

A large, circular, semi-transparent overlay containing a microscopic view of a silicon chip. The chip's surface is a grid of intricate patterns, with colors ranging from blue and purple at the top to red and orange at the bottom, suggesting a thermal or spectral analysis. The background of the slide is a solid blue color.

Bricks Evolve as Form Factors, Architectures and Digital Control Technologies Shift

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Background

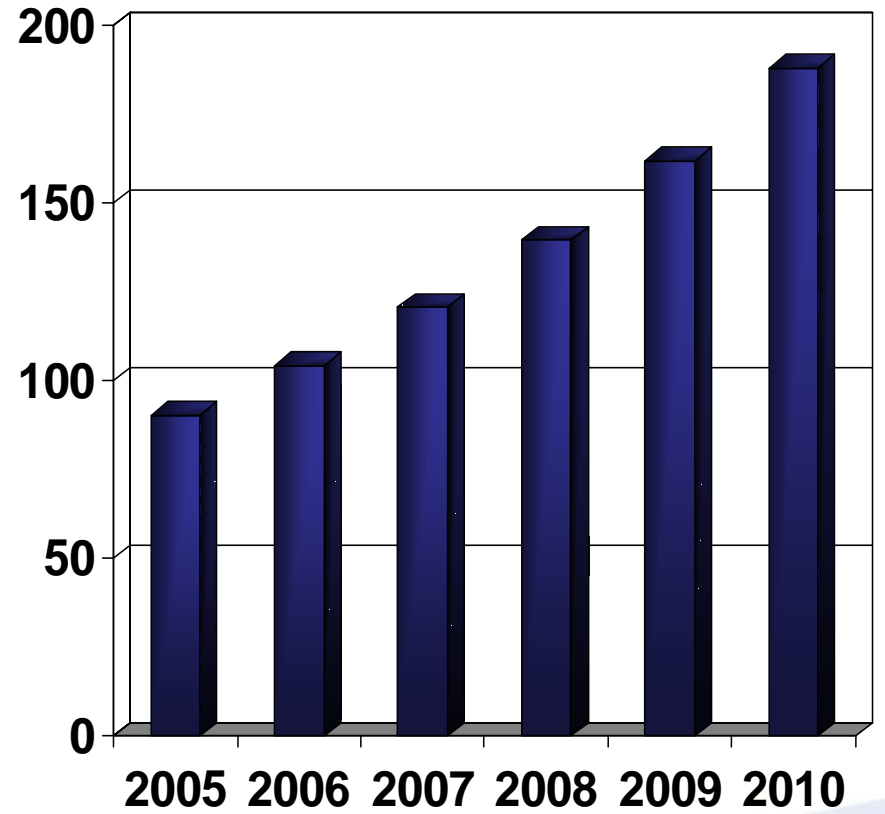
- Darnell Group is a publishing and market research company that focuses exclusively on the power electronics industry.
- The data provided in this presentation stem from the eighth update of our dc-dc converter modules forecasts and our first edition digital power forecasts.

DC-DC Converter Module Market Snapshot

- The worldwide dc-dc converter module market is projected to rise
 - 90.3 Million in '05
 - 188.0 Million in '10
 - CAGR 15.8%

 - Note: Just modules, not discrete/down solutions.

Worldwide DC-DC Converter Modules
(millions of units)



Source: DC-DC Converter Modules, Eighth Edition

Methodology

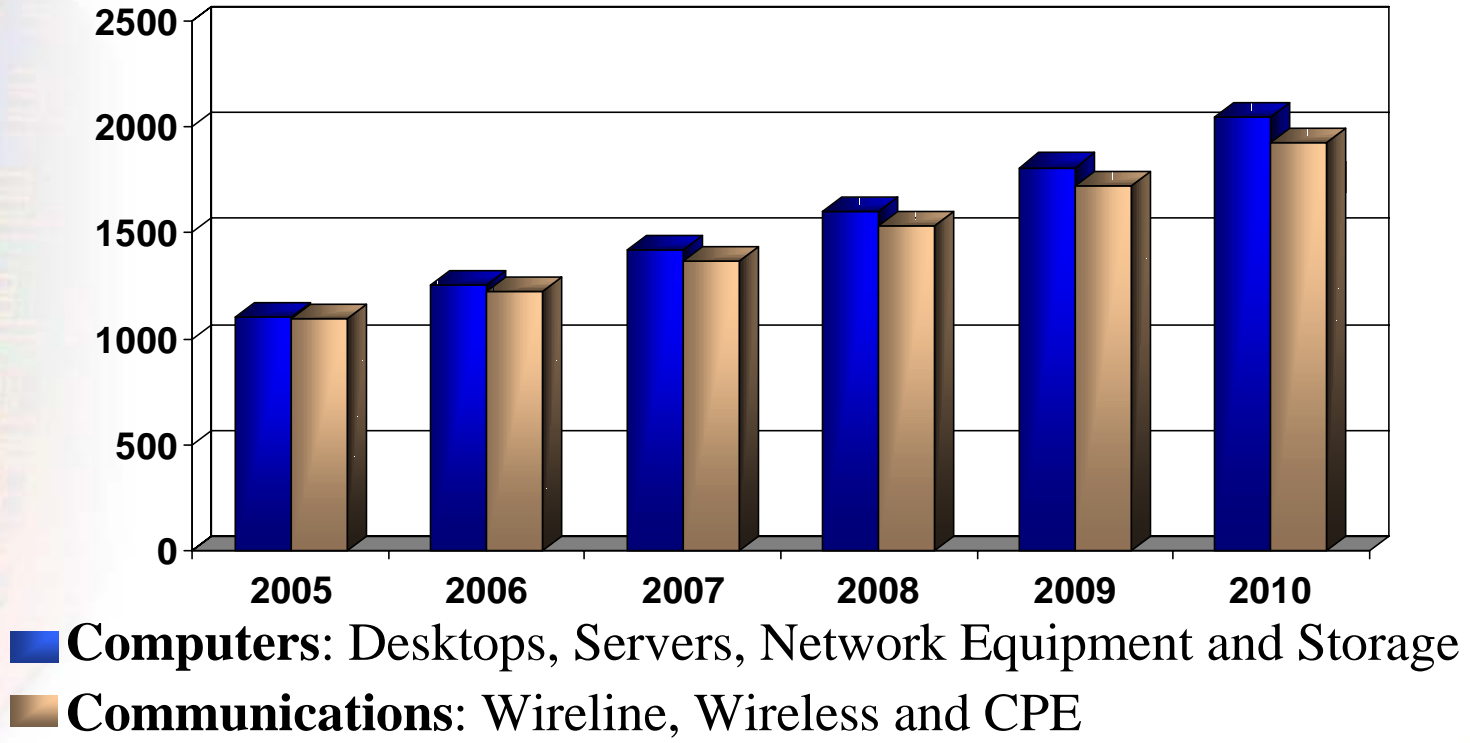
- These forecasts are derived via application-based research.
 - Computers, Communications, Industrial and Military/Aerospace
 - Based on typical application and typical number of converter modules.
- Forecasts by wattage, amperage, V_{in} , V_{out} , Isolated/non-isolated and so on are derived from application data.

Computers & Communications

- Application and Architecture shifts drive dc-dc converter market.
- Traditionally, dc-dc modules sales were heavily weighted towards Communications with Computers ranking second.
- However, computers' dc-dc module demand has surpassed communications' dc-dc module demand.
 - This is true worldwide, but is primarily driven by high-end servers, storage and networking equipment in North America.

Computers surpass Communications

Worldwide DC-DC Converter Modules
By Computers and Communications
(millions of dollars)



Source: DC-DC Converter Modules, Eighth Edition

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Computer vs. Communications Implications

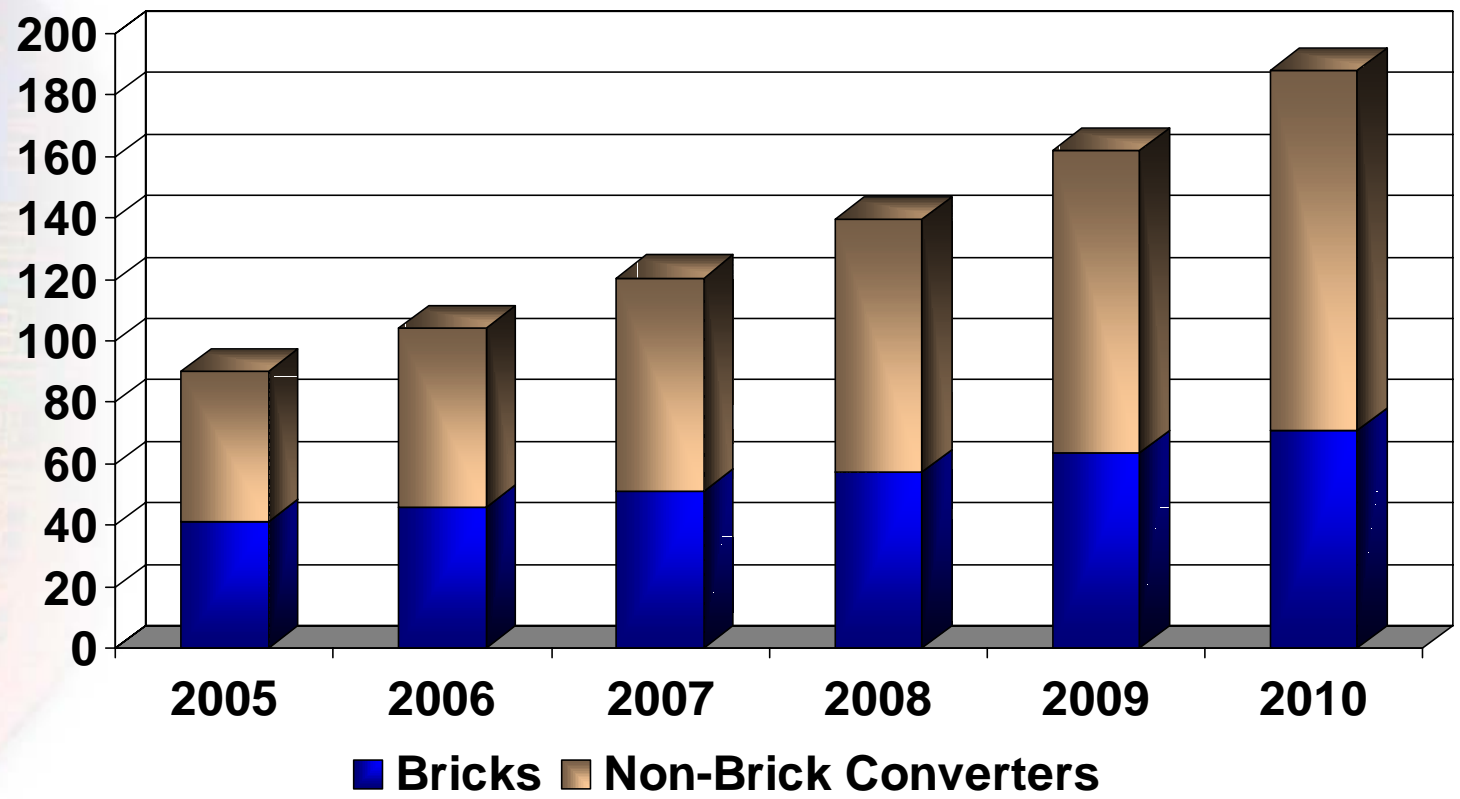
- Pricing, Pricing, Pricing
 - In late 2004 dc-dc pricing averaged \$0.26 per W for isolated modules. Now that price has continued to drop into the high teens per W.
 - Point-of-Load converters seeing similar large price declines in terms of dollars per amp.
- Faster adoption of Intermediate Bus Architecture (IBA)
 - Greater market penetration of Point-of-Load (POL) converters and Bus Converters.
 - Smaller share of market for bricks.

Have Bricks Hit the Wall?

- Bricks are traditionally the largest portion of the dc-dc converter module market.
 - In 2005, they accounted for 45% of all dc-dc module sales.
- Increasing focus on the IBA and other distributed power architectures is eroding brick's market share.
 - It is expected to drop to 37% by 2010.

Worldwide Brick Sales

Worldwide DC-DC Converter Modules By Product Type (millions of units)



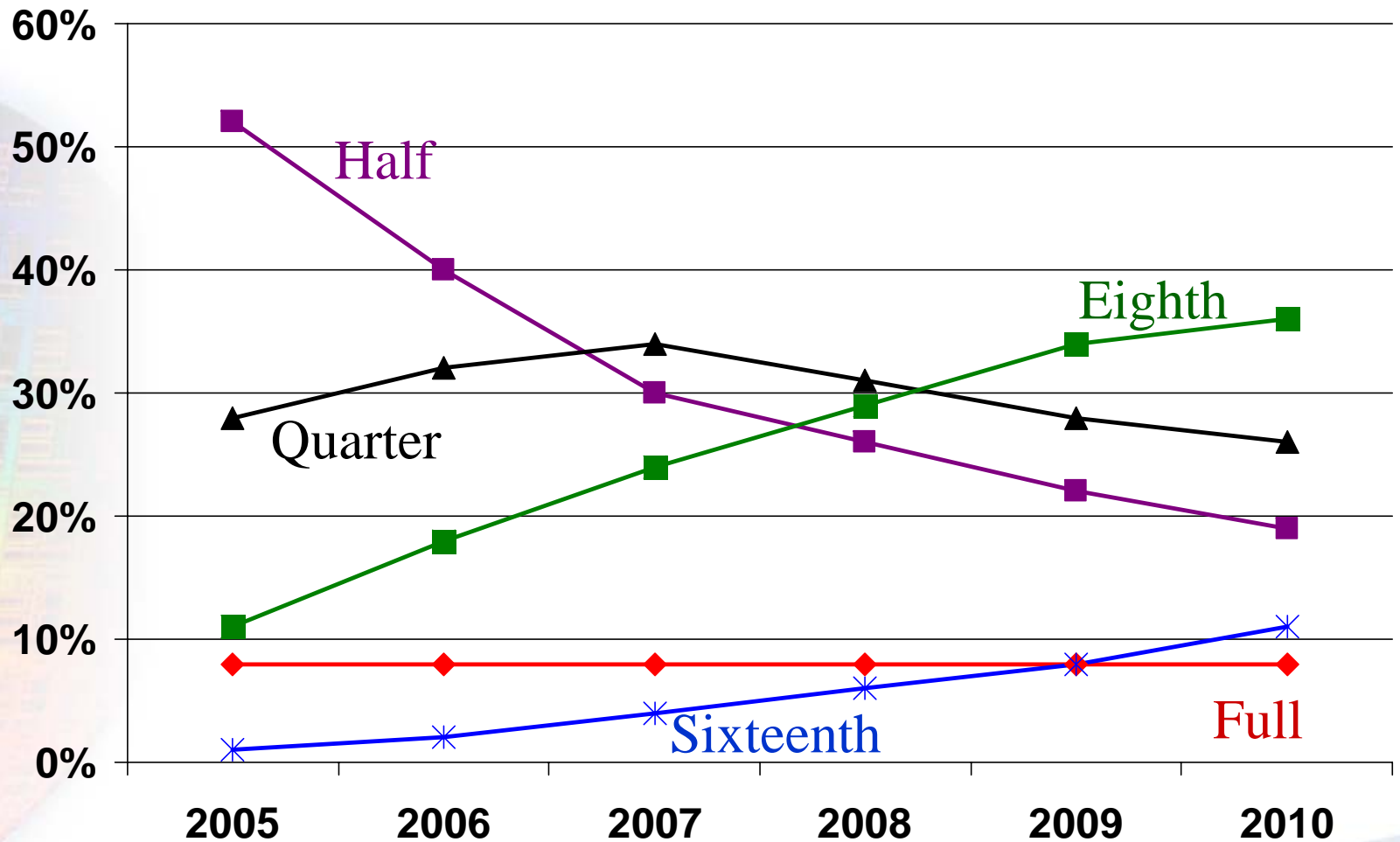
Source: DC-DC Converter Modules, Eighth Edition

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Focus on Bricks

- Since Vicor introduced the brick in 1984, the brick market has been pushing smaller form factors.
- But as the focus of dc-dc modules makers has shifted from bricks, the move towards smaller bricks has slowed.
 - Sixteenth bricks were introduced a few years ago, but adoption of this form factor has been slow.

Brick Form-Factor Market Shares



Source: DC-DC Converter Modules, Eighth Edition

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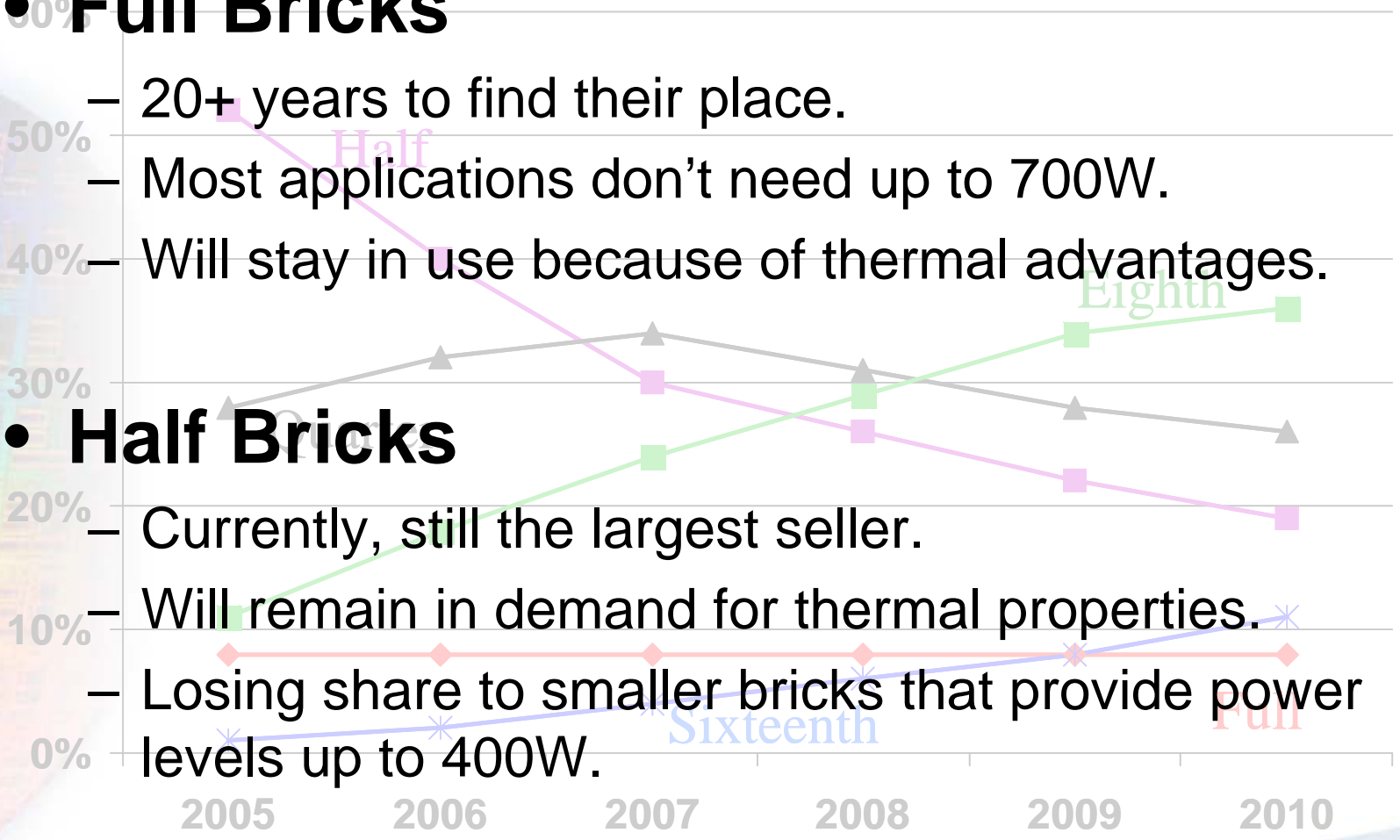
Larger Bricks

• Full Bricks

- 20+ years to find their place.
- Most applications don't need up to 700W.
- Will stay in use because of thermal advantages.

• Half Bricks

- Currently, still the largest seller.
- Will remain in demand for thermal properties.
- Losing share to smaller bricks that provide power levels up to 400W.



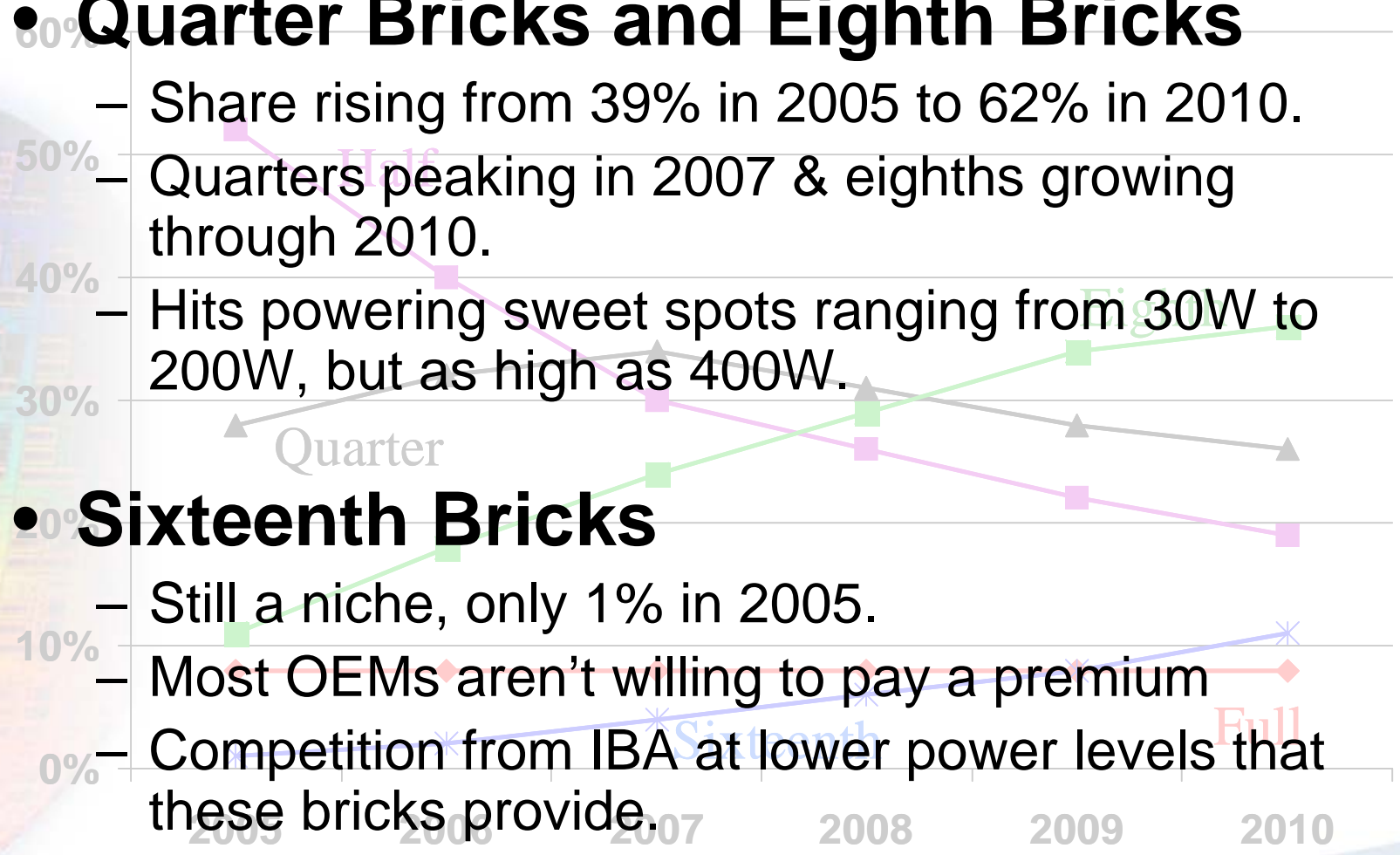
Smaller Bricks

• Quarter Bricks and Eighth Bricks

- Share rising from 39% in 2005 to 62% in 2010.
- Quarters peaking in 2007 & eighths growing through 2010.
- Hits powering sweet spots ranging from 30W to 200W, but as high as 400W.

• Sixteenth Bricks

- Still a niche, only 1% in 2005.
- Most OEMs aren't willing to pay a premium
- Competition from IBA at lower power levels that these bricks provide.



Bricks conclusion

- Bricks haven't hit the wall,
 - but they are a low-margin, relatively high-volume commodity product,
 - they are seeing increased pricing pressure as more non-traditional brick suppliers move into this market,
 - and they are seeing pressure as R&D spending is aimed at other areas of dc-dc converter market, such as
 - IBA
 - Digital Control and Conversion

Distributed Power Trends

- Over the last 3 years, 36 new bus converters have come to market according to stories run on PowerPulse.Net.
- Most of these have been in the last 18 months.
- Response to the increased number of voltage rails on system boards and the higher current levels required.

Distributed Power Consequences

- Greater number of modules per system.
 - POLs and Bus Converters are driving fastest sales growth for dc-dc converter module market.
 - So, unit sales are increasing.
- Dollars per system may be falling.
 - Average Selling Price of POLs and Bus Converters is much less than bricks.
 - Revenue growth is hit hard by falling prices.
 - Even though unit sales are projected to grow 15.8%, revenue growth not keeping up.

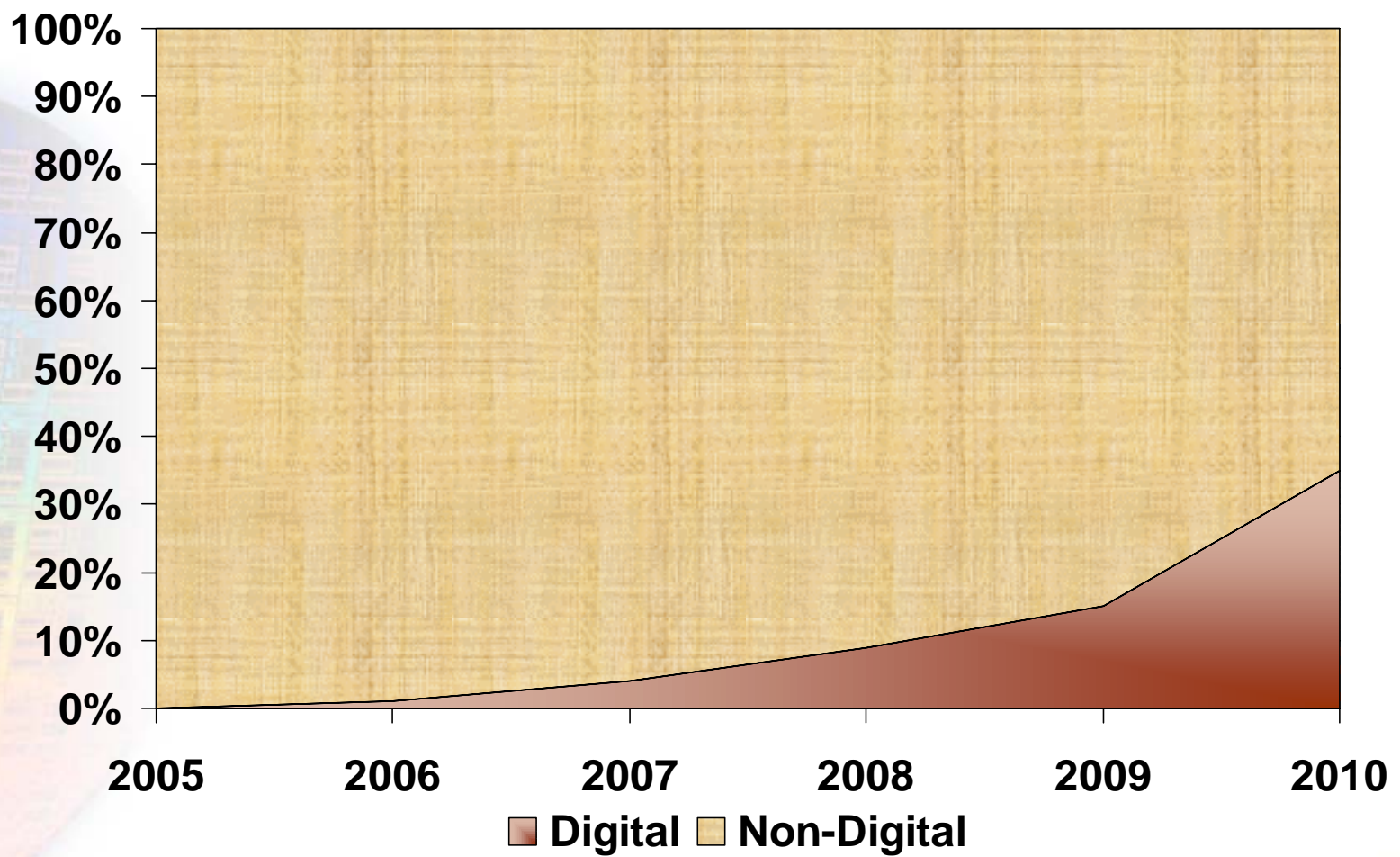
Distributed Power Threats

- The move to distributed power architectures and the IBA allows for increased competition from Power Semiconductor makers.
- Module makers supply the bus converter while POLs can easily come from power semis.
 - Recent products from Linear Tech (μ Module) and others are pushing the threat into the 10A range.
 - More similar products are expected in the near future.

Digital Bricks

- Digital has been the hot dc-dc topic for at least the last two years.
- Despite interest and products, adoption has been slow.
- May remain slow as largest players in digital dc-dc market are involved in lawsuits and large acquisitions.
- POLs are projected to adopt digital before bricks, but bricks are still moving towards digital.
 - Recent product introduction from Astec

Digitally Controlled Bricks



Source: Emerging Markets in Digital Power Electronics

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Conclusion

- The biggest potential markets for digital control in embedded dc-dc converters are Communications, Data Communications and Servers. Data Communications and Servers present the earliest opportunities, with Communications picking up a year or two later.
- But, any growing use of digital control and conversion technologies will increase the differentiation in the brick market. As such, a move towards “digital bricks” will slow the process of brick commoditization.
- However, OEMs are generally unwilling to pay a premium. Even digital may not resurrect strong revenue growth for bricks.