# Mobile Capacity Inputs

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| **4G** | | | **5G** | | |
| **Parameter** | **Value** | **Source** | **Parameter** | **Value** | **Source** |
| Transmitter antenna type | Directional | [1] | Transmitter antenna type | Directional | [1] |
| Transmitter Power, Tx (dBm) | 43-46 | [2] | Transmitter Power, Tx dBm | 40 | [1] |
| Transmitter Antenna Gain (dBi) | 15-18 | [2] | Transmitter Antenna Gain (dBi) | 16 | [1] |
| Transmitter height (m) | 30 | [1] | Transmitter height (m) | 30 | [1] |
| UE antenna gain (dBi) | -5 - 10 | [2] | UE antenna gain (dBi) | 4 | [1] |
| UE antenna height (m) | 1.5 | [1] | UE antenna height (m) | 1.5 | [1] |
| Transmitter Feeder Loss (dB) | 2 | [3] | Transmitter Feeder Loss (dB) |  |  |
| Transmitter fade margin (dB) | 10 | [3] | Transmitter fade margin (dB) |  |  |
| UE losses (dB) | 4 |  | UE losses (dB) | 4 | [1] |
| UE fade margin (dB) | 0 | [3] | UE fade margin (dB) | 0 |  |
| Interference margin (dB) | 2 | [3] | Interference margin (dB) |  |  |
| UE noise figure (dB) | 8 | [3] | UE noise figure (dB) | 9 | [4] |
| Total sub-carriers | 512 | [3] | Total sub-carriers |  |  |
| Bandwidth (MHz) | 10 | [5] | Bandwidth (MHz) | 10 | [1] |
| Number of sectors | 3 | [6] | Number of sectors | 3 | [1] |
| Transmitting frequency (GHz) | 0.7, 1.8 | [5] | Transmitting frequency (GHz) | 0.7, 0.85 | [1] |
| Frequency reuse factor | 1 | [1] | Frequency reuse factor | 1 | [1] |
| Propagation model | HO | [7] | Propagation model | HO | [7] |
| System temperature (k) | 294 |  | System temperature (k) | 294 |  |
| Network load | 0.5, 0.6, 0.8 |  | Network load | 0.5, 0.6, 0.8 |  |
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Noise figure calculation: Evaluation of Radio Communication Links of 4G Systems

# Emissions Inputs

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| **Manufacturing Phase** | | | | | |
| **Parameter** | | | | **Value** | **Source** |
| BBU & RRU printed circuit board (kg) | | | | 28.2 | [8] |
| BBU & RRU Aluminum (kg) | | | | 112.8 | [8] |
| Antenna system copper (kg) | | | | 47.6 | [8] |
| Antenna system Aluminum (kg) | | | | 19.7 | [8] |
| Antenna system PVC (kg) | | | | 6.8 | [8] |
| Antenna system iron (kg) | | | | 8.5 | [8] |
| Antenna system steel (kg) | | | | 89.9 | [8] |
| Tower (kg) | | | | 11,967.1 | [8] |
| Aluminium frame (kg) | | | | 69 | [8] |
| Steel pole (kg) | | | | 30.4 | [8] |
| Machine room concrete (kg) | | | | 98,524.8 | [8] |
| Machine room steel (kg) | | | | 895.7 | [8] |
| Basic device Aluminum (kg) | | | | 66.8 | [8] |
| **Transportation Phase** | | | | | |
| **Parameter** | | | | **Value** | **Source** |
| Vehicle emission factor (kg CO2 eq.) | | | | 0.3234 |  |
| Class 8 truck fuel consumption (liters per km) | | | | 2.4 | [9] |
| Light truck/van fuel consumption (liters per km) | | | | 7.652 | [9] |
| **Construction Phase** | | | | | |
| **Parameter** | | | | **Value** | **Source** |
| Machinery fuel efficiency (liters/hr) | | | | 24.33 | [10] |
| Machine operating hours (hours) | | | |  |  |
| Diesel emission factor (kg CO2 eq.) | | | | 2.68 | [11] |
| **Operations Phase** | | | | | |
| **4G** | | | **5G** | | |
| **Parameter** | **Value** | **Source** | **Parameter** | **Value** | **Source** |
| CPE power consumption (kWh) |  |  |  |  |  |
| Energy consumption (kWh) | 1.1 | [6] | Energy consumption (kWh) | 4.3 | [6] |
| Base band unit power, PBBU (W) | 89.377 | [6] | Base band unit power, PBBU (W) | 305.04 | [6] |
| Slope () | 6.6283 | [6] | Slope () | 1.6928 | [6] |
| Offset () | 156.6234 | [6] | Offset () | 389.7695 | [6] |
| Remote radio unit power, PRRU (W) | 288.8752 | [6] | Remote radio unit power, PRRU (W) | 406.6975 | [6] |
| Electricity emission factor (kg CO2 eq) | 0.1934 | [12] | Electricity emission factor (kg CO2 eq) | 0.1934 | [12] |
| **Material Carbon emission Factors (kg CO2 eq.)** | | | | | |
| **Material** | | | | **Value** | **Source** |
| Printed circuit board, (kg CO2 eq.) | | | | 29.76 | [6] |
| Aluminium, (kg CO2 eq.) | | | | 19.4 | [6] |
| Copper, (kg CO2 eq.) | | | | 4.91 | [6] |
| PVC, (kg CO2 eq.) | | | | 3.413 | [12] |
| Iron, (kg CO2 eq.) | | | | 2.14 | [6] |
| Steel, (kg CO2 eq.) | | | | 2.56 | [6] |
| Concrete, (kg CO2 eq.) | | | | 0.12 | [6] |
| **End of the Life Treatment, Open-Loop Recycling Carbon emission Factors (kg CO2 eq.)** | | | | | |
| **Material** | | | | **Value** | **Source** |
| Printed circuit board, (kg CO2 eq.) | | | | 21.28 | [6] |
| Aluminium, (kg CO2 eq.) | | | | 0.9847 | [6] |
| Copper, (kg CO2 eq.) | | | | 0.9847 | [6] |
| PVC, (kg CO2 eq.) | | | | 21.28 | [12] |
| Iron, (kg CO2 eq.) | | | | 0.9847 | [6] |
| Steel, (kg CO2 eq.) | | | | 0.9847 | [6] |
| Concrete, (kg CO2 eq.) | | | | 0.9847 | [6] |

Considering in Watts, the remote radio unit power (PRRU) is given by;

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| --- | --- |
|  | (1) |

The

References

[1] E. J. Oughton, K. Katsaros, F. Entezami, D. Kaleshi, and J. Crowcroft, “An Open-Source Techno-Economic Assessment Framework for 5G Deployment,” *IEEE Access*, vol. 7, pp. 155930–155940, 2019, doi: 10.1109/ACCESS.2019.2949460.

[2] M. Ayad, R. Alkanhel, K. Saoudi, M. Benziane, S. Medjedoub, and S. S. M. Ghoneim, “Evaluation of Radio Communication Links of 4G Systems,” *Sensors*, vol. 22, no. 10, Art. no. 10, Jan. 2022, doi: 10.3390/s22103923.

[3] M. Deruyck, W. Joseph, and L. Martens, “Power consumption model for macrocell and microcell base stations,” *Transactions on Emerging Telecommunications Technologies*, vol. 25, no. 3, pp. 320–333, 2014, doi: 10.1002/ett.2565.

[4] K. Bechta, J. Du, and M. Rybakowski, “Rework the Radio Link Budget for 5G and Beyond,” *IEEE Access*, vol. 8, pp. 211585–211594, 2020, doi: 10.1109/ACCESS.2020.3039423.

[5] E. J. Oughton, N. Comini, V. Foster, and J. W. Hall, “Policy choices can help keep 4G and 5G universal broadband affordable,” *Technological Forecasting and Social Change*, vol. 176, p. 121409, Mar. 2022, doi: 10.1016/j.techfore.2021.121409.

[6] T. Li *et al.*, “Carbon emissions of 5G mobile networks in China,” *Nat Sustain*, vol. 6, no. 12, Art. no. 12, Dec. 2023, doi: 10.1038/s41893-023-01206-5.

[7] T. Rappaport, *Wireless Communications: Principles and Practice*, 2nd ed. Cambridge University Press, 2024. Accessed: Sep. 24, 2024. [Online]. Available: https://www.cambridge.org/us/academic/subjects/engineering/wireless-communications/wireless-communications-principles-and-practice-2nd-edition, https://www.cambridge.org/us/academic/subjects/engineering/wireless-communications

[8] Y. Ding, H. Duan, M. Xie, R. Mao, J. Wang, and W. Zhang, “Carbon emissions and mitigation potentials of 5G base station in China,” *Resources, Conservation and Recycling*, vol. 182, p. 106339, Jul. 2022, doi: 10.1016/j.resconrec.2022.106339.

[9] US department of Energy, “Average Fuel Economy by Major Vehicle Category.” Accessed: Sep. 25, 2024. [Online]. Available: https://afdc.energy.gov/data/10310

[10] Climate Neutral Group, “Research Report: Carbon Footprint of Construction Equipment,” European Rental Association, Brussels, 2019.

[11] US Energy Information Administration, “Carbon Dioxide Emissions Coefficients.” Accessed: Aug. 28, 2024. [Online]. Available: https://www.eia.gov/environment/emissions/co2\_vol\_mass.php

[12] United Kingdom Government, “Government conversion factors for company reporting of greenhouse gas emissions,” Department of Business, Energy and Industrial Strategy, London, Jun. 2023. Accessed: Feb. 07, 2024. [Online]. Available: https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting