Thermal Energy Harvesting Increases the Value of Wireless and Wired Devices

Thermoelectric energy harvesters are highly versatile wireless power sources—requiring only small temperature differences to generate electricity for wireless at Chevron and other companies.

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EMERSON GLOBAL USERS EXCHANGE

Presenters

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Presentation Outline

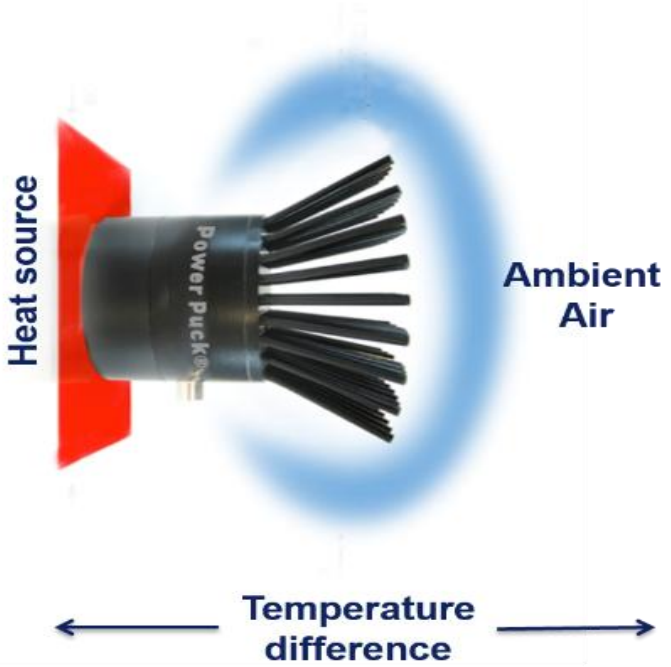
- Quick introduction to thermoelectric energy harvesting
  - How energy harvesters generate electricity
  - Why use thermoelectric technology for industrial applications

- Focus application: Chevron Upstream Oil & Gas
  - Importance of data capture for strategic businesses
  - Where wireless has benefitted Chevron operations
  - How energy harvesting adds to wireless benefits

- Applying energy harvesting to other applications
  - Typical applications and heat sources
  - Minimum temperature differences – how much do you really need

How Power Pucks Generate Electricity

- Partial or full power from warm/hot equipment or pipes commonly found in industrial areas
- 40C temperature difference: full power for any configurable update rate
- 20C temperature difference: doubles battery life at 2- and 4-second rates



Rosemount 3051S Power Lifetimes:

Battery Only		Energy Harvesting (ΔT = Temperature Difference)					
	No EH	ΔT °C	20	25	30	35	40
		ΔT °F	36	45	54	63	72
1 sec.	0.60		0.7	0.9	1.33	2.7	>10
2 sec.	1.30		2.0	5.2	>10	>10	>10
4 sec.	2.20		5.5	>10	>10	>10	>10
8 sec.	3.70		>10	>10	>10	>10	>10

Sample Scenario	Celsius	Fahrenheit
Heat Source Temp.	52° C	126° F
Ambient Temp.	22° C	72° F
Temperature Difference	30° C	54° F

Why Use Thermoelectric for Industrial Wireless

- Update rate flexibility without battery life impact
- Up to 20 years of power
- Fewer battery replacements lower maintenance costs & decrease time in hazardous areas
- Works anywhere a temperature difference exists, with heat sources ranging from -45C to 450C
- Backup power from Intelligent Power Module batteries

Power Puck Hazardous Area Certifications

USA - Class I, Division 1, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Class III, Division 1; Class I, Zone 0, AEx ia IIC T4

Canada - Class I, Division 1, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Class III, Division 1; Class I, Zone 0, Ex ia IIC T4

ATEX – II1G Ex ia IIC T4 II1D Ex ia IIIC T135°C

IECEx – Ex ia IIC T4 Ga Ex ia IIIC T135°C Da

EMC, RoHS and IP67 certified

CEI/IEC 60529:2001, 2004/108/EC, 2011/65/EU

Chevron: Wireless Increases Operational Efficiencies

- Wireless has enabled new monitoring capabilities
- Chevron has identified critical areas for wireless, described on the following slides, and realized benefits that include:
  - Lower installation costs
  - Additional monitoring points

Wireless Benefits in Upstream

- Remote well production oil field monitoring
  - Reduces well downtime
  - Enables early detection of well issues

- Remote equipment monitoring
  - Quicker response to downtime
  - Process optimization

Wireless Benefits in Upstream Offshore

- Replaced legacy field monitoring equipment at production facility with wireless
  - Improves monitoring ability with automated data acquisition
  - Provides trending capability at central control location

- Well head monitoring with wireless
  - Monitoring of flowing well dynamics by inferential measurements.
  - Determines changes to well operating characteristics.

Wireless Benefits in Upstream Flowline Monitoring

- Determine flowline and well head issues
  - Provide additional data on existing facility with minimal cost
  - Diagnose sand/wax buildup issues in piping

Wireless Benefits - Downstream

- Reduce “steam blow” on failed steam traps to save energy
- Improve processing of product on key steam heat applications
- Easy installation, quick to install

Increased Battery Life With Energy Harvesting

- With Wireless comes the need to consider battery maintenance.
- Some Chevron applications require update rates of 1, 4, or 8 seconds. For these applications, it isn't possible to rely on batteries alone.
- With the only requirement being a temperature difference, thermal is the best match for flexibility with update rates and longer power life.
- Ample temperature differences are available from oil & steam pipes, and from operating equipment.

Energy Harvesting Offers Update Rate Flexibility

3051S Wireless Pressure Transmitter

Power Source Lifetimes

Battery Only		Energy Harvesting *(ΔT = Temperature Difference)*							
	No EH	ΔT °C	20	25	30	35	40	50	60
		ΔT °F	36	45	54	63	72	90	108
1 sec.	0.60		0.7	0.9	1.33	2.7	>10	>10	>10
2 sec.	1.30		2.0	5.2	>10	>10	>10	>10	>10
4 sec.	2.20		5.5	>10	>10	>10	>10	>10	>10
8 sec.	3.70		>10	>10	>10	>10	>10	>10	>10
16 sec.	5.80		>10	>10	>10	>10	>10	>10	>10
32 sec.	8.60		>10	>10	>10	>10	>10	>10	>10
60 sec.	10.00		>10	>10	>10	>10	>10	>10	>10

Battery life shown in table based on ideal conditions of 70F or 21C.

Chevron oilfield conditions are often described as “severe and extreme”, ranging from 0 to 115 F, which reduces battery life.

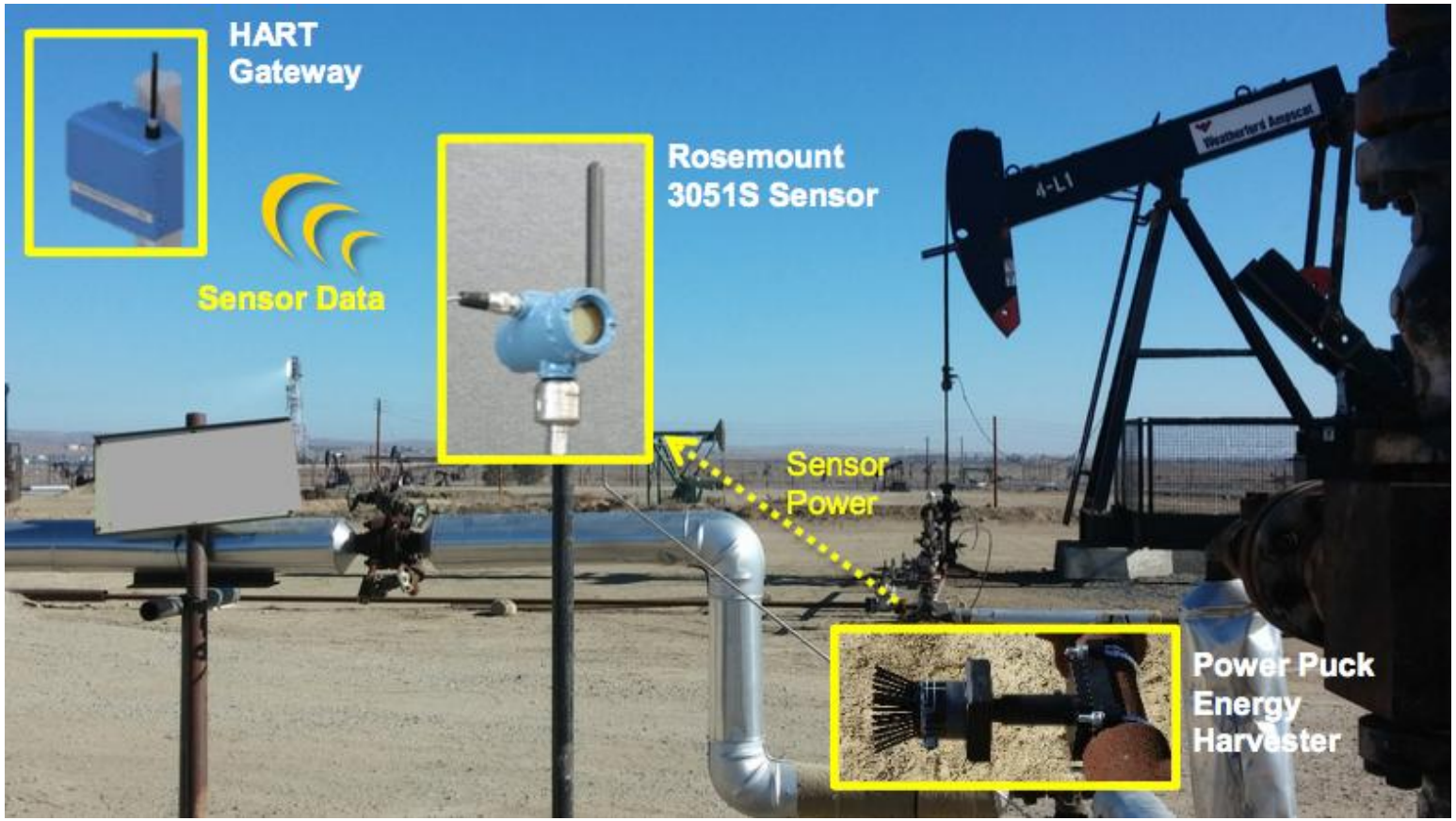
Steam Injection Monitoring Example

Power Pucks®

Wireless + Energy Harvesting

- Update rate flexibility
- Wireless power lifetime comparable to the life of the transmitter
- Power for 3 transmitters from 1 Power Puck using steam heat source

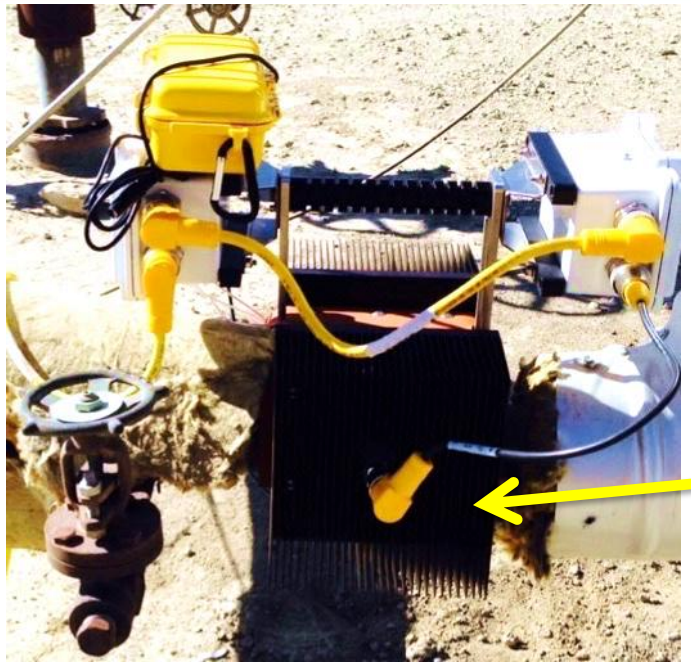
Steam Injection Monitoring Configuration

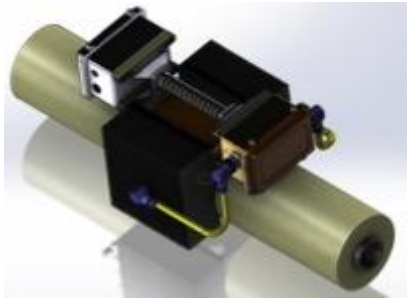


Wireless & Energy Harvesting in Chevron Upstream Oilfield

Mobile Monitoring – An Alternative to Wired Power

Chevron Portable Q-Test





mPower Tiles®

- mPower Tiles replace two 35ah, 32lb lead-acid batteries per unit
- Result is longer monitoring cycles without swapping batteries for recharging
- Decreases in battery costs, and personnel time in field

Energy Harvesting Application Opportunities



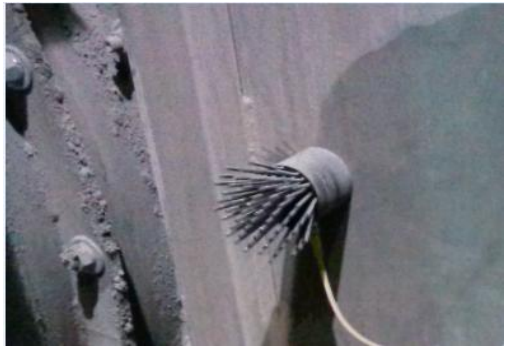



Power Wherever a Temperature Difference Exists

Generates electricity around the clock indoors or outdoors in the most extreme environments

Typical Industrial Heat Sources

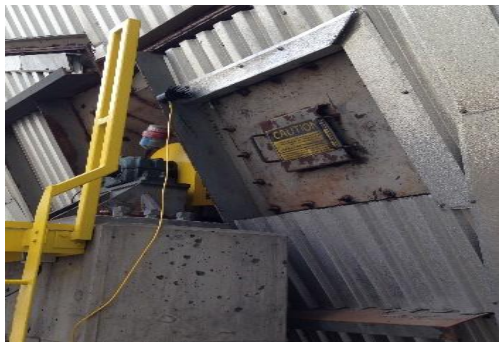
Hot or Warm Pipes



Machine Casings

Heat Exchangers

Motors, Pumps



Boilers

Compressors

Any source of temperature within 100 meters (300+ feet) of the transmitter can be used to tap the benefits of energy harvesting

Energy Harvesting Wired & Wireless Portfolio

Power →

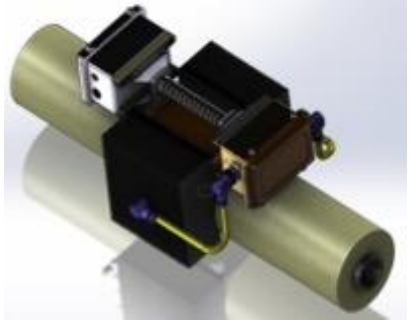
Wireless transmitters

Power Pucks® + IPM

Power for traditionally Wired Devices with requirements of about 1 Watt Including 4-20mA, 12- 24VDC Sensors

Power Tiles®

Power for traditionally Wired Devices with requirements in the 4+ Watt range



mPower Tiles®

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Applications: Oil Well Monitoring – Extreme Cold

- **Situation:** Monitoring remote oil well pads that are not staffed full-time, and where access costs are very high.
- **Solution:** Power Pucks using oil production pipes at ~52°C that generate ~30°C temperature difference.
- **Results:** Data can be captured at fast rates without incurring high battery maintenance costs.

Applications: High Volume Manufacturing

- **Situation**: Personal Care product manufacturer prefers wireless with requirement for 1- and 2-second update rates, which would make maintenance costs prohibitive.
- **Solution:** Power Pucks using steam pipes that generate the temperature difference.
- **Results:** Wireless is deployed as the standard configuration now that the high update rates don’t decrease battery life.

Applications: Agricultural Processing

- **Challenge:** Large number of transmitters require ongoing battery maintenance program, which is costly and requires interruptions in productivity.
- **Solution:** Energy harvesting using holding tanks containing hot (~90°C) liquids for the heat source.
- **Results:** Rosemount 3051S transmitters at 4-second rates powered with energy harvesting eliminates most all maintenance and downtime from battery changes.

Applications: Power Plants

- **Challenge:** Transition from manual to electronic meters for billing applications. Wiring is costly and the preference is for wireless. This indoor area requires an alternative to solar.

- **Solution:** Vortex Flowmeters with Power Tile energy harvesters can power these applications. Heat from steam pipes creates ample temperature difference.

Summary

- Wireless provides significant benefits to Chevron.
- Powering wireless with energy harvesting extends the value of wireless to applications with rigorous data requirements, or have battery maintenance challenges due to numerous transmitters, or remote, hazardous locations.
- Traditionally wired instrumentation can be located anywhere a heat source is present.
- Significant cost savings from energy harvesting can be realized over the life of the transmitters.

Where To Get More Information

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Thank You for Attending!

Enjoy the rest of the conference.

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