Energy Technologies Area Lawrence Berkeley National Laboratory

Cost-Benefit of Improving the Efficiency of Room Air Conditioners in India

Nihar Shah, Nikit Abhyankar, Amol Phadke, Won Young Park

Lawrence Berkeley National Laboratory

Saurabh Diddi

Bureau of Energy Efficiency(BEE), Government of India

And

Deepanshu Ahuja, P.K. Mukherjee and Archana Walia,

Collaborative Labeling and Appliance Standards Program (CLASP)

This work was funded by the U.S.-India Space Cooling Collaboration through the U.S. Department of Energy's Office of International Affairs under Lawrence Berkeley National Laboratory Contract No. DE-AC02-05CH11231.

Summary of Findings

- **We estimate that the efficiency of room ACs in India can by improved by up to 45% (i. e. based on improving the Indian Seasonal Energy Efficiency Ratio or ISEER from 2.9 to 5.2) with a payback period of less than three years.**

- **We estimate that the efficiency of room ACs in India can by improved by up to 20% (i.e. from 2.9 to 3.5 ISEER) with a payback period of nearly one year.**

- **Increasing the stringency of the Minimum Energy Performance Standard (MEPS or one star level) should be evaluated rigorously considering the findings of this study.**

Presentation Outline

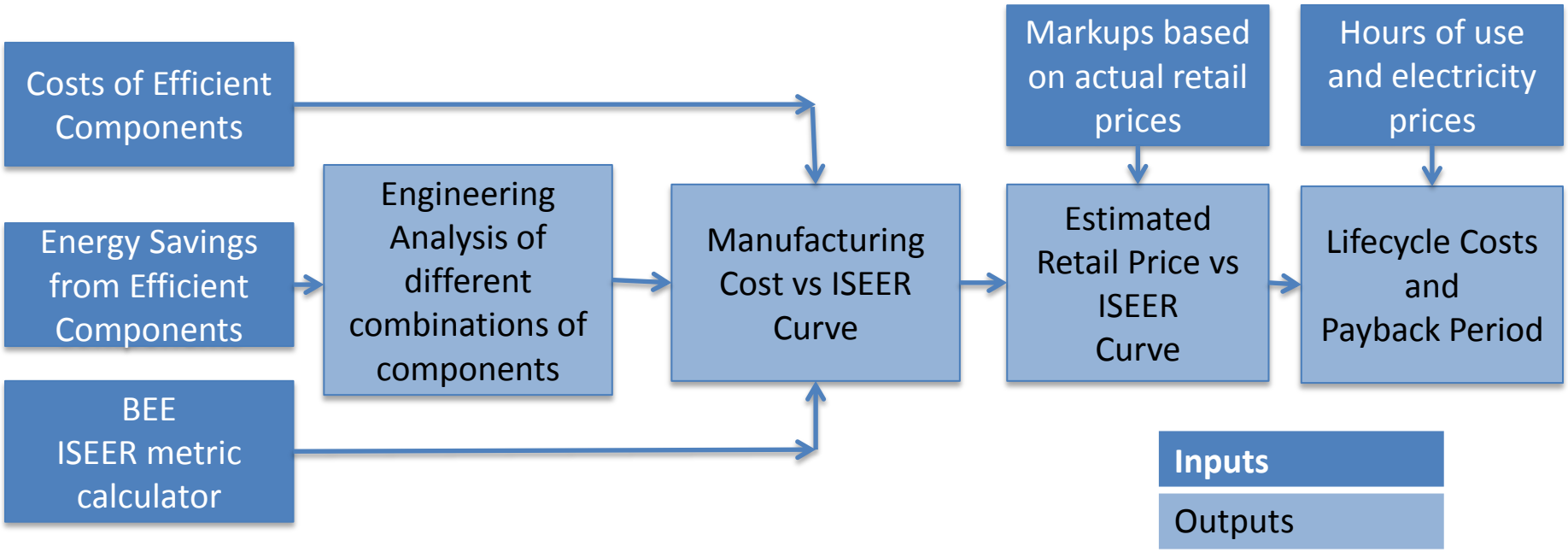
- Motivation
- Methodology and Data
- Results and Conclusions

Motivation

- Electricity demand due to Room ACs (RACs) in India is likely to increase multifold due to increasing incomes and urbanization, falling prices, and high cooling requirements due to a hot and humid climate.
- RAC use is already causing significant adverse impacts on the electricity grid by increasing peak load and power purchase costs of the utilities.
- Improving the energy efficiency of RACs can help mitigate these impacts, while saving significant amounts on consumer electricity bills.
- Improving RAC efficiency typically involves improving the efficiency of various components such as compressors, heat exchangers, expansion valves, variable speed drives and fans.
- In this study, we estimate the cost and benefit of improving the efficiency of room ACs based on a "bottom-up" engineering analysis.

Methodology and Data

Methodology



- Energy savings from more efficient RACs are calculated based on engineering analysis of possible efficiency improvement from various components.
- Costs of these efficient components are collected from manufacturers in India.
- Estimated improvement of ISEER is calculated for various combinations of components using the BEE ISEER metric calculator to generate a manufacturing cost vs ISEER curve.
- Retail price increase required to cover the cost of efficiency improvement is compared with electricity bill savings to calculate the payback period for consumers.

Data: Base Case Assumptions

- The "base case model" from which efficiency improvements are modeled is a1.5 ton mini-split AC with efficiency of 2.8 W/W (ISEER).
- 1.5 tons (or 5.25 kW) is the most popular cooling capacity and accounts for roughly 60-65% of the market in India.
- Manufacturing cost of various components are collected by PWC and CLASP from various manufacturers in India.
- The total "bill of materials" manufacturing cost for the base case model is Rs 11,000-14,500 as shown below.

	Component	Cost Low Range Rs	Cost High Range Rs
Indoor Unit	Heat Exchanger	1200	1370
Indoor Unit	Fan motor	600	680
Outdoor Unit	Compressor	3400	4100
Outdoor Unit	Heat Exchanger	1500	1940
Outdoor Unit	Sheet Metal	1200	1550
Outdoor Unit	Fan blade	200	570
Outdoor Unit	Fan Motor	450	640
Outdoor Unit	Refrigerant	450	800
Outdoor Unit	Other Components	2000	2850
	Total	**11000**	**14500**

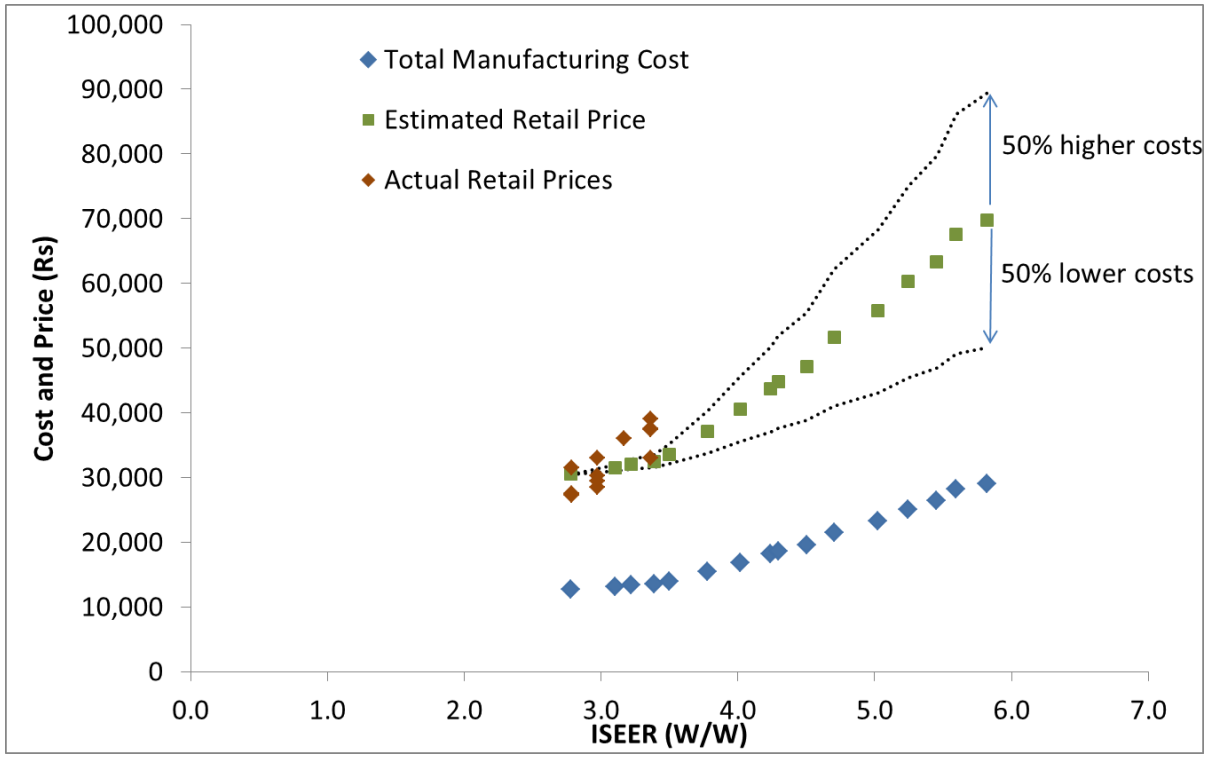
Data: Energy Savings and Component Cost Assumptions

	Component	Energy Savings from Base Case	Incremental Manufacturing Cost (Rs)	
			Baseline	Range
Compressor	Baseline Compressor (2.8 EER), 1.5 TR Cooling	-	-	
	3.0 EER compressor	5.50%	200	100-300
	3.2 EER compressor	10.50%	400	200-600
	3.4 EER compressor	15.00%	575	280-860
Variable speed drive	Alternating Current Compressor variable speed drive	21.00%	3,600	1800-5400
	Direct Current Compressor variable speed drive	23.00%	5,400	2700-8100
	Variable speed drives for fans and compressor	26.00%	6,300	3150-9450
Heat Exchanger	UA value of both heat exchangers increased by 20%	7.50%	1,470	735-2200
	UA value of both heat exchangers increased by 40%	13.50%	3,240	1620-4860
	UA value of both heat exchangers increased by 60%	17.50%	4,210	2100-6310
	UA value of both heat exchangers increased by 80%	21.00%	6,080	3040-9120
	UA value of both heat exchangers increased by 100%	24.00%	7,350	3675-11000
Expansion valve	Thermostatic Expansion Valve	3.50%	250	125-375
	Electronic Expansion Valve	6.50%	1500	750-2250

- % Energy savings for each component are based on EU EcoDesign Study.
- Manufacturing costs are estimated based on data collected by PWC and CLASP from various manufacturers.
- Markup of ~140% is arrived at by collecting actual retail prices on the market for 1.5 ton base models ~30,000-34,500.
- Sensitivity analysis is conducted with markup between 80%-160%.

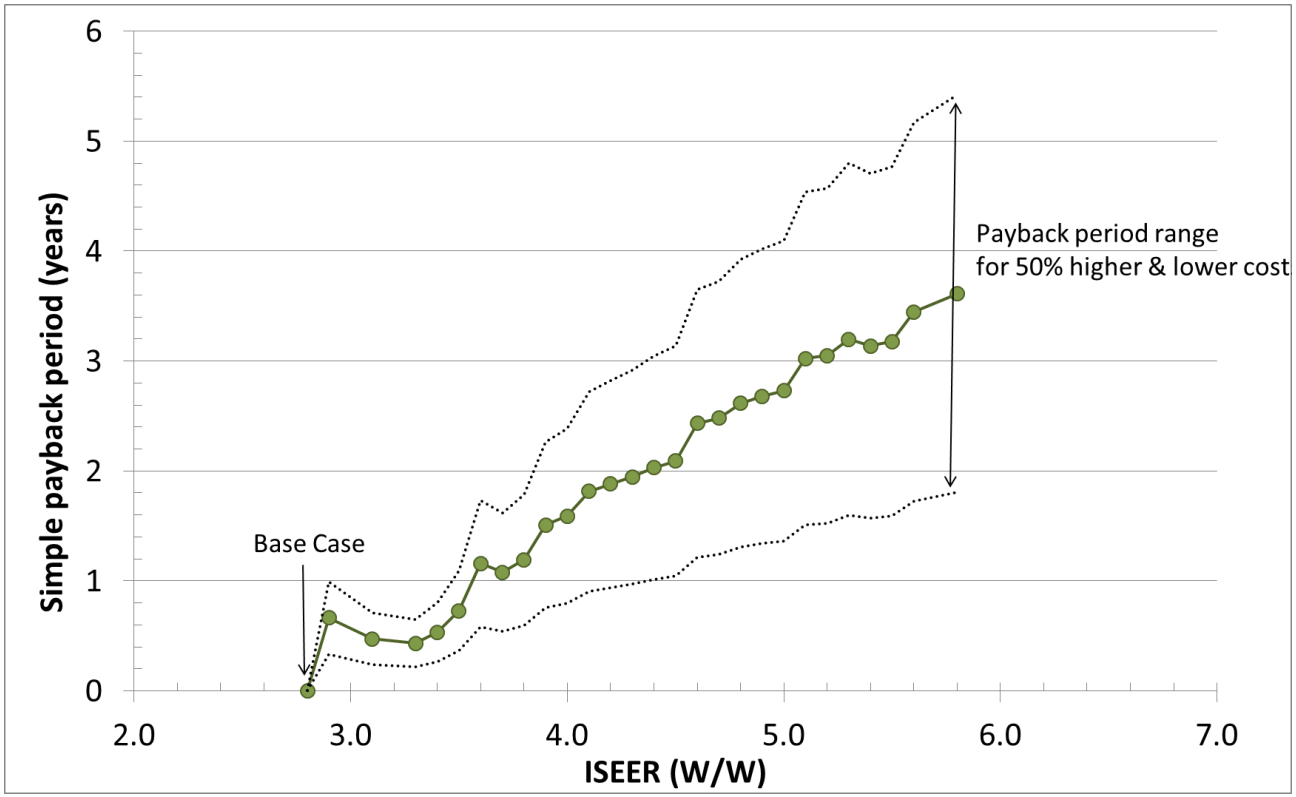
Results and Conclusions

Results: Manufacturing Costs, Retail Prices



- **Estimated retail prices based on the engineering analysis assuming a markup of 140% are aligned with actual retail prices of RACs on the Indian market.**

Results: Payback Period



- **Payback period analysis shows efficiency improvement up to 5.2 ISEER has a payback of less than 3 years even under a "high cost" scenario.**
- **Efficiency Improvement up to 3.5 ISEER has a payback period of nearly 1 year even under a "high cost" scenario.**

Results: Bill Savings and Payback

ISEER (W/W)	Retail price increase required to cover the cost of efficiency improvement (Rs. %)	Bill savings per year for 1000 & 1600 hours of use (Rs.)	Bill savings over lifetime for 1000 & 1600 hours of use (Rs.)	Simple payback period for 1000 & 1600 hours of use (years)
2.8 (base case)	0,0%	0	0	0
3.5	4900, ~15%	2625 -4200	18300 -29400	1.9-1.2
4	9360, ~27%	3950- 6300	27500-44100	2.4-1.5

- **Payback period analysis shows efficiency improvement from 2.8 to 3.5 and 4 ISEER levels is less than 3 years even for 1000 hours of use/year**
- **3.5 and 4 ISEER levels show significant electricity bill savings (17% and 26% respectively) with respect to 2.8 ISEER for 1000 hours of use or higher.**

Conclusions

- If a least cost strategy is followed, significant efficiency improvement can be achieved at a modest incremental manufacturing cost which requires a modest increase in retail price.
- ISEER improvement by 20% to 3.5(W/W) may require a retail price increase of Rs. 4900 (~15% increase over baseline) to cover the cost of efficiency improvement.
- ISEER of a Room AC improvement by over 30% to 4(W/W) may require a retail price increase of Rs. 9360 (~27% increase over baseline) to cover the cost of efficiency improvement.
- These price increases could be paid back relatively quickly (less than 3 years) through electricity bill savings.
- Increasing the stringency of MEPS is one of the key strategies to ensure improvement in the efficiency of the AC models sold in the market and should be evaluated rigorously considering the findings of this study.

Contact:

Nihar Shah

Lawrence Berkeley National Laboratory

nkshah@lbl.gov

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