The RF Energy Alliance

Transformative Heating & Power Technology
About Solid-State RF Energy

What is it?
Controlled electromagnetic radiation used to heat items and power processes.

Why does it matter?
Solid-state RF energy (S²RFE) is a highly efficient and clean energy source.

Efficiency
S²RFE Lamps 120lm/W vs. Fluorescents 70lm/W

Performance
S²RFE Ovens reduce cook times by 25-75%

Lifespan
S²RFE Generator >100k hrs vs. Tube Magnetrons ± 5K hrs
Classical RF Use
Magnetron Drive for Local Heating

Object heated through absorption of RF Energy

Closed cavity to localize heating and limit unwanted RF emission

Magnetron
Classical RF Use
Long-Distance Data Transmission

- Transmit Data
  - RF Synthesizer
  - RF Power Amplifier
  - 1-2 GHz RF Transmission over 20-100 km
  - Receiver
S²RF As Local Heating
= RF Energy

Object heated through absorption of RF Energy

Closed cavity to localize heating and limit unwanted RF emission

Closed loop control

RF Synthesizer
RF Power Amplifier

[Diagram showing the components and process]
Competitive Landscape

Alternative tube-generated RF energy lacks:
- Frequency & phase variability & resolution
- Feedback forward & reflected power
- Load independent power delivery efficiency
- Consistency & repeatability

Mass market adoption of S²RFE is impeded by:
- Cost
- Volume supply base
- Design complexity & application integration
Standardizing solid-state RF energy components, modules and application interfaces to:

- Reduce system cost
- Minimize design complexity
- Ease application integration
- Increase market adoption & growth
Board of Directors

Technical Committee
  - TC1: HPA Team
  - TC2: System Integration

Regulations & Standards Committee

Marketing Communications Committee
S²RFE Benefits

- Provides precise and even energy distribution
  - Fast load conditions feedback to tune RF signal and heating process
  - Leverages ISM frequency bands
  - Introduces dynamic frequency “hopping” and/or phase shifting
- Very reproducible, non-degrading operation
- Low voltage electronics
- Supports electronics cost base
S²RFE is entering high volume markets, offering alternative revenue streams to maturing RF power businesses.

<table>
<thead>
<tr>
<th>TRANSITIONING</th>
<th>EMERGING</th>
<th>CURRENT</th>
<th>POTENTIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Cooking</td>
<td>• Industrial Lighting</td>
<td>• Ablation</td>
<td>• Auto Ignition</td>
</tr>
<tr>
<td>• Drying</td>
<td></td>
<td>• MRI/NMR</td>
<td>• Auto Lighting</td>
</tr>
<tr>
<td>• Industrial Processing</td>
<td></td>
<td>• Lasers</td>
<td></td>
</tr>
<tr>
<td>Benefits from better control, form factor, design freedom</td>
<td>Benefits from higher volume, better control, form factor</td>
<td>Benefits from higher volume, cost-efficiency, form factor</td>
<td>Benefits from standardization, reliability, control and form factor</td>
</tr>
</tbody>
</table>
## Market Opportunities

<table>
<thead>
<tr>
<th>TRANSITIONING</th>
<th>EMERGING</th>
<th>CURRENT</th>
<th>POTENTIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Cooking</td>
<td>• Industrial Lighting</td>
<td>• Ablation</td>
<td>• Auto Ignition</td>
</tr>
<tr>
<td>• Drying</td>
<td>• Industrial Lighting</td>
<td>• MRI/NMR</td>
<td>• Auto Ignition</td>
</tr>
<tr>
<td>• Industrial Processing</td>
<td>• Industrial Lighting</td>
<td>• Lasers</td>
<td>• Auto Lighting</td>
</tr>
</tbody>
</table>

- > 70 million microwaves per year (global)
- > 10.9 million dryers per year (US + EU)
- High-bay luminaires market alone will reach $17B (2017)
- > 2000 MRIs per year
- Global ablation CAGR of 9.6% (2014 to 2019)
- US ablation market reach of $295M (2017)
- > 87 million automobiles per year

MORE INNOVATIONS
Roadmap

Q4 2014
RFEA Launches
6 founding member companies

Q1 2016
RF PA Roadmap: Residential Appliances
2.45 GHz, consumer and professional
TC1: HPA Team

Q2 2016
System Integration Guidelines
Subsystem components specifications, system model
TC2: Integration
## Membership Benefits

<table>
<thead>
<tr>
<th>Promoters</th>
<th>+ Associates + Contributors benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Board of Directors seat</td>
<td>• Strategy and policy approval</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Contributors</th>
<th>+ Associates benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Committee chair/vice-chair nomination</td>
<td>• Propose work products</td>
</tr>
<tr>
<td>• Voting rights</td>
<td>• Contribute to draft specifications</td>
</tr>
<tr>
<td></td>
<td>• Unrestricted members’ collaboration space access</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Associates</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Final specification access</td>
<td>• Global, members-only meeting access</td>
</tr>
<tr>
<td>• Publication access prior to public release</td>
<td>• Educational event invitations</td>
</tr>
</tbody>
</table>