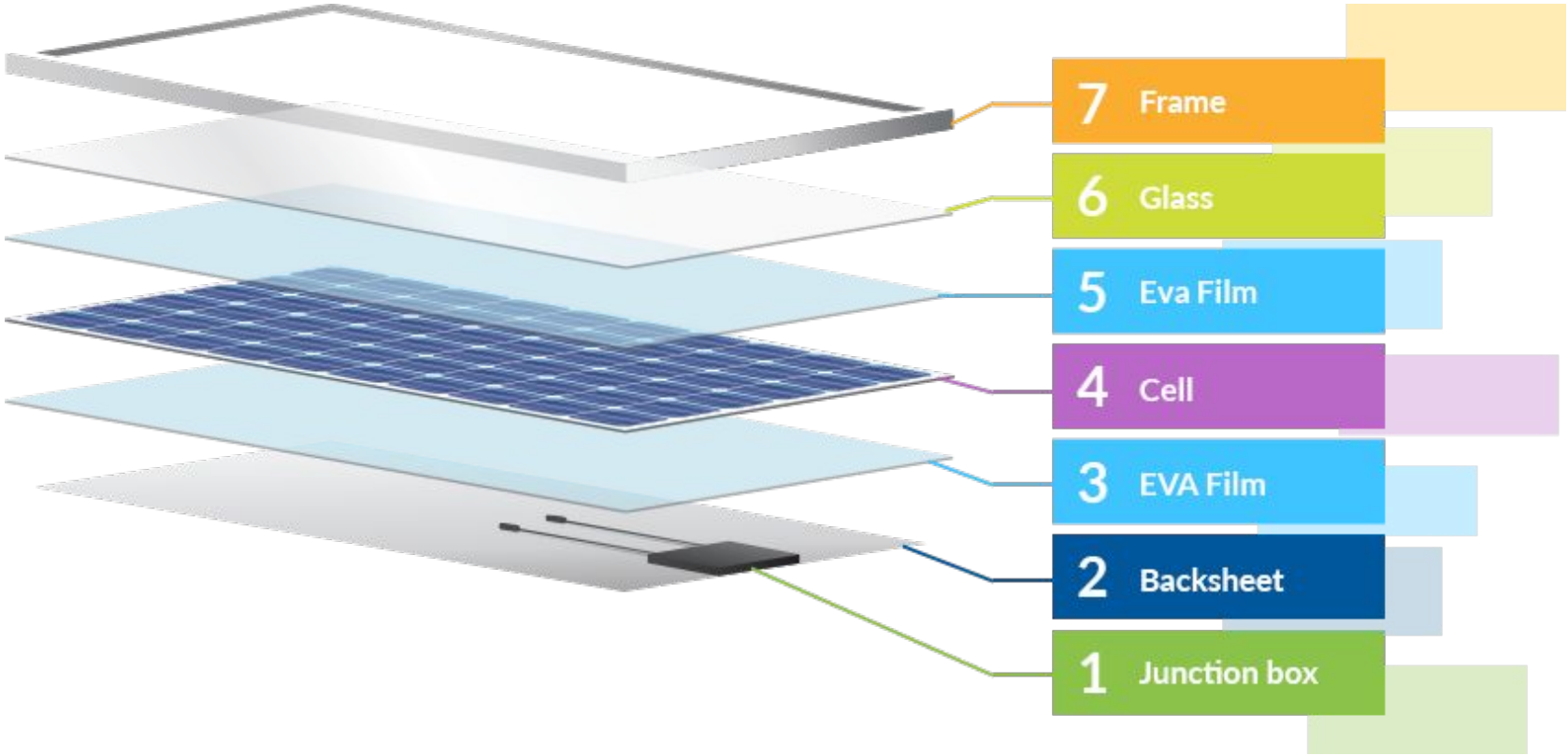
Tech Review Day

This presentation was prepared by Shake Energy Collaborative to frame the conversation on selecting photovoltaic panels and battery energy storage systems when co-designing community-owned solar and battery projects.

Anatomy of a solar panel



Types of solar panels

Monocrystalline	Polycrystalline	Thin film
Single silicon crystal cut into wafers	Silicon fragments melted into wafers	Can be silicon or other material, non-crystal = flexible
More efficient	Less efficient	Least efficient
More expensive	Less expensive	Least expensive (usually)
Black	Blue	Black or blue

Bifacial - makes panel more efficient by allowing light to be absorbed by both front and back of panel

PERC - Passivated Emitter and Rear Cell - makes panel more efficient with the addition of a back layer

Attributes of a panel

Watts - maximum power produced per panel (higher is better because less racking is required)

Price - usually quoted in a $/Watt, anonymized for this activity but proportional to actual quoted price

Efficiency - ability to convert energy of the sun‘s rays into electricity (higher is better)

20 year warranted energy - according to manufacturer‘s warranty, the expected energy produced by the panels over 20 years accounting for degradation

Ethical labor and supply considerations

This is a new field and documentation is still developing, but here are some resources to track it:

- Silicon Valley Toxics Coalition's Solar Scorecard
- SEIA's Commitment to an Ethical Supply Chain

2018-19 SOLAR SCORECARD

SVTC

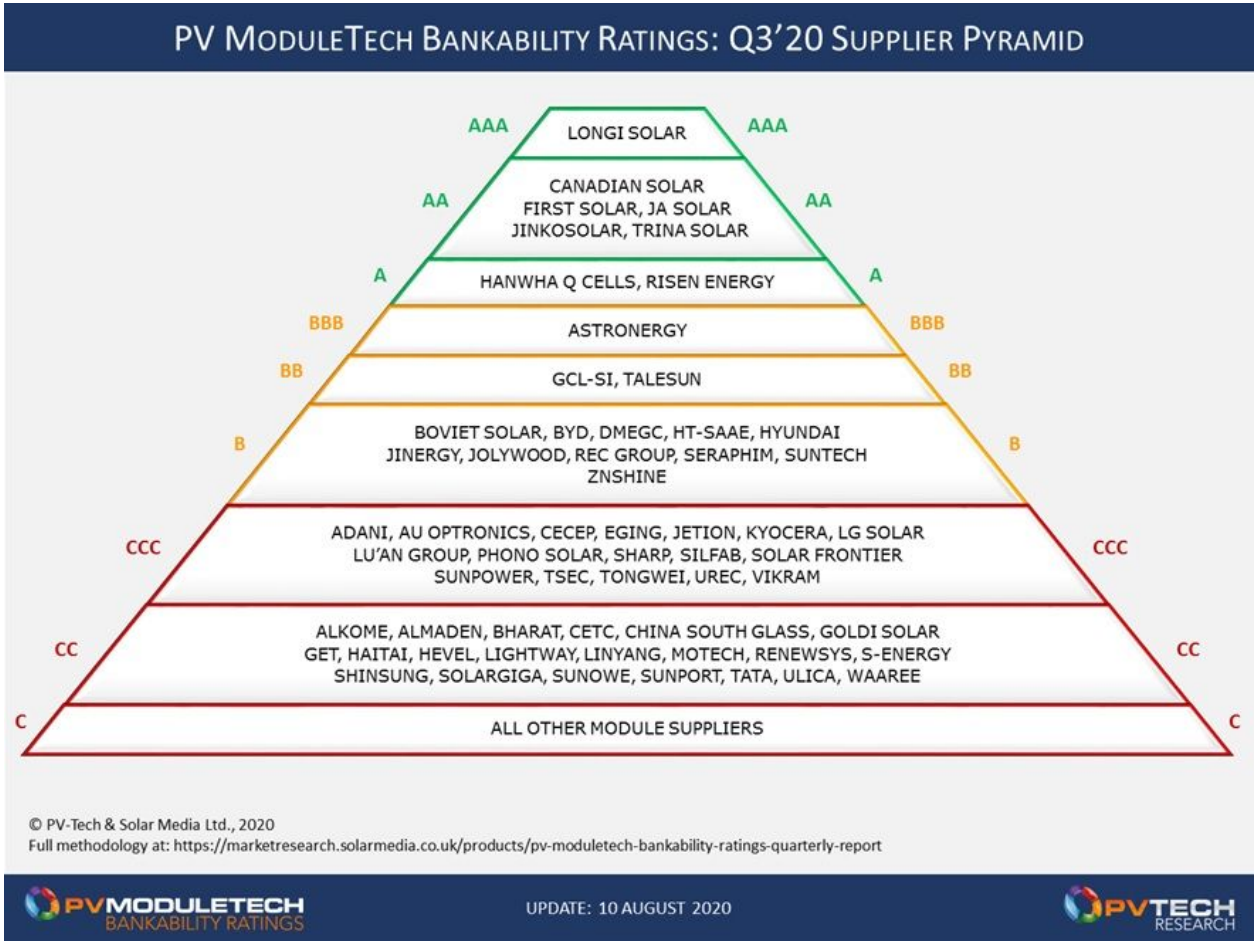
SUNNY
PARTLY CLOUDY
RAINY

	Company	Extended Producer Responsibility	Emissions Reporting & Reduction	Worker Rights, Health and Safety	Supply Chains	Energy Use & GHGs	Water	Conflict Minerals	Module Toxicity & Recycled Content	2018-19 OVERALL SCORE
	Maximum Score	15	15	15	15	10*	10	10	10	100
2018-19 Leaders	Jinko	15	15	13	15	12	10	10	10	100
	Trina	15	14	13	15	12	10	10	10	99
	SunPower	15	15	13	13	11	10	7	10	94
	JA Solar	14	11	13	15	9	10	10	10	92
	Hanwha Q CELLS	10	13	13	15	12	10	7	10	90
	CS Wismar	10	13	15	10	9	10	9	8	84
	LG	12	11	13	15	12	10	10	1	84
	WINAICO	8	13	13	15	8	10	7	10	84
	Silfab	13	7	13	15	10	10	9	0	77
	AUO	11	13	13	15	8	10	6	0	76
Above Average	Boviet Solar	8	9	11	10	8	1	9	10	66
	Talesun	10	5	13	13	12	2	7	0	62
	First Solar	10	8	9	5	6	7	0	10	55
	Astronergy	8	5	13	5	12	2	8	0	53
	GCLSI	11	3	15	8	6	1	5	0	49
	SolarWorld	2	5	12	4	9	2	7	0	41
Below Average	Aleo	5	0	0	0	0	0	0	0	5
	Avancis	0	0	0	0	0	0	0	0	0
	BYD	0	0	0	0	0	0	0	0	0
	Calyxo	0	0	0	0	0	0	0	0	0
	China Sunergy-Csun	0	0	0	0	0	0	0	0	0
	ET Solar	0	0	0	0	0	0	0	0	0
	Gintech	0	0	0	0	0	0	0	0	0
	Hanergy	0	0	0	0	0	0	0	0	0
	Hareon Solar	0	0	0	0	0	0	0	0	0
	Hyundai	0	0	0	0	0	0	0	0	0
	Kyocera	0	0	0	0	0	0	0	0	0
	Longi Solar	0	0	0	0	0	0	0	0	0
	Mitsubishi	0	0	0	0	0	0	0	0	0
	Motech	0	0	0	0	0	0	0	0	0
	Panasonic	0	0	0	0	0	0	0	0	0
	REC	0	0	0	0	0	0	0	0	0
	Renesola	0	0	0	0	0	0	0	0	0
	Risen	0	0	0	0	0	0	0	0	0
	Solar Frontier	0	0	0	0	0	0	0	0	0
	Suntech	0	0	0	0	0	0	0	0	0
	Yingli	0	0	0	0	0	0	0	0	0

*Solar companies can earn up to 2 extra credit points in the Energy Use & Greenhouse Gas Emission Section

Performance and bankability

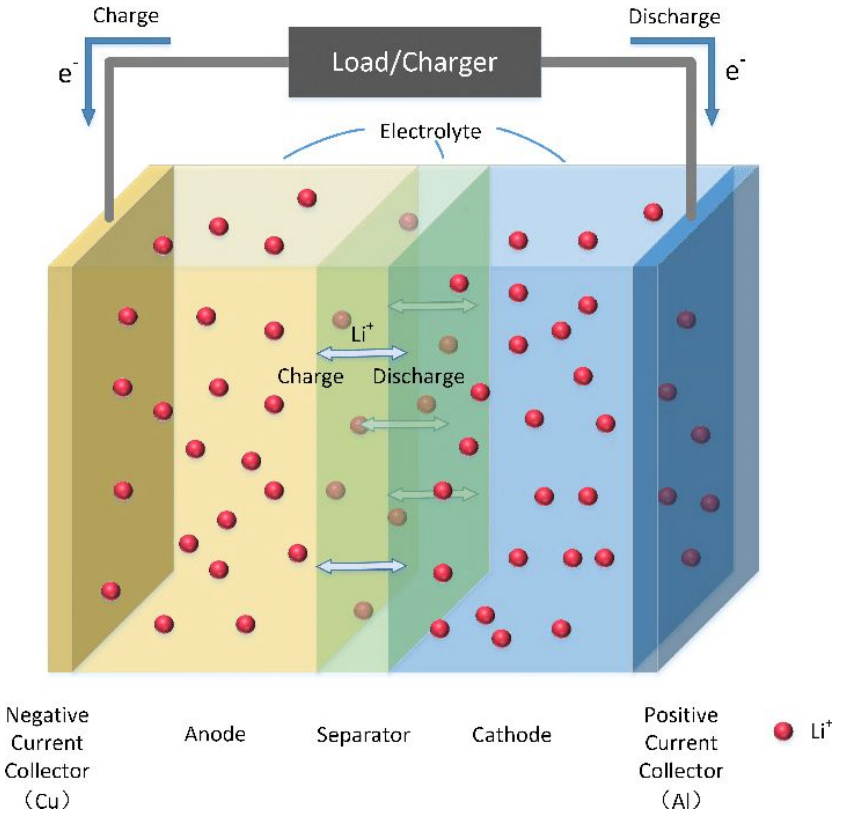
Bankability = the reliability of the output from PV module manufacturers based on past performance



Anatomy of a Battery

This is a Lithium Ion battery diagram but many chemical batteries function in much the same way - with charges between the anode to cathode. Differences include:

- Solid vs. liquid/gel state
- Chemical makeup of nodes



Battery Chemistry

Lead Acid*	Lithium Ion Including Lithium Iron Phosphate (LFP) Lithium Nickel Manganese Cobalt Oxide (NMC)	Solid State Including Lithium Metal Polymer (LMP)	Zinc hybrid	Sodium Ion*
Most mature technology	Commercialized technology	Newly commercialized technology	Newly commercialized technology	New technology
Toxic	Uses rare earth metals	Uses fewer rare materials	Uses abundant materials	Uses abundant materials

* These chemistries just included for reference, no battery profiles below use this chemistry. Of course, there are many more battery technologies not included here as well.

Attributes of a Battery

Years of warranty - higher is better

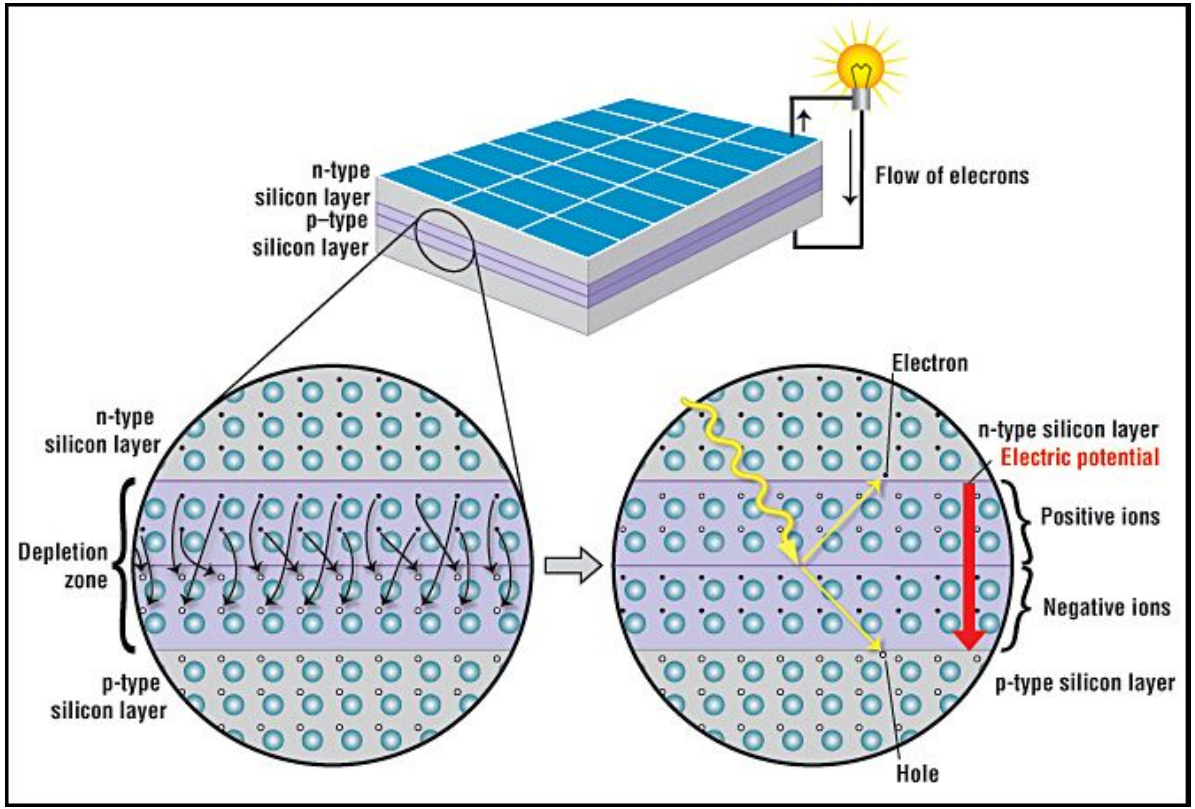
Unit price - usually expressed in $/MWh, prices are anonymized for this exercise but are proportional to other battery systems. Note: does not include ongoing costs which will be an important factor

Past Performance - because BESS is a newer field than Solar PV, there are fewer metrics to use in comparison. We try to approximate past performance by a combination of years in business and MWh deployed locally and globally

Appendix

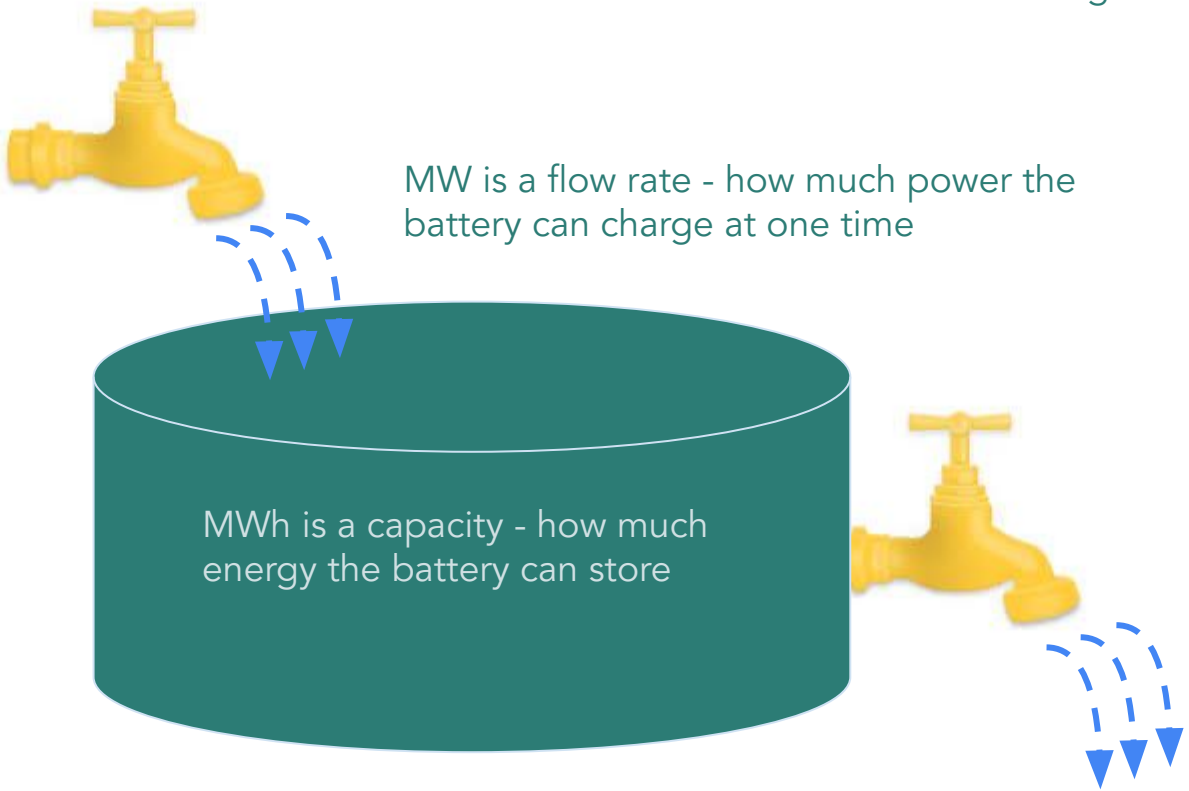
Extra nerdy stuff and references

How a panel generates electricity



What is a MWh vs a MW?

The analogy:
MWh ~ gallons
MW ~ gallons/second



References

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PERC - https://news.energysage.com/perc-solar-cells-overview/

How a panel works - https://www.acs.org/content/acs/en/education/resources/highschool/chemmatters/past-issues/archive-2013-2014/how-a-solar-cell-works.html

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