Local Governments for Sustainability

100% RENEWABLES CITIES & REGIONS ROADMAP

Supported by:
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INTERNATIONAL CLIMATE INITIATIVE

solutionsgateway
Climate, Energy, and Finance Solutions

100% RENEWABLES SOLUTIONS PACKAGE

Rooftop solar for public buildings

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

Solar photovoltaic (PV) technology is an excellent option as an environmentally friendly alternative to fossil fuels, and will be a key technology in tackling the climate emergency since it exploits clean and renewable sources of energy.

Solar PV is a financially attractive low-hanging fruit for local governments seeking to reach their urban sustainability goals. It is cost-effective, and easy to deploy on various surfaces and scales. Local governments can take the lead in expanding the use of solar PV in their communities. The benefits of public sector investment in energy translate into reduced environmental costs, more efficient energy use, increased financial resources and the creation of an enabling business environment.

The local government's role in this solution is to provide adequate policy, incentives, capacity building and to develop successful bankable projects to start the energy transition inside out, using the technology in their own buildings and acting as an example for the rest of the community.

1.1 RELEVANCE

Municipalities are front-line actors in tackling the climate emergency. Cities in many parts of the globe are under growing strain because of the consequences of climate change, as well as demographic pressures. Energy demand in cities is high, and will continue to grow.

Because of economic expansion and rising urbanization, buildings constitute an essential component of societal energy use. Understanding and utilizing the potential of rooftop PV is crucial for energy planning, improving system capacity, developing innovative finance schemes, and creating more responsive energy policies. As solar PV technology has become more accessible and affordable, the financial feasibility of these steps has only increased.

Local clean energy initiatives in public buildings, transportation, water treatment, street lighting, and other municipal services can assist to cut energy expenditures and may lead to significant positive impacts, improved financial indicators, and an increase in possible funding options.

1.2 MAIN IMPACTS

- Reduction of dependency on fossil fuels for energy generation
- Reducing GHG emissions from power generation in a city/region
- Promotion, influencing and inspiring both inhabitants and visitors to adopt sustainable energy practices e.g. household-level rooftop solar PV
- Attract investments and open a new market sector, and encouraging private investment and expanding the solar PV supply chain
- Reduce the use of grid electricity to help cut energy expenditures
- Budget increase in the medium-term due to savings—the money saved can be used to develop the institution and make improvements to the facilities
- Improvement of air quality and the reduction of pollutants in the city in used in a significative scale
- Increase sustainable, renewable energy generation in the city while enhancing resilience to climate change through decentralized generation
- Generation of local, high-quality jobs e.g. in installation and maintenance of solar PV
- Improvement of local level grid reliability by providing additional flexibility

1.3 BENEFITS

BENEFITS TO THE CITY

- Learning by doing, in terms of managing solar PV deployment and the challenges and enablers for it
- Developing a data-driven understanding of solar potential and deployment
- Maximizing the value of the buildings
- Obtaining a return on the investment and potentially an alternate source of income
- Reducing exposure to traditional power producers and volatile energy costs
- Expansion of professional training and technical qualifications to build a qualified workforce
- Cost reduction in electricity bills
- Leading from the front, by increasing visibility and encouraging the expansion of solar PV by other actors, which can lead to a positive cycle of investment

BENEFITS TO THE USERS

- Rooftops offer the greatest potential for PV integration because of their strong solar radiation and low shade from nearby buildings and vegetation, helping to create a viable business case
- Other positive impacts, such as PV that can be employed as exterior solar shading devices have the potential to significantly improve inside thermal comfort conditions.
- Reduced distribution losses, lower energy production costs, and less cost to utilities and the environment due to a reduced need for grid expansion
- PV systems are modular, easy to transport and install, and may be adapted to existing public and private buildings

BENEFITS TO THE ENVIRONMENT

- Low waste generation as a result of the long life span of major PV components such as modules and inverters
- Efficient use of available space, reducing the pressures on land use
- Electricity generation with no noise, minimal environmental effect, and no atmospheric pollution emissions
- Contributing to improving air quality and climate change mitigation.

1.4 SUGGESTED INDICATORS FOR MONITORING RESULTS

- Reduction of local government's annual energy expenditure (%)
- Reduction of local government's annual energy GHG emissions (tCO2/year)
- Functional contribution to the building (Qualitative)
- Electricity generation per year (MWh)
- Potential rooftop area for solar PV and use (% of total rooftop area)
- Operation and Maintenance costs per year (currency/year)
- Number of jobs generated in the clean energy field
- Number of new business and industry linked to the solar sector

1.5 TYPICAL LOCAL GOVERNMENT ROLES

- Data analysts/data management team
- Policy makers
- Operator of municipal facilities and infra-structures
- Procurement
- Stakeholder engagement
- Consumer
- Provider of technical capacitation

2. INTEGRATED SOLUTION OVERVIEW

	Enabler Actions	Required Actions	Multiplier Actions
Policy	• Evaluate and map regulations, energy legal framework and success case studies • Certify that the province/ state or country has adopted support scheme for PV and distributed generation • Map the need of adequate existing laws that regulate budget use, technology and public building requirements, at the local level • Set clear goals and strategies for implementation, binding them in local policy or law instruments • Design administrative processes and procedures to be transparent, uniform and accessible	• Outlining objectives for the solar PV project and defining measurable indicators • Provide incentives to units that require additional adequation on rooftops to fit the PV plants • Establish incentives for technological development, for the use and installation of solar energy and for the adoption of PV systems • Align and include the initiative with existing instruments for GHG mitigation, climate change, energy transition • Adopt and regulate net metering and billing approaches • Set limits or targets for the size of individual systems and on overall capacity for interconnection to the grid • Establish an appropriate tax incentive to ensure policy objectives are achieved • Set interconnection standards to define which power generation owned by entities other than the utility are allowed to connect to the utility grid • Facilitate participation by providing transparent, timely, and consistent information	• Creation of a municipal fund dedicated to implement PV solar rooftops in public buildings • Plan regulation for the correct disposal of equipment • Considering linkages with other policies and other projects • Set regulation/policies/law for designing all newly built public blocks with at most open space with solar-ready roofs • Create a local clean energy generation and efficiency labeling system to buildings • Promote and regulate competition in PV systems markets • Set tariff incentives or subsidies for PV adoption in the local level • Create a fund with energy bill savings to replicate the initiative in other public buildings • Use the project as a demonstration to improve domestic familiarity with solar technologies and provide information on costs, construction timelines, supply-chain issues, and grid integration considerations

	Enabler Actions	Required Actions	Multiplier Actions
Stakeholders and Awareness	• Engage the community and all involved stakeholders spreading awareness, informative and educational campaigns • Ensure that all internal stakeholders are aligned in terms of information, opinion and general knowledge. • Engage civil society, NGOs and youth that are interested in sustainability topics • Involve and inform other levels of government	• Map local stakeholders and consolidate a communication plan that indicates who will engage which stakeholder, how, and when • Highlight the benefits of the implementation of this solution • Information campaigns for staff who work in the selected buildings • Get feedback from the process through consultation sessions	• Communicate the progress and outstanding results from the project in media and public places • Build educational centers in public buildings that received the PV installations, that are open for visitation and environmental education activities • Openly share results and benefits openly with industries, private companies and citizens
Governance	• Set up an expert committee in charge of the project(s), with representatives from across the municipality • Include social participation in the process • Include and empower the participation of minority groups, ensuring a diversity of opinions • Assess laws and regulations of the PV sector and identify gaps that can be acted on	• Check if the legal status of the intended public buildings or land allows for the installation of a solar PV plant • Define how financial savings generated by the project will be distributed • Definition of the legal framework/local support scheme • Analysis of any environmental restrictions or whether permits are necessary • Provide dedicated technical advisors based within the city administration; • Include key actors in the decision-making process, such as the local electricity utility, city council, relevant municipal departments, state government, financial institutions, potential suppliers and service providers, as well as civil society	• Set up a department dedicated to institutional relations or strategic partnerships • Guarantee the distribution and integration of data, such as solar production and savings, to interested sectors and parts • Re-evaluation of the initial plans to find opportunities and challenges as time progresses • Expand the adoption of the solution by other sectors • Reflect on lessons learned and participate in advocacy • Try and streamline permitting processes to enable the expansion to other publicly-owned areas as well as privately owned buildings

	Enabler Actions	Required Actions	Multiplier Actions
Capacity Building	• Assess the availability of a qualified labor force • Build capacities of decision-makers from a managerial perspective, including indicators and reporting, financial aspects of the project, relevant policies and the basic workings of the technology • Make available extra capacity building on safety certifications and electrical norms that are required and recommended by law for technicians	• Train city staff to plan and design solar PV rooftop systems for public buildings, and take this knowledge forward • Involve the existing technicians staff in the inspection, structure installment and panel application • Enable the designed PV system operation and maintenance team to follow the execution of operation tests, maintenance, as well as train them in the effective execution of these procedures • Build capacities on building strong technical and bankable projects	• Promote research and studies around the topic • Increase relations with universities and research institutes • Select buildings to become capacity building centers to the community on solar rooftop PV • Include PV training and knowledge in universities and technical schools curriculum • Form exchange centers with industrial actors as well as developers to scale up the solution
Technical	• Assess required safety measures and considerations • Determining the preferred generation modality (self-consumption, condominium, remote consumption, shared generation). • Assess different technology standards in view of their local applicability • Check the characteristics of the products on the local market	• Assess the rooftop area and average daily radiation • Perform feasibility studies • Calculate the electricity consumption patterns of the consumer unit(s) • Calculate the average amount of solar irradiation that will shine on the PV array per day in a year • Estimate the PV nominal power needed to meet the yearly electricity generation expected • Calculate the number of panels needed and, consequently, the area the PV installation will occupy • Monitor the system through periodic inspections and analysis of data, if possible through a data management application	• Integrate PV with smart metering systems to demonstrate to users how solar can support the idea of sustainable energy behavior • Implement programs for assessment and continuous improvement of the systems • Generate and make public a technical operation manual, with good practices for system maintenance and new installations • Provide PV installations to other public buildings, parking places, etc.

	Enabler Actions	Required Actions	Multiplier Actions
Technical		• Ensure that the technical requirements regulated by policy are being delivered to the users. • Have a clear and defined contact point with the equipment manufacturer in case of faults • Choose the location of the solar PV project • Define a preliminary project timeline	
Finance	• Find financing for the technical feasibility studies needed to make the project bankable • Analyze the source of financial resources, if it is internal, loan, PPPs (public-private partnerships), performance contracts or leasing • Assessing initial financing options. • Map and involve possible external sponsors, such as private companies and the energy utility • Set strategic partnerships to be connected to funding, such as ICLEI's TAP and IRENA • Explore various financing models including crowdfunding or public-private partnerships	• Develop an investment payback assessment and financial indicators such as ROI, to communicate and support decision making • Review different project financing options available and whether there are any restrictions on access to those options • Legal and institutional study to develop tender documents, financing strategies and contract models depending on the type of investments • Decide the source of funding and follow public procedure for communication and procurement	• Attract investments to improve the system and the program in general • Make finance indicators open to the public, such as savings and other impacts • Build capacities of directors and managers on understanding and monitoring the energy bill, as checking the financial PV results. • Create a fund with the PV savings or earnings that can sponsor new projects on other public buildings in the community

3. WORKFLOW /PROCESS PHASES

3.1 PREPARATION

- Assess necessary demand and resource data: potential rooftop area, solar resource potential, average daily radiation and building energy consumption
- Analyze the correlation between solar radiation/PV electricity generation and electricity consumption
- Create the scope of the project with the milestones to be reached
- Model the electricity generation potential of PV installations under different scenarios
- Identify the potential for energy savings to maximize emissions reduction
- Enhance institutional capacities for project management, energy efficiency etc.
- Site and building analysis for feasibility
- Architectural values of the locations and surrounding buildings, whether they are suitable for rooftop solar
- Assess shading effect from buildings and vegetation to determine site suitability the production of electricity
- Preliminary selection of locations
- Selection of PV system type and design strategy
- Assess costs, necessary investments and observed payback time in the region
- Map necessary internal bureaucratic procedures for implementation
- Map necessary law changes and available sponsors
- Formalize all gathered information in a pre-project report to present to interested parties

3.2 APPROVAL

- Assess and follow the current energy and environmental regulations related to solar energy and seek relevant approvals when necessary e.g. environmental, grid connections etc.
- Ensure the approval of the project by the responsible institutions within the scope of the local government, and in the other level of governments

3.3 PROCUREMENT

- Assess different technology standards in view of their local applicability
- Check the characteristics of the products on the local market
- Observe the capability of suppliers and producers, including the quality of after-sales service
- Acquire the equipment
- Elaborate procurement documents containing full technical specifications, the technical information related to the project, and applicable standards
- Set a reverse-logistic strategy with suppliers for equipment disposal, and explore other waste-management strategies

3.4 IMPLEMENTATION

- Identification of suitable areas/facades/rooftops for PV integration
- Installation of the selected PV system, involving local staff if possible to various degrees
- Ensure accessibility for maintenance
- Increase awareness and informative campaigns regarding the solar energy and renewable sources
- Guarantee the safety of the workers, equipment and materials used
- If needed, adapt the infrastructure, ranging from structural reinforcement to ensure that the building supports the weight of the materials
- Follow the necessary procedure set by regulation to register the PV system in the distributed generation local system
- Workshop for training responsible and key staff on PV functioning and how to understand/monitor future energy bills
- Ensure stable internet connection to the inverter and install monitoring software in interested parties' devices to take advantage of digital technologies and granular data

3.5 MONITORING

- Review the results and collect more samples to have a better estimation of rooftop solar potential for the whole city
- Ensure the cost-effectiveness of the project
- Set up adequate performance indicators for operation and maintenance
- Create the maintenance schedule (recommended every 6 months)
- System maintenance includes visual inspection for signs of damage, dirt buildup or shade encroachment, and corrosion. The functionality of the inverter (15 year lifespan), lighting-surge voltage protection, and cabling/ junction box should be regularly inspected
- Create a routine to check the inverter app and check the system performance
- Distribute data to local governance committees or groups, and publicize indicators

4. REALITY-CHECK

This solution is applicable for:

- Cities, local communities, and territories that need more independence from polluting sources of energy and want to explore renewable forms of energy

- Policy makers that want to start increasing energy efficiency and decarbonizing buildings in their communities
- Cities that are seeking for clean energy solutions to territories without energy access
- Cities that want to build up decentralized generation projects and microgrids
- Cities that wish for more environmentally conscious citizens engaged with the energy transition

4.1 REQUIRED PRE-CONDITIONS

- Possibility to afford the PV system infrastructure, or access finance to do so
- Existence of geographical data and open-source geospatial software
- Qualified workers and specialized suppliers/producers

4.2 SUCCESS FACTORS

- Economic gains are reinvested by the local government in order to achieve more ambitious policy goals, which can help increase popularity of the project and buy-in
- Municipal authority or control over utilities, for on-grid connections
- Application in socially vulnerable areas contributes to energy and climate justice
- Coordinate energy strategies and municipal budget to find synergies and cost savings
- Consider the local energy capacity and energy consumption through feasibility studies
- Installation in schools can help the environmental education programs

4.3 FOLLOW-UP NEEDED AND/OR RECOMMENDED

- Consider the eventual increase of demand once the transition to renewable sources are completed (e.g. more use of electric cars and smart devices in buildings) and plan accordingly
- Consider the rebound effect, where there can be a behavioral change in consumption after the installation, increasing energy demand
- Eventually audit the project in order to find opportunities for cost savings/greater efficiencies
- Involve the community in the decision making process and to spread awareness
- Prioritize local suppliers and workforce
- Monitoring if utilities are billing and crediting energy correctly after the PV application, in case of on-grid systems

4.4 BARRIERS

- The availability of high-quality GIS data to assess the energy potentials is not possible everywhere; efforts can be made to improve raw data, working with partners if need be
- Possible need for adjustments to be made in the roof to install the PV system, which should be accounted for with details studies
- Lack of support and additional bureaucracy from the utilities in the project, which can cause delays
- Conventional power generators may not be interested in investing in renewable electricity generation, believing in the reduction of wholesale electricity prices
- Lack of PV industry expertise and qualified workforce

4.5 RISKS

- The generation capacity of PV is mainly influenced by solar irradiation, which can vary
- The possible risk of non-acceptance of the "alternative visual impact"
- Shading effects, especially by other buildings in urban areas, can cause reductions in electricity generation
- Sabotage/mishandling of PV modules if installed within the reach of the public can be a risk
- Incorrect disposal of equipment after its lifetime can have environmental impacts due to the toxic elements used—a waste management strategy should be devised at the earliest
- The need to build more panels after project implementation due to an energy demand increase caused by the commonly observed rebound (reduced electricity prices lead to more consumption)
- Natural disasters or weather events can damage equipment

5. CLIMATE CHANGE MITIGATION POTENTIAL

Cities are at the forefront of efforts to reduce global carbon emissions because they house the largest part of the population and account for more than 70% of CO_2 emissions. Buildings are the most significant source of emissions in cities, accounting for 50–70 percent of city emissions and 38 percent of global emissions. Action in the buildings sector is critical for meeting global net-zero emissions targets.

Matching electrical supply to demand is a balancing process, and buildings may assist in achieving this equilibrium by hosting new distributed resources, storing power, and optimizing usage. Solar PV systems are a good option to meet energy demand in a low-carbon way for buildings. PV systems are combustion-free, which means that no fossil fuels are burned during the operating period. As a result, there is no production or release of greenhouse gasses (GHG) such as CO_2, NO_X, water vapors, and so on.

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

6.1 BENEFITS TO LOCAL GOVERNMENT

- Reduction of CO_2 emissions
- Power outages can be better managed due to higher independence from the grid, in case of hybrid systems (batteries + on grid)
- Attraction of investments and development of the solar PV industry and ecosystem.
- Generation of local, high-quality jobs.
- Improvement of local level grid reliability
- Job generation and capacitation of staff
- Provides savings in energy bills and even profiting, depending on the business models (net billing, for instance)

6.2 BENEFITS TO OTHER LEVELS OF GOVERNMENT

- Enable data to feed and make feasible smart grid/cities on a larger scale
- Environment protection
- Engagement of the citizens in sustainability matters in general
- Concrete cases for improving public policies on solar energy and decarbonization of public buildings
- Starting transition to renewable energy sources of the country in general
- If numerous, decentralized PV systems alleviates the demand pressure of the national grid and need to plan new centralized power plants
- Have examples and case study that can facilitate multiplying the project in other cities and regions
- Contribution to the country's NDCs and subnational mitigation goals

7. RESOURCES/SUPPORT

7.1 CASE STUDIES

THE ECONOMIC VIABILITY OF PHOTOVOLTAIC SYSTEMS IN PUBLIC BUILDINGS: EVIDENCE FROM ITALY

D'Adamo, Idiano; Falcone, Pasquale Marcello; Gastaldi, Massimo; Morone, Piergiuseppe (2020). The economic viability of photovoltaic systems in public buildings: Evidence from Italy. Energy, 207(), 118316–. doi:10.1016/j.energy.2020.118316

Abstract (retrieved from the article): "Photovoltaic (PV) systems transform solar irradiation into electricity, thereby substituting for traditional energy sources and reducing environmental pollution. The present work evaluates a developed market (Italy) in which subsidies have been reintroduced for PV plants with a nominal capacity above 20 kW through the FER1 (renewable energy sources) Decree. The discounted cash flow (DCF) methodology is applied to several cases of PV plants in public buildings, in order to determine the value of several critical variables (i.e. level of insolation, plant size, share of self-consumption, investment cost, electricity purchase price). In particular, differences in net present value (NPV) and discounted payback time (DPBT) between subsidy and no-subsidy scenarios are quantified. Break-even point (BEP) analysis is used to define the share of self-consumed energy for which NPV is positive. This share is found to range from 9 to 28% in 105 kW plants and from 10 to 35% in 25 kW plants. In addition, the results verify profitability in almost all of the baseline case studies and only half of the alternative scenarios (involving no subsidies). The estimated profits are consistent with investments aimed at increasing the share of self-consumed energy."

ENERGY EFFICIENCY AND SOLAR ENERGY AT SCHOOLS PORTO ALEGRE, BRAZIL

Energy efficiency and solar energy at schools Porto Alegre, Brazil. Published by: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, March 2019. Available at: https://www.giz.de/en/downloads/giz2019-felicity-energy-brazil.pdf

Abstract copied from case study: "The municipality of Porto Alegre, capital of the state Rio Grande do Sul with approximately 1.48 million citizens, foresees the use of solar energy and increased energy efficiency of their public buildings. In this project, schools, mostly located in socially disadvantaged areas, will be equipped with photovoltaic (PV) panels and energy efficient appliances. In cooperation with the local utility, the electricity surplus from PV panels would be sold to the electricity grid, following a successful pilot. The first phase of the project will include schools located in the 4th District, as part of an urban revitalisation programme facilitated by the 100 Resilient Cities Platform."

7.2 OTHER RESOURCES

- Technical Guide for Estimating Building Rooftop Solar Potential in a City
- Grinberg, E. (2022, March 11). Technical Guide for Estimating Building Rooftop Solar Potential in a City. Bookdown.org. https://bookdown.org/einavg7/sp_technical_guide/
- Tool for Analyzing Solar Potential in Public Building - FASES (available for Brazil): https://ukbrazilgreenfinanceprogramme.com/baixar-ferramentas

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