EEA fondată în 1950
ELECTROTEHNICĂ, ELECTRONICĂ, AUTOMATICĂ

pag. Articole

Miscellanea Section

* * *

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Home

Electrotehnică, Electronică, Automatică (EEA)
Founded in 1950
The new series since 1974

The **Electrotehnică, Electronică, Automatică (EEA)** [Electrical Engineering, Electronics, Automation] is a scientific journal publishing papers in the field of the engineering both in print and online.
The print and online versions of all papers are identical.
The online open access ensures a high visibility of the papers.
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online ISSN: 2392-828X

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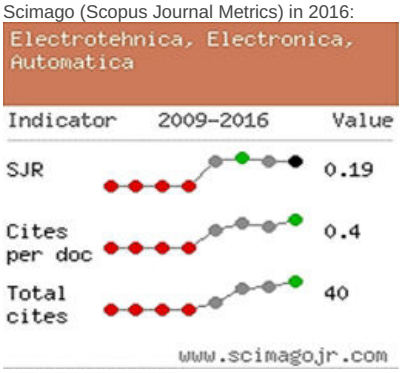

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About

Subcategories »

- History
- Journal Genealogy

T h e **Electrotehnică, Electronică, Automatică (EEA)** [Electrical Engineering, Electronics, Automation] is a peer-reviewed scientific journal in the field of the engineering published by "Electra" Publishing House (as part of Icpe).

Scope
The EEA Journal aims to publish only those papers that by the new ideas and the results shown to bring significant contributions to research in the Romanian and international avant-garde engineering as electrical engineering, electronics, automation and other engineering sciences.

Abstracting and indexing
The EEA journal is included in the B+ category by the National Council of Scientific Research in Higher Education (CNCSIS) and indexed in international databases:
Ulrichsweb.com™ (1997-present) (Since 2007, Ulrich's becomes a part of Serials Solutions in the ProQuest family.)
Index Copernicus International (2009)
Elsevier- Engineering Village-Scopus (2012)
Elsevier- Engineering Village-Compendex (2012)
ProQuest (2010)
EBSCO (2014)
Currently, EEA is under evaluation by Thomson Reuters - ISI.

Description
The EEA Journal is founded in **1950** under the name „Electricitatea" (ISSN 1220-2533; vol. 1-3) that, in 1953, changed its name in „Electrotehnica" (ISSN 0013-5321; vol. 1-22) that, in 1975, after including „Automatica și Electronica (ISSN 1220-2584), is published under the present name „Electrotehnica, Electronica, Automatica (EEA)" (for further details, please read "History" and "Journal Genealogy" on this site).
Since the early issues, although it was the only scientific journal specialized in the field of electrical engineering, and the EEA has been highly rated thanks to the scientific level of its papers.
The Editorial Board includes academicians, university professors and researchers from Romania and abroad that are well-known personalities in the field of engineering sciences (especially, in electrical, electronics, automation, computer science and other fields of engineering, etc.).
At present, the EEA is recognized as a leader among the scientific publications for the quality and high standards of the papers belonging to the field of engineering sciences. The authors are specialists, researchers and academics from Algeria, Belgium, PR of China, Finland, France, Germany, Italy, Moldova, Slovakia, Hungary, etc.
In the EEA, there are published original papers, that haven't been previously published and are not under consideration for publication somewhere else, as well as papers presented at conferences only if they have not been published (partially or fully) in the proceedings of that scientific event (min. 6 pages, max. 16 pages), syntheses of research projects, scientific debates and syntheses on priority themes of fundamental and applied research (max. 20 pages), reviews / reading notes of the latest scientific and technical books (max. 1 page), commented lists of bibliographic resources in engineering sciences (max. 8 pages).
Papers should be written in English.

EEA

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vol. 66 nr. 4 octombrie-decembrie 2018 publicaţie a ICPE ISSN: 1582-5175

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Icpe was founded by the Government Decision no. 868 of 5 August 1950 (under the name „Institutul de cercetări electrotehnice" [Institute of Electrical Research]).

Icpe is a complex structure that covers a wide range of innovative activities connected via the electric profile:

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"ELECTRA" Publishing House (founded in 1993) is listed among the publishers recognized by CNCS [National Council of R&D and High Education], starting 2001. So far, 300 technical and beyond books have been published. It is the editor of the journal *EEA*

The Technological Information Centre helps in the innovation implementation in economy and society by the dissemination information of the R&D results, technological documentation and operators training in order to facilitate the capitalization results.

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By its *HR structure* - as PhD researchers, scientists, doctoral students, master students and associated professors - Icpe has the scientific expertise to approach research topics of national or European level:

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Scopul revistei

Revista EEA își propune să publice numai acele articole care atât prin ideile noi, cât și prin rezultatele prezentate, să aducă contribuții importante la cercetarea românească de avangardă din electrotehnică, electronică, automatică, informatică și din celelalte domenii ale științelor inginerești.

Articolele, publicate în două versiuni pe suport de hârtie și online, sunt identice. Accesul liber online asigură o mare vizibilitate articolelor.

Prezentare

Revista EEA a fost fondată în anul 1950 sub numele de *Electricitatea* (ISSN 1220-2533; vol. 1-3) care, în 1953, și-a schimbat numele în *Electrotehnica* (ISSN 0013-5321; vol. 1-22), care, în 1975, după integrarea *Automatica și Electronica* (ISSN 1220-2584) apare cu numele actual ***Electrotehnică, Electronică, Automatică (EEA)*** [ISSN 1582-5175; e-ISSN 2392-828X] (pentru detalii, a se naviga pe site-ul www.eea-journal.ro).

Încă de la primele numere, deși era unica revistă specializată din domeniul electrotehnicii, EEA a fost constant apreciată pentru nivelul științific ridicat al articolelor publicate.

În prezent, EEA este recunoscută ca lider printre publicațiile științifice, pentru calitatea și standardele înalte ale articolelor apărute în domeniul științelor inginerești. Printre autori se numără specialiști, cercetători și cadre didactice din: Republica Algeriană Democratică și Populară, Regatul Belgiei, Canada, Republica Populară Chineză, Repubica Arabă Egipt, Republica Elenă, Republica Finlanda, Republica Franceză, Republica Federală Germania, Republica India, Republica Indonezia, Republica Italiană, Republica Moldova, Federația Rusă, Republica Serbia, Republica Slovacă, Regatul Spaniei, Republica Tunisia, Republica Turcia, Ungaria etc.

În paginile revistei, se regăsesc lucrări științifice originale care nu au mai fost publicate și care nu sunt luate în considerare pentru publicare în altă parte, cât și articolele prezentate la conferințe, cu condiția să nu fi fost publicate (parțial sau integral) în volumele manifestărilor științifice (min. 6 pag.-max. 16 pag.), sinteze ale unor proiecte de cercetare, dezbateri științifice și sinteze pe teme prioritare din cercetarea fundamentală și aplicativă (max. 20 pag.), recenzii / note de lectură ale celor mai recente apariții de cărți tehnico-științifice (max. 1 pag.), liste de resurse bibliografice comentate din domeniul științelor inginerești (max. 8 pag.).

Pentru a dovedi deschiderea către noile domenii de frontieră, Colegiul editorial a creat o secțiune-varia (*Miscellanea Section*), în care sunt publicate articole a căror tematică aparține altor domenii (matematică, științe socio-umane, științe economice, științele vieții și ale pământului (inclusiv mediul), științe agricole, științe medicale etc.) și care, *tangențial*, pot fi corelate cu domeniul științelor inginerești datorită viziunii, conexiunilor și al abordării inedite a subiectelor.

Revista are un *Colegiu de redacție* format din academicieni, profesori universitari și cercetători științifici din România și din străinătate – personalități recunoscute din domeniul științelor inginerești (în special, din electrotehnică, electronică, automatică și din celelalte domenii ale ingineriei).

Revista EEA este clasificată B+ de Consiliul Național al Cercetării Științifice din Învățământul Superior (CNCSIS) și este indexată în bazele internaționale de date: Elsevier, Scopus, Compendex, ProQuest, EBSCO, Ulrich's, Index Copernicus International. În prezent, este în proces de evaluare de Thomson Reuters - ISI.

Scope

The EEA Journal aims to publish only those papers that by the new ideas and the results shown to bring significant contributions to research in the Romanian avant-garde engineering as electrical engineering, electronics, automation and other engineering sciences.

The papers, published in two versions on paper and online, are identical. The online open access ensures a high visibility of the papers.

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At present, the EEA is recognized as a leader among the scientific publications for the quality and high standards of the papers belonging to the field of engineering sciences. The authors are specialists, researchers and academics from: People's Democratic Republic of Algeria, Kingdom of Belgium, Canada, Peoples' Republic of China, Arab Republic of Egypt, Republic of Finland, Republic of France, Federal Republic of Germany, Hellenic Republic, Hungary, Repubic of India, Republic of Indonesia, Italian Republic, Republic of Moldova, Russian Federation, Republic of Serbia, Slovak Republic, Kingdom of Spain, Tunisia Republic, Republic of Turkey etc.

In the EEA, there are published original papers that haven't been previously published and are not under consideration for publication somewhere else, as well as papers presented at conferences, only if they have not been published (partially or fully) in the proceedings of that scientific event (min. 6 pages, max. 16 pages), syntheses of research projects, scientific debates and syntheses on priority themes of fundamental and applied research (max. 20 pages), reviews / reading notes of the latest scientific and technical books (max. 1 page), commented lists of bibliographic resources in engineering sciences (max. 8 pages).

To prove the openness to new frontier areas, the Editorial Board has created a *varia* section (*Miscellanea Section*) for papers belonging to other thematic areas (mathematics, social studies, economics, life and earth sciences (including the environment), agricultural sciences, medical sciences, etc.) and, *tangentially*, they are related to engineering sciences thanks to vision, connections and novel approach of the topics.

The *Editorial Board* includes academicians, university professors and researchers from Romania and abroad that are well-known personalities in the field of engineering sciences (especially, in electrical, electronics, automation, computer science and other fields of engineering).

The EEA journal is included in the B+ category by the National Council of Scientific Research in Higher Education (CNCSIS) and indexed in international data bases: Elsevier, Scopus, Compendex, ProQuest, EBSCO, Ulrich's, Index Copernicus International. Currently, EEA is under evaluation by Thomson Reuters – ISI.

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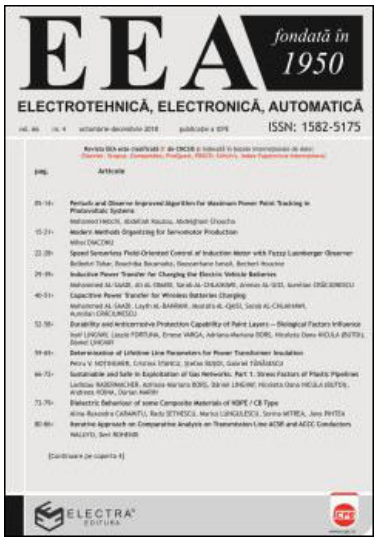

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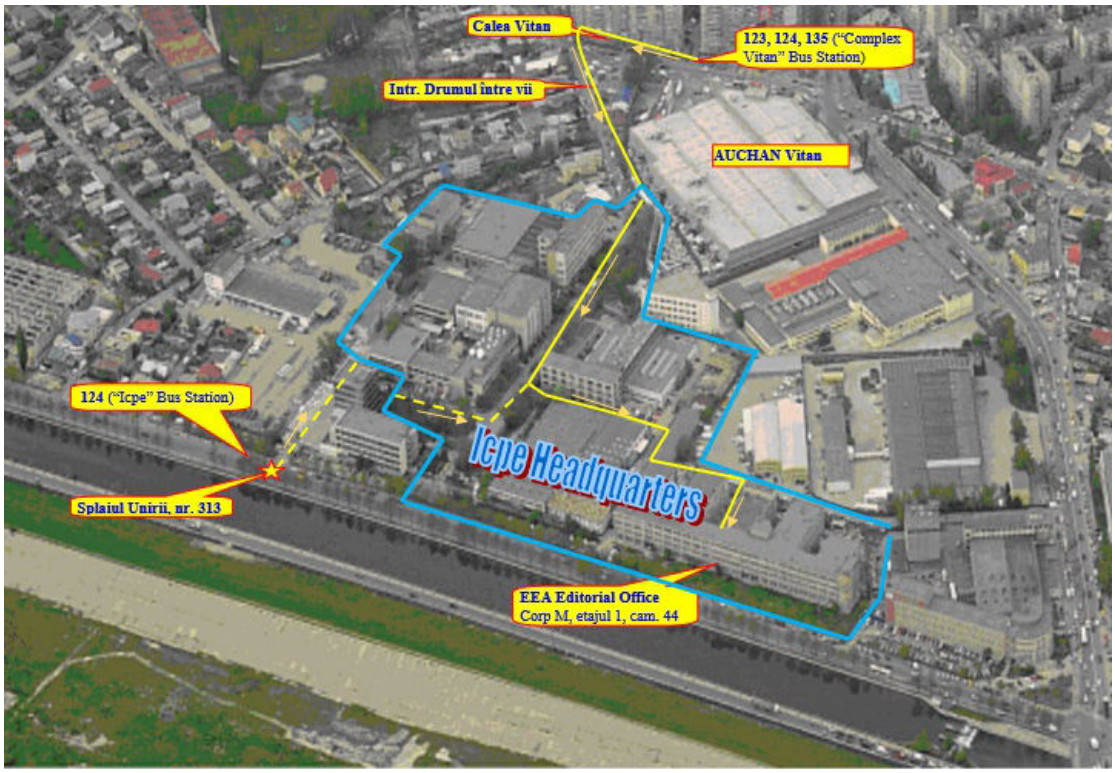

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- Electrical and Electronic Engineering

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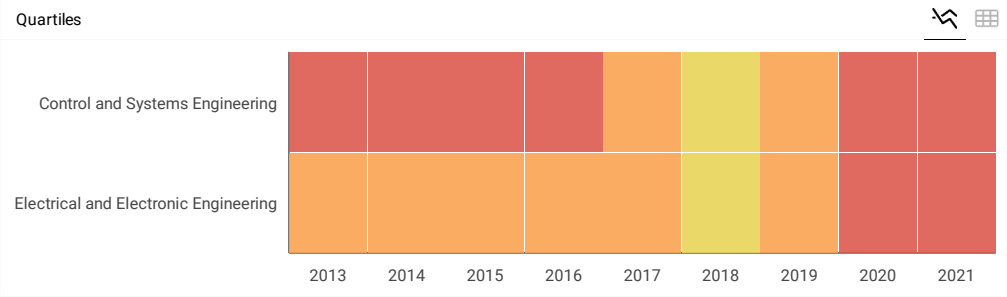

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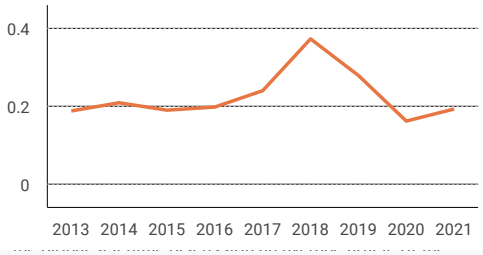

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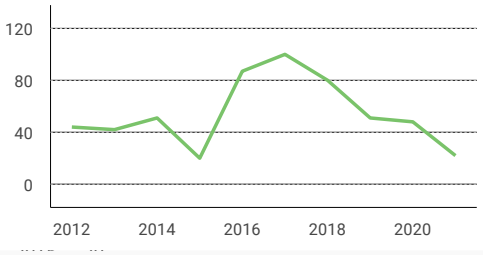

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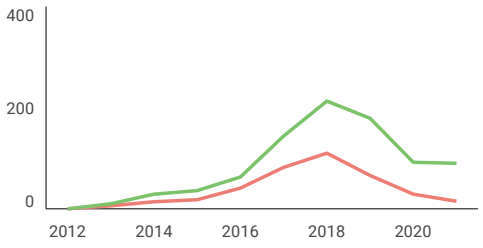

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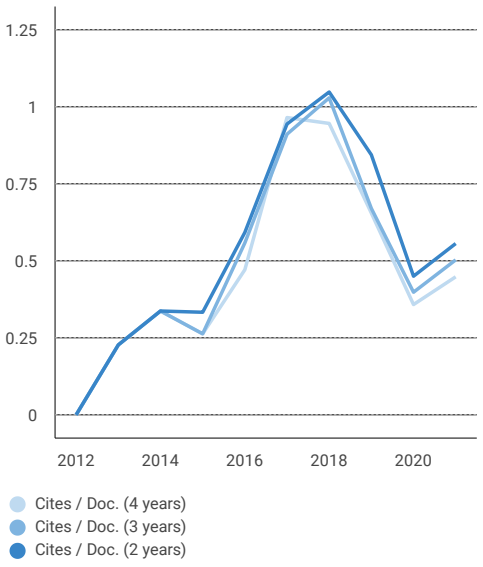

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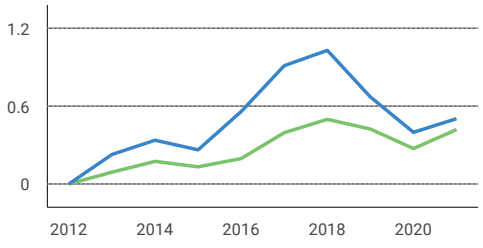

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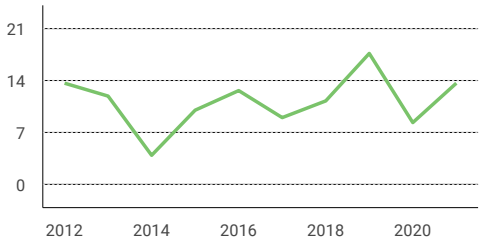

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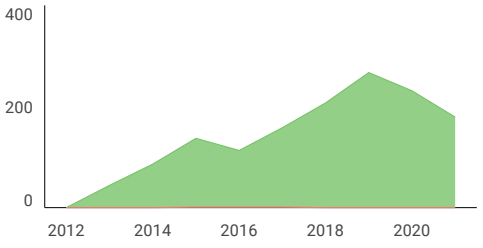

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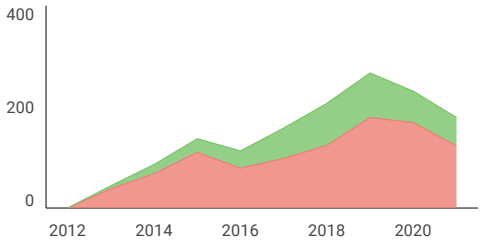

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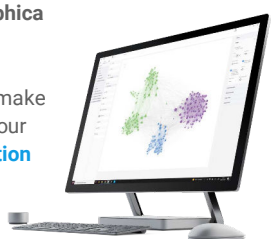

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Iterative Approach on Comparative Analysis on Transmission Line ACSR and ACCC Conductors

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Abstract

Electric demand always increases rapidly. For its transmission, it is necessary optimal systems in transmission lines. One of them is a high quality conductor type, where it is ACCC, as an alternative for ACSR conductors. This research was a comparative investigation in the iterative approach on the superior ACCC to ACSR conductors based on the data of external and internal factors. Furthermore, the data were used for computation, both ACCC and ACSR characteristics. The ACCC average temperature and wind sags, length, losses and drop voltage were 8.744%, 0.029%, 22.42% and 369.2% respectively than those ACSR. Thus, some characteristics of ACCC conductor have advantages compared to that ACSR conductor.

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1. Introduction

In recent year, electric power demand has increased drastically. The electric utilities have very significantly increased in applications, not only for industrial but also for domestic and commercial purposes.

Therefore, it is required high voltage transmission. Overhead high voltage (HV) and extra high voltage (EHV) transmission lines are in the air means to deliver large-scale electric power from generations to load centres using high voltage and extra high voltage systems respectively. The posed problems in using high voltages are different from those encountered at low voltages, such as corona. It is one of cause power losses and this is uneconomical and undesirable. The distance between generating stations and load centres as well as the amount of power to be handled increased to such extents used. Expansions of electrical transmission system are needed to access and deliver location-constrained renewable resources. Constructions of high-voltage transmission lines have been based on economic and reliability criteria [1]-[7].

The transmission lines in Indonesia, generally, are based on the high and extra high voltage classes. The high voltage class is 70 kV and 150 kV, and the extra high voltage class is 230 kV, 275 kV and 500 kV. The power transmission model had two types of transitions as the load power demand increased, because of the limit on total generator capacity, and characterized by a sudden jump in the power shed [8].

Losses in electric transmission system are ranged from 1.5 percent to 5.8 percent based on the utility loss studies. The primary lost source incurred in a transmission system is line conductor resistance [9]. It was the main parameter due to short distance in this case [10]. It was analysed the estimating transmission losses in planning studies [11].

Under rainy weather, rain-induced vibration on high-voltage transmission line often occurs, which intensifies fatigue conductors and tower collapses [12]-[13]. The data were inadequate to judge whether the environmental standards should be the same or significantly different from a transmission line appropriate to protect human health [14].

Power transmission line exhibits many electrical properties, such as inductance and capacitance for various transmission line configurations [15].

Although there is not any certain known mechanism of how the electromagnetic fields at power frequency (50/60 Hz) to influence human health, it has been epidemiologically shown that they have many hazards on human health. As an example, magnetic and electric fields reductions can reach up to 81 % and 84 %, respectively, considering ice and wind effects, and it can reach up to 97 % for both magnetic and electric fields, neglecting the effects of ice and wind [16].

The influence of electric power transmission is a controversial issue for sitting of transmission lines [17].

Up rating, upgrading, life extension, refurbishment and increased capacity were the associated probability of failure and consequences of failure [18].

There are many types of conductors for transmission lines. Overhead transmission lines generally use ACSR conductor type, where it has allowable maximum temperature of 90 ^{o}C. To take into consideration of increasing electric demand recently, it is necessary to effort to expand of transmission line capacity with developing new transmission, as Prasetyono said [19-20].

ACSR (aluminium conductor steel reinforced) is the conductor with steel core surrounded by aluminium based alloy layer.

The conventional conductors having allowable temperature limit does not exceed 75 °C on a daily loading, and in an emergency condition, it may be increased up to 90 °C [21].

Lamsoul [22] revealed that a better knowledge of the actual capability or the real capacity and availability of the overhead transmission line obtained by the standard methodology of technical audit and the historical data based on performance statistics and inspection reports. A strain in overhead power line tower shows a correlation to temperature, which change conductor length, sag and tensile force. A strain change is possible to detect a change in force and sag conductor [23].

The reduced thermal elongation coefficient is one of the greatest advantages that ACCR and ACCC/TW conductors offer on overhead lines [24].

It has been developed the high-capacity low-sag ACCC conductor. The ACCC conductor operated at 60 °C to 80 °C cooler than the other conductors tested under equal load conditions [25].

Another type of ACSR conductor is GTACSR conductor, which is the one that allows a greater increase in the operating temperature, to around 80 ºC [26]. HTLS (high temperature low sag) conductors, for instance as ACCC, could be an important cost effective solution to up rating existing transmission lines [27].

ACCC-CNS line has superior performance compared to that of ACSR line in terms of reduced operating temperature and line sag [28]. ACCC/TW conductors have very low sag values, which result of the very low thermal expansion coefficient and density, as well as high modulus [29].

The strength of ACCC/TW at 100 ºC to 180 ºC decreased only 10 % from the room temperature strength. ACCC/TW utilizes high purity fully annealed aluminium wires which reduces resistivity. The hybrid composite core is 60% lighter than the steel core in ACSR [30]-[31].

The HTLS type conductors are included ACSS, G(Z)TACSR, (Z)ACIR, ACCC and ACCR as well as CRAC. ACCC was developed to improve several key performance metrics over ACSR conductors [32]-[33]. Otherwise, 3M Drake conductor was better to the ACSR

Zebra in comparison of the maximum sag and current at maximum operating temperature [34].

An increase one ampere of current, ACSR could increase a sag as 0.00012 %, one degree centigrade of temperature could produce as sag as 0.415 % and one m/s of wind speed could yield the sag as 0.0002 % [35].

Based on the above literatures, in order to avoid the topic too broad, in this computation, in the discussion of report relates only based on the limits of the ACCC and ACSR conductor characteristics, and analyze the influence of external and internal factors on the conductors. The coefficients for tensile strength were obtained by the iterative methods, not only considered a constant value. This method was conducted to obtain the values of computation results as close as possible to the actual values.

Besides that, the average peak load current data were obtained from The State Electricity Company, and the average temperature and wind speed data were obtained from The Meteorology, Climatology, and Geophysics Council. Therefore, the computation results were more accurate, to close to the actual values.

The objectives of study were comparing the temperature effect tension, temperature effect sag, wind pressure and weight effect sag, temperature and wind effect sag, temperature effect tensile strength, length of conductors, conductor losses and drop voltage for both ACCC and ACSR conductors.

2. Materials and Methods

The determination of sag due to temperature effect is required to conductor tension strength (T_t) by using the below equations [1], [19]-[21], [33], [36]-[37].

$$A=\frac{L^2\left(\frac{w}{q}\right)^2}{24\sigma_t^2}E+\alpha E\left(t_2-t_1\right)-\sigma \tag{1}$$

$$A=\frac{L^2\gamma^2}{24\sigma_t^2}E+\alpha E\left(t_2-t_1\right)-\sigma \tag{2}$$

$$B=\frac{L^2\gamma^2}{24}E \tag{3}$$

Thus,

$$\sigma_t^3+A\sigma_t^2=B \tag{4}$$

Based on the latest equation, σ_t could be obtained. This last differential equation should be computed in the iterative manner. It was not possible to find the solution using an analytical method. In this computation, it was used the iterative bisection method.

The algorithm for this method is as choosing the interval by finding points **a** and **b**, so that **f(a).f(b)<0, c**alculating the estimation of numerical solutions by X_{NS} **= (a+b)/2, d**etermining whether the true solution is between **a** and X_{NS} or X_{NS} and **b** and selecting the subinterval that contains the true solution. These steps were repeated until, for this case, under 0.00001 of error tolerance [38].

Furthermore, the conductor tension due to the influence of temperature was also obtained.

$$T_t=\sigma_t.q \tag{5}$$

Once the voltage conductor influence of temperature (T_t) was known, the value of sagging due to the temperature that could be calculated using as below equation.

$$d=\frac{L^2 w}{8T_t} \tag{6}$$

To determine the sag due to the influence of wind pressure, it takes the total weight of the conductor which can be calculated by using following equation.

$$P=0.1v^2 D \tag{7}$$

Then, the total weight of the conductor,

$$w_{tot}=\sqrt{w^2+P^2} \tag{8}$$

Thus, the sag of conductor was obtained.

$$d_w=\frac{L^2 w_{tot}}{8T} \tag{9}$$

The worst sag value of conductor is occurred when there is the effect of temperature and wind pressure simultaneously. To determine the value of sagging due to the both effect factors, it is known the conductor tension value on the temperature (T_t) and the weight conductor total (w_{tot}).

$$d_{tot} = \frac{L^2 w_{tot}}{8T_t} \tag{10}$$

The tensile strength of conductor due to temperature effect can be solved as following equation.

$$T_{AB} = T_t \left(1 + \frac{1}{8} \left(\frac{L w}{T_t} \right)^2 \right) \tag{11}$$

The tensile strength of conductor due to wind pressure effect can be solved as following equation.

$$T_{AB} = T \left(1 + \frac{1}{8} \left(\frac{L w_{tot}}{T} \right)^2 \right) \tag{12}$$

The tensile strength of conductor due to temperature and wind pressure effect can be solved as following equation.

$$T_{AB} = T_t \left(1 + \frac{1}{8} \left(\frac{L w_{tot}}{T_t} \right)^2 \right) \tag{13}$$

Determining the conductor length due to temperature effect can be solved as following equation.

$$l = L \left(1 + \frac{8 d^2}{3 L^2} \right) \tag{14}$$

Determining the conductor length due to wind pressure influence effect can be solved as following equation.

$$l = L \left(1 + \frac{8 d_w^2}{3 L^2} \right) \tag{15}$$

Determining the conductor length due to temperature and wind pressure influence can be solved as following equation.

$$l = L \left(1 + \frac{8 d_{tot}^2}{3 L^2} \right) \tag{16}$$

The computation of ohmic power loss in the lines is using following equation [10].

$$P_{L3\phi} = 3 |I|^2 R \tag{17}$$

The power efficiency computation in the lines is using following equation.

$$\%P_{3\phi} = \frac{P_k - P_{L3\phi}}{P_k} x100\% \tag{18}$$

The voltage drop across the transmission line is the difference between the voltage at the base of the delivery (sending end) and the voltage at the receiving end. On the alternating current, the voltage drop magnitude is depending on the magnitude of the line impedance and admittance as well as on the load and power factor. In this case, the equivalent circuits of transmission line were revealed in short line, due to only 13 km of transmission line. Thus, the equivalent circuit consisted of resistive and inductive components only. If it was represented in first one, it was suitable as following equation [10].

$$\Delta V = V_S - V_R \tag{19}$$

$$\Delta V = I.Z.l \tag{20}$$

$$\Delta V = l.I \left(R \cos\varphi + X \sin\varphi \right) \tag{21}$$

where ΔV, V_S, V_R, I, Z, l are voltage drop (V), voltage of sending end (V), voltage of receiving end (V), current in the lines (A), line impedance (Ω) and length of line (m). The percentage of voltage drop is [10]

$$\%\Delta V = \frac{\sqrt{3}.l.I.\left(R\cos\phi + X\sin\phi \right)}{V_{LL}}.100\% \tag{22}$$

Percentage of voltage regulation is as below equation, where A is unity [10].

$$\%\Delta V = \frac{|V_S|/|A| - |V_{R,FL}|}{|V_{R,FL}|}.100\% \tag{23}$$

3. Results and Discussion

Table 1 lists the conductor parameters of investigated transmission line.

Table 1. Conductor parameters of transmission line

No	Parameters	ACCC	ACSR
1	Route distance (km)	13.5	13.5
2	Circuit distance (km)	154.217	154.217
3	Conductor type	ACCC Lisbon	ACSR Hen
4	Conductor diameter (d, mm)	21.78	22.40
5	Cross-sectional area (q, mm^2)	318.7	298.07
6	Material	Aluminium & composite	Aluminium & steel
7	Conductor tensile strength (T, kg)	1700	1465
8	Specific conductor tensile strength (T/q, kg/mm^2)	5.3342	4.9149
9	Conductor weight (w, kg/m)	0.957	1.112
10	Specific conductor weight (w/q, (kg/m)/mm^2)	0.003	0.0037
11	Average span distance (L)	350	350
12	Elastic modulus (E, kg/mm^2)	11 900	12 567
13	Linear expansion coefficient (α)	1.909 x10^{-5}	1.759x10^{-5}

No	Parameters	ACCC	ACSR
14	Maximum temperature (ºC)	180	180
15	Tower height (m)	35	35

It is shown that the point of views for route distance, circuit distance, average span distance, maximum temperature and tower height were same.

However, the remaining ones for conductor parameters were different. Nevertheless, they were similar. These data would be used as further computation, as an example, for the computations of the sag and tension of the conductors due to the external influences. These were obtained from The State Electricity Company.

Table 2 lists the average temperature (ºC), average wind speed (m/s) and average peak load current (A).

Table 2. The average temperature, wind speed and average peak load current data

No.	Month	Average Temperature (ºC)	Average Wind Speed (m/s)	Average peak load current (A)
1	January	23.8	2.0	282
2	February	23.7	2.5	264
3	March	24.0	2.5	264
4	April	24.2	2.0	128
5	May	24.0	2.0	91
6	June	23.7	2.0	310
7	July	23.7	2.0	273
8	August	24.2	2.0	282
9	September	24.4	2.0	210
10	October	25.1	2.0	182
11	November	24.5	2.0	301
12	December	24.3	2.0	191

The first two factors, wind speed and temperature data, were obtained from The Meteorology, Climatology and Geophysics Council. The rest data, the average peak load currents, were from The State Electricity Company in the year of 2015, which was used to calculate the power loss and voltage drop.

Figure 1 shows the comparison of temperature effect tensions between ACCC and ACSR conductors.

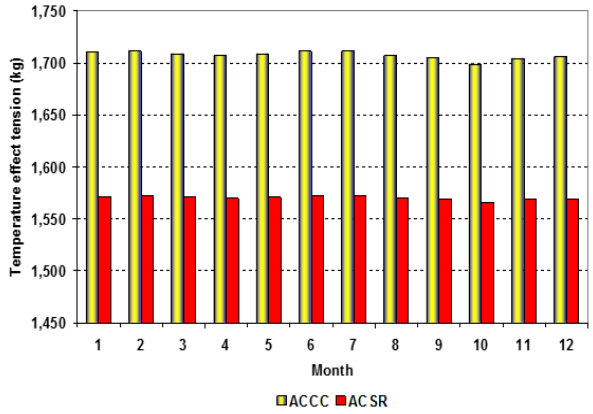

Figure 1. Comparison of temperature effect tension between ACCC and ACSR conductors

It is shown that the tensions due to temperature effect for ACCC conductor was higher than those ACSR ones.

In this case, the different of average tension between ACCC and ACSR conductors was 137.3 kg or 8.74 % based on the ACSR conductor.

Thus, ACCC conductor would be stronger than ACSR conductor.

Figure 2 shows the comparison of temperature effect sags between ACCC and ACSR conductors.

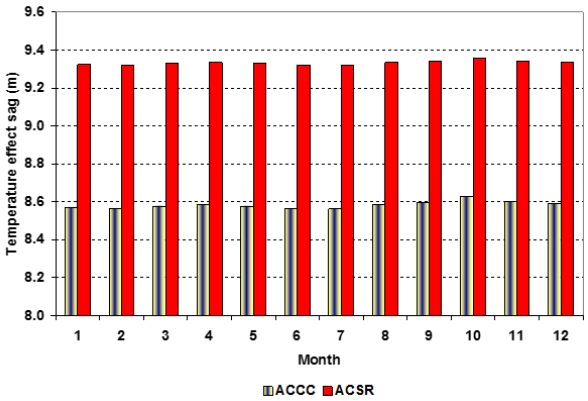

Figure 2. Comparison of temperature effect sag between ACCC and ACSR conductors

It is shown that the sags due to temperature effect for ACCC conductor was lower than those ACSR ones. In this case, the different of average sag between ACCC and ACSR conductors was 0.75 m kg or 8.74 % based on the ACCC conductor. Thus, ACCC conductor had smaller sag than ACSR conductor.

Figure 3 shows the comparison of wind pressure and weight effect sags between ACCC and ACSR conductors.

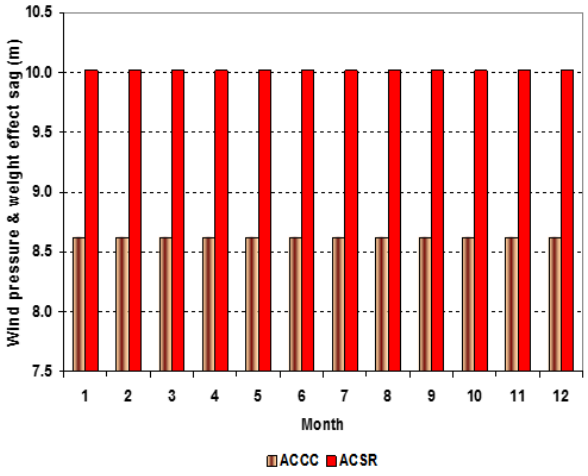

Figure 3. Comparison of wind pressure and weight effect sag between ACCC and ACSR conductors

It is shown that the sags due to the temperature effect for ACCC conductor was lower than those ACSR ones. In this case, the different of average sag between ACCC and ACSR conductors was 1.396 kg or 16.195 % based on the ACCC conductor. Thus, ACCC conductor had smaller sag than ACSR conductor.

Figure 4 shows the comparison of temperature and wind effect sags between ACCC and ACSR conductors.

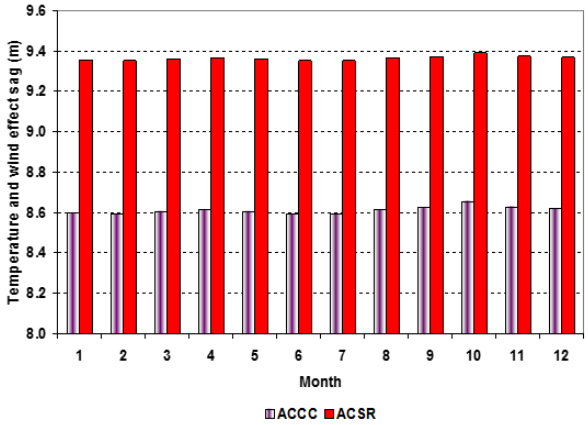

Figure 4. Comparison of temperature and wind effect sag between ACCC and ACSR conductors

It is shown that the sags due to temperature and wind effect for ACCC conductor was lower than those ACSR ones. In this case, the different of average sag between ACCC and ACSR conductors was 0.753 m kg or 8.744 % based on the ACCC conductor. Thus, ACCC conductor had smaller sag than ACSR conductor.

Figure 5 shows the comparison of temperature effect tensile strength between ACCC and ACSR conductors.

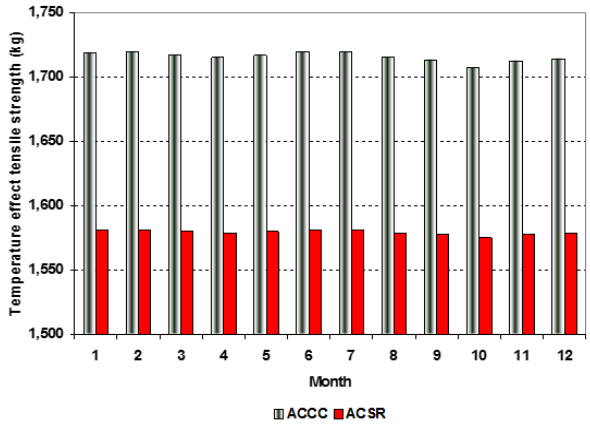

Figure 5. Comparison of temperature effect tensile strength between ACCC and ACSR conductors

It is shown that the tensile strength due to temperature effect for ACCC conductor was higher than those ACSR ones. In this case, the different of temperature effect tensile strength between ACCC and ACSR conductors was 136.57 kg or 8.65 % based on the ACSR conductor. Thus, ACCC conductor had higher tensile strength than ACSR conductor.

Figure 6 shows the comparison of length of conductor between ACCC and ACSR conductors, based on 350 span distance.

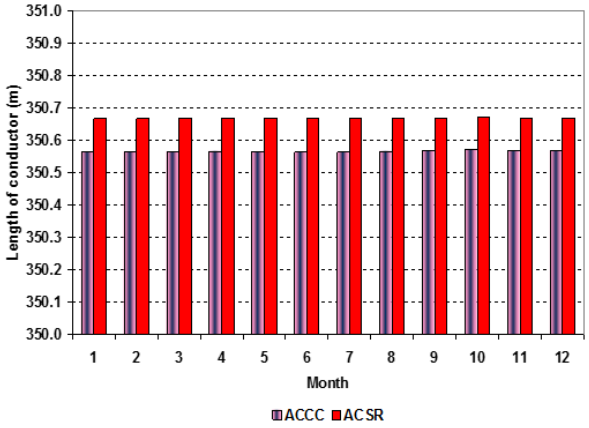

Figure 6. Comparison of length of conductors between ACCC and ACSR conductors

It is shown that the length of conductor for ACCC conductor was shorter than those ACSR ones. In this case, the different of temperature effect tensile strength between ACCC and ACSR conductors was 0.103 m or 0.029% based on the ACCC conductor. Thus, ACCC conductor had shorter length than ACSR conductor.

Figure 7 shows the comparison of conductor ohmic losses between ACCC and ACSR conductors.

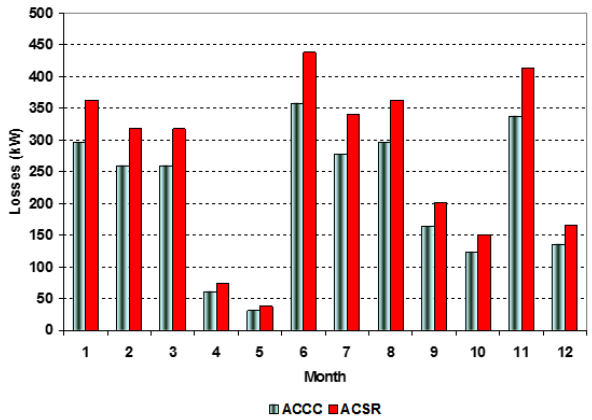

Figure 7. Comparison of losses between ACCC and ACSR conductors

It is shown that the loss of conductor for ACCC conductor was smaller than those ACSR ones. In this case, the different of losses between ACCC and ACSR conductors was 48.58 kW or 22.42 % based on the ACCC conductor. Thus, ACCC conductor had smaller losses than ACSR conductor.

Figure 8 shows the comparison of conductor drop voltage between ACCC and ACSR conductors.

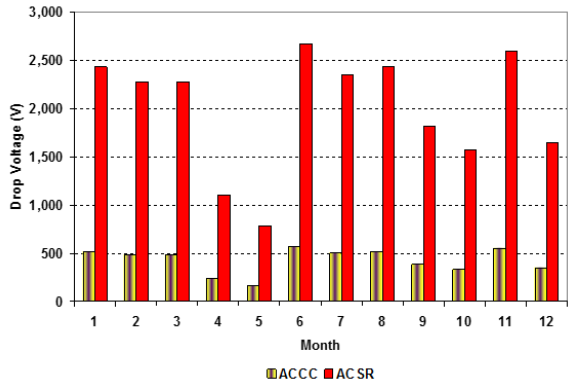

Figure 8. Comparison of drop voltage between ACCC and ACSR conductors

It is shown that the drop voltages of ACCC conductor were smaller than those ACSR ones. In this case, the different of losses between ACCC and ACSR conductors was 1,572 Volt or 369.2 % based on the ACCC conductor. Thus, ACCC conductor had smaller voltage drop than ACSR conductor.

Table 3 lists the average computation result summary of comparison between ACCC and ACSR conductors.

Table 3. Computation result tabulation for ACCC and ACSR conductors

Parameters	ACCC conductor	ACSR conductor	Difference	Remarks
Temperature effect tension	1707.39 kg	1570.10 kg	**137.29 kg (8.74%)**	**Based on ACSR**
Temperature effect sag	8.58 m	9.33 m	**0.750 m (8.74%)**	**Based on ACCC**
Wind pressure & weight effect sag (m)	8.620 m	10.017	1.396 m (16.195%)	**Based on ACCC**
Temperature and wind effect sag	8.611 m	9.364	0.753 m (8.744%)	**Based on ACCC**
Temperature effect tensile strength	1715.61 kg	1579.03 kg	136.57 (8.65%)	**Based on ACSR**
Length of conductors	350.565 m	350.668 m	**0.103 m (0.029%)**	**Based on ACCC**
Conductor losses	216.71 kW	**265.290 kW**	**48.58 kW (22.42%)**	**Based on ACCC**
Drop voltage	425.72 V	1,997.49 V	1,572 V (369.2%)	**Based on ACCC**
Voltage Regulation	0.4916%	2.3065%	1.8149%	**Based on ACSR**

Generally, it is indicated that the properties of ACCC conductor are better than those ACSR one, which are lower sag, lower losses and lower drop voltage, as well as higher tension compared to the latter.

4. Conclusions

It has been computed the comparative investigation between ACCC and ACSR conductors, based on the data of external and internal factors.

The ACCC average temperature and wind sags, length, losses and drop voltage were 8.744 %, 0.029 %, 22.42 % and 369.2 % respectively than those ACSR.

On other hand, the temperature effect tension of ACCC was higher, with 8.74 % different from that of ACSR. Thus, some characteristics of ACCC conductor have advantages compared to that ACSR conductor.

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