ACCELERATING SDG 7 ACHIEVEMENT

POLICY BRIEF 26

ENERGY PATHWAYS TOWARD SUSTAINABLE FUTURES TO 2050 AND BEYOND

7 AFFORDABLE AND CLEAN ENERGY

ACCELERATING SDG 7 ACHIEVEMENT

POLICY BRIEFS IN SUPPORT OF THE FIRST SDG 7 REVIEW AT THE UN HIGH-LEVEL POLITICAL FORUM 2018

Lead Organizations

Facilitated by

UNITED NATIONS
DEPARTMENT OF ECONOMIC
AND SOCIAL AFFAIRS

With the financial support from
Governments of Norway, Netherlands, and China through the UN sub-trust fund for the 2030 Agenda for Sustainable Development
as well as the European Commission, ENERGIA and HIVOS

POLICY BRIEF #26

ENERGY PATHWAYS TOWARD SUSTAINABLE FUTURES TO 2050 AND BEYOND

Developed by

International Institute for Applied Systems Analysis (IIASA)

In collaboration with

International Energy Agency (IEA) and International Renewable Energy Agency (IRENA)

KEY MESSAGES

Progress on energy pathways to achievement of SDG 7 and beyond

- The SDG 7 targets for 2030 (universal access to affordable, reliable and modern energy services; increase substantially the share of renewable energy; and double the global rate of improvement in energy efficiency) were based on the recommendations of the Secretary-General's Advisory Group on Energy and Climate Change (AGECC) and the six sustainable development pathways developed b for the Global Energy Assessment (GEA, 2012), as well as on other research, particularly the work of the International Energy Agency (IEA) on access. These are ambitious goals, but achievable with appropriate policy frameworks and institutional support.
- There are other pathways in more recent literature that would meet some of the SDG 7 targets by 2030, including scenarios by the IEA and International Renewable Energy Agency (IRENA), and some of the community pathways developed for the International Panel for Climate Change (IPCC). The new scenarios, as well as the original GEA pathways, extend the sustainability transformation into the future beyond 2030. The sustainable energy pathways show it is possible to harmonize human need for greater energy services without transcending planetary boundaries.
- Reduction of energy intensity is central to the achievement of sustainable energy futures across a wide range of pathways presented in the literature. Appropriate policies for vigorous efficiency improvments are essential, not just on the supply side but especially in end uses. A number of studies indicate that, based on the second law of thermodynamics, the potential for efficiency improvement is huge, because the current efficiency might be on the order of only a few per cent.
- The world is on a good track to achieve increasing shares of renewable energy and also great progress has been made in reducing energy intensity and access. However, we are far from doubling the rate of energy intensity improvement as well as achieving sustainable energy access for all. Thus, these two targets need additional efforts and strong support to be achieved.

Priority actions

- Increase energy investments to around US$ 2.5 trillion per year until 2030, with further increases beyond that. This will require new models of de-risking that can attract the capital needed.
- Investments in science, technology and innovation need to complement deployment and diffusion in order to reduce costs and make the transition to sustainable energy affordable.
- Energy policies and regulations should be integrated and reliable to support long-term investments. They should also consider multiple benefits and potential synergies with other SDGs to decrease the costs of the transformation.
- New behaviours and the emergence of sustainable social norms and values are central to the energy transformation toward sustainable future. Digitalization can be a great facilitator of this transformation.
- The future transformation needs to take place at a much higher rate of change than observed in the past. This requires disruptive thinking in terms of the imagined futures and the complementary disruptive policy interventions.

Sustainable Energy Pathways and the SDGs

The Role of Pathways in SDG 7

Energy was one of the first areas in which researchers applied methods of systems analyses to develop scenarios and pathways of future developments—including work by Shell, the World Energy Council, the International Energy Agency (IEA), the Energy Modeling Forum, and the International Institute for Applied Systems Analysis (IIASA). Both narrative and quantitative energy pathways were developed early on, including variants leading to sustainable futures. The pathways in the literature clearly show energy as key for human development.

However, the Millennium Development Goals (MDGs) did not include an energy goal, even though energy is essential for development. Consequently, the Global Energy Assessment (GEA, 2012) brought together about 500 authors and reviewers across the world to provide comprehensive, science-based perspectives on sustainable energy futures, quantitative pathways, and the policies needed so they could be achieved.

In 2010, the United Nations SG's High-Level Advisory Group on Energy and Climate Change (AGECC, 2010) called on the UN system and its member states to commit themselves to two complementary goals: 1. Ensure universal access to modern energy services and 2. Reduce global energy intensity by 40 per cent, all by 2030. Successful adoption of these measures was estimated to reduce global energy intensity by about 2.5 per cent per year, approximately double the historical rate. A third target—to double the share of renewables in final energy to 30 percent, also by 2030—was added later as the need to increase substantially the share of renewable energy. The three targets were based on six sustainable development pathways developed in GEA, as well as other research, particularly work by IEA on access and by IRENA on renewable energy. In 2011 the Vienna Energy Forum (VEF, 2011) confirmed the three targets, and they were also later adopted by United Nations Energy and the United Nations SG's High-Level Group on Sustainable Energy for All.

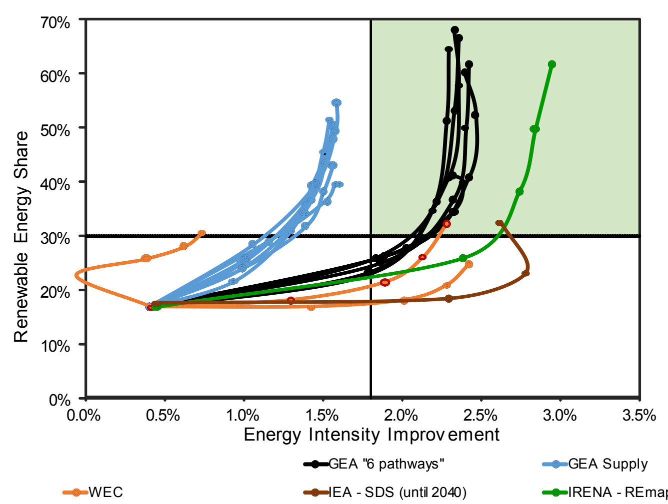
Thus, there was strong evidence-based knowledge on which SDG 7 was rooted. The three goals adopted in 2015 by the United Nations General Assembly closely mirrored the original AGECC and VEF formulations. There are also many other pathways in the more recent literature, including scenarios developed for the IPCC, which meet the SDG 7 targets by 2030.

Are we on track to achieving the SDG 7 targets?

The world is on a good track to achieve increasing shares of renewable energy, and also great progress has been made in reducing energy intensity. However, we are far from doubling the rate of energy intensity improvement, or achieving sustainable energy access for all (see Policy Brief 1). Thus, these two targets need additional efforts and strong support to be achieved. A key question is whether the ambitious SDG 7 goals can be achieved through incremental improvements or if they require transformational change. This question is important for the roadmaps to 2030 and even more for sustainable pathways that go beyond that.

Figure 26.1

Renewable energy shares and energy intensity improvements to 2050 in 10 year steps. Green quadrant indicates SDG targets for renewable energy share and energy intensity improvement. Six GEA sustainability, IRENA Remap and IEA SDS scenarios are shown that clearly fulfil the two SDG 7 targets. All GEA pathways fulfil the third target of universal access to energy services. It also displays recent pathways from the literature. Please note that the RE shares refer to the net increase, i.e., by accounting for decreases in traditional biomass. For instance, the IEA SDS meets the clean cooking goal, which dramatically reduces traditional biomass, thus the gross increase in modern renewables is actually higher than shown by displayed shares. (Sources: based on data from Riahi et al., 2012, IRENA, 2017, IEA, 2017 and WEC, 2017)



Energy transformation beyond 2030

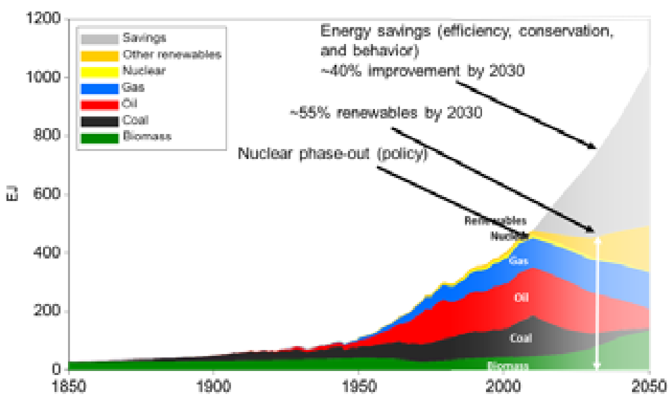
The more recent scenarios, as well as the original GEA pathways, extend projections for the sustainability transformation into the future beyond 2030, and show that energy continues to be key to achieving a sustainable future for people and life-supporting functions of the planet. The sustainable energy pathways show that it is possible to meet human needs for greater energy services without transcending planetary boundaries.

Recent literature abounds with questions about the ultimate limit for renewables, particularly whether they can provide for all energy needs. Exceedingly high contributions of renewables are conceivable, with the caveat that this needs to occur in conjunction with efficiency improvements and sustainable behaviours, especially in end use.

One of the six GEA pathways emphasises a future where renewable energy sources will play a particularly important role. In this pathway (see Figure 2) by 2030 the renewable share increases to more than 55 per cent primar energy use and continues to grow toward the middle of the century. In conjunction with this large role for renewables, energy efficiency improvements avoid almost 40 per cent of potential demand, especially in end use. Efficiency is the largest "source of energy" in the six pathways.

Figure 26.2

Global energy requirements in one of the six GEA pathways that informed SDG 7 targets. This pathway emphasises the role of renewables, while others in the set of six pathways show higher roles of fossils and nuclear. All fulfil the three SDG 7 targets and also SDG 13 and many other dimensions of sustainable futures. (Source: based on Riahi et al., 2012)



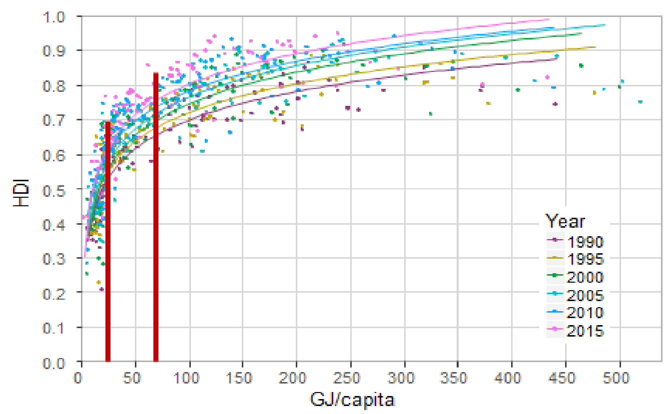
Reduction of energy intensity is central to the achievement of sustainable energy futures across a wide range of pathways presented in the literature. A reasonable question to ask is whether this is feasible both in the short and the long run. In both cases vigorous policies are essential, not just on the supply side but especially in end uses.

A number of studies indicate that, based on the second law of thermodynamics, the potential for efficiency improvement is huge, since the current efficiency might be on the order of only a few percent (Nakicenovic et al., 1996). Realization of this potential in practice is another story (cf. Banerjee et al., 2012).

Another perspective is given in a energy per capita and human development index (see Figure 3). With development, ever less energy is required to achieve high levels of the index. With further progress, it can be expected to decrease even further. In fact, current average per capita energy needs are in the range of about 80 per cent of the index, meaning that total energy will not need to increase much more in the future. However, inadequate distribution must be improved, and those excluded need to be served to afford them a decent life.

Figure 26.3

Per capita energy is shown with the human development index (HDI) indicating that after an initial rapid increase the improvements of HDI start to level off at high levels of per capita energy. Current average per capita global final energy is about 70GJ/capita, achieving values in excess of 80 per cent HDI index. (Source: based on Steinberger and Roberts, 2010)



There are many energy pathways in the literature, well over a thousand. Many pursue sustainable energy futures. Across the scenarios, the roles of different energy sources, as well as the role of efficiency, are varied. GEA pathways, in general, and the six related to SDG 7 portray possible futures with a large share of nuclear, as well as futures with continued reliance of fossil energy, but all six achieve the three SDG 7 goals.

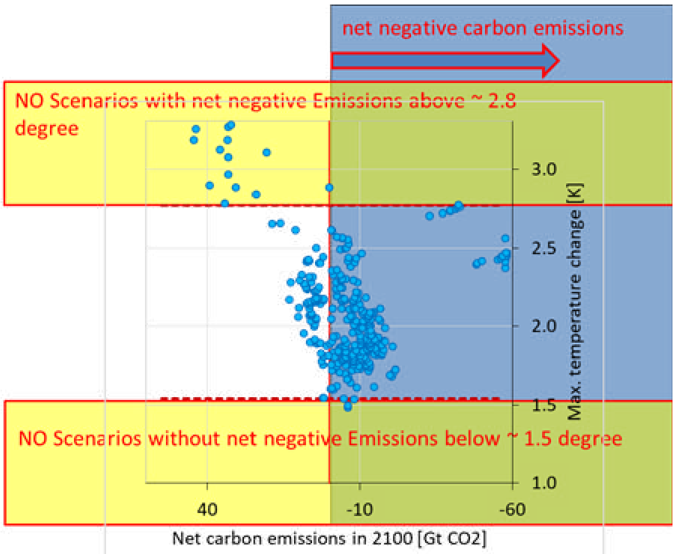
Interlinkages with other SDGs

SDG 13

Many of the scenarios in the literature are related to achieving SDG 13, namely stabilizing emissions to reduce global warming below 2°C compared to preindustrial levels. One of the major constraints for sustainable energy pathways is the global carbon budget. For stabilizing at below 2°C about 600 to 800 billion tons of CO_2 can be emitted and for 1.5°C only 200 billion tons or so. This budget will be exhausted in no time with current energy-related annual emissions of some 36 billion tons CO_2 per year.

Figure 26.4

Emissions pathways in the literature indicate for low climate stabilization levels, say between 1.5 and about 2.7°C stabilization, a very high share of pathways have huge net-negative emissions by 2100. (Data Source: IAMC AR5 Scenario Database, 2014)



One of the ways forward to reach climate goals is with huge efficiency improvements and increases of renewables as shown in the GEA pathway in Figure 4. The other ways are to continue the reliance on fossil energy in conjunction with carbon capture and storage. Nuclear is also an option in pathways that assume public acceptance and resolution of the proliferation challenges. In all cases, the pathways (including from recent literature and the GEA), indicate that net-negative emissions would be required to achieve SDG 13 with stabilization at below 2°C. The lower the stabilization level, the higher the need will be for net-negative emissions in order to stay within the remaining carbon budget—assuming nothing else changes. Afforestation is an obvious option for achieving net negative emissions. Another is sustainable use of biomass in conjunction with carbon capture and storage. However, carbon removed from the atmosphere would need to be stored in reservoirs that are virtually leakage-proof over a time scale of thousand years or more. The need for net-negative emissions will have important implications for the energy sector; if they are required for a sustainable future both carbon capture and sustainable biomass will need to be scaled-up and deployed at a large scale as soon as possible.

SDG 15

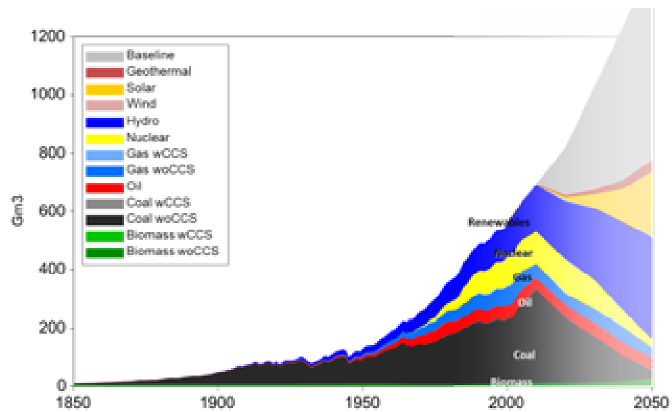
Energy is essential for food security, as it provides motive power, production of fertilisers, food processing and transport. An important connection between projected energy pathways and SDG 15 relates to the impacts of energy on land use, and potential conflicts between land use for energy and food. This is not only related to biomass as an energy source. Other potential conflicts relate to renewables and fossil energy, especially with respect to air and water pollution.

SDG 6

The energy sector is responsible for about 15 per cent of global water withdrawals, mainly for cooling of thermoelectric power plants (IEA, 2012). Thus, there is a strong connection to SDG 6 on water. The GEA pathways shown in Figure 5 with high shares of renewables do not pose a huge challenge for water withdrawals averaged for the world, but may do so in some arid areas using hydropower, which are likely to see increased negative impacts with continued climate change. However, other GEA pathways that rely more on fossil fuels and carbon capture and storage need ever-increasing water withdrawals. This is one of many cases of possible trade-offs and synergies among the SDGs.

Figure 26.5

Water withdrawals for the GEA pathway with high share of renewables indicating that water demand shifts from coal as its share in energy declines toward renewables, including hydropower.



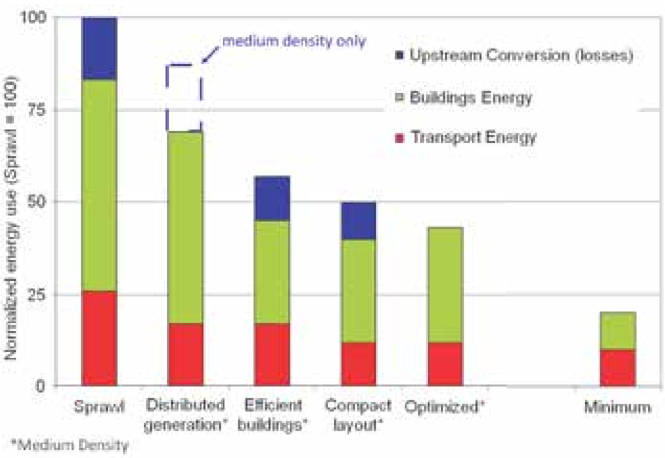
Source: based on Fricko et al., 2017

SDG 11

Another great challenge is the rapid urbanization in the world (relating to SDG 11). In the highly-developed countries of the world, most of population lives in urban areas or within urban sprawl. Globally, just over half of the people live in urban areas, mostly in small to medium-sized cities. This share is likely to rise to about two-thirds by 2050.

Figure 26.6

Model simulations for a 'synthetic' city with 20,000 inhabitants suggest improvement potentials of at least a factor of two each from buildings that are more energy-efficient and from a more compact urban form, with energy system optimization through distributed generation and resulting cogeneration of electricity, heat, and air conditioning adding another 10–15 per cent improvement in urban energy use. (Source: Grubler et al., 2012)



Without vigorous energy-efficiency improvement of cities, energy demand will continue to increase with increasing urbanization in the world. Cities can have very high levels of efficiency assuming, for example, there are sustainable developments such as "closed metabolism" systems with full recycling (circular economy) and "urban mining" of wastes, and more collective transportation infrastructure.

Policy implications and recommendations

Stimulate additional energy investments: Energy investments need to increase to US$ 2.5 trillion per year by 2030, with further increases beyond that. These investments should also provide substantial savings in operation costs and positive externalities so that they would be cost-effective in the long term. Attracting capital is a major challenge, because most investment today is oriented toward high yields in the short term rather than sustainable gains in the long run. In particular the high up-front investment needs require new models of de-risking and a reliable regulatory and policy framework.

Science, Technology and Innovation: Vigorous investment in Science, Technology and Innovation (STI) needs to complement deployment and diffusion. STI and deployment of new technologies offer opportunities for learning by doing, and rapid decreases in costs that can make the transformation to a sustainable energy future affordable. This has to be embedded in a facilitating environment along the whole value chain that is rewarding to innovators.

Design energy policies that seek synergies to shield against severe distributional consequences of the energy transformation: Energy policies should consider multiple benefits and potential synergies with other SDGs. This would also decrease the costs of the transformation. Integrated policy frameworks and new institutions are required for achieving the synergies across SDGs. Sustainable policies are a must, because volatility of regulatory mechanisms blocks long-term investments. Strongly negative distributional effects have to be avoided in order keep acceptance high for the energy transformation. For instance, recycling of carbon revenues could offer an option to compensate for disproportionally high costs on the poor.

Enable and support behavioural changes: New behaviours and emergence of sustainable social norms and values are central to the energy transformation toward a sustainable future. This includes a shift in focus towards the demand side, with an emphasis efficient services rather than increased energy use—'negawatts instead of megawatts' needs to become a new credo. Digitalization can be a great facilitator in this regard. Moreover, the right incentive structures—such as real time pricing—need to be in place in order to trigger these types of behavioural changes.

Accelerate transformation and avoid lock-ins in old path dependencies: The future transformation needs to take place at a much higher rate of change than observed in the past. This requires disruptive thinking in terms of the imagined futures and the complementary disruptive policy interventions. For instance, coal based electricity generation without the use of CCS will have to be phased out well before the end of its technical lifetime. Also, the current rate of change in the transport sector towards emission-free vehicles is much too slow and bears the risk of creating technology lock-ins. Rapid transformation of the energy system offers a window of opportunity for developing countries to leapfrog toward sustainable futures.

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Published by the United Nations

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