Renewable Energy and Energy Efficiency Technology Transfer

Ty Ferretti, Licensing Executive

NREL

10/15/2014
Scope of Mission

Energy Efficiency

Residential Buildings

Commercial Buildings

Personal and Commercial Vehicles

Renewable Energy

Solar

Wind and Water

Biomass

Hydrogen

Geothermal

Systems Integration

Grid Infrastructure

Distributed Energy Interconnection

Battery and Thermal Storage

Transportation

Market Focus

Private Industry

Federal Agencies

Defense Dept.

State/Local Government

International
Innovation, Integration, and Adoption

Reducing Investment Risk

- Enable basic and applied clean energy technology innovation
- Accelerate technology market introduction and adoption
- Integrate technology at scale
- Encourage collaboration in unique research and testing “partnering” facilities
- Provide analysis and expertise to inform decisions
The privately funded NREL IGF facilitates access to financial capital and partnership resources for clean energy startups independent of technology origin www.industrygrowthforum.org

Apply - July -
- 200+ startups apply- national reach
- Startups receive a discounted registration to attend

Select - September -
- 100 investors screen startup business plans
- Startups receive constructive feedback
- Investors have access to all startup business plans

Forum - October -
- 30 startups pitch, 500+ attendees
- 50+ investors, corporations, agencies, and stakeholders are available for dedicated 1:1 meetings

Since 2003, the presenting cleantech startups have collectively raised more than $5.1 billion in growth financing!
Welcoming Remarks - Michael B. Hancock  Mayor of Denver
Luncheon Speaker - David Danielson  Assistant Secretary Office of Energy Efficiency & Renewable Energy
Rick Tempchin  Edison Electric Institute  Executive Director, Retail Energy Services
Keynote Address Speaker
Bryan Hannegan  National Renewable Energy Laboratory  Associate Lab Director of Energy Systems Integration
Buildings-to-Grid Integration
Bobi Garrett  National Renewable Energy Laboratory  Deputy Laboratory Director

Colorado’s largest Cleantech and Renewable Energy Networking Event.
Featuring:

• Presentations from 30 Emerging Cleantech Companies;
• Energy Investors from around the world;
• Thought leadership on today’s energy issues.
Benefits of Technology Transfer

- Attracts research funding
- Forms industrially relevant partnerships
- Earns royalty income – NREL staff receive 25% of all royalties.
- Moves discovery to market
Role of Intellectual Property in Research

• Tools of commerce, not a measure of good science.

• Provides incentives:
  • For private investment in product development.
  • For research staff to disclose their innovations.

• Establishes ownership in invention.

• A means to communicate the value of research at national labs.
Tech Transfer Process

Discovery
- Disclosure
- Evaluation
- Protection
- Marketing
- Negotiation
- License

Development and Commercialization
IP Investment: Focus on Value

TTO protects technologies based on a commercialization readiness assessment:

- Stage of development of the technology
- Availability of funding to further develop toward market readiness
- Strength of available patent protection or ability to consolidate copyrights
- Market opportunity:
  - Likelihood of finding commercialization partner
# IP Evaluation Rubric

## External business drivers

<table>
<thead>
<tr>
<th>MARKET SEGMENT</th>
<th>DOES NOT MEET EXPECTATIONS</th>
<th>MOVING TOWARD EXPECTATIONS</th>
<th>MEETS EXPECTATIONS</th>
<th>EXCEEDS EXPECTATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEFINITION</td>
<td>Un-defined market segment.</td>
<td>Somewhat defined market segment.</td>
<td>Defined market segment.</td>
<td>Highly defined market segment.</td>
</tr>
<tr>
<td>SIZE IN DOLLARS</td>
<td>Market segment as a whole books &lt;$5M per year.</td>
<td>Market segment as a whole books between $5M and $25M per year.</td>
<td>Market segment as a whole books between $25M and $125M per year.</td>
<td>Market segment as a whole books &gt; $125M per year.</td>
</tr>
<tr>
<td>SIZE IN NUMBER OF COMPANIES</td>
<td>Fewer than 5 companies known to C&amp;TT active in this technology area.</td>
<td>Between 5 and 10 companies known to C&amp;TT active in this technology area.</td>
<td>Between 10 and 20 companies known to C&amp;TT active in this technology area.</td>
<td>20 or more companies known to C&amp;TT active in this technology area.</td>
</tr>
</tbody>
</table>

### POTENTIAL IMPACT

<table>
<thead>
<tr>
<th>TIMING OF MARKET NEED</th>
<th>Does not meet expectations. Unclear when need will emerge.</th>
<th>No current need evident. Projections of significant need in ~5 years</th>
<th>Evidence of need in today’s market. Need likely will increase in ~5 years.</th>
<th>Present and longstanding need for this invention. Need likely to last for 10+ years.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARKET SHARE</td>
<td>Invention is applicable to &lt; 5% of its market segment. Potential to win market share is significantly impaired.</td>
<td>Invention may capture a modest share of the market segment. Potential seems capped at “also-ran” market status.</td>
<td>Invention is likely to capture a sizable share of the market segment. Potential to become one of the segment-leading technologies.</td>
<td>Invention likely to dominate its market segment. Potential to become de facto standard.</td>
</tr>
<tr>
<td>ADOPTABILITY</td>
<td>Invention adoption costs very high. Benefits vs. status quo are small.</td>
<td>Invention adoption costs moderate. Significant benefits vs. status quo.</td>
<td>Invention adoption costs moderate to low. Outstanding benefits vs. status quo.</td>
<td></td>
</tr>
</tbody>
</table>

## Internal business drivers

<table>
<thead>
<tr>
<th>BUSINESS DEVELOPMENT</th>
<th>CUSTOMER ENGAGEMENT</th>
<th>TOTAL POTENTIAL REVENUE</th>
<th>UP-FRONT FEES POTENTIAL</th>
<th>TIME TO LICENSE</th>
<th>TIME TO ROYALTY INCOME</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No potential customers ID’ed by C&amp;TT team. No relationships are in place. No specific licensing interest expressed.</td>
<td>&lt;$10k royalty stream is likely.</td>
<td>&lt;$5k up-front licensing fee likely.</td>
<td>Licensing deal likely executed in 3-6 months of R&amp;D date.</td>
<td>Continuous royalty payments likely to begin ~4 years from licensing deal.</td>
</tr>
<tr>
<td></td>
<td>Potential customers ID’ed by C&amp;TT. Some relationships exist. No specific licensing interest expressed.</td>
<td>$10k to $250k royalty stream is likely.</td>
<td>$5k to $25k up-front licensing fee likely.</td>
<td>Licensing deal likely executed in 18 to 36 months of R&amp;D date.</td>
<td>Continuous royalty payments likely to begin 2 to 4 years from licensing deal.</td>
</tr>
<tr>
<td></td>
<td>All potential customers ID’ed by C&amp;TT. Good relationships in place with multiple potential customers. Some licensing interest expressed.</td>
<td>$250k to $1M royalty stream is likely.</td>
<td>$25k to $75k up-front licensing fee likely.</td>
<td>Licensing deal likely executed in 6 to 18 months of R&amp;D date.</td>
<td>Continuous royalty payments likely to begin 1 to 2 years from licensing deal.</td>
</tr>
<tr>
<td></td>
<td>All potential customers ID’ed by C&amp;TT. Good relationships in place with multiple potential customers. Strong licensing interest expressed.</td>
<td>&gt;$1M royalty stream is likely.</td>
<td>&gt;$75k up-front licensing fee likely.</td>
<td>Licensing deal likely executed in ~6 months of R&amp;D date.</td>
<td>Continuous royalty payments likely to begin in 1 year or less from licensing deal.</td>
</tr>
</tbody>
</table>

| TECHNOLOGY BUNDLING OPPORTUNITY | INVENTION CURRENTLY, AND LIKELY TO REMAIN, "STAND ALONE." NO BUNDLING OPPORTUNITIES. | LICENSED TECHNOLOGIES. BUNDLING IS POSSIBLE BUT NOT LIKELY. | LICENSED TECHNOLOGIES. BUNDLING IS LIKELY. | LICENSED TECHNOLOGIES. BUNDLING IS LIKELY AS AN "ANCHOR" FOR MULTIPLE DOE TECHNOLOGIES. EXCELLENT BUNDLING OPPORTUNITIES. | |
| EXTERNAL FUNDING FOR RESEARCH | Not funded. No future possibility DOE or CRADA funding. | Limited funding. Unlikely to secure future DOE or CRADA funding. | Funded project. Good chance for future DOE and/or CRADA funding. | Well-funded project. Secure future DOE and/or CRADA funding. | |

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<tr>
<th>REVENUE POTENTIAL</th>
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<td>Licensing deal likely executed in 18 to 36 months of R&amp;D date.</td>
<td>Continuous royalty payments likely to begin 2 to 4 years from licensing deal.</td>
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## IP Evaluation Rubric (continued)

### Product

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<tr>
<td><strong>TECHNICAL MATURITY</strong></td>
<td>TRL 1 to 2: basic principles observed, minimal data collected.</td>
<td>TRL 3 to 4: proof of concept experiments performed; feasibility testing ongoing.</td>
<td>TRL 5 to 6: Prototype built, substantial development still required.</td>
<td>TRL &gt; 6: operational system has been demonstrated.</td>
</tr>
<tr>
<td><strong>MATUREIZATION COST</strong></td>
<td>&gt;$100k required to create licensing revenue from this invention.</td>
<td>$100k to $50k required to create licensing revenue from this invention.</td>
<td>$50k to $10k required to create licensing revenue from this invention.</td>
<td>&lt;$10k required to create licensing revenue from this invention.</td>
</tr>
<tr>
<td><strong>MISSION ALIGNMENT</strong></td>
<td>Invention is outside of DOE / NREL mission. Invention field is an area of technical and commercialization weakness for DOE / NREL.</td>
<td>Invention is arguably within DOE / NREL mission. Invention field is an area of technical and commercialization weakness for DOE / NREL.</td>
<td>Invention is within DOE / NREL mission. Invention field is an area of technical and commercialization competence for NREL / DOE.</td>
<td>Invention is unquestionably within DOE / NREL mission. Invention field is an area of technical and commercialization strength for NREL / DOE.</td>
</tr>
</tbody>
</table>

### Patent Potential

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<tbody>
<tr>
<td><strong>PATENT POTENTIAL</strong></td>
<td>Previous disclosure made over 1 year ago. All rights lost.</td>
<td>Public disclosure within 12 months. Foreign patent rights lost.</td>
<td>No past disclosures. Future public disclosure(s) planned in 3-12 months.</td>
<td>No past disclosures. Future public disclosure(s) not planned.</td>
</tr>
<tr>
<td><strong>NOVELTY</strong></td>
<td>Numerous substantial prior art references. Narrow claim scope likely.</td>
<td>Several prior art references. Broad claim scope possible.</td>
<td>Few prior art references. Broad claim scope possible.</td>
<td>No prior art references (confirmed by C&amp;TT). Broad claim scope likely.</td>
</tr>
<tr>
<td><strong>POLICEABILITY</strong></td>
<td>Use of invention is impossible to detect in the final commercial product/process. Enforcement impossible.</td>
<td>Use of invention is difficult to detect in the final commercial product/process. Enforcement challenging.</td>
<td>Use of invention is easy to detect in the final commercial product/process. Enforcement straightforward.</td>
<td>Use of invention is transparent in the final commercial product/process. Enforcement easy.</td>
</tr>
</tbody>
</table>

### Inventor Disposition

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<tbody>
<tr>
<td><strong>INVENTOR ENGAGEMENT</strong></td>
<td>Inventor is inaccessible; deceased, no longer at NREL, or otherwise unavailable to C&amp;TT.</td>
<td>Inventor is accessible. But, it is either no longer working in this area, is hostile, or is disinterested in C&amp;TT collaboration.</td>
<td>Inventor is accessible. Continues to work in this area, is collegial and willing to consider C&amp;TT collaboration.</td>
<td>Inventor is accessible. Continues to work in this area, is enthusiastic and has demonstrated C&amp;TT collaboration.</td>
</tr>
<tr>
<td><strong>INDUSTRY CONNECTIONS</strong></td>
<td>Inventor unknown in the industry. Inventor has few personal commercial connections.</td>
<td>Inventor mostly unknown in the industry. Inventor has a few personal commercial connections.</td>
<td>Inventor is known in the industry. Inventor has many personal commercial connections.</td>
<td>Inventor is a celebrity in the industry. Inventor has many valuable personal commercial connections.</td>
</tr>
<tr>
<td><strong>COMMERCIALIZATION EXPERIENCE</strong></td>
<td>Inventor never named in provisional or full patent application. No exposure to the IP licensing process.</td>
<td>Inventor named in at least one patent application(s), but no patents issued. Some previous exposure to IP licensing process.</td>
<td>Inventor named in 1 to 3 issued and allowed patents. Some experience in IP licensing, but no current revenue.</td>
<td>Inventor named in &gt;3 issued and allowed patents. Experienced in IP licensing, currently generating licensing revenue.</td>
</tr>
</tbody>
</table>
Historical Trends

![Graph showing historical trends]
SPX Heat Transfer

- NREL Direct Contact Condenser technology deployed in geothermal power plant in Hawaii.
- Substantial earned royalty payments.
- Expanded technology use to alternative fields of use.
Skyfuel - *SkyTrough* parabolic trough

- Concentrating solar collectors capture and concentrate solar radiation to produce thermal energy, usually as steam, for use in large power plants.
- Ideally suited for delivering heat or steam to industrial, mining and manufacturing processes as well as waste-water treatment and desalination.
- SkyTrough can also be used to heat water for large commercial or institutional facilities such as prisons and hospitals which require large volumes of hot water.

SkyTrough and the steam it produces match up particularly well with certain natural gas combined cycle power plants; a combination referred to as integrated solar combined cycle or “ISCC”.

When a host plant uses solar generated steam to displace natural gas fired steam, it saves on fuel costs and cuts emissions of CO2 and other harmful pollutants.
B-Si Patent Portfolio has grown:
- 07-10: US 8,075,792
- 09-69: US 8,828,765
- 12-18: US 8,815,104
- Issued Patents in China and Japan

Reduce Costs & Test Feasibility in Real World Environment:
- Demonstrated successful etch using Copper (NREL 12-18) at $20/oz t as opposed to Gold ($3,000/oz t) and Silver ($1,000/oz t).
- Partnership with Fraunhofer Institute successfully demonstrated B-Si process at scale in Chinese PV manufacturing facility with 40% longer charge carrier lifetime (greater efficiency).
- Exploring alternative passivation techniques that may require broadening the Licensed FOU to include atomic layer deposition.
Netzsch Instruments

Isothermal Battery Calorimeter

- Pending patent protection in U.S., EU, Japan & China

IBC 284™

- First Orders placed – expect royalties in FY15:
GeoSolarHeat

- NREL Transpired Solar Collector on south wall of RSF
- Adaptable to poultry farms where propane is burned to warm barns, thereby liberating ammonia = toxic to birds and humans.
- TSC warms clean
• NREL Wind Blade Resonance Test System.
• Evaluates wind blades for defects or areas susceptible to defects, thereby increasing performance and reducing costs to wind industry.

Blade Fatigue testing

Blade Static testing
DuPont Cellulosic Ethanol

- NREL dilute metal acid pretreatment and *Z. mobilis* technologies
- DuPont opened 300 million gallon/year cellulosic ethanol facility in Nevada,
<table>
<thead>
<tr>
<th>Anne Miller Sr. Licensing Executive</th>
<th>Jennifer Ramsey Licensing Executive</th>
<th>Ty Ferretti Licensing Executive</th>
<th>Eric Payne Sr. Licensing Executive</th>
<th>Bill Hadley Licensing Executive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology Areas</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Software Analysis Tools</td>
<td>Software Analysis Tools</td>
<td>Concentrating Solar</td>
<td>Renewable fuels &amp; chemicals</td>
<td>III-V, Thin film and Silicon PV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electrochromics</td>
<td>Vehicle Systems</td>
<td>CIGS &amp; CdTe PV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Batteries &amp; Energy Storage</td>
<td>Biochemical/Thermochemical</td>
<td>OPV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IMM PV</td>
<td>Conversion</td>
<td>TCOs &amp; Coatings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PV metrology</td>
<td>Hydrogen, Fuel Cells &amp; Algae</td>
<td>Buildings &amp; Smart Grid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wind &amp; Geothermal</td>
<td></td>
<td>Power Systems</td>
</tr>
<tr>
<td>NREL Centers</td>
<td>National Wind Technology Center (5000)</td>
<td>Materials &amp; Chemical S&amp;T (5F00)</td>
<td>National Center for Photovoltaics (5200)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Power Systems Engineering (5D00)</td>
<td>Building &amp; Thermal Systems (5500)</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>National Wind Technology Center (5000)</td>
<td>Transportation &amp; Hydrogen Systems (5400)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Materials &amp; Chemical S&amp;T (5F00)</td>
<td>Power Systems Engineering (5D00)</td>
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</table>
Energy Innovation Portal - Supports US Industry

- The Energy Innovation Portal is a resource for Department of Energy (DOE) developed innovation and specifically highlights Energy Efficiency and Renewable Energy (EERE) technologies.
- 17,000+ patents from all labs
- 850+ business-friendly marketing summaries
- Since 2010 the portal has generated **1,755 licensing inquiries** resulting in **247 active licensing negotiations** and **27 completed licensing transactions**.

http://techportal.eere.energy.gov
PV Portfolio

- Black Silicon
- High Efficiency CdTe
- CIGS Solar Cells
- Electrical Calcium Test Method
- High-throughput Semiconductor Deposition Technique
- Lattice-mismatched

Photos: (left to right) PIX 17852, PIX 15779
Biofuels Portfolio

- Attrition Resistant Catalysts
- Bio-based Production of Ethylene
- Biomass Treatment
- Cellulase Production
- Endoglucanase
- Wet Chemical Composition
- *Zymomonas Mobilis 8b*

Photos: (left to right) PIX 17375, PIX 15644
Energy Generation and Storage Portfolio

- Binderies Electrodes
- Fail-safe Design for Large Capacity Li-ion Battery Systems
- Hybrid Radical Batteries
- Simultaneous Distribution of AC/DC Power

Photos: (left to right) PIX 22068, PIX 22021
Wind Portfolio

- Airfoils

Photos: (left to right) PIX 21924, PIX 10969
Vehicles Portfolio

- Vehicle Component Heat Dissipation Improvements

Photos: (left to right) PIX 20037, PIX 22731
Buildings Portfolio

- Augmented Reality Building Operations Tool
- Image Processing Occupancy Sensor

Photos: (left to right) PIX 19350, PIX 17653
NREL Commercialization Assistance Program

NCAP provides up to 40 hours of NREL assistance and information to help energy efficiency and renewable energy small businesses with technology challenges. Funded with licensing revenues.

Examples of Assistance

- Test and measurement of systems or components
- Analytical testing of materials
- Insights on existing or emerging technologies
- Assistance in addressing technological performance and market analysis
- Addressing general technology problems