Digital Transformation

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Exelon Generation®

The Perfect Storm

- The merchant fleet faces unprecedented financial challenges driven by shale gas, subsidized renewables and fundamental flaws in the structure of the energy market

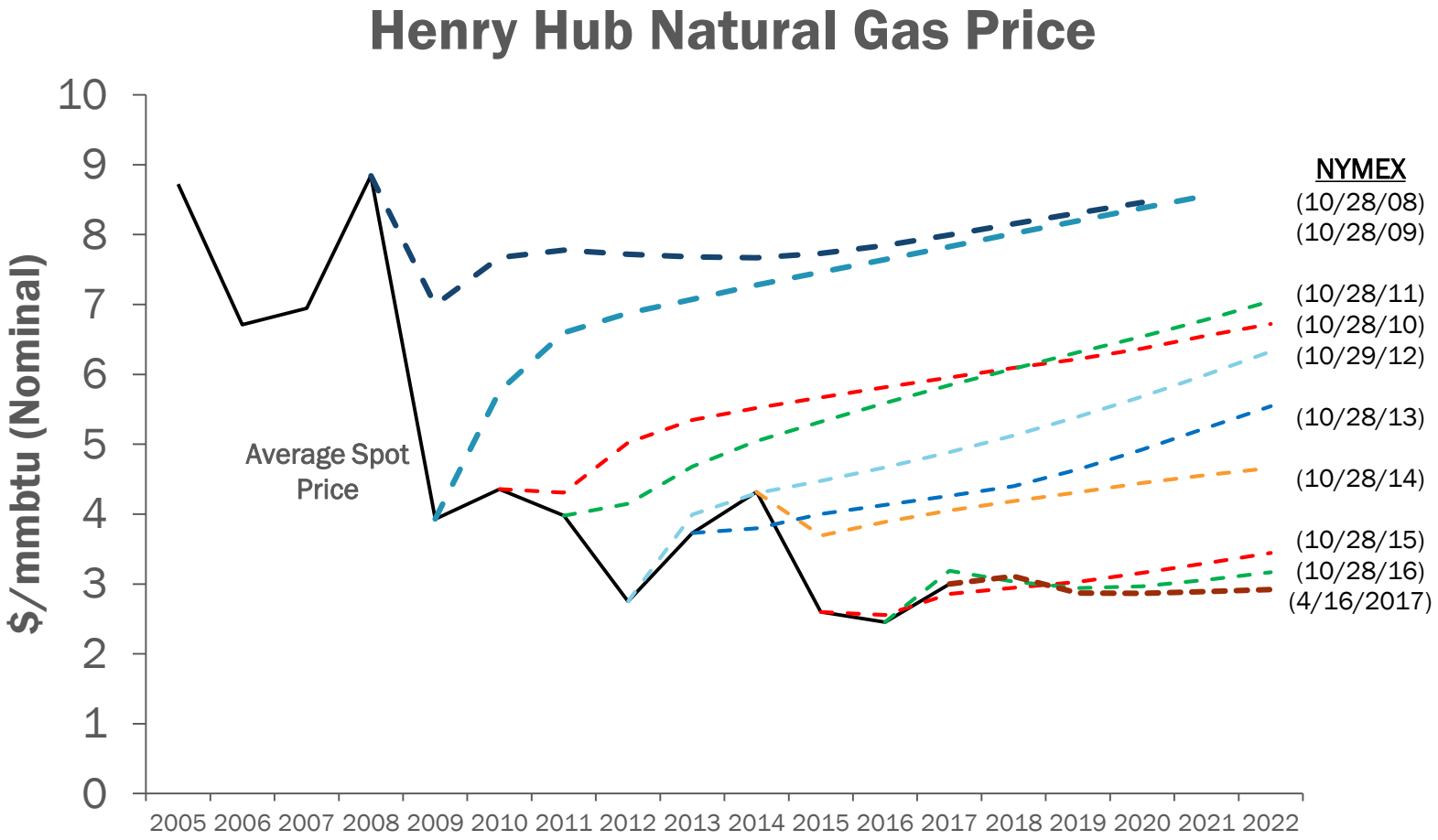
- The industry Capacity Factor averaged 91.7% in 2016. The Exelon 2-year average Capacity Factor was 94.3% - economic challenges cannot be overcome through performance improvement alone (nor can we tolerate performance decline)

- Regulatory barriers to modernization of Safety-Related systems are falling away rapidly creating opportunities to capitalize on advanced technologies and make our facilities safer and more efficient

The application of advanced technologies and harvesting the resulting efficiencies is the only viable path to long-term sustainability – innovate or evaporate

Natural Gas Price Forecasts

Spot gas prices have fallen precipitously since 2008 and price forecasts have followed this downward trend



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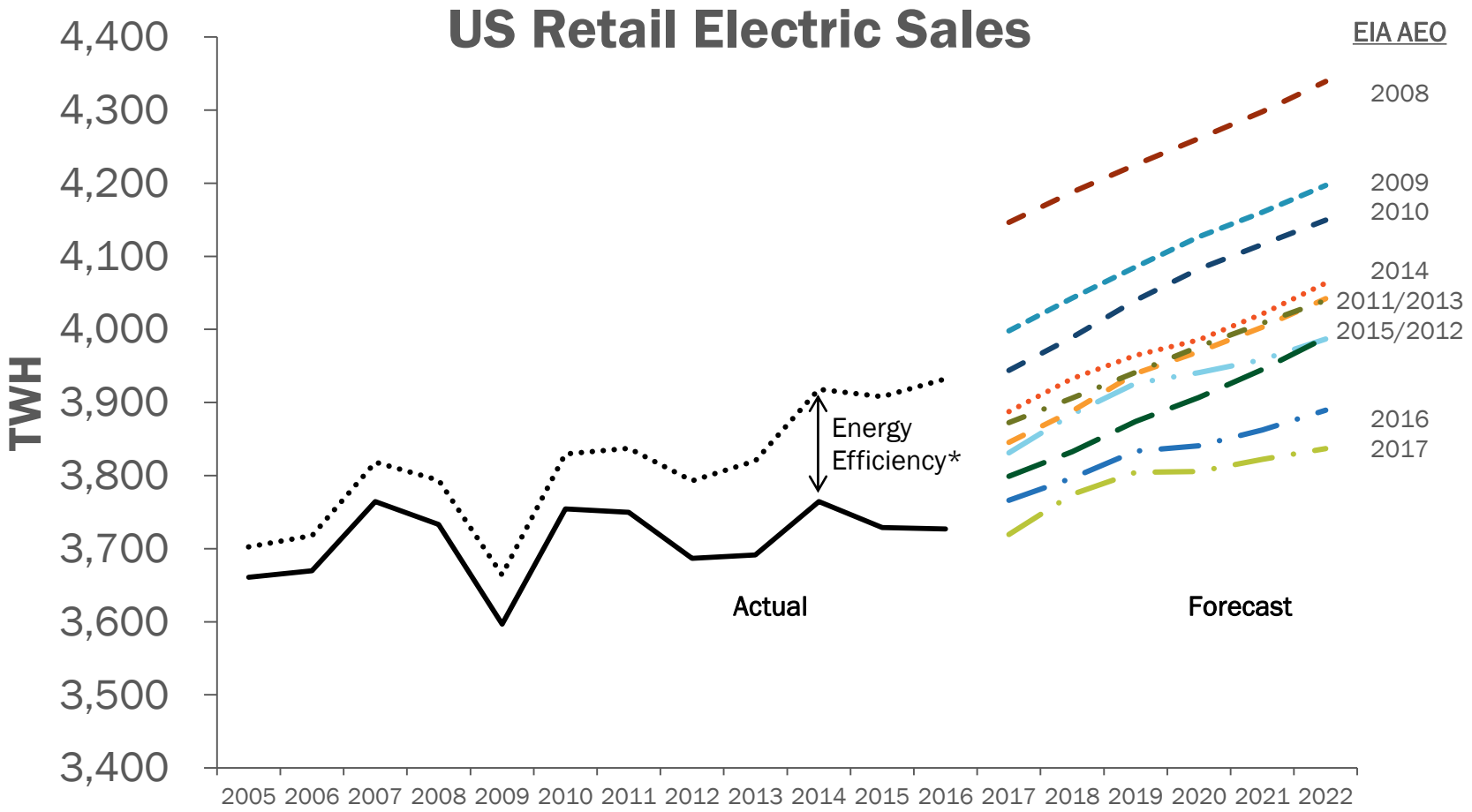
Load Growth Forecasts

Electric load growth has slowed due to a combination of a changing economy and energy efficiency programs. EIA load forecasts have been steadily adjusted downward



* Cumulative EE is derived from ACEEE State Energy Efficiency Scorecards for 2006-2012: Incremental annual MWH assuming a 10-year measure life.

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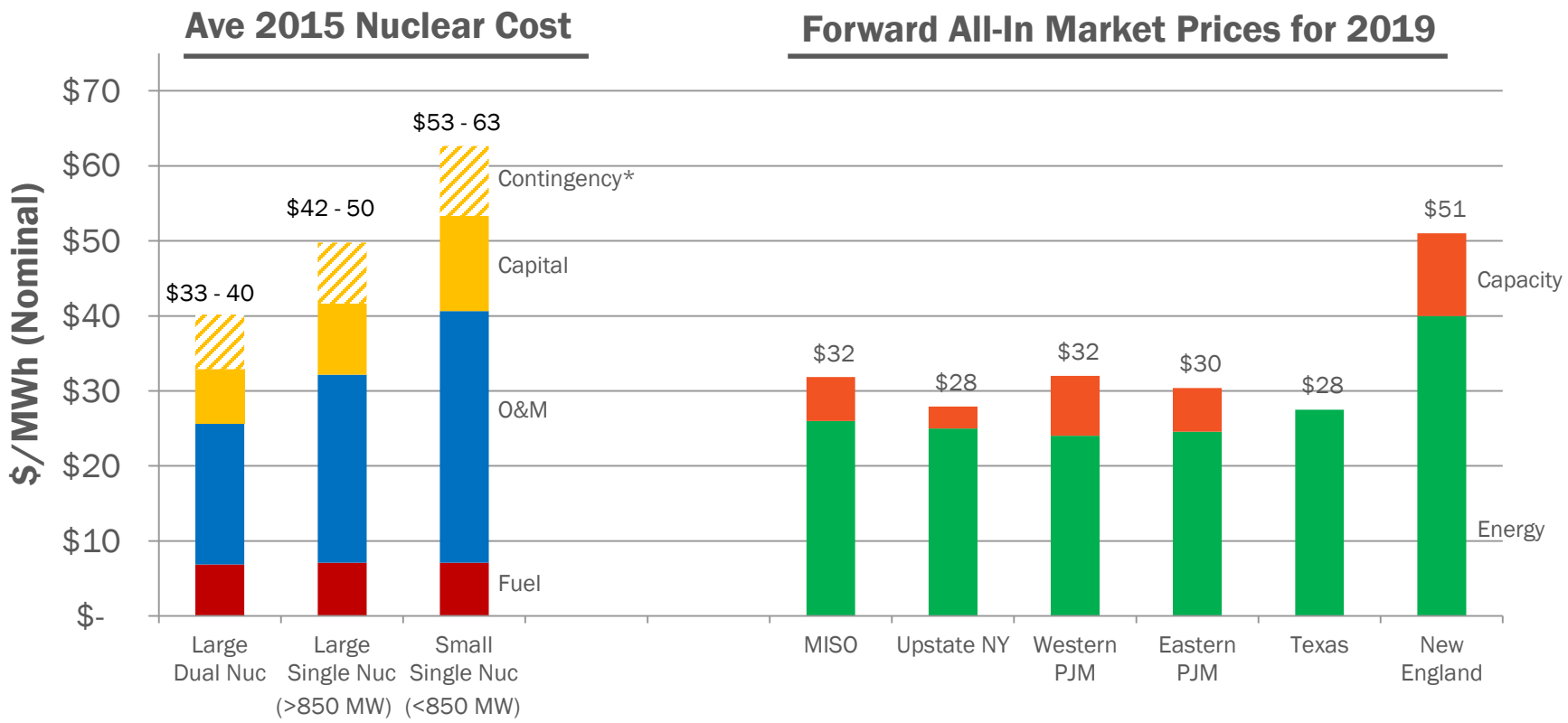
Merchant plants in all regions face a shortfall of market revenues relative to costs



**Contingency (or risk) is calculated as 10% of total costs plus $4/mwh*

Source: Nuclear Energy Institute, "Nuclear Costs in Context," April 2016. p. 2., assumes roughly 50% of capital and O&M for single units varies with size
Market price estimates as of 1/17/2017, adjusted for 2016 zonal basis

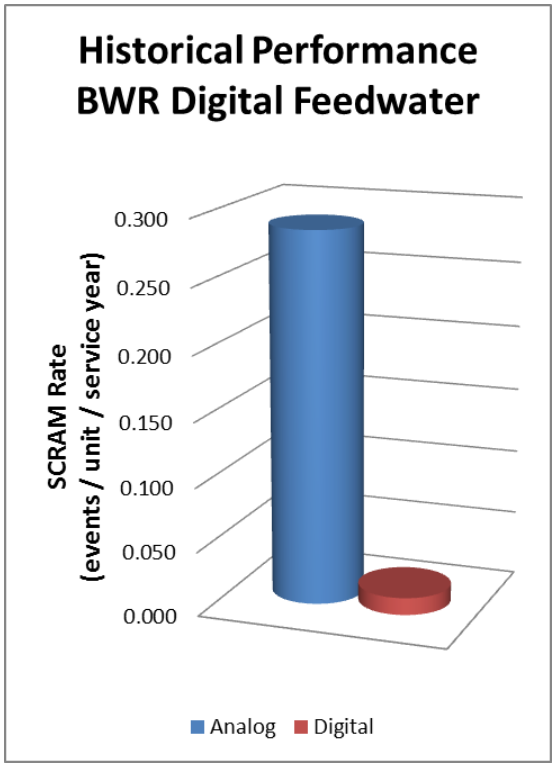
The Exelon Perspective

- We continue to invest heavily in advanced technologies for Non-Safety Related (NSR) systems / structures / components:
  - Digital Turbine Controls
  - Digital Feedwater Systems
  - Reactor Recirculation Adjustable Speed Drives
  - NSSS Control Systems
  - Digital Rod Control
  - Main Generator Voltage Regulation
  - Open Phase Detection
  - Plant Process Computers
  - Cyber Security
  - Wireless Technology
  - Discrete Digital Components (relays, transmitters, stand-alone controllers, positioners…)

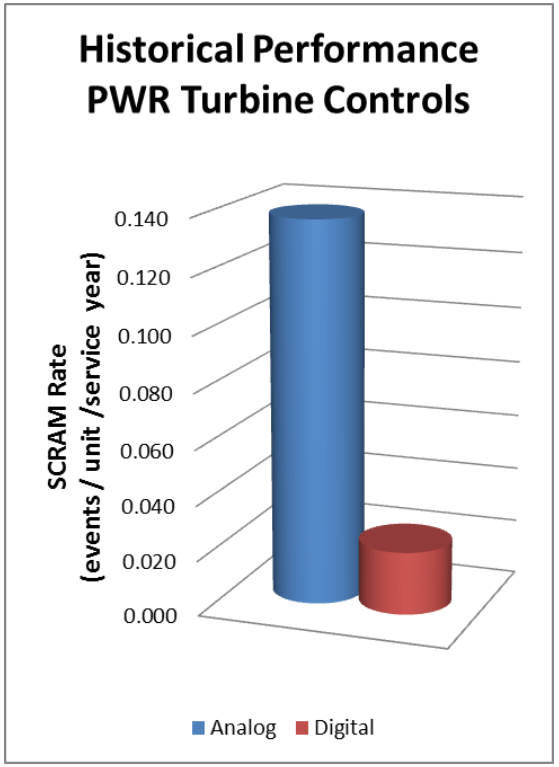
The cost of these upgrades is measured in hundreds of millions of dollars but this investment has produced exceptional performance improvements

Why Digital? – Performance

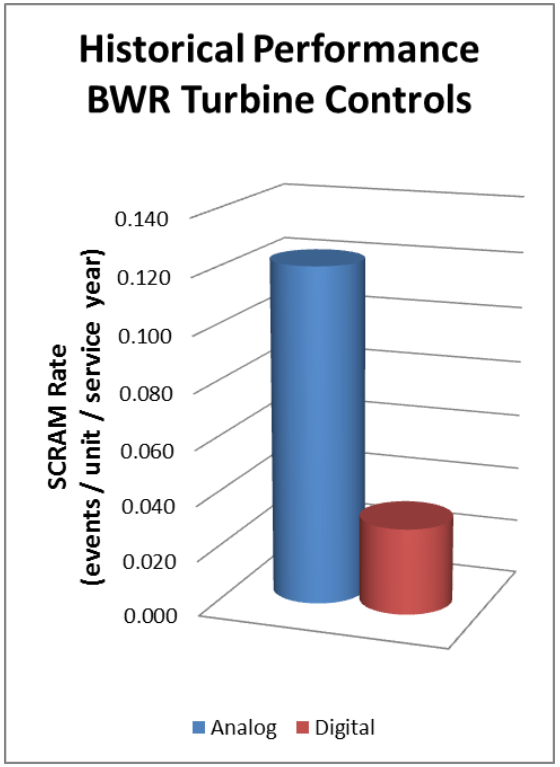
- Exelon began installing digital upgrades in the early 90's beginning with the feedwater systems at Dresden, LaSalle, Quad Cities and Limerick
- Turbine controls were upgraded beginning in 2004 at Byron, Braidwood, Dresden, LaSalle, Quad Cities and Limerick and continue across the balance of the fleet
- 500+"unit years" of operating experience conclusively demonstrates a significant reduction in initiating events



95% SCRAM rate reduction



83% SCRAM rate reduction



74% SCRAM rate reduction

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Regulatory Issues – A brief history

- With substantial industry input, the NRC commissioners acknowledged the urgency of elimination of regulatory barriers for modernization of Safety Related SSC's

- SECY 15-0105, I&C Branch was directed to develop an Integrated Digital Action Plan (IDAP) to resolve long-standing regulatory issues and identify any policy issues that warrant additional consideration

- The IDAP is comprised of 4 discrete Modernization Plans (MP1 through MP4)
  - MP1 – Mitigation of Common Cause Failure
  - MP2 – Application of 50.59 to SR digital systems
  - MP3 – Digital Item Equivalency
  - MP4a – Interim streamlined licensing process (for upgrades outside of 50.59)
  - MP4b – Regulatory infrastructure improvements (longer term)

Regulatory Issues – Where are we today?

- The majority of systems that we want to modernize are comparatively simple and of very low risk significance - the industry position remains that modernization should be allowed without prior NRC approval
  - Industry and NRC worked collaboratively to identify acceptable methods to mitigate risks of software induced common cause failure
  - NRC codified the resulting consensus in RIS 2002-22, Supplement 1 (approved 5/31/2018)
  - Enables the application of mature concepts of 10 CFR 50.59 to SR digital upgrades (with specific constraints)

- Modernizing systems that require a License Amendment
  - RPS and ESFAS are specifically excluded from RIS 2002-22
  - Governing licensing process is ISG-6 – burdensome and significant financial risk
  - Industry task force was assembled to work with the staff to develop a streamlined licensing process within the ISG-6 framework (Alternate Tier 1)
  - For platforms with an NRC approved Topical Report, LAR content and scope is scaled down significantly
  - Fully coordinated with industry standardized engineering process (DNP ENG-008)
  - Currently undergoing NRC internal review
  - Streamlined licensing process is expected to be endorsed by NRC by 12/2018

The regulatory barriers are falling away – this is a fundamental enabler for the application of advanced technology

Going Forward – Standardization Of Digital Engineering

The processes used to implement digital modifications vary widely across the industry

As digital technology becomes more pervasive, several issues are self-evident:

- Mixed performance in implementation - some utilities have strong processes, some do not
- Design processes need to be scalable and risk-informed – one size does not fit all
- Design content and methods are not consistent across utilities therefore the ability to share information is commensurately limited
- EOC's / OEM's must operate to multiple playbooks – not efficient and does not naturally result in continuous improvement
- Each licensee must create and maintain its own training and qualification process
- The skills inventory for designing, implementing and managing advanced technologies are *very* different when compared to legacy systems
- The regulator does not have a clear line-of-site on the processes the industry uses to design and implement digital modifications

The industry and EPRI have worked collaboratively to integrate the EPRI Digital Engineering Guide into the Standardized Design Process under DNP ENG-008

Going Forward – A Wholistic Approach

- There are a variety of advanced technology initiatives being pursued by different stakeholders that are not coordinated but should be:
  - Licensee Modernization Strategies
  - Staffing Optimization Strategies
  - Analytics / Predictive Maintenance
  - Application Of Wireless Technology
  - Process Standardization / Optimization
  - Advanced Sensor Technology
  - Common Information Models
  - Regulatory Transformation
- An industry consortium was assembled through EPRI in 2017 to bring all of these elements together into a single cohesive effort under DE-FOA-0001817
  - The intent was to apply DOE funding to enable rapid execution
  - DOE did not approve the FOA

While the DOE did not approve funding for this initiative, developing the FOA package reinforced the need for a fully coordinated modernization strategy

A Holistic Approach

EPRI ELECTRIC POWER RESEARCH INSTITUTE

The Modernization of Nuclear Plants

VISION

Achieve economic viability of nuclear power through RADICAL and TIMELY transformative innovation & modernization, including:

- Business Process Transformation
- Monitoring
- Analytics
- Automation
- Integration

GOALS

Achieve local market economic competitiveness through cost reductions

COMMON ENABLERS

CIM Common Information Model
Common Information Model to describe data exchange between various tools and applications

Agile Business Processes
- A technical and regulatory framework that supports adoption of new digital technologies and control systems
- Business and engineering processes that encourage and promote rapid adoption of new technology in safe and reliable manner

Connectivity
Connectivity for sensors and devices to gather and transport data (e.g. Distributed Antenna Systems for wireless) and to support location tracking within the plant

Common Integrated Tools/Applications
- Data analytics tools that automatically and reliably identify scenarios that require action or provide opportunities for more efficient operations
- Common integrated tools and applications (e.g. the proposed PowerSuite integrated package)
- Centralized data aggregation & leveraging of learnings across the industry

Digital Upgrade
Full-scale, plant-wide digital modernization strategy. Modernization options will be broken down with enough detail to determine systems and components that warrant being included in a long-term modernization plan

Inform Regulatory Change
Investigate the applicability of current regulatory structure that affect the use of advanced digital technology

FUNCTIONAL AREAS

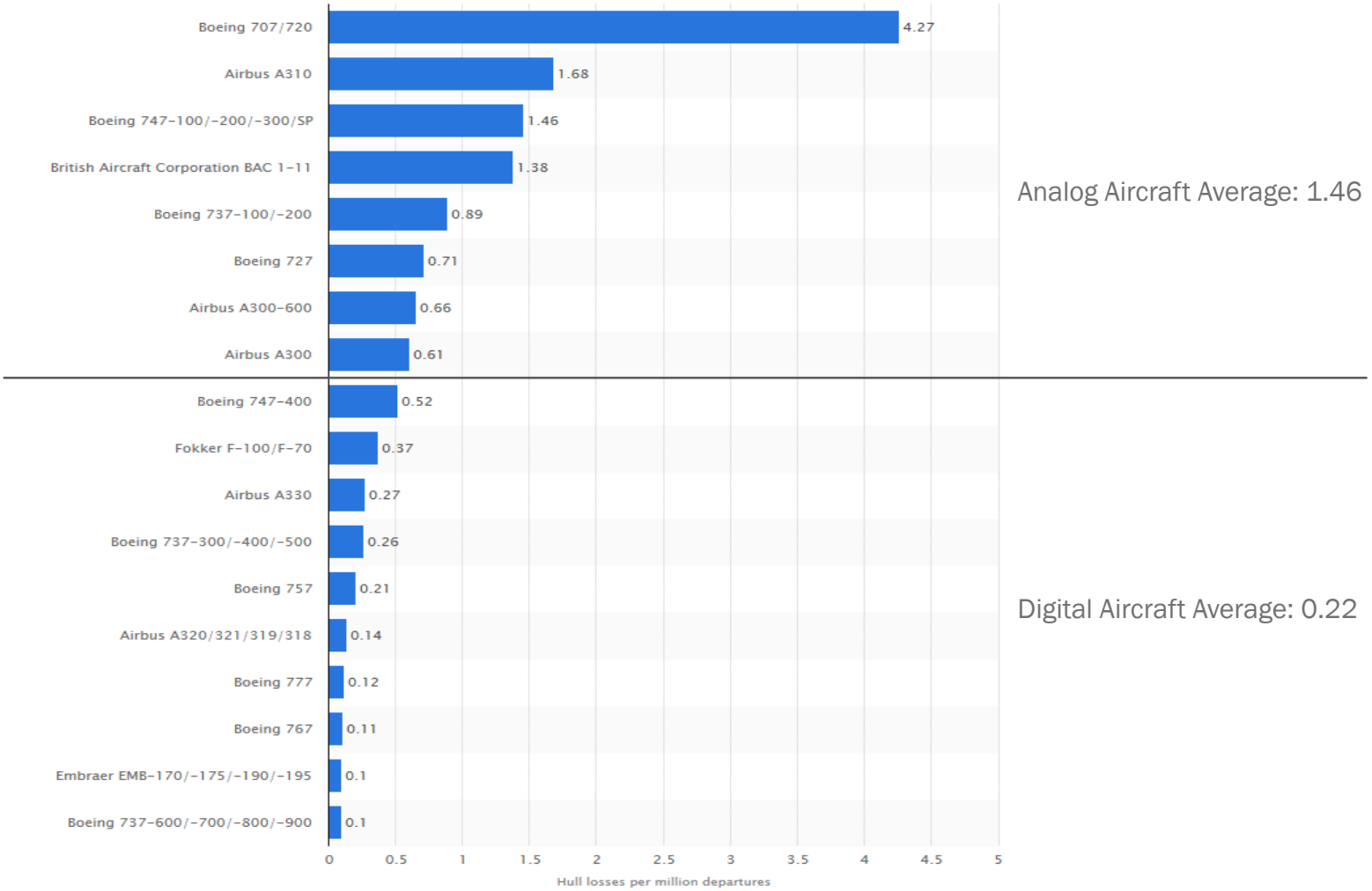
- Operations
- Emergency Preparedness
- Maintenance
- Outage Management
- Engineering
- Warehouse & Supply Chain
- Chemistry
- Training
- Radiation Protection
- Security
- Work Management

Yesterday

Exelon.

Today

A case study in modernization



While <u>not</u> the only contributor to improved safety performance, “digital” aircraft hull losses average 15% that of analog aircraft

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