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SUSTAINABLE POWER GENERATION

Harnessing the Potential of Renewable Energy Sources

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EDITORIAL

Sustainable Power Generation: Harnessing the Potential of Renewable Energy Sources

Prof. Dr. Petraq PAPAJORGJI
EDITOR IN CHIEF

The world is at a critical juncture in its energy evolution, facing the pressing need to transition from fossil fuels to sustainable and environmentally friendly alternatives. Renewable energy sources, particularly wind energy, have emerged as a promising solution for electricity generation. Renewable energy sources: wind, solar, hydro, geothermal, and biomass are resources that can be naturally replenished and harnessed without depleting finite reserves. Differently from fossil fuels, renewable energy offers a clean and sustainable pathway for meeting the world's increasing energy demands without emitting harmful greenhouse gases and contributing to climate change.

Among various renewable energy sources, wind energy stands out for its remarkable potential and rapid growth. Wind energy is generated through the kinetic energy of wind, which is converted into electricity by modern wind turbines. These turbines consist of large blades that rotate when exposed to wind, activating a generator to produce electrical power. The wind energy sector has witnessed remarkable advancements in turbine technology and operational efficiency. While wind energy is environmentally friendly during operation, its manufacturing and installation processes do have some environmental impacts. These include raw material extraction and land use changes. However, these impacts are relatively minor compared to the long-term benefits of clean energy production.

Advantages of Wind Energy:

1. Abundance: Wind is an inexhaustible resource, available in vast quantities across the globe. Both onshore and offshore wind farms can be set up in diverse locations, ensuring a reliable and continuous supply of electricity.
2. Job Creation and Economic Growth: Wind energy projects stimulate economic activity by creating job opportunities and attracting investments.
3. Zero Emissions: Wind energy is entirely clean and emits no greenhouse gases or air pollutants, making it a pivotal tool in mitigating climate change and improving air quality.
4. Land Multiplicity: Wind turbines can be erected on agricultural lands or in remote areas without interfering with existing land use significantly.
5. Energy Independence: Utilizing wind energy reduces dependence on finite fossil fuel reserves and lessens the vulnerability to energy price fluctuations.

Meanwhile, energy production from biomass involves converting organic materials, such as plant matter and agricultural waste, into usable energy. This renewable energy source offers several benefits, including reducing greenhouse gas emissions and utilizing organic waste. Biomass can be processed through various methods, such as: combustion, gasification, and anaerobic digestion, to produce heat, electricity, or biofuels.

Biomass energy contributes to sustainable development and energy diversification. However, it also faces challenges related to land use, competition with food production and efficiency. Proper management, supportive policies and technological advancements are crucial to harnessing the full potential of biomass as a clean and renewable energy solution.

Embracing renewable energy sources, with a primary focus on wind energy, is essential for Albania's sustainable energy future. By tapping into its abundant wind resources, Albania can reduce its dependence on conventional energy sources, minimize greenhouse gas emissions, and strengthen its energy security. Continued government support, technological advancements, and collaborative efforts between public and private stakeholders will be instrumental in fully realizing the potential of wind energy and making Albania a leader in the region's renewable energy transition.

Improving the Service Quality of the Billing System for Water Suppliers. Case Study: Albania

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Abstract

The Water Supply sector in the Republic of Albania uses billing systems to fulfill its main role, generating the monthly water bill. This study aims to empirically analyze the dynamics that the billing system has and the importance of adding a new module to this system on the most frequent questions that users usually have and seeking support directly from the system without having to make phone calls or send emails at limited times. This is because the system has many functionalities and based on experience, users do not use the user manual but seek direct assistance from the company with which they have a support contract. It is also worth mentioning the newest reform in the Water Supply Sector, where the structuring of all Water Supply will be done by joining certain units. This merger will cause new users to be added to these systems so the need for a new module in the system is necessary. For this reason, the questionnaire was conducted with the staff of fifteenth water companies where the company where I worked offered the service of the billing system and has an active

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support contract. For privacy reasons, no images from the system will be presented in this paper. The results of the conducted study confirm the importance of adding a new module to the system, the customer care module for the billing system.

Keywords: *Billing system, Water Supply Sector, Customer Care, Support.*

Introduction

A billing system for water suppliers is software or a group of processes used to calculate and generate invoices for customer water usage. Water suppliers utilize billing systems to efficiently track customer payments, calculate and charge consumers for water consumption, and manage other billing-related operations. Tools for managing clients, creating bills, reading meters, and calculating tariffs are usually included. (Smith, 2022).

In addition to functions for rate control, online payment processing, billing dispute resolution, and reporting for financial and operational analysis, water suppliers may employ billing systems. In order to speed up procedures, some billing systems may additionally communicate with other systems like meter reading devices and accounting systems.

The target group for the billing system, or the system's users, is closely related to this article's objective. Due to having a complete understanding of the billing system and being in constant contact with clients, it has been found that helping with system use is highly important and regular. Additionally, it has been concluded that the combination of the Water Suppliers will result in an increase in system users. Therefore, assistance will be essential (Johnson, 2023).

The purpose of this paper is to enhance the billing system's customer service, which will be made possible by the addition of a new module for the support component. Despite the existence of certain generic academic articles on information systems, it has been observed from the review of all the literature that there is a dearth of genuine scientific publications that examine the billing and water supply systems in Albania.

Literature Review

In the context of this literature review, an information system is a collection of interconnected components, including hardware, software, data, people and processes, that work together to gather, store, manage, process, and distribute information within an organization. According to Miller and Turner (2018), some key features of a Water Billing System are:

Correct Meter Reading and Billing - The amount of water consumed by each customer should be precisely calculated by the water billing system. Meter readings should be able to be recorded, and the system should be able to compute use fees using tariffs and produce bills accordingly.

Flexible Tariff Management - A system for water billing should enable administrators to create variable rates depending on several criteria, including location, customer type, and water usage. Complex tariff structures like variable rates, tiered tariffs, and time-of-use tariffs should all be supported by the system.

Customer Management - An accurate view of client data, including contact information, billing history, and consumption patterns, should be available from a water billing system. Also, it should make it simple to update customer information and handle payments while managing accounts.

Analytics and Reporting - A water billing system must offer thorough reports on revenue and water usage patterns. The reports should be able to be modified and offer information on consumption trends, revenue forecasts, and revenue collection efficiency.

International Billing Systems

Below is a comparison of the two international billing systems, their features and importance, which are used by Water Utility Companies.

1) *Elster AMCO Water:*
According to Elster AMCO Water (2023), it products contains a number of significant characteristics, including:

- AMI or advanced metering infrastructure: Smart water meters from Elster AMCO Water have AMI features, enabling remote meter reading and real-time data collecting. This makes it possible for utilities to more effectively monitor water use, find leaks, and optimize water management.
- Water flow may be measured accurately using Elster AMCO water meters, which also provide accurate data that can be used for billing, monitoring, and conservation efforts. They use a variety of methods, including positive displacement, ultrasonic, and electromagnetic, to provide precise measurement even in difficult settings.
- Tamper Detection and Prevention: "Elster AMCO Water meters have advanced meter security features, anti-magnetic tamper sensors, sealable enclosures, and other tamper detection and prevention features to guard against unauthorized entry, tampering, and meter fraud" (Elster AMCO Water, 2023).

- Elster AMCO Water meters are created from high-quality materials to ensure durability and long-term performance. They are also built to endure harsh climatic conditions. They are made to be resistant to external conditions including temperature changes and water intrusion, ensuring dependable functioning throughout an extended lifespan.
- Data collection, storage, analysis, and visualization are all made possible by Elster AMCO Water's comprehensive data management and analytics solutions, which are provided to utilities. Billing, demand forecasting, leak detection and general water resource management can all be done with the help of this data.

2) *Sensus FlexNet Water:*
According to Sensus (2023), Sensus FlexNet Water is an all-encompassing advanced metering infrastructure solution for water utilities that is created to offer effective and dependable water metering and data management capabilities. Sensus FlexNet Water has several important features, including:

- Two-Way Communication: This system has two-way communication capabilities, making it possible to collect data in real-time and read meters from a distance. This makes it possible for utilities to remotely monitor water usage, find leaks, and improve water management.
- Communication Network: FlexNet, a strong and dependable mesh network built on open standards, is the name of the dedicated, secure and scalable communication network used by Sensus FlexNet Water. This network provides two-way communication with water meters, data collectors, and other utility devices and guarantees dependable data delivery.
- "Sensus FlexNet Water uses smart water meters, which are outfitted with cutting-edge metering technologies like ultrasonic and electromagnetic, to precisely and consistently monitor water flow" (Sensus, 2023). These meters can record precise consumption information and offer perceptions into patterns and trends in water use.
- Data collection, storage, analysis, and visualization are all included in Sensus FlexNet Water's comprehensive data management and analytics capabilities. To aid in decision-making, utilities can use this data for billing, demand forecasts, leak detection, and other aspects of water management.
- Sensus FlexNet Water features built-in algorithms for leak detection that can identify unusual water usage patterns indicative of probable leaks. Having access to real-time alerts and notifications about suspected leaks allows utilities to respond quickly and save water.

3) *Comparison of these two systems*
Solutions for water metering and utility management are available from the brands Elster AMCO Water and Sensus FlexNet. But there are certain distinctions between the two that may be compared in terms of their primary characteristics, features and advantages.

- Elster AMCO Water provides precise water measurement and monitoring using a combination of mechanical, electronic, and smart metering technologies. Sensus FlexNet, on the other hand, is a wireless communication network that collects, transmits, and analyzes data using advanced metering infrastructure (AMI) technology.
- Sensus FlexNet is renowned for its scalability, which makes it ideal for utility providers controlling water meters across a large geographic area. It can manage large-scale deployments with thousands of endpoints. On the other hand, Elster AMCO Water might be more suited for smaller-scale deployments or places where wired communication infrastructure is already present.

To sum up, Sensus FlexNet Water is an all-encompassing AMI solution that offers cutting-edge capabilities for precise water metering, dependable data communication, effective data management, and efficient leak detection, assisting utilities in streamlining their water management operations and enhancing customer service.

Albanian Billing System

According to ERRU (2023), as it works to give its people access to clean, safe and dependable water services, the Republic of Albania's water supply sector has several opportunities and problems. The size of the property and the number of residents is used to calculate the monthly cost for residential clients in Albania. Business clients, on the other hand, have their bills calculated according to how much water they use. The Albanian Regulatory Authority of the Water Supply and Wastewater, which oversees overseeing the Albanian water industry, determines the tariff rates.

The following are some significant elements of Albania's water supply industry:

1. *Infrastructure and Service Coverage:* Albania's water supply infrastructure requires major investment and renovation due to its relative age. Many water delivery systems experience water losses, unpredictable service, and inadequate coverage in rural areas as a result of aged infrastructure, poor maintenance, and inefficient operations.

2. *Regulatory Framework:* The Water Law and other pertinent laws serve as the cornerstone for the management of water resources, water supply, and wastewater. Albania has a legislative and regulatory framework in place for the water supply industry. Yet, there are still issues with governance, enforcement, and the development of regulatory organizations' ability (ERRU, 2023).
3. *Tariffs and Financing:* The comparatively low cost of water supply services in Albania makes it difficult to sustainably finance the industry. Several water supply businesses experience financial instability, poor revenue collection, and a lack of funding for infrastructure maintenance and improvement projects.
4. *Water Quality and Safety:* The Albanian water supply industry places a high premium on maintaining the safety and quality of drinking water. While improvements in water treatment and monitoring have been made, there are still issues with testing for water quality, meeting drinking water requirements, and dealing with water pollution and contamination (AKUM, 2022).
5. *Access to Water Supply:* In some rural and distant areas of Albania, access to a safe and consistent water supply is still a problem. Water supply services are being extended to underserved areas to expand service coverage, resolve access disparities, and protect vulnerable people.
6. *Institutional Capacity and Governance:* Albania's water delivery sector confronts difficulties with institutional capacity, governance, and stakeholder cooperation. To improve the overall performance and sustainability of the sector, water supply corporations, regulatory organizations, and other pertinent bodies must be strengthened.

Notwithstanding the difficulties, there are chances for Albania's water supply sector to develop and flourish. This includes "making investments in infrastructure upgrades, stepping up regulatory enforcement, enhancing service providers' governance and financial sustainability, fostering public-private partnerships, improving water quality and safety and guaranteeing that everyone, especially in underserved areas, has access to a reliable water supply" (ERRU, 2023).

Customer support module

A feature that helps customers with their billing-related questions, problems, and concerns is called a customer support module in billing systems (Cassandra, Hartono and Karsen, 2019).

It is intended to simplify the billing procedure and provide effective communication between the billing department and clients. The business must be reliable and have sound policies in place if it is to offer all consumers the best professional service possible. The most crucial step in becoming sustainable is developing a company vision that includes customer service. The company's vision must be informed by an understanding of client needs.

In its simplest form, Customer Care can consist of a phone number and a person who can resolve customer issues in real-time. According to Peterson (2019), this approach does not scale well, so more advanced customer care involves a customer support module on a billing system that performs some or all the following functions:

Ticket creation: The customer uses the Customer Care module to create tickets for a specific issue and in this way, the issue is tracked until it is resolved by the support team.

Answer: Staff answer customer questions submitted in Customer Care tickets and solve their problems.

Escalation: When a support member cannot resolve a request, the next step is to direct the ticket to another team member or escalate it to another level. Escalation of a ticket should occur only after the first responding Customer Care personnel have verified their resources for resolving a customer problem.

Knowledge base: Customer Care staff use a knowledge base to find out if a customer problem has been analyzed and if so then what the corresponding solution is. Staff must be able to add and update content to the knowledge base as they discover new customer requirements.

In larger companies, Customer Care may consist of a customer service team. This is a set of experts that Customer Care uses to track the status of tickets created (Peterson, 2019).

Any company or organization that engages in consumer interaction should have a customer support module. It is the first line of defense for responding to consumer questions, resolving problems, and offering support and it is crucial to ensuring client satisfaction and loyalty. According to Cassandra, Hartono and Karsen (2019), these are some major justifications for the significance of the customer support module:

Fixing Consumer Problems: The customer support module oversees resolving client problems, which might include everything from technical issues to product questions to financial concerns. A favorable relationship with consumers may be maintained and possible customer complaints can be avoided with prompt and efficient handling of client issues.

Increasing Customer Experience: Increasing the entire customer experience can be done by offering good customer assistance. Customers are more likely to feel valued and happy with their encounters with the company or organization when they receive timely and courteous assistance. Increased consumer loyalty and repeat business may arise from this.

Developing Customer Trust: A responsive and dependable customer care module can aid in increasing client trust in a company or organization. Consumers must have faith that their issues will be handled quickly and effectively. Trust is an essential component of customer relationships and can help with long-term client loyalty and retention.

Managing Reputation: The customer support module is crucial to managing a company's or organization's reputation. Good customer experiences with the customer care module may result in favorable reviews and recommendations, which may improve the company's standing and draw in new clients. On the other side, inadequate customer service can result in unfavorable evaluations and bad word of mouth, which can harm the company's reputation.

Receiving Customer Feedback: The customer support module provides a method of receiving beneficial client feedback. Customer comments and grievances might reveal ways to improve a business's products, services, or processes. This information can be used to make the necessary modifications and improvements, which will lead to the company's growth and overall success (Cassandra, Hartono and Karsen, 2019).

Handling Emergency Situations: The customer assistance module is essential for handling client questions, concerns, and complaints in emergency situations. Rapid and effective response to crisis situations can assist in reducing possible harm and preserve client trust in the company or organization.

For these reasons, the customer support module is crucial for businesses and organizations since it has a direct impact on client happiness, brand loyalty, and general success. Offering first-rate customer service can result in improved customer satisfaction, boosted customer confidence, a good reputation, and priceless consumer feedback. In order to achieve customer happiness and corporate success, it is a crucial element of customer relationship management and should receive the proper attention and resources (Cassandra, Hartono and Karsen, 2019).

According to Anderson (2020), billing system can also be integrated with other systems such as:

- *Integration with the fiscalization system:* After the closing of the billing period, i.e., after the monthly invoice is generated, the fiscalization process is performed. This process means that these invoices go in real time to the tax system thus ensuring transparency. After the completion of the fiscalization process, several distinguishing elements are activated on the invoice: NIVF code, NSLF and QR code (Fiscal Service, 2023). Only after the invoices have a successful fiscalization status, subscribers can make the payments of the invoices at the cash desks of the Waterworks or at third parties.

- *Third-party payment integration:* The billing system can be integrated with third-party systems such as Western Union, MoneyGram, second-tier banks, etc. These payments are automatically entered into the system and are reflected in the cash register module as well as in the corresponding reports.
- *Installment Payment Agreements:* The system provides the possibility for a subscriber's debit to be restructured to create opportunities for repayment in installments. A subscriber is called a debtor if he has unpaid bills. For this, the Agreements concluded between the subscriber and the Water Company for making payments in installments can be registered in the system.
- *Creation of discount invoices:* In cases where a subscriber has been billed incorrectly, discount invoices or return invoices can be made in the system. If a discount invoice is made in the invoicing system, then this action must be accompanied by a corrective invoice in the fiscalization system (Fiscal Service, 2023).

Methodology

The purpose of the survey utilized in this study was to find out how customers felt about the value of customer service in a billing system. To guarantee its clarity and usefulness, the questionnaire was pilot tested with a small sample of clients. In order to learn more about how consumers feel about the value of the customer support module in the billing system, the survey responses were statistically examined. For the realization of this study, two types of primary and secondary data were used. The primary data consists of the construction and data analysis of a questionnaire which will be carried out with the employees of the different Water Departments in Albania, as these are the users of the billing system.

The questionnaire was answered by 100 users, employees of the following Water Supplies:

- Bulqizë Water Supply
- Delvina Water Supply
- Devoll Water Supply
- Dibër Water Supply
- Durrës Water Supply

- Elbasan Water Supply
- Kamëz Water Supply
- Kavajë Water Supply
- Krujë Water Supply
- Mallakastër Water Supply
- Patos Water Supply
- Tropoja Water Supply
- Vlora Water Supply
- Vora Water Supply
- Gjirokastër Water Supply

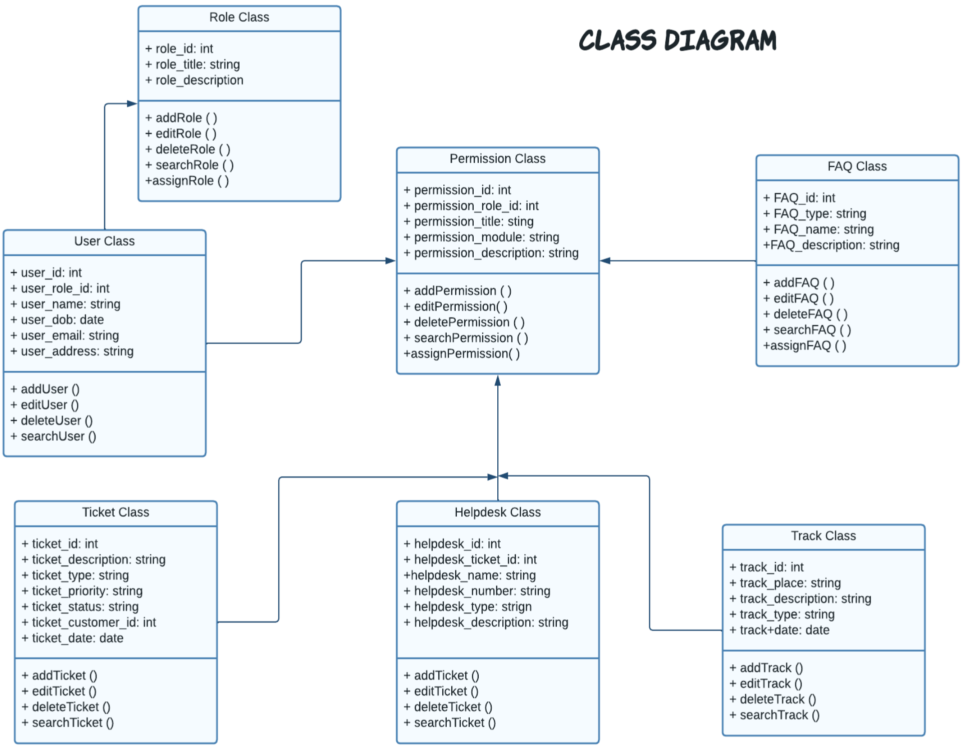
The secondary data is related to the review of the literature that consists of various sources such as books related to the field of research, publications in scientific journals, reports of various institutions, Water Suppliers Sectors and relevant Entities which present facts and statistics on the issues addressed, etc. An important place will also be occupied by the data published by the National Agency of Water Supply (AKUM). Based on this reform, there will be a restructuring of the water supply in certain directorates. A concrete example is the Durres Regional Water and Sewer Society (AKUM, 2022).

This directory will have these units: Durres Unit, Kavajë Unit, Krujë Unit and Rrogozhinë Unit. Therefore, from the current four different Water Suppliers Sectors, there will be one single directorate. According to AKUM, at the end of 2023, it is expected that directorates from the above list will be created throughout Albania. During the research done for the reference sources of this study, an obvious lack of literature about this topic in Albania was observed.

For the description of the structure of the system on the added functionalities, a class diagram has been realized below, modeling the classes, attributes, operations and the relationship between the objects.

This diagram shows all the classes that will make up the new customer care module, as well as the functions that each of these classes will have. A user in the system has a certain role, in addition to that role, the user also has certain rights. Based on these rights, they operate in the system. The Ticket, Helpdesk, and Track classes relate to entitlements. While FAQ (frequently asked questions) is a separate class which is not directly related to Helpdesk because it is foreseen that it can only be processed by support users. Each class has the basic functions of adding, editing, deleting and searching as well as other functions based on the role they will have in the system.

TABLE 1. Class Diagram



The Billing system is accessed by all Water Suppliers' employees and by persons authorized by the company that provides this service and has an active support contract. Each user in the system has a defined role and each role has corresponding rights.

The admin user will have full rights in the new module, i.e., they can access and perform all actions in the customer care module. Also, another user is the support user who has more specified rights in this module. Specifically, the support user has the following rights: Helpdesk management, ticket management, ticket updating, FAQ updating, accessing the FAQ page, and accessing the status of the ticket in its follow-up. As for the client, it is the other user who has limited rights to this module. When he accesses the module the first thing, I can do is look at the FAQ and look there for the question he has in case it has been reviewed before by others and has an answer. If the customer looks in the FAQ and does not find the question, he has then he has the right to create, edit or delete a ticket. Also, after creating a ticket, the customer has the right to monitor the progress of the milestones, i.e., to see if he is being seen by a support specialist, if the answer has been given, etc.

Empirical analysis

Below will be shown how the new module that will be added to the system for customer support will work. The customer care module will be organized into two interfaces, FAQ and Help Desk.

If you click on FAQ, then the most frequent questions that users of the billing system may have will be displayed with the corresponding answers. The customer care module will operate on a milestone basis. Therefore, if you click on Help Desk, you will be given the opportunity to create issues through milestones.

When a user in the case of a customer will click on the customer care module the FAQ interface is initially generated so that before I create a ticket I see if the question he must ask will be part of the page. In this interface, the client has the right to search by setting a word in order to find a specific question. On the other hand, users in the case of admin or support specialist, in addition to viewing or searching for questions, will be able to do the following actions:

- FAQ editing: In case a milestone has the completed status, then support specialists can add it to the FAQ interface.
- Deleting the FAQ: Deleting the FAQ in case the interface is structured.
- Misassignment: In the case of a support specialist following the issue but at a certain moment he will delegate it to a colleague of his, then there is the possibility of assigning another user.

A customer has the right to create, edit or delete a ticket in the Help Desk interface. In the created checkpoint I will be able to fill in the following data:

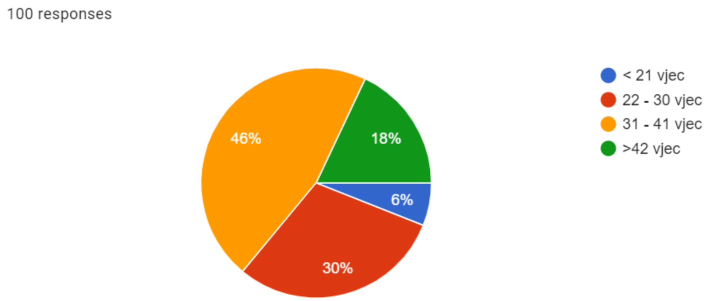
- Milestone number: this number will be unique and through each one the milestones will be identified.
- Milestone description: in this field, the client's request for support or his problem can be described concretely.
- Milestone priority: consists of a dropdown menu where the priority of the milestone is selected if it is high, medium or low priority.
- Milestone status: indicates for the milestone if it is being reviewed by a support representative and the status is in progress, if the issue has been assigned to another support specialist or if a response has been returned to the customer and the milestone is complete.
- Date of creation consists of the date of creation of the milestone by the client.
    - Prioritization of questions: Through this functionality, it will be possible to prioritize questions based on their importance, specifically high, medium and low priority.

- Monitoring the status of milestones: After creating a milestone, the customer has the right to monitor its progress, i.e., to see if the issue raised by a support specialist is being investigated, if the answer has been given, etc.

Below are presented the questions contained in the questionnaire and the corresponding analysis based on the answers given.

First question: How old are you?

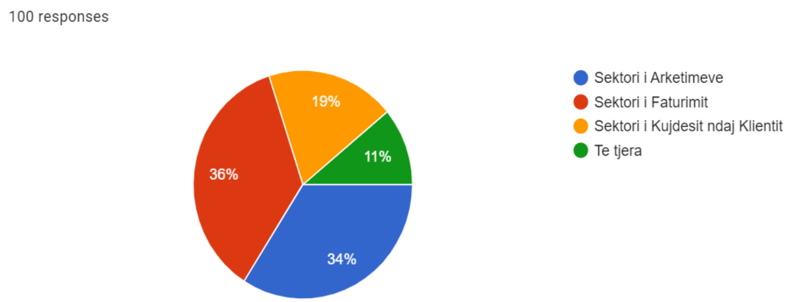
TABLE 2. Age of users



From the results of the survey, it is noticeable that most employees who participated in the survey belong to the age group of 31 to 41 years, which is expressed in percentage of 46% of them. Following then 30% of the age group is 22 to 30 years, 18% older than 42 years and 6% of them are younger than 21 years. Based on work experience, that is, from communication with customers or meetings held with different representatives from Water and Sewerage, it has been noticed that most of the employees, especially in the Billing Sector or the Data Processing Sector, are of average age.

The second question: In which sector of Water Supply do you work?

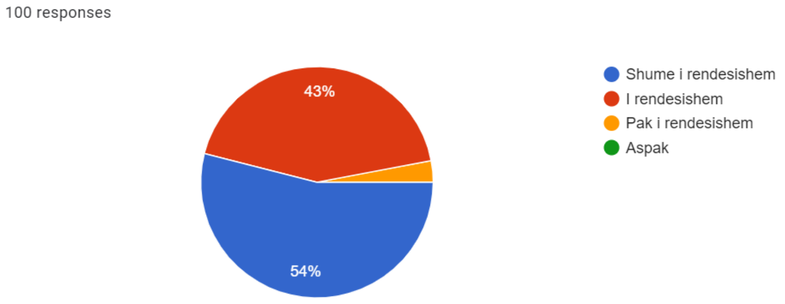
TABLE 3. User employment sector



The conducted survey shows that the sectors with the most users are the Billing Sector and the Collection Sector with respective values of 36% and 34%. Also, 19% of users are employed in the Customer Care Sector, while the rest belong to other sectors in the amount of 11%.

Third question: How necessary is the addition of a new module to the system for support?

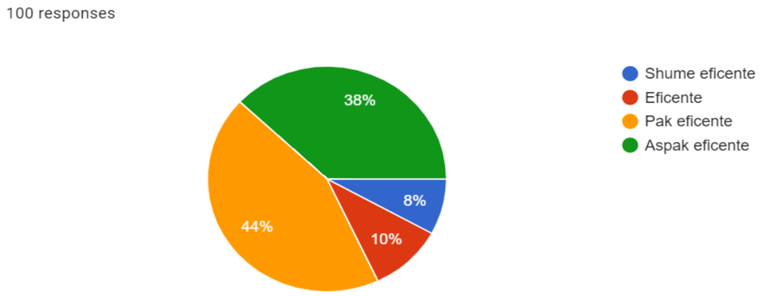
TABLE 4. Importance of adding a new module



In relation to the third question, it is clearly observed that 54% of users vote that the addition of the new module to the system for support is very important, 43% vote that it is very important, and 3% vote that it is a little important. In contrast to the other questions here it is noticeable that there is no answer "Not at all" Important for adding the new module to the system indicating that all the complaining users find the new development necessary.

Fourth question: How efficient is it to ask for support and get answers only through emails and phone calls?

TABLE 5. Current support efficiency

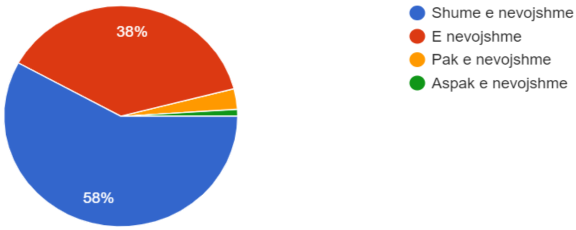


Currently, Water Supply Companies request support by phone or by sending an e-mail to the company with which they have an active support contract. Regarding the question of how efficient this way of seeking support is, the answers are 44% a little efficient, 38% not at all efficient, 10% efficient, and 8% very efficient.

The fifth question: How necessary would a support module be in the system after the reform of the Waterworks union?

TABLE 6. The importance of the module after the merger of Water Supply Sectors

100 responses



In the question of how necessary it would be to add a support module after the merger of Waterworks, the following results are observed: 58% the voted "Very necessary", 38% voted "Necessary", 3% voted that it is "A little necessary" and only 1% "Not at all necessary". From the conducted questionnaire it is concluded that:

- 64% of users are older than 31 years. Older people are less inclined to adapt to new systems. For this reason, most respondents (97% of them) state that they consider it necessary to create a new module in the system on customer care.
- The way of providing support used so far does not seem to meet the needs of the respondents, where 82% of them say that this does not seem to them to be an efficient way of providing support.
- Following the implementation of the Water Supply Union Reform, users see more challenges in obtaining support, therefore the number of respondents who estimate that a new module would be necessary is increasing from 82% to 96% of respondents.

Conclusions and recommendations

At the end of this paper, the conclusions that will be shown below have been reached. The hypothesis has also been proven and all the research questions raised at the beginning of this paper have been answered. It is first necessary to upgrade the billing system's customer care module. The users' needs are not being met by the current method of assistance delivery; thus, a new module would be more useful and in line with those needs.

Second, the customer service module would make it easier for users to do their tasks. By submitting a support ticket directly through the system, you can avoid accessing email and any potential phone call problems. Also, the work is made easier by recording the queries and responses in the system, giving users the option to refer to them if they are asked again.

Thirdly, there is a growing requirement to use the customer care module as a result of the Water Supply Union Reform. This is because the merger of the Water Supply Sectors will result in more system users (AKUM, 2022).

Recommendations

1. A new customer care module should be added to the Water Supply billing system, according to the study's findings. In order to be as user-interactive and straightforward as feasible, this module ought to include some of the following features:
   - FAQ: An interface that lists all the users' most asked inquiries.
   - Help Desk: Users create milestones in the Help Desk interface to specify the problem or query they have for system support experts.
   - Prioritization of milestones: To provide the option of ranking all queries in order of importance.

Monitoring the status of the inquiries till the billing system experts have responded to them is information about the milestone status.

2. Include certain system users in the planning and development of the module so they can provide real-time input on the functionality and style of its display.
   - building use cases for the module's fundamental functionality is aided by user interaction.
   - modifying the module to make it as user-friendly as possible.

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The Use of Renewable Energy Sources and Mainly Wind Energy for the Production of Electricity in Albania

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Prof. Dr. Angjelin SHTJEFNI[2]

Abstract

Electricity production in Albania is dominated by hydropower plants, Vau i Dejës, Koman and Fierzë with a capacity of 1,350 MW. The total net domestic electricity production realized for 2021 was 8,962,699 MWh, of which: 5 343 974 MWh was

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[2] Angjelin Shtjefni graduated as a mechanical engineer at the Faculty of Mechanical Engineering of USHT in 1968. After working for about 3 years in the construction of the HPP of Vau de Deja (where he became active in the branch of the Faculty of Engineering of USHT, in Vau i Dejës and then at the University of Shkodra, Luigj Gurakuqi). In 1971, he was appointed lecturer in the Department of Thermotechnics of FIM (USHT), today the Department of Energy at UPT, which he directed in 1999-2008. He received his doctorate in the field of Energy Sciences (Thermoenergetics) at UPT, a field in which he has a rich publishing, educational and scientific balance. He was the subject holder of: Thermotechnics, Technical Physics, Heat Transmission, Energetics and Thermal Machines; field in which he has published as an author and as a co-author over 23 titles of textbooks and teaching aids. He was the head of the doctoral school in Thermoenergetics, Energy and Air Conditioning where he conducted lectures in the field of post-university groups. In his field of doctoral studies on: Evaluation of the thermodynamic effectiveness of combined energy production with the exegetic method, other studies on cogeneration; the concentration of energy production and the use of geothermal energy (for heating), has given many reports and has published many scientific articles both inside and outside the country, in scientific conferences or congresses; or in different press bodies. He has designed several programs for university and postgraduate level subjects and has also participated in many study and implementation projects at the university, ministerial and state level.

produced by the power plants owned by the public company KESH sh.a.; 3 618 725 MWh was produced by other power plants (INSTAT, 2021). This production was realized by public hydropower plants to the extent of 59.6%, by private and concessionary hydropower plants to the extent of 39.9% and by other producers (Photovoltaics) to the extent of 0.5% of the net domestic electricity production. The gross import of electricity (energy in receipt) reached the value of 2,253 GWh from 3,239 GWh that was a year ago, marking a decrease of 30.4%. The gross export of electricity (energy in delivery) reached the value of 2,800 GWh from 963 GWh, marking an increase of 2.9 times. Wind energy is a renewable energy such as energy produced from water, solar and biomass. Thanks to the progress in the reconstruction of modern wind energy converters, wind energy is becoming one of the main factors in providing electricity from renewable energies.

***Keywords**: Renewable energy, Wind energy, Wind turbine, Rated turbine power.*

1.Introduction

Accelerating greenhouse gas emissions pose a growing threat to climate change, with potentially devastating human consequences. The use of Renewable Energy Sources together with the improvement of the efficient use of energy by users can contribute to the reduction of primary energy consumption, the reduction of greenhouse gas emissions and thus to the prevention of dangerous climate changes.

The main focus of the paper is on Renewable Wind Energy which offers many advantages which explains why it is one of the fastest growing energy sources in the world. Research efforts are aimed at addressing challenges for greater use of wind energy.

In recent years, Albania has struggled to meet all the electricity demand of its citizens due to a combination of factors, including: the lack of primary energy sources; lack of interconnected gas networks; high levels of electricity losses especially in the distribution system; limited generation and interconnection capacities and high consumption of electricity for heating and cooking. 37% of a household's annual energy consumption is only for two final uses of energy: space heating and air conditioning. (ERE[3], 2021).

In the graph of Figure 1, the structure of the use of Albania's energy resources (INSTAT, 2021) is presented.

[3] Energy Regulator Authority

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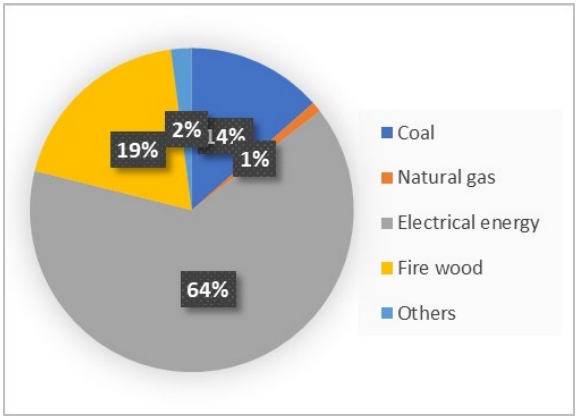
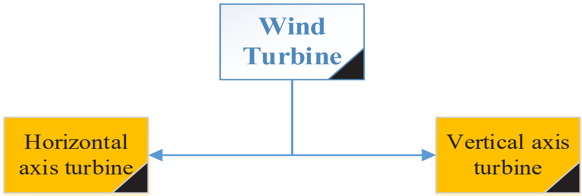


Figure 1. The structure of the use of Albania's energy resources.

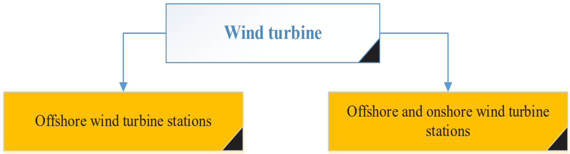
2.Wind Turbines

[1] Energy Regulator Authority

Wind turbines can be classified based on the orientation of their axis of rotation in relation to the wind current, into two types:



According to the installation location, wind turbines are divided into:



2.1 Nominal power of a wind turbine.

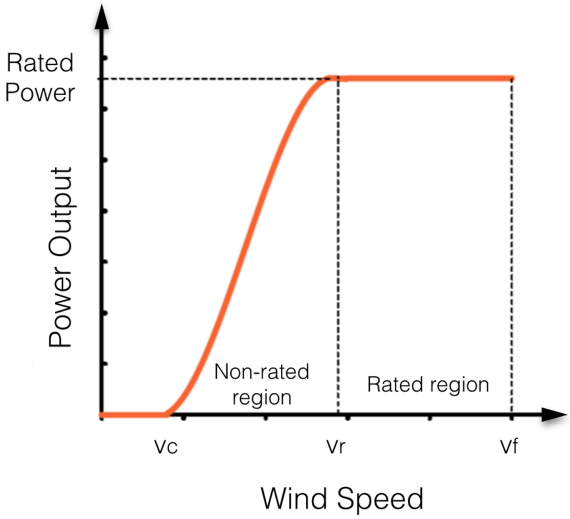
A steady supply of acceptable strong wind is a necessary requirement for harnessing wind energy. The maximum power with which wind turbines are designed is called "nominal power" and the wind speed at which it is reached is called "nominal wind speed". This is chosen to match the field wind regime and is often about 1.5 times the average field wind speed. The Beaufort scale, a classification of wind speed, gives a description of the effect of the wind. It was originally designed for mariners and described the state of the sea but has been modified to include the effects of wind on land.

The power obtained from the wind depends on a multitude of factors, such as the type of turbine and rotor, or blades with more sophisticated designs. In reality, this figure is typically around 45% (maximum) for a large power generation turbine and around 30%-40% for a wind pump. So, by modifying the formula for "Wind Power" we can say that the power produced by wind turbines is given by the equation:

$$P_T = \frac{1}{2} \cdot C_p \cdot \rho \cdot A \cdot V^3$$

Where:

P_T → is the available power (W) that the turbine has.
C_p → is the coefficient of performance of the wind turbine, also known as the Betz[2] limit.
ρ → Air density, ρ=1.225 kg/m^2.
A → is the area included in contact with the wind, given as the area of the circle formed by the turbine blades.
V → wind speed.



3. Albania and its energy potential

Albania ranks among the countries with the highest hours of sunshine in Europe per year that can be used to generate solar electricity and heat water with the continuous installation of solar thermal panels.
In addition, cost-effective solar and wind potential is estimated at more than 7 GW, more than three times the country's total installed electricity capacity, the report notes.
About 616 MW of this wind power could be installed by 2030.
Although due to large hydropower resources, Albania has the highest share of renewable energy in South-Eastern Europe, it is still highly dependent on annual rainfall – resulting in high sensitivity to climate externalities.

[2] Betz's law indicates the maximum power that can be extracted from the wind, independent of the design of a wind turbine in open flow.

In 2020, the country was forced to import nearly 40% of its energy needs due to low rainfall, at a cost of $240 million. Diversifying the energy mix will mitigate Albania's exposure to external factors and build stability.
Plants located in the coastal lowlands account for about 30 GWh/year (about 0.7% of domestic energy production). The studies presented by AKBN[3] have shown that these areas have sufficient sources of wind energy to be considered suitable areas for the placement of turbines.
The average annual wind speed is estimated to be around 4-6 m/s at a height of 10 m (with an average energy density of 150 W/m). The limited meteorological service information currently available represents only a preliminary assessment of wind energy potential in Albania.
However, the Institute of Geosciences has counted on 22 meteorological stations throughout the country for 30 years, but only 4 stations (Durrës, Kryevidh, Gllavë and Xarrë) have detailed data about wind speed and its duration. Long time periods are analyzed for 22 stations across the country.

3.1 Wind sources in Albania.

The data show steady winds with an annual average speed of about 4 m/s. The economic limit for the implementation of wind energy is calculated for an average annual speed of about 5 m/s. Based on these criteria, from the four stations represented by the table, the station in Xarrë seems like an optimal opportunity, as it is closer to the economic limit to implement wind turbine plants, but the other stations also present interest for the application of wind turbines.
These data are based on measurements performed by specialists (anemometers) calculated at a height of 10 m at ground level.
But it is already known that the higher we climb, the stronger the wind speed becomes. As a result, for a 30% increase in wind speed, which is assumed to be reached at a height of 50 m above ground level, a height that is quite suitable for the installation of wind turbines.

A preliminary assessment of wind energy resources is shown in Figure 5. There the areas are shown according to the number of annual hours with a speed of more than 5m/s. Wherever opportunities exist, areas for wind energy utilization are labelled and shown in the figure.
Considering the period of 4500 hours/year as economically satisfactory, the areas with the highest premium are those of Xarra and Sheqeras. Other possible stations are the Durrës,

[3] The National Agency of Natural Resources (AKBN) has as its object of development, supervision of rational use of natural resources, according to the government policy, and monitoring of their post-exploitation in mining, petroleum and energy.

Glavë, Kryevidh and Pukë areas. Areas in the Mati valley or in the Western Lowlands are also considered important study and investment stations.
It should be noted that the meteorological stations are located in places where the climate factor is taken as the primary criterion. Consequently, the natural potential of wind energy should be even greater.

Month	**Durrës**	**Kryevidh**	**Tepelenë**	**Sarandë**	**Vlorë**
January	4.2	5	5.8	4.9	5.1
February	4.2	5.1	5.7	4.9	5.2
March	4.2	4.6	5.9	4.8	4.5
April	4.1	4.5	4.3	4.6	4.4
May	3.6	3.7	4.6	4.3	4.1
June	3.4	4.1	4.4	4.5	4.1
July	3.3	4.3	3.5	4.6	3.9
August	3.2	4	3.5	4.4	3.8
September	3.3	4.3	4.1	4.1	4
October	3.6	4.7	5.3	4.5	4.5
November	4.2	4.9	4.7	4.7	4.6
December	4.4	5.1	5.6	5	5
Average	3.833	4.525	4.783	4.608	4.433
Density (W/m^2)	75-150	100-230	100-235	110-250	100-230

Table 1. Wind speed during the months of the year in some areas in Albania.

Wind speed [m/s]	3-4	4-5	5-6	6-7	>7
Place (where the measurements were taken)					
Durrës	5694	4906	3416	2453	1752
Gllavë	5256	4380	3679	2716	2365
Kryevidh	6132	5081	4117	2891	2190
Pukë	5781	3942	3066	2540	2115
Sheqeras	7008	5957	4643	3066	1577
Xarrë	7709	7096	5256	2453	1752
	Total annual number of hours for 6 areas				

Table 2. Number of annual hours in six areas in Albania.

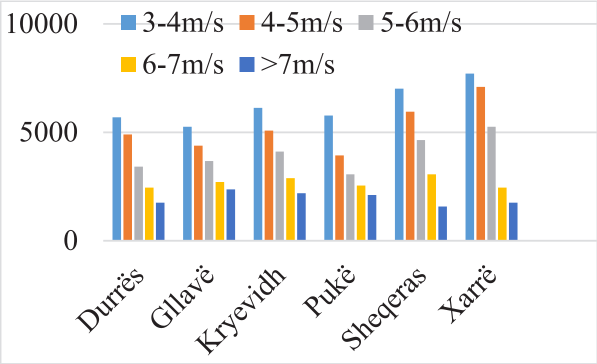


Figure 2. Distribution of the annual number of hours with different wind speeds.

3.1 Average annual wind distribution in Albania.

Five different average speed zones can be defined, these are named A, B, C, D and E in accordance with the Figure below.

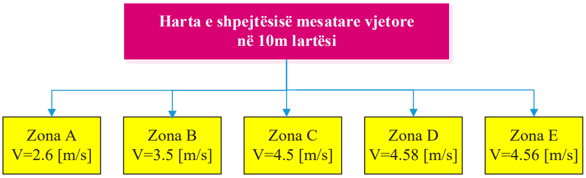


Figure 3. Breakdown chart of wind distribution map of Albania.

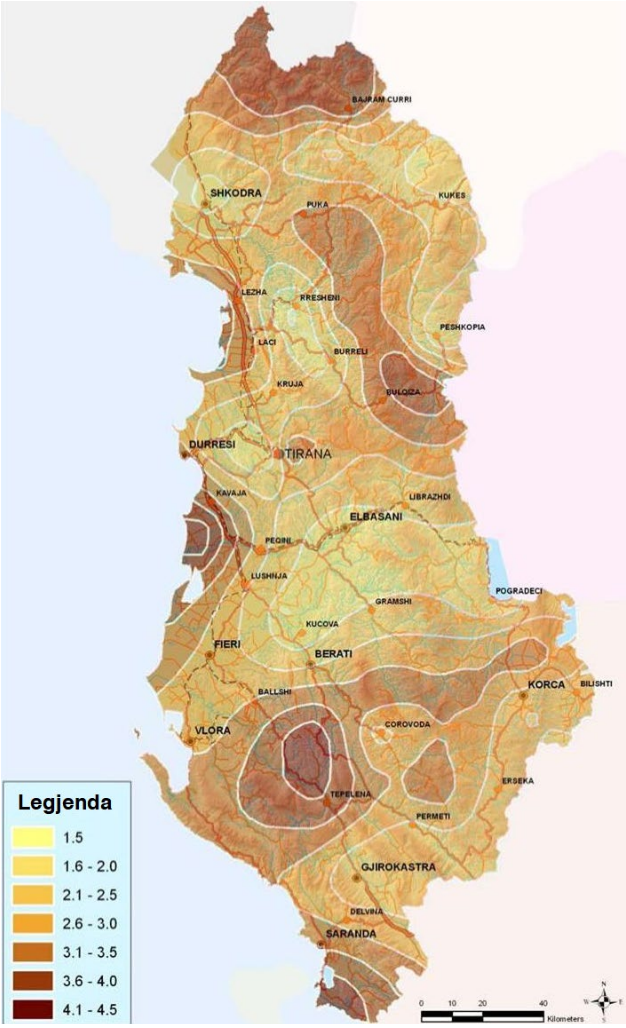


Figure 4. Map with average wind speed in Albania

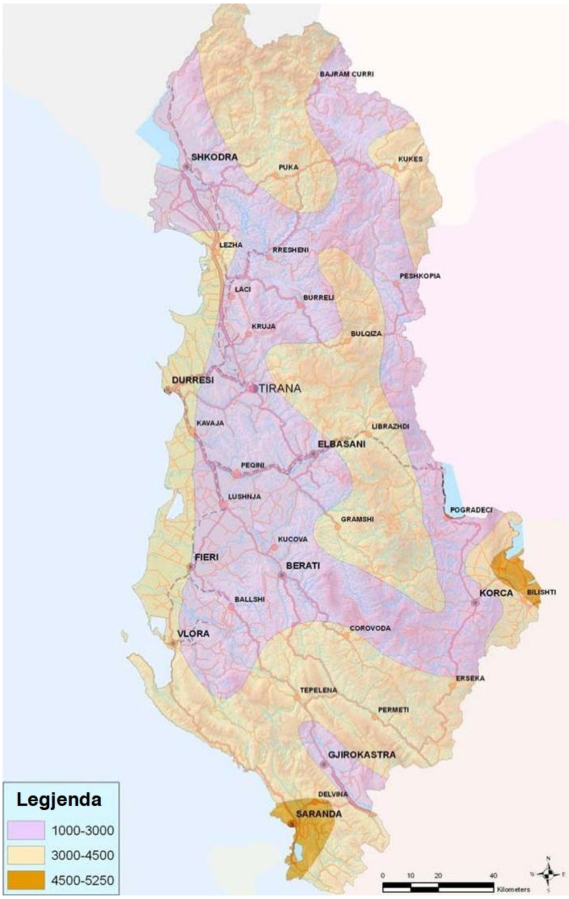


Figure 5. Territorial velocity of the annual amount of wind hours

3.1 Quantitative measurement of Albania's wind resources.

Severity class 3 was chosen for all calculations. The most likely areas for the installation of wind turbines in Albania are characterized by villages, small towns, agricultural areas. Thus, the corresponding length of the roughness is z_0=0.4 m.

Based on this summary, average annual wind speeds can be calculated for different altitudes. Of interest is the calculation of the wind speed above 50m height because the rotor centres of modern wind turbines are above this height.

Based on 10-meter height data, the Table below shows the calculated values of wind speeds at different height levels for the five map areas A, B, C, D, E.

	Hight [m]												
AREA	10 m	20 m	30 m	40 m	50 m	60 m	70 m	80 m	90 m	100 m	110 m	120 m	130 m
Area A	2,6	3,16	3,49	3,72	3,9	4,05	4,17	4,28	4,46	4,46	4,54	4,61	4,67
Area B	3,5	4,25	4,69	5,01	5,25	5,45	5,62	5,76	5,89	6	6,11	6,2	6,29
Area C	4,5	5,47	6,04	6,44	6,75	7	7,22	7,41	7,57	7,72	7,85	7,97	8,09
Area D	4,58	5,57	6,14	6,55	6,87	7,13	7,35	7,75	7,71	7,66	7,99	8,12	8,23
Area E	5,56	6,76	7,46	7,95	8,34	8,65	8,92	9,15	9,36	9,54	9,7	9,85	9,99
	v [m/s]												

Table 3. Calculated values of wind speeds at different altitude levels.

4.Potential profit of wind energy from typical Albanian sites

4.1Annual Energy Produced (AEO).

One of the measures of the cost efficiency of a wind turbine is the power it produces. Calculations of the annual energy produced require knowledge of the frequency distribution of wind speed as well as the system of produced power as a function of wind speed. Also, any forecast of the annual energy produced is specific to the location, the number of surrounding turbines, air flow, turbulence and air density. The required distribution frequency is the wind speed at the height of the rotor hub.

After some calculations of the Raleigh distribution, we find the frequency of the wind speed distribution during the year.

We can also present the total annual energy produced at a wind speed.

$$\Delta E_{a,k} = c_P P_w \Delta t \eta_T = c_P \frac{1}{2} \rho A v^3 \Delta t \eta_T \qquad \left[\frac{kWh}{year}\right]$$

The general equation for calculating the annual energy produced is presented.

$$AEO_g = \sum_{k=1}^{k} \Delta E_{a,k} = \sum_{k=1}^{k} P_k \Delta t_k \qquad \left[\frac{kWh}{year}\right]$$

AEO_g Annual energy produced (kWh/year)
k Wind speed index from 1 to k
$\Delta E_{a,k}$ Total energy produced for one speed (kWh/year)
P_k Average power produced per wind speed in turn (kW)
Δt_k Time accumulated wind speed at rotor hub height $\Delta t = 8760 * h_{Ray.distr}$ [hours/year]

After being interested in large wind turbines we received information from various companies about the large wind turbines that these companies manufacture and sell. In Tab. 4 below, a summary of several different turbines is made with all the parameters they have, such as launch speed (cut-ins), stop speed (cut-out), control type, etc.

PRODUCER	**Enercon GmbH**	**Vestas**	**Sudwind**	**Vescraft I/S**	**WEST/ENEEL**
Type	E-66	V-63	S70/1.5 MW	NTK1500/60	Range 60WE/504/86-T
AXIS	Horizontal	Horizontal	Horizontal	Horizontal	Horizontal
Optimum power	1800kW	1500 kW	1500 kW	1500 kW	2000 kW
Node height	65,85,98,114 m	60 m	65 m	60 m	66 m
Rotor diameter	70 m	63 m	70 m	60 m	60 m
Number of rotor blades	3	3	3	3	2
Rotor speed	Var. 10-22 rpm	Obsessed 21 rpm	10.6-19 rpm	obsessed 19.2 rpm	Var. 15-55 rpm
Release speed		4.5 m/s	3 m/s	4 m/s	4 m/s

Optimal speed		16 m/s		16 m/s	14.5 m/s
Stopping speed		25 m/s		25 m/s	27 m/s
Power control	Electric self-checking	Sheet self-rotation	Sheet self-rotation	Fixed Control (Stop)	Active guidance system
The generator		1500 kW induction	Asynchronous	2 x 275 kW induction	Synchronous
Mechanical brakes	Active hydraulics. Positioned on the low-speed shaft	Active hydraulics. Positioned on the low-speed shaft		Active spring. Positioned on the high-speed shaft	Active hydraulics. Positioned on the low-speed shaft
Aerodynamic brakes	Electrically active	Hydraulic self-rotating blade		Active spring brake	Hydraulics with active orientation
Tower and weight		73000 kg		98000 kg	110000 kg
The slope		5 deg		4 deg	6 deg

Table 3. Summary of different wind turbines with their parameters

4.2 Annual Energy Produced (AEO) from typical Albanian sites using modern wind turbines.

After seeing all the turbines given in the table, we can choose between five types of wind turbines. Before we choose, we must base ourselves on the wind conditions in Albania, and as we said in the previous chapters about the wind conditions in Albania, Albania does not have high levels of wind speed, always keeping in mind the reason they were made for the energy use of wind but from meteorological institutes. Considering the aforementioned fact, we can say that the ENERCON wind turbine, E-66 is the best option for us because:

- Low cut-in wind speed
- Low rated wind speed

- High cut-out wind speed
- There is no gearbox

But we can still compare the potential profit of these turbines. It should be noted that the yield for all turbines was obtained η = 0,9 and the power coefficient c_P= 0.435, the comparison was made assuming all turbines with the same height, except for their real height.

		Type of wind turbine		
		Vestas 63	**NTK 1500/60**	**Enercon66 (Supposed)**
		AEO [MWh/Vit]	AEO [MWh/Vit]	AEO [MWh/Vit]
Areas at 60m height	A60	840.0132141	740.4360762	958.1183647
	B60	2091.36593	1873.431813	2314.945913
	C60	4437.420085	3931.695678	4896.699064
	D60	4687.728671	4232.944444	5173.971898
	E60	8228.76668	7448.897994	9194.532286
Totali [MWh/Vit]		**20285.29**	**18227.41**	**22538.27**
Areas at 70m height	A70	921.0826111	813.241884	1044.500227
	B71	2293.62561	2057.218833	2536.47427
	C70	4866.0979	4284.065854	5371.890464
	D70	5131.070576	4635.71437	5666.487023
	E70	8959.347018	4236.366977	10058.55786
Totali [MWh/Vit]		**22171.22**	**16026.61**	**24677.91**

Table 4. Annual energy produced for three types of turbines at the same height

From Table 5 we can see which one is better, but it should be taken into account that these wind turbines do not have the same power capacity. The factor on which AEO depends is the rotor surface because the other factors (v,gh, ρ,c_P) are taken constant.
To calculate the Annual energy produced (AEO) we will do the calculations for the ENERCON wind turbine:

- Turbine type E-66/1.8 MW

- Rotor diameter 70 m
- The height of the node is 85 m
- Optimum wind speed. 12.5 m/s

Table 6 shows the percentage distribution throughout the year for wind speed values higher than the optimal wind speed for the ENERCON turbine, this is done to show how often this turbine works during the year at full capacity.

Height [m]	**Zone**				
	A	B	C	D	E
65	0.15	2.99	12.3	13.19	25.57
85	0.29	5.71	15.12	16.22	29.3
98	0.39	4.98	16.69	17.81	31.16
	Percentage [%] of wind speed with v>12.5 [m/s] where: 12.5 [m/s] - the optimal speed of E-66				

Table 5. Percentage (%) of wind speeds in different areas of Albania with v>12.5 (m/s)

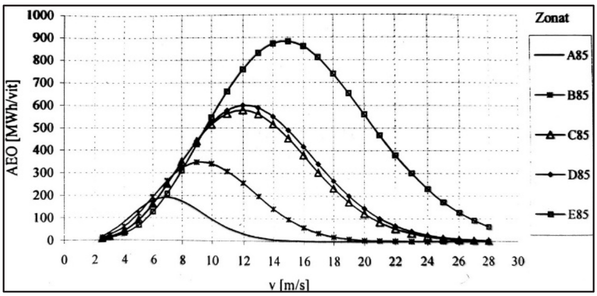


Figure 6. Annual energy produced (AEO) of the ENERCON wind turbine (E-66 70 m rotor diameter),
at 85 m height.

We have made the calculations based on only one E-66 installed, and it has been assumed that this type of turbine is installed on all five (A, B, C, D, E). This is done to compare the potential profit of these areas, to see how the AEO varies from one area to another. For the calculations made, it should be made clear that some factor values were obtained as follows:

c_p- Power coefficient $c_p = 0.435$ because large modern turbines strive for high efficiency.

p- Air density.

The efficiency of the wind turbine is:

$$\eta_T = \eta_{mek}\eta_{elec}\eta_{aerodyn} \qquad \eta_T = \frac{P_{el}}{P_T}$$

η_{elec} = Generator efficiency (depends on generator type) $\eta_{elec} = (60 - 90)\%$.

η_{mek} = Gearbox and gearbox efficiency (95%).

$\eta_{aerodyn}$ = Wind turbine aerodynamic efficiency.

Finally, the power produced by the wind turbine is given in the following equation.

$P = c_p P_{wind} \eta_T$

A summary of the annual energy produced at different heights is presented in Table 7, the ENERCON wind turbine was used.

Enercon E-66		
		AEO [MWh/Year]
Areas at 65m height	A65	1.093,74
	B65	2.707,66
	C65	5.091,57
	D65	5.275,55
	E65	7.466,16
Total [MWh/Year]		**21.634,678**
Ar eas at	A85	1.280,5998

	B85	3.311,3509
	C85	5.654,1921
	D85	5.862,9
	E85	8.040,0214
Total [MWh/Year]		**24.149,064**
Areas at 98m height	A98	1.382,397
	B98	3.589,5358
	C98	5.951,514
	D98	6.156,1843
	E98	8.314,7602
Total [MWh/Year]		**25.394,391**

Table 6 Summary of annual energy produced at different altitudes for different areas (E-66 is used)

In addition to ENERCON, which is the best variant, calculations were also made for VESTAS 63 and NTK 1500/60. These two turbines have the same node height but a difference of three meters in the diameter of the rotor, and this difference certainly influences the annual energy produced. After some calculations we can find and present the graph of AEO, Fig.8, and Fig.9, as for:

Vestkraft I/S, type NTK1500/60 at 60m height.

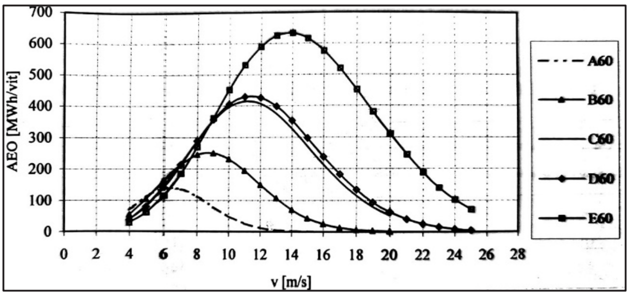


Figure 7. Annual energy produced (AEO), by Vestkraft I/S, type NTK1500/60

Vestas V63 at 60 m height.

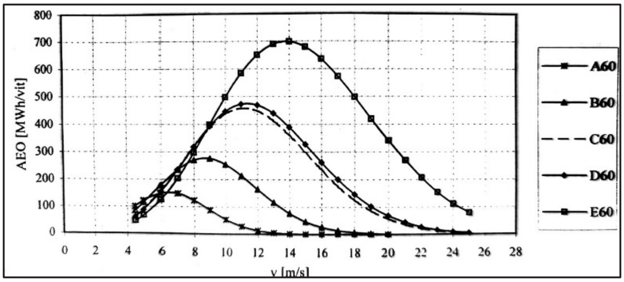


Figure 8. Annual energy produced (AEO), from VESTAS V63.

From the chart we clearly see the difference between the AEO produced by Vestas and Vestkraft I/S, this has to do with the existence € difference in rotor diameter (difference = 3 meter)

4.3Annual Energy Density produced.

To create an idea about the potential profit from typical Albanian countries it was necessary to calculate the annual energy produced. These calculations were done for three different types of turbines so we were dependent on the type of turbine. To see in an independent way the potential profit that means not depending on the type of turbine, we can calculate the annual energy density produced at different heights. To do this in the formula for the annual energy produced (AEO) the area of the rotor A is not entered, and the yield (not including the yield means that there is no loss). The values are presented in a table and in a graph that refers to this table.

	Zonat				
Height [m]	A	B	C	D	E
60	0,3033	0,7451	1,5803	1,6695	2,9325
70	0,3315	0,8173	1,7331	1,8276	3,1930
80	0,3588	0,8801	1,8723	1,9713	3,4211
90	0,3822	0,9413	1,9945	2,1053	3,6334
100	0,4066	0,9951	2,1133	2,2277	3,8176
110	0,4291	1,0510	2,2194	2,3370	3,9827
120	0,4495	1,0982	2,3200	2,4490	4,1383
	Annual energy density produced [MWh/m^2]				

Table 7. Annual energy density produced in five different areas for different altitudes

Below is presented the chart that refers to table 8.

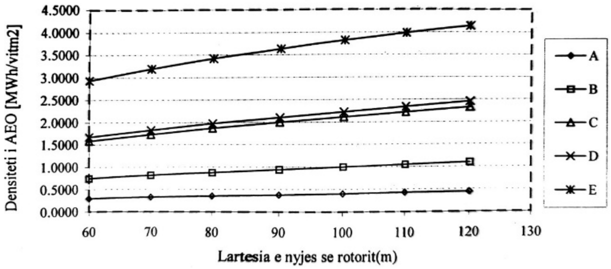


Figure 9 AEO density at different rotor hub heights.

4. ASSESSMENT OF THE POTENTIAL OF WIND UTILIZATION.

The multi-year measurements on the wind parameter have had the main goal of using wind data for meteorological forecasts, but after the 1990s and especially the last decade, one of the main goals of wind monitoring is the assessment of its energy potential. Currently, in Albania, steps have been taken in the direction of generating electricity from wind energy sources, and concretely, for the next few years, it is expected that around 2000 MW will be produced.

Based on studies on the average wind speed, it turns out that this parameter reaches over 5 m/s in the coastal areas, in the mountain ranges in the north of the country as well as in many mountainous areas of Southern and Northeastern Albania (meteoalb). It is worth highlighting some areas in Albania such as Velipoja, Hasi, Kukësi, Shëngjin Island, Tale, Balldre, Ishëm, Porto Romano, Kryevidh, Seman, Karavasta, Vlorë, Sarandë, Korçë and Tepelena, which present a high wind energy potential. The evaluation of the energy potential of the wind is based on the measurement and analysis of several parameters such as the distribution of the average wind speed according to the directions, the daily and annual progress of the wind speed, the distribution of the wind speed for different thresholds, the number of hours with a speed of certain wind, etc.

As a result of these measurements, it turns out that the coastal area is dominated by westerly winds that change direction in the depth of the territory with an average annual speed that fluctuates from 0.8 to 6.6 m/s (measurement made at 10 m height from the ground). Specifically, in Albania there are many areas where the average annual wind speed varies from 6 to 8 m/s and consequently the energy generated by these speeds is estimated to be around 250-600 W/m2. These results can be significantly improved if one tries to optimize the wind speed by performing measurements at higher altitudes. The above measurements and results apply to the heights of 45, 50, 55 and 60 meters above the earth's surface, but a better result would be obtained if we increase the height of the wind exploitation, based on the fact that the wind speed increases with the increase in height. Aiming to evaluate the potential of this resource, it has been estimated that the production level of wind farms planned for construction in Albania is about 2400 MW

During the period 2010-2021, the granting of licenses continued and until the end of December 2021, in Albania, their total amounts to approximately 2500 MW, based on the information provided by the Ministry of Energy and Industry, with an energy production potential of approx. 5 twh/year. The capacity of the Albanian electrical system to transmit and absorb wind energy has been estimated at approximately 180–200 MW.

The identification of the most suitable areas for the development of power plants based on the use of wind energy has been carried out, thus representing a preliminary assessment that must also be matched with the support of the competent authorities of Albania.

The main obstacles that exist (height, land ownership, infrastructure, natural protected areas, power) were applied to the current wind speeds and its potential map, in order to provide an assessment of the wind exploitation potential in Albania.

The maps obtained by applying the simulation codes, the corrections made to the corresponding data on the ground, quite clearly show the areas with the most wind potential, unfortunately not entirely suitable for wind plants, this is due to natural, economic, or financial limitations. In order to evaluate the areas of use, the following limitations, whether positive or negative, have been taken into account:

- Altitude above sea level (areas lower than 1,800m)
- Natural protected areas
- Road network (distance from national roads or good gravel roads less than 5 km)
- Electrical power supply system (distance from the electrical power supply system less than 10 km).

Taking financial factors into account, suitable areas for wind energy production are limited to those areas that are not too far from main roads and the energy supply system, and that have promising capacity factors (e.g. the ratio between the actual energy produced in a given period and the hypothetical maximum) thus making it an opportunity or potential to invest. In order to identify these areas, the restrictions described above are superimposed on the wind maps, considering only the characteristic areas with average annual wind speed at a height of 50m above ground level, between the values of 5.5m/s and 7.0m/s, or even more.

This estimate is a simple indicator, to present a clear idea of the size and potential of installing wind plants in Albania.

Constraints on annual average wind speed are expressed through two different productivity scenarios. Possible scenarios: high productivity (HPP) and medium productivity (MPP). As shown in figure 10, suitable areas are divided into:

1. **Ridges**[4], for mountainous areas where wind plants are mainly located in a linear fashion along the highest ridges.
2. **Flat areas**[5], they are almost residential areas, where the installation of turbines can be done not only in a single row.
3. **Offshore areas**[6], although the possibilities for such a plant go beyond the scope and calculation of this study.

The most interesting areas for the use of wind energy in Albania, namely the ridges, and the areas shown in the figure, correspond to the final assessment:

- High Productivity Scenario (HPP) – 261.5 km ridge, 66.3 km2 mostly flat area.
- Medium Productivity Scenario (MPP) – 1329 km ridge, 1689 km2 flat area.

[4] The red line
[5] Green areas
[6] Offshore areas, known as "blue areas"

Figure 10. High productivity potential

Figure 11. Medium productivity potential.

6.Economic evaluation of wind turbine

6.1Wind Turbine Economic Evaluation.

To make the economic evaluation of the wind turbine, we will use the financial methods of investment evaluation:

1. Payback method.
2. The net present value (NPV) method.
3. The internal rate of return (IRR[7]) method.

Payback method

It is known as the payback period of the initial investment and simply estimates how long it takes for a firm to recover its initial investment in a project, regardless of the time value of money.

If the payback period is less than the maximum acceptable period for the return of the initial investment, then the project is decided to be accepted.
If the payback period is greater than the maximum acceptable period for the return of the initial investment, then the project is rejected.

Net present value (NPV) method

NPV compares the sum of the present values of each year's inflows to the initial investment. Discounting can be done using cost of capital, opportunity cost and discount rate.

By means of the formula it can be presented:

$$NPV = \frac{CF1}{1+K} + \frac{CF2}{(1+K)^2} + \cdots + \frac{CFN}{(1+K)^N} - I_0$$

[7] The internal rate of return (IRR) is a metric used in financial analysis to estimate the profitability of potential investments. IRR is a discount rate that makes the net present value (NPV) of all cash flows equal to zero in a discounted cash flow analysis.

$$NPV = CF1 * PVIF(1;k) + CF2 * PVIF(2;k) \dots. + CFn * Pvif(n:k) - I_0$$

While in the case where the annual flows are equal, then the formula can be used:

$$NPV = CF \cdot PVIFA_{(n;k)} - I_O$$

Where:

CF_t is the expected income for year t (1, 2, 3,…,n).

I_0 is the initial investment in period zero.

K is the cost of capital or **PVIF (k;n)** the actualization factor for year t.

The steps followed in using this technique are:

- Using the present value table to find the present value of each annual entry.
- We collect the actual values in order to find the actual value of all inputs for all the years of the life of the project we are studying.
- From this found value, we subtract the initial investment.
- Accept or reject the proposed project.

To make the decision whether the proposed project should be accepted or rejected, we act according to the following rule where:

If **NPV>0** Project Accepted.

If **NPV<0** the Project is Rejected.

Internal Rate of Return (IRR)

The internal rate of return (IRR) is perhaps the most widely used and sophisticated capital budgeting technique.

The Internal Rate of Return (IRR) is that discount rate that equates the present value of outflows to the present value of inflows.

It is the compounded annual rate of return that the firm will earn if it invests in the project and receives the given inflows. IRR is the specific rate of return for the project.

The price of electricity is calculated for a period of 15 years, therefore it is underlined:

After the request of the company OSHEE, OST and KESH to increase the price of electricity on average by 12%, the independent unions reacted. According to the trade

unionists, the increase in the price of energy is not justified by an increase in costs, and in these conditions, they request the intervention of the government so that this price increase does not happen.
Currently, the price of electricity for household consumers is charged 0.1 $ for kilowatt/hour.

Energy evaluation and determination of the total energy produced by the turbine.

The energy assessment aims to determine the total energy produced per year by the turbine we have chosen and compare this value with the monthly need of a family for electricity.
Power Coefficient C_p and Betz Criterion:

$$\mathbf{C_p} = \frac{\textbf{Electricity produced by wind turbines}}{\textbf{Total wind energy}}$$

Albert Betz was a German physicist who calculated that no type of wind turbine can convert more than 59.3% of its kinetic energy into mechanical energy of rotor movement. This is known as the limit, or Betz criterion, and is the maximum theoretical power factor for any type of wind turbine.

Wind Energy:	Energy Used:
100%	40.7%

Conversion to electricity:

70% and 59.3% of wind energy.

In the diagram above, the wind turbine converts 70% of the Betz criterion into electricity. In other words, the C_p of the wind turbine will be $0.7 \times 0.59=0.41$. So, wind turbines convert 41% of total energy into electricity. This is a satisfactory power factor.

Quality wind turbines mainly fluctuate in the values of 35-45%.

The calculation is based on the following formulas:

$$P_T = \frac{1}{2} \cdot C_p \cdot \rho \cdot A \cdot V^3$$

The power that goes into producing electricity.

$A= \pi r^2$, Wind contact surface.
$\mathbf{C_p = 0.41}$, Performance coefficient.
Air density $\boldsymbol{\rho}$**=1.225 kg/m²**.
V wind speed.
Energy is calculated as the product of power times time.
$\mathbf{E=P_T \times t}$ Unit: (kWh/month) or (kWh/year).

CASE STUDY

Installation of a wind turbine in a private house in Durrës.

The characteristics of the annual wind hours, at a height of 10m, serve to calculate the energy produced by the wind turbine, installed in a private house in the city of Durrës.

Hours/ Years	10 m		50 m		75 m	
	m/s	W/m2	m/s	W/m2	m/s	W/m2
6230	> 3	30	3.9	60	4.5	100
5000	> 4	70	5.2	160	6	250
4300	> 5	150	6.5	300	7.5	500
3100	> 6	250	7.8	550	9	800
1400	> 7	400	9.1	830	10.5	1300
V_{ave}; Dens.	4.5 m/s	100	6.0 m/s	250	7.0 m/s	400

Table 8 Characteristics of annual wind clocks.

The turbine is calculated to be placed at a height of 10m. The selected turbine is a 10 kW turbine model: NE-10k G which has the following specifications:

Figure 12. Illustrative photo, 10 kW wind turbine generator / Estonia

Product Name (Turbine):	Ten-High
Type:	Wind power generator
Voltage (V) / Power (P) [kW]	240/10
Initial working speed [m/s]	3
Average working speed [m/s]	11
Material of sheets (blades):	Glass fiber
Rotor diameter [m]	6.3
Maximum power [kW]	11
Safety speed (Break) [m/s]	50
Working speed [m/s]	3-45
Weight [kg]	480 kg
Tower height [m]	12/15

Table 9. Characteristics of the NE-10k G model wind turbine

Installation Costs:

Wind Plant Parts:

1- Turbine and Tower	4000$
2- Battery Controller	70$

3- The regulator	50$
4- Fuse Box	20$
5- Discharge Resistor	400$
6- Battery	700$
7- Inverter	120$
8- Electric Socket	20$
9- Transportation cost	2000$
10- Installation cost	500$
Total in $	7,880$

Table 10. Wind Plant Parts and Costs

Maintenance costs are calculated around $200/year.

Calculations:
We find the total Energy according to the table:

$$P_T = \frac{1}{2} \cdot C_p \cdot \rho \cdot A \cdot V^3$$

The power that goes into producing electricity.

$A = \pi \cdot r^2 = 3.14 \cdot 9.92 = 31.1 m^2$

C_p **= 0.41** Performance coefficient (Betz).

Air density ρ**=1.225 kg/m²**

V wind speed.

Energy is calculated as the product of power times time.

$E = P_T \times t$ [kW hours/month]

For each speed and each time period, we have respectively:
V_1=3m/s; V_2=4m/s; V_3=5m/s; V_4=6m/s; V_5=7m/s; t_1= 6230 hour; t_2=5000 hour; t_3= 4300 hour; t_4=3100 hour; t_5=1400 hour.

$$E_{Totale} = \sum (E_1 + E_2 + E_3 + E_4 + E_5)$$

$E_1 = P_{T1} \times t_1$ =2130885 W hour /year

E_2=4053765 W hour /year
E_3=6809050 W hour /year
E_4=8482503 W hour /year
E_5=6083180 W hour /year
E_{Total}=27559380 W hour /year =27559.38 kW hour /year
E_{Total}= 2296 kW hour /month

Profit: 2296–500=1,796 kW hours/month, (it is assumed that a household consumes about 500 kW hours per month).
The lifetime of the Wind Turbine is about 15 years.
The price of electricity is about $0.1/kWh.

After finding the value of the annual energy obtained from the wind turbine, we also find its monetary value: E_{Total} = 27559.38 kW hours / year
The monetary value is: $27559.38 \cdot 0.1 = 2{,}755.9\ \$/vit$

To find the cash flow that will be benefited each year we subtract the annual maintenance cost:
CF = 2755.9 $/year – 200 $/year = 2735.9 $/year
I_0 = 7,880 $/year (Initial investment)

$$\text{Term of repayment} = \frac{7{,}880\$}{2735.9\ \$} = 2.88 \approx 3 \text{ vite.}$$

This investment is classified as a very good investment.

8.Conclusions and recommendations

8.1Conclusions

Referring to this study, Albania presents a fantastic wind potential, with wind speeds reaching 8-9 m/s in many areas. A number of interesting areas, mainly along the seacoast, and mountain ridges, with strong winds mainly in the South of the country, have been identified. The overall wind potential is estimated by taking into account factors that have a direct impact on wind plants (eg distance to roads, protected areas, electrical system, etc.).
The identification of the most suitable areas for the development of power plants based on wind energy has been carried out, thus making a preliminary assessment which will

require the cooperation of the relevant authorities of the Republic of Albania. Two potential uses are considered:

a. High productivity scenario (HPP) and
b. Medium Productivity Scenario.

Advantages of using wind turbines:

- Wind power is powered by the wind, so it is a clean source of energy.
- Wind energy does not pollute the air, like power plants that rely on burning fossil fuels, such as coal or natural gas.
- Wind turbines do not produce atmospheric emissions that cause acid, rain, or greenhouse gases.
- The current produced by the wind turbine does not release CO2.
- Wind is an inexhaustible resource.
- Wind turbines are cheap to maintain.
- Wind turbines can be built on farms. Farmers can continue to work the land, because the wind turbines use only a part of it.

The designated areas present a total installed power between 980 - 11700 MW, which corresponds to a total energy production of 3000 - 25800 GW hours/year.
The economic feasibility of installing Wind Plants in Albania shows that, with the existing tariffs, the financial feasibility is acceptable only for areas with high productivity (eg capacity factor 35%). A future possibility, based on incentives (such as the Italian Green Certificates), was included in this analysis, thus presenting a suitable ground to invest in the realization of Wind Plants.

- Environmental Viewpoint

    - Wind energy is an ecological, renewable and clean energy. However, when planning such a project, several environmental factors are taken into consideration, as follows:
    - Electromagnetic interference. Some TV waves are susceptible to interference from wind generators.
    - Noise. The rotor, gearbox and generator create acoustic noise as they operate, which must be considered when considering turbine placement.
    - Visual Impact. Modern wind machines are large objects, and therefore have a visual impact on the area around them. Some consider this influence positive, some do not.

- Investment of wind turbines for family consumption.

From the above analysis, we emphasized that Albania has a good wind energy potential, and seeing the stages that our country is going through on the road to Europeanization, it is worth noting that the price of electricity is increasing, this paves the way for the introduction of a newer technique, that of renewable energies, mainly wind, sun or water. It seems that the investment is satisfactory since in addition to covering personal (family) needs for energy, it also manages to sell it through an agreement with the distribution network. Also, such an investment paves the way for another technology, that of electric cars, which are charged by electricity, and thus breaks away from dependence on exhaustible resources such as oil, gas, etc.

8.2 Recommendations

In addition to families, such a technique can also be used by private businesses, hotels, complexes or even in transport, where it is seen as a potential use in traffic lights and lighting with solar energy or wind energy.

- It is recommended that in the family economy, the use of renewable energies is combined, in other words, solar panels for sanitary water and residential heating, and the rest in combination with wind energy, in order to meet family needs.
- Albania as a connecting part with Europe, and using its geographical position and its energy potential, to transform into a power of electricity distribution and production in the Balkans and beyond. Annual hours of wind, sunny days per year, the second place for water resources in Europe (after Norway) which are signs of a strong energy potential of Albania.

The European Wind Energy Technology Platform predicts that "in 2030, wind energy will be a major source of modern, reliable and cost-competitive energy in terms of cost per kWh". In addition, they predict that wind energy will contribute 21% to 28% of European Union (EU) energy demand, which is similar to the scenario described earlier for the United States. The European Wind Energy Technology Platform describes a long series of research and development improvements that will be necessary to make wind cost competitive by 2030. The reader interested in this multi-disciplinary research program is referred to the reference 5. There is no "major technology" breakthrough predicted for wind technology in the United States or Europe. However, many evolutionary steps executed with technical skill could cumulatively bring a 30% to 40% improvement in the cost-effectiveness of wind technology over the next two decades.

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Design and Implementation of Docker Architecture for Parking Management Systems

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Ph.D.(c) Roland PLAKA[2]

Abstract

Docker Container is a virtualization method becoming an alternative to today's virtual machines. Containers isolate processes from each other and not the entire operating system. This study presents the usage of docker containers as an optional solution for

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virtualization, which can replace virtual machines. As proof of concept, we design and implement a parking lot management system using containers. Our work shows that adapting docker containers instead of virtual machines makes the system use the resources more efficiently and access them shorter in time. An overview of the topic is presented by investigating and identifying the following features: challenges, issues, solutions, techniques, factors, and effects regarding the adoption of docker technology. Finally, this study highlights the benefits of containers and the possibilities of their application in particular processes of current systems.

Keywords: *docker container, virtual machine, parking system, optimization, design*

Introduction

The world of IT is constantly evolving, and there is no doubt that part of this development has happened thanks to virtualization. Virtualization is one of the most preferred techniques that has dramatically benefited businesses. Virtualization creates a virtual version of something instead of having it in a physical environment. For example, to create a virtual network, application, or server version. This makes it possible to split a physical server into several virtual servers sharing physical resources. Each server can then run its operating system. This technology has become so popular due to hardware consolidation, as virtualization reduces the need for physical hardware by increasing its availability and simplifying administration. As the use of the Internet has increased, so has the need for servers and data centers because companies want their websites to be available to their customers to expand their business.

The bigger the company, the more equipment is needed, meaning large companies can have hundreds of servers. This increases the need for fencing, which leads to an increase in the cost of maintenance, energy, and time; an exceptional staff is needed to perform these tasks. Virtualization is an alternative technique that solves scalability problems and reduces costs simultaneously. With virtualization, some physical machines can be replaced with one that runs these machines virtually. Virtualization brings significant benefits to businesses because it significantly reduces IT costs and enables time savings by increasing the efficiency and flexibility of resources.

These advantages have brought great interest in the market, where businesses want to stay constantly updated on the most efficient and cost-effective virtualization solutions. Virtualization has been around for several years and is commonly known as hypervisor-based virtualization. Virtualization is a technology that enables the creation of several virtual machines on a single physical machine. Virtualization reduces the number of servers, reduces the size of data centres, and reduces hardware costs and the need for maintenance. A virtual machine is a software that emulates a physical computer system and its functionalities using the resources such as processor, memory, and bandwidth of the physical machine on which it is installed. The physical host is called "host," and the virtual machine built on the "host" is called "guest." Hypervisors enable resources for virtual machines and make it possible to allocate resources so that virtualization works appropriately. A general approach to virtualization has been the use of virtual machines. This was the first method on the market that enabled virtualization.

Hypervisor-based virtualization uses the hypervisor to segment a system into several systems. This segmentation is achieved by creating several virtual machines that can run on the "host." There are two types of hypervisor-based virtualization, type 1 and type 2. Type 1, a "bare-metal hypervisor," runs directly on the host's hardware (see Figure 1). The host operating system and the hypervisor are combined into a single hypervisor layer. This creates a direct hardware connection where the hypervisor can communicate directly with the host's hardware components. A system can leverage resources such as performance and scalability through this integration. Type 2, called "hosted hypervisor," separates the host operating system and the hypervisor into different layers (see Figure 2). All virtual machines will run through the host's operating system and not directly on the hardware, as in type 1. In type 2, an operating system is built into the host's hardware, and its top layer, a hypervisor, is installed and behaves like software used for virtualization. It is the most widely used in virtualization; however, it is no longer the only method that offers virtualization options.

Container-based virtualization is another type that has created a lot of curiosity and interest in the IT market. Container-based virtualization provides operating system virtualization and does not use a hypervisor. This is the most significant difference between containers and virtual machines; they are visualized on the operating system, not the hardware. Each container created on the same physical host can share the same host operating system with another. This makes it possible to run several applications simultaneously without using several operating systems, unlike the traditional virtual machine method. Containers package software, making running several containers on the same operating system possible. These containers can run concurrently and separately on the same operating system. It does not require access to the entire operating system to run the software, as they have its resources and libraries. Different applications, servers, and databases can run on the same physical machine by placing them in isolated containers.

FIGURE 1. Type 1 Virtualization

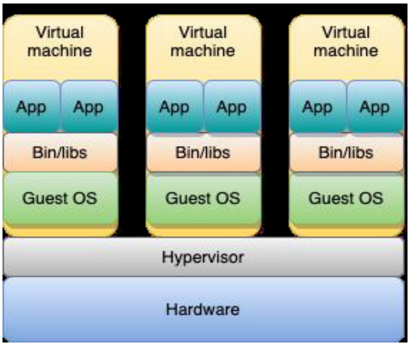


FIGURE 2. Type 2 Virtualization

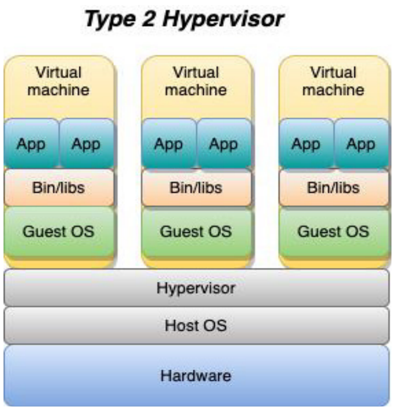
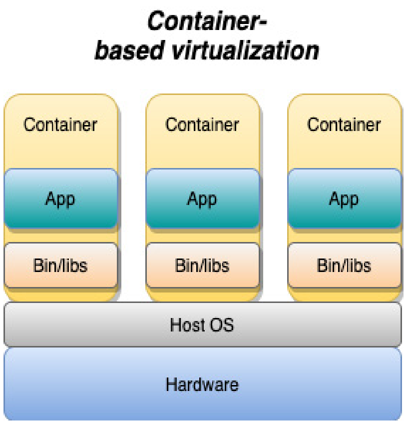


FIGURE 3. Container-based virtualization



This study focuses on designing and implementing a parking management system in a docker container and identifying the challenges and opportunities this deployment will create. Our first goal is distinguishing the differences between containers and virtual machines regarding performance, security, and adaptability. Moreover, we aim to re-create the functionalities of a system in a docker container.

The contributions of this study are as follows:

1. We propose a parking management system architecture developed on docker container technology.
2. We analyze the model parking management system regarding resource management, efficiency, and portability.

Our work reveals a better understanding of the docker technology applicability in real-world systems. The remainder of this paper is organized as follows. Section 2 describes the background and definitions to understand the architecture. Section 3 describes the proposed docker container-based parking management architecture and all its components. In section 4, we discuss the implementation of the use case. Section 5 presents the results. In section 6, we conclude our work.

Background

Docker container

A container is a sandboxed process on the computer that is isolated from all other processes on the host machine. Docker makes these capabilities easy to use. The container becomes the unit for distributing and testing the application. Briefly, the container is an instance of an image that can be created, started, stopped, moved, or deleted using DockerAPI or CLI, which can run on local machines or virtual machines or be deployed in the cloud. Also, it is portable and can be run on any operating system. It is isolated from other containers and has its software, binaries, and configurations.

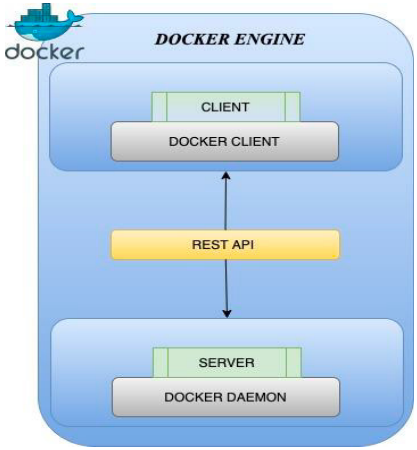
Docker Engine

Unlike traditional virtual machines, docker has no hypervisor. It has a "docker-engine" layer that takes care of everything running in these containers. The Docker engine creates and manages containers. It has two versions: Docker Engine Community and Docker Engine Enterprise. Docker-Engine Community is an open-source code and is complimentary, while Enterprise costs extra because it offers more advanced services. We used Docker Engine Community. The Docker engine is the client-server application whose architecture is a docker client that communicates with a docker daemon. The Docker daemon creates, runs, and deploys containers, and it does so by listening to incoming REST API requests. The REST API enables a communication path for docker objects such as images, plugins, networks, and containers to communicate with the docker daemon. A daemon can communicate with other daemons when necessary. The docker client is the primary channel for users to integrate with docker. When a docker client executes a command, that command is sent to the docker daemon via the REST API to be executed, see Figure 4.

Docker Build

Docker Build is one of the most used features of Docker Engine. Whenever we build an image, Docker Build is used. Docker Build is a crucial part of the software development lifecycle, allowing us to package and ship code anywhere. Docker Engine uses a client-server architecture and consists of multiple components and tools. The most common method of executing a build is by issuing a docker build command. The CLI sends the request to the Docker Engine, which, in turn, executes the build. Two components in the Engine can be used to build an image. Starting with the 18.09 release, Engine ships with Moby BuildKit, the new component for running builds. BuildKit is the evolution of Legacy Builder, which comes with new and greatly improved functionality that can be a powerful tool to improve the performance of building or reusing Dockerfiles and provide support for complex scenarios. Docker Buildx is a CLI plugin that extends the docker command with full feature support provided by the BuildKit Builder Toolkit. Docker Buildx provides the same user experience as docker builds with many new features such as instance creation, building against multiple nodes simultaneously, output configuration, internal build caching, and target platform specification. In addition, Buildx also supports new features yet to be available for regular docker builds, such as building manifest lists, distributed in-memory storage, and exporting build results to OCI images. Docker Build is much more than a simple build command. It is not only about packaging code but is an entire ecosystem of tools and features that support everyday workflow tasks and provide more complex and advanced scripting support.

FIGURE 4. Communication between docker daemon and docker client



Docker file

Docker uses a docker file to build the images that build containers. The docker file is a text file that contains commands with instructions on how to merge containers. Docker reads instructions from top to bottom, see Figure 5, where docker starts by reading the command FROM ubuntu:20.04. Docker builds images by reading instructions from a Dockerfile. This text file contains instructions that adhere to a specific format needed to compile the application into a container image. Docker files are an important development for building images and can facilitate the automated building of multi-layered images based on your unique configurations. Dockerfiles can start simple and grow with needs and support images that require complex instruction.

FIGURE 5. Docker file example

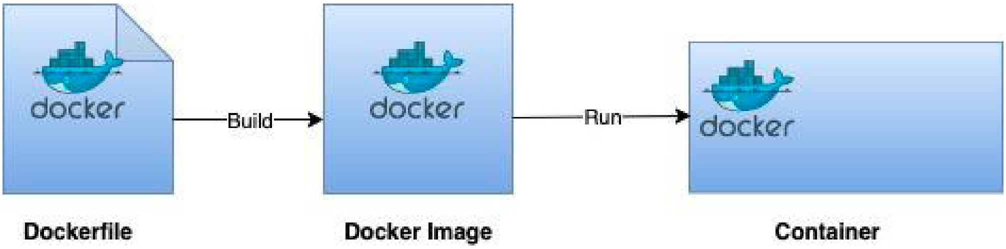
```
FROM python:3
WORKDIR /app
COPY ./requirements.txt requirements.txt
RUN pip install -r requirements.txt
COPY . .
ENTRYPOINT ["python3"]
CMD ["app.py"]
```

Docker Compose

Docker compose an orchestration tool used by Docker to run multiple containers simultaneously. The advantage of docker-compose is that it makes it possible to split all services across their containers instead of having them in a single container.

The logic of this technology lies in creating a multi-container solution, which makes containers more manageable and easier to build and maintain. To realize this, it is necessary to maintain a particular service in the respective container and not by interacting in a standard container. A YAML file is used to build these multi-containers, specifying the configurations required to implement the services needed in the container. Services specified in a YAML file are based on a docker file. The docker architecture is given in Figure 6.

FIGURE 6. Docker container build process



Docker Image

When a container runs, it uses an isolated file system. An image container powers this file system. Since the image contains the container's filesystem, it should contain everything needed to run an application—all configurations, scripts, binaries, etc. The image also contains other configurations for the container, such as environment variables, a default command to run, and other metadata.

Docker Application Architecture for Parking Management System

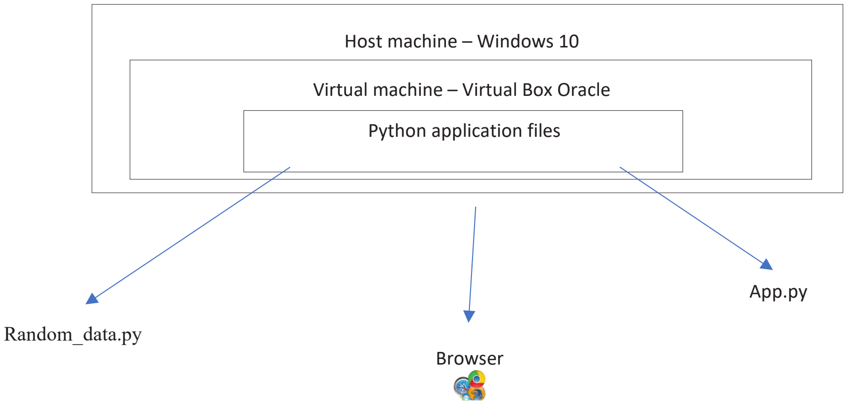
System architecture

To test the hosting of a web app in a virtual machine and containerized in a Docker, we took as an example the construction of an application that displays free parking spaces in the points in Tirana. First, we study the types of parking systems and how we can apply them. Recently, parking systems are changing in significant ways, driven primarily by the adoption of new technologies. New apps and digital services are making it easier for people to find and pay for parking, while sensor-connected car features are helping cities monitor where spaces are most needed. Emerging innovations such as artificial intelligence, virtual reality, and blockchain are transforming the industry.

Parking is a significant problem for cities. Many drivers circle for almost an hour, hoping to find a place. In contrast, other drivers abandon their cars on the side of the road, blocking emergency vehicles and even other pedestrian and bicycle lanes. Parking apps make it easier than ever to find and pay for parking. Drivers use their phones to find available parking spots near their destination, reserve the spot, and then pay automatically with a mobile wallet like Apple Pay or Google Pay. Apps also organize carpooling, making parking more manageable and efficient for everyone.

We developed a parking management system based on docker containers that can be run locally in an enterprise data center or any cloud environment shown in Figure 7. Our host machine runs on Windows 10 operating system (OS). Windows 10 OS supports virtual machine applications such as Oracle Virtual Box. We selected an Ubuntu 22.04 .iso image to implement the parking management system application. Moreover, we developed two Python scripts. The first script, named random_data.py, automatically generates random data and shows them in the corresponding tables of parking points. The second script, named app.py, connects to the database and, using specific buttons for the different parking points, updates the data for the user who will access them. We run the scripts on two different docker containers, and the data for the regular users is accessible through a public website.

FIGURE 7. System architecture model



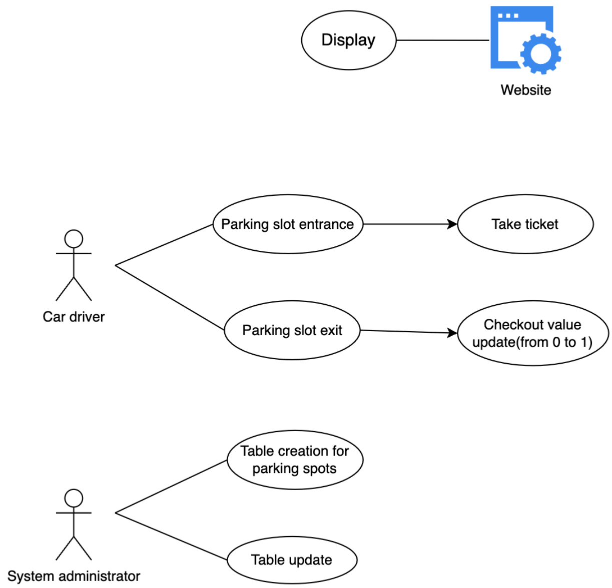
System components

This study deals with a model of a parking system that contains seven different points in the city of Tirana. Below is the corresponding UML diagram. The parking system has three actors, the primary named system administrator, the visual presentation(website), and the driver. The visual display actor visually displays free parking spaces for web users. It counts the number of cars entering the parking system.

The car/driver generates data for the visual presentation when entering the parking point and gets a ticket which takes the value 0. Then when the car leaves the checkout parking point, it will take the value 1.

The administrator actor has full access to the database, which is built in MySQL. The system administrator deals with architecture configurations, building the database, building tables for seven parking spots of the parking system, and updating the number of free spaces with current values.

FIGURE 8. UML diagram of system actors



System configuration

The machine we are working on has a Windows 10 operating system with 8GB of Ram and four processors. On this machine, we install the required virtual machine. The virtual machine we use is Virtual Box Oracle. VirtualBox is a powerful x86 and AMD64/Intel64 virtualization product for Enterprise and home use. VirtualBox is a highly feature-rich, high-performance product for enterprise customers and the only professional solution freely available as Open-Source Software under the GNU General Public License (GPL) version 3 terms. Currently, VirtualBox runs on Windows, Linux, Macintosh, and Solaris hosts and supports many guests operating systems.

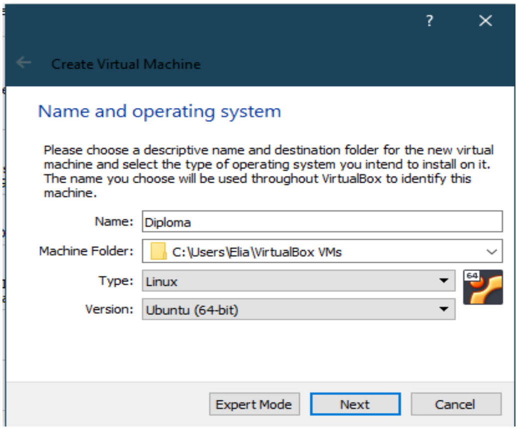
Advantages of Ubuntu:

1. Open Source. This operating system is free to download, use and distribute. This makes it even more necessary and preferred by users.
2. Security. Ubuntu is one of the most secure operating systems with a built-in firewall and virus protection software.
3. Accessibility. Being among the few systems with translations of up to 50 languages makes it even more accessible to different individuals.

Installing a virtual machine

- First, we download an image of the operating system we will use and VirtualBox, which serves to virtualize the environment where we want to do the testing.
- After both applications are downloaded, we start with installing the virtual machine like most other applications.
- After installing VirtualBox as an application on our physical machine, we move on to creating the virtual environment where we choose the name; we will give the machine and the operating.
- After that, we will choose the parameters that the virtual machine will have, including the amount of memory, CPU, and storage as below, considering the size and complexity of the application we want to develop in this machine.
  - 4Gb Memory
  - 2 CPUs
  - 50 GB Storage system will have along with the selected version.
  - After we have given the specifications and gone through all the steps, we can execute the run command on the machine we just built.

FIGURE 9. Operating System selection



Installing Ubuntu OS on Virtual Box

- When we turn on the machine, a startup disc will be created (which is practically the image of the Ubuntu operating system that we downloaded).
- Select the system we want to use and click start.

FIGURE 10. Installing Ubuntu

- After that, we follow the steps of installing the system, and after we finish with this part, we give the last details to work as simply as possible.
- Guest Additions is another software that unlocks some more advanced features of VirtualBox. This includes a better integration between the virtual machine and the host machine, making it possible to use the copy-paste option from one machine to another, adjust the image quality, and share folders.

Docker installation

We must have a file with the program's requirements to publish a project in Python and install them on our machine. This file contains the packages and dependencies and their respective versions to run the project. Run the command below in root.

- pip freeze > requirements.txt

One good thing about containerization with Docker is that I can package the application with all the runtime dependencies required to make it self-contained. Therefore, the application works without worrying about incompatibilities with the environment where it will be hosted.

FIGURE 11. Docker file creation

```
FROM python:3
WORKDIR /app
COPY ./requirements.txt requirements.txt
RUN pip install -r requirements.txt
COPY . .
ENTRYPOINT ["python3"]
CMD ["app.py"]
```

To install Docker, we first need a Dockerfile. FROM python:3.6-buster

WORKDIR /app

COPY requirements.txt.

RUN pip install -r requirements.txt

COPY. .

CMD [“python3”, “app.py”]

FROM python:3.6-buster - Since Docker allows us to use existing images, we install a Python image and install it on top of our Docker image.

WORKDIR /app – defining this folder as the directory where we will work.

COPY requirements.txt. ; COPY. . – copy every file in this directory

CMD [“python3”, “we_app.py”] – defines which application will be executed

• Building the Docker image

docker image build -t flask_docker .

• Starting the container

After we finish building the image, we try to launch it

docker run -p 5000:5000 -d flask_docker

Building the Flask application

Flask is a free and open-source Python framework designed to help developers build secure, scalable, and maintainable web applications. Flask is based on wrkzeug and uses Jinja2 as a template engine.

Flask is built with extensions and Python packages that add functionality to a Flask application.

There are different methods to install Flask on Ubuntu.

Flask packages are included in the Ubuntu repository and can be installed using the apt package manager. This is the easiest way to install Flask on Ubuntu 20.04, but not as flexible as installing it in a virtual environment.

Virtual environments allow us to create an isolated environment for different Python projects. This way, we can have many different Flask environments on a single machine and install a specific module version on a per-project basis without worrying about it affecting other Flask installations.

First, we create a directory that will contain the application.

• mkdir flask_app

The next step is to install Flask in this directory.

• cd flask_docker

• pip install flask

After success What is MySQL?

MySQL is a relational database management system (RDBMS) developed by Oracle that is based on Structured Query Language (SQL).

A database is a structured collection of data. It can be anything from a simple shopping list to a photo gallery or a place to hold large amounts of information on a corporate network. In particular, a relational database is a digital store that collects data and organizes it according to the relational model. In this model, tables consist of rows and columns, and the data elements' relationships follow a strict logical structure. An RDBMS is a set of software tools to implement, manage, and query such a database.

MySQL is integral to many of the most popular software suites for building and maintaining everything from customer-facing web applications to robust data-driven B2B services. Its open-source nature, stability, and rich feature set, coupled with continued development and support from Oracle, have meant that critical web organizations like Facebook, Flickr, Twitter, Wikipedia, and YouTube all use MySQL support.

Benefits of MySQL

Ease of use: Since it supports the SQL language, users do not need to be technical experts to access the database. It can be easily accessed by users with basic SQL knowledge and experience with other relational databases fully installing Flask; the next step is to install MySQL.

Free of Cost: Another benefit of using this database is that the user does not have to spend money to pay the license fee, as it is free of cost and available on the official website for download.

Customizable code: Since it is an open-source tool, software developers can customize and use the source code according to their applications. The source code is freely available to web users.

Security: It offers one of the most secure databases in the world and is therefore used by popular web applications such as Facebook, Twitter, Instagram, etc. Its various security features, such as Firewall, Encryption, and User Authentication, are the basis for protecting sensitive user information from intruders.

Better performance: Supports the multi-engine storage feature, which facilitates database administrators to configure the database to balance the workload. Hence, it makes the database perfect in terms of performance.

High Availability: It provides 24*7 hours availability and offers solutions like Master/Slave Replication and specialized Cluster servers.

Platform Friendly: It is a platform-friendly database that supports several platforms like Microsoft Windows, Oracle Solaris, AIX, Symbian, Linux, MAC OS, etc.

User-friendly interface: It has a user-friendly interface with many self-management features and various automated processes like configuration and administration-related tasks, which allows users to get work done effectively right from the start.

Installing MySQL on Ubuntu 20.0.4 LTS

First, we need to update the packages that the system itself has:

sudo apt update

Then we install the mysql server package:

sudo apt install mysql-server

Make sure the server is running using the systemctl start command:

sudo systemctl start mysql.service

The default data for this installation will be:

User: root

Password: ‘root ‘

First, we created a database called PARKING

CREATE PARKING DATABASE;

USE PARKING;

To store the data of each parking point, we build a table for each point with ticket and checkout columns.

CREATE TABLE liqeni_artificial (bileta int, checkout int);

CREATE TABLE asllan_rusi (bileta int, checkout int);

CREATE TABLE 7_xhuxhat (bileta int, checkout int);

CREATE TABLE bulevardi_i_ri (bileta int, checkout int);

CREATE TABLE sheshi_italia (bileta int, checkout int);

CREATE TABLE sheshi_skenderbej (bileta int, checkout int);

CREATE TABLE qyteti_studenti (bileta int, checkout int);

CREATE TABLE stadiumi_dinamo (bileta int, checkout int);

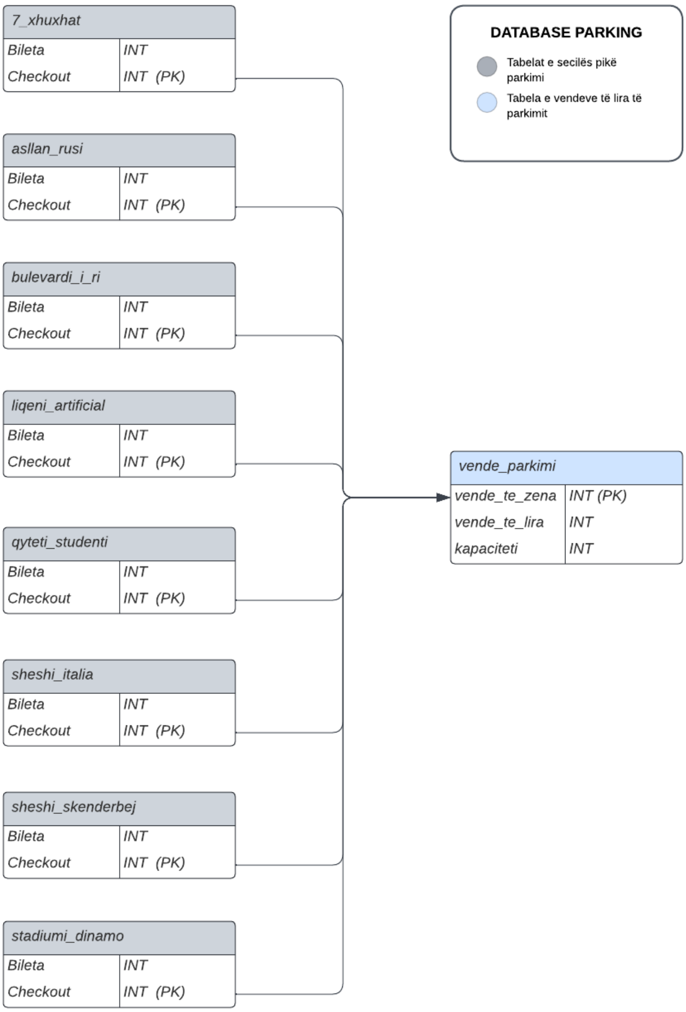
The ticket received a random number from 1-2000. Checkout I received a value of 1 when the ticket was scanned to exit and a value of 0 when the car was still parked (randomly generated values). I got the parking points online from the site http://tiranaparking.al/.

CREATE TABLE vende_parkimi (vende_tw_lira int, vende_tw_zwna int, kapaciteti int);

The last table created is parking_places. This table will have columns named vacant_seats, occupied_seats, and capacity. The capacity will have a value of 2000 and indicate the maximum number of parking spaces. The other two fields will be automatically updated via the web button functions. Occupied_seats will be the number of generated tickets with checkout value = 0, while free_seats will be calculated as capacity – occupied_seats.

The capacity is set to a fixed figure of 2000; the occupied places will be automatically updated according to the parking points and the number of cars with the checkout value 0; the free places will be the difference between the capacity and the occupied places.

FIGURE 12. Database connection



Results

Docker provides the ability to package and run an application in an isolated environment called a container. Isolation and security allow us to run many containers simultaneously on a given host. Containers are lightweight and contain everything needed to run the application, so we do not need to rely on what is currently installed on the host. We can easily share containers as we work and ensure everyone we share them with has the same container that works the same way. Docker provides tools and a platform to manage the lifecycle of containers. Dockers make a fast and stable distribution of applications. Docker streamlines the development lifecycle by allowing developers to work in standardized environments using local containers that deliver applications and services. Containers are great for continuous integration and continuous delivery workflows. Developers use Docker to push their applications to a test environment and run automated and manual tests. When developers find bugs, they can fix them in the development environment and redeploy them to the test environment for testing and validation. When testing is complete, getting customer acceptance is as simple as pushing the updated image to the production environment. Docker allows for portable workloads. Docker containers can run on laptops, physical or virtual machines in a data center, cloud providers, or other mixed environments. Dockers make it easier to dynamically manage workloads and scale up or down applications and services as business needs dictate in near real-time. Docker is easy and fast. It provides a stable and cost-effective alternative to hypervisor-based virtual machines, so we can use more of our server capacity to achieve business goals. Docker is perfect for high-density environments and small and medium deployments with limited resources.

Conclusion

Parking is expected to grow as a new industry integrated with technology. Parking management systems need integration and analytical solutions that combine data from distributed parking slots, which use local storage. However, cities need to grow more; thus, more resource-efficient solutions must be implemented. Our study shows that virtualization is an innovative solution that provides scalability, portability, and security. We provide a solution that can easily be implemented in Tirana city, needing more parking points and management. Our docker container-based web application impressively performs as better as the traditional solutions in terms of hosting services and performs better in terms of process management. As a future work, we aim to provide a central solution that can be implemented nationally to offer parking solutions in every major city of Albania.

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Demographic Dynamics and Characteristics of Urbanization in Albania During the Second Decade of Transition

Next steps in shaping the demographic-territorial model of transition

Dr. Urb. Gentian KAPRATA[1]

Abstract

During the second phase of urbanization, 2001-2011, the strong dynamics of the demographic movements that started in the first phase (1990-2001) continued. They include: (i) external migration and (ii) internal migration. The population of Albania decreased by 237,534 inhabitants. There were two reasons for this decline: (i) external migration; and, (ii) the reduction of the natural addition of the population, as a result of the fall of the Synthetic Fertilization Index (ISF). Another demographic phenomenon, very negative, was the aging of the population. During this period, a contradiction appears between: (i) the continuous increase in the number of buildings; and (ii)

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rapid population decline. Migration from one district of the northern and southern region to another district in the central and western area of the country included 228,952 individuals, while movements within the same district (at the city and village level) mark a figure of 280,863 individuals. They brought that, for the first time in the history of Albania, the population living in urban areas was higher than the rural one. The Greater Tirana-Durrës Region and the Fier-Vlora Medium Region would follow the division of the general national population, deepening the concentration-dispersion characteristics of the demographic-territorial model in the regional approach. This was also reinforced by the disproportional demographic relationship between the counties of the same region, but specifically in the demographic density between each of the residential centers (municipalities and municipalities) with the national average.

Keywords: *demography, external migration, internal migration, fertility rate, population aging, level of urbanization, demographic-territorial model, population concentration, population abandonment*

Presentation

This paper aims to present and analyze the demographic structure, the level of urbanization and the demographic-territorial model of Albania in the second decade of transition. It tries to put together all the information collected by other researchers regarding demography, external and internal migration, population distribution and inhabited centers throughout the National territory.

The paper aims to analyze these data, to understand and present the level of urbanization of the country and the characteristics of the urban-spatial structure, in the period studied.

The paper starts with an overview of the level of demography, in the period between 2001-2011. Strong dynamics of demographic movements continued during the second phase of urbanization, including: (i) external migration and (ii) internal migration. The population of Albania suffered a decrease of 237,534 inhabitants, which is 7.7% in these ten years (INSTAT, 2014: 15).

There were two reasons for this decline: (i) external migration, as a result of which, Albania lost something between 480 - 573 thousand people (INSTAT, 2014: 35; INSTAT, 2014: 5); and, (ii) the reduction of the natural increase of the population, as a result of the decline of the IFC from 2.1 in 2001 to 1.6 in 2011 (INSTAT, 2014: 5, 31, 32; INSTAT, 2014: 45). Another demographic phenomenon, very negative, was the aging of the population (INSTAT, 2014: 5).

Further, the paper presents and analyzes the growth of the housing stock as a contributor and indicator in the increase in the level of urbanization and the concentration-abandonment of the territory by demographics. The paper talks about a contradiction between a continuous increase in the number of buildings by 16.8% and a faster decrease of the population by a figure of 8.8% compared to 2001 (INSTAT, 2014: 10).

The distribution of inhabited dwellings by districts illustrates the concentration of new buildings, showing a construction boom in Tirana, Vlora, Durrës and Fier (INSTAT, 2014: 14). The phenomenon of uninhabited houses or for secondary use also proves this demographic and urbanistic phenomenon (INSTAT, 2014: 12-13).

The two basic trends of internal migration (rural-rural, rural-urban) as a contributor to the increased level of urbanization and concentration of demography, will be dealt with further in the paper. Migration from one county in the northern and southern region to another county in the central and western area of the country included 228,952 individuals, who make up 8% of the resident population in 2011, while movements at the city and village level mark a figure of 280,863 individuals. (INSTAT, 2014: 12).

Both trends of internal migration brought for the first time in the history of Albania: (i) the population living in urban areas was higher than the rural one, and included something between 1,498,508 - 1,642,359 inhabitants or about 54-58.2% of the total number of the population: (ii) while in rural areas live something between 1,301,630-1,179,618 inhabitants or about 46-41,8% of the total number of the population (INSTAT, 2011, 2014; INSTAT, 2014: 23).

In the following, the paper analyzes internal migration from the inter-regional approach as a contributor to the increase in the level of urbanization and the concentration-abandonment of the territory by demography. The Tirana-Durrës Greater Region and the Fier-Vlora Medium Region would follow the domination of the total national population. Specifically, Tirana would be inhabited by 670,553 urban residents and 86,375 rural residents, with an urbanization level of 88.6%; Durrës from 198,749 urban residents and 64,938 rural residents, with an urbanization level of 75.4%; and Vlora from 99,812 urban residents and 81,576 rural residents, with an urbanization level of 55.0% (INSTAT, 2014: 31). Likewise, the northern and southern districts have recorded a population loss of up to 60% (Vullnetari, 2012: 96).

Internal migration within the region as a contributor to the increase in the level of urbanization and concentration - the abandonment of the territory by demography, is the issue addressed below. The fact that about 18% of the migrants who come to the Fier district originate from the Vlora district (INSTAT, 2014: 22), testifies to the impact of internal migration on the urban concentration of the Fier district compared to the Vlora district, although both belong to the same region.

A demographic situation, but on a larger scale, also occurs within the Tirana-Durres region. Two were that shaped these phenomena: (i) terrible with the trend from Durrës to Tirana, which migrates 5-10% of all the growth that Tirana has experienced; and (ii) the different levels of host migration between the two districts (INSTAT, 2014: 22). In this sense, Tirana marked the increase with 112,180 new residents, while Durrës with 34,059 new residents, or in other words 49% of migrants settled in Tirana, 15% in Durrës (INSTAT, 2014: 19, 22; Vullnetari, 2012: 61).

In the following, the paper presents and analyzes the internal migration within the district as a contributor to the increase in the level of urbanization and the concentration-abandonment of the territory by demographics. This is distinguished by the fact that of the 373 municipalities and municipalities in the country, 48 of them, in the northern and southern parts of the country, have lost more than half of their population (INSTAT, 2014: 12; Vullnetari 2007, 2010, 2012). Likewise, if the population density in the national context was 97 inhabitants/km^2, the counties of Tirana and Durrës present respective densities of 454 inhabitants/km^2 and 343 inhabitants/km^2, while Gjirokastra 25 inhabitants/km^2, Kukësi 36 inhabitants/km^2 and Korça 59 inhabitants/km^2 (INSTAT, 2014: 17).

Punimi mbyllet me disa gjetje dhe konkluzione, si dhe disa rekomandime modeste.

The purpose and methodology of the work

The first aim of this paper is to collect data regarding the population level (demography), the housing stock, the level of urbanization and internal demographic movements during the period 2001-2011 (the second decade of transition). In this sense, the study, first, aims to contribute to the expansion of knowledge on these demographic and urban/territorial aspects, which is also its first contribution.

The purpose of the paper is to analyze these data to understand the way of development of the country, throughout the period under study, in the aspects of: (i) the urban-rural ratio; (ii) the way of development and growth of residential centers, focusing on the city as the essence of urbanization; (iii) the characteristics of the Albanian city; (iv) of the urban-spatial structure of the country and its characteristics. The conclusions of this analysis, within the scope of this paper, will contribute to a wider understanding of the urban phenomena of the period under study and the contextual reasons of the subsequent urban-territorial development.

The methodology of this paper is based on the analytical one, which is foreseen as the most appropriate in this work, as it explains in a systematic and detailed way the phenomenon taken in the study, throughout the time that the study includes.

The methods used in this paper are qualitative. This paper theoretically evaluates demography, the level of urbanization, the urban-spatial structure, the characteristics of the urban-spatial structure of the country, and the characteristics of the Albanian city in the period studied. This is done by using secondary sources of Albanian authors who have spoken on these topics.

Overview of the level of demography, 2001-2011

The strong dynamics of demographic movements continued during the second phase of urbanization, 2001-2011. They expressed the same forms as in the first phase (1990-2001), including: (i) external migration and (ii) internal migration.

The population of Albania decreased by 237,534 inhabitants in the second decade of transition, from 3,069,275 inhabitants in 2001 (INSTAT, 2001, 2003, 2004) to 2,831,741 inhabitants in 2011 (INSTAT, 2014: 15). This figure is expressed as 7.7% in these ten years (INSTAT, 2014: 15), which is even higher than the decrease of about 7% in the first ten years of the transition.

Thus, in the first two decades of the transition, Albania lost about 15% of its population, as the main consequence of external migration but also the decrease in the natural increase of the population. If we refer only to external migration, we can say that referring to INSTAT "the number of immigrants for the period 2001-2011 is calculated over 480,000 people." (INSTAT, 2014: 35).

A higher figure will be given by INSTAT in its study '*Population and its dynamics*' in 2014. According to it, "even 573 thousand more people left the country than entered it" (INSTAT, 2014: 5). However, external migration "is one of the main reasons for the decrease in the number of the population in Albania in the period between 2001 and 2011." (INSTAT, 2014: 31).

The population in this decade is also due to the decline in the natural growth of the population, especially in terms of the decrease in the fertility rate. If we refer to INSTAT if in the first decade "... the child per woman index speaks of a downward trend from 3.3 in 1990 to 2.2 in 2000" (INSTAT, 2004: 32), "Until 2011, the ISF [Synthetic Index of Fertilization] had dropped to 1.6." (INSTAT, 2014: 5).

This is a figure that does not replace the population, and explained and analyzed by INSTAT, in its study '*Population and its dynamics*', it can be said that:

> "The fertility rate in Albania is significantly lower than the replacement rate, i.e. the average number of children a woman would have to give birth to in order to replace herself by giving birth to a girl who should live to her reproductive age. The replacement level value is roughly the ISF value of 2.1." (INSTAT, 2014: 45)

The decrease in the level of natural growth, as a result of the decrease in the ISF, is also noticeable in comparison with other European countries. If we refer to INSTAT:

> "In fact, in recent years it has also dropped from the top 10 countries for birth rates in Europe. Only four countries in Europe have fertility rates of more than 2 children per woman: Turkey, Ireland, Iceland and France. Albania now has a lower birth rate than some Western European countries such as Belgium, the Netherlands and the United Kingdom and some Northern countries such as Norway, Finland and Sweden." (INSTAT, 2014: 48)

As in the first decade, the population experienced its aging in this period as well. Referring to the same INSTAT study, "In the same period, the share of children under 15 years of age fell sharply from 33.4 to 20.7 percent. At the same time, the share of elderly people (65 years and older) increased from 5.3 to 11.3 percent." (INSTAT, 2014: 5). The aging of the population is a negative demographic phenomenon, among others, in relation to its impact on natural population growth (Vulllnetari, 2007, 2012)

Both of these demographic phenomena: (i) the decline in the level of natural growth; and (ii) external migration, are also very important in their impact on the level of urbanization, since there is a strong connection between the types of migration between them (King and Vullnetari, 2003; Vullnetari, 2007: 69-70), but in this article we will focus on internal migration, which is the main and direct reason for the growth and changes in urbanization.

The increase in the stock of buildings and housing as a contributor to the increase in the level of urbanization and the concentration - abandonment of the territory by demography

The period 2001-2011 is characterized by the same internal and external migration trends as the previous period. As Vullnetari would emphasize in 2012, "Internal and external migration on a large scale have profoundly reformatted the population distribution map of Albania" (Vullnetari, 2012: 95).

The population continued to migrate in two directions, as (i) leaving Albania to other western countries, but also (ii) leaving the settlements of origin to other areas of Albania (Vullnetari, 2012: 70, 93; INSTAT, 2011, 2013, 2014). INSTAT would underline that "In particular, internal migration brought a large-scale urbanization of some areas and a drastic depopulation of some others" (INSTAT, 2014: 12).

We will first see this very harmful urban phenomenon in relation to the dynamics of the development of the apartment during the time taken in the study. In the first decade, the increase in residential spaces has served to improve the surface indicator, serving to correct the low level of housing in socialism (IHS alumni, et al., 1998; Aliaj, 2008; Misja and Misja, 2004). This phenomenon would also be accepted by INSTAT, according to which "During the cycle of the previous Census [1989-2001], there was an increase of 32.8% in the number of dwellings and a decrease of 3.6% in the population, which can have been indicators of the improvement of living conditions." (INSTAT, 2014: 10).

The second decade would not justify the argument that the increase in the number of residential buildings comes as a response to the need to increase the housing rate indicator. The data show that the phenomenon of unoccupied housing would further strengthen in this decade. Referring to INSTAT, it can be said that: "Uninhabited dwellings in 2011 constitute about 21.7% of the total number of dwellings in Albania, compared to only 11.3% in 2001." (INSTAT, 2014: 12).

A new phenomenon observed in this decade is the creation of a housing stock for seasonal use, which at least for a long period of time remains unoccupied. According to INSTAT "Eight percent of buildings and dwellings are for secondary purposes and for seasonal use, which means that the number of unoccupied dwellings has increased faster than people's demand or their ability to buy them." (INSTAT, 2014: 13).

This fact proves that construction did not address the need for improving housing indicators, but for a redistribution of the population across the national territory. The argument that "In 2011, there was a continuous increase in the number of buildings by 16.8% and a faster decrease in the population by a figure of 8.8% compared to 2001." (INSTAT, 2014: 10), is another indicator of the strengthening of the model of concentration-abandonment of the territory by the population.

The distribution structure of new buildings shows the strengthening of the population concentration pattern in the four main districts of the country. INSTAT would also identify this phenomenon, when it emphasized that "The distribution of inhabited dwellings according to districts illustrates this situation in the country, showing a construction boom in Tirana, Vlorë and Durrës", and that "The concentration of inhabited dwellings in the area extended area of Tirana represents more than a quarter of the overall distribution of inhabited dwellings in the country, followed by Durrës, Fieri" (INSTAT, 2014: 14), which are the four districts of the Great Region and the Region of Middle of the model.

The two basic trends of internal migration (rural-rural, rural-urban) as a contributor to the increased level of urbanization and demographic concentration.

In the second decade of transition (2001-2011) the directions of internal migration continued to be in the two directions defined in the first period 1989-2001, (i) migration from one county to another and (ii) within the same county from rural areas to urban areas (Vullnetari, 2012: 93; King, 2010).

Migration from one district of the northern and southern region to another district in the central and western area of the country involved 228,952 individuals, which constitute 8% of the resident population in 2011 (INSTAT, 2014: 12). But also according to the other trend, from rural areas to urban areas within the same county, internal migration presents high numbers. INSTAT will also notice this phenomenon, according to which "Movements at the city and village level, in the same period, mark a figure of 280,863 individuals" (INSTAT, 2014: 12).

Both trends of internal migration, but especially the second one, brought about the reversal of the urban-rural ratio in Albania. For the first time in the history of Albania: (i) the population living in urban areas was higher than the rural one, and includes 1,498,508 inhabitants or about 54% of the total population: (ii) while 1,301,630 live in rural areas inhabitants or about 46% of the total population (INSTAT, 2011, 2013, 2014).

The percentage of the urban population is higher if we refer to the study *'A new urban-rural classification of the Albanian population'*, of INSTAT in 2014. This study used the methodology used by the European Union and came to the conclusion that "The urban population of the Census, (including rejections) calculated with this methodology is 1,642,359 inhabitants (58.2%), while the rural population is 1,179,618 inhabitants (41.8%)." (INSTAT, 2014: 23).

However, the dynamics of internal migration in the second decade of transition overturned the characteristic of the rural dominance of the Albanian population, and for the first time, more than half of the Albanian population lives in cities. If we refer to INSTAT in the report *'Housing and living conditions'* we can quote that "The distribution by place of residence shows that there was an increase in the percentage of inhabited dwellings in urban areas of 24.7% and a decrease in rural areas of 20.5%." (INSTAT, 2014: 14).

This fact, empirically measured by the INSTAT report, confirms the theoretical conclusion that the level of urbanization in transition Albania is growing at a high speed as a result of the reduction of the rural population compared to the urban one. Referring to the housing stock, INSTAT would underline that "The reduction of the rural population by 26.7% and the increase of the urban population by 15.8% confirm the process of urbanization, while the urban-rural comparison regarding the stock of buildings gives an increase of 54.4% in urban areas compared to only 2.2% in rural areas" (INSTAT, 2014: 10).

The phenomenon of increasing the level of urbanization is also distinguished according to the indicators of housing construction. Referred to INSTAT "As a result [of new housing construction], the total stock of housing in Albania has increased, and the concentration of housing units between rural and urban areas has changed" (INSTAT, 2014: 10). This is also distinguished in relation to unoccupied dwellings, because "the number of unoccupied buildings in 2011 in rural areas is higher than that of buildings in urban areas (24.6% against 19.0%)" (INSTAT, 2014: 13).

The concentric characteristic of the demographic-territorial model is also identified by the fact that "Tirana remains the largest host of internal migration, and as a result, the construction boom has occurred in the city and its suburbs." (INSTAT, 2014: 14). As in the first decade (IHS alumni, et al., 1998; Aliaj, 2008; Misja and Misja, 2004), also in the period under study, Tirana is accepting internal migrants, further densifying the city and "urbanizing rural" (Fuga, 2012) of its surroundings.

Internal migration from the inter-regional approach as a contributor to the increase in the level of urbanization and concentration - abandonment of the territory by demography

The acceleration of urbanization rates as a result of internal migration is not only discernible from the observation according to the three regions of the country: the Tirana-Durrës Greater Region, which includes the counties of Tirana and Durrës; Fier-Vlora Middle Region, which includes Fier and Vlora counties; and, the Abandoned Region, which includes the other eight counties of the country. In addition to the flows from the northern and southern regions to the central region, internal migration is also clearly visible at the county level (Vullnetari, 2010, 2012; INSTAT, 2014: Kaprata, 2018, 2019, 2020, 2021, 2023).

Observed from both levels, both from the level of regions and from the level of districts, internal migration would emphasize the differences between the three components of the territorial model, which had been outlined since the first decade of transition (Vullnetari, 2012: 95; King , 2010). This dynamic would also be distinguished by INSTAT in 2014, when it underlined that "In particular, internal migration brought a large-scale urbanization of some areas and a drastic depopulation of some others" (INSTAT, 2014: 12).

Thus, the Tirana-Durrës Greater Region and the Fier-Vlora Medium Region would continue to dominate the general national population, due to the incoming internal migration that they suffered in this second phase of urbanization. Referring to Table 5.8 *'Urban population based on the network of cells according to NUTS 3 regions in Albania'*, of the study *'A new urban-rural classification of the Albanian population'*, it would underline that "Tirana, 670,553 urban inhabitants, 86,375 rural inhabitants, 88 .6% urbanization"; "Durrës, 198,749 urban residents, 64,938 rural residents, 75.4% urbanization"; "Vlora, 99,812 urban residents, 81,576 rural residents, 55.0% urbanization"; (INSTAT, 2014: 31).

This demographic phenomenon can be distinguished from the differences in the level of urbanization of each district separately. If the ratio of the urban population to the total population, expressed as a percentage in the national dimension, is presented at 53.52%, the districts that make up the two main components of the territorial model, have this ratio more pronounced, for example, Durres 74.56%, Tirana 70.20% and Vlora 65.62% (INSTAT, 2014). This is the result of internal migration in the central part of Albania, where incoming flows predominate, and "most internal migrants are concentrated in Tirana and Durrës." (INSTAT, 2014: 19).

In contrast to the first phase of urbanization, in the second phase an increase in the absolute value of internal migration to Tirana and its surrounding villages "especially from Vlora and Fieri" can be seen (INSTAT, 2014: 16). This migratory phenomenon would further deepen the concentrating characteristic of the territorial model in the population ratio in its two main components, the Tirana-Durrës Greater Region and the Fier-Vlorë Middle Region. Although these two regions represent parts of the national territory where the population is concentrated, they begin to deepen the difference between them, presenting the Tirana-Durrës Greater Region as the only one that dominates the spatial structure of the country (Kaprata, 2018, 2019, 2020, 2021, 2023).

The characteristic of 'abandonment' of the national territory, which together with the characteristic of 'concentration' constitute the essence of the territorial model of transition, was deepened even more in this phase of the country's urbanization. All eight counties that represent this characteristic have suffered a loss of population in this period as well, which has generally gone in the direction of the Tirana-Durra Greater Region (Kaprata, 2018, 2019, 2020, 2021, 2023).

Internal migrants who came to Tirana, in the period 2001-2011, mostly belonged to the districts of this component of the territorial model. As expressed by INSTAT "19% came from Dibra, 12% from Kukësi and Fieri and 5-10% from Shkodra, Berat, Durres, Elbasan, Gjirokastra, Korça, while less than 5% came from Lezha and Vlora" (INSTAT, 2014: 22). Similarly, for the district of Durres, which is the other district of the Tirana-Durres Greater Region, it can be said that the majority of internal migrants who arrived in Durres "came from Dibra (30 percent), Elbasan (14 percent) and Kukësi (11 percent)." (INSTAT, 2014: 22).

This testifies to a great loss of the population of other districts of the country in favor of Tirana and Durrës, and in this sense the deepening of the phenomenon of the abandonment of these districts by the resident population. This phenomenon would also be recognized by Voluntari when he pointed out that "some northern and southern counties have recorded population losses of up to 60%, generally due to migration" (Vullnetari, 2012: 96).

Observed from a macro approach, the flows of population displacement originate from the northern districts, where the districts of the northeast of the country stand out, but also the districts of the south-central and southeastern part, the numbers end up towards the two districts of the center of the country (INSTAT, 2014: 19). The abandonment of these districts by the population is very pronounced in this phase of urbanism, but what stands out are "the districts of Dibra, Kukes and Gjirokastra, where more than 21 percent of their population left during the period 2001-2011 " (INSTAT, 2014: 19).

Likewise, Fieri seems to be an attractive district for internal migrants who come mainly from "Berati (19 percent), Vlora (18 percent), Gjirokastra (15 percent) and Elbasani (13 percent)" (INSTAT, 2014: 22). The district of Fier, together with that of Vlora, have attracted internal migrants from other districts of the country, contributing to their abandonment, and in this sense to the strengthening of the territorial 'abandonment' characteristic of the country's territorial model.

Internal migration within the region as a contributor to the increase in the level of urbanization and concentration - abandonment of the territory by demography

The Tirana-Durres Greater Region, which dominates the spatial structure of the country in terms of population level, underwent internal dynamics during this urbanization phase (Vulnetari, 2012: 96). This dynamic is presented with a deepening of the difference between the resident population in the two counties that make it up.

There were two dynamics that shaped this phenomenon: (i) first, we have an internal migration with a trend from Durrës to Tirana, which represents 5-10% of the entire population growth that Tirana has suffered from incoming migration; and (ii) secondly, we have different levels of host migration between the two counties (INSTAT, 2014: 22). This is because Tirana recorded a higher increase, with 112,180 new residents coming from other regions of Albania, than Durrës with 34,059 new residents, or in other words "49 percent of internal migrants settled in Tirana, while 15 percent in Durres." (INSTAT, 2014: 19).

In fact, Tirana is the dominant district in terms of the number of incoming migrants (Vulnetari, 2012: 61), with 58% of all internal migrants, surpassing even itself a decade ago because "this [figure] is 9 points higher percentage compared to the period from 2001 to 2011." (INSTAT, 2014: 22). This was presented very clearly by INSTAT when it underlined that "Even though internal movements are multidimensional, it is obvious that the vast majority of internal migration flows are concentrated towards Tirana." (INSTAT, 2014: 12).

But also the Fier-Vlora Middle Region, apart from losing population as a result of out-migration to Tirana (King, 2010; Vullnetari, 2012), presents its internal dynamics. About 18% of the migrants who come to the Fier district are originally from the Vlora district (INSTAT, 2014: 22).

This phenomenon has been studied by INSTAT in the study *'Migration in Albania'*, which has defined a new instrument that explains it. This instrument is called by INSTAT the "movement rate" and is an indicator that expresses to what extent the population of a county is affected by migration in both directions. INSTAT would present that "The values of this measurement are high, if a large part of the population leaves the county, or if a large part of the population has arrived during the last decade, or if both occur simultaneously in a county certain" (INSTAT, 2014: 18).

This instrument explains why the same districts are presented both as districts that have lost population and as districts that have gained population, as a result of internal migration. This comes as a result of the fact that the internal migration dynamics affect all districts in both directions, i.e. both in the outgoing and incoming direction of the population.

This indicator also proves the two formative characteristics of the territorial model of the country, 'concentration' and 'abandonment'. Referring to INSTAT "The highest values in Albania [of the movement rate] can be found in Dibër, with 30.4 percent, Kukës with 29.4 percent, Gjirokastër with 25.3 percent and Berat with 20.7 percent", and the lowest values in "Tirana with 16.6 percent and Durrës with 16.9 percent" (INSTAT, 2014: 18). Which reflects in a different way the emphasis that the Greater Region is receiving, and in particular the district of Tirana.

Internal migration within the district as a contributor to the increase in the level of urbanization and concentration - abandonment of the territory by demography

Acceleration of the rates of urbanization in the country due to massive displacements of the population within the national territory, apart from the inter-regional and inter-district point of view, are also distinct from the point of view of the local administrative units. Referring to INSTAT, "Out of 373 municipalities and municipalities in the country, 48 of them have lost more than half of their population in the period 2001-2011" (INSTAT, 2014: 12).

This means that, while the vast majority of municipalities and communes have lost population due to internal migration, the resident population of about 13% of them has been halved. In fact, "These 48 municipalities/communes are mainly located in the center of the northern and southern parts of the country" (INSTAT, 2014: 12), a finding that proves the deepening of differences even between the second-level local government units.

This phenomenon presents us with another characteristic of the territorial model of the concentration-abandonment of the territory by the population, which is the densification of the population in the most important municipalities and communes of the respective districts. So, even the districts that have experienced population growth, but also the districts that have suffered population loss, have faced an internal urbanization dynamic that has brought a concentrated distribution of the population in the center of the districts (Vullnetari, 2007, 2010, 2012).

This generally comes as a result of the migratory trend within the same district, from rural areas to urban areas, but there are cases when the migration trend from one district to another also contributes, as is the case of the county of Tirana that we will present below.

In fact, as INSTAT presents it, "the more detailed the administrative division [for which the phenomenon of internal migration is observed], the higher the migration rate" (INSTAT, 2014: 12), which means that the characteristics of concentration expressed at the level of administrative units through population densification and intensification of buildings is more significant.

To remain at the district level, we can say that the difference between the districts that make up the formative components of the territorial model is also distinguished in terms of the density of inhabitants in the unit of territorial surface under their jurisdiction. If the population density in the national context, according to the measurements made by the *'Population and Housing Census 2011'*, was 97 inhabitants/km^2, the counties of Tirana and Durrës present densities much higher than this indicator, with respective densities of 454 inhabitants/km^2 and 343 inhabitants/km^2 (INSTAT, 2014: 17).

The same phenomenon also applies to the 'abandoned' districts, such as Gjirokastër, Dibër, Kukës, Korçë and Shkodër, which are represented at very low levels of population density per unit area. Some examples to make this statement concrete are Gjirokastra with a level of 25 inhabitants/km^2, Kukësi 36 inhabitants/km^2 and Korça 59 inhabitants/km^2 (INSTAT, 2014: 17).

As we presented, the densification of the population in the central administrative units of the districts is a phenomenon that affects all the districts of the country.

This phenomenon, for most districts, occurs as a result of internal migration within the same district because the vast majority of communes have lost their population as a result of their departure to urban centers. The communes of suburban Tirana makes exceptions to this widespread phenomenon (INSTAT, 2014:15).

The communes around urban Tirana have not only not suffered a population decline, but have continued to grow during this urbanization phase (Vullnetari, 2007, 2012; INSTAT, 2014). Many authors have distinguished and presented this phenomenon, from IHS Alumni in 1998, Faja in 2003, Misja and Misja in 2004, Aliaj in 2008, Fuga in 2012, the World Bank in 2007, but we will remain at the studies published by INSTAT, because this is the only way we remain in the quantitative field.

According to INSTAT, this phenomenon originates from the fact that internal migrants tend to move as close as possible to the desired destination. Due to many economic and governance factors, it has been impossible for many migrants to settle in the city of Tirana (Aliaj, 2007; Fuga, 2012), they have settled in the six surrounding municipalities, such as Kamza, Pakuqani, and Farka, which are the communes that have experienced the highest population growth (INSTAT, 2004, 2014).

Referring to the study *'Migration in Albania 2014'*, the communes around Tirana have had the highest population growth in the period 2001-2011, while the population of Farka, Dajti and Kashari has tripled (INSTAT, 2014: 15). If we consider the region of origin of the internal immigrants who arrive in the six communes around Tirana, we see that most of them come from the north and northeast of Albania, more precisely from Kukësi and Dibra. Referring to numbers, this statement is presented with 39% of migrants who came to the six communes in question came from Kukësi, while 34% of them came from Dibra (INSTAT, 2014: 15).

On the other hand, it is noted that the communes of Kashari and Farka are preferred by internal migrants coming from the southern districts (INSTAT, 2014: 16), while internal migrants coming from the northern districts prefer the municipalities of Kamza and Paskuqani (INSTAT , 2014: 16). For example, 44% of migrants moving from Kukësi settle in Kamëz, while 61% of migrants coming from Gjirokastra settle in Kashar (INSTAT, 2014: 17).

Communes such as Dajti, Farka and Kashari that attract migrants with residential origins from the southern regions have experienced an increase in the number of inhabitants only during the decade 2001-2011. In fact, Farka still experienced population loss in the period 1989-2001 (INSTAT, 2014: 16). These figures measured empirically by INSTAT present the fact that Tirana has not only grown and densified in its urban area but also in its rural territories.

Findings and conclusions

Strong dynamics of demographic movements continued during the second phase of urbanization, 2001-2011, including: (i) external migration and (ii) internal migration. The population of Albania suffered a decrease of 237,534 inhabitants, which is 7.7% in these ten years.

There were two reasons for this decline: (i) external migration, as a result of which, Albania lost something between 480 - 573 thousand people; and, (ii) the reduction of the natural addition of the population, as a result of the fall of the SFI from 2.1 in 2001 to 1.6 in Another demographic phenomenon, very negative, was the aging of the population.

During this period, a contradiction appears between: (i) a continuous increase in the number of buildings by 16.8%; and (ii) a more rapid decrease of the population with a figure of 8.8% compared to 2001. The distribution of inhabited dwellings according to districts, illustrates the concentration of new buildings, showing a construction boom in Tirana, Vlorë, Durrës and Fern. The phenomenon of uninhabited houses or for secondary use also proves these two demographic and urbanistic phenomena.

Migration from one district of the northern and southern region to another district in the central and western area of the country involved 228,952 individuals, who make up 8% of the resident population in 2011, while movements at the city and village level mark a figure of 280,863 individuals.

Both trends of internal migration brought for the first time in the history of Albania: (i) the population living in urban areas was higher than the rural one, and included something between 1,498,508 - 1,642,359 inhabitants or about 54- 58.2% of the total number of the population: (ii) while in the rural areas live something between 1,301,630-1,179,618 inhabitants or about 46-41,8% of the total number of the population. The concentric characteristic of the demographic-territorial model is also identified by the fact that Tirana remains the largest host of internal migration.

The Tirana-Durrës Greater Region and the Fier-Vlora Medium Region would follow the domination of the total national population. Specifically, Tirana would be inhabited by 670,553 urban residents and 86,375 rural residents, with an urbanization level of 88.6%; Durrës from 198,749 urban residents and 64,938 rural residents, with an urbanization level of 75.4%; and Vlora from 99,812 urban residents and 81,576 rural residents, with an urbanization level of 55.0%. Likewise, northern and southern counties have recorded population losses of up to 60%.

Internal migration within the region as a contributor to the increase in the level of urbanization and concentration - the abandonment of the territory by demography, is the issue addressed below. The fact that about 18% of the migrants who come to the Fier district are originally from the Vlora district, testifies to the impact of internal migration on the urban concentration of the Fier district compared to the Vlora district, although both belong to the same region.

The same demographic situation, but on a larger scale, also occurs within the Tirana-Durres region. There were two dynamics that shaped this phenomenon: (i) internal migration with a trend from Durrës to Tirana, which represents 5-10% of the entire population growth that Tirana has experienced; and (ii) different levels of host migration between the two districts. In this sense, Tirana recorded an increase with 112,180 new residents, while Durrës with 34,059 new residents, or in other words, 49% of migrants settled in Tirana, while 15% in Durrës.

Internal migration within the district as a contributor to the concentration-abandonment of the territory by demographics is distinguished by the fact that out of 373 municipalities and communes in the country, 48 of them, from the northern and southern parts of the country, have lost more than half of the population. Likewise, if the population density in the national context was 97 inhabitants/km^2, the districts of Tirana and Durrës present respective densities of 454 inhabitants/km^2 and 343 inhabitants/km^2, while Gjirokastra 25 inhabitants/km^2, Kukësi 36 inhabitants/km^2 and Korça 59 inhabitants/km^2.

Recommendations

Within its modest limits, the paper recommends more detailed studies on this topic, in the same time period or in other periods along the Albanian transition.

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Power Factor, Correction and Optimal Value of This Factor in The Power Network

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Abstract

Power factor is an expression of energy efficiency. It is usually expressed as a percentage—and the lower the percentage, the less efficient power usage is.

Power factor (PF) is the ratio of working power, measured in kilowatts (kW), to apparent power, measured in kilovolt amperes (kVA). Apparent power, also known as demand, is the measure of the amount of power used to run machinery and equipment during a certain period. It is found by multiplying (kVA = V x A). The result is expressed as kVA units.

Power factor (pf), is the cosine of the phase shift between voltage and current, it is also found as the cosine of the load impedance angle. The main purpose of this study

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is to find the best method to correct the power factor in order to obtain economic, environmental and quality benefits from it. etc., as well as finding the optimal level of its value. The importance of studying the power factor is related to the many benefits that its correction offers us. First, we found out theoretically what the power factor is, its relations with active, reactive and complex power, then we found the way to correct it in order to get this optimal value. At the end we presented all the conclusions and results.

Key words: *Active power, reactive power, apparent power, complex power, power factor, power factor correction.*

Introduction

Electric power in alternating current circuits consists of three components: active power (P), reactive power (Q) and apparent power (S).

Active power (P), is the power that an electrical device consumes. So, circuits, devices or electrical loads use active power to work. Active power is measured in *watts, kilowatts or megawatts* (W,KW or MW). Real power produces the mechanical power in an engine – eg. in a packaging environment, or conveyor power moving materials through the factory. It is otherwise called real power or real power (Circuit Globe).

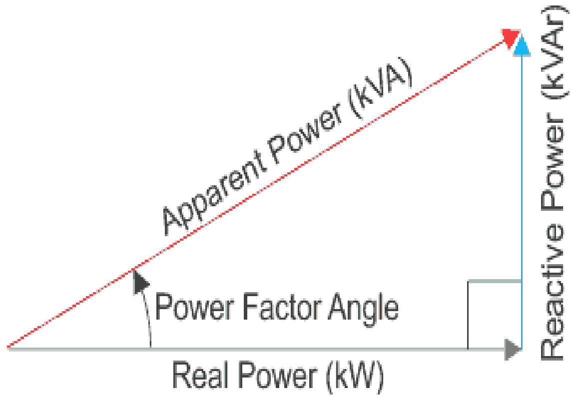
Reactive power (Q), doesn't do any real work. The power that flows before and after, which means it moves in both directions in a circuit or opposes itself, is called reactive power (Circuit Globe). Reactive power moves from source to load and back, from load to source. The transfer of this power is done without loss Reactive power is measured in , ,,(VAR,KVAR OR MVAR) (Circuit Globe)

Apparent power (S) is the product of the effective value of the voltage and the effective value of the current. This power is so named because of the power analogy that is calculated as voltage x current in DC circuits. Apparent power is measured in *voltamper, kilovoltamper, or megavoltamper* (VA, KVA or MVA) (Circuit Globe)

Power factor (pf), is the cosine of the phase shift between voltage and current. It is also found to be as the cosine of the full load resistance angle. Power factor is expressed as the ratio of active power (P) to apparent power (S). power factor is a quantity that takes values from 0 to 1.

The zero value is encountered for purely inductive or purely capacitive loads. A power factor value of 1 is encountered for pure resistive loads (Circuit Globe), (Alexander, Ch. & Sadiku,M. 2009).

FIGURE 1. Power factor triangle



Purpose of the work

The presented thesis is a small contribution to the ongoing studies being done on power factor utilization and regulation. Various methods have been used to adjust the power factor, the most used of which is the addition of capacitors. The purpose in choosing this topic is that the power factor can be used to have benefits such as: economic, environmental, voltage wave quality, cable losses, etc.

This paper analyzes the results obtained from studies made by well-known and interested engineers and analysts on power factor. Some of the materials are based on various books or engineering websites that have addressed the topic of power factor.

By studying the different methods of adjusting the power factor, I tried to determine the optimal level of the power factor in order to get optimal benefits from it. By studying different methods of adjusting the power factor we can distinguish which of these methods is the most suitable and most used in different working conditions.

Adding capacitors is the most economical way to improve the power factor of a facility. Capacitors serve as the main current generator to counteract the residual reactive current in the system.

Maintaining a high-power factor in a system will give us direct savings. As the power factor of the system is improved, the overall current flow will decrease, allowing additional loads to be added and served by the existing system.

FIGURE 2. Explanation of reactive and real energy

If equipment such as transformers, cables and generators are thermally overloaded, improving the power factor is the most economical way to reduce the current and eliminate the overload condition.

Based on what was said above, the finding to use the adjustment of the power factor will come as a result of numerous studies, which comparing them will give us a satisfactory result.

So, from what we said above and from what we will see below, we will understand that adjusting the power factor is a process of great interest to us. Electrical engineers must continue to study and improve the power factor to have economic benefits, in terms of quality of the voltage wave as well as environmental benefits.

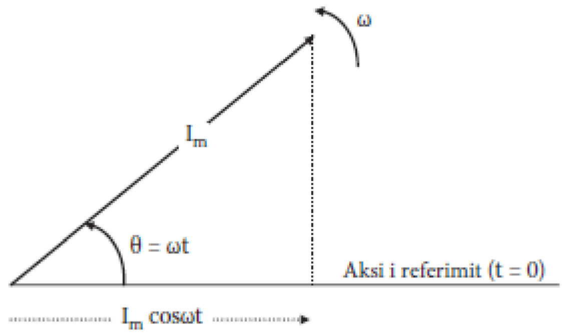
The power triangle

Electrical engineers have made constant efforts to determine the power that an electrical device consumes. To determine this power, it is necessary to determine the complex power, which gives us information on the nature of the load. (Circuit Globe), (Alexander & Sadiku, 2009).

The instantaneous value of the current passing through an element of the electrical circuit is $\mathbf{i(t) = Im\ cos\omega t}$. This quantity is represented as a vector of length Im rotating in the complex plane with angular velocity (frequency) ω rad/sec as shown in the Figure below. The instantaneous value of i(t) at any time t is **Im cosωt**, which is the projection onto the horizontal axis. It varies between +Im and –Im, going to zero twice at ωt = 90° and 270° each cycle. Since the actual value of i(t) depends on the phase angle of the rotating vector, this vector is called phase (Patel, 2011).

In general, the voltage and current phasors have a phase difference between their maximum values, that is, the maximum values can appear at different moments of time. The voltage and current phasor shown in Figure 1 has a phase difference θ, the maximum value of the current lags in phase by the angle θ to the voltage. Two phasors of the same frequency with a phase shift θ between their maxima will have the same phase shift θ between their zeros. The waveform above V and I imply that these quantities vary sinusoidally with respect to time. (Patel, 2011)

FIGURE 3. Phasor representing alternating current.



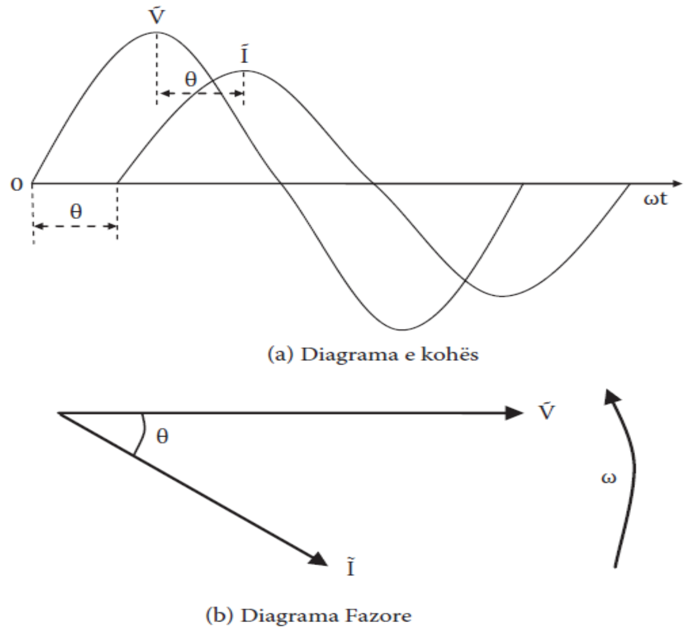
For average power, we know that when voltage and current are out of phase they produce less average power than when their peaks appear at the same time. If *V* and *I* are in phase (θ = 0), their product is always positive even when V and I are negative throughout the half cycle. However, when , the instantaneous power is negative when either V or I is negative and the other is positive. If positive power means power flowing from the source to the load, then negative power means power flowing back to the source as energy stored in the inductive or capacitive load. The average power in such cases is less than the maximum power that V and I can produce if they are in phase. The average power of the voltage V and the current I with phase delay against the voltage with the phase angle θ is given by the time average for one cycle with period T, so,

$$P_{mes} = \frac{1}{T}\int_0^T V_m\, cos(\omega t) \cdot I_m\, cos(\omega t - \theta)dt = \frac{V_m I_m}{2} cos\,\theta = V_{ef} I_{ef}\, cos\,\theta \quad (1)$$

If the voltage and current are in phase with $\theta = 0°$, they will produce the maximum possible power equal to $V_{ef} \times I_{ef}$.

When they are out of phase they produce less average power. The reduction factor $cos\,\theta$ is called the power factor (pf). It is clear that, $pf = 1.0$ (unit) when $\theta = 0°$, and $pf = 0$when $\theta = 90°$. (Patel, 2011)

FIGURE 4. Two sinusoidal phasors (vectors) staggered by the angle θ.



Power factor improvement

The most economical way to improve the power factor of a facility is by adding utility power capacitors. It is important to understand the utility rate structure to determine the return on investment to improve power factor. (Meyers & Prado, 2016) (Small Business)

Maintaining a high-power factor in a facility will provide direct savings. In addition to reducing the power factor penalties imposed by some utilities, there may be other economic factors that, when considered as a whole, may lead to adding power factor correction capacitors that provide a justifiable return on investment. Other savings such as reduced distribution losses, improved voltage reduction and increased current-carrying capacity are less obvious but true nonetheless. In addition, there are other indirect benefits such as a result of more efficient equipment performance or lower carbon emissions, to be considered. (Meyers & Prado, 2016) (Small Business)

As the power factor of the system is improved, the overall current flow will decrease - allowing additional loads to be added and served by the existing system. In case of equipment, such as transformers, cables and generators, can be thermally overloaded, improving the power factor can be the most economical way to reduce the current and eliminate the overload condition. (Small Business)

Incorporating power factor correction capacitors into new construction or facility expansions can theoretically reduce project cost by reducing the size of transformers, cables, buses, and switches.

In practice, however, damping ratings are a function of full-load equipment values, and size reductions may be excluded by electrical codes. (Islami, 2017) (Small Business)

What is power factor correction?

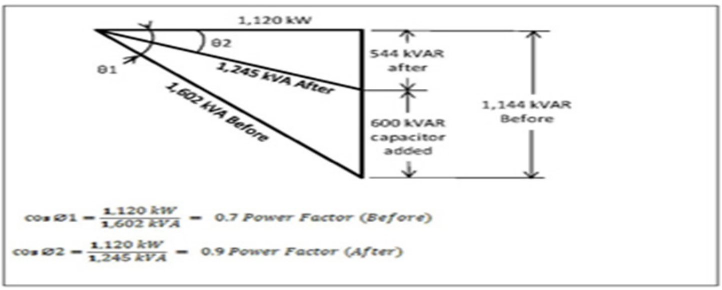
Power factor correction is a technique of increasing the power factor of a power supply. Switching power supplies without power factor correction draws the current in short, high-magnitude pulses. These impulses can be attenuated using active or passive techniques. This reduces the actual and apparent input RMS power, thereby increasing the power factor. (Islami, 2017)

Power factor correction shapes the input current to maximize the real power from the AC supply. Ideally, electrical equipment should present a load that emulates a pure resistance, meaning that the reactive power will be zero. And the current and voltage waves would be the same sine wave and in phase with each other.

The power generating company must produce more power to meet the demand for useful power and what is lost. This means more capital investment in generation, transmission, distribution and control. The costs are passed on to the consumer in addition to contributing to global warming. (Meyers & Prado, 2016)

Power factor correction tries to push the power factor of the electrical system, such as the power supply, towards 1, and although it does not achieve this, it gets as close as 0.95 which is acceptable for most applications. (Islami, 2017)

FIGURE 5. Energy triangle in relation to power factor.



Power factor correction methods

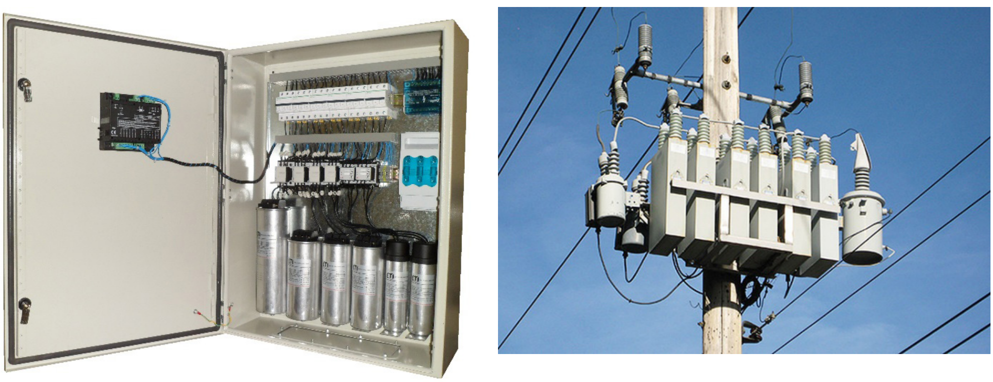
Fixed capacitor location schemes include:

1. Combining the required number of capacitors in the main bus. This will eliminate the power factor penalty but will not reduce losses in the facility. Capacitors located in this location are more sensitive to harmonic resonance.
2. Distribute capacitors in motor control centers and sub-panels proportional to the average load. This will generally improve losses, although it is not an optimal solution.
3. Distribute the capacitors using the motor sizes and NEMA tables as a guide. This solution does not reflect the need for more released capacity if that is a goal. Capacitors sized for small loads are often proportionally much more expensive than larger fixed capacitors, mainly due to installation costs.

Improving the power factor in electrical systems requires the installation of capacitor banks which act as a source of reactive power. In the low voltage system compensation can be provided by:

1. Capacitors with constant capacity
2. Capacitor battery which automatically adjusts the demand for reactive energy, i.e. the automatic change of capacity.

FIGURE 6. Banks of capacitors



Correction of the power factor in the economic aspect, (example)

A company absorbs active and reactive energy according to table 1:

TABLE 1. Active and Reactive energy consumption of company

MONTH	ACTIVE POWER	REACTIVE POWER	AVERAGE POWER FACTOR	HOURS OPERATED	ACTIVE POWER	Q_C=P(tangΘ-0.484)
January	7221	6119	0.76	160	0.76	16.4
February	8664	5802	0.83	160	0.83	10.0
MARCH	5306	3858	0.81	160	0.81	8.1
APRIL	8312	6375	0.79	160	0.79	14.7
May	5000	3948	0.78	160	0.78	9.5
JUNE	9896	8966	0.74	160	0.74	26.1
JULY	10800	10001	0.73	160	0.73	29.8
August	9170	8910	0.72	160	0.72	27.9
September	5339	4558	0.76	160	0.76	12.3
OCTOBER	7560	6119	0.78	160	0.78	15.4
NOVEMBER	9700	8870	0.74	160	0.74	26.1
December	6778	5879	0.76	160	0.76	16.2
TOTAL	93746	79405				

We start by calculating 0.484 as the tangent corresponding to a cosΘ=0.9.

If an automatically controlled capacitor bank for power factor correction with Qc = 30 kvar, against a total installation cost per year cc of €25 / kvar, gains a total cost of €750. The saving for the consumer, without considring the payment and financial payments, will be:

$$\mathbf{C_{EQ} - C_{QC} = 1370€ - 750€ = 620€}$$

As we can see from the example above, the installation of a bank of capacitors automatically controlled for the correction of the power factor of power there will be a considerable saving, a saving which is far greater than the cost of installing the capacitor bank.

Benefits of power factor improvement

1. *Reduction of cable size.* The table below shows the increase in cable cross-section for reducing the power factor from 1 to 0.4 for the same transmitted active power.
2. *Reduction of losses (P, kW) in the cable (conductor).* Losses in the cable are proportional to the current squared. Reducing the current in the conductor by 10% for example, the losses will be reduced to about 20%.
3. *Reduction of voltage drop.* A lower power factor causes a higher current flow for a given load. As the current increases, the voltage drop across the conductors increases, which can result in a lower voltage across the device. With an improved power factor, the voltage drop across the driver is reduced, improving the voltage across the device.
4. *Increasing the capacity of transformers, lines, etc..* By improving the power factor, the load current fed by the transformer will decrease which will make it possible to increase the load on it.
5. *Reducing carbon footprints.* By reducing the demand load on your power system through power factor correction, your utility is putting less strain on the power grid, reducing its carbon footprint. With the passage of over time, this reduced demand on the electricity grid can account for hundreds of tons of reduced carbon output, all thanks to improved electrical efficiency of your power system through power factor correction.
6. *Losses of use of the energy system.* Although the financial return from conductor loss reduction alone is rarely sufficient to justify the installation of capacitors, it is sometimes an attractive additional benefit, especially in older plants with long outlets or in field pumping operations. System driver losses are proportional to the square of the current and, since the current is reduced in direct proportion to the improvement in power factor, the losses are inversely proportional to the square of the power factor.
7. *Cost savings.* Most electric utility companies charge for peak demand measured based on the highest recorded demand in kilowatts (KW meters), or a percentage of the highest recorded demand in KVA (KVA meters), whichever is greater. If the power factor is low, the percentage of measured KVA will be significantly greater than the required KW. Improving the power factor through power factor correction will lower the load demand, helping to reduce your electricity bill.

Conclusions

- From the analysis done for adjusting the power factor, we see that adding capacitors is the most economical way to improve the power factor.
- Different power factor correction techniques give us the opportunity to solve the optimal type of power factor correction technique for different networks with different voltage levels.
- Reducing the size of the cable is a benefit obtained by adjusting the power factor.
- Another benefit of power factor regulation is the reduction of cable losses as they are proportional to the squared current.
- The reduction of the voltage drops which is obtained by adjusting the power factor by means of capacitors reduces the reactive component.
- By adjusting the power factor, we can increase the capacity of transformers and lines as the load current fed by the transformer will decrease increasing the load on it.
- Another benefit is the environmental benefit as power factor adjustment because of more efficient equipment performance or lower carbon emissions, to be considered.
- All the above-mentioned benefits result in three main benefits where they are all included. Economic benefits, voltage wave quality benefits and environmental benefits.

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Energy Production From Biomass, Case Study: Cow Farm

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Abstract

Recently the use of biomass for biogas production is very limited in Albania. According to data acquisition from the study, the highest share in the entire structure of urban solid waste is that of organic waste 41-61.2%.

A large part of these wastes is bio digestible and can used for production or utilized as potential substrate in anaerobic digestion to produce biogas, a renewable source of energy and environment friendly too.

Live stocks waste and especially cow manure farms are concerned in this study because there are a high number 11813 of them are spread all over Albania. In addition, the amount of cow manure exceeds 37,693.92 ton/year.

In this case study is presented a cow farm located near Tirana, capital city of Albania with 200 cow heads which in the future will become 700 cow heads. The

[1] Prof. Dr. Tania Floqi after graduating from the course of 'Industrial Chemistry' in the University of Tirana, has started working at the Public Health Institute where she has set up for the first time the Laboratory of Drinking Water and Wastewater. Later, at the University of Tirana, completed her doctoral studies in the field of Biotechnology and Environmental Technology. After the 1990s, she worked as Head of the Environmental Department and Director of the Institute of Industrial Studies and Design. During this period, she has completed numerous qualifications in different countries of the world for water treatment, urban waste, environmental management, etc. Subsequently, as a lecturer and head of the Department of Environmental Engineering, she has led and participated in many national projects as well as those of the EU (such as SouthEast Europe, Tempus, IPA Adriatic etc.), giving her contribution in the environmental field. She has also worked for the accreditation of UPT (Polytechnic University of Tirana) programs in the position of director of the Quality Assurance Center at UPT and as a member of the editorial board of the technical sciences bulletin of UPT and member and head of Professors Council at Civil Engineering Faculty.

total amount of cow manure produced in this farm is 1825 ton/year, a considerable quantity of manure available for biogas production.

This paper presents the type of digester, calculation of the biogas production yield, the obtained energy, the payback period of the initial investment and the net present value of this farm batcher digestor.

***Key words:** Batch digester, biogas production, cow farms, cow manure, cost investment, energy.*

Introduction

After 1990s in Albania, the data indicate a significant increase in urban waste generation. In the total percentage of solid urban waste, organic waste component represents the highest percentage (41-66%) at the waste composition. Many livestock farms were developed. Recently the number of them is increase up to 23654 and approximately 50 % of them are cow farms, as shown in the Table I. In 2021 the waste forms the livestock sector is estimated to be 383,234.4 tons (INSTAT, 2022).

As is shown in the Table I the quantity of cow manure in 2021 in Albania is approximately 37,693.92 ton/year.

The reasons that are chosen cow manure farm are: the substrate quality for biogas production, the high quantity of available manure, the methane production yield up to 63% (Handbook 2005).

The results on biogas production in laboratory scale from cow manure (25 Nm^3/ton) are very optimistic to implement in the concrete cow farm with 200 cow's heads.

TABLE 1: The quantity of cow Manure in Albania

Region	Number of cow farms	Cow heads (+5)	Manure quantity (kg)
BERAT	542	5266	1 553 470
DIBER	593	5004	1 476 180
DURRES	529	5574	1 644 330
ELBASAN	488	4073	1 201 535
FIER	1687	16795	4 954 525
GJIROKASTER	455	9737	2 872 415
KORCE	1365	15253	4 499 635
KUKES	1749	13481	3 976 895
LEZHE	868	8347	2 462 365
SHKODER	1407	12816	3 780 720
TIRANE	1203	10791	3 183 345
VLORE	927	20639	6 088 505
Total	11813	127776	37 693 920

Materials and methods

As mentioned above, the study aimed to establish a biogas production plant with cow manure near the Cow Farm, located in Kashar village, approximately 15 km far away from Tirana, with a maximal capacity of 700 cow heads.

- Total surface area of the farm is 12,500 m^2
- Building surface + stalls are 5500 m^2 (Close system). Cow manure is collected within an open area in a natural dump.
- Actually, this farm has 200 cow heads.
- One head produces approximately 20 – 30 kg manure/day
- Average monthly consumption of electric energy is 3381 kWh/year.
- The price of electricity is 14 ALL/kWh without VAT. (0.14 $)
- Heating-cooling system for the building is assumed from heat pumps

Taking in consideration that one head produces 20–30 kg manure per day, 200 head of cows produce 5 tons of waste per day so 150 tons of waste in 30 days. Cow litter density is 500 kg/m3:

- The plant will be a batch digester type like what is shown in figure 2.
- The digester volume – 300 m^3
- Retention time – 30 days.

The samples of cow manure are analyzed in the biogas lab.

The method applied for the cow manure samples is the same as Mico and co (2013) for biogas production in laboratory scale.

Results and discussion

The biogas produced in the laboratory scale from cow manure is approximately 25 Nm^3 /ton.

- Five-ton manure produce 125 Nm3 /day biogas.
- The daily energy produced from the biogas quantity 125 Nm3 /day × 9.67 kWh = 1208.75 kWh.
- The monthly energy produced is 36262.5 kWh, which can be used to generate heat and electricity.

- The monthly energy produced by generator is 36262.5 kWh × 0.37 = 13417 kWhel (see Table I, Fig. 1)
- Annually energy produced is 161 MWhel.
- Demand for electricity based on bills paid for one year is approximately 42664 kWhel/year.

Annual gross profit taking in consideration the price of 14 ALL (0.14$) per 1 kWh is: Bt = 161 000 MWhel × 14 ALL/kWhel = 2 254 000 ALL (22 540 $)

Annual net profit is the difference between energy produced from the generator and the demand for electricity 161 000 – 42664 = 118 336kWhel, converted to monetary value 1 656 704 ALL (16 567 $).

TABLE 2: Monthly profits in (kWH) from production of Biogas

TABLE II: MONTHLY PROFITS IN (KWH) FROM PRODUCTION OF BIOGAS

Months	January	February	March	April
Demand	3849	3577	3672	3400
Incomes	13417	13417	13417	13417
Profits	9568	9840	9745	10017
	May	June	July	August
Demand	3256	3400	3900	3800
Incomes	13417	13417	13417	13417
Profits	10161	10017	9517	9617
	September	October	November	December
Demand	3361	3200	3462	3787
Incomes	13417	13417	13417	13417
Profits	10056	10217	9955	9630

FIGURE 1: Monthly profits in (kWH from biogas

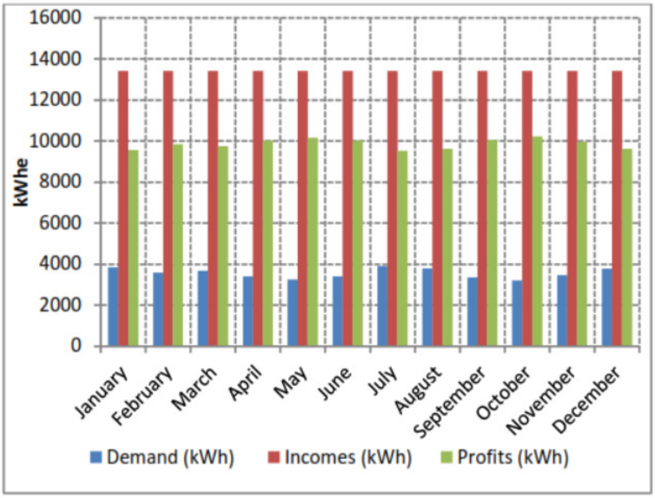
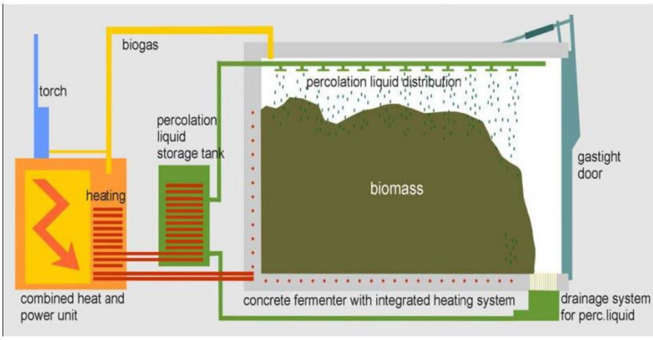


Fig. 1. Monthly profits in (kWh) from biogas.

Establishing a batch digester in Farm is profitable for the company because the handling and the storage of the feedstock is already available within the farm territory; have low operation costs and low costs of the mechanical technologies; this process is also a contribution to the reduction of farm waste (Ricci & Confalonieri, 2016).

FIGURE 2: Batch digester



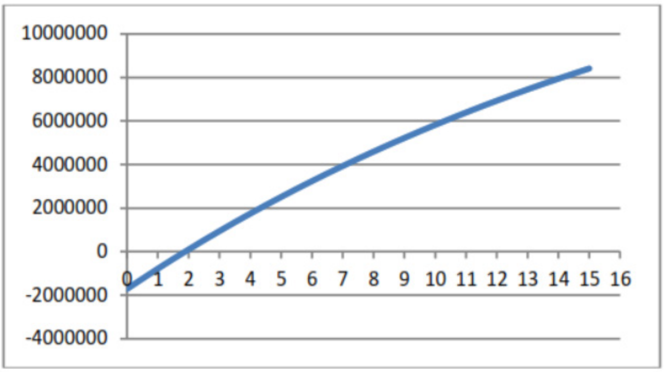
Total installed costs for an AD biogas plant can depend on the feedstock. Those based on manure and sewage are typically cheaper. This is because the handling and storage of the feedstock is already available (Kiely, 2019).

According to the literature review the total installed capital costs for an anaerobic digestion system vary from USD 7 310 to USD 5 050/Nm^3/hour. This is for systems with hourly output capacities of 100 Nm^3 and 500 Nm^3, respectively (IRENA, 2013).

Taking into consideration the biogas produced from experiments in the lab, the quantity of biogas produced is 25 Nm^3 /ton in a day. From 200 head cows, the quantity of biogas produced in a day is 125 Nm^3 /ton.

The biogas produced in an hour is 5.2 Nm^3/hour. Referring to the literature (IRENA, 2013) and to the quantity of biogas produced in an hour we calculated the initial cost of the investment that is 38 072.91 $.

FIGURE 3: The payback period of the investment cost.

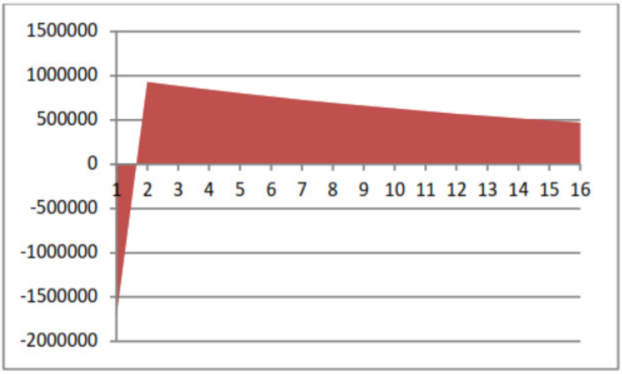


The electrical capacity of the biogas plant is 161 MWhel/year.

- Maintenance cost is 50,000 ALL (500 $).
- Interest rate is 5%.
- The cost per kWh electricity produced by biogas is 3.28 ALL (0.0328 $)/kWh without VAT, a low price comparing with electricity price by national grid (14ALL, 0.14$).

The payback period of the initial investment is 1 year and 6 months (see Fig. 3). The cash flow graphic of the investment is shown in figure 4.

FIGURE 4: Cash flow graphic of the investment.



The Net Present Value after 15 years is 14 527 088 ALL or 145 027.8 USD.

The batch digester to be implemented in the Farm is been studied as per real conditions.

Conclusions

- Different biomass samples of "Cow farm" cow manure analyzed in the biogas lab are easily biodegradable and as result was produced a considerable quantity of biogas.
- From the case – study, the payback period is assumed 1 year and 6 months.
- Net present value 145 027.8 $.
- The cost per kWh electricity produced by biogas is 0.0328 $/kWh, a low price comparing with electricity price by national grid (14 ALL, 0.14$) without VAT.
- The initial investment is economically profitable.

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