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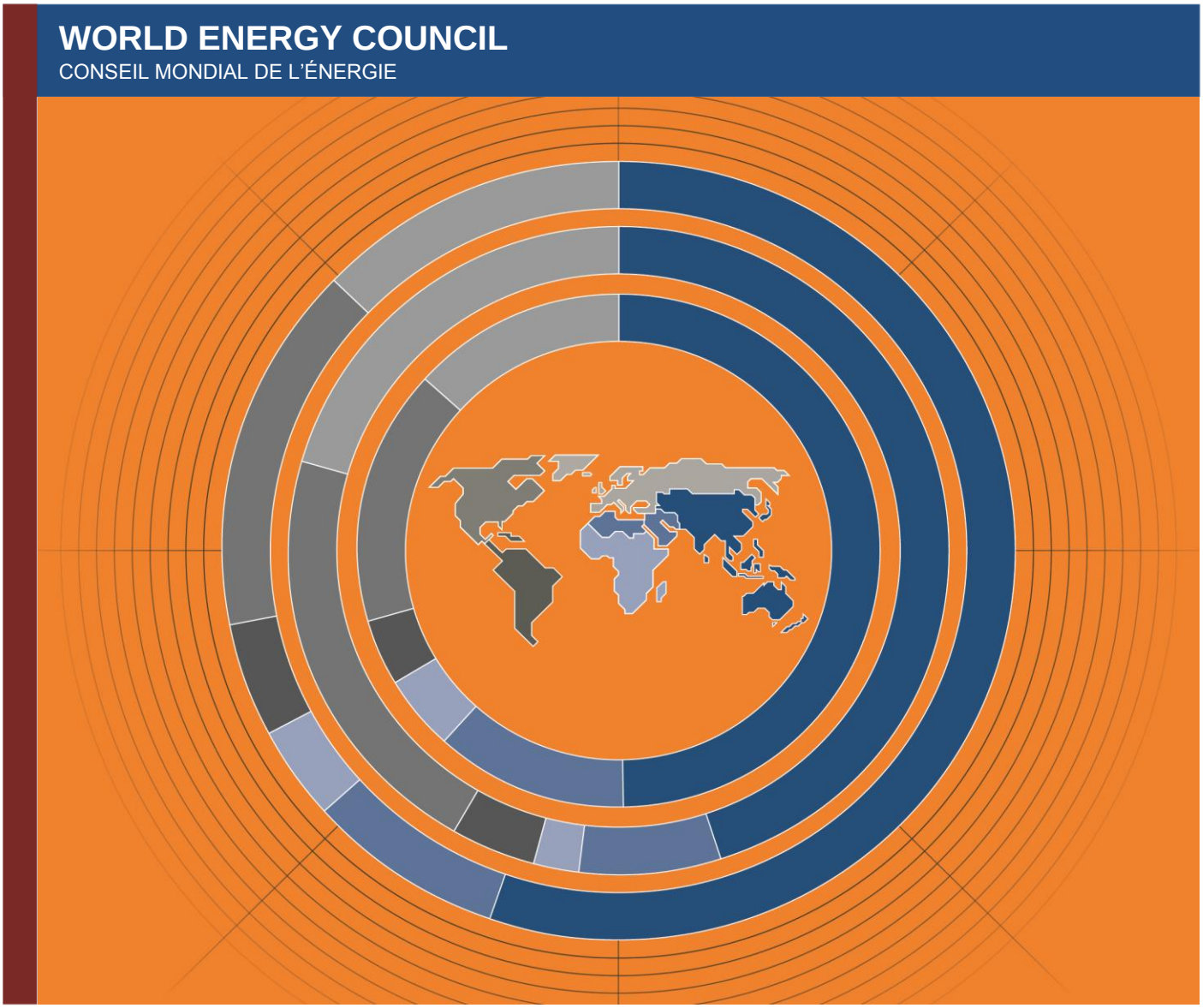
CONSEIL MONDIAL DE L'ÉNERGIE
For sustainable energy.

World Energy Trilemma

Priority actions on climate change and how to balance the trilemma

Project Partner OLIVER WYMAN



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World Energy Council

Project Partner
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Foreword by Marie-José Nadeau

The 2015 World Energy Trilemma report is published in a year that is likely to be remembered as one of the most important for the global energy sector in recent history. Decisions made – or not made – will leave an indelible mark on the sector, which could have an impact on the world for generations to come.

The Clean Energy Ministerial members will come together for the sixth time in Mérida, Mexico. Ministers will identify the critical next steps needed to accelerate the transition to a global clean energy economy, a process that the World Energy Council believes is absolutely essential to ensure that the three pillars of the energy trilemma – energy security, energy equity and environmental sustainability – are met across the globe.

The United Nations (UN) is set to agree on a package of Sustainable Development Goals which should, for the first time, formally place energy at the heart of the development agenda.

The 21st Conference of Parties (COP21) will meet in Paris, France, to finalise an agreement on tackling climate change and reducing greenhouse gas (GHG) emissions, to come in to force in 2020.

Taken together, there is a strong focus on the critical role of energy in delivering economic and social development, while respecting the need to ensure that energy is environmentally sustainable.

However, it is clear that when, as Chair of the World Energy Council, I meet with global energy leaders, ministers and policymakers, the message they give me time and time again is that the continued lack of an agreement on an international climate framework is creating an unacceptable level of uncertainty for the energy sector. No one, neither policymakers nor business leaders, believe that we can go forward with business as usual. Everyone realises that there is a need to move towards an entirely new, balanced, low-carbon energy system. But in order to achieve this energy transformation, the energy sector needs a clear roadmap – one that can only be achieved by coming to a consensus and setting an internationally accepted target.

As previous World Energy Trilemma reports have highlighted, there is often a gap between these important negotiations and what is happening on the ground. This is why I commend the work of the team behind this report, under the leadership of Joan MacNaughton, for identifying the factors that will enable these global initiatives to succeed. The World Energy Council is uniquely placed to facilitate a dialogue among our members in nearly 100 countries, representing the broad energy community, and to identify some clear, unbiased recommendations that we hope will help to guide meaningful outcomes.

The reality is, of course, that there will be enormous costs, both in the form of necessary new investments and in stranded assets. But these costs will only increase with a continuing lack of clarity. I firmly believe that, after years of talks with limited progress, the time has come to finally get something done. This year's World Energy Trilemma report provides a valuable input for policymakers and climate change negotiators to achieve the creation of a new roadmap towards a sustainable energy future.

Marie-José Nadeau
Chair, World Energy Council

Foreword by Joan MacNaughton

This 2015 World Energy Trilemma report is a key departure for the World Energy Council's community. In our previous research we have engaged business leaders, policymakers and investors in analysing what is needed for energy investment to flow in support of achieving the three goals – energy security, energy equity and environmental sustainability – of the energy trilemma. This year we have focused on getting the Council's community to articulate their views on what is needed from the forthcoming negotiations in Paris on climate change, COP21, to enable them to continue to make progress on balancing the trilemma goals effectively across all the regions of the world. The report distils the views of a wide range of energy policymakers, investors in the energy sector, and energy business leaders. A key finding is the call from energy business leaders in particular or the energy sector to be more involved in the climate change negotiations – and for these to move away from the 'theology' of the commitments required from individual countries and towards a pragmatic approach with more focus on delivery of actions which can be measured and monitored.

The first reason prompting the call for engagement – to ensure that negotiators do not inadvertently destroy value in the sector – may seem to some outside the energy sector as somewhat self-serving. But in fact it is not so much about the vested interests of business as about the need for huge investment to manage the energy transition which is fundamental to tackling climate change. Unless we ensure that that investment can flow to the energy sector, the 2 degree Celsius target espoused by the parties to the negotiations, as long ago as COP15 in Copenhagen in 2009, will be impossible to meet. Decisions on the nature, scale and speed of the energy transition must recognise the realities of energy supply and demand which are changing faster than ever before, how to accommodate the accelerating deployment of clean technologies and what will be needed by way of change to existing business models. A close partnership and dialogue between the public and private sectors will be key.

In specific terms, the World Energy Council's community calls for a stable and clear policy framework, with a single measurable target, while stressing that the Paris agreement must be flexible in recognising the differing circumstances and vulnerabilities of individual countries. This recognises that the agreement will not be a single top down one, but will be based on an aggregation of individual country commitments. The energy sector says the agreed framework must allow for systematic monitoring, for adjustment of individual country targets as their circumstances develop, and, to ensure longevity, an internal feedback loop.

Five enablers have been identified which are key to the successful transition to a low-carbon energy system.

First, barriers to technology transfer – such as tariffs on environmental goods and services, or lack of protection for intellectual property rights – need to be addressed. If they can, energy businesses will take a lead, but not the sole role in scaling up technology transfer to the degree required.

Secondly, a global carbon price could help deal with concerns over competitiveness (or so called 'carbon leakage'), and would be more economically efficient than localised pricing. This means we need to ensure that there is the potential for the many regional and national trading schemes operating or under development to be linked. But, most importantly, a price reflecting the true costs of high-carbon activities is seen as needed to help avoid distortion of investment decisions between high- and low-carbon projects.

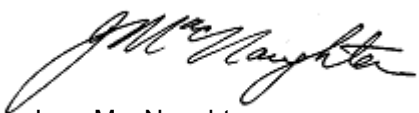
The third enabler is giving the right policy signals to encourage financing to flow. As we learnt from the financial sector in our report last year, energy businesses must build a pipeline of bankable projects to take advantage of the finance which is available.

Fourthly – and some might find this surprising – energy business leaders call for there to be more emphasis on managing demand as well as supply.

Finally, strongly echoing the call from energy business leaders in our 2012 World Energy Trilemma report is the requirement for a step change in investment, and in collaboration between the public and private sectors, in research, development and demonstration (RD&D).

Perhaps more important than any of these individual messages is the strong emphasis emerging from our workshops and individual conversations for the development of an integrated voice and common language on how to describe the challenges of tackling climate change and the best ways in which the energy sector can respond to them. As we heard, social acceptance is the greatest challenge in managing the energy transition and we must work together – energy business leaders, policymakers, and the investor community – to inform public understanding of the nature of the challenges and the true implications of various approaches to solving them. Only in that way will we gain popular support for the hard decisions we face.

What this report shows is that the energy community believes the time is ripe for stronger action on climate change, and that it is perfectly feasible to move to another level in doing so. Indeed, without progress from the negotiations which move us on from commitments to vigorous implementation of them, it will become increasingly difficult to deliver across the three trilemma goals of energy security, energy equity and environmental sustainability. The energy industry is more than ready to play its full part, building on the many examples of leadership which some businesses are already showing. As they told us, it is now time to get something done.



Joan MacNaughton
Executive Chair, WEC World Energy Trilemma

Tackling policy uncertainty

The energy sector is ready for policymakers to agree on a clear target to reduce greenhouse gas (GHG) emissions. Policy stability will enable the energy sector to deliver the transition to a sustainable energy future. Individual countries will contribute to the target through a variety of measures, in line with their energy profiles and priorities.

Regional differences and priorities

Solutions to accommodate the energy transition need to be devised according to regional and country level differences.

North America

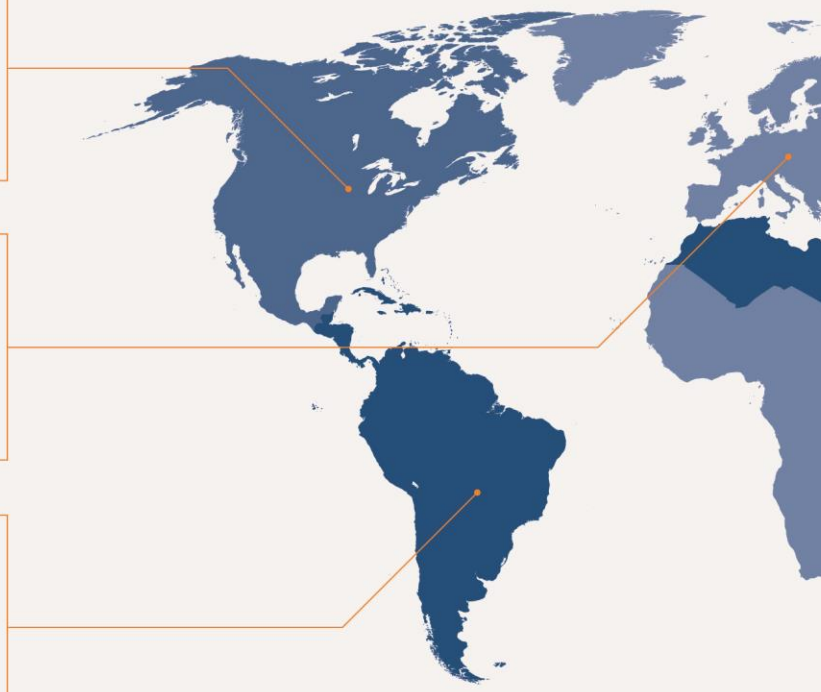
- Research,development and demonstration
- Lower carbon fossil fuel use through gas and technology deployment

Europe

- More efficient energy use
- Greater share of low-carbon energy sources in energy supply

Latin America & Caribbean

- Regional integration and interconnection
- Education and information to drive behavioural changes in consumers and increase energy efficiency



Priority actions from the energy sector

To meet climate and development goals, and balance the trilemma, a focus on some key mechanisms is needed.

AT THE INTERNATIONAL LEVEL

Trade and transfer of technology

Eliminating tariffs on environmental goods and services, carefully designing local content requirements and protecting intellectual property rights are key to reducing costs, stimulating business and incentivising the use of low-carbon technologies, especially in developing countries.

Carbon pricing

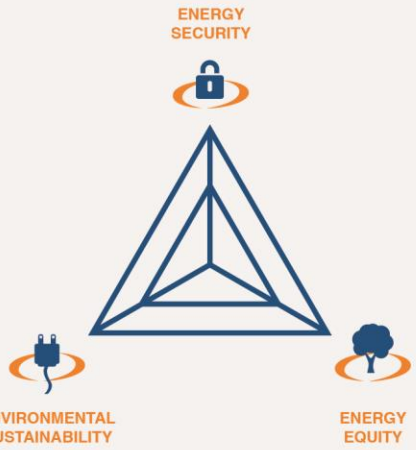
An effective price on carbon will redirect investments towards low-carbon solutions and 'level the playing field' among different technologies. Many business leaders already use a 'shadow carbon price' for their operations, corporate planning or when analysing investment options.

Financing mechanisms

The right policy signals need to be provided and a portfolio of bankable projects needs to be in place to attract more private capital. Financial markets will develop innovative financing mechanisms if the regulatory rules indicate a clear and stable direction towards sustainable energy systems.

World Energy Trilemma

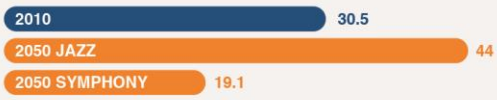
Balancing the three core dimensions of the energy trilemma is the basis for prosperity and competitiveness of individual countries. If the energy sector is to deliver on climate goals and support the achievement of development goals, it needs to do so in balance with the other two dimensions, to ensure sustainability of energy systems.

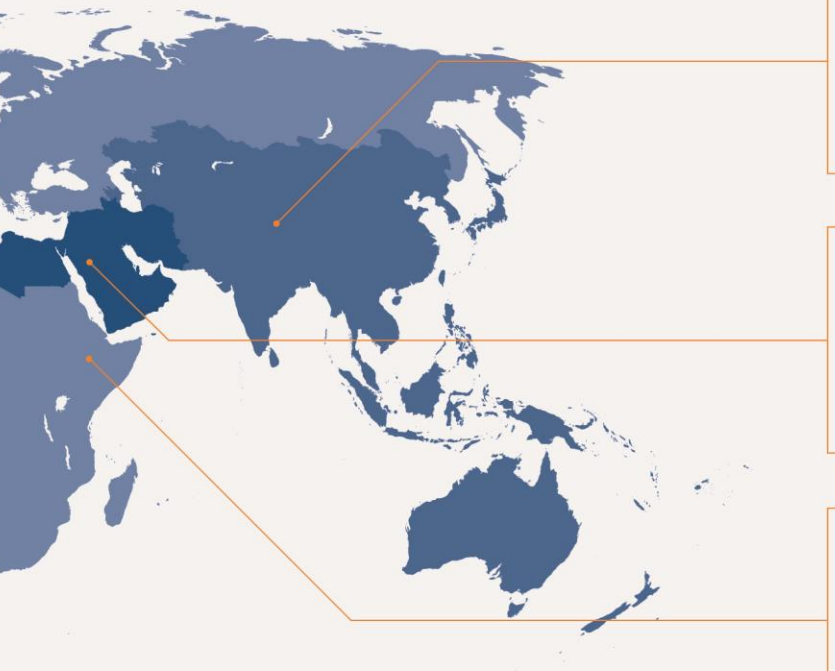


Whose views?

This report presents findings from workshops convened across all the Council's regions and from interviews with leading figures from the energy sector to highlight bottlenecks, opportunities and solutions.

Total global CO_2 levels ($GtCO_2$/year)





Asia

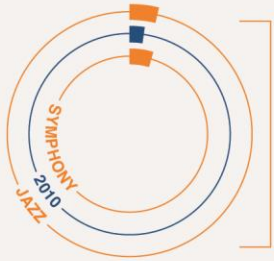
- Technology transfers to manage demand growth
- Greater social acceptance of changing energy supply

Middle East and North Africa

- Transparent energy pricing to incentivise efficient energy use
- Increase share of solar and wind energy in energy supply

Sub-Saharan Africa

- Tap potential for renewables and gas for energy supply
- Access to energy and clean cooking fuels



AT THE NATIONAL LEVEL

Demand management and energy efficiency

Energy leaders emphasise that a sustainable energy future will require improved energy efficiency on the supply side and an equally strong focus on managing energy demand and increasing energy efficiency across all sectors including residential, commercial, industrial, and transport.

Prioritise innovation and RD&D

Investments in research, development and demonstration, including new technologies, materials, and fuels are essential to achieve climate targets and development goals. National and international public–private collaborations have to be encouraged.

Greater dialogue among government, business and finance is essential for a successful energy transition. More interaction would ensure a focus on practical, economically-sound solutions.

“

A single target supported by flexible instruments will deliver high-impact results

”

Introduction

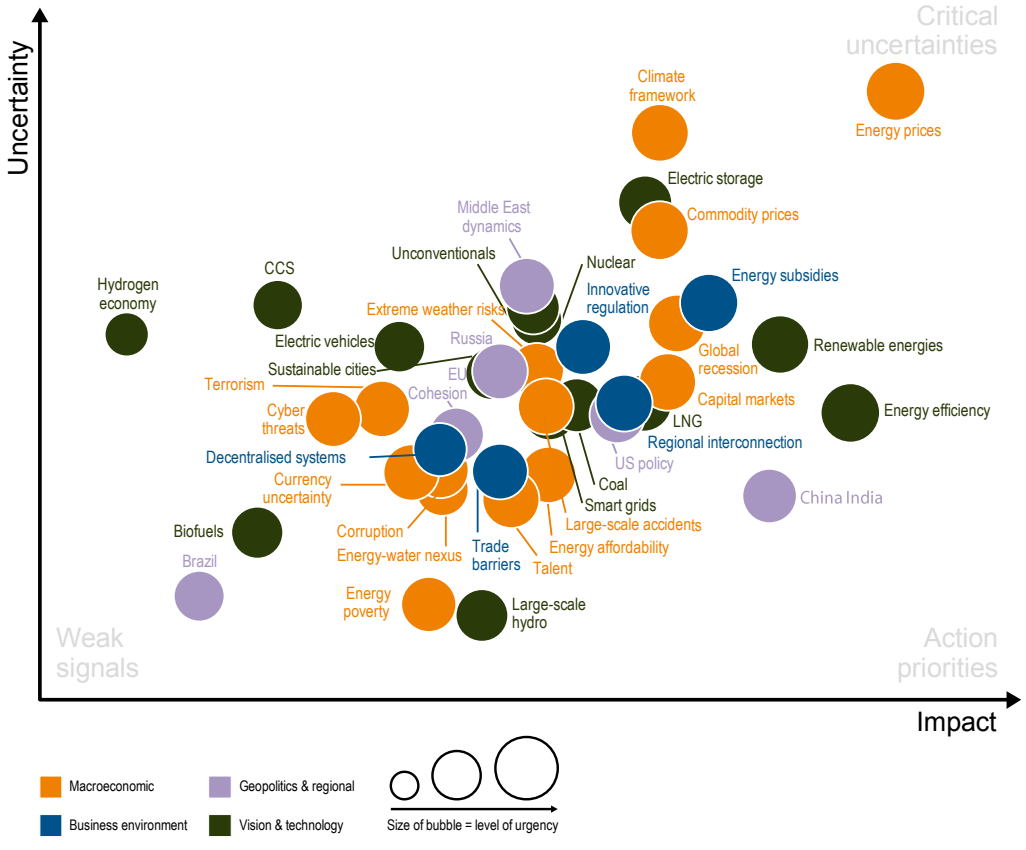
The energy sector is ready for an ambitious climate agreement and calls for an international framework with a single measurable target for GHG emissions that enables fair competition and sets a clear pathway towards low-carbon energy systems. It is time, energy leaders noted, for climate negotiators to “get something done.”

While a global target for reducing GHG emissions will provide the long-term policy guideline for the energy sector, solutions to accommodate the transition will need to be devised at the regional and country level in light of differing resources, economic structures, stage of development and policy preferences. The energy sector points to key measures that will support the development of a meaningful framework. Some of these mechanisms will require international cooperation, including trade and technology transfers, carbon pricing and financing mechanisms. Other efforts can be implemented at the national level, such as national carbon-pricing mechanisms, demand management and energy efficiency, but also research, development and demonstration (RD&D) initiatives.

Figure 1

Global uncertainty caused by lack of a global climate framework

Source: World Energy Council, 2015: World Energy Issues Monitor



The current lack of an overarching international climate framework has created uncertainty for the energy sector, both for policymakers and business leaders, as they try to determine priorities in moving towards a balanced, low-carbon energy system (see Figure 1).

This report aims to support policymakers as they set climate and development goals and design policies in international and domestic forums. The recommendations in this report build on and reinforce the global dialogue between the energy sector, policymakers and the financial sector presented in previous World Energy Trilemma reports.

Through its extensive and diverse network, the World Energy Council, in partnership with global consultancy Oliver Wyman, along with the Global Risk Centre of its parent Marsh & McLennan Companies, convened workshops across all the Council's regions and conducted interviews with leading figures to record insights from around the world (see Appendix A). Their feedback, summarised in this report, highlights the bottlenecks, opportunities and implementation guidelines for policymakers in setting meaningful climate and energy goals and policies.

Time and again energy leaders called to "produce an agreement – keep it simple, keep it measurable, and with implementable penalties for missing the target set."

“

Produce an agreement:
keep it simple,
keep it measurable

”

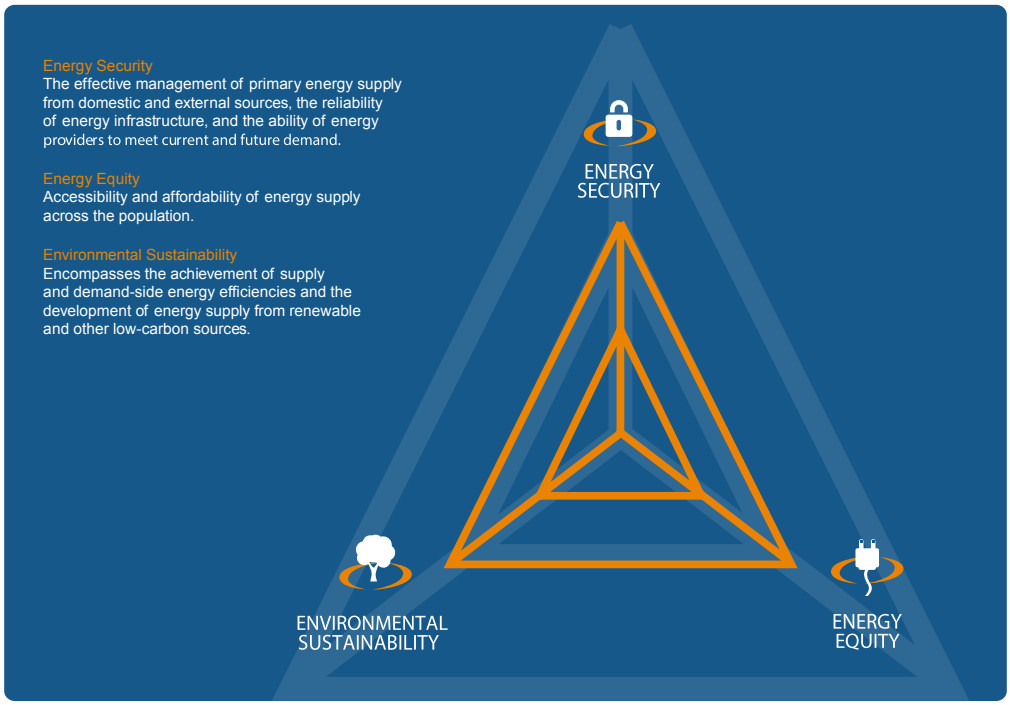
1. The importance of balancing the energy trilemma

Energy leaders noted that both an international climate change agreement and new development goals should be addressed through the lens of balancing the energy trilemma. The energy trilemma recognises the complex interwoven links among the three core dimensions – energy security, energy equity and environmental sustainability – and their importance in ensuring sustainable energy systems. In balance and considered together, these three dimensions are a prerequisite for the prosperity and competitiveness of individual countries (see Figure 2).

Figure 2

The World Energy Trilemma

Source: World Energy Council/Oliver Wyman, 2013



It was noted that one of the key challenges in coming to an international consensus on energy, climate and development targets is the concern about the potentially negative impacts on at least one of the trilemma dimensions. For example, a focus on the supply side of GHG reduction may impede energy security and access, while a focus

on increasing access may impact energy security and environmental sustainability. As one energy leader stressed: "Until we get the environment, energy and commerce ministers in one room, we won't get good climate decisions." In particular, countries have concerns that an international climate agreement may limit their autonomy to set national energy and climate policy and ensure energy security as well as continued economic development and competitiveness. The issue is most crucial in emerging countries, with large and growing energy markets such as Brazil, India and China, but also a concern in other countries such as the United States (US).

There are reasons for concern for all economies – both developing and mature. The investments required to update mature and installed energy systems in developed economies are significant: Germany's energy transition may require as much as US$469bn by 2033, if not more.[1] Transitions in technology have to be accompanied by as yet uncertain developments and innovations in business models, processes and regulatory frameworks to accommodate new sources of energy supply and distributed generation systems to ensure a robust and competitive energy sector. Some utility companies have already begun to modify corporate structures to better compete in the new business environment. Increased policy and regulatory certainty will accelerate this transition and opportunity.

Research, reinforced by the findings of the workshops and interviews conducted, clearly shows that there are considerable opportunities for countries to balance the three dimensions of the energy trilemma while maintaining economic competiveness. Mature economies will continue to benefit from a greater focus on energy efficiency and ongoing structural changes in their economies, which will result in near-zero growth in energy demand, despite growing gross domestic product (GDP) over the next 20 to 30 years. A recent report suggests that bold policies on resource efficiency could deliver a US$318bn boost to the European Union's (EU's) economy.[2] Some OECD economies, supported by a combination of continued deindustrialisation, greater energy efficiency and the use of more renewable energy are, already starting to decouple economic growth and GHG emissions (see Figure 3).

Rapidly growing economies can leverage technological developments in energy supply as well as global best practices in demand management to efficiently increase supply and ensure effective energy use. Investments in renewable energy supply in developing countries were US$131bn in 2014 (compared to US$139bn for developed countries) with China investing US$83.3bn, Brazil US$7.6bn, India US$7.4 billion and South Africa investing US$5.5bn.[3] As one energy executive noted, "In some regions where the lack of energy sources is an economic growth barrier, investing in renewable energy is a far quicker way to increase energy supply compared to setting up nuclear or thermal energy plants. In these instances, renewables are a critical enabler of economic development." Many countries are also focusing on managing energy demand by stimulating the adoption of efficient industrial equipment, implementing smart grids and smart logistics, and other programmes such as reducing ageing household appliances, product labelling and improving consumer education programmes.

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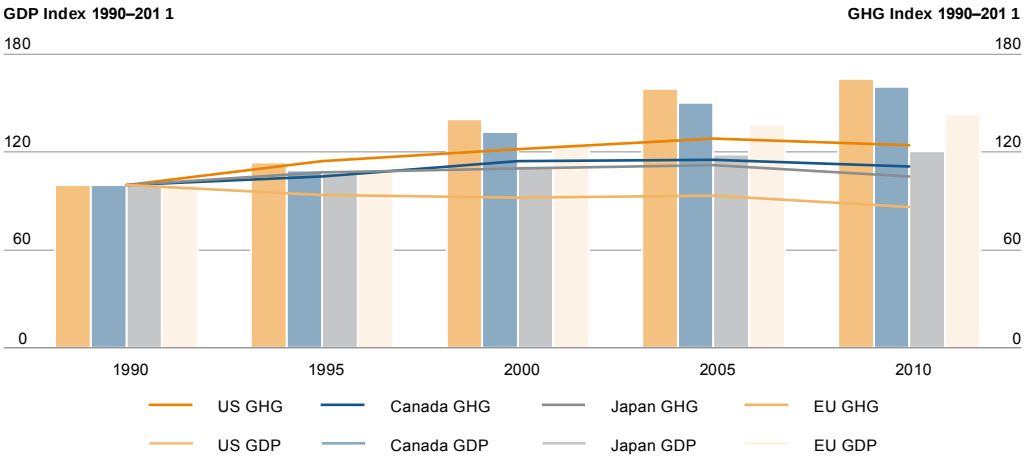
[1] Oliver Wyman, 2014: Sustainable Energy: Financing Germany's energy transition
[2] World Wildlife Federation, 2015: From crisis to opportunity: Five steps to sustainable European economies; Global Commission on the Economy and Climate, 2014: Better Growth, Better Climate: The new climate economy
[3] Frankfurt School UNEP Collaborating Centre for Climate Change & Sustainable Energy Finance, 2015: Global Trends in Renewable Energy Investment 2015

Figure 3

EU, US, Canada and Japan decoupling GHG emissions and economic growth

Source: World Resources Institute (WRI), 2014: CAIT 2.0 - WRI's Climate Data Explorer climate; World Bank, 2014: World Bank Open Data (GDP)



With technological developments in energy supply and demand, a trilemma balanced, low-carbon energy system is increasingly viable and there are indicators that environmental sustainability will not require a significant trade-off with energy security or affordability. Indeed, as some industry executives suggest, "the real cost of the energy transition may be political, not economic." Focusing on the benefits and rewards of the investments for achieving sustainable energy systems can drive a positive shift in the tone and focus of the climate framework negotiations.

Box 1: China and US announce climate goals

The US–China joint announcement on climate change in November 2014 marked a significant moment in international cooperation on climate change. The US announced a target to cut net GHG emissions to 26% to 28% under 2005 levels by 2025, while China announced targets to peak CO_2 emissions and increase the share of non-fossil fuels in the energy mix to around 20% by 2030. This will require China to deploy an additional 800-1,000 GW of zero-emission generation capacity, including nuclear, wind and solar, over the next 15 years – a greater total capacity than that of all the coal-fired power plants currently existing in China.

To reach the targets, both countries agreed to: expand joint research and development; advance carbon capture and storage (CCS); promote trade in green goods; enhance cooperation on hydrofluorocarbons; launch a climate-smart/low-carbon cities initiative and demonstrate clean energy on the ground, a combination of pilot programmes, feasibility studies and other collaborative projects in the areas of building efficiency, boiler efficiency, solar energy and smart grids.[4]

[4] The White House, 2014: US–China Joint Announcement on Climate Change and Clean Energy Cooperation, 11 November 2014; Lander, M, 2014: US and China Reach Climate Accord After Months of Talks (New York Times, 11 November 2014)

“

Until we get the environment, energy and commerce ministers in one room we won’t get good climate decisions

”

2. The importance of an agreed framework with a clear target with monitoring

The dialogue among energy leaders from business, government and finance this year (and in previous years) established the readiness of the energy sector to have a clear and ambitious target to reduce global GHG emissions. Business leaders identify the concept of a stable and clear framework, with a single measurable target, at international level as the most effective way to catalyse the opportunities to deliver lower emissions. A clear framework will reduce policy uncertainty which has been lingering over the energy sector, and is proving detrimental to unlocking the US$48-53trn[5] necessary investments in global energy infrastructure and energy-efficiency measures.[6] As one executive noted, “There is a need to create clarity and show that there is a clear will backed by some decisions.” Another noted, “COP21 is a crucial platform to deliver policy certainty and incentives to countries to deliver on environmental targets.”

A focus on a GHG emission-reduction target will support policy parity for all low- and zero-carbon emission technologies, including renewables, nuclear, energy efficiency, or CCS and stimulate resource efficiency and demand-side responses. This will help to focus resources and investments, as well as innovation and RD&D efforts, resulting in more efficient system solutions.

A global goal would have to take into account countries’ and regions’ domestic political, economic and social differences. For example, in the US, a binding climate agreement could face a constitutional and political barrier. In India, China and other developing and quickly emerging countries, GHG emissions reductions must not hinder development and poverty alleviation goals. In the Middle East, fragmented leadership is a major obstacle to developing a consistent and stable energy policy, whereas in Japan and South Korea, social acceptance for energy supply is a key issue. In Latin America, regional integration is the key opportunity to address energy and climate goals, with lack of trust among governments as the major obstacle.

A single, global emission-reduction target will build on national-level objectives and unique approaches identified in intended nationally determined contributions (INDC).

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[5] This publication uses the short-scale version of a trillion, i.e. one thousand billion.
[6] International Energy Agency (IEA), 2014: World Energy Investment Outlook

The INDC approach enables countries to set credible targets, in line with their long-term economic, climate and energy security goals, factoring in available resources, social and economic development, technologies and industrial skills, as well as compatibility with the internal market (see Box 2). This bottom-up approach is aimed to ensure that all countries, developed and developing, contribute as they can to the achievement of the target. In this context, one executive concurred, “Negotiators should ensure that GHG reduction targets are set according to the conditions of each country, as one of the key objectives of the negotiation is to find a way to encourage countries to join the global effort to reduce emissions to the extent that their nation’s interest can be protected.” Another executive noted, “This agreement should be designed to give a guide to the different countries taking into account their vulnerabilities and level of economic development.” A fossil-fuel oriented economy may choose to focus on energy efficiency and demand management measures, and expanding research and development on building efficiency, clean vehicles and advanced coal technology. In contrast, a country that relies on fossil-fuel imports may choose to focus on a combination of energy-efficiency and demand-management measures. Carbon pricing could also be a means to levelling the playing field among different technologies and increasing the share of renewable energy sources.

Box 2: The long road to Paris

Under the UN Framework Convention on Climate Change (UNFCCC), countries are making progress towards achieving a new international climate agreement at the climate change conference in Paris in December 2015. The Paris meeting will be the 21st annual meeting of the conference of parties (COP21).[7]

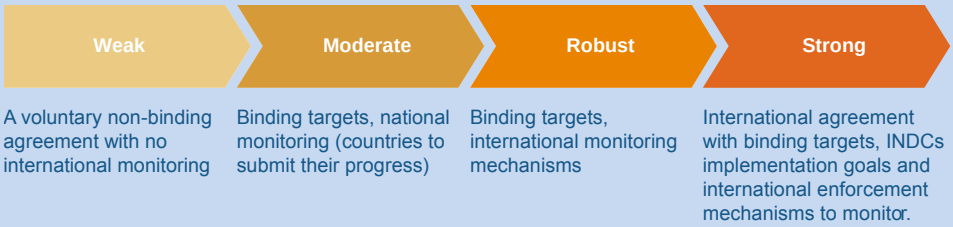
The objective of the 2015 conference is to achieve, for the first time in over 20 years of UN negotiations, a universal agenda on climate action to come into effect in 2020.

Heading into the Paris meeting, countries will be communicating their INDCs to the UNFCCC secretariat. The INDCs will reflect national priorities, circumstances and capabilities and account for “common but differentiated responsibilities and respective capabilities.” In setting out their contributions, countries are encouraged to include quantifiable information on the reference point (including, as appropriate, a base year), timeframes and/or periods for implementation, scope and coverage, planning processes, assumptions and methodological approaches. Also, countries will provide a perspective on why they consider their INDCs to be fair and ambitious, and how it contributes to achieving the objective of an international target. Countries are expected to communicate their INDCs in the first half of 2015.

While there is growing support from businesses and societies, and INDCs to reduce GHG emissions have been announced by some major economies, the INDCs process is behind schedule and will likely not be completed on time. The lack of capacity in developing countries, as well as the restraint exercised by other countries to come forward with their INDCs has slowed the process down.

[7] For more information on the UNFCCC and the process see: www.cop21.gouv.fr/en

Figure 4
Potential spectrum of agreements at the Paris COP21
Source: World Energy Council/Oliver Wyman, 2015



There are still strong indications that a consensus will be reached in Paris, however, the actual outcome of the meeting is uncertain in terms of strength and format (see Figure 4). An international agreement with a binding target will be hard to achieve, but a monitored voluntary agreement remains plausible. In that sense, Paris could be the first step towards achieving a single, global target based on INDCs.

The energy sector also stressed the importance of mechanisms to assess and monitor adherence to commitments. As one energy leader noted, “rules and accountability are essential for a ‘good’ package.” Backing commitments by monitoring can also reduce concerns over carbon leakage (see Box 3) and the loss of economic competiveness as a result of uneven adherence to commitments. Transparent monitoring from the outset would also help to highlight gaps where more efforts are needed. As one executive highlighted, “We need to be able to assess the totality of efforts. Some commitments may just not be enough.” In the case of an international climate agreement, a tracking system has yet to be developed. However, as one interviewee noted: “The Trilemma Index may be a tool to help classify countries to determine ‘common but differentiated responsibilities and respective capabilities’ but also to track progress against the agreed upon target,” (see Box 4). Data gathering and monitoring can help identify gaps and, therefore, business opportunities to catalyse the transition to low-carbon energy economies.

A monitoring mechanism would also allow the development of dynamic and evolving individual targets that can change to reflect a country’s economic and social development as well as developments in the energy sector. It is suggested that the Paris outcomes should include a defined process to update country targets and commitments on a regular basis, for example, every five or ten years. As the past decade has shown, a country’s energy profile (supply and demand) can change quite dramatically over a relatively short period. As recommended by the energy leaders, “It would be important to have a long-term process that you do not have to renegotiate every few years.” A process to update commitments and targets against a backdrop of a long-term climate goal will set a stable, long-term investment climate while enabling a country’s commitments to reduce emissions to be adjusted as its economic profile and energy trilemma balance evolves. “Following Paris, we need implementation, monitoring and review to ensure longevity of the agreement.”

Box 3: Avoiding carbon leakage

Carbon leakage is a term used to describe the situation that may occur if, for reasons of costs related to climate policies, businesses relocate their production to other countries which have no, or fewer, regulation for certain GHG emissions, such as CO_2. In such instances, the carbon 'leaks' out of one regulatory regime and increases the emissions in the country the production is transferred to, as well as globally.

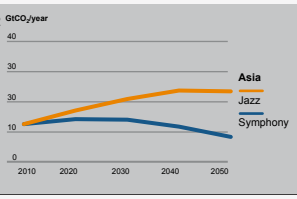
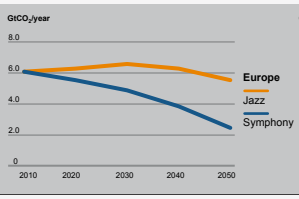
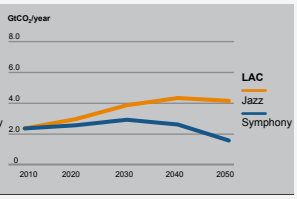
In response to the problem, and to address competiveness, the European Commission developed and updates a carbon leakage list on a regular basis. This list seeks to identify those sectors and sub-sectors which are deemed to be exposed to a significant risk of carbon leakage and increase their free allocation of allowances under the EU Emission Trading Scheme. The list was established by the European Commission in the wake of an agreement by the member states and the European Parliament, and following extensive consultation with stakeholders, including member states, industry, non-government organisations and academia.[8] The purpose is to prevent Energy Intensive Trade Exposed industries from relocating their production and emissions while still providing some incentives for improved performance and structure change (via the efficiency benchmarks based allocation method).

Box 4: The Energy Trilemma Index – what gets measured, gets done

The annual Energy Trilemma Index prepared by the World Energy Council and Oliver Wyman tracks countries' relative energy performance over time on three dimensions: energy security, energy equity and environmental sustainability (see also Figure 2). It compares countries on their overall ranking on meeting all three elements of the energy trilemma as well as performance on individual dimensions and the balance of performance between the rankings. The rankings use a range of databases that capture energy performance and its context. Energy performance indicators consider supply and demand, the affordability and accessibility of energy, and the environmental impact of a country's energy production and use. These performance indicators are augmented by contextual indicators that consider a country's political, societal and economic strength and stability.

The Energy Trilemma Index, updated annually, can support efforts to track country-level progress in meeting energy goals and climate framework commitments and capacity to implement climate framework goals.

[8] European Commission, 2015: Carbon Leakage, http://ec.europa.eu/clima/policies/ets/cap/leakage/index_en.htm

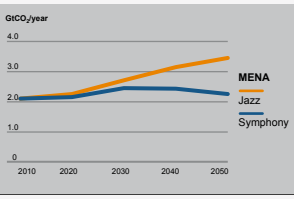
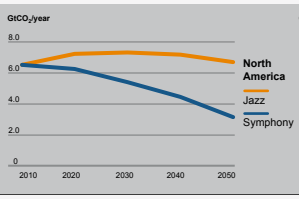
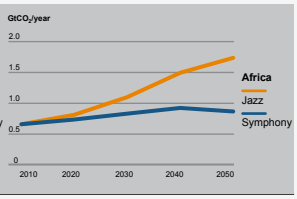
	Asia	Europe	Latin America and Caribbean
Energy Trilemma profile (2014)			
Priority areas	Diverse array of economies and focus areas, stretching from increased access to a stronger emphasis on energy efficiency in energy supply and demand side and active demand management. Social acceptance to changing energy supply is a barrier in many countries. Increasing resilience of the energy system is viewed as important.	Reducing GHG emissions, increasing energy efficiency, and diversification of the energy mix by growing share of renewable energy are viewed as three key instruments to reach climate and energy security targets. Address growing concerns around competitiveness and changing purchasing power of consumers.	Changing weather patterns pose a threat to current energy mix (hydropower), and require a focus on adaptation measures. Managing energy demand growth is key. Regional integration as an opportunity to ensure sustainable development and optimise the use of energy resources.
Voices from the regions	"It should be within the responsibility of richer countries and those who have enjoyed prosperity without the limitations of carbon caps to help the least developed countries to support and facilitate their growth rather than penalising it."	"Today's mitigation investment costs are lower than tomorrow's adaptation costs."	"The biggest bottleneck to greater energy efficiency is the natural resistance to change, which must be countered with an adequate incentive policy and a rigorous programme of socialisation and communication."
Energy demand	By 2050, nearly half of global economic growth is expected to take place in Asia. The share of global total primary energy consumption is expected to increase from 40% in 2010 to between 45–48% by 2050.	By 2050, European GDP will almost double and contribute roughly 20% to the global economy (2010: 32%). Energy consumption is expected to remain fairly stable over the next 35 years.	With economies expanding, energy consumption continues to rise creating energy security challenges for some countries. Energy demand in the region is predicted to increase and almost double by 2050.
Energy supply [9]	Primary energy supply may increase by as much as 90% with China and India at the core of future growth. Coal will likely remain the dominant fuel. Renewable energy sources, including hydropower, may contribute by as much as 45% to electricity generation in 2050.	Region lacks large natural deposits of fossil fuels. Focus on diversification of energy supply portfolio, but still faces regulatory challenges. Share of renewable energy sources, including hydro power, may contribute between 40–47% to electricity generation in 2050.	Region is energy-rich with large oil and gas deposits and great natural endowments of exploitable renewable energy. To adapt to changes in hydrological patterns and cycles, region may need to increase fossil-fuel power generation as well as focusing on solar and wind energy.
Population with access to electricity (%) [10]	89.5	99.9	98.1
Emission intensity (kCO_2 per US$, PPP) [11]	0.40	0.33	0.29
$C0_2$ Emissions [12]			

[9] World Energy Council, 2013: World Energy Scenarios: Composing energy futures to 2050; The lower number refers to the WEC's 'Symphony' scenario, which focuses on achieving environmental sustainability through internationally coordinated policies and practices, while the higher number reflects WEC's 'Jazz' scenario, which focuses on energy equity with priority given to achieving individual access and affordability of energy through economic growth.

[10] Sustainable Energy for All, 2013: Global Tracking Framework

[11] World Energy Council, 2015: Energy Efficiency Indicators Database

[12] World Energy Council, 2013: World Energy Scenarios: Composing energy futures to 2050

	Middle East and North Africa	North America	Sub-Saharan Africa
Energy Trilemma profile (2014)			
Priority areas	Energy efficiency and diversification of energy mix are priority areas given growing focus to sustain energy security and address environmental sustainability, including GHG emissions. Increasing transparency in market value of energy would support improved demand management.	Committed to tackling global climate change “on their own terms” as economies rely heavily on energy production for energy exports and heavy industries. Focus on energy-efficiency improvements and development of lower carbon energy solutions.	Focus on increasing energy access and affordability as a means to grow economies, improving quality of life and life expectancy.
Voices from the regions	“Energy-efficiency measures that are commercially viable, whilst generating environmental, economic and social benefits to the end-user are the most sustainable and address all three dimensions of the energy trilemma.”	“A fossil-fuel-based economy will reduce carbon emissions differently than a fossil-fuel import dependent economy.”	“Without seeing a direct impact, developing countries may have limited incentives to make investments in emission reductions as compared to energy access.”
Energy demand	By 2050, GDP in the region will almost triple, but still only represent roughly 5% of the global economy. Energy demand is predicted to increase significantly by 2 to 2.5 times by 2050.	By 2050, the region’s GDP will almost double and contribute close to 20% to the global economy (2010: 27%). Energy consumption is expected to remain fairly stable over the next 35 years.	About 590 million people currently lack access to electricity. Increased access and comparatively strong economic growth are expected to drive demand, which is predicted to more than double by 2050.
Energy supply	Region has an estimated 66% of the world’s oil and 45% of the world’s natural gas reserves concentrated in Gulf Cooperation Council member countries. Focused on diversifying energy supply to increase overall energy security, using both renewable energy sources and nuclear.	Relatively self-sufficient as all three have large natural endowments of oil, natural gas, and coal as well as potential to exploit renewable energy sources. Electricity generation portfolio varies greatly among countries.	Naturally endowed to integrate more low-carbon sources, and for gas to play an increasing role. Renewable and conventional thermal power generation expected to be equally represented in 2050.
Population with access to electricity (%)	93.9	99.7	36.9
Emission intensity (kCO_2 per US$, PPP)	0.53	0.36	0.25
$C0_2$ Emissions			

“

Policymakers must drive a sense of ambition by setting a courageous target that allows people to become creative

”

3. Priority actions to achieve that target

Each country will need to determine how to meet GHG reduction targets in consideration of its national economic circumstances, energy profile, and energy trilemma results. Energy sector leaders from around the globe stressed a number of priority mechanisms. Some of these mechanisms will require international cooperation, including financing mechanisms, technology transfer and integrated carbon-pricing mechanisms. These actions need to be carefully designed to help address the "challenge of navigating in a two-speed world." That is, the need to meet increasing demand for energy in less-developed countries and potential associated growth of GHG emissions in these economies, while mature economies are able to reduce energy demand and GHG emissions. Other efforts, including national carbon-pricing mechanisms, demand management and energy efficiency, as well as prioritising research and development, can be implemented individually by each country.

Trade and technology transfer

Trade and technology transfer are crucial parts of addressing climate change, enabling an energy transition as well as balancing the three dimensions of the energy trilemma. As one interviewee noted, "There needs to be some sort of technology transfer mechanism; we won't be able to address this on a pure business basis." Another one added, "The elimination of tariffs on environmental goods also matters. It addresses all three aspects of the energy trilemma by promoting more energy supply, cutting energy costs, and reducing emissions. Cutting tariffs will also enable the development of clean energy industries in the countries that participate."

Developing countries have stressed the importance of robust technology transfer mechanisms for many years. In particular, it has been pointed out that even technologies that are off-patent and in the public domain are often difficult to access for developing countries that lack local capacity.[13] Technology transfer, by redistributing abatement costs and increasing human and industrial capacity, is the enabler to a more sustainable path to growth. As one interviewee noted, "To develop the energy sector, we need: technology at an affordable cost, human and industrial capacity, and a portfolio of bankable projects."

From the workshops and interviews conducted, executives noted that the best technology transfer is achieved by "doing business" through partnerships (joint business and project development). However, this method of transfer also requires

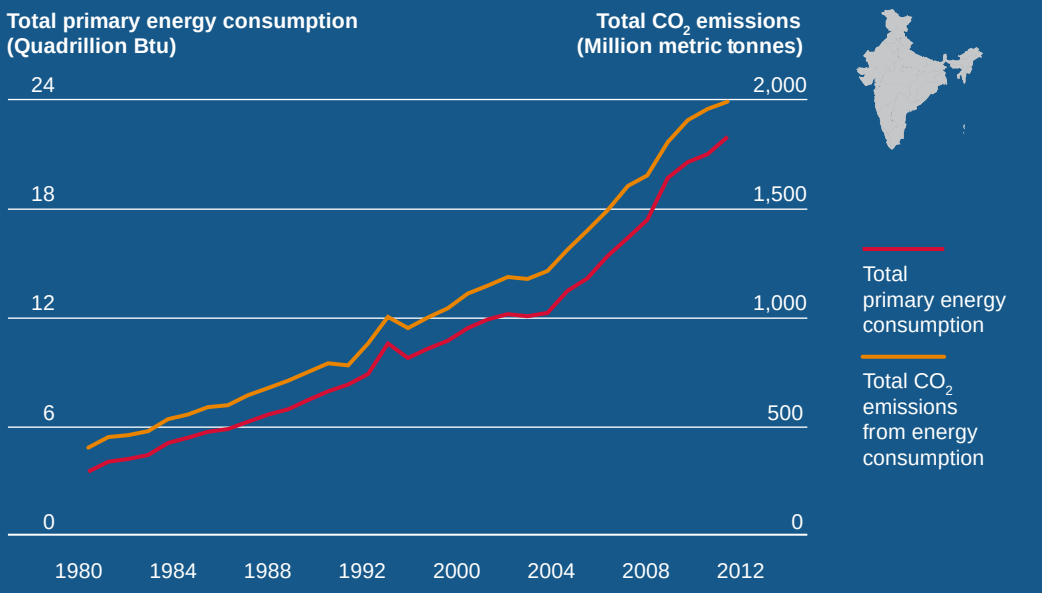
[13] International Centre for Trade and Sustainable Development, 2012: Realizing the Potential of the UNFCCC Technology Mechanism: Perspectives on the way forward

India: ensuring growth and managing impact

Figure 5

India's growing energy demand and CO_2 emissions 1980–2012

Source: US Energy Information Administration (EIA), 2012: International Energy Statistics



India faces a unique combination of hurdles in addressing the energy trilemma and meeting climate goals. With its fragmented energy market, low generation capacities, unstable energy infrastructure, and significant transmission and distribution losses, India struggles to ensure the volume and stable supply of energy needed to maintain economic growth. India must also increase access to modern energy services to continue to drive social development. As one of the world's major emitters of GHG, India struggles with low air and water quality and high CO_2 emissions from electricity generation due to the predominance of coal in the country's energy mix.

For emerging countries like India, it is crucial that the requirements of adhering to an internationally agreed climate framework be divided in an equitable way and according to the economic, financial, technological and human capacities of individual countries. Mechanisms to support the flow of existing technologies within and between markets are key enablers to achieving GHG emission-reduction goals at the lowest possible economic cost. For example, in India, where coal represented close to 55% of the primary energy consumption mix in 2013, CCS will play a vital role in facilitating continued economic growth and related CO_2 emissions reductions. New-built coal-fired power plants should be CCS-ready to avoid carbon lock-in.

While developing and emerging countries may not be able to invest in the development of CCS and other important abatement technologies, they can support the creation of robust and enabling environments that would encourage and leverage investment in and take-up of new low- and zero-carbon technologies. For example, the elimination of tariffs on environmental goods can help reduce the cost of clean energy technology and increases deployment, thereby increasing energy efficiency and reducing emissions. Elimination of such tariffs would also enable the broader development of industry across the economy.

business opportunities and markets in order for partnerships to deliver, creating a "chicken and egg situation" which well-designed technology transfer mechanisms should help overcome. Also, it is necessary to consider the countries' technological needs, depending on whether they are technology developers, implementers or aid recipients. Training can be a useful means of transferring knowledge, but only if there is real demand and an actual application of knowledge.

A technology transfer mechanism was established in 2010 by COP16, aiming "to accelerate technology development and transfer in support of action on adaptation and mitigation."[14] The success of the mechanism has been limited, failing to deliver the envisaged project scale-up. In particular, it was viewed as not effectively considering national frameworks to encourage private investments, not distinguishing between countries or technologies, and not providing adequate tools to measure its effectiveness.[15]

When designing technology transfer mechanisms, policymakers should, therefore, think about how to incentivise the demand for technology (and creation of markets), the production of technologies at competitive costs (acknowledging industrial capabilities and potential), and the collection of information to assess the effectiveness of the mechanism. Impacts on pre-existing policies will also have to be considered. Careful design is needed around local content requirements to ensure that the technology transfer is achieved alongside sustainable development. While local content requirements may help to build up domestic workforces and manufacturing sectors, they can also slow down development and, in some instances, impose too much of a barrier or prevent foreign investment altogether.

For technology transfer mechanisms to refrain from hindering the development of new technologies, it is fundamental that they safeguard intellectual property rights in order to keep companies investing in RD&D. Overall, these mechanisms need to consider both the receiver and the sender, incentivising partnerships that allow the technology transfer to occur where it is most effective.

Eliminating government-imposed barriers to trade in environmental goods and services, thereby reducing their cost and spurring their use, is also a central means of contributing to international GHG reduction objectives. Today, much clean energy equipment is taxed as it crosses national borders. Those tariffs add to the cost challenge and make it more difficult and, in some instances, impossible to deliver zero- and low-carbon energy technologies. Tariffs not only raise the cost of any project that uses imported products, they also drive up the cost of production by making it harder to achieve scale. Ultimately, by reducing the size of a potential market, they undermine incentives for innovation in the clean energy area.

The elimination of tariffs on environmental goods matters and efforts are underway on various platforms. Eliminating tariffs will allow for a greater total energy supply than under the status quo. It will reduce the cost of energy and promote projects that reduce GHG emissions. In short, tariff elimination will have a positive impact on all three aspects of the energy trilemma – reducing the cost of clean energy technology, increasing deployment and enabling the development of industries in the countries that eliminate their tariffs.[16]

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[14] United Nations Framework Convention on Climate Change, 2008: Bali Action Plan
[15] Pueyo and Linares, 2012: Renewable technology transfer to developing countries: one size does not fit all
[16] World Energy Council, 2015: Catalysing the low-carbon economy

Carbon pricing

There are growing calls for an international system to price carbon: “To really get the investments to flow into energy infrastructure, we need to put a dollar value on CO_2 to create a pool of potential money.” Indeed, during the UN Climate Summit 2014, more than 1,000 companies and investors globally indicated their support for carbon pricing.[17] In 2014, more than 150 major businesses worldwide used an internal carbon price, a so-called ‘shadow carbon price’ for their operations, corporate planning or investment analysis.[18] With the expectation that a carbon price will eventually appear, this approach allows companies to evaluate long-term investment projects, costs and revenues, and ensures that the most profitable investments are pursued.

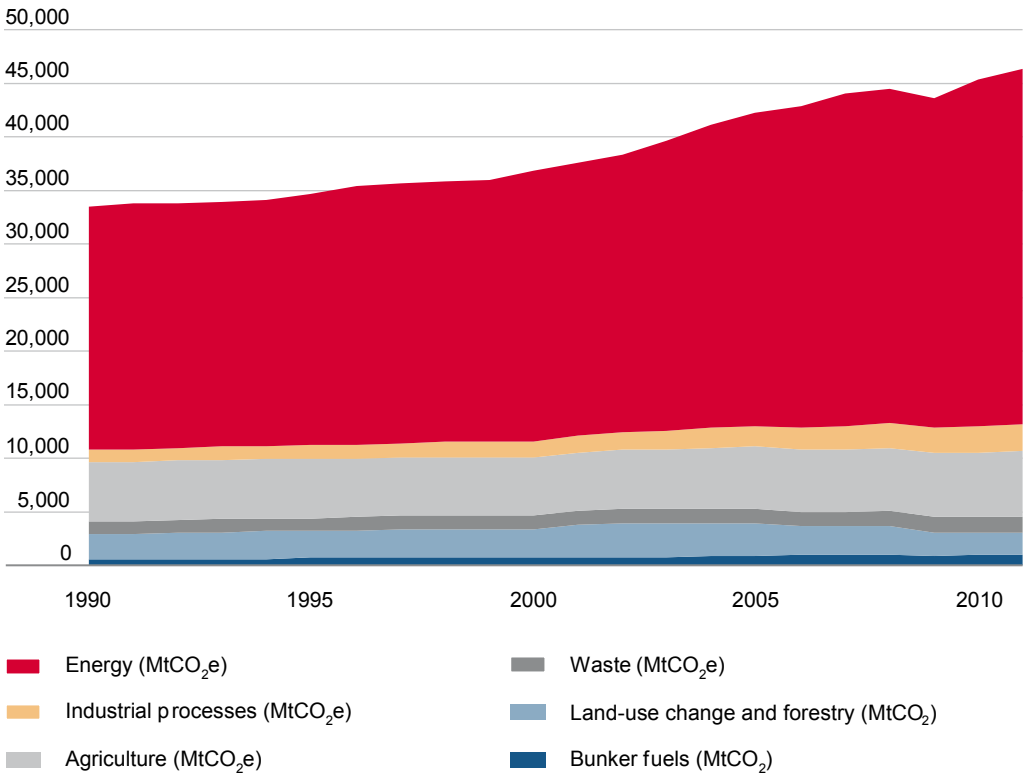
As first noted in the 2012 World Energy Trilemma report, the energy industry believes that a meaningful carbon price would send a clear market signal to investors and, by “levelling the playing field” (as one executive noted) redirect investments to low-carbon projects.

When setting a carbon price, policymakers should acknowledge that GHG emissions arise from a number of sources, mainly fossil-fuel combustion in the power generation, industrial, residential and transport sectors (see Figure 6). In this context, energy leaders called for the application of a carbon price to all sectors that emit GHGs.

Figure 6

GHG emissions by sector from 1990 to 2010 ($MtCO_2$ / $MtCO_2e$)

Source: World Resources Institute (WRI), 2014: CAIT 2.0 - Climate Data Explorer



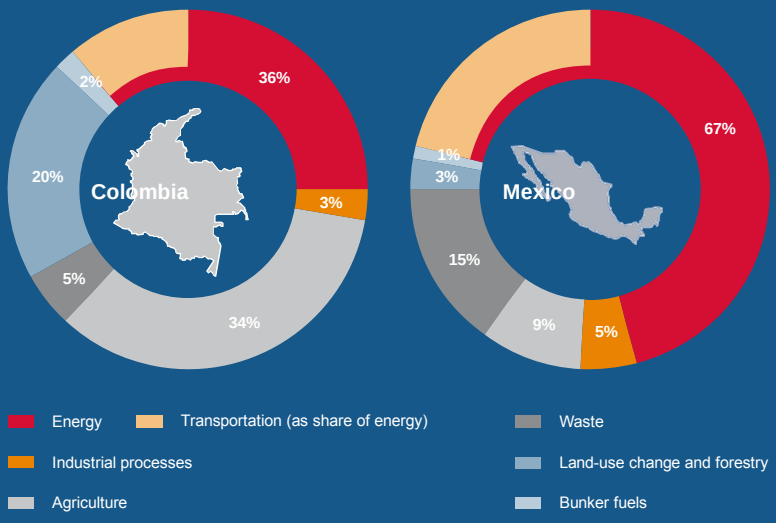
[17] World Bank, 2014: Pricing Carbon, www.worldbank.org/en/programs/pricing-carbon
[18] Carbon Disclosure Project, 2014: Global corporate use of carbon pricing

Colombia: looking beyond the energy sector

Figure 7

Comparison of GHG emissions by sector

Source: World Resource Institute (WRI), 2014: CAIT 2.0 - WRI's climate data explorer



Unlike many other energy exporting countries, such as Mexico, the US, Canada, or countries in the Middle East, Colombia has very low GHG emissions related to the supply and use of energy (see Figure 7). This is largely due to the use of hydropower – more than 80% in domestic electricity generation.[19] Colombia faces a range of responsibilities, opportunities and challenges regarding climate goals and must look outside the energy sector towards fields such as transport and agriculture to seek out opportunities for emission reduction. Also, the nation can manage demand growth by implementing energy-efficiency measures and encouraging widespread adoption of energy efficiency. Opportunities for Colombia in the upcoming climate negotiations include the potential for credits, or other compensation, in exchange for reducing deforestation and preserving its forests, which serve a critical environmental service by absorbing emissions.

However, the nation also faces looming challenges with climate change and potential shifts in its energy mix. The oncoming effects of climate change may disrupt water cycles and reduce available hydro resources. Colombia is looking to diversify its energy mix and possibly consider greater use of fossil fuels as well as incorporating renewables such as solar and wind. The effectiveness of this diversification and integration of a wide range of renewables will be crucial in determining Colombia's ability to meet climate goals and balance the energy trilemma in the future.

Colombia stands as an example of a nation which, despite low emissions, faces significant climate challenges and opportunities to meet climate goals and ensure energy security and affordability.

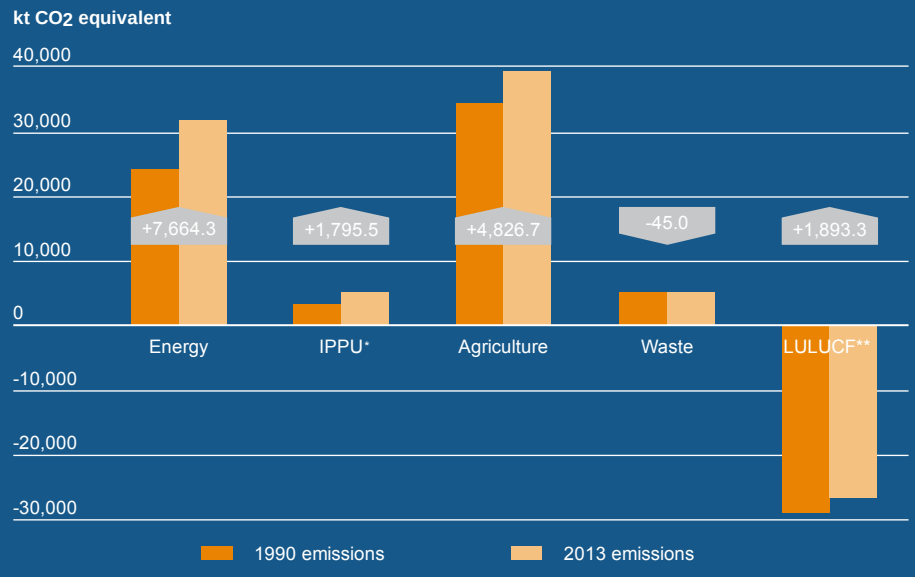
[19] US Energy Information Administration (EIA), 2012: International Energy Statistics

New Zealand: leveraging challenges to create future opportunities

Figure 8

Change in CO_2 emissions by sector (1990–2013)

Source: Ministry for the Environment, 2015: New Zealand's greenhouse gas inventory 1990–2013



*IPPU = Industrial Processes and Product Use; **LULUCF = Land Use, Land-Use Change and Forestry

New Zealand has a unique set of climate-related challenges that complicate its ability to reduce its emissions, but also provide opportunities for the country and for other nations to learn from its success. In light of its abundance of natural resources, the country generates 80% of its electrical energy from renewables – hydro, geothermal and wind – and around 70% of its exports come from the land sector. As a result, just under half of its total GHG emissions come from agriculture, not industry or energy use. The country also faces some unique challenges in the road transport sector, with emissions growing by 69% since 1990 and contributing around 16% of total emissions in 2013. New Zealand is ranked fifth for per capita emissions in the OECD but net emissions (net of land uses like forestry) are relatively small at 55 million tonnes per annum, or 0.2% of global emissions.[20]

This unusual mix of endowments and challenges has led to a variety of policy responses. At the heart is a recognition that research (especially for agriculture), technology, finance and markets will be vital to unlocking innovative emission-reduction solutions. Also, predictable, stable long-term policies are more likely to encourage the best long-term behaviour by businesses and consumers and deliver balanced outcomes.

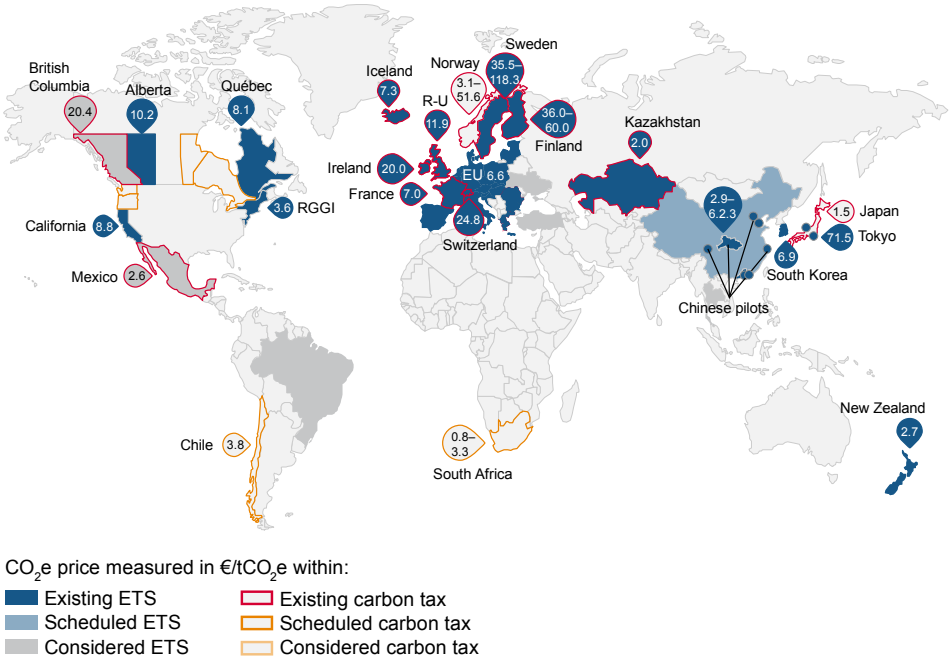
Consistent with this, New Zealand already has one of the few economy-wide emission trading schemes and, with substantial international investment being made in new technologies, is now well-placed to maximise its renewable energy in low-carbon transport modes, battery technologies and grid-based solutions. New Zealand's success in these areas has the potential to act as a catalyst for positive change in other lower GDP, land based economies as they transition to renewable electricity.

[20] Ministry for the Environment, 2015: New Zealand's greenhouse gas inventory 1990–2013

The most common mechanisms to price carbon are emissions trading schemes (ETSs), carbon taxes, and emissions standards. To date, there are 18 ETSs, including sub-national jurisdictions in the US and China, and 12 carbon taxation schemes implemented worldwide to meet ambitious goals to reduce GHG emissions. The price of carbon varies greatly across the different schemes. When implemented, all carbon schemes together would encompass almost half of global CO_2 emissions (see Figure 9).[21] As more and more carbon-pricing schemes are being developed and implemented across the globe, collecting and analysing experiences from existing schemes can serve as the basis for the design and implementation of successful carbon- pricing instruments.

Figure 9
Carbon pricing world map in 2014

Source: CDC, 2015: Climate Research; World Bank, Ecofys, 2014: State and trends of carbon pricing



There is a range of views on whether ETSs or carbon taxes are more effective; taxes guarantee a stable carbon price, while ETSs guarantee stable emission reduction and provide an opportunity for linking several independent schemes in and across regions, as seen with the Québec and California (US) ETS. A number of the private sector energy leaders surveyed praised the flexibility of an ETS, noting: “An ETS provides the private sector with the flexibility required to reduce emissions while stimulating technological innovation.” Others referred to the tax as most effective in delivering a strong price signal for carbon. As one executive noted, “Taxation is probably the only way to price carbon; with the ETS, the private sector will find a weakness and drive a truck through it.”

Experience with carbon pricing reveals that the design and implementation is more important than the measure adopted. The development of hybrid arrangements may also be considered, for example, with cap-and-trade (legal emission limits) for large

[21] World Bank, Ecofys, 2014: State and trends of carbon pricing

Canada: a hybrid approach to carbon pricing

Canada is a net exporter of most energy commodities and a significant producer of conventional and unconventional oil, natural gas, and hydroelectricity. On a sub-national level, the country is very diverse. Large oil and gas resources drive the economies of Alberta, Saskatchewan, British Columbia, and Nefoundland and Labrador whereas in British Columbia, Québec, and Ontario, hydroelectric power is an abundant, cheap energy source that has enabled the creation of several important industries. These differences on a sub-national level lead to very different GHG emission profiles on a provincial level and strategies to reduce them.

The approach to reducing carbon emissions is not mandated at the federal level; individual provinces are free to pursue different mechanisms in achieving climate goals. For example, the province of Alberta was the first to develop legislation regulating GHG emissions that require large industrial emitters to report their emissions and take actions to make mandatory reductions. The programme also put a price on carbon and regulates an Alberta-based carbon offset system. British Columbia introduced a carbon tax in 2008, while the province of Québec launched a cap-and-trade system in 2013 (see Table 1 for comparison). Ontario is planning to launch a cap-and-trade system that will link into the system already in place in the partnership between Québec and California, creating a carbon market of 61 million people and covering more than half of Canada's economy. [22]

Table 1

Comparison of two Canadian carbon-pricing schemes [23]

Source: World Energy Council / Oliver Wyman, 2015

	British Columbia: carbon tax	Québec: cap-and-trade
Policy type	Tax	Emissions trading scheme
Goal	Reduce emissions by putting a price on carbon emissions; resulting level of emissions varies.	Reduce emissions by capping total emissions at a predetermined level; issue permits to allow emissions up to that level; allow participants to trade permits; impose penalties for non-compliance
Overview	Tax implemented in 2008 to reduce Britsh Columbia's GHG emissions by 33% below 2007 levels by 2020. The tax rate was increased annually by CA$5 per tonne of CO_2 equivalent, ultimately reaching a cap of CA$30 per tonne in July 2012. After a 2012 review, the province confirmed that it would keep its carbon tax, maintaining a rate of CA$30 per tonne of CO_2 equivalent.	System launched in 2013. Businesses emitting 25,000 metric tonnes of carbon or more annually are subject to the system; the market is also open to other entities not subject to regulatory requirements. At the end of each compliance period, all emitters subject to the system must have enough emission allowances to cover their total reported and audited emissions for the period. Emission allowances are obtained at auctions, by purchasing from other participants, or by purchasing offset credits.
Revenues	Revenue-neutral; all carbon tax revenue is returned to individuals and businesses through reduction of other taxes.	Revenues fund the Québec Green Fund and are earmarked for the financing of initiatives in the 2013–2020 Climate Change Action Plan.
Coverage	Virtually all emissions from fuel combustion in British Columbia that are captured in Environment Canada's National Inventory Report are taxed.	From 2013 to 2014, only industrial-end electricity sectors were subject to cap-and-trade; as of 2015, fossil-fuel distributors are also included.
Yearly adjustments	Tax rate increased by $5 per tonne, peaking at CA$30 in 2012.	Cap on emissions units decreases yearly, from 65.30 million in 2015 to 54.74 million in 2020.
Partnerships	None	International partnership with California; markets linked together in 2014 to form North America's largest carbon market. Their second joint carbon auction was held in March 2015. Ontario is planning to link to the system.
Impacts	Widely considered to be a success; fuel use has decreased by 16% in the province while increasing by 3% in the rest of Canada. The economy has not been adversely affected.	Initial auctions lacked interest. Since partnering with California, auctions have been successful. Impact on reducing GHGs is yet to be determined.

[22] Morrow, A, 2015: Cap and Trade Explained: What Ontario's shift on emissions will mean (The Globe and Mail, 13 April 2015)

[23] British Columbia Ministry of Finance, 2013: June Budget Update 2013/14 to 2015/16; Québec Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques, 2013: Québec's cap-and-trade system; British Columbia Ministry of Finance: What is a carbon tax?; The Economist, 2014: British Columbia's carbon tax, the evidence mounts, July 31 2014; US EIA, 2015: California and Québec complete second joint carbon dioxide emissions allowance auction

emitters and a carbon tax for other emitters, or cap-and-trade with collar mechanisms, such as price collars, ceilings or floors. Market dynamics must be carefully considered and corrective measures applied when necessary.

One executive noted, “Carbon pricing is instrumental in attracting investors and creating incentives to invest in the necessary infrastructure.” But, despite the consensus on the importance of carbon pricing, it is not sufficient to deliver the transition to a low-carbon economy. The effective and thoughtful integration of carbon pricing with other policies is fundamental, such as energy-efficiency measures or energy-diversification related targets. The limitations of carbon pricing are also linked to the volatility of the commodity market. In this context, stable prices would be impossible to achieve, especially as stabilising mechanisms such as subsidies are increasingly being perceived as negative policy instruments and reducing these subsidies is akin to levying a positive carbon tax.

While carbon- pricing schemes are being implemented in more and more countries, it needs to be recognised that any scheme requires sufficiently capable institutional frameworks to work. These frameworks are often not in place in developing countries. It can therefore be expected that a globally connected carbon market will not be possible in the foreseeable future, and that carbon markets will continue to develop nationally from the bottom up, connecting regionally where possible.

Financing the costs of climate action

For a climate agreement and energy transition to be effective, policymakers need to carefully consider the issue of finance. They must determine how to address the costs that may accompany countries’ commitments to targets, particularly the costs for developing countries. As one interviewee noted, “Constrained systems will always cost more than non-constrained ones, but will deliver more benefits. You cannot just […] deny short-term costs.” Costs may be driven by a direct set minimum carbon price or by the 'shadow carbon price' of a regulatory requirement to acquire and deploy low-carbon technologies. In particular, some developing countries may need to acquire technologies from the more developed countries, taking on short-term costs that are too burdensome, and that may discourage these countries from participating in an international agreement altogether. As another interviewee noted, “If financing instruments are included in the negotiations, they can help overcome this imbalance.” Financing mechanisms also act as enablers for deploying energy efficiency, increasing RD&D and encouraging technology transfers.

Previous research conducted by the World Energy Council in partnership with Oliver Wyman has shown that there is enough capital available to flow into the energy sector if the right policy signals are provided and a portfolio of bankable projects is in place.[24] To support an energy transition and climate agreement, policymakers should be focused on how to attract more private capital and ensure a pipeline of projects is developed.

In collaboration with the public sector, the energy sector can work to ensure that bankable projects are brought forward. The financial sector was called on to contribute and better understand new assets emerging from the latest technological

[24] World Energy Council, 2014: World Energy Trilemma: Time to get real – the myths and realities of financing energy systems

developments and how to address volatility of energy prices. If the regulatory rules are devised adequately to provide a clear direction and stability, the financial markets will be able to respond and find innovative ways for clean energy financing.[25]

Past climate agreements included financing systems, such as the Clean Development Mechanism (CDM), joint implementation or ETS developed under the Kyoto protocol. These initiatives, while helping to reduce global emissions and providing additional funding to low-carbon projects, have seen a variety of criticism, including allegations that some projects lack environmental integrity.[26] While there was scant evidence to support the suggestion that problems were widespread, nevertheless reforms are needed to restore confidence in the mechanisms on the part of some important stakeholders. The future role of the mechanisms is currently uncertain, putting at risk the raising of substantial sums of private sector investment which they have hitherto mobilised. New financing mechanisms have been part of the climate discussions over the past few years, such as the new market-based mechanism and Framework for Various Approaches, but negotiations around technical design and purpose have stalled as developing countries questioned the relevance of having these discussions before determining the ambition of the targets and amid confusion on how the proposed new mechanisms would differ from a reformed CDM.[27]

Multilateral institutional bodies can support governments in setting and delivering on climate and energy targets. At COP16 in Cancun, the Green Climate Fund was established to "support projects, programmes, policies and other activities in developing countries using thematic funding windows." With a US$10bn budget target achieved in Lima in 2014, the Fund's board is working on setting a framework to mobilise capital towards adaptation and mitigation projects while ensuring alignment between climate and development policy and increasing private sector participation.[28] The Fund also contributes to channelling investments from developed countries, which have historically produced more emissions and have more means of funding, to developing and emerging countries, where abatement costs are actually lower, as is the incentive to reduce GHG emissions. However, a number of steps are needed before the Fund becomes fully operational, including project specifications, delivery mechanisms and implementing entities.

Though the Green Climate Fund can provide an important means of channelling investments to developing and emerging countries, policymakers need to realise that such institutions are effective only where they are able to fulfil their mandate through transparent rules and clear deliverables. The delay in launching these initiatives diminishes the credibility of policymakers and institutions.

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[25] World Energy Council, 2014: World Energy Trilemma: Time to get real – the myths and realities of financing energy systems
[26] Clean Development Mechanism Policy Dialogue, 2012: Climate Change, Carbon Markets and the CDM: A call to action
[27] World Bank, Ecofys, 2014: State and Trends of Carbon Pricing
[28] Dzebo, A, 2014: With $10bn banked, what next for the Green Climate Fund? (RTCC News, 16 December 2014)

Demand management and energy efficiency

Demand management and energy efficiency support progress in all three areas of the trilemma – security, equity and environmental sustainability. The energy sector stressed that climate goals cannot be achieved by increased energy efficiency in energy supply alone. There must be an equally strong focus and increasing efforts to managing energy demand across all other sectors, including residential, commercial, industrial, and transportation. As noted by the Council's Secretary General at the 22nd World Energy Congress, "The inconvenient truth is: we are looking in the wrong place to address the issues facing the energy sector. We need more demand-side investments, innovation, incentives, and stronger technical standards to reduce energy intensity."

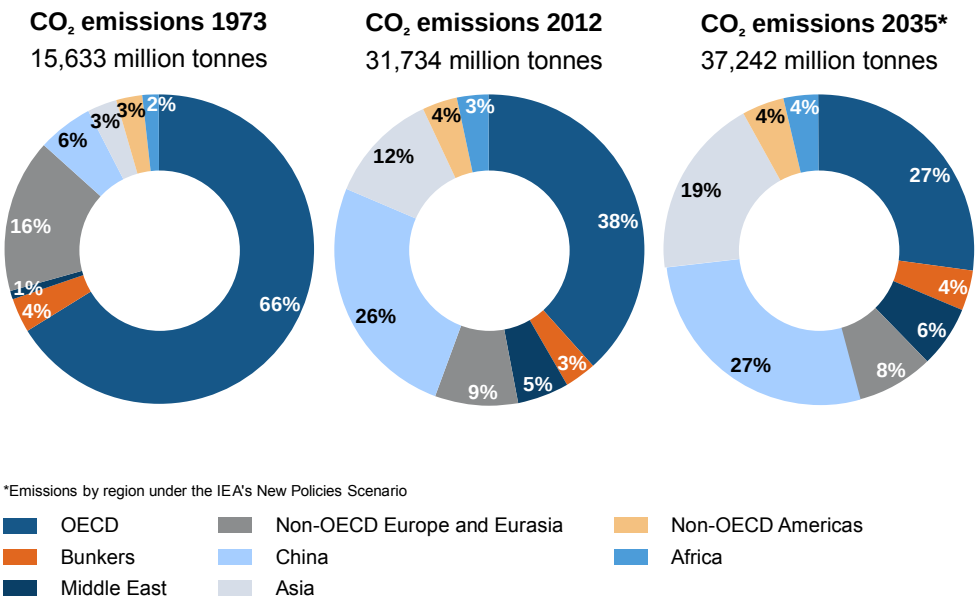
Progress is underway. In developed countries, energy-efficiency improvements have cut the effective demand for energy by 40% over the past 40 years.[29] Also, in 2014, global emissions of CO_2 from the energy sector stalled, marking the first time in 40 years that there was a halt or reduction in GHG emissions that was not tied to an economic downturn.[30] The halt in emissions growth is attributed to changing patterns of energy consumption in China and OECD countries.

The energy sector acknowledged that, in developing countries, the focus on energy efficiency as a means to reduce CO_2 emissions can be less of a priority than expanding energy access, affordability or security. The economic and social impacts of increasing those elements of the energy trilemma can often be more compelling than costs invested to increase energy efficiency. Yet an early and focused effort on energy efficiency can significantly reduce energy demand, increasing energy security and economic competitiveness.

Figure 10

Changes in regional shares of CO_2 emissions in 1973, 2012 and 2035

Source: International Energy Agency (IEA), 2014: Key World Energy Statistics



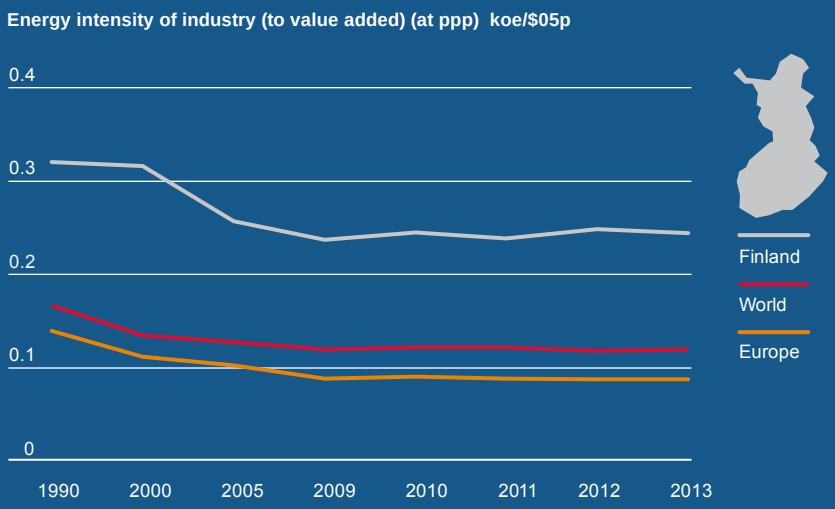
[29] IEA, 2013: Energy Efficiency Market Report
[30] IEA, 2015: Global energy-related emissions of carbon dioxide stalled in 2014, 13 March 2015

Finland: success of voluntary agreements

Figure 11

Energy efficiency improvements in Finland (1990 –2013)

Source: World Energy Council, 2015: Energy Efficiency Policies and Measures Database



Finland has an extensive history of promoting energy efficiency through voluntary agreements, having first implemented such measures in 1997. A new Energy Efficiency Agreement (EEA) scheme began in 2008 and is set to run to the end of 2016. It covers approximately 80% of Finland's total energy consumption from areas such as energy production and services, municipalities, industry, transport, buildings, private services, agriculture and appliances. The scheme is a key instrument to fulfil the country's 9% energy savings target (on the 2001–2005 average) by 2016.[31]

Companies and entities joining the agreement commit to implementing the measures agreed by sector-specific action plans. Each entity also participates in government-subsidised energy audits and reports annually on their progress. All reporting is compiled into a central monitoring database. Some energy-efficiency investments are also subsidised by the government.

These voluntary agreements are supplemented by additional mechanisms relevant to the various sectors. For example, minimum energy performance standards and energy performance certificates have been implemented to encourage energy-efficient construction. The use of transport telematics has boosted the efficiency of the transport sector.[32] Meanwhile, appliance labelling schemes, alongside education and awareness campaigns such as Annual Energy Awareness Week and preschool-level initiatives, aim to have a positive impact on consumer behaviour.[33]

The agreements and associated instruments have had a significant impact. Analysis shows that generated savings in 2013 equalled 2.4% of the country's total energy consumption.[34]

With its significant energy savings and wide reach, Finland's approach to energy efficiency demonstrates the power of voluntary agreements in combination with robust reporting and monitoring. The improved energy use analysis enabled by Finland's EEAs allows the programme to achieve its goals of continual improvement in energy efficiency while driving adoption of the latest energy-efficient technologies and services. By focusing on energy efficiency, Finland is able to rationalise its energy demand, reduce emissions, and boost competitiveness.

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[31] Industrial Efficiency Policy Database, http://iepd.iipnetwork.org/policy/energy-efficiency-agreements

[32] Transport telematics, also referred to as intelligent transport systems, are used to make traffic and transport (especially in cities) faster, safer, more sustainable, comfortable and user-friendly. They can help coordinate traffic flow, improve public transport by providing faster, more reliable travel times, and make road use safer for cyclists and pedestrians.

[33] Ministry of Trade and Industry, Finland (Motiva), 2006: Energy Efficiency in Finland: A competitive approach

[34] Motiva, 2013: Energy Efficiency Agreements in Finland: Results 2008–2013

One mechanism to drive energy efficiency and energy savings on the demand side is transparent and cost-reflective pricing. A number of the countries surveyed noted that existing policies focusing on ensuring low energy prices for citizens and industry can hinder improvements in efficiency. In the Middle East, for example, the low cost of energy driven by subsidies causes distortions in the market on the demand side and dissuades the adoption of more efficient technologies. Until this issue is addressed, energy-efficiency policies will not be able to deliver the impact expected and investments in energy-efficiency technology and services will be limited. One example of this is the impact of pricing for water desalination, a key component of demand for energy in the Middle Eastern region. Currently, the majority of water is desalinated thermally using multi-stage flash (MSF) distillation. MSF distillation plants are built alongside gas-fired power plants. By applying a gas price below market value, this leaves little incentive to switch from MSF thermal desalination to reverse osmosis, a process which would consume up to 66% less gas. Such examples highlight the huge untapped potential for energy efficiency in many countries.

Numerous experts worldwide have called on the current exceptional opportunity that low fuel prices offer to countries with highly subsidised energy systems to revisit their subsidy schemes. Experts from the Middle East noted that fuel prices should not necessarily coincide with the market price, but the pricing should be transparent to build consumer awareness.

Another mechanism that can raise consumer awareness of energy use is ‘time-of-day’ pricing. As one executive noted, in many countries, “we need a price signal that makes people think about use at different times of day.” In South Africa, the pricing of electricity is considered by some as a missed opportunity – both on the supply and demand side. Time-of-day metering is considered to be one solution to the problem. As one interviewee noted, “If you implement time-of-day pricing that is based on supply and demand, that situation may sort itself out mathematically.” In other countries, the lack of metering systems means there is no data to assess consumption and demand at different times of the day and develop effective price signalling regimes. Price signals can provide strong incentives for consumers to reassess and modify their energy use. Along with adjusting energy pricing, energy leaders also pointed to the importance of “policies and regulations that continuously enhance the demand management by enabling companies to commercialise demand management solutions to become part of their services.”

Box 5: Energy efficiency in Ecuador

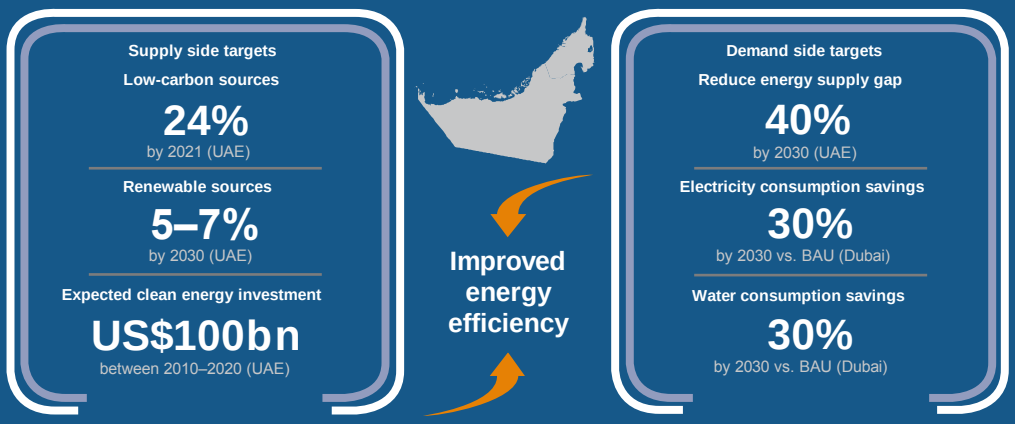
Ecuador has a strong performance on the Energy Trilemma Index, particularly in its environmental sustainability dimension. To further bolster its energy security, it has implemented a number of initiatives to increase the efficiency of energy usage. These include: the complete replacement of incandescent lamps with compact fluorescent lamps; replacing old, inefficient appliances with new, more efficient equipment; and the mass introduction of electric induction cookers, whose technology can achieve efficiencies of up to 90%, replacing stoves that use liquefied petroleum gas. The government implemented these programmes with the recognition that natural resistance to change is a huge bottleneck that must be countered with adequate incentives and a rigorous communication programme.

UAE: pursuing sustainability

Figure 12

Energy targets in the United Arab Emirates (UAE)

Source: United Arab Emirates Ministry of Energy, 2014: The UAE State of Energy Report 2015



The United Arab Emirates (UAE), a country with major oil and gas reserves, has performed well on the energy security and energy equity dimensions of the trilemma. High energy intensity and overall emissions – although also driven by local climate conditions – have resulted in lower performance on environmental sustainability. The UAE is undertaking significant steps to diversify its energy mix and increase its energy efficiency through a number of key policies and initiatives designed to improve environmental sustainability and maintain energy security in the face of sharply rising demand.

The country is beginning to incorporate renewable and nuclear power into the energy mix. At least 1.2 GW of solar and 5.4 GW of nuclear power are expected to become available between 2017 and 2020, complementing the current, predominantly fossil-fuel generation. Utility-scale solar, smaller-scale solar rooftop mechanisms, wind, geothermal and waste-to-energy are also being explored. Solar power in the UAE has the potential to improve not only the environmental sustainability and energy security dimension of the trilemma, but also affordability and equity. Latest solar power costs have reached grid parity and are undercutting it at US$0.0584 per kWh, lower than current gas-fired generation in Dubai.[35]

The UAE is also committed to increasing energy efficiency and was one of the 26 signatories of the Clean Energy Ministerial's Global Energy Efficiency Challenge in 2010. Dubai has set a demand-reduction target to be achieved through a mix of demand-side management programmes, including building regulations, power and water tariff rates, standards and labels for appliances and equipment, and district cooling, supported by a range of mechanisms such as policy and regulatory reform, education programmes and measurement and verification. Energy-efficiency efforts are key, since even moderate adoption could reduce energy demand by a quarter to half in the year 2030, freeing up capital for other investments, and reducing the region's impact on the environment. Significant electricity and water tariff increases in Dubai in recent years and in Abu Dhabi in January 2015, are strong signs of genuine change towards more sustainable consumption levels – electricity tariffs rose up to 112% and water tariffs up to 350% on 1 January 2015 in Abu Dhabi.[36]

With a more diversified energy mix, sustained focus on energy efficiency and other reforms, the UAE will be empowered to improve environmental sustainability and continue to ensure energy security and equity.

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[35] The National, 2015: UAE beats renewables cost hurdle with world's cheapest price for solar energy, 18 January 2015; International Renewable Energy Agency, 2015: Renewable Energy Prospects: United Arab Emirates – Remap 2030 analysis

[36] Regulation & Supervision Bureau (RSB) Abu Dhabi, 2015: New water and electricity tariffs structure; Al Wasmi, N, 2014: Abu Dhabi Residents Brace for Utility Price Hikes (The National, 23 December 2014); kWh rose from 15 fils to up to 31.8 fils (112%) and water rose from 2.2 fils/1,000 litres to up to 9.9 fils (350%).

Ghana: improving energy efficiency of the refrigerating appliances market

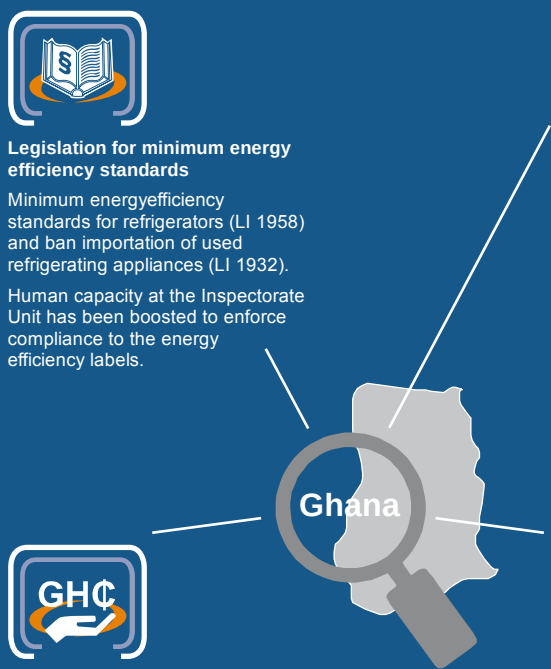
The primary objective of this project is to improve the energy efficiency of appliances marketed and used in Ghana through the introduction of a combination of regulatory tools such as Energy he tEfficiency Standards and Labels (S&L), and innovative economic tools.[37]

The project is exploring and testing efficient market-based economic incentives, complemented by repeated public outreach campaigns. Domestic refrigeration appliances are the first end-use devices to be tackled, with a specific focus to address ozone-depleting substances contained in the current stock of equipment. The total project budget for 2013 was US$857,958. The Global Environment Facility provided US$667,958 while the United Nations Development Programme supported with US$190,000. The total delivery as at 20 May 2014 was US$1,650,000.[38]

Figure 13

Steps to deliver the transformation of the refrigerating appliances market in Ghana

Source: World Energy Council / Oliver Wyman, 2015



Legislation for minimum energy efficiency standards

Minimum energyefficiency standards for refrigerators (LI 1958) and ban importation of used refrigerating appliances (LI 1932).

Human capacity at the Inspectorate Unit has been boosted to enforce compliance to the energy efficiency labels.

Television and radio campaigns

A 20-minute segment on a popular daily television soap opera served to raise consumer awareness.

A documentary and animated film were prepared and aired on television.

Jingles and interviews were aired on popular radio programmes. Billboards, posters and pamphlets have been prepared to advertise the rebate programme.

A well-designed website that features project activities and videos.

A rebate and turn-in programme

Economic incentives for consumers to exchange inefficient refrigerators for energy efficient ones that are purchased at a discounted price.

An innovative partnership and collaboration: Energy Commission to provide overall administration and oversight; retail shops to collect old refrigerator and sell energyefficient ones; banks to process rebate claims and provide consumer loans; scrap dealers to dismantle the old refrigerators; and Environmental Protection Agency to dispose of the recovered ozone depleting substances.

A dismantling and degasifying facility for refrigerators

Established as a joint venture with a private company, who provided equipment and training.

Company collects, dismantles and recycles refrigerators received from the rebate programme.

Market value of recovered CFCs, metals and plastics is helping to ensure the facility is financially sustainable after the end of the project.

[37] World Energy Council, 2015: Energy Efficiency Policies and Measures Database

[38] UNDP, 2011: Promoting of appliance of energy efficiency and transformation of the refrigerating appliances market in Ghana

Energy executives noted that, while appropriate price mechanisms are important, these need to be supported by national education and information programmes to drive long-term changes in consumer behaviour in efficient energy use and purchase of energy-efficient appliances. As one executive noted, “The biggest challenge with regards to energy use is the installed stock of inefficient systems.” For example, electricity for lighting accounts for roughly 15% of global electricity consumption and 5% of global GHG emissions. A switch to super-efficient Light Emitting Diode (LED) lighting could reduce global power consumption for lighting by more than 50% and avoid more than 700 Mt of CO_2 emissions, almost equivalent to the total emissions of Germany.[39] Consumer education and information strategies, including labelling on appliances and electrical equipment, practical tips on electricity bills, consumer alerts for energy usage levels, real-time feedback mediums or media advertisement, are means to improve the market for energy-efficient products. Labelling on appliances and electrical equipment has been implemented in more than 70 countries and has proved to be successful and cost effective, and could be rolled out to more countries. Similarly, minimum energy performance standards, voluntary and mandatory, are active in more than 60 countries, with 10 more planning to implement such measures.[40] International institutions can be important information centres on such programmes and provide support for their development and roll-out.

Prioritising innovation and RD&D

A clear target for GHG emissions will drive and focus much-needed innovation as well as RD&D in key areas. These areas include, but are not limited to, CCS, electricity storage, smart grids, high-efficiency combustion engines, fuel cells and batteries, new renewable technologies and advanced biofuels. As one executive noted, “policymakers must drive a sense of ambition by setting a courageous target that allows people to become creative. Then you get the technological innovation you are looking for.”

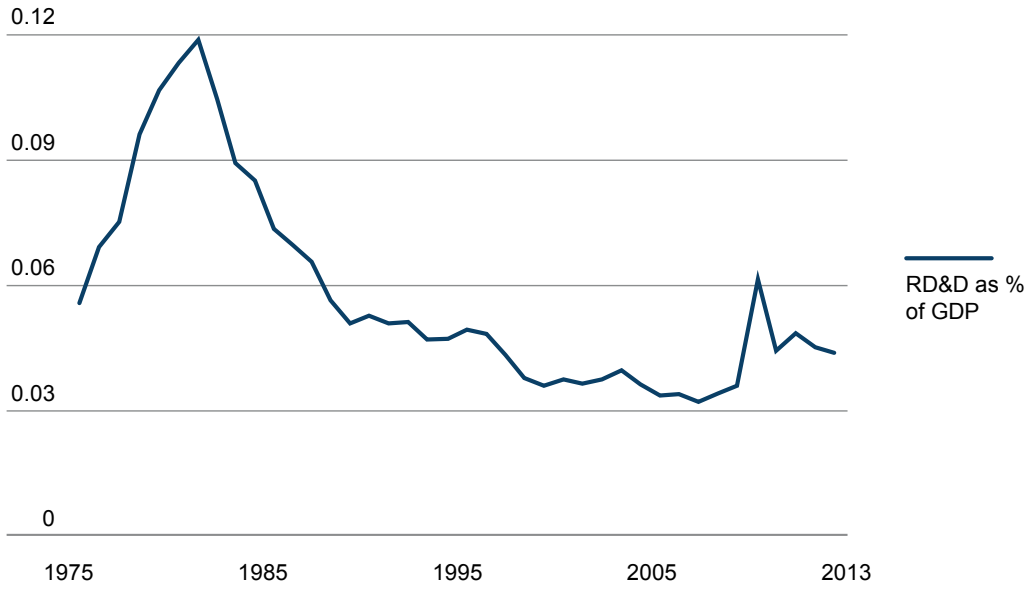
The research carried out among the Council’s extensive network repeatedly highlighted that achieving a transition in energy supply and demand will require prioritisation and achievements in RD&D as a way of ensuring that decarbonisation occurs in the least costly way for consumers and governments. However, investments in energy RD&D have generally fallen in the past few decades (see Figure 14). Yet, as recognised in previous Trilemma reports, RD&D is critical to achieving current energy goals and post 2030–2050 needs. Industry repeatedly called on governments to continue their focus on fostering RD&D, both financially and also by encouraging national and international public–private collaborations. The energy sector also reinforced calls for increased partnerships between companies and technology institutes, with both private and public funding. Private technology providers are incentivised to conduct research and reduce costs, while academia and institutes often possess the skills relevant to conducting such research. Agreements and targets to reduce GHG emissions on a national level should also include the facilitation of such partnerships.

[39] United Nations Development Programme (UNDP), 2014: Policy Options to Accelerate the Global Transition to Advanced Lighting
[40] World Energy Council, 2015: Energy Efficiency Policies and Measures Database

Figure 14

Select OECD countries' energy RD&D as a percentage of GDP, 1974–2013[41]

Source: World Bank, 2014: World Bank Open Data (GDP), IEA, 2014: RD&D Statistics



While a switch from oil or coal to natural gas would itself lead to significant reductions in GHG emissions, CCS remains essential for future progress. As fossil fuels will remain dominant up to and including 2050, with a share of between 59% and 77% of the primary energy mix,[42] numerous scenarios that consider climate mitigation include some level of CCS deployment. Without it, the cost of decarbonisation could be significantly higher and it will be challenging to meet the 450 ppm target. "If we don't have CCS commercial in the next five years, we will not reach the 2 degrees goal." It is estimated that 30 large-scale projects would be needed by 2020, capturing and storing 50 million tonnes (Mt) of CO_2 per year, to achieve the 2 degree target agreed on the Copenhagen Accord at the UN Climate Change Conference in 2009.[43]

There is still a great need to improve efficiency as well as reduce the costs of capture technology and resource consumption through RD&D.[44] Pending the operationalisation of more large-scale demonstration projects, CCS remains very expensive and capital intensive and there are questions about how and when it will be truly commercialised at the necessary scale. This will not happen until the right policy framework and conditions for the deployment of CCS are put in place. For example, carbon pricing is viewed as an important supporting factor. As one executive noted, "Unless there is a meaningful price on carbon, CCS will not happen, except if government RD&D really steps up."

The introduction of policies on CCS will have to be considered in light of existing energy policies, as well as the demand for power plants. As remarked by one energy

[41] Countries included in this analysis are Canada, Japan, Netherlands, Norway, Spain, Sweden, Switzerland, United Kingdom and US. The energy RD&D data for Japan in 2012 and 2013, Netherlands in 2004 and 2013, and Norway in 2013 were calculated as an average of two preceding years due to lack of data availability.
[42] World Energy Council, 2013: World Energy Scenarios: Composing energy futures to 2050
[43] IEA, 2013: Carbon Storage Roadmap
[44] IEA, 2013: Actions and Milestones for the Next Seven Years: Creating conditions for deployment

leader, “Thermal power plants (coal) under construction and planning should be CCS-ready, as including this capability adds only a small proportion to the total cost if elements are added up front.”

For example, in the US, regulation around CCS in coal-fired power plants already exists, but there are no projects to build new plants in the next 10 years. This year, the Environmental Protection Agency is expected to announce the extension of the regulation to gas-fired plants starting in 2020. Due to the low concentration of CO_2 in the flue stream of natural gas power stations, CCS is significantly more expensive for gas than for coal, and this could have the unintended consequence of seeing coal power plants boom from 2015 to 2020. Europe has also put aside money to fund CCS deployment; however, there are no projects underway, with the exception of several Front End Engineering Design (FEED) studies in the UK. Poland, a major coal burner, has reduced its focus on CCS, viewing it as too costly. Canada, however, is moving towards becoming a global leader in CCS. In 2014, the Boundary Dam integrated CCS project was launched as the world’s first large-scale CCS project in the power sector, making a viable technical, environmental and economic case for the continued use of coal, although large-scale replication remains a challenge.

Research and development in energy storage materials and batteries is also crucial for reducing GHG emissions. Storage will be vital to enable the flexibility of the electricity system necessary for the integration of intermittent (renewable) energy sources at a global scale while maintaining energy security. An energy executive commented, “The main remaining bottleneck is storage, which is where investments now need to be directed.” Advancements in electricity storage may have an outsized impact on the transition to a renewable and decentralised energy system. As storage technologies mature, variable electricity production can be smoothed.[45]

Developments in electricity storage remain uncertain; it is one of the top three critical uncertainties in the Council’s 2015 World Energy Issues Monitor (see Figure 1 in the Introduction). Market designs and regulations are viewed as factors that are slowing the development of electricity storage as the incentives are not strong enough under current regimes. Recent developments such as the newly launched Tesla Powerwall in-home battery pack show that progress is being made in this area that have the potential to make solar power more accessible in the long run.[46] It is important that: “business models and regulatory models must catch up with the technology.”

Smart grids, which transport power and also the data about power use, are another critical enabler to increase energy efficiency and the integration of renewable energy and decentralised generation. As with improvements in storage, developments in smart grids are occurring at an uneven and unexpected pace, heavily influenced by policy and regulation.[47] Energy leaders commented that, “only if policy catches up will we be able to capture the full value of the transition.”

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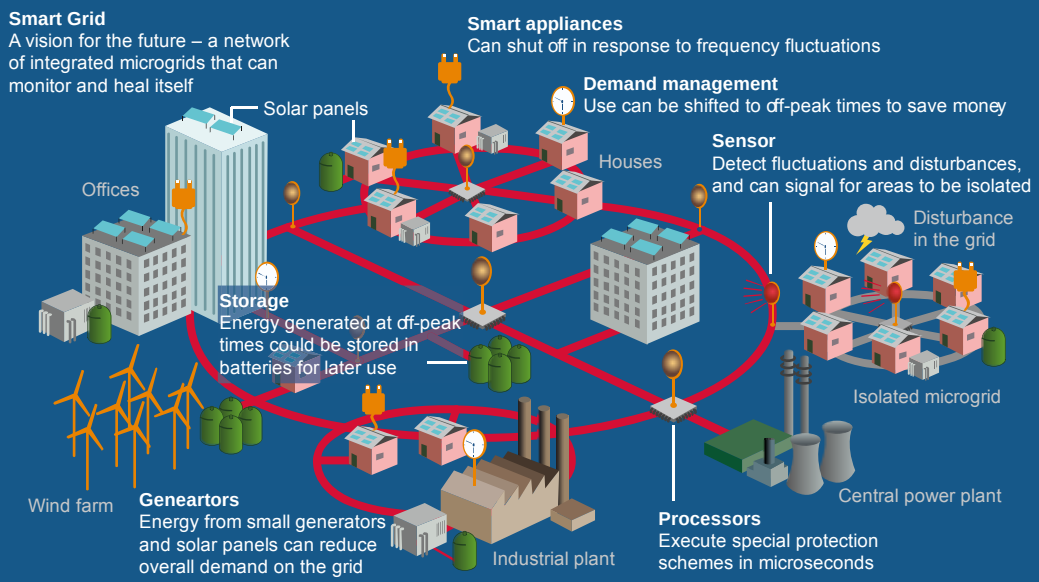
[45] World Energy Council, 2015: 2015 World Energy Issues Monitor – Energy price volatility: The new normal
[46] Liedtke M, Fahey J, 2015: Tesla CEO plugs into new market with home battery system (The Associated Press, 1 May 2015)
[47] Imperial College London, NERA Economic Consulting and DNV GL, 2014: Integration of Renewable Energy In Europe

Korea: smart grid technology for competitive advantage

Figure 15
Smart-grid power system
Source: Smart Grid 2030 Associates, SG2030™ Smart Grid Portfolios



Smart electric grids, which support energy transmission and data about energy use, are an essential element in facilitating the transition towards a low-carbon economy. This technology can help improve energy efficiency by managing the consumption patterns of users connected to the grid. Smart grids contribute to reducing transmission and distribution losses and optimise existing infrastructure use by helping to regulate power flows and meet peak demand. They also assist in the integration of renewables, as they better accommodate significant volumes of decentralised and renewable energy into the grid.

Two main challenges need to be overcome to fully capitalise on the potential benefits of smart grids: the first relates to the level of implementation and the necessary standardisation and certification, operation, system testing, and consumer participation. The second obstacle is financial, given the large amount of funding needed throughout the lifecycle of smart grid development. Mechanisms that allow stakeholders to collaborate to accelerate the development and deployment of smarter electric grids, such as the International Smart Grid Action Network (ISGAN), are crucial to improving understanding of the value that smart grids can offer.

South Korea views the development of smart grid technology a significant economic opportunity. Since 2005, South Korea has played a leading role in developing appropriate energy IT and the country possesses significant technologies in related industries, including advanced smart meters, electric car chargers, and energy storage systems. Given these existing technologies and infrastructure, smart grid promotion plays a key role in transforming the country's economy by introducing a new economic sector. Smart grids will also have a significant impact on general industry, including power, heavy electric machines, communication, appliances, construction, and transportation. South Korea can, therefore, enhance its economy by attaining a high level of competitiveness within the smart grid industry.[48]

[48] World Energy Council, 2012: Smart Grids: Best practice fundamentals for a modern energy system

Overall, leveraging the full benefits of developing and emerging technologies to meet GHG emission-reduction goals will require policy flexibility. “Different technologies are playing out in parallel and the question is when they will start to more dynamically interact and reinforce each other. This is unclear and could be the biggest change. We will need to adapt and adjust to dynamics and innovations that we don’t anticipate yet.”

Public acceptance in the deployment and use of traditional and new energy technologies was recognised globally as a priority area that needs to be actively addressed by both public and private sector players.

“

Don’t go backwards and make sure that if you are ambitious, you understand the consequences

”

4. Conclusion

During the workshops convened across all the Council's regions, and in interviews with leading figures, energy leaders called for "more rationality in decision making on the road to COP21, bringing the different voices of the scientific, economic, social, political and business communities together." It was noted that there is frequently a disjunction between industry, thought-leaders and governments (and within government departments), with limited common language or perspectives to discuss the challenges. More and improved interaction would serve to reduce theoretical approaches to questions about 'what is perfect' and would focus more on practical, economically sound solutions that can be implemented by business and communities. As one interviewee noted, "Policymakers and regulators have to have a good fundamental technical and economic understanding of the implications of what it is they are about to decide or put into place for regulation."

Coordinated leadership on how to approach climate change issues provides the necessary confidence to the private sector regarding stability and coherency in energy policy. Reduced regulatory and political risk is a key factor in reducing the cost of capital for large-scale energy projects and increasing investor confidence. Integrated leadership will also help with the development of the "social licence" for change. Governments must gain popular support for their country's chosen approach or face strong political opposition and policy disruption to the implementation of regulations, processes and infrastructure supporting energy transition. This will require a common language from business leaders, investors and policymakers. "Social acceptance is the greatest challenge in the transition in the energy supply system."

The energy sector has a key part to play in driving the climate debate and delivering the investment and technologies that will help achieve better access to cleaner energy. Through our interviews and workshops, clear messages emerged in terms of what the energy sector believes is necessary to deliver sustainable energy systems that meet climate targets, development goals, and support to balance the three dimensions of the energy trilemma.

To deliver on climate and development goals policymakers, business and financial sector leaders need to continue innovating existing business models and market designs to reflect the dynamics and changes of the energy sector.

- **Stable and clear policy.** Global climate policy uncertainty is consistently raised as a key concern of the energy sector and is a significant barrier to driving the necessary changes needed to build sustainable energy systems. Energy leaders across the globe were clear in their message to policymakers and negotiators: it is time to agree on a single global target, and make it measurable. A stable framework is necessary to reduce political risk and ensure investments in the energy sector will flow.

- **Recognise differences.** International agreements must be sufficiently flexible to allow countries to develop their own paths using a combination of customised measures to meet their goals while contributing to the overall objective. As energy usage patterns evolve and countries develop, any agreement should provide scope for dynamic target adjustment at the country level. This will also ensure the longevity of such a consensus. “Unless there is a feedback loop, the Paris conference might be an empty promise.”
- **Greater dialogue between policymakers, business leaders and financial sector.** To retain value in the sector and encourage investments in low-carbon energy systems, the transition to a lower-carbon future will require new policies, regulations and financing solutions to support the evolution, while maintaining a robust energy sector. “We need ‘regulation 2.0.’ so that we can clarify the future regulatory framework for energy businesses as technologies evolve.”
- **Five priority action areas.** For energy and climate goals to succeed, the right enablers must be in place to deliver the associated policies:

    - **Trade and technology transfer.** Policymakers must put mechanisms in place to ensure that technology is an enabler and not a barrier to change, especially in developing countries. Eliminating tariffs on environmental goods and services, carefully designing local content requirements and protecting intellectual property rights are effective measures to reduce abatement costs, incentivise the use of low-carbon technologies, and attract private capital.
    - **Carbon pricing.** Putting a price on carbon is recognised as one way of ensuring the true cost of energy production and use is recognised, and a range of carbon-pricing schemes is increasingly being implemented at national and regional levels, as well as by businesses. A global carbon price could avoid distorting investments away from low-carbon solutions. It would also help to reduce concerns around competiveness and carbon leakage and promote economic and energy efficiency.
    - **Financing.** Though capital is available to flow in the energy sector, the right policy signals need to be provided and a portfolio of bankable projects needs to be in place to attract more private capital. Financial markets will find innovative ways to finance clean energy if the regulatory rules provided indicate a clear and stable direction towards sustainable energy systems.
    - **Focus on demand as well as supply.** Demand management is the often neglected side of the energy equation. Negotiators must recognise the technological as well as the behavioural dimensions that lead to a more efficient use of energy and the opportunities these offer for the future. The balance between demand and supply also needs to be carefully considered as new technologies allow for a higher share of unplanned supply – for example, renewables.
    - **Innovation and RD&D.** To achieve climate targets and development goals, new technologies, materials and fuels will be essential. Governments have to continue their focus on fostering RD&D, both financially and also by encouraging national and international public-private collaborations.

Appendix A: Interviews and workshops

The World Energy Council and Oliver Wyman, a subsidiary of Marsh & McLennan Companies, would like to thank the following global energy leaders – ministers, senior policymakers, chief executives, senior executives – and their teams for taking the time to talk to us during the preparation of this report and for taking an active role in driving forward this critically important dialogue regarding our global energy future. Your perspectives and insights on bottlenecks, opportunities and implementation strategies in setting meaningful climate and energy goals and policies have been very helpful and enriched the process greatly.

- Guillermo Bravo Mancheño, Senior Vice President Strategic Relations, Abengoa
- Paddy Padmanathan, President and Chief Executive Officer, ACWA Power International
- Dean Oskvig, President and Chief Executive Officer, Black & Veatch Energy
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