

Lec #6: Transitioning to a New Paradigm

LAST TIME: Expiring Resources and Crises

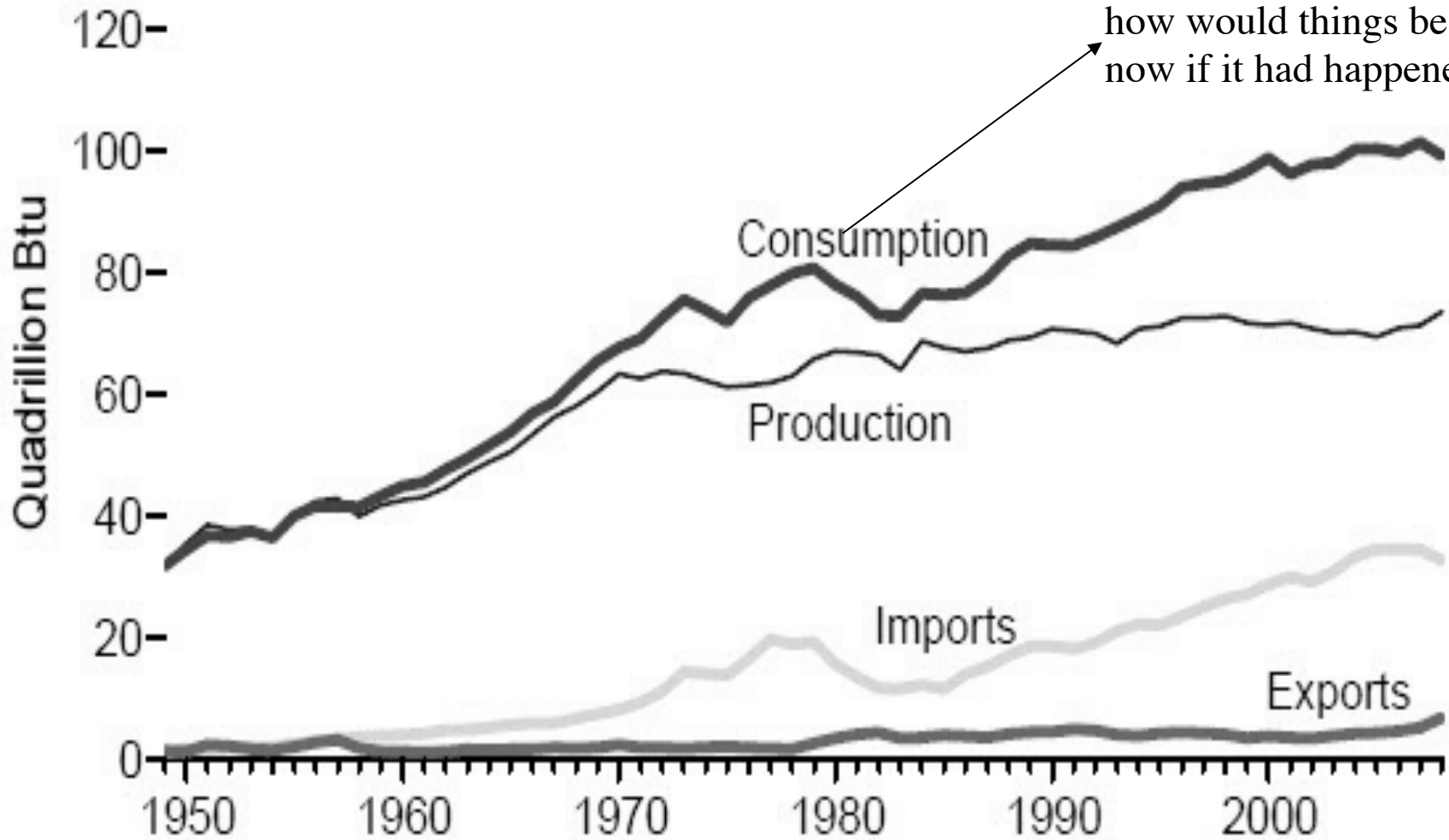
NEXT: Wrap-Up Intro: What Should We Do?

- What to do about Chicken Little?
- A new accounting scheme

NEXT: Mechanical Energy (Chapters 2 & 3)

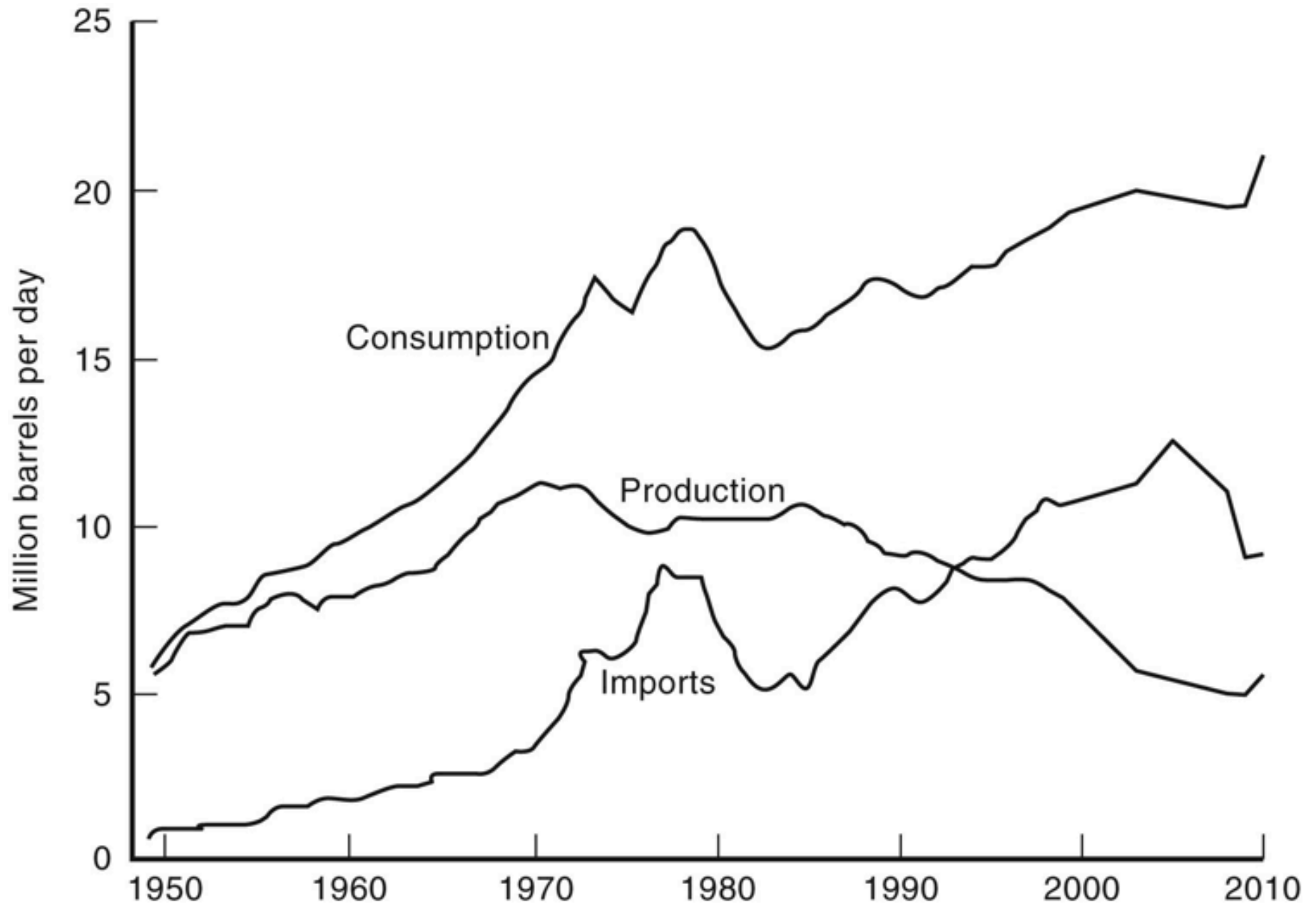
- Forms of Energy
- Laws of Motion; Forces in Nature
- Work, Kinetic Energy, Potential Energy, Power
- Conservation of Energy

US Total Energy Consumption and Production History

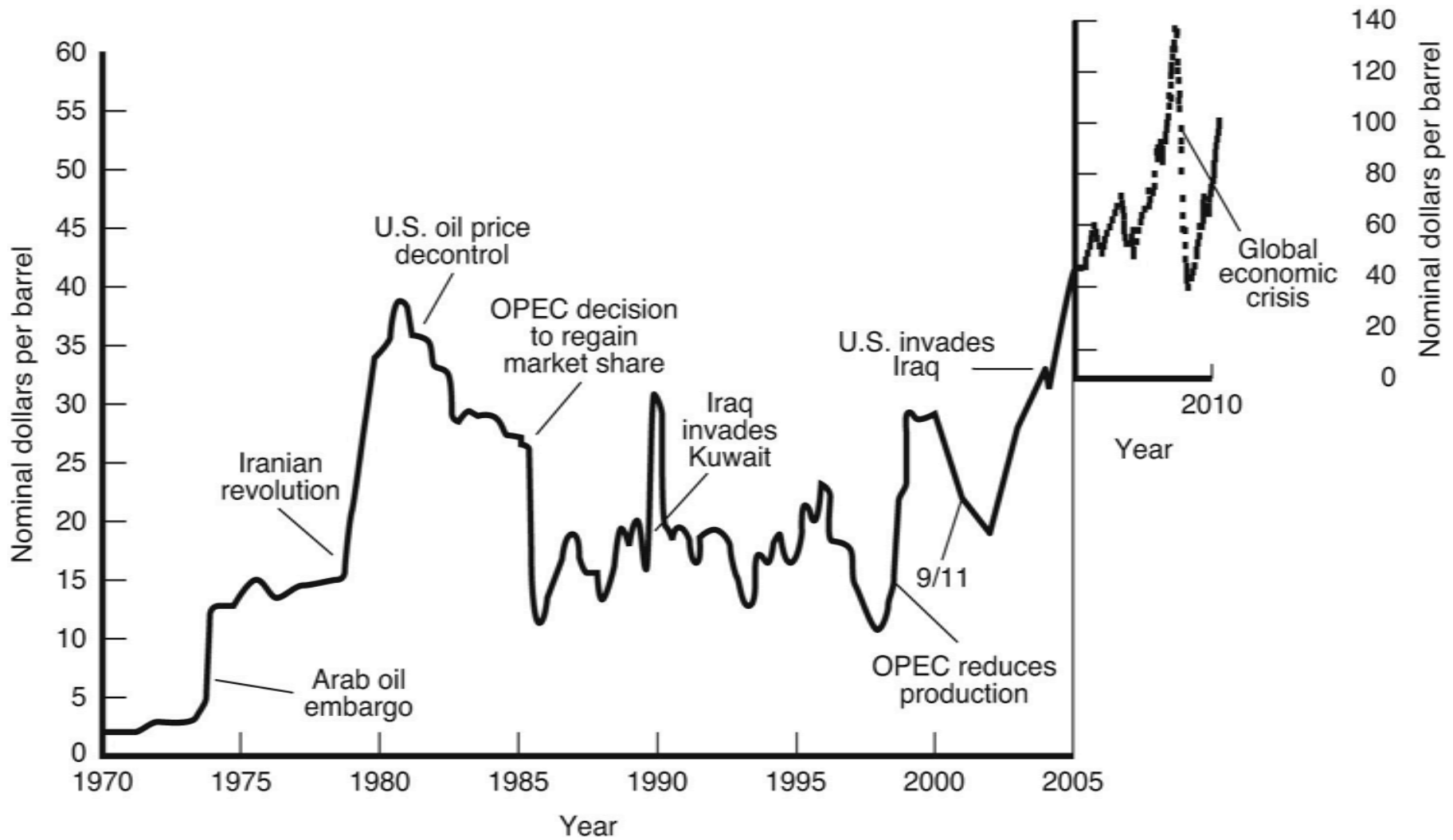


didn't happen; why?
how would things be
now if it had happened?

US OIL Consumption and Production History



Crude Oil Price History



What Then Must We Do?

- Growth must stop. Earth has finite carrying capacity, and we are approaching it (almost certainly in *your* lifetime).
- Per capita use will go up in developing world; hopefully down in developed world.
- Tremendous investment in fossil fuels required.
- Must also accelerate pace of renewables.
- Nuclear power?
- Conservation plays a critical role!

“Consumption” of What?

$$\text{ENERGY IN} = \text{ENERGY OUT}$$

- in: {(energy “content”)+(energy)} + (material & human input)
- out: {(useful energy)+(waste energy)} + (by-products)
 - what is “consumed”? “produced”?
 - what do we want to maximize?
 - what do we want to minimize?
 - Resource consumption can grow much more quickly than population (increased per capita rates)
[e.g. US oil 7%/y until mid 70’s]

ENERGY IN

- Energy Content - natural; provided by gravity, sunlight, or formation of solar system; want to *maximize*, but we can't change it
- Energy Input - (to produce and distribute fuel) some forms are intrinsically more difficult to extract; we should *minimize* this by using efficient sources
- Material and Human Input - finite resources; fossil fuels; often not accounted for in cost of production; would like to *minimize* this effort

ENERGY OUT

- Useful Energy Out - want to *maximize* this to keep up with growth and to keep cost down; use electrical power grids and on-site generation
- Waste Energy Out - unavoidable natural phenomenon in any process; want to find processes that *minimize* or make use of it
- Waste Products - environmental damage --> limitations; want to *minimize* (or find alternative uses for byproducts)

ENERGY FUNDAMENTALS

- Types of Energy
 - mechanical
 - thermal
 - chemical
 - nuclear
 - radiant (electromagnetic)
 - electrical
- How can we calculate how much energy is available but hidden?
- How can we tap into it?

Total amount of energy is constant.

We cannot create or destroy energy, only **convert** it.

But sometimes conversions produce useful things...

Table 2.2 ENERGY CONVERSIONS

Conversion From:	To Chemical	To Electric	To Heat	To Light	To Mechanical
Chemical	Food Plants	Battery Fuel cell	Fire Food	Candle Phosphorescence	Rocket Animal muscle
Electrical	Electrolysis Electroplating	Transistor Transformer	Toaster Heat lamp Spark plug	Fluorescent lamp Light emitting diode	Electric motor Relay
Heat	Gasification Vaporization	Thermocouple	Heat pump Heat exchanger	Fire	Turbine Gas engine Steam engine
Light	Plant photosynthesis Camera film	Solar cell	Heat lamp Radiant solar	Laser	Photoelectric door opener
Mechanical	Heat cell (crystallization)	Generator Alternator	Friction brake	Flint Spark	Flywheel Pendulum Water wheel

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Mechanical Energy: the energy associated with MOTION