Analysis of Improved AC & HP Designs for Hot/Dry Climates

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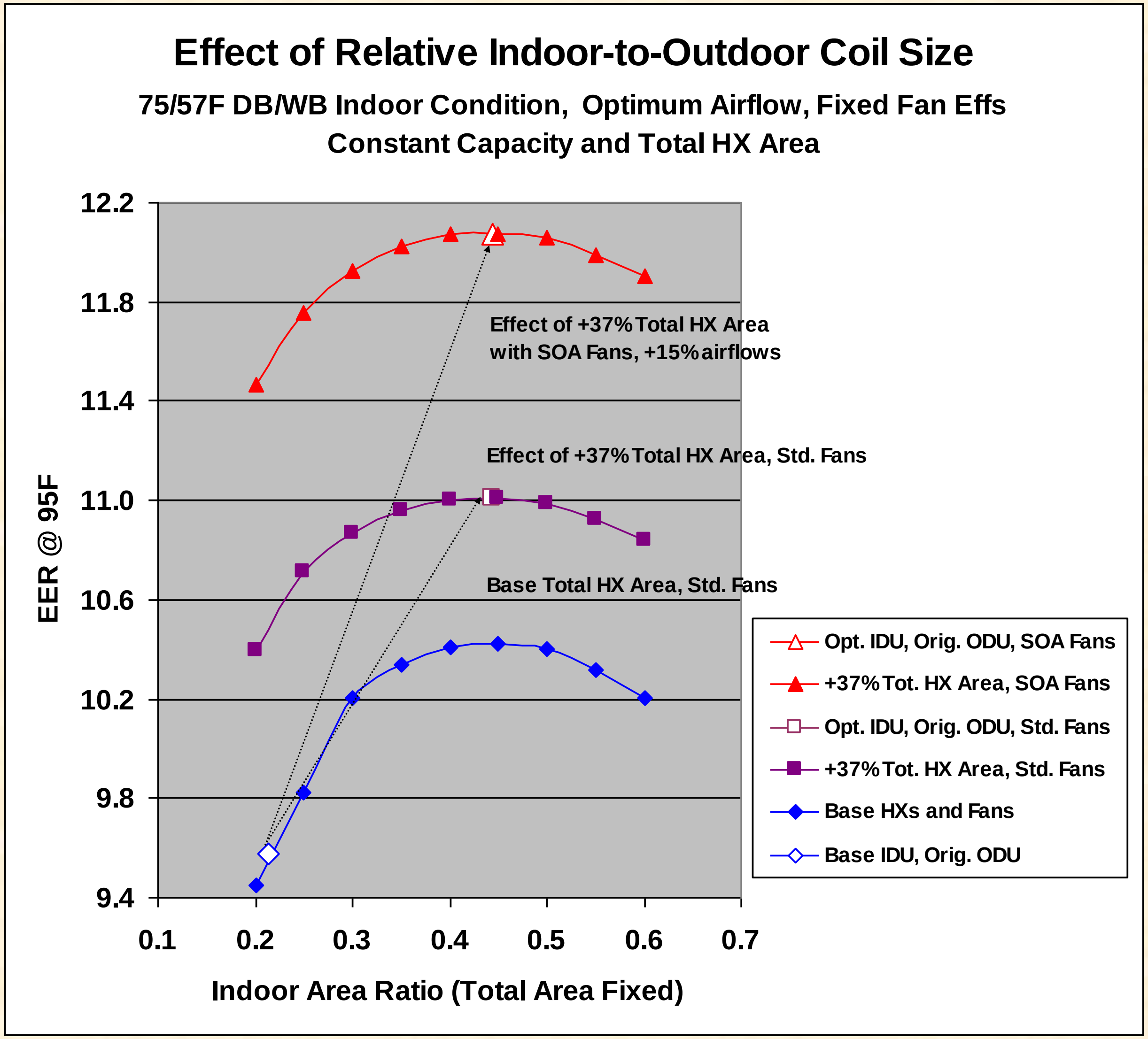
AC Performance in Hot/Dry Climates

- In CA and SW climates, little dehumidification is required of ACs
  - Result is reduced efficiency (>5%) from colder supply and evap. temps under dry coil conditions
  - And even more loss of SEER potential
    - from limits of dehumidifying design
- Typically the indoor coil is undersized
  - to dehumidify properly
- What if units were designed for minimal dehumidification at design conditions
  - Larger airflows and coils to raise supply and evaporator temperatures
  - and thus performance
- and to dehumidify only as needed?

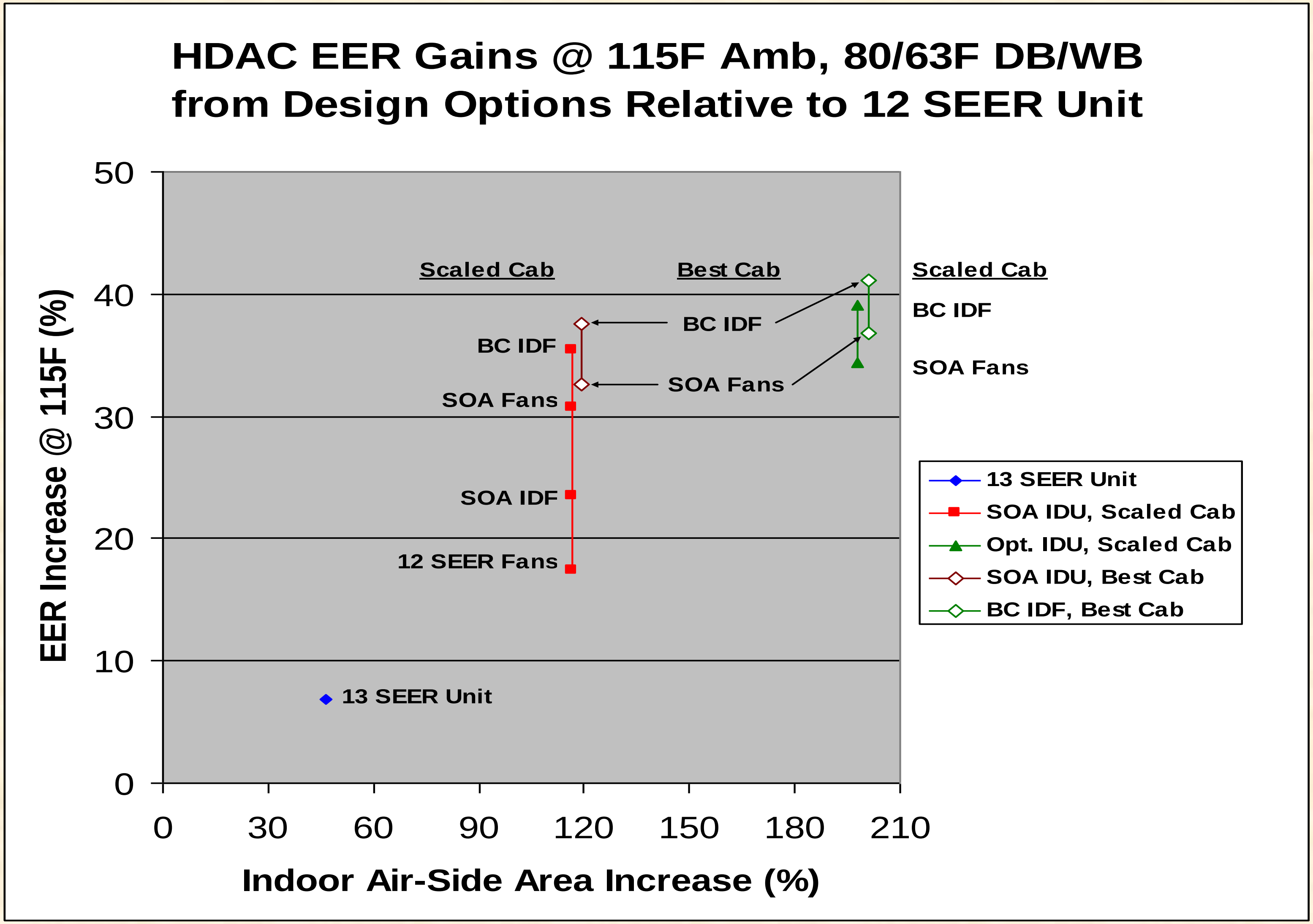
Hot/Dry Climate AC Design

- Optimum indoor coil HX size for dry coil is near 45% of total HX area
  - vs 20-25% generally used for standard ACs (although above 35%, the returns are diminishing)
- More efficient blowers allow higher airflow (+15%) and higher evaporator temps
  - Increasing dry coil evap temp from 41F to 51F max (from the higher airflow and larger coil)
- Compressor is reduced by one size or more
- Suggests pairing larger air handlers with smaller capacity, high SEER ODUs

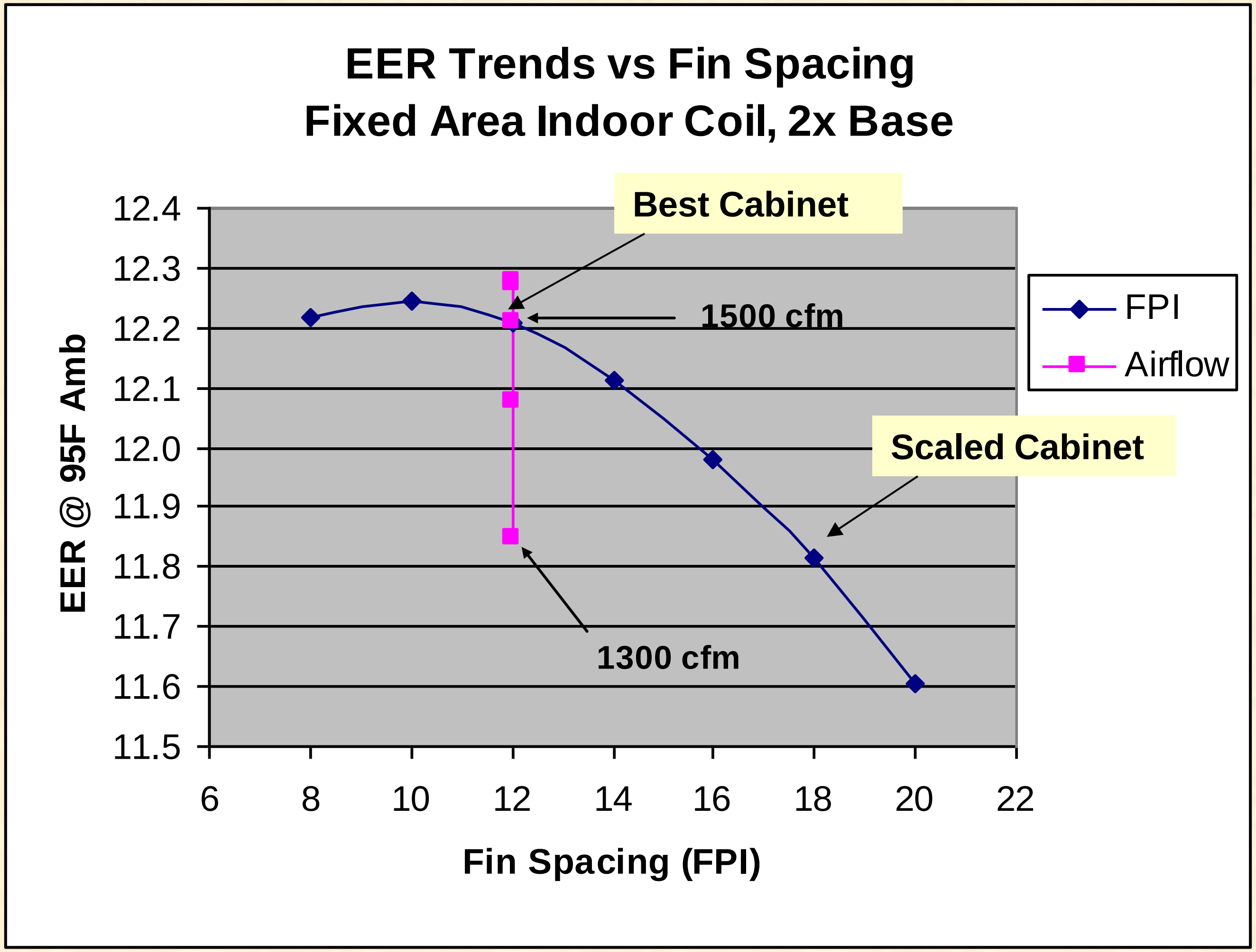
Effect of Larger Indoor HX Area and Flow



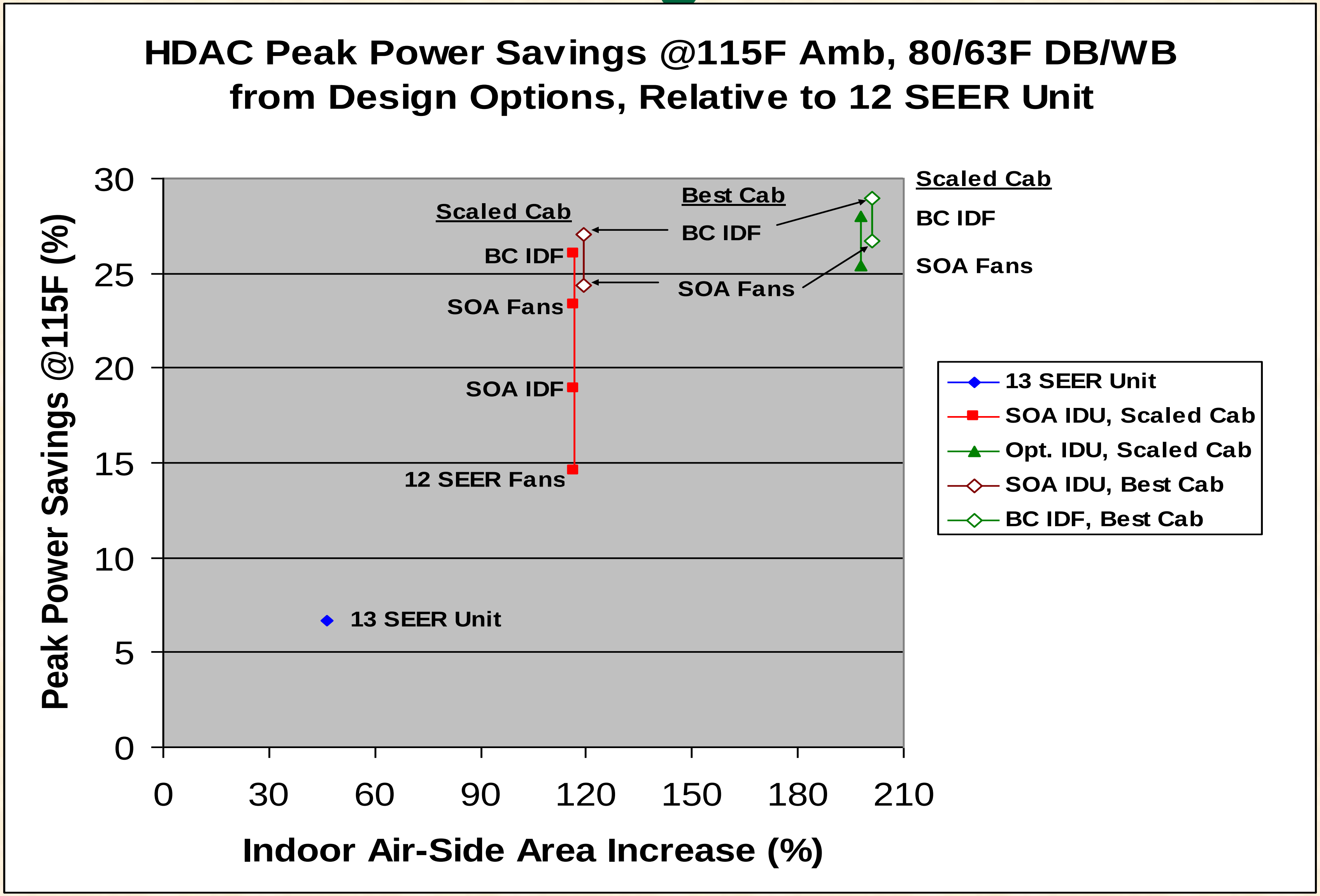
HDAC EER Gains from 12 SEER



IDU Designs at 2x Base Unit



HDAC Peak Savings from 12 SEER



Initial LBNL Payback Analysis, 6/04

- 12 SEER baseline
- With intermediate and optimum HX sizes
- SEER 12 fans and best fan cases
- Found that all four HDAC designs
  - "provided LCC savings and relatively short payback periods" in CA and SW climates
- Recommended further analysis vs 13 SEER baseline

HDAC Performance vs 13 SEER Baseline Unit

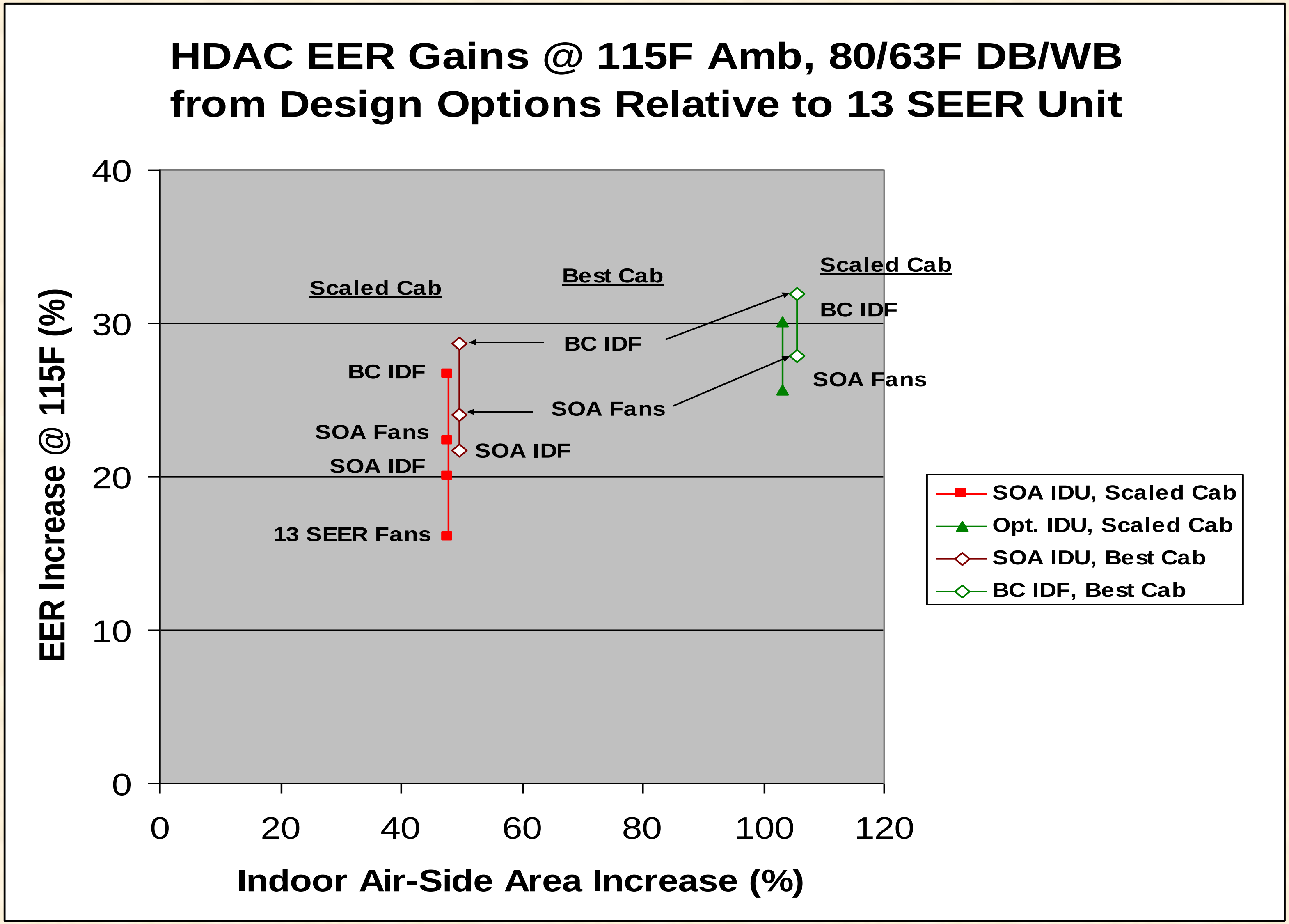
Selected 13 SEER baseline unit has:

- **Same compressor**
- **Larger indoor coil**
- **Better ID blower**
- **Better OD fan but same outdoor coil**

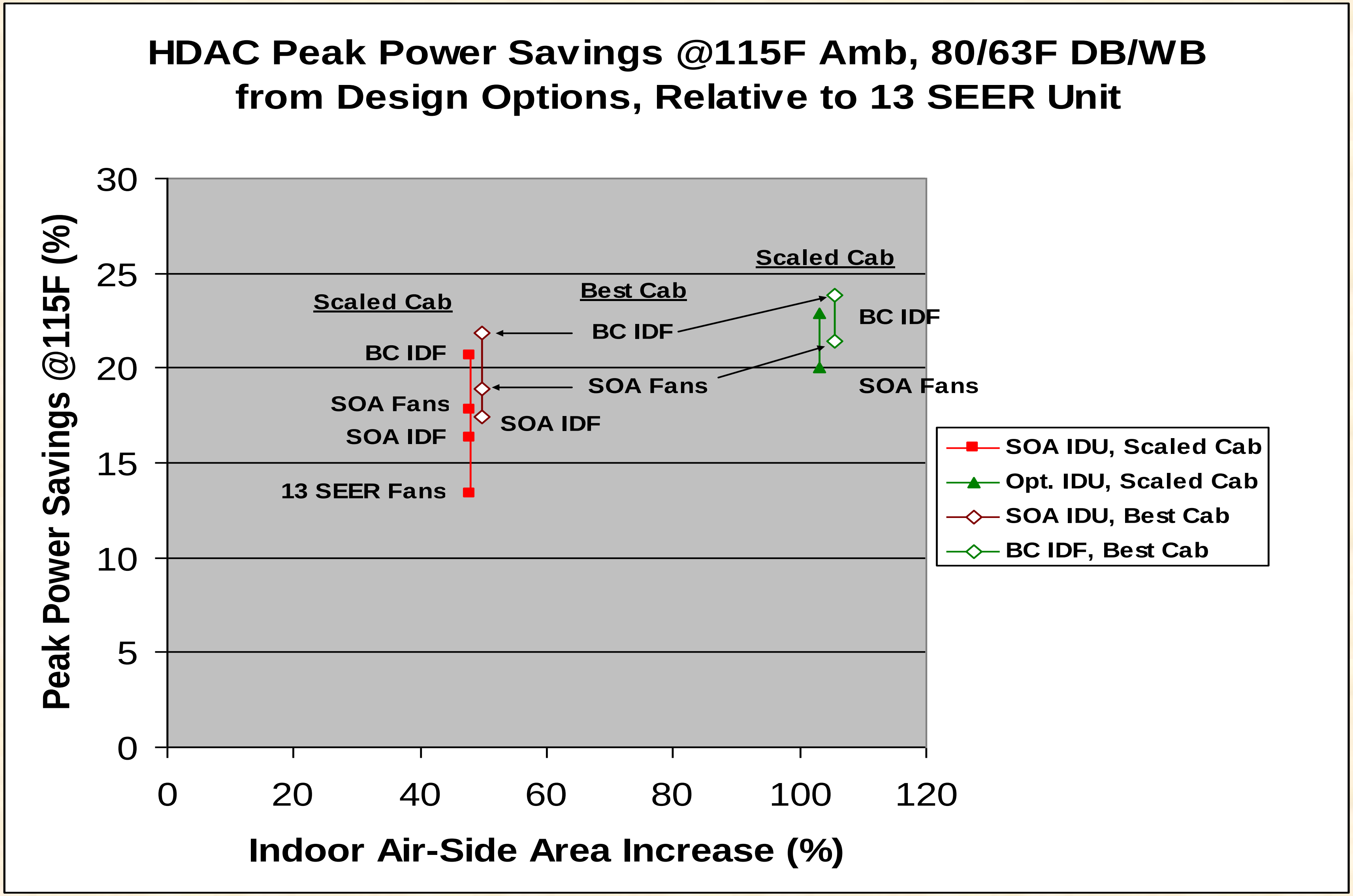
vs 12 SEER baseline by same manuf

(Conservative case for comparison as some manufs first increase only outdoor unit performance)

HDAC EER Gains from 13 SEER



HDAC Peak Savings from 13 SEER



Hot/Dry Climate AC Designs

- Suggests that ½ -1½ ton larger air handlers be paired with ½ -1 ton smaller compressors, as cost effective
- Use BDC blower motors for high-efficiency and dehumidif. as needed.
  - Reducing blower speed with RH signal
- Analysis suggests that HDAC designs possible with existing equipment
  - Using existing oversized premium air handlers matched with undersized high SEER ODUs

Summary -- HDAC Designs

- **EER gains over 20% and peak reductions of 17% at high ambients**
  - **with best combinations of existing equipment**
- **EER gains nearing 30% and peak reductions over 22%**
  - **With designs using adv. blowers and fans**
- **Energy savings close in size to peak reductions**
- **SEER increases only slightly smaller than those in EER (benefits over full ambient range)**

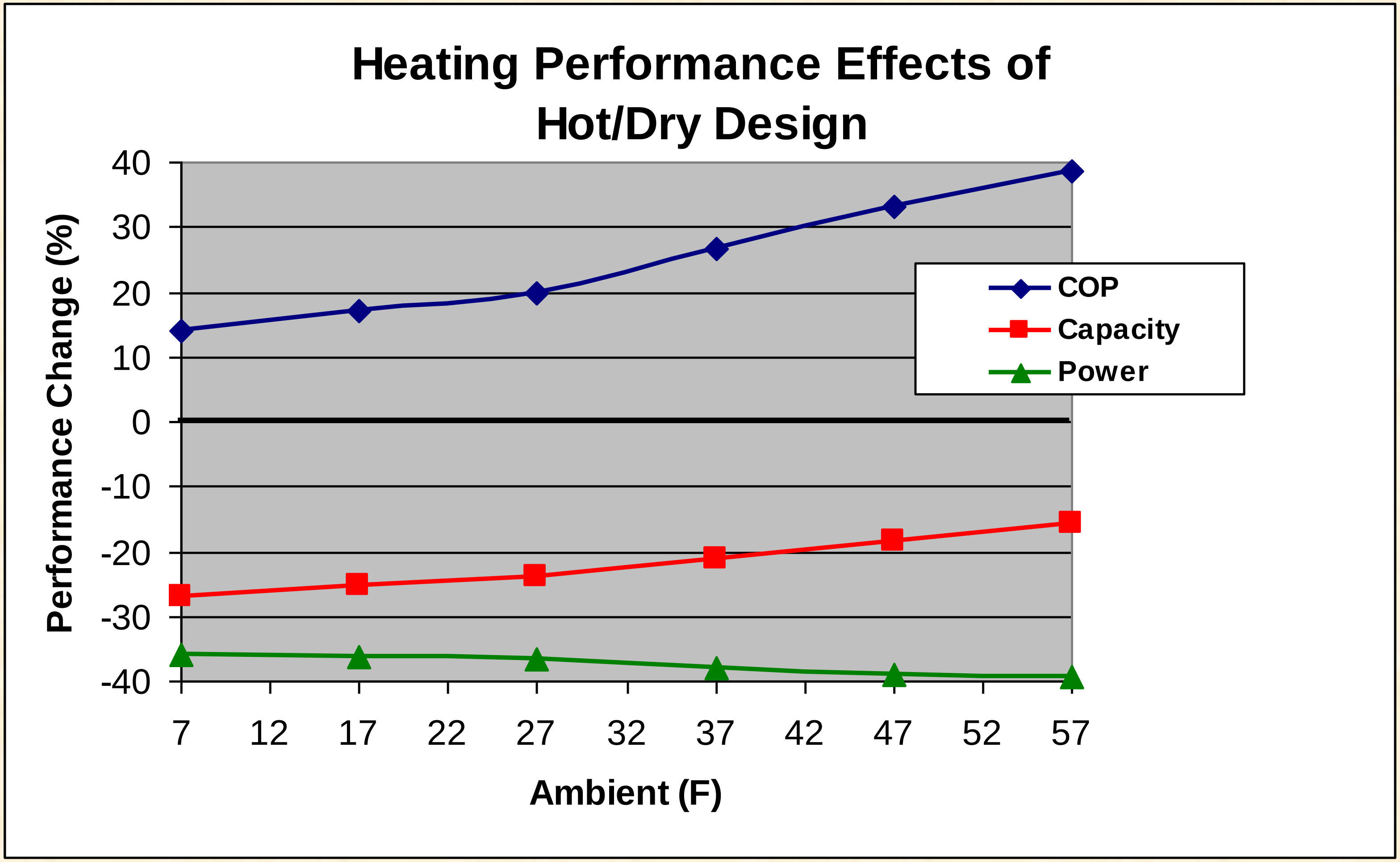
Summary -- HDAC Designs

- Assumes duct system sized to give rated external static of 0.15” at elevated airflow
  - effic. gains reduced at higher ΔPs
- More restrictive duct systems
  - Increase blower power
    - almost linearly with increase in static
  - Limit optimal airflow to lesser degree (e.g. 1400 vs 1500 cfm)
  - So reduces effic. potential somewhat

Heating Benefits of Hot/Dry Design

- Large indoor coil boosts heating COP
  - Heating mode condensing is most loaded HX
- Availability of VS Blower
  - Reduces blower power significantly
  - Allows supply temp. control to customer preference
- Evaluated case of optimum indoor HX size
  - DOE Region II

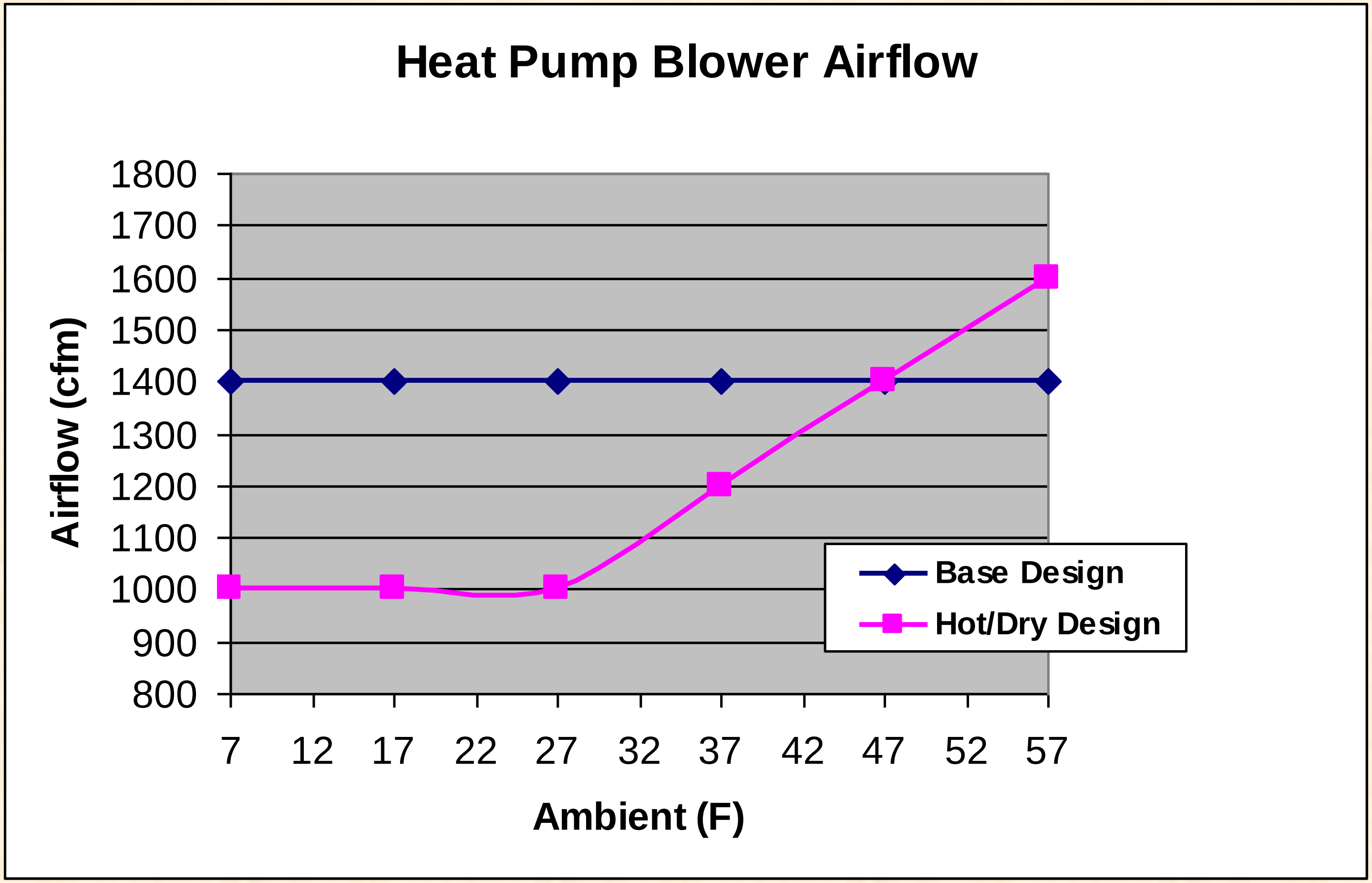
HDHP Performance Change



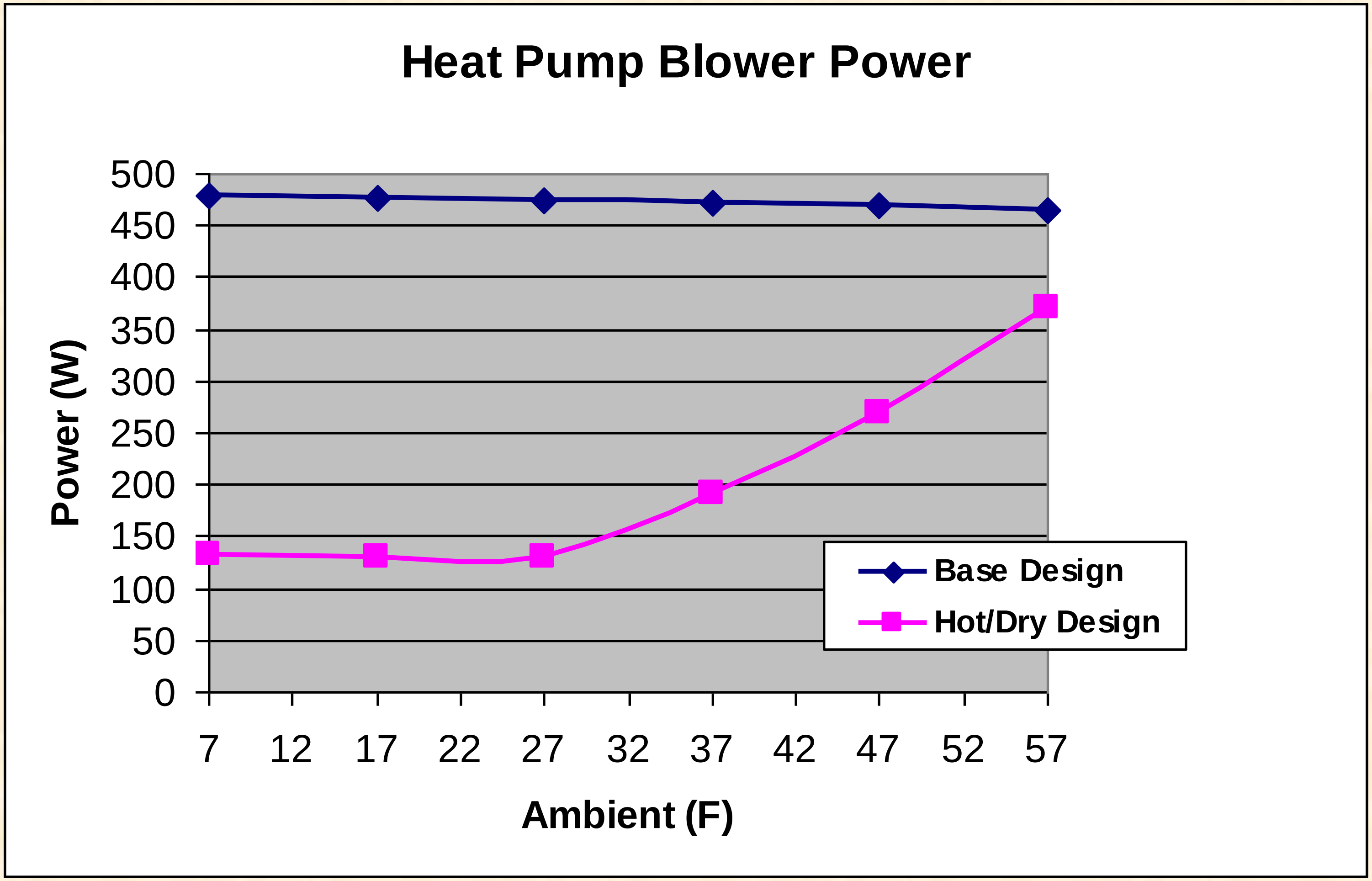
Heating Benefits of Hot/Dry Design
DOE Region II

- For case of optimum indoor HX size
  - HSPF increase of 27.5%
  - HSPF gain was 70% of SEER gain
  - No backup heat required
- Heating savings
  - 66% of cooling mode savings
  - Shortens payback time by 40% over AC only

HDHP Indoor Airflow



HDHP Blower Power



AC/HP Performance in Hot/Dry Climates

- Hot/Dry regional designs show potential for significant performance improvement
- Improved blowers and fans enable higher airflows needed to maximize these gains
- Restrictive duct systems limit potential performance gain for hot/dry designs
  - Most eff. potential in houses with well sized ducts
  - Or in houses where envelope improvements allow unit downsizing leaving more rightsized ducts
- HP rather than AC-only designs have more potential to payback higher equipment costs