



SUSTAINABILITY DIVISION

Research, Testing and Development

Technical Memorandum

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 Eskom	RT&D TECHNICAL MEMORANDUM		
Cost of Unserved Energy 2021 & 2022 Update	Memorandum No RTD/CONS/2022/1963682	Rev. A	Page 2/8

1 INTRODUCTION

Cost of Unserved Energy (COUE) is used to provide an economic value to the cost of electricity interruptions to electricity customers and the economy. These values are used to inform several investment and refurbishment decisions on the electrical power system, with the aim of optimising the reliability of the network.

Both the South African Grid Code and the Distribution Network Code require a NERSA-approved method of determining Cost of Unserved Energy (COUE) as a key economic parameter for network investment criteria. Additionally, COUE is defined as an input parameter to South Africa's Integrated Resources Plan for future generation investment.

During 2015 a COUE methodology was proposed by Eskom and approved by the NERSA [1]. As a condition of the methodology approval, it was agreed that Eskom would annually update the COUE results with the latest available economic data (as released by StatsSA) and electricity sales data.

This document describes the 2021 and 2022 COUE update.

2 REVIEW AND UPDATE PROCEDURE

The 2021 and 2022 update to the COUE model did not involve methodology changes. The COUE model update was thus only on the new data for 2021 and 2022 (GDP & employment data, Eskom sales, and Eskom customers). The full update details conducted to the COUE model as part of the 5 Year review are as follows:

- The GDP and employment data update was with the Statistics South Africa 4th quarter GDP report (excel file: GDP P0441 – 2021 Q4, and GDP P0441 – 2022 Q4),
- The Eskom customers and sales data for 2021 come from Eskom's Pricing and Sales division,
- The Eskom customers and sales data for 2022 come from Eskom's 2022 Integrated Report,
- Calculate the 2021 and 2022 Official COUE.

Also, worth to note:

1. The *Residential* record in the COUE model combines the *Residential* and *Pre-Paid* values from the sales data provided.
2. The *Redistributors* field in the COUE model links to the *Bulk/Distributors* field.
3. Lastly, in the Eskom sales table, the Eskom domestic sales (GWh) calculation is done by subtracting the international sales from the Eskom sales.

This submission supersedes the 2021 submission (2021 results are included in the model itself) as several interactions took place between the Eskom and NERSA technical teams with respect to modelling outcomes that took time to resolve. Given the delay this caused it was agreed to submit the 2022 COUE results as data had become available.

3 COUE 2021 & 2022 RESULTS

The macro-economic method is used to update the COUE figures as approved by NERSA. The method uses official, published macro-economic data such as gross domestic product

 Eskom	RT&D TECHNICAL MEMORANDUM		
Cost of Unserviced Energy 2021 & 2022 Update	Memorandum No RTD/CONS/2022/1963682	Rev. A	Page 3/8

(GDP) (and gross value added (GVA)) and household expenditure measures. This method divides the macro-economic indicators by total electricity usage to estimate a cost of interruption per kWh.

3.1 COUE OUTPUT MEASURES: ECONOMIC AND RESIDENTIAL

The method used estimates:

1. An Economic COUE for economic sectors that use electricity for production purposes; and
2. A Residential COUE for households that use electricity for various household applications.

The Economic COUE, following from the COUE definition, measures the value (in Rand GVA per kWh) placed on unit of electricity not supplied due to an unplanned outage of short duration (less than three hours). For economic activities, Gross Value Added (GVA) (see footnote¹ for relationship between GVA and Gross Domestic Product (GDP)) is used as an indicator of economic activity. Annual GVA and GDP, by economic sectors, are both officially measured and reported annually by Statistics South Africa.

The Economic COUE is expressed both as direct and total impacts on the economy. Thus, the direct cost of short duration power outages to the economy is measured in terms of production opportunity forgone, as GVA/kWh per economic sector.

The Residential COUE is measured as the portion of household expenditure, by South African households, on goods and services that are electricity dependent, expressed as a ratio of residential electricity consumption. Residential lifestyles are increasingly electricity dependent for goods and services such as communication, personal care, security, education, household income generation and leisure activities. Short duration power outages result in an opportunity cost of not having or using these goods and services and results in discomfort, nuisance and lost leisure opportunities.

3.2 DIRECT AND INDIRECT NATIONAL ECONOMIC COUE ESTIMATE

The national COUE estimates are calculated for the latest available GDP data from StatsSA. In this case it is for the 2022 calendar year. The updated methodology has closed the 2-year time lag and produces a historic data.

The estimated direct COUE = 39.24 R/kWh and the Total Effect COUE = 137.42 R/kWh for 2021. Table 1 indicates the economic and electricity sales data associated with the COUE estimates.

¹ GVA and GDP are both measures of economic output. The relationship is defined as $GVA + \text{taxes on products} - \text{subsidies on products} = GDP$. As the total aggregates of taxes on products and subsidies on products are only available at the national economy level, GVA is used for measuring gross regional domestic product and other measures of the output of entities smaller than a whole economy.

 Eskom	RT&D TECHNICAL MEMORANDUM		
Cost of Unserved Energy 2021 & 2022 Update	Memorandum No RTD/CONS/2022/1963682	Rev. A	Page 4/8

The estimated direct COUE = 40.08 R/kWh and the Total Effect COUE = 140.37 R/kWh for 2022. Table 2 indicates the economic and electricity sales data associated with the COUE estimates.

Sector	GVA / Income	Total economic electricity use	Direct Effect	Total Effect
Units	R millions	GWh	R GVA	R GVA
1 Agriculture	150 857	5 461	27.62	92.62
2 Mining	480 992	26 991	17.82	70.58
3 Manufacturing	726 429	50 193	14.47	134.72
4 Electricity	171 865	17 054	10.08	35.91
5 Construction	138 976	453	307.05	598.81
6 Trade	759 773	7 990	95.09	115.98
7 Transport	392 313	1 931	203.18	811.95
8 Finance	1 319 923	13 002	101.52	392.36
9 Community services	941 413	9 042	104.12	205.02
10 General Government	480 937	9 668	49.75	59.68
Total	5 563 477	141 783	39,24	137,42

Table 1: Economic COUE for South Africa at aggregated national economy level for 2021

Sector	GVA / Income	Total economic electricity use	Direct Effect	Total Effect
Units	R millions	GWh	R GVA	R GVA
1 Agriculture	170 644	5 382	31.71	106.31
2 Mining	484 664	28 030	17.29	68.48
3 Manufacturing	799 529	64 885	12.32	114.70
4 Electricity	193 210	25 826	7.48	26.66
5 Construction	145 214	597	243.26	474.41
6 Trade	803 286	4 346	184.82	225.43
7 Transport	448 861	2 128	210.93	842.94
8 Finance	1 407 611	7 073	199.02	769.21
9 Community services	967 962	4 918	196.80	387.52
10 General Government	528 688	5 259	100.53	120.61
Total	5 949 671	148 444	40.08	140.37

Table 2: Economic COUE for South Africa at aggregated national economy level for 2022

The historic COUE data is shown in Figure 1. The COUE history plot shows that there has been a sharp increase in the 2021 COUE value, as compared to previous years. In 2022 the trend increase is not as large as the year prior, and this has resulted in the national Total COUE increasing from 137.42 R/kWh in 2021 to R140.37 R/kWh in 2022.

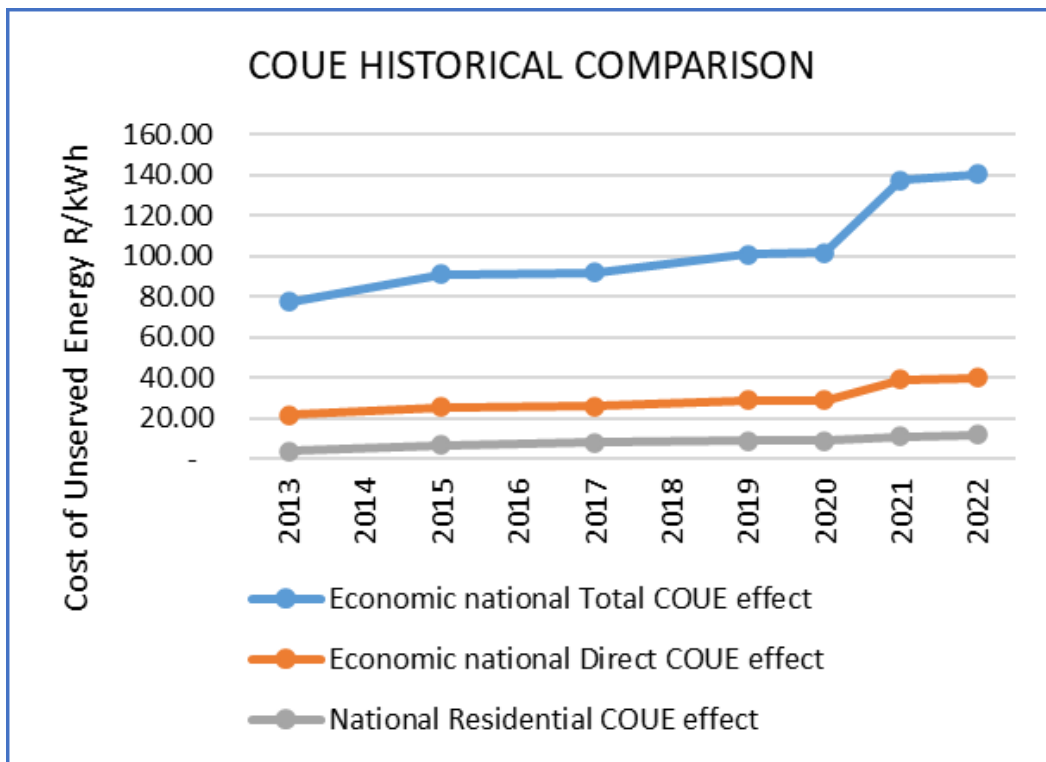


Figure 1: COUE History

The sharp increase in COUE over the last calendar year can be attributed to the overhaul of the national accounts conducted by StatsSA which resulted in a rebasing and upward revision of South Africa's GDP. The rebasing exercise indicated that South Africa's economy was 11% larger in 2020 than previously estimated and all estimations and calculations based on these revised GPD values also see an upward shift.

3.3 RESIDENTIAL COUE

Whereas the Economic COUE estimated above provides a proxy measure for the dependence of economic productivity on electricity, the Residential COUE provides a proxy measure for the utility of using electricity in the household. Consequently, short duration power outages result in a discomfort or nuisance value. This is because, in well-planned power systems, for which the COUE measure is relevant, it is extremely unlikely that household behaviour and expenditure patterns will change as a result of households' anticipation of possible power outages.

The 2021 and 2022 residential COUE is shown below.

COUE: Household Effect	Residential
Total household income (compensation of employees)	2 836 258
Electricity dependent household expenditure	14,3%
Household leisure and convenience expenditure (R millions)	406 466
Total residential electricity use (GWh)	36 479
Electricity utility (R HH Expenditure/kWh)	11,14

Table 3: Residential COUE 2021

 Eskom	RT&D TECHNICAL MEMORANDUM		
Cost of Unserved Energy 2021 & 2022 Update	Memorandum No RTD/CONS/2022/1963682	Rev. A	Page 6/8

COUE: Household Effect	Residential
Total household income (compensation of employees)	3 009 551
Electricity dependent household expenditure	14.3%
Household leisure and convenience expenditure (R millions)	431 301
Total residential electricity use (GWh)	36 539
Electricity utility (R HH Expenditure/kWh)	11.80

Table 4: Residential COUE 2022

4 ECONOMIC IMPACT OF INTERRUPTIONS GREATER THAN 3 HOURS

The cost of unserved energy (COUE) is the measure used to provide an estimate of the cost of unplanned outages of duration less than 3 hours. This is typically interruptions that occur in the normal course of power system operation and for which users have little or no forewarning. This methodology does not account for the resilience, response to warning and adaptive response of electricity consumers to persistent interruptions, particularly where forewarning is provided.

The COUE methodology is not appropriate for planned and longer duration interruptions as well as the impact of loadshedding on the economy. To account for planned interruptions of longer duration, as typically found during loadshedding events, Eskom commissioned an independent economic study (conducted by NOVA Economics) to estimate the Cost of Loadshedding (CoLS). This study utilised econometric methods, based on historic economic, electricity usage and loadshedding data and produced estimates for loadshedding per economic sector as well as an overall impact on the economy.

The overall impact of the Cost of Loadshedding based on this study estimated the cost of Loadshedding as 9.53 R/kWh (year 2020).

 Eskom	RT&D TECHNICAL MEMORANDUM		
Cost of Unserved Energy 2021 & 2022 Update	Memorandum No RTD/CONS/2022/1963682	Rev. A	Page 7/8

5 CONCLUSION

The Cost of Unserved methodology has been updated as required by the methodology and NERSA. The COUE results for 2021 and 2022 are as follows:

Customer Interruption Costs	Direct Effect (R GVA/kWh)	Total Effect (R GVA/kWh)
Agriculture	27.62	92.62
Mining	17.82	70.58
Manufacturing	14.47	134.72
Electricity and Water Supply	10.08	35.91
Construction	307.05	598.81
Trade	95.09	115.98
Transport and Communication	203.18	811.95
Finance	101.52	392.36
Community Services	104.12	205.02
General Government	49.75	59.68
Residential	N/A	11.14
Total Economy	39.24	137.42

Table 5: COUE results for 2021

Customer Interruption Costs	Direct Effect (R GVA/kWh)	Total Effect (R GVA/kWh)
Agriculture	31.71	106.31
Mining	17.29	68.48
Manufacturing	12.32	114.70
Electricity and Water Supply	7.48	26.66
Construction	243.26	474.41
Trade	184.82	225.43
Transport and Communication	210.93	842.94
Finance	199.02	769.21
Community Services	196.80	387.52
General Government	100.53	120.61
Residential	N/A	11.80
Total Economy	40.08	140.37

Table 6: COUE results for 2022

Longer duration planned interruptions are calculated by means of the Cost of Loadshedding study, a separate study, conducted independently of COUE.

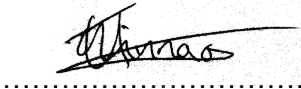
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