Houston After (Peak) Oil
Scenarios

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Association for the Study of Peak Oil—USA
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Houston, Texas
United States of America
2007

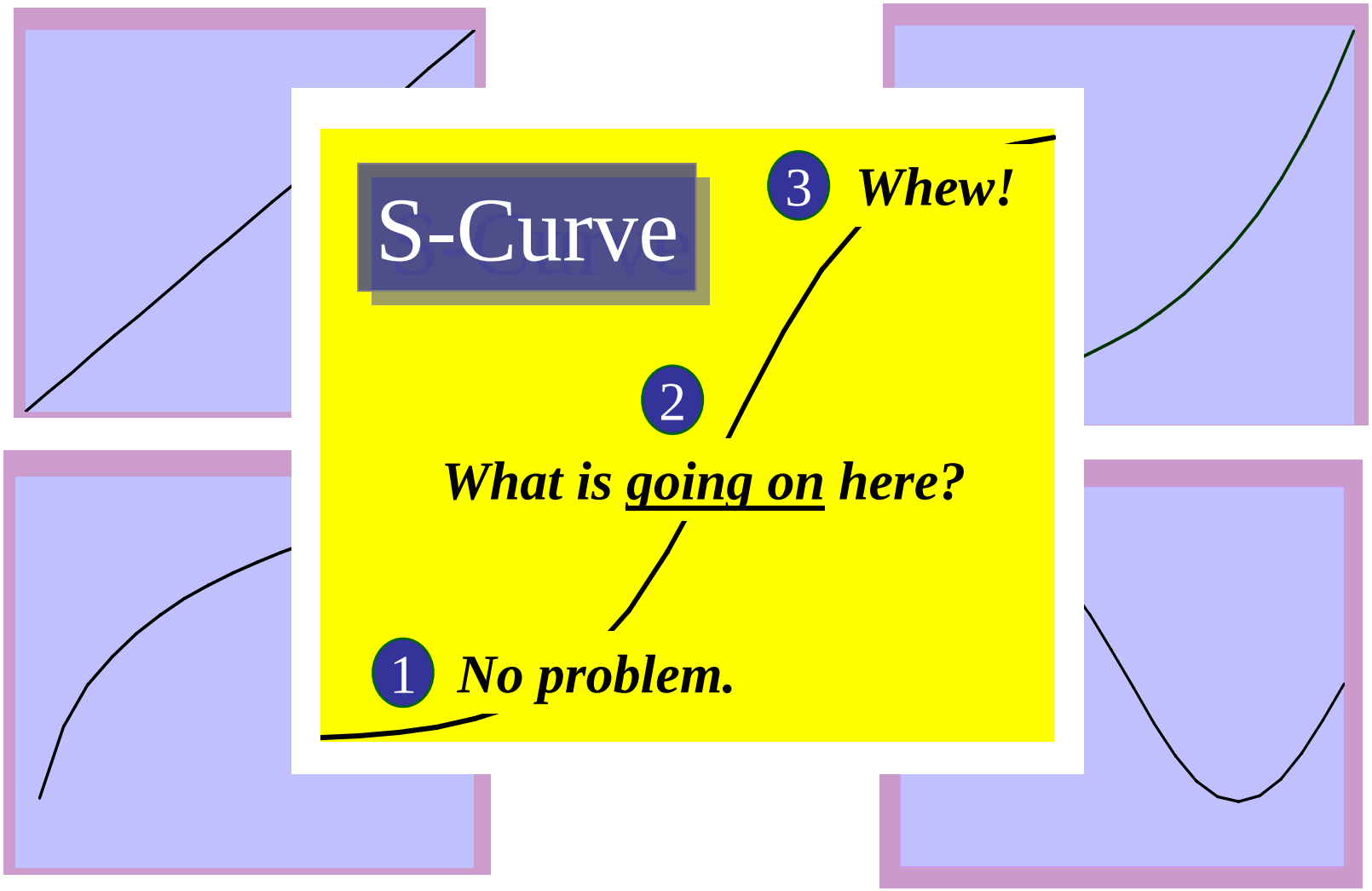
Futures Studies

- The long-term future
- Can’t predict the future over that time; can’t ignore it either
- A set of alternative plausible possibilities – scenarios
- Reflection and discussion more than accuracy and precision
- Peak Oil -- 50% of today’s oil production/consumption by 2020-40 at 2-5% decline rate from 2011.
- Houston transformed?

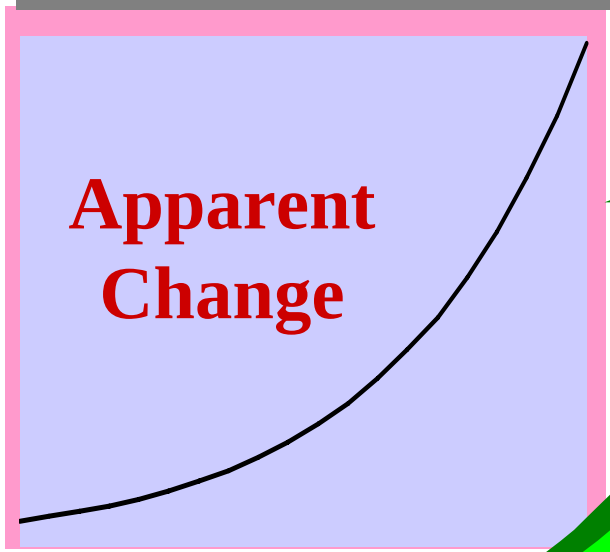
Agenda

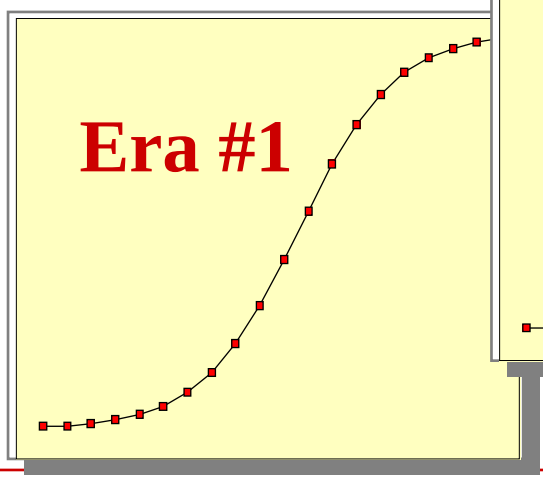
- **Thinking about the future**
- **Houston today**
- **The Houston After Oil scenario**
  - Energy sources
  - Demand efficiencies
    - Transportation
    - Buildings
  - Industry transformation
- **Current developments**
  - Business ventures
  - Research initiatives
  - Government programs
- **Take-aways**

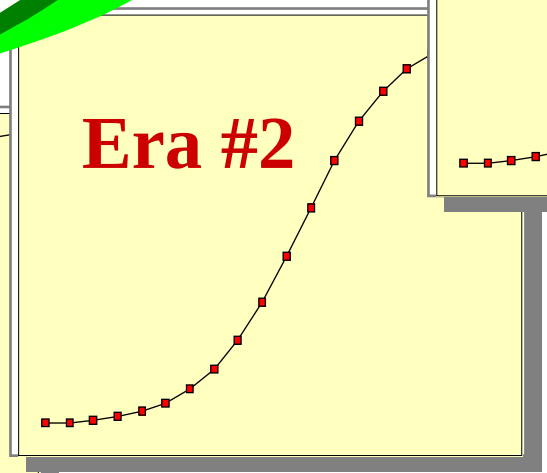
Shape of DISRUPTIVE Change

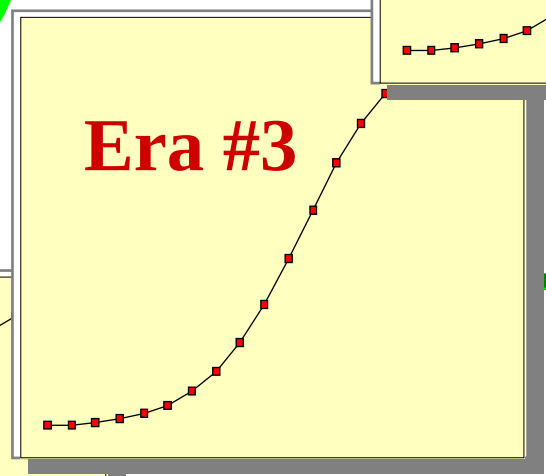


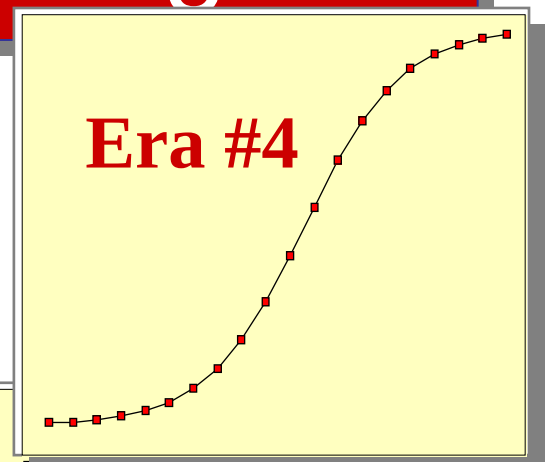
The Escalators of Change











Successive Eras

Different types of society have different primary energy sources.

Increasing energy density

Fossils

Animals

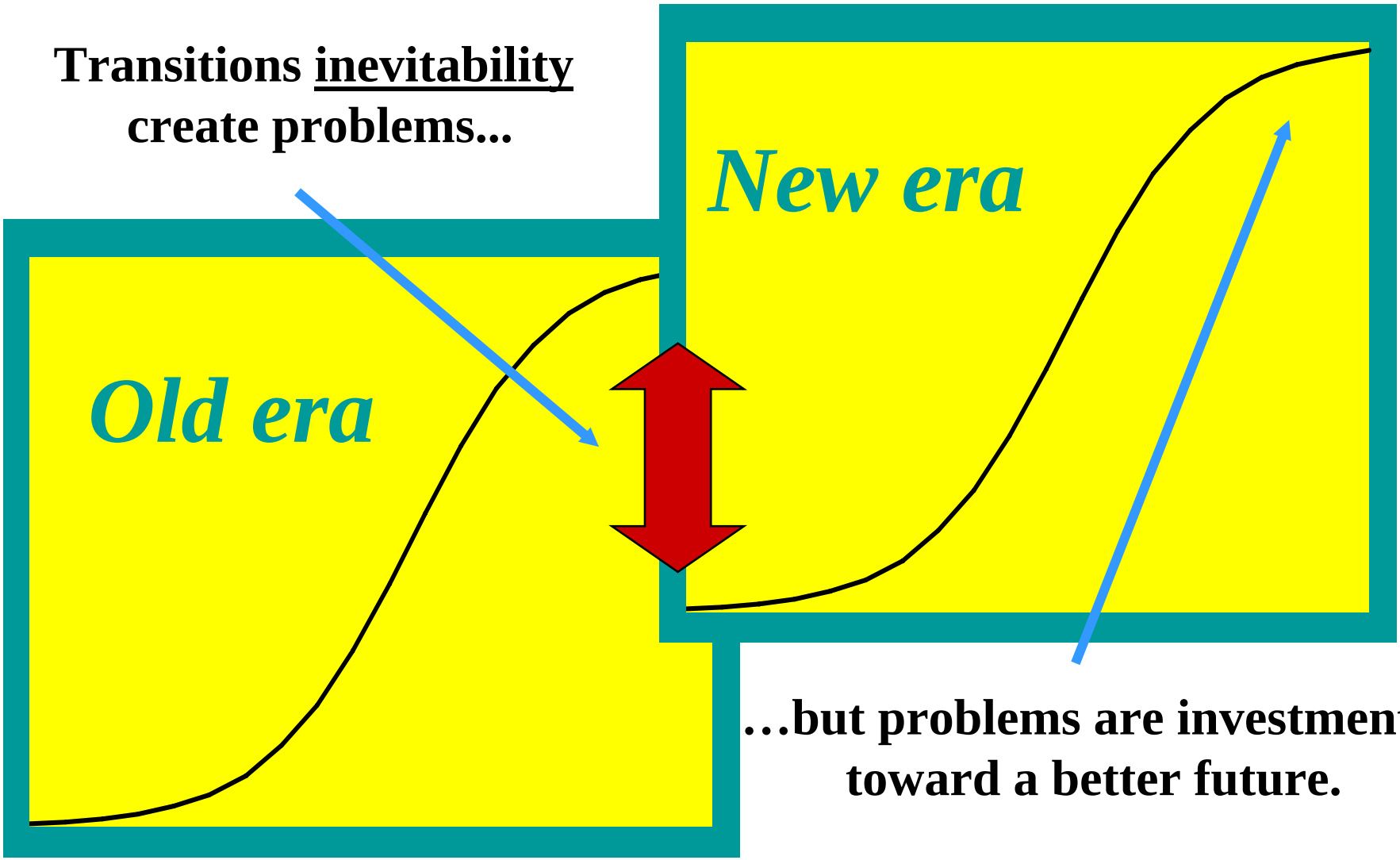
Fire/ Tools

Human/ somatic

The complexity of a society is a function of the energy it has.

The Transformation Problem

Transitions <u>inevitability</u> create problems...

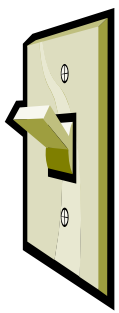


…but problems are investments toward a better future.

The Reality of Change

Improvement

- *Substantive* — *solving problems*
- *Procedural* — *altering procedures*
- *Normative* — *changing attitudes*
- **Cognitive** — **adjusting worldview**

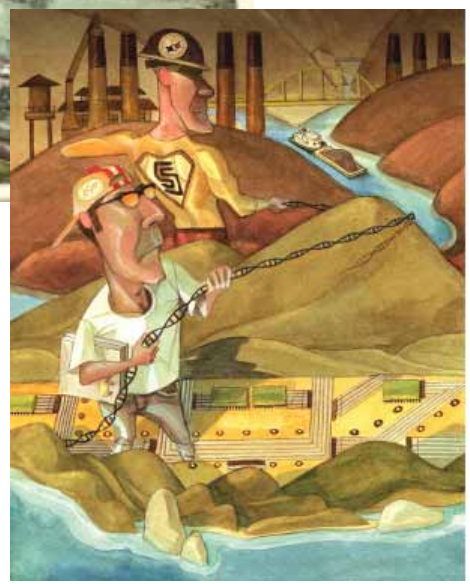


Transformation

Cyclic Cites

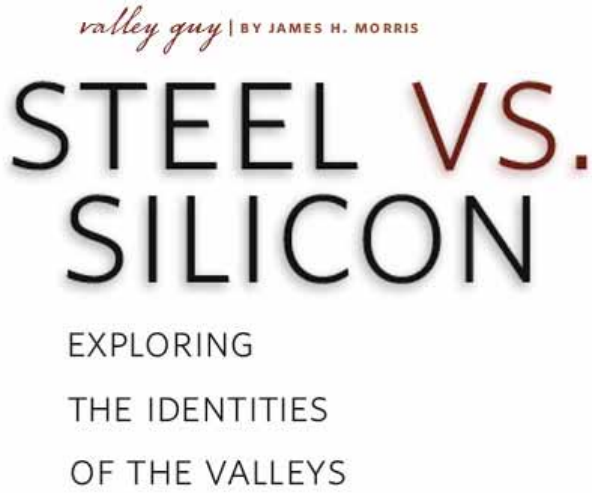
New Bedford MA

Lowell MA

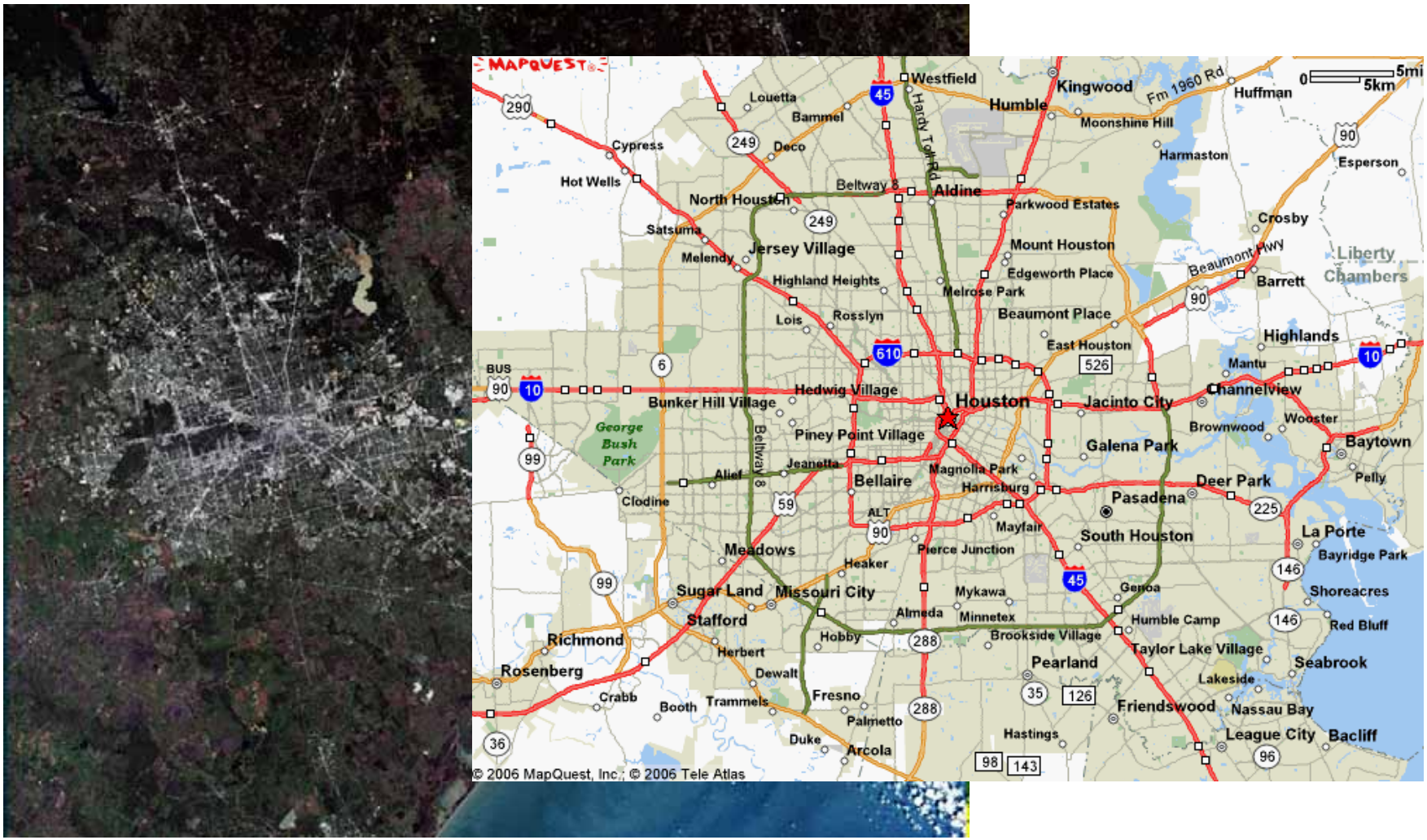


Fort Worth TX

Detroit MI



Houston TX


MAPQUEST
Westfield
Kingwood
Humble
Fm 1960 Rd
Huffman
0 5km 5mi
Louetta
Bammel
Cypress
Deco
Hot Wells
Moonshine Hill
Harmaston
Esperson
North Houston
Beltway 8
Aldine
Parkwood Estates
Satsuma
Jersey Village
Mount Houston
Crosby
Melendy
Highland Heights
Edgeworth Place
Beaumont Pwy
Liberty
Chambers
Barrett
Melrose Park
Lois
Rosslyn
Beaumont Place
Highlands
East Houston
Mantu
BUS
Hedwig Village
Channelview
Bunker Hill Village
Houston
Jacinto City
Wooster
Brownwood
George Bush Park
Piney Point Village
Baytown
Galena Park
Jeanetta
Magnolia Park
Pelly
Alief
Bellaire
Harrisburg
Deer Park
Clodine
Pasadena
ALT
Mayfair
La Porte
South Houston
Meadows
Pierce Junction
Bayridge Park
Heaker
Shoreacres
Sugar Land
Missouri City
Mykawa
Genoa
Stafford
Almeda
Minnetex
Humble Camp
Red Bluff
Richmond
Hobby
Brookside Village
Herbert
Taylor Lake Village
Rosenberg
Pearland
Seabrook
Dewalt
Lakeside
Crabb
Booth
Trammels
Fresno
Friendswood
Nassau Bay
Palmetto
Hastings
League City
Bacliff
Duke
Arcola
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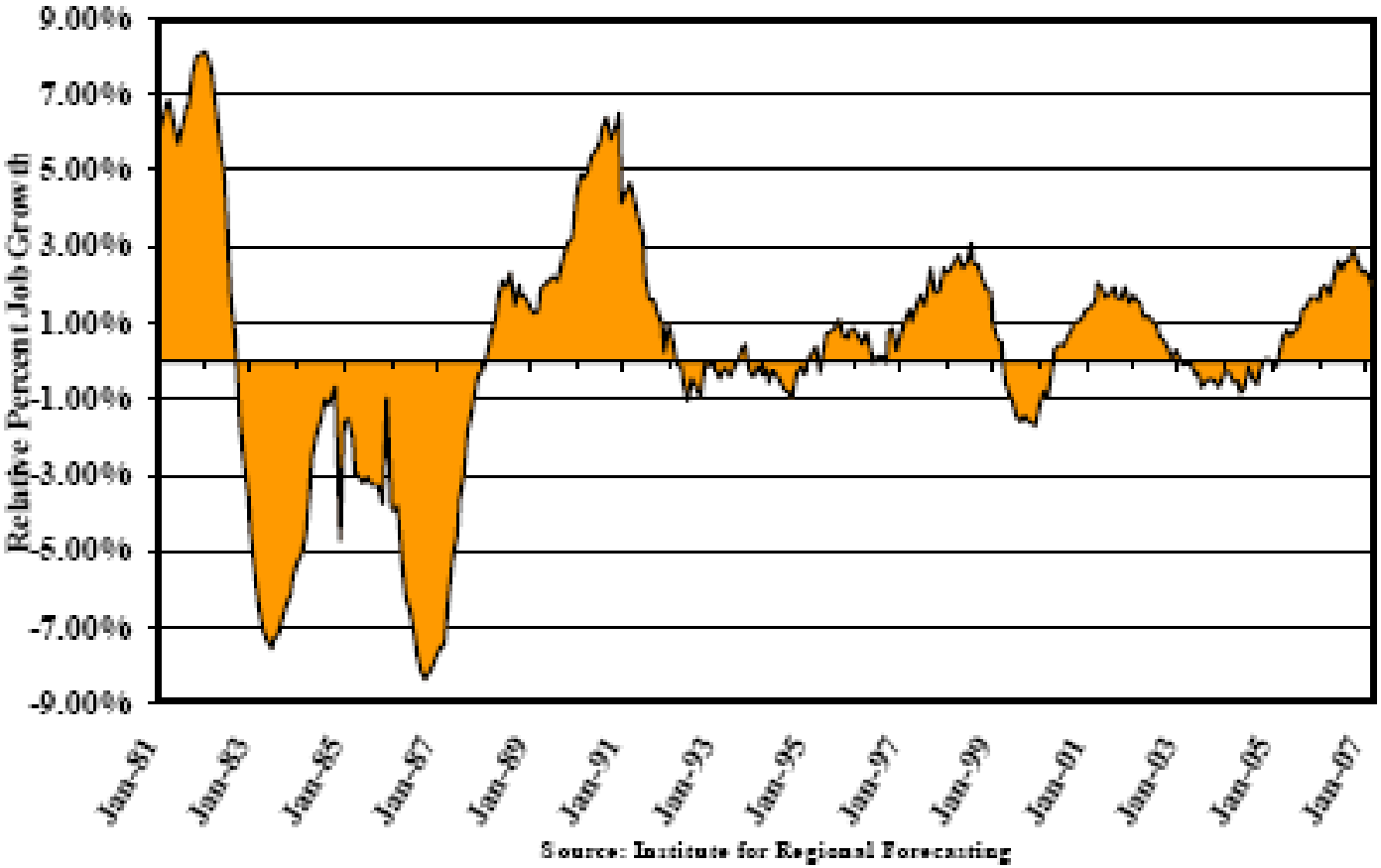
Houston (SMSA) Today

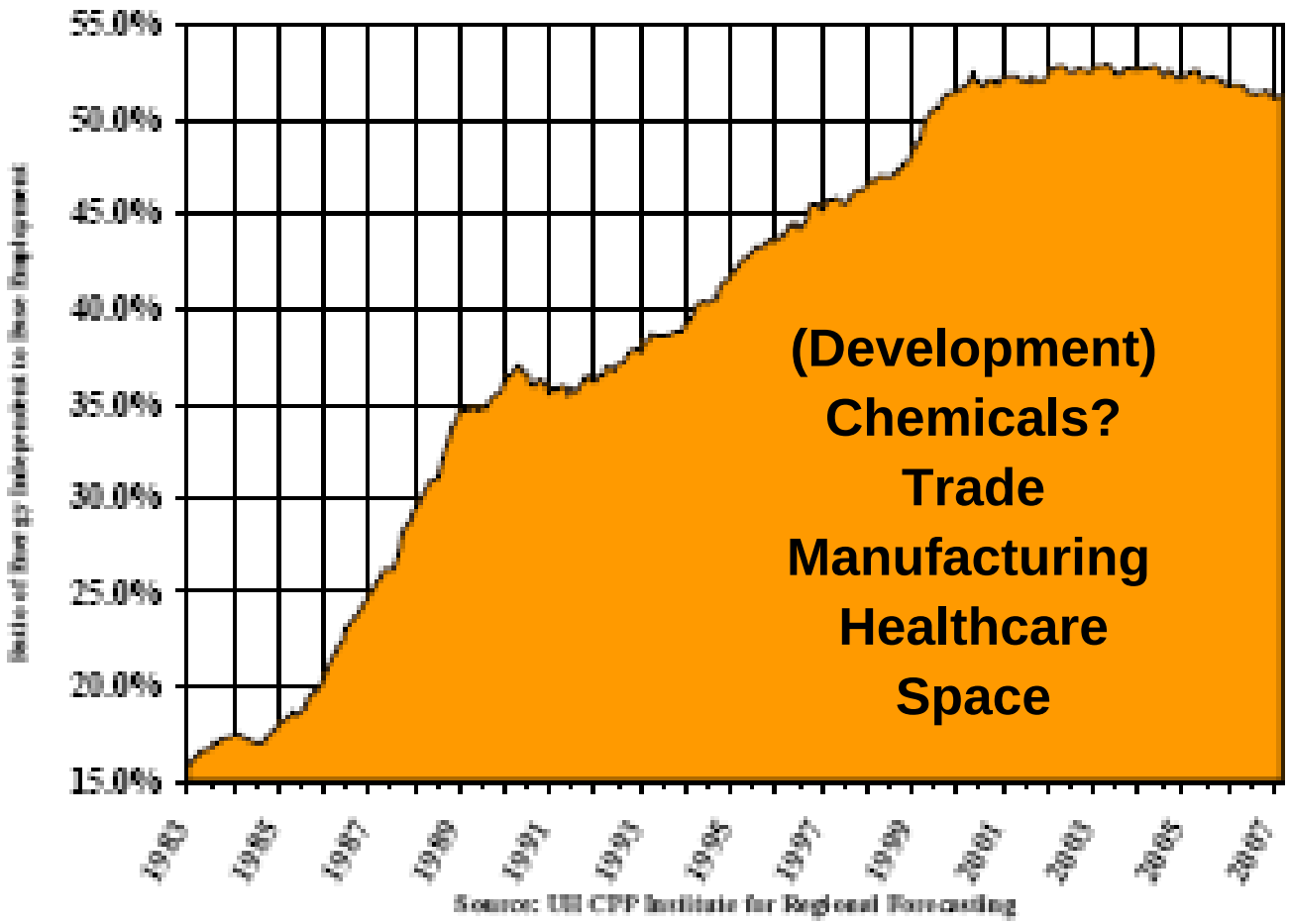
- Population = 4.7 million (20% of TX, 1.5% of U.S.)
- Density (Harris County) = 760 per km^2 *(Compare NYC = 10K)*
- Economy = 50% energy/chemicals
- TX energy = 12 Quads
  - Largest next to CA at 8.1 Q
  - 50% more energy per cap than U.S.; 7x of per cap global
  - 12% more energy intensity than U.S.
- Houston energy -- more industry; more transportation; more cooling

Houston Power Index

Used to being successful



Non-energy Related Industry



The Second Golden Age *or* Indian Summer

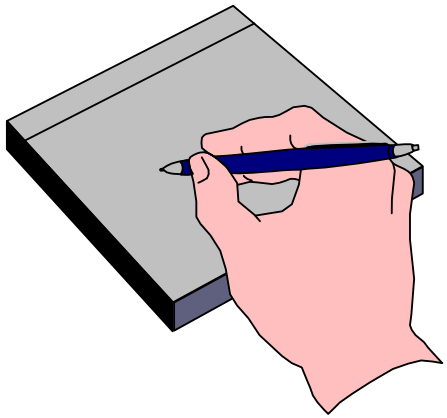
Houston Strengths

- Central to U.S. and NAFTA
- Culturally and ethnically diverse, high immigration rate, attractive
- Experience in science, technology, engineering – petroleum, aerospace, medicine, nanotechnology
- Flexible, entrepreneurial, opportunities for advancement and success
- Used to dealing in large, risky investments
- Inexpensive to live and do business – land, labor, taxes

Houston Liabilities

- Already large and successful, less upside (growth) potential as some cities in developing countries have
- Oil legacy, not as knowledgeable about high tech investment as some other U.S. cities are
- Less educated workforce – lower spending per capita
- More commercial than civic, less support for public/collective action/investment – lower taxes and regulations
- Poor image (industrial) for attracting new talent

The Benefits of Scenarios



*Conveying the **reality** of alternative futures*

- They convey **images** more than facts.
- They contain the **essence** not the details.
- They capture the **assumptions** and forces of the future.
- They **portray** the future in a vivid, engaging manner.

Scenario 2040

- Assumes a relatively smooth transition—i.e., no extreme events (political disruption, atmospheric tipping point, fusion breakthrough, etc.)
- Assumes no insurmountable constraints on other variables
  - **Supply** -- assumes other non-petroleum resources (coal, nuclear, renewables are developed up to capacity and within constraints of externalities)
  - **Demand** -- assumes significant energy efficiencies in production and consumption and consumer behavior and lifestyle modifications to make up the difference
  - **Externalities** – assumes carbon capture and sequestration (CCS) and some measurable limitation on other externalities, such as pollution and waste
- Worse cases emerge to the extent that any of these assumptions turn out differently

Houston 2040

- Population = 8.5 – 12.5 million (+75 to 175%), depending on immigration rate
- Population and Economy projected to increase…

assuming the same energy per cap and per $

- Otherwise, what's the alternative for primary economy?
  - **Energy** -- Electricity?
  - **Chemicals** -- Bio-feedstock?
  - **Trade** -- Transportation energy?
  - **Healthcare** -- Cost?
  - **Space** – Energy?
  - **Immigration** -- Who's hurt the most?

Energy (stationary) 2040

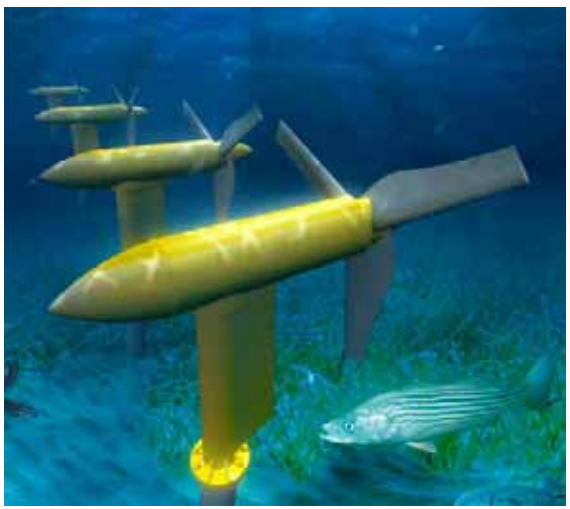
- **Oil** – petrochemicals
- **Natural gas** – large proportion imported as LNG
- **Coal** – at least as much, if not more (CCS and mercury capture)
- **Nuclear** – probably more (Bay City)
- **Renewables** (size?)
  - Centralized – wind, biomass, solar thermal, tidal
  - Distributed – solar thermal, geothermal, PV (needs net metering or local storage), fuel cell (if natural gas), human
- **Storage** (capacity?)
  - Centralized -- pumped water, ice, compressed gas, flywheel, hydrogen
  - Decentralized – battery (lithium?), compressed gas, flywheel, hydrogen

"**Small is big**" -- Robert Hirsch, 10/19/07

Future Energy Images

Current Sources

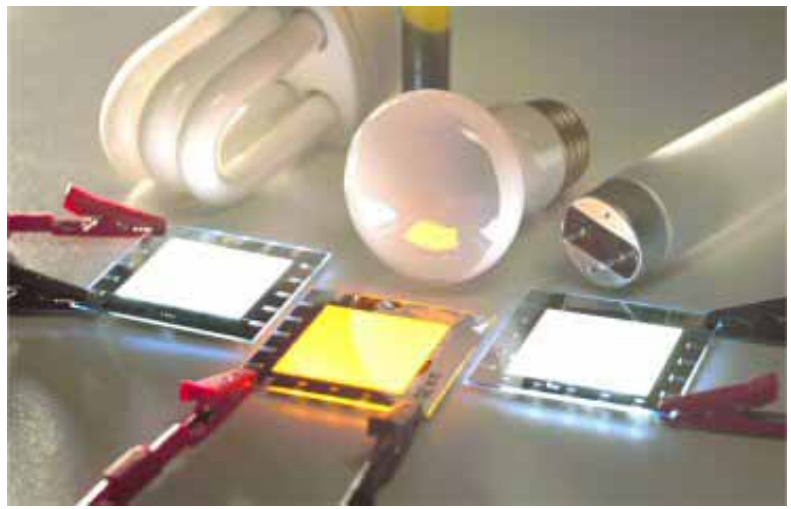
Future Energy Images



New Sources

Future Energy Images

New Devices



Dr. Peter Bishop, Futures Studies, University of Houston

Energy (mobile) 2040

- Personal vehicles – new all plug-ins, but hybrids still in use, no ICE
- Trucks – (bio)diesel-electric with PV assist
- Transit (bus, train) – (bio)diesel-electric with PV assist
- Long distance
  - Rail between large cities along interstates – electric with PV assist, replaces regional airlines (can't compete on fuel)
  - Air for interstate, transcontinental and intercontinental – still jet fuel, but much more efficient engines

Demand Efficiencies

- **Amory Lovins --** *the Matt Simmons of negawatts!*
- **Who does not care about everyday money**?
  - Very poor – don't have any to know about
  - Very rich – don't need to know any (the family treasure)
- **Energy acts like money**
  - Where it comes from -- production : income
  - How we get it -- transmission : checking/EFT
  - Where we keep it -- storage : banking
  - How we use it -- consumption : spending
  - What we get in return -- investment : benefit
- **Macro → Micro –** intelligent, personal generation and use

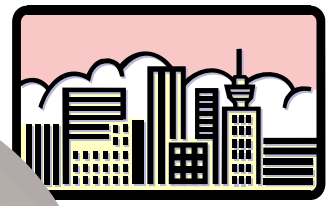
Transportation Efficiencies

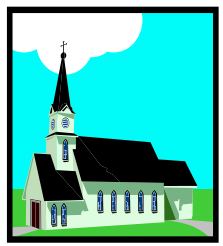
- Real-time monitors on efficiency and other parameters
- More aerodynamic shell
- Closed undercarriage
- TV monitors instead of side mirrors
- Composite material

- Recapture braking *(get correct name)*
- LED (OLED?) lighting – inside and out?
- More efficient tires -- less rolling friction
- ITS with alerts and forecasts
- Toll roads, VMT tax

Going to Work?

Oh,The Places We **Used to** Go!



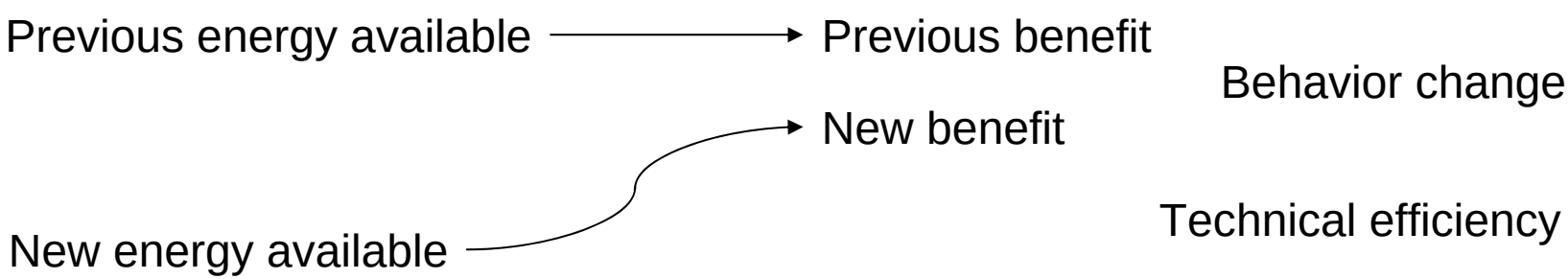


- Fast
- S
- St
- Mov
- Ball P
- Courth
- Church

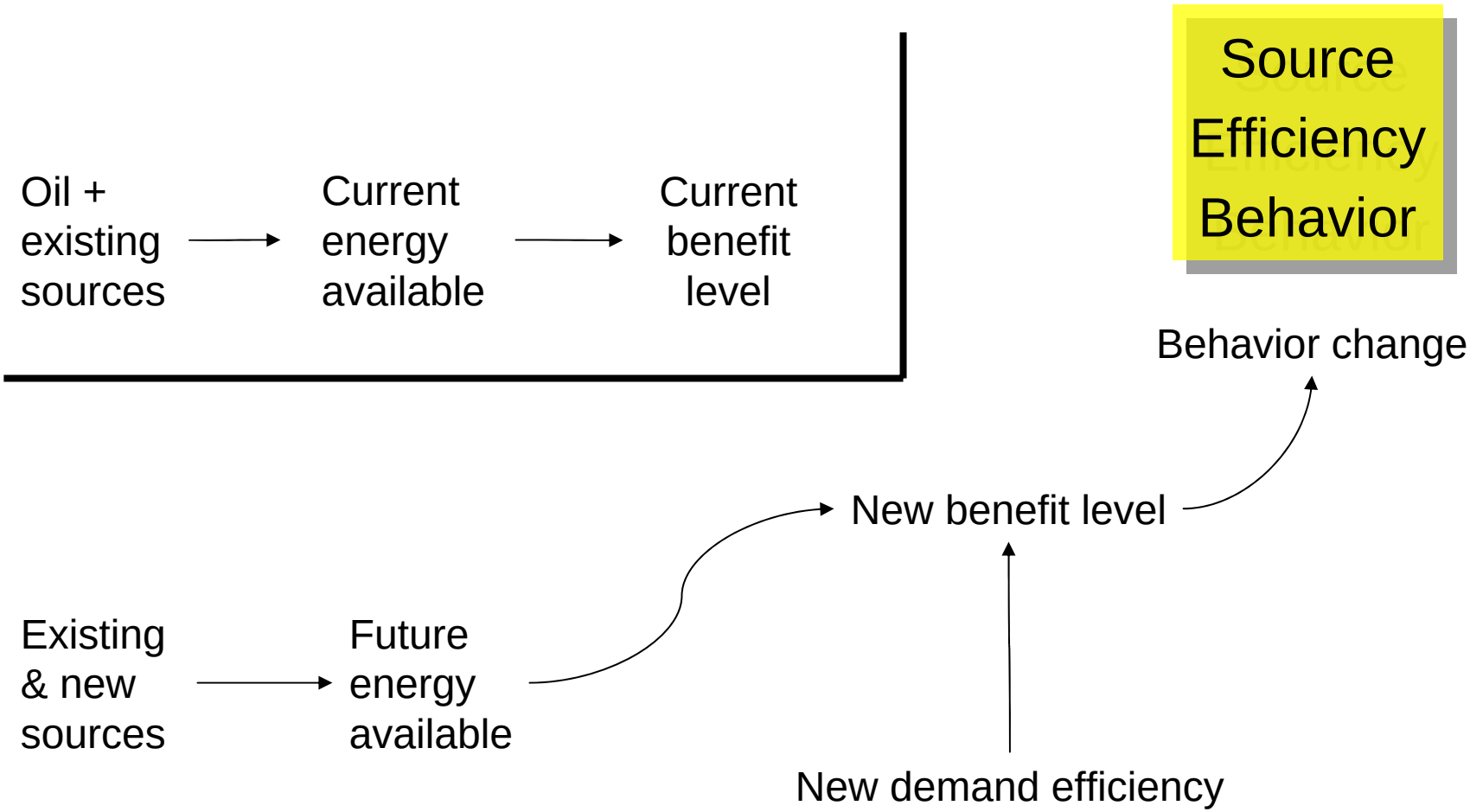
The new transportation device

Behavior Differences

- More natural fabrics, lighter clothes, less formal dress
- Warmer and cooler temperatures
- More directed lighting
- Less vehicular travel – teleconference, telecommute
- Higher proportion of trips using transit (bus, light- and commuter-rail, multi-modal), but most trips still in personal vehicles
- More human power, such as walking, biking, exercise machines
- More local consumption because of higher transportation cost for remote products – food, goods
- More seasonal foods



Elements of the Future



Getting from Here to There

- Business ventures
- Research activities
- Government programs

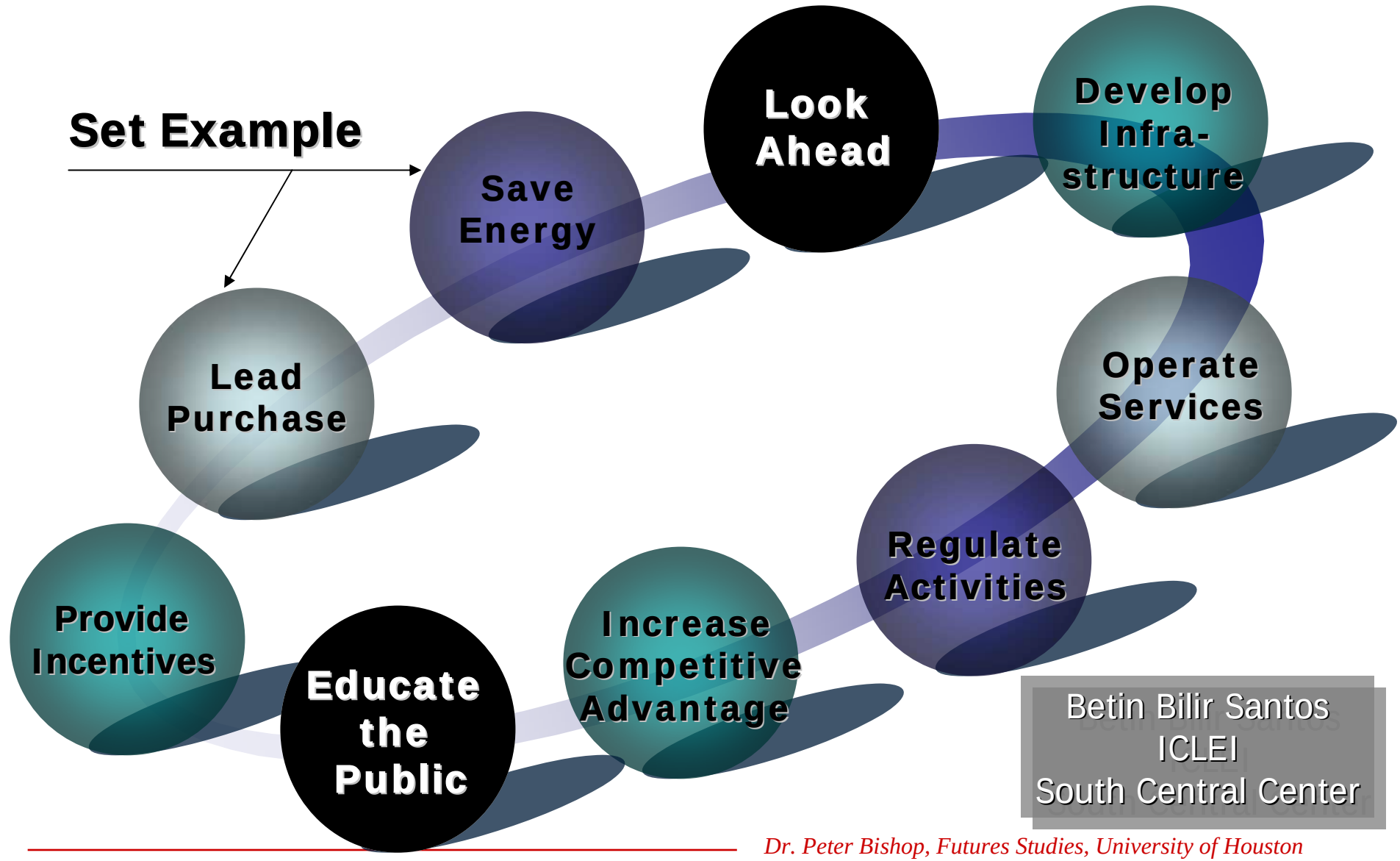
Business Ventures

- **Wind** -- TX largest with 3300 MW
- **Nuclear** -- South Texas Nuclear, Bay City
- **Biofuels** -- two new biodiesel plants, but only 100-350K bpd
- **Solar** (thermal and PV, but not great for Houston)
- **New technology** in Houston – Houston Technology Center has 30 energy clients --
  - 6 are clearly part of this development: 1 fuel cell testing, 1 metal oxide frameworks (superconductivity), 2 nanotechnology, 1 wind and 1 tidal power.
  - 3 are marginal to this problem – more efficient engine and better batteries

Research Initiatives

- **University of Houston** (research area and # faculty involved)
  - Energy exploration – 25
  - Oil & gas production – 14
  - Nuclear energy – 3
  - Alternative energies (solar, wind, hydrogen, fuel cells, biomass/biofuels, hydroelectric, ocean) – 28
  - Energy distribution and transmission -- 19
- **Rice University**
  - Biofuels
  - Carbon Capture and Sequestration
  - Gas Hydrates
  - Nanotechnology
- **Houston Advanced Research Center**
  - CHP – Combined heat and power
  - Fuel cells
  - Nano materials for energy

Functions of Government



Betin Bilir Santos
ICLEI
South Central Center

Houston Initiatives

Look ahead	Hybrid vehicles by 2010
Provide minimum benefit	Pleasantville weatherization (640 homes) Houston HOPE Homes – energy efficient
Educate the public	Educational website www.houstonpowertopeople.com.
Provide incentives	Quick Start for LEED registrations
Lead purchase	1/3 wind power
Save energy	LED traffic lights – 2400 intersections LEED construction Clinton Climate Initiative

A Cyclic City?

Indian Summer on the Bayou

Productivity

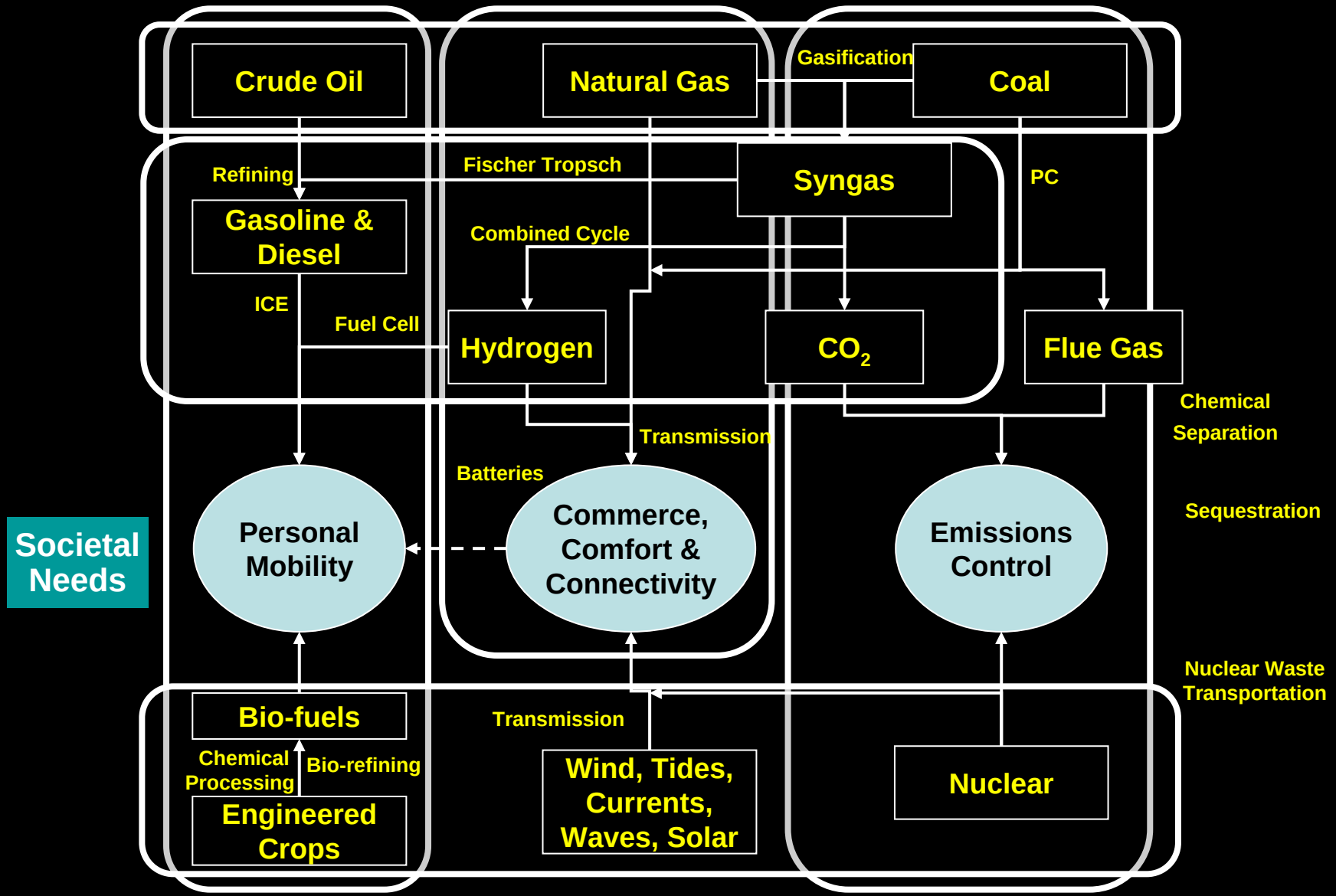
$$\text{Productivity} = \frac{\text{Output}}{\text{Input}}$$

- Output → *More quantity*
- Output → *Better quality*
- Input → *Lower inputs*
- Input → *Shorter time*

Doing More With Less

Source: S. Andrews, ASPO-USA

Complexity



Source: L Sloan, *Terra Incognita*, 2007

Adaptation

- Rules of transformational change –

  "You'll hate the journey, but you'll like the destination."
  - The transition sucks – a new Depression generation
  - But people value the outcome – a new type of society
- The destination
  - Many smaller energy sources used with much higher efficiency
  - Less material consumption and mobility
  - More intangibles – information, communication, experience
  - More awareness, self-sufficiency
- "A nice place to visit, but I wouldn't want to live there."
- For now –
  - Read *Limits to Growth: The 30-year Update*
  - Participate in the Houston After Oil discussion group (http://groups.google.com/group/**HoustonAfterOil**)
  - We'll leave the rest to you!…

2007 Houston World Oil Conference

Proceedings

- Conference Program
- Conference DVD
- Video Highlights
- Peak Oil Review
- ASPO-USA