The Modern Energy Workplace: Intersection of Technology and People

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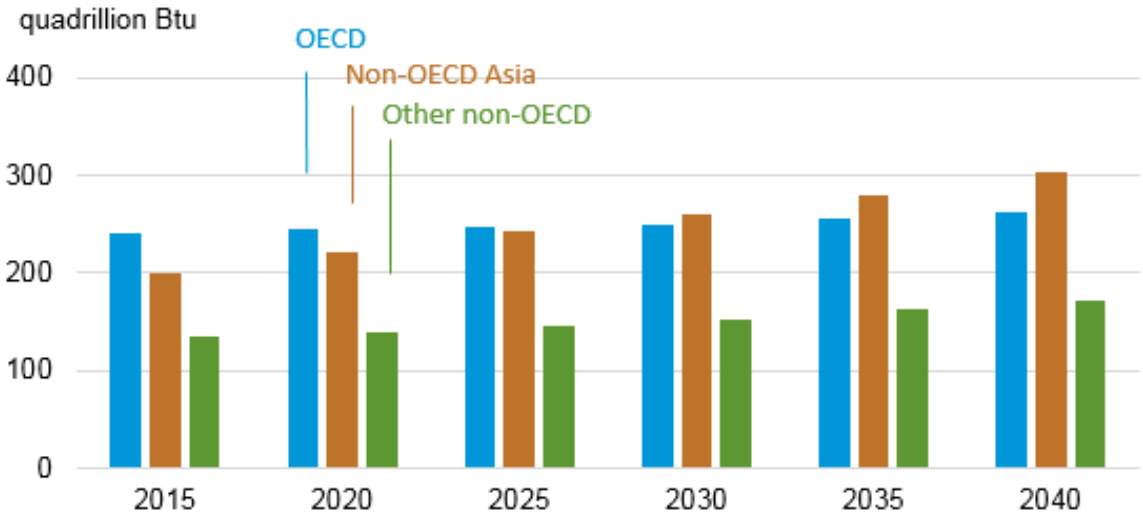
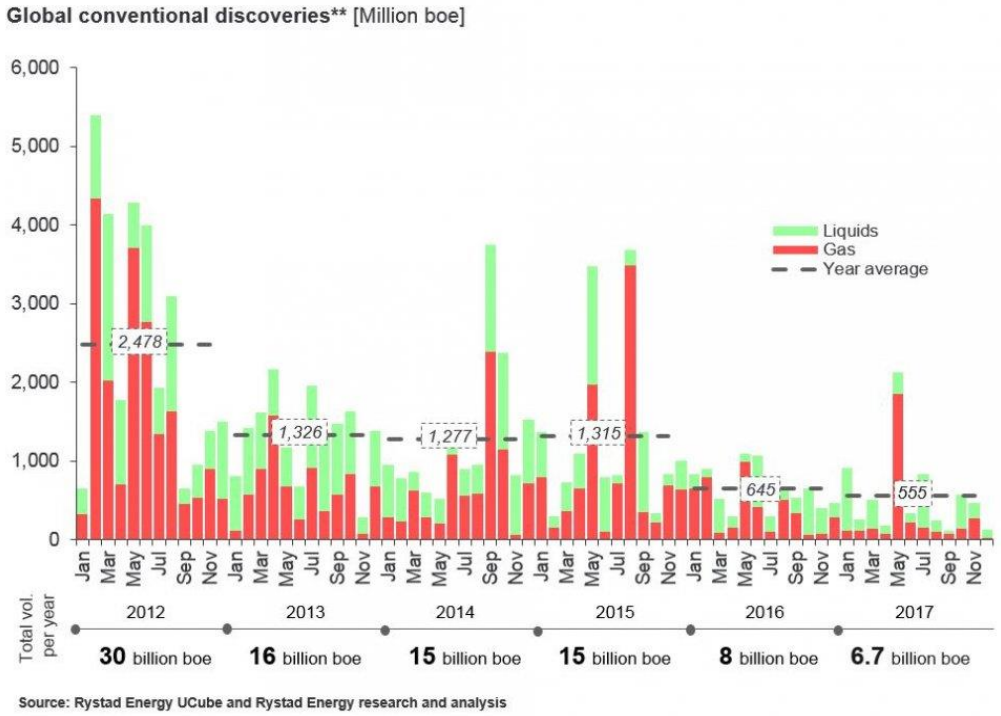
Energy

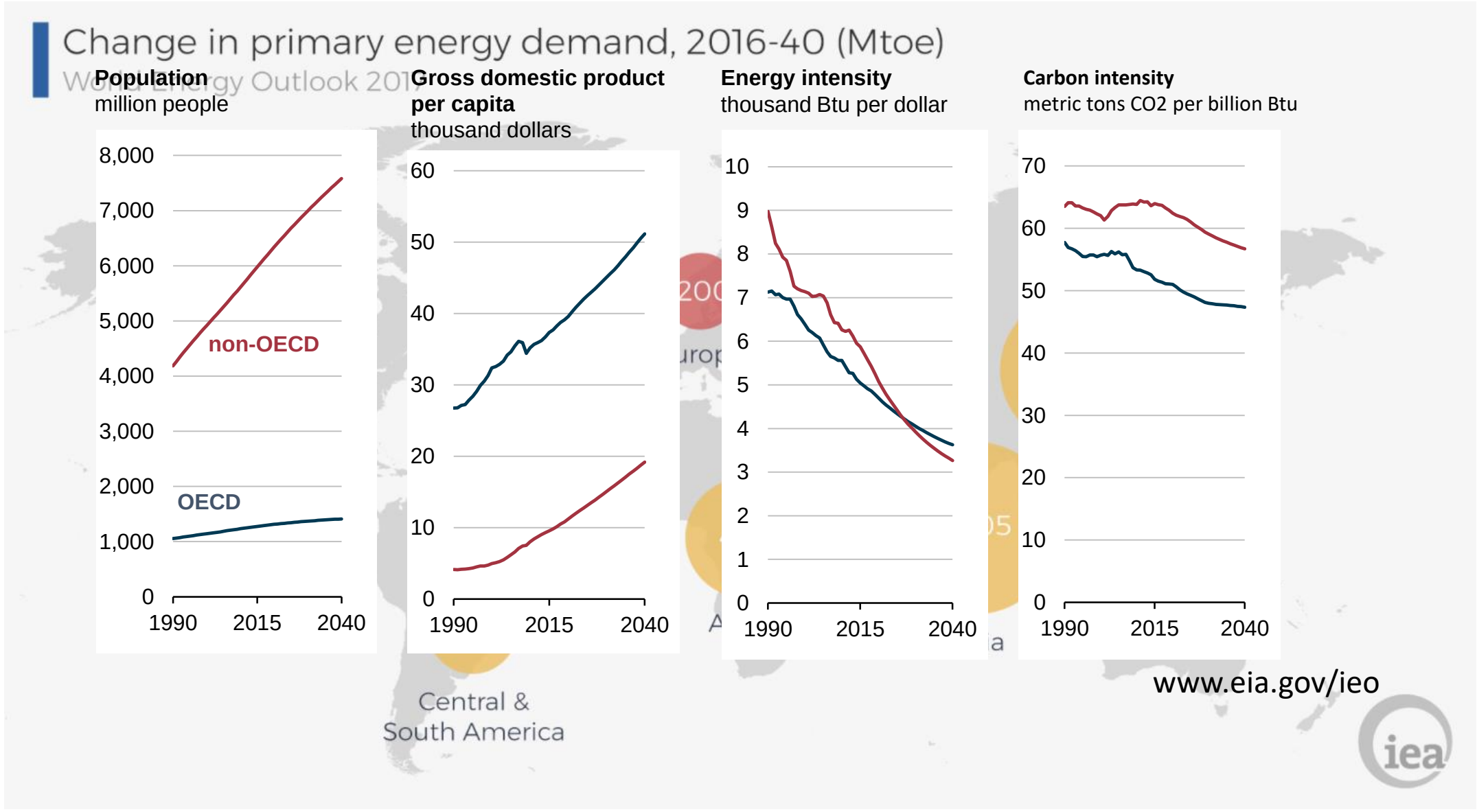
- Global energy demand is surging:
  - IEA in 2017 estimated energy consumption globally will increase from 575 Quad BTU in 2015 to 736 Quad BTU in 2040: 28 % Increase
- Energy Production & Distribution:
  - Cost Challenges and Harsh/Remote Locations.
  - New Discoveries are down!
- Key Challenge: Cost, Safety and Reliability, Social License to Operate
- Globalization: Disruptive Technologies

Figure 1. World energy consumption by country grouping

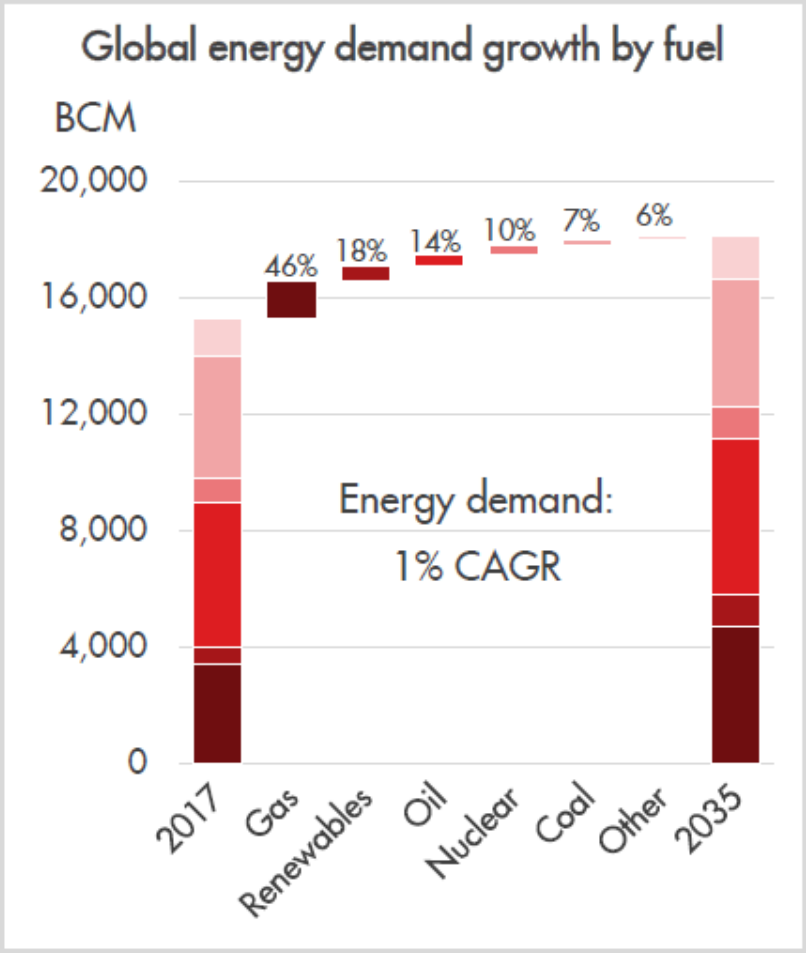


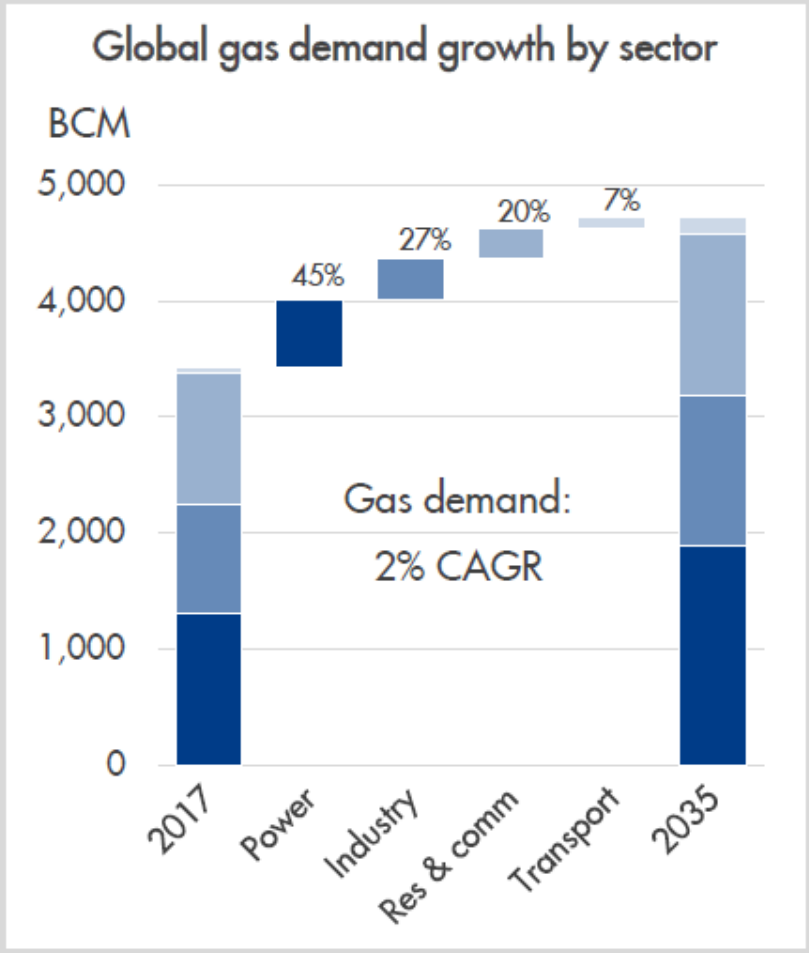


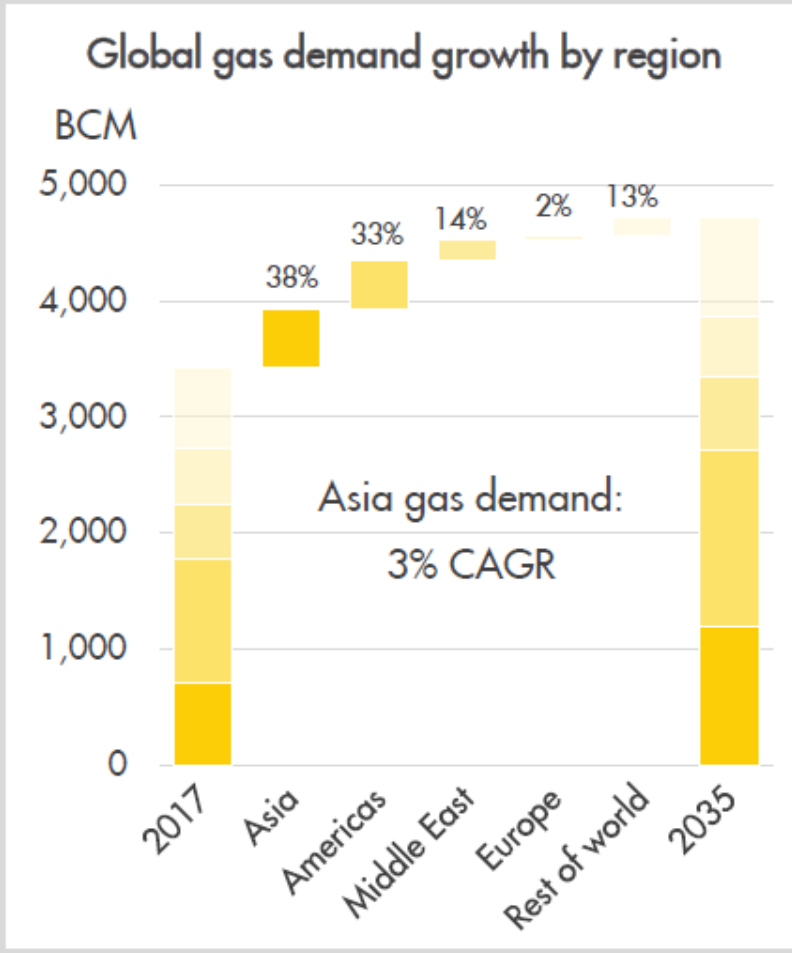
Global Energy Trends



Technology Drives Global Trends



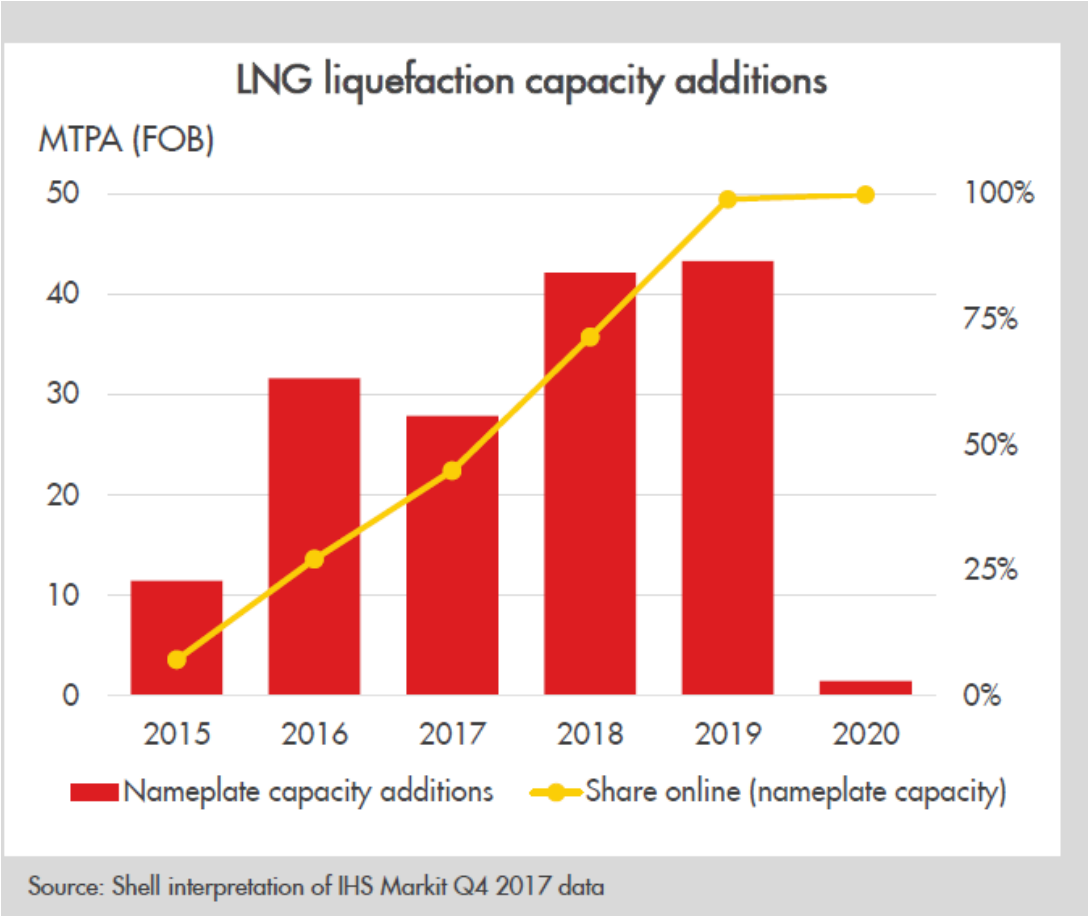




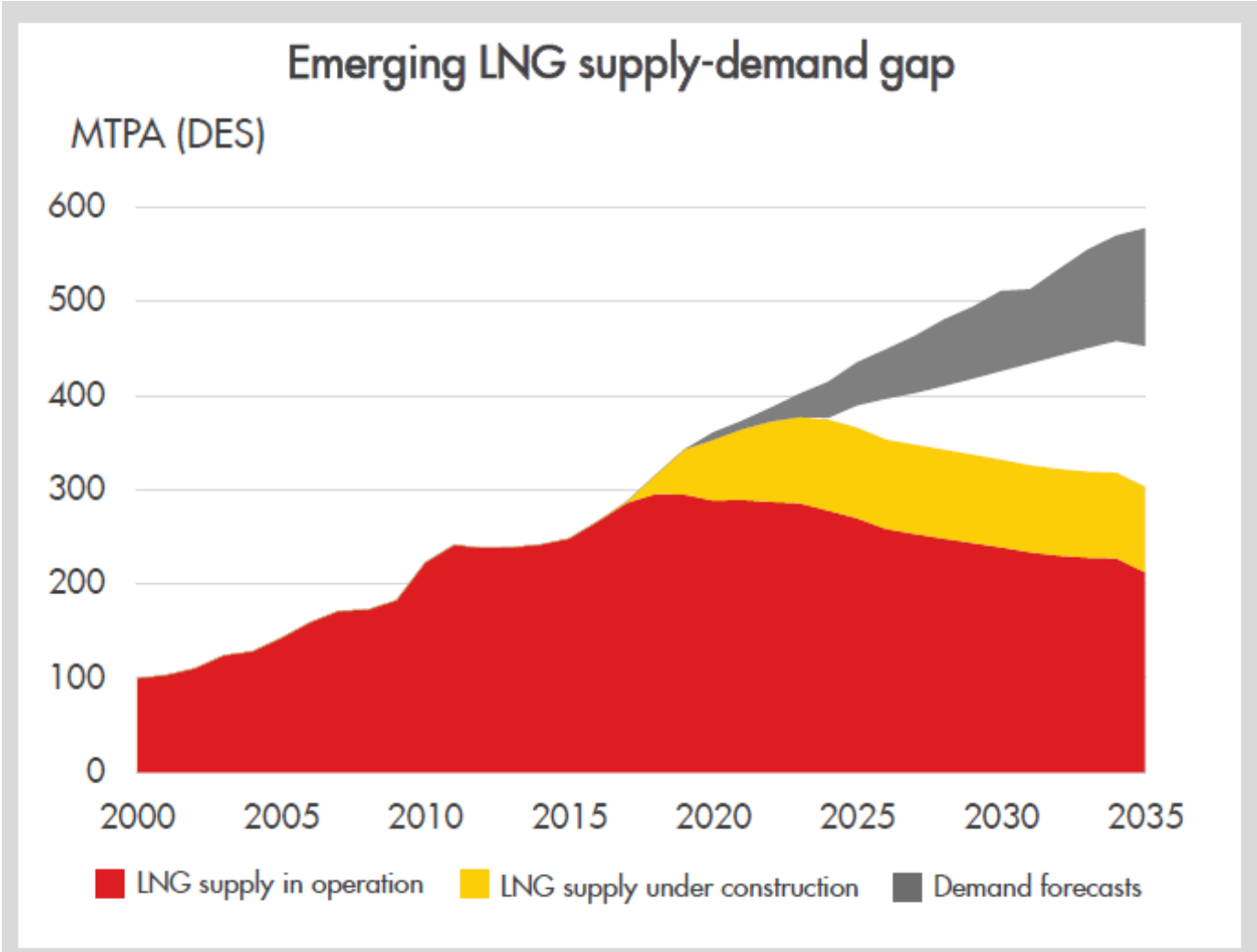
Source: Shell interpretation of Wood Mackenzie Q4 2017 data

CAGR - Compound Annual Growth Rate

LNG: Making Gas Global

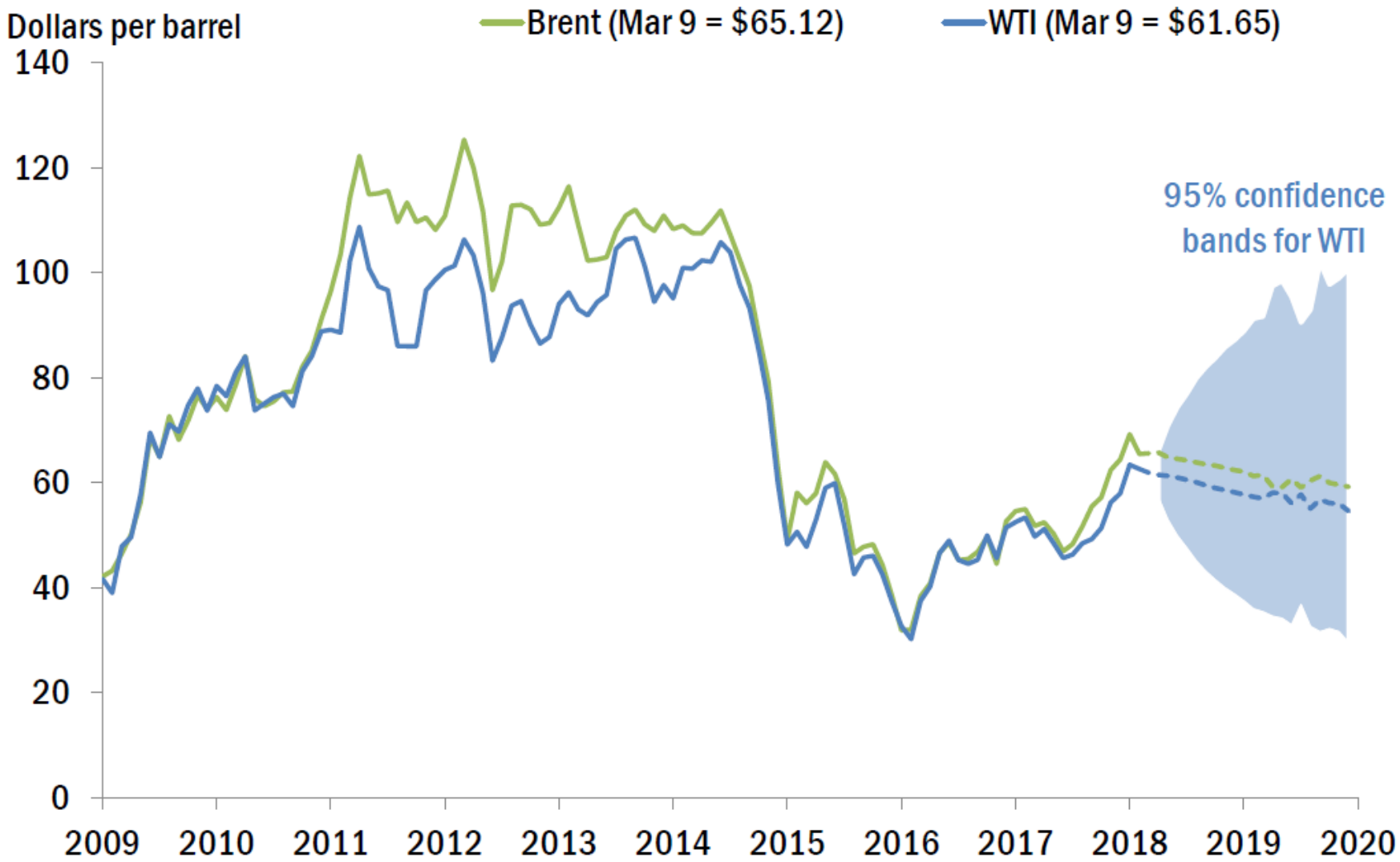


Source: Shell interpretation of IHS Markit Q4 2017 data



Source: Shell interpretation of IHS Markit, Wood Mackenzie, FGE, BNEF and Poten & Partners Q4 2017

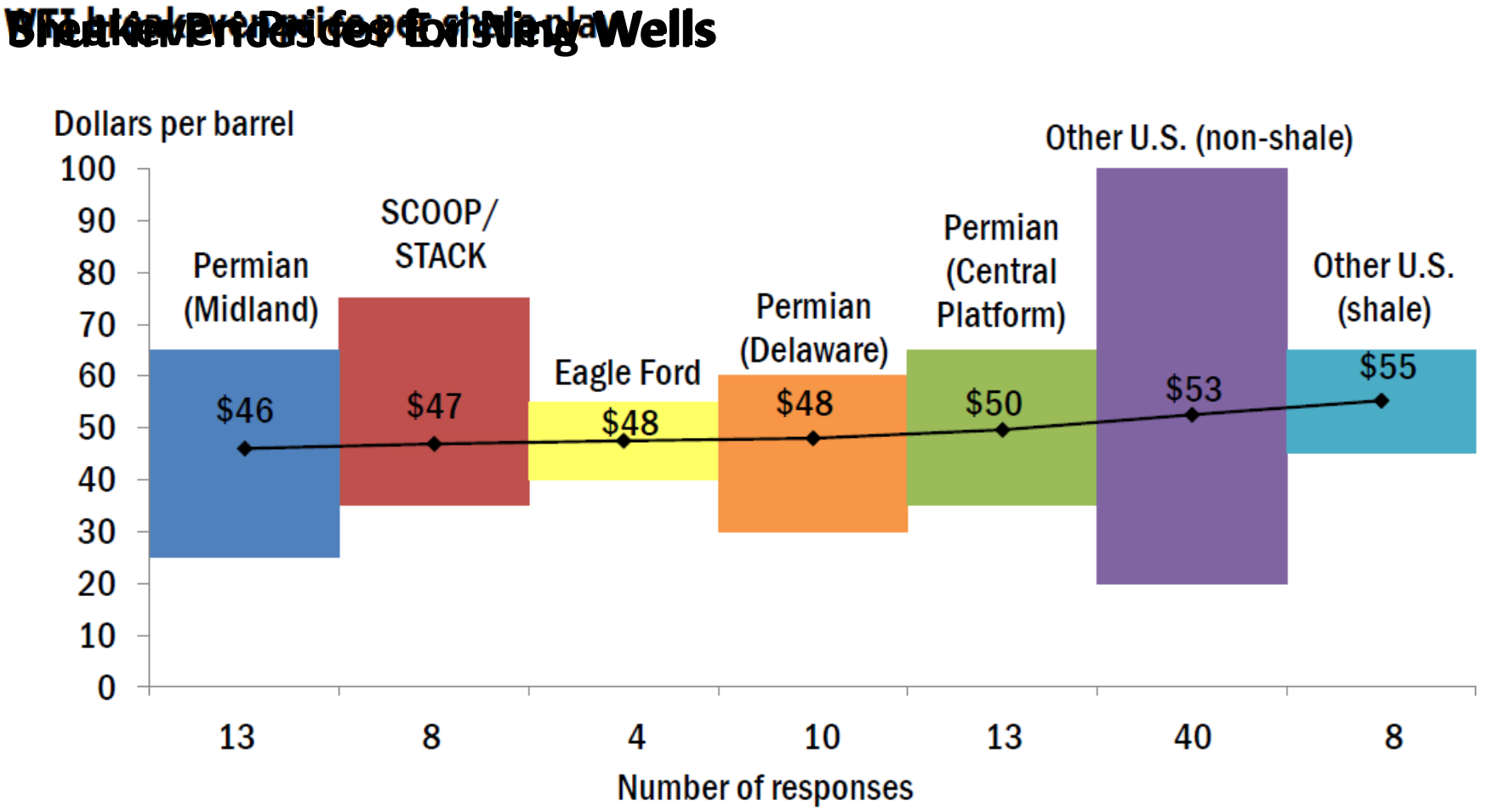
Oil: "Lower for Longer"



Federal Reserve Bank of Dallas

NOTES: Latest prices are averages for the week ending 3/9/18.
Dashed lines are forward curves. WTI is West Texas Intermediate.
SOURCES: Bloomberg; Energy Information Administration.

Reduction in Cost

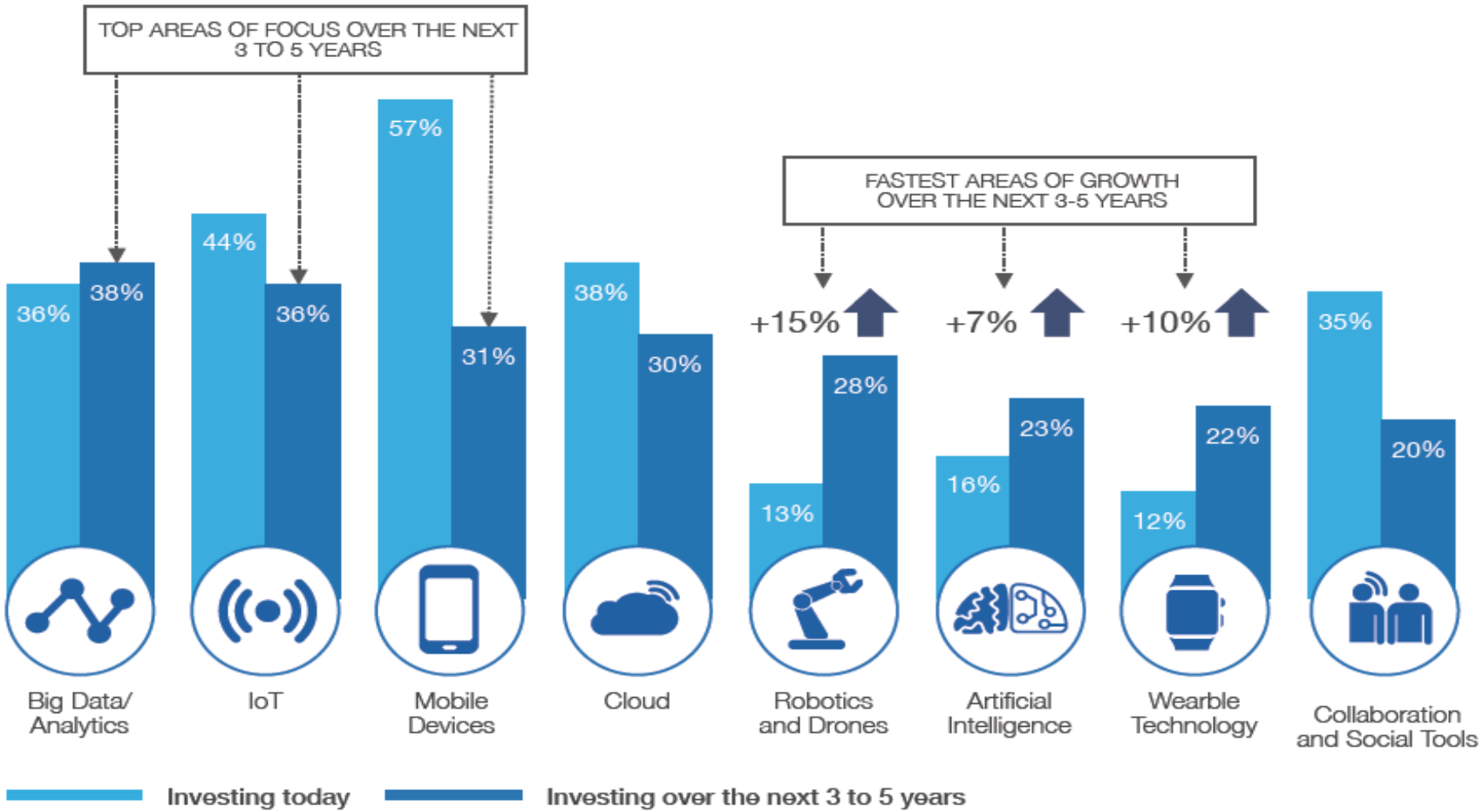


Federal Reserve Bank of Dallas

NOTES: Line shows the mean, and bars show the range of responses.
62 E&P firms answered this question from March 15-23, 2017.
SOURCE: Federal Reserve Bank of Dallas.

Technology Driving Cost Down

Figure 3: Investments in Digital Technologies*



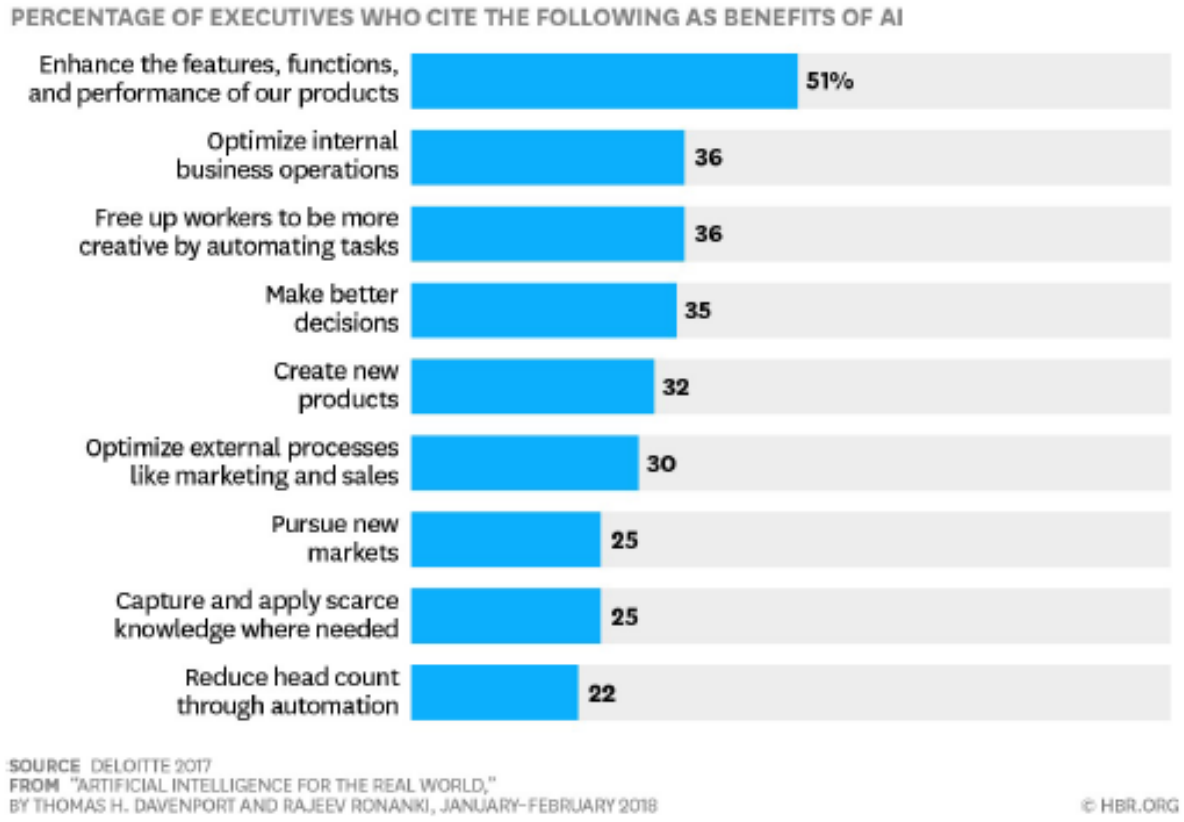
* The percentages in the bars are the proportion of Oil and Gas companies surveyed.
Source: Accenture, The 2016 Upstream Oil and Gas Digital Trends Survey

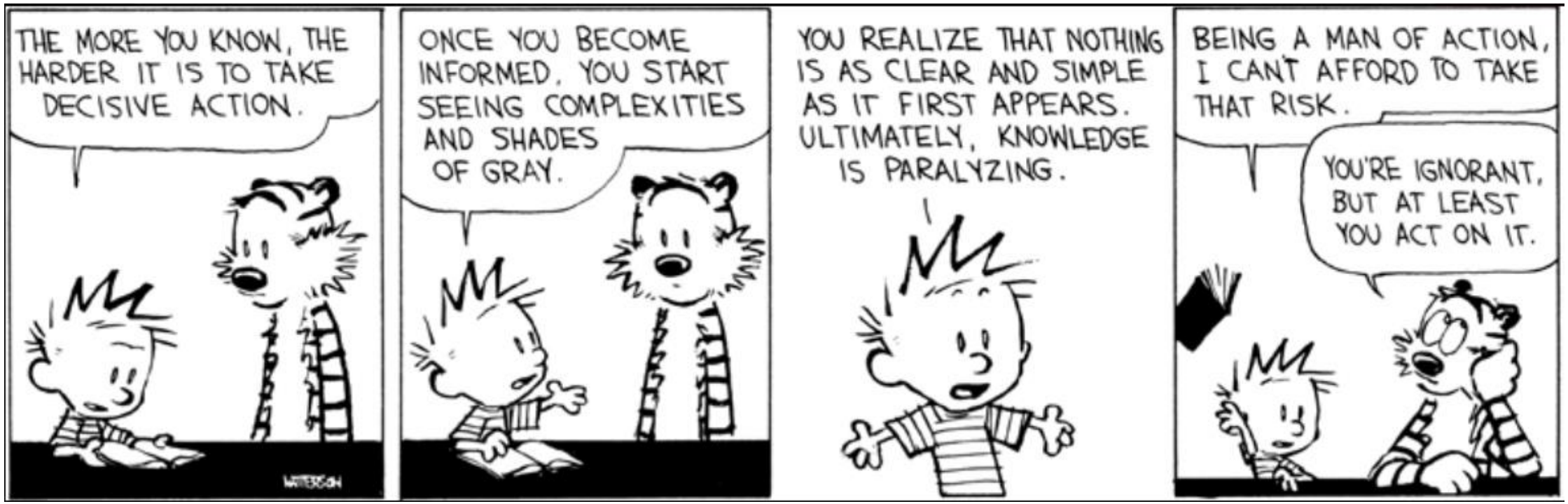
Big Data & Data Analytics

Artificial Intelligence & Robotics

- Artificial Intelligence (Business Focus):
  - Automating Business Processes
  - Insight from Data Analytics
  - Engaging Customers and Employees

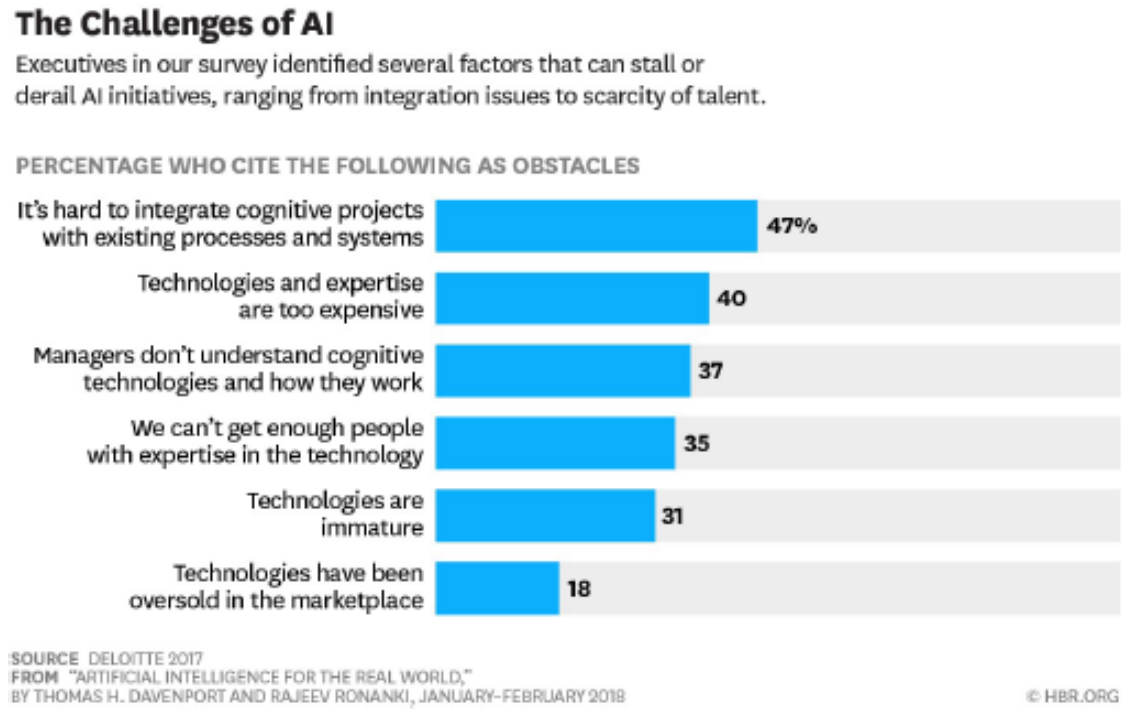
- Key Enablers:
  - Robotics and Process Automation
  - Cognitive Insight: Machine Learning, Deep Learning…
  - Cognitive Engagement: Virtual Reality, Augmented Reality




THE MORE YOU KNOW, THE HARDER IT IS TO TAKE DECISIVE ACTION.
ONCE YOU BECOME INFORMED, YOU START SEEING COMPLEXITIES AND SHADES OF GRAY.
YOU REALIZE THAT NOTHING IS AS CLEAR AND SIMPLE AS IT FIRST APPEARS. ULTIMATELY, KNOWLEDGE IS PARALYZING.
BEING A MAN OF ACTION, I CAN'T AFFORD TO TAKE THAT RISK.
YOU'RE IGNORANT, BUT AT LEAST YOU ACT ON IT.

Is it all hype?

- This is not our “First Rodeo”
  - 1921: Notion of Robot (Karel Capek)
  - 1941: Three Laws of Robotics (Isaac Asimov)
  - 1950: Alan Turing & Turing Test
  - 1956: AI Defined (Dartmouth College Conf)
  - 1970s: First AI Winter
  - 1981: Expert Systems
  - Late 1980s: Second AI Winter
  - 1997: Deep Blue beat Gary Kasparov



- Today: Confluence of Computer Power, Big Data (IOT, Robotics, Vision, Language Recognition) Machine Learning & Cognition …

Future: Impact on People

- Preparing for the Future
  - Artificial General Intelligence (General AI):
  - Notional system with intelligent behavior at least as advanced as a person across full range of cognitive tasks.
    - “Intelligence explosion”
    - Most people think decades away; Elon Musk disagrees


DILBERT
BY SCOTT ADAMS
I MADE A HUGE BREAKTHROUGH IN ARTIFICIAL INTELLIGENCE.
DilbertCartoonist@gmail.com
ASK THE DEVICE ANYTHING.
WHAT DO YOU WANT FOR DINNER?
© 2017 Scott Adams, Inc./Dist. by Andrews McMeel
I DON'T CARE. WHAT DO YOU WANT?
I WAS THINKING MAYBE CHINESE FOOD.
I'M NOT IN THE MOOD FOR THAT.
THEN WHY DID YOU SAY YOU DON'T CARE???
NOW I'M NOT EVEN HUNGRY.
WHY? WHAT'S WRONG?
www.dilbert.com
12-31-17
NOTHING IS WRONG.
YOU NAILED IT.

Future: Impact on People

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  - Artificial General Intelligence (General AI):
  - Notional system with intelligent behavior at least as advanced as a person across full range of cognitive tasks.
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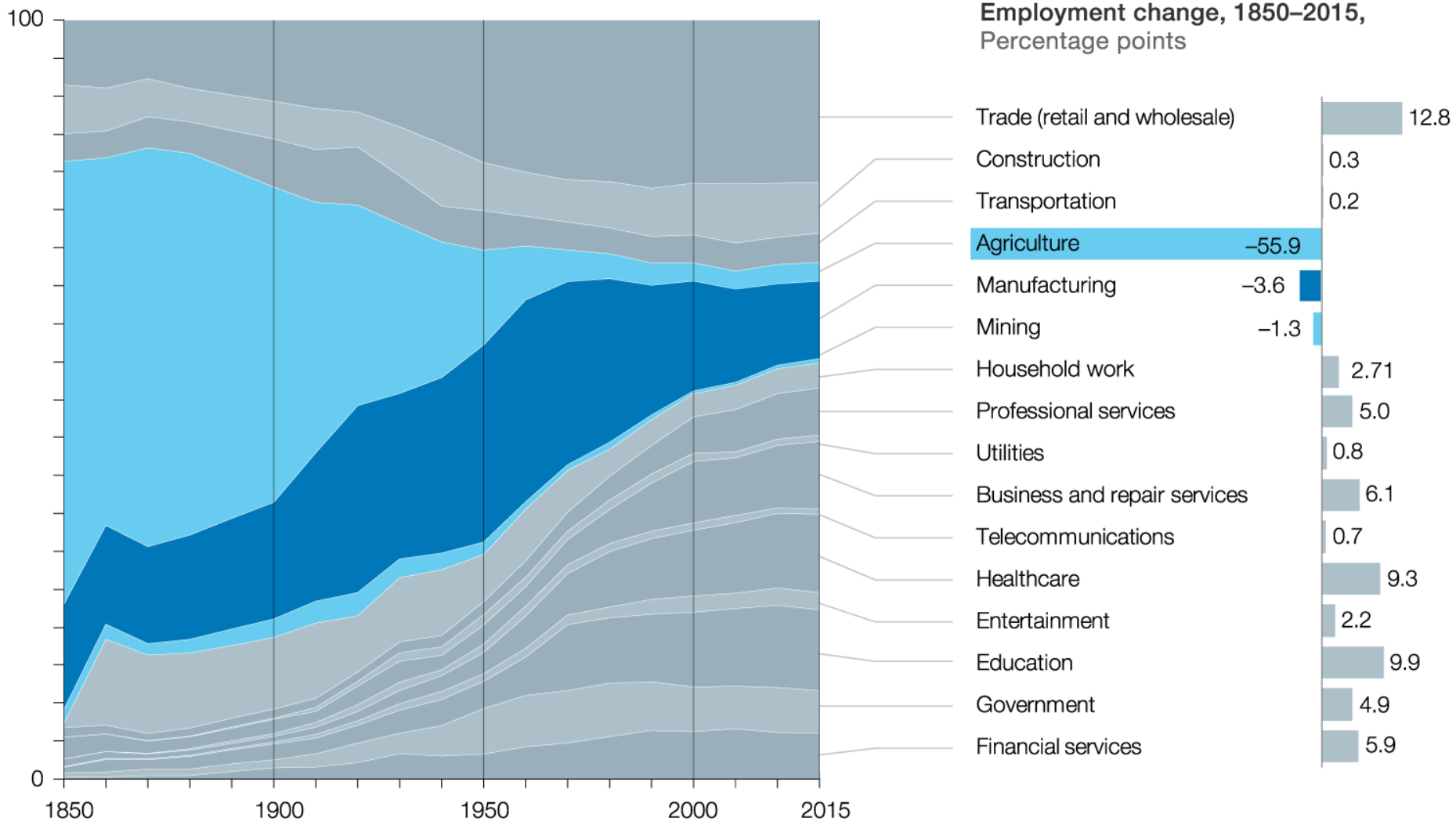
  - Automation vs. Human-Machine Teaming
  - Ethics, Regulations, Safety, Reliability & Cyber-Resilient
  - Standardization
- Workforce: Development, Diversity and Obsolescence
  - Should Computer Science be a “New Basic” skill?
  - How does Higher Education prepare for the transformation?

History shows that technology has created large employment and sector shifts, but also creates new jobs.

Share of total employment by sector in the United States, 1850–2015, % of jobs



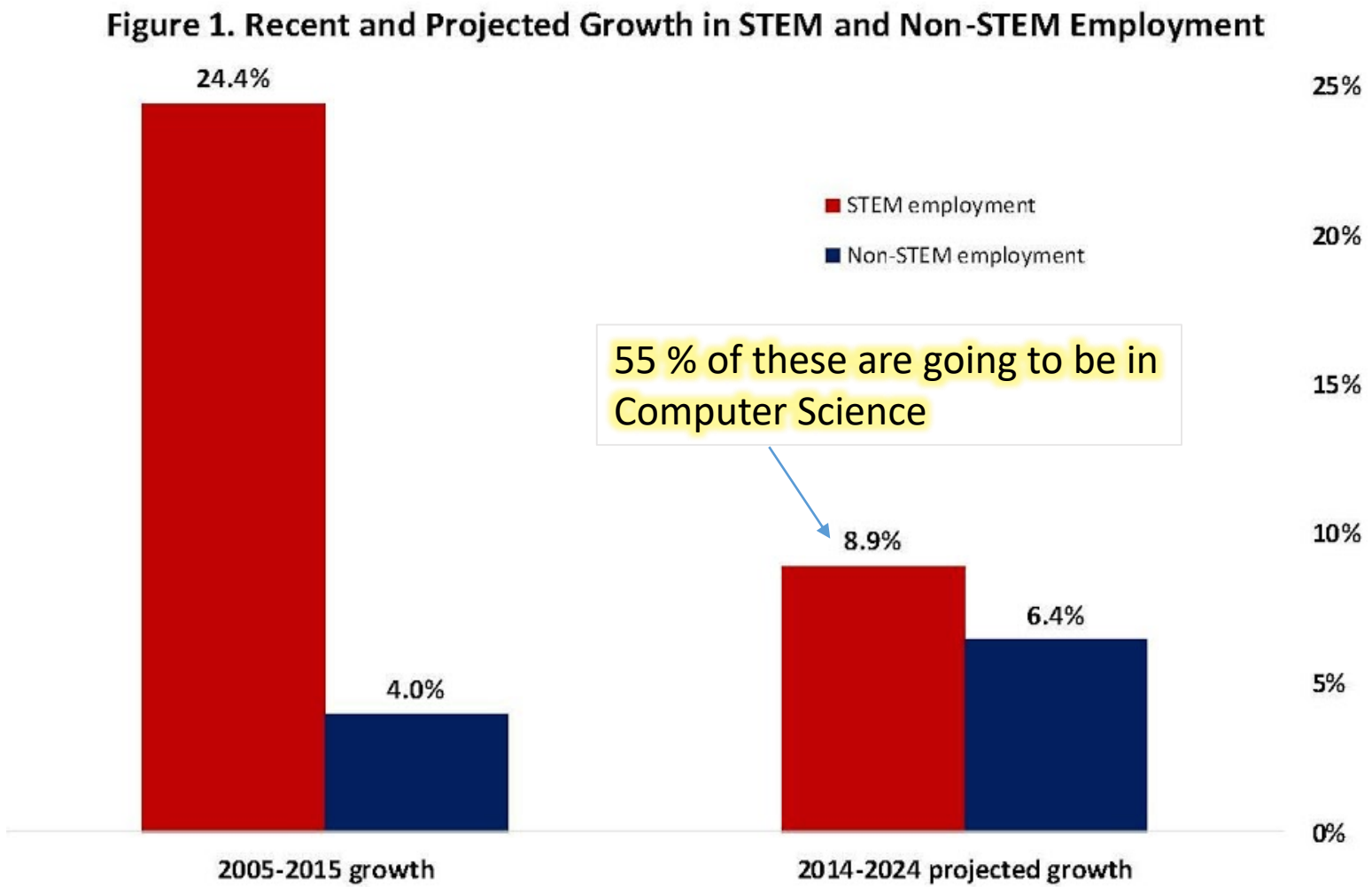
Employment change, 1850–2015,
Percentage points

McKinsey&Company | **Source:** IPUMS USA 2017; US Bureau of Labor Statistics; McKinsey Global Institute analysis

Transforming Workforce Development

- Fostering entrepreneurship: Technology & Social
  - Growth of Service Learning
  - Capital Expense Barriers
- Encouraging collaboration with the private sector
  - Connecting the real world challenges
- Promoting diversity and inclusion
- Engaging the nexus of technology and society

Jobs and Pipelines



Source: OCE calculations using Current Population Survey public-use microdata files of annual merged outgoing rotation groups from the National Bureau of Economic Research, and esimates from the Employment Projections Program of the Bureau of Labor Statistics.

Transforming Workforce

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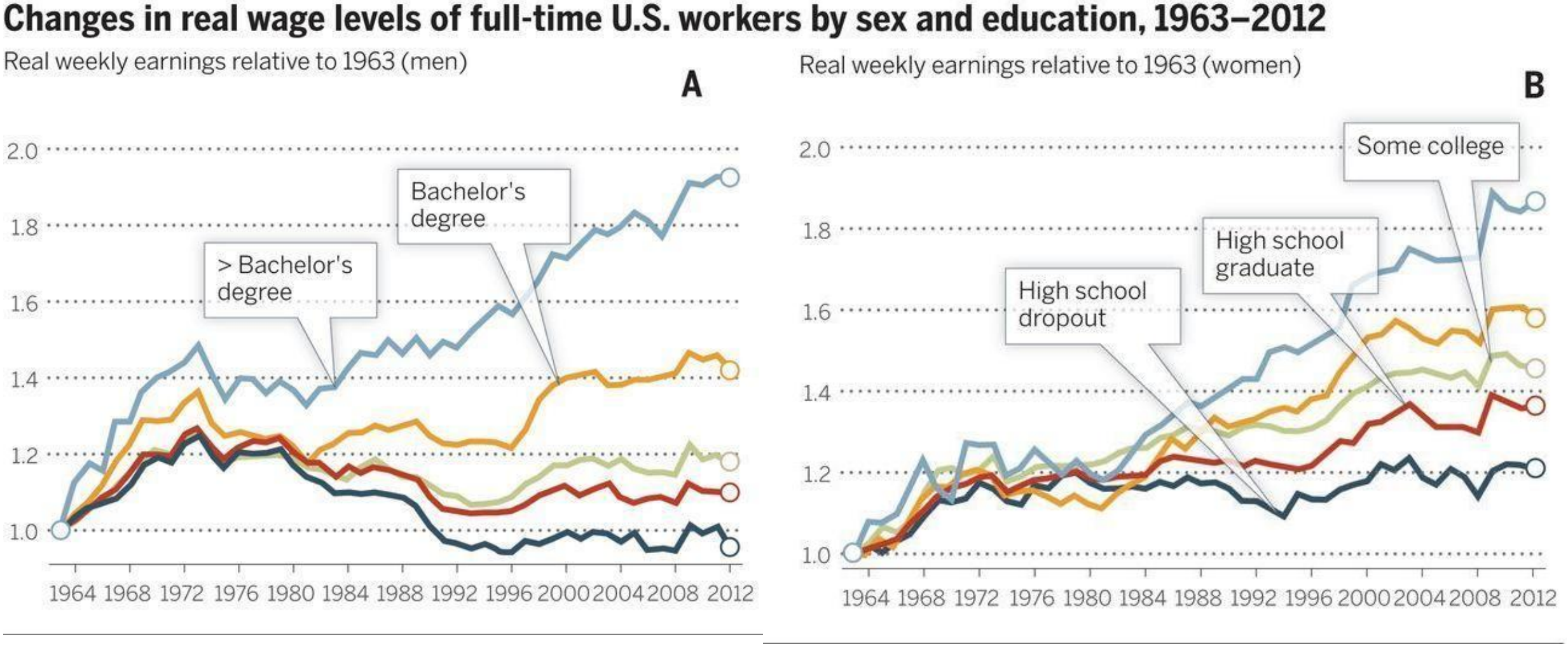
Technology Driven Inequality



Transforming Workforce

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- Continued learning & evolving models
  - Partnered & Global
  - Online; Stackable; Progressive

The Higher-Ed Disconnect

Current System

- Disconnected from Industry Pressures & Objectives
- Competition
- Individual
- Single-number answers
- Strict Assumptions

Desired System

- Understanding Business Objectives & Values
- Collaboration
- Team-work
- Uncertainty
- Fuzzy Complexities

Multi-disciplinary, Real-world, Problem Solving Based on Critical Thinking & Effectively Communicating

Closing Thoughts

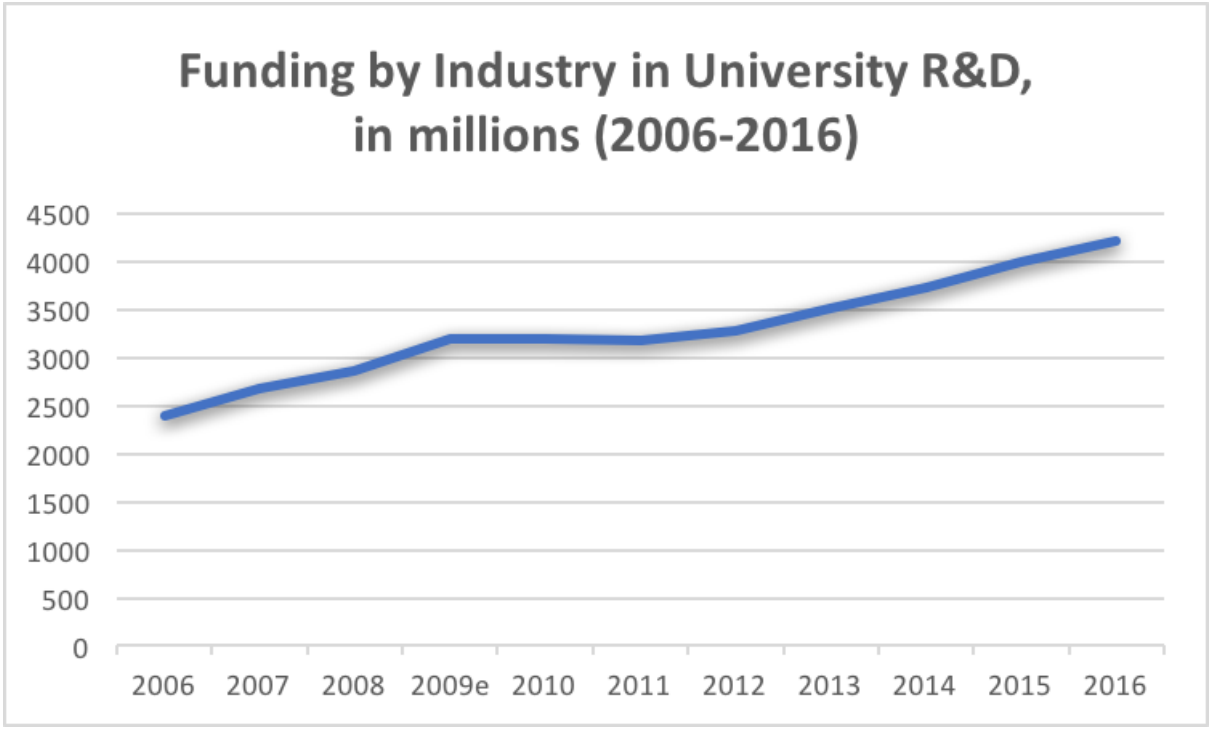
- Energy is a growth industry: Transforming
- Data Analytics, AI, Cognitive: Incredible Opportunity
- Skilled (Entrepreneurial, Diverse, Engaged) Workforce Critical for the Energy Transformation
- Thank you!

1. Fostering entrepreneurship

- As the pace of discovery accelerates and global competition intensifies, universities are embracing entrepreneurship as part of the academic experience, creating cultures where innovative thinking is inspired and nurtured. As of 2017, more than 200 colleges and universities have launched centres dedicated for innovation or entrepreneurship as members of the Global Consortium of Entrepreneurship Centres.
- It seems that no matter what field they study, students come to college seeking to make a difference in society through startups, social entrepreneurship, and other ventures of their own creation. We see the same kind of energy and excitement in young faculty, too, who now expect to develop new technologies or engage in startups as part of their academic career.
- At a time when societal challenges are demanding discoveries at the intersections of diverse disciplines, fostering a culture of entrepreneurship is one of the most powerful ways that universities act as economic accelerators. In fact, US-based data from the Association of University Technology Managers (AUTM) shows technology transfer from universities is playing an even more prominent role in economic development. The number of invention disclosures – a direct measure of institutional impact on innovation – has been on the rise the past five years, growing to 25,825 in 2016.

2. Encouraging collaboration with the private sector

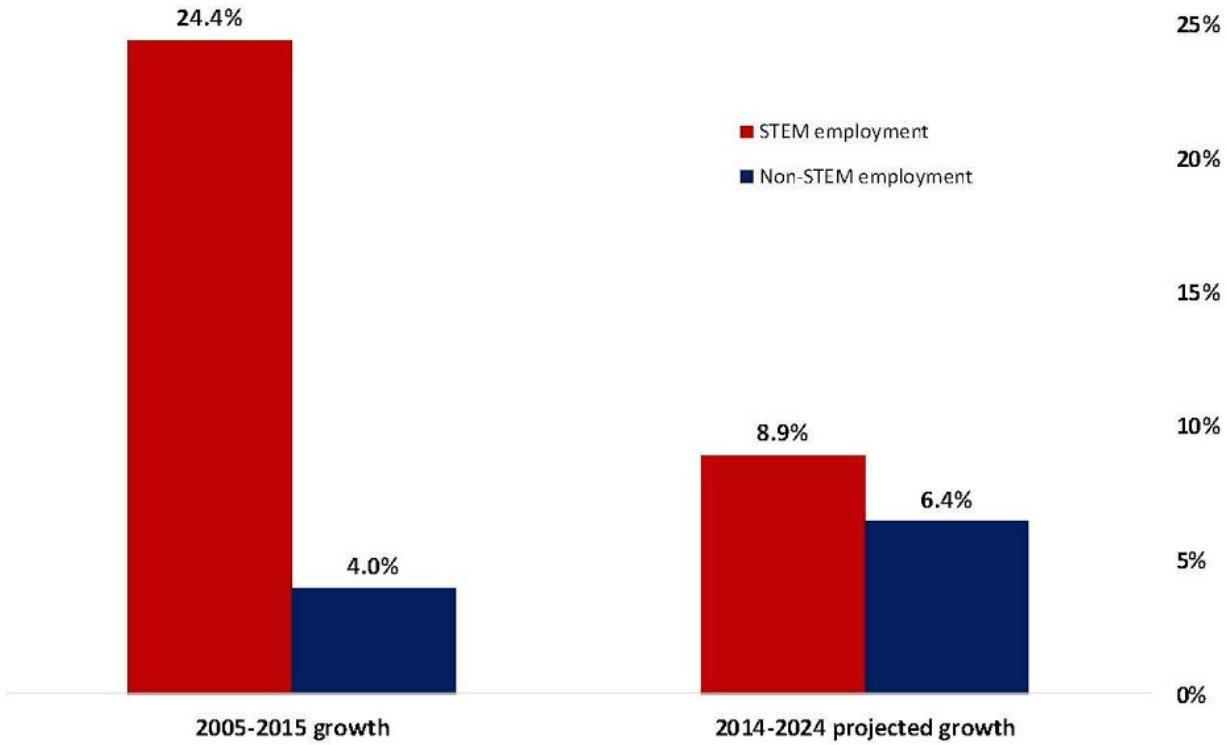
- In today's competitive environment, universities must also develop new partnerships with leading companies, foundations, and other research-intensive institutions. These partnerships are not just about transferring knowledge from lab to practice. They provide critical funding for talented faculty and students to pursue foundational research, enable students and faculty to exchange ideas with the very best minds inside and outside the academy, and perhaps most importantly, help to prepare students to be citizens of a rapidly changing world.
- Corporations are recognising the high-value, high-return offered by these collaborations. According to data compiled by the National Science Foundation for the US, industry funding for university research and development has grown by more than 5.5% per year on average over the past 10 years, from about $2.4 billion in 2006 to more than $4.2 billion in 2016.
- Even after adjusting for inflation, this funding has grown at roughly 4% per year, from about $2.5 billion in 2006 to about $3.8 billion in 2016 (denominated in 2009 dollars).



3. Promoting diversity and inclusion

- Successful university spin-offs and corporate partnerships don't tell the full story. As this economic transformation quickens, it is critical that universities continue to focus on incorporating diverse perspectives into our work.
- In the US, expanding the opportunity for diverse voices, especially in STEM-related jobs is not just the right move – it is necessary to meet the economic demand posed by our tech-driven economy. The US Bureau of Labor Statistics projects STEM occupations to grow by about 8.9% from 2014 to 2024, compared to 6.4% growth for non-STEM occupations. Most of those jobs will be in computing-related disciplines – about 55%. Data also tells us that more than two-thirds of those jobs could go unfilled due to the insufficient pool of college graduates with computing-related degrees.
- By not expanding the pool of job-seekers, we risk falling short of the growing demand, with serious consequences for the future of technical innovation.

Figure 1. Recent and Projected Growth in STEM and Non-STEM Employment



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4. Exploring the nexus of technology and society

- There is no guarantee, of course, that technology will automatically benefit humanity. Here, perhaps, lies the greatest obligation for institutions of higher education in the digital revolution. It is up to us to provide the ethicists, artists, and philosophers who can point the way; the policy experts and economists who can draw the map; and the cognitive scientists and sociologists who help ensure the destination is designed for people as well as machines. And it is up to us to make sure these scholars are working side-by-side with the applied researchers and technologists who are driving the revolution.
- US labour markets have evidenced an impressive ability to absorb staggering changes in technology – but not without a troubling increase in inequality among our citizens.