Renewable Energy
Opportunities and Challenges for Entrepreneurs

May 8, 2010

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NANOBIZ, LLC
growing global businesses

Who We Are

Our Principals (with over 50 years nanotech experience)

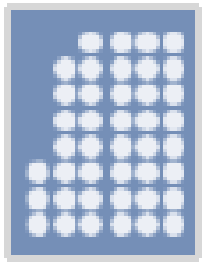
- Charles Brumlik, J.D., Ph.D.
- Dana Durham, Ph.D.
- Samuel Brauer, Ph.D.

Focus

- Commercialization of advanced materials
- Interdisciplinary technology

Industry sectors:

- Materials / Chemistry
- Coatings
- Electronics / Photonics
- Energy
- Cleantech / Sustainable
- Water



NANOBIZ, LLC
growing global businesses

Our Clients

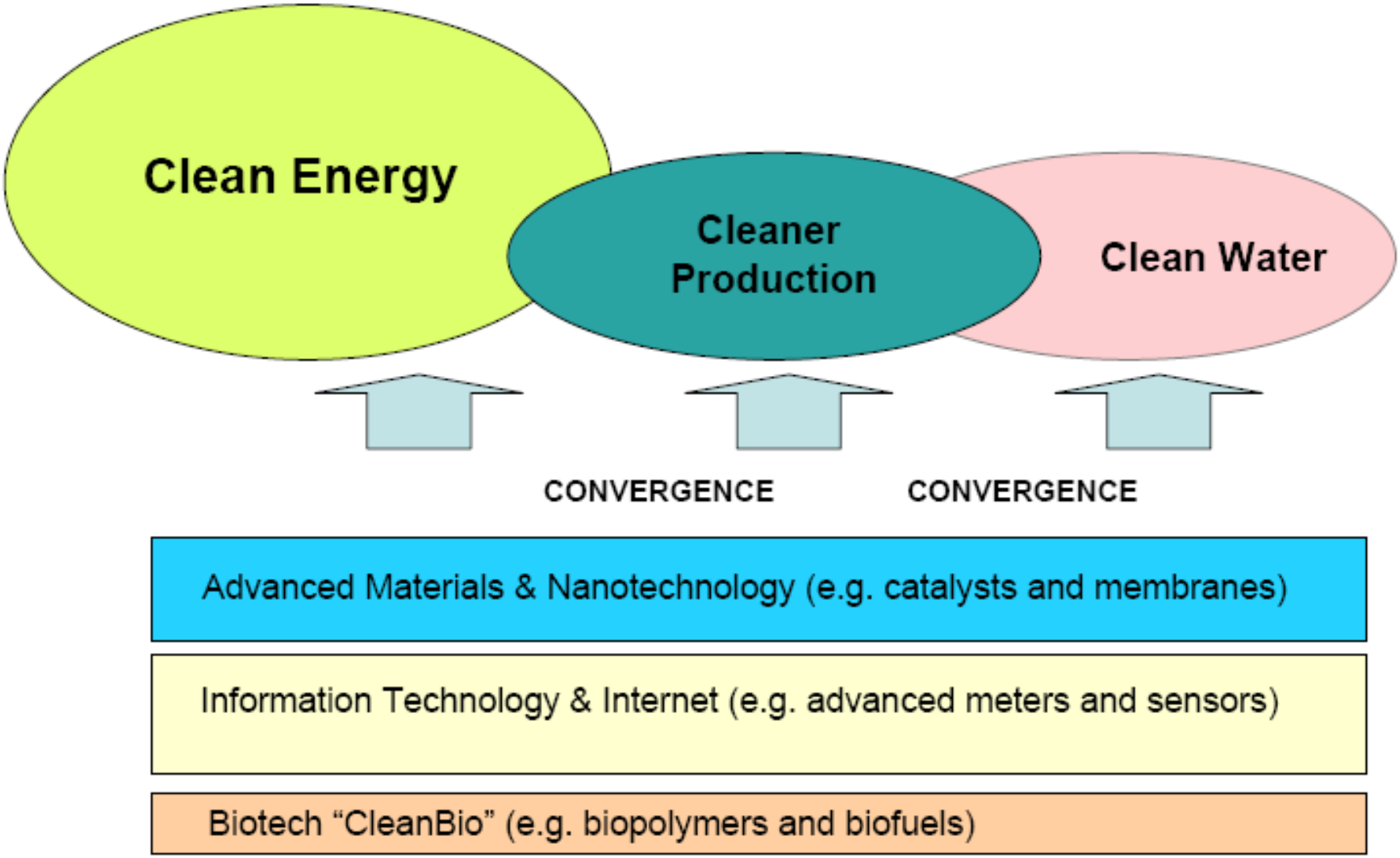
- Fortune 500 Companies
- Japan & Asia-based Multinationals
- Governments
- Investment Groups

- Typical Projects for M&A, licensing, partnering
  - Identifying and comparing potential partners
  - Identifying commercializable technology
  - Technology due diligence
  - Market and industry evaluations
  - Corporate due diligence
  - Cross border collaborations
  - Patent portfolio analysis in a business context

Outline

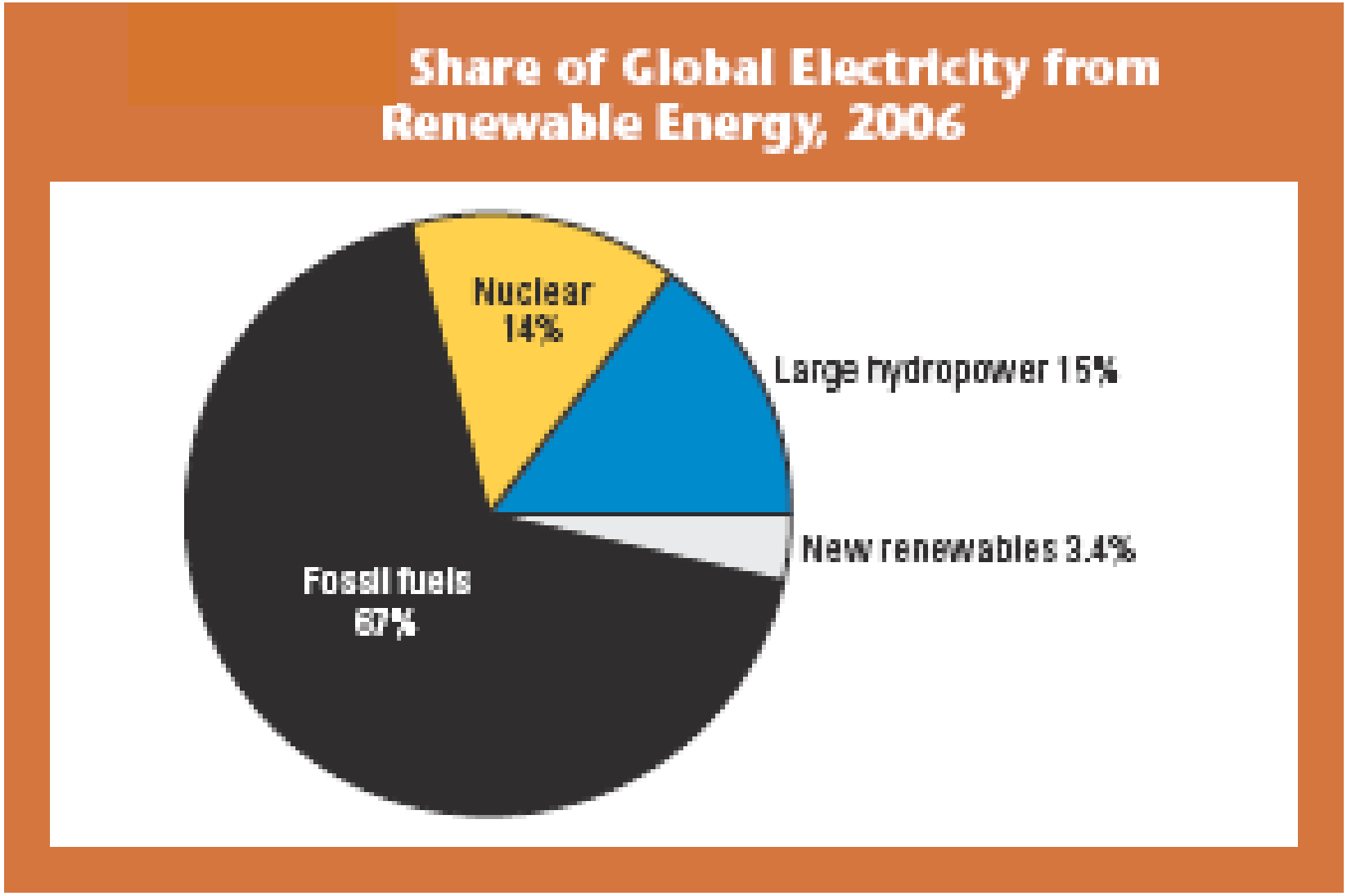
- Overview of Renewable Energy
  - Generation
  - Distribution
  - Storage
  - Efficient Use
- Commercial Reality vs. Opinion
- Show me the Money
- Opportunities & Risks
  - Future Employee / Student
  - Current Employee
  - Entrepreneur / Investor
- Resources

Cleantech



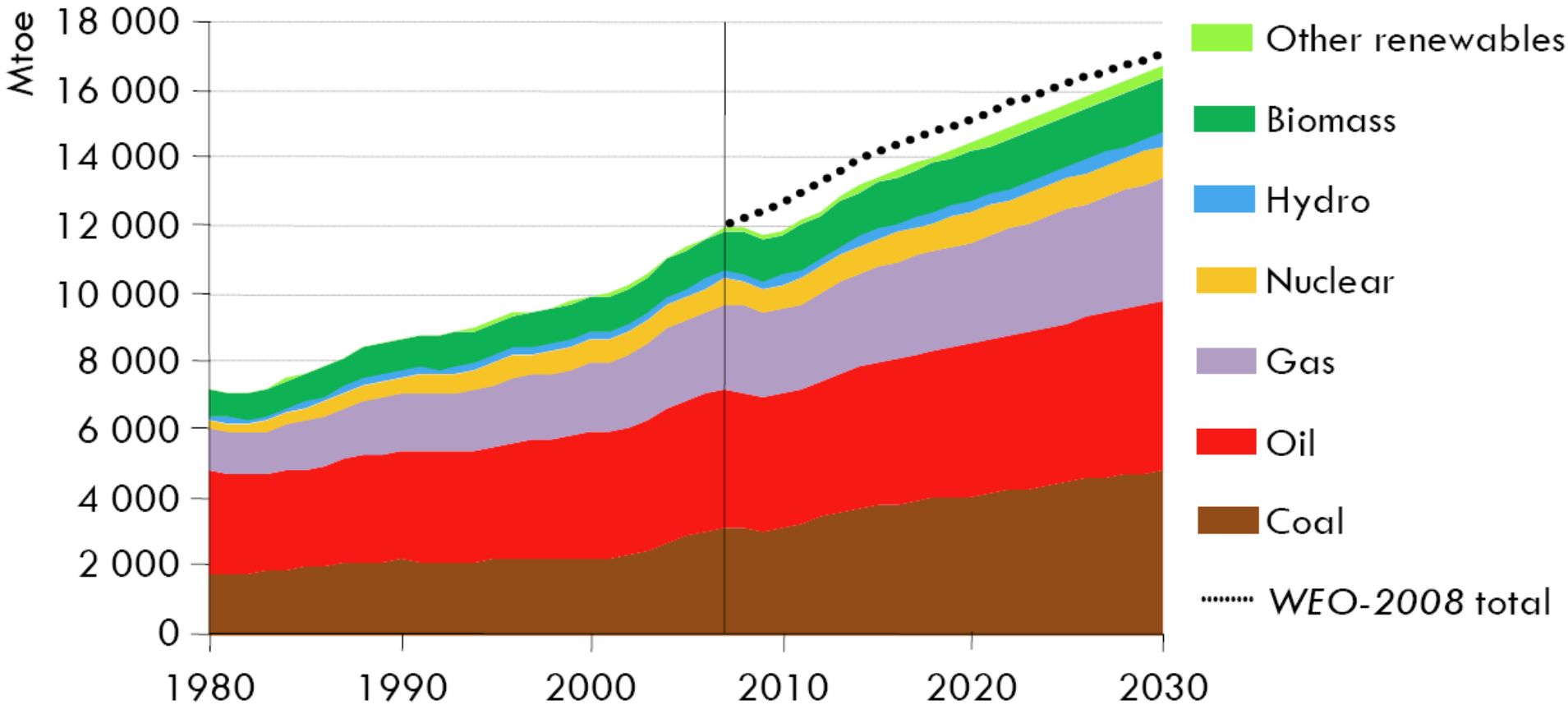
Source: Cleantech Group, 2007

Renewable Energy Market



RENEWABLES 2007 GLOBAL STATUS REPORT

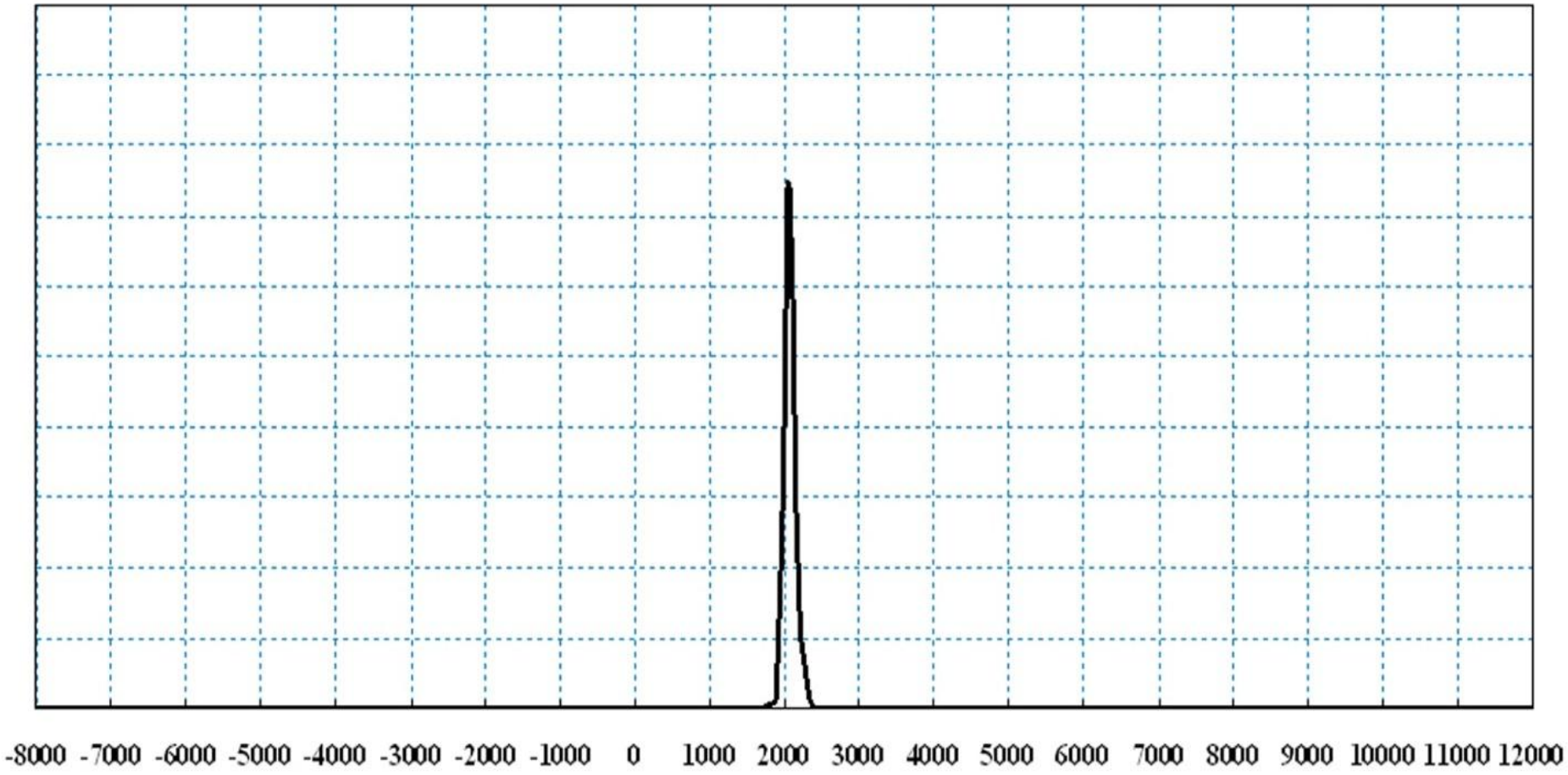
World Energy Demand by Fuel



Source: OECD

Fossil Fuel Use

A brief episode in the world's history

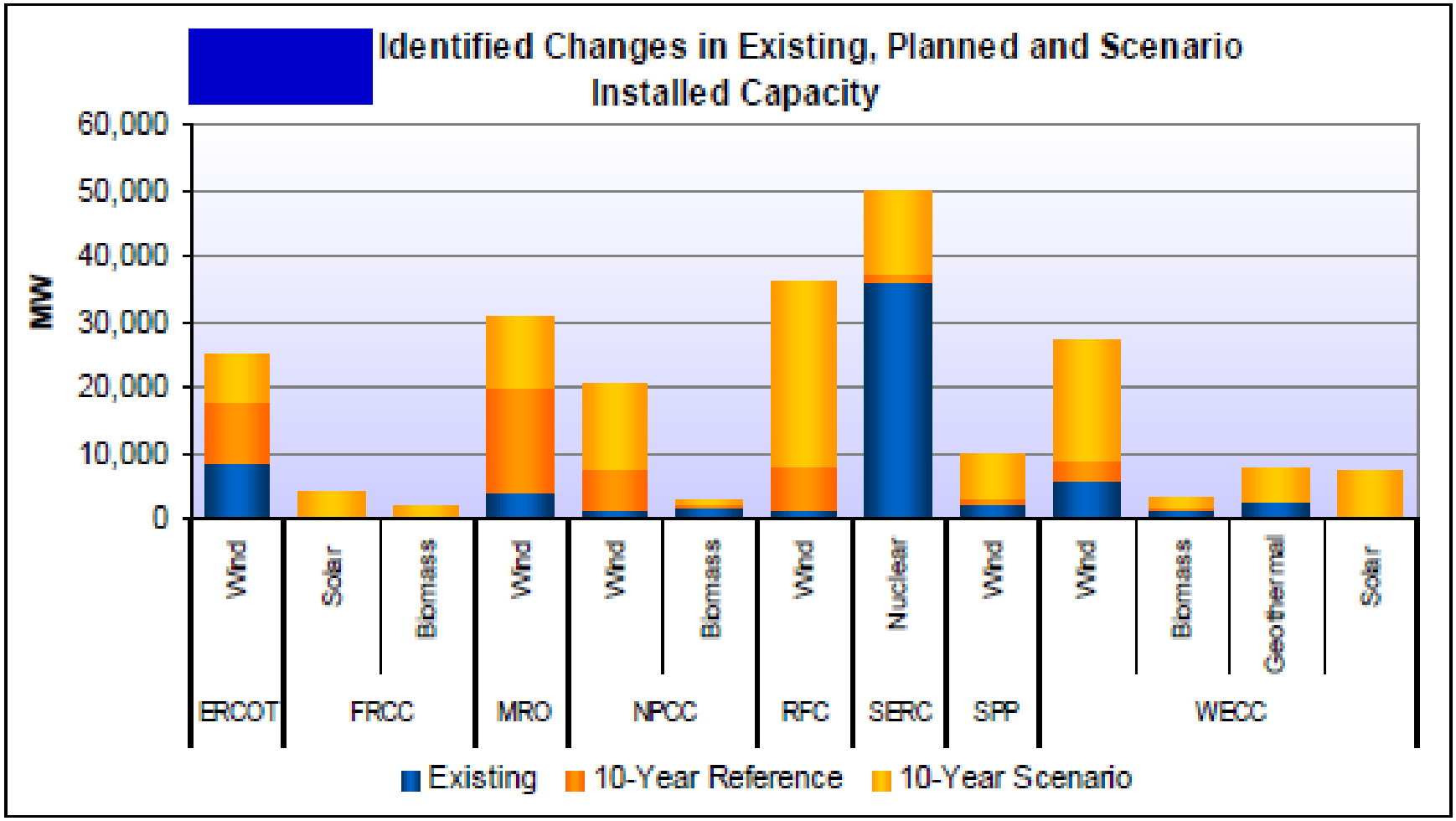


Renewable Power Generation

- Wind
- Solar
  - Photovoltaic (PV)
  - Thermal & hot water
- Hydro
  - Low head
- Waste capture
  - Heat
  - Mechanical
  - Chemical

Capacity Expansion

Scenario Reliability Assessment Summary

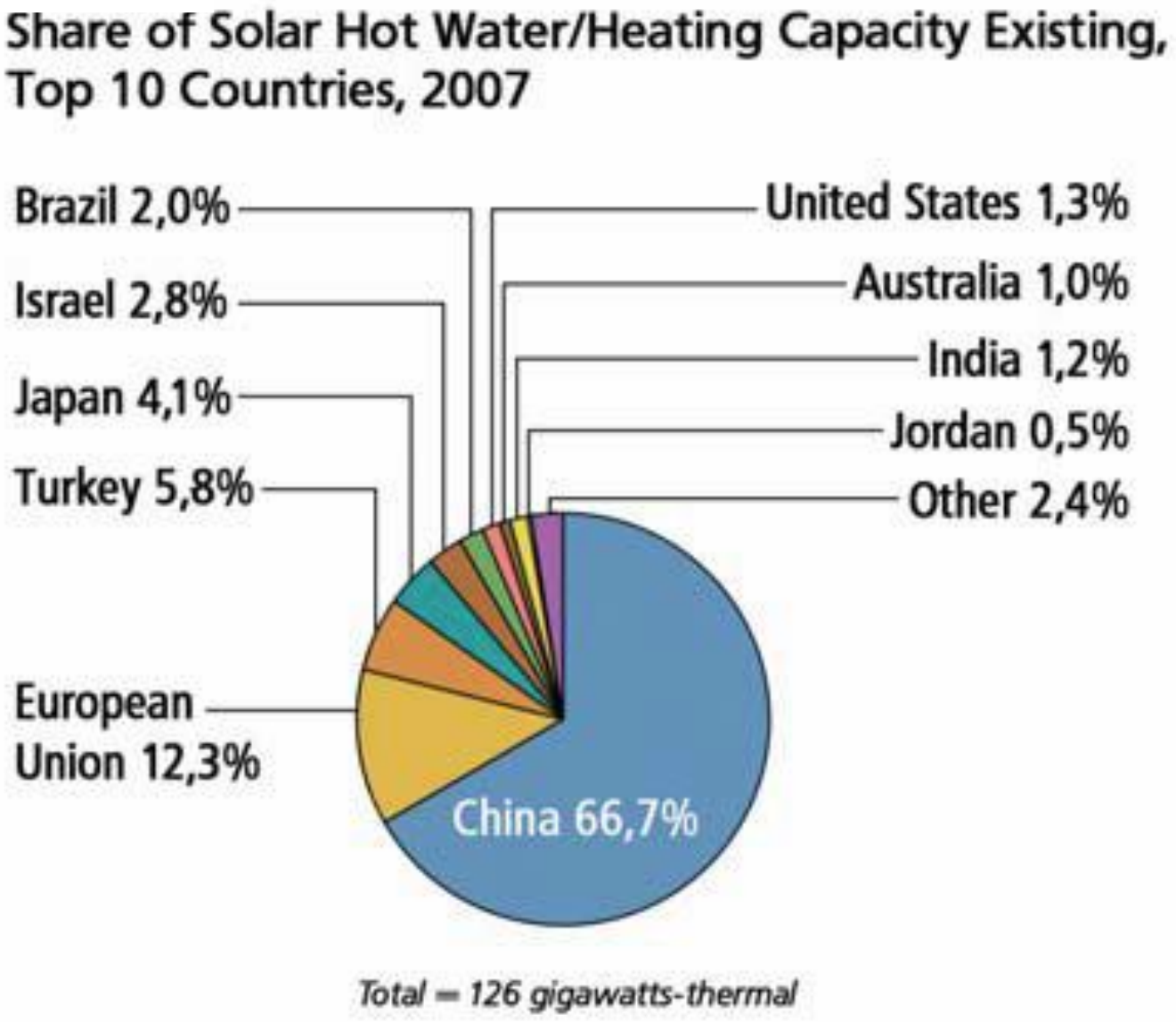


Source: 2009 NREL Scenario Reliability Assessment

Wind Power

Source: www.wwindea.org

Solar Hot Water



Storage

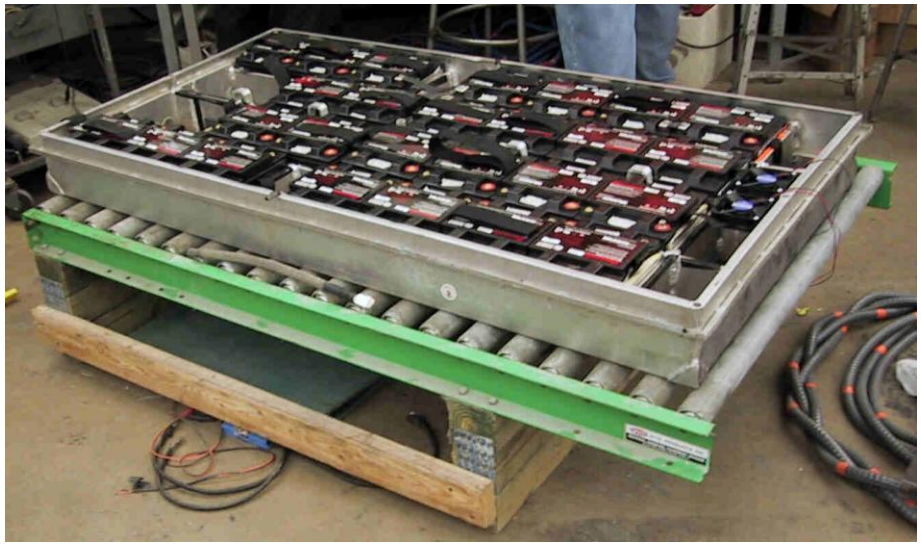
- Battery
  - Hybrids
  - Fuel Cell
- Super Capacitor
- Pumped Hydro
- Flywheel

Energy and Power

Storage technology	Energy density
Lead-acid batteries	100 kJ/kg (30 W-h/kg)
Lithium-ion batteries	600 kJ/kg
Compressed air, 10 MPa	80 kJ/kg (not including tank)
Conventional capacitors	0.2 kJ/kg
Ultracapacitors	20 kJ/kg
Flywheels	100 kJ/kg
Gasoline	43000 kJ/kg

Energy Density

- **Lead-acid battery energy density is only about 1% of the usable energy in gasoline.**
- **Sample test car: 275 kg battery pack → equivalent to 4 L of gas!**



Markets for Nano-enabled Batteries 2008-2013 ($ Millions)

Type	2008	2013	AAGR % 2009-2013
Large Format Modules	64	960	71.8
Customized Battery Packs for Cordless Tools	100	123	4.2
Fast Charging Customized Nano Safe Battery for Laptops	5	50	58.4
Total	160	1,133	46.3

Source: iRAP, Inc. Report En-102 Nano-enabled Batteries – A Global Industry and Market Analysis

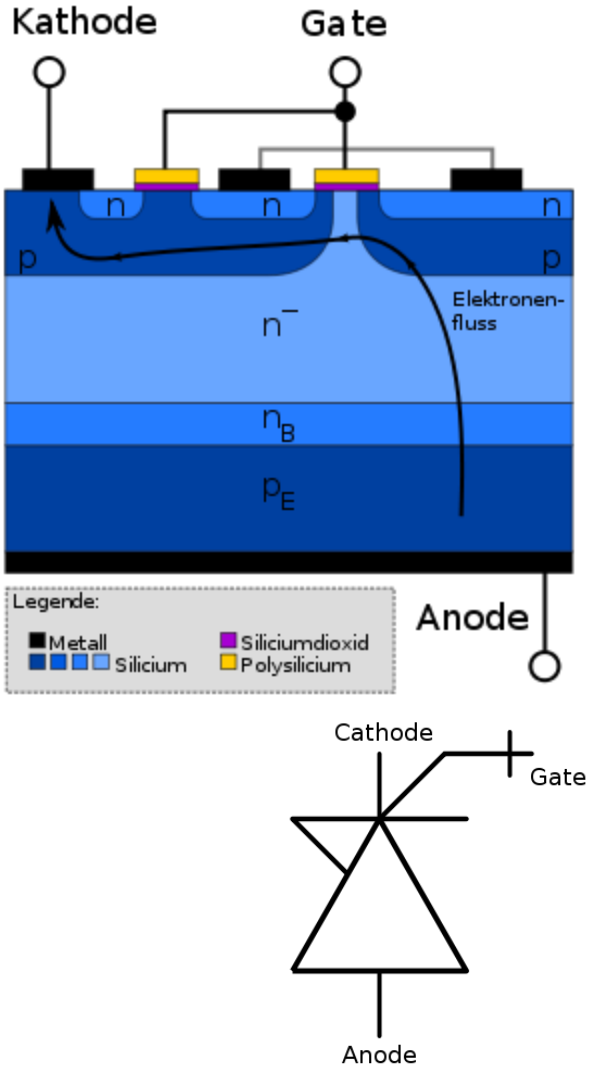
FUEL CELL TECHNOLOGIES

Fuel Cell Technology	Electrolyte	Operating Temperature	Efficiency (%)	
			Electrical	Overall
PEMFC	Ion exchange membrane	50 C	30-35	50-60
AFC	KOH	80 C	Low	Low
PAFC	Phosphoric Acid	200 C	36	80
MCFC	Alkali carbonates	650 C	45-55	75-80
SOFC - High Temp.	Solid metal oxide	980 C	45-47	75-80
SOFC - Reduced Temp.	Solid metal oxide	660 C	42-45	60-70

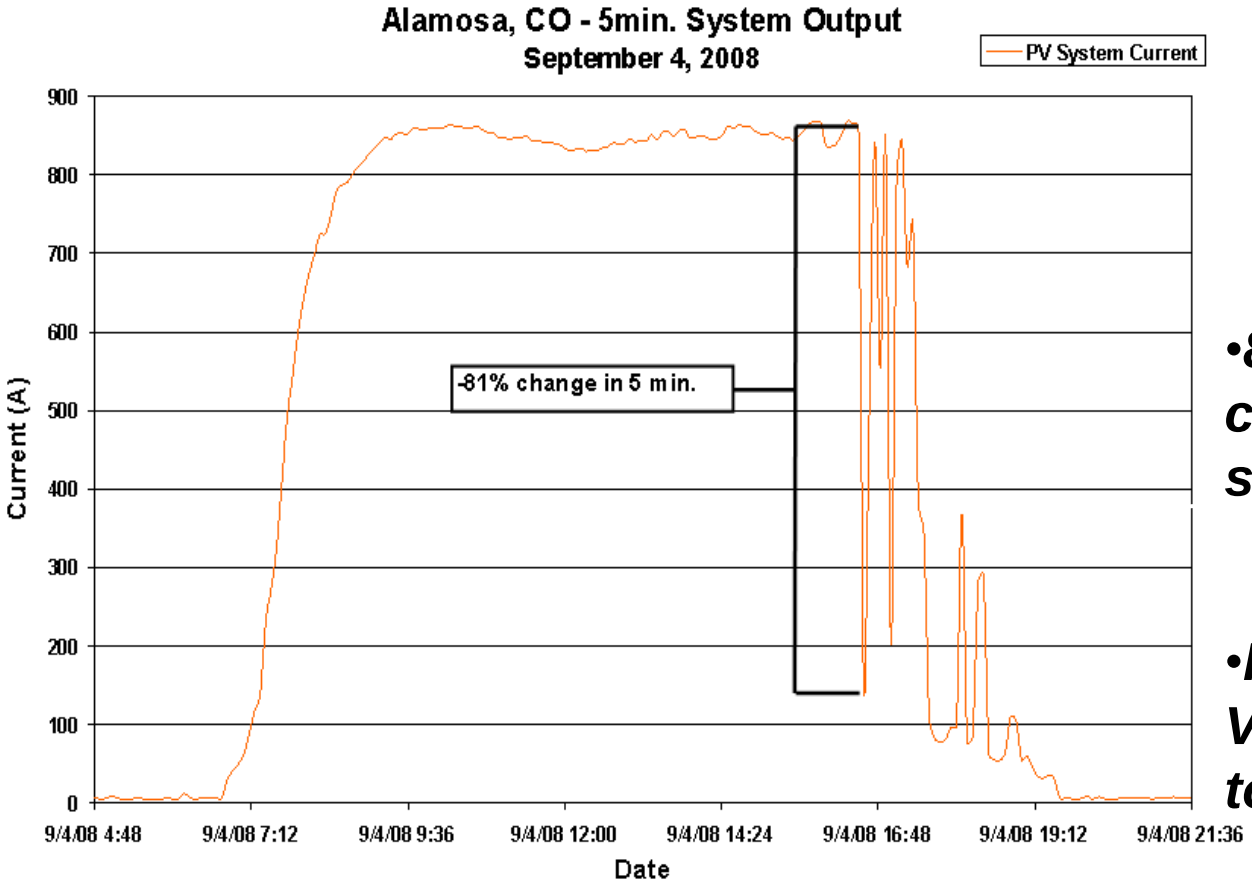
Grid

- Efficiency
- HV DC
- Smart Metering, Net Metering
- Reselling back to the utility
- Security
- Intermittent sources
  - Wind
  - Solar (clouds)

Integrated gated control thyristor (IGCT) - ABB



Accommodating Variability

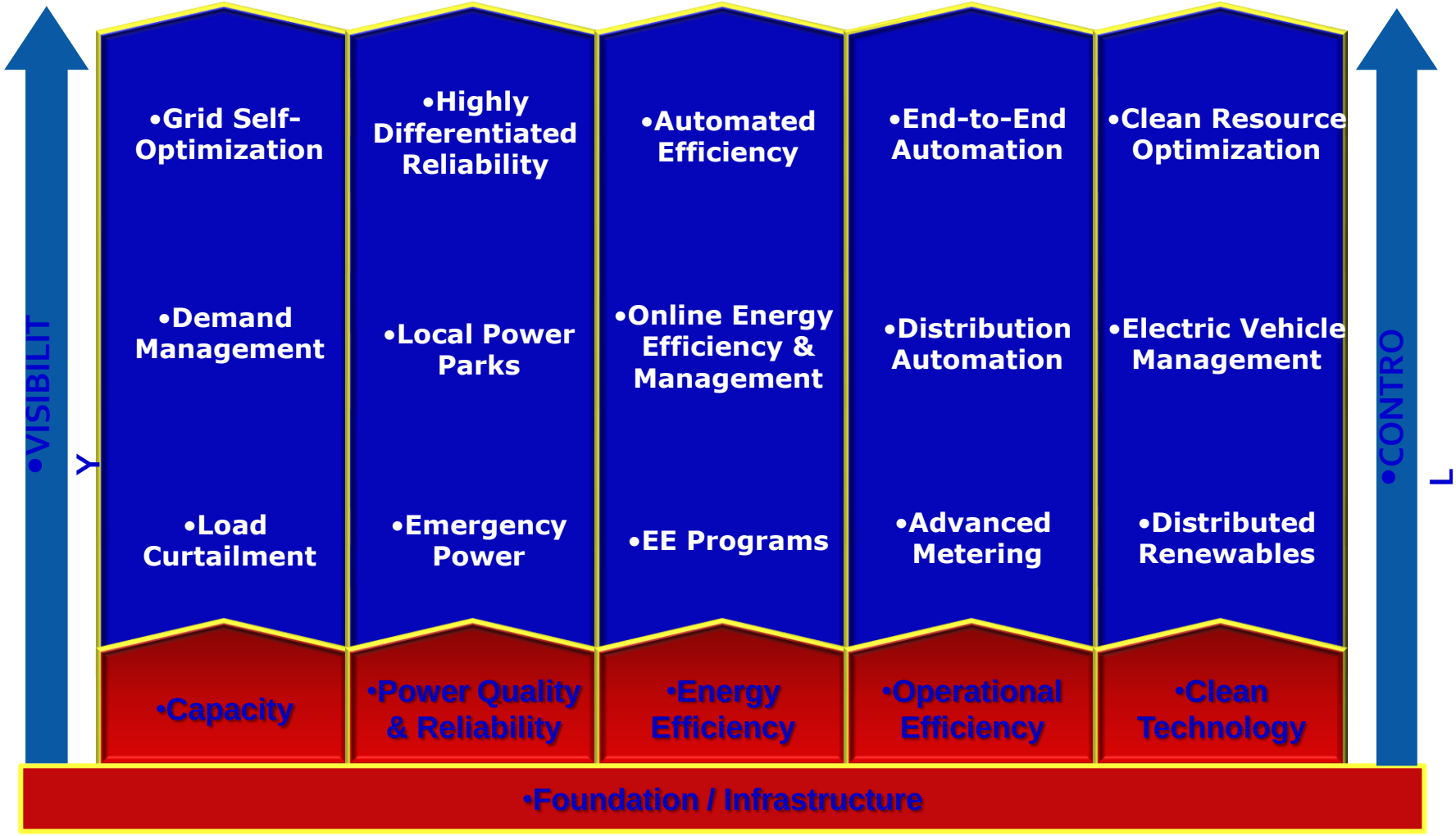


- ***8MW connected to substation***
- ***High Variability due to clouds***

Source: Xcel Energy – Alamosa System

Electricity System Framework

GRID 3.0

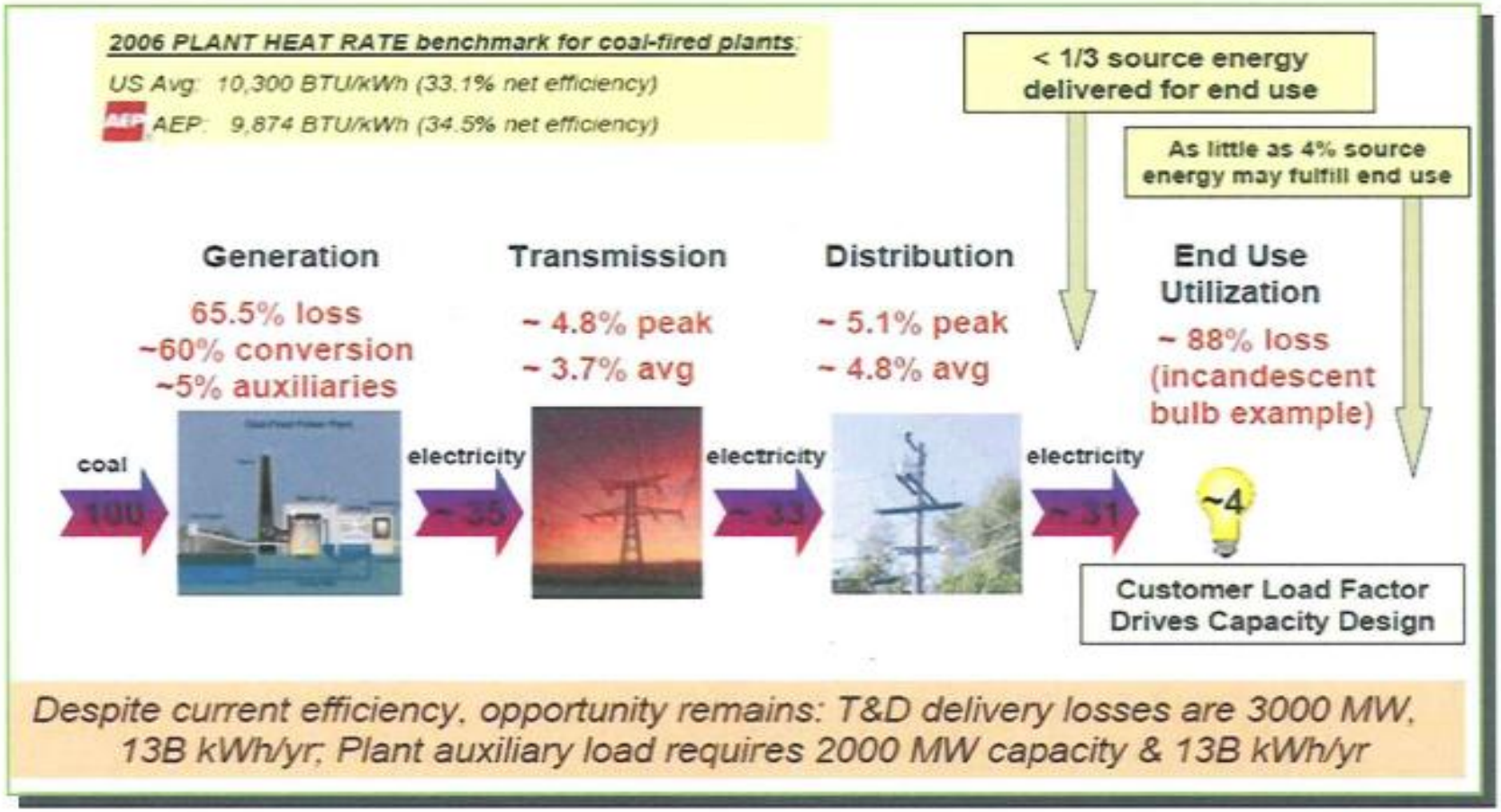


Source: NREL

Efficiency

- LED & solid state lighting
- Electric Motors
  - Rare earth magnets
- Materials
  - Insulation
  - Lightweight Materials
- Power management
- Sensors and control systems

Grid inefficiency



Source: AEP PUC Hearing

Pushing a Bright Idea

Wal-Mart is promoting consumer use of compact fluorescent light bulbs over incandescents. Here's how the bulbs compare.

	INCANDESCENT	FLUORESCENT
Energy used (watts)	60	13
Light output (lumens)	850	800
Average cost (dollars)	$0.25 to 0.60	$2 to 4
Annual savings (dollars)	$0	$8
Annual carbon savings (pounds)	0	roughly 100
Life (hours)	1,000	5,000 to 10,000
Mercury in the bulb (miligrams)	none	4
Mercury emissions (miligrams)	10	2.4
Number of bulbs sold annually*	1.5 to 2 billion	130 to 150 million

**Includes all wattages*

Sources: Environmental Protection Agency; Environmental Defense; Itron; Philips

The New York Times

LED Light Bulbs

- **Beautiful warm color, highly energy efficient, will last 35 years.**
- **Input: 4W (Output 40W)**
- **Original Price:$ 69.00**
- **Sale Price:$ 39.95**

Free Websites & Newsletters

Renewable Energy & Grid

- Greentech Media - www.greentechmedia.com
- Renewable Energy World - www.renewableenergyworld.com

PV

- Solar Industry - www.solarindustrymag.com
- PV Times - www.electroiq.com/index/photovoltaics

Wind

- World Wind Energy Association - www.wwindea.org
  - Online book at www.wwindea.org/technology/ch01/en/

LED

- LED Magazine - www.ledsmagazine.com

Finance

- Renewable Energy Stocks Directory - www.renewableenergystocks.com

Energy Organizations & Meetings

Local

- Cleantech Corridor– www.cleantechcorridor.org
- NJTC – www.njtc.org
- Farleigh Dickinson – http://JumpstartGreen.org
- NJ's Clean Energy Program - www.njcleanenergy.com

National

- IEEE PV Conference - www.ieee-pvsc.org
- CSTI - www.techconnectworld.com

Symposium on

Power Electronics and Machines in Wind Applications

PEMWA 2009

Topics of interest include, but are not limited to:

- Generator design
- Control of wind turbine induction & permanent magnet generators
- Power electronics converter topologies for wind turbine systems
- Modeling and simulation of wind power converters
- Residential applications and other small wind turbine systems
- Low wind-speed technologies
- Wind forecasting for siting & dispatching of distributed generation sources
- Islanding and protection capabilities
- Grid connection issues
- Energy storage technologies for use with wind generating sources
- Rural development associated with wind applications

Dates for Symposium:

June 24-26, 2009

5-page digest submission deadline is February 15, 2009

Location:

University of Nebraska-Lincoln
Lincoln, Nebraska USA

Sponsors:

- **IEEE Power Electronics Society, Distributed Generation and Renewable Energy Technical Committee**
- **Nebraska Center for Energy Sciences Research**
- **Nebraska Wind Applications Center**
- **IEEE Power and Energy Society, Technical Co-Sponsor**

For Further Information, Please Contact:

Symposium Co-Chairs: Jerry L. Hudgins, University of Nebraska
j.hudgins@ieee.org
Dean J. Patterson, University of Nebraska
patterson@ieee.org

Technical Program Co-Chairs: Dionysios Aliprantis, Iowa State University
dali@iastate.edu
Wei Qiao, University of Nebraska
w.qiao@ieee.org

Clean vs. Renewable Energy

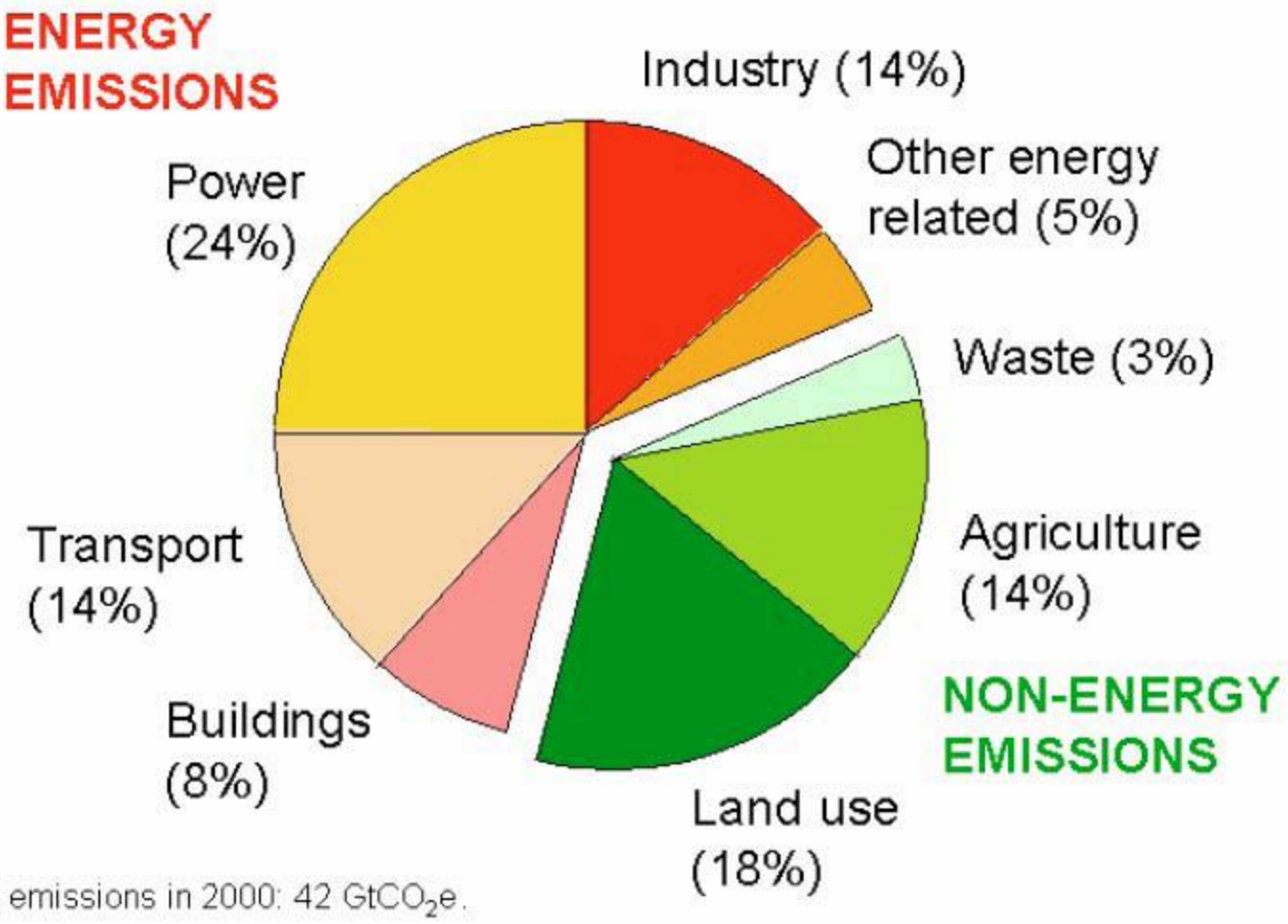
Clean

- Emissions
  - Gas (air)
    - Carbon Dioxide
    - Particulate
    - Sox
  - Liquid (water, groundwater)
  - Solid (landfill)

Renewable

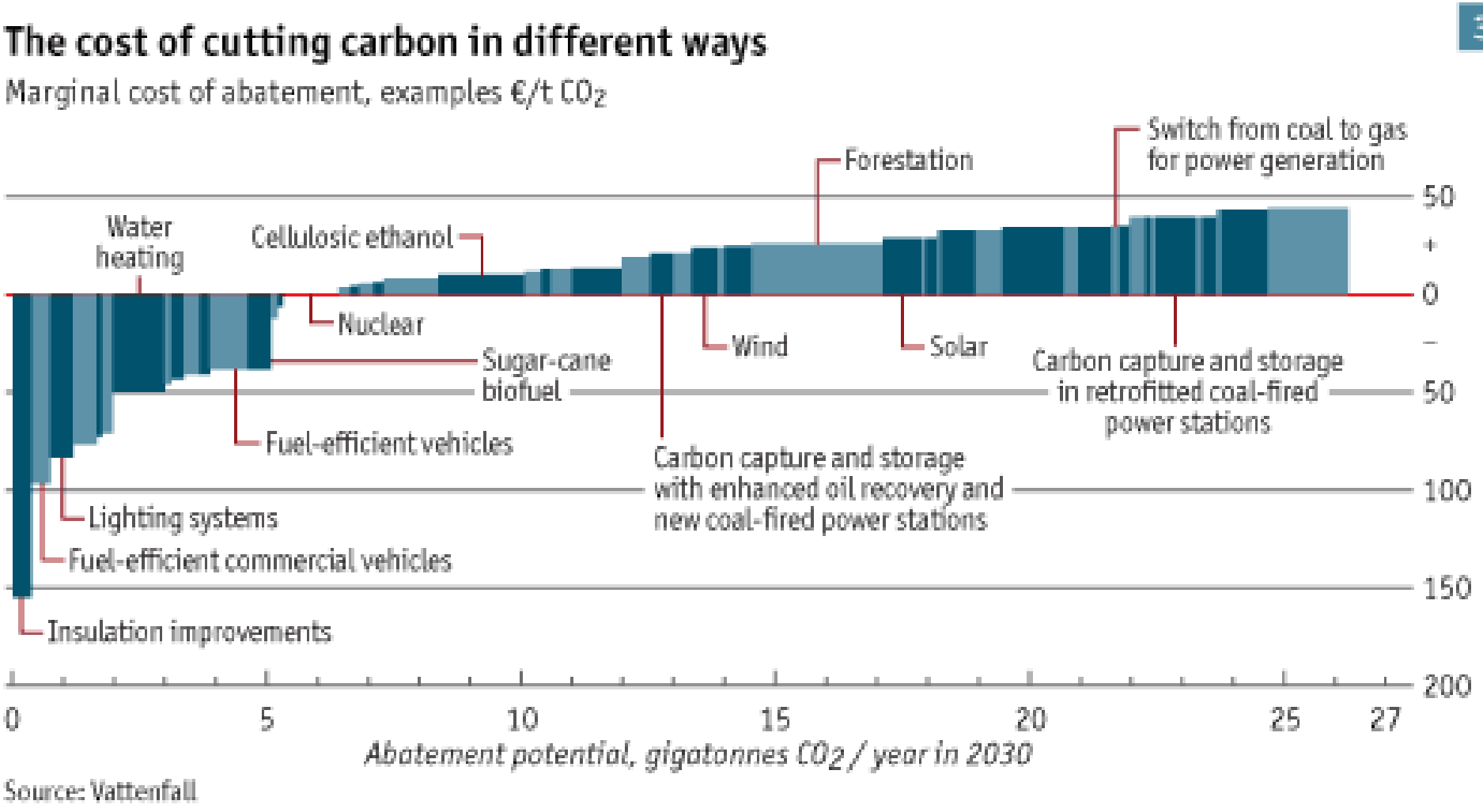
- Uses less material
  - Unused energy
    - Sun
  - Efficiency
  - Recycle & reuse

Global Emissions by Sector



Source: Cleantech Group, 2007

Emission Reductions - Cost or Savings?



Opportunities & Funding

- Government
- Venture Capital

- Sales
- Licensing
- Joint Development

Raising Money: the beginning

Most Early Stage Investments (<$1 to 2M for pre-commercialization) come from founders, friends & family, angels, and regional governments

Stage	Pre-Seed	Seed/Start-Up		Early	Later
Source	Founders, Friends and Family	Individual Angels	**Funding Gap between $500,000 and $2,000,000/$5,000,000** (depending on region)	Venture Funds	
Investment	$25,000 to $100,000	$100,000 to $500,000		$2,000,000/$5,000,000 and up	

Grants & Bootstrapping

- Federal & State grants, loans, & incentives
- University collaboration
- Incubators
- Stock for $ and work
- Consult for cash flow if necessary
- Contract manufacture for cash flow
- Keeping very low overhead
- Used equipment

Government Funding & Resources

DOE - www.doe.gov

NREL - www.nrel.gov

ARPA-E - http://arpa-e.energy.gov/

DoD Energy Security Task Force - www.dod.gov/ddre/doc/DoD_Energy_Security_Task_Force.pdf

EPA - www.epa.gov/cleanenergy/

Ben Franklin Energy Commercialization Institute - www.sep-energy.org/eci.html

National Renewable Energy Laboratory
Innovation for Our Energy Future

NREL is a national laboratory of the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy in Golden, Colorado

Energy Data Sources

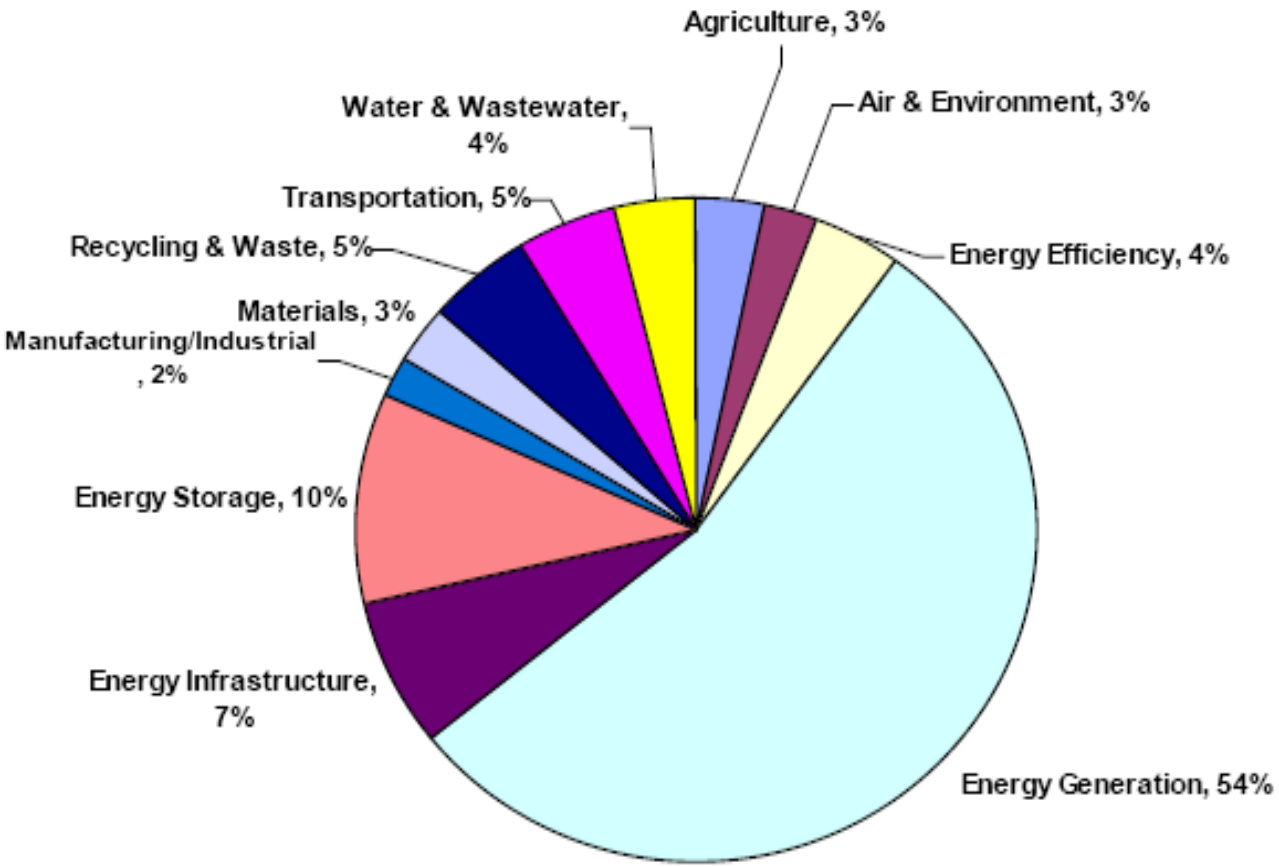
- Department of Energy Data Explorer
  - http://www.osti.gov/dataexplorer/
- National Renewable Energy Laboratory
  - http://www.nrel.gov/gis/data_analysis.html
- USGS Energy Program Publications and Data
  - http://energy.usgs.gov/search.html
- UNEP World Solar and Wind Energy Assessment
  - http://na.unep.net/swera_ims/map/
- MIT Geoweb and the Geodata Repository
  - http://web.mit.edu/geoweb/
- MassGIS Transmission Lines
  - http://www.mass.gov/mgis/trnslns.htm

Venture Capital 2009-2010

- Global investment fell 36% to $29.4 billion in 2009
- Cleantech – Shift to energy efficiency deals with lower capital requirements
- Since 2000, actively investing firms fell 32% in the U.S., but grew in China
- Global M&A activity is growing again
- Median time to exit in the U.S.
  - M&A = 5 years
  - IPO = 8 years (few IPOs but restarting now, e.g., A123)
- There are now 880 venture backed cleantech companies

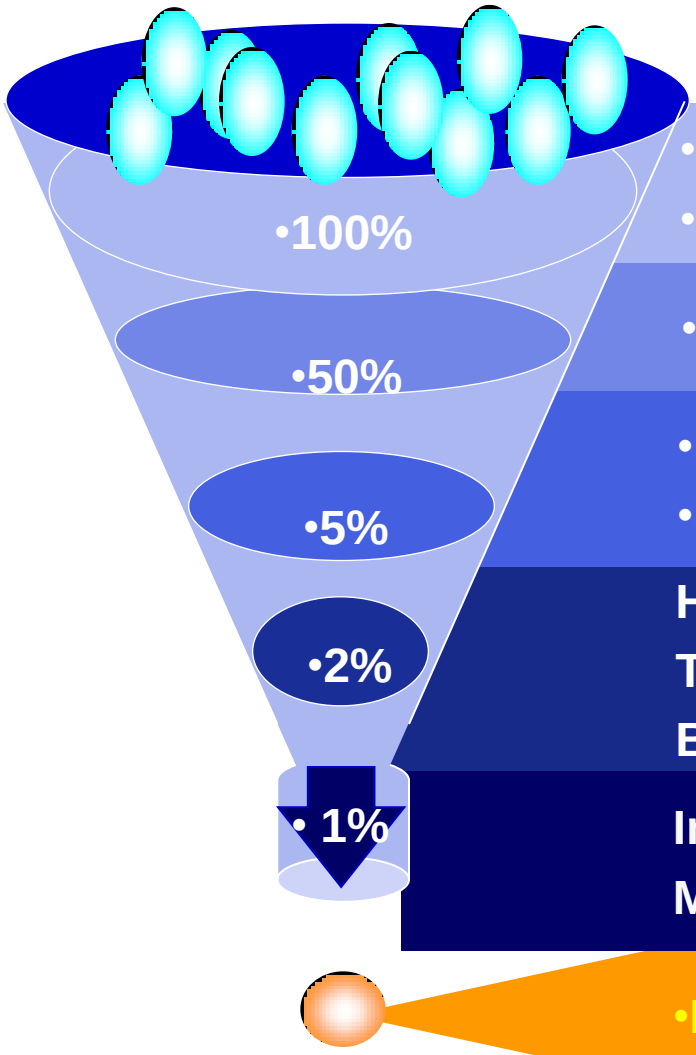
Source: Ernst & Young

Cleantech VC by Segment: 2006 & Q1 2007 Worldwide (China, North America & Europe/Israel)



Totaling $5.729 billion

Investment Process



•First Contact
•Majority of deals rejected as inappropriate

•Screening

•Early Due Diligence
•NDA, meetings, evaluation

Hot Deal
Term sheet, in-depth due diligence
Business development begins

Investment
Managing and controlling the investment

•Exit

A123 SYSTEMS

Raised $378 million in 2010 IPO

- Manufactures batteries for DeWalt, Chrysler, Navistar and Fisker (in return for $23M)
- Asian competition
- US and state funding, yet moved manufacturing to China
- Promises $6,500/car ($350/kWh) by 2016

Competitors:

- SK (Korea)
- LG Chem (Korea) for Chevy Volt
- Bosch (Germany) / Samsung (Korea)

New Enterprise Associates – Energy VC

Scale and Capital Commitment

One of the largest VC portfolios in energy technology

$1 Billion committed; already helped 21 portfolio companies raise $1.5Bn

Energy Technology Relationships

Government & Research

Utilities

Key Industry Partners

Domain Expertise

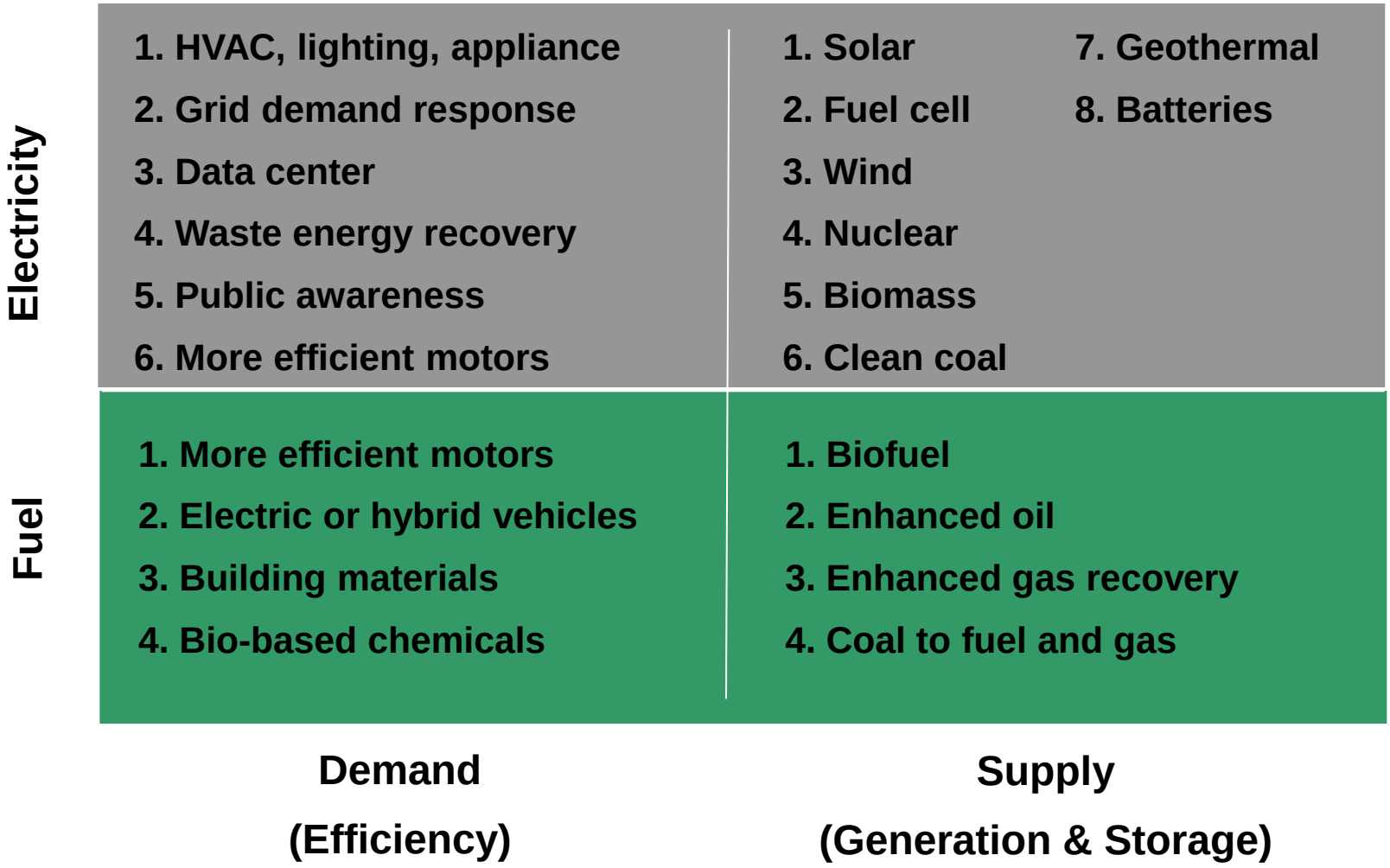
Core team of 10 investment professionals with deep technology expertise across the US and abroad (China, India)

Diversified Strategy

Portfolio spans both the supply side (generation, storage) and the demand side (efficiency, conservation) of the energy equation, across electricity and clean fuels

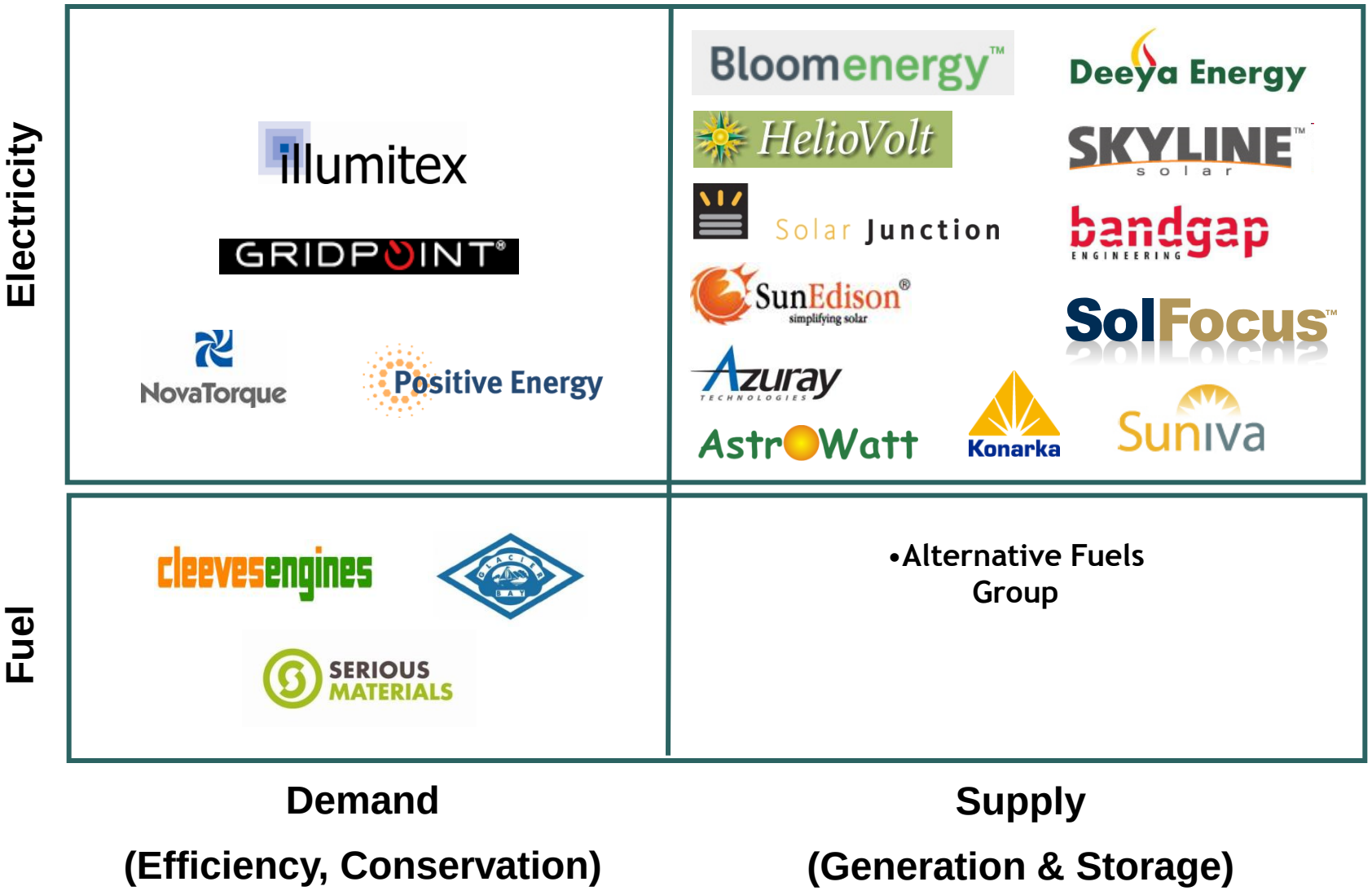
- New Enterprise Associates (NEA) closed its thirteenth fund in Q1 2010, with nearly $2.5 billion.
- The new fund represents about 17% of all US VC funds raised in 2009 and is the largest single fund raised since 2007.

Many Areas to Innovate and Invest



Source: New Enterprise Associates

NEA Energy Technology Portfolio



Renewable Energy Applications

HelioVolt
Azuray
Suniva
SKYLINE solar
Konarka
SolFocus

Solar PV

Deeya Energy

Grid Storage

Bloomenergy™

Fuel Cells

SERIOUS MATERIALS

Dry Wall
Efficient Windows

illumitex

High-Efficiency LEDs

GRIDPOINT®

Smart-Grid Platform

Positive Energy

Behavioral Modification

Source: New Enterprise Associates

Local VC Organizations & Meetings

- NJEF - www.njef.org
- NJEN – www.njen.com
- VANJ – www.vanj.com
- Ben Franklin - www.sep.benfranklin.org
  - Renewable Energy Group - www.sep-energy.org
- SFJ Ventures - www.cleantechinvesting.com
- Young Startup - www.youngstartup.com
- Meeting Notices
  - NJ Entrepreneur newsletter - www.njentrepreneur.com
  - NJBIZ – www.njbiz.com
  - US-1 - www.princetoninfo.com

Intellectual Property License Agreements
9/15/2009 – 1/1/2010

- Princeton-based Universal Display licensed solution processed white OLED technology to Showa Denko (Japan)
- Unidym licensed fullerene derivatives for solar cells to Nano-C
- Harvard University licensed STORM super resolution microscopy to Nikon (Japan)

Partnership and Supply Agreements
9/15/2009 – 1/1/2010

- Joint Development between Unidym and a major LCD manufacturer (Asia) for CNTs for use in glass based LCD displays

- Joint Development between Unidym and Samsung Electronics (Korea) for CNTs for flexible displays

Partnership Types

- International finance
  - M&A
  - Investor
  - Joint Venture
- Customer
- Joint Development
- Vendor
- Outsourcing
- Branch Office
- License

Resources

- Trade Councils, Embassies & Consulates
  - U.S. - helping you locally in each country
  - Foreign - helping you benefit their country (JETRO, KOTRA)
- U.S. Government
  - Department of Commerce
  - Export Assistance Office - www.export.gov
- States
  - SBA U.S. Export Assistance Center
- Professional Organizations (ACS, IEEE)
- International Firms
  - Law
  - Accounting
  - Consulting

Accounting & Valuations

Find the right people

- If you are in transition
  - how do you balance between your job search and building a business or buying a business?
- If you are considering starting a business
  - what structural pieces do you need to put into place?
- If you are creating, acquiring, or selling Intellectual Property
  - how would you value it?

Resources:

Lloyd F. George, CPA/ABV/CFF, CVA, CLU, ChFC
Valuation and Forensic Accounting Services
Business and Career Consulting
Lloyd.George@LFGCPA.com
Ph. (609) 799-5863

Opportunities (EE)

- Efficiency
- Grid
  - but who pays
- Inverters & chargers
  - plug in hybrids, solid state lighting, PV
- Batteries
  - but not made in US
- Printed PV
  - faster cost, emissions and energy payback
- Building integrated PV (BIPV) – solar roof tiles
- PV without storage or grid connection
  - for shaving peak demand loads

Risks

Global

- Oil/gas price
- Warming/cooling & ability to affect
- War/unrest
- Govt. regulation & uncertainty (e.g., incandescent in EU/US, Cadmium)
- Commodity price (e.g., Indium)

Business

- Is there a market?
- Time to market
- Competitors – PV glut
- Funding, Cost of capital

Technology

- Complexity
- Legal, regulatory, IP, environmental (CdTe)
- Costs (development, manufaturing)

Conclusions

- You have to guess the future
- You can help influence the future IF there is an eventual need
  - Can you show a return on investment (ROI)?
  - Will people pay for it?
  - Is there a real advantage over the competition?
  - Is it sustainable?
- Do not rely on government subsidies for more than a few years
- Know your entire chain
  - What is your optimal part (value chain, development stage)
  - Payback time (financial, energy, environmental)
- Partner!