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LF ENERGY

Open Source and Energy Interoperability

Opportunities for Energy Stakeholders in Canada

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Open Source and Energy Interoperability

Digital Technology Impact: Digital technology alone is projected to generate $2.1 trillion in annual revenue.

Energy Sector Challenges: The energy sector needs to meet a 50% increase in demand by 2050 while becoming greener and smarter.

Promise of Open Source: Open source technology shows the greatest promise to accelerate the transition to clean energy.

Microgrids Role: Microgrids are key for energy access and transition, providing reliable and sovereign electricity.

Smart Grid Development: Digitalization involves developing a smart grid with two-way communication and advanced sensors.

Open Source Benefits: Open source platforms reduce costs, enhance interoperability, and improve integration across energy systems.

Standards and Collaboration: There is a need for industry-wide standards to facilitate interoperability and reduce silos.

Data Sharing Importance: Open source platforms enable better long-term planning through transparent and real-time data sharing.

Future-Proof Technology: Adopting open source solutions ensures assets remain adaptable and compatible with evolving standards and technologies.

Interoperability: IEEE 2030.5 standardizes communication between the smart grid and consumers using open web standards such as TCP/IP and XML.

Interoperability solution: The EVerest project empowers industry stakeholders by simplifying compliance while providing a scalable, interoperable foundation for innovation in EV charging.

Interoperability solution: The SPEEDIER project highlights the significant opportunity for open source software & open standards to improve DERs and their integration into smart grid systems.

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Introduction

The Business and Sustainable Development Commission in 2017 established an economic prize for businesses to achieve the United Nations Sustainable Development Goals and described how businesses could achieve the goals by deploying technology.[1] The opportunity to revolutionize sectors including healthcare, agriculture, logistics, energy, finance, and education is enormous; however, in order to be effective, digital solutions need to be democratized and deployed across the global economy. The project estimates that accelerating the Global Goals could generate business revenues and savings exceeding $12 trillion per year and create 380 million new jobs by 2030. Further analysis from the Global e-Sustainability Initiative and Accenture also suggests that digital technology on its own will generate $2.1 trillion in annual revenue.[2]

Among the most urgent of the efforts is accelerating Goal 13, Climate Action, through widespread electrification coupled with digitalization of the energy sector. The electricity sector faces the combined challenges of at least a 50% increase in demand by 2050 while also needing to make its services greener and smarter. The current need is shifting from massive new hardware to more software-defined infrastructure that connects an agile and evolving system. It requires infrastructure that is amenable to continuous, easier, and lower-cost upgrading.

A lack of interoperability between utilities and other electricity system stakeholders such as the growing number of connected devices is an overarching problem due to issues around security, data sharing, communication, and vendor lock-in. Open source standards and protocols show the greatest promise to accelerate innovation and the pace of the transition to clean energy while addressing these interoperability issues. However, the adoption of open source technology in the Canadian electricity distribution system is still in its early stages. Organizations such as the Linux Foundation support most open source technologies in this sector rather than individual contributors. Energy stakeholders from across the Canadian electricity ecosystem are not actively involved in energy-specific open innovation communities and initiatives. Recently, there has been a growing recognition of the need for interoperability, driven primarily by concerns over cybersecurity. One example within the energy sector where open source technology will play a role is with microgrids. Manoj Sinha, CEO of Husk Power, states, "Microgrids are becoming the platform for both energy access and energy transition for emerging markets. They are helping hundreds of countries delink the grid from fossil fuels and obtain electricity with a high degree of reliability and sovereignty."[3] We can assume a forward-looking lens, looking at various regulatory customer trends, including reducing carbonization and increasing the use of renewable energy, including that by Distributed Energy Resources (DERs).

1 "**Better Business, Better World**," Business & Sustainable Development Commission, December 2017.

2 "**Uniting to Deliver Technology for the Global Goals**," 2030Vision, SustainAbility, December, 2017.

3 **The Open Source Opportunity for Microgrids Five: Ways to Drive Innovation and Overcome Market Barriers for Energy Resilience**, The Linux Foundation, June 2023.

Digitalization in the energy sector leverages digital technologies to improve the efficiency, reliability, and sustainability of energy systems. This process integrates automation, IoT, data analytics, and cloud computing across the energy value chain. It is important to ensure near-perfect uptime but do so in a more sustainable manner—a situation that requires transparent sharing of data in real time. This transformation involves developing a "smart grid" that facilitates two-way communication between utilities and consumers and incorporates sensing capabilities along transmission lines. Traditionally, the energy sector's centralized, one-way approach, dominated by large companies relying on fossil fuels, has been inefficient, with limited opportunities for energy storage and consumer energy production. Digitalization can revolutionize the sector by enabling more effective integration of renewable energy sources, with advanced sensors and control systems managing the variability of wind and solar power.

Benefits of Open Source and the Need for Harmonization

Open source platforms can reduce costs associated with licensing fees for proprietary software and offer flexibility and customization to meet specific needs, facilitating better and faster development, integration, and interoperability. Travis Lusney, Director, Power Systems at Power Advisory LLC, states, "Open source platforms can provide common tools, modules, and applications that enhance interoperability by meeting performance criteria and facilitating easier integration among diverse systems."[4] He is 100% correct; open source can provide all these benefits and more.

Reduced Lock-In Risk

At least at its core, open source technology can reduce the risk of vendor lock-in. When an organization is using a proprietary system, there is a risk of cost increases, use restriction, and the risk of abandonment—especially when an organization is acquired or a product is removed. In addition, open source software is usually available at a lower cost than the expensive licensing fees associated with proprietary software.

Increased Visibility

Additionally, the transparent and independent nature of open source software enhances trust, as stakeholders can inspect and audit the code. Javad Fattahi, Professor at the University of Ottawa, advises, "While transparency is a benefit, it also means vulnerabilities can be more easily discovered and exploited if not properly managed. Open source solutions may face difficulties integrating with proprietary systems and standards, requiring additional customization and expertise. There are many successful open source communit[ies] that we can learn from to address those challenges."[5] Proper management of open source can, however, increase security; best practices can

4 Interview of Travis Lusney conducted by Mike Dover, May 17, 2024.

5 Interview of Javad Fattahi conducted by Mike Dover, June 5, 2024.

be found at the OpenSSF.[6] A University of Washington–led study agrees that open source projects are more secure: "With open source, any who wish to see the source code for any part of a project can do so. Bugs including security vulnerabilities may be spotted by the many eyes—both the experts and novices alike—on the code. Open source code is subject to security reviews (as in any professional software developing enterprise), but in addition to 'in-house' reviews by those engineers tied to the project, is also subject to unsolicited security reviews that may be conducted by anyone in the world. One could argue that, in general, more code walkthroughs are likely to occur in open source projects, since usually an entity responsible for a project will test it to some amount and outside sources will also test your source some amount, potentially resulting in more code scrutiny in this paradigm. This is especially true when large corporations have a vested interest in or sell products based on an open source project. In this case, they have the same interest in the project being secure as if it were proprietary. Finally, while security is oft cited as a primary reason for not opening source code to the public, there seems to be little conclusive evidence to support this."[7]

Improved Integration

Different jurisdictions often manage their energy data in distinct formats, making it difficult to integrate and use this data for comprehensive energy modeling and analysis. This lack of standardization requires significant effort to convert and harmonize data, churning up the resources available for modeling and policy analysis.

There is a call for industry-wide standards to facilitate interoperability across different regions and sectors, reducing silos and improving collaboration

— KEVIN PALMER-WILSON, ENERGY ANALYTICS LEAD, OTHERSPHERE

Kevin Palmer-Wilson is the Energy Analytics Lead at Othersphere. His statement that "There is a call for industry-wide standards to facilitate interoperability across different regions and sectors, reducing silos and improving collaboration"[8] is prescient. Travis Lusney agrees: "Regulators can leverage open source solutions to set standards and encourage stakeholders to share and adopt common protocols, thereby reducing the need for custom and disparate systems."[9]

Jow Ortiz, General Manager at Ubicquia, Inc, explains: "Then you have the interoperability among the different countries and nations, that kind of drives that diversity that a common standard should negate. But it's hard... you can't really tell the countries which standards to follow. So, you're back to having some sort of international cooperation, especially at tie points."[10] Cross-industry and international collaboration on a shared code base allows for customization while maintaining overall harmonization, leveraging community contributions to drive innovation.

6 For more information, see **https://openssf.org/**.

7 "**Is Open Source Software More Secure?**" Russell Clark, David Dorwin, and Rob Nash.

8 Interview of Kevin Palmer-Wilson conducted by Mike Dover, March 20, 2024.

9 Interview of Travis Lusney conducted by Mike Dover, May 17, 2024.

10 Interview of Jow Ortiz conducted by Mike Dover, May 7, 2024.

Supported Data Sharing

Open source platforms enable better long-term planning by providing open data, which allows for replicating existing infrastructure, conducting connection studies, and investing in grids. DERs generate a lot of data that provides a great deal of valuable insights if harnessed correctly. Grid modernization involves deploying sensors and controls at points of generation and consumption to ensure efficient matching of generation with load requirements. This effort entails understanding the capacity of the grid, prioritizing cost-effective and environmentally friendly solutions, and implementing smart grid technologies.

Max Parzen, CEO of Open Energy Transition, says, "Open data helps me to actually get a good idea of the energy system. Like, let's say I can replicate the operation of existing infrastructure or … I could do connection studies for new demand or generation assets."[11] Data comes in from multiple sources, and it all should be considered when evaluating the overall health of the grid. Jow Ortiz ponders, "You also have to have sensors that are telling you how the grid is performing … [I]s my current flowing from this coal power plant out to the customer where I really want it to be, from the solar panel on the rooftop solar into the grid—so that means something has got to control the grid. I have a big, 2,000 megawatt nuclear generator. So, it's going to take priority over your 500 watt solar panel."[12]

Developed Future-Proof Technology

By adopting open source solutions, companies can ensure that their assets remain adaptable and compatible with evolving industry standards and technologies. For more data behind innovation within renewable energy, see the text box.

11 Interview of Max Parzen conducted by Mike Dover, March 25, 2025.

12 Interview of Jow Ortiz conducted by Mike Dover, May 7, 2024.

INNOVATION AND ELECTRICITY REGULATION INITIATIVE SURVEY

To support net zero goals, the Innovation and Electricity Regulation Initiative set out to examine the role of economic regulation and related programs in scaling successful innovations and accelerating grid modernization.[13]

Responses from the 73 submissions received from various organizations across Canada were categorized into five themes focused on accelerating the pace of electrification, electric grid modernization, and innovation:

- **Pairing utility innovation with regulatory innovation will more effectively address the challenges of the energy transition.** Respondents highlighted several areas that could benefit from government support, including establishing regulatory sandboxes and other mechanisms to facilitate piloting and experimentation, promoting research and knowledge sharing activities on regulatory innovation, and enhancing capacity at the regulatory level to foster regulatory and procedural innovation and organizational change.

13 "**What we heard: Request for information on Canadian electricity regulation and grid modernization**," National Resources Canada, December 6, 2023.

INNOVATION AND ELECTRICITY REGULATION INITIATIVE SURVEY (CONTINUED)

- **Federal leadership is necessary to promote interjurisdictional policy alignment and certainty.** Respondents identified several areas that could benefit from government support, including:
  - **a.** interjurisdictional working groups
  - **b.** system planning studies
  - **c.** innovation road maps to build capacity
  - **d.** alignment of policy guidance
  - **e.** legislative mandates across different government levels creating adaptable guidelines for electrification pathways
  - **f.** incorporation of innovation into technology, market, cost, and resource assumptions for each jurisdiction

- **Government support can accelerate the pace of change while mitigating ratepayer risk.** Respondents identified several areas that could benefit from further government action and support. These include promoting innovation and technology deployment through program funding, investment tax credits, and low-interest loans. Additionally, they suggested expanding incentive measures to cover expenditures beyond initial capital costs, such as operations and maintenance, particularly in smaller jurisdictions. They also highlighted addressing knowledge gaps through funding ongoing jurisdiction-specific studies, assessments, and equity-focused research as crucial.

- **Gaps exist in research and development for integrating and enabling new technologies.** Respondents indicated that several areas could benefit from government action and support, such as funding research, development, and demonstration projects focused on systems integration and operation. They also emphasized the need for funding enabling and auxiliary infrastructure, particularly in remote communities, and the importance of increasing standards for cybersecurity and interoperability.

- **Grid modernization presents risks of disproportionate impacts on low-income households and rural and remote communities.** Respondents highlighted several areas needing government action and support, such as offsetting electrification costs for low-income, rural, and Indigenous communities, facilitating opportunities for collaboration and knowledge sharing across regional borders, and funding capacity building for Indigenous communities. This would enable these communities to provide input on grid modernization activities and participate in the energy transition.

Real and Perceived Barriers to Open Source Adoption

Despite the vast potential impact of open source technology on interoperability, real and perceived barriers remain.

Incumbent Proprietary Systems

At present, many utilities rely on proprietary software that does not easily integrate with other systems or open source solutions, leading to a fragmented infrastructure. Integrating open source tools with existing proprietary systems can be challenging due to differences in standards and technical specifications. In some cases, this situation is simply a function of legacy infrastructure; in others, the battle seems to be against those parties benefitting from the status quo. Kevin Palmer-Wilson boldly states, "Closed source models in policy design should not exist ... The only reason why they exist is to facilitate profiteering off these models."[14] Travis Lusney agrees: "A lot of the provinces have vertical utilities that own, operate, plan, and invest in generation, transmission, distribution, and essentially the retail side. So, there's a natural kind of conflict of interest to get involved in a lot of DERs, because that harms their business from a business model point of view."[15]

Regulatory Disparities

Different regulatory frameworks across jurisdictions can create barriers to seamless interoperability, especially in data sharing and privacy compliance. To wit, each province has a different set of regulations, driven by multiple factors, including the fact that energy generation methods differ. According to Travis Lusney, "Each province is its own province. So therefore, you have essentially 10 different regulatory bodies ... If you're operating in Alberta and BC, there's no entity you can go to that says, 'Hey, you should be harmonizing these rules.'"[16]

A significant issue is the lack of a centralized entity for decision-making and standard maintenance that serves the interests of the public, businesses, and utilities. Javad Fattahi explains, "Most utilities rely on their own approved vendor lists, which may not always be approved by the Canadian Standards Association (CSA), leading to fragmented standards and interoperability issues. This legacy problem stems from the CSA's shortcomings in special tools and equipment used in the utility sector. Additionally, national standards bodies such as the CSA are often reluctant to adopt copyrighted standards such as IEEE. This reluctance creates gaps and inconsistencies, prompting utilities to develop their own standards and approved lists, further complicating interoperability."[17]

Most utilities rely on their own approved vendor lists, which may not always be approved by the Canadian Standards Association (CSA), leading to fragmented standards and interoperability issues.

14 Interview of Kevin Palmer-Wilson conducted by Mike Dover, March 20, 2024.

15 Interview of Travis Lusney conducted by Mike Dover, May 17, 2024.

16 Interview of Travis Lusney conducted by Mike Dover, May 17, 2024.

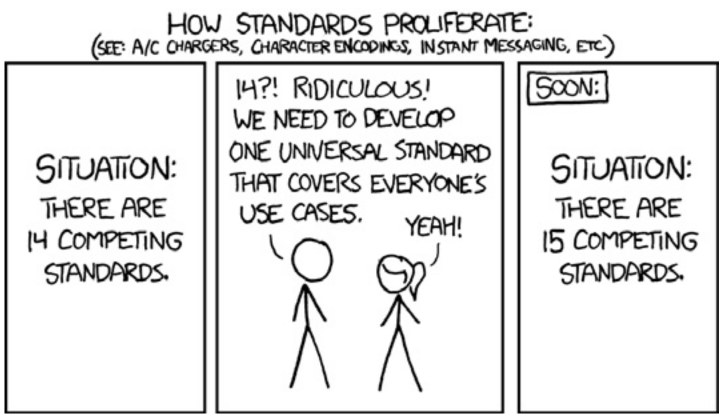
17 Interview of Javad Fattahi conducted by Mike Dover, June 5, 2024.

Lack of Standardization

Similarly, diverse utilities and regions often use different tools and standards for planning and operations, leading to incompatibility. This problem gets worse when Canadian regulators want to adapt lessons drawn from European or American data sets. Marco Möller, CEO of Pionix, invokes a famous XKCD comic that shows stick figures delighted that they have made a single technical standard that will harmonize all others. The punchline in the final panel shows us that the new "universal" standard is just a new entry on top of the pile.

FIGURE 1

HOW STANDARDS PROLIFERATE



Source: **https://imgs.xkcd.com/comics/standards_2x.png**.
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Heavy-handed systems like SCADA (Supervisory Control and Data Acquisition)—that do not scale efficiently with modern high-bandwidth, low-latency fiber communications—underscore the need for interoperability in transmitting diverse data types, since the complexity of data exchanged is now so much higher between the millions of smaller devices that comprise the rise of DERs and energy IoT.

Communication Gaps

There is sometimes poor communication and collaboration among different stakeholders, such as regulators, utilities, and transmission system operators, leading to misaligned planning and operations. These gaps exist in no small part due to the (sometimes legitimate) interest of stakeholders to keep information proprietary to preserve a competitive advantage. Unfortunately, this lack of collaboration limits the benefits of interoperability. Operational decisions may also hurt the national knowledge base, as Kevin Palmer-Wilson opines: "A lot of the [energy industry] modeling that the Canadian government has done was outsourced to American consulting companies when we really should foster that expertise in Canada."[18]

Privacy Concerns

Ensuring data privacy and security while using open source tools is a significant concern, especially when dealing with sensitive information. Max Parzen acknowledges that "there are certainly privacy issues on the demand side. If I analyze historic demand profiles of a certain location or a certain household, I can predict when people are on holiday or interfere in business operations."[19]

18 Interview of Kevin Palmer-Wilson conducted by Mike Dover, March 20, 2024.

19 Interview of Max Parzen conducted by Mike Dover, March 25, 2025.

Ownership of DER-generated data resides with the resource owner, emphasizing the importance of data privacy and security measures. Encryption, penetration testing, and continuous improvement are essential to safeguard sensitive information and address privacy concerns. Jow Ortiz states, “It’s always a cat and mouse game as soon as you get smarter. There’s somebody smarter out there who figures out how to crack that mousetrap, and so you always have to … do that continuous improvement around encryption, data privacy, and data penetration capabilities.”[20]

Ian Palm, a partner at Fasken, reminds us that sharing and collecting information among various sources creates at least a perception of risk. He says, “I can certainly see the benefits of being able to share information or aggregate data from different jurisdictions. But I can also see people getting concerned about it … I think, based on my experience in working with various utilities, [they] are afraid [of] rogue actors getting access to all kinds of information that’s going to result in some risk to the electricity system in Canada or parts of it.”[21]

“However, a balance must be struck between privacy and openness to avoid siloing data that is important for innovation. Alex Simakov, Director of External Affairs at Energy Storage Canada, recommends reducing caution levels regarding privacy for certain types of consumption and generation data, advocating for more open data sharing to improve sectoral visibility and efficiency. He says: “We recommend data openness and transparency as the starting point, and deferring to privacy only when absolutely essential. The energy transition cannot succeed without robust and readily accessible data at the grid edge.”[22]

Open source technology still sounds risky to some organizations due to a lack of familiarity, perceived risks, and uncertainty about support and maintenance. Open source solutions may lack dedicated support services, leading to challenges in troubleshooting and maintenance.

Risk Management

While this factor may be more perception than reality, open source technology still sounds risky to some organizations due to a lack of familiarity, perceived risks, and uncertainty about support and maintenance. Open source solutions may lack dedicated support services, leading to challenges in troubleshooting and maintenance. The fact that open source projects often rely on community contributions for support and maintenance may concern regulators and power generators who are expected to provide near 100% uptime. It is worth noting, however, that some open source projects, such as Red Hat, do have fantastic support—the challenge here may be one of education.

20 Interview of Jow Ortiz conducted by Mike Dover, May 7, 2024.

21 Interview of Ian Palm conducted by Mike Dover, June 7, 2024.

22 Interview of Alex Simakov conducted by Mike Dover, May 5, 2024.

Standards and Energy Sector Innovation

Adoption of various interoperability standards varies by province and even by utility. There is no unified approach, leading to fragmented implementation. The most relevant standards for interoperability are IEEE 2030.5, IEEE 1547-2018, and IEEE 2800-2022.

IEEE 2030.5 is a standard for communications between the smart grid and consumers. It is based on open web standards such as TCP/IP, TLS, HTTP, and XML, facilitating interoperability. The standard uses IoT concepts and gives consumers a variety of means to manage their energy usage and generation. Information exchanged using the standard includes pricing, demand response, and energy usage, enabling the integration of devices such as smart thermostats, meters, plug-in electric vehicles, smart inverters, and smart appliances. IEEE 2030.5 further defines a framework to support these applications to enable a secure, interoperable, and plug-and-play ecosystem of smart grid consumer devices. David Trafela of the University of Ljubljana describes it as follows: “Basically, it supports interoperability in terms that it defines a common language. It provides, let’s say, common messages that all devices should implement so that all devices speak the same language … It provides a standardized protocol of communication so that one device cannot say, ‘Okay, I’m communicating in this protocol. I don’t understand you.’ So, all devices are communicating using the same protocols … It’s quite scalable. So, it’s future-proof.”[23] Javad Fattahi believes that “by harmonizing IEEE 2030.5, we can bridge the gap between the technical requirements specified in IEEE 1547-2018 and IEEE 2800-2022 and the operational needs of electronic packaging society (EPS) operators.”[24]

The IEEE 1547-2018 and IEEE 2800-2022 standards help integrate DERs into EPS. However, they primarily focus on electrical interoperation rather than operational interoperability. In essence, these standards specify the minimum requirements for DERs to connect to the grid but do not prescribe how different elements of the grid should communicate and interact with each other for effective operation. One excellent resource that supports IEEE 1547 is **SunSpec Academy**, which provides support including technical training for DER and vehicle-to-grid industry participants. On the other hand, protocols such as IEEE 2030.5 emphasize operational interoperability by defining communication protocols and data exchange formats for DER integration. IEEE 2030.5 provides a framework for seamless communication between DERs, EPS operators, and other grid stakeholders, enabling more efficient and coordinated operation of the grid.

IEEE 1547-2018 focuses on ensuring that DERs can interconnect with the grid without causing adverse effects on grid stability or reliability through voltage regulation, response to abnormal conditions, power quality, islanding, and anti-islanding protection (primary and secondary controls). There is a section of this standard that references communications protocols—Section 10.7. The DER shall support at least one of the protocols specified in Table 41. The area EPS operator may specify the necessary protocol. Additional protocols, including proprietary protocols, may be allowed under mutual agreement between area EPS operator and DER operator. Additional physical layers may be supported along with those specified in the table. IEEE 2800-2022 sets grid reliability requirements

23 Interview of David Trafela conducted by Mike Dover, June 7, 2024.

24 Interview of Javad Fattahi conducted by Mike Dover, June 5, 2024.

for the performance and testing of inverter-based resources connected to bulk power systems (tertiary controls).

While there is a lot of potential in the standard, some aspects of IEEE 2030.5 generate some problems. Gordon Lum, who is CTO, Kitu Systems, Inc., and Vice-Chair of the IEEE 2030.5 Standard Workgroup, states the following: “Despite the use of standard tools, different interpretations of the standard can lead to non-interoperable implementations. If you read the 2030.5 standard, almost everything in there is optional. So, now that you have this infinite optionality, that is not very conducive to interoperability … Even though everyone uses the same tools, there are aspects of interpreting the standard that may make things non-interoperable. They may interpret the sentence slightly differently.”[25] At the same time, Lum says, “IEEE 1547 is a key standard for interconnecting DERs to the grid, with specific protocols for different use cases.”[26]

Despite the use of standard tools, different interpretations of the standard can lead to non-interoperable implementations. If you read the 2030.5 standard, almost everything in there is optional. So, now that you have this infinite optionality, that is not very conducive to interoperability … Even though everyone uses the same tools, there are aspects of interpreting the standard that may make things non-interoperable. They may interpret the sentence slightly differently.

— GORDON LUM, CTO, KITU SYSTEMS, INC, AND VICE-CHAIR, IEEE 2030.5 STANDARD WORKGROUP

The question of leadership can become tricky. Hudson Hollister, Co-Founder and CEO, HData, points out that “it’s nobody’s job to create or to maintain a standardized digital structure for this kind of content that is separately reported by the industry to different regulators and different jurisdictions.” While there are significant benefits to open source software, Hollister reminds us that “by nature of open source, nobody enforces it. Open source is voluntarily joined and contributed to by multiple players.”[27]

The **EVerest project**, which the Joint Office of Energy and Transportation (a collaboration between the U.S. Department of Energy and the U.S. Department of Transportation) and the Linux Foundation developed, uses a standardized open source software layer to support electric vehicle (EV) infrastructure. Sarah Hipel, Standards and Reliability Program Manager at the Joint Office, explains: “By providing a unified framework and fostering collaboration, the EVerest project empowers industry stakeholders to accelerate the transition to zero-emission transportation … EVerest simplifies compliance while providing a scalable, interoperable foundation for innovation in EV charging.”[28]

25 Interview of Gordon Lum conducted by Mike Dover, June 11, 2024.

26 Interview of Gordon Lum conducted by Mike Dover, June 11, 2024.

27 Interview of Hudson Hollister conducted by Mike Dover, June 11, 2024.

28 **Joint Office of Energy and Transportation and Linux Foundation Energy to Advance Electric Vehicle Charging Interoperability with EVerest Open-Source Platform**,” Joint Office of Energy and Transportation, June 11, 2024.

Case Study: SPEEDIER

SPEEDIER[29] is a smart grid program in the Parry Sound, Ontario, region that Natural Resources Canada sponsors through its smart grid green infrastructure program to develop smart grids to reduce greenhouse gas emissions and generate economic benefits, including new green employment. The purpose of the project is to reduce energy consumption in the community as well as increase energy independence.

According to Peter Ewald, Project Technical Lead of Lakeland Holding (the lead consortium), “we have a 500 kilowatt solar facility. We have a 1.25 megawatt battery energy storage device. We also have a fleet of residential energy storage devices and Tesla power walls. We also have hot water tank controllers, and we have electric vehicle charging stations, which we can use for demand control as well (see FIGURE 2). A lot of these DERs, smaller generating sources located within the grid, are renewable in nature or at least provide the ability to reduce greenhouse gas emissions. What’s unique about SPEEDIER, though, is incorporating these into a distribution energy management system so that we can actively control these resources to provide the most benefit to the distribution network and the local municipality.”[30]

FIGURE 2

SPEEDIER FACILITIES

Source: Marjorie MacDonald, Lakeland Strategies.
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29 SPEEDIER stands for smart, proactive, enabled energy distribution— intelligently, efficiently, and responsive.

30 “Speedier,” Bracebridge Power Generation, January 12, 2022.

The project benefited from strong backing from the Parry Sound community, including the town council and the mayor, who championed sustainability and environmental initiatives. Partners such as Georgian College and the Georgian Bay Biosphere Reserve also supported the project. Early on, however, it faced challenges such as vendor lock-in and supply chain issues that resulted from the COVID-19 pandemic. The project encountered regulatory hurdles, such as requirements for utility-grade meters that were cost prohibitive, hindering broader market participation. Marjorie MacDonald, Project Process Lead—Innovation Team, Lakeland Holding, commented: "Managing DERs such as solar and battery systems required seamless communication between different software and hardware components, often hindered by proprietary protocols."[31]

Academic partner Scott McCrindle, a professor at Georgian College, helped exemplify one of the overarching philosophies of open source as he demonstrated generous data sharing with respect to the environmental impact of the project. He commented: "[We worked to] quantify and qualify the greenhouse gas mitigation impacts of SPEEDIER. [Taking] energy consumption data and then extrapolating from that how much in the way of greenhouse gases are produced by the activity. Also looking at how these technologies can be used to mitigate the amount of greenhouse gas produced in supplying the Parry Sound area with electrical services."[32]

The project principals agreed that the philosophy of open source technology improved all areas, including communication, transparency, and future-proofing. Marjorie MacDonald states, "Emphasizing the adoption of open source solutions can mitigate issues related to proprietary software and improve long-term project sustainability and adaptability."[33] Scott McCrindle agrees, adding, "The challenge with the project was that the system is an aggregation of proprietary hardware and software, connected using APIs that would obtain telemetry via a number of protocols over a network. This data is often transmitted as JSON, as XML, or in text-based formats. While many of the DER vendors offer cloud-based portals with APIs that likely incorporate a variety of open source web-based technologies, the team has recognized here that a lack of open source software and open standards for communications and data has sometimes resulted in barriers to continuous improvement, adaptation, and interoperability. What the project has revealed is a significant opportunity for open source software and open standards to improve DERs and their organization and integration into smart grid systems."[34] He adds: "The incorporation of an open source DER management platform to orchestrate the aggregated elements of the smart grid system would unshackle the team by eliminating waits for software updates or modifications from the vendor. Such changes are frequently needed, as DER APIs are upgraded regularly by their respective vendors ... sometimes breaking the connection and affecting control of the assets."[35]

31 Interview with Marjorie MacDonald conducted by Mike Dover, May 14, 2024.

32 Interview with Scott McCrindle conducted by Mike Dover, May 24, 2024.

33 Interview with Marjorie MacDonald conducted by Mike Dover, May 14, 2024.

34 Interview with Scott McCrindle conducted by Mike Dover, May 24, 2024.

35 Email correspondence between Scott McCrindle and Mike Dover, July 26, 2024.

LESSONS FROM THE DEVELOPING WORLD

When assessing Canada's energy needs, especially with respect to off-grid development, the best comparisons for test sites are not urbanized areas with power sources so dependable that even a short power outage is considered an unacceptable calamity. Some of the most important developments come from areas of the world where power outages are a regular—in some cases daily—occurrence. Off-grid innovation is a top priority, as the World Bank estimates that the yearly economic losses that the lack of dependable power causes is more than $26 billion US.[36] The International Energy Agency estimates that by 2030, 660 million people will not have dependable access to electricity, with 85% of those living in sub-Saharan Africa.

According to Luiz Villa, Associate Professor at the University of Toulouse, international foundations need to bypass vested interests to provide true leadership. He states during a panel discussion about accelerating energy access for people off the grid, "We need to train people with open source technology. We need to bypass industry that tries to lock people in … Open source is a whole paradigm of development that needs to be appropriated and channeled into the educational system just as much as the field." [37]

Open source is a whole paradigm of development that needs to be appropriated and channeled into the educational system just as much as the field.

Daniel Komolafe, founder at First Electric, a Lagos-based solar energy company and developer of the smart meter, describes using open source technology. He states, "I wanted to find a solution between polluting fossil fuel and expensive solar solutions. I couldn't find a good IoT prepaid meter that was not expensive. I wanted to find a way where I could invest in a solar project and meter with the ability to make projections—allowing customers to use what they know they will be able to pay for, thereby reducing their barrier to energy access."[38] While he has seen success with his projects, he believes that open source technology remains limited due to a lack of awareness and support. In addition to education, additional funding is required as well as improving access to genuine components vital to the development of open source. He states, "There are many disparate systems in Africa, so the major challenges in building interoperable systems in Africa and globally are chiefly standardization."[39]

36 Ayobami Adedinni, "**Breaking Barriers: How Open Source Technology is Increasing Energy Access in Nigeria**," EnAccess, 2019.

37 "**How Can Open-Source Technologies Accelerate Energy Access For People Off The Grid?**," WISIONS of Sustainability, February 26, 2019.

38 Ayobami Adedinni, "**Breaking Barriers: How Open Source Technology is Increasing Energy Access in Nigeria**," EnAccess, 2019.

39 Interview with Daniel Komolafe conducted by Mike Dover, March 20, 2024.

LESSONS FROM THE DEVELOPING WORLD (CONTINUED)

Canada has much to learn from energy innovation from the developing world. The Arctic has many off-grid communities that would benefit from innovative energy systems.[40] Since these communities rely on diesel fuel, non-emitting solutions represent an important improvement not just from a cost basis but also an environmental one.

40 Middleton, A. (2023). **Mapping the portrayal of small modular reactors in Canadian Energy Solutions. The Polar Journal, 13(2), 264–287**.

Recommendations

To support the use of open source technology to encourage interoperability, consider the following recommendations.

Support the Open Source Community

Collaboration among various stakeholders, including regulatory bodies, utilities, and vendors, is essential to develop and maintain interoperability standards. The open source community can play a pivotal role in this collaborative effort in terms of infrastructure and skills and convening different stakeholders together.

According to Javad Fattahi, "Government agencies can play a crucial role by funding grants for training programs, providing subsidies for research and development in open source technologies, and offering incentives for adopting interoperable solutions. These efforts should lead to the creation of collaborative platforms where stakeholders can share knowledge, experiences, and best practices. Such platforms could include industry forums, working groups, and online communities dedicated to interoperability and open source standards."[41] Leadership should come from a central agency; Jow Ortiz states, "You want to have some sort of standards body come in and give direction so that you don't have hundreds of bespoke solutions being propagated through the system."[42]

41 Interview of Javad Fattahi conducted by Mike Dover, June 5, 2024.

42 Interview of Jow Ortiz conducted by Mike Dover, May 7, 2024.

Deploy Agile Public Sector Decision-Making

Often, legislation and regulation around technology suffer due to the challenge of keeping up with the speed of innovation. Alex Simokov advises against getting bogged down by analysis. "We need to get comfortable with the idea of moving at different speeds"[43]; stakeholders need to be able to speak freely about issues related to innovation around issues such as smart grids. This aligns with the finding from Powering Canada: A Blueprint for Success by the Canada Electricity Advisory Council. Two of the recommendations were "Streamline scoping of clean electricity project reviews" and "Create an energy efficiency accountability framework."

Build Capacity Through Education

There is a growing need for capacity building among various stakeholders to understand and implement interoperability and open source standards. Education is key to overcoming misconceptions about open source and clearly demonstrating the business case. Utilities and regulators should take proactive measures to document and share their progress in adopting open source solutions, creating a repository of knowledge that can benefit the entire sector. Regulators should promote the publication of data and advancements. Richard Hendriks laments that modeling sometimes needs to use American data, since that is all that is available: "We also want to build the next generation of modelers, but Canada has a serious dependency on the United States in terms of this kind of energy modeling."[44]

Travis Lusney suggests reviewing the work of the Independent Electricity System Operator (IESO) in Ontario, which has conducted extensive analysis on the integration and coordination of DERs. The IESO's Transmission and Distribution Working Group has produced valuable papers and analysis on these topics. In addition, he says, "It is important for early adopters of new technologies and standards to document and share their experiences. This trailblazing can help others avoid reinventing the wheel and facilitate smoother adoption and implementation of interoperable solutions."[45] An example of data sharing in the Canadian context is the Green Button Alliance, which is a non-profit group that supports the creation, compliance, and use of the Green Button standard in the industry. This standard provides a simple and secure way to access and share energy and water usage data. Green Button solutions help customers manage their consumption and costs digitally, meet reporting requirements, and contribute to decarbonization efforts. These efforts mesh with the Canada Electricity Advisory Council's recommendation to "drive open and transparent data and modeling."

Regulatory Support

Government or regulatory bodies should provide direction and enforce standards to avoid a fragmented landscape of bespoke solutions, ensuring cohesive and interoperable systems. Travis Lusney believes that a unified system across Canada is essential to improve communication, stating, "The absence of a unified system for sharing critical energy information in Canada is a significant gap that regulators should address to improve data transparency and interoperability."[46] Jow Ortiz comments, "I

43 Interview of Alex Simakov conducted by Mike Dover, May 5, 2024.

44 Interview with Richard Hendriks conducted by Mike Dover, March 20, 2024.

45 Interview of Travis Lusney conducted by Mike Dover, May 17, 2024.

46 Interview of Travis Lusney conducted by Mike Dover, May 17, 2024.

think participation in standards groups is the key. I think that's been the longstanding key … engaging in Canadian standards, or IEEE. I think the difficulty … is when I go to do work in Mexico, they might do something in an IEEE standard. But then, when I go over the border, they might use a European standard."[47]

Javad Fattahi states, "Natural Resources Canada, provincial regulators such as the Ontario Energy Board and the Alberta Utilities Commission, and professional bodies such as Engineers and Geoscientists BC and Professional Engineers Ontario can play significant roles in promoting and enforcing these standards. These entities can help establish frameworks and regulations that mandate interoperability. The CSA and the North American Electric Reliability Corporation could develop and maintain interoperability standards in collaboration with industry stakeholders. They ensure these standards are robust and meet the technical and safety requirements of the energy sector. Industry groups such as the Canadian Electricity Association could advocate for the adoption of open source interoperability standards. They can provide a platform for collaboration and knowledge sharing among utilities, OEMs, and other stakeholders. These groups can help drive consensus and alignment on the standards to be adopted and ensure that the industry is moving in a coordinated direction."[48] This aligns with the recommendation from the Canada Electricity Advisory Council to "conclude equivalency agreements to limit duplication with provinces."

Industry groups such as the Canadian Electricity Association could advocate for the adoption of open source interoperability standards. They can provide a platform for collaboration and knowledge sharing among utilities, OEMs, and other stakeholders. These groups can help drive consensus and alignment on the standards to be adopted and ensure that the industry is moving in a coordinated direction.

— JAVAD FATTAHI, PROFESSOR, UNIVERSITY OF OTTAWA

47 Interview of Jow Ortiz conducted by Mike Dover, May 7, 2024.

48 Interview of Javad Fattahi conducted by Mike Dover, June 5, 2024.

Establish a Steering Committee

To address these gaps and promote the adoption of open source technology, a steering committee should be established. This committee would have the task of engaging with stakeholders to explain the benefits of participating in open source projects. Government-backed projects and funding could play a crucial role in this effort, supporting the enhancement of the electricity distribution infrastructure through contributions to open source initiatives. This would be similar to the process that the Electric Power Research Institute manages in the United States.

Scott McCrindle states, “We need to have consortiums and collections of different stakeholders from all aspects of industry—verticals that are involved in this—and we need to all sit around the table on a regular basis and begin to collect all these standards.”[49]

Richard Hendriks, Director at Camerado Energy Consulting Inc., suggests that addressing barriers to data access and harmonizing standards are critical for grid modernization. Collaborative efforts at the national level, led by organizations such as the Energy Modelling Hub and industry associations, are essential for overcoming communication gaps and filling information needs.

Invest in Future-Proofed Technology

To ensure interoperability in the face of evolving energy landscapes, grid technology must be future-proofed. This involves anticipating future needs and deploying systems capable of adapting to changing requirements, such as accommodating distributed generation and bidirectional energy flows. Marco Möller believes that “using an open protocol and open source on the asset itself avoids a situation where you can’t update software because of a vendor lock-in.”[50] A good example of this was when the Belgian car charging company Powerdale went bankrupt: Its users were unable to update their apps, leaving them in a situation where they could not charge their EVs. Möller points out, however that “open protocols can enable third-party clouds to take on assets, even if the manufacturer is bankrupt. Also, an open source code base helps to maintain the software in the charger by other companies if the manufacturer dies, so this ensures long-term availability of the assets.” Hilary Carter, SVP of Research at the Linux Foundation, states: “I think part of future-proofing is being at the center of gravity for where disruption and innovation and evolution of any given stack or the role of AI or whatever is taking place. The energy sector needs to be at the forefront of technological change in whatever forum that can take place. The best way to anticipate future needs is to locate and be present in spaces/communities that live and breathe emerging innovation and transformation.”

49 Interview with Scott McCrindle conducted by Mike Dover, May 24, 2024.

50 Interview of Marco Möller conducted by Mike Dover, April 25, 2024.

Conclusion

The integration of open source technology within the energy sector represents a transformative opportunity to achieve the United Nations Sustainable Development Goals, particularly in addressing climate action. The wide-scale adoption of digital and open source solutions can drive significant advancements in efficiency, reliability, and sustainability, offering a pathway to more agile and future-proof energy systems. As initiatives such as SPEEDIER demonstrate, open source platforms enable cost reductions, improved data sharing, and enhanced interoperability, ultimately fostering innovation and supporting the global transition to cleaner energy.

To fully realize these benefits, it is important to overcome existing barriers such as regulatory disparities, lack of standardization, and perceived risks associated with open source adoption. Collaborative efforts among government agencies, regulatory bodies, utilities, and the open source community are crucial to establishing robust standards, promoting education and capacity building, and fostering a supportive regulatory environment. By investing in future-proof technologies and ensuring continuous improvement and collaboration, the energy sector can benefit from open source solutions, drive forward the sustainable development agenda, and pave the way for a more resilient and efficient global energy ecosystem.

Methodology

This qualitative study was conducted between November 2023 and August 2024. The author built and peer-reviewed an interview guide. Interviewees were contacted through Linux Foundation employees and one-on-one virtual meetings were scheduled between the author and participants. Findings from the interviews were written up alongside secondary data found in external resources. The full draft was peer-reviewed by Linux Foundation and NRCan employees.

Interview Participants

- Javad Fattahi, Professor, University of Ottawa
- Richard Hendricks, Director at Camerado Energy Consulting Inc.
- Hudson Hollister, Co-Founder and CEO, HData
- Daniel Komolafe, First Energy, Senior Commercial Manager, GE Power
- Gordon Lum, CTO, Kitu Systems, Inc., and Vice-Chair of the IEEE 2030.5 Standard Workgroup
- Travis Lusney, Director, Power Systems at Power Advisory LLC
- Marjorie MacDonald, Project Process Lead—Lakeland Solutions
- Scott McCrindle, Faculty Researcher, Georgian College
- Marco Möller, CEO, Pionix
- Robbie Morrison, OpenMod
- Ian Palm, Partner, Fasken
- Kevin Palmer-Wilson, Energy Analytics Lead at Othersphere
- Max Parzen, CEO, Open Energy Transition
- Jow Ortiz, General Manager, Ubicquia, Inc.
- Alex Simakov, Director of External Affairs, Energy Storage Canada
- David Trafela, Software Engineer, Sunesis
- Christophe Villemer, EVP/GM, Savior-Faire Linux

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Mike Dover is the author of *Dante's Infinite Monkeys: Technology Meets the 7 Deadly Sins* and the co-author of *Wikibrands: Reinventing Your Company in a Customer-Driven Marketplace*. He teaches at the Schulich School of Business at York University and the Longo Faculty of Business at Humber College. At the latter, he is head of analytics for the men's varsity baseball team.

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