On the Trade-offs of 5G networks and Beyond

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Abstract. Towards offering productive organizations and clean condition, green organization is an essential for the future correspondence ages. This paper talks about the comprehensive and best compromises that are simultaneous with empowering the green advancement. This paper numerically assesses the impacts of the numerous measurements and factors, for example, powering sufficiency, deployment cost, revenue, economy dimension, delay up on CO2 emission, bandwidth, consumed power, cost efficiency, transmitted power, energy efficiency and spectral efficiency. This work likewise shows that green situated organizations may think about generally significant expense productivity. In like manner, the organization suppliers and financial specialists can decide after utilizing the suitable wellspring of vitality and supporters one of them.

Keywords: Green communications, Network performance, Green cost, performance.

1. Introduction
The continues rising of the network subscribers including mobile and internet technology, using different network devices such as laptops, mobile devices and tablets [1], has urged to deploy more base stations to provide higher data rates [2,3,4]. This in return has pushed the service providers to consume more energy. Consequently, a contribution to the unbidden crisis of global warming has been assured [5]. As a solution, in literature, there are methods and techniques aimed to improve the network energy efficiency by reducing the power consumption, such as, cognitive radio, heterogeneous methods, energy harvesting techniques [6], optimizing the resources allocation [7] and [8], cloudification the networks [9], network virtualization [10] and discrete transmission [11]. These methods can surely reduce the transmitted power or power consumption; however, they hold using the traditional or conventional electricity as their power grid. Therefore, the 5G future technologies are required to overcome using the diesel based traditional electricity and replace it with green or renewable ones. Generally, there is huge ambition that in 2020, 20% of the demanded energy can be green. In 2035, it can reach about 30% [12]. In particular, the European Union acted towards energy saving by targeting 20% reduction in greenhouse gas. Moreover, China also promised 20% reduction in greenhouse gases and 10% reduction of pollution by 2020. Such evolution is needed to replace the method of energy consumption, hence, conserving the environment via reducing the harmful emissions and bearing the climate change [13]. The term ‘green’ is used to signify about the power supply of the communication network, which is from of green energy generators from the green farms. In contrary, the traditional networks are powered by the conventional mains grid. Being green indicates offering a new system that can be environment friendly, aiming of using such method...
without disturbing the environment. Furthermore, the existing expectation towards green energy sources is to enhancement the current and futuristic daily life via supplying the next generation networks with clean energy without draining the resources of earth [14,15]. These goals must be achieved without any comptonization regarding changing the methods of consumption and production the energy. Generally, the researches have focused up on assuming powering the networks with green energy rather than traditional grid without measuring the formed or generated cost underlying using the green method. Consequently, some operational provocations are generated, and at the same time, are unbeatable. The majority of these challenges and costs are experimentally tested in this article, described below:

- The initial cost is relatively high. However, regaining such cost can certainly occur regarding the power gain and revenue after a time. This gain happens as the spending on traditional electricity bills becomes less over time. Nevertheless, when will this gain be returned? Such matter requires a system level modelling that evaluates the total tradeoffs.
- Green systems require exceptionally high expenses, including purchasing, installing and regular maintenance to operate them. Consequently, propelling a green system is practically challenging, except if the legislatures and abnormal state organizations bolster this jump.
- Green systems are exceptionally important to decrease the CO2 discharges due to burning the non-renewable energy sources. Thus, coordinating the logical frameworks to green energy becomes unstoppable.
- The topographical region required to execute a green project is commonly bigger than for conventional structures, this may render the lease exceptionally high with regards to the previous.
- The production of green energy has complexity, which happens at slow rate when compared with traditional power generators that uses the available petroleum.

The objective of this paper is to demonstrate these issues by giving a top-down framework assessment, with the end goal of increasing more noteworthy comprehension and along these lines, have the option to improve the exhibition of green system arrangement. In like manner, this paper addresses the difficulties that disrupt the general flow of cultivating the acceleration of green system improvement. It is foreseen that by perceiving the inherent hindrances within this field, zones where conceivable improvement can be distinguished.

2. Green cost

In this section, we proposed a model incorporated many essential sections, these are as the following:

(i) Sufficiency, the power sufficiency ($Su$) for the generated power $P$ is characterized by the condition, if valid, it ensures that $P$ is likewise valid. Essentially, it alludes the capability the source to give sufficient power in the coming period ($nu$), the overall period is ($t = \sum_{k=0}^{Nu-1} n_k$), and $Nu$ indicate the all out of time moments. Succession rule is used to to speak to this contingent likelihood. The believability that a power source is sufficiently ready for power generation ($P$) increments with the occasions $nu$, these occasions on which, the source was effective to enable up until this point. Accepting $Su$ is uniformly distributed over $[0; 1]$ interim, at that point the probability of sufficiency $Su[P/P_{nu}]$ can be given by:

$$Su[P/P_{nu}] = \frac{\int_{0}^{1} Su^{nu-1}dSu}{\int_{0}^{1} Su^{nu}dSu} = \frac{nu + 1}{nu + 2}$$

(1)

This demonstrates that more past created energy, denoted by n, the larger likelihood the energy is produced in the following snapshot ($nu + 1$) [16-18].
(ii) Reliability, the most effortless approach to evaluate such parameter to be done using the rate failure. This is understood as component neglects working after period, which is spoken to faults/t. Inverse to that, comes the reliability \(R_i(t)\). It is characterized by the likelihood part won’t come up short during the interim \((0; t)\). On the off chance that the failure \(F(t)\) is discovered, at that point the inverse, reliability \(R_i(t)\) id likewise is evaluated, it is demonstrated by \(1 - F_a(t)\). [19].

Besides, green locales to be for the most part settled a long way from urban communities, there are additional links losses \((lic)\) when examination with conventional networks. Such expense is combined with the previous representation to produce

\[
R_i(t) = 1 - F_a(t) - li_c
\]

(iii) Economy, there are key contemplations should be tended to while surveying the economy factor of green system: offering jobs \((K)\), setting up new investing \((V)\), ambiguousness constant \((i)\) and equipment costs \((E)\). In contrast with traditional grid systems, the initial 2 variables are altogether advantages because they force extending to new employment opportunities and carrying more ventures to the communities. Henceforth, the impact of these variables within the model boosted after some time. As green power is new when contrasted with conventional, ambiguousness parameter \((i)\) to be expected to depict a danger for putting resources into such market, such parameter influences adversely to green power. Be that as it may, to demonstrate occupations offering, it was depicted as \(\frac{dk}{dt} = FK\). The increment/decrement in occupations \(K\) as for the \(t\), solve such condition produces \(K(t) = K_{init}e^\theta t\), where \(K_{init}\) denotes to the employments zero time, to be specific, before propelling [20].

green project. In addition, \(\£\) signifies expanding consistent of the quantity of occupations. We have utilized the exponential function to demonstrate the majority of the components inside this work due to the accompanying reasons: (i) its conduct can be seen as linear when it is slow, and exponential when it is fast. If \(\£\) approaches 0, the model will in general be straight instead of exponential, (ii) this provides primary or underlying amount to demonstrate such beginning stage. Such initial is significant to depict the conduct at zero time, lastly (iii) the exponential behavior avoids falling fall into zero. For instance, costs of solar panel is a lot less expensive after some time, however it is non zero cost. We utilized a similar behavior to demonstrate investing \((V)\), which increments by \((t)\). In other words, \(\frac{dv}{dt} = 9v\), solve such condition results \(V(t) = V_{init}e^\theta t\), where \(V_{init}\) indicates the initial investment, \(\theta\) is a consistent that depicts the expanding in investing factor after some time.

In contrary, ambiguousness \((Am)\) diminishes as time goes where business owners are progressively acquainted with green. It was created as \(Am(t) = Am_{init}e^{-\Sigma v}\), where \(Am_{init}\) shows the underlying ambiguousness, and \(\Sigma\) is the steady that evaluates the diminishing.

The costs can assume extra role in this model. We utilized solar panels and batteries. Such costs drop over time, for instance, from \(\£250\) per Watt in 1956, to \(\£27\)per Watt in 1980, at that point to \(\£2\)per Watt in 2009, down to \(\£0.2\)per Watt in our trial. This sensational fall in the costs clearly promoters to utilizing green advancements [21,22]. Obviously, this connection is conversely exponential, for example dropping from high cost to an exceptionally low one. As the last cost is extremely low and thus, must be additionally marked down by an insignificant sum, the displaying of these costs must join exponential conduct, for direct demonstrating would take into consideration an unreasonable zero cost. As needs be \(\frac{dE}{dt} = -iE\), yielding \(E(t) = E(t)_{init}e^{-iE}\), where \(E(t)_{init}\) is the initial cost of panels and batteries, while \(t\) is the diminishing constant. Consequently, economy parameter \((Eco(t))\) is figured to be a mix of every one of the elements:

\[
Eco(t) = K_{init}e^\theta t + V_{init}e^\theta t + Am_{init}e^{-\Sigma v} + E_{init}e^{-iE}
\]
these variables are fundamentally affected by the area size, for instance, utilizing sun boards, more used territory, greater power will be created. As a rule, this rationale consistently remains constant while managing various sorts of green power. If we assume \((A)\) to be the territory, lease cost to be denoted by \((Rn)\), that increments directly with \(A\), after that, lease cost is presented as \(Rn = \eta \times A\), as \(\eta\) denotes a constant. In addition, maintenance cost \((Cn)\) is two crease, expanding straightly with \(A\), where it is given as \((Cn = \varepsilon \times A\) ). In addition, will be a synchronized periodical maintenance, denoted by \((Mn_p)\). Subsequently, the total maintenance \((Mn)\) can be demonstrated as \((Mn = Cn \times Mn_p)\), where \((\varepsilon)\) is constant. On the opposite side, the cost of deployment \((De)\) is thought to be linear, for example it increments with the area covered. If we accept \((i)\) to be the increasing consistent, at that point, \(De = \ell \times A\). At long last, OPEX and CAPEX \((COP)\) parameters as an element of \(A\), this is communicated as \(COP (A) = Rn + Mn + De\).

(iv) Environment, in 2007, an experimental work for three years long has been done that consolidated solar and wind to control the mobile base station, this has spared approximately 4,585Kg of harmful emission every year contrasted with traditional based stations [30]. It is presumed that this sparing increments after some time. On a solitary site level, the CO2 outflow is diminished. Besides, on framework level, expanding the quantity of green locales yields more CO2 reserving. In the event that factor \((Ent)\) signifies the CO2 sparing, which expands directly as per time \(t\), beginning from an initial worth \((Ent_{init})\) that speaks to the present level of CO2. Henceforth, the environment model is given as \(Ent = Ent_{init} e^{\zeta \alpha}\), as \(\zeta\) denotes an increasing consistent. With more utilization of green advances, it is conceivable that such sources will deliver obscure hurtful impacts. The enormous measure of utilized batteries could cause a waste emergency, yet on account of reusing, each piece of the battery can be re-made, which is, in any case, exorbitant. Moreover, a few source kinds have unstoppable perils, such as wind turbines can deadly affect flying creatures, biomass sources incorporate consuming trees for warmth and cooki

3. Green efficiency

The criteria of estimating system CEF is better over the assessment of bare channel capacity or spectral efficiency since CEF demonstrates the cost pointer, this gives extra understanding when evaluating a system execution. \(CEF\) \((\text{bps/Hz/£})\) is utilized for portraying the proportion of the spectral efficiency to the system cost. Cloud mobile has been suggested with \(N\) \(RRHs\) together with \(U\) users. Fading amongst \(u\)-th \(UE\) and \(n\)-th \(RRH\) is assumed \(hn,u\) as Rayleigh and consequently, the received power by \(UE\) from the \(RRH\) can be given as \(P_{n,u}^r = P_{n,h}^r h_{n,u} r_{n,u} \). Moreover, \(r_{n,u} = d_{n,u}^{-\alpha}\) indicates the path loss, \(dn,u\) denotes the Euclidian distance between the user and the \(RRH\), \(\alpha\) is the exponent of path loss, and \(P_{n,h}^r\) means \(RRH\)’s power transmitted. Thus, the cost efficiency can be demonstrated as:

\[
CEF_G = \frac{BW \log_2(1 + P_{m,u}^r g_{m,u}^k)}{\text{Cost}_g}
\]
Where \( \gamma_{n,u} = \frac{h_{n,u}r_{n,u}}{BN_{o}} \) means the SNR proportion. In a particular time \( (t_o) \), this model is estimating both green and conventional CEFs. It merits referencing that \( \text{Cos}_{gt} \) is a component of \( nu, A \) and \( t \), while \( \text{Cos}_{Tt} \) is an element of just \( A \) and \( t \) in light of the fact that the traditional based networks power is accessible all time, which implies \( S(n) = 1 \). Additionally, the traditional CEF (CEF\(_T\)) is displayed in similar method of green CEF, yet the expense is supplanted with conventional one.

\[
CEF_T = \frac{BW \log_{2}(1 + P_{m,u}^t \gamma_{m,u}^t)}{\text{Cos}_{Tt}}
\]  

Moreover, \( C_T(A,t) \) can be assessed utilizing a similar equation of \( (3) \), where estimating any parameter is separated from \( (3) \), this appeared within Table 1 [25,26].

4. Solar based set up
We used 100 boards [31], the kind of the boards is (forturner). The panel can produce 22KW, that is equivalent to 50 pence for an amount of power equal to 250W. This has been translated into cost, where the price can reach 150 pounds/board. In radiant day, the board creates around 1.1Amp continually. The 100 boards charged 40 batteries, every expense 102 pounds and 3 years’ expiration date. Moreover, three inverters are introduced that expenses 660 pounds. Subsequently, the underlying expense of this experiment is \( (100 \times 150 + (40 \times 100) + 660) \), that is about, 19,660 pounds. To create reasonable outcomes, the \( t \) that is mentioned in \( (3) \) has been selected as three years. Such time is indistinguishable from battery expiry time. The explanation of picking such time because after three years, the batteries demand substitution and forces additional expenses for the system.

It merits referencing that the such expiry time is perfect, for all intents and purposes, because it is susceptible for additional decrement due to consistent utilization of the batteries. Accordingly, the expiry time is diminished by factor \( @ \). Henceforth, the expiry time for the batteries, as an element of \( t \), is presented \( E \chi_c(t) = Acc(t) - N \), as \( Acc(t) \) indicates the battery expiry date. Likewise, the boards and inverter have no expiry time, yet, they are obligated with different device’s aftermaths, for example, maintenance, efficiency and reliability.

5. Results
The most significant parameter for our model is represented by \( t \), because it is in charge of demonstrating when do the investors recover their expenses, and when does the CEF for the green and traditional match? As recently referenced, at \( t \), batteries should be re-established, which implies the expense to be restored inside the overall expense.

| Table 1. Network Parameters. |
|-----------------------------|
| **Factor** | **Traditional** | **Green** |
| \( \kappa \) | 0.0071 | 0.007 |
| \( \nabla \) | 0.00040 | 0.0004 |
| \( \ell \) | 0.00021 | 0.0006 |
| \( \varepsilon \) | 0.00021 | 0.0008 |
| \( \eta \) | 0.00032 | 0.01 |
| \( \iota \) | 0.0042 | 0.02 |
| \( \Sigma \) | 0.0011 | 0.015 |
| \( \vartheta \) | 0.0013 | 0.01 |
| \( \xi \) | 0.0014 | 0.009 |
| \( \aleph \) | 0.501 | 0.5 |
These parameters of Table 1 have been utilized for delivering conclusive outcomes. An examination is made among green, together with conventional. Sufficiency of green can be assessed utilizing (1), where it is equivalent to 0.9902, this implies it is equivalent to 99.02% when n=100, whilst the conventional is equivalent to 100% or 1. The economy parameter has been partitioned to 4 columns, while the occupations are expected to rise after sometime between 22% to 52%, correspondingly to investing, whereas the ambiguousness parameter is reduced over long haul. Besides, the costs of green gadgets drastically decline t. Since this model presents future signs, the last desire for every parameter can be somewhat adjusted, while keeping a similar conduct. In the event that we expect the traditional case, at that point the extended employment opportunities are not exactly as green, the open door for investing becomes lesser when compared to green. In addition, ambiguousness decreases as well.

Concerning OPEX and CAPEX, more often than not, the required topographical region for green task is unmistakably bigger than the conventional generators requirements. In our test, the region is around 800 m². Be that as it may, this territory is reduced to about 700m² by accommodating and tilting the panels around 30 degrees towards the sun rise. Furthermore, the arrangement cost De is expected just like the main establishment cost. Since De is directly corresponding to A, impact of De becomes larger with green system.

| Area (m²) | Rent | Maintenance | overall maintenance | Installing | OPEX and CAPEX |
|-----------|------|-------------|---------------------|------------|----------------|
| 400       | 0.4112 | 0.3214 | 0.4221       | 0.2234     | 1.0213         |
| 450       | 0.4734 | 0.3887 | 0.4842       | 0.2832     | 1.0876         |
| 500       | 0.4915 | 0.4134 | 0.5131       | 0.3125     | 1.2543         |
| 550       | 0.5122 | 0.4223 | 0.5223       | 0.3213     | 1.4221         |
| 600       | 0.5767 | 0.4845 | 0.5866       | 0.3845     | 1.4723         |
| 650       | 0.6124 | 0.5212 | 0.6232       | 0.4223     | 1.6441         |
| 700       | 0.6756 | 0.5836 | 0.6854       | 0.4816     | 1.7829         |

In the maintenance, deployment and lease expenses are presented Table 1. The environment plays critical role while choosing the technology for empowering a system. As to green structure, requesting to diminish CO2 emissions is required. Henceforth, accepted that environment impact to be less contrasted with conventional generators. In particular, the green power diminishes CO2 cost from 0.61 to 0.31, while conventional scales the cost from 0.61 to unity. In Table 2, it was demonstrated the all-out green and customary costs, it very well presented that underlying venture of green power to be
nearly multiplied in contrast with conventional. As we have expected the spending of this test (19,660 pounds) is proportional to 1 within cost pattern. Subsequently, duplicating the expenses of Table 2 by 19,660 pounds results total expense. Subsequently, information of Table 3 are effectively changed over to identify the cost efficiency (SE/pounds). Subsequently, it is important to think about this amplified measure of costs if moving from conventional to green. Nevertheless, the expenses of traditional and green sources even out after about 40% of the time, about 1 year. From there on, it is conceivable to recuperate the green costs rapidly as the expense drops drastically.

Table 3. Cost comparisons of traditional and green energy sources.

| Time (t₀) | Cost (Pounds) | Total Cost | Total Cost |
|-----------|---------------|------------|------------|
|           |               | Green      | Traditional|
| 0         | 5.5787        | 3.1342     |
| 10        | 5.5221        | 3.3256     |
| 20        | 5.3768        | 3.5153     |
| 30        | 5.1229        | 3.5612     |
| 40        | 4.9134        | 3.5512     |
| 50        | 4.7345        | 4.1268     |
| 60        | 4.6123        | 4.3314     |
| 70        | 4.5114        | 4.4129     |
| 80        | 4.5125        | 4.5456     |
| 90        | 4.5465        | 4.5591     |

By utilizing (5), the $CEF$ execution becomes possible, as appeared in Table 3, conventional technique behaves better. Moreover, conventional $CEF$ is at first twofold the green one, in light of the high essential venture, installing and costs of innovation. Later about 70% of timeframe, green expense ($Cost_g$) turns out to be lesser, this directs green $CEF$ pushing forward of the conventional partner. Batteries cost speaks to 26% from the all-out expense and consequently, after 2.5-time, green $CEF$ falls for such sum due to substitution.

Table 4. CEF evaluation for green and traditional sources in five years' time.

| Time (t₀) | Bit/s/Hz/Cost | Cost efficiency   | Cost efficiency   |
|-----------|---------------|--------------------|--------------------|
|           |               | Green              | Traditional        |
| 0         | 72.1236       | 136.5787           |
| 10        | 75.1234       | 129.5221           |
| 20        | 78.1232       | 124.3768           |
| 30        | 81.1230       | 117.9573           |
| 40        | 84.1228       | 111.8564           |
| 50        | 85.1226       | 105.7554           |
| 60        | 87.1224       | 99.6545            |
| 70        | 90.1222       | 93.5535            |
| 80        | 92.1220       | 92.4526            |
| 90        | 94.1218       | 89.3516            |
6. Conclusions and recommendations
The work displayed a model which demonstrates the exchange offs associated while using conventional and green power. The proposed numerical model aides to evaluate various factors to show when green power is supported. In spite of this model is explicit with respect to the quantity of boards or batteries. However, the model can fill the generality case that covers various nations, locales and equipment. For instance, the present costs of solar panels shift for various sellers, and influenced by tax rate, factory cost, importing and type of solar panels or batteries. In light of the trial information, this exploration has demonstrated that the underlying expense of green power is double the conventional. This expense is recovered in around 1 year, trailed with huge CEF gain. In 3 years time, the battery expense debases CEF. The CEF for various sustainable power is contrasted with the proposed work. Furthermore, this model opens an exchange regarding the performance indicator which impacts green networks, for example, economy or environment. Thus, the proposed work operates as a device for surveying CEF for distinctive next generation innovations and recommendations, at the same time powering these innovations utilizing sustainable sources.

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