CLEAN DISRUPTION

WHY CONVENTIONAL ENERGY AND TRANSPORTATION WILL BE OBSOLETE BY **2030**

Presentation to: Swedbank

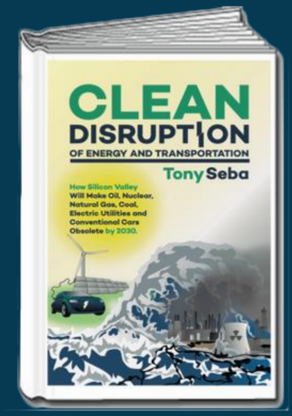
Nordic Energy Summit

Oslo, Norway

17 March 2016

Tony Seba

www.tonyseba.com



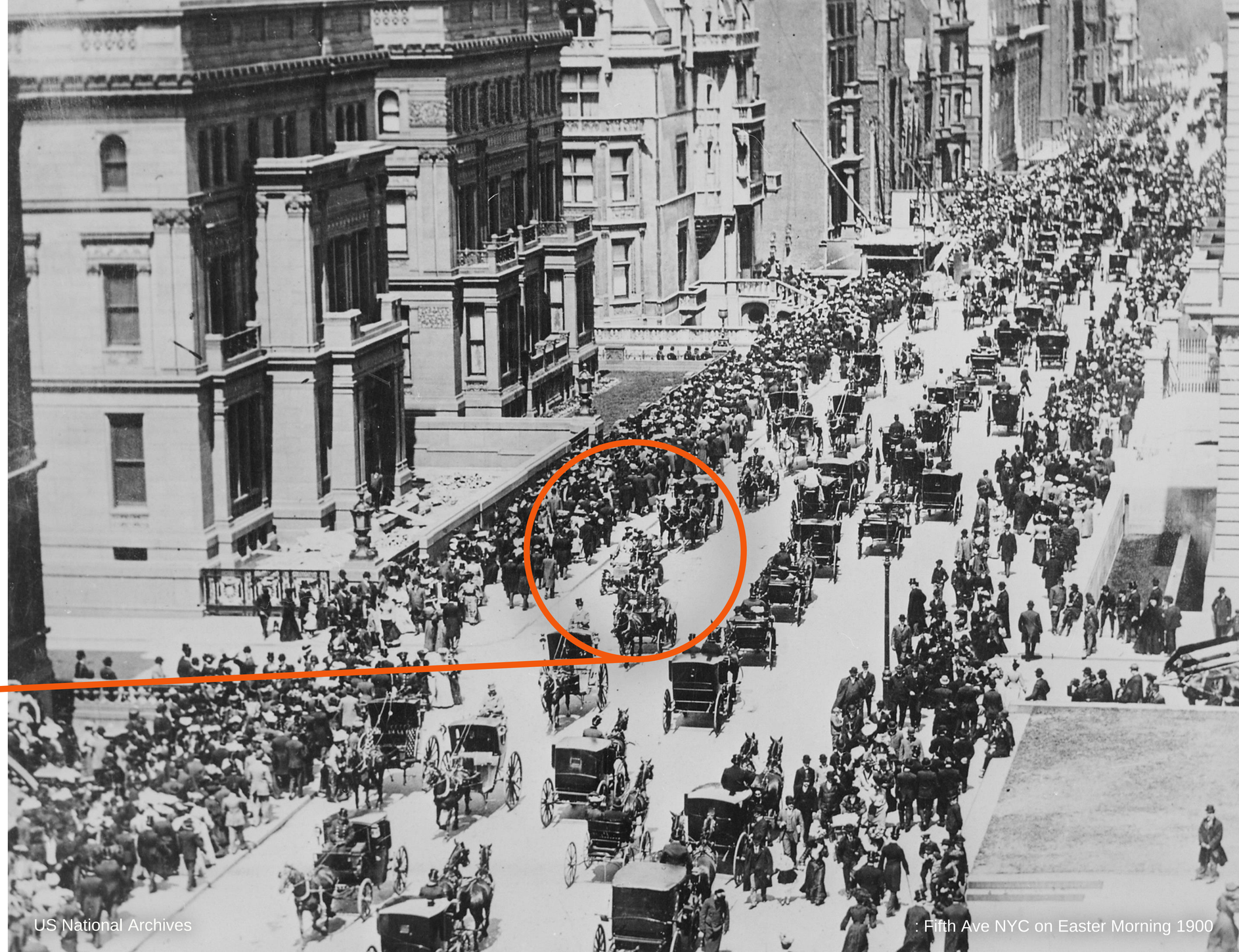
A STROLL DOWN

Memory Lane

5th AVE NYC

1900

Where is the car?



US National Archives

: Fifth Ave NYC on Easter Morning 1900

5th AVE NYC

1913

Where is the horse?

George Grantham Bain Collection

Photo: Easter 1913, New York. Fifth Avenue looking north.

TECHNOLOGY BASED

Disruption

Rodin – Thinker
Photo: Tony Seba

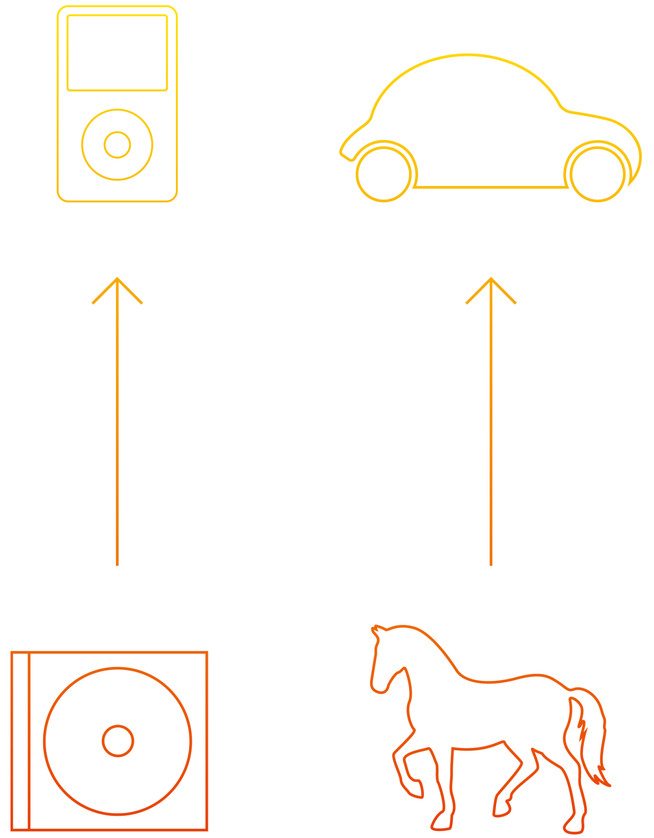
What is a Disruption?

WHEN A NEW PRODUCT OR SERVICE HELPS

create a new market

AND

significantly weaken,
transform, or
destroy an existing product,
market category / industry



FAST FORWARD TO 1985

1985

Image: GMAuthority.com

‘Expert’ Disruption Forecasts

In the mid-1980s AT&T hired McKinsey & Co to forecast cell phone adoption by the year 2000

THEIR (15-YEAR) PREDICTION

900,000

SUBSCRIBERS

THE ACTUAL NUMBER WAS

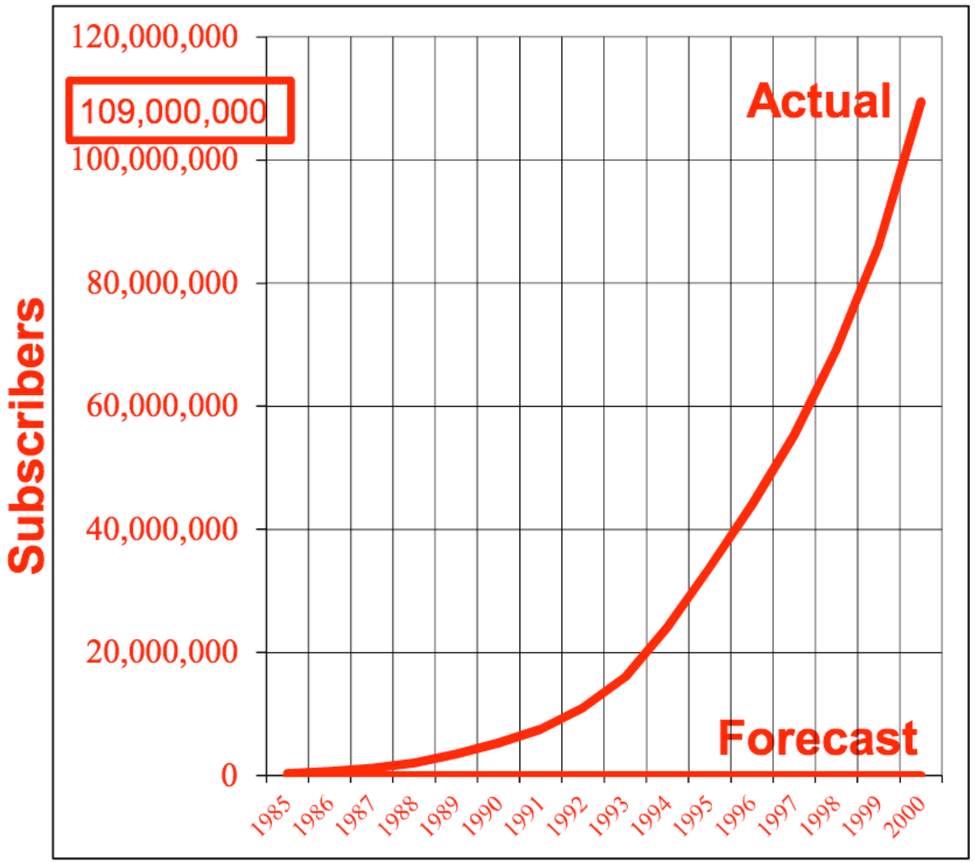
109 million

They were **off** by a factor of:

120 x

Motorola DynaTAC 8000X from 1984. Source: Wikimedia, Source: Economist

AT&T Disrupted - while $$ Trillions Created



	Company	Home Country	Market Cap. ($MM)
1	Apple	USA	$763,567
2	Google	USA	373,437
3	Alibaba	China	232,755
4	Facebook	USA	226,009
5	Amazon.com	USA	199,139
6	Tencent	China	190,110
7	eBay	USA	72,549
8	Baidu	China	71,581
9	Priceline Group	USA	62,645
10	Salesforce.com	USA	49,173
11	JD.com	China	47,711
12	Yahoo!	USA	40,808
13	Netflix	USA	37,700
14	LinkedIn	USA	24,718
15	Twitter	USA	23,965
Total Market Cap of Top 15			$2,415,867

$2.4 trillion - Market Cap Top 15 Global Internet Public Companies (2)

- AT&T's landline telephony market was disrupted
- It missed out on multi-trillion dollar opportunities!

Subscriber Data Source: CTIA - The Wireless Association Internet Companies: Internet Report 2015 - Mary Meeker

It's usually the 'experts' and 'insiders' who dismiss Disruptive Opportunities

"The Internet will catastrophically collapse in 1996."

Robert Metcalfe, 1995

"There is no reason anyone would want a computer in their home."

Ken Olson, 1977

"I do not believe the introduction of motor-cars will ever affect the riding of horses."

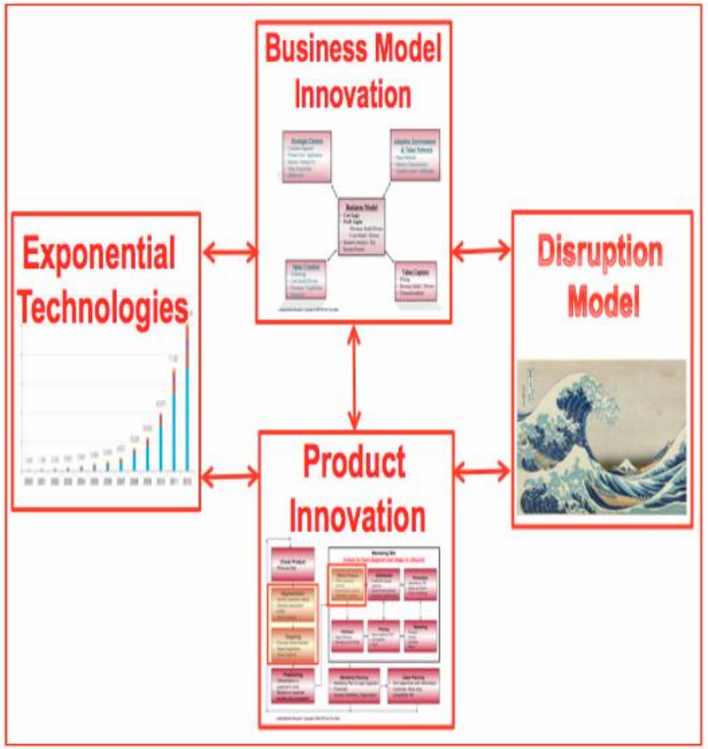
Scott-Montague, 1903

Why do smart people at smart organizations consistently fail to anticipate or lead Market Disruptions?

Rodin – Thinker
Photo: Tony Seba

Created New Tech Disruption Framework to Anticipate / Lead Market Disruptions

1. Disruption Models
2. Exponential Technologies
3. Business Model Innovation
4. Product Innovation



EXPONENTIAL

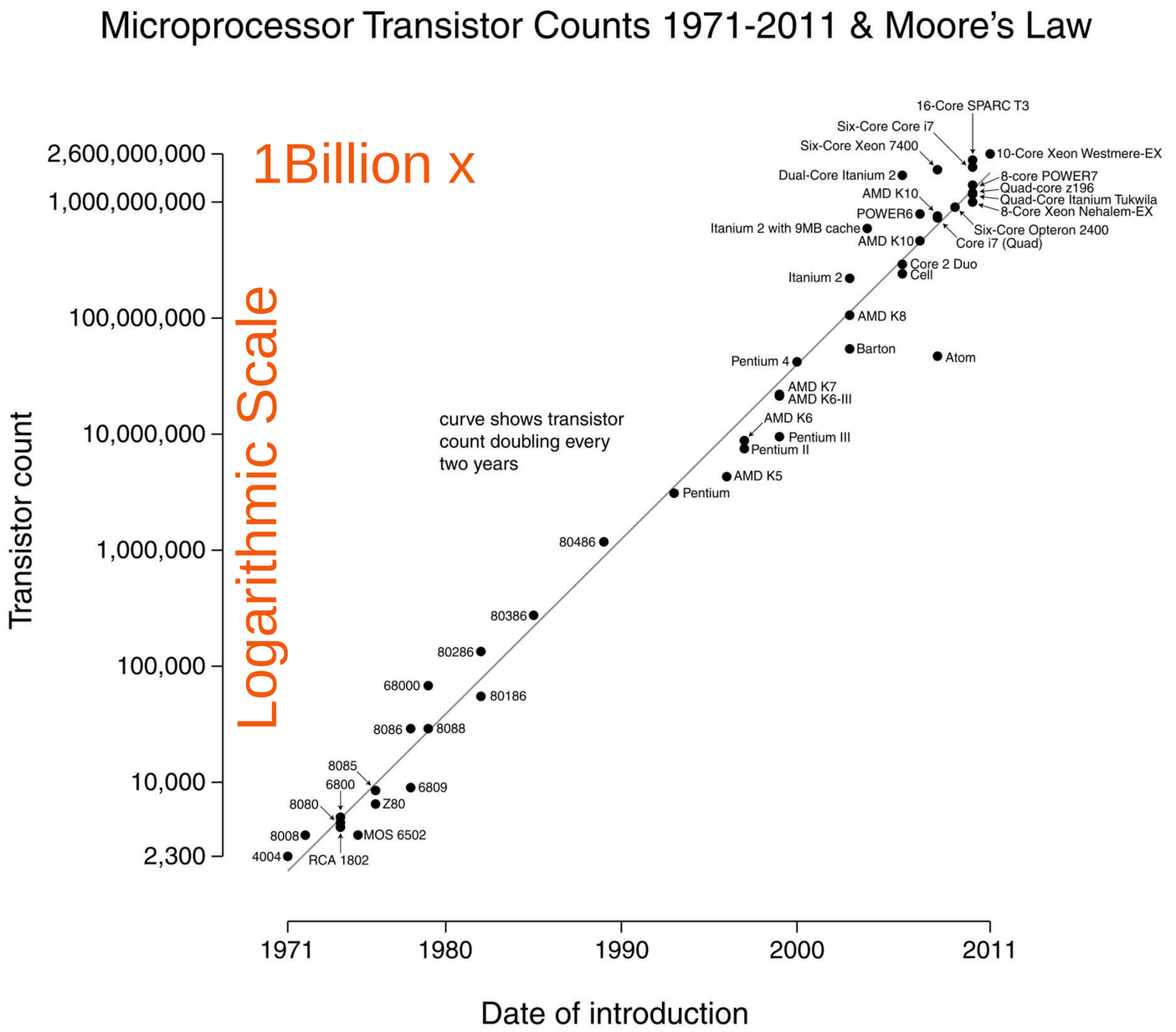
Technologies

“If the rate of change on the outside is greater than the rate of change on the inside, the end is near.”

JACK WELCH

Computing: Moore's Law (1971 - 2011)

- # of transistors doubles (roughly) **every two years**.
- Annual improvement rate **~41.4%**
- Exponential growth in # of transistors



Source: Wikipedia

PC / Internet / Mobile Phone industries: Convergence of Exponential Technologies

- **Technologies improving at exponential rates**

- **Data Storage** – Kryder's Law
  - Hard Disk $ cost per bit down **50% every 18 months**

- **Digital Imaging** – Hendy's Law
  - Pixels per $ - **59% / year**

- **Network Capacity** – Butter's Law of Photonics
  - The $ cost of transmitting a bit decreases by **50% every 9 months**

Source: Wikipedia Image: apple.com

2016: Key Exponential Technologies

1. Sensors / Internet of Things
2. Artificial Intelligence / Machine Learning
3. Robotics
4. Solar PV
5. Energy Storage
6. 3D Printing
7. 3D Visualization
8. Mobile Internet & Cloud
9. Big Data / Open Data
10. Unnamed Aerial Vehicles / Nano Satellites
11. eMoney / eFinance

Sensors: 1,000X changes in 7 Years (2007 - 2014)

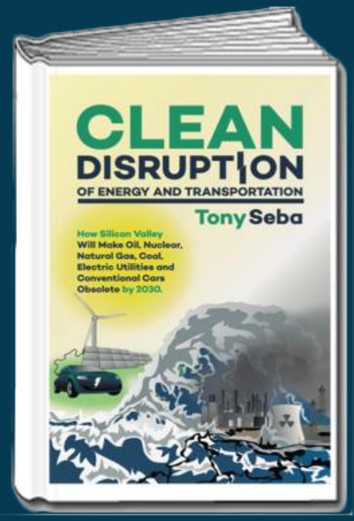
UNIT	CHANGE	COMMENTS
Number of **Sensors**	UP 1,000x	From 10 million to 10 billion
Cost	DOWN 1,000x	E.g., from $250/axis for gyros to $0.75 for three axis
Power consumption	DOWN 1,000x	From W to mW and mW to µW, depending on sensor
Physical **Size**	DOWN 1,000x	E.g., gyro from 2,000 mm^3 to 2 mm^3/axis
Number of **Transistors**	UP 1,000x	From 1,000s per sensor to 1,000,000s/sensor

On the road to trillions of censors: Exponential Unit Growth

Source: Janusz Bryzek, TSensors

CLEAN DISRUPTION OF ENERGY & TRANSPORTATION

1. Energy Storage
2. Electric Vehicles
3. Self-driving Cars
4. Solar



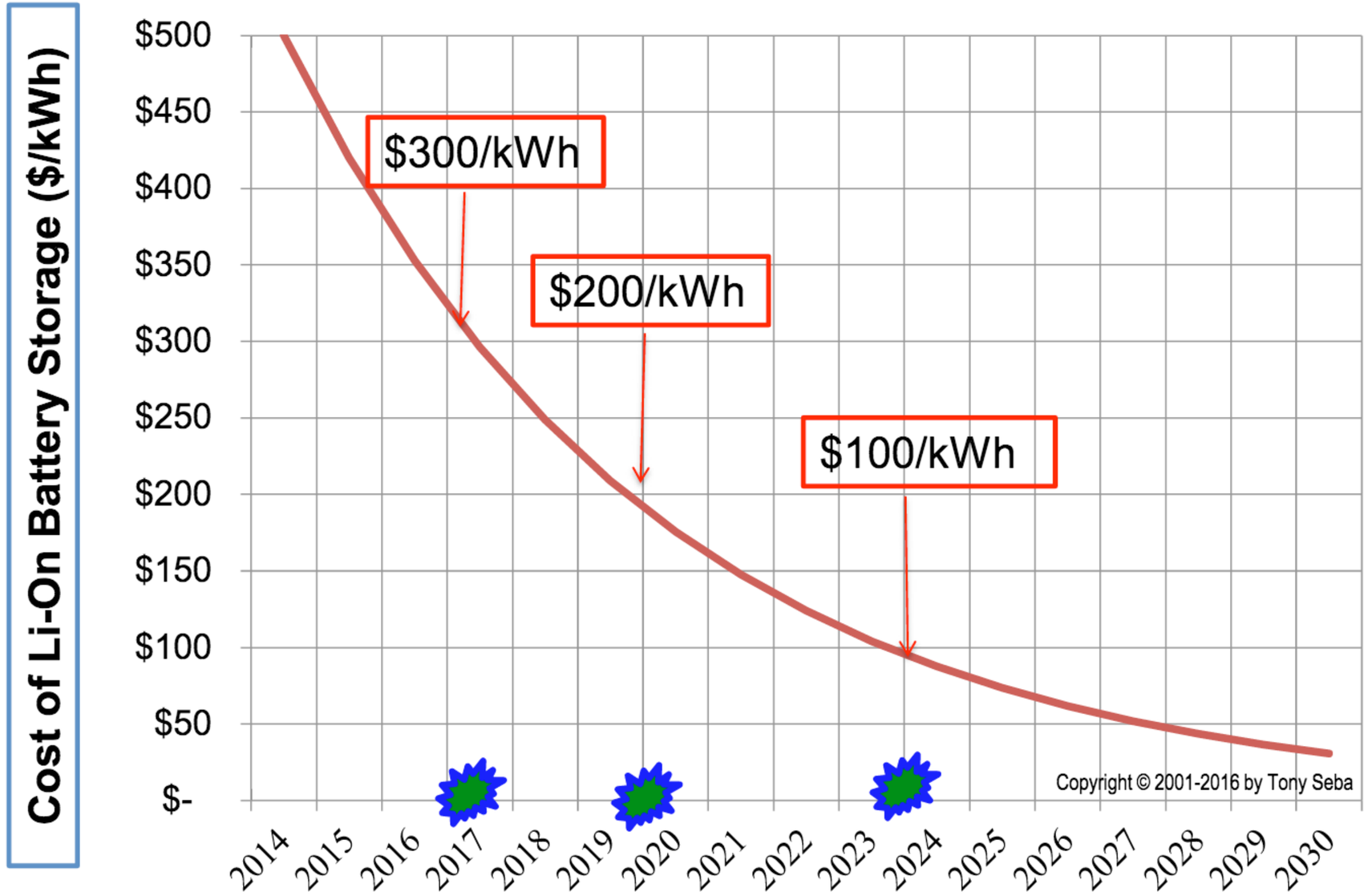
1 Energy Storage

Li-on Battery costs dropping exponentially

- **Laptop Li-on battery costs dropped ~14% per year over 15 years.** (1)
- Investments in battery tech increasing dramatically:
  - **3 multi-trillion $ industries investing:**
    1. **IT/ Electronics**
    2. **Automotive**
    3. **Energy**
- Since 2010, battery costs have dropped at ~**16%/year ⟶ ACCELERATING**

(1) Clean Disruption

Projected cost of Li-On Battery $/kWh



Assumption: 16% /year Technology Cost Curve

Source: Clean Disruption

Tesla's Battery GigaFactory

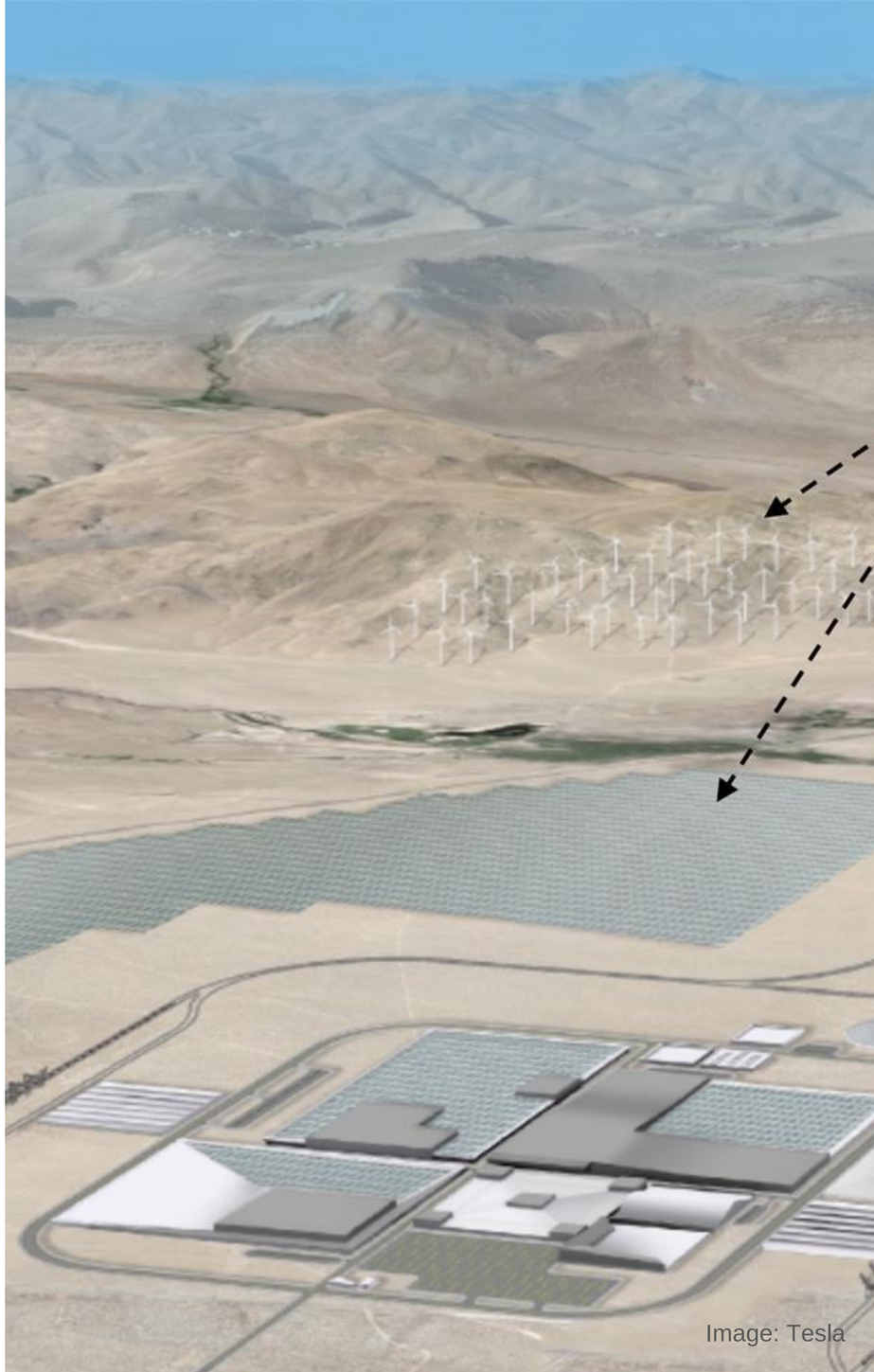
- $5 Billion investment (6,500 jobs)
- Battery pack output: 50 GWh year

  ⟶ 500,000 cars/year

- Double world battery production

Reduce battery pack costs by 30-50+ %

Tech improvement. "Tesla expects to increase pack capacity by roughly 5% per year." (1)



Sources: Tesla, (1) ChargeDevs Mag

Image: Tesla

Tesla's Battery—Ahead of the curve

Tesla PowerWall residential battery

$350/kWh (7kWh or 10kWh)

Tesla Microgrid/Commercial battery

$250/kWh For Commercial/Microgrid (100kWh)

Image: Tesla

Market reaction: Tesla received

$800+million in orders/ reservations first week!

Sources: Tesla, Bloomberg

Battery Megafactories are coming!

- **BYD** plans to add **6 GWh** every year.
  - Could ramp up to **34 GWh** by 2020 - matching Tesla's **35 GWh** (1)
- **Foxconn** and **LG Chem** could add combined **22 GWh** (2)
- Nissan: 4.5 GHh
- **Samsung SDI**, TDK, Apple, Bosch, VW, etc.

Tech Cost Curve could accelerate!

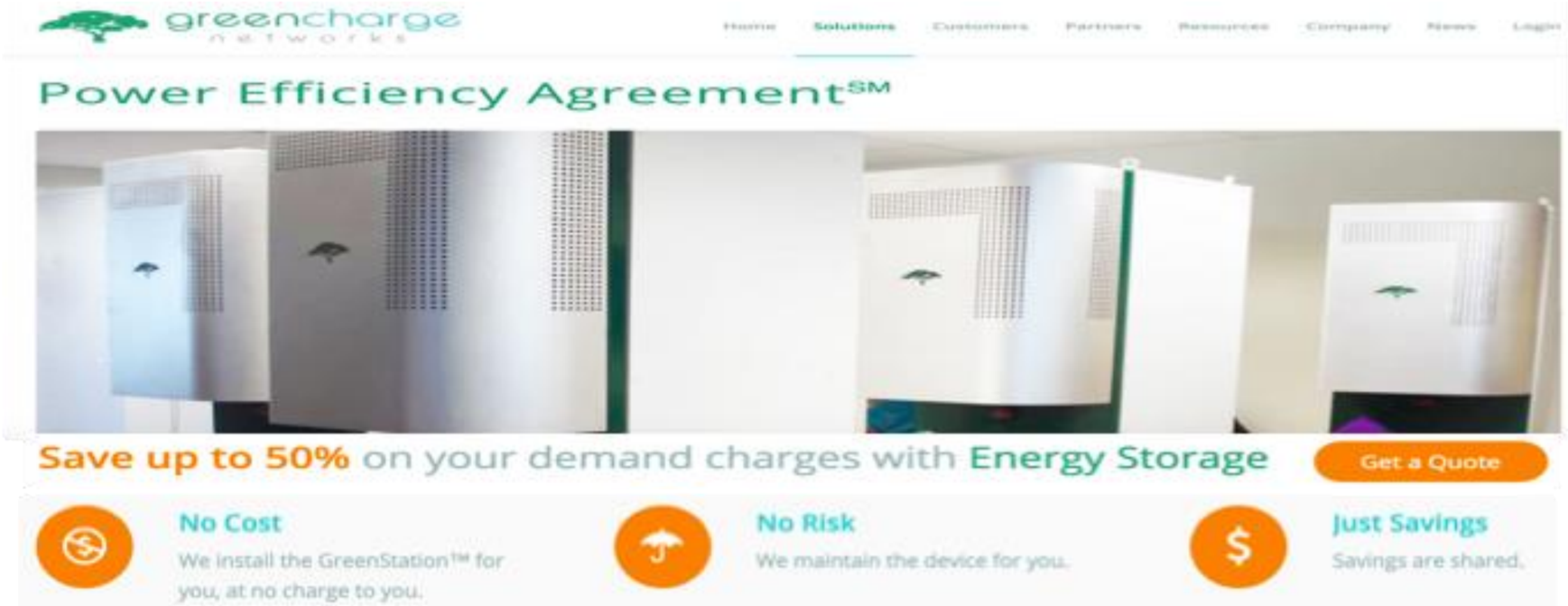
Image Source: Samsung SDI

Sources: (1) Reuters, (2) Benchmark Minerals

ENERGY STORAGE

Business Model Innovation

Business Model Innovation: Storage as a Service



- Stem and GreenCharge Networks offering **storage-as-service** to reduce DEMAND CHARGES for businesses
  - **Zero-money down**, 10 years
- **Lower utility bills by 10-50%** (1)
- Similar business model that made solar skyrocket

Sources: (1) Bloomberg

Storage Disruption - Residential and Commercial

- Average American consumes 903 kWh/month ⟶ ~ 30kWh/day
- By 2020 it will cost $36.8/month ($1.2/day) for a full day of electricity storage

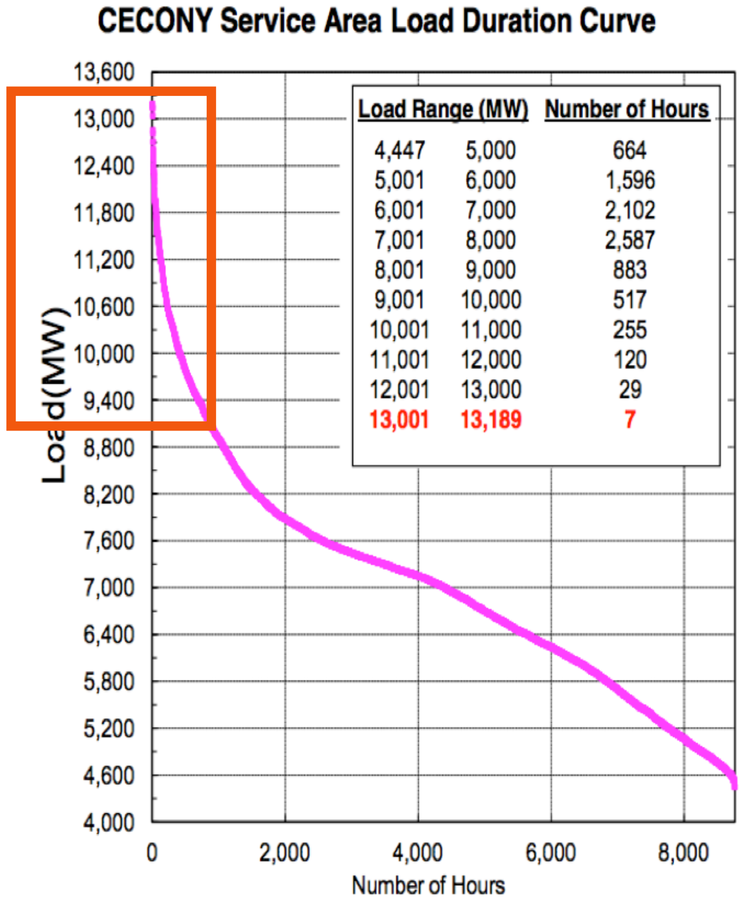
Monthly Cost of Residential Storage		Target Year ->	2014		**2020**	2024	2028
Purchase Cost of Battery Storage System (**$/kWh**) ->			**$600**	**$500**	**$300**	**$200**	**$100**	**$50**
SaaS Services	Hours	kWh	**Storage: Monthly Cost**					
Demand Response	1	1.25	$4.6	$3.8	$2.3	$1.5	$0.8	$0.4
Avoid peak, buy low & shift usage	4	5	$18.4	$15.3	$9.2	$6.1	$3.1	$1.5
Store all solar self-generation	8	10	$36.8	$30.7	$18.4	$12.3	$6.1	$3.1
Self-sufficiency	16	20	$73.6	$61.3	$36.8	$24.5	$12.3	$6.1
Off-grid	24	30	$110.4	$92.0	$55.2	**$ 36.8**	$18.4	$9.2

Assumptions: 4% cost of capital (mortgage) over 20 years

Source: Clean Disruption

Storage Disruption - Grid Scale

- The grid works like a **just-in-time supply chain without inventory**
- Grid: inefficient use of Assets
  - $$ Billions in generating assets used just a few hours per year
- Ex: ConEd - **32%** of Generation **assets** used < 517 hrs/yr (5.9%)
  - 189 MW used 7 hrs (0.08%)
  - 1 GW used 29 hrs (0.33%)
  - 1 GW used 120 hrs (1.37%)
- **Energy Storage can replace generation assets on the grid**
  - Peaking power = obsolete



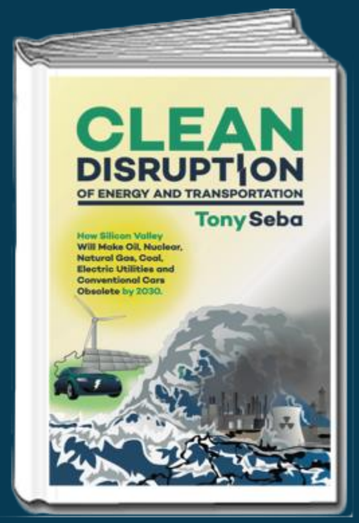
"Post 2020 there may never be another peaker built in the US."

NextEra Energy CEO Jim Robo (2)

Sources: (1) Consolidated Edison of New York, (2) GreentechMedia

2 The Electric Vehicle Disruption

Photo: © Tesla Motors



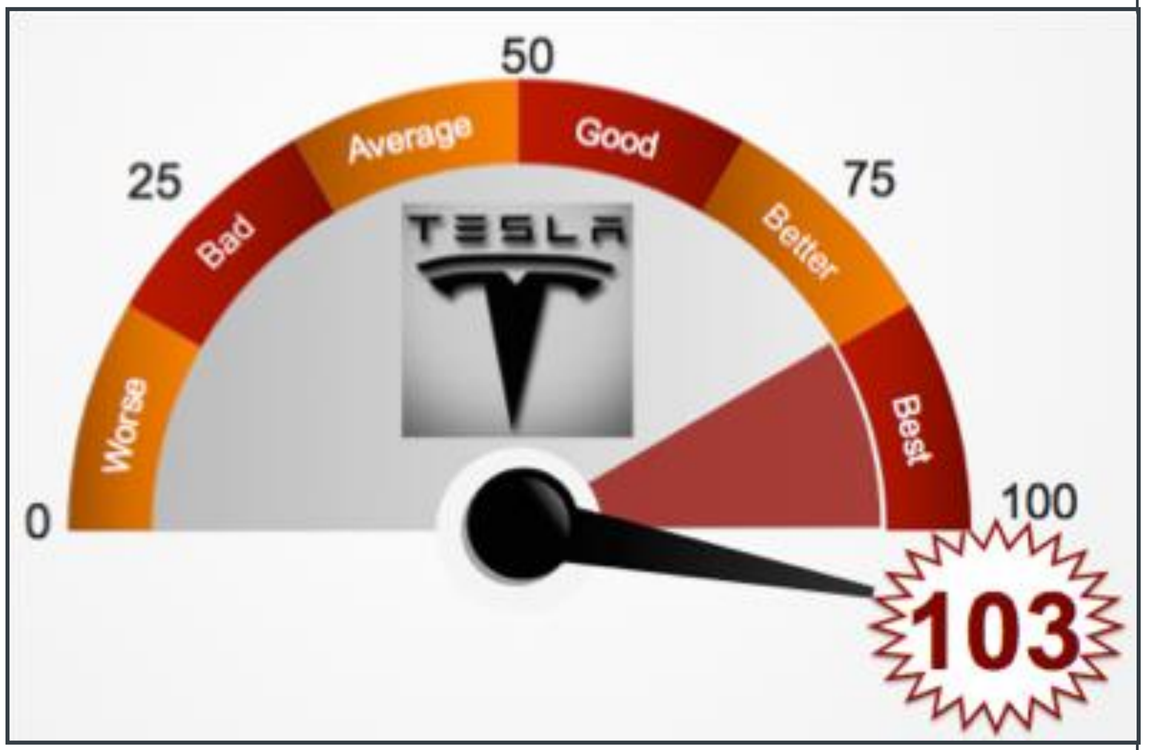
2013 CAR OF THE YEAR: TESLA MODEL S

"It drives like a sports car, eager and agile and instantly responsive. But it's also as smoothly effort-less as a Rolls-Royce and carry almost as much stuff as a Chevy Equinox. Oh, and it'll sashay up to the valet at a luxury hotel like a supermodel working a Paris catwalk."

Consumer Reports:

Best Car EVER! (1)

Best-selling high-end large luxury car in America! (2)



Source: Motor Trends, (1) Consumer Reports, (2) ExtremeTech.com

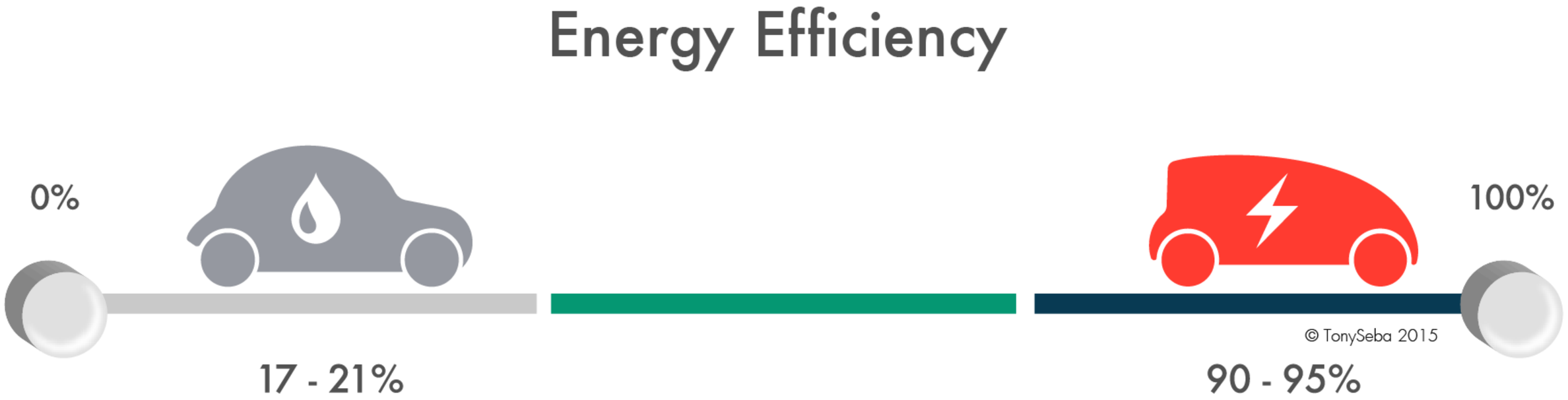
Photo: © Tony Seba

IS THE ELECTRIC VEHICLE Disruptive?

(You always need to ask)

Rodin – Thinker
Photo: Tony Seba

1. Electric Motor - 5X more Energy Efficient



Internal Combustion Engine

Electric Motor

Sources:ICE - DOE, EM Wikipedia, Image Sources: ICE - Tony Seba, Electric - BradMerritt.com

2. EVs are 10X cheaper to charge/fuel

- It costs $15,000 to fill up a (gas) Jeep Liberty over five years (Consumer Reports)
- An Electric Jeep Liberty would cost $1,565 in electricity
- Improvements in power electronics will increase 10X


Image Source: jeep.com

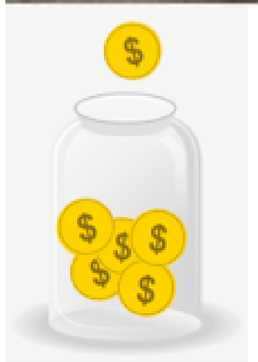
Assumptions:

12,000 miles/year

Tesla Roadster: 4.6 miles per kWh.

Ave retail electricity in the U.S.: 12 ¢/kWh

5 year-cost = (60,000 miles * 0.12 $/kWh) / 4.6 miles/kWh = $1,565.



Sources: Consumer Reports, DOE, Clean Disruption

3. Maintenance - Gasoline Car: 2,000+ moving parts (1)

Image Source: © Todd McLellan

Source: (1) Baron Funds

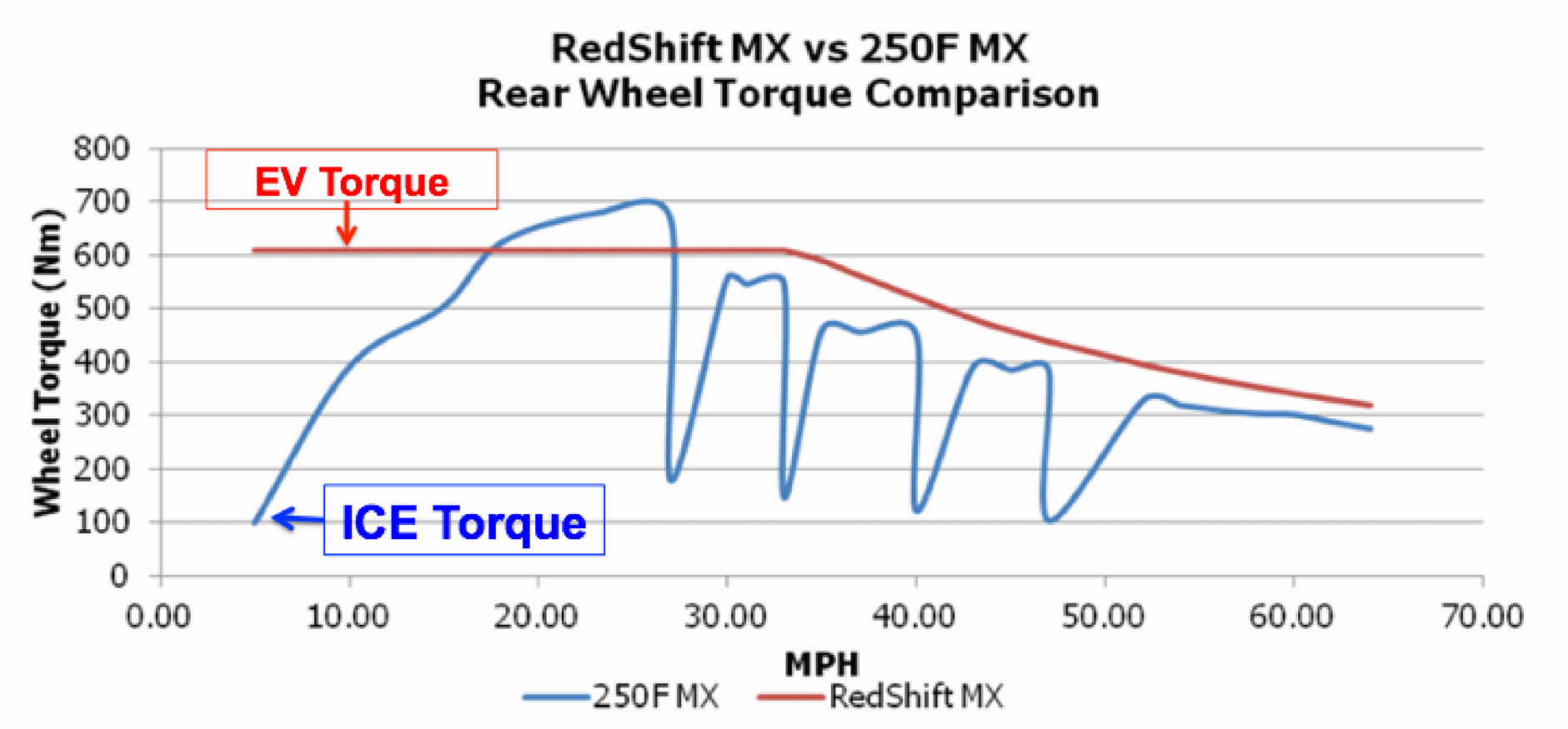
3. EVs: 100X fewer Moving Parts

ICE (Gas) Vehicle	Electric Vehicle (EV)
2,000+ moving parts (1)	18 moving parts (1)
Transmission, driveshaft, clutch, valves, differentials, pistons, gears, carburetors, crankshafts...	

- EVs 10X-100X cheaper to maintain!
- Tesla: Infinite Mile Warranty! (2)

Source: (1) Baron Funds, (2) Tesla Blog

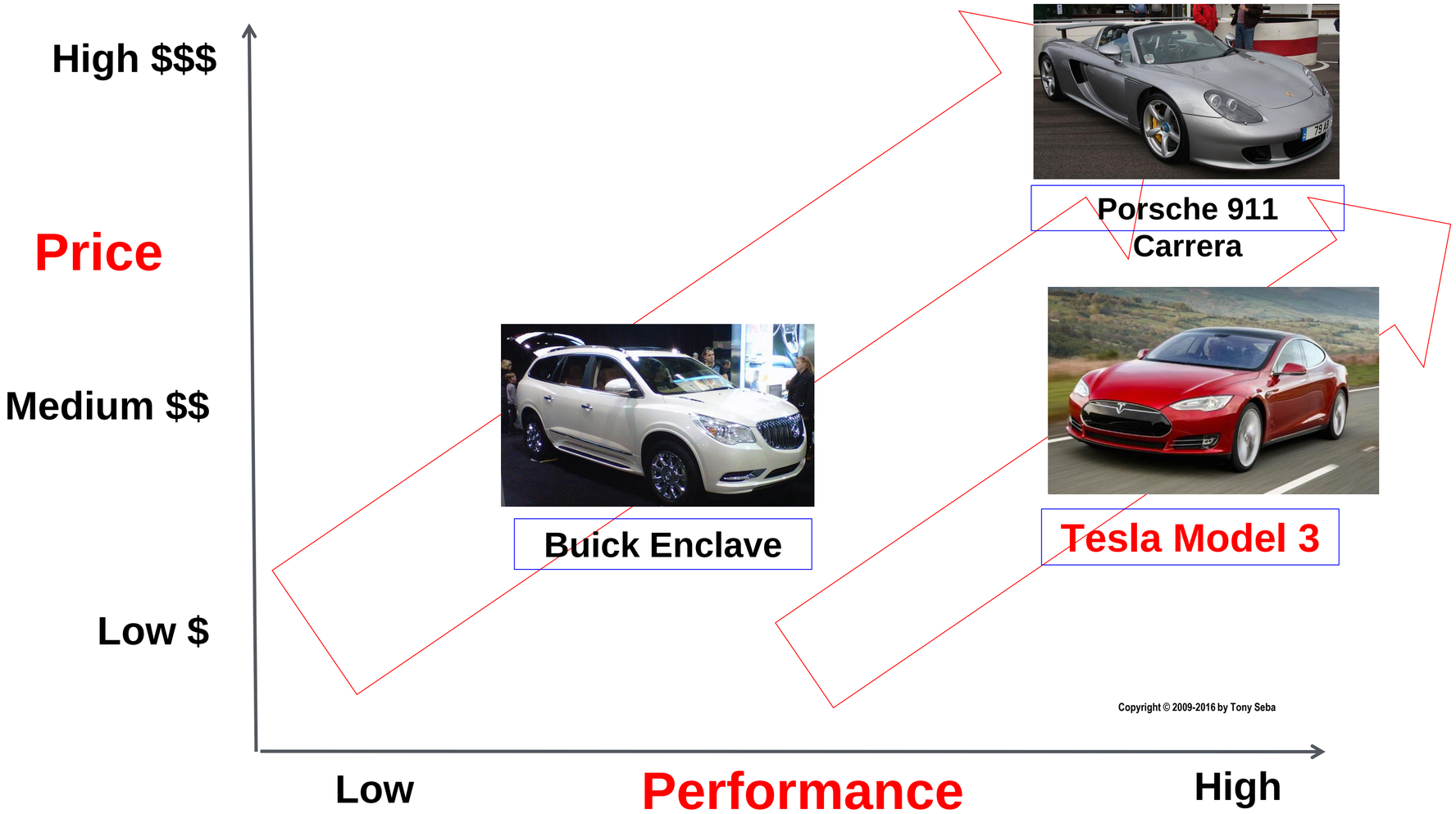
4 – EVs FAR MORE powerful than ICE



"The **Tesla** P90D **accelerates faster than $1 million gas 'supercars'** from Ferrari, McLaren, Lamborghini, Pagani and Porsche." (1)

(1) ChargeDevs Magazine, Image: BRD Motorcycles

EVs Shift the Price/Performance equation: Disrupt the BASIS of COMPETITION



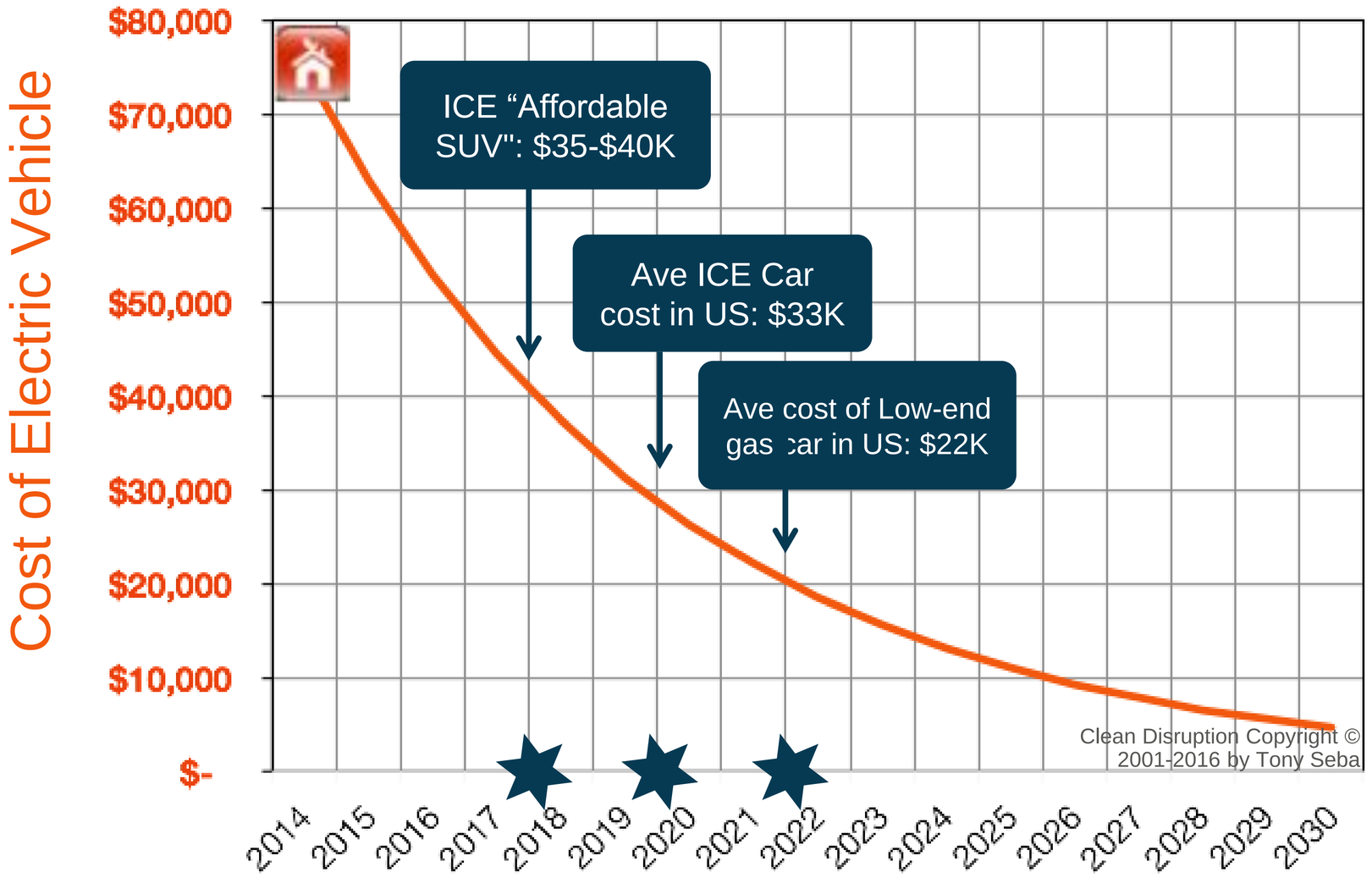
EVs: **Porsche performance for Buick prices!**

Car Image Sources: WikiMedia

OK, SO THE EV IS DISRUPTIVE

How long will the transition take?

Disruption from Above:
Cost of EV with 200-mile (320 Km) range



Assumptions:
4 miles/kWh,
50kWh batteries,
16% yearly improvement in battery costs,
EV Costs = 3X cost of battery

Source: Clean Disruption

FORTUNE

January 9th, 2016

CEO BARRA UNVEILS BOLT EV @CES

2017 Chevy Bolt: **200-mile** range
Electric Vehicle for $37,500 [unsub]

"It's more than a car, it's an upgradeable platform for new technologies." (1)

"Car-sharing, new ownership models, automated driving… down the road."

Image Source: Fortune

Source: (1) Fortune

BBC NEWS

December 11th, 2015

FORD TO INVEST $4.5B IN ELECTRIC CARS

“CEO Fields said Ford will invest $4.5 billion to develop 13 EVs by 2020.”

The company will enter the carsharing market and become a 'mobility service provider', a market worth $5+ trillion.

“We [now] get zero of that market.” (1)

Source: (1) BBC News

COMPUTERWORLD

September 4th, 2014

FOXCONN TO MAKE EV FOR $15,000

"Foxconn, the maker of the Apple iPhone to invest $811m to develop Electric Cars."

"Foxconn CEO Terry Gou said they are targeting EVs priced at less than ***$15,000****."* *(1)*

Source: (1) Computer World

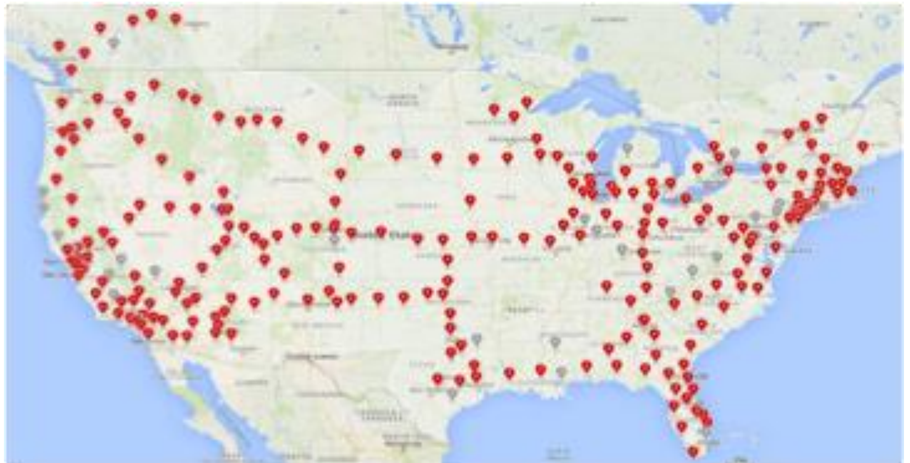
ELECTRIC VEHICLE

Business Model Innovation

(That might accelerate the Disruption)

EV Free Charging

- EV Companies such as Nissan and Tesla offering limited Free EV Charging networks.
- SV Startup Volta offering FREE EV charging in exchange for media rights at prime high-value properties.
- If this business model succeeds, the EV **MARGINAL COST** of energy will be **ZERO**.



Sources: Volta, Nissan, Tesla

Image Sources: Tesla, Volta Charging

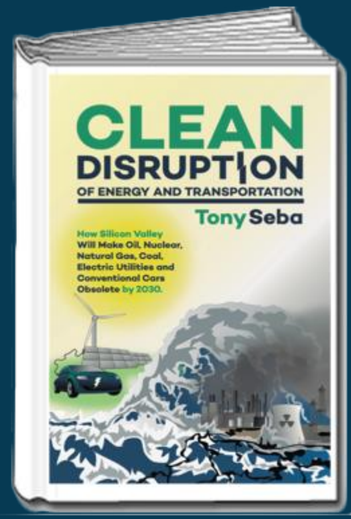
EVs Generating $ Providing Services to Grid

- With Vehicle-to-grid (V2G) technology, an Electric Vehicle (Nissan Leaf) can power a house or a small apartment building for a day or two.
- EVs can also provide the grid with ancillary services that can **generate revenue for the EV owner.**
- At COP21 Paris, Nissan showed V3G product that ENEL will roll out in 1Q 2016
- **EVs = Power Plants on Wheels**

Image Sources: Tony Seba

3 The Autonomous Vehicle Disruption

Image: Wikipedia



FINANCIAL TIMES

May 5th, 2015

NEVADA APPROVES AUTONOMOUS TRUCKS

THE VERGE

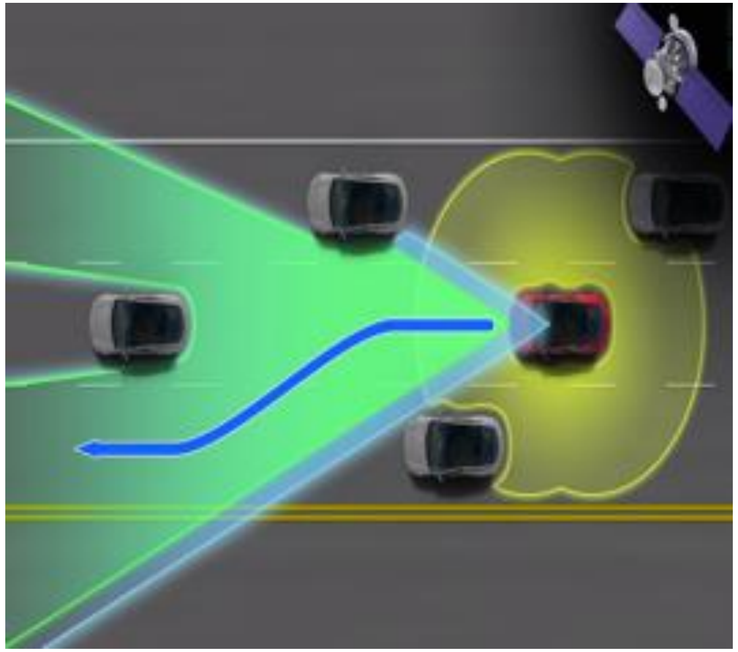
October 2nd, 2015

TESLA CAPABLE OF SELF-DRIVING 90% OF THE TIME

"90% Autonomous. For sure on highways." (1)

"Fully self-driving within 2 years." (2)

Elon Musk, Dec 2015



Autonomy Capability

Sources: (1) UK Daily Mail, (2) Fortune

REUTERS

June 3rd, 2014

SELF-DRIVING CARS MAY HIT THE ROAD IN 2018: RENAULT-NISSAN CEO

PARIS Tue Jun 3, 2014 1:03pm EDT

0 COMMENTS | Share this Email Print

WHAT ABOUT THE COST of Autonomous Vehicles?

What an autonomous car sees

Graphic Popular Science

Exponential Technologies: Machine Vision (LIDAR Sensors)

2012

Google announced that the cost of technology in its self-driving car was **~$150k**

LIDAR Sensor (for Machine Vision) was **$70k**

By the end of

2013

The next generation LIDAR was **$10k**

By Oct

2014

A SV Startup company announced LIDAR for **$1k**

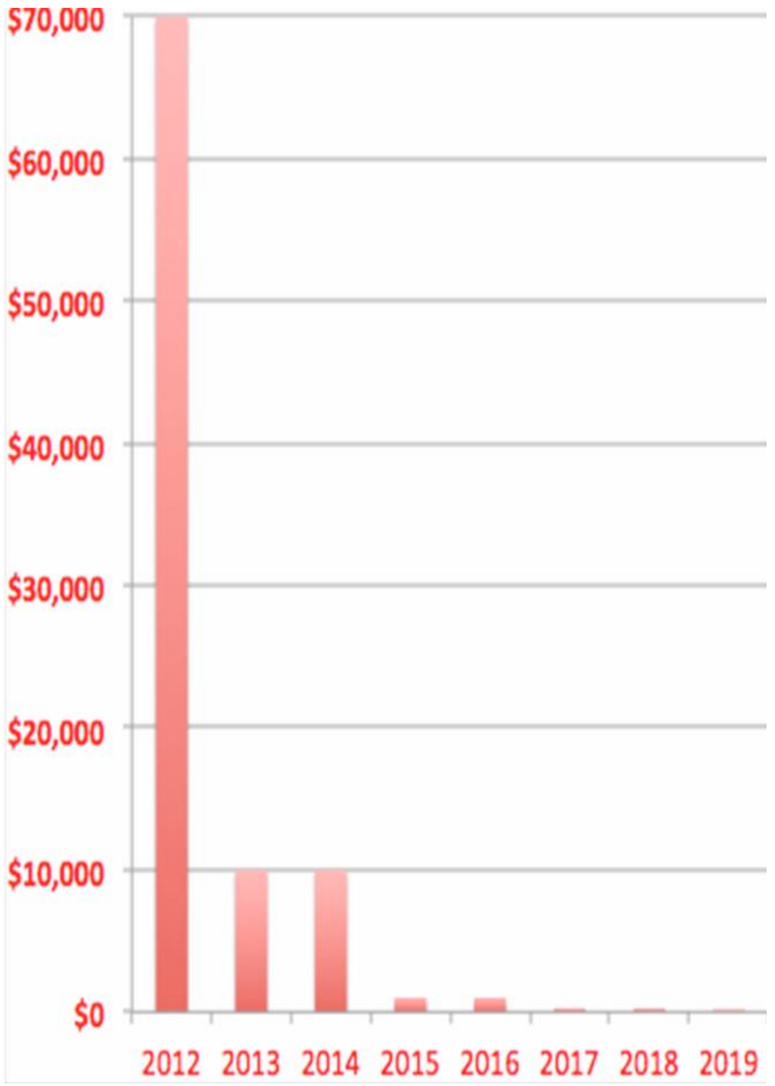
Image: Wikipedia

LIDAR: From $70,000 to $250

2015 GEN 1 LIDAR $1,000

2016 GEN 2 SOLID STATE LIDAR $250

GEN 3 (POSTAGE STAMP) $90



Sources: Quanergy

Autonomous Vehicles = Computer on Wheels

WHAT IS THE

Cost Curve of Computing Power

TO PROCESS SENSOR INPUT?

Year 2000: World's 1_{st} 1-TeraFlops Computer

ASCI RED - Sandia National Labs

- Space = 1,600 sq ft **(150 m2)**
- Power Consumption = 850 kW
- **Cost = $46 million**

Image: Extreme Tech

Source: Wikipedia

Exponential Technologies: GPU: NVIDIA Drive™ PX

Dual Tegra® X1 GPU Processor
2.3 TeraFlops

Power Consumption = 15 W

56,666X improvement

Cost = $59

~1 million improvement

Built for Self-Driving Cars

- Surround Computer Vision (CV) with Advanced Rendering
- Deep Learning S/W
- Over-the-air updates

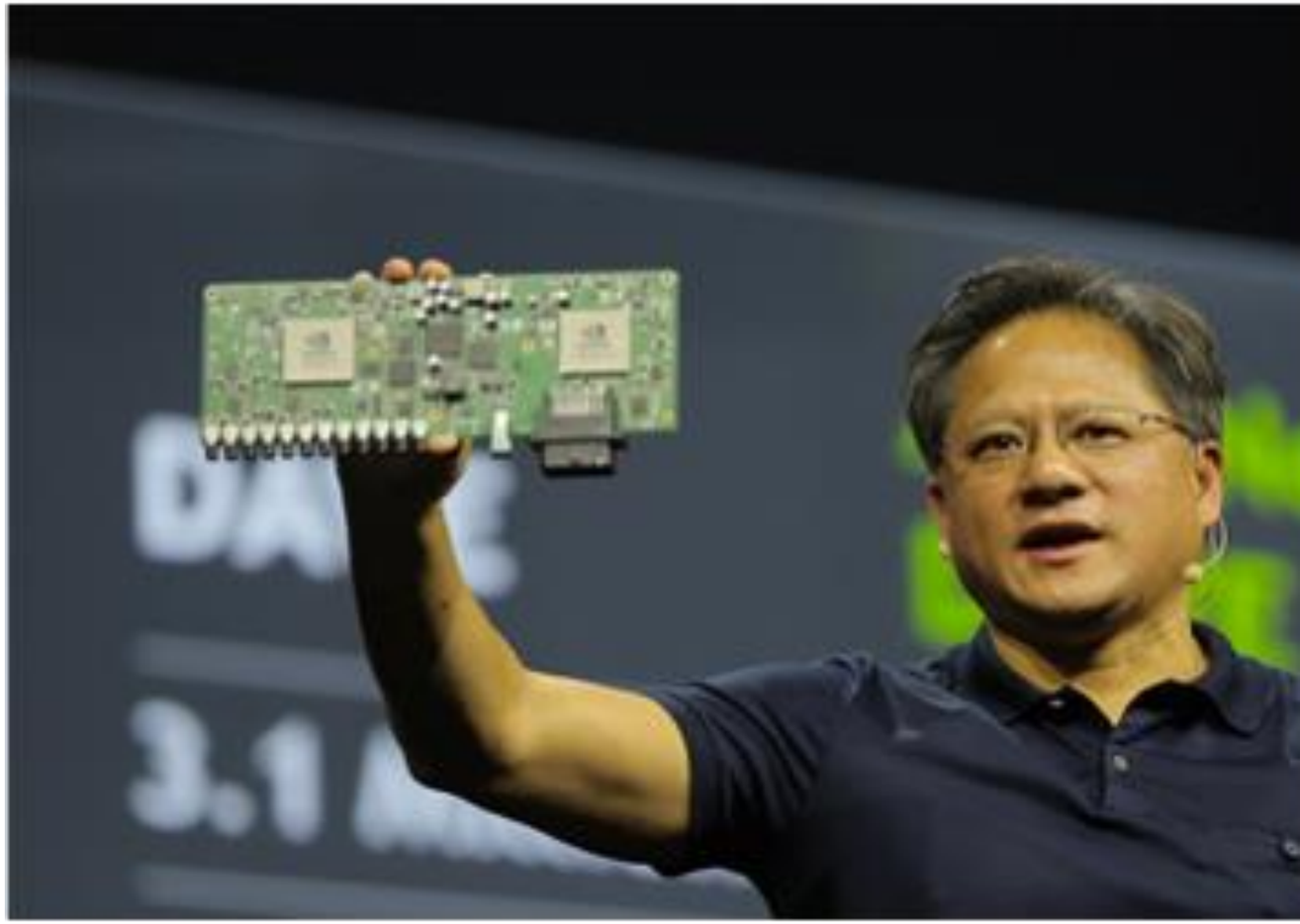


Image and Data Sources: NVIDIA

OK, COST IS NOT AN ISSUE… BUT,

Is the market ready for the Self-Driving car?

Rodin – Thinker
Photo: Tony Seba

Are consumers ready for autonomous cars?

2.8 b people

Consumers Desire More Automated Automobiles

Consumers Trust Driverless Cars

57%

of consumers, globally, trust driverless cars—even more so in emerging markets

Brazil	95%	Canada	52%
India	86%	France	45%
China	70%	UK	45%
USA	60%	Germany	37%
Russia	57%	Japan	28%

Source: Cisco Customer Experience Report for Automobile Industry, May 2013 survey of 1,511 consumers in 10 countries.

Source: Cisco Systems

Are consumers ready for autonomous cars?

China 70%

Brazil 95%

India 86%

Images Source: chinawshisper.com, inrix.com, ryot.org

Cool! I can

and also

while NOT driving!

BUT WHAT'S THE

Disruptive Impact?

Rodin – Thinker
Photo: Tony Seba

BUSINESS MODEL INNOVATION:

Car-as-a-Service

Rodin – Thinker
Photo: Tony Seba

My Smartphone: On-demand Car-as-a-Service

Plan & schedule All transportation needs with Apps

1. Buses: Muni, NextBus
2. Trains: CaltrainMe, iBART
3. **Car-Sharing: Zipcar**
4. **Ride-Sharing: Uber, Lyft**
5. On-Demand Bus: VTAFlex
6. Taxis: FlyWheel

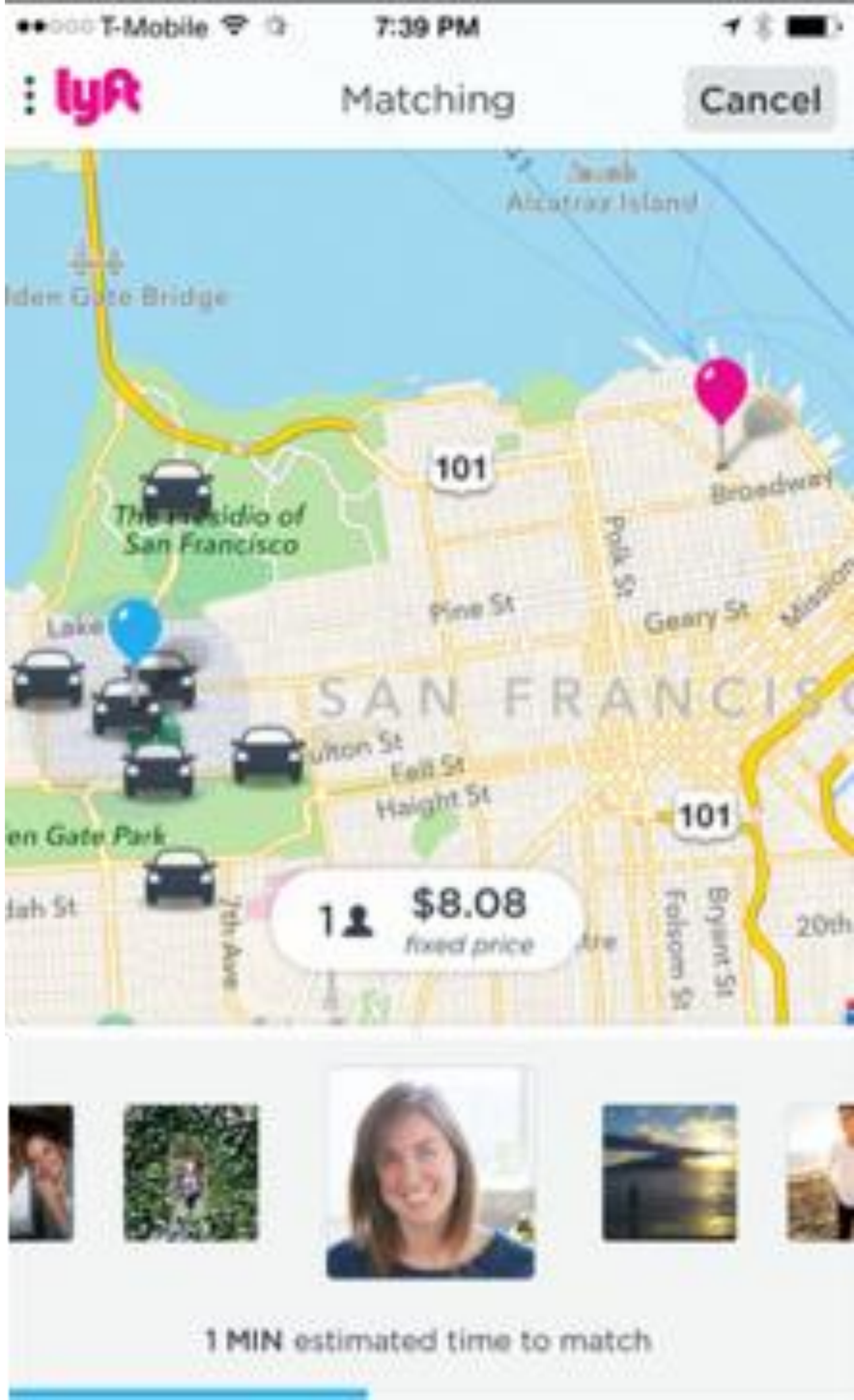
RIDE - Sharing

Companies disrupting private and public transportation.

- Connecting users with drivers
- Ex: Uber, Lyft
- **Uber** (started 2009):
  - May ’15 - 311 cities in 58 countries (1)
  - Est. **2015 Bookings = $10 billion** (2)
  - **1 million drivers** (global) (3)

San Francisco Figures

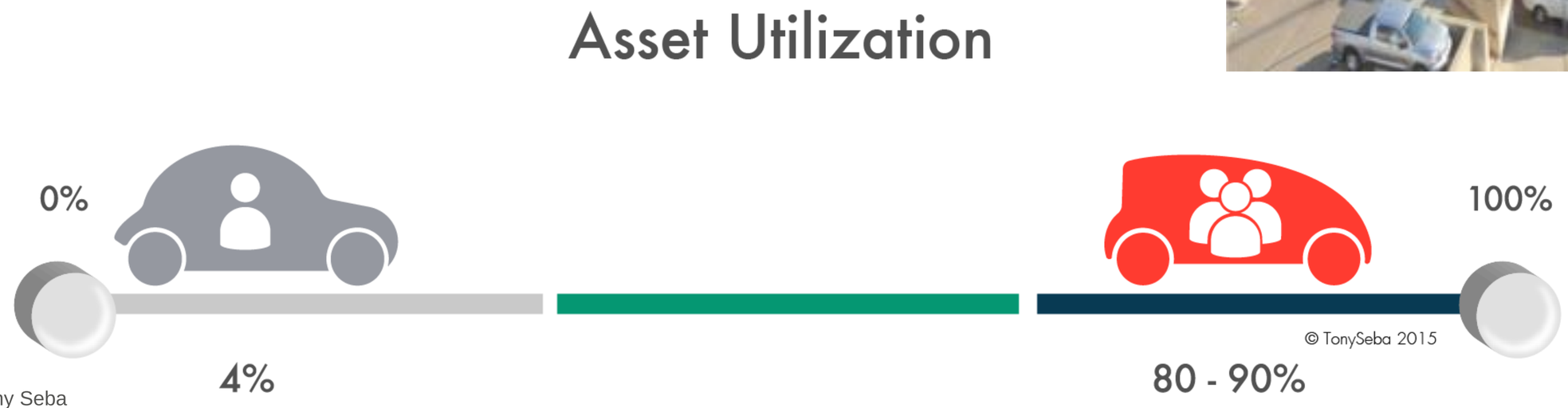
- # Uber Drivers (2015): 22,000
- # of Taxicabs (2012): 1,825 (4)
- **Carpooling** ~= **half** of Uber Rides



(1) (2) (3) Business Insider, (4) Wikipedia

Cars: Hugely Inefficient Use of Assets

- Cars = 2nd largest Capital Expense
- Ave. car costs = $31k
- **Cars are parked 96% of the time!** (1)
- **4% Asset Utilization** is a disruption waiting to happen!



Source: (1) Donald Shoup

SELF-DRIVING + CAR SHARING:

Convergence of Technology & Business Model Innovation

Rodin – Thinker
Photo: Tony Seba

THE VERGE

February 2nd, 2015

UBER ANNOUNCED SELF-DRIVING CAR PROJECT

"Uber announced plans with Carnegie Mellon University to create the Uber Advanced Technologies Center: R&D of autonomous vehicles."

"When there's no [driver], the cost of taking an Uber anywhere becomes cheaper than owning a vehicle… and then ***car ownership goes away****." said Uber's CEO*

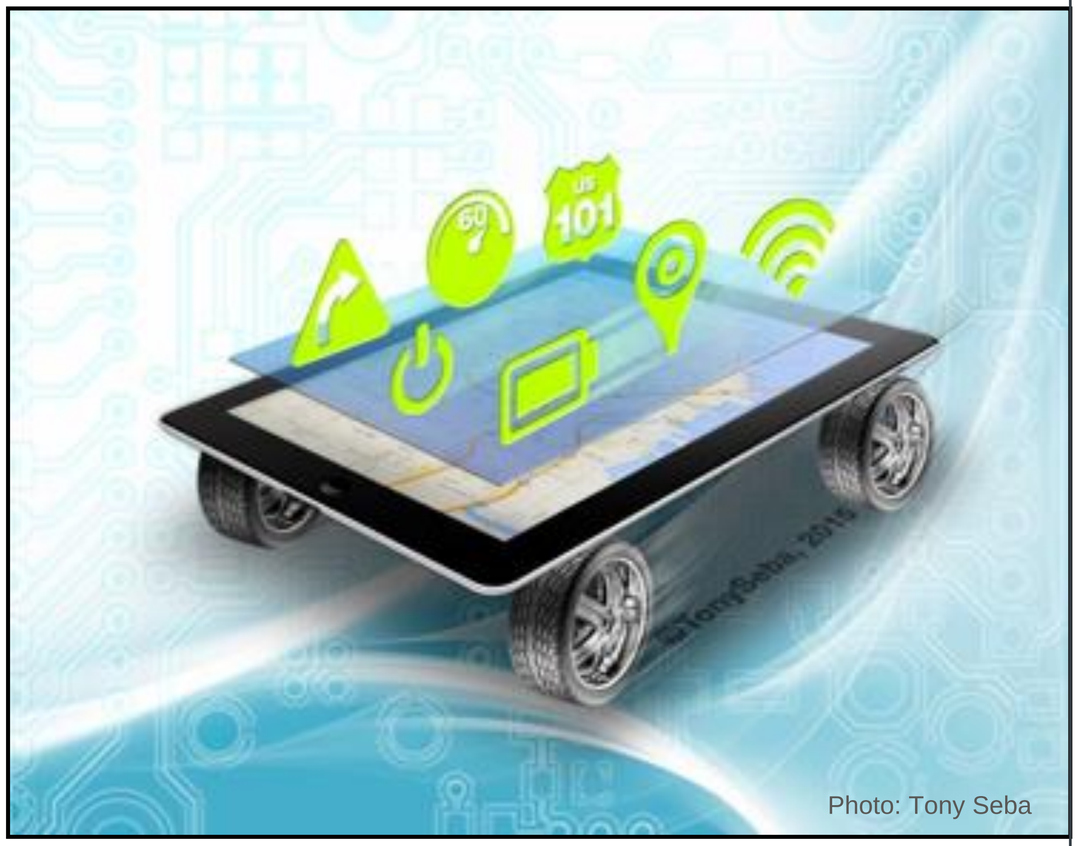


Photo: Tony Seba

Mashable

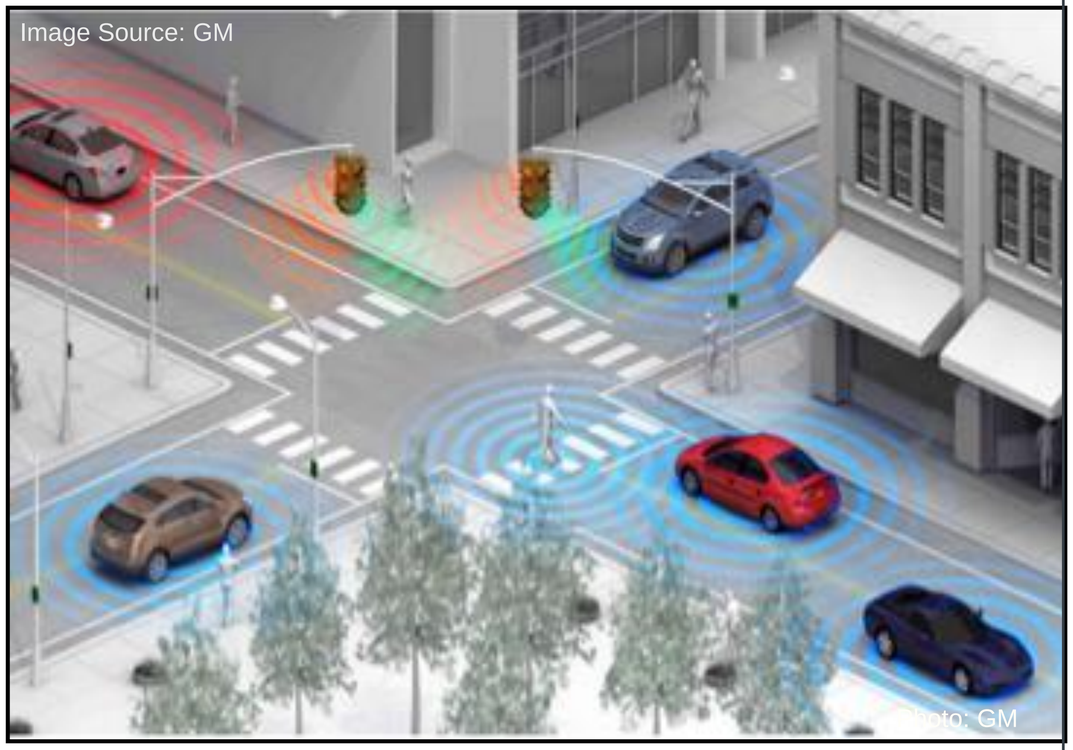
January 13th, 2016

GM TO LAUNCH SELF-DRIVING LYFT FLEET IN AUSTIN, TX

*"The first mainstream deployment of **autonomous** vehicles won't be to customers but to a **ride-share** platform." GM President Dan Ammann*

"This makes sense for GM:

1. An **autonomous Bolt EV** will be in use **60-70%** of the **time**.
2. Easier to create a car that works in a known city within certain limits below 30mph.
3. Open up new markets."

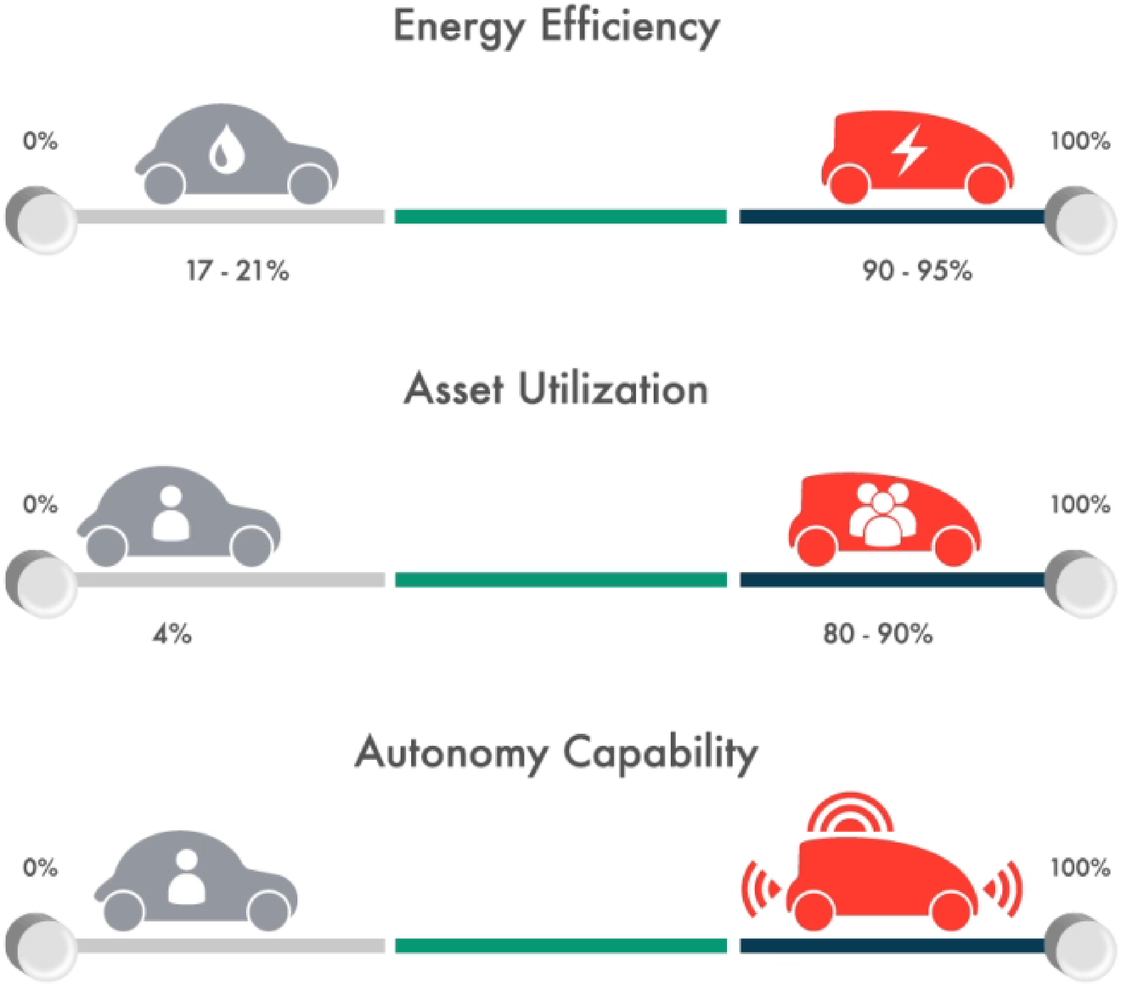


Car-as-a-Service: The End of Car Ownership

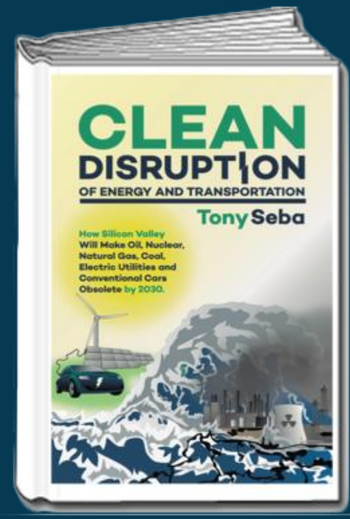
- Mobility on Demand / Car-as-a-service:
  - **Self-Driving Cars** tech with
  - **Car/Ride Sharing** biz model
- Cars go from **parking ~90+%** of time to **driving ~90+% of time.**
- **Cost** / mile ~**10X cheaper** than car ownership
- We'll need **~80% fewer cars**
  - 80+% fewer parking spots (1)

Source: (1) Clean Disruption

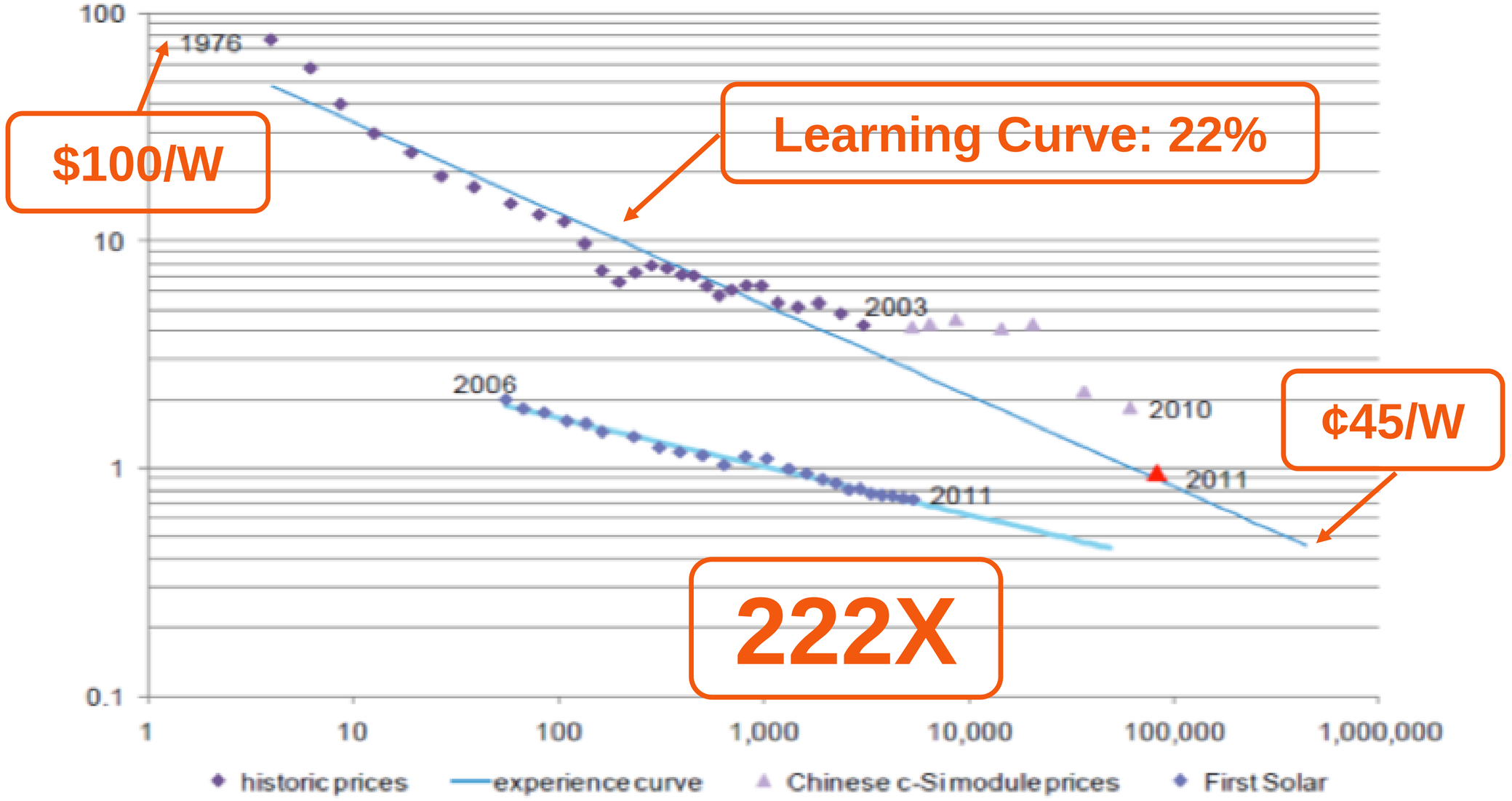
3D – CLEAN DISRUPTION OF TRANSFORMATION



4 The Solar Disruption

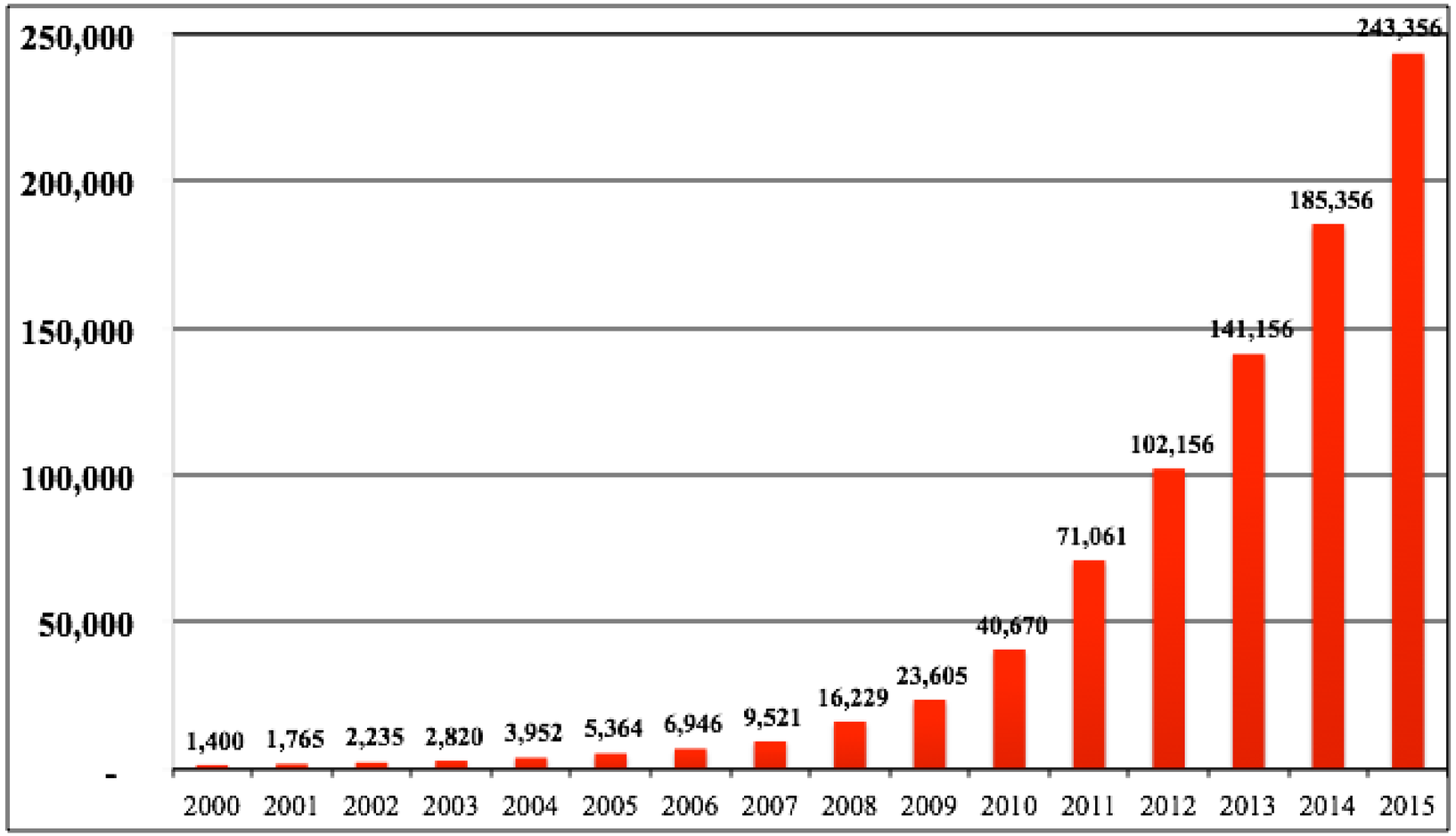


Solar PV Costs: DOWN 222X



Source: BNEF - Economics of PV Power

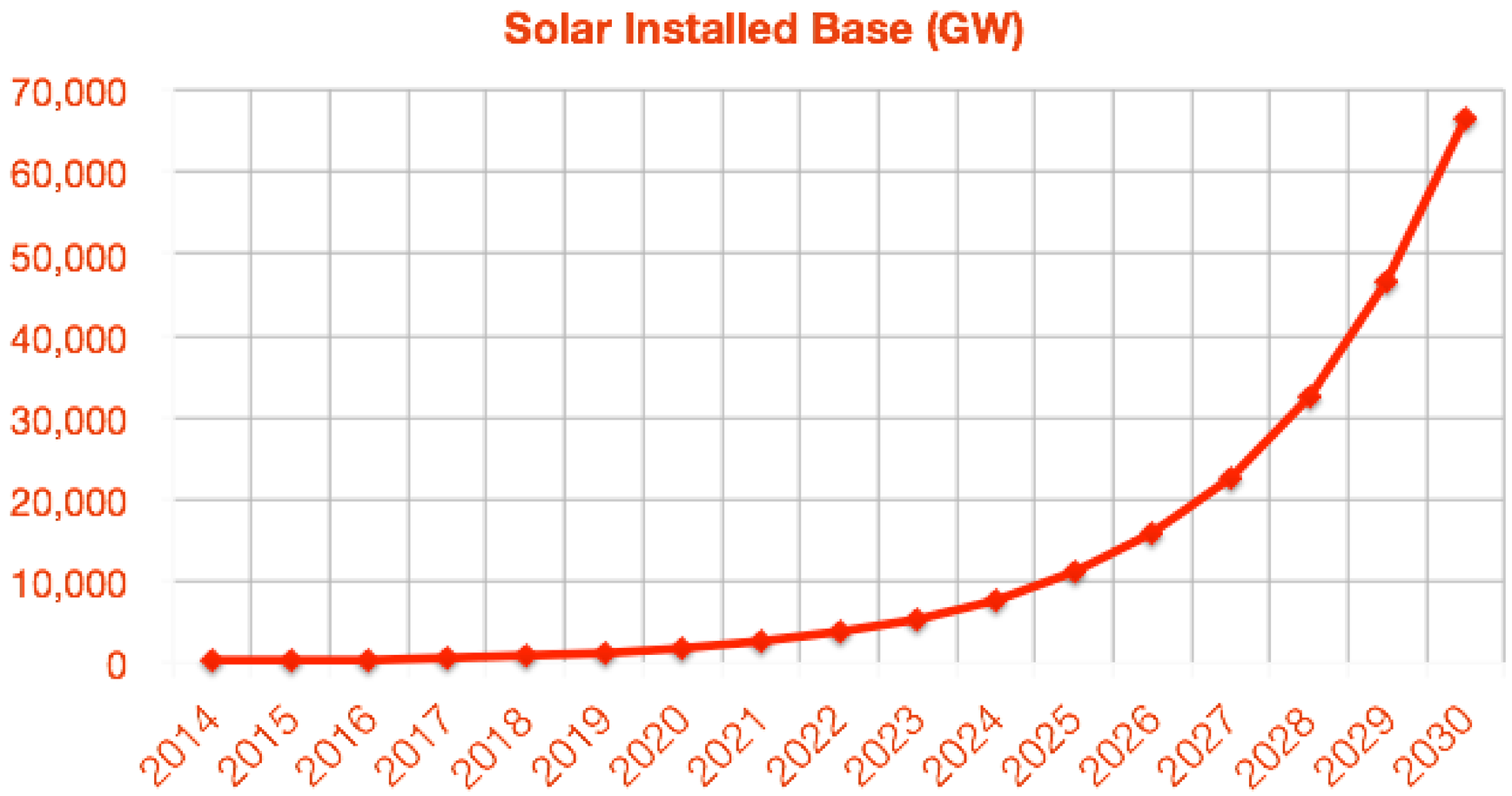
Market: Solar PV Installed Capacity: UP 174X



- **Solar PV Market CAGR 2000-2015 ~41%**
- Solar PV installed Capacity 2000-2015 Growth **~ 174X**

Source: EPIA, PV Magazine

Energy = 100% Solar by 2030?



- **If Solar PV continues to grow at ~41% CAGR**
- **100%** of all **energy** (not just electricity) in the world would be solar by 2030

Source: Clean Disruption

Can Solar Continue Growing at this Rate?

Rodin – Thinker
Photo: Tony Seba

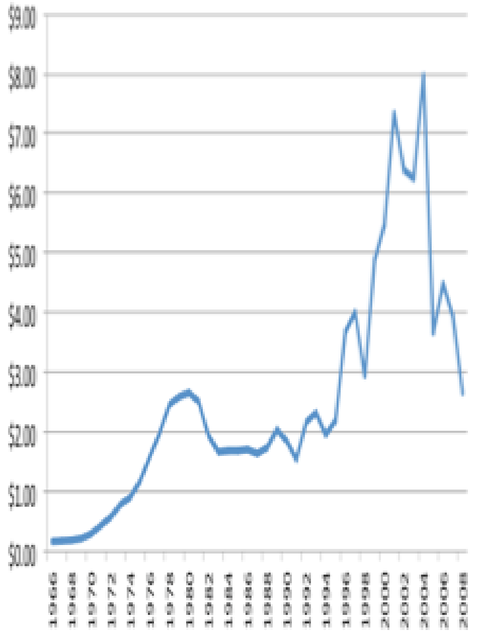
Solar Cost Trends

vs

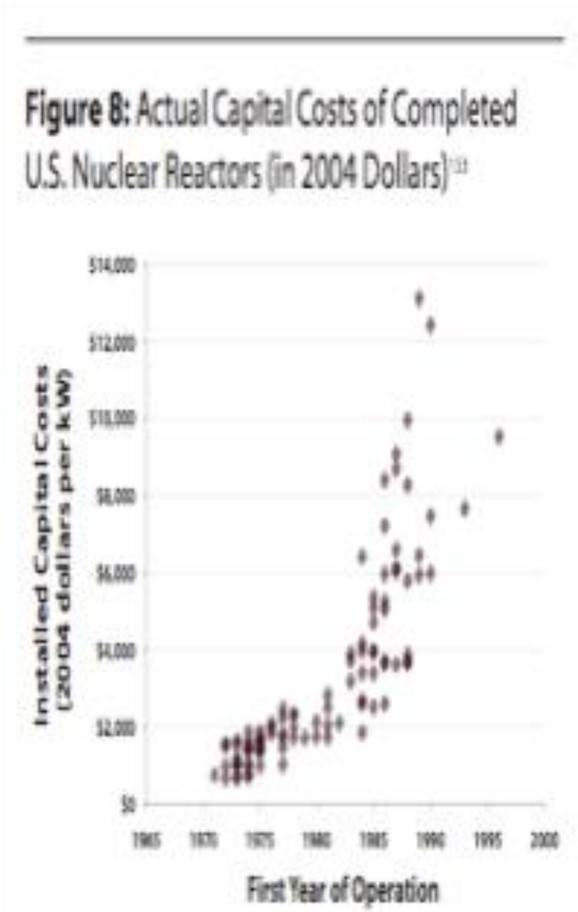
Conventional Energy

Since 1970 Prices for conventional resource-based energy sources are up 6X - 16X

Oil



Nat Gas



Nuclear

Coal

Source: DOE, Clean Disruption

Solar Cost Improvement vs. Conventional Energy

Solar PV Cost Improvement relative to:	Times improvement (1970-2016)
Petroleum	2,110x
Nuclear	2,929x
Natural Gas	3,284x
Coal	1,294x

Oil at $30/bbl

- Since 1970 Solar PV has improved cost by thousands of times relative to most conventional forms of energy
- Note: unsubsidized cost of solar PV

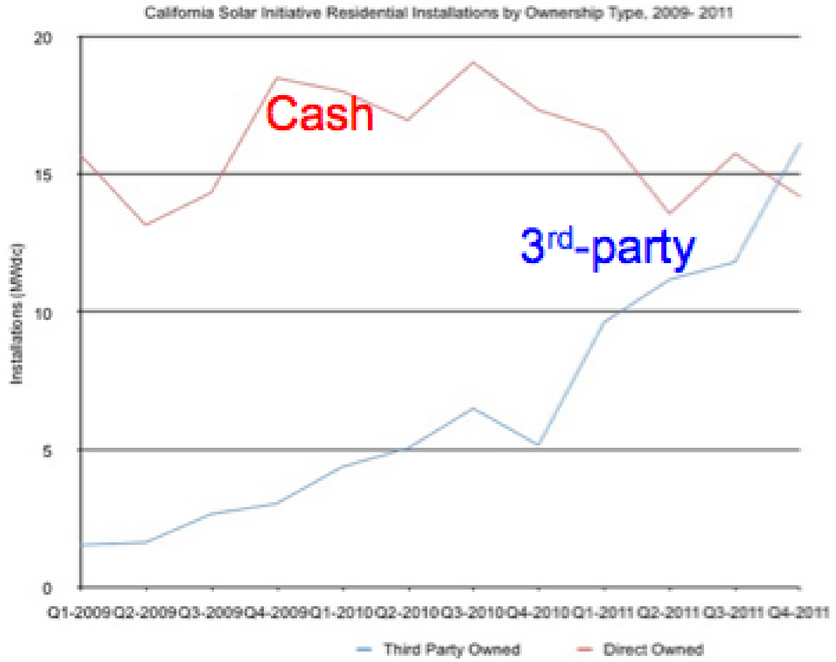
Source: Clean Disruption

BUSINESS / FINANCIAL

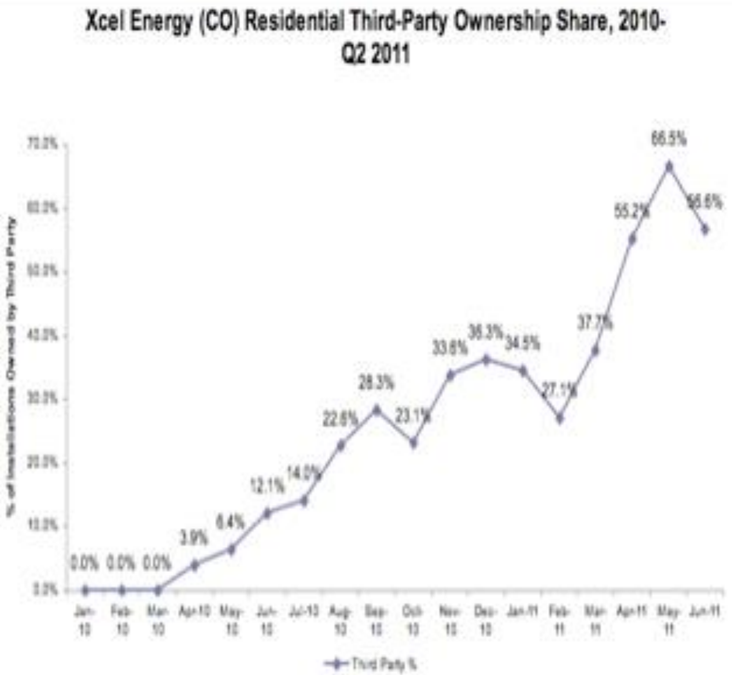
Model Innovation

Zero Money Down Solar – 3rd Party Finance

- **~80%** of California Residential Solar PV was **third-party** owned & financed (March 2012) (1)
  - Including Solar PPA and Leasing
  - CA 3rd party finance = **enabled substantially all growth in residential solar**… since 2009



California Solar Initiative



Colorado Excel Energy

Image Source: GTM Research,

Source: (1) PV Solar Report

Financial / Business Innovations

Financial / business model innovations are **lowering the cost of capital** and **accelerating solar adoption**

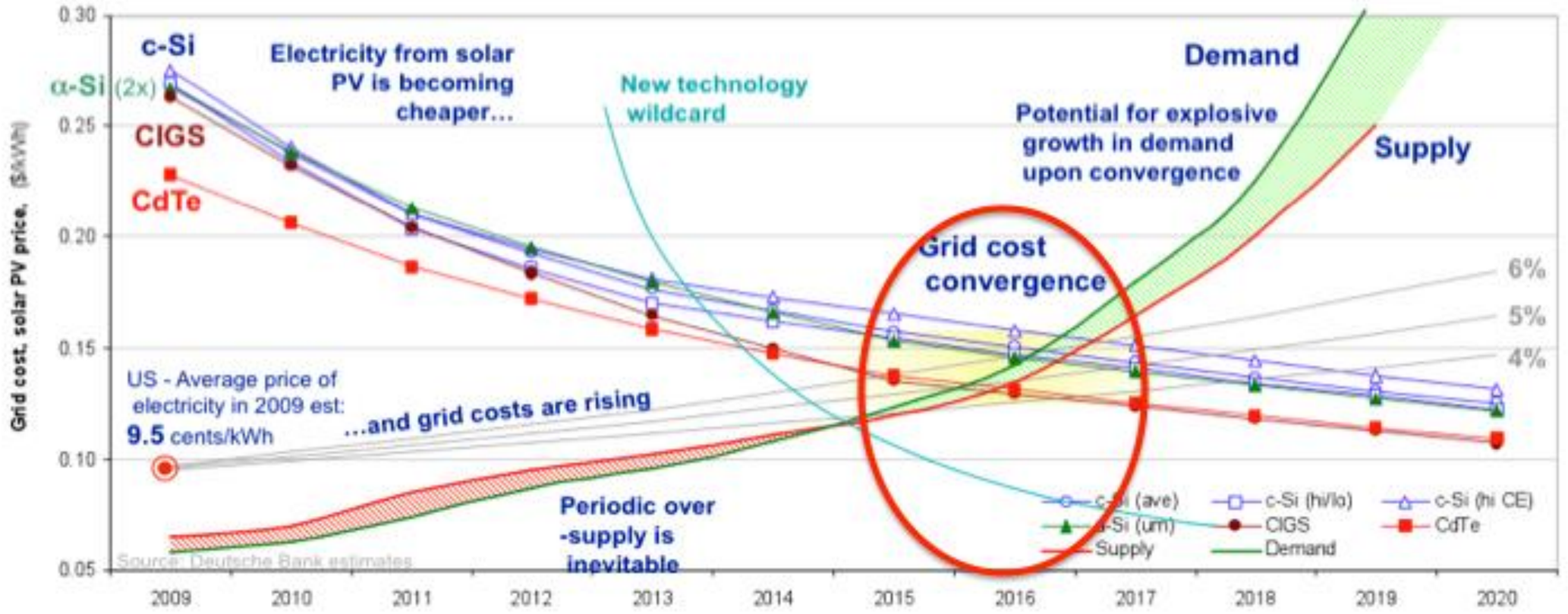
1. **Third-Party Finance -** PPA & Lease
2. Solar Loans
3. YieldCo
4. PACE - Property Assessed Clean Energy
5. Bond - PPA Hybrid
6. CrowdFunding
7. MLP - Master Limited Partnership?
8. REIT - Real Estate Investment Trust?

BACK TO SOLAR COST TRENDS:

Grid Parity or God Parity?

Rodin – Thinker
Photo: Tony Seba

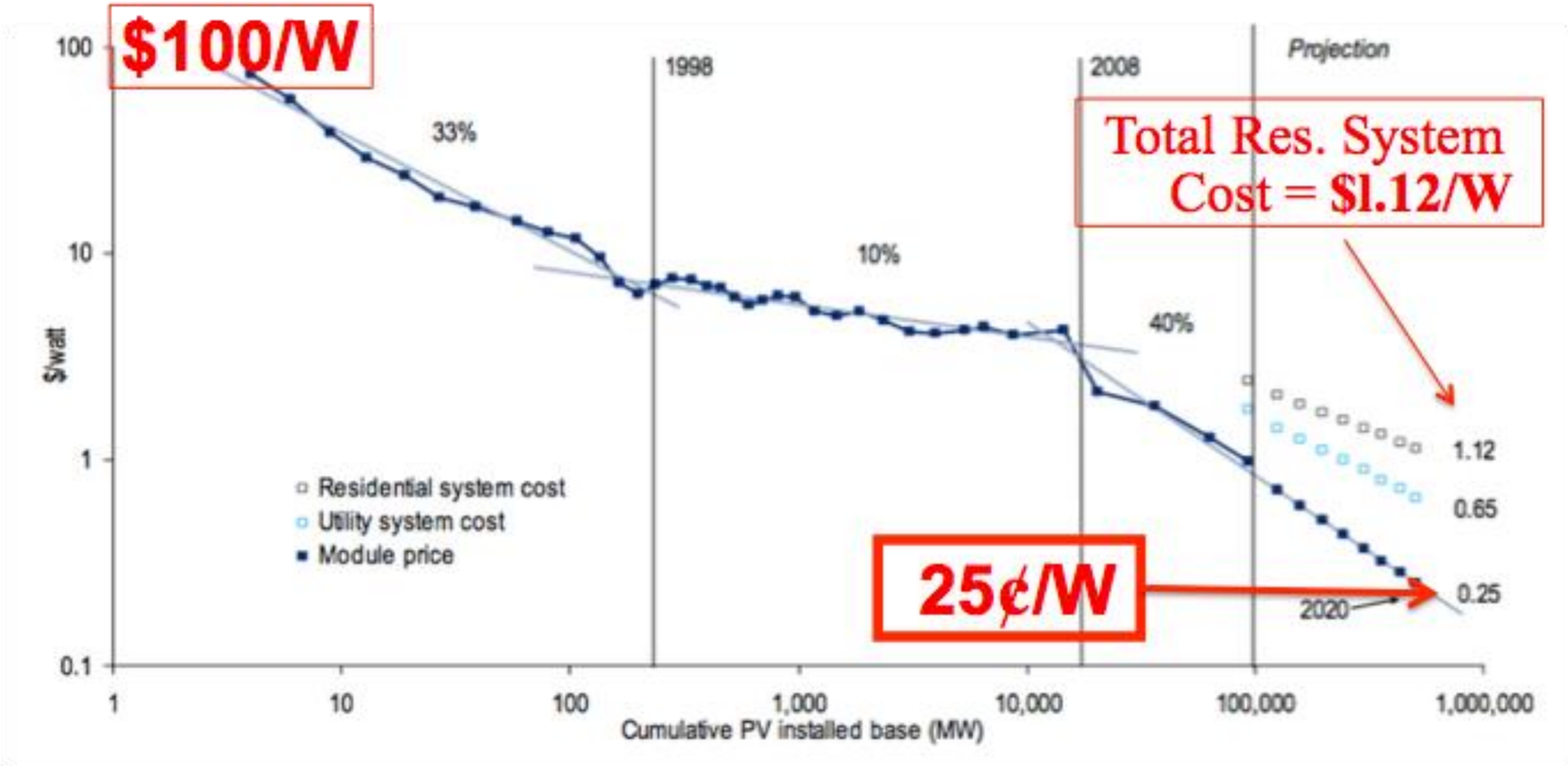
DB: Grid Parity in 80% Global Markets by 2017



- **Solar at/below grid parity in 100's of markets globally** TODAY
- Deutsche Bank: **Solar Below Grid Parity** in
  - 47 states in the US by 2016
  - Up to **80% of Global market by 2017**

Source: Deutsche Bank

Solar PV costs to drop another 50%+ by 2020



- **Solar PV costs down 400X from 2970-2020**
- Citibank: installed cost of Residential solar ~$1.12/W by 2020
  - Installed cost is already <$1.4/W in Australia (2)

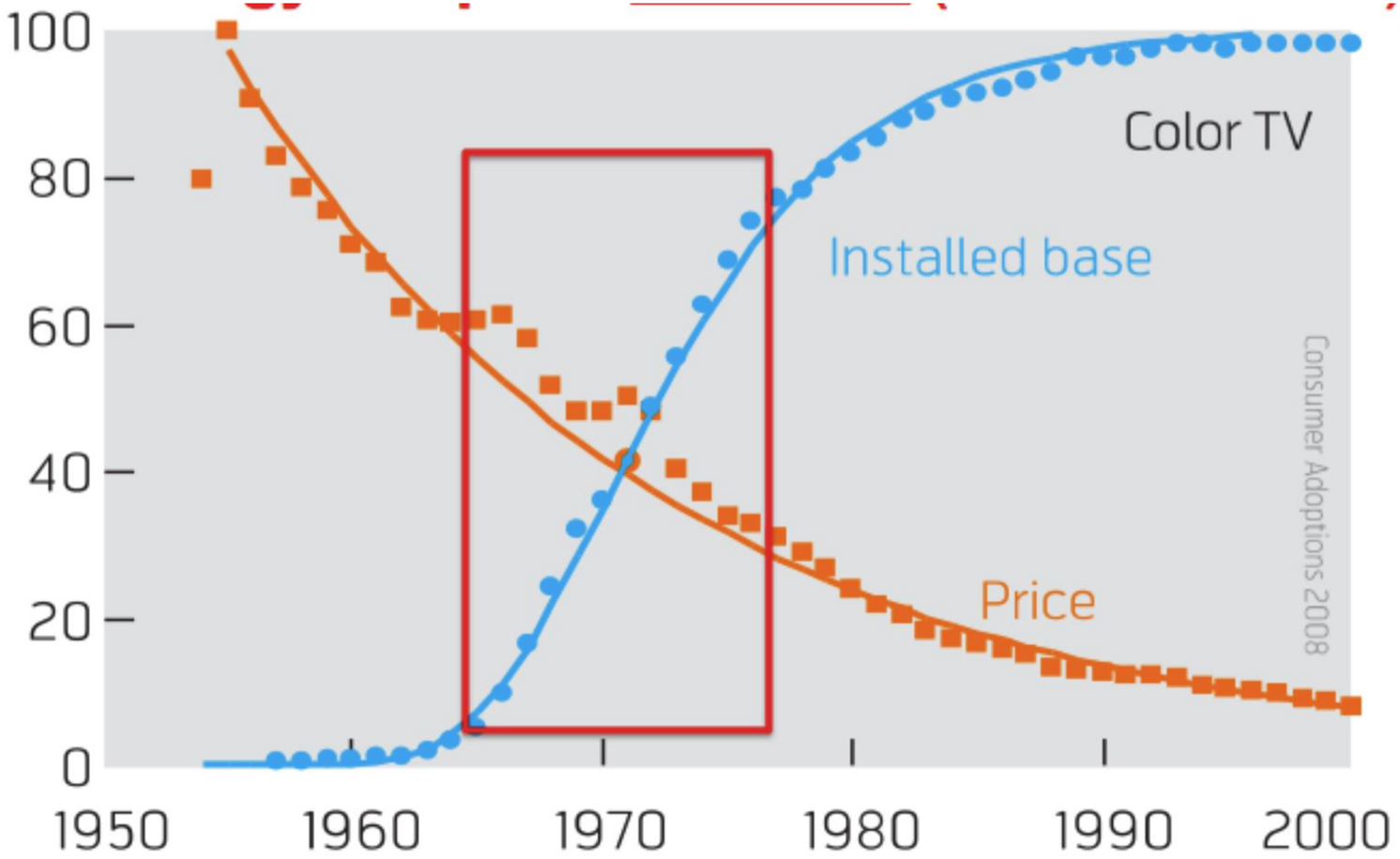
Source: 1) Renew Economy, (2) SolarChoice.net.au Graph Source: Citi Bank and GTM

Solar Growth Rate may Accelerate!

(TECH S-CURVE)

Rodin – Thinker
Photo: Tony Seba

Technology Adoption S-Curve (Color TV % US)

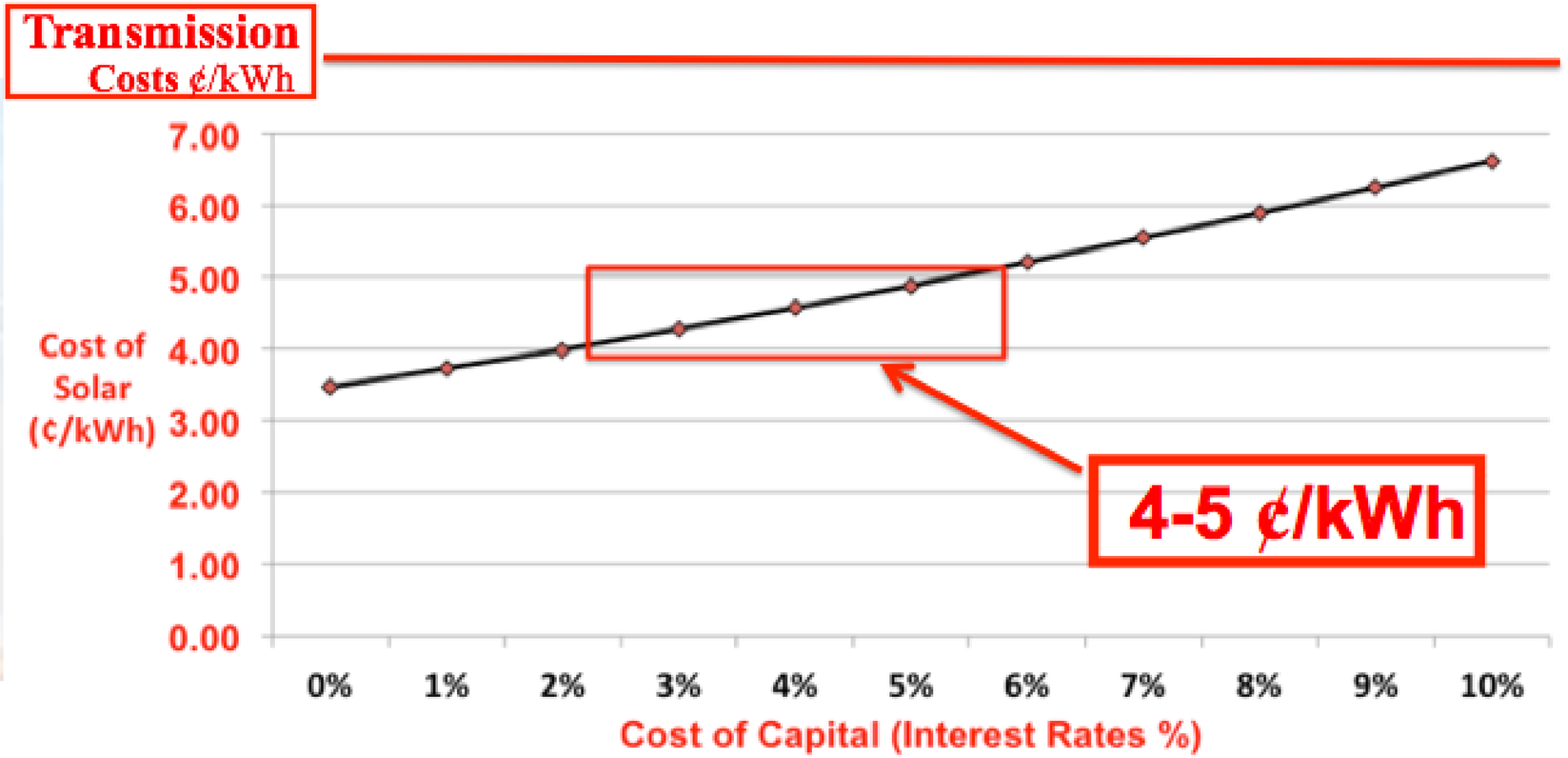


- Solar PV is a technology
- Tech adoption is not linear but follows an **S-Curve**

Graph Source: Technology Futures, Inc.


Solar GOD Parity
Point of No Return
RedOrbit.com

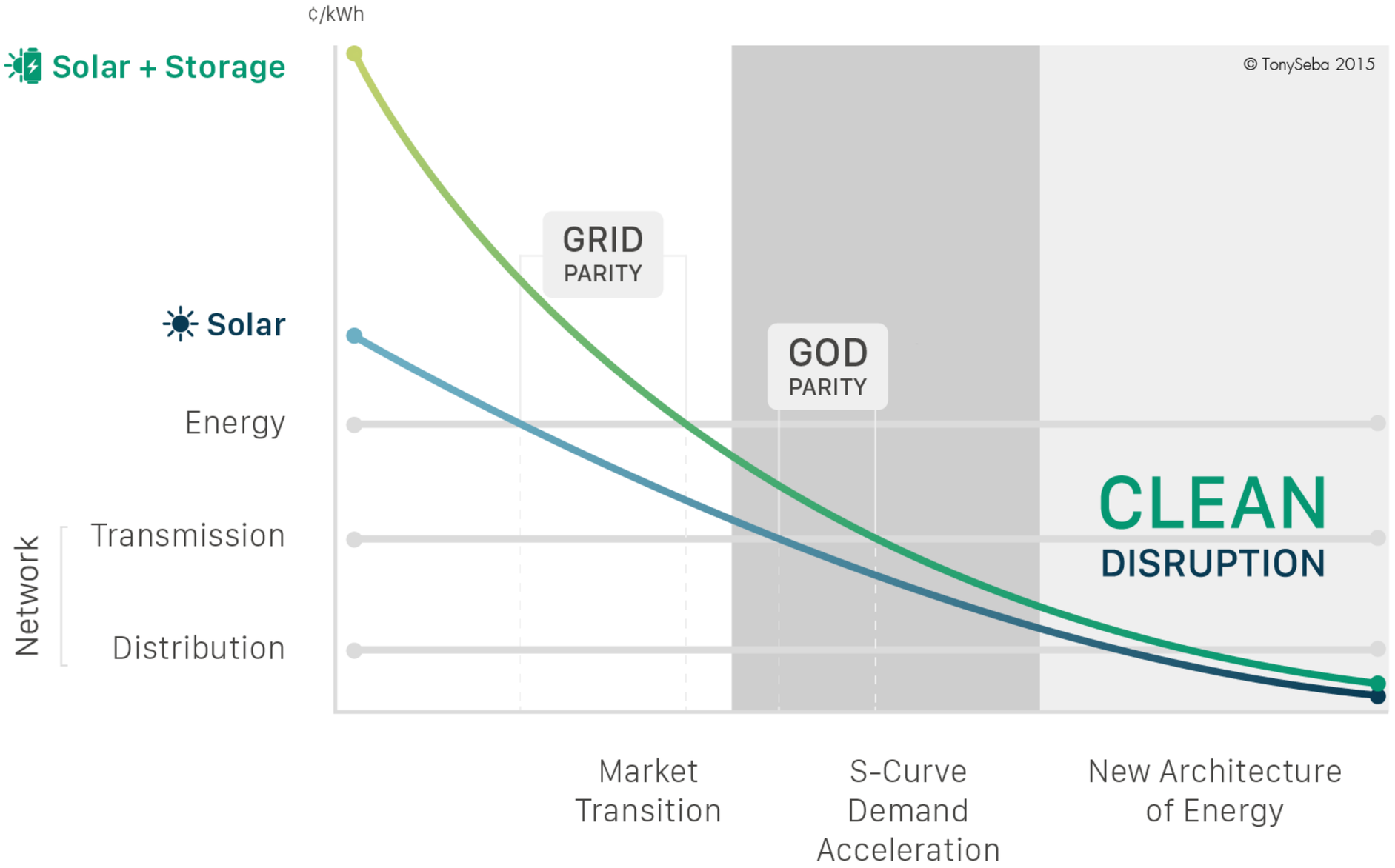
God Parity by 2020 - $ Rooftop Solar < $ Transmission



- **God Parity: cost of** (unsub) **rooftop solar lower than cost of transmission!**
- Centralized Generation can't complete
  - Obsolete: Nuclear, Natural Gas, and Coal

Source: Clean Disruption

Solar + Storage GOD Parity



- **Solar and Storage costs decreasing exponentially**

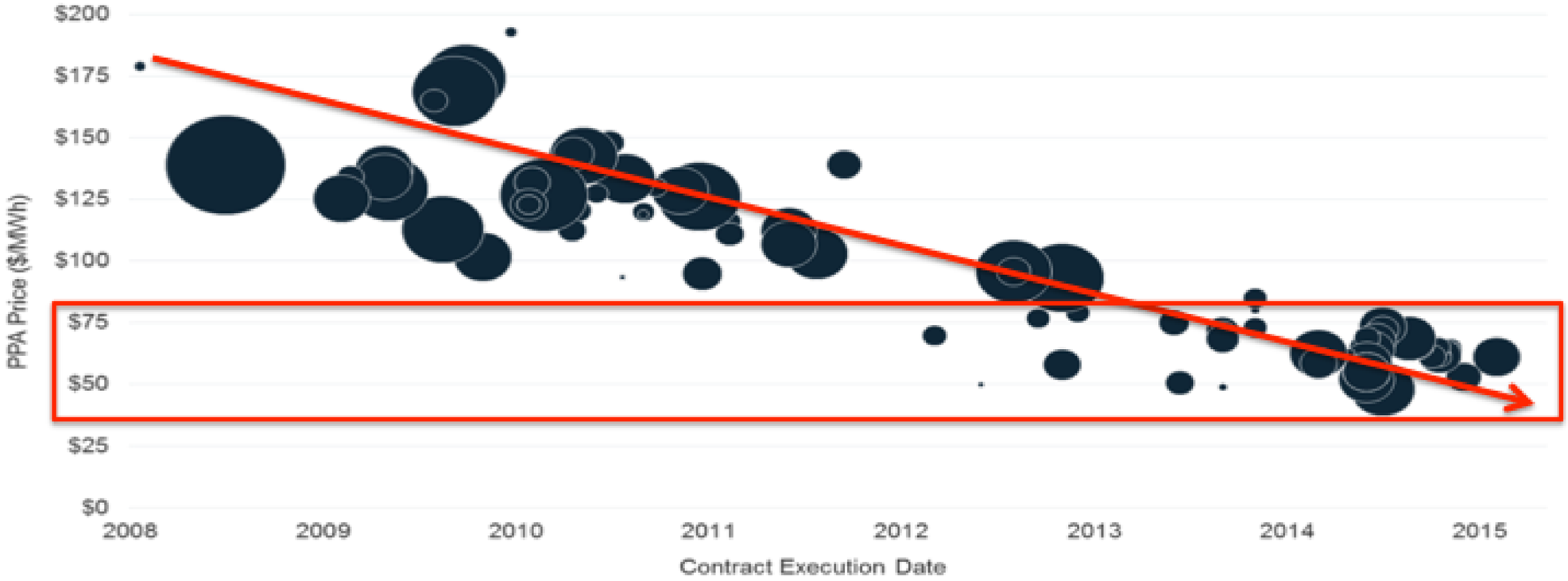
Graph Source: Tony Seba

BUT NOT ALL POWER GENERATION WILL BE ROOFTOP, RIGHT?

What about **Utility Scale**?

Rodin – Thinker
Photo: Tony Seba

Utility Scale Solar in USA –> Dropping to ~5¢/kWh



- USA 2015 PPAs **~5 ¢/kWh** (+/- **1¢/kWh**) (1)
  - NV Energy Solar PPA ⟶ **3.87 ¢/kWh** (Jul ’15) (2)
- Saudi Arabia PPA **4.9 ¢/kWh (unsub)** (Aug ’15) (3)
- “Solar at **5.8** ¢/kWh is competitive with **oil** at **US$10/bbl** and gas at US$5/MMBtu” (4)

Sources: (1) GTM Research (2) PV Magazine (3) CleanTechnica (4) University of Cambridge& PwC

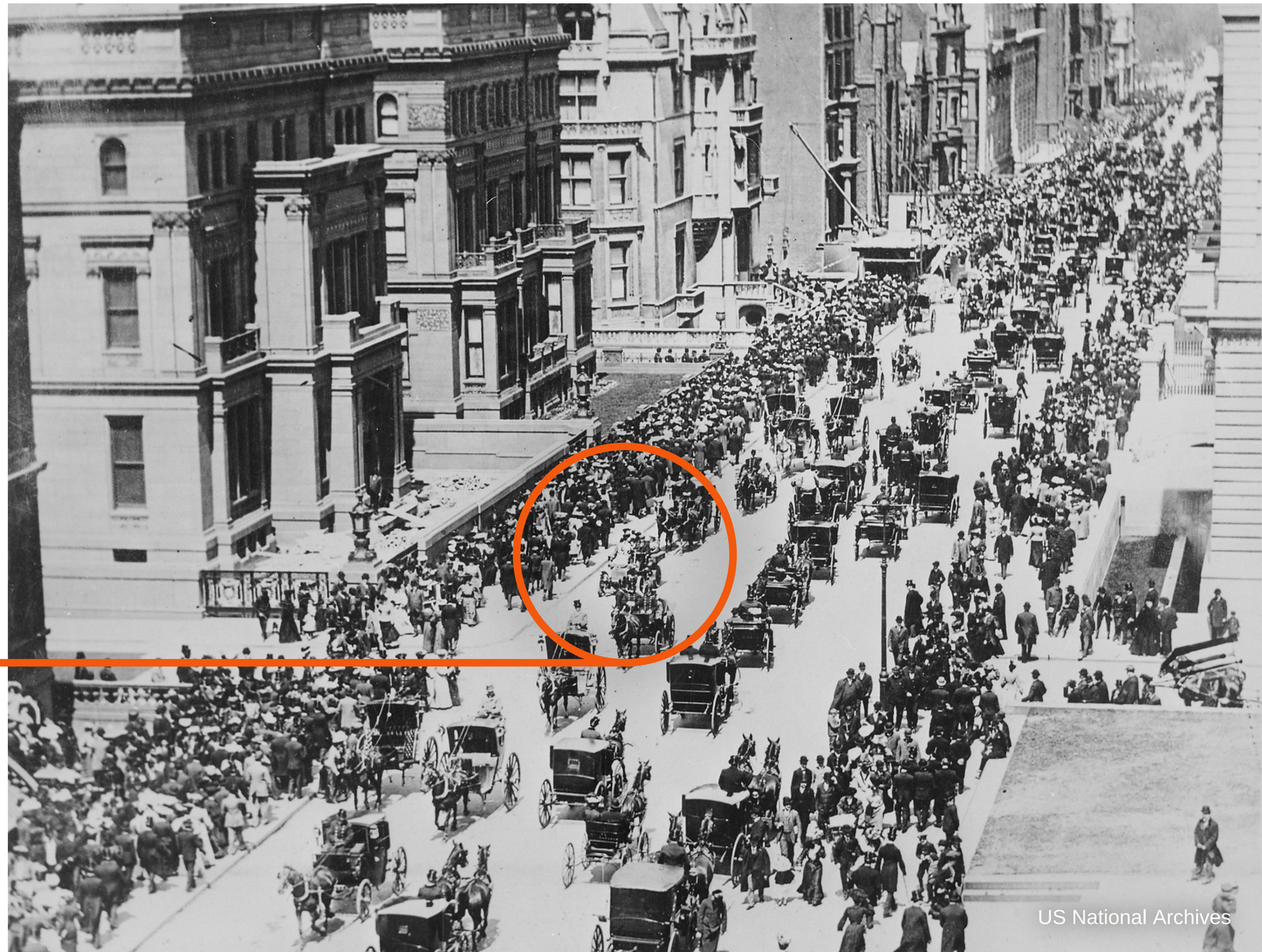
Back to the Future

abc7news.com

Summary: On the Cusp of major Disruptions in Energy and Transportation

2016

We are here



US National Archives

2016 - Clean Disruption of Energy & Transportation

- The technologies, skills, and organizations of the industrial revolution have run out of steam
- They are being replaced by the technologies, skills, and organizations of the **information technology revolution**

    1. **Energy Storage**
    2. **Electric Vehicles**
    3. **Self-Driving Cars**
    4. **Solar PV**

- We will see **more changes** in energy & transportation over the **next 5-10 years** than we have seen in a century - since the invention of **the gasoline/diesel ICE vehicle** and the **central generation electric utility**

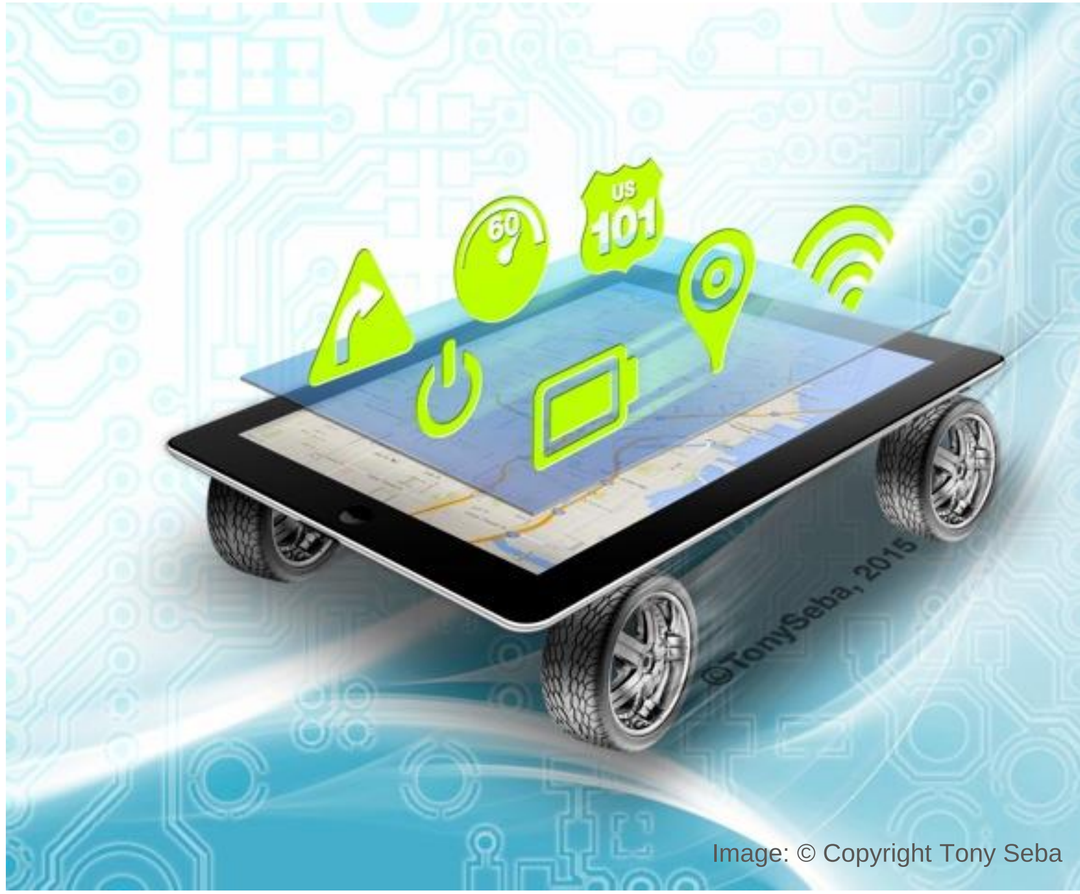


Image: © Copyright Tony Seba

The Future is NOW.

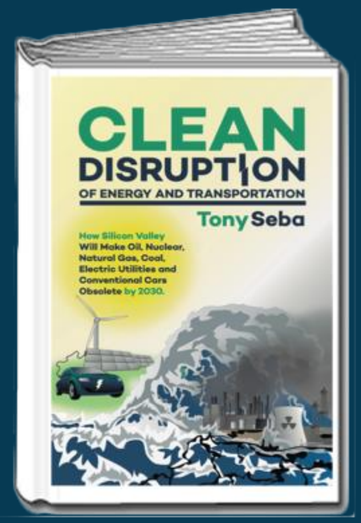
This Disruption is not in the future.

It is NOW!

Photo: Tony Seba

Thanks!
Q&A

www.tonyseba.com



CLEAN DISRUPTION

WHY CONVENTIONAL ENERGY AND TRANSPORTATION WILL BE OBSOLETE BY **2030**

Presentation to: Swedbank

Nordic Energy Summit

Oslo, Norway

17 March 2016

Tony Seba

www.tonyseba.com