“Green” Technology and IP: A Diverse Landscape

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Background problem of “double” market failure

- Positive externalities of innovation (partly addressed through IP)
- Price signals (even as bolstered through IP) don’t reflect carbon externalities (up to $80/ton) (vs. $2/ton)
- So IP only a (small) part of problem
- In virtually all green sectors, government “push” through R&D subsidies
- But see example of Integrated Gasification Combine Cycle (IGCC) for coal
  - Lots of patents (several hundred that mention IGCC)
  - Lots of push (in U.S., half the capital cost of 2 facilities)
  - But no further adoption

Diverse Technologies

- Power generation (wind, solar, biofuels, IGCC (with and without CCS)
- Industrial processes (e.g. less carbon intensive products of cement)
- Energy efficient consumer goods (e.g. lightbulbs)
- Transportation: hybrid cars; fuel cells
- Building efficiency

At Different Stages

- “**Theoretical” R&D**
  - 4G solar (nanotech)
  - 3G biofuels (synbio)
- “**Applied” R&D**
  - thin-film solar
  - 2G biofuels (enzyme-based cellulosic biofuels)
- “**Commercial” stage**
  - low-carbon cement production
  - IGCC without CCS
  - low-carbon consumer goods
  - hybrid cars

Diversity even within three early-stage "power generation" technologies

- Thin-film solar
- 2nd generation biofuels
- Third generation biofuels

Thin-Film Solar

- First generation: silicon-based
- 2nd generation: consists of improvements that result in cheaper PV cells (thin films of semiconductors applied to glass)
- 4 or 5 firms hold majority of market
- Each firm uses slightly different technology (which is subject of patent portfolio)
- Unclear whether there are informal patterns of x-licensing (like semiconductors)
- Will patent portfolios pose barriers to entry for new entrants?

2nd generation biofuels (better enzymes for turning cellulose into fuel)

- Some similarities with medical biotech
- Partnerships between small (patent-based) R&D firms and large product makers
  - Diversa/Cellulol **with** Syngenta/Dupont/Khosla Ventures
  - Iogen **with** Shell, Goldman Sachs
  - Genencor **with** Cargill/Dow/Khosla Ventures

Economic Structure

- Different from biomedicine
- End product (fuel) may not be patentable
- So upstream patents (e.g. on enzyme) may be more important for market differentiation
- OTOH, FDA regulatory hurdles won’t be there either

3rd generation biofuels (syn bio)

- Micro-organisms that use DNA “parts” (e.g. promoters, repressors, inverters) assembled into “systems” to produce different chemicals, including fuels
- Systems put into micro-organism “chasses”

Registry of Standard Biological Parts

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Registry Community

- Participate in the Registry Logo Redesign contest! more info here!
- For information about iGEM 2007, see www.igem2007.com
- We have a new tutorial for starting teams in the Help section
- iGEM 2007 team parts have new parts sandboxes and favorites available

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Regulatory Regions (Promoters)

Available repressible regulators (normally ON) -?-

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-?-	Name	Description	Direction	Control -?-	Output Low	Output High	Length
A W	BBa_I14032	promoter P(Lac) IQ	Forward	lacI			37
A W	BBa_R0040	promoter (tetR, negative)	Forward	aTc, tetracyline			54
A W	BBa_R0051	promoter (lambda cI regulated)	Forward	lambda cI			49

Available inducible regulators (normally OFF) -?-

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-?-	Name	Description	Direction	Control -?-	Output Low	Output High	Length
A	BBa_I12007	Modified lambda Prm promoter (OR-3 obliterated)	Forward	cI			82
A	BBa_R0062	Promoter (luxR & HSL regulated -- lux pR)	Forward	luxR, HSL			55
A	BBa_R0079	Promoter (LasR & PAI regulated)	Forward	PAI			157
A	BBa_R0080	Promoter (AraC regulated)	Forward	araC			149

Available other regulators

Show 272 more parts

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-?-	Name	Description	Direction	Control -?-	Output Low	Output High	Length
A W	BBa_I0500	Inducible pBad/araC	Forward	araC, arabinose			1210
A W	BBa_I13453	Pbad promoter					130
A W	BBa_J13002	TetR repressed POPS/RIPS generator	Forward	ATc			74
A W	BBa_J13023	3OC6HSL+LuxR dependent POPS/RIPS generator					117
A W	BBa_J23100	constitutive promoter family member					35
A W	BBa_J23101	constitutive promoter family member					35
A W	BBa_J23102	constitutive promoter family member					35
A W	BBa_J23103	constitutive promoter family member					35
A W	BBa_J23104	constitutive promoter family member					35
A W	BBa_J23105	constitutive promoter family member					35
A W	BBa_J23106	constitutive promoter family member					35
A W	BBa_J23107	constitutive promoter family member					35

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Featured Parts

These parts and devices perform particularly interesting functions. Check them out!

cell-cell-signaling - These parts enable communication between cells in a population
conjugation parts - These parts relate to the passing of information through plasmid transfer in a process known as conjugation between bacterial cells
fluorescent proteins - These proteins are often used to visually detect the state of a cell or device.
light sensor - These parts enable you to take a **coliroid** or bacterial photograph.
RNA-lock-and-key - RNA based transcription control.
cell death
Tools to facilitate cloning - These plasmids aid the construction of basic Biobrick parts and their assembly

Coming soon

[edit]

chemotaxis
temperature sensors
flipping dna
parameter measurement

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Different Types of Patents

- Different types of patents (apparently important for VC funding)
  - Patents on “part” components (inc. ordinary gene sequence patents) (e.g. Sangamo)
  - Patents on large scale gene synthesis (Codon Devices, Blue Heron)
  - Patents on “chasses” (Craig Venter of Synthetic Genomics)

Patents on Parts

- Role may depend on whether standardization of parts is achieved
- If achieved, secret infringement (currently a routine strategy for avoiding thickets by firms that produce products in biopharm) may not be possible

Patents on Gene Synthesis: Analogies to Open Source?

- Some companies that have strong patent positions in large scale gene synthesis (e.g. Codon Devices) want “parts” to be free available
- The more demand for “parts,” the more demand for the gene synthesis tech
- Lawsuits over gene synthesis patents (Codon vs. Blue Heron)
- Monopolist in gene synthesis? (exceptions to one monopoly profit principle)

Patents on Chasses

- Patent app on “minimal genome” chassis (Craig Venter)
- This particular chassis may not work
- But a good patent on a chassis might be similar to a patent on an operating system (with concomitant push towards standardization)
- Social welfare effects?

Conclusion

- Very complex economics
- Huge diversity of tech
- Even within early-stage biotech, new puzzles and diversity