MEASURING THE BAKKEN

Metering and Monitoring Power Consumption in Western North Dakota and Eastern Montana

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3:00 PM
A CASE STUDY ON TRANSMISSION METERING AND POWER MEASUREMENT

- Western North Dakota and Eastern Montana
- One of the quietest parts of the United States to rapid industrialization for oil and gas production
- Extensive and expansive growth of infrastructure needed throughout the region
- Intense need for accurate measurement of power use
  - Cowboy days are over
- Part 1: Load Monitoring
- Part 2: Transmission Metering
- Upper Missouri is a transmission services cooperative
- 11 cooperatives - 6 in Montana, 5 in North Dakota
- Powering oil, gas, and agriculture
- 1,069 MW Dec 2015 peak
- 7,116 GWh in 2015
- Lots of growth
  - UMPC sold 1 of every 523 kWh sold in the U.S. in 2015
  - 0.19% of all U.S. sales
Beautiful Country
Beautiful Country
Oil, Gas, Wind, Agriculture
Big and Small
Energy Sales (GWH)

Year | Energy Sales (GWH)
--- | ---
2005 | 1,445
2007 | 1,870
2009 | 1,786
2011 | 2,587
2012 | 3,700
2013 | 4,671
2014 | 5,927
2015 | 7,116
Power Supply

WAPA
4%

Basin
96%
Basin Electric Power Cooperative

- Upper Missouri is a Class A Member of Basin
- Basin is a G&T based in Bismarck, ND
- Member-Owned like Upper Missouri and Mid-Yellowstone
- 96% of our power comes from Basin
- We now make up >30% of Basin
Basin’s Current Resource Portfolio

March 2016

Maximum winter capability in MW
- Wind: 810.7
- Recovered Energy Generation: 44
- Coal-based: 1,154.1
- Hydroelectric dams: 318.7
- Nuclear: 62.2
- Natural Gas: 1,026.5
- Oil, diesel, and jet fuel: 180.8
- Renewables (Recovered & Wind): 0.8

Total: 5,594 MW
Western Area Power Administration

- About 4% of Upper Missouri’s Power comes from WAPA
- Federal power – almost entirely hydro
- Low cost power
We’re Big...Yet Small!

- 4 Friendly Employees
- Mostly a “Paper G&T”
- Billing, Metering, Load Monitoring, Compliance
- Mega-Contracting
  - MDU (Montana Dakota Utilities)
  - HDR
  - Ulteig Engineering
  - Chapman Metering
11 Extremely Different Members

- Huge Variance of Member System Size, Infrastructures, Capabilities, and Needs
Need for Good Data

- Prior to joining an RTO, Basin was scrambling to understand our load
  - 2010-2014
- Growing rapidly and had ~56% of load quantified, and ~61% of that data “accurate”
  - 2 Member systems SCADA data
  - 12 Telemetry points from WAPA (TOP)
    - Crude, measured MDU load with it
- Even with multipliers, we had a very poor representation of our system
Time to Do Something

- Real-time marketing desk, losses to Basin and MDU for some months exceeded $1M
- Pressure to ACT!
To Build a SCADA System

- A Big Task, starting from scratch
- Do you put in a SCADA system for status and measurement only?
- We Considered It...
  - Looked at ACS
  - Looked closer at OSI
Existing SCADA

- **Existing SCADA**
  - At 2/11 Systems: ACS Platform

- **SCADA in Construction:**
  - At 4/11 Systems: ACS and OSI Platforms

- **No SCADA Plans:**
  - At 5/11 Systems: In the Future, maybe...

- **At Basin**
  - OSI
SCADA Needs Varied

- No Strong Desire for a Unified Platform
- Some fully established, some far away
- Operational differences
  - Distribution automation
  - Control centers
  - Transmission automation (where not BES/NERC)
- Too far apart
- May have been a good plan 15 years ago
Load Management and Demand Response

- High Load Factor at Upper Missouri
- 90-95% throughout the year
- Weak price signal from Basin
  - Especially at the time, under non-coincidental billing
  - No mechanism (at time) to follow the market, just Basin demand rates
- Maybe a consideration later...
What About the Economics?

- Real-time marketing desk, losses to Basin and MDU for some months exceeded $1M
- So?
- “Load Monitoring Incentive Program” by Basin:
  - $0.10/MWh if LM SCADA DATA is ±3% of MV90 DATA for 95% of the time
  - $0.05/MWh if LM SCADA DATA is ±3% of MV90 DATA for 90% of the time
- Benefits to Upper Missouri
  - $0.6M/year - $0.8M/year
So...

- Where do we get the data?
- What do we do with the data?
- How do we get the data from A to B?
- And we want it secure, economical, and reliable!!
- Big questions!!
Where do we get the data?

- Without SCADA, where do we have real-time load info?
  - RTU with relay data, yes, but what about tiny transmission sites?
- The revenue meter made the most sense
  - DNP3 data
- One BIG problem
  - Upper Missouri didn’t own the metering, they were all owned and maintained by WAPA
WAPA Metering

- WAPA doesn’t use DNP3 data from their meter
  - Some capable, some not
- Only communication to the meter was a phone line (dial tone)
  - MV90 / Billing data polled by WAPA monthly
- How do we get this fast DNP3 data?
- Meter Sharing Agreement
  - WAPA agreed to share their data IF we did so securely
  - UMPC responsible for all costs of communications, metering upgrades, etc
  - Months of work, negotiation, and planning
What Do We Do With the Data?

- Build our Own SCADA System?
  - Ruled out
- Have a Hosted SCADA System?
  - OSI
  - Basin ✅
- Basin has greatest need for the data
- Bring to their eDNA Historian (Schneider Electric) software
How do we get the data?

- Multiple communications methods
- What is most reliable and secure?
  - Basin microwave system
  - WAPA OPGW fiber network
    - Basin has 7% share of their system
    - Member’s OPGW networks
- What is most economical?
  - Verizon
  - DSL
  - HughesNet Satellite
Communications Hurdles

- WAPA Fiber option really off the table
  - Except where 7% given to Basin
- Microwave communications
  - Costliest
  - Used for largest sites, or if other alternatives aren’t feasible or reliable
- Most often utilized DSL, Verizon, and HughesNet
  - Higher security risk
  - Needed to meet rigorous security requirements with WAPA
A very simplified view of how our load monitoring security was designed for DSL locations (phase 1).
A very simplified view of how our Verizon security works for Verizon communications (phase 1).
- Evolving to same tactics we apply to CIP-003-6 for Low Impact Assets
  - Validation / assurance of our Encrypted Ethernet Client devices
    - More robust than serial to IP convertor
    - May firewall at the meter
  - Through security gateways SEL-3620 at headend
    - Local only access
Building a Load Monitoring Solution

- With WAPA
  - Upgrading meters to accommodate a serial connection (do not allow IP connection)
  - DNP Programming
  - Meter Sharing Agreement
    - Big and arduous task
    - IP Security and data flow
    - Basin, WAPA, Our Members, and Upper Missouri all part of the agreement
Building a Load Monitoring Solution

- With Our Members
- Working out the most effective communications and getting it installed
- Many sites did not have any more than a dial-tone previously
- Installation of load monitoring at 248 delivery points
  - SPP Deliveries
  - Splits (Submeters beyond the Deliveries)
  - WAPA Customers
  - MDU/MISO Wheeling Points
Building a Load Monitoring Solution

- With Basin
  - Calculations, losses, mapping points
- 22 Points of measurement:
  - MW (A,B,C, Total)
  - MVAR (A,B,C, Total)
  - A (A,B,C)
  - V (A,B,C)
  - PF (A,B,C, Total)
  - Hz (A,B,C, Total)
- Presentment

<table>
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<tr>
<th>Name</th>
<th>Instantaneous MW</th>
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<tr>
<td>Burke-Divide</td>
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<tr>
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<tr>
<td>Lower Yellowstone</td>
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<td>McConoe</td>
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<tr>
<td>Southeast</td>
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<tr>
<td>Totals</td>
<td>892.84</td>
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The Results

- A comparison of old to new
- Our new data was 94% accurate within a week of turning on our new system
LOAD MONITORING

- Data started "officially" with Basin on January 13
- Looking good!!! +/- 1%
- PLUS Roughrider

Need Roughrider, Slope, X, Y, Z
Upper Missouri
Total Load

99.86% Accuracy
Load Monitoring Successful

- 248 installations complete
  - We measure every delivery of any size, and every WAPA customer >300 kW.

- Lessons on load monitoring (to me anyway):
  - We might not have needed to be so stringent
  - The best solution might not be the most expensive one
  - The government will work with you, and can be very helpful, but often on their own terms
  - Security threats are dynamic, the design you have today might have to change tomorrow
  - As with any project management, keep the communications and buy-in process strong throughout
  - Money can’t always buy speed
Measuring the Bakken Continues...

- Taking things to the next level!
- Going into SPP changes everything
The SPP Game Changer

- New Rules
- New Questions on Our Metering Path with WAPA
Measuring at the Point of Distribution

- For assets into SPP tariff, pricing is at points of distribution
- One of our members was “Pocket Metered”
  - Flows into and out of their system in two “pockets”
  - Needed 71 delivery meters installed in a very short amount of time
SPP Meter Protocols and Needs

- Annual Testing of Metering & CT’s
- Loss Compensation Analysis & Methodology
- Tight Reign on Drawings, Nameplate Photos, Factory Test Records
- Acceptance Testing
- Time Synchronization
- Real Time and Interval Data for Settlements
The Tide Shifts

- Basin wishing to get billing/settlement data directly in long-term

- Can WAPA get 71 meters installed in 8 months?
  - We didn’t think it could happen

- Do we need to have dial-tone run to every one of these 71 sites?
  - Yes if WAPA
  - IP already there through member’s fiber network

- Can the DNP data used for load monitoring be shared with our member systems?
  - Not under WAPA, would have to go through Upper Missouri first
Upper Missouri Goes into Metering

- Starts with All New Installations
  - Including the 71 under the SPP tariff we needed by end of 2015
- Replacements and Existing Meters to stay Under WAPA
- Utilize Same Communications & Network Security as for Load Monitoring
- Not a Little Thing, to Go Into Transmission Metering!
Transmission Metering is a Big Deal

- Need High Caliber Program with High Integrity on Day ONE
- UMPC bills about $1.3M/Day through our meters
  - The Tiniest of Errors can Cost a LOT Quickly
- Need a Top Notch Interconnection Process and Procedures
- Lots of Checks and Balances Are Required
WAPA Seeks a Sunset on Maintenance at Non-WAPA Facilities

- Dec 31, 2016, All WAPA metering at Non-WAPA facilities will cease, and will thereafter be operationally controlled and maintained by Upper Missouri
Notification of New or Changed Delivery and Member Requests for Data (steps 1-4)

Site Verification and SPP Settlement Location (steps 5-6), determines next step

SPP AQ Processes
DPA
DPNS
NTC
Approval (steps 7a, 7b, 7c, 7d)

Meter Installation, Communications, Networking, Security, and Programming (Steps 16-19)

Loss Compensation and Quality Assurance of Programming Intent (steps 12-15)

Submittal of Factory Test Records, Nameplates, and Station Drawings (Steps 8-11)

SPP and UMPC Records for Security and Information Databases (Steps 20-22, 28, 29)

Installation Reports to Basin, WAPA, and UMPC for Completion of EDNA, Billing, Inventory (Steps 23-27, 30)

Interconnection Process Complete Notification to member that power can be delivered through meter (Step 31)
Metering Integrity Assurance
(Checks and Balances)

- UMPC Interconnection Process
  - Continuous Improvement
- Point of Metering / Point of Delivery
  - Validated and Calculated by Basin
- Loss Compensation and Meter Programming
  - Engineered and Calculated by HDR
  - HDR QA/QC #1
  - Basin QA/QC #2
- Phasor Verification
  - Part of Acceptance Testing (Meter Commissioning) process
  - Test Equipment and Basin where possible

Comparison of Phasors between UMPC Metering (↑) and Basin Relays (→) at Patent Gate 2
Metering Integrity Assurance
(Checks and Balances)

- Load Monitoring Data Monitoring
  - Aware of data problems very quickly
  - UMPC, HDR, Basin, and SPP watching

- Backup Data Available
  - Not everywhere, continuous improvement

- Building a CT/PT Program
  - Goal of < 30-day data outage
  - Metering voltages from 7.2 kV to 230 kV
Metering Integrity Assurance
(Checks and Balances)

- Network Data Security
  - Top notch and cost effective, CIP-compliant, follows best practices of industry, and approved by WAPA
  - All data is firewalled and encrypted
  - Security Gateway / Monthly Scrambled Password Management
    - No unauthorized access to meters
    - Unique user ID for each technician accessing meters

- Billing Data
  - Stored on MV90 at UMPC and backed up offsite
  - Stored on MV90 at Basin and backed up offsite
Metering Integrity Assurance
(Checks and balances)

- Time Synchronization
  - Important for Coincidental Billing Accuracy
  - GPS and GLONASS
  - $\pm 100$ ns from exact at our office
    - Adjusted for latency
  - Or Satellite clock at substation (IRIG-B)
  - All meters are on CST with no daylight savings adjustments

*Upper Missouri's satellite clock used for synchronizing meters*
Metering Integrity Assurance
(Checks and Balances)

- Coincidental Billing
  - Less errors, no switching concerns

- Annual Meter and CT Testing
  - Chapman Metering

- Compliance to SPP Metering Protocols

- Upper Missouri’s Commitment to Metering Integrity
  - Continuous monitoring of integrity
  - Program modifications where needed
  - Best Industry Practices with prudence

Lenard McCall from Chapman Metering testing a UMPC meter at Mountrail-Williams North Missouri Ridge substation
Measuring the Bakken: Success

- It is measured accurately and effectively
- Continuous Evolution
- Integrity is First Priority
  - Budgets, Feelings, Politics all come after
Contact Me

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Questions?