ISSN:3030-332X
Impact factor: 9,493
International journal of scientific researchers
2nd International Conference on Green Economy & Sustainability 2.0, 30 April 2026

RENEWABLE ENERGY AND GREEN TECHNOLOGIES: GREEN TECHNOLOGIES NECESSITY

G'iyosov Muhammad Ayub
Student, Andijan Law College
nabiyevnad@gmail.com

Abstract

Renewable energy is often described in technical terms such as megawatts, carbon offsets, or energy efficiency ratings. Some green technologies are even more technical, including smart grids, hydrogen electrolysis, and flow batteries. But buried beneath all of the data and jargon is an even more powerful story, that of human resilience, curiosity, and hope. This is not just a scientific or engineering perspective, but a human one, with an overview of renewable energy and all other green technologies, including solar, wind, water, geothermal, tidal, bioenergy, energy storage, distributed and transmission grids, electric vehicles and other transport, green hydrogen, carbon capture, energy efficiency, and material efficiency. And it looks deep into how these technologies work, what trade-offs they carry, and how they reshape communities, restore dignity, and reconnect us to the natural world. From the farmer in rural India who uses rooftop solar to light his home, to the former coal miner in Appalachia who now takes care of the wind turbines, to the neighborhood in Denmark that owns and manages its own offshore wind farm, clean energy and green technology present a human choice. They challenge us to recreate not just how we provide energy for our daily lives, but how we relate to the earth and each other. Denmark is one real-world example of a small Nordic country that has become a world leader, not by waiting for miracles to happen, but through the systematic combination of renewables and green tech. Wind and solar produce over 65-70% of Denmark's electricity, and wind power sometimes exceeds half the supply. What makes Denmark truly unique is not the wind power but what goes with the wind power.

Keywords: Renewable energy, green technologies, solar power, wind energy, hydropower, geothermal, bioenergy

Introduction

When we talk about renewable energy - solar panels, wind turbines, hydroelectric dams - most people think about science and engineering. When we talk about economics, most people think about money, markets, and numbers. But once we put them together, what we get is something powerful and very human: green economics. Green economics is not just an academic term. At its core, it is the study of how we can power our lives without destroying the planet or leaving behind the poor. It poses a question that is relevant for all of us: Can we afford to go green? Can we afford not to? Who pays for it? Who benefits? How do we move from the fossil fuel economy we live in to the clean energy economy that we need to have in a way that is fair, practical, and hopeful, not just for the richest countries, but for the entire planet? The book is wide, in the sense that it covers many areas of renewable energy and green economics, from solar farms to wind auctions to carbon pricing to green jobs to energy justice to the circular economy. It is also deep, in that we ask what actually works, what are the trade-offs, and how is the transition affecting people. And always, we write in a human voice, because economics is not just about graphs and spreadsheets - it is about livelihoods, families, children breathing cleaner air, and communities building their own futures.

In the past economics has seen the environment as something outside the system - free air, free water, a free dumping ground for pollution. Green economics says no. The economy lives inside the environment, not the other way around. You cannot have a healthy economy on a dying planet. At the core of the green economics agenda is a simple but radical idea: natural capital - forests, clean air, healthy soil, and a stable climate - is a real asset with real value, even if no one has put a price on it. Renewable energy is an investment, because every solar panel or wind turbine invested in today pays for

itself tomorrow. The sun and wind have no fuel bills and they never get more expensive. But hidden costs of coal-fired power include the asthma of coal smoke, and homes and lives lost to climate change floods from burning fossil fuels. And a just transition is essential. We can't allow workers, communities and families who depend on fossil fuel to be left behind in our clean energy future. They deserve new jobs, retraining, and real support. These projections are grounded in decades of climate and economic research. Economists have estimated the costs of inaction (floods, fires, droughts, crop failures, population dislocations) will reach trillions of dollars a year by the year 2050. The price of solar and wind power has dropped 80 to 90 percent in the last fifteen years. Green economics is not idealism. That is hard-headed realism. The other major form of green economics pricing is the levelized cost of energy (LCOE). LCOE is the average costing for the construction and operation of a power plant over its lifetime. Solar and wind power at utility-scale now costs less than new coal and gas power in most of the world without subsidies, and includes many definitions of green economics pricing. Policies such as tax credits, feed-in tariffs and renewable portfolio standards support clean energy. Fossil fuels are still heavily subsidized, costing more than seven trillion dollars per year across the world when environmental and human health damages are included. A carbon price (a carbon tax or a carbon price with cap and trade) makes polluters pay for their emissions and incentivizes companies to invest in clean technologies. Over seventy national and subnational jurisdictions, including the EU, Canada, and subnational governments in countries such as China, have some form of carbon pricing. Globally, solar, wind, hydropower and other renewable industries employ more people than fossil fuels. This includes more than 13 million people employed in manufacturing, installation, maintenance, services, project development, and Research & Development. Within energy justice, energy equity considers whether the transition to a clean energy economy benefits everyone, or only the wealthy. A green economics targets cheap energy for all, community ownership, and benefits for low-income communities and communities of color. The circular economy, which seeks to make products reusable, repairable, and recyclable rather than takable, makeable, and disposable, can turn solar panels, wind turbine blades, and electric vehicle batteries from a waste problem into an opportunity.

But a fuller picture is complex, and involves trade-offs. High up-front costs mean poor countries and poor communities cannot afford renewables without external assistance even if they pay back over time. Renewable energy intermittency means it requires storage, backup and grid upgrades, which in turn require up-front investment. These costs can be reduced every year, but they are real. Stranded assets (coal, oil and gas reserves that may be worthless if fossil fuels are phased out rapidly) will cost many trillions of dollars to companies and countries. We will need to deal with that crisis without the entire economy collapsing. Green jobs are clearly trending, but not always in the same place or accessible to the same people. A West Virginian coal miner can't just become a California solar installer, especially without retraining, relocating, and winning the support of their community. Critical minerals for solar PV, wind turbines, batteries, and electric vehicles (including lithium, cobalt, copper, and rare earth elements) also have their own environmental and human rights issues. Green economics looks at and addresses issues along the entire supply chain, not just at end-of-pipe clean energy. These are not reasons to give up, but rather reasons to be mindful, to be calculated, and to be human. One of the most convincing real-world demonstrations of renewable energy and green economics has been in Germany, under the Energiewende or energy transition program. This slow-moving project began in the 1990s, but then took off after 2000 as Germany decided to phase out nuclear and fossil fuels. The passage of the Renewable Energy Sources Act created feed-in tariffs, legally mandated fixed prices, for anyone producing solar power, wind power or biogas power. Suddenly, it made sense to everyday people - farmers, homeowners or small business owners - to put solar panels on their roofs or small wind turbines on their land. Renewables have risen from under five percent of electricity generation in 1990 to over 50% by 2024. More than four hundred thousand jobs have been created in the renewable energy sector. The thousands of energy cooperatives founded by citizens created a new class of energy providers among ordinary Germans. The relatively high prices of this tariff were immediately paid by an extra fee on electricity bills, but costs fell rapidly along with solar and wind.

Literature Review

To understand where we are in renewable energy technology and green economics today, we need to listen to what researchers, economists, theorists, and scientists have been saying and observing for several decades. A literature review is not just a collection of studies. It is a conversation, spanning breadth and depth, among many voices that have studied the subject. This review draws extensively from the literature in climate economics, behavioral economics, energy economics, and environmental policy making and digs in detail on key findings with a focus on the human aspects.

Climate change and energy are topics that have been written about in the scientific literature since the first warnings in the 1970s. It is only the IPCC, with its massive reports attuned to universal interest, that can set the world item of immediate urgency. In 2022, its Sixth Assessment Report made it clear that humans have unequivocally warmed the planet, mainly by burning fossil fuels. The message is clear from the report: limiting warming to 1.5C, still possible, will require global greenhouse gas emissions to peak before 2025, and to fall sharply thereafter. What makes this literature so powerful is not just the conclusions, but also the people and their stories behind them. The report reflects how climate change is already displacing families, destroying crops and widening inequality, and reflects a world where science and the human experience collide.

British economist Nicholas Stern's 2006 Stern Review on the Economics of Climate Change for the UK government changed the climate change economics debate forever. He argued that the costs of climate change through loss of crops, flooding of cities, mass migration, and conflict are far higher than the costs of taking early action. He argued that climate change could cost the global economy between five and twenty percent of gross domestic product (GDP) each year while limiting greenhouse gas emissions would cost about one percent of global GDP. Some objected that Stern's discount rate was low, because he gave so much weight to future generations. But that was precisely the point. Stern was asking one of the hardest questions ever in moral philosophy: why shouldn't we value our children's and grandchildren's lives as highly as we value our own comfort today? His work has been cited thousands of times and is a foundation of green economics. Another major contributor was William Nordhaus, awarded the 2018 Nobel Prize in Economic Sciences for his development of the Dynamic Integrated Model of Climate and the Economy, or the DICE model. The model assesses the interaction between the economy and the human-induced greenhouse gas emissions that causes climate change, proceeding with a relatively high discount rate and a more moderate pace of reductions than Stern. But Stern and Nordhaus' disagreement is not just about the numbers, but a moral one about how much we owe future generations. If you read them both, the question remains the same: what is the right speed for change when human lives are a stake?

Studies on renewable energy costs have come a long way in 15 years. Early studies found solar and wind energy expensive, but with promise. That is no longer true: the International Renewable Energy Agency (IRENA) publishes annual reports on renewable power generation costs, and there are extraordinary trends. As of 2010 to 2023, the cost of utility-scale solar photovoltaics has fallen almost 90%, along with a 70% reduction in the cost of onshore wind and a more than 60% reduction in offshore wind. The first two are that around the world, in most regions, solar and wind are now the cheapest way to generate new electricity, without subsidies. What makes this literature very exciting is that this has happened much more quickly than anyone thought. It's not just scientists but also normal people who are now able to afford putting solar on their rooftops. The economics have flipped. However, further research cautioned that low generation costs alone do not determine overall cost and these costs are discussed in studies sponsored by the International Energy Agency (IEA) and the peer reviewed literature. Because the sun does not shine all the time and the wind does not always blow, integrating these into the electrical grid involves storage, transmission, back-up generation and smarter grid technology. But these costs are real, and are declining as the price of batteries falls. At that time, in a 2023 Nature Energy study, high penetration costs were estimated to account for twenty to fifty percent of the levelized cost of wind and solar in a deep decarbonization electricity system. However, these costs could be reduced through encouraging policies, interregional cooperation and continuing technological

advances, the study said. The human lesson is that renewable energy is not a swap out but an entirely new system built piece by piece.

Methodology

A methodology is more than a set of technical procedures. It is the story of how we come to know what we know. Tools and approaches used for over 30 years of research on renewable energy and green economics policy evaluation and case studies have ranged from economic modeling, life cycle assessment, case studies, surveys, and participatory action research, experimentation, and action. Each of these perspectives lends different insights into the unfolding global transition to new forms of energy and associated changes in people's lives. This section describes the different approaches used in the literature to understand renewable energy and green economics both from a scientific perspective and from a human perspective. Economics, at its broadest, is a science. Many researchers in renewable energy and green economics begin with country-specific or region-specific economic models. Models are simplifications of reality, and they are useful tools for asking "what if" questions. What if we put a price on carbon? What if we subsidized solar power? What if we invested heavily in energy storage? Such models give economists and policymakers a chance to consider alternative paths such as this, without needing to wait for the real world to run the experiment. An IAM (Integrated Assessment Model) is one of the most widely used kinds of climate model. IAMs link together models developed by the climate and economics communities to examine how human sectors (e.g. energy, land use, transportation) influence climate, and how climate change influences human sectors. DICE is an early example of a model by William Nordhaus that performs integrated assessment of the global economy, emissions, carbon concentrations, temperature and climate change damages using a single model. Such models can identify the mitigation pathway that most optimally balances the short-term costs of avoiding carbon emissions with the long-term costs of not doing so. This is fundamentally the same question as: how much are we willing to sacrifice today for the future? That is not just a technical question. It is a moral one.

But models like these have limitations. They are often aggregated by country or region and do not attempt to estimate local inequalities. More detailed approaches may be needed. Life-cycle assessment (LCA) is a methodology to evaluate the environmental impact a product or technology has throughout its life-cycle, from extracting the raw materials, through production, use and end-of-life treatment such as recycling. LCA can answer questions about renewable power production that a simple cost accounting will not address. For example, for a solar panel to provide clean electricity for twenty-five years, what energy and resources were used to make the panel? What about the water used to clean it? What happens once the panel reaches the end of its operational life? LCA shows that the life-cycle GHG emissions of solar power and wind power are 10 to 50 times lower than coal or natural gas, and that there are tradeoffs with associated land and water use. Solar panels use silver, copper, and in some cases rare earth elements. Wind turbines use neodymium and dysprosium, which come at a social and environmental cost. A good LCA does the valuable work of shining a light on these costs, making them available to policymakers and researchers. The human side of the LCA is about integrity - looking at the whole issue, not just the clean energy that is at the end of the wire. Another critical tool is cost-benefit analysis (CBA), the economic technique for comparing the total costs of a policy or project against its total benefits through evaluating both in common monetary units. Green economics has applied CBA to assessing the costs and benefits of carbon pricing, subsidies to renewables, energy efficiency programs, and investments into climate change adaptation, with the Stern Review being perhaps the best-known example. He estimated the economic impacts of global warming due to declines in agricultural productivity, damage from extreme weather, rising sea levels, health changes, and many other effects. He also estimated the costs that would be needed to prevent climate change. He concluded that strong early action is cheaper, influencing subsequent debate on climate change policy worldwide. Other criticisms of CBA focus on the impossibility of quantifying some costs and benefits. How do we assign a value to a human life, an extinct species, an asthma attack in a child, or a harvest lost due to bad weather? This is a fair point, reminding us that the numbers aren't everything. But employed with humility and

transparency, CBA can shed light on choices that remain otherwise hidden. Qualitative methods are a useful way to tackle questions about human behavior and social phenomena. Case studies are common. Case studies, often using interviews, document analysis, site visits and observational studies, investigate a real-world example (a country, a region, a community, a project, etc.) to understand not just what was done, but why and how. There is not one case study of the German Energiewende, but dozens covering one aspect of the energy system transition. For example, one could study how the feed-in tariff law was passed based on interviews with politicians or civil servants who wrote it. Or one could study one single village that became energy independent using solar energy and biogas and speak to the farmers who invested money in such a technology. Or in the coal region of Lusatia, where mines are closing and experiencing both the fears and the hopes of the workers first hand. These case studies offer a patchwork or puzzle of how green economics works in practice. The human heart of case study research is listening. This method is the most direct route for letting ordinary people voice their concerns to the academy.

Case Studies

A case study is a window into a real place, a real time, and real people. It takes us out of the abstract world of models and theories and drops us into the messiness of actual life. In the field of renewable energy and green economics, case studies are essential because they show us what works, what fails, and what ordinary people experience when the energy transition arrives in their community. This case study examines one of the most celebrated examples of renewable energy success in the developing world: Costa Rica. It looks widely at the country's entire energy system and deeply at the human and economic dimensions of its achievement. And it does so in a voice that honors the people who made it happen.

Costa Rica is a small country in Central America, home to just over five million people. It is known around the world for its lush rainforests, incredible biodiversity, and commitment to environmental protection. But what many people do not realize is that Costa Rica has also become a global leader in renewable energy and green economics. For several years in a row, Costa Rica has generated more than ninety-eight percent of its electricity from renewable sources. In some years, it has reached one hundred percent renewable electricity for hundreds of consecutive days. This is not a small achievement. It places Costa Rica alongside countries like Norway, Iceland, and Paraguay at the very top of the global ranking for clean electricity.

How did Costa Rica achieve this? The answer lies in a combination of natural resources, historical choices, political stability, and economic policies that prioritized long-term sustainability over short-term profits. To understand the case widely, we need to look at the full mix of renewable sources that Costa Rica uses. Hydropower is the backbone of the system, accounting for about seventy-five percent of the country's electricity generation. Costa Rica has dozens of rivers flowing from its mountainous interior to the Caribbean Sea on one side and the Pacific Ocean on the other. The heavy rainfall, especially in the Caribbean slope, feeds these rivers year after year. The state-owned electricity company, Instituto Costarricense de Electricidad, or ICE, has built a network of hydropower plants over many decades, ranging from small run-of-river facilities to large reservoirs. The largest is the Reventazón Dam, which began operating in 2016 and has a capacity of over three hundred megawatts. When the rains come, Costa Rica's rivers provide a steady, reliable flow of clean electricity.

But hydropower alone is not enough. Costa Rica experiences dry seasons, and in some years, El Niño brings drought that reduces river flows. That is where the country's other renewable sources come in. Geothermal energy provides about thirteen percent of Costa Rica's electricity. The country sits on the Pacific Ring of Fire, a volcanically active region, and that geological reality is a gift for green economics. Costa Rica has developed several geothermal plants, most notably the Las Pailas facility near the Rincón de la Vieja Volcano. Geothermal energy runs twenty-four hours a day, seven days a week, rain or shine. It is not affected by droughts. When hydropower drops, geothermal can fill the gap. Wind power provides about ten percent of Costa Rica's electricity. The country has windy mountain passes, especially in the Guanacaste region, where wind turbines now spin above the dry tropical forests. Solar energy is growing, though it remains a smaller share due to seasonal cloud cover. Together, this diverse mix of

hydropower, geothermal, wind, and a small amount of solar creates a resilient, balanced system. No single source is asked to do everything. They work together.

To understand the case deeply, we need to look beyond the engineering and explore the human and economic story. Costa Rica's commitment to renewable energy is not an accident. It grew out of a broader national identity centered on peace and nature. Costa Rica abolished its army in 1949, redirecting military spending into education, health, and environmental protection. That decision, made more than seventy years ago, planted the seeds for the green economy that exists today. The state-owned electricity company, ICE, was given a mandate to develop the country's energy resources for the public good, not for private profit. This institutional framework meant that investments in hydropower and geothermal could be made with long time horizons, not quarterly earnings reports. A private company might hesitate to build a dam that takes ten years to complete and twenty years to pay back. A state-owned company with a public service mission can make that investment.

Data Analysis

Data analysis is where the numbers start telling the story. Megawatts of solar capacity, tons of carbon dioxide emissions, dollars of investment: they are all silent and cold. But when we analyze it, when we look for patterns, trends, relationships and outliers, the data begins to talk to us. In the area of renewable energy and green economics, data analysis is particularly important. It converts measurement into meaning. It helps us understand what is working, what is not, and why. This section on data analysis provides an overview of global and national datasets and also gives a close look into the datasets behind one of the world's most successful renewable energy transitions: Denmark. This includes everything from electricity generation and costs, job creation, emissions reductions, and interactions with and public acceptance of these technologies, all in a human context. To understand renewable energy and green economics, we should first look at the global data. According to the International Energy Agency (IEA) and REN21, renewable energy sources provided thirty to thirty-five percent of the global electricity generation in 2024. That is an increase from twenty percent a decade prior, and has largely been driven by solar and wind energy. Solar photovoltaic capacity has grown from less than fifty gigawatts in 2010 to more than one thousand gigawatts in 2024. Wind capacity has grown from about two hundred gigawatts in 2010 to over one thousand gigawatts in 2024. Hydropower with fourteen hundred gigawatts of capacity is the largest source of renewable energy, but cannot grow as fast because the best sites for dams have already been developed. They are millions of solar panels on rooftops and in fields and hundreds of thousands of wind turbines, on hills and offshore. Every gigawatt of renewable generation replaces fossil fuel power; avoiding millions of tons of carbon dioxide pollution annually.

For green economics, understanding costs is key. The levelized cost of energy, the average cost of construction and operation over the life of a power plant, has radically plummeted for renewables. IRENA claims that from 2010 to 2023 global weighted-average LCOE of utility-scale solar PV declined by almost 90% from ~US$380 to US$40-60/MWh. In this period, onshore wind LCOE fell by about 70% from ~US$100 to US$30-50/MWh in 2023, and offshore wind fell by 60%. It remains a little more expensive than onshore wind and solar, but these numbers are transformational. Historically, renewable energy was more expensive than coal and gas so the economic case was weak. Now renewable energy is the cheapest source of electricity across the world, so it has become an obvious choice. According to the data, the claim that we cannot afford to go green is false. Instead, we cannot afford not to go green. Levelized cost of energy does not reflect the full cost, as it ignores the integration of variable renewables into the electricity system. These integration costs (storage, transmission, backup generation, and grid management) on average add 10-50% to the true cost of wind and solar in deep decarbonization scenarios, driven by the penetration of renewables in the energy mix, flexibility of the system and other zero-carbon energy resources, like hydropower. In a 2023 Nature Energy study, the integration cost added 15-25% to the levelized cost of a fully integrated system made up of 50% wind and solar. It increased this by 30-50% when 80% was wind and solar capacity. However, these are not reasons not to invest in renewables. They are a reminder that the transition involves investment throughout the system, not just generation. One of the most pressing pieces of data is carbon pollution: per the Global Carbon

Project, global energy-related CO2 emissions reached an all-time high of roughly thirty-seven billion tons in 2023. That is the opposite direction from where we need to go. To have a good chance of staying below 1.5 degrees Celsius, the IPCC found, global emissions need to peak before 2025, drop by forty-three percent by 2030, and reach net zero by 2050. These emission gaps are large, but the data shows that countries with a high share of renewable energy tend to have much lower emissions per unit of electricity produced. Electricity emissions in Costa Rica are close to zero, while emissions in Denmark have fallen more than 70% since 2000 due to increased renewable generation from wind and solar. In Germany, increased use of renewables means that carbon emissions from electricity have dropped by about forty percent. Data analysis does not by itself establish causation, but combined with engineering and economics, it can provide strong evidence. Now let us turn to a more personal data analysis via an example of a real world data set: the case of Denmark, the tiny Nordic country of six million people that has become the worldwide laboratory for renewable energy and green economics. The Danish data tell a powerful story of what is possible when a country decides to transition. Let us look at the most important data. First, electricity generation. In 2023, more than seventy percent of Denmark's electricity generation came from renewables, according to the Danish Energy Agency. Wind power supplied about fifty-five percent (with onshore and offshore split thirty-five to twenty), solar ten percent, and biomass seven percent. The remainder came from burning gas, coal and waste incineration. This is a far cry from 1990, when more than ninety per cent of Denmark's electricity was produced from fossil fuels. Denmark has fundamentally changed its electricity system in just 30 years. Data shows that wind and solar are variable, but in a heavy wind, wind energy can produce more than one hundred percent of Danish consumption, exported to Germany, Norway and Sweden. But on a clear but windless cloudy day, wind and solar only cover ten to twenty percent, requiring Denmark to import or burn natural gas to fill the gap, which is not a failure of renewable energy. It simply needs to be traded, stored, and matched against flexible energy demand.

Second, cost data. The electricity price for households, among the most expensive in Europe, was around forty euro cents per kWh in Denmark in 2024. At first glance, this appears at odds with the claim that renewables are cheap. A closer look at the data tells a different story. Only twenty to thirty percent of the final cost of electricity per household in Denmark is generation, the rest being taxes, grid fees and VAT. Denmark taxes electricity highly to reduce electricity use and to create green investments. For this reason, the wholesale price of electricity (the price paid to generators) has fallen sharply with the increase in wind and solar power. On particularly windy days, turbines may have to pay to put energy on the grid when wholesale prices fall below zero. Hence, high prices paid by Danish households are a policy choice rather than a need. Industrial power prices in Germany are actually much cheaper and competitive (because industry is exempted from most of the taxes). However, prices are not necessarily the same as costs. Costs for renewable electricity generation are low, but the price to consumers is affected by taxes and policies. Third, employment data. The Danish Energy Agency and ILO report that Denmark has created tens of thousands of jobs in renewables and green technologies. Around thirty thousand Danes are employed in the wind industry, mainly in manufacturing, installation, maintenance and research at such companies as Vestas and Siemens Gamesa, giving Denmark the highest per capita employment in wind energy. It shows that these really are good jobs, with above average wages, strong unions and a growing market. Denmark has also managed a just transition for fossil fuel workers. Despite a decline in coal jobs, the enormous majority of workers shifted to jobs in renewables or other sectors due to labor market policies and training, suggesting that fossil fuel job losses need not lead to a rise in unemployment rates. With investments and planning, workers can be shifted to other industries.

The case of Denmark shows that the data supports hope. The transition to renewable energy and green economics is not only necessary it is possible, affordable, and already happening. The data is not perfect. There are challenges, trade-offs, and uncertainties. But the overall direction is clear. The numbers are moving in the right direction: more renewables, lower costs, fewer emissions, more jobs. That is not just a statistical trend. It is a story of human ingenuity, courage, and persistence. And it is a story that is still being written, with each new data point adding a sentence, a paragraph, a page.

Conclusion

After extensively studying solar and wind power, hydropower, geothermal, and green technologies such as storage, smart grids, and hydrogen, and diving into the human stories, costs and benefits, and challenges in the energy transition, we are ready to give you the facts. The biggest lesson is that renewable energy works. It is not now expensive, nor futuristic. Solar and wind power are now the cheapest sources of electricity in most countries, the price having dropped by eighty to ninety per cent over fifteen years. Batteries are also getting cheaper. This is not a dream. This is really happening. Secondly, green economics is real. Countries like Denmark and Costa Rica cut emissions while growing their economies, and they created hundreds of thousands of jobs in clean energy in the process. They have proved that protecting the planet and building prosperity can go hand in hand. The old idea that we have to choose between jobs and the environment is wrong. But the third lesson is honest about this. The transition is not automatic. It requires substantial investment, long-term planning, political will and courage, and dislocated fossil fuel industry workers need to be retrained. Even some of the materials for solar energy panels and batteries come from mining, and that has its own problems. The sun doesn't always shine and the wind doesn't always blow, so we also need storage, better grids, and more cooperation. These are real problems, but they are solvable. The fourth lesson is that there are indeed real places like Denmark that show wind power can be made to work. Costa Rica shows us that a small country can run almost entirely on rivers, volcanoes, and wind. Germany gives us a sense of how an industrial economy can grow and change, but the road is messy and takes time. These are not perfect case studies and they shouldn't be pushed too far. The fifth lesson, on people, makes the case that technology alone does not solve problems. We need good laws, carbon pricing, worker support and community ownership. When people have access to clean energy and a say in the process, they will support it. Trust, fairness, and hope are the human heart of this transition. The sixth lesson is time: the climate crisis is now. Emissions must fall fast. But urgency does not mean panic. It means focused action. It is in our hands. What we need is the will to use them.

The final lesson is that we all have to play a part. The green economy is not just for government and business. Every solar panel that goes up, every electric vehicle that gets driven, every home that gets insulated, every vote that gets cast to put in place climate action and environmental protections is part of this story. This one is no different. So here is the truth in a nutshell: renewable energy is currently cheaper than its fossil-fuel alternatives. Green economics is working in real countries with real people. These problems are indeed challenging. But they are all solvable. And we are not starting from zero. We are already on the way. The only question that remains is whether we will walk faster, together, with courage and hope. The future is not something that happens to us. It is something we build. Let us build one powered by clean energy, fair economics, and human dignity.

References

1. Agora Energiewende. (2023). The German Energy Transition: Status Quo and Perspectives. Berlin: Agora Energiewende.
2. Arias-González, J. E., & Rodríguez-Montero, M. (2021). Geothermal development in Costa Rica: History, status, and future prospects. Geothermics, 92, 102045.
3. Arvesen, A., & Hertwich, E. G. (2012). Assessing the life cycle environmental impacts of wind power: A review of present knowledge and research needs. Renewable and Sustainable Energy Reviews, 16(8), 5994-6006.
4. Bloomberg New Energy Finance (BNEF). (2024). Global Energy Transition Investment Trends 2024. New York: Bloomberg.
5. Carley, S., & Konisky, D. M. (2020). The justice and equity implications of the clean energy transition. Nature Energy, 5(8), 569-577.
6. Chang, M., & Berndt, E. R. (2019). The political economy of renewable energy in Costa Rica. Energy for Sustainable Development, 52, 68-77.

7. Creswell, J. W., & Creswell, J. D. (2018). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (5th ed.). Sage Publications.
8. Danish Energy Agency. (2022). Energy Island in the North Sea: Feasibility Study. Copenhagen: Danish Energy Agency.
9. Danish Energy Agency. (2023). Denmark's Climate and Energy Outlook 2030. Copenhagen: Danish Energy Agency.
10. Danish Energy Agency. (2024). Energy Statistics 2023. Copenhagen: Danish Energy Agency.
11. Danish Wind Turbine Owners' Association. (2023). Annual Report 2023. Copenhagen: DWTOA.
12. Devine-Wright, P. (2011). Renewable Energy and the Public: From NIMBY to Participation. Earthscan.
13. Energy Policy. (2022). Public acceptance of wind energy in Denmark: A longitudinal survey study. Energy Policy, 168, 113-124.
14. European Commission. (2023). The European Green Deal: Two Years Later. Brussels: European Commission.
15. European Network of Transmission System Operators for Electricity (ENTSO-E). (2024). Reliability and Adequacy Report 2024. Brussels: ENTSO-E.
16. Eurostat. (2024). Electricity Price Statistics. Luxembourg: European Union.
17. Fernández, L., & Gutiérrez, J. (2022). Community acceptance of wind energy in Costa Rica: A survey-based study. Energy Research & Social Science, 85, 102408.
18. Fraunhofer Institute for Solar Energy Systems ISE. (2024). Recent Facts about Photovoltaics in Germany. Freiburg: Fraunhofer ISE.