Under what conditions is HVDC conversion a cost effective way to increase transmission capacity conversion in an existing HVAC corridor?

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**Motivation**

Transmission expansion will be necessary for decarbonization
• Electrification could double electricity demand by 2050 due to industrial and transportation loads
• Renewable resources are often located in remote regions, away from population centers
• ~50% to ~120% expansion in electricity transmission capacity likely needed for decarbonization

Siting new transmission lines in the US is increasingly difficult
• Multiple levels of conflicting regulatory bodies: local through federal
• Courts reject FERC siting power created in 2005 EPAct for “National Interest Electric Transmission Corridors”

Maximizing potential of existing corridors could speed the energy transition
• HVDC conversion can transmit 3.5X power in the existing right-of-way (ROW)
• UltraNet project in Germany using HVDC conversion to increase renewables in grid

**Methods**

HVDC costs dominated by converter station scales with power), HVAC costs by conductors (scales with distance)

\[
\text{Cost}_{\text{total}} = \text{Cost}_{\text{power}} P_{\text{MW}} + \text{Cost}_{\text{distance}} L_{\text{miles}} + \text{Cost}_{\text{losses}}
\]

<table>
<thead>
<tr>
<th>Power Costs</th>
<th>Distance Costs</th>
<th>Electrical Losses</th>
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<td>Util. &amp; Industry est.</td>
<td>Industry est.</td>
<td>EIA wholesale $/MWh</td>
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<td>HVAC Type 1: Existing Corridor</td>
<td>Transformer</td>
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<td>HVAC Type 2: Expanded Corridor</td>
<td>Transformer</td>
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<td>ROW, conductors, structures</td>
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**Results & Implications**

HVDC least or comparable cost at 50%-150% power increases and over 150 miles, much lower and shorter than new transmission conventional wisdom

HVDC conversion is technologically and economically feasible; should be included in industry and academic analyses
• Federal regulation focuses primarily on new transmission
• Not included in utility transmission planning software, limiting fair market consideration
• May impact recommendations if incorporated into decarbonization optimizations
• Lowering conversion costs (capital costs and energy losses) and increasing flexibility of HVDC operational configurations may support energy transition

Costs of permitting, regulatory approval, delay, and public response expected to further favor HVDC

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**References**


**Corridor Upgrades Compared**

**Results & Implications**

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