How 3M™ Aluminum Conductor Composite Reinforced can help improve sustainability for electrical utilities.

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Introduction

Canada, like every developed nation, thrives on electrical energy. Electric power drives our economy, provides for our safety, and helps ensure our health and well-being. Although actual demand may fall during economic hard times and rise during good times, overall consumption will inevitably continue to grow. Ours is a power-hungry society.

Feeding that hunger is the function of the grid, the largest interconnected machine in the world. Running that machine is the responsibility of the electric utility industry. They can satisfy the increasing demand for power by building new transmission and distribution lines to serve expanded cities and communities. However, they also need to bolster the existing infrastructure, which is facing pressure as the population and economy within previously developed regions continue to grow over time.

Yet today the utility industry finds itself facing a rapidly changing playing field, where the rules are being rewritten; where public expectations can conflict with sound planning and engineering; and where efforts to ensure environmental and social acceptance is critical to plan and manage the grid successfully.

Sustainability has never been so critical. Our world is rapidly changing. It’s a brand-new game.

This paper describes how an advanced conductor technology from 3M™ Aluminum Conductor Composite Reinforced (ACCR) can help utilities improve sustainability in grid construction projects and mitigate environmental and social impact through its advanced properties in a cost-effective manner.
The public’s concern about large grid construction projects around their communities, like a new transmission line, is easy to understand.

There are several environmental and social impacts that can come with new grid projects and construction. They include land use changes, forest and wetland impacts, hydrologic changes and soil erosion, biodiversity and wildlife impacts, safety and public health risks, electromagnetic fields (EMF) and electromagnetic interference (EMI) issues, audible noise, potential economic disruption, and aesthetic impacts.

Over the years, the utility industry has explored many best practices to both assess and help reduce the potential environmental impacts associated with grid construction projects and gain public acceptance. A few examples include the use of alternate routings, implementation of certain design features, public consultation, mitigation plans to reduce certain impacts, and the use of alternate project implementation and execution methods.

3M™ ACCR can help utilities reduce a project’s footprint in a variety of ways.

What is 3M™ ACCR?

3M™ ACCR is a high-capacity transmission conductor with a high-strength, lightweight aluminum matrix core. The outer, current-carrying strands are composed of a hardened aluminum-zirconium alloy. 3M™ ACCR core and outer wires are both helically stranded for greater strength and conductivity.

Although similar in construction and dimensions to ACSR, 3M™ ACCR has outstanding features:

- Half the thermal expansion for less sag at high energy levels, so can carry up to twice the ampacity of aluminium conductor steel-reinforced cable (ACSR)
- Higher strength-to-weight ratio because it is lighter compared to ACSR at similar or higher strength

These attributes can result in two or more times the ampacity while maintaining or improving clearances, tensions and mechanical loads on structures, thus optimizing the potential of the upgrade. In addition, 3M™ ACCR’s lightweight, conductive aluminum-based core generally means more overall conductivity than steel core conductors, and more aluminum with less weight.

Inside the technology

3M™ ACCR’s high-strength, lightweight core is a fibre-reinforced metal matrix, and contains no polymers or plastics.

The aluminum-zirconium outer wires can be heated to high temperatures without softening (annealing). This allows 3M™ ACCR to retain its strength after high temperature operations.
What sustainability benefits can 3M™ ACCR offer?

The properties of 3M™ ACCR that mitigate environmental impact, improve sustainability and can help reduce the total cost of a project include lighter weight, higher ampacity, low sag, and shorter installation time.

**a. Less weight**

3M™ ACCR is lighter than the ACSR equivalent.* Depending on specific project requirements, 3M™ ACCR can bring the following benefits:

- Fewer towers required along a new transmission line
- Smaller tower foundations
- Fewer tower reinforcements on existing structures (or none)
- Lighter and less intrusive installation equipment

**b. Higher ampacity**

There are multiple environmental benefits that can be derived from a conductor that can double ampacity for an equivalent size of a standard ACSR or aluminum stranded conductor (ASC):

- Re-conductoring with the same size 3M™ ACCR as the existing line allows for desired ampacity upgrades while retaining existing infrastructure (towers, foundations, insulators etc.), thus helping eliminate the negative footprint of manufacturing, transporting, and installing heavy-duty infrastructure
- On new or existing lines, conductor size can be decreased, thus reducing tower and foundation strength and weight requirements.
- Prolongs transmission line asset life, eliminating the negative environmental impact of new line construction (e.g., defer new line construction due to power demand growth)*
- Enhances grid safety and sustainability by allowing N-1 contingency planning if upgrading neighbouring lines with 3M™ ACCR, and lowers power outage probability*
- Enables integration of renewable energy and intermittent loads from renewables by upgrading existing thermally limited lines*
- Helps accommodate grid power flow changes due to distributed generation, and decreases grid complexity, thus increasing grid safety and reliability
- Re-conductoring with 3M™ ACCR maintains use of existing power corridor without negatively impacting the environment due to expansions, new right of ways/permitting, vegetation removal, etc
- Lowers greenhouse gas (GHG) impact by reducing or eliminating the need to manufacture and install new transmission line infrastructure and deployment of heavy equipment over large construction areas
- Increases grid sustainability by enhancing robustness and overall flexibility and reliability with added load capacity.
Low sag

3M™ ACCR offers higher ampacity at same or lower tensions while maintaining or reducing sag due to its lower thermal expansion core.

- A new or existing project can be designed with shorter, lighter towers, thus lowering environmental footprint and improving aesthetics
- Due to its lower weight and low sag properties, 3M™ ACCR can increase span lengths, thus lowering total number of towers used in a new project, which increases the likelihood of public acceptance*
- Certain 3M™ ACCR choices can reduce the right-of-way width and increase clearance thus increasing safety
- Lower 3M™ ACCR sag allows for longer spans, which can help optimize route selection to avoid construction on additional land around a body of water, instead of direct crossings. In specific projects, 3M™ ACCR has proven to be the best design choice that was used to avoid placing towers and foundation in rivers and lakes*
- Depending on specific project requirements, a smaller 3M™ ACCR size could be used for the equivalent ampacity of an ACSR conductor. In turn, this decreases tensions on towers due to ice build-up, which is less on the smaller 3M™ ACCR diameter, and can reduce sag when compared to ACSR

Other considerations

- 3M™ ACCR can substantially reduce re-conductoring project installation time, thus minimizing social and environmental impact and increasing chances of public acceptance*
- 3M™ ACCR can reduce transmission line footprint by minimizing the impact on environmentally sensitive areas such as wetlands or forests by reducing tower and foundation size
- The aluminum oxide fibre core minimizes the risk of corrosion of the outer AL strands, thus lowering the risk of replacing the conductor prematurely in highly corrosive areas and reducing the need to inspect for corrosion damage*
- 3M™ ACCR can bring renewable energy into the grid sooner, rather than later, by re-conductoring existing lines today as opposed to dealing with long permit and regulatory burdens related to new project approvals. Certain estimates indicate that getting one megawatt of renewable generation on the grid one year earlier could save approximately 2,300 million metric tons of annual emissions**
Summary

Improving the electrical network in a sustainable way and reducing negative impacts are critical to the success of today’s large grid construction projects. In addition to economic advantages, 3M™ ACCR can help bring sustainable, environmental benefits to power utilities and to the public through its advanced properties. In turn, they can help improve the social acceptance and smooth the construction of the project.
References


iii According to the Union of Concerned Scientists, existing state renewable portfolio standards will require 76,750 MW to be installed by 2025, resulting in 183,000,000 MMT of annual carbon dioxide emission reductions. See the following link: http://www.ucsusa.org/clean_energy/technology_and_impacts/impacts/renewable-energy.html.

*Data on file

Glossary

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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>ACCR</td>
<td>Aluminum conductor composite reinforced</td>
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<tr>
<td>ACSR</td>
<td>Aluminium conductor steel reinforced</td>
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<tr>
<td>ASC</td>
<td>Aluminum stranded conductors</td>
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<tr>
<td>GHG</td>
<td>Greenhouse gas</td>
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<tr>
<td>MMT</td>
<td>Million metric tonne</td>
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<td>MW</td>
<td>Megawatt</td>
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