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Economic role of electricity transmission by
alternative energy in the world

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Abstract

Each phase of monetary advancement has been joined by a trademark vitality progress starting with one noteworthy fuel source then onto the next. Today, petroleum products—coal; oil and flammable gas—are by a wide margin the prevailing vitality source in mechanical economies, and the fundamental wellspring of vitality creation development in creating economies. Yet, the twenty-first century is as of now observing the beginning of the following incredible change in vitality sources—far from petroleum products towards sustainable power sources. This progress is spurred by numerous variables, including worries about ecological effects (especially environmental change), restrains on petroleum derivative supplies, costs, and innovative change.

Vitality is an essential factor for the monetary development and advancement of a nation. Vitality utilization is quickly expanding around the world. To satisfy this vitality request, elective vitality sources and effective usage are being investigated. Different wellsprings of sustainable power source and their proficient usage are extensively audited and displayed in this paper. Likewise, the pattern in innovative work for the mechanical progression of vitality use and brilliant framework for future vitality security is introduced. Results demonstrate that sustainable power source assets are winding up progressively pervasive as greater power age ends up important and could give half of the all out vitality requests by 2050. To fulfill the future vitality request, need to build power transmission by elective vitality on the planet. Since, power transmission by elective vitality has the significant monetary job for the world.

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Introduction

At present, sustainable power sources assume the instrumental job in incitement worldwide world economy. For the motivations behind setting up a lawful routine overseeing and empowering private-area interest in sustainable assets and advances, the strategy strategist will utilize three applied methodologies. Just as the previous specialized definition, both political definitions and legitimate definitions, factor into a strategy meaning of what assets merit discrete treatment as "sustainable assets".

From the political point of view, sustainable power source assets can be separated into various classes relying on the political objectives or destinations under thought. For instance, in a given nation, inexhaustible assets might be recognized by arranging those, which are entrenched versus those, which are immature; those which have prompt improvement potential versus those which don't; and those with potential rustic versus those with urban client bases. The political point of view of the arrangement producer in one nation might be to legitimize distinctive treatment for built up assets, for example, huge hydroelectric from early assets, for example, geothermal. In another nation, the invert might be valid. In like manner, the majority of the sustainable assets might be dealt with diversely for urban application than for provincial application.

From the lawful point of view, existing laws, for example, land use, water, mining, and hydrocarbon laws should be examined to decide their potential ward over and relevance to inexhaustible assets. It is critical to characterize what advances are to be considered "sustainable" for the motivations behind any bit of enactment. Such enactment can characterize "inexhaustible assets" as suitable, given the condition of advancement of the common assets in that nation. In the event that a court, official or official deciphers a law carefully, the expression "sustainable assets" as utilized in a bit of enactment implies what that particular bit of enactment says it implies, yet just for the motivations behind that particular

enactment. In this way, if a law characterizes coal as "sustainable", however discards wind, this legitimate definition will win without reference to the specialized qualities of either fuel. In most lawful routines, be that as it may, the expression "sustainable power source" is utilized to recognize normally replenishable powers from those powers of which the earth is invested with fixed stocks. The fundamental instances of stock-constrained assets are the non-renewable energy sources (essentially coal, oil, petroleum gas, tar sands and oil shales) and the atomic fills (basically uranium, thorium, deuterium and lithium).

The use of alternative energy sources can save us money, assure that in next generations will have enough energy, and free us from the uncertainties of depending on foreign energy suppliers.

The purpose of the diploma work is to explain the importance of economic role of electricity transmission by alternative energy in the world. Then analyze comparably long-term energy scenarios.

The subject of research is the Economic role of electricity transmission by alternative energy in the world.

The objects of research are emerged global energy drivers and flourishing developing states.

Problem statement - this writing assignment analyzes several types of implementation –economic role of electricity transmission by alternative energy, positive and negative factors, and the ways of revenue energy for future generations.

The research questions are the followings:

The role and influence of the alternative energy in the world.

The ways of using of electricity transmission by alternative energy and its further implementation

The ways of increasing of energy security and innovations

The drivers of renewable energy policy

Influence of RE policy on economy of the World.

Future vision and forecasts on global renewable energy fields.

Research methodology

The nature of the study will be mixed, employing exploratory and inductive research types. Due to exploratory research, the qualitative methodology will be used in order to gain insights in energy channels. The study will use one of the common qualitative methodology designs. Following structure is proposed for methodology; in the first phase, various scholar articles will be used to find the structure and the patterns in implementation and use of Nordpool practice.

In the second phase, approach will be used to collect data through interviews, documents and observations of the chosen countries. The research will focus on information and experience of leading NordPool practice user countries, especially developing countries. Moreover, the ways of energy security and development of alternative energy policy in European Countries. In the predictive part of the research, the forecast of the future impact on management and business culture of these countries will be provided by generalizing from the analysis of case studies and the predictions.

Chapter 2. Theoretical analysis

2.1 Theoretical and methodological basis of global electricity transmission

2.1.1. Development milestones of global alternative energy sector

The advancement of sustainable power source over the previous decade has outperformed all desires. Worldwide introduced limit and generation from every single inexhaustible innovation have expanded generously; costs for most advancements have diminished fundamentally; and supporting approaches have kept on spreading all through the world.

The most recent decade saw an enduring increment in the worldwide interest for sustainable power source. While in general essential vitality supply from renewables in 2004 was 57.7 EJ every year, by 2013 the all out supply had developed to 76 EJ yearly—a general increment of 30%. By 2013, renewables provided roughly 19% of the world's last vitality utilization, somewhat less than half of which originated from conventional biomass. Warmth vitality from current inexhaustible sources developed from an expected under 1% in 2004 to 10% of all out definite vitality use in 2014; hydropower developed slower than the general increment in power request, with the outcome that its offer dropped marginally to 3.8% in 2014. All other new renewables utilized for power age made progress and expanded their essential vitality share from 0.5 to 3.5% over the previous decade. In 2013, fluid biofuels met around 2.3% of complete transport fuel request. Besides, the most recent decade saw an expansion in activities to connect electric transport frameworks with sustainable power source, especially at the city and local dimensions .

Out of the three end-use divisions—power, rationale, and warming and cooling—renewables' offer became quickest in the power part. Absolute inexhaustible power limit—barring substantial hydro—saw a sevenfold increment amid the previous decade; from 85 GW in 2004 to 560 GW before the finish of 2013. Wind control saw a comparative increment moving from a complete introduced limit

of 48 GW in 2004 to 318 GW in 2014. Sunlight based photovoltaic (PV) control age developed by a factor of 70, from 2.6 GW to 139GW.

The all out worldwide working limit of sunlight based PV crossed the 100 GW achievement in 2012, achieving a complete limit of 139 GW before the finish of 2013. Since 2004, the yearly market has detonated developing from around 1 GW to 39 GW in 2013. Through the span of 2010 more sun oriented PV was introduced than the previous 20 years consolidated. While the significant development over the previous decade has been in Europe—generally 70% of all PV establishments worldwide are in Europe—China's market is developing quickly. China's yearly introduced PV limit developed from 0.3 GW in 2009 to 3.3 GW in 2011 and achieved 13 GW by 2013. The aftereffect of this terrific development in 2013 implies that China presently represents about 33% of worldwide limit included. China is trailed by Japan (6.9 GW) and the United States (4.8GW). Germany represents 3.3 GW of sun oriented PV with the UK and Italy both contributing 1.5 GW. In Italy, sun powered PV met 7.8% of all out yearly power request. In spite of these noteworthy numbers, the development to date in the sun based PV division reflects just a little piece of the colossal market potential; a few nations from high sun oriented radiation districts, for example, Africa, the Middle East, Southeast Asia and Latin America, which are all on the precarious edge of scaling up their sun powered arrangement. Driven by falling costs, sun oriented PV is extending to new markets, covering Africa and the MENA locale to Asia and Latin America. Enthusiasm for network possessed and self-age frameworks has kept on becoming relentlessly over the previous decade while the number and size of huge sunlight based PV ventures have likewise expanded. On the other hand cell and module makers battled as extraordinary challenge and diminishes in costs and income edges drove industry combination, bringing about a few Chinese, European and U.S. producers leaving business.

As far back as the association of the principal business CSP plant to the framework in 1989 in Arizona/United States, the advancement of this renewables

showcase has confronted difficulties. It was the appropriation of Spain's sustainable power source law in 2008, which at last conveyed development to the business following a time of stagnation and no new CSP plant lattice associations. The yearly market in 2010 achieved 0.5 GW, with extension to just shy of 1 GW in 2013. The all out worldwide CSP limit expanded amid the most recent decade by a factor of 14 to 3.4 GW with most of this limit included Spain, home to 65% the world's CSP limit. Falling PV and gaseous petrol costs, the worldwide monetary downturn, and approach changes in Spain all made vulnerability for CSP producers and engineers, coming about an abating in the Spanish market. At the same time expanding enthusiasm for CSP in different pieces of the world has prompted 5 GW tasks which are at present under development, with extension in Australia, Chile, China, India, the MENA locale, and South Africa, The industry is additionally situating itself in new parts, for example, water desalination, modern warmth supply and dispatchable, sun oriented power stockpiling frameworks .

Before the finish of 2013 total worldwide breeze limit was 318 GW, an expansion of 270 GW since 2004. Notwithstanding, in 2013, after over 20 years of unfaltering development, the yearly wind showcase dropped out of the blue; down 10 GW to 35.5 GW. This decay was expected principally to the lofty drop in US establishments, from 13 GW in 2012, to a little more than 1 GW in 2013. The disappointment of the US Congress to re-approve the US Production Tax Credit, which terminated end2012, viably slaughtered the 2013 market. The United States—that was the biggest worldwide market from 2006 to 2008 and in 2012—tumbled to 6th spot behind Canada. Anyway all things considered, it will rise again in 2014; this opportunity to second place behind China. Somewhere else wind control is extending. While the underlying foundations of the cutting edge wind control industry are in Denmark, Germany and the United States, 2004 saw the breeze advertise spread. From 2004 to 2010, China multiplied its breeze establishments every year from 0.5 GW to 19 GW. It drove in yearly, yearly establishments (aside from in 2012) and held the top spot in 2011 regarding total establishments. In spite

of the fact that the Chinese market plunged to simply underneath 13 GW in 2012, it developed to 16 GW in 2013 and is back on an upward direction. Notwithstanding Europe, China, and the United States, Canada, Brazil and India have turned out to be significant markets with Mexico and South Africa developing quickly. Falling costs because of high challenge and innovation upgrades make wind control a financially practical power age innovation contending legitimately with intensely sponsored non-renewable energy sources in an expanding number of business sectors. Starting at 2014, more than 240,000 breeze turbines are working in excess of 90 nations.

An expected 285 GW of new hydropower limit went ahead line among 2004 and the finish of 2013, expanding worldwide introduced limit from 715 GW to an expected 1000 GW. Hydropower age expanded from 2,900 TWh to an expected 3,700 TWh of power amid 2012. Worldwide power request expanded in like manner, keeping a lot of the worldwide power supply at 16%. China drove as far as limit augmentations, with most of different establishments showing up in Turkey, Brazil, Vietnam, and Russia. Joint-adventure plans of action including nearby and universal organizations are ending up progressively unmistakable as the measure of ventures and the limit of hydropower advances increment. There is additionally expanding acknowledgment of the potential for hydropower to supplement other sustainable advances, for example, factor wind and sun based power .

Sea vitality is still at a beginning time of advancement and can be contrasted with the condition of the breeze business in the mid 1980. Sea vitality remains a special case in the sustainable power age portfolio. There are at present various structures accessible with a correspondingly low institutionalization rate; two clear markers of how youthful the part is. Business sea vitality limit was approximately 527 MW before the finish of 2013. The tidal power office in the north of France speaks to by a wide margin the biggest piece of introduced limit; little scale ventures have been sent in the United States and Portugal. Governments and provincial specialists kept on supporting sea vitality innovative work, while real power

enterprises expanded their quality in the segment, which is seeing estimated yet unfaltering improvement.

Geothermal assets gave an expected 805 PJ (223 TWh) of sustainable power source in 2013, conveying 66% as immediate warmth and the rest of power and speaking to an expansion of a factor of five contrasted with 2004. While the development of geothermal power age is just in six nations—United States, Philippines, Indonesia, Mexico, Italy and New Zealand—the utilization of ground-source heat siphons is developing quickly in various nations and came to an expected 91 GWth of limit in 2013. Notwithstanding 66% of worldwide limit being situated in the United States, China, Sweden, Germany, and Japan no less than 78 nations as of now tap geothermal assets for direct warmth. Geothermal electric producing limit developed by an expected 456 MW amid 2013, conveying the worldwide aggregate to 12 GW and creating something like 76 TWh .

Utilization of biomass in the warmth, power, and transport areas expanded 20% in the course of recent years to an expected 55.6 EJ. Warming represented most by far of biomass use, including conventional biomass. Somewhere in the range of 2004 and 2014 present day biomass heat limit ascended around 73 GWth to an expected 296 GWth. The most recent decade likewise observed worldwide bio-control limit develop from 39 GW in 2004 to roughly 88 GW, with remarkable increments in some BRICS nations. Through the span of 2013 an expected 405 TWh of power were produced from biomass. Current interest for present day biomass is driving expanded worldwide exchange, especially for biofuels and wood pellets. Worldwide creation and transport of wood pellets surpassed 23.6 million tons in 2013 contrasted with around 4.5 in 2004.

2.1.2. Economic role and concept of Global electricity transmission

Power is created at power plants and travels through an unpredictable framework, in some cases called the matrix, of power substations, transformers, and electrical cables that associate power makers and purchasers. Most

neighborhood lattices are interconnected for dependability and business purposes, shaping bigger, progressively trustworthy systems that upgrade the coordination and arranging of power supply.

The starting point of the power that shoppers buy changes. Some electric utilities create all the power they sell utilizing only the power plants they possess. Different utilities buy power straightforwardly from different utilities, control advertisers, and autonomous power makers or from a discount showcase sorted out by a provincial transmission dependability association.

The retail structure of the power business shifts from area to district. The organization offering you power might be a not-for-benefit civil electric utility; an electric helpful possessed by its individuals; a private, revenue driven electric utility claimed by investors (regularly called a financial specialist possessed utility); or in certain states, you may buy power through a power advertiser. A couple of governmentally possessed power specialists—including the Bonneville Power Administration and the Tennessee Valley Authority, among others—additionally produce, purchase, sell, and disperse control. Neighborhood electric utilities work the circulation framework that associates purchasers with the network paying little mind to the wellspring of the power.

The power that control plants produce is conveyed to clients over transmission and dispersion electrical cables. High-voltage transmission lines, for example, those that hang between tall metal towers, convey power over long separations to where purchasers need it. Higher voltage power is increasingly effective and more affordable for long-separate power transmission. Lower voltage power is more secure for use in homes and organizations. Transformers at substations increment (venture up) or lessen (venture down) voltages to conform to the various phases of the adventure from the power plant on long-remove transmission lines to conveyance lines that convey power to homes and organizations .

The worldwide power area is confronting three noteworthy difficulties: the security of supply to stay aware of regularly mounting interest, the battle against environmental change, and the worldwide pattern toward monstrous urbanization. Power will assume a key job through low-transmitting vitality age advancements that decrease ozone depleting substance discharges. These advancements as of now exist. Achievement will rely upon how open strategies are utilized to support advancement.

Necessities and constraints and more ability with respect to policymakers to support advancement programs. The primary test will be to contribute enough to stay aware of the developing interest for worldwide vitality while monitoring last vitality costs.

The International Energy Agency appraises that \$33 trillion more than 25 years. 66% of these ventures should be in rising and creating economies to fulfill the anticipated 2% yearly development in essential vitality needs while the staying third will be required to supplant obsolete framework in OECD nations.

The second test relates explicitly to the guideline of ozone depleting substance (GHG) outflows. To have a half possibility of constraining the worldwide temperature increment to 2°C in connection to turn-of-the-century levels, worldwide outflows should be diminished half among now and 2050, though under a the same old thing situation, emanations would practically twofold by that year. The vitality segment is on the bleeding edge, as 66% of worldwide GHG emanations are carbon discharges connected to that area .

The third real test is enormous urbanization, especially in rising and creating nations, where the pattern is especially obvious since urban areas, notwithstanding when they create in a moderately disarranged manner; offer a superior shot of getting away neediness than provincial zones. Urban development rates have achieved phenomenal dimensions: it took 130 years for the number of inhabitants in London to ascend from 1 million to 8 million, however Bangkok saw a similar

increment in 45 years, Dhaka in 37 years and Seoul in 25 years. By 2030, the urban populace will probably have multiplied from 2 billion to 4 billion around the world. Urban communities represent 66% of worldwide vitality utilization today and this will presumably ascend to seventy five percent in 20 years. They are additionally in charge of 70% of worldwide vitality related CO₂ outflows and a vast dominant part of nearby air contamination. This has made vitality advancement a vital component to overseeing both social and ecological externalities of present day urban communities. To be productive, this advancement should go connected at the hip with foundational and long haul arranging of "maintainable urban areas". To address these three difficulties all the while, power should assume a definitive job inside the vitality framework.

Power at present records for 40% of carbon discharges created by the vitality part, or 25% of worldwide ozone harming substance outflows. An immediate connection can be followed between this flow situation and the age blend used to stay aware of regularly expanding interest for power: 66% petroleum products (41% coal, 26% gas and oil) and 33% sans carbon sources (14% atomic, 16% hydroelectric, and 3% different renewables). Coal age discharges around one ton of CO₂ for every MWh contrasted and 450 kg for joined cycle gas turbine innovation. The test may seem overwhelming however is in no way, shape or form unfavorable. For the following two decades, we as of now have low-and no-carbon age innovations that are focused .

On the interest side, advancements exist for a wide scope of end-utilizes: warm protection in structures, proficient lighting, increasingly productive electric engines, heat siphons, sun powered fueled water radiators, and so on. Vitality effectiveness will influence a key commitment in assisting the power area with reducing discharges. On paper, the expense related with related measures could be moderately low, however there is a need to screen exchange costs, which are commonly covered up and can reflect lopsided data, standards of conduct, family

unit spending imperatives, or the interests of the concerned gatherings (for example surely understood issues that emerge among inhabitants and proprietors).

On the supply side too, there are advances that can convey lower-carbon power at a reasonable cost (\$60-90 for every MWh in OECD nations). Models incorporate supercritical coal-terminated plants (efficiencies of up to 45%) and joined cycle gas turbines. Above all, without carbon advances like hydroelectric, atomic and wind control are accessible.

Hydropower limit could be expanded three-to fourfold from the present dimension, for the most part in creating nations, at an aggressive expense. Since hydropower is capital-concentrated, financing must be encouraged at all created economies. It will likewise be pivotal to screen the effect of dams on biodiversity, populace resettlement, and incorporated water asset the board.

Atomic power is additionally aggressive. Without prejudging the full consequences of examinations of the ongoing Fukushima mishap, it appears to be certain that undertakings will be exposed to increasingly prohibitive and particular measures, with more accentuation put on recognition of the most noteworthy security principles: this will mean plants which further decrease hazard notwithstanding outrageous occasions, and national wellbeing experts and worldwide administration bodies (IAEA, WANO, WENRA) that have more power as far as controls, allowing and the sharing and usage of best practices. These are key components for the innovation to be acknowledged .

As respects wind control, land-based turbines are quickly nearing development (10-30% more costly than officially focused age advances). In areas with plenteous breeze (over 3,000 hours, for example Texas), inland wind can be aggressive as of now, if circuitous expenses coming about because of the irregular idea of the asset are all around overseen. These roundabout expenses can be separated into three classes: costs related with system extension to permit transmission and advancement in a bigger number of regions, cost of interests in extra offices to

ensure that request can generally be met, and costs related with dynamic system the executives to keep up the supply-request balance for the time being.

These innovations can have any kind of effect. The power frameworks of Sweden and France, where over 90% of power originates from atomic and hydro plants, discharge under seven tons of CO₂ for every capita, contrasted and more than 11 tons in Denmark and Germany, where coal makes up near half of the blend (Eurostat figures, 2008).

2.1.3 Global challenges and opportunities of RES electro-energy power market

The transition to an energy system that is largely based on renewable energy sources (RES) is one of the greatest challenges of our time. This transition, as it is currently unfolding, is leading to a number of sometimes paradoxical situations in the energy sector. To begin with, advances in RES technologies in recent years have led to sharp cost-reductions and, in concert with government support schemes, a marked growth of the installed RES capacities worldwide. At the same time, however, troublesome signatures of typical RES characteristics such as negative wholesale prices are now becoming more visible in the operation of power systems¹.

The main RES integration challenges relate to the fundamental characteristics that the most widespread RES technologies – wind and solar – possess: variability and uncertainty. These RES characteristics, often summarized in the notion of *intermittency*, cause friction – technical, operational, financial - when integrating them in the energy system. A widely accepted approach for effectively dealing with these aspects is based on the notion of *flexibility*. In flexibility is defined to ‘*express the extent to which a power system can modify electricity production or consumption in response to variability, expected or otherwise*’. The energy system is clearly more than a collection of interlinked technologies: it also comprises market

¹ IRENA (2016c), “Renewable Energy Innovation Policy: Success Criteria and Strategies”, www.irena.org/DocumentDownloads/Publications/Renewable_Energy_Innovation_Policy.pdf.

actors and network companies as well as the rules and regulations that govern them, the *institutions* of energy systems. Markets on which energy is traded, are bounded on one side by legislation and (financial) interests and on the other side by the technological system, while the markets in turn shape decisions on strategy, development and (dis)investment.

The energy system can be viewed as a system where technology and institutions are inexorably intertwined, as a socio-technical system that consists of several interconnected sub-systems. While RES integration issues have received a large amount of attention in the scientific literature lately, the focus has mostly been on the technical challenges. This paper, therefore, has two goals. The first is to review the challenges related to RES integration by extending a purely technical viewpoint to the institutional challenges that come in parallel with the technical changes. The second goal of this paper is to show how the energy transition is creating even stronger interdependencies between the technological and institutional sub-systems that require a more integrated approach to research and policy making.

Flexible generation capacity has traditionally been used to cope with changes in demand, foreseen and unforeseen, and outages of generating units. With the continuing growth of renewable energy sources, the system needs to cope with even larger variations to ensure the load-generation balance for an analysis of European flexibility demand). Two aspects of renewable energy play a key role: variability and uncertainty².

While the technical energy system as we know it today has been shaped in the last 50 years, the social subsystem we see today is the result of the process of unbundling and liberalization that (only) started in the 1990s. A central role in liberalized power systems is played by the spot-market, also referred to as wholesale market or day-ahead market: a market place where electricity can freely be traded between producers and consumers that are usually represented by retailers. A

² IRENA (2016c), “Renewable Energy Innovation Policy: Success Criteria and Strategies”, www.irena.org/DocumentDownloads/Publications/Renewable_Energy_Innovation_Policy.pdf.

number of additional markets and mechanisms are needed to deal with the characteristics that make electrical energy a peculiar commodity: intra-day markets and balancing markets make sure that uncertain demand and supply are matched in real-time. Capacity based reserve markets; ancillary services (frequency and voltage control) and transmission congestion management further enhance the reliability of the power system. The central tenet of this system, though, is that the conventional, controllable, fossil fuel based generation capacity is providing the majority of this energy. Marginal generators set the electricity price; all generators that are dispatched under this price collect revenues they need for capital cost recovery. Together, the generators provide the additional system functions required for system stability and security. This picture is rapidly changing however, with the continuing growth of renewable energy sources³.

Over the world economy, GDP increments from 2018 to 2050 in both the reference and change situations. In any case, the vitality change invigorates financial action extra to the development that could be normal under a nothing new methodology. The aggregate addition through expanded GDP from 2018 until 2050 will add up to USD 52 trillion. The increase over the Reference Case is most noteworthy in 2031, topping at 1.5% of GDP, and after that continuously limits to 1.0% in 2050. The reference situation has a compound yearly development rate somewhere in the range of 2018 and 2050 of 3.0%. The per capita world normal GDP for the change situation increments from 10,800 USD (in steady 2015 dollars) in 2018 to 22,400 USD in 2050. The principal positive effect on GDP is because of a net speculation boost in renewables, vitality productivity, matrices and vitality adaptability. Initially, changes in duty rates, fundamentally connected with carbon charges and the eliminate of non-renewable energy sources, help GDP development in the medium term. Second, after a dynamic time-slack, circuitous and instigated impacts dominate and positively affect GDP in the second 50% of the vitality progress (to 2050 and past). Not surprisingly worldwide exchange minorly affects

³ IRENA (2015b), “Renewable Energy Auctions in Developing Countries”, www.irena.org/DocumentDownloads/Publications/IRENA_Renewable_energy_auctions_in_developing_countries.pdf.

the worldwide GDP increment all through the entire change, given the inborn necessity of worldwide exchange being adjusted in ostensible terms.

The extra expenses of the complete, long haul vitality change would add up to USD (United States Dollars) 1.7 trillion yearly in 2050. Be that as it may, cost-investment funds from decreased air contamination, better wellbeing and lower ecological harm would far exceed these expenses. The RE map Case proposes that investment funds in these three regions alone would average USD 6 trillion every year by 2050. What's more, the vitality progress would fundamentally improve the vitality framework's worldwide financial impression contrasted and nothing new, improving worldwide welfare, GDP (Gross Domestic Product) and work. Over the world economy, GDP increments by 2050 in both the reference and progress situations. The vitality progress invigorates monetary movement extra to the development that could be normal under a the same old thing approach. The total addition through expanded GDP from 2018 until 2050 would add up to USD 52 trillion. Substantial extra interest in low-carbon advancements will be required contrasted with present and arranged strategies. Combined interest in the vitality framework somewhere in the range of 2015 and 2050 should increment around 30%, from USD 93 trillion as per present and arranged strategies, to USD 120 trillion to empower the vitality progress. Interest in sustainable power source and vitality effectiveness would retain the main part of all out vitality speculations. Likewise incorporated into this complete is USD 18 trillion that would should be put resources into power frameworks and vitality adaptability – a multiplying over present and arranged approaches. Altogether, all through the period, the worldwide economy would need to contribute around 2% of the normal worldwide GDP every year in decarbonisation arrangements, including sustainable power source, vitality productivity, and other empowering advancements. Monetary limitations and idleness can repress the speculation required to convey the vitality progress. Expanding access to back and bringing down acquiring expenses would increment both GDP and business further, while additionally empowering the change pathway

itemized in this report. Strategy measures and basic financial alterations increment the accessibility of money without trading off local monetary strength. Wellsprings of fund that at present contribute little to reasonable vitality venture ought to be opened. Potential sources incorporate institutional speculators (annuity reserves, insurance agencies, blessings, sovereign riches assets) and network based fund. Rare open accounts ought to be utilized to moderate key dangers and lower the expense of capital in nations and areas where sustainable power source speculations are seen to be high hazard. Quick activity is required to expel this conceivably critical progress hindrance and guarantee that the presentation of spotless and current vitality sources isn't additionally postponed.

Depending on which analysis one reads, the global market for energy storage is poised to grow rapidly, but few can agree on how much. According to one widely publicized projection, the storage market could reach more than \$26 billion in annual sales by 2022, a compound annual growth rate (CAGR) of 46.5 percent.¹ Another analysis envisages growth at a more modest, but still robust, pace, expanding at a compound annual growth rate of 16 percent and reaching \$7 billion annually by 2025.² Others put it somewhere in the middle, while a few take a slightly more optimistic or pessimistic view. The divergence of opinions largely originates with how one defines energy storage. Some analyses calculate only “front-of-the-meter” utility-scale technologies, while others include “behind-the-meter” solutions implemented by commercial and industrial (C&I) customers⁴. In addition, others include electric vehicle batteries and smaller scale battery-plus-solar combinations implemented by residential consumers, which could have not only behind-the-meter applications but also front-of-the meter uses if aggregators or utilities control them. Complicating the picture even more are the many applications for energy storage, which can be useful in integrating renewables, supporting smart grids, creating more dynamic electricity markets, providing ancillary services, and bolstering both system resiliency and energy self-sufficiency. Despite the complexity of the landscape,

⁴ IRENA (2015a), “Renewable Energy and Jobs”, www.irena.org/rejobs.pdf.

many growth projections agree that energy storage is gaining traction around the world and could fundamentally change market dynamics. To understand these shifting dynamics, we peered beneath the aggregate growth projections to examine how some of the more active nations in renewable development and grid modernization are now approaching energy storage. These countries include Australia, Chile, Germany, Japan, India, Italy, South Korea, the UK, and the US. Particularly focusing on battery storage, which is presently the leading technology, our examination sought to uncover what has been driving the push for energy storage in these nations and what utilities and policymakers have been doing to define battery storage, develop storage markets and to support ongoing deployment.

Only a few years ago, the concept of aggregating batteries to provide grid services or to facilitate peerto-peer electricity trading seemed like science fiction. Leaps in adjacent digital technologies, such as artificial intelligence, predictive analytics and block chain, are multiplying the uses and benefits of battery deployment. These mutually reinforcing mechanisms—not just improvements in battery performance and cost—are why the sector is so dynamic. Also, though “storage” and “renewables” are often used in the same sentence, energy storage isn’t just about integrating intermittent wind and solar output: battery solutions, which can be deployed rapidly and with pinpoint precision, can be used to make the overall grid more efficient and resilient, regardless of the generation sources. This makes the storage story all the more compelling. For these reasons, battery storage is becoming supercharged around the world. In addition, battery prices are falling and storage markets are developing much faster than anticipated (see Figure 4). Storage solutions are already a focal point of national energy policy in nations that are establishing their energy systems, while they are being used to add flexibility and stability to the grid in countries with more mature energy sectors⁵.

⁵ Intergovernmental Panel on Climate Change (IPCC). 2016. IPCC Special Report on Alternative Energy Sources and Climate Change Mitigation.

2.2 Renewable energy policy

2.2.1 Institutional composition of energy security and innovations

It is obvious that energy security is one of the key factors ensuring the stable functioning and development of any state. Therefore, one of the most important policies of European states is the EU's energy security. Since the EU countries are for the most part among energy importers, the political context of relations with energy suppliers and transit countries becomes a pivotal factor in ensuring energy sustainability.

The use of systemic and structural-functional analysis made it possible not only to draw conclusions regarding the current state of the EU energy security problem, but also to apply prognostic methods in assessing internal and external factors affecting energy security, identify security mechanisms, identify problems and ways to overcome them.

In the last decade, energy security issues have become most significant and relevant for the EU. In the modern world, there are trends of depletion of exhaustible natural resources, especially those that are needed, such as hydrocarbons. In turn, these changes lead to higher energy prices, high demand and higher energy prices; the issue of maintaining the energy balance becomes very significant. For the next two decades, the International Energy Agency predicts not a fall, but a further increase in oil prices, which will be accompanied by a decline in reserve capacity. The problems of energy supply are particularly relevant for EU countries, as there are several reasons for this:

In terms of energy consumption, the EU needs ranks third after the United States and China. A significant source of energy is the North Sea, whose resources, according to experts, at the current rate of energy production will be enough for the

next eight years, which will lead to an even greater dependence of the EU on foreign energy supplies compared to the US⁶.

Because of active integration processes, EU expansion, an increase in energy demand is also observed, since the majority of Eastern European countries in the past were part of the USSR energy supply system, which also creates new difficulties in creating a single European energy supply system. If we compare the indicators of energy consumption in the 70s and in the 2000s, the difference increased by 40%.

Relations in the EU-Russia energy dialogue are still tense enough. Russia at the present stage is trying to secure the role of an influential actor, actively using energy levers in the sphere of political and economic issues. Russia did not accept the conditions of one of the defining documents in the European energy policy - the EU Energy Charter, also repeatedly entered into energy disputes with Ukraine and Belarus.

Thus, the increase in energy prices and the steady escalation of global energy demand, which is expected to grow by about 60% over the next 20 years, led to a major debate about how to cope with energy needs in the future. In turn, for the EU, with its 27 member states, energy security is also became a priority part of the policy. About 50% of EU imports come from its energy needs. In the process of ongoing changes, experts of the European Commission predict an increase in figures to 65% by 2030.

In terms of quantitative indicators, in the 27 EU member states, states account for about 17% of the total energy consumption in the world. Europe imports about 50% of total energy supplies - just over 80% of oil and about 57% of natural gas. Its dependence on imported energy sources, especially natural gas, is expected to increase significantly in the coming decades. Russia, Norway, the Middle East and North Africa are the largest energy suppliers in the EU⁷.

⁶ Intergovernmental Panel on Climate Change (IPCC). 2016. IPCC Special Report on Alternative Energy Sources and Climate Change Mitigation.

⁷ FS-UNEP Collaborating Centre, Global trends in renewable energy investment, 2016

Europe covered through imports from Russia 40% of its gas needs (as of 2008) and 32% of the demand for oil. Recent calculations by Deutsche Bank analysts indicate that in 2030 the European Union will import up to 93% of oil and 84% of natural gas.

Experts predict that natural gas consumption in the EU will double in the next 25 years, natural gas, in turn, is a necessary element of energy production in the European market. EU natural gas consumption currently accounts for 18% of global consumption. European gas imports are expected to be at just over 80% of total consumption in 2030.

For the first time, Europe's concern about its energy security was provoked during the Arab oil embargo in the 1970s. It was the embargo that contributed to the identification of three main issues. First, there was the question of the need to expand cooperation in the field of energy policy between the European countries themselves and between Europe and the world's energy producers. Secondly, it became clear that institutional mechanisms for strengthening coordination in the event of future supply disruptions were necessary. Thirdly, the consensus was manifested in the fact that Europe should develop a strategy that would not allow it to become a victim of attempts by exporters to use energy as a political and economic weapon in the future.

The creation in 1974 of the International Energy Agency, which became Europe's instrument for monitoring and analyzing energy markets, was the first response to the embargo. In addition, European countries are seeking to develop strategies to diversify energy supplies. After the embargo, European countries began to consider Russia and other Eurasian countries as potential energy suppliers.

In 1991, the EU developed the Energy Charter Declaration as an initiative to encourage cooperation in the field of energy and the diversification of Europe's energy supply. The declaration was followed by the Energy Charter Treaty in 1994, which entered into force in 1998, establishing a system of rules and agreements to promote international energy cooperation. To date, 51 countries and the EU have

signed or acceded to the Treaty. The Treaty aims to create equal rules regarding the promotion of foreign investment in the energy sector, free trade in energy materials, products and equipment; freedom of energy transit through pipelines and networks; increasing energy efficiency in providing dispute resolution mechanisms⁸.

Since the signing of the Energy Charter Treaty, the European Commission has used existing competition and environmental and consumer protection policies to try to shape European energy policies in various ways. These include promoting the domestic energy market, developing alternative sources of energy, and in collaboration with the High Representative Office of the CFSP, in seeking a collective approach to external relations with current and future energy suppliers. In the 2006 Green Paper, the energy relations of the EU were identified as fundamental to the EU's energy security and stability.

Another important goal was to expand the EU's internal energy market to neighboring countries, which resulted in the preparation and signing of multi-level forms of cooperation: partnership and cooperation agreements, memorandums of understanding, association agreements, mechanisms within the European Neighborhood Policy, etc. The EU was considered as a “key actor in the development of international agreements”, which included the expansion of the EU regulatory framework outside the EU. Under the influence of modern challenges, the latest political decisions of EU members focus on increasing energy efficiency, developing renewable sources and using environmentally friendly sources of fuel, as well as reducing the total greenhouse gas emissions. All these trends have contributed to the adoption of a number of important changes in the EU, namely the development of a new energy strategy, which is reflected in a number of regulatory and legislative documents.

Modern technologies in various industries and areas are constantly evolving through the introduction of creative innovations. The energy field is no exception -

⁸ FS-UNEP Collaborating Centre, Global trends in renewable energy investment, 2016

energy innovations stimulate the development of business, automotive, oil and gas and other industries, and significantly improve the quality of life of the population. Innovations, or innovations, represent the testing and use of technological or other new products aimed at the qualitative development of life processes, industry, etc⁹. Innovations in the energy plan are being introduced by various countries in the most actively used industries, as well as being borrowed from each other (Table 1).

Table 1. The most significant innovations

Freckling technology using a shock wave
The latest oil extraction technologies
The use of bacteria to eliminate oil spills
The use of biofuels for cars

Source: Adapted from Fraunhofer ISI et al. 2015; BMU 2016a

Speaking of the first innovation, it is worth noting that the shock wave is the most effective way to dissipate energy. It can be successfully applied at a depth of shale formations up to a thousand or a thousand and a half meters. An Indian company specializing in the study of fracking technology has suggested using a shock wave as a simpler and more cost-effective technology for fracturing, compared to hydraulic fracturing. Such an energy innovation can significantly change the oil and gas industry, since the need to use water in these works will completely disappear. This will significantly reduce the level of water pollution, because fracturing requires at least 4 million gallons per well.

The second interesting innovation in the energy sector is an improved method of oil production. The so-called enhanced oil recovery method involves tertiary formation treatment to extract as much product as possible. This technology is based

⁹ Energy for People, Energy for Peace, Results of the 18th World Energy Congress, Buenos Aires, Argentina, October 2001, World Energy Council Statement 2002.

on the use of carbon dioxide, which increases the flow rate of oil and reduces its viscosity¹⁰.

Regarding the use of bacteria to eliminate oil spills, this innovation is based on the use of two groups of bacteria - both of them have the ability to oxidize oil and thus reduce the scale of the spill, or prevent it in advance. Now, experts are studying the genus of bacteria *Oleispiraantartica*, to determine the ability to exist in low temperatures. This innovation will allow developing an effective strategy for the preservation of the environment and the prevention of oil pollution. And finally, another innovation is automotive biofuels derived from plant and animal cells. Biodiesel and ethane (the most popular types of biofuels) will help to stabilize the situation with prices on the world market and reduce research and development costs.

In addition to the above, innovations in the energy sector, include other achievements, some of which are already widely used. For example, this is wind energy - the use of wind energy for the operation of various types of engines. Such systems can be found in many foreign countries, we have this technology also finds its application.

Do not deprive attention and heat pumps; they can rightly be called the future of energy. They will significantly improve the environmental situation due to the production of heat, significantly increasing the standard of living of the population, since heat supply is one of the key energy sectors. The principle of operation of heat pumps is based on the transformation of low-temperature renewable energy, it has been known for more than a century, but it is only now that is actively used.

In 2004, the study of such innovations as the use of liquefied petroleum gases (LPG) for thermal power plants started. The use of LPG instead of diesel fuel will improve environmental safety. In addition, this fuel has high consumer properties

¹⁰ Energy for People, Energy for Peace, Results of the 18th World Energy Congress, Buenos Aires, Argentina, October 2001, World Energy Council Statement 2002.

and lower cost compared to other fuels. Today, this innovation has already passed numerous tests and is distinguished by reliability and efficiency¹¹.

The original innovation of the world of energy is the osmotic station, which is based on the use of sea salt water. Osmosis is a physical effect that occurs in the trunks of trees and is designed to transfer nutrient juices to the area where photosynthesis occurs. Scientists have suggested using a similar process to interact with water. If fresh and salt water is placed in a single vessel with a septum, the pressure difference is made to make the osmosis process work. A similar reaction can be used in the operation of hydroelectric power plants. An interesting idea requires improvement - in particular, while scientists cannot solve the problem with the selection of the most suitable membranes for osmotic stations. If this can be done, the novelty will firmly take its place in the field of hydropower and will significantly increase the volume of energy generation, consistently providing a constantly growing population around the world. The reserves of such a process as osmosis can be called quite impressive. This innovation will help to easily use the energy of the depths of the ocean in human life, because the degree of salinity of water depends largely on temperature, and it varies with the level of depth. In this regard, the technology will avoid tying the construction of hydroelectric power stations to the mouths of rivers, they can be placed directly in the waters of the oceans. Therefore, today scientists are actively engaged in the development of this innovation for its early implementation.

Successful and full-fledged development of the conditions of existence, improvement of the quality of life and the ability to save on daily needs depend on how actively innovations are introduced in the energy and other sectors of human life. It is for these reasons that experts around the world study new developments

¹¹ Energy Information Agency (EIA), database. 2017.

every day and try them in practical terms in order to find truly profitable and useful innovations¹².

2.2.2 Political drivers of renewable energy

This subject has two main goals. The first is to empirically analyze to what extent political factors explain the countries' decisions to deploy renewable energy (RE). The deployment of RE is a good indicator of countries' commitment in the promotion of environmental friendly energy policies and, as we shall see, one that has received little attention in the scientific literature. The second, closely connected one, is to compare the explanatory power of those political determinants with that of other economic, energy and environmental drivers that have received greater attention in the literature so far, at least in the particular case of RE. The reasons for interest in this analysis are manifold. To begin with, the attention devoted to the political and institutional drivers fills an analytical lacuna in our understanding of RE deployment. This lacuna is all the more serious, since investing in RE sources is, first and foremost, a political decision. Governments actually finance the deployment of RE in response to multiple political factors. Among them, the pressure of lobbies that demand a greater use of RE sources, like the environmentalists and the green energy industry; the pressure of lobbies instead contrary to such deployment, like the nuclear and the oil based industries; and, last but not least, governments invest in RE provided that it yields a positive rate of return in terms of expected votes.

Furthermore, the deployment of REs is a 'hot' policy issue, as the COP21 conference held in 2015 shows. In the EU; the combined needs of reducing its energy dependency and protecting the quality of the environment have pushed the Commission to set a series of targets that member countries must reach by 2020

¹² Annual Report of the Ministry of Energy (DoE) at IRENA, August 2017b. Media briefing newsletter on August 31, 2011. The Independent Renewable Energy Producer (IPP) program.

(Directive 2009/28/EC); among those, a share of REs in gross final energy consumption of at least 20%¹³.

The task is daunting, since considerable differences exist in RE gross final energy consumption among the member countries. Malta, for instance, consumes no RE at all, while in Sweden they represent 43% of total energy consumption. Such large cross country differences among a group of rather homogeneous and closely integrated economies cast doubts on the validity of models that rely exclusively on economic and environmental determinants. Political factors must also play a role.

To compare the explanatory power of the politico-institutional factors with that of the better studied economic and environmental drivers, our empirical strategy adopts the following road-map. First, as virtually all of the theoretical and empirical models that have studied the influence of political drivers on energy and environmental policy have focused on indicators different from the deployment of RE, we begin by illustrating the simple correlations between the countries' RE shares and the main political explanatory variables identified in the literature. In a second step, we collapse the politico-institutional variables with the economic, energy and environmental ones into a single empirical model. This allows us to assess the relative explanatory power of the political determinants, but also to investigate whether they exert their influence on REs directly or indirectly, through the mediation of other conditioning phenomena. The influence of a leftist government, for instance, can be expected to be conditional on the cohesion of its parliamentary majority. The estimates yield several interesting results. First, political factors play a significant role in explaining countries' decisions to deploy RE, even when the standard economic, energy and environmental phenomena are explicitly controlled for. The most relevant political drivers are the lobbying power of the manufacturing industry, which effectively retards the deployment of RE, and

¹³ Annual Report of the Ministry of Energy (DoE) to IRENA, August 2017 Media Statement, Independent Renewable Energy, Media and Publication Program.

measures of governance quality, which instead show a positive effect. Left wing parties appear to promote the deployment of RE more than right wing ones¹⁴.

2.2.3 Alternative energy sustainable development. Influence on socio-economic strategy of international relations.

The connection among RE and manageability can be seen as a pecking order of objectives and imperatives that include both worldwide and territorial or neighborhood contemplations. Vitality pointers can help nations in observing advancement made in vitality subsystems reliable with maintainability standards. Estimation and revealing of markers checks as well as goads the usage of SD and can pervasively affect basic leadership. Be that as it may, estimating vitality manageability is encompassed by a wide scope of reasonable and specialized issues and may require refreshed strategies. In the course of recent decades, advance has been made towards building up a uniform arrangement of vitality pointers for reasonable improvement, which identify with the wide topics of economy, society and condition. For RE advances, quantitative pointers incorporate cost of created power, GHG emanations amid the full lifecycle of the innovation, accessibility of inexhaustible sources, efficiency of vitality transformation, land prerequisites and water utilization. Different methodologies build up a figure of legitimacy to analyze the diverse RE frameworks dependent on their execution, net vitality necessities, GHG outflows and different markers.

All countries around the globe should consider sustaining its welfare and resources to future generations through respecting sustainable development goals that comprise social progress, poverty reduction, equity, enhanced resilience, economic growth, and environmental sustainability. On the basis of the evidence currently available, it seems fair to suggest that all countries of the world community are interdependent that is to say they are committed to the “tragedy of the commons” unwillingly. To make it much more clear, tragedy of the commons means a situation

¹⁴ Annual Report of the Ministry of Energy (DoE) to IRENA, August 2017 Media Statement, Independent Renewable Energy, Media and Publication Program.

within a shared-resource system where individual states acting independently and rationally according to their own self-interest behave contrary to the common environment and planet of all states by depleting that resource. Energy politics affects all the aspects of daily life through the vast use of energy from household to industries, hence, the issue of energy security remains a very crucial yet compelling one. Before there was a challenge of Energy Security in front of the states to tackle, starting from 1990s the intrusion of climate change into energy issues stir up states to adopt costly policies on climate change and energy security that would reduce growing emissions that is the result of the dependence from the non-renewable energy sources such as oil, gas and coal which promise the unsustainable future¹⁵.

World vitality utilization depends on 80% upon petroleum products, which are the dirtying sources that quicken a worldwide temperature alteration. In addition, environmental change uncovered that present vitality and condition balance is unsustainable. Vitality approaches should now incorporate environmental change strategies so as to spare the condition that the general population live in. This test is critical one before the a solitary nation, yet additionally all nations on the planet. Consequently, unsustainable examples of vitality creation and utilization in any nation compromise human wellbeing and personal satisfaction as well as influence environments and add to environmental change. There emerges an inquiry that who is going to spare or continue our planet for the who and what is to come? Who is going to pay for the best possible support of earth? Can supportable vitality improvements be a motor for (un)sustainable future? The world has seen a sharp increment in sustainable power source (RE) limit over the previous decades. This is because of an ascent in RE advancement plans; activities to make vitality progressively secure in light of environmental change; and a sharp fall in RE innovation costs. This is an empowering pattern, as sustainable power source arrangements can yield significant social, monetary and natural advantages, for

¹⁵ Annual Report of the Ministry of Energy (DoE) at IRENA, 2013a. Independent Renewable Energy Procurement Program, formalhomepage 2016.

example, evacuating weight on significant biological systems and enabling nations' electrical lattices to be steady and dependable motors of financial development .

Renewable energy and Energy efficiency are central to a transition to a sustainable future. Efficiency slows down energy demand growth so that rising clean energy supplies can make deep cuts in fossil fuel use. Moreover, Renewable energy presents major economic opportunities such in elimination of energy poverty. If non-renewable energy prevails renewable energy, the future becomes unsustainable that will affect all states around the world. Most of the studies concerning climate change and its consequences show that developing countries may be the first victims of climate change. There arises contradiction that how is it possible to produce more energy in order to avert the energy poverty and simultaneously to reduce emissions significantly in order to be committed to the sustainable energy development? The resolution of the contradiction can be achieved via the actions, adaptations and higher prices. Because climate belongs to the citizens of the world that is to say climate change is a global public good that requires global governance by the International Community.

Some countries, particularly EU and U.S engaged in mitigation process specifically the process of emissions reductions and commitment to sustainable energy development. Many others, particularly the developing world countries escape the problem and give priority to economic growth. Powerful world organizations or lobbies are highly efficient at hiding problems which doesn't vest any interest to them in case of enlightening. Even, there is strong contradiction among the pursued policies by these leaders in the world. EU's 20/20/20 package on climate change and energy policy and the costly policies adopted by the US are not the best alternative to avert the growing emissions due the reason that these states are not the only polluters of the environment.

Climate Change is the global public good that needs not only developed world but the developing world all together to cooperate in adoption and mitigation of climate change policies, because the growing emissions are the outcome of activities

of all states in the world. Heavy impact on nature is made considerably by industries, and it is no by chance that the concept of sustainable development forced countries, particularly developing states to convert their fossil fuel based industries to green industries¹⁶.

Energy democracy and energy transitions are also fundamentally political. Given the seemingly pervasive grip that fossil fuel industries and their financial and political allies command over contemporary political life, energy democracy activists seek to make visible within the public sphere the hidden infrastructures, privatized decisions and distant consequences of modern energy systems. The instinct to politicize renewable energy transition reflects an implicit understanding that the transition from fossil-fuel dominant systems to those based on renewables offers an unprecedented yet potentially unrepeatable opportunity.

As with new forms of media communications, new energy technologies present an opportunity to more deeply engage with questions of technological determinism. Through selection and construction of these large-scale infrastructural technologies, the world will again be re-ordered: decisions and investments will be made, groups of actors will be politically re-positioned, and material structures as well as social and ecological patterns will be established that may endure for generations. The form of politics used to steer renewable energy transitions will greatly influence the possibility for more democratic futures.

In other words, if governed largely to preserve existing power relations, the renewable energy political economy may replicate existing dynamics of power, continuing to strengthen the powerful and weaken the marginalized. Energy democracy sees renewable energy transitions as unavoidably political processes as well as key opportunities for advancing renewable energy and democracy together. This framing rejects the view of energy transition as simple technological substitution; rather renewable energy transitions cannot avoid the re-ordering of

¹⁶ Annual Report of the Ministry of Energy in IRENA (DoE), 2016.

social and political relations. Energy democracy urges us to consider how, by whom and for whom renewable energy transitions proceed. In this way, energy democracy stands in sharp opposition to the strategy of “renewable energy by any means necessary”, and instead embraces energy as politics by other means.

Chapter 3. Development of alternative energy in the world

3.1 Global approach in RES development

3.1.1 Opportunities of development of global RES electricity transmission

Expanded natural mindfulness has prompted solid activities in the vitality division as of late. Models are the European Commission's objective of 20% interest of sustainable power sources (RES) in the EU vitality blend by 2020 and California's choice to increment sustainable power source in the state's power blend to 33% of retail deals, again by 2020. In the meantime, a few examinations have been completed researching the conceivable outcomes of a higher offer of renewables in the vitality supply arrangement of things to come. For example, the German Energy Agency (DENA) accept 39% RES investment by 2020, while a point by point consider from the National Renewable Energy Laboratory recommends that satisfying the US power need in 2050 with 80% RES supply is an achievable choice. In Refs., a 100% sustainable power source supply framework in Europe with interconnections in North Africa and West Asia is talked about. A comparative

report on a worldwide scale was completed by WWF and Ecofys in Ref. The examination presumed that a 100% sustainable power source supply by 2050, despite the fact that a driven objective, is both practical and actually attainable. All the more as of late Ref., researched "the attainability of giving overall vitality to all reasons (electric power, transportation, warming/cooling, and so on.) from wind, water, and daylight". The creators made a definite examination and proposed an arrangement for usage. They found that the boundaries to the organization of this arrangement are not mechanical or financial, yet rather social and political .

Every one of these investigations propose that for an effective combination of progressively sustainable sources in the present framework, a fortification of the transmission framework is vital so as to dependably fulfill the vitality request. In Ref., the requirement for developing 1700-3600 km extra transmission lines in Germany and the neighboring areas is underscored, so as to keep away from non-transmissible power from a 39% RES entrance in the German power framework. Towards a similar end, the "Tres Amigas" venture has been started in the US so as to interconnect the three US transmission frameworks and encourage expanded RES reconciliation. Advantages from interconnection are likewise called attention to in Ref. The creators considered the interconnection of 19 scattered breeze age destinations and found that, by and large, 33% of the yearly arrived at the midpoint of wind power can be utilized with a similar unwavering quality as a traditional power plant.

In the meantime, long transmission lines are being considered for reaping sustainable power source from remote areas and conveying it to real load focuses. Paris et al. appear to have introduced the principal possibility examination of this sort. Afterward, an investigation about the development of an extensive hydro control plant at the Congo River (Inga Dam) in Central Africa and the transmission of the delivered capacity to Italy was additionally detailed. The determination was that such an answer was both doable and monetarily focused. Correspondingly, in Ref., the productivity of delivering power from geothermal and hydro control plants

in Iceland so as to transmit it and pitch it to the UK was illustrated. At present, just about 20 years after the fact, the two governments are examining approaches to understand this undertaking. In Ref., it was additionally recommended that interconnecting Europe to control plants in districts with higher RES potential, for example, North Africa, Russia, and West Asia could have a cost tantamount to the present framework. Ref. concentrated on the Russian RES potential and contended, "an EU Russian collaboration in the sustainable power source field would display a wine win circumstance". Russian sustainable power source could accomplish the EU ecological targets, while, in the meantime, "Russia could start to build up a national sustainable power source industry without gambling potential cost increments for residential customers". Critical system fortifications, as a Russian EU Super network, would be vital in such a case .

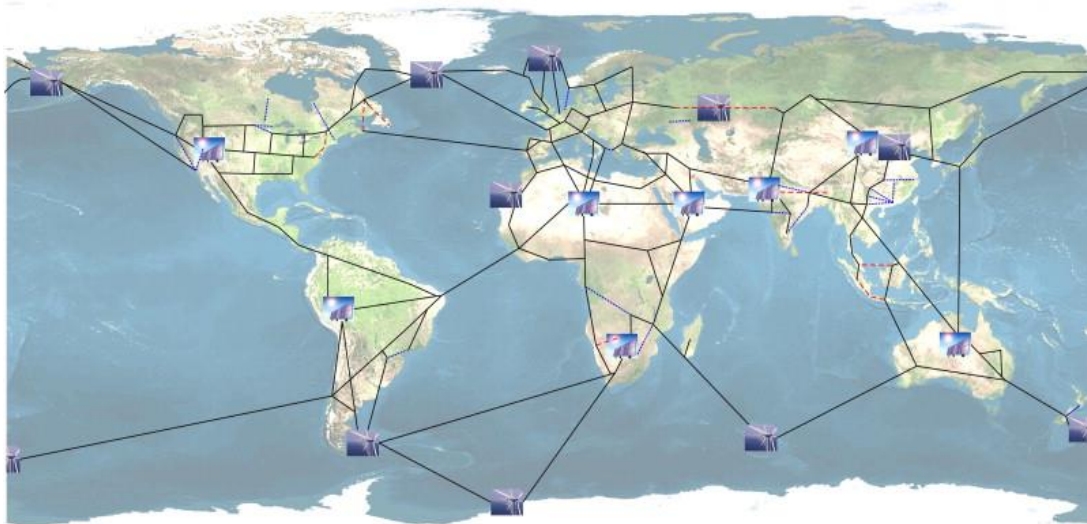
Solid moves have been made to abuse the advantages of interconnections. EU rules as of now support transmission ventures, for example, the Baltic Ring. Undertakings, for example, Desertec, Medgrid and Offshore Grid have been propelled, so as to interconnect Mediterranean states with Europe and exchange sustainable power source from the African deserts or North Sea to the significant burden focuses. In the meantime, activities, for example, Gobitec in Asia and Atlantic Wind Connection in the USA intend to interconnect the Asian power lattices or transmit seaward wind vitality to the US East Coast.

Be that as it may, a significant number of these thoughts have stayed provincial or between local in nature, moving in Europe and its neighboring districts, North America, or Asia. Contrasting the power system and systems of comparable size, for example, the transportation or the broadcast communications arrange, one understands that few of them have just figured out how to traverse the globe. It appears that the main system of comparative size, which does not shape interconnections over the world, is the electric power lattice.

We foresee that a power supergrid will be fabricated, filling in as a transmission spine. The new network ought to be of a coincided nature,

interconnecting all local power frameworks into one. Invested individuals would most likely "enter" the Global Grid and transmit control anyplace on the planet.

Figure 1: Illustration of a possible Global Grid



Source: Adapted from Fraunhofer ISI et al. 2015; BMU 2016a

The blue specked lines demonstrate the HVDC lines with a length more than 500 km, that are as of now in task. The HVDC lines more than 500 km at present in the structure/arranging stage are shown in dashed red lines. The area of the RES control plants has been founded on sun oriented radiation maps, normal breeze rates, and ocean profundities.

A large portion of the lines framing this huge system are relied upon to be High Voltage Direct Current (HVDC) lines or links. There are three primary purposes behind this. To start with, HVDC links are right now the sole answer for submarine long-separate transmission. Air conditioning links can be laid for a most extreme separation of ca. 60 km without receptive pay, while current innovations for Gas-Insulated Lines⁶ don't take into account a separation surpassing 100 km. An extra reason is that long-separate HVDC lines have lower warm misfortunes than AC lines. The third reason comes from the way that non-synchronous zones will be associated. Power frameworks in various districts work at various voltage

frequencies. Coupling the frameworks at an AC level would not just mean the appropriation of a worldwide ostensible recurrence, yet additionally that each provincial power framework would likely be progressively helpless to the disappointment of a neighboring framework. HVDC connections can locally deal with dynamic security issues, see Section 3.5, and go about as a firewall for unsettling influences between the interconnected matrices. By the by, ashore and inside synchronous frameworks or frameworks wishing to be synchronized e UltraHigh Voltage AC lines (UHVAC) just as short sections of GasInsulated Lines could likewise be foreseen. A few of the advances required for the Global Grid are as of now generally full grown. For the rest, advancement is required however no noteworthy boundaries are foreseen from the specialized perspective. For instance, extra experience may be essential for the multi-terminal innovation, which can associate a few HVDC lines to one hub . The improvement of profound undersea links for mass power transmission will likewise be required, extra mechanical difficulties are distinguished which additionally apply to the Global Grid, for example, the further advancement of HVDC circuit breakers, security and control frameworks, just as an institutionalized working voltage level. Concerning the working voltage level, we expect that a lot of a few distinctive voltage levels would be required in a Global Grid condition.

3.1.2 Economic role of development of European electricity transmission.

Given that the objectives for 2020 are on course to be reached, the European Commission has proposed new ambitious targets for 2030. On this basis, in October, the European Council has adopted new 2030 energy and climate goals. These include reducing greenhouse gas emissions by 40%, increasing energy efficiency by at least 27%, and bringing renewable energy's share of energy consumption in Europe to 27%. However, to strike a balance between the three pillars of the energy policy (sustainability, competitiveness, and security of supply), the Commission strongly emphasized the importance of a robust and interconnected electricity transmission network. Means of production and consumption profiles can be

mutualised through an adequately interconnected network, enabling authorities to get the most possible benefits out of the various complementary energy sources as well as limit the use of additional generating capacity and improve the security of supply at a lower cost to society. In view of the current state of storage technologies, the flexibility of the transmission network makes it the best method for integrating wind and solar energy; given that, production sites of this type of electricity are often located far from consumers. Creating connections between European electricity networks helps optimize the diversity of the energy mix in Europe¹⁷.

Whereas in Europe, the energy mix remains a national choice, and therefore cannot be subject to any overarching prospective, the transmission network operators, joint since 2009 in the association “European Network of Transmission System Operators for Electricity (ENTSO-E)” have been given by European regulation the responsibility of jointly establishing a ten-year indicative development plan for the electricity transmission network. This plan, which is drawn up every two years, accounts for predictable changes in consumption and production sources, based on various scenarios, in order to identify the infrastructure projects needed to create an integrated European energy market. Since 2012, the plan has earmarked a list of “common interest projects”, for which permitting procedures and construction have to be accelerated. Five electricity interconnection projects involving France are included on this list. In addition, each transmission network authority is planning for the investments necessary for guaranteeing its own network’s security and funding the renewal of infrastructures, some of which are ageing.

Based on these different planning levels, one may anticipate that expanding and adapting the European network will require an investment of approximately 250 billion euros between now and 2030. This “investment cliff” represents both a challenge and an opportunity.

¹⁷ Annual Report of the Ministry of Energy (DoE) to IRENA, August 2017 Media Statement, Independent Renewable Energy, Media and Publication Program.

An opportunity: It is one of the rare instances of European consensus with regard to the needs and priorities of projects that combine proven expertise with the most innovative technologies and provide benefits to all of society; the latter will be especially true should the recognised priorities be met at the right time. Consequently, during this period of increased investment, access to funding via the markets has rarely, until now, proven to be problematic for these projects¹⁸.

But also a challenge: The amount of investment required for the energy transition means that network authorities, must, in order to maintain their access to funding, preserve healthy balance sheets and acceptable debt levels if they are to remain solvent over the long term. Concretely, this means that the electricity transmission tariffs of these regulated monopolies must continue to cover operating costs as well as all investment costs (amortization and financial costs), without increasing tariffs beyond a level that consumers can afford. Looking beyond isolated, temporary solutions (i.e. financial support provided to certain common interest projects), public, regulatory, and transmission network authorities must come together to schedule investment priorities and thus fulfil stated needs, while maintaining a balanced financial situation, a stable regulatory framework, and tariff rates that are acceptable to the community.

Finally, citizen support will make all the difference in ensuring that the electricity transmission network is on time to tackle Europe's energy transition challenges.

3.1.3 Future vision and forecasts on global alternative energy fields

No place has this been more the situation than in contemporary discussions about vitality and nature. Over 50 years prior, atomic supporters advanced a future in which atomic vitality would be too shoddy to even think about metering. In the three decades that pursued, the United States and other progressed created

¹⁸ Annual Report of the Ministry of Energy (DoE) to IRENA, August 2017 Media Statement, Independent Renewable Energy, Media and Publication Program.

economies set out on a huge form out of atomic power plants. For nearly as long, sustainable power source advocates have guaranteed a hyper-productive future controlled completely by the sun and the breeze, and in ongoing decades countries around the globe have contributed several billions of dollars to make that future a reality.

The two dreams demonstrated judicious somehow or another. At its pinnacle, the worldwide atomic armada created 18 percent of worldwide power and more than 20 percent of power in the United States. France demonstrated that atomic vitality was fit for both fueling an advanced economy and decarbonizing its capacity part. What's more, despite the fact that it never turned out to be too shoddy to even think about metering, over the operational lifetime of atomic plants, the full expense of producing atomic power proved to be surprisingly low. Present day economies around the globe have likewise turned out to be considerably more vitality proficient, and the expense of assembling wind turbines and sun based boards has fallen abruptly with supported organization, as sustainable power source advocates anticipated.

In any case, it is likewise obvious that neither one of the visions has verged on conveying on its guarantee. Barely any created economies are assembling new atomic reactors. Additionally, in spite of the fact that an atomic renaissance is well and really in progress in the creating scene, the work out of fossil vitality framework in creating countries is continuing considerably quicker. Coordinated endeavors to convey sun oriented and wind vitality in different areas around the globe, in the interim, have neglected to push wind and sun powered much past 20 percent of absolute yearly age on any substantial electrical network.

Vitality prospects, it turns out, are not all that effectively twisted to idealistic dreams. However, we keep on proposing them, to contend about them, and to discover others to accuse when they neglect to appear. The explanations behind this are simple enough to see. The present is confused and considerable. The future, on

the other hand, is sparkling, weightless, and consummately enhanced: a spot where exchange offs are pointless and requirements can be expected away.

The matter of anticipating and demonstrating vitality fates detonated after the Arab oil embargoes of the 1970s. The scope of fates that reviews from that time envisioned is genuinely head turning. All things considered, the one element that they shared was that they dependably neglected to foresee what's to come. Standard gauges from the 1980s reliably overestimated both future vitality request and the extension of atomic vitality .

Amory Lovins and other sustainable power source prognosticators of that period were here and there nearer to the imprint regarding vitality request. Notwithstanding, they were fiercely off in their projections of inexhaustible and decentralized vitality. Also, even their interest estimates were directly for the wrong reasons. Lovins asserted that sensational upgrades in vitality productivity would result in lower vitality consumption. But slower financial development, deindustrialization, and sectoral moves in the U.S. economy are what generally represented slower request development. With the approach of universal endeavors to address environmental change, the transcendence of models, situations, figures, and plausibility examines in dialogs about vitality and natural prospects has just developed. With that the chances to present all way of mistake, predisposition, and daydream have developed also, all finished with a sheen of numerical accuracy and logical specialist.

Subtleties aside, it is essential to comprehend what a significant change an inexhaustible overwhelmed eventual fate of this sort would speak to. Vitality frameworks are very way reliant and are implanted in more extensive techno-financial ideal models. The ascent of coal can't be unraveled from the steam motor, railways, and power. The time of oil is indistinguishable from the inner ignition motor, present day transportation systems, and urbanization. Concentrated electrical matrices coevolved with present day urban areas and industry.

As present day economies developed in scale in the course of the only remaining century or somewhere in the vicinity, they have turned out to be progressively concentrated, as have the vitality frameworks that controlled them. Preceding the mechanical unrest, all vitality frameworks were conveyed, decentralized, diffuse, and inexhaustible. Early electrical frameworks were little scale, and contending suppliers offered interwoven support of the couple of organizations and living arrangements ready to manage the cost of it. The brought together network and managed utility were the executioner applications that enabled power to change assembling, industry, and at last urban life in the main many years of the twentieth century. Thick non-renewable energy sources and progressively proficient ignition and end use innovations have kept on making present day vitality benefits ever less expensive, progressively plentiful, and progressively available to more individuals and more areas of the economy. Therefore, for the majority of two centuries, the long haul development of vitality frameworks has been towards denser energizes and increasingly incorporated power age and dissemination.

In later occasions, the advantages of new powers and vitality advances have been less radical, which maybe clarifies how tough the fundamental plans of our fossil-energized vitality foundation have been. Flammable gas at first discovered buy because of its predominant characteristics as a warming and cooking fuel. In late decades, radical upgrades in gas turbine configuration made gas a progressively adaptable and adaptable fuel for power age, guaranteeing it a developing job in the power division even before gas costs hit absolute bottom gratitude to the shale insurgency. The quick removal of coal with gas in the United States in the course of the most recent decade owes not exclusively to the way that it was so modest yet additionally to the way that it could likewise fundamentally attachment and play with the current brought together power lattice. Notwithstanding their innovative curiosity and multifaceted nature, atomic reactors can likewise fitting and play with the current, brought together power matrix and thus have demonstrated equipped for dislodging concentrated fossil vitality age at a vast scale.

Wind and sun powered vitality are tormented by low limit factors. Limit factor is the proportion of how much power a power plant delivers every year in connection to how much power it would create on the off chance that it worked 24 hours per day, 365 days a year. Coal plants regularly have limit factors over 60 percent, while atomic plants routinely surpass 90 percent. Wind ranches, paradoxically, ordinarily have limit factors around 30 percent, and the best sun oriented homesteads have a limit factor of around 20 percent.

Since the limit factors related with wind and sunlight based age are so low, when the offer of wind and sun oriented age begins to approach around 20 percent of all out power request, the estimation of those assets breakdown. Wind and sun based in these conditions routinely produce more vitality than the framework requires at specific occasions of day, requiring the reduction of electrical creation from either inexhaustible assets or atomic and fossil assets. In either occasion, expensive capital hardware goes unutilized, expanding the all out framework cost of conveying solid power to clients all year.

On the off chance that the last 50 years of fizzled vitality visualization should temper eagerness for clearing vitality dreams of assorted types, it is additionally obvious that important alleviation of environmental change will require a change of the worldwide vitality economy at a remarkable scale and pace. In addition, in spite of the fact that there stays tremendous vulnerability about the fate of the worldwide economy and of vitality advances, there is much that we can gain from both the disappointment of past vitality estimates and the long haul development of the worldwide vitality framework that may enable us to more readily get ready for the future and relieve environmental change.

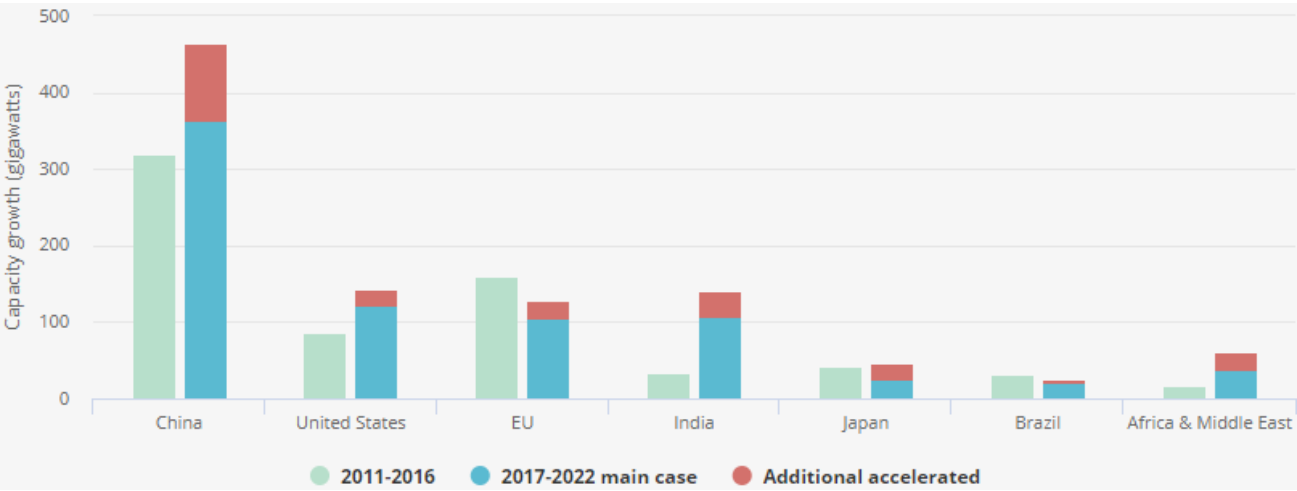
Begin with the probability that, in spite of the fact that we can't know the definite greatness, worldwide vitality request is probably going to develop for quite a while and to remain extremely high for any longer. This is simply straightforward socioeconomics and financial matters. Under the best of conditions, the worldwide populace will balance out at around nine billion individuals sooner or later amidst

this century. The vast majority of those individuals are poor today and don't devour much vitality. In this way, it is almost guaranteed that a bigger populace will keep on pursuing better expectations for everyday comforts, and during the time spent accomplishing those models, will devour more vitality, even with proceeding with enhancements in proficiency.

In that capacity, future vitality and decarbonization situations that accept that worldwide vitality request will be level over the coming decades ought to be seen with a reasonable level of incredulity. The size of low-carbon vitality foundation that should be sent to fulfill developing need and supplant existing fossil framework is colossal and won't be wished away through shrewd demonstrating presumptions.

Looked with extraordinary worldwide difficulties, a developing populace (the greater part of which should devour more vitality), and an atmosphere that needs that vitality to be zero carbon, we would all be very much encouraged to leave behind our mechanical priors ask ourselves what things we truly care about. A prosperous and evenhanded world, a low carbon future, and a sensible and responsible vitality framework are on the whole conceivable. To arrive, we will require better inexhaustible and better atomic vitality advancements. What's more, the two sides of the atomic/sustainable discussion should relinquish their decades old fight and work together to send both atomic and sustainable power source as quick as possible.

Figure 2. Renewable capacity growth by country/region



Source: IEA annual outlook, 2017

Among the best three countries, China is the undisputed inexhaustible development pioneer, representing over 40% of the all out worldwide clean vitality blend by 2022. This is because of gathering different limit targets and tending to worries about the nation's air contamination.

As of late, for instance, China has conveyed various novel advances intended to clean the air, including a 100-meter-tall brown haze sucking tower in the city of Xian. China has additionally as of now outperformed its 2020 sunlight based board target, and the IEA says it anticipates that the nation should surpass its breeze focus in 2019. China is likewise the worldwide market pioneer in hydropower, bioenergy for power and warmth, and electric vehicles.

Maybe shockingly, the United States is the second-biggest development advertise for renewables. In spite of President Donald Trump's choice to haul out of the Paris Agreement, sustainable tasks in the US are relied upon to profit by multi-year government charge motivating forces and state-level approaches for disseminated sunlight based boards in the coming years. Be that as it may, the report cautions of vulnerabilities around proposed charge changes, universal exchange, and vitality arrangements, which could thwart renewables development in the US.

Conclusion

All in all, guaranteeing a solid, effective, and moderate vitality is an incredible test. Producing power from sustainable power sources can give immediate and circuitous monetary advantages in abundance of expenses just as natural advantages through the decrease of CO₂ discharge. Strategy producers should advance inexhaustible assets (i.e., sunlight based, wind, biomass, hydropower, and geothermal) for economical and sans carbon vitality. It is anticipated that about 57% of all out vitality request could be created from sustainable sources by 2050. The

sustainable power source control age incorporated into the keen lattice framework can be a standout amongst the best choices for future vitality security. The brilliant lattice framework tends to the corruption of vitality source and present day data innovation for correspondence and improves the proficiency of intensity appropriation. A brilliant framework can change the twentieth century control matrix as an increasingly insightful, adaptable, solid, self-adjusting, and intuitive system that empowers financial development, natural oversight, operational proficiency, vitality security, and expanded purchaser control.

Besides, the brilliant matrix would make new markets as private enterprises create vitality effective and keen apparatuses, new correspondence capacities, and shrewd meters. Brilliant framework can supplant conventional types of vitality with sustainable wellsprings of age. Sustainable power source is constantly required by hippies with expectations of building up a cleaner and increasingly proficient power age. A shrewd framework is earth helpful in light of the fact that it uses the appropriation of inexhaustible sources. Keen matrix offers a certified way toward huge ecological improvement.

Concerning referenced the accompanying rundown of proposals is advertised:

- There is far reaching prevalent help for utilizing sustainable power source, especially sun powered and wind vitality, which give power without offering ascend to any carbon dioxide emanations.
- Harnessing these for power relies upon the expense and proficiency of the innovation, which is continually improving, in this manner lessening costs per top kilowatt, and per kWh.
- Utilising power from sun based and wind in a matrix ends up problematical at abnormal states for complex however at this point well-shown reasons. Supply does not relate with interest.

- Back-up creating limit is required because of the discontinuous idea of sun based and twist, however at abnormal states the financial aspects of this are undermined.
- Policy settings to help renewables are commonly required to present need in network frameworks and furthermore sponsor them, and somewhere in the range of 50 nations have these arrangements.
- Utilising sun oriented and wind-created power in an independent framework requires relating battery or other stockpiling limit.
- The probability of extensive scale utilization of hydrogen later on as a vehicle fuel builds the potential for both renewables and base-load power supply.

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