Introduction to Market and Business Strategy Perspective

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Today: green chemistry meets business strategy

- **What is happening inside the companies in the biofuels ind?**
  - Business challenges
- **Relationship between business and environmental goals**
  - Synergies
  - Conflicts

Business element of course

- **What is driving business growth and innovation?**
- **Market structure of biofuel industry**
  - What companies are making what?
  - Structure of competition – within and between sectors
- **How close to/ far from successful commercialization are companies producing specific biofuels?**

Business element of course

- **Barriers: What problems have companies run into?**
  - **Economic, technological, internal organizational, political etc.**
    - How serious are these problems?
    - What are the solutions?

Big picture

- **Are things moving in a "good" direction from a health and env sustainability perspective?**
  - **Can they be put on a better track?**
  - **What policies, technological breakthroughs, other changes would help?**
    - How feasible? (organizationally, economically, politically etc.)
    - Strategies for getting there?

New level of complexity

- How we should we define "success?"
- What is it
  - in business terms?
  - in climate change terms?
  - in broader green chemistry terms?

This is a potentially huge transition for whole energy industry

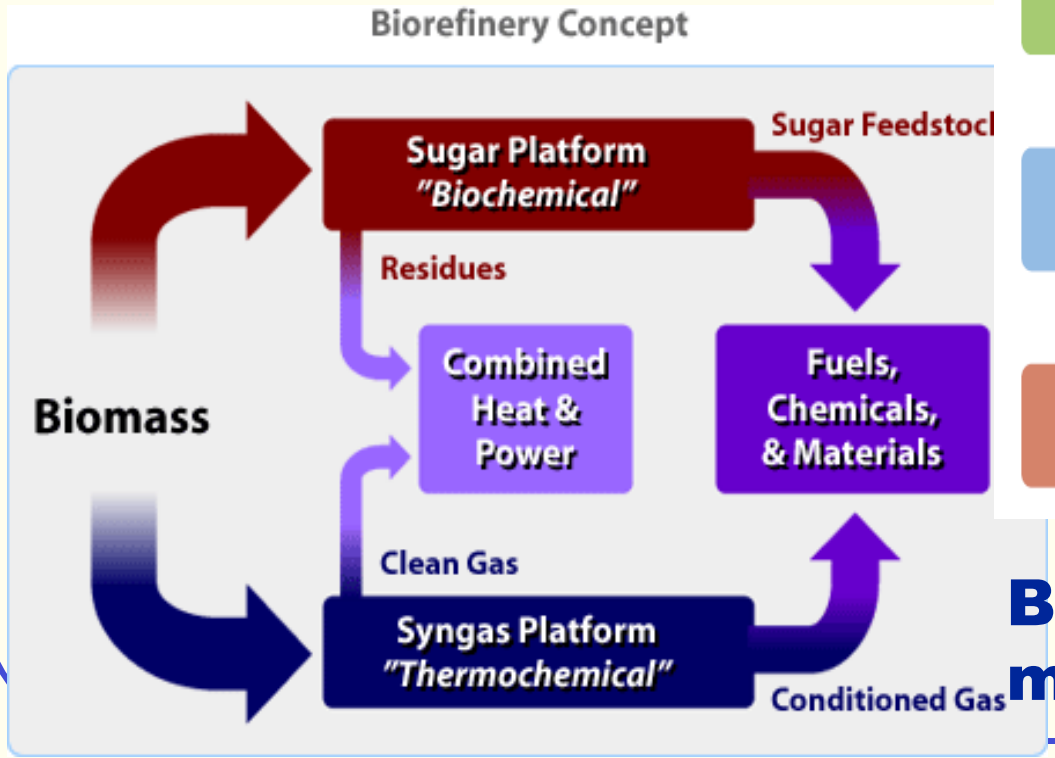
- **Technological/design revolution**
- **Systems change**
  - **Could be like**
    - water power to coal steam?
    - buggies and whips to cars?
    - print media to digital media?
- **Lots of $$ at stake**
- **Winners and losers**

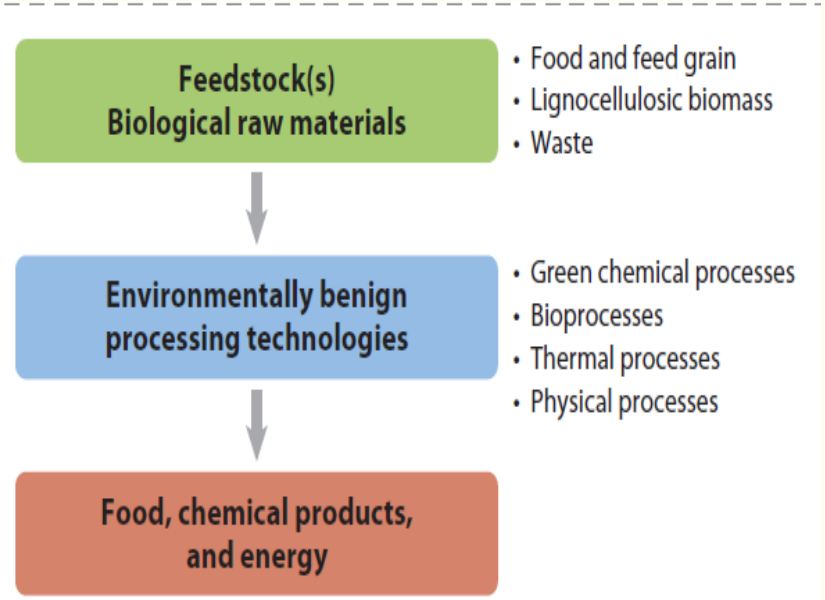
Today's game plan

- **General overview of business dimension**
- **Focus on this part:**
  - Competitiveness and complexity of biofuels market
    - Broader significance of this
  - **In class exercises**
  - Barriers to commercialization and sources of competitive advantage

The biofuels business

- **We've been talking about flows of materials and energy**





Businesses produce & manage these flows!

Long value chain of businesses involved with biofuels

- Venture capitalists
- Feedstock producers (biomass and other inputs)
- Feedstock processors
- Bio-refineries
- Distributors
- Car and airline manufacturers
- Electric utility companies
- Etc.

Biofuels firms are differentiated in many ways:

1. **Scale, independence, age etc.**
   - **Start-up companies**
     - (private vs public)
     - (new vs more mature)
   - **Big oil and petrochemical companies with biofuel initiatives**
     - (well vs poorly supported)
     - (new vs more mature)

Firms are differentiated in many ways:

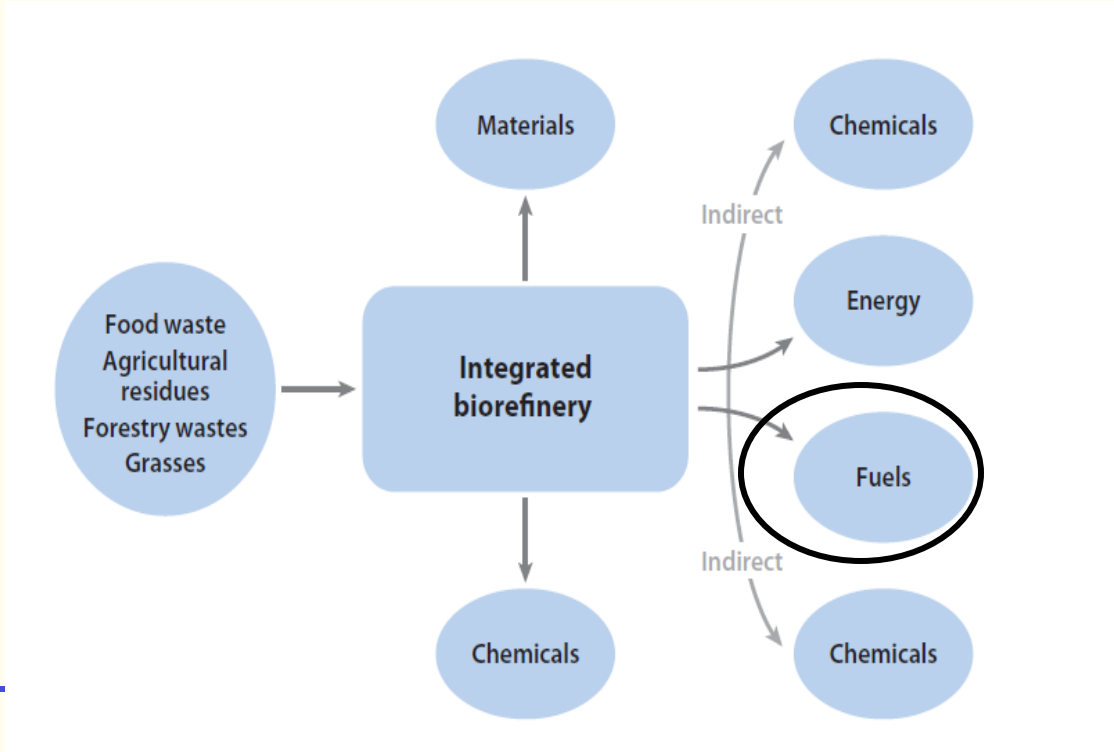
- **Range of feedstocks utilized**

Classification	Feedstock	Examples
Dedicated feedstocks	Sugar crops	Sugar beet, sugarcane
	Starch crops	Wheat, corn, sweet sorghum
	Lignocellulosic crops	Wood, short-rotation poplar, switchgrass, *Miscanthus*
	Oil-based crops	Rapeseed, soy, palm oil, *Jatropha curcas*
	Grasses	Green plant materials, grass silage, immature cereals, plant shoots
	Marine biomass	Micro- and macroalgae, seaweed
Residues	Oil-based residues	Animal fat from food industries; used cooking oil from restaurants, households, and others
	Lignocellulosic residues	Crop residues, sawmill residues
	Organic residues and others	Organic urban waste, manure, wild fruits and crops

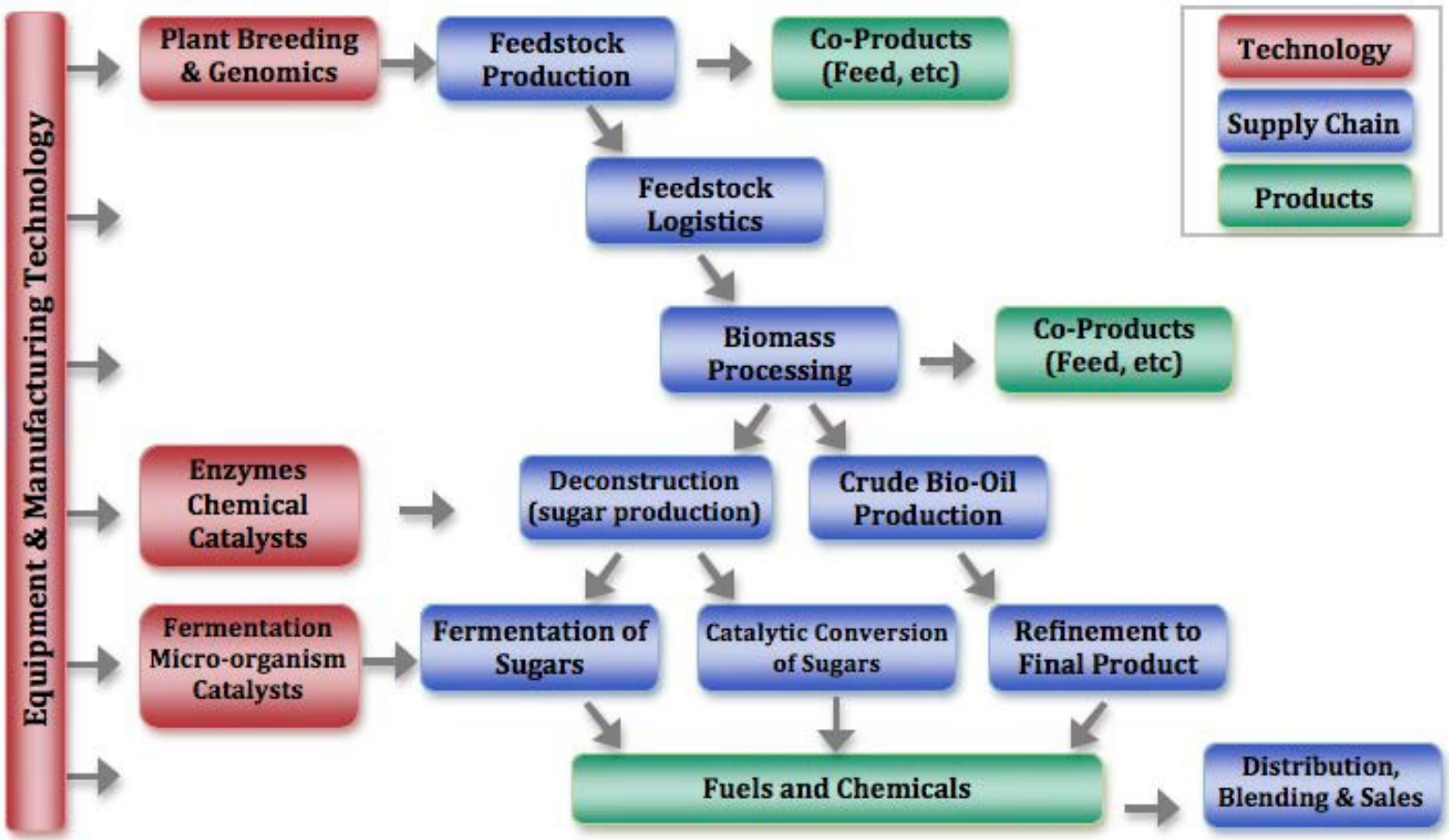
Clark, Luque, Matharu, (2012), p. 200

Firms are differentiated in many ways:

- **Levels of integration**
  - **into feedstock processing**
  - **chemicals and other co-product manufacturing**

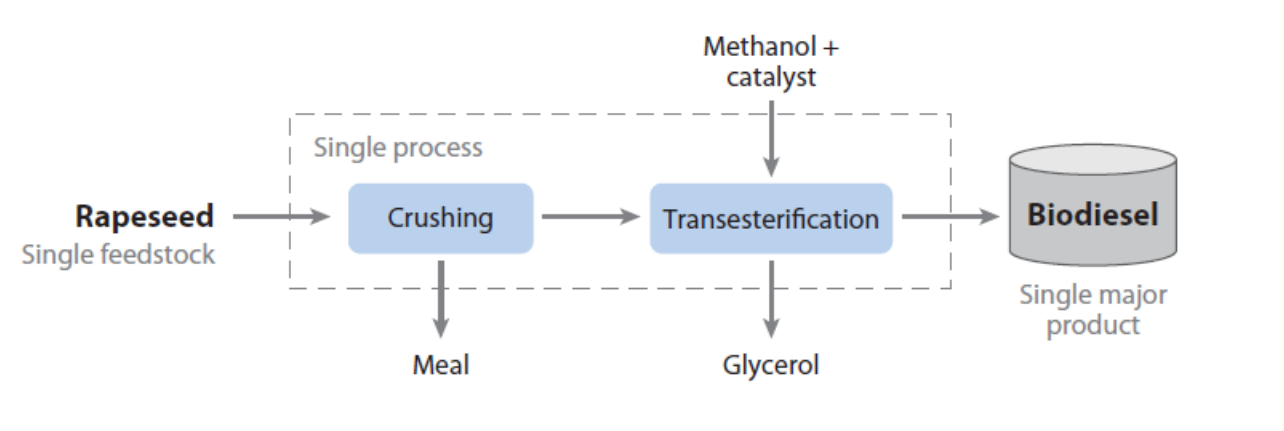


Integrating the value chain



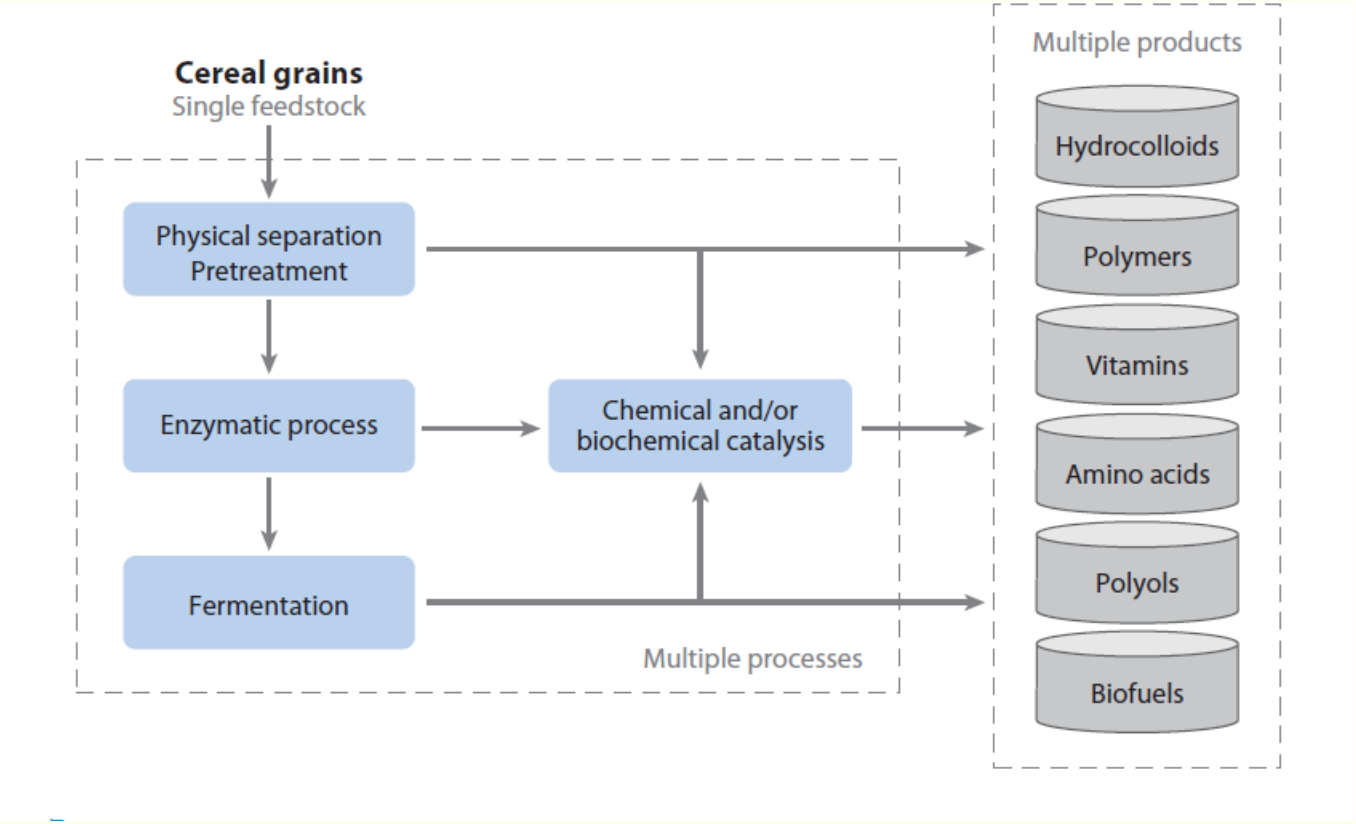
Solecki et als, 2012, p. i

“Phase I” Bio-refinery



Clark, Luque, Matharu, (2012).

Phase II Bio-refinery



Clark, Luque, Matharu, (2012).

Firms are differentiated in many ways:

- **Process technologies utilized**

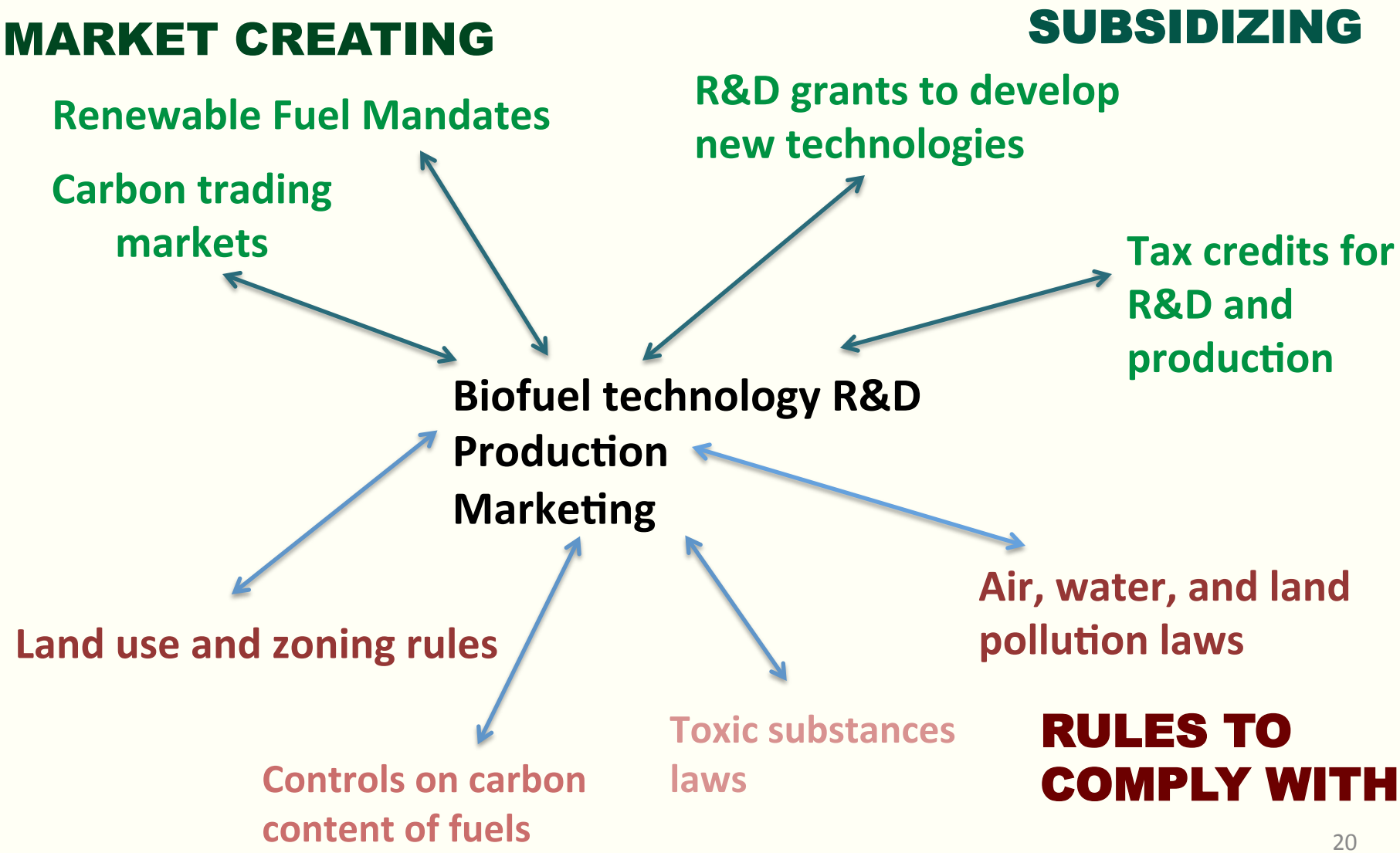
Company	2011 $/ gallon	Year	Fuel Type	Feedstock	Conversion Technology
Aliphajet	$0.75	2017	Diesel, Jet, Gasoline	Oils, Fats	Boxcar
Fulcrum	$1.30	2014	Ethanol	MSW	Gasification
Joule	$0.60	2013	Ethanol, Diesel (cost with subsidies)	sunlight	Photosynthetic micro-organisms
Kior	$1.80	2012	Renewable Gasoline, Diesel	Woody Biomass	Pyrolysis
POET	$3.00	2013	Cellulosic Ethanol	Cellulosic	Biochemical
Solazyme	$3.44	2015	Crude Oil	Sugars	Microalgae
Study	**2011 $/ gallon**	**Year**	**Fuel Type**	**Feedstock**	**Conversion Technology**
DOE MYPP	$2.51	2012	Cellulosic Ethanol	Corn stover	Biochemical
DOE MYPP	$2.02	2012	Cellulosic Ethanol	Woody	Gasification
DOE MYPP	$2.01	2012	Cellulosic Ethanol	Corn stover	Biochemical
DOE MYPP	$2.44	2017	Gasoline, Diesel	Wood	Pyrolysis
NAS	$4.66	2015	Gasoline	Cellulose	Low Temp Gasification
NAS	$5.21	2015	Gasoline	Cellulose	High Temp Gasification
EPA	$2.24	2022	Diesel	Biomass	Thermochemical
EPA	$4.92	2022	Biodiesel	Algae	Microalgae

- **How much financing and other resources they've mobilized**
- **How far along toward successful commercialization**

Key Drivers of Growth:

- **Market creating regulation**
- **Public funding and incentives**
- **Private investment**
- **Sufficient?**
- **Appropriately targeted?**

Complexity of Policy Environment



Other drivers

- **What else is stimulating growth?**
  - **Scientific advances?**
  - **Market demand?**
  - **“Societal need”?**
  - **Entrepreneurial spirit?**
  - **Other?**

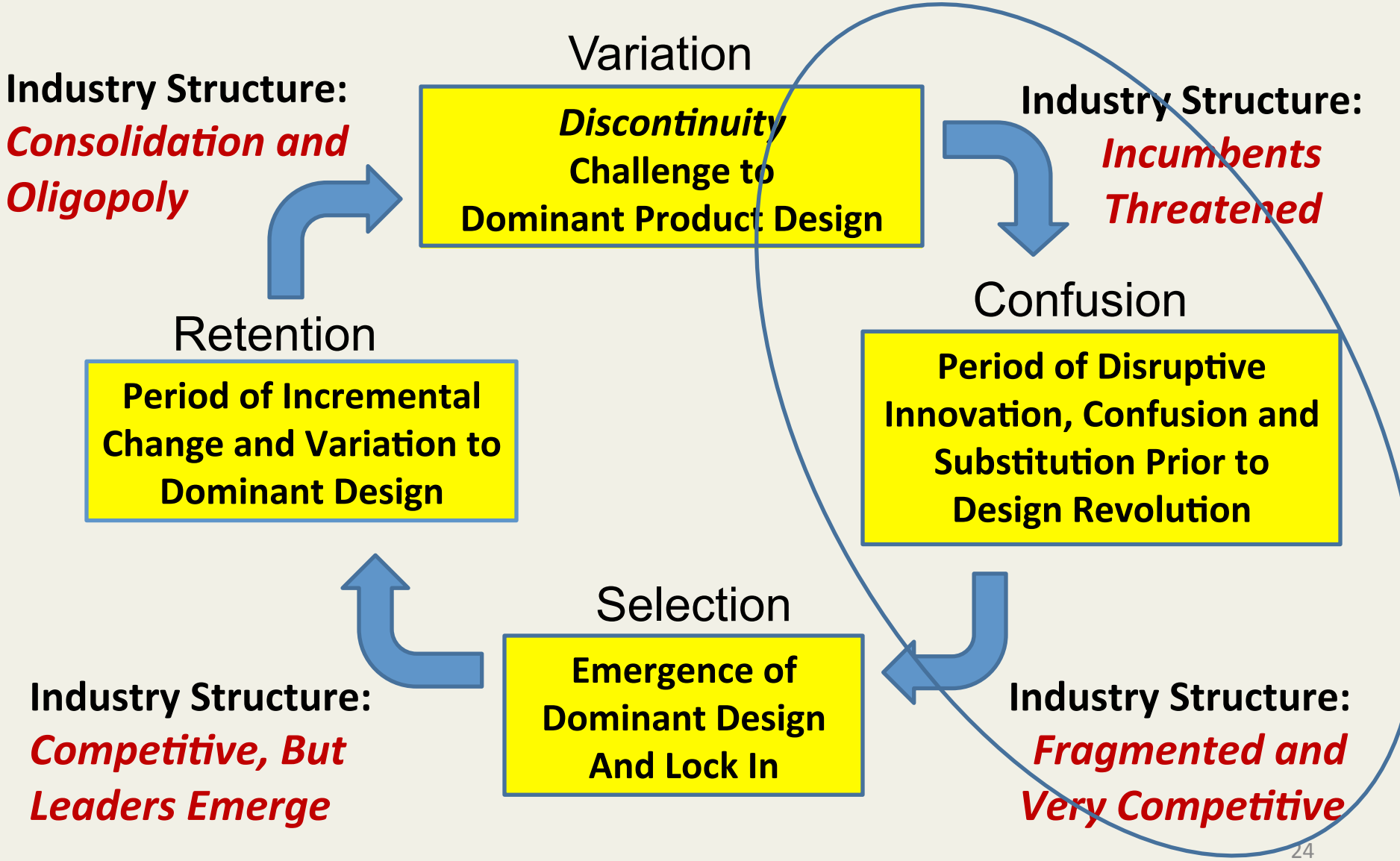
Huge market transitions in the making

- ***From conventional energy company domination (big oil companies, public utilities):***
  - Large, highly centralized, huge economies of scale, mature technologies, relatively low cost commodities
  - Market structure: Oligopolistic or regulated monopolies
- ***To a much more competitive structure***
  - Small start ups (and projects inside large conventional oil cos.)
  - Technologies evolving quickly, fewer economies of scale, higher costs
  - Intense competition

Huge implications for

- Entrepreneurs, start ups
- Conventional oil companies
- Vehicle manufacturers and transportation systems
- Public utilities
- Investors
- Policy makers
- Consumers

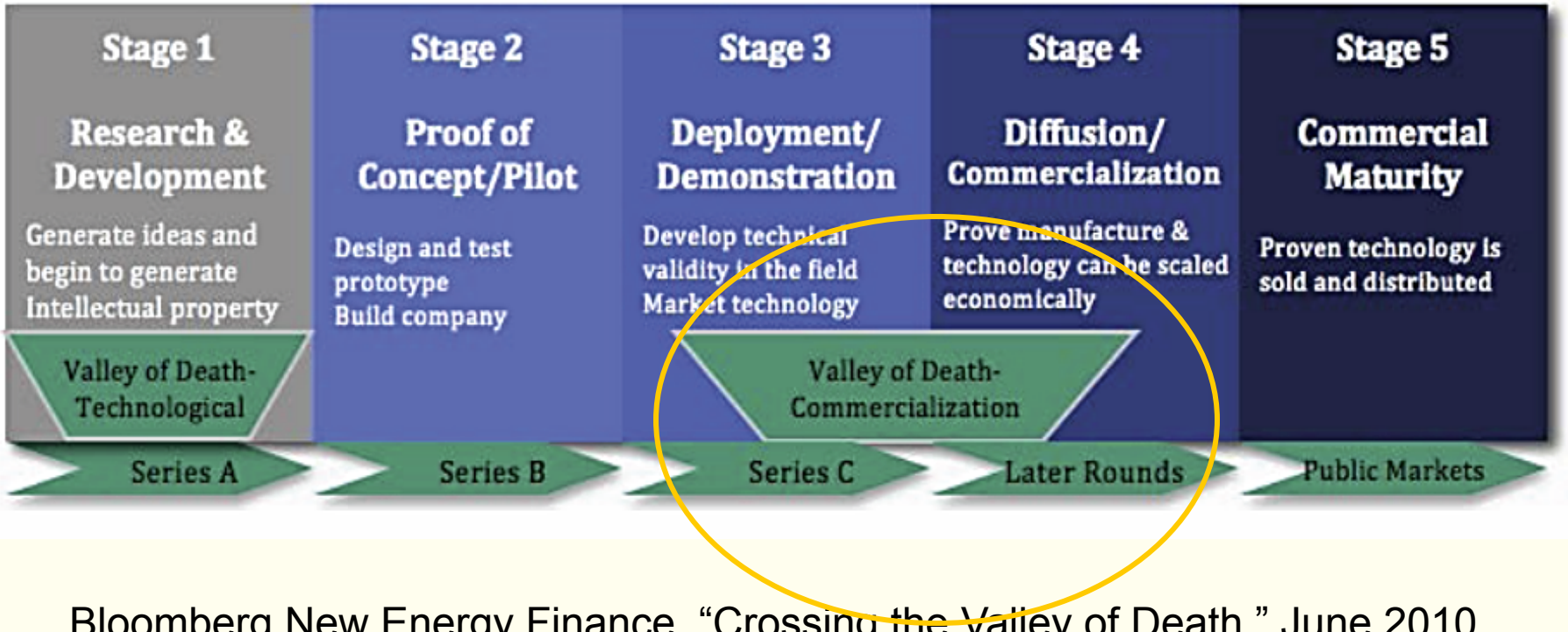
Design Revolutions, Technology Cycles, and Market Change



We are in a Period of Market Confusion

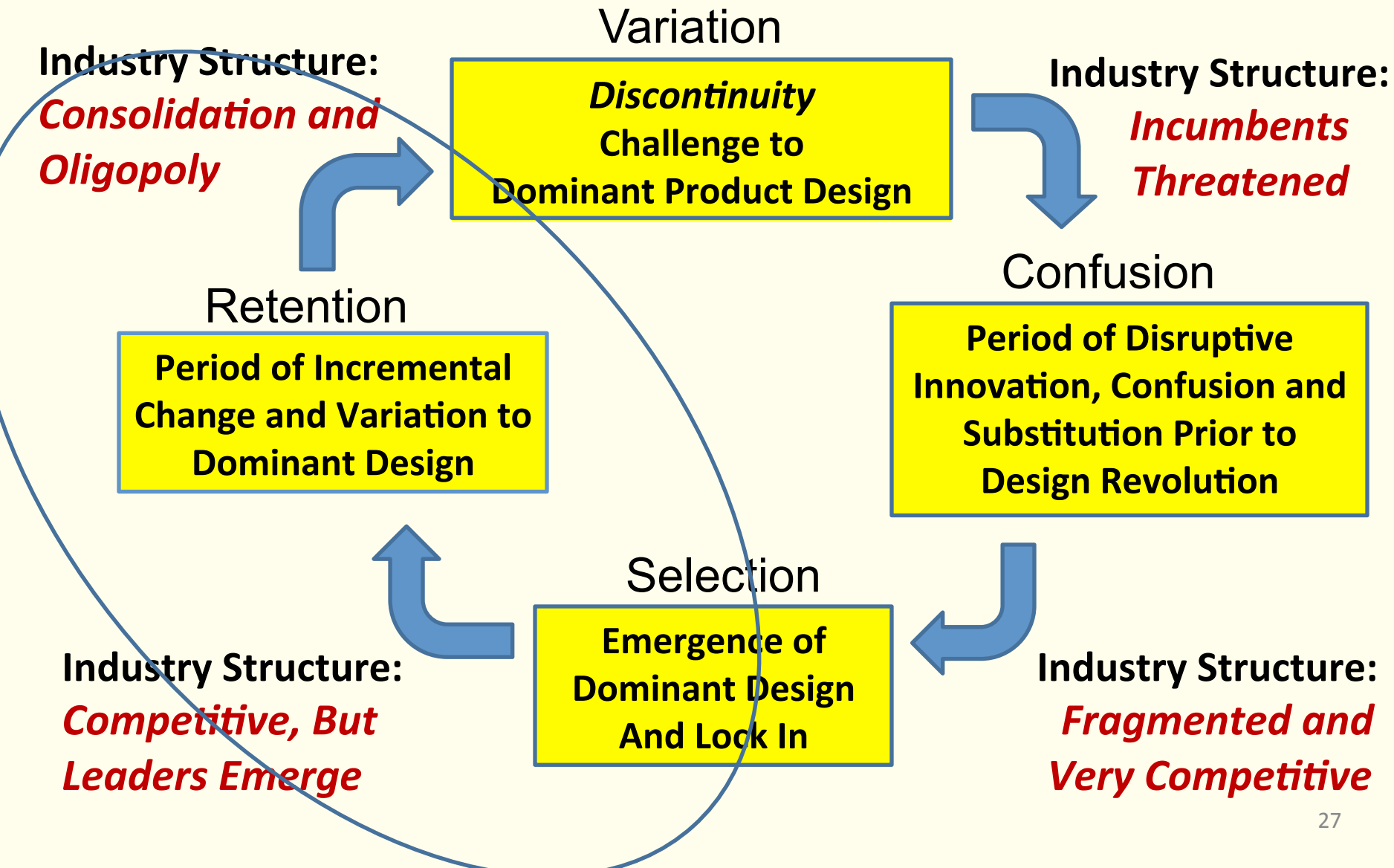
- **Many sources of confusion**
  - **Competing technologies, sectors**
  - **Companies having problems meeting goals**
    - Technological problems
    - Unexpectedly high costs
    - Management problems
  - **Private investors getting cold feet**
  - **Public policies and support in flux**

Stages of Development



Bloomberg New Energy Finance, "Crossing the Valley of Death," June 2010
https://www.bnef.com/WhitePapers/download/29

Design Revolutions, Technology Cycles, and Market Change



Long term questions

- **Which biofuel products and processes are furthest along toward successful commercialization?**
  - **Why?**
- **Which *should* dominate the market?**
  - **What criteria should be used to answer?**
  - **What information do we need?**

Barriers

- **Companies have run into lots of problems**
  - **Financial**
  - **Technological**
  - **Political**
  - **Internal (managerial & organizational)**

Valleys of death

In class exercises on your huddle boards:

1. **Your biofuel and number of firms producing it**
   - **How are they differentiated?**
     - Feedstocks – which in use?
     - Scale/capacities
     - Start ups? How many are initiatives inside big oil or chemical companies?

In class exercises

2. **Select 3-4 (or more if you have time) individual companies to focus on. Based on info in Solecki and on the web, what can you say about their**
   - Levels of integration into feedstock processing, specialty chemicals processing etc. ?

In class exercises

3. **What is the broader significance of this complexity?**
   - **Benefits? Drawbacks?**
     - For firms?
     - For policy makers?
     - For society?