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Simulation of smart meters deployment in Algeria

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Introduction

In a press release Ms. Marzouki Fatma, SONELGAZ's communications officer, said that the company's receivables were 171,442 billion dinars in the first quarter of 2020, 63 % of which are in the private sector, hence the need to modernize the management and operation of distribution in a more intelligent way and at a distance what smart meters offer. (4 IoT business models in 2021, 2020) (https://www.algerie-eco.com/2020/11/23sonelgaz-les-creances-ont atteint-171-milliardsds-da-au-1er-semestre-2020/, 2020)

This study, is a simulation on the digitalization of the energy distribution sector and specifically the electrical distribution in Algeria by the deployment of smart electricity meter throughout the territory (The document does not necessarily reflect the opinion of **SONELGAZ** on the matter and its content is entirely the responsibility of its authors)

The advent of information technology (IT) has revolutionized the daily life of companies and the way they conduct their businesses. Indeed, companies, whatever its fields and size, are investing in IT and integrating digitization into its businesses in order to remain relevant and competitive.

Thanks to these new technologies, businesses are able to work in smarter ways and faster by putting more real-time information, Internet of Things or IoT is one of the latest and the most impactful technology that revolutionizes many areas of our life and has a major role in digital transformation for companies and users.

The Internet of Things is transforming our physical world into a complex and dynamic system of connected devices on a high scale.

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In this contribution, we are presenting a brief description of the IoT technologies and its infrastructures, the mode of communication, the architecture of the IoT platform, and the major appliances of IoT technologies, then we are representing the economic and social aspect of IoT solution by estimating the overall cost and the expected financial and societal benefits, as well as the several impacts on the functions and businesses of the company.

Part (01) : Conceptual frame

Definition of the Internet of Things (IoT)

The Internet of Things, or IoT, refers to the physical devices that are connected to the internet, all collecting and sharing data.

IoT is described as set of technologies composed by Hardware, Network and Software.

It is commonly defined as the interface between the physical and the digital worlds, and as a solution.

IoT solution life cycle :

1- Deploying ;

2- Monitoring ;

3- Servicing ;

4- Managing ;

5- Decommissioning.

The architecture of the Internet of Things: (Learn about the 3 layers of IoT Architecture, 2019)

IoT architecture can be described as a technology stack with three layers: the IoT device layer, the IoT communication layer or IoT gateway, and the IoT platform layer.

The IoT Device Layer

Device constitutes the things in the internet of things. Devices act as the interface between the physical and the digital worlds. They are the first layer of the IoT architecture.

The IoT device layer consists of all the smart devices that are connected to the system. Smart devices are products or assets that are embedded with sensors, actuators, processors, and the ability of transmitting data over the internet.

These devices can collect data from their environment (physical world) and share it with operators, users, other smart devices, and applications connected to the internet.

The IoT Connectivity layer or gateway layer (Communication)

Communication refers to the way a device will exchange with the rest of the world the various IOT devices of the first layer need to be connected to the internet via a more powerful computing device called the IOT gateway or the IoT connectivity.

The IoT connectivity layer or IoT gateway layer sits between the IoT device layer and the IoT platform layer. This layer consists of a physical device or software program that collects data from smart devices and transmits it to the cloud. The gateway layer offers two practical benefits to the IoT architecture: load management via data pre-processing and security.

The gateway layer can consist of a dedicated software program that pre-processes data before sending it on to the cloud.

Gateway devices can also play a role in securing data transmission from smart devices. Features like tamper detection, encryption, and hardware random number generators can be implemented to prevent malicious attacks against IoT devices and secure data that is moving to the cloud.

This layer is in charge of all communications across devices, network, and cloud service. It determines how to get data from the cloud (Wi-Fi, 4G and 5G) and how to communicate with other devices.

The IoT platform layer

The processing layer collects stores and processes data that comes from the previous layers. All these tasks are handled via Iot platforms.

Once data from the IoT is uploaded to the cloud, it can be processed by tools and applications in the IoT platform layer. The platform layer consists of data centers that play a role in data analytics, management, and archiving.

IoT and business model

IoT has a complex business model.

IoT cost model

Many companies have turned their attention towards IoT solution in order to enable their business. Indeed, there is an investment that will be done to build an IoT solution.

Thus, we are indicating briefly the various costs related to IoT application or IoT solution:

- Capital to product the software / hardware and industrialization design
- Per device costs related to production and distribution
- Recurring investment to maintain the software stack
- Recurring cost for supporting maintenance, communications, platform run and end-user-support

IoT revenue model

IoT technology is reconfiguring industries drastically. As IoT devices are intrinsically connected and can produce data, they are able to generate new revenue.

The data generated from IoT devices turns out to be of value.

Unlike traditional devices, in order to work IoT products need a network on which to function, and a service platform on which to collect and manage data.

IoT technology can deliver recurring and continuous value for the customer.

That value can come from various forms: (4 IoT business models in 2021, 2020)

- B2B and B2C model : their revenue consists in everything linked to their product.
- Outcome business model ;
- Platform business model : the objective is to assemble producers and consumers to eliminate frictions and make money on the transaction.
- Compliance monitor.

Data mining: (https: //doi.org/10.1145/3312714.3312728 how to generate value from IOT data University of Sheffield)

Data mining is a broad concept of discovering knowledge from raw data.

The steps of data mining process are data gathering, data preprocessing, model learning and testing and validation.

The value of the IoT data

The Internet of things is becoming a key component of many companies' data-driven transformation. Indeed, IoT is used as a mean of achieving cost and productivity optimization, improving decision-making, improving safety measures and developing their artificial intelligence needs.

But, in order to establish a successful IoT strategy it must analyze the amounts of data IoT creates in order to make sense of it to gain real business insights.

The value of the data is not just financial. Gathering, analyzing and managing can have many benefits. By using IoT solution, the impact of human activities is highly minimized, for smart cities, the data collected delivers valuable information to establish development initiatives, in the transport sector the IoT solution allows the improvement of the transport processes, in the health sector, the data collected can help to better understand diseases and epidemics (Sunshare et Chattopadhyay, 2020).

In addition to the IoT's financial value, the environmental dimension should be taken into account.

Therefore, understanding and managing data is important to enable and be ready for future's challenges.

Mining data let you make a stock ; the stock value comes from the number of markets/customers you can reach with unique Insights.

This is related to the volume of data you have and the lack of competition. Selling you raw data is making new competitors

- Data mining has a cost
- Data can be reuse indefinitely
- Selling raw data destroy its value
- Data value comes from your stock or raw data
- Any competitor having more data than you destroy your data value

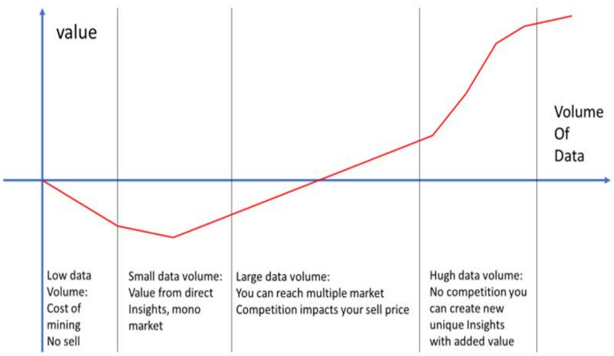

Figure 1 : Value and volume of data

Source : Pinault, P. (2020)

Utility of IoT

IoT is an interconnection of several devices networks, technology and human resources to achieve a common goal

IoT based applications are used in different sectors it provides a huge benefits to the users.

In addition to connect the device to the internet, the IoT technology provides the user, various features like real-time analytics, platform to analyze the collected data,

The innovative technology provides a wide range of applications, which can be integrated into a daily life (smart watch, smart door lock, smart security system) as well as the industries' and businesses' life.

The IoT provides a platform that creates opportunities for people to connect these devices and control them with big data technology, which in return will promote efficiency in performance, economic benefits and minimize the need for human involvement. It is the most important development of the 21st century (Iot-most-important-development-of-21st-century, 2018).

IoT makes technology reaching a new scale

IoT scalability is the ability of a device to adapt to the changes in the environment and meet the changing needs in the future.

Today, most companies realize the potential of digital transformation as a part of staying agile and competitive in future markets by incorporating IoT into different segments of their operations. IoT solution is mainly used for getting data to make better business decisions.

By now, the Internet of things is reaching a tipping point and being deployed in all sectors on a massive scale. IoT solution will include an important number of devices that all need to be connected reliably and safely. This solution will generate massive loads of data that need to communicate safely.

Massive scale IoT solution has several requirements such as: (Massive scale IoT- What and why, 2020)

- Reliable devices
- Low power consuming devices
- high-end security
- Scalable connectivity
- Cloud that fit for massive amounts of data

The implications of massive scale IoT

In order to ensure that the IoT solution is successful, the next steps should be followed:

- Defining the needs for the IoT solution
- Choosing competent partners
- Testing the solution with PoC (Proof-of-Concept)
- Making a pilot to find any final improvement needs for the solution

The technologies of IoT

Some of the main IoT technologies and communication protocols are: Bluetooth, Wi-Fi, LTE. These Communication protocols are the modes of communication between the IoT devices.

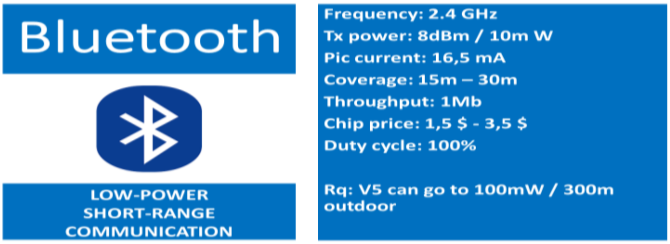

Figure 2 : Bluetooth

Developed in 1994, Bluetooth is a short-range wireless communication technology that allows devices such as mobile phones, computers, and peripherals to transmit data or voice wirelessly over a short distance. The purpose of Bluetooth is to replace the cables that normally connect devices, while still keeping the communications between them secure (what-is-bluetooth, 2019).

Bluetooth is equipping all modern smartphones and devices can use the smartphone connections to reach internet. That way, the communication cost seems to be free for the consumers

Bluetooth can also be used for Smart Home and smart building with long range version of thanks to meshed networks

You need to know Bluetooth background communications with smartphones is complex to make working and diversity of smartphone is a big issue for Bluetooth IoT designs.

Figure 3 : ZigBee

ZigBee and its competitor Z-wave has been leader in smart home domain, they are not integrated into smartphone and need to have a gateway to propagate the data to internet and the central servers, this extra cost limit the application domains, mostly to smart home, industrial domains also makes sense

ZigBee also supports Meshed networks to extend the covrage

ZigBee technical name : 802.15.4

Figure 4 : WiFi

WiFi stands for **Wireless Fidelity**. Regardless of what you call it, WiFi is a wireless networking technology that gives devices like desktop computers, laptops, mobile phones, smart TVs, game consoles, and other compatible wireless devices Internet access. (what-is-wifi-and-how-does-it-work, 2019).

Wi-Fi have the advantage to be well deployed at home and in the industries & services, it have different negative points limiting its usage for IoT.

The setup complexity

The pic consumption over 100 mA impacting the battery choice

The power consumption requiring large battery charge and short autonomy Wi-Fi requires a local gateway (access point), to communicate to internet where the backend servers are.

***3 GPP** (About-3gpp, 2020)*

The 3rd Generation Partnership Project (3GPP) unites [Seven] telecommunications standard development organizations (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC), known as "Organizational Partners" and provides their members with a stable environment to produce the Reports and Specifications that define 3GPP technologies.

The project covers cellular telecommunications technologies, including radio access, core network and service capabilities, which provide a complete system description for mobile telecommunications.

The 3GPP specifications also provide hooks for non-radio access to the core network, and for interworking with non-3GPP networks.

3GPP specifications and studies are contribution-driven, by member companies, in Working Groups and at the Technical Specification Group level.

The three Technical Specification Groups (TSG) in 3GPP are:

1. Radio Access Networks (RAN),
2. Services & Systems Aspects (SA),
3. Core Network & Terminals (CT)

Figure 5 : LTE

LTE stands for Long-Term-Evolution, LTE is a standard for 4G wireless technology that offers increased network capacity and speed for cellphones and other cellular devices compared with 3G. (Long-Term-Evolution-LTE, 2020).

LTE (Long Term Evolution) or the E-UTRAN (Evolved Universal Terrestrial Access Network), introduced in 3GPP R8, is the access part of the Evolved Packet System (EPS). The main requirements for the new access network are high spectral efficiency, high peak data rates, short round trip time as well as flexibility in frequency and bandwidth (technologies/keywords-acronyms, 2020).

The motivation for LTE

Need to ensure the continuity of competitiveness of the 3G system for the future

User demand for higher data rates and quality of service

Packet Switch optimized system

Continued demand for cost reduction (CAPEX and OPEX)

Low complexity

Avoid unnecessary fragmentation of technologies for paired and unpaired band operation

LTE internet of things (IoT) specifications (https://searchmobilecomputing.techtarget.com/definition/Long-Term-Evolution-LTE, 2020)

In June 2016, 3GPP Release 13 delivered new IoT cellular connectivity options designed for IoT machine-to-machine (M2M) use. LTE-machine-type communication (LTE-M) and narrowband IoT (NB-IoT) were both based on the LTE standard, but with significant changes to enable low-power wide area network M2M operations.

LTE-M delivers data speeds of around 1 Mbps, while NB-IoT supports up to 26 Kbps in downlink. These drastically reduced data speeds increase the battery life of M2M devices that use the IoT cellular standards. For sensors and other devices that need mobility on the cellular network, NB-IoT can support a battery life of up to 10 years.

LTE-M can support up to 10 years of battery life on two AA batteries, but only if the device is static and broadcasting for seconds daily. If a device is on, moving about on an LTE network and using LTE-M supported voice features, the battery life will be reduced.

The characteristics of an IoT project

A successful IoT project is the one getting the best field experience in the early stages and owning a range of characteristics:

- **POC (Proof-of-Concept),** refers to a demonstration to verify that certain concepts have the potential for real-word application, it is an important step for the launch of a fully prototype of the IoT's project.

- **Field test** aimed to reveal the faults and to answer whether the raw data captured would reach the expected business value creation.

- **POT (Proof-of-Technology)** is a term which is used to describe testing an idea verify whether the technology used can support protect goals fix the technologies and make small batch of the future design solution and ensure it respects the constraints.

- **INDUS (industrialization)** is create the final product, create the associated platform.

Applications of IoT technologies

Nowadays, the IoT is everywhere from home to industrial fields, IoT technologies have a lot of applications in various fields. The IoT solution enables reducing labour and eliminating the chance of human errors.

The major application of IoT technologies are: smart home applications, smart cities, smart cars, healthcare applications, industrial automation…

Smart home

Smart home aims to increase the comfort and the high quality of lifestyle, by using IoT technologies like connected sensors to collect and analyze data, here are some of the major smart home technologies:

- Smart lighting;
- Automated windows and doors;
- Automated air conditioning

Smart city

The IoT solution implanted in cities aims to improve the infrastructure, public utilities and services by using wireless communication, connected sensors.

There are many appliances of loT technologies in urban environment, such as:

- Smart energy grid allowing the most efficient management of energy consumption ;

- Smart transportation with smart vehicles ;

- Smart air quality monitors that can detect pollutant particles in the air and alert people to one's smartphones.

Industrial IoT

Industrial IoT, defined as a network of devices and sensors connected to each other via internet, enable collecting data and analyzing it to apply this information in continuous process improvement.

There are many IoT industrial applications:

- automated management : the ability to remotely control via digital machines

- predictive maintenance : once installed on the machines and operating platforms can send alerts when certain risk factor emerge

- IoT generates valuable information enable to improving processes of business model analyzing data faster and automatically

- Exchanging information in real time that allow increasing supply chain efficiency.

Companies should invest in this paradigm to improve their productivity and optimize their businesses and profits.(Pinault, 2020)

An IoT project as a complex project

It can be managed in an agile approach to get deliverables more frequently, but never consider it as a simple IT project, it's much more complex.

It complexity depends on :

- **Deployment scale** : making 10 devices will not be the same as 1M ;

- **Size of company**: this is relation with the risk level accepted to take and the investment supported ;

- **The geographical scope** : hardware deployment requires certification, certifications are made per zones, technology availability also differ per zone ;

- **Typical IoT project team :** IoT requires a lot of different expertise

These skills are far away from the one you find in a furniture industry, this is a problem for the IoT transformation, and this problem is bigger than in the digital transformation.

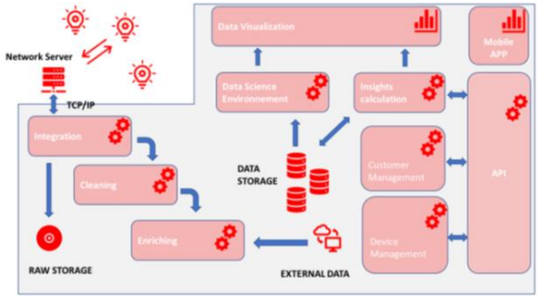

Figure 6 : The IoT platform

Source : Pinault, P. (2020)

The IoT platform brings together a set of services that enable the collection, storage, correlation, analysis and exploitation of data. It thus refers to the supporting software that connects the entire IoT system, facilitating communication, data flow and device management and application functionality. The platform connects devices to a cloud through flexible connectivity options (https://www.journaldunet.fr/web-tech/dictionnaire-de-l-iot/1440690-plateforme-iot-definition-et-role-pour-le-device-management/)

- **Integration:** once the data has been collected by the devices, it is introduced into an integration chain that allows for raw data storage.
- **Raw storage :** is an additional storage of the raw data that has not been modified, it acts as a backup in case of a bug or a loss of the database.
- **Cleaning :** this phase aims to clean up incorrect, incomplete or inaccurate data sent from the currencies.
- **Enriching :** its role is to enrich the data collected by the devices with external environmental or situational data such as metrological or other data to increase the value of our data.
- **Data storage :** is the storage of our data in a massive way, since we never destroy data, it will increase in a gigantic way, and for this we use a technology such as big data.
- **Data science environment :** represents the phase of data analysis and research in the database in order to extract value to create Insights.
- **Insight calculation :** is the classification and ordering of insights.
- **Data visualisation :** is the step that allows the visualisation of our insights for a clear and comprehensible reading in the form of text, table or graph
- **API (Application Programming Interface) :** is the interface that will restore the data following a request, it is made available to the user
- **Mobil API :** is the consumption or mobile access to the API

Customer management: is the management of the database of customers who have access to the API (user account, access level and others).

- **Device management :** the management and monitoring of the device throughout its life cycle.

Today there are global and turnkey solutions, like MicrosoftAzur, or amazon web service and many others, which avoid the need to create its own data center, and lower costs and faster, both solutions have their advantages and disadvantages (Pinault, MooC IoT).

Part (02) : The simulation

The simulation consists on the one hand of replacing the old electricity meters, i.e. **10494465** meters, and on the other hand of installing the new **1365034** meters according to SONELGAZ's forecasts over a period of **seven** years until 2018. Our simulation is based on a ten year period, with the same constant number of new subscribers, In order to predict the financial revenues after the change of almost all the old meters and that 100 % of the subscribers are equipped with smart meters, we have voluntarily added **5501** as a margin of error and simplify the calculation of damaged or affected meters as explained in the following table :

Table 1 : Number of devices to change

	Réel 1	forecast 2	deviation estimate
replacement of old meters	10 494 465	10 497 000	2 535
installation of new meters	1 365 034	1 368 000	2 966
total	11 859 499	11 865 000	5 501

Source : Produced by authors

Timeframe

Our scenario is spread ove : r a period (N) of 10 years in 3 phases:

Phase 01 : N=1 to N=3 (start of the project)

Phase 02 : N=4 to N=6 (end of replacement of old meters)

Phase 03 : N=7 to N=10 (installation of meters than new subscribers)

The advantages of digitizing the network : (comparateur-energie, 2020)

- Remote reading of consumption indices ;
- Billing based on the amount of energy actually consumed
- Faster and automatic detection of faults
- Faster and automatic detection of fraud
- Possibility of organizing consumption according to hourly rates

- A more accurate view of consumption data
- Remotedis connection of electricity
- Better management of the network and implementation of a SMART GRID

These different functionalities therefore aim to bring benefits to the different actors in the value chain (infrastructure managers, suppliers, producers and end customers): (S.A, 2021)

- Reduction in the cost of the service provided
- Reduction in energy consumption by consumers
- Improved security of supply and reduced greenhouse gas emissions (reduced peak demand)
- emissions (reduction of the national peak through multi-hourly tariffs and remote load disconnection)
- Marketing of value-added services

The smart meter (device)

A smart meter is an energy meter (usually electric) capable of monitoring in detail, and often in real time, the electricity consumption of a building, a company or a household.

This smart meter also communicates and transmits the information collected via various channels (carrier current, Internet, telephone). (developpement-durable-compteur-intelligent, 2020)

Characteristics (according to 9001 certified)

Technical features

- Long-term non-volatile memory
- Liquidcrystal display
- IP54 protection degree for internal counters
- Overvoltagealarm display
- Flashing phase indicators in case of phase inversion.
- Operating temperature : - 10°c to + 60°c
- Storage temperature : - 25°c to + 70°c

Functional characteristics

- Number of tariffs 8 per energy
- Energy registers 32 max
- Historical registers 36 max

- Activation of billing period by internal clock, button or communication
- Dry contact inputs support 230 V
- Two RS485 connections with RJ45 connectors
- Communication speed up to 19200 baud
- Communication protocol DLMS-COSEM and IEC1107 mode E

Technical specifications of the configuration software

- Meterreading and programming
- Communication with the meter from the PC using the optical head
- Processing and saving of the returned information
- Consultation of saved data, updating of data and printing

Technical specifications of the SPARKET modem

- Operating temperature : - 20°c to + 65°c
- IP 20 protection
- External power supply (supplied by the meter): 10 V/100 mA
- Voltage range : 8 - 11V
- Remote configuration
- Remote firmware update
- Saving of parameters in non-volatile memory (NVRAM)
- Interface for SIM cards : 3V/1.8V
- Password protection of configuration via configuration tool
- Modem power failure alert via SMS

The cost of acquiring the smart meter (device)

From the growing offer of the smart meter market we have selected five that meet our needs, so we have been able to determine a reference price which is the average of the prices of our selection, which is : 15780,00 Dzd (including all taxes) or : 97,20 Euro or 117,70 US dollar (Bank of Algeria, 2021).

We have calculated the price with a price increase of 10 % every three years, for simplicity we have deliberately fixed the exchange rate

Observation : our forecast of a 10 % increase is calculated on the inflation rate and the fluctuation of the currency exchange rate

Table 2 : Device prices

Period	Price in DzD	Price in Euro	Price in Dollar
N=1 to N=3	15 780,00	97,03	118,09
N=4 to N=6	17 358,00	106,73	129,90
N=7 to N=10	19 094,00	117,41	142,89

Source : Produced by authors

The communication

We chose a GPRS communication on M2M (machin to machin) package available in Algeria with the three telephone operators (Djezzy, Ooredoo, Mobilis), which all offer an internet package of 50 Mb and 40 or 50 SMS per month, i.e. :

12500 messages of 4Ko (16 characters) per month so about 403 msg day for a need of :

- A sending of 96 messages per day as followed by consumptions of every 15 minutes.
- A sending of 96 messages per day on the status of the meter
- Remains 211 messages for the various alerts (fraud, breakdowns, maintenance)

The cost of communication

Table 3 : Current M2M subscriptionsare

operator	price/month DZD	internet packtage Mo	nomber of SMS
djezzy	100,00	50	40
ooredoo	100,00	50	50
Mobilis	N/D	50	50

Source : Produced by authors

The cost retained is 100,00 DZD with a forecasted cost increase of 20% every 3 years.

Table 4 : Cost of communication per device

Period	Price in DzD
N=1 to N=3	100,00
N=4 to N=6	120,00
N=7 to N=10	144,00

Source : Produced by authors

Installation costs

There are two types of installation, the replacement of old meters and installation of a new smart meter and the installation of smart meters to new customers.

Table 5 : Device replacement cost

	N=1 to N=3	N=4 to N=6	N=7 to N=10
remplace old device	1 200,00	1 320,00	1 452,00
installe new device	1 000,00	1 100,00	1 210,00

Source : Produced by authors

Preliminary costs

The preliminary expenses, are all the expenses of launching the project, study of the ground, technological study, training of the personnel, and the communication related to the project, we estimate them at **10.000.000,00** DZD.

Additional costs

The additional costs are recurrent costs related to the operation which include the costs of scheduled or unscheduled maintenance, intervention on affected or damaged meters as well as communication and updates of the firmware, we estimate it at **1.000.000,00** DZD per year.

Management and support (platform)

We opted for a global solution on the cloud of MICROSOFT AZUR, less expensive than the realization of a data centre, it guarantees a storage hub, a total security from end to end and a personalized working environment and the development of API (Application Programming Interface) at a cost of 0,40 DZD per device the first three years, then in anticipation of an increase of 10 % every three years.

Table 6 : Platform cost

Period	N device	N of IoT Hub	Price in Euro	Price in DZD	Price per device
N=1 to N=3	5393100	5	13 176,56	2 142 772,19	0,40
N=4 to N=6	11865000	16	51 019,65	8 296 815,48	0,70
N=7 to N=10	12860040	18	63 136,81	10 267 308,04	0,80

Source : Microsoft Azure Estimate 5/31/21, https://azure.microsoft.com/fr-fr/(bank-of-algeria, 2021)

Financial income

Includes, the installation price charged to customers, the digital contribution and the subscription to services

Installation price charged to customers

Currently to be a subscriber it is necessary to pay the sum of 20000 DZD for the acquisition of the meter and the expenses of connection, we kept this price as reference with the provision of an increase of 10 % every 3 years.

Table 7 : Installation price charged to customers

Period	price charged to the customer
N=1 to N=3	20 000,00
N=4 to N=6	22 000,00
N=7 to N=10	24 200,00

Source : Produced by authors

Digital contribution

Digital contribution, is a quarterly contribution paid by the subscriber, it contributes to the financing of the project, in return, the subscriber will have additional services, such as his monthly consumption, and a consumption overrun alarm that he will have set himself

The amount of the contribution is fixed at 100 DZD per month, then an increase of 10 % every three years.

Table 8 : Digital contribution

Period	Digital contribution
N=1 to N=3	1 200,00
N=4 to N=6	1 320,00
N=7 to N=10	1 452,00

Source : Produced by authors

Subscription to services (optional)

Subscription to services (optional), which is an additional service that offers from an application detailed information on its electricity consumption in real time, graph of consumption over a given period, alarm of exceeding consumption, it will be accessible for an amount of 150,00 dzd bimonthly, we estimate that only 10% of subscribers will subscribe to this service then an increase of 10 % every 3 years.

Table 9 : Subscription to services (optional)

Period	Subscription to services
N=1 to N=3	1 800,00
N=4 to N=6	1 980,00
N=7 to N=10	2 178,00

Source : Produced by authors

Table 10 : Results of the simulation

		N=1	N=2	N=3	N=4	N=5	N=6
Num of device	ND	124 360,00	248 720,00	248 720,00	248 720,00	248 720,00	248 760,00
	RoD	954 260,00	1 908 520,00	1 908 520,00	1 908 520,00	1 908 520,00	1 908 660,00
costs	preliminary charge	10 000 000,00	-	-	-	-	-
	CAS	17 020 623 600,00	34 041 247 200,00	34 041 247 200,00	37 445 371 920,00	37 445 371 920,00	37 448 496 360,00
	IND	124 360 000,00	248 720 000,00	248 720 000,00	273 592 000,00	273 592 000,00	273 636 000,00
	RoD	1 145 112 000,00	2 290 224 000,00	2 290 224 000,00	2 519 246 400,00	2 519 246 400,00	2 519 431 200,00
	CoC	107 862 000,00	215 724 000,00	215 724 000,00	258 868 800,00	258 868 800,00	258 890 400,00
	management &	1 294 344,00	2 588 688,00	2 588 688,00	4 530 204,00	4 530 204,00	4 530 582,00
	support	-	-	-	-	-	-
	additional costs	500 000,00	1 000 000,00	1 000 000,00	1 000 000,00	1 000 000,00	1 000 000,00
	Total	**18 409 751 944,00**	**36 799 503 888,00**	**36 799 503 888,00**	**40 502 609 324,00**	**40 504 766 564,00**	**40 505 984 542,00**
financial income	IPCC	2 487 200 000,00	4 974 400 000,00	4 974 400 000,00	5 471 840 000,00	5 471 840 000,00	5 472 720 000,00
	DC	161 793 000,00	2 265 102 000,00	4 853 790 000,00	7 539 553 800,00	11 034 282 600,00	13 881 839 400,00
	subscription	24 268 950,00	339 765 300,00	728 068 500,00	1 130 933 070,00	1 655 142 390,00	2 082 275 910,00
	Total	**2 673 261 950,00**	**7 579 267 300,00**	**10 556 258 500,00**	**14 142 326 870,00**	**18 161 264 990,00**	**21 436 835 310,00**

		N=7	N=8	N=9	N=10	Total	0
Num of device	ND	248760	248760	248760	248760		2 363 040,00
	RoD	0	0	0	0		10 497 000,00
costs	preliminary charge	-	-	-	-		10 000 000,00
	CAS	4 749 574 680,00	4 749 574 680,00	4 749 574 680,00	4 749 574 680,00		216 440 656 920,00
	IND	300 999 600,00	300 999 600,00	300 999 600,00	300 999 600,00		2 646 618 400,00
	RoD						13 283 484 000,00
	CoC	36 070 200,00	36 070 200,00	36 070 200,00	36 070 200,00		1 460 218 800,00
	management &	557 222,40	557 222,40	557 222,40	557 222,40		22 291 599,60
	support						-
	additional costs	1 000 000,00	1 000 000,00	1 000 000,00	1 000 000,00		9 500 000,00
	Total	**5 088 201 702,40**	**5 088 201 702,40**	**5 088 201 702,40**	**5 088 201 702,40**		**233 874 926 959,60**
financial income	IPCC	6 019 992 000,00	6 019 992 000,00	6 019 992 000,00	6 019 992 000,00		52 932 368 000,00
	DC	15 842 370 720,00	16 323 970 080,00	16 805 492 000,00	17 287 091 360,00		105 995 284 960,00
	subscription	2 369 584 206,00	2 658 691 134,00	2 712 871 062,00	2 767 050 990,00		16 468 651 512,00
	Total	**24 231 946 926,00**	**25 002 653 214,00**	**25 538 355 062,00**	**26 074 134 350,00**		**175 396 304 472,00**

Num of device	ND	2 363 040,00
	RoD	10 497 000,00
costs	preliminary charge	10 000 000,00
	CAS	216 440 656 920,00
	IND	2 646 618 400,00
	RoD	13 283 484 000,00
	CoC	1 460 218 800,00
	management & support	22 291 599,60
		-
	additional costs	9 500 000,00
	Total	233 874 926 959,60
financial income	IPCC	52 932 368 000,00
	DC	105 995 284 960,00
	subscription	16 468 651 512,00
	Total	175 396 304 472,00

Period	Costs	F Income
N=1	18 409 751 944,00	2 673 261 950,00
N=2	36 799 503 888,00	7 579 267 300,00
N=3	36 799 503 888,00	10 556 258 500,00
N=4	40 502 609 324,00	14 142 326 870,00
N=5	40 504 766 564,00	18 161 264 990,00
N=6	40 505 984 542,00	21 436 835 310,00
N=7	5 088 201 702,40	24 231 946 926,00
N=8	5 088 201 702,40	25 002 653 214,00
N=9	5 088 201 702,40	25 538 355 062,00
N=10	5 088 201 702,40	26 074 134 350,00
total	**233 874 926 959,60**	**175 396 304 472,00**
balance		**- 58 478 622 487,60**

The balance:

The total cost of the project is :**233'874'926'959,60 DZD** for a financial income forecast of **175'396'304'472,00 DZD**, i.e. a difference of **-58'478'622'487,60 DZD**

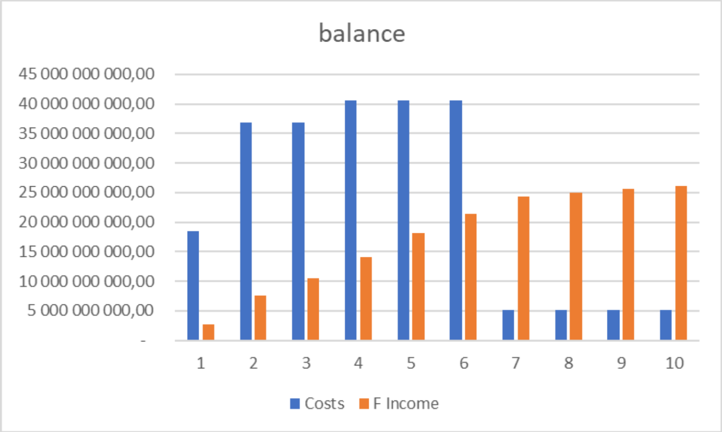

Figure 7 : Balance

Source : Produced by authors

From this graph we can see that costs are increasing linearly up to year 6 and then falling as the replacement of old devices, which represent the bulk of the costs, is completed, while financial revenues are still increasing due to the continuous increase in new devices, exceeding costs from year 7 onwards and continuing in a slight increase

Table 11 : The financial incomes

financial income	IPCC	52 932 368 000,00	30,1787%
	DC	105 995 284 960,00	60,4319%
	subscription	16 468 651 512,00	9,3894%
	Total	175 396 304 472,00	

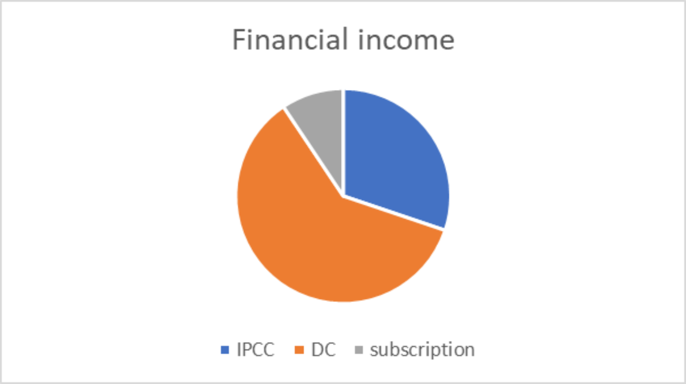

Figure 8 : The financial incomes

Source : Produced by authors

The financial incomes, amounting to 175396472,00, are 60,44 % from the Digital Contribution, the Installation Price Charged to Customers which represents 30,18 % are unique and not repetitive revenues which is a positive point for the project, while the subscriptions represent less than 10% but may increase with time.

Table 12 : The total costs

costs	preliminary charge	10 000 000,00	0,0043%
	CAD	216 440 656 920,00	92,5455%
	CIND	2 646 618 400,00	1,1316%
	CROD	13 283 484 000,00	5,6797%
	CC	1 460 218 800,00	0,6244%
	management & support	22 291 599,60	0,0095%
		-	
	additional costs	9 500 000,00	0,0041%
	Total	233 874 926 959,60	

Source : Produced by authors

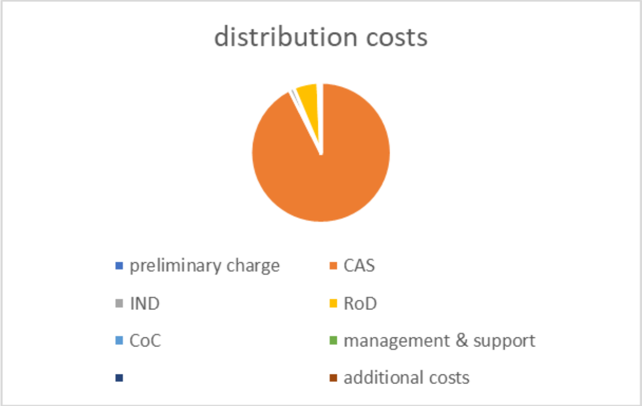

Figure 9 : Distribution costs

Source : Produced by authors

The total costs are 233874926959,60 DZD, distributed as follows, 92,54 % or 216440656920,00 dzd for the purchase of the smart meters which is the biggest part of the investment, the installation which is only 6,8 % is weighed down by the replacement of the old device which represents 5, 68% of the total costs, the communication when it is 1460218800,00 dzd takes up the cost of operation the most elever While the management and support represent only 0,0095 % and that is possible thanks to the solutions of hosting standariser proposed by microsoftazur.

Table 13 : Calculate CAPEX and OPEX

CAPEX	**232 380 759 320,00**	**99,36%**
OPEX	**1 492 010 399,60**	**0,64%**

Source : Produced by authors

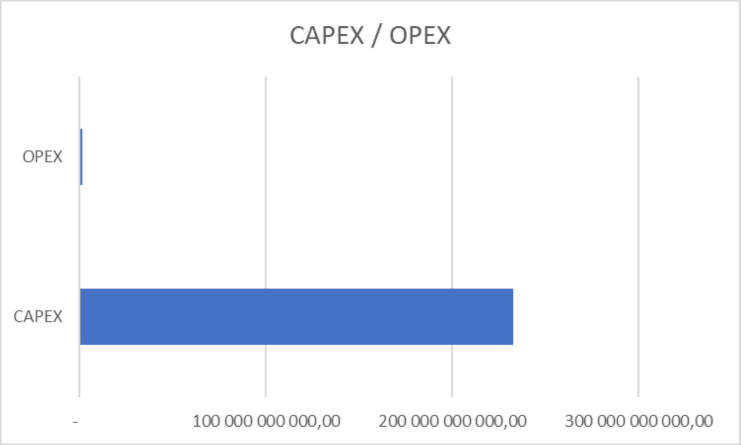

Figure 10 : CAPEX and OPEX

Source : Produced by authors

With a CAPEX of 99.36 % and an OPEX of only 0.64 %, this represents an investment that is certainly much higher than the operating costs, but it allows a great return on investment in the long term and a control of variable costs in the short term

Table 14 : Comparison between countries

Country	overall cost of the project (in billions of euros)	Number of smart meters (in millions)	Overall cost per meter (in euros)	Overall cost per meter (in algerian dinars)
Germany	14,5	47,9	546,00	88 790,52
Belgium	4,59	5,97	243,00	39 516,66
Finland	0,69	3,3	210,00	34 150,20
France	4,50	35	135,00	21 953,70
Netherlands	3,34	7,6	220,00	35 776,40
United kingdom	9,30	3,9	161,00	26 181,82
Algeria	1,44	11,86	121,21	19 711,17

Source : (benchmarking-smart-metering-deployment-eu-28_en, 2020)

Compared to other countries, the deployment in Algeria is inferior to the others and this is possible thanks to the choice of a management and supports on external provider contrary to other countries which chose to create their own data centre, and of the other the expenses of installation which are less expensive.

Conclusion

At first glance, the simulation of the deployment of smart meters appears to be an unsuccessful investment with a financing requirement of 233,874,926,959.60 dzd and financial income of 175,396,304,472.00 dzd.

The financial income of 175 396 304 472,00 dzd gives a gap of - 58 478 622 487,60 dzd but compared to the 171 000 000 000,00 dzd of debts and receivables of SONALGAZ this solution would have allowed a gain of about 112 500 000 000,00 dzd which is almost double, in addition to the savings made on the costs of reading the meters, The deployment of such a device is more than necessary, especially since there are still several advantages to such a deployment, such as the creation of qualified jobs represents a technological leap and an accumulation of knowledge imperative to the economy of the future.

The deployment of smart meters is the first step towards a smart energy distribution network (smart grid), which allows a better management of the network and a reduction in costs, which is also essential for the realization of smart cities.

This deployment will also allow the implementation of time slots which is a win-win model that will automatically regulate consumption, reducing the electricity bill for the subscriber and reducing the tension on the network thus avoiding overheating.

In addition to the social and societal impacts such as customer satisfaction and experience are not to be neglected, the time it takes to regulate complaints is also an additional cost that the company has to face.

For all these reasons, we recommend that SONALGAZ consider deploying smart meters and digital services as soon as possible to effectively prepare for the future challenges of energy management.

Abbreviation

ND : New Device

ROD : Replace Old Device

CAD : Cost of Acquiring the Device (Smart meter)

CIND :Cost of Intallation New Device

CROD : Cost of replace old device

CC : Cost of Communication

IPCC : Installation Price Charged to Customers

DC : Digital Contribution

OPEX : Operational expenditure

CAPEX : capital expenditure

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