BUILDING A BUSINESS CASE: FIELD AREA NETWORK FOR GRID MODERNIZATION

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TABLE OF CONTENTS

BACKGROUND

In the 140 years since Edison first patented the lightbulb, the electric utility industry has gone through a level of change unlike many other industries.

Driven by a requirement to connect the entire population to a reliable source of power, the 1960s saw the development of high voltage transmission lines to connect communities at the same time the interstate highway system connected people physically. The resulting vast networks of the electric grid were listed by the National Academy of Engineering in 2008 as the greatest achievement of the 20th Century.[1]

And while grid modernization has only become a buzzword in recent years, its roots actually lie in the deregulation period of the late 1970s and early 1980s. The passing of the Public Utility Regulatory Policy Act (PURPA) in 1978 paved the way for the introduction of renewable energy production via solar and wind. This was followed in 1982 by the decoupling of sales from revenue for investor-owned utilities in California[2], incentivizing utilities to focus on energy efficiency and make the shift towards demand-side management. Furthermore, the birth (and rapid growth) of Information Technology from the early 80s saw the advent of relays and other grid equipment based on micro-processors – heralding the very start of the IT/OT integration we see as part of grid modernization.

Thirty years on and the grid has become intrinsically linked with communications. The proliferation of data coming out of the grid and the requirement to have visibility over an ever-increasing number of endpoints have created the need for a more robust communication network running beneath the grid.

1. https://www.nae.edu/19582/Bridge/EngineeringAchievements/GreatAchievementsandGrandChallenges.aspx
2. https://eetd.lbl.gov/sites/all/files/publications/the-theory-and-practice-of-decoupling-utility-revenues-from-sales.pdf

BUSINESS DRIVERS FOR GRID MODERNIZATION COMMUNICATION

Upgrading the grid and the associated communications network is seen by many utilities as a necessary step to stay relevant in a rapidly changing utility industry. It's a "build it and they will come approach"[3] which often rests on predictions of future growth, expansion and consumer behaviour more than on hard data around costs and benefits. These strategic business decisions are often centered around solving business problems and streamlining operations. The end aim is to cut costs, deliver better services, be more resilient during large-scale weather events and, overall, boost efficiency.

> Weather-related [electric] outages are estimated to have cost the U.S. economy an inflation-adjusted annual average of $18 billion to $33 billion between 2003 and 2012.
>
> **Grid Resiliency Report, US Department of Energy**

*"Another important component of reducing the impact of weather-related outages and improving grid resiliency… relates to **communication**. Utilities that are faced with storm damage are using data to identify and quickly respond to problem areas in much quicker timeframes with much success."*

How Utilities Can Protect the Grid against Potential Outages Due to Extreme Weather Events

Customer expectations regarding access to electricity have changed so significantly in the last decade to the point that it is the end consumer, to some degree, who is unwittingly driving the requirement for the modernized grid and all that it entails.

While the average consumer will be ignorant of many grid applications like demand-side management, teleprotection, distributed energy resources and ADMS, the outputs of these applications are the tangible components which are meaningful to a utility customer. Furthermore, consumers are more engaged than ever with where and how their electricity is generated and, equally, far more aware of their own consumption patterns and trends. This desire for more data to be collected on their usage, delivered in a timely fashion, thereby allowing them to make informed decisions about consumption has become a game-changer in boosting customer satisfaction.

What does a modernized grid look like from a consumer point of view?

- Ultra-reliability to support highly electrified lifestyles;
- Resilience in the face of large-scale weather events;
- The ability to make sustainable choices with their energy consumption;
- Improvements in power quality;
- Security of their personal data;
- The ability to participate in a transactional grid by generating their own energy at home.

In order for any of the above to occur, a utility must have an extensive, reliable communications network lying beneath their grid to provide a new level of visibility across all of their operations. Combining AMI backhaul with data streams from systems such as SCADA, DA and FLISR plus the emergence of DERs with their need to integrate other generation assets makes the argument for a unified private communication network much stronger.

"Great River Energy's decision to install a private IP telecommunication network was based on reliability, control of the network, and security."

UTC Journal, Q1 2019, page 15.

3. *Creating an Effective Fan Business Case Webinar September 2018* – Utilities Technology Council. https://register.gotowebinar.com/register/5109211025075403011

And as endpoints proliferate, the grid both spreads outwards and becomes denser, requiring a step up in monitoring and data throughput. Upgrading the grid communications network therefore becomes an integral step during the initial stages of any major grid modernization project.

KEY DRIVERS FOR GRID MODERNIZATION

- Integrating renewables & distributed generation
- Effectively managing customer demand
- Enabling bi-directional flows of data and energy
- Electrification of society
- IT/OT convergence

MAKING A BUSINESS CASE FOR A FIELD AREA NETWORK TO SUPPORT GRID MODERNIZATION

"As digital devices approach the edge and are densified across the grid by more than 1500%, utilities need an advanced wireless network that goes beyond supporting AMI and SCADA devices."[4]

A traditional business case would cover the business problem (or opportunity) at the center of the project along with the benefits, costs, risks, timelines and predicted operational impact. The business case would also obviously outline recommended solutions and internal changes required to facilitate the project deployment.

Using traditional methodologies, however, which compare costs with savings and/or increases in revenue is not an effective measure for large-scale grid modernization projects such as Field Area Networks.

The reasons for this are:

1. The lengthy timelines involved;
2. The lack of data available on expected results (due to the fact these projects are based on emerging technology with little history)
3. The rapidly changing technological landscape making it very difficult for accurate measurement.

Instead, utilities must use non-traditional methods such as the benefits associated with cost avoidance as opposed to hard cost savings[5] to make the business case. As mentioned above, the decision to forge ahead is often a strategic move based more on long term estimated demand and the predicted functionality required to meet changing government regulation, changing environmental conditions and changing consumer demand.

4. Black & Veatch Smart Utilities Report 2019

5. *Insights into Advanced Distribution Management Systems*, February 2015, US Department of Energy

HARD COST SAVINGS

- Reduced truck rolls due to greater grid visibility
- Reduced operational expenditure via automation
- Reduced costs for outages due to swift restoration

SOFT COST SAVINGS

- Improved reliability using SAIDI measures
- Lower greenhouse gas emissions
- High customer satisfaction
- Better customer service

Compared with making business cases for other smaller scope projects within a utility, when proposing large-scale projects such as Field Area Networks, Smart Meter rollouts or ADMS deployments, it may be necessary to incorporate a number of intangible factors such as:

- Predicted improvements in reliability and efficiency,
- Benefits associated with greater grid visibility,
- The value of gained efficiencies via integrating multiple systems,
- Improved SAIDI & CAICI scores,
- Better integration of renewable energy resources, and;
- A reduction in manual labour/truck rolls following automation.

"No doubt, the Interstate Highway System would likely never have been built if it had to pass a benefit-cost test."[6]

COST SAVINGS vs EFFICIENCY GAINS

"Today's market leaders understand that ROI is multidimensional and that, in many cases, the cost-savings component can be secondary to other returns such as improving customer satisfaction, brand differentiation and the collection of accurate data, all of which can also drive increased revenues."[7]

It is worth noting that a large scale, multi-disciplinary project such as the deployment of a Field Area Network may not necessarily save costs across all aspects of the organization it touches.

This is due to the fact you will need to factor in the additional training required for existing staff plus the costs involved in hiring new employees with the skillsets required to work with the new technology. There may also be additional hardware or software to purchase and you will need to factor in the costs associated with integrating equipment from different vendors.

Balancing these costs against the efficiency gains of having a skilled workforce, well-integrated systems and greater automation, can be a large project in itself but is necessary to make a strong business case. Ensure you build in plenty of time at the start of the project to dedicate resource to estimating value.

"Integration costs will probably be double or triple what you might expect."

Insights into Advanced Distribution Management Systems, February 2015, US Department of Energy

6. https://www.westmonroepartners.com/en/Insights/Newsletters/Grid-Modernization-Nearing-the-Tipping-Point
7. https://www.ptc.com/-/media/Files/PDFs/IoT/Quantifying_Return_On_Investment.ashx

MAINTAINING A GLOBAL VIEW

For a large-scale, long term project, it is important for the project team to keep a global view when it comes to pitching the argument for greater efficiency and cost-savings.

While certain departments may only reap the benefits (as opposed to costs) of a faster, more reliable communications network, there will be some business units which bear the brunt of the additional costs. And given the long period of deployment for a project like a Field Area Network, it may be that some departments in the business will see results far more rapidly than others, due to wider strategic decisions.

It is therefore obviously important to look at the gains to the business from a global standpoint as opposed to maintaining a silo effect where one department may oppose the deployment due to the costs they will incur at the outset.

Within a large utility organization, the likelihood is that the leaders of a grid communications project will not have full oversight of how the project will touch all of the different business units. For this reason, the project needs to be multi-disciplinary in scope to ensure representation from each team who can identify predicted efficiency gains as well as associated costs such as new hires, new processes, new hardware or additional training.

And since the overall results of the project may relate more to added functionality, better reliability, quicker recovery from outages and the ability to run more applications, **the business case may need to focus more on tying together the project's impacts with the company's strategic goals**.

Also, as the quote below suggests, often the investment in a large-scale grid modernization project (in this case, smart metering) may in fact be less than other investments the utility may need to make to meet changing customer, environmental and legislative demand.

"The cost of a smart meter rollout allowing electricity users to make...decisions [around consumption] is significantly less than the cost of new generation and transmission."[8]

Carl Monroe, Chief Operating Officer at the Southwest Power Pool (SPP)

KEY TIPS

- Create a multi-disciplinary team to gain oversight of the whole business
- Keep your view on benefits to the business as a whole – not just to each department
- Link project to strategic business goals.

8. https://www.utilitydive.com/news/how-to-get-the-most-out-of-grid-modernization-in-5-simple-steps/437900/

SCOPING REQUIREMENTS

While in the process of scoping out a Field Area Network, you will also need assistance to ascertain details such as the data throughput, latency and protocols required for the various applications you run.

See the table below for examples:

Application	Latency	Bandwidth	Protocol
Recloser	10s msec	< 56 kbps	DNP3/Serial & DNP3/LAN
Capacitor Banks	100s msec	< 56 kbps	DNP3/Serial & DNP3/LAN
RTU	1000s msec	56 kbps	DNP3/Serial & DNP3/LAN
Advanced Metering	100s msec	56 kbps	C12.22 LAN
AGGREGATE TOTALS	**10s msec**	**<224 kbps**	**Serial + IP**

Without the multi-disciplinary oversight discussed in the pages above, you may not understand the impact of a network which doesn't fully support the applications run by different business units.

In the example above, one of the applications requires much lower latency than the others. To maintain a resilient network, you would therefore need to design the network to suit the latency requirements of that application. This may seem like a case of over-engineering in regard to the other applications but is unavoidable when building a system which supports multiple departments of your organization.

AVOIDING THE PITFALLS

- GIS data may not be up to date. To ensure asset management is up to date you must allocate time (and document costs) to clean up this data.
- Check whether your new proposed technology has associated maintenance requirements in terms of network health monitoring, carrying out regular software updates. Gather this information from your vendors and estimate the costs involved.
- Begin with data collection BEFORE you begin the project itself. Set members of your multidisciplinary team with the task of capturing relevant metrics for their business unit and agree regular times for gathering metrics – daily, weekly, monthly.
- Integrating new technology is a key area where time and resource will be spent. Even products made by the same vendor may experience issues during integration. Ensure up front that your primary vendor has the capacity to integrate their products with other technology in your network.
- Review your human resources – will the introduction of new technology reduce your head count via automation? Or will you need a new team with new skills to run the new technology?
- Find out from vendors the level of training they recommend and incorporate these costs in the business case;
- For a communications network, carry out robust forecasting for future grid growth – include predictions for number of endpoints and loads for DERs etc to help you ascertain the level of data throughput and latency you need.
- Use historical data to track costs of outages and pitch those against costs for your project.
- Use metrics to measure tasks, pre-automation, in terms of employee hours, truck roll costs etc and assign costs to each. Compare with a post-automation model to outline predicted savings.

THREE-STEP PROCESS - FIELD AREA NETWORKS FOR GRID MODERNIZATION

Step 1: Identify Grid Modernization challenges & opportunities

Step 2: Evaluate Technology platform: cellular, LTE, licensed vs unlicensed

Step 3: Evaluate Hardware & Vendor options

SUMMARY

As grid modernization projects become the norm, there is an acceptance that building a more resilient communications network is one of the foundation blocks of the project. Connecting more assets and providing visibility to the edge of the network lies at the heart of a grid which can support greater electrification of society and meet the increasing legislative demands on reliability. Without an upgraded communications network allowing more granular monitoring and data capture, your ability to optimize your investment in other grid assets will be compromised.

In order to make a compelling business case for a Field Area Network, you will need to assemble a multi-disciplinary team who can provide you with the details required to maintain a global view of the project. Balancing fixed costs against hard cost savings or benefits should be a straightforward, if somewhat time-consuming, task. The team members representing each business unit should be able to assist with these figures. Predicting soft cost savings and benefits can be a significant challenge, however, given the long duration of such a project and the lack of historical industry data to base predications on.

As a result, you may therefore need to present your business case more in terms of how the project has the potential to positively impact the organization's business strategy. Aim to tie in your project to upgrade grid communications with wider business goals responding to changing customer demand and the push towards DERs and greater sustainability. In the absence of hard data, focus instead on elements such as greater customer satisfaction, the ability to better manage bi-directional flows of energy and predicted improvements in reliability and efficiency.

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