DuraMAT
Durable Module Materials Consortium

Estimating the value of worker training: a system reliability & LCOE perspective

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U.S. DEPARTMENT OF ENERGY | DuraMAT | NREL | Sandia National Laboratories | BERKELEY LAB

Motivation: Inflation Reduction Act (IRA)

To receive IRA tax credits, systems **1 MW_{ac} or larger** must:

- pay local prevailing wages
- use 10-15% apprentice labor

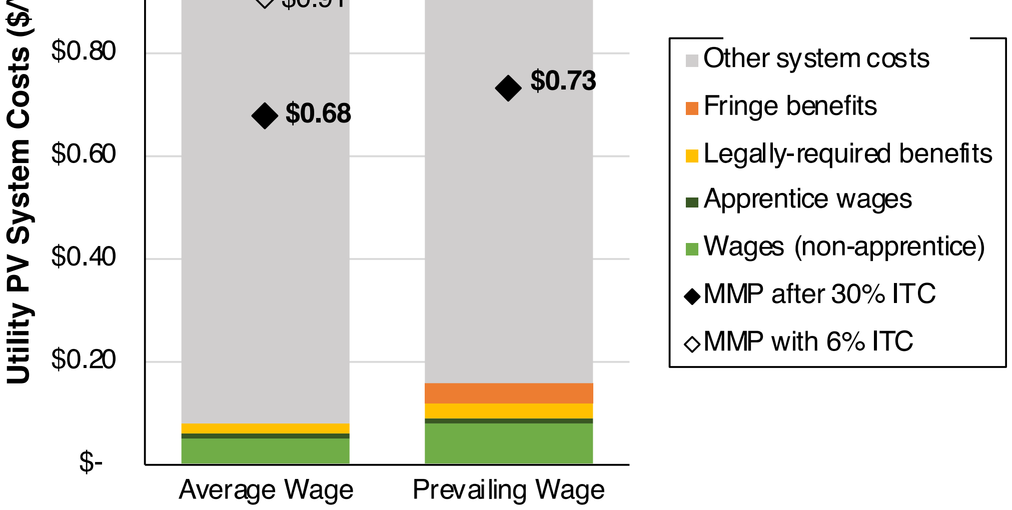
	ITC	PTC
Labor requirements met	**30%**	**2.6 ¢/kWh**
Requirements not met	6%	0.5 ¢/kWh

Projects may choose either:

- investment tax credit (ITC)
- production tax credit (PTC)

Installation cost comparisons

Utility system (>1MW$_{ac}$)



Compare average wage price with 6% ITC to prevailing wage price with 30% ITC:

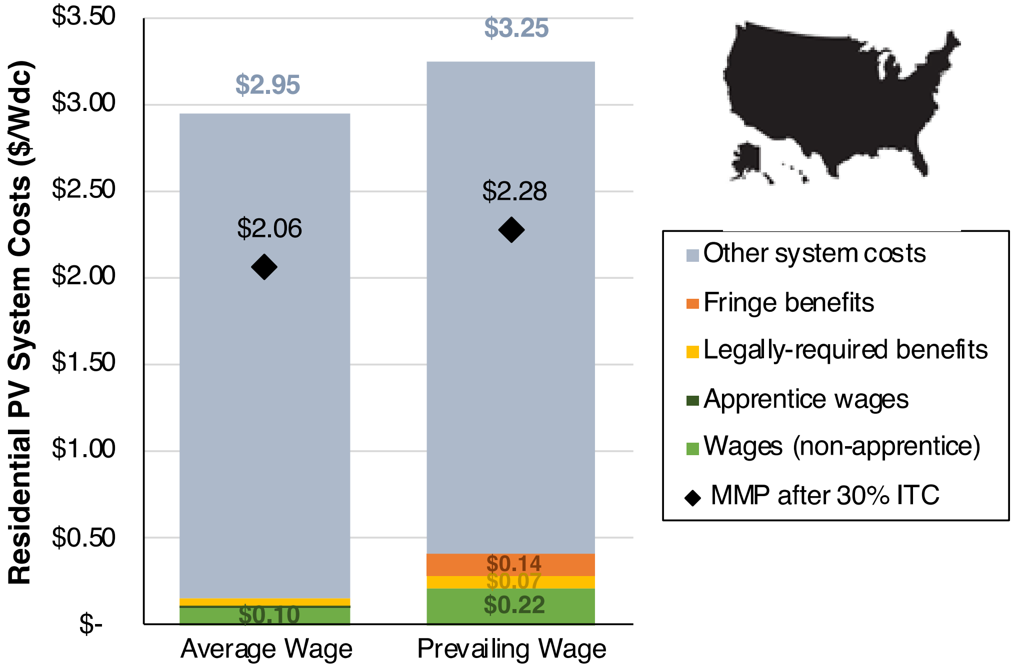
- Prevailing wage ***premium*** would need to outweigh 24% of total system price
- Labor costs typically <15% of total system price

Installation cost comparisons

6% ITC penalty doesn't apply to smaller systems

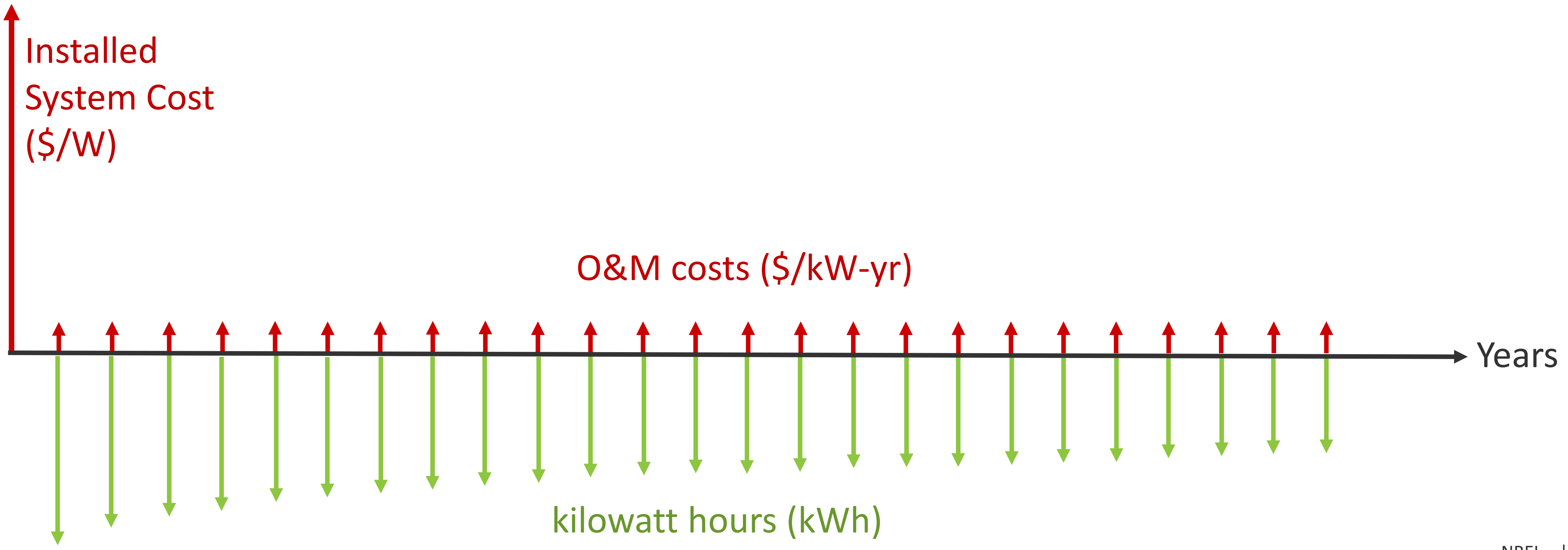
- Will commercial systems be strategically sized less than $1MW_{ac}$?
- Could there be ancillary benefits associated with higher labor expenses?

Residential system (<<$1MW_{ac}$)

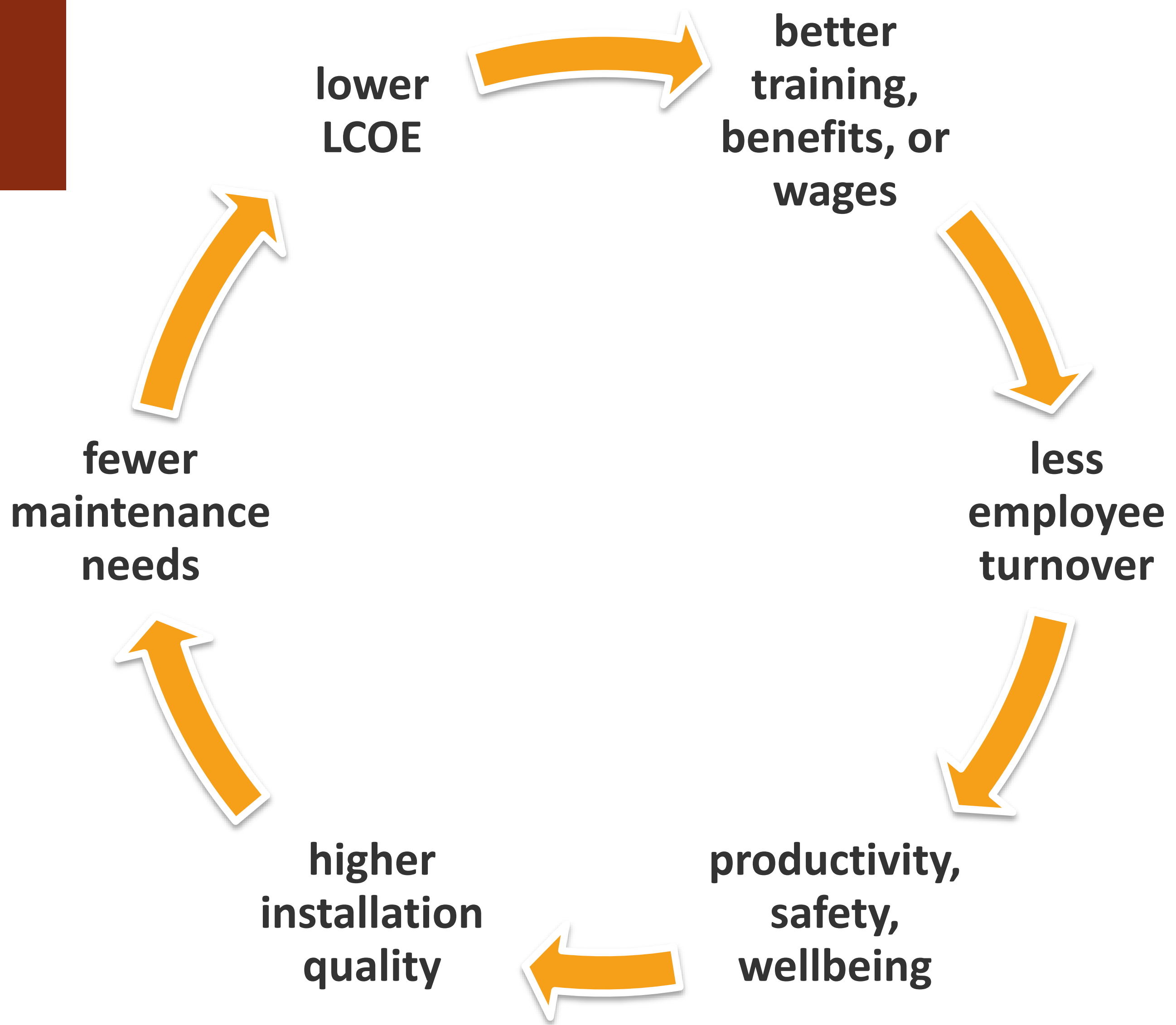


Levelized Cost of Energy (LCOE)

$$\text{LCOE (\$/kWh)} = \frac{\text{Total Costs over Service Life (\$)}}{\text{Total Energy Produced over Service Life (kWh)}}$$

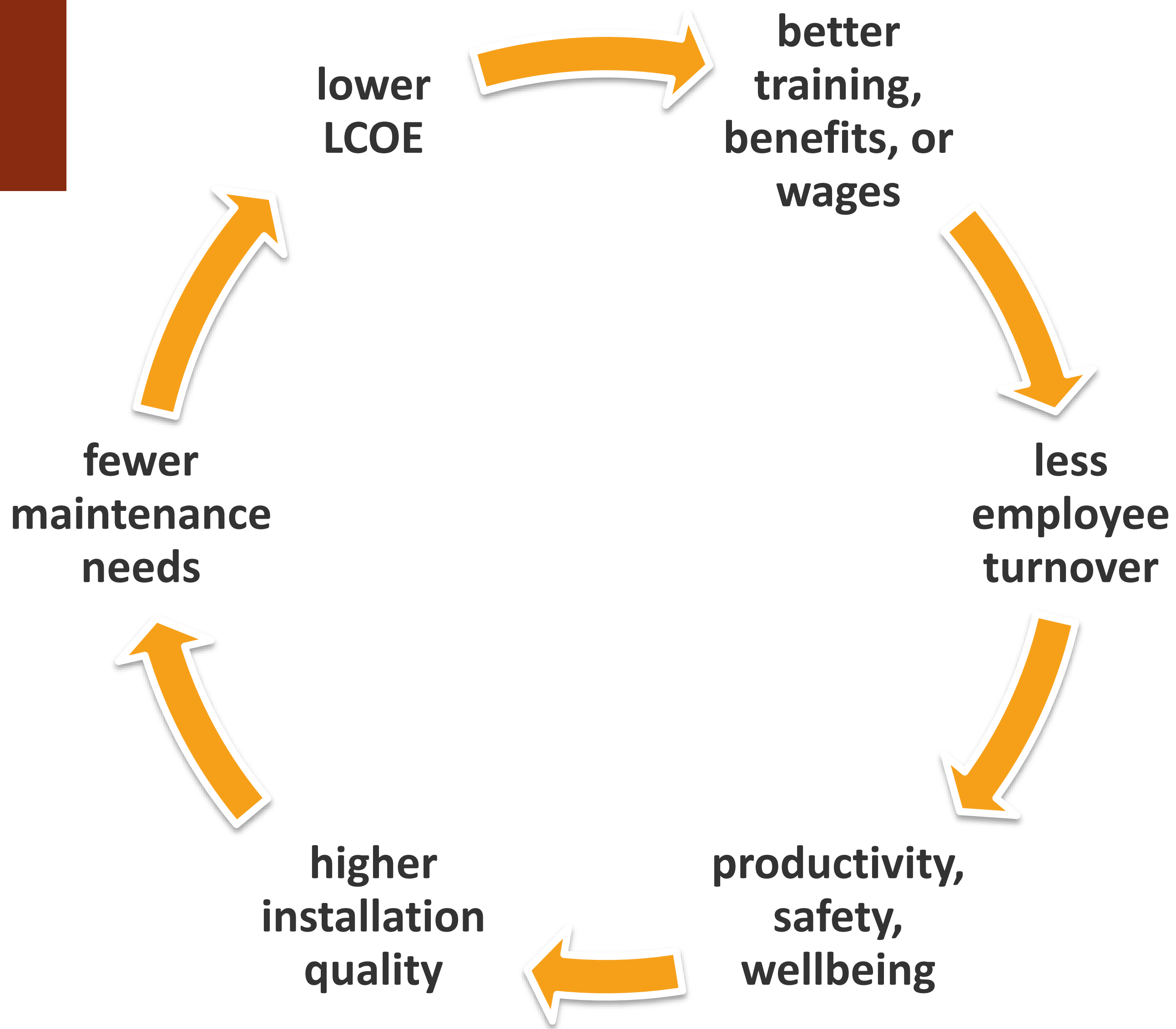


Potential LCOE effects



Potential LCOE effects

Higher productivity could offset higher labor expenses



Approach: comparing equivalent LCOEs

How much **additional energy generation** would offset **higher labor expenses**?

What **reduction in maintenance costs** would offset **higher install labor expenses**?

– **Higher Labor Expenses**

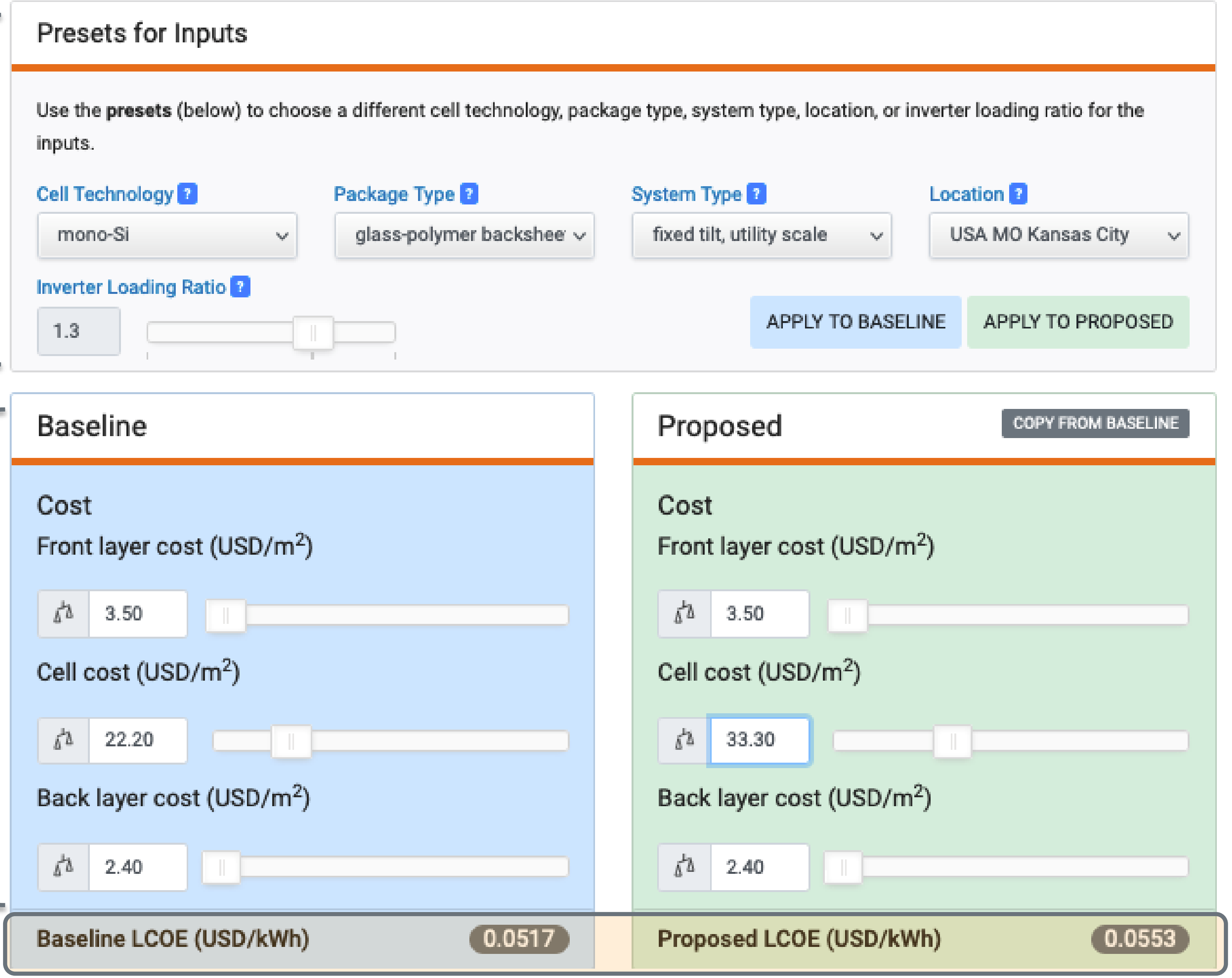
+ **...improved energy yield?**
+ **...lower degradation rate?**
+ **...longer system life?**
+ **...lower maintenance costs?**

PVLCOE.NREL.GOV

Step 1: Select from a set of system options

Step 2: Default input values pre-populate (additional fields visible on website)

Step 3: Results generated include LCOE (module price & system cost also)



Estimating training costs

If each worker receives 1 week (40 hours) of training each year at full pay, and we distribute this expense across the projects they install per year:

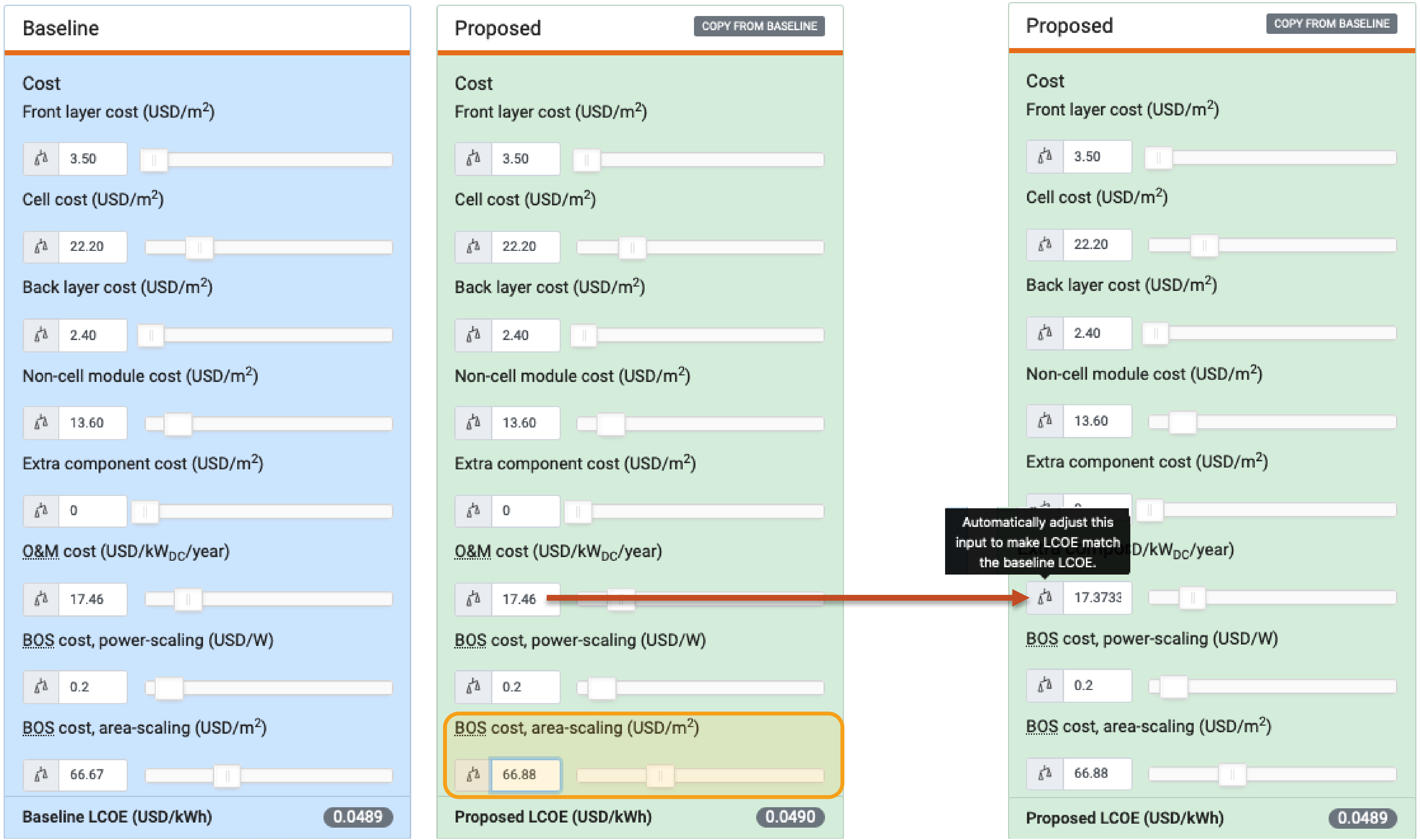
	Utility	Commercial	Residential
Projects per year	5	20	80
% increase labor costs per project	1.9%	1.9%	1.9%

- PVLCOE calculator includes labor in "area-scaling BOS costs" per m^2
- Estimate using NREL annual system cost benchmark reports:
  - labor hours per m^2
  - hourly wage & legally-required benefits

Step 1: Select system type from top menu
Step 2: Propose increased install labor cost

Increase labor costs by 1.9%
(not total BOS costs)

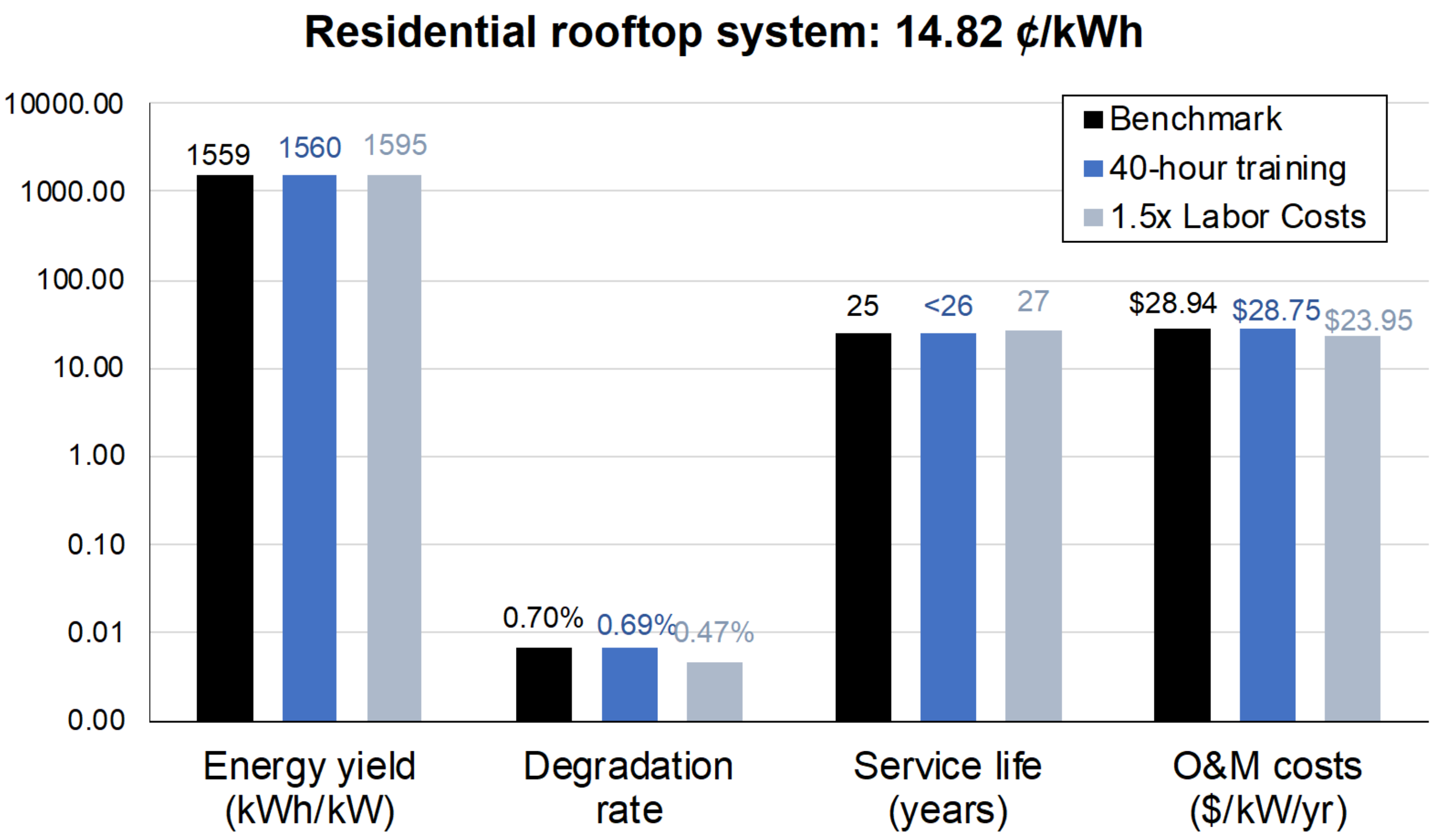
Step 3: Compare results



Find break-even points (equivalent LCOE) for:

- Energy yield
- Degradation rate
- O&M costs
- Service life

Residential Systems



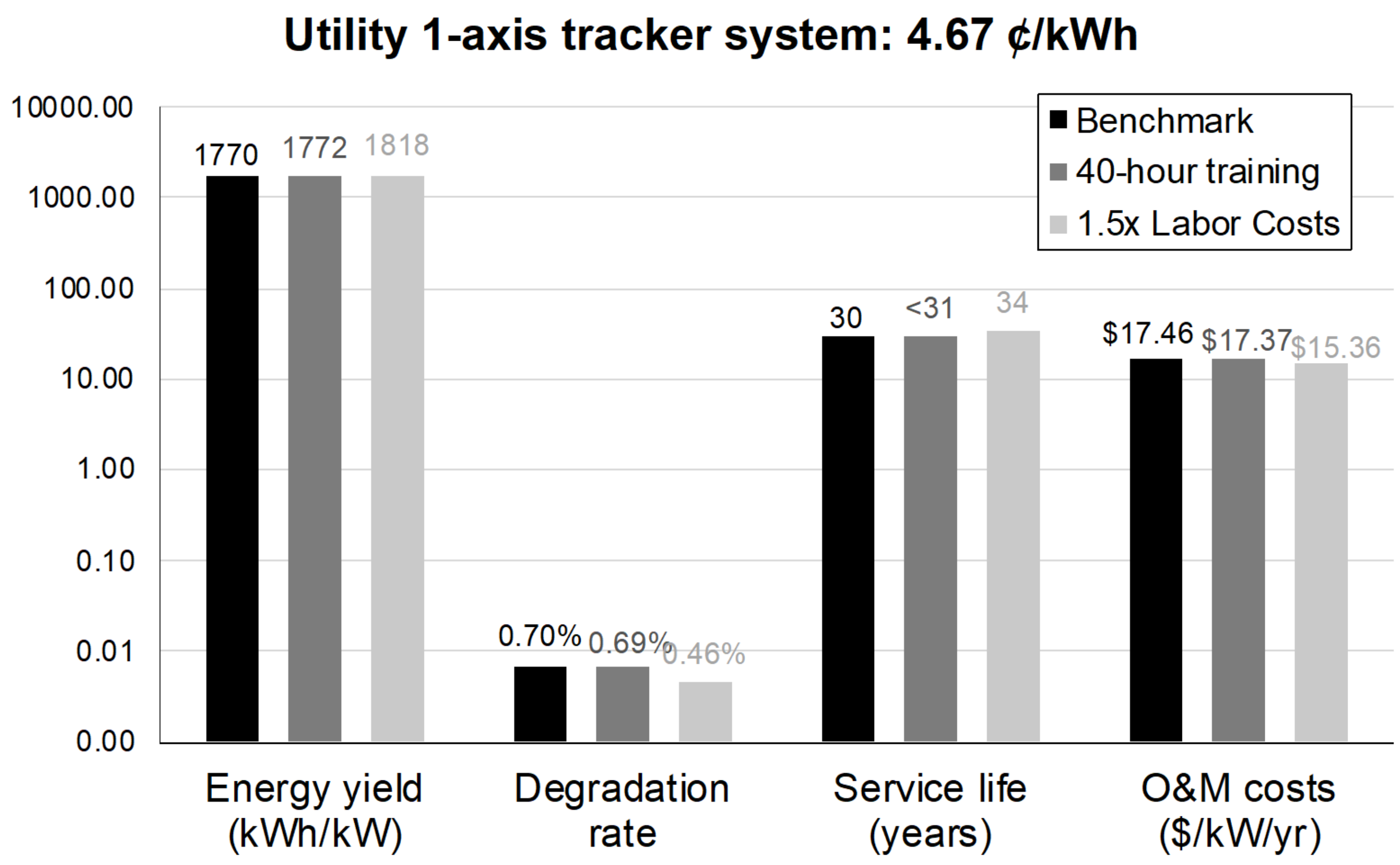
% change	40-hour training	1.5x Labor Costs
Energy yield	0.1%	2.3%
Degradation rate	-1.4%	-32.9%
Service life	0.4%	8.0%
O&M costs	-0.7%	-17.2%

Modest changes for:

- Energy yield
- Service life
- O&M costs

Degradation rate is challenging, but could play a role when effects are combined

Utility Systems



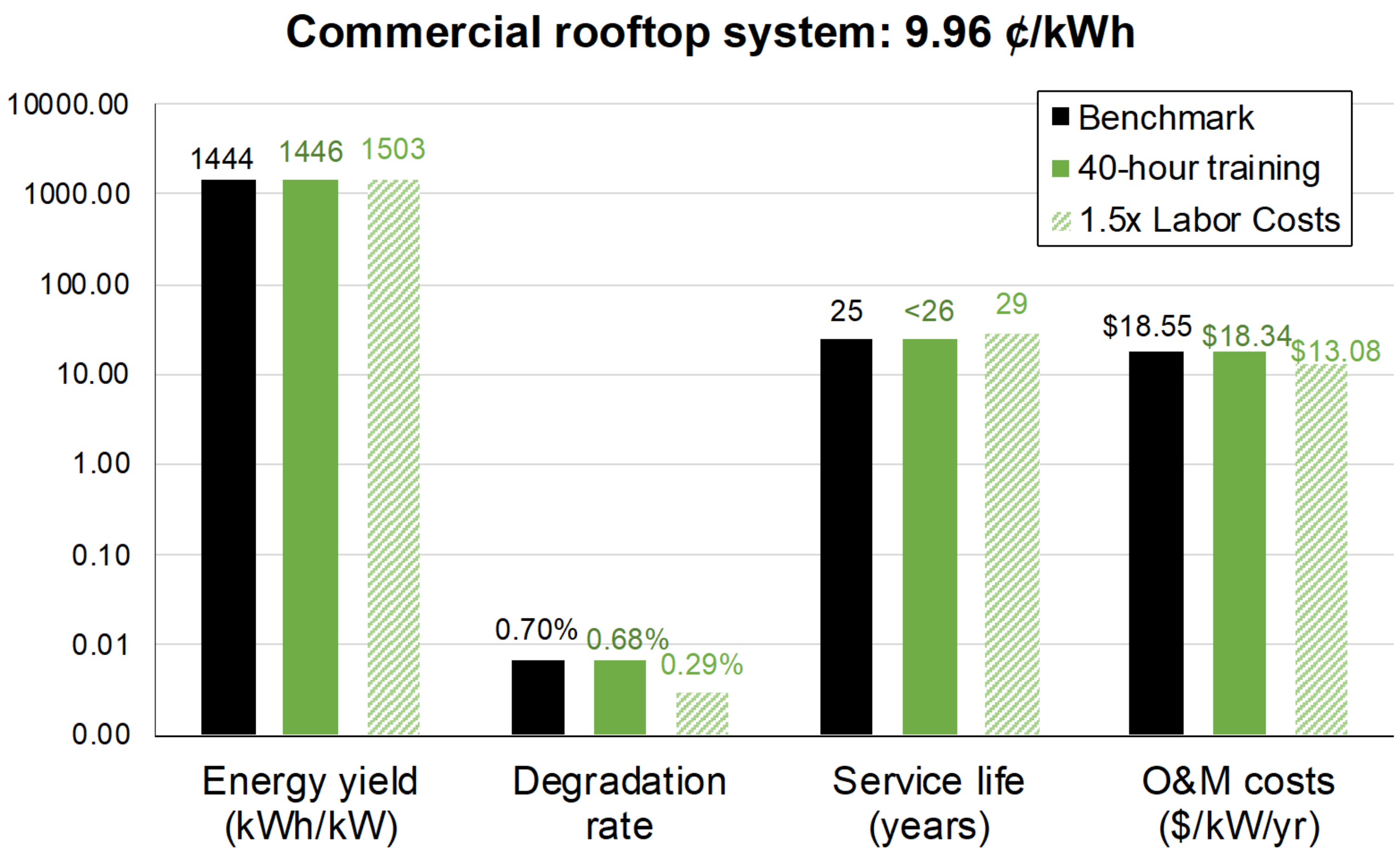
% change	40-hour training	1.5x Labor Costs
Energy yield	0.1%	2.7%
Degradation rate	-1.4%	-34.3%
Service life	0.3%	13.3%
O&M costs	-0.5%	-12.0%

Modest changes for:

- Energy yield
- Service life
- O&M costs

Degradation rate is challenging, but could play a role when effects are combined

Commercial Flat-Roof Systems



% change	40-hour training	1.5x Labor Costs
Energy yield	0.1%	4.1%
Degradation rate	-2.9%	-58.6%
Service life	0.4%	16.0%
O&M costs	-1.1%	-29.5%

- Modest change for energy yield, service life
- Degradation rate and O&M costs are challenging, but could play a role when effects are combined

Similarly, if O&M labor costs increase $1-$2 per kW/yr, service life needs to increase by 1 year to achieve same LCOE

Detailed Cost Analysis Model (DCAM): dcam.openei.org

- Free, public, user-friendly online tool
- Enables bottom-up modeling of PV costs:
  - Manufacturing of ingots, wafers, cells
  - Assembly of modules
  - Installation of PV systems
- Leverages NREL component and system cost benchmark research
- Can be used to analyze cost impacts of technology or installation choices

Detailed Cost Analysis Model (DCAM): dcam.openei.org

Utility + PV / **Q1-2022 Utility PV Benchmark** Public Updated: **January 23 2023**

Copy project | Upload JSON | Download | Options

Save | Calculate | Notes

Search | Inputs | Advanced Inputs | Output

INPUTS

System Description + add note

Year	2022	
Project Location	United States	
Axis Type	One-Axis	
Project Size	5	MWDC
System VDC	1500	VDC
Transmission Line	2.7	miles
Nominal to Real USD Factor	0.952	

Modules + add note

Module Efficiency	20.3	%
Module Width	40.32	inches
Module Length	76.68	inches
Module Power	405	W
Module Weight	47.84	lbs
Module Price	0.33	$/W

OUTPUT

Utility-PV MSP Results ($/Wdc)

MSP - Minimum Sustainable Price

Project Size (MWDC)	5
Axis Type	One-Axis
EPC/Developer Net Profit	0.0893
Contingency	0.0292
Developer Overhead	0.111
Transmission Line	0
Permitting Fee	0.0419
Interconnection Fee	0.0217
Sales Tax	0.0419
EPC Overhead	0.0898
Installation Labor & Equipment	0.133
Electrical BOS	0.143
Structural BOS	0.151
Inverter	0.0397
Module	0.314
Total Utility + PV System Cost	1.21

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www.duramat.org

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Background Slides

Simplified PV-LCOE Calculator: pvlcoe.nrel.gov

- PV technology-specific
- Editable preset fields, targeting research applications
- Instant comparison of proposed changes to a baseline system
- Distinct from:

System Advisor Model (SAM): sam.nrel.gov

+ Different financial models
+ Detailed options for module and system designs
+ Can model solar + storage

– May be more challenging for new users to navigate
– Difficult to quickly evaluate research directions without introducing confounding factors