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HTLS CONDUCTORS

Aryaman Gupta

Mayo College , Ajmer

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ABSRACT

Stringent environmental constraints make it more difficult to identify new energy corridors and build new power lines. The increase in the generation of electricity from renewable energy sources (RESs) makes the operation of electrical systems increasingly difficult in some areas. The transmission Utility in India, are forced to exploit the existing overhead transmission lines, increasing the possibility of dispatching energy for optimizing the transmission capacity. Therefore, a brief description of high-temperature low-sag (HTLS) conductors is presented. It is shown how it is possible to optimize the dispatching from generation sources and, finally, it is demonstrated how the use of HTLS conductor can contribute to efficient transmission of power, to the creation of a market with fewer constraints, and to new operating conditions that increase the resilience of the electricity system in case of disturbances.

Keywords- Power, energy, HTLS, India, and economy.

1.0 Introduction

Gupta Power Infrastructure Limited (GPIL) is a long-established name for the manufacturing of Electrical products & Turnkey projects in India. GPIL has provided immense support for this research paper in understanding the HTLS Products & the importance it holds in improving the Energy grid of India & globally. Established in 1961, GPIL is a USD 500 Million Company with a brand presence across the world through large-scale EHV Turnkey Projects in Railways & Power Transmission, Power conductors, HTLS conductors, specializing in Power Cables, ADSS, Optical fiber cable, Medium Voltage Covered Conductor, Thermocouple extension, House Wires & Cables, and LED products

2. The Research

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Within the overall development policy framework outlined above, the integration between growth and environmental protection is also confirmed by the founding principles of the new energy policy which aims at the following:

- To accelerate the transition to a low carbon economy, by acting on the development of renewable sources,on the diversification of the mix of sources, and on research in the field of energy technologies able to reduce emissions from energy production.
- To adopt a multi-sector impact energy efficiency plan, with the proposal of a new international agreement for the achievement of common quantitative targets.

The energy-climate strategy is based on a package of measures aimed, on the one hand, at combating climate change through the reduction of greenhouse gas emissions and, on the other, at reducing the dependence on energy imports and increase of prices; in this context, the production of energy from renewable sources plays a fundamental role in achieving these objectives. The government of India has recently launched a series of measures that clearly outline the path to be followed from now to drasticallyreduce the effects of energy consumption on the climate, energy, and environmental impacts.

Power Scenario in India

Power is among the most critical components of infrastructure, crucial for the economic growth and welfare of nations. The existence and development of adequate power infrastructure are essential for the sustained growth of the Indian economy. India's power sector is one of the most diversified in the world. Sources of power generation range from conventional sources such as coal, lignite, natural gas, oil, hydro and nuclear power, to viable non-conventional sources such as wind, solar, agricultural, and domestic waste. Electricity demand in the country has increased rapidly and is expected to rise further in the years to come. To meet the increasing demand for electricity in the country, massive addition to the installed generating capacity is required. India was ranked fourth in wind power, fifth in solar power, and fourth in renewable power installed capacity, as of 2020. India is the only country among the G20 nations that are on track to achieve the targets under the Paris Agreement.

As of April 2022, India's installed renewable energy capacity stood at 158.12 GW, representing 39.43% of the overall installed power capacity. Solar energy is estimated to contribute 55.34 GW, followed by 40.53 GW from wind power, 10.68 GW from biomass, 4.85 GW from small hydropower, and 46.72 GW from hydropower. The renewable energy capacity addition stood at 8.2 GW for the first eight months of FY22 against 3.4 GW for the first eight months of FY21. With electricity generation (including renewable sources) of 1,490.27 BU in India in FY22, the

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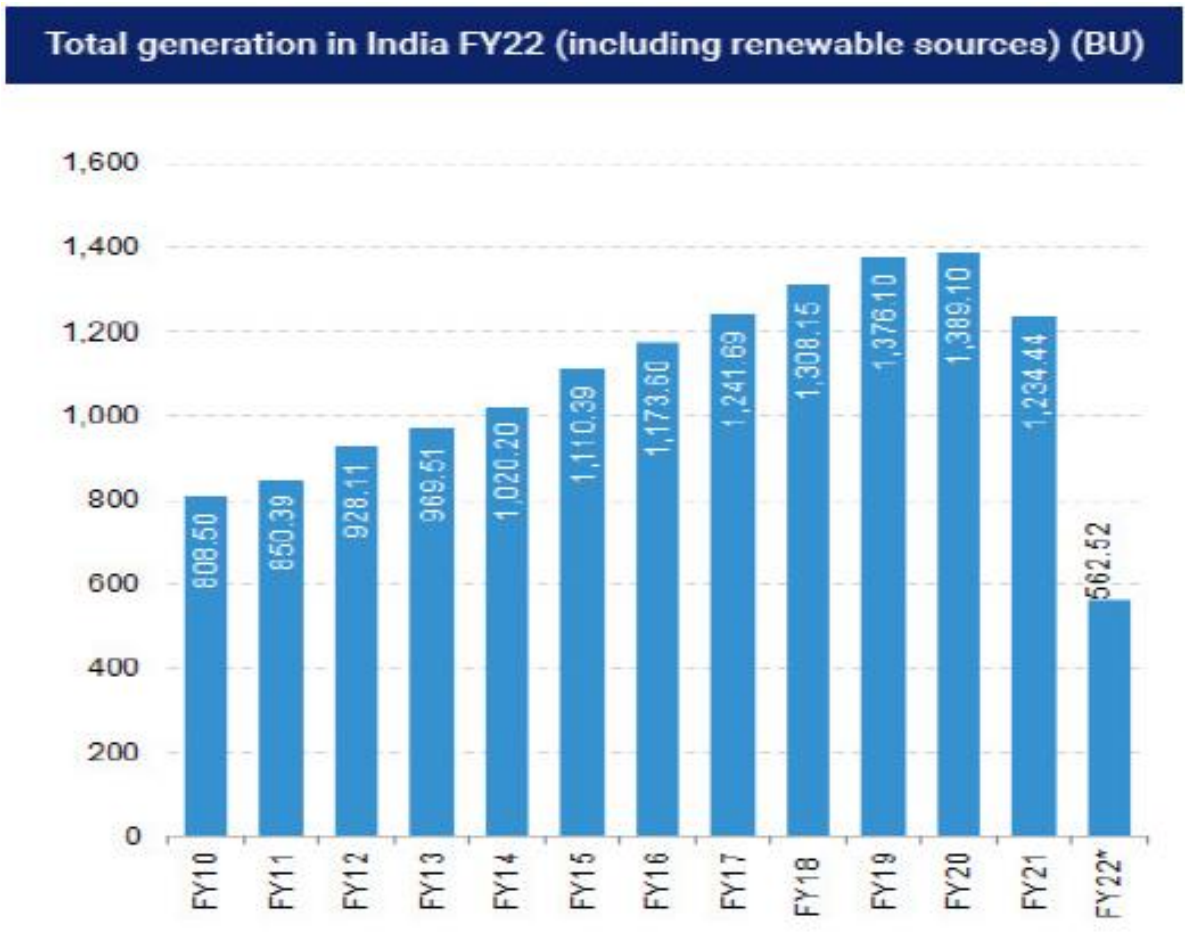
country witnessed an increase of 7.85% over the previous fiscal year. The peak power demand in the country stood at 210.79 GW on June 9, 2022.

The data showcases the Year on Year (YoY) increase in Power generation.

An increase in generation is directly proportional to the increase in power transmission.

Installing new infrastructure for electric transmission lines requires additional land & various approvals.

This also destroys the natural habitat of living beings. The only possible way to increase transmission capacity without fresh transmission lines is to optimize existing infrastructure.



Source: Central Electricity Authority, Ministry of New and Renewable Energy, Media Reports, Press Releases, Press Information Bureau (PIB)

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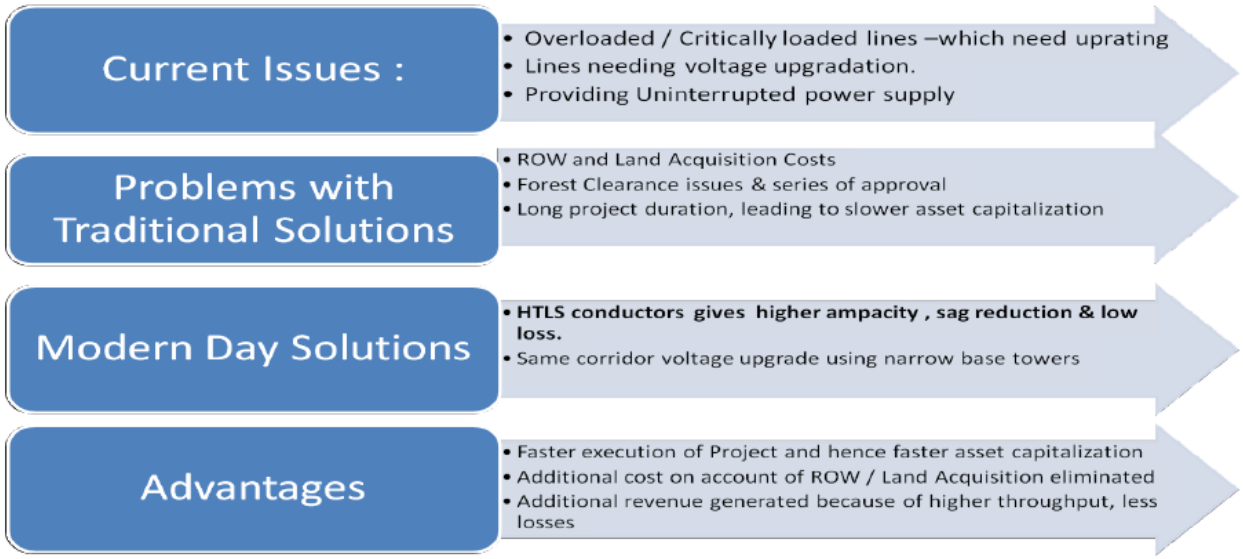
Why HTLS conductors are need of the hour: Solution for congestion & Right of Way (ROW) issues



Why Reconductoring with HTLS:

3.0 HTLS Conductors:

The electric transmission lines use bimetallic conductors (ACSR-aluminum conductor steel reinforced). This type of conductor consists of a steel core characterized by a high mechanical

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strength and external layers of different aluminum wires wound spirally on the core. Today, the market offers different reconductoring solutions with heat-resistant conductors and low linear thermal elongation (called high- temperature low-sag conductors). These features offer, besides the possibility of being able to operate the line up to temperatures even over 180°C, even to be able to use the same existing energy corridors without substantial changes to the structure of the power line. The main HTLS conductors are as follows: GTASCR, ZTACIR, ACCC, and ACSS. These conductors can operate at temperatures between 150°C and 250°C without changing the mechanical and chemical properties.

Benefits of HTLS Conductors:

Capable of operating at higher temperatures (230ºC Vs 85ºC)

- Higher current carrying capacity (Twice) for the same Diameter of the conductor.
- Lower sag than the conventional conductor at higher operating temperatures.
- Certain technologies give up to 25% lower losses at the same Power Levels.
- Can transfer up to twice the power using the same towers and line corridor.
- Existing lines can be uprated to carry twice the power.
- ROW issues are nullified & optimization of existing assets is ensured.
- The existing infrastructure achieves futureproofing.

The TACSR conductor (conductor made of heat-resistant aluminum alloy in reinforced steel) has steel wires in the core and TAL wires (aluminum- zirconium alloy which has stable mechanical properties up to150°C) around it.

GTACSR (gap-type thermal aluminum conductor steel reinforced) conductor presents a small gap between the steel core and aluminum outer layers to apply strain only on the steel. The gap is filled with heat-resistant grease (filler) to decrease friction between core and outer layers and to prevent water penetration.

ZTACIR (super thermal aluminum conductor invar reinforced) conductor consists of steel-invar galvanized alloy core (ACI core) and ZTAL wires in the outer layers. It does not present annealing phenomena up to 210°C.

ACSS (aluminum conductor steel supported) conductor presents steel wires on the core and aluminum wires in the outer layers subjected to an annealing process. There are two different types: “standard round strand ACSS” (aluminum rope with circular cross-sectional wires) or “trapezoidal aluminum wire ACSS” (aluminum rope with trapezoidal cross-section wires).

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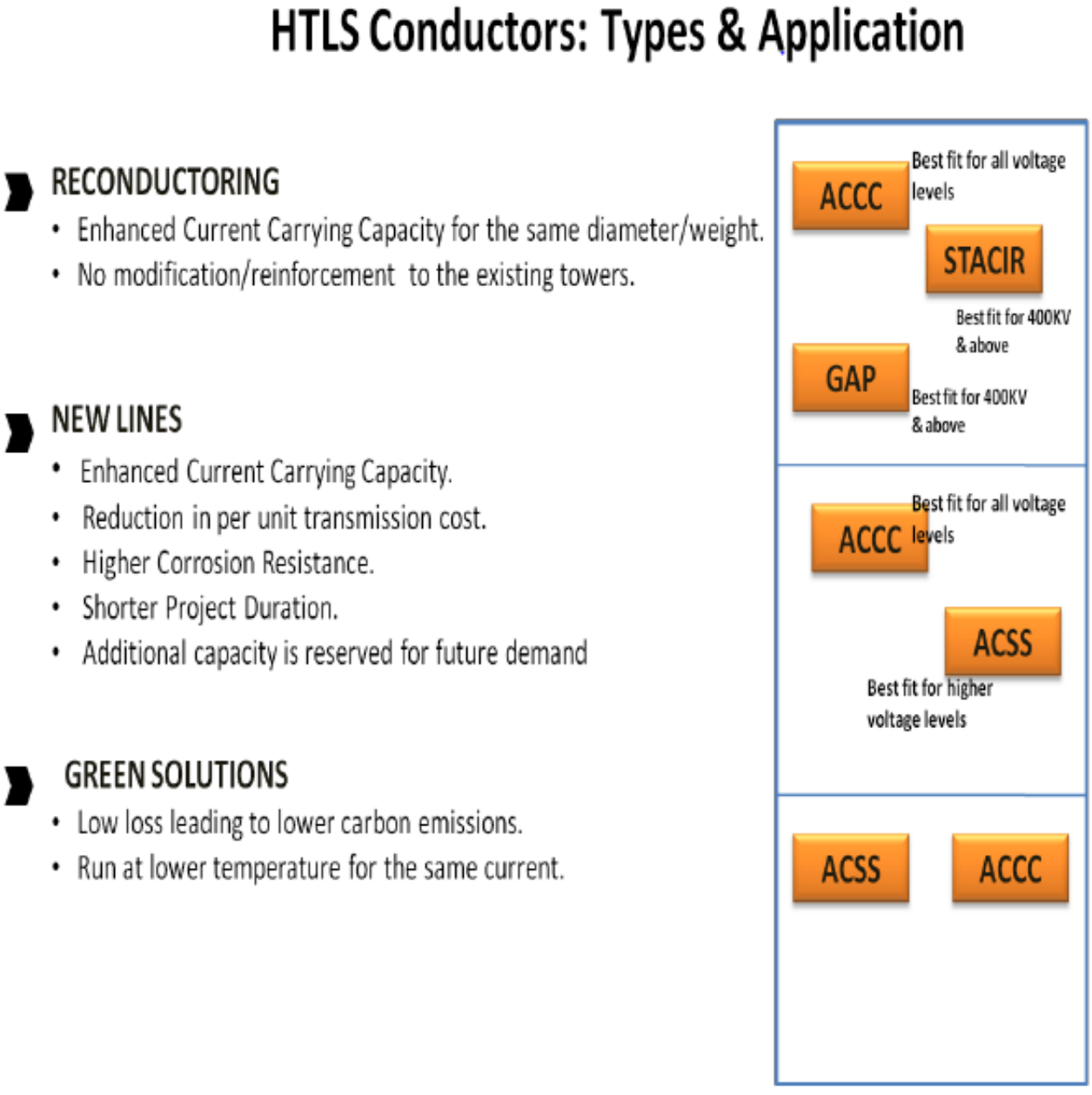
ACCC (Aluminum Conductor Composite Core: Built on the highly evolved foundation of aerospace- derived carbon fiber hybrid composites, the ACCC® conductor utilizes high strength, lightweight, and dimensionally stable single strand composite core that is stranded with trapezoidal-shaped aluminum wire. ACCC® conductor offers superior performance and capacity compared to conventional conductors of the same diameter and weight.



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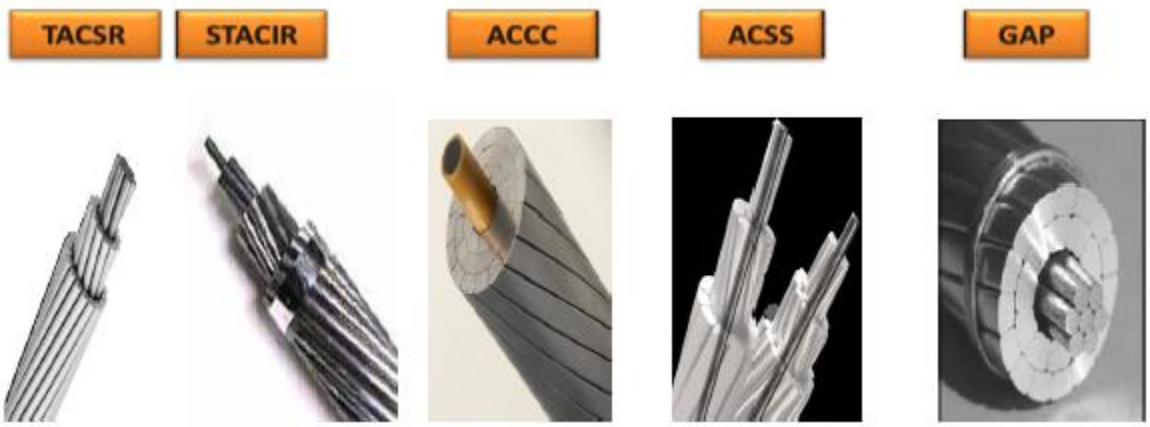

The HTLS conductors explained, are both electrically and geometrically very similar to the conventional ACSR conductor. The main differences are the resistance to high temperatures of the aluminum alloy which constitutes the outer layer and the low value of linear thermal elongation. The advantage deriving from the use of HTLS conductors is that therefore they can withstand a higher temperature (up to 150°C or 210°C) and present lower sag (Figure 6), guaranteeing at the time a certainly higher transport capacity.

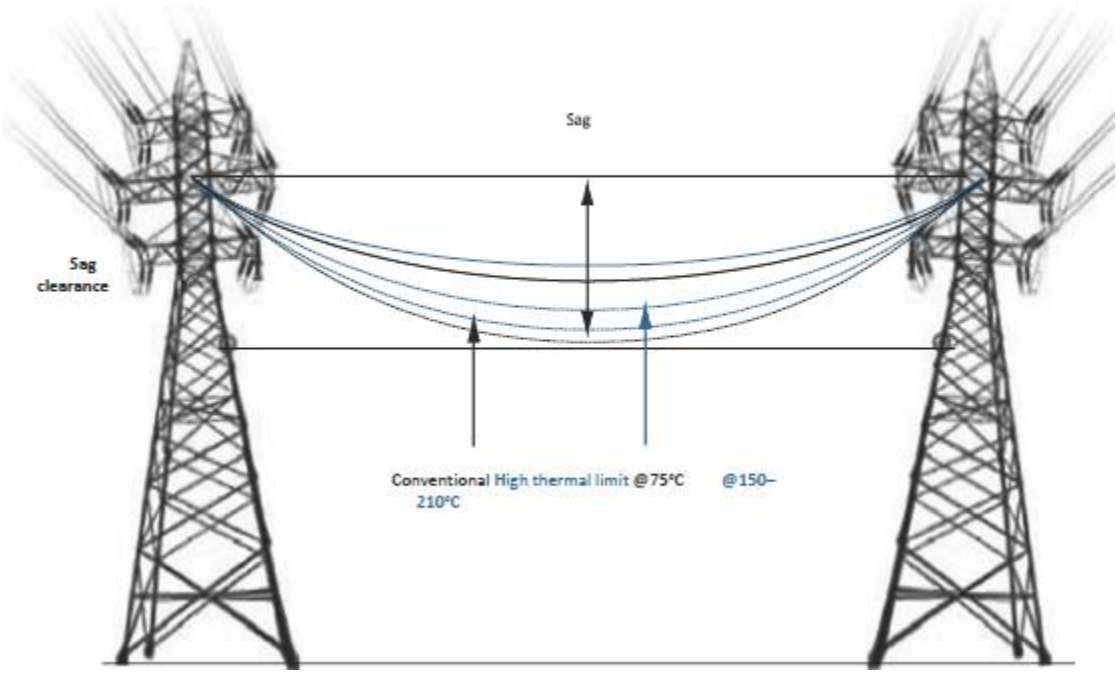

*****Illustration for showcasing Low sag after usage of HTLS conductors compared to conventional conductors**

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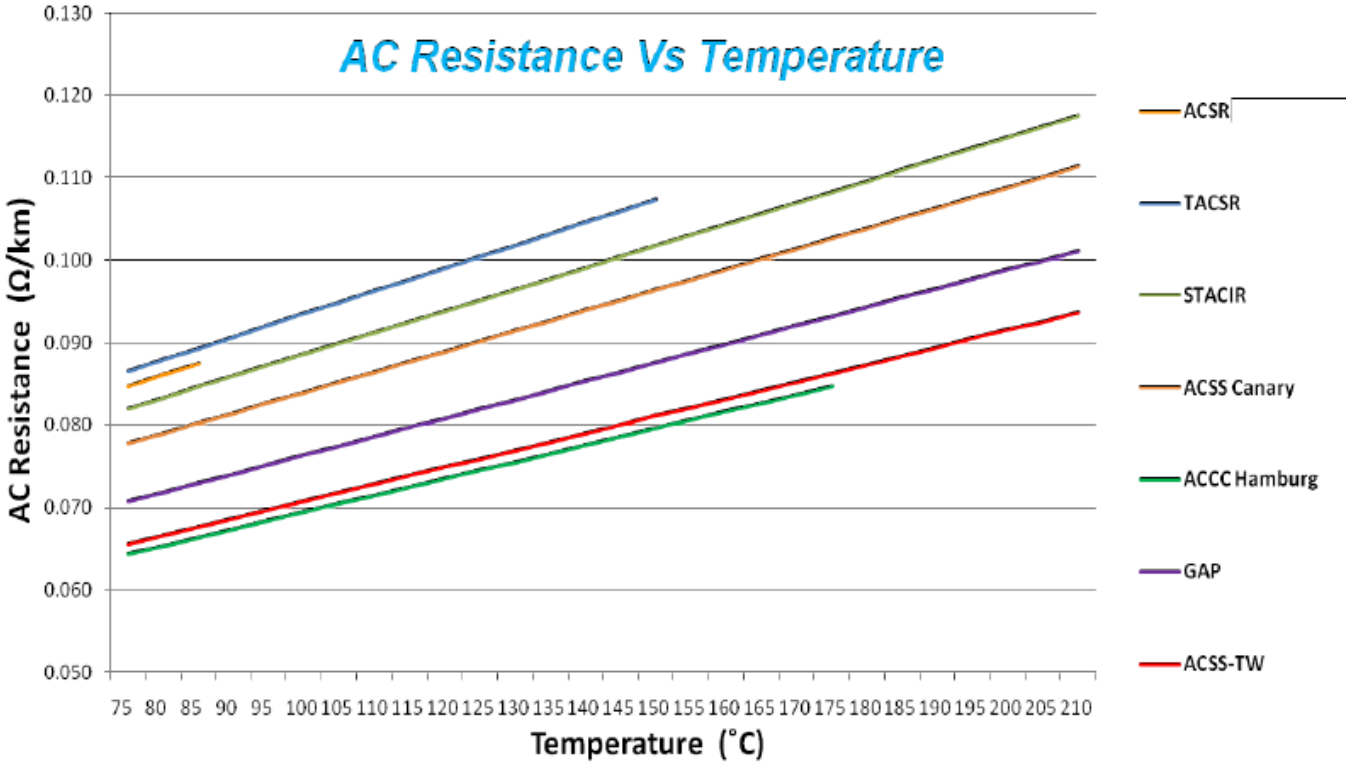
Technologies Comparison



****Empirical working demonstrated by PLS CADD, High-quality Power Transmission Designing software lowest increase in Resistance with temperature exhibits the core properties of an HTLS conductor, which provides the least losses, demonstrating a low carbon footprint**

HTLS Classifications: As per CIGRE

With the ever-growing need for more power to be transmitted along existing lines, new types of conductors have been developed to run at higher temperatures than traditional materials

According to Cigré, these conductors can be put into 4 basic classifications

- **Type 1.** Conductors are composed of a steel core and an envelope for which the high-temperature effects are controlled through **thermal-resistant aluminum alloys** (e.g., GAP,TACSR, STACIR)

- **Type 2.** Conductors are composed of a steel core and an envelope for which the high-

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temperature effects are controlled through **annealed** aluminum or aluminum alloy (e.g., ACSS)

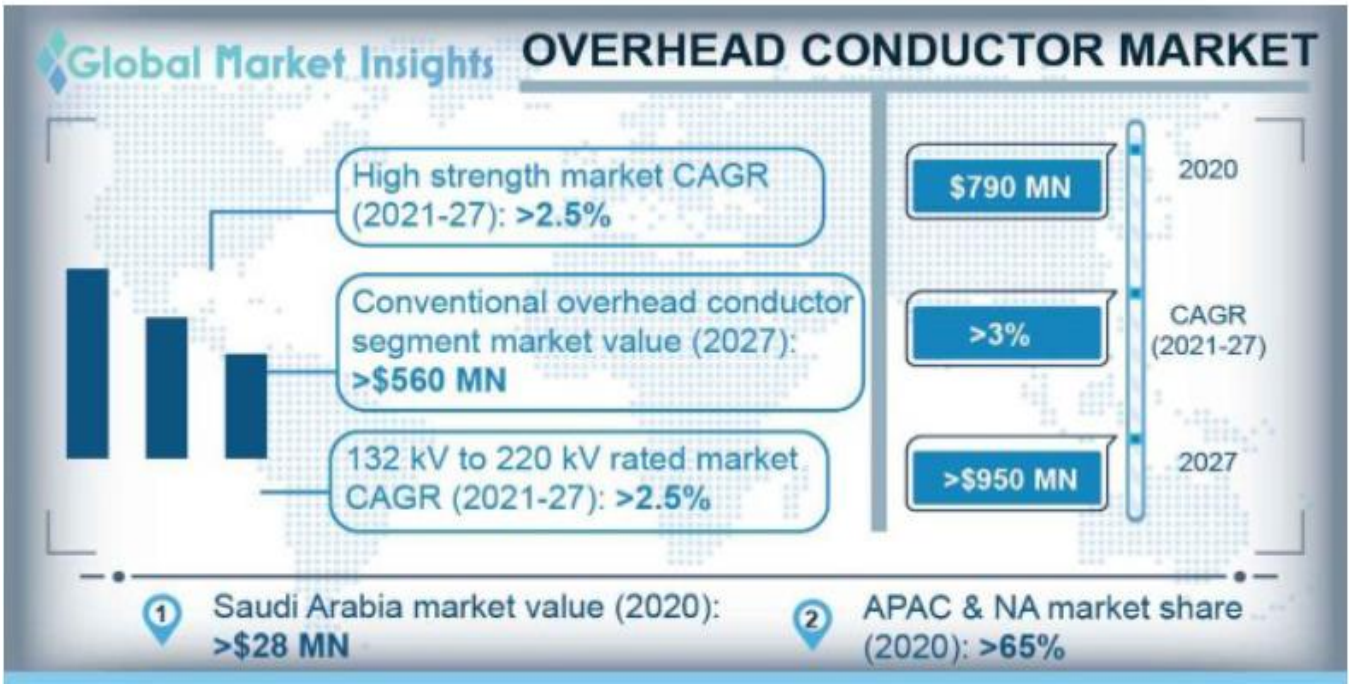
- **Type 3**. Conductors are composed of a non-metallic core, and an envelope for which the high-temperature effects are controlled through thermal-resistant **aluminum alloys** (e.g., ACCR)

- **Type 4**. Conductors are composed of a non-metallic core and an envelope for which the high-temperature effects are controlled through **annealed** aluminum or aluminum alloys (e.g., ACCC)

Reference: CIGRE WG B2.12, Conductors for the Uprating of Overhead Lines, ELECTRA, vol. 213, CIGRE, Paris, France, 2004, ISSN: 1286-1146

HTLS: Market Watch

The overhead conductor industry is set to witness growth due to favorable regulatory reforms toward the expansion of microgrid networks and the integration of a sustainable electrical infrastructure. A paradigm shift toward IT integration across the power sector will fuel smart grid deployment, which in turn, will positively sway the industry dynamics. The increasing disposable income, sustainable population, and higher electricity consumption, primarily across developing nations, will energize the business scenario.



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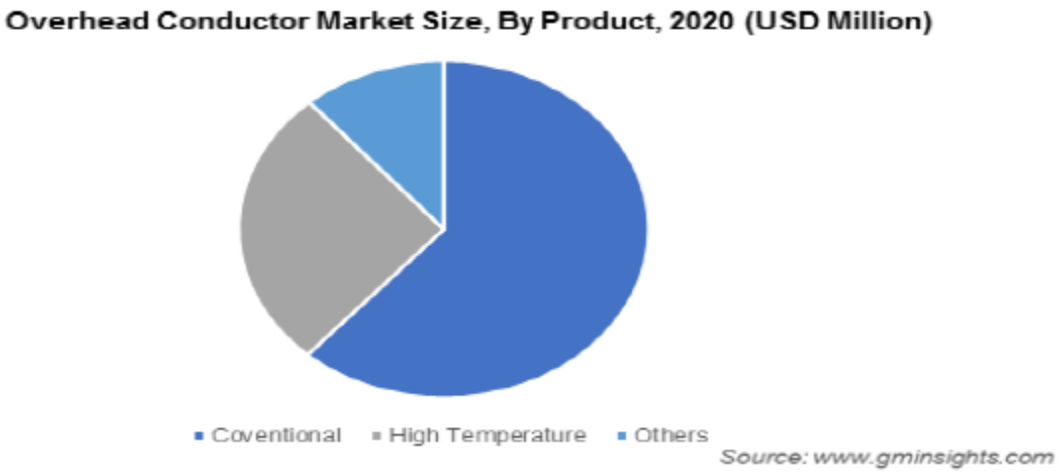
Re-Conductoring: The overhead conductor market share



The conventional overhead conductor market is estimated to reach over USD 560 million by 2027. Modernization of the grid infrastructure to make it smarter and extra resilient through the integration of cutting-edge equipment and controls & technologies will complement the business outlook. The ability of these units to efficiently deliver reliable electricity, reduce the frequency of power outages, provide faster service, and reduce storm impacts is set to boost the product adoption.

4. Global Growth Driver:

- **Asia Pacific**

  - Rising Load Demand
  - Expansion of microgrid networks
  - Grid Stability & security of supply concerns

- **North America & Europe**

  - Expansion of Smart Grid networks
  - Refurbishment & Re-conductoring of existing grid infrastructure

- **Middle east, Africa & Latin America**

  - Increasing electricity demand
  - Integration of a sustainable electrical network

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5. Pitfalls & Challenges:

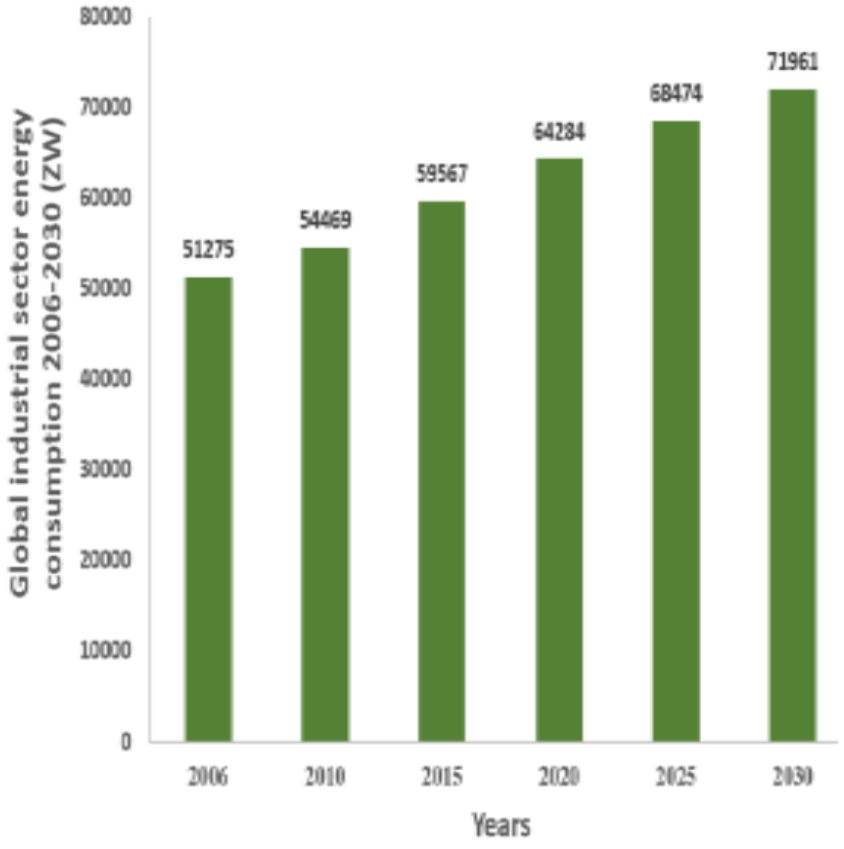
- Slow-paced technological evolution across developing regions
- High dependency on Imports

Increasing applicability across large industrial establishments will stimulate the extra-high-strength overhead conductor segment:

The overhead conductor market from the extrahigh-strength segment is estimated to exceed USD 340 million by 2027. Wide-scale utilization across large-capacity industrial developments and utility-aided transmission networks will energize the industry dynamics.

Increasing demand for high ampacity and power reliability across industrial processes including mining and oil & gas will boost the business landscape.

The technology provides key advantages including lower conducting losses, efficient operational feasibility, longer lifespan, and stimulating product penetration.



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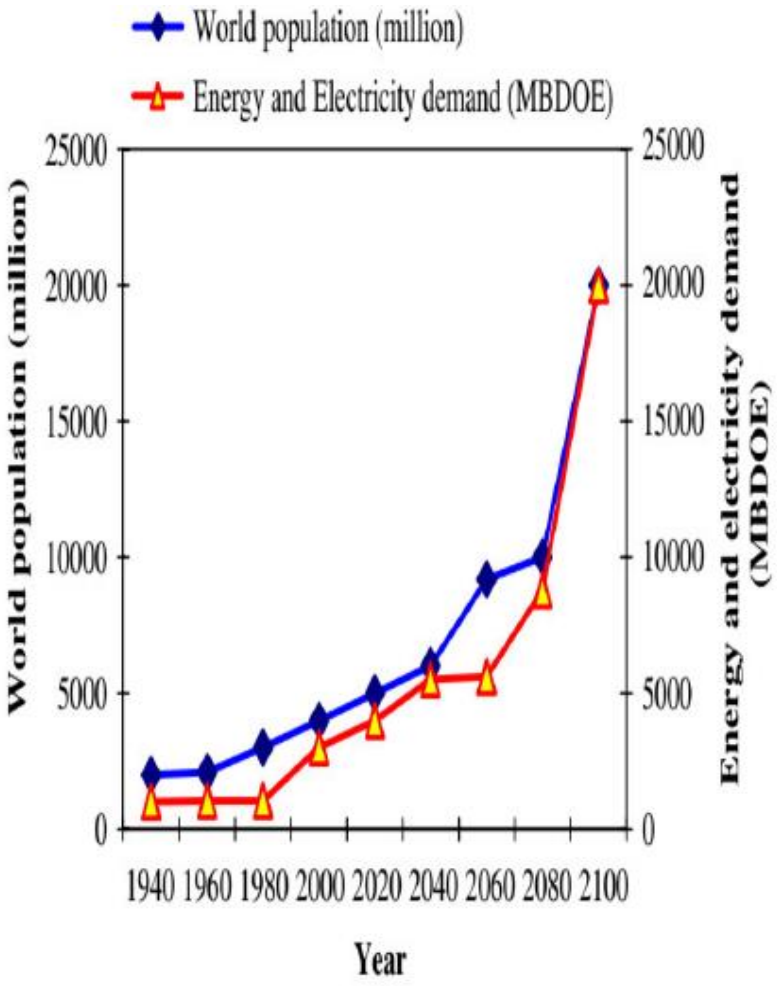
Increasing funding for the expansion of commercial establishments to boost the high-tension overhead conductor segment:

The increasing urbanization rate in line with the robust development of commercial establishments will escalate the high-temperature overhead conductor segment.

Rising investments to establish a sustainable electrical network along with favorable regulatory reforms pertaining to electrification across grid-isolated areas will propel business growth.

The world economy has been hit hard by an unpredicted outbreak of the novel coronavirus (COVID-19). Global economies are focusing on over-compensating the pandemic impacts by fast-tracking their operations, resulting in the anticipation of gradual market growth by the second half of 2021 Favorable conditions including the ongoing upgrading & modernization of existing transmission lines and deployment of advanced power cables with lower transmission losses are anticipated to stimulate the overhead conductor industry.



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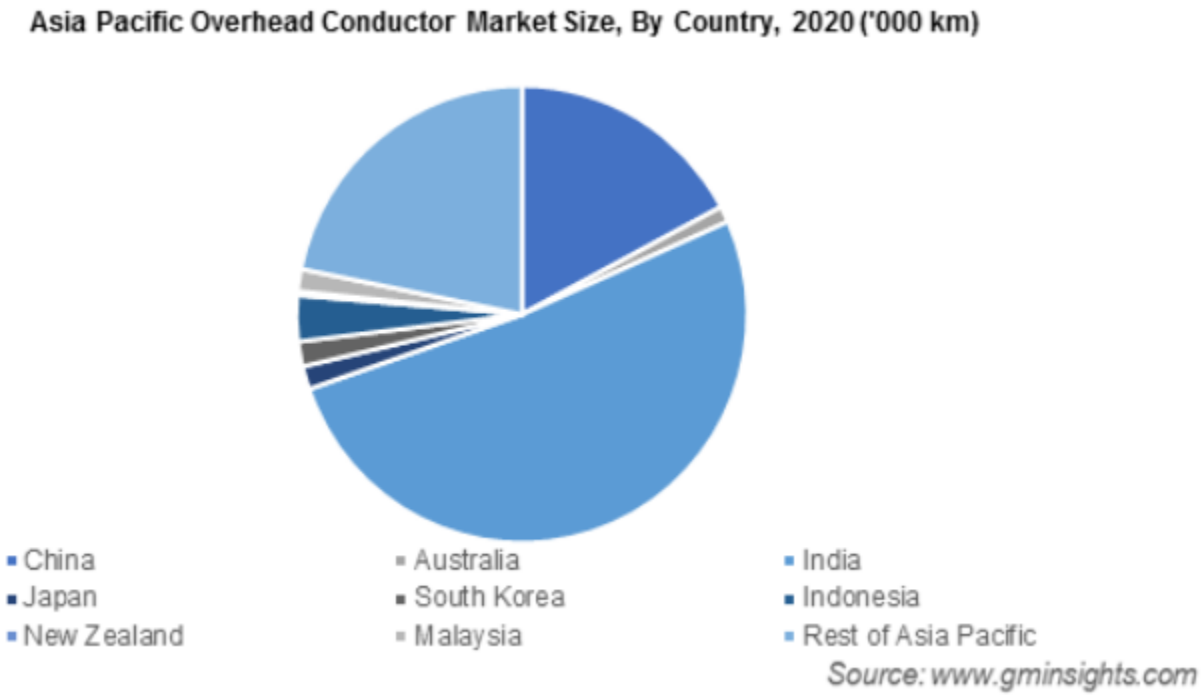
The Asia Pacific is anticipated to witness significant growth owing to the expansion of microgrid networks



The Asia Pacific and North America overhead conductor market together held a major share of over 65% in 2020. The deployment of renewable coupled with ongoing advancements in distributed generation technologies will favor the industry scenario. Growing concerns toward energy security along with surging decentralized power generation will energize product penetration. Ongoing measures to refurbish existing grid infrastructures followed by the rapid adoption of smart transmission & distribution systems will augment the business landscape.

Product innovations and partnerships will act as crucial points for marketparticipants

Eminent companies are focusing on technological advancements along with partnerships and acquisitions to meet the predominant competition in the industry. Industry manufacturers are laying importance on economies of scale and forward integration to nourish quality standards.

Major participants operating in the overhead conductor market include Sumitomo Electric Industries, ZTT, Gupta Power Infrastructure Ltd, APAR, Lamifil, Nexans, LUMPI-BERNDORF Draht- und Seilwerk GmbH, 3M, Midal Cables, Sterlite Power, LS Cable & System & Southwire Company.

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6. ROAD AHEAD

In the current decade (2020-2029), the Indian electricity sector is likely to witness a major transformation concerning demand growth, energy mix, and market operations. The Government of India is preparing a 'rent a roof' policy for supporting its target of generating 40 gigawatts (GW) of power through solar rooftop projects by 2022. It also plans to set up 21 new nuclear power reactors with a total installed capacity of 15,700 MW by 2031. The Central Electricity Authority (CEA) estimates India's power requirement to grow to reach 817 GW by 2030. The government plans to establish a renewable energy capacity of 500 GW by 2030.

Outlook on T&D Sector India:

The Transmission & Distribution segment holds massive potential in India when it comes to growth & innovation, while the expected annual growth in T&D is expected to be around 12% CAGR. More avenues of green corridor & interstate corridor will accelerate the growth rate to manifolds.

The present trend of the growth cycle:

1. The Transmission Line Capacity has increased to 4,50,552 cKm during FY 2020-21 as compared to 4, 25,071 cKm during FY 2019-20.

2. The addition of Transformation Capacity was 10, 25,468 MVA during March 2021 an increase of 6 percent from 9, 67,893 MVA in March 2020.

3. The Inter-Regional Transmission Capacity Addition was 1,12,250 MW during FY 2021-22 as compared to 99,050 MW during FY 2018-19

The capacity addition suggests that we need a more robust transmission system to addressthe holistic generation from conventional & renewable sources.

7. Recommendations:

- The transmission sector in India needs a lot of investment in new technology to:
- Remove constraints of time associated with new lines.
- Funding agencies need to be sensitized concerning the adoption of reconductoring/augmentation asa preferred way of life.
- Technology development programs need to be sponsored by the sector.

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- The government & private sector need to work together to review & develop a new technologyroadmap for security.
- Central & state utilities to plan & allocate new technology in the budget.

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