GREENTECH 2013

300+ days

Sustainability Technologies for the 21st Century

Juris Kalejs

American Capital Energy

email: jkalejs@americancapitalenerrgy.com

Keynote address, Denver CO, April 4-5 2013

R. Buckminster Fuller

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"[Our challenge is to] make the world work for 100% of humanity in the shortest time possible through spontaneous cooperation without ecological offence or the disadvantage of anyone." (www.bfi.org).

Topics of Presentation

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- Overview
- Sustainability Technologies
- Barriers to Adoption
- Global Competition for Subsidies
- Summary

American Capital Energy

- Started in 2006 to design, develop and install commercial PV power plants
- Cumulative installations of over 50 MW in >45 projects; over 70 MW currently under contract
- EPC specialists for commercial roof tops, landfill, and brownfield utility-scale PV power plants

A Plus for the Environment:
1, 850 kW PV Array on Landfill in western MA at WMECo

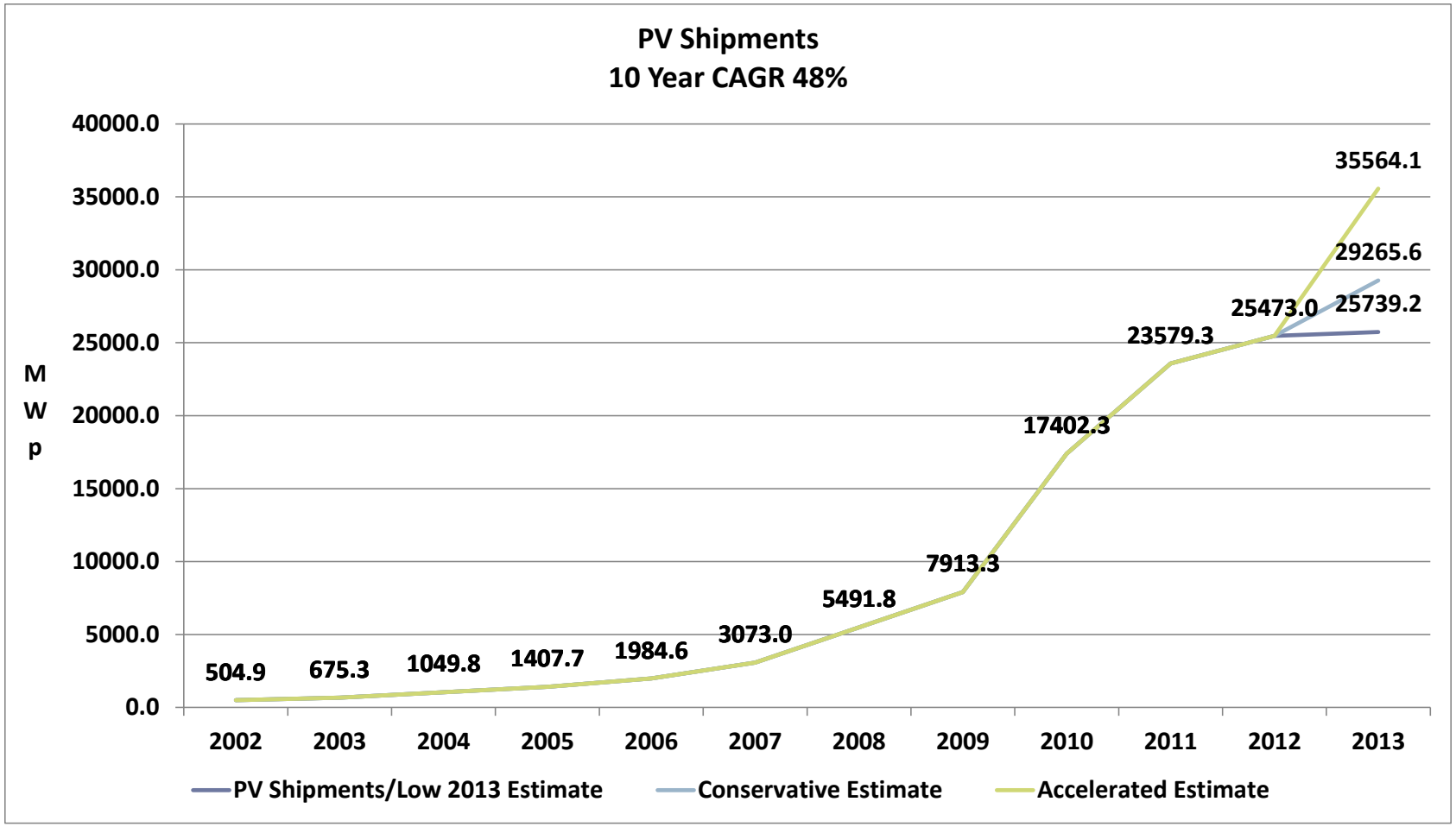
Status of Wind and Solar Photovoltaic Power Production

Generator	2012 Installed	Cumulative US
Wind	13 GW 42% of new incremental capacity > capacity of gas installed in 2012	>60 GW (3%) (20% of world's wind capacity)
Solar	3.3 GW ($11 Billion)	>8 GW (<1%) (less than 10% of world's PV capacity)

Historic footnotes: May 25, 26, 2012, solar PV in Germany operated near its ~25 GW installed capacity of solar PV electricity and produced close to 22 GW peak for several hours (~40% of demand)

Installed PV capacity (32.5 GW) in Germany now greater than wind (30.3 GW), but wind energy is x2-4 greater because of higher capacity factor

Global PV Markets
(Source: Paula Mints, SPV Market Research)



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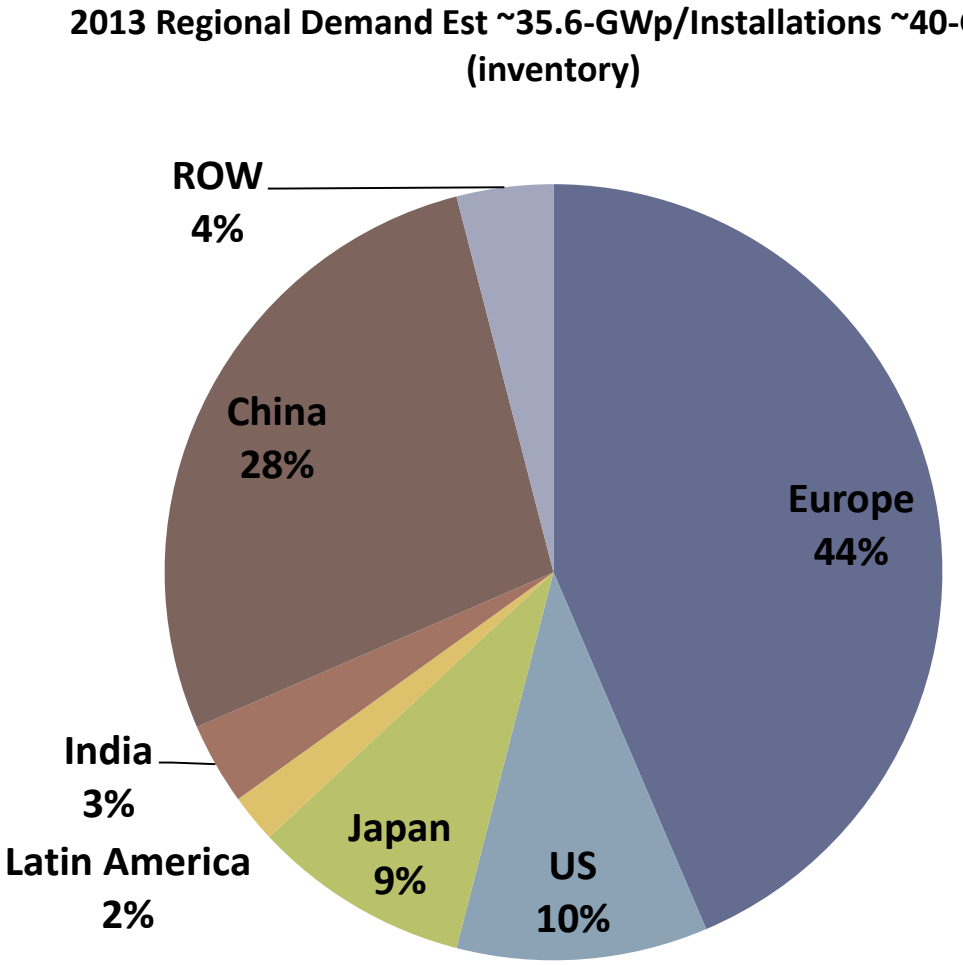

What is Driving/Hindering Renewable Energy Technology Adoption?

Pluses:

- Availability of clean technologies
- Costs are declining
- Clean environment emphasis
- Rise of subsidies for renewables in global markets

Minuses:

- Lack of infrastructure
- Lack of political support/will
- Embedded subsidies for fossil fuels in global economy

Carbon and Emission Free Technologies for Sustainability

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- Electricity:
  - Wind and Photovoltaics
- Fuel:
  - Steam Reforming of Organic Waste Products for Fuel and Byproducts
  - Potable water
  - Commercial syngases: (H2, CH4, CO2)
  - Fertilizer

Sustainability with PV

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- Available at all levels:
  - Large PV power power plants
  - Distributed PV on rooftops, large and small
  - Landfills

Springerville

ACC

Silver Lake

Sustainability with Biomass Steam Reformer Technology

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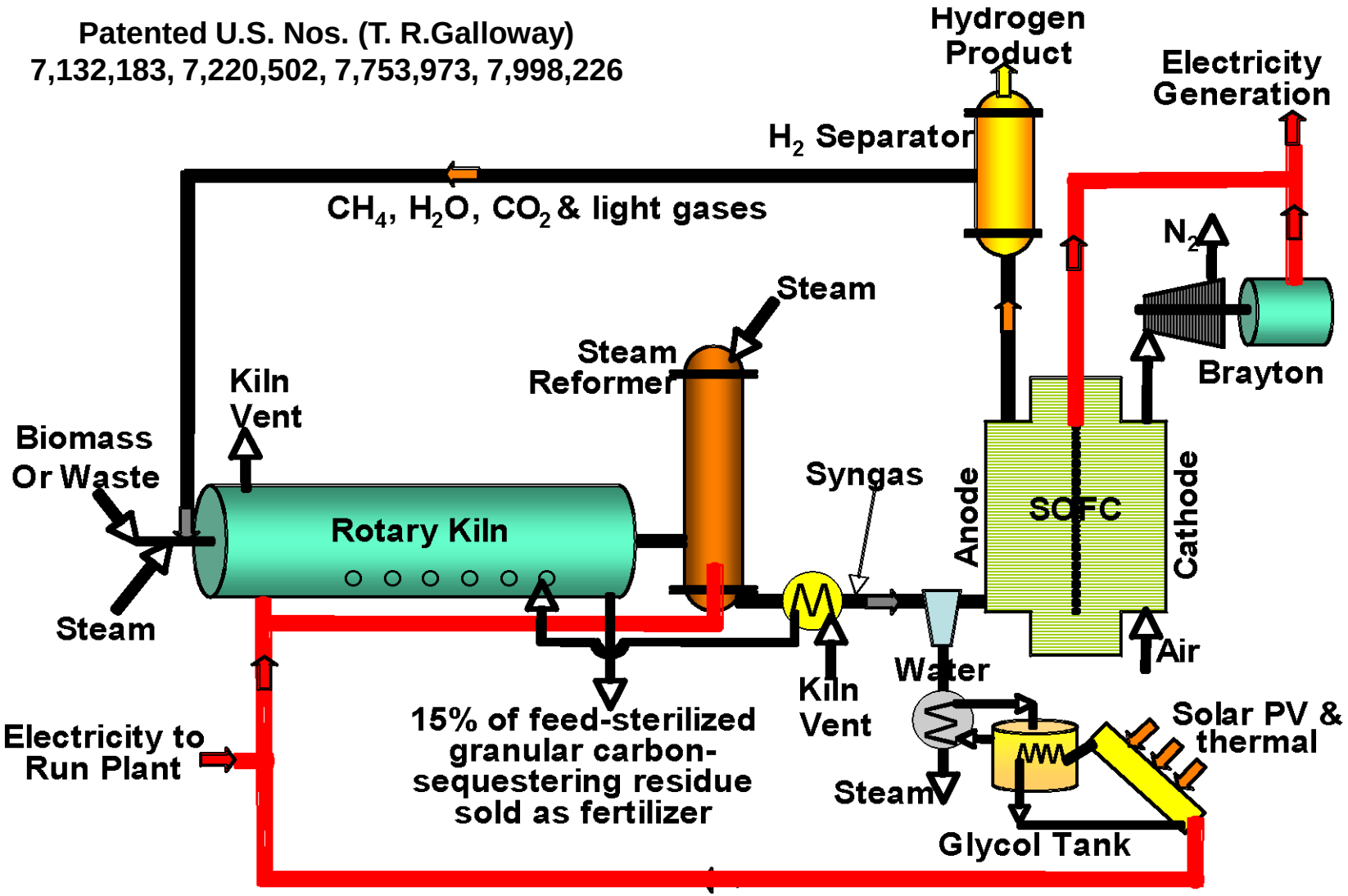

STEAM/CO_2 GAS TEST RESULTS
Average of all feedstocks

H_2	Hydrogen	59 - 63 vol%
CO	Carbon Monoxide	19 - 30
CO_2	Carbon Dioxide	3 - 10
CH_4	Methane	5 - 8
C_2H_6	Ethane	0.5
Higher HCs	Propane thru hexane	<0.01
Sulfur Cmps	All compounds	<4 ppm
Polychlorinated dibenzofurans + dioxins		0.0041 ppt TEQ

ng/m^3

Sustainability with Steam Reformer Technology

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- Feedstock can be mixture of municipal/commercial solid waste and agricultural biomass
  - sewage sludge, toxic waste, chemical waste
  - pharmaceuticals, hospital waste, medical waste,
  - agricultural waste, biomass, coal, etc.
- Process operates *via* chemical reduction to generate a clean H_2-rich syngas, CO, CO_2, H_20 steam, and other commodities:
  - nitrogen-free fertilizer, irrigation water, mixed alcohols
- Syngases can be operated in closed loop with **fuel cell** (hydrogen or SOFC), **storage options** for night-time use
- No toxic emissions (which are characteristic of incinerators)

Barriers to Sustainable Development of Renewables (PV, Wind)

- Capacity factor
  - 10-15% for PV, >20% for wind
- Lack of convenient, low cost storage
  - storage doubles cost of electricity
- Standards
  - written for base load power plants
- Capital costs
  - ITC for solar PV, PTC for wind temporary
- Regulation and Interconnect - Smart Grid and Plant Control
  - Regulations block IPP operations in many states
  - lengthens and complicates interconnect studies (adds to increase “soft” costs)

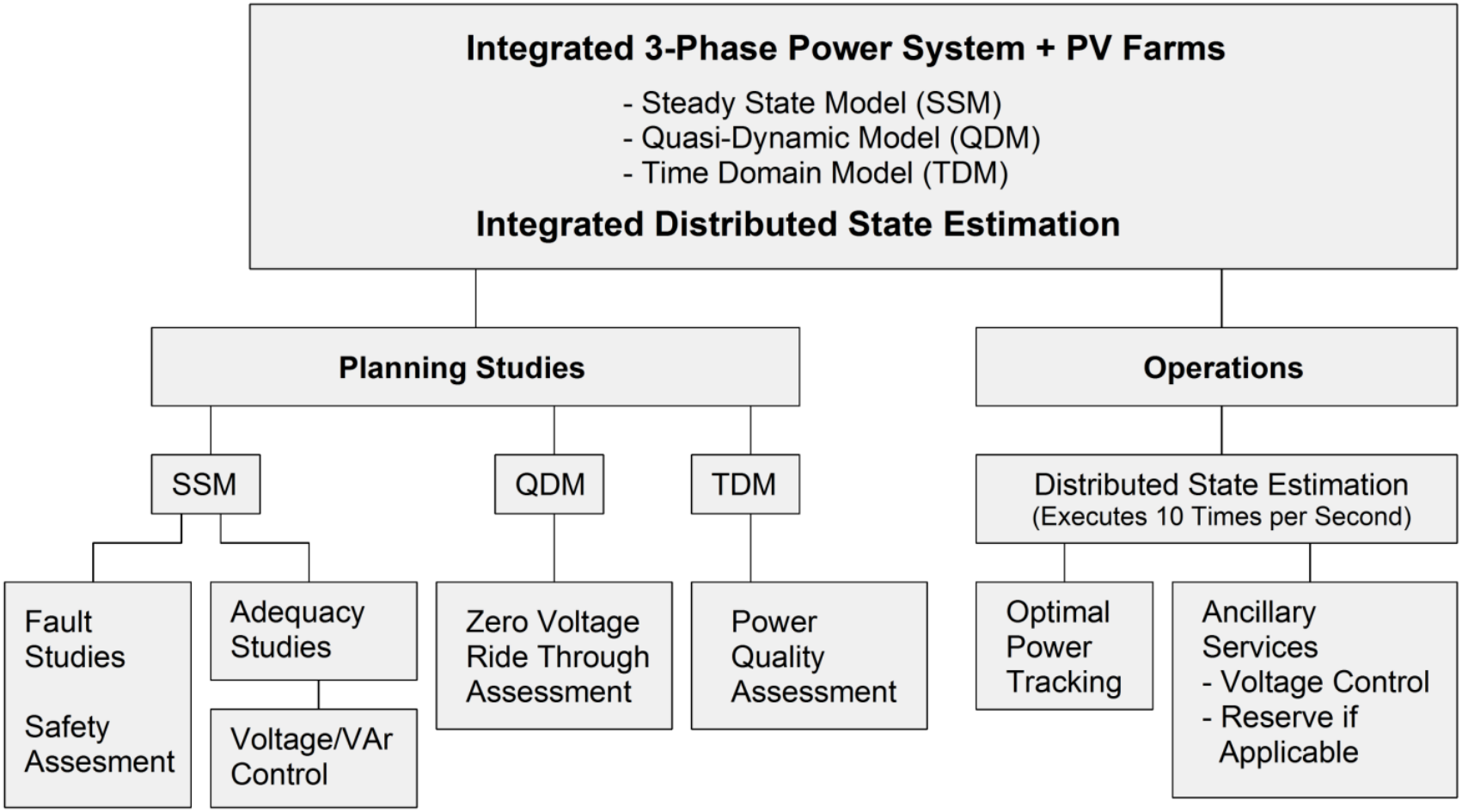
Interconnect Issues Contributing to "Soft" Costs in PV Plant Deployment

- PV and wind intermittency is basic issue
- Current SCADA-based PV power plant supervision and control is system of choice for utilities
- SCADA is not suited for real time PV plant control that will best deal with intermittency
- Combination of Smart Grid for demand-side and enhanced real time PV plant generation-side monitoring and control may be solution

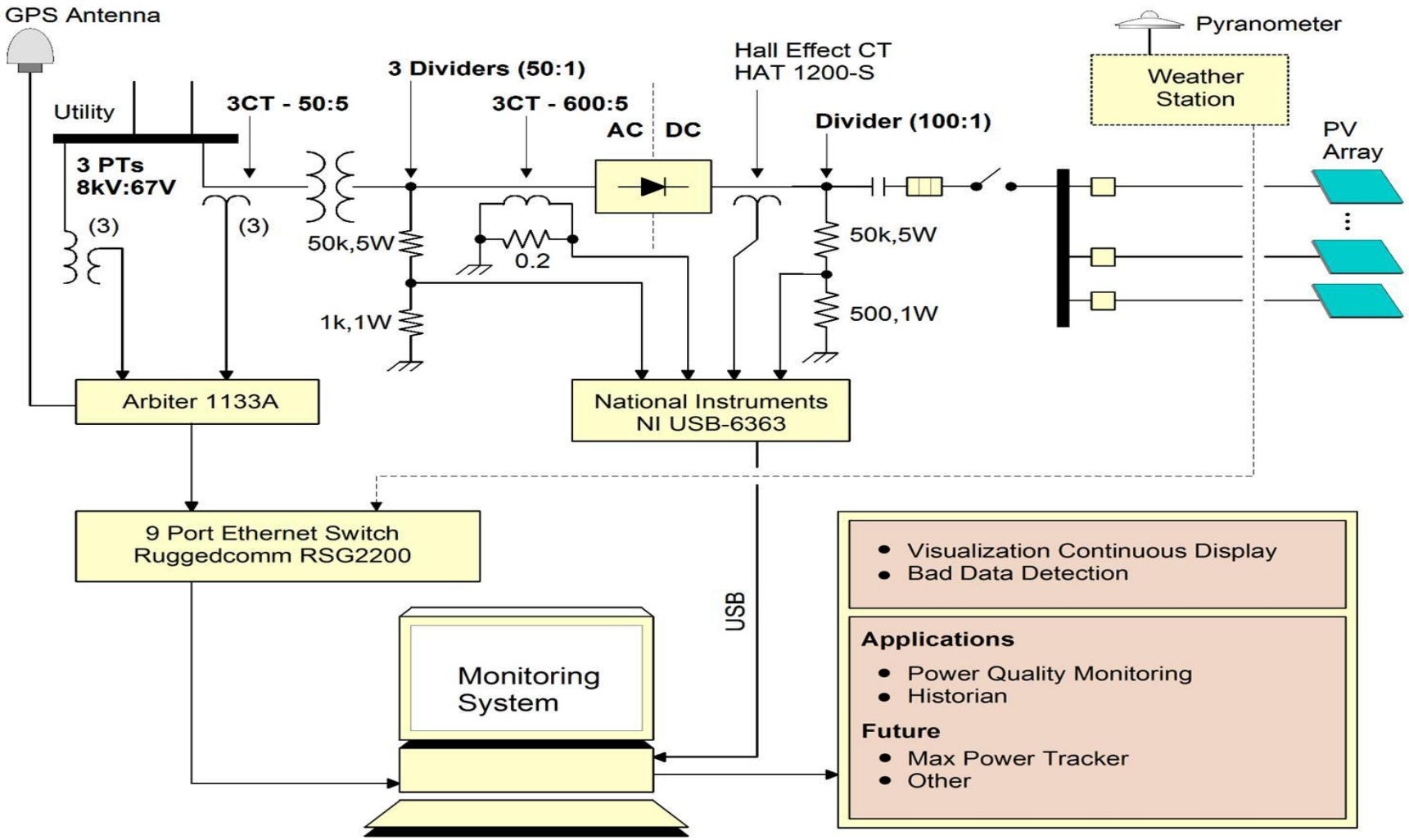
Reference: "Development of a Model for Integrated PV Power Plant Design, Impact Studies, Commissioning and Operations", A. P Meliopoulos, A. Ellis and J. Kalejs, paper presented in session on PV Power Plants at Intersolar Europe, June, 2012)

PV Plant Performance Analysis and Control Strategy

One Physical Model for Three Types of Analysis: (a) Steady State, (b) Quasi-Dynamic, and (c) Time Domain
Seamless Applications: (a) Fault Studies, (b) Adequacy Studies, etc. (see graph below)



Barriers to Sustainable Development of Renewables – (cont'd)



What Do We Hope to Learn From PMU-Base Analysis

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- Can PMU technology contribute to improved PV plant monitoring and control
- Will PMU monitoring add value to PV energy from the utility perspective
- Are monitoring and Control technologies robust enough to be deployed remotely

This discussion will continue in panel tomorrow Friday 10:15 am, “Utility-Scale PV: Next Generation Technology”

Barriers to Sustainable Development of Renewables – (cont'd)

- Lack of clean non-polluted air valuation
  - public policy and incentives ignore environmental and health costs of fossil fuels
- Global subsidy infrastructure for fossil fuels
  - embedded in 1st world countries as a pillar guaranteeing a high standard of living

Clean Air Valuation…. More Publicity Needed

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"Pollution kills… One study by Cornell University concluded that a staggering 40 percent of deaths worldwide are caused by water, air and soil pollution Think about that. In the United States alone, 100,000 people die a year because of pollution. That's more than the combined deaths from car accidents, drunk drivers, gang wars, suicides or Iraq and Afghanistan" *.

* *Excerpt from speech by former CA Governor Arnold Schwarzenegger at the Vienna Energy Forum Hofburg, 21 June 2011 (www.unido.org).*

CA still leader in adopting and implementing direct measures to reduce emissions and protect public health, including CA's clean car standards (www.calcleancars.org), goods movement measures and the Low carbon Fuel Standard (www.energy.ca.gov)

Global Subsidies and “Grid Parity”

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Unstable Incentives in USA for PV and Wind at Best

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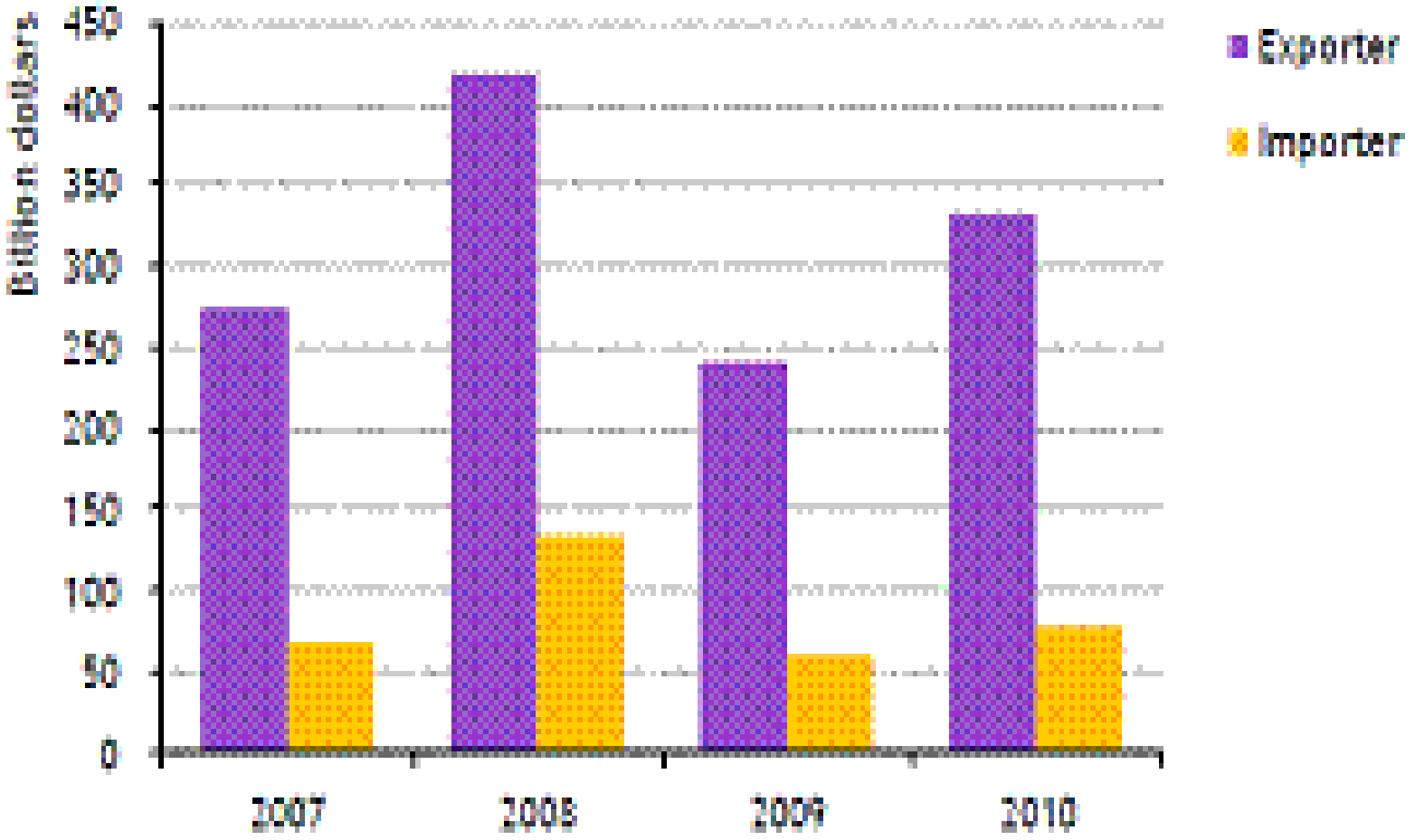
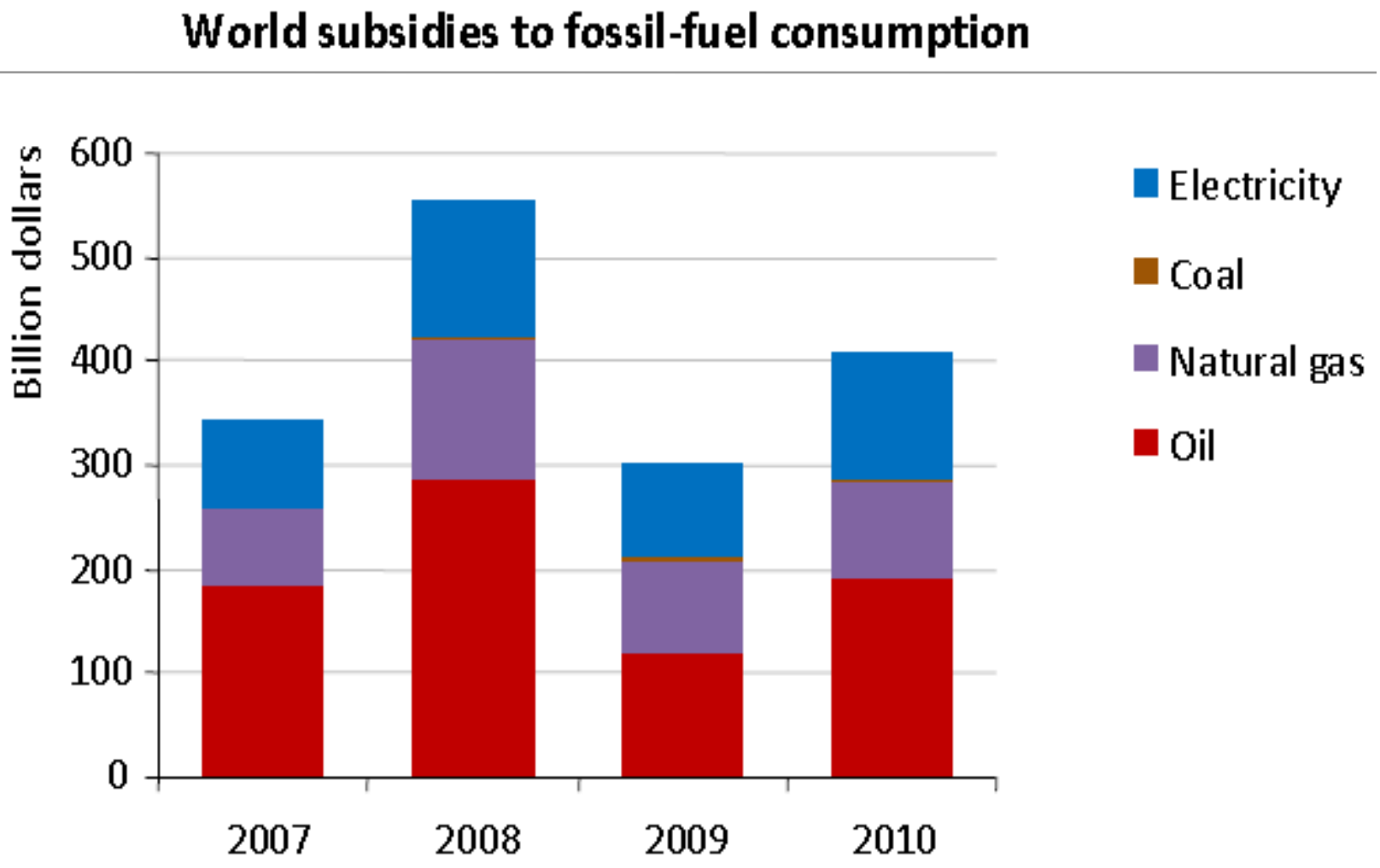
Generator	Conventional U.S. subsidies and renewable energy PTC/ITC
Oil	-$ 4 Billion annually; -100% depreciation allowance
Wind	-2.2 c/kWh PTC, yearly renewal -$1.3 Billion annually
Solar	-30% ITC will be terminated in 2016 -accelerated plant depreciation being phased out at the end of 2013 -State Solar Renewable Energy Credit (SREC) programs poorly designed for sustainable PV businesses (gold rush, crash and burn cycles)

World fossil fuel consumption subsidies by net oil and gas exporter/importer

(IEA World Energy Outlook Report, October 4, 2011, www.iea.org)



Rich get richer: only 8% of $409 Billion of global subsidies went to poorest 20% of population *



*IEA World Energy Outlook Report, October 4, 2011, www.iea.org

Why is there National/Global Competition for Subsides (www.iea.org)?

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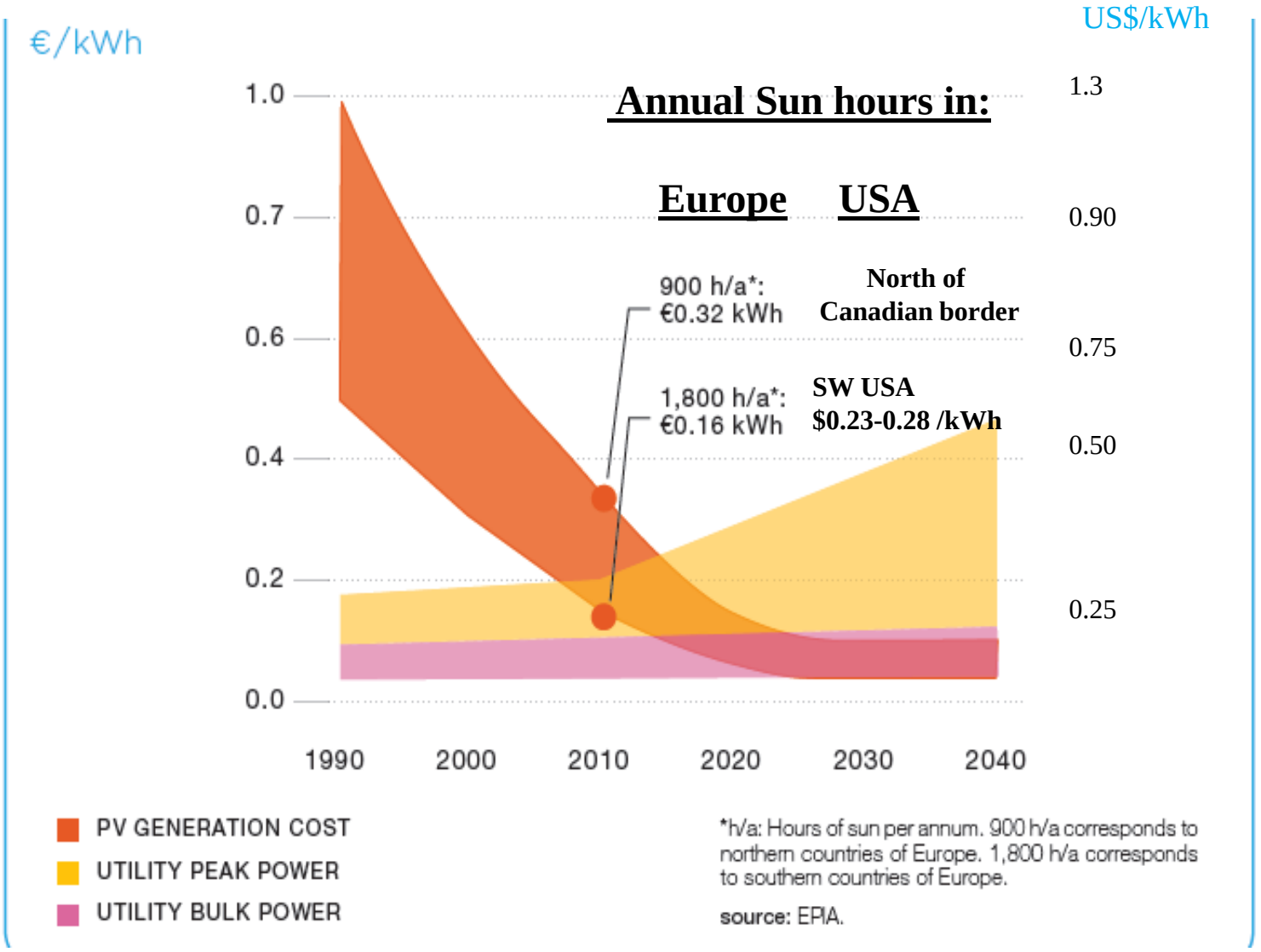
- Subsidies lower energy costs, increase standard of living (if someone else pays for them)
- Disproportionally benefit middle class and rich
- Exacerbate global wealth disparities - make rich richer, poor poorer
- Encourage use of energy so as to enhance CO2 emission and particulate pollution

Conventional fuel subsidies relegate renewables to be the "poor man" of the energy world!

"Grid Parity" for PV Prices and Conventional (Fossil Fuel) Retail Prices is Here (www.pvparity.eu)



Summary

- Technologies for sustainable living are available NOW to fulfill the Buckminster Fuller vision
- Multiple non-technological barriers slow US. adoption
- Monetization of pollution cost on human health are lacking
- Global fossil fuel subsidies distort the playing field and discussions of “grid parity”
- Struggle to recognize multiple values of renewable energies and incentivize them adequately is global
- Lack of value recognition not confined to any one political system or philosophy