REINVENTING FIRE

Rocky Mountain Institute
Marty Pickett, Executive Director
Michael Potts, CEO & President

12 November 2009

RMI2009
FROM IDEAS TO SOLUTIONS

20th Century Economy

20X

Per Capita GDP (1990 International Dollars)

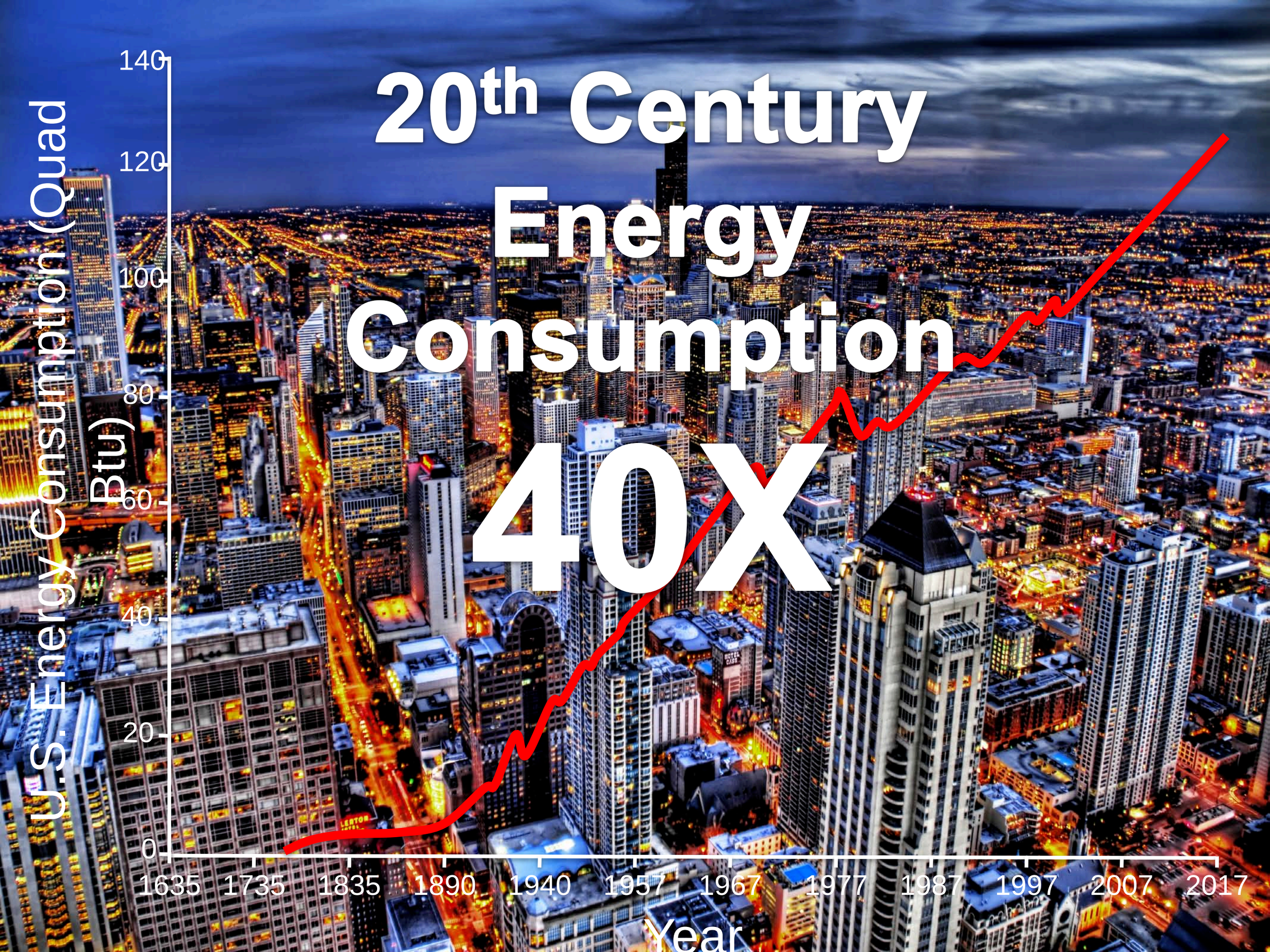
30,000
25,000
20,000
15,000
10,000
5,000

1900
1915
1930
1945
1960
1975
1990
2005

Years

20th Century Energy Consumption

40X



Fossil fuels have given the world unprecedented prosperity over a long period of time.

1908:
26mpg of oil

2009:
26mpg of oil

1888:
Burned coal

2009:
Burns coal

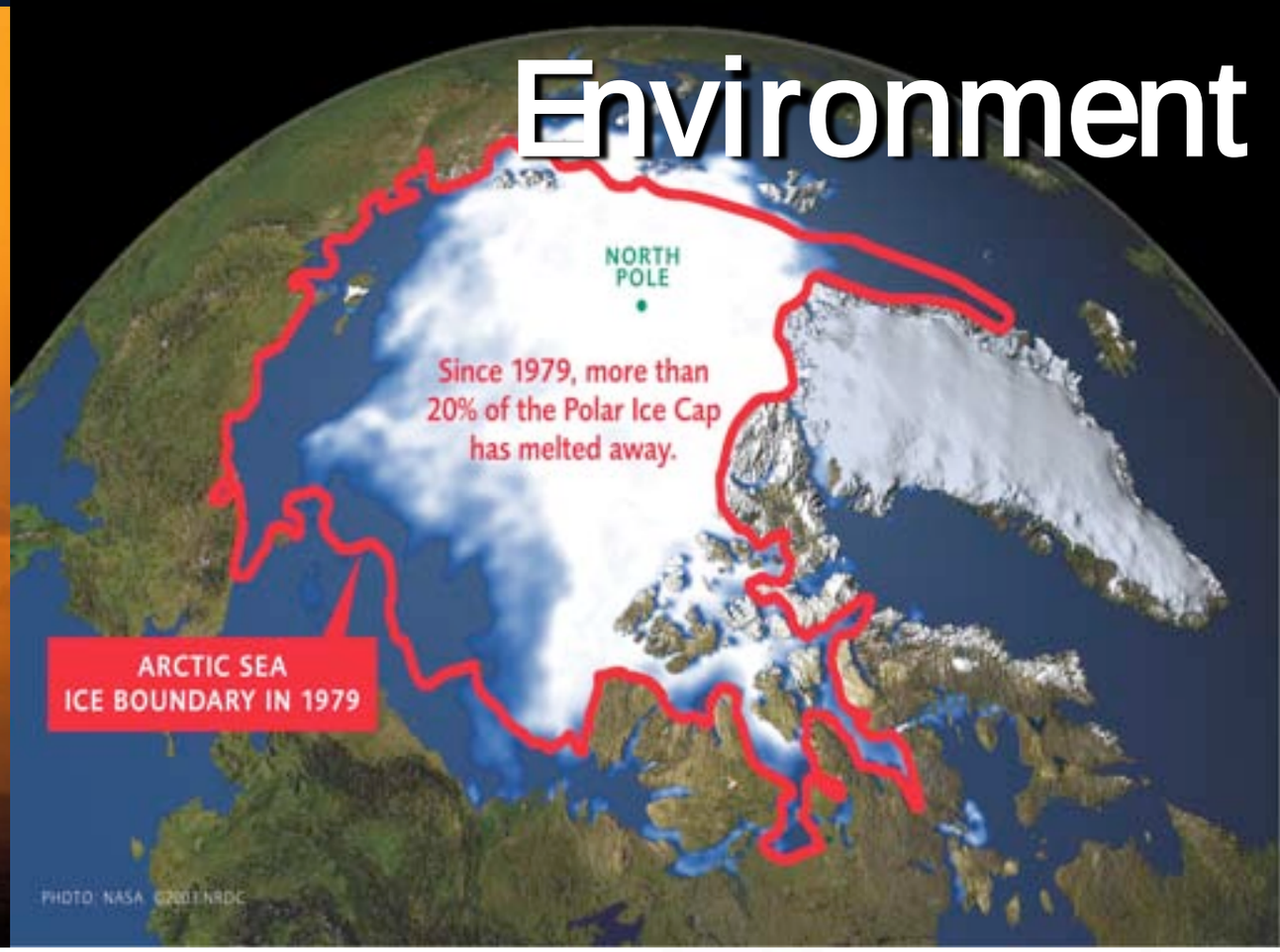
Can’t we do better than that?

1785:
Runs on fossil fuels

2009:
Runs on fossil fuels

Economics

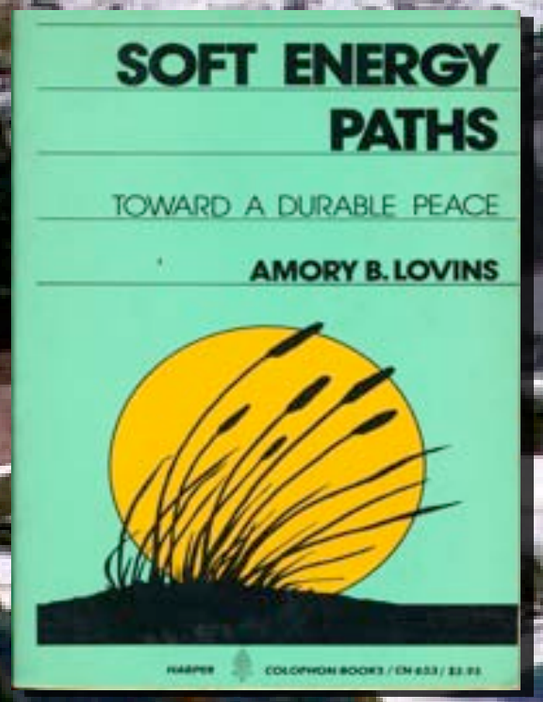
Environment



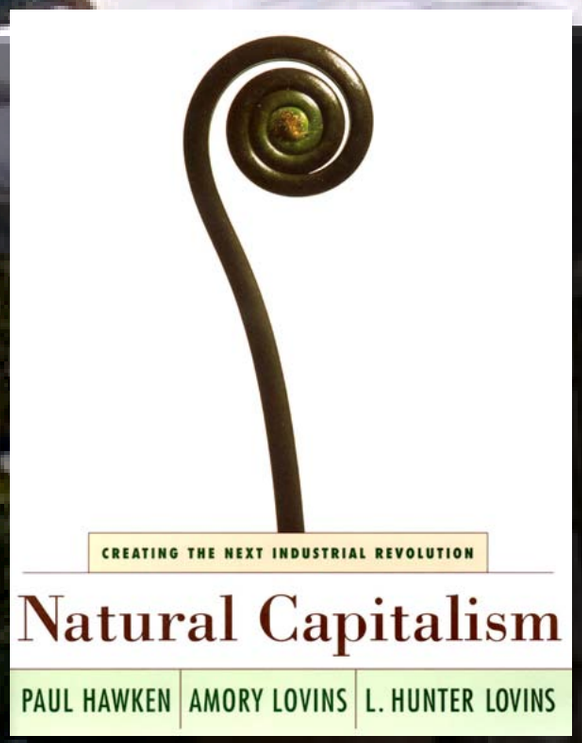
Security

“Drive the efficient and restorative use of resources…”

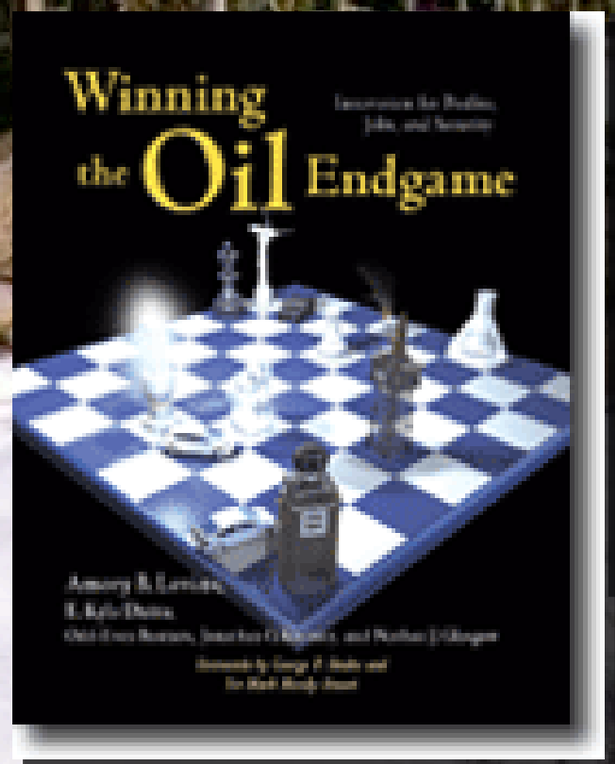
Rocky Mountain Institute



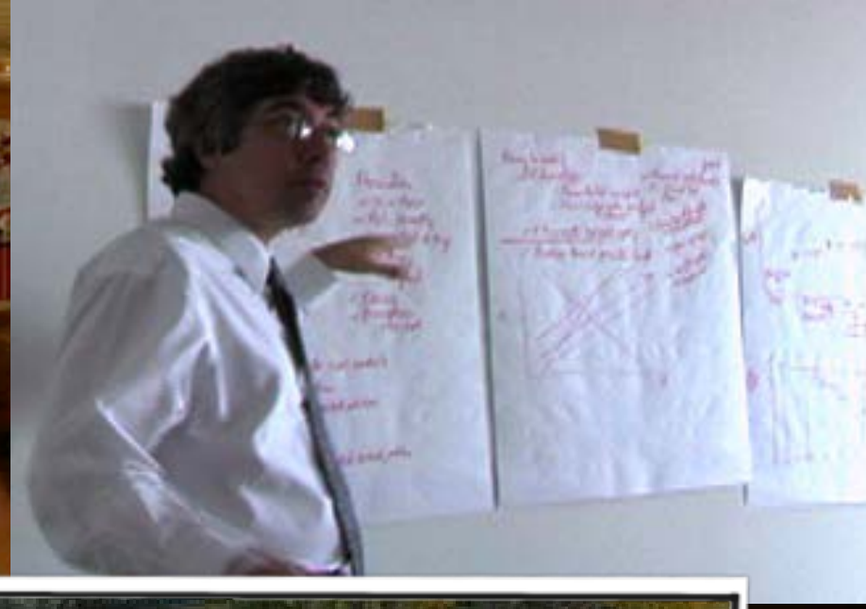
1983: RMI Founded by Amory and Hunter Lovins in Snowmass, Colorado

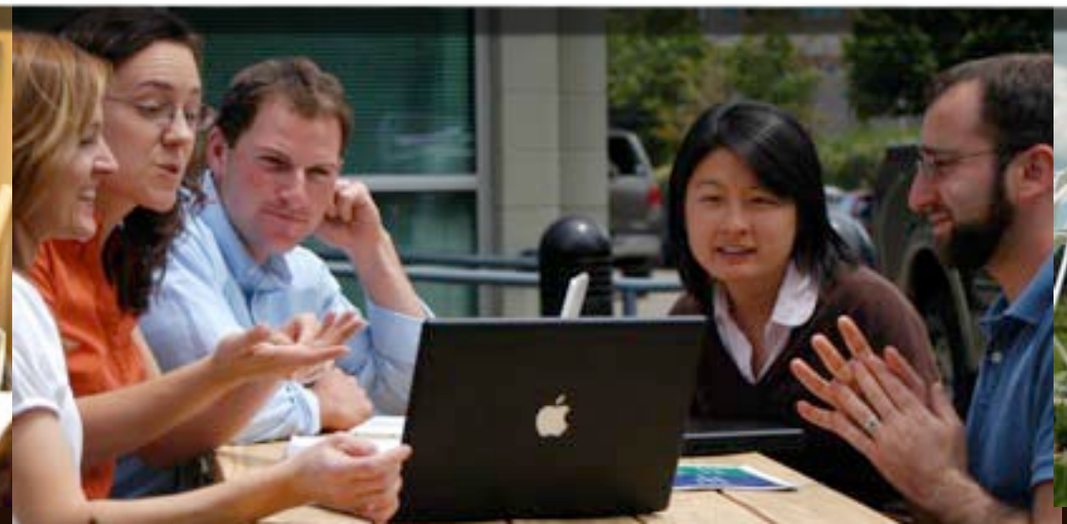


1999: RMI publishes *Natural Capitalism*



2004: RMI publishes *Winning the Oil Endgame*, strategizing the U.S. off oil by the 2040s






Rocky Mountain Institute
www.rmi.org
GIVEN INSTITUTE
Health Sciences Center

BRIGHT AUTOMOTIVE™

Rio Tinto

W&H PROPERTIES

hp

MGM

ALCOA

Johnson Controls

Autodesk®

PORT of TACOMA U.S.A.

Interface

TEXAS INSTRUMENTS

UNITED STATES NAVY

Port of Seattle

WAL★MART
Save money. Live better.™

CANADIAN TRUCKING ALLIANCE
ALLIANCE CANADIENNE DU CAMIONNAGE

Lubrizol

PG&E Corporation

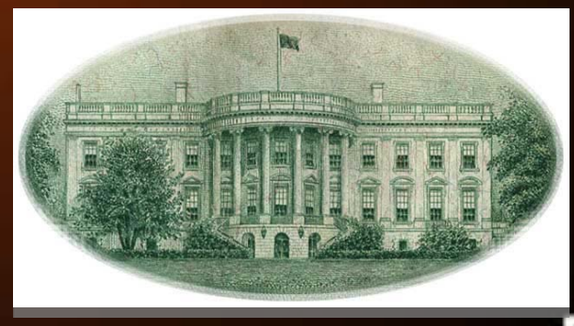
Coca-Cola

SOUTHERN CALIFORNIA EDISON®
An EDISON INTERNATIONAL® Company

CLINTON FOUNDATION

STATE OF HAWAII 1959

Google™



RMI2009

“Drive the efficient and restorative use of resources…”

Rocky Mountain Institute

speed the shift from fossil fuels to efficiency and renewables

RMI2009

REINVENTING FIRE

RMI2009

FROM IDEAS TO SOLUTIONS

Standard Practice

Radical Resource Efficiency

Renewable Energy Sources

RMI2009

Fossil Fuel	Convey	Convert	Convey	Sell/Distribute	Convert	End use	Final user

Oil → Ship/ Pipe → Refinery → Pipe / Truck

Gas station → Cars/Trucks → Road transport

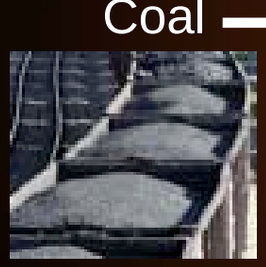
Train station → Train → Rail transport

Airport → Plane → Air transport

Port → Ship → Sea transport

Transportation

Coal → Rail



Ship/ Pipe

Natural Gas

Buildings → Cooling, heating, lighting, mobility

Appliances

HVAC

Buildings

Electricity

Plants

Transmission & Distribution

Industries (many and varied)

Motors

Pipes

Processes

Manufacturing goods

Industry

Military

Individuals

Companies

Cities

Colleges

Food production

Water

→ **Main use**

⋯⋯→ **Secondary use**

– – → **Anticipated future use**

RMI2009


Buildings


Transportation


Electricity


Industrial Processes

SECTOR STRATEGY

BUILDINGS

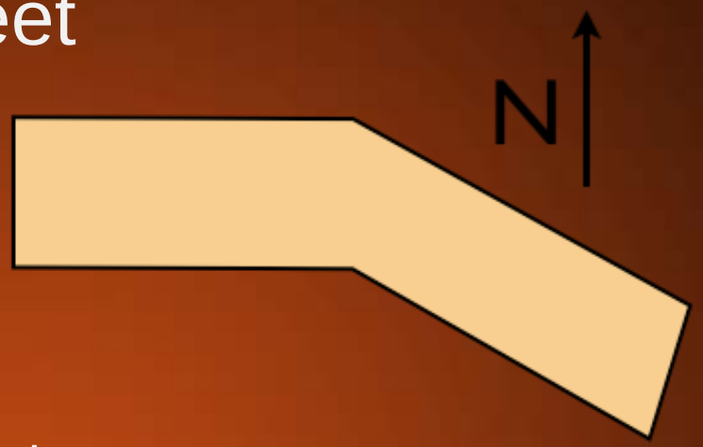
Case Study: Lewis and Clark State Office Building

120,000 square feet

400 occupants

$17 Million

State Government



Missouri Lewis and Clark State Office Building DNR

Images courtesy of the Missouri Department of Natural Resources

RMI2009

Sound Orientation

Effective Daylighting

Shading and Insulation

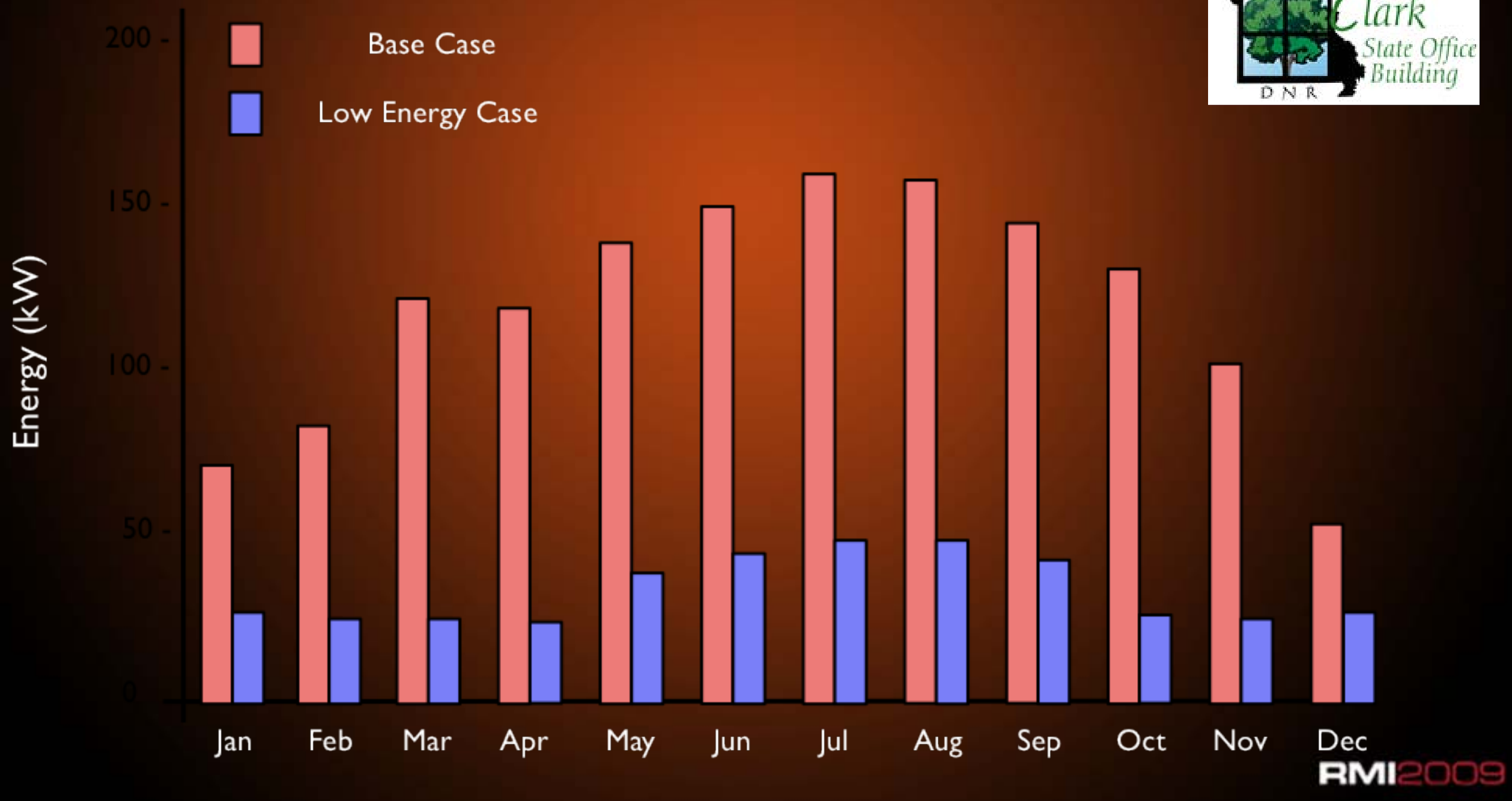
Energy Efficient HVAC and Mechanical Systems

Solar Paneling

MODNR Energy Demand

Monthly Electric Demand Peaks

Missouri Lewis and Clark State Office Building DNR



RMI2009

- Zero net increase in capital costs
- $80,000 per year in energy savings

Missouri Lewis and Clark State Office Building
DNR

Integrated Design

Why isn’t everybody doing it?

Players Involved:

Building Owners

Architects

Corporations

Manufacturers

Developers

Designers

Planners

Investors

Utilities

Construction Management

Realtors

Lenders

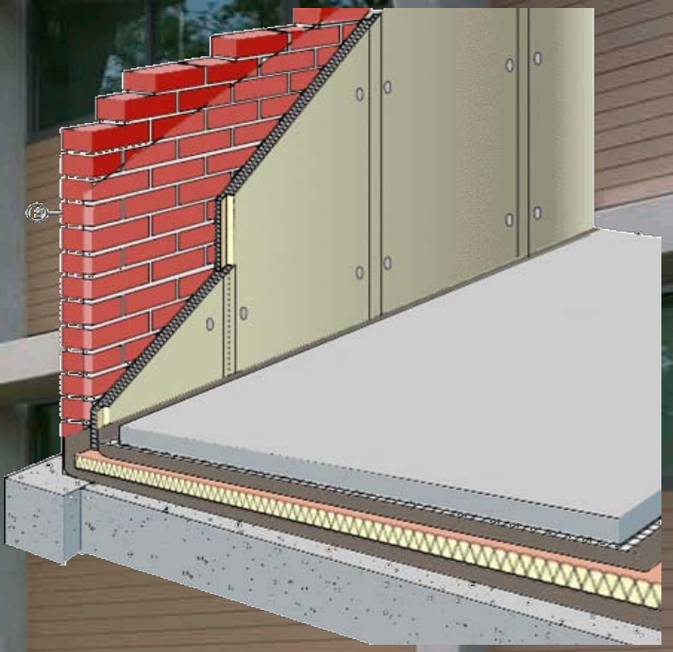
Public Agencies

Government Policy

Tenants

- Zero net increase in capital costs
- $80,000 per year in energy savings

Missouri Lewis and Clark State Office Building



Typical Incremental Cost Analysis

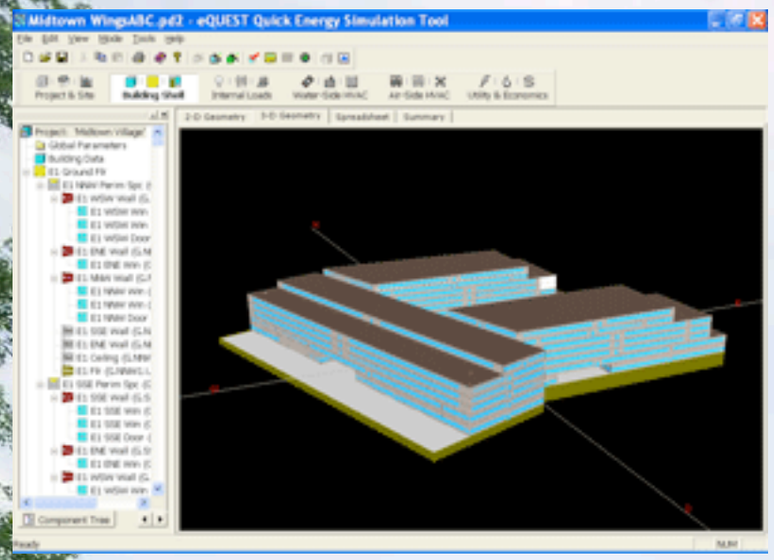
Energy Measure	Cost ($)	Savings ($)	Payback (Years)
Daylighting	$1,900	$1,560	3.14
Energy Efficient Lighting	$1,400	$860	1.63
Energy Efficient HVAC	$3,880	$739	5.25


Build on the Ideas of Others
Stay Focused on Topic
CARGO – How might we enable services to be supported out of the workshop on wheels?
Streamline storage of bulky, daily use items (such a ladders)
Support storage but not working inside
What level of access do we need to provide?
BLUE

Energy Modeling

Missouri Lewis and Clark State Office Building

DNR



Added Costs
$26,200

Cost Reductions
$21,860

Incremental Cost
$4,340

Simple Payback
1 Year

Energy Savings
$4,500/yr

ROI
100%

Empire State Building

CLINTON FOUNDATION

RMI2009

Commercial Building Retrofit Initiative

Commercial Building Retrofit Initiative

KEY BARRIERS & LEVERS

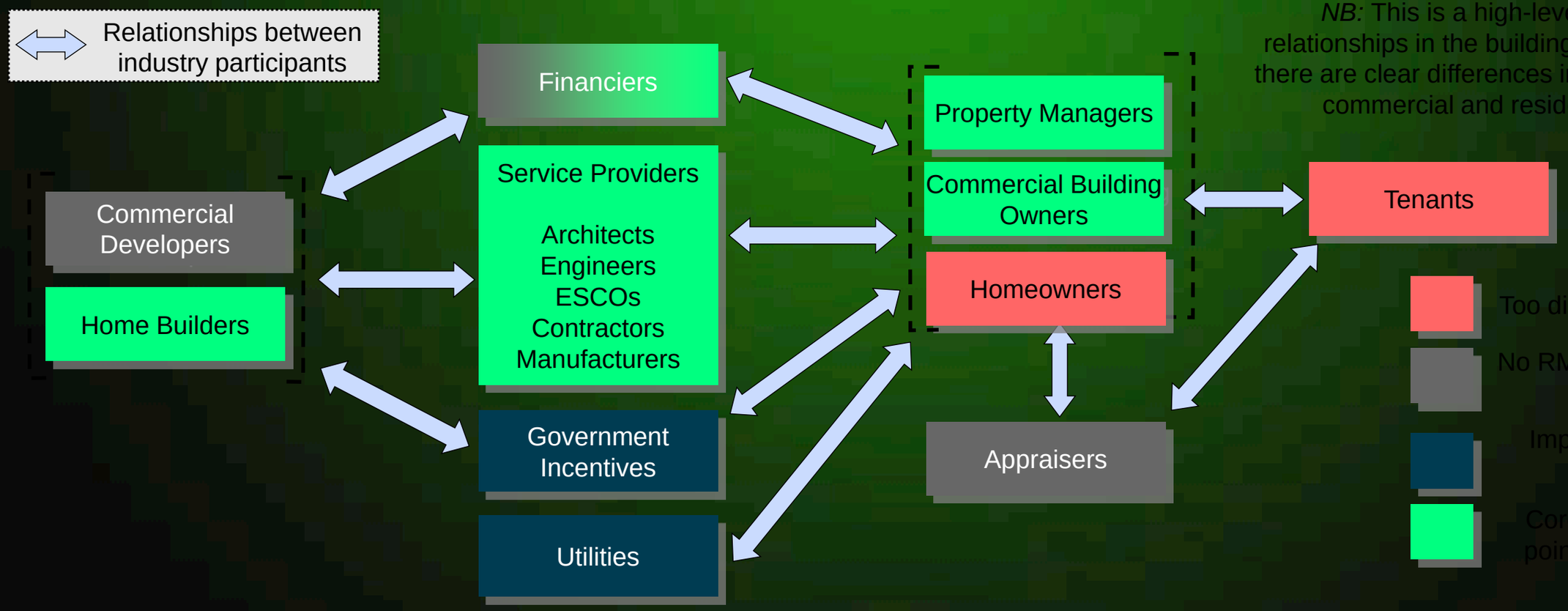
Challenges/Barriers:

- Access to financing/capital
- Lack of skilled practitioners
- Poor conventional business case
- Increased or perceived increase in first cost
- Insufficient demand

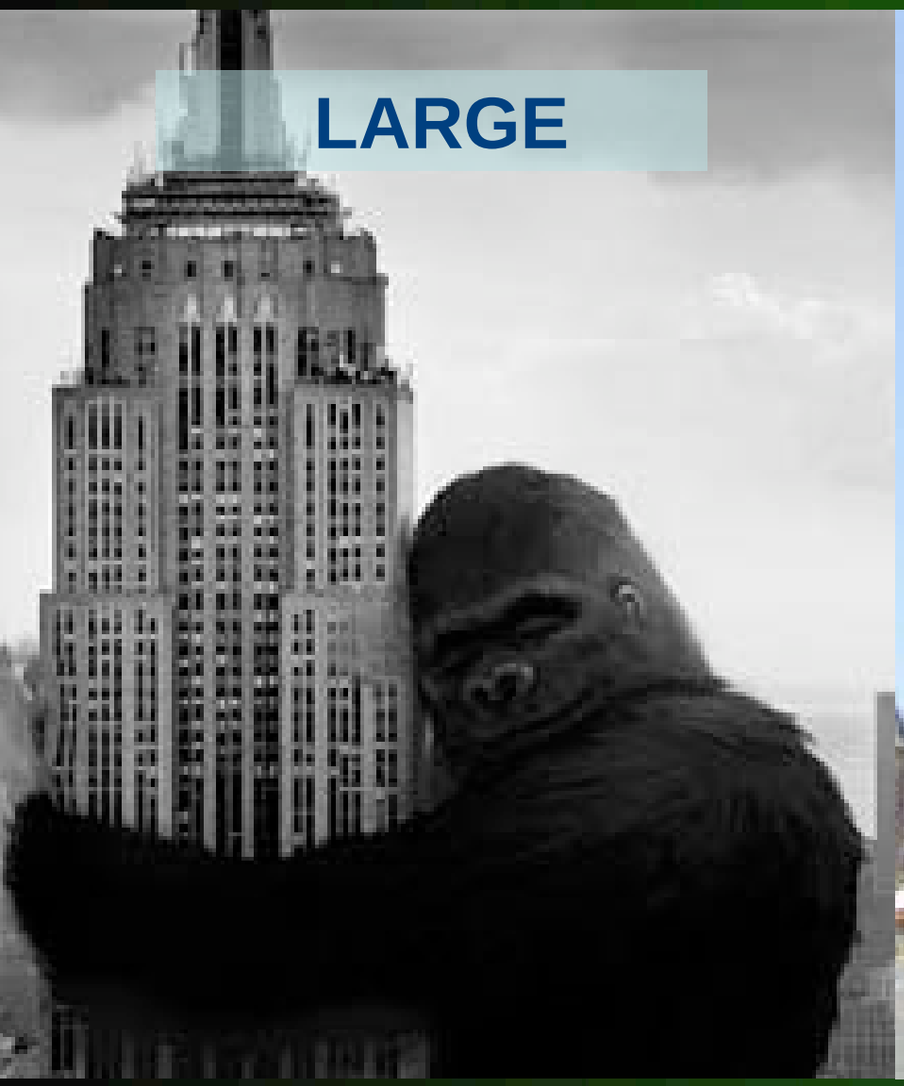
Opportunities:

- Stimulus funding and financial innovations (pacenow.org)
- Climate change awareness
- Increasing energy prices and volatilities
- Growth in Energy Star and LEED buildings/homes
- City, state, and federal requirements for energy efficiency

MATRIX OF INDUSTRY PLAYERS



RMI Strategic Initiative Attributes



Amplification Approaches

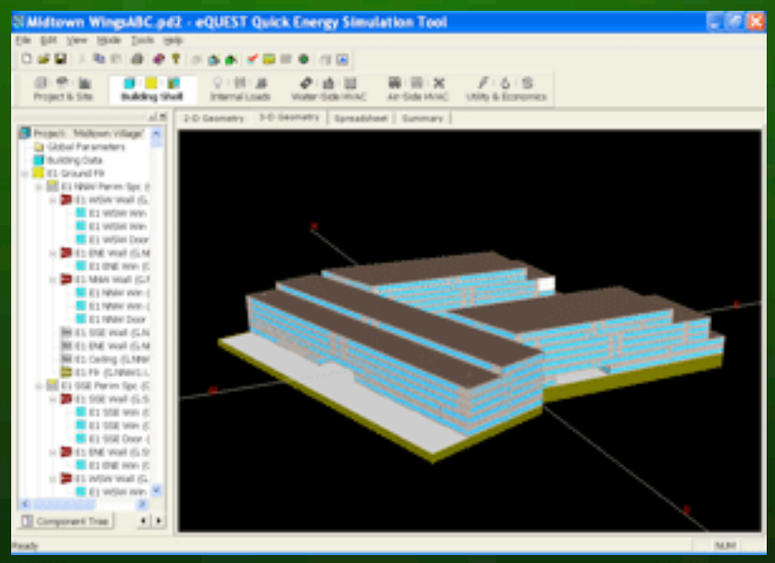
1

Clients with inherent amplification potential

SIMON MALLS | more choices®

2

Developing industry tools/solutions

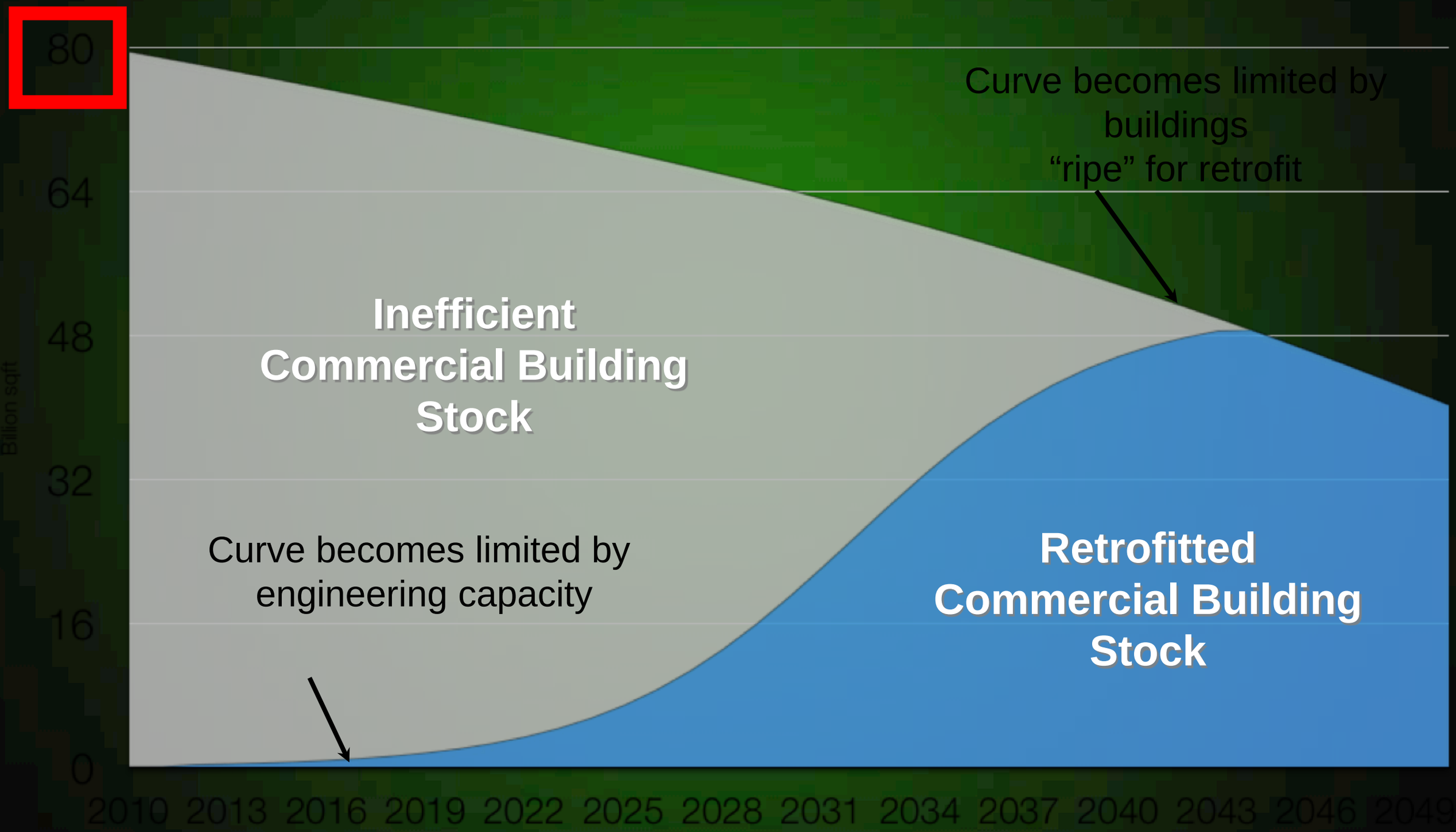


3

Targeted outreach / acupuncture

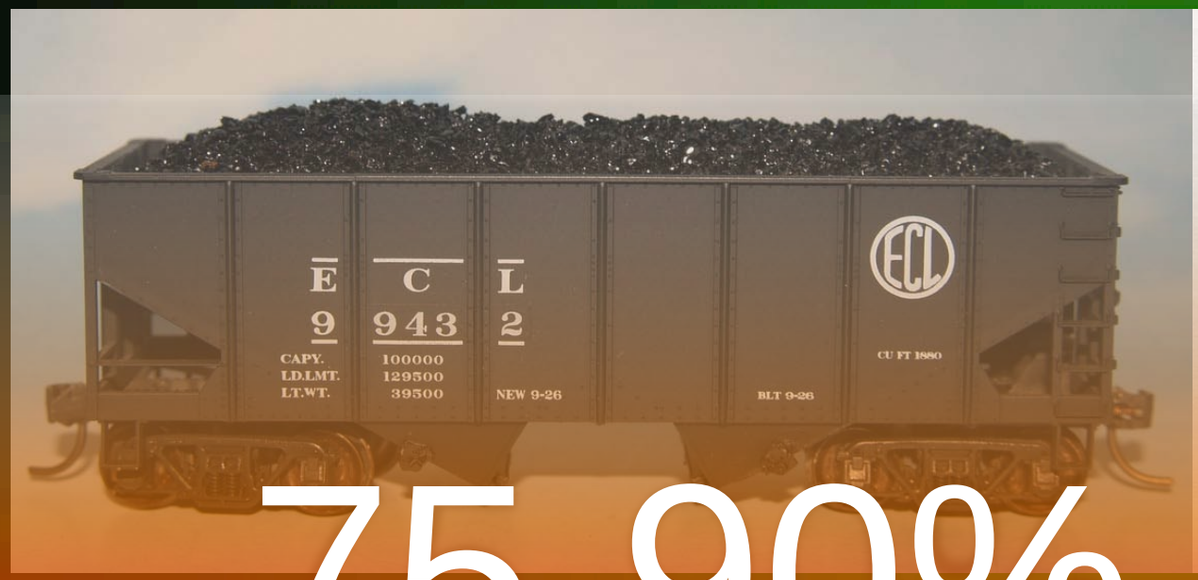
RMI2009

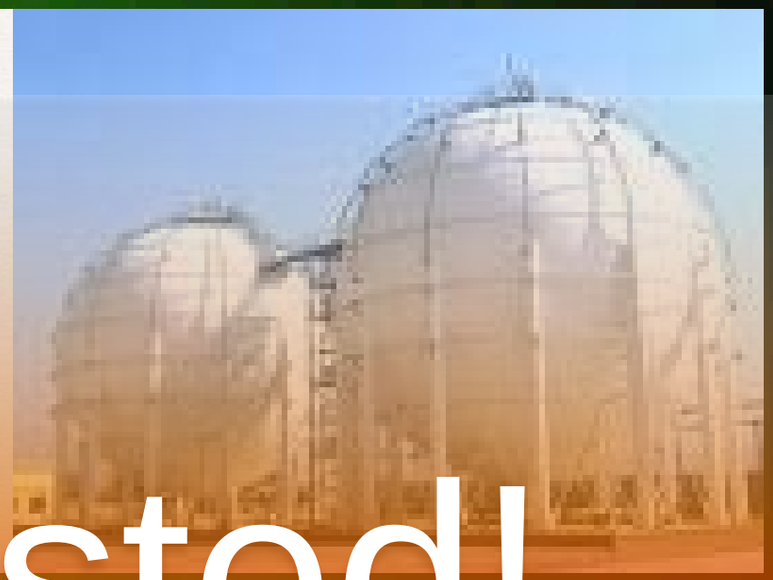
Projected Amplification Trajectory



RMI2009

High-Efficiency Production Homes





75-90% Wasted!

RMI2009

Fuel input = 100

Power plant losses 70%

Transmission and distribution losses 9%

Motor losses 10%

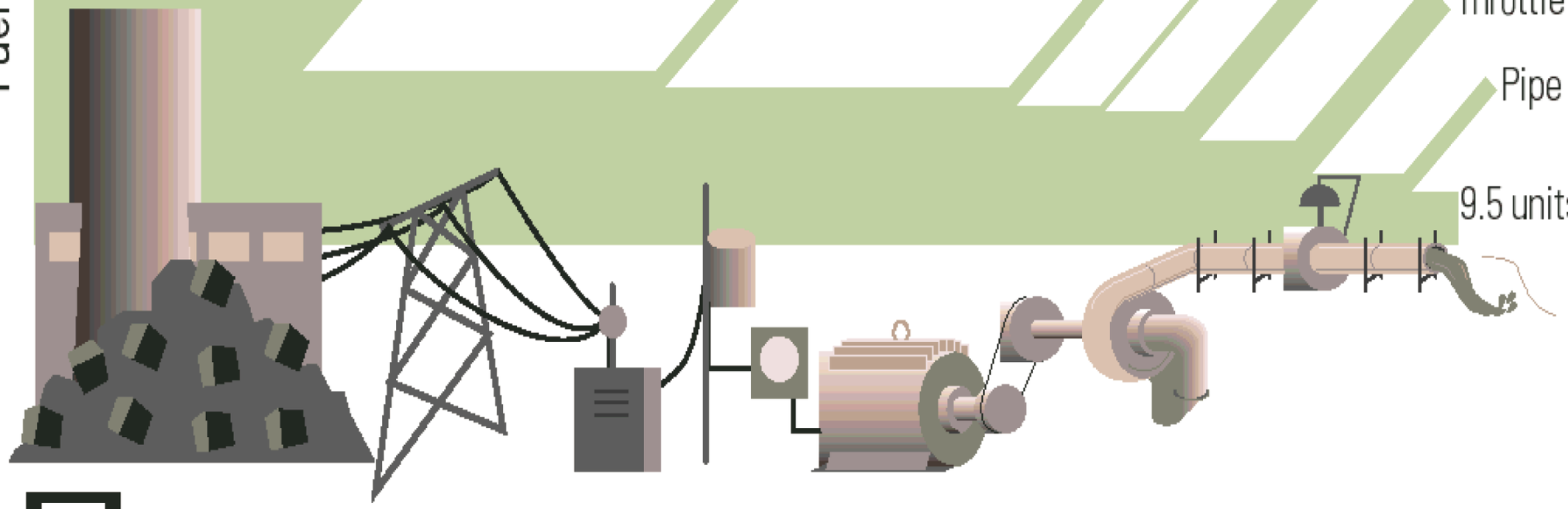
Drivetrain losses 2%

Pump losses 25%

Throttle losses 33%

Pipe losses 20%

9.5 units of energy output



From the *Drivepower Technology Atlas*.
Courtesy of E SOURCE, www.esource.com

Cooling System
5%

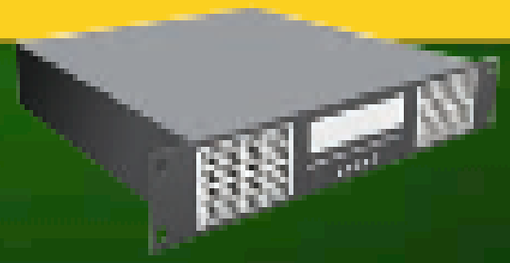
Lighting
1%

UPS Losses
10%

Server Fans
10%

Server
Power Supply
15%

Low
Utilization
70%



Power Used by
Data Center
100 W

Power Used
by Servers
85 W

Power Used
by IT Loads
61 W

Useful
Computing
18 W

RMI2009

Fuel: 100%

Tires: 4%

Aerodynamics: 3%

Brakes: 6%

Drivetrain: 5%

Accessories: 3%

Idling: 19%

Engine: 60%

> 0.5% Moves The Driver

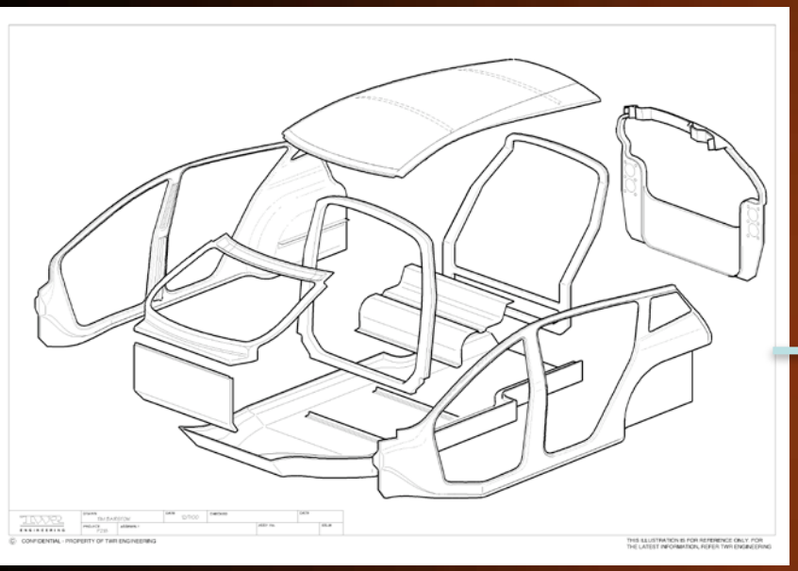
6% Moves The Car

RMI2009

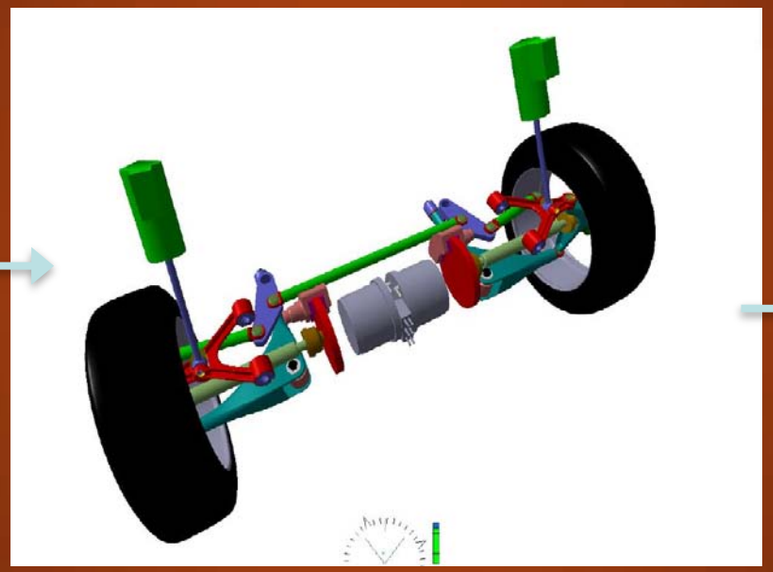
TRANSPORTATION

Combining ***lightweight design*** with ***electrification***

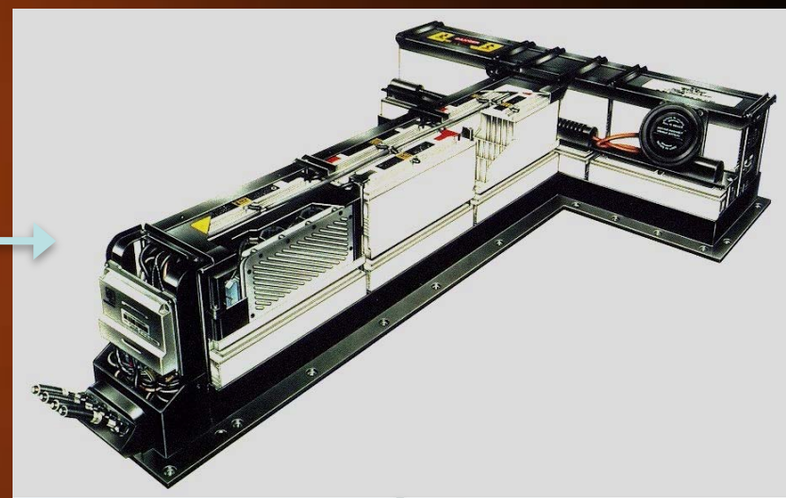
1. Start with an advanced, lightweight structure



2. Lightweight structure enables lighter, simple modules (suspension, interior, etc.)



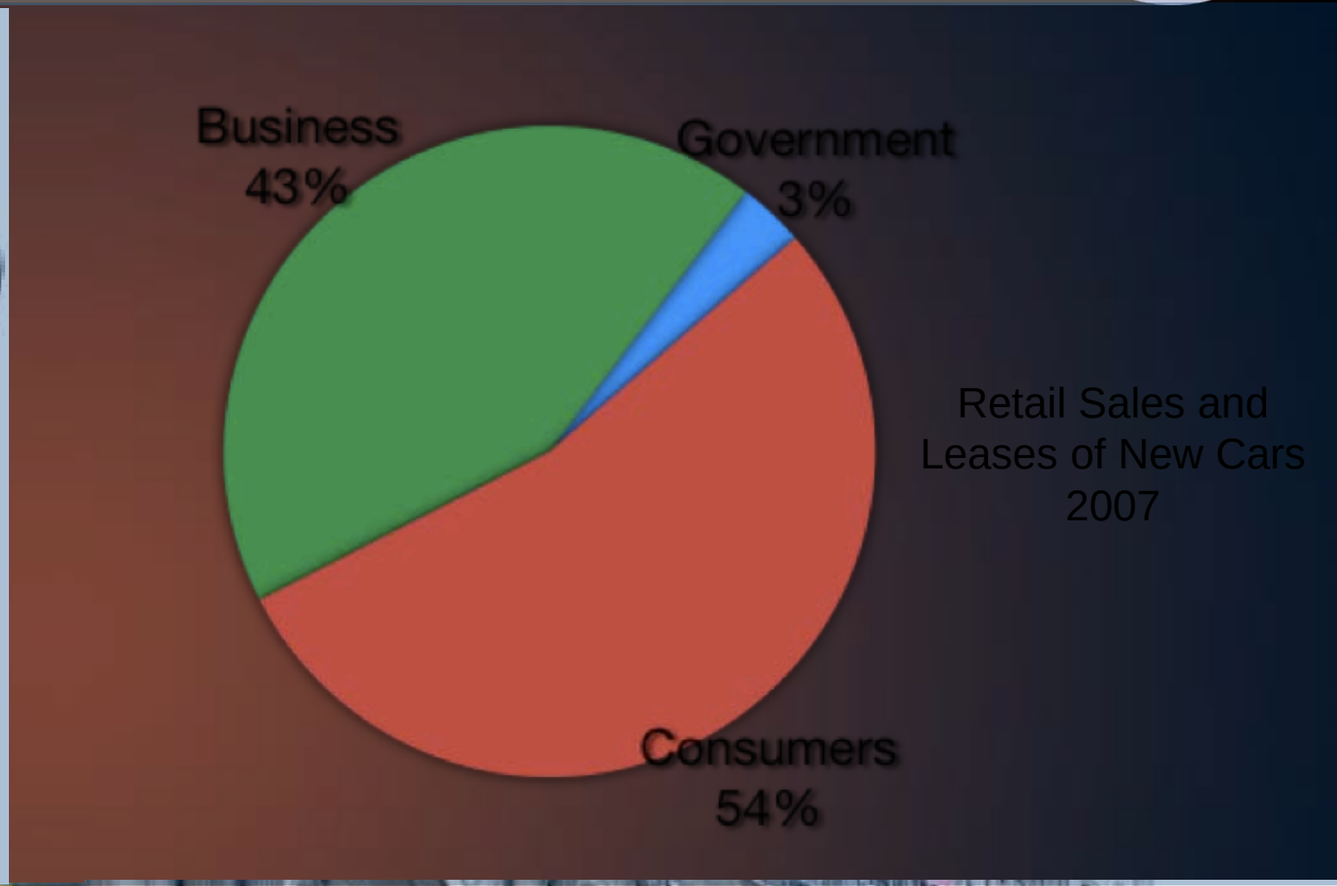
3. The efficient platform enables downsized, radically cheaper, and simpler PHEV drive



4. Resulting vehicle has breakthrough affordability and capability

Freight Without Borders Initiative

Fleet Efficiency Initiative

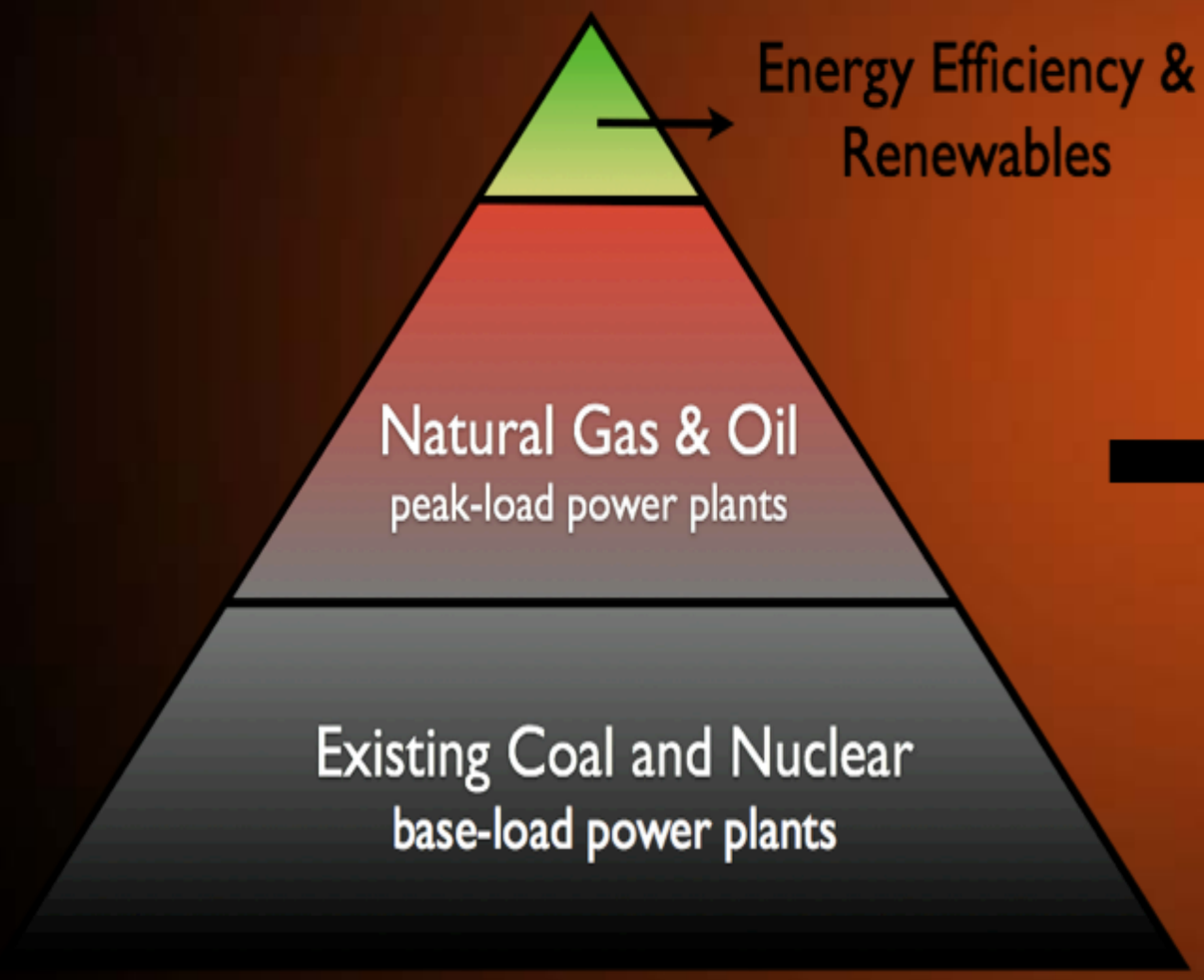


ELECTRICITY

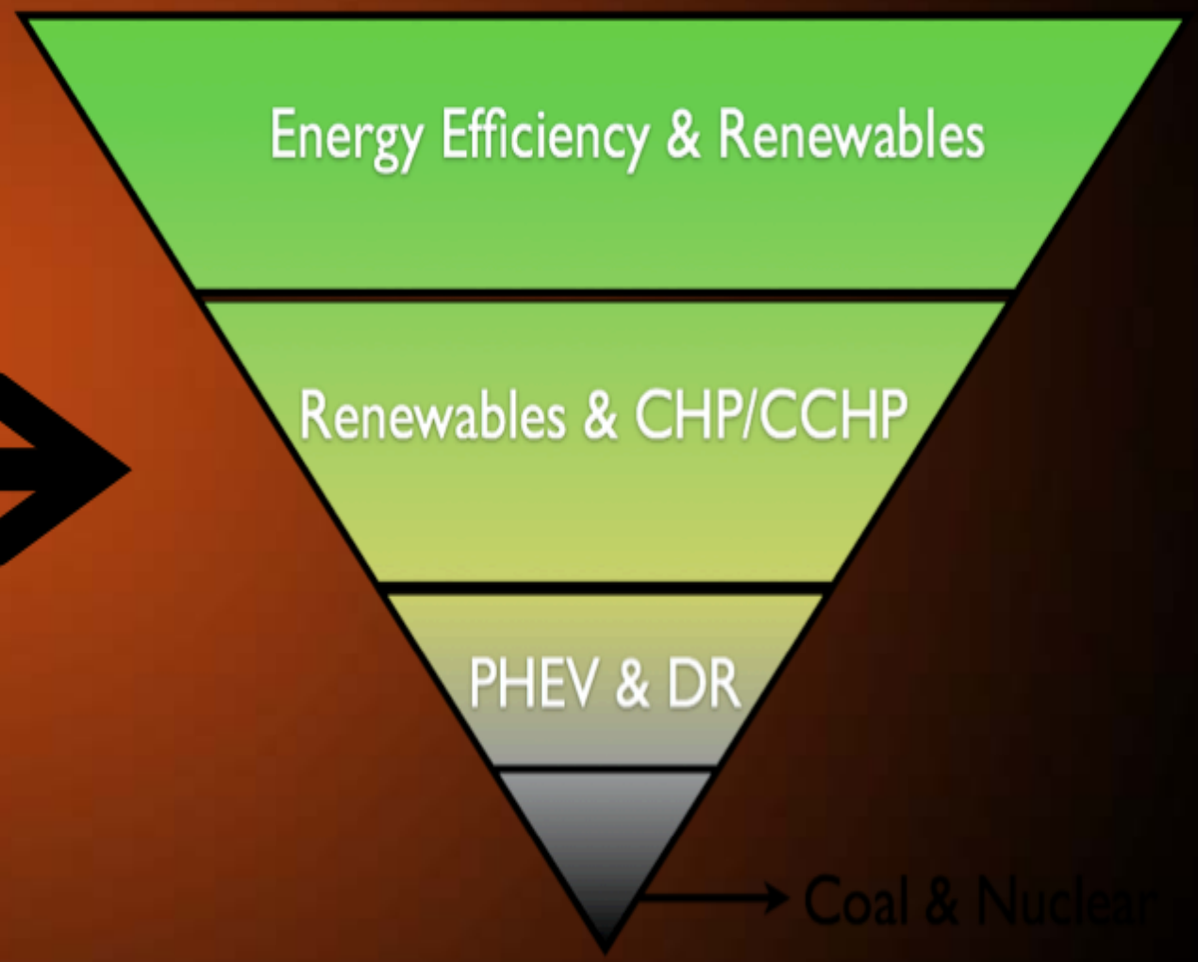
The Next Generation Utility

RMI2009

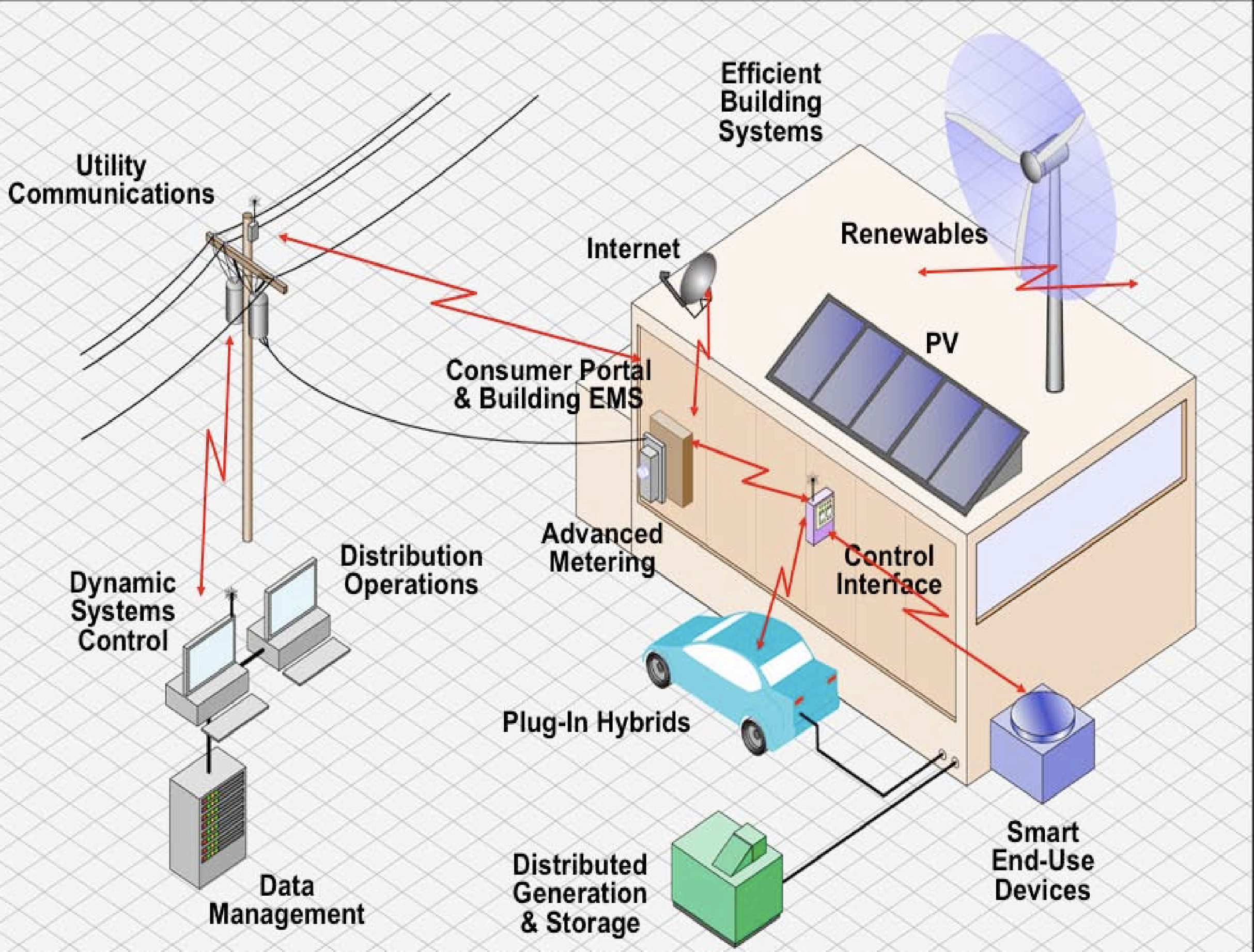
Current utility structure

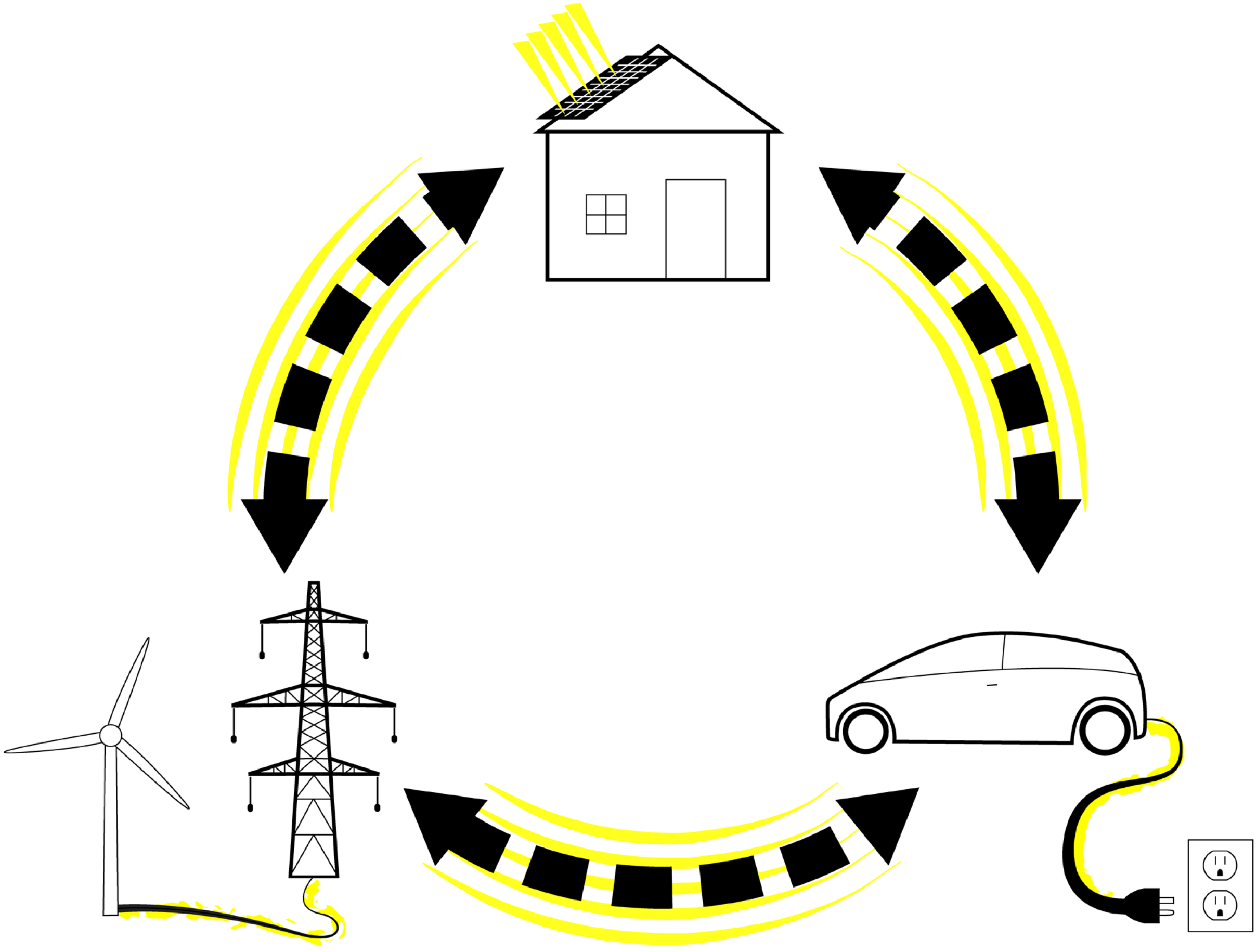


Next Generation Utility



RMI2009


Efficient
Building
Systems
Utility
Communications
Internet
Renewables
PV
Consumer Portal
& Building EMS
Advanced
Metering
Control
Interface
Distribution
Operations
Dynamic
Systems
Control
Plug-In Hybrids
Smart
End-Use
Devices
Distributed
Generation
& Storage
Data
Management



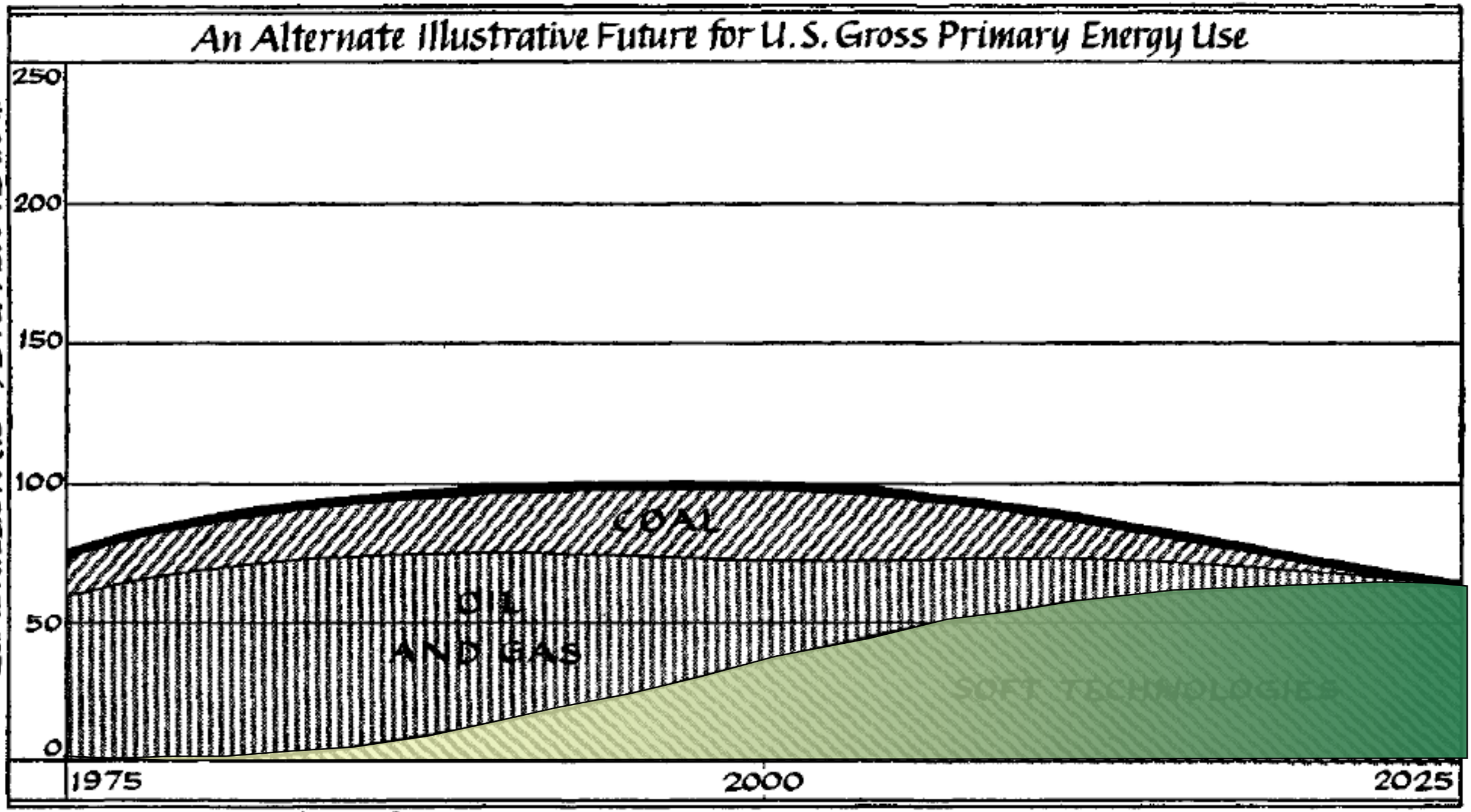
INDUSTRY

Solar Value Chain

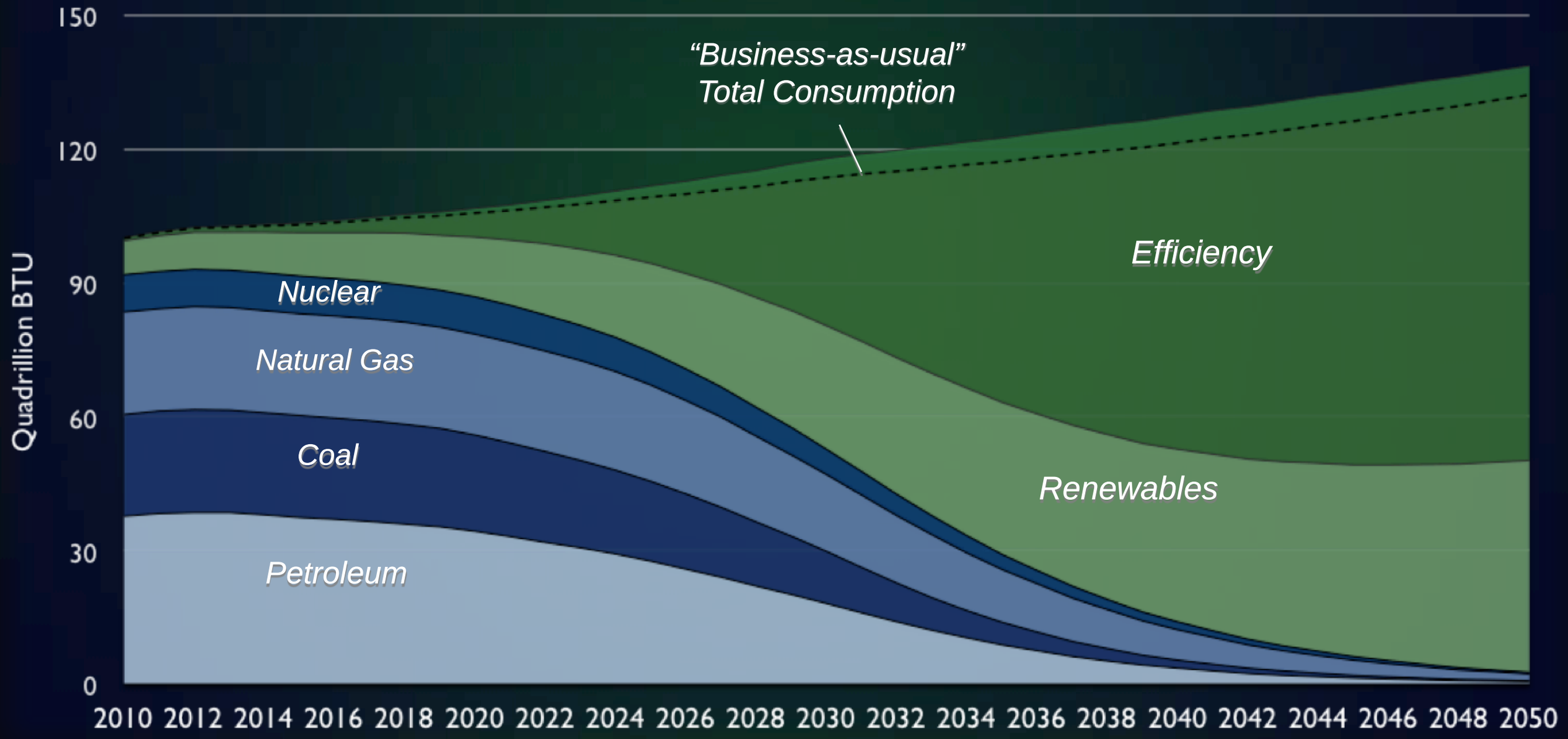
Factor 10 Engineering

The RF Synthesis Project

2010: RMI *initiates a bold plan to speed our shift from coal and oil to efficiency and renewables.*


An Alternate Illustrative Future for U.S. Gross Primary Energy Use
QUADRILLION (10^{15}) BTU PER YEAR *
250
200
150
100
50
0
COAL
OIL AND GAS
SOFT TECHNOLOGIES
1975
2000
2025
* OR QUINTILLION (10^{18}) JOULES PER YEAR

U.S. Energy Consumption



RMI2009

REINVENTING

FIRE

Thank You!

RMI2009

FROM IDEAS TO SOLUTIONS