Finding Innovation Success in Biofuels and Forest Bioproducts

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Forest Bioproducts: A Heritage of Innovation

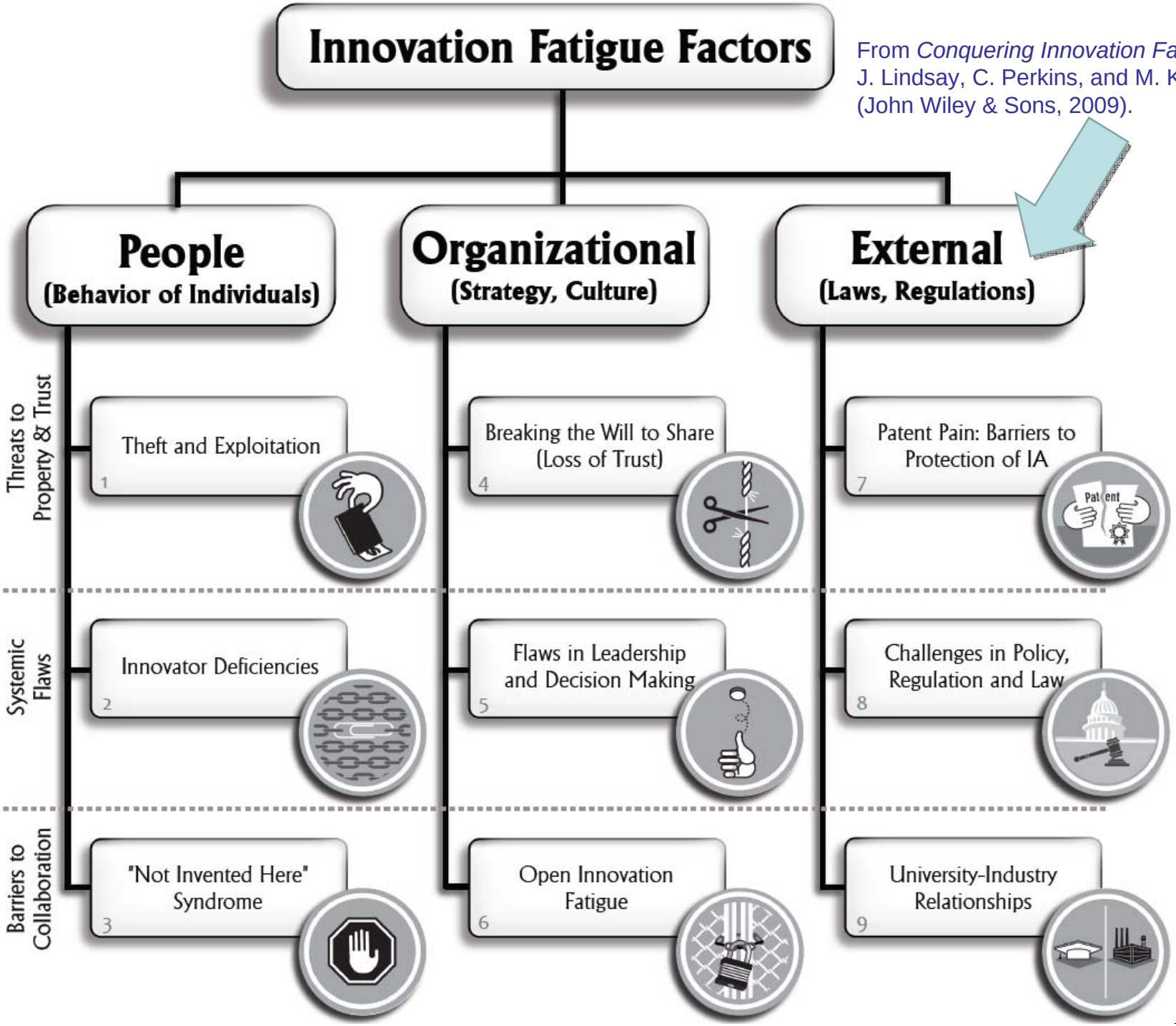
- Green Innovation: cellulose to ethanol, biorefineries, biodiesel, energy recovery, and innovation in renewable bioproducts
- Nanotechnology
- Advanced process control & informatics
- Composite materials
- Advanced fluid mechanics, heat transfer, manufacturing technology, etc.
- Microencapsulation
- Supply chain management
- Forestry, genetics, land management

Innovation Fatigue?

- Market cap decline
- Innovation spending down
- Discouragement, brain drain
- Few recognize the technical and economic contributions of the pulp and paper industries
- Numerous regulatory pressures
- Is the industry innovative?
- How can we find innovation success in emerging areas?

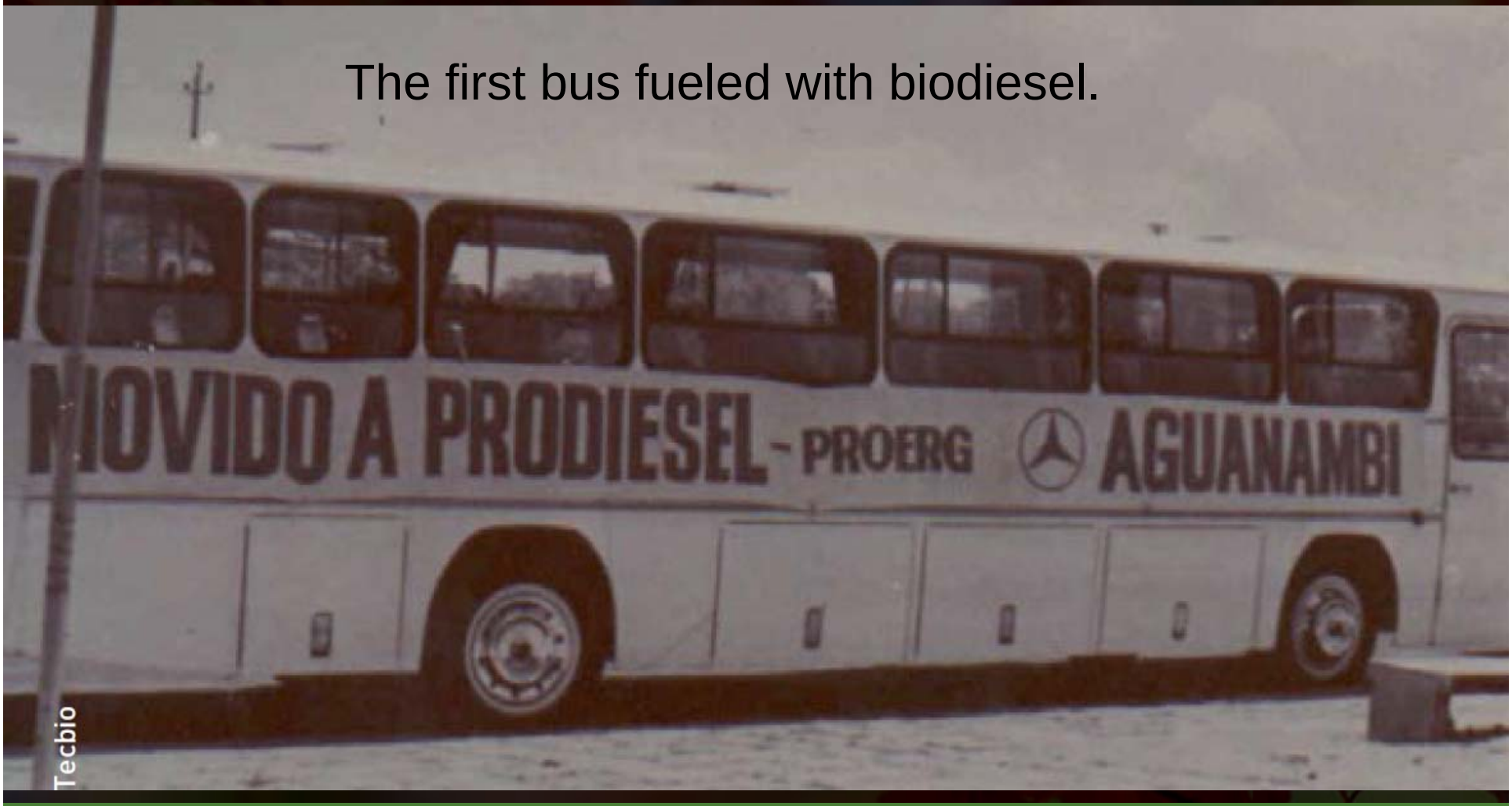
Threats to Innovation

- Internal: Strategy and decision making
- Failure to nurture relationships with innovation communities
  - External: partners, sources of innovation
  - Internal: employees
- External “innovation fatigue factors”
    - Regulatory burdens
    - Intellectual property barriers


Innovation Fatigue Factors
From *Conquering Innovation Fatigue*, J. Lindsay, C. Perkins, and M. Karanjikar (John Wiley & Sons, 2009).
People
(Behavior of Individuals)
Organizational
(Strategy, Culture)
External
(Laws, Regulations)
Threats to Property & Trust
Systemic Flaws
Barriers to Collaboration
Theft and Exploitation
1
Innovator Deficiencies
2
"Not Invented Here" Syndrome
3
Breaking the Will to Share (Loss of Trust)
4
Flaws in Leadership and Decision Making
5
Open Innovation Fatigue
6
Patent Pain: Barriers to Protection of IA
7
Challenges in Policy, Regulation and Law
8
University-Industry Relationships
9

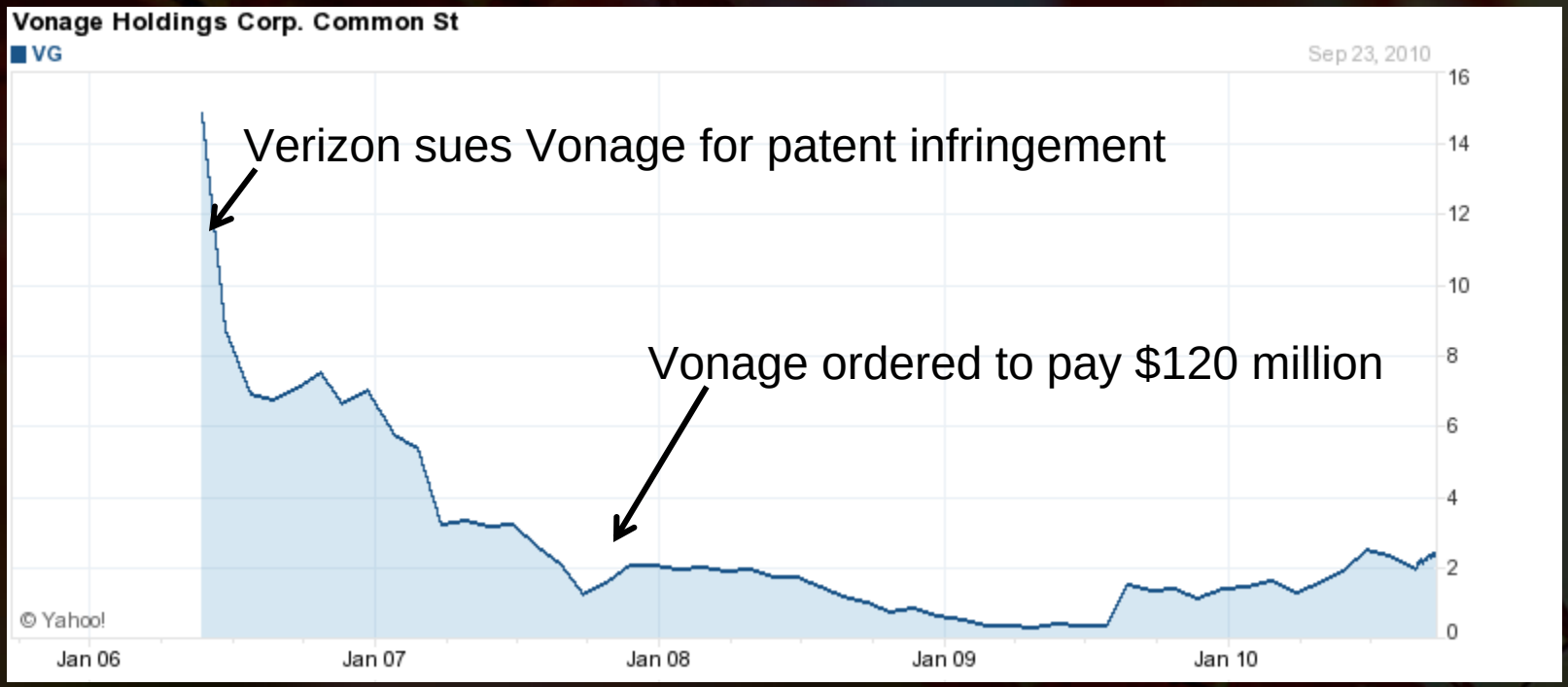
The 1st Biofuel Patent(?)

The first bus fueled with biodiesel.

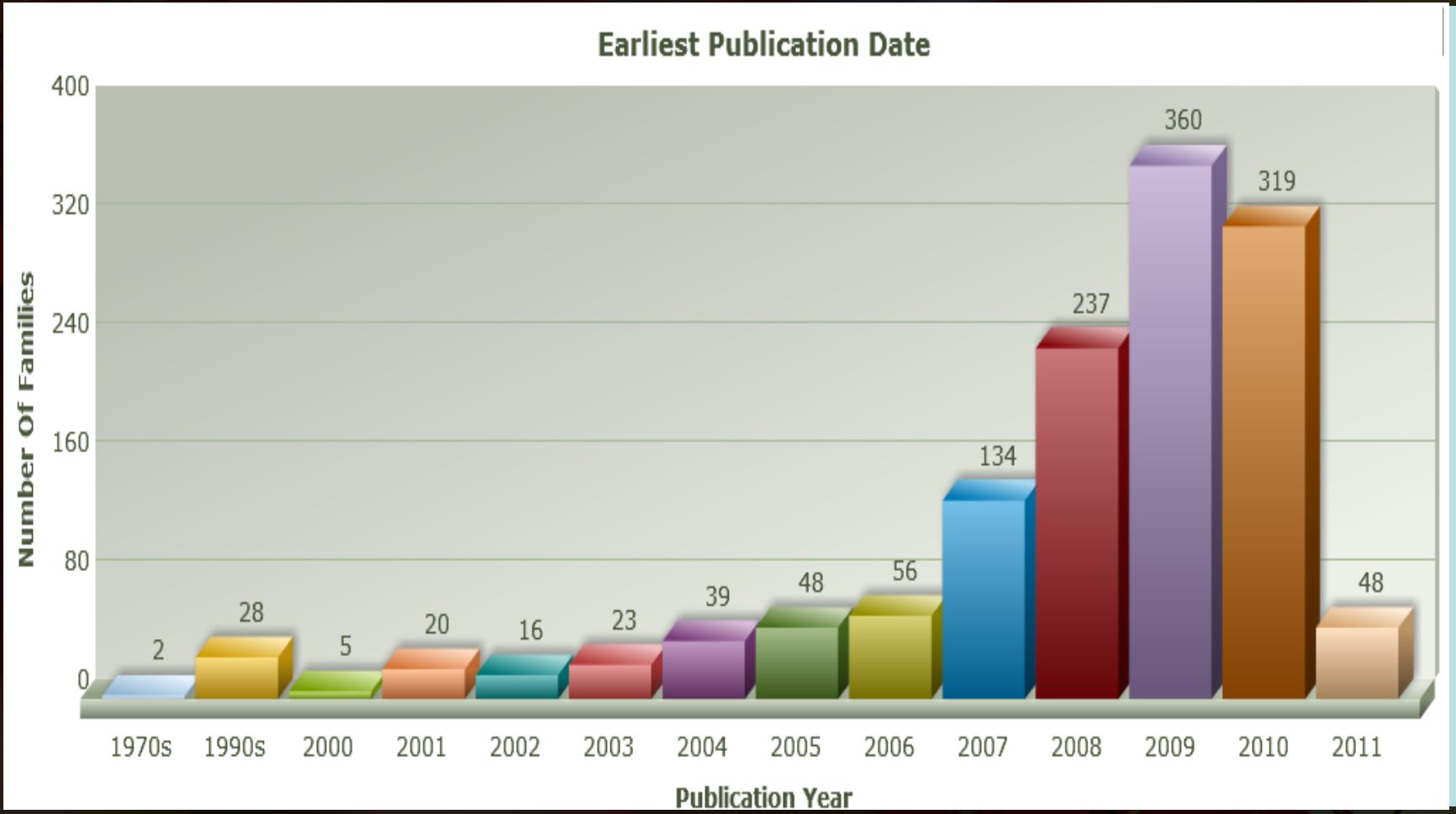


Patents Matter

- But often not enough to exuberant startups
- Lesson from Vonage and VOIP fever

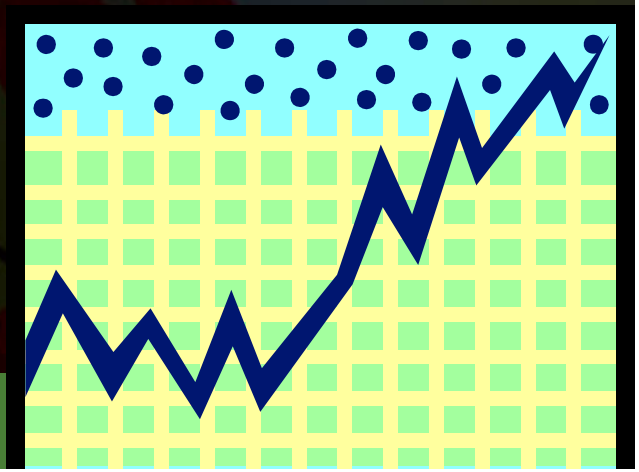


The Rise of Biofuels in IP



Key Trends

- Explosion in biofuels technologies, from gasification to fermentation (intl. class C10, C12)
- Very large recent boom in biological conversion of biofuels (e.g., intl. class C12)
  - Synthetic biology
  - New microbial strains
  - New uses of microbes
  - New enzymes
  - Fermentation methods



Forest Biofuels: A New Face in Forest Bioproducts

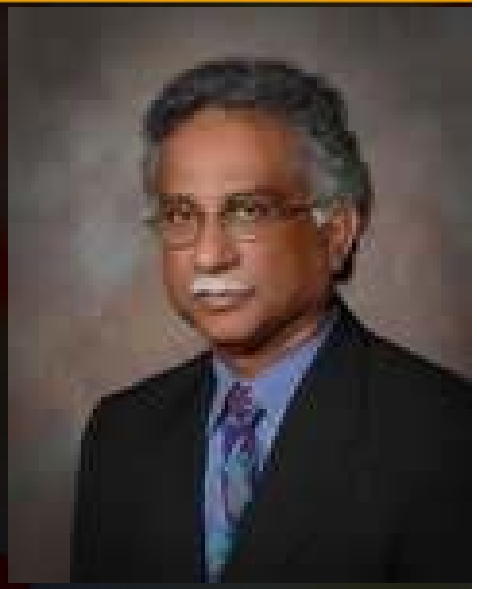
- Young, small, rapidly evolving
- Many startups
- Significant university influence
- Patents are key to survival
- Finding the business model is an essential part of the innovation journey

Example: Coskata

- Flexible three-step conversion process:
  - Incoming material converted to synthesis gas (gasification)
  - Fermentation of synthesis gas into ethanol
  - Separation and recovery of ethanol
- Coskata's proprietary microorganisms can simultaneously convert both CO and H2.
- Bioreactor design said to mitigate problems with phage infections.
- Anaerobic microorganisms licensed from Oklahoma State & Univ. of Oklahoma (Dr. Ralph Tanner et al.):
  US Pat. No. 7,704,723; US 2007275447.
- Novel species of bacteria found in a swamp in O2-free mud.

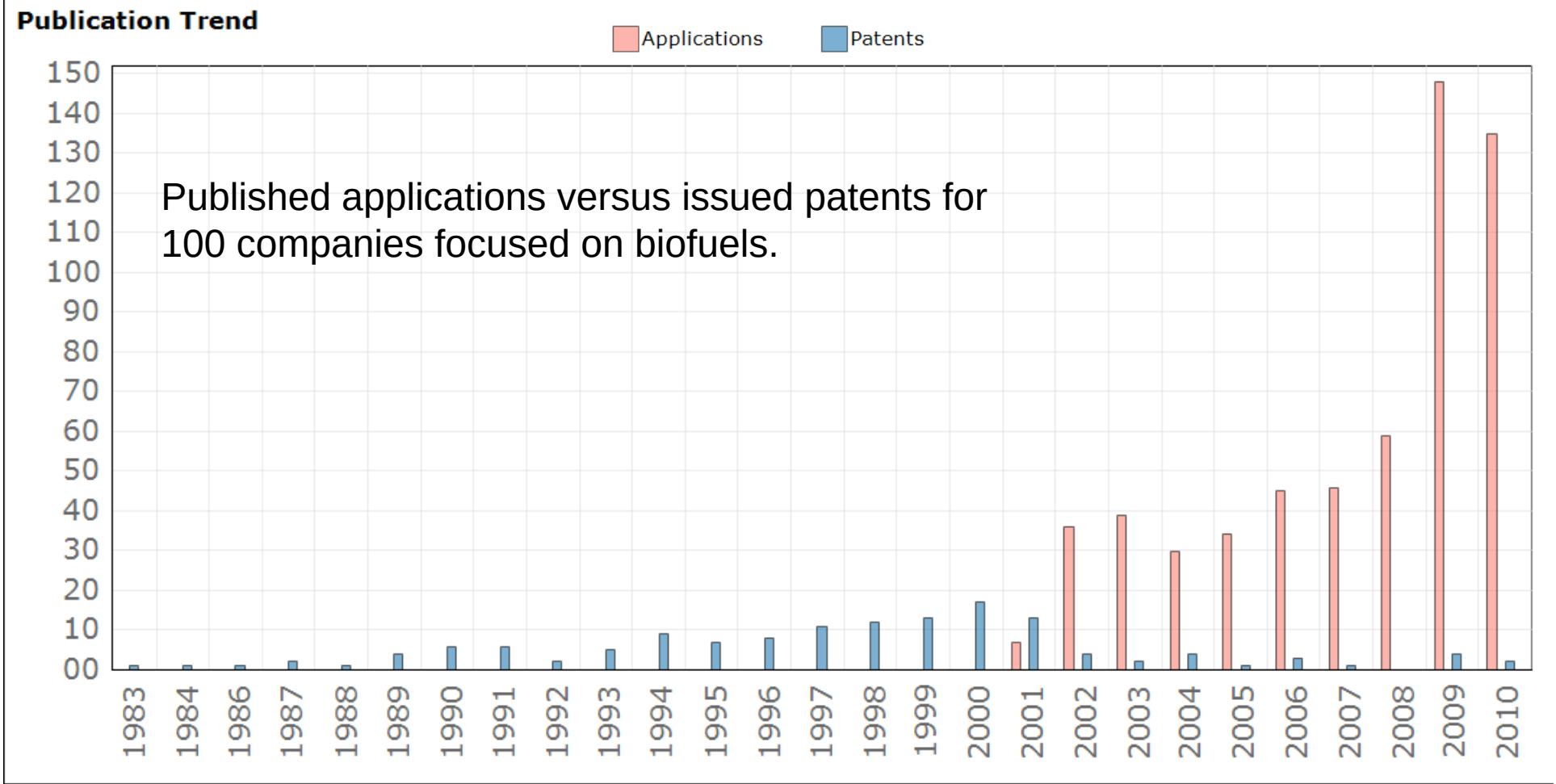
History: see http://www.coskata.com/company/ & http://tinyurl.com/coskata7

Interesting Inventors: Rathin Datta



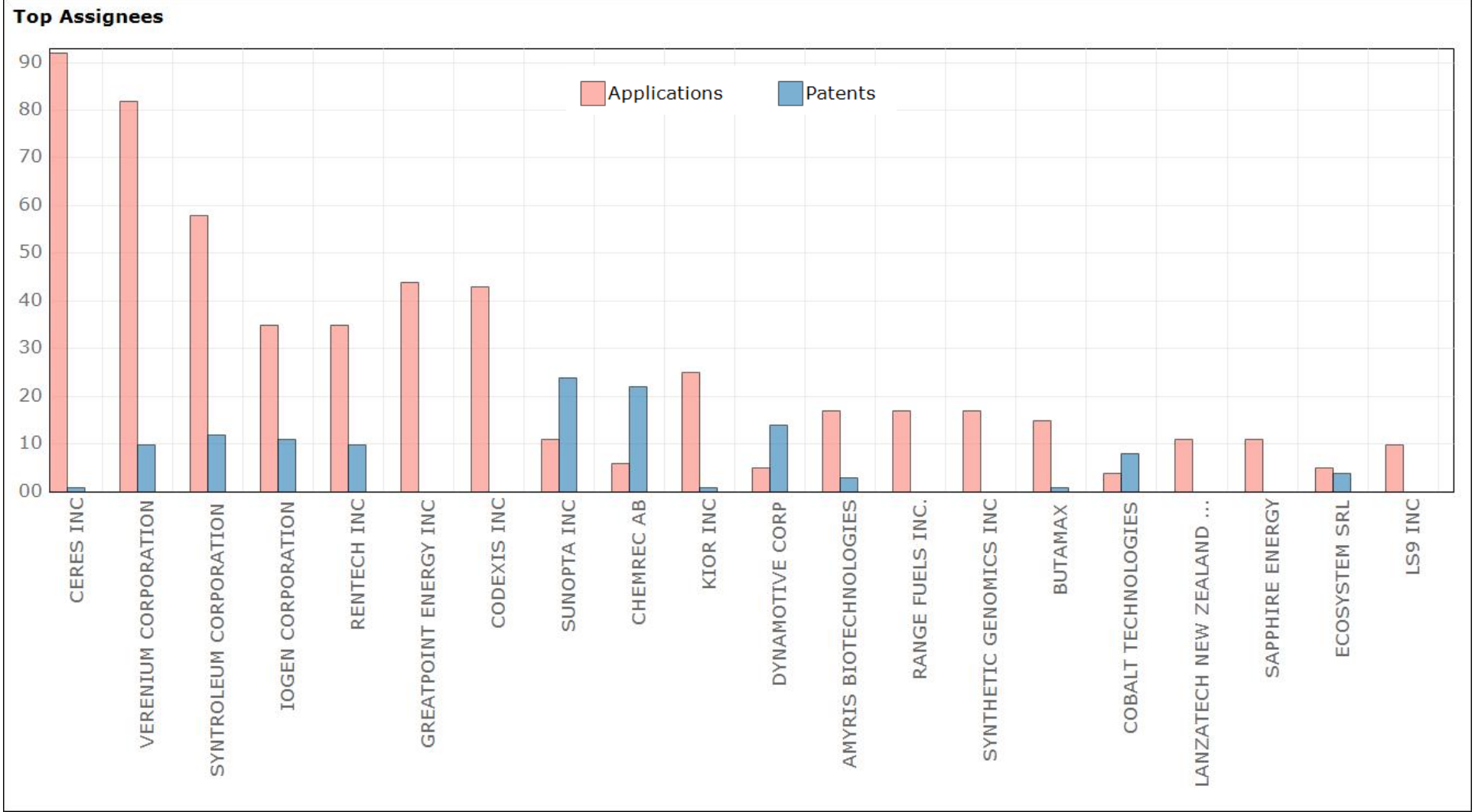
- Chief Scientific Officer/Founder of Coskata
- 28 patent families assigned to:
  - Coskata
  - Argonne / Univ. of Chicago
  - Michigan Biotech Institute
  - Vertec Biosolvents
- Methods for producing ethanol, butanol, lactic acid, acetic acid, citric acid, etc., including anaerobic microbes that can convert syngas into other molecules

The Rise in IP: Most Still Pending



Published applications versus issued patents for 100 companies focused on biofuels.

Focused Corporations: 1019 docs



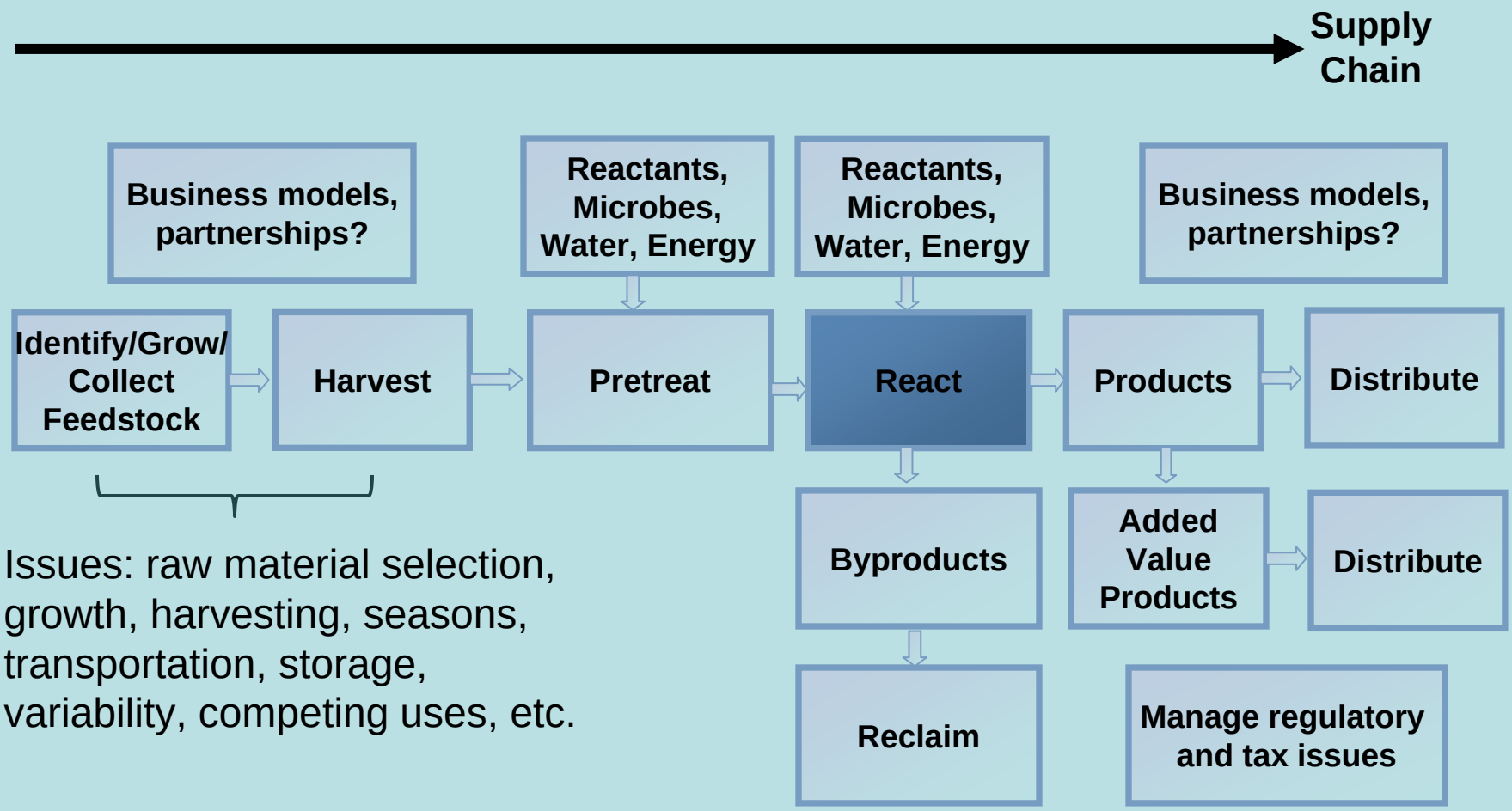
Warning Signs on the Horizon

- Much of the IP that will govern the future of the forest biofuels industry is in the form of pending applications
- Which ones will be granted and prevail?
- Very hard to predict. Much uncertainty.

Facing IP Uncertainty: Tips

- Prepare for future IP challenges today
  - Create your own IP bargaining chips
  - Protect your future patent clearance position with defensive publications, other assets
  - Build bridges, not walls, with IP
- Build relationships now with future winners
- Maintain a culture of open innovation so you can bring in the IP you will need.

IP Across the Supply Chain



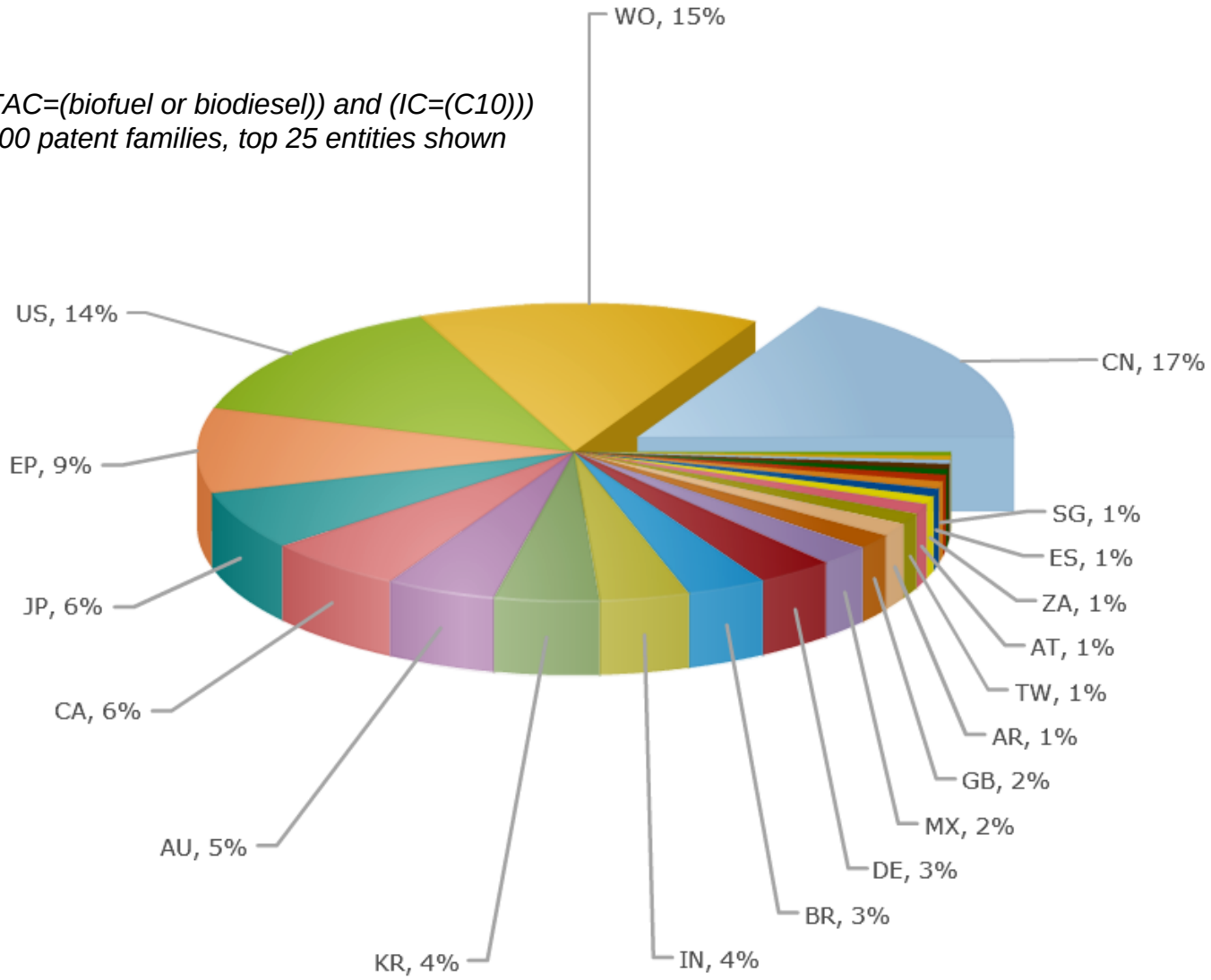
Issues: raw material selection, growth, harvesting, seasons, transportation, storage, variability, competing uses, etc.

Reviving Old Technologies

- Gasification
  - Biomass, black liquor (Chemrec), municipal waste (Enerkem), etc.
  - Mixed Alcohol Synthesis (Range Fuels), packed bed, catalytic reactors (Fulcrum), or fermentation (INEOS and Coskata).
- Fischer Tropsch upgrades, catalytic processes to deliver many chemical products (Syntroleum, Greatpoint, etc.)
- Pyrolysis (e.g., UOP Honeywell, Dynamotive) – updating uses of bio-oil (conversion to useful fuels)
- Acid and enzymatic hydrolysis – many players
- Fermentation – very hot
  - Discovery of new microbes (e.g., thermophilic strains)
  - Improved enzymes (Novozymes, Codexis, Novo Nordisk, Genencor/Danisco, Dyadic, etc.)
  - Upgraded with genetic engineering /synthetic biology

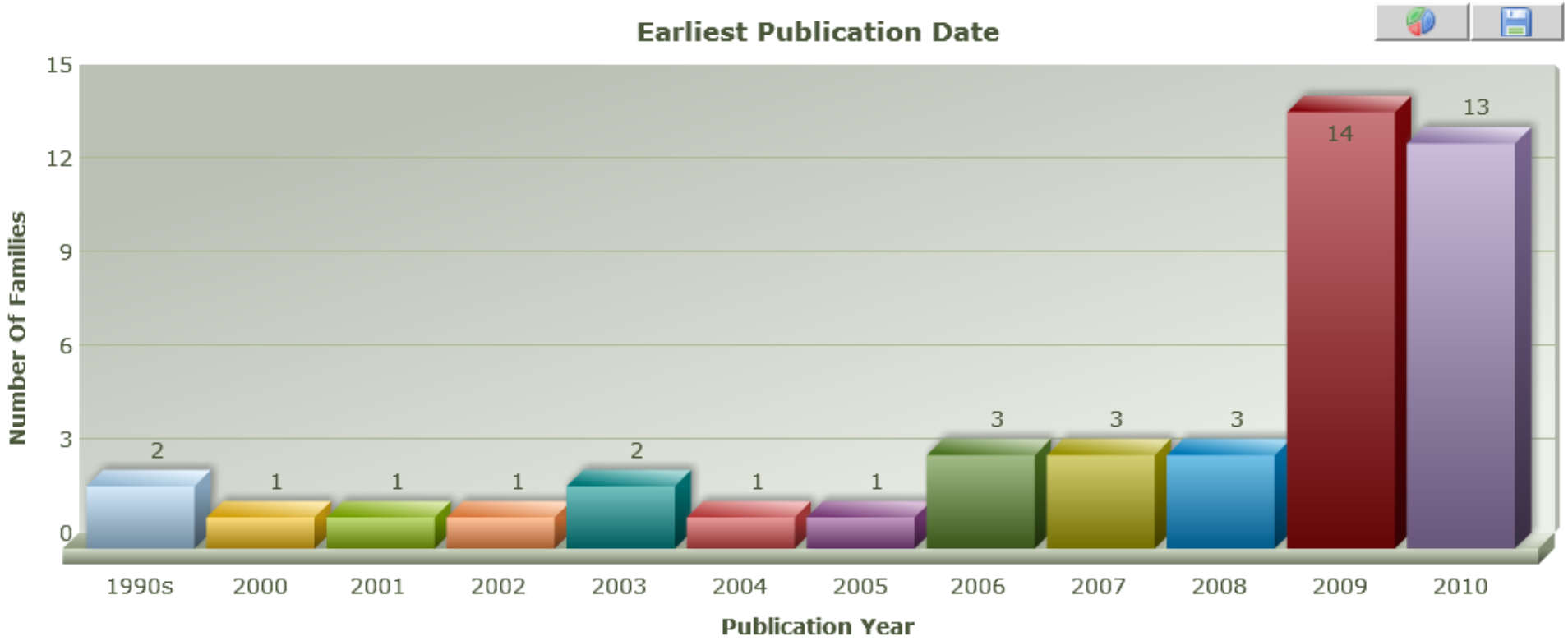
Where Are Filings Occurring?

((TAC=(biofuel or biodiesel)) and (IC=(C10)))
1600 patent families, top 25 entities shown



Validated Paper Ind. Biofuels IP

- Only 55 active patent families from paper & lumber companies and major suppliers dealing with biofuels, biomass power.
- The push for biofuels IP is very recent.



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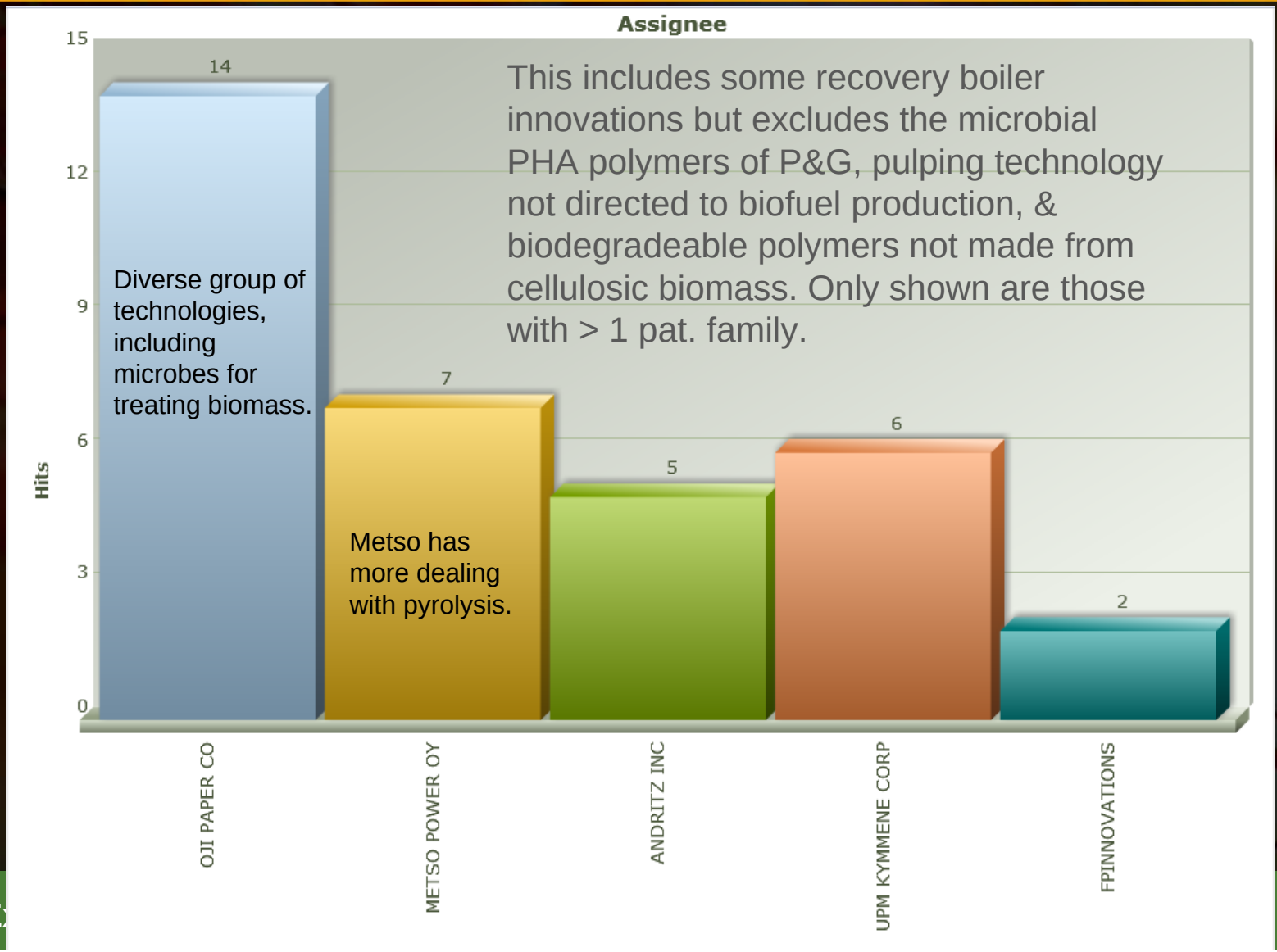

360 IA™ Review

- Low-cost intellectual assets include publications of many varieties, domain names and other digital assets, trademarks, etc.
- 360 IA™ also requires taking advantage of broad patent approaches, including business method-based patents and early patents in potentially disruptive areas.
- Proactive, cost-effective strategies can help you maintain competitive advantage and overcome some of the “innovation fatigue factors”™ in your business.

Two-Pronged Disruptive IA Strategy

Proactive IA can be used to:

- Shield from disruptive threats.
- Open doors for future disruptive innovation.

Detailed article available in *JPIM* available on request.

Conclusions

- Emerging innovation opportunities in biofuels and forest bioproducts require careful attention to:
  - Intellectual property strategy (offense + defense)
  - Healthy relationships (ecosystem thinking)
  - Flexible business models (iterations)
  - Innovation across the supply chain