Impact of Telemedicine on GHG emissions reduction (pilot study)

Sponsored by Sanofi Egypt

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Abbreviations and Acronyms

AD	Atopic Dermatitis
ASU	Ain Shams University
CDM	Clean Development Mechanism
CFP	Carbon Footprint
CH_4	Methane
CO_2	Carbon Dioxide
COP	Conference of the Parties
EF	Emission Factor
EPA	Environmental Protection Agency
G	Gram
GHG	Greenhouse Gas
GP	General practitioner
GWP	Global Warming Potential
HCP	Healthcare personnel
kWh	Kilo Watt hour
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
Kg	Kilograms
km	Kilometer
L	Liter
LCA	Life Cycle Assessment
m^3	Cubic Meter
MENA	Middle East/North Africa
MT CO_2e	Metric Tonnes of Carbon Dioxide Equivalent.
N_2O	Nitrous Oxide
SDS	Sustainable Development Strategy
SI units	International System of Units
SSR	Sources, sinks, and reservoirs
UNFCCC	United Nations Framework Convention on Climate Change

Key Definitions

Activity Data	Quantitative measure of the museum's activity that results in a GHG emission or removal.
Assumed Parameter	A parameter that is not site-specific but based on best practices, global averages, etc. that is more or less representative to the actual value
Baseline Candidates	They are alternative technologies or practices, within a specified geographic area and temporal range, that could provide the same product or service as a project activity.
Baseline Emission Estimates	They are used to estimate baseline emissions relating GHG emissions to the production of a product or service or to a certain period, they may be dynamic or static.
Baseline Emissions	They are used to quantify GHG reductions from a project activity which refers broadly to baseline GHG emissions, removals, or storage.
Baseline Procedures	They are methods used to estimate baseline emissions and are classified into two procedures.
Baseline Project-Specific Procedure	This procedure produces an estimate of baseline emissions through the identification of a baseline scenario specific to the proposed project activity where the baseline scenario is identified through a structured analysis of the project activity and its alternatives.
Baseline Project-Standard Procedure	This procedure produces an estimate of baseline emissions using a GHG emission rate derived from a numerical analysis of the GHG emission rates of all baseline candidates and is sometimes referred to as a multi-project baseline or benchmark.
Baseline Scenario	It is a reference case for the project activity and a hypothetical description of what would have most likely occurred in the absence of any considerations about climate change mitigation where it is used to estimate baseline emissions.
Climate Change	Long-term shifts in temperatures and weather patterns. These shifts may be natural or human driven activities.
CO_2e	Carbon dioxide equivalent – standardization of all greenhouse gases to reflect the global warming potential relative to carbon dioxide.
Dynamic Baseline Emission Estimates	Dynamic baseline emission rates change over time, and they are better suited to GHG projects that are part of a system that changes significantly over time.
Emission Factor	A factor allowing GHG emissions to be estimated from a unit of available activity data (e.g. tonnes of fuel consumed, tonnes of product produced) and absolute GHG emissions).
Facility	Single installation, set of installations or production processes (stationary or mobile), which can be defined within a single geographical boundary, organizational unit or production process.
Greenhouse Gas (GHG)	A gas that absorbs and emits radiant energy within the thermal infrared range, causing the greenhouse effect.
Greenhouse Gas Assessment Boundary	It is an unintended change caused by a project activity in GHG emissions, removals, or storage associated with a GHG source or sink and they are typically small relative to a project activity's primary effect.
GHG Emission / Removal Factors	Specific value used to convert activity data into greenhouse gas emission / reduction values.

Greenhouse Gas Effects	They are changes in GHG emissions, removals, or storage caused by a project activity. There are two types of GHG effects: primary effects and secondary effects.
Greenhouse Gas Emission	Total mass of a GHG released to the atmosphere over a specified period of time.
Greenhouse Gas Primary Effects	It is the intended change caused by a project activity in GHG emissions, removals, or storage associated with a GHG source or sink and defined as a change relative to baseline emissions. Each project activity will generally have only one primary effect.
Greenhouse Gas Project	It consists of a specific activity or set of activities intended to reduce GHG emissions, increase the storage of carbon, or enhance GHG removals from the atmosphere.
Greenhouse Gas Reduction	It refers to either a reduction in GHG emissions or an increase in removals or storage of GHGs from the atmosphere, relative to baseline emissions and they are quantified as the sum of its associated primary effect(s) and any significant secondary effects.
Greenhouse Gas Report	Stand-alone document intended to communicate an organization's or project's GHG-related information to its intended users.
Greenhouse Gas Secondary Effect	It is an unintended change caused by a project activity in GHG emissions, removals, or storage associated with a GHG source or sink and they are typically small relative to a project activity's primary effect. In some cases, however, they may undermine or negate the primary effect.
Greenhouse Gas Source/Sink	It is any process that releases GHG emissions into the atmosphere.
IPCC	The Intergovernmental Panel on Climate Change is an intergovernmental body of the United Nations responsible for advancing knowledge on human-induced climate change.
Project Activity	It is a specific action or intervention targeted at changing GHG emissions, removals, or storage. It may include modifications to existing production, process, consumption, service, delivery or management systems, as well as the introduction of new systems.
Valid Time Length for the Baseline Scenario	It is a finite period where the baseline scenario or performance standard should be valid for the purpose of estimating baseline emissions. After this certain period, either no further GHG reductions are recognized for the project activity, or a new (revised) baseline scenario or performance standard is identified.

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Message from Sanofi

Climate change is one of the most pressing risks to global health[1]: rising temperatures are resulting in an increase in hospital admissions and heat-related deaths; extreme weather events such as flooding and droughts are disrupting food systems, displacing people, or undermining access to healthcare. Climate change is also exacerbating the incidence of many communicable and non-communicable diseases (NCDs)[2], including cardiovascular, inflammatory and respiratory illnesses, through increased air pollution, extreme heat, and other factors[1]

The healthcare sector generates approximately 5% of total global CO2 emissions, and care pathways are responsible for over 40% of these. Choices in patient care – in terms of the design of healthcare facilities, the way care is delivered, or the choice of intervention – can play a critical role in reducing the environmental impact of healthcare systems.

We believe Sanofi, as a leading pharmaceutical company, is uniquely positioned to design and develop innovative science-based solutions to fight climate change and it's impacts on health.

One of our fundamental actions consist of minimizing the impact of our activities and products on the environment. But beyond, Sanofi is also committed to collaborating across the healthcare sector to drive concrete actions to reduce emissions in the healthcare system. We have an opportunity to rethink how to deliver healthcare in the future, including medicines and vaccines that can change the practice of medicine in a more environmentally sustainable way.

Walking the talk and driven by recent COP27, Sanofi presented the first outcomes of a study assessing the 74% potential reduction of the GHG emissions along the care pathway of Chest and Dermatology patients by providing e-health consultation (Virtual Clinics). This study has been carried out in partnership with Ain Shams university and with one of the eminent universities' public hospitals and is a steppingstone towards building robust evidence on local interventions that reduce by design the carbon footprint of the entire health system. This comparative study will also enable both Sanofi and ASU to assess the points of strength and limitations of the program and improve their virtual clinics systems.

We would like to thank all the members, departments, and staff for their remarkable assistance throughout this project. Particularly Prof. Dr. Mahmoud ELMeteini, the President of Ain Shams University, for his support in making this project evolve. Dr. Nasser Ayoub, Dcarbon Chief Executive Officer, and Environmental Product Declarations (EPD) Egypt for the scientific inputs for the study.

Finally, we strongly support further studies in this domain to complement and develop a robust set of evidence on health sector GHG emissions reduction initiatives to accelerate the prioritization of decarbonization initiatives and policies along the patient care pathway.

Sandrine Bouttier-Stref
VP Global Corporate Social Responsibility
Sanofi

[1] World Health Organization. Climate Change and Health. [Updated 30/10/21]. Available from: https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health. [Accessed 21/09/22]
[2] European Academies Science Advisory Council. 2019. The Imperative of Climate Action to Protect Human Health in Europe. Halle (Saale): German National Academy of Sciences Leopoldin.

A message from The President of Ain Shams University

For so many years, Ain Shams University has contributed to different innovative projects for the benefit of the Egyptian community. It is an alignment with our vision and strategy to collaborate with stakeholders to provide innovative solutions for the local and regional communities.

In line with Egypt 2023 vision towards sustainability and climate action mitigation, our partnership with Sanofi in the decarbonization using virtual medicine and clinics (D-Carbon) is one of the solutions for what we are facing globally right now regarding climate change issues.

I think this study provides a new level of progressive medical action especially in the Egyptian Community.

Prof. Dr. Mahmoud El-Meteini

President of Ain Shams University

1. Introduction

Sanofi, the innovative global healthcare company, performs the first of its kind Greenhouse Gases (GHG) emissions reduction report resulting from Telemedicine and the application of Virtual Clinics as the first accredited hospital for Telemedicine in Egypt and Africa. Sanofi is sponsoring digital solutions to integrate social and environmental elements into the healthcare business to reach more patients and reduce physical consultation to bring the transportation GHG emissions to a minimum as part of its responsibility towards decarbonizing its supply chain.

Telemedicine project was initiated in a partnership between Sanofi, Faculty of Medicine at Ain Shams University (ASU), one of the eminent universities' public hospitals in Egypt, El-Dmerdash Hospital. The reduction of GHG emissions study is being calculated by D-Carbon Egypt.

The project endeavors to decrease the time spent in referrals across different Type II Inflammation specialized physicians, facilitate Atopic Dermatitis & Asthma patient virtual consultation and follow-up to avoid patient physical traffic, especially in COVID-19 waves restrictions, and capitalize on the co-benefits associated with the project's implementation by reducing GHG emissions resulting from the existing scenario of patients' transportation to and from the hospital.

Sanofi is continuously seeking methods to incorporate social and environmental concerns into its business objectives, employing technology to reach more patients and aid in its commitments toward climate actions as part of its obligation to neutralize its GHG emissions through the whole healthcare supply chain. Sanofi is also mindful of its obligation to ensure a healthy planet. Sanofi is working to minimize the direct and indirect impacts of its activities and products on the environment, due to commitment to achieving carbon neutrality by 2030 for Scopes 1, 2, and 3.

A substantial amount of fuel is consumed by patients from using different transportation means to reach hospitals and clinics to seek medical support and consultations. Patients spend a long time in referrals from General practitioners (GPs) to other specialized Healthcare personnel (HCPs) (Dermatology, Pulmonology, ENT & Allergy) to accurately diagnose Type II Inflammation and decide on the proper management plan. In addition, Patients struggle to access HCPs clinics within public hospitals due to long waiting queues & COVID-19 waves restrictions, especially Asthmatic patients in Chest clinics.

According to Egypt NDC, in 2015, the transportation sector contributed to more than 15% of the country's total Greenhouse Gases (GHG) emissions.

One way to reduce these emissions is to leverage the new technological advancement regarding communication and telemedicine applications and make use of the state of familiarity with video-conferencing tools and work-from-home applications we have encountered daily during the COVID-19 pandemic.

This report presents the Sanofi's telemedicine project, a GHG reduction project, which is a collaboration between Sanofi and the Faculty of Medicine at Ain Shams University (ASU). The GHG project was developed to reduce GHG emissions resulting from the existing scenario of patients' transportation to and from El-Demerdash hospital. The Virtual Clinics will replace this scenario by introducing virtual and online consultations without needing physical ones.

2. Project Description

The project's potential reduction methodology developed by DCarbon Egypt followed the best practice guidance to identify GHG sources, sinks, and reservoirs (SSRs), determine the baseline scenario, quantify the emissions and emission reductions, monitor the project, and report on the project. DCarbon applied these practices and guidance to the project:

- ISO 14064-2:2019 Specification with guidance at the project level for quantification, monitoring, and reporting of greenhouse gas emission reductions or removal enhancements (2006).
- WRI/WBCSD GHG Protocol for Projects.

The ISO 14064-2:2019 standard and the WRI/WBCSD GHG Protocol for Projects (December 2005) are good practice guidance for identifying project sources, sinks, and reservoirs (SSRs) for the project and baseline. They also provided good practice guidance for quantifying, monitoring, and reporting GHG emissions and emission reductions. In identifying SSRs, a seven-step procedure based on streamlined life cycle assessment (LCA) techniques were applied, as described further in section 3.

2.1. Project Title, Purpose, and Objectives

The title of the project is "Telemedicine - Virtual Clinics." The main purpose of this project is to reduce carbon dioxide emissions (CO_2), methane (CH_4), and nitrous oxide (N_2O) associated with the existing system of patients' transportation and to capitalize on the co-benefits associated with the project's implementation that involve:

- Facilitate Atopic Dermatitis & Asthma patient virtual consultation and follow-up to avoid patient physical traffic, especially during the CODID-19 wave.
- Support the establishment of Type 2 Inflammation clinics such as severe Atopic Dermatitis & severe Asthma.
- Strengthen Sanofi Specialty Care position as an innovative healthcare partner.

2.2. Type of GHG Project

The GHG accounting for the telemedicine Application Project quantifies emission reductions achieved through the following procedure:

1- Emissions of transportation from home to hospital to meet their physicians.
2- Emissions of transportation from hospital to the lab analysis.
3- Emissions of transportation to get back home.
4- Emissions from papers used for writing prescriptions.
5- Instead of repeating the above cycle again, patients are supposed to use the Virtual Clinics application in order to avoid repetitive visits to the hospital or the lab analysis.

2.3. Project Location

The boundary of the telemedicine Project encompasses El-Demerdash hospital, Abbasya Square, Cairo, Egypt, where the patients are supposed to visit from all over Egypt since El-Demerdash hospital is one of the antique free government medical facilities that contain all medical specialties, as it is an integrated medical group equipped with the best doctors that provides the best and most advanced medical services (dental, obstetrics and gynecology, dermatology, children, internal medicine, orthopedics, general medicine).

The hospital doesn't only serve the residents who live nearby. Still, it serves patients from every corner of Egypt due to the integration of complex medical equipment with the best modern medical devices, managed by cadres who work passionately to provide the finest health and treatment services to ensure the safety and comfort of patients.

In addition to El-Demerdash hospital, the study covers lab centers near patients' homes, technical support offices, and their data centers and the patients' homes. The Virtual Clinics Project includes many sites and a variety of enterprises.

2.4. Conditions Prior to Project Initiation

Prior to project initiation, the patients have to leave their homes prior to their consultation appointment with the doctors in the hospital, get to the hospital, whether by public transportation or private cars, attend the physical consultation, receive a prescription paper from the doctor indicating the needed medications and lab analysis required, visit the nearest lab service, finally head back home using the available transportation mean. This cycle repeats itself in each consultation, which could reach more than 24 consultations in a year for some clinics. Figure 1 below illustrates the normal physical consultation process before the virtual clinic option is introduced.

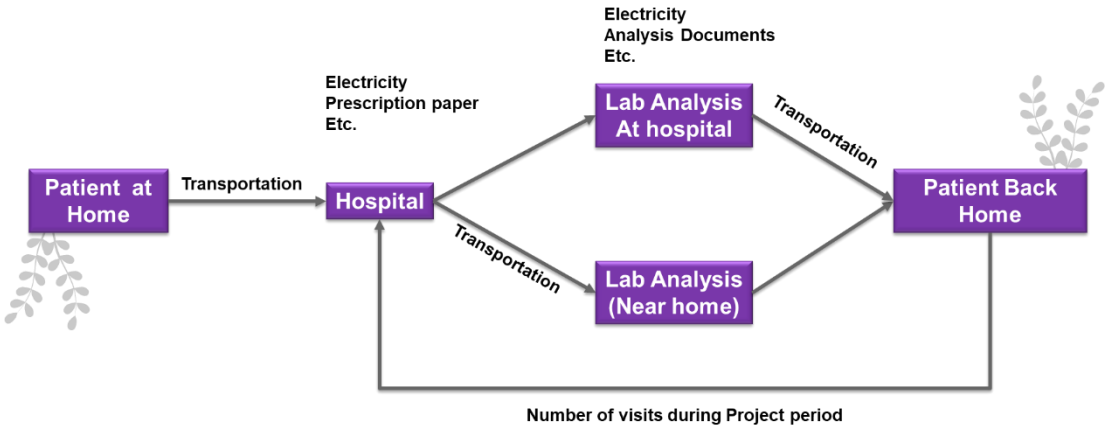


Figure 1. Baseline Scenario prior to virtual clinics implications

2.5. Project strategy to reduce emissions

The main way the project decreases reductions is through the displacement of transportation process to and from the hospital and replacing it with virtual consultation using a video-conferencing mobile application. Emissions resulting from fuel burning in vehicles will be eradicated.

There are also upstream emissions associated with the production and delivery of paper used in prescriptions that will be displaced by the use of the electronic alternative through mobile applications. Figure 2 illustrates the alternate solution proposed by the virtual clinic project during the follow-up consultations along the treatment journey.

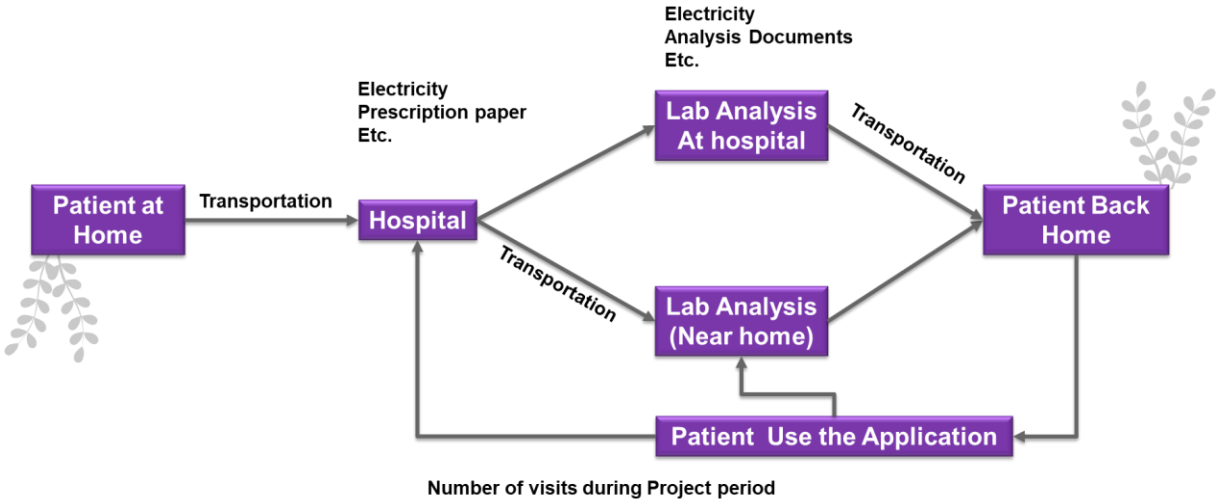


Figure 2. Project Scenario after Virtual clinics implications

Improvements in the system of physical consultation and shifting to Virtual Clinics will reduce the GHG emissions resulting from this traditional scenario and be suitable for dermatology patients whose skin is sensitive to the sun and asthma patients that frequent transportation affects their health state in a negative way.

2.6. Project technologies, products, services, and the expected level of activity

Sanofi collaborated with IQVIA Egypt, the developers of Shamel application, to be the official platform where the virtual clinics perform their duties and services. Through Shamel app, patients can easily:

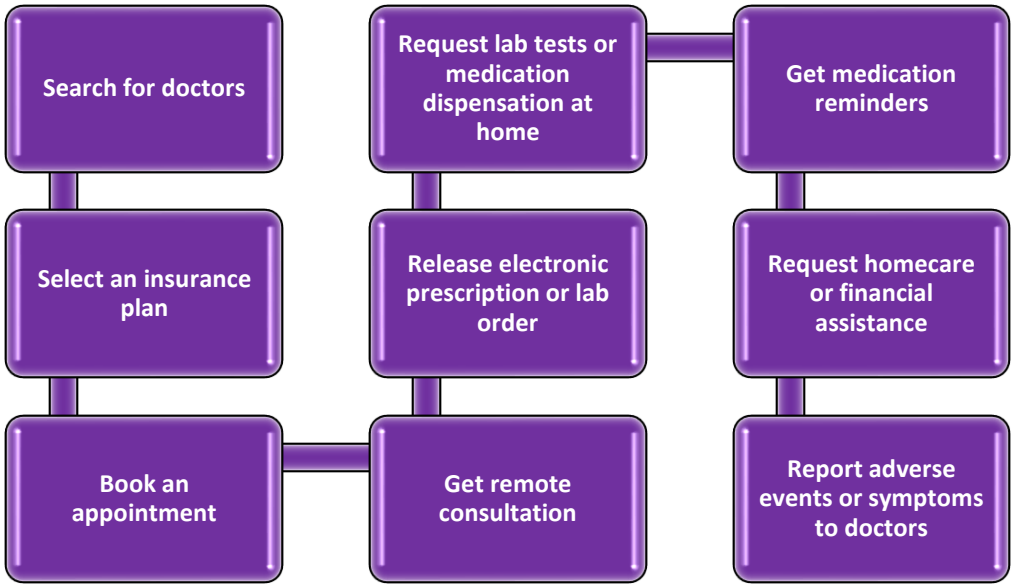


Figure 3. Patients benefits package from Shamel Application

In addition, From the physician's perspective, Shamel app will provide the following:

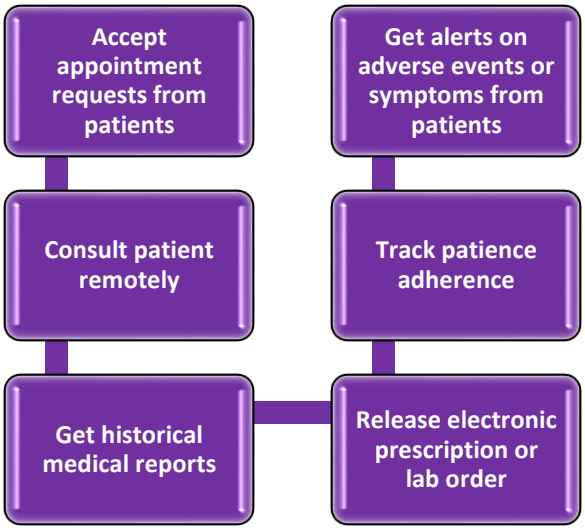


Figure 4. Doctors benefits package from Shamel Application

2.7. Aggregate GHG Emission Reductions Likely to Occur from the Project

The Project has started its operation serving only 2 clinics, Asthma and Atopic Dermatitis, in September 2022. Until the issuance of this report in November 2022, the project had an annual GHG emission reduction from 108 patients from both clinics, 18.03 MT CO_2e. Also, the total expected reductions over the three years of the project reach 54.09 MT CO_2e, assuming serving only the 108 patients used in the baseline estimation.

2.8. Identification of Risks that May Affect the Project's GHG Emission Reductions

The main risks that may affect the GHG emission reductions estimated for this project include the following:

- Malfunctions with the project mobile and web application,
- Application of technology novel for the project's use and context,
- Difficulties with patients and doctors onboarding through the application, and
- Doctors' and patients' unfamiliarity with the new proposed consultation service.

2.9. Chronological project plan

The project consists of three major stages: (project major milestones and timeline is reflected in Table 1)

1. **Doctors' Onboarding into the system**

Sanofi engaged IQVIA early in 2022 to facilitate the transition process from physical consultation to virtual consultations and host these virtual clinics through their mobile and web application service (Shamel) starting in June 2022. Following that, couple of engagements have been done by DCarbon Egypt with Sanofi's project manager, Ain Shams doctors and IQVIA technical team demonstrated type of data needed to be collected during the implementation process to estimate the potential GHG reduction from project implementation.

By the end of July 2022, customizing a workspace that suits El-Demerdash doctors phase has been completed. Then in August 2022, induction sessions were presented to Dermatology and Chest diseases doctors to onboard them on the application and illustrate all the processes and commands that "Shamel" application could provide to the doctors and patients and how to utilize all its services efficiently.

2. **PROJECT OPERATION & MONITORING**

Starting from September 2022, the patients' onboarding process has been implemented by the Dermatology and Chest diseases doctors to just Asthma and Atopic Dermatitis (AD) patients. During September and the start of October 2022, 108 patients (70 AD patients and 38 Asthma patients) were onboarded and began their virtual consultation service through the "Shamel" application.

3. **PROJECT EXPANSION**

Expansion of the virtual consultations system to serve all patients and diseases is expected to occur gradually in 2023 and 2024. Also, after serving and covering all the patients in El-Dmerdash hospital, Sanofi plans to expand the virtual consultations experience among other health service entities.

Table 1 Virtual Clinics Project Activity Timeline

Task	Date	Status
Engaging with IQVIA	June 2022	Complete
DCarbon engagements with Sanofi's project manager, Ain Shams doctors and IQVIA technical team	June 2022	Complete
Customize a workspace relevant to El-Dmerdash Hospital's doctors	July 2022	Complete
Doctor's onboarding and delivering induction sessions	August 2022	Complete
Patients' onboarding and the start of virtual clinics operations	September 2022	On-going
Design of GHG quantification documentation	September - October 2022	On-going
Review of operation and monitoring procedure and collected data	Every three months from the project start date	On-going
GHG report on yearly emission reductions	Every year in October	On-going

3. Identifying Sources, Sinks, and Reservoirs Relevant to the Project

3.1. Selection and Establishment of Criteria and Procedure

The method used to identify SSRs for the Telemedicine (Virtual Clinic) Project closely followed the GHG Protocol standard for Project Accounting. The project was also developed by applying the ISO 14064-2 standard. The project proponents conducted extensive consultation with researchers and technical experts to inform the selection of the GHG Protocol for Project Accounting and facilitate its appropriate application to the Virtual Clinics Project.

Moreover, applicable good practice guidance for criteria and procedures was sought to identify SSRs relevant to the project by examining the Clean Development Mechanism (CDM) GHG project and several voluntary carbon standards.

3.2. Procedure for identifying SSRs

The procedure is a systematic approach based on the GHG quantification principles illustrated in Figure 5.

Figure 5. GHG Accounting Principles based on GHG Protocol for Project Accounting

The following seven-step procedure was applied in identifying the relevant SSRs:

1. Identify (potential) SSRs for the Virtual Clinics Project controlled and/or owned by the project proponent. Focus on the primary project activities (i.e., the SSRs that will have the largest impacts on GHGs).
2. Identify (potential) SSRs that are physically related to the project. Trace patients, technology, materials, and energy inputs/outputs upstream to their origins in natural resources and downstream along their life cycles to end-users.

3. Identify (potential) SSRs that are affected by the project. Consider the economic and social consequences of the project (compared to the baseline). Look for activities, market effects, and social changes that result from or are associated with the project activity.
4. For each identified SSR, determine the parameters required to estimate or measure GHGs. This includes materials, energy inputs/outputs, and information on activities, products, and services connected to the SSR.
5. Select SSR scale by aggregating or disaggregating identified potential SSRs. The number of SSRs defined and the degree of detail required is a function of the availability of data, the management of data collection, and the assurance of accurate GHG quantification. As a general rule, more detailed (disaggregated) SSRs are appropriate where it is known that the project system differs from the baseline system regarding that SSR. Disaggregated SSRs may also be appropriate if more accuracy in quantification is necessary or if disaggregated SSR data are readily available. Aggregated SSRs are sufficient where the project and baseline systems are identical and when a high level of accuracy is not required.
6. Determine the function(s) provided by the system of SSRs. The whole system of SSRs may perform one or more functions, plus individual SSRs may have specific functions.
7. Confirm that all SSRs are identified, that each is classified appropriately as controlled, related, or affected, that all GHG inputs and outputs for each SSR are identified, and that the sequence of SSRs for the system is correct. Repeat previous steps as necessary.

3.3. Application of Procedure

By following the above steps, Table 2 was generated to show all the SSRs associated with the implication of the project. The SSRs controlled or directly owned by the project are those elements whose operations are under the direct influence of the project proponents, and they are often found on the project site. The related SSRs have material or energy flows into, out of, or within the project. These SSRs are generally found upstream or downstream of the project and include activities involved with the project's operations.

Table 2 Identification of controlled, affected, or related SSRs for the project

SSR	Description	Controlled, Related or Affected
Data servers	GHG emissions are generated from electricity consumption from servers storing all patients' data.	Controlled
Technical support	GHG emissions are generated from electricity consumption from technical office activities such as computers, lighting, and phones	Controlled
Patients' transportation to and from the lab analysis centers	GHG emissions are generated during transportation using private cars or public transportation to or from the lab centers	Related
Devices and network systems	GHG emissions are generated from electricity consumption from devices used in video-conferencing between patients and doctors.	Controlled

4. Determining the Baseline Scenario

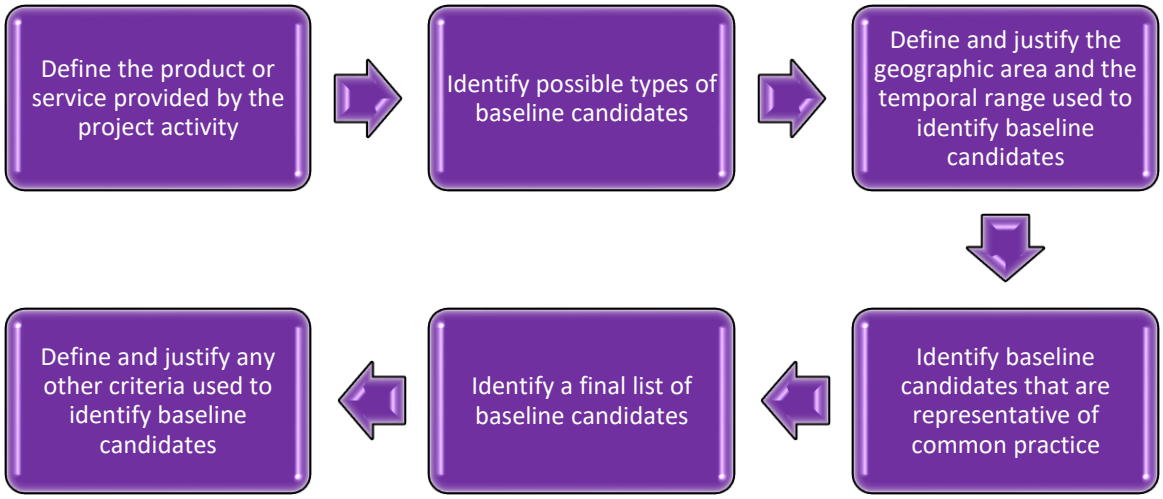
4.1. Identification of Baseline Scenario Candidates

The baseline is the most appropriate and best estimate of GHG emissions that would occur in the absence of the project. The WRI/WBCSD GHG Protocol for Projects (2005) is the relevant good practice guidance for identifying the baseline scenario.

Two approaches are specified in the GHG protocol for identifying/determining the baseline:

- Project-specific approach uses a procedure and information based on the project's specific circumstances.
- Performance standard approach identifies existing or planned processes/physical units to establish a benchmark with spatial and temporal boundaries relevant to the proposed project.

The project-specific approach is appropriate for the telemedicine Project. To identify potential baseline candidates using the project-specific approach, the GHG protocol outlines the following steps:



4.2. Application of the procedure and justification of baseline scenario

Based on the above procedure, the identified baseline scenario is the Business-as-usual scenario (existing practices prior to project initiation), which is physical consultations clinics, where patients use private vehicles and public transportation to head to or from the hospitals for consultations.

5. Identifying Sources, Sinks, and Reservoirs for the Baseline Scenario

5.1. Criteria and procedures

To identify the SSRs associated with the baseline scenario, the same seven-step procedure will be employed as was applied to identify SSRs for the project.

5.2. Application of procedures

Table 3 describes the SSRs identified for the baseline scenario.

Table 3: Identification of controlled, affected, or related SSRs for the baseline

SSR	Description	Controlled, Related or Affected
Patients' transportation to and from the hospital	GHG emissions are generated during transportation using private cars or public transportation to or from the hospital	Related
Paper used in prescriptions	Includes upstream activities involved in producing the paper, such as manufacturing paper and tree-cutting processes needed to produce the raw material for paper production. GHG emissions are generated during these activities.	Related

6. Quantifying GHG Emissions

6.1. Data Collection

During the project initiation phase, the project and the baseline scenarios were assessed to identify emission sources and the type of data available. Accordingly, customized data collection spreadsheets were designed for each proponent in the GHG reduction project. The data collection sheets covered the following:

- Patients' sides, where data collected was their addresses, used vehicles to commute to the hospital, number of needed physical and virtual visits conducted in each clinic, estimated duration of each virtual consultation, type of device used during the virtual consultation, and type of internet connection.
- Doctors' sides, where data collected was the amount of papers used in prescribing medicine for each patient in each physical consultation, the type of device used during the virtual consultation, and the type of internet connection.
- Application technical side, where data collected was power consumption of data servers, electricity consumption by the technical offices working on the project, and percentage of time allocated for this project.

Data collection sheets were communicated and reviewed simultaneously with the focal points to ensure transparency and completeness in the data collection process. An example of a data collection sheet for the patients' side can be seen in Table 4.

Table 4 Examples of data collection sheets for stationary combustion

Patient ID	Clinic	Address	Mean of transportation	Used device and internet connection for the virtual consultation	Number of physical and virtual visits
XXXX	X	XXX	XXX	XX	XXX

X = representing values

6.2. GHG Emission Calculation

To calculate GHG emissions, the main formula used to calculate GHG emissions is:

$$\text{GHG Emissions (MT } CO_2e) = \text{Activity Data (unit of activity)} \times \text{Emission Factor} \times \text{GWP}$$

Where;

Activity data are those associated with the consumption of energy, electricity, or consumables of the proponents and were obtained via customized data collection sheets.

Emission factors are representative values that relate a quantity of gas emitted to the atmosphere with an activity associated with the emission of said gas. Each emission factor is reported in metric tonnes of a GHG per unit of activity, where the unit of activity is expressed in either the

International System of Units (SI units) or U.S. customary units. Since Egypt released no emission factors except the national grid emission factor, all other emission factors were adapted from Ecoinvent and IPCC Databases with priority given to the IPCC.

Global warming potential, or GWP, is the heat absorbed by any greenhouse gas in the atmosphere as a mixture of the heat that the same carbon dioxide would absorb. GWP is 1 for CO_2. The global warming potentials of the fifth IPCC report have been used.

6.3. GHG estimation assumptions

Part of following the GHG Protocol Project Standard is to ensure fulfillment of the accounting principles that set an implicit standard for the faithful representation of the project's GHG emission through its technical, accounting, and reporting efforts. Accordingly, all activity data relevant to previously stated proponents' activities were collected directly from traced inputs, such as patients' addresses, the average consultation time, and data servers' power consumed. On the other hand, some other data was estimated based on proponents' experience.

Assumptions made in this inventory:

1. The heating value of all fuels consumed in vehicles.
2. The densities of all fuels consumed in vehicles.
3. All private cars and public transportation use gasoline and diesel as their fuel sources, respectively.
4. Number of passengers in public transportation vehicles is assumed to be 20 passengers.
5. Working days were assumed to be 365 days/year and working hours for the technical office were 8 hours/day.
6. Number of visits to the lab analysis centers during the whole virtual consultation process is 2 visits, and the distance to the nearest center is within 5 km.
7. Weight of 1 A4 paper is 5 grams.

6.4. Calculations procedures

6.4.1. Baseline (Physical Consultation)

- **Transportation to and from the hospital**

To estimate emissions generated from used vehicles to commute to the hospital, the distance traveled to and from the hospital and the vehicle used were required. In addition, emission factors for GHG emissions resulting from fuel burning utilized in vehicles were estimated using the IPCC database.

General equation to calculate GHG emissions from transportation:

$$E_{Transportation} = Distance\ traveled * 2 * Fuel\ economy * EF_{Fuel}/Number\ of\ passenger$$

Where;

- Distance traveled: the distance between patient address and the hospital in meters;
- Fuel economy: the number of liters used by each vehicle to travel 1 km (liter/km);
- EF(fuel): the amount of GHG emissions resulting from burning 1 liter of fuel (kg CO_2e / liter);

- Number of passengers: in the case of using private cars, it will be 1, and in public transportation, it will be 20.

Table 5. Data collected to calculate GHG emissions from transportation

Parameter	Required data	Data Source	Value	Unit
Transportation	Patients Addresses	Patients	74439.47	km / year
	Means of transportation	-	-	-
	EF for Gasoline private cars	IPCC	0.210366647	kg CO_2 eq / km
	EF for Diesel public vehicles	IPCC	0.731958436	kg CO_2 eq / km
	Private Car percentage	Calculated	72.86	%
	Public vehicle percentage	Calculated	27.14	%
	Number of passengers in public vehicles	Assumed	20	passenger

- **Paper-related emissions**

To estimate emissions generated from the extraction and manufacturing of the paper used by doctors, the amount of paper used in each consultation and the number of visits for each patient were required. In addition, paper's upstream GHG emission factor was estimated using the Ecoinvent database.

General equation to calculate GHG emissions from paper use:

$$E_{paper} = Num\ of\ paper\ used * Num\ of\ consultations * Average\ weight\ of\ paper * EF_{Paper}$$

Where;

- Paper used: the amount of A4 paper used by the doctor in each consultation;
- Num of consultations: Number of physical consultations per patient;
- Weight of paper: Average weight of A4 paper used in grams;
- EF(paper): the amount of upstream GHG emissions resulting from manufacturing 1 kg of paper (kg CO_2e / kg)

Table 6. Data collected to calculate GHG emissions from paper-use

Parameter	Required data	Data Source	Value	Unit
Paper	Number of paper used per consultation	Doctors	1	paper
	Weight of A4 paper	Assumed	0.005	kg / paper
	Number of virtual consultations	Doctors	946	consultation / year
	LC Paper emissions	Ecoinvent database	1.47	kg CO_2e / kg

6.4.2. Virtual Clinic Project (Virtual Consultation)

- **Transportation to and from the lab**

To estimate emissions generated from used vehicles to commute to the lab, the distance traveled to and from the lab and the type of vehicle used were required. In addition, emission factors for GHG emissions resulting from fuel burning utilized in vehicles were estimated using the IPCC database.

General equation to calculate GHG emissions from transportation:

$$E_{Transportation} = Num\ of\ visits * Distance\ traveled * 2 * Fuel\ economy * EF_{Fuel}/Number\ of\ passenger$$

Where;

- Num of visits: the estimated number of needed visits to lab analysis centers during virtual consultation service;
- Distance traveled: the distance between patient address and the lab in meter;
- Fuel economy: the number of liters used by each vehicle to travel 1 km (liter/km);
- EF(fuel): the amount of GHG emissions resulting from burning 1 liter of fuel (kg CO_2e / liter);
- Number of passengers: in the case of using private cars, it will be 1, and in public transportation, it will be 20.

Table 7. Data collected to calculate GHG emissions from transportation to lab centers

Parameter	Required data	Data Source	Value	Unit
Lab visits	number of lab visits in virtual case	Assumed	2	visits / year
	Distance from lab to patient	Assumed	5	km / visit
	EF for Gasoline private cars	IPCC	0.210366647	kg CO_2 eq / km
	EF for Diesel public vehicles	IPCC	0.731958436	kg CO_2 eq / km
	Private Car percentage	Calculated	72.86	%
	Public vehicle percentage	Calculated	27.14	%
	Number of passengers in public vehicles	Assumed	20	passenger

- **Electronic Devices-related emissions**

To estimate emissions generated from the operation of the electronic devices used by doctors and patients to perform video-conferencing calls for virtual consultations, the type of device used by doctors and patients in each consultation, type of internet connection and average consultation time. In addition, the devices' operation GHG emission factor was estimated using the Ecoinvent database for laptop devices and the Life cycle assessment study performed by Sony mobiles for mobile devices.

General equation to calculate GHG emissions from electronic devices use:

$$E_{device} = Num\ of\ virtual\ consultation * consultation\ time * EF_{device}$$

Table 8. Data collected to calculate GHG emissions from video-conferencing devices

Parameter	Required data	Data Source	Value	Unit

Video-conferencing devices	Average consultation time in Dermatology clinics	Doctors	15-10	mins
	Average consultation time in Respiratory Clinics	Doctors	10	mins
	Average consultation time	Assumed	12.5	mins
	LC Laptop + WIFI	Ecoinvent database	0.049	kg CO_2e / h
	LC Mobile + Mobile Data	Sony	0.00708	kg CO_2e / h

- **Application support-related emissions**

To estimate emissions generated from the operation of the data servers and application support team, the amount of energy consumed by data servers, electricity consumption in application support offices and percentage of working hours on "Shamel" app.

General equation to calculate GHG emissions from the application team-support side:

$$E_{support} = electricty\ consumption * working\ hours/year * EF_{electricity}$$

Where;

- Electricity consumption: the electricity consumed by data servers and support office in kW/hour;
- Working hours: hours of operation of data servers and office support in hours.

Table 9. Data collected to calculate GHG emissions from the application technical support team

Parameter	Required data	Data Source	Value	Unit
App support side	Power consumption by servers	IQVIA	1.2	kWh
	Electricity consumption in the supporting team office	IQVIA	0.4	kWh/hr
	Time consumed by the support team in this project	IQVIA	0.5	%
	Electricity EF	Biennial Report	0.000532767	Ton CO_2/kWh
	Servers working hours	Assumed	24	hour
	Servers working days	Assumed	365	day
	App support working hours	Assumed	8	hour
	App support working days	Assumed	365	day

6.5. GHG Reduction Results

Total emission reductions are obtained by taking the difference between total emissions from the project and total emissions from the baseline. The following Figure 6 illustrates the major sinks and sources of emissions that are generated as the result of the Sanofi's Telemedicine Project.

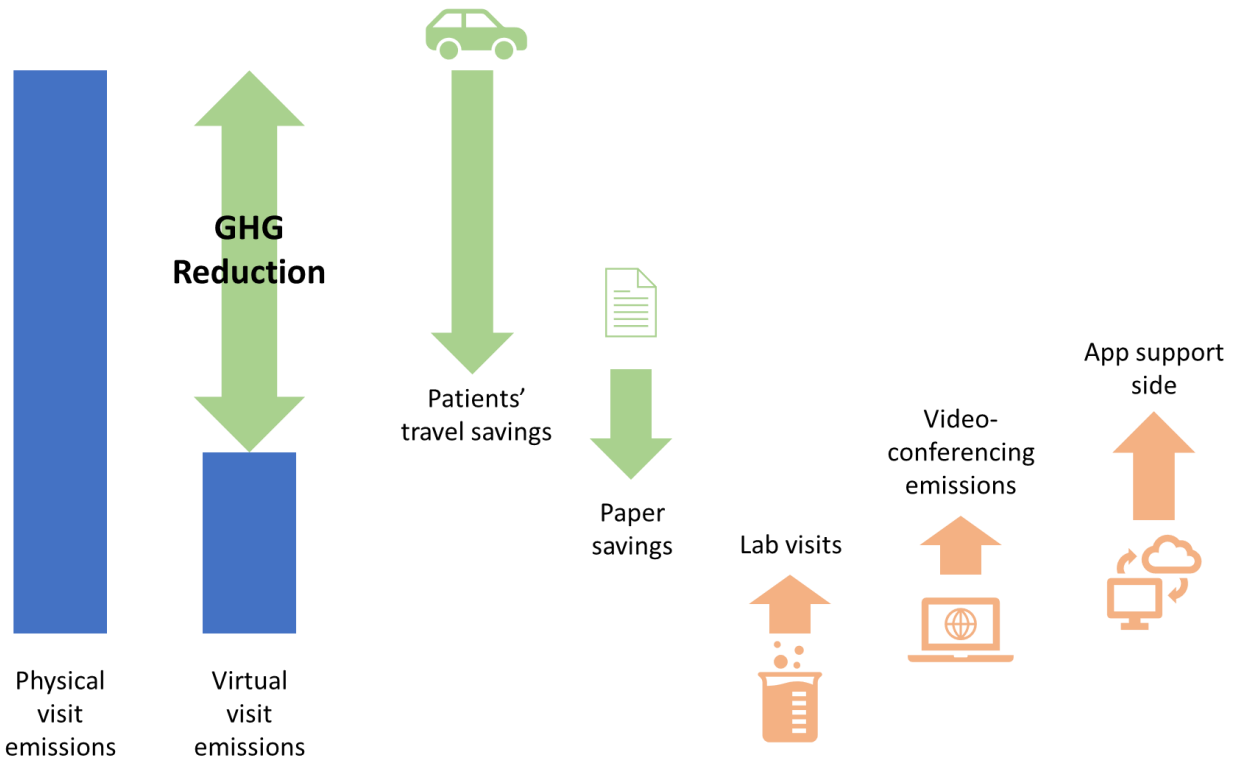


Figure 6. GHG emissions sinks and sources resulting from baseline and project scenarios

Based on the previously mentioned methodology and data analysis, Table 10 summarizes the outcomes of the activity data collected from patients, doctors, and application support teams.

Table 10. Activity data outcomes from the data collection phase

Outcome	Value	Unit
Number of patients in the study	108	Patient/year
Total distance traveled	148878.94	km / year
Average paper used	4.73	kg paper / year
Power consumption by servers	10512	kWh/year
Electricity consumption in the supporting team office	584	kWh/year
Average consultation time	12.5	mins

Outcome	Value	Unit
Total virtual consultations	946	consultation / year
Percentages of patients depending on private cars	72.86	%
Percentages of patients depending on public transportation	27.14	%
Total distance traveled to labs	2160	km/year
Doctors' device	Laptop	
patients' device	mobile	

According to illustrated Figure 6, Table 11 and Figure 7 present a summary of total GHG emissions and emission reductions for the project (virtual clinic) and baseline (physical clinic).

Table 11. GHG emissions reduction resulting from transforming from physical to virtual clinics

SSR	Value	Unit
Physical Clinics		
Paper	0.007	ton CO_2e / year
Transportation	24.298	ton CO_2e / year
Total physical	24.305	ton CO_2e / year
Virtual Clinics		
Application support side	5.912	ton CO_2e / year
Video-conferencing devices	0.011	ton CO_2e / year
Lab visits	0.353	ton CO_2e / year
Total virtual	6.275	ton CO_2e / year
Results		
GHG reduction	18.030	ton CO_2e / year
GHG Reduction %	74.2%	%
Number of patients	108	
Reduction per patient	0.167	ton CO_2e / year

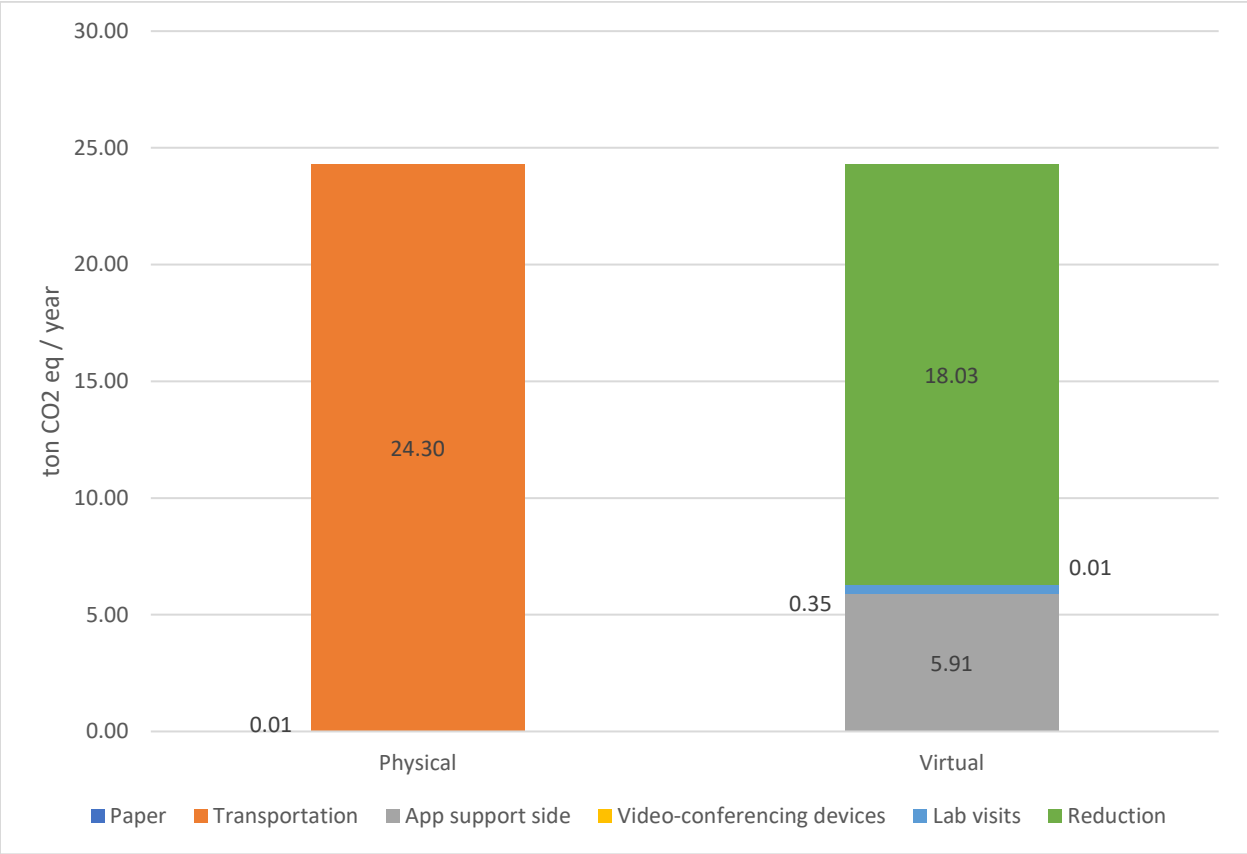


Figure 7. GHG emissions resulting from baseline and project scenarios

Virtual Clinics project GHG reductions are estimated preliminarily on an annual basis and using data of only 108 patients of just 2 clinics. In reality, GHG project (and baseline) emissions will change over time. E.g., the overall number of patients covered in the project expands over time and migrates toward virtual consultations instead of physical consultations whenever possible. The following Figure 8 shows the potential GHG reduction that could result from an increasing number of patients in one year.

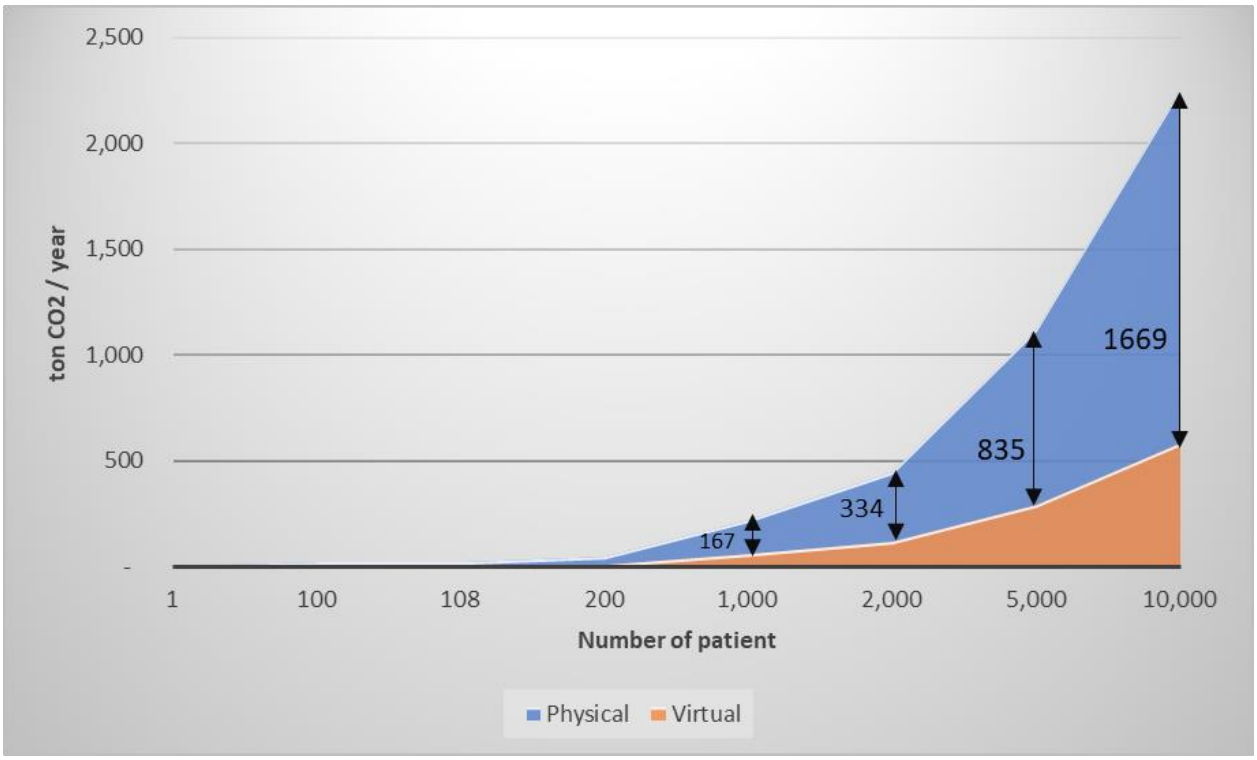


Figure 8. GHG emissions reduction based on the number of patients

7. Managing Data Quality

To fulfill the GHG Protocol for Project Accounting requirements, the Telemedicine Project members must establish and apply data and information quality management procedures. Written procedures need to be established for each record-keeping task, outlining the following:

- The person responsible
- When the task is to be performed
- Where the records are to be kept

The Virtual Clinics members must ensure data quality management complies with all requirements of the GHG Protocol for Project Accounting requirements rules. The primary principle is that all procedures must be designed and records maintained to provide ease of access and facilitate third-party review by an auditor. At several critical points in the data collection process, the GHG Protocol for Project Accounting requires the declaration of accuracy. These declarations must be maintained with all other project records.

The Virtual Clinics members must implement a system that meets the following criteria:

- All records must be kept in areas that are easily located.
- All records must be legible, dated, and revised as specified by third-party auditors or internal QA/QC checks.
- All records should be maintained in an orderly manner.
- All documents must be retained for the life of the project.
- Electronic and paper documentation are both satisfactory.
- Copies of records should be stored in two locations (physical or cloud storage) to prevent loss of data.

8. Monitoring the GHG Project

Table 12. GHG emissions monitoring log sheet

Parameter	Data Parameter	Directly Monitored/ Estimated	Source	Data Unit	Monitoring Frequency	Methodology
General	Number of registered patients	Monitored	Application Technical office	patient	Weekly	Application Records
	Number of patients in Dermatology clinics	Monitored	Application Technical office	patient	Weekly	Application Records
	Number of patients in Respiratory clinics	Monitored	Application Technical office	patient	Weekly	Application Records
	Virtual consultations in Dermatology clinics	Monitored	Application Technical office	consultation / patient	Weekly	Application Records
	Virtual consultations in Respiratory Clinics	Monitored	Application Technical office	consultation / patient	Weekly	Application Records
Physical Clinics						
Paper	Number of paper used per consultation	Monitored	Doctors	paper	Monthly	Doctors
	Weight of A4 paper	Estimated	Assumed	kg / paper	NA	NA
	Number of virtual consultations	Monitored	Application Technical office	consultation / year	Monthly	Application Records
	Life cycle Paper emissions	Estimated	Ecoinvent database	kg CO_2e / kg	NA	NA
Transportation	Patients Addresses	Monitored	Application Technical office	km / year	Once	Application Records
	Means of transportation	Monitored	Application Technical office	-	Once	Application Records
	EF for Gasoline private cars	Estimated	IPCC	kg CO_2e / km	NA	NA
	EF for Diesel public vehicles	Estimated	IPCC	kg CO_2e / km	NA	NA
	Private Car percentage	Calculated	Application Technical office	%	Monthly	Application Records
	Public vehicle percentage	Calculated	Application Technical office	%	Monthly	Application Records
	Number of passengers in public vehicles	Calculated	Assumed	passenger	NA	NA

Parameter	Data Parameter	Directly Monitored/ Estimated	Source	Data Unit	Monitoring Frequency	Methodology
Virtual Clinics						
App support side	Power consumption by servers	Monitored	Application Technical office	kWh	Monthly	Technical support team
	Electricity consumption in the supporting team office	Monitored	Application Technical office	kWh/hr	Monthly	Technical support team
	Time consumed by the support team in this project	Monitored	Application Technical office	%	Monthly	Technical support team
	Electricity EF	Estimated	Biennial Report	Ton CO_2/kWh	NA	NA
	Servers working hours	Monitored	Application Technical office	hour	Yearly	Technical support team
	Servers working days	Monitored	Application Technical office	day	Yearly	Technical support team
	App support working hours	Monitored	Application Technical office	hour	Yearly	Technical support team
	App support working days	Monitored	Application Technical office	day	Yearly	Technical support team
Video-conferencing devices	Average consultation time in Dermatology clinics	Monitored	Doctors	mins	Weekly	Doctors
	Average consultation time in Respiratory Clinics	Monitored	Doctors	mins	Weekly	Doctors
	Average consultation time	Monitored	Application Technical office	mins	Weekly	Doctors
	LC Laptop + WIFI	Estimated	Ecoinvent database	kg CO_2e / h	NA	NA
	LC Mobile + Moible Data	Estimated	Sony	kg CO_2e / h	NA	NA
Lab visits	number of lab visits in virtual case	Monitored	Patients	visits / year	Monthly	Patients + Application records
	Distance from lab to patient	Monitored	Patients	km / visit	Monthly	Patients
	EF for Gasoline private cars	Estimated	IPCC	kg CO_2e / km	NA	NA
	EF for Diesel public vehicles	Estimated	IPCC	kg CO_2e / km	NA	NA

Parameter	Data Parameter	Directly Monitored/ Estimated	Source	Data Unit	Monitoring Frequency	Methodology
	Private Car percentage	Calculated	Application Technical office	%	Monthly	Application Records
	Public vehicle percentage	Calculated	Application Technical office	%	Monthly	Application Records
	Number of passengers in public vehicles	Calculated	Assumed	passenger	NA	NA