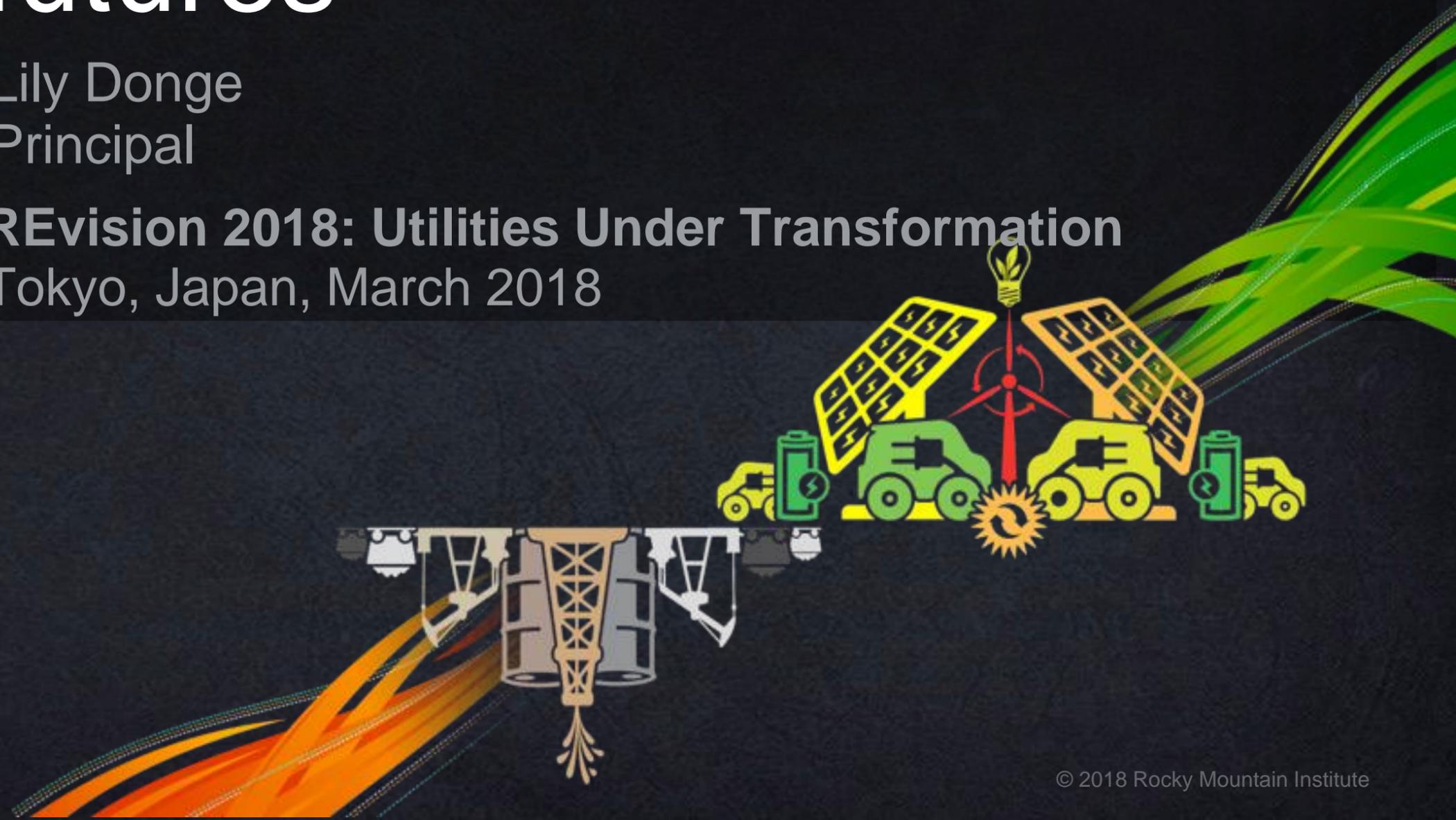




Disruptive energy futures

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Principal

REvision 2018: Utilities Under Transformation
Tokyo, Japan, March 2018





“I can’t wait
to see what
happens
when our
industries
merge.”

Flexible demand

Integrative design

Customer choice

Efficiency

Distributed renewables

Utility revenues

Regulatory shifts

New financial and business models

Storage (including EVs)



Designing to save ~90% of pipe and duct friction—
equivalent to about half the world's coal-fired electricity

thin, long, crooked



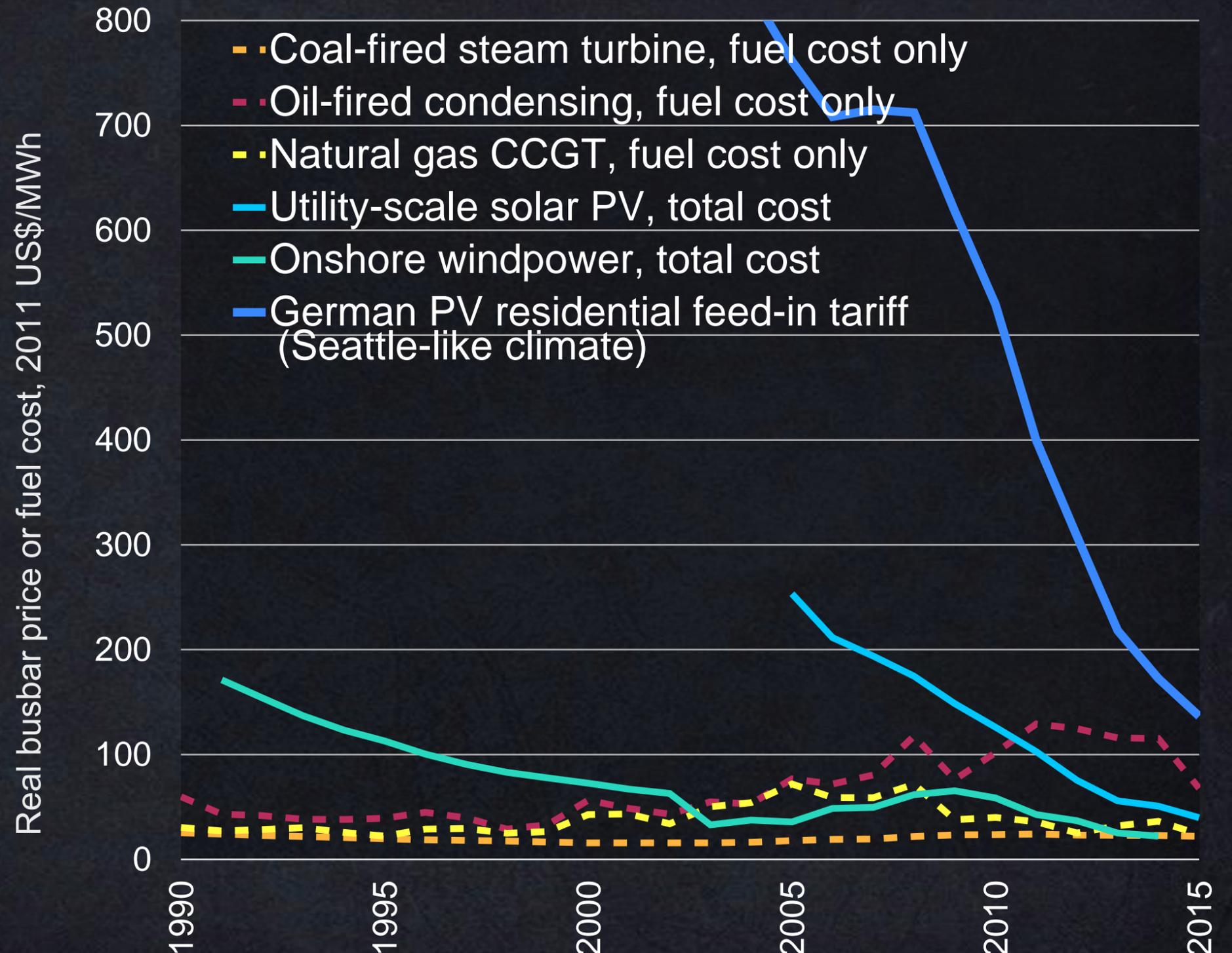
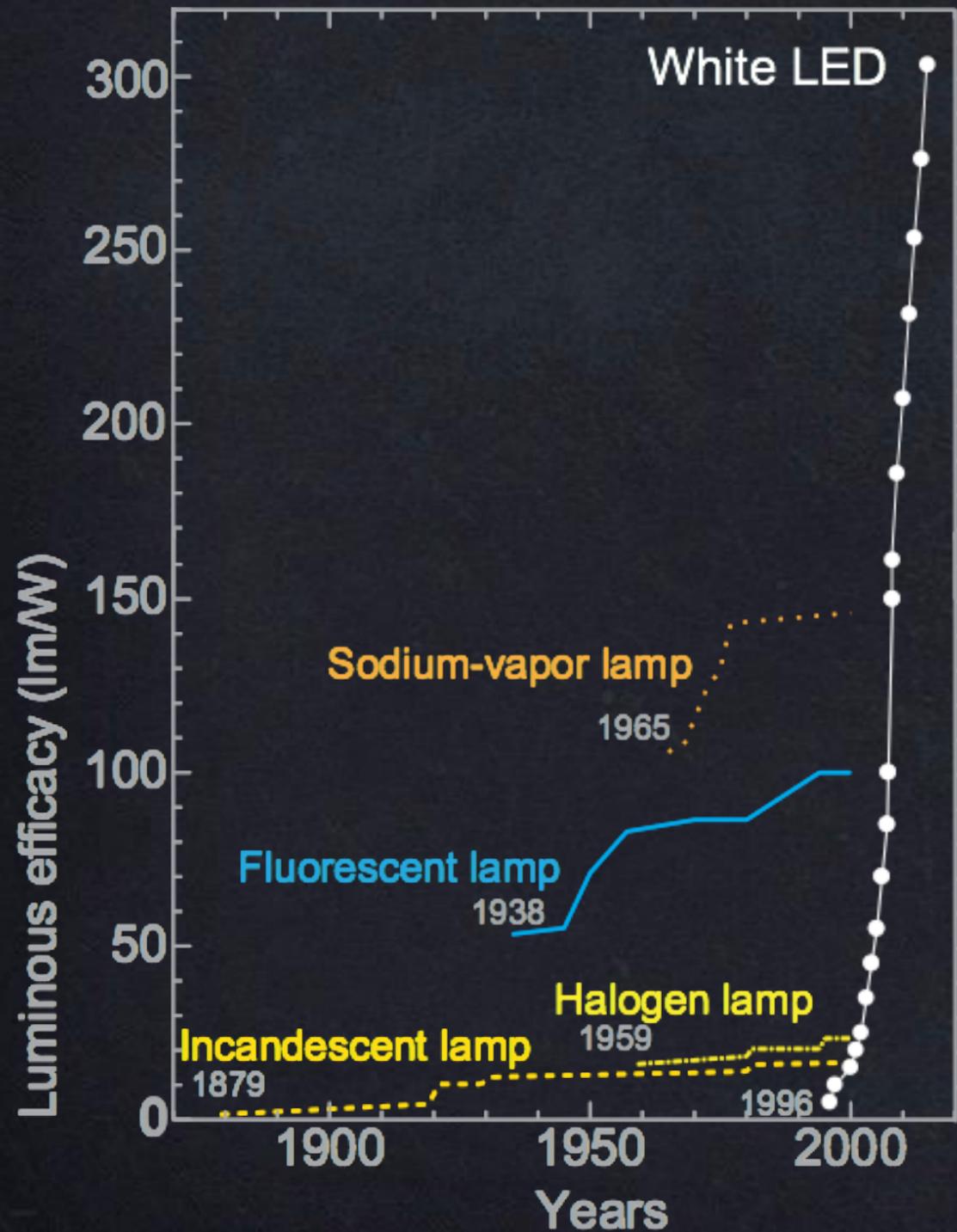
fat, short, straight



Typical paybacks ≤ 1 y retrofit, ≤ 0 new-build

But not yet in any textbook, official study, or industry forecast

LED and PV



Sources: L: courtesy of Dr. Yukio Narukawa (Nichia Corp., Tokushima, Japan) from *J. Physics. D: Appl. Phys.* **43**(2010) 354002, doi:10.1088/0022-3727/43/35/354002, updated by RMI with CREE lm/W data, 2015, www.cree.com/News-and-Events/Cree-News/Press-Releases/2014/March/300LPW-LED-barrier; R: RMI analysis, at average 2013 USEIA fossil-fueled generation efficiencies and each year's real fuel costs (no O&M); utility-scale PV: LBNL, *Utility-Scale Solar 2013* (Sep 2014), Fig. 18; onshore wind: USDOE, *2013 Wind Technologies Market Report* (Aug 2014), "Windbelt" (Interior zone) windfarms' average PPA; German feed-in tariff (falls with cost to yield ~6%/y real return): Fraunhofer ISE, *Cost Perspective, Grid and Market Integration of Renewable Energies*, p 6 (Jan 2014); all sources net of subsidies; graph inspired by 2014 "Terror dome" slide, Michael Parker, Bernstein Alliance

Netherlands: trade electricity with fellow-customers

soorten bronnen: Wind Water Bio Zon

Stap 1: jouw situatie

Maak een schatting van je verbruik: ?

Rijtjeshuis 3 bewoners

Of vul je verbruik zelf in: ?

Ik heb een enkele meter

Elektriciteit 2850 kWh

Gas 1200 m³

50 Beschikbaar Bespaar €2,44 per maand * €44,74 per mnd

1 Beschikbaar Bespaar €0,00 per maand * €51,67 per mnd

131 Beschikbaar Bespaar €3,03 per maand * €44,15 per mnd

Biovergister van Gerard Oude Lenferink, FLERINGEN

Windenergie van Gerard en Monique, LELYSTAD

Uitverkocht

Windenergie van Jaap en Feikje, MOLKWERUM

6 Beschikbaar Bespaar €3,02 per maand * €44,17 per mnd

2 Beschikbaar Bespaar €2,73 per maand * €44,46 per mnd

0 Beschikbaar Bespaar €2,73 per maand * €44,46 per mnd

Uitverkocht

Windenergie van Wim Fokkema, ZEEWOLDE

Uitverkocht

Zonnepark Azewijn, AZEWIJN

Uitverkocht

Windenergie van Gorrit Jansen, St. Annaparochie

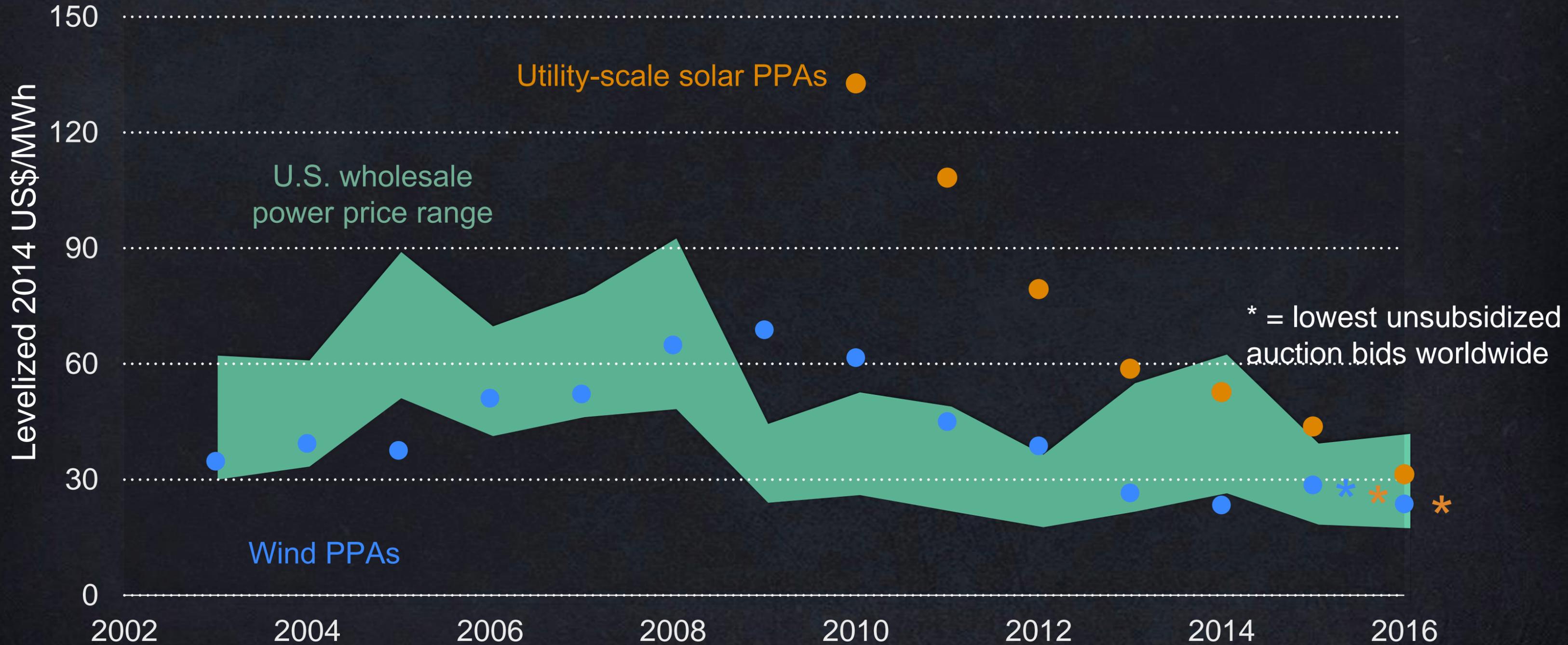
0 Beschikbaar Bespaar €2,73 per maand * €44,46 per mnd

0 Beschikbaar Bespaar €1,87 per maand * €45,32 per mnd

0 Beschikbaar Bespaar €1,58 per maand * €45,61 per mnd

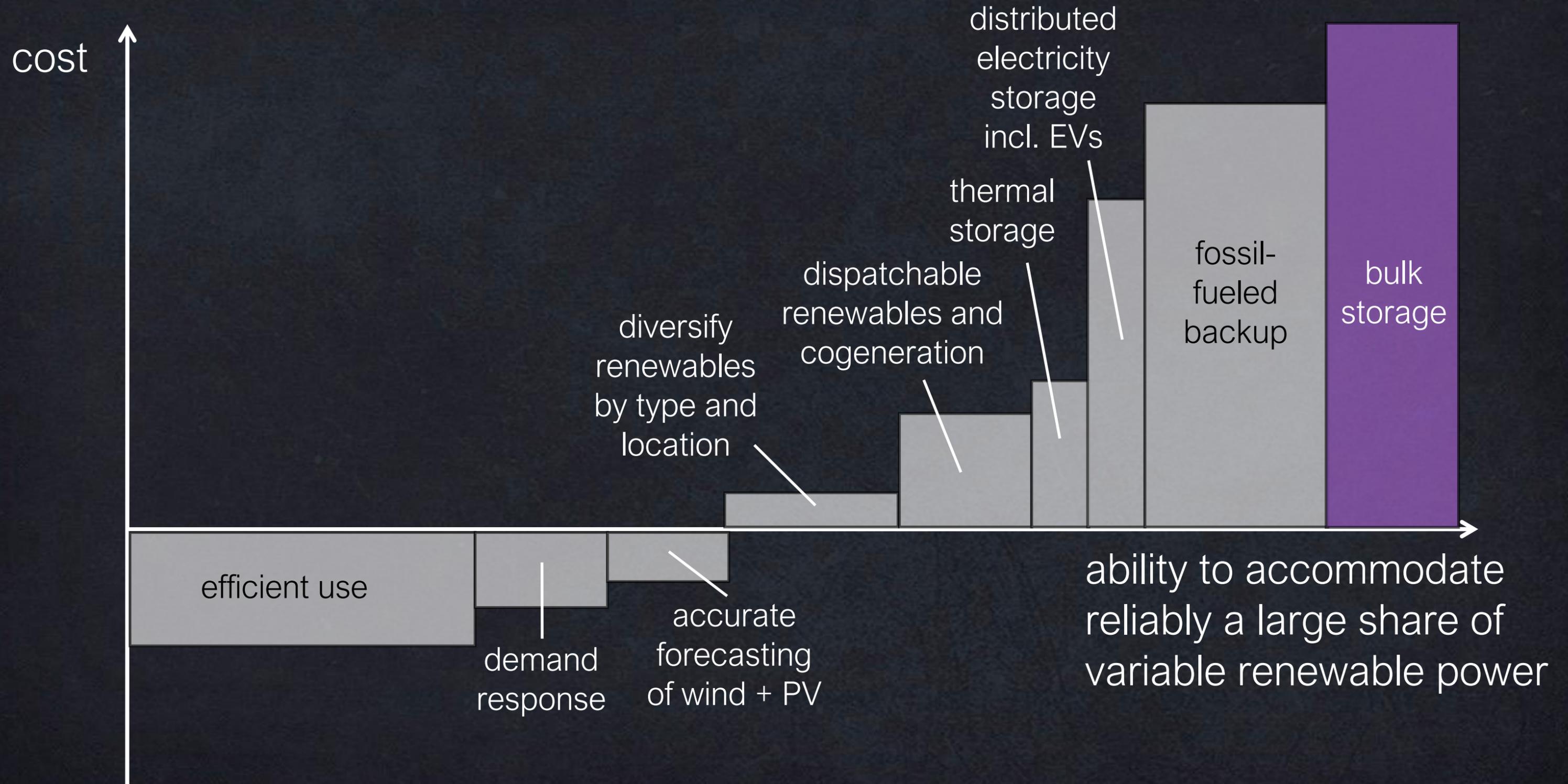
Renewable energy's costs continue to plummet

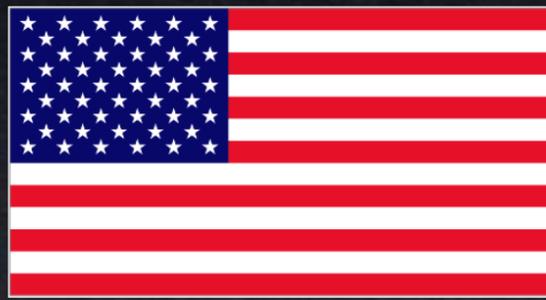
Wind and photovoltaics: U.S. generation-weighted-average Power Purchase Agreement (PPA) prices, by year of signing



Grid flexibility supply curve

(all values shown are conceptual and illustrative)





\$5T

in savings

+158%

bigger economy

0

oil, coal, nuclear



RMB 21T
2010 NPV

in savings
经济节约

+587%

bigger GDP
经济规模

42%

less carbon
碳排放减少

Easter Parades on Fifth Avenue, New York, 13 years apart

1900: where's the first car?



1913: where's the last horse?

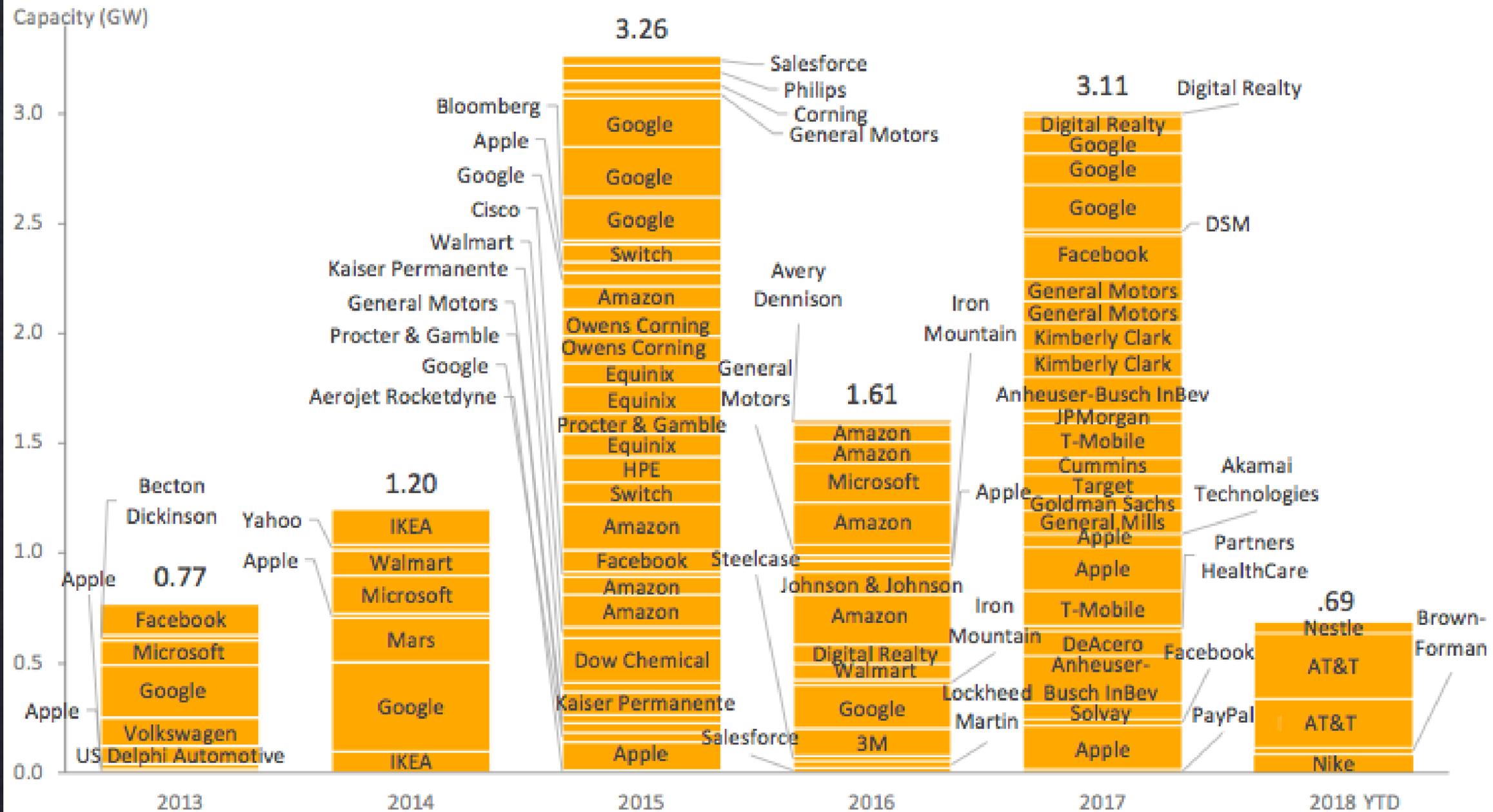


Images: L, National Archive, www.archives.gov/research/american-cities/images/american-cities-101.jpg; R, shorpy.com/node/204.

Inspiration: Tona Seba's keynote lecture at AltCar, Santa Monica CA, 28 Oct 2014, <http://tonyseba.com/keynote-at-altcar-expo-100-electric-transportation-100-solar-by-2030/>

Corporate Renewable Deals

2013 – 2018 YTD



Publicly announced contracted capacity of corporate Power Purchase Agreements, Green Power Purchases, Green Tariffs, and Outright Project Ownership in the US and Mexico, 2013 – 2018 (YTD). Excludes on-site generation (e.g., rooftop solar PV) and deals with operating plants. Last updated: February 13, 2018.

All through cities, up and down the supply chain

WE ARE STILL IN

BUSINESSES & INVESTORS CITIES & COUNTIES STATES & TRIBES COLLEGES & UNIVERSITIES FAITH ORGANIZATIONS

Walmart

ProjectGigaton
We're working with our suppliers to reduce greenhouse gas emissions from our supply chain by **1 Gigaton**.

Suppliers can make commitments in

- Energy
- Agriculture
- Waste
- Products
- Deforestation
- Packaging

How much really IS a **GIGATON?**
[gig-uh-tuhn] noun: one billion tons

It is equivalent to...

- Removing all **211 MILLION CARS** from the road for a year
- The average annual emissions of **100 MILLION** U.S. homes
- The weight of **100 MILLION** elephants*
- 6 MILLION** blue whales**

* The Washington Post. **According to the NOAA

From the Age of Carbon to the Age of Silicon



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BUSINESS
RENEWABLES
CENTER

A ROCKY MOUNTAIN INSTITUTE INITIATIVE

