



LineVision PACT™

A background image showing a power line tower in the center, with power lines extending from it. The scene is set against a bright, hazy sky, possibly at sunrise or sunset, with a line of trees visible on the left side. The image is overlaid with a blue and white abstract graphic consisting of curved lines and circles.

# Monitoring Solutions for Pipeline AC Interference

- Introduction to LineVision
- LineVision PACT
  - Pipeline AC Tracking
- Monitoring Technology
- Installation Process
- Data-Portal
  - Real-Time Data Feed
  - PACT Services Report
    - AC Study Report
  - Phasing Report
  - Inspection Timing Heatmap

# LineVision Inc.



Based in Boston, Massachusetts, USA

Spin out from Genscape, Inc. the leading global provider of data and intelligence for energy commodity trading

LineVision leverages their global reach and 18 years of expertise in transmission lines, with thousands of monitors deployed worldwide.

LineVision leadership team brings over 50 years of combined experience in electromagnetic field expertise and asset monitoring

Provider of AC Power Flow Monitoring Services



# AC Induced Corrosion Puts Pipelines at Risk

*“High Voltage interference poses multiple threats to pipeline integrity for co-located and crossing pipelines under both steady state and fault conditions.”*

– Interstate Natural Gas Association of America  
Criteria for Pipeline Co-Existing with Electrical Powerlines, 2015



- Transmission line power flows are dynamic and change constantly
- Information from utilities is difficult to obtain, unreliable, and expensive



# Improving AC Interference Models



Inputs for AC Interference Models:

Easy to Obtain:	
✓ Separation Distance	✓ Co-location Length
✓ Soil Resistivity	✓ Crossing Angle

Difficult to Obtain:	
? HVAC Power Line Flows	
? HVAC Phasing Information	

Lack of Accurate **High Voltage AC** Input Data Results In:

## Oversized mitigation systems

- Unnecessary capital expenses and potentially increased corrosion risk from overprotection

## Undersized mitigation systems

- Pipelines exposed to increased risk of corrosion and dangerous failures
- Safety risk if voltage levels are not properly mitigated

## LineVision PACT service offering

- PACT services are available for Short Term deployment in support of AC studies, or Long Term for trend analysis

## LineVision PACT Services – Providing Real-Time Accurate HVAC Information

Combines patented non-contact sensors and advanced analytics to help pipeline owners and operators better understand their risk exposure and track the impacts of AC interference to improve modeling and manage corrosion risk:

- Real-time power flow readings of HVAC lines from our Electromagnetic Field sensors
- Web-based interface and customized reports provide information to integrity engineers
- Monitors installed in pipeline right of way at ground level, no approval from power utility needed

# LineVision PACT Services



## FEATURES & CAPABILITIES

- Ground based remote monitors
- No specialized installation equipment required
- Turnkey service includes:
  - Patented AC power flow monitor
  - Installation on Pipeline RoW
  - Full Hardware Warranty & Software License
  - Secure Web Data Portal
  - Data integration with leading corrosion modeling solutions

## DATA PROVIDED

### Power Line Flows

- Amps
- Watts
- VARs
- Power Factor

### Magnetic Field Strength

- bH (horizontal)
- bV (vertical)

### Phasing Information Report

### Configurable Alerts



# PACT Services at Critical Areas



A current client with a 5-mile stretch of pipeline co-located with HVAC lines.

PACT monitors are placed strategically to provide real-time data on AC levels and changes over time.



Transmission line A and pipeline shared ROW for .75 miles

**PIPELINE**  
**TRANSMISSION LINE**

Transmission line C and pipeline shared ROW for .5 miles

Transmission line B intersects pipeline

Dual Circuit transmission lines D & E and pipeline shared ROW for .25 miles



# PACT Installations are Fast and Non-Intrusive



## SITE SELECTION



Select site based on transmission line and pipeline co-locations

## PACT INSTALLATION



Installation without specialized tools or outages

## PROFESSIONAL CALIBRATION

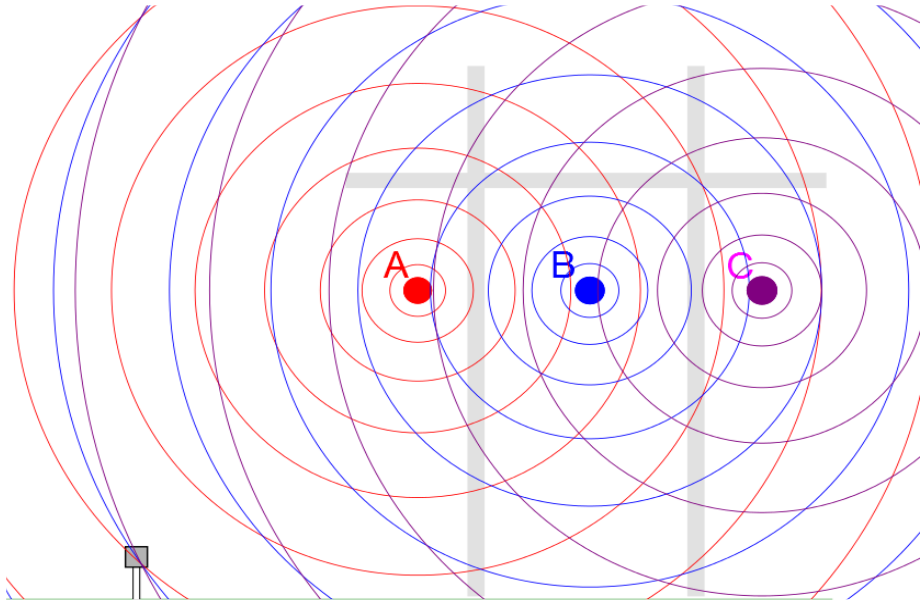


Measure distance from sensors to transmission lines

# Non-Contact AC Power Flow Monitoring



## INDIVIDUAL PHASE EMFs

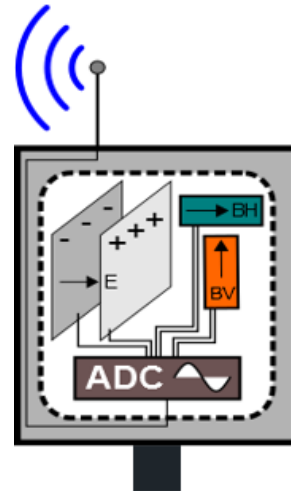
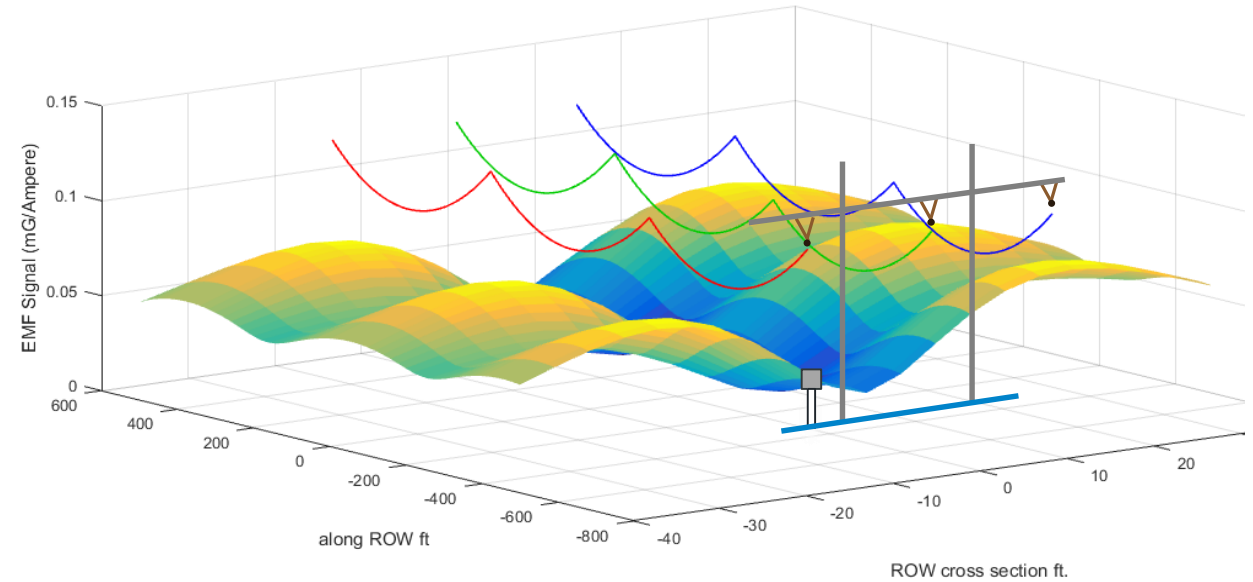


Biot-Savart Law: 
$$\mathbf{B}(\mathbf{r}) = \frac{\mu_0}{4\pi} \int_C \frac{I d\mathbf{l} \times \mathbf{r}'}{|\mathbf{r}'|^3}$$

$\mathbf{B}$ : Magnetic field vector  
 $\mu_0$ : permeability of free space  
 $I$ : electric current

$r$ : radial distance from conductor  
 $d\mathbf{l}$ : conductor element

## EMF FIELDS SUPERIMPOSE



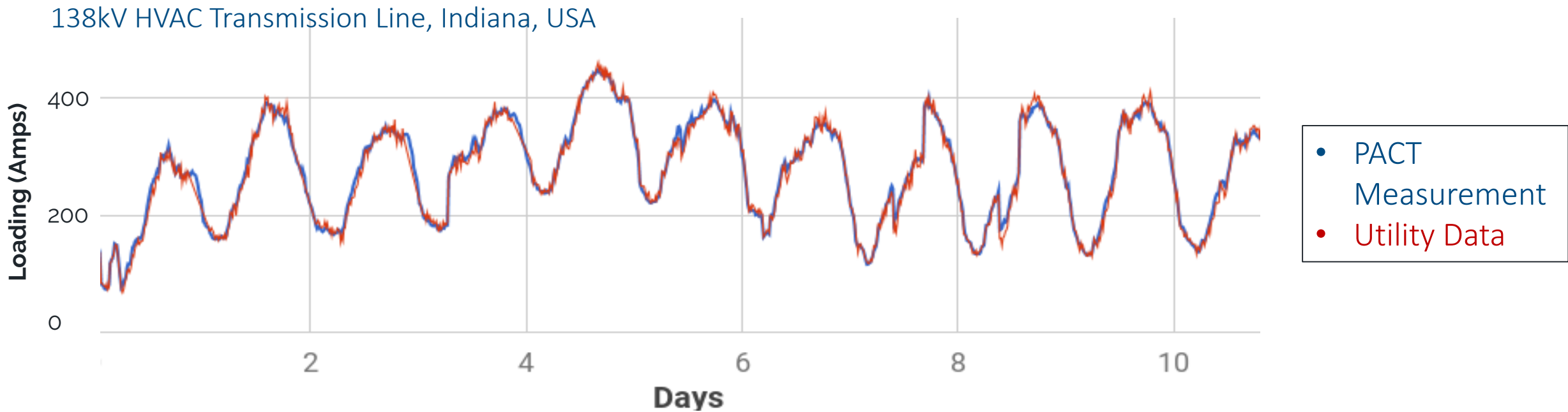
- Electrometer measures E-Field
- Two inductive coil magnetometers measure: Horizontal & Vertical B-field
- A-to-D Converter samples 50/60 Hz waveform from each sensor at ~10 kHz
- Microcontroller for light onboard processing
- Battery powered with photovoltaic charging
- LTE or satellite wireless data transfer

# PACT Power Flow Measurement



Blind Comparison of PACT Measurement vs Utility Data	
RMS Error Amps	9.65
Avg % Err	-0.42%
Average Absolute % Err	1.22%

Reliable measurement  
with  $\pm 3\%$  Accuracy





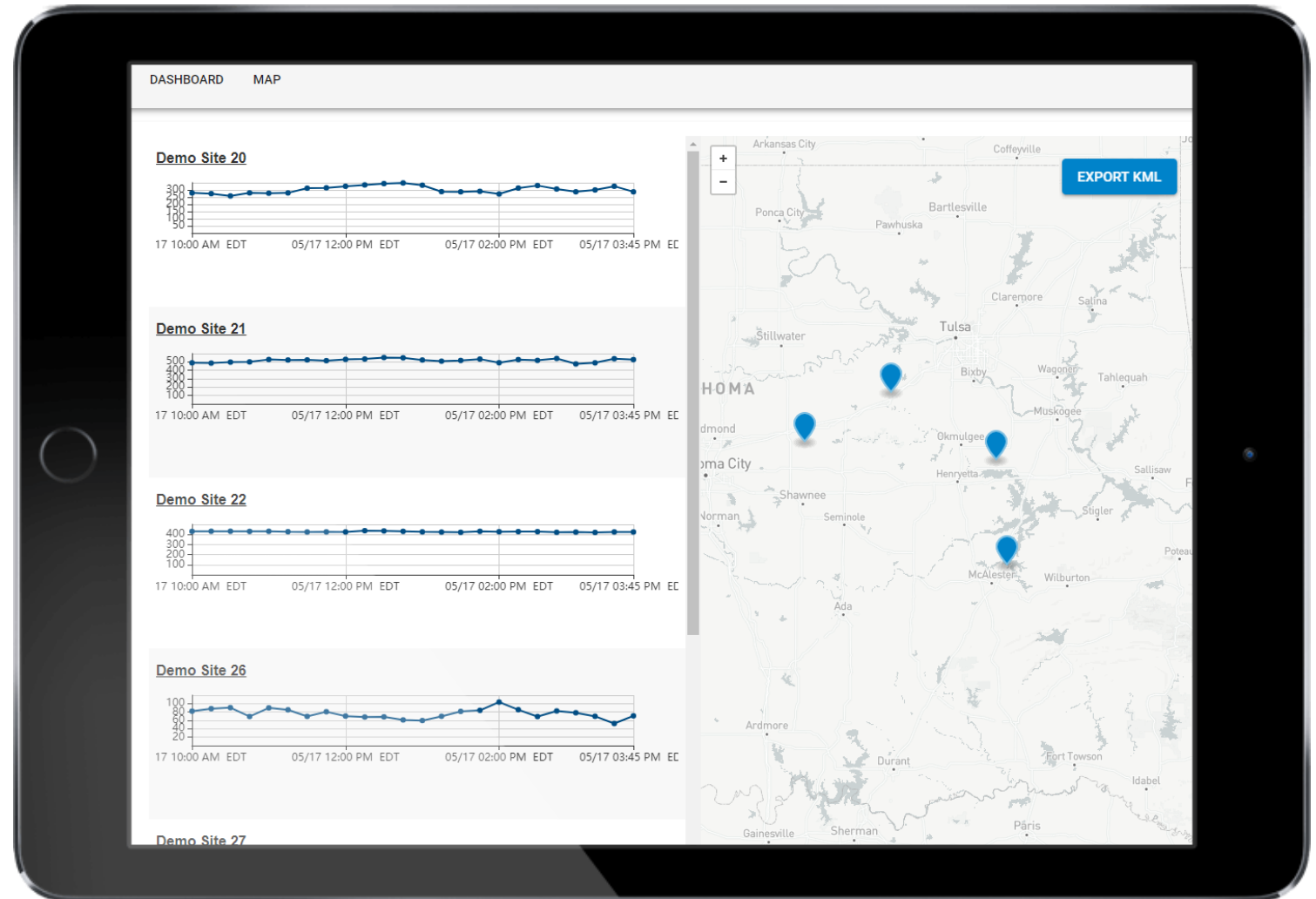
# LineVision PACT™

## Data Portal & Reports

# PACT Data Portal For Data Viewing



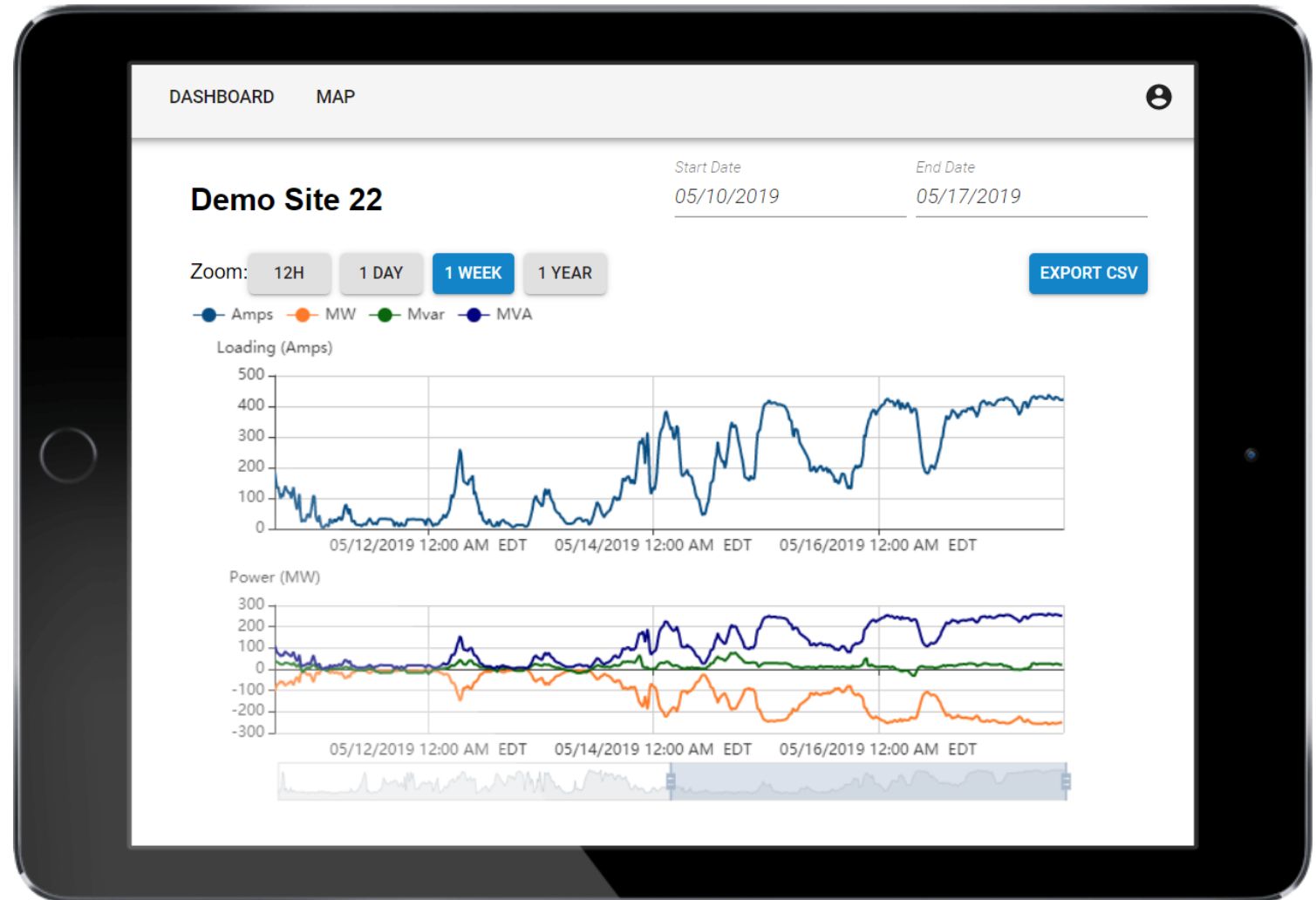
- Cloud-based platform means users can log in from any device, anywhere
- Dashboard view offers a snapshot of all information
- Interactive map makes it easy to navigate between sites
- Configurable alerts can be sent when loading reaches set levels which could increase field work safety risk



# Data Portal cloud hosted website displays individual historical and present monitoring data



- See data on:
  - Amps
  - MW
  - Mvar
  - MVA
  - Phasing
- Date Range selection zooms in on relevant timeframe
- Export information in .CSV format



# PACT Services Reports



## Sample Report with collected data for HVAC Interference Study

**PROJECT DESCRIPTION**

XYZ Transmission Engineering identified 5 spans in Line 123456 (ABC – DEF; 138 kV; ISD = 1989) for which there existed uncertainties relative to conductor physical behavior, characteristics, margins for conductor clearance, and temperature, the as-is Conductor vs. Clearance relationship, and the actual vs. calculated ampacity. XYZ Utility retained LineVision to provide an as-is physical assessment (CPA) of these parameters, characteristics, and behavior for the period starting November 15<sup>th</sup>, 2015 and ending January 1<sup>st</sup>, 2016.

LineVision engineering and project management representatives met with XYZ Transmission engineers on-site (ABC, NJ) on January 3<sup>rd</sup>, 2015 to survey the pre-identified line/span locations in order to determine optimum sensor placements in and across the Transmission ROW for Line 123456. LineVision then worked closely with Duke Transmission Engineering personnel to acquire the necessary data on and for the site(s)/span(s) listed in Appendix 1, following.

All project data gathered on and for the target site(s)/span(s) is included in an Excel Workbook listed in Appendix 2, following.

range: 1d 1w 1m 1y

start: 2019-02-02 00:00

end: 2018-08-02 00:00

Explore: Amps DLR MW Mvar Sag Temperature Blowout

	Now	Avg	Min	Max	Units
Amps	177.2	225.0	88.0	422.0	Amps
DLR	1234.0	1100.0	909.0	2751.0	Amps
MW	134.2	170.3	66.7	319.7	MW
Mvar	21.3	27.0	10.6	50.6	Mvar
Sag	4.2	4.1	3.3	8.1	meters
Temperature	28.0	25.0	-14.0	79.0	degC
Blowout	0.2	0.0	-0.7	0.9	meters

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**FIGURE 1: LAYOUT OF LINEVISION TL-CPA EQUIPMENT IN THE TRANSMISSION ROW**

**FIGURE 2 – MAP OF LINE <NAME>**  
<Insert Map Image of Line>

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**FIGURE 3: LINE LOADING (Iavg); STATIC RATING; AND REAL-TIME RATING (Ampacity)**

Client: Line #/Name: Line kV; City, State; Conductor Type; Span Length, ISD  
August 2013 Physical Data: Real-time Loading, Static Rating, and Actual, Real-time Dynamic Ampacity

**DESCRIPTION OF GRAPH/DATA**

Two time-varying physical parameters are shown: Line Loading (Iavg; Amps) and Real-time [Dynamic] Rating (Amps). Line Loading is measured directly; Real-time Rating is calculated with an IEEE-738-consistent Ampacity Algorithm. This algorithm is rendered more accurate in that Tcond is known, to +/- 3.5 °C, and is input directly into the IEEE-738-based Rating calculation.

**KEY PARAMETERS**

Average Loading	277 MW
Max Loading	682 MW
Average Line Utilization (vs static limit)	14.9%
Max Utilization (vs. static limit)	36.7%
Average 1 hr STE (Short Term Emergency) Rating	2250 MW

**COMMENTARY & FINDINGS**

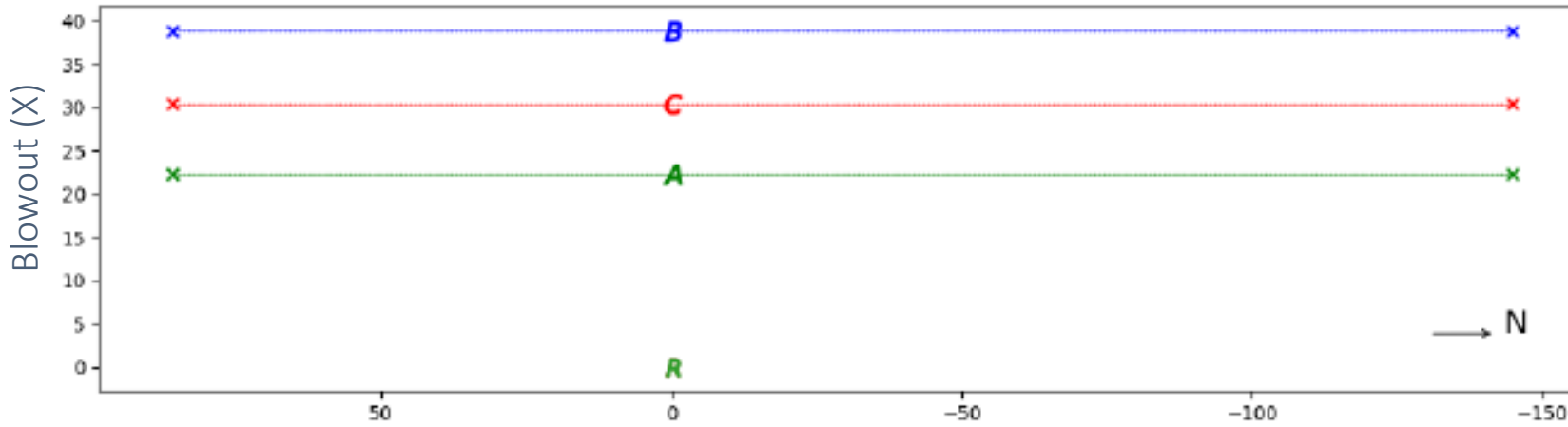
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# Phasing Report Characterizes Phase Order

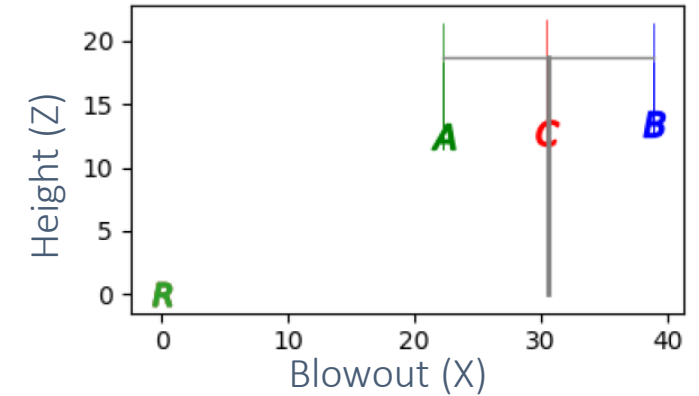


## Local Site Information

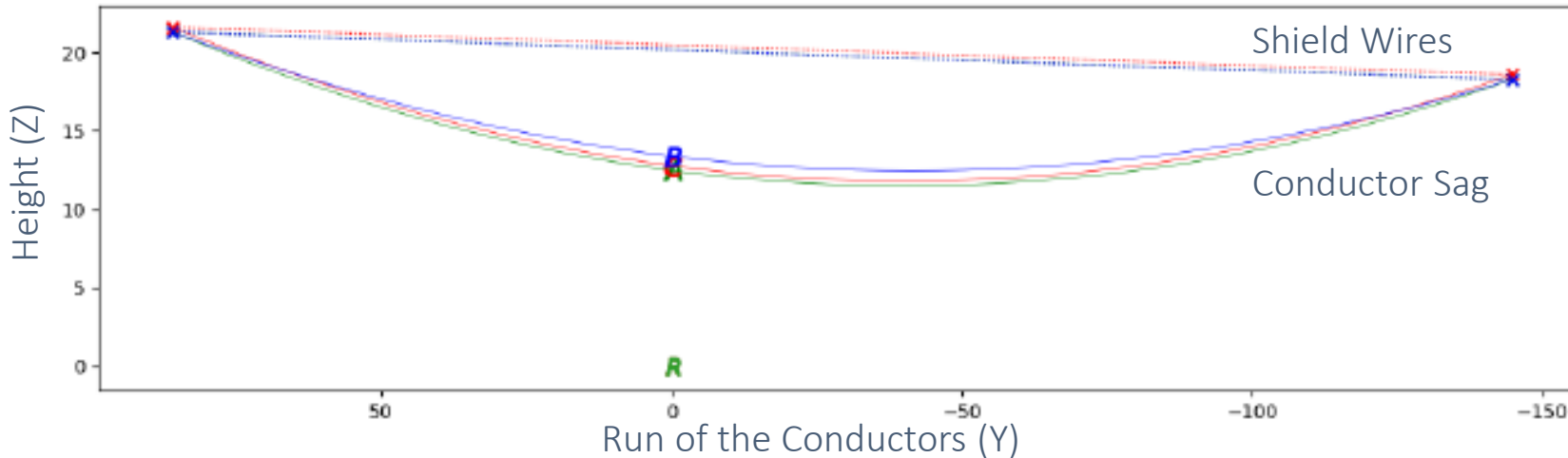
Top View of Conductors



Front View of Conductors



Side View of Conductors





# AC Intensity Heat Map

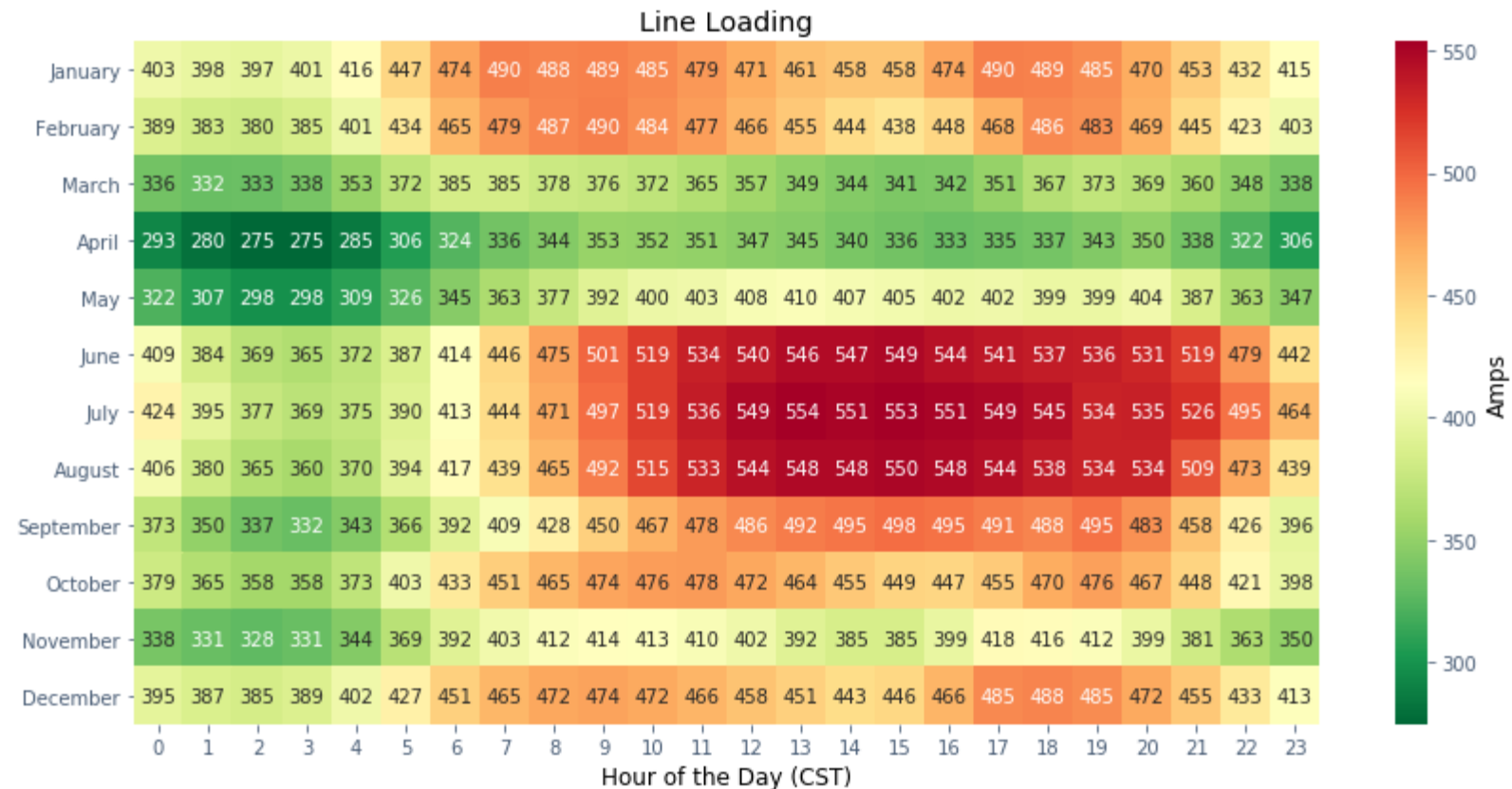
## Inspection support



Pipeline field inspections are part of routine maintenance and at times on an emergency basis.

LineVision PACT **Heatmap** and **RealTime Alerting capabilities** offer support for Optimal inspection and **Alerting** to field crew if line load changes suddenly, potentially triggering a safety concern.

- Safety
- Productivity
- Accuracy



# Why LineVision PACT ?



## Better AC Interference modeling results

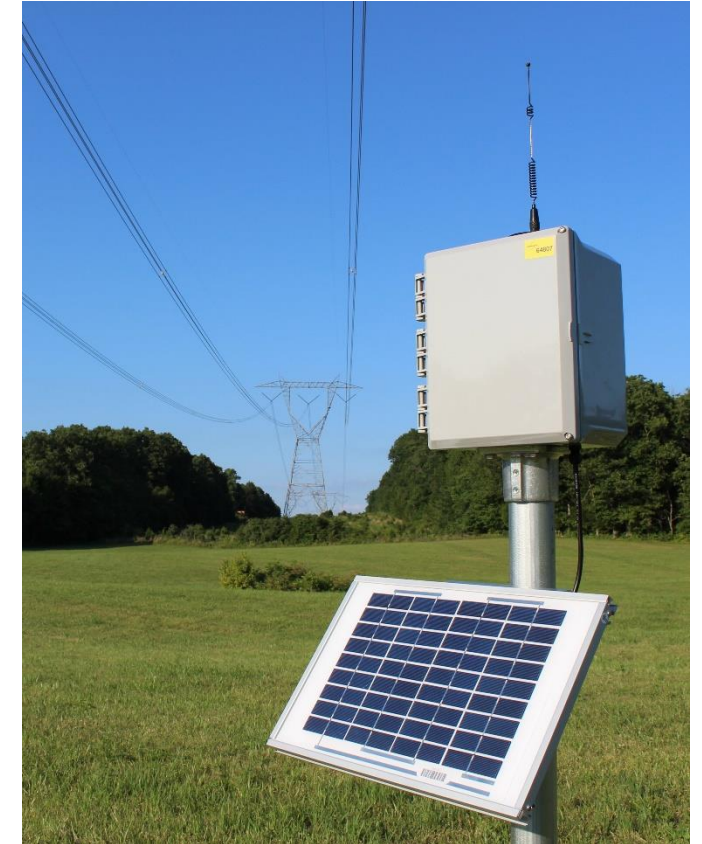
- Optimize protection system design, size and placement, by deploying LineVision PACT monitors on a temporary basis – Replacing the dependency on power utilities!

## Insights into HVAC loading trends

- Continuously monitor power flow patterns for changes over time which could put pipeline integrity at additional risk

## Improve field crew safety

- Real-time information on line loading and monthly heatmaps to identify times of increased touch potential risk





To learn more, visit: **LineVision.co**

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