
KUWAIT ENTERPRISE RISK MANAGEMENT CONFERENCE
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Principal, A.T. Kearney

Mapping the Unknown: Mitigating Disruptive Innovation Risk in Oil & Gas

There is a tendency to regard technology change as the result of “black swans” i.e. unpredictable game-changing events ...

New technology examples

Major investments in new technologies

IBM: Watson

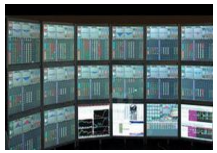
Beat humans at Jeopardy! and now developing commercial applications

DARPA: Big Mechanism

Developed to read cancer research papers and create new hypotheses about cancer

Google: Self-Driving Car

Combines sensors, lasers, and pre-loaded maps to drive autonomously



Binatix: Trading tool

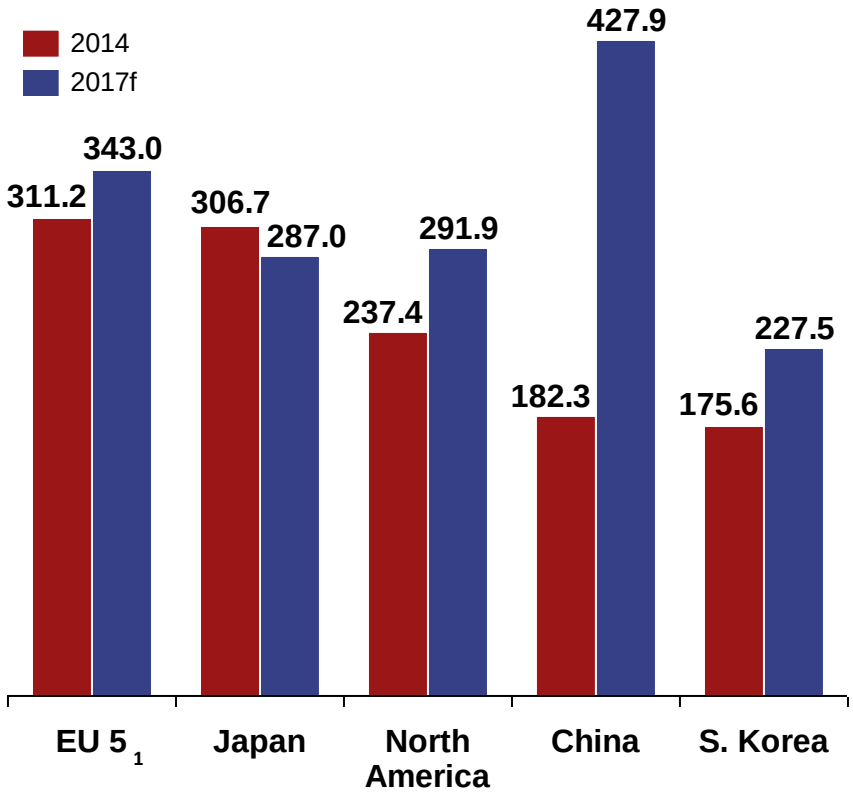
Tool learns from how information changes over time, updating its own trading algorithm

Hong Kong: MTR rail system

Uses AI to schedule and complete maintenance on the subway system

Operational stock of industrial robots

(thousands of units)



1. EU 5 = Germany, Italy, France, Spain, and UK

… underpinning the “eternal gale of creative destruction” that ultimately drives the dynamics of capitalism itself

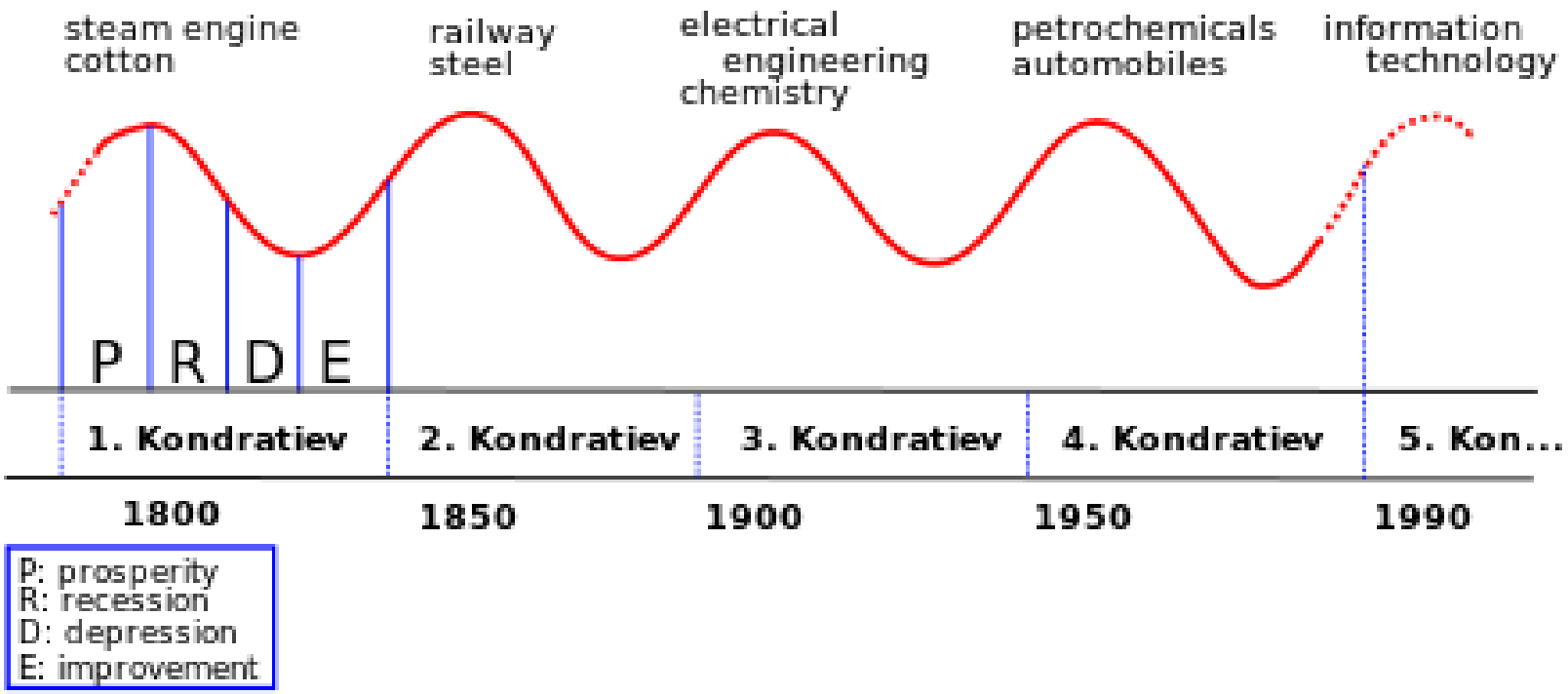
Joseph Schumpeter on the role of innovation

[Innovation] “incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one. This process of Creative Destruction is the essential fact about capitalism. It is what capitalism consists in and what every capitalist concern has got to live in”

- *Joseph Schumpeter (1942)*
  Capitalism, Socialism and Democracy

History's major innovations can indeed be mapped to the global economy's long cycles, but correlation does not imply causation

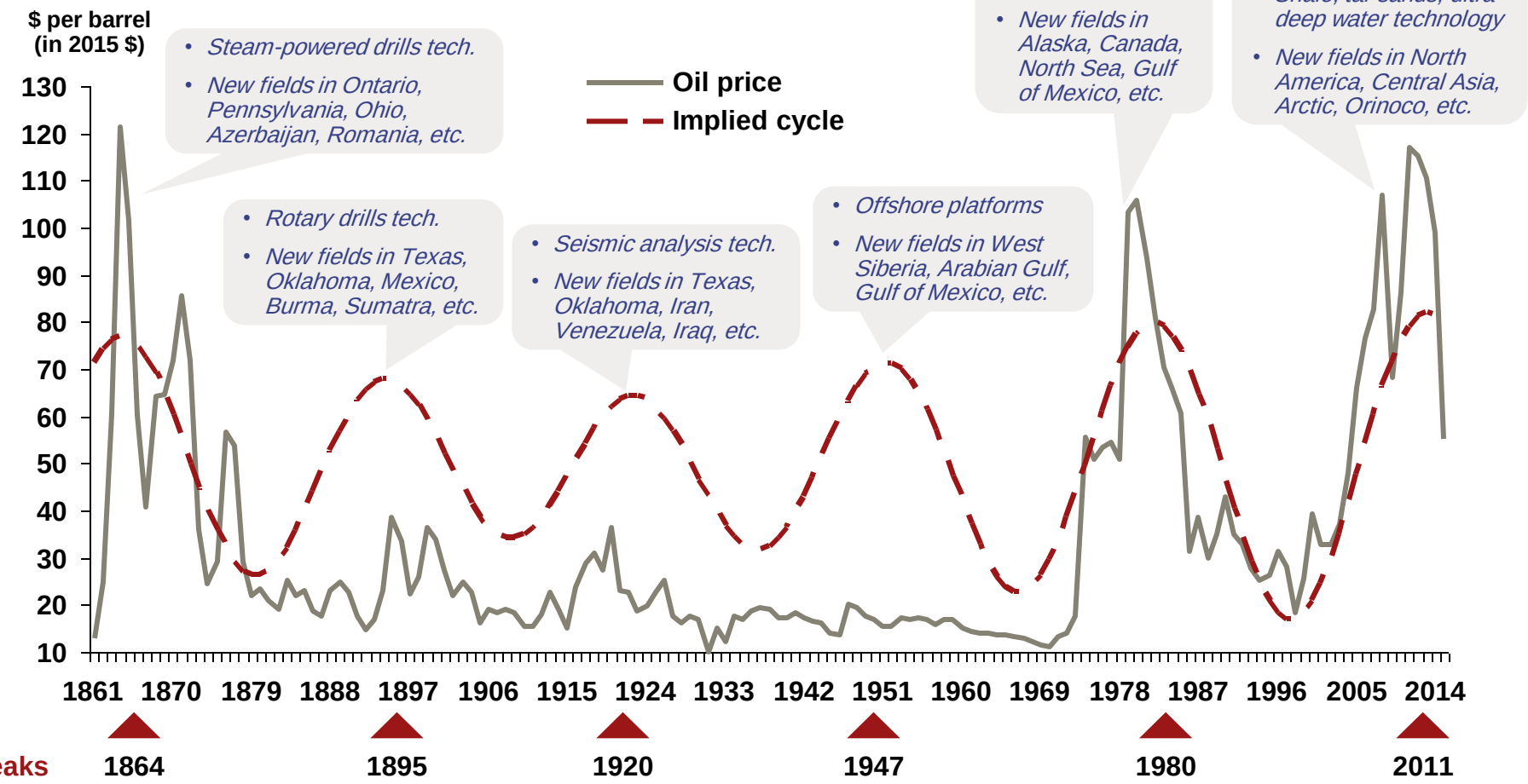
Innovation waves along the Kondratiev long business cycle



Are innovation shocks the primary cause of growth waves, or do they actually result from underlying causes that explain the regularity of the wave?

The oil & gas industry provides an excellent example, as its disruptive innovations always cluster around oil price peaks

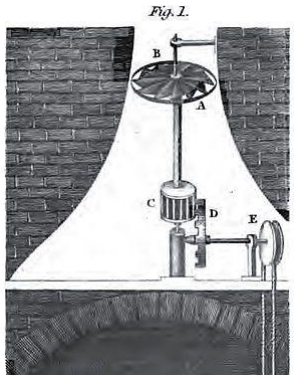
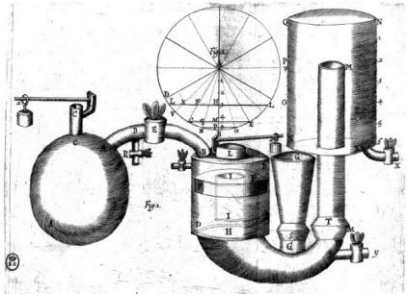
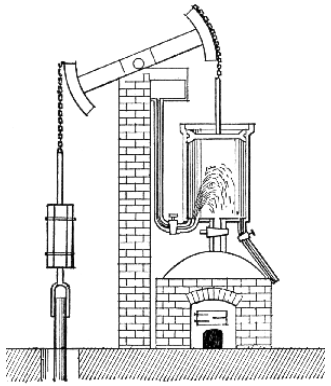
Real long-term oil price series (1861 to 2015)



Without the right conditions, innovation alone cannot improve productivity or drive actual change …

Pre-history of the steam engine

Example

Aeolipile	Steam Turbine	Papin's Machine	Newcomen's Machine
			
Hero of Alexandria	***Taqi al-Din***	***Denis Papin***	***Thomas Newcomen & Thomas Savery***
1st Century	***1551***	***1690***	***1712***

Timeline

18th Century Britain gave rise to the steam engine as well as other industrial innovations because the prevailing conditions defined a good environment for entrepreneurship

… and, even with strong public and private interest, promising technologies may be unable to take off if they are not competitive

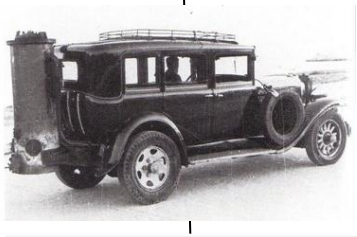
Electric vehicles 20th Century timeline

Example

1910s

- By 1900, 7 electric vehicles circulated in the USA for every 4 hydrocarbon-fueled
- By the end of the 1920s, however, electric cars had all but disappeared

1940s



- Electric taxis tested during the gasoline shortages after the Spanish Civil War …
- … yet taxi drivers soon turned to other fuels, as recharging batteries was too slow

1960s

- In 1959, the Henney Kilowatt started to be produced in the USA
- Only 47 of them had been sold by the time their production was discontinued in 1961

1990s

- In 1996, California Air Resources Board regulation triggered several new designs
- By 1999 many of the new models (e.g. GM EV1, Honda EV Plus) were discontinued

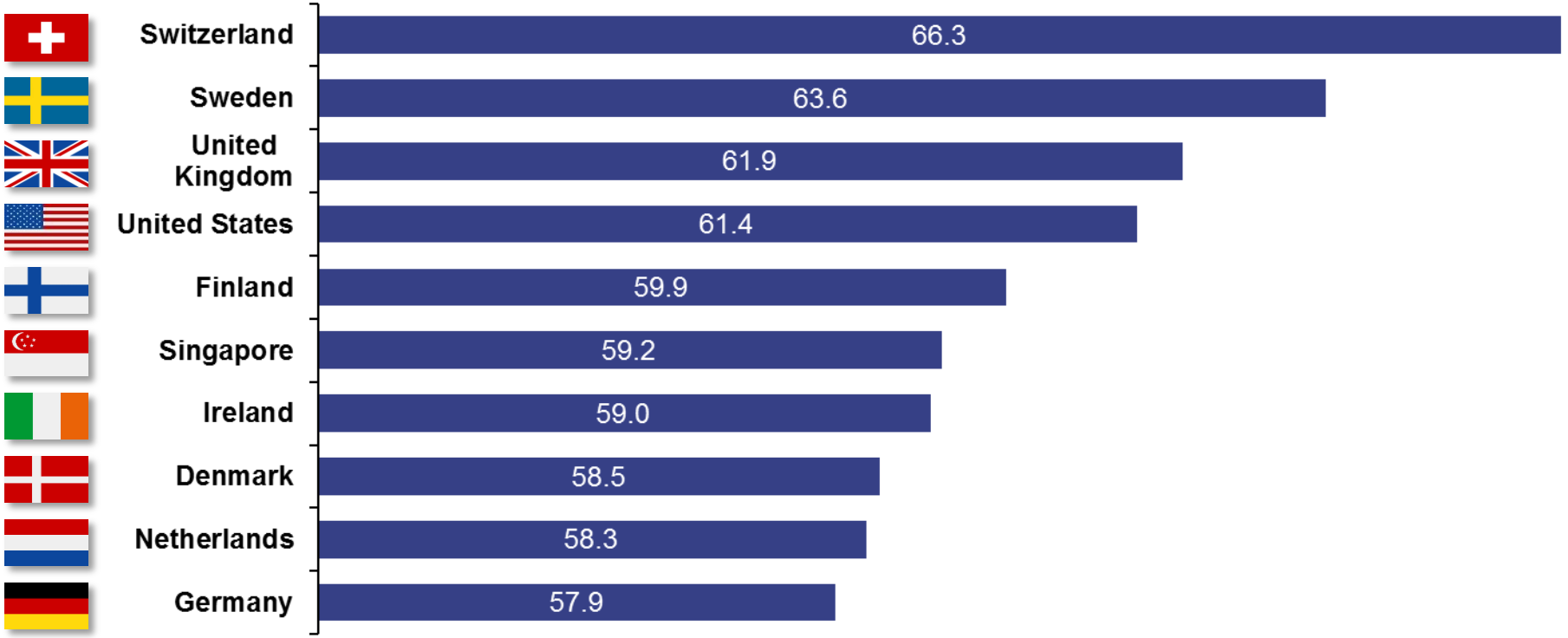
Throughout the 20th Century, efforts to reinvigorate the electric vehicle market consistently stumbled with the limitations of battery technology

The key common characteristics of the world's most innovative economies are human capital and global market openness

Global Innovation Index 2016

A.T. Kearney / Cornell / INSEAD / WIPO

Top-10 most innovative economies

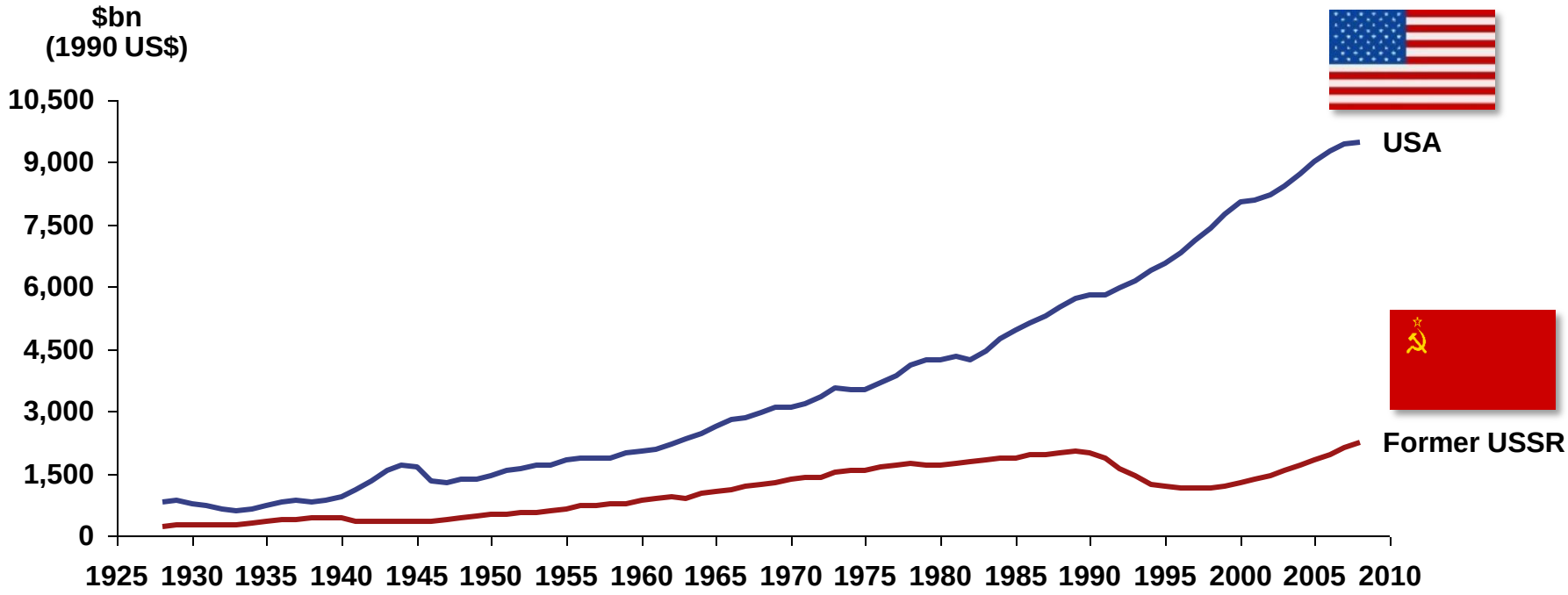


Government support can play a major role in innovation but, with no market anchor, it can be very inefficient (e.g. in the USSR)

USA vs. Former USSR Gross Domestic Product

(1928 to 2008)

Example



The USSR temporarily overtook the U.S. in key technologies (such as rocket science e.g. with the Sputnik) but its long-term economic performance remained weak

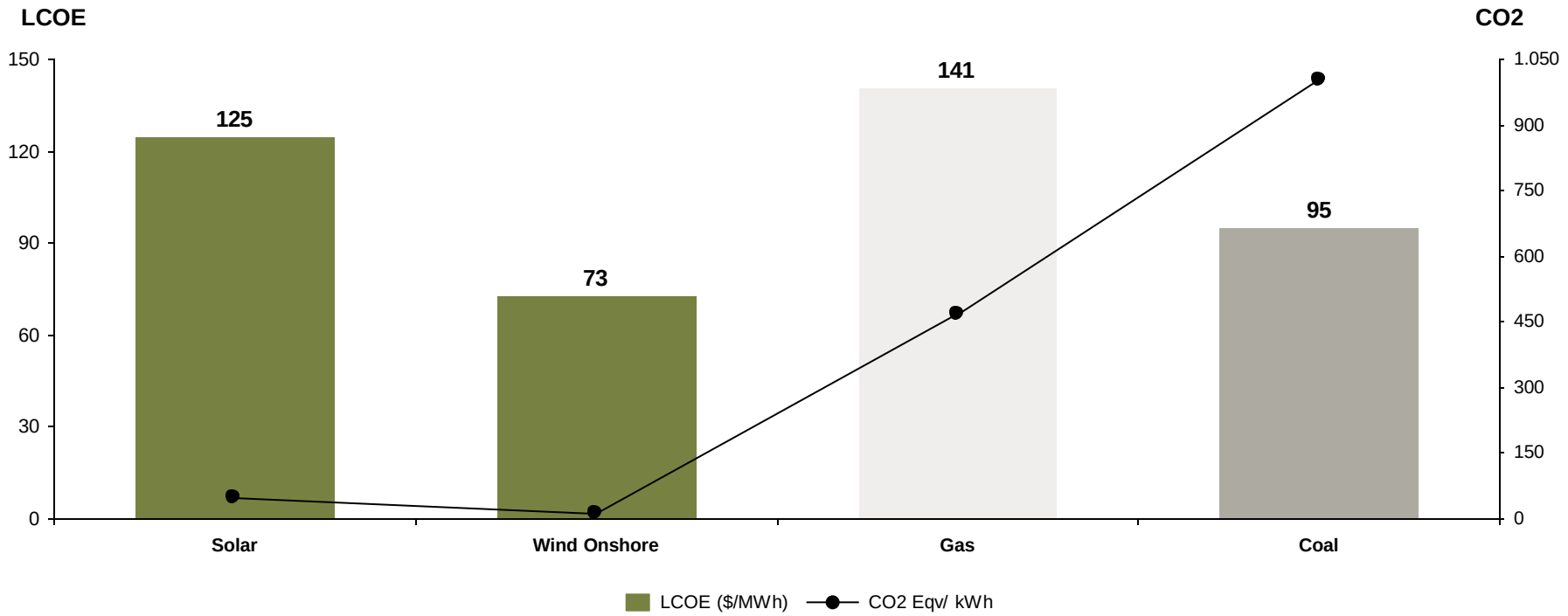
This is why it is so important that renewable technology start to be cost-competitive without government subsidies …

Comparative profitability of utility energy sources (EIA estimates)

Example

Levelized Cost of Electricity[1] (LCOE)

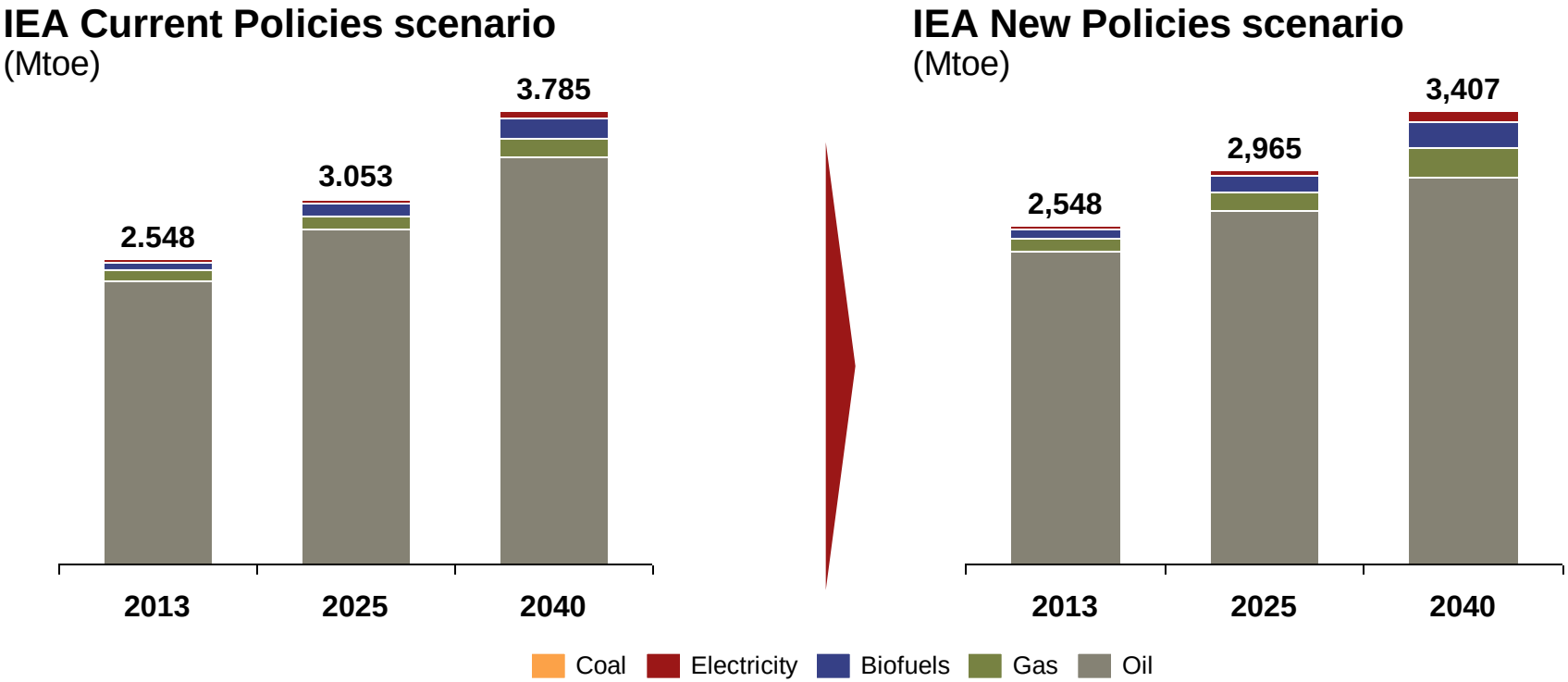
($/MWh) & ($CO^2$ Eqv./kWh) (2020 estimates)



1. Levelized cost of electricity (LCOE) is often cited as a convenient summary measure of the overall competiveness of different generating technologies. It represents the per-kilowatthour cost (in real dollars) of building and operating a generating plant over an assumed financial life and duty cycle.

… and why continued dependency on government support raises a question on the future impact of electric vehicles

Final energy consumption in transportation (IEA scenarios)

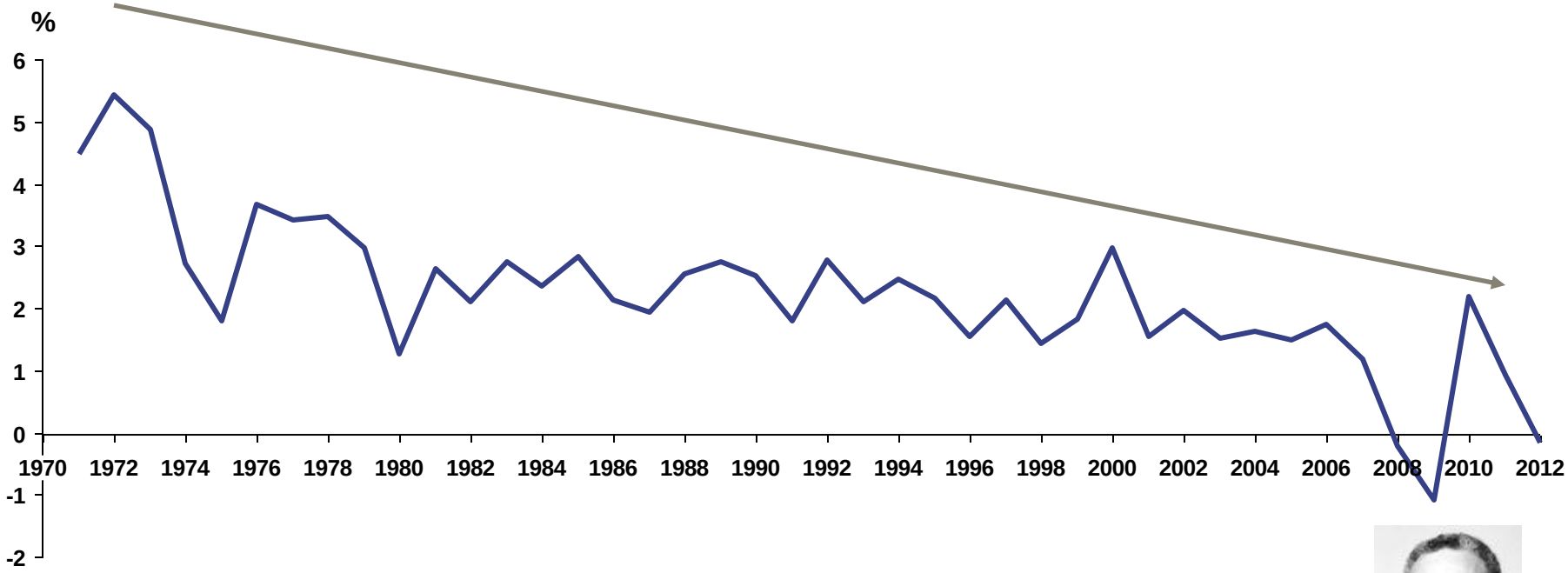


Due to electric vehicle technology limitations and regulatory dependency, the IEA forecast they would only represent c. 2% of global transport fuel demand by 2040

Regulation ultimately stiffens innovation: even the computer age impact is low in today's highly regulated western economies …

Labor productivity growth rate

(non-weighted average of top-6 developed economies, 1971 to 2012)



"You can see the computer age everywhere but in the productivity statistics"

- Robert Solow, Economics Nobel Prize, 1987

Note: Top-6 developed economies are France, Germany, Italy, Japan, UK and USA

… as there is strong evidence that the system's very stability results in a slowdown of innovation adoption and impact

Clayton Christensen on innovation adoption

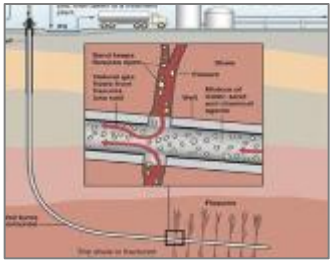
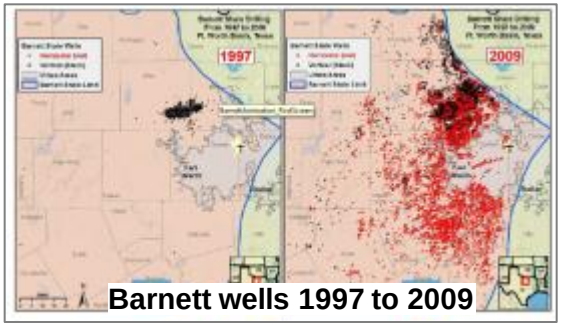
"Good management itself was the root cause" [of great firms failing to tackle the challenge of disruptive innovation.] "The very decision-making and resource-allocation processes that are key to the success of established companies are the very processes that reject disruptive technologies"

- *Clayton Christensen (1997) The Innovator's Dilemma*

Last but not least, even under the right conditions, R&D efforts that result in disruptive innovation take time …

Shale / tight oil & gas technology timeline

Example

	1980s	1990s	2000-2005	2006-2010	2011-2016
	 Perceived dwindling of conventional NG resources led to Government sponsored research to estimate unconventional NG resource and improve ways to extract NG from rock; shales considered uneconomic	Early 90s: Mitchell Energy combines horizontal drilling and hydraulic fracturing to make Barnett Shale economic 	2004: Shale NG production crosses 2 Bcf/d  Barnett wells 1997 to 2009	2005-2010: Barnett shale production grows to 5 Bcf/d; other major shale plays developed	2011: Bakken shale oil production hits 500k BPD  2010: Major find in the Marcellus shale dramatically increases overall resource estimate
Proved Reserves:	16% decrease	No growth	8% increase	Increase by >40%	Shale Oil hits 10% of US crude production
Production:	Decreases by 2 Tcf to 18 Tcf	Increase to 19 Tcf	~ 19Tcf	Increase by 16% to > 21 Tcf	**Shale/Tight Gas hits 56% of US gas production**

… so disruptive innovation is not an event striking entirely by surprise, but a process companies can and should prepare for

Johan Aurik on innovation timing

"Technology may be advancing rapidly, but it will not cause time itself to collapse. The momentous –indeed, revolutionary– changes ahead will take place over many decades, not as a big bang. Individuals, companies, and societies do have time to adjust; but there is no time for delay. Creating a future in which all can benefit must start now. "

- *Johan Aurik (2017)*

Work in an Automated Future

Note: Johan Aurik is A.T. Kearney's Global Managing Director and Chairman of the Board

In sum: companies can, and should, develop scenarios and plans to prepare themselves and tackle disruptive innovation

Key takeaways

- Companies should develop plans to tackle disruptive innovations. This can be achieved by developing realistic scenarios for the future

- Scenarios model the potential impact of disruptive innovations by considering their key drivers, in particular:

1. **Economic Case:** Innovation only takes hold when adequate economic incentives exist (e.g. high energy prices stimulate energy research)

2. **Supportive Environment:** Effective innovation only takes place where the environment encourages it (e.g. entrepreneurship, regulation, etc.)

3. **Time to Develop:** No innovation with true disruptive potential is ever developed overnight: a development process of several years is typically required

Thanks for Attention