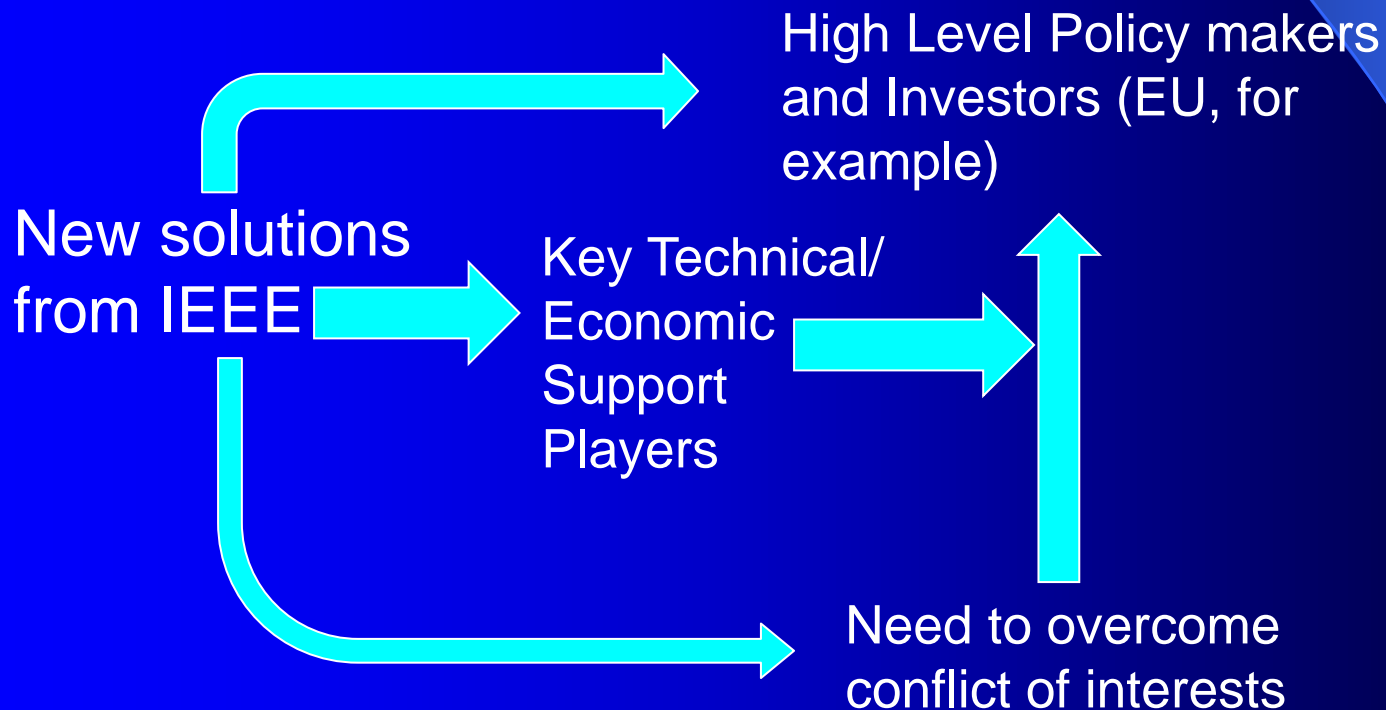


New Technology & Market Design to Prevent Climate Extinction:

Problem: New Science Shows Serious Threat of Human Extinction Due to New Climate Changes



New Technology & Market Design to Prevent Climate Extinction:

● Findings From IEEE PES Book Effort*

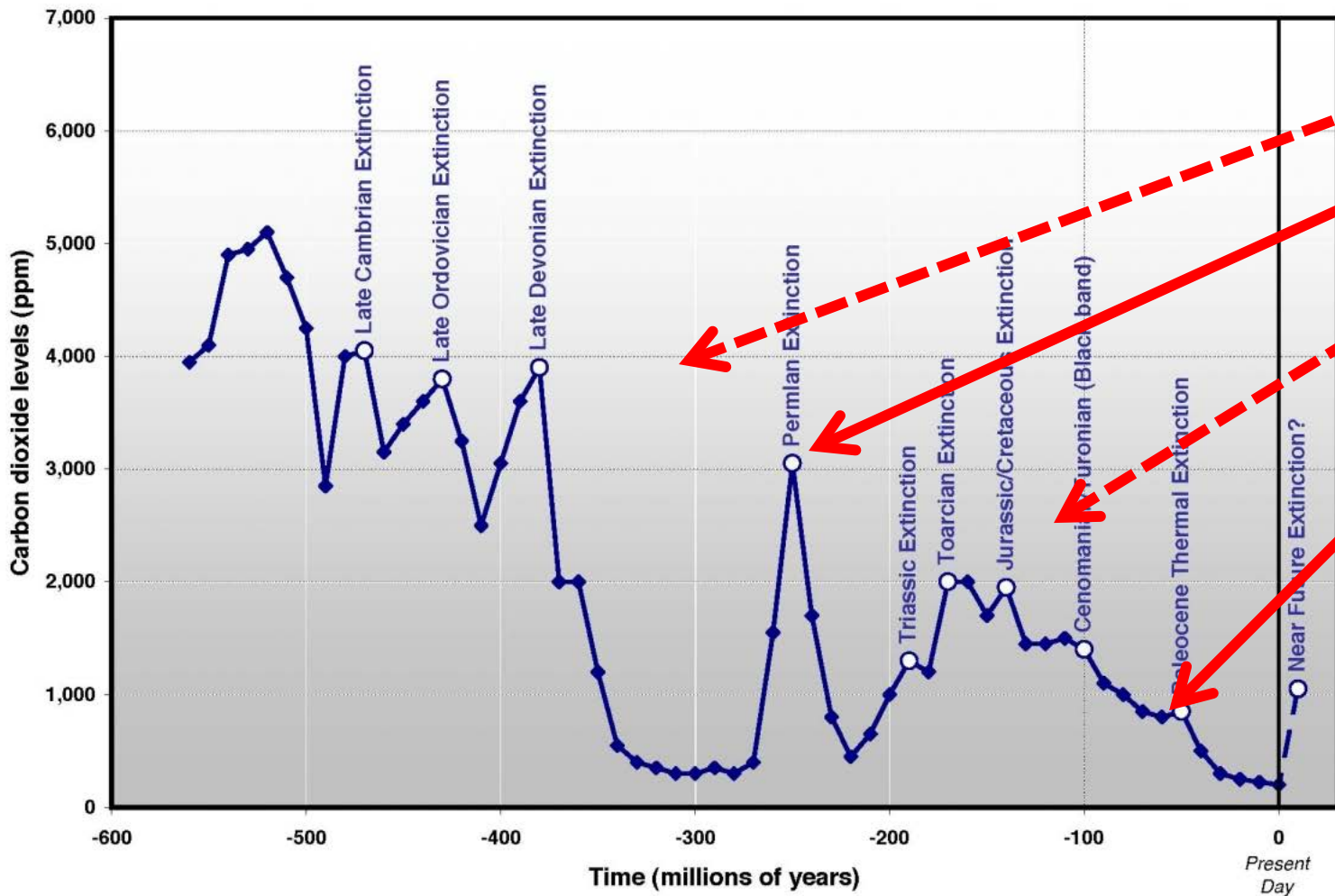
- New data shows we are closer to extinctions than anyone serious believed a year ago.
- IEEE options from US and Chile offer solutions to policy and investors
- The major obstacle for implementation is conflict of interests
- The problem is further complicated by other existential risks and yet there is hope

*** See Drafts and Details in active links at build-a-world.org**

US Senate skeptics 2009: “CO2 was >2000 ppm for millions of years in earlier earth. Didn't life just go on as usual? How bad could it be?”



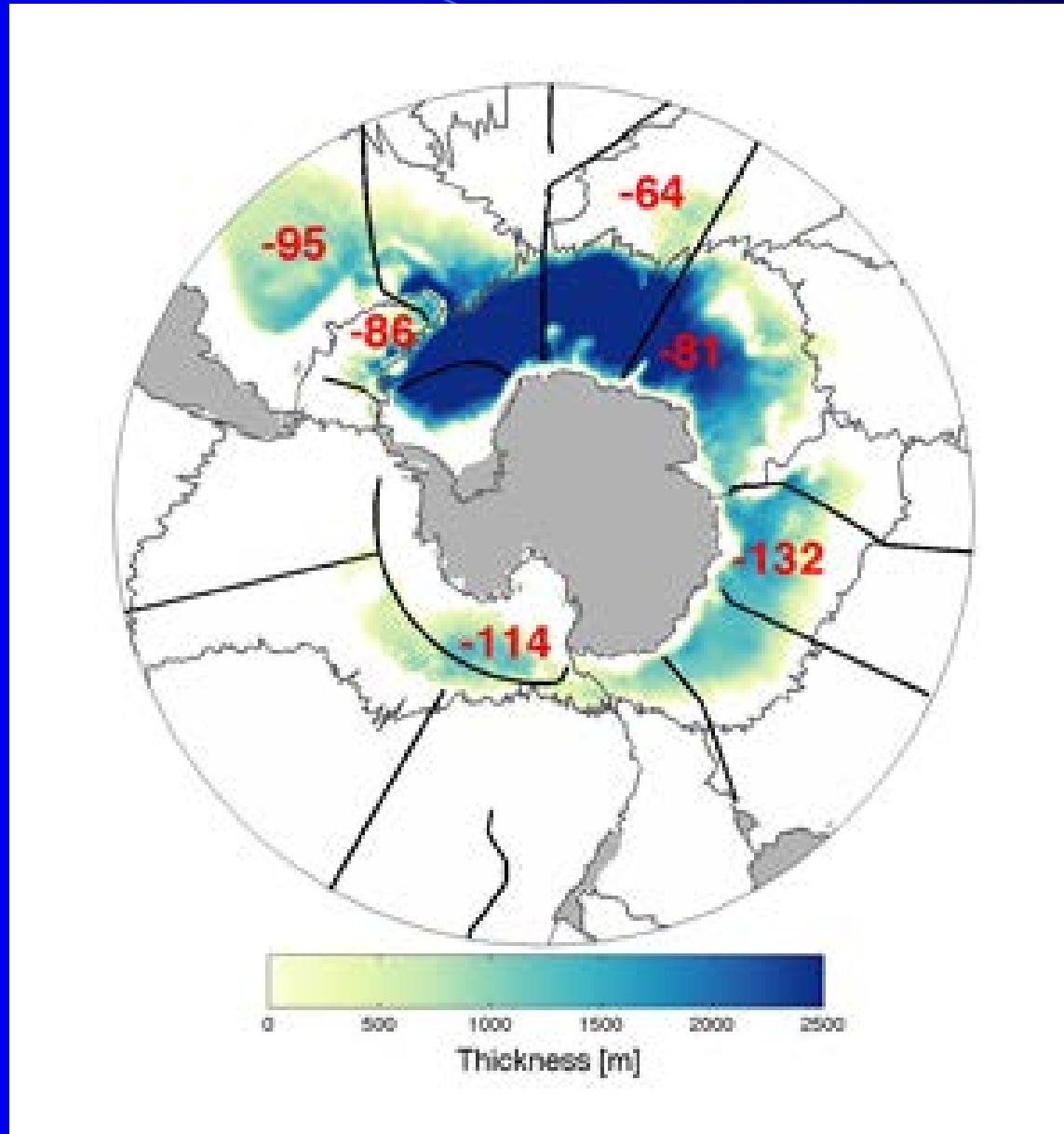
No one in the room knew,
but I decided to find out



H2S in air
And
Radiation
Enough
To kill
All humans

- NSF Geosciences sponsored best data on past:
- Graph from Peter Ward, Under a Green Sky, adapted by Englander. Ward theory half right.

NOAA data: 40 years for Pacific O₂?



Comparing Sources in 2022: Bad News

- See Preface by Ward, Wadhams, Werbos
- Started with discussion comparing past extinction science and new ocean current data, drawing on new work by Kump, Kirschvink, Hazen
 - posted at <https://tosavetheworld.ca/>

Comparing Sources in 2022: Bad News

- MAIN CAUSE OF PAST EXTINCTIONS:
 - low O₂ in deep ocean
 - High fertilization in major sources of ocean currents like Humboldt and Gulf Stream
- Latest data says problems coincide, worst case, soon

Policy and Investment

- On reliable solutions, IEEE and NSF have been imperfect, but provide uniquely rich sources of real frontline information.
- IEEE needs to reach Policy Makers and Investment Information Networks

Real Solutions vs. Conflicts of Interest

- Many EU climate activists claim they already have solutions.
 - Von Der Leyen's more serious evaluation shows otherwise.
 - Frightening dependence on fossil imports for years to come.
- IEEE and NSF review systems, when used at their best, provide deeper evaluation and ability to map richer set of options from open large sets of credible sources.

What's Important for CO₂: Data from DOE/EIA-0573 (2009)

- Total US CO₂ emissions: **5426** million tons (Table 7, page 22)
 - **2160** direct CO₂ from electric utilities
 - **1854** direct from transportation
 - **1412** all other places, including electricity generation by industry and commercial sectors
- 1404 is the total emissions of industry (direct plus indirect)

5 Point Plan To Reduce the Worst Climate Risk

1. Sectoral Bill:
Cut net GHG in
Electricity Generation

5. New Basic R&D:
Ocean options,
Archaea, currents

2. Sectoral Bill:
Cut net GHG in
Cars and Trucks

4. Geoengineering:
R&D for better
options from aerosols
to mirrors to..

3. Agriculture:
Recycle \$20-\$40/ton
CO2 fee to recycle CO2
From terra preta to happy cows



π

About 10 Independent Systems Operators (ISOs) Run the US Grid



Transco
like IOU



ISOs Decide:

- Unit Commitment (Contracts to Generators a Day Ahead) & Advance Planning
- Economic Dispatch (Generators Used and Loads & Prices every 15 minutes)

Balancing Authorities:

Regulation Functions (every 2 seconds):
stability, V , ω

• Big Loads

Distribution
Companies Discos



• Small Loads

• See www.ferc.com, event calendar, June 2010

“NSF is currently supporting research to develop a ‘4th generation intelligent grid’ that would use **intelligent sytem-wide optimization** to allow up to **80% of electricity to come from renewable** sources and **80% of cars to be pluggable** electric vehicles (PEV) without compromising reliability, and at minimum cost to the Nation (Werbos 2011).”

obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/nstc-smart-grid-june2011.pdf
(or search on White House smart grid 2011)

Computational Intelligence for the Smart Grid—History, Challenges and Opportunities



IEEE COMPUTATIONAL INTELLIGENCE MAGAZINE

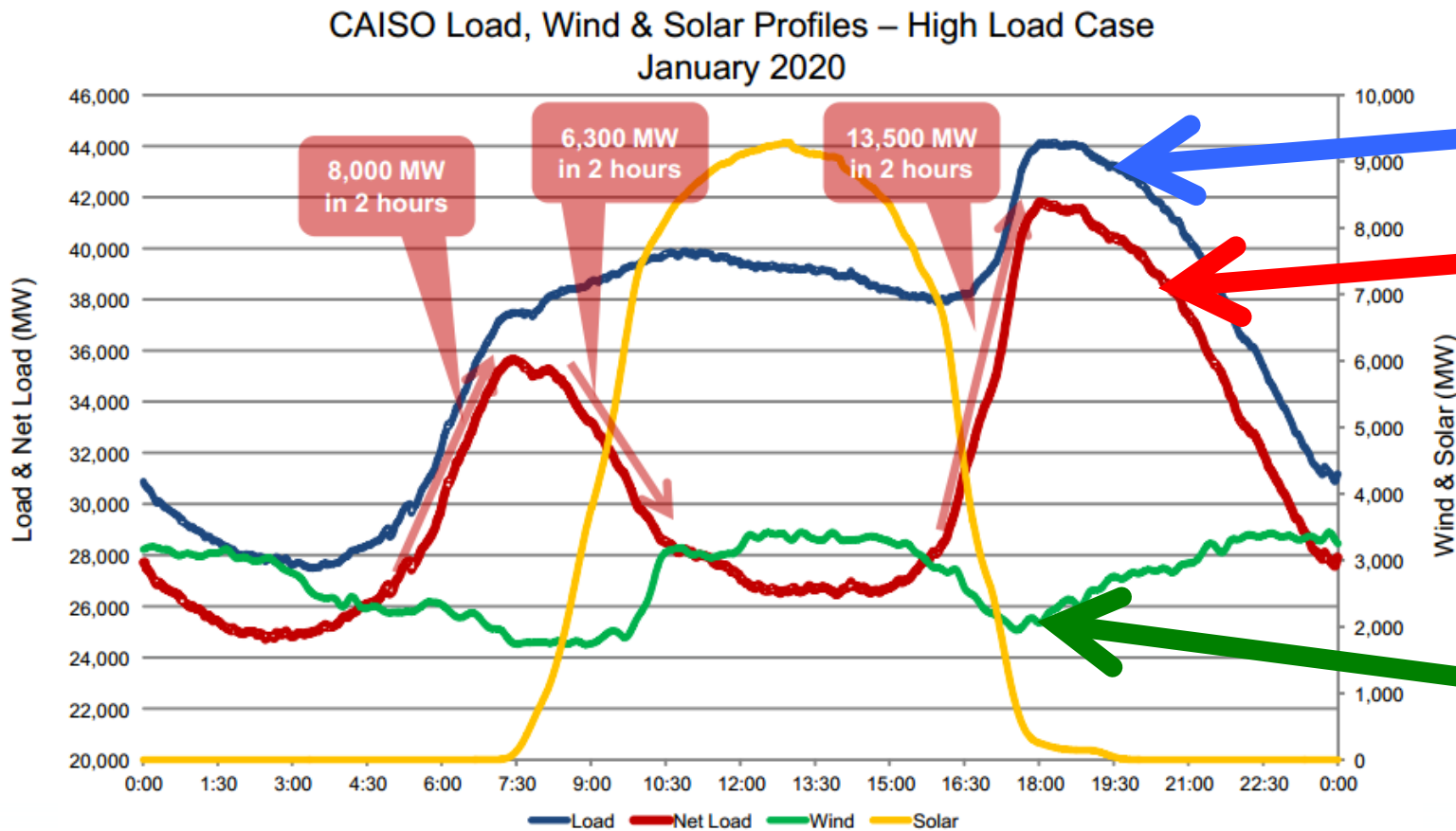
AUGUST 2011

Also posted at www.Werbos.com/energy.htm

Three Requirements for Affordable Renewable Electricity

- Less cost to generate enough for national needs
- Storage to supply it when you use it
- Intelligent grid to make full use of storage,
- Which requires **FORESIGHT** in **FACE OF UNCERTAINTY** ** RLADP, NSF 1988--

Time of day and predictability are crucial



Demand

Demand
Minus
2020
solar

Wind

- Chile and Brazil have unique hydro base, so intelligent timing of its use avoids need for more storage
- Most of rest of world faces tricky choices, 10¢ extra

2016: 3¢/kwh PPAs based on solar cells seemed safe for Chile, but time of day, backup issues and decline of subsidies from China made real cost much higher

- Power towers now look much better, with breakthrough efficiency in heat to kwh and in thermal storage, better than batteries, now mainstay for Chile
- Important experience from Stirling solar farms can transfer to even better in power towers



Neural Nets for the Power Grid 16 Years Later*

- Opportunities for Neural Nets As Such in Grids
- Crucial Issues in Partner Technologies for Grid
 - Cybersecurity and cyberblitkrieg
 - New technology for renewables
 - New power electronics, motors, fuel flexibility
- Power grids can lead development of more sustainable “Internet of Things” (IOT)
- IOT challenges in general

***www.werbos.com/E/GridIOT.pdf**

Biggest Opportunities for true Intelligent optimization (RLADP) in US Power Grid and Many Others

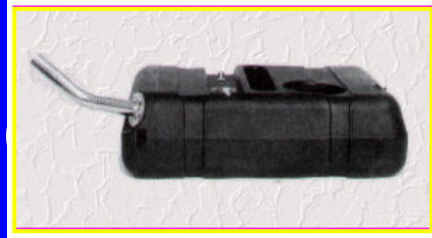
- ISO Level
- Distribution Level
- User Level
- New extension - quantum RLADP

- ISO Level: **Cut Cost of Renewables in Half**
 - **FORESIGHT**: From Optimal Power Flow to DSOPF, allows optimal management of storage, dams, time of day
 - **Speed**: Implementation on Neural Net Chips, allows optimization every second, not every 5 minutes. Control of power electronics turns wind from cost to asset
- Distribution Level: Enable Optimal Control
 - Use meshed networks, **handle electric cars and PHEV**
- User Level: (Mannheim) Intelligent Demand Response Can Accommodate Even Wind
- New Technology Quantum RLADP can handle more complicated decision problems (IEEE QCE 2021)

Oil and Economic Security In the Coming Decade

- Before the September 2008 economic collapse: oil (Brent) about \$150/barrel and rising, half due to expectations – Hotelling rent
- ****IF**** world economy recovers, many project about \$200/barrel... a \$ trillion/year bill for US.. more serious than federal deficit. (Latin American experience.) Crucial to hope of real recovery!
- Expectations can change quickly if trends and plans change.
- See www.werbos.com/oil.htm from Specter...

Optimal Strategy for Total Energy Security



Maximize Fuel-Flexible Plug-in Hybrid Cars



Open door to US natural gas (e.g. to trucks) while it lasts

R&D for more efficient use of diverse fuels

R&D for batteries for affordable electric cars



Minimize cost and then maximize supply of renewable electricity

Maximize supply of Alternate liquid fuels
– Not oil
– Incentives, standards and R&D

Plug-in Hybrids (PHEV) : A Large-Scale Opportunity Here and Now

- Hybrids cut liquid fuel use 50% already. Plug-ins cut **50% of that**.
 - “Researchers have shown .. (PHEV) offering.. electric range of 32 km will yield... 50% reduction..” (IEEE Spectrum, July/05). Shown in working Prius.



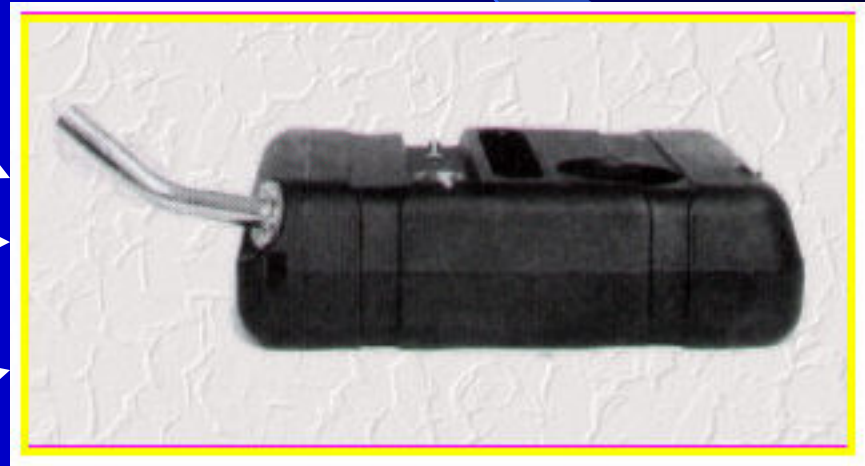
- Battery **breakthroughs in China**: from 10/07, 10kwh batteries (larger than) cost **\$2,000**. www.thunder-sky.com. Thus an extra \$2,000 per car can cut gas dependence in half.
- Gives economic security in case of sudden gasoline cutoff.**
- Does not strain grid – actually strengthens it, if done right**

GEM Flexibly Fuel Vehicles (FFV) One Tank To Hold Them All

G: Gasoline

E: Ethanol

M: Methanol



With an FFV, you choose each day which to buy
At \$100-200/car, a more open competition, level playing field,
better unleash the power of the free market
GEM flexibility \Rightarrow use of any corrosive fuel, adaptive engine
control

☰ We can dramatically reduce cost and expand supply of biofuel, present and future, if we stop requiring so much purity in our ethanol/alcohol!

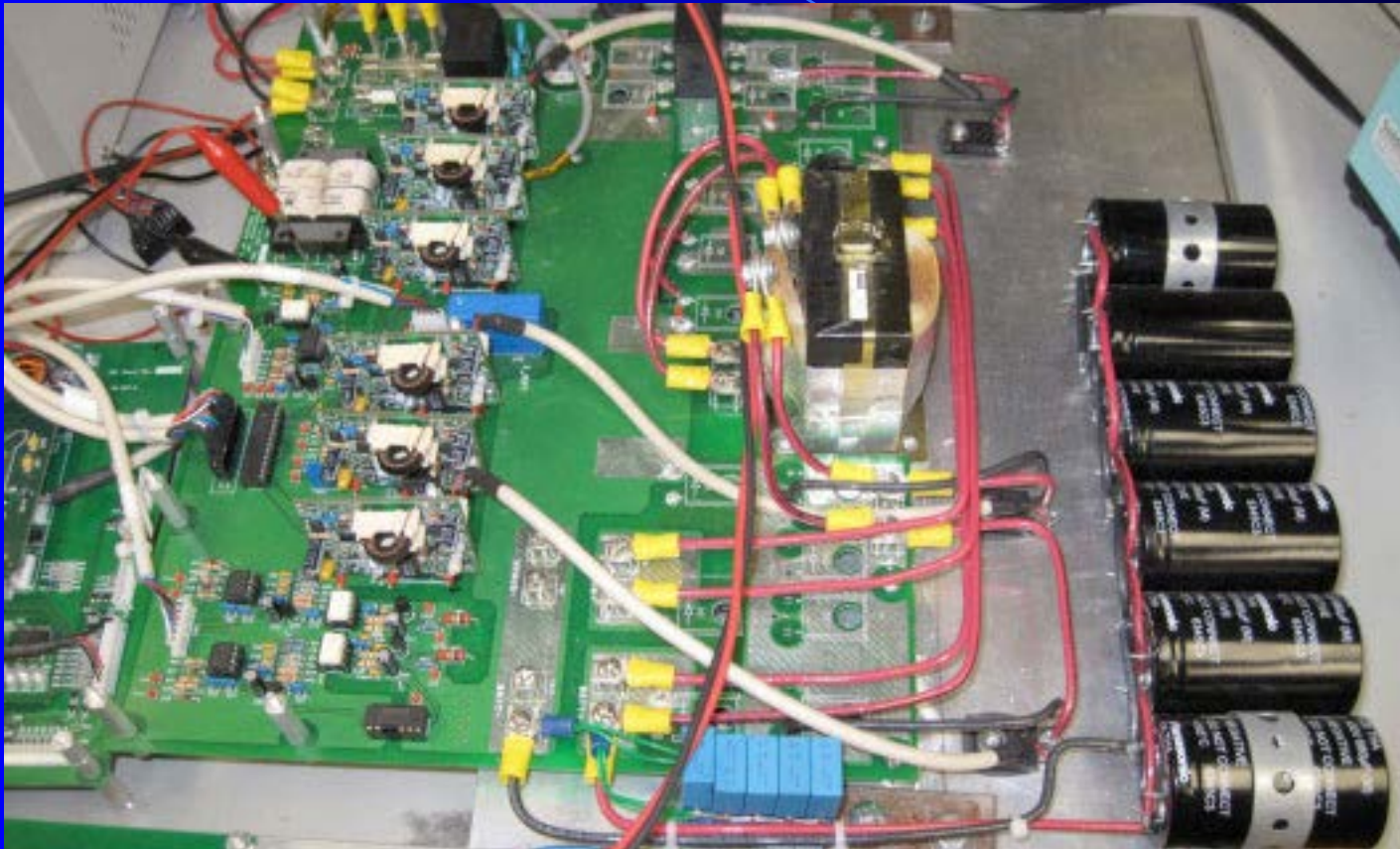


We need to give this guy permission to compete with Saudi Arabia and Iran for the car fuel market! He doesn't need a subsidy – only more freedom and an open door! Just give him a chance, and within 15 years...
(Also, try a google on “forest industry” methanol.)

What limits rate of deployment of hybrids & plug-ins? Cost, cost, cost... (and recharge: don't fall into chademo!)

- Hybrid Prius vs. regular Prius: cost penalty = **\$3000** (2006 data Car & Driver, Financial Times) about enough to pay off at \$3-4/gallon without interest
- About **\$2000** of the \$3000 is for small fast battery, currently nickel hydride less than 1kwh.
- **\$1,000-\$2,000 tax incentive** per car, for the first million hybrids from each manufacturer, essential to speed of development, becoming cheaper, **in US**
- **Outside the US**, higher gas price bigger market now

- Example 1 of Funded Work: Alireza Khaligh IIT
- (Similar megawatt work by SMazumder for solar farms)



- New **integrated** power electronics can cut cost of total power electronics for cars
- like Volt by 1/3 – 1/2 while adding a flexible AC/DC fast recharge capability
- making fast recharge stations “free” instead of \$100,000-\$200,000 each
- Similar technology crucial to distribution level (Rahman issues) constraints

To The Rescue: Lonnie G. Johnson

- Founder and President Johnson Research
- NASA (Voyager, Mars Observer, CRAF, Cassini, Galileo)
- Holds over 140 patents
- National Inventor's Hall Of Fame Inductee
- Currently Focused on Energy Technology Breakthroughs
 - Solid State JTEC Engine for Direct Heat to Electric Conversion
 - High Capacity Solid State Ceramic/glass electrolyte batteries
 - High Specific Energy Lithium Air Batteries



*“One of the Top
Inventors in the World”*

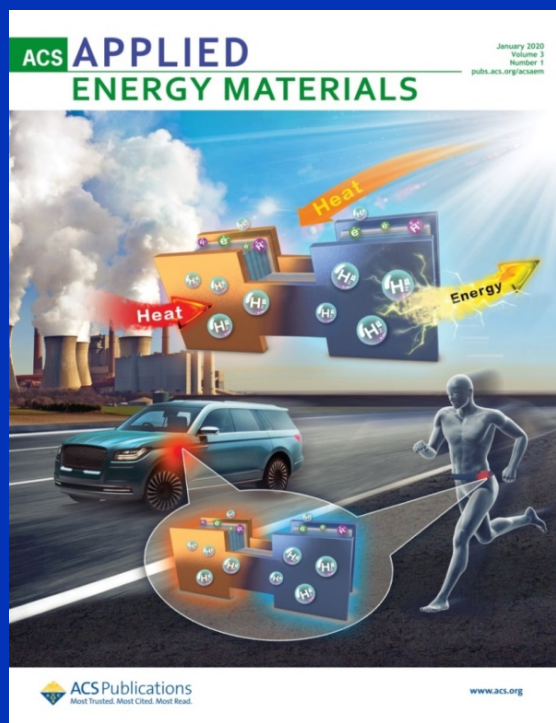
Time Magazine

Exciting credible new ideas (risky but near term) for US to leapfrog the world both in batteries and in more efficient heat-to-electricity for flexible cars !!!!!!!

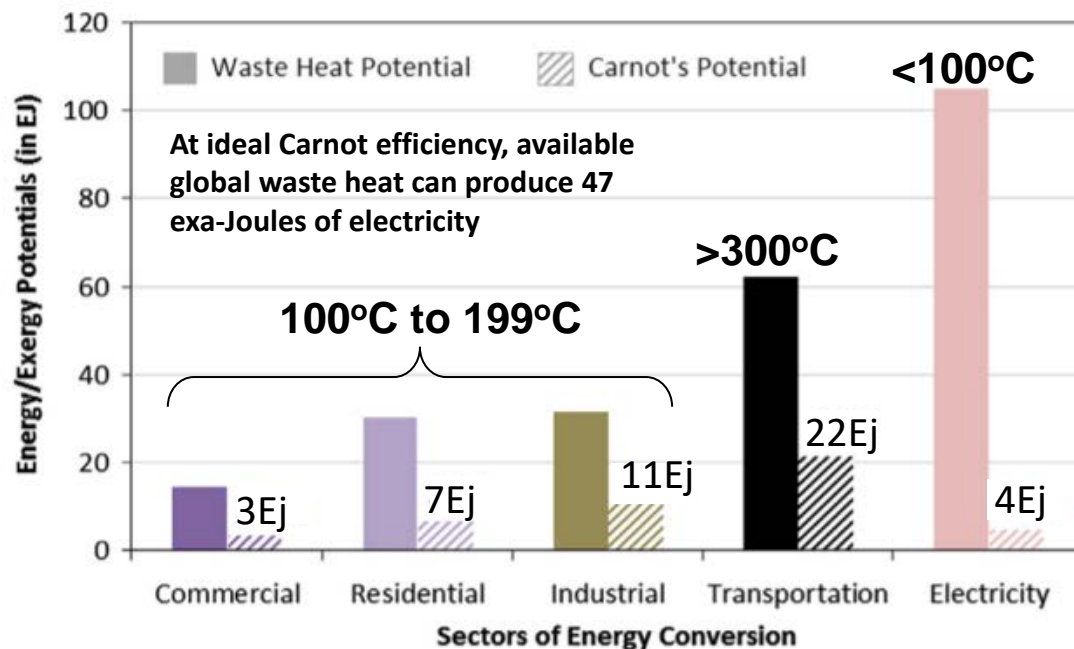
Johnson Thermo-Electrochemical Converter (JTEC)

Uniquely suited to produce electricity using primary heat sources as well as abundant low temperature waste heat

- At JTEC's 70% of Carnot conversion efficiency, global waste heat sources would yield 9.1×10^{12} kWh of Electricity
 - Value at Cost of Electricity from Nuclear Power = \$190B
 - Value at Cost of Electricity from Petroleum = \$1.9T



JTEC's Versatility Featured on the Cover of the January 2020 Issue of the American Chemical Society Publication



Waste heat potential Renewable and Sustainable Energy Reviews 57 (2016) 1568–1579

•On average, in 2011, nuclear power had the lowest electricity production costs at \$0.0210 cents per kilowatt hour, and petroleum had the highest at \$0.216 cents per kilowatt hour.

•<https://instituteofenergyresearch.org/analysis/electric-generating-costs-a-primer/>

Johnson's All Solid State Ceramic/glass Batteries Will Make Electric Vehicles Safer and More Affordable

•Electric Vehicle

- 66% for Renewable ,
- 24.5% Well-to-Wheel Efficiency



•Charging
•4 Units

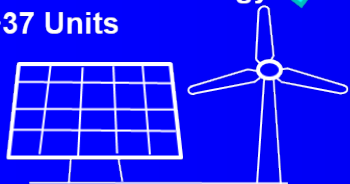
•Delivered Energy
•32 Units

•Transmission +
Distribution
•5 Units

•Generated Energy
•37 Units

•Conversion
•Waste Heat
•59 Units

•Renewable Energy
•37 Units



• Transport
•4 Units



•Extracted Energy
100 Units

•Internal Combustion Vehicle

- 13% Well-to-Wheel Efficiency

•Useful energy
•13 Units

•Engine Waste
Heat
•69 Units



•Delivered Energy
•82 Units



•Refining + Transport
•18 Units



•Extracted Energy
•100 Units

Johnson's Approach To Li-Air Will Provide Critically Needed Electric Vehicle Performance

Lithium Air Will Store 2000Wh/kg Vs. Lithium Ion's Only 200Wh/kg



- 777 Class Passenger Aircraft Fuel Costs are **\$17.86/mi**

- Cut to **\$4.20/mi** with Lithium Air at current power utility rates

What We Have Missed: Links to Other Existential Risks & Hope (section 5)

- New Internet Risks AGI/IOT even bigger, sooner, related to IEEE, but climate is an important testbed, even for Quantum AGI (AGI), patent
- Misuse of nuclear and biotech still threaten human existence. Agriculture linked to biotech and internet fintech, wanted a whole section for the book
- Human potential offers great hope of better future if we improve our networks better

Extra Slides In Case of Questions

How much does electricity cost?

Average national electricity prices in US cents/kWh (2011)



Data: average prices from 2011 converted at mean exchange rate for that year

Sources: IEA, EIA, national electricity boards, OANDA shrinkthatfootprint.com

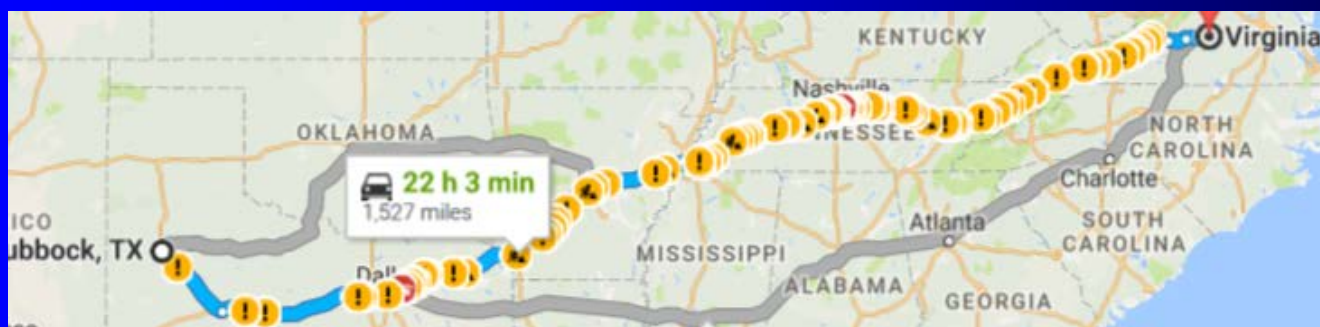
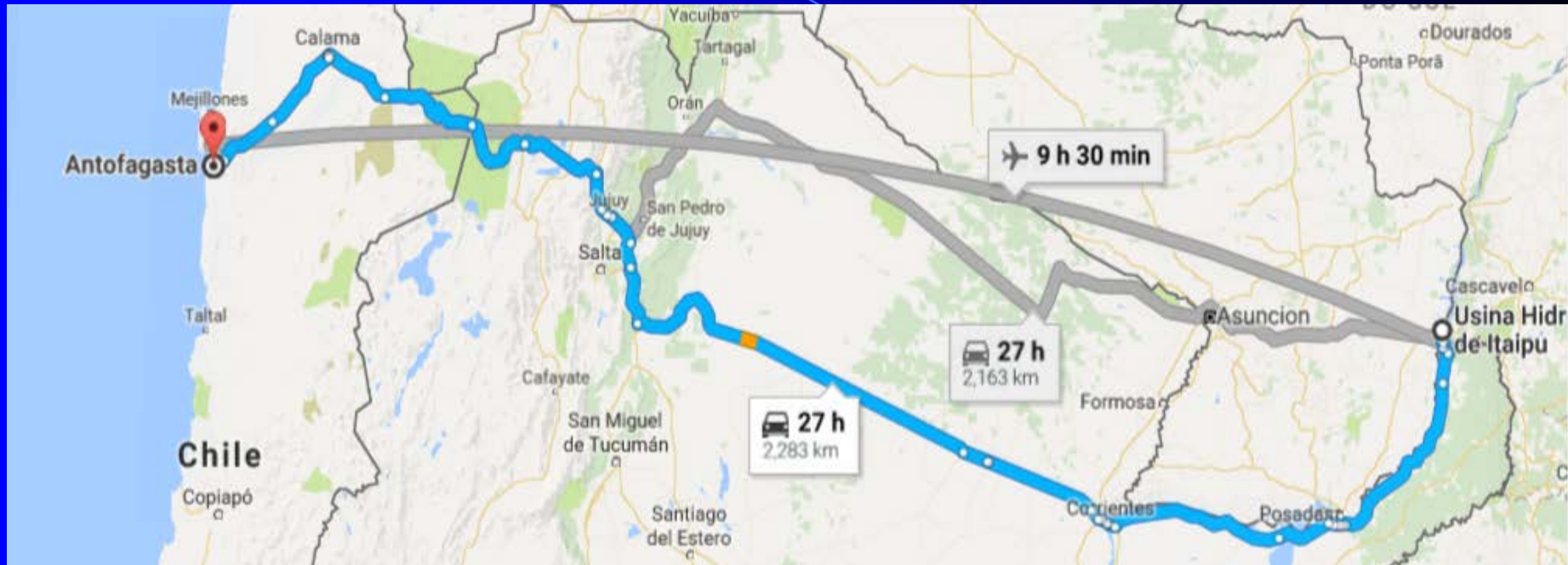
- US and EU are already above 10 cents per kWh. China is less, but heavily subsidized, encountering shortages and price rises with coal (not counting CO₂)
- OECD/IEA: world uses 21 thousand terawatt hours per year (2011). At 10 cents per kWh, that is worth **\$2 trillion per year**. With wind or solar supplying all, that would double or more. (Storage needs, backup, regulation.)

Will Euxinia Kill All Humans? How Big is the Risk, How Soon?

Dr. Paul J. Werbos

- Research Program Director, National Science Foundation 1988-2015 (“AI”, power grids, quantum)
- Detailed to Senator Specter/EPW in 2009
- Search on “Werbos” at youtube
- Still active in IEEE and many other professional groups like Chile Solar Energy Research Consortium

Proposed Start: 10 gigawatts on new line as long as TX→PJM 2¢/kwh



1gw→2.8TWH/year. With $(10¢-3¢-2¢)*28TWH$,
\$1.5 billion/year extra profit on \$3b investment