MSc Program
Renewable Energy Systems

Developing Sazan Island with Renewable Energy. Case Study of Vitalizing and Urbanising the first uninhabited Albanian Island into a self-sufficient, smart, zero waste, touristic and free economic zone

A Master's Thesis submitted for the degree of
“Master of Science”

supervised by
Ao. Univ. Prof. Dipl. -Ing. Dr. Reinhard Haas

Vojna Ngjeqari, BA

00941682

Vienna, 21.11.2018

Affidavit

I, **VOJNA NGJEQARI, BA**, hereby declare

1. that I am the sole author of the present Master's Thesis, "DEVELOPING SAZAN ISLAND WITH RENEWABLE ENERGY. CASE STUDY OF VITALIZING AND URBANISING THE FIRST UNINHABITED ALBANIAN ISLAND INTO A SELF-SUFFICIENT, SMART, ZERO WASTE, TOURISTIC AND FREE ECONOMIC ZONE", 94 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted this Master's Thesis as an examination paper in any form in Austria or abroad.

Vienna, 21.11.2018

Signature

ABSTRACT

The tourism industry performance in Albania remains far below its potential. Albanian coast length of 427km remains undeveloped and only 10% of it has been used. Unlocking the touristic potential of Albania is the purpose of the research theses, while environmental sustainability is maintained. .

The uninhabited Sazan Island is one of the greatest natural resource of the Albanian coastline. The government has proposed and prepared a technical document for the management of Sazan Island. The knowledge gap of the governmental Sazan management plan is limited to a management scenario and does not explore the development potential of the Island.

The thesis aims to investigate the potential of the uninhabited Sazan Island to be developed and urbanised as an eco-friendly free economic zone with smart grid for sustainable tourism. As such, the main objective is to conduct a feasibility analysis by estimating renewable energy potentials in Sazan Island

The renewable energy potentials for Sazan Island from solar power, wind power and marine currents were estimated based on geographic and climatic conditions.

The self-sufficiency of Sazan Island could be achieved only through efficient management of energy and integration of renewable energies into smart grid. The results offer a fresh perspective on accelerating green economy, green jobs, and green communities on local, national and regional level.

On this basis, it is recommended the urbanisation and development of Sazan Island as smart island for sustainable tourism. Further research could be undertaken to explore more in depth the feasibility study of Sazan Island.

Key Words: Renewable Energy Albania, Sazan Island, Sustainable Tourism, Self-sufficient Island, Smart Grid Island

PREFACE

My interest for Sazan Island started in 2014 inspired by the book of the Albanian Engineer Xhevair Ngjeqari. The idea of urbanizing Sazan Island and developing it as a self-sufficient island was treated in his book.

Under the mentorship of the Eng. Ngjeqari, the idea was conceptualized and submitted as a start-up project in different entrepreneurship events in Europe. An important milestone on the development of this project was in 2016, where I got the opportunity to study the Master Program Renewable Energy Systems at Vienna University of Technology, Continuing Education Centre.

The odyssey of presenting the project and search for investors started in 2014 and continues (below some of the highlights of this journey):

- In 2016, I received the scholarship from the Technical University of Vienna, Continuing Education Centre and Energiepark Bruck/Leitha on students from Southeast Europe, as an opportunity to advance the knowledge and research in this project.
- In 2016, the project was awarded a scholarship to participate at the seventh CEE-Economic Forum Velden in Austria as one of the 50 most promising start-up project in Central and Southeast Europe. Over 450 participants, among them top-class international speakers, high-ranking politicians, renowned managers, start-ups, investors and the 50 most exciting start-ups from the Eastern and South-eastern Europe took part in this Forum.
- In 2015, it was selected out of 800 applications from all over the world to participate to The Global Entrepreneurship Summer School (GESS). GESS is a global initiative of six universities in Munich, Mexico City and Shanghai that is organized by the Social Entrepreneurship Academy, where young leaders from all over the world solve the world's biggest challenges through entrepreneurial means.
- In 2014, the project was ranked number. six regarding Energy projects at the Women Innovative Entrepreneurship (European Venture Contest) in Brussels, Belgium.

ACKNOWLEDGMENTS

I own an enormous debt of gratitude to my advisor, Prof Reinhard Haas, who believed in me and the vision I had for this research paper since the beginning of the MSc Program.

I have benefited from his broad and profound knowledge. I would like to thank the Programs Manager of the Continuing Education Centre, Elizabeth Hasslinger, for being supportive during the entire Master Program. A special thanks to the architect Jochem Käferhaus for offering me instructive guidance throughout my research. A great warm, genuine, moral support came from the two founders of Dreamicon Valley, Herman and Harold. I thank them for their genuine interest.

I am deeply grateful to my parents, Xhevair Ngjeqari and Liljana Ngjeqari for their unfailing love and continuous encouragement through my life. I sincerely thank my father for his wholehearted support and daily encouragement. I am blessed that he has shared with me the vision he had for Albania. One of this vision is vitalizing Sazan Island. In this research, he had an important role by giving an interview and sharing his knowledge as a senior expert in transport infrastructure.

I would like to acknowledge the scholarship award from the Technical University of Vienna, Continuing Education Centre and Energiepark Bruck/Leitha on students from Southeast Europe. The scholarship ignited the fire and gave me a sense of hope and reassurance, that they believe in this project and that I need to continue this journey.

Table of Contents

CHAPTER 1

Introduction

1.1 MOTIVATION

The motivation for this master thesis has been the love and the intention to serve to my country. The intention to follow into steps of the Albanian renaissance writer Faik Konica, who left a will to our generation: "*Students don't bring Albania a diploma, but an idea that would heal its wound*."

The belief that I am on the face of the earth to vitalize Albanian Shores. The belief to generate ideas that only make a significant contribution to my nation. The belief of raising above the circumstances and taking responsibility of the destiny of Albania.

Based on these values my father and I had the vision to vitalize Albanian shores in sustainable tourism development and renewable energy resources. We seek to do this in ways that benefits society on a national and a regional scale. In order to do so, we choose one of the greatest natural resources of Albania to vitalise it. Sazani Island is one of the greatest natural capital resource of Albania.

Based on this intention, the mission is to develop and urbanise the first self-sufficient Island in the Adriatic Sea, ensuring significant contributions to sustainable economic growth. In alignment with the vision and mission, I started the MSc Renewable Energy Systems Program, so that I could advance the knowledge and conduct the research.

1.2 CORE OBJECTIVES

The core objective of the thesis is to investigate the potential of the uninhabited Sazan Island to be developed and urbanised as a free economic zone with 100 % renewable energy, smart, sustainable and touristic island.

The government of Albania has published two technical documents as a management plan of Sazan Island. In this study, another management plan scenario was proposed, which intend to develop the first zero-carbon and zero-waste sustainable place, self-sufficient island in Albania and the Balkan region.

The main goals of this thesis is to estimate energy potentials for electric power harnessing the renewable energy resources. Hence, a feasibility analysis on matching the energy demand and supply estimations was conducted. Based on this notion, a prototype of smart gird could be designed. The solar, wind energy and sea current energy were used as the local energy source, possibly to achieve energy balance. To achieve these goals, following objectives were formulated:

- Presenting the stages of the urbanization of the island
- Analysing the load demand and potential

It is to seek the load profile, solar irradiance and wind speed based on the database. The shape and distribution of the parametric curve and the mix of different loads and renewable sources of Sazan Island were analysed.

- Balancing the energy demand and supply

It is to match the energy as much as possible. In order to optimize the energy mixture and to close to the energy neutral for the island, the size of the solar panel and wind turbine was determined. After that, the financial cost was estimated to determining the costs of urbanizing of the island.

Accordingly, to achieve the above-mentioned objectives the following research questions must be answered:

1. Can the uninhabited Sazan Island be urbanised?
2. How to urbanise and develop Sazan Island for sustainable tourism as a self-sufficient, zero waste island in Albania?
3. What energy resources does the island poses?
4. How much energy can be produced by harnessing its energy resources?
5. Can Sazan Island be self-powered and self-sufficient with renewable energies and cover its energy demand?
6. Can Sazan Island be developed from uninhabited Island into a smart island by applying smart grid in renewables?
7. What are the costs of deployment of a smart grid with renewable energy in Sazan Island?

1.3 Major Literature

In terms of Sazan Island information search two major resources were screened:

In first step, the technical document of Albanian government, the management plan scenario for Sazan Island, was evaluated. The technical document was compared with another study realized by the Albanian Engineer Xhevair Ngjeqari, where the new proposal was based on. In addition, an interview with the Engineer Ngjeqari was conducted to deepen the understanding of his proposal study.

In terms of energy demand calculations, the data was based on a typical household demand power in Gibraltar provided by World Data. Due to lack of the necessary information for Sazan Island, the real data measured in Gibraltar were employed. Regarding energy supply, the data provided by Albanian Energy Association (AEA) for the closest city with Sazan Island were applied.

The financial costs were estimated based on the prices that are in the current market.

1.4 Structure of the Thesis

This thesis contained five (5) chapters presented as follows.

Chapter 1 introduced the motivation, core objectives, research questions, major literature and the structure of the thesis.

Chapter 2 gave an overview of the Albanian Energy Sector, with the focus on the electricity situation in the country.

The research method was developed in Chapter 3. This chapter was dedicated with background information about solar/wind system. Each individual original data analysis, energy calculation to the different load of renewable source were presented.

In Chapter 4, Sazan Island characteristics e.g. geographical position, climate, history, flora, vegetation, and fauna were illustrated. In addition, it presented the government plan management for the island. The knowledge gap of the management plan was analysed, and used as a foundation for creation of another management plan scenario.

In chapter 5, the new management plan scenario was introduced. The stages of urbanization of Sazan were proposed. Then, the individual model of different load profiles and energy resources was first established to achieve energy balance in the island. Different situations about the energy balance were analysed without battery storage system, and the

financial costs was used as an index for estimation of the total costs of the urbanization of the island.

Chapter 6 provided the conclusions and recommendations on new development perspectives.

Albania and Energy Sector

2.1 Background

Albania is a country located in South-eastern Europe, with a population of approximately of 3 million as of 2016. Situated on the south-western portion of the Balkan Peninsula, it shares land borders with Montenegro to the northwest, Kosovo to the northeast, the Republic of Macedonia to the east, and Greece to the south and southeast. Adriatic Sea lies to the northwest of the mainland, and Ionian Sea to the southwest. Albania has a coastline at 362 km in length, featuring 13 known islands and islets. Tirana is the nation´s capital and the main economic centre. The Gross Domestic Product (GDP) in Albania was worth 13.04 billion US dollars in 2017, which represents 0.02 percent of the world economy.[1]

Fig.2. 1 Borderline Map of Albania
Source: Google

Albania's exceptional economic transformation since the Nineties has helped ride the country's potential and a few of the challenges embody maintaining macro-fiscal and money sector property, rising the investment climate, unleashing non-public sector growth, removing employment barriers, and rising governance and public service delivery. [2]

Albania's real GDP grew by 3.8% in 2017, up from 3.4% in 2016.[3] Key drivers were private investment and consumption.

The Trans-Adriatic Pipeline and a hydropower plant were two massive projects supported by foreign direct investment, which were reflected in investment dynamics. Public consumption created a low contribution to growth, reflective to the rise of public sector wages. High touristy exports and convalescent artefact exports over stipendiary for the High investment-related machinery and equipment imports were compensated by tourism exports and commodity exports.[4]

Table 2. 1 Albanian GDP
Source: World Bank

Albania	2017
Population, Million	2,9
GDP, current US$ billion	12,5
GDP per capita, current US$	4,297
Poverty rate ($5/day 2011 PPP terms) (2017)	32.8
Life Expectancy at birth, years (2014)	78.2

2.2 Energy Sector in Albania

Albania's primary energy supply (127 PJ) is sourced predominantly by oil, hydropower, biomass and energy imports (57 PJ).[5]

Albania consumed about 2,805 ktoe of primary energy in 2015, from which gross inland consumption estimated 2,346 ktoe, and net imports estimated 1490 ktoe. This came mostly from oil, hydropower, and imported electricity, imports of oil by products.[6] The number one sector consuming the foremost final energy is the transport sector, followed by household and trades. Electricity and a small amount of coal comprise over 56% of all primary energy consumption.[7] In figure 1.2 is shown shares of primary energy supply in Albania.

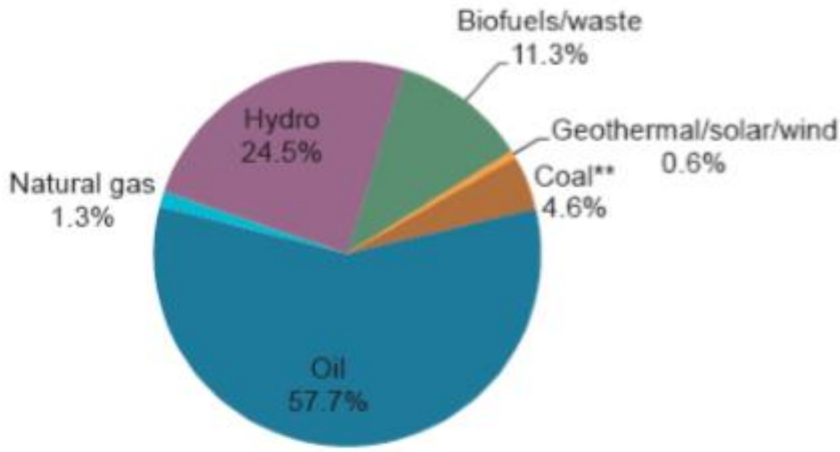


Fig.2. 2 Shares of primary energy supply in Albania
Source: IEA 2017

As shown in figure 1.2 the energy mix in Albania is heavily skewed toward oil and hydropower. Oil is by far the dominant fuel in the country, accounting for almost 60 per cent of total demand.[8] Electricity in Albanian is based largely on hydro. The generation mix consisted of 11,3 % biomass and waste, 0,6 % of geothermal, solar and wind, 4,6% of coal and 1,3 % of natural gas.

According to the Institute of Energy for South-Eastern Europe Albania is the largest producer of crude oil in the Western Balkans. The Albanian Energy Association (AEA) estimates the country to have relatively high oil reserves of up to 400 million tons, where only Patos-Marinëz-Kolonjë oil area is recognised as the largest oil field in continental Europe and is estimated to have more reserves of more than 277 million barrels. Despite the abundance of natural resources, the country has exploited only 2.18% between 2010 and 2014.

The Patoz-Marinza heavy oilfield has been under development since mid-2016 by China's Geo Jade. Before the chinese Company, the Canadian Company had a concession contract with the Albanian Government to operate in Patoz-Marinza for 25 years.

The National Agency of Natural Resources introduced its report to all hydrocarbon companies, which are exploiting and/or producing oil/gas in Albania. The report showed that during the first semi-annual of this year the total amount of produced oil reached 649.817 tons of crude oil, from which 45% of it (249.425 tons) was traded for domestic consumption in Albania, while 410.398 tons were exported to external markets.[9] Banker's Petroleum Canadian-based oil exploration and Production Company holds the first place in Albania for the highest production activity compared to 5 other oil exploration companies. The state-owned company Alb petrol reached 22.266 tons of crude oil, which counts for a small quantity tin comparison to the foreign companies.

The gas sector in Albania played a major role and the country was a large gas producer. After 1990, the gas production and consumption started to decrease. In 2016, Albania produced about 92 million Nm^3/y[10]. This amount served only to supply the refineries and technological process oil industry. It is worth mentioning, that Albania and Kosovo are the only countries in the Western Balkan that are not connected to the international natural gas networks.

Liquid Petroleum gas has increased as an alternative source to replace electricity in the residential sector and services mainly for heating and cooking, increasing the total consumption to approximately 12,4ktoe in 2015. Given the LPG as alternative energy, the government has just approved a Gas Master Plan to bring positive change to construction of gas infrastructure and private investment. One of the projects is the Trans Adriatic Pipeline project (TAP AG).

TAP is currently the most important infrastructure project with a length of 878 km, from which 215 km onshore and 37 km offshore. Albgas has been assigned to develop and manage the project as a transmission operator. The project has an essential role not only strengthening the energy resilience in Albania, but on regional level to reduce EU dependence on Russian gas too.

Fig.2. 3 Trans Adriatic Pipeline
Source: TANAP

2.2.1 Electricity Situation in Albania

Albania is quite rich in rivers, counting more than 152 rivers with eight big rivers. They have a southeast-northwest flow and are mainly oriented towards the Adriatic coast. The most important rivers are Drin with a velocity of 340 m3/sec, Vjosa´s velocity 210 m3/sec, Seman river´s velocity 101 m3/sec, Mat river´s velocity 74 m3/sec, Shkumbin river´s velocity 60 m3/sec. The cascade of these rivers plays a crucial role for the hydropower potential offered to the country.

"Consequently, Albania is seen as a country rich in water reserves and a hydropower potential that bears an important developmental role for the country".[11]

Historically, electricity needs in Albania have been satisfied solely by hydropower plants. The total installed energy capacity in Albania reaches up to 1.8 GW, dominated by hydropower plants.[12] Water resources are the most important natural resources in Albania and the general hydropower potential is assessed up to 4.500 MW.[13] Today, the country has exploited only 35% of the hydropower stations potential.

Fig.2. 4 Main Hydro Basins
Source: Albania Energy

Approximately 80% of the energy production is covered by hydropower plant stations on the Drin River.

In Albania, currently, there are 45 hydropower plants operating, from which seven are large scale and the rest small size.

Some. On Drin River there are three operational hydropower plants with a total installed capacity of 1350 MW, "Vau i Dejës" HPP, "Fierza" HPP and "Koman" HPP

On Mat River, there are two operational hydropower plants, "Ulëza" HPP "Shkopet" HPP, with an installed capacity of 49 MW.[14]

"Banja" hydropower plant in Devoll River 60MW has been suspended right after 40 % the work were completed.

"Actually, it is signed the concessionary contract for the construction of the HPP's cascade on Devolli river between METE and the Austrian Company EVN AG, where it is planned to be constructed 3 (three) Hydropower Plants "Lozhan", "Grabove", "Skenderbegas-Çekin" and Banja HPPs, with a total installed capacity of 319 MW.[15]

On Vjosa River, it is in construction phase "Kalivaç" hydropower plant, with an installed capacity up to 100 MW". [16]

On Bistrica River, there are two operational hydropower plants, "Bistrica I" and "Bistrica II", with an installed capacity of 27, 5 MW.[17]

Table 2. 1 Big scale Hydro Power Plants constructed in Albania
Source: Albania Energy Association

Nr.	Nomination of HPPs	Installed Capacity (kW)	Annual Generation capacity (kWh)
1.	Ulza HPP (Mat)	25.000	120.000.000
2.	Shkopeti HPP (Mat)	24.000	94.000.000
3.	Bistrica I HPP (Saranda)	22.500	100.000.000
4.	Vau Dejes HPP (Shkodra)	250.000	1.000.000.000
5.	Fierza HPP (Tropoja)	500.000	1.800.000.000
6.	Komani HPP (Puke)	600.000	2.000.000.000
	Total	**1.421.500**	**5.114.000.000**

Conclusion to the current electricity situation is as stated before, that Albania is living below its potential regarding to its hydropower capacity. The amount of electricity produced by the hydropower plants (HPPs) depends on climate factors. The instability of the electricity sector is to be seen through the years in Albania. In 2002, the domestic production of electricity covered only 49% of the demand, while in 2004, 92.4% of the total demand was supplied with the domestic hydropower potential. Hence, there is a need to import electricity from the neighbouring countries.

According to a Study[18] of World Bank Albania is highly exposed and sensitive to climate change, in addition to low adaptive capacity to offset these vulnerabilities. The high dependency of the Electricity sector on hydropower makes it very vulnerable in the long term, due to impacts of climate change like high temperatures and drought.

CHAPTER 3

Methodology

3.1 INTRODUCTION

This paper reviews literature that have been published providing the most important information related to sustainable development of Sazan Island. To this end, an extensive search was carried out to find management plan scenario for the Island in titles, abstracts, keywords and research methodologies. The researched showed that there are two existent study proposal for Sazan Island. These two study proposals were compared and analysed. The first management scenario is from the government and the second proposed scenario was found in the book of an Albanian engineer. The second management plan scenario is treated and developed in this paper. The management plan scenario of the government for the Island was published in 2005 and in 2014 as technical document from the government of Albania. These technical documents are the reference point for the comparison.

The second development scenario proposes the development of a smart eco-friendly urban-touristic island with 100% renewable energy. The paper assesses, whether the Island can be supplied 100% with renewable energy using smart grid. Smart grids allow optimal usage of intermittent resources, such as solar and wind. However, when they reach their peak generating capacities during off-peak hours, energy redundancy is caused. Such energy storage devices as batteries and new off-peak loads as electric vehicles, that reduce the overall energy redundancy, are integrated in the smart grid.[19] Based on these understandings, smart grid design and operation were used to resolve these two impacts:

- Energy balance, matching electricity production with demand
- Stability of electricity operation.

The developed methodology is described below in steps.

3.2 Data Collection

The purpose of an energy balance is to satisfy energy consumption on a smaller scale. Thus, a real-time adjustment between energy demand and supply requires a complete availability of data.[20] Since Sazan Island is uninhabited, the data of Gibraltar has been used to assess the energy demand, energy consumption, and energy balance.

On the other hand, for the calculations of the energy potentials the availability and magnitude of solar and wind energy is influenced by the climatic conditions. Hence, a pre-feasibility analysis is necessary to investigate into weather data of solar irradiance and wind speed in Sazan Island.[21] After dealing with the appropriate weather data required, the energy consumption was calculated to design the system.

3.2.1 Climate Data

In this project, the local weather pattern is referred to the Albanian Energy Association (AEA). The AEA provides relevant data in Albania. The values of solar irradiance are recorded on a monthly basis. As such, a moving average is used to illustrate the trends on the solar irradiance and below wind speed.

The table 3.1 shows Albania has an average of daily solar radiation of 4.1 kWh/m2, which is considered as a good solar energy regime.[22] The yearly available insolation at 15° was 4.**1** kWh/m2/day**.** Sazan Island receives the highest insolation and was produces approximately 139 kWh/m2 electricity monthly. The data used for Sazan Island were the ones from city of Fier, due to the similarity of the geographical position.

The wind speed was measured at a 10-meter height. Table 3.2 exhibits the yearly moving average wind speed. Since the wind speed measurement for Sazan Island are not available, the data of city of Vlora has been used, which is the closest City to Sazan. Though the two figure above are not the real fluctuations of the solar irradiance and wind speed in Sazan Island, it can still reflect the general trend of them, and can be used to calculate the energy output of the photovoltaic and wind turbine.

Table 3. 1 The solar radiation intensity for the 6 metrological stations (kWh/m^{2}day)
Source: Q.E.E, 2006

Month	Shkoder	Peshkopi	Tirana	Fier	Erseke	Sarande
January	1,70	1,55	1,80	2,15	1,90	1,90
February	2,30	2,30	2,50	2,85	2,70	2,40
March	3,35	3,25	3,40	3,90	3,40	3,60
April	4,50	4,15	4,20	5,00	4,40	4,80
May	5,45	5,25	5,55	6,05	5,60	5,80
June	6,10	5,85	6,40	6,80	6,40	6,80
July	6,50	6,25	6,70	7,20	6,80	6,10
August	5,55	5,45	6,05	6,40	5,90	4,80
September	4,45	4,35	4,70	5,15	4,70	3,60
October	2,90	2,90	3,20	3,50	3,10	3,20
November	2,10	1,85	2,15	2,40	2,10	2,10
December	1,70	1,50	1,75	1,85	1,80	1,80

Table 3. 2 The energy density and average speed of wind in height of 10 m according to the cities
Source: Albania Energy Association

Month	Durres	Kryevidh	Tepelene	Sarande	Vlore
January	4.20	5.00	5.80	4.90	5.10
February	4.50	5.10	5.70	4.90	5.20
March	4.20	4.60	5.90	4.80	4.50
April	4.10	4.50	4.30	4.60	4.40
May	3.60	3.70	4.60	4.30	4.10
June	3.40	4.10	4.40	4.50	4.10
July	3.30	4.30	3.50	4.60	3.90
August	3.20	4.00	3.50	4.40	3.80
September	3.30	4.30	4.10	4.10	4.00
October	3.60	4.70	5.30	4.50	4.50
November	4.20	4.90	4.70	4.70	4.60
December	4.40	5.10	5.60	5.00	5.00
Annual	3.833	4.525	4.783	4.608	4.433
Density (W/m^2)	75 -150	100- 230	100-235	110-250	100- 230

3.2.2 Load Data

For the profile of energy demand in Sazan, Gibraltar household demand power in 2014 are provided from World Data. There are no data available for Sazan Island, since the island is uninhabited. The overall load slowly changes in terms of average power consumption, and its profile is different for every building category. As a result, the generalized electricity load profiles of only household viz. a villa was unveiled. Due to lack of the necessary information for Sazan Island, the real data measured in Gibraltar are employed based on an assumption of a similar life habit.[23]

3.3 ENERGY CALCULATION

The value of the energy demand can be directly from the data provided from World Data. The energy supply was calculated from the climate data. Three categories of power generation (i.e. photovoltaic and wind turbine and tidal stream generator) are complemented during the energy collection. The photovoltaic power generation have a reliable supply and low operation and maintenance fee; wind power generation possess a high capacity, however low reliability.

3.3.1 Solar Power Calculation

The solar power is the conversion of sunlight into electricity, proportional to the corresponding solar irradiance.[24] Through the photovoltaic effect, solar panels can use light energy to generate electricity.[25] They can be harvested to generate electricity by the means of photovoltaic systems. On the flat roofs, the photovoltaic modules will be frequently allocated in arrays in the optimized tilted position towards the sun.[26] The tilt of receiving surfaces deliver a great influence on energy yielding when solar irradiance is calculated.

The efficiency of a solar cell is derived by comparing the electric power produced by the cell with the solar light power reaching the cell. Temperature plays also an important role. When temperatures play a role, a sufficient ventilation of the cells has to be secured. Free distance behind the PV modules to the surroundings provides to the cells the ventilation needed. PV cells generate about half a percent less power for each degree temperature increase. In addition, a key factor in reaching high output are avoidance of shadowing and use of modules that are as identical.[27]

The maximum efficiency of a photovoltaic panel can be derived by the following equation 1:

$$\dot{\eta}_{max} = \frac{P_{max}}{E * A_c} \qquad (1)$$

$\dot{\eta}_{max}$ - maximum efficiency

P_{max}- maximum power output (in W)

E - Incident radiation flux (in W/m^2)

A_C - Area of collector (in m^2)

The "incident radiation flux" is the solar irradiation (W/m²) dependant on the location. As described above manufacturers use Standard Test Condition (STC) 1000 W/m² for temperature 25°C, which in Sazan is higher.

Another important parameter is the "performance ratio" (PR), which can reach 80% in case of high-performance PV plants. The PR shows the proportion of the solar energy which is not converted into usable energy during the period under review due to conduction losses, thermal losses or defects in components. This can be calculated by the following formula

(SMA):

$$PR(\%) = \frac{E}{Q * Ac * \acute{\eta}} \qquad (2)$$

*) Nominal plant output (kWh) = Solar irradiation (kWh/m²) x collector area (m²) x PV module efficiency (%). The nominal plant output is equal to a PR of 100%.

3.3.2 Wind Power Calculation

The energy produced by a wind turbine is essentially the kinetic energy of the wind. In general, kinetic energy is described as $E_k = 1/2\ mv^2$ where v is speed in m/s and m is the mass. In the case of wind, m can be described as the flow of air through a fixed area, A (for example the area that a particular wind turbine sweeps). In that case it is reasonable to redefine m = ρAvt, where ρ is the

$$E_k = \frac{1}{2} mv^2 \qquad (3)$$

$$\mathbf{m = \rho Avt} \qquad \mathbf{(4)}$$

Density of the wind and t is the time interval of the wind flowing through the area. This leads to an equation for wind energy, E, and wind power, P (since by definition P = E/t).[28]

$$\mathbf{P = E/t} \qquad \mathbf{(5)}$$

Due to fundamental laws of mass flow and energy conservation, no wind turbine can extract all the energy stored in the wind. In order for that to happen, the wind would come to a complete stop at the turbine blades and no more wind could arrive to pass the blades.[29] The formula for calculating the power from a wind turbine is:

$$\mathbf{P = Cp\ 1/2\ \rho\ A\ V^3} \qquad \mathbf{(6)}$$

Where:

- P = Power output, watts
- Cp = Maximum power coefficient, ranging from 0.25 to 0.45, dimension less (theoretical maximum = 0.59)
- ρ = Air density, kg/m³
- A = Rotor swept area, m² or
- π D² / 4 (D is the rotor diameter in m, π = 3.1416)
- V = Wind speed, mps [30]

3.4 UNIT SIZING

The unit sizing for an integrated power system plays a crucial role in speculating the reliability and economy of the system.[31] Upon completion of the pre-feasibility analysis, the selection of proper size of equipment was conducted based on weather data and maximum capacities.[32]

3.4.1 Solar Panel Sizing

For solar panel, considering the GCR, only 35% of the surface area can be used to absorb the solar irradiance for solar panel. The best module efficiency so far has been 21%. New technologies aim for 30% efficiency.

3.4.2 Wind Turbine Sizing

For this project, the average wind speed in Sazan Island is nearly 4.5 m/s at 10 m, and the wind power per unit area is approximately 30 W/m2. Good wind evaluations can be measured in a higher place. In the last decade large commercial wind turbines increased from approximately 50 kW to 5 MW.

In this research, two types of wind turbines can be installed: one is a large-scale built in the ground with capacity 100kW. Chapter 5 elaborates more in details.

The other is the small-scale wind turbine built on the roof. The maximum height of the building is assumed 8 m (3 floors). In order to save the space, the vertical axis wind turbines are used, with the mounting height of 5.5 m at a rated speed 13 m.[33] The rotor diameter and blade length are 3 m and 3.6 m respectively, which means the swept area is 10.6 m^2.[34] The cut-in and cut-out speed are achieved at 3 m and 50 m, respectively. The ground space per wind turbine would be calculated as (10*3)*(5*3) = 450 m2. [35]

3.5 Cost Analysis

In interest of evaluation wind system and solar system, the economic viability was estimated. In this section, the electricity cost components such as investment, maintenance and operation costs were analyzed. The methods for assessing the financial performance of a project used the RENSCET software:

CHAPTER 4

Sazan Island

4.1 Geographical Position and Characteristics of Sazan Island

In this chapter, the characteristics of Sazan Island are described and analysed. Firstly, the history, geography, flora and fauna of Sazan Island are described. In addition, the uniqueness of the Island is highlighted. Third, the management plan of the government is presented. Furthermore, the gap of the governmental management plan is identified and argued. Finally, a new management plan scenario of Sazan Island is introduced in chapter 4.

4.1.2 Geographical Position and Characteristics of Sazan Island

Sazani Island is located on the boundary between the Adriatic Sea and Ionian Sea. It is administratively part of the Bay of Vlora and Vlora Municipality. The island is located 8, 25 km far from Cape of Dajlan in the north of Vlora City, which is the nearest point to the coastline.

There is a marine area between the Island and Karaburun Peninsula, with a width of 4.8 km and a depth 50 m, named Mezzo Channel. The island is located min 16.5 km from Vlora city centre.

The island is located min 17 km away from the Cold-Water Source of Vlora (quality drinking water). Cold Water is a Natural Water Source 100 -200 L / sec, which flows into the Adriatic Sea. The island is located 16 km away from Electric Station of Vlora.

In Picture 4.1 the composition of three main structures that build of the Gulf of Vlora are illustrated: Karaburun Peninsula, Mezzo Chanel and Sazan Island.

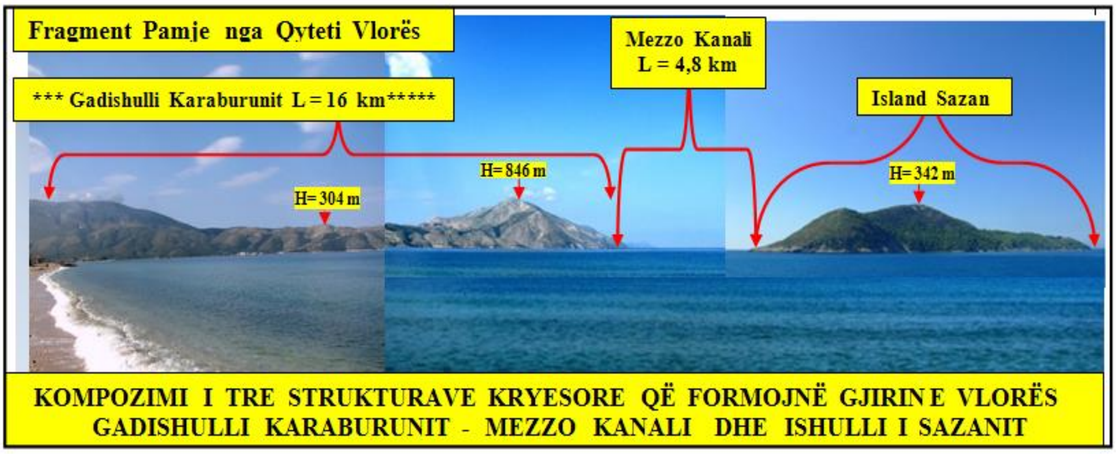


Fig. 4. 1 Sazan Island and Gulf of Vlora

Source: Xhevair Ngjeqari Notes

a) Dimensions of Sazan Island

The Island has a surface 5.7 km2 or 570 ha = 5 700 000 m2. The island has a surface area of 5.7 km2 (2.2 sq mi) with a length of 4.8 km (3.0 mi), width of 2 km (1.2 mi) and a coastline of about 15 km (9.3 mi).36 The highest point of Sazan is 344km.37 The coastline for urban-tourist development is over 9.6 km (80% of the natural line 20% while rocky and steep).38 The island is bordered to the South side by the Ionian Sea on the Northern side of the Adriatic Sea. Sea depth in south-west is -50-100m, and in east of Vlora -32 m.

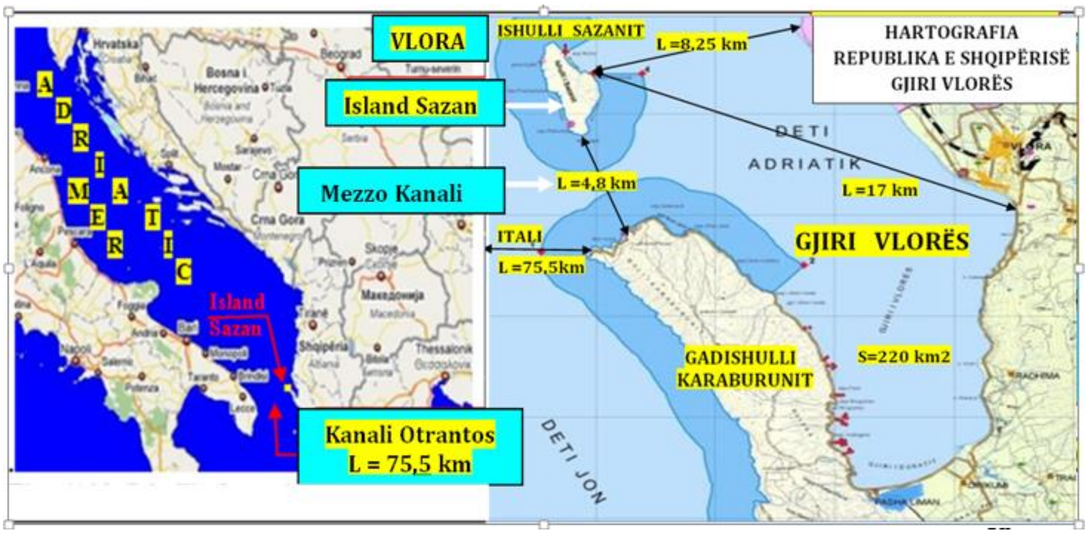


Fig. 4. 2 Geographical Location of Sazan Island in relation to Adriatic-, Ionian Sea, Gulf of Vlora and Otranto Channel
Source: Xhevair Ngjeqari Notes
8.

b) Climate and Meteorology

There is no meteorological data for Sazani Island, and the nearest locality with data is Vlora. The climate in Vlora is warm with little rainfall throughout the year, with an average annual temperature of 16.4°C and an average annual rainfall of 983 mm.[39] the warmest month of the year is July with an average temperature of 24.3°C, and the lowest average temperature occurs in January: 9.1°C (figure 7). 40 Vlora climate is categorized as (Dry-summer subtropical or Mediterranean climate) according to Köppen-Geiger climate classification system.[41] The difference in precipitation between the driest month and the wettest month is 145 mm. The average temperatures vary during the year by 15.2°C.[42] The island radiates 2500 hours of sun, which can produce 1450 kwh/m2/year.[43] Wind blows with a speed of 4-5m/sec, which can be harnessed to produce energy.[44]

Fig. 4. 3 Sunny Day in Sazan Island
Source: Vlora Municipality

c) Geology and Geomorphology

Sazani Island is composed of limestone rocks (Fig. 3.5) of the Cretaceous period and in the eastern part partially of Terri genic and cleistogenic deposits.[45] The western coast is fragmented and steep, with high cliffs up to 40 meters deep cut by a number of gorges, caves, and small bays, such as Bay of Paradise (Gjiri i Parajses) and the Devil Gorge (Gryka e Djallit).[46] In the east, the coast has gentle slopes with St. Nicholas Bay (Gjiri i Shënkollit), where the harbour and military facilities are, as an important geomorphological feature, and more to the south-west slanted folds of limestone that plunge into the sea.[47] The island has a rugged topography, with two main hills, at an altitude of 334 (northern hill) and 307 meters (southern hill).

According to Ngjeqari´s study, the limestone rock has a hardness of 800kg/cm2, which is an indicator for being homogeneous and does not carry geological slides.[48] This characteristic of Sazan Island is highly important, because limestone is the most important and widely distributed carbonate rock, which are used in many industrial purposes and construction purpose.[49] In addition, for the purpose of this project, this characteristic adds value to the urbanization process of the island.


Fig. 4. 4 Sazan Island Sea Coast Source: Vlora Municipality

Fig. 4. 5 Limestone rocks in Sazan Island Source: Céline Damery, Conservatoire du littoral, PIM2012

d) The Biological Environment

The terrestrial biodiversity of Sazani Island is largely unknown. Very few studies have been carried out and in most cases; they were related to the marine environment.[50] In autumn 2012 and spring 2013 two field missions were carried out by a team of Albanian and international scientists in the framework of the PIM Initiative.[51] The two field missions collected field data for different biodiversity compartments: flora and vegetation, invertebrates, amphibian, reptiles, birds, mammals and rocky shore marine communities, and carried out an assessment of land-based pollution.[52] This information is explained in the sessions below and contributed to define and formulate a new proposal management plan for this thesis.

4.2 History of Sazan and Human Impact

Sazan Island has been always a strategic military defence point, due to its strategic geographical position. The presence of bunkers, military buildings, the network of galleries and trenches since the 20th century, witness for its military use and history of occupation.

During the Roman and Byzantine Empire era, Sazan has experienced different settlements. In 1279, it was acquired by Anjou of Naples and was held by some Albanian lords.

In the 15th century, Sazan was occupied by Ottoman Empire. In the 17th century, the Venetians took control of the Island; early 19th century the British occupied Sazani with the rest of the Inion islands. In 1864, Great Britain handed the Ionian Islands over to Greece and this country claimed Sazani territory, which remained under the Ottoman Empire until the Balkan wars in 1912-1913, when Greece occupied the island and subsequently abandoned in 1913. At this moment, Sazani was recognized as territory of Albania.

During the World War I in 1915, Italy sent its troops to occupy city of Vlora including the Sazan Island. Five years later Italy and Albania reached an agreement and Italy Constructed a military base, a lighthouse and naval fortifications and established several families of fishermen; a large headquarters building of the Italian Army was built in 1929 on the central plateau. The Treaty of London ratified this as part of Albania-Italian protocol, where Albania formally handed the Island to Italy. Until World War II, Sazan was united to the Italian Governor of Dalmatia. In February 1947, the Treaty of Peace with Italy and other superpowers of World War II was signed. Part of the Treaty of Peace was recognition of the independence of Albania and the return to Albania of Sazan Island.

After the World War II, The rise of communism in Albania after the World War II affected Sazan Island, which was transformed into whiskey-class submarines and chemical weapons plant from the Soviet.

Fig. 4. 6 View of former military port constructions in the Sazan Island before the 1990s
Source: Vlora Municipality

From the beginning of the Cold War (1947) until the dissolution of Soviet Union in 1991, which ended the 50 years communism in Albania, the Island maintained its defensive role.

In the 1970s, some 300-400 families of the Albanian Army and Navy inhabited the island.[53] In parallel with the development of the military base, all the necessary facilities and infrastructures to afford for this permanent population (up to 2,000 people, according to some sources) were constructed forming a true village: housing blocks, houses, a hospital, a power house and the electricity supply network, a water supply system, two schools, a library, a cinema, a cultural centre with a party hall, a football field, and obviously a large road network to access all these areas around the island.[54] Furthermore, hundreds of defence bunkers, several kilometres of tunnels and trenches, many military buildings and facilities were constructed all over the island.[55] Sazan Island and the village was abandoned in the middle 1980 from the families, and since then has been for more than 30 years uninhabited. Today, can still be seen the remains of buildings of that period (Fig. 4.8).

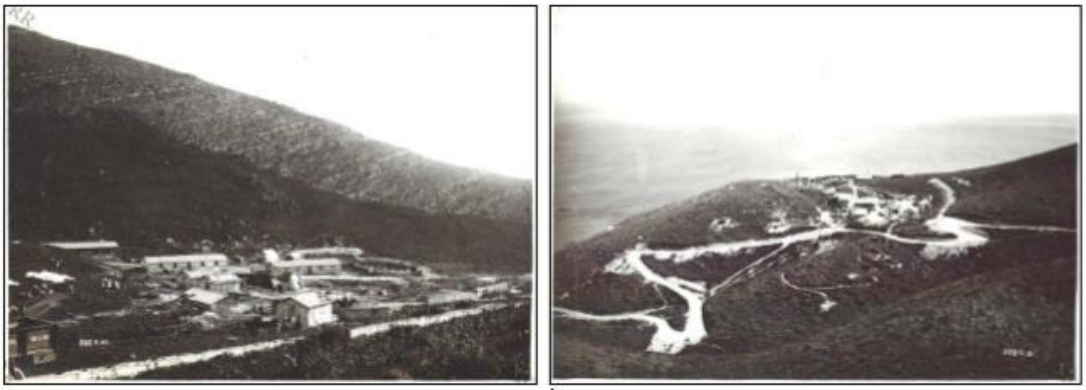


Fig. 4. 7 Sazan during the Italian military occupation in 1918
Source (MCRR)

The figure 4.7 demonstrates photos of Sazani Island during the Italian military occupation, in 1918. The photos found from the archives of MCRR show creation of roads and military buildings near San Nicolo gulf at the north-eastern part of the island. [56]During the post-communist period, the Island was used as military base from an Italian-Albanian joint base. The Italo-Albanian naval base was use for control purposes to counter contraband between two countries. Moreover, the Royal Navy, United Kingdom´s naval warfare, was using the Island at the same time as its training field.
Currently, the Albanian government proclaimed the island's surrounding seawaters and those of adjacent of Karaburun Peninsula a National Marine Park.

Fig. 4. 8 Remaining Building from 1970

Source: Management Plan for Sazan

4.2.1 Human Induced Impacts

a) Waste

Sazan Island involved different actors and owners throughout the history, mostly in the context of war and conflicts. Hence, the human induced- impacts especially regarding waste and some pollutants are present in the island. The PIM field mission in 2013 carried out a survey relating to the waste and pollutants taking into consideration: Waste assessment, state of conservation of buildings and their interests, gamma radiation pollution, soil pollution preliminary evaluation.

The results of the zones surveyed, and assessment are shown in the Table 4.1

Table 4. 1 Waste Recorded in Sazan Island PIM Mission 2013
Source: Management Plan for Sazan Island 2015

ZONES	Metal (Tonnes)	Non Hazardous Waste (Tonnes)	Hazardous Waste (except asbestos) (Tonnes)	Hazardous Waste Asbestos (m^2)
Est sector	10.6	1.1	---	10
Harbour	8.5	1.3	---	110
Village	14.8	7.8	0.01	20
Centre	28.3	2.9	0.03 + 8 barrels	30
TOTAL	**62.2**	**13.1**	**0.04 + 8 barrels**	**170**

The most abundant type of waste is metal with an estimate of 62.2 Tonnes, followed by non-hazardous waste with 13.1 Tonnes.[57] Among the hazardous waste, 170 m2 of asbestos are present and 40 kg (0.04 Tonnes) plus eight barrels of other hazardous waste.[58]

The non-hazardous waste is composed of wood, plastic, glass, rubble, mattresses, building debris. According to the field mission, hazardous waste includes the materials and substances that must be evacuated.[59] They are: 1) three barrels of calcium hypochlorite: labelled as Oxidant (O), Corrosive (C), Harmful (Xn), Dangerous for the environment (N), R-phrases: R8, R22, R31, R34, R50; 2) Five barrels full of undefined substances (likely to be toxic); 3) Asbestos: on broken roofs or disposed as debris. A large proportion (65%) of asbestos is found in the harbour area (110 out of 170

Tonnes); 4) Batteries: 40 units; 5) Ammunition: some apparently unexploded pieces of ammunition are present in some galleries.[60]

b) State of buildings conservation

The state of the abandoned buildings in Sazan Island is bad and they do not present a rich architectural concern. The field mission stated that, despite, the bad stage they may represent heritage values or may be used for future visitor facilities. In the Table 4.2 is a summary of buildings of certain interests based on four criteria: conservation state, architectural interest, historical and technical interests.

Table 4. 2 State of Buildings in Sazan Island
Source: PIM 2013

Location	Building	Conservation state	Architectural interest	Historical interest	Technical interest
Harbour zone - location2	Building next to road to school	Average	+	-	+ / close to the pier
Village zone - location 3	Large School	Average	-	+	-
Village zone - location 4	Small school	Average	+	++	-
Village zone - location 5	Cinema	Average	-	+	+
Village zone - location 6	Building close to the cinema	Quite good	-	-	++
Central zone - location 7	Power house	Average	++	++	-
Central zone - location 8	Italian Army headquarters	Average and bad locally	++	++	+
Central zone - location 9	Building at the central plateau	Average	-	-	++
Central zone - location 10	Small building with terrace	Average	+	+	-

Fig. 4. 9 Pic. Photocomposition of remaining buildings in Sazan Island
Source: PIM 2013
a: Large school; b: small school; c & d: cinema; f: powerhouse; g & h: Italian headquarter

c) Conclusions

Recent findings of the PIM missions have led to the conclusion that the pollution and waste diagnosis do not reveal any major risk for public health or ecosystems. However, the mission has recognized the importance of waste management for the Island. It is underlined the need to evacuate the dangerous waste (batteries, asbestos, chemicals, powder filled barrels, ammunition, etc.). According to the historical evaluation assessment most of the buildings have no interest to be preserved or restored and could be demolished.[61] In addition, a few buildings are considered of cultural and historical interests. [62]

4.2.2 Current human uses and socio-economic activities

At present, only a small garrison of the Albanian Ministry of Defence exists on the island. No civil population live there and no economic activity exists on or from the island (farming, livestock, fishing, tourism or others).[63] The access to the island is controlled and ruled by the Albanian Ministry of Defence, and it is possible only by authorization from the Ministry and the Border Police.[64] An additional permit is needed from the Ministry of Environment in case of research or environmental activities.[65] There is no regular transport to the island, but access by boat can be provided by local fishermen, after the authorizations have been obtained.[66]

Under the status, there are no socio-economic activities related to Sazani Island. At present, the island does not play any role in the socio-economic development, as it does not generate any income to the local community or any social benefit.[67]

The whole of the 570 hectares of Sazani are state-owned land, managed, controlled and ruled by the Ministry of Defence, with no private properties on the island and no resident population.

4.3 FLORA AND FAUNA IN SAZAN ISLAND

4.3.1 Flora

The terrestrial biodiversity of Sazani Island is quite unknown. The majority of studies that have been carried in relation to marine environment. In 2012 and spring 2013 two field mission were carried out by a team of Albanian and international scientist. This chapter gives an overview of the assessment land based pollution of these two field missions.

The Ministry of Environment and other international partners organized the field missions. The thematic reports of the field mission were based on Small Island Mediterranean Initiative (PIM) surveys.

According to the two field missions in 2012 and 2013 and its botanic surveys, the island is home to 306 species and subspecies were recorded ("current floristic richness"), 288 of which are native and 18 introduced; of these 306, a total of 152 taxa are new for the island and 21 are new for the whole Albania.[68]

Table 4. 3 Flora and vegetation facts of Sazani from the 2012 and 2013 field trips
Source: Management Plan of Sazan Island, Albania 2015

FLORA
• 435 plants species recorded (419 native) • 8-12% of the Albanian flora • 152 new species for Sazani • 21 new species for Albania • Great biogeographic interest: 12 species in their limit of distribution • 7 species with very limited distribution area in central Mediterranean • 1 endemic species: Limonium anfractum • 3 subendemic species: Centaurea pawlowski, Scutellaria rupestris subsp. Adenotricha, Verbascum guicciardii • 18 alien species (including the invasive Carpobrotus edulis, Agave americana)
VEGETATION
• Important sea cliff and rocky shore communities and rocky grasslands • Main habitat types: pinewoods, Mediterranean scrub, grassy open areas, stony slopes • Very interesting vegetation mosaic • Great diversity of habitats: 54 plant communities of 8 vegetation type

Fig. 4. 10 Plant formations of the cliffs and rocks of Sazan
Source: Managemnt Plan of Sazan Island, Albania 2015

The figure 4.10 shows a photocomposition of the plant formations of the cliffs and maritime rocks of Sazan.

4.3.2 Vegetation

The field trips identified eight major types of vegetation with 54 plant communities in an area of 570 hectares; the collected data is shown in the figure 3.4.
According to the field study, the plant communities found in Sazani Island represent communities with an original character and strong biogeographic interest.

One Vegetation type is the sea cliffs and rocks rocky shores.[69] These communities are well represented on the southern part of the island and are composed mainly by the endemic Limonium anfractum and Lotus cytisoides, which is very rare in Albania. The rocky ledges, fairly ruderal as they are used as resting points for seabirds, host a aerohaline grassland community dominated by Allium commutatum, a specialist of small islands and new to Albania, and Lotus cytisoides (very rare in Albania), with Malcolmia maritima, Euphorbia linifolia, Beta vulgaris subsp. maritima.[70]

Perennial rocky communities are present too. On the limestone rocks, mainly of the south coast, and on the frequent landslides on the slopes surrounding the three hills, various types of vegetation are present, from rocky grasslands to low open scrub, both of which can form mosaics.[71]

Chasmophytic vegetation of is another group of inland rocks and cliffs hosted in the island.

Thermophile shrubs cover the majority of the island in different successional phases, and in some areas, they are in a pre-forest stage.

Some proliferating plant species occupy large areas of the island; this is the case of bracken (Pteridium aquilinum) and bramble (Rubus plicatus) that can form extensive mono-specific faces, and also other ruderal plants (favored by disturbance and soil rich in nitrogen and phosphorus compounds) as the inulea Dittrichia viscosa and D. graveolens.[72] The high density of some of these faces, including the inextricable thickets of bramble, lead to a closure of the grassy areas which could be detrimental to the maintenance of certain habitats for the fauna. [73]

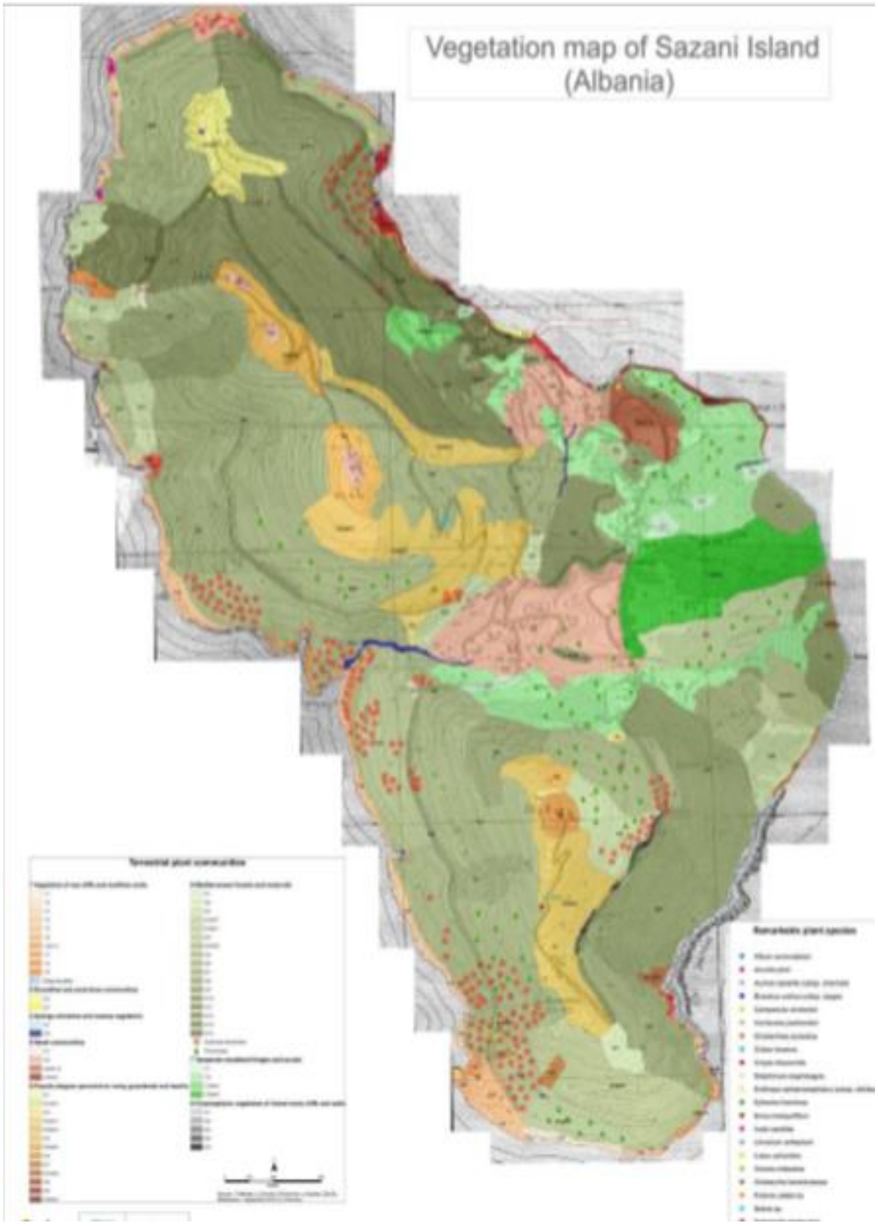


Fig. 4. 11 Vegetation Map of Sazan Island
Source: PMI

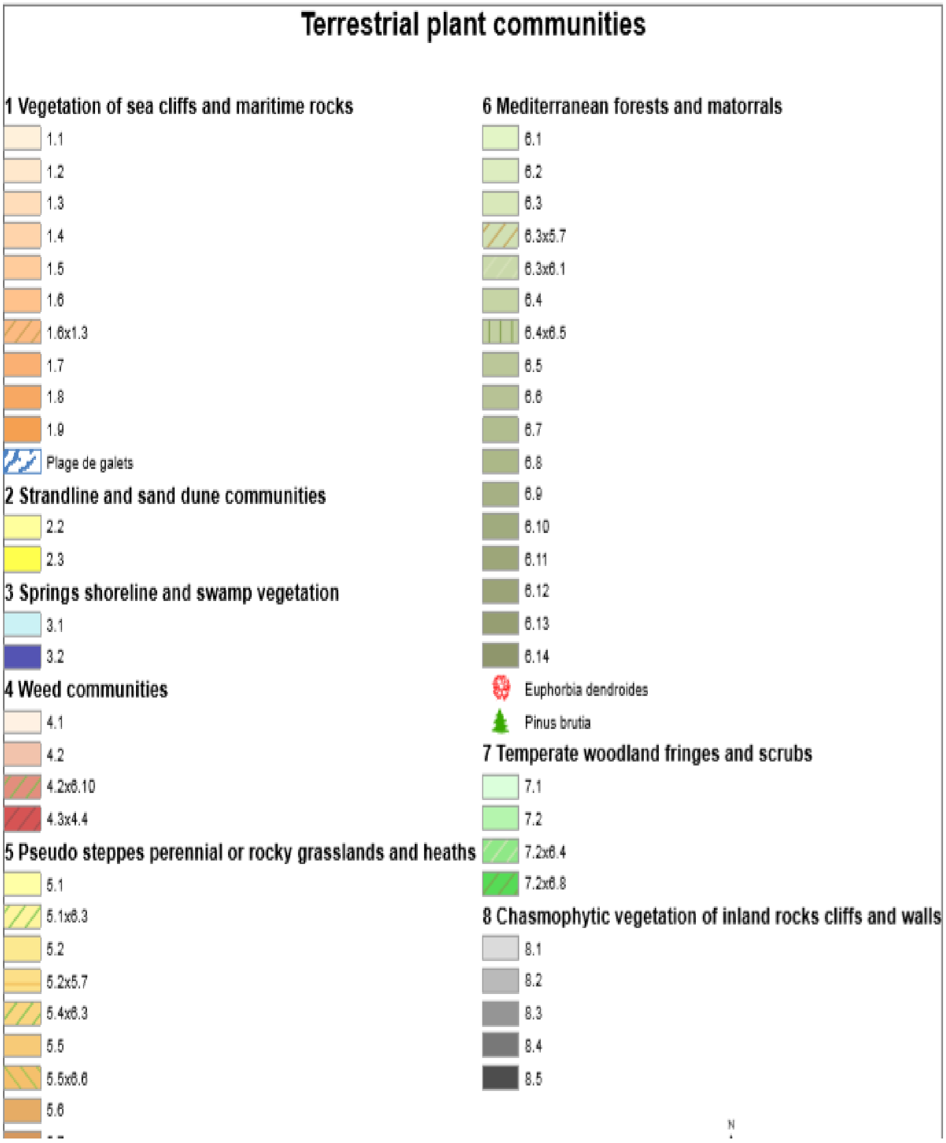
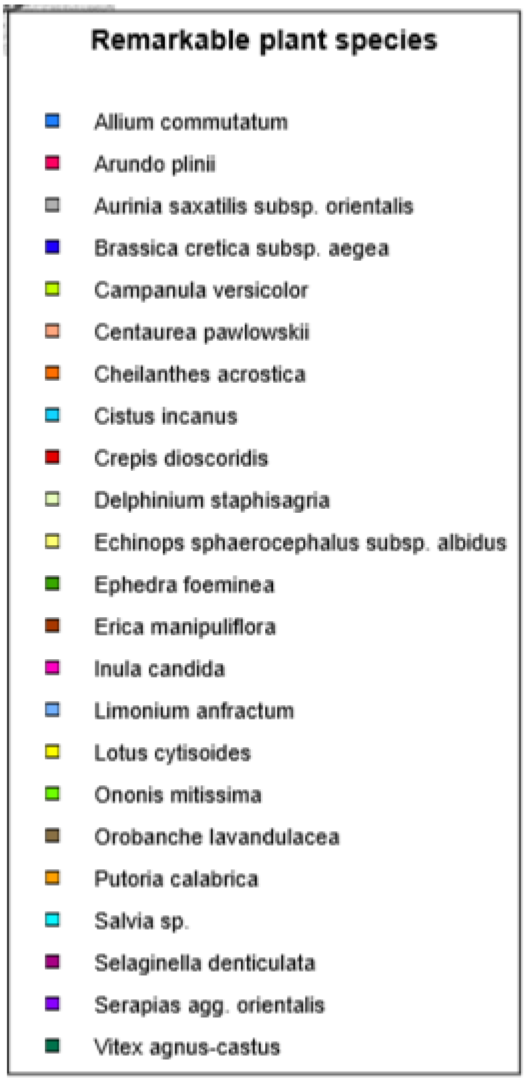


Fig. 4. 12 Legend of the Vegetation map of Sazan Island
Source: PMI



In Fig. 4.12 and 4.13 the legend of the vegetation map of Sazan is shown zoomed and clearly.

The field missions stated that the flora and vegetation communities that the Island hosts in comparison to Karaburun Peninsula and the coast south of Vlora, poses an original character. At the same time, of the sea and inland rupicolous communities (rocky and cliff formations), and certain rocky grasslands possess a strong biogeographic interest.

Fig. 4. 13 Legend of the Vegetation map of Sazan Island
Source: PMI

4.3.3 Fauna

The Mediterranean Small Island mission in Sazan Island in 2012, recorded 122 species: 22 arthropods, one species of Myriapoda, five Arachnida, three woodlice (Crustacea), and 113 insects. Table 4.4 shows all the species, whereas of 122 species nine are new (Table 5) for Albania.

a) Invertebrates

Table 4. 4 Anthropods recorded in Sazani island
Source: Management Plan of Sazan Island 2015

Subphylum/Class /Order	Group	No. species	New species for Albania
MYRIAPODA	Millipedes, Centipedes...	1	
ARACHNIDA	Spiders, scorpions	5	1
CRUSTACEA	Woodlice	3	
INSECTA		113	8
Coleoptera	Beetles	40	3
Hemiptera (Heteroptera)	Bugs	22	3
Lepidoptera	Butterflies	16	
Orthoptera and neighbouring groups	Grasshoppers, crickets, mantids, stick insects...	20	
Odonata	Dragonflies, damselflies	5	
Hymenoptera	Wasps, ants	10	2
TOTAL		122	9

b) Amphibian and Reptile

According to the two field missions in 2012 and 2013, one species of amphibian and eight reptiles were found. The Green toad Bufo viridis is recorded as the only amphibian found on Sazan Island.[74] Among the reptiles, the Mediterranean house gecko Hemidactylus turcicus is very common in all parts of the island where there are suitable shelters (stone, walls, ruins), from sea level to the top of the hills. [75]

The Eastern Hermann's tortoise Testudo hermanni boettgeri occupy the majority of habitats on the island. This species is included in the IUCN Red List as Near Threatened (NT) (figure 3.7).

The most abundant reptile in the island is the Eastern Montpellier snake Malpolon insignitus. The field missions have highlighted the fact of the high density of Dalmatian Algyroides Algyroides nigropunctatus nigropunctatus. Moreover, the field missions stated, "*this species, endemic to the Balkans, Greece and Italy, are particularly interesting in view of its rarity on the continent. It perfectly illustrates the phenomena associated with insularity. This makes the Dalmatian Algyroides an important element of the natural heritage of the island.*"[76]

However, the hypothesis of Dalmatian Algyroides an important element of the natural heritage of the island are disputable. Other researching studies have listed this species “as Least Concern in view of its wide distribution, presumed large population, and because it does not appear to be declining fast enough to qualify for listing in a more threatened category”.[77]

Fig. 4. 14 Eastern Hermann's tortoise Testudo hermanni boettgeri
Source: Managemnt Plan of Sazan Island, Albania 2015

Fig. 4. 15 (left). European legless lizard Pseudopus apodus Figure 15 (right). Dalmatian Algyroides
Source: Management Plan of Sazan Island, Albania 2015

c) Birds

The field mission in 2013 recorded approximately 39 bird species: passerines (songbirds and crows), erratic (Shag, Golden Eagle, Yellow-legged Gull), migrating (Bee-eater, Garden Warble, Isabelline Shrike and Golden Oriole), four more species (Sparrowhawk, Hobby, Barn Swallow and Black-eared Wheatear), where 28-29 are mostly breeding. The field mission found it hard to determine their local status. Table 4.5 gives an overview of the number of species Sazan Island hosts.

Table 4. 5 Bird Species recorded in Sazan Island
Source: Management Plan of Sazan Island 2015

Order	Group	No. species
Passeriformes	Song birds and crows	23
Accipitriformes and Falconiformes	Birds of prey	5
Columbiformes	Pigeons	3
Apodidiformes	Swift and swallows	3
Strigiformes	Owls	2
Caprimulgiformes	Nightjars	1
Charadriformes	Gulls	1
Coraciformes	Bee-eaters	1
Pelecaniformes	Cormorants	1

The main reason for the rich and diverse community of breeding songbirds the Island hosts is the complex landscape pattern (mosaic of pinewoods and oaks, Mediterranean scrub, grassy open areas, stony slopes).

d) Mammals

Bats: Sazan Island hosts eight species of mammals, which are all bats. The most abundant species by far is Pipistrellus kuhlii /nathusii13, being found around the houses and the bunkers to the north.[78] Tabell 4.6 shows the recorded bats in the Island.

Table 4. 6 Bats recorded during PIM mission and the international protection status
Source: Management Plan of Sazan Island 2015

Species	Albanian name	English name	Bern Convention Appendix[14]	Habitat Directive Annex[15]
Pipistrellus pipistrellus	Pipistrel i zakonshem	Common Pipistrelle	III	IV
Pipistrellus kuhlii /nathusii	Pipistrel i Kuhlit	Kuhl's/Nathusius' pipistrelle	II	IV
Pipistrellus pygmaeus		Soprano pipistrelle	II	IV
Myotis sp.		Mouse-eared bat	II	II or IV
Tadarida teniotis	Lakuriq nate bisht-lire	European free-tailed bat	II	IV
Plecotus kolombatovici		Mediterranean long-eared bat	II	IV
Hypsugo savii		Savi's pipistrelle	II	IV
Nyctalus leisleri		Lesser noctule or Leisler's bat	II	IV

Six species of mammals have been recorded on the island: a native steppe mouse Mus spicilegus and five introduced dog, rat, rabbit, donkey and horse.[79] A pair of domestic dogs and feral dog were present at the Island. Feral dogs may pose a risk to visitors. The island hosts a large wild population of rabbits and black rats.

This species plays a key ecological role on the island, as it is the main prey for several important species such as the Eagle Owl. At the harbour two donkeys and a mare were recorded, with no functioning impact on the island ecosystem.

Fig. 4. 16 Recorded Mammals in Sazan Island: one donkey and a mare
Source: Management Plan of Sazan Island 2015

4.4 GOVERNMENT MANAGEMENT PLAN FOR SAZANI ISLAND

The PIM Initiative for Mediterranean small islands are an international program of promotion and assistance to the management of Mediterranean small islands. Since 2005, the Conservatoire du littoral, a French public agency dedicated to coastal conservation, coordinates the PIM Initiative.

Since 2011, the Conservatoire du littoral offers its assistance to the Albanian authorities and other local stakeholders involved in the integrated management of coastal areas, notably on

Sazani Island as pilot site.[80]

The French agency carried out in 2012 and 2013 two field missions in Sazan Island. The ecological diagnosis of Sazani treated (inventories of terrestrial flora, birds, amphibians, reptiles, invertebrates, bats, invasive species and study on waste and pollution) and evaluated the ecological quality of the rocky shores around Sazani and part of Karaburun peninsula.

In 2014, in accordance with Albanian Authorities and benefiting from the French-GEF project «Management models of coastal, insular and marine areas in the Mediterranean», the Conservatoire du littoral developed a proposal for a management plan for Sazani island, in coordination with the preparation of the Karaburun-Sazan National Marine Park management plan and tourism plan (by UNDP, WWF Mediterranean and INCA).[81]

The actors and supporter of this Management Plan were:

- PIM: Petites Iles de Méditerranée French –
- GEF: French - Global Environment Facility
- UNDP: United Nations Development Programme
- WWF Mediterranean - World Wide Fund for Mediterranean
- INCA: Institute for Nature Conservation in Albania
- Albanian Authorities
- Ministry of Environment

The scenario proposed by the French agency is based on the results of the field missions carried out in 2012 and 2013, and meetings and exchanges with stakeholders at national (Ministry of Environment, Ministry of Defence, Ministry of Territorial

Planning and Tourism, National Coastal Protection Agency, UNDP Albania) and local scale (Vlora Forestry Directorate, fishermen association, NGOs...).[82]

The vision of this scenario is, “To conserve, restore, and enhance the remarkable heritage of Sazan Island while providing opportunities for sustainable economic and ecological benefits to the local community in Vlora region and developing a centre of excellence for conservation, research and training.”[83]

In other words, the management plan propose to:

1. Designate Sazani as a natural protected area, in order to ensure both the conservation of the heritage (natural, historical, cultural, landscape);
2. Organization of one-day visit for tourist boats (tours around the island and disembarkation of passengers on the island), guided tours on the island, scuba diving activities, visits by private leisure boats;
3. Training of stakeholders involved in the management of island, coastal and marine protected areas at national and international level (managers, technical and educational staff, rangers, environmental agents, etc.);
4. Public welcoming and the setting-up of the site (signboard and information panels,
5. Visitor centre (discovery trails,) contribute to communicate on Sazan heritage.[84]

4.5 Knowledge Gap of The Management Plan

There are two plan management scenarios for Sazan Island known so far. One Scenario from the French Agency as described above at 3.4. The second scenario is described in the book of Engineer Xhevair Ngjeqari, *Mediterranean-, Adriatic-, and Ionian Sea. Projection of Touristic Fishing Trade Ports and the Realisation in Albanian Coast.* [85]

In order to shed light to the Albanian proposal an interview has been conducted with the Eng. Ngjeqari about the potential and perspectives of Sazani Island and the knowledge gap regarding the governmental proposal.

According to the interview, the Engineer recognize a knowledge gap in the assessment of the potential of Sazan Island. Ngjeqari order the following reason of the knowledge gap:

The Conservatoire du littoral developed a proposal for a management plan for Sazani Island, in coordination with the preparation of the Karaburun-Sazan National Marine Park management plan and tourism plan. According to Ngjeqari Sazan Island and Karaburun Peninsula are two different structures. Hence, the management plan of each of these structures must be treated separately. The peninsula is steep, rocky, uninhabited, undisturbed, and perched on the sea stream, and has a very high cost to urbanize or vitalize.

On the contrary to Sazan, which is completely green, has an 80% exploitation land, with gentle hills that look southwest and are not beaten by sea winds. Sazan Island is not to be designated as a protected area, because it does not possess any cultural heritage, architectural and historical heritage. The unused island is a gift and a very good ground to develop all urban activities. The island must return to private property, of course under conditions determined by the state. Trading the island as a private property encourages free initiative and investment in the country, because the state itself has no economic capacity to develop the island. Examples are the islands of Maladies, Fiji, which were offered for a 99 years lease to develop the islands.

In his book, Ngjeqari treats the island as a free economic zone and proposes the urban/touristic development of the Island.[86] He mentions that the management of the government leaves the country to live below its touristic potential, as it does not empower Albania economically.

CHAPTER 5

Results: A New Management Plan Proposal

The Albanian Renewable Energy Island new management plan aims to use Albanian natural resources to make tourism an active generator of Albania's economic development. The idea started in 2014 in response to a report from World Bank stating Albania remains one of the poorest countries in Europe. The mission of a new management plan project is to lead the Western Balkan transition to renewable energy. While it is no small ambition, the vision of a Western Balkan with a sustainable clean energy economy can transform the way people live. Part of this Master thesis to play in the transition is creating wealth and societal benefits through the sustainable recombination of resources.

This management plan directs the efforts on natural resources as a source of entrepreneurial opportunities and how they work in the entrepreneurial process from discovery to sustainable exploitation. The master thesis recognizes the untapped potential of Sazan Island and proves that the Island faces no technical difficulties in covering the energy needs by energy from marine currents, solar panels and wind. These efforts will make it the first self-sufficient island in the Adriatic Sea and a stepping-stone toward green economy.

The thesis proposes to offer the island as a free economic zone for 99 years to investors, to develop urban tourism, gradually housing up to 20,000 residents and supply the energy demand 100% with renewable energy.

5.1 Proposal for a New Management Plan

The thesis proposes the urbanization and development of eco-tourism in Sazan Island starting by:

1. Declaring the island as a free economic zone with the motivation to attract foreign direct investments. As stated in chapter one, direct foreign investments contribute to an increased GDP of the country. The research on this thesis does not recognize the island as a protected zone, as argued in chapter three.

2. Offering the island for 99 years lease to foreign investors to develop sustainable urban tourism with the objective to spark a new wave of investment in the tourism industry.
3. Offering the island to investors with defined obligations, rights in compliance with EU standards of nature conservation and developing sustainable smart eco island. The exclusivity of the Concession of Sazani Island, Type "BOT", Construction-Ownership-Utilization-Return for 99 years with legal, administrative, urban-tourist and technical, economic rights.
4. Develop a smart island with a smart grid that would power the island 100% through renewable energies sources. A successful example is Gibraltar Peninsula (Island).

5.2 Legal Perspective

a) Receive from the Albanian Government the legal and administrative rights of the concession:
   - Possess the right to own, sell, purchase, lease property for the concession period.

b) Urban-tourist rights:
   - Own the right to construction according to Euros standards of study, design and construct Urban-Tourist Island for gradual housing up to 20,000 residents during the years 2020-2020-2050-2100.

c) Technical-economic rights:
   - Own the building right according to the European Union standards and invest to power the Island with renewable energy from the sun, wind, and sea currents.

5.3 Technical Perspective

The technical perspective proposes the first phases of Urbanization, where the supply with energy is covered. The Urbanisation phases proposed are as follows:

5.3.1 Phases of Urbanization

a) First Phase of Urbanization

The starting point for bringing life to Sazan Island is construction of facilities for commencing living on the island of Sazan. Secondly, conducting a complex technical-urban-environmental study on the use of natural resources for urbanization of the island. The study includes study of relief, pedology (soil science), flora, fauna and geologic terrain and the prospect of urban development of the island. In addition, realization of the project for the construction of an electricity station on Sazan Island. At an early stage, the supply of electricity is recommended to use fibre optic lines connected to Vlora city with a capacity to power 5000 inhabitant. After the construction of the renewables power plants, the powerhouse can serve as a backup in case of energy blackout in the island.

Moreover, the supply with drinking water from Cold Water Source in Vlora is 20 km far away the island. In order to satisfy the daily needs for water approximately 200l/day are initially needed to be covered by setting up two Water Depots with the volume of 1000 m3 in in height of 150 m and 340 m above sea level. The observations in this master thesis have found out that, according to the hydrology of the island, water resources are available while digging in the depth of the island's foundation. In a final step of the first stage of urbanization, the realization of the maritime transport project by building a touristic harbour where the first tourist and passengers embark from Vlora coastline and vice versa.

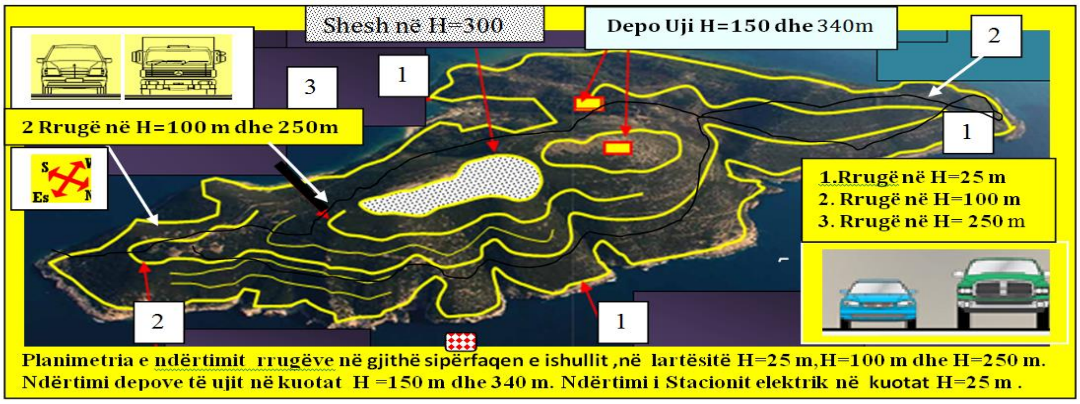


Fig. 5. 1 Road construction in the Island at height of 25m, 100m, and 250 m.
1) Road construction at height of 25 m; 2) Road construction at the height of 100m ; 3) Road at the height of 100m & 250m; 4) Water Depots
Source: Eng. Xhevair Ngjeqari Notes 2018

b) Second Phase of Urbanization

The second phases of the urbanization consisted of the road construction. The construction of transport roads is estimated 50km and facilitate the movement of passengers and goods.

The first road is built at the height 25 m from the sea level and circles the whole island. The road with two crossing lines reaches a length of 24 km. The construction of the road creates the possibility of building tourist buildings below and above the 25 m height. The second road is built at the height 100 m above the sea level and circles the whole island with two passing lines and length 16 km. The construction of the road creates the possibility to build tourist buildings under and above 100m sea level. The third road is planned at height of 250 m from the sea level and circles the entire island with two crossing lines 10 km long. The construction of the road creates the possibility to build tourist buildings under and above the level 250 m. In addition, secondary roads need to be constructed.

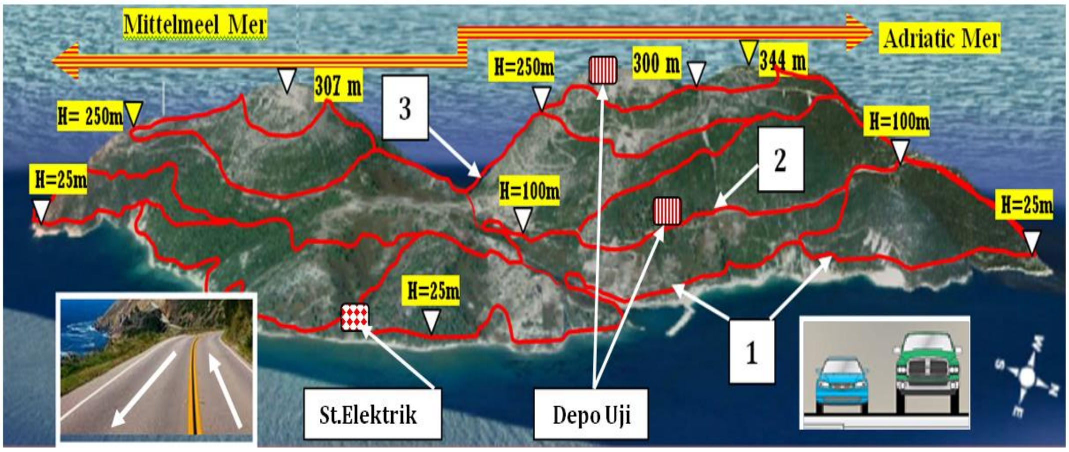


Fig. 5. 2 Road construction in the Island at height of 25m, 100m, and 250 m. East View. Perspective; 1) Road construction at height of 25 m;
2) Road construction at the height of 100 m;
3) Road at the height of 100m & 250m;
4) Water Depots;
5) Power Station
Source: Eng. Xhevair Ngjeqari Notes 2018

c) Third Phase of Urbanization

Third stage of urbanization consisted of building 1000 self-sufficient eco-villas for 5000 inhabitants. In this project two self-sufficient buildings structure were considered. One called, Regen villages, which creates integrated, self-sufficient villages that use information and technology so that to combine smart tech and green energy in one ecosystem.

Fig. 5. 3 ReGen Villages
Source: dezeen

The other smart self-sufficient building structure, Villa Sera (Fig. 5.4) that harnesses "power from solar panels, collects rainwater and uses grey water for plants, creating a microcosm that not only reduces the carbon footprint but contributes to the ecological system".[87] ReGen Villages is a pilot project from the EFFEKT architecture studio. The Regen Villages objective is tackling food and water waste and rises of CO2 emissions by creating communities that produce their food and energy within the community. They also integrate sustainable energy technologies, producing all their own electricity.[88] Hence, Ren villages would contribute to build a shared local eco-system in Sazan Island. Since the goal of the thesis is bringing 5000 habitants to commence life, the social benefit of ReGen Villages would facilitate the sense of community.

Fig. 5. 4 Villa Sera
Source: Echoing Green Living

The two selected structure use solar panel to power the house with energy. The calculations for the grid modelling in the island: energy demand, energy supply and solar production were estimated in general for a house with no specification.

5.4 GRID MODELLING

5.4.1 Energy Demand of Gibraltar

In order to present the energy production for the case study of the uninhabited Sazan Island, the data of energy demand of Gibraltar has been used. The rational of choosing Gibraltar lies in the similarities the islands have regarding size area, population and climate. Gibraltar covers 6.7 km^2, while Sazan 5.7 km^2. Moreover, the population of Gibraltar in 2017 was estimated 32,194, while in this case study the urbanization of Sazan is proposed to host up to 20,000 habitants and tourists. Additionally, the example of Gibraltar serves as a motivation and model of how human nature has vitalized a difficult rocky island and brought life to it. While Sazan poses a green not rocky and rich in limestone rocks, which facilitates the construction in the island.

Fig. 5. 5 Gibraltar
Source: Google Map

Gibraltar gets 100% of its total energy from fossil fuels (oil, coal, natural gas).
The entire production of all electrical energy-manufacturing facilities is 195 m kWh, conjointly 103% of own needs. The remainder of the self-generated energy is either exported into different countries or unused.
There are presently three installations in Gibraltar generating energy. Two of those installations specifically Water port and OESCO power stations offer electricity to the civil population, while the third one provides electricity to Ministry of Defence institutions. Water port station is operated by the governmental authorities and contains a thermal power output of 40 MW. OESCO station is a private company and contains a thermal power output of 58.9 MW. The GMES Station, supplying the Ministry of Defence, contains a thermal power output of 48 MW.

Table 5. 1 Production Capacities from energy sources
Source: World Data

Energy source	total in Gibraltar	percentage in Gibraltar	percentage in Europe	per capita in Gibraltar
Fossil fuels	376.68 m kWh	100,0 %	48,9 %	10,895.84 kWh
Nuclear power	0.00 kWh	0,0 %	7,2 %	0.00 kWh
Water power	0.00 kWh	0,0 %	23,4 %	0.00 kWh
Renewable energy	0.00 kWh	0,0 %	16,2 %	0.00 kWh
Other energy sources	0.00 kWh	0,0 %	4,3 %	0.00 kWh
Total production capacity	376.68 m kWh	100,0 %	100,0 %	10,895.84 kWh

Table 5.1 shows that the total energy production in Gibraltar from fossil fuels under ideal conditions are 376.68 m kWh and the energy production per capita 10,895 kWh.

The statistical data for Gibraltar were provided by government documents and national energy plans, since Gibraltar holds a unique position within the European Union and data provided by EUROSTAT were not available.

Table 5. 2 Electricity Output from Gibraltar Power stations in GWh
Source: National Energy Efficiency Action Plan

Year	Total [in GWh]
2003/2004	176
2004/2005	185
2005/2006	192
2006/2007	192
2007/2008	194
2008/2009	208
2009/2010	211
2010/2011	207
2011/2012	205
2012/2013	218
Total	**1,990**

Table 5.2 shows the electricity output for 2003-2013. The electricity outputs has increased within 10 years. Sources of energy production were petrol and gas oil.

Table 5. 3 Fuel Consumption 2010-2012 in Gibraltar (in GWh)
Source: National Energy Efficiency Action Plan

Category [in GWh]	2010	2011	2012
Motor spirits (petrol)	172	156	154
Gas Oil (diesel)	342	318	285
Total	**515**	**475**	**439**

Recently, another source of energy in Gibraltar are wave energy. The ECOWAVE pilot project has developed wave energy devices that generate electricity and connect merely to the grid. A five MW onshore wave station is currently planned which will cover 15% of Gibraltar´s. electricity. In this thesis, the energy production from wave power station is not considered due to unavailable data.

- Energy production in Gibraltar 376.68 million kWh per year

- Energy production per capita 10,895 kWh per year

5.

6. Energy Consumption in Gibraltar

According to World Data Gibraltar has a total energy consumption of 188.60 million kWh of electric energy per year. Per capita, this is an average of 5,455 kWh.

- Total energy consumption per year of 188.60 million kWh
- Energy consumption per capita per year average of 5,455 kWh

The electrical load profile of Island included the villas and amenity loads. The study predicted to use 40% or 230 ha of the island from 570ha. The island's construction coefficient was calculated 20%. Sazan Island specific areas contained two blocks: one occupied approximately for living; the other contained for amenities. The estimation of energy demand has taken the data of Gibraltar into consideration. Due to the lack of data for Gibraltar the electric load profile could not be demonstrated

7.

8. Energy Balance in Gibraltar

According to World Data table 5.5 illustrates the energy balance in Gibraltar related to electricity production and consumption yearly in total and per capita. This data has been used to build up on the Sazan Island model of energy balance.

Table 5. 4 Energy Balance in Gibraltar
Source: World Data

Electricity	total	Gibraltar per capita
Own consumption	188.60 m kWh	5,455.44 kWh
Production	194.60 m kWh	5,629.00 kWh

9.

10. Primary Energy of Gibraltar in different sectors

The electricity load data for Gibraltar was unavailable. Instead, the data of targeted primary energy consumption savings from the National Energy Efficiency Action Plan were applied asin Table 5.5.

11.

Table 5. 5 Overview of measures of targeted Primary Energy Savings in Gibraltar
Source: National Energy Efficiency Action Plan

Sector	Measure	Targeted Primary Energy Savings
Public	New gas fueled power station, Street lighting (LED), Street Lighting (solar), Electric charging points	37.5 GWH
Building	Tax allowance scheme. Loan scheme to promote energy efficient technologies and processes	60GWh
Commercial	grant schemes, public bus services	70 GWh
Transport	Tax scheme e-mobility, Tax allowance scheme, tax scheme on import duty	47 GWh
Cross Sector	Tax schemes renewables, energy advice and consultation	GWh

5.4.2 Energy Supply in Sazan

In order to make an energy balance, the yearly energy supply also should be provided for Sazan Island. In the section 5.5 and 5.6, the energy potentials and production of solar panel and wind turbine were demonstrated in detail.

5.5 Solar Energy Potentials

Six steps were followed to assess the solar energy potential (part of the methods is described in Chapter 3). In order to calculate the output of Solar PV System for one eco villa:

Firstly, the photovoltaic array area was determined. Secondly, the tilt angle of array was determined also. The tilt angle of the PV array plays a crucial role in the efficiency of PV. This was done by choosing an angle when they are perpendicular to the sun´s rays. The third step determined the geographical coordinate and the corresponding solar radiation. The Energy Association Albania is an excellent source to determine this information. The fourth step consisted of taking into consideration the effect of temperature and its impact on the conversion factor. The fifth step calculated the energy output on a monthly basis. Finally, a cost analysis was carried out.

5.5.1 Technical Analysis of Solar Panel Production

In chapter two, it was proved the potential of the solar energy in Sazan Island. From the yearly solar irradiance data shown in Fig. 5.6, the solar power was calculated. In this study, the eco-villas were introduced to determine the solar panels for available areas. One eco-villa is approximately $100m^2$ of which $20m^2$ of the rooftop building area were available for solar panels. Regarding the tilt angle, a roof with 15° slope was considered. The geographic coordinates of Sazan Island and the corresponding solar radiation were determined as shown as follows:

Latitude: 40° 29' 59.99" N

Longitude: 19° 16' 60.00" E

Albania has a sub-tropical climate; as a result, the solar radiation is quite high. According to the data of World Energy Council (2010) Albania receives insolation in average of 1500 kWh/m2/yr varying from 1185 to 1690 kWh/m2/yr. Irradiation (GHI) are 5.4 kWh/m2/day.[89] As shown in Table 5.6, the part of the country receiving the highest insolation are the cities in the seaside like Fier and Sarande.

The highest irradiation was measured in the west part of Albania with a production of 139kWh/m2 electricity per month.

Table 5. 6 The solar radiation intensity for the 6 metrological stations [kWh/m2 day]
Source: Q.E.E, 2006

Month	Shkoder	Peshkopi	Tirana	Fier	Erseke	Sarande
January	1,70	1,55	1,80	2,15	1,90	1,90
February	2,30	2,30	2,50	2,85	2,70	2,40
March	3,35	3,25	3,40	3,90	3,40	3,60
April	4,50	4,15	4,20	5,00	4,40	4,80
May	5,45	5,25	5,55	6,05	5,60	5,80
June	6,10	5,85	6,40	6,80	6,40	6,80
July	6,50	6,25	6,70	7,20	6,80	6,10
August	5,55	5,45	6,05	6,40	5,90	4,80
September	4,45	4,35	4,70	5,15	4,70	3,60
October	2,90	2,90	3,20	3,50	3,10	3,20
November	2,10	1,85	2,15	2,40	2,10	2,10
December	1,70	1,50	1,75	1,85	1,80	1,80

Sazan Island receives the highest insolation up to 139 kWh/m2 electricity monthly. The data used for Sazan Island were the ones from city of Fier, due to the similarity of the geographical position. The average of daily solar radiation can change from a minimum of 3.2 kWh/m2 in the Northeast (day in Kukes) up to a maximum of 4.6 kWh/m2 in the South-Western (day in Fier).[90] The average daily solar radiation in Albania was measured 4.1 kWh/m2. The yearly available insolation at 15° was 4.1 kWh/m2/day.

Since Sazan Island is surrounded by water, solar panels that are resistant to salt and water deterioration are required. C-Si cells have been chosen as the preferred solar cells technology given the overall higher efficiency rate, which ranges from 21 – 25%. Module efficiency of 21%, typical for C-Si sells, was considered.

The "incident radiation flux" is the solar irradiation (W/m²) dependent on the location. As described above manufacturers use Standard Test Condition (STC) 1000 W/m² for temperature 25°C, which in Sazan Island is higher. The following efficiency of 16% can be derived for Sazan Island.

Table 5. 7 Calculations of installed capacity of PV for one Villa
Source: Own Calculations

Global formula :	E = A * r * H * PR	
E = Energy (kWh)	3598	kWh/an
A = Total solar panel Area (m²)	20	m²
r = solar panel yield (%)	16%	
H = Annual average irradiation on tilted panels (shadings not included)*	1500	kWh/m².an
PR = Performance ratio, coefficient for losses (range between 0.9 and 0.5, default value = 0.75)	0,75	
Total power of the system	3,2	kWp

The installed capacity of the project in direct-current kilowatts would be:

A photovoltaic panel of 3,2 kWp at its maximum capacity produces 3, 2 kWh. Afterwards the energy output of the PV on a monthly basis for an eco-villa was calculated. The global formula to estimate the electricity generated in output of a photovoltaic system is:

$$E = A * r * H * PR \qquad (6)$$

Energy output (kwh/month) = solar array area (m2) x conversion efficiency x solar radiation for the month (kwh/m2/day)

- Area = 20 m2
- Conversion Efficiency = 16%
- Solar radiation according to Q.E.E, 2006 table

Table 5. 8 Calculation of energy output on a monthly basis
Source: Own Calculations

MONTH	SOLAR RADIATION (kWh/m2/day)	DAYS PER MONTH	OUTPUT (kWh/month)
January	2,15	31	213,28
February	2,85	28	255,36
March	3,90	31	386,88
April	5,00	30	480
May	6,05	31	600,16
June	6,80	30	652,8
July	7,20	31	714,24
August	6,40	31	634,88
September	5,15	30	494,4
October	3,50	31	347,2
November	2,40	30	230,4
December	1,85	31	183,52
Yearly Totals		**365**	**5193,12**

Table 5.8 shows the calculations of energy outputs on a monthly basis for one PV installed in an eco-villa. The project yielded a yearly production of 5193, 12 kWh (DC), with higher production in the summer months due to the increased solar radiation available. As a result, if house´s energy consumption is ≤ 500 kWh per month it means that its energy needs can be meet 100% by becoming a net zero energy building.

Since the analysis is monthly, a bar graph was set up for a visual representation of output throughout the year: Figure 5.7.

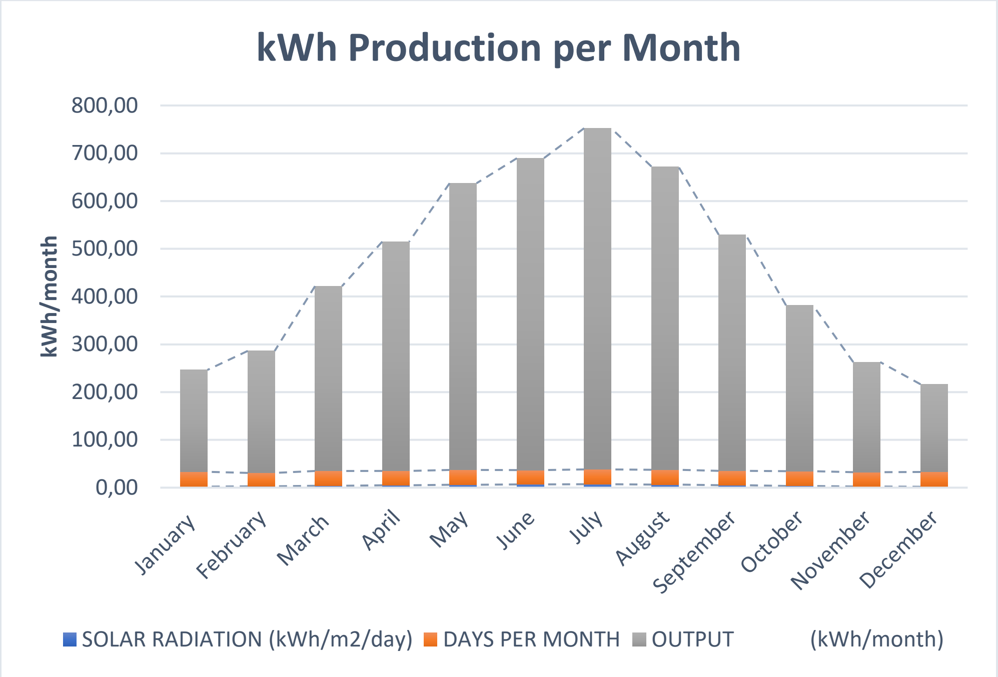


Fig. 5. 6 Bar graph of output throughout the year
Source: Own Graph

5.6 Wind Power Potential

In this section assessment of wind power potential were estimated.

Sazan Island has a wind speed of 3-7m/sec. In order to decide for the technology and process, certain components like the proper site, designing a turbine array to fit it, wind class and cut-in speed, optimal wind speed were determined. For this project, two power scenarios were considered. One rooftop wind turbine scenario and another scenario for wind turbines with rotor diameter 20-40m.

Fig. 5. 7 Rooftop Wind Turbines
Source: Xhevair Ngjeqari Notes

a) Rooftop Wind Turbine Scenario

The rooftop wind turbines are rated 1kW. For the eco- villas, the rooftop wind turbines are installed together with the solar panel, taking into account avoiding shading into the PV. One rooftop turbine would generate 24kWh of energy each day (1kW x 24 hr). The rated power of a 1kW rooftop wind turbine is shown in Fig. 5.9 through the power curve.

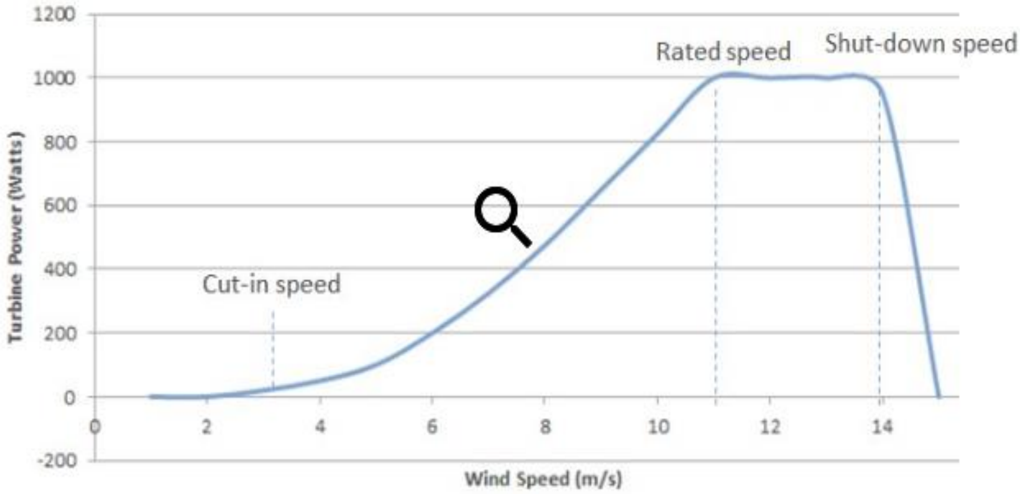


Fig. 5. 8 Power Curve for a 1 kW turbine
Source: Engineering

The curve of a 1kW wind turbine in the Fig. 5.9 shows that wind speed below 3m/s do not spin the rotor. Wind speed above 3m/s increases the power output. The power output hit 1kW when wind speed reaches 11m/s. At 14m/s wind speed the wind turbine shuts off.

b) Wind Turbines Scenario

For Sazani project intermediate wind turbines 100kw -200kW were chosen. Intermediate wind turbines can supply with energy a village. In absence of grid connection, they can be linked to diesel generators and batteries. Between two types of wind turbines, the horizontal axis wind turbines were selected, in which they are parallel to the ground. In chapter two, the methods of data collection are explained more in depth.

Figure 5.10 shows a map with wind average speed in Albania, which is a schematic map (there are no space gradients available).[91] As a result, it shows only a number of regions characterized by high wind speed. Nevertheless, the main regions with high wind energy potentials are identified and they are Shkoder (Velipoje, Cas), Lezhe

(Ishull Shengjin, Tale, Balldre), Durres (Ishem, P.Romano), Fier (Karavasta, Hoxhara 1, Hoxhara 2), Vlore (Akerni), Tepelene, Kryevidh, Sarande.[92] Sazan Island belongs to Vlora municipality and to one of the territories with high wind speed.

Accurate estimations of wind speed territory distribution belongs to an important challenging factor. A detailed study includes the modelling of the speed wind taking into the consideration topography, as well.[93] Researchers have proved that when it comes to identifying suitable sites, wind speed varies with height above the terrain. Another factor that contributes to the increase of wind speed are air convergences, found in the narrow valleys of rivers and/or mountainous saddles.

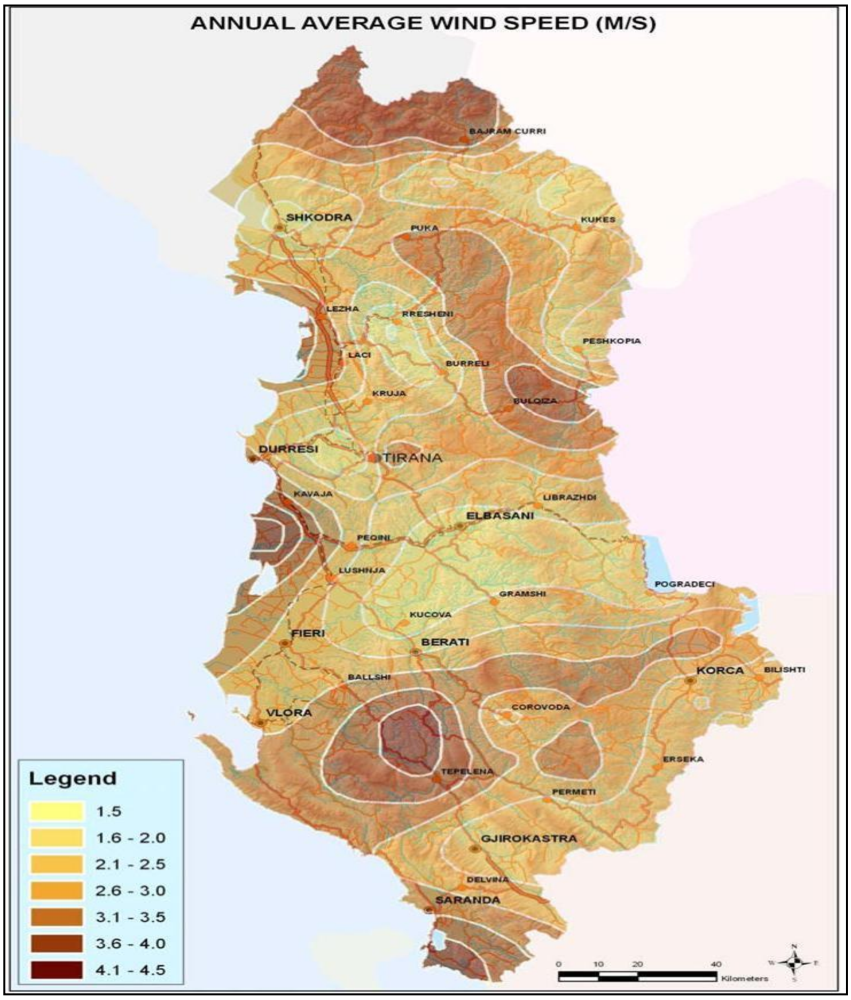


Fig. 5. 9 Territorial distributions of annual average wind speed
Source: Albania Wind Energy Association

5.6.1 Technical Analysis of Wind Turbine Production

In order to reach the Energy balance for 100 eco-villas and 5000 inhabitants in Sazan Island, the wind turbine production has been measured for both scenarios.

There are several approaches to calculate the estimated power output of a wind turbine, given a wind profile and a power curve. The ideal way is to integrate the published power curve of the turbine and the probability distribution of the wind, over wind speeds from zero to infinity.[94] One of the most informative measures of how efficiently a wind turbine is functioning at a specific location is the Capacity factor (CF). It is defined as the ratio of the energy actually produced by a turbine at a given site and the maximum energy that the specific turbine can produce.[95]

The table 5.9 below shows the energy density and average speed of wind in height of 10 m according to five cities in Albania. Except Tepelena all the other cities are lowland and in the seaside. Sazan Island 'closest city is Vlora. Due to the climate similarity of Sazan Island with Vlora, the data of Vlora City has been used to calculate the energy output of Sazan Island.

Table 5. 9 The energy density and average speed of wind in height of 10 m according to the cities
Source: Albania Energy Association

Month	Durres	Kryevidh	Tepelene	Sarande	Vlore
January	4.20	5.00	5.80	4.90	5.10
February	4.50	5.10	5.70	4.90	5.20
March	4.20	4.60	5.90	4.80	4.50
April	4.10	4.50	4.30	4.60	4.40
May	3.60	3.70	4.60	4.30	4.10
June	3.40	4.10	4.40	4.50	4.10
July	3.30	4.30	3.50	4.60	3.90
August	3.20	4.00	3.50	4.40	3.80
September	3.30	4.30	4.10	4.10	4.00
October	3.60	4.70	5.30	4.50	4.50
November	4.20	4.90	4.70	4.70	4.60
December	4.40	5.10	5.60	5.00	5.00
Annual	3.833	4.525	4.783	4.608	4.433
Density (W/m^2)	75 -150	100- 230	100-235	110-250	100- 230

The data of table 5.10 were extracted from Albanian Energy Association. Table 5.10 mirrors the energy density and average speed of wind in height of 10 m of 5 important coastal cities in Albania. In order to assess the wind energy potential data of wind speed and energy density for coastal areas have been applied. The tables 5.9 and 5.10

show windy hours, average speed and the energy density for the coastal area, based on the land measurements.

Table 5. 10 Wind Potential in the coastal area Albania (wind speed and density W/m^2)
Source: Albania Energy Association

Hour/year		10 m		50 m		75 m	
		m/s	W/m^2	m/s	W/m^2	m/s	W/m^2
6230		> 3	30	3.9	60	4.5	100
5000		> 4	70	5.2	160	6.0	250
4300		> 5	150	6.5	300	7.5	500
3100		> 6	250	7.8	550	9.0	800
1400		> 7	400	9.1	830	10.5	1300
V_{med}	Dens.	4.5 m/s	100	6.0 m/s	250	7.0 m/s	400

a) Rooftop Wind Turbine Energy Output

The annually energy output of the 1kW rooftop wind turbine was calculated using the data from power curve Figure 5.7 above. The equation used for calculating the annual Energy Output was the equation no. 7 in chapter 3:

$$P = Cp\ 1/2\ \rho\ A\ V^3 \qquad (7)$$

Where:

- P = Power output, watts
- Cp = Maximum power coefficient, ranging from 0.25 to 0.45, dimension less (theoretical maximum = 0.59)
- ρ = Air density, kg/m^3
- A = Rotor swept area, m^2 or
- $\pi D^2 / 4$ (D is the rotor diameter in m, π = 3.1416)
- V = Wind speed, mps
- k = 0.000133 A constant to yield power in kilowatts.

Table 5. 11 Calculations and Results of 1kW Rooftop Wind Turbine
Source: Own Calculations

Inputs:		Results:	
Ave. Wind (m/s) =	4,33	Hub Average Wind Speed (m/s) =	4,20
Weibull K =	4	Air Density Factor =	-1%
Site Altitude (m) =	150	Average Output Power (kW) =	0,15
Wind Shear Exp. =	0,250	Daily Energy Output (kWh) =	3,6
Anem. Height (m) =	9	**Annual Energy Output (kWh) =**	**1.307**
Tower Height (m) =	8	Monthly Energy Output =	109
Turbulence Factor =	0,1%	Percent Operating Time =	93,0%

In table 5.11, the estimations of annual energy output of the 1kW wind turbine were presented. The estimation applied equation (7).

Another important estimation in wind turbine production is related to the variation of the wind. The information of wind variation plays a crucial role in estimation of incomes form electricity generation. Thea measurement of wind speed throughout the year has shown that in most areas strong winds are rare, while moderate and fresh winds are quite common. For investors and the wind, industry is very important the description of variation of wind speeds.

The wind variation for a typical site is described by Weibull distribution. For 1kW wind, turbine Weibull distribution performance is described in table 5.12. In Table 5.12, the probability that the wind will be blowing at some wind speed including zero must be 100 per cent. From figure 5.8 the bar graph curve shows that the curve has its median distribution 12m/s, which means that half the time it will be blowing less than 12m/s, the other half it will be blowing faster than 12m/s.

Table 5. 12 Weibull Performance Calculations
Source: Own

Wind Speed Bin (m/s)	Power (kW)	Wind Probability (f)	Net kW @ V
1	0,00	0,71%	0,000
2	0,00	5,55%	0,000
3	0,10	16,68%	0,017
4	0,15	28,93%	0,043
5	0,18	29,25%	0,053
6	0,20	15,26%	0,031
7	0,30	3,37%	0,010
8	0,40	0,24%	0,001

9	0,60	0,00%	0,000
10	0,80	0,00%	0,000
11	1,00	0,00%	0,000
12	1,00	0,00%	0,000
13	1,00	0,00%	0,000
14	1,00	0,00%	0,000
15	0,80	0,00%	0,000
16	0,60	0,00%	0,000
17	0,50	0,00%	0,000
18	0,40	0,00%	0,000
19	0,30	0,00%	0,000
20	0,30	0,00%	0,000
2011, BWC	Totals:	100,01%	0,155

"Wind speed probability is calculated as a Weibull curve defined by the average wind speed and a shape factor, K. To facilitate piece-wise integration, the wind speed range is broken down into "bins" of 1 m/s in width (Column 1). For each wind speed bin, instantaneous wind turbine power (W, Column 2)) is multiplied by the Weibull wind speed probability (f, Column 3). This cross product (Net W, Column 4) is the contribution to average turbine power output contributed by wind speeds in that bin. The sum of these contributions is the average power output of the turbine on a continuous, 24-hour, and basis.

b) Conclusion

Because of the calculations, the annual energy output for one rooftop wind turbine was 1.307kWh. In order to achieve energy balance for one villa 4000 kWh, four rooftop turbines cover this energy demand 1.307kWhx 4 = 5.228 kWh. This system allows a building with an average monthly energy consumption of 500 kWh or below to become a net-zero energy building**,** since it is possible to meet 100% of energy needs with rooftop turbines and replace PV.

c) Wind Turbines 100kW Application

The second scenario of wind energy potentials were suggested 100kW Wind turbines. Aeolos-H 100kW were chosen for Sazan Island. "This wind turbine uses three phase direct-drive generator, no gearbox or booster device. It is more reliable and efficient than the induction generator with gearbox or booster. The 100kW wind turbine is controlled by PLC controller with touch screen".[96] In Table 5.13 the specification of Aeolos were presented. Aeolos wind turbine has a rotor diameter of 24.5m and a maximum output of 120 kW.

Table 5. 13 Wind Turbine 100kW Specification
Source: Wind Turbine Star

Aeolos Wind Turbine 100kW Specification	
Rated Power	100 kW
Maximum Output Power	120 kW
Generator	Direct-Drive Permanent Magnet Generator
Blade Quantity	3 Glass Fiber Blades
Rotor Blade Diameter	24.5 m (80.4 ft)
Start-up Wind Speed	2.5 m/s (5.6 mph)
Rated Wind Speed	10 m/s (22.3 mph)
Survival Wind Speed	59.5 m/s (133.1 mph)
Controller	PLC With Touch Screen
Safety System	Pitch Control, Electrical Brake & Hydraulic Brake
Turbine Weight	8350 kg (18408.6 lbs)
Noise	60 db(A) @ 7m/s
Temperature Range	-20°C to +50°C
Design Lifetime	20 Years
Warranty	Standard 5 Years

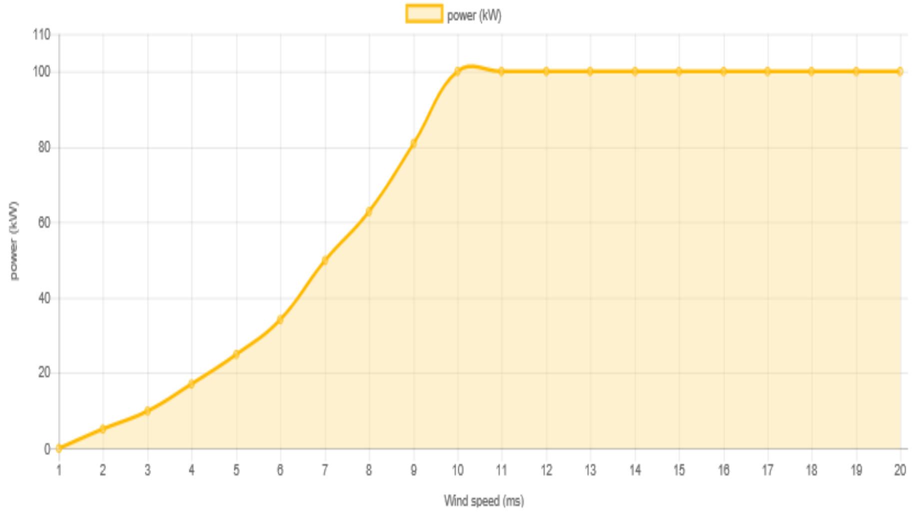


Fig. 5. 10 Annual Energy Production of H-100kW Wind Turbine
Source: Wind Turbine Star

From Figure 5.11, three key points on the velocity scale are to be seen.

- Cut-in speed: the minimum wind speed at which the turbine started to produce useful power is 2 -3 m/s.
- Rated wind speed: the wind speed at which the rated power or max. Power was reached at 10m/s.
- Cut-out speed: the maximum wind speed at which the turbine was allowed to deliver power was 20m/s.
-
- The energy output of annually of the 100kW wind turbine was calculated using the data from power curve in Figure 5.11. The same procedure was followed for the 100kW wind turbine as for 1kW wind turbine. Firstly, the energy power output was estimated using equation (7). Secondly, Weibull distribution was estimated. According to Weibull, distribution mean speed was reached at 7m/s wind velocity generating 50 kW.

Table 5. 14 Calculations and Results of 100kW Wind Turbine
Source: Own Calculations

Inputs:		Results:	
Ave. Wind (m/s) =	5	Hub Average Wind Speed (m/s) =	6,76
Weibull K =	4	Air Density Factor =	-2%
Site Altitude (m) =	200	Average Output Power (kW) =	51,47
Wind Shear Exp. =	0,250	Daily Energy Output (kWh) =	1235,2
Anem. Height (m) =	9	**Annual Energy Output (kWh) =**	**450.852**
Tower Height (m) =	30	Monthly Energy Output =	37.571
Turbulence Factor =	0,1%	Percent Operating Time =	98,9%

Table 5. 15 Weibull Performance Calculations
Source: Own

Wind Speed Bin (m/s)	Power (kW)	Wind Probability (f)	Net kW @ V
1	0	0,12%	0
2	5	0,96%	0,048
3	15	3,17%	0,476
4	19	7,14%	1,356
5	25	12,47%	3,119
6	38	17,61%	6,693
7	50	20,05%	10,025
8	65	17,96%	11,677
9	80	12,17%	9,74
10	100	5,93%	5,928
11	100	1,95%	1,95
12	100	0,40%	0,404
13	100	0,05%	0,049
14	100	0,00%	0,003
15	100	0,00%	0
16	100	0,00%	0
17	100	0,00%	0
18	100	0,00%	0
19	100	0,00%	0
20	100	0,00%	0
2011, BWC	Totals	100,00%	51,467

d) Conclusions

The annual energy output for 100kW wind turbine was ***450.852kWh***. In order to achieve energy balance for one villa with annual energy demand 4000 kWh, one wind turbine 100kW covers the energy demand for over 20 villas.

This system allows a building with an average monthly energy consumption of **37,571 kWh or below** to become a **net-zero energy building.** This scenario meet 100% of energy needs of the island for 5000 inhabitant with 60 wind turbines 100kW.

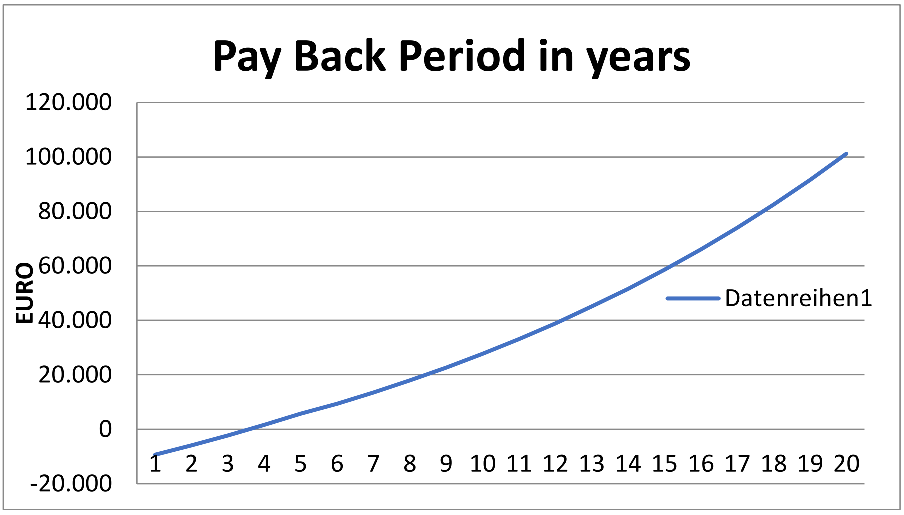
5.7 COST ANALYSIS

The following calculation evaluates the financial model for a roof top solar panels and wind turbine 100kW by estimating costs and expenses, investments and return of investment. The estimations were done with the logarithm in Microsoft Excel explained more in details in chapter 3. Table 5.16 shows a financial model for rooftop solar panel for Sazan Island. The simple payback time is in 3 years. The cash flow is positive after 3 years (Table 5.17). The result is that the project is economic feasible. The total investment for the rooftop PV estimated 12.600 EUR. The cost for 1000 rooftop PV in 1000 Eco villa would be 12.600 Mio. Euro.

Table 5. 16 Financial Parameters for Rooftop Solar Panels in Sazan Island. Source: Own Calculations

FINANCIAL MODEL ROOFTOP PV		
Output		
Total capacity	3	kWp
Annual insolation	1.500	kWh/m^2
Performance ratio	83,0%	
Annual degradation	0,30%	
Yearly production (first year)	3.735	kWh
Percent self use	95%	
Income and rates		
Customer tariff (avoided electricity)	1,35	Eur/kWh
Feed in Tariff	0,65	Eur/kWh
Carbon credit	0	Eur/kWh
Tax Rate	28%	
Inflation adjustment	7%	per annum
Investment & installation		
Turnkey EPC	4.000	Eur/kWp
Grid connection	0	EUR
Project development	600	EUR
Other initial cost	0	EUR
Decommission	0	Eur/kWp
Expenses		
Upkeep (first year)	100	Eur/kWp/annum
Allowance for component change (first year)	600	Eur/annum
Rooftop lease	0	Eur/annum
Insurance premium	0,8%	of initial invest
Finance structure		
Total investment	12.600	EUR
Senior Debt Leverage (% bank finance)	10%	
Total debt	1.260	EUR
Cost of Debt Funding	11%	
Maturity	6	years
Equity	90%	
Total equity	11.340	EUR
Ratios		
Project Return Post Financing and Tax	43,8%	
ROI (Return on Investment)	3	years

Table 5. 17 Cash Flow for Rooftop Solar Panels in Sazan Island
Source: Own calculations



Cost Analysis for Wind Turbines 100kW

The following calculation evaluates the economic feasibility for wind turbine 100kW by estimating costs, expenses, investments and return of investment, net present value and the cash flow. The economic analysis was done with the software Retscreen.

Table 5.18 shows economic feasibility of a wind turbine 100kW in Sazan Island. The simple payback time is in 36, 5 years. The total cost for on wind turbine was 720 292 **$**. The cumulative cash flow decreases within the first 15 years. (Table 5.18). In this project the grant of 1 million were calculated. The result of the project is that the wind power plant might not be quite feasible for Sazan Island comparable to PV.

For the supply of 5000 inhabitants with electricity, 60 wins turbines 100kW are required.

Table 5. 18 Financial Feasibility of Wind Turbine 100kW in Sazan Island
Source: RENSCET Software

Financial parameters

General		
Inflation rate	%	2,5%
Discount rate	%	8%
Reinvestment rate	%	9%
Project life	yr	25
Finance		
Incentives and grants	$	1 000 000
Debt ratio	%	60%
Debt	$	432 175
Equity	$	288 117
Debt interest rate	%	8%
Debt term	yr	20
Debt payments	$/yr	44 018
Income tax analysis		☐

Annual revenue

Electricity export revenue		
Electricity exported to grid	kWh	284 070
Electricity export rate	$/kWh	0,10
Electricity export revenue	$	28 407
Electricity export escalation rate	%	2,5%
GHG reduction revenue		
Gross GHG reduction	tCO_2/yr	2
Gross GHG reduction - 25 yrs	tCO_2	50
GHG reduction revenue	$	0
Other revenue (cost)		☐
Clean Energy (CE) production revenue		☐

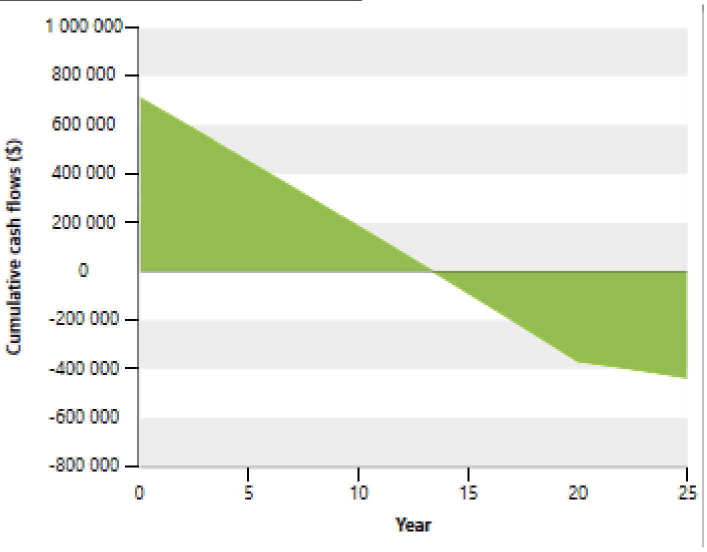
Costs | Savings | Revenue

Initial costs			
Initial cost	39,8%	$	286 667
User-defined	60,2%	$	433 625
Total initial costs	**100%**	**$**	**720 292**
Incentives and grants		$	1 000 000
Annual costs and debt payments			
User-defined		$	26 074
O&M costs (savings)		$	10 000
Debt payments - 20 yrs		$	44 018
Total annual costs		**$**	**80 092**
Annual savings and revenue			
Electricity export revenue		$	28 407
Total annual savings and revenue		**$**	**28 407**

Financial viability

Pre-tax IRR - equity	%	4,7%
Pre-tax MIRR - equity	%	10,2%
Pre-tax IRR - assets	%	18,4%
Pre-tax MIRR - assets	%	6,2%
Simple payback	yr	36,5
Equity payback	yr	Immediate
Net Present Value (NPV)	$	175 504
Annual life cycle savings	$/yr	16 441
Benefit-Cost (B-C) ratio		1,6
Debt service coverage		-0,29
GHG reduction cost	$\$/tCO_2$	-8 289
Energy production cost	$/kWh	0,069

Yearly cash flows		
Year	Pre-tax	Cumulative
#	$	$
0	711 883	711 883
1	-51 877	660 007
2	-52 073	607 934
3	-52 275	555 659
4	-52 481	503 178
5	-52 692	450 486
6	-52 909	397 576
7	-53 132	344 445
8	-53 359	291 085
9	-53 593	237 492
10	-53 832	183 660
11	-54 078	129 582
12	-54 329	75 253
13	-54 587	20 666
14	-54 851	-34 186
15	-55 122	-89 308
16	-55 400	-144 707
17	-55 684	-200 392
18	-55 976	-256 367
19	-56 275	-312 642
20	-56 581	-369 224
21	-12 877	-382 101
22	-13 199	-395 300
23	-13 529	-408 830
24	-13 868	-422 697
25	-14 214	-436 911



5.8 Marine Tidal Current Electric Power Generation

Oceans cover 70 % of the earth and are an immense renewable energy source. The kind of energy that ocean poses is thermal, kinetic, chemical and biological. Extracting energy from the seas has been divided into categories as following: marine and tidal current energy, wave energy, energy from salinity gradients, cultivation of marine biomass, and ocean thermal energy. In order to convert the kinetic energy stored in marine and tidal currents into electricity, turbine technology can be used.[97]

"The global marine current energy resource is mostly driven by the tides and to a lesser extent by thermal and density effects. The tides cause water to flow inwards twice each day (flood tide) and seawards twice each day (ebb tide) with a period of approximately 12 hours and 24 minutes (a semi-diurnal tide), or once both inwards and seawards in approximately 24 hours and 48 minutes (a diurnal tide). In most locations, the tides are a combination of the semi-diurnal and diurnal effects, with the tide being named after the most dominant type. The resource assessment is generally based on oceanographic databases containing data with a fixed grid square resolution". 98

5.8.1 State of Art and Currents Status

Three categories of tidal energy technologies are:

1. Barrage tidal power: A physical barrier is constructed within the sea with Sluice Gates to control the flow of seawater. The potential energy from the water level difference can then drive turbines to generate electricity. [99]
2. Tidal stream system- A horizontal axis turbines like horizontal axis of wind turbines. The ecological impact and costs in this method are lower compared to other tidal energy technologies.[100]
3. Tidal lagoons: are similar to barrages but constructed as self-contained structure.

Marine turbines use the same principles as wind turbines. The power equation (1) is slightly different since the condition of the water are different:

$$P_{avail} = \frac{1}{2}\rho A v^3 C_p \qquad (1)$$

As the marine turbine works in water rather than air, the density of water instead of air was used: Density of water, w ρ = 1000 kg/m3

The average power coefficient, p C, for marine turbines is also different from that of wind turbines. The theoretical maximum for marine turbines is still defined by Betz Law with a limit of 0.59 and we will use the following value of this coefficient: Power Coefficient Marine Turbine, pm C = 0.35. Assume v = 2.5m/s, which is the typical rated tidal flow speed. [101]

a) Tidal stream system generators

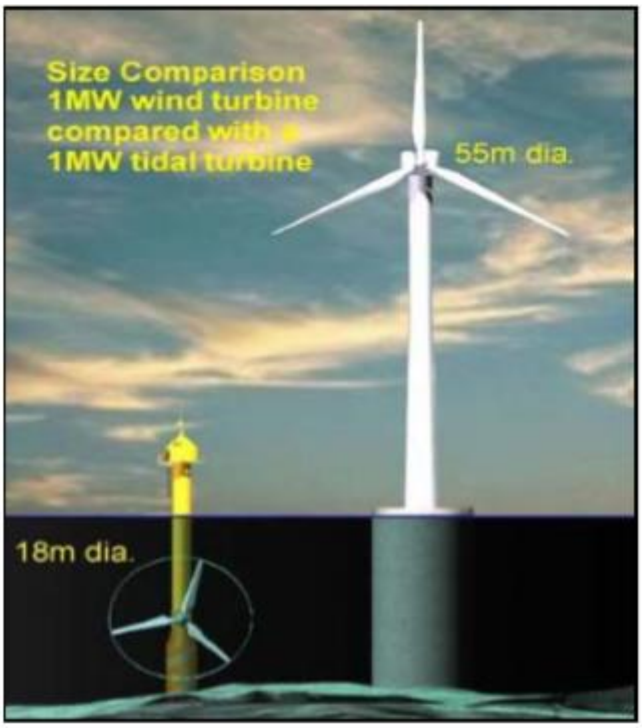


Fig. 5. 11 Tidal turbine against an offshore wind turbine
Source: MCT

In a similar way like wind turbines draw energy from the wind, draw marine tidal turbines from currents. The density of water is 832 times higher than the density of water, which mean that can provide power at a low turbine velocity. Figure 5.11 compares a tidal turbine 1MW with a diameter 18, and a wind turbine 1 MW with a diameter 55m. Hence, water velocities of about one-tenth of wind speed generates a similar capacity to a similar size of turbines.

There are three main types of tidal turbines as illustrated in Fig, 5.13:

- Horizontal axis systems installed in Bristol Channel between England and Wales, or in Hammerfest Strum, in Norway.
- Vertical axis systems have been tested in Strait of Messina
- Variable foil systems have been tested in Yell Sound in Shetland, in North of Scotland and Orkney.

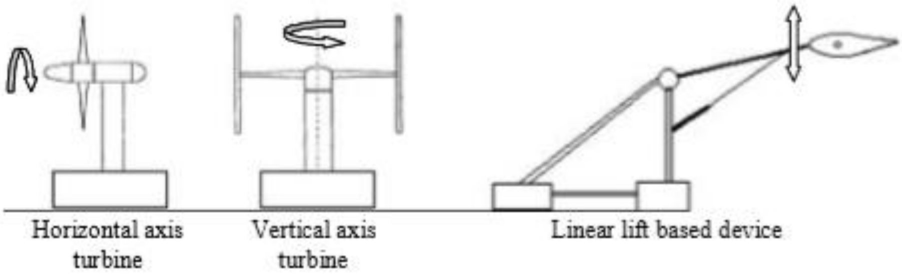


Fig. 5. 12 Tidal turbine fundamental types
Source: MCT

b) Marine Current Projects in the world

- The Marine Current Turbine (MCT) Projects (UK). A hybrid illustration of the Sea flow turbine illustrated in Fig 5.13. This marine turbine has a 11 m diameter rotor, with full span pitch control, 25 m water depth, and 1.1 km from the nearest landfall in North Devon, UK.Under optimal condition, the marine tidal has reached a 300kW rate power. As an experimental stage, the marine tidal is not connected to the grid but dumps its power into resistance heaters capable.

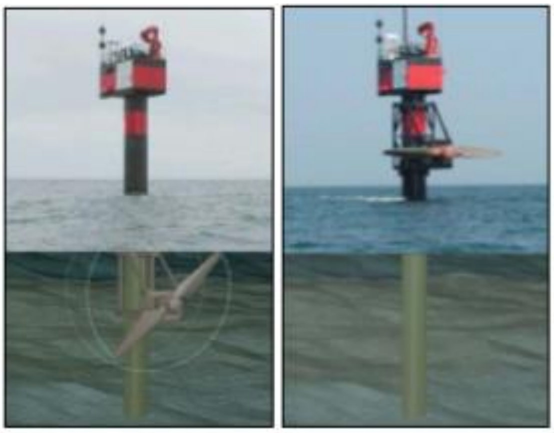
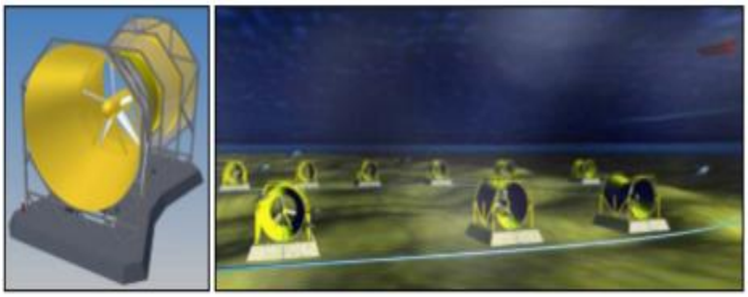


Fig.5. 13 Hybrid Illustration of the sea flow turbine
Source: MCT

- “The Lunar Energy Project (UK) and the Hydro Helix Energies Project (France). These systems feature a ducted turbine, fixed to the seabed via gravity foundation. In principle, the duct captures a large area of the tidal stream and accelerates the flow through a narrowing channel into the turbine”.102
- The Lunar Energy tidal turbine operate bi-directional making thus the design simple and more cost effective (Fig. 5.14).



(a) Lunar turbine. (b) Lunar farm.

Fig. 5. 14 The Lunar Energy system illustration
Source: Lunar

(a) Kobold turbine. (b) Floating platform.

Fig. 5. 13 Enemar Project Italy

Source: Ponte di Archimede

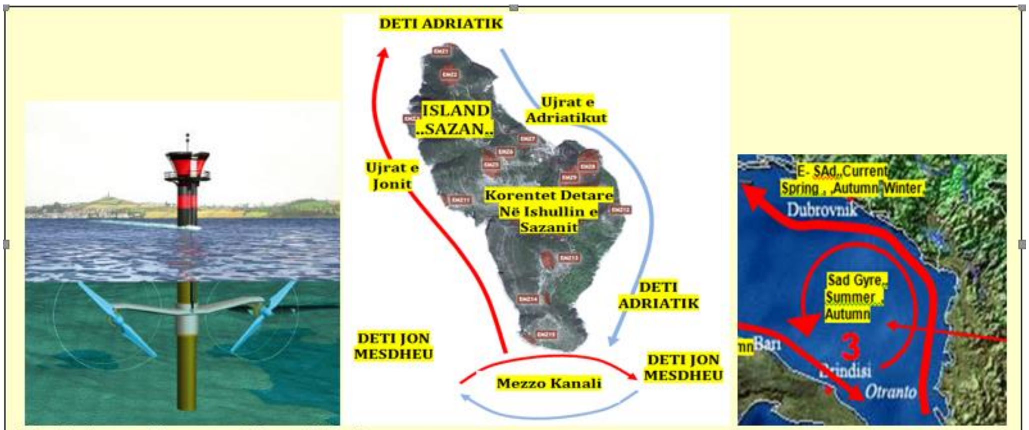
The Enermar Project (Italy) is a patented Kobold turbine. Fig. 5.15 a). "The Kobold turbine has a very high starting torque that makes it able to start spontaneously even in loaded conditions. A pilot plant is moored in the Strait of Messina, close to the Sicilian shore in Italy, in an average sea tidal current of about 2 m/sec (Fig. 5.15b). With a current speed of about 1.8 m/sec, the system can produce a power of 20 kW".[103]

5.8.2 Marine Tidal Current Electric Power Generation in Sazan Island

Sazan Island is located between Strait of Otranto and Bay City of Vlora. The island is bordered by the Adriatic Sea to the north and by the Ionian Sea to the south. Xhevair Ngjeqari talks in his book about the marine power potential of Sazan Island. [104]
According to his observation, Sazan Island poses marine power and suggest three ways that energy can be extracted from the two seas boarding the Island:

1. Wave Energy, which can be generated by surface distortion with a capacity of 5-6-10 kW / m2. [105]

2. Marine and tidal current energy, which can be generated from the sea currents of the water flow between the Adriatic and the Ionian Sea.[106]
3. Sea thermal energy, which can be generated from the temperature difference at Mezzo Channel having the depth of 50 m.[107]



Vendosja e turbinave në Mezzo Kanal
Korentet detare në ishullin e e Sazanit dhe korentet përmanente Adriatikun dhe Jonin Shqiptar

Fig. 5. 15 Marine Current in Sazan Island and the permanent current of Adriatic Sea and Ionian Sea
Source: Xhevair Ngjeqari

For this project, marine and tidal current energy are chosen to be developed for electricity generation, because strong marine current exists where Sazan Island is located. Ngjeqari argues in his book that according to the marine hydrology of Adriatic-, Ionian-, Mediterranean Sea three marine currents exist108 and can generate electricity:

1. Sad Current (south – north) operating for 9 months on the Albanian coast (spring autumn, winter). The currents are caused due to counter clockwise seawater flow entrance of Mediterranean waters into the Adriatic.[109]
2. North-south current, which are present for 6 months, called Sad Gyre (summer, autumn) affect the inner coast of Sazan island. The current come from central Adriatic Sea due to counter clockwise circulation that regulates the temperature and salinity of Bay Vlora.[110]
3. Mezzo Channel has depth of -50 m, and at the bottom, there is a rocky threshold.[111] In fact, the Sazani Island is a continuation of the rocky massif of Karaburun peninsula, but greener and more paved as a terrain. The Mezzo Channel Current has underwater and surface circulation and in height of +50 - 100 m above sea level.[112]

The three current are present in Sazan Island, however annual and monthly measurement need to be measured and researched in more depth. All the three marine current can generate electricity for the island and the Bay of Vlora.

Another Study conducted by Adrian Bilibashi as Country Module Assignment in his Master Studies Renewable Energy Systems, has estimated the following electricity production from the marine tidal current:

Table 5. 19 Marine Tidal Current Electricity Potential generation around Bay Vlora
Source: CSI 2016

Tidal Current Farm	Area (km^2)	Generation GWh/y	Equivalent (ktoe/y)	Power MWe	Hours/year
Potential	1,000	30,000	2,579	6,000	5,000
Technical	50	1,500	128	300	5,000
Practical	50	1,500	128	300	5,000

The potential area for the development of tidal current turbines has been assumed 1000km^2 and rhw technical area 50km^2. The 50km^2 have the capacity for 20 turbines of 300kW/km^2, with a water speed 1-2m/s, depth level > 50m.[113]

The annual power generation was estimated 30GWh/km^2 [114](Table 5.19).

CHAPTER 6

Conclusions and Recommendations

6.1 CONCLUSIONS

The study was focused on estimating renewable energy potentials in Sazan Island. Accordingly, the simulation on the potential energy was conducted, implying that the energy demand could be met. As such, the main objective is to conduct a feasibility analysis by developing Smart Island with a smart grid with solar, wind and marine currents to reach self-sufficiency.

- Evaluation of the Government Management Plan

Because of the completion of the literature review, the study identified two management plans for Sazan Island. The administrative technical evaluation of the Albanian government proposal to designate the island as a protected area was analysed. In this regard, the natural ecological, cultural values like flora, fauna, and vegetation were investigated. Therein it was found that Sazan Island does not possess any cultural, architectural and historical heritage. After comparing the different management proposals and choosing the second proposal to develop and urbanize Sazan as a smart island. The latter allowed advancing the knowledge that the physical conditions of Sazan Island are appropriate and very good to be urbanised and populated by humans. Owing that Sazan Island can be urbanized, an urbanisation scenario was proposed. Thus, the proposal to declare Sazan Island as a free economic zone to develop sustainable tourism by applying smart grid with renewable energy was simulated.

- Estimation of renewable energy potentials

The renewable energy potentials from solar power, wind power and marine currents were estimated for Sazan Island based on geographic and climatic conditions.
Real-time weather data were applied in the simulation to calculate renewable energy utilisation. Albanian Energy Association data were used in the simulation to calculate

renewable energy utilization as climatic and weather data in this research. The energy demand of Gibraltar was chosen as a reference point for Sazan Island, since the latter is uninhabited. World data and National Action Plan for Energy Efficiency in Gibraltar were adopted. Based on the case study following conclusions can be drown:

1. Marine current power had the highest potential for electricity production, followed by wind power and solar power. The estimation has shown that for the simulated urbanisation of Sazan Island applying smart grid for 1000 Eco villas and 5000 habitants:
    a. 3.598,00kWh/year could be produced from solar power in one Eco Villa
    b. 450.852,00kWh/year could be produced by one wind power 100kW
    c. 1500 GWh/year could be produced from marine current power
2. Renewable energy was sufficient to fulfil electricity demand for the simulated 1000 Eco Villas of 5000 habitants and even up to 34,000.00 habitants like in Gibraltar. The electricity demand in Gibraltar is 188.60 mio kWh/ year and 5,455 kWh per capita per year for a population of 34 000 habitants. Alone the marine current could meet this demand.
3. The self-sufficiency of Sazan Island could be achieved only through efficient management of energy and integration of renewable energies into smart grid.
4.

Table 6. 1 Energy Balance in Gibraltar
Source: World Data

Electricity	total	Gibraltar per capita
Own consumption	188.60 m kWh	5,455.44 kWh
Production	194.60 m kWh	5,629.00 kWh

Table 6. 2 Energy Output from Solar, Wind and Marine Current Power
Source: Own

	Solar Power (kWh)	Wind Power (kwh)		Total (kWh)	Marine Current GWh
Rated Capacity	3kW	1kW	100 kW		6000MW
Year	3.598,00	1.307,00	450.852,00	454.450,00	1500
Month	300,00	109,00	37,57	337,57	125,00
Day	10,00	3,60	1.235,20	1.245,20	4,16

6.2 RECOMMENDATIONS

This research has revealed a new perspective on managing Sazan Island. It has identified a range of areas for attention and suggests the following recommendations:

1. Limiting Sazan Island to a protected area is a significant barrier to develop Albanian coast. Albanian coast length of 427km remains undeveloped and only 10% of it has been used. Sazan Island needs to be declared as a free economic zone and open for sale internationally. The development of Sazan Island for tourism shed lights on the need of developing Albanian coast, which will open new perspectives for the country and the entire region.
2. There is a need to explore and study the potential and development of Albanian coast. It is important to address how its potential affects opening a new chapter of change and development of Albanian natural resources and the future of the nation.
3. There is a need to explore studies of renewable energy solutions for sustainable tourism in Albanian coastline. Research could study and explore more in depth the feasibility study of Sazan Island.

7 REFERENCES

[1] Trading Economy,''Albania GDP," Accessed on June 12. 2018. https://tradingeconomics.com/albania/gdp

[2] Wolrd Bank, ``World Bank in Albania Snapshot, `` Accessed June 12, 2018. pubdocs.worldbank.org/en/492941524131007829/Albania-Snapshot-Spring2018.pdf

[3] Wolrd Bank, ``World Bank in Albania Snapshot

[4] Wolrd Bank, ``World Bank in Albania Snapshot

[5] Österreichische Entwicklungsbank, "Study Energy Efficiency Finance Country Profile file:///C:/Users/Vojna/AppData/Local/Packages/Microsoft.MicrosoftEdge_8wekyb3d8bbwe/TempState/Downloads/OeEB-Study-Energy-Efficiency-Finance-Albania%20(1).pdf, Accessed on June 12, 2018.

[6] Artan Leskoviku, "Eighth International Forum on Energy for Sustainable Development, " Presentation (2017) https://www.unescwa.org/sites/www.unescwa.org/files/events/files/1.7_re_project_from_albania-_artan_leskoviku.pdf, Accessed June 12, 2018

[7] Artan Leskoviku, "Eighth International Forum on Energy for Sustainable Development.

[8] Anastasios Giamouridis, "Natural Gas in Greece and Albania," Oxford Institute for Energy Studies (2015): 21.

[9] See Ibid.

[10] AKBN source 2017

[11] See Albania Energy Association, "Hydro Energy Potential in Albania,“ 2012, http://aea-al.org/wp-content/uploads/2012/04/HYDRO-ENERGY-ALBANIA.pdf Accessed June 14, 2018.

[12] See Ministry of Energy, "National Action Plan for Renewable Energy Resources in Albania 2015-2020, “ pg. 6,

[13] Ministry of Energy, "National Action Plan for Renewable Energy Resources in Albania 2015-2020, “ pg. 6.

[14] Albania Energy Association, "Hydro Energy Potential in Albania,“ 2012.

[15] See Albania Energy Association, "Hydro Energy Potential in Albania,“ 2012.

[16] See Albania Energy Association, "Hydro Energy Potential in Albania,“ 2012.

[17] See Albania Energy Association, "Hydro Energy Potential in Albania,“ 2012.

[18] World Bank Report 2009.

[19] Tomas Markvart, "*Sizing of hybrid photovoltaic-wind energy systems*," Solar Energy, vol.57, no. 4, (1996): 277–281.

[20] M. A. Habib, S. A. M. Said, M. A. El-Hadidy, and I. Al-Zaharna, "Optimization procedure of a hybrid photovoltaic wind energy system," Energy, vol. 24, no. 11. (1999) :919–929

[21] W.Zhou, C.Lou, Z.Li, L.Lu, and H.Yang, "Current status of research on optimum sizing of stand-alone hybrid solar-wind power generation systems," Applied Energy, vol. 87, no. 2. (2010): 380–389.

[22] Albania Eergy Association

[23] J. A. Jardini, C. M. V. Tahan, M. R. Gouvea, S. U. Ahn, and F. M. Figueiredo, "Daily load profiles for residential, commercial and industrial low voltage consumers," IEEE Transactions on Power Delivery, vol. 15, no. 1, (2000):375–380.

[24] Lingxi Mi, "Analysis on Energy Balance for a Smart Grid in Stadtshavens Area, Rotterdam," Master Thesis, Delft University of Technology, 2012, 20-25.

[25] Lingxi Mi, "Analysis on Energy Balance for a Smart Grid in Stadtshavens Area, Rotterdam," Master Thesis, Delft University of Technology, 2012, 20-25.

[26] Lingxi Mi, "Analysis on Energy Balance for a Smart Grid in Stadtshavens Area, Rotterdam," Master Thesis, Delft University of Technology, 2012, 20-25.

[27] Prifti, 2012.

[28] Kristbjorn Helgason, Selecting optimum location and type of wind turbines in Iiceland, Master Thesis, Reykjavík Universit, 2012.

[29] Lingxi Mi, 2012, 20-25.

[30] Manwell, James. (2010). Wind Energy Explained. John Wiley & Sons

[31] Ibid., 20-25.

[32] P. Katti and M. Khedkar, “Alternative energy facilities based on site matching and generation unit sizing for remote area power supply,” Renewable Energy, vol. 32, no. 8. (2007): 1346–1362.
[33] Lingxi Mi, 2012, 20-25.
[34] Lingxi Mi, 2012, 20-25.
[35] Lingxi Mi, 2012, 20-25.
[36] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 9.
[37] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 9.
[38] Xhevair Ngjeqari, Mesdheu-Adriatiku. Projektimi i Porteve Tregtare Turistike Pedhkimi dhe Realizimi ne Bregdetin Shqiptar (Tirane:Grafon, 2017), 271. (In Albanian)
[39] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 17.
[40] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 17.
[41] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 17
[42] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 17
[43] Xhevair Ngjeqari, 2017, 272.
[44] Xhevair Ngjeqari, 2017, 272.
[45] Kashta et al., 2011.
[46] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 18.
[47] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 18
[48] Xhevair Ngjeqari, 2017, 272.
[49] Xhevair Ngjeqari, 2017, 272.
[50] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 19.
[51] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 19.
[52] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 19
[53] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 36.
[54] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 36
[55] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 36
[56] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 36.
[57] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 38.
[58] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 38
[59] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 38
[60] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 38
[61] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 43.
[62] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 43
[63] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 43
[64] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 44
[65] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 37.
[66] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 37.
[67] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 37.
[68] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 19.
[69] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 24.
[70] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 24.
[71] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 24.
[72] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 24.
[73] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 24.
[74] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 28.
[75] Ibid., 28.
[76] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 28.
[77] Wolfgang Böhme et al, *Algyroides nigropunctatus. The IUCN Red List of Threatened Species 2009.*
[78] Agjensia Kombëtare e Bregdetit, “Management Plan for Sazani Island, Albania,” pg. 33.
[79] Ibid., 33.
[80] Ministry of Environment Albania, Synthesis of Sazani Island Management Plan, 2014, Tirane, 2014.
[81] Ministry of Environment Albania, Synthesis of Sazani Island Management Plan, 2014, Tirane, 2014.
[82] Ministry of Environment Albania, Synthesis of Sazani Island Management Plan, 2014, Tirane, 2014.

[83] Ministry of Environment Albania, Synthesis of Sazani Island Management Plan, 2014, Tirane, 2014.
[84] Ministry of Environment Albania, Synthesis of Sazani Island Management Plan, 2014, Tirane, 2014.
[85] Xhevair Ngjeqari, Mesdheu-Adriatiku. Projektimi i Porteve Tregtare Turistike Pedhkimi dhe Realizimi ne Bregdetin Shqiptar (Tirane:Grafon, 2017), 271. (In Albanian)
[86] Interview with Xhevair Ngjeqari, August 3, 2018.
[87] Eco Chung green living " Villa Sera : A self sustaining structure for a clean future," http://www.ecochunk.com/2728/2012/09/27/villa-sera-a-self-sustaining-structure-for-a-clean-future/, Accessed July 18, 2018.
[88] Eco Chung green living " Villa Sera
[89] (EBRD, 2010)
[90] Albania Energy Association, " Albania Solar Energy Report ," 2013, aea-al.org/albania-solar-energy/
Accessed June 18, 2018
[91] Albania Energy Association, "Albania Solar Energy Report ," 2013.
[92] Seifeddine Benelghali et al, 2007, 1407-1412.
[93] Seifeddine Benelghali et al, 2007, 1407-1412.
[94] J.F. Manwell & Rogers, 2002, 63
[95] Seifeddine Benelghali et al, 2007, 1407-1412.
[96] Seifeddine Benelghali et al, 2007, 1407-1412.
[97] Seifeddine Benelghali, Mohamed Benbouzid, JeanFrédéric Charpentier. Marine TidalCurrent Electric Power Generation Technology: State of the Art and Current Status. IEEE IEMDC'07, May 2007, Antalya, Turkey. 2, (2007): 1407-1412
[98] Seifeddine Benelghali, Mohamed Benbouzid, JeanFrédéric Charpentier
[99] Seifeddine Benelghali et al, 2007, 1407-1412.
[100] Seifeddine Benelghali et al, 2007, 1407-1412.
[101] Seifeddine Benelghali et al, 2007, 1407-1412.
[102] Seifeddine Benelghali et al, 2007, 1407-1412.
[103] Seifeddine Benelghali et al, 2007, 1407-1412.
[104] Xhevair Ngjeqari, Mesdheu-Adriatiku. Projektimi i Porteve Tregtare Turistike Pedhkimi dhe Realizimi ne Bregdetin Shqiptar (Tirane:Grafon, 2017), 271. (In Albanian)
[105] Xhevair Ngjeqari, 2017, 271.
[106] Xhevair Ngjeqari, 2017, 271.
[107] Xhevair Ngjeqari, 2017, 271.
[108] Xhevair Ngjeqari, 2017, 271.
[109] Xhevair Ngjeqari, 2017, 271.
[110] Xhevair Ngjeqari, 2017, 271.
[111] Xhevair Ngjeqari, 2017, 271.
[112] Xhevair Ngjeqari, 2017, 271.
[113] Ardian Bilibashi, "Renwable Energy in Albania, Country Module", CEC Vienna University of Technology, 2018, 88-90.
[114] Ardian Bilibashi, "Renwable Energy in Albania, Country Module", CEC Vienna University of Technology, 2018, 88-90.

8 BIBLIOGRAPHY

Albania Energy Association. *Albania Solar Energy Report*. aea-al.org/albania-solar-energy/ (accessed June 18, 2018).

Albania Energy Association. *Hydro Energy Potential in Albania*. http://aea-al.org/wp-content/uploads/2012/04/HYDRO-ENERGY-ALBANIA.pdf (accessed June 14, 2018).

Bahaj S. Abubakr and Luke Myers. "Fundamentals applicable to the utilisation of marine current turbines for energy production." *Renewable Energy*, 2003, no. 28: 2205-2211.

Benelghali, Seifeddine, Mohamed Benbouzid, and Jean Frédéric Charpentier. "Marine Tidal Current Electric Power Generation Technology: State of the Art and Current Status." *IEEE IEMDC'07*, no. 2, (2007): 1407-1412.

Bilibashi, Ardian. "Renwable Energy in Albania, Country Module". CEC Vienna University of Technology, 2018.

Billinton, Roy and Karki, Rajesh. "Capacity expansion of small isolated power systems using pv and wind energy." *IEEE Power Engineering Review 21*, no. 10 (2001): 62–62.

Eco Chung green living. *Villa Sera : A self sustaining structure for a clean future*. http://www.ecochunk.com/2728/2012/09/27/villa-sera-a-self-sustaining-structure-for-a-clean-future/, (accessed July 18, 2018).

Frearson, Amy. *EFFEKT design ReGen Villages that could produce all thei own food and energy*. https://www.dezeen.com/2016/05/20/effekt-designs-regen-villages-produce-own-food-energy-danish-pavilion-venice-architecture-biennale-2016/ (accessed July 18, 2018).

Giamouridis, Anastasios. "Natural Gas in Greece and Albania Research Paper." Research Paper, Oxford Institute for Energy Studies, 2015.

Habib, M.A., Said, S.A.M., El-Hadidy, M.A., Al-Zaharna. "Optimization procedure of a hybrid photovoltaic wind energy system." *Applied Energy*, no. 11 (1999):919–929.

Helgason, Kristbjorn. "*Selecting optimum location and type of wind turbines in Iiceland*." Master diss., Reykjavík University, 2012.

Invest in Albania. *45% of produced crude oil in Albania is used for domestic consumption, 2015*. https://invest-in-albania.org/45-of-produced-crude-oil-in-albania-is-used-for-domestic-consumption/ (accessed June 26).

Jardini, A. Jose, Tahan, M. V. Carlos, Gouvea R. Marcel, Se Un Ahn, and Figueiredo, M Fidel. "Daily load profiles for residential, commercial and industrial low voltage consumers." *IEEE Transactions on Power Delivery*, no. 1 (2000):375–380.

Katti, Pradeep and Khedkar, Mohan. "Alternative energy facilities based on site matching and generation unit sizing for remote area power supply." *Renewable Energy 32*, no. 8 (2007): 1346–1362.

Leskoviku, Artan. *Eighth International Forum on Energy for Sustainable Development Presentation*. https://www.unescwa.org/sites/www.unescwa.org/files/events/files/1.7_re_project_from_albania-_artan_leskoviku.pdf (accessed June 12, 2018).

Lingxi, Mi. "*Analysis on Energy Balance for a Smart Grid in Stadtshavens Area, Rotterdam*." Master diss., Delft University of Technology, 2012.

Lombardo, Tom. “Rooftop Wind Turbines.” *Engineering*. February 8, 2015. https://www.engineering.com/3DPrinting/3DPrintingArticles/ArticleID/9556/Rooftop-Wind-Turbines-Are-They-Worthwhile.aspx,, (accessed August 2, 2018).

Markvart, Tomas. “Sizing of hybrid photovoltaic-wind energy systems.” *Solar Energy 57*, no. 4 (1996): 277–281.

Ministry of Environment, Agjensia Kombëtare e Bregdetit. *Management Plan for Sazani Island, Albania.* January 2015, Technical Document, Online.

Ministry of Environment Albania. “*Synthesis of Sazani Island Management Plan*.” 2014, Technical Document, Tirane.

Ministry of Energy. “National Action Plan for Renewable Energy Resources in Albania 2015-2020.” National Action Plan, 2015.

Ngjeqari, Xhevair. *Mesdheu-Adriatiku. Projektimi i Porteve Tregtare Turistike Pedhkimi dhe Realizimi ne Bregdetin Shqiptar*. Tirane: Grafon, 2017. (In Albanian)

Österreichische Entwicklungsbank. *Study Energy Efficiency Finance Country Profile*. file:///C:/Users/Vojna/AppData/Local/Packages/Microsoft.MicrosoftEdge_8wekyb3d8bbwe/TempState/Downloads/OeEB-Study-Energy-Efficiency-Finance-Serbia%20(1).pdf (accessed on June 12, 2018).

Seng, Yun, and Song Lee Koh. “Marine Tidal Electric Power Generation; State of the Art and Current Status.” Research Paper, University of Tunku Malaysia, 2009.

Tirana Times, World Petroleum Congress. *Albania lures foreigner investors through incentives*. http://www.tiranatimes.com/?p=133185 (accessed June 12, 2018).

Trading Economy. *Albania GDP*. https://tradingeconomics.com/albania/gdp (accessed on June 12. 2018).

Transition Report 2017-18: Sustaining Growth. *Country Assessments: Albania*. file:///C:/Users/Vojna/Downloads/transition-report-201718-albania.pdf (accessed on June 12).

Varinsky Dana. *The 'Tesla of eco-villages' is developing off-grid villages that grow their own food and generate their own power*. https://www.businessinsider.de/self-sufficient-village-regen-2016-9?r=US&IR=T (accessed July 18, 2018).

Wind Turbine Star. *Aeolos-H Turbine Profile*. http://www.windturbinestar.com/100kwh-aeolos-wind-turbine.html, (accessed August 10, 2018).

Wolrd Bank. *World Bank in Albania Snapshot*. pubdocs.worldbank.org/en/492941524131007829/Albania-Snapshot-Spring2018.pdf (accessed June 12, 2018).

Zhou,Wei, C.Lou, Z.Li, L.Lu, and H.Yang. “Current status of research on optimum sizing of stand-alone hybrid solar-wind power generation systems.” *Applied Energy 87*, no. 2 (2010).

9 LIST OF TABLES

10 LIST OF FIGURES