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RENEWABLES AND ENERGY EFFICIENCY WORK IN TANDEM

Increased use of renewable energy means more efficient production of electricity. This is because most types of renewables involve no energy loss during transformation or conversion

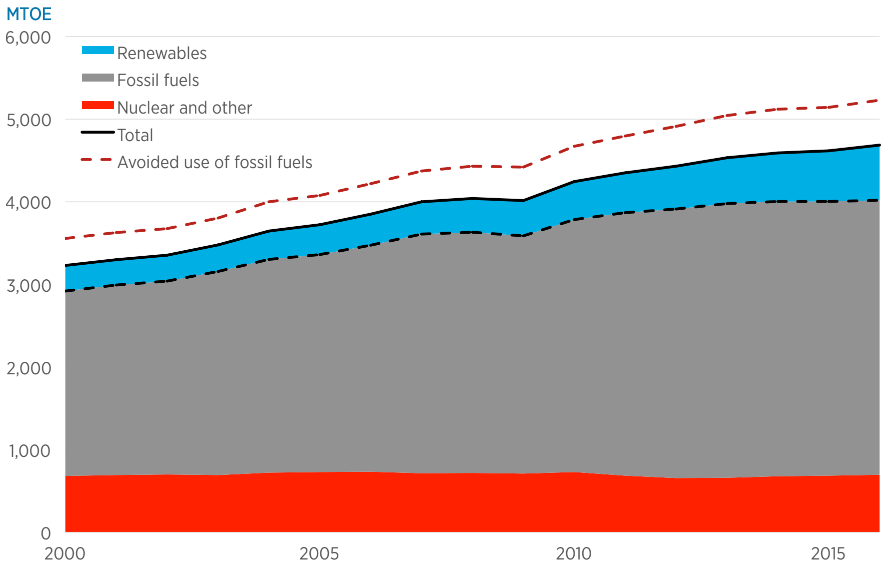
In this sense renewables are inherently less wasteful than conventional fossil fuels like coal, oil or gas. This means the synergy between renewables and efficiency works both ways. One way renewables can contribute to energy efficiency is by reducing the amount of primary energy used to generate electricity.

Primary energy can be thought of as the fuel that is used in electricity generation. All non-renewable electricity is produced through thermal conversion, where heat is used to generate electricity. Consequently, the energy content of the primary energy source is usually about two or three times higher than the energy content of the electricity that is produced.

Similar conversion losses occur when electricity is produced from bioenergy or renewable heat (geothermal and solar heat). But hydro, marine, wind and solar photovoltaic (PV) power are recorded in energy statistics as primary sources of electricity. This means the primary energy content of the natural force generating the electricity is recorded only as the amount of electricity that is produced. Consequently, the amount of primary renewable energy used to generate electricity is far lower than if the same electricity had been produced from non-renewables.

The global impact of a greater use of renewables in electricity production can be seen in the figure. In 2016, the world used about 4 000 Million Tonnes of Oil Equivalent (MTOE) of fossil fuels and nuclear energy, and 670 MTOE of primary renewables, to produce electricity. The share of renewables in this primary energy consumption (below 15%) was much lower than their share of electricity production (24%). Even so their incremental growth helps to meet a proportionally larger share of growing electricity demand. Thus, due to renewables, the world's non-renewable energy use did not increase between 2013 to 2016, despite total electricity production increasing by 7% over the same period.

Primary energy used in electricity generation



This valuable impact of renewables on the primary energy use in electricity generation can be analysed by looking at the primary energy factor (PEF), which reflects the ratio of primary energy use to electricity generation. Where the power output equals the primary energy output, the factor comes out as 1.0.

The combined PEF for renewables has been constant, since 2000, at about 1.3, due to the renewable heat such as bioenergy. By comparison the PEF of nuclear energy is 3.0, while for fossil fuels, the values in 2016 were 2.1 for gas, 2.5 for coal and 2.9 for oil.

Amount of diesel replaced by 1 megawatt of solar PV

Region	Annual use of diesel ('000 litres)
Africa	140
Asia	135
Central America and Caribbean	145
Middle East	160
Oceania	105
South America	185

Avoided fossil fuel use.

Based on the PEF for fossil fuels, analysts can estimate the amount of fossil fuels that would have been needed to produce the amount of electricity that was actually produced from renewables. This is shown as the gap between the two broken lines in the figure. In the absence of renewable electricity production, the world's fossil fuel use for electricity generation would be about one-third higher than the current trend.

The PEF can also be used at a more detailed level, to show how renewables can reduce fossil fuel use in electricity generation. For example, 1 megawatt of solar PV capacity could replace up to 185 000 litres of diesel use each year. This is a rapidly growing area of interest, especially for remote locations and other isolated systems.

More efficient than other sources

Statistics acknowledge that renewables are a more efficient way to generate electricity. Energy efficiency is usually calculated as some measure of output (e.g. gross domestic product) divided by primary energy use.

Primary energy is generally used in such calculations as this captures efficiency changes in both final consumption and in the processes of converting one type of energy to another. This means scaling up renewables in itself tends to ramp up overall energy efficiency. Because renewables are mostly non-thermal they have a low PEF in most countries. Consequently, boosting renewable electricity production improves energy efficiency when calculated as a function of primary energy use.

For comprehensive statistics on renewables, see **Data and Statistics.**

Energy transformation calls for increased power system flexibility

To ensure a reliable and secure supply of electricity, power generation should ideally equal demand at all times. As variable renewable energy (VRE) sources, such as solar photovoltaic (PV) and wind, become more prevalent on the grid, then more flexibility is needed to cope with the increased variability and uncertainty in the balance between supply and demand.

Absorbing more solar and wind power, therefore, requires an increase in power system flexibility. Flexibility here refers to the capability of a power system to cope with the variability and uncertainty that VRE generation introduces in different time scales, from the very short to the long term, to avoid curtailment and to ensure the reliable supply of electricity to customers.

Traditionally, discussions on flexibility have focused on thermal generators such as gas turbines or diesel generators with quick ramping capability, short start-up times and low minimum stable levels. However, flexibility should be harnessed in all parts of the power system and sourced in the broader energy sphere, which encompasses direct heat, buildings and transport fuels. Enabling technologies and practices like smart grids, energy storage, demand-side management and sector coupling all improve flexibility and help to scale up renewables.

Absorbing more solar and wind power requires an increase in power system flexibility

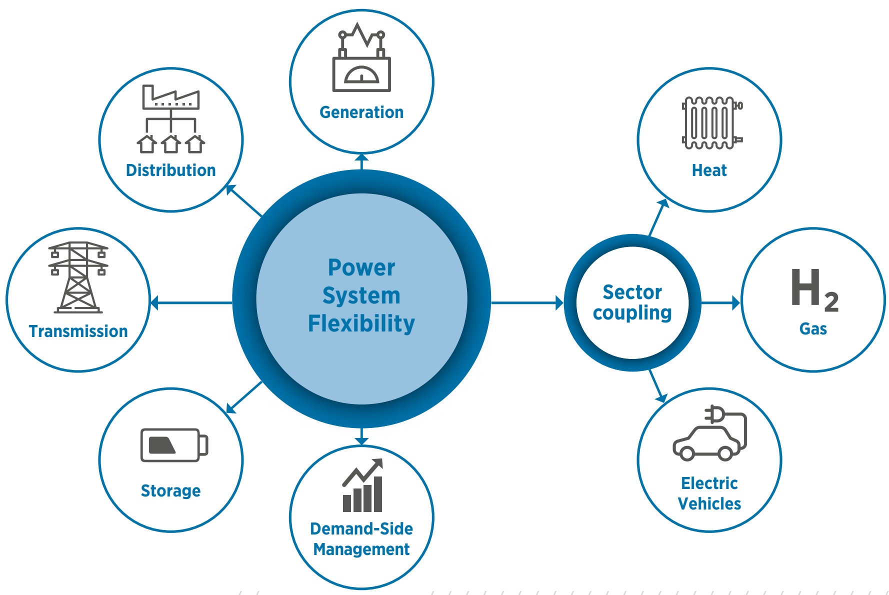
Along with technical flexibility, operational flexibility and good market design are needed for successful VRE integration.

Yet analysing the interplay and cost-effectiveness of different sources of flexibility can be a challenge. VRE planners, therefore, need optimisation tools that can capture a meaningful set of flexibility indicators, including loss of load and VRE curtailment, and identify a least-cost mix of flexibility enhancements.

The IRENA FlexTool is the first freely and publicly available tool that performs capacity expansion and economic dispatch with a focus on power system flexibility. It complements other power system planning tools.

For more information, see **IRENA's FlexTool report** *and country case studies.*

Power system flexibility enablers in the energy sector



Photograph: Shutterstock

Hydrogen from renewable power can help to realise a low-carbon future

Electricity from renewables already accounts for a quarter of global power generation. However, there is still a long way to go, as renewables must supply at least 70% of electricity by 2050 to avert serious global warming, according to the latest report from the Intergovernmental Panel on Climate Change (IPCC).

This could include channelling large amounts of renewable power into industry, transport and buildings. Yet direct electrification in these sectors can be challenging, unless renewable based power can be further converted and stored via other energy carriers.

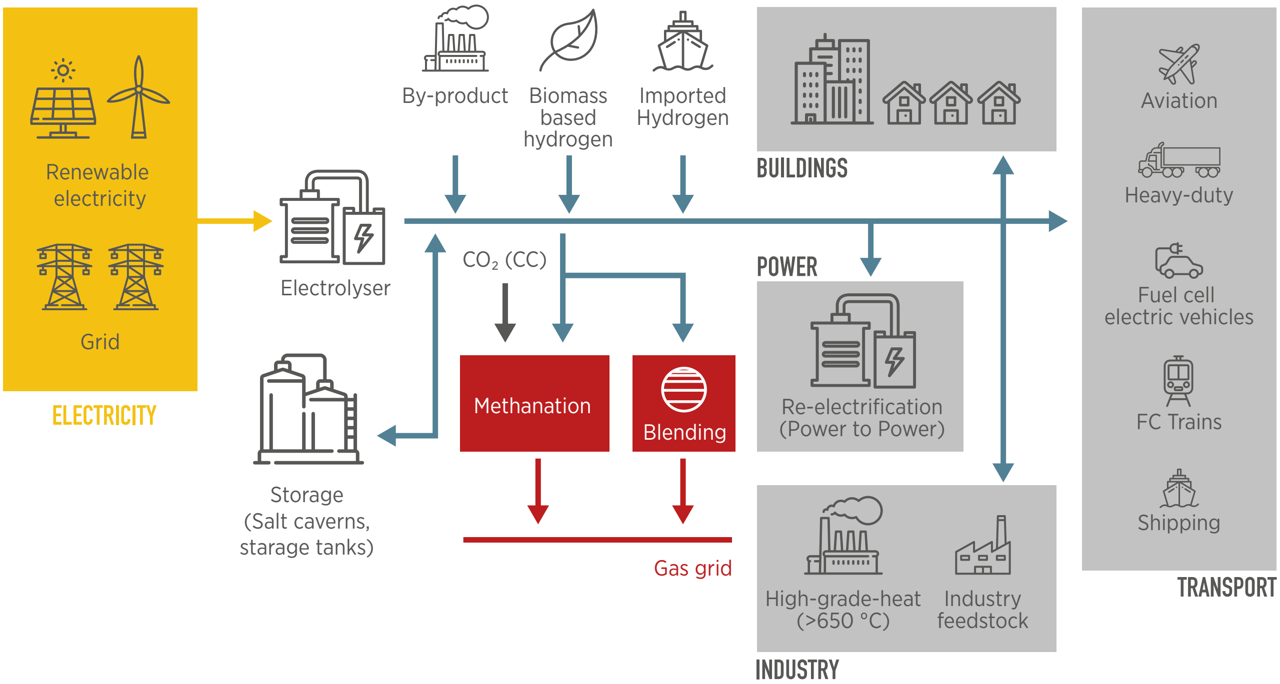
> Hydrogen could be the missing link for industry, transport and buildings

Hydrogen could be the missing link. It can be easily produced by splitting water into hydrogen and oxygen using renewable electricity. Besides, the transport of hydrogen in various forms can complement power transmission lines by offering another means to transport the energy contained in solar and wind resources to where demand is located. Today hydrogen is already employed in industry. Although it is overwhelmingly produced from natural gas and coal, the key processes are well established to use it.

Global hydrogen demand was estimated at 8 exajoules (EJ) in 2015, predominantly from the chemical sector to produce ammonia and for oil refining.

Hydrogen produced from renewable electricity could help to decarbonise industry and transport sectors either by directly displacing grey hydrogen made from fossil fuels or by replacing fossil-fuel feedstock in other processes.

Integration of VRE into end uses by means of hydrogen



Today hydrogen is already employed for industrial uses. Although it is overwhelmingly produced from natural gas and coal, the key processes are well established to use it.

While the opportunities and technologies for producing hydrogen exist, technology development policies have to focus on scaling up production to make hydrogen from renewable power competitive in the market.

To discover more about hydrogen and its place in a low-carbon energy future, see **Hydrogen from renewable power: Technology outlook for the energy transition**

Potential applications for hydrogen from renewable power

- **Industry:** Replace fossil fuel-based feedstocks, high-temperature heat.
- **Transports:** Utilise in fuel cell electric vehicles to decarbonise the road, rail, maritime and aviation sectors.
- **Buildings:** Hydrogen blended with natural gas or combined to produce synthetic methane and injected in gas grids. The gas grid in this scenario would function as an existing large-scale storage asset, accommodating and distributing low-cost renewable electricity.

Major economies aim to boost renewables and mitigate climate change

Last October, the Intergovernmental Panel on Climate Change (IPCC) released a special report calling for urgent global action at an unprecedented scale and speed. With only a 12-year window remaining to avert catastrophic climate change the decarbonisation of the energy system must be pursued at every level. Renewables, in combination with energy efficiency, are the key to uncoupling economic growth from an increase in greenhouse gas emissions.

The Group of Twenty (G20), an international forum of the world's 20 leading industrialised and emerging economies, represents nearly four-fifths of global energy consumption and a similar share of installed renewable power generation capacity. G20 members are well positioned to drive the global transformation of energy supply and demand.

Unless current and planned policies are further upgraded, the share of renewable energy would rise from below 15% of primary energy supply in 2015 to 27% by 2050.

However, to meet global development and climate objectives, the share of renewables must rise to at least two-thirds of primary energy supply by 2050. This requires renewables to be deployed six time faster, according to analysis by the International Renewable Energy Agency (IRENA). Significant advances in energy efficiency must happen in parallel.

Governments have a critical role, namely to promote an enabling policy framework in each country that provides long-term certainty for the private sector and provides suitable investment conditions for low-carbon solutions.

Greenhouse gas emissions by G20 members are among the highest in the world. Key measures whereby they can transform their energy sectors include:

» **Large-scale power generation.** Auctions with record low prices and innovative policy design are driving renewable energy growth.

» **Feed-in tariffs.** These have helped to boost solar photovoltaic and onshore wind in countries such as China, Germany, Indonesia and Japan.

» **Fiscal and financial incentives.** Such mechanisms have helped to drive large-scale deployment in several G20 countries.

» **Biofuel mandates and electric vehicle incentives.** Both help to expand renewables for transport. European Union countries have used the former, while many G20 countries have adopted the latter to advance electric vehicle use.

For more on the key role of the G20 countries see: **Opportunities to accelerate national energy transitions through advanced deployment of renewables**

Photograph: Shutterstock

West African nations target shared prosperity through renewables

Apart from large hydropower, West African countries use relatively little of their vast renewable energy potential. Solar, wind and bioenergy together accounted for just 1% of power generation in 2015, according to official totals.

But this should soon change, based on ambitious plans laid out by West African nations for the next decade. New renewable power could help expand household electricity access, which still falls short of 50% across the region.

Solar, wind and biomass could make up a quarter of the region's annual power generation by 2030, even amid projections of a fourfold increase in regional power demand and 50% population growth. Renewable capacity, including hydropower, could reach 65% of annual peak demand.

These figures emerge from an analysis of National Renewable Energy Action Plans (NREAPs) in the Economic Community of West African States (ECOWAS). NREAPs have evolved in line with the ground-breaking ECOWAS Renewable Energy Policy (EREP) of 2013, which aims to increase renewables in the region's generation mix to 23% in 2020 and 31% in 2030.

As national governments look for low-cost renewable energy opportunities, their collective ambitions could even surpass those targets.

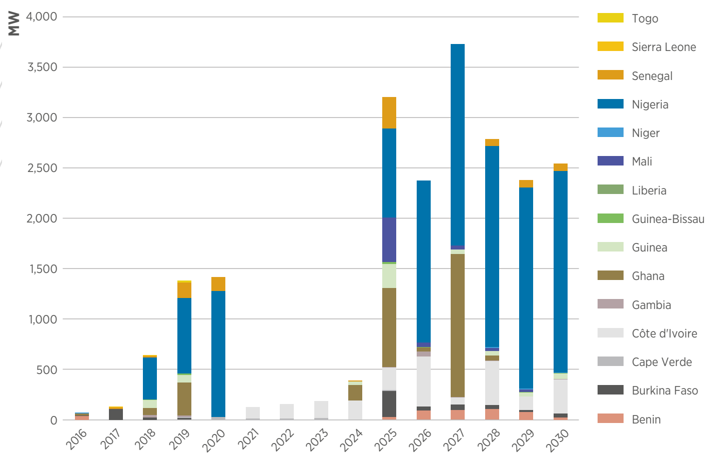
Solar photovoltaic (PV) installations make this possible. National targets shows that the market for solar PV could reach an average size of 1.5 gigawatts (GW) in the 2020s, representing a major new sector of economic activity. By 2030, the total grid-connected capacity of solar PV in the region could grow to over 20 GW, with large markets in Côte d'Ivoire Ghana and Nigeria, and significant national markets most ECOWAS countries.

Solar, and in some countries wind, could expand significantly, in part due to an improving regional transmission network. Greater interconnection and co-operation within the West African Power Pool would enable the countries with the best renewable resources to export power and reduce energy costs for their neighbours. Examples include wind potential in Niger and Senegal and solar in Burkina Faso.

National governments continue to revisit, revise, and potentially raise the ambition of their targets. Steadily improving modelling tools and planning practices for renewables can help to implement the region's vision on the ground.

For more, see: **Planning and Prospects for Renewable Power: West Africa.** *The complete report is also available in French*

National Targets Scenario: A potential pathway for new grid-connected solar PV capacity additions (IRENA analysis)



IRENA side-events during World Future Energy Summit (WFES) 2019

14–17 January 2019, Abu Dhabi

Event	Time	Venue
	MONDAY, 14 JANUARY 2019	
Solar and wind cost-reduction potential in the G20 to 2030	14.00 – 15.00	IRENA Pavilion
Accessing funding: 7th Cycle IRENA/ADFD Project Facility	15.30 – 16.00	IRENA Pavilion
Knowledge framework: Decarbonisation of energy systems	16.30 - 17.30	IRENA Pavilion
	TUESDAY, 15 JANUARY 2019	
Renewable energy market analysis: GCC 2019	13.30 - 15.00	Capital Suite 7
IRENA Youth Circle	10.00 - 12.00	IRENA Pavilion
Regulatory indicators for sustainable energy	14.00 - 15.00	IRENA Pavilion
SIDS project facilitation	15.30 - 16.00	IRENA Pavilion
Transformative renewable energy innovations	16.00 - 17.00	IRENA Pavilion
	WEDNESDAY, 16 JANUARY 2019	
Long-term energy scenarios (LTES) for the clean energy transition	10.30 - 11.30	IRENA Pavilion
Concentrated solar power (CSP) cost-reduction potential and competitiveness in the MENA Region	14.00 - 15.00	IRENA Pavilion
Open Solar Contracts: IRENA/TWI	16.00 - 17.30	IRENA Pavilion

Times may be subject to change.