ICLEI Local Governments for Sustainability

100% RENEWABLES CITIES & REGIONS ROADMAP

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IKI INTERNATIONAL CLIMATE INITIATIVE

solutionsgateway Climate, Energy, and Finance Solutions

100% RENEWABLES SOLUTIONS PACKAGE

Renewables-based vehicle charging stations

This solution is part of a package of solutions meant to guide local and regional governments in implementing a local renewable energy transition by providing guidance on mechanisms, applications or technologies that can help accelerate their climate and energy action.

It was produced as part of the 100% Renewables Cities and Regions Roadmap project, which supports nine cities and regions across Argentina, Indonesia and Kenya to develop bankable renewable energy projects and in-depth local strategy and action plans to achieve one hundred percent renewable energy. The 100% Renewables Cities and Regions Roadmap project is implemented by ICLEI – Local Governments for Sustainability and funded through the International Climate Initiative (IKI), which is implemented by the Federal Ministry for Economic Affairs and Climate Action (BMWK) in close cooperation with the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) and the Federal Foreign Office (AA).

DISCLAIMER

All cities are unique. The Solutions Gateway has been developed as an advanced knowledge catalogue to provide an overview of possible Low Emissions Development Solutions. The Solutions and Packages it contains provide guidance on general conditions, which may not correspond to the existing conditions in your city or jurisdiction. The consultation and use of the Solutions Gateway does not waive the need for the Local Government to assess the feasibility of a Solution or Package in the local context in its city or jurisdiction, prior to implementation. Please note that the impacts, benefits and co-benefits indicated are generally valid but may not materialize in particular circumstances.

ABOUT SOLUTIONS GATEWAY

Solutions Gateway is an online resource platform for Local Governments where they will be able to find possible Low Emissions Development (LED) Solutions for their cities. In the context of the Solutions Gateway, Solutions are processes, or groups of actions, which Local Governments can implement to deliver climate change mitigation results and enhance local sustainable development. Taking an integrated approach, and focusing on Local Governments usual responsibilities and roles, Solutions include core actions as well as enabling and multiplying actions essential to maximize their effectiveness and efficiency. These include policy, regulatory, governance, capacity building, awareness raising, stakeholder engagement, etc.

ABOUT ICLEI – LOCAL GOVERNMENTS FOR SUSTAINABILITY

ICLEI – Local Governments for Sustainability is a global network working with more than 2,500 local and regional governments committed to sustainable urban development. Active in 125+ countries, ICLEI influences sustainability policy and drives local action for low emission, nature-based, equitable, resilient and circular development. ICLEI's Members and team of experts work together through peer exchange, partnerships and capacity building to create systemic change for urban sustainability.

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1. INTRODUCTION

Rapid advances in infrastructure, transport and technology have significantly increased harmful greenhouse gas (GHG) emissions, exacerbating the effects of climate change. In particular, the transport sector relies heavily on fossil fuels and is a major contributor to carbon dioxide (CO2) emissions. In response, many governments are emphasizing the introduction of environmentally friendly electric vehicles (EVs) as part of their national and sub-national climate change mitigation strategies, leading to significant investment in EV research and development. EVs are vital in shifting to a more efficient and emissions free transport sector. However, EVs today are still mostly powered from electricity generated from fossil fuels, such as coal-fired power plants. This situation will hinder the ambition to have a zero-emission transport sector from being fully achieved.

Renewable energy (RE) based EV charging stations provide the solution to this challenge, which is a charging facility for EVs that operates using renewable energy sources, such as solar, wind, or hydroelectric power, to generate the electricity required for charging EV batteries. These stations are designed to reduce reliance on fossil fuels, lower carbon emissions, and promote sustainable transportation.

Typically, RE-based charging stations are equipped with solar panels, wind turbines, or other renewable energy generators installed on-site to produce electricity. Battery storage systems are often integrated into the charging station setup to store excess renewable energy generated during periods of high production or low demand. This stored energy can then be utilized during peak charging times or when renewable energy generation is insufficient. Functionally, these charging stations are equipped with charging points or stations compatible with various types of electric vehicles. These could include Level 2 chargers (typically found in homes or workplaces) or faster Level 3 DC fast chargers capable of rapidly charging EVs. Another important component is the Smart charging technology which allows for efficient management and optimization of the charging process, and can include features such as load balancing, demand response, and remote monitoring to maximize the use of renewable energy and minimize grid dependency. While the primary source of electricity is from renewable sources, these charging stations can be connected to the grid. This allows for supplementary power when renewable energy production is insufficient or during high-demand periods.

RE-based EV charging stations play a crucial role in promoting sustainable transportation and reducing carbon emissions associated with conventional vehicles.

1.1 RELEVANCE

Renewable energy-based EV charging is crucial for several reasons:

- **Environmental Sustainability:** By using renewable energy, these charging stations significantly reduce greenhouse gas emissions associated with charging electric vehicles, contributing to a cleaner and greener transportation system.
- **Energy Independence and Resilience:** Relying on renewable energy sources promotes energy independence and resilience, reducing dependency on fossil fuels and the traditional electricity grid.
- **Cost Savings:** Over time, utilizing renewable energy can lead to cost savings, especially if the initial investment in renewable energy infrastructure is leveraged effectively.
- **Promotion of EV Adoption:** Renewable energy-based charging stations can incentivize and encourage EV adoption by offering a sustainable and eco-friendly charging option.

As the world continues to shift towards EVs, it will become increasingly important to ensure that these vehicles are powered by clean and renewable energy sources, with the right technologies and infrastructure in place.

1.2 SDGs ADDRESSED

SDG 7: Ensure access to affordable and clean energy for all

SDG 8: Promote decent work and economic growth

SDG 9: Build resilient infrastructure, promote sustainable industrialization, and foster innovation

SDG 11: Build safe, resilient, and sustainable cities and communities

SDG 13: Take more ambitious action to combat climate change and its impact.

1.3 MAIN IMPACTS

- Reduction of dependency on fossil fuel, which is often imported, will enhance energy security and resilience of the transport sector.
- Divestments from internal combustion engine (ICE) vehicles which helps to mitigate climate change from avoided CO_2 emissions traditionally associated with the transport sector.
- Increased public knowledge on RE based EV charging, and promotion of sustainable energy adoption and practices among citizens.
- Attract investments and open a new market sector, enabling system enhancement and optimisation.
- Reduced impacted impact on the grid through the resultant substantial load decrease on the existing electricity generation system and distribution infrastructure
- Reduction in Government's annual energy costs in the medium term from adoption of RE based EV charging, due to budgetary savings sparing limited resources for other infrastructural development.
- Improvement of environmental quality in cities, towns and regions due to significant reduction in noise and air pollution resulting from the adoption of RE based EV charging technologies, with increased public health benefits.
- Effectively propels governments towards achievements of local/national renewable energy targets.
- Generation of local green jobs and stimulating local economic growth that boosts the local economy.

1.4 BENEFITS

BENEFITS TO THE CITY

- Reduced local government dependency on fossil fuel for transport sector, boosting local resilience in energy and transport sectors.
- Reduce the impact on local grid and enhancing grid quality and stability.
- Enhanced citizens' understanding of RE based EV charging station.
- The cost effectiveness of clean transportation can improve businesses and households gains and boost the local economy and also help eradicate poverty.
- Site location of RE based EV charging stations increase nearby property values and rental rates of the area with charging stations.
- Opportunities for professional training and technical qualification to build qualified workforce.

BENEFITS TO THE USERS

- Depending on the setup and availability of renewable energy sources, users may experience cost savings in the long run, compared to conventional grid electricity.
- Renewable energy-based charging stations, especially those equipped with energy storage systems, provide a certain degree of energy independence. Users can benefit from more reliable charging options, even during grid outages or disruptions.
- Users of renewable energy-based charging stations contribute directly to the promotion and adoption of sustainable lifestyles and indirectly support the growth of renewable energy infrastructure.
- Renewable energy-based charging stations provide access to alternative charging solutions in areas where traditional grid infrastructure is limited, providing EV drivers with alternative charging solutions.

BENEFITS TO THE ENVIRONMENT

- Improved environmental effect, with significantly reduced GHG and other pollutant emissions, mitigating climate change and contributing to air quality and human health.
- Renewable energy-based charging stations help reduce noise pollution compared to ICE vehicles, and boost environmental integrity.

1.5 SUGGESTED INDICATORS FOR MONITORING RESULTS

- Number of RE based EV charging units installed
- Reduction of Local Government´s annual energy costs - %
- Reduction of Local Government´s annual energy GHG emissions – tCO_2/year
- Functional contribution to transport sector – Qualitative
- Success of overall design concept of RE integration to EV charging station – Qualitative
- Motivational effect on the users – Qualitative
- Operation and Maintenance costs per year - $/year
- Number of jobs generated

1.6 TYPICAL LOCAL GOVERNMENT ROLES

- Creating and implementing policies, regulations, and standards that support the installation, operation, and safety of renewable energy-based charging stations. This involves zoning laws, permitting processes, and building codes that encourage the deployment of charging infrastructure.
- Identifying suitable locations for charging stations, especially in public spaces, streets, parking lots, or government-owned facilities. Planning and investing in infrastructure such as electrical connections, parking spaces, and charging equipment.
- Providing financial incentives, grants, tax credits, or subsidies to businesses, property owners, or charging station operators to encourage the installation of renewable energy-based charging infrastructure. This could include support for initial setup costs or ongoing operation.
- Collaborating with private entities, utilities, or charging station operators to develop partnerships that facilitate the deployment and management of charging infrastructure. These partnerships can leverage resources, expertise, and investment to expand charging networks.

- Streamlining and expediting permitting processes for the installation and operation of charging stations. Ensuring that regulations are clear, efficient, and supportive of renewable energy-based infrastructure development.
- Educating the public, businesses, and stakeholders about the benefits of electric vehicles and renewable energy-based charging stations. Promoting awareness campaigns, workshops, and outreach activities to encourage adoption and usage.
- Aligning efforts with broader renewable energy policies and sustainability goals to promote the use of clean and sustainable energy sources for transportation.
- Developing standards for charging infrastructure and ensuring interoperability among different charging station networks to improve user experience and encourage broader adoption of electric vehicles.
- Implementing monitoring systems to track the usage, performance, and impact of charging stations. This information can be used to assess the effectiveness of policies and infrastructure deployment strategies.
- Engaging with local communities, stakeholders, and businesses to gather input, address concerns, and build support for renewable energy-based charging stations. Seeking feedback to improve planning and implementation.
- Encouraging fleet electrification initiatives, such as converting municipal fleets to electric vehicles and supporting infrastructure to facilitate this transition.

Figure 1: Honda's solar-powered public EV charging station. *Source: New Atlas*

2. INTEGRATED SOLUTION OVERVIEW

	Enabler Actions	Required Actions	Multiplier Actions
Policy	• Develop plans and allocate resources for integrating charging infrastructure into public spaces, such as streets, municipal parking lots, public buildings, and transportation hubs. • Set targets for the deployment of renewable energy-based charging stations, aligning with broader sustainability goals and clean energy targets. • Advocate for supportive state or federal policies that incentivize and promote renewable energy based charging infrastructure and collaborate with higher levels of government to align policies and regulations. • Implement mandates or requirements for new construction or major renovations to include a certain percentage of parking spaces equipped with EV charging stations, especially those powered by renewable energy sources. • Implement mechanisms to collect data on charging station usage, availability, and user feedback to inform policy decisions, optimize infrastructure placement, and address user needs.	• Develop and streamline zoning laws and permitting processes to facilitate the installation of charging stations. This involves creating clear guidelines and fast-tracking permits for charging infrastructure in public and private spaces. • Develop regulations and guidelines for the installation, operation, and maintenance, as well as safety standards and technical specifications of renewable energy-based EV charging stations. • Establish standards for charging infrastructure, ensuring interoperability among different charging networks and equipment providers. • Establish financial incentives, grants, rebates, or tax credits to encourage property owners, businesses, and charging station operators to invest in renewable energy-based EV charging infrastructure. • Implement small-scale demonstration projects or pilot programs to showcase the benefits and viability of renewable energy-based charging stations.	• Ensure equitable access to charging infrastructure across diverse communities, through policies that focus on deploying charging stations in underserved neighborhoods to reduce disparities in access to clean transportation. • Develop educational programs and awareness campaigns to inform residents, businesses, and stakeholders about the benefits of electric vehicles and renewable energy-based charging infrastructure. • Invest in research and development to improve the technology and lower the costs of renewable energy-based EV charging stations. • Foster Public-Private Partnerships with utilities, private businesses, property developers, and EV manufacturers to collectively invest in and expand the charging network. • Adopt fleet electrification policy initiatives, such as converting municipal fleets to electric vehicles and supporting infrastructure to facilitate this transition.
Stakeholders and Awareness	• Collaborate across different government departments involved in transportation, urban planning, environment, and energy to ensure coordinated efforts and support for EV charging infrastructure deployment.	• Conduct a thorough analysis to identify and understand the various stakeholders involved, with focus on residents, businesses, EV users, property owners, utility companies, transportation authorities, local groups, and relevant government departments.	• Share findings and benefits with businesses, private organizations, and individuals in an open manner

	Enabler Actions	Required Actions	Multiplier Actions
Stakeholders and Awareness	• Building partnerships with private companies, utilities, and other organizations to build partnerships that help promote the development and deployment of renewable energy-based EV charging infrastructure. • Collaborate with businesses, property owners, and commercial entities to encourage the installation of charging infrastructure on their premises.	• Organize public meetings, town halls, or forums to involve local residents and stakeholders in talks regarding the installation, location, and operation of charging stations, and gather feedback, address concerns, and incorporate community input into planning processes. • Work closely with local utility companies to plan for grid connections, energy supply, and demand management strategies related to charging infrastructure.	• Promote public education and awareness about the benefits of renewable energy-based EV charging stations, and how to use them safely and efficiently. • Maintain open lines of communication with stakeholders throughout the planning, installation, and operation phases. Seek continuous feedback, address concerns promptly, and keep stakeholders informed about progress and upcoming developments.
Governance	• Continuously updating policies to adapt to technological advancements and changing market dynamics. • Examine the legislation and regulations governing RE-based EV charging, particularly those involving private sector investment • Ensure equitable access to charging infrastructure across diverse communities, including underserved or disadvantaged areas, to promote social equity in transportation. • Negotiating agreements and contracts with private partners to ensure transparent and mutually beneficial arrangements.	• Establishing mechanisms for monitoring compliance with regulations, safety standards, and operational guidelines related to charging station installations. • Implementing systems to collect data on charging station usage, energy consumption, user patterns, and infrastructure performance and use collected data to evaluate the effectiveness of charging stations, inform future planning, and make data-driven decisions. • Outline how the project's financial savings will be dispersed; define the legal framework; and define the local support plan • Enforce regulations to ensure the proper functioning, safety, and reliability of charging infrastructure.	• Establish dedicated departments for institutional interactions across all levels of governance • Implement measures to make EV charging stations accessible, user-friendly, and inclusive for individuals with disabilities. • Create innovative financing mechanisms or low-interest loan programs to support the deployment of charging stations

	Enabler Actions	Required Actions	Multiplier Actions
Capacity Building	• Organize training programs, workshops, and seminars for local government officials, planners, engineers, and relevant staff to enhance their understanding of renewable energy technologies, charging station infrastructure, permitting processes, and regulations related to EV charging. • Provide decision-makers with managerial concepts such as indicators, financial components, policy, and basic technologies • Facilitate knowledge-sharing sessions among departments to disseminate best practices and lessons learned.	• Invest in developing in-house expertise or partnerships with external experts in renewable energy and electric vehicle technology. This includes understanding the policy and technical aspects, as well as project management for renewable energy systems, zoning, incentives, installations, maintenance, and troubleshooting, etc. • Involve existing technicians and staff in inspection, installation, and maintenance • Equip staff with technical and financial/fundraising skills to explore various financing options, apply for grants, incentives, or subsidies, and manage budgets effectively for charging station projects.	• Provide guidance on fostering partnerships, collaborations, and public-private initiatives necessary for successful deployment, maintenance, and operation of renewable energy-based charging stations. • Encourage research and study on the subject and strengthen linkages with universities and research institutions • Establish a culture of continuous learning within the local government by encouraging staff to attend conferences, seminars, or webinars related to renewable energy and EV charging. • Incorporate training and information into vocational high school and university curricula
Technical	• Determine the number of required RE-based EV charging stations • Determine the renewable energy potential for RE-based EV charging development • Implement smart charging technology and energy management systems that optimize charging schedules, manage power demand, and balance load distribution. • Conduct tests and commissioning procedures to ensure the functionality, reliability, and interoperability of charging equipment, renewable energy systems, and associated infrastructure.	• Identify suitable locations for charging stations, considering factors such as proximity to main roads, accessibility, visibility, availability of renewable energy sources (solar exposure, wind potential), and parking space availability. • Ensure that the electrical design of the charging station complies with local/state level codes and standards. • Facilitate permitting and approval processes required for the installation and operation of charging stations. • Ensure compliance with safety regulations, fire codes, and electrical standards to guarantee the safety of users, technicians, and the general public. Conduct regular inspections and maintenance of charging infrastructure.	• Design charging stations with user convenience in mind, including adequate signage, clear instructions, accessible locations, and amenities that enhance the overall user experience. • Implement programs for ongoing system improvement • Implement systems for ongoing monitoring, maintenance, and troubleshooting of charging stations to ensure optimal performance, reliability, and minimal downtime.

	Enabler Actions	Required Actions	Multiplier Actions
Finance	• Provide financial incentives, rebates, or subsidies to incentivize private entities, businesses, or property owners to invest in and install renewable energy-based charging stations. • Explore innovative financing mechanisms such as green bonds, revolving loan funds, or public-private investment models to secure long-term funding for renewable energy-based charging infrastructure. • Engage in partnerships with private companies, utility providers, or charging station operators to share costs, resources, and risks associated with establishing charging infrastructure.	• Allocate dedicated budgets or funds specifically for the planning, installation, and maintenance of renewable energy-based charging infrastructure. • Implementing user fees or tariffs for using charging stations to generate revenue that can be reinvested in expanding charging infrastructure, maintaining existing stations, or funding other sustainability initiatives. • Incorporate renewable energy-based EV charging station projects into the local government's long- term financial planning, considering ongoing operational costs, maintenance, and potential expansion needs.	• Establishing grant programs or funding initiatives that support the deployment of renewable energy-based charging stations, especially in underserved or strategic locations identified by the local government. • Develop revenue-sharing models between public entities and private operators of charging stations, where profits from charging services are reinvested in expanding the charging network or used for public benefit.

3. WORKFLOW /PROCESS PHASES

3.1 PREPARATION

- Conduct rigorous needs assessment and planning to identify the need for renewable energy-based charging stations by assessing the local demand for electric vehicles and potential locations for charging infrastructure.
- Conduct feasibility studies to determine suitable sites for charging stations, considering factors like proximity to main roads, parking facilities, power grid connections, and availability of renewable energy sources.
- Develop policies, regulations, and standards that support the installation, operation, and safety of renewable energy-based charging stations. This may constitute zoning laws, permitting processes, and building codes.
- Allocate budgets or secure funding for the planning, installation, and maintenance of charging infrastructure. Identify funding sources such as grants, incentives, public-private partnerships, or budget allocations.
- Promote awareness among the community, businesses, and potential users about the availability and benefits of renewable energy-based charging stations through outreach programs, workshops, and marketing campaigns.
- Develop technical specifications of RE based EV charging stations in specific areas and local geographical contexts.

3.2 APPROVAL

- Obtain the necessary permits and approvals from local and state governments to install the RE based EV charging station
- Ensure the approval of the project by the responsible regulatory institutions and stakeholders
- Ensure that the charging station complies with all applicable zoning and land-use regulations.

3.3 PROCUREMENT

- Issue Requests for Proposals (RFPs) or solicit bids from qualified vendors, contractors, or charging station manufacturers for the design, installation, and maintenance of renewable energy-based charging stations.
- Evaluate proposals based on technical expertise, cost, and feasibility.
- Procure charging equipment, including Level 2 or Level 3 chargers, energy storage systems (if applicable), and necessary electrical infrastructure.

3.4 IMPLEMENTATION

- Select suitable sites for charging stations, considering factors like accessibility, power grid connectivity, parking availability, and solar/wind potential.
- Install renewable energy generation systems (e.g., solar panels, wind turbines) on-site or nearby to supply clean energy to the charging stations.
- Install charging equipment, including Level 2 or Level 3 chargers, energy storage systems (if applicable), and necessary electrical infrastructure.
- Test and commission the charging stations to ensure proper functionality and connectivity. Thus ensuring it meets all safety and technical specifications, as well as performance requirements.
- Develop a marketing and promotion plan to inform the public about the availability of the EV charging station, and to encourage citizens to to adopt and use it.

3.5 MONITORING

- Implement systems for monitoring the performance, usage, and maintenance needs of charging stations.
- Regularly inspect and maintain equipment to ensure optimal operation.
- Collect data on charging station usage, energy consumption, user patterns and feedback, and environmental impact. Use this information for reporting, decision-making, and improving future infrastructure planning.
- Evaluate the effectiveness and demand for charging stations and plan for expansion if needed.
- Consider technological advancements and upgrade infrastructure to meet evolving user needs.

4. REALITY-CHECK

This solution is applicable:

- In a situation where electric vehicles already penetrate the market in the city (even if it is only two- or three-wheeler) or where there is a high concentration of electric vehicles or anticipated growth in EV adoption.
- Cities and communities that want to build a more clean and environmentally friendly transport sector. Local governments committed to reducing greenhouse gas emissions and achieving sustainability targets can promote renewable energy-based charging stations as part of their broader environmental initiatives.
- Geographical areas with abundant renewable energy resources, such as regions with ample sunlight for solar power or strong winds for wind energy, are particularly suited for establishing charging stations powered by these resources.
- Remote locations with limited access to traditional grid infrastructure may leverage renewable energy-based charging stations as a more viable and sustainable option for EV charging.

4.1 REQUIRED PRE-CONDITIONS

- Existence of electric vehicles (private or public transportation)
- Sufficient renewable energy resources
- Qualified workers and specialized technicians
- Financing capacity
- Grid quality and stability

4.2 SUCCESS FACTORS

- Ensuring policy consistency and long-term commitment from local government authorities to sustain efforts, overcome challenges, and support the growth of renewable energy-based charging infrastructure.
- Technical know-how and capacity building of relevant city officials
- Conducting awareness campaigns and educational programs to inform the public about the benefits of electric vehicles, renewable energy-based charging, and how to use the infrastructure effectively.
- Adopting advanced and interoperable charging technologies that facilitate efficient charging, smart grid integration, and user convenience while embracing future advancements in EV technology.
- Providing user-friendly, convenient, and accessible charging facilities with adequate signage, parking, payment options, and information for EV drivers.

- Implementing systems for regular monitoring, maintenance, and data collection to ensure optimal performance, identify usage patterns, and make informed decisions for improvements or expansions.
- Planning for scalability by designing flexible infrastructure that can accommodate future increases in EV adoption and technological advancements in charging systems.
- Continuously evaluating the performance, impact, and effectiveness of charging stations, seeking feedback, and implementing improvements based on collected data and user experiences.

4.3 FOLLOW-UP NEEDED AND/OR RECOMMENDED

- Consider the eventual increase of demand once the transition to renewable sources is completed (e.g., more use of electric cars and smart devices.)
- Consider the rebound effect, once there can be a behavioral change in the consumption after the installation, increasing the demand
- Involve community in decision-making process
- Provide trainings to relevant local government officials
- Prioritize local suppliers and labor forces

4.4 BARRIERS

- Unavailability of data regarding renewable energy resources in the specific area
- Unclear pricing or tariff scheme
- Lack of political and non-existing regulatory frameworks
- Lack of attractive financing mechanism

4.5 RISKS

- Power grid quality might be adverse if the charging station is connected to the main grid
- Inadequate financing to cover the cost over the long-term operationalization of the system
- Inadequate technology selection or poor quality of technology chosen
- No or limited availability of trained technicians
- Slow uptake due to the limited budget or allocations

5. CLIMATE CHANGE MITIGATION POTENTIAL

Electric vehicles (EVs) are already a low-emitting transportation option compared to internal combustion engine vehicles (ICEVs), and by charging them with renewable energy sources such as solar or wind power, their emissions are further reduced. The amount of emissions reduced by shifting from grid-connected EV charging to fully renewable energy-based charging will depend on the specific renewable energy sources used and the mix of sources in the grid. But, it is widely accepted that renewable energy sources produce significantly lower emissions than fossil fuel-based power generation. For example, shifting from grid-connected EV charging to fully solar-based charging can result in a significant reduction of greenhouse gas emissions. According to the US Department of Energy, the average emissions from grid-connected EV charging are about 0.5 pounds of CO_2 per kilowatt-hour (kWh) of electricity. In

comparison, the average emissions from utility-scale solar power generation are about 0.07 pounds of CO_2 per kWh. Additionally, renewable energy-based EV charging also offers the benefits of reducing dependence on fossil fuels, and increasing energy security, as well as creating new jobs and economic opportunities in the renewable energy sector. It's worth noting that the potential of renewable energy-based EV charging will be limited by the availability of renewable energy resources. It will also depend on the development of the renewable energy sector, and the availability of advanced technologies, such as energy storage and smart grid.

Figure 2. Fastned's 350 kW fast EV charging. *Source: Zapmap*

6. NATIONAL – SUBNATIONAL INTEGRATION IN THE CONTEXT OF THIS SOLUTION

6.1 BENEFITS TO LOCAL GOVERNMENT

- Reducing local government dependency on fossil fuel / ICE vehicles
- Generation of local green jobs
- Contributing to the achievement of CO_2 emissions reduction targets
- Opportunity to attract investments
- Reducing centralized energy system reliance and promoting energy self-sufficiency
- Enhanced local grid quality and stability

6.2 BENEFITS TO OTHER LEVELS OF GOVERNMENT

- Accelerate national renewable energy share target achievement
- Contribute to national GHG emission reduction target
- Enhanced national grid quality and stability

7. RESOURCES/SUPPORT

7.1 CASE STUDIES

TECHNO-ECONOMIC ASSESSMENT OF A RENEWABLE ENERGY-BASED ELECTRIC VEHICLE FAST-CHARGING STATION IN QATAR [1]

Abstract: (retrieved from the article): "Electrical vehicles' (EV) deployment as an alternative eco-friendly transport solution has become a promising initiative worldwide to reduce greenhouse gas emissions and fossil fuel depletion. This fact triggers the need to roll out fast-charging stations to fulfill daily road charging demand. Securing the power requirement for those stations has become a significant challenge that would cause substantial load increase on the existing electricity generation system and distribution infrastructure if supplied from the conventional resources. Hence, grid-independent charging stations with renewable energy sources (RES) and multiple energy storage systems has become an alternative solution to overcome the raised challenge. This paper aims to assess the implementation of a standalone fast charging station technically and economically in the State of Qatar comprising of a wind turbine (WT), concentrated photovoltaic (CPV) system and a bio-generator as RES along with various storage systems. The proposed design is built, modelled, and simulated using Hybrid Optimization System for Electric Renewable (HOMER) software to determine the optimal techno-economic configuration to fast charge 50 EVs daily in a reliable manner. Predefined constraints such as space limitation, stochastic nature of EV demand, and site-specific metrological conditions are considered. Multiple sizing portfolios of incorporated subsystems are evaluated through simulation. Sensitivity analysis is used to evaluate the impact of selected decision variable values such as the WT height where the generated analytical results are compared from the technical and economic perspectives. The results show that a stand-alone micropower system consisting of 450 kW CPV, 250 kW WT with 60 m hub height, 100 kW bio generator, and 324 kWh batteries is the optimal configuration with minimal 2.378 million dollars net present cost (NPC), 0.284 $/kWh cost of energy (COE) and 0.02 % unmet demand."

RENEWABLE ENERGY BASED AUTOMATIC RECHARGING MECHANISM FOR FULL ELECTRIC VEHICLE [3]

Abstract: (retrieved from the article): "This paper describes the hybrid renewable sources, for instance, the wind generator and the photovoltaic modules utilized to produce power to recharge the electric vehicles (EVs) storage system automatically. The current recharging mechanism of EVs requires recharging stations and it will affect the travelling distance for a long travel. This paper presents an automated charging mechanism (ACM) automatically recharges the battery packs, therefore, no need to wait for recharging EVs thereby increases the traveling distance. The proposed ACM is developed using the MATLAB-Simulink model. The output voltage of the wind turbine is measured for three dissimilar speed scenarios. The performance of the solar photovoltaic had undergone different irradiance levels in the analysis. A series of studies have been carried out for the developed model of ACM under different load conditions. The total harmonic distortion (THD) of both the output current and voltage, efficiency, and the coverage distance of the vehicle has been studied. For illustrating the capability of ACM it is compared with commercial charging mechanism including different EV brands. The simulation result indicates that the performance of ACM is satisfactory for recharging the batteries of EVs without involving recharging stations. Automatic recharging of EV increases the usage of EVs thereby immensely reduce the fossil fuel vehicles as a result greatly reduced CO_2 and CO-related emissions. Therefore the authors strongly believe that the method proposed decreases the complete travel time and as well as in increased EVs usage.

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