The Impact of 5G Communications and Clean Power on Global Economic Growth

Reed Hundt, CEO, Coalition for Green Capital
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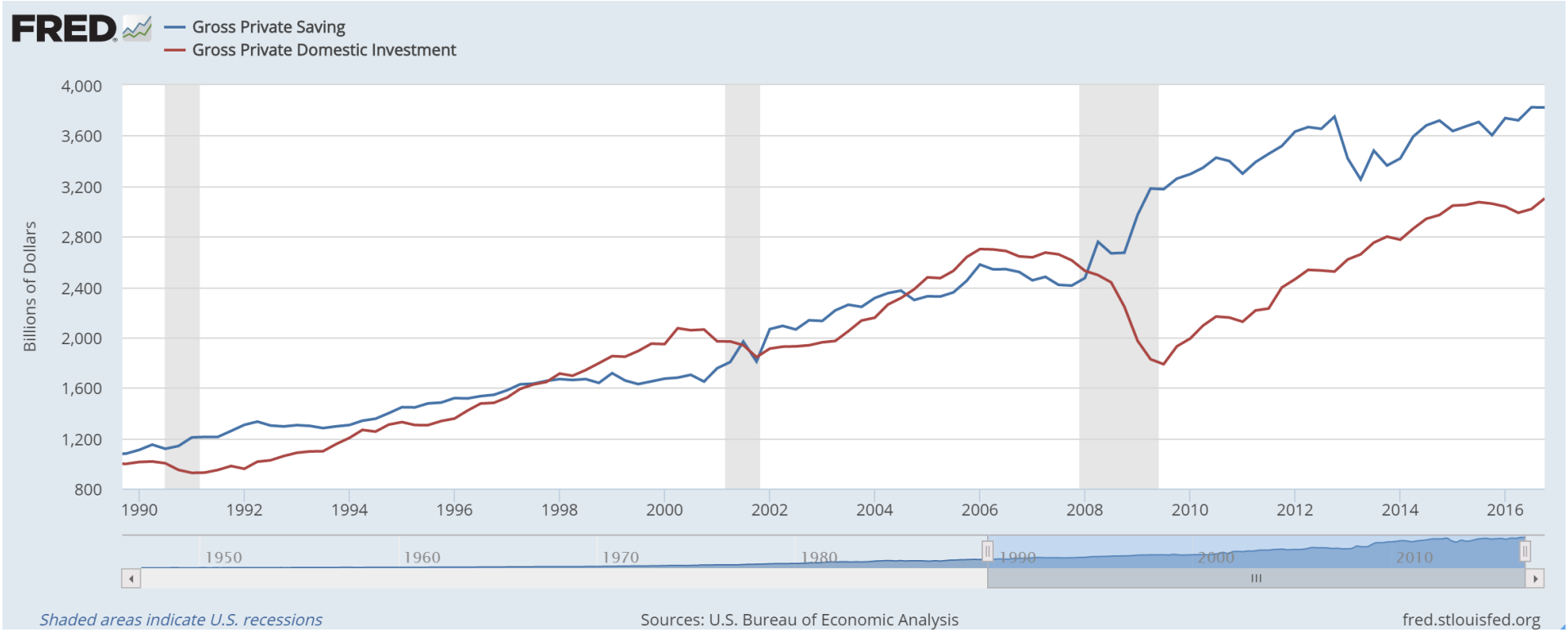
Impact of 5g and Clean Power on Global Growth

- Making global economy grow
  - Global growth disappointing
  - USA private savings exceed private investment
- Networks/platforms cause growth
  - Global growth of broadband
  - An increasingly connected world
  - Change happens fast
  - US GDP in 90s broke records
  - The golden decade
- 5G can be major driver of growth
  - Towards the 5G internet-of-things; data is the new oil
  - 5G can be engine of growth
  - National 5G infrastructure supporting automated driving
  - The 5G way to automated driving
- Clean power platform
  - $5.2 trillion more investment in renewables is needed above BAU to hit 2 degree target
  - Current trajectory of investment and set of activities is not sufficient to achieve goals
  - Need a switch from carbon to clean
- Policy Challenge: Bringing in the investment
  - Utility industry capital expenditures expected to decline by 20%
  - Broadband providers capex stagnant: who pays?

Global growth disappointing

US private savings>private investment



$721b gross private savings surplus in 2016; $7t cumulative gap since 2009

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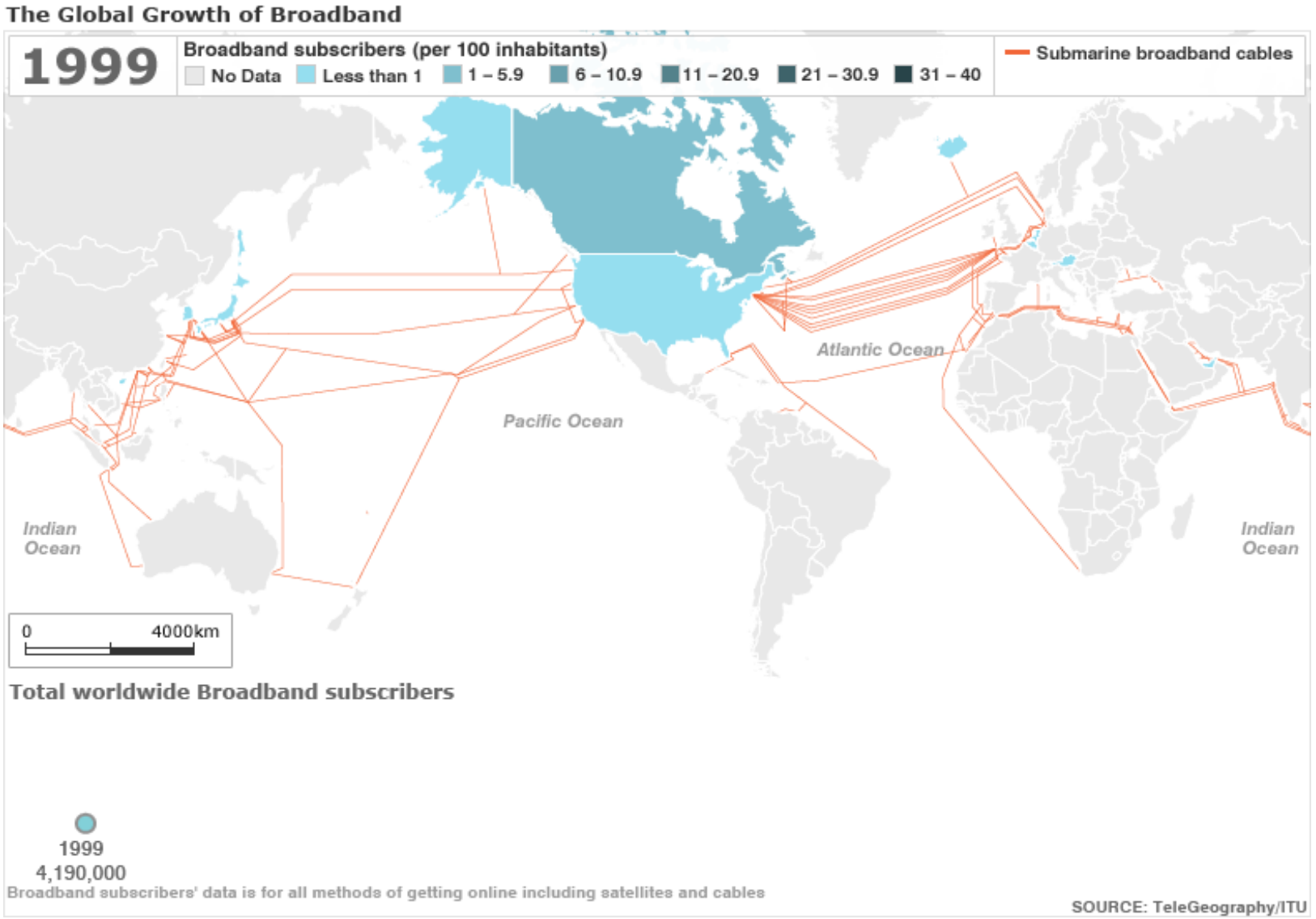
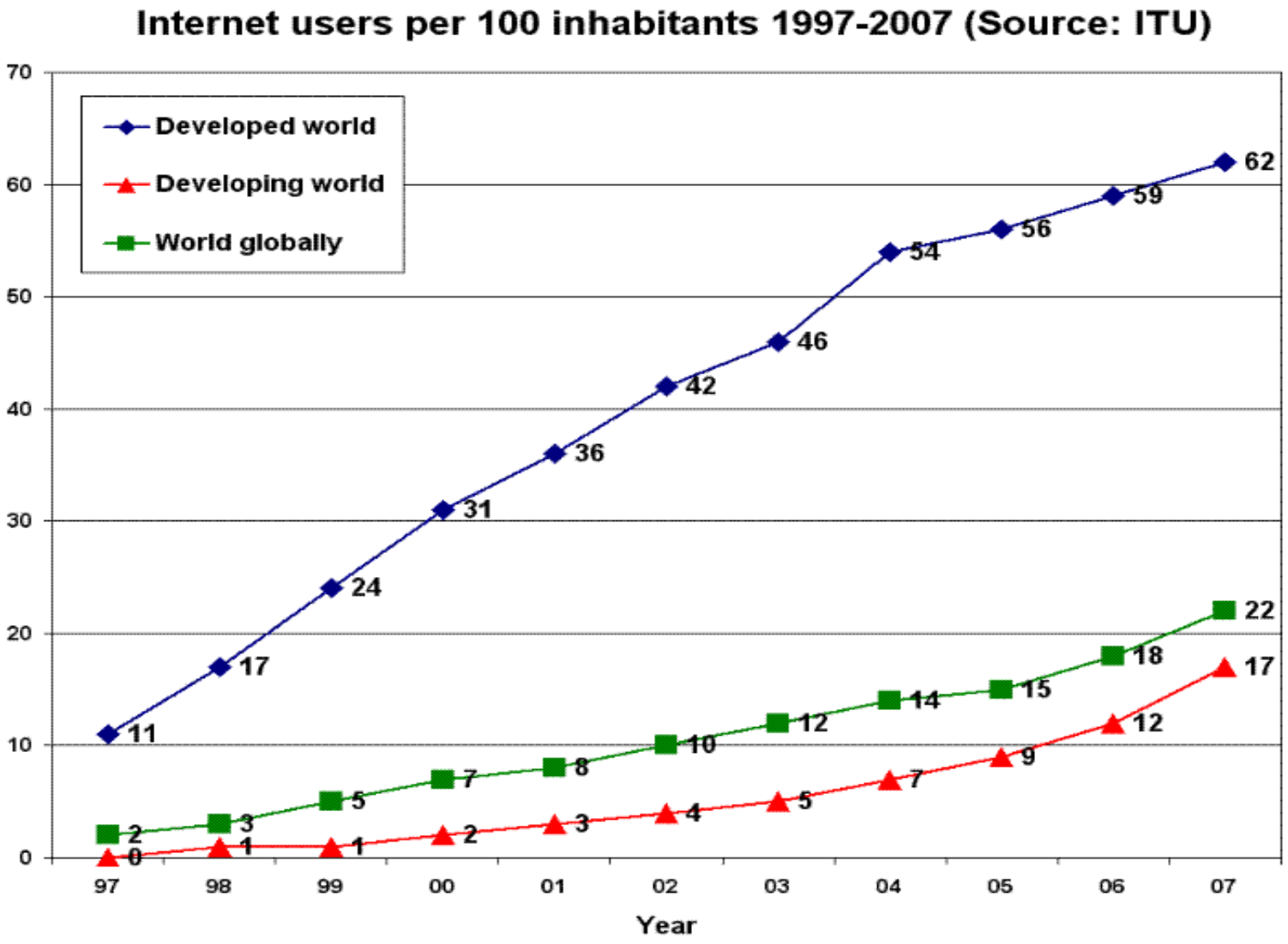
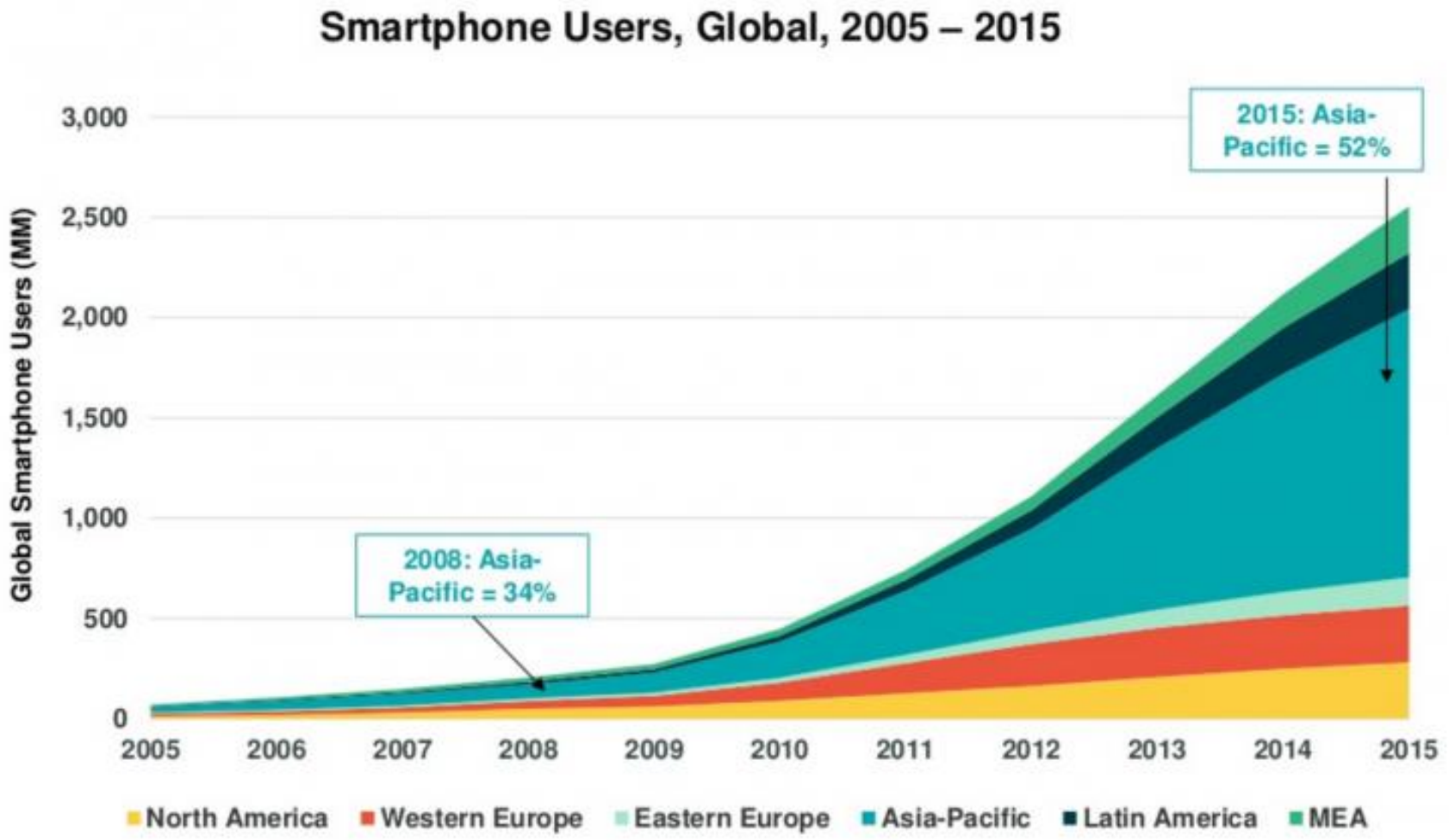
Global growth of broadband



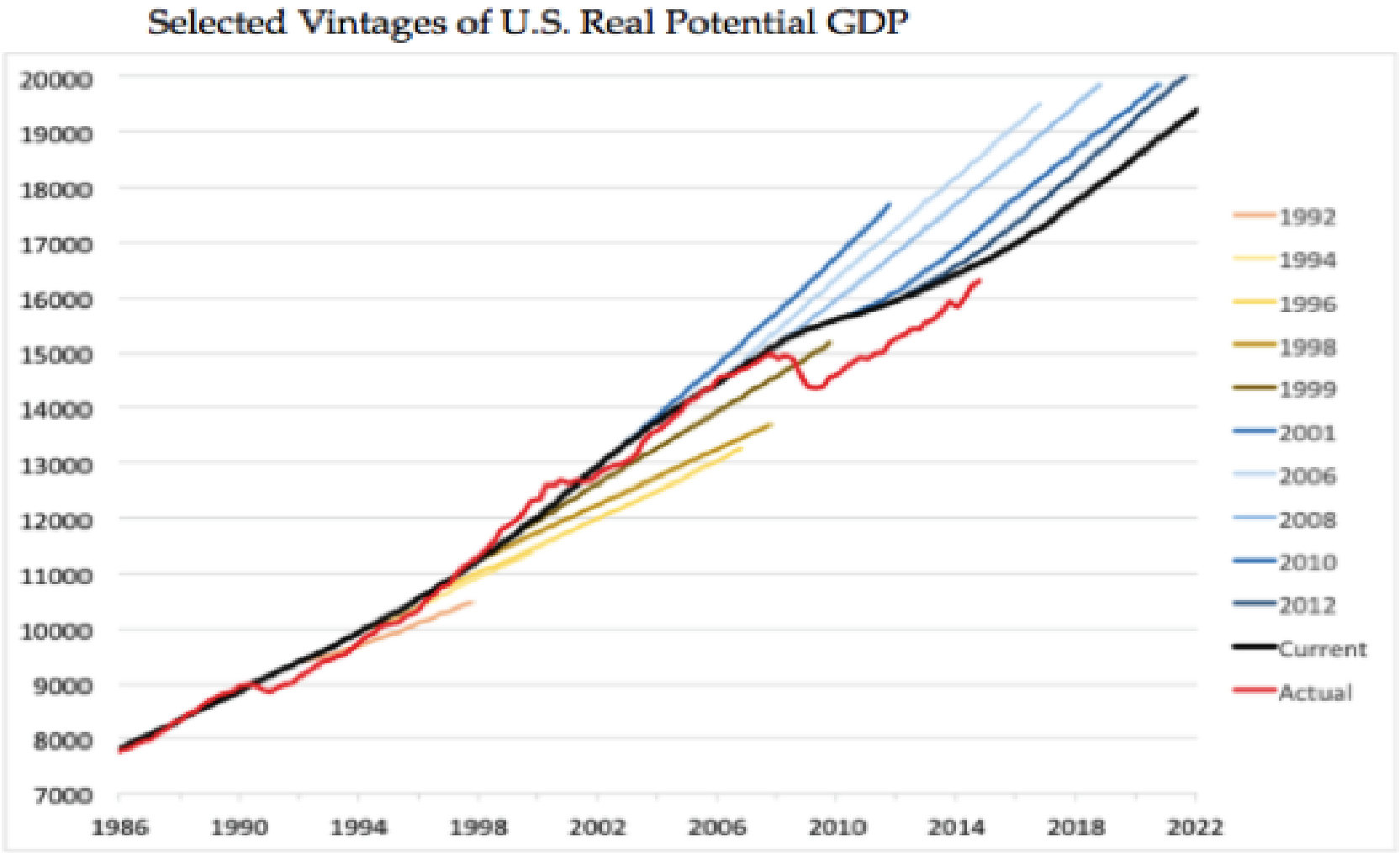
An increasingly connected world



Change happens fast

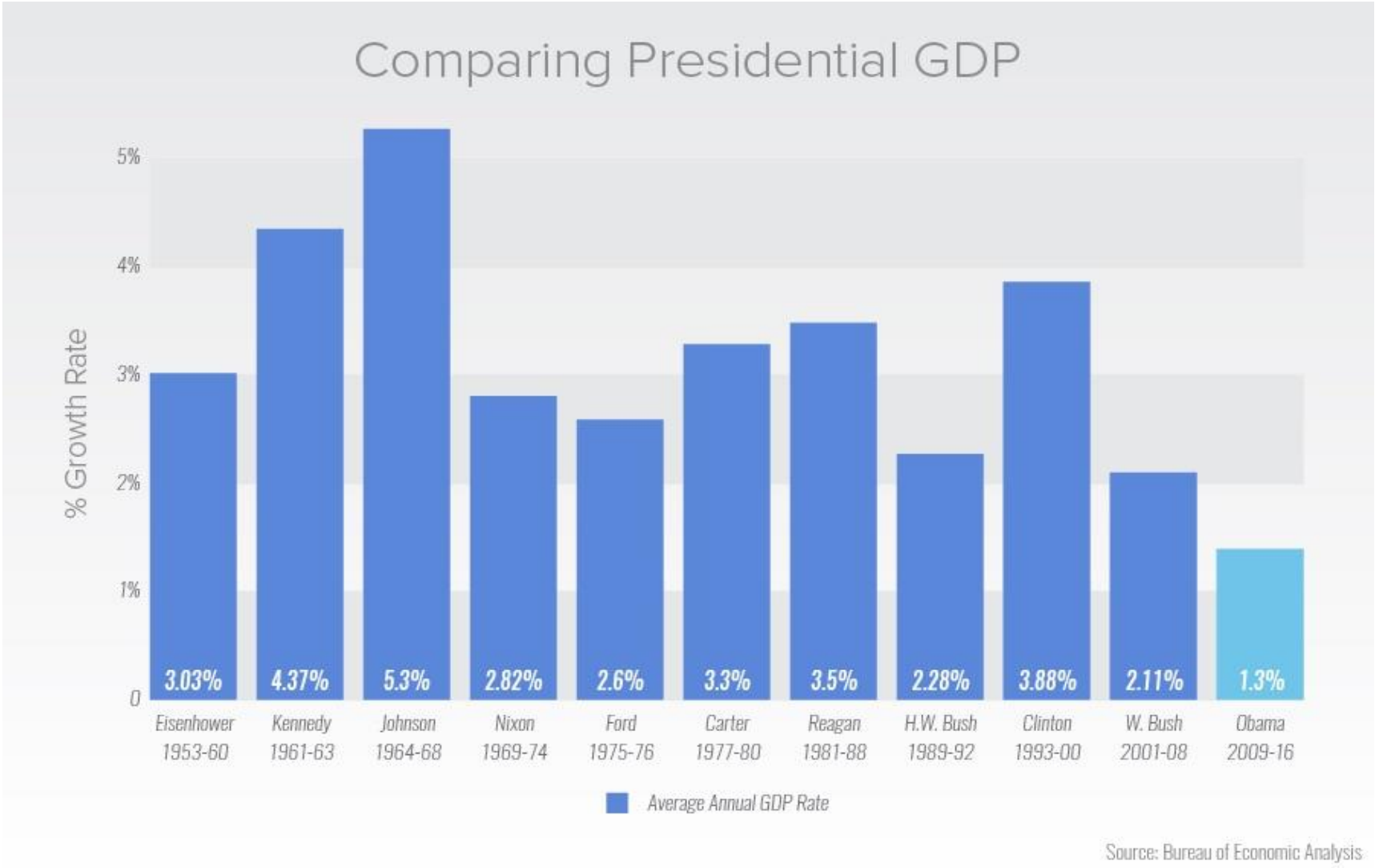


USA broke GDP records in 1990s



Source: CBO, Federal Reserve Bank of St. Louis (ALFRED) and authors' calculations

The golden decade



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Towards The 5G Internet-of-Things
Data Is The New Oil

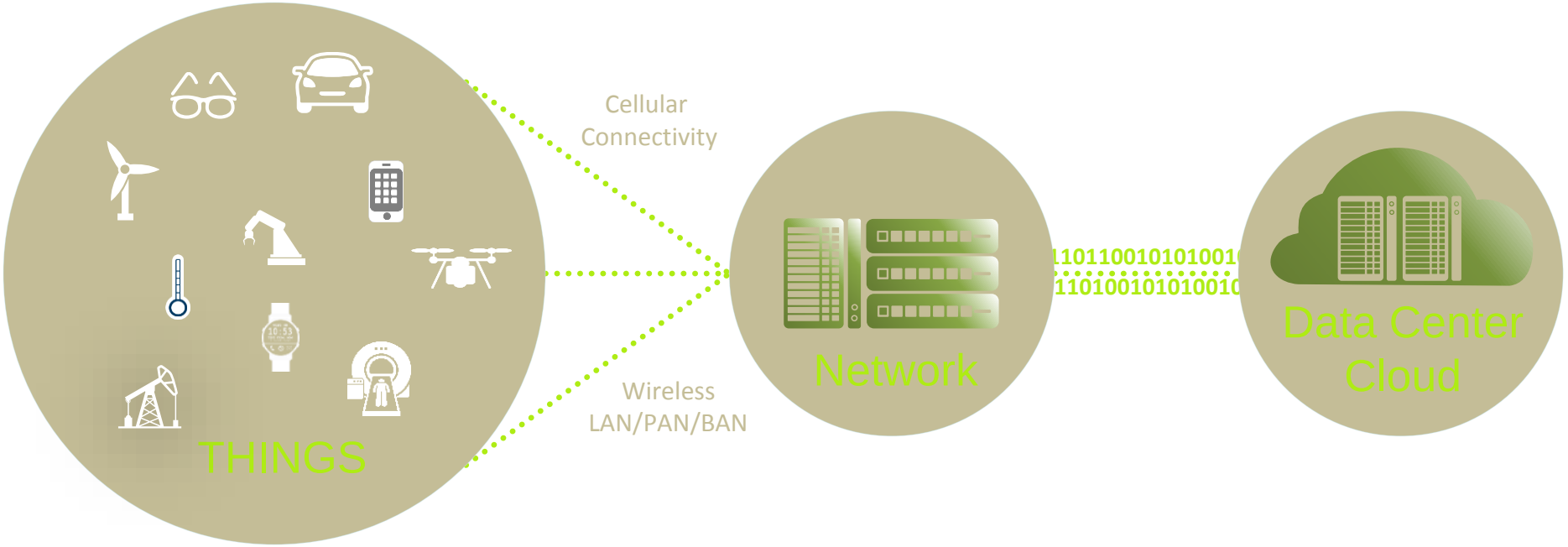
50 Bn
Things[1+2]

1.5 GigaByte
Internet user per day[3]

4 TeraByte
Self-driving car per day[4]

1 PetaByte
Connected factory per day[4]

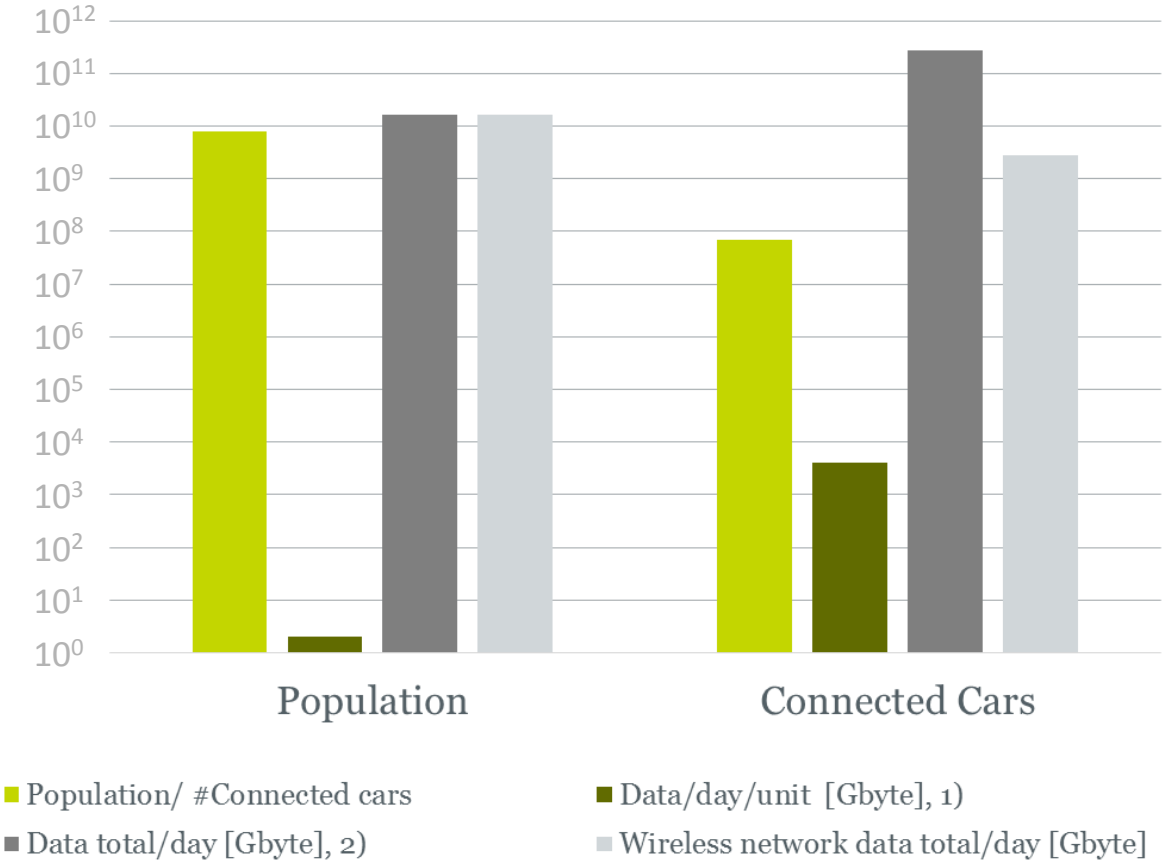
2.3 ZetaByte
Annual IP data[5] in 2020



Note: all figures (where applicable) are global.

1. IDC 2016: 212 Bn sensors in 2020, 1:n thing to sensor ratio varies with use case
2. 4Q15 Gartner connected devices forecast: installed base 20 Bn devices in 2020
3. Internet user includes fixed access and mobile users
4. IP data used in the car/ generated in the smart factory
5. 2016 Cisco VNI Global IP Traffic Forecast for 2021: 1 ZB = 1Zettabyte = 1 Bn Terabyte

5G can be engine of growth



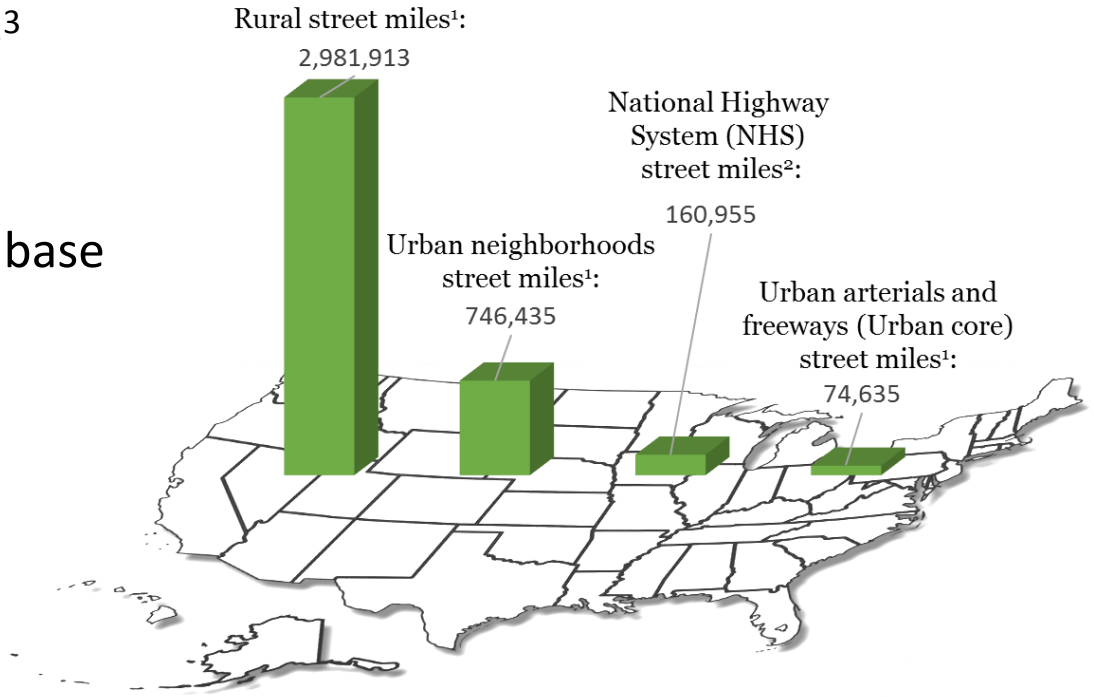
In **2027**:

- **16.5 Exabyte** global mobile data/ day[3)]
- **8.15 Bn** capita on earth[4)]
- 2 Gigabyte mobile data/capital/ day
- Connected cars: 3 Million self-driving to **70 Million** highly-automated cars[5)]
- **4 Terabyte** data/self-driving car/ day[6)]
- **40 Gigabyte** self-driving car data passing wireless network[7)]

1: Data used/ generated per day by member of population/ self-driving car
2: Total data used/ generated by population/ connected cars
3: CISCO VNI 2017: extrapolation with CAGR 2016 – 2021 of total mobile data traffic per month
4: https://en.wikipedia.org/wiki/World_population_estimates
5: http://www.transparencymarketresearch.com/autonomous-cars-driverless-cars-market.html: 90/ 3 Million fully autonomous cars in 2035/ 2027
The Advent of Unmanned Electric Vehicles, S. Van Themsche: 15%-20% of cars sold highly automated 2025 – 2030/ 70 Million automated cars in 2027
6: Intel: e.g. in www.networkworld.com/article/3147892/internet/one-autonomous-car-will-use-4000-gb-of-dataday.html
7: Combined from Hitachi: in qz.com/344466/connected-cars-will-send-25-gigabytes-of-data-to-the-cloud-every-hour and from U.S. DOT investigation on average vehicle travel: http://nhts.ornl.gov/2009/pub/stt.pdf

National 5G infrastructure supporting Automated Driving

- Full deployment until 2035[3]
- ~4 million miles
- Mix of 5G road-side units (~8 per mile) and 5G small base stations (~3 per mile)
- 28.5 million sites[4]
- 190 Bn $US CapEx (total)

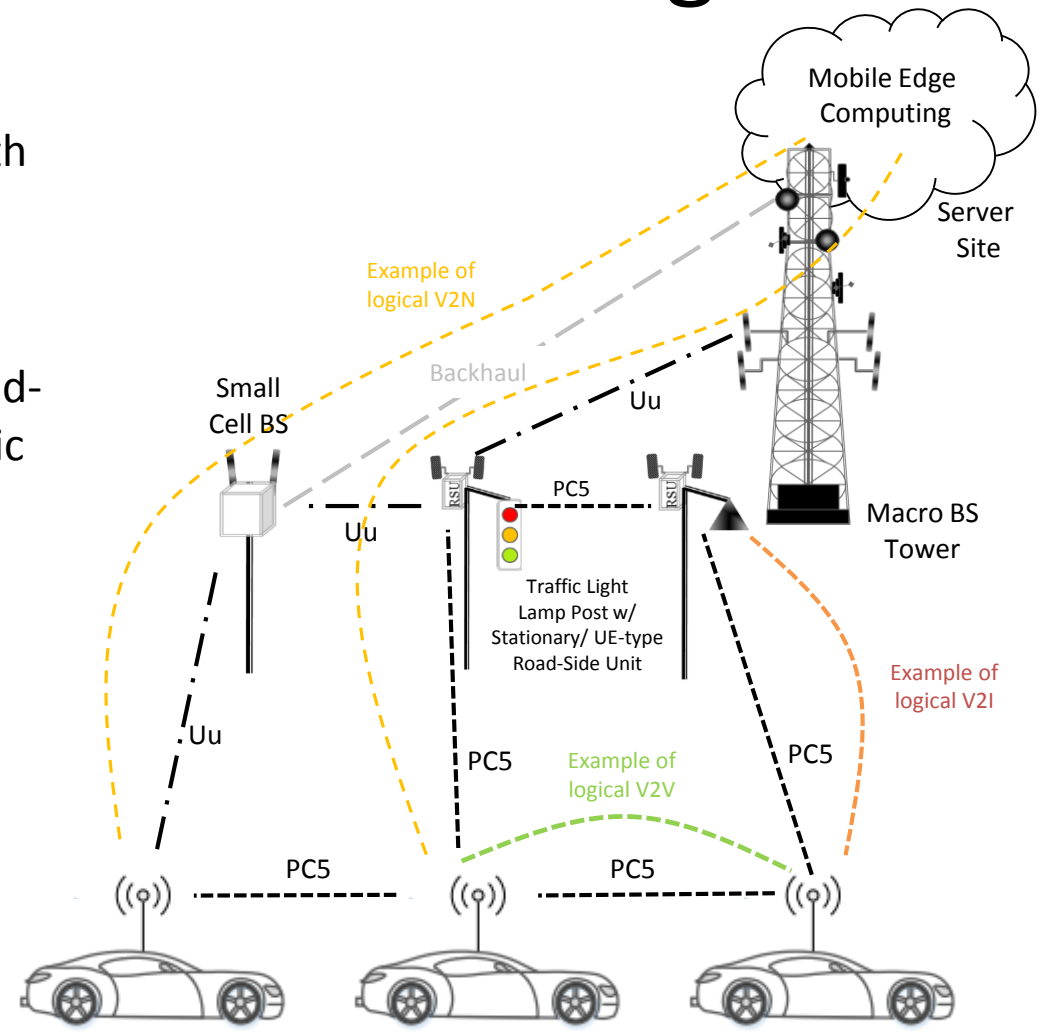


1) Source: National Connected Vehicle Field Infrastructure Footprint Analysis Deployment Scenarios, Final Report, December 27, 2013
2) Source: Wikipedia
3) 100% deployment complete in all categories in 2035, 100% deployment complete in NHS and Urban Core in 2030
4) Includes: 5G road-side unit sites, 5G small base station sites, core sites for Mobile Edge Computing (MEC), and Real-Time-Kinematics (RTK) sites

The 5G way to automated driving

All 5G V2X[1] communication paths with lowest latency and highest reliability:

- Vehicle-to-vehicle/ V2V
- Vehicle-to-infrastructure/ V2I: Road-side units e.g. in signal lights, traffic signs, parking meters, ...
- Vehicle-to-network/ V2N: Application server as close to the Mobile Edge as required
- Vehicle-to-pedestrian/ V2P



1) LTE V2X architecture (simplified) TR 23.785, 5G V2X expected to be similar, PC5: phys. UE-to-UE interface, Uu: phys. UE-to-RAN interface

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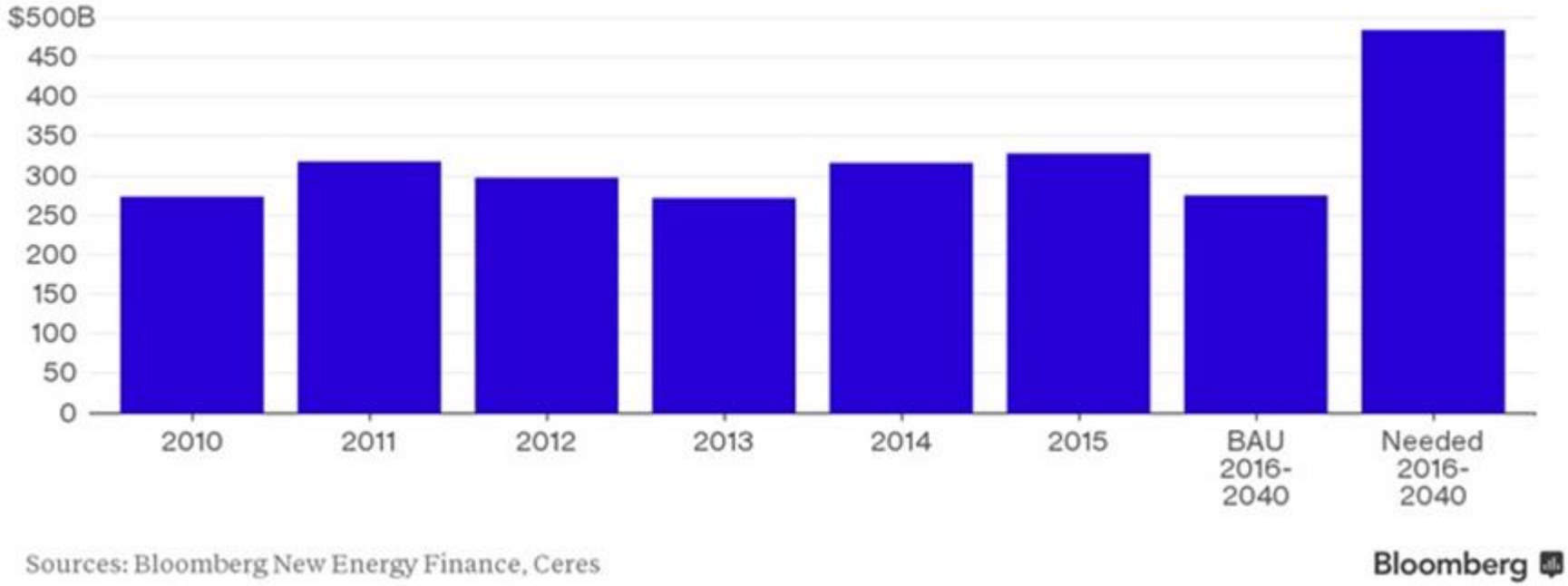
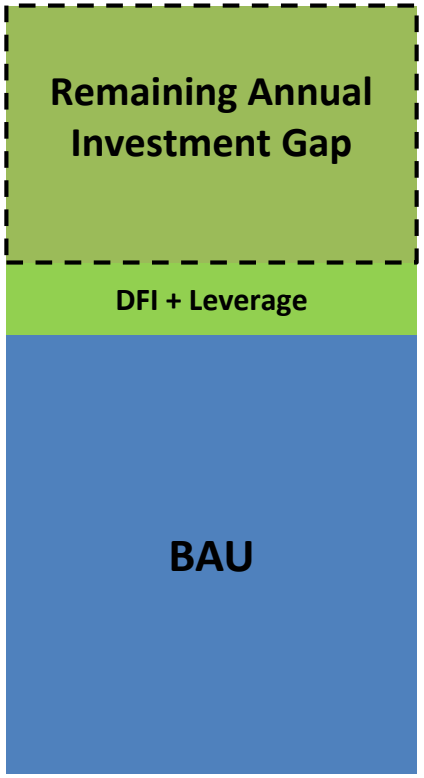


Annual global gap of more than $200B must be filled right now and for next 25 years

Current trajectory of global investment and set of activities is not sufficient to achieve goals

- DFIs have committed to increase size of their climate investments
- OECD has calculated these pledges will amount to annual increase of $23 billion.
- Assuming high leverage under OECD model, this will come with another $23 billion in private capital.
- Only fills 22% of gap.

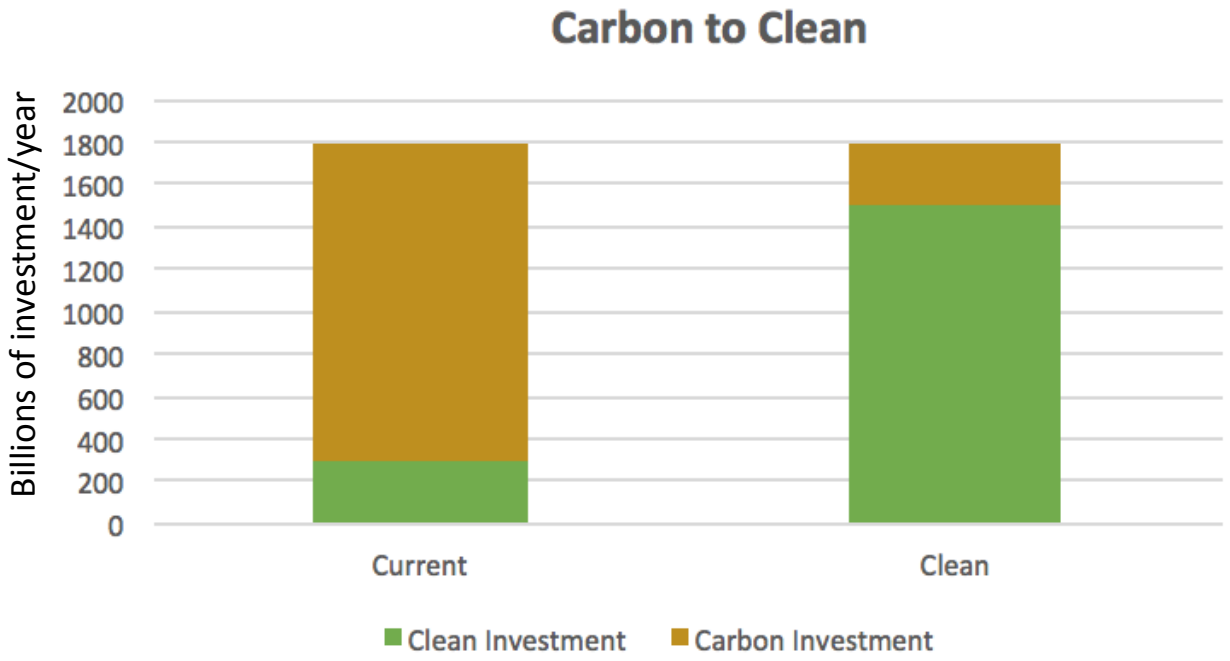
Still leaves, at least a $162 billion annual global investment gap



Source: Bloomberg

Need a global switch from carbon to clean

The Big Switch



Sources: International Energy Agency & Bloomberg New Energy Finance

This great switch must occur in less than a decade and produce clean energy that is affordable across developing economies.

Source: IEA, renewables plus efficiency, achieve goal by 2030

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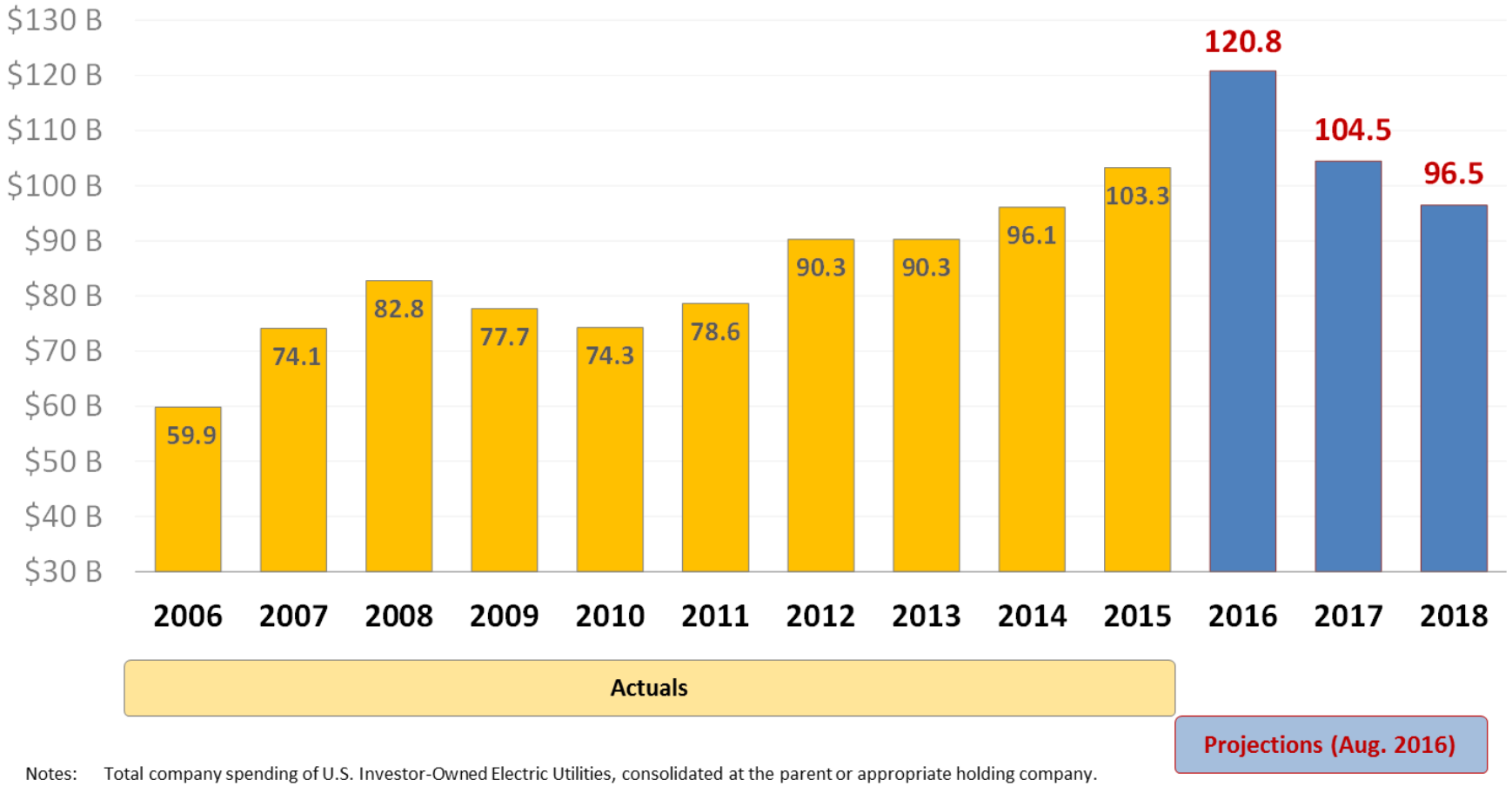
Utility industry capital expenditures expected to decline by 20%



Notes: Total company spending of U.S. Investor-Owned Electric Utilities, consolidated at the parent or appropriate holding company. Projections based on publicly available information and extrapolated for companies reporting fewer than three projected years (11% and 15% of industry for 2017 and 2018).

Source: EEI Finance Department, company reports, S&P Global Market Intelligence (August 2016).

Broadband provider capex stagnant: **who pays?**