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A startup that revolutionize the access to solar energy in Algeria
TaQa-Tech

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Dedication:

الحمد لله الذي أنشأ وبرى ... وخلق الماء والثرى

وأبدع كل شيء وضرى ... الرحمان على العرش استوى

والصلاة والسلام على من بكى ... على أمته المبعوث في أم القرى

صلى الله وسلم على الحبيب المصطفى

أما بعد، فإنما طلبنا العلم لوجه الله تعالى ولم نرد بذلك إلا وجه الله وذلك حب الله يؤتيه من يشاء
وقال تعالى: **{يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنْكُمْ وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَات}** وقد رفعنا الله بذلك، فأسأله أن يرفع مقامنا في الاخرة كما رفعه في الدنيا

إنما طلبت العلم لوجه الله ثم لأفرح والدي وعائلتي ورفقاء دربي وأساتذتي وجميع من ساهم في نجاحي وتفوقي
فإلى جميع من ساندني وقدم لي يد العون خلال رحلتي، **أهدي إليكم هذا العمل المتواضع، ثمرة جهودي ومساعيي**

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{وَآخِرُ دَعْوَاهُمْ أَنِ الْحَمْدُ لِلَّهِ رَبِّ الْعَالَمِينَ}

الحمد لله حبا وشكرا وامتنانا، الحمد لله الذي بفضله أدركت أسمى الغايات.

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وآخر دعوانا أن الحمد لله رب العالمين

CHEURFI Ghada Imane

بسم الله الرحمن الرحيم

"وَقُل رَّبِّ زِدْنِي عِلْمًا" طه (114)

حكاية اكتملت فصولها وخيوط انتهى التألق من غزلها

الحمد لله حمدا وافرا فما سلكنا البدايات الا بتيسيره وما بلغنا النهايات الا بتوفيقه

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اللهم انفعني بما علمتني

"وَآخِرُ دَعْوَاهُمْ أَنِ الْحَمْدُ لِلَّهِ رَبِّ الْعَالَمِينَ" يونس(10)

LOUGHRAICHI Mohamed

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Abstract:

Today’s world faces significant challenges, including the transition to renewable energies, notably wind power, hydroelectricity, biomass, and above all, solar energy, which stands out for its immense potential and adaptability to diverse geographical conditions compared with other types of energy to fight climate change and satisfy growing energy demand while eliminating harmful environmental impact.

Although the country's solar potential is immense in Algeria, several obstacles stand in the way of this transition, like the complexity and cost of primary energy sizing and the inaccessibility of reliable information and energy products.

To overcome these challenges, a dedicated mobile application could respond to these needs in the solar energy sector by providing three primary services that facilitate the link between the world of solar energy and a requester of energy service, job, or product.

Simplifying energy sizing, facilitating contact with experts in the field, and providing an up-to-date exposition space encourage the adoption of solar energy and indirectly contribute to reducing pollution caused by conventional electricity.

Key words: Application, solar energy, Algeria, solar installation, Sizing, experts, Algorithm, Programing, Photovoltaic,

Résumé:

Le monde actuel est confronté à des défis majeurs parmi lesquels la transition vers les énergies renouvelables notamment l’éolien, l’hydroélectrique, la biomasse et surtout le solaire qui se distingue par son potentiel immense et son adaptabilité aux diverses conditions géographiques comparant avec d’autres types d’énergie afin de lutter contre le changement climatique et répondre à la croissance de la demande énergétique en éliminant l’impact nocif environnemental.

En Algérie, malgré son potentiel solaire immense, plusieurs obstacles freinent cette transition, notamment la complexité et le coût du dimensionnement énergétique primaire et l’inaccessibilité à des informations fiables et des produits énergétiques. Pour surmonter ces défis, une application mobile dédiée pourrait répondre à ces besoins dans le secteur de l’énergie solaire en assurant trois principaux services qui facilite le lien entre le monde de l’énergie solaire et un demandeur de service, travail ou produit énergétique.

Simplifiant ainsi le dimensionnement énergétique, facilitant le contact avec des experts dans le domaine et fournissant un espace d’exposition à jour ce qui encouragerait l’adoption de l’énergie solaire et contribuerait de façon indirecte à réduire la pollution causée par l’électricité conventionnelle.

Mots-clés : Application mobile. Énergie solaire, Algérie, Installation solaire, Dimensionnement, expert, Algorithme, Photovoltaïque,

الملخص:

يواجه العالم اليوم تحديات كبيرة من بينها الانتقال إلى الطاقات المتجددة، لا سيما طاقة الرياح والطاقة الكهرومائية والكتلة الحيوية وقبل كل شيء الطاقة الشمسية التي تتميز بإمكانياتها الهائلة وقدرتها على التكيف مع مختلف الظروف الجغرافية مقارنة بأنواع الطاقة الأخرى، وذلك من أجل مكافحة تغير المناخ وتلبية الطلب المتزايد على الطاقة مع التخلص من التأثيرات البيئية الضارة.

في الجزائر، على الرغم من الإمكانات الهائلة للطاقة الشمسية في البلاد، إلا أن هناك عدد من العقبات التي تقف في طريق هذا التحول، مثل تعقيدات وتكلفة تحديد حجم الطاقة الأولية وعدم إمكانية الوصول إلى المعلومات الموثوقة ومنتجات الطاقة.

للتغلب على هذه التحديات، يمكن لتطبيق مخصص للهاتف المحمول أن يستجيب لهذه الاحتياجات في قطاع الطاقة الشمسية من خلال توفير ثلاث خدمات رئيسية تسهل الربط بين عالم الطاقة الشمسية وطالب خدمة أو وظيفة أو منتج الطاقة.

ومن شأن تبسيط عملية تحديد حجم الطاقة، وتسهيل الاتصال بالخبراء في هذا المجال، وتوفير مساحة عرض حديثة أن يشجع على اعتماد الطاقة الشمسية ويساهم بشكل غير مباشر في الحد من التلوث الناجم عن الكهرباء التقليدية.

الكلمات المفتاحية: الطاقة الشمسية، تركيب الألواح الشمسية، الجزائر، تطبيق هاتف، تحجيم الأنظمة،

Table of abbreviations / acronyms

RnE	Renewable Energy
NREL	National Renewable Energy Laboratory
pv	Photovoltaic
UI/UX	User interface / User experience
iOS	iPhone Operating System
CC	Creative Cloud
IDEs	Integrated Development Environments
IOT	Internet of Things
Pt	The appliance's power consumption (W).
t	hourly usage time (h)
Ec	Energy consumption (W)
P_p	the peak power of the photovoltaic array (w/m^2)
I_r	Average daily global solar irradiation received by (1 m2) area of the PV array
K	Performance ratio
Np	number of the panels
C	Capacity of the battery (Ah)
U_b	The voltage of the battery (V)
N_D	Desired number of days of system autonomy.
D	Depth of Discharge (DOD).
η_B	Battery efficiency
$U_{\max}$	The inverter's maximum input voltage
Voc	exceed the highest voltage the solar panels can produce
$U_{mpp\ min}/U_{mpp\ max}$	The minimum and maximum voltage limits of the inverter's Maximum Power Point Tracking (MPPT) range (V).
$K_{U(Tmin)}$ / $K_{U(Tmax)}$	The Temperature correction factors for voltage determined at the minimum (T_{min}) and maximum (T_{max}) temperatures of the site.
V_{mpp}	The voltage at which a single solar panel produces its maximum power (V).
$I_{\max inverteur}$	The inverter's maximum input current (A)
I_{SC}	The total short-circuits current produced by the solar panels (A)
K_I	the Safety Factor
ρ	cable resistivity (Ωm)
L	Total cable length (round trip) (m)
I	Current flowing through the cable. (A)
ε	The maximum permissible voltage drop (%)
V_A	Reference voltage at the origin of the cable. (V)
N_d	Dynamic level (m)
H_r	reservoir height (m)

H_f	The total losses
E_{hyd}	Hydraulic energy [Wh/day].
P_{hyd}	Hydraulic power [W].
C_H	Hydraulic constant [Wh/m^4]
η_{MP}	The pump efficiency.
P_{inv}	Inverter power [W].
η_{inv}	Inverter efficiency
P_p	Peak power of PV(w_c or Wp)
n	Coefficient of loss due to temperature, dust, electrical losses
nb_{PV}	Total panels number.
P_{panel}	Peak power of a PV panel [Wc].
A_c	Number of person
nb_T	Number of tubes in the collector.
V_{Tank}	The Tank volume [L].

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General introduction

The fight against climate change and the search for sustainable energy security drive the world towards renewable energies (RnE) to meet growing energy needs while reducing environmental impact.
However, this transition is accompanied by several challenges. In Algeria, many specific problems stand in the way of this transition, particularly in the field of solar energy.
In these challenges, renewable energies, known as "green energy" or "clean energy," offer a sustainable and essential solution. These energy sources, such as wind power, hydroelectricity, biomass, and, above all, solar power, represent a range of ways of producing electrical energy from theoretically unlimited and inexhaustible sources.
Among these renewable energies, solar power stands out for its vast potential and adaptability to diverse geographical conditions compared with other types of energy. Moreover, solar installations are modular and flexible, suitable for a wide range of energy needs, and have less visual and environmental impact, unlike wind turbines or biogas.
With its abundant sunshine, solar energy could revolutionize the energy sector in Algeria. However, several issues need to be overcome to achieve this goal. Primary energy sizing, essential for solar system installations, is still a complex and costly process, discouraging many potential operators and users, who often need help with technical and financial difficulties to determine the correct energy capacity and optimize their installations.
In addition, the inaccessibility of reliable sources perturb the search and the testing of information, holding back the quality of knowledge and informed decision-making.
On one side, lack of awareness and limited access to reliable solar energy products and information create significant challenges for sellers and experts. This lack of credible and accessible sources of information weakens their confidence in the solar technologies available.
Conversely, the need for energy autonomy compounded by frequent electricity problems due to limited access to energy in sparsely populated rural areas far from existing electricity grids makes energy management even more critical in these regions.
Finally, pollution caused by conventional electricity generation is a growing environmental problem, contributing significantly to greenhouse gas emissions and environmental damage. This reality underlines the need for cleaner and more sustainable energy solutions, particularly solar energy.

To face these challenges, creating a dedicated mobile application could revolutionize the solar energy sector in Algeria. Providing customers with a functional, user-friendly, and more efficient interface, accessibility, and portability, enabling them to access information and services anytime and anywhere, even offline, and benefiting from practical real-time functionalities that increase engagement.

This application would be designed to simplify primary energy sizing, making the process more accessible and less costly. It would also provide reliable, up-to-date information on solar products and technologies, raising awareness and confidence among potential users. In addition, the app could help overcome logistical and infrastructural obstacles, offering solutions adapted to isolated areas and promoting energy autonomy. Finally, by facilitating access to several services in the solar energy sector, the app would help encourage users to go solar, thereby indirectly reducing the pollution caused by conventional electricity production.

By connecting users, experts, and sellers in a fluid and efficient way, this application could transform the solar energy field in Algeria, allowing accessible and comprehensible use of its three (03) primary services:

- Primary sizing of the different types of solar installations (photovoltaic panels, solar water heaters, solar pumps, and generators).
- Find an expert in the solar energy field for any consultation or work request.
- Having a diversified choice of solar equipment in an exhibition space.

The work presented in this dissertation concerns implementing a multiplatform application to provide the three (03) services noted by connecting the world of solar energy with a requester of service, work, or energy product. This dissertation contains four (04) chapters entitled:

- **Chapter 01:** Actual situation and local insight.
- **Chapter 02:** Application background review.
- **Chapter 03:** Overview on the sizing features and principals.
- **Chapter 04:** Case study and results discussion.

1.Chapter 01: Actual situation and local insight

1.1 Introduction

The global pursuit of Renewable Energy (RnE) is driven by environmental concerns, resource depletion, and economic crises. Solar energy, within RnE, offers an abundant alternative.

This chapter investigates the prospect of solar energy in Algeria by examining the Algerian government's current and future strategies for integrating solar energy alongside the social and economic advantages of solar power. This chapter discusses the rise of mobile applications and software tools in this field by evaluating existing solutions.

1.2 Algeria insight

Since the oil price crisis in 1980, the Algerian government has considered solar energy a possible replacement for fossil fuels. Setting new regulations and forming specialized agencies, all to limit the country's dependency on fuel as a first income and restrict the massive reliance on petrol and natural gas in electricity production.

1.2.1 The current state

Through the "Development Plan for Energy Efficiency and Renewable Energy," Algeria put a fixed foot in the world of RnE; during the program's phases, several projects and actions were carried out.[3]

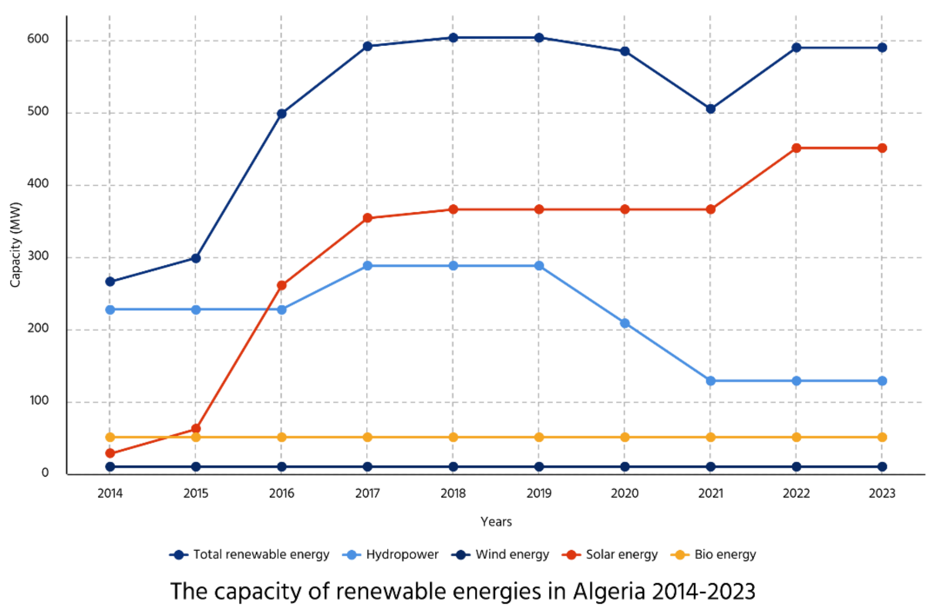

Figure -1 The chart shows the country's RnE capacity evolution from 2014 to 2023, with the rise in solar energy capacity compared to the stability in the other forms.[4]

1.2.2 The future insight

The Algerian primary plan, the "Development Plan for Energy Efficiency and Renewable Energy," was proposed on Feb. 03, 2011, and revised in May 2015.

The updated version (2015) aimed to install 4500 MW of new projects for 2020 and an overall 22.000 MW by 2030.[5]

The 2030 Target capacity is:

- **Solar PV: 13 575 MW**
- **Wind: 5010 MW**
- **Solar Thermal: 2000 MW**
- **Biomass: 1 000 MW**
- **Cogeneration: 400 MW**
- **Geothermal 15 MW**

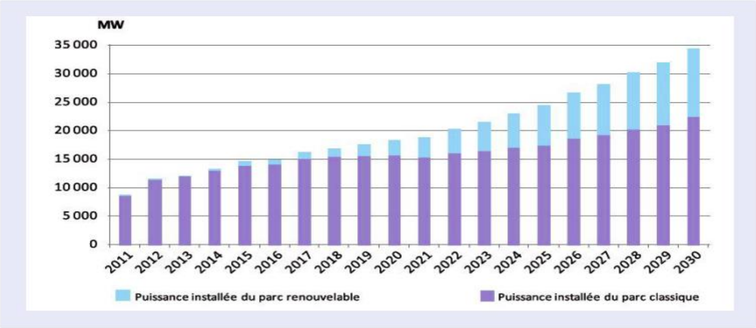

Figure 2 the government plan of electricity production [6]

If the above capacity target is achieved, renewable generation share in total power generation of Algeria will reach 27% in 2030.[3]

1.3 Solar energy potential in Algeria (motivation/drawbacks)

Problem	Motivation
Despite the favorable conditions for solar energy in Algeria, the lack of awareness and the fear of the new market with several other barriers prevent its optimal use Complexity and the expensive cost of Energy Sizing discourage potential users from adopting solar solutions. Finding qualified professionals and accurate up-to-date information on the solar world and technologies is limited. The limited Availability of Solar Products is challenging due to the fragmented market and the need for centralized information sources.	The country's regulations and support for investment and new companies in the field. Algeria has one of the highest solar deposits. There are more than 2,000 hours of sunlight yearly. It can reach 3900 hours, in the high plateaus and the Sahara desert, around 80 percent of the country's area [1]. The total solar energy received per day varies from 5.1 KWh in the North and 6.6 KWh in the Deep South.[2] According to the French expert Gil Bonavi, Algeria uses only 0.003 percent of its solar energy. According to one estimate, 254km2 in the Sahara would meet the total electricity demand of the world.[1]

Table 1: Solar energy potential and drawbacks in Algeria

1.4 Literature Review on other existing solution

Several mobile applications and platforms globally have been developed to support the adoption of solar energy.

	Feature	The gaps		
		Regional Adaptation	Services	Complexity
SolarEdge Monitoring	SolarEdge Monitoring provides real-time solar power production and consumption data, system health alerts, and detailed energy usage reports.	SolarEdge Monitoring is a global series of applications and does not offer specific adaptations or localized data for Algerian users.	It focuses on monitoring existing installations and does not assist with initial sizing, finding experts, or providing a marketplace for products.	The platform require the email address as a first step, without the Algerian location and made only for SolarEdge installations
PV Watts Calculator	Developed by the National Renewable Energy Laboratory (NREL), PVWatts Calculator estimates grid-connected PV energy systems' energy production and cost savings.	It does not focus on all the Algerian market, missing out on local regulatory, environmental, and market-specific details.	It does provide integrated services for initial system sizing but only in Algiers location, without expert consultation, or an equipment marketplace.	Adding the location is manually, the interface is plane and made only for desktop view plus the complex final report.
Solar-Log™	Offers detailed monitoring, reporting, and energy management for residential and commercial solar PV systems.	Like other global applications, it does not focus on the Algerian market.	The application excels in monitoring but does not provide integrated services for initial system sizing, expert consultation, or an equipment marketplace.	The complex interface, lack of intuitive design, and inability for an initial sizing, necessitate extensive user training and experience.

Table 2: review on existing solution on the market

1.5 Conclusion

However, existing applications often fail to provide comprehensive solutions tailored to the unique needs of specific regions, such as Algeria. Despite the existence of several solar energy applications, there are particular gaps that our application aims to address.

The next chapter will provide some details on the application that will revolutionize the world of solar energy in Algeria.

2.Chapter 02: Application background review

2.1 Introduction

With the growth of technology and smartphones, a company or brand without a dedicated mobile application is rare.

This evolution also affected the renewable energy sector, as now anyone interested may construct a wind farm with thousands of megawatts with just a few clicks on his smartphone.

Due to this expansion in the quantity and quality of mobile applications, the app market is expanding rapidly, particularly in the app development sector.

In this chapter, the mission and the vision of the mobile application are clarified, as well as the services provided and to whom this application is dedicated. Also, this part explores the tools that helped create TaQa-Tech mobile application, from the sketching to the deployment stage, explaining the coding language used and the overall environment that backed the project.

2.2 Our mobile application

2.2.1 Description

TaQa Tech, an innovative mobile application available on Android and iOS, aims to revolutionize access to solar energy in Algeria. Taking advantage of the country's exceptional solar potential, the app aims to overcome the information, complexity, cost, and logistical challenges of installing solar systems.

2.2.2 Services: TaQa tech is an on-demand serviceable mobile application

It offers an intuitive, accessible interface for sizing solar photovoltaic systems, solar pumps, solar water heaters, and diesel generators.

The application provides customized sizing reports and cost estimates

Moreover, TaQa Tech connects users with a network of local, certified, and reliable installers who guarantee high-quality, standards-compliant installation or maintenance.

The exposition platform facilitates researching and comparing solar equipment by providing a base of information and resources.

Finally, TaQa Tech fosters real-time communication between users, sellers, and experts to facilitate transactions and resolve problems.

2.2.3 Client Segment

The clients	The sellers	The experts
● Individuals, and industries interested in solar energy (sizing, installing, equipment, maintenance) ● Individuals, industries looking for an energy consultancy office	● A company that sells electronics/ electricity PV related elements ● A store that wants to promote its merchandise. ● An expert/consultancy agency that wants to promote its services.	● An engineer, an electrician technician looking for primary or parallel work. ● An expert consultancy.

Table 3: The client segment of TaQa Tech

2.3 Realization process

There are many steps between the idea and its realization to transform the vision into a reality ready for usage. Like all mobile applications, there is a process of steps that must be done.

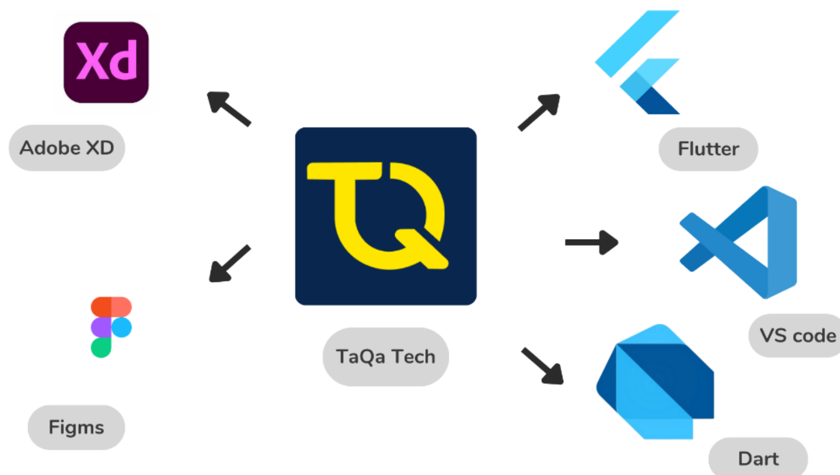

Figure 3: figure represents the tools used to create the app

2.3.1 Design phase

This phase is about sculpting the application's core objectives, services, and mission by creating a user interface (UI) and a user experience (UX). While the UX refers to overall satisfaction with the app, the UI refers to the visual aspects people see on a device.

2.3.1.1 UI/UX design tools

The mission of those tools is to develop the UI/UX for digital goods, like software, websites, and mobile apps. They provide services like wireframing, creating user interface elements, and prototyping. AdobeXD, Figma, and Illustrator were used to design TaQa Teck.

AdobeXD: This is a vector-based [(1)] digital design tool for websites and apps developed by Adobe.Inc, released in 2016 – initially Adobe Experience Design CC (Creative Cloud)-. Used to create and collaborate on prototypes and mockups to execute full app designss.[7]

Figma: This collaborative web application for interface design uses a range of vector graphics editors and prototyping tools. Figma's purpose is to provide a user interface and user experience design with the ability to enable additional offline features through desktop applications for macOS and Window.[8]

2.3.2 Development phase

The development phase entails a rigorous process of turning all the designs into a functional application; this phase balances writing reliable code, testing, and debugging.

2.3.2.1 Integrated Development Environments (IDEs)

Visual Studio Code: Visual Studio Code is a powerful source code editor supporting development operations like debugging, task running, and version control. It comes with built-in support for JavaScript, TypeScript, and Node.js and has a rich ecosystem of extensions for other languages and runtimes such as C++, C#, Java, Python, PHP, Go, .Net, Dar[11]

2.3.2.2 Frameworks

Flutter: Flutter is an open-source framework launched in May 2017 by Google that allows the build of natively compiled, multiplatform Android, iOS, Windows, macOS, Linux, and even Web applications from a single codebase backed by Dart language.[12]

2.3.2.3 **Development Languages**

Dart: Dart language is an open-source general-purpose programming language developed by Google and released in 2011. It supports application development on both the client and server-side; it is widely used for developing Android apps, iOS apps, IoT (Internet of Things), and web applications using the Flutter framework.[13]

2.4 Conclusion

As seen in the chapter, TaQa Tech went through many phases to reach its vision as a tool that links the solar energy world in Algeria and the service seeker, gives experts an opportunity, and offers a primary study on solar energy effectively.

In the next chapter, we will delve into one of the main objectives of TaQa Tech, which represents the innovative and core aspect of the project: sizing.

3.Chapter 03: Overview on the sizing features and principals

3.1 Introduction

Choosing the right equipment for solar systems requires proper sizing, which guarantees optimal system operation. That is why our application offers sizing methods based on algorithms validated by experts in the field, which take into account numerous factors such as local solar radiation, specific energy requirements, equipment characteristics, and weather conditions.

Using current data and precise calculations, the application guides users through every step of the sizing process, ensuring optimal, customized, and cost-effective solutions.

This chapter aims to provide an overview of the sizing principles and techniques used by our app, from sizing photovoltaic and other solar systems like solar heaters, and solar water pumps, to diesel generators, making it easier for people who don't know how to encounter sizing.

3.2 PV sizing

Sizing in Photovoltaic is a crucial step in establishing an installation, even though there are various types of PV installations(OFF-Grid, ON-Grid, Hybrid system), they all share somewhat similar 6 main steps to fully conduct the sizing process.

In the literature sizing is divided into two methods categories:

- The quasi-static method, which described as an empirical method.
- The dynamic methods for the optimal sizing of photovoltaic systems which are classified into several groups as shown in Figure:

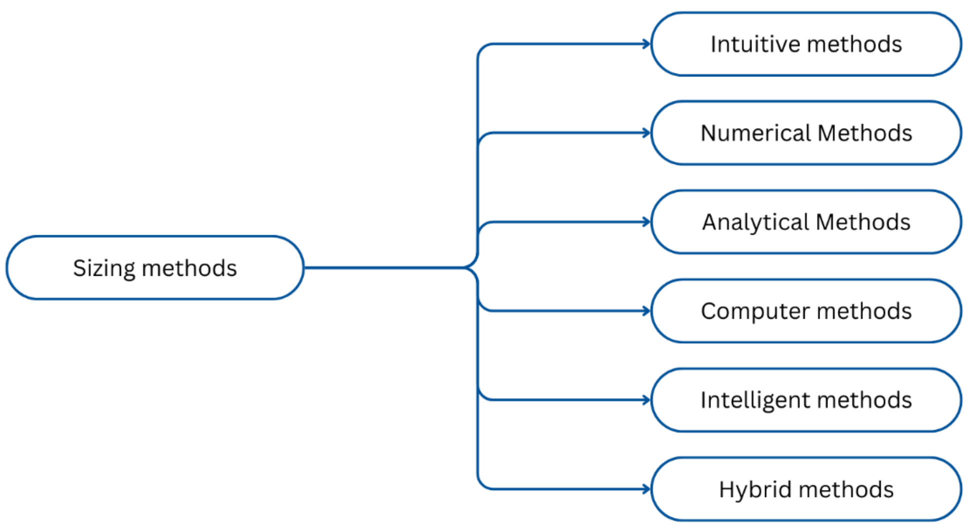

Figure 4: sizing dynamic methods classification

3.2.1 PV Sizing steps

All components of PV installations must be optimally sized, neither too oversized nor too undersized, in order to meet energy needs while also reducing investment costs. For that, our team provide six steps that satisfy the needs in techno-economical way.

STEP01: Calculate the Daily Energy Consumption

It refers to the total amount of energy used over a 24-hour period, typically measured in kilowatt-hours per days (Kwh/j). It is calculated by the sum of multiplying the power consumption (in watts) of each electrical appliance by the number of hours it is used per day. It can be expressed by the equation:

$Ec = \Sigma(Pt * t)\ \ Eq\ I$

Pt: The appliance's power consumption (W).

t: hourly usage time (h).

STEP02: Calculating the Peak Power of the PV Array

This refers to the peak power of the photovoltaic array (P_p) required to meet the energy needs. It depends on whether the PV system incorporates battery storage or not. It can be expressed by the equation:

$$P_p = \frac{E_c}{I_r * K} * 1000\left(\frac{w}{m^2}\right)\ \ Eq\ II$$

- E_c : Daily Energy Consumption (Wh/day)
- I_r : Average daily global solar irradiation received by (1 m^2) area of the PV array ($\frac{Kwh}{m^2 * day}$)

Where I_r is dependent on the geographic location and on time of the year. In our case, we use the geographic location of Annaba and the month with the least amount of irradiation.

Month	Jan	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Sept	Oct	Nov	Dec
$\boldsymbol{I_r(\frac{Kwh}{m^2.day})}$	4.97	4.94	6.77	7.16	7.9	8.66	9.41	9.24	7.09	6.63	5	4.12

Table 4: the monthly average irradiation in ANNABA

- K: Performance ratio, this later considers various factors (equipment efficiency, cable losses, inclination, uncertainties related to weather conditions, etc.) The performance ratio value ranges from 0.70 to 0.85 for ON-Grid and from 0.5.5 to 0.75 for autonomous system.

STEP03: Determining the number of panels

From the peak power P_p we can determine the number of the panels N_p:

$$N_p = \frac{P_p}{P_{panal}} \quad Eq\ III$$

Where: P_{panal} : is the power of the selected panel

STEP04: Determining the battery capacity

This step is only needed in the photovoltaic systems that incorporate battery storage, every battery bank is characterized by its capacity C (Ah) and voltage U_B(V). In general, the choice of the battery bank voltage is made according to the power, as the table below shows:

Load power	Less Than 500 W	From 501 W to 2000 W	From 2001 W to 10000 W	More Than 10000 W
Batteries Voltage (V)	12	24	48	96

Table 5: the classification of batteries according to the load power

The general formula for calculating battery bank capacity is:

$$C_{Nd}(Ah) = \frac{E_C * N_D}{D * U_B * \eta_B} \quad Eq\ IV$$

Where:

- N_D: Desired number of days of system autonomy.
- D: Depth of Discharge (DOD).
- η_B: Battery efficiency

STEP06: Number of Batteries

$$N_{Batteries} = \frac{C_{Nd} * U_b}{C_{battery} * U_{battery}}$$

Where:

- U_b: Recommended battery voltage.
- $C_{battery}$: Single battery capacity.
- $U_{battery}$: Single battery voltage

STEP07: Inverter Selection

Selecting the inverter for photovoltaic (PV) systems (whether it incorporates battery storage or operates independently) hinges on ensuring compatibility across several key factors, which are:

1 - Power compatibility:

The inverter needs to respect the following rule:

$$0.8 * P_p \leq P_{Inverteur} \leq 1.2 * P_p$$

2 - Voltage compatibility:

The inverter's maximum input voltage (U_{max}) needs to exceed the highest voltage the solar panels can produce (V_{oc}),

$$\frac{U_{mpp\ min}}{V_{mpp} * K_{U(Tmin)}} \leq N_S \leq \frac{U_{mpp\ max}}{V_{mpp} * K_{U(Tmax)}}$$

- $U_{mpp\,min}$ and $U_{mpp\,max}$: Represent the minimum and maximum voltage limits of the inverter's Maximum Power Point Tracking (MPPT) range (V).
- $K_{U(Tmin)}$ and $K_{U(Tmax)}$: Represent The Temperature correction factors for voltage determined at the minimum (T_{min}) and maximum (T_{max}) temperatures of the site. In the case of Annaba, Algeria, we can consider a correction factor of 0.85 for the minimum temperature and 1.15 for the maximum temperature.
- V_{mpp} : represents the voltage at which a single solar panel produces its maximum power (P_{mpp}) (V).

3- Current compatibility:

The inverter's maximum input current ($I_{\max inverteur}$) needs to be greater than the total short-circuits current produced by the solar panels (I_{SC}), of all the solar panels connected in parallel, multiplied by a safety factor. This principle guides the selection of the appropriate number of panels to connect in parallel according to the following formula:

$$N_P \leq \frac{I_{\max inverteur}}{I_{sc} * K_I}$$

Where:

- $I_{\max inverteur}$: represents the inverter's maximum input current rating (A).
- I_{sc}: represents the short-circuit current of a single solar panel (A).
- K_I: represents the Safety Factor, typically between 1.1 and 1.3 used to account for potential variations in current output due to factors like temperature or aging.

STEP08: Cable Sizing

The selection and sizing of cables for PV systems is determined based on current carrying capacity and voltage drop. It is calculated by:

$$S = \frac{\rho * L * I}{\varepsilon * V_A}$$

- ρ: Represent cable resistivity (Ωm)
- L: Total cable length (round trip) (m)
- I: Current flowing through the cable. (A)
- ε: Represents the maximum permissible voltage drop expressed as a percentage, regarding that the voltage drop between components must not exceed 5% of the system voltage.
- V_A: Reference voltage at the origin of the cable. (V)

3.2.2 PV sizing diagram

The following diagram summarize the mobile application algorithm in Photovoltaic installations sizing

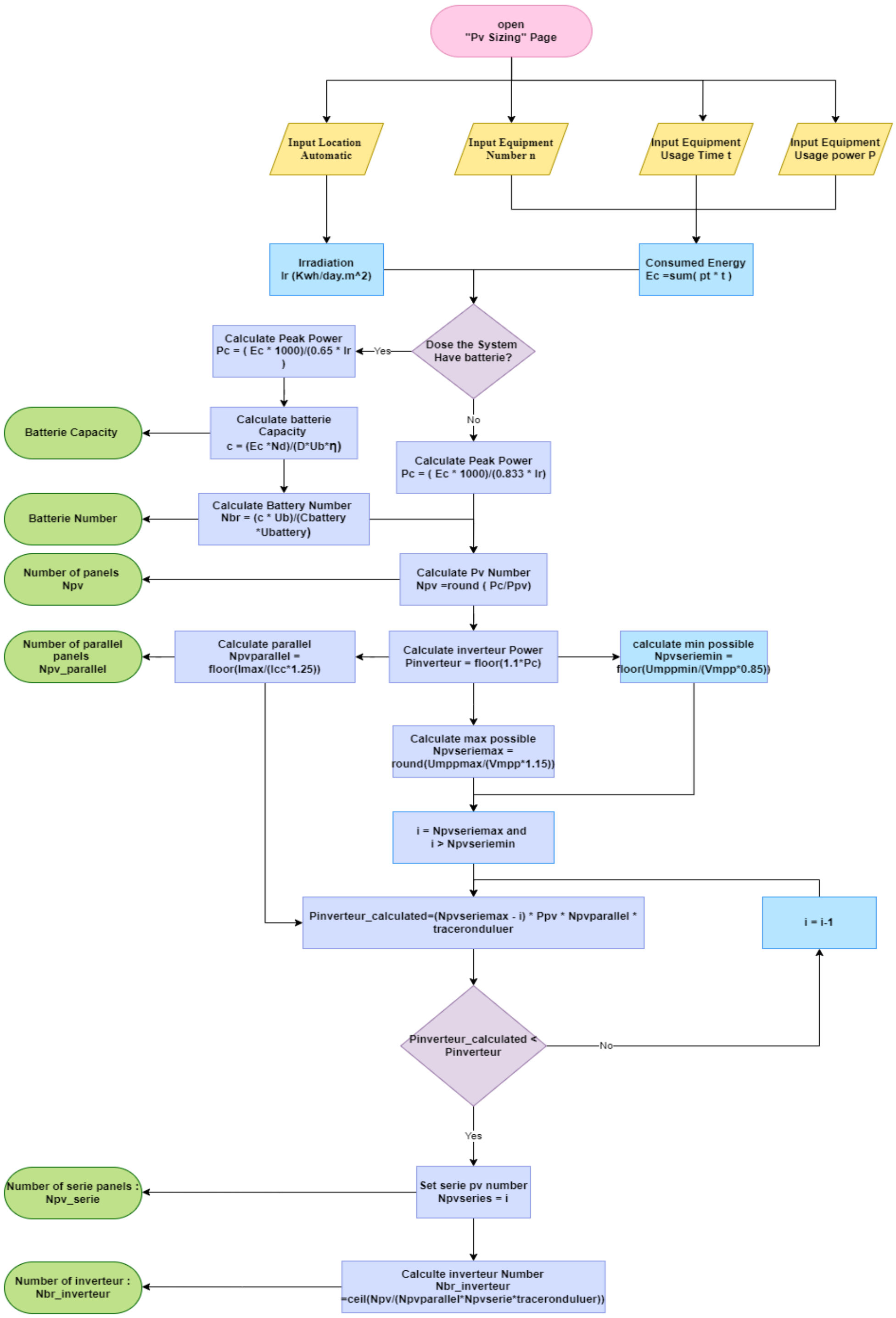

Figure 5: PV sizing diagram

3.3 Water pump sizing steps

In off-grid areas, solar water pumping is proven as a reliable solution for bringing clean water to homes, farms, and communities. For that, we develop these steps:

Step01: Defining site conditions

Including good characteristics and irradiation of the site.

Step02: Determine the daily water requirements

That should be defined by cubic meters per day (m^3/day) which allows us to calculate the flow rate by cubic meters per hour (m^3/h).

Step03: Calculate Total Dynamic Head (TDH)

A pump's total head is the pressure difference in meters of water column between the suction and discharge ports. This head can be calculated as follows:

$$\mathrm{TDH} = N_d + H_r + H_f$$

Where:

N_d: Dynamic level (m)
H_r: Reservoir height (m)
H_f: Total Head Losses

Note: The total losses H_f should not exceed 10% of the total vertical lift ($N_d + H_r$).

Step04: Calculate the required hydraulic energy and power

It is the energy required to lift a certain quantity of water to a certain height during one day.

$$E_{hyd} = C_H \, . \, Q_d \, [m^3/day] \, . \, TDH$$

$$P_{hyd} = C_H \, . \, Q_h [m^3/h] \, . \, TDH$$

Where:

E_{hyd}: Hydraulic energy [Wh/day].

P_{hyd}: Hydraulic power [W].

C_H: Hydraulic constant [Wh/m^4];

$$\mathrm{C_H} = \frac{\rho \, . \, g}{3600} = 2.725 \; (WH/m^4)$$

ρ: Water density = 1000 [Kg/m^3].

Step05: Calculate the electrical required power

It is the power that the pump needs to function properly:

$$\mathrm{P_{elect}} = \frac{\mathrm{P_{hyd}}}{\eta_{\mathrm{MP}}}$$

Where:

P_{pump}: The pump power [W].
η_{MP}: The pump efficiency.

Step06: Calculate the inverter power

$$P_{inv} > P_{elec}$$

$$\mathrm{P_{inv}} = \mathrm{P_{elect}} * Safety\ factor$$

Where:

P_{inv}: Inverter power [W].

Safety factor = 1.3

<u>Step07:</u> Calculate peak power of the PV generator

$$P_p = \frac{P_{elect}}{n}$$

Where:

P_p : Peak power of PV (Wp)

n: Coefficient of loss due to temperature, dust, electrical losses,…., generally n = 80%

(1 – Losses mostly 20%).

- **Total panels number**:

Finding the peak power allows us to calculate the total number of panels:

$$nb_{PV} = \frac{P_p}{P_{panel}}$$

Where:

nb_{PV}: Total panels number.

P_{panel}: Peak power of a PV panel (Wp).

3.3.1 Solar water Pump Sizing Diagram

The following diagram provides a summary of the steps solar water pumping system sizing is in TaQa-Tech mobile application:

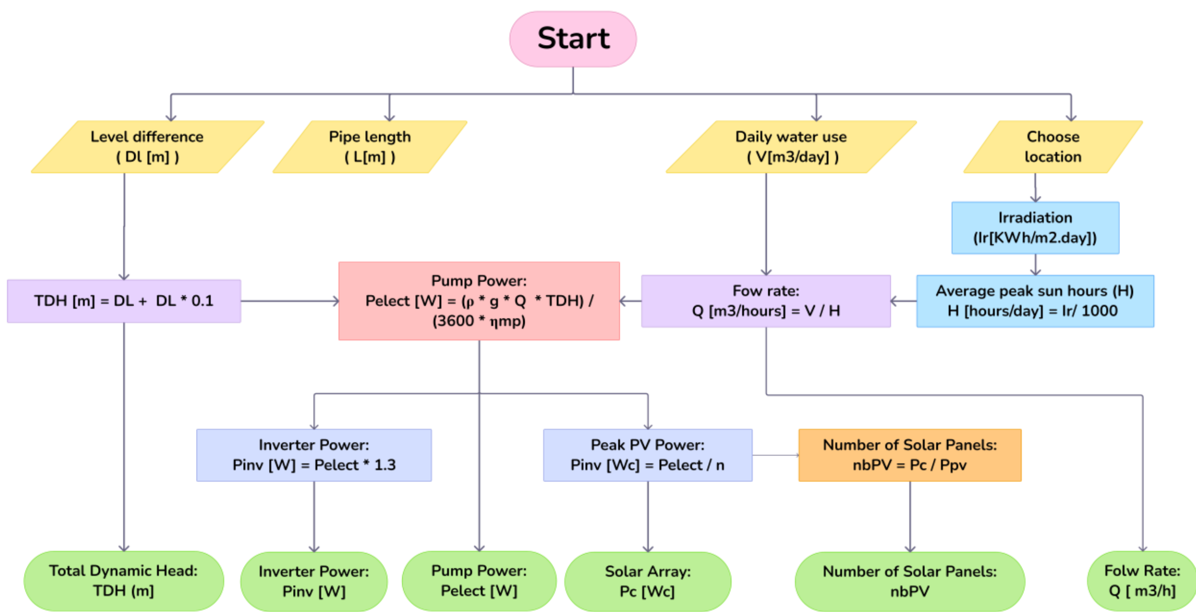

Figure 6: Solar water pump in the mobile application

3.4 Solar water heater sizing steps

A solar water heater is a device for harnessing the sun's energy to provide all or part of the domestic hot water supply. It essentially consists of a thermal collector, a circulation circuit and a water storage tank.

STEP01: Estimate Daily Hot water Usage

Typical usage: 50 liters per person per day gives

Daily Water Use [L] = Number of person x 50

STEP02: The Collector

- If the collector used is a flat plate collector: We have the thumb rule of 1m^2 per 50 liters

A_c = Daily Water Use / 50   Where: A_c: Is the collector surface [m^2].

To simplify the calculation it is considered that: A_c = Number of person

- If the collector used is Evacuated Tube Collectors (ETC): Then we use the thumb rule of 3 tubes per person

nb_T = Number of person x 3 nb_T: Number of tubes in the collector.

STEP03: Finding the Tank Volume

The storage tank should typically hold 1.5 to 2 times the daily hot water usage which gives:

V_{Tank}= daily Water Use x 1.5   where: V_{Tank}: The Tank volume [L].

3.4.1 Solar water heater Sizing Diagram

The following diagram provides a summary of the steps for solar water heater sizing in our mobile application:

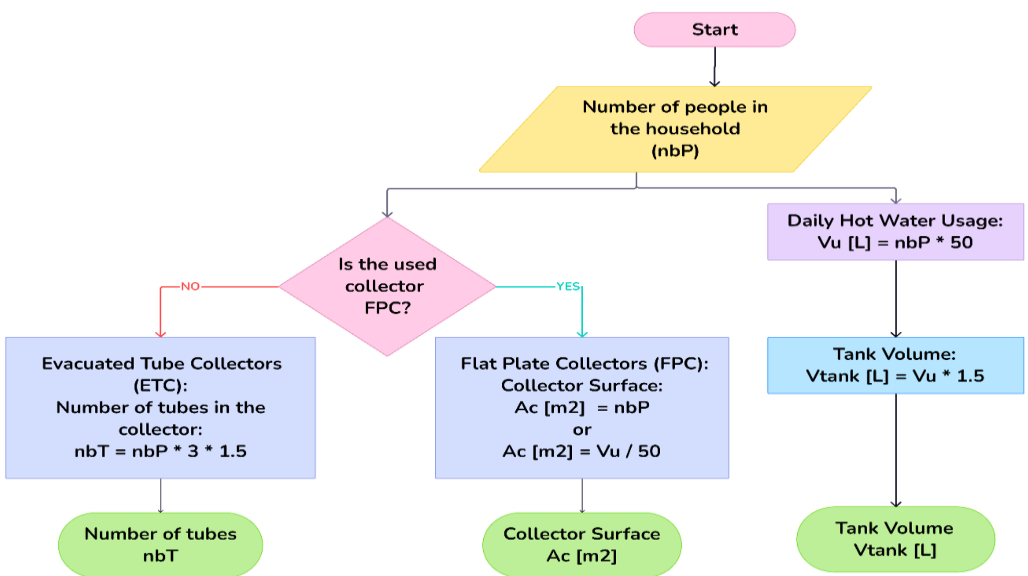

Figure 7: solar water heater diagram

3.5 Generator sizing steps

Calculating the energy needs for sizing a generator, focus on identifying major energy consumers, according to the formula:

$$E_P = K * \Sigma_{i=0}^{n} (P_i * t_i)$$

- K: Safety factor, typically chosen between 1.2 and 1.3 to account for unexpected surges or future appliance additions.
- P_i: Power consumption of each appliance in watts (W).
- t: Usage time of each appliance in hours (h).

3.5.1 Generator sizing diagram

This diagram summarizes the steps our mobile application was built on to come up with the sizing study report:

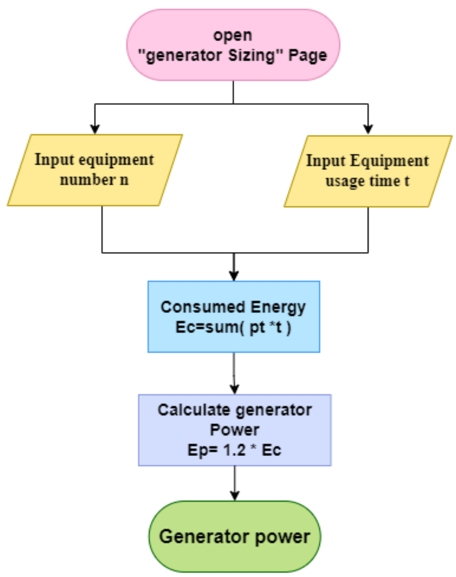

Figure 8: The generator sizing diagram

3.6 Conclusion

In summary, this chapter has stressed the critical role of accurate sizing in the selection and implementation of solar systems. By leveraging validated algorithms and considering a variety of factors such as local solar radiation, specific energy needs, equipment characteristics, and weather conditions. Our application ensures that users receive tailored, efficient, and cost-effective solutions. The step-by-step guidance provided by the app empowers even those with limited knowledge of sizing methods to make informed decisions about their solar installations. Ultimately, this approach not only simplifies the complexity of system design but also enhances the performance and economic viability of solar projects.

In the next chapter, our application is going to be under test, with a real case study scenario that tests the application's reliability and results compared to other existing methods and programs.

4. Chapter 04: Case study and results discussion

4.1 Introduction

After describing the methods for sizing various solar systems in the previous chapter, in this chapter, the focus is on putting that knowledge under examination, by creating a real scenario using realistic specifications for a complete solar system study.

The aim is to size a photovoltaic system in a rural house and its agricultural equipment, including a water pump for irrigation and a solar heating system for domestic use, with a backup generator for energy security.

The specifications will detail the technical principles and requirements for optimal installation forming a great test for our mobile application.

This chapter will illustrate how our application helps to design efficient and reliable solar systems, maximizing economic gain and environmental benefits.

4.2 Case study: The scenario

The father of a family of 4 owns a small house in a rural area, along with 1 hectare of farmland.

To escape the complete reliance on the utility grid and its problems, ensure their energy autonomy, and reduce their carbon footprint, he decided to install a complete solar system that would supply not only their house but also their farm equipment including a water pump for irrigation and a solar heating system for their domestic hot water needs. To enhance their energy security, he is adding a back-up diesel generator as an alternative power source.

To carry out this installation, the father needs to know the total requirement and the energy consumption for each type of installation. The specifications below describe the technical requirements for this installation:

Objectives	Complete self-sufficient autonomous power supply with : – PV installation for daily electrical consumption with a 1-day autonomy storage system. – Agricultural water pump – Solar heater for domestic water – Back-up generator
Characteristics of the site	Location : Wilaya Annaba, Algeria Roof orientation : South Available roof area : 40 m2 Roof type: horizontal. Optimum annual inclination : 32 Irradiation : 4.12 KWh/m^2.day

	Surface of agricultural land: 1 hectar.

PV and Generator installation				
Load	**Power(w)**	**Number**	**User hours(h/day)**	**Energy consumption (Wh/day)**
Refrigerator(250L)	150	1	24	3600
Television+ sat reserved	150+100	1	5	1250
Computer	80	1	5	400
Washing machine	2000	1	1	2000
LED Light	11	6	4	264
Kitchen appliances	800	2	1	1600
Fan	40	2	5	400
The Sum				9514

Solar water pump				
Inputs	**Daily water demand (m^3)**	**Height difference**	**Pipe length**	**Pipe diameter**
	40	54	100	57

Solar water heater	
Inputs	**Number of people in the house**
	4

Table 6: case study specifications

4.3 Sizing trough TaQa Tech

In the mobile application, the home page shows the 3 main services of the app, and sizing appears in the left corner.

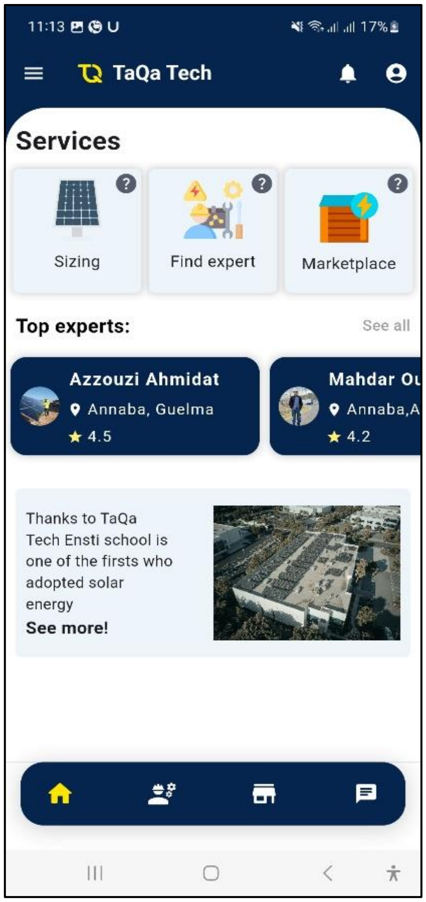

Figure 9: The home page

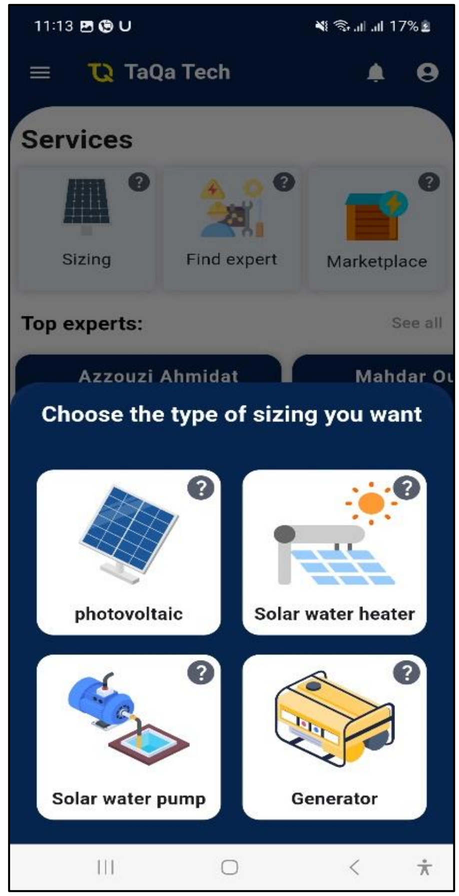

Figure 10: : The installation to be sized

4.3.1 PV sizing:

After selecting the sizing part of our app and choosing a photovoltaic installation, And because the sizing process require information related to the user's location (like the irradiation) the application is deigned to locate the user place automatically. The sizing process is as follows, and the app will give a result in the form of a report (Figure11, 12, 13)

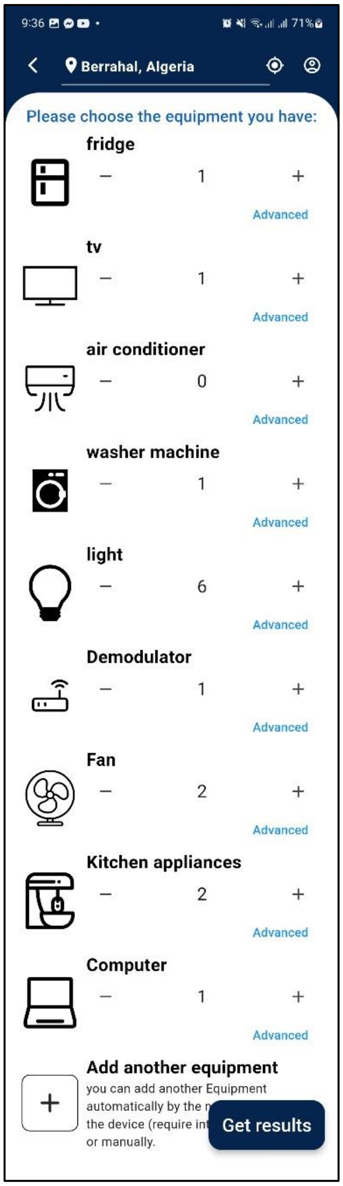

Figure 11: PV installation sizing main page

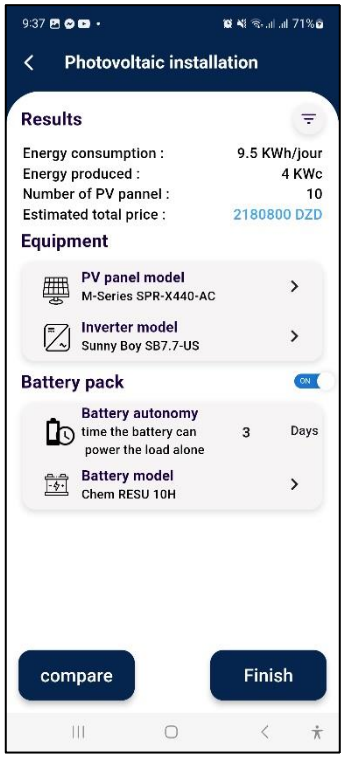

Figure 12: Equipment changing options for PV installation

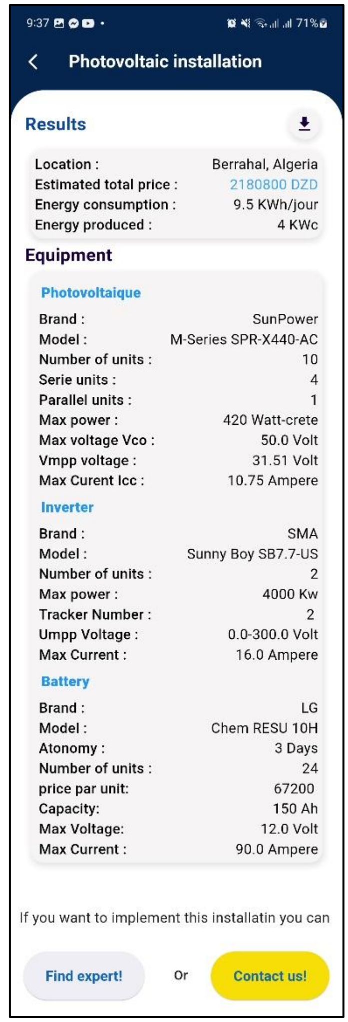

Figure 13: Results page for PV sizing

We organized the provided data into a table to assess the efficiency of TaQa Tech. We then compared this information with PVsyst, a reliable sizing software, and computed the percentage error between the results of both tools to provide a thorough comparison summarized in this table:

	Array nominal. Power (Wp)	Error (%)	Battery Capacity (Ah)	Error (%)	Number of panels	Number of battery
PV system	3374	5.2	666	7.2	9	7
TaQa Tech	3553		714		10	6

Table 7: Comparison between PVsyst and TaQa Tech

Comments:

The comparison between the PV system and the TaQa Tech application reveals notable similarities with minor differences. These variations arise due to several reasons:

1. Different Simulation Algorithms:

- PVsyst calculates the nominal peak power of the PV array based on the autonomy of the batteries, considering energy storage requirements to ensure a certain level of autonomy. While TaQa Tech focus on the average daily energy consumption and local irradiation data without emphasizing battery autonomy. The array nominal power for the PV system is 3374 Wp, while TaQa Tech estimates it at 3553 Wp, this translate to 5.2% error in the nominal array power, which leads to a difference in PV panels number.

2. Varying Security Factors (K):

- PVsyst may incorporate more conservative or higher security factors to account for potential uncertainties in system performance, degradation rates, and environmental conditions. While TaQa Tech use different security factors, reflecting a different sizing philosophy and risk management approach. This difference is shown in the 7.2 % error in battery capacity and number.

3. Databases and Localization Factors:

- Differences in the databases used for local irradiation data and other environmental conditions can lead to variations in the sizing equations and component requirements.

By understanding these differences, users can better understand the reasons behind the differences in recommendations from PVsyst and TaQa Tech, allowing for more informed decision-making in the design and optimization of photovoltaic systems.

4.3.2 Water pump sizing

As mentioned in Chapter three the water pump sizing depends on the daily water use, dynamic head and reservoir height. Based on that, our application gave the following results:

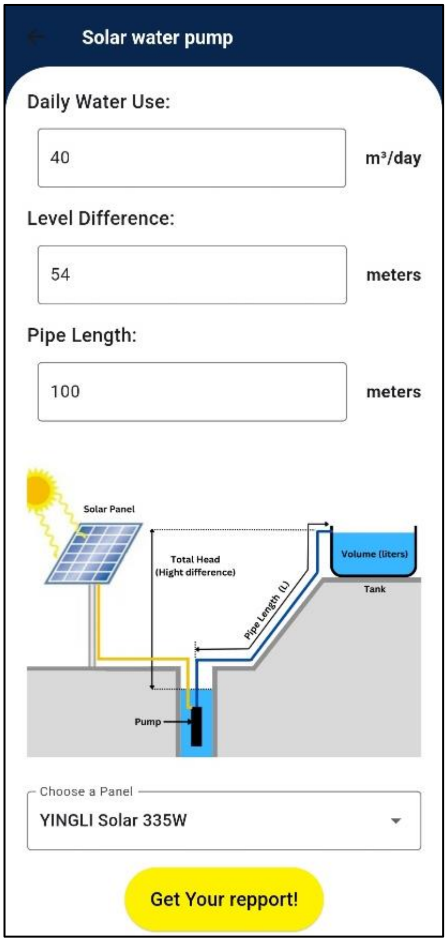

Figure 15: The Pump Sizing Main Page

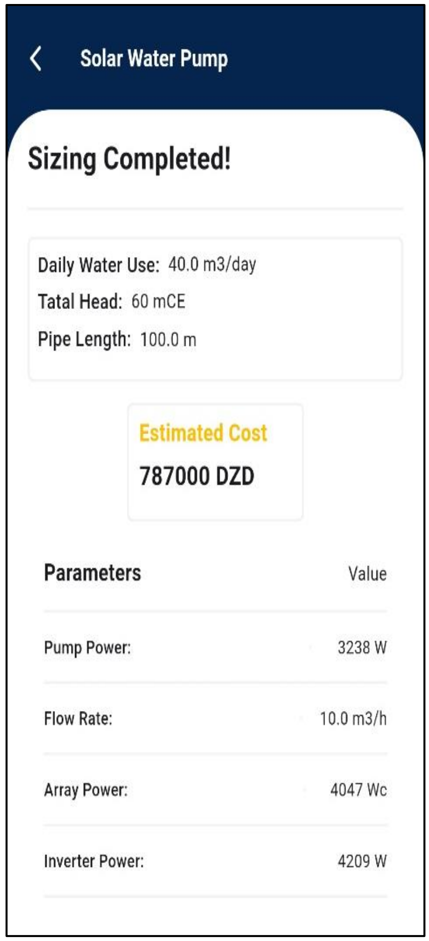

Figure 14: The Results Given by Our Application

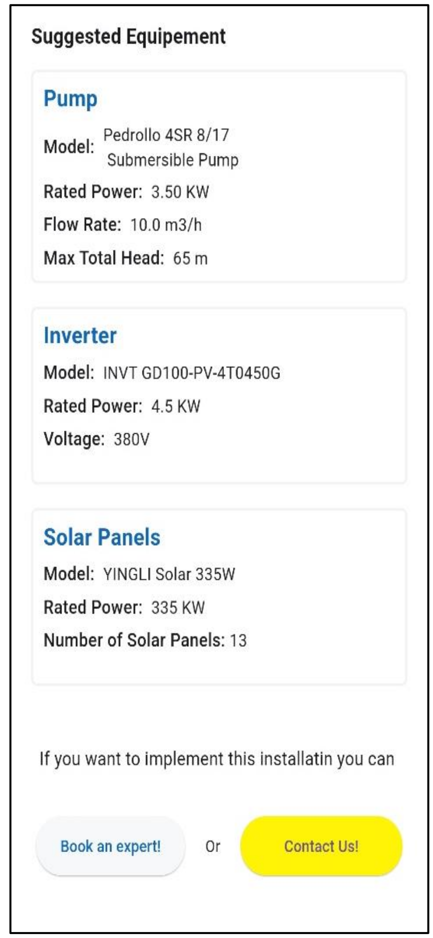

Figure 16: The Suggested Equipment by Our Application

To evaluate the performance of TaQa Tech, we compiled the given information in a structured table, comparing it with PVsyst, a trusted sizing software, and calculating the percentage error between the results of both for a more comprehensive comparison.

	Pump Power (W)	Error (%)	Array nom. Power (W)	Error (%)	Number of panels
PV system	3223	0,46	4071	0.6	13
TaQa Tech	3238		4047		13

Table 4: Comparison of PVsyst and TaQa Tech Solar Pump Sizing

Comments:

The comparative analysis between the TaQa Tech application, and the established PVsyst software demonstrates significant coherence across critical parameters, punctuated by minor deviations. Specifically, for pump power estimation, PVsyst yields 3223 W while TaQa Tech provides 3238 W, translating to a negligible discrepancy of 0.46%. Similarly, nominal array power projections are 4071 W by PVsyst and 4047 W by TaQa Tech, reflecting a slight variance of 0.6%. Notably, both tools consistently converge on the requirement of 13 panels

4.3.3 Solar water Heater Sizing

The sizing of the solar heater is contingent upon the household's occupancy, which, as detailed in the aforementioned case study, comprises 4 individuals. Based on this criterion, our application generated the subsequent outcomes:

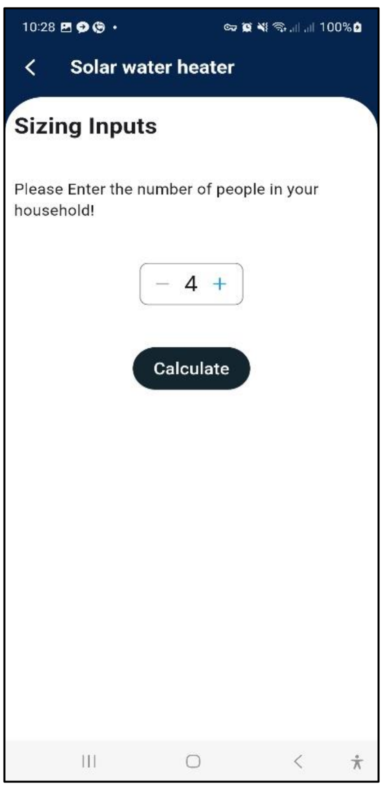

Figure 17: The Heater sizing main page

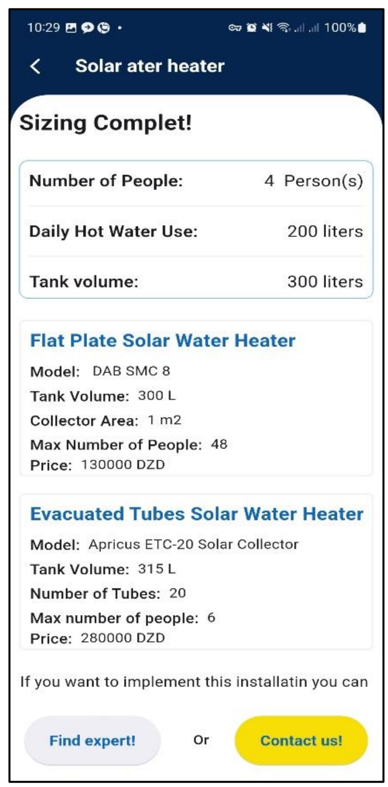

Figure 18: The results page for heater sizing

Comment:

Using the TaQa Tech application, the sizing process of a solar water heater indicates that for a household of 4 people, a 300-liter capacity water heater is recommended. The user have the option to choose either the flat plate DAB SMC 8 model, which costs 130000 DA, or the evacuated tubes model.

4.3.4 Generator sizing:

By inputting the electrical appliances for our case study, the process to estimate the size of the generator by TaQa Tech is given in the figures below:

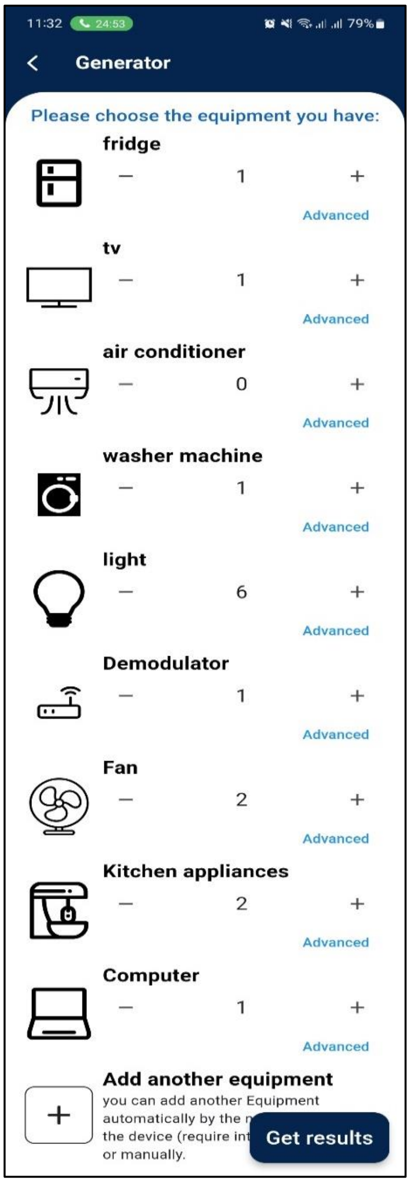

Figure 20: The generator sizing main page

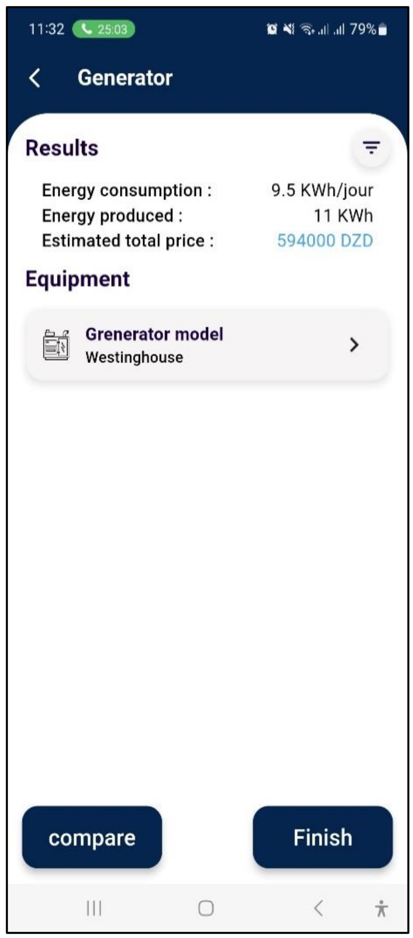

Figure 19: Equipment changing options for the generator

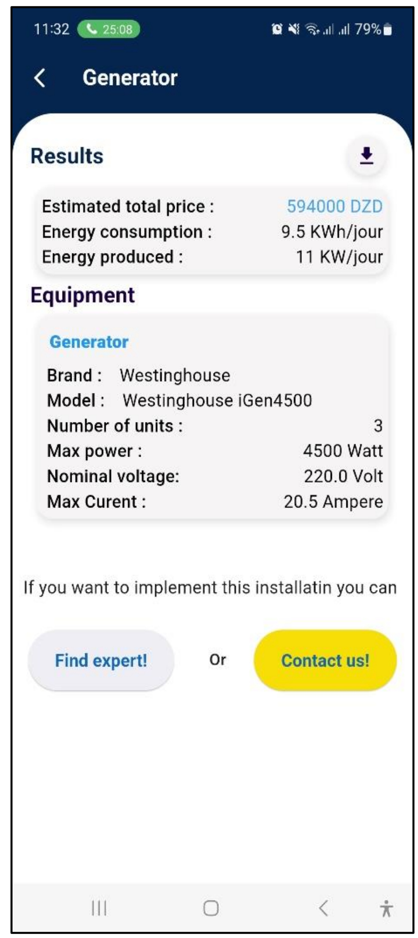

Figure 21: Results page of generator sizing

Comments:

When determining the generator size for 9.5 kWh/day energy consumption by TAQA Tech, 3 Westinghouse iGen4500 models were recommended at a price of 594000 DA.

4.4 Conclusion

In this chapter, we studied a sizing case involving various solar systems (such as photovoltaic system, solar pump, solar water heater, and a generator) using TaQa Tech. We compared the results with those obtained from PVsyst software. The closely aligned results emphasize the reliability of TaQa Tech in assessing the performance of photovoltaic systems. It's important to note that there might be marginal differences resulting from different assumptions or calculation methodologies. To enhance TaQa Tech's accuracy, validation and calibration against empirical data will be essential. This will refine its estimates and bring them even closer to PVsyst benchmarks.

General Conclusion:

The four chapters elaborated in this work led us to develop a user-friendly and accessible interface, TaQa Tech, our innovative application. This dissertation has detailed the technical and practical aspects of this solution, highlighting its potential to transform the Algerian energy sector.

It also outlined the significant benefits of this application, such as reducing costs, improving access to solar energy and promoting cleaner and more sustainable energy.

The proposed application would significantly solve today's energy challenges and help transform the energy landscape through its three main services. By simplifying the energy sizing process, providing up-to-date and reliable information, and overcoming logistical obstacles, it would play a key role in accelerating the adoption of solar energy in Algeria.

More than just an energy management tool, this application would become a real driver of change, facilitating the transition to cleaner and more sustainable energy. It would strengthen the confidence of users and experts in these technologies, encouraging wider and faster adoption.

In addition, TaQa Tech could have positive impacts beyond energy management. By providing access to solar energy, it would improve the quality of life of rural communities, stimulate the local economy by creating new employment and training opportunities, and reduce dependence on polluting energy sources. By promoting a culture of innovation and sustainability, TaQa Tech would raise awareness of environmental issues and encourage a more equitable energy transition.

As well as responding to current challenges, TaQa Tech opens up new perspectives for the energy sector. It could revolutionize the way users interact with solar energy, by integrating advanced technologies and offering novel functionalities, including augmented reality. These innovations will position TaQa Tech not only in the solar energy market, but also, in time, in the general electricity market.

In conclusion, the creation and adoption of this dedicated mobile application is a crucial step towards overcoming current obstacles and realizing the full potential of solar energy in Algeria. By offering practical, accessible solutions, TaQa Tech could not only meet today's energy needs, but also pave the way for a greener, more resilient energy future, in harmony with the world's sustainable development goals.

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الجمهـــوريـــــة الجزائـريـــــة الديـمقراطيـــــة الشـعبيـــــة
People’s Democratic Republic of Algeria
وزارة التعليم العالي والبحث العلمي
Ministry of Higher Education and Scientific Research
المدرسة الوطنية العليا للتكنولوجيا والهندسة-عنابة
The National Higher School of Technology and Engineering - ANNABA

SECOND CYCLE DEPARTEMENT

FIELD OF STUDY

ELECTRICAL

SPECIALITY

Electricity Production and Renewable Energy

A project to obtain a certificate for a start-up organization under Ministerial Decision 1275

The title of the project:
A start-up to revolutionize access to solar energy in Algeria: autonomy, sustainability and innovation

Brand Image

Brand Name

TaQa Tech

Academic year :
2023/2024

Information card

1.Supervisory team

	Name and surname	Department	Speciality
Main supervisor	Azzeddine DEKHAN	EEA ENSTI	Electrical
Co-supervisor 1	Abdallah BOUZITOUNA	EEA ENSTI	Mathematic
Co-supervisor 2	Zoubir TALAI	UBMA-ANNABA	Computer science

2.Team work

Member of the group	Department	Speciality
BACHIRI Asma	EEA ENSTI	Electrical
HOUMANI Khaoula	EEA ENSTI	Electrical
BENGAOUER Chaima	EEA ENSTI	Electrical
CHEURFI Ghada Imane	EEA ENSTI	Electrical
LOUGHRAICHI Mohamed	EEA ENSTI	Electrical
BENKHALED Souad Nour Elhouda	EEA ENSTI	Electrical

1.Project idea (proposed solution):

The idea of the project is to develop an innovative mobile application that aims to revolutionize the access to solar energy in Algeria.
“TaQa Tech” is the result of the work of a team of 6 electrical engineering students, specialized in electricity production and renewable energy. Through our 5-year university course and continuous training in renewable energy, particularly solar energy, as well as essential programming modules, we have acquired the skills needed to design and develop “TaQa Tech”.
Taking advantage of Algeria's exceptional solar potential, this application aims to overcome the information, complexity, cost and logistical challenges associated with installing solar systems.
To address these issues, TaQa Tech offers a unified platform to facilitate customized solar installations, by connecting users with experts, providing transparent cost estimates, and offering a comprehensive range of services.
The aim is therefore to simplify the process of adopting solar energy in Algeria by providing easy access to the information, products and services required.
The app will be developed with an intuitive interface, accessible on Android and iOS platforms, to ensure an optimal user experience.
‘’TaQa Tech’’ aims to empower the use of solar energy in Algeria by increasing awareness and interaction with renewable energies. This will help to increase the energy security of homes and businesses while helping environmental sustainability.

This table summarize our project idea:

Field of activity	Mobile application, Renewable energy, On-demand services, Electronics, Consulting, Commercial
How did the idea start	Seeing frequent complaints, doubts, and questions about solar energy due to limited awareness, interaction, and access to reliable products and information is a common problem likely shared by many regardless of their location (city suburb)
What we will provide	This subject inspired us to develop a solution as a mobile application that dims the gap creates easy access and empowers people to explore solar energy.
What we will do that	**Phase one:** Create the application prototype, conduct the first market analysis, study the competitors, define the niche client segment

	Phase two: Release the application for a test trial, analyze the feedback and the data from the trial, develop the application's backend, conduct a second market analysis **Phase three**: deployment and releasing the application to users. Focusing on ongoing improvement. Gather feedback from users, and make updates to the application.
Who will accomplish it?	• Group for developing: work on the application UI/UX design, write the base code, test, debug, and update the software. • **Group for managing:** study the market, collect data, conduct interviews, and surveys, and examine customer behavior.
Where will it be done	• The launch/test is in Annaba • In the southeast of Algeria (Skikda, Geulma, ...) • In the Algerian market

2.Proposed values and domains:

Despite barriers and competition, our team focused on a set of strengths that give the app additional value, including:

- Mobile application dedicated to several categories, offering users a useful and reliable interface
- Promoting access to solar energy as a sustainable and essential solution to satisfy growing energy needs while reducing environmental impact
- Fast online search for qualified experts
- Free, instant and personalized solar sizing and energy optimization.
- Equipment display platform facilitates direct access to solar equipment
- Intuitive user interface and integrated chat for real-time help
- Collaboration with local partners to offer special user incentives and access to new ideas
- Integration of the latest technological advances and artificial intelligence for energy optimization
- Continuous enhancement of the mobile application with new functionalities
- Ensure simplicity and ease of use
- Offer comparative analysis of options

3.Team work:

It’s essential to consider the roles and responsibilities of each group member when assembling a mobile app development team. Therefore, to reach the project goal it was decided from the beginning to divide the teamwork into two sub-teams

- A team interested in designing, developing, and testing the prototype
- A team specializes in organizing, managing, collecting information, and building a database for the project.

This table contains the essential information for each member of the group:

Team member	The position	His role in the team	His skills
The management Team			
HOUMANI KHAOULA	Project Manager	-Monitor progress and evaluate project performance, timekeeping, and responsible for managing project timelines. - Make necessary adjustments to keep the project on schedule. - Facilitate transparent and consistent communication among team members	Time and team-management. ● Leadership and negotiation. ● Critical thinking. ● Interpersonal skills.
BENKHALED SOUAD NOUR ELHOUDA	Business Analyst	-engage with the team and end-users, to gather and analyze objectives. -identify, document, prioritize, and validate business needs by conducting interviews and surveys -Prepare functional requirements for the app. -Conduct in-depth research on business challenges and opportunities	●Communication (oral and written). ● Documentation and visualization. ● Analytical thinking.
BENGAOUER CHAIMA	Sales and marketing specialist	-Promoting the app, attracting users -Create an interest around the app using marketing strategy tactics including: ● Social media campaigns. ● Content marketing. ● Email marketing. ● Advertisements.	● Communication and copywriting. ● Understanding the Market, ●Data analysis tools to track marketing
The Development Team			
BACHIRI ASMA	UI/UX Designer	-Creates a visually appealing and user-friendly app design. -Design the app interface. -Ensure a seamless user experience.	● Creativity and design expertise. ● Understanding of user behavior. ● Proficiency in design tools.

		-Design mockups that highlight the app's visual design elements (colors, typography, icons).	
LOUGHRAICHI MOHAMED	Backend Developer	-Handles server-side logic and APIs. -Write clean efficient code, execute features, and assure functionality. -Must be familiar with the latest tools and technologies. -Conduct debugging and troubleshooting to fix bugs and errors.	● Mastery of code and backend languages
CHEURFI GHADA IMANE	Quality Assurance (QA) Engineer	-ensuring the final product is free from bugs. -Ensures the app meets quality standards in the entire development lifecycle. -Test the app thoroughly (functionality, performance, security). -Identify and report any inconsistencies.	● Technical expertise in programming, ● Ability of finding and fixing flaws

4.Project goals:

- ✓ **Successful development and launch of our application:** Design, develop and successfully launch our application on schedule and offer a functional, high-quality solution that satisfies users' needs, with the accent on simplicity and efficiency.

- ✓ **Customer Acquisition and Retention:** We aim to attract large numbers of customers through effective marketing and sales strategies, while ensuring their satisfaction and loyalty through excellent customer service, responsive technical support and regular updates.

- ✓ **Strengthening our Team and our competences:** As our business grows, we make a point of strengthening our team by recruiting additional talent specializing in solar solutions and advanced technologies. We will also invest in the ongoing training and professional development of our existing staff. This is to maintain our competitive edge and ensure that we remain at the forefront of the latest developments in solar energy and technology.

- ✓ **Collaboration with local partners:** It is essential for stimulating innovation, accessing new ideas and offering attractive incentives to our users. By partnering with local players, we can not only reinforce our market presence, but also develop solutions tailored to the specific needs of communities

- ✓ **Geographic expansion and market extension:** we aim to expand its geographical presence and explore new opportunities in the general electricity market, beyond its current solar expertise. This strategic expansion aims to diversify its activities, reach new market and customer segments and make a significant contribution to the energy industry.

- ✓ **Financial growth and profitability:** we aim to increase revenues and improve profits by optimizing services and constantly innovating to remain competitive in the market.

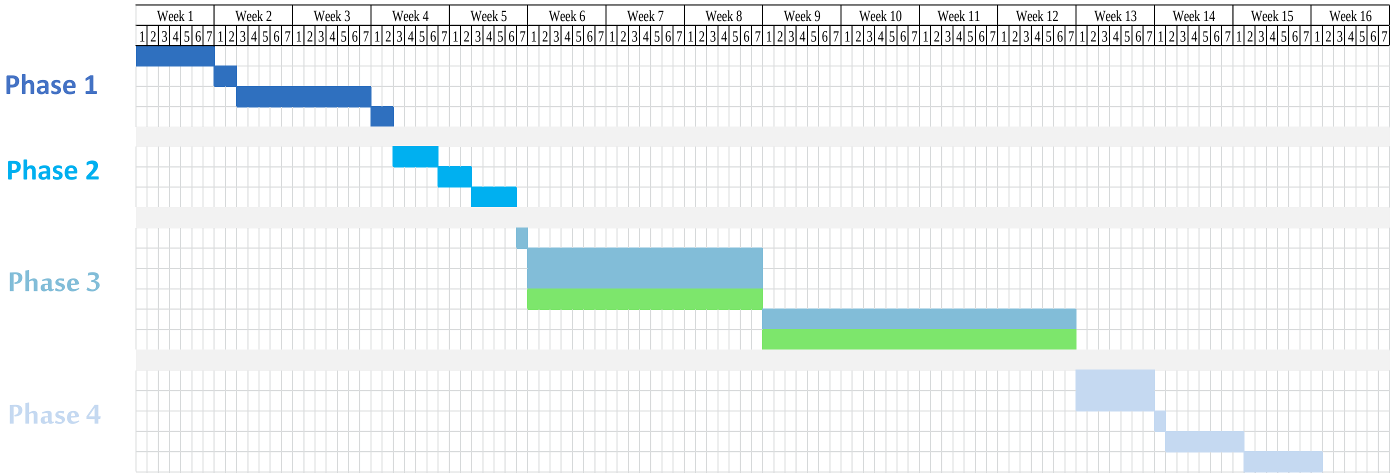
- ✓ **Continuous improvement of the mobile application with new functionalities:** integrating new technologies such as energy optimization and augmented reality.

5.Realization timeline for the project:

Here is the summary table outlining our 16-week schedule, detailing the key phases, tasks, durations, start and end dates, as well as dependencies, to ensure a clear and organized project timeline.

Phase	Task number	Task	Duration	Start	End	Dependancy
Initiation	0	Brainstorming	1 week	04/02/2024	12/02/2024	/
	1	Definition of project objectives	2 days	13/02/2024	14/02/2024	0
	2	Feasability and market study	12 days	15/02/2024	03/03/2024	1
	3	Project approval	2 days	04/02/2024	05/02/2024	2
			23 days			
Planning	4	Development of project plan	4 days	10/03/2024	13/03/2024	3
	5	Resource planning	3 days	14/03/2024	18/03/2024	4
	6	Creation of project schedule	4 days	19/03/2024	24/03/2024	5
			11 days			
Execution	7	Ressource mobilization	1 day	25/03/2024	25/02/2024	6
	8	UI/UX design development	3 weeks	26/03/2024	16/04/2024	7
	9	Preparation for the innovative project labelling presentation	3 weeks	26/03/2024	16/04/2024	7
	10	Quality control	au cours	/	/	8,9
	11	Application developpement (Programming)	4 weeks	17/04/2024	22/05/2024	8,1
	12	Quality control	au cours	/	/	11
			50 days			
Closure	13	Finalisation of the MVP	1 week	26/05/2024	02/06/2024	12
	14	Finalisation of the presentation	1 week	26/05/2024	02/06/2024	12
	15	Ask for the project's labelling	1 day	03/06/2024	03/06/2024	13,14
	16	Register a patent to obtain a filing number and industrial protection	1 week	/	/	15
	17	Follow the patent process and correct examiners feedback from INAPI	1 week	/	/	16
			29 days			

- # Gant diagram:



6.Why choosing the solar energy market:

- Motivation to work in the solar energy market:

Algeria has one of the highest solar deposits in the world due to its geographic location. Across the whole country, there are more than 2,000 hours of sunlight every year. It can possibly reach 3900 hours.[1]
The total solar energy received per day varies from 5.1 KWh in the North and 6.6 KWh in the Deep South.[2]
According to one estimate, 254km^2 in the Sahara would be enough to meet the total electricity demand of the world.

- **Problem in the market we consider to remedy:**

According to the French expert Gil Bonavi, Algeria uses only 0.003 percent of its solar energy to produce electricity, despite the great potential of the vast Sahara[1]
Many potential operators and clients are discouraged by the complicated and expensive process of primary energy sizing, which is crucial for solar system installations but frequently presents technical and financial challenges.

Obstacles faces merchants and specialists due to lack of awareness and limited access to trustworthy solar energy products and information. They become less confident in the current solar technology due to the absence of reliable and easily accessible information sources. Which holds back the solar energy market

However, in sparsely inhabited rural locations far from existing electricity grids, the lack of energy autonomy combined with frequent power outages brought on by limited energy availability makes energy management even more crucial in these areas.

7.Market study :

7.1. SWOT matrix :

To better understand the strengths, weaknesses, opportunities and threats facing TAQA Tech, we will carry out a detailed SWOT analysis, which will help us to assess the internal and external aspects influencing the application's performance.

Strengths:	Weaknesses:
• All-in-one platform offering a complete range of services related to solar energy. • In-depth expertise with a qualified team and transparent pricing that builds customer confidence. • Adaptation to the local market and response to a growing need • Innovative technology and intuitive user experience for solar energy management. • Potential strategic partnerships with key players in Algeria's solar energy sector • Growing environmental awareness	• New application on the market • Dependence on partnerships • Need for stable Internet connection • Risk of increased competition in the solar energy market • Challenge of raising awareness and educating people about the benefits of solar energy and the use of the application • Continued need for investment in research and development to remain competitive in the market.
Opportunities:	**Threats:**
• Growth of the solar energy market in Algeria • Increased awareness of digital tools among Algerian consumers • Expanding range of services to include complementary offerings • Strategic partnerships with government organization • Enhancements based on user feedback to optimize customer experience	• Strong competition from other existing market players • Rapid technological developments in the mobile applications • Unstable solar energy prices and falling conventional energy • User Resistance to Adopting the Application • Changing government regulations

7.2. Analysis of the 5 strengths of porter:

To assess TAQA Tech's competitive position in the technology market, we will use Porter's Five Forces analysis, a strategic tool for identifying and understanding the different competitive dynamics facing the application

Threat from new entrants	Low to medium	Creating a start-up requires advanced technical expertise and considerable research and development resources. This can limit the entry of new players into the market. However, the increasing accessibility of technologies and the growing need for solar energy may encourage new entrants to offer similar solutions, which may increase competition in the long term
Negotiating power of suppliers	Low to Medium	The market of solar energy technologies is growing, and there are probably a growing number of suppliers. This gives TAQA Tech some negotiating power. However, some key components may come from a limited number of suppliers, giving them, some bargaining power.

Negotiating power of Customers	Medium to high	Customers have some bargaining power, as there are several service providers like TaQa Tech. However, our application offers unique, innovative and high-quality solutions in the solar energy field
Threat of substitute products or services	Low	At present, in Algeria there are probably no widely available alternative technologies that can encompass different services in one application and offer the same benefits as TAQA Tech's solutions. Although other renewable energy options exist, solar power is currently the most cost-effective and environmentally friendly option for many consumers
Competitive intensity	medium	The solar energy market in Algeria can be considered relatively competitive, with both local and international players offering solar solutions. However, Differentiation, quality of service and adaptability to specific user needs can play a key role in standing out in this market.

7.3. Market Segment View:

- **Targeted customers:**

Our mobile application is designed to meet the needs of a large range of customers, including:

✓ **Service seeker:**

This includes individuals or companies in the energy sector or other, who are interested in solar energy. They can use the application to efficiently size their installations and obtain cost estimates.

✓ **Sellers:**

suppliers, companies and stores of all sizes, who can display their solar products on the exhibition platform by choosing the type of offer to be used, which can provide an information and comparison base of products or prices that can generate an increase in clientele of TaQa Tech.

✓ **Experts:**

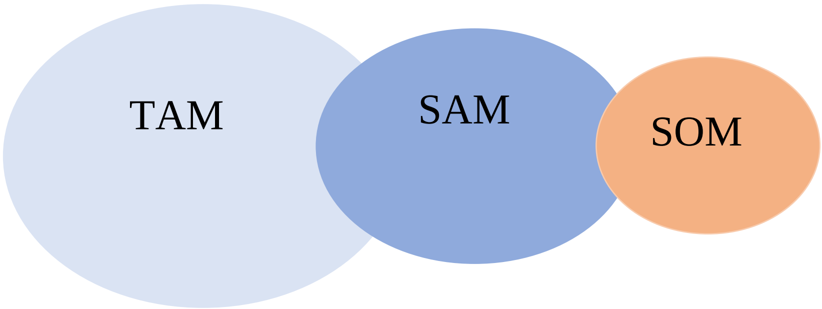
Engineer, technician, repairer, installer, consultancy office who are qualified to obtain a work opportunity, whether an installation or maintenance of solar systems and satisfies the need of a client.

7.3. National market analysis:

After a complete and detailed study and analysis of the market we found that:

The specialized survey of 189 respondents from different categories (energy or other) and of different ages revealed that	✓ **78.4%** are interested in solar installations ✓ **61.9%** opt for a remote consultation to evaluate their installations.
A specialized study carried out of 100 solar energy professional’s solar energy professionals, including experts, consultancy offices and sellers established that	✓ **60%** are experts ✓ **40%** are sellers

To evaluate and estimate the rate of use and acceptance of TaQa Tech in Algeria, the following calculation was made:



TAM ***Total Addressable Market***	**SAM** ***Serviceable Available Market***	**SOM** ***Serviceable Obtainable Market***
the total possible market for our services	the portion our application can actually reach given limitations of the business	the portion of the market you are aiming to capture
Population: 1 million Age: 18~70 years APM= 200 DA	Population: 400 000 Age: 18~70 years APM= 300 DA	Population: 6 000 (experts sellers teachers students APM=600 DA
200 000 000 DA	120 000 000 DA	12 000 000 DA

APM : Average price per month

8. Competition Intensity measurement:

Competitors	Examples	Logo	Free sizing	Find an expert	Product exhibition	Technical support and reliability	Technical ease
Mobile application	Jobby		✗	✓	✗	✓	✓
	SolarCT		✗	✗	✗	✓	✗
websites	Ouedkniss		✗	✓	✓	✗	✓
	dimel.dz		✓	✓	✓	✗	✓
software	PV syst		✓	✗	✗	✗	✗
	Solarius PV		✗	✗	✗	✓	✗

Experts	Companies and consulting offices specialized in solar energy	/	×	✓	✓	✓	×
Our application	TaQa Tech		✓	✓	✓	✓	✓

9. Dependency:

The right to use the incubator as a location during the launch of the project has been taken into account.

Expenses	Type	Estimated cost in DZD
Declaration of existence commercial register CASNOS Bank account creation	Constant	**400 000**
salary	Variable	25 000*6 personnes=**150 000** + Casnos: 26% * 25 000 * 6= **39 000**
Administrative costs (notary, etc.)	Constant	**15 000**
Cost of marketing activities	Variable	**10 000**
Infrastructure and server costs	Variable	**400 000**
Rental costs and furniture	Constant	**0 (Benefit from incubator use)**
Test equipment and design	Variable	**0 (Benefit from incubator use)**
Other (electricity, water, etc.)	Variable	**0 (Benefit from incubator use)**
TOTAL	1 000 000 DZD	

10.Pricing strategy:

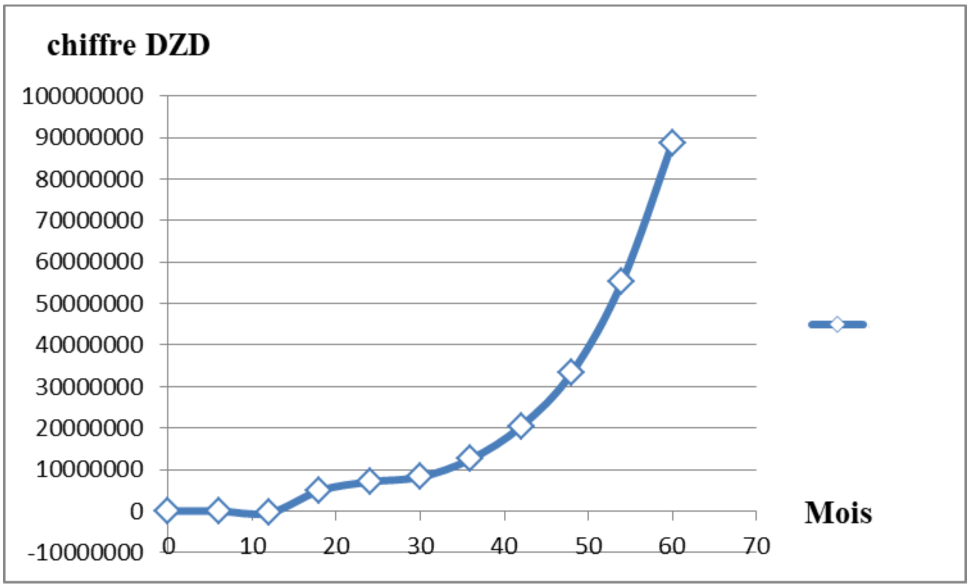
The following is the pricing strategy developed by the team for TAQA Tech's clients and for all of their offerings:

<table>
<tr><th>Client</th><th>Type</th><th>Cost/ Offer</th></tr>
<tr><td rowspan="2">Service seeker</td><td>Free access</td><td>Free access to the sizing function</td></tr>
<tr><td>12 000DZD/Report</td><td>12 000 DZD for a more detailed personalized sizing report</td></tr>
<tr><td rowspan="4">Expert</td><td>Testing and visibility</td><td>For the first 3 months of expert work with TaQa Tech:
Free access
1 000DZD / work opportunity
12 000 DZD for a more detailed personalized sizing report</td></tr>
<tr><td>Sponsored advertising
Cost per thousand</td><td>4 000DDZD/Month: 1000 advertising impressions are published at the top for 2 seconds each day</td></tr>
<tr><td>6-month offer</td><td>One detailed, personalized fold sizing report is free every 6 months
10 000 DZD for a 6-month subscription
1 000DZD / work opportunity
10 500 DZD for a more detailed personalized sizing report</td></tr>
<tr><td>1-year offer</td><td>2 more detailed, personalized sizing reports are free every 1 year
18 000DZD for an annual subscription
1 000DZD / work opportunity
9 500 DZD for a more detailed personalized sizing report</td></tr>
<tr><td></td><td>Testing and visibility</td><td>For the first 3 months of seller work with TaQa Tech:
Exposition a list of 5 free product</td></tr>
</table>

Seller	Sponsored advertising Cost per thousand	• **4 000DDZD/Month**: 1000 advertising impressions are published at the top for 2 seconds each day
	Silver pack	• Exposition a **list of 10 product**
	Gold pack	• Exposition a **list of 20 product**
	Diamond pack	• Exposition a **list of 35 product**

11.Business sales:

In order to calculate our sales, a 5-years study was carried out, based on a precise and detailed pricing strategy for each service and function. This study is presented to highlight our expected financial performance, key trends and growth highlights with an exponential growth potential.

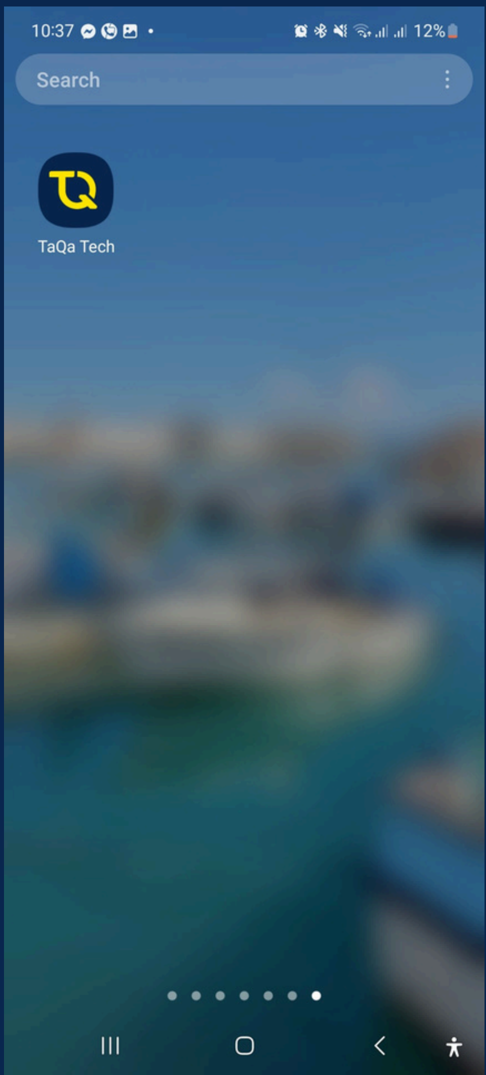


By the beginning of the 5th year, sales will have reached 91 160 000DZD with a net profit of 88 660 000DZD. In addition, our project has an estimated payback period of 18 months, demonstrating the profitability and financial viability of our initiative.

12. Prototype

In order to introduce the application and its various services , here are some images of our prototype. Each service is shown separately to make it easier for you to understand.

- **Launcher Screen**



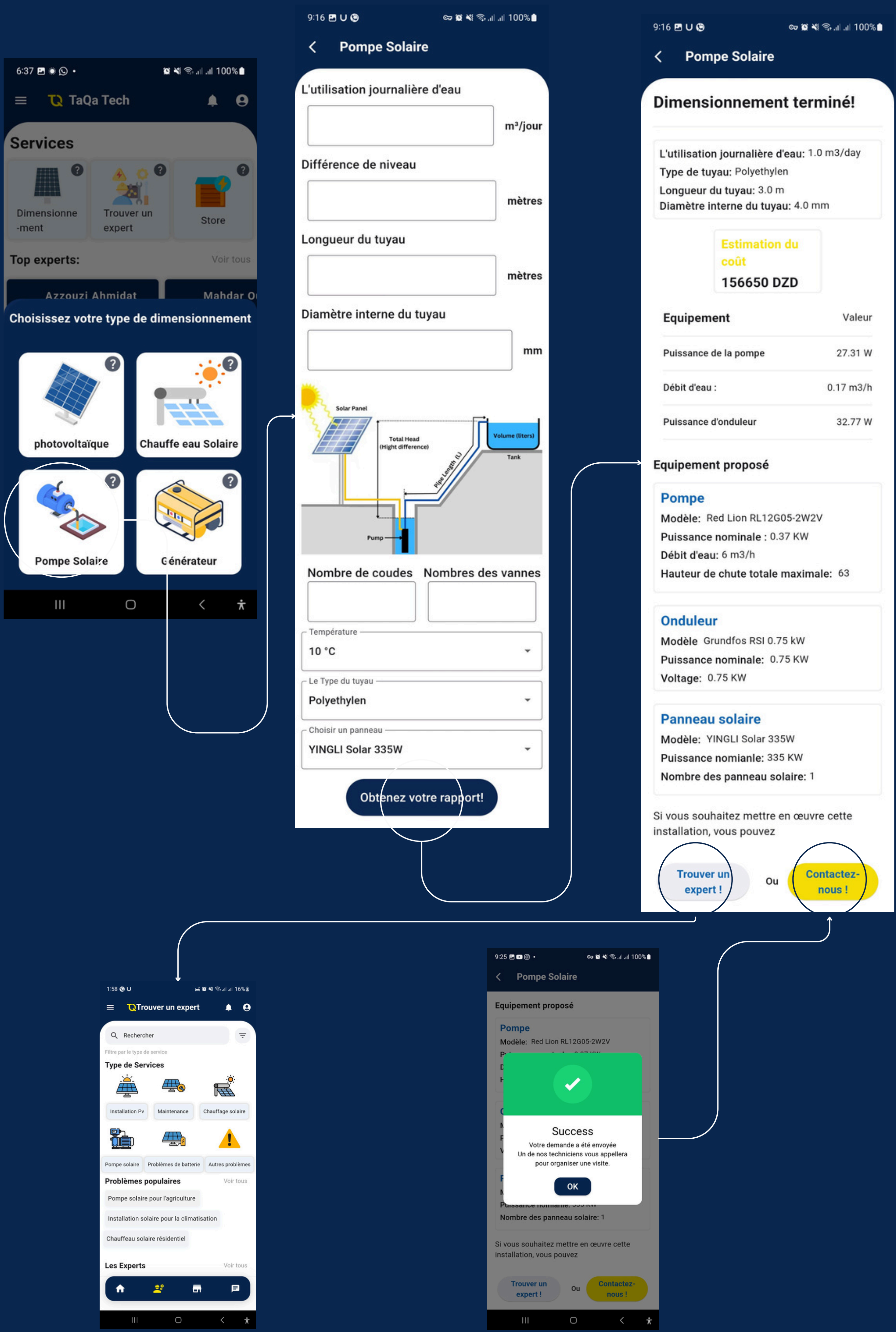
• Home page:

The home page is an easy-to-read interface that provides a comprehensive overview of all Taqa ech services.

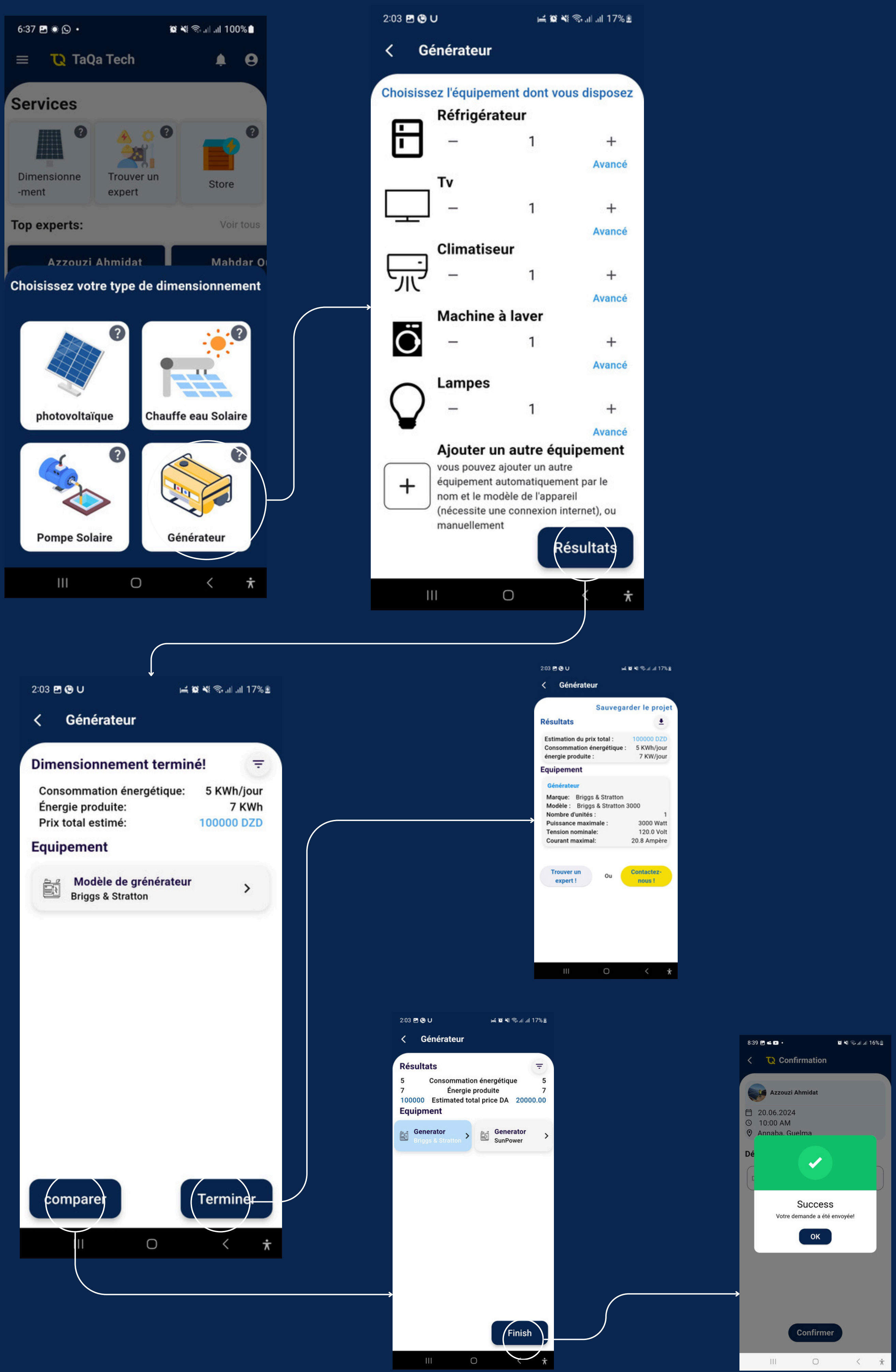
• Sizing photovoltaic installation

- # Sizing the Solar heater

- # Solar pump sizing

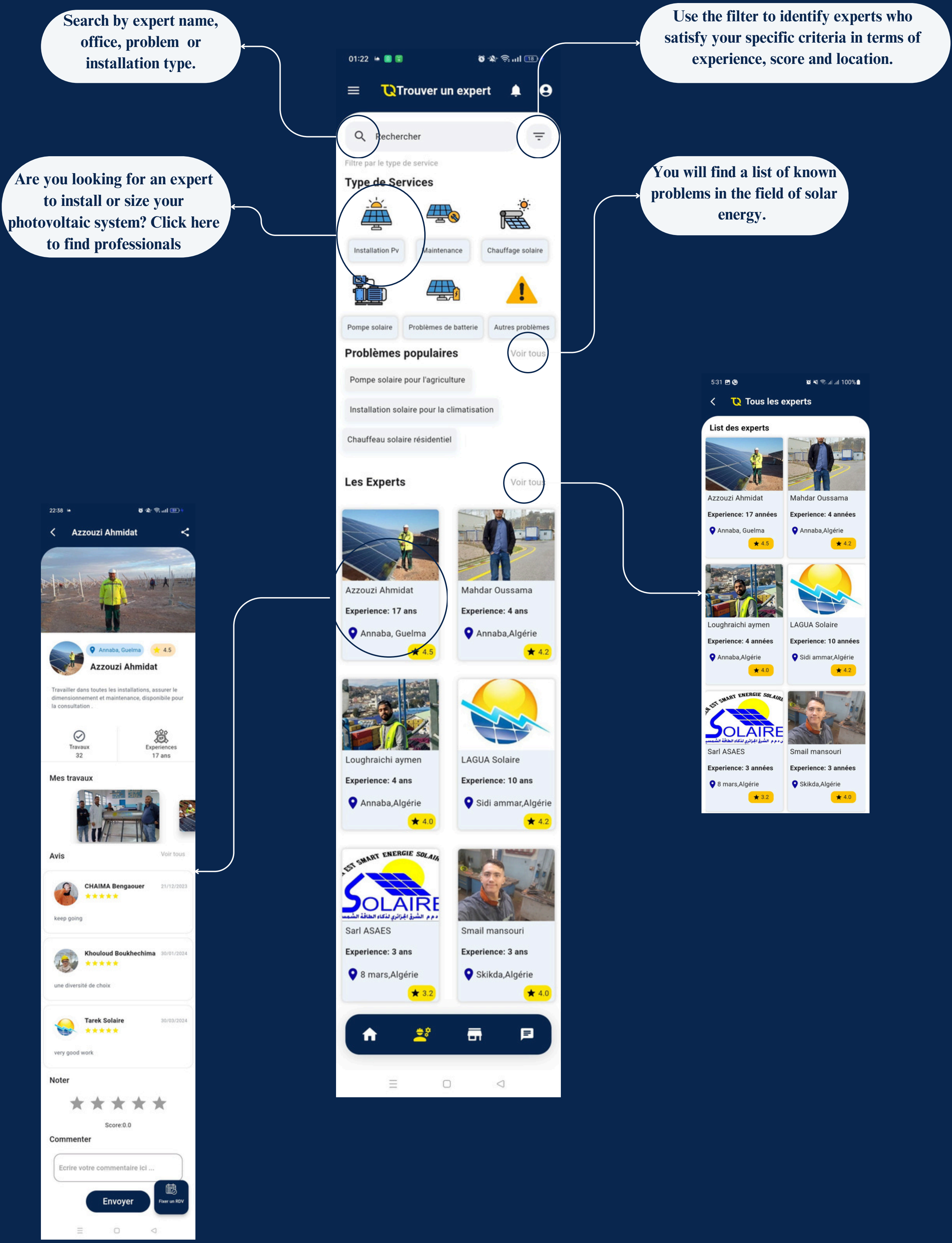


- **Generator sizing**

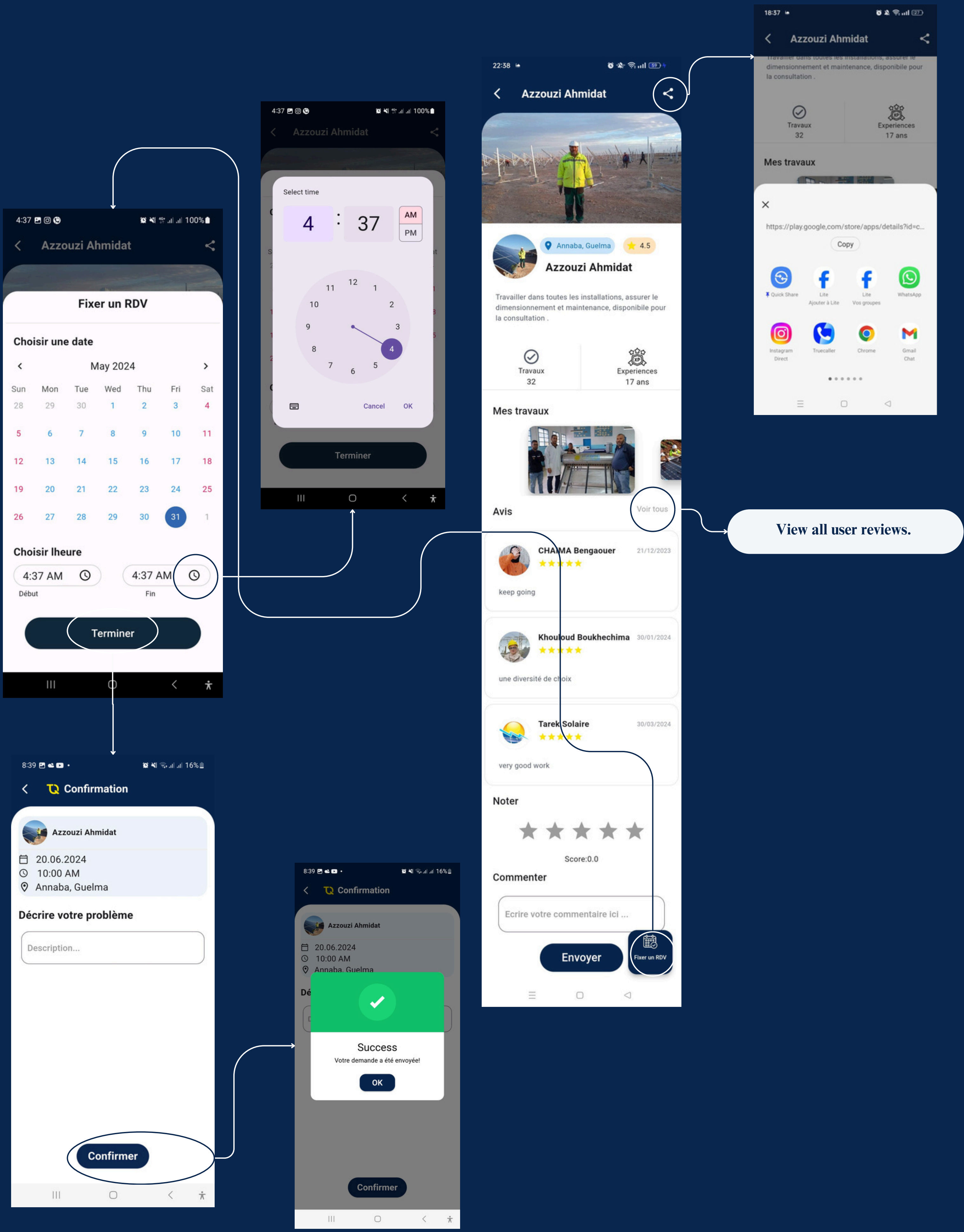


- # Find an expert:

Connects users with a network of local, certified, and reliable solar panel installers, ensuring quality installation or maintenance under the standards.



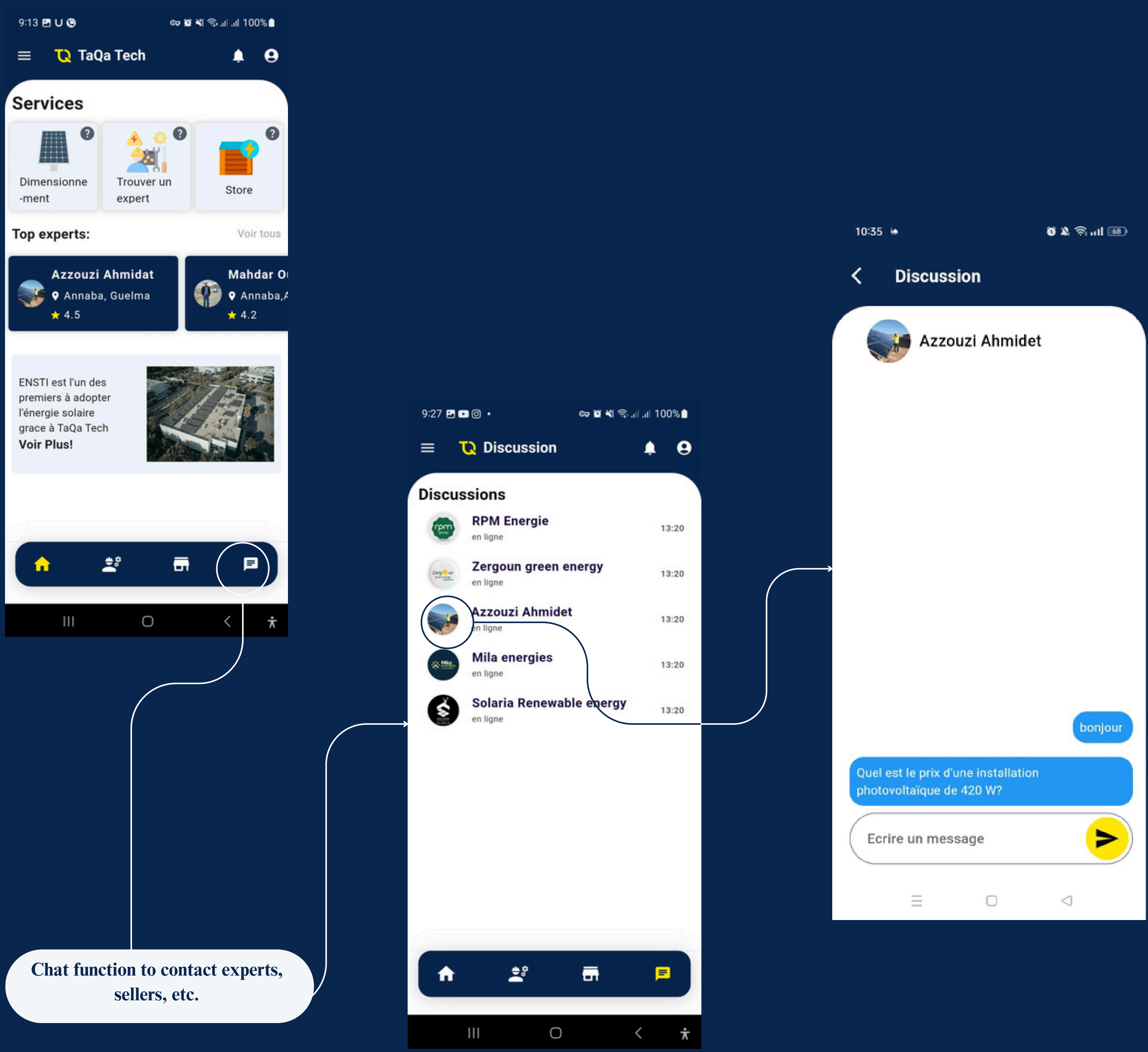
- # Expert profile



- # Marketplace

- # Chat

Real-time communication between users, vendors and experts to facilitate transactions and resolve problems.



13. Business model canvas:

Key Partners

- Experts.
- Sellers
- Energy companies of all sizes.

Key Activities

- Application Development and System Monitoring
- Strategic testing on customer samples
- Establishing partnerships
- Marketing and Promotional Strategy Development
- Financial management

Key Resources

- Development team
- Management, marketing and data analysis team
- Qualified expert database
- Server and test equipment
- Code base

Value Propotions

- Free Personalized Solar System sizing and transparent Cost Estimates
- Expert Connection for Installation and Equipment Maintenance
- Display of high-quality products from qualified suppliers
- Online help and contact with experts through integrated Chat

Customer Relationship

- Customer service via e-mail, phone calls, live chat or integrated into the application
- Assistance from a dedicated person
- OnLine community (social networks)
- Proactive communication and co-creation

Channels

- Mobile application available on Android /IOS
- Online advertising and social networks, websites
- Collaboration and partnerships with companies
- Offline advertising (flyers, brochures, energy conferences and events).

Customer Segments

- **Service seeker::**

Individual/company in the energy sector or other.

- **Seller :**

Supplier, company and store of all sizes.

- **Expert**:

Engineer, technician, repairer, installer, consultancy office.

Cost Structure

- Personnel payments (developer, manager, etc.)
- Administrative and legal expenses.
- Marketing and advertising costs.
- Technology Infrastructure Costs(server, test and development equipment,etc.)
- Workspace and furniture
- Other expenses (electricity, water, etc.)

Revenue Streams

- Freemium and Premium functionality (more detailed report)
- Offer packs for sellers
- Offer packages and commission per job opportunities for experts
- Sponsored advertising
- Annual or monthly subscription

References

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[2] « Rapport_CEREFE_TE-2020-4.pdf ». Consulté le: 11 juin 2024. [En ligne]. Disponible sur: https://www.cerefe.gov.dz/wp-content/uploads/2022/02/Rapport_CEREFE_TE-2020-4.pdf