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Request for Stakeholder Comments for the IURC's Advanced Transmission Technologies Study

As you may be aware, Senate Enrolled Act (SEA) 422 from the 2025 legislative session requires the Indiana Utility Regulatory Commission ("Commission" or "IURC") to conduct a study on advanced transmission technologies ("ATTs"). The Commission is requesting your input, comments, ideas, research, and any relevant information you would like to provide, including regarding the following from Indiana Code § 8-1-8.5-14. **The first round of comments is due no later than June 3, 2026.**

Disclaimer: Duke Energy Indiana's responses herein are being provided only 1) in an effort to assist the IURC in its study of advanced transmission technologies; and 2) within the limited context of our transmission system. None of the responses herein should be construed as a declaration of company policy, nor extrapolated to alternative circumstances including but not limited to resource adequacy, generation resources, and/or integrated resource planning.

1) The potential use or deployment of ATTs by public utilities to enable those utilities to:
   a) safely, reliably, efficiently, and cost effectively meet electric system demand; and
   b) provide safe, reliable, and affordable electric utility service to customers?

   Duke Energy Indiana Response:

   Although ATTs can be a reliable and cost-effective interim and long-term alternative solution to identified transmission system needs, such as enabling faster interconnection of resources in limited cases. Alternative solutions such as ATTs must be dependable and reliable for customers and Duke Energy does not favor using its transmission systems as test beds for these advanced technologies. Some vendors' ATTs lack sufficient operating history or accelerated aging and harsh environment testing to properly understand potential failure mechanisms. Duke Energy is committed to working with industry colleagues and the Electric Power Research Institute ("EPRI") programs that are performing such testing to understand which ATTs can be reliable and cost-effective for customers.

   Examples of reliability issues to consider in selecting alternative solutions include dependability, security, and coordination. Reliability Coordinator/Transmission Operator review and approval of a solution should be considered.

   Dependability is a component of reliability that is the measure of certainty of a device to operate when required. If an alternative is selected to meet performance requirements of North American Electric Reliability Corporation (NERC) Reliability Standards, a failure of the solution, when intended to be available, would put the system at risk of violating NERC Reliability Standards if specified contingencies or system conditions occur. This risk can be mitigated by designing the solution so that it will accomplish the intended purpose while experiencing a single component failure. This is often accomplished through redundancy.

Security is a component of reliability that is the measure of certainty of a device to not operate inadvertently. Design of the automated solutions must consider false or inadvertent operation that results in taking a programmed action without the appropriate arming conditions, occurrence of specified contingencies, or system conditions expected to trigger the action. Some automated actions include shedding load or generation or re-configuring the system. Such actions, if inadvertently taken, are undesirable and may put the system in a less secure state. Security enhancements to the design, such as voting schemes, are acceptable mitigations against inadvertent operations.

Coordination between automated solutions and other protection and control systems needs to be examined for possible adverse interactions. This review can include wide-ranging electrical design issues involving the specific hardware, logic, telecommunications, and other relevant equipment and controls that make up the proposed solution.

2) The attributes, functions, costs, and benefits of various ATTs, including grid enhancing technologies and advanced conductors.

Duke Energy Indiana Response:

The main benefit of ATTs is first and foremost effectively resolving the identified transmission system need. Other benefits include reliability and economic benefits such as enabling generator capacity to meet reliability margin needs, production cost savings, and reliability and resiliency benefits for customers. Cost estimates can vary widely depending on application and location. (Also see response to 3).

The rest of the response provides high-level attributes, functions, costs, and benefits of various ATTs.

Transmission Topology Optimization (transmission switching) is a software-enabled operational tool that seeks to improve grid efficiency by reconfiguring existing transmission assets. Any transmission system reconfiguration needs to be studied to ensure stability issues are not introduced and coordinated with MISO, the Reliability Coordinator, prior to implementation.

Advanced Conductors can continuously operate at higher temperatures than traditional conductors, allowing more electric current to flow through a conductor of a given size. They are made with a variety of core materials, including high strength steel, carbon-fiber-reinforced resin composites, and ceramic-fiber-reinforced aluminum. Compared with traditional conductors such as Aluminum Conductor Steel Reinforced (ACSR), advanced conductors typically exhibit lower sag at the same conductor temperature. Typical applications include replacing existing conductors on existing structures to increase capacity or improve performance with minimal structural modification.

Advanced conductors cost more than traditional conductors. For a given conductor size, Aluminum Conductor Steel Supported (ACSS) with different steel-core grades typically costs about 1.2 to 1.5 times more than ACSR of the same size, while typical composite-core conductors cost about 2 to 10 times more than ACSR.

Dynamic Line Ratings (DLR) use measured or modeled environmental conditions to adjust the maximum ampacity of a transmission line. Dynamic Line Ratings should provide more accurate real-time thermal conductor line ratings for system operations. DLR ratings may be higher or lower than static or ambient temperature adjusted ratings (AAR) depending on the environmental conditions used to generate the static rating or AAR. Economically, DLRs could deliver value by unlocking latent transmission capacity in real-time without building new lines or requiring reconductoring. These real-time gains can potentially translate into reduced congestion costs, lower renewable curtailment, deferred capital investments, or improved market efficiency if the DLR is higher than the AAR.

Recent research from EPRI has suggested the average costs of DLR deployments including internal and external costs in year one can be in the range of $60k per mile, with lower ongoing costs for several years before hardware replacements are needed, triggering another high cost-per-mile year. The year one costs vary significantly by vendor, therefore it is challenging to provide a specific cost at scale beyond the figures provided by EPRI until a specific vendor and percentage of system coverage is defined.

Tower Lifting is most applicable on lines where conductor material properties permit operation at a higher temperature, but the line is operated at a lower temperature to reduce sag to manage clearance requirements. It is necessary to reduce sag when the structure height is insufficient to maintain code-required vertical clearances. Tower lifting restores or increases conductor-to-ground clearance by raising one or more transmission structures. Tower Lifting also includes strengthening/reinforcing structures to support the additional loads and the expected life of the modified structure will be lower than a new replaced structure. The pros and cons of both options including expected structure life (new replaced structure v. raised existing structure) need to be evaluated when selecting which technology to apply.

Tower lifting is generally less costly, faster to deploy, and less disruptive than a full line rebuild or new transmission construction because it reuses the existing right-of-way and much of the existing structure. Benefits include increased transfer capability, deferred capital spending on new lines, reduced environmental and land-use impacts, shorter implementation timelines, and making better use of existing corridors. Tower lifting is typically preferred when clearance constraints in only a few spans limit the line rating, because those spans can be addressed individually. It is generally not a practical solution when many spans have clearance issues. Key cost drivers include engineering analysis, structural condition and foundation adequacy, terrain access, outage or energized-work requirements, permitting, and any associated conductor or hardware upgrades. Tower lifting costs can vary widely depending on project scope, outage requirements, and risk, and may range from 50% to 75% of the cost of full structure replacement.

Advanced Power Flow Control Devices (APFC) are power electronic based devices, which are used to change the impedance in a transmission line to redirect current flow from highly loaded transmission lines to less loaded ones. This is done by injecting leading or lagging voltage into the transmission line, which changes the impedance. Benefits of APFC include avoiding the need to build or reconductor transmission lines, dampening power oscillations, and maximizing grid capacity without building or changing the grid topology.

Static VAR Compensators (SVC) improve system stability by regulating voltage, correcting power factor, and damping oscillations. An SVC is typically connected to the transmission network near a large industrial load(s) to manage voltage fluctuations. An SVC uses fast-acting thyristor valves to switch capacitor banks and shunt reactors to control the flow of reactive power to the transmission grid. The switching strategy allows for a fast, dynamic response to rapidly changing grid conditions, but also introduces harmonics that must be mitigated.

Static Synchronous Compensator (STATCOM) is a modern power electronics-based device designed to enhance grid stability, reliability, and efficiency by providing dynamic reactive power compensation. A STATCOM utilizes Voltage Source Converter (VSC) technology, typically comprised of insulated gate bipolar transistors (IGBTs) or similar semiconductor switches. This allows for rapid and precise control of reactive power, voltage regulation, and system stability. STATCOMs operate by generating or absorbing reactive power instantaneously, according to system needs. By injecting reactive current in response to voltage fluctuations, the STATCOM supports grid voltage at its connection point, counteracting voltage sags, swells, and flicker. The device connects to the transmission grid at a Point of Common Coupling (PCC) and modulates output within milliseconds, making it highly effective for dynamic grid scenarios and for mitigating disturbances caused by large loads, renewable integration, or network faults.

Synchronous Condensers primarily generate or absorb reactive power to stabilize voltage, improve power factor, and are a source of inertia to the system. This is achieved by adjusting the excitation current of the machine. Use of a synchronous condenser had been in decline due to newer technologies providing better reactive power compensation and power factor correction capabilities; however, they have been making a comeback recently due to the increasing presence of renewable energy sources for the physical inertia they can supply to the grid for overall strength and voltage/frequency stability.

AC to DC Line Conversion uses existing tower structures, conductors, and right-of-way. Typically, the implementation will require new insulators and hardware for DC. Additionally, a converter substation is required at both ends of line. An increase in the power transfer capability of the transmission line is largely obtained by increasing the voltage on the line. Potentially higher power transfer capability of the transmission line but will vary by structure design (heights and spacing) and clearances. The conversion allows the utility to change/control power flows from one end of the line to the other.

The largest cost components include the cost of the converters at both ends of the line, the converter substation and the cost of the new insulators (and hardware).

3) Whether each particular technology does the following:

Duke Energy Indiana Response: The following is a list of common ATTs:

- Advanced Conductors
- Advanced Power Flow Control Devices (APFC)
- Static Synchronous Compensators (STATCOMs)
- Static VAR Compensators (SVCs)
- Synchronous Condensers
- Transmission Switching Technologies
- Tower Lifting Techniques
- Voltage Source Converters (VSCs)
- Dynamic Line Ratings (DLRs)

a) Increases transmission capacity. Advanced Conductors and Tower Lifting can increase transmission capacity. Dynamic Line Ratings can increase (or decrease) transmission capacity compared with seasonal line ratings in real-time (not used for planning study ratings); Advanced Power Flow Control Devices can reroute power flow increasing utilization of the existing transmission system.
b) Increases transmission efficiency. Dynamic Line Ratings can increase (or decrease) transmission capacity compared with seasonal line ratings in real-time (not used for planning study ratings) and thus increase transmission line utilization when the dynamic line rating is above the seasonal line rating; Advanced Power Flow Control Devices can reroute power flow increasing utilization of the existing transmission system.
c) Reduces transmission congestion. Advanced Conductors and Tower Lifting can increase transmission capacity and thus relieve congestion. Dynamic Line Ratings can increase (or decrease) transmission capacity compared with seasonal line ratings or ambient adjusted ratings in real-time and thus potentially relieve congestion when the dynamic line rating is above the ambient adjusted or seasonal line rating. Dynamic Line Ratings are not used for planning studies. Advanced Power Flow Control Devices can reroute power flow through changing the impedance of a transmission circuit dynamically thus increasing utilization of the existing transmission system. Voltage Source Converters used with HVDC lines can be used to transfer bulk power and relieve loading on HVAC transmission lines.
d) Reduces the curtailment of generation resources. If curtailment is for thermal loading, any of the aforementioned technologies that can provide for relieving congestion can reduce curtailment/need for redispatch of generation resources.

e) Increases system reliability. Whether an ATT can increase system reliability depends on due diligence and studies performed for reliability and sustainability for the intended application of the technology. For example, transmission switching technologies may alleviate thermal overload issues, but introduce system stability issues if not properly studied prior to application. Where Advanced Conductor have been properly tested and installed, the increase in transmission capacity can provide for additional reliability for customers.

f) Increases system resiliency? When advanced conductors are applied in combination with new transmission structures, resiliency is improved for customers with speed to restoration following a storm. If not properly tested for resiliency, some advanced conductors can be subject to failing internally from impacts of trees falling into lines during storms potentially resulting in longer outages.

g) Increases the capacity to connect new energy generation resources. Advanced Conductors and Tower Lifting can increase transmission capacity. Advanced Power Flow Control Devices can reroute power flow increasing utilization of the existing transmission system and can be an interim solution to connecting new generation resources. STATCOMs, SVCs, and Synchronous Condensers can be used to resolve voltage stability issues when connecting large loads to the transmission system.

4) What is the potential of each ATT to be used or be deployed by public utilities to provide safe, reliable, and affordable electric utility service to customers in Indiana, considering existing and planned transmission infrastructure and projected demand growth?

Duke Energy Indiana Response:

Advanced conductors are being tested for sustainability and reliability and Duke Energy is progressing toward engineering standards that allow for the use of more types of advanced conductors based on the identified transmission need and solution application (e.g. reconductor using existing structures v. rebuild with new structures) considering costs. Duke Energy is monitoring the testing being conducted by EPRI of various ATTs as well as by utility industry colleagues for ensuring reliability is maintained or improved with application of a given ATT/GET. In addition, Duke Energy is performing testing of its own on technologies like DLR for potential future application on its transmission systems.

5) What potential reductions in project costs and project completion deadlines can be furthered by ATTs compared to traditional transmission infrastructure?

Duke Energy Indiana Response:

In some of Duke Energy's jurisdictions, generator interconnections are being accelerated through the use of switchable reactors in lieu of traditional line rebuilds. In addition, the use of advanced conductors can be cost effective for providing additional long-term transmission line capacity.

6) What are potential ways to streamline the deployment of ATTs, including streamlined processes for permitting, maintenance, and upgrades?
Duke Energy Indiana Response:

To streamline deployment, Duke Energy recommends that EPRI and utility industry testing of various ATTs/GETs be aggregated and published to ensure application of ATTs/GETs is prudent, sustainable, and reliable for customers. In addition, ATTs/GETs are not a one size fits all proposition and the engineering design for the ATT/GET application in a given location needs to be considered. For example, application of advanced conductors needs to consider the transmission structures, and weather such as wind, ice loading, etc. experienced in the location of application. Utility standards for construction and maintenance are important to deployment as well as sustainability and reliability.

7) Are there any other aspects of ATTs that can assist the IURC to understand the potential role of ATTs in Indiana?
Duke Energy Indiana Response:

Duke Energy encourages the IURC to inquire with EPRI and local utilities about providing a webinar or workshop for the Commission on ATTs/GETs.