Not So Clever When They Are Off: Standby Power Use in Smart Lamps
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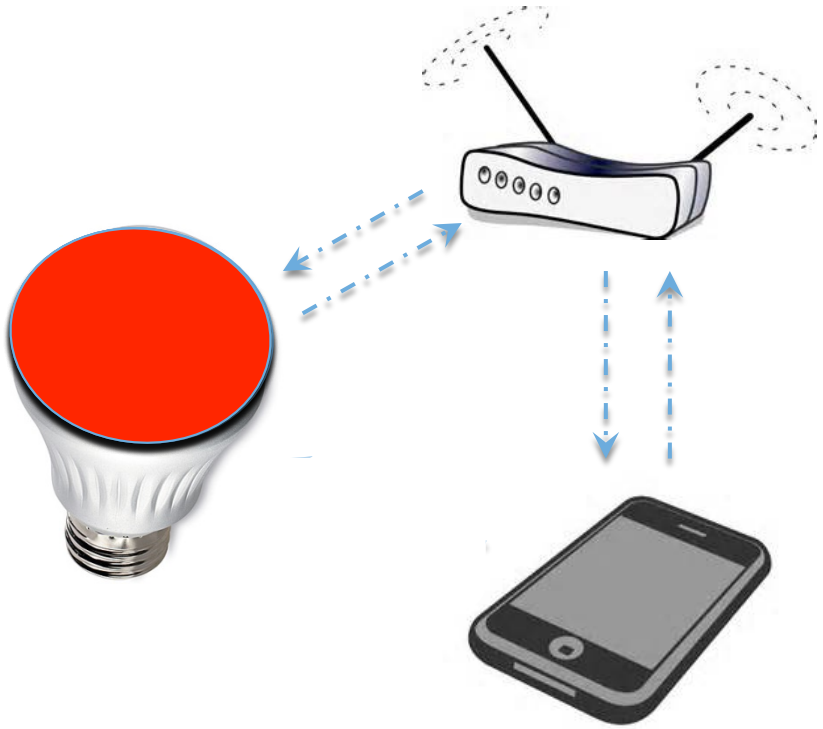
Smart lights – what do we mean?



- A lamp that communicates with some remote device (eg smart phone):
  - Directly (eg via bluetooth)
  - Indirectly (eg via WiFi, Zigbee)
- Allows user control of:
  - Light output (dimming)
  - Colour (tunability)
- Potential additional functionality:
  - Movement/other sensing/…
  - Data upload/download/relay/mesh

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Scaling the issue

- Smart lamps rapidly growing part of the LED lamp market, which is itself growing rapidly:
  - Estimate smart lamps sales could reach 300 million in 2020
- Efficacy can be expected to rise as LEDs improve.
- Added levels of control may result in:
  - Increased usage (e.g., lamps are used longer because they offer new features such as scheduling, colour changing, etc)
  - decreased usage (e.g., lamps are easier to efficiently dim or turn off)
- “Standby-mode” the picture is clearer—these lamps use power in ways that traditional lamps do not.

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Research Objective

- Smart Lamps have potential for enormous energy saving:
  - (Almost) Universally LED, hence high/increasing efficacy
  - Potential to use “smarts”, eg respond to occupancy
- Potential risk:
  - Potential to use considerable energy in “off/standby” mode
- Study Objectives:
  - Investigate potential energy impact of “active” vs “off/standby” mode
  - Identify potential barriers to policy makers managing consumption

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Research summary

- 11 commercial available smart lamp procured (US):
  - 5 required separate wireless bridge/gateway
  - Many with potential for “mesh” connection
- Tested for:
  - Active (light emitting) power and light output
    - CCT adjusted to be between 2700K and 3200K
  - Dimming at 80%, 60%, 40%, and 20% of initial, holding CCT
  - Off/Standby power (plus bridges/gateway)
    - Using DoE “instruction for zero light output”

Issue 1

- Test procedures not yet well defined:
  - Both IES LM-79 and IEC 62612 require luminous flux and power when the lamps are not dimmed.
  - Do not address:
    - Dimmed efficiency
      - Large *potential* savings from dimmed smart lamps which by-pass compatibility issues
      - Standby vs Deep sleep; meshing/hub lamps, etc
    - Tunability eg some lamps can be at full output at 2700K or 6500K or saturated colours
      - Performance can vary dramatically based on the colour setting, ie need to define how to adjust colour settings for repeatability

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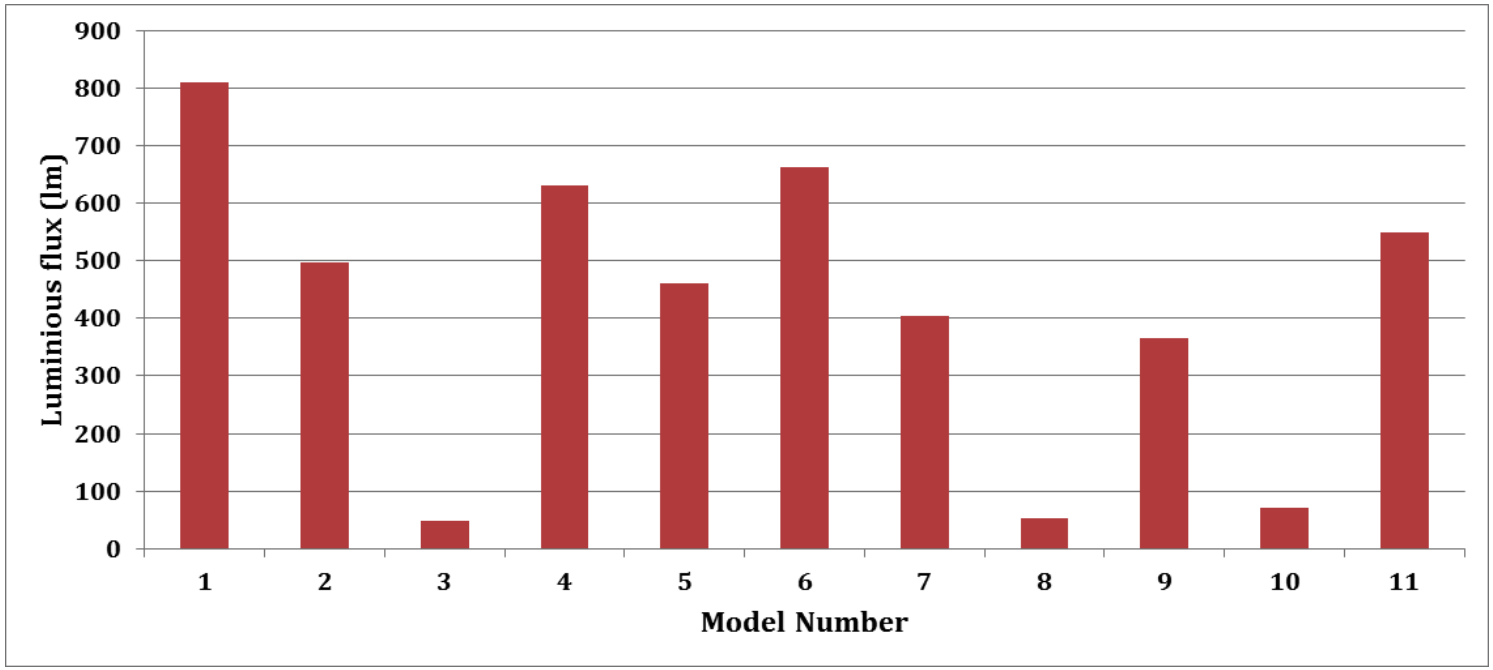
Luminous Flux – Full Power



- 3 lamps below 100lm so may not be considered appropriate for general illumination

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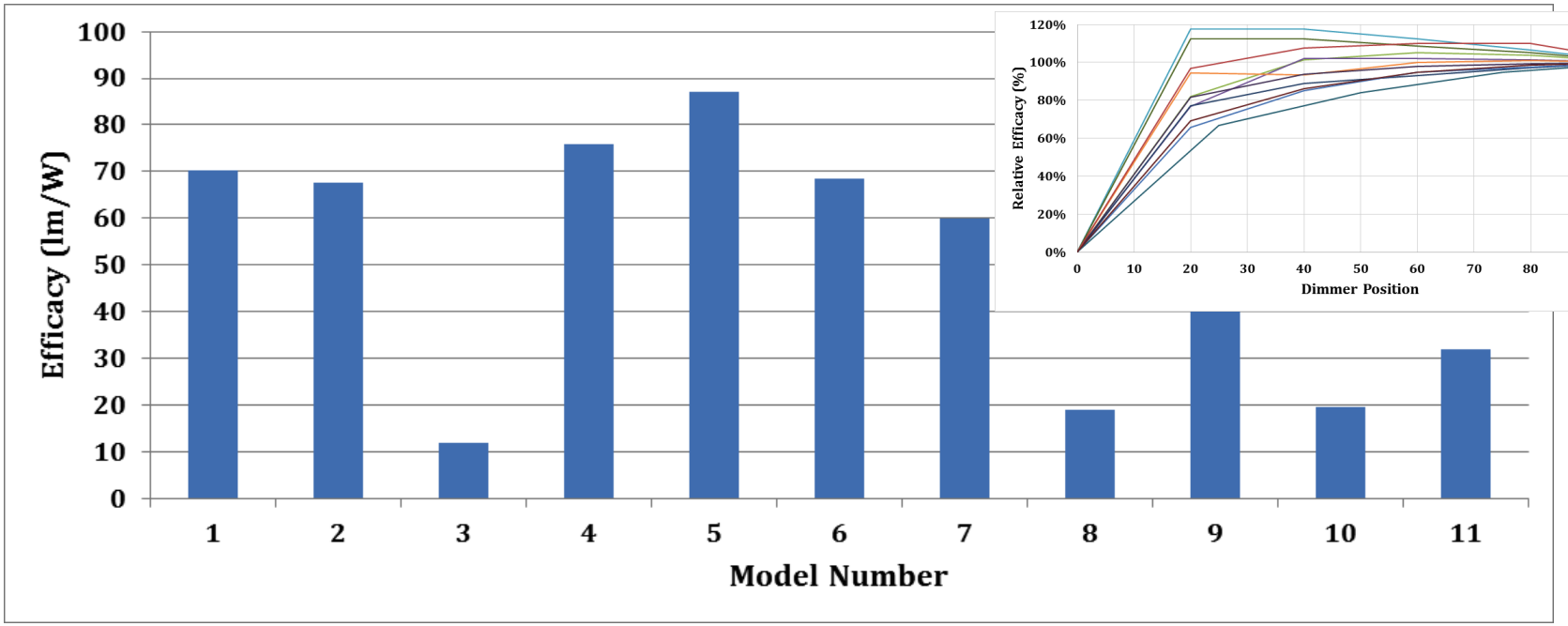
Efficacy – Full Power/Dimmed



- Range from 12.0 - 86.9 lm/W (average = 51.2 lm/W; median = 60.0 lm/W)
- Efficacy broadly stable when dimmed down to 40%, slight drop-off thereafter

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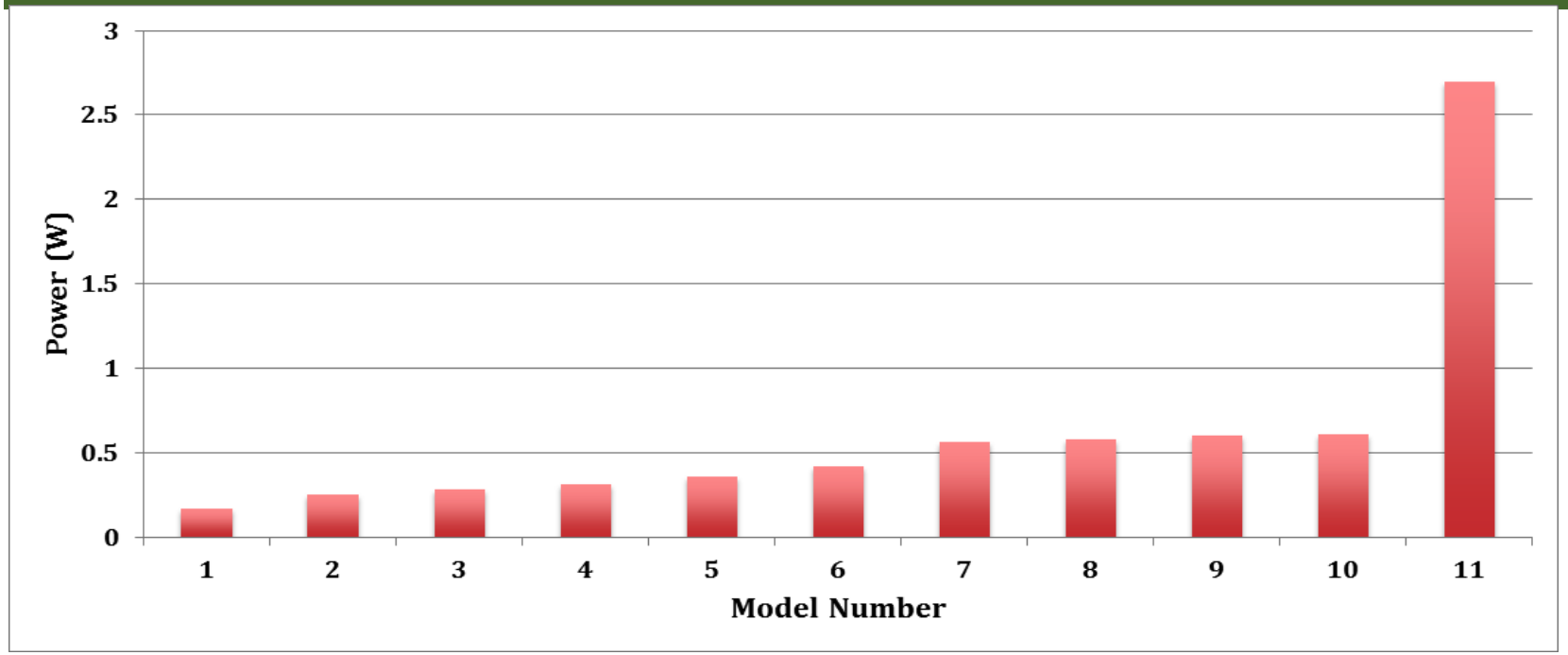
Standby – Excluding Bridges



- Range from 0.17 - 2.7W (average = 0.62W; median = 0.42W)
- Models 1, 5, and 6 had additional bridges drawing 1.72 - 2.17W

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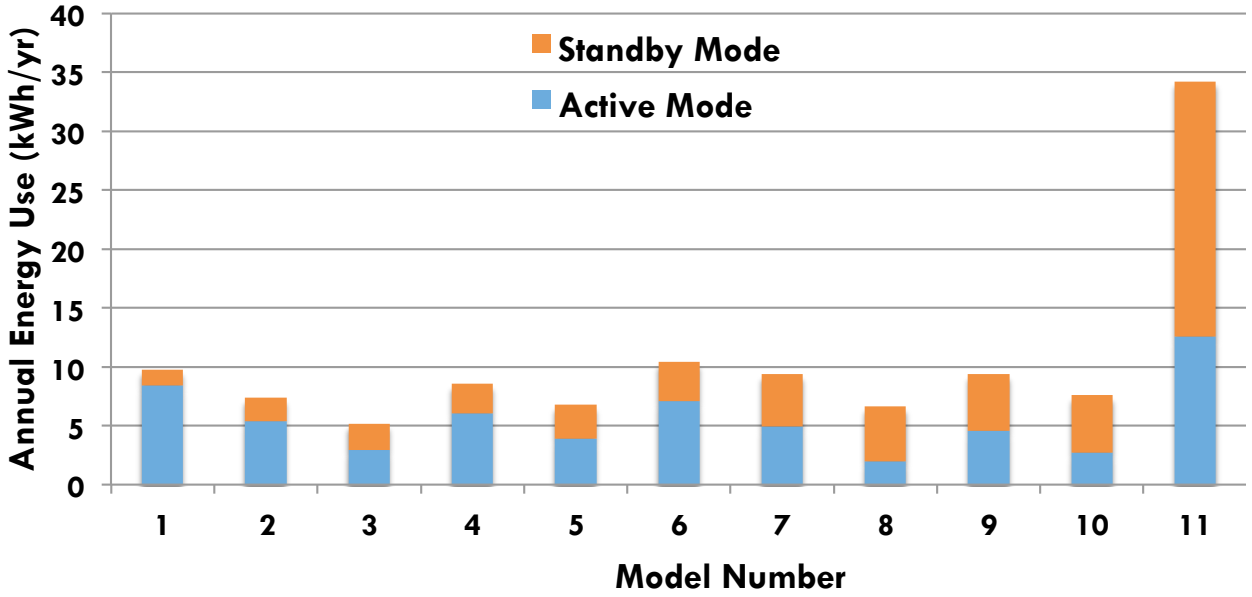
Annual Energy Consumption



- Assumes 2 hours/day full light output, 22 hours standby, no bridge power
- Broadly speaking, 100% increase in consumption/significant lost savings

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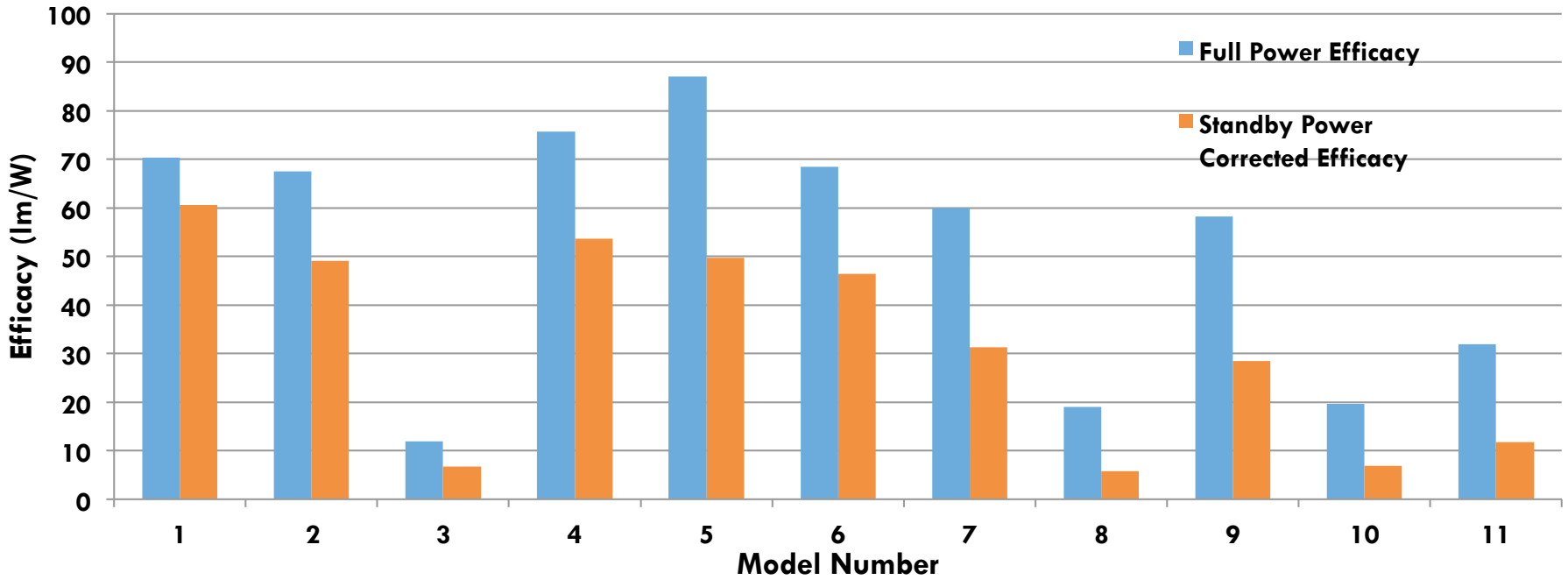
Standby Power Corrected Efficacy



- Standby Efficacy = Full power efficacy x (active/standby annual energy use)
- Average full power efficacy = 51.8 lm/W, average standby power corrected efficacy = 31.9 lm/W

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Key Issues

- Area policy makers need to address
  - 300 million smart lamps (single year sales) represents nearly 26.5 billion kWhs per year or approximately $2.65 billion per year in lost savings to standby
    - *Based on 0.5W (the average standby power we measured during our testing was 0.62W)*
  - Best tested 0.17W *already* technically possible to reduce "lost savings" by 65%
- Test Procedures need addressing
  - Type of standby, dimmability, tunability

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EASY Questions Please

Additional Info

- Hard to make any strong statements about Wifi vs Bluetooth for standby
  - This is just how phone is communicating – the bridge/gateway (or even a primary lamp) may convert to Zigbee or similar
  - Wifi average 0.7W, Bluetooth average 0.5W,
  - Wifi would be less that Bluetooth if not for one model
- Helpful to have this info to for first pass evaluations
- Hard to make any definitely statements as the reality is a little more nuanced that the simple “WiFi vs Bluetooth" evaluation might imply

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Model and Consumption Details

Model #	Lamp only	Router	Lamp + Router	
1	0.17	1.72	1.89	wifi
2	0.25		0.25	bluetooth
3	0.28		0.28	wifi
4	0.31		0.31	wifi
5	0.36	1.77	2.11	wifi
6	0.42	2.17	2.58	wifi
7	0.56		0.56	bluetooth
8	0.58		0.58	bluetooth
9	0.60		0.60	bluetooth
10	0.61		0.61	bluetooth
11	2.70		2.70	wifi

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- The type of connection listed below (wifi/bluetooth) is just how your phone is communicating. The “router” (we called it a “bridge”) is converting the WiFi to Zigbee or 6LoWPAN (similar to Zigbee).
- The bridge, or even the “primary" lamp (e.g. in the case of LIFX) will generate a Zigbee/6LoWPAN network. So the way the phone is communicating (wifi/bluetooth) is not relevant to lamp power consumption.

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