Municipalities as Agents for Renewable Energy Technology Diffusion:

How Can Communities Participate?

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Renewable Energy Technology Diffusion in Albanian Municipalities

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by
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ABSTRACT

An estimated 95% of Albania's electricity comes from hydropower, an energy source threatened by changing precipitation patterns associated with climate change. To assist the country's transition to renewable energy, the German Development Agency, GIZ, works with Albanian municipalities to expand solar photovoltaic and energy-efficient technologies through pilot programs. To support the diffusion of these technologies, we analyzed the GIZ pilot program in Elbasan. We interviewed municipal officials and community-based organizations to assess the drivers and barriers to the diffusion of renewable energy technology and community participation. We found community involvement faces difficulties in Elbasan and recommend collaborative workshops between municipalities, development agencies, and NGOs.

ACKNOWLEDGEMENTS

We would like to thank the many people who contributed to the success of this project. Thank you to Melanie Doka and Anisa Bali who acted as our translators and accompanied us to Elbasan.

Thank you to Bledar Bacova, CEO of ALVision, for your insight into solar legislation here in Albania and for providing us with your expertise.

Thank you to Vice-Mayor of Elbasan Aullona Blylkbashi for taking the time to speak to us about Elbasan's involvement in the pilot program and its plans to become a greener city.

A special thanks to Ahmet Mehmeti and Ervis Çota, Executive Directors of the Elbasan Ecological Club and the Youth Roma and Egyptian Community, respectively. Thank you for sharing your stories and the stories of your communities. Thank you for your kindness and honesty, and for your ongoing work.

We would like to acknowledge our advisors, Professors Robert Hersh and Leslie Dodson. Your guidance, knowledge, as well as your commitment to pushing us to go beyond despite the challenges we encountered, shaped this project in a wonderful way.

Finally, thank you to everyone on the GIZ Climate Programme team at GIZ for embracing us with your knowledge and hospitality. We would especially like to acknowledge Emi Kaduku who acted as our primary sponsor. Your passion for your work and your eagerness to share it with us made long days in the office good days. We are extremely grateful for this opportunity to have worked on such a current issue.

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Brianna is a third-year student at WPI studying computer science. She wants to work with both robotics and software after graduating. She really enjoyed hiking and exploring nature in Albania.

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Understanding Hydropower, Solar Potential, Pilot Programs, and Diffusion in Albania - Overview	ALL	N/A
Factors Supporting Increased Solar Investment	BS, MS	N/A
Albania’s Energy Mix, Hydrological Resources in Albania	BS	N/A
Climate Change Impacts on Hydropower	BS	N/A
An Alternative to Hydropower	MS	BS
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Energy Imports and Increasing Demand	MS	N/A
Challenges to Solar	MS	BS
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The Pilot Program in Elbasan and Shijak	MS, ER	KC
Diffusion and Citizen Participation Frameworks	KC	BS
Our Approach	ALL	N/A
Our Discoveries	KC, BS, MS	ER
Recommendations	ALL	N/A
Conclusion	ER	ER

EXECUTIVE SUMMARY

BACKGROUND

Albania currently relies on hydropower to generate an estimated 95% of the country's total power supply (IRENA, 2021). Due to seasonal production deficiencies from fluctuations in precipitation and water levels, Albania must import oil, gas, and coal from neighboring countries. Furthermore, the Russian war in Ukraine has created an energy crisis in Europe that has led to a steep price increase for energy imports.

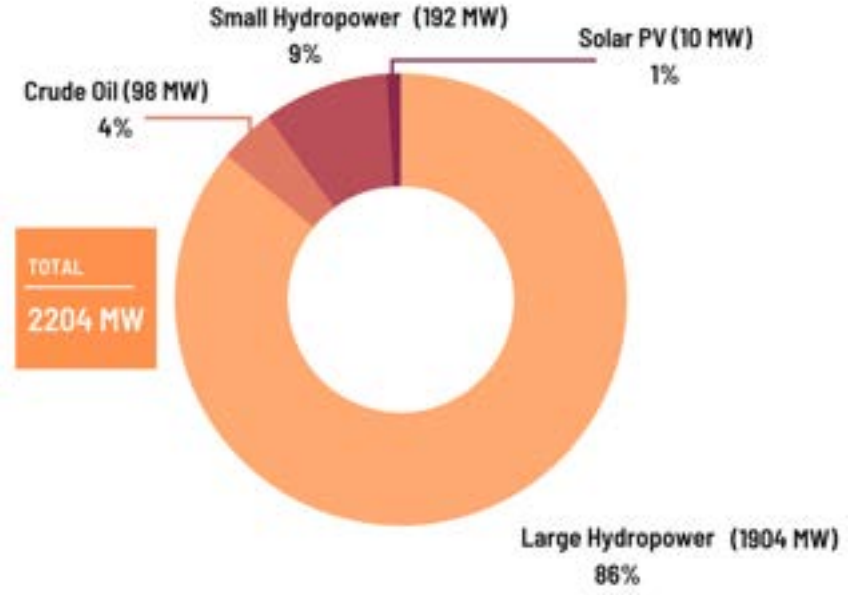

Figure A Hydropower stations account for 95% of Albania's energy production (Graph adapted from IRENA)

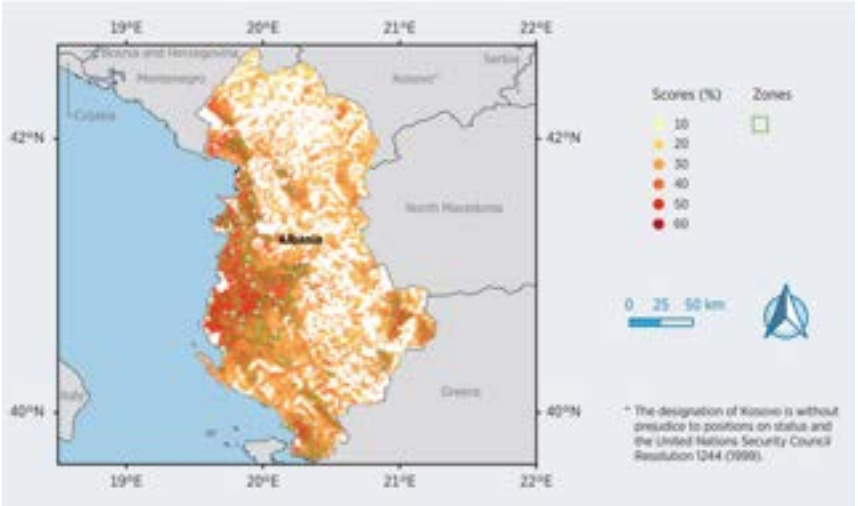

Figure B: Suitable zones in Albania for PV development (IRENA, 2021)

Albania has a Mediterranean climate: winters are rainy, while the summers are hot and dry (Qatar Embassy in Tirana - Albania, n.d.). A 2013 study by Anuela Prifiti (2013) collected and analyzed 30 years worth of meteorological data and concluded that Albania experiences approximately 280 sunny days/year. Not only are these sunny days frequent but also intense: the average daily solar irradiation in Albania is approximately 4.1 kWh/m2, compared to 2.8 kWh/m2 in northern Europe making it a viable candidate for successful photovoltaic implementation (Alkholidi & Hamam, 2019) (Inforse, n.d.)

GIZ's municipal PV pilot program provides municipalities of Elbasan and Shijak with an opportunity to install, and potentially, diffuse PV and EE bulbs into surrounding cities and private residences. GIZ provided the installation of PV and EE at no cost to the municipalities. This pilot program provides a framework and model for what other municipalities can expect to save upon implementing these systems. GIZ provides the cities with a report of average supplies, costs, and all other aspects of the installation.

APPROACH

This project aims to support the diffusion of renewable energy technologies by analyzing the role municipalities can play and identifying opportunities for community-based organizations to participate in energy transition initiatives. These pilot programs intend to spread awareness of solar energy benefits, reduce energy expenditures, diversify means of energy production, and potentially address current energy price increases.

In our interview, with Merita Mansaku-Meksi, GIZ Senior Climate Advisor, and Emi Kaduku, GIZ Junior Climate Advisor, we asked about the structure of the pilot program and the motivation behind the pairing of EE and solar panel technology in these programs. With the CEO of ALVision, Bledar Bacova, we inquired about the logistics of the implementation of solar panels. To better understand municipal motivations to implement PV, current efforts to promote PV to the public, and challenges to expand the program, we interviewed Aulona Bylykbashi, the Vice-Mayor of Elbasan. We interviewed Ahmet Mehmeti, executive director of the Elbasan Ecological Club, and Ervis Çota, executive director of the Youth Roma and Egyptian Movement, to understand how their community members could benefit from the savings from the pilot program. To assess changes in Elbasan's energy production, efficiency, and expenditures surrounding the pilot program we utilized criteria from the Cloud-TODIM model established by Wu et al., the Sunny Portal software, and GIZ's feasibility study. We applied Roger's Diffusion of Innovation Theory, OECD Framework for Innovation in the Public Sector, and Arnstein's Ladder of Participation to key informant interviews with the Vice-Mayor of Elbasan, the CEO of Alvision, GIZ, and NGO representatives to identify and analyze the different aspects of diffusion present in GIZ's municipal pilot program.

RESULTS

GIZ sees municipalities as an important catalyst and partner to transition to sustainable energy sources as specified in the NDC Assist II program. GIZ chose to support the dispersal of solar photovoltaic technology to municipalities due to their capability to maintain the installments and the high solar irradiance in western Albania. GIZ determined that EE bulbs would not only help with the public lighting expenses, but were inexpensive as an energy efficiency technology. When developing interventions for municipalities, GIZ's efforts align with the Matching Stage of Rogers' Diffusion of Innovation in Organizations framework.

Municipal departments in Shijak seem to lack collaboration, pilot project management, leadership, and engagement found in the municipality of Elbasan. The lack of interest of Shijak's municipal leaders could unfortunately hinder diffusion at the innovator and organizational level (leaves public administration or society to push for innovation).

The municipality has taken it upon itself to use its expertise to decide where the savings from the pilot program should go without community input; this interaction corresponds to the Informing rung of Arnstein's Ladder.

Although our observations and interviews did not identify an existing knowledge gap as an obstacle to expansion, other barriers are preventing the spread of photovoltaics. Knowledge about solar does not lack; technical know-how, planning, communication, "investment" and interest does.

In Elbasan, we're seeing how a lack of technical knowledge in the Department of Projects is preventing implementation of more PV programs. The city made efforts to start a private-public joint program in 2015 to implement solar panels and EE bulbs around the city before budget constraints required the municipality to invest more in non-solar infrastructure and halt the solar project.

In Albania, there is currently no standards entity ensuring the quality and safety of solar installments. The four largest private solar companies in Albania have taken it upon themselves to act as this entity, a prime example of the importance of partnerships in the process of diffusion (OECD Ways of Working). Solar companies are equipped with the resources to safely and effectively install and maintain large projects (Bacova, personal communication, November 25, 2022). However, there is limited interest in these projects due to current constraints placed on the private use of PV.

PV Power Generation	Regulation
Under 500kW	PV unit can self-consume
Between 500kW - 2MW	Operators of the PV unit must obtain "Energy Producer" status that requires licensing and potentially additional cost. They must abide by energy prices set by the government.
Above 2MW	Operator of the PV unit can sell this energy at their own price

Figure C: Current regulations for PV production in Albania (2022)

Cooperation and collaboration among NGOs in Elbasan strengthens the community voice and increases public participation. According to Mr. Mehmeti, it is his NGO's responsibility to pressure governments in cooperation with the community to change things to be more beneficial (Mehmeti, personal communication, December 1, 2022). Arnstein's Ladder of Participation indicates the Ecological Club of Elbasan's participation in the municipal budgeting process is at the bridge between Placation and Partnership. The Youth Roma and Egyptian Movement experiences limited influence in municipal decisions about resource allocations. As soon as a campaign involves municipal spending they are no longer heard at consultation meetings. With the savings from the Imunicipal pilot program, local NGOs prioritize addressing high levels of pollution in Elbasan and improving infrastructure in the Roma and Egyptian community, including the school and the addition of a multi-purpose facility.

RECOMMENDATIONS

To explain how PV and EE technologies work, promote their savings and benefits, and involve the community in energy initiatives, we suggest the widespread use of science communication materials. We sought to utilize meaningful data that could be transformed into familiar and relatable science communication materials for the respective audience.

Based on our interview with the Vice-Mayor of Elbasan, one of the greatest obstacles to the diffusion of renewable energy technologies is funding. We recommend that savings generated from municipal PV and EE installations be earmarked, at least in part, for further renewable energy investment. For example, an earmark of about 50% of the pilot program savings could be reinvested in renewable energy technologies whereas the other 50% could be invested into other priority areas for the municipality like parks, housing, hospitals, and schools. This will facilitate the expansion of these necessary renewable energy technologies by ensuring

there are available funds. With the earmarked savings, the municipality could offer subsidies for residential energy conservation including EE bulbs and thermal insulation.

Our interviews with Ahmet Mehmeti and Ervis Çota taught us that NGOs commonly address and promote their goals through collaboration. Each director identified campaigns and protests that involve multiple NGOs working towards a common goal. To reinvigorate effective NGO collaborations, we recommend that GIZ organize strategy sessions with NGOs. Before these sessions, we recommend that GIZ create a guidebook to be shared with the participants. The guidebook should be an agenda for the session containing information about PV and EE savings and how NGOs can better work together to obtain more from these savings through municipal budgeting processes.

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ALBANIA'S NEED FOR AN ENERGY TRANSITION

In Albania, as is the case around the world, there is an increasing interest in initiating a transition to renewable energy. A transition to renewable energies aims to limit greenhouse gas emissions while also keeping up with energy demand. The shift toward renewable energy incorporates the use of energy sources such as biomass, hydropower, geothermal, wind, and solar (U.S. Energy Information Administration, 2022).

Albania currently relies on hydropower to generate an estimated 95% of the country's total power supply (International Renewable Energy Agency [IRENA], 2021). Due to seasonal production deficiencies from fluctuations in precipitation and water levels, Albania must import oil, gas, and coal from neighboring countries. Furthermore, the Russian war in Ukraine has created an energy crisis in Europe that has led to a steep price increase for energy imports. According to the European Council and the Council of the European Union (2022), "the deliberate reduction of gas supplies by Russia is the main cause of the recent skyrocketing gas prices in the EU, which have impacted the price of electricity produced in gas-fired power plants and affected electricity prices overall," (para. 2).

Albania currently relies on hydropower to generate about 95% of the country's total power (IRENA, 2021). Due to seasonal production deficiencies from fluctuations in precipitation and water levels, Albania imports oil, gas, and coal from neighboring countries. The current European energy crisis has led to a steep price increase for energy imports, "the deliberate reduction of gas supplies by Russia is the main cause of the recent skyrocketing gas prices in the EU, which have impacted the price of electricity produced in gas-fired power plants and affected electricity prices overall" (European Council & Council of the European Union, 2022, para. 2).

Efforts to broaden Albania's energy mix invites an analysis of incentive structures, conditions for innovation, and strategies for expansion. What incentives are offered to support the diversification of the energy sector? What are the circumstances driving or hindering diffusion in Albania? What are the developing strategies to promote expansion?

The sponsor of this project, GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit) GmbH has been active in Albania since 1988 across many priority areas including adaptation to climate change, municipal services, and energy efficiency (GIZ, 2021). In Albania, GIZ has invested in renewable technologies to address the energy crisis and contribute to an energy transition from two avenues. The first is energy production by means of solar photovoltaics (PV). The second is to address the consumption side of the equation through energy-efficient (EE) streetlight bulbs. In 2021, GIZ implemented pilot projects of PV panels and EE bulbs in two municipalities, Elbasan and Shijak. In each municipality, GIZ and its partners installed rooftop solar photovoltaic systems and replaced high-pressure mercury bulbs on urban roads with EE bulbs to address energy consumption.

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

As of December 2022, GIZ was assessing early-stage data on the power generated from the photovoltaic systems installed in Elbasan and Shijak and the cost savings resulting from EE streetlights in both cities. The organization was also particularly interested in determining municipal-level motivation to expand the use of these technologies throughout the municipality and to identify opportunities to support the spread of PV and EE technologies in municipalities across Albania.

To further our sponsor's efforts to spread awareness of solar energy benefits, reduce energy expenditures, diversify means of energy production, and potentially address current energy price increases; our team pursued the following objectives:

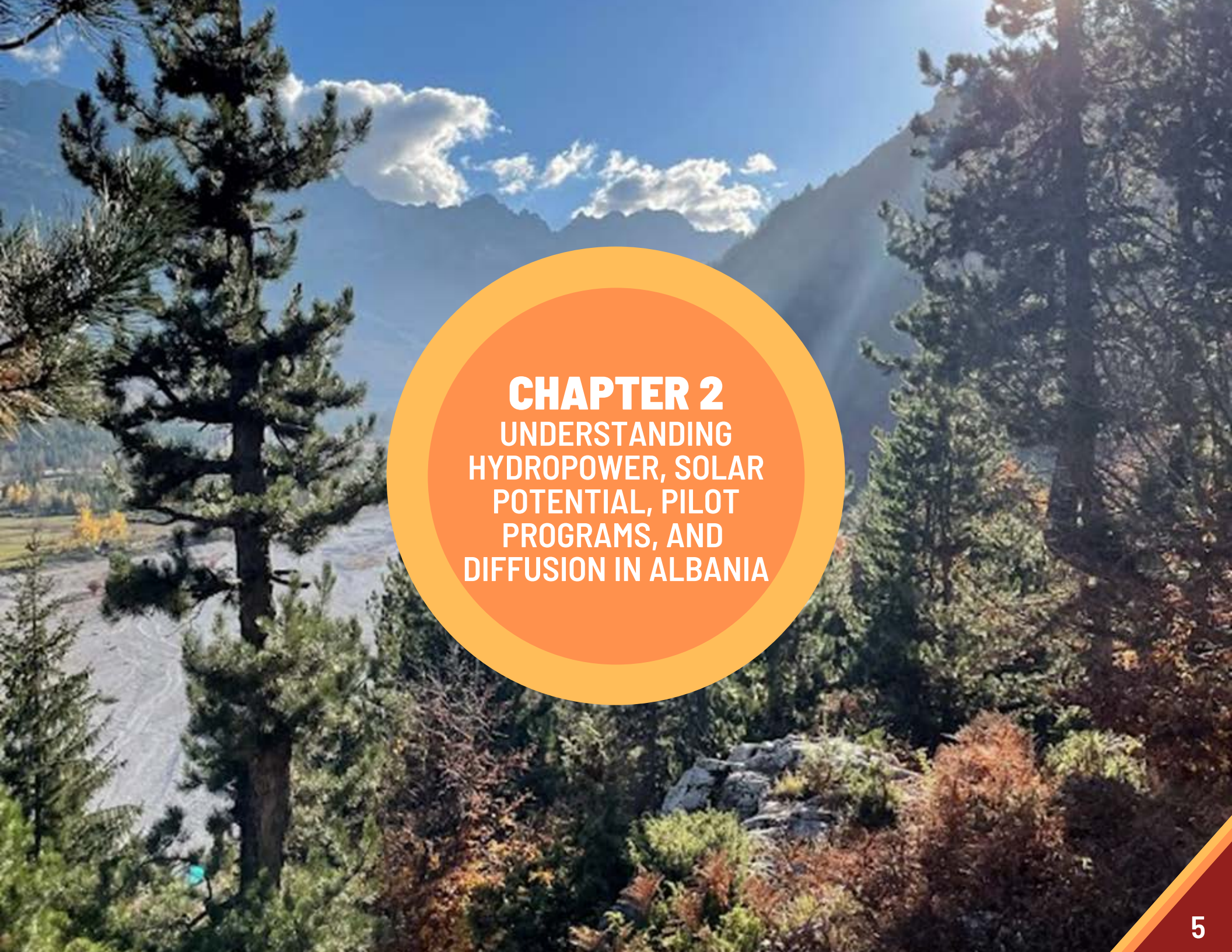
i. Understand the design and planning of each municipal pilot program

ii. Document the current state of each municipal pilot program as well as municipal capabilities to implement, manage, and expand PV and EE technologies over the long term

iii. Identify how community-based organizations can influence the allocation of municipal savings from PV and EE technologies

iv. Analyze PV energy production, energy consumption by the municipality, and efficiency of EE bulbs to compare with data from the previous year (before PV and EE) and identify savings

Based on these research objectives, our goal was to understand the process of renewable energy technology diffusion in Albanian municipalities and identify opportunities for community-based organizations to participate in energy transition initiatives. To accomplish our mission, we analyzed the role of the municipalities of Elbasan and Shijak in the diffusion of renewable energy technologies, assessed community participation in energy transition initiatives, and how residents can access the savings from these initiatives. We conducted interviews with experts, including the Vice-Mayor of Elbasan, the CEO of ALVision, and local NGO leaders in Elbasan to learn more about municipal savings from the pilot program, PV system implementation, and municipal budgeting processes. We utilized these various perspectives to develop a series of next steps to support the further diffusion of PV and EE technologies at the municipal level and develop strategies to increase community engagement.



CHAPTER 2
UNDERSTANDING HYDROPOWER, SOLAR POTENTIAL, PILOT PROGRAMS, AND DIFFUSION IN ALBANIA

UNDERSTANDING HYDROPOWER, SOLAR POTENTIAL, PILOT PROGRAMS, AND DIFFUSION IN ALBANIA

FACTORS SUPPORTING INCREASED SOLAR INVESTMENT

Albania signed the Paris Climate Agreement in July 2016, initiating the Albanian government's responsibility to reduce greenhouse gas emissions by 2030. The country's revised National Determined Contribution (NDC) targets a CO2 emissions reduction of 20.9% from 2021-2030 (NDC Partnership, n.d.). Albania is also a candidate country for the European Union (EU). Accomplishing the NDC and continuing to diversify sources of energy is important for Albania to gain membership to the EU. To start to address the requirements of the NDC and EU membership, municipal pilot programs involving photovoltaics and energy-efficient bulbs have been implemented.

ALBANIA'S ENERGY MIX

Solar photovoltaic (PV) power generation accounts for only a tiny portion of Albania's energy mix. According to the International Renewable Energy Agency's Renewables Readiness Assessment [IRENA] (2021) for Albania, the 2021 production capacity of hydropower stations (small and large) totals approximately 2096 MW, or roughly 95% of Albania's total power generation capacity. Other energy generation sources include 4% of total energy from crude oil, and only 10 MW, or just 1%, from solar photovoltaic capacity (Figure 1).

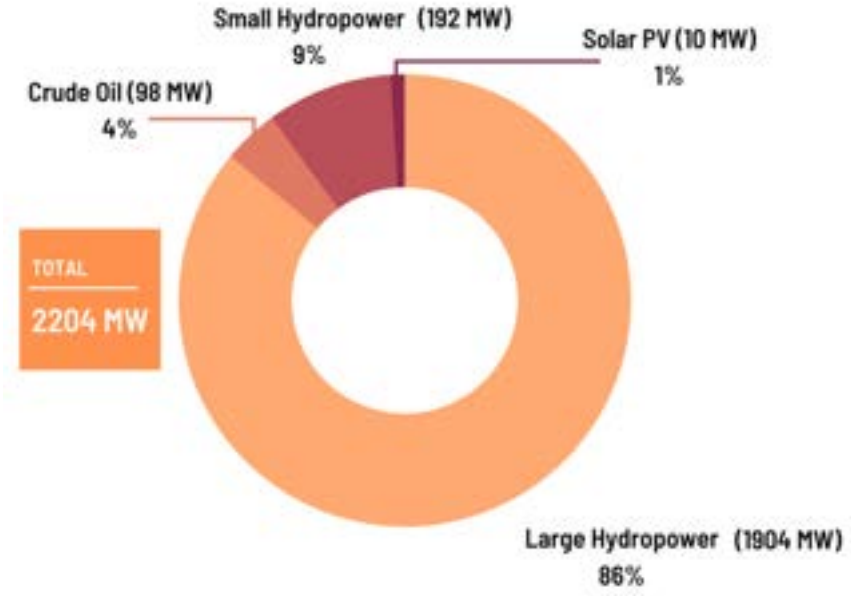


Figure 1: Hydropower stations account for 95% of Albania's energy production. (Graph adapted from IRENA)

HYDROLOGICAL RESOURCES IN ALBANIA

Albania has rich hydrological resources that are advantageous for hydropower plant construction and generation (National Agency of Natural Resources, 2019). The country contains several major rivers that empty into the Adriatic Sea on which numerous hydropower stations are constructed (International Hydropower Association, n.d.). The Drin River in northern Albania is the largest river and the site for the three major hydropower stations including the Fierzë (500 MW), Komani (600 MW), and Vau I Dejës (250 MW) stations (IRENA, 2021). These three stations produce 61% of Albania's domestic energy.

CLIMATE CHANGE IMPACTS ON HYDROPOWER

Droughts cause hydropower energy sources to become less productive. According to the National Integrated Drought Information System (n.d.), when water levels in reservoirs become low, the force of water pressure required to turn hydro turbine blades is reduced, which affects productivity" (para. 3). The Climate Change Knowledge Portal drought simulation projections indicate that Albania will face severe drought conditions by the end of the 21st century (World Bank Group, n.d.).

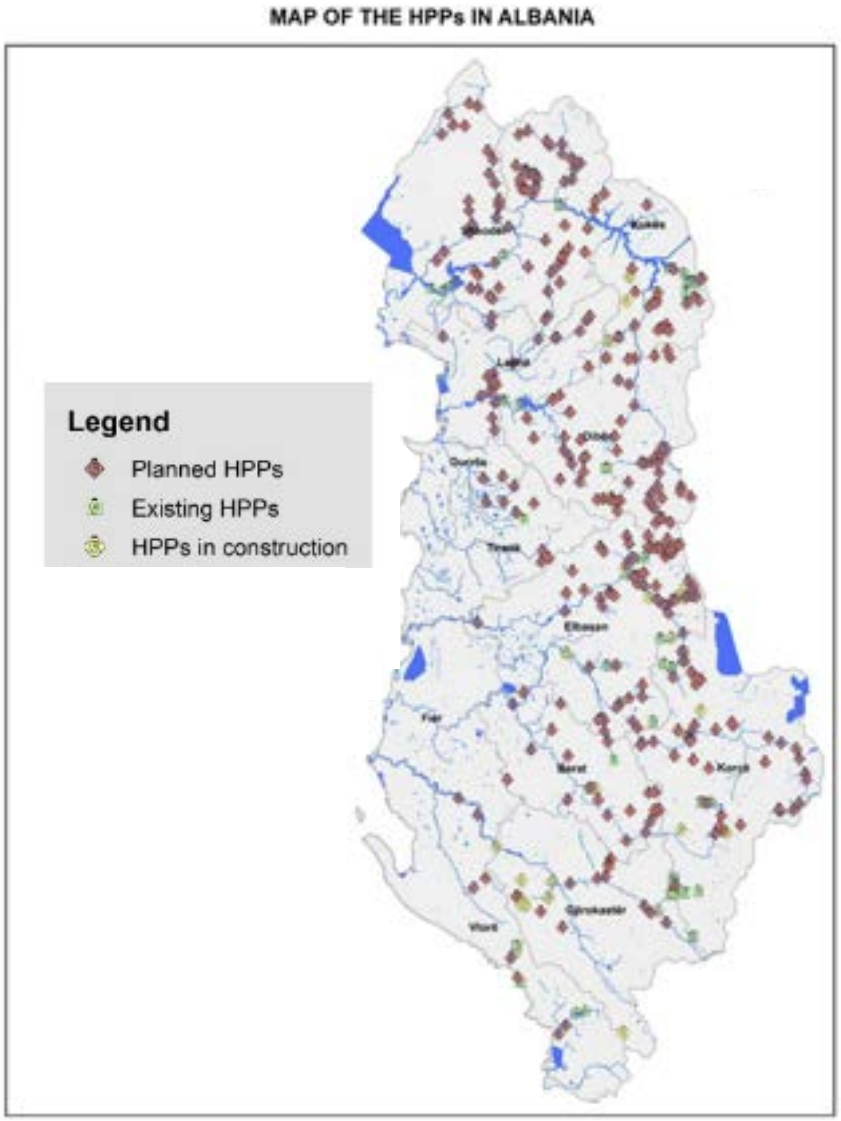


Figure 2: This map shows the locations of hydropower plants across Albania. The red markers represent planned HPPs, yellow markers represent HPPs under construction, and green markers represent existing HPPs. (Adapted from EcoAlbania, 2017)

Alongside drought, the combination of extreme rain events and the dwindling snowpack is a threat to hydropower production. Extreme rain events and associated flooding creates a risk for "overtopping [of dams], [power] outages, damage to equipment and adverse downstream impacts" (Climate ADAPT, 2019, para. 1).

In October 2021, Prime Minister Edi Rama declared a state of energy emergency in Albania, which has been extended until December 31, 2022 (Ceta, 2022) (Kuka, 2021).

AN ALTERNATIVE TO HYDROPOWER

A Nature Communications academic journal argues that solar power "enhances drought resilience" (He et al., 2019, para. 1). This is because globally, hydropower plants compete for water for other uses such as crop irrigation. This competition between water for hydropower production and irrigation use increases during drought periods, much like the ones Albania currently experiences. Using solar power generation instead of hydropower will allow for more water resources to be available during drought periods, thus enhancing drought resilience while also producing renewable, reliable energy.

Another benefit of solar is that, unlike hydropower plants, solar installations are more durable and require less maintenance. Solar panels are built from monocrystalline silicon or tempered glass, durable materials that are able to withstand heavy rain and other extreme weather events (New Day Solar, 2022). Albania experiences a rainy winter season, according to New Day Solar (2022), "rain does not negatively affect solar panels. In fact, they may help naturally clean the panels of dirt and debris. And rain also is reflective, attracting more light to the panels and, therefore, more energy" (para. 5).

BENEFITS OF SOLAR ENERGY

As a renewable energy source, solar energy is not only constantly replenished but also does not emit greenhouse gasses and thus does not contribute to climate change. Solar energy production also does not emit contaminants into the environment; while solar installations take up space, they do not pollute the air, land, and water. It is especially important that water is preserved in solar power production because hydrological resources are dwindling (Acciona, n.d.).

Solar power is also more reliable than other energy sources because solar resources do not decrease like fossil fuels and hydrological resources. Solar energy also comes with financial benefits. Solar is cheaper to produce and consume and offers feed-in incentives. In October 2022, Bloomberg reported that solar energy was 33% cheaper than gas power in the US (Adegbesan, 2022). A study conducted by Rystad Energy (2022) projected that operating a gas-fired plant in Europe would be ten times more expensive than building a new PV plant. Typical solar setups also allow for unused or excess energy to be fed back into the grid and sold back to the supplier which is a way to lower monthly bills for consumers.

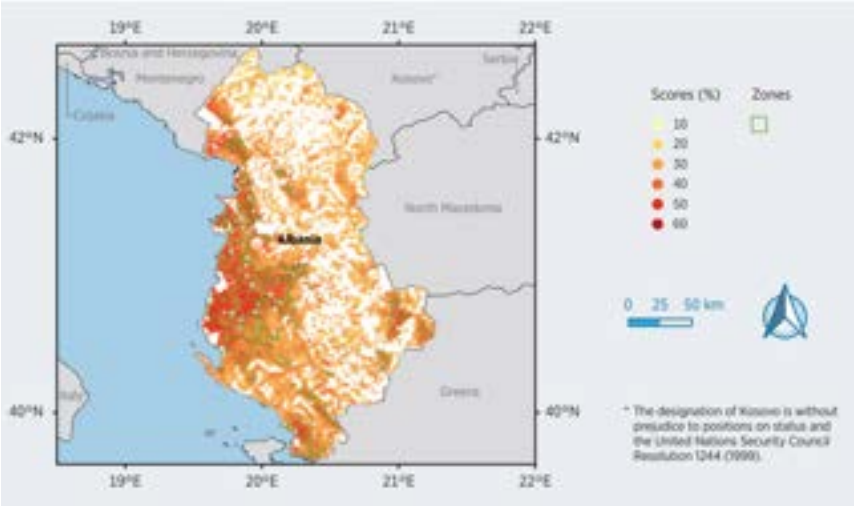


Figure 3: Suitable zones in Albania for PV development (IRENA, 2021)

SOLAR RESOURCES IN ALBANIA

Albania has a Mediterranean climate: winters are rainy, while the summers are hot and dry (Qatar Embassy in Tirana - Albania, n.d.). A 2013 study by Anuela Prifti (2013) collected and analyzed 30 years worth of meteorological data and concluded that Albania experiences approximately 280 sunny days/year. Not only are these sunny days frequent but also intense: the average daily solar irradiation in Albania is approximately 4.1 kWh/m2, compared to 2.8 kWh/m2 in north Europe making it a viable candidate for successful photovoltaic implementation (Albanian Investment Development Agency, n.d.)(Inforse, n.d.).

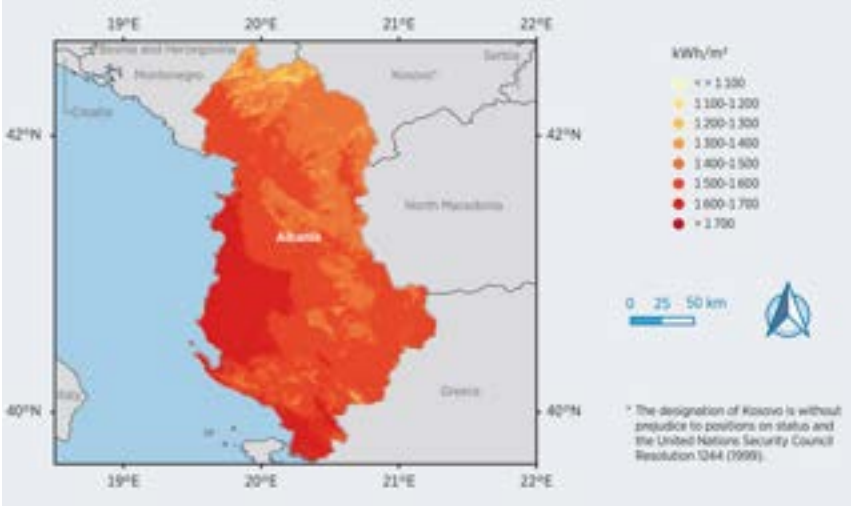


Figure 4: Albania's annual average Global horizontal irradiance (GHI). GHI is the total solar radiation acting on a horizontal surface on the earth. (IRENA, 2021)

A 2020 study conducted by EcoAlbania on rooftop PV potential in Tirana affirmed that implementing photovoltaic sources could lead to more stable power production by eliminating some of the load on the electrical grid while simultaneously reducing residents' energy bills (Kroemke, 2020).

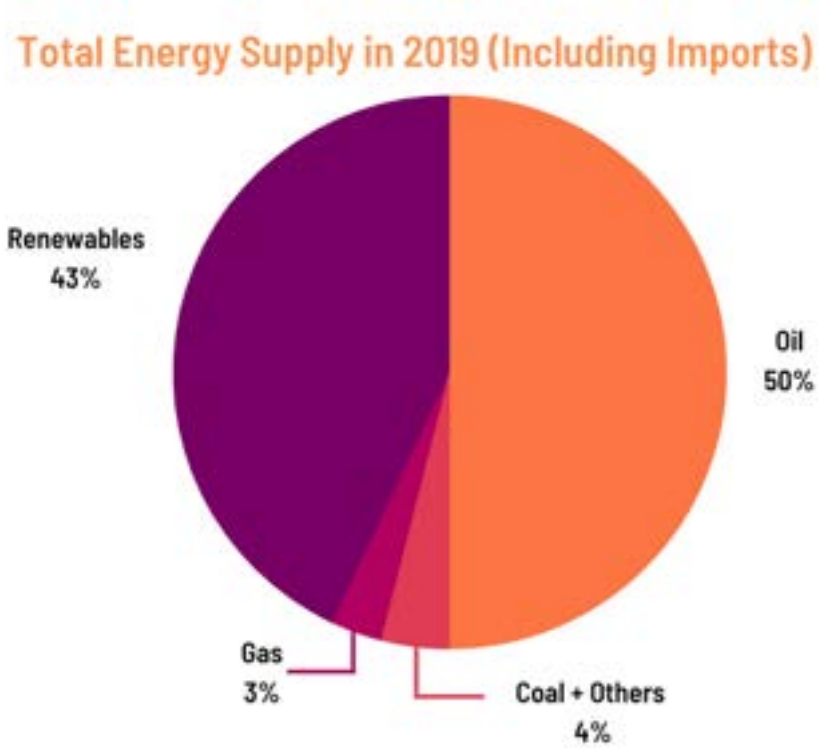


Figure 5: Oil makes up 50% of Albania's energy supply (Adapted from IRENA)

ENERGY IMPORTS AND INCREASING DEMAND

One weakness of Albania's current energy system is its dependence on fossil fuel imports. In the summer of 2017, Balkan Green Energy News (2017) reported that Albania had to import around 80 percent of its electricity "due to the exceptionally dry period and high temperatures" (para. 1).

By November 2021, Albania had spent 213 million euros on energy imports. This amount grew to over 300 million euros by September 2022 and the central government said energy imports could reach 680 million euros by the end of the year (SEE Energy News, 2022) (Kote, 2022).

Reasons for the increased imports in Albania include a 40 percent decrease in domestic energy production in the first eight months of 2022 compared to the same months in 2021. The European energy crisis has led to the price of energy imports skyrocketing.

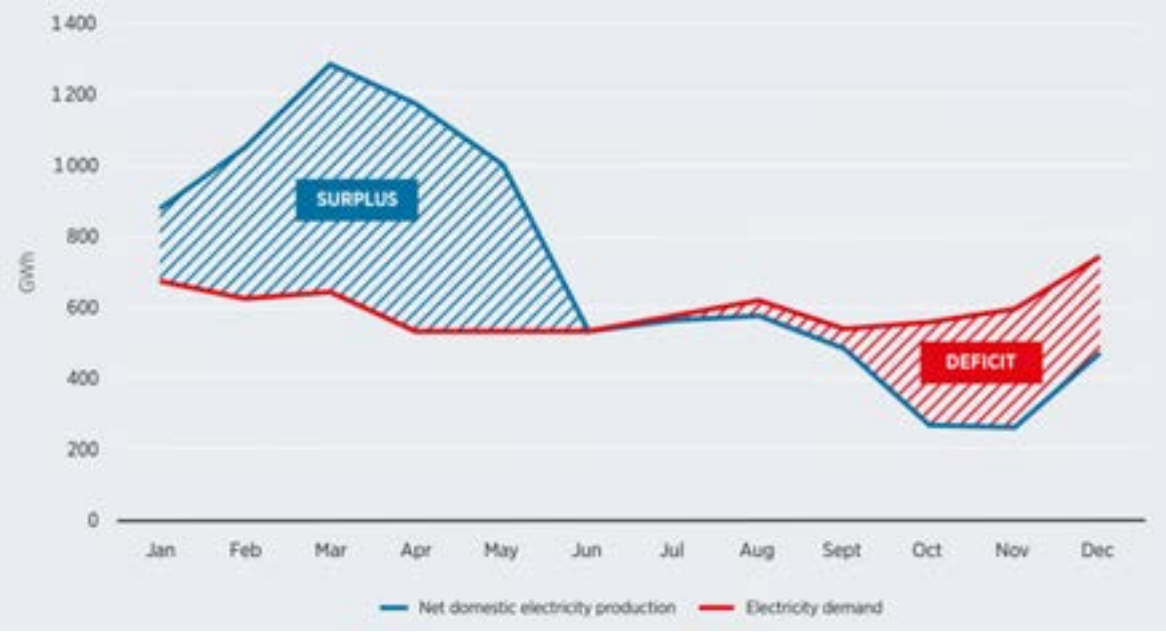


Figure 6: Albania's electricity production vs. demand from 2018 (IRENA, 2021)

Russia has been withholding its natural gas supply from Europe in response to sanctions imposed following the Kremlin's invasion of Ukraine. Nuclear and hydroelectric generation across Europe has not been sufficient to meet energy demand, making the continent more dependent on gas despite its surging price (Zettelmeyer et al., 2022).

Albania's energy demand is expected to increase by 77% in 2030 compared to 2018's energy demand (IRENA, 2021). As previously mentioned, Albania has to import energy to meet its current rising demand. A 77% increase would seriously burden Albania's energy system and lead to a greater need to import, reducing Albania's energy independence.

CHALLENGES TO SOLAR

Despite the conditions increasing the practicality of solar energy, there are socio-economic, institutional, and technical barriers preventing the implementation of photovoltaics (Zavalani & Spahiu, 2011).

One challenge to solar is the lack of incentives that exist because solar is such a new technology in Albania and because of the focus on hydropower. "Until 2017 Albania only offered renewable energy incentives for hydropower and as a result, solar PV and wind have remained underdeveloped" (Bankwatch Network, n.d., para. 6). Without incentives and financial assistance, a high initial investment cost deters residents from installing solar systems.

A lack of understanding of the technology is also an obstacle to the diffusion of PV, especially for private PV use. A UNECE report claims that for solar energy to be more widely adopted at the household level citizens need to "understand the direct benefits of renewable energy technologies" (Vajdic, 2021, p.34). Furthermore, a "lack of understanding of the payback periods of such investments discourage citizens to participate and to help uptake the renewable energy sector in Albania" (Vajdic, 2021, p.34). In addition, Albanian policymakers and engineers do not have experience implementing renewable energy projects which can prevent and delay new projects (Gallop, 2021).

Another factor contributing to the need for a new energy resource is the increased energy demand in Albania, which is expected to increase by 77% in 2030 compared to 2018's energy demand (IRENA, 2021).

ASSESSING MUNICIPAL PV PROGRAMS

Municipalities are commonly at the center of energy transition projects (Seetharaman et al. 2019). Wu et al. (2019) used a cloud-TODIM (Multicriteria Interactive Decision Making) model to assess a case study of a rooftop PV project in Shandong, China. The model identified key elements of a municipality's economy, available resources, potential risk factors, and engineering capacity affecting the operation and production of municipal PV programs (Figure 7).

Evaluation Criteria (Wu et al. 2019)	
Economic Factors	• Construction Cost • Operation and Maintenance Cost • Annual Average Capital Income
Resource Factors	• Sunshine • Global Horizontal Irradiance • Gross Installation Area
Risk Factors	• Extreme Weather Damage • Fluctuations in Policy (Energy Price) • Loan Financing and Solvency
Engineering Feasibility	• Electrical Transmission and Distribution System • Influence on Power Quality • Electricity demand

Figure 7: Evaluation Criteria to Assess PV Projects (Adapted from Wu et al., 2019)

LED PILOT PROGRAMS IN THE UNITED STATES

Municipal pilot programs in the United States have successfully implemented Light Emitting Diode (LED) systems. LEDs are up to 90% more efficient than standard incandescent bulbs and require much less maintenance (Jones, 2018).

LED streetlight programs in Boston and Los Angeles showed financial and social benefits (Jones, 2018). LED lights use 50-65% less energy than traditional gas-discharge lamps. This, along with low maintenance costs sets up the LED programs for success (Jones, 2018, p.1). In 2013, the city of Los Angeles also saw substantial positive impacts on the community. The city previously spent $15 million per year on energy and was able to save $10 million a year on energy and maintenance costs after replacing 141,000 lights. The author states that LED lights produce brighter, broad-spectrum light that closely represents real daylight (Jones, 2018, p.1). Better lighting, in turn, mitigates both vehicle and pedestrian accidents on the road. "The City of Los Angeles has partially attributed reductions in vehicle thefts, burglaries, and vandalism to improved visibility after their LED retrofit," (Jones, 2018, p.1).

Massachusetts's second largest city, Worcester, also has implemented LED streetlights that have greatly benefited the city financially (Worcester Department of Public Works [WDPW], n.d.). The city of Worcester installed 14,000 LED lights over a nine-phase plan with a total start-up cost of $9.9 million. The retrofit is expected to save approximately $910,000 per year in energy costs which equates to a 60% decrease and a 10.9-year turnaround period of making back their initial investment. Approximately $90,000 of the yearly savings are accredited to just 4 municipal garages. The city justifies the switch to LED streetlights by explaining that LED lights last four times longer than their predecessors.

A Pittsburgh LED research project showed additional municipal benefits (Quick & Carter, 2018). LEDs have lower outputs of light, and are more compact which allows the grouping of more LEDs compared to high pressure mercury bulbs. Other advantages of LED lights include longer life span, lower maintenance costs, and better performance in cold weather.

FEASIBILITY STUDY BY GIZ

A 2021 GIZ feasibility study named "Intervention Study for PV System Installation and EE Bulbs Replacement Study Report" analyzed seven municipalities in Albania.

This study ruled Elbasan and Shijak as favorable candidates for the Photo-Voltaic system installation and EE bulb replacement (GIZ & Illyrian Consulting Engineers, 2021). This study includes information regarding initial investment costs, expected savings and detailed projections for other municipalities looking to implement PV systems and EE replacement bulbs. Projections for the energy saved, costs avoided, and energy generated by the PV system considered the following: installed power, mounting structure type, specific yield, design, estimated energy production, estimated annual budget savings, estimated project cost, and payback period. The Energy Efficient replacement bulbs project analysis considered the number of bulbs to be replaced, the power of existing bulbs, the power of new bulbs, annual power saving, annual budget saving, estimated project cost, and payback period. These projections also include project costs of replicability and expansion.

The study estimates that the initial investment of over 20,000 Euros per municipality would save Elbasan over 5,000 Euros per year from the Pedagogical School Dormitory building and the Municipality Administration Offices. The Building of Shijak Municipality and "Muharrem Dollaku" School - Shijak were projected to save around 4,000 Euros each year.

GIZ states that the cost for the PV system varies from 900 to 950 Euros per kWp with a payback period of 6 to 8 years. As for the EE bulbs, GIZ estimates 200 euros of savings per bulb with a payback period of 1 to 2.5 years.

THE PILOT PROGRAM IN ELBASAN AND SHIJAK

GIZ's municipal PV pilot program provides municipalities of Elbasan and Shijak with an opportunity to install, and potentially, diffuse PV and EE bulbs into surrounding cities and private residences. GIZ provided the installation of PV and EE at no cost to the municipalities. This pilot program provides a framework and model for what other municipalities can expect to save upon implementing these systems. GIZ provides the cities with a report of average supplies, costs and all other aspects of the installation.

GIZ worked with municipal officials to determine that the official sites for the program would be the Pedagogical School Dormitory in Elbasan and the Building of Shijak Municipality. EE bulbs were placed on Streets "Rinia" and "Unaza" in Elbasan and "4 rrugët" and "Unaza e Shijakut" in Shijak (GIZ & Illyrian Consulting Engineers, 2021).

The municipality of Elbasan lies on the north bank of the Shkumbin River and its economic activities consist of engineering works, timber processing, and production of cement (Britannica, 2021). As of 2022 the city has a population size of more than 141,000 people and consists of both urban and farmland (AZNations, 2022).

Shijak, on the other hand, is a municipality located in the region of Durres (Places in the World, 2022). It is approximately 21 km away from Tirana and has a population size of approximately 14,000 residents.

Figure 8: Map of sections of streets where streetlights were replaced in Elbasan
(GIZ and Illyrian Consulting Company, 2021)

DIFFUSION OF RENEWABLE TECHNOLOGIES

To conduct an assessment of the current pilot programs and understand benefits and barriers to the expansion of PV and EE technologies, we researched frameworks, theories and other analytic tools regarding diffusion and citizen participation in government.

ROGERS' DIFFUSION OF INNOVATION (DOI) THEORY

Originally developed by Everett M. Rogers (1983), the Diffusion of Innovation (DoI) Theory describes the stages of implementing new ideas or technologies within organizations (Figure 9). The Stages of Innovation in Organizations theory utilizes two phases, Initiation and Implementation, and five stages, Agenda Setting, Matching, Redefining and Restructuring, Clarifying, and Routinizing, to model diffusion. The organizational model highlights "a number of individuals each of whom plays a different role in the innovation decision," (Rogers, 1983, p. 348).

INNOVATION IN THE PUBLIC SECTOR

According to the European Commission, "public sector innovation is about new and improved processes and services," (Karakas, 2020, p. 2).

Dearing & Cox (2018) discuss government policies and actions in the context of Rogers' theory of diffusion. When researchers study the diffusion of government

Figure 9: Stages of Innovations in Organizations Framework (Adapted from Rogers, 1983)

policies, they often modify the sequential nature to increase or decrease the time-ordered structure of the DOI theory (Dearing & Cox, 2018). This is likely a result of differences in ownership, regulation, and policy between the public and private sectors. The article also mentions that communication technology improvements, including widespread internet access and social media have allowed for quicker awareness of innovations. This relates to the **Initiation** phase in Rogers' DOI original theory.

In reference to the **Matching** stage, decision-makers may value information about the prior adopters of innovation over specifics about the technology and its effects (Dearing & Cox, 2018). The European Parliamentary Research Service (EPRS) identifies collective articulation as one of the principal drivers of innovation in the EU, further supporting the importance of prior adopter identity (Karakas, 2020). The ERPS also notes political ambition, public demand, tightening resources, and financial savings as important motivators for innovation.

For the **Implementation** phase, an EU study found the most important step to support innovation in the public sector is the creation of new laws and regulations (Gow, 2014). Dearing and Cox (2018) further emphasized that national policy and media attention to local successes can influence diffusion across other localities. The ERPS lists the following challenges to Implementation and Routinization: weak enabling factors (knowledge, resources, leadership), internal problems (management, structure, logistics), fear of negative publicity and/or public doubts about the innovation, difficulty accessing the target group, and opposition from the private sector due to new or increased competition (Karakas, 2020).

To further understand the complexities of public sector innovations the Organization for Economic Cooperation and Development (OECD) offers the *Innovation in the Public Sector* model (Figure 10). The OECD is an international organization that works with governments, policy makers, and citizens to support "equality, prosperity, and opportunity" in the creation of policy (OECD, n.d., para. 1).

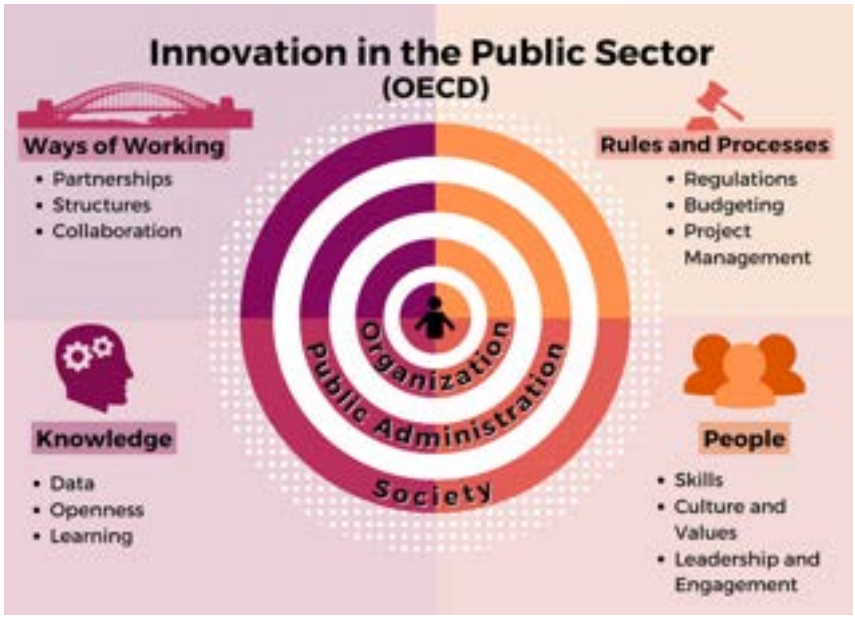


Figure 10: Innovations in the Public Sector framework (Adapted from OECD)

Innovation in the Public Sector model establishes four levels where innovation will occur. The levels include the innovator, the organization in which they work, the public sector as a whole, and society. There are four organizational factors that intersect at each level. **People** considers cultural dimension, motivation, and willingness to try new things. **Knowledge** examines issues regarding information collection, analysis, sharing, and overall knowledge development. **Ways of working** accounts for organizational structure and collaborations. **Rules and Processes** include legal and regulatory framework, budgeting, and approval processes that can support or hinder innovation.

LADDER OF CITIZEN PARTICIPATION

Arnstein's Ladder of Citizen Participation can be used to explore the relationships between municipalities and citizens (Figure 11). The Ladder includes three groupings of citizen power in democratic decision-making and eight total steps of participation. From the bottom to the top, the ladder increases in level of "citizen agency, control, and power," (Organizing Engagement, n.d.). The three levels of participatory power include Nonparticipation where citizens have no power, Degrees of Tokenism where citizens have counterfeit power, and Degrees of Citizen Power where citizens have actual power (Organizing Engagement, n.d.).

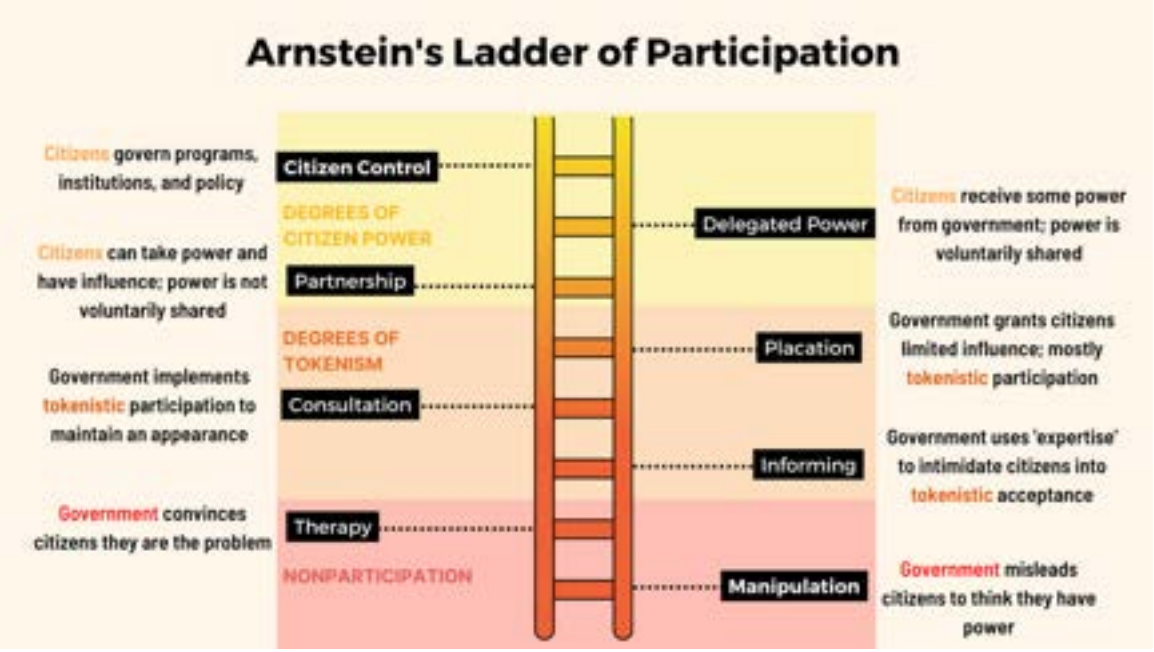


Figure 11: Arnstein's Ladder of Participation (Adapted from Organizing Engagement)

CHAPTER 3
OUR APPROACH

OUR APPROACH

This project aimed to support the diffusion of renewable energy technologies by analyzing the role municipalities can play and identifying opportunities for community-based organizations to participate in energy transition initiatives. These pilot programs intend to spread awareness of solar energy benefits, reduce energy expenditures, diversify means of energy production, and potentially address current energy price increases. Our objectives were as follows:

i. Understand the design and planning of each municipal pilot program

ii. Document the current state of each municipal pilot program as well as municipal capabilities to implement, manage, and expand PV and EE technologies over the long term

iii. Identify how community-based organizations can influence the allocation of municipal savings from PV and EE technologies

iv. Analyze PV energy production, energy consumption by the municipality, and efficiency of EE bulbs to compare with data from the previous year (before PV and EE) and identify savings

SEMI-STRUCTURED INTERVIEWS

We utilized semi-structured interviews to collect responses from key informants. The nature of this interview structure, with a few prepared questions acting as guidelines, allowed us to listen to the participants instead of confining the conversation to a series of predetermined questions. "One of the main advantages is that the semi-structured interview method has been found to be successful in enabling reciprocity between the interviewer and participant…enabling the interviewer to improvise follow-up questions…and allowing space for participants' individual verbal expressions," (Kallio et. al., 2016, p. 2955). Following up with interesting topics the officials brought up in conversation allowed us to initiate further exploration into these topics during our interviews.

PILOT PROGRAM DESIGN

Our team used key informant interviews to gain expert opinions on the design and initial stages of the pilot programs in Elbasan and Shijak. Our team conducted two interviews which included key informant interviews with GIZ and the solar company ALVision. The interview protocols and transcriptions can be found in Appendices A-D.

KEY INFORMANT INTERVIEW WITH MERITA MANSAKU-MEKSI, GIZ, SENIOR CLIMATE ADVISOR AND EMI KADUKU, GIZ, JUNIOR CLIMATE ADVISOR

During our interview with Merita Mansaku-Meksi, GIZ Senior Climate Advisor, and Emi Kaduku, GIZ Junior Climate Advisor, we asked about the structure of the pilot program and the motivation behind the pairing of EE and solar panel technology in these programs.

We aimed to investigate whether the short-term savings from EE was meant to serve as an incentive for investment in technology with higher total savings but a longer-term payback period. We were also interested in other reasons why EE and solar panel technologies would be a complementary pairing for the pilot program design.

The interview with GIZ considered the following questions:

- *Why was EE paired with PV? Were there technical, financial, or social implications behind this choice?*
- *Why were Elbasan and Shijak chosen?*
- *What has been the biggest challenge to a successful pilot program from a development agency perspective?*
- *What could the municipalities have done better to get the most out of this program?*

KEY INFORMANT INTERVIEW WITH BLEDAR BACOVA, ALVISION, CEO

We conducted a semi-structured interview with the CEO of ALVision, Bledar Bacova, about the logistics of the implementation of solar panels. We inquired about quality changes in solar panels depending on municipal budgets, while also getting information on installation time, costs, and maintenance costs. The PV company was a resource to provide technical analysis and data. We also sought to learn what challenges the company faced throughout this specific program and what changes municipalities can implement to streamline the implementation process.

The interview with ALVision considered the following questions:

- *What were some obstacles to the installation of the solar panels in Elbasan and Shijak?*
- *If the municipality worked with you, how did you work with each municipality leading up to the installation? (If they ask for specifications this can mean what officials were contacted, if calculations were checked, how was communication carried out?*
- *Do you have contracts with any municipalities?*
- *What is the size of the projects municipalities are contracting you for? (Answer could be amount of panels, KWh, etc,)?*
- *What maintenance do you offer?*
- *What were the time and manpower requirements for the installation?*

UNDERSTANDING THE CURRENT STATE OF MUNICIPAL PILOT PROGRAMS AND MUNICIPAL CAPABILITIES

KEY INFORMANT INTERVIEW WITH AULONA BYLYKBASHI, ELBASAN, VICE-MAYOR

We conducted a semi-structured interview with the Vice-Mayor of Elbasan to better understand municipal motivations to implement PV, current efforts to promote PV to the public, and challenges to expand the program.

We sought to understand if the municipality understands the benefits of PV and if there are plans for expansion. It was also very important for us to understand if the municipality has plans to encourage the private use of PV and if so, what steps they are taking to achieve private PV use. The transcription from this interview can be found in Appendix E.

The interview with Vice-Mayor Bylykbashi considered the following questions:

- How does the municipality think about expanding the use of solar and EE bulbs?
- What location would be used if the municipality expanded the solar program? Which buildings/what land?
- What are some of the barriers to expanding solar in the municipality?
- What does the municipality intend to do with the savings from the program?
- How has the municipality communicated with residents about new renewable energy projects?
- How does the municipality plan to encourage the diffusion of solar technology for residential use?

UNDERSTANDING HOW COMMUNITY-BASED ORGANIZATIONS COULD INFLUENCE ALLOCATION OF PV AND EE SAVINGS

KEY INFORMANT INTERVIEW WITH

AHMET MEHMETI, ELBASAN ECOLOGICAL CLUB, EXECUTIVE DIRECTOR, AND ERVIS ÇOTA, YOUTH ROMA AND EGYPTIAN MOVEMENT, EXECUTIVE DIRECTOR

We interviewed leaders of NGOs to understand how their community members could benefit from the savings from the pilot program. Mr. Ahmet Mehmeti is the Executive Director of the Elbasan Ecological Club and Mr. Ervis Çota is the Executive Director of the Youth Roma and Egyptian Movement. We sought to understand how community-based organizations could participate and benefit from energy transition initiatives. We aimed to understand the participatory budget process in Elbasan and to hear how it works from those who actively participate in the process.

The interviews with NGO leaders considered the following questions:

- What is the mission of your organization?
- What are some of the needs of the people you work with?
- What other NGOs do you work with?
- How does your organization currently participate in the formation/planning of municipal initiatives?
- What would your organization like to do with savings and any money generated from the PV/EE Pilot Program with GIZ?

ASSESSING CHANGES IN ENERGY PRODUCTION, EFFICIENCY, AND EXPENDITURES

To assess changes in Elbasan's energy production, efficiency, and expenditures surrounding the pilot program we utilized criteria from the Cloud-TODIM model established by Wu et al., the Sunny Portal software, and GIZ's feasibility study. The Cloud-TODIM model considers the following factors that influence PV project investment: cost, resource availability, risk, and engineering feasibility. For the EE bulbs, data from the GIZ feasibility study was used. GIZ provided the initial investment for this pilot, meaning there was no cost to the municipality. However, if municipalities were to replicate and expand upon these programs they would have to cover these costs themselves.

ILLYRIAN CONSULTING ENGINEERS

Figure 12: Logo of the engineering company GIZ worked with to develop the feasibility study

PV SOFTWARE DATA

The newly installed solar panels in Elbasan include Sunny Portal software that measures energy consumption of the dormitory building and energy production by the PV system. The software also provides a breakdown of external and internal energy supply in addition to self-consumption and grid-feed in. All variables provided by the software are included in Table 2. We compared projections from GIZ's feasibility study with real-time data from the month of November.

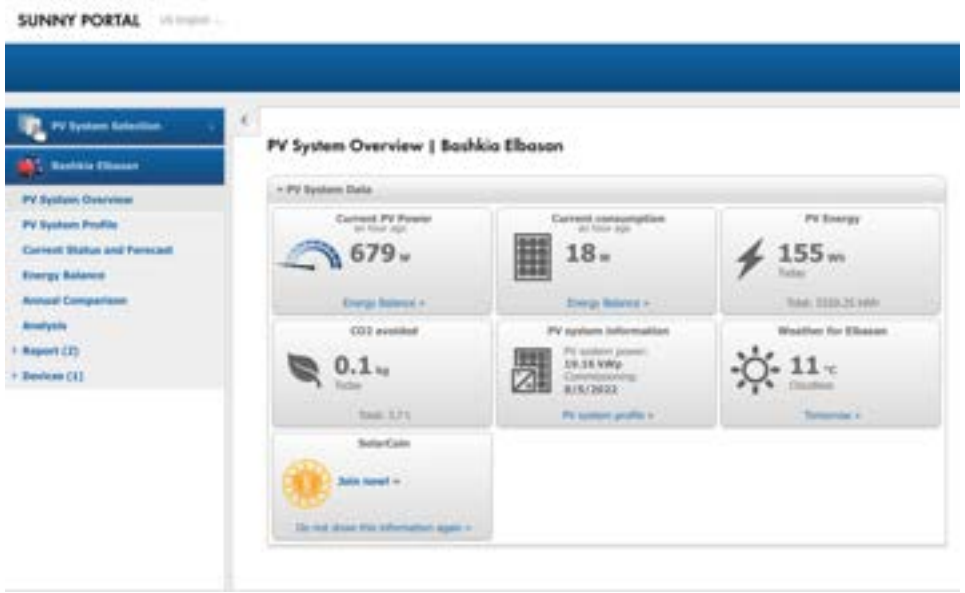


Figure 13: PV software overview window. This is showing some quick statistics from Elbasan

Using data from GIZ's Feasibility Study and Sunny Portal software, the Cloud-TODIM model allowed our team to conduct a preliminary analysis of the factors influencing photovoltaic investment. We created a table to assess differences in PV energy production using projections from the Feasibility Study and live Sunny Portal data.

An analysis of the Cloud-TODIM criteria based on data from the PV software allowed our team to understand the energy production and subsequent savings from the pilot program. Our team created a table using projections from the feasibility study and software calculations. This table includes topics such as savings, power production, and discrepancies between projections and true energy generation. The analysis protocol can be found in Appendix F. There is no live information for the EE bulbs so we utilized projections to assess these savings. Ultimately, we sought to understand the cost difference in pursuing EE or PV.

With our analysis, we assessed economic factors, resource factors, risk factors, engineering feasibility, and overall savings from the pilot program. We sought to understand:

- What impact has the switch to PV had on energy production?
- What change has the switch to EE lights had on consumption and overall energy efficiency in each municipality?
- Is excess energy being fed into the grid? If so, how much money is recovered from the sale?
- How has the switch to PV affected monthly/yearly electricity bills?
- How has the switch to PV affected the production of electricity (KWh)?

OPERATIONALIZING FRAMEWORKS

We applied Roger's Diffusion of Innovation Theory, OECD Framework for Innovation in the Public Sector, and Arnstein's Ladder of Participation to key informant interviews with the Vice-Mayor of Elbasan, the CEO of Alvision, GIZ, and NGO representatives to identify and analyze the different aspects of diffusion present in GIZ's municipal pilot program. We applied Roger's Diffusion of Innovation theory to determine the corresponding phase of diffusion for the implementation of the pilot program in Elbasan. We also investigated the social, technical, and political factors of diffusion that were present or lacking in the pilot program process through the OECD Framework. Finally, we applied the Ladder of Participation to explore the degree of community involvement, specifically from marginalized communities, in municipal initiatives similar to the pilot program.

CHAPTER 4
OUR DISCOVERIES

OUR DISCOVERIES

Our project evaluated the role of two municipalities in Albania in the diffusion of renewable energy technologies and also considers how community-based organizations may engage in or advocate for further expansion. This analysis focused on GIZ, Elbasan, Shijak, ALVision, and local NGOs as stakeholders involved in the diffusion of PV and EE technologies. We interviewed representatives from each stakeholder group to better understand factors driving renewable technology diffusion and those inhibiting it. We also considered how municipalities can apply benefits from renewable energy technologies to underrepresented communities and how NGOs can advocate for access to those savings.

GIZ SEES MUNICIPALITIES AS AN IMPORTANT CATALYST AND PARTNER TO TRANSITION TO SUSTAINABLE ENERGY SOURCES AS SPECIFIED IN THE NDC ASSIST II PROGRAM

GIZ partners with municipalities because it sees them as initiators of a top-down approach to diffusion with the authority and resources, both human and financial, to expand the use of new technologies. Municipal governments are the closest that state power can get to actual civilians; the remaining obstacle is the legal framework (Kaduku, personal communication, November 15, 2022). Specifically, there are limited regulations on solar power in Albania and solely the central government can pass new legislation to create more regulations. The municipality does not have the legal power to establish their own policies on solar power.

PV WAS CHOSEN TO TARGET ENERGY PRODUCTION; EE WAS CHOSEN TO REDUCE ENERGY EXPENDITURES

GIZ considered both wind and solar energy for the pilot but chose solar photovoltaic (PV) panels because wind has "a high cost, high maintenance, and lack of potential for productivity in Albania." GIZ chose to support the dispersal of solar photovoltaic technology to municipalities due to their capability to maintain the installments and the high solar irradiance in western Albania. Kaduku insisted, "solar is tangible and realistic" for energy production in comparison to wind. Our research shows that the large amount of sunny days, solar's ability to produce energy in extreme weather events, and the durability of solar panels also make solar a feasible candidate for energy production.

EE technologies, on the other hand, target energy expenditures. GIZ determined that EE bulbs would not only help with the public lighting expenses, but were inexpensive as an energy efficiency technology. Mansaku-Meksi reported GIZ wanted "something attainable to municipalities." Kaduku added, "EE bulbs can be purchased and installed very easily." This means municipalities can afford to expand or install EE bulbs without much difficulty.

GIZ SELECTED TWO MUNICIPALITIES FOR ITS PILOT PROGRAM, ELBASAN AND SHIJAK, TO COMPARE HOW THE DIFFUSION OF PV AND EE IS INFLUENCED BY MUNICIPAL RESOURCES, THE INTEREST OF LEADING LOCAL POLITICIANS, AND INSTITUTIONAL CULTURE

GIZ considers solar potential, municipal budget, size, donor history, and previous collaborations with GIZ when selecting municipal candidates for the pilot program. GIZ pilot programs typically work with two different municipalities: a larger, more structured one that could expand the program without much difficulty and a smaller, less structured municipality where the savings and financial gains from this program would be much greater. (Mansaku-Meksi and Kaduku, personal communication, November 15, 2022).

GIZ also held meetings with Mayors of each candidate municipality to gauge "level of commitment to collaborate with GIZ for PV and EE installment, invest in the public, and present results of the pilot to their city council," (Mansaku-Meksi, personal communication, November 15, 2022).

GIZ SELECTED ELBASAN FOR THE PILOT PROGRAM BECAUSE OF THE MUNICIPALITY'S POTENTIAL TO MODEL IMPLEMENTATION AND EXPANSION OF RENEWABLE TECHNOLOGIES FOR BIGGER MUNICIPALITIES

The Municipality of Elbasan was selected to showcase implementation, and future expansion, of solar PV and EE technologies for bigger municipalities because "Elbasan was very responsive and eager to participate in this program. They spread the information about the pilot through the government structure quickly. The *GIZ Climate Programme* team at GIZ had previously completed three successful projects with Elbasan and believed the municipality was prepared for installation of PV and EE technologies (Mansaku-Meksi, personal communication, November 15, 2022).

GIZ SELECTED SHIJAK FOR THE PILOT PROGRAM TO PROVIDE SIGNIFICANT SAVINGS FOR THE MUNICIPAL BUDGET

Upscaling and expanding the use of PV and EE was not GIZ's main focus for Shijak. GIZ chose the Municipality of Shijak because they determined that investments in PV and EE would "have a significant impact on savings for the municipal budget," (Kaduku, personal communication, November 15, 2022). Shijak also had no prior experience with GIZ, and GIZ was also interested in a candidate municipality that they had not worked with before.

WHEN DEVELOPING INTERVENTIONS FOR MUNICIPALITIES, GIZ'S EFFORTS ALIGN WITH THE MATCHING STAGE OF ROGERS' DIFFUSION OF INNOVATION IN ORGANIZATIONS FRAMEWORK

The Matching Stage of the *Stages of Innovation in Organizations* framework involves identifying difficulties in an organization and finding an innovation to address them. GIZ's intervention in a municipality facilitates this stage. When GIZ collaborates with a municipality, they avoid projects that require large financial investments that make replication and expansion harder for municipalities.

Figure 14: Matching Stage of Innovation in Organizations (Adapted from Rogers, 1983)

GIZ energy related projects with municipalities have been hindered due to minimal technology access, insufficient finances, or limited capacity including a lack of expertise. Therefore, GIZ wants to ensure their interventions can be maintained by the municipality long-term. Mansaku-Meksi added that GIZ must "understand a municipality's status, needs, and difficulties" (But that is why you do research to find out how municipalities differ).

INNOVATION IN THE PUBLIC SECTOR (OECD) FRAMEWORK ILLUMINATES ORGANIZATIONAL BARRIERS TO DIFFUSION IN SHIJAK

Sometimes GIZ works with "unresponsive or inefficient municipalities," (Kaduku, personal communication, November 15, 2022). For this project specifically, Mansaku-Meksi shared, "Shijak has been reluctant throughout this process. They have not been as responsive as other small municipalities." She expanded to say, "Shijak has presented unexpected difficulties including a lack of responsiveness, commitment, and willingness to help complete this pilot project." Mansaku-Meksi suggested there may be a lack of human resources in Shijak. During our investigation, we discovered organograms displaying the departmental structure for each municipality.

Figure 15: Innovation in the Public Sector framed for GIZ intervention in Elbasan and Shijak

From these organograms we concluded that Shijak and Elbasan's municipal structures are very similar with most of the departments overlapping and exercising similar functions. However, municipal departments in Shijak seem to lack collaboration, pilot project management, leadership, and engagement found in the municipality of Elbasan. Kaduku mentioned, "Shijak's organigram lacks organization in practice." He added that the "lack of cooperation and access" has hindered GIZ's collaboration with Shijak.

The Deputy Mayor of Shijak declined our request for an interview. The lack of interest of Shijak's municipal leaders could unfortunately hinder diffusion at the innovator and organizational level (leaves public administration or society to push for innovation).

Before any collaboration between GIZ and Shijak the GIZ branch will be informed of the lack of responsiveness, preparedness, and communication among municipal officials, making Shijak a weaker candidate in future pilot program selection process. The municipal officials involved in the program did not cooperate with GIZ during the pilot program, nor did officials from Shijak respond to OSHEE, Albania's electrical distributor, with the paperwork necessary to connect the solar panel to the grid. Shijak will now be less likely to receive new technologies from development agencies and the municipality and its residents are unlikely to benefit from the reduced energy costs, and savings from energy efficiency programs that could be applied to other social needs.

LIVE DATA NEEDS MORE TIME BEFORE BEING COMPARED WITH PV ENERGY GENERATION PREDICTIONS FROM FEASIBILITY STUDY

From the Sunny Portal software, we considered monthly consumption, monthly yield, external energy supply, grid feed-in, internal power supply, and dormitory self-consumption from November 9th through the 30th (Figure 14). We also looked at the weather for each day to understand the impacts of the rainy season on energy production.

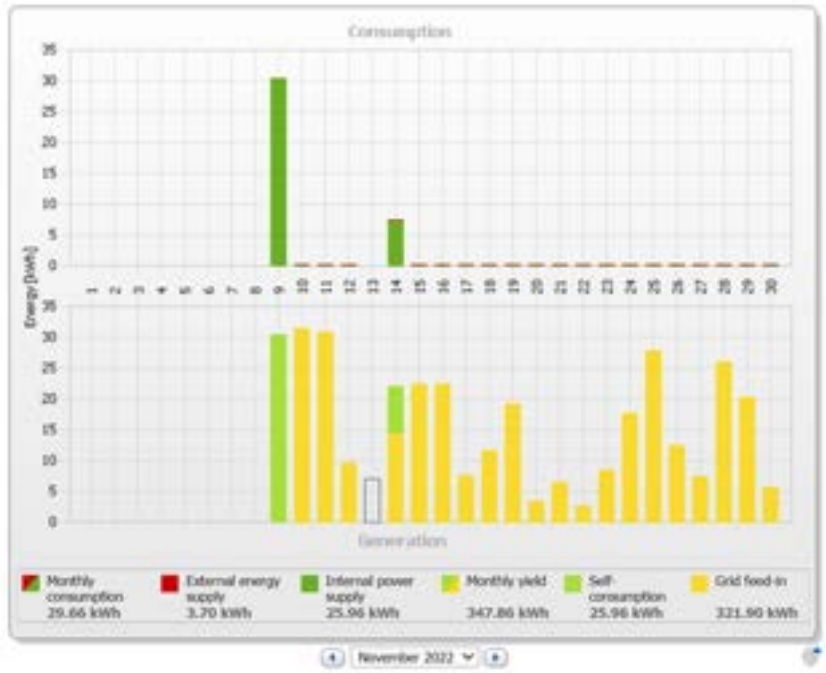


Figure 16: Sample graph of PV system data created by Sunny Portal software

Our analysis concluded the PV system in Elbasan produced approximately a third of the energy predicted by the Feasibility Study (Appendix D). This is likely due to the fact that there were only four fully sunny days between November 9th and 30th. However, in November 2022 the dormitory building consumed 99% less power than the feasibility study anticipated. Kaduku explained to us that this is because the PV energy generated is fed into the grid if the dormitory consumed more than what the PV system produced.

If the dormitory consumed less energy than the system produced, then the PV energy generated is used for the dormitory and the excess is fed into the grid. To thoroughly understand the PV energy production potential of the dormitory in Elbasan, the software data should be revisited after a year.

EE BULBS SIGNIFICANTLY REDUCE MUNICIPAL ENERGY EXPENDITURES

Mrs. Mansaku-Meksi informed us that many municipalities in Albania spend much of their budget on public lighting. The new EE bulbs are five times more energy efficient than Elbasan's municipal streetlight bulbs, meaning that they save 80% of the energy cost. The EE bulbs on both streets saved Elbasan 14,206.4 kWh of energy and €1634.4 in expenditures per month (Appendix E). The savings from the EE bulbs indicate a very short return on investment. If municipalities across Albania could increase their use of EE bulbs, they would experience quick and significant savings in energy and money.

	November Power Consumption (kWh)	*November Expenditures (EUR)*
Before EE (GIZ Feasibility Study)	17,758 (average from 2019 and 2020)	2,043
After EE (GIZ Feasibility Study)	3,551.6	408.6
Savings	**14,206.4**	**1634.4**

Figure 17: EE Streetlight savings

EE BULBS SIGNIFICANTLY REDUCE MUNICIPAL ENERGY EXPENDITURES

The feasibility study GIZ conducted provides projections that serve to illustrate the long term benefits of PV and EE integration. These benefits include savings and payback period for PV and EE technology. In Elbasan, the PV installation on the Ymer tola dormitory will save the municipality €52,133 ($54,246) over a period of 25 years with the project (€12,271 or $12,768) paying itself off in the first seven years. The payback period for the EE bulbs is shorter, the EE bulb component of the pilot project in Elbasan pays itself off within a year.

THE MUNICIPALITY OF ELBASAN DETERMINED PLANS FOR THE SAVINGS FROM THE PILOT PROGRAM WITHOUT COMMUNITY INPUT

Though municipal officials have not yet spread information regarding the PV and EE pilot program or its savings publicly with the community, they have some ideas about how to spend the savings. Vice-Mayor Aulona Bylykbashi mainly aims to invest savings from the pilot program into educational institutions. She noted, "if we do a logical analysis of the entire budget, at the end of the day, this [saved] income goes to the students" (Bylykbashi, personal communication, November 17, 2022). The Education and Economic Center is part of the mayor's cabinet, they will be in charge of investing these funds within the school system.

Despite the Vice-Mayor telling us her plans, we found that citizens of Elbasan were not informed of initiatives to invest PV and EE savings back into the community. Following our interviews with NGOs, we found that the leaders in these organizations were not aware of the PV and EE pilot program or their savings. They were, however, excited and attentive to learn about the program and what benefits it could hold for the community.

The municipality has taken it upon itself to use its expertise to decide where the savings from the pilot program should go without community input; this interaction corresponds to the Informing rung of Arnstein's Ladder.

KNOWLEDGE ABOUT THE BENEFITS OF SOLAR ENERGY IN THE COMMUNITY HAS THE POTENTIAL TO DRIVE DIFFUSION OF PV

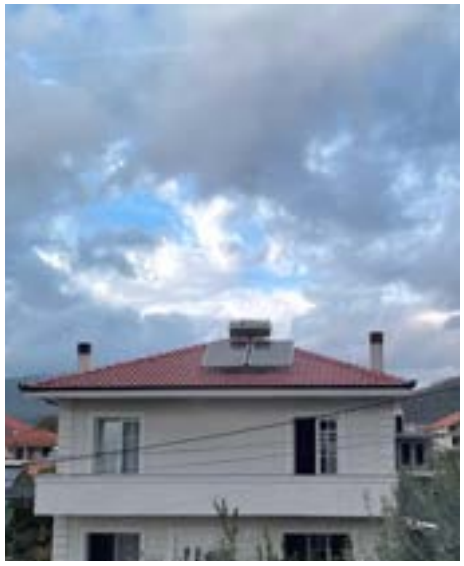
There is knowledge about solar energy among municipal workers and residents of the inner ring of Elbasan. We observed rooftop solar water heating systems on many municipal, residential, and commercial buildings. We did not observe any photovoltaic systems besides the dormitory panels.

Solar water heating projects are starting to become relatively common because solar water heating technology is less expensive than photovoltaics and the central government offers 50% subsidies for residents interested in this project across Albania's municipalities. This "head start" of understanding the merits of solar energy could assist the dissemination of PV among residents.

The Ecological Club NGO also indicated that there is a public awareness of environmental issues in Elbasan. People have made major protests concerning city pollution; during one protest people blocked the streets in the industrial zones of Elbasan until the government taxed the industries that were causing pollution.

The OECD *Innovation in the Public Sector* suggests increased awareness at the society/community level of innovation has the potential to drive municipal implementation.

Although our observations and interviews did not identify an existing knowledge gap as an obstacle to expansion, other barriers are preventing the spread of photovoltaics. Knowledge about solar does not lack; technical know-how, planning, communication, "investment" and interest does.



IN ELBASAN, A LACK OF EXPERTISE AND BUDGET CONSTRAINTS INHIBIT THE MUNICIPALITY'S ABILITY TO IMPLEMENT PV

A LACK OF EXPERTS DELAYS MATCHING STAGE OF INNOVATION

Capacity barriers inhibit the adoption and expansion of new technologies at the municipal level. Municipal capacity is defined as "the ability of a municipality to ensure services are provided on a sustained basis in pursuit of local and regional objectives" (Chicago Metropolitan Agency for Planning [CMAP], 2017).

The municipality of Elbasan intends to integrate the planning and implementation of solar projects. However, the city cannot find experts to complete the design of new solar expansion plans.

According to the Matching stage of the *Stages of Innovation in Organization* framework, planning and designing precede the Implementation phase of diffusion. In Elbasan, we're seeing how a lack of technical knowledge in the Department of Projects is preventing implementation of more PV programs.

> "It is not so easy to find specialists in the market, starting from electrical engineers, to make the design of projects for this purpose. Then the second most difficult phase is the part of implementation and budgets for implementation effects"

AULOUNA BYLYKBASHI, PERSONAL COMMUNICATION, NOVEMBER 17, 2022

The lack of skilled people in municipal departments in Elbasan is also a problem according to the Ways of Working and People organizational factors from the OECD framework, making it difficult to explore and develop plans for PV and EE projects. Elbasan's Department of Projects and Engineering Services currently lacks the ability to properly plan projects, although Elbasan seeks to integrate more technical know-how into this department. However, the municipality is having trouble finding the engineers or electricians that have adequate technical expertise for this design aspect of expansion. Elbasan's hiring process starts with an open call for engineers that would have the required technical knowledge for project design. After this open call, Elbasan evaluates the engineers who answer the call to determine their suitability for employment. As of 2022, no one has applied through these open calls. The only other way to hire experts is by outsourcing to private companies or professionals, which is more expensive than having in-house experts who work for the municipality. This extra expense can be prohibitive given Elbasan's lack of budget resources for solar projects.

MUNICIPAL BUDGET CONSTRAINTS INHIBIT THE DECISION TO ADOPT

Elbasan also struggles to finance expansion projects due to a lack of dedicated solar budget resources, which supports the importance of sufficient funding to move from Redefining and Restructure to the Clarifying Phase in Rogers' DOI theory. In the Innovation in the Public Sector framework, budgeting is also an essential

component in the Rules and Processes organizational factor. The city made efforts to start a private-public joint program in 2015 to implement solar panels and EE bulbs around the city before budget constraints required the municipality to invest more in non-solar infrastructure and halt the solar project. The program sought to generate electricity and improve energy efficiency as part of a dual-ended effort to reduce energy costs.

MINIMAL REGULATORY SUPPORT AND FEW GOVERNMENT INCENTIVES FOR SOLAR ENERGY IS HINDERING THE IMPLEMENTATION OF PV IN ALBANIA

SOLAR COMPANIES REGULATE ONE ANOTHER DUE TO A LACK OF STANDARDS ENTITY

In Albania, there is currently no standards entity ensuring the quality and safety of solar installments. The four largest private solar companies in Albania have taken it upon themselves to act as this entity, a prime example of the importance of partnerships in the process of diffusion (OECD Ways of Working). Bledar Bacova, CEO of ALVision, revealed "ALVision is trying to maintain standards alongside other Albanian solar companies. Together we are trying to build knowledge by communicating about the technology, power, and need for energy diversification in our country" (Bacova, personal communication, November 25, 2022). Upholding the quality of solar panel installation is important to future diffusion of this technology. "We [ALVision and other solar companies] have a responsibility to make sure solar is seen in a good light. If quality falls and solar installation is done incorrectly, it could lead to a fire. This would hurt how people view solar here in Albania," (Bacova, personal communication, November 25, 2022). When we asked if people would blame the company that did the installment or the government, Bacova revealed that ultimately, it would not matter; people would not support the use of solar products. Diffusion would abruptly end at the Decision Phase.

ALVision and the other three main solar companies continue to submit drafts of legislation based on their technical expertise to the central government every month; they have yet to receive a response.

GOVERNMENT DISINCENTIVES HINDER THE SPREAD OF LARGE SCALE PV SYSTEMS

Our interviews with GIZ, ALVision, and NGOs showed that legislation has struggled to keep up with the diffusion of PV in Albania.

Kaduku explained that there is a lack of legislation and few government incentives regarding solar energy in Albania (Kaduku, personal communication, November 15, 2022). These claims were later echoed and expanded upon by the CEO of ALVision, Bledar Bacova.

Solar companies are equipped with the resources to safely and effectively install and maintain large projects (Bacova, personal communication, November 25, 2022). However, there is limited interest in these projects due to current constraints placed on the private use of PV. As seen in Figure 15, PV installments intended for self-consumption cannot exceed 500kW, if that threshold is exceeded then the entity must become an energy producer. The status of energy producer requires licensing that must be approved by the government. Energy within the 500kW and 2MW range is priced at the rate set by the government; meaning the entity that installed the PV system no longer experiences the benefit of reduced energy cost past the 500kW threshold. Energy produced above 2MW can be sold at any price.

Current legislation hinders further development of PV energy, threatening the diversification of Albania's energy. Entities interested in implementing solar are not encouraged by the law to self-consume on a large scale, even though PV companies have the means to install the required technology.

PV Power Generation	Regulation
Under 500kW	PV unit can self-consume
Between 500kW - 2MW	Operators of the PV unit must obtain "Energy Producer" status that requires licensing and potentially additional cost. They must abide by energy prices set by the government.
Above 2MW	Operator of the PV unit can sell this energy at their own price

Figure 18: Current regulations for PV production in Albania (2022)

EFFECTIVE INVOLVEMENT OF NGOS CAN CREATE A CONSTITUENCY FOR THE SPREAD OF PV AND EE

PARTICIPATORY BUDGET AND CONSULTATION MEETINGS DESIGNED AS MECHANISMS FOR COMMUNITY INPUT

Participatory budgeting describes a process that allows the community to participate in the allocation of the municipal budget. In Elbasan, this process occurs once a year and involves two stages: the submission of budget requests and the voting meeting.

Mr. Mehmeti, the Executive Director of the Elbasan Ecological Club, elaborated on the participatory budgeting process from his NGO's standpoint. In the first stage, before the participatory budget meeting, NGOs and other organizations submit their ideas to the municipality. The municipality and the organization then work to refine the idea within a scope that the municipality can work with. In the second stage, the municipality holds a meeting for discussion of the organization proposals.

Any resident of the municipality can attend and vote on presented topics but only organizations can present topics. The voting serves to rank the ideas presented in order of importance or urgency.

Mr. Ervis Çota, the Executive Director of the Youth Roma and Egyptian Movement NGO, spoke about another participatory mechanism called consultation meetings. During these meetings, NGOs and municipal officials discuss the municipality's strategic plans. NGOs also propose and fight for plans in front of municipal officials.

In theory, these two participatory mechanisms reflect a municipal effort to hear the community members' ideas and consider community requests when drafting the budget. Participatory budgeting and consultation meetings would fall between the Placation rung and the Partnership rung of Arnstein's Ladder of Participation. These meetings are not quite a partnership between the municipal government and the NGOs because they require NGOs to bring their requests to the government; the government does not actively seek out NGOs to ask for their input and ideas.

However, the purpose of the participatory budget meeting is to give the community a way to provide input on municipal decisions. Consultation meetings are

similarly designed to act as a platform for the NGOs to be heard when presenting their own ideas. These meetings are not designed to make the community think they are actively participating when their ideas and votes are not given weight. This means they would be above the Placation rung. While the design of these meetings reflect an attempt to give the community a voice, in practice these meetings fall on different rungs of the ladder depending on the NGO and the community issue.

ARNSTEIN'S LADDER OF PARTICIPATION INDICATES THE ECOLOGICAL CLUB OF ELBASAN'S PARTICIPATION IN THE MUNICIPAL BUDGETING PROCESS IS AT THE BRIDGE BETWEEN PLACATION AND PARTNERSHIP

According to Mr. Mehmeti, it is his NGO's responsibility to pressure governments in cooperation with the community to change things to be more beneficial (Mehmeti, personal communication, December 1, 2022). The Ecological Club does this by attending the municipality meetings to discuss the budget and proposing plans to the municipality that support their NGO mission. The Ecological Club has an influence in determining where the budget should go during participatory meetings, and the municipality has an obligation to listen to the organizations who propose plans. The municipality is incentivized to listen to NGOs

because they need to be able to get NGO help in their own projects. For example, in Elbasan's green school project, the municipality asked for the Ecological Club's assistance.

The participatory budget process for the Ecological Club is at the bridge between the Placation rung and Partnership rung of Arnstein's Ladder of Participation. This ladder placement is identical to the theoretical placement of the participatory budgeting process. A reason for the same ladder placement may be the close ties between environmental issues and Albania's EU membership goal. Elbasan's air pollution levels are three times greater than the permissible EU levels. This level of pollution stands as a large obstacle to Albania's EU entry, therefore; the Ecological Club's work in Elbasan helps to address Albania's EU requirement needs. Another factor in the ladder placement may be the amount of resources available to the Ecological Club. The Ecological Club has an array of experts, skills, and knowledge that contribute to the organization's mission. These resources give the NGO more influence in processes like participatory budget proposals.

THE YOUTH ROMA AND EGYPTIAN MOVEMENT IN ELBASAN EXPERIENCES LIMITED INFLUENCE IN MUNICIPAL DECISIONS ABOUT RESOURCE ALLOCATIONS

Mr. Çota explained that he and his community are so often ignored that they can tell when officials are being disingenuous. When his NGO proposes projects that would require a sizable portion of the budget, municipal officials only 'pretend' to listen. He told us that a member of Elbasan's city council identifies as Roma which is a step forward in being heard but it unfortunately is not enough.

The Youth Roma and Egyptian Movement has been advocating for free school lunches and kindergarten for Roma children for about a year now. They have explained to the city that such an initiative could allow parents of Roma children to work instead of caring for their young kids and that this initiative could even create jobs but it still has not been enough to convince the city. As soon as a campaign involves municipal spending they are no longer heard.

The participatory budget process for the Youth Roma and Egyptian Movement is at the bridge between the Consultation rung and the Placation rung of Arnstein's Ladder of Participation.

The way that municipal officials 'pretend' to listen to this NGO or ignore their requests entirely is reminiscent of tokenism; the NGO is allowed to participate just to say that they have participated. However, the municipal officials at meetings accept some of the NGO's requests, depending on how much budget these ideas require. This very limited degree of influence places the Youth Roma and Egyptian Movement above the Consultation rung but below the Placation rung. One factor for the ladder placement may be that marginalized community issues, not directly tied to an EU requirement, are not seen as priorities for the municipality. In addition, when Mr. Çota told us about his NGO, he stated that they are the only Roma NGO in Elbasan and that they face challenges because they do not have enough experts (Çota, personal communication, December 1, 2022). The lack of experts, skills, and other Roma-focused NGOs within the municipality may lead to less power and attention in participatory budget processes. Finally, the Roma community struggles with a lack of computer access; many people in the community do not know how to use a computer (Çota, personal communication, December 1, 2022). Without access to resources and knowledge, the community is at a disadvantage in the participatory budgeting process.

WITH THE SAVINGS FROM THE MUNICIPAL PILOT PROGRAM, LOCAL NGOS PRIORITIZE ADDRESSING HIGH LEVELS OF POLLUTION IN ELBASAN AND IMPROVING INFRASTRUCTURE IN THE ROMA AND EGYPTIAN COMMUNITY, INCLUDING THE SCHOOL AND ADDITION OF A MULTI-PURPOSE FACILITY

The Ecological Club wants the savings from municipal initiatives to go towards making people more aware of pollution. The municipality could get 24-hour apparatuses that measure air and water pollution and broadcast these over the radio in the municipality.

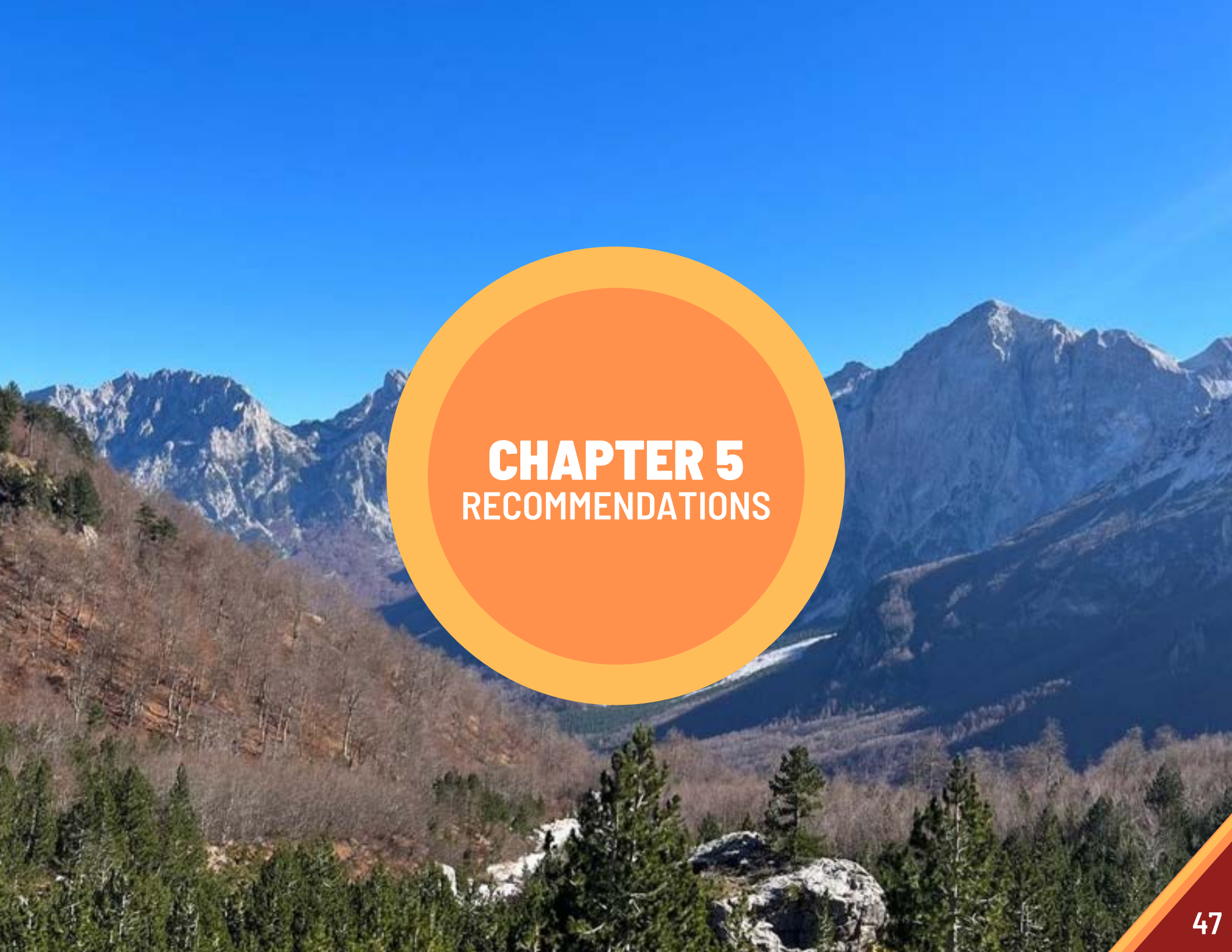
The Youth Roma and Egyptian Movement has an interest in using savings towards bettering the environment as well. During our interview, Mr. Çota stated that "life is just not in the home" (Çota, personal communication, December 1, 2022). There is a Roma and Egyptian community near the metallurgical factory where many people have died because of cancer from smog and land pollutants. Green spaces, water filtration, and environmental efforts would better the quality of life for the Roma and Egyptian people. The school located near the Roma and Egyptian community is also a possible investment for the Youth Roma and Egyptian Movement. This school is the worst-maintained in the city, the windows are even broken. The NGO has been campaigning for the repair of the school for four years with no success; these savings could go towards these repairs. In addition, the Youth Roma and Egyptian Movement is interested in using savings to build a multi-functional building with doctors, psychologists, and other specialists that serve the local kids in need free of charge.

COOPERATION AND COLLABORATION AMONG NGOS IN ELBASAN STRENGTHENS THE COMMUNITY VOICE AND INCREASES PUBLIC PARTICIPATION

NGO leaders Mr. Mehmeti and Mr. Çota both recognize that there is strength in numbers. Cooperation builds power and strengthens the community's voices. With other NGOs, the Ecological Club has run campaigns to clean the air, deal with hospital waste, protect the forests, and recycle. According to Mr. Mehmeti, alone, NGOs cannot change anything, therefore; it is a good thing that they have a good sense of cooperation. Mr. Mehmeti even remarked that "we [NGOs] are in the cooperating business" (Mehmeti, personal communication, December 1, 2022).

NGO cooperation is key to raising community voices together. During the World Cup, when an individual used discriminatory language toward the Roma and Egyptian community during a news report, the Youth Roma and Egyptian Movement created a mini-protest in front of the news service with other NGOs. The cooperation between the NGOs allowed their voices to be better heard. In addition, while the Youth Roma and Egyptian Movement mainly works with Egyptian and Roma communities, they also work with other NGOs like women's NGOs. Both NGO leaders showed a willingness to cooperate with other organizations to amplify their voices.

The relationship between NGOs represents the Partnership rung on Arnstein's Ladder of Participation because of the shared work, decisions, and goals between these organizations. Staging joint campaigns and protests demonstrates a level of cooperative partnership and allows these organizations to take power from the municipal government that they do not receive voluntarily.



CHAPTER 5
RECOMMENDATIONS

RECOMMENDATIONS

PRODUCE EFFECTIVE SCIENCE COMMUNICATION MATERIALS TO SPREAD AWARENESS OF PV AND EE BENEFITS

The expansion of PV and EE technologies can help reduce the country's need to import costly electricity from neighboring countries generated by fossil fuels. PV is a feasible and effective option to achieve the long-term goal of diversifying Albania's energy production. While PV implementation can require significant upfront costs, EE by contrast, as we have seen in the case of Elbasan's LED streetlight replacement program---can lead to significant savings in the short term. We heard about how Elbasan uses information centers, social media, and village chiefs to spread information, but did not discover any materials dedicated to solar power benefits or the pilot program.

To explain how PV and EE technologies work, promote their savings and benefits, and involve the community in energy initiatives, we suggest the widespread use of science communication materials. Science communication is essential to transfer information to a non-expert audience. We sought to utilize meaningful data that could be transformed into familiar and relatable elements for the respective audience.

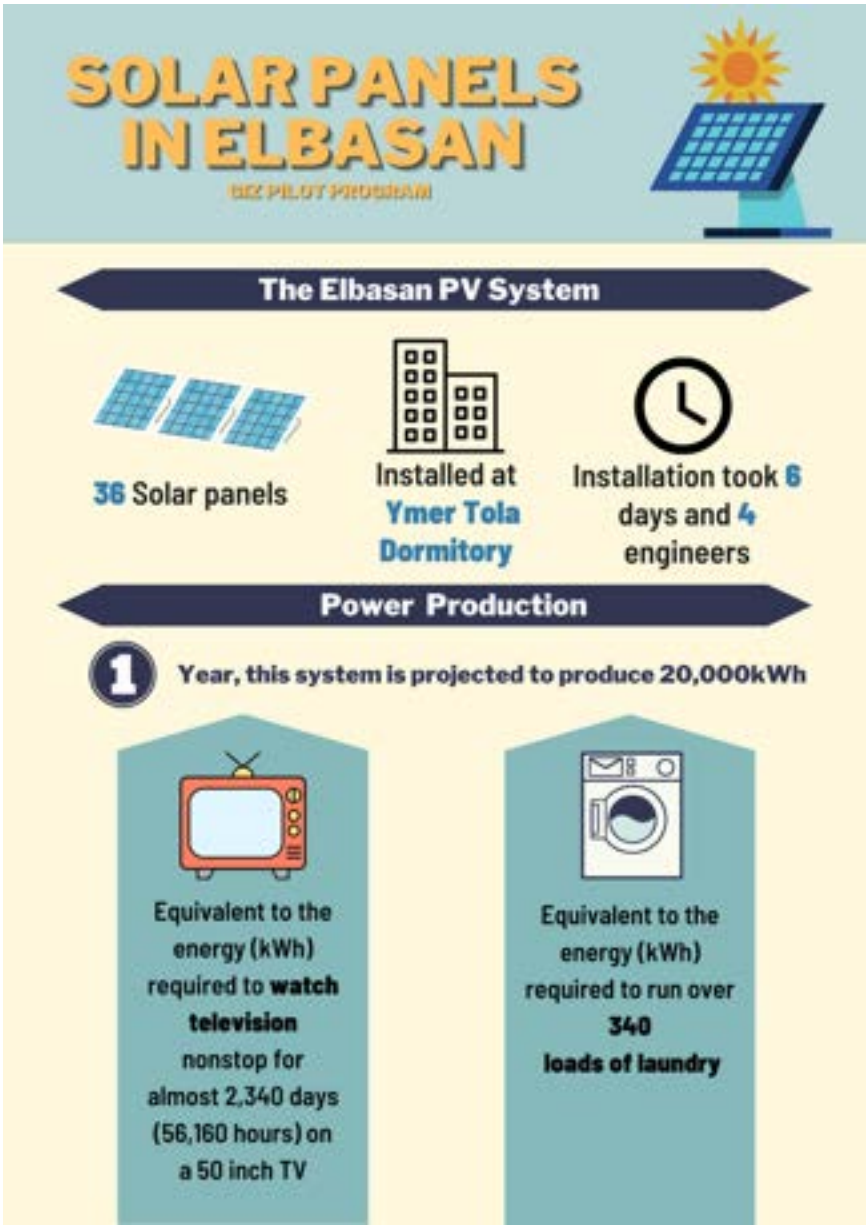


Figure 19: Sample Infographic to communicate PV energy production from the pilot in Elbasan

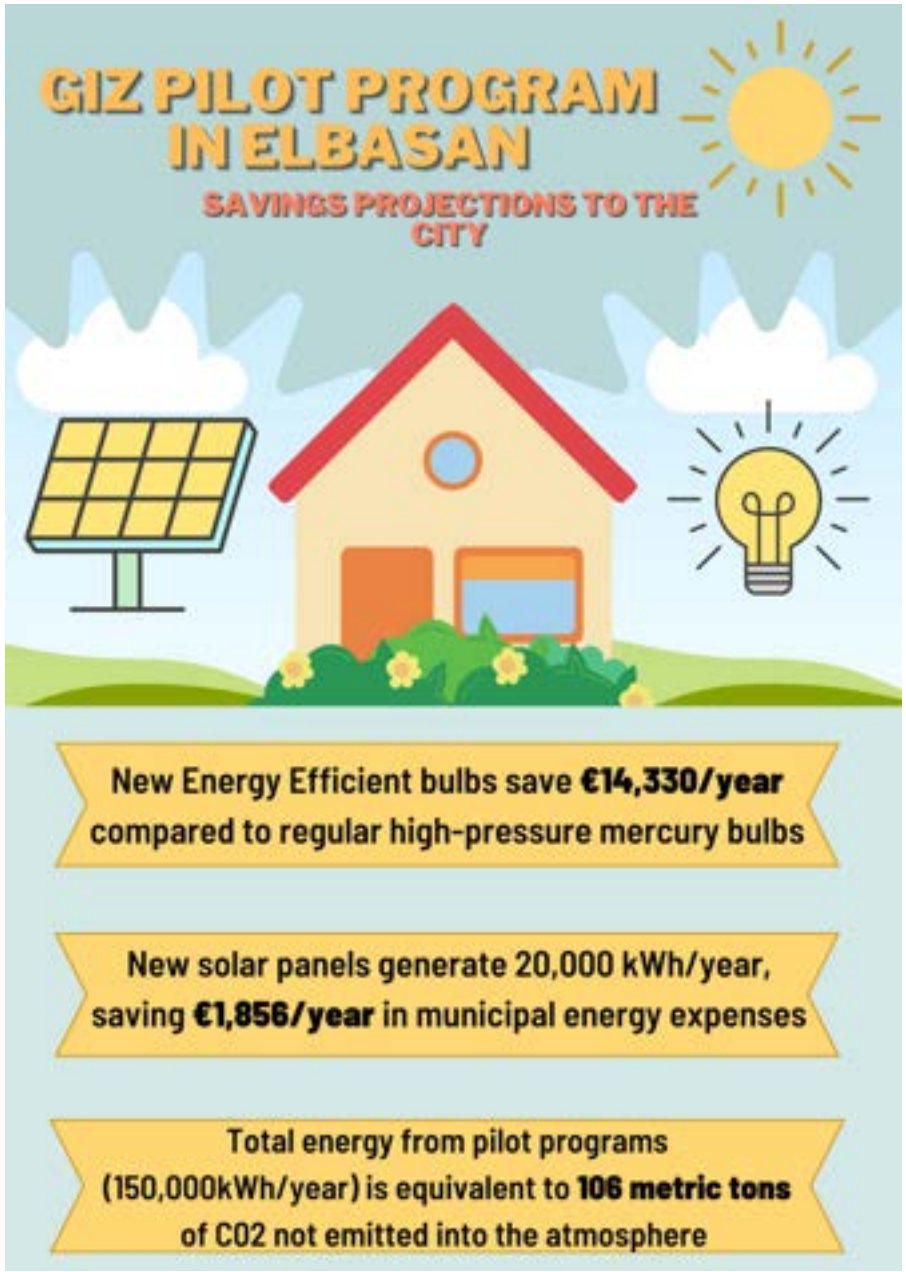


Figure 20: Sample infographic to summarize PV and EE savings from the pilot program in Elbasan

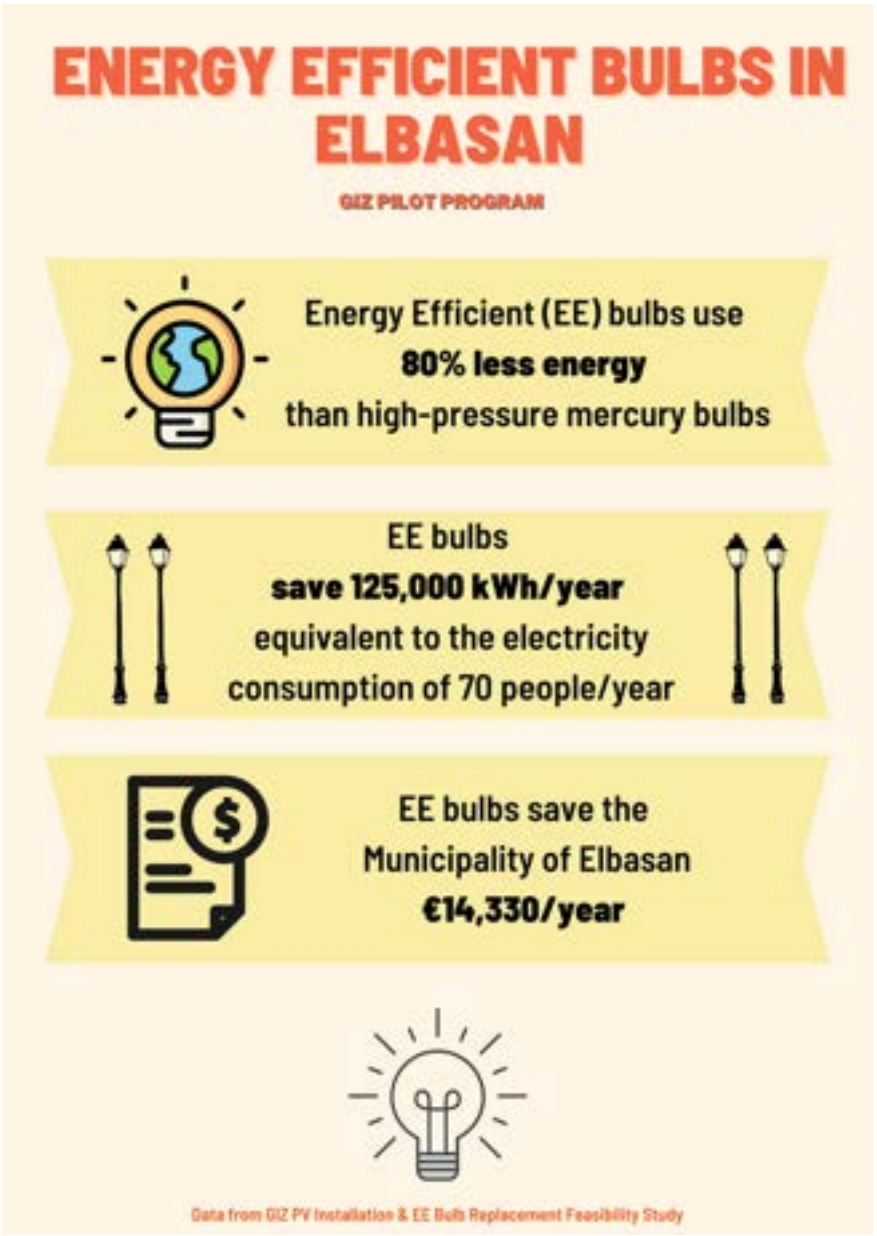


Figure 21: Example infographic to communicate key features of EE savings from the pilot program

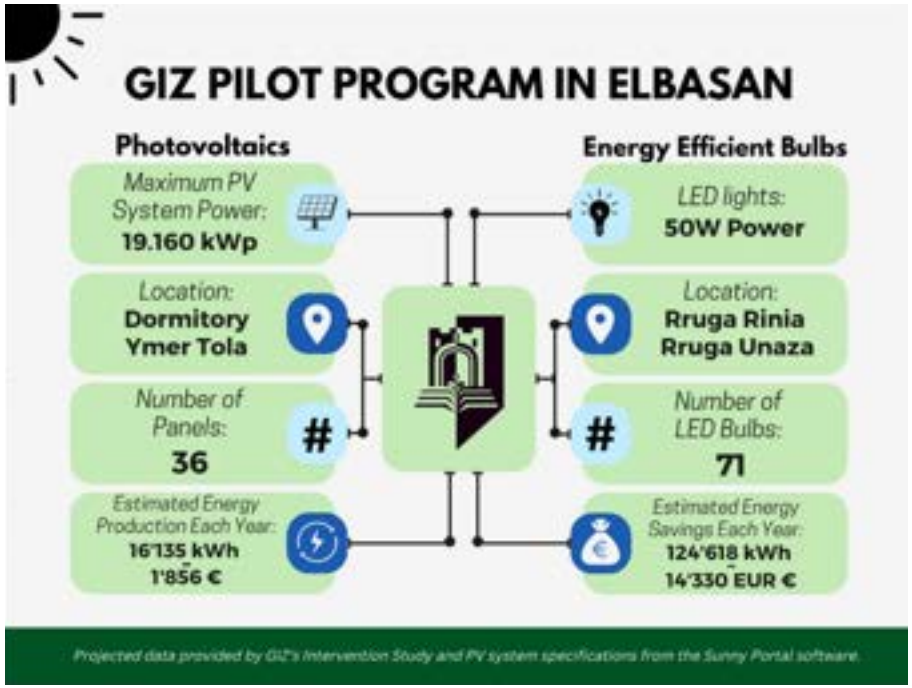


Figure 22: Infographic with overview of pilot program presented to Vice-Mayor Bylykbashi at an interview

For example, to communicate energy savings by EE bulbs, we framed kilo-watt hours in terms of the number of washing machine cycles. This is a common household practice, making the information widely applicable. This idea of using familiar elements for the reader is part of the Audience science communication core principle, where adapting information to suit a specific audience's values makes the information relevant (COMPASS, n.d.). We also converted energy (kWh) savings to monetary values because it is universally understood.

We produced infographics to present and user test during each of our interviews. From these interviews, we learned that monetary values can be especially meaningful to the reader. NGO leader Ervis Çota initiated a discussion about the PV and EE programs after remarking on the large value of the projected EE savings.

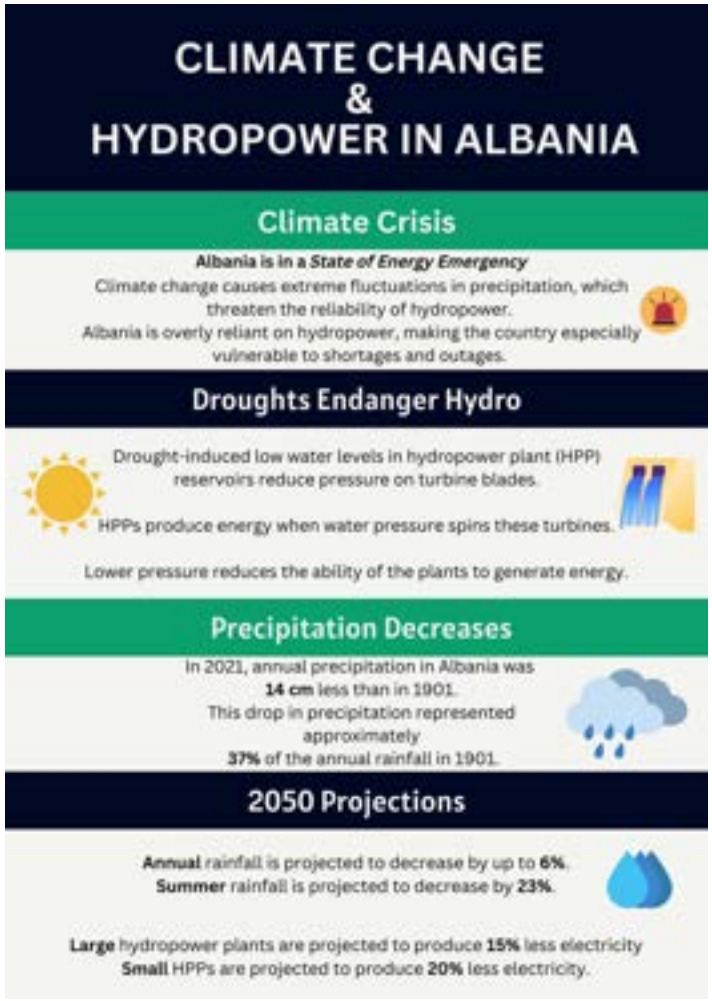


Figure 23: Infographic about the future of hydropower in Albania

ENCOURAGE MUNICIPALITIES TO EARMARK SAVINGS TO SUBSIDIZE EE AND OTHER ENERGY CONSERVATION PRACTICES

Based on our interview with the Vice-Mayor of Elbasan, one of the greatest obstacles to the diffusion of renewable energy technologies is funding. We recommend that savings generated from municipal PV and EE installations be earmarked, at least in part, for further renewable energy investment. For example, an earmark of about 50% of the pilot program savings could be reinvested in renewable energy technologies whereas the other 50% could be invested into other priority areas for the municipality like parks, housing, hospitals, and schools. This will facilitate the expansion of these necessary renewable energy technologies by ensuring there are available funds. With the earmarked savings, the municipality could offer subsidies for residential energy conservation including EE bulbs and thermal insulation.

Data from the feasibility study and our background research indicate that EE bulbs have a short return on investment while also generating significant savings. The team has determined that EE bulbs can serve as a "first step" for Albanians to reduce energy consumption and preserve the current energy supply. A subsidy program for EE bulbs is likely to increase public interest in replacing inefficient lighting with LEDS. Expanding private use of EE will generate significant savings for residents, allowing them to have additional money directly in their pockets and alleviate some consumers from the rising cost of living prices in Albania. For example, in the United States, lighting costs account for about 15% of the average household electricity use; switching to LED lights saves about $225 of yearly energy costs (U.S. Department of Energy, n.d.).

Thermal insulation programs are effective in reducing the heating and cooling costs of homes because temperature regulation appliances didn't have to run as long or hard. Better insulation also provides a measure of comfort, as heat is more effectively kept within an insulated space (U.S. Department of Energy, n.d.). Insulation subsidy programs (of up to 50% covering costs of insulation and installment) are currently offered in the municipality of Tirana and have been well received by residents thus far.

SERIES OF STRATEGY SESSIONS WITH NGOS TO ASSESS AWARENESS, COLLABORATION, AND PARTICIPATION REGARDING RENEWABLE ENERGY TECHNOLOGIES

Our interviews with Ahmet Mehmeti and Ervis Çota taught us that NGOs commonly address and promote their goals through collaboration. Each director identified campaigns and protests that involve multiple NGOs working towards a common goal. To reinvigorate effective NGO collaborations, we recommend that GIZ organize strategy sessions with NGOs. Before these sessions, we recommend that GIZ create a guidebook to be shared with the participants. The guidebook should be an agenda for the session containing information about PV and EE savings and how NGOs can better work together to obtain more from these savings through municipal budgeting processes. In these strategy sessions, GIZ should first assess NGO's current knowledge about renewable energy initiatives in the municipality, alliances among NGOs, and methods used to engage in municipal decision making. Then, GIZ should develop strategic plans with NGOs that will help the organizations better collaborate and engage in municipal decision-making. From this NGOs can learn how to participate in advocacy campaigns and municipal budgeting processes.

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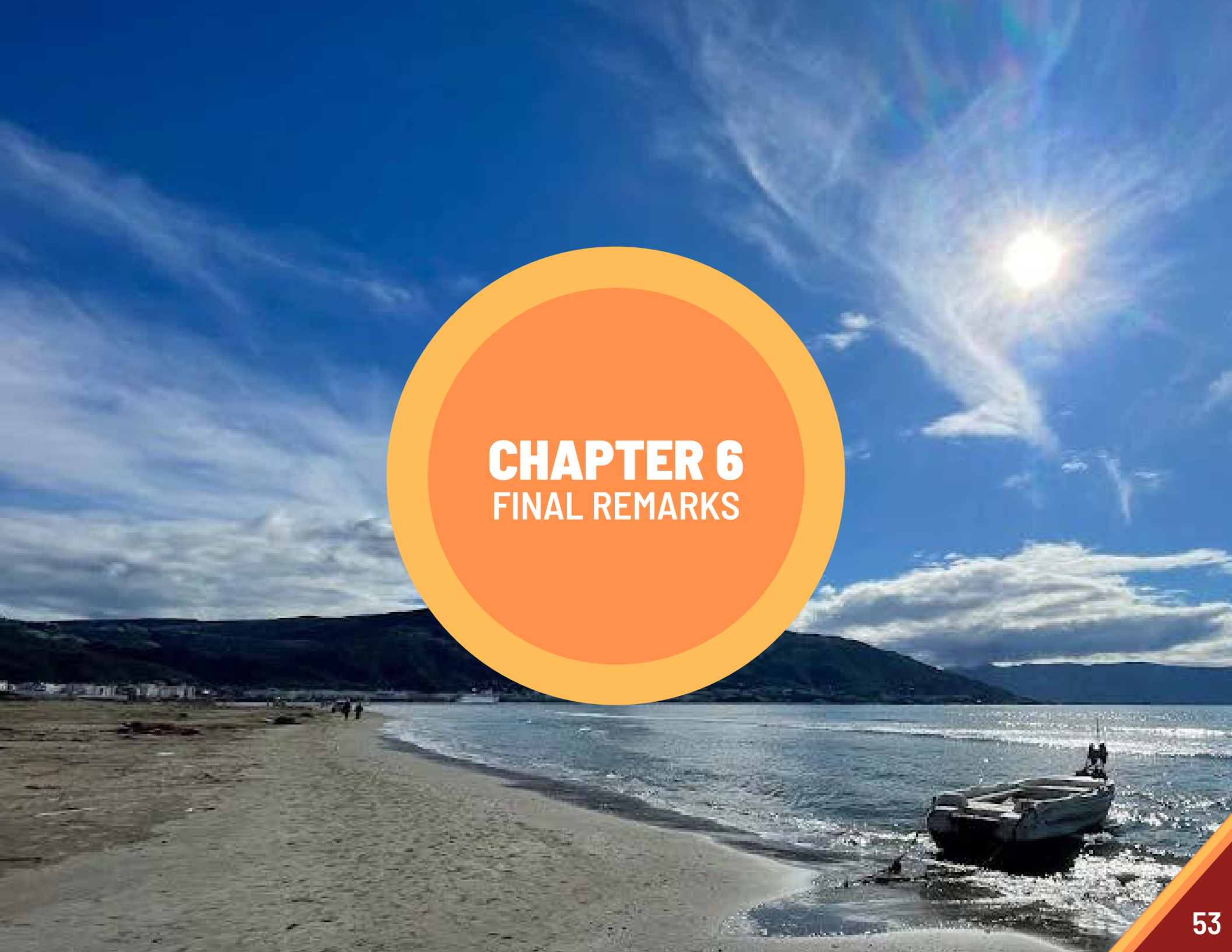
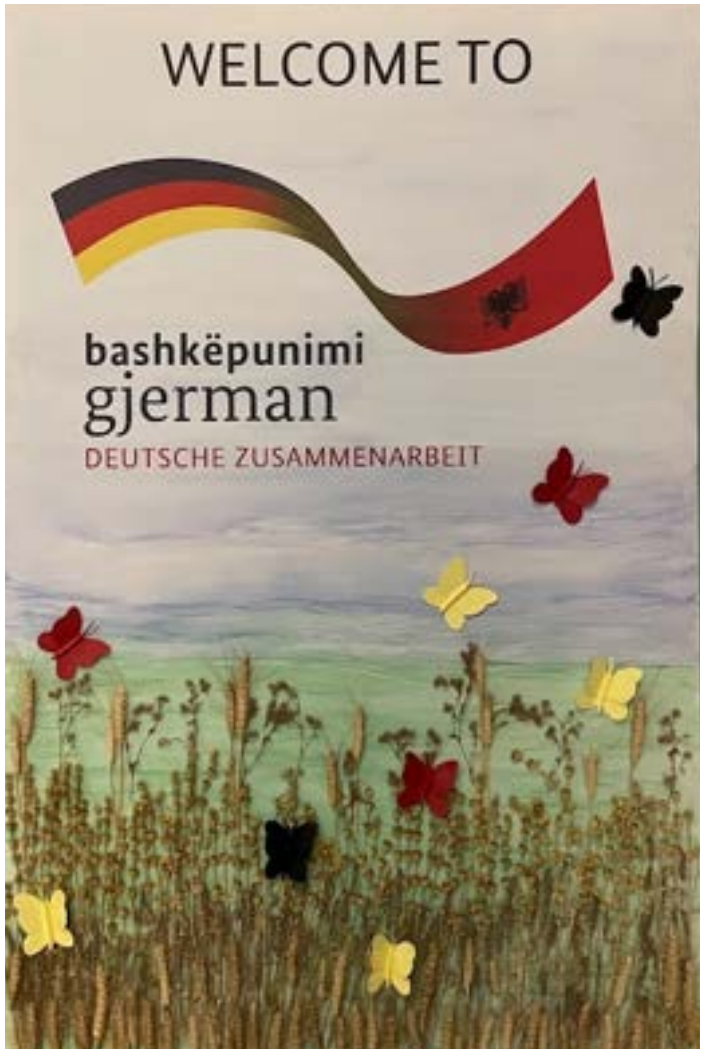


CHAPTER 6
FINAL REMARKS

FINAL REMARKS



Albania's NDC was negotiated under the Paris Climate Agreement (PCA) in 2016. The revised version of this NDC committed Albania to lower CO2 emissions by 21% from the years 2021 to 2030. Our research found that there are many barriers that even larger municipalities who are willing and ready to implement these technologies will face. We found that the expansion of PV and EE is inhibited by other needs that municipalities face. These findings show that if larger, well-prepared municipalities have a hard time implementing and expanding these technologies, then it is especially harder for smaller municipalities like Shijak where we found poor communication between the municipality and other stakeholders. Given our research, we hope that Albanian municipalities not only support renewable energy projects but also use the savings to help NGOs and residents in need. We also hope that earmarking savings will lead to further expansion of these renewable energy technologies. We concluded that science communication and closing the knowledge gap on climate change and renewable energy technologies may be an effective first step at tackling the larger issue. A bottom-up approach of having residents push for the expansion of these technologies and expressing their concerns for climate change is also key to municipalities making greater efforts to improve.

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APPENDIX A

KEY INFORMANT INTERVIEW WITH BLEDAR BACOVA, ALVISION, CEO

- What were some obstacles to the installation of the solar panels in Elbasan and Shijak?
    a. What factors, if any, made installation easier?
- If the municipality worked with you, how did you work with each municipality leading up to the installation? (If they ask for specifications this can mean what officials were contacted, if calculations were checked, how was communication carried out?
- Do you have contracts with any municipalities?
- What is the size of the projects municipalities are contracting you for? (Answer could be amount of panels, KWh, etc,)
- What maintenance do you offer?
- What were the time and manpower requirements for the installation?

APPENDIX B

KEY INFORMANT INTERVIEW WITH MERITA MANSAKU-MEKSI, GIZ, SENIOR CLIMATE ADVISOR AND EMI KADUKU, GIZ, JUNIOR CLIMATE ADVISOR

- Why was EE paired with PV? Were there technical, financial, or social implications behind this choice?
    a. Why did you choose EE technology over other forms of energy efficiency technology?
- Why were Elbasan and Shijak chosen?
    b. What were the research methods employed?
    c. How did you inform the municipalities that you chose about the program?
        i. What was the response/reaction from each municipality?
    d. How have the municipalities worked with GIZ so far in the implementation of the pilot program?
- What has been the biggest challenge to a successful pilot program from a development agency perspective?
    e. What was the biggest challenge in setting up the pilot program? [different option]
- What could the municipalities have done better to get the most out of this program?

APPENDIX C

KEY INFORMANT INTERVIEW WITH INTERVIEW WITH AULONA BYLYKBASHI, ELBASAN, VICE-MAYOR

We are a group of American students doing research to support the diffusion of new renewable energy technologies among Albanian municipalities. We aim to analyze the strategies developed for expansion after the completion of the pilot programs. To do so we are working with GIZ and assessing their photovoltaic and EE retrofit program. Our understanding is that municipalities play an important role in the diffusion of new renewable energy technologies in the midst of the European energy crisis. We are interested in hearing more about the current state of the pilot program in your municipality and future plans regarding the savings from the program and the potential for expansion. To further investigate this we have developed the following questions:

1. How does the municipality feel about expanding the use of solar and EE bulbs?
    a. What are the municipality's concrete plans to expand solar and EE bulb programs in the near future?
2. What location would be used if the municipality expanded the solar program? Which buildings/what land?
3. What are some of the barriers to expanding solar in the municipality?
    a. How is the municipality planning on funding future renewable energy programs?
    b. Do you have a specific official or department in mind to lead the expansion of this energy transition?
    c. Which municipal facilities are more in need of this technology?
4. What does the municipality intend on doing with the savings from the program?
    a. What are some of the immediate needs of the community?
    b. Would these savings go into expanding this program or would they fund other needs of the community/more urgent needs?
5. Do you need the community's approval for new renewable energy projects?
    a. How do you plan to collect community feedback on future renewable energy projects?
6. How does the municipality plan to encourage the diffusion of solar technology for residential use?
    a. What has the municipality done to inform the population about the benefits of solar energy? What [else] is the municipality planning to do to inform the public?

APPENDIX D

KEY INFORMANT INTERVIEW WITH INTERVIEW WITH AULONA BYLYKBASHI, ELBASAN, VICE-MAYOR

1. What is the mission of your organization?
2. What are some of the needs of the people you work with?
    a. How well are those needs met by current resources (funding, staffing, etc)?
    b. How do you see those needs or demands changing in the next five years?
3. What other NGOs do you work with?
4. How does your organization currently participate in the formation/planning of municipal initiatives?
5. What would your organization like to do with savings and any money generated from the PV/EE Pilot Program with GIZ?

APPENDIX E

SUNNY PORTAL SOFTWARE RAW DATA AND COMPARISON WITH FEASIBILITY STUDY

Sunny Portal Software Data							
Day	**Weather**	**Daily Consumption (kWh)**	**External Energy Supply (kWh)**	**Internal Energy Supply (kWh)**	**Daily Yield (kWh)**	**Self-Consumption (kWh)**	**Grid Feed-In (kWh)**
11/09/2022	Sunny	30.37	0.01	30.36	30.36	30.36	0.00
11/10/2022	Partly Cloudy	0.17	0.17	0.00	31.09	0.00	31.37
11/11/2022	Sunny	0.17	0.17	0.00	30.55	0.00	30.81
11/12/2022	Sunny	0.157	0.157	0.00	9.427	0.00	9.586
11/13/2022	Cloudy	--	--	--	6.994	--	--
11/14/2022	Partly Cloudy	7.48	0.18	7.30	21.98	7.30	14.68
11/15/2022	Mostly Cloudy	0.16	0.16	0.00	22.22	0.00	22.39
11/16/2022	Cloudy	0.18	0.18	0.00	22.13	0.00	22.41
11/17/2022	Rain. Cloudy.	0.178	0.178	0.00	7.493	0.00	7.628
11/18/2022	Cloudy	0.18	0.18	0.00	11.44	0.00	11.57
11/19/2022	Mostly Cloudy	0.18	0.18	0.00	18.83	0.00	19.11
11/20/2022	Thunderstorms	0.191	0.191	0.00	3.246	0.00	3.402
11/21/2022	Rain. Cloudy.	0.194	0.194	0.00	6.327	0.00	6.440
11/22/2022	Rain. Cloudy.	0.181	0.181	0.00	2.383	0.00	2.515
11/23/2022	Rain. Cloudy	0.183	0.183	0.00	8.210	0.00	8.353

APPENDIX E CONTINUED

11/24/2022	Partly Cloudy	0.17	0.17	0.00	17.40	0.00	17.66
11/25/2022	Mostly Cloudy	0.17	0.17	0.00	27.49	0.00	27.75
11/26/2022	Cloudy	0.17	0.17	0.00	12.11	0.00	12.38
11/27/2022	Cloudy	0.176	0.176	0.00	7.120	0.00	7.378
11/28/2022	Sunny	0.17	0.17	0.00	25.72	0.00	26.00
11/29/2022	Mostly Cloudy	0.17	0.17	0.00	19.91	0.00	20.17
11/30/2022	Mostly Cloudy	0.172	0.172	0.00	5.445	0.00	5.633
November Totals	**---**	**29.66**	**3.70**	**25.96**	**347.86**	**25.96**	**321.90**

APPENDIX E CONTINUED

Before PV Installment	
Average November Power Consumption (kWh)	3666
Average November Energy Expenditures (EUR)	422

	November Power Consumption (kWh)	November Power Yield (kWh)	Budget Saving [EUR] *Power tariff: 0.115 EUR/kWh*
Software	29.66	347.86	36.59
PV Projections (Feasibility)	4,746	953	110

APPENDIX F EE BULBS FEASIBILITY STUDY DATA

Before PV Installment	
Average November Power Consumption (kWh)	3666
Average November Energy Expenditures (EUR)	422

	November Power Consumption (kWh)	November Power Yield (kWh)	Budget Saving [EUR] *Power tariff: 0.115 EUR/kWh*
Software	29.66	347.86	36.59
PV Projections (Feasibility)	4,746	953	110

APPENDIX F

	November Power Consumption (kWh)	November Expenditures (EUR)
Before EE (Feasibility Study)	17,758 (average from 2019 and 2020)	2,043
After EE (Feasibility Study)	3,551.6	408.6
Savings	14,206.4	1634.4

APPENDIX G CLOUD-TODIM PV ANALYSIS

Economic Factors	
Construction Cost *From Feasibility Study*	The cost of PV Systems varies from 900 to 950 EUR/kWp approx.
Operation and Maintenance Cost *From Feasibility Study*	Operation and Maintenance Costs account for 3% of capital expenditures (CAPEX) or 370 EUR/year approx.
Annual Average Capital Income / Municipal Budget	Information not publically available.

Resource Factors	
Sunshine (hours) *From Feasibility Study*	Annual: 2476 November: 129 Highest Month (July): 335 Lowest month (December): 105
Global Horizontal Irradiance *From Feasibility Study* **[kWh/m²]**	Annual: 1574 November: 66 Highest Month: 230 Lowest Month: 53
Gross Installation Area	1755x1038x35 mm *36 = 63.18m by 37.368

APPENDIX G CLOUD-TODIM PV ANALYSIS CONTINUED

Risk Factors	
Extreme Weather Damage *From [Elbasan PV System Overview]*	Annual Extreme Low Temperature: -4°C Annual Extreme High Temperature: 38°C Full Load Hours: 1398.1 h
Fluctuations in Policy (Energy Price) *From Feasibility Study*	According to current regulations for PV energy generation in Albania, production that exceeds 500kWh must abide by prices set by the government. Power tariff: 0.115 EUR/kWh.
Loan Financing and Solvency	N/A for municipality

Engineering Feasibility	
Electrical Transmission and Distribution System *From [Elbasan PV System Overview]*	Grid Voltage: 380 V (220V / 380V) Max. DC Power: 15.33kW Max. AC Active Power: 15.00kW One SMA STP 15000TL-30 Inverter
Influence on Power *From [Elbasan PV System Overview]*	Nominal Power Ratio: 79%
Electricity Demand - Dormitory Building *From Feasibility Study*	Yearly average: 56'951 kWh