



# Project 7: Advanced LED Downlighting Systems

Keith Graeber  
CLTC

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# Project Summary



- The project on Advanced LED Downlighting Systems seeks to commercialize a component-based system that will:
  - Be specifically tailored to LED sources
  - Be energy efficient
  - Be cost effective
- We expect this project to result in Samsung manufacturing a component-based LED downlight system design that they will sell to a fixture manufacturer



# Current Activities



- Market Analysis
- Thermal and Optical refinement
- System Integration Design and Development
- Pre-production prototypes
- Finalizing a fixture manufacturing partner

# Market Analysis



## Existing Products

	Standard Incandescent (BR30)	4-pin CFL Downlight System	LED Downlight System
<b>Total # of Downlights</b>	10	8	10
<b>Delivered Lumens per Downlight</b>	620	850*	650
<b>Power per Downlight (watts)</b>	65	28	12
<b>Material Cost per Downlight</b>	\$ 20	\$ 38	\$ 90
<b>Installation Cost per Downlight</b>	\$ 30	\$ 30	\$ 30
<b>Total Kitchen Lamp Lumens</b>	6200	6800	6500
<b>Total Kitchen Power (watts)</b>	650	224	120
<b>Total Initial Installed Cost</b>	\$ 500	\$544	\$ 1200
<b>Operating Cost per year</b>	\$99.65	\$34.34	\$18.40
<b>Additional Initial Cost vs. Incandescent</b>	n/a	\$ 44	\$ 700
<b>Annual Savings vs. Incandescent</b>	n/a	\$65.31	\$81.25
<b>Simple Payback</b>	n/a	0.67	8.62
<b>CRI</b>	100	~82	~92

Calculations based on an average use of 3.5 hrs/day, an electricity cost of \$0.12/kWh, and initial lamp lumens.

\*Assumes a 50% luminaire efficiency. Luminaire efficiency taken from the following sources:

Davis, Roberts and Welhong Chen. Specifier Reports, "CFL Downlights," Vol. 3 No. 2, page 29. August 1995.

DOE – Building Technologies Program, "LED Application Series: Recessed Downlights." PNNL-SA-52145, November 2006.

# Market Analysis



## Samsung Product Goals

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TARGETED AREAS

# System Integration Design and Development

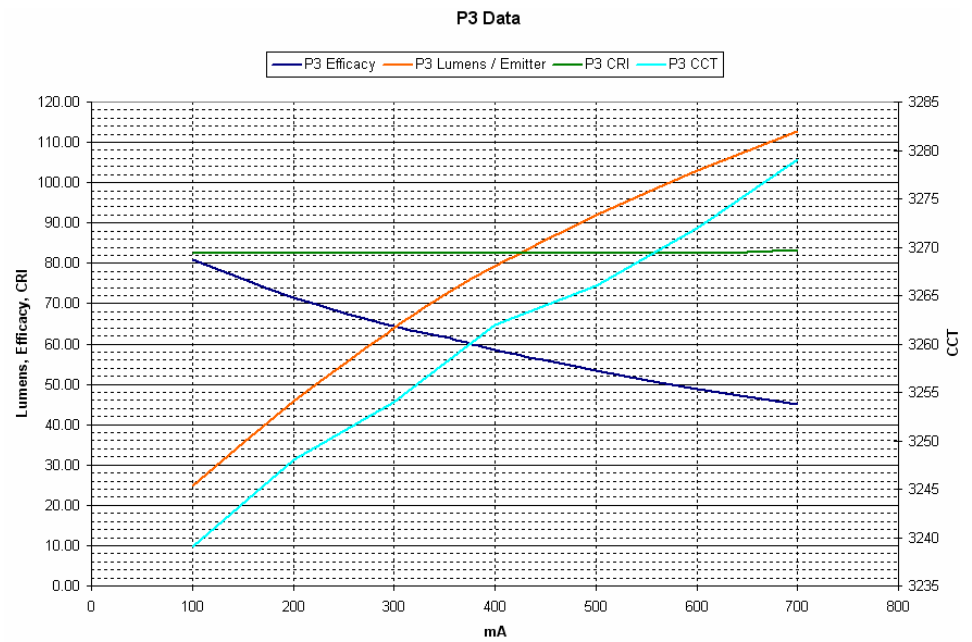
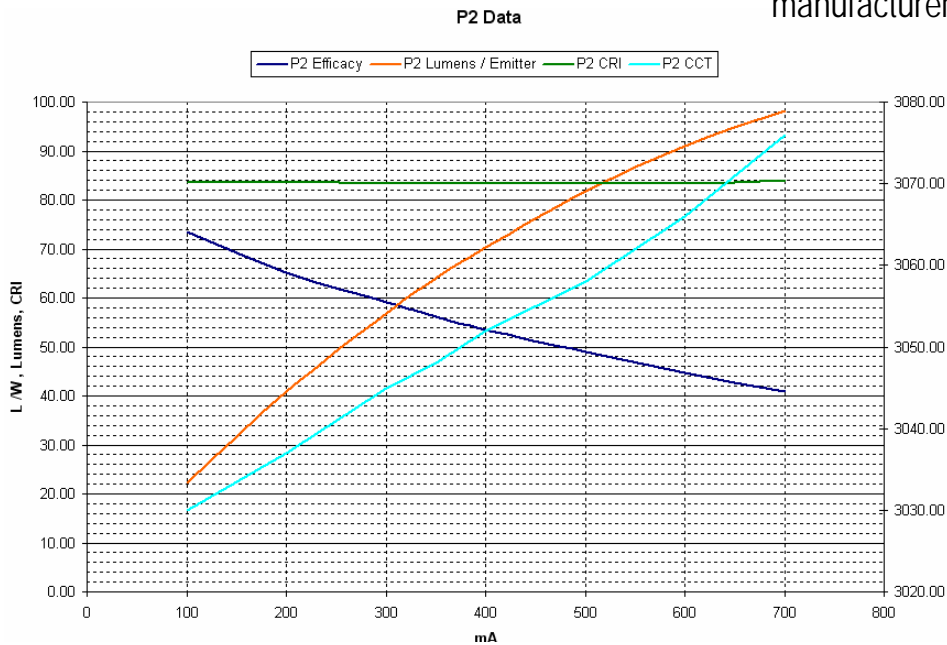


- System refinement based on results from proof of concept prototypes and software modeling techniques
  - Optical design
  - Thermal design
  - Electrical topology
  - Installation techniques
- Interviewed local home builders for feedback on installation requirements and novel features

# Pre – Production Prototypes

- Source Selection criteria

- Performance vs. Cost
- Energy Star
- Samsung has existing relationship with LED manufacturer



# Energy Star



- ***Recessed Downlights Requirements:***
- Minimum Light Output:
  - $\leq 4.5$ " Aperture: 345 lumens (initial)
  - $> 4.5$ " Aperture: 575 lumens (initial)
- Zonal Lumen Density Requirement: Luminaire shall deliver a minimum of 75% of total lumens (initial) within the 0-60° zone (bilaterally symmetrical).
- Minimum Luminaire Efficacy: 35 lm/W
- Allowable CCTs: 2700 K, 3000 K and 3500 K for residential products; No restrictions for commercial.
- Reduced Air Leakage: Recessed downlights intended for installation in insulated ceilings shall be IC rated and be leak tested per ASTM E-283 to demonstrate no more than 2.0 cubic feet per minute (cfm) at 75 Pascals (1.57 lbs/ft<sup>2</sup>) pressure difference. The luminaire must include a label certifying "airtight" or similar designation to show air leakage less than 2.0 CFM at 75 Pascals when tested in accordance with ASTM E283.

# Fixture Manufacturing Partner



- CLTC and Samsung are shopping the Downlight concept
- Multiple Manufacturers interested
  - Established, conventional partners
  - Smaller, innovative partners
- University, CLTC, and Samsung working to finalize an MOU with one manufacturer for the Field Demonstration fixtures

# Initial Product Specification

- **Optical system**
  - Indirect optical system
  - Meets Energy Star Criteria for total lumen output and efficacy
  
- **Power supply:** the SMPS shall meet the following specifications:
  - Minimum 87% efficient
  - Operate up to 10 downlights
  - UL 1598
  - FCC Class B
  - THD < 10%
  - PF > 90
  - Optional low voltage control inputs
  - Occupancy
  - Manual dimmer
  - Scene controller
  - Timer
  - Daylight harvesting
  - Power supply can withstand Insulation Contact at 55°C ambient
  
- **Driver:** The driver shall meet the following specifications:
  - Minimum 94% efficient
  - Operate up to 2 downlights
  - Input 48 V Max
  - Output 700mA Max
  - Drive 14 LEDs@700mA max
  - Current follows voltage from 48V-32V
  - <32V=Off



# Market Barriers



- Total system cost
- Acceptance of installers
- Consumer acceptance of indirect aesthetic
- Housing market
- Fixture manufacturers market presence