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THE NEW CLIMATE ECONOMY: PATHWAYS FOR THE U.S.

KARL HAUSKER

OCTOBER 2017

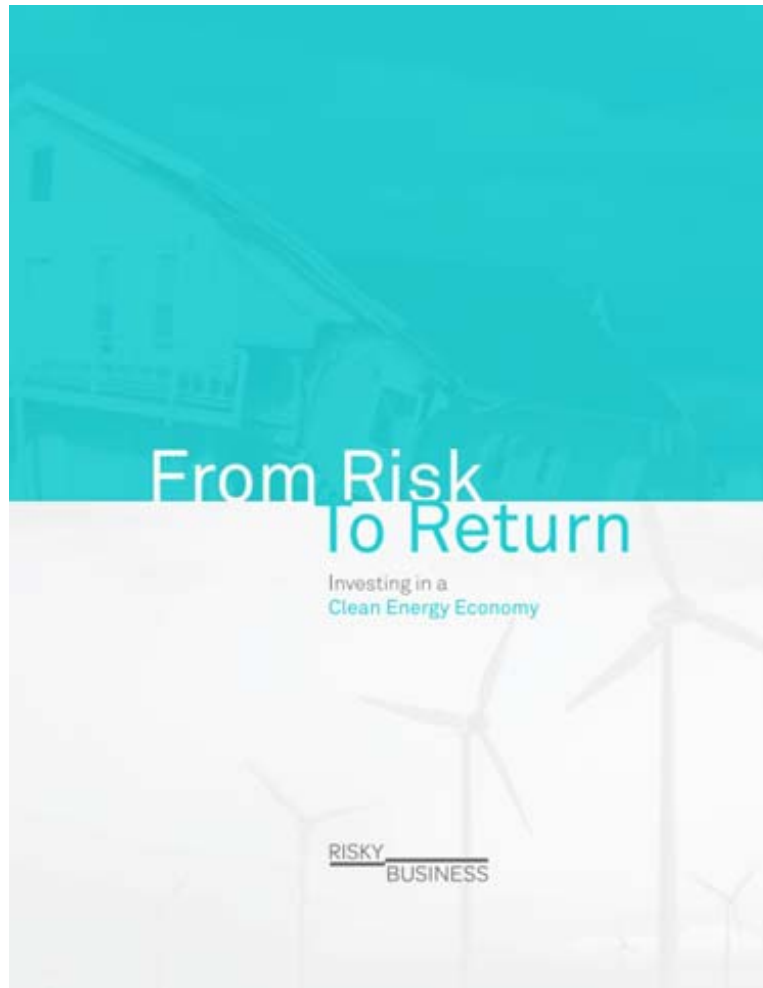
OUTLINE

- What is the New Climate Economy?
- Results of two recent studies of U.S. pathways to 80% reductions in CO2 by 2050
 - Technical and economic feasibility
 - Implications for power sector
 - Implementation challenges
- 100% renewable energy?
- Policy implications
- A deeper dive:
8pm Castilian Room seminar

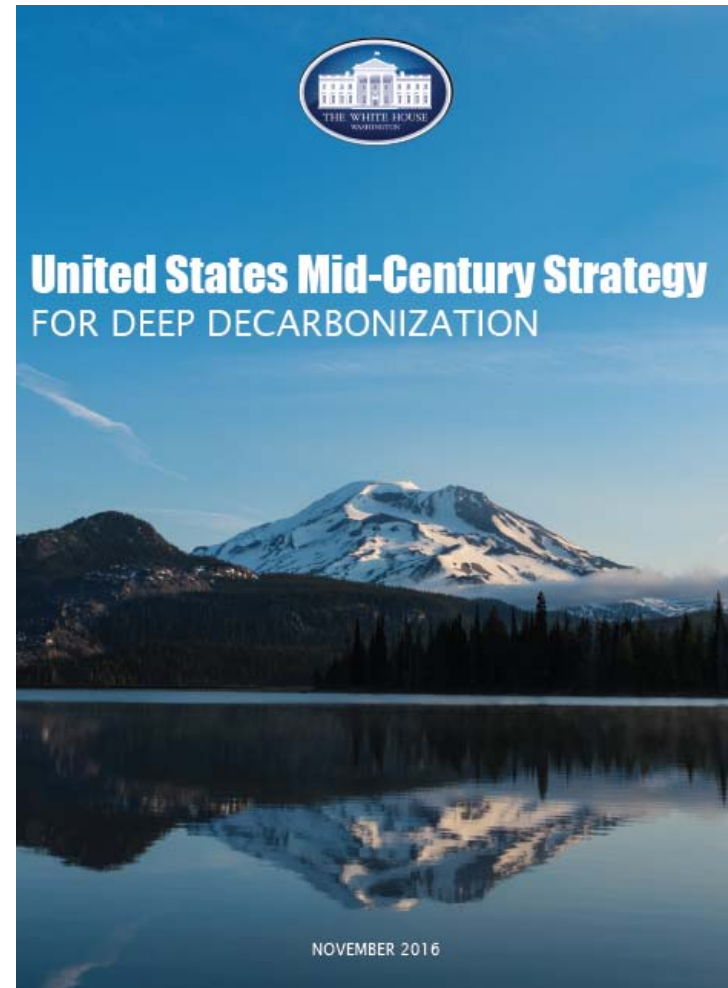
Disclaimer, URLs



TWO STUDIES WITH A LONG SHELF LIFE



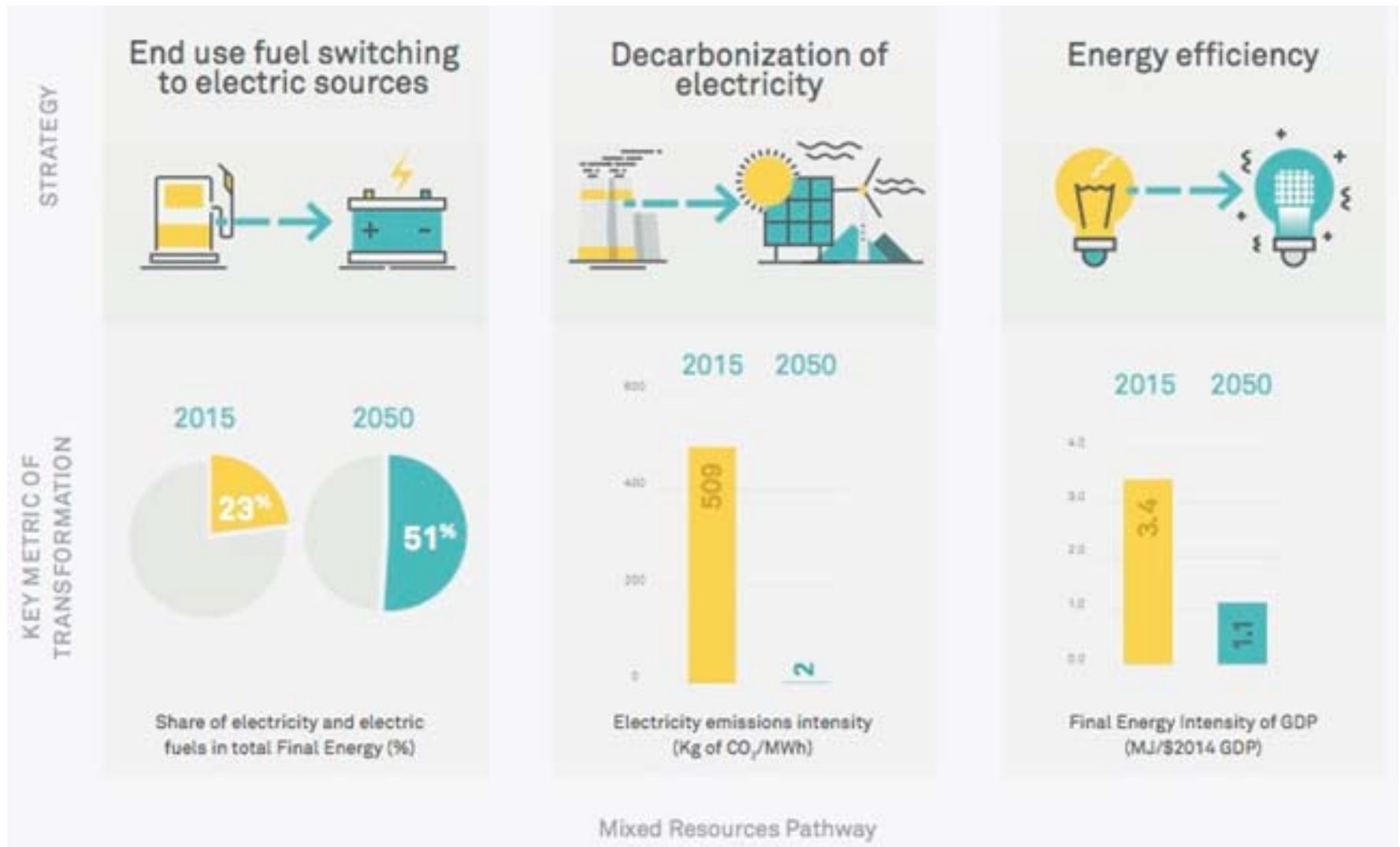
<http://riskybusiness.org/fromrisktoreturn/Archives>



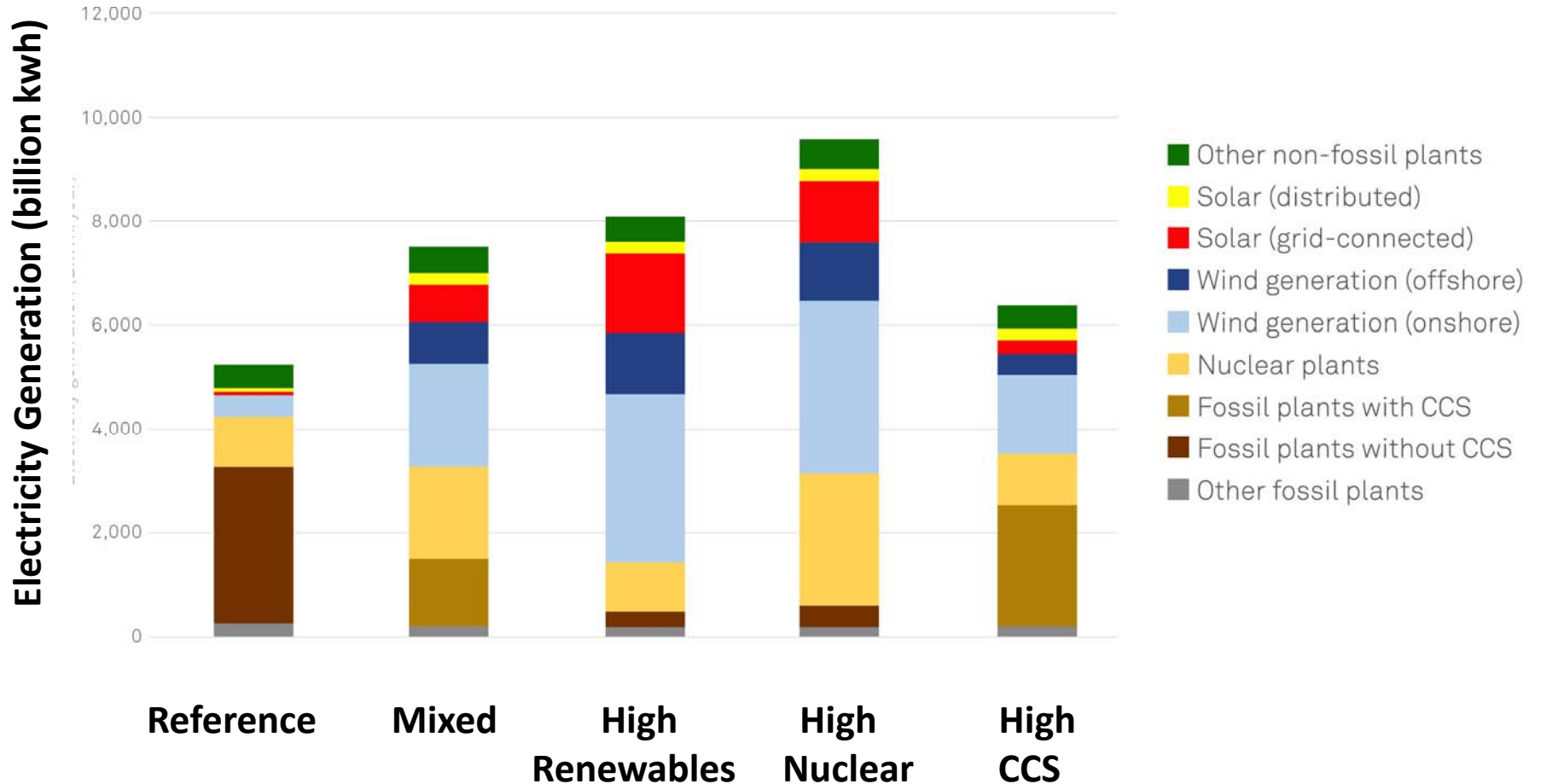
UNFCCC and Obama WH

https://unfccc.int/files/focus/long-term_strategies/application/pdf/mid_century_strategy_report-

Three Pillars: Strategies and Metrics

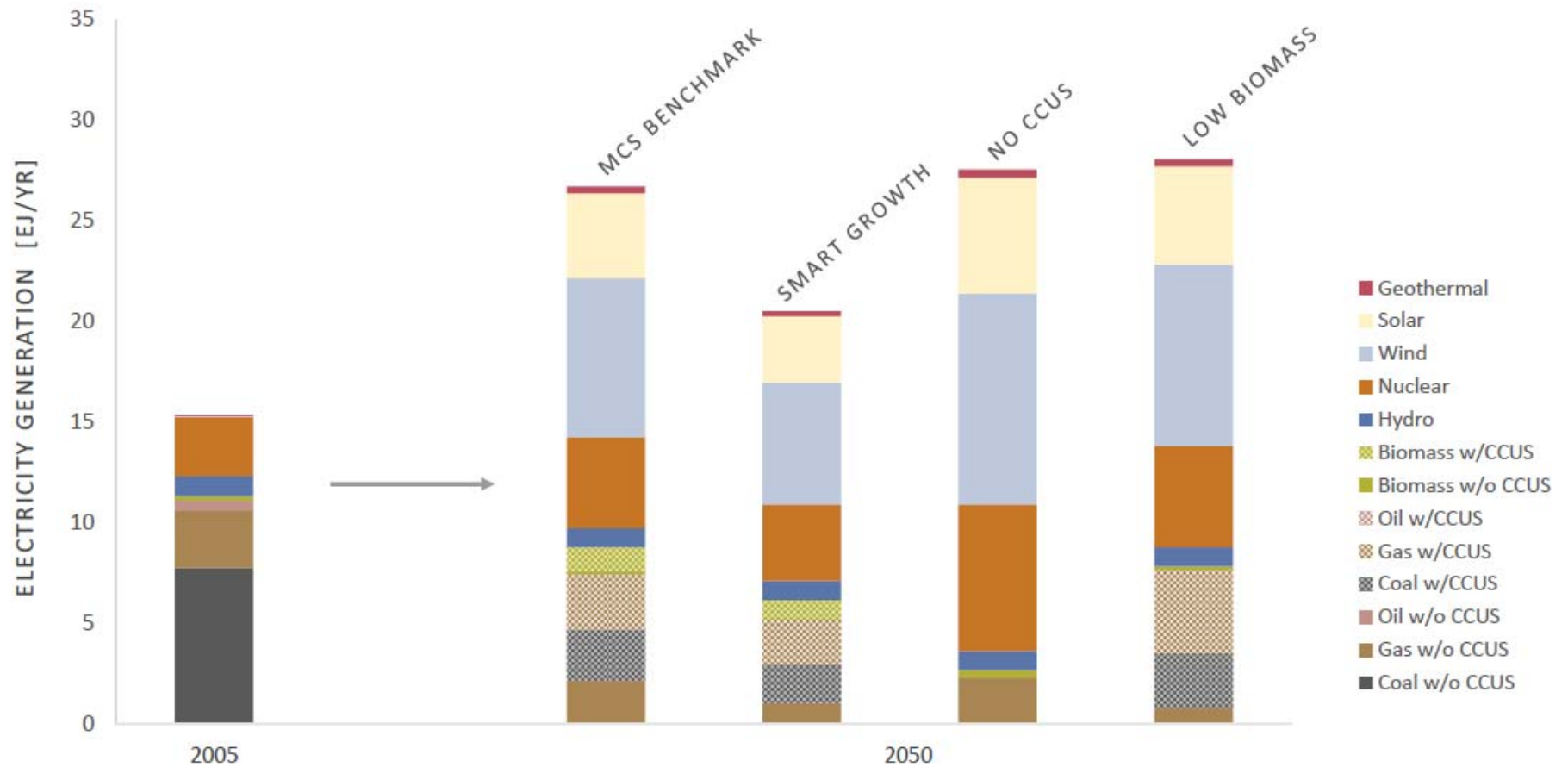


POWER GENERATION IN 2050 (RB)



The bottom line on climate change

POWER GENERATION IN 2050 (MCS)



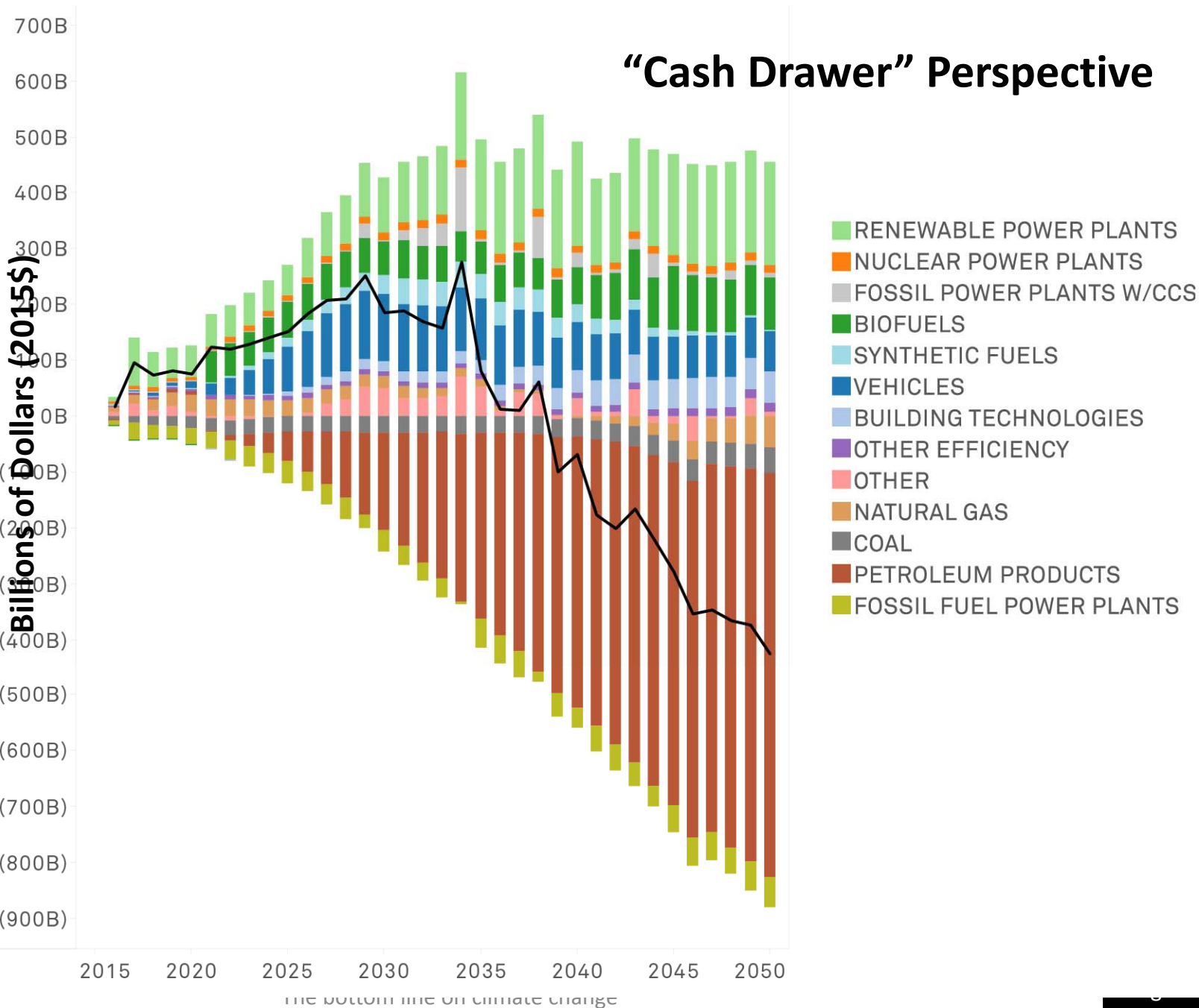
INVESTING IN CLEAN ENERGY

Average annual change in investments and fuel expenditures by decade.

- Roughly equal to average annual US IT spending over the past decade.
- \$18 trillion GDP
- \$3 trillion in investment (16%)
- 15%-22% of GDP since 1980



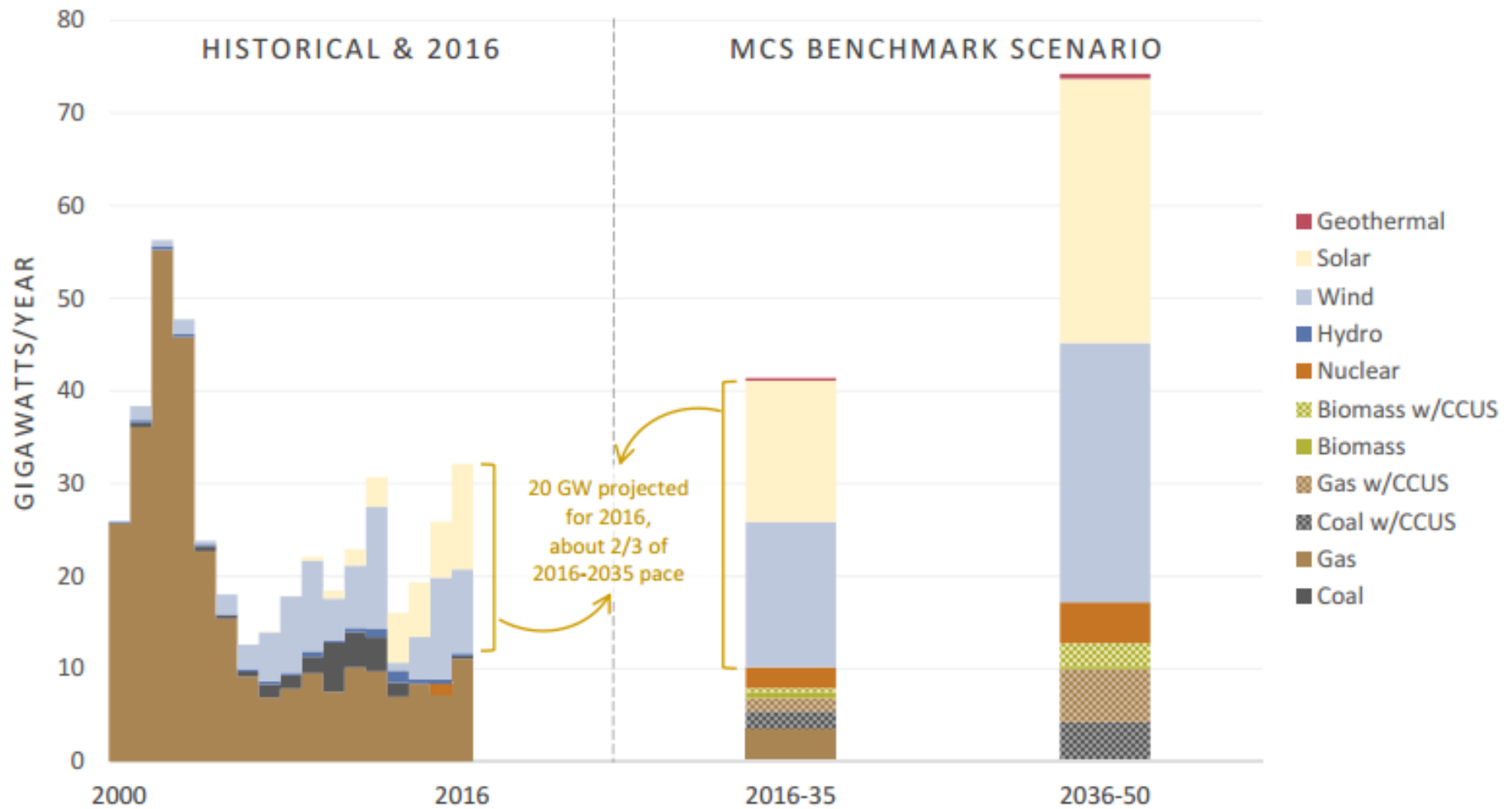
As-Spent Costs and Savings



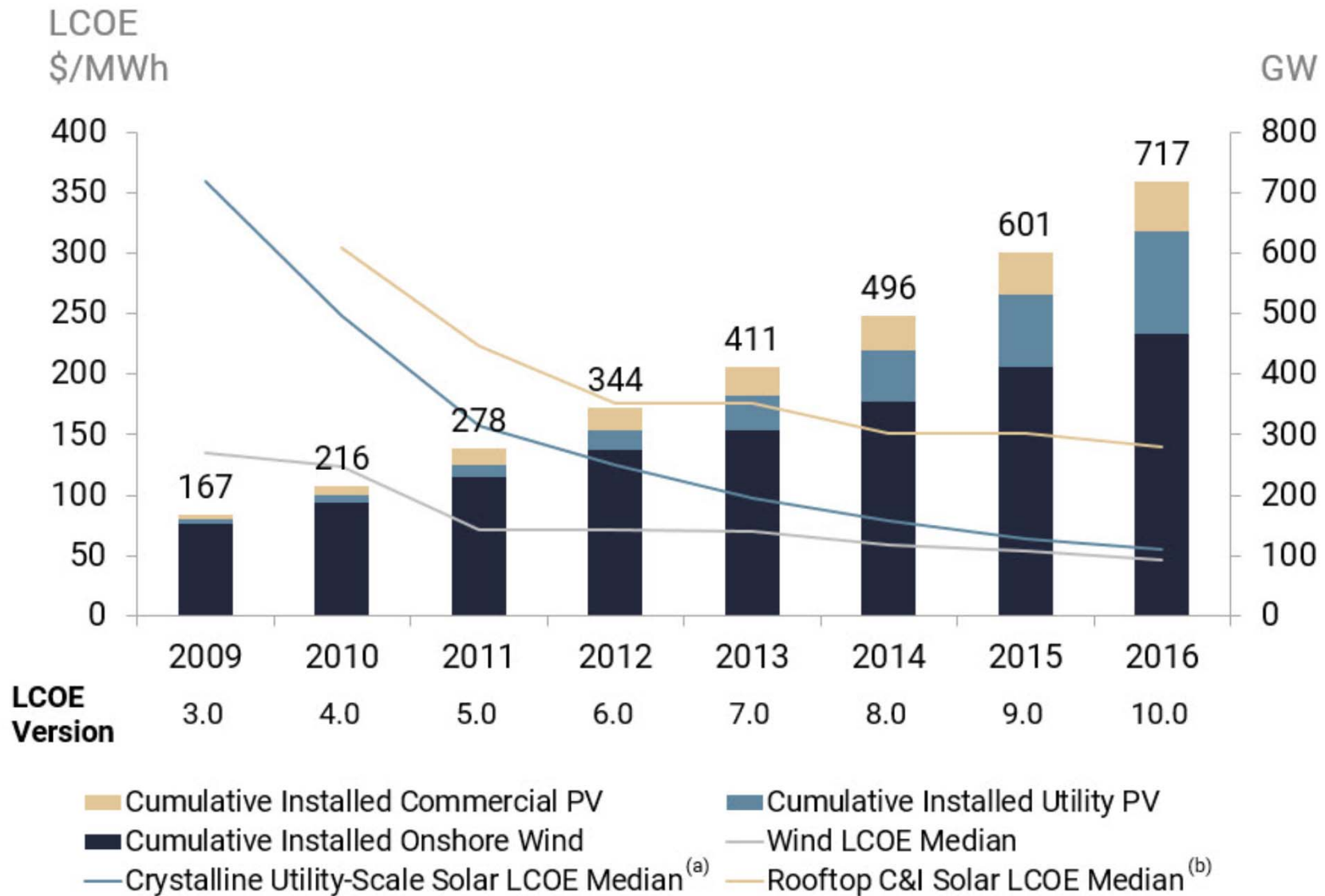
IMPLEMENTATION CHALLENGES

- Rate of power plant construction: challenging, but doable.
 - 2-4 X historical rates
- Expansion of transmission and distribution system.
 - Transmission line siting likely a major obstacle
- Electric vehicle infrastructure and charging.
 - Workplace? Home? Fast Charging? Battery Swapping?
- Utility business models and design of power markets
 - Compatible with VG, nuclear, CCS, distributed energy resources, smart grids and smart devices
- Effective policies that can withstand declines in fossil fuel prices
 - IEA modeling suggests that by 2050, oil and coal prices could drop by 40% and gas prices by 1/3.

ELECTRIC CAPACITY ADDITIONS



LAZARD'S ANNUAL TRACKING OF WIND AND SOLAR PV COSTS & CAPACITY ADDITIONS

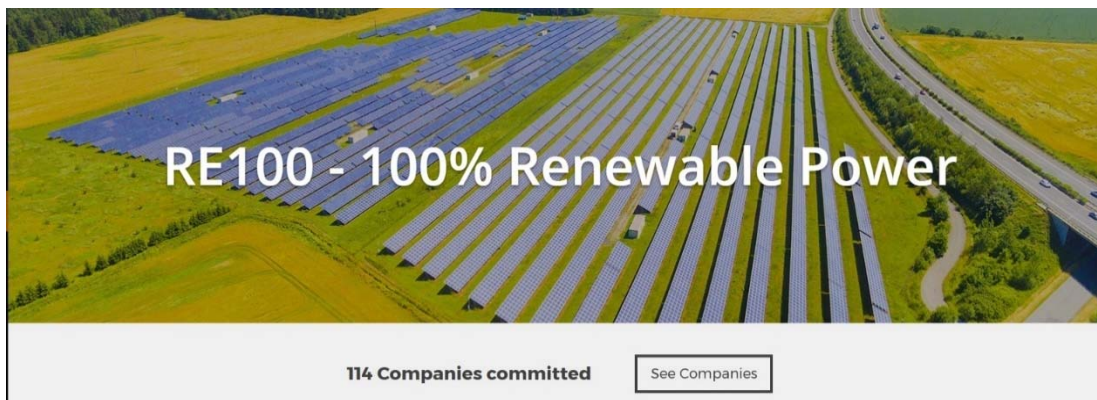


THEREFORE...

- Renewables have reached “grid parity”
- Renewables are “beating” conventional power sources
 - Renewables bid zero (or even negative) in day-to-day wholesale power markets
- Baseload power plants are “not needed” and are “obsolete”

CAN WE DO IT WITH 100% RENEWABLES?

- Hawaii sets goal of 100% RE by 2045
- California S.B. 100 would set goal of 100% RE by 2045
- Four Senators introduce “100 by ’50 Act”



Mayors For 100% Clean Energy



COMPREHENSIVE CRITIQUE OF “100% WWS” BY 20 AUTHORS, JUNE 2017

PNAS PNAS



Evaluation of a proposal for reliable low-cost grid power with 100% wind, water, and solar

Christopher T. M. Clack^{a,b,1,2}, Staffan A. Qvist^c, Jay Apt^{d,e}, Morgan Bazilian^f, Adam R. Brandt^g, Ken Caldeira^h, Steven J. Davisⁱ, Victor Diakov^j, Mark A. Handschy^{b,k}, Paul D. Hines^l, Paulina Jaramillo^d, Daniel M. Kammen^{m,n,o}, Jane C. S. Long^{p,3}, M. Granger Morgan^d, Adam Reed^q, Varun Sivaram^r, James Sweeney^{s,t}, George R. Tynan^u, David G. Victor^{v,w}, John P. Weyant^{s,t}, and Jay F. Whitacre^d

In this paper, we evaluate that study and find significant shortcomings in the analysis. In particular, we point out that this work used invalid modeling tools, contained modeling errors, and made implausible and inadequately supported assumptions. Policy makers should treat with caution any visions of a rapid, reliable, and low-cost transition to entire energy systems that relies almost exclusively on wind, solar, and hydroelectric power.

SYNTHESIS OF STUDIES OF POWER SECTOR DECARBONIZATION



DEEP DECARBONIZATION OF THE ELECTRIC POWER SECTOR INSIGHTS FROM RECENT LITERATURE

JESSE D. JENKINS AND SAMUEL THERNSTROM

MARCH 2017

The electric power sector is widely expected to be the linchpin of efforts to reduce greenhouse gas (GHG) emissions. Most studies exploring climate stabilization pathways envision a decline in global anthropogenic GHGs of 50-90% below current levels by 2050 (IPCC 2014; Loftus et al. 2015). To reach these goals, the power sector would need to cut emissions nearly to zero, while expanding to electrify (and consequently decarbonize) portions of the transportation, heating, and industrial sectors (GEA 2012; IPCC 2014; Krey et al. 2014; McCollum et al. 2014).

There is a strong consensus in the literature that reaching near-zero emissions is much more challenging — and may require a very different mix of resources — than comparatively modest emissions reductions (50-70% or less). Planning and policy measures should therefore focus on long-term objectives (near-zero emissions) in order to avoid costly lock-in of suboptimal resources.

In addition, there is strong agreement in the literature that a diversified mix of low-CO₂ generation resources offers the best chance of affordably achieving deep decarbonization.

POLICY IMPLICATIONS

- The purpose of modeling
- “All of the above” vs. “100% Renewables”
 - Portfolios, risk management, avoiding lock-in
 - Existing nuclear plants
- Global perspective on nuclear and CCS
 - Countries with slim renewable resources
 - Small countries / political stability
 - Who is setting standards? Operation, waste, prolifer.
- RD&D
 - Renewables
 - Nuclear
 - CCS – coal, gas, industry, bioenergy (BECCS)
 - Storage, Smart Grid
- Key role of expanded transmission



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THANK YOU

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