Punditry, Innovation, & Solutions

Vinod Khosla
Khosla Ventures
May 2010

agenda

experts… get in our way

Black Swan thesis

the technology/entrepreneurial engine

policy approach

“All progress depends on the unreasonable man”

- George Bernard Shaw

“Human salvation lies in the hands of the creatively maladjusted”

- Martin Luther King

experts reality check?

“when the train of history hits a curve, the intellectuals fall off.”

- Karl Marx

“Heavier-than-air flying machines are impossible”

- Lord Kelvin, President, Royal Society, 1895

“There is no reason for any individuals to have a computer in their home”

- Ken Olsen, President, Chairman and Founder of DEC, 1977

Extrapolating the past…

“TCP / IP Technology will never replace ATM”

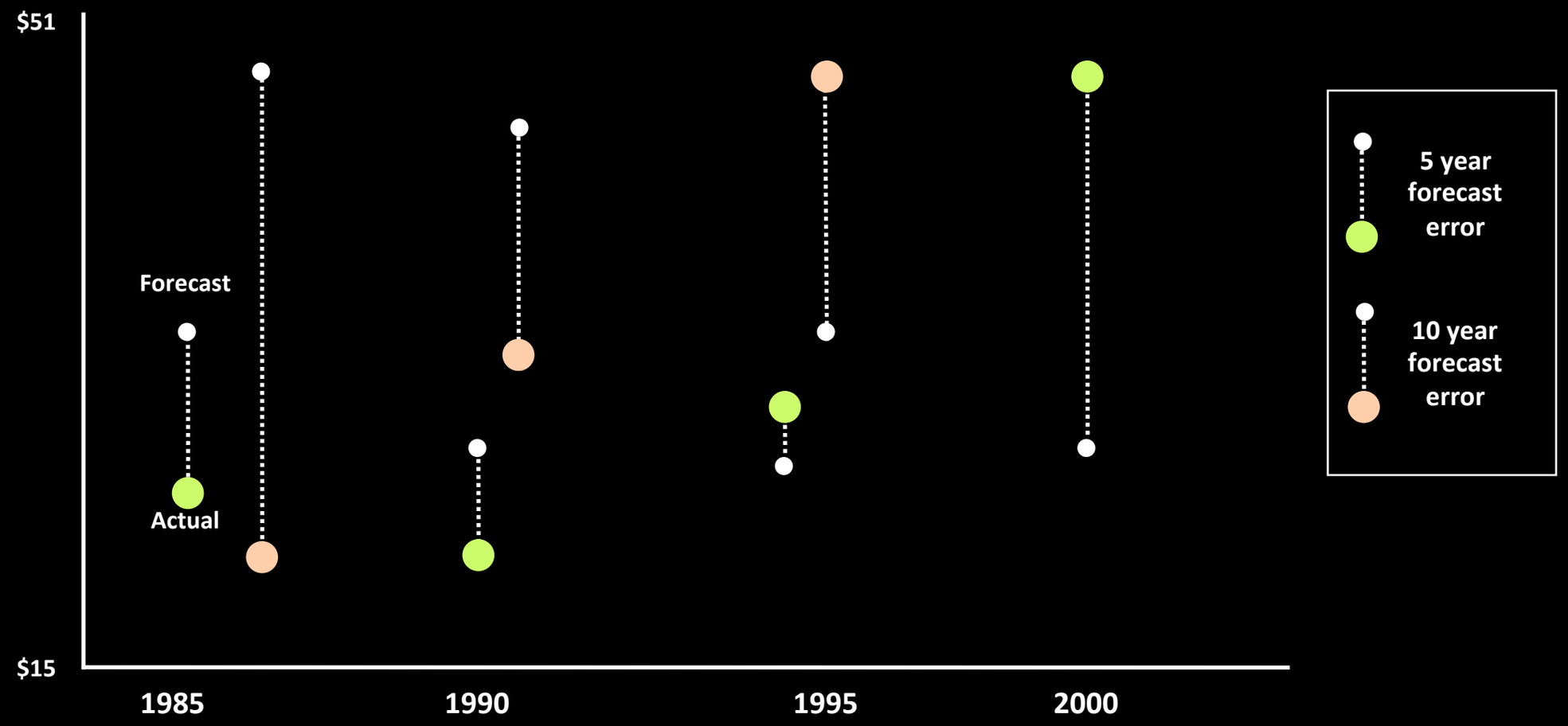
- various telecommunication co’s (1995) when Juniper was started

The reality…

Today, the world runs on TCP / IP!

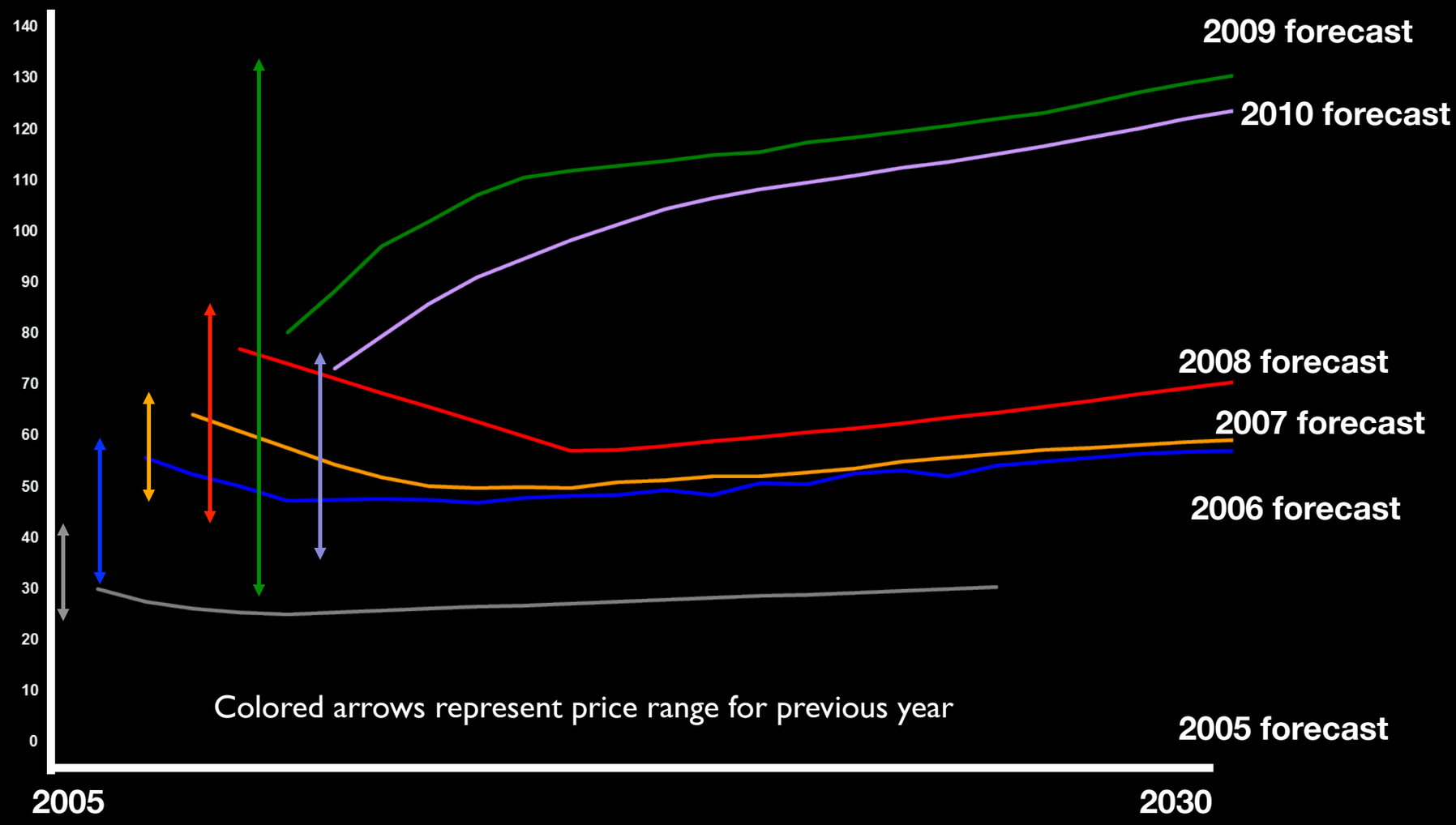
forecasting

oil price forecasts (1985-2005)



Data/Source: World Oil Prices Barrel) (current $ / - EIA Office of Integration Analysis and Forecasting

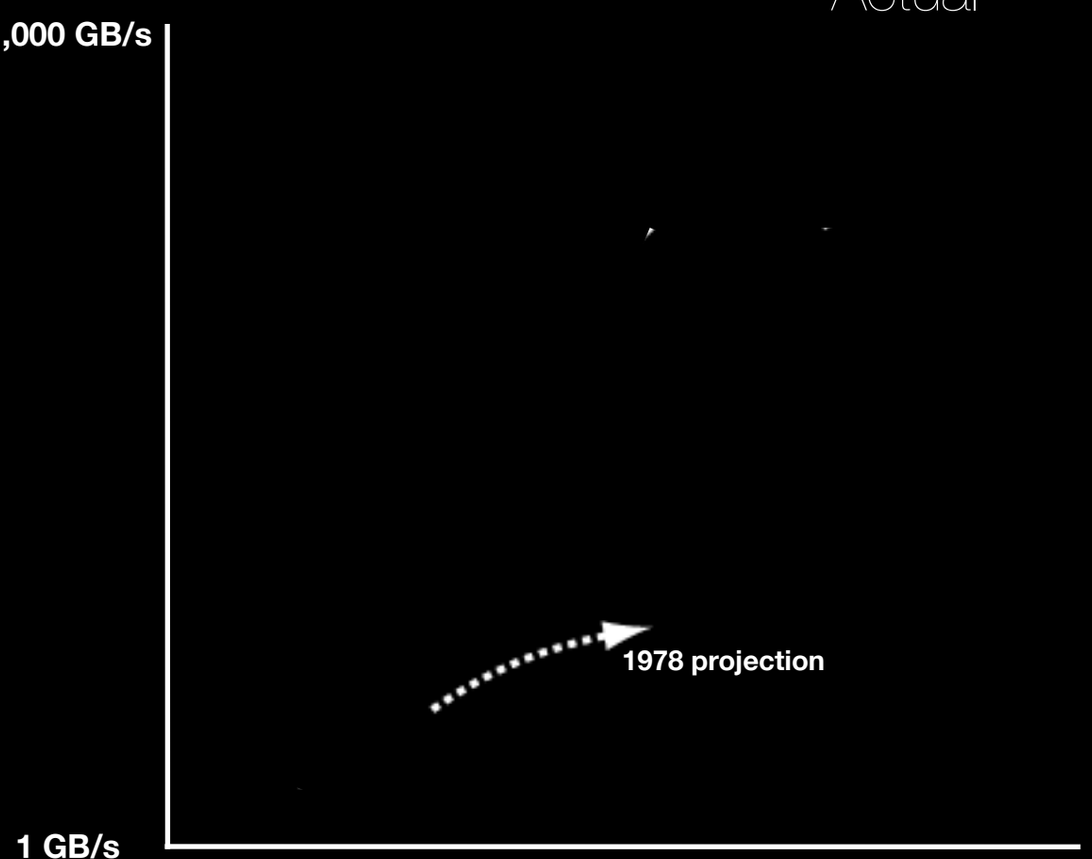
EIA Oil Price Forecasts: 2005 through 2010



Source: EIA, data for Imported Low-Sulfur Light Crude Oil (2006-2010), 2005 forecast is “world oil price”

The same regression repeated year after year!

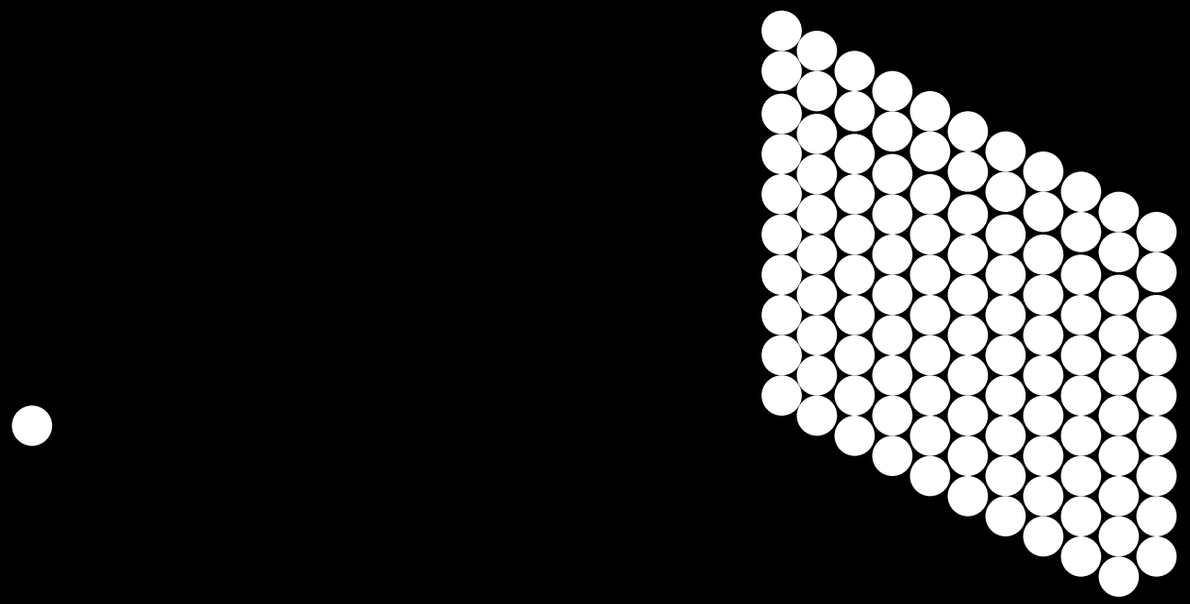
telecommunications: actual vs. forecast demand



Source: internal forecasts for major telecommunications company

Mckinsey : US mobile subscribers

1980 forecast for 2000



forecast

actual

Source: American Heritage Magazine - http://www.americanheritage.com/articles/magazine/it/2007/3/2007_3_8.shtml

yesterday's technology, tomorrow's forecast

1980's phone:

year 2000 phone:

quantitative modeling flaws

models with given inputs are precise but inaccurate

- **chasing "false precision"**
- **input the measurable, ignore the immeasurable**
- **obscured embedded assumptions**

the folly of predictions:
tetlock study

hundreds of experts.

80,000+ “expert” forecasts & 20+ years

Results: Experts are poorer forecasters than dart-throwing monkeys

Source: http://www.newyorker.com/archive/2005/12/05/051205crbo_books1

why?

"…. experts were much tougher in assessing the validity of information that undercut their theory than they were in crediting information that supported it."

- Tetlock

Source: http://www.newyorker.com/archive/2005/12/05/051205crbo_books1

How many predicted…

"How many in 1945 would have predicted Japan and Germany would be in 35 years be the 2nd and 3rd most powerful economies?"

"How many that China in 1970 (still in the convulsive grip of Mao's cultural revolution), would be the 4th biggest economy in 2007 and moving up the rankings fast?"

- Tetlock

… experts were asked to predict about

- **Soviet Union (in 1988) - by 1992, Communist Party control will**
  - **strengthen**
  - **weaken**
  - **remain unchanged**

- **EU Monetary Union (in 1991) - by 1996, the plan for a common currency**
  - **abandoned**
  - **seriously delayed**
  - **on schedule**

- **South Africa (In 1989) - by 1994 there will be**
  - **more repressive white control**
  - **continuation of the status quo**
  - **less repressive minority rule but no serious power-sharing with blacks**
  - **major movement toward black majority rule**
  - **formal establishment of black majority rule**

… with unexpected results

No relation between experience and accuracy!

A robust finding – based on thousands of forecasts made by hundreds of experts.

so how do we pick?

“extrapolation of the past”

vs.

“inventing the future”

redefining swans

“black swan”

…rarity, extreme impact,
and retrospective
(though not prospective)
predictability

Source: Nassim Nicholas Taleb, author of “The Black Swan”

“what if…”

PRODUCTION

- “coal plants were cleaner than solar”
- “cement was carbon negative & cheap”
- “a million year crude production cycle reduced to hours?”

CONSUMPTION

- “internal combustion engines were 50% more efficient?”
- “lighting was 80% more efficient?”
- “HVAC was 80% more efficient?”

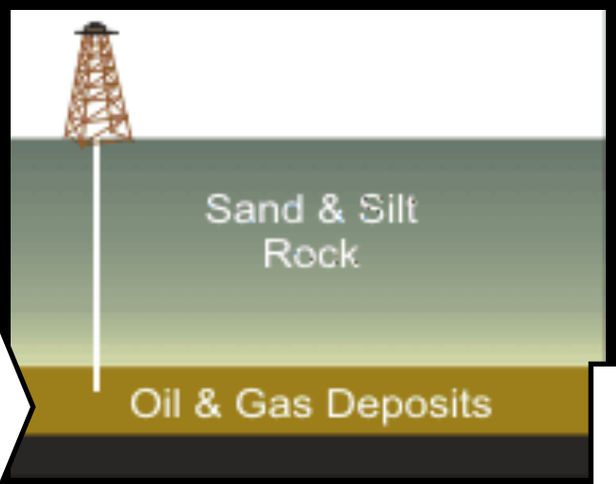
} **With a 12 month payback**

kior

“a million year crude production cycle reduced to hours?”

The big idea: accelerating nature

Millions of years



Crude oil

KiOR seconds

Re-Crude

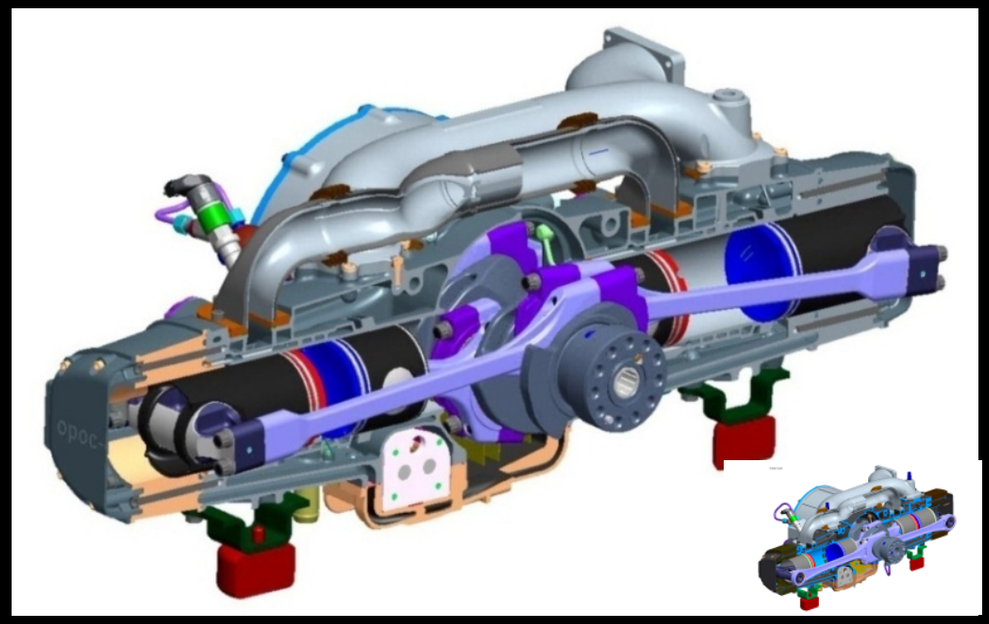
…renewable crude oil that can be dropped into existing refinery infrastructure

transonic/ecomotors

“50-100% more efficient engines cutting world oil usage in half”

OPOC engine technology…new power system

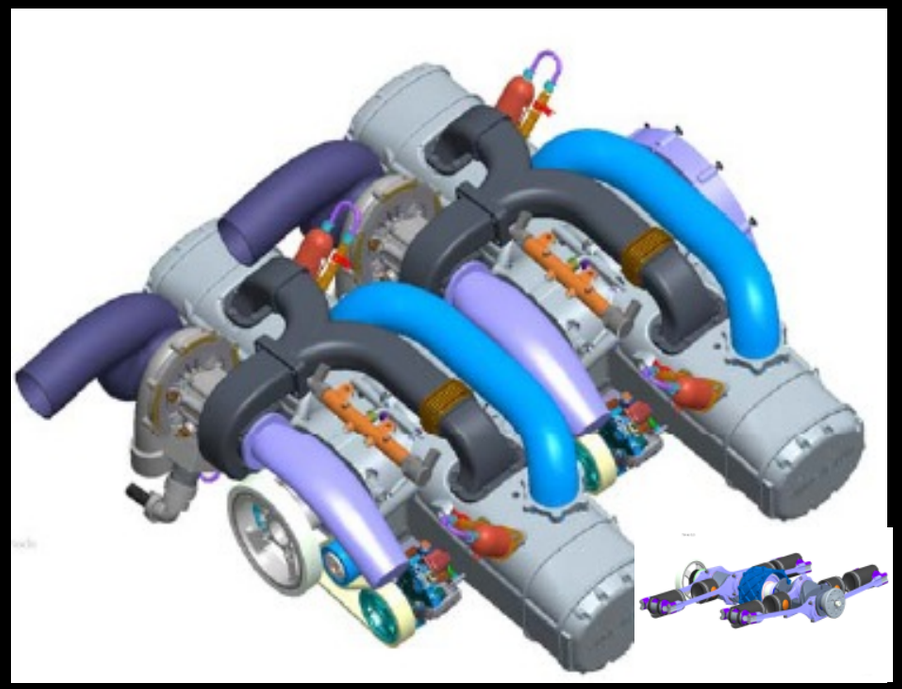
Single Power Module



Opposed-Piston Opposed-Cylinder

Fuel Efficiency Improvement (+50-60%)

Unique Modular Displacement



Fully Balanced Module

- Enables “Stackable” Power Modules
- Enables Hybridization and Tribrids
- Enables module shut off

-Fewer parts, less cost, more reliable

Attitude: everyone told me…

1.It is not possible to convert a gasoline engine to a Diesel, using the same transfer line. I did it and it is the most successful Diesel in the world and it was copied by everybody.

2.The combustion for a high speed Diesel is not possible. I started production with a 5000 rpm Diesel with 2000 engines/day on the gasoline engine transfer line.

3. You cannot use a rubber toothed belt to drive the camshaft and the injection pump. I did it and it is the standard solution today.

4.It is not possible to use an aluminum radiator because the corrosion will destroy the engine. I did it and it is the standard solution today.

5.It is not possible to create an “emission free” natural gas burner. I did it. It is in mass production at VIESSMANN. BUDERUS sued VIESSMANN about “emission free” and lost.

Prof. Dr.-Ing. Peter Hofbauer, Chairman and CTO

EcoMotors INTERNATIONAL™

soraa

“10X less electricity use for lighting”

…soraa

Revolution for LEDs

caitin

“no new functional thermodynamic cycle for cooling has been implemented in decades…”

…reinventing the HVAC

75% less energy for cooling

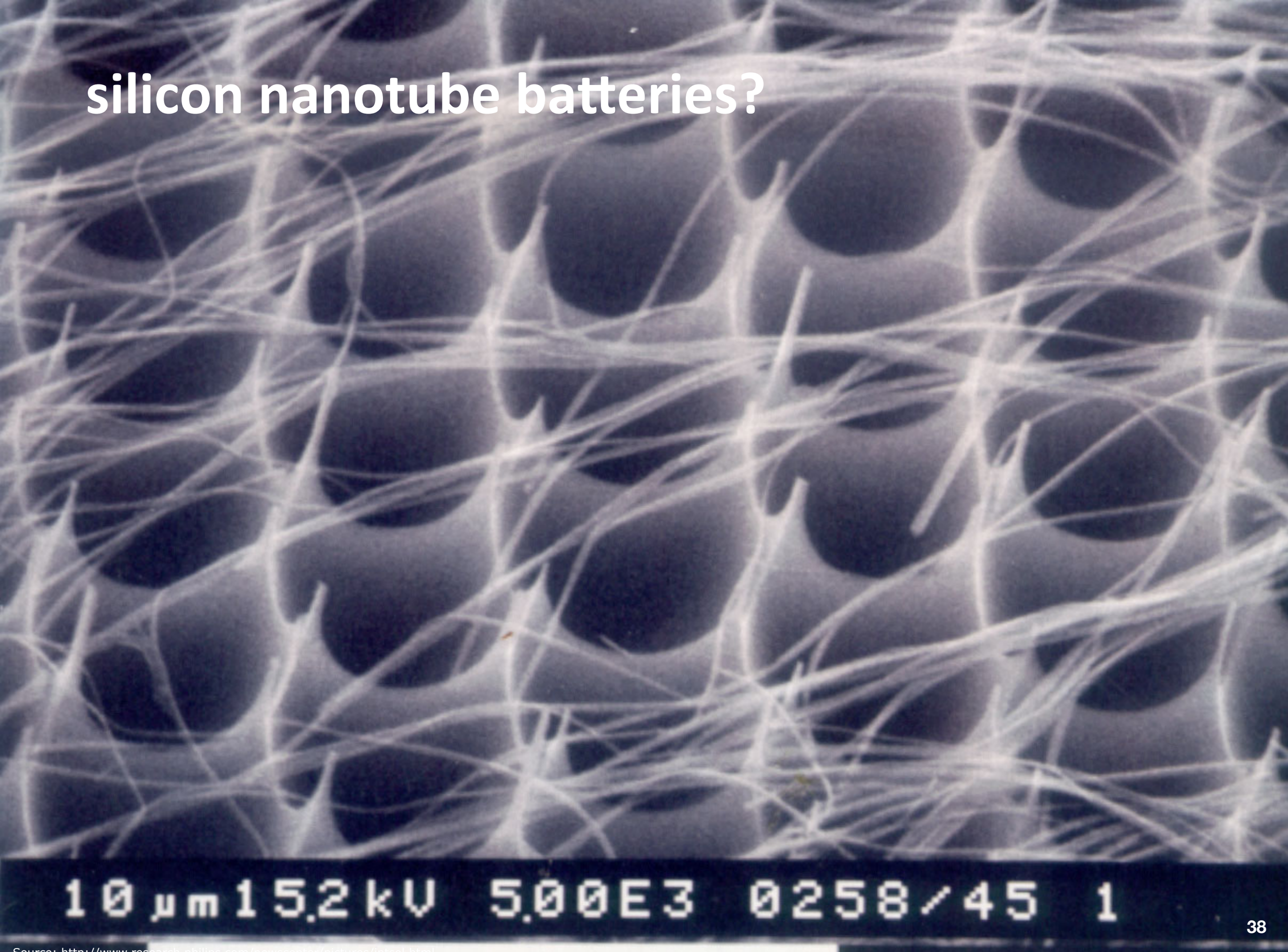
calera

“ ... turning problem carbon dioxide into a feedstock.”

artificial leaves to produce energy?

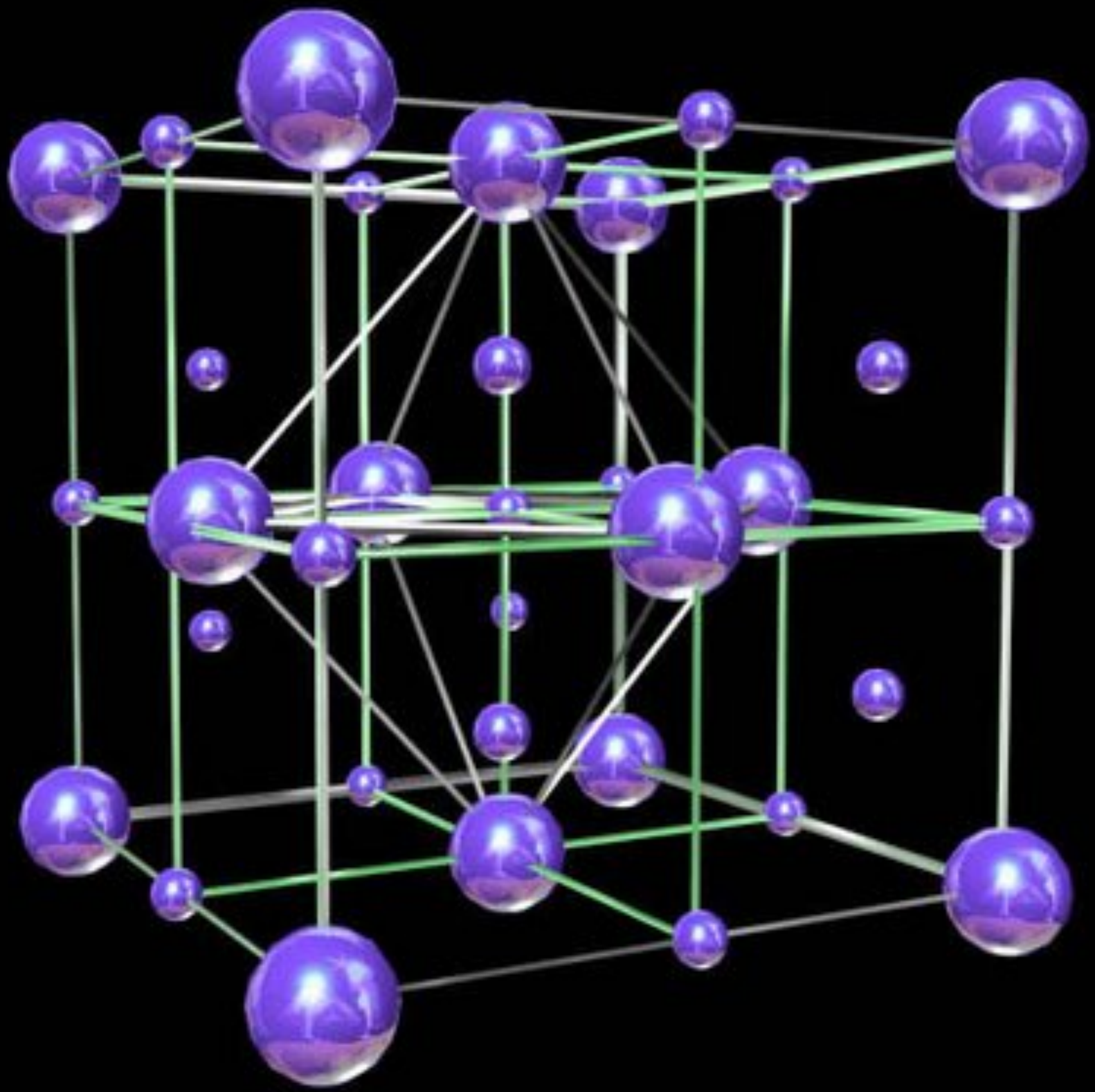
Source: http://blog.greenenergytv.com/blog/define-solar-energy/0/0/the-green-invention-maverick-of-solar-energy-dr-nate-lewis

silicon nanotube batteries?



Source: http://www.research.philips.com/newscenter/pictures/intsol.html

LENR ?



Source: http://www.cafeterra.info/2009/03/cold-fusion.html

…the power of ideas & entrepreneurship

NASA vs. the X-Prize (billions vs. millions)

telecom goliaths vs. the internet (free long distance)

Human Genome Project vs. the entrepreneur

...the sources of innovation

Google, Facebook, Twitter : Fox, NBC, CBS

Amazon : Walmart

First Solar : Shell Solar

Cree: GE

DNA Sequencing

“relevant scale” solutions for

... oil

... coal

... materials

... (efficiency of oil & coal use)

“…relevant cost”

“…relevant scale”

“…relevant adoption”

…the “cost” chindia test

only scalable if competitive unsubsidized

...relevant scale “resources”

resource multipliers

computational design of materials

nanostructured materials

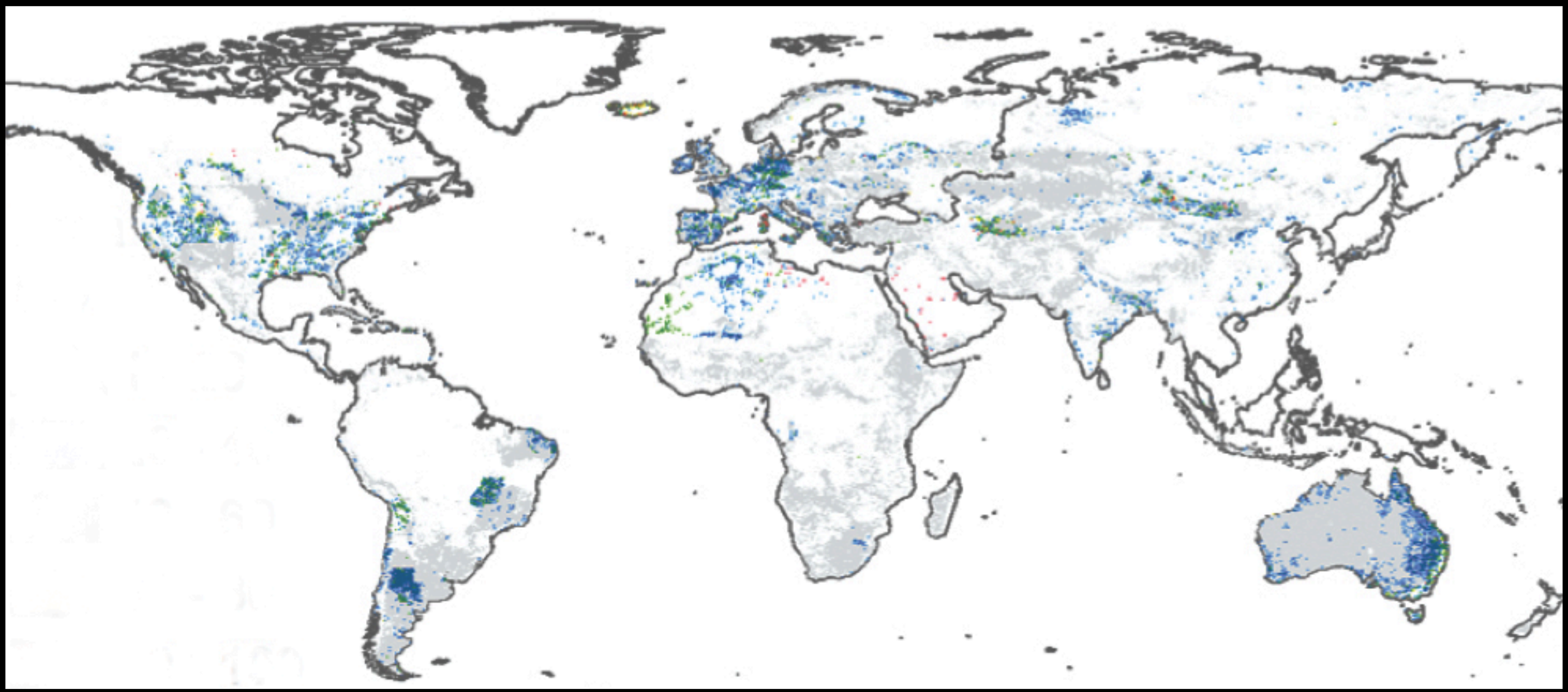
non-chemistry batteries

resonance: microwave catalysis, depolymerization

synthetic biology

……

one billion acres…



Area - % former agriculture land abandoned

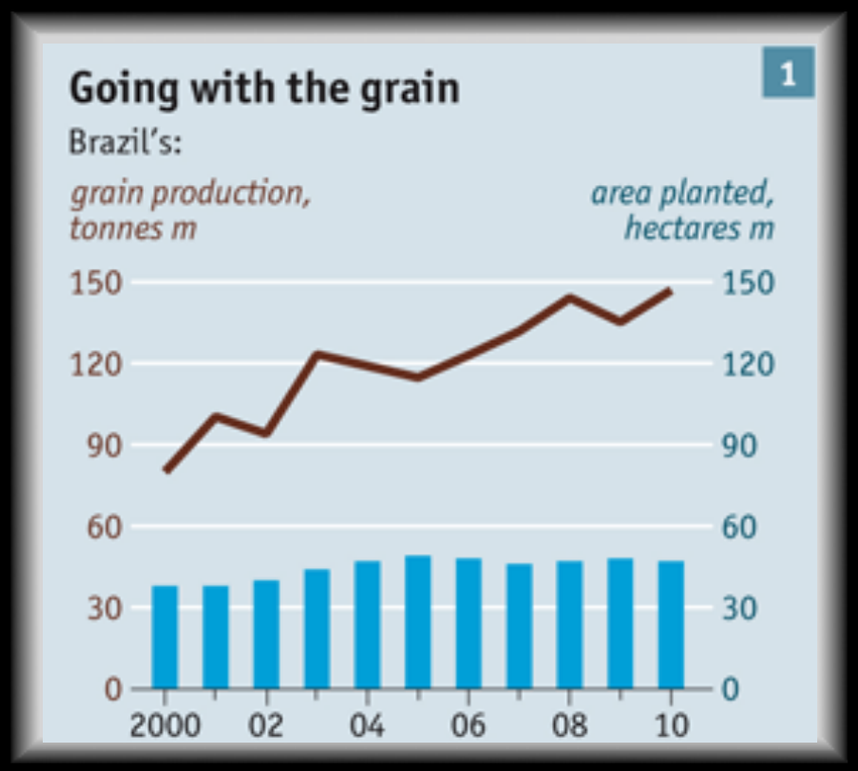
1 – 20% 20 – 40% 40 – 60% 60 – 80% 80 – 100%

Source: Chris Somerville, citing Campbell et al., Env. Sci. Technol. (2008) 42,5791

…Brazilian Cerrado – evolution of a bread basket

the father of the Green Revolution thought these soils were never going to be productive. They seemed too acidic and too poor in nutrients…

Source: Economist, Brazilian Ministry of Agriculture



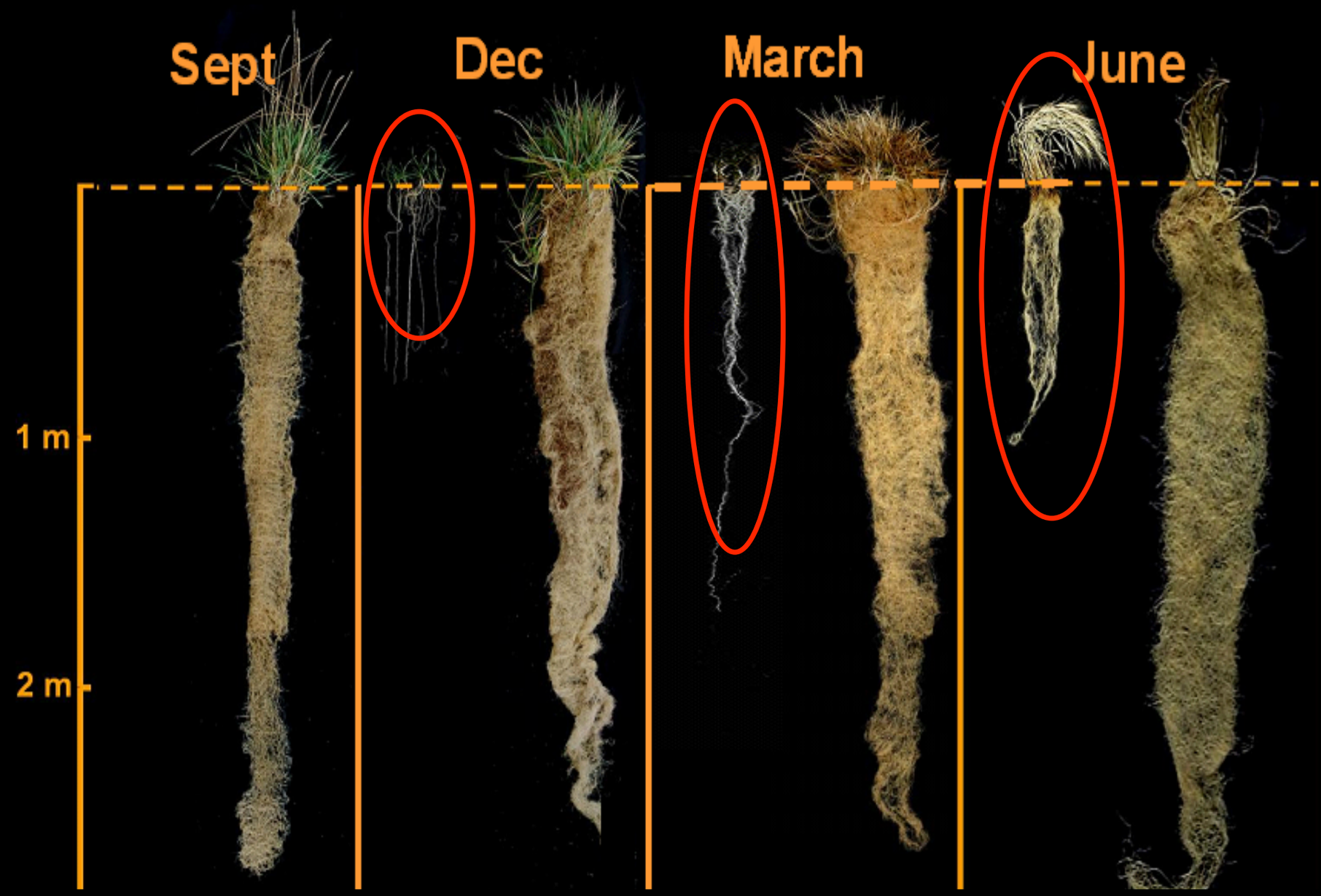
…More arable land has been *created* in Brazil than is under cultivation in the US and India combined

energy crops: miscanthus

Source: Ceres Inc

little water, little fertilizer, no tillage, lots of biomass

the perennial advantage



Perennial crops:

- less land erosion
- Better water/ nutrient management
- Diversity protects against diseases

Source: Wes Jackson, Land Institute

the **polyculture** advantage

Source: Wes Jackson, Land Institute

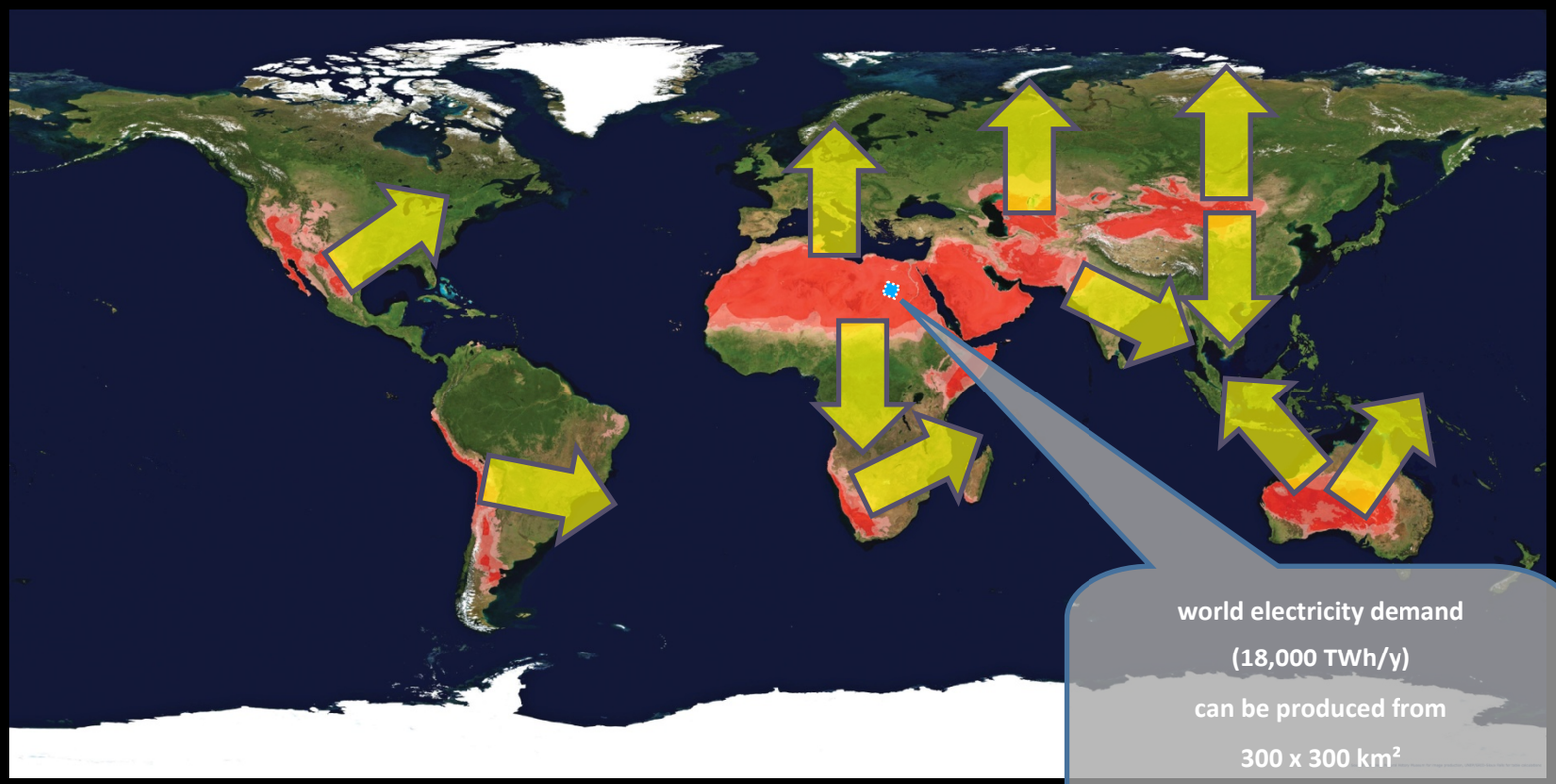
another billion acres…

winter cover crops, underutilized lands,….

another billion acres?

deserts as solar farms

3000 km



world electricity demand
(18,000 TWh/y)
can be produced from
300 x 300 km²
=0.23% of all deserts
distributed over "10 000" sites

Source: Gerhard Knies, CSP 2008 Barcelona

yet another billion acres...

Geothermal?

negawatt energy savings!

negabarrel energy efficiencies!

path to black swans...

more shots on goal!

…technology expands the ‘art of the possible.’

…today’s ‘unimaginable’ is tomorrow’s ‘conventional wisdom.’

…the “relevant adoption” test

adoption risk/trajectory matters

key criteria

- Trajectory: “What is” or “What Can Be”
    - Cost Trajectory
    - Scalability Trajectory
- Adoption Risk
- Capital Formation
- Optionality
- Carbon Reduction Capacity

reality / perspective

goals, not solutions

electric cars?

… of the next billion cars?

reality: electric cars


nano
TATA nano

reality: $2,500 nano

hybrid subsidy distorts hydraulic hybrids & efficient engin

(un)traditional wisdom…

LCES vs renewables: can coal be cleaner than solar?

LCFS vs coal powered cars: gms/mile

solar ITC vs hybridized "quality" power

geological CCS vs Sequestration

biofuel vs. carbon standard

… the right & wrong battles: framing

"do good/climate crisis" or risk mitigation?

"carbon risk + uneconomic bets" or "model accuracy debate"?

What is possible or technology progress based standards?

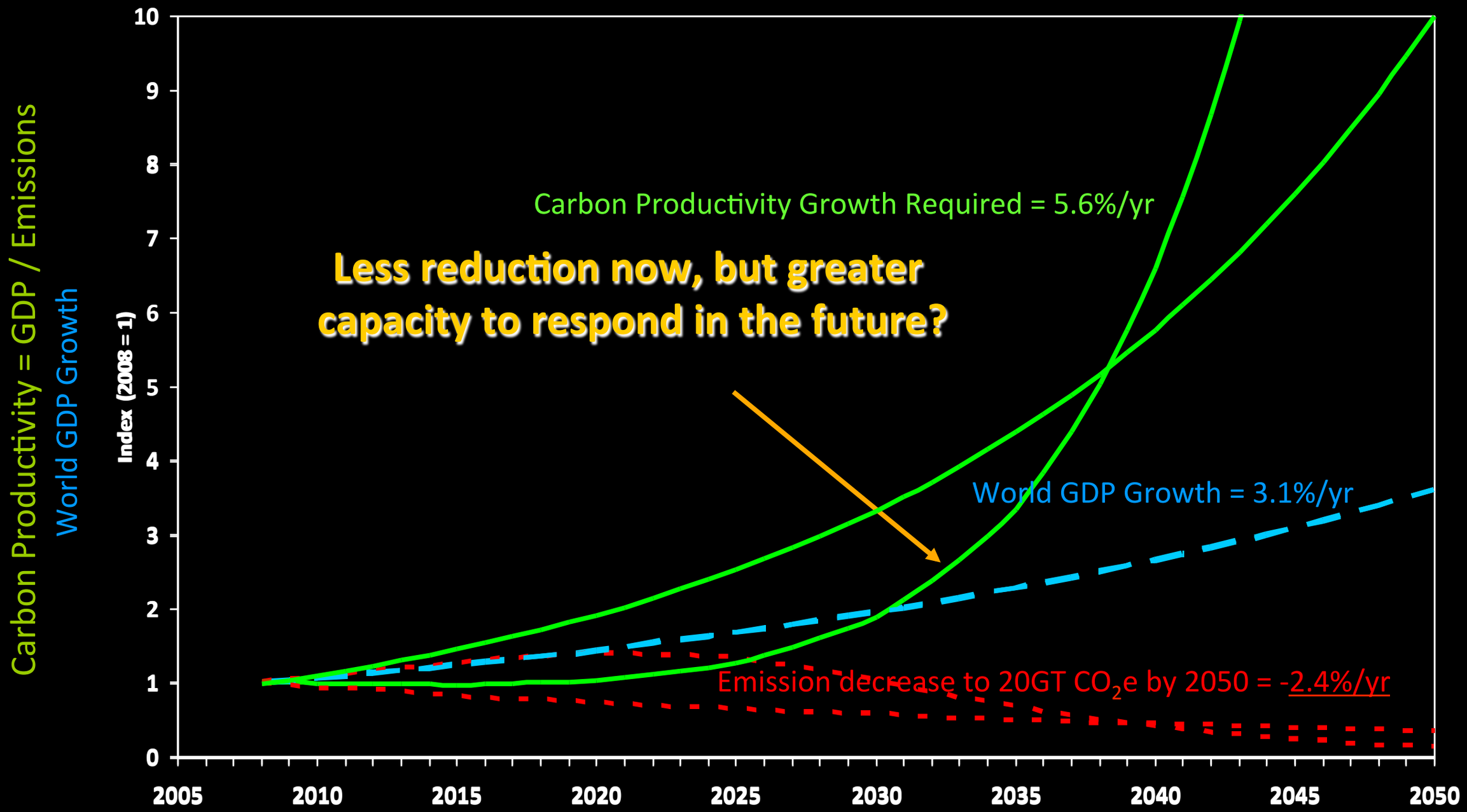
carbon caps or carbon efficiency of GDP?

environmentalists or pragmentalists?

…carbon reduction capacity

May want to move

carbon reduction capacity: 10X increase in carbon productivity!



Source: "The Carbon Productivity Challenge", McKinsey – Original GDP projection from Global Insight through 2037

… the takeaway

don't believe experts, econometrics, big companies

traditional wisdom gets in the way

most of us are wrong; most of us know too much

solutions are going to be Black Swan(s)

Takeaway: entrepreneurial engine is powerful!

take a big problem (challenge)

… add the best minds

… the power of ideas

… the fuel of entrepreneurial energy

… and a dash of greed

exponential innovation…

assuming ~2% rate of change…

= 1.8X units

= 1.8X units

1926

2010

2040

takeaway: to predict 2040 in 2010, we would need to predict 2010 in 1926!

as surely as...

1985: NOT a PC in every home

1990: NO email for grandma

1995: NOT the internet

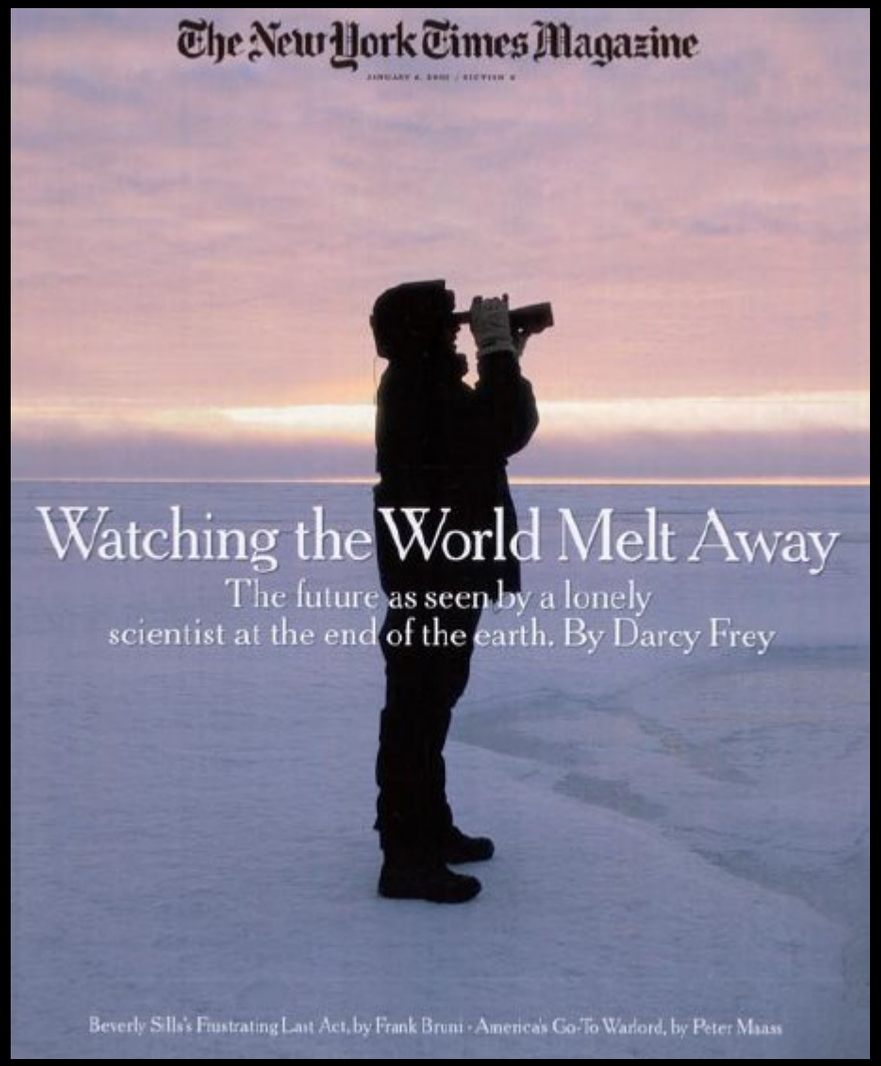
2000: NO pervasive mobile

2005: NO financial implosion

2010+: reason for optimism

to predict the future

invent it!



… or get to work.

vk@khoslaventures.com
khoslaventures.com/resources.html