

IBM Innovations for Energy and the Environment

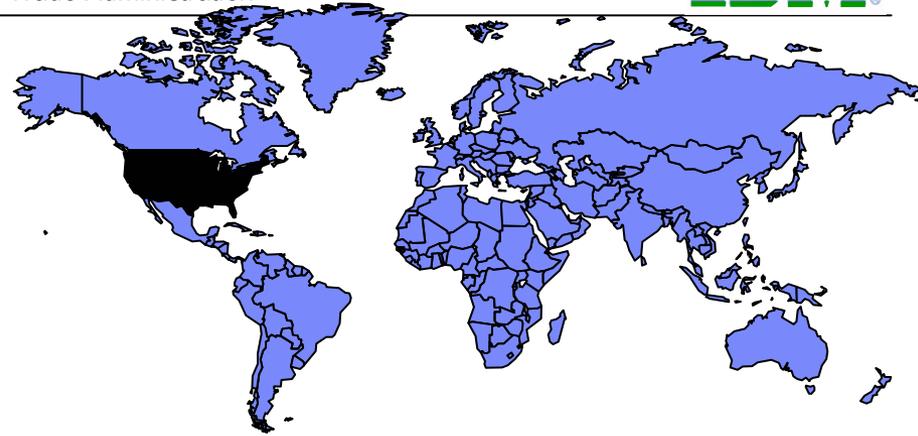
“The New Environmental Industry” Forum

U.S. Commerce Department, International Trade Administration

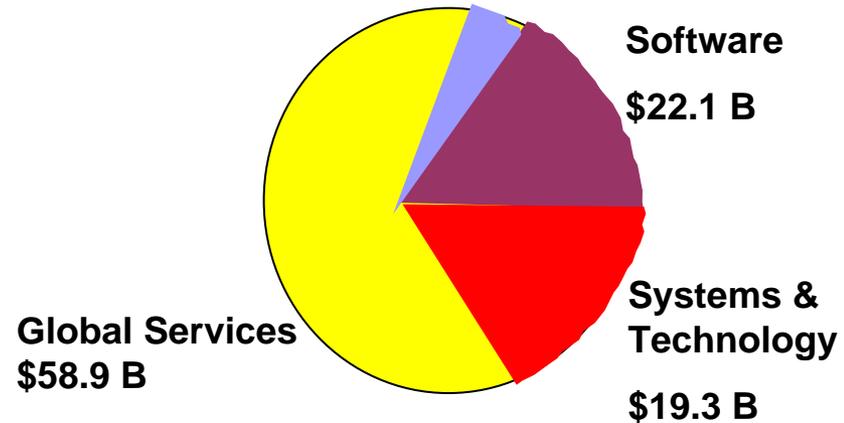


Who Are We?

- A global company
 - Corporate headquarters: Armonk, NY
 - Serving customers in over 165 countries worldwide
 - Nearly 60% of revenue generated outside the United States
- Year end 2008, IBM reported:
 - \$103.6 billion in revenue – up 5%
 - \$16.7 billion in net income
 - \$8.89 Earnings per share – up 24%
 - More than 390,000 employees worldwide
 - 4,186 patents awarded (#1 in US, 16 consecutive years, 1st time ever greater than 4,000)



Other - \$3.3 B



Client & Shareholder Value through Innovation
Globally Integrated, High-Performance Enterprise.
Values Driven Company



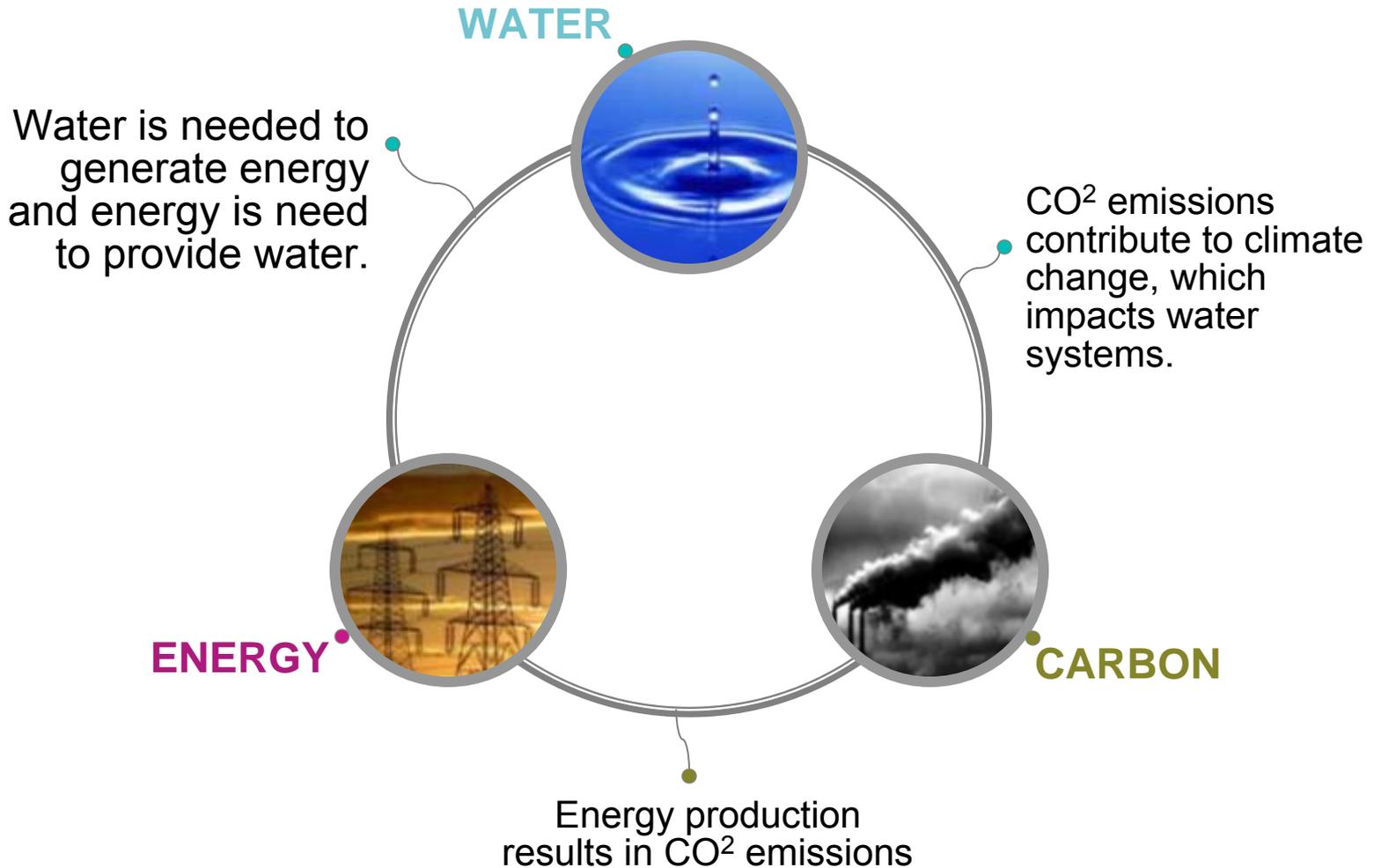
Dedication to every client's success.
Innovation that matters—for our company and for the world.
Trust and personal responsibility in all relationships.

The ecological reality of living in a globally integrated world is upon us.

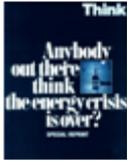
- Economic downturn requires doing more with the same.
- The effects of climate change are both a societal and business concern.
- Empowered consumers demand more responsible business practices.
- Managing water supplies and sources is a growing challenge.
- Energy use is rising at an unprecedented rate.

Organizations play a major role in shaping this reality, and therefore have a responsibility to manage its impact.

Organizations need to approach environmental impact by first understanding their impact to:



IBM has a long history of environmental tradition and leadership.



1976: Think!, the company magazine, devoted an entire issue to IBM's energy conservation and environmental programs

1990: Think! Devoted an entire issue to IBM's environmental programs – beginning IBM's annual Corporate Environmental Reporting

1991: Established IBM's Product Stewardship Program



1997: IBM becomes the first major multi-national to earn a single global registration to the ISO 14001 environmental management system standard

96% **2006:** Amount of IT product and product waste processed by IBM's product End-of-Life Management operations that was **reused or recycled**

2006: IBMers * "Jam" on innovation for a better planet, and IBM invests in Big Green Innovations

44% **1990 - 2006:** Between 1990 and 2006, IBM's global energy conservation actions reduced or avoided CO₂ emissions equal to 44% of its 1990 emissions



95% **1987 - 2006:** Reduction in hazardous waste generation since the 1987 base year of this pollution prevention metric

2007: Invested in Intelligent Utility Networks, Intelligent Transportation Systems, Project Big Green

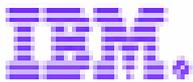
1971: T. J. Watson Jr. issued IBM's first corporate policy on environmental protection

1989: IBM offers its first product take-back program

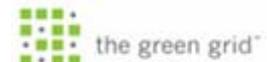
1992: IBM becomes charter member of Energy Star Program



1994: Established Global Materials Recovery Center Network for product re-use and recycling



Collaborating to develop solutions ...





The Bad News: IT accounts for 2% of global CO₂ emissions



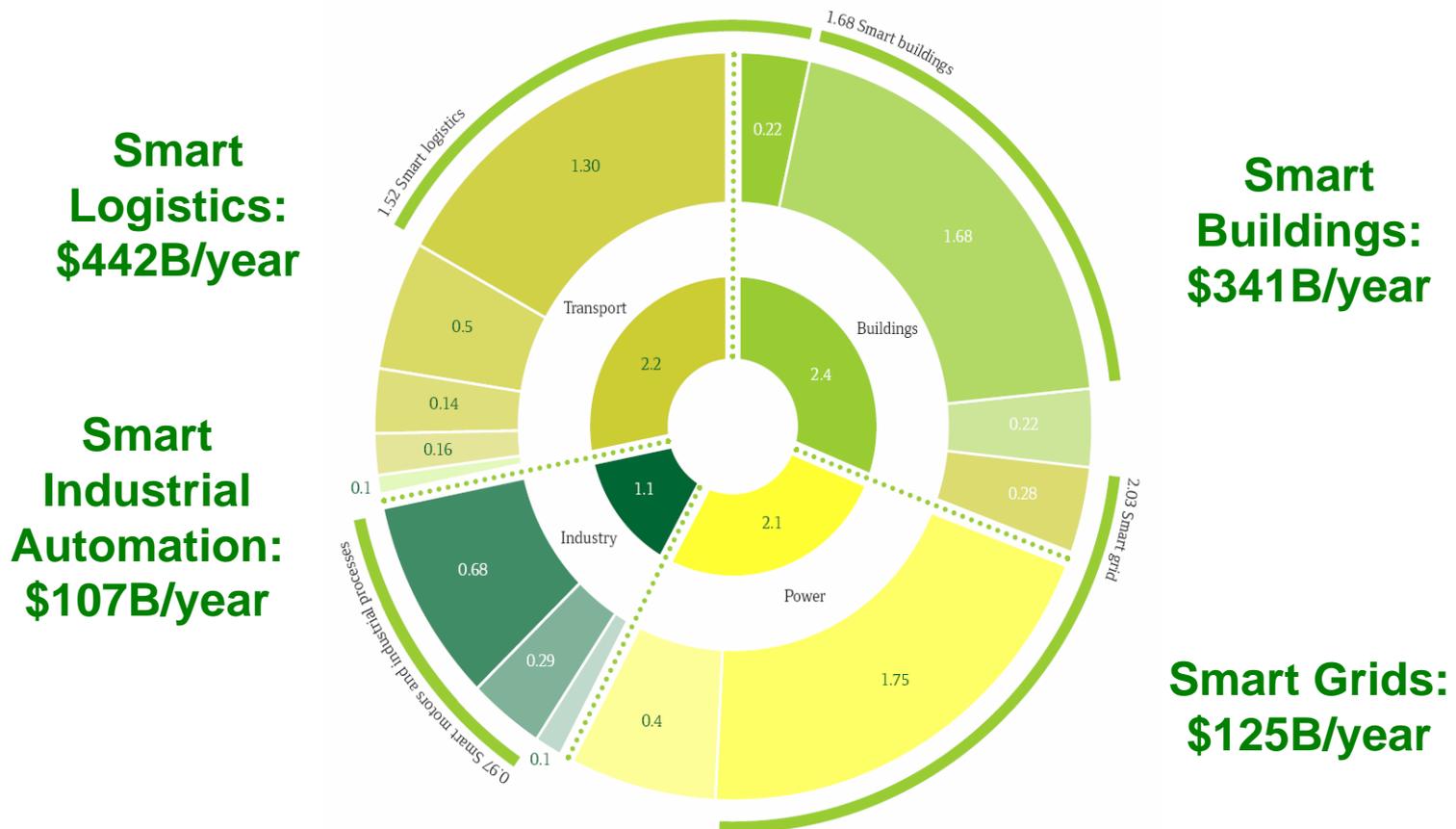
The Good News: IT can significantly contribute to control and reduce the 98% of CO₂ emissions caused by other activities and industries

"... you can't make a product greener, whether it's a car, a refrigerator or a traffic system, without making it smarter — smarter materials, smarter software or smarter design." - Thomas L. Friedman

Sources: Gartner, Green IT, October 12, 2007; "The Green Road Less Traveled" by Thomas L. Friedman, The New York Times, July 15, 2007, <http://select.nytimes.com/2007/07/15/opinion/15friedman.html?scp=2&sq=thomas%20friedman%20july%202007%20greener%20smarter&st=cse>

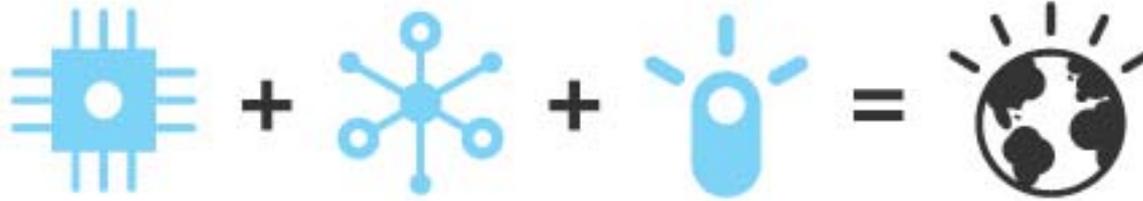
Tackling climate change is good for the climate and economy

Information and Communications Technology (ICT) can significantly improve energy efficiency and reduce GHG emissions, driving potentially \$1 Trillion in energy savings per year by 2020 and 7.8 Gigatons CO₂ equivalent abatement

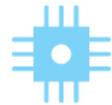


Building A Smarter Planet

Interconnected Technologies Are Changing The Way The World Literally Works



An opportunity to **think and act in new ways** — economically, socially and technically.



Our world is becoming

INSTRUMENTED



Our world is becoming

INTERCONNECTED



Virtually all things, processes and ways of working are becoming

INTELLIGENT

To realize the benefits of 'green' or sustainability, an organization must take a systemic view of its **value chain....**

Environmental sustainability is an imperative for 21st century business —one that not only encompasses conservation, pollution prevention, and more, but also enables the creation of entirely new value and benefits.

Lower costs while overcoming operational barriers.

Strengthen reputations while meeting regulations.

Create products and services that give rise to new markets.

MANUFACTURING

IT

CUSTOMERS

WORKFORCE

SUPPLY CHAIN

TRANSPORTATION

FACILITIES



IBM's Sustainable solutions span this value chain.

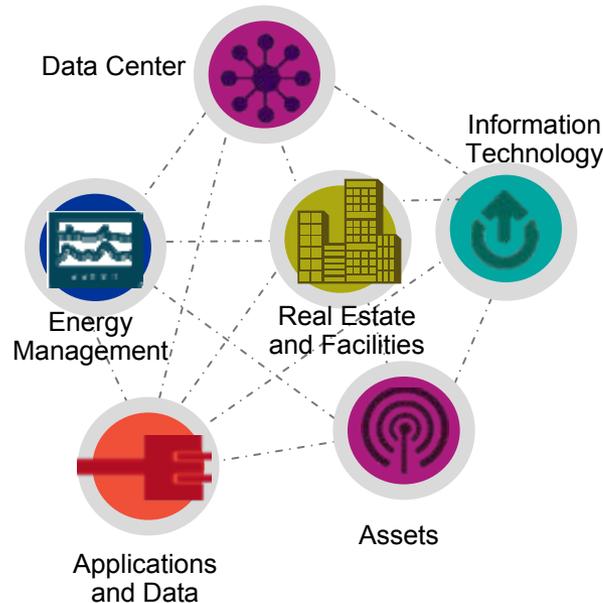
Sustainable solutions

- ⇒ Increase organizational efficiency, abating impact of processes, products and people.
- ⇒ Create ability to measure, monitor, improve and report on processes.
- ⇒ Decrease employee environmental impact with remote work and collaboration strategies.



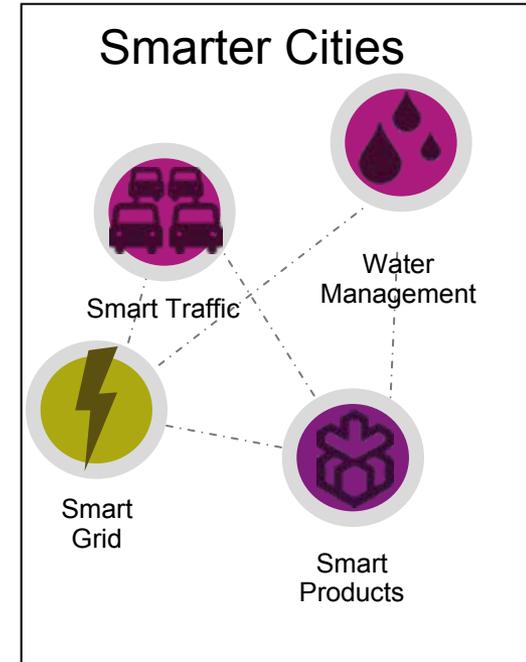
Green infrastructures

- ⇒ Take out cost and improve the efficiency of IT and other built infrastructure.
- ⇒ Manage environmental impact of assets.
- ⇒ Enable readiness with regulatory compliance.



Intelligent systems

- ⇒ Use predictive analytics for water management.
- ⇒ Optimize power grid performance; automate, monitor and control two-way flow of energy from power plant to plug.
- ⇒ Optimized transportation systems.



IBM innovations address energy & environment challenges

Energy Efficient Technologies and Services Green IT and Data Centers



- IT and data center facilities energy efficiency
- Monitoring & verification of efficiency goals
- Energy Efficient, Virtualized, Dynamic IT/DC
- IBM and client case studies: 40% to 80% energy use reduction, up to 85% less floor space

Mobility Services



- Reduce traffic and pollution
- Retain and attract talent
- Cut facility costs/impact

Intelligent Transportation Systems



- Reduce traffic congestion
- Reduce CO₂ emissions
- Increase mass transit usage
- Improve environment
- Stockholm case study: Reduced traffic congestion 25%, Carbon emissions 15%

Intelligent Utility Networks – ‘Smart Grids’



- Reduce energy usage
- Improve grid management, reduce outages
- U.S. case study: 10% energy use reduction, up to 50% reduced load on electric grid

Sustainable Business Solutions & Services

- Strategy
- Corporate Social Responsibility
- Green Sigma TM
- Business Operations/Supply Chain - SNOW
- Smarter Cities
- Smarter Buildings
- Cap and Trade Systems



Advanced Water Management

- Flood avoidance
- Reduce water usage
- IBM case study: 27% reduced water usage, with 30% increase in manufacturing output, saving \$M in energy and water cost



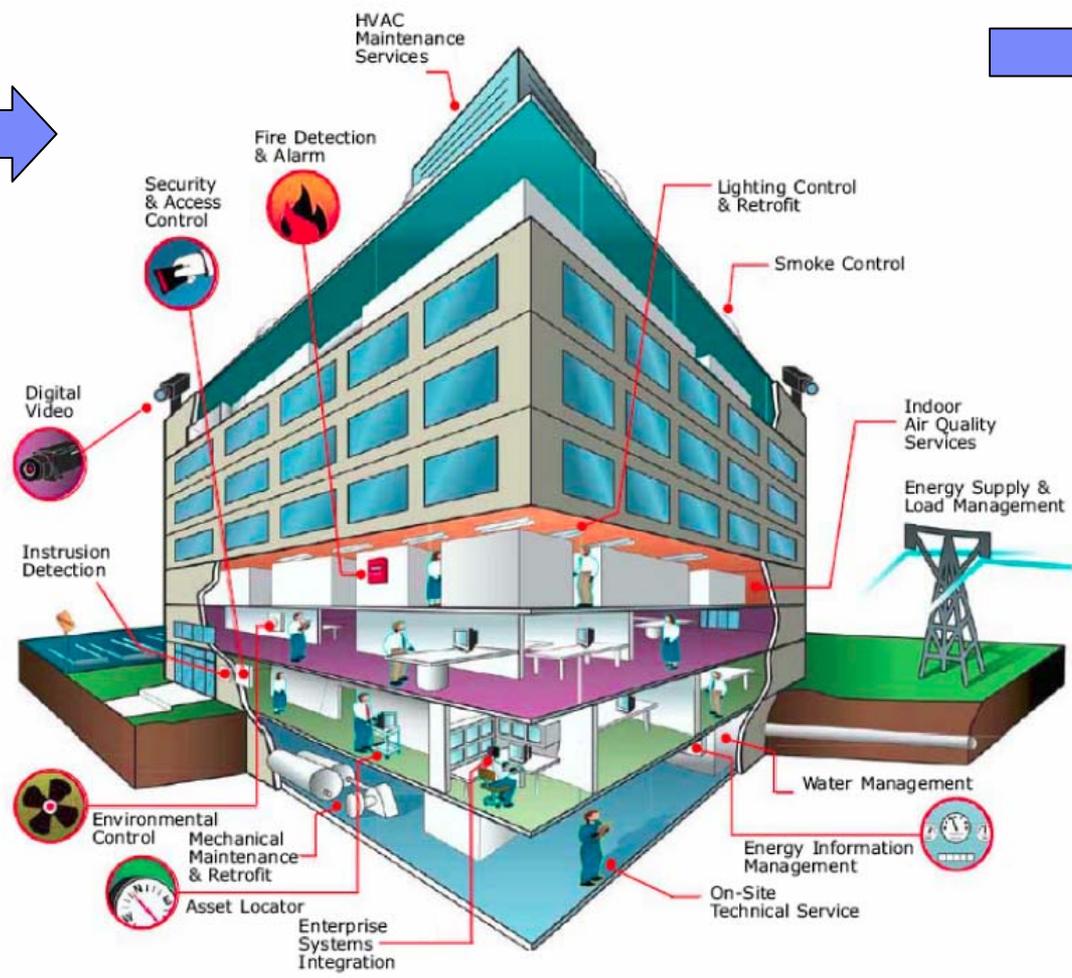
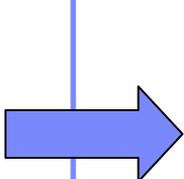
Alternative Energy Research

- IBM know-how in thin films, semiconductors, advanced photovoltaic materials, applying IT cooling technologies to concentrator photovoltaics, IT to ET, nanomembranes for desalination, energy storage; etc.

Smart Buildings enable measurement, monitoring and management of building systems and real-time external events with implementation of control mechanisms to better optimize energy consumption.

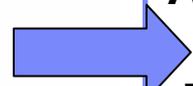
Real-time external events

- Weather forecast
- Energy prices
- Human location information, - e.g., People leaving or coming to work & home
- Utility



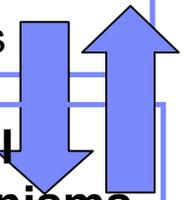
Analytics

- Demand Management System
- Are any building systems out of spec?
- Gas
- Water
- HVAC
- Pumps
- Chillers

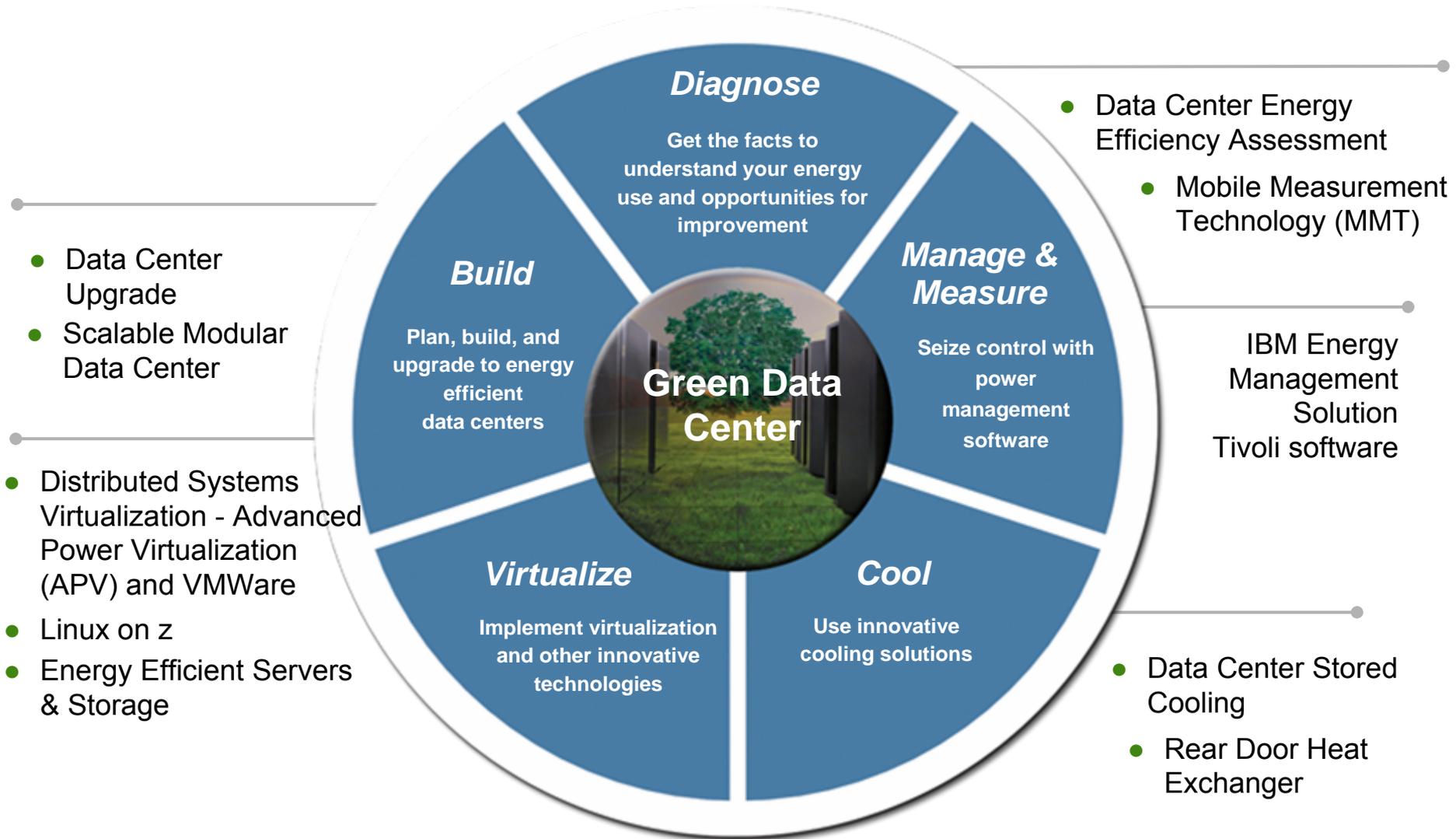


Control Mechanisms

- Automatically control the equipment



Five Areas for Energy Efficiency in Data Centers



IBM Case Studies – Intelligent Buildings and Data Centers

SMART IS

Holistic energy mgmt that enhances the efficiency of buildings and other assets.



Mabuchi-motors: Designed and built an intelligent HQ building in Japan that delivered 22% reduction of CO₂, 13% reduction of life cycle cost.

SMART IS

Building green data centers to support corporate brand objectives



Fullerton Hotel: Singapore's luxury hotel improved operational efficiency and lowered power and cooling costs by 30%. New infrastructure has reduced the data center server footprint by 75%.

SMART IS

Proactively monitoring and managing information for improved performance.



Shanghai St Regis Hotel: Implemented an Intelligent Building Management System making it the only smart five star hotel among 33 in the region. Designed at 5.1% energy cost to revenue, now at 4.9% ... all others average 8%. Results are 40% reduced energy cost / revenue vs. others.

Smarter Traffic: City of Stockholm breaks gridlock with a smart road use management system



What's smart?

- New, Dynamic Business Model
- Congestion Charging
- Real-time traffic prediction
- Technology to optically recognize cars in milliseconds
- Real-time congestion tolling

Smarter Business Outcomes

- 25% Reduction in Traffic
- 15% reduction in CO2 emissions
- 40,000 more citizens on public transportation
- Less noise pollution and lower carbon emissions
- \$120M/yr in revenue to City of Stockholm with Congestion charges will fund transit improvements

Fact: Cost of congestion in U.S. transportation system nears \$200 billion each year

Smart Grid Rethinks the Electrical Grid and Empowers Customers to Make Intelligent Choices about their Energy Use

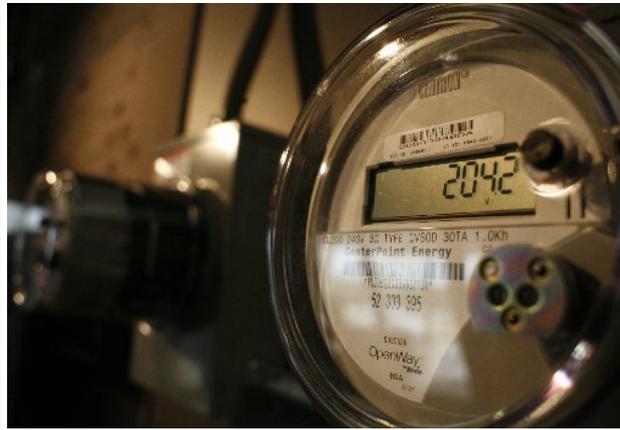
Monitoring power everywhere on the grid



INSTRUMENTED

Remote monitoring devices tell when and where faults occur, and where the inefficiencies are, enabling smarter sourcing and distribution of power.

Real-time line of sight to energy consumption



INTERCONNECTED

Virtual market-places between consumers and providers, allowing consumers to trade flexibility in usage for lower costs.

Reducing greenhouse gas emissions



INTELLIGENT

Power grids that use sensors, smart meters, digital controls and analytic tools to automatically monitor and control two-way energy flow.

IBM Industry Involvement and Commitment

IBM chairs the Gridwise Alliance

- A group which represents a broad range of the energy supply chain from utilities to large tech companies to academia to venture capitalists to emerging tech companies

IBM chairs the Gridwise Architecture Council

- Formed by the U.S. Department of Energy to promote and enable interoperability among the many entities that interact with the nation's electric power system

IBM is a member of the U.S. Department of Energy's Electricity Advisory Committee (EAC)

- A 30 member group representing some of the country's top public and private sector electricity and energy policy leaders – IBM chairs the smart grid subcommittee

IBM formed the Global Intelligent Utility Network Coalition

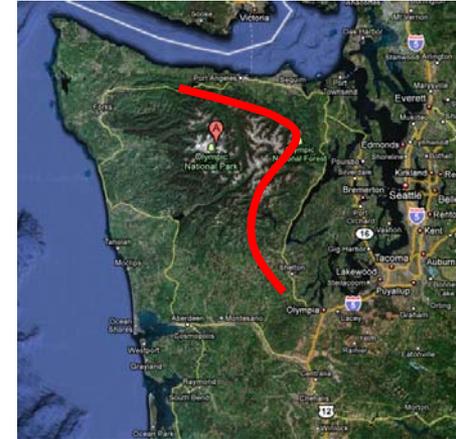
- Shape, accelerate, and share in the development of a smart grid by collaborating in the market to enable the rapid creation of solutions, adoption of open industry-based standards, and informed policy/regulation, thereby driving the adoption of IUN/smart grid

IBM is participating in open standards definition with NIST Smart Grid Interoperability Roadmap and OASIS demand response and pricing signal technical committees



Working with US DoE and other partners, IBM implemented one of the most advanced real-time retail market distributed energy management systems

- 112 Homes with Grid Friendly Appliances
- Demonstration of automated price-based demand response and distributed generation dispatch system to manage system constrained without affecting consumer comfort



GOALS

- Manage the transmission constraint and peak load on the Olympic Peninsula to avoid local capacity expansion.
- Provide spinning and non-spinning reserves, voltage support, and reduction of cold-load pickup, by delaying restart after an outage.
- Minimize power purchases and maximize power sales to wholesale markets in the Western Interconnection, and minimizing a distribution utility's peak demand charges

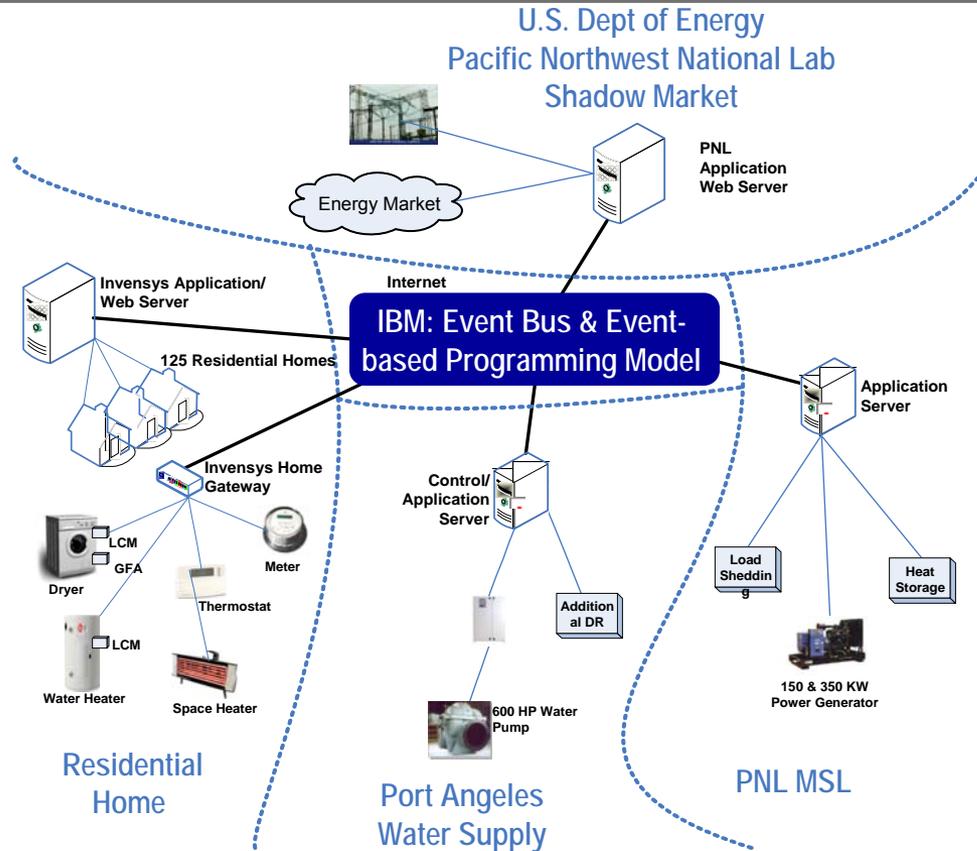
APPROACH

- Integrated multiple commercial and residential assets -Distributed Generation (DG) across commercial sites using individual dispatchable DG
- Demand Response (DR) with Residential and Commercial assets managed with direct load control. Customers saw results of actions
- Created Shadow Real-Time Market to drive this test with both DR and DG assets bid into market
- Base clearing price calculated from the Mid-Columbia wholesale market price, adjusted based on real-time market demand and constraints

Results: Olympic Peninsula GridWise Demo Project

Through intelligent utility technologies, such as smart metering and utility grids, providers offer consumers a choice when to buy energy based on variable pricing at different times.

- Consumers specified temperature set-point and comfort vs. economy
- Settings became bids in a real-time energy market on 5 minute cycles
- Consumers saved 10% on electricity bills
- Reduced peak load requirements on the grid by 15% on average, and up to 50%
- Provided dynamic response to constraints on the grid
- Demonstrated effectiveness of event-based architecture



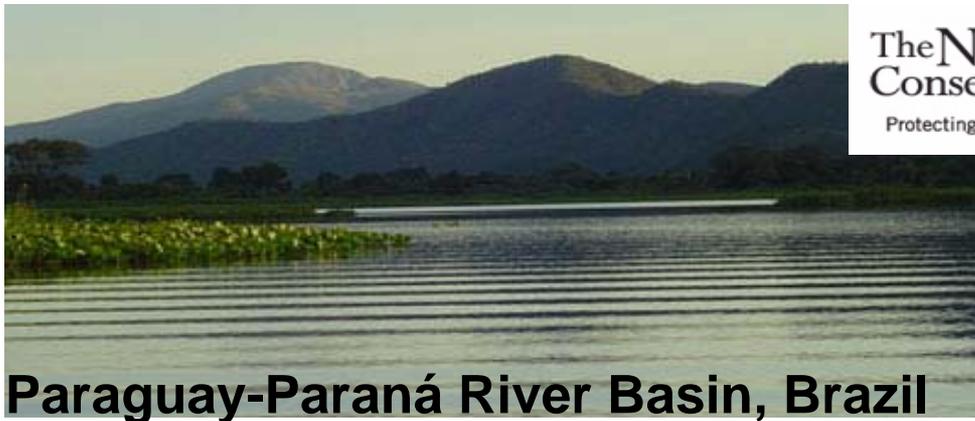
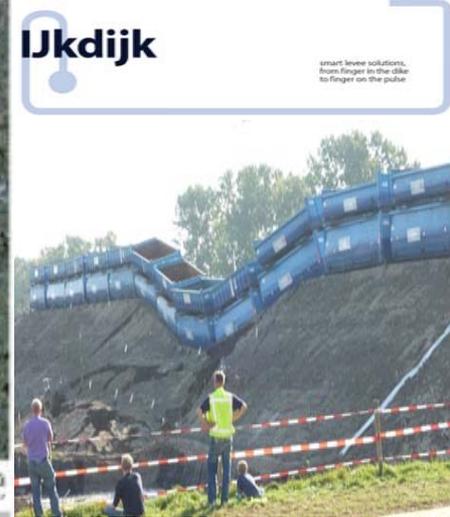
Sources: "Juicing the System", Forbes November 12, 2007; "Gridwise Demonstration Project Fast Facts", Pacific Northwest National Laboratory, Dec 2007, http://www.gridwise.pnl.gov/docs/pnnl_gridwiseoverview.pdf

Water is a Critical Challenge for the World

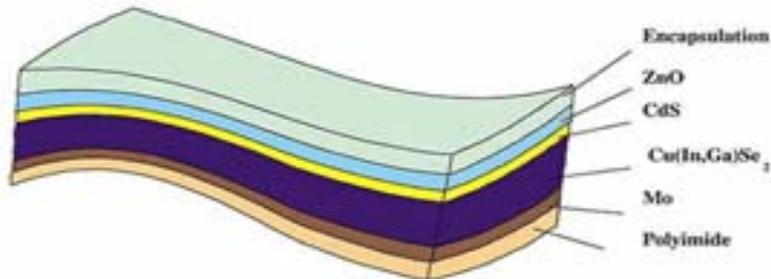
- Only 1% of the world's water is fit for human consumption – 97% is in the oceans
- Globally, billions of people are deprived of adequate clean water
 - Approximately 40% of the world's population does not have adequate water and sewer systems
 - Only 20% of the world's population has access to running water
 - In the developing world, only 20% have access to safe drinking water
- We are heading for an era of change where we need to guard our water resources for the next generations
 - If present consumption rates continue, by 2025 63% (5B) of the world's 7.9B people will live in areas where safe water is scarce
 - By 2050, per capita water availability may fall to one-third, affecting 7B people in 60 countries

Managing & Monitoring Water Systems

By measuring, monitoring and managing environmental systems, decision makers will have more knowledge of how their decisions will influence the environment & business.



Smart Research for energy and environment: Harnessing solar energy: Novel Photovoltaic Systems



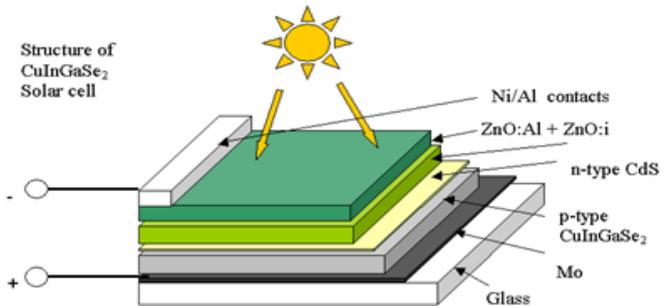
Compound semi-conductors; Wafer-bonded multi-junction cells
Flexible substrates

SMART IS

Improving the efficiency of solar PV generation from 12% in the field today to beyond the present day lab performance of 19% by understanding the surface chemistry of novel compounds and determining the physics of active interfaces

SMART IS

Enabling solar concentration to dramatically increase generation by breakthrough improvements in the power and heat performance of PV cells



Self-assembly; Solution-based processing;
Nano-pattern templates

SMART IS

The ability to do cost-effective local generation of electricity, avoiding the energy losses of transmission which can amount to some 20% from waste and 10% from fraud depending on the age and sophistication of the network

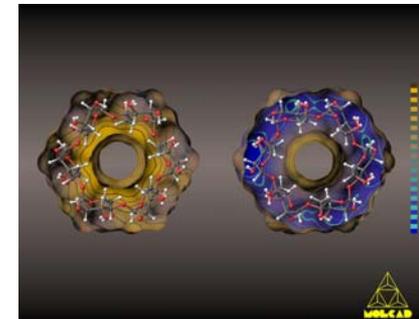
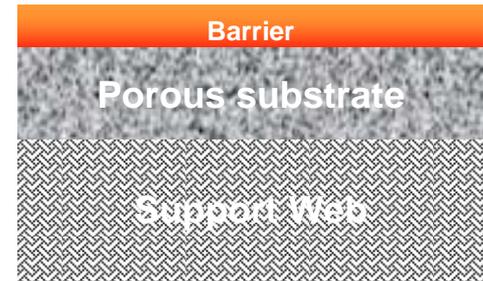
SMART IS

Modeling materials and processes to make thin solar film 100 times thinner than traditional PV cells, reducing the cost of manufacturing by 50%

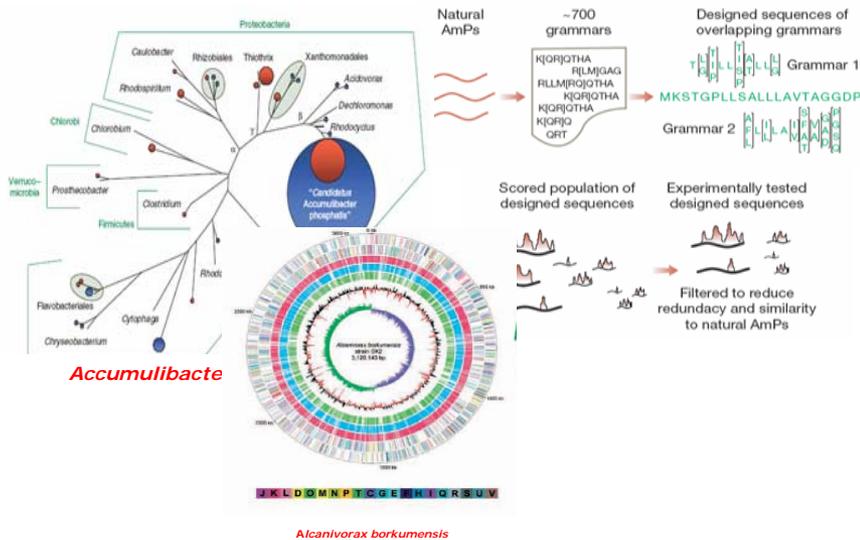
Smart Research for energy and environment:

Water Filtration and Desalination Project Using Nanomembranes

- IBM Almaden (San Jose, CA) Lab is focusing on water filtration through low cost, low energy membranes from “nano-materials”
- New membranes are being developed that filter out salts and harmful toxins while using less energy than other forms of water purification.
- The innovative new membrane materials are resistant to chlorine damage and transform into a “water superhighway” in mildly basic conditions, making it suitable for arsenic removal in addition to water desalination.
 - High pH causes arsenic to become ionic resulting in it being filtered out when contaminated water is forced through the membrane
- Work being done in collaboration with Central Glass (Tokyo), KACST (Saudi Arabia) and the University of Texas
- A video about the new membrane can be viewed at:
http://www.youtube.com/watch?v=M1Mo_rVZVws



Smart Research for energy and environment: Environmentally friendly energy from plants



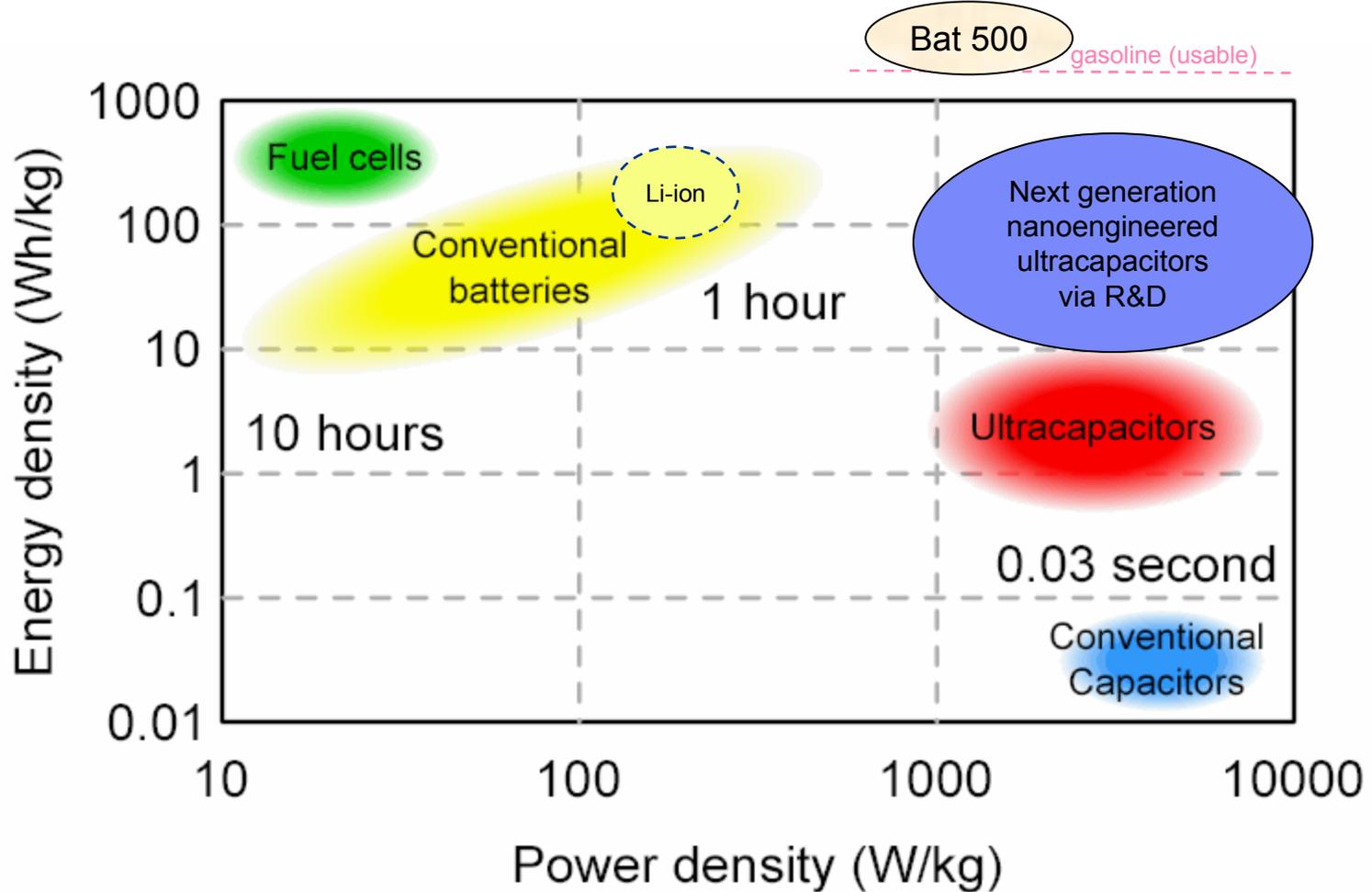
SMART IS

Making use of non-food plant material and insights from the way Nature works to create novel enzymes that produce fuel in ways that are both efficient and environmentally benign

SMART IS

Using computer models to aid understanding of the biological processes of microbes so that we can imitate termites and turn waste corn stalks into fuel.

Smarter Energy - Batteries: Energy Density vs. Power Density Chart



R. Haight, S. Rosnagel, W. Wilcke

Smart Research for energy and environment: Powering the next generation of vehicles

Vejen banet for elbiler

EDISON

Vision: 400.000 elbiler i Danmark i år 2020



SMART IS

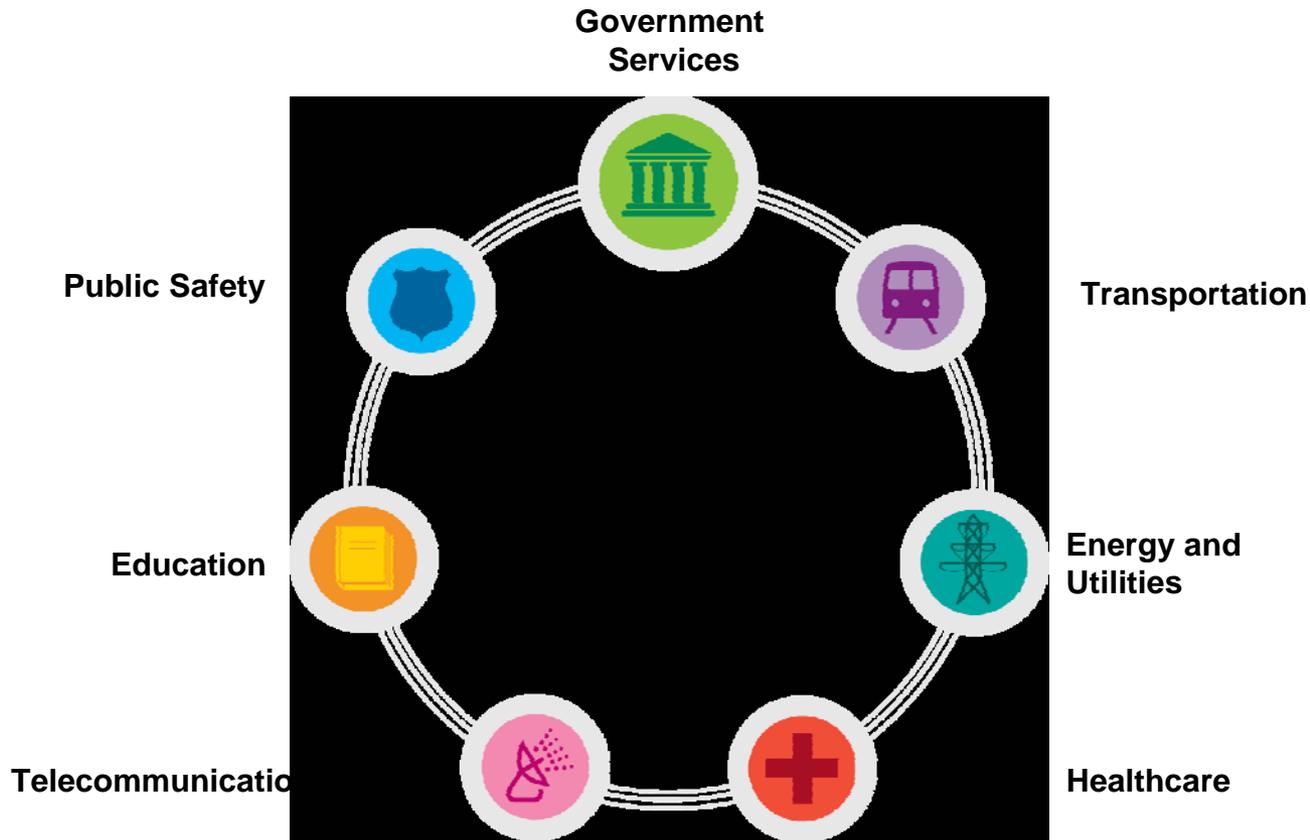
A fleet of electric vehicles able to use a network of rapid re-charging points at a variety of locations ... with the right payments being made and operating safety ensured



A planet of smarter cities: In 2007, for the first time in history, the majority of the world's population—3.3 billion people—lived in cities. By 2050, city dwellers are expected to make up 70% of Earth's total population, or 6.4 billion people.



The city is a microcosm of the major challenges and opportunities facing the planet today—intensified and accelerated. Here, all man-made systems come together and interact with one another.



Smarter cities are intensive users of information technologies...

Intelligent Transportation Systems

- Integrated Fare Management
- Road Usage Charging
- Traffic Information Management

Public Safety

- S3 Surveillance System
- Emergency Management Integration
- Micro-Weather Forecasting

Telecommunications

- Fixed and mobile operators
- Media Broadcasters

Smart Building Management

- Network Monitoring & Stability
- Smart Grid – Demand Management
- **Energy Management**
- Automated Meter Management

Environmental Management

- City-wide Measurements
- KPI's
- CO2 Management
- Scorecards
- Reporting

Water Management

- Water purity monitoring
- Water use optimization
- Waste water treatment optimization



IBM Green Sigma™ Coalition



"The New Environmental Industry" – U.S. Commerce Department, International Trade Administration



Green Sigma™ Coalition

Metering and Monitoring

1

3

Continuous Improvement of Buildings & Facilities

Daily Management with Green Sigma™ Dashboard

2



- Accelerating the move toward sustainable enterprises
- Implementing high value projects that drive quick ROI
- Enabling enterprises everywhere to reduce energy, water, waste and GHG Emissions...

Smarter companies working together to co-create a Smarter Planet, Smarter Cities and Smarter Buildings – today



Green is not a fad, it is an imperative. Companies of all sizes need to ***take action now*** on energy, the environment, and sustainability.

The challenges facing the planet are demanding. ***Leverage emerging smart systems*** and have a substantive effect.

We are witnessing the emergence of a new economy and profound societal shifts.

Be a leader.

ibm.com/green
ibm.com/think
ibm.com/gio



धन्यवाद

Hindi

多謝

Traditional Chinese

ขอบคุน

Thai

Спасибо

Russian

Thank

Gracias

Spanish

شكراً

Arabic

You

English

Obrigado

Brazilian Portuguese

Grazie

Italian

多谢

Simplified Chinese

Danke

German

Merci

French

நன்றி

Tamil

ありがとうございました

Japanese

감사합니다

Korean