Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Why the vision of interregional electric transmission development in FERC Order 1000 is not happening

Robert H. Schultea,*, Fredric C. Fletcherb

a Schulte Associates LLC, 2226 Coley Forest Place, Raleigh, NC 27607, United States
b Power from the Prairie LLC, 165 Malcolm Drive, Pasadena, CA 91105, United States

ARTICLE INFO

Keywords:
Power from the Prairie
Interregional
Transmission
Clean energy
Renewable energy
Federal Energy Regulatory Commission (FERC) Order 1000
Notice of Proposed Rulemaking (NOPR)
Diversity
HVDC transmission
Seam Study
Over-generation

ABSTRACT

The Federal Energy Regulatory Commission (FERC) on March 19, 2020 announced a Notice of Proposed Rulemaking (NOPR) to further investigate how financial incentives might be used to encourage development of high-voltage electric transmission in the United States. An extension of previous efforts in FERC Order 679 issued in 2006, the NOPR-proposed incentives would consist of up to 250 additional basis points of equity return to be allowed on qualifying transmission projects. The NOPR was published in the Federal Register on April 2, and public comments were due back to FERC by July 1.

Such incentives, if adopted, would be helpful to address prior FERC business that is yet undone. Issued in 2011, FERC Order 1000, “Transmission and Cost Allocation by Transmission Owning and Operating Public Utilities” among other things envisioned coordinated planning of interregional transmission developments spanning between individual Regional Transmission Organizations (RTO) and Independent System Operators (ISO), the operators of the FERC-regulated organized wholesale markets. In addition to traditional goals of generator interconnection and service reliability, the purpose of such interregional transmission development was to support public policy goals including renewable energy development, and lower costs for consumers.

But little or no such interregional development has happened since Order 1000. Why? The authors have spent the last several years promoting development of one such interregional transmission project. While the effort is ongoing, the on-the-ground experience to-date clearly shows the reasons why interregional development envisioned by FERC Order 1000 is not happening. The authors offer solutions to the issues, including how the new FERC NOPR for transmission incentives can be helpful.

1. Introduction

1.1. The FERC NOPR

The Federal Energy Regulatory Commission (FERC) on March 19, 2020 announced a new Notice of Proposed Rulemaking (NOPR) to examine the potential for establishing enhanced economic incentives for development of new electric transmission. The idea is to offer additional incremental allowed return on equity for investments in qualifying transmission projects that meet certain criteria including fulfilling public policy goals (Example: enhancing renewable energy development), enhancing reliability and reducing costs for customers.

The NOPR was published in the Federal Register on April 2, commencing a 90-day public comment period.

1.2. FERC Order 1000

In a previous related effort, FERC Order 1000 titled “Transmission Planning and Cost Allocation by Transmission Owning and Operating Public Utilities” (“the Order”) was issued on July 11, 2011. Among other things, the Order directed utilities and their Regional Transmission Organizations (RTO) and Independent System Operators (ISO), responsible for operating the nation’s bulk power transmission network and wholesale markets in their respective geologic territories, to conduct regional electric transmission planning studies to fulfill various public policy objectives.

The Order also encouraged the utilities and RTOs/ISOs to coordinate together to conduct interregionalii transmission planning studies between them, for the same objectives. While some intra-
coordinated is happening, and the RTOs/ISOs have fulfilled Order 1000 requirements to post their interregional planning efforts on their websites, interregional transmission projects are not happening, nearly ten years later. Why is that?

2. Potential benefits of interregional transmission

2.1. Why transmission?

"Transmission 101": The purpose of electric transmission is to share generation capacity reserves between entities such that together they can minimize their total generation investment needed to ensure service reliability to their customers.

Because transmission costs less per kilowatt of capacity than generation does.

This is a lesson learned in the early days of the utility industry. Then, each small utility or town had its own electric generator. In order to protect against that generator failing, they installed another redundant generator to back up the first one. Today, we would call that (i.e., one kilowatt of reserve generation to back up one kilowatt of generation) a 100% installed capacity reserve margin.

As time went on the towns or small utilities realized that if they would connect their systems together with transmission, they could share the backup generation between them. That is, there was time diversity between their respective needs for backup. This resulted in reductions in the amount of total generating capacity they needed when operated together

Over time, towns were connected by larger utilities formed by combining smaller utilities. And these larger utilities in turn then connected to each other using transmission—basically for the same original purpose. Today, large utility networks share generation resources such that their reliability-based minimum installed capacity reserves might be only 8%–15% of their coincident annual peak customer demands.iii

2.2. Why interregional transmission?

Interregional transmission would take the “Transmission 101” concept to the next system architectural level. Regional planning organizations studies show that widely dispersed regions of the country (Say, the West Coast and Upped Midwest) have significant spatial and thus time diversity between their electric demands.iii That is, the combining of separate diverse loads, each having load requirements at different times during the day and year, produces a net total load that will have less variability than if served separately.

For example, the Upper Midwest and Southern California have about 6.4 Gigawatts (GW) of load diversity between them (Fig. 1). Plus, they have significant time diversity between the outputs of the renewable energy resources located there. If the regions could be effectively interconnected with high-voltage high-capacity transmission using technology that is already available, they could conceptually save consumers money by sharing generation reserves while supporting their service reliability.

In addition, this same diversity can be applied to energy supply resources as easily as it applies to load. Thus, such combining could support higher levels of renewable energy by enabling innovative, time-diversified renewable energy swaps of surplus renewable energy between regions. It would also take advantage of the spatial variability of wind and sunlight between them. For diversity not only reduces the variability of load, it also reduces the variability of wind and solar resources when they are interconnected together.

2.3. The NREL interconnection study

The U.S. Department of Energy (DOE) supported a major study of this interregional transmission concept in 2017 – 2018 as part of its Grid Modernization Effort. This $1.5 million effort, called the “Interconnections Seam Study” was performed by the National Renewable Energy Laboratory (NREL) in Golden, Colorado, in cooperation with Iowa State University in Ames, Iowa.

The purpose of the study was to investigate the viability of a national high-voltage direct current (HVDC) transmission overlay on top of the existing alternating current (AC) system. Doing this would require the transmission to span the “seam” between the Western and Eastern Interconnections, which are AC systems that do not operate in synchronization with each other. Thus, the name: Seam Study. Today, they are connected only via seven relatively small (200 MW or less) interfaces (Fig. 2); many of which are already approaching 40 years in age. vi

2.4. Why HVDC?

• It is more efficient (i.e., lower line losses) than AC when used over long distances.

• Unlike AC, where the energy flows along the paths of least impedance, the energy flow on an HVDC line can be controlled electronically.

• It can be used to connect asynchronous AC systems together; like the Western and Eastern Interconnections (Fig. 2). This would be impractical for an AC transmission overlay.

• The HVDC transmission line uses less right-of-way land for the same MW of transfer capacity than does an AC transmission line. That is, a HVDC line has more electric capacity per square foot of required right-of-way land than an AC line can achieve.

The Seam Study found an interregional HVDC overlay would:

1. Support reliable operation of the grid.

2. Result in lower operating and capital costs than the separate systems. Present value benefit/cost ratios of 1.15–2.56 were calculated, depending upon which of the three scenarios were examined.viii



vi A similar seam exists between the Western and Eastern Interconnections and the Electric Reliability Council of Texas (ERCOT)—essentially the state of Texas. The Seam Study did not address this seam.

viii NREL presentation of Seam Study results at TransGrid-X Symposium, Iowa State University, Ames, Iowa, July 26, 2018.
3. Support integration of large amounts of additional renewable energy without additional energy storage or controllable loads.
4. Support the economic retirement of most of the remaining coal-fired generation fleet over the 20-year planning period.

This important study, however compelling, was conceptual and academic in that it did not involve specific transmission projects sponsored by specific commercial entities. It did however identify in a broad concept that such interregional transmission overlays have high potential value.

So, how do we best proceed with transmission planning to insure the capture of such potential economic promise of interregional transmission?

3. Power from the prairie project

3.1. About the power from the prairie project

About the same time the Seam Study was being developed, in 2016 the authors of this article began conceptual development of a specific interregional transmission project called Power from the Prairie (PfP). It would consist of a nominal 4000 MW HVDC line starting from the wind energy fields of Southeastern Wyoming, crossing either South Dakota or Nebraska to the wind energy fields of Northwest Iowa (Fig. 3).

It would feature a DC/AC/DC convertor station in the middle of its length. This would enable interconnection of massive quantities (thousands of MW) of new wind energy developments in South Dakota and Nebraska, which represent some of the best wind energy resource in the country, but is currently landlocked due to lack of transmission and access to markets. When interconnected with other proposed high capacity HVDC lines from Wyoming to California (e.g., the Anschutz “TransWest Express” or Duke-ATC “Zephyr” lines as well as an existing HVDC line currently associated with the coal-fired Intermountain Power Plant in Utah scheduled to be retired in 2025 and connected to the Los Angeles Department of Water & Power (LADWP) and California Independent System Operator (CAISO) systems), and the proposed Soo Green HVDC line from Northwest Iowa to Chicago and the PJM Interconnection (“PJM”), it would enable a bi-directional renewable energy superhighway connection between Southern California and Chicago/PJM.

It could also include massive, long duration, grid-level energy storage like the proposed Gregory County pumped hydro project in South Dakota (1200 MW, 26 hours of storage) if found to be cost-effective in addition to the benefits of the transmission line itself.

Making the Seam Study vision of a national HVDC overlay happen is too big to do all at once. So, the PfP project was designed to be the first practical instance of the concepts of the more global and conceptual Seam Study. An initial Concept Development Study (CDS) was defined, working with ABB Consulting, to explore the viability, economics and regulatory viability of the PfP concept. Plans for the CDS were presented at Iowa State University in July 2018 at the same meeting where the Seam Study results were announced.

The idea behind the CDS is to provide initial quantified data to demonstrate whether a PfP interregional transmission development makes sense by using currently-available HVDC technology in existing and planned projects linked together with HVDC line extensions. Most importantly, the CDS would identify specifically what utilities, renewable energy projects and other entities would benefit from such an interregional connection. With that information, potential participants in and owners of the project could be identified and joined together as a “federation of the willing” – a coalition based on securing the economics of renewable energy with the time and spatial diversity that interregional transmission can uniquely deliver to match diversified loads and resources.

3.2. The theory

Based on recent HVDC projects proposed by non-utility, independent transmission companies, the authors observe the following about such developers:

1. They often have an excellent financial background.
2. They are good at promoting.
3. They are good at securing right-of-way.
4. However, they are as-yet generally unable to secure utility off-takers for their project. After all, they need the commitment of eventual customers to make their projects financeable.

The authors are former utility managers and executives. When you are a hammer, everything else tends to look like a nail. So, the initial and obvious CDS marketing focus (that is, finding participants to fund and participate in the study and thereafter the project) would be on utilities. Starting from a direction opposite to independent developers, the authors first sought to secure utilities’ interest and participation as potential off-takers of the transmission developments.

The authors’ subsequent experience has shown their theory was probably wrong for the following reasons:

1. The Scale is Daunting.
2. A Divided Camp (aka, Tribes do not play well with others).
3. State Parochialism.
4. Waiting for Godot.
5. Fear for State Cost Recovery.
6. High Wholesale Prices are Good.
7. Renewables in Denial.
8. Fear for Coal.
9. Federal Ambiguity (and Hostility).
10. Traditional Focus on Cost vs. Value
11. The DER Distraction.

While many of these same challenges also apply to transmission
development within a single region, the authors found them to be barriers to the FERC Order 1000 vision of coordinated interregional transmission planning.

Let’s take each one of these reasons in turn, and potential solutions:

4. Scale is daunting

The complexity and scale of an interregional transmission development can be daunting. A 600-mile, 4000 MW Power from the Prairie HVDC line could cost about $3 Billion. A 1200 MW pumped hydro storage facility connected to it (say the proposed Gregory County project on the Missouri River in South Dakota) could cost about $3.5 Billion. 2400 MW of new wind machines connected to the pumped storage plant could be another $3 Billion.

Multiple and potentially diverse project participants would be required. 4000 MW is too large for a single utility to absorb. Non-utility investors/developers may be involved including independent transmission companies. Plus, multiple federal, state and local regulatory processes would be necessary. The HVDC technology is available, but unfamiliar to many utilities. The concept of interconnecting widely-dispersed and time-differentiated renewable sources is also foreign to them.

Although daunting, it still is not nearly as big or complicated as the nation has successfully accomplished before. One such project is the mainstream hydro dams on the Missouri River in the Dakotas built by the Pick Sloan Plan in the 1950s. The interstate highway system built during the Eisenhower Administration, or the moon landing. The nation can raise $2 Trillion relatively quickly for an economic development package as we have seen recently for the coronavirus pandemic. Where there is a will, there definitely is a way.

5. A Divided Camp (AKA, Tribes do not play well with others)

Utilities traditionally focus on their own service areas; not outside of them. Competitive jostling among utilities is traditional. However, except for competition in the open markets for wholesale generation in regions where such generation is fully deregulated, they do not really have competitive pressures on or for their territory.

Even large utilities typically do not think beyond the boundaries of their own service territories. And, while the incumbent utilities may not be building much transmission themselves, they are not enthused about independent, non-utility transmission developers taking a lead in the utilities’ traditional transmission business.

6. State parochialism

States have a number of entities that have an interest in electricity infrastructure development, including utility regulation, transmission siting, economic development, taxation, as well as political and legislative interests associated with energy policy. Like utilities, states naturally think in terms of their own self-interest. Economic development, and particularly renewable energy development and associated jobs, is typically focused at home. Example: states like California would like to have all their solar developments happen in-state. Energy storage, similarly. And who can blame them?

Too, most of the revenues of investor-owned utilities are retail-regulated at the state level. Several of the investor-owned utilities (IOUs) we visited with expressed concern about whether their state regulators would allow them cost recovery of investments in out-of-state transmission resources; regardless of how cost-effective they may be for their consumers.

Although not rate-regulated by their states, public power utilities (i.e., municipals and cooperatives) are, by definition, primarily driven by their local customers/members. And profit motives (example: the proposed enhanced equity rate of return incentives envisioned by the new FERC NOPR) are not important to such not-for-profit entities.

Beyond the utilities, proposed efforts for multiple states to band together to form wholesale markets have run into parochial barriers over control of who might be running the market. Example: State of California efforts to expand the California Independent System Operator (CAISO) into other Western States.

7. Waiting for Godot

“Waiting for Godot” is a tragicomedy play by Samuel Beckett that premiered in 1953. It is a typical example of the Theatre of the Absurd, and people use the phrase ‘Waiting for Godot’ to describe a situation where they are waiting for something to happen, but it probably never will.

The primary goal of the financial departments in the IOUs is to recover from customers via regulation whatever costs their operating divisions incur. While they may outwardly grumble about regulatory decisions or legislation that may change their plans or increase their costs, such decisions provide them some assurance of regulatory recovery of those costs. So, clear regulatory or legislative directives to do certain things, perhaps not things the utility proposed themselves, is not a bad thing from a financial perspective.

FERC Order 1000 encouragement notwithstanding, there currently are no states ordering utilities to consider or do interregional transmission. (See prior section on State Parochialism). So, any entity expecting a state to promote interregional transmission is Waiting for Godot.

8. Fear for state cost recovery

Related to State Parochialism, some IOUs are concerned about the prospects of being able to secure state retail cost recovery for any investments in interregional transmission developments. Their state might want the money spent in-state, regardless of how cost-effective the project may be for their consumers.

This belies the fact that cost recovery for an interregional transmission line may be FERC-regulated at the wholesale level instead. Or like a natural gas pipeline, where the producer pays for the transmission and includes it in the cost of their output product. It is not rate-based by the IOU in their state-regulated retail rates.

9. High wholesale prices are good

An executive of an (unnamed) IOU expressed a unique but brutally honest reason for not being interested in interregional transmission development. He first expressed their company’s policy that they are focused on what is good for their customers. Then, he observed that a development like Power from the Prairie would likely lower wholesale market prices by enabling additional renewable energy resources.

But as the executive explained, they wanted high (not low) wholesale prices (!!!). Their rationale:

---

x Exception: Occasional squabbles between electric distribution cooperatives and municipal utilities where a city wants to expand its corporate limits.
1. They are currently over-built with (conventional) coal-fired generation capacity.
2. When they make sales on the wholesale market, a portion of the profits is returned to retail customers.\textsuperscript{xiv} So high wholesale prices benefit their retail customers.

This is a half-truth. While true, this potential benefit to retail customers is small relative to the penalty they simultaneously pay for having high wholesale prices affecting their retail rates overall.

10. Renewables in denial

With the potential for interregional transmission to support massive additional quantities of renewable energy, one would expect renewables companies would be promoting them. Not so. Renewable energy has only recently become economically competitive with conventional energy sources like coal and gas. Previously, they could not afford the additional cost that transmission development would impress on their projects.

So, they became very adept at ignoring the topic of transmission and expecting the utility industry (with encouragement from state legislators’ interests in promoting renewables) to just make it appear. If they build the transmission, renewables will come. More recently, renewables are cost effective and regions like the Midcontinent Independent System Operator (MISO) are very transmission constrained to support more.\textsuperscript{xi, xvi}

11. Fear for coal

Several utilities in the Upper Midwest have announced plans to retire their coal-fired generating plants in the coming years. Regardless of concerns for carbon emissions, as a practical matter most of the existing coal-fired plants in the Upper Midwest are already 35–50 years old (Fig. 4). Such resources typically have a book life of 30 years.

So, they are aging-out anyway. And no new coal plants are on the drawing board nationwide. Coal for electricity generation may not be dead. But it is certainly on its way out.

Nevertheless, some public power utilities we interviewed expressed concern for what increasing levels of renewable energy, although cost-effective, were already doing to the operation of their legacy coal plants. The renewables (with zero fuel costs) are being dispatched in the wholesale markets before the coal plants, reducing the coal plants’ hours of operation and associated revenues. They apparently did not like the image that participating in an interregional transmission study, that could enable more renewables, might represent to their members.

12. Federal ambiguity (and hostility)

It is clear that interregional transmission development needs leadership from entities that individually or collectively span multiple regions. At the federal level, FERC Order 1000 attempts to encourage coordination of interregional transmission development, but another federal agency is actively countering that thought.

The NREL Seam Study described earlier painted a bright future for renewable energy. If interregional transmission was available, this over-generation study.\textsuperscript{xvii} They disappeared from the NREL website, although many industry representatives have copies of them. It is as if the Seam Study never existed. Apparently, this happened because the Seam Study did not paint a bright future for coal-fired generating plants. ‘Hope for a cogent federal energy policy? Good luck with that.

13. Traditional focus on cost vs. value

Another challenge to interregional transmission planning is the traditional mindset of utility executives that is based on comparisons of costs, rather than value. A senior utility executive challenged the usefulness of interregional transmission to integrate renewable energy. If a wind machine in Illinois can generate electricity at the same $/MWh busbar cost as a similar machine located in Wyoming, then why connect them with transmission?

Such traditional cost-based comparisons miss the point. In the future, at high levels of renewable energy in the generation mix, the value of the wind machine’s output becomes more important than the contract-based average cost. There will be two critical differences:

1. At very high levels of renewables in the future (say 60% renewables or more), there will be many hours during the year when the market value of a wind machine’s output in a specific wind regime will be zero (or worse, negative). This will happen when there is too much installed wind (or solar) capacity installed in a region compared to the customer load in that region. The average contracted busbar purchase cost of the wind energy does not matter in such a situation.
2. This defies traditional cost-based utility thinking.

2. At the same time, another region may need wind energy, but the wind is not blowing there. So, the value of interregional transmission would be to get the otherwise worthless wind energy from where it is blowing to the load region where it is not blowing and needed.

This value vs. cost consideration requires a different mindset going forward. For example, Los Angeles Department of Water & Power is currently doing an “LA100” study to identify how they can achieve 100% renewables. LA100 forecasts very high levels of solar over-generation, and thus curtailment when the non-dispatchable solar does not match the hourly customer loads in the future as their Renewable Portfolio Standard (RPS)\textsuperscript{xviii} increases toward their goal of 100% clean energy (Fig. 5).\textsuperscript{xxv}

If interregional transmission was available, this over-generation

\textsuperscript{xiv} ‘This is typical of state retail ratemaking rules. The retail ratepayers are paying for the transmission. So they should share in benefits of wholesale sales to others when the volume of such sales exceed the assumed levels used to determine the utility’s retail rates.

\textsuperscript{xxv} ‘MISO-West is Running Out of Room for Renewables’, Tom Silva, PV magazine US, November 13, 2019.

\textsuperscript{xvi} MISO’s 50 GW Gap!
\textsuperscript{xxvii} Will Kaul, Fresh Energy Renewable Energy blog, December 16, 2019. Available at: https://fresh-energy.org/misos-50-gw-gap/.

\textsuperscript{xviii} A Renewable Portfolio Standard (RPS) is the portion of a utility’s retail electric sales that by law must be supplied for renewable energy. It is expressed in percent of the utility’s total annual retail electricity sales.

\textsuperscript{xxv} ‘SB 100 Scenario, Initial Run Highlights’ presentation, Los Angeles Department of Water & Power, LA100 Advisory Group Meeting #10, Daniel Steinberg, National Renewable Energy Laboratory, December 5, 2019 at Chart 16.
could be sent to other markets Eastward when it occurs. And it could return wind energy from the Midwest to California when the sun goes down in LA. Let California build all the local solar resources it wants. Then, use interregional transmission to both absorb the excess production and return renewable energy from other regions to California at night to help fulfill their 100% clean energy goals.

14. The DER distraction

The concept of distributed energy resources (DER) is currently very popular. Example: A solar panel on a residential roof, with a storage battery in the garage. Although there has not been a lot of activity yet except in high-solar, high-cost areas like Hawaii and California, the idea of such “non-wires” alternatives to traditional utility transmission and distribution lines is attractive. As rooftop solar penetration continues, DERs are an opportunity to achieve some personal energy independence from the grid and potentially defer utility distribution system and generation investments.

Meanwhile, the DER discussion is taking some of the oxygen out of consideration of traditional wires solutions. However, both wires and non-wires approaches will be needed in the future. They are not mutually exclusive in the overall effort to achieve high levels of clean energy.

DER and interregional transmission are complimentary. DER typically features solar but not wind, while interregional transmission can accommodate both solar and wind. And interregional transmission can enable renewable energy swaps between regions while DER cannot. A result of interregional transmission DER can achieve high levels of reliability without requiring excessive amounts of battery storage to continue service through extended non-solar periods, and without excessive curtailment of solar over-generation.

15. Solutions

The authors have realized their original theory of utilities leading interregional transmission development as potential off-takers may be incorrect for the reasons described above. Some form of non-utility entity that is not bound by individual utility service territories and purely state-based regulatory considerations, and has a global scope and vision, is necessary to provide leadership.

- Such an entity would not be FERC (as lack of progress to-date on the vision of Order 1000 demonstrates).
- And it does not include RTOs/ISOs who, like the utilities, are regulated by FERC who issued Order 1000.
- RTOs/ISOs, by definition, do not develop or own transmission facilities.
- They study and operate facilities proposed and owned by others; not themselves.
- And who might such an entity be?
  - The federal government would have the appropriate multi-region scope and hopefully broad national energy policy purview. However, as recent experience with DOE and the Seam Study would attest, this is not a likely outcome. In fact, the federal government has not led such development since the Colorado River Storage Project which began over 60 years ago.
  - The federal government could encourage such development as part of a nationwide infrastructure program as an economic stimulus package. Not only would such projects support clean energy development and lower consumer costs, they represent thousands of well-paid jobs.
  - One or more states (several states in coordination would be best), acting in their own self-interest as coalitions in their efforts to achieve high levels of carbon-free energy. For example, we are already seeing such governor-led, multi-state coalitions forming to plan processes for transitioning out of current coronavirus social distancing orders.
  - An independent project developer with a profit motive. With IOUs apparently discouraged for prospects of state retail cost recovery for such interregional projects, and public power utilities without a profit motive, it is this group that may be productively encouraged by the FERC NOPR.

Although it certainly would be helpful, such projects do not need a cogent federal energy policy to happen. It does not need a Western Interconnection-wide regional transmission operator (RTO), a proposal that has been introduced in the California legislature (Assembly Bill 13) but has faced severe political headwinds in Wyoming and other states.

Instead, it can be done by and among a limited number of interested energy entities and states acting together as coalitions in their own and their customers/citizens mutual interests.

Funding sources

The authors are members of Power from the Prairie LLC, an energy and regulatory consulting firm for due diligence studies of high voltage direct current transmission projects like those described in the article. The research for this article was independently funded by Power from the Prairie LLC.

Robert H. (“Bob”) Schulte, Principal Schulte Associates LLC. Bob Schulte has 40 years of experience in the electric power industry. He is a Principal in Schulte Associates LLC (SA, www.schulteassociates.com), an executive management consulting firm with offices in Raleigh, North Carolina providing project management and interim CEO/COO services to energy industries. Bob is an expert in generation and transmission integrated resource planning and project development; distribution planning, engineering, construction and operations; and utility business and regulatory affairs for both public and private utilities. Bob is very familiar with the electric industry and its participants in the Upper Midwest. A native of South Dakota, he was the Project Manager of the proposed 270 MW Iowa Stored Energy Park compressed air energy storage (CAES) project, and is the primary author with Nick Critelli of “Lessons from Iowa”, the U.S. Department of Energy/Sandia Labs report on lessons-learned there (www.lessonsfromiowa.org). “Lessons” is a recognized textbook on how to do a large-scale grid energy storage project in an Independent System Operator (ISO) region. He also performed the Gregory County (South Dakota) Pumped Hydro Storage study, combining large-scale (1200 MW) pumped hydro storage with renewables to create a 100% renewable, fully dispatchable, baseload generation resource. Bob served as a consultant to Burbank (California) Water & Power, leading modeling and economic analysis of a proposed 1200 MW CAES facility, 3000 MW wind field in Southeast Wyoming, HVDC transmission from Wyoming to Delta, Utah, and 10,000 MW of solar (the “Duck Curve”) in Southern California as they would operate in the Western U.S. electric grid. Output of the project would serve utilities in Southern California and elsewhere and replace an

Residential and commercial building rooftops are ideal for solar, but not for wind.

The various RTOs/ISOs for the most part have been professional and cooperative with the Power from the Prairie team in discussions about the CDS.
existing 1800 MW coal-fired generation station. More recently, he coordinated development of the BWP 2019 Integrated Resource Plan (IRP). He is co-author with Ingrid Bjorklund of “Market and Tariff Challenges to Grid-Level Energy Storage Enabling Renewable Energy in RTO/ISO Markets”, available on the SA website. Prior to SA, Bob served 16 years at Northern States Power Company (NSP) in Minneapolis, now a unit of Xcel Energy. At NSP, he held a variety of positions in resource planning for large-scale generation and transmission projects, marketing, distribution engineering and operations, and legislative/regulatory affairs. He was lead resource planning engineer for planning, permitting and contracting for the 800 MW Sherburne County #3 coal-fired generating unit near Becker, Minnesota. He led development of the first large-scale utility customer energy efficiency programs now in common use in the Upper Midwest, and led the NSP decision to install the first large-scale wind energy developments on the Buffalo Ridge in Southwest Minnesota where more than 1000 MW are now in operation. He served as General Manager of NSP’s South Dakota Region, VP of Rates and Corporate Strategy, and VP of Marketing and Customer Service. He holds a BSEE (Power Systems) from South Dakota State University, and an MSEE (Power Systems) from the University of Missouri-Columbia.

Fredric C. (“Fred”) Fletcher, Assistant GM– Power Supply Burbank Water & Power (retired) Fredric Fletcher has led power system planning, engineering, development and operations since the 1970s. Like Bob Schulte, he is very familiar with and connected in the utility industry in the Upper Midwest, the location of the proposed project. Fred is Chairman of Power from the Prairie LLC. A native of South Dakota, in the 1970s Fred was part of the original staff of the then newly-formed Missouri Basin Power Agency in Sioux Falls (now Missouri River Energy Services), supplier of power to 57 municipal systems in a four-state region. He not only performed the planning for the agency, but also was responsible for operations. In the 1980s, he became the Assistant General Manager of Burbank Water and Power, the position from which he retired in July 2016. He has a long history of successful innovation, efficient and reliable operations, business line development, and leading multiple utility undertakings. He has developed a combustion turbine project, Lake, that was power plant of the year for Combustion magazine in 2004, a combined cycle project, Magnolia, that was power plant of year for Power magazine in 2005, he developed smart grid technology that lead to a $20 million grant from the DOE and was one of the best smart grid implementations winning numerous national awards. Fred was the first in California to use biomethane to displace natural gas, and he repositioned his energy portfolio from no renewable energy to 33% renewable energy in 8 years with rate increases less than the rate of inflation. Other innovations include a utility fiber optic network to support television and movie production, the development of an advanced automated dispatching system that incorporates demand response into system operation, a wireless Wi-Fi network that covers the entire city of Burbank and can respond in less than 15 milliseconds, and transmission and substation protection improvement that now deliver power to Burbank customers with 99.999 % reliable power. At BWP, Fred was the originator and executive sponsor of the proposed bulk storage, HVDC transmission and large-scale wind project to replace the existing 1800 MW Intermountain Power Project coal-fired generation plant in Utah when it is retired in 2025.