Iranian Energy Experts Club

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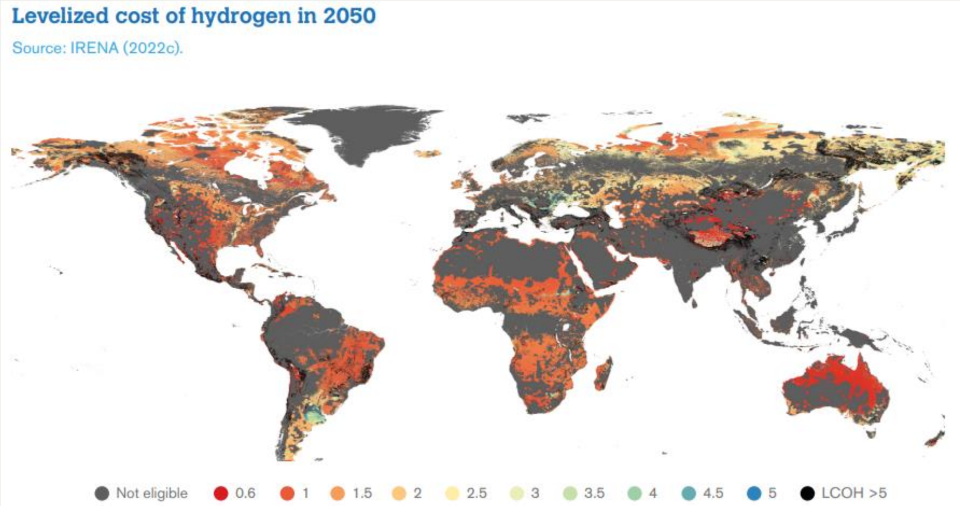
The role of green hydrogen in a global low-carbon economy [1]

To meet the goals of the Paris Agreement by mid-century, the global energy system will need to be deeply transformed within the next two and a half decades. According to the scenario proposed in the International Renewable Energy Agency's (IRENA) World Energy Transitions Outlook 2023: 1.5°C Pathway (IRENA, 2023a), more than two-thirds of the carbon dioxide (CO_2) emission reductions towards a net-zero energy system can be achieved through an increased supply of renewable energy, the electrification of energy services currently supplied with fossil fuels, and the improvement of energy efficiency. In this scenario for a decarbonized world, electricity would become the central energy carrier, accounting for more than half of the worlds' final energy consumption, up from about one fifth today. However, not all energy uses can be electrified. In some cases, a renewable molecule is needed as part of the process, either as feedstock – such as hydrogen for ammonia production – or as a chemical agent – such as hydrogen for primary steel production. In other cases, electrification is not technically feasible at present due to the energy density requirements of the fuel, such as in the aviation and shipping sectors. Therefore, there is a need for solutions to close the decarbonization gap for applications in which the direct use of renewable electricity or fuels is not a technically viable or cost-effective solution. Renewable – green – hydrogen can act as the link between renewable electricity generation and hard-to-abate (i.e., for which the transition to net zero is difficult either in terms of technology or cost) sectors or applications (IRENA, 2022a). Renewable electricity can be converted to green hydrogen via electrolysis, broadening the scope of renewable energy utilization. Green hydrogen is a key complement to renewable electrification, offering a solution to decarbonize some applications, for example in heavy industry (including those where fossil hydrogen is used today), shipping and aviation, and seasonal energy storage.



Green hydrogen is a key complement to renewable electrification.

Considering all these applications, IRENA estimates that hydrogen and its derivatives would satisfy a sizeable fraction (14 per cent) of final energy demand in 2050 in a scenario in which rising global temperatures resulting from emissions are limited to not more than 1.5°C (see Figure 1). The bulk of this hydrogen and of its derivatives should be renewable in order to reach climate neutrality in the energy system overall (IRENA, 2023a). Today, the global production of hydrogen – around 95 megatons of hydrogen per year (MtH_2 /year) – is almost exclusively derived from fossil fuels without associated carbon capture and storage. This fossilbased hydrogen is predominantly utilized in industries such as oil refining, fertilizer production, and downstream chemical processes. Current production of hydrogen emits the equivalent of 1,100- 1,300 megatons of CO_2 (Mt CO_2) globally (IEA, IRENA and UN Climate Change High-Level Champions, 2023). Thus, at present, hydrogen production is a major net contributor to climate change, rather than a vector for decarbonization. In a net-zero world, the current landscape of hydrogen production and consumption will need to have changed dramatically. First, existing hydrogen uses need to transition to a clean hydrogen supply. Second, hydrogen supply overall needs to expand to serve a broader range of applications in hard-to-decarbonize sectors. IRENA estimates that total hydrogen production will need to grow more than five-fold from now until 2050 (IRENA, 2023a). Delivering on this scenario will require a massive expansion in renewable power supply, as the electricity needed for that purpose is comparable to today's total global electricity consumption.1 It will also require an unprecedented scale-up and deployment of electrolyser capacity, from a negligible installed base today to more than 5,700 gigawatts (GW) by 2050 (see Figure 2). This expansion of hydrogen production will require the development of new supply chains. This, in turn, will have trade implications, both in terms of the trade of renewable hydrogen itself (or tradable commodities produced with it, such as ammonia, methanol and reduced iron)2 as well as trade in the required equipment and services to produce the hydrogen, transport it, store it and deliver it to the consumers at the end of the chain.

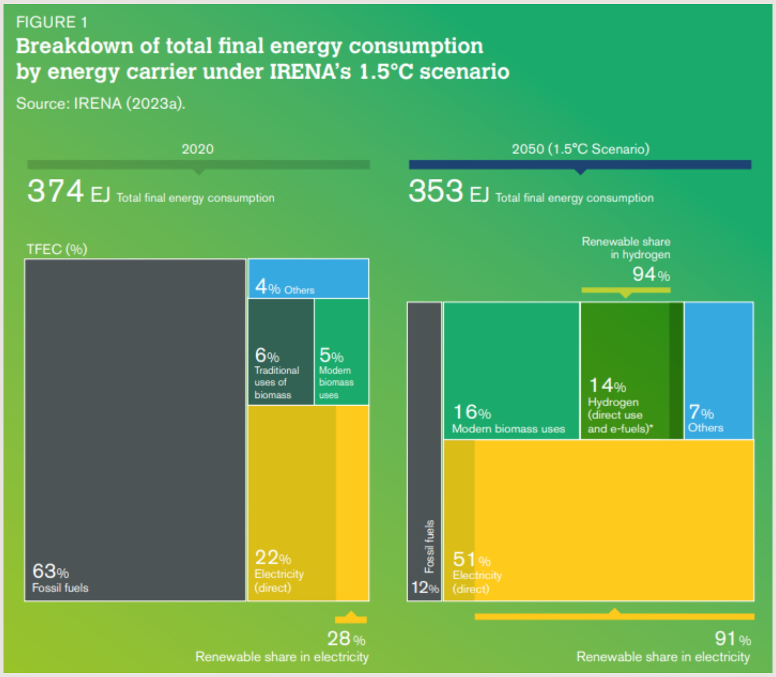


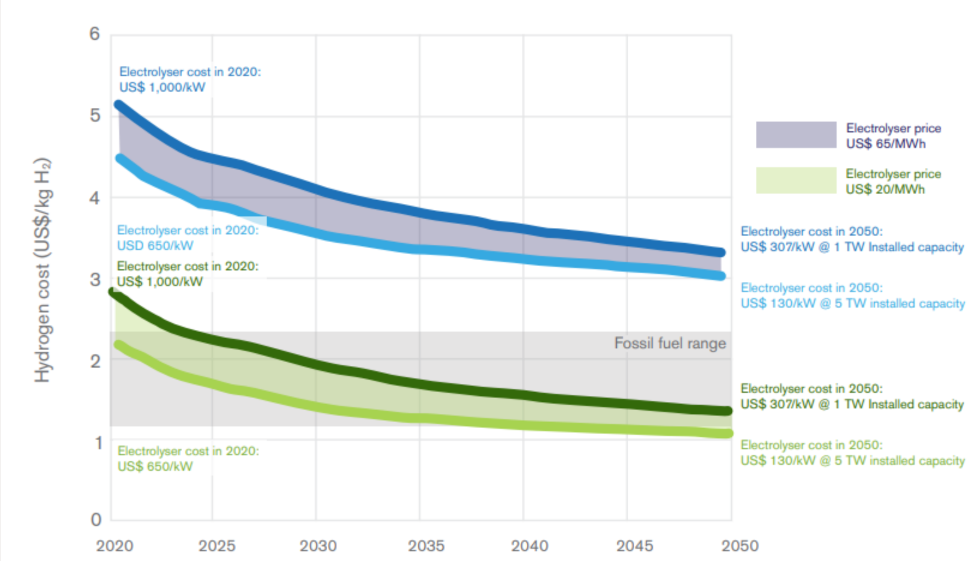
FIGURE 1
Breakdown of total final energy consumption by energy carrier under IRENA's 1.5°C scenario
Source: IRENA (2023a).

Prospects for green hydrogen production

A major barrier to the deployment of green hydrogen to date has been the higher costs of production compared to unabated (i.e., which causes high carbon emissions) fossil-based hydrogen. The prospects for cheaper green hydrogen in the future are driven by two key factors: the cost of renewable electricity and the cost of electrolysers. The cost of renewable power generation is falling very quickly. For instance, over the last 12 years, the cost of solar photovoltaic (PV) power has dropped by almost 90 per cent. The costs of onshore and offshore wind generation have also dropped very substantially, by 69 per cent and 59 per cent respectively (IRENA, 2023b). Today, solar and wind are the cheapest forms of new power generation in many regions of the world, and costs have the potential to continue to decline as the technology continues to improve. There could potentially be a similar cost reduction phenomenon with electrolysers to produce green hydrogen from renewable electricity. IRENA's analysis suggests that, if technology deployment volumes were to be in line with what is needed to meet the goals of the Paris Agreement by 2050, the effects of learning by doing and economies of scale would trigger substantial reductions in the cost of electrolysers (IRENA, 2020a). Such reductions in the installed costs of electrolysers, paired with further cost reductions in renewable power generation, could make green hydrogen competitive with fossil-based hydrogen already by the second half of this decade in locations with favourable renewable resource conditions.

Green hydrogen cost estimations based on deployment levels, power supply and electrolyser cost

Source: IRENA (2020a).



Green wheels, bright skies: Analysis unveils the connection between electric vehicles and photovoltaics (2)

People who own electric vehicles (EVs) are more likely to go a step further and add solar panels to their home, according to an analysis of a behavioral study by researchers at the U.S. Department of Energy's National Renewable Energy Laboratory (NREL). Conversely, the impact of owning solar panels also has a bearing on whether a homeowner buys an electric vehicle but not as strongly.

The study relied on a survey of 869 households in the San Francisco Bay Area.

NREL's Shivam Sharda, lead author of the newly published research paper that analyzes the survey results, said the owners of EVs may be more inclined to invest in photovoltaics (PVs) because the addition of solar panels might offset the residential portion of the energy bill needed to charge them at home.

"Both EVs and PVs have a complementary nature, which might play a pivotal role in energy systems resiliency, addressing concerns regarding grid stability and power management strategies," said Sharda, a computational research scientist in NREL's Center for Integrated Mobility Sciences.

The paper, "The Electric Vehicles-Solar Photovoltaics Nexus: Driving Cross-Sectoral Adoption of Sustainable Technologies," appears in the journal Renewable and Sustainable Energy Reviews. The study is co-authored by an interdisciplinary team of researchers including Venu M. Garikapati, Janet L. Reyna, and Bingrong Sun, all from NREL, and researchers from the University of California Santa Barbara and Lawrence Berkeley National Laboratory.

The survey was conducted in 2018 as part of the WholeTraveler Transportation Behavior Study. The researchers noted a lot might have transpired from the year when the survey was conducted. They revisited the topic with the newly released 2022 Residential Energy Consumption survey and observed that EV-PV relationship might still hold true. In the 2018 survey, more of the participants owned or previously owned rooftop solar panels than an electric vehicle (9.1% vs. 6.5%). The researchers noted PV technology has been around longer compared to EVs, and the cost of having solar panels is less than that of most EVs.

They found a correlation between the two technologies. Of EV owners, 25% also owned a PV system, while only 8% of the non-EV owners owned PVs. The behavioral survey highlighted two areas that might have prompted someone to adopt one or both technologies: being cognizant of them and being social enough to ask about them.

"If you have a friend or a family member who owns a rooftop solar panel or an EV, you become more educated about the technology, so you know the pros and cons by talking to them," Sharda said. "That has a significant influence on your owning EVs or PVs."

While governments offer incentives to adopt both EVs and PVs, the researchers suggested considering policies that jointly accelerate the acceptance of the two technologies. Because EV owners are inclined to use PV anyway, such incentives might provide a push for EV owners to adopt solar technology much earlier than what is currently observed. How soon a household adopts cross-sectoral sustainable technologies will play an important role in achieving decarbonization goals.

The researchers said while the survey provided valuable insights on EV-PV interconnection, more holistic surveys are needed to unpack the evolving transportation and residential energy use nexus to identify pathways to decarbonize energy use across sectors.

Renewable Power Set to Surpass Coal Globally by 2025 [3]

Renewable energy will surpass coal power by 2025 and, with nuclear energy, will account for nearly half the world's power generation by 2026, the International Energy Agency forecasts.

CLIMATEWIRE | Global electricity demand will step up its rate of growth over the next three years — but the additional power use will be covered by low-emissions sources, according to a report released Wednesday by the International Energy Agency.

By 2026, the report projects, renewables and nuclear will account for almost half of the world's power generation. In 2023, by contrast, they were less than 40 percent. The outlook is key because the United Nations has said a move to clean energy will be key to limiting global warming to 1.5 degrees Celsius — or as close to that as possible — compared with the preindustrial era.

IEA Executive Director Fatih Birol said in a statement that it's "encouraging that the rapid growth of renewables and a steady expansion of nuclear power are together on course to match all the increase in global electricity demand over the next three years."

"This is largely thanks to the huge momentum behind renewables, with ever cheaper solar leading the way, and support from the important comeback of nuclear power, whose generation is set to reach a historic high by 2025," Birol said. "While more progress is needed, and fast, these are very promising trends."

At the COP28 climate summit in Dubai, United Arab Emirates, in December, negotiators agreed to a road map for "transitioning away from fossil fuels," as well as a commitment to triple renewables capacity by 2030.

The changing electricity mix will drive down emissions from the power sector — currently the world's largest source of carbon dioxide emissions — even as demand rises, the IEA said. Electricity demand grew just 2.2 percent globally in 2023, lower than the 2.4 percent increase a year before, according to the agency. Demand is forecast to accelerate, with a 3.4 percent yearly average between 2024 and 2026.

That increase is driven by a number of factors, including the electrification of homes and businesses, the growing role of electric vehicles, and industrial growth.

Data centers are also driving significant growth around the world. The IEA projects that electricity use from data centers globally could double between 2022 and 2026, reaching a demand roughly equivalent to Japan's. The agency said that updated regulations and technological improvements "will be crucial to moderate the surge in energy consumption" from data centers.

Crucially, that growth in demand will be decoupled from a rise in emissions. After a 1 percent increase in 2023, global emissions from the electricity sector are set to fall by over 2 percent in 2024, followed by smaller declines in the subsequent two years. The reduced carbon intensity of electricity generation will be felt around the world, which the IEA said means that emissions savings through electrification of cars and appliances "will become even more substantial."

Despite the trend toward zero-emission sources, natural-gas-fired power is set to rise slightly over three years as it replaces coal power. Europe has been responsible for sharp declines in gas power, the report found, but that was offset by growth in the United States and projected gains in Asia, Africa and the Middle East thanks to the availability of liquefied natural gas supply.

Still, fossil fuels are expected to fall to 54 percent of global generation in 2026, the first time they will be below 60 percent in the IEA records going back more than 50 years. In 2023, that figure was 61 percent.

Efficiency policy momentum builds, but global energy intensity progress slows (4)

Energy efficiency is currently seeing a strong global focus among policy makers in recognition of its important role in enhancing energy security and affordability, and in accelerating clean energy transitions. This comes, however, as the estimated 2023 rate of progress in energy intensity – the main metric used for the energy efficiency of the global economy – is set to fall back to below longer-term trends, to 1.3% from a stronger 2% last year. The lower energy intensity improvement rate largely reflects an increase in energy demand of 1.7% in 2023, compared with 1.3% a year ago.

At the same, this year's slower progress in global energy intensity masks exceptional gains in some countries and regions, where strong policy action, increased investments and consumer behaviour changes led to sharp improvements well above the average global rate. This year the European Union and the United States, among many others since the beginning of the energy crisis, including Korea, Türkiye and the United Kingdom, have registered robust improvements ranging from 4% to 14%.

In 2023, global momentum to target a doubling in the rate of efficiency progress to 4% gathered pace, which could cut today's energy bills in advanced countries by one-third and make up 50% of CO_2 reductions by 2030. In June, 46 governments participating in the IEA's 8th Annual Global Conference on Energy Efficiency endorsed the 'Versailles Statement: The crucial decade for energy efficiency', agreeing to strengthen energy efficiency actions in line with a doubling of global energy intensity progress each year this decade to 203.

The energy crisis has unambiguously accelerated the energy transition, with energy efficiency policy action a central plank of government initiatives.

Since the start of the energy crisis in early 2022 there has been a major escalation in action, with countries representing 70% of global energy demand introducing or significantly strengthening efficiency policy packages. Annual energy efficiency investment is up 45% since 2020, with particularly strong growth in electric vehicles and heat pumps. Almost one in every five cars sold today is an electric vehicle and growth in global heat pump sales is now outpacing gas boilers in many markets.

According to the IEA's Government Energy Spending Tracker, since 2020 almost USD 700 billion has been spent on energy efficiency investment support, with 70% of this in just five countries: The United States, Italy, Germany, Norway and France. The Inflation Reduction Act of 2022 in the United States includes USD 86 billion for energy efficiency actions, while the European Union has strengthened its Energy Efficiency Directive to curb energy demand.

However, the impact of new government policies, regulations and energy saving programmes, coupled with an unprecedented level of investments to scale up more efficient technologies, are not always immediate, with efficiency gains and energy intensity progress realised over a period of years. Moreover, this year's overall global intensity progress masks more significant gains in some countries and regions as others saw much lower progress.

After an energy intensity improvement of 8% in the European Union in 2022, another exceptionally high year is expected in 2023, with a 5% gain in progress. The United States is also on track to post a 4% improvement in 2023.

A strong post-pandemic resurgence in China's economic growth of around 5% is forecast in 2023, along with a similar rebound in energy demand. These preliminary estimates for 2023 suggest that the overall level of energy intensity in China is not expected to change this year. It takes 40% more energy to fuel GDP in China than in the United States, and almost double the energy to fuel the same growth as in the European Union. This shift in the balance of economic activity, along with a slowing of the country's energy intensity improvement along with that of some other regions this year, helps explain the slowdown in global energy intensity progress in 2023.

In 2023 the world also experienced its hottest year on record, threatening to trigger a vicious cycle of both higher electricity use and carbon emissions. Heat waves can also worsen health disparities, reduce productivity, raise electricity costs, disrupt essential services, and drive migration. Extreme heat puts strains on electricity systems, requiring substantial investments in grid infrastructure and power generation while burdening consumers with high cooling costs, especially for the most vulnerable.

Data shows extreme heat drives increased demand for air conditioners, with sustained average daily temperatures of 30 °C boosting weekly sales by 16% in China, for example. During the May to September global heat wave this year, people were looking online for air conditioners more than ever, with the search term's relative popularity on Google up more than 30% worldwide compared with the historical average level of searches for those months.

Higher temperatures also have different impacts on electricity demand on a regional basis. For example, IEA analysis shows that every 1°C increase in the average daily temperature above 24°C drives a rise of about 4% in electricity demand in Texas, while in India, where air conditioner ownership is lower, the same temperature increase drives a 2% rise.

Between May and September in 2023, power grids hit record levels of peak demand in many of the largest countries in the world, including China, the United States, India, Brazil, Canada, Thailand, Malaysia and Colombia – together accounting for more than 60% of total global electricity demand. In some regions, such as in the Middle East and parts of the United States, space cooling can represent more than 70% of peak residential demand on hot days.

A milder winter, the second warmest on record in Europe, also contributed to reduced energy demand, helping improve this year’s energy intensity results in Europe and the United States.

As momentum builds around the global target to double efficiency progress from the 2022 level of 2% to 4% each year until 2030, international efforts, including those at COP28, have a major role to play in shaping future energy efficiency and demand pathways.

While doubling the rate of global energy intensity progress is a challenging target, it is not an unprecedented level of progress. In the past ten years, 90% of countries have achieved the 4% rate at least once, and half have done so at least three times. However, only four G20 countries – China, France, the United Kingdom and Indonesia – have done so over a continuous 5-year period within the last decade, though several others have come close.

In most sectors, governments can make rapid progress towards doubling by building upon best practice in existing policies and accelerating the deployment of already-available technologies. For example, lighting standards in the European Union, India, Japan, South Africa and the United Kingdom are already at or exceed the level set out in the NZE Scenario. Similarly, all industrial electric motors within a certain output range sold in the European Union, Japan, Switzerland, Türkiye and the United Kingdom must adhere to the efficiency class seen in the NZE Scenario. Similar cases can be found for building regulations, and vehicle standards improvements set to come into force by 2030.

IEA assessment of the evolving pledges at COP28 (5)

At the COP28 climate change conference in Dubai, pledges have been made in three key areas – by many countries on renewables and energy efficiency, and by a significant number of companies on methane. These are three of the five crucial areas for action highlighted by the International Energy Agency (IEA) ahead of COP28.

The IEA has now analysed what the impact would be on global energy-related greenhouse gas emissions if all the signatories of these pledges delivered on them in full. It shows that, while the pledges are positive steps forward in tackling the energy sector's greenhouse gas emissions, they would not be nearly enough to move the world onto a path to reaching international climate targets, in particular the goal of limiting global warming to 1.5 °C.

As of Friday 8 December, around 130 countries had signed up to the pledge to triple global renewable power capacity by 2030 and double the annual rate of energy efficiency improvements every year to 2030. Those countries together account for 40% of global carbon dioxide (CO_2)

emissions from fossil fuel combustion, 37% of total global energy demand and 56% of global GDP.

In addition to the potential impact of those pledges, the IEA has assessed what the effect would be of the full implementation of the methane pledge of the Oil and Gas Decarbonisation Charter, which is to zero-out methane emissions and eliminate routine flaring by 2030. The 50 companies that have signed up to it account for about 40% of global oil production and 35% of combined oil and gas production.

IEA analysis shows that the full delivery on these pledges – covering renewables, efficiency and methane/flaring – by the current signatories would result in global energy-related greenhouse gas emissions in 2030 being around 4 gigatonnes of CO_2 equivalent lower than would be expected without them (based on the Stated Policies Scenario in the IEA's World Energy Outlook 2023).

This reduction in 2030 emissions represents only around 30% of the emissions gap that needs to be bridged to get the world on a pathway compatible with limiting global warming to 1.5 C (the IEA's Net Zero Emissions by 2050 Scenario).

The IEA will continue to monitor the ongoing developments at COP28 and update its assessment as needed.

Reference:

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