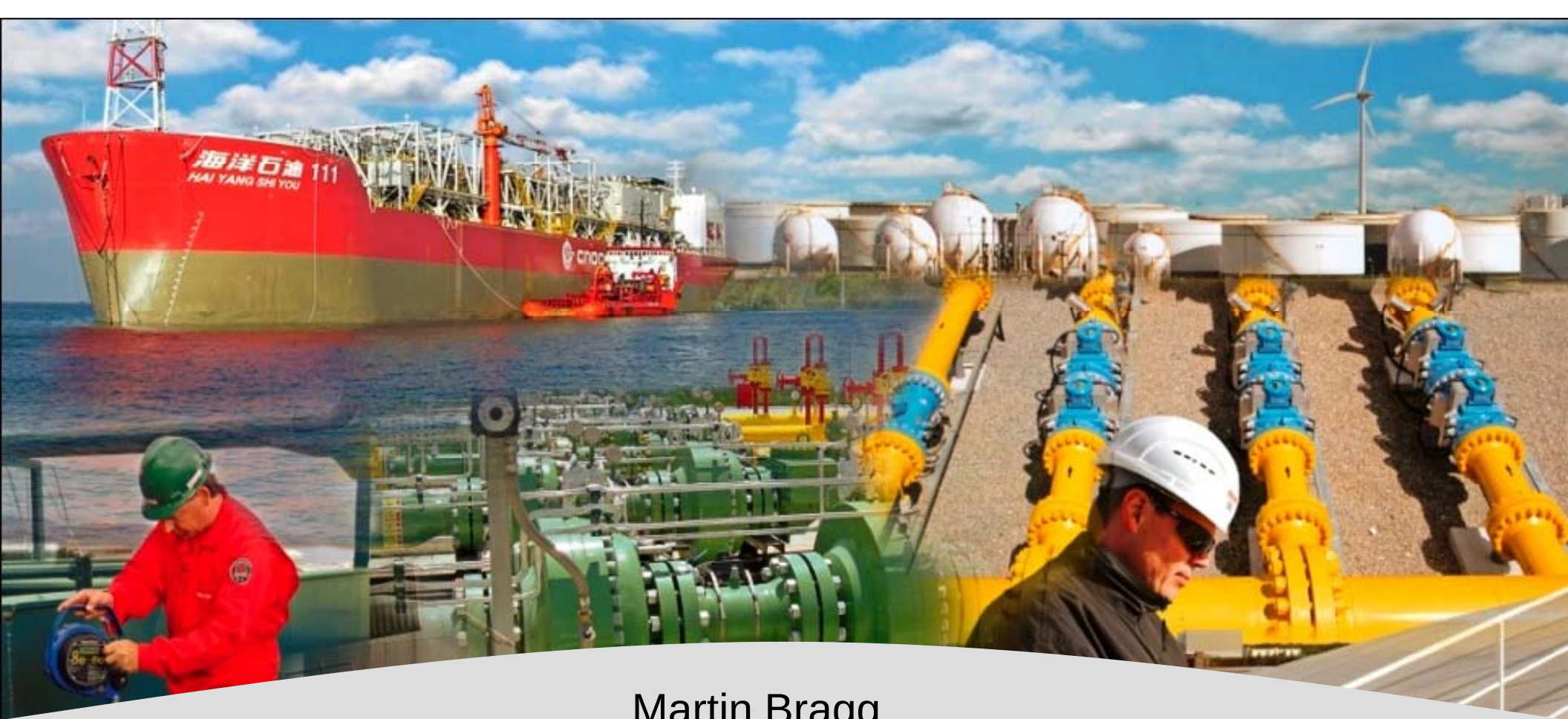




Martin Bragg
12th March 2014

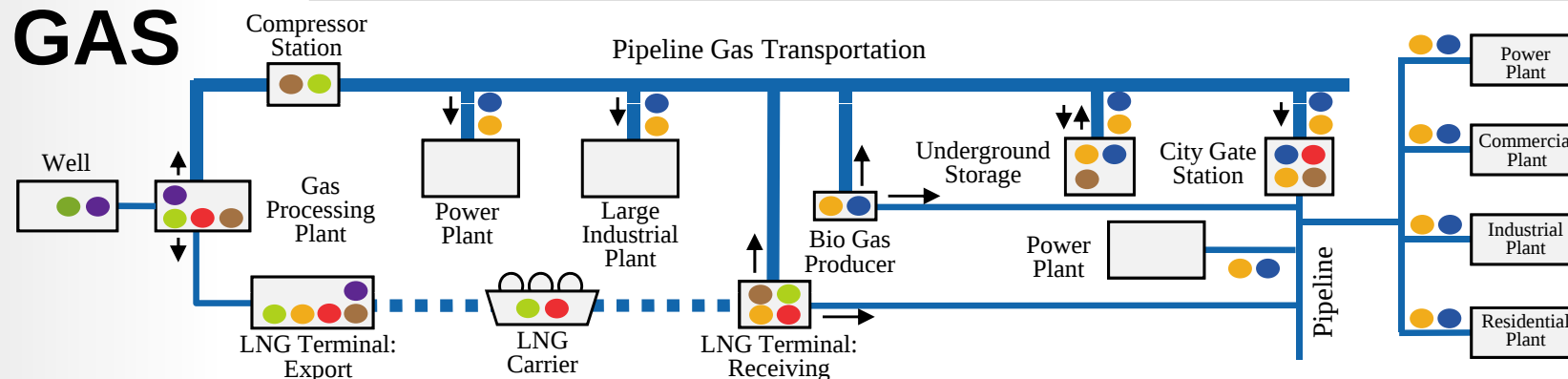
ENERGY HARVESTING in the OIL & GAS sector

Honeywell

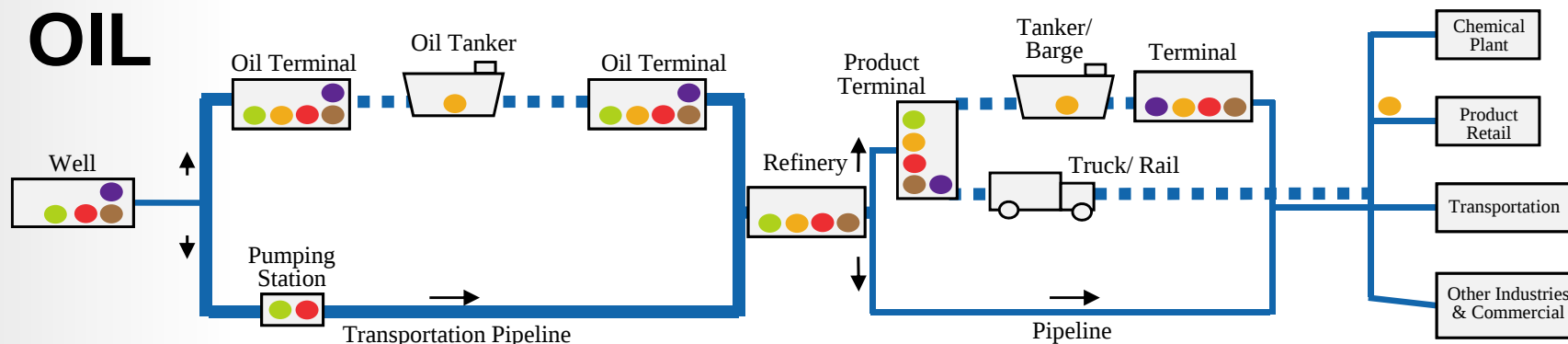


Supply Chain

GAS



OIL



● Pressure Reduction
● Fire & Gas Systems

● Custody Transfer Metering
● Security, Surveillance, Access Control

● Distributed Control System
● SCADA

● Simulation Optimization, ERP Software



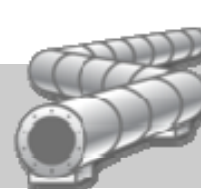
Production



Processing



Storage



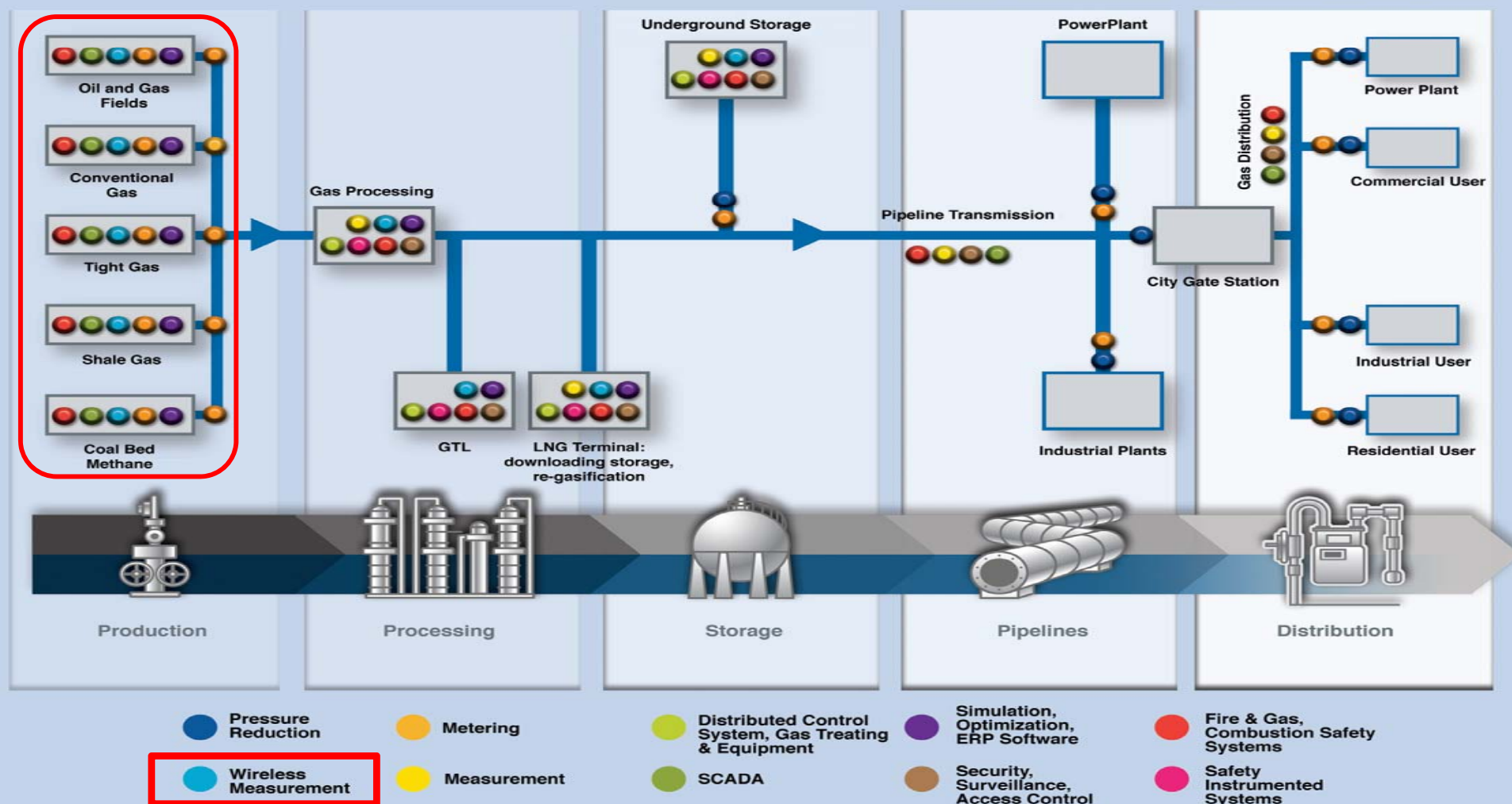
Pipelines



Distribution



Gas Supply Chain



Top 3 Measurements are Flow, Pressure, and Temperature

Energy Harvesting

- Wired “systems” and measurements have dominated the sector
- Communications buses have grown in an attempt to reduce the wiring burden within a “system”
- Open standards are appearing but not as successful as one might imagine
- The supply chain is growing in complexity and new developments such as Shale Gas, Shale Oil and Coal Bed Methane (“unconventionals”) are growing
- Battery powered or low energy devices are more frequently found across the supply chain where once they would have been the domain of the “distribution” system (downstream)



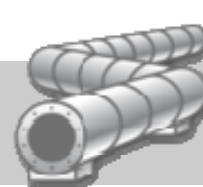
Production



Processing



Storage



Pipelines



Distribution



Industrial Transmitters Dominate

- Traditionally, one looks to low power “transmitters” as likely candidates for Energy Harvesting
 - Pressure
 - Temperature
 - Position Sensors
 - Vibration Sensors
- Adapters are available to adapt traditionally wired devices to wireless
 - OWA 100 OneWireless™ from Honeywell
 - Accessing HART devices to align with ISA100.11a compliant control systems



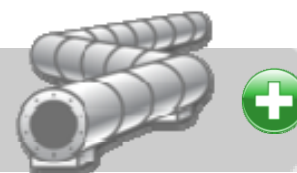
Production



Processing



Storage



Pipelines



Distribution



Energy Harvesting

Pressure Transmitter Worldwide Outlook

Market Forecast Group Figure 4-35

Total Shipments of Pressure Transmitters by Transmission Method

Figures in Millions of US Dollars

Transmission Method	2011	2012	2013	2014	2015	2016	CAGR
Wired	2,641.8	2,769.1	2,893.5	3,021.6	3,142.6	3,271.9	4.4%
Wireless	87.6	104.9	122.3	140.9	159.1	179.1	15.4%
Total	2,729.5	2,874.0	3,015.8	3,162.6	3,301.7	3,450.9	4.8%

Wireless
15.4% CAGR

Pressure Transmitter Worldwide Outlook

Market Forecast Group Figure 4-5

Total Shipments of Pressure Transmitters by Industry

Figures in Millions of US Dollars

Industry	2011	2012	2013	2014	2015	2016	CAGR
Chemical	704.4	740.6	775.9	812.3	846.7	883.5	4.6%
Electric Power Generation	372.6	394.3	415.9	438.3	459.9	483.1	5.3%
Food & Beverage	124.8	131.1	137.3	143.7	149.8	156.2	4.6%
Mining & Metals	142.6	151.9	161.3	171.1	180.6	190.9	6.0%
Oil & Gas	677.9	718.8	759.4	801.9	842.8	886.9	5.5%
Pharmaceutical & Biotech	63.3	66.5	69.7	73.0	76.1	79.4	4.6%
Pulp & Paper	85.7	87.7	89.4	90.9	92.0	93.2	1.7%
Refining	286.2	302.6	318.8	335.7	351.9	369.3	5.2%
Water & Wastewater	82.3	87.1	91.9	96.8	101.6	106.7	5.3%
Other Industries	189.8	193.4	196.3	198.9	200.3	201.7	1.2%
Total	2,729.5	2,874.0	3,015.8	3,162.6	3,301.7	3,450.9	4.8%

Oil & Gas
\$887 Million



Production



Processing



Storage



Pipelines



Distribution



Energy Harvesting

Berg Insight estimates that the shipments of Oil & Gas M2M devices with cellular or satellite communication capabilities reached 33,000 worldwide in 2011. Growing at a compound annual growth rate of 30.7 percent, the shipments are expected to reach 126,000 in 2016. Compound annual growth rates for cellular and satellite based devices will be 32.5 percent and 26.8 percent respectively during the same period. The installed base of active oil & gas M2M devices is forecasted to grow at a compound annual growth rate of 21.5 percent from 164,000 units at the end of 2011 to 435,000 units by 2016. The installed base of cellular and satellite based M2M devices in 2016 are forecasted to be 275,000 units and 160,000 units respectively. Berg Insight anticipates that **on-shore well field equipment monitoring and in-land pipeline monitoring will be the top two applications for wireless M2M in the oil & gas industry**".

BERG
INSIGHT
Premier business intelligence



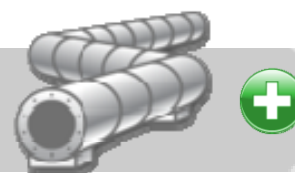
Production



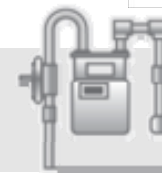
Processing



Storage



Pipelines



Distribution

Oil & Gas is the biggest Industry



OneWireless™



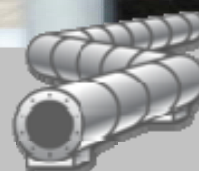
Production



Processing



Storage



Pipelines



Distribution

How Remote is Remote?

- **SHALE GAS - AMERICAS**

- The first Marcellus gas production from the well began in 2005. Between then and the end of 2007 more than 375 gas wells with suspected Marcellus intent had been permitted in Pennsylvania
- Large number of “short-life” wells compared to traditional conventional wells
- **Well Spacing >>** Marcellus wells can be spaced in 40 acre units or 16 wells per square mile. An average town could contain up to 1,500 wells. The following slide shows a photograph below of the Jonah field in the Rockies; this is what a 40 acre spacing gas development looks like from the air



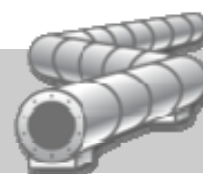
Production



Processing



Storage



Pipelines



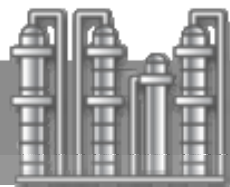
Distribution

How Remote is Remote?

Unconventional gas production is forecast to increase from 42 percent of total US gas production in 2007 to 64 percent in 2020 (Ref: API).



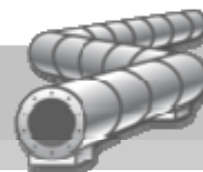
Production



Processing



Storage



Pipelines



Distribution

OneWireless™

- OneWireless Network is made up of the following components:
 - **Honeywell OneWireless Field Device Access Point (FDAP):** An industrial meshing access point for ISA100 Wireless field instruments
 - **Honeywell OneWireless Wireless Device Manager:** Manages the wireless field instrument network and all wireless field devices, including ISA100 Wireless field instruments, FDAPs, the field instrument radio embedded in the access points and any wired field devices with an ISA100 Wireless Adapter
 - **Cisco® Aironet® 1552S Access Point:** An industrial meshing access point for IEEE 802.11 devices and ISA100 Wireless field instruments
 - **Cisco Wireless Controller:** Manages the IEEE 802.11 network and all IEEE 802.11 devices connected to the network



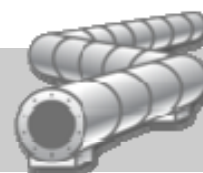
Production



Processing



Storage



Pipelines



Distribution

OneWireless™

- The Honeywell OneWireless™ Network is a multi-application, multi-standard industrial wireless network that extends the process control network into the field ...

Inputs		Editable
Insert the number of wireless instruments.		100
Insert the distance between transmitter and existing junction box (meters)		200
Insert the distance between the wireless gateway (FDAP or Cisco 1552S AP connected to LAN) and the control room (meters).		30

Value	Wired (USD)	Wireless (USD)
Instruments and infrastructure	50,400	227,300
Instruments materials	231,100	1,210
Installation cost (labor)	110,000	10,000
Engineering, Design and Commissioning	90,000	45,000
Terminations	7,500	N/A
Battery replacement (labor + cost)	N/A	30,000
Total	498,000	313,510
% difference of cost		37%



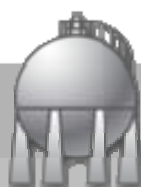
Wireless Field Instruments versus
Wired Field Instruments Calculator



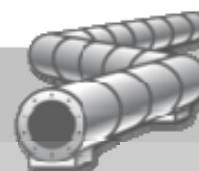
Production



Processing



Storage



Pipelines



Distribution

Energy Harvesting Power Module

- Allows much faster update rates and extends battery life
- Replaces the standard I.S. Battery Pack in the Honeywell XYR 6000 transmitters
- Accepts many external power sources
- Batteries included as normal pack but only necessary for network joining
- Internal energy storage capacitor powers “normal” radio transmissions
- ATEX, IECEx, FM approved
 - Baseefa13ATEX0063X / IECExBAS 13.0037X



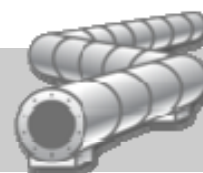
Production



Processing



Storage



Pipelines



Distribution

Energy Harvesting

- Perpetuum Energy Harvester on suitable vibration source
 - Extends battery life to >10years
 - Allows 4 seconds transmitter update rate
- Fully certified (Zone 0)
- Very high reliability
- Simple connection to Power Module
- Batteries still available for “normal” power



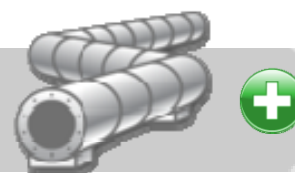
Production



Processing



Storage



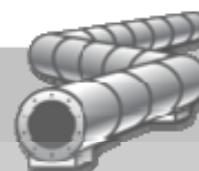
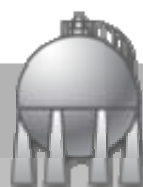
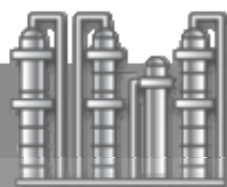
Pipelines



Distribution

Energy Harvesting

- Honeywell Power Module will **also** accept
 - Existing Thermal Harvesters
 - Example: Micropelt, Perpetua
 - DC Power up to 20V
 - Other suitable types of Energy Harvester
 - Note: All these may require certification



Production

Processing

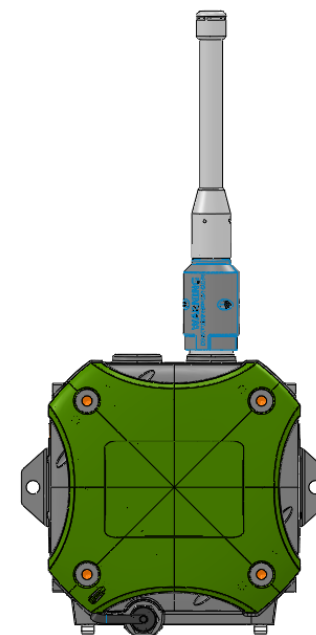
Storage

Pipelines

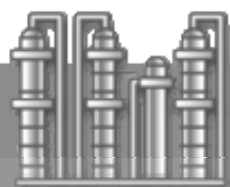
Distribution

Trend Toward Other Devices

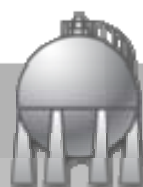
- Other wireless devices are utilised in the oil sector for tank gauging applications (on a tank farm)



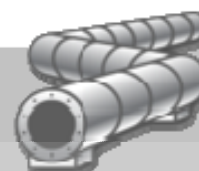
Production



Processing



Storage



Pipelines



Distribution

Wireless First followed by Energy Harvesting

Trend Toward Other Devices

- The SmartRadar FlexLine tank gauging system uses the OneWireless™ universal mesh network to seamlessly integrate with any supervisory system such as Entis or Experion, making it simple to manage and efficient to operate. OneWireless™ helps optimise plant productivity and reliability, improve safety and security, and ensure regulatory compliance. Specific benefits include:
 - Reduced installation cost by 50% or more
 - Improved measurement accuracy
 - Reduced operational costs



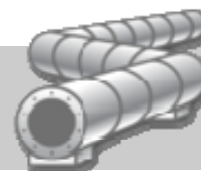
Production



Processing



Storage



Pipelines



Distribution

Trend Toward A System Solution



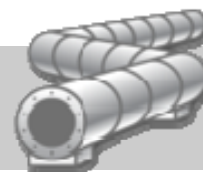
Production



Processing



Storage



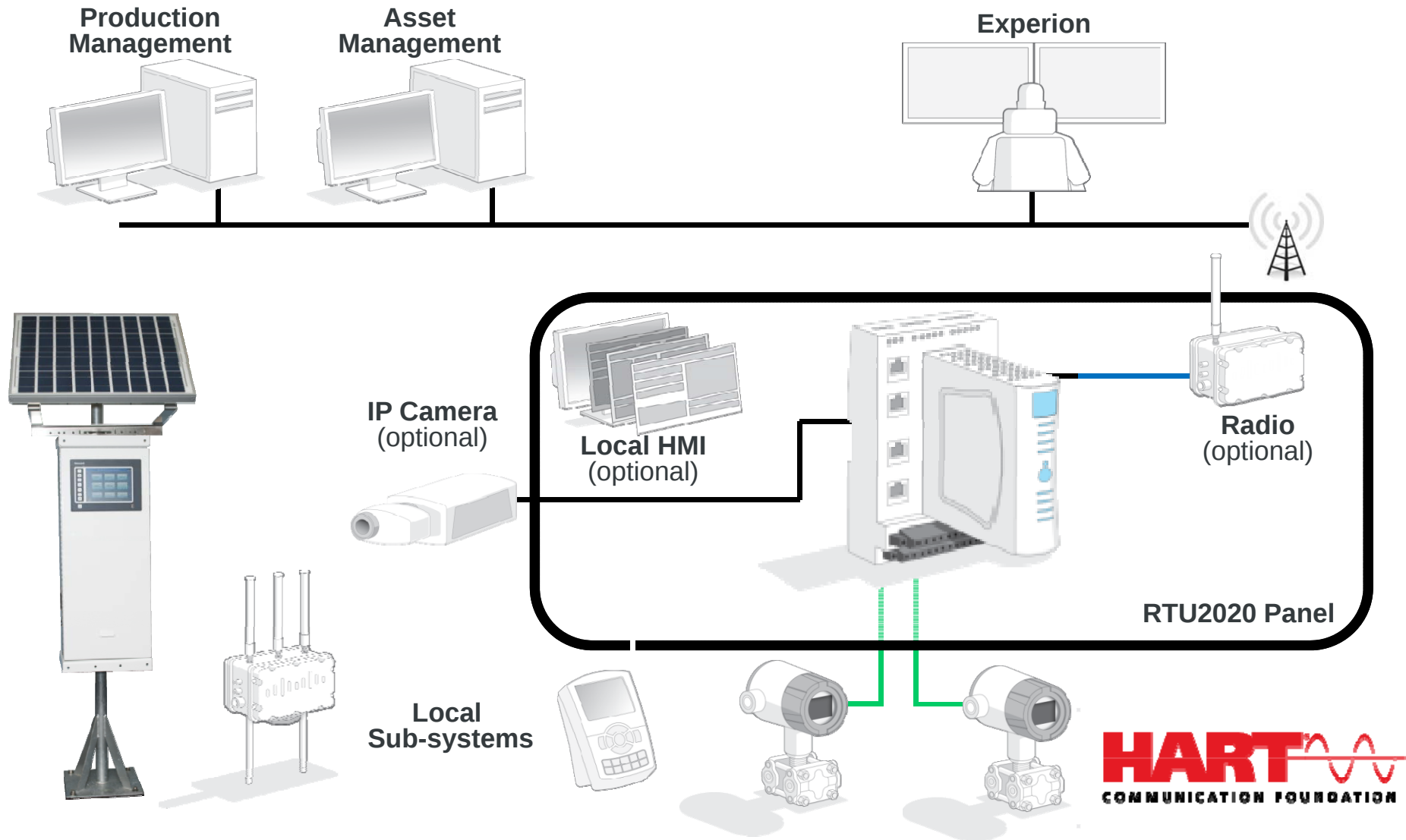
Pipelines



Distribution



Trend Toward A System Solution



Lowering Power Consumption



Includes



How does this help?

- ENERGY HARVESTING
 - Smaller Batteries = \$\$
 - Smaller Solar Panels (RTU2020)
 - Less infrastructure = \$\$

Lower Power = Great Energy Harvesting Application

Honeywell Proprietary



SMART Metering - EU

According to Jan Panek, head of unit for the internal market at the Commission's energy department, so far €6 billion has been invested in 300 smart meter projects across Europe. "But we need more investment: €50 billion for 250 million smart meters by 2020, and €480 billion to upgrade the rest of the grid system by 2030", he told an audience at EU Sustainable Energy Week in Brussels (June, 2013)

- This represents only 80% of meters in Europe!





SMART Metering - Global

Report from Telefonica, January 2014: “Asia and Europe will be major drivers of market growth, the report stated, predicting that more than 800 million smart meter devices will be installed worldwide by 2020.” [435 Million in China, 132 Million in the USA]

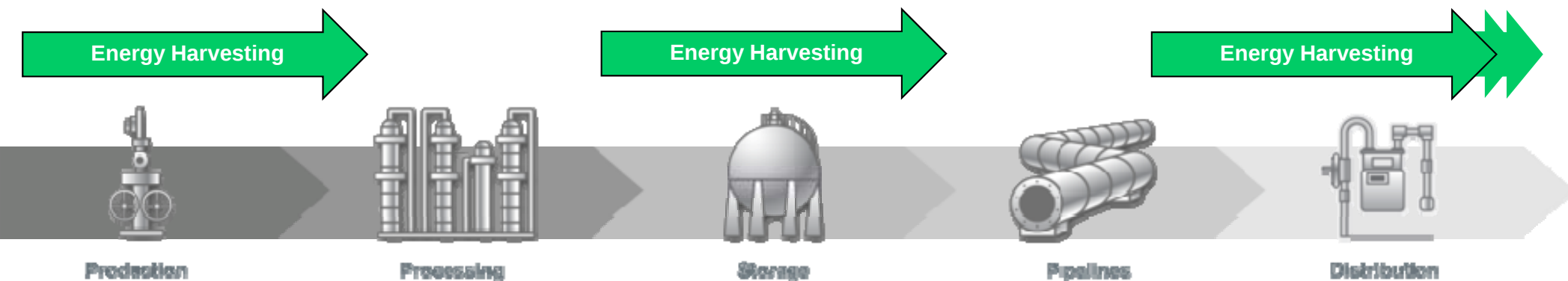
- Plus infrastructure
- May only be 70% of the market





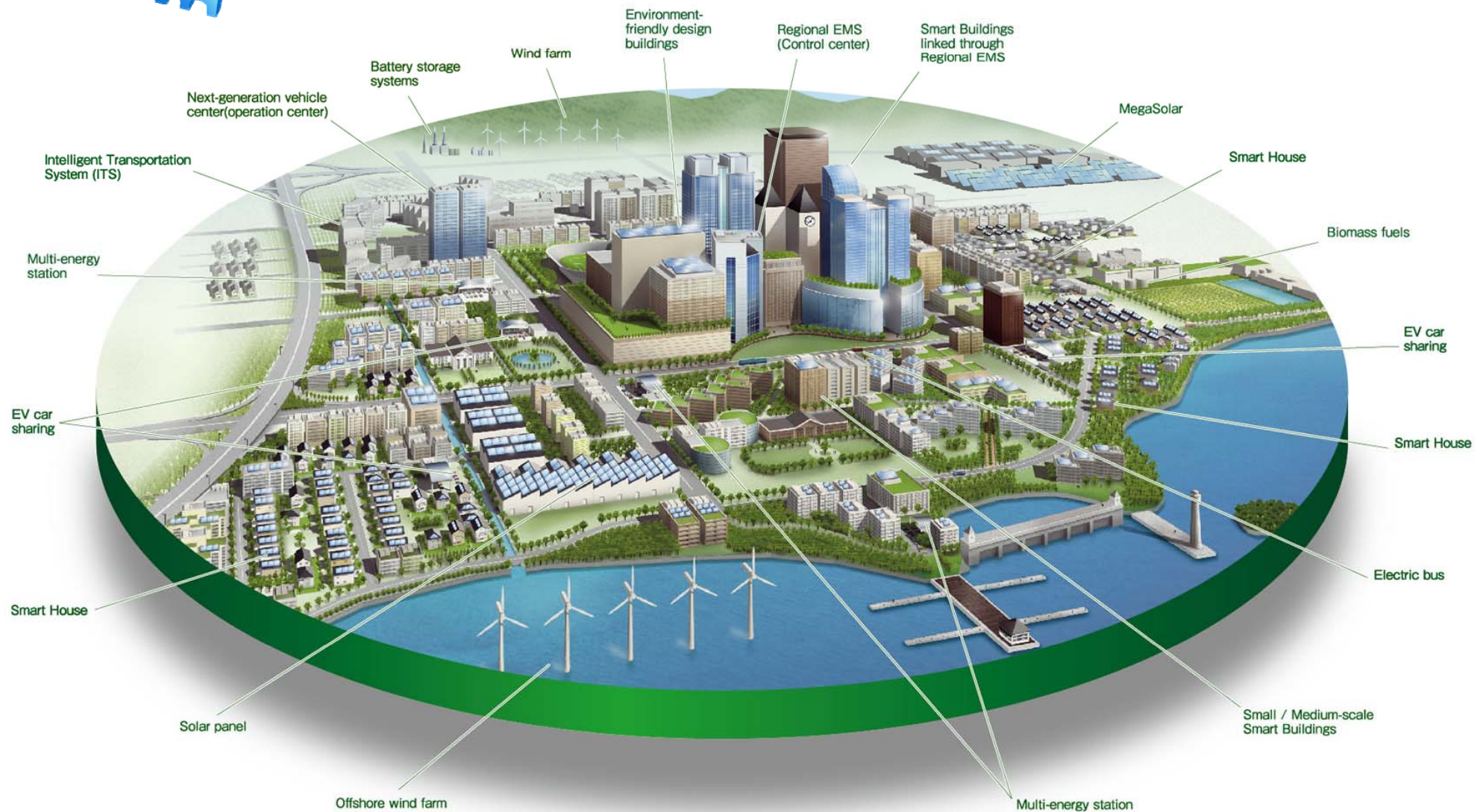
Energy Harvesting in SMART

- There is an opportunity for **Energy Harvesting** in the **SMART** metering space that is mandated in **Europe** and growing on a **global basis** - employing low energy designs and, in some cases, replacing traditional mechanical meters with electronic meters creating a requirement for electrical power where non previously existed
- The small sample data presented here today is evidence of the scale of the opportunity - consider the future **SMART CITY** where Oil & Gas remains to be a key resource





Energy Harvesting - The Smart City



Ref: Holyrood Magazine (Connect),
January 8th, 2014 by Will Peakin

Energy Harvesting Summary

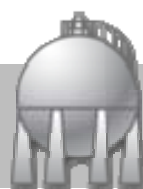
- **Typical transmitters were the target for energy harvesting**
 - Pressure
 - Temperature
 - Position sensors, Vibration sensors, etc.
- **The trend appeared for other wireless devices**
 - The OneWireless™ initiative supported by a growing product range
- **Now we foresee systems solutions** that are employing lower energy designs enabling energy harvesting technologies to be realised in more applications
- There is no **“one energy harvester”** but a requirement for an **“Intelligent Power Module”** to harvest from a number of sources



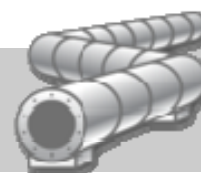
Production



Processing



Storage



Pipelines



Distribution



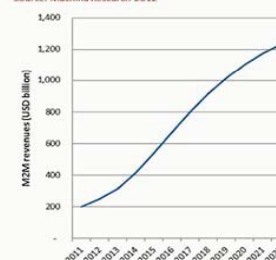
Energy Harvesting Summary

- There is an opportunity for Energy Harvesting in the SMART metering space that is mandated in Europe and growing on a **global basis** - employing low energy designs and, in some cases, replacing traditional mechanical meters with electronic meters creating a requirement for electrical power where non previously existed
- There is a **growing M2M market** in Oil & Gas



By 2022, M2M will be a USD 1.2 trillion opportunity

Total revenue from machine-to-machine, 2011-22
Source: Machina Research 2012



Machina Research

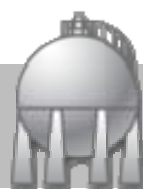
- Total M2M revenue will grow from USD200 billion in 2011 to USD1.2 trillion in 2022, a CAGR of 18%
- Total revenue includes:
 - device costs where connectivity is integral to the device
 - module costs where devices can optionally have connectivity enabled
 - monthly subscription, connectivity and traffic fees



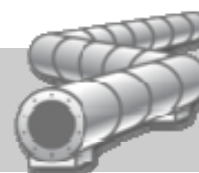
Production



Processing



Storage



Pipelines



Distribution

Energy Harvesting Summary

- Question was: **“Is Energy Harvesting a Realistic Proposition within the Oil & Gas Sector?”**
- The answer is: **“Yes, there is growing evidence that Energy Harvesting is a realistic proposition within the Oil & Gas sector when considering the total supply chain (end to end).”**
- **Wireless shall continue to be realised across the Oil & Gas supply chain** while employing, relatively, a smaller number of **Intelligent Energy Harvesting technologies**



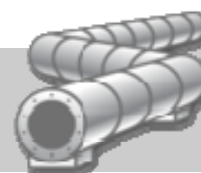
Production



Processing



Storage



Pipelines



Distribution



Energy Harvesting in the Oil & Gas Sector

THANK YOU

Honeywell

