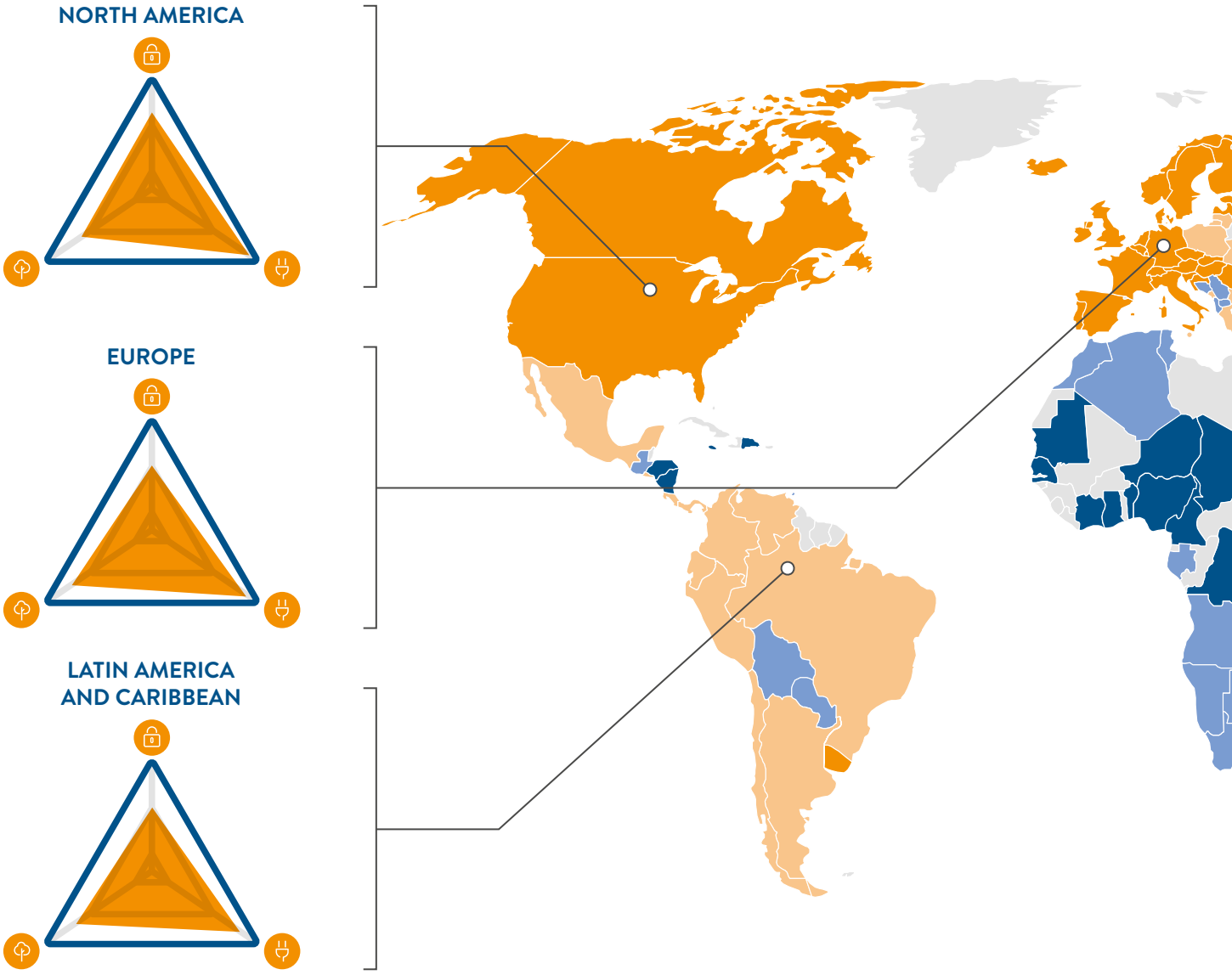


Full results and profiles per country, historical trends in each dimension and analysis from national stakeholders are available via the online Trilemma Tool:

https://trilemma.worldenergy.org

World Energy Trilemma 2019 Map

WORLD ENERGY TRILEMMA INDEX 2019: REGIONAL OVERVIEWS



NORTH AMERICA

OPPORTUNITIES IN THE ENERGY TRANSITION

North America has strong energy security based on a long track record of developing abundant and diverse energy resources. Large energy trade flows between the countries enable supply diversity and the redundancy inherent in the continental transmission networks with mutual aid cooperative arrangements. Energy equity is strong and generally remains a relatively low-profile matter in the region. Energy is a critically important and highly-valued component of the North American economies, and the energy transition creates a challenge and a major opportunity. Countries will take diverse pathways given their diversity in environmental policy and also the diversity in policies between national and state or provincial governments in Canada and the United States.

EUROPE

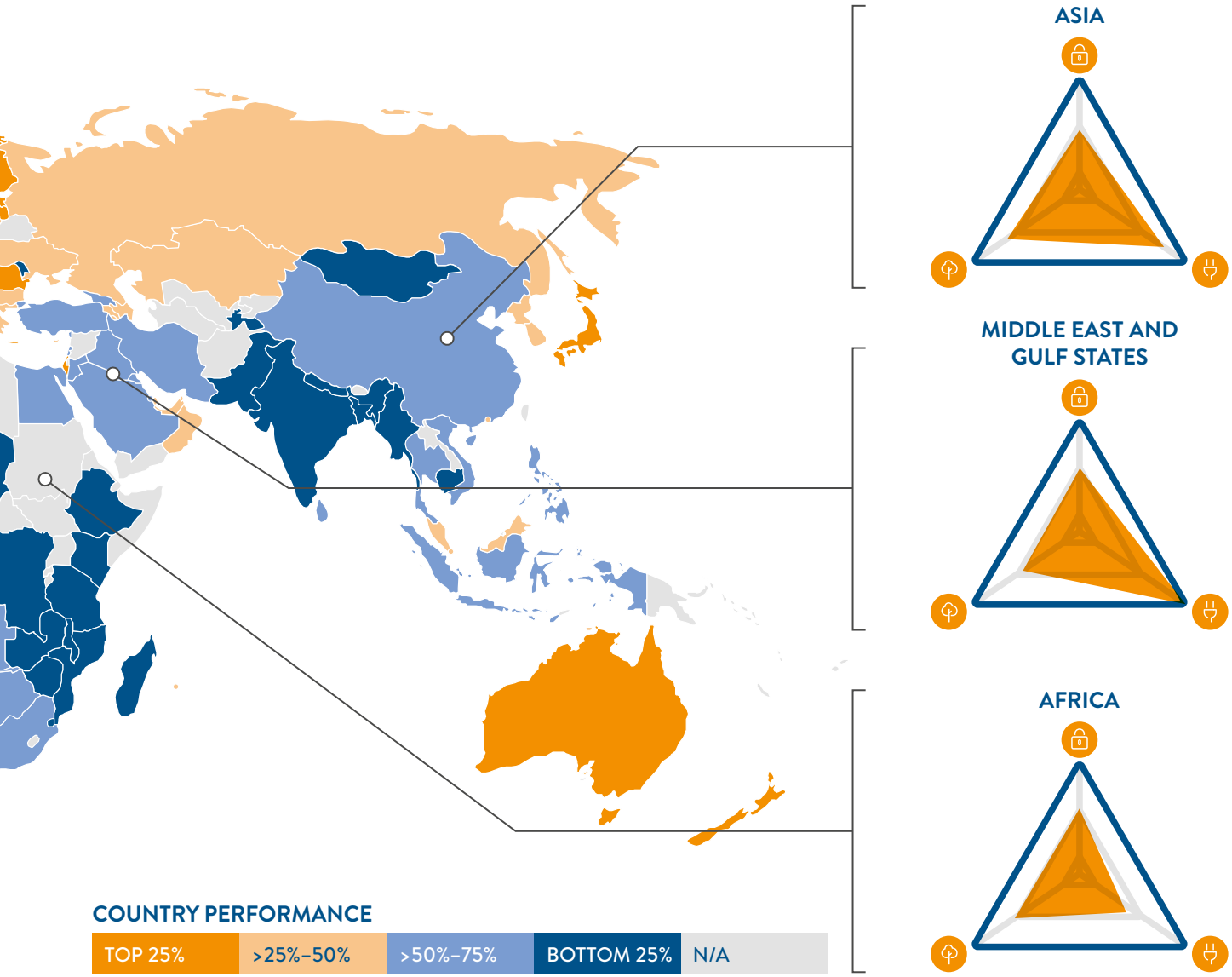
TRILEMMA CHALLENGES OF ADVANCED TRANSITION

European countries dominate the top 50 overall Index recognizing Europe's substantial progress on the energy transition pathway, yet multiple policy challenges remain. The European Union's current mitigation commitments will not allow it to meet its sustainable energy objectives, whilst further rapid penetration of renewables can be a risk to supply reliability and short-term affordability of energy to citizens. Energy poverty is a concern in Europe, as high prices affect affordability. European countries have focused on increasing diversity of energy sources and supply and interconnection to improve energy security. Modernising and optimising fossil-based infrastructure and integrating new renewable infrastructure will require coordinated efforts to ensure a technology-neutral, level playing field of fiscal policies.

LATIN AMERICA AND CARIBBEAN (LAC)

REGIONAL INTERCONNECTIONS NEEDED TO STRENGTHEN TRILEMMA OUTCOMES

Eleven LAC region countries rank in the Trilemma top 50 on environmental sustainability, and show positive trends. However, extreme weather challenges energy security given the region's high dependence on hydro generation. The region also faces challenges of poor diversification of energy sources, inequality of wealth distribution, and limited utilisation of interconnections and grid infrastructure. A 250% projected rise in electricity usage over the next 40 years highlights the need for large-scale infrastructure development and regional integration to improve energy security and resilience. Energy access is nearly 100% but 30 million people still do not have access to power. Distributed generation can play a key role in improving energy equity in the region.



ASIA

TRYING TO MEET RISING ENERGY DEMAND AND BALANCE THE TRILEMMA

Trilemma rankings reflect regional diversity, with nine of the 23 countries ranking in the top half of the Index, and only New Zealand ranking in the top ten. Despite significant progress in energy equity, the region struggles with energy security as the largest market for energy imports, and energy sustainability as growing demand currently exceeds the ability to rely on renewables to mitigate emissions. To improve trilemma performance, many countries are developing energy plans that include a focus on renewables. Yet challenges remain including outdated infrastructure; a lack of coordinated national energy policies; limited regional integration; trade patterns; an unbalanced distribution of resources and an uncertain global economic situation.

MIDDLE EAST AND GULF STATES (MEGS)

THE TIME TO FOCUS ON ENERGY DIVERSIFICATION IS NOW

MEGS countries have a range of energy resources and economic diversification, but face common environmental challenges including extreme weather, desertification and water stress. The group is strong in energy access and affordability, but increased diversification of energy generation and innovative solutions need to be adopted to meet rising energy demand and improve energy sustainability. Going forward, renewable and nuclear energy programmes are expected to be deployed throughout the region, improving energy security, system resilience, and environmental sustainability. The easing of energy subsidies, coupled with energy efficiency measures, have slowed the unsustainable growth in energy demand while freeing up some capital for investment in renewable energy infrastructure.

AFRICA

PROGRESS TOWARDS SUSTAINABLE ENERGY FOR ALL NEEDS IMPROVED INSTITUTIONAL CAPABILITIES

Many African countries are making substantive improvements in energy access but long-standin issues such as grid stability and supply reliability remain. Large disparities in demographics and consumption patterns, in the context of lower economic development has the region in the bottom half of Trilemma rankings.

Cost-effective development of the region's abundant energy resources along with expanded use of decentralised grids and distributed generation would enable a more reliable energy supply. Top security performers have developed energy resources to meet domestic and export demands. Energy efficiency programmes and increasing deployment of renewables are growin in the continent. Further development, along with improved grid stability and universal access would help Africa improve its Trilemma triangle.

Introduction

INTRODUCTION

The Energy Trilemma

The world is undergoing an unprecedented energy transition, from a system based on carbon-intensive fossil fuels to a system based on low carbon, renewable energy, driven by the twin imperatives of mitigating climate change and generating economic prosperity. The speed of change and the effectiveness of individual countries to develop and implement policies to deliver energy sustainability varies across countries and geographies. The World Energy Council recognises the value of adopting a whole energy systems approach in delivering the benefits of sustainable energy to all.

Energy transition is a connected policy challenge – success involves managing the three core dimensions; Energy Security, Energy Equity and the Environmental Sustainability of Energy Systems throughout the transition process. Together, they constitute a 'Trilemma', and achieving high performance across all three dimensions entails complex interwoven links between public and private bodies, governments and regulators, economic and social factors, national resources, environmental concerns, and individual consumer behaviours.

The World Energy Trilemma Index provides an objective rating of national energy policy and performance across these three Trilemma dimensions. The Index tracks pathways countries have taken in advancing each of the dimensions over the past 20 years. Looking at these trends can inform impactful dialogue with policy makers and energy communities, navigating the energy transition effectively, building prosperity for a nation's citizens. Adopting the Trilemma conceptual framework for analysis of the three dimensions promotes policy coherence and integration to enable better calibrated energy systems in the context of the global energy transition challenge.

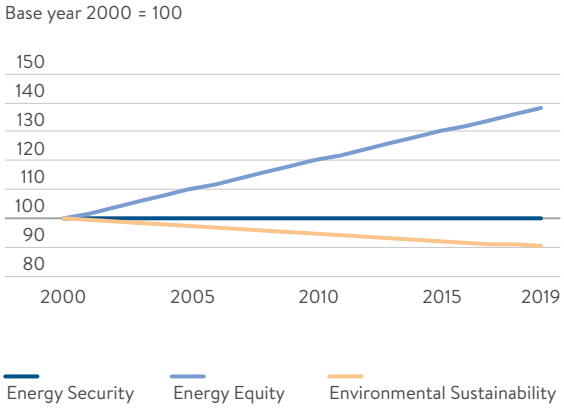
Each year the World Energy Council, in partnership with global consultancy Oliver Wyman, runs the Trilemma model to quantify national energy system performance across the three dimensions and their composite sub-indicators. Each country is assigned a three-letter grade, representing the balance of the system. This year, for the first time, the Trilemma also shows for each country indexed trends in each dimension over a 20-year time frame.

The Trilemma conceptual framework sees success in the balanced and consistent performance across all three dimensions, which implies effective management of potential trade-offs. Economic growth can increase the energy intensity of the economy, impeding Security through unmanaged demand and affecting Sustainability. Conversely, rapid transition to renewables can risk the robustness of supply causing intermittency. Rapid electrification connects remote communities to the grid, improving Equity, but the stability of these nascent connections can impede a country's overall performance in Security.

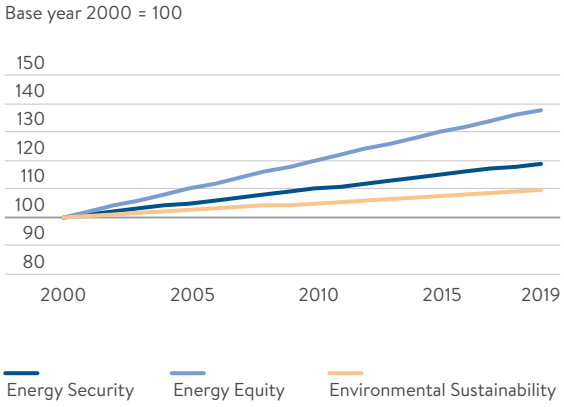
The shape of transition matters: the gradual growth of a balanced Trilemma triangle represents success, even for low baseline countries. In the historical frame, this is represented by an upward trajectory of the three Trilemma indices.

Figure 2: The shape of transition.

POOR PERFORMING SYSTEMS: IMBALANCED GROWTH ACROSS A FEW DIMENSIONS OF THE ENERGY TRILEMMA



WELL PERFORMING SYSTEMS: SUSTAINABLE GROWTH ACROSS ALL DIMENSIONS OF THE ENERGY TRILEMMA



Imbalanced growth in the three dimensions can be tracked using Trilemma Index trend analysis from 2000. Countries' performance in each dimension can show an upward, stable or downward trend. The top figure represents poor balance, rapidly improving energy Equity at the expense of Sustainability. The best performing systems, illustrated in the bottom figure, will be making managed and sustainable improvements to each dimension, without the need for significant trade-offs.

Objectively comparing the success of energy systems around the globe is challenging, but a high-level ranking of performance against a set of benchmark indicators helps start a conversation about policy coherence. Deeper analysis at regional and national level can give policy makers real insights on trajectories and outlooks, informing future policy priorities.

Readers are encouraged to use the Trilemma framework with its three dimensions of Security, Equity and Sustainability to inform an engaged dialogue with policy makers and energy communities about navigating the energy transition effectively and building prosperity for a nation's citizens.

About this report

The 2019 Energy Trilemma Index Report presents the results an analysis of global energy systems data for some 128 countries[1] in terms of their ability to develop a secure, affordable, and environmentally sustainable energy system. Each country is assigned a three-letter balance grade, representing how well the country manages each of the three dimensions, and identifies top performing countries with an 'AAA' score. The Index represents trends in national performance against a set of indicators. Although the overall rankings are important, trends and the balance within the three dimensions provide the most valuable information in helping countries address their Energy Trilemma through policy change.

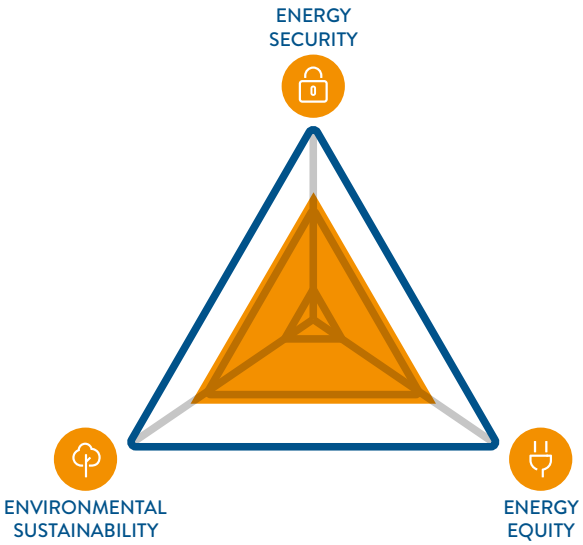
Figure 3: The Trilemma dimensions

ENERGY SECURITY
Reflects a nation's capacity to meet current and future energy demand reliably, withstand and bounce back swiftly from system shocks with minimal disruption to supplies.

ENERGY EQUITY
Assesses a country's ability to provide universal access to affordable, fairly priced and abundant energy for domestic and commercial use.

ENVIRONMENTAL SUSTAINABILITY OF ENERGY SYSTEMS
Represents the transition of a country's energy system towards mitigating and avoiding potential environmental harm and climate change impacts.

COUNTRY CONTEXT
Focuses on elements that enable countries to effectively develop and implement energy policy and achieve energy goals.



The scores and rankings are based on a range of global data sets that capture both energy performance and the national context in which energy is managed. Performance indicators include supply and demand, the affordability of and access to energy, intensity and efficiency of energy use, and emissions associated with energy systems. The contextual indicators consider the broader circumstances of energy performance, including a country's ability to provide coherent, predictable and stable policy and regulatory frameworks, initiate R&D and innovation, and attract investment.

The Trilemma assessment framework has been run annually since 2010 by the World Energy Council in partnership with global consultancy Oliver Wyman, along with Marsh & McLennan Insights of its

1. The World Energy Trilemma Index includes 133 countries but rankings have only been produced for 128 countries due to data limitations. Countries that are tracked but not ranked are: Chinese Taipei, Libya, Barbados, Syria, and Yemen.

parent Marsh & McLennan Companies. The methodology reflects a changing global context and has substantially evolved this year.

Included in this report are:

- 2019 Energy Trilemma Index rankings and balance grades based on the updated methodology;
- Insights into the 2019 Trilemma Index results;
- A discussion of the methodology and the usefulness of indexation;
- Regional profiles by key geographies, prepared by the Word Energy Council regional representatives;
- Appendices including Frequently Asked Questions and Methodology.

Countries have differing political and societal contexts with unique resources, policy goals and challenges. The absolute ranking of a country may be informative for starting a conversation, but is less meaningful than the country's relative individual dimension score and historical trends that reflects the impacts of longer-term policy choices.

Trends and the balance within the three dimensions provide valuable insights for countries to consider how they can navigate the energy transition using their Energy Trilemma as a compass. Decision makers in both the public and private sectors are encouraged to look at trends in performance over the years for each dimension, and to compare their country's performance against their peers– including regional or GDP group peers.

To support decision makers and stakeholders, the World Energy Council and Oliver Wyman have developed an interactive online tool that allows users to view Index results, compare countries' performance against other countries and explore how Energy Trilemma performance might be improved. The tool also features expert national commentaries from Council Member countries. The tool can be accessed at: **https://trilemma.worldenergy.org**

Taken as a whole, the World Energy Trilemma Index is a unique and unparalleled resource and guide for policymakers and stakeholders seeking to develop solutions for sustainable energy systems in a time of transition, and for energy leaders to inform strategic decisions

What are we measuring?

The World Energy Trilemma Index is a summary measure of performance across the core dimensions of Energy Security, Energy Equity and Environmental Sustainability. The model combines 32 quantitative indicators based on 59 datasets to represent this. (For details, please see Figure 27 in Annex A.) The data underpinning indicator scores comes from a variety of global datasets, including the following sources:

- International Energy Agency World Energy Balances, World Energy Prices, and Emissions;
- World Bank/UN Sustainable Development Goal 7 tracking data;
- World Bank Getting Electricity report;
- Joint Organisations Data Initiative (JODI) and International Gas Union (IGU) data;
- World Economic Forum, Global Competitiveness Index.

As the model aggregates raw data into indicators, dimensions, and overall balance grades, nuances can become obscured while enabling overall trends to emerge.

The Trilemma Index presents two sets of results: **Annual scores** and **Index trends**.

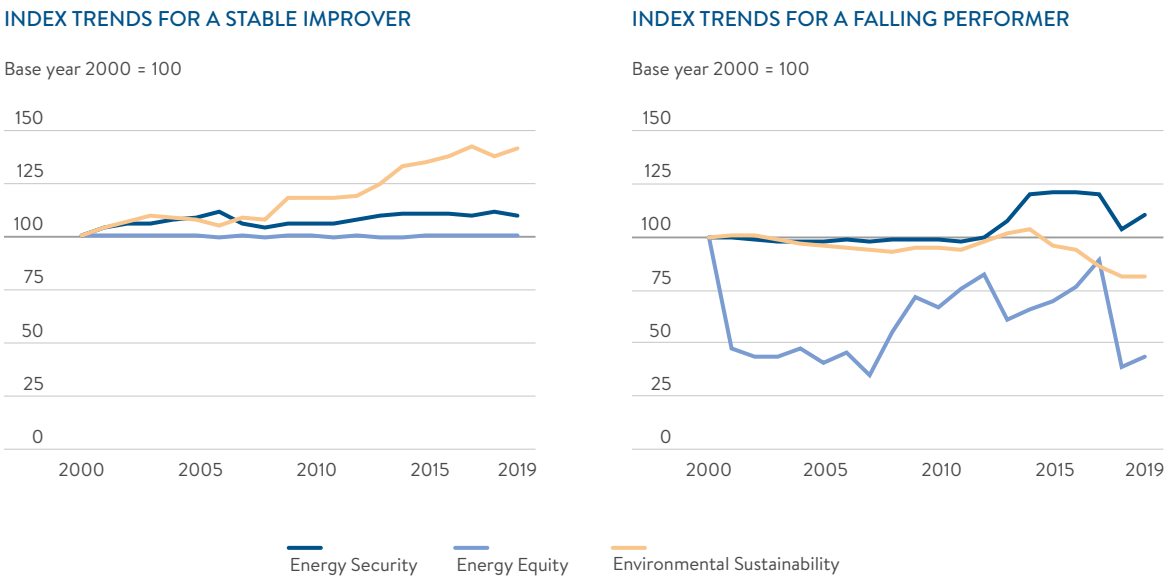
Annual scores are calculated from each dataset and rescaled from 0 to 100, with higher scores representing better performance and a higher annual rankings. Individual indicator scores are combined into annual dimension scores using relative weights. Weighted dimension scores are also categorised into grades, from A to D, with A grade countries achieving scores over 0.75 standard deviation above the mean. The balance grade of three dimensions, ranging from AAA to DDD, gives an immediate impression of a county's overall performance and balance across the dimension. Countries achieving the highest AAA scores tend to be developed with stable economies and strongly defined energy policy goals, ranking in the top 10 globally.

For the first time in 2019, the report also provides Index trends, representing true mathematical indexation, demonstrating country performance since a base year – set here as 2000. There are two steps to create an index. First, each indicator dataset is assigned a minimum and maximum value, representing goalposts or aspirational targets within which countries can improve or decline. For most indicators, this is a natural zero to 100 range. This is true of indicators such as proportion of electricity generated from renewables. For other indicators, the 'goalposts' are set relative to the historical range of possible points; for example, energy prices are assessed on a range from $0.00 per kwh (best) to the average of the five most expensive price points (worst). A country's score for each indicator in each year is calculated relative to the minimum-maximum range, meaning that the overall scores are relative and balanced.

Dimension **Index trends**, or dimension indices, are calculated to show improved dimension performance from a baseline year, set as 2000. Each dimension score in the year 2000 is assumed to represent an Index value of 100. Dimension scores each year are represented as percentage change from the base year. This is useful to show historical trends in each dimension: countries which successfully balance the Trilemma will show an upward trend in all three dimensions. Importantly, it means that the Trilemma results can identify strong progress in countries that usually rank low in the overall Index. By comparing progress relative to national contexts and not to the farthest advanced, the Index trend reflects the effectiveness of implemented national policies that previously would be lost in the global ranking.

Further details on the datasets, calculations, and Index methodology can be found in Annex A: Frequently Asked Questions, and Annex B: Methodology.

Figure 4: Exploring Index trends for a stable improver (left) and a country with a falling trend (right).



Analysing Index trends in the three dimensions from a year 2000 baseline can help explain why countries rank as they do, and how they can improve performance. From the Index trend graphs above, the country in the left graph is a stable improver, with relative stability in Security and Equity – this does not mean that nothing has changed. On the contrary, we can see the Sustainability index rising steadily, which means that other dimensions are being maintained without trade-offs. The country with a falling trend (right) likely starts from a much lower baseline, and relative to its 2000 performance it demonstrates an overall decline. Energy Equity, although addressed, cannot keep up, likely due to significant population growth. Meeting demand with fossil fuels causes a downward trend in Sustainability, and eventually Security.

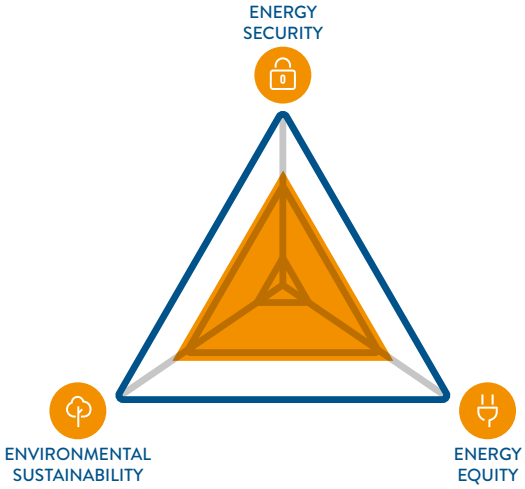
2019 World Energy Trilemma Results

2019 WORLD ENERGY TRILEMMA RESULTS

Figure 5: 2019 World Energy Trilemma top 10 performers

TOP 10
OVERALL RESULTS

1. Switzerland
2. Sweden
3. Denmark
4. United Kingdom
5. Finland
6. France
7. Austria
8. Luxembourg
9. Germany
10. New Zealand



TOP 10
ENERGY SECURITY

1. Sweden
2. Denmark
3. Finland
4. Latvia
5. Canada
6. Angola
7. Ukraine
8. Romania
9. Slovenia
10. Czech Republic

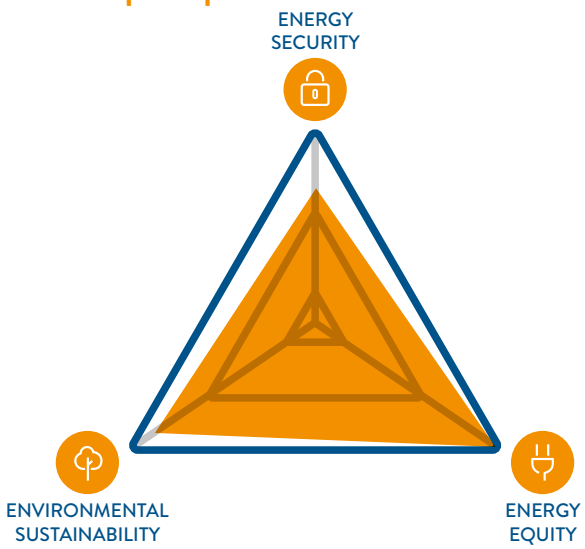
TOP 10
ENERGY EQUITY

1. Luxembourg
2. Bahrain
3. Qatar
4. Kuwait
5. United Arab Emirates
6. Oman
7. Saudi Arabia
8. Netherlands
9. Iceland
10. Singapore

TOP 10
ENVIRONMENTAL SUSTAINABILITY

1. Switzerland
2. Denmark
3. Sweden
4. France
5. Norway
6. United Kingdom
7. Costa Rica
8. Luxembourg
9. Namibia
10. Slovakia

Figure 6: Average Trilemma balance triangle for 2019 Top 10 performers.



The average Trilemma triangle for the top performing nations shows a reasonable balance of dimension scores, with Equity as the strongest dimension: all top 10 performers are well developed economies where the challenge of energy access has been solved and is being maintained at a high level. There is progress to be made in Sustainability, and Security scores, due to differing speeds in the implementation of the decarbonisation agenda and the associated diversification of energy sources and suppliers.

Leaders in the three dimensions

The top three countries across all three Trilemma dimensions are Switzerland, Sweden and Denmark. These countries represent balanced policies for the three dimensions, a high baseline in each area of the Trilemma, and consistent performance in maintaining Trilemma balance in the context of economic and population growth.

Looking at the individual dimensions, overall the most robust and secure systems, able to manage supply and demand effectively, and therefore scoring highest on the Energy Security dimension, can be found in Sweden, Denmark, and Finland.

The Equity dimension traditionally ranks well-endowed or well-connected countries with concentrated populations the highest. In these countries access to abundant energy is long solved, whilst the price of that energy is highly affordable: Luxembourg, Bahrain and Qatar represent the top of this dimension.

The top of the 2019 ranking for the Environmental Sustainability of Energy Systems is held by countries making steady gains on the pathway to decarbonisation and pollution control, in the context of sustainable economic growth. The overall Trilemma top countries also score highly in this dimension with Switzerland, Denmark and Sweden once again heading the list.

Biggest improvers

For the first time, the 2019 Trilemma Index allows users to analyse indexed trends of each country. This provides a much more useful analysis of the global energy transition beyond the snapshot of top performers, which do not change very much year-on-year due to their advanced starting points and stable policy environments.

While there are many countries doing well in the overall Trilemma balance, it is interesting to note that no countries have consistently improved in each dimension since 2000: the historical trend shows a variety of peaks and troughs. As the Transition accelerates, so does positive Trilemma performance: 50% of Trilemma countries shown consistent upward trends in their overall Trilemma score since 2015, compared to 15% consistently improving since 2000.

The historical Index shows that Cambodia, Myanmar, and the Dominican Republic have demonstrated the greatest overall improvement across the three dimensions, with 30%-40% improvement in the overall Index from the 2000 baseline. Their rapidly improving energy systems represent a focus on electrification, generation diversity, and infrastructure investment, pushing up performance from a low baseline.

Since 2000, the greatest leaps in improving Energy Security have been observed in Malta, Jordan and the Dominican Republic. The improvement in these countries' rankings has been realised by implementing relatively small but significant changes that have had big impacts. These include broadening supplier diversity and significant investment in grid stability.

The historical improvement story for Equity highlights countries that have placed significant focus on advancing UN Sustainable Development Goal 7, which aims to achieve universal access to basic energy needs. Cambodia, Nepal, and Myanmar have made access improvements of over 100% above their 2000 baseline: Nepal has improved access from 27% to 90%, Cambodia from 17% to 89%.

The top improvers in the Sustainability dimension over time are very different to the Sustainability top 10, and represent countries that are rapidly and tangibly decarbonising their energy systems, including China and Poland.

Laggards since 2000

A time-series analysis also provides unique insights into countries where the energy transition is resulting in less sustainable trade-offs. Countries that lose points on their indices over time illustrate the challenges of balancing sustainable transition and indicate areas which need to be addressed with strong policies and decisions.

Security Index scores for Kazakhstan, Nepal and India have dropped since the year 2000, partially explained by rapid improvement in access to energy in Nepal and India, which has raised the Equity score for these countries. However, this is counterbalanced by challenges caused by the increased demand and the need for grid infrastructure stability to catch up with new networks. In Kazakhstan, domestic electricity consumption has doubled, with the growth largely met by fossil fuels, which has reduced the diversity of its energy system, depressing the country's score in this dimension.

Countries which have dropped below their 2000 baseline in the Equity Index include Malawi, Niger, and Congo (DRC), reflecting cases where political instability and investment uncertainty have restricted progress on basic access to energy. However, richer countries can also drop their equity performance due to the growing cost of energy for consumers, which affects the affordability indicator – Sweden is an example of this trend.

Drops in the Sustainability dimension are exhibited by nations that are slow to decarbonise, or where the transition to renewables is slower due to fossil fuelled economic growth. Oman, Gabon, and Nigeria are examples of this trend: Oman represents the impact of environmental externalities (air pollution and emissions) associated with fossil fuel intensive growth economy; Gabon and Nigeria see Sustainability decline in the context of political volatility and population growth.

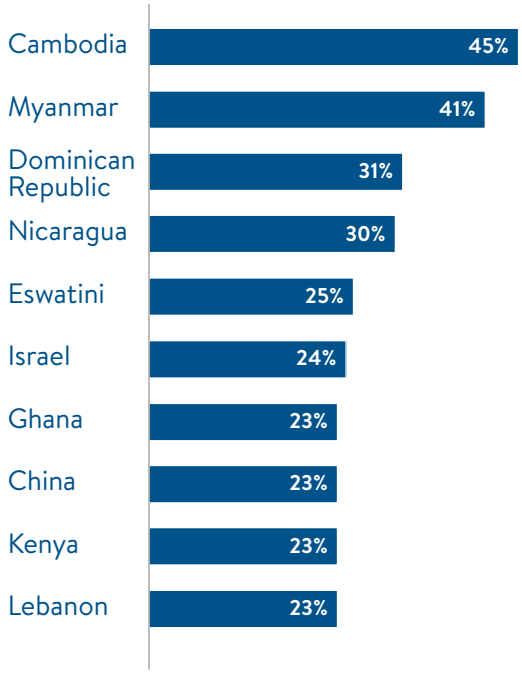
Absolute Trilemma scores are an important conversation starter, monitoring the development of sustainable energy systems. Results for all countries are presented in Figure 8 on the next page. Index trends are a new feature of the Trilemma tool, available online for each country, and explored in the following chapter tracking two decades of Trilemma Index trends.

Figure 7: Top 10 performers and Top 10 improvers

TOP 10
OVERALL PERFORMERS
2019 RANKING

1. Switzerland
2. Sweden
3. Denmark
4. United Kingdom
5. Finland
6. France
7. Austria
8. Luxembourg
9. Germany
10. New Zealand

TOP 10
OVERALL INDEX SCORE IMPROVERS
2000 – 2019



The biggest improvers are important countries to watch for the future. These countries represent a fast-paced energy transition, overcoming multiple challenges at the same time. Top performers can make incremental changes and efforts towards further efficiencies and maintaining balance, whilst the top improvers can select policy pathways with the biggest net gains.

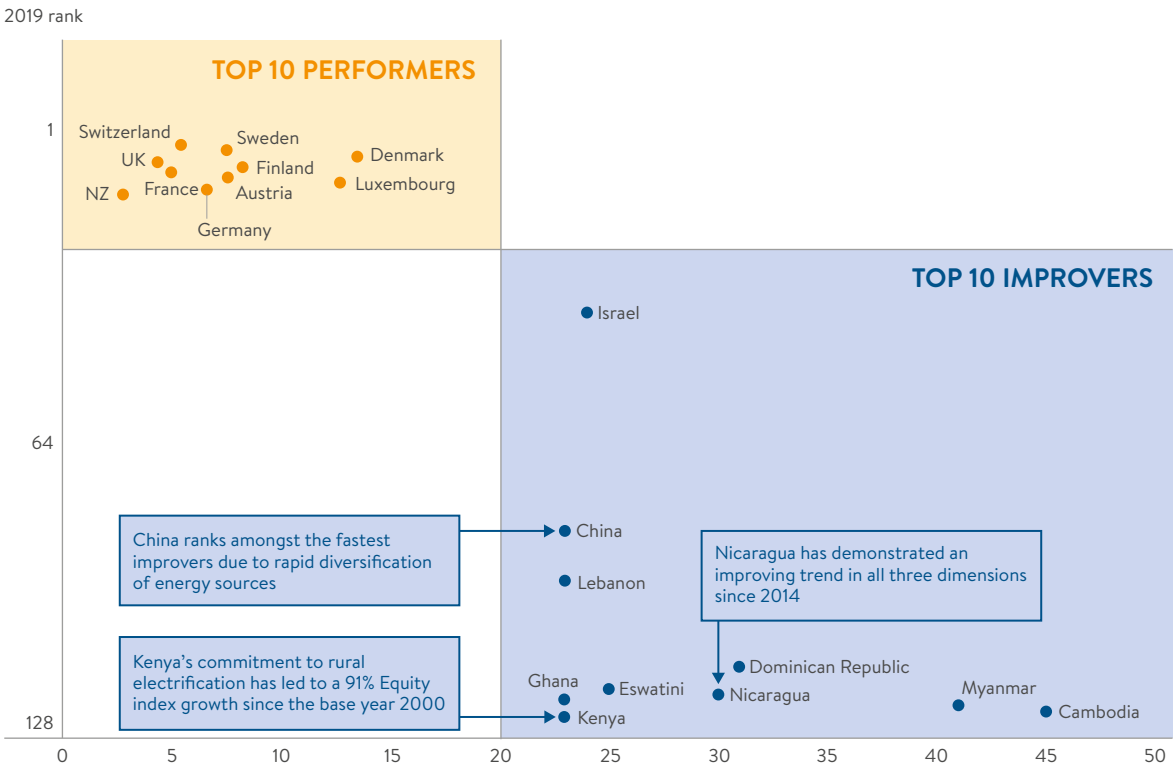
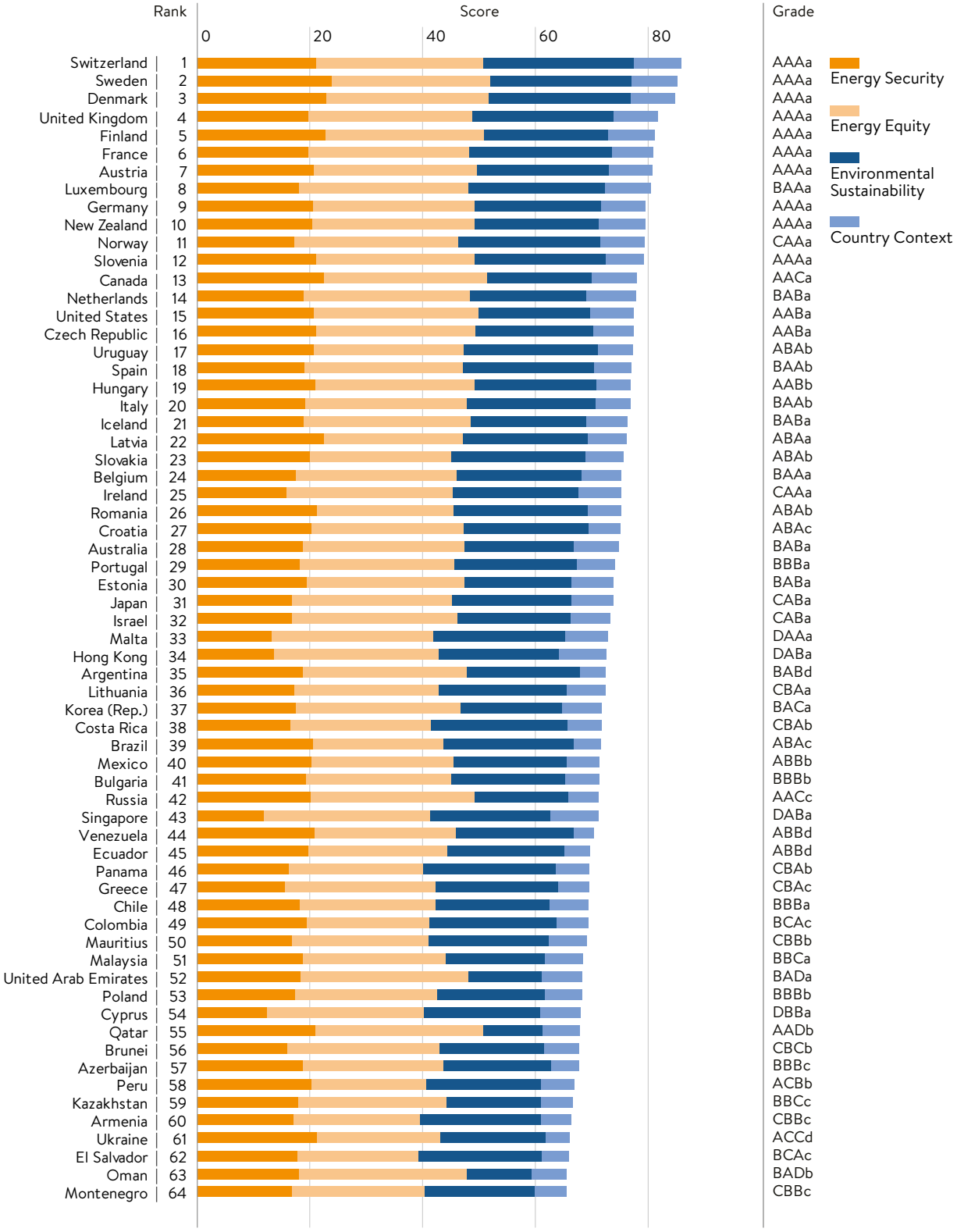
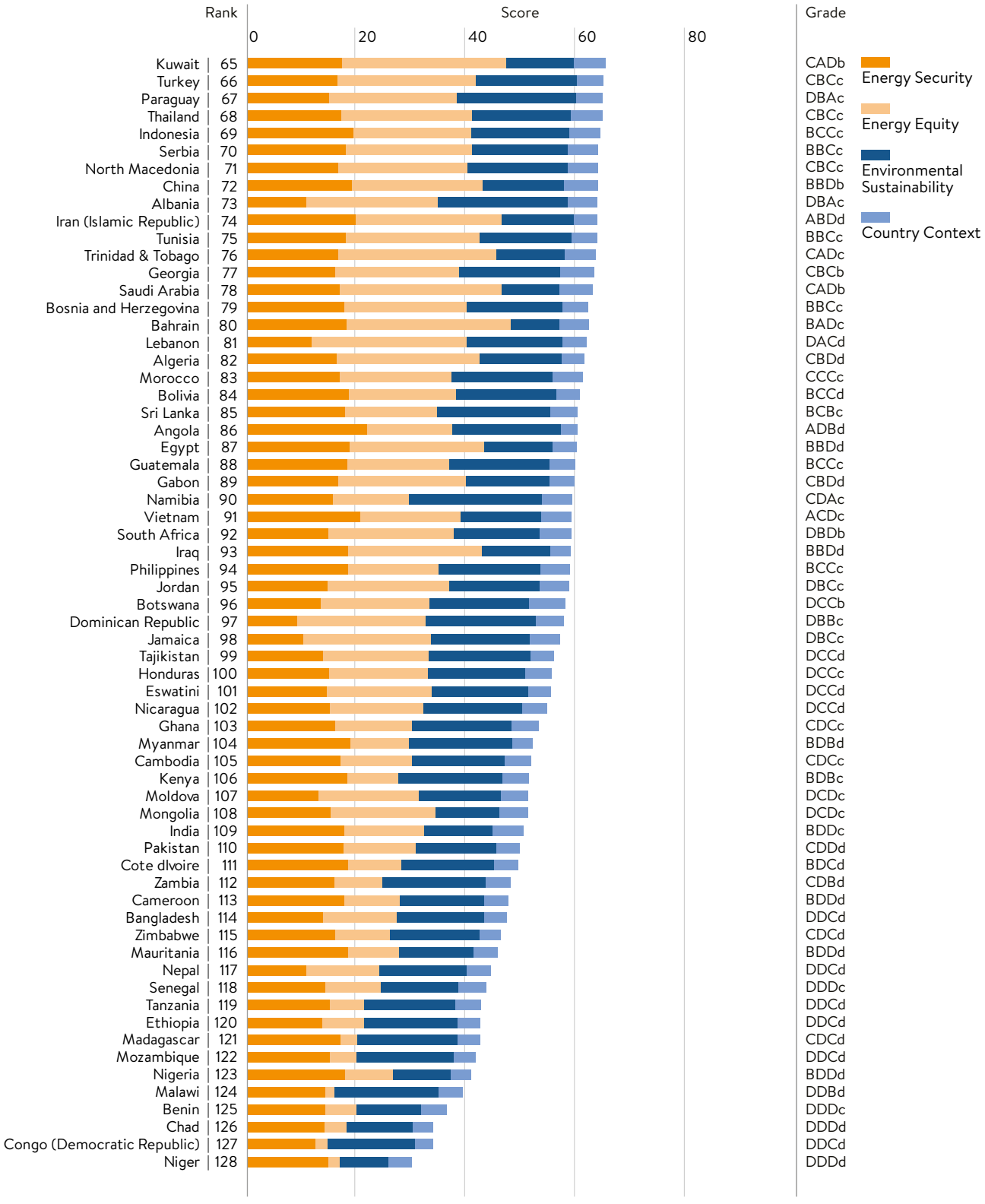


Figure 8: 2019 World Trilemma ranking for 128 countries





Full results and profiles per country are available via the online Trilemma Tool: https://trilemma.worldenergy.org

Insights From Two Decades Of Trilemma

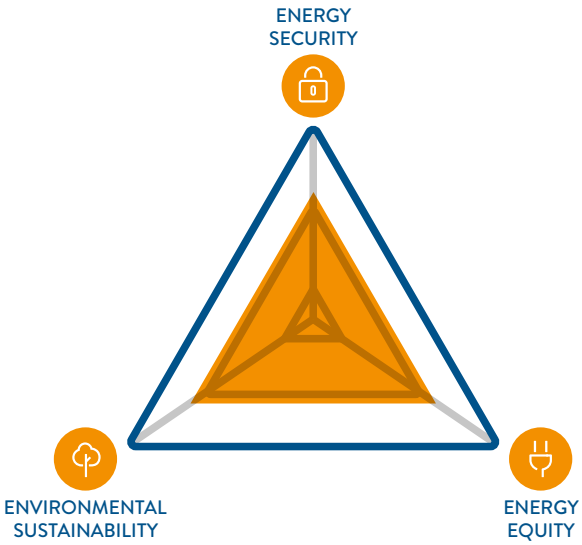
INSIGHTS FROM TWO DECADES OF TRILEMMA

The relative stability of the Trilemma performance rankings over time shows that at a global scale, energy policy does not change much year on year, but there is evidence of annual incremental change and long-term transformational change. There are time lags in globally available energy data, meaning that annual snapshots are sometimes reflecting short-term system shocks, rather than established trends.

Figure 9: Top improvers per Trilemma dimension 2000-2019

TOP 10
OVERALL IMPROVERS

45%	Cambodia
41%	Myanmar
31%	Dominican Republic
30%	Nicaragua
25%	Eswatini
24%	Israel
23%	Ghana
23%	China
23%	Kenya
23%	Lebanon



TOP 10
SECURITY IMPROVERS

84%	Malta
70%	Jordan
62%	Dominican Republic
54%	Israel
54%	Cyprus
49%	Tanzania
47%	Singapore
41%	Uruguay
25%	Cameroon
25%	Jamaica

TOP 10
EQUITY IMPROVERS

140%	Cambodia
131%	Nepal
114%	Myanmar
112%	Bangladesh
95%	Indonesia
91%	Kenya
76%	Ghana
67%	Nicaragua
65%	Sri Lanka
64%	Ethiopia

TOP 10
SUSTAINABILITY IMPROVERS

66%	Myanmar
65%	Qatar
62%	Poland
57%	China
52%	Czech Republic
49%	Malawi
48%	Israel
46%	Ireland
46%	United States
46%	Australia

List of top improvers with percentage improvement in dimension scores from a year 2000 baseline. This list represents the countries making the most tangible transitions. The greatest gains in the last twenty years have been made in the Equity dimension, mostly through addressing the energy access challenge. Since 2000, the number of people without access to electricity worldwide has reduced significantly from 1.38 billion to 900 million.

For the first time this year, the Trilemma report and tool addresses this through the use of longitudinal analysis of Index trends. Using a consistent set of indicators, the 2019 Trilemma model tracks

dimension performance back to 2000 and visualises these trends. Analysing the best improvers over time in addition to the top performers in a particular year, provides more nuanced and deeper insights on differing pathways through transition and policies which enable them. Readers are encouraged to use the tool to explore country profiles and historical trends to identify moments when policy impacts start to be reflected in indicators that illustrate significant shifts within the dimensions over time rather than year-on-year differences.

Trends in Energy Security

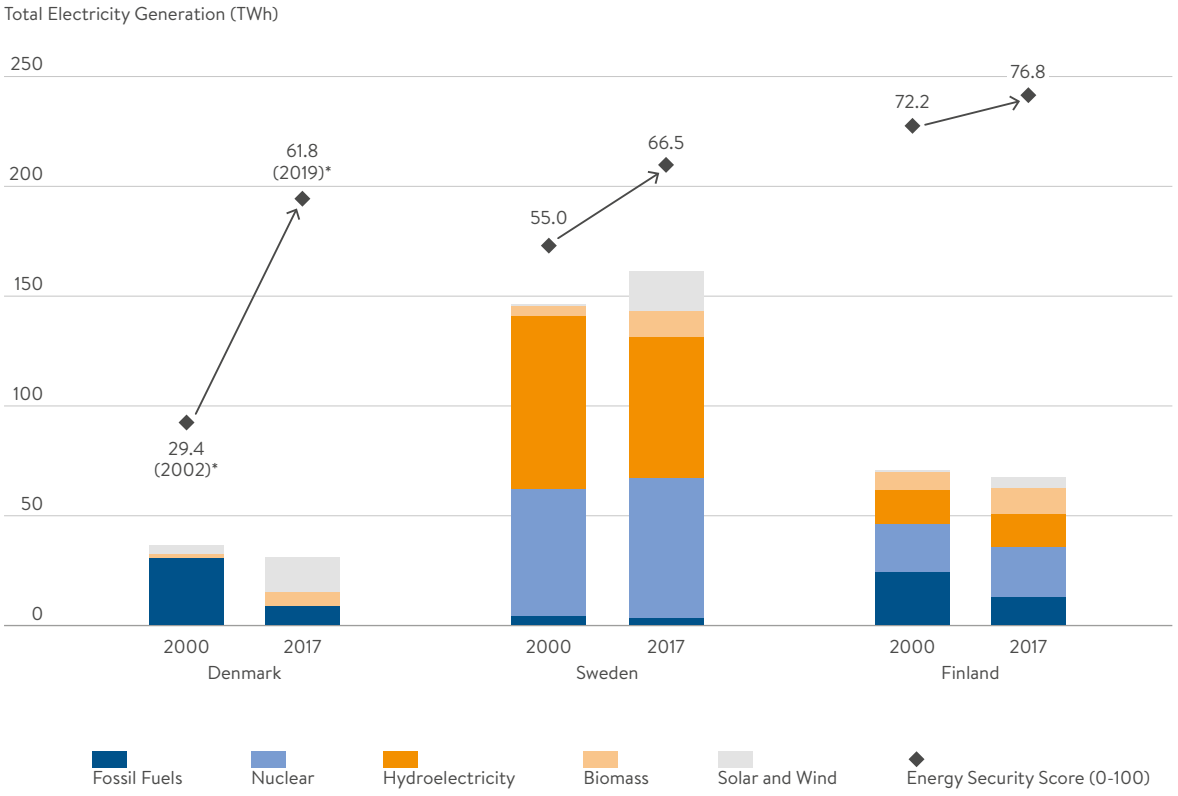
The nature of what countries and stakeholders understand and mean by 'energy security' is evolving and will continue to change as the energy transition progresses. Trilemma indicators are designed to consider security and reliability of supply, as well as factors affecting resilience.

Historically, energy security related solely to oil, although in recent years, most stakeholders have adopted a more nuanced understanding to reflect growing electrification underpinned by the move towards decentralisation, digitalisation and decarbonisation of their energy systems. This evolving understanding of energy security needs to be reflected in our definition of the Trilemma Security dimension and its supporting underlying sub-indicators. For example, oil stocks and fossil fuel reserves are becoming progressively less important, while indicators that reflect the flexibility and resilience of energy systems become more relevant.

For 2019, there is a strong European presence in the top ten countries for the security dimension, but this is a relatively recent trend and not necessarily a European Union story given the strong Nordic presence in the top five. The Nordic nations have long focused on decarbonising their energy systems, see figure 10 below. Sweden's power generation had relied upon nuclear and hydro but, since 2000, it has further diversified with increasing biomass, wind and solar generation capacity. The change in Denmark's energy mix has been even more stark. Denmark has been a pioneer of wind power, generating some 12% of its electricity from renewables in 2000. The country has subsequently increased the share of wind generation to over 50%, while increasing the share of biofuels to over 20% by 2017. Together, this has reduced Danish fossil fuelled electricity generation from 83% in 2000 to 27% in 2017, while substantially increasing its energy diversity and reducing its import dependency. Finland has also increased its generation diversity by reducing its fossil fuel generation and introducing solar and wind. These results illustrate the benefits of strong power market integration.

Looking more widely at the European situation, membership of the European Union has been an important driver to help the new and prospective members to improve their energy policies by ensuring stable regulatory and market frameworks to attract investment. One aspect of the EU accession has noticeable impact on Trilemma security performance with the EU Oil Stocking Directive coming into force at the end of 2012, requiring the new EU members to build oil stocks above commercial inventories. While this is an older aspect of Energy Security, it has helped bring the Czech Republic, Romania, Latvia and Slovenia into the top ten for 2019. The impact of joining the EU is particularly clear for Malta and Cyprus which are among the top five greatest improvements in the Security dimension since 2000. This increase was largely due to their increased oil stock levels as seen below in Figure 11. The relative importance of oil within the Energy Security dimension will decline as the transition progresses with increasing electrification.

Figure 10: The electricity generation mix in Denmark, Finland and Sweden (2000-2017)

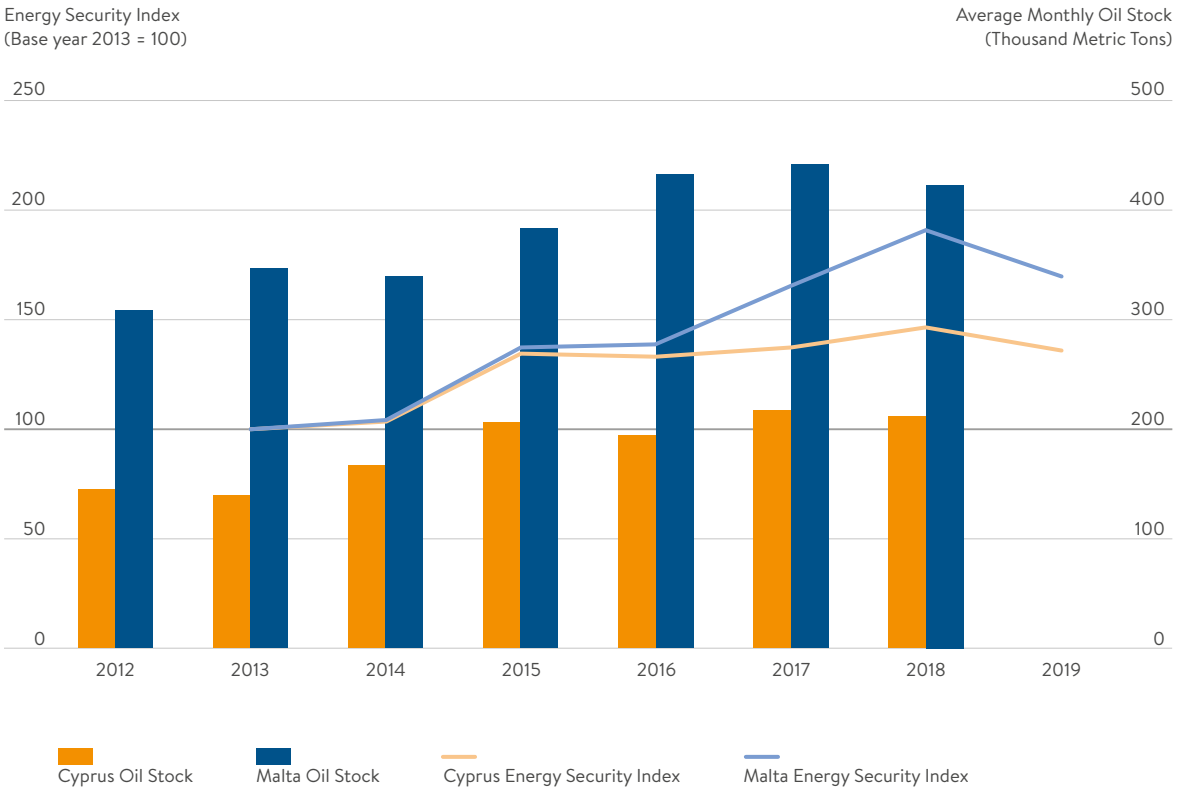


* 2002 and 2019 are the corresponding Trilemma energy security scores for electricity generation data from 2000 and 2017

There has been considerable fluctuation in the top ten countries for Trilemma Security scores since 2000 with only Canada consistently maintaining a ranking in the top ten. While natural resource endowment influences the Security dimension, generation and primary supply diversity are important factors together with stock levels. Canada's significant natural resource endowment provided a strong basis for its energy security but the country's consistent efforts to diversify its energy system and maintain a diversified economy lies behind its persistent top ten ranking.

In contrast to Canada, other resource-rich countries have had less success at maintaining high Security dimension scores or in improving their performance. Partly, this has stemmed from broader economic problems for countries such as Venezuela, but there also appears to be a deeper issue at play with some countries experiencing a 'resource dilemma'. Several resource-rich countries with poor or declining performance on the Security dimension have focused their overall economies on their indigenous natural resources and consequently have developed more concentrated or less diverse energy systems. With the overall drive towards decarbonisation, less diverse power systems are a hinderance to the energy transition. However, resource-rich countries can also be better placed to afford to diversity their systems more quickly. This is exemplified by several countries in the Gulf region, which have been developing plans and are making significant efforts to diversify their economies away from hydrocarbons. We anticipate that the energy security dimension performance of these countries will improve going forward.

Figure 11: Trilemma Security Indices compared to oil stock level for Cyprus and Malta



There are different drivers for the declining Security dimension performance since 2000. For some countries, this could be considered as the classic Trilemma challenge of building capability in one dimension at the expense of another. For example, Bangladesh and Nepal have focused their policy attention on improving basic energy access with some considerable success (see following section). At the same time, they have reduced the generation diversity within their systems and may be stretching the reliability of their energy systems in the newly connected areas, thus reducing the country's Security performance. Given their considerable progress, some form of performance lag could be expected, although this is almost certainly temporary as both countries build capability across the other dimensions and boost performance there too.

Different paths are emerging that will in turn create different policy challenges, as countries seek to improve their energy security. Traditional hydrocarbon producing countries have met increased domestic demand through fossil fuels, further concentrating their energy mix, although with increasing recognition of local pollution issues and the need to diversify economies and the generation mix. Where oil remains significant in the energy mix, some countries have been able to improve their security by building oil stocks above commercial levels in the traditional oil security approach. But the high cost of stockpiling (inventory and infrastructure), combined with the declining importance of oil within a decarbonising energy mix suggest that very few countries will follow this route in the future.

Others have improved their Security as they have sought to improve the sustainability of their energy systems. Many countries have diversified their generation mix with the inclusion of variable

renewable generation. This has reduced import dependency but instead created a dependency on the weather, whose variability will need to be dealt with, possibly through greater interconnectivity with neighbouring grids or by new energy storage technologies. Renewables and digitalisation have also enabled greater decentralisation, but the trade-off has been new energy security challenges such as cyber security, grid reliability and system integration. Increased interconnectivity within the energy sector raises the risk of cascading cyber events where adjacent sectors can affect and be affected by the energy sector or where a disruption can spread virally. These emerging challenges will need more agile and adaptive responses that and are being explored by the Council through its Dynamic Resilience workstream.

Trends in Energy Equity: towards quality access

The Equity dimension aims to reflect performance in quality energy access, abundance, and affordability for all. Embracing the overarching principle of energy for prosperity, indicators in this dimension are evolving and adapting to measure energy availability at levels which enable modern lifestyles. This implies looking at energy access, first and foremost, but also considering the abundance of accessible power per capita and its costs.

In contrast with other dimensions, where multiple indicators can show synchronous improvement, the Equity dimension is sequential: access and electrification are prerequisites of abundance and quality, which in turn present the challenge of long term equitable affordability to consumers.

Aligning with UN Sustainable Development Goal 7 (SDG7), the dimension relies heavily upon indicators of access to energy and clean cooking as the basic foundations of Equity. However, there is 100% access in all developed economies, and near 100% in many developing nations. This means the distribution of the Equity scores is skewed towards top performers, which is a positive outcome globally, but makes individual country Trilemma performance difficult to distinguish. Countries tend to be more closely bunched together and differences between scores can be less pronounced.

However, the UN SDG7 access goals are binary, in that a household has access or it does not. More nuanced indicators are needed to reflect the quality or affordability of that access. The introduction of quality energy access and affordability indicators tries to address these issues and will be further refined in future Trilemma iterations. These indicators use total consumption figures per head of population, and the cost to residents, to set some proxy benchmarks of power demand per head and cost as a percentage of income. The Trilemma model sets a benchmark minimum at 300 kwh per capita per year and costs not exceeding 3% of per capita GDP where no household figures are available.

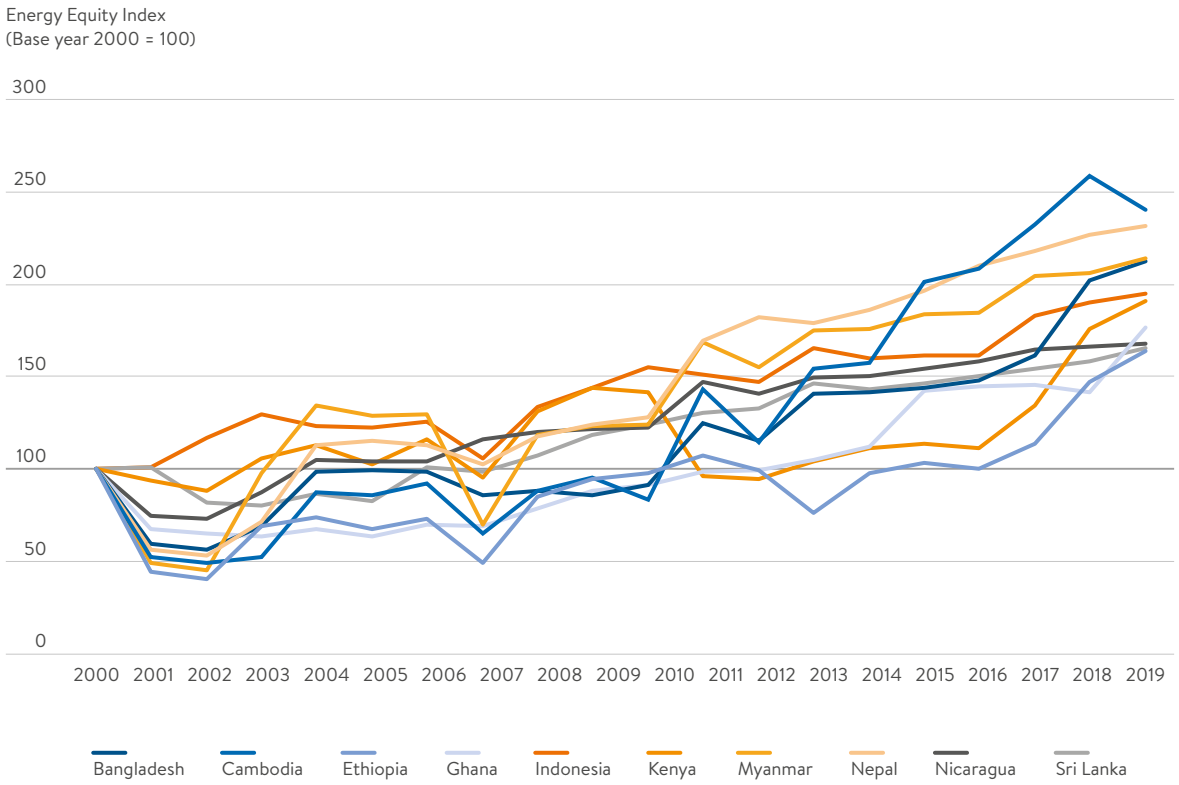
Looking at the global Equity top 10, all are countries that have solved the energy access challenge, with near 100% access since 2000; differences between them are the result of differences in cost and affordability. Much Equity success can be explained by factors of geography and population distribution: Luxembourg has persistently had the highest score for Equity and benefits from being a rich country with strong interconnections that enable a vibrant energy market with highly competitive prices. Road fuel taxes in Luxembourg are lower than in neighbouring countries, so there

are significant cross-border sales boosting any taxation shortfall, with price benefits for consumers. Singapore and the Netherlands have rich populations concentrated in small areas, making energy both affordable and easily accessible. Iceland is another perennial high-scoring country in the equity dimension, with its cheap electricity prices arising from its abundant renewable power generation (hydro-/ geo-thermal).

Abundant domestic fuel reserves, albeit traditional hydrocarbons, explain the strong placing of countries from the Gulf Cooperation Council in the Equity top ten. Bahrain, Kuwait and the UAE have consistently been in the top ten since 2000, while Qatar, Oman and Saudi Arabia have moved in and out of the top ten. Revenues from upstream production mean that road fuels tend to be sold in the Gulf countries at near production cost price and societal norms mean that even Gulf countries without significant oil production will tend to have similarly low-cost road fuels with some of the lowest global prices. The local hydrocarbon abundance has also impacted upon power generation producing cheap electricity. The downside of the cheap energy abundance is that it has not encouraged efficiency, and the Gulf countries tend to have high emissions intensities reflected in their relatively poor performance on the Sustainability dimension.

The future performance of the Gulf countries on the Equity dimension will be closely linked with the success of their effort to diversify their power generation and improve the long-term sustainability of their energy systems. Ambitious plans are already being developed (e.g. Saudi Arabia's 2030 plan) as the region responds to the energy transition and the shift to lower carbon or carbon-free energy.

Figure 12: Top 10 improvers in Energy Equity since 2000



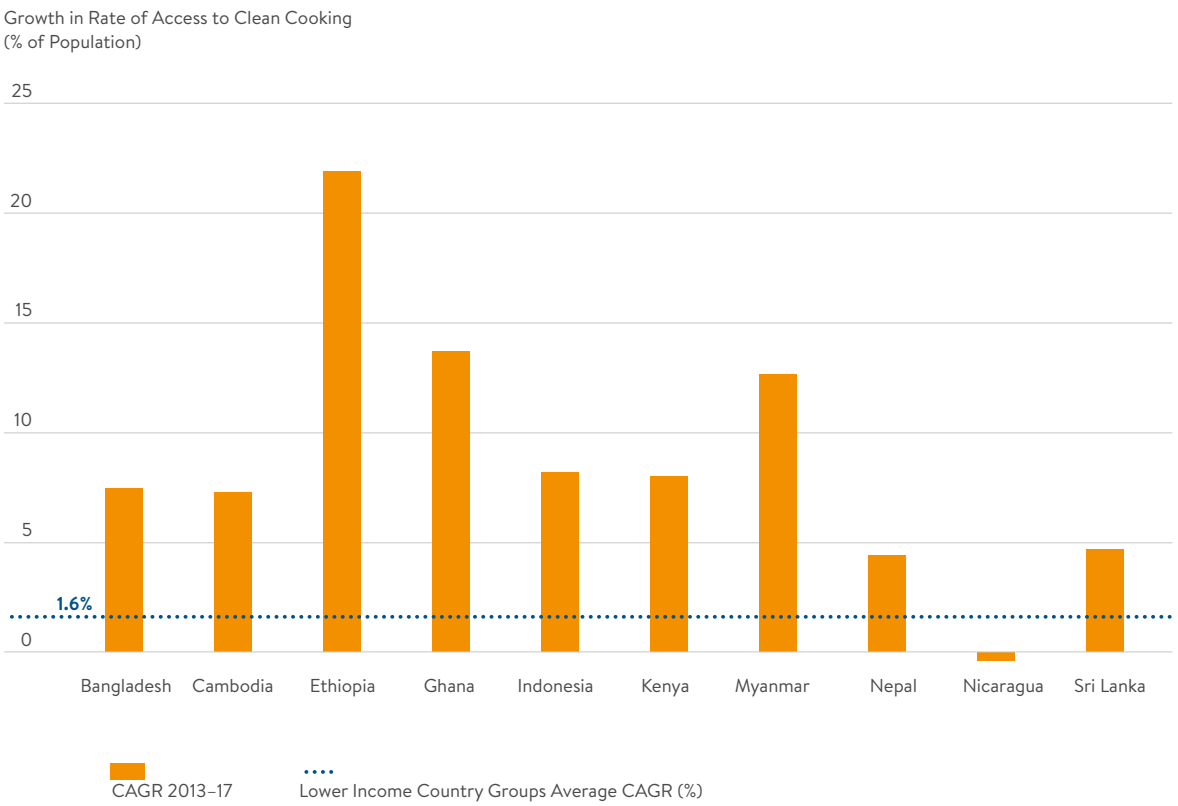
Developing countries recorded the strongest improvements in Energy Equity scores due to significantly increased energy access from relatively low baselines, representing major transformations.

A very different Equity story emerges from analysing historical trends in performance, rather than the stable Top 10. Reflecting success against SDG7 indicators, the greatest improvements in Equity since 2000 are to be found among developing countries, where rapid increases in energy access and incomes have been achieved, as can be seen in Figure 12. Looking at indexed trends, many of these countries have improved their Equity performance by between 60% and 160% compared to a 2000 baseline. This is in contrast to the global Top 10, where indices show very little change, despite scores being high.

The fastest improvers include Cambodia, Nepal, Bangladesh, Myanmar, Ethiopia and Kenya, where policies and investment have prioritised access to grid and off-grid electricity and households have become progressively wealthier. These countries have seen rates of electricity access increase in the range of 2% to 4% of the population per year since 2000 during which time per capita incomes have increased between three and six times. These countries have also seen significant increases in household electricity consumption, contributing to increased prosperity and higher standards of living.

Another driver of strong improvements in energy equity in developing nations is the strong growth in access to clean cooking fuels and technologies. Although, according to the Sustainable Development Goal 7 (SDG7), close to three billion people still lack access, the strong trends amongst the top improvers are clearly reflected in the Trilemma Equity dimension. The compound annual growth rate (CAGR) of lower income countries for clean cooking access between 2013 to 2017 is about 1.6% whilst, the top 10 improvers demonstrate CAGRs of 4% to 22%, see Figure 13.

Figure 13: Top improving countries in the access to clean cooking indicator between 2013 and 2017



Top improving developing countries saw massive improvements in rates of access to clean cooking over the period of 2013 to 2017

This means that drivers of success in the Equity dimension include investment in access and electrification infrastructure, and therefore are coupled with economic growth. Geography also plays a part, as well as population distribution, with more dense populations being easier to connect. Large producers can afford to provide cheap energy to their populations, but there may be a trade-off for these affordability gains, as other transition priorities come to the fore.

A number of countries have shown a declining Equity index over the past 20 years. It is harder to draw insights from the declining equity performance due to sparsity of price data, although it is clear that a number of African countries have made little progress in expanding access to energy. There remains considerable scope for these countries to improve energy access by learning from the positive policies of Ethiopia, Ghana and Kenya.

It is important to recognise the great progress that has been made to extend energy access, reducing the number of people worldwide without access to energy to under one billion people. However, increasing access through expanding the grid creates new challenges for grid reliability, infrastructure quality and energy affordability. Energy access should be more than a lightbulb, it should be providing sufficient supply at fair cost to enable transformative development. In developed countries with almost universal access, Equity becomes more focused on affordability where targeted policy interventions must support vulnerable low-income groups. At the same time, affordability is increasing across many countries, including those with advanced energy systems. Ensuring affordable and universal access to evolving energy services will continue to remain a policy challenge and suggests a more nuanced approach to the Equity dimension will be necessary to tackle the diverging challenges.

Trends in the Environmental Sustainability of energy systems

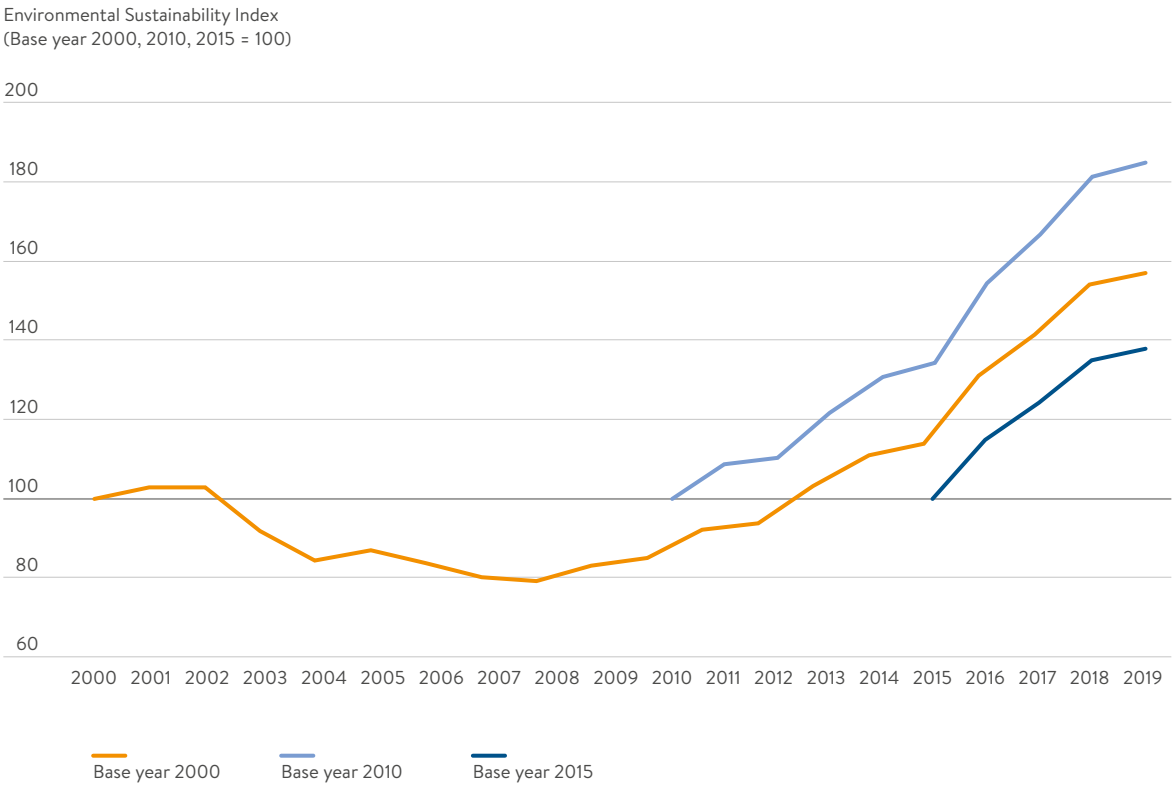
The strong performance of certain countries in the Environmental Sustainability dimension is reflective of their ambitious targets to improve the productivity and efficiency of energy generation, transmission, and distribution; to move towards a low-carbon economy through the increasing use of renewables in their energy supply; to reduce their greenhouse gas emissions and improve air quality.

Europe is prominent in this dimension with many EU members ranking among the top ten performers, which is in line with the region's strong sustainability policies, implementing ambitions in response to the Paris Agreement. Switzerland and Norway are also top and consistent performers in achieving high levels of Sustainability.

Costa Rica and Namibia are the sole representatives for their respective regions, Latin America and Caribbean, and Africa. Costa Rica has shifted almost all of its electricity generation towards renewable sources, while Namibia has implemented several reforms aimed at diversifying its sources towards a greater variety of renewable supply.

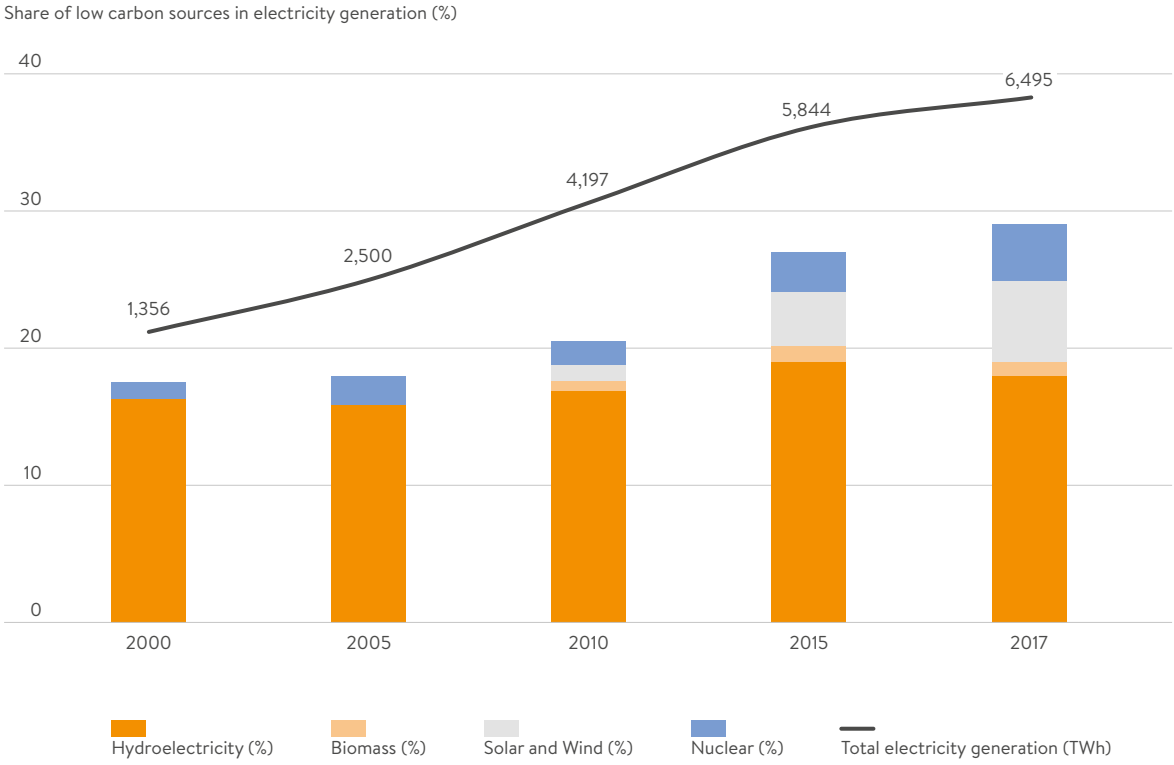
One interesting example of significant growth in the Sustainability index trend is China, see Figure 14.

Figure 14: Steady growth of China's Sustainability score over multiple time periods



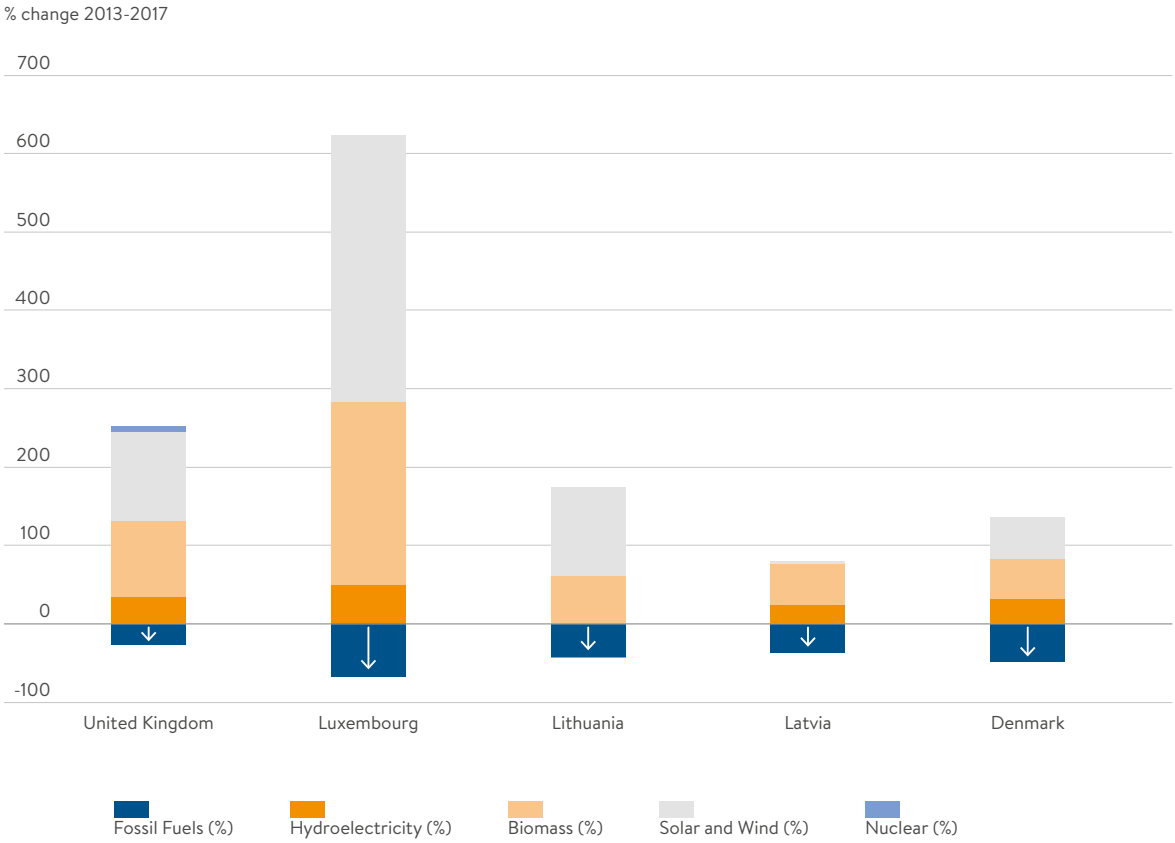
China's four-decade long economic expansion has been fuelled in large part by coal. This has had significant impact on the country's Environmental Sustainability score through intensity of CO_2 and limited energy efficiency, high emissions and low air quality. Although China remains a significant polluter, it has made progressive strides in transitioning away from coal and towards renewables. It is the only country in the Index which remains in the top 10 improvers across different time periods, showing steady and pronounced growth in its Sustainability score over time.

Figure 15: China's increasing use and diversity of low carbon sources in electricity generation



Since its inaugural Renewable Energy Law was enacted in 2006, the Chinese government has been active in implementing policies promoting sustainability. The current 13th Five-Year Plan of China, for example, indicates 'Green Growth' as one of its key objectives, and aims at reducing emissions and pollution and supporting the shift towards green energy. China has also been directing substantial investments to promote sustainability and solar power generation in both the public and private sector. China is now the biggest sovereign investor in clean energy and low carbon sources have grown over the past years include solar, wind, nuclear and biomass, see Figure 15 above.

Figure 16: Countries leading in indicator score change for increasing low carbon electricity generation, % change 2013–2017

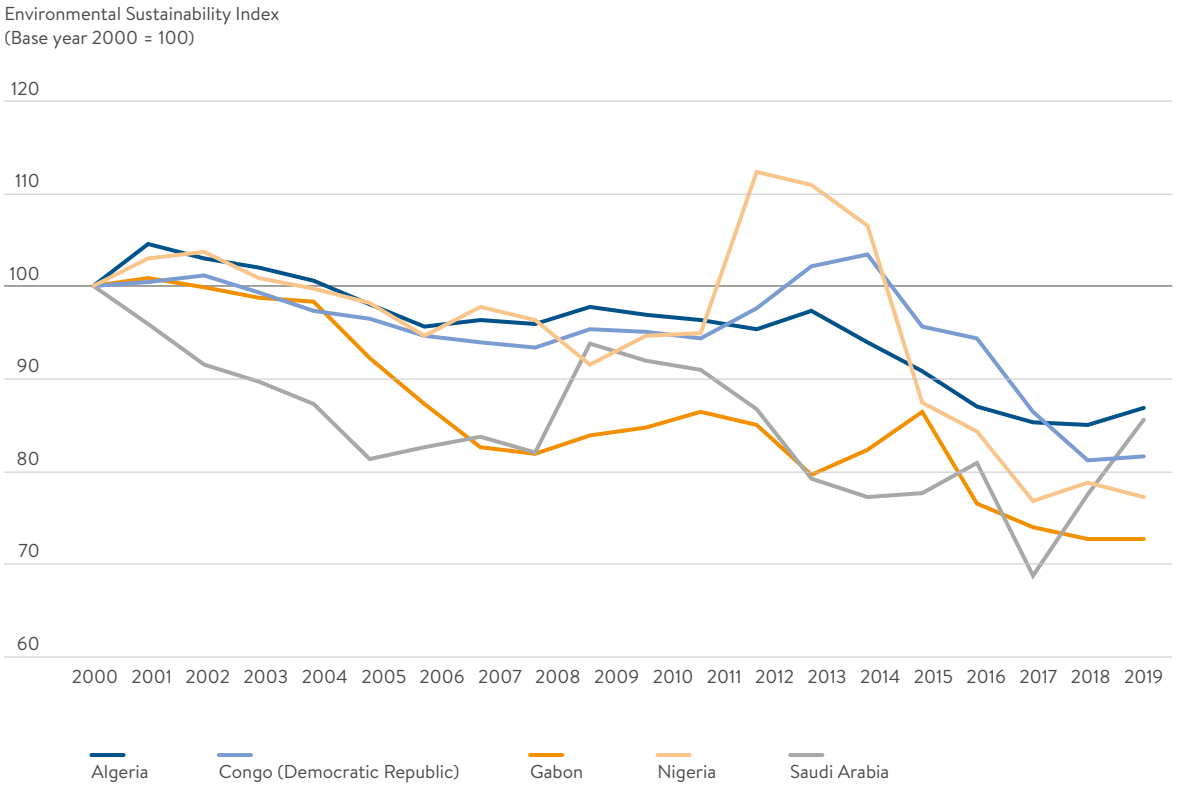


The top five countries showing an improvement in low carbon electricity generation are Denmark, Latvia, Lithuania, Luxembourg, and United Kingdom. Their five-year improvements have been achieved by the fall in use of fossil fuels and the rise in renewable sources for electricity generation, especially in solar, wind, biomass, and hydroelectricity, see Figure 16.

Strong improvements in these five countries showcase the results of regional and domestics actions undertaken by EU nations to hit a binding target of 20% final energy consumption from renewable sources by 2020. These efforts are being reinforced by renewable energy entering a virtuous cycle of falling costs, increasing deployment and accelerated technological progress, especially in solar and wind power. Future trends and developments in electricity storage technologies will make these improvements even more significant in driving dimension performance and sustainable goals.

Fossil fuels rich countries tend to have lower Environmental Sustainability scores, and their performance over time shows little to no improvement. Some countries exhibit a long-term negative trend in their Sustainability scores falling below the baseline in 2019 as economic growth fuelled by polluting fuels drives down scores in energy and CO_2 intensity, which are key indicators in this dimension.

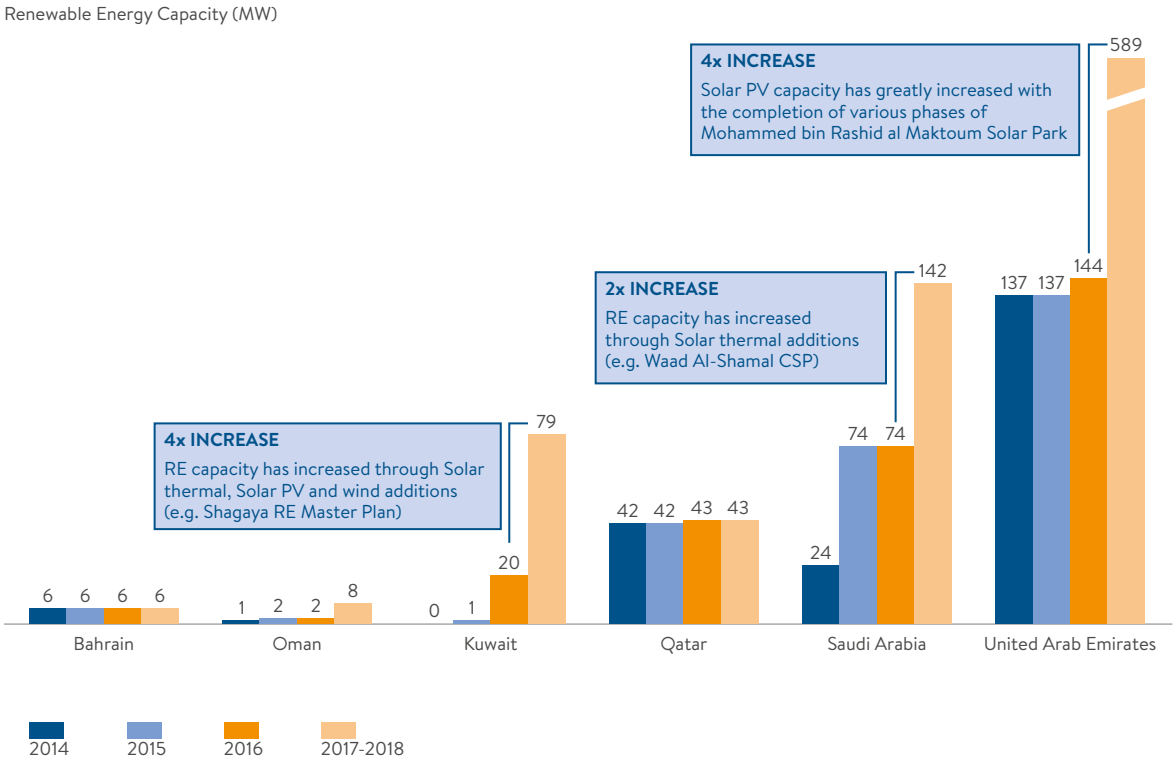
Figure 17: Countries with falling Sustainability Index trends, 2000–2019



OPEC Nations make up half of the top 10 drops in Sustainability from 2000 to 2019

Although the Gulf region's share of renewables in electricity generation is the lowest compared to all other regions in the world, several GCC nations are taking early steps towards diversifying into renewables, see Figure 18. Saudi Arabia has unveiled plans to develop 59GW of renewable energy by 2030, and projects for solar generation are underway in the UAE. Although this only makes up a small portion of the countries' overall energy profile, it illustrates a positive future transition trend, likely to be reflected in future Trilemma indices. Other fossil rich countries, such as Nigeria, Congo (DRC) and Gabon, are less able to restructure their systems towards renewables, due to economic and political instability, sometimes characterised by corruption slowing down policy implementation.

Figure 18: Renewable energy capacity (MW) has advanced rapidly in several Gulf Cooperation Council nations since 2014 creating potential to improve sustainability



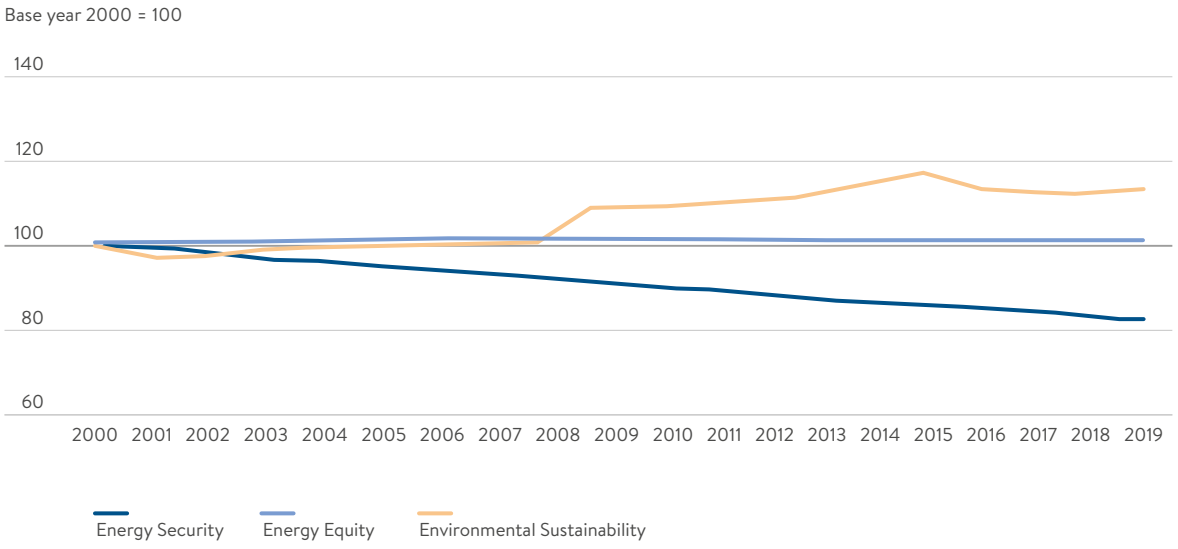
Improving performance in the Sustainability dimension tends to be prompted by localised concerns in developing economies in contrast to the broader climate agenda drivers for OECD and EU countries. For both developing and developed countries, the energy transition is still encouraging countries to explore pathways to a lower carbon and more sustainable future, although slower than many would advocate to mitigate higher levels of climate change.

Overall Index trends

There are no continual improvers in all three Trilemma dimensions since 2000. This is an important insight as it implies that the global energy transition has historically necessitated various trade-offs, where countries could manage one or two dimensions of energy performance, at the expense of the third dimension. This means that the classic 'Trilemma' challenge still remains relevant.

For example, using 2000 as a baseline, 49 countries have improved or maintained their Equity and Sustainability above the base year, but have dropped in their Security score. This represents trade-offs in the ability to meet growing demand as access extends to remote rural areas, or the increasing intermittency of a diversified grid and the teething problems of new infrastructure.

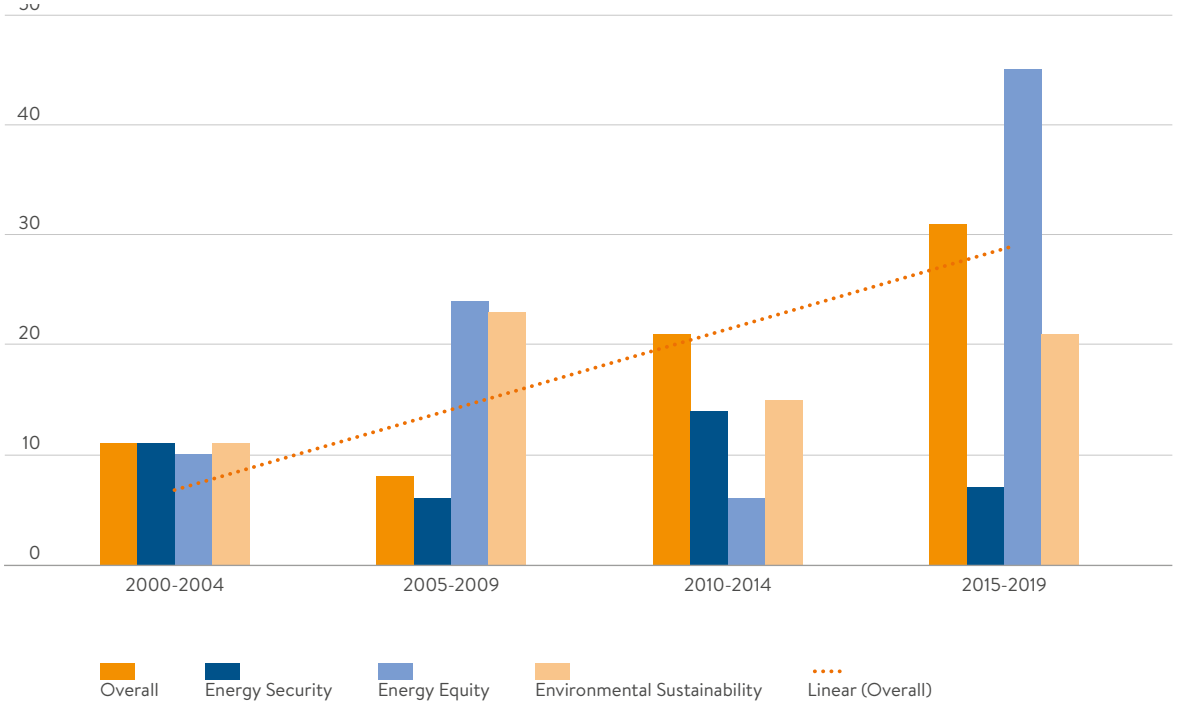
Figure 19: Illustrative example of a trade-off Index trend.



Improving one dimension or maintaining high performance in one area of the Trilemma, can come at the cost of another. For example, improving Sustainability through rapid diversification towards multiple renewable sources can have initial intermittency and supply stability problems, leading to a drop in Energy Security performance, at least for some time.

However, global energy communities are gradually addressing these drawbacks, and an increasing number of countries show improving indices across all three dimensions from 2010 or 2015. This means that more and more countries annually are able to overcome the need for trade-offs and advance the three dimensions in a balanced way.

Figure 20: Number of countries with positive overall indices across all three dimensions.



Addressing the Sustainability dimension reflecting decarbonisation and pollution control is becoming a key driver of overall Trilemma performance. For advanced energy systems, Security is usually quite stable. Once basic access is achieved, managing Equity becomes a less significant obstacle to dimension performance. Therefore, changes in the Sustainability dimension can have the greatest impact on a country's overall Trilemma performance. Six of the most significant drops in the Index are represented by countries reporting greatest reductions in Sustainability indicators. The dimension reflecting decarbonisation and pollution control is becoming a key driver of overall Trilemma performance. This insight can be useful in encouraging policy makers to explore how best to focus efforts in the sustainability sphere.

Countries from the OECD, and European countries in particular, have tended to dominate the overall Trilemma Top 10 since 2000. New Zealand is the only Asia-Pacific country in the overall top ten and has been there consistently since 2000, demonstrating longstanding sound energy policies. The only other non-European country to feature in the overall top ten is Canada, although it dropped out of the top ten in 2016. Aside from a persistent Nordic presence, there has been some change in European countries, for example with Austria, UK, and Germany cycling in and out. Given the longstanding OECD and European focus on improving energy policy, it is not surprising to see these countries with the highest overall scores, although this sometimes masks where there have been significant energy policy improvements.

One notable insight from historical trends is that generation diversity initially boosts performance in both Security and Sustainability. Those countries that heavily invested early on in nuclear energy (France, Sweden, Finland) have performed at a persistent high level but are now facing the new challenge of replacing their nuclear assets due to operational lifetimes and policy shifts.

The expansion of wind and solar power has been beneficial although here the Nordic countries have been able to incorporate high levels of variable renewable generation through high levels of inter-connectivity across borders. Interconnectivity and diversity of generation capacity are perhaps the hidden enablers for strong Trilemma performance. While some other regions could benefit from greater interconnectivity (LAC, Africa, Asia), this is not an option for all countries and reinforces the particularly strong and consistent performance by New Zealand that is truly an islanded system with no little realistic possibility of increasing its connectivity with other countries.

Higher scores can tend to be associated with smaller countries with higher population densities. Large land masses with sparsely populated countries tend to have more challenges connecting their citizens with a reliable energy supply at a fair price.

Reassuringly, less than 10 countries have seen their overall Trilemma decline in the period since 2000, but this does include a number of major oil producers. The declines for these resource rich countries stem from their weak performance on the Sustainability dimension where they have met increased domestic energy demand via their hydrocarbon assets; their growing emissions could be considered as a 'resource dilemma'. None of the overall decreases are irreversible, but offset improvements in the other dimensions.

In contrast, those countries that have seen the greatest improvement in their Trilemma performance in the period since 2000 have largely achieved this on the basis of their improved Energy Equity performance. Extending energy access has been one of the primary drivers for the largest improvement. Some of those improving their Equity scores have also made substantial improvements to their Sustainability dimensions, although it should be noted that many of these countries were starting from a low basis where small improvements can have a very tangible impact.

The most substantial overall Trilemma improvement over the past 20 years has stemmed from the Equity dimension through concerted efforts to increase access, spearheaded by the UN SDG7 goal. While considerable scope remains for subsequent improvement within the Equity dimension, it is unlikely to drive the overall improvement of Trilemma performance going forward given the more complicated challenges of affordability. Concepts of Energy Security are evolving away from strengthening oil stocks to methods for flexibility and resilience, which suggests that the main growth potential for future Trilemma performance is likely to be the Sustainability area. In some aspects, we are already seeing this with efforts by countries in the Nordic region to improve their Sustainability performance producing co-benefits in the security dimension. But many of their improvements have been underpinned by greater interconnectivity and market coupling enabling a higher take-up of variable renewable generation. New digital technologies are likely to enable more renewables and decentralised energy systems in less well-connected markets that would need to be supported by astute policy choices.

The Trilemma provides a conceptual framework to help energy stakeholders determine which policies would be the most effective to navigate the transition. Future high performance is likely to come from countries embracing the framework of balanced, multi-dimensional growth through integrated policies.

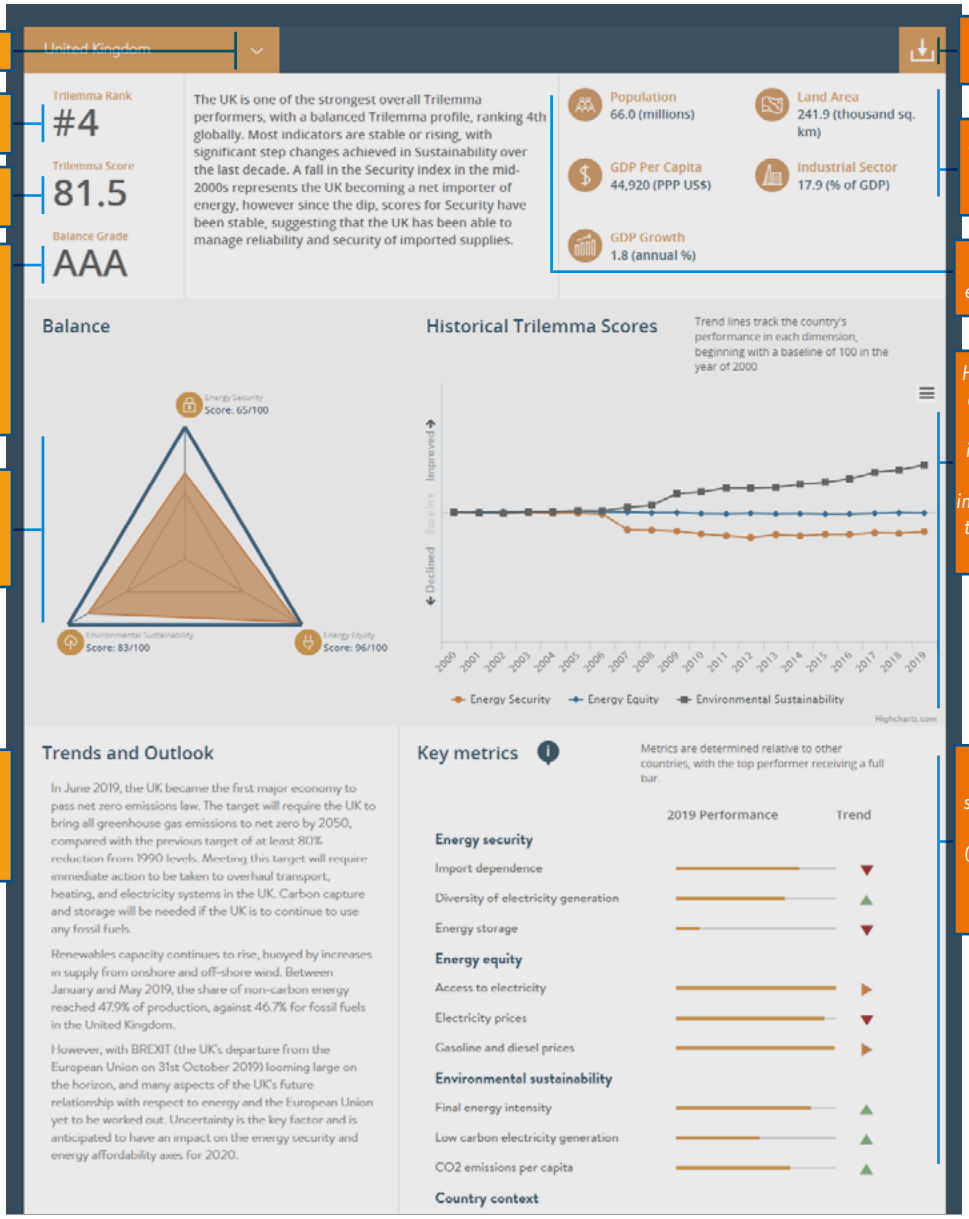
How To Use The New Trilemma Index Tool

HOW TO USE THE NEW TRILEMMA INDEX TOOL

This report presents highlights of the 2019 World Energy Trilemma Index results, as well as some insights from the scores and trends.

Users are encouraged to read this report in conjunction with the online Trilemma Tool, which presents full results per country, as well and commentary and insights from national experts.

Country profile preview



Country drop down list

World Energy Trilemma Index Rank

Overall Trilemma Score out of 100

Overall 2019 balance grade. The first letter refers to Energy Security, the second to Energy Equity and third to Environmental Sustainability

The Trilemma Triangle is a snapshot of the balance of a national energy system

Commentary on national trends and outlook from Council Member Commitee experts

Each country profile can be downloaded as a PDF

High level country statistics for context, based on World Bank data

Performance commentary explains the trends observed

Historical Trends for all three dimensions using 2000 as a base year. Each dimension is tracked from a base score in the year 2000 to show improvements or declines over time compared to a national baseline

Key indicators driving the scores in each dimension are presented: the 2019 score (full bar represents 100) and a trend since 2010 (rising, falling or stable)

New features of the Trilemma for 2019

The Trilemma Index has been gradually refined since its introduction and now covers 128 countries. The original methodology has been revised throughout the years with the aim of improving transparency and offering stakeholders better insights to help improve their energy policies.

The World Energy Council strives to improve the Index continuously. Working with its partners, stakeholder community and governance body, the report methodology is reviewed and adjusted when deemed necessary.

The 2019 Index is based on a substantially revised methodology which supports the ongoing evolution whilst broadening of the Trilemma conceptual framework. There are four main areas of methodological evolution.

Data sources. Data sources were revised to use the most reliable and up-to-date information available.

Indicators. To improve relevancy and coherency, the list of indicators on which the 2019 Trilemma is based has changed. Some indicators were added, while others were removed or reassigned to a different dimension.

Weighting. Indicators weights were changed to enhance transparency and ensure a fair distribution of scores across countries.

Indexation. Country historical performance is now calculated against a baseline year of 2000. This has been enabled by improved historical data. It is now possible to identify countries demonstrating long-term improvement, stagnation, or decline. Each year's data has been used to calculate scores using the new methodology, providing a consistent trend that can be used for analysis. This also addresses concerns that the Trilemma's annual ranking favours wealthy countries and those with large resource endowments, because it now recognises progress against national baselines as well as providing a comparative snapshot against other countries.

Scalable conceptual framework for analysis: Global, Regional, National and Sub-national

The Index is calculated at a global level with globally comparable data, delivering a global level ranking of most countries in the world. For some indicators, using the same "ruler" to measure vastly different nations, of different size, geography, reserve and governance structure blurs the detail. The global Trilemma is just the start of the conversation. Beyond it is the opportunity to explore dimension performance at regional, national, and sub-national level.

The Council has already conducted regional and country group Trilemma analyses for the G20 and ASEAN results. These allow ranking and analysis of dimension performance between countries with more shared characteristics than a global comparison, and draw out insights on policy opportunities for collaboration and progress.

National Trilemma pilot projects are under way with some Member Committees of the Council. These look to use nationally relevant indicators and nationally reported data to track dimension progress, comparing country performance to aspirational targets and real, observed baselines, rather than international comparisons.

Feedback from the potential regional or national Trilemma pilot studies will also help develop the broader programme and continued improvement of the Trilemma concept, encouraging iterative Trilemma learning.

The evolution of the Trilemma work will extend the global conceptual framework to regional country groupings (e.g. Latin America or Europe), individual countries and economies and beyond that to the sub-national level of provinces or states. The sub-global frameworks will mirror the global Trilemma model using the same dimension building blocks but with different underlying national or local data and with a revised contextual dimension to aid categorisation.

Using the Trilemma for energy policy pathfinding

Until this year, the Energy Trilemma has been a comparative ranking of 128 countries assessed across the dimensions of Security, Equity and Sustainability. A comparative ranking is a strong conversation starter about energy policy, galvanising a desire to improve in rank and highlighting which dimension might need the most focus.

A comparative ranking is not sufficient to provide guidance on how to improve a country's energy policy. One could look at the top-ranking countries for the different dimensions to understand the reasons for their better performance although whether or not their policies would be relevant to other countries would require further analysis of the differing domestic contexts. Another limitation of only considering the comparative rankings comes from the fact that improving performance by one country may not be recognised if other countries have improved more. These limitations are addressed by a nuanced analysis of trend indices through longitudinal insights.

A time-series analysis in Index trends enables performance to be assessed over time against a country's own baseline to understand whether a policy intervention has made a positive impact or if further refinement might be necessary. It also provides guidance for identifying the more effective policy interventions that enables the Energy Trilemma to become a policy pathfinding tool.

By seeing performance at a country level over time, it becomes easier to identify where a policy intervention might be best targeted and then to subsequently track its impact. This follows an evidence-based policy assessment approach. The Trilemma provides potentially greater insight by assessing performance across the three related dimensions so that unintended consequences can be spotted but also by enabling comparison with other countries with similar contexts.

Extending impact: What's next for the Trilemma?

The Trilemma methodology will need to follow a "Kaizen" philosophy of continuous improvement in order to maintain and build its relevance. This can already be seen where the evolution has

highlighted several areas where we need to build better metrics and create new sub-indicators to understand the impact of the energy transition on energy policy performance.

At the same time, we will build upon the scalable Trilemma conceptual framework with more pilot studies at regional and national levels using local data and revising indicators to reflect the local context. There is also scope to cluster countries with similar characteristics to explore which policies are performing best and understand why this might be so. This type of country cluster analysis has already begun with the G20 countries.

The scalable Trilemma conceptual framework will also be extended to consider sub-national levels. As an initial step, we anticipate piloting the Trilemma at a provincial level in a country with a federal system and good provincial level data that can use the same Trilemma calculations. The next step will to explore a city-level Trilemma although this will be complicated by the greater need for data proxies and use of qualitative data as opposed to the quantitative data currently used.

We are particularly keen to develop the longitudinal analysis presented for the first time in this report. The underlying time-series data provides a sound basis to explore some of the sub-indicators going forward. Using this approach, we will build Trilemma Trajectories to explore future possible Trilemma performance, with the intention to combine these with the World Energy Scenarios to create a policy gaming framework investigating differing policy pathways under alternative possible futures.

Our goal is to be able to present completed pilot studies of the city-level Trilemma and Trilemma Trajectories at the 25th World Energy Congress in St Petersburg in 2022 with intermediate progress presented to the intervening World Energy Weeks.

Regional Energy Profiles

REGIONAL ENERGY PROFILES

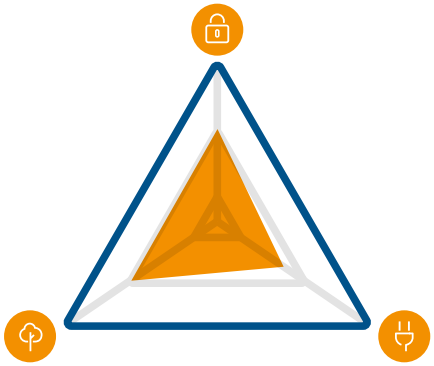
The transition of energy systems is a long and complex process, following multiple trajectories. Scaling the World Energy Trilemma analysis to the regional level provides useful insights on the pathways to robust and balanced energy systems. Some regions, like Europe, exhibit relatively homogenous trends in the Trilemma dimensions, with common regional policies across parts of Europe, shared priorities and similar funding mechanisms. Other regions, like Asia, represent a diversity of pathways for change.

The ultimate Trilemma goal is to enable a balanced transition, where each dimension is addressed without detriment to the others. Analysis of regional average performance can provide a big picture of the relative priority balance between multiple countries. Identifying leaders and accelerators in each region, and specific policy priorities which enable their advancement, showcases possible best practice approaches for regional neighbours.

The six regional Trilemma profiles are compiled by the Council's Regional Managers, with the help of Region Committee Chairs and other experts from the region.

Africa

Figure 21: Africa region Trilemma balance



AFRICA 2019 ENERGY TRILEMMA INDEX RANKING

Mauritius (50)	Eswatini (101)	Ethiopia (120)
Tunisia (75)	Ghana (103)	Madagascar (121)
Algeria (82)	Kenya (106)	Mozambique (122)
Morocco (83)	Cote d'Ivoire (111)	Nigeria (123)
Angola (86)	Zambia (112)	Malawi (124)
Egypt (87)	Cameroon (113)	Benin (125)
Gabon (89)	Zimbabwe (115)	Chad (126)
Namibia (90)	Mauritania (116)	Congo (DRC) (127)
South Africa (92)	Senegal (118)	Niger (128)
Botswana (96)	Tanzania (119)	

The Africa region covers the African continent including North and Sub-Saharan Africa. Within the region, there are large disparities in terms of country demographics, access to natural resources, economic development and energy consumption. Africa's lower economic development tends to mean that the region's countries to be in the bottom half of the overall Trilemma rankings. The low ranks reflect the lower starting point and do not mean that African countries are not improving their energy policy performance, as many are making substantive improvements, particularly in access to energy and clean cooking under the UN Sustainable Development Goal 7. While these improvements are promising, long-standing issues such as grid stability to unlock its rich endowment of diverse energy resources and potential for renewable energies by improving its energy policies and regulatory frameworks. An improved regulatory environment with enhanced institutional capabilities would help to attract the necessary investment to develop and improve Africa's energy systems to meet future energy demand sustainably and affordably.

Africa's low overall performance masks a diverse picture where improvements to low scores across all dimensions are being made. Energy Security could improve through the cost-effective development of the region's abundant energy resources to enable a more reliable energy supply. While Energy Equity remains low, the situation is mixed with North Africa having high levels of access to electricity and clean cooking, while elsewhere affordability and access can remain challenging. Sustainability is Africa's strongest dimension with many countries in the region beginning to act upon the Paris Climate Change Agreement. Despite some national and sub-regional focus on clean energy deployment and actions to protect the local and global environment, there are still emerging environmental challenges, which require better governance of resources, infrastructure investments, access to appropriate technologies and policies to improve the overall energy systems management and development in a more sustainable way.

In the Energy Security dimension, one African region country, Angola, is amongst the top ten global performers with the next highest African country (Egypt) ranked 45th. Angola is successfully exploiting its oil reserves while maintaining low-carbon generation mix which includes 58% hydro and has developed an integrated transmission network to improve supply. The region's top

performers have developed their energy resources to meet their domestic energy demands while also establishing energy efficiency programmes and increasing deployment of renewable energies that have improved the reliability of the energy systems.

Most African countries tend to score C or D for Security with 12 countries being outside of the top 100 countries. The poor performance results from a variety of different causes that disrupt the reliability and security of energy supplies. Conflict or political instability lead to dysfunctional government that will delay or prevent vital infrastructure investment.

Many African countries need to develop their grid infrastructures and are exploring innovative approaches that offer step change improvements. Decentralised grids and distributed generation using pay-as-you-go solar power systems are enabling micro-grids for more remote areas. The lower cost of solar and wind generation together with advances in energy storage with a distributed energy resource system could offer an alternative to a centralised grid system for locations.

In the Energy Equity dimension, Africa is challenged by having the lowest level of electricity access – 52 % overall and 43% in Sub-Saharan Africa, so that more than 600 million people in Africa still do not have access to electricity. Africa's average electricity consumption estimated at 576 kWh/capita is considerably lower than other regions and does not reflect the potential energy needs of the population. Energy affordability remains a serious concern for almost all African countries, with high electricity prices and high connection fees affecting low-income households and restricting the extension of electricity access. More affordable electricity tariffs would improve living standards by boosting access to modern energy services and bringing electricity to a greater proportion of the population.

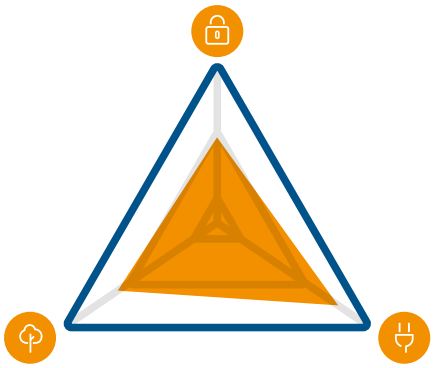
Addressing Africa's Energy Equity challenge requires bold action that includes improving infra-structure with more power generation and better transmission / distribution capacity that could be enhanced by better regional energy integration and common regulatory frameworks enabling cross-border projects.

In the Environmental Sustainability dimension, Namibia is a top ten performer. Although a small country, Namibia's energy system is low-carbon and well-connected, with a generation mix dominated by hydropower (58%). Currently, the country imports 60% of its power supply from neighbouring countries (Zimbabwe, South Africa, Zambia); in the future the government aims to build upon this by setting an ambitious plan to develop renewables further. Other African countries do not perform so well, although many are implementing national climate action plans aligned with Nationally Determined Contributions (NDCs) further to the Paris COP 21, which actively promote renewable energy deployment and commit to reducing carbon emissions in electricity generation and in transport.

Greater use of renewable resources would help Africa improve its Environmental Sustainability Trilemma performance. There is an emerging consensus to push renewable energy with almost all African countries now promoting renewable energy solutions, particularly solar and wind due to falling costs supporting decentralised energy solutions.

Asia

Figure 22: Asia region Trilemma balance



ASIA 2019 ENERGY TRILEMMA INDEX RANKING

New Zealand (10)	Azerbaijan (57)	Myanmar (104)
Australia (28)	Thailand (68)	Cambodia (105)
Japan (31)	Indonesia (69)	Mongolia (108)
Hong Kong (34)	China (72)	India (109)
Korea (Rep.) (37)	Sri Lanka (85)	Pakistan (110)
Singapore (43)	Vietnam (91)	Bangladesh (114)
Malaysia (51)	Philippines (94)	Nepal (117)
Brunei (56)	Tajikistan (99)	

Asia, and more broadly Asia Pacific, is one of the largest and most diverse regions in the world, with a multiplicity of languages, religions, stages of economic development, forms of government and energy systems. It is comprised of both small island nations and large landmass countries; highly developed, transitional and developing countries; energy exporters and energy importers; countries with abundant energy resources and those with scarce resources.

The region is widely predicted to be the focus of global economic growth to 2040 and beyond. Despite the slowdown in China's economy, the expected continuing growth of the economies of India and many of Asia's emerging nations will have an impact in the future not only on the energy situation in the region but globally as well. The 2019 Trilemma rankings reflect the diversity of the Asia region, with only nine of the 23 countries ranking above 50% overall and only one Asian country, New Zealand, ranking in the top ten globally. While significant strides continue to be made in terms of energy equity (71.5), the region as a whole still struggles with Energy Security (56.5) and Energy Sustainability (59).

Some Asian countries are far advanced in setting forward-thinking, progressive energy policies that aim to advance their ability to meet the UN's seventeen Sustainable Development Goals and their commitments to the Paris Agreement. Simultaneously, other Asian countries still struggle to address some of the most basic energy issues and are still at the early stages of laying the foundations for an equitable, secure and sustainable energy future.

Dramatically increasing demand from both consumers and from industry and buildings, the challenge of outdated infrastructure and aging power plants; a lack of coordinated national energy policies; trade wars; an unbalanced distribution of resources; unstable or frequently changing governments; and an uncertain global economic situation make it difficult to construct effective policies that will help Asian countries meet the energy challenges they face. However, no matter at what stage these countries are in terms of their energy transition, they recognise the importance of setting a clear vision for the future to help them develop and implement sound and effective energy policies.

Asia continues to improve its score on equity, with access to modern energy having gained momentum across the region and many Asian countries now closing in on 100% access. That said, there

is still a noticeable difference within some countries such as Indonesia, where the remote islands still have very limited access, or India, where urban areas can boast nearly 100% access, but where the remoteness of the rural areas making up much of the country makes connection to the grid extremely difficult.

Despite good progress toward full energy access, however, there needs to be a focus not just on providing basic access, but on moving the dial toward providing affordable, quality access as the next step in true energy equity.

Energy security is an issue for many Asian countries. Asia continues to be the largest market for energy imports, due to rapid growth of demand led by China and India. Last year, China became the world's second largest net importer of LNG, surpassing Korea; Japan remains the largest importer of LNG. These are not the only countries that rely on neighbours both near and far to help meet energy needs. Singapore, for example, relies on imports to provide more than 90% of its electricity. In a region where demand is growing exponentially, this makes for a difficult situation. With global trade disputes and an uncertain global economy creating ambiguity, the situation becomes even more volatile.

To meet the challenge of a secure energy supply in Asian countries, regional integration will be critical in the coming years. Regional integration could be leveraged to share both fossil and renewable resources, infrastructures and systems at different scales. An "Asian Supergrid" could encompass, for example, grid interconnections known as the "ASEAN Power Grid" project, which has slowly been progressing over recent years. It is politically challenging but possible, and economically very beneficial. The Belt and Road initiative in China is another example of a plan for sub-regional grid and pipeline connections. There are further examples of focused R&D, new technologies, and strategic policies which aim to increase security, such as Sri Lanka's plan to become energy self-sufficient by 2030. Increasing the share of renewables will help increase the level of security in the region, but these will take some time come to fruition and deliver actual improvements.

Many Asian countries have abundant hydro, solar or biomass resources. Although wind power potential is scarce in Southeast Asia, it is abundant elsewhere with substantial investment in offshore wind planned in Asa Pacific. However, high costs, uneven distribution of resources, intermittency and the lack of either the necessary infrastructure or

the necessary investment levels (or both) are barriers to higher levels of integration for renewables. That said, governments are beginning to recognise that renewables must play a role in their energy mix going forward as a way to help mitigate carbon emissions and improve security of supply, and there has been a move to develop energy plans and policies that include a higher share of renewables in the energy mix.

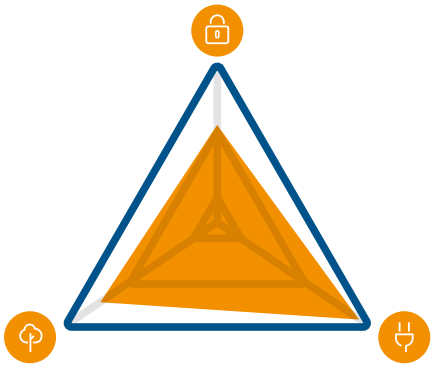
China and India, two of the biggest GHG emitters in Asia – mainly due to their massive populations and sharply increasing demand from both consumers and industry – continue to use coal as a major source of energy. Although experts generally see India's use of coal continuing to grow, China's desire to improve air quality, coupled with the growth of non-fossil fuels (renewables plus nuclear

and hydro power) that, according to BP's 2019 Energy Outlook, will more than match the entire growth in Chinese energy demand [to 2040] should result in some improvement in China's overall sustainability score. India is also focused on cutting emissions, for example, by increasing the use of electric vehicles in its major cities.

Although there are positive signals from a handful of countries including New Zealand, where about 40% of its energy supply and 85% of its electricity comes from renewables, the overall picture for the region continues to be one of growing demand outstripping the ability to rely on renewables to mitigate emissions. Clearly, this will continue to have a major impact on the ability of the Asia region as a whole to perform well on the sustainability dimension of the Trilemma.

Europe

Figure 23: Europe region Trilemma balance



EUROPE 2019 ENERGY TRILEMMA INDEX RANKING

Switzerland (1)	Italy (20)	Poland (53)
Sweden (2)	Iceland (21)	Cyprus (54)
Denmark (3)	Latvia (22)	Kazakhstan (59)
United Kingdom (4)	Slovakia (23)	Armenia (60)
Finland (5)	Belgium (24)	Ukraine (61)
France (6)	Ireland (25)	Montenegro (64)
Austria (7)	Romania (26)	Turkey (66)
Luxembourg (8)	Croatia (27)	Serbia (70)
Germany (9)	Portugal (29)	North Macedonia (71)
Norway (11)	Estonia (30)	Albania (73)
Slovenia (12)	Malta (33)	Georgia (77)
Netherlands (14)	Lithuania (36)	Bosnia and Herzegovina (79)
Czech Republic (16)	Bulgaria (41)	Moldova (107)
Spain (18)	Russia (42)	
Hungary (19)	Greece (47)	

European countries feature significantly in the overall Trilemma top ten reflecting concerted efforts to improve energy policy performance. Ranking, however, is relative and not an absolute result; challenges of maintaining high performance and making further improvements can be even greater than initial steps from a low baseline.

The European Union (EU) has set out ambitious climate change goals, but the European region is falling short on delivery of its sustainable energy objectives. The region has specific climatic, economic, social, environmental and political circumstances leading in parts of the region to inefficient use of energy, increasing energy costs, and unsustainable and unaffordable energy access. According to the UNECE project “Pathways to Sustainable Energy” results, current National Determined Contribution mitigation commitments are insufficient to achieve a 2°C target. There is an urgent need to accelerate the transformation; more determined action is therefore needed before 2030.

The Nordic countries have been leaders at developing progressive energy policies with climate change goals aligned to their NDCs using their hydro, renewable and nuclear resources, together with their geographical preconditions. Other European countries (UK / France) are starting to consider more ambitious plans with net-zero carbon targets with future bans on sales of new fossil fuelled vehicles being considered.

While the European region is considered to be rich in economic terms, it is quite diverse and includes countries that are in earlier stages of economic transition with lower incomes, as well as developed high income countries. Additionally, the region is diverse in its energy resources with both energy resource rich and poor countries. The European region as a whole uses significantly higher energy per capita than world levels, although with significant variation within the region. Previous analysis

by the Council showed that there is a strong correlation between the Trilemma ranking position and gross domestic product per capita classification that also partly explains the EU higher rankings within the broader European region.

Importantly, parts of Europe report some of the highest residential electricity prices in the world, making energy poverty, the inability to afford sufficient levels of energy, a real concern in some European countries. Overall market design in Europe is a challenge, both in terms of equity and security of electricity supply, with EU TSOs raising concerns.

In terms of security of energy supply, European countries have tended to be amongst the most highly ranked. Their individual energy balances tend to be well diversified and include fossil fuels, increasing penetration of renewable energy sources and utilisation of nuclear energy for electricity generation. Most countries in the European region do not have significant oil and gas resources and so focus on improving their energy security through increasing diversity of energy sources and supply while increasing interconnection. The EU has played a strong role in energy security through the traditional oil security focus, encouraging the building of oil stocks above commercial levels and by actively encouraging energy market integration. The influence of the EU on energy security has been felt beyond its membership with the work of groups such as Energy Community and programmes including the EU-for-energy working with other European countries to improve their energy policies, usually focusing on market function and security.

European leadership of energy security continues to evolve with the Nordic influence in the overall security dimension top ten being driven by strong efforts to diversify the energy and generation mixes with a strong focus on decarbonising to meet climate goals. Denmark has significantly increased the share of variable renewables in its generation mix by being able to use its strong interconnectivity. It has further goals to eliminate fossil gas from its energy system within 20 years. Outside of EU membership, other European countries promote energy independence or self-sufficiency as a means to ensure their energy security and are prepared to pay a premium for it.

The Russian Federation has vast potential for development of renewable energy including wind, solar, biomass, geothermal and hydro potential, but currently has not tapped into this with the share of renewable energy in the energy mix being below 4%. Economic challenges and low oil prices that provide cheap access restricts Russia's ability to afford a higher uptake of renewable energy in the short term. The country's harsh winters and relatively poorly insulated housing stock mean that energy subsidies persist but could be refocused to encourage energy efficiency measures.

South East Europe also has considerable potential for cost-competitive deployment of solar and wind power generation. However, renewable energy is being challenged politically, given the cost of government support policies. Montenegro and Albania have achieved a high share of renewable energy in their energy mix, with 47% and 38%, whilst Serbia and North Macedonia follow with approximately 23% and 18%, respectively.

As the European region has been richer and more developed, energy access tends not to be a substantive issue although remote and less populous areas, even in the richest countries, may still

have limited energy access. Energy Equity in Europe therefore tends to focus on affordability that can be a political concern and has prompted work looking at fuel or energy poverty within the EU. The EU work on energy poverty has focused on sharing best policy practice and encouraging better standards for efficiency and disconnection protocols.

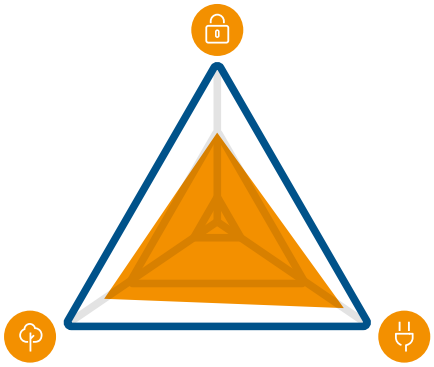
In South Eastern Europe, affordability remains an important issue as energy poverty rates remain high, with growing numbers of households spending more than 10% of their income on their energy bills. In order to further promote access to cleaner energy resources, policy makers need to mitigate rising electricity prices while increasing willingness to pay and explore how to raise community awareness about carbon-neutral energy access solutions, energy efficiency and other measures.

Modernising and optimising fossil-based infrastructure and integrating it with new renewable infrastructure is essential to achieve sustainable development. This is a long-term undertaking and must embrace all pillars of sustainable development seeking to leave nobody behind and maintain social cohesion. The European region has long been at the forefront of encouraging environmentally sustainable development with the EU supporting policy efforts to improve energy efficiency and reduce greenhouse gas (GHG) emissions. The European region includes the strongest performers under the Environmental Sustainability dimension, but the region also includes a number of countries outside of the EU that heavily rely on fossil fuels and score lower. Coordinated efforts are required in order to ensure a technology-neutral, level playing field of fiscal policies that allow investment in carbon abatement and other technologies to position them in parity with other low carbon/ no carbon electricity generation technologies.

Some of the efforts to increase renewables have had a co-benefit of helping to improve security performance as illustrated by efforts in the Nordic region. A number of European countries have legislation with mandated emission reduction targets (UK, France, Nordics) with some now looking to be more ambitious with net-zero targets. These more ambitious targets will require greater policy intervention and deeper societal changes; for example, banning the sale of new internal combustion-engine vehicles where cities such as Amsterdam and Paris are taking the lead with national governments following.

Latin America and Caribbean

Figure 24: LAC region Trilemma balance



LATIN AMERICA AND CARIBBEAN 2019 ENERGY TRILEMMA INDEX RANKING

Uruguay (17)	Chile (48)	Guatemala (88)
Argentina (35)	Colombia (49)	Dominican Republic (97)
Costa Rica (38)	Peru (58)	Jamaica (98)
Brazil (39)	El Salvador (62)	Honduras (100)
Venezuela (44)	Paraguay (67)	Nicaragua (102)
Ecuador (45)	Trinidad & Tobago (76)	
Panama (46)	Bolivia (84)	

Results from this year's Trilemma Index indicate a mixed Trilemma profile overall for the Latin America and Caribbean (LAC) region with countries rangong from an overall rank of 17 achieved by Uruguay, to 102 by Nicaragua.

Despite the efforts and the slight improvement in the region compared to past years, the region is still defined by critical uncertainties such as extreme weather phenomena, poor diversification of energy sources, inequality of wealth distribution, inadequate and inefficient methods of tax collection, as well as a weak utilisation of interconnections and grid infrastructure. However, there are positive signs to be seen, with many countries including Chile and Colombia setting ambitious goals for reduced emissions and increased targets for for the uptake of electric vehicles.

In order to balance the Energy Trilemma, the LAC region must continue to focus on designing attractive energy markets for large-scale investments in infrastructure to diversify the energy mix and must encourage regional co-operation in order to unlock the long-term benefits that further integration of power systems between countries could provide.

Nevertheless, notable progress has been made to promote general distributed generation (DG) in the region, and examples of distributed generation projects are present in many countries including Costa Rica, with the aim of improving competitiveness, achieving sustainable economic growth and increasing Energy Security. Countries adopting DG, must focus on effective policy making and interconnection with the distributed network. Chile and Mexico are the countries with the highest share of DG in their energy mix of renewable energy and conventional generation, with 10% of their total generation coming from DG.

Energy Security remains a key challenge for the region. Nevertheless, 8 out of 20 countries in the region feature in the top 50 countries for the Energy Security dimension globally in this year's Trilemma Index. LAC is heavily impacted by the effects of changing weather patterns, which are exacerbated by the region's high dependence on hydro generation. The effects of El Niño and La Niña, as well as extreme weather events and earthquakes in the region remain a significant issue for Energy Security for the region.

Projected rises in electricity usage between 2.3 -2.7 times by 2060 mean that there is still a pressing need for large-scale infrastructure development, and an urgent need for regional integration. Nevertheless, there are signs of improvement to be seen regarding public policies on resilient infrastructure and resilience mechanisms to improve the response to extreme weather events, such as the Central American Integrated System Project (SIEPAC), which aims to improve energy security through integrating regional power systems.

The building of the HVDC link between Panama and Colombia will be a key factor in minimising the risk of energy supply disruption, as the entire region will be interconnected enabling a range of different market interactions. The assurance of a robust electric infrastructure by each country will be of paramount importance for the success of the regional interconnection. This effort will enable Central America to better manage events such as the energy crisis resulting from a prolonged drought in 2013.

As noted in the World Energy Council's 2017 Latin America & the Caribbean Energy Scenarios publication, LAC countries must seek to improve energy resilience to extreme weather events and look to diversify the energy mix with the use of decentralised and/or low-carbon generation sources. Costa Rica's focus on diversifying energy generation through increasing investment in non-hydro renewables is one example. Although hydropower is Costa Rica's dominant energy source, accounting for 74% of electricity generation in 2016, the country has invested heavily in wind farms, expanding its wind generating capacity from only 2.1% in 2009, to 15.6% of electricity generation in 2018. In addition, Costa Rica generated 12.8% of the country's electricity from geothermal energy in 2016. This is especially significant given the effects El Niño had on countries in the region in 2015 and considering that the country experienced low rainfall levels throughout 2013 and 2016. With such a diverse mix of renewable energy sources, Costa Rica can take advantage of a greater availability of wind and biomass to guarantee sustainable renewable generation of energy – even during the dry season.

On the Trilemma Energy Equity scores, only three countries in the LAC region are in the top 50 countries globally in 2018. In addition, while the LAC region was the developing region that came closest to achieving 100% electricity access in 2014 among developing regions, there are nearly 30 million people in the region that are still without electricity access, most of them living in rural and remote areas with low population density. National public policies must recognise the energy access to households located in the Amazonas, taking into consideration the size of the region and the fact that isolated communities demand a different business model.

In Argentina, due to the abundance of natural resources, the main goal is to diversify the power generation mix with greater participation from non-conventional renewable, hydro and nuclear energy sources. In this way, Argentina defined eight priority areas for G20 collaboration under its Presidency, one of which is "Energy transitions towards cleaner, more flexible and transparent systems". The real challenge is to provide electricity access with reliable quality to consumers.

Although showing the greatest variability out of all Trilemma dimensions, there is a slow improvement in the region's environmental sustainability score, with countries ranging from 7 to 118. Costa

Rica's strong performance at rank 7 helps to put Environmental Sustainability as LAC's strongest Trilemma dimension.

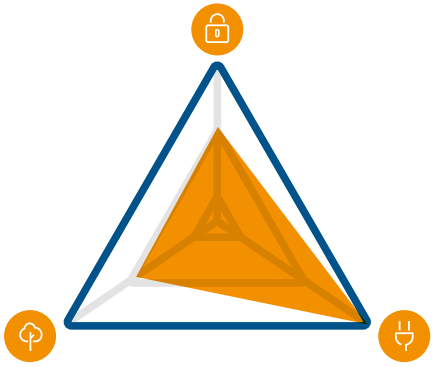
The LAC region derives a significant amount of electricity from hydropower, accounting for 54% of the overall electricity mix in 2014. As a result, 11 countries in the LAC region are placed in the top 50 in the Environmental Sustainability dimension including Costa Rica and Uruguay. In Brazil, Ecuador and Colombia in particular, the extensive use of hydropower has led to lower GHG emissions, as well as the development of energy efficiency programs to reduce energy consumption and the lower the demand from coal and fossil fuel power plants.

The transport sector in Latin America accounts for the largest and fastest-growing source of energy-related emissions, being responsible for more than one-third of CO_2 emissions, and some countries are starting to view EVs as a potential solution to this. Some discussions have been initiated around hydrogen, but the technology and infrastructure costs are still very high.

It is important to note the potential role that electric vehicles (EVs) could play in reducing the region's pollution problem that is particularly evident in many cities. For example, in Chile and Colombia, EV trends are looking towards the sustainability dimension mostly in high populated cities such as Medellín, Bogotá and Santiago de Chile. In Colombia electrification of the transport fleet – including buses and taxes – has been identified as a top priority, with the city of Bogotá planning to substitute its entire bus fleet with hybrid and electric vehicles by 2024. In Chile, where the transport sector is expected to grow by 40% by 2020 under a business-as-usual scenario, EVs have been recognised as one way of combatting the current air quality problem

Middle East and Gulf States

Figure 25: MEGS region Trilemma balance



MIDDLE EAST AND GULF STATES 2019 ENERGY TRILEMMA INDEX RANKING	
Israel (32)	Saudi Arabia (78)
United Arab Emirates (52)	Bahrain (80)
Qatar (55)	Lebanon (81)
Oman (63)	Iraq (93)
Kuwait (65)	Jordan (95)
Iran (Islamic Republic) (74)	

The Middle East and Gulf States is a geographic cluster of countries that face common environmental challenges, though they are not homogeneous with respect to energy resource distribution and economic diversification. There is no uniform energy policy that fits all, with the wealthier oil-producing countries taking the lead in diversifying their energy mix by introducing renewables. There is scope for further growth given the abundance of renewable resources and high solar irradiation levels across the region.

The oil-producing countries remain highly exposed to oil price volatility and need to adopt a more sustainable economic model and diversify their revenue sources to prepare for the inevitable peak in demand for fossil fuels in the next few decades. Innovative solutions need to be applied rapidly to satisfy rising energy demand in the region in a sustainable and environmentally sound manner. Public–private partnerships are being introduced in most countries in the region, which will help ease the burden on utilities that have traditionally been state-owned. Allowing more private sector involvement in the economies of the region will also help with job creation. Young people under the age of 24 make up more than half the population in the region today and are better equipped to deal with the demands of the energy transition to more modern and digitalised systems.

The MEGS group overall performs strongly in terms of energy access and affordability although Lebanon and Jordan face challenges on both fronts. The group also performs relatively well in terms of Energy Security if geopolitical threats are taken out of the equation. The environment challenge looms large across the region, where the Gulf states are particularly vulnerable to extreme weather phenomena, desertification and water stress. A surge in temperatures in the summer of 2019 was a taster of what may come without urgent mitigation action.

The region's energy-intensive economies rely heavily on fossil fuels for power generation, transportation and industry, all of which contribute to high GHG emissions and concentrations of particulates in urban centres. However, this is being addressed through the acceleration in deployment of renewable energy technologies and the introduction of efficiency standards. Planned and completed renewable energy projects in the Gulf Cooperation Council (GCC) over the past five years has resulted in almost 7 GW of new power generation capacity, according to IRENA. However,

the UAE accounts for 79% of installed capacity in the region. Saudi Arabia has announced ambitious plans to deploy renewable energy starting in 2023. Under the Saudi Vision 2030 economic reform programme, 30% of power generation would come from renewables and nuclear. The UAE has set a revised clean energy target of 27% by 2021 and a longer term target to increase the share of renewables to 50% by 2050.

The increase in deployment of solar PV and, to a lesser extent, concentrated solar power (CSP) technologies in several countries has been helped by a steep decline in costs. Some of the lowest bids for solar tenders have been registered in the UAE and Saudi Arabia in recent years, making them competitive with conventional fuels even without subsidies. Going forward, renewable and nuclear energy programs are expected to be deployed increasingly throughout the region, diversifying energy sources, reducing GHG emissions, and improving system resilience. But renewables make up a low percentage of the energy mix and will need to be deployed more rapidly and evenly in the region if it is to avoid the environmental degradation associated with a dominant fossil fuel industry.

Several countries are exploring the possibility of using Carbon Capture Storage and Utilisation (CCSU) in the oil and industrial sectors but this will need to be applied on a much larger scale and will take years to become affordable. Oman, for example, is using solar power to generate steam for injection into its oil fields as an alternative to gas injection. Other GCC countries are investing in innovative energy solutions. Saudi Arabia and the UAE are also exploring the possibility of hydrogen production for use primarily in the transport sector, though this is still in the early stages of developing into a viable solution.

The gradual easing of energy subsidies and in some instances the elimination of price controls, coupled with energy efficiency measures, has helped to slow the previously unsustainable growth in energy demand while freeing up some capital for investment in infrastructure necessary to sustain expansion of supply from wind and solar. However, subsidy reform is not being applied uniformly, which is why the region continues to score strongly on the Energy Equity as prices remain far below international market rates in some countries.

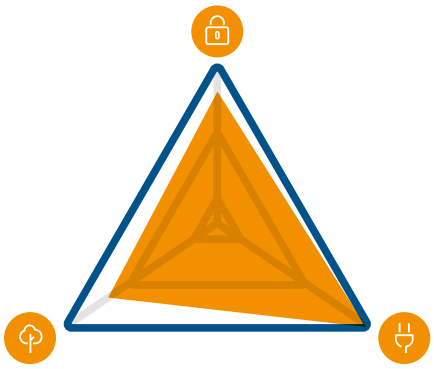
The region does not score highly on Energy Security and Environmental Sustainability because of its exposure to fossil fuels for revenues, power generation and export earnings. Iraq, for example, relies on oil exports for 90% of its revenues and 99% of export receipts. It also flares more than half the natural gas it produces at high cost to the environment. It has not yet emulated other MEGS countries in taking advantage of its renewable resources, which have become far more affordable in recent years. Falling costs of renewable energy technologies and enabling policies have helped to accelerate the deployment of clean energy solutions across the rest of the region with the United Arab Emirates leading the way. Having deployed photovoltaic solar parks initially, the falling costs of CSP will lead to wider deployment across the region.

The UAE, which relies on natural gas for more than 90% of its power generation, is leading the move into nuclear energy. The first unit of its Barakah nuclear power plant is due to be operational at the end of 2019 or in early 2020. This will help to diversify its energy mix and reduce demand for natural gas, some of which is being imported via pipeline from Qatar or in the form of Liquefied Natural Gas

(LNG). Even Kuwait, a significant oil producer and a member of OPEC, has suffered from blackouts and is forced to import LNG. A regional gas grid and price hub help overcome barriers to regional accessibility. A GCC electricity trading platform exists but does not operate at full capacity, partly because of the uneven pricing policies in each of the member countries.

North America

Figure 26: North American region Trilemma balance



NORTH AMERICA 2019 ENERGY TRILEMMA INDEX RANKING
Canada (13)
United States (15)
Mexico (40)

Energy is widely recognised as a critically important and highly-valued component of the North American economies, so the transition to clean energy both creates a large challenge and also a major opportunity. Opportunities to accelerate the energy transition are already being actively pursued and include: expanding clean continental-scale electricity generation from further development of large-scale hydropower; replacement of coal and fuel oil for power generation: aggressive development of the continent's rich endowment of wind, solar, and small-scale hydro resources; and leadership in innovation to manage and optimise the electricity grid on regional and local scales.

Two important factors need to be considered when surveying the North American energy picture. First, the responsibility for energy is divided in the United States and Canada between national and state or provincial governments while energy is a federal responsibility in Mexico. This division of power means that a full assessment needs to reflect the energy policies of both levels of government. Second, while election of new governments can result in sudden shifts or reversals in policy directions, the situation in the United States and Canada is compounded by election dates for national and sub-national governments being typically out-of-phase. Given the capital-intensive, long-term nature of the energy sector, sudden policy changes can undermine the effectiveness of previous policies and potentially discourage energy investment.

Diversity amongst North American countries is greatest in environmental policy. Current policy direction in the United States features renewed support for traditional energy sources and an announced withdrawal from the Paris Agreement on Climate Change. In the World Energy Council's 2019 Issues Monitor, North American energy leaders identified "US Policy" as having the most significant impact and uncertainty. At the same time, significant progress in emissions reduction is being made with carbon dioxide emissions from the US power sector having decreased by 28% from 2005 levels to already meet the Paris Accord goals for the sector. Some US states have also taken a different energy policy direction with global-scale leadership positions by setting aggressive climate goals and investing heavily in solar and wind energy.

Mexico is also returning to earlier energy policy perspective with the government's plan to work towards energy self-sufficiency by reducing energy imports and to providing energy that is abundant

and cheap. The policy aims to increase production of oil and natural gas, increase refinery capacity, modernise hydroelectric power plants and replace diesel or fuel oil generation with natural gas, and eliminate market mechanisms supporting wind and solar projects. The previous administration set up a cross-ministry committee to coordinate climate change policies that had been active promoting energy efficiency and renewable electricity generation to help decouple economic growth and energy intensity. While the new administration aims for economic development to be sustainable, its specific programmes have not yet been announced.

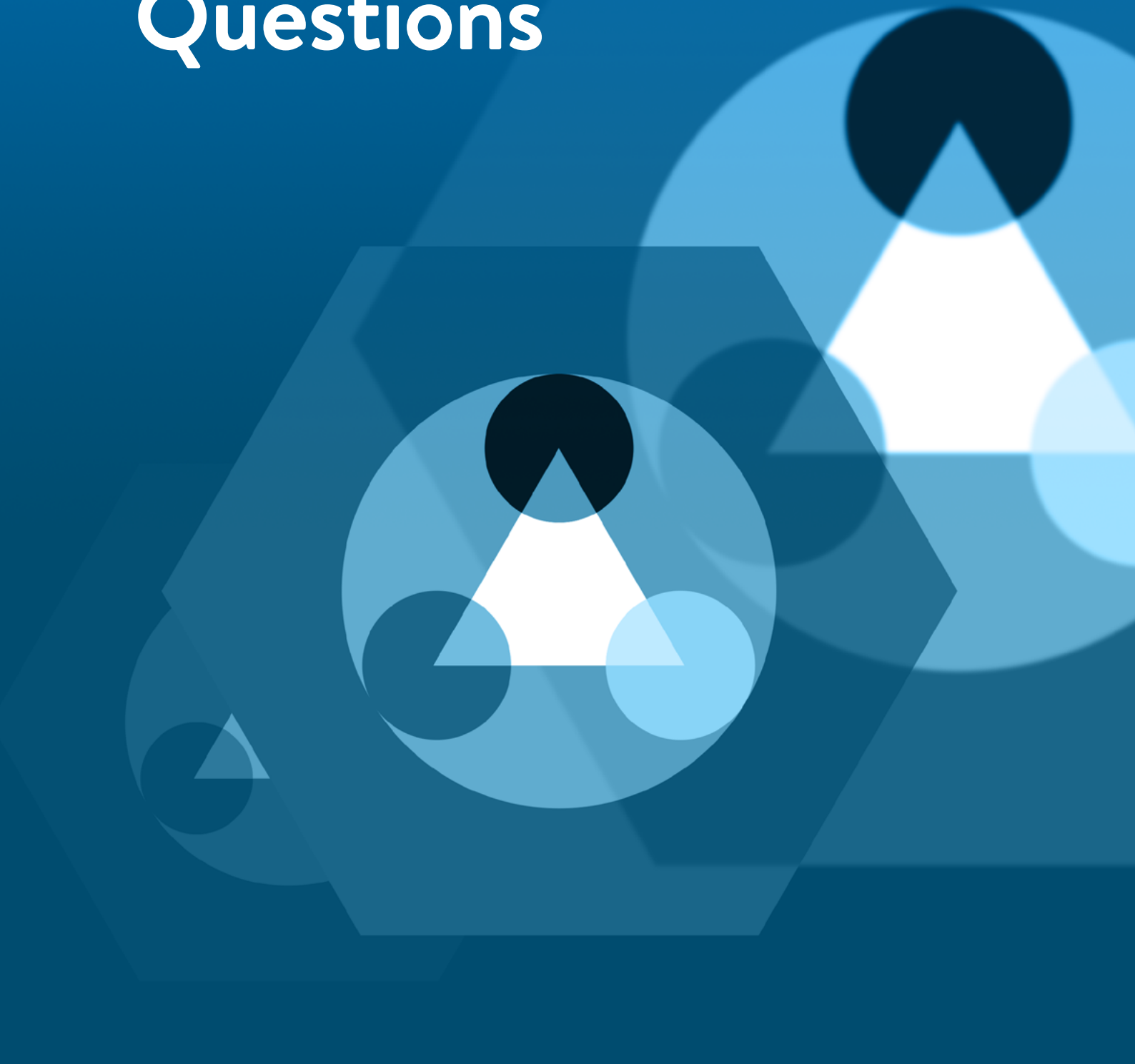
The Pan-Canadian Framework on Clean Growth and Climate Change is a national plan to meet the country's emissions reduction targets, to grow the economy, and to build resilience to a changing climate. Some provinces have set their own emissions reduction goals with sector-specific targets; for example, increasing the share of renewable energy supported by incentives. At the same time, some Canadian provinces are opposing the carbon tax provisions in the federal government's Pan-Canadian Framework.

Energy Security in North America is widely seen as a positive continental strength based on a long track record of developing abundant and diverse energy resources. The large energy trade flows between the three countries further enhances energy security through supply diversity and the redundancy inherent in the continental transmission networks with mutual aid cooperative arrangements in place to restore supply in times of regional outages or supply interruptions. Nonetheless, "Regional Integration" and "Trade Barriers" remain areas of uncertainty for energy leaders despite the resource abundance that has led to the US become the world's largest gas producer and a major exporter of crude and LNG.

Energy Equity generally remains a relatively low-profile matter in North America. With widespread access to energy and energy services, there is a perception that prices are not excessive. There are energy cost concerns for some remote Canadian communities due to the high transportation cost for supplying fuel and power. In urban areas, energy price increases due to energy policy initiatives can lead to acute difficulty for the underprivileged. In the US, there is growing recognition that some American consumers are having difficulty paying their energy bills and are being disconnected despite nearly universal access, historically low energy prices, a strong economy and low unemployment. In Mexico, plans to reinforce the two national companies involved in oil and gas production and electricity generation are likely to reduce the effectiveness of the recently opened markets.

The diverse policies illustrate that the energy transition is moving ahead in many ways. Notwithstanding the varying degrees of alignment, each country's actions mark out a viable pathway towards the energy transition now underway. The constitutionally-divided responsibility for energy matters and frequent shifts in policy direction will continue to impact upon the progress of energy and climate policies in North America unless a greater consensus emerges.

Annex A: Frequently Asked Questions



ANNEX A: FREQUENTLY ASKED QUESTIONS

The Energy Trilemma Index aims to support an informed dialogue about improving energy policy by providing decision-makers with an objective relative ranking of countries' energy system performance across three core dimensions of Energy Security, Energy Equity and the Environmental Sustainability of energy systems. The 2019 Index is based on an evolved methodology and focuses on a historical index of progress. This means that while the results cannot be directly compared with previous report iterations, the Index provides a new time-series analysis capability that has calculated Trilemma performance back to 2000.

What is the World Energy Trilemma Index?

The World Energy Trilemma Index is a quantification of the Energy Trilemma, which is defined by the World Energy Council as the triple challenge of providing secure, equitable and affordable, environmentally sustainable energy. Balancing these priorities is challenging but is also the foundation for the prosperity and competitiveness of individual countries.

The Energy Trilemma Index assesses current and past performance across the three dimensions of Energy Security, Energy Equity, and Environmental Sustainability. A fourth dimension of Country Context is also included within the calculations, to capture important differences in countries' institutional and macroeconomic contexts.

- **Energy Security** measures a nation's capacity to meet current and future energy demand reliably, withstand and bounce back swiftly from system shocks with minimal disruption to supplies. The dimension covers the effectiveness of management of domestic and external energy sources, as well as the reliability and resilience of energy infrastructure.

- **Energy Equity** assesses a country's ability to provide universal access to reliable, affordable, and abundant energy for domestic and commercial use. The dimension captures basic access to electricity and clean cooking fuels and technologies, access to prosperity-enabling levels of energy consumption, and affordability of electricity, gas, and fuel.

- **Environmental Sustainability** of energy systems represents the transition of a country's energy system towards mitigating and avoiding potential environmental harm and climate change impacts. The dimension focuses on productivity and efficiency of generation, transmission and distribution, decarbonisation, and air quality.

- **Country Context** focuses on elements that enable countries to effectively develop and implement energy policy and achieve energy goals. The dimension describes the underlying macroeconomic and governance conditions, reports on the strength and stability on national economy and government, attractiveness to investors, and capacity for innovation.

The Energy Trilemma Index has been prepared annually by the World Energy Council in partnership with global consultancy Oliver Wyman and Marsh & McLennan Insights since 2010.

The goal of the Index is to provide insights into a country's relative energy performance with regards to Energy Security, Energy Equity and Environmental Sustainability. In doing so, the Index highlights a country's challenges in balancing the Energy Trilemma and opportunities for improvements in meeting energy goals now and in the future. The Index aims to inform policy makers, energy leaders, and the investment and financial sector. Index rankings provide comparisons across countries on each of the three dimensions, whilst historical indexed scores provide insights into the performance trends of each country over time.

What is the scope of the Index?

The Index tracks 133 countries, 92 of which are member countries of the World Energy Council. However, rankings have only been produced for 128 countries, with five countries not being ranked due to political instability and/or poor data coverage. The countries that are tracked but not ranked are: Barbados, Chinese Taipei, Libya/GSPLAJ, Syria (Arab Republic) and Yemen.

The Index aggregates 59 datasets into 32 indicators to create a snapshot energy profile for each country. Furthermore, it calculates a historical index for each dimension back to a baseline year of 2000.

What time period does the 2019 Index capture?

The 2019 Index ranking reflects data from 2015 to 2019 using the most recent available data at global levels. The online Trilemma Tool presents Index performance since 2000 using longitudinal data with individual country profiles. Particular indicators feature some data delays which mean recent world events or the most recent transitions in the energy sector that could affect the Index's outcomes may not be fully captured (e.g. recent geopolitical or social unrest in the Middle East or Venezuela).

How are the Index results presented?

Countries are provided with an overall Index ranking from #1 to #128, as well as rankings for each dimension of Energy Security, Energy Equity and Energy Sustainability of energy systems. The top performing country is awarded a #1 ranking, while the lowest ranking country is assigned rank #128.

In addition, scores for the three dimensions of Energy Security, Energy Equity, and Environmental Sustainability are distributed into four balance grades (A, B, C and D). Every country is thus assigned a set of balanced grades (e.g. 'ABC'). Each letter reflects one dimension of the Energy Trilemma: the first letter refers to Energy Security; the second letter to Energy Equity and the third letter to Environmental Sustainability.

The mean and standard deviation of the scores in each dimension is calculated; balance grades for each dimension are then assigned using bands based on the mean and standard deviation. High performance across all three dimensions is awarded 'AAA'. Sets of grades such as 'ABC' or 'CBD', highlight the balance or imbalance across a country's energy performance. An imbalance in energy performance suggests current or future challenge in the country's energy policy.

Index results and analysis are also complemented by regional overviews as well as individual country profiles with expert commentary form the Council's national Member Committees.

Where can I find the full results?

The results are published once a year. Results can be downloaded for free from the Council's web-page. Index data is available at: https://www.worldenergy.org/data/

The full report with country and regional profiles is available at: https://www.worldenergy.org/publications/

INDEX RANKINGS & POLICIES

What does the Index tell us about the country's energy performance and policy?

The Index shows how well each country is performing on the Energy Trilemma and captures the aggregate effect of energy policies implemented over time. Because the Index shows aggregate policy effects, it does not identify the effectiveness of a particular policy; each policy interacts with a set of policies specific and contextual factors unique to that country over different periods. Nonetheless, by broadly measuring aggregate policy outcomes, the Index provides important insights into the efficacy of energy policies and choices.

Historical calculations for each of the three energy dimensions indexed to the year 2000 provide performance trends for Security, Equity and Sustainability, which can be compared to policies and exogenous factors over time, providing potential insights on the effects of different factors on energy outcomes.

What will affect a country's ranking in the Index?

The Index is weighted in favour of energy performance (dimensions A, B, and C) versus contextual performance (dimension D). Therefore, changes in energy performance will have a greater effect on a country's ranking than changes in its macroeconomic and governance conditions.

Few countries manage to perform well across all three energy dimensions, just 10 out of 128 countries managed to achieve AAA grades across the energy Trilemma dimensions. Currently, many countries achieve stronger performance in two dimensions but falter in one, suggesting trade-offs between energy dimensions. For example, the abundance of oil in some energy exporting countries means that they enjoy highly secure and affordable energy. However, low prices limit incentives to reduce energy consumption and to engage in energy efficiency programs affecting their performance in Environmental Sustainability due to higher greenhouse gas emissions.

How does this year's ranking compare with last year?

It has been challenging to compare Trilemma rankings across years due to the methodology which comparatively ranked countries solely on that year's Trilemma calculation. Using the rankings alone, it was not possible to judge whether a country had improved its own performance or not, and instead only whether a country's ranking had improved in comparison to others in that year.

The inability to provide insight into country performance year-on-year was a key driver in evolving the methodology to include indexation so that direct comparison with earlier years' performance could be made. While direct comparison with between 2018 and 2019 Index rankings is not possible given the change in methodology, the indexation illustrates now how performance by key dimension indicators has evolved for each country.

How can a country move up or down the Index?

It is important to note that the Index is a comparative ranking and shows the performance of a country relative to all other countries. To move up in the Index, a country must improve its overall score. For example, a country's ranking on the indicator "Diversity of electricity generation" will depend on how its diversity of electricity generation (from hydroelectricity, biomass and waste, geothermal, solar and wind) ranks against other countries.

Similarly, if a country's score remains stable but those of its peers improve, it will move down in the rankings. Put differently, a country's underlying indicator data can remain the same year-on-year, but its Index position can move due to changes within other countries. Thus, performance stagnation could impact the Index position in the same way as retrograde motion of the energy performance data.

In 2019, the World Energy Council, in partnership with Oliver Wyman and Marsh & McLennan Insights, used a new methodology to calculate indicator scores. The use of a new methodology has resulted in a new set of relative performance rankings, strengthened by historical trend analyses. It should however be stressed that the results published in 2018 are not directly comparable to those published in 2019 due to the change in methodology.

Why are some countries with triple-A balance grades not included in the top 10 countries while others, which do not have triple-A balance grades are?

A country's overall score is determined by the weighted average of dimensions A to D scores. A country with triple-A balance grades highlights their superiority within a dimension compared to other countries which do not have A grades. However, they may not fall into the top 10 as the values based on which the grades are assigned may be at the lower threshold for the specific grade category. A country's triple-A grades may be composed of relatively 'lower-score' As. This could in practice result in a lower overall weighted average score than an AAB country where the A grades and B grade are well beyond the threshold levels.

What policies will affect a country's score and position on the Index?

Policies can affect multiple data points aggregated by the Index such that their effects are not exclusive to a single indicator or even a dimension. Thus, it is often difficult to pinpoint how any single policy affects a country's performance against an indicator or dimension. For example, policies to increase penetration of renewable energy could affect security (by diversifying energy mix and reducing demand for imports) and sustainability (by reducing carbon dioxide emissions). If the

policies contributed to higher electricity prices, the policies could also impact the equity dimension. External factors like technological change (e.g. changes in renewables technology) can also have an impact, and are not directly measured by the Index.

Those factors noted, countries which implement a range of clear and predictable energy policies resulting in an overall framework that addresses the three aspects of Energy Trilemma typically rank higher in the Index.

INDEX METHODOLOGY

How are indicators selected for the Index?

Each indicator category is composed of a set of carefully selected indicators that meet the selection criteria and are highly relevant to the World Energy Council's understanding of the Energy Trilemma.

It is also critical that the indicators can be consistently and readily derived from reputable sources and cover a high proportion of the World Energy Council's member countries; some potential indicators were excluded from the Index due to low member country coverage. The key data sources for the Energy Trilemma Index model are:

- IEA World Energy balances, World Energy Prices, and Emissions
- World Bank/UN SDG 7 tracking data
- World Bank Getting Electricity report
- JODI and IGU data
- Global Competitiveness Index, WEF

Indicator selection criteria includes:

- Coverage: The World Energy Council includes indicators that are critical to the Index's methodology and strives to ensure that each indicator possesses a strong coverage of data (more than 75% coverage across the 133 tracked countries).

- Comparability: data to calculate indicator scores are derived from as unique and comprehensive sources as possible, focusing on a single source per indicator as far as practical, to ensure comparability between countries.

- Relevance: indicators are chosen or developed to provide insight into country situations in the context of the project goals and in line with the narrative.

- Distinctiveness: each indicator focuses on a different aspect of the issue being explored and avoids overlaps or redundancy with other indicators.

- Contextual sensitivity: indicators capture different country situations (e.g., wealth, size) and where appropriate indicators are normalised by GDP (PPP), GDP (PPP) per capita, population, or other relevant metrics.

- Robustness: indicator scores are computed from data made available by reputable sources with the most current information available at sufficient coverage.

- Balance: indicators within each dimension (and dimensions across the Index) exhibit coverage of different issues.

What is the 2019 Index based on?

Each country's overall Index ranking is based on the calculation of 32 underlying indicators which aggregate up to 11 categories across the four dimensions (including country context). Some of these indicator calculations are based on multiple datasets, others rely on just one. For example, the category "Affordability" is measured using four indicators, each of which is supported by multiple datasets. Two additional indicators (A2d. System resilience and C2c. Transport sector decarbonisation) and one sub-indicator (A2b.c. Energy storage - electricity) were not included in the model due to lack of available data, and remain placeholders for future Trilemma iterations. Figure 27 provides an overview of the indicators and their weighting.

Figure 27: 2019 Energy Trilemma Index structure and weighting

DIMENSION		INDICATOR CATEGORY		INDICATOR		
ENERGY SECURITY	30%	A1 Security of Supply and Energy Demand	12%	a	Diversity of primary energy supply	6%
				b	Import dependence	6%
		A2 Resilience of Energy Systems	18%	a	Diversity of electricity generation	6%
				b	Energy storage	6%
				c	System stability and recovery capacity	6%
ENERGY EQUITY	30%	B1 Energy Access	12%	a	Access to electricity	6%
				b	Access to clean cooking	6%
		B2 Quality Energy Access	6%	a	Access to "modern" energy	6%
		B3 Affordability	12%	a	Electricity prices	3%
				b	Gasoline and diesel prices	3%
				c	Natural gas prices	3%
				d	Affordability of electricity for residents	3%
ENVIRONMENTAL SUSTAINABILITY OF ENERGY SYSTEMS	30%	C1 Energy Resource Productivity	9%	a	Final energy intensity	5%
				b	Efficiency of power generation and T&D	4%
		C2 Decarbonisation	9%	a	Low carbon electricity generation	5%
				b	GHG emissions trend	4%
		C3 Emissions and Pollution	12%	a	CO2 intensity	2%
				b	CO2 emissions per capita	1%
				c	CH4 emissions per capita	1%
				d	PM2.5 mean annual exposure	4%
				e	PM10 mean annual exposure	4%
COUNTRY CONTEXT	10%	D1 Macroeconomic Environment	2%	a	Macroeconomic stability	2%
		D2 Governance	4%	a	Effectiveness of government	1%
				b	Political stability	1%
				c	Rule of law	1%
				d	Regulatory quality	1%
		D3 Stability for Investment and Innovation	4%	a	Foreign direct investment net inflows	1%
				b	Ease of doing business	1%
				c	Perception of corruption	0.5%
				d	Efficiency of legal framework in challenging regulation	0.5%
				e	Intellectual property protection	0.5%
				f	Innovation capability	0.5%

Why was the Index methodology revised in 2019?

The Trilemma Index has been gradually refined since its introduction and now ranks 128 countries. The original methodology has been revised throughout the years with the aim of improving transparency and offering stakeholders better insights to help improve their energy policies.

Until this year, the Energy Trilemma has been a comparative ranking of about 130 countries assessed across the dimensions of security, sustainability and equity. A comparative ranking is a great way to start a conversation about energy policy by tapping in the competitive instinct and highlighting which dimension might need the most focus.

A comparative ranking is less helpful in providing guidance on how to improve a country's energy policy. One could look at the top-ranking countries for the different dimensions to understand the reasons for their better performance although whether or not their policies would be relevant to other countries would require further analysis of the differing domestic contexts. Possibly the main criticism of the comparative rankings comes from the fact that improving performance by one country may not be recognised if other countries have improved more, which is where time-series or longitudinal analysis can be more insightful.

A time-series analysis enables performance to be assessed over time to understand whether a policy intervention has made a positive contribution or if further refinement might be necessary. Presenting a dynamic picture of the performance over time also helps to identify the most effective policy interventions and enables the Energy Trilemma to become a policy pathfinding tool.

By seeing performance at a country level over time, it becomes easier to identify where a policy intervention might be best targeted and then to subsequently track its impact. This follows the usual evidence-based policy assessment approach. Although the Trilemma provides potentially greater insight by assessing performance across the three related dimensions so that unintended consequences can be spotted but also by enabling comparison with other countries with similar contexts.

What are the key design and methodology changes in the 2019 Index?

The 2019 Index includes a number of new indicators and has seen the modification of others. It provides a richer view of a country's energy performance, utilising contemporary indicators and datasets representing the current energy situation in the world. The number of indicators has been condensed to 32. Nine of the 32 indicators have either been conceptually revised or newly added. Additionally, many indicators utilise new datasets with better quality of reporting, which were not available previously. As such, comparisons between 2018 and 2019 rankings are not comparing like with like. New data sources have also been introduced.

The most exciting and substantive change is the inclusion of historical Index trends, with scores calculated back to 2000 using the new methodology. Typically, changes in a country's energy performance evolve slowly over several years which will be reflected in gradual upward or downward trend in the Index graph, which can be tracked via the online tool.

Changes made to the Index design and methodology, as indicated in Figure 28 below

Figure 28: Overview of changes to Index design and methodology

Index methodology 2018	Index methodology 2019
35 indicators and **72** data sets	**32** indicators and **59** data sets
Equal weights across categories and indicators	**Unique** weights across categories and indicators
Standardisation and **normalisation** of scores	**Normalisation** of scores
Normalisation range determined by **minimum** and **maximum** values	Normalisation range determined by **derived** and **calculated** values
Gate criteria for **6** indicators and sub-indicators	Gate criteria for **5** indicators and sub-indicators (4 removals; 3 additions)

Why are category and indicator weights given unique weights instead of equal weights?

Unique weights are assigned for indicator categories and indicators in the 2019 World Energy Trilemma Index to account for their relative importance, while balancing scientific robustness and transparency.

The indicator categories have been set up to provide a comprehensive picture of each dimension. Their weights are determined by the number of indicators included in it and its relevance to the dimension.

The individual indicators reside at a level under dimension categories; they serve as the building blocks of the dimension categories. Their weights are determined by its relevance to the indicator category.

Why are scores normalised? And what is the benefit of using normalisation only over standardisation and normalisation?

Aggregating scores using normalisation rescales them to the range 0 to 100. Scores with different range of values are thus adjusted to a common scale for comparison, allowing for a more accurate reflection of the data within Index results. As analogous results can be obtained by applying both standardisation and normalisation, an approach involving normalisation only is preferable as it is simpler and increases transparency.

Why is the rescaling range for indicators determined by calculated and/or derived values instead of actual minimum and maximum values?

When using actual minimum and maximum values for normalising, outliers can cause the distribution of normalised data to be skewed. Furthermore, actual minimum and maximum values may not be meaningful and/or accurate in representing the indicator if there is a theoretical minimum and maximum involved or it does not consider the nature and significance of the indicator in relation to the status quo and goals of the energy system.

In contrast, using calculated or derived values help to mitigate the effects of outliers. For example, taking the average of the bottom and top five performing countries for the indicator C2c. CH4 emissions per capita as the minimum and maximum values mitigates the impacts of countries with extremely high or low values. Additionally, such values help to better represent indicator scores with a theoretical minimum and maximum. For example, indicator B1a. Access to electricity, which is represented as a percentage of total population has a natural minimum value of 0% and a maximum value of 100%. Moreover, it helps indicators to accurately depict the status quo and goals of the energy system. For example, indicator C3a. CO_2 intensity uses a minimum score calculated by the global average CO_2 intensity targets to reach the 2030 1.5°C IPCC target.

Why are grades assigned using the actual distribution of scores within a dimension?

Assigning grades using the actual distribution of scores provides a better representation of the data. It presents the absolute difference between the countries' performance in each dimension and avoids artificially dividing countries into different categories with a fixed number of countries within each category, as would occur with for example, using an even distribution approach.

Why are gate criteria used?

Gate criteria were introduced to address heavily skewed data and address the differences in countries' natural endowments and macroeconomic positions. This is to ensure that cross-country comparisons across the three dimensions are meaningful. For example, a gate criterion for electrification rate was introduced for the indicator B3d. Affordability of electricity for residents. Only countries with more than 90% access to electricity are assigned a score for this affordability indicator, as it is mostly relevant for countries that are already largely electrified. A gate criterion helps group similar countries (e.g., those with a high rate of electricity access) and thereby prevents the skewed data from excessively influencing outcomes.

Which (sub)-indicators are subject to a gate criterion?

The following indicators and sub-indicator are subject to a gate criterion:

- A1a. Diversity of primary energy supply
- A1b. Import dependence
- A2b.b Energy storage (gas)
- B3c. Natural gas prices
- B3d. Affordability of electricity for residents

Please refer to section 4 Indicators description in the Index Methodology document for a detailed explanation of the gate criteria and the rationale behind the gate criteria for each of the indicators and sub-indicator.

Why is missing data replaced by the country group average?

The country group average is a good representative of countries in the same region in terms of economic development, social situation, political conditions, etc. This representativeness renders missing values less likely to distort country outcomes.

The groups are established based (jointly) on economic groups and geographic region. Economic groups are defined as:

- GDP Group I: GDP per capita greater than USD 33,500
- GDP Group II: GDP per capita between USD14,300 and USD 33,500
- GDP Group III: GDP per capita between USD 6,000 and USD 14,300
- GDP Group IV: GDP per capita lower than USD 6,000

Geographic regions are defined as:

- Asia
- Europe
- Latin America and Caribbean (LAC)
- Middle East and North Africa (MENA)
- North America
- Sub-Saharan Africa (SSA)

For example, Gabon lacks PM10 data. It will be given a PM10 score equal to the average score of the countries in the country group with similar GDP and geographic location, which would be more reflective of the economy and energy profile of Gabon.

What are the limitations of the Index?

- The Index cannot capture real-time Energy Trilemma performance due to the challenges of capturing large volumes of reliable data for a wide range of countries.
- The Index cannot isolate the impact of a single policy.
- The Index uses 59 data sets. In a few instances, data for specific countries is not available (i.e. the data set has missing data), in which case missing data is replaced by the country group mean.

Are more details on the new methodology available?

Full details on the Index methodology, including the sources of all datasets and how each indicator is calculated and treated, are provided in the comprehensive “Methodology” document.

ACKNOWLEDGEMENTS

The project team would like to thank the individuals who informed the project's approach, supplied information, provided ideas and reviewed drafts. Their support and insight has provided an invaluable contribution the report. We also thank our Council's national Member Committees for the reviewed and updated Country Profile contributions.

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