



RESFEN Modeling Assumptions for Energy Star Analysis: Status Report

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Summary



- Work in Progress with RESFEN 6
- Considered all NFRC 901 recommendations
- Updated assumptions to reflect changes in the building sector or incorporate better information available over the past decade
- “Tweaked” some questionable or poorly substantiated modeling assumptions
- Completed initial sensitivity analysis of impact of revised assumptions

Specific modeling changes in seven areas (1)

- 1. *Building size and type*** - change from a single 2000 ft² one-story prototype to two prototypes – a 1700 ft² one-story and a two-story prototype with floor areas of 2800 ft² for New construction and 2600 ft² for Existing construction.
- 2. *Shell conditions*** – change from 1993 MEC to 2006 IECC for New construction, but no change in insulation levels for Existing construction.
- 3. *Infiltration*** – change from 0.00057 ELA for all vintages to ELAs of 0.00037 for New and 0.00047 for Existing construction.



Specific modeling changes in seven areas (2)

- 4. *Internal gains*** – change from LBNL equation with a large constant and low sensitivity to floor area to a FSEC equation with a smaller constant and greater sensitivity to floor area. Calculated internal loads are similar for a 1700 ft² house (57.3 to 56.0 kBtu), with larger differences in a 2600 ft² house (64.9 to 72.8 kBtu).
- 5. *HVAC System sizing*** - change from a fixed HVAC size irrespective of window properties, to an autosized HVAC for New construction, but retaining a fixed HVAC size for Existing construction. The rationale is that while builders do size new HVAC installations, it is unrealistic to expect the HVAC to be replaced during window retrofits.



Specific modeling changes in seven areas (3)

6. **Natural Ventilation** – no change in assuming natural ventilation occurs when beneficial between 6 am and 11 pm; the amount of window opening is halved from 25% to 12.5% of total window area, and maximum amount of ventilation halved from 20 to 10 ACH.
7. **HVAC System efficiencies** – system efficiencies are increased for both New (AFUEs from 0.78 to 0.80-0.90, and COPs from 2.7 to 3.8) and Existing construction (AFUEs from 0.74 to 0.78, and COPs from 2.4 to 2.7), but largely offset by higher assumed duct losses (from 10% to 12-20% depending on foundation type)



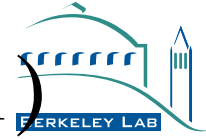
RESFEN 6 Modeling Assumptions



Consistent with NFRC's March 2007 version of 901 for Reference House definition in many areas:

- Floor Area
(RESFEN6 uses more specific areas for 1 and 2 story homes)
- House Type
(RESFEN6 uses 1 and 2 story houses, proportionally weighted per RECS data instead of 1.5 story house)
- House Aspect Ratio
- Foundation Type
- Insulation
- Infiltration
- Structural Mass
(RESFEN6 uses an explicit model of walls/floors; result is similar)
- Internal Mass
- HVAC System
- HVAC Efficiency
- Duct Losses
- Part Load Performance
- Internal Loads

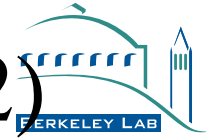
RESFEN 6 Modeling Assumptions (1)



Where NFRC offered a range, we had to pick a specific number:

- Thermostat Set Point
 - NFRC offered "higher/lower," not offered a specific setpoint
- Window distribution by orientation
 - NFRC suggested user percentages, not an equal or other specific distribution
- Solar Gain Reduction: Interior Shading
 - NFRC offered "higher/lower," not a specific level

RESFEN 6 Modeling Assumptions (2)



Changes consistent with NFRC's suggested direction:

- HVAC System Sizing
 - NFRC suggestions adopted, except for factor of safety multiplier
- Natural Ventilation
 - RESFEN 6 reduces max. ventilation by 50% compared to RESFEN5
 - NFRC "no ventilation" is unrealistic

Thermostat Set Point



- NFRC did not offer guidance on a specific single setpoint.
- NFRC suggested
 - Heating: lower 68/65; higher 75
 - Cooling: lower 78/82; higher 72
- RESFEN 6 is the same as RESFEN 5 since there is no conclusive research to support changes (Heating 70/65; Cooling: 78)

HVAC System Sizing



- NFRC suggested Autosizing for the specific window being modeled for New Construction
 - Adopted
- NFRC HVAC safety factor of 1.0 unrealistic
 - RESFEN 5 factor of 1.3 maintained

Window Distribution



- RESFEN 5 assumption of equal distribution maintained

Solar Gain Modeling



Much discussion, but no new definitive research to suggest any changes to current algorithms.

- Exterior Shading
 - NFRC suggested "none;" - this is unrealistic
- Current RESFEN 5 algorithms remain: "Typical" to represent a statistically average solar gain reduction for a generic house, this "package" includes:
 - Interior shades (Seasonal SHGC multiplier, summer value = 0.80, winter value = 0.90);
 - To account for other sources of solar heat gain reduction (insect screens, trees, dirt, building & window self-shading), the SHGC multiplier was further reduced by 0.1. This results in a final winter SHGC multiplier of 0.8 and a final summer SHGC multiplier of 0.7
 - 1' overhang;
 - Adjacent building shading: 67% transmitting same-height obstruction 20' away

Natural Ventilation



NFRC suggested no natural ventilation

- Unrealistic

Recent California research suggests use of ventilation in swing seasons, consistent with RESFEN5 implementation.

- But current values reduced by 50%

Natural Ventilation



- Sherman and Price report, “Study of Ventilation Practices and Household Characteristics in New California Homes:”
<http://www.arb.ca.gov/research/apr/past/03-326.pdf>
- Research suggests windows may not be open as much, thus
 - maximum open area reduced from 25% to 12.5%
 - screens reduce flow to 60%.
- Many constraints on window opening
 - temperature
 - humidity
 - time of day
- End result is minimal impact on cooling, particularly in cooling dominated climates.

Assumption Sensitivity Analysis



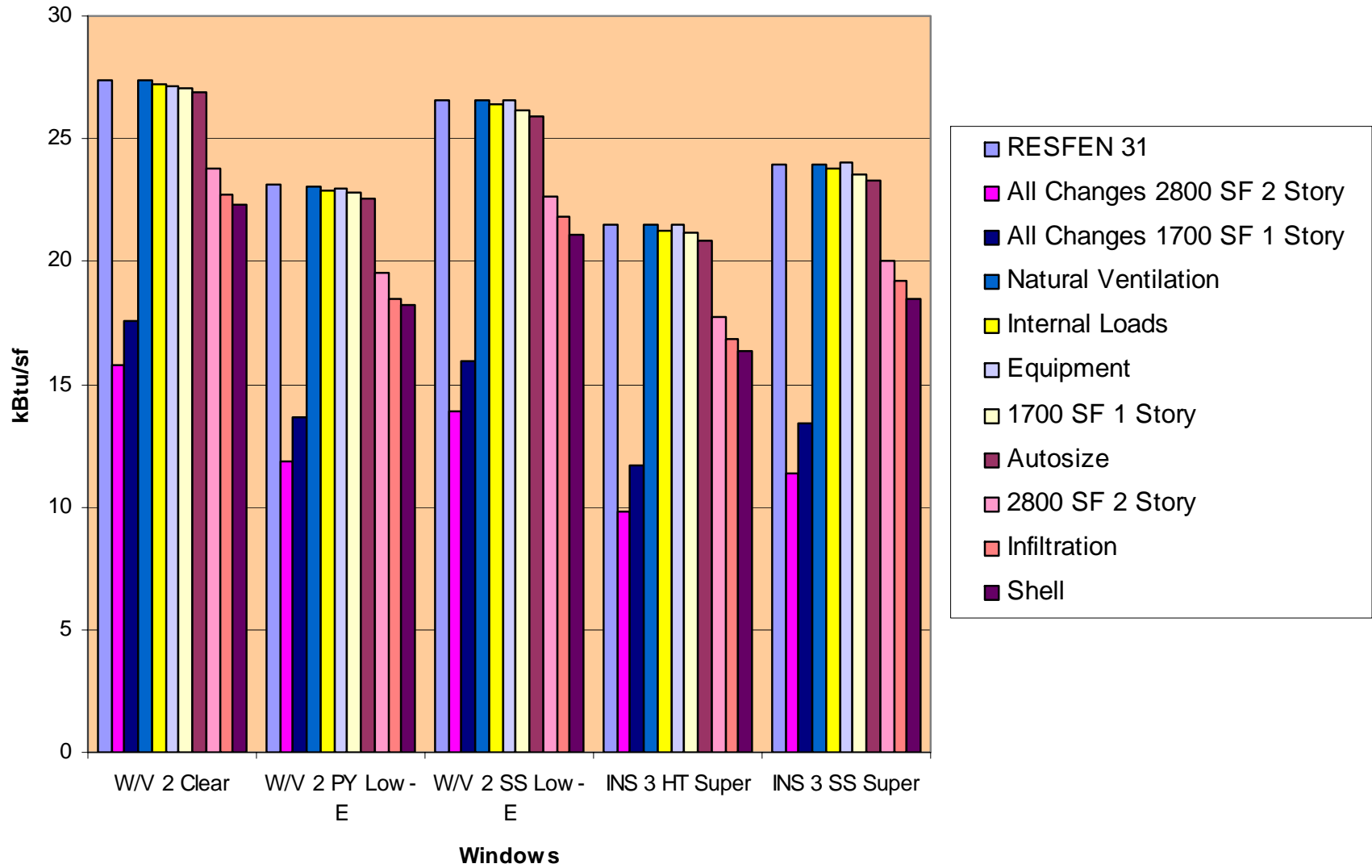
| | | |
|----------------|---|---------------------|
| Vintages | New and Existing | |
| Building types | One and Two Story Prototypes | |
| Locations | Salt Lake City Phoenix Minneapolis Charleston SC Washington | |
| Window Types | W/V 2 Clear | (U=0.49, SHGC=0.56) |
| | W/V 2 PY Low-E | (U=0.37, SHGC=0.53) |
| | W/V 2 SS Low-E | (U=0.34, SHGC=0.30) |
| | INS 3 HT Super | (U=0.18, SHGC=0.40) |
| | INS 3 SS Super | (U=0.18, SHGC=0.26) |



CAUTION

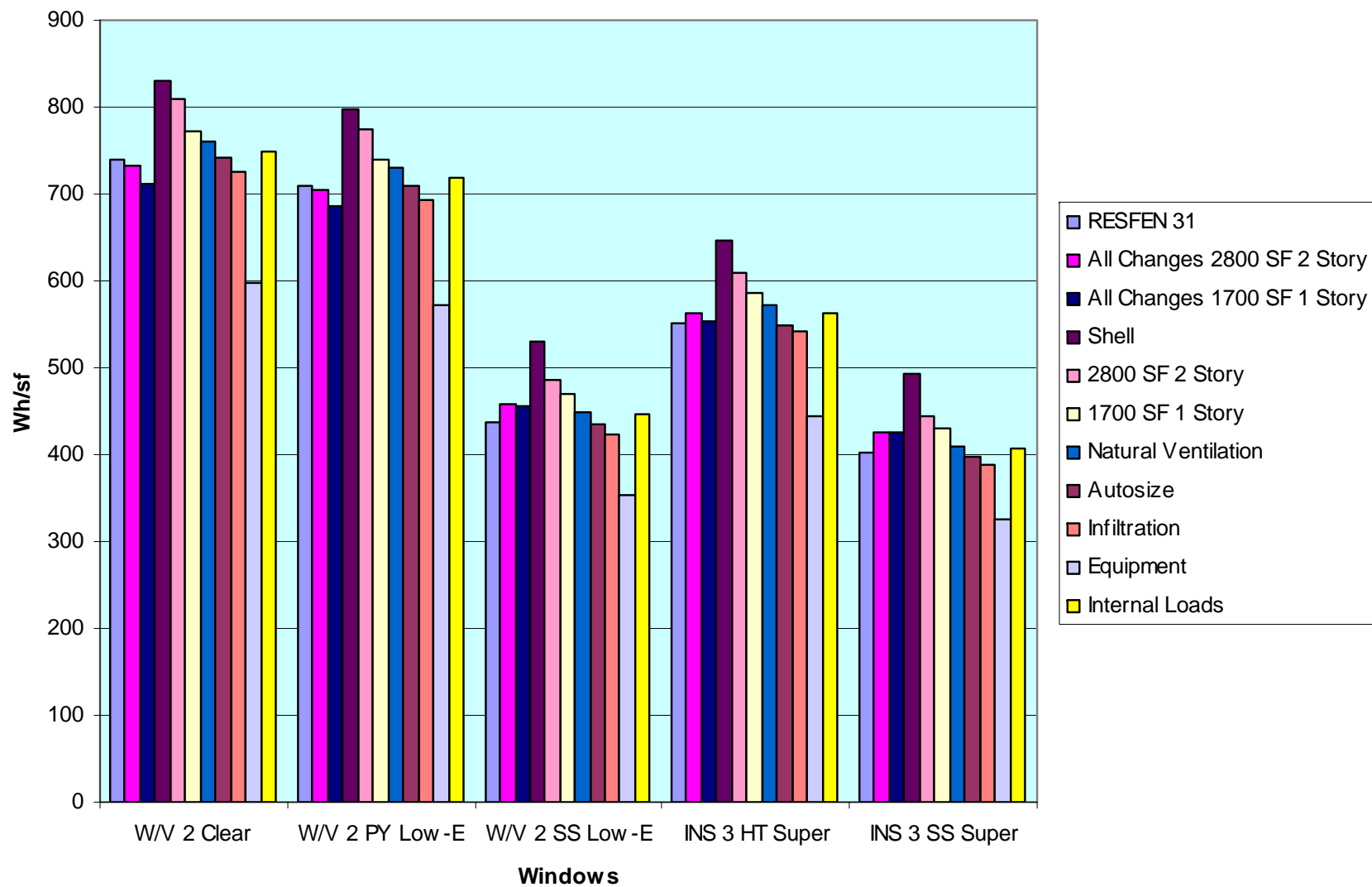
Work in Progress
Preliminary Results
Under Review
Subject to Change
Don't Bet the Farm Yet
Not Final - Do Not Quote

Salt Lake City Heating / SF New Construction



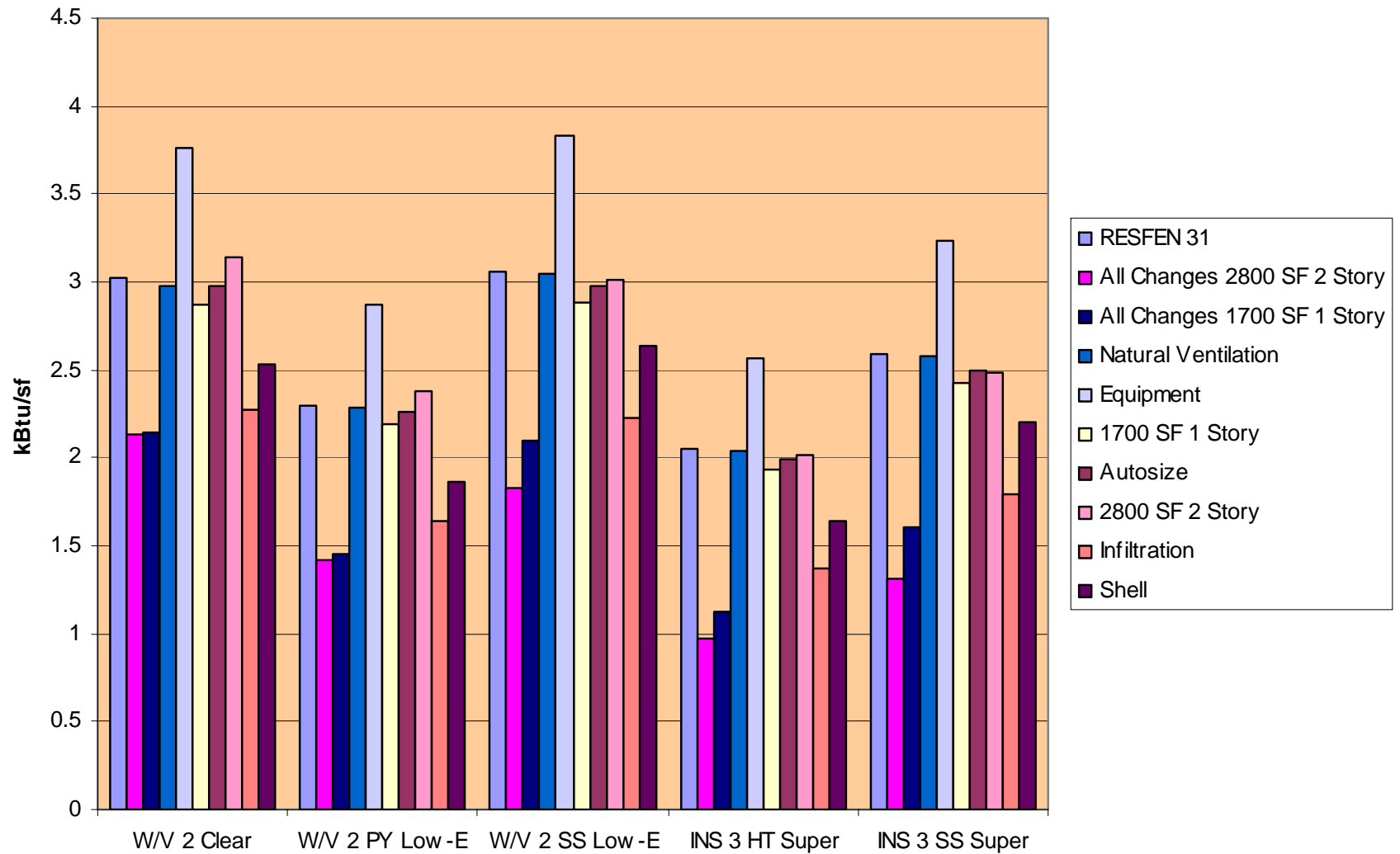
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Salt Lake City Cooling / SF New Construction



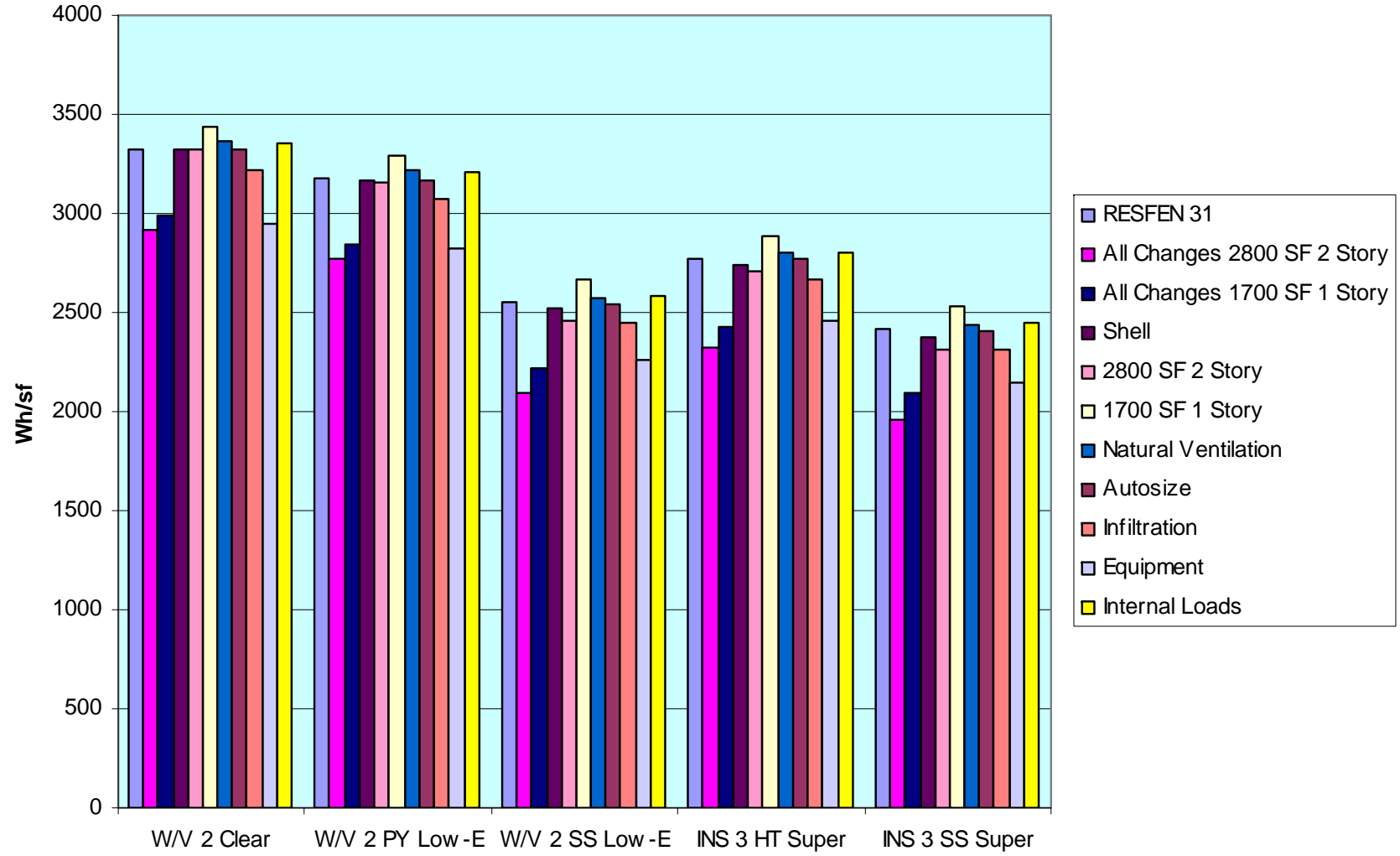
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Phoenix Heating / SF New Construction



Windows
Not Final - Do Not Quote

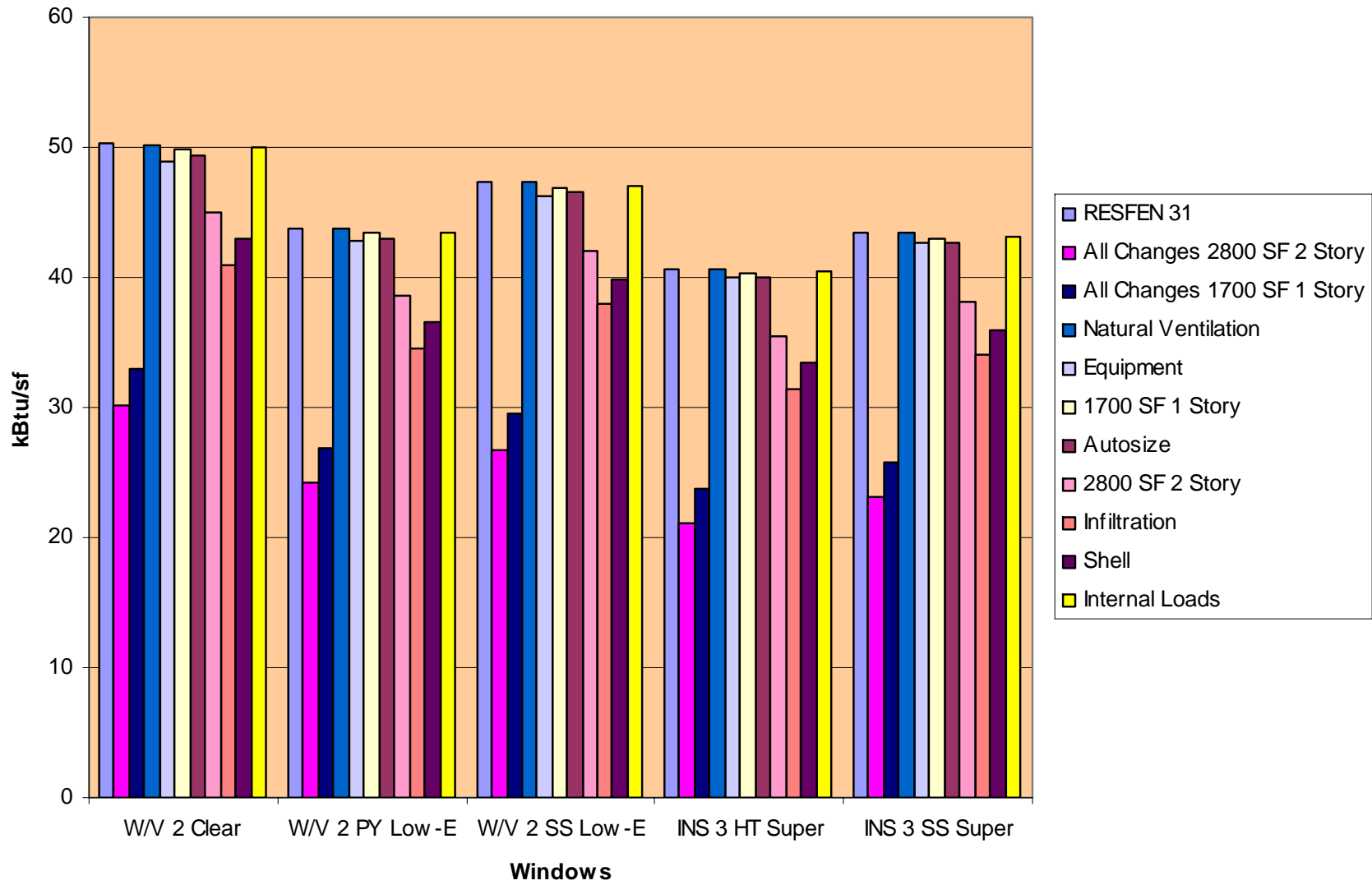
Phoenix Cooling / SF New Construction



Windows

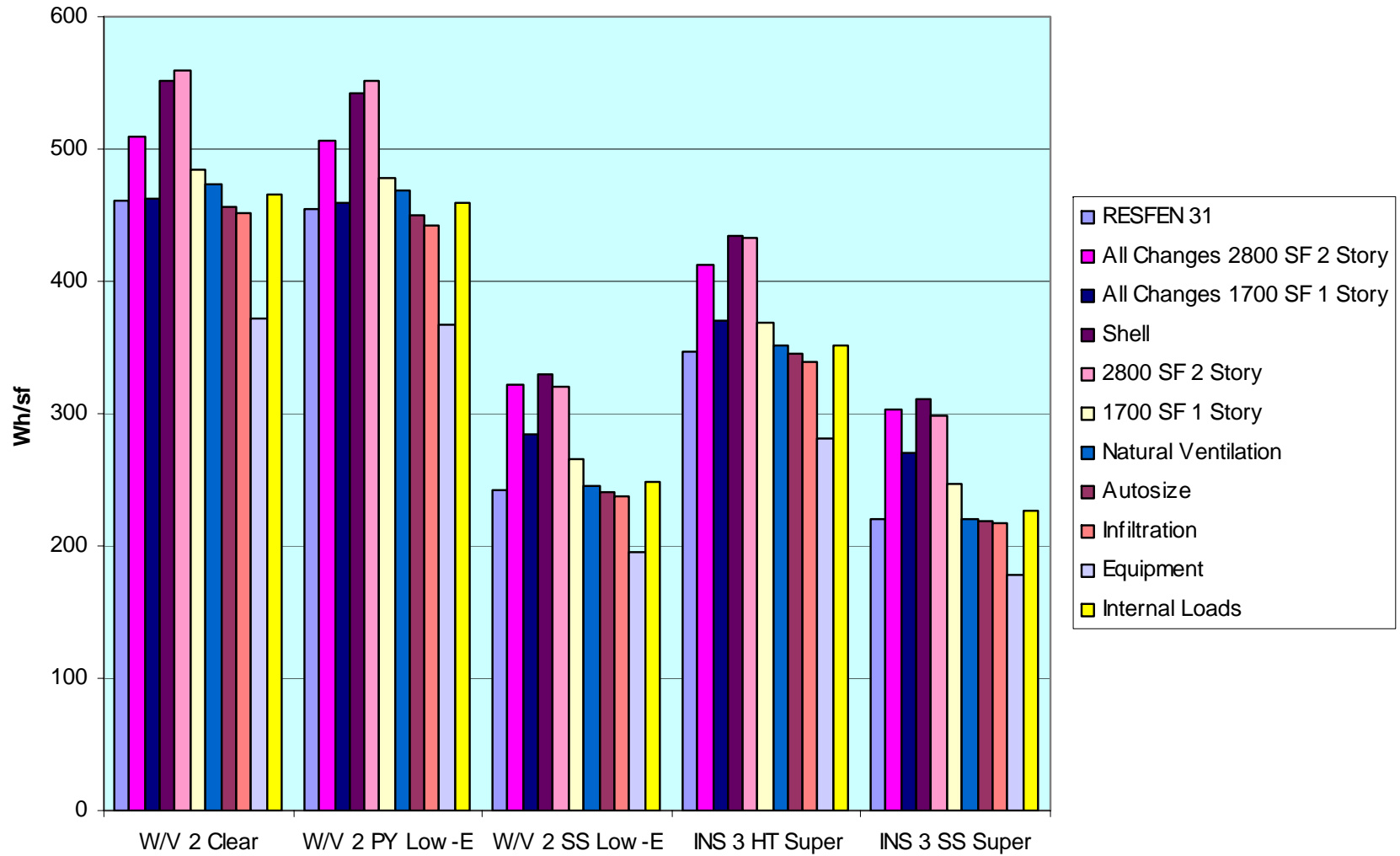
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Minneapolis Heating / SF New Construction



Not Final - Do Not Quote

Minneapolis Cooling / SF New Construction



Windows

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