FLORIDA SOLAR ENERGY CENTER®

Creating Energy Independence

New ASHRAE Standard 90.2-2018 for High Performance Homes

RESNET Building Performance Conference

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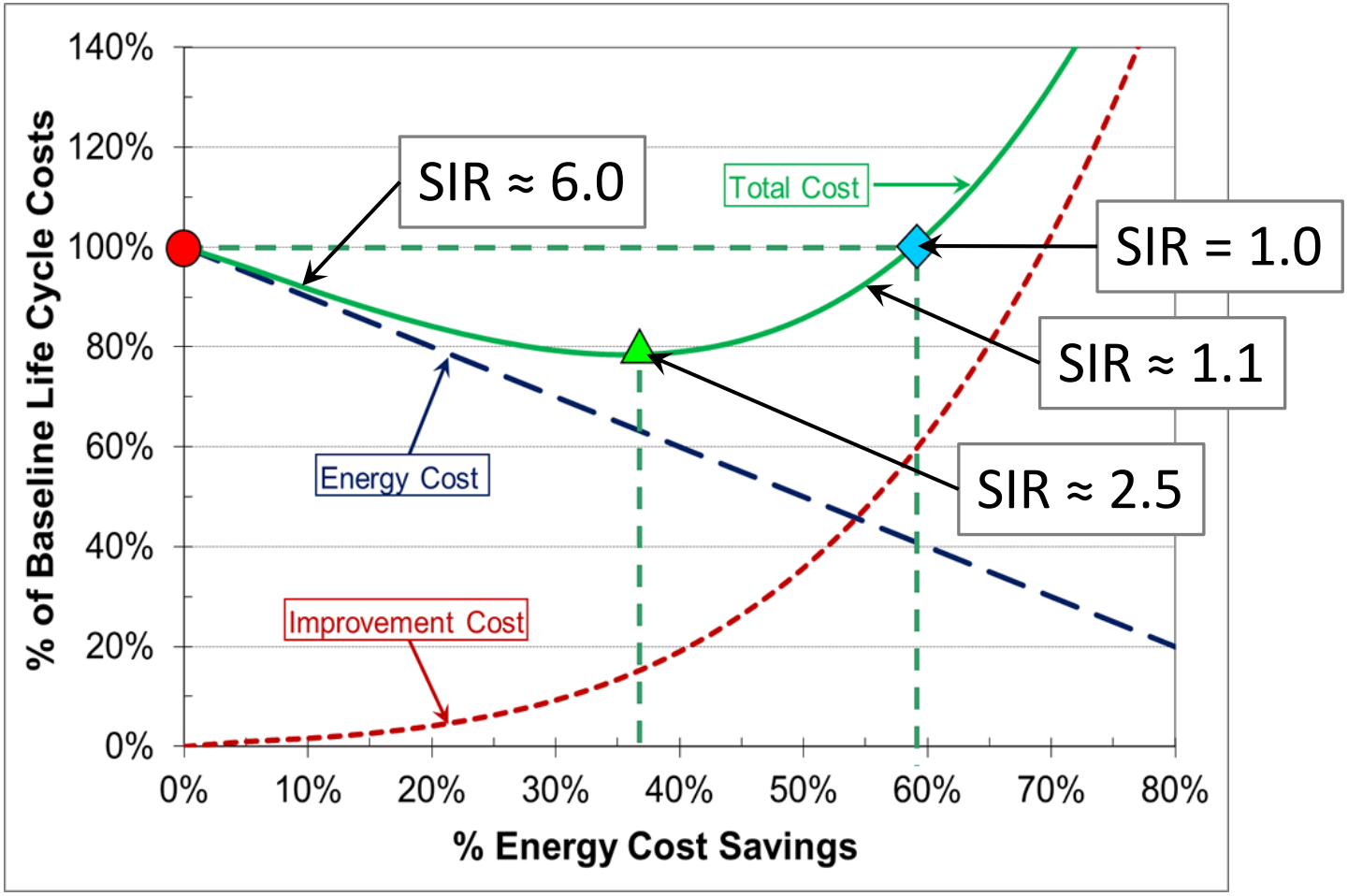
Background

- ASHRAE SSPC 90.2 has promulgated a residential standard that uses the Energy Rating Index (ERI) as the method of determining compliance (largely in accordance with ANSI/RESNET/ICC Standard 301)
- The new 90.2 is a performance-base leadership Standard intended to provide homes with about 50% lower energy cost than the 2006 IECC baseline
- The new 90.2 is not prescriptive so it allows wide flexibility as long as the required ERI performance is achieved
- The ERI scores required to achieve compliance with the new 90.2 Standard are climate based and in the 40s.

Goal: Maximize Energy Efficiency

- Using Life Cycle Cost (LCC) analysis, determine the maximum levels of energy efficiency that are cost effective to the consumer using:
  - SSPC 90.2-adopted economic parameters
  - SSPC 90.2-adopted national average energy prices
  - DOE *Building America* source energy multipliers
  - 30-year Life-Cycle Cost analysis using Duffie & Beckman P1/P2 Present Worth Factor method
- Whole-home LCC analysis (including lighting, appliances and miscellaneous energy use)
- Target LCC Savings/Investment Ratio (SIR): 1.0-1.1

General Life Cycle Cost (LCC) Theory



LCC Economic Parameters

- As adopted by SSPC 90.2:

Analysis Period	30 years
General Inflation Rate (GR)	2.5%
Nominal Discount Rate (DR)	5.0%
Mortgage Interest Rate (MR)	5.0%
Down payment Rate (DnPmt)	10.0%
Nominal Energy Inflation Rate (ER)	2.5%
Effective Income Tax Rate (iTR)	25.0%
Property Tax Rate (pTR)	1.136%

Other Analysis Parameters

- National energy prices as adopted by SSPC 90.2:

Electricity Price	$0.1180/kWh
Natural Gas Price	$1.078/therm

- Source energy multipliers from DOE *Building America* research program:

Electricity Multiplier	3.16
Natural Gas Multiplier	1.09

Building Characteristics

- 1-story, 2000 ft^2 (186 m^2), 3-bedroom
- 2-story, 2400 ft^2 (223 m^2), 3-bedroom
- 15% window/floor area
  - 35% facing N and S (*best case*)
  - 15% facing E and W
  - Rotated 90° for *worst case*
- Two baseline home configurations:
  - SSPC 90.2 reference case (virtually HERS Reference case)
  - 2015 IECC minimum compliance case
- 156 simulations
  - Three configurations (SSPC 90.2, 2015 IECC, Improved)
  - Four simulations (1-sty, 2-sty, best case, worst case) for each home configuration for each climate

Analysis Strategy

- Find maximum cost effective energy efficiency (i.e. Savings/Investment Ratio (SIR) between 1.0 and 1.1)
- Perform analysis with and without the use of on-site renewable energy production (PV)
  - Installed PV costs assumed to be $4.00/Wp with 30% ITC (2015 national average ~$3.60/Wp)
  - Quantity of installed PV differs by climate from a minimum of 1 kWp to a maximum of 4 kWp.

Example: Phoenix Energy & Cost

noPV Case	2015 Code Homes			Improved no-PV Homes		
	kWh/y	Th/y	$/yr	kWh/y	Th/y	$/yr
1-sty Best Case	13,112	0	$1,543	9,583	0	$1,128
1-sty Wrst Case	13,307	0	$1,566	9,725	0	$1,145
2-sty Best Case	14,548	0	$1,712	10,567	0	$1,244
2-sty Wrst Case	14,782	0	$1,740	10,749	0	$1,265
Averages	**13,937**	**0**	**$1,640**	**10,156**	**0**	**$1,195**

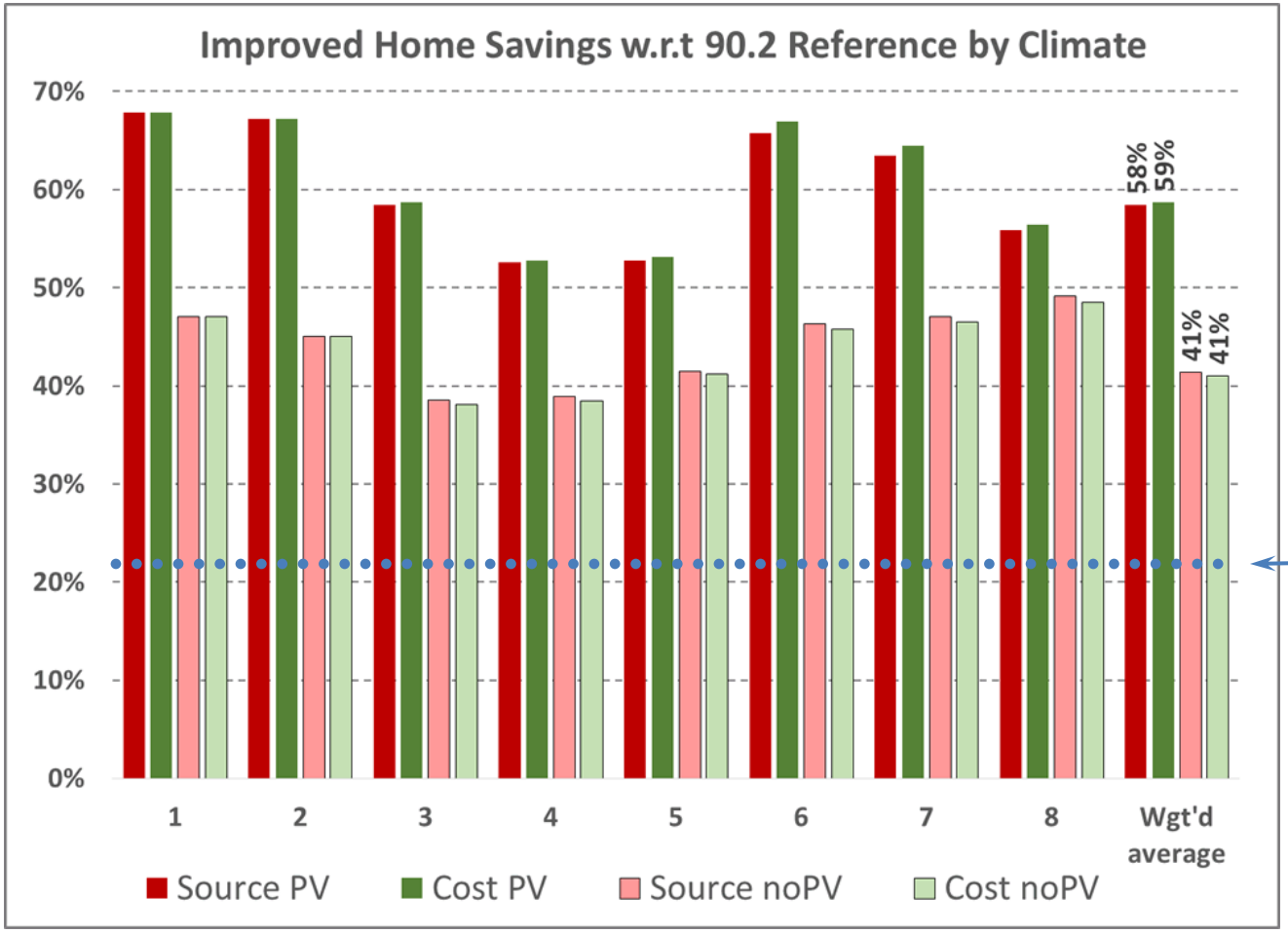
PV Cases (3 kWp)	2015 Code Homes			Improved PV Homes		
	kWh/y	Th/y	$/yr	kWh/y	Th/y	$/yr
1-sty Best Case	13,112	0	$1,543	4,257	0	$501
1-sty Wrst Case	13,307	0	$1,566	4,399	0	$518
2-sty Best Case	14,548	0	$1,712	5,215	0	$614
2-sty Wrst Case	14,782	0	$1,740	5,404	0	$636
Averages	**13,937**	**0**	**$1,640**	**4,819**	**0**	**$567**

Example: Phoenix LCC & SIR

noPV Cases	Savings over 2015 Code			Costs Effectiveness			
	Δ kWh/y	Δ Th/y	Δ $/yr	1stCost	LC Cost	LC Save	SIR
1-sty Best Case	3,529	0	$415	$4,828	$7,983	$8,551	1.07
1-sty Wrst Case	3,582	0	$422	$4,828	$7,983	$8,679	1.09
2-sty Best Case	3,981	0	$469	$5,377	$9,011	$9,646	1.07
2-sty Wrst Case	4,033	0	$475	$5,377	$9,011	$9,772	1.08
Averages	**3,781**	**0**	**$445**	**$5,103**	**$8,497**	**$9,162**	**1.08**

PV Cases (3 kWp)	Savings over 2015 Code			Costs Effectiveness			
	Δ kWh/y	Δ Th/y	Δ $/yr	1stCost	LC Cost	LC Save	SIR
1-sty Best Case	8,855	0	$1,042	$13,228	$20,240	$21,456	1.06
1-sty Wrst Case	8,908	0	$1,048	$13,228	$20,240	$21,585	1.07
2-sty Best Case	9,333	0	$1,098	$13,173	$20,212	$22,614	1.12
2-sty Wrst Case	9,378	0	$1,104	$13,173	$20,212	$22,724	1.12
Averages	**9,119**	**0**	**$1,073**	**$13,201**	**$20,226**	**$22,095**	**1.09**

Savings Over 90.2 Reference



Pollution Savings (no PV Cases)

Climate Zone	CO2 lb Saved	SO2 lb Saved	NOx lb Saved	CO2 % Saved	SO2 % Saved	NOx % Saved
1	9,524	20	9	47.1%	47.1%	47.1%
2	9,655	21	9	45.0%	45.0%	45.0%
3	7,784	10	2,392	40.8%	35.6%	52.3%
4	7,911	8	3,117	40.3%	33.4%	51.0%
5	10,418	12	3,858	41.3%	38.0%	45.9%
6	12,607	12	5,594	46.1%	38.0%	55.1%
7	13,684	11	6,835	46.8%	37.0%	55.3%
8	17,847	11	10,128	48.8%	36.2%	56.6%
Average	**11,179**	**13**	**3,993**	**44.5%**	**38.8%**	**51.0%**
Wgt'd average	**9,207**	**13**	**2,621**	**42.2%**	**37.9%**	**49.3%**

Pollution Savings (PV Cases)

Climate Zone	CO2 lb Saved	SO2 lb Saved	NOx lb Saved	CO2 % Saved	SO2 % Saved	NOx % Saved
1	13,731	29	12	67.8%	67.8%	67.8%
2	14,507	31	13	67.2%	67.2%	67.2%
3	10,095	16	1,961	58.6%	61.5%	50.1%
4	9,911	14	2,808	52.7%	55.5%	47.5%
5	13,348	18	3,786	52.9%	58.7%	45.1%
6	18,152	26	4,865	66.3%	82.5%	48.0%
7	18,704	24	6,043	63.9%	81.2%	48.9%
8	20,523	20	8,730	56.1%	68.1%	48.8%
Average	**14,871**	**22**	**3,527**	**60.7%**	**67.8%**	**52.9%**
Wgt'd average	**12,382**	**20**	**2,364**	**58.5%**	**62.4%**	**52.1%**

90.2 ERI Compliance Analysis

- Two options evaluated:
  - NAECA Minimum heating, cooling and hot water equipment with on-site power production
  - Alternative Equipment (and improved envelope) without on-site power production
- Both options have additional requirements that significantly exceed the minimum requirements of the 2015 IECC.
- Both options seek to cost effectively achieve energy cost savings of ~50% over the 90.2 Reference Design

NAECA Minimum Miami w/PV (1.2 kWdc)

Miami Homes (attic ADS; Qn=0.04) PV								
	2015 Code Homes				Improved Homes - PV			
Case	kWh/y	Th/y	$/yr	$save '06	kWh/y	Th/y	$/yr	$save '06
1-sty Best Case	12,433	0	$1,463	22.6%	7,831	0	$922	51.2%
1-sty Wrst Case	12,516	0	$1,473	22.1%	7,927	0	$933	50.6%
2-sty Best Case	13,667	0	$1,609	23.4%	8,779	0	$1,033	50.8%
2-sty Wrst Case	13,763	0	$1,620	22.9%	8,901	0	$1,048	50.1%
Averages	**13,095**	**0**	**$1,541**	**22.7%**	**8,360**	**0**	**$984**	**50.7%**

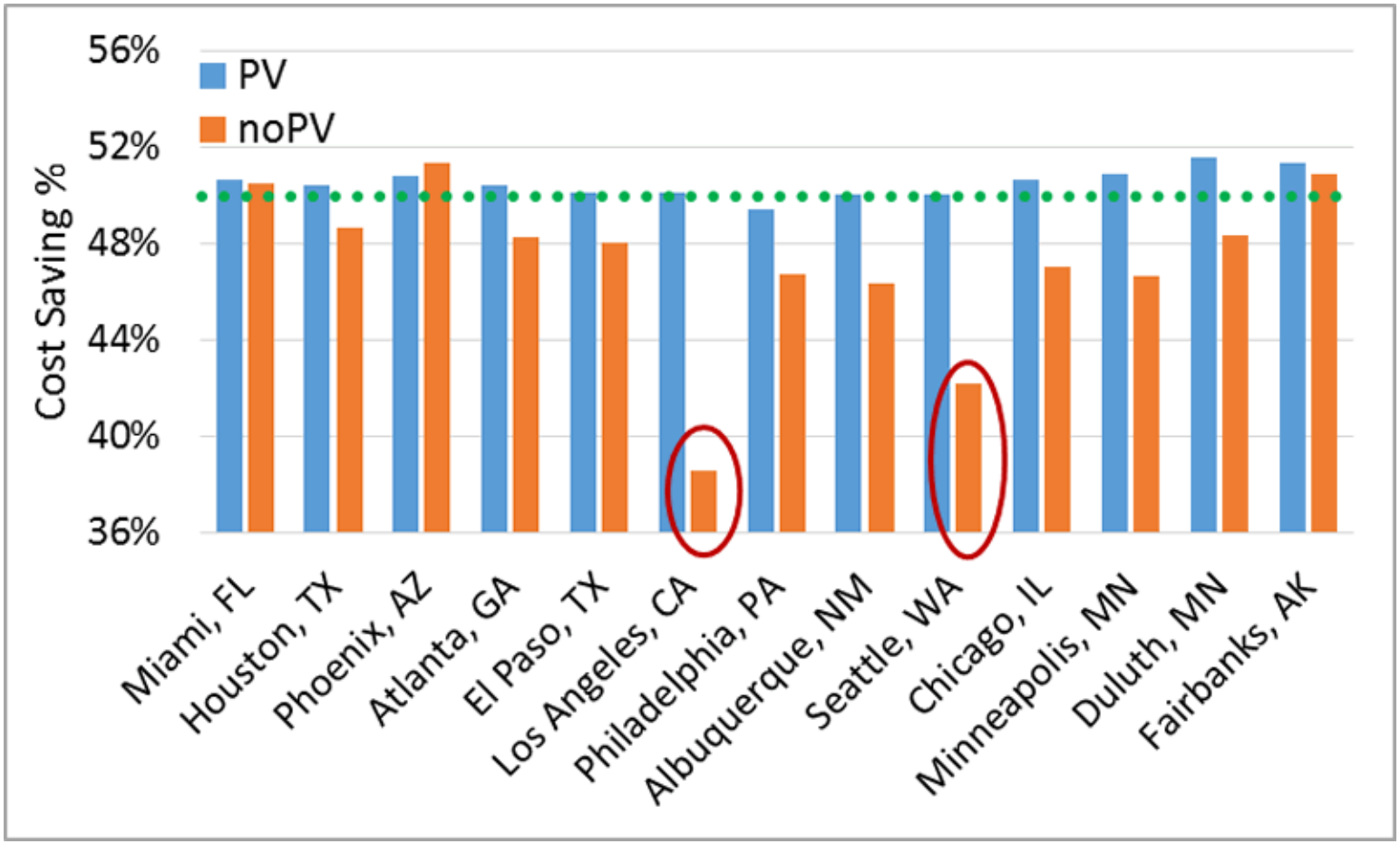
	Savings over 2015 Code				Costs Effectiveness		P1 =20.587	
Case	Δ kWh/y	Δ Th/y	Δ $/yr	$save '15	1stCost	LC Cost	LC Save	SIR
1-sty Best Case	4,602	0	$542	37.0%	$5,927	$8,610	$11,151	1.30
1-sty Wrst Case	4,589	0	$540	36.7%	$5,927	$8,610	$11,119	1.29
2-sty Best Case	4,888	0	$575	35.8%	$5,930	$8,683	$11,844	1.36
2-sty Wrst Case	4,862	0	$572	35.3%	$5,930	$8,683	$11,781	1.36
Averages	**4,735**	**0**	**$557**	**36.2%**	**$5,929**	**$8,647**	**$11,474**	**1.33**

Alternative Equipment Miami (noPV)

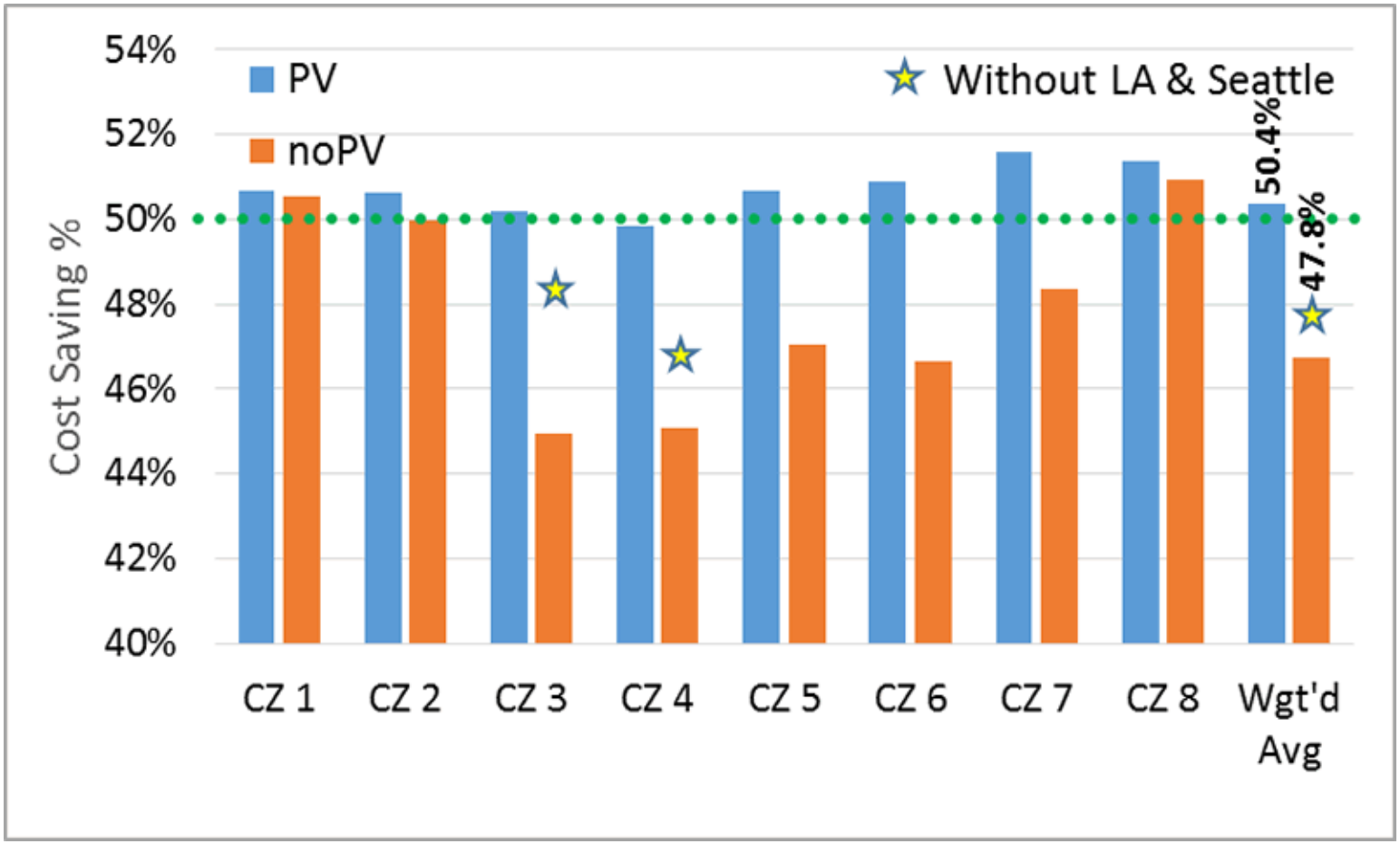
Miami Homes (attic ADS; Qn=0.04) noPV								
	2015 Code Homes				Improved Homes - noPV			
Case	kWh/y	Th/y	$/yr	$save '06	kWh/y	Th/y	$/yr	$save '06
1-sty Best Case	12,433	0	$1,463	22.6%	7,935	0	$934	50.6%
1-sty Wrst Case	12,516	0	$1,473	22.1%	7,992	0	$941	50.2%
2-sty Best Case	13,667	0	$1,609	23.4%	8,770	0	$1,032	50.8%
2-sty Wrst Case	13,763	0	$1,620	22.9%	8,845	0	$1,041	50.4%
Averages	**13,095**	**0**	**$1,541**	**22.7%**	**8,386**	**0**	**$987**	**50.5%**

	Savings over 2015 Code				Costs Effectiveness		P1 =20.587	
Case	Δ kWh/y	Δ Th/y	Δ $/yr	$save '15	1stCost	LC Cost	LC Save	SIR
1-sty Best Case	4,498	0	$529	36.2%	$5,751	$10,356	$10,899	1.05
1-sty Wrst Case	4,524	0	$532	36.1%	$5,751	$10,356	$10,962	1.06
2-sty Best Case	4,897	0	$576	35.8%	$5,522	$10,176	$11,866	1.17
2-sty Wrst Case	4,918	0	$579	35.7%	$5,522	$10,176	$11,917	1.17
Averages	**4,709**	**0**	**$554**	**36.0%**	**$5,636**	**$10,266**	**$11,411**	**1.11**

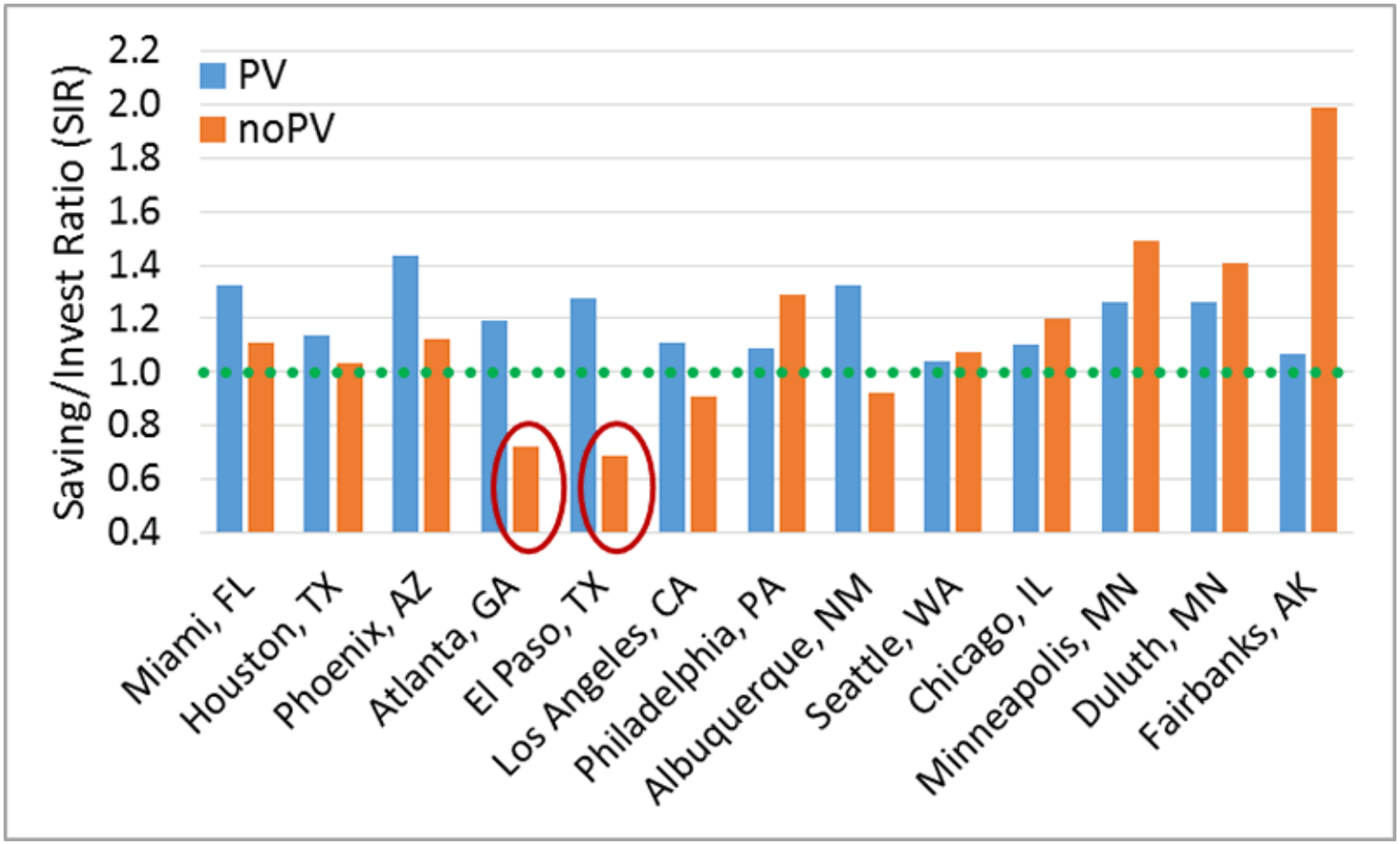
Cost Savings: All TMY Sites



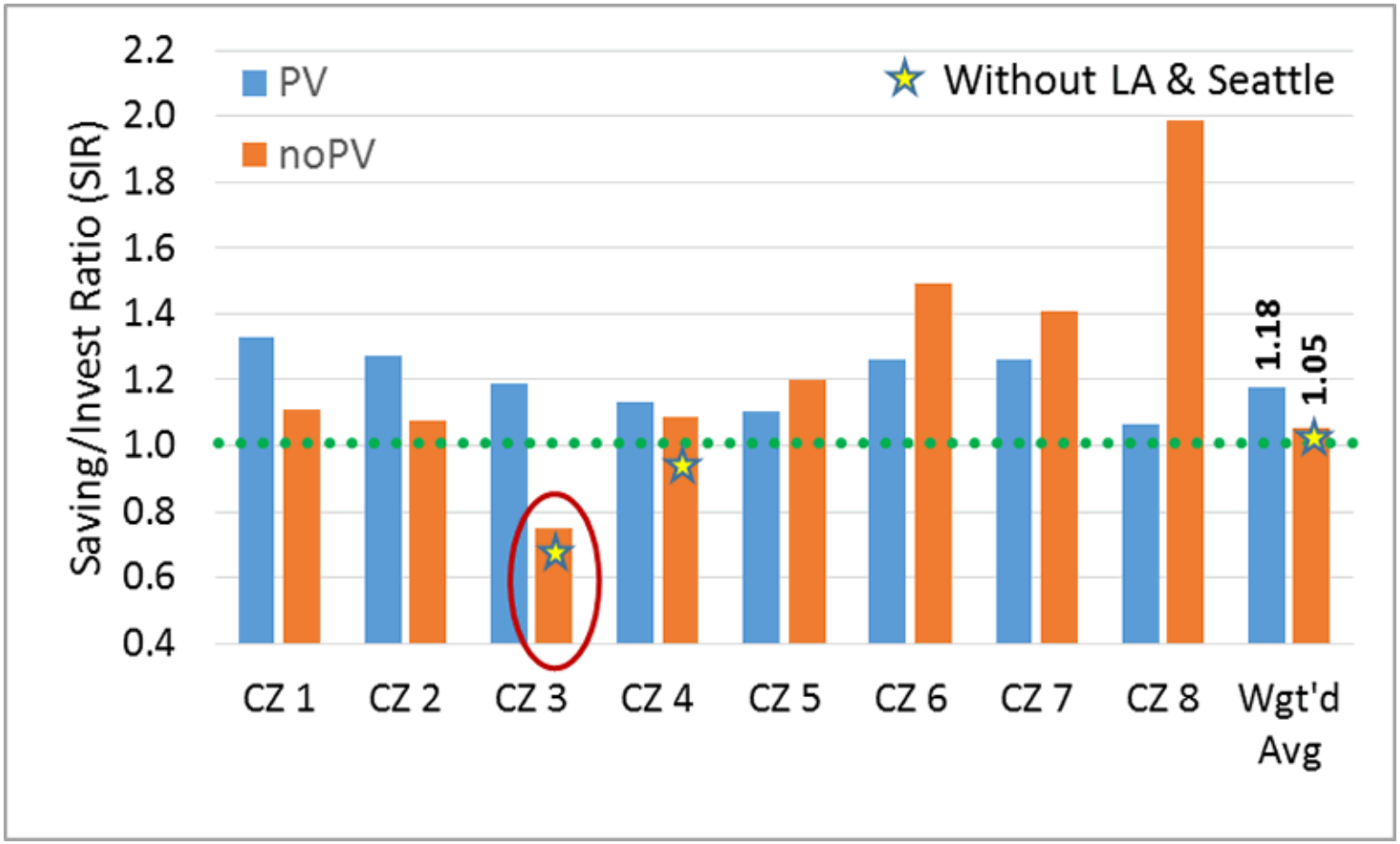
Cost Savings by Climate Zone



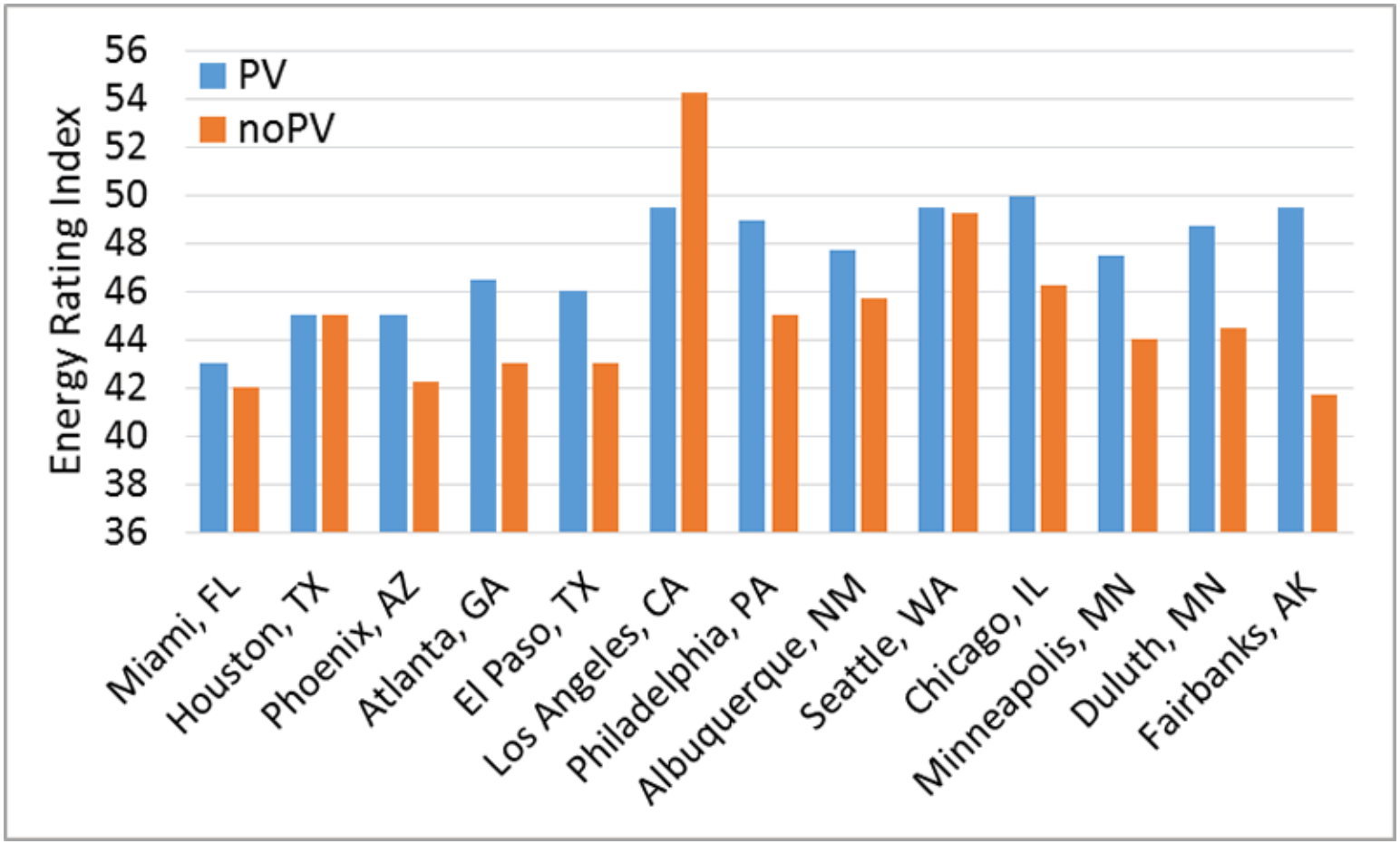
SIR: All TMY Sites



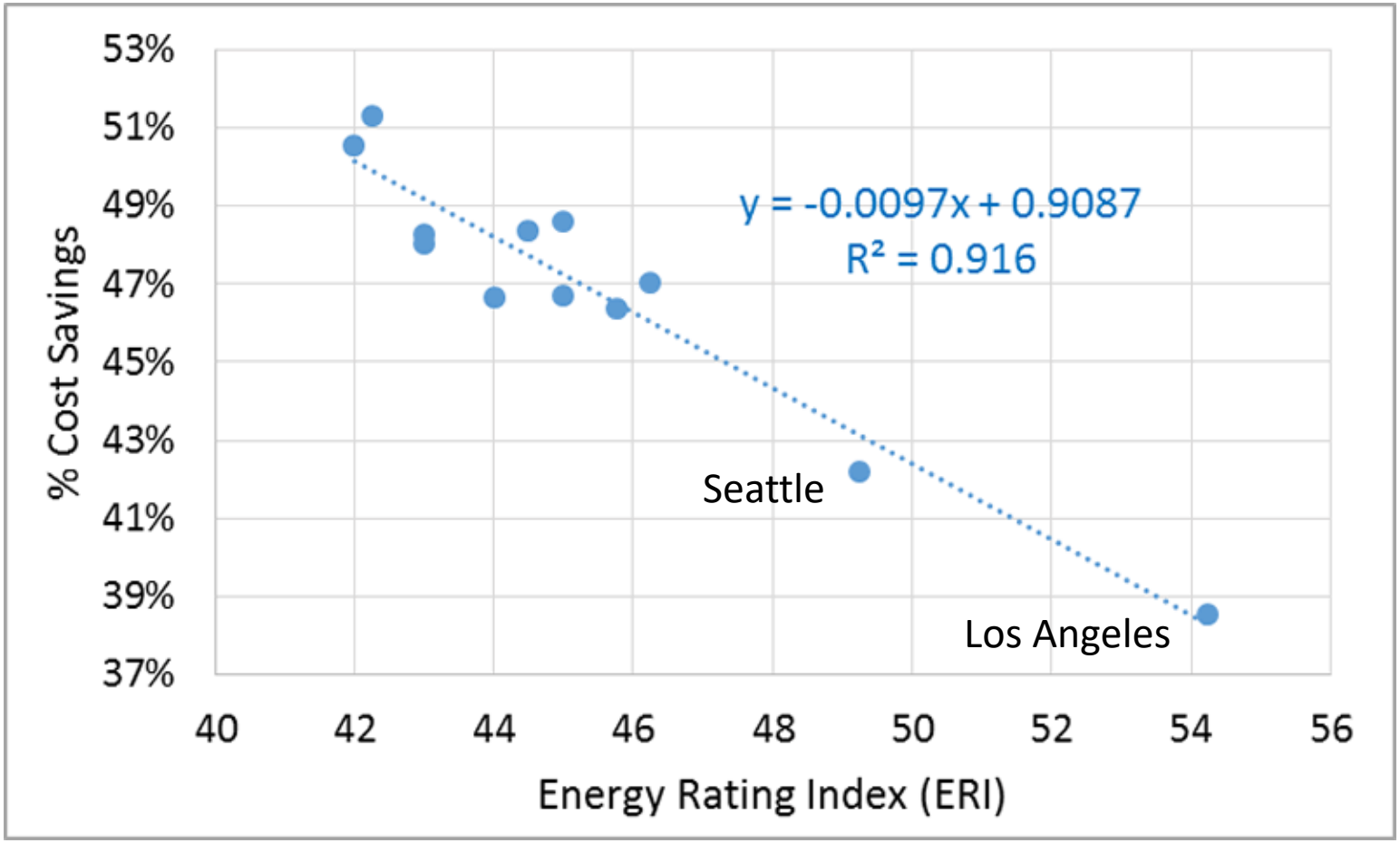
SIR by Climate Zone



ERI: All TMY Sites (lower is better)

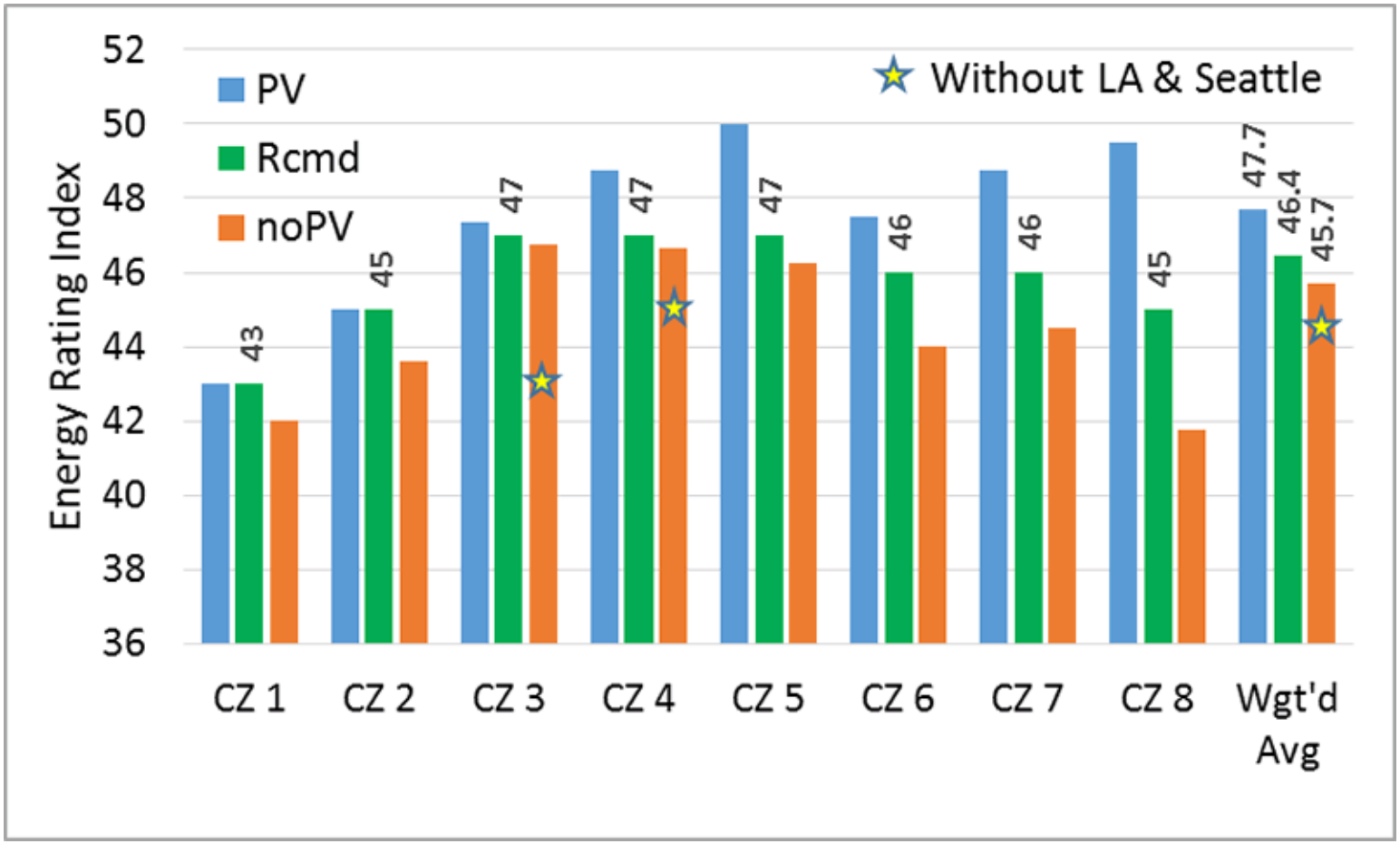


Cost Savings vs. ERI



Alternative Equipment Cases Only

Recommended Compliance ERIs



90.2 Compliance ERI Scores

Climate Zone	ERI
Zone 0	43
Zone 1	43
Zone 2	45
Zone 3	47
Zone 4	47
Zone 5	47
Zone 6	46
Zone 7	46
Zone 8	45

Conclusions

- The new 90.2 is not a minimum standard but rather is a leadership standard that significantly exceeds the requirements of all existing minimum codes
- Compliance with the new 90.2 will achieve approximately 50% energy cost savings and approximately 50% pollutant savings as compared with the 2006 IECC minimum standards
- Compliance with the new 90.2 is purely performance-based, allowing maximum design flexibility
- While the 90.2 standard contains certain minimums that must be met, there is no normative set of prescriptive requirements that will comply with the new 90.2 Standard.

Questions