Beyond the Energy Techlash: The Energy & Carbon Footprint of IT

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9 July 2020

Join the Conversation: Submit questions to the panel at itif.org/energy-efficiency

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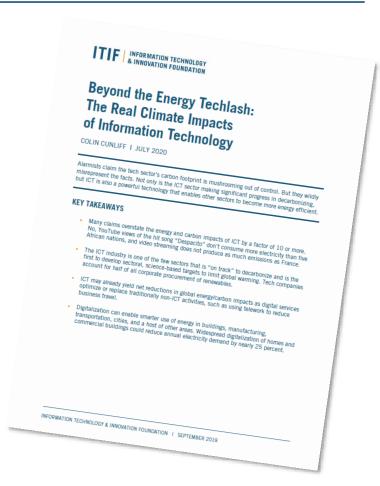




ITIF report: Beyond the Energy Techlash

- What is the energy and carbon footprint of information technology?
- How does integration of IT (aka "digitalization") affect energy use in other sectors?

https://itif.org/energy-techlash



Sorry, wrong number! Fact-checking the headlines

YouTube views of 'Despacito' consume as much electricity as five African countries

-- BBC, The Guardian, Fortune, Al Jazeera

Claim: 5 billion views of 'Despacito' consumes 1 TWh

of electricity

Is this reasonable? No. For this to be true, YouTube

would have to consume 930 TWh, more than

4x all data centers

Better estimate: 5 billion views ~ 0.005 TWh



Luis Fonsi - Despacito ft. Daddy Yankee - YouTube www.youtube.com > watch

Data services have grown exponentially, but energy demand has stayed flat

Between 2010 and 2018, data center:

- > Storage capacity increased 26x
- > IP traffic increased 11x
- Workloads increased 6.5x

But

- Computing efficiency doubled every
 1.6 years
- Storage energy intensity decreased 90 percent
- Average PUE decreased 25 percent

Electricity Demand	2010	2018
Data Centers	194 TWh	205 TWh
World	17,900 TWh	23,000 TWh
Share	1.08 %	0.89%

Source: Masanet et al. (2020), IEA (2020)

Carbon Footprint of the ICT Sector

Like all sectors, the ICT sector will have to do its part to address global climate change.

ICT accounts for

- > 4 percent of electricity demand
- > 1.4 percent of GHG emissions

Iron and Steel 3487 Chemicals & Plastics 3347 Cement 2545 Aluminum 1109 Refining 950 Machinery 1937 Pulp and Paper 836 Ceramics 754 ICT Sector 730 Food & Tobacco 694

1,000

■ Data transmission networks

0

■ Data Centers

Figure 5. Global GHG Emissions by Industry in 2014

Source: Malmodin (2018) and Rissman (2020)

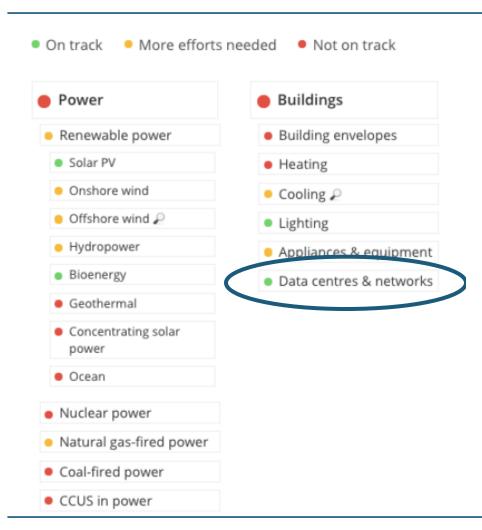
3,000

User devices

2,000

4,000

Data centers and networks are "On track" for a 2 °C scenario

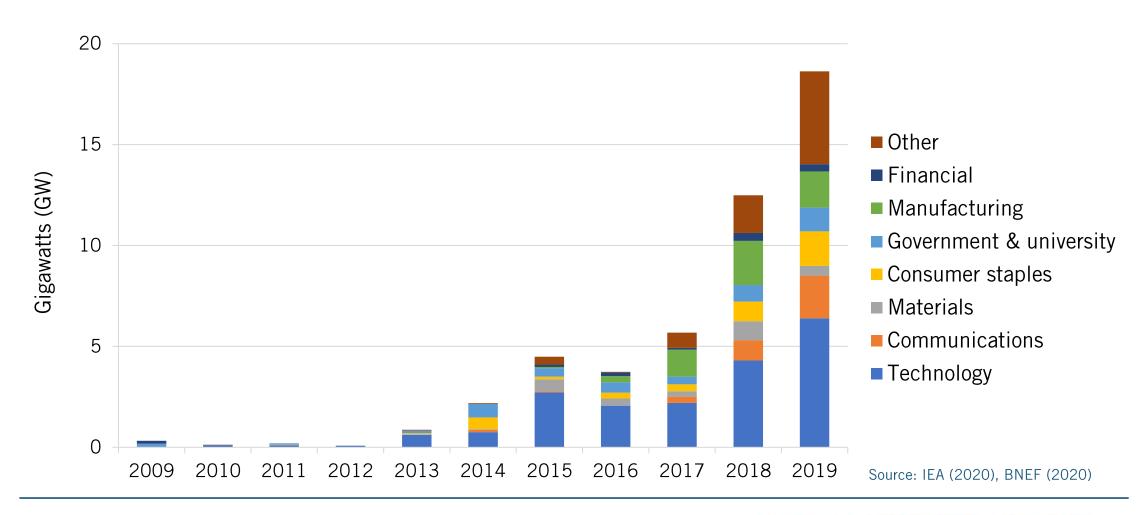


3 reasons the IT sector is "On track" to decarbonize:

- 1. Rapid improvements in efficiency have kept energy demand flat
- 2. Tech companies are decarbonizing their own electricity supply faster than the grid
- 3. ICT was the first industry to develop sectoral targets approved by the Science Based Target Initiative

Source: IEA (2020)

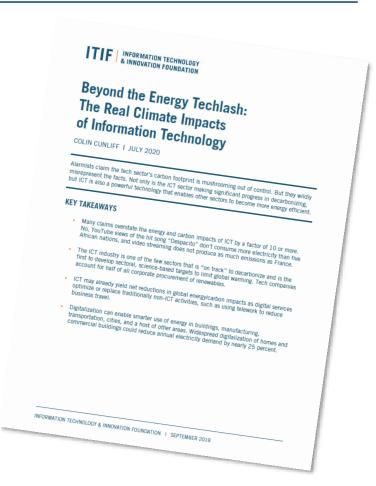
ICT companies lead in corporate procurement of clean energy



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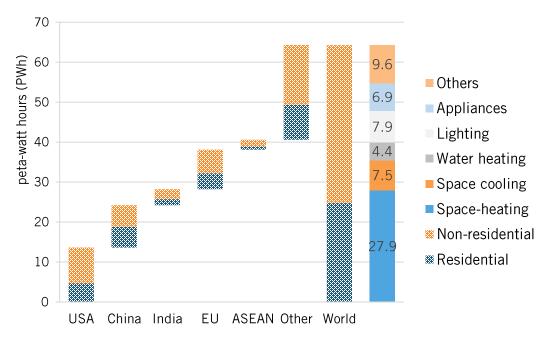


Digitalization enables efficiencies in buildings

Homes and commercial buildings account for 1/3 of global energy demand and 55 percent of electricity.

- ➤ Smart sensors and controls can enable peak demand reductions of 10-20%, saving U.S. consumers \$18 billion in annual energy costs.
- Smart thermostats can reduce heating & cooling demand by 15-50 percent.
- ➤ ICT could reduce global annual building energy demand by 4.65 PWh (nearly 25 percent) by 2040, at an energy cost of only 275 TWh.

Figure 8. Cumulative energy savings in buildings from widespread digitalization (2017-2040)



Source: IEA (2017)

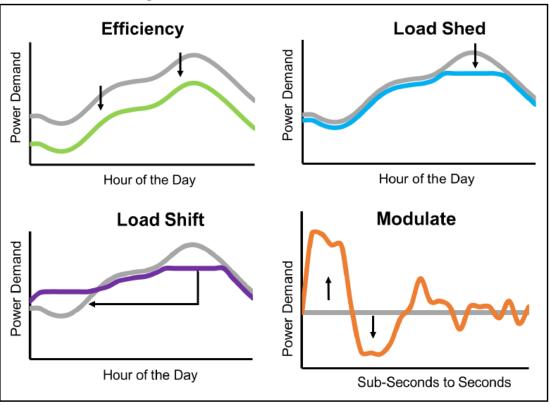
Grid-integrated buildings provide demand management benefits

U.S. DOE is launching a new initiative for grid-integrated efficient buildings.

Benefits:

- > Improved reliability and resilience
- ➤ Greater demand response, reducing peak demand (and avoided capacity buildout)
- Avoided curtailment of wind and solar
- ➤ Optimized use of distributed energy resources (e.g. rooftop solar, storage)

Figure 9. Changes in building electricity demand as a result of demand-side management tools



Source: DOE (2019)

ITIF Digital Mfg. Reports





A Policymaker's Guide to



Smart Manufacturing

Why Manufacturing Digitalization Matters and How Countries Are Supporting It

BY STEPHEN EZELL | APRIL 2018

manufacturing is changing how products are designed, fabricated used, and serviced. just as it's transforming the operations, processes and energy footprint of factories and supply chains.

This report explains how digitalization is transforming manufacturing globally, detailing what exactly smart manufacturing (or "Industry 4.0") is and examining the productivity impacts that digitalized manufacturing promises to deliver. The report examines the small- to medium-sized enterprise (SME) manufacturing support programs and policies of ten nations—Argentina, Australia, Austria, Canada, China, Germany, Japan, Korea, the United Kingdom, and the United States—and provides insights countries can leverage to support the digitalization of their manufacturers. The report further examines how the development of common standards can facilitate technology adoption and proposes a typology that helps conceptualize different manufacturing production systems and strategies, showing how these need to be supported by

The Digitalization of Modern Manufacturing

Whether it's called "Industry 4.0," as in Europe, the "Industrial Internet of Things (IIoT)," as in the United States, or just "smart manufacturing," the application of information and communication technology (ICT) to every facet of manufacturing is in the midst of reshaping modern manufacturing. This digitalization of manufacturing is changing how products are designed, fabricated, used, operated, and serviced post-sale, just as it's transforming the operations, processes, and energy footprint of factories and the management of manufacturing supply chains. This convergence of digital technologies with manufacturing industries also promises to recast the landscape of global

Manufacturing Strategy NSON AND STEPHEN EZELL I JANUARY 2017

the Trump Administration's

Ten Principles to Guide

suld be clear in the wake of the election, it is that President s about growing U.S. manufacturing. But while he has conomic news with his comments warning companies jobs and his involvement in the deal that led Carrier to nanufacturing jobs that were previously headed to s and actions have largely elicited derision from entators and analysts. Their dismissive responses have is totally trivial" to "it will never work," "picking ces economic welfare," and "we shouldn't care about wway." Emblematic of this widespread pundit opinion pronouncements have been nonsense, or worse, sessor Stephen Kobrin writes, "What happens when we been taken?" In other words, the consensus the president is pulling a fast one on ignorant and

ided little substantive guidance for the incoming administ sective U.S. manufacturing strategy should look like. On one using: the Washington establishment and the broader conomists have no real idea what to do other than fall back on ies such as reforming the tax code, training workers, and building or do they even offer an analysis of what has happened to U.S.

INNOVATION FOUNDATION 1 JANUARY 2017

Manufacturing Digitalization: Extent of Adoption and Recommendations for Increasing Penetration in Korea and the U.S. BY STEPHEN J. EZELL, ROBERT D. ATKINSON, DR. INCHUL KIM, AND JEAHAN CHO I AUGUST 2018

Whether it's called "Industry 4.0," as in Europe, the "Industrial Internet of Things (IIoT)," as in the United States, or simply "smart manufacturing," information and communication technology (ICT) is if the midst of reshaping modern manufacturing.\(^1\) This digitalization of

manufacturing will transform virtually every facet of modern manufacturing, from how products are researched, designed, fabricated and produced, distributed, and consumed to he

chains integrate and factory floors operate. smart manufacturing revolution: for instance manufacturers still lack plans to implement I applications over the next three years. This re smart manufacturing adoption by U.S. manuf recommendations to increase smart manufactu United States, Korea, and beyond.

Smart manufacturing enables manufacturers to converge combining sophisticated hardware with innovative software massive amounts of data and analytics to produce smarter p processes, and more closely linked customers, suppliers, and digitalization of modern manufacturing holds the potential of manufacturing productivity growth, but also to reshape the li manufacturing, bolstering the competitiveness of the most in technology-adopting companies while croding the advantage

INFORMATION TECHNOLOGY & INNOVATION FOUNDATION | A

International Benchmarking of Countries' Policies and Programs Supporting SME Manufacturers

The Manufacturing Evolution How Al Will Transform Manufacturing & the Workforce of the Future





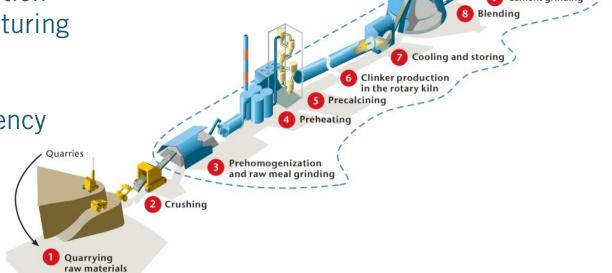
Digital Manufacturing Saves Energy

Industrial facilities account for 38 percent of global final energy consumption (32 percent of US energy).

U.S. Smart Manufacturing Leadership Coalition estimates that integrating ICT into manufacturing could yield:

> 25 percent improvement in energy efficiency

- ➤ 25 percent reduction in packaging
- > 40 percent reduction in water usage



Source: IEA (2018), ICEF (2019)

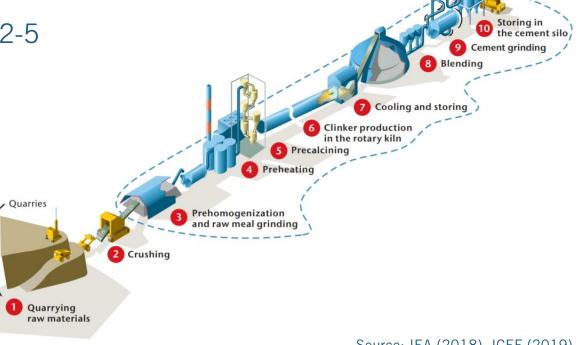
Digital Manufacturing in the Cement Industry

Smart manufacturing is especially important for hard-to-abate sectors, such as cement, steel, and chemicals.

➤ Petuum – using AI to reduce energy inputs 2-5 percent and increase yields 2 percent

Argos / DOE / University of Louisville partnership to integrate predictive models, data analytics, sensors, and AI to reduce energy intensity of clinker

➤ Lafarge Holcim – using "digital twins," automation, AI, and robotics to improve efficiency 15-20 percent

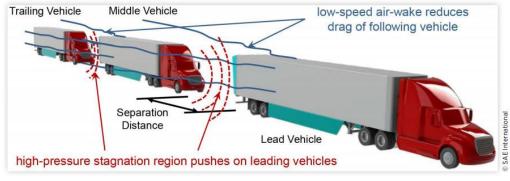


Source: IEA (2018), ICEF (2019)

Digitalization enables efficiencies in Transportation

Transportation accounts for 70 percent of petroleum use and 28 percent of U.S. GHG emissions.

- Adaptive traffic signals use signal timing to reduce congestion & idling, lowering emissions by 8.5 percent compared to "dumb" traffic signals.
- ➤ Platooning trucks can reduce fuel consumption by 10-17 percent.
- Wake-energy retrieval" enables a plane to fly in the wake of another, reducing fuel by 5-10 percent (at 2 miles apart).



Source: NREL, NRCC (2018)



Source: Airbus (2016)

Digitalization enables efficiencies in Transportation

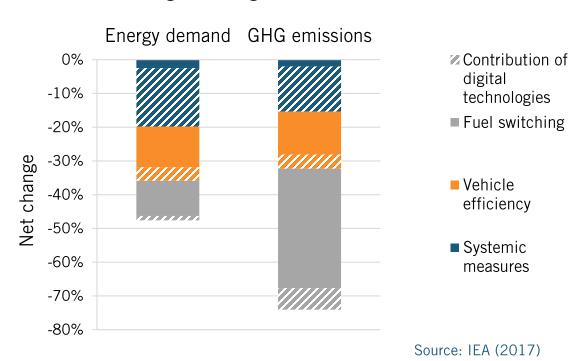
IEA's "Future of Trucks" identifies decarbonization opportunities:

- Systemic measures (e.g. platooning & route optimization)
- Improved vehicle efficiency (e.g. automatic tire pressure adjustment)
- ➤ Fuel switching to low-carbon fuels (including electricity)

Digital technologies can reduce trucking

- Energy demand: 23 percent
- GHG emissions: 24 percent

Figure 10. Digitalization's impact on energy use and emissions reductions in freight trucking



Thank You!

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