NEPAL TELECOMMUNICATIONS AUTHORITY
KAMALADI, KATHMANDU, NEPAL

FINAL REPORT

"Consultancy service to Study and Development of Regulatory Framework on Green Telecom"

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1. EXECUTIVE SUMMARY

This final report is submitted as part of the deliverable for consultancy service to study and develop regulatory framework on green telecom and the core assignment is centered on reducing the carbon footprint of telecom operators in Nepal. Plenty of research and case studies have been carried out in developed countries and perhaps one of the key outcomes of the study is to extract the best practices of successful cases and make suggestions to adapt in local context following ITU recommendations. The study also explores setting up targets for operators to meet carbon neutrality and regulatory approach to support reducing carbon emission to net zero.

The study commenced with collecting primary data on the current status of power consumption by telecom sector in Nepal as well as information on existing e-waste management system in place. Overall, the report covers estimated carbon emissions produced by telecom sectors in Nepal followed by international activities in relation to ICT sector trajectory for CO_2 emissions. The study delves into identifying factors and components that contribute to CO_2 emissions as well as exploring the prevalent energy efficiency technologies considering maximizing the use of renewable energy. Finally, a comprehensive guideline/regulatory framework surrounding the reduction of carbon footprint for telecom sectors in Nepal is included along with this Final Report.

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1.1. BACKGROUND INTRODUCTION

Global warming is presumably one of the major burning issues that has been a threat to the existence of human mankind. Plenty of research and study has been carried out in order to understand the cause and finding a way to work around to minimize the effect. Many countries have formulated legal provisions surrounding the environmental issue and have given efforts to mitigate the emissions of greenhouse gases. Although, Nepal contributes only 0.05 percent of global emissions; Nepal's CO_2 emission grew by 5.8 percent per year between 1990 and 2017 which is the highest in South Asia. Currently, Nepal stands in policy documentation stage and has pledged to achieve net zero emission by 2050[1] as depicted in the figure (1) below.

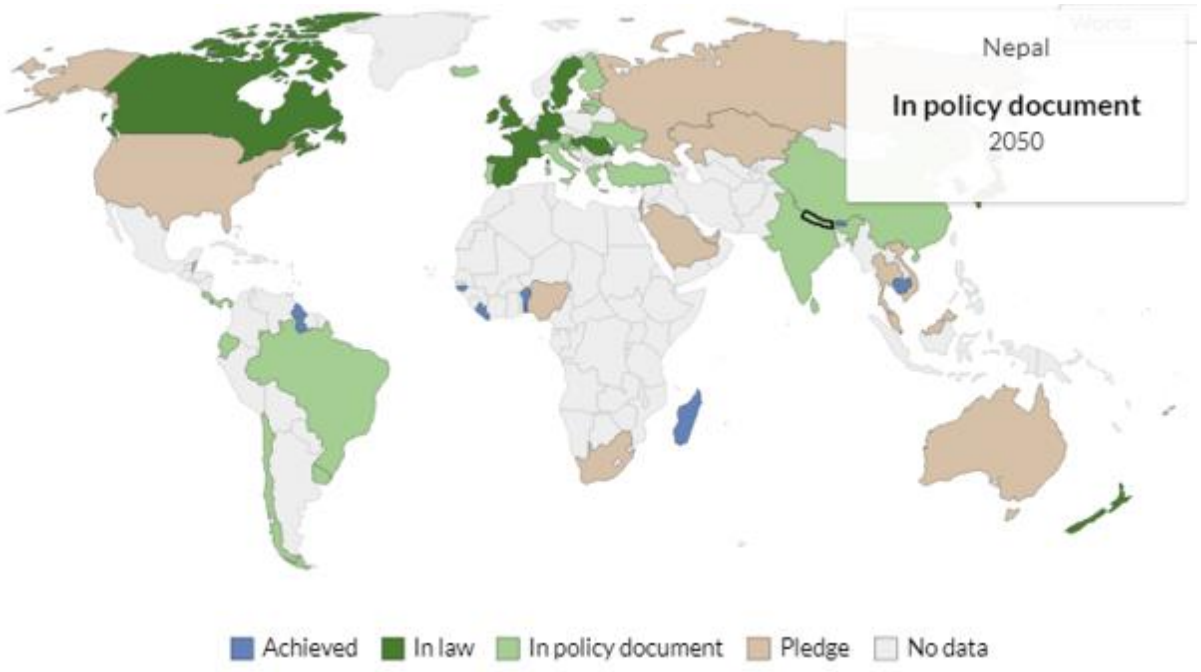


Figure (1) Status of net zero emission targets

Since record-keeping began in 1880, global temperature has significantly gone up and 19 hottest years for over a century have occurred since 2000. The latest global temperature stands at 1.02°C[2] as depicted in the Figure (2) below.

[1] Net Zero Tracker, Energy and Climate Intelligence Unit
[2] NASA's Goddard Institute for Space Studies (GISS)

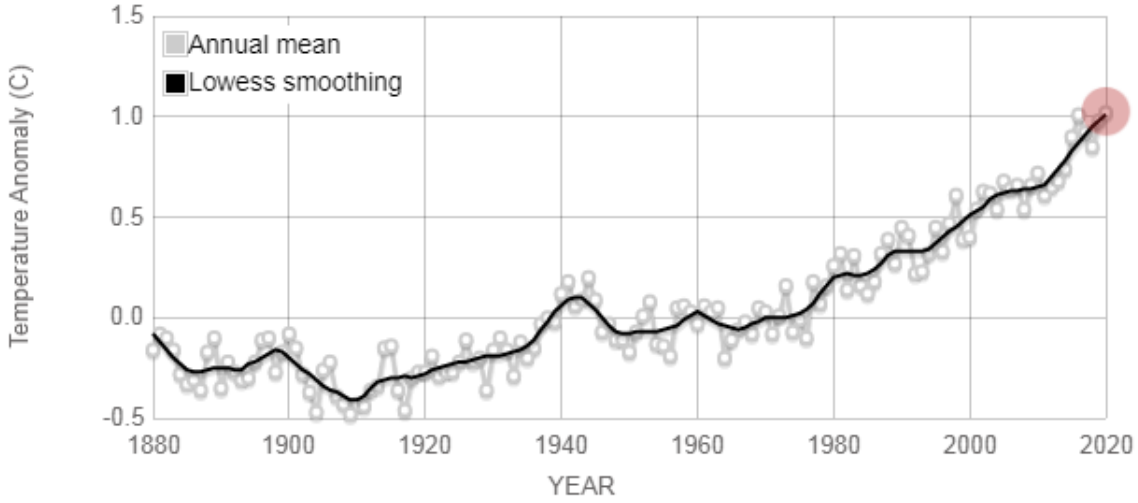


Figure (2) Global Temperature

Greenhouse effect is the natural warming of the earth that results when gases in the atmosphere trap heat from the sun. For most of the past 800,000 years, the concentration of greenhouse gases in our atmosphere was between about 200 and 280 parts per million. But in the past century, that concentration has jumped to more than 400 parts per million, driven up by human activities such as burning fossil fuels and deforestation. The higher concentration of greenhouse gases, and carbon dioxide in particular, is causing extra heat to be trapped and global temperature to rise as illustrated in Figure (3) below.

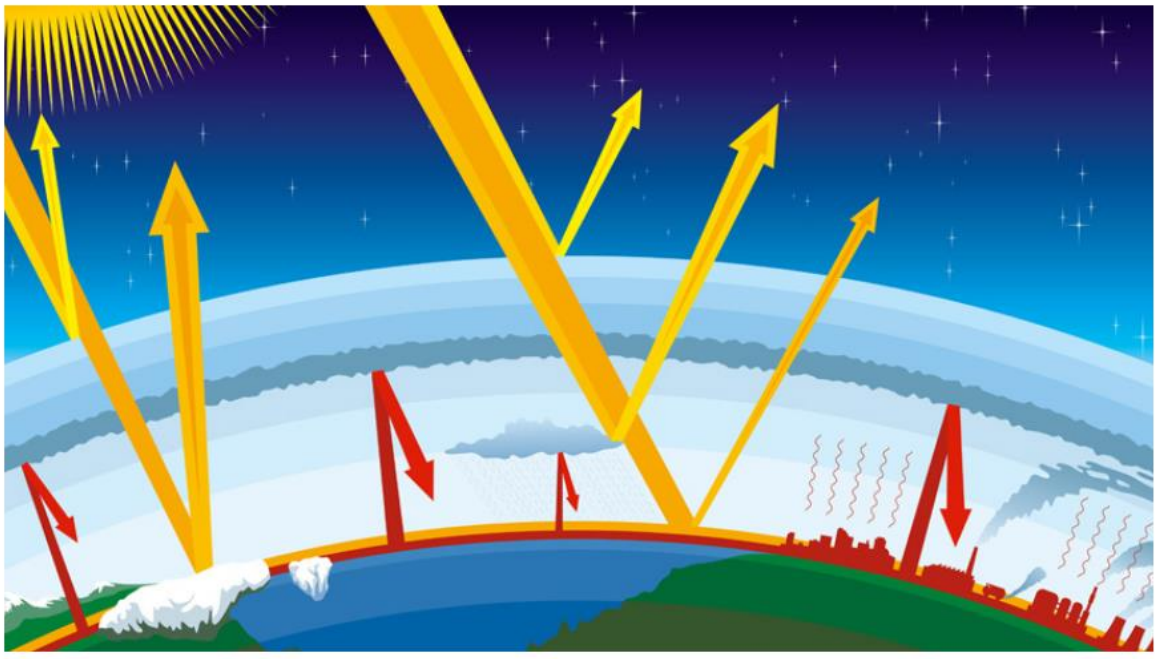


Figure (3) Greenhouse effect

1.2. Greenhouse gases

Greenhouse gases are those gases in the atmosphere that have an influence on the earth's energy balance. There are many chemical compounds that act as greenhouse gases in the earth's atmosphere. When sunlight strikes the earth's surface, some of it radiates back toward space as infrared radiation (heat). Greenhouse gases absorb this infrared radiation and trap its heat in the atmosphere, creating a greenhouse effect that results in global warming and climate change. There are five major greenhouse gases that causes global warming via greenhouse effect as summarized below:

Carbon Dioxide

Carbon Dioxide accounts for about 76% of global human caused emissions and once it is emitted into the atmosphere, 40% still remains after 100 years, 20% after 1000 years and 10% as long as 10000 years later.

Methane

Methane's global warming impact is 25 times greater than that of Carbon Dioxide over a 100 year period and globally it accounts for approximately 16% of human generated greenhouse gas emissions.

Nitrous Oxide

Nitrous Oxide is a powerful greenhouse gas and has 300 times greater warming impact than that of Carbon Dioxide on a 100 year period and it accounts for about 6% of human caused greenhouse gas emission worldwide.

Fluorinated Gases

Fluorinated gases are man-made (manufactured) and accounts to just 2% of man-made global greenhouse gases but they trap substantially more heat comparing to the other gases. There are four main categories: Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur hexafluoride (SF_6) and Nitrogen Trifluoride (NF_3).

Water Vapor

Water vapor differs from other greenhouse gases in that changes in its atmospheric concentrations are linked not to human activities directly, but rather to the warming that results from the other greenhouse gases being emitted. Since water vapor is a greenhouse gas, more

water absorbs more heat, inducing even greater warming and perpetuating a positive feedback loop.

Globally, the primary sources of greenhouse gas emissions are electricity and heat (31%), agriculture (11%), transportation (15%), forestry (6%) and manufacturing (12%). Energy production of all types' accounts for 72% of all emissions[3] as depicted in figure (4) below;

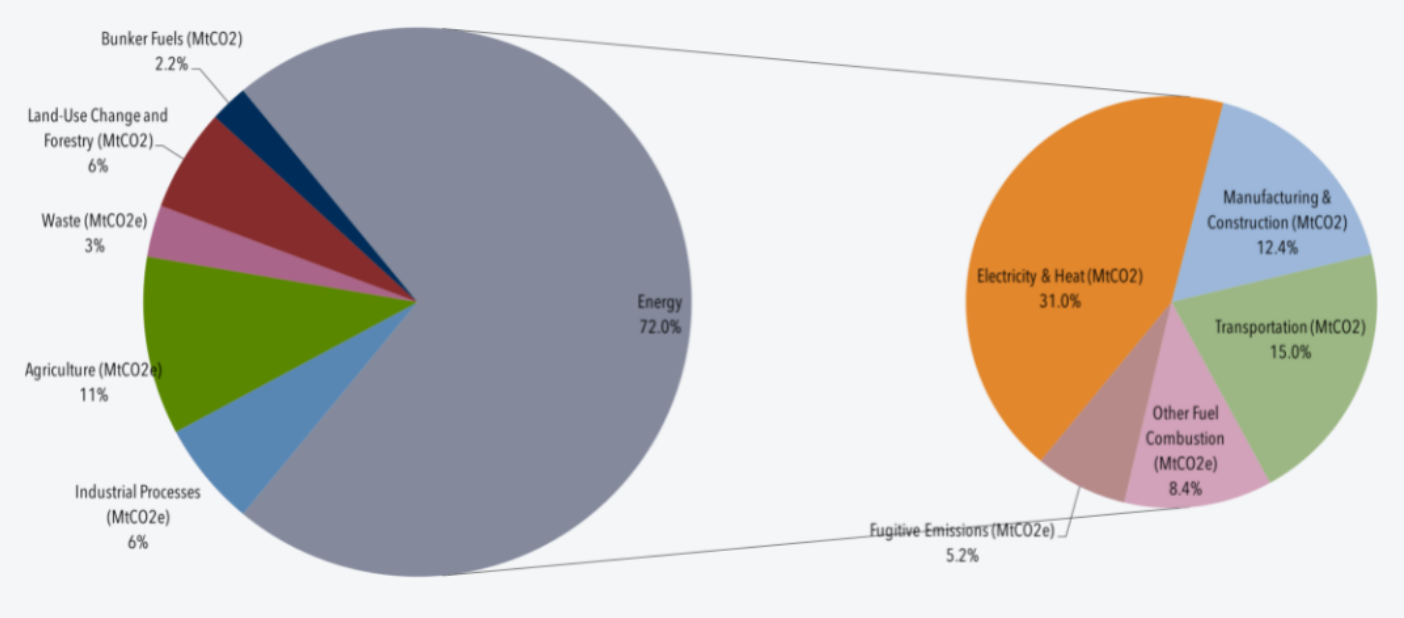


Figure (4) Global man-made greenhouse gas emissions by sector

1.3. Nepal's Carbon emission status

Since, The Government of Nepal have ratified and signed the Kyoto Protocol and the 15th Conference of the Parties (COP15) for the reductions in global greenhouse emissions, the commitment to meet 2030 Sustainable Development Goal target is already under immense pressure even though Nepal has pledged to reduce dependency on fossil fuel by 50 percent by 2050. Further, to address climate change and reduce climate hazards; Nepal has introduced several policies and strategies such as: Climate Change Policy (2011), Forestry Sector Policies and Strategies, Energy policy, Environment-Friendly Vehicle and Transport

[3] World Resource Institute, Climate Analysis indicator tool

Policy. The figure (5) below depicts that as of 2020, Nepal's total share of global CO_2 emission is around 0.05%.

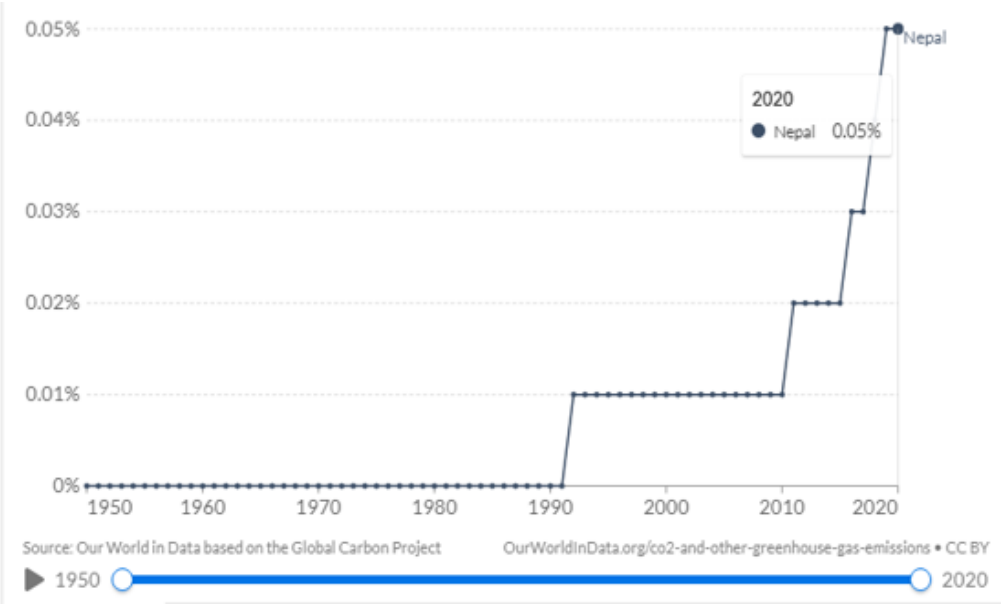


Figure (5) Nepal's annual share of global CO_2 emission

Interpreting in terms of numerical value, Nepal emits around 16.96 million tons of CO_2 emissions as depicted in figure (6) out of which our study suggests that 178,943 tons of CO_2 is contributed by telecom sector which equates to 0.0105% of overall carbon footprint. However, comparing to Greenhouse gas emissions by sectors in Nepal; the top three combined sectors viz. Agriculture, Land-Use Change and Forestry, and fuel combustion amounts to 83.55 percent of the total emissions.

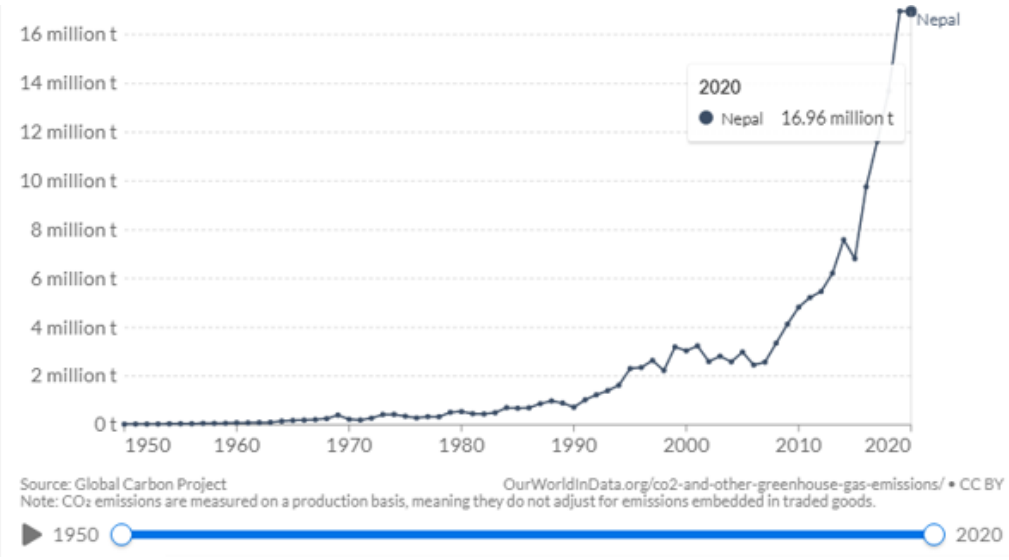


Figure (6) Nepal's CO_2 emission

So, comparing to other sectors, the emissions produced by telecommunications sector is negligible. In addition, within the Green House Gas produced from Nepal, figure (7) explicitly illustrates that the CO_2 emission produced by Telecom sector is significantly low.

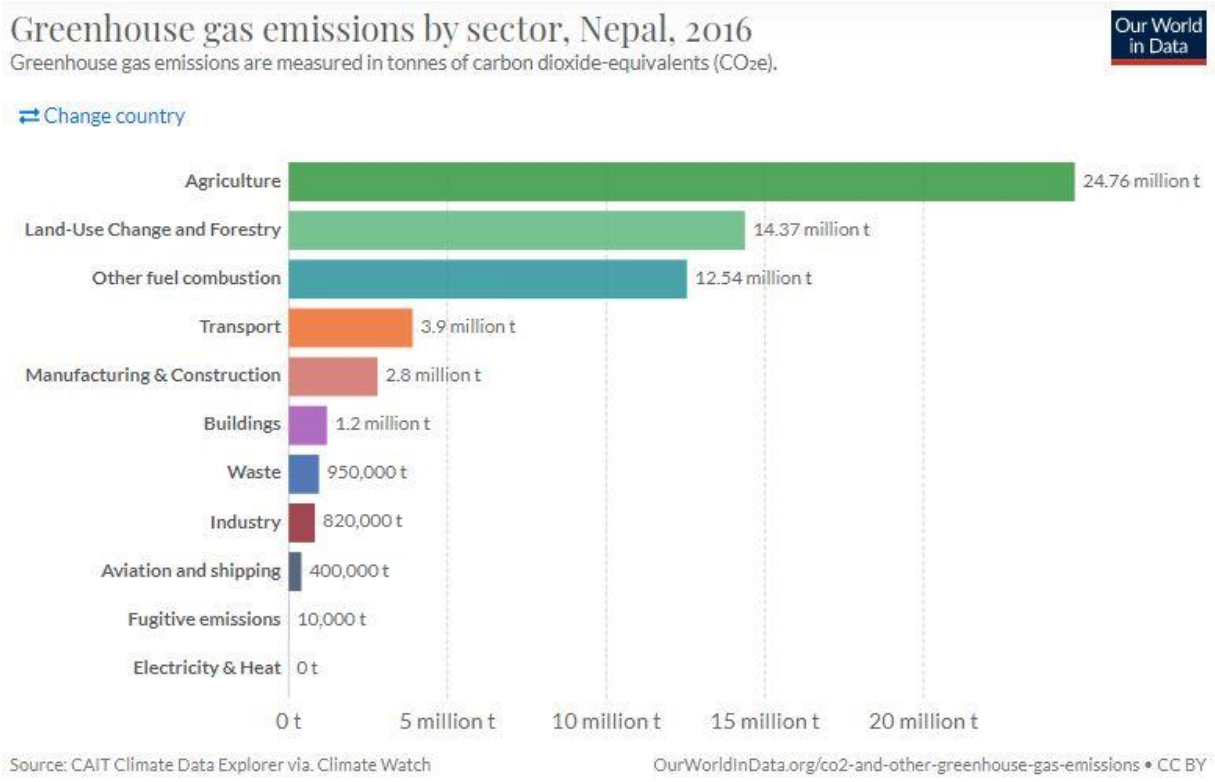


Figure (7) Nepal's Green House Gas emission by sector.

Having said that, telecommunications industry can make a major difference to fight against global warming, lowering emissions by around five times its own footprint. Hence as a concerned regulatory body, Nepal Telecommunications Authority has initiated the study and is developing a regulatory framework in relation to reducing Greenhouse Gas emissions which is termed as "Green Telecom".

Overall, the consulting services incorporates study and identification of existing status, the components that contributes to emissions, energy efficient technologies, options for renewable energy and develop general guideline/regulatory framework. The core of the study is expected to provide comprehensive recommendations on the cost-effective solutions that can be adopted in telecommunications sector in Nepal to mitigate Greenhouse Gas emissions.

2. FINDINGS IN BRIEF

i. Nepal contributes around 0.05% to global carbon emissions.
ii. Nepal emits around 16.96 million tons of CO_2 emissions.
iii. It is estimated that telecom sector in Nepal emits 178,943 tons of CO_2 emissions.
iv. In comparison, the emissions produced by telecommunications sector is negligible, 0.0105%.
v. Study suggests that as of 2020, 76.25% of the BTS towers in Nepal were running on electricity grid, 20.15% on diesel generators and 3.6% on solar power.
vi. It was observed that majority of the services were outsourced by the telecom operators to third party vendors and thus they hardly own company vehicles. In addition, whatever they owned none of them were electric vehicles.
vii. So far, SMART telecom has no e-waste management in place whereas NT and NCELL call for bidding from scrap buyers and it would be the scrap buyer's responsibility to manage the waste produced by the operators.
viii. There are five major greenhouse gases that causes global warming via greenhouse effect viz. Carbon dioxide, Methane, Nitrous oxide, Fluorinated gases and water vapor.
ix. In an effort to decarbonize ICT sector a joint consortium of ITU, SBT, GSMA and GESI has initiated ICT sector trajectory in line with the aim to keep the global temperature rise below 1.5^{o}C.
x. The overall ICT sector produces around 2% of global carbon emissions.
xi. ITU highly recommends ICT sector to reduce CO_2e emission by 42% by 2030, 72% by 2040 and net zero by 2050.
xii. It appears that 65% of telecom operation cost goes to tower sites equipment and energy costs.
xiii. Among various components of a mobile network, base station alone draw 60-80% of the whole network energy consumption.

3. STUDY OBJECTIVE

The prime objective of the proposed assignment is to study, explore, identify diverse issues in relation to the Green Telecom for achieving the energy efficiency in the Telecom Sector minimizing the relatively less carbon emission and develop general regulatory framework for the reduction of carbon footprint for the Telecom operators in Nepal.

3.1. OUTLINED SCOPE OF WORK

The general scope of study stipulated by NTA includes the following:

1. Study and analyze the existing status of the power supplied for the telecom infrastructure and services in Nepal.
2. Study and analyze the international activities/findings in relation to ICT sector trajectory for CO_2 emissions for mobile networks, fixed networks, data centers, user devices, enterprise networks as applicable.
3. Explore the issues for guidance to operators of mobile networks, fixed networks and data centers on setting aligned targets complaint with ITU recommendation.
4. Identify the different components of the telecommunication network that contributes to the carbon emission.
5. Study the global ICT footprint on carbon emission and identify the approach towards Green Telecommunications.
6. Explore the different drivers for designing energy efficient telecom networks.
7. Identify the various aspects of energy efficiency in Telecom Network.
8. Explore the energy efficient technologies which may be adopted to reduce the energy 20consumption at tower site.
9. Explore the various options available for renewable energy solution for Telecom sector.
10. Identify the different approaches for incorporating renewable energy technologies in telecom networks including energy efficiency into account.
11. Develop the general guideline/Regulatory Framework for the reduction of carbon footprint for the Telecom operators.
12. Study and recommend any other relevant issues in relation to Green Telecom.

4. STUDY APPROACH AND METHODOLOGY TO CONSULTING SERVICES

OVERALL APPROACH

The consultant followed sound project management practices for conducting study to ensure quality and adherence to project timelines. The proposed team comprised of senior domain experts on-board who did not only contributed in the study of carbon emission in reference to telecommunication networks but also contributed in the development of general regulatory framework.

4.1. Project Management Approach

The following general management approaches were followed and adopted during the service period:

- Selected and mobilized of appropriate project personnel.
- Selected those methods and process, which had been tested and proven to be successful and effective,
- Applied an optimal combination of the methods and technologies based on practicality, project aim, site-specific analyses, and sound technical judgment,
- Worked on products of high quality with systematic procedure to meet all project objectives,
- Worked in close contact and effective co-ordination with the client and all concerned authorities.
- Regularly briefed to the client and other concerned personnel and authorities on the progress of the Project and problems connected thereto.
- Fully used of available and applicable reports and other information for execution and completion of the proposed assignment in accordance with accepted professional standards and sound engineering practices.
- Clearly defined roles and responsibilities for each member of the proposed Team.
- Strictly adhered to the work schedule.
- Sufficient flexibility to respond to desired changes and directions.
- Systematically monitored of both process and performance.
- Completed of the proposed assignment within the stipulated time and budget.
- Did not compromise to the quality and standards.

4.1.1. Approach to Consulting Services

In order to achieve various requirements, the approach had been conceived and developed to fulfill the objective and scope of work. We believed that the approach presented herein reflected the commitments for providing quality services for the successful implementation of the project in time bound manner.

We understood this Project as:

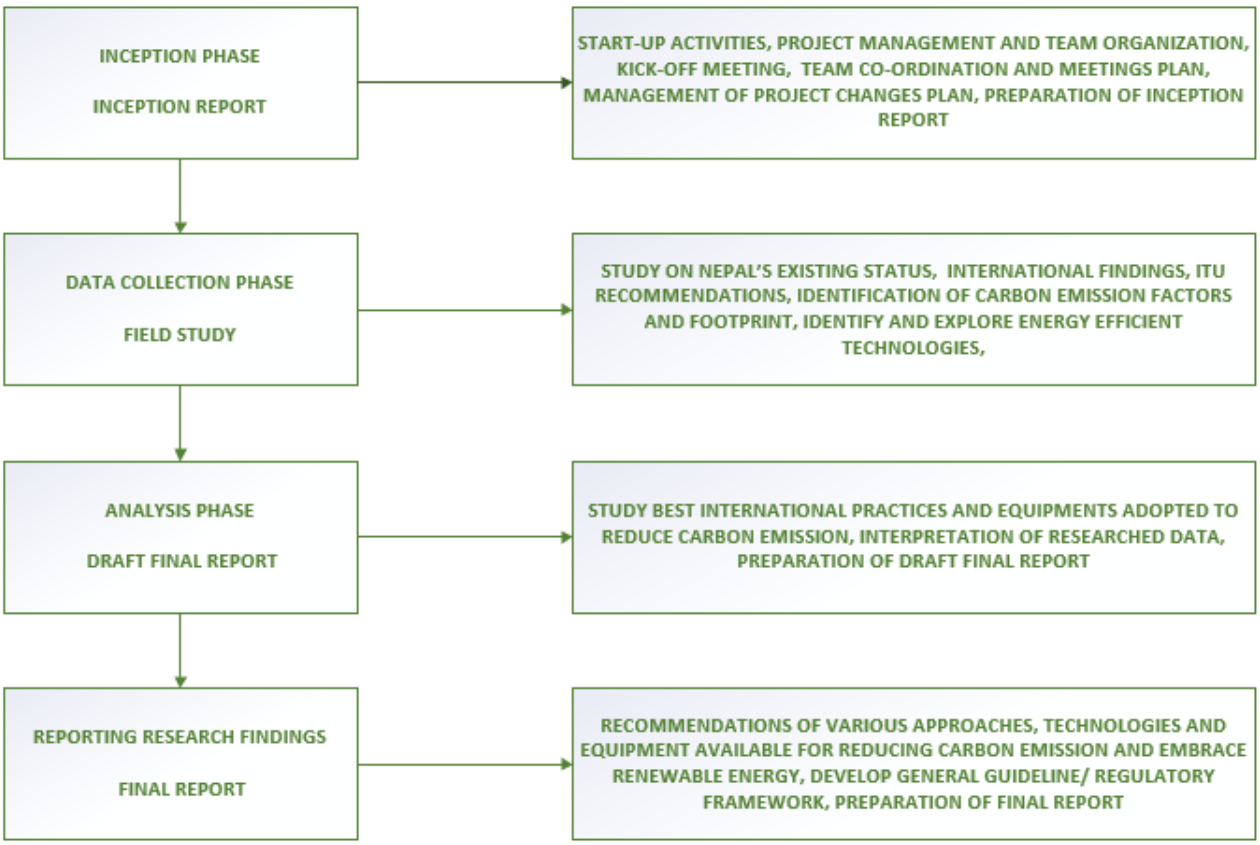
- An opportunity for capacity building and professional development and would ensure active and effective participation of its professional staff in all activities of technical dialogues and transfer of knowledge and skills.
- A process to be explored, identified and tested further improvements in the methodologies of proposed assignment that was most suitable.

4.1.2. Project Management Structure

Our first approach was to establish a clear project management structure, including setting out of the responsibilities of all participants and lines of communication. We organized an internal project familiarization and orientation programme with the project team at the commencement of the services. It was our opinion that only by integrating all members of the Project Team into one team, where all were fully aware of duties and informed of the goals and required outputs of the Project, the prescribed works would be achieved with the desired quality and within the time frame. The diagram was developed to prepare the practical and implacable methodology for the project.

The Project Management diagram below determined the steps or actions during the course of providing service and processes needed to link for integration of services to produce expected output. These would be modified and refined during the consultation stage after interaction with the Client.

Project Management Diagram



4.1.3. Approach to Survey/Data Collection

The field works was planned meticulously and implemented systematically. The priority was be given on:

- Project familiarization and Team Orientation
- Effective coordination and liaison with the Client
- Design and use of standard workable checklist formats for ensuring uniform data collection, for minimizing subjective deviations, and for establishing effective and objective interpretation of the data according to the objectives of the assignment
- Close coordination with NTA and stakeholders
- Effective coordination and close interaction between the team members
- Good management of logistics
- Minimize the work duplication by good planning, effective control and timely communication

4.2. TECHNICAL APPROACH/METHODOLOGY

In order to fulfill the objectives and scope of works, generalized methodology was followed in the following phases and each phase involved series of tasks as discussed in the following sections.

4.2.1. INCEPTION PHASE

The following activities were carried out in this phase:

(i) **Start-up activities:**

The entire study on Green Telecom was designed and led by Team Leader in close coordination with the project team. Upon signing the contract the Team Leader instigated the following activities:

- Ensure the project teams' understanding on the objectives and scope of work of the assignment including deliverables
- Reviewed work plan to meet the realistic deadlines
- Collected all the available information related to the project

(ii) **Project Management and Team Organization:**

The initial approach was to establish a clear Project Management Structure including setting out responsibilities of all team members and lines of communications. A strong and organized Project Management Structure ensured that all the activities were met within the stipulated work plan, ensured quality of work was retained and ensured the objective of the assignment was fully met. Some of the activities that took place were as follows:

- Defined the roles and responsibilities of each team member
- Set up individual plan of activities for each member
- Defined line of communication and efficient flow of data and information among the team members

(iii) Kick-Off meeting:

The consultant team was supposed to meet the co-ordination team of NTA & stakeholders as proposed to familiarize the project, existing facilities and detail project requirement and plan for the project initiation but due to NTA's office relocation kick-off meeting is postponed for later date. The activities expected to have taken place in the meeting were as follows:

- Introduced key experts of the project team
- Reviewed project objectives, scope of work, deliverables and time schedule
- Anticipated any possible deviation that would affect the assignment
- Understood Green Telecom
- Discussed on the status and existing issues on carbon emission
- Agreed on method of collecting quantitative data
- Verified Progress reporting mechanism
- Appointed and defined roles and responsibilities of focal person from each side

(iv) Document Collection and Review:

The Consultant team were supposed to collect all the relevant documents from the client where available as proposed and again this activity did not take place but some of activities expected to take place were as follows:

- Collected existing data, information, reports from ITU on international practices
- Gathered complete list of existing mobile networks, fixed networks, data centres, user devices, enterprise networks
- Studied and summarized the findings of the reviewed documents

(vii) Team Co-ordination and meetings Plan:

The Team Leader led and convened the internal project progress meeting with the project team. The typical topics that were discussed in the regular meetings were as follows:

- Review status of progress of the assignment
- Review and update time schedule
- Update any changes and/or client requirements
- Identify necessary actions for any issues encountered
- Follow up progress on previous actions

(ix) Inception Report:

The inception report was prepared by the Team Leader in close coordination with NTA. The report was supposed to include all the conclusions of kick-off meeting and documents reviewed unfortunately it did not happen in this particular instance.

Further, the inception report included revised research methodology. The report incorporated detailed responsibility and schedule of activities to be carried out by the team members. Finally, the report included review of preliminary study, ITU study group publications and existing Nepal's status on Green Telecom. The report was submitted to NTA within 30 days from the signing of the contract agreement.

4.2.2. DATA COLLECTION

Data collection primarily involved gathering all the information relevant to the project and two different methods were used. Frist of all, the secondary data were collected for desk study where the current status of the carbon emission, and international best practices were thoroughly examined. Secondly, interactive meeting were to be held and survey questionnaires were be distributed to all the stakeholders. Some of the activities the team member carried out during data collection are as follows:

Secondary Data Collection

Secondary data are those that have already been collected, analyzed and published as reports or publications. This method was used to study the international findings and global footprints, including identifying components of telecommunication network that contribute on carbon emission. However, care was be given on the reliability, suitability, accuracy and adequacy of data.

Qualitative Research

Qualitative archived data were collected to be reanalyzed, reworked and compared. Restudy of original research, and replication were done. New observations and new interpretations were done during re-analysis.

Information/Data Collection

In order to understand the current status of carbon emission in Nepal particularly in telecommunications sector, information on mobile networks, fixed networks, data center, user subscribers, and enterprise networks were supposed to be collected from the telecom operators. NTA would facilitate in the collection of information/data from the concerned stakeholders. However, due to lockdown this activity is still pending.

Research/Study

As part of the study the consultant explored the guideline issued and recommendation provided by ITU. The consultant will research on the components that contributes to carbon emission, study various energy efficient technologies and options for renewable energy as well as explored the different drivers for designing energy efficient telecom networks.

4.2.3. DATA ANALYSIS

Date collected through various sources were analyzed, and useful information were drawn and referenced. The information supported in determining the recommendations and will assist in drawing up the conclusion that will be included in Final Report. Preliminary data were manipulated in different ways such as plotting it out to graphs and correlations found. The findings of the analysis were further interpreted in support to the reduction of carbon emission where feasible. As carried out in the research/study, the various elements that contributes to carbon emission as well as energy efficient technologies for renewable energy were thoroughly examined and interpreted for reporting of the findings. Conclusion and recommendations on the study were based on these findings. The draft final report is prepared by the Team Leader in close coordination with NTA. The report includes all the nitty-gritty of analytical procedure, information and interpretation of the data.

4.2.4. REPORTING RESEARCH FINDINGS

The findings of the overall study on the reduction of carbon emission in relation to Green Telecommunications is summarized in the reporting. Recommendations is included on the various options and technologies to reduce carbon emission in telecommunications sector in Nepal. A comprehensive draft final report is prepared that includes a general guideline/regulatory framework on Green Telecom. The draft final report is supposed

submitted to NTA within 3 months of signing the contract (extended one month due to lockdown)

The comments and feedbacks to be received on draft final report will be incorporated in the preparation of the final report. Finally, the team leader will draw up the conclusions and recommendations with decision in the final report. The final report will be submitted within 4 months of signing the contract.

4.3. PROJECT MILESTONES AND DELIVERABLES

Upon signing the contract the consultant submitted Inception Report with 30 days. The Inception report included revised methodology and brief review of literature research. The consultant conducted in depth study on the status of carbon emissions of telecom operators, studied on available options/technologies to curb carbon emissions, studied on international best practices/ITU recommendations and finally prepared regulatory framework to address Green Telecom. This Draft Final Report is submitted within 90 days of signing the contract. Upon receiving the feedbacks on the Draft Final Report, the consultant will incorporate the comments and submit the Final Report within 120 days.

5. ANALYSIS OF ENERGY DEMAND FOR TELECOM INFRASTRUCTURE AND SERVICES IN NEPAL

After signing the contract for this particular assignment, strict lockdown came into effect due to second wave of COVID-19 pandemic in Nepal which adversely affected on the study progress particularly that involved discussion, interaction and data collection. The consultant team was not able to hold even a kick-off meeting or collect any information pertinent to this assignment. The consultant tried to obtain some basic information on the power consumption from the telecom operators but was severely delayed. Hence, after continuous effort and support from NTA the consultant was finally able to collect tentative data to study, analyse and estimate the current status of the power supplied to telecom infrastructure and services in Nepal. However, even after following up over dozens of times the consultant was unable to obtain power consumed by ISPs in Nepal and is not included in this report.

The consultant was finally able to obtain only basic information such as purchase of fuel and grid electricity and calculated the carbon emissions based on the provided data. It was merely impossible to obtain minute details as operators have so many departments in so many locations and receiving/consolidating all the data would take months and months. So, the generic information obtained from the telecom operators were sufficient to estimate the carbon emissions produced in year 2020. As of November 2021 there were 7,787 telecom towers in Nepal (NT 3600, NCELL 3594 and SMART 593) as depicted in Figure (8) below.

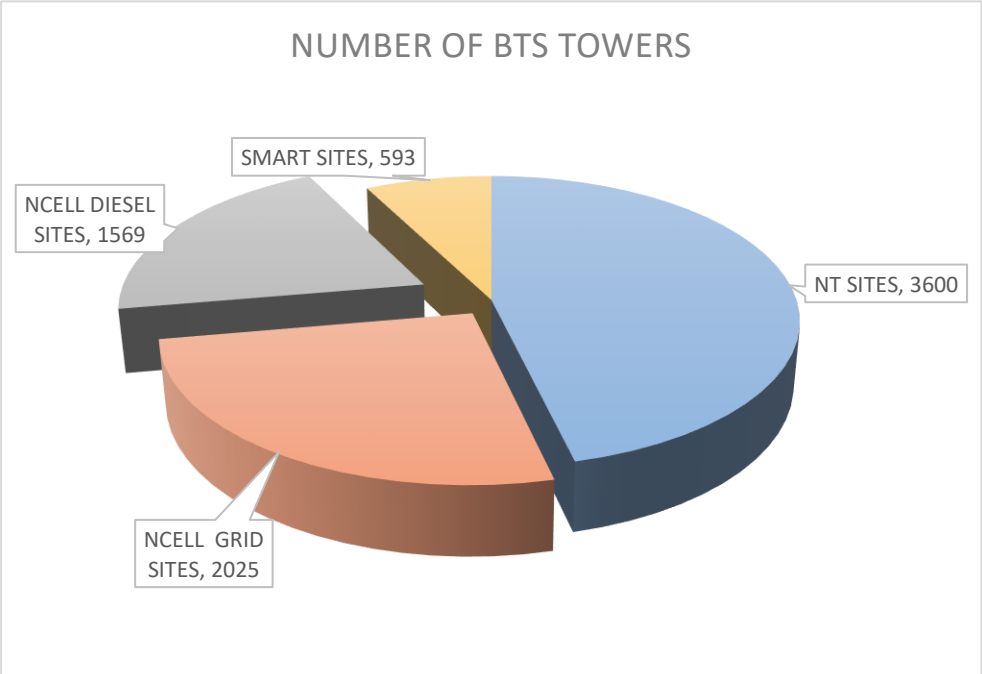


Figure (8) Total number of BTS towers in Nepal.

As per the findings, 76.25% of the towers were running on national grid, 20.15% on diesel generators, 3.6% on solar power as depicted in the figure (9) below.

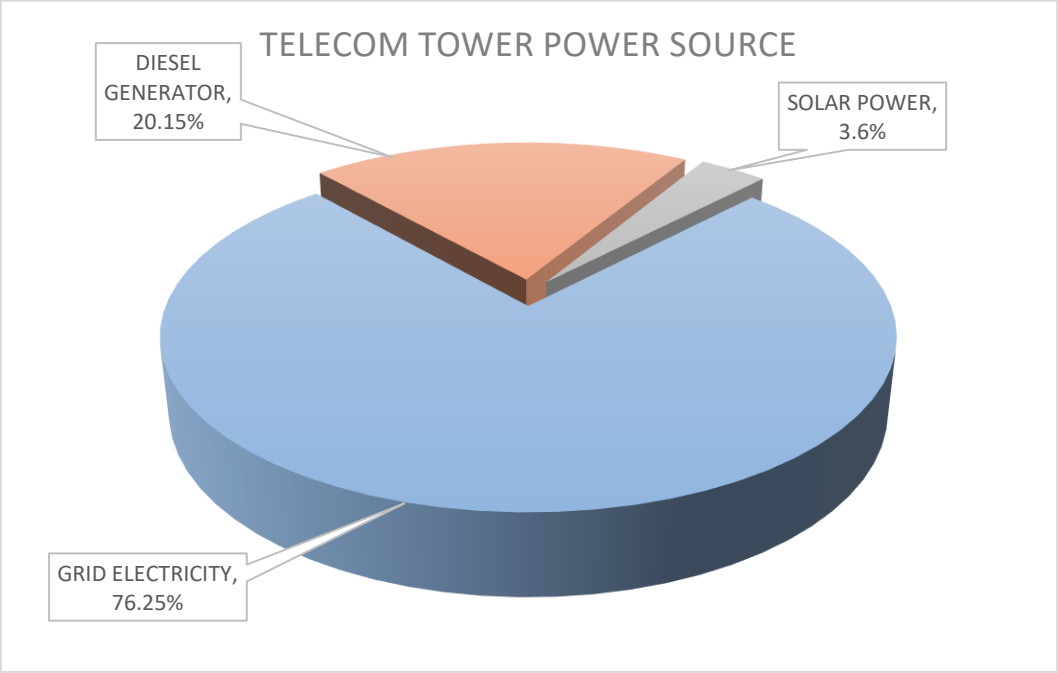


Figure (9) Power Source of telecom towers

The study also found out that only NCELL was running 1569 sites on diesel generators which equates to around 20% of the overall telecom towers in Nepal. It appears that NCELL and SMART were running only GSM network and most of their services were out-sourced, so the Carbon emissions produced by their vendors were unaccounted for. Based on the study, the combined CO_2 emission of the overall three operators were estimated around 178,943 tonnes in 2020 as depicted in the figure (10) below.

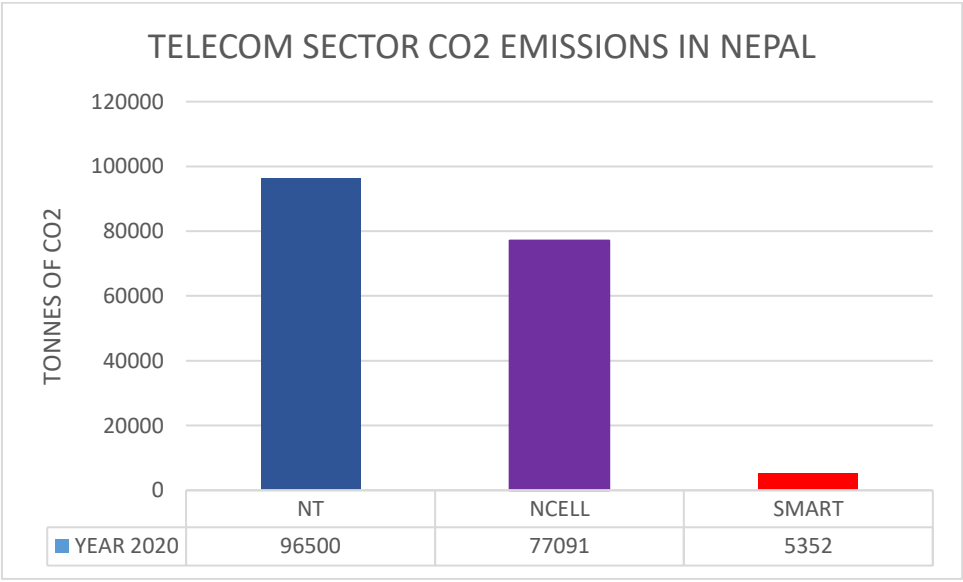


Figure (10) Carbon emissions from telecom sector

NT has 3 major data centres located at Hetauda, Butwal and Sundhara where Hetauda has replication site running on HA at Jawakhel and Sundhara has replication site running on HA at Babarmahal. These data centres were part of power craving sites for NT and in addition NT has offices at almost all the districts in Nepal.

It is also observed that all the operators outsource their services to third party vendors from commissioning a system to infrastructure rollout or providing any kind of services including VAS. So, the operators hardly own vehicles in their fleet and most of them are provided for senior and management level staffs. However, NT has 836 vehicles in their fleet, whereas NCELL has 21 vehicles and SMART has 7 vehicles as depicted in the Figure (11) below. Unfortunately none of them has a single electric powered vehicles.

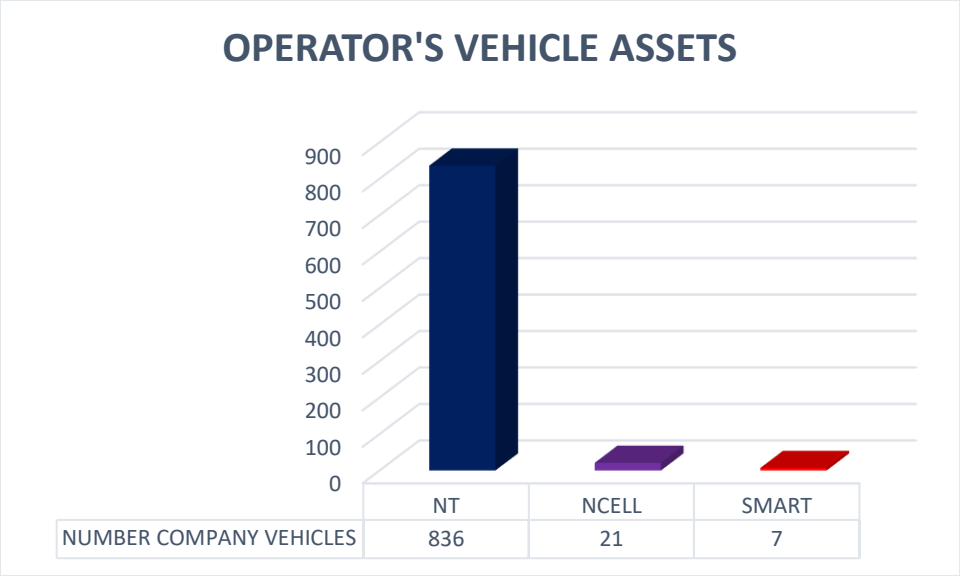


Figure (11) Number of vehicles owned by operators

5.1. STATUS OF ENERGY SOURCES OF TELECOM SERVICE PROVIDERS

At the time of the consulting services undertaken and throughout the study period there are 3 active telecom operators in Nepal. Amongst the many energy sources, telecommunications sector in Nepal have only three alternatives viz. hydroelectric grid supplied by Nepal Electricity Authority (NEA), mini/micro solar powered grid projects run by Alternative Energy Promotion Center (AEPC) and diesel generators in off-grid sites.

Since Nepal has so much uncapped hydroelectricity potential, all the other means of energy generations have been ruled out except solar energy for power supply. However, study suggest that there are many rural areas that are still deprived of grid electricity and power is supplied through family sized biogas plants. Overall, there are around 250,000 households with biogas energy supported through AEPC.

That being said, there are very limited energy sources that telecom sector can turn to meet their power demands. It is found that all the energy demands for radio access network, backhaul transmission, core network, data center, etc, in the cities, urban/suburban, and some rural areas are supplied through NEA electricity grids generated through hydropower energy. So, wherever there is national grid power is supplied through hydroelectric energy. It appears that SMART telecom is totally running on national grid and they don't have coverage in off-grid areas. Nepal telecom has used solar energy to power their off-grid sites. Whereas only NCell has opted for diesel generators in their off-grid sites. Considering, hydroelectric and solar power as a source of renewable energy that accounts to zero emission, we can conclude that NCell is the only telecom operator with higher emission producer from their off-grid sites. The overall sources of energy supplied in tower sites in telecom sector is depicted in Figure (12) below:

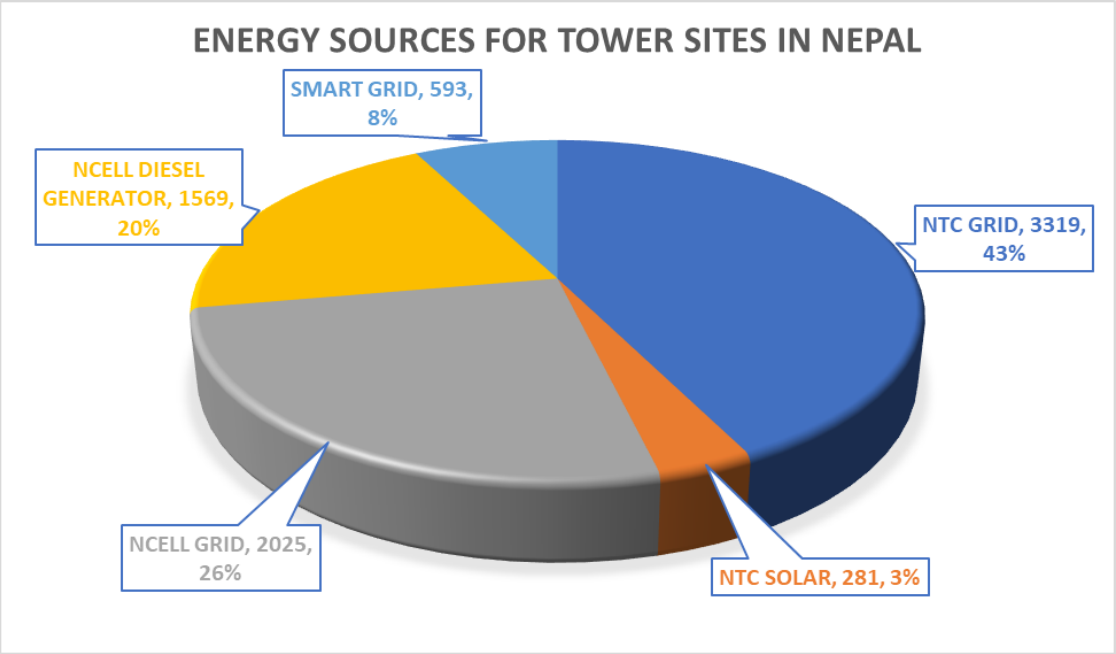


Figure (12) Energy sources status of telecom service providers

6. ANALYSIS OF ICT SECTOR TRAJECTORY FOR CO2 EMISSIONS

In relation to ICT sector trajectory for CO_2 emission a collaboration between ITU, Science Based Targets (SBT) initiative, GSMA and Global Enabling sustainability Initiative (GeSI) was initiated for the sole purpose of assisting ICT industry to set decarbonisation target in line with the aim to keep a global temperature rise below 1.5°C. The 1.5°C trajectory on ICT sector's potential climate impact is derived from a life cycle-based carbon footprint of the ICT sector in line with climate science. Trajectories for the GHG emissions for the global ICT sector, the baseline year is set to 2015 and provides estimates for 2020, 2025, 2030 and defines long-term plan for 2050.

The trajectories recommend and categorises company GHG emissions into three different scopes as outlined below;

- Scope 1, which covers direct emissions emanating from the company's own assets,
- Scope 2, which covers emissions related to purchased energy,
- Scope 3, which covers remaining value chain emissions over which the company has some influence.

The ICT sector is generally divided into three main sub-sectors viz. end user goods (user devices); networks (including both mobile and fixed); and data centres including enterprise networks. Table (1) summarizes the details of the overall sector trajectories for the decarbonisation of the sector in line with 1.5°C. During the research conducted by ITU -T Rec L1470, the primary data had been collected from about 100 of the world's largest equipment manufacturers, operators as well as ICT and E&M service companies. During the survey, data for different products have been compiled, together with sales statistics for these devices.

	CO2e emission including electricity supply chain and grid losses (MT Co2e)			
	2015	**2020**	**2025**	**2030**
Mobile Networks				
Mobile network manufacturers (s1-s2)	3	3	2	1
Mobile network manufacturers T&D (s3)	0.3	0.3	0.2	0.1
Mobile network manufacturers, electricity supply (s3)	0.45	0.45	0.3	0.15
Mobile network operator overheads - electricity (s2)	6.4	6.4	6.4	6.4
Mobile network operator overheads - excluding electricity (s1-s2)	4	4	4	4

Mobile network own electricity generation (s1-s2)	25	23	21	18
Mobile network electricity consumption (s2)	48	46	35	21
Mobile network electricity consumption, T&D (s3)	5.4	4.6	3.5	2.1
Mobile network electricity consumption, electricity supply (s3)	8.2	6.9	5.3	3.2
Mobile network supply chain s3	12	12	12	12
Mobile network supply chain, T&D (s3)	0.75	0.75	0.75	0.75
Mobile network supply chain, electricity supply (s3)	1.5	1.5	1.5	1.5
Fixed networks				
Fixed network manufacturers (s1-s2)	1	1	0.7	0.3
Fixed network manufacturers, T&D (s3)	0.1	0.1	0.07	0.03
Fixed network manufactures, electricity supply (s3)	0.15	0.15	0.1	0.05
Fixed network operator overheads - electricity (s2)	3.2	3.2	3.2	3.2
Fixed network operator overheads - excluding electricity (s1-s2)	2	2	2	2
Fixed network electricity consumption (s2)	43.2	38	25	14
Fixed network electricity consumption, T&D (s3)	4.6	3.8	2.5	1.4
Fixed network electricity consumption, supply (s3)	6.9	5.7	3.8	2.1
Fixed network supply chain s3	4.5	3.8	3.4	3
Fixed network supply chain, T&D (s3)	0.5	0.4	0.4	0.3
Fixed network supply chain, electricity supply (s3)	0.75	0.6	0.6	0.45
Data Centres				
Data Centre manufacturers s1-s2	3	3.3	3.7	3.7
Data centre manufacturers, T&D (s3)	0.3	0.33	0.34	0.36
Data centre manufacturers, electricity supply (s3)	0.45	0.48	0.51	0.54
Data centre operator overheads (electricity) s2	6.4	7.2	7.2	7.2
Data centre operator overheads (excluding electricity) s1-s2	3	3	3	3
Data centre electricity consumption (s2)	91.2	84	60	40
Data centre electricity consumption, T&D (s3)	9.1	7.8	5.6	3.5
Data centre electricity consumption, supply (s3)	13.7	11.6	8.4	5.2
Data centre supply chain s3	12	12.5	13	13
Data centre supply chain T&D (s3)	0.75	0.8	0.8	0.8
Data centre supply chain, electricity supply (s3)	1.5	1.6	1.6	1.6
User devices				
User device manufacturers (non-electricity)	35	35	35	35
User device manufacturers electricity (s2/s3)	70	64	41	23
User device manufacturers, T&D (s3)	7	6.4	4.1	2.3

User device manufacturers, electricity supply (s3)	10.5	9.6	6.15	10.5
User device operation (s3)	169	161	115	72
User device operation (T&D, s3)	17	16.1	11.5	7.2
User device operation, electricity supply (s3)	25	24.2	17.3	10.8
User device supply chain non-electricity s3	35	35	35	35
User device supply chain, electricity (s3)	26	22	15	9
User device supply chain, T&D (s3)	2.6	2.2	1.5	0.9
User device supply chain, electricity supply (s3)	3.9	3.3	2.3	1.35
Enterprise networks				
Enterprise network manufacturers electricity (s2/s3)	0.5	0.5	0.35	0.2
Enterprise network manufacturers, T&D (s3)	0.05	0.05	0.04	0.02
Enterprise network devices manufacturers, electricity supply (s3)	0.08	0.08	0.07	0.03
Enterprise network operation (s2/s3)	12	11	6	4
Enterprise network operation (T&D, s3)	1.2	1.1	0.6	0.4
Enterprise network operation (supply, s3)	1.8	1.6	0.9	0.6
Total				
Total including grid electricity supply and loses	**740**	**693**	**530**	**388**
Number of mobile subscriptions (SIM-cards excluding M2M)	7.2 billion	8.2 billion	8.9 billion	9.4 billion
Number of fixed subscriptions (lines)	1.85 billion	2 billion	2 billion	1.9 billion
Number of servers (data centres)	43 million	48 million	52.5 million	55 million
Number of active PC or employee "users" (enterprises)	800 million	850 million	900 million	950 million
Number of end-user goods	13 billion	15 billion	18 billion	20 billion
Number of additional IoT/M2M (possible, included in forecast)	2 billion	7.5 billion	14 billion	20 billion
Fixed data traffic (ZB)	1	3	7	12-27
Mobile data traffic (ZB)	0.06	0.6	2	6-10

Table (1) Trajectory including electricity supply chain and grid losses in line with LCA principles[4].

[4] ITU-TL 1470

During the course of survey and data collection by ITU –T L.1470, the list of telecommunication operators, data centre operators and manufactures are depicted in Table (2), below:

Telecommunication Operator	Data Centre Operator	Manufacturer
AT&T	Facebook	Apple
Verizon	Google	Samsung
China Mobile	Apple	Foxconn
NTT	Microsoft	HP
DT	SAP	IBM
Softbank	Accenture	Dell
Vodafone	Oracle	Sony
Telefonica	Amazon	Panasonic
Orange	Tencent	Huawei
America Movil	Equinix	Intel
China Unicorn		LG Electronics
KDDI		Cisco
China Telecom		Fujitsu
British Telecom		Pegatron
Telecom Italia		Quanta Computer
Telstra		China Electronics
BCE		Canon
Telenor		Ericsson
Vimpel corn		TSMC
Axiata		NEC
Singtel		LG Display
SK Telecom		Compal
Bharti Airtel		Flextronics
MTN		Micron
TRAI (10 Operators, excluding Airtel)		SK Hynix
		TI
		Innolux
		AUO
		BEO
		JDI
		Lenevo

7. ITU RECOMMENDATIONS TO OPERATORS FOR MOBILE NETWORKS, FIXED NETWORKS AND DATA CENTERS

ITU-T L-Series Recommendations – Supplement 37 provides specific guidance to operators of mobile networks, fixed networks and datacentres on setting 1.5°C aligned targets complaint with Recommendation ITU-T L.1470 and was jointly developed by ITU-T Study Group 5, SBTi, GSMA and GESI. As per the guidance, possible trajectories were developed and considered using three approaches:

- IPCC 1.5°C P2 scenario requiring a halving of emissions between 2015 and 2030;
- SBTi 1.5°C trajectory demanding 42% reduction over 10 years;
- A 1.5°C scenario, carbon budget approach based on the ICT sector maintaining a fixed share of overall electricity usage.

The trajectories for operational emissions of ICT operators (scope 1 and 2 emissions only) is depicted in the figure (12) below.

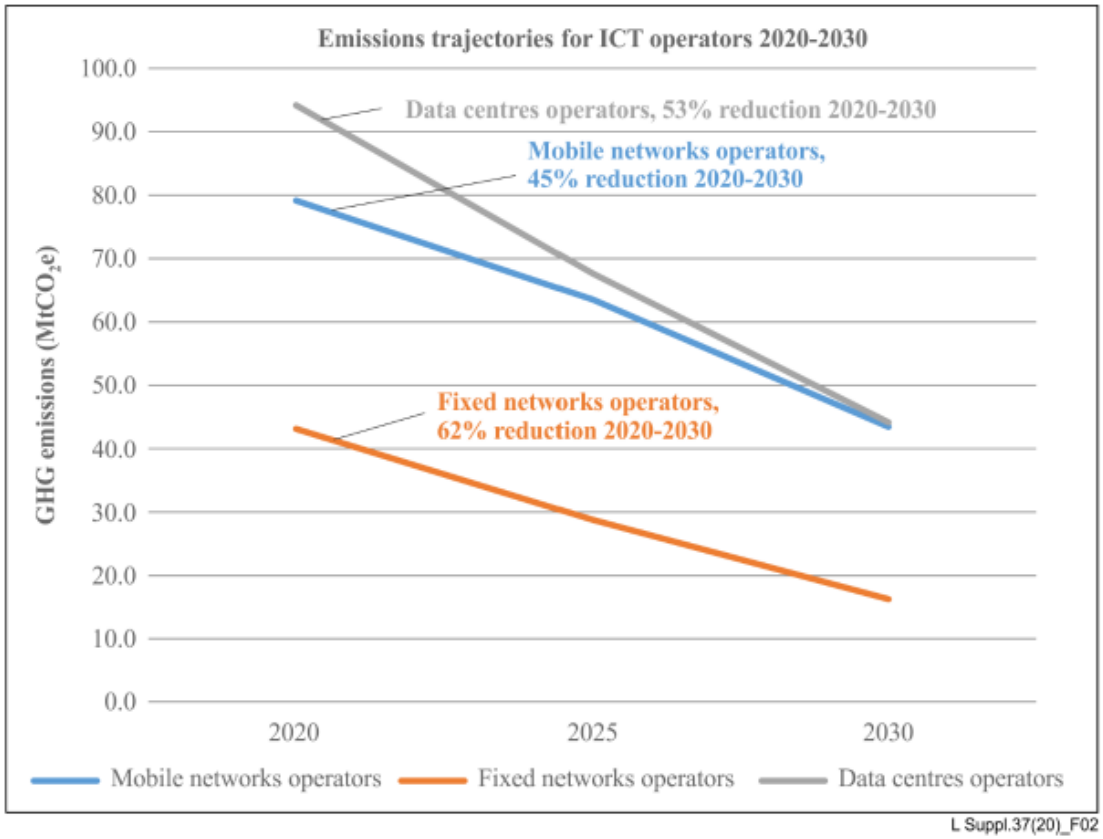


Figure (12) Trajectories for ICT operators

As ICT sector is dynamic, the sector has been able to mitigate the energy requirements ICT sector the implementation of simultaneous, vigorous, and urgent actions is required in the following fields;

- Continued implementation of energy efficiency plans;
- Switch to renewable/low carbon electricity supply;
- Encouragement of carbon consciousness among end users.

All these three mechanisms should be utilised and addressed to decarbonise in line with 1.5°C trajectories.

Setting and ICT company sub-sector target for scope 1 and 2 emissions

The following steps should be adopted to set a science based target by a company with ICT operations.

Select a baseline year

The most recent year should be selected for which data is available.

Select a target year

A minimum of 5 years should be selected and since digital technologies are rapidly changing a target year should not go beyond 2030.

Measure scope 1 and 2 emissions

Scope 1 and 2 emissions need to be measured for the baseline year according to the GHG protocol. Most of the companies have activities beyond ICT operations such as office buildings and/or a transport fleet. In such cases, companies may choose to combine all their scope 1 and 2 emissions and derive a single SBT following ICT sector method, thereby allowing the overall trajectory to stay within 1.5°C trajectory.

Calculating the science based target

A sub-sector science based target (SBT_s) is calculated by multiplying the combined scope 1 and 2 emissions in the base line year (CC_b) by an emissions reduction factor (ERF). The emissions reduction factor is based on the appropriate sub-sector emission reduction pathway and the baseline and target years.

$$SBT_s = CC_b \,.\, ERF$$

Setting a target for Scope 3 emissions

SBTi criteria require that a company sets a scope 3 target when its scope 3 emissions are 40% or more of its total scope 1, 2 and 3 emissions. The scope 3 target must cover at least 2/3 of total scope 3 emissions. For most ICT companies it is likely that the 40% criterion will be met and the company will need to set a scope 3 target. The most significant scope 3 categories for an ICT company are likely to be:

- Category I – purchased goods and services
- Category II – use of sold products

Companies can set either a scope 3 emissions reduction target, or a supplier or customer engagement target, or a combination of the two.

8. FINDINGS ON TELECOM NETWORK COMPONENTS THAT CONTRIBUTE TO CARBON EMISSION

It is a common misconception that Carbon Dioxide (CO_2) emission is presumably the only element that affects the climate change but on the contrary, there are various gases that contribute to global warming. Some of the common GHGs produced by telecommunications industry are outlined in Table (2) below.

Gases	Sources in telecommunications
Hydrofluorocarbons (HFCs)	Refrigerants, propellants & cleaners
Sulphur Hexafluoride (SF_6)	Electrical insulation
Perfluorocarbons (PFCs)	Refrigerants and fire suppression systems
Nitrous Oxide (N_2O)	Vehicle engines and power generation
Methane (CH_4)	Waste products
Carbon Dioxide (CO_2)	Vehicle engines and power generation

Table (2) GHGs in telecommunications

It is estimated that around 25% of the emission within the ICT sector is produced from telecom sector alone. The global telecom footprint in 2020 was estimated around 349 million tonnes ($MtCO_2$) CO_2e. Typically, the emissions produced by Telecom Companies are divided in 4 major categories[5] as depicted in the figure (13) below.

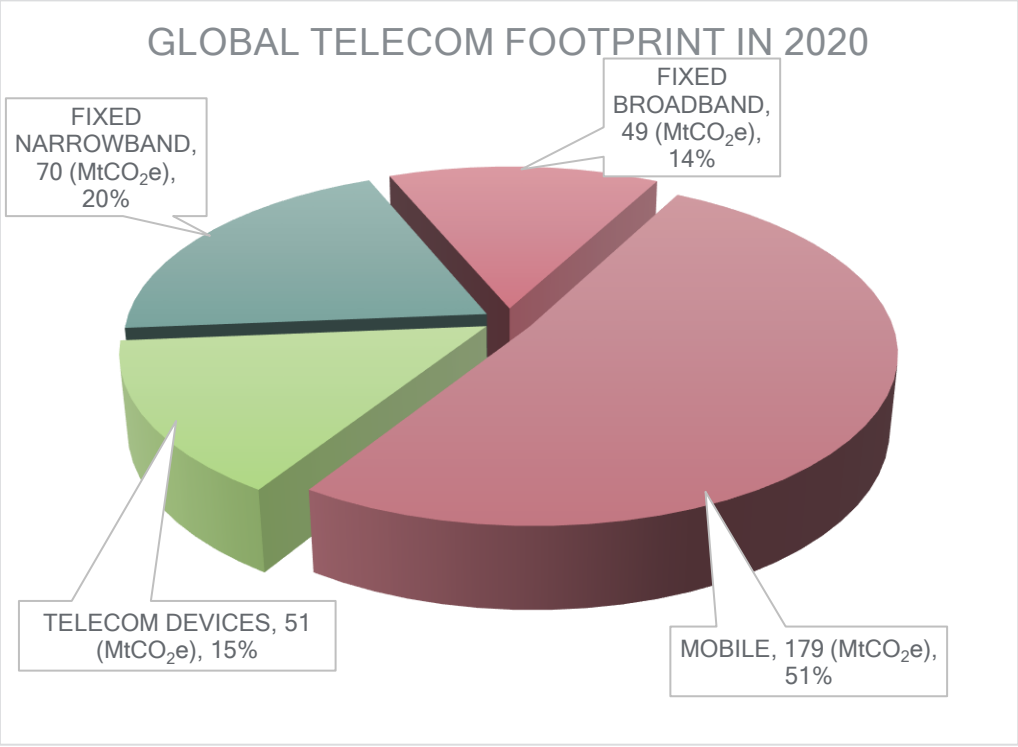


Figure (13) Global telecom footprint

[5] Smart2020.org

Generally, the components that contribute to carbon emissions in a telecom network are: Radio Access Network (RAN), Fixed Line Network, Fibre to the x (FTTx) network in the access networks, the Core, Aggregators (backhauls) and the Transmission systems in the central core network. The distribution of power consumption across the telecom access network is depicted in the figure (14) below.

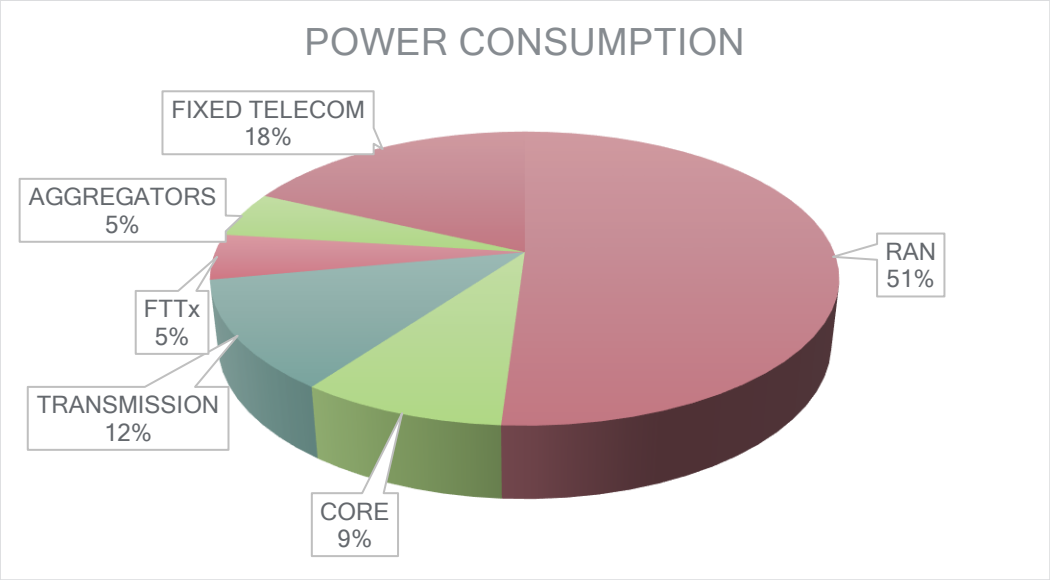


Figure (14) Power consumption of telecom access network

Figure (15) below presents how the power consumption is distributed across the different functionalities of the network. As far as the overall network performance is concerned the energy consumption is higher at the access part of the network and the operation of data centres that provides consumption, storage, applications and data transfer in the network. On the other hand, backbone and aggregation network present lower energy demands. Therefore, energy efficiency architecture should focus on intelligent and efficient access techniques and efficient operation and data manipulation by data centres. It is observed that large part of energy is consumed for routing/switching, regeneration and processing of data. Both communication protocols and electronic devices are responsible for this consumption and imposes challenges for more sophisticated transport techniques, thermal removal from switches or the servers and less redundant data transfers. One of the primary objective of green initiatives is to implement telecommunication networks enabling power efficiency, yielding a small ratio of required Watts per Gbps and Watts per user; a typical characteristic example of energy efficiency in electronic equipment for these functionalities is shown in table (3) below.

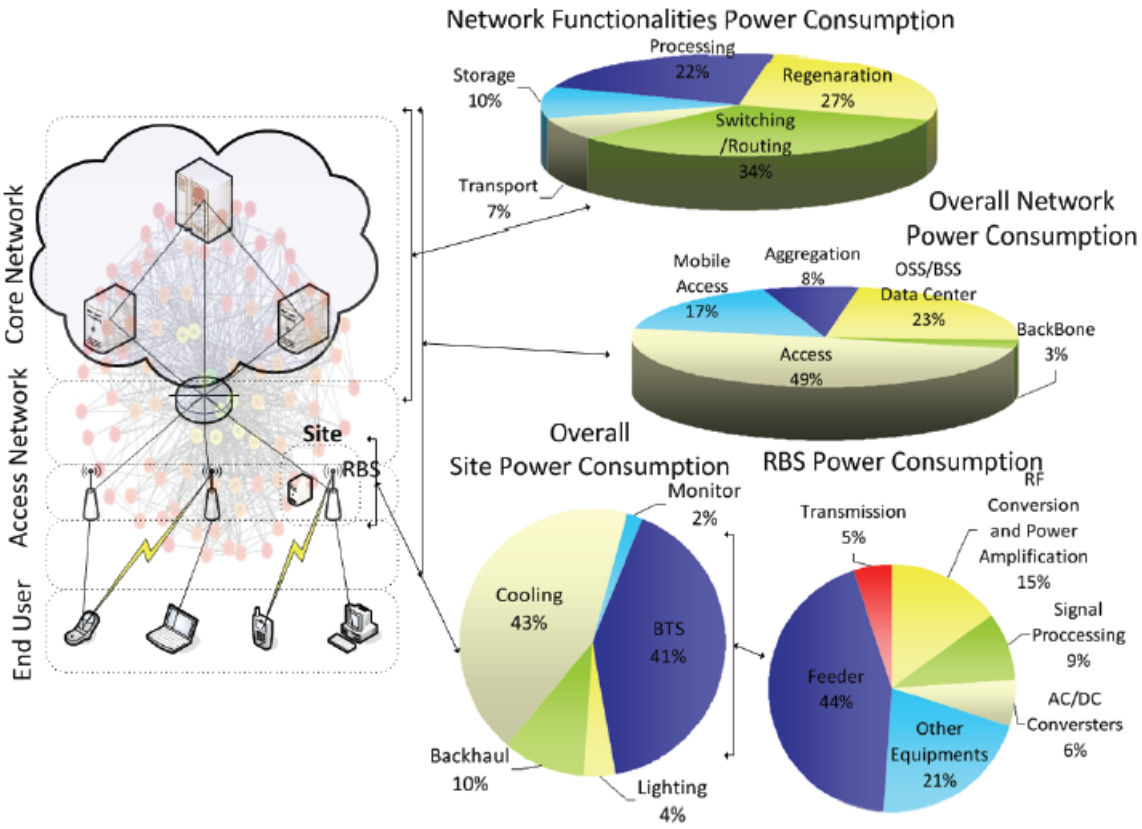


Figure (15) Power consumption in the different layers of a network

EQUIPMENT	POWER EFFICIENCY (W/Gbps)
Router	40
IP Switch	25
Transport TDM	80
ATM Switch	80

Table (3) Energy efficiency in electronic equipment

The overall power consumption of a data centre is related to the associated power consumed by each unit. Efficiency at individual parts is an important step for 'greening' the data centre but optimization is achieved when the efficiency aims to the overall data centre design. The input power is divided into an in-series path and an in-parallel path to feed the switchgear and the cooling systems respectively. At the switchgear, UPS and PDUs great losses occur due to AC/DC/AC conversions in the form of thermal heat. Typical UPSs present an efficiency of 80%. The parallel path feeds the cooling system that is important for heat protection of a data centre. The cooling system incorporates fans and liquid chillers. The power consumption at different layers of the data centre is presented in Figure (16) below.

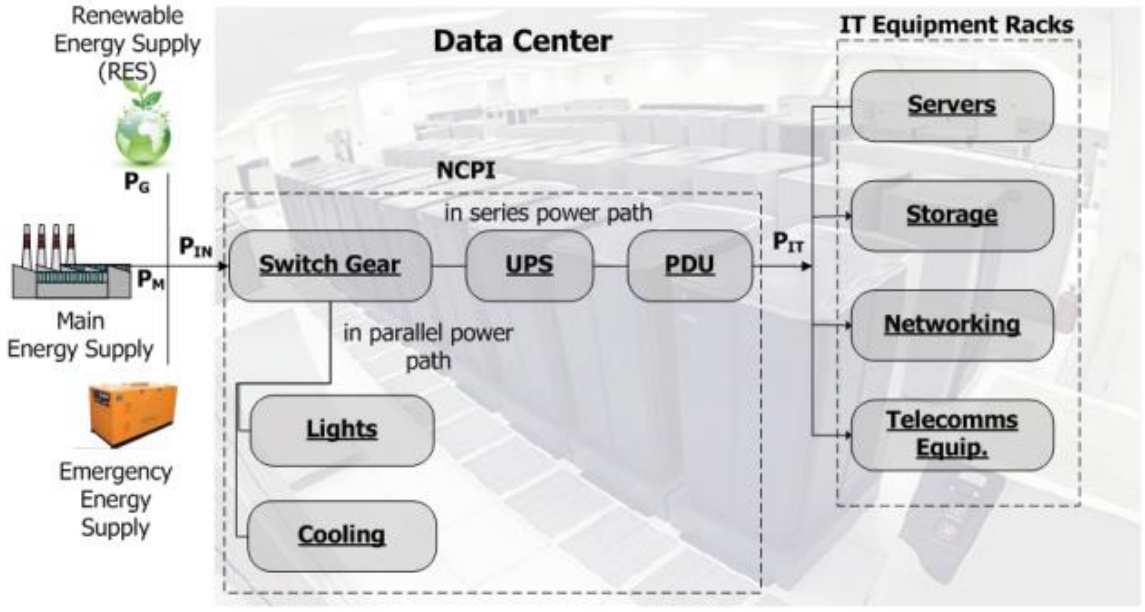


Figure (16) Power consumption at different layers of typical data centre

NCPI EQUIPMENTS	PERCENTAGE OF POWER CONSUMPTION (Total 70%)
Chiller	33
CRAC	9
UPS	19
PDU	5
Switchgear, Lights	4
IT EQUIPMENTS	**PERCENTAGE OF POWER CONSUMPTION RELATIVE TO (Total 30%)**
System	25
Disks	5
Power Supply	13
Networking	9
CPU	40
Memory	8

Table (4) Power waste distribution in typical data centres

In the Access network, the carbon footprints produced by telecom sector are usually divided into four categories and their associated blocks/components are outlined in table (5) below.

LANDLINE	MOBILE	FIXED BROADBAND	FTTX
Exchanges	Switching centres (including GGSN, SGSN)	Digital Subscriber Line Multiple Access Multipliers (DSLAM)	Optical Network Control Unit Equipment (ONU)
Distribution Network	Base Station Controller Centres	Customer Premise Equipment (CPEs)	Optical Network Terminating Equipment (ONT)
Telephones	Base Transceiver Station • Air condition • Signal processing • Power plant • Power Amplifier	Splitters	Passive/Active Splitters
	Mobile phones		

Table (5) categories of access network for producing carbon footprints

9. GLOBAL ICT FOOTPRINT ON CARBON EMISSION

In the last 70 years, ICT has significantly advanced and has been adopted in wider socio-economic development sectors. As a cross cutting tool around 70% of the population today directly use products or services related to ICT for personal, business, leisure or social entertainment purposes. In consequence, the ICT's carbon footprint does not only include electricity usage of products but also incorporates greenhouse gas emissions associated with energy and materials used throughout the life cycle of a product. In essence, it includes raw material acquisition, production and assembly, transportation, operation and end-of-life treatment. Technically, the carbon footprint of ICT sector includes both mobile and fixed access networks, data centres and enterprise networks, as well as all user equipment such as phones, computers, small routers, Internet of Things (IoT)[6] and so forth as depicted in figure (17) below.

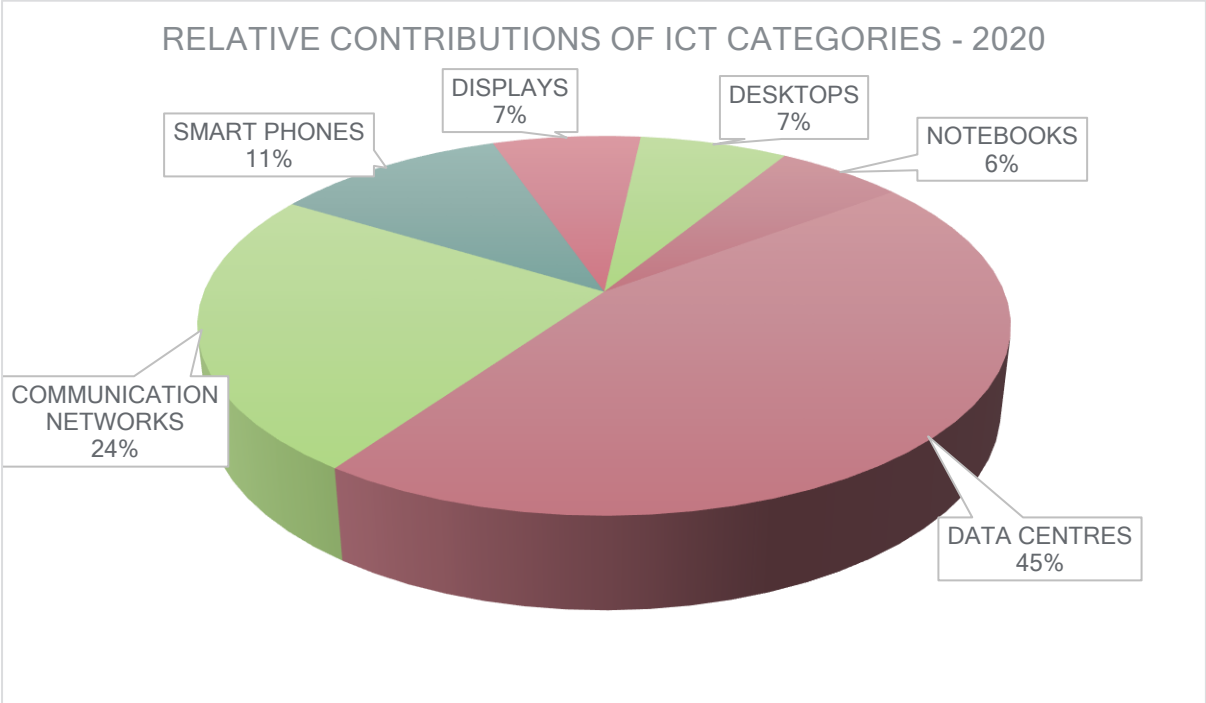


Figure (17) Relative contributions of ICT categories

The global use of Internet which relies on ICT is expected to grow at least 30%-40% per year. In 2020, ICT's global CO_2 footprint is accounted for around 2% of all emissions, or about 1250 $MtCO_2e$. As the future is gearing up for Internet of Things (IoT) with billions of devices communicating to each other, the carbon footprint of ICT will accelerate at an unsustainable

[6] Belkhir and Elmeligi (2018)

rate. At this growth rate, if nothing is done then ICT will consume about 60% of global energy resources. That being said, significant efforts have been made in energy efficiency improvements and phasing out of older technologies. Moreover, the global ICT sector's carbon footprint can be reduced by over 80% if all electricity consumed came from renewable energy sources.

As stated in the ICT sector trajectory above, the world needs to decrease its GHG emissions to stay in line within 1.5°C warming. Therefore, ITU has highly recommended the ICT sector to reduce its CO_2 emission by 42% by 2030, 72% by 2040 and 91% to net zero by 2050; or deliver equivalent savings in other sectors to meet these targets.

9.1 INTERNATIONAL TRENDS AND BEST PRACTICES

GHG emission is a burning issue concerning all the sectors and countries, and telecommunications industry is no exception. Some of the global initiatives taken from telecom operators across the world have already been included in the Final Report and additional few more initiatives taken by operators are highlighted here.

- In 2008 China mobile had total 2135 base stations powered by alternative energy sources like wind, solar, or other renewable energy sources. Of them, 1615 were powered by solar energy, 515 by solar and wind and 5 by other alternative sources. Due to the usage of low carbon resources for power generation China Mobile had saved 58.2 million metric tons of direct carbon dioxide emission in 2009 and projected to deliver as much as 615 tons in carbon savings by 2020.

- In order to reduce the energy requirement of telecom services, operators have entered into active infrastructure sharing agreement such as T-Mobile and 3 Group in UK, Telstra and 3 Group as well as Vodafone and Optus in Australia, Tele 2 and Telia in Sweden.

- Nokia has launched a good initiative toward recycling of old Nokia phone by placing kiosks at public place in many countries. These kiosks are used for collecting old phones for recycling and use. For every phone dropped in these kiosks, Nokia plants a tree and provides the customer with a unique URL and instructions with which to view their tree through Google Earth.

- For providing macro coverage in Sumatra and rural areas of Indonesia, Indonesian operator PT Telekomunikasi Secular (Telkomsel) is using latest generation low power consumption RBSs which are powered by solar technology from Ericsson.

- Sprint indicated that 75% of the energy used at Sprint's 200 acre headquarters facility in Overland Park, Kansas, is generated with wind energy. That makes Sprint the 15th largest purchaser of renewable energy in the U.S.

Orange

In 2020, Orange launched their 'Green Act', a programme to encourage both the company and its stakeholders to place environmental issues at the heart of their processes and activities. They strongly believe that technological advancements must be useful to both man and the environment, meaning they defend ethical and responsible technology. They also focus on sustainable growth and this takes center stage in their 'Engage 2025' plan.

Aircel

A green-field data center of 50,000 sq ft has been built in Gurgaon to deliver highly available, secure services for Aircel customers. It follows green practices to reduce the carbon footprint as well as keep costs in check.
The data center uses many eco-friendly initiatives such as motion-sensor lighting, used of LED lights and CFLs, adaptive cooling, geothermal heat exchange and earth air tunnel for reducing load on chillers, solar water heating and rain water harvesting.

Optus

Optus's sustainability approach is focused on reducing waste through their re-designed sim card packaging. They are committed to saving around 50 tonnes of cardboard each year as well as recycling 98.5% of their provider's waste. Their vision is to deeply embed sustainability in our culture, values, decision-making, operations, products and services to create a sustainable business. They also place a heavy focus on responsibly sourcing products by working closely with their suppliers on the environmental and social aspects of the supply chain.

Felix Mobile

TPG Telecom, a recently merged entity of TPG and Vodafone, owns Felix Mobile and it is already powered by 100% renewable energy which is achieved by investing in renewable energy projects across the country. The company's carbon emissions are neutralized by supporting certified Carbon Offset schemes both in Australia and internationally and they have pledged to plant one tree per subscriber, per month with the goal to plant one million trees within their first year.

Ericsson Tower Tube

The Ericsson Tower Tube is truly pioneering construction that houses base stations and antennas, full encapsulating them in an aesthetic and energy-efficient with low environment impact. The tower's concrete exterior protects equipment effectively from the elements and provides a stable internal environment as depicted in the figure below. The Radio Base Stations (RBSs) are enclosed within the tower, initially installed a the bottom of the tower and then raised to the top by an elevator. Elevating the RBSs reduces feeder loss and allows for improved network coverage and capacity. The antennas are protected by a radome, or weatherproof enclosure.

Concrete itself has a lower environmental impact than traditional steel, producing 30% less CO_2 emissions during production and transportation. In addition, the Ericsson Tower Tube does not require feeders and cooling systems. This results in up to 40% lower power consumption than traditional base station sites, helping operators reduce their operating costs significantly.

Huawei SingleRAN

Huawei has developed single RAN solution based on software-defined radio (SDR) system to truly combine multiple networks. They have employed the usage of energy-efficient equipment which was powered by green energy for their network system and able to reduce power consumption and carbon footprint to some good extent.
Huawei's SingleRAN allows mobile telecommunications operators to support multiple mobile communications standards and wireless telephone services on a single network. The technology incorporates a software-defined radio device and is designed with a consolidated set of hardware components, allowing operators to purchase, operate and maintain a single communications network and set of equipment, while supporting multiple mobile communications standards.

Vodafone – net zero roadmap

Vodafone has committed to reducing total carbon emissions to net zero by 2040. By 2021 Vodafone's European network will be powered 100% renewable energy. By 2025 all the network waste will be reused, sold or recycled and 100% of the electricity used by the network will be supplied from renewable sources. By 2030 Vodafone aims to eliminate carbon emissions from their own activities and the electricity they purchase and use. Further, Vodafone intends to halve their carbon emissions from their supply chain, business travel, joint ventures and use of product they have sold. By 2040, Vodafone is targeting to meet fully net zero with 0% carbon emissions.

MTN – Climate commitment

MTN has committed to reduce 47% of absolute emissions by 2030 and announced to achieve net zero emissions by 2040. MTN has launched 'Project Zero' programme to leverage the latest technologies and service partners to enable business sustainability via greater energy efficiencies, low carbon emissions, risk reduction and cost control. The programme priorities renewable solutions, efficient emerging technologies and energy storage. MTN's strategy is to continually seek opportunities to extract greater efficiencies from technical infrastructure, and replace inefficient and old products with more efficient solutions to reduce energy use and greenhouse gas emissions. MTN also invest in renewable energy sources and MTN's strategy is to maintain investment in renewable sources of energy to mitigate climate impact.

BT – Corporate Climate Action

BT aims to achieve net zero carbon emissions across its overall business by 2045 and have reduced its operational carbon emissions by 42% in 2016/17 as well as its supply chain carbon emissions by 8% over the same period. BT has announced that it is sourcing 100% renewable electricity worldwide and is working in collaboration with members of the RE100, the global renewable energy campaign initiative. BT has the second largest commercial fleet in the UK with 33,000 vehicles accounting for approximately two-thirds of its direct operational emissions. BT has committed to upgrade all its vehicles to 100% electric by 2030.

Reliance Jio - Energy Efficiency

Reliance Jio's energy efficiency project has introduced initiatives and measures to optimize energy consumption that includes:

Smart lightning system: the installation of motion sensors on every floor of the server halls has resulted in an annual saving of 1600 tonnes of CO_2e.

Energy- saving: the company is turning off radios of certain frequencies for all the towers across India during 02:00 and 05:00 which has reduced power consumption by 3% and saved 32,641 tonnes of CO_2e.

Diesel generator mitigation by using Li-ion batteries: Lithium-ion batteries have significantly reduced the need for diesel generators, which are needed for emergency power. So far, 3032 underutilized diesel generators have been demobilised, resulting in a reduction of 7571 tonnes of CO_2e per year.

Enhanced DG operation philosophy: the company as enhanced its DG operation philosophy for its DG (diesel generators) sites. Each site runs on electron beam (EB) power supply. Once the EB supply is off, a lithium-ion battery caters the electronics load. The battery is allowed to drain up to 60% of its capacity. Once DG starts, DG power feeds the electronic load. However, the battery is charged through EB only. This change in the operation philosophy has reduced the DG operating hours by 2-3 hours per incident (EB outage) per site. The annual CO_2e reduction on account of delaying DG start on an average for total 99,810 DG small sites is 303,384 tonnes of CO_2e per year.

10. ENERGY EFFICIENT SOLUTIONS FOR TELECOM NETWORKS

The green operation of cellular networks mainly depends on base station infrastructure/design and the efficiency of the electronic equipment, optimized network planning, efficient transmission techniques and physical layer characteristics (access schemes, modulation, coding, etc) and the penetration of RES into the network as depicted in the Figure (18) below. For cellular networks, intelligent and efficient network planning is of utmost importance. The deployment of a cellular system under strict and efficient plans can dramatically reduce the required number of base stations to cover a given area. This can be achieved when a sophisticated radio propagation algorithm, a detailed GIS map coupled with an optimization technique is used. The optimization in terms of RF planning incorporates accurate propagation models and sophisticated optimization techniques. The physical layer of wireless communications is more power demanding compared to a fixed access due to serious signal impairments of mobile radio channels.

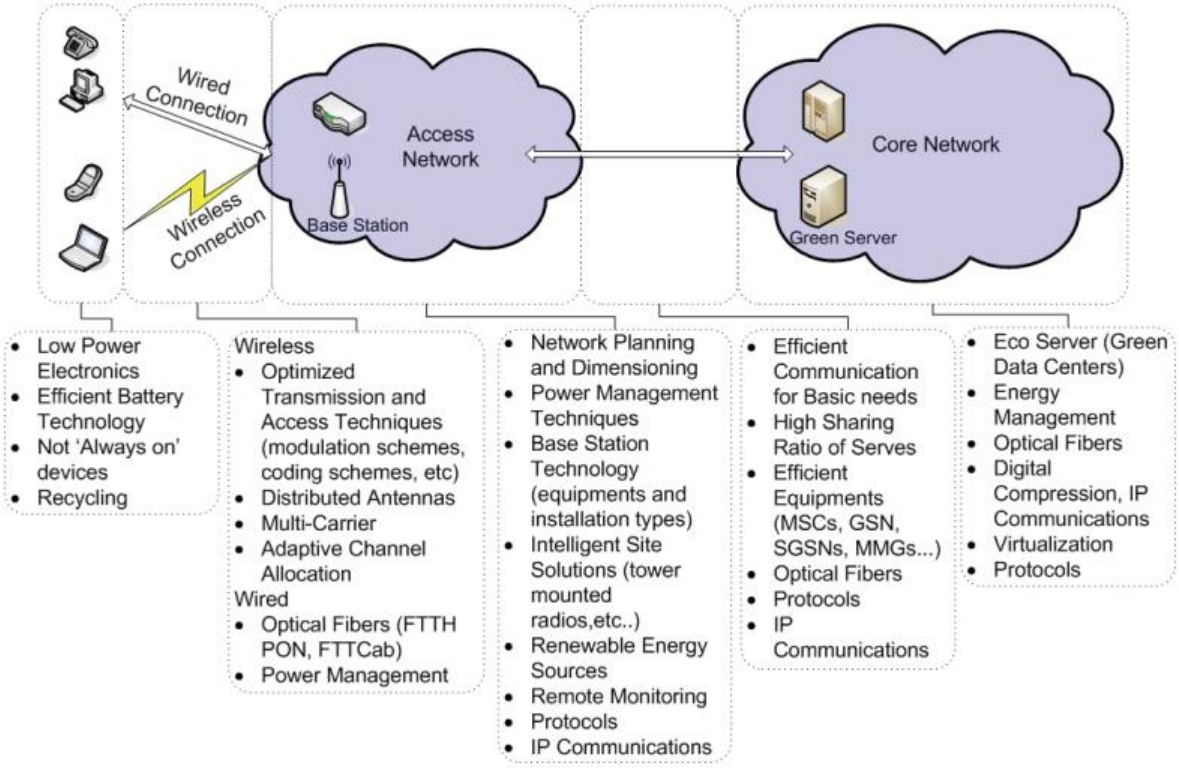


Figure (18) Energy efficient solutions of telecommunication networks

It is found that the characteristics of the physical layer are an important factor for energy consumption of the network and they depend on the traffic load and the environment of each scenario that needs to be considered in the deployment of the system.

As discussed earlier, amongst the various operational components of a telecom operator the telecom network consumes most of the energy and releases GHG emissions proportionately. So before the network rollout commences better network planning can help significantly reduce the carbon footprint and some of the best designs are discussed in this analysis. It is estimated that if the network system is planned properly it can save up to 35% on energy costs.

During planning phase it would be smart to design the network comprising of energy efficient equipment and technologies. The carbon footprint from a telecom network can be reduced if energy efficient equipment is used that require less energy to operate and dissipate lesser power as heat. Since technology has advanced, innovative equipment are available that avoids active cooling.

ETSI standardization is already addressing the Green Agenda for telecom equipment and is implementing ISO 14001:2004 and 14004:2004 standards. Network design should comply with the use of tested, certified and standardized ISO equipment. As a regulator, NTA has the authority to provide type approval to standardized equipment only.

Networks should be optimized at design level and should avoid running underutilized. If network solutions and services can be designed to use fewer sites obviously it reduces energy consumption. The design should focus in energy management that the base stations should operate with power saving mode to save energy. Switching off Base Stations (BS) is probably the best strategy of network planning solutions. This system model consists of M + 1 macro cells distributed with in a geographical area with partially overlapping coverage areas. The network configuration can be viewed as a grid of cells or as a cluster of macro cells as depicted in the figure (19).

A part of the BS infrastructure in the M + 1 cells may be switched off during low traffic conditions, while the remaining active BSs can extend their transmission power and range in order to form wider service cells and cover their area and the area of the switched off BSs. When some BSs are switched off, the traffic is served by the corresponding BSs of the neighbouring cells that must increase their transmission power in order to provide service in an extended area. Hence, the active cells increase their coverage area as depicted in the figure (20).

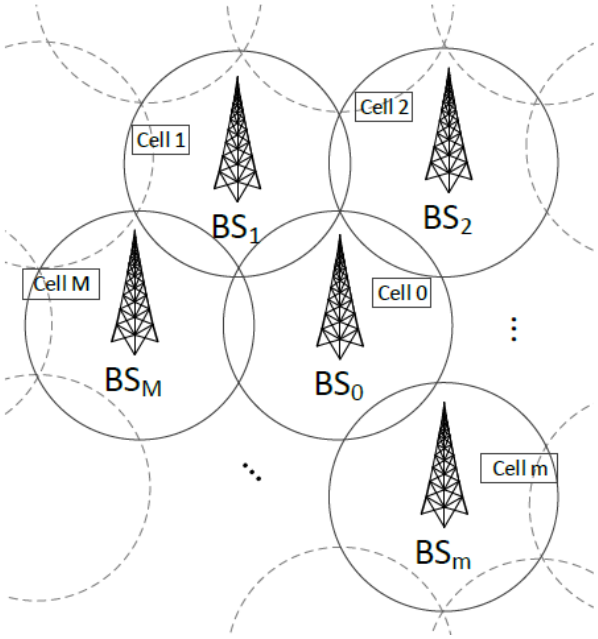


Figure (19) Cluster of macro cells

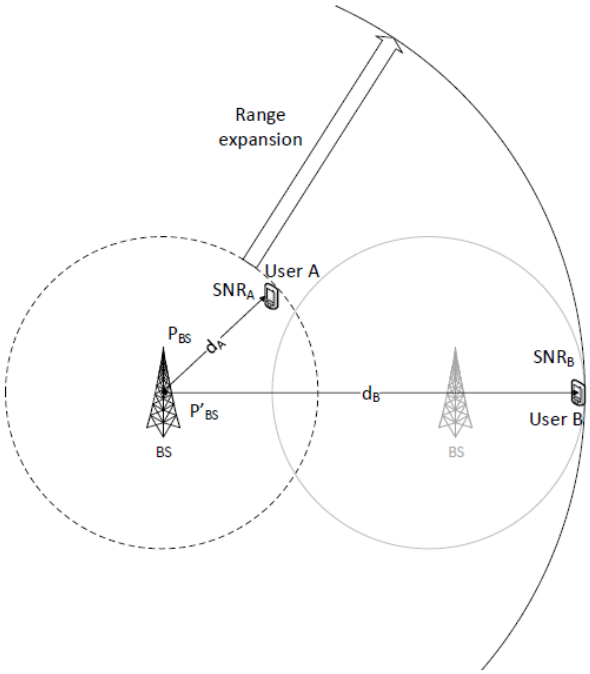


Figure (20) Increased coverage area of active cells

It is considered that the peak hours are observed in the morning and during early afternoon, while during night hours the traffic is low. So, the algorithm is divided in two phases: the switching off phase that begins when the traffic load decreases and the switching on phase that begins when the traffic demand increases again, early in the morning as depicted in the figure (21).

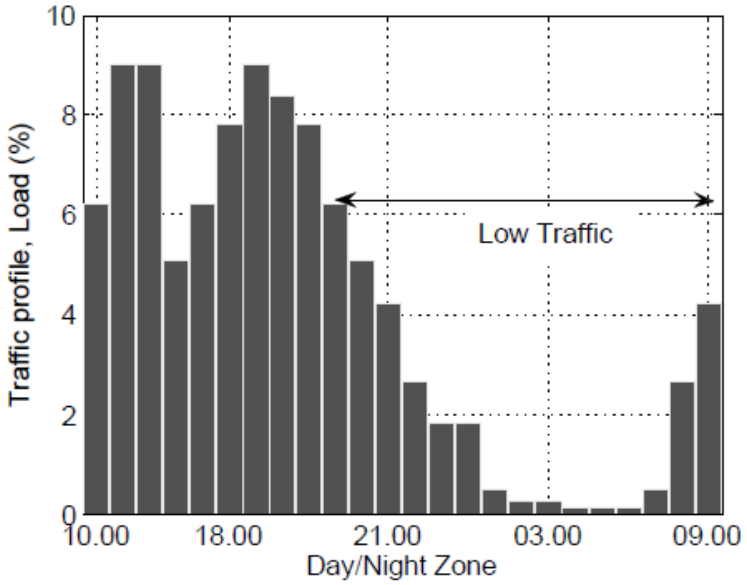


Figure (21) Day/Night traffic zone

- Switching off phase: The switching off phase starts at 19:00 pm and ends at 07:00 am. During these hours, the traffic load is low, and a reduced number of BSs could be used to serve the existing traffic. In a wireless network that consists of BSs, the algorithm calculates the minimum number of BSs that should remain active based on the traffic variations. So, maximum number of BSs will be switched off. Based on the total network capacity and the desired data rate, the BSs estimate the maximum number of the users that can be served in the coverage area and they decide if more BSs can be switched off.
- Switching on phase: in a typical traffic load scenario, since the cell load increases at 08:00 am, the number of active BSs is not adequate for serving the traffic load. Therefore, the BSs should be switched on gradually in order to have the appropriate number of BSs to serve the existing traffic load. At 08:00 am the existing active BSs calculate the number of BSs that should be turned on in order to serve the traffic of the network based on the traffic requirements and the position of the existing users. The active BSs are responsible for informing the neighbouring non-active BSs to be turned on. At 10:00 am when the traffic load reaches its peak, all the BSs should be turned on.

In addition, network resources can be virtualized where virtualization is a technique that combines available resources in a network by splitting up the available bandwidth into channels, each of which can be assigned to a particular server or device in real time. Network virtualization centralizes network administration tasks while improving scalability, work load and energy efficiency.

11. ENERGY EFFICIENCY ASPECTS IN TELECOM NETWORK

A telecom service provider constitutes of many departments and services to operate successfully from technical to marketing and billings to operations. Since systems and networks being the core of the business, also they consume maximum energy and are equally responsible for production of most of the GHG emissions. However, there are other areas within the telecom industry that also contribute in the consumption of energy and production of emissions which can be managed to mitigate the overall carbon footprint as briefly discussed below:

- Energy efficient equipment and technologies

  Generally it is estimated that over 65% of a telecom service provider's operating expenses accounted for the tower site equipment and energy costs. The equipment, networks, systems and solutions required to operate and provide the services are the integral components of radio network telecom solutions including end users equipment. Hence, during new installation or replacement, selection of energy efficient equipment or technology is of paramount importance because it is not only environment friendly but it also significantly reduces expenses.

  By adopting energy efficient equipment and technologies, Telefonica avoided 1.27 million tonnes of CO_2e emissions and made 553 million Euro savings in a span of 9 years *(Source: Telefonica Energy and Climate Change Strategy, GSMA)*. Telefonica has been implementing number of initiatives and green projects as a result of which the energy consumption remained constant despite the increment of data traffic in the network by 176% in 3 years. Some of Telefonica's projects are as follows:

    - Lighting: Replacement of fluorescent lights with LED technology and installation of presence detecting sensors.
    - Power Saving Features: activation of energy saving functions during periods of low traffic in base stations and centres.
    - Cooling: technological update of the cooling devices and the installation of free cooling facilities, especially in the base stations and centres.
    - Power: technological update for power units and substitution of poor efficiency rectifiers.
    - Transformation of the network: shut down of old equipment, network upgrades and local optimisation.

- Renewable self-generation: implementation of renewable systems for self-consumption and reduction of fuel consumption.

- Standardization of equipment, test and certification

  NTA has been providing Type Approval of radio telecommunications equipment to ensure that they conform to the specified quality and safety standards for their use in Nepal. NTA has a mechanism in place to certify telecommunications equipment and has its own structured method and procedure. NTA certifies the equipment based on a test report(s) and certificate of conformity issued by the manufacturers and/or by NTA-approved international standardization bodies or regulatory inspection/certifying bodies.

  In addition to type approval from safety and quality standards' perspective, NTA is recommended to further review the Life Cycle Assessment (LSA) to analyse the total potential environmental impacts associated with the product or service. Hence, the following two environmental management standards are recommended for product asivaes compliance;

  - ISO 14001:2004
    Specifies the requirements for such an environmental management system.

  - ISO 14004:2004
    Provides guidelines on the elements of an environmental management system and its implementation, and discusses principal issues involved.

  The above standardizations are intended to address the following green activities;
  - Specifications for energy definitions, reference models, measurements, etc.
  - Specifications that include solutions for reduction of energy consumption.
  - Implementation and use of ICT standardization results can positively contribute to the green agenda.

- Infrastructure sharing

  Nepal Telecommunications Authority (NTA) has introduced Infrastructure Sharing Guideline (2072) and Infrastructure Sharing Regulation (2074) for sustainability and cost-effectiveness of the telecom sector. Infrastructure sharing avoids duplication of

unproductive huge investments of CAPEX and OPEX to serve the same number of subscribers in a given network coverage. Repetitive investments made in the same network coverage area by several telecom operators eventually have to be borne by the subscribers. In addition, the repetitive telecom infrastructure will consume more energy and consequently produce unnecessary GHG emissions.

Passive infrastructure sharing usually comprise of physical components such as GBT/rooftop tower, cables, cabinet shelters, power supply, air conditioning, alarm systems, security and surveillance, etc where networks remain separate. Active infrastructure sharing involves sharing of antenna systems, entire base stations or even elements of the core network. Active sharing includes mobile roaming, which allows an operator to make use of another's network in a place where it has no coverage or infrastructure of its own.

Even though infrastructure sharing regulation is prevalent in Nepal, it seems far from being implemented. Therefore, it is highly recommended that NTA should strictly enforce the regulation.

- Waste Management

On top of regular waste produced by any organization, telecom operators produce electronic waste (e-waste) which are electrical and electronic equipment that have reached the end of their life. These e-waste contain numerous toxins which can potentially cause environmental pollution and health hazards if they are not disposed scientifically. The e-waste also contains resources like metals and rare earth that can be recovered, recycled and reused. Hence, a proper waste management in place for the recycling of the e-waste ensures that these resources are extracted and the toxins disposed appropriately.

12. ENERGY EFFICIENT TECHNOLOGIES TO REDUCE POWER CONSUMPTION AT TOWER SITE

Generally a mobile network consists of three basic elements, viz. a core network that takes care of switching, base stations that provide radio frequency interface and mobile equipment that make voice and data connections. Among these components, base station alone contributes 60-80% of the whole network energy consumption. A base station usually consists of power supply, power amplifier, air conditioning and signal processing components and amongst these, the power amplifier consumes 65% of the energy as depicted in the figure (22) below.

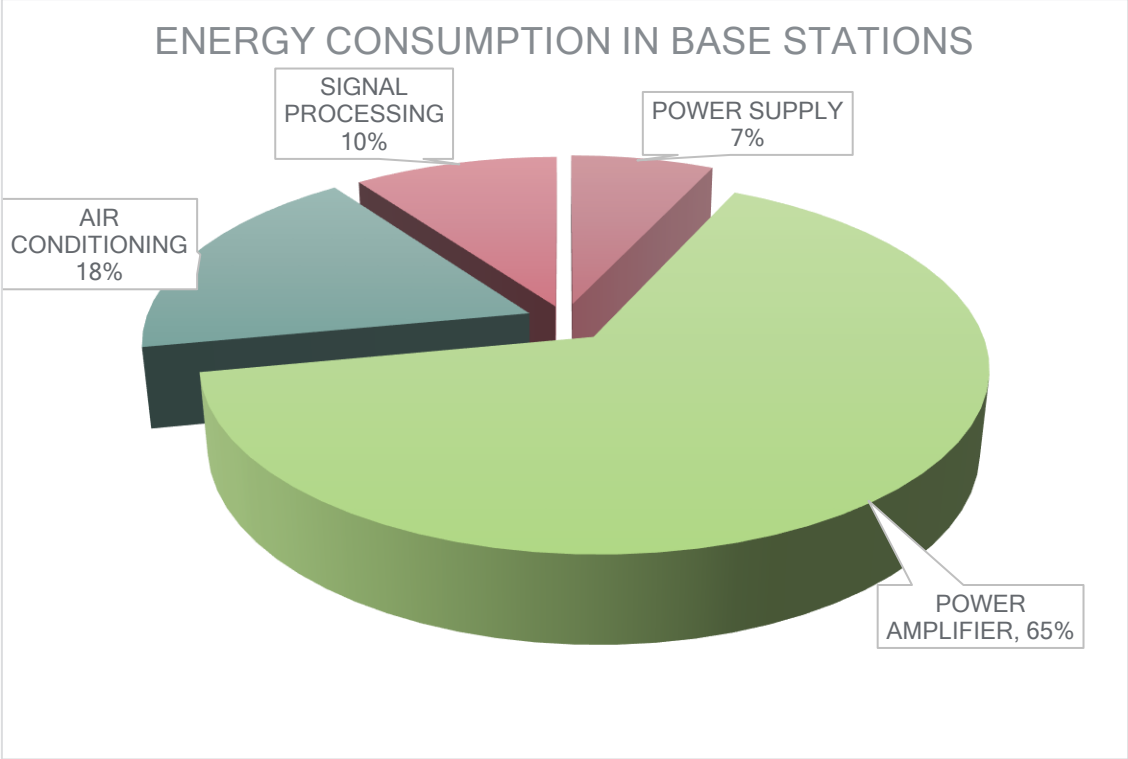


Figure (22) Energy consumption in base stations

Plenty of research have been carried out in an effort to reduce the energy consumption by base stations and some of the effective measures that can be adopted at tower sites are outlined below:

- Remote Radio Units: This strategy requires moving of RF converters and power amplifiers from the base of the station to the top of the tower close to the antenna and

connecting them via fibre cables. This topology offers the higher potential energy savings.

- Radio standby mode: This strategy typically consists of a software and basic hardware upgrade offering ECO mode or Power Saving Mode with the ability of turning radio transmitters and receivers off when call traffic goes down during the night. While running in ECO mode, the power consumption can be reduced up to 40% during low traffic.

- Passive cooling: This strategy implements cooling techniques such as free ventilation, forced fan cooling with hydrophobic filtering or heat exchangers that will significantly reduce energy consumption. It is observed that passive cooling can provide energy savings above 10%.

- DC Power System ECO Mode: The implementation of an advanced system controller scheme can ensure that rectifiers will operate at their peak efficiency over virtually all conditions.

- Higher Efficiency Rectifiers: This strategy uses higher efficiency rectifiers that will operate at optimum level.

It is estimated that when all the above strategies are applied the potential total savings of more than 58% are feasible.

13. RENEWABLE ENERGY SOLUTIONS FOR TELECOM SECTOR

Renewable energy often referred to as clean energy, comes from natural sources or process and can naturally replenished. Generating renewable energy produces no greenhouse gas emissions and reduces pollutions. As radio sites have become energy-efficient, use of renewable energy has become technically and economically viable. There are number of approaches used in deploying renewable energy as power sources that can be used individually or in combination as hybrid. Since Nepal is a land locked country, the ocean/tidal energy seems to be irrelevant and is not included as part of the available renewable energy options for telecom sector in Nepal. The pragmatic options for renewable energy solutions are outlined below:

- **Hydropower energy**

  Nepal is the world's second richest country in inland water resources with around 6000 rivers, rivulets and tributaries Hydropower can play an important role to address growing demand for clean, reliable, and affordable energy. Hydropower avoids use of carbon-intensive energy sources such as coal, oil and gas, and also helps integration of other intermittent renewable energy based power generation sources such as solar and wind power into the main grid, moving the economies toward a low-carbon development path.

[7]Major River Basins	Theoretical Potential	Technical Potential		Economic Potential	
	Megawatts	Project Sites	Megawatts	Project Sites	Megawatts
Sapta Koshi	22,350	53	11,400	40	10,860
Sapta Gandaki	20,650	18	6,660	12	5,270
Karnali & Mahakali	36,180	34	26,570	9	25,125
Southern Rivers	4,110	9	980	5	878
Total	**83,290**	**114**	**45,610**	**66**	**42,133**

Table (6) Major river systems and their hydropower potential

Nepal is said to have uncapped potential to generate over 83,000 MW of hydroelectric power as illustrated in the table (6) above. Nepal Government's priority is on generating renewable energy and is targeting to produce 12,000 MW by 2030. The cities and

[7] Hydropower development and economic growth in Nepal, ADB South Asia Working Paper Series

suburban areas with dense population are already connected to electric grid, so the offices and sites in those areas are already using renewable energy for power sources. As Nepal Electricity Authority (NEA) is the only power supplier in the country, almost all of their energy comes from hydropower generation except few solar powered projects. It is understood that NEA is struggling to distribute generated electricity and around 1200MW is wasted due to lack of transmission infrastructure. On the other hand, there are many rural areas deprived of grid electricity and traditional lamp is their only options. Also, telecom operators have to opt to diesel generator to run their BTS towers at off grid sites which is detrimental to the environment. Even solar powered sites are too costly both in CAPEX and OPEX in comparison to grid electricity.

As Nepal's hydropower sector is underutilized, government agencies should develop, promote and concentrate on local supply/consumption rather than selling abroad. Hydroelectric power is the most viable, appropriate, cost effective and environment friendly in Nepal's local context.

- **Solar Energy**

Since Nepal has challenging landscape terrain particularly in rural hilly and mountainous region, there are many far flung areas deprived of national grid connectivity. Telecom operators are under obligation to extend their mobile network coverage by installing off-grid sites to reach the underserved rural areas. These off-grid sites are normally powered by diesel generators that contribute to high CO_2e emissions.

In recent years these off-grid site diesel generators are replaced by photovoltaic solar panels that converts sunlight energy into electricity. As solar energy is free, economically it eliminates the cost of expensive fuel and maintenance expenses of generators. Environmentally it produces no GHG emissions and helps to significantly reduce carbon footprint. The global changes observed from transition of mobile towers to solar energy are depicted in the figure (23) below:

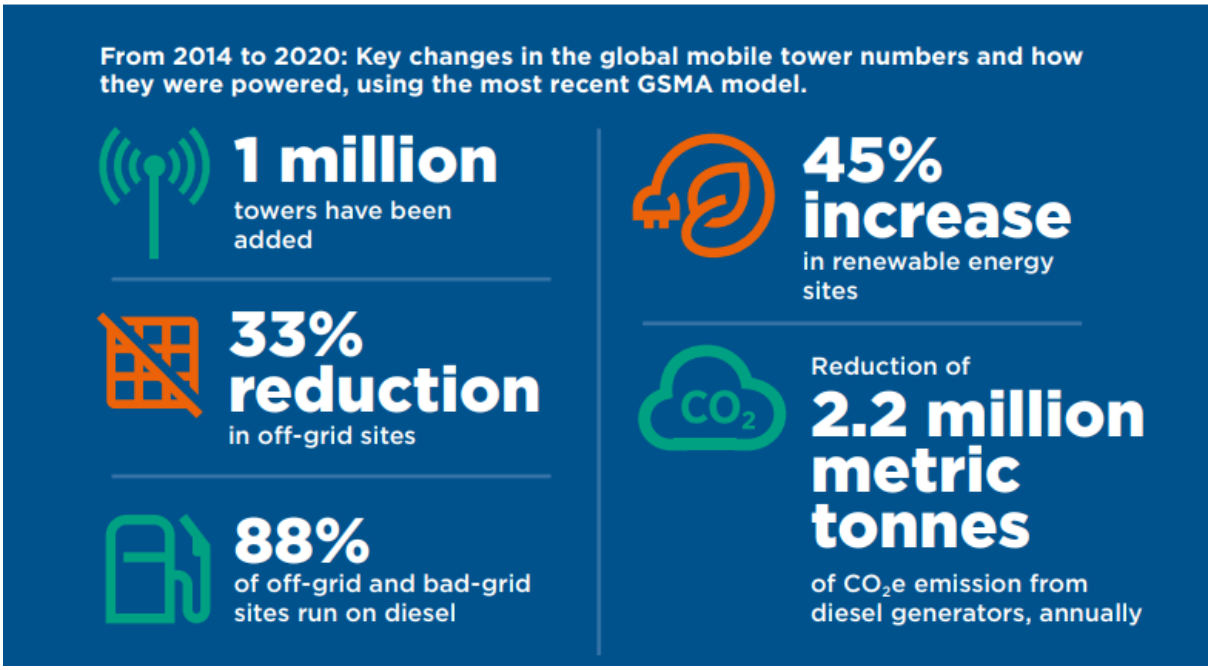


Figure (23) Global changes observed from transition of mobile towers to solar energy.

During energy efficiency planning, while designing for passive cooling, these solar panels can be designed to shelter base stations to provide free ventilation which could reduce the power consumption by 10%.

In Nepal, under AEPC Rural electrification program, there are several off-grid areas served by solar powered grid which is mutually beneficial from commercial and environmental aspects. Telecom operators can take benefit by connecting their base stations to these solar powered grid.

- **Wind energy**

As technology has evolved, a light weight wind turbine can be fully integrated into existing site infrastructure to produce renewable energy. In the effort to reducing or replacing the use of diesel generators, wind energy are 100% environment friendly in terms of emissions and pollutions. Some of the benefits of wind energy are outlined below:

  - It fully utilizes the site space
  - Wind turbines can fully substitute diesel generators in new energy efficient equipment installed sites.
  - Wind energy is available 24 hours a day.

- Wind turbines are easy to install.
- Almost no maintenance is required.
- They can be remotely monitored and controlled

In an off-grid site the wind energy are often used for back up source to solar energy, however a combination of wind and solar energy is highly recommended to fully replace diesel generators. An off-grid site can house up to 2 wind turbines and on a best day they are found to produce up to 10 kWh energy. A schematic diagram of a regular wind turbine is illustrated in the figure (24) below.

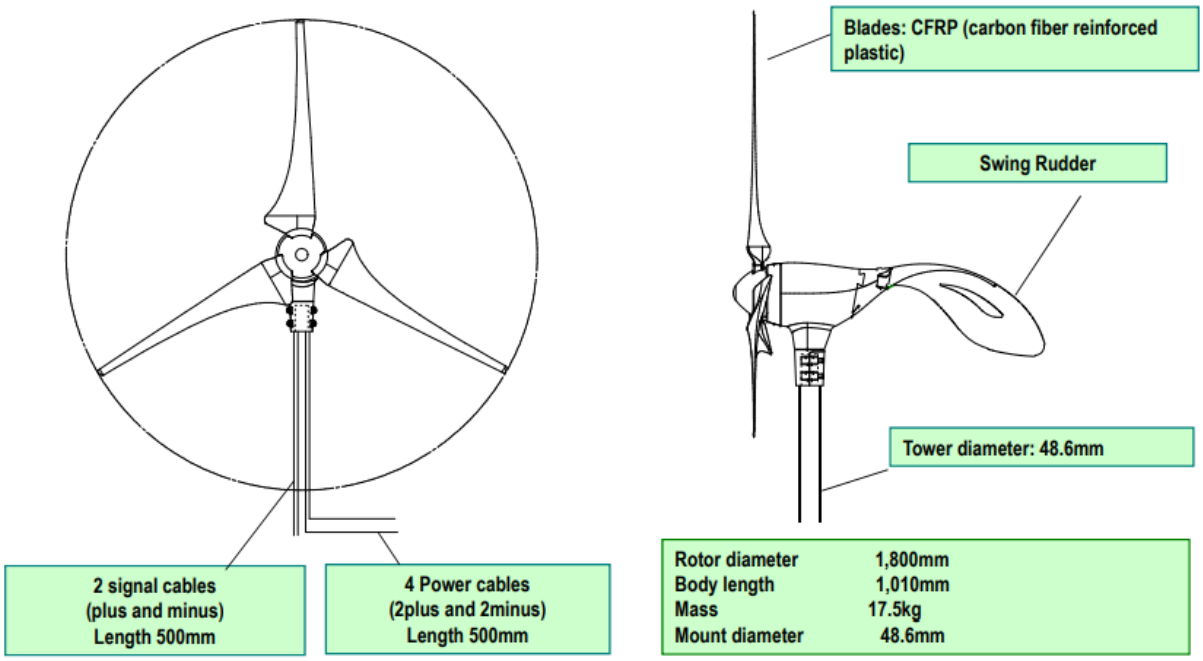


Figure (24) Wind energy turbine

- **Biomass energy**

Biomass energy also termed as bio energy or bio power is rather an advanced waste management project that transforms organic components of industrial and municipal waste into energy. Municipal Solid Waste (MSW) is collected and processed in an incineration site where the waste products are naturally fermented and moisture removed. The waste products are then sent to leachate treatment system which uses biochemical, ultra-filtration, nano-filtration and reverse osmosis treatment technologies

to process further. The waste product are then sent into furnace to be burned. At the furnace the high temperature flue gas generated by waste incineration exchanges heat with the water of the waste heat boiler to generate medium temperature and medium pressure steam. The steam generated by the waste heat boiler drives the steam turbine generator set to generate electricity. The generated electric energy is then sent to power grid to provide green energy. The technology is so advanced that it uses de-acidification, gas purification, carbon injection, etc. processes to remove toxins and purified flue gas is discharged into the atmosphere.

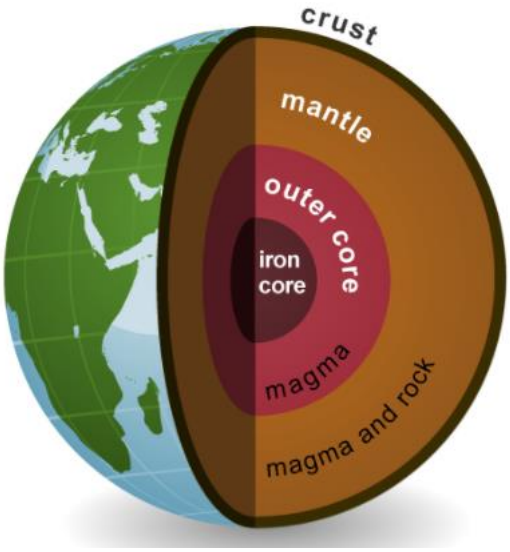
- Geothermal Energy

Geothermal energy is the heat energy taken from the earth's core. Geothermal heat has been used for bathing (such as hot spring at Tatopani), heating houses/buildings and generating electricity. Geothermal energy is produced through a process of slow decay of radioactive particles in the earth's core which happens in all rocks. Geologically, the earth is divided into four major layers as depicted in the figure below:

- An inner core of solid iron that is about 2400 km in diameter
- An outer core of hot molten rock referred to as magma that is about 2400 km thick
- A mantle of magma and rock surrounding the outer core that is about 2880 km thick
- A crust of solid rock that forms the continents and ocean floors that is 24 to 56 km thick under the continents and 4.8 to km thick under the oceans

Temperatures at the core-mantle boundary can reach over 4000^{o}C and 200^{o}C at the mantle-crust boundary. The earth's crust is broken into pieces called tectonic plates. Geothermal electric plants were traditionally built exclusively on the edges of tectonic plates where high-temperature geothermal resources are available near the surface.

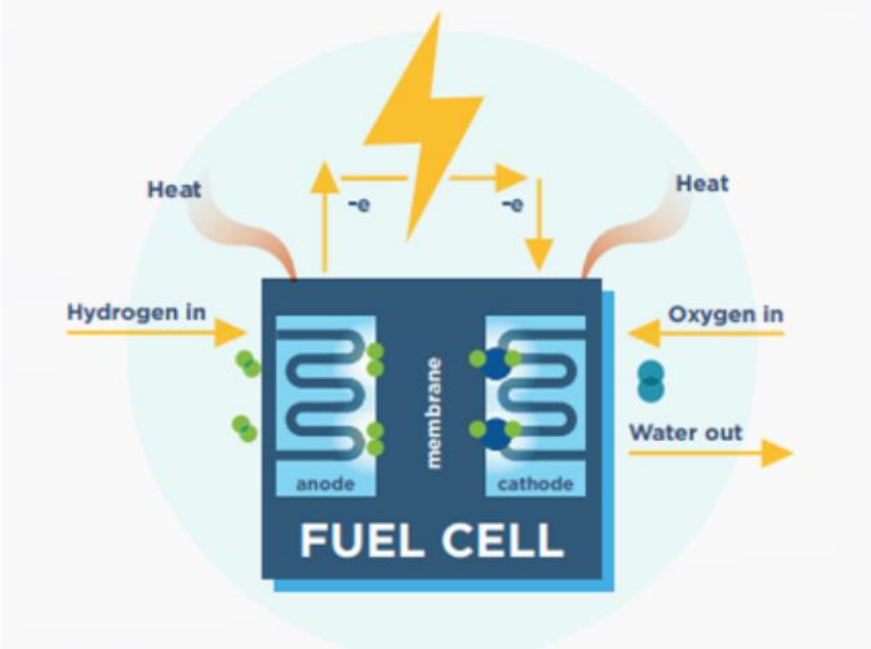
Wells up to 1.6 km or more are drilled into underground reservoirs to tap into the geothermal resources. These resources can be exploited from naturally occurring heat, rock and water permeability or through enhanced geothermal systems, which enhance or create geothermal resources through a process called hydraulic stimulation. These geothermal resources, drive turbines linked to electricity generators.



Geothermal electricity generation is currently used in 26 countries and countries generating more than 15% of their electricity from geothermal sources include El Salvador, The Philippines, Kenya, Iceland, New Zealand and Costa Rica. USA is leading the geothermal energy producer and has over 3700 MW of installed geothermal electric capacity.

- **Fuel Cell Energy**

A fuel cell is a device that generates electricity through an electrochemical reaction, where hydrogen and oxygen are combined to generate electricity, heat and water. Fuel cell continues to produce electricity as long as a fuel source is provided. Generally, a fuel cell is composed of an anode, cathode and an electrolyte membrane where hydrogen is passed through the anode and oxygen through the cathode during electricity generation. At anode side, a catalyst splits the hydrogen molecule into electrons and protons. The protons then pass-through porous electrolyte membrane, while electrons are forced through a circuit which generates electric current and excess heat. At cathode side, protons, electrons and oxygen combine to produce water molecules as depicted in the figure below.



There are numerous types of fuel cells that are designed to generate electricity depending on the chemical used as electrolyte as the source for hydrogen as outlined below:

- Proton-exchange membrane fuel cell
- Phosphoric acid fuel cell
- Solid acid fuel cell
- Alkaline fuel cell
- High-temperature fuel cell
    - Solid oxide fuel cell
    - Molten-carbonate fuel cell
- Electric storge fuel cell

Even though fuel cells were discovered as early as 1838, they never came into proper utilization until the beginning of last century. In the 60's fuel cell has been in use in powering very specialized projects such as NASA's spacecraft and defense submarines. Recently, fuel cell has resurfaced as hydrogen energy and lots of research and development, testing, piloting has been carried out in many diverse fields such as in vehicles like cars, buses and predominantly back up power for critical facilities like hospitals and data centers. However, fuel cell is not easily available for commercial use yet and does not look like in near future. Therefore, we can rule out the possibility of using fuel cell in Nepalese context in next few years.

Amongst the options available to be adopted in the use of renewable or clean energy, the implementation of hydropower and biomass energy are beyond the scope of telecom sector as some of the hydropower projects are several folds bigger than the telecom operator itself. These measures should be initiated or implemented by the government, municipality or private sector as a separate project or entity. As far as adoption of renewable energy is concerned particularly in local context, telecom operators are recommended to implement solar and wind energy combined together at off-grid sites to replace diesel generators and reduce CO_2e emissions.

14. GENERAL GUIDELINE/REGULATORY FRAMEWORK FOR THE REDUCTION OF CARBON FOOTPRINT FOR TELECOM OPERATORS

As mobile communications are enabler of change, it is recommended that policymakers should consider and assist telecom operators to reduce carbon footprints while developing guideline/regulatory framework since there are direct, indirect and third party emissions associated with the industry. A draft regulatory framework for Green Telecom is included in Annex I. It is highly appreciable that NTA is providing financial subsidy to telecom operators/ISPs to expand their network in rural areas through bidding as part of RTDF projects, however the infrastructure developed should be designed to use energy efficient equipment and technologies to reduce carbon footprint.

Under the European Commission's (EC) Green Deal, Europe is committed to becoming carbon neutral by 2050, and climate neutral by the end of 21st century. A study commissioned by EC in 2018 suggests that "the energy consumption of data centres and telecommunication networks will grow with an alarming rate of 35% and 150% respectively over 9 years". Hence policies are focused towards mitigating associated impacts with consumption through efficiency and renewable energy, and science-based targets were set for achieving categories of emissions as scopes that are defined as:

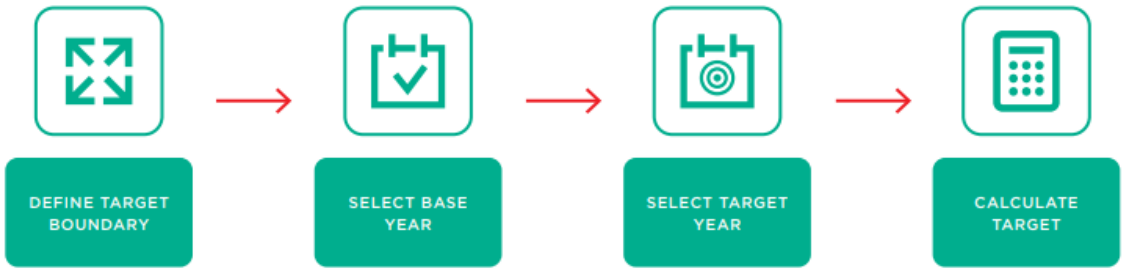
Scope 1 (Direct emissions): Activities owned or controlled by an operator that release emissions straight into the atmosphere.

Scope 2 (Energy Indirect): Emissions being released into the atmosphere associated with an operator's consumption of purchased electricity, heat, steam and cooling. These are indirect emissions that are a consequence of an operator's activities but which occur at sources the operator do not own or control.

Scope 3 (Other Indirect): Emissions that are a consequence of an operator's actions, which occur at sources which the operator do not own or control and which are not classed as scope 2 emissions. Examples of scope 3 emissions are business travel by means not owned or controlled by an operator, waste disposal, or purchased materials or fuels.

Scope 1: Direct	Scope 2: Energy Direct	Scope 3: Other Direct
Fuels Combustion (e.g. boilers, furnaces or turbines)	Consumption of purchased electricity, heat, steam and cooling	Purchased materials and fuels (e.g. extraction, processing and production)
Owned Transport (e.g. trucks, buses, cars, motorbikes)		Transport-related activities (e.g. commuting, business travel, distribution)
Process Emissions (e.g. cement, aluminium, waste processing)		Waste Disposal (e.g. waste, recycling)
Fugitive Emissions (e.g. air conditioning and refrigeration leaks, methane leaks)		Leased assets, franchising and outsourcing
		Sold goods and services (e.g. use of goods and services)

In order to reduce telecom operator's carbon footprint, each operator should come up with their energy efficiency plan and integration of renewable energy strategy. SBTI recommends to select a baseline year, select a target year, and calculate emissions for scope 1, 2 and 3.



Since we are already in the middle of 2021, the end of the year could be selected as baseline year. Realistically following ITU targets for emissions is highly recommended in local perspective that is perceived to be achievable as follows.

- 42% reduction in carbon emissions by 2030.
- 72% reduction in carbon emissions in 2040
- 91% carbon emission to carbon neutrality by 2050.

In order to achieve the above targets, telecom operators should draw up and strictly adhere to their energy efficiency plan and submit their carbon emission report to NTA once a year. The table (7) below outlines the reporting format for contents recommended to be included in the carbon emission report.

S.N.	CONTENT TOPICS	REMARKS
1	General company information	Company information
2	State the reporting period covered	Reporting period
3	State the reason for any significant changes in emissions since previous year	Changes in emissions
4	State the measuring and reporting approach followed	Measuring and reporting approach
5	State the approach chosen to identify the operations for data collection	Organizational boundary
6	State the scopes included. Provide a list of specifying the activity types included in each scope	Operational scopes
7	Provide detail of any specific exclusions of emissions from scopes 1 and 2	Operational scopes
8	Provide a brief explanation for the reason for any exclusions from scopes 1 and 2	Operational scopes
9	State the calculation approach used, specifically stating for each activity	Operational scopes
10	State the conversion tools / emission factors used	Operational scopes
11	State the base year chosen and approach used to set the base year	Base year
12	State base year recalculation policy	Base year
13	State appropriate context for any significant emissions changes that trigger base year emissions recalculation (outsourcing/insourcing, changes in reporting boundaries or calculation methodologies, etc).	Base year
14	State target, including scopes covered and target completion date. Provide a brief overview of progress towards target.	Target
15	State the reason for intensity measurement choice	Intensity measurement
16	State the reason for any significant changes in intensity measurement from the previous year	Intensity measurement

Table (7) Example of Carbon emission reporting contents

Since it is a collective effort, the government's support, cooperation and facilitation in achieving the above targets are highly desirable and some of them are outlined here:

- Approve and encourage mobile handset importers by reducing tax or providing tax incentives to import handsets with low GHG footprints or with a high share of recyclable materials.
- Supporting telecom operators in investment in GHG emission reducing technologies including antennas with reduced GHG footprint and energy efficient radio equipment for base stations by enabling some form of carbon credit. Substantial homework and consultation has to be carried out on how the carbon credit can be used /exchanged in the telecom market place. There should be a clear policy on what benefit the telecom operator can enjoy if they reduce the carbon emission or alternatively what price they need to pay in case they fail to achieve the benchmarked figure of permissible CO2 emissions.
- Supporting telecom operators to reduce emissions by facilitating infrastructure sharing provisions.
- Ensuring spectrum availability, especially making harmonised low-frequency spectrum available to reduce the need for densely- constructed mobile networks. For instance, it takes three times as many as base stations to build a 3G network using the 2100 MHz spectrum band as it does using 850 MHz.
- Supporting infrastructure deployment of energy efficient networks through streamlining planning approval.
- Government could lead by example and promote increased mobile-enabled teleworking amongst public sector employees.
- Government can support their energy port the vision of efficient buildings by creating open codes and standards for new and existing building mandating labels for all buildings that state their energy and carbon emissions, both for designed and in-use emissions. Those standards should support IP-enablement and fixed broadband and mobile access throughout buildings, ensuring that connected, smart, energy-efficient solutions are available to all users whether in-building or whilst mobile. Government can show leadership by building embedded mobile-enabled smart building technologies, e g, in schools, hospitals and in government office buildings.

14.1 Green Certification

With the aim to reduce energy consumption and achieve Green Telecom milestones, the consultant highly recommends NTA to introduce Energy Consumption Rating (ECR) mechanism for standardization of test procedures and certification of telecom products, equipment's and services for Green Certification.

In order to test the equipment/devices and certify, it requires an establishment of a Green Certification Lab which is conceptualized as a test bed created for a host of devices and test equipment offered by clients. The testing of telecom devices referred to as Device Under Test (DUTs) offered by Telecom Equipment vendors connected in a network configuration for Energy Efficiency Testing of GSM/BTS, IP related equipment such as IP Routers, Edge Routers, GPON, GEPON etc. A typical test set up is depicted in the Figure (25) below.

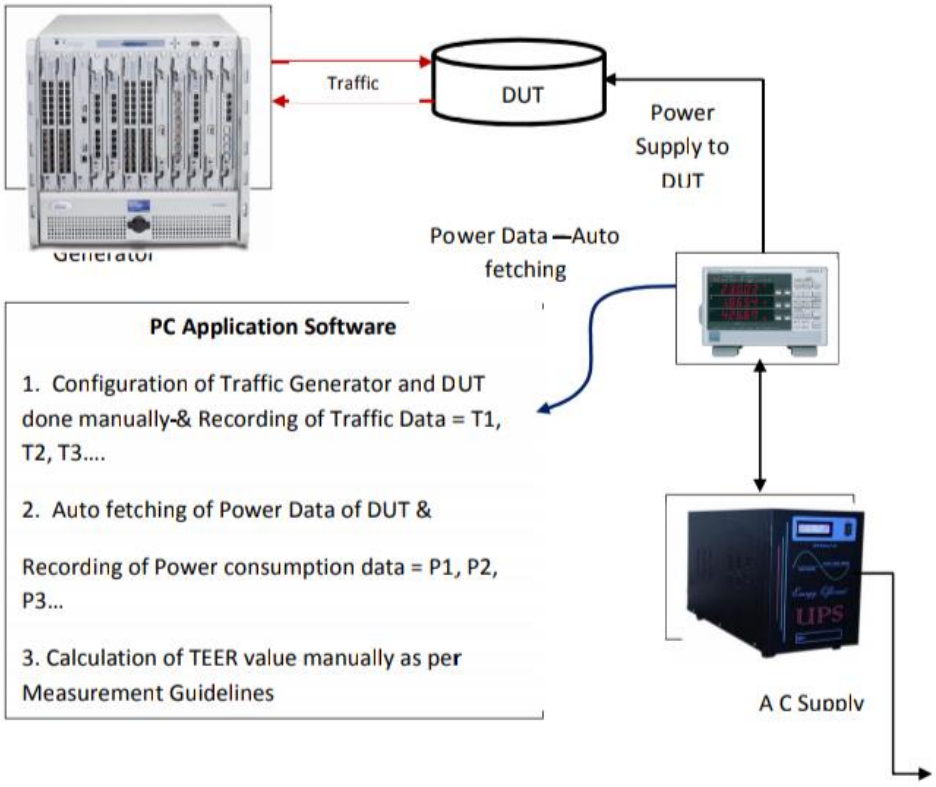


Figure (25) A typical test set up of Green Passport Lab

The Green Certification Lab will accept devices offered by different vendors and subject them to Energy Efficiency Testing on measurement metrics and testing procedure/measurement methodologies set by NTA standards. Post completion of tests,

NTA will release the test results and issue necessary certifications based on Energy Consumption Rating (ECR) that will facilitate Green Certification of such tested equipment.

14.2 Roles of regulatory body (NTA)

Most of the major activities for NTA is already covered in the recommendations part of the Final Report, however as NTA also oversees policy making such as ICT policy, Broadband policy, Telecom policy, etc. it would be NTA's jurisdiction and responsibility to enforce Green agenda through policies. Having said that, overall Green ICT covers four major goals to protect the environment and abate ICT sector's own GHG emissions as outlined below:

- Reduce the use of hazardous materials
- Recycle defunct ICT products and ICT wastes
- Reuse ICT products
- Maximize energy efficiency

So, in reference to our counterparts, few examples are covered here to understand the initiatives they have been taking in national level to curb GHG emissions as follows:

Malaysia's National Green Technology policy

In 2009, Malaysia launched National Green Technology predicting four primary pillars viz. Energy, Environment, Economy and Social perspective with five main objectives as follows:

- Decreasing growth of energy consumption while enhancing economic development;
- Facilitating growth of the Green Technology industry and enhancing its contribution to the national economy;
- Increasing national capability and capacity for innovation in Green Technology development and enhancing Malaysia's Green technology competitiveness in the global arena;
- Ensuring sustainable development and conversing the environment for future generations; and
- Enhancing public education and awareness on Green Technology and encouraging its widespread use.

The policy is further complemented by the National Waste Minimization Master Plan and Action Plan, National Strategic Plan for Solid Waste Management, Small Renewable Energy Power Programme and Green Technology Financing Scheme.

Government Administration Policy of Thailand

The Royal Thai Government recently adopted a Government Administration Policy aiming to have a balanced and strong economic structure with a quality and sustainable economic growth. The Government will promote and fully drive the concept of complete-cycle energy conservation, targeting the 25% reduction of energy consumption per productivity within 20 years. It also promotes exploitation of highly efficient products and buildings, and supports clean energy development mechanism to reduce GHG emissions and mitigate the effects of global warming. It will raise consumer awareness in saving energy consumption continuously and systematically, in all sectors including manufacturing, transportation and household.

The Government will utilize ICTs to support those policy objectives by developing affordable, universal and good-quality ICTs broadband infrastructure to bring Thailand toward knowledge-based and innovative economy.

The Thailand Information and Communication Technology Policy Framework (2011-2020), the Second Thailand ICT Master Plan (2009-2013) and the National Broadband Policy will be further aligned to reflect the newly adopted Government Administration Policy.

14.3 Carbon Credit Policy

Nepal has signed an agreement with the World Bank's Forest Carbon Partnership Facility (FCPF) at the beginning of 2021 under which Nepal can potentially access up to $45 million by selling 9 million tonnes of CO_2 by 2025 for implementing activities as per the UN mechanism called Reducing Emissions through Deforestation and Degradation (REDD). Through this carbon trade deal Nepal is eligible to sell carbon to developed countries that want to offset their carbon emissions under the REDD program. So, as a nation Nepal already has this experience and has successfully implementing this program.

Likewise, in international arena telecommunication industry has also followed this practice where huge carbon emitting telecom operators are offsetting their emissions. So, the

consultant strongly recommends that it is about time Nepal should exercise on introducing carbon credit policy where carbon emission cap should be imposed to industries including telecom sector. This topic is intended to give some insight on carbon credit policy.

One carbon credit is equal to one tonne of carbon dioxide, or some markets, carbon dioxide equivalent gases. A carbon credit is a generic term meaning that a value has been assigned to a reduction or offset of greenhouse gas emissions. Nepal has to introduce carbon credit policy to encourage reduction of carbon footprint from all stakeholders including telecom sector and the policy should be administered by the environment ministry/department in conjunction with NTA for telecom sector. The policy would usually involve setting a limit or cap on the amount of a GHG that can be emitted by a telecom operator. The limit or cap is allocated or sold to firms in the form of carbon credits which represent the right to emit or discharge a specific volume of the Green House gasses. Operators are required to hold a number of carbon credits equivalent to their emissions. The total number of credits cannot exceed the cap, limiting total emissions to that level. Operators that need to increase their credits must buy them from those who have a smaller footprint than permitted. This transfer of credits is referred to as carbon trading. Such policies could include economic instruments, government funding and regulation.

A carbon credit policy would indicate the services that have high carbon footprints so that customers can use them sparingly. The telecom operators would get an indication of products that use more, less or none carbon during service operation so that operators can go for low carbon inputs. It may also specify the rating of various products that are used in a telecom network so that the ones that emit lesser CO2 can be selected. This would also lead to market incentives for inventors and innovators to develop and introduce low-carbon products and processes that can replace the current generation of technologies. A polluting company that has to buy too many carbon credits to be within its cap would see its products become more expensive than the competitors.

When a firm invests in a renewable energy source to meet growing energy needs, it would be able to acquire carbon credits. These carbon credits are sold on international markets generating income for the owner of the credits. Firms in the European Union and the OECD member countries are buying carbon credits, also called CER (Certified Emission Reductions), from firms in countries where emission is less. The World Bank estimates that in 2006 approximately US $5 billion worth of CER were sold. The CER for December 2008 delivery was trading at about US $30 (EU €21) billion on September 1, 2008 on the

European Climate Exchange. Current rate of the Carbon Credit is around US $14. However, under the REDD programme Nepal is receiving $5 per carbon credit.

15. EFFORT AND CHALLENGES OF SERVICE PROVIDERS TOWARDS ENERGY EFFICIENCY

Telecommunications technology is rapidly evolving and telecom operators have to frequently update their systems and services to keep up with the pace of ever-changing industry. As devices and equipment are moving towards eco-friendly systems, telecom service providers in Nepal are also embracing energy saving technologies otherwise the cost of energy for running the systems and networks will be unsustainable. Therefore, some of the efforts taken by telecom service providers in Nepal are outlined below:

- **Optimize network design for long range coverage**

  It is found that operators are planning and designing their base station infrastructure to extend their transmission power and range so that traffic can be served by the base station to their neighboring cells and provide service in extended area. This optimized design gives a flexibility for a base station to be switched off during low traffic and active cells to increase their coverage area.

- **Switch device/equipment to power saving mode**

  Nowadays, new device and equipment comes with power saving mode. At the end of life of a device/equipment, telecom operators are replacing new device/equipment that comes with power saving mode so that it can automatically switch off or on depending on the volume of traffic.

- **Use of low power consumption device/equipment in systems and networks**

  In comparison to earlier version of products, manufacturers are producing low power consumption devices and/or equipment to improve efficiency and driving the cost down. It has been observed that at the of life of device/equipment, telecom operators are opting low power consumption device/equipment where possible.

- **Use of low power consumption ac/led lighting at office premises**

  In order to save energy costs, telecom operators have and are switching towards low power consumption air conditioning and replacing led bulbs for lighting as and when required.

- **Implement solar power at off-grid sites**

  At least NTC have been found to have implemented solar power at off-grid sites. So far NTC had 281 solar power sites and have planned to install more in off-grid coverage areas during expansion of their network.

- **E-waste management**

  Telecom sector produces electronic waste that are potentially hazardous to health and harmful to environment, hence it requires meticulous system in place to manage and dispose the waste. Further, the rare earth metal used in telecom equipment has to be recovered, recycled and reused. We have witnessed the scarcity of these rare earth metals and semiconductors during these COVID pandemic and as a result of which device manufacturers and equipment suppliers are struggling to meet the growing demands.

  However, telecom operators in Nepal have a small quantity of e-waste and since they don't sell mobile handsets, the end users' mobile handsets are not considered as part of their responsibility. So, it would not be worthwhile for them to establish an e-waste management system and would be cost effective and sensible for them to outsource the produced e-waste. Hence, telecom operators (NTC and NCell) call for scrap buyer bidding and have been outsourcing their e-waste management to the winning scrap buyer.

15.1. IMMEDIATE CHALLENGES FOR TELECOM OPERATORS TO ADAPT GREEN TELECOM

- **Huge capital costs in replacing devices/equipment**

  Comparatively, Nepal is a small market for telecom industry due to low population and low penetration due to geographical predicament. In addition, the cost of expanding network coverage in hilly and mountainous region comes in many folds in comparison

to other counterpart regions due to severe terrain and lack of transportation. So, the CAPEX is very high and on the contrary the rural areas are sparely populated that it takes much longer to achieve ROI and break even. Hence, without even recovering the initial investment it would be counterproductive for a telecom operator to replace newly available environment friendly device/equipment and would make sense to fully utilize them until the end of life of that device/equipment.

- **Require more time to replace until the equipment end of life**

  As a regulator, NTA is recommended to follow the ITU roadmap in achieving Green Telecom and enforce decarbonization in telecom sector. Likewise, a transition period will be given to the telecom operators so that green initiatives will be imposed. However, due to high CAPEX and tough competition telecom operators may require more time to replace the equipment until it has reached its end of life.

- **Waste produced too small in quantity to establish own disposal system**

  Despite being a service sector, telecom industry is a business and decisions regarding investment is always dictated by cost benefit analysis, business case and profitability. Since, the end users mobile handset and/or CPEs/modems/routers are not considered as part of their responsibility, the e-waste produced by a telecom operator is too small for establishing a proper e-waste management system. Hence, it would not hold any commercial value and would be much more cost effective to call a bid and appoint a scrape buyer their waste.

- **Cost effective and less responsibility in opting for outsourcing services, rollout, support and maintenance to vendors**

  As a regulating body, NTA has the obligation to monitor and enforce green initiatives to cut down carbon emissions from the telecom sector, but on the contrary telecom operators are shifting their burden to third party vendors by outsourcing all their services, implementation projects, support and maintenance works. The situation can be visualized in a way that it seems like the operators are not producing majority of the emissions and the third-party vendors are emitting the greenhouse gases. So, as to our report the scope 3 emissions are more prevalent in local context and as it stands, it would be a mission to assess, account for and reduce the carbon emissions from those third-party vendors.

16. RECOMMENDATIONS

Green Telecom is significantly huge and vital subject area that needs to be seriously studied and collectively addressed giving plenty of time and effort between the service providers, concerned government agencies and of course the regulator. It is such an eminent concerning matter with high priority that there has to be a proactive participation and solidarity/collaboration between the government policy makers and the enforcement/monitoring agencies such as regulator, department of environment, municipalities, forestry department and so forth. Developed countries and giant telecom operators have already streamlined their sophisticated system in place to mitigate GHG emissions but some of them may not be pragmatic in local context. Therefore, the consultant has recommended selected activities that is crucial and could be realized and realistically achieved as outlined below:

i. As part of day-to-day business NTA provides type approval to telecom related equipment before they are being imported. The consultant strongly suggests that NTA should provide type approval for energy efficiency equipment only following compliance guideline of ISO 14001:2004 and 14004:2004 standardization.

ii. As green telecom regulations are being introduced, NTA should regulate telecom service providers to optimize their power consumptions and request them to thoroughly prepare their detailed energy efficiency plan and detailed roadmap of renewable energy plan at the earliest.

iii. On regular basis, NTA should monitor and enforce the adaptation of renewable energy in their network and system by telecom service providers as per their renewable energy plan.

iv. Infrastructure sharing avoids duplication of network infrastructure and eliminates unnecessary power consumption as a result of which it reduces carbon emissions. The consultant strongly suggests that NTA should support telecom service providers to reduce emissions by facilitating and enforcing infrastructure sharing mechanisms.

v. Technology is moving forward towards virtual world and one of the excellent benefits of virtualization is it reduces unnecessary hardware saving power consumption which is good for decarbonizing emissions. It is recommended that NTA should encourage telecom service providers to implement virtualization in their data center and network (SDN-Software Defined Network) where possible to reduce power consumption.

vi. Equipment manufacturers are producing eco-friendly devices that goes into power saving mode during standby period. It is recommended that NTA should regulate telecom service providers to have or upgraded their BS to support power saving mode so that they can be auto switched off during low traffic particularly at night and designed their BS network to overlap geographical area so that active BS can provide services in extended area.

vii. Since, use of diesel generators is detrimental to the environment, it is highly recommended that NTA should regulate that at off-grid sites, telecom service providers should opt for solar energy to replace diesel generators.

viii. One of the key concerns in telecom industry is the waste produced that cannot be dumped in regular municipal waste eco system. The consultant strongly suggests that NTA should regulate and monitor telecom service providers to have electronic waste management and recycling system/ procedure in place so that reusable resources are extracted and toxins are disposed appropriately.

ix. As study suggests most of the telecom service providers outsource their services to third party vendors. It is suggested that telecom service providers should target to upgrade their commercial fleet and/or vehicles near to 100% electric where possible. In scope 3, it outlines that the emission produced by suppliers/vendors to a telecom provider is also their responsibility. So, the telecom service provider should ensure that their supplier/vendor are using electric vehicles while providing them services. During the carbon emission reporting, NTA is advised to monitor the telecom service provider's supplier/vendors' carbon emissions as well.

x. During the COVID 19 pandemic lockdown period most of the institutions, organizations including government agencies were working online as well as organized meetings/seminars/conferences remotely through online applications. This has proven to be very effective and environment friendly. Hence, the consultant highly suggests NTA to support telecom service providers to promote teleworking (work from home), online meetings, etc. for office-based employees where possible.

xi. Monitoring and evaluation are very crucial while implementing any programmes/projects. In order to make Green Telecom programme success, the consultant highly recommends that telecom service providers should submit their carbon emission report once a year to NTA.

xii. In order to control carbon emissions, it will be necessary to cap a limit to the quantity of emissions for telecom service operators, otherwise it will be very difficult to regulate. Hence, the consultant highly recommends NTA to introduce Carbon Credit Policy to successfully implement and promote Green Telecom.

xiii. Since Nepal does not manufacture telecom equipment or products, there should be a mechanism to test and certify the imported devices for energy consumption. The consultant highly recommends NTA to establish a Green Certification Lab where imported telecom devices are tested for energy consumption rating and provide green certification.

xiv. Most of the developed countries have commenced the decarbonizing initiatives in telecom sectors as early as 25 years ago. So, at that time ITU had recommended to reduce CO_2 emissions to 42% by 2030, 72% by 2040 and net zero by 2050. In addition, Nepal government has also pledged to reach net zero by 2050 in country's overall emissions. As we are at the end of 2021, and almost Nepal's overall energy comes from hydroelectricity, the above target can be easily achieved. By 2030 most of equipment and hardware infrastructure that have been commissioned will have reached its end of life. So, the consultant strongly recommends NTA to set the baseline year as 2022 and work around to meeting the very ITU recommended reducing carbon emission targets.

17. CONCLUSION

This Final Report (D3) is submitted as part of the consulting services and includes the excerpts of relevent study, findings, analysis and most importantly recommendations that should be taken into account to reduce carbon emissions from telecom service providers in Nepal. The report also includes a draft copy of regulatory framework surround green telecom that need to be discussed and finalized.

The Final Report commences with Executive Summary followed by Recommendations. Recommendations is the crux of the overall study and in a nutshell it outlines the steps that need to be addressed by all the stakeholders including NTA to meet the objectives of Green Telecom. The recommendations are made on the basis of the findings that are successfully adopted as international best practices, recommendations from ITU, and what is viable in local context. The consultant sincerely suggests NTA to follow the recommendations so that Nepal can significantly reduce carbon emissions from telecom sector.

Recommendations is followed by findings in brief, which outlines in a gist the outcome of the assignment and the analysis the study. Technically, it covers the major findings such as the overall status of carbon emission of both local and international, causes of GHG emissions and solutions that are practiced sucessfully around the world. The report moves on to giving the background introduction on the GHG emissions such as how and what causes the emissions. Also it analyses where Nepal stands on carbon emissions issue, targets and policies governning the climate situation. The report moves on to underlining the objectives and scope of the assignments. Further, the report moves on to the approaches/methods taken in accomplishing the assignment and expected deliverables/milestones.

Moving on the report covers the analysis of energy consumption by telecom service providers in Nepal and the status of carbon emissions from those telecom service providers. Unfortunately, after following up for months the consultant was unable to retrieve any data from ISPs. So, the analysis is based on the power/fuel purchased made available from central accounts department and/or energy consumed estimations.

Moving forward, the report covers analysis of ICT sector trajectory for CO_2 emissions from where it summarizes the decarbonization of sector in line with 1.5^{o}C and also includes the

list of major telecom operators, data centre operators and manufacturers involved during survey and data collection conducted by ITU-TL.1470. The report moves on to covering ITU recommendations to operators for mobile networks, fixed netwoks and data centers where it briefly discusses on setting target for scope 1, 2 and 3 emissions and calculating science based target.

Moving on the report investigates the major components of a telecom infrastructure that contributes to carbon emission. Basically it identifies the part of the infrasture network that are high on power consumption. Moving forward, the report covers global ICT footprint and categorically points out the the various devices that relatively contributes to carbon emissions. The chapter also covers some the innovative approches adopted by leading telecom operators across the globe to reduce GHG emissions.

The report moves on the discussing one of the major element on energy efficient solutions for telecom networks such as effective planning, increasing coverage of active cells, night time auto switching off of base stations during low traffic, standardization of ISO certified equipment in line with green telecom, etc. Moving on, the report covers some of the important energy efficient aspects of telecom network including the role of infrastructure sharing and e-waste management. As tower site is one of the major power consuming component of network infrastructure, the report moves on to discussing what can be possible done to reduce the power consumption. The chapter basically covers identification of power consuming elements and how power can be saved at tower sites.

The report moves on to covering the available renewable energy solutions for telecom sector. However, during the course of the study plenty of alternate energy solutions were identified but were fo und to be unsuitable in local context. Hence, this chapter covers the solutions that are feasible in Nepal and stress is given to NEA grid infrastructure.

Finally, the report includes a discussion on general guideline/regulatory framework for reducing carbon footprint for telecom operators where green telecom is not conceptualized yet, so stress is given on the active role of NTA as regulatory body until the target is defined and system/procedures are in place. Some of topics that are recommended to introduce are Green passport and carbon credit policy. In order to regulate, enforce and monitor the progress on green telecom, the report also includes a draft copy of supporting legislation and wraps up with conclusion and references taken during the course of the study.

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ANNEX - 1

DRAFT REGULATORY FRAMEWORK

DRAFT THE GREEN TELECOMMUNICATIONS BY-LAWS, 2079 (2022)

In exercise of the powers conferred by Section 62 of the Telecommunication Act, 2053 (1997) Nepal Telecommunications Authority (NTA) has framed these Bylaws for regulating of carbon emissions, setting up activities and targets for operators to meet carbon neutrality, adapting energy efficient technologies and renewable energy under the initiatives of Green Telecommunication.

Chapter- 1

Preliminary

1. Short title and commencement:

(1) These Bylaws is called as the "Green Telecommunication Bylaws, 2079 (2022)".

(2) These Bylaws shall come into force immediately.

a) "Act" means the Telecommunication Act, 2053 (1996).

b) "Authority" means Nepal Telecommunications Authority established under the Telecommunication Act, 2053 (1997).

c) “Green House Gases (GHG)” means compound gases that trap heat in the atmosphere whose presence in the atmosphere makes the earth’s surface warmer. Five major Green House Gases are considered for causing global warming through Green House Effect that includes – Carbon dioxide, Methane, Nitrous oxide, Fluorinated gases and water vapor.

d) “Carbon emission” means carbon dioxide (CO_2) emitted from the business and network operations of telecommunications sector.

e) “Decarbonizing” means ICT sector trajectory with the aim to keep the global temperature rise below 1.5^{o}C.

f) “Standardization of equipment” means environmental management standards for potential environmental impacts associated with the product during its life cycle.

g) “Renewable energy” means clean energy that comes from natural sources or process that can naturally replenished and does not produce Green House Gas emissions.

h) “Green Certification” means carrying out energy efficiency testing for telecom products, equipment and services with the Energy Consumption Rating (ECR) mechanism for standardization of test procedures and issuance of Green Certification.

i) “E-waste Management” means a systemic process to collect e-waste, recover and recycle material by safe methods, dispose of e-waste by suitable techniques to reduce its adverse impacts on environment.

j) “Implementation” means in relation to Green Telecommunication, includes:
   i. Preparation of detailed energy efficiency plan and renewable energy roadmap; and
   ii. Set up CO_2 reduction targets; and
   iii. Submit yearly carbon emission report strictly following to energy efficiency plan.

Chapter – 2

Scope of Green Telecommunications

3. Provision of Green Telecommunication Services:

These by-laws apply in relation to licensees of telecommunication services which operate within the territory of Nepal.

4. Power consumption optimization:

Telecom Service Providers are required to prepare submit their energy efficiency plan and detailed roadmap of renewable energy plan within six months of the Green Telecommunication Bye-law comes into effect.

5. Carbon emission reduction targets:

Nepal will align and follow ITU recommended targets for reduction of carbon emission in telecommunications sector as follows:

- 42% reduction in carbon emissions by 2030.
- 72% reduction in carbon emissions by 2040.
- 91% reduction in carbon emissions by 2050.

6. Categories of GHG emissions:

In order to set decarbonizing target for the telecom industry to keep the global temperature rise below 1.5^{o}C, the company GHG emissions are categorized into three different scopes.

Scope 1 (Direct emissions): Activities owned or controlled by an operator that release emissions straight into the atmosphere.

Scope 2 (Energy Indirect): Emissions being released into the atmosphere associated with an operator's consumption of purchased electricity, heat, steam and cooling. These are indirect emissions that are a consequence of an operator's activities but which occur at sources the operator does not own or control.

Scope 3 (Other Indirect): Emissions that are a consequence of an operator's actions, which occur at sources which the operator does not own or control and which are not classed as scope 2 emissions.

Scope 1: Direct	Scope 2: Energy Direct	Scope 3: Other Direct
Fuels Combustion (e.g. boilers, furnaces or turbines)	Consumption of purchased electricity, heat, steam and cooling	Purchased materials and fuels (e.g. extraction, processing and production)
Owned Transport (e.g. trucks, buses, cars, motorbikes)		Transport-related activities (e.g. commuting, business travel, distribution)
Process Emissions (e.g. cement, aluminium, waste processing)		Waste Disposal (e.g. waste, recycling)
Fugitive Emissions (e.g. air conditioning and refrigeration leaks, methane leaks)		Leased assets, franchising and outsourcing
		Sold goods and services (e.g. use of goods and services)

7. Setting target for scope 1, 2 and 3 emissions

Select a baseline year

The most recent year should be selected for which data is available.

Select a target year

A minimum of 5 years should be selected and since digital technologies are rapidly changing a target year should not go beyond 2030.

Measure scope 1 and 2 emissions

Scope 1 and 2 emissions need to be measured for the baseline year according to the GHG protocol. Most of the companies have activities beyond ICT operations such as office buildings and/or a transport fleet. In such cases, companies may choose to combine all their scope 1

and 2 emissions and derive a single SBT following ICT sector method, thereby allowing the overall trajectory to stay within 1.5°C trajectory.

Calculating the science-based target

A sub-sector science-based target (SBT_s) is calculated by multiplying the combined scope 1 and 2 emissions in the base line year (CC_b) by an emissions reduction factor (ERF). The emissions reduction factor is based on the appropriate sub-sector emission reduction pathway and the baseline and target years.

$$SBT_s = CC_b \,.\, ERF$$

Setting a target for Scope 3 emissions

SBTi criteria require that a company sets a scope 3 target when its scope 3 emissions are 40% or more of its total scope 1, 2 and 3 emissions. The scope 3 target must cover at least 2/3 of total scope 3 emissions. For most ICT companies it is likely that the 40% criterion will be met and the company will need to set a scope 3 target. The most significant scope 3 categories for an ICT company are likely to be:

- Category I – purchased goods and services
- Category II – use of sold products

Companies can set either a scope 3 emissions reduction target, or a supplier or customer engagement target, or a combination of the two.

8. Reporting Carbon emissions

Telecom operators are required to submit their carbon emission report to NTA once a year and the following reporting format for contents shall be included in the carbon emission report.

S.N.	CONTENT TOPICS	REMARKS
1	General company information	Company information
2	State the reporting period covered	Reporting period
3	State the reason for any significant changes in emissions since previous year	Changes in emissions
4	State the measuring and reporting approach followed	Measuring and reporting approach
5	State the approach chosen to identify the operations for data collection	Organizational boundary
6	State the scopes included. Provide a list of specifying the activity types included in each scope	Operational scopes
7	Provide detail of any specific exclusions of emissions from scopes 1 and 2	Operational scopes
8	Provide a brief explanation for the reason for any exclusions from scopes 1 and 2	Operational scopes
9	State the calculation approach used, specifically stating for each activity	Operational scopes
10	State the conversion tools / emission factors used	Operational scopes
11	State the base year chosen and approach used to set the base year	Base year
12	State base year recalculation policy	Base year
13	State appropriate context for any significant emissions changes that trigger base year emissions recalculation (outsourcing/insourcing, changes in reporting boundaries or calculation methodologies, etc).	Base year
14	State target, including scopes covered and target completion date. Provide a brief overview of progress towards target.	Target
15	State the reason for intensity measurement choice	Intensity measurement
16	State the reason for any significant changes in intensity measurement from the previous year	Intensity measurement

Chapter – 3

Standard and Practices

8. Type Approval of energy efficiency equipment

During type approval NTA shall review Life Cycle Assessment (LSA) for analysis of the total potential environmental impacts associate with the telecommunications equipment. The products shall comply with the following two environmental management standards.

- ISO 14001:2004
  Specifies the requirements for such an environmental management system.

- ISO 14004:2004
  Provides guidelines on the elements of an environmental management system and its implementation, and discusses principal issues involved.

The above standardizations address the following green activities;

- Specifications for energy definitions, reference models, measurements, etc.
- Specifications that include solutions for reduction of energy consumption.
- Implementation and use of ICT standardization results can positively contribute to the green agenda.

9. Power Saving (Radio Standby) mode

Telecom operators shall upgrade their BS network (where required and is possible) to support power saving mode that has the capability to auto switched off during low traffic. The BS network shall be designed to overlap geographical area so active BS can provide services in extended area.

10. Use of Renewable energy

Telecom operators shall use suitable source of renewable energy to power up off grid sites and power back up for network infrastructures and data centers during power outages.

11. Infrastructure sharing

Telecom operators shall develop/expand their network infrastructure in compliance with Infrastructure Sharing Regulation (2074) to avoid unnecessary GHG emissions.

12. Green Certification

Use of telecom products, equipment and services shall be approved for Green Certification subject to energy efficiency testing reports. NTA shall issue Green Certification based on the Energy Consumption Rating (ECR) compliance.

13. Carbon Credit Policy

Carbon Credit Policy shall be introduced to cap a limit to the quantity of emissions an operator can release. Exceeding the quantity of carbon emissions, the operator shall offset their emissions by purchasing carbon credits.

Chapter – 4

Miscellaneous

14. E-waste management

Telecom operators shall have e-waste management and recycling system in place (where possible) to extract reusable resources and dispose toxins.

Telecom operators shall submit yearly report on the prevailing e-waste management procedure and the estimated amount of waste produced until the operators have their own system.

15. Electric vehicle

Telecom operators shall target to upgrade their commercial fleet and/or vehicles near to 100% where possible. In the energy efficiency plan, telecom operators shall include their expected target year to meet the e-vehicle upgradation.

16. Teleworking

Telecom operators are encouraged to promote teleworking (work from home) for office-based employees and organize meetings/seminars/conferences remotely through online applications (where possible) to curb unnecessary travelling and minimize carbon emissions.