Resource Revolution

Investor Opportunities in New Climate

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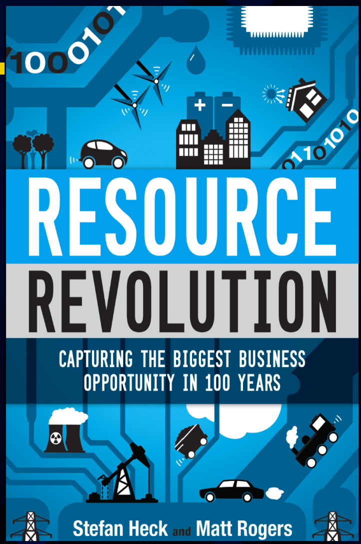
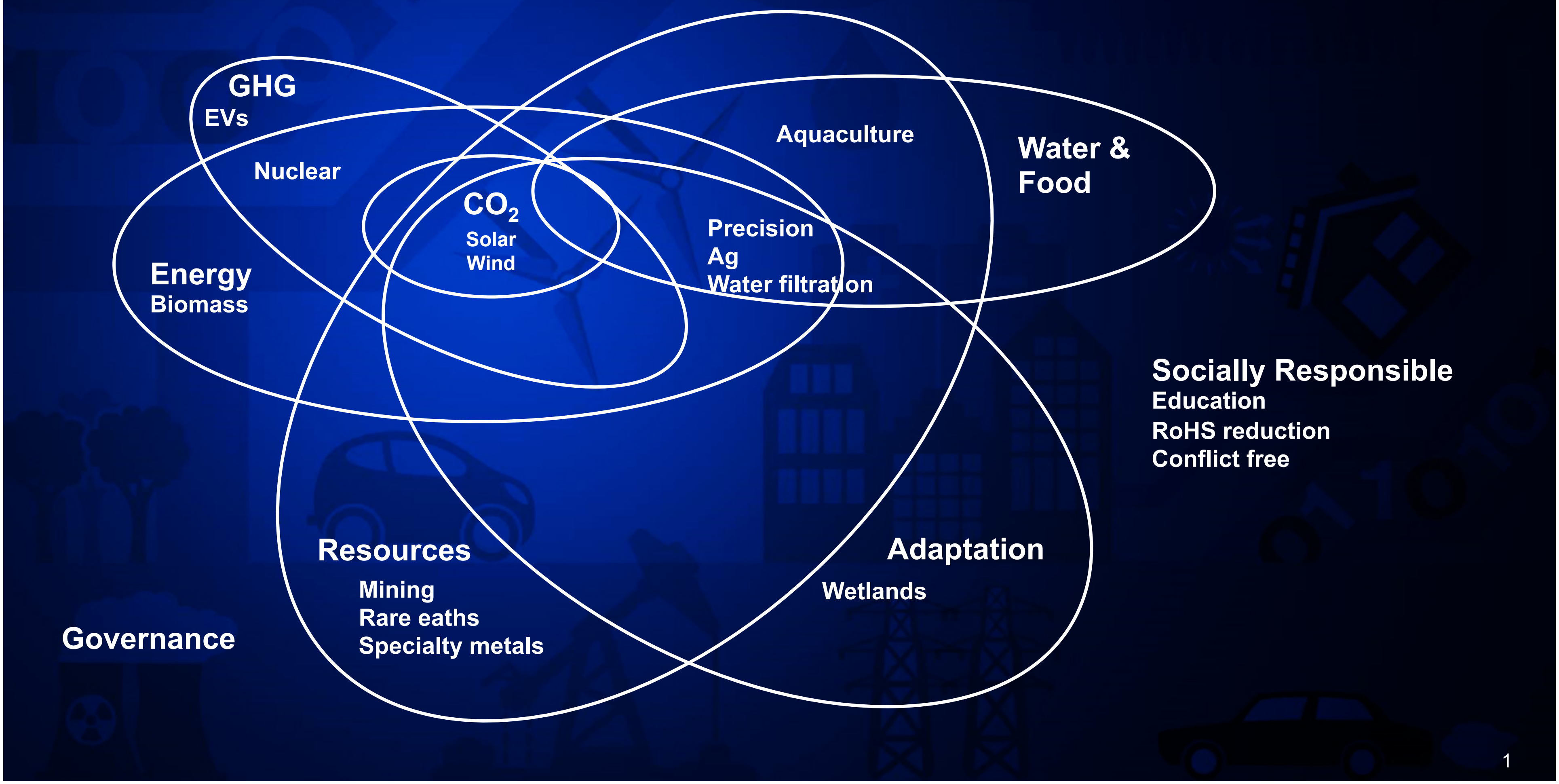
Stanford University

#ResourceRev #NewClimate

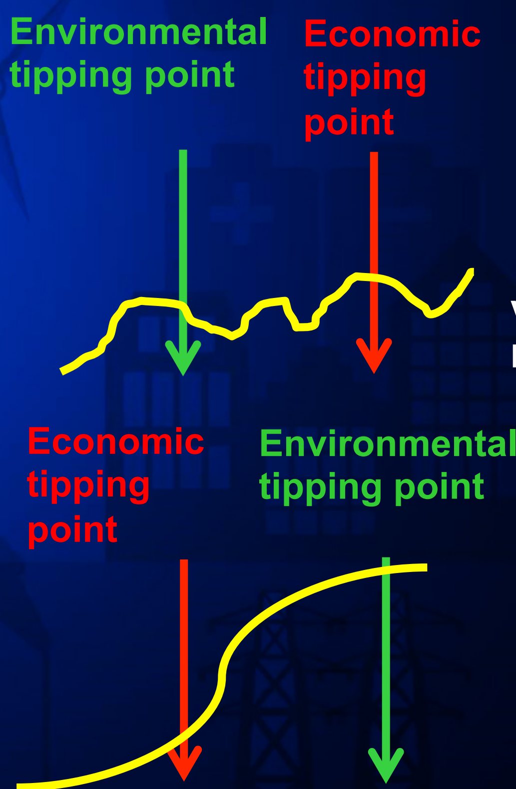


Scope Definitions of Climate Investing - Examples



A framework for new climate investing

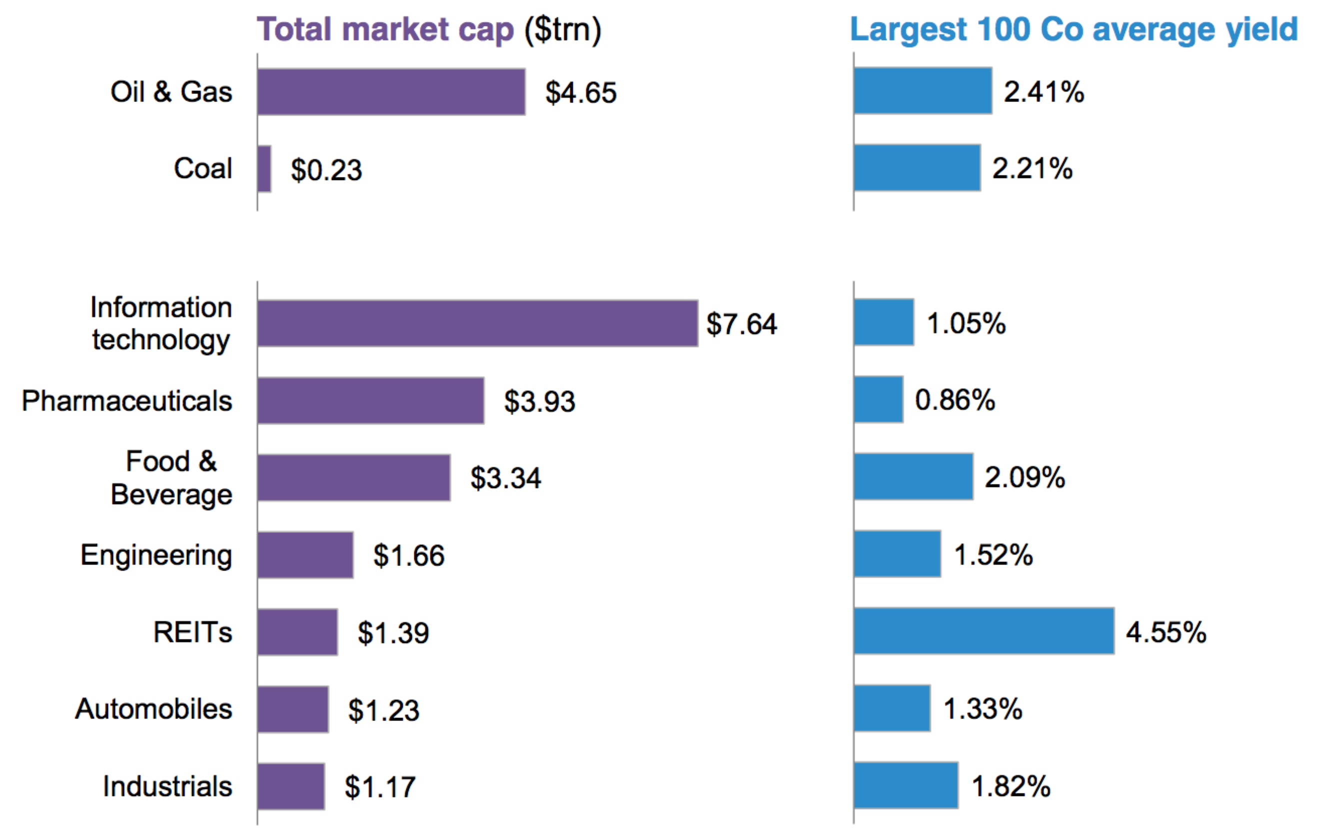
	Near Term (3-5 years): Shape through ownership	Near Term (3-5 years): Redeploy capital	Long Term (5-20): Shape through ownership	Long Term (5-20): Redeploy capital
Risk Screen	Regulatory disruption Consumer preference Limited growth		Severe event damage Stranding/bans Cost disadvantage	
	Carbon disclosure	350.Org Fossil free index	Voting proxies	KFW
Finding Alpha	New business models: sharing, automation Sexy premium with feel good future		Resource revolution Scaling of in-the-money products (DG solar, efficiency)	
	KKR	Green bonds Generation	Mubadala GIC	UC Regents



Overview

- Industrial revolutions transform the economy – creating wealth, broad spillover benefits, and profound risk for old models
  - 13-fold increase in GDP/capita, 100x energy/capita
  - 25 cents/ton-mile to 0.88 cents/ton-mile – 6 week to 2 days for NY-Chicago
  - Doubled life expectancy
- **We are on the cusp of another industrial revolution driven by a tenfold increase in resource rather than labor productivity**
  - 2.5B new middle class, resource price spikes, lower grades, correlation
  - New materials and internet of things changing industries
- **Applying this lens to investments entails a substantial portfolio shift sometime over next decade**
  - New Metrics: energy, water, metals, land, GHG, risk
  - System waste reduction, substitution, circularity, optimization, virtualization
  - The macro direction is clear, timing the market is difficult

Orthodox view: Shifting 15-20% of assets in energy to clean

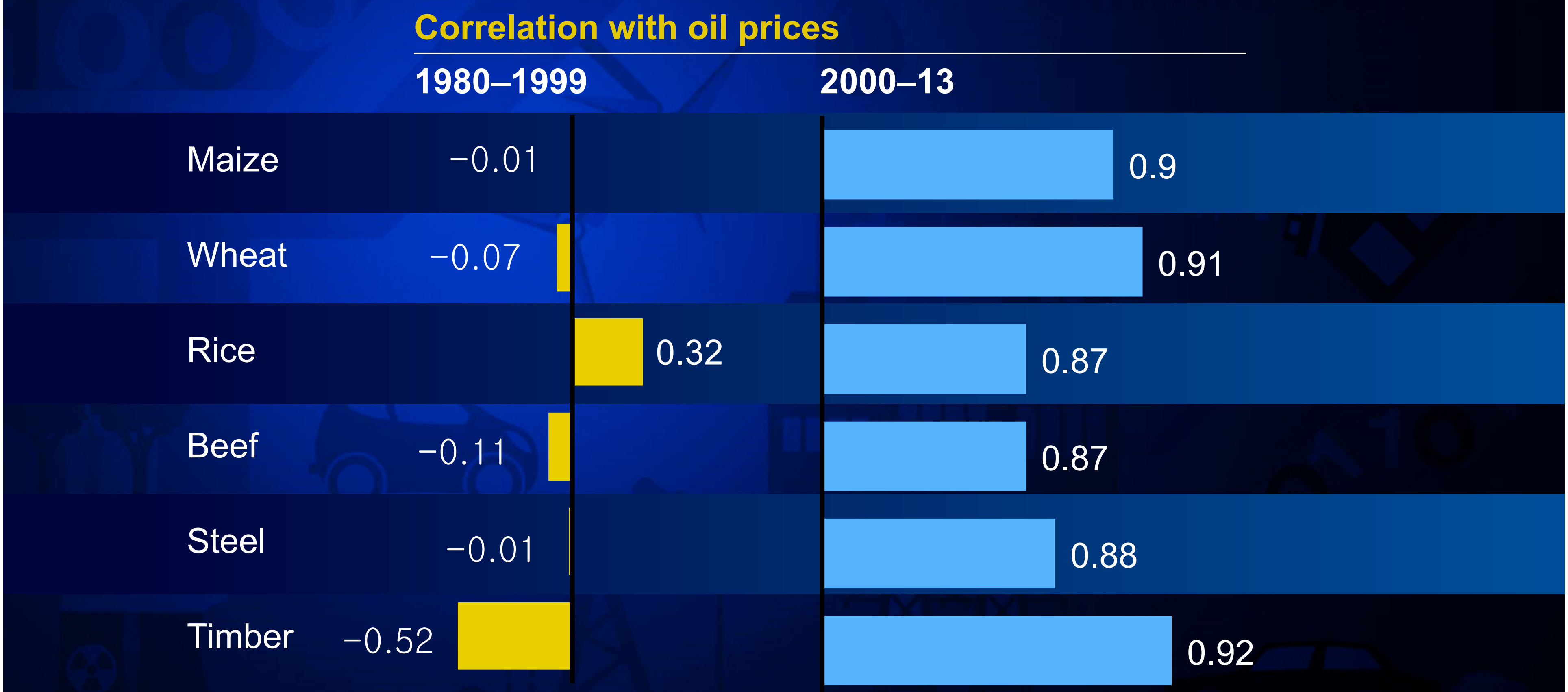


Source: *Bloomberg*

Note: *"average yield" is current average annual dividend yield. Includes the largest 3,000 companies in each sector, or fewer if the sector has less than 3,000 listed firms. Data as at 31 July 2014.*

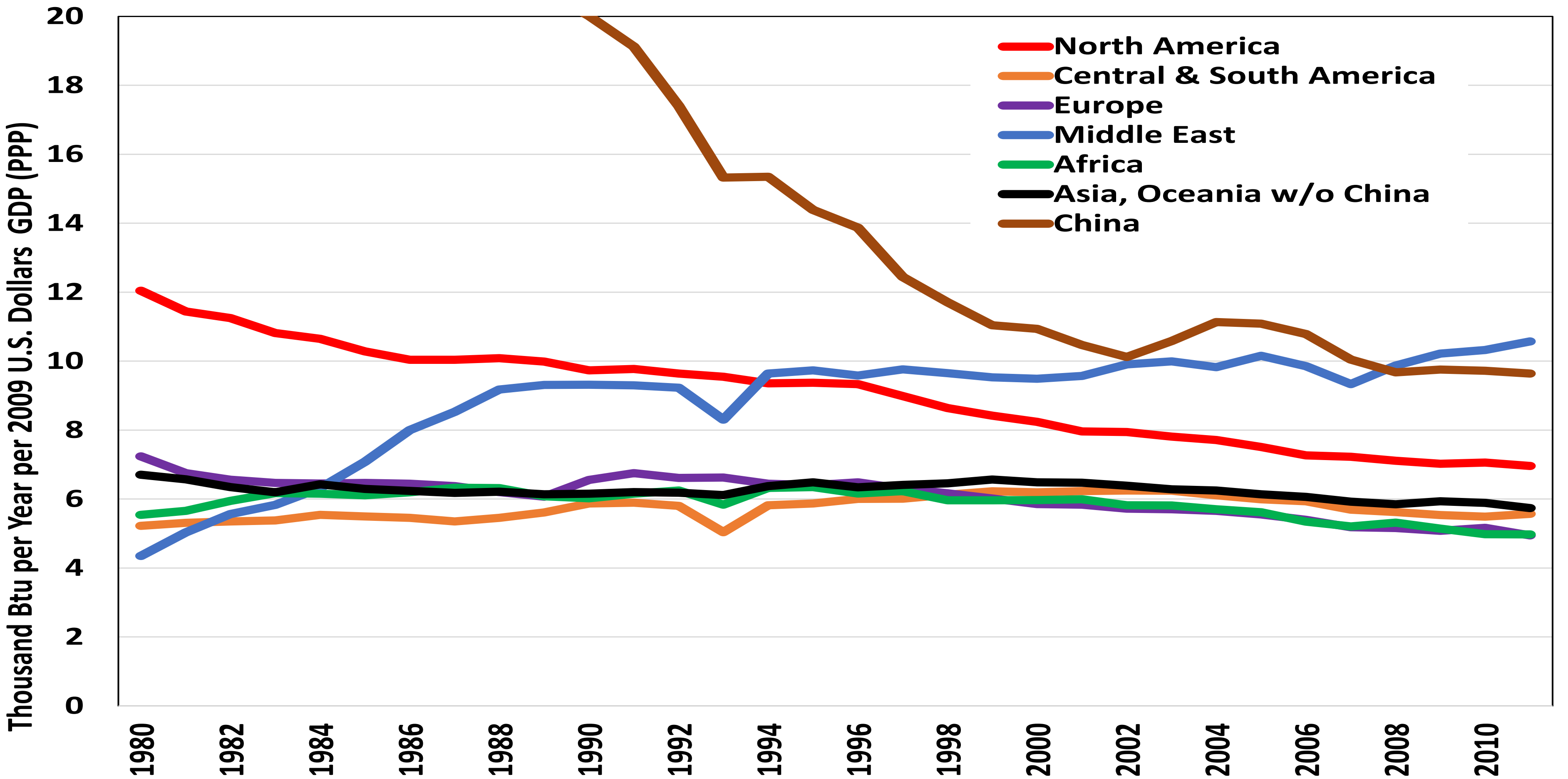
Hypocrisy of divesting oil

Most commodities now correlate with oil prices



SOURCE: McKinsey analysis

The real problem is energy intensity of the economy

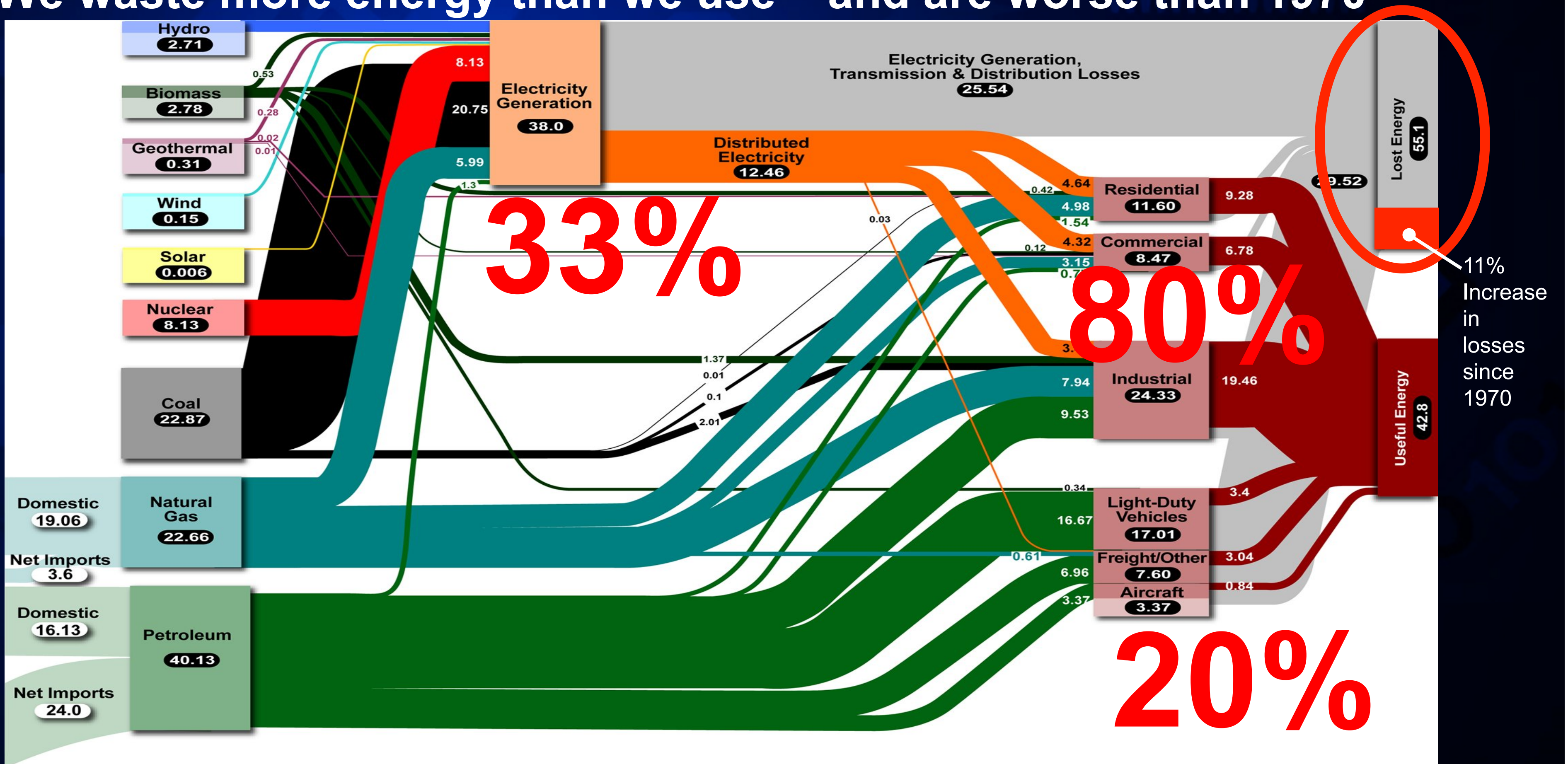


Cement example: buildup of infrastructure

1 Emerging African countries including: Benin, Cameroon, Congo DR, Djibouti, Eritrea, Ethiopia, Gambia, Ghana, Guinea, Ivory Coast Kenya, Mali, Malawi, Mozambique, Nigeria, Rwanda, Senegal, Somalia, Tanzania, Togo, Zimbabwe

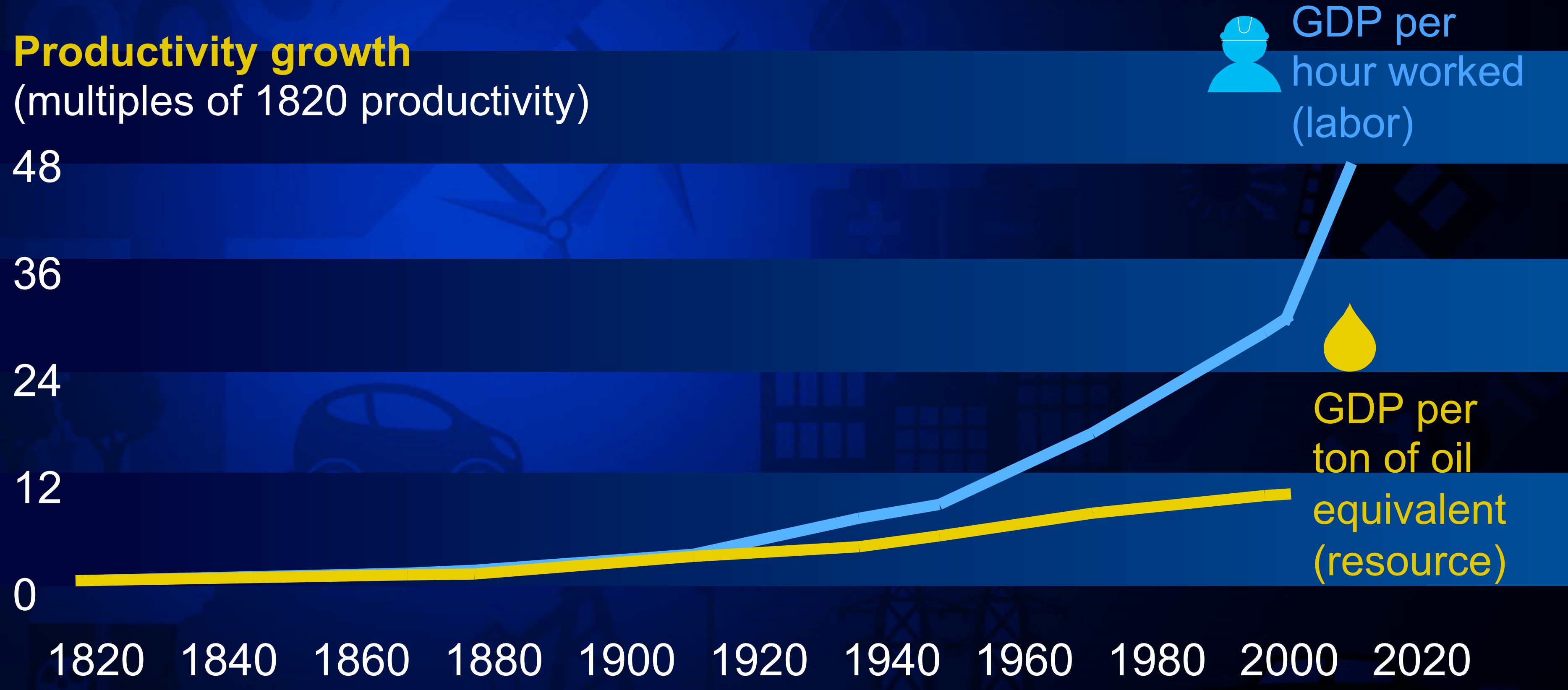
Source: Global Insight; ICR

We waste more energy than we use – and are worse than 1970



Sources: Lawrence Livermore National Labs

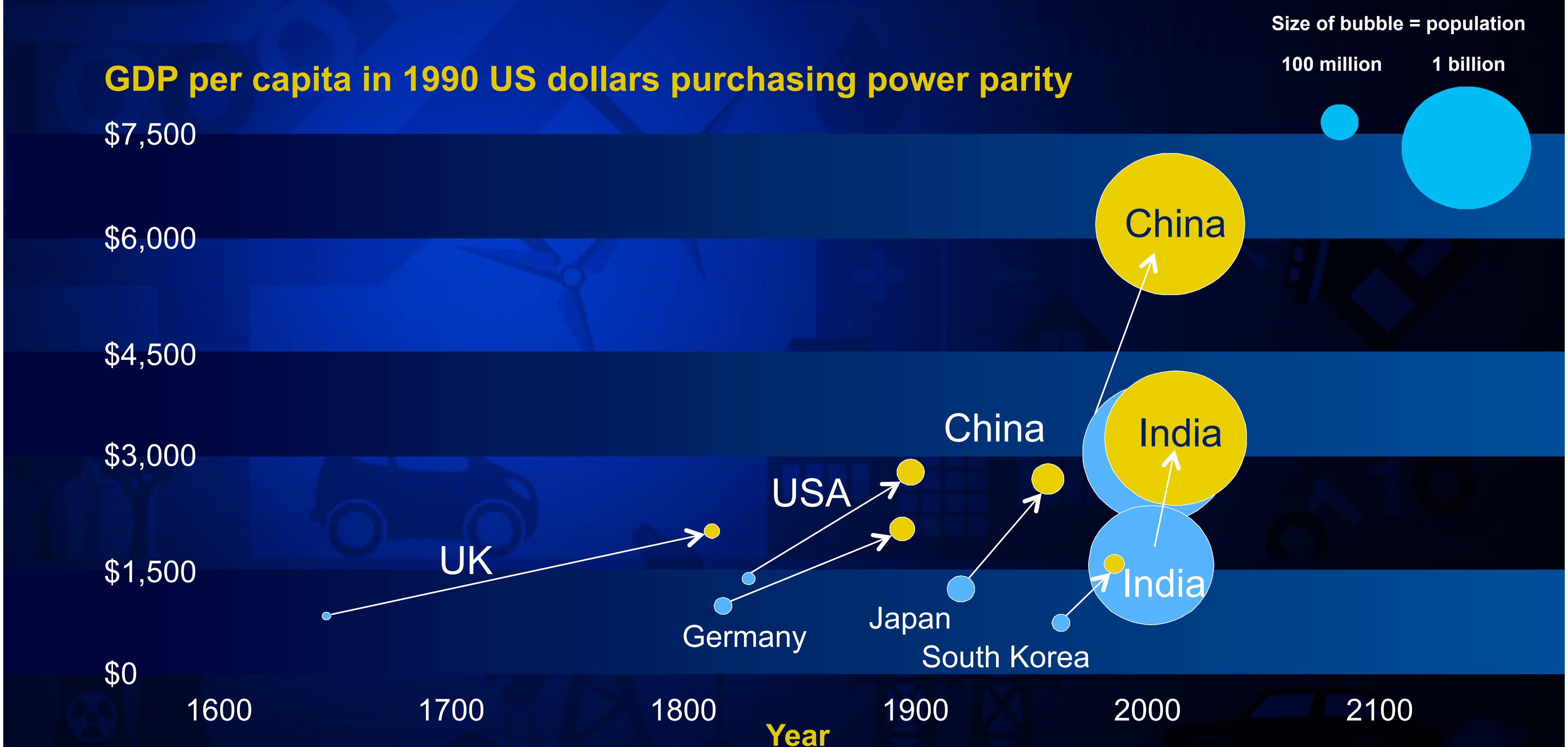
The real problem: we haven't seen productivity shift we have experienced for labor in energy



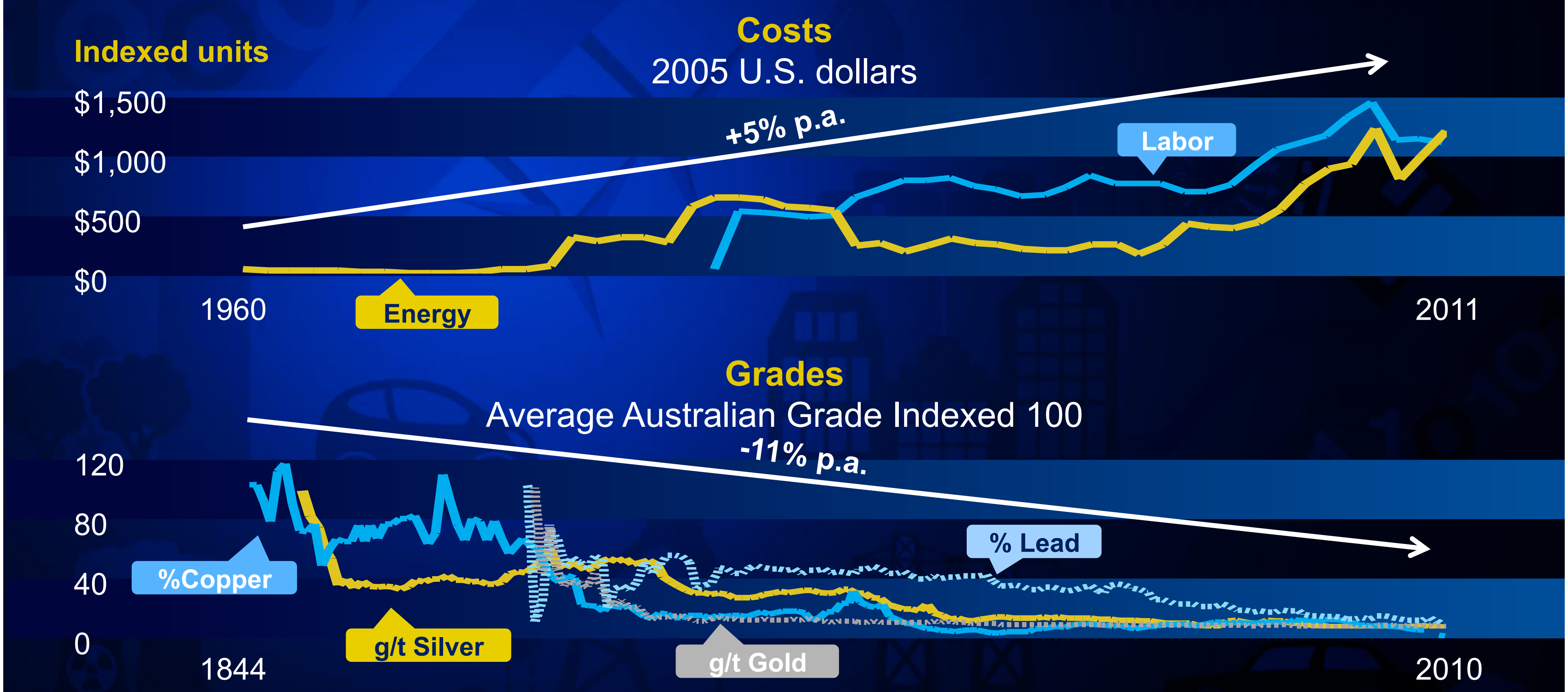
New York 1930s

- 13x increase in GDP/capita in 200 years (after only doubling in 2000 years)
- 100x increase in energy per person – animals/wood to coal and then oil/gas
- Transport costs dropped (25 cents/ton-mile to 0.88 cents)
- NY to Chicago time dropped from 6 weeks to 2 days to 2 hours
- Life expectancy more than doubled
- 3 elements (iron, carbon, calcium) to over 20 in common usage
- Light, books, education affordable for middle class

Discontinuity today: 100x more people, 10x more income, 10x faster

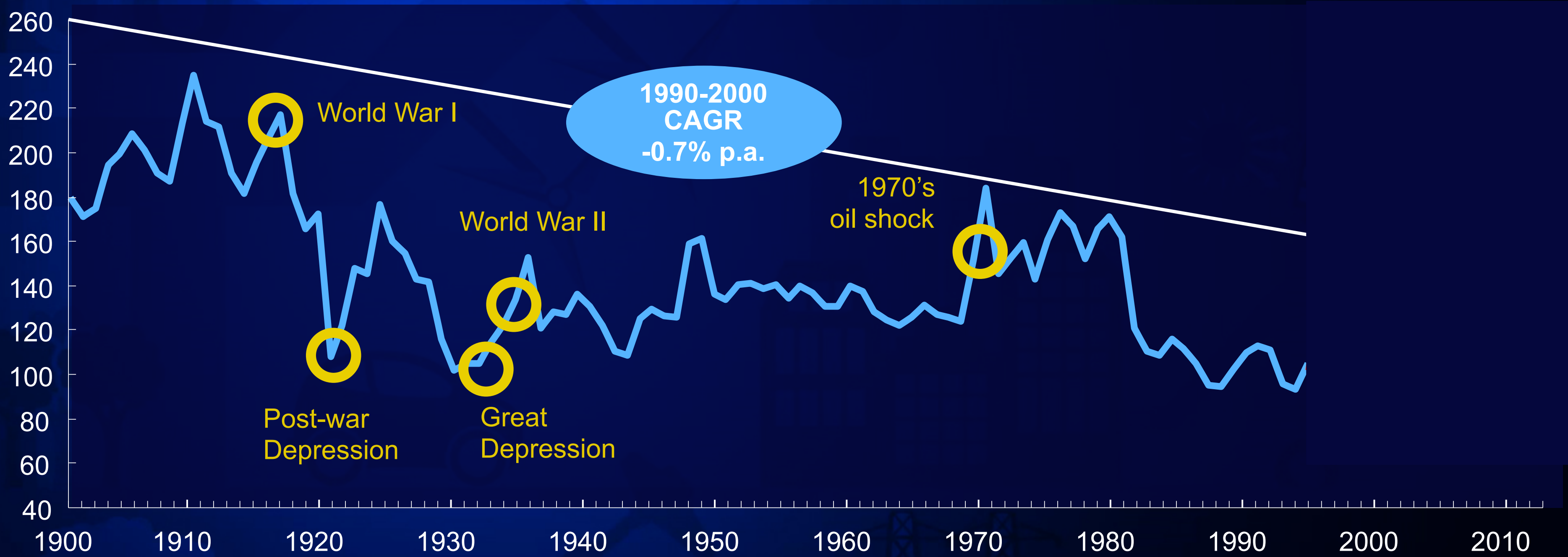


Concurrent supply challenge: Reserves are getting more expensive to extract and lower grade



A hundred year 1% annual commodity price benefit has reversed

MGI Commodity Index (years 1999-2001 = 100)[1]



1 Based on arithmetic average of 4 commodity sub-indices of food (coffee, cocoa, tea, rice, wheat, maize, sugar, beef, lamb, bananas and palm oil), agricultural raw materials (cotton, jute, wool, hides, tobacco, rubber and timber), metals (steel, aluminum, tin, copper, silver, lead and zinc), and energy (oil, coal, and gas) with each sub-index weighted by total world export volumes 1999-2001 at indexed prices over the same time period in real terms – note that gas prices are only available since 1922 and are therefore excluded from the index before this timeframe

2 2011 prices based on average of first four months of 2011

SOURCE: Grilli and Yang, 1988; Pfaffenzeller et al, 2007; World Bank Commodity Price Data; IMF primary commodity prices; OECD statistics; FAOStat; UN Comtrade; MGI Analysis

It is not just energy: water, food, materials

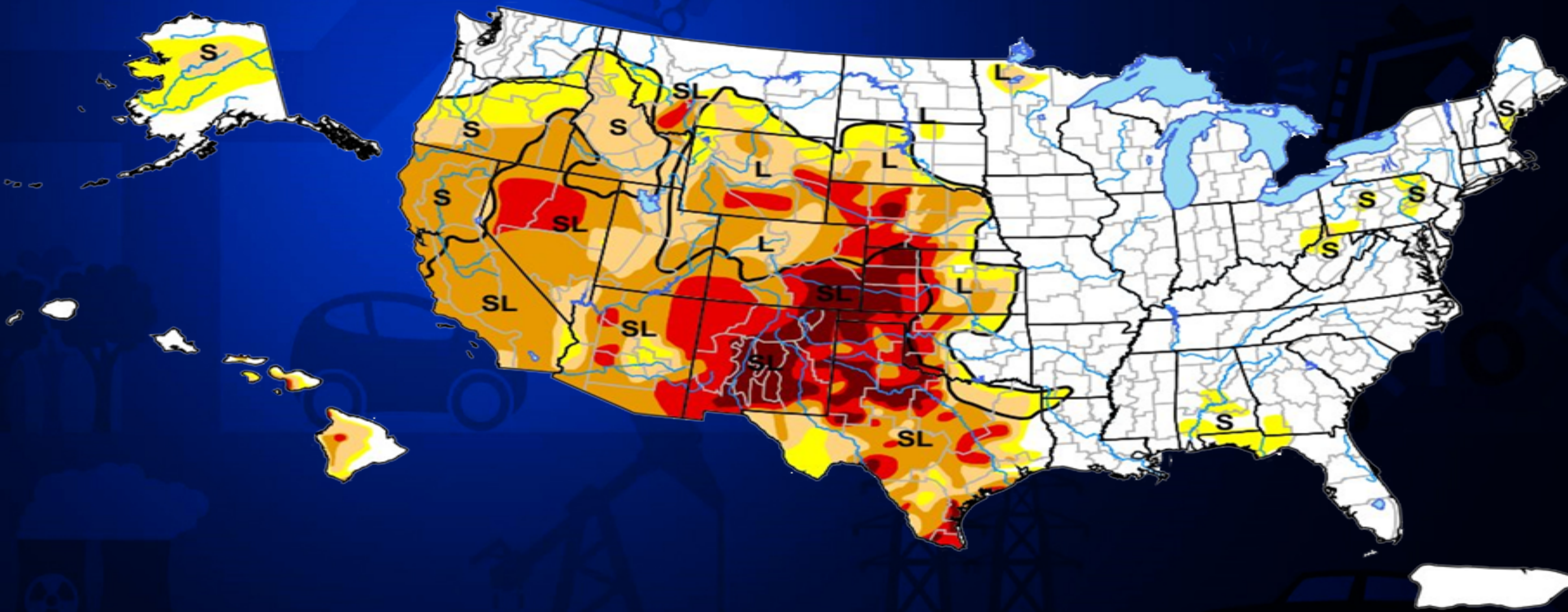
July 25, 2013

Intensity

- D0 Abnormally dry
- D1 Drought – Moderate
- D2 Drought – Severe
- D3 Drought – Extreme
- D4 Drought – Exceptional

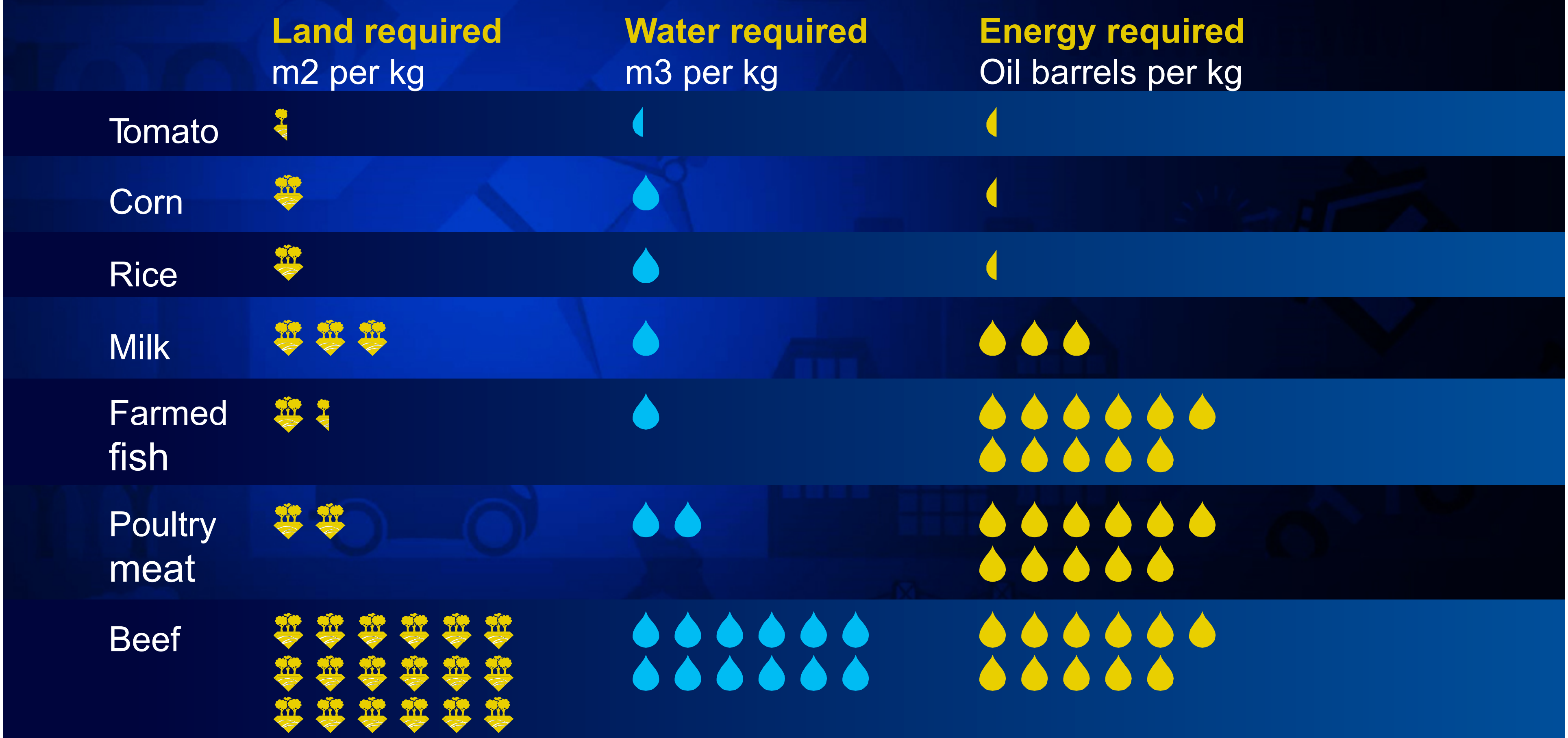
Drought impact types

- Delineates dominant impacts
- **S** = Short-term, typically <6 months (e.g., agriculture, grasslands)
- **L** = Long-term, typically >6 months (e.g., hydrology, ecology)

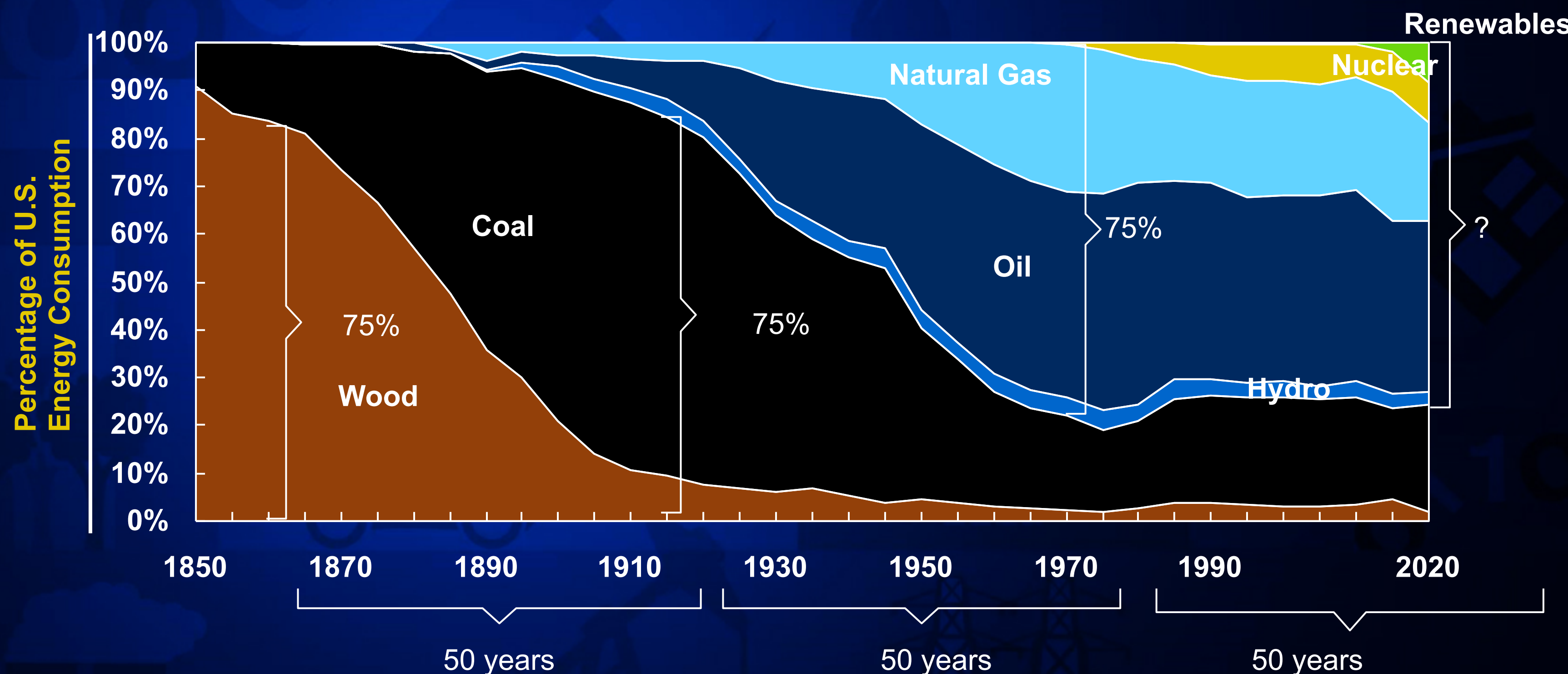


SOURCE: USDA; National Drought Mitigation Center; NOAA; Department of Commerce

Our diet changed, and with it the resources required



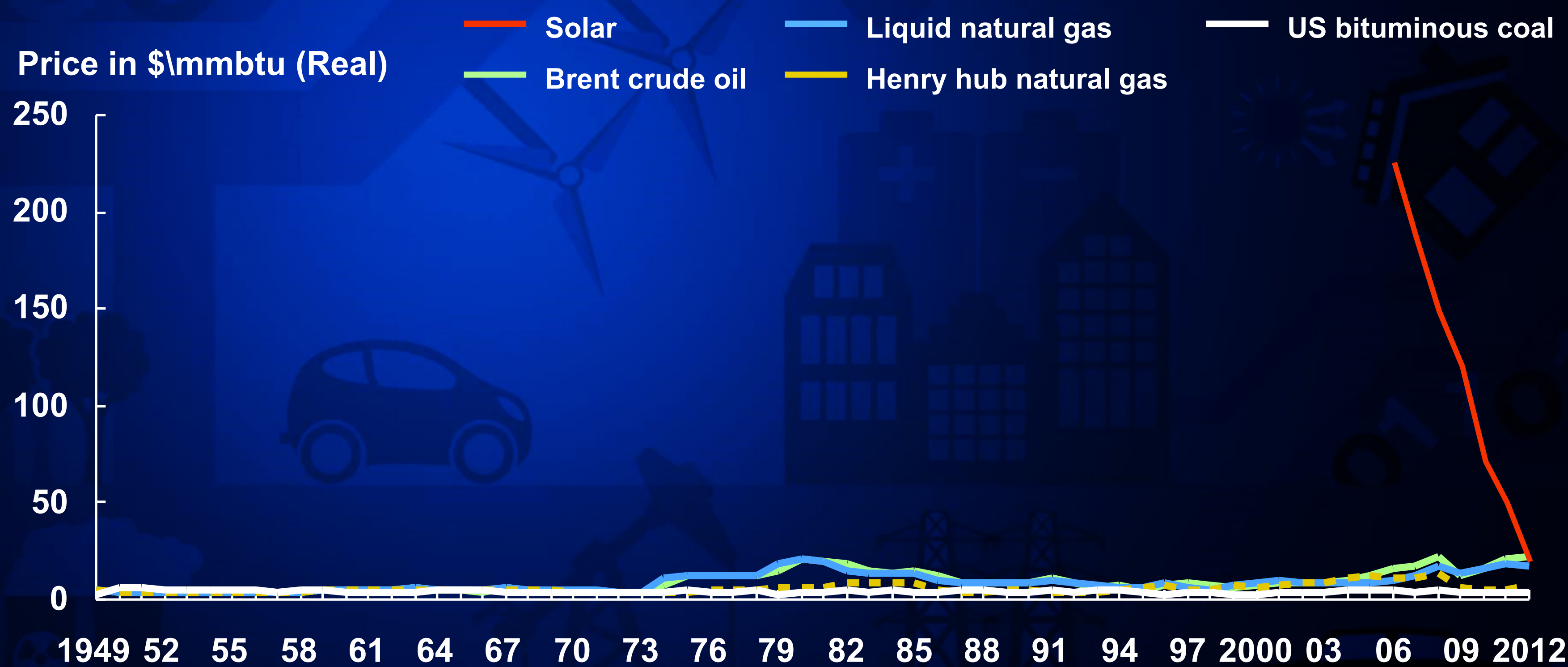
The good news is we have seen complete shifts in energy system before



Sources: EIA, *Annual Energy Review: 2008*; EIA, *Annual Energy Outlook: 2009 with Recovery Act Update*

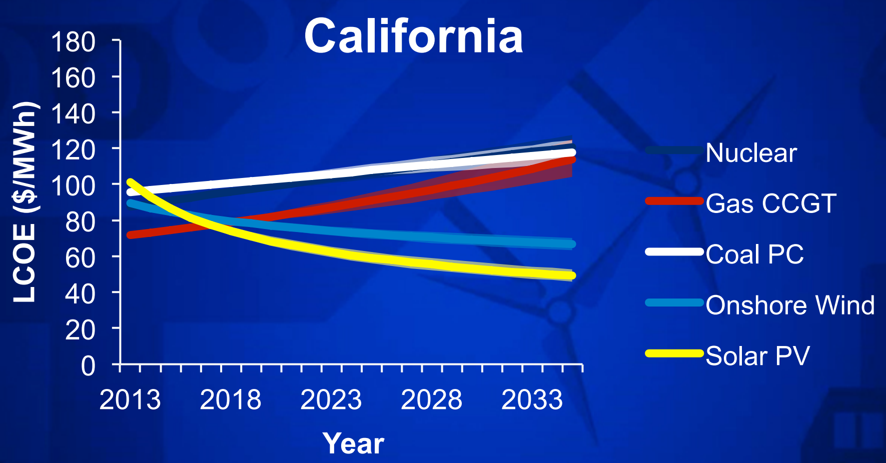
Why was grid parity a surprise?

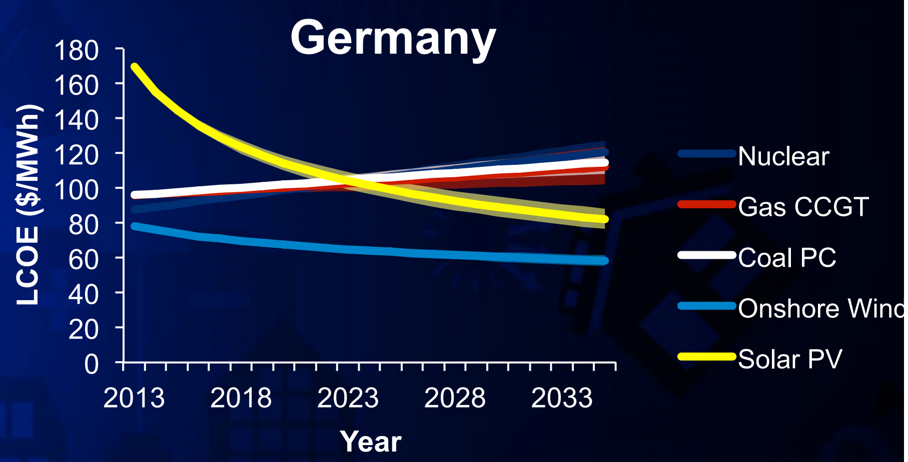
Those who said "solar is too expensive" were once right, but no longer are – the entire picture has changed in less than 5 years

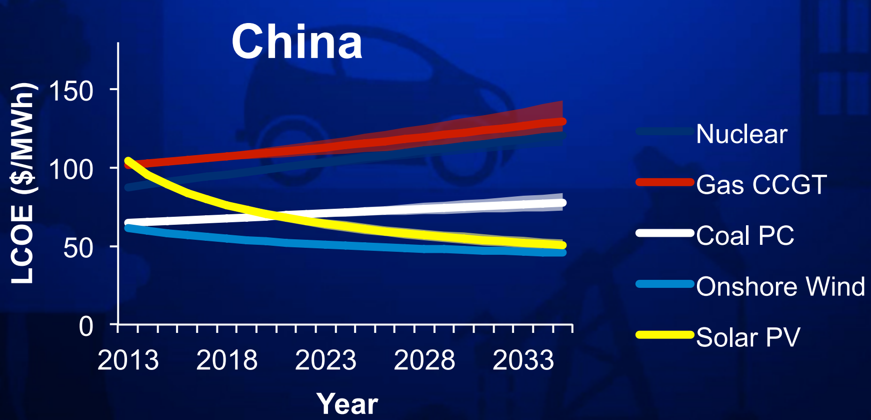


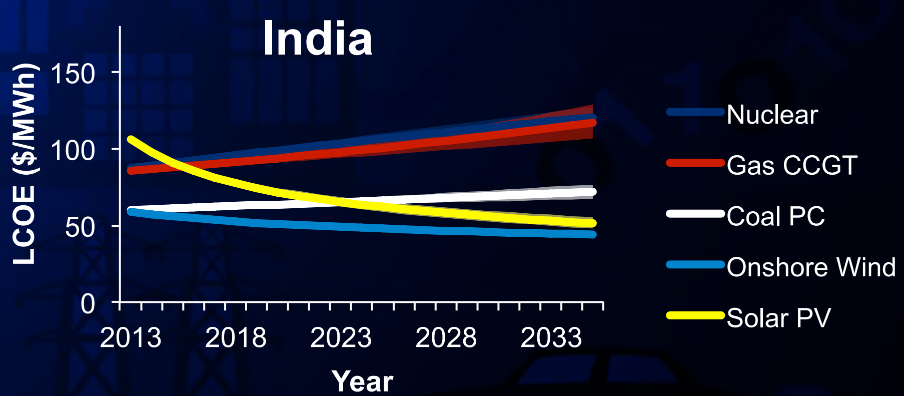
SOURCE: EIA, CIA, World Bank, Alliance Bernstein

Taking learning into account is critical









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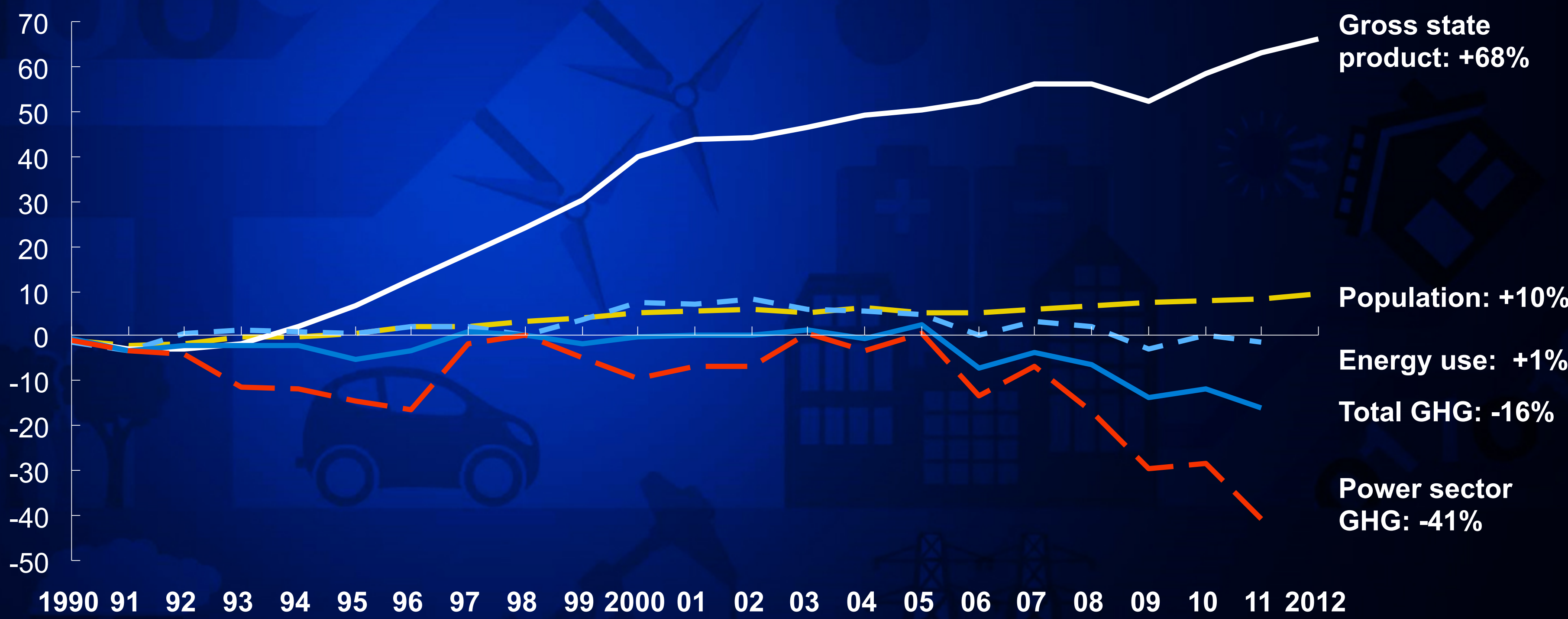
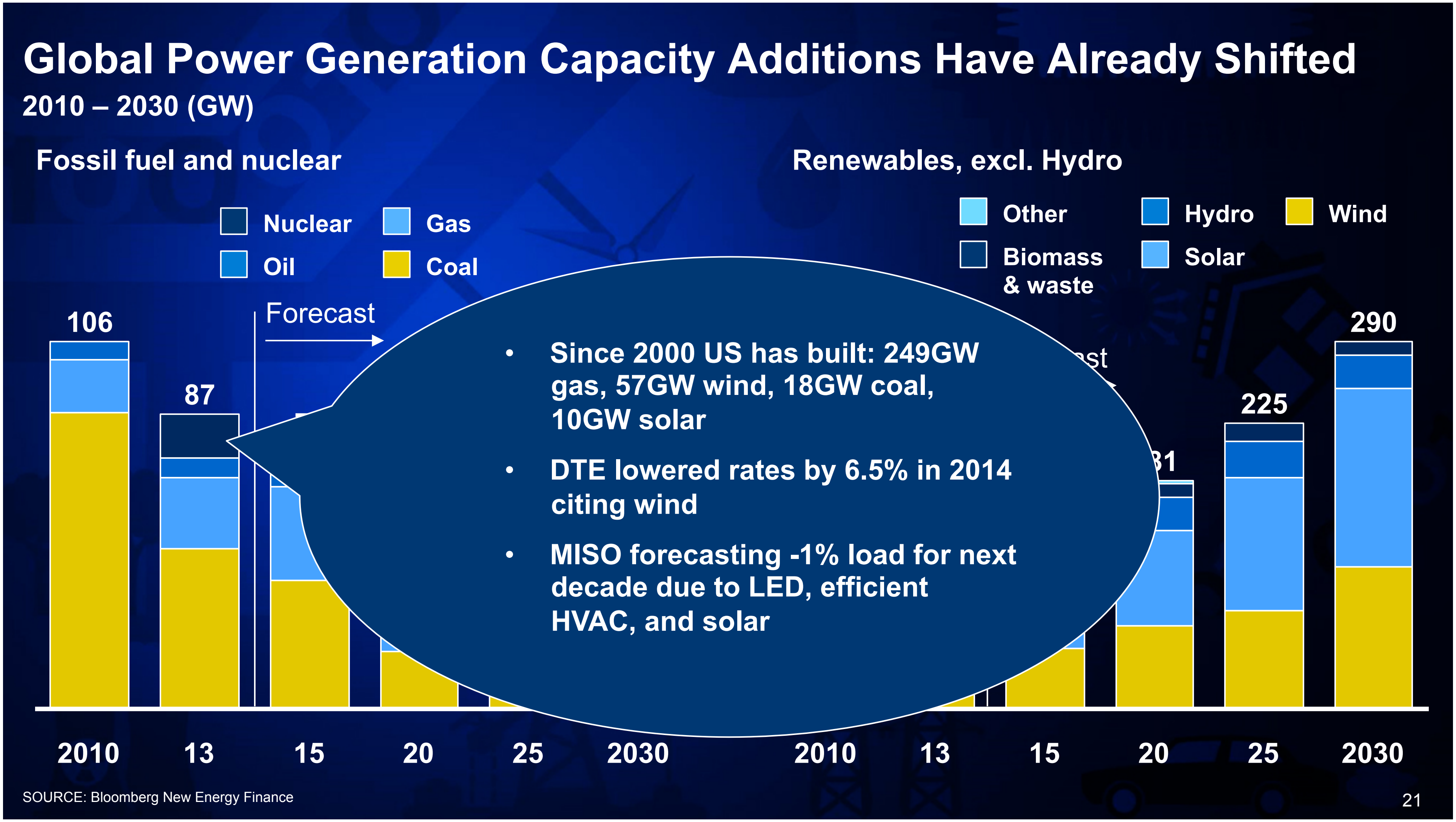
We can decouple GHG from energy use, energy services, and GDP

Massachusetts since 1990: Economic growth and GHG reductions



SOURCE: <____________>


Global Power Generation Capacity Additions Have Already Shifted
2010 – 2030 (GW)
Fossil fuel and nuclear
Nuclear
Gas
Oil
Coal
Forecast
106
87
2010
13
15
20
25
2030
Renewables, excl. Hydro
Other
Hydro
Wind
Biomass & waste
Solar
290
225
2010
13
15
20
25
2030
• Since 2000 US has built: 249GW gas, 57GW wind, 18GW coal, 10GW solar
• DTE lowered rates by 6.5% in 2014 citing wind
• MISO forecasting -1% load for next decade due to LED, efficient HVAC, and solar
SOURCE: Bloomberg New Energy Finance
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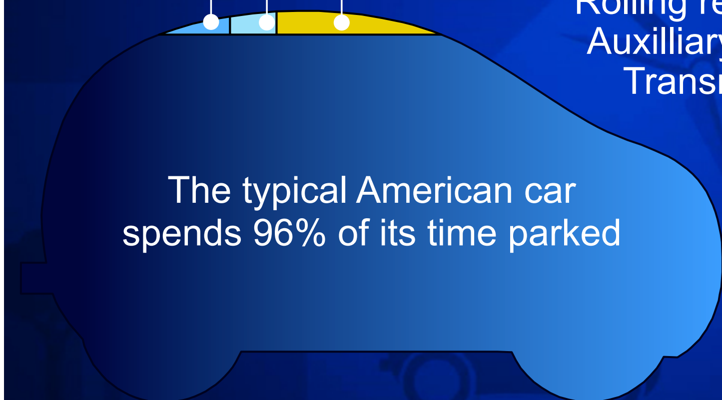
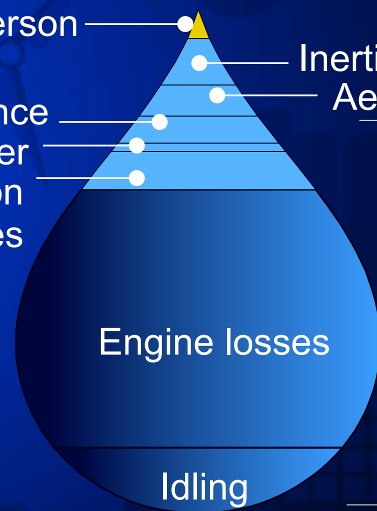
Our transport system today is extremely inefficient

Productive use



Energy flow through a combustion engine

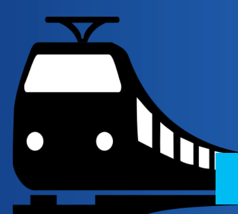


Deaths per year from transport

More than 33,000 in US
$300B annually in cost

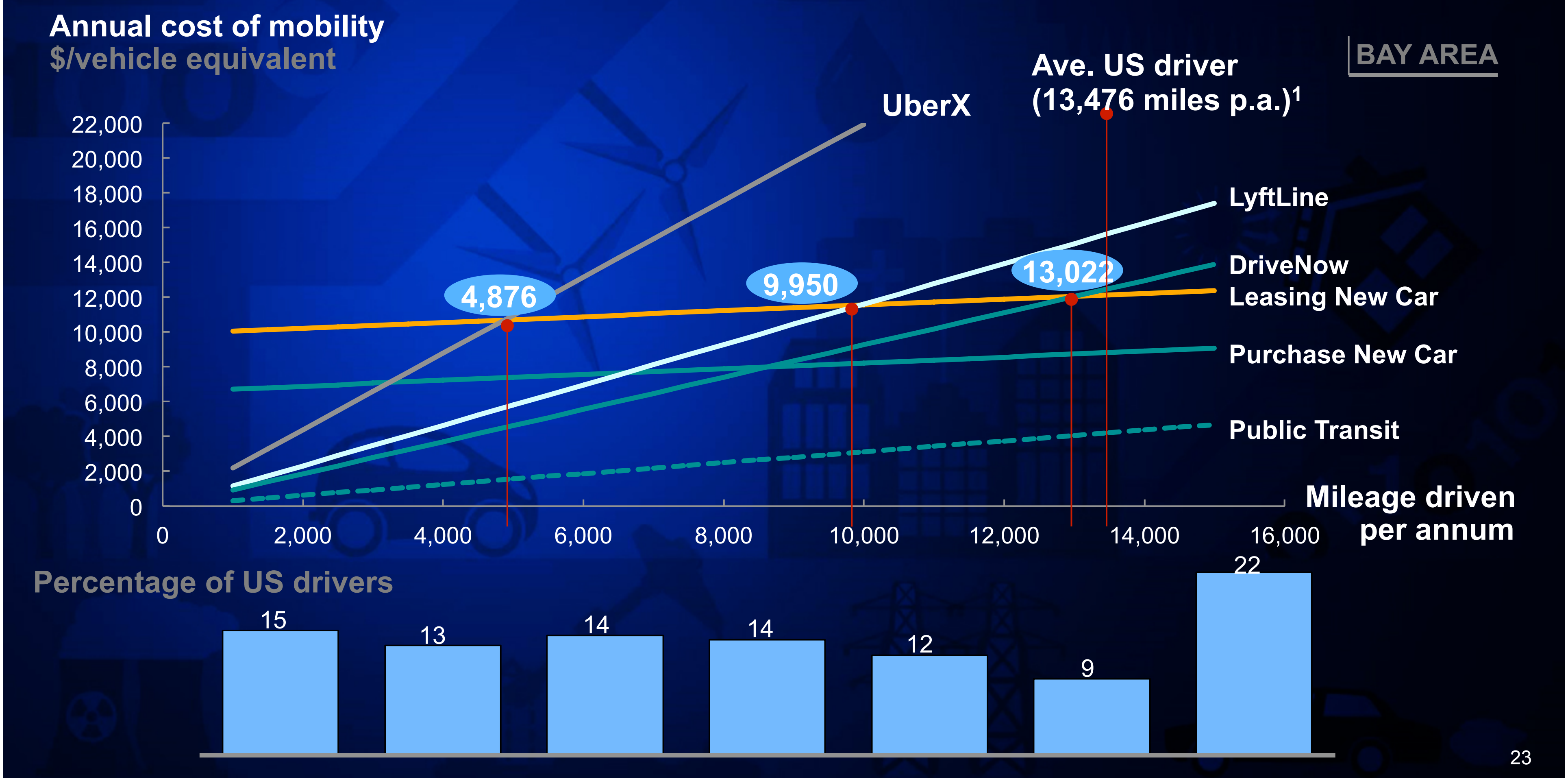
An American road reaches peak throughput only 5% of the time...

...and even then, it is only 10% covered with cars



US Transit - 5% of trips, 77% on-time vs 90%+ OECD, frequencies of 20-60 min in most cities
Starved infrastructure: 2.4% of GDP on transport infrastructure (vs. 5% Europe, 9% China, 5%+ US before 1960) and <25% on transit

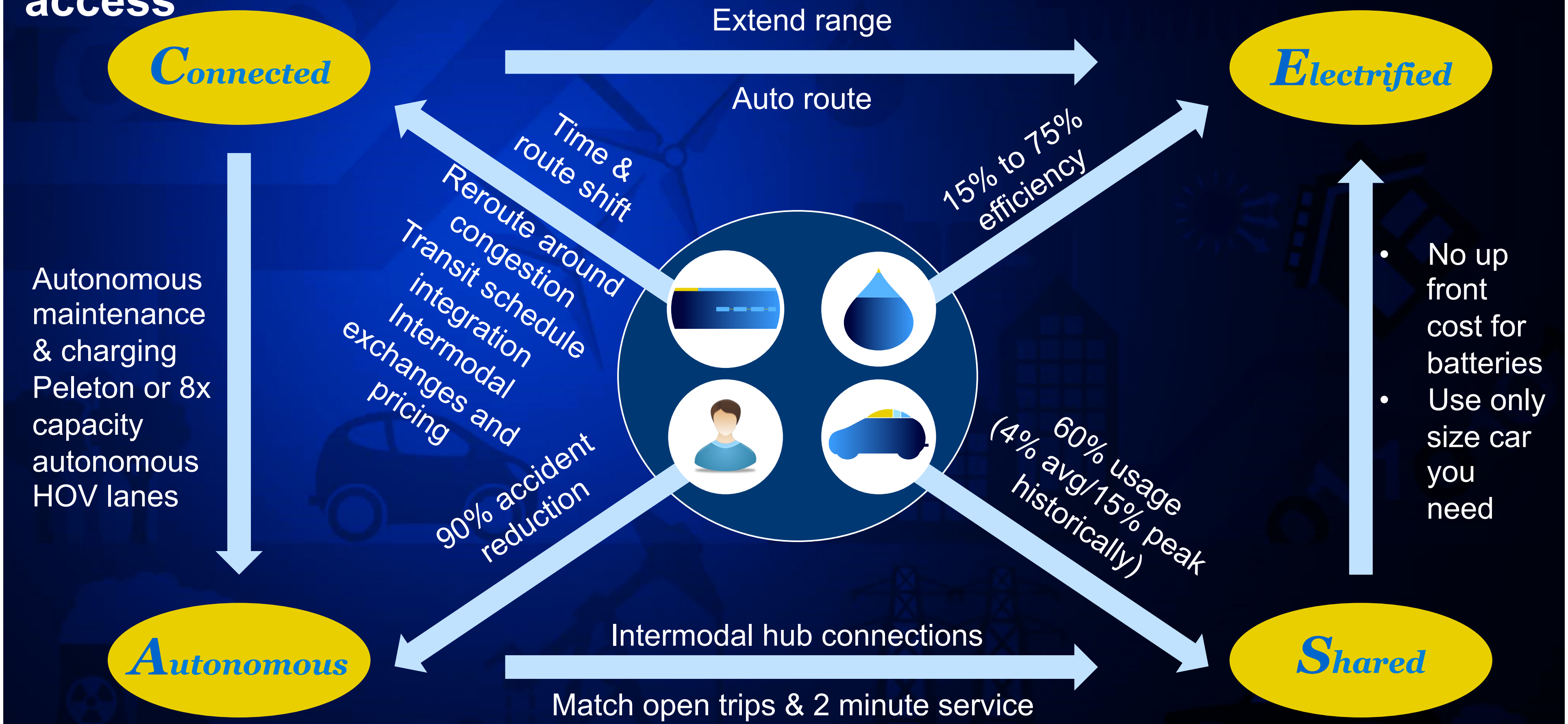
Sharing is “in the money” for low mileage customers



Virtualize

AMTRAK
SIGN HERE
NEW YORK PENN,NY
WASHINGTON,DC
WELCOME ABOARD ACELA EXPRESS
NO PARTIAL RFND IF USED ON
SOUTHEAST FAMILY DENTAL
Mark V. Bohnert, DDS
317-359-8000
6020 Southeastern Ave.
Indianapolis, IN 46203
www.SoutheastFamilyDental.com
MIDDLE EARTH THEA
Presenting
The Hobbit: A
12:01 AM Fri 12/14
AD1 MID $13.00
Tax $ 1.11
PG13
11/07/12 12:00 PM
9:41 AM
Wednesday
12
Messages
Calendar
Photos
Camera
Videos
Maps
Weather
Passbook
Notes
Reminders
Clock
Stocks
Newsstand
iTunes
App Store
Game Center
Settings
Phone
Mail
Safari
Music
DEPOSIT TICKET
Real Rewards
PRIVILEGE
HOTOGRAPHS
Souvenir of
Hauppauge
TEXAS INSTRUMENTS
TI-30X IIS
7A Yucca Valley North
MBTA
INFORMATION
BRITISH AIRWAYS
WORLD TRAVELLER
29B
Monday
July 2015

ACES: from 67-120 cents/mile today to 9 cents/mile and universal access



What does the goal look like?

Convenient and backwards compatible
- Works with existing infrastructure
- Complementary with other products
- Easy to use (no or minimal learning required)
- Looks, smells, feels familiar

Greener
- Consumes less energy (or water) in use
- Less material or new eco material
- No or less waste or biodegradable
- Less packaging or transport
- Emits less CO_2

Cheaper
- Cheaper to produce
- Better Total Cost of Ownership
- Turn product into service (boosting utilization)
- Lower supply chain costs
- No disposal costs

Surprisingly better
- Quieter (EcoRock, EVs)
- More comfortable (new HVAC that adjust humidity)
- Safer, faster, stronger
- No hunt for parking or HOV access
- Solar power in remote locations
- Convenient automation

Scalable
- Underlying potential
- Supply chain ready
- Business model for scale
- Champions

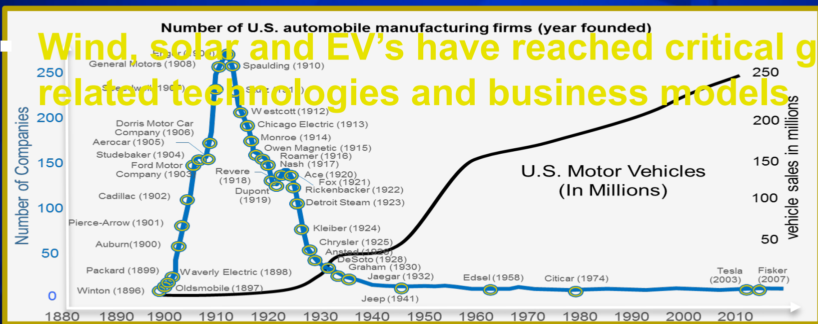
SOURCE: McKinsey

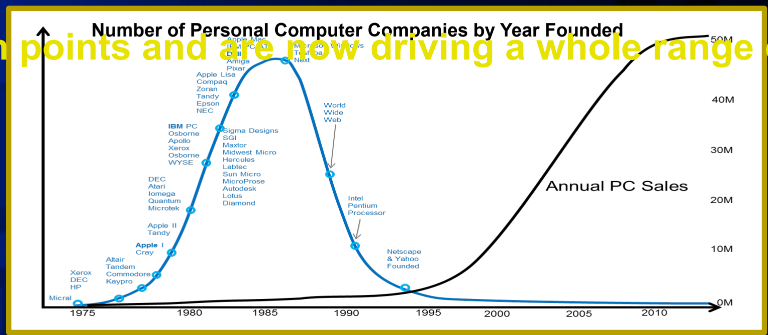
Investors: Less is more = portfolio shift

	New Risks	New Opportunities
Transport	Combustion	Batteries, EVs, sensors
Energy	Coal	Renewables development
Structures	Cement and iron	Reuse, modularity
Fuels	Marginal oil	Shale Gas productivity
Industrial	Brakes, repair trucks	Variable speed drives, analytics
Utilities	Generation	Demand management
Food	China contamination	Organics, plant productivity
Water	Shortages	Water treatment, embedded water
Materials	Machining	Design, circularity, 3D printing
Services	Large firms	Online remote

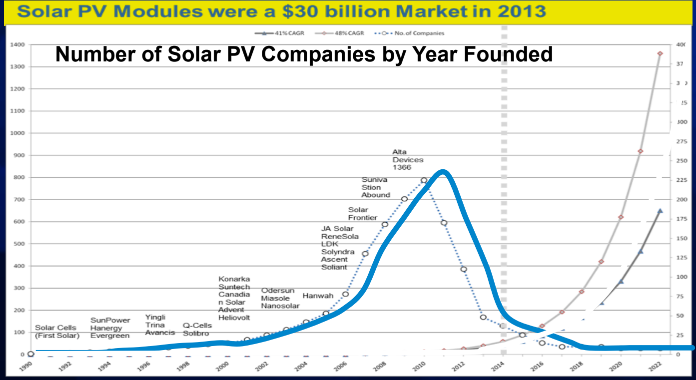
We Have seen This Type of Growth Before

- Attractive returns from technology investments are typically the result of leveraging breakthrough fundamental technologies that themselves were not good investment sectors, but which formed the underpinning of a broad market of related technological and business model innovations
- Wind, solar and EV's have reached critical growth points and are now driving a whole range of related technologies and business models

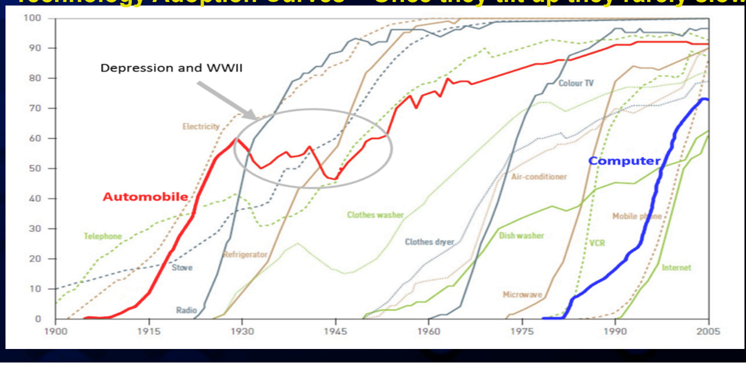




Solar PV Modules were a $30 billion Market in 2013

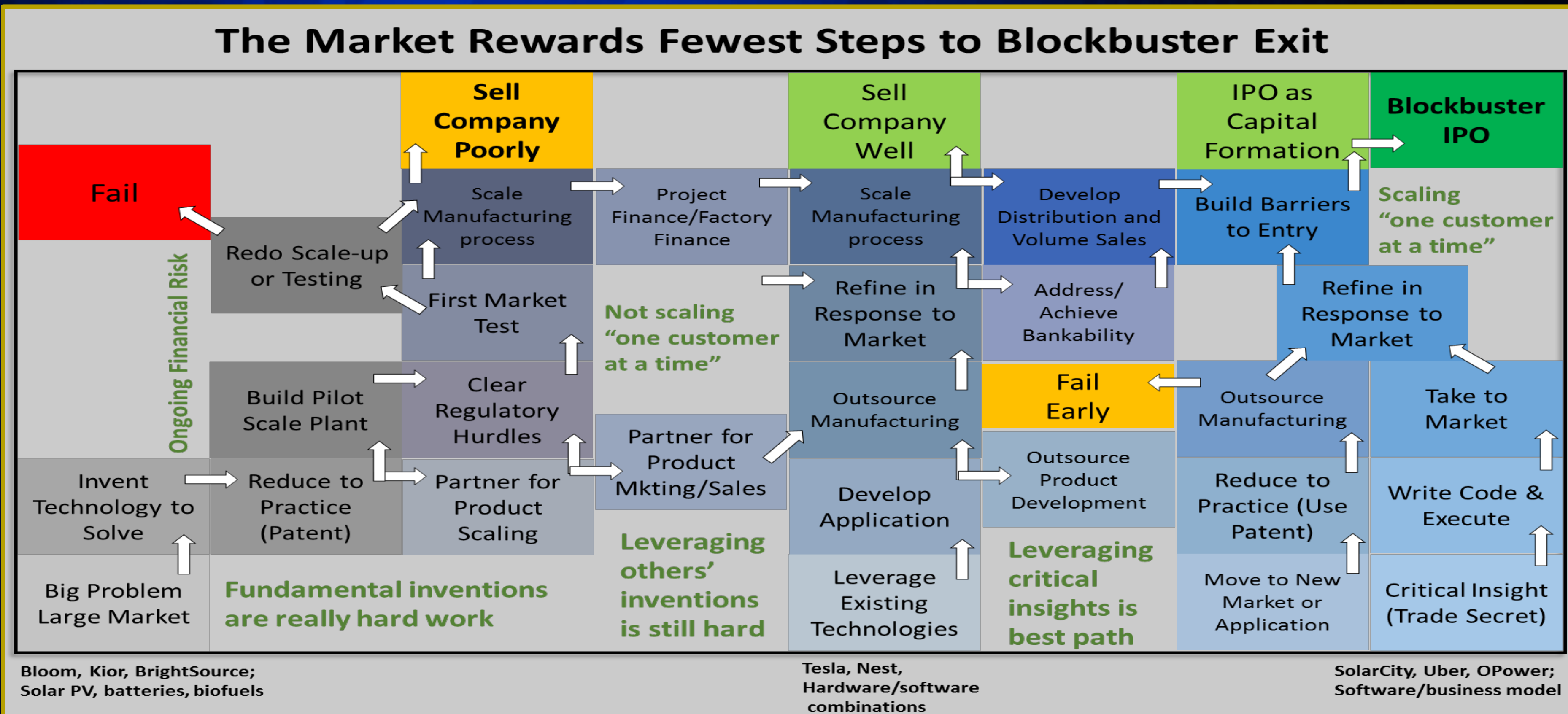


Technology Adoption Curves – Once they tilt up they rarely slow down



A More Realistic Perspective on Achieving Success

(Why some parts of CleanTech are still much harder than others)

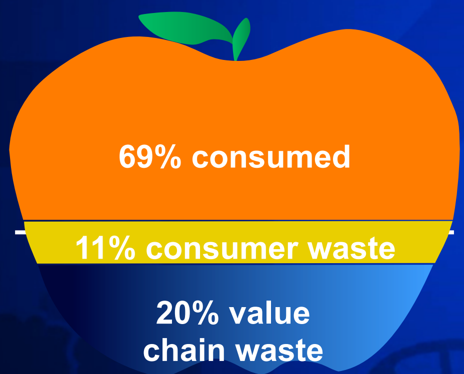


Structural waste in the nutrition system

Productive use

Food waste

In Europe, ~31% of edible food mass produced is lost or wasted



Fertilizer utilisation

95% of fertilizers do not provide nutrients to human body

Malnutrition deaths and diseases

Obesity is responsible for ~5% of deaths

Land degradation

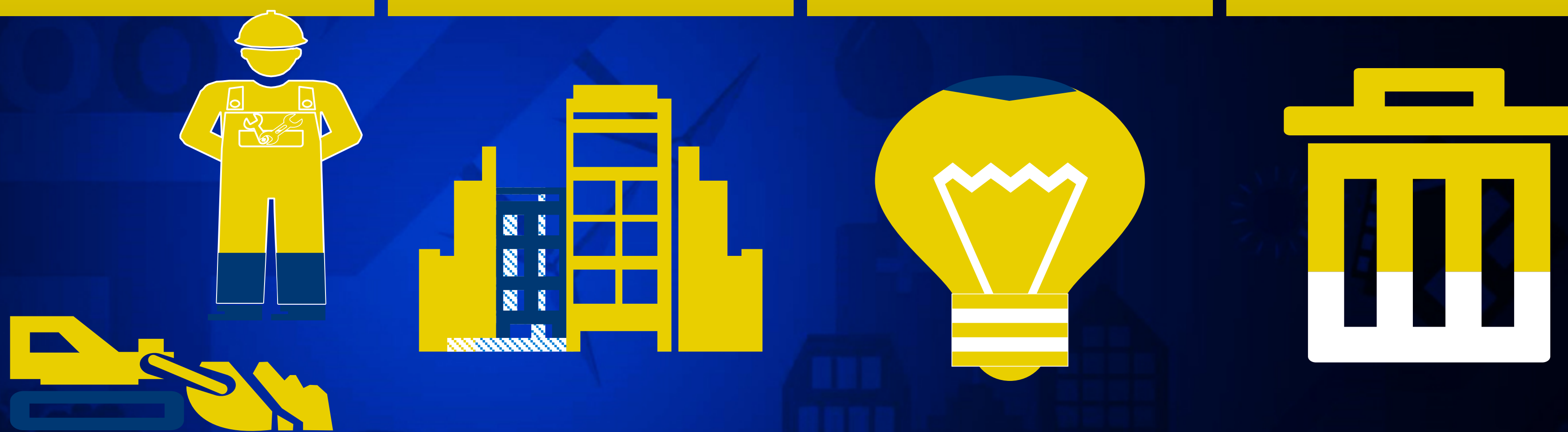
~20% of arable land in EU is affected by soil degradation

1 In Europe ~46% of edible mass of fruit and vegetables is lost or wasted (FAO, “Global food losses and food waste”)
2 BMI >25 (overweight) or >30 (obese)
3 On average 23% of vegetable crops is not edible (peels, leaves, ...)

SOURCE: FAO: 'Global food losses and food waste - extend causes and prevention'; WRAP; MGI; WHO; “Towards efficient use of water resources in Europe”, EEA, 2012 ; IFDC; Ljungqvist O & de Man F. (2009); Team analysis

Structural waste in the built environment

Construction	Utilization	Utilities	End of life



Construction
- 0-0.5% productivity development/year
- New modular and 3D technologies lower construction costs 30-80%

Utilization
- 5-40% of European offices are used even in working hours
- 30-40% of residential dwellers report living too small or too big

Utilities
- 20-30% of energy can be conserved in existing buildings
- Passive houses competitive with other new construction

End of life
- 30% of solid waste landfilled from construction and demolition

SOURCE: Waste in construction projects: call for a new approach, Per-Erik Josephson and Lasse Saukkoriipi, Chalmers University of Technology, 2007; Workplace Implications for Future Office Demand, Norm G. Miller, PhD University of San Diego; Workspace Utilization and Allocation Benchmark , GSA Office of Governmentwide Policy, 2011; "Shrinking the office", Flexibility.co.uk; International Energy Agency (IEA Statistics © OECD/IEA, http://www.iea.org/stats/index.asp), Energy Statistics and Balances of Non-OECD Countries and Energy Statistics of OECD Countries, and United Nations, Energy Statistics Yearbook

The ReSOLVE framework

REgenerate	Nespresso, Dow, SAB Miller, Bunge, P-REX, Savory Institute
Share	airbnb, autolib', Nearly New Car by Mercedes-Benz, patagonia, Bla Bla Car
Optimise	Toyota, Cisco, BSB Broad Sustainable Building, The Vauban Quarter, wrap
Loop	CAT, patagonia, Renault, mazuma mobile.com, Dell, Winsun 盈创, Veolia
Virtualise	Google, Cisco, Netflix, iTunes, skype, zalando, kindle
Explore	Iberdrola, Tesla, skyTran, Beyond Meat, Philips

SOURCE: Team analysis