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Series L

Supplement 44

(05/2021)

SERIES L: ENVIRONMENT AND ICTS, CLIMATE CHANGE, E-WASTE, ENERGY EFFICIENCY; CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

Guidelines on best practices and environment friendly policies for effective information and communication technology deployment methods

ITU-T L-series Recommendations – Supplement 44

ITU-T L-SERIES RECOMMENDATIONS

ENVIRONMENT AND ICTS, CLIMATE CHANGE, E-WASTE, ENERGY EFFICIENCY; CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

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Supplement 44 to ITU-T L-series Recommendations

Guidelines on best practices and environment friendly policies for effective information and communication technology deployment methods

Summary

In accordance with the instructions and directives of WTSA-16 on Resolution 73, "Study Group 5 is to develop an appropriate Recommendation on ICTs, the environment and climate change issues within the mandate and competency of ITU T, including telecommunication networks used for monitoring and adapting to climate change", Supplement 44 to ITU-T L-series Recommendations identifies best practices and opportunities for new applications using information and communication technologies (ICTs) to foster environmental sustainability, identify appropriate actions and promote best practices towards implementing environmental friendly policies and practices.

Supplement 44 to ITU-T L-series Recommendation also includes a questionnaire that has been developed to gather relative information from stakeholders for use cases and key success factors, including exemplary collection of green best practices to ultimately formulate guidelines on best practices and environment friendly policies for effective ICT deployment methods.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T L Supp. 44	2021-05-20	5	11.1002/1000/14763

Keywords

Climate change, EMF, green ICT.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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Introduction

Global climate change is arguably the most commonly known and widely reported environmental concern. The introduction of information and communication technologies (ICTs) has revolutionized daily life, but has also resulted in the increase of greenhouse effect, since the carbon footprint (CF) is continually increasing, contributing to the overall amount of carbon dioxide (CO_2) and other greenhouse gas emissions. [b-Gartner] showed that the total amount of CO_2 emissions from the ICT industry is responsible for approximately 2% of worldwide carbon emissions. The demand for technology services from both an individual and an organizational perspective has increased rapidly. This demand is being generated from dependencies on ICT to provide solutions for both business and personal needs. Notwithstanding the environmental issues with which organizations have to contend, it has become a driving factor for global organizations to adopt green best practices, especially in the ICT industry.

Green information and communication technology (GICT; green information technology (IT) or green computing) is the study and practice of using computers and telecommunications in a way that maximizes positive environmental benefit and minimizes the negative impact. If strategically and tactically implemented, GICT not only focuses on reducing the environmental impact of the ICT industry, but also helps reduce the organization's overall CF, regardless of the type, shape or size of the organization. The potential for IT to deliver greener goods, services or individual lifestyles is enormous. Green or environmentally friendly ICTs are key elements supporting the growth of e-government initiatives, strategies and projects. For example, several immense contributions from GICT can be observed through inventing innovative energy-saving systems, technologies and smart devices, using smart energy management, applications for energy-saving policies using renewable sources, solar energy and PV, wind energy, bio-fuel, bio-climatic technology, anti-pollutants technology, etc., recycling and reducing of e-waste, e.g., old IT systems, chips, personal computers (PCs), hardware, printers and mobile phones.

In other examples, ICT has introduced the convergence of electronic services (e-services), i.e., broadband network infrastructure, wireless technologies and mobile services. This confluence has resulted in a combination of devices, products, tools, services and technologies with enhanced social network abilities that are globally recognized. Subsequently, GICTs have become the way to advance public sector performance in terms of information and service delivery, to encourage public participation in the decision-making process and to make government more accountable, transparent and effective. In overview, GICT mainly focuses on energy efficiency and equipment utilization that addresses energy and environmental issues such as:

- designing energy efficient chips and disk drives;
- replacing PCs with energy efficient thin clients;
- use of virtualization software to run multiple operating systems on one server;
- reducing the energy consumption of data centres (DCs);
- using renewable energy sources to power DCs;
- reducing electronic waste from obsolete computing equipment;
- promoting telecommuting and remote computer administration to reduce transportation emissions.

Adopting GICT practices offers business and individuals financial or tangible benefits. Reducing power consumption and lowering cost have the highest percentages among the other benefits, because most organizations prioritize environmental issues for energy efficiency and cost control imperatives. Through observation, IT service providers and DC specialists like major semiconductor chip manufacturers and computer companies, along with corporate strategy consultants, position and align their business with environmental sustainability practices to comply with government and legitimate environmental regulators. The application of GICT ensures that these enterprises develop a policy, outline the aims, objectives and goals, plans of action and schedules to effectively implement green IT strategies.

Supplement 44 to ITU-T L-series Recommendations

Guidelines on best practices and environment friendly policies for effective information and communication technology deployment methods

1 Scope

This Supplement collates use cases from implementations of green information and communication technology (GICT) projects or applications from member states including policies and strategies with key success factors or challenges to develop guidelines for effective information and communication technology (ICT) deployment methods. This Supplement provides specific references for the improvement of GICT driven projects.

GICT can be applied to telecommunication networks in the following contexts:

- radio access network or radio base station;
- fixed access network access site;
- radio hotspot such as wireless fidelity (Wi-Fi);
- data transmission network Internet protocol (IP) or other collect network using equipment, e.g., gigabit Ethernet switch);
- core network sites using terabit routers, etc;
- data centres (DCs) using servers for computing and storage.

This Supplement covers use cases in some of these areas, but is not limited to the use of GICT for smart energy for customers and Internet of things services (smart city, smart building, medical health, agriculture, business). For this purpose, a questionnaire was furnished to gather inputs and collective use cases from different stakeholders to be used as supportive information in producing guidelines on best practices and environment friendly policies for effective GICT deployment methods, in short, meeting present needs without comprising the ability of future generations to meet their own needs. The prospects for success have never been greater. A dawning era of creativity and innovation in green technology brings the promise of a better future ahead.

2 References

None.

3 Definitions

3.1 Terms defined elsewhere

This Supplement uses the following terms defined elsewhere:

3.1.1 energy [b-ISO 16818]: Capacity for doing work; having several forms that may be transformed from one to another, such as thermal (heat), mechanical (work), electrical or chemical.

NOTE – Energy is conventionally expressed in joules. For the purpose of this Supplement, energy is expressed in watt-hours or kilowatt-hours.

3.1.2 ICT equipment [b-ITU-T L.1200]: Information and communication equipment (e.g., switch, transmitter, router, server and peripheral devices) used in telecommunication centres, data-centres and customer premises.

3.1.3 infrastructure [b-ITU-T L.1325]: Equipment that supports the ICT equipment, e.g., power delivery components and cooling system components.

3.1.4 power [b-ISO 16818]: Rate at which energy is transmitted.

3.1.5 power feeding system [b-ITU-T L.1325]: Power source to which ICT equipment and facilities are intended to be connected, such as uninterruptible power supply (UPS) and backup generator, etc.

3.2 Terms defined in this Supplement

None.

4 Abbreviations and acronyms

This Supplement uses the following abbreviations and acronyms:

AC	Alternating Current
BTS	Base Transceiver Station
CF	Carbon Footprint
DC	Data Centre
DC	Direct Current
DCIE	Data Centre Infrastructure Efficiency
EMS	Energy Management System
FCU	Free Cooling Unit
FTTT	Fibre To The Tower
GICT	Green Information and Communication Technology
HOMER	Hybrid Optimization Model for Electrical Renewables
ICT	Information and Communication Technology
IP	Internet Protocol
IT	Information Technology
LiB	Lithium ion Battery
PC	Personal Computer
PUE	Power Usage Effectiveness
PV	Photovoltaic
UPS	Uninterruptible power supply
Wi-Fi	Wireless Fidelity

5 Conventions

None.

6 Summary of GICT use cases

6.1 Feasibility analysis of stand-alone renewable energy supply for telecommunication tower using hybrid optimization model for electrical renewables (HOMER)

The analysis used consists of using a solar photovoltaic (PV) system as a stand-alone system instead of diesel generators for electrical energy supply to a communication tower. The analysis is based on the technical properties and lifecycle cost of the system. The system offered better reliability, efficiency, flexibility of planning and environmental benefits compared to diesel generator systems by saving the environment from the burning of fossil fuels. The proposed system was able to supply 3.5 kW of power, which is suitable for an actual site loading requirement of around 3 kW. The economic output from HOMER exhibited a higher total net present cost as compared to a tower with diesel generator.

The proposed hybrid renewable consists of solar PV panels, a battery bank and charge controller (inverter), included as part of a back-up and storage system. Figure 1 is a block diagram for the hybrid PV-diesel generator system.

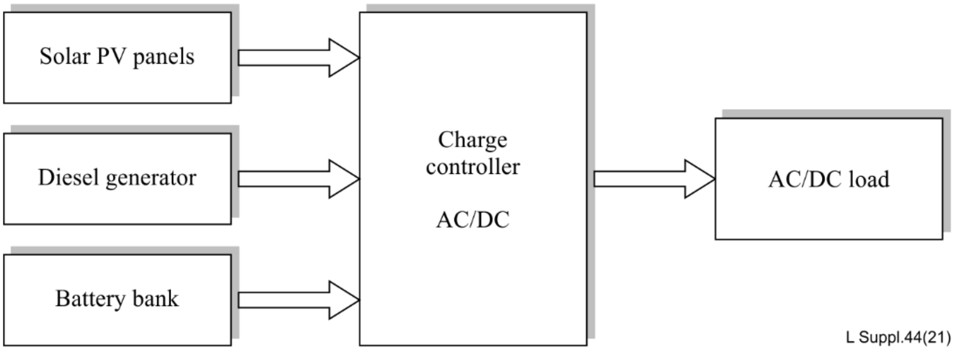

Figure 1 – Block diagram of the hybrid PV-diesel generator system

AC: alternating current; DC: direct current

Figure 2 shows the annual PV radiation characteristic of a PV module. The average 5.343 kWh/m/day value was derived from a HOMER simulation.

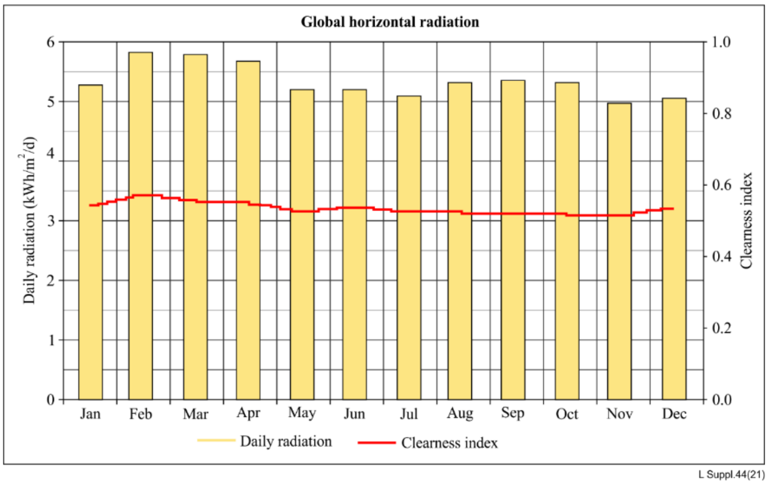

Figure 2 – PV radiation characteristic of PV module

6.2 Data centre baseline study

The objective of the study was to analyse the energy used to operate typical DCs. The study involved placing data measuring equipment on the electrical distribution board to record the energy consumption of ICT equipment and energy used for lighting, cooling and powering up the DC, while logging the temperature and humidity levels within the DC environment.

[b-EU CC DCE] recommends power usage effectiveness (PUE) as the ideal metric. The PUE, U_{PUE}, is the ratio of the total energy used by the DC, $E_{\text{tot DC}}$, to the energy used by information technology (IT) equipment, $E_{\text{tot IT}}$ (Equation 1).

$$U_{\text{PUE}} = \frac{E_{\text{tot DC}}}{E_{\text{tot IT}}} \qquad (1)$$

Table 1 lists the classification of the derived PUE measurement. The minimum PUE measurement should not be more than 2.0. Data centre infrastructure efficiency (DCIE) is a metric used to determine the energy efficiency of a DC that is expressed as a percentage; it is calculated by dividing IT equipment power by total facility power.

Table 1 – DC efficiency ratings chart according to PUE and DCIE (Source: Uptime Institute)

PUE	DCIE (%)	Efficiency level
3.0	33.3	Very inefficient
2.5	40.0	Inefficient
2.0	50.0	Average
1.5	67.6	Efficient
1.2	83.0	Very efficient

6.3 Solar power as renewable energy

An IT and electronics company applied its energy management technologies in order for mobile phone base stations to effectively use power. Moreover, the project reduced the amount of power used inside base stations by coating the outer walls and roofs of the base station housing with a high-solar reflectance photocatalytic paint to curb temperature rises within the housing. Through these measures, the project reduced the consumption of diesel fuel and developed a system with a stable supply of electricity.

To give an idea of potential impact, if demonstration tests were introduced at all 400 000 mobile phone base stations throughout India, the rate of base station energy savings (rate of reduction) is expected to be approximately 50% or an annual reduction of 1 Ml in diesel fuel consumption.

The base station design is illustrated in Figure 3.

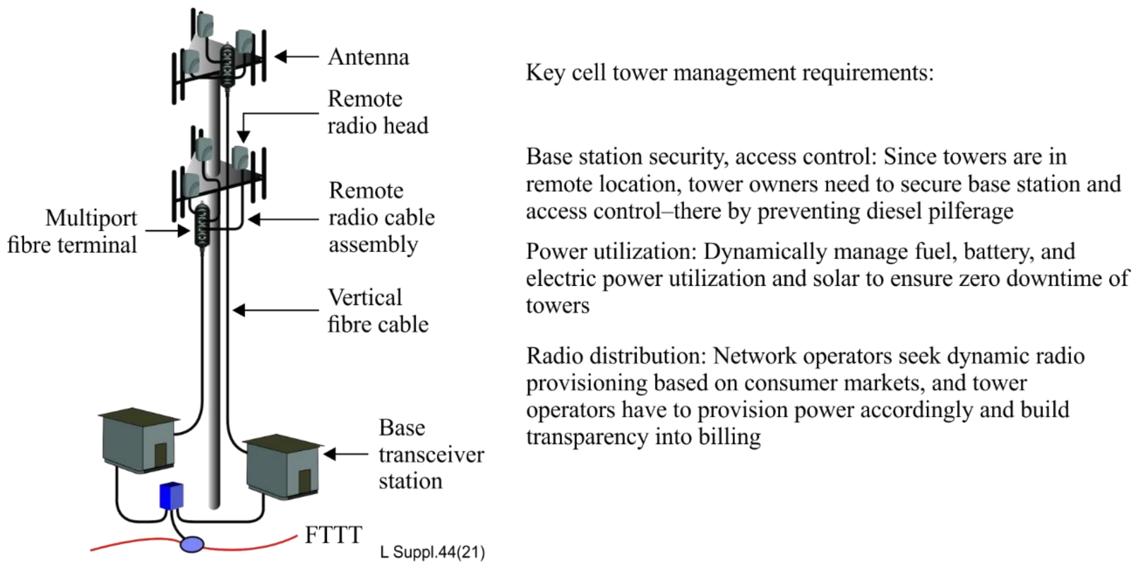

Figure 3 – Key cell tower management requirements

FTTT: fibre to the tower

A PV generation system is installed adjacent to a mobile phone base station. The outside of the base station housing is coated with a photocatalytic paint to reduce indoor temperature rises due to sunlight as illustrated in Figure 4.

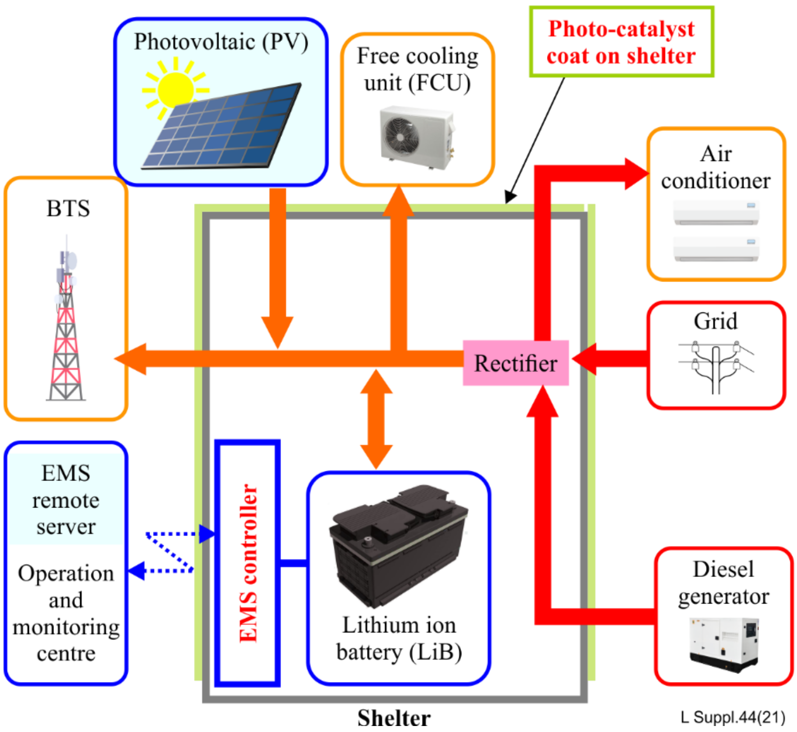

Figure 4 – LI-PV-energy management system of an IT and electronics company
BTS: base transceiver station; EMS: energy management system

6.4 Energy-efficient mobile modular data centre

A major international provider of telecommunications, enterprise and consumer technology solutions for the mobile Internet, has joined a leading Internet company to successfully build a fully mobile containerized DC with world-leading levels of energy efficiency. This successful collaboration has delivered a DC that features multiple technological breakthroughs, with most notably an overall power usage effectiveness.

DC development in China has accelerated in recent times with over 400 000 DCs now operating. According to China's Ministry of Industry and Information Technology, the annual power consumption of the DC industry exceeds 1.5% of the total for the country. This is creating an urgency to initiate more industry-leading green and energy-saving DC projects as the PUE of the majority of China's DCs is higher than 2.2, while the global average for DCs is around 1.7 according to 2014 data from the Uptime Institute. Given this challenge, the jointly constructed fully mobile containerized DC that is fully mobile and modular in design has been implemented. The new facility features technological breakthroughs around cooling, power consumption, design structure, management and control.

The key elements that have realized significant energy savings lie in two major areas: the cooling system; and the power distribution system. The fully mobile containerized DC uses a unique power supply combination of solar PV + high-voltage direct current + mains power. With respect to cooling, the project is the first in China to put indirect evaporative free cooling technology into business application. The energy efficiency ratio achieved by this method can reach 16.0, which is five times the efficiency of conventional mechanical compression cooling air-conditioning systems. As a result, the project has realized the environmental protection and energy-saving goals, while also ensuring low operation costs and low carbon emissions.

Another big innovation from the project is the T-block design feature. Using a prefabricated container approach avoiding the traditional lengthy civil engineering construction cycle, the DC was constructed block by block in a modular fashion. The equipment can be installed within two weeks after being shipped to the site. Equipment can be assembled and deployed in mobile mode to enable a fully transportable and mobile green and energy-saving DC.

The fully mobile containerized facility also uses a self-developed integrated DC infrastructure management system to realize asset unit management, smart linkage operation of sub-systems, and radio frequency identification wireless management and control to help realize smart and efficient operations and management processes.

A collaboration with China Unicom has resulted in the construction of the Shenzhen Pingshan Project, the largest micro module DC in Asia. The implementation of the fully mobile containerized DC further highlights the advanced technical standards and rich experience in the area of DC development. Currently, the uSmartDC solution has been put into over 40 business offices. In addition, the major international provider of telecommunications, enterprise and consumer technology has been engaged in a comprehensive ongoing DC collaboration with China's advanced Internet enterprises.

7 Introduction to the questionnaire

In order to accommodate the need to define GICT strategies and adoption, the composition of the questionnaire focuses on the derived key areas described in clauses 7.1 to 7.4, which will facilitate the gathering of more use cases that will serve as a reference to prepare guidelines for best practice and environment friendly policies for effective ICT deployment methods.

7.1 GICT project implementation

This section aims to understand the nature of a country's ICT project implementation, including regulations and compliance, where respondents are required to specify any conformity of activities, processes, deliverables, products or services within the criteria of specified regulatory or compliance standards, local standards, best practice or other documented requirements. This may relate to, for example, asset management, network security tools, firewalls and Internet security, real-time systems and application design.

7.2 GICT project cycle

This section aims to identify green or eco-friendly elements incorporated into various stages of the ICT project cycle, the documentation of new and emerging hardware, software and communication technologies, products, methods and techniques and the assessment of their relevance and potential value to adopting green elements. This information will provide insight into how ICT systems can reduce energy and materials use by improving the efficiency of business systems by replacing the movement of goods with information (dematerialization), improvement in the efficiency of machines (smart motor systems), logistics, buildings and grids etc.

7.3 Implementation factors

This section aims to ascertain key success factors that can be measured from the implementation of the ICT project, including challenges or limitations encountered during the course of implementation. Respondents are to propose how appropriate methods and tools for the planning, development, operation, management and maintenance of systems are adopted and used effectively throughout the implementation. This may also include analysis of business processes, including recognition of the potential for their automation, assessment of the costs and potential benefits of the new approaches considered and, where appropriate, management of change and challenges or mitigation during implementation.

7.4 Communal engagement

This section aims to clarify the nature of the public engagement, awareness activities or areas of consideration throughout the ICT project, to establish the factors affecting community participation in GICT projects, and identify the relationship between community participation and project outcomes in the selected ICT projects. This will further determine whether such participation led to sustainability of projects or efficiency in the process of identifying, implementing, monitoring and evaluating developmental projects.

Appendix I

Questionnaire

Part A: Respondent information

1) Particulars of organization responding to this Questionnaire and details of the contact person

Name	
Country	
Organization	
Address	
Telephone	
Fax	
E-mail	

2) Please state the role and responsibility of the respondent

Insert (X) where applicable

Government – Policy maker	
Equipment manufacturer	
Telecom operators	
Non-governmental organization, activist, environmentalist	
R&D institution	
Other	

If other, please specify

Part B: GICT project implementation

1) Who was/were the responsible party/parties in deploying the GICT project? Please specify the name of the project and the corresponding party/parties involved.

No.	Project name	Responsible party/parties
1		
2		
3		

*** Please add if more**

2) What were the GICT project(s) implemented in the last 12 months within or outside your country?

No.1

Project Name	
Purpose	
Location	

No.2

Project Name	
Purpose	
Location	

No.3

Project Name	
Purpose	
Location	

*** Please add more, if appropriate**

3) Was there a requirement to meet local regulations or compliance to implement these GICT project(s)?

Insert (X) where applicable

	Yes	**No**
Project 1		
Project 2		
Project 3		

*** Please add more, if appropriate**

If yes, please describe details of the regulations or compliance

Project 1	
Project 2	
Project 3	

*** Please add more, if appropriate**

4) If your country does not currently have any regulations or compliance, what is the alternative approach taken?

Method 1	
Method 2	
Method 3	

*** Please add more, if appropriate**

Part C: GICT project cycle

1) In the following stages of the GICT project implementation, what were the green or eco-friendly elements incorporated? Please replicate sections (a) to (d) if there are multiple projects

Insert (X) where applicable

(a) Planning

Risk management pertaining to location and vicinity	
Conservation and protection of nature and surrounding areas	

(b) Design

Optimization of infrastructure to minimize conventional energy usage	
Incorporation of renewable energy source e.g., solar, water, wind	

(c) Built

Efficiency of site selection and design aspects	
Usage of sustainable materials used for structure	

(d) Operations

Efficient emission management and reduction of carbon footprint	
Enhancement of outdoor environment quality and sustainability	

(e) Project Completion

Was the Project completed on time and according to specifications?	

What was the length of the Project cycle?

One (1) to Three (3) years	
Three (3) to Five (5) years	
Five (5) years and above	

If others, please describe a brief statement of the green or eco-friendly element

1.	
2.	
3.	

*** Please add if more**

Part D: Implementation factors

1) **What were the identified key success factors from implementing the GICT project?**

	Insert (X) where applicable	Results or outcome
Electricity consumption		
Water utilization		
Landfill wastages		
CO_2 Emissions		

If others, please state the contributing factor

1.	
2.	
3.	

*** Please add if more**

2) **What were the challenges and limitations from implementing the GICT project?**

	Insert (X) where applicable	Provide brief details
Cost Constraint		
Inaccessibility		
Lack of Expertise		
Dependencies		

If others, please state the challenges and limitations

1.	
2.	
3.	

*** Please add more, if appropriate**

Part E: Communal engagement

1) **During the GICT project implementation, were any of the following areas considered?**

(a) **Public awareness** **Insert (X) where applicable**

Yes	
No	

If yes, please describe details of the action taken

(b) **Publications** **Insert (X) where applicable**

Yes	
No	

If yes, please describe details of the action taken

(c) Community Feedback

Pre-Project Post-Project

	Pre-Project	Post-Project
Yes		
No		

If yes, please describe details of the action taken

(d) Benefits to the public

Yes	
No	

If yes, please describe details of the action taken

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