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115/34.5kV Solar Plant & Substation Senior Design Project

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| Senior Design Team 41

| 09/26/2024

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AGENDA

- Safety Moment: Sun Exposure and Proper Hydration
- New Technology: Advanced Metering Infrastructure
- Land Comparison: Ames vs New Mexico
- PV Systems: I-V Curve Characteristics
- Discuss Array Parameter tool

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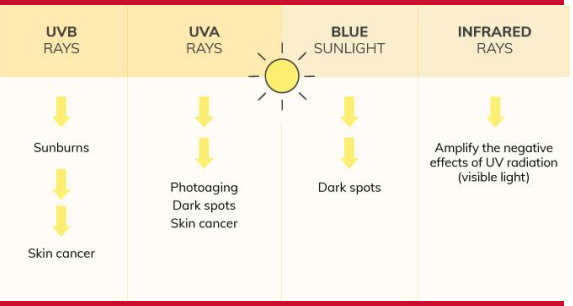
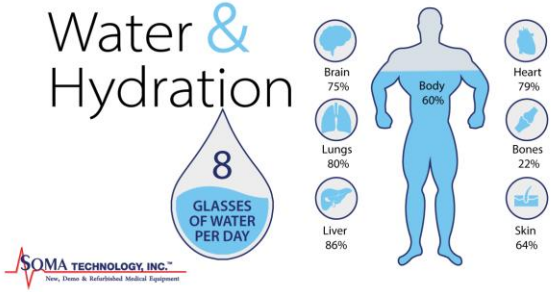


SAFETY MOMENT



Sun Exposure and Proper Hydration

- Too much time in the sun unprotected can lead to potential health issues including:
- Heat Exhaustion and Dehydration- Symptoms include headache, dizziness, red skin, tiredness
- Sunburn and too much exposure to rays can cause certain skin cancers
- Without proper treatment and rehydration, death is possible
- Safe practices to avoid the above issues
- Drink plenty of water throughout your time in the sun, mixing electrolytes in as well. Experts recommended drinking up to a quart per hour when working in extreme heat
- Wear sunscreen or cover up exposed skin to protect against the sun's rays

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NEW TECHNOLOGY

Advanced Metering Infrastructure

- AMI is an innovation to the power grid that involves using smart meters for better data acquisition and communication between customer and utility
- Smart meters can have many uses such as:
  - Outage detection and management
  - Enhanced customer service
  - Enabling of distributed generation

https://www.ibm.com/topics/advanced-metering-infrastructure

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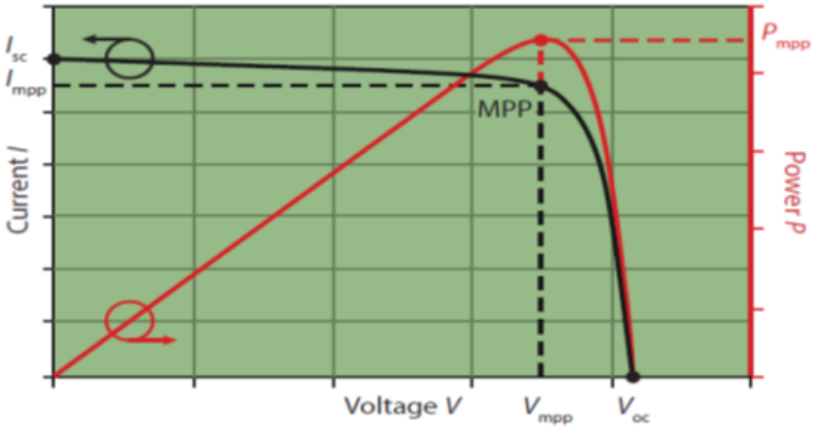
I-V Curve Characteristics

Definition:

- I-V Curve – Represents the relationship between the current (I) and output of a solar cell and the voltage (V) across it

Importance:

- It helps us to understand the performance of solar panels, including their efficiency and power output under different conditions



I-V and P-V Curve of a Solar Cell

Components:

- Short Circuit Current (Isc)
- Open Circuit Voltage (Voc)
- Maximum Power Point (Mpp)

https://www.electricalengineeringtoolbox.com/2021/12/the-behavior-of-illuminated-solar-cell.html

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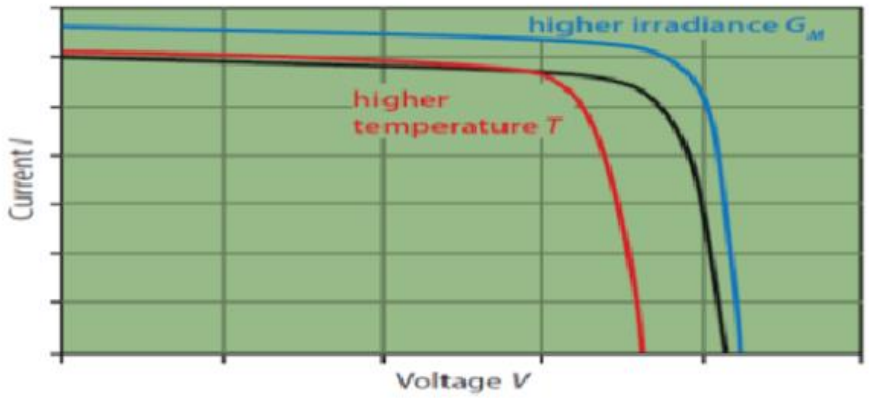
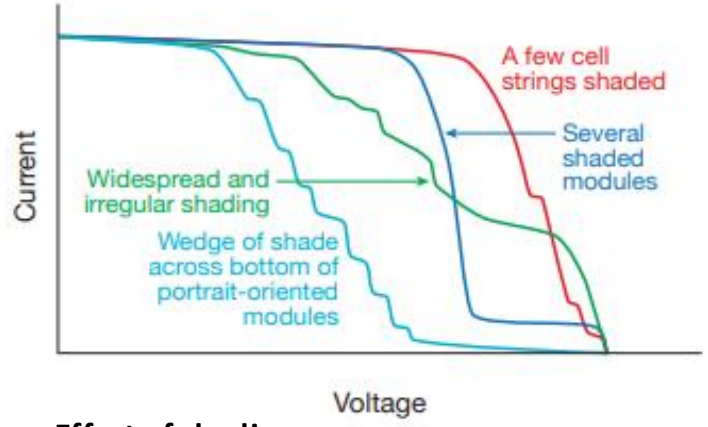
Factors Affecting I-V Curves

- Irradiance – Sunlight intensity
- Shading – Partial shading can affect panel I-V curve
- Cell Type – Material being used
  - Thin-Film, Monocrystalline, Polycrystalline
- Temperature – Higher temps typically increase short circuit current



Effect of increased temperature and irradiance on the I-V Curve



Effect of shading

https://www.electricalengineeringtoolbox.com/2021/12/the-behavior-of-illuminated-solar-cell.html

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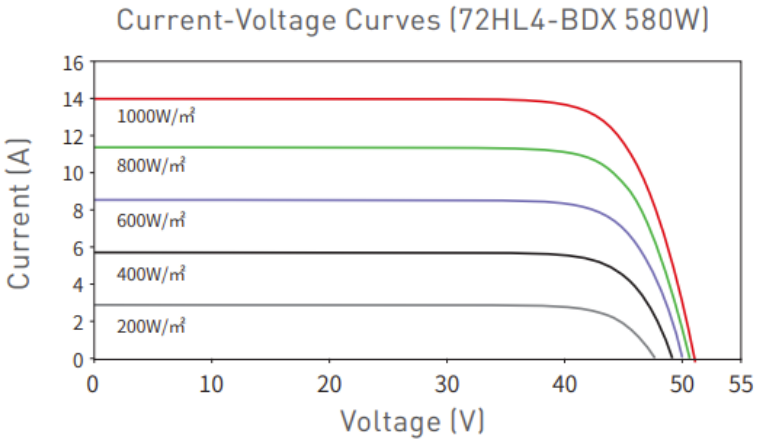
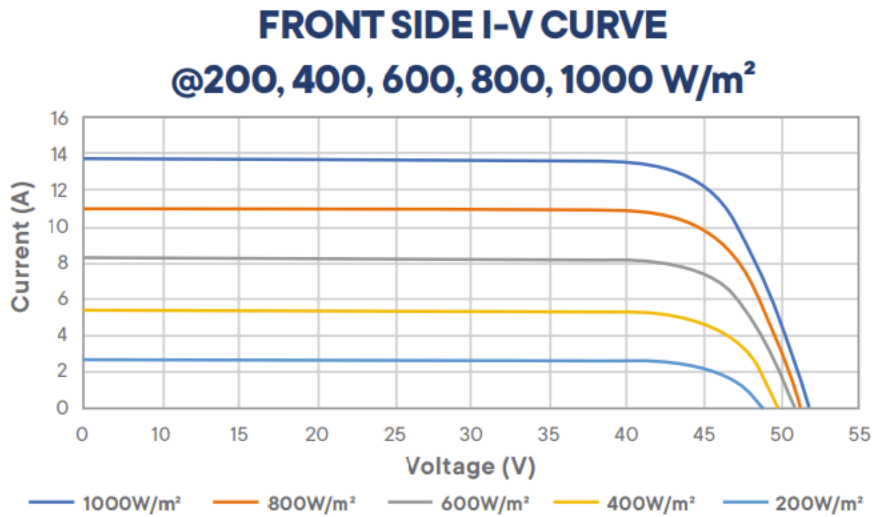
I-V Curve Examples



Eagle G6X



TOPcon M110-144

https://jinkosolar.us/wp-content/uploads/2024/09/30mm-EAGLE-G6X-JKM570-590N-72HL4-BDX-F30R-F2-US.pdf
https://kalyonpv.com/en/wp-content/uploads/2024/03/M10-144-TOPCON-GG-04_EN.pdf

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Buying land in Ames IA Vs New Mexico

Ames, Iowa:

Pros:

- **Renewable Energy Policies**: Iowa provides strong incentives for solar energy, including **tax credits and sales tax exemptions**. The federal Inflation Reduction Act (IRA) further supports solar projects, offering up to **30% tax** credits for residential and commercial projects (Agricultural Policy Review)
- **Affordable Land**: Compared to urban areas, land in rural Iowa, including around Ames, can be relatively affordable, making it feasible to install solar arrays (MPR News).
- **Flat Terrain**: The topography of Iowa is mostly flat, which reduces installation costs for solar farms.

https://agpolicyreview.card.iastate.edu/fall-2023/solar-energy-surge-iowa-policies-public-opinions-and-future-opportunities

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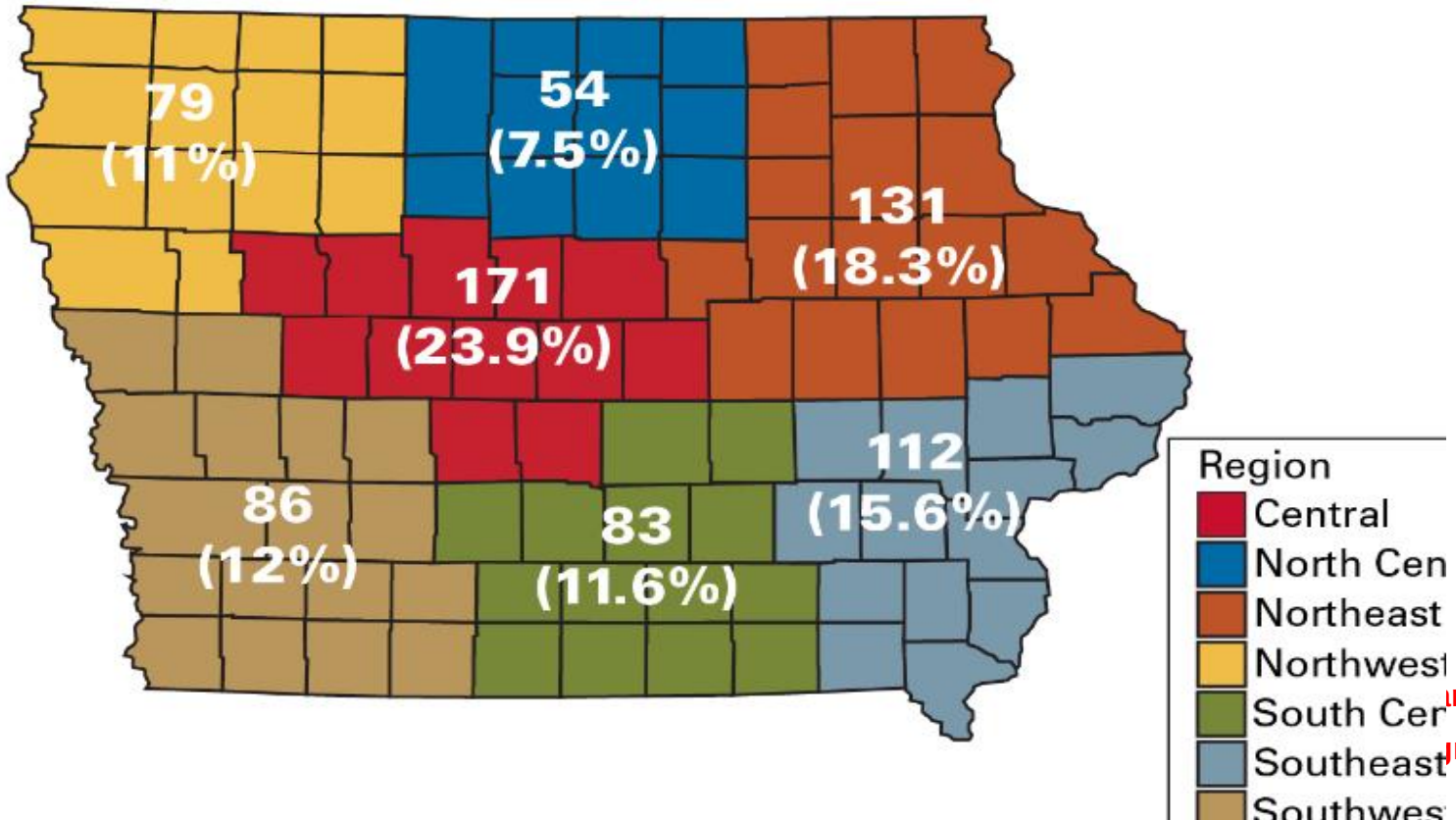
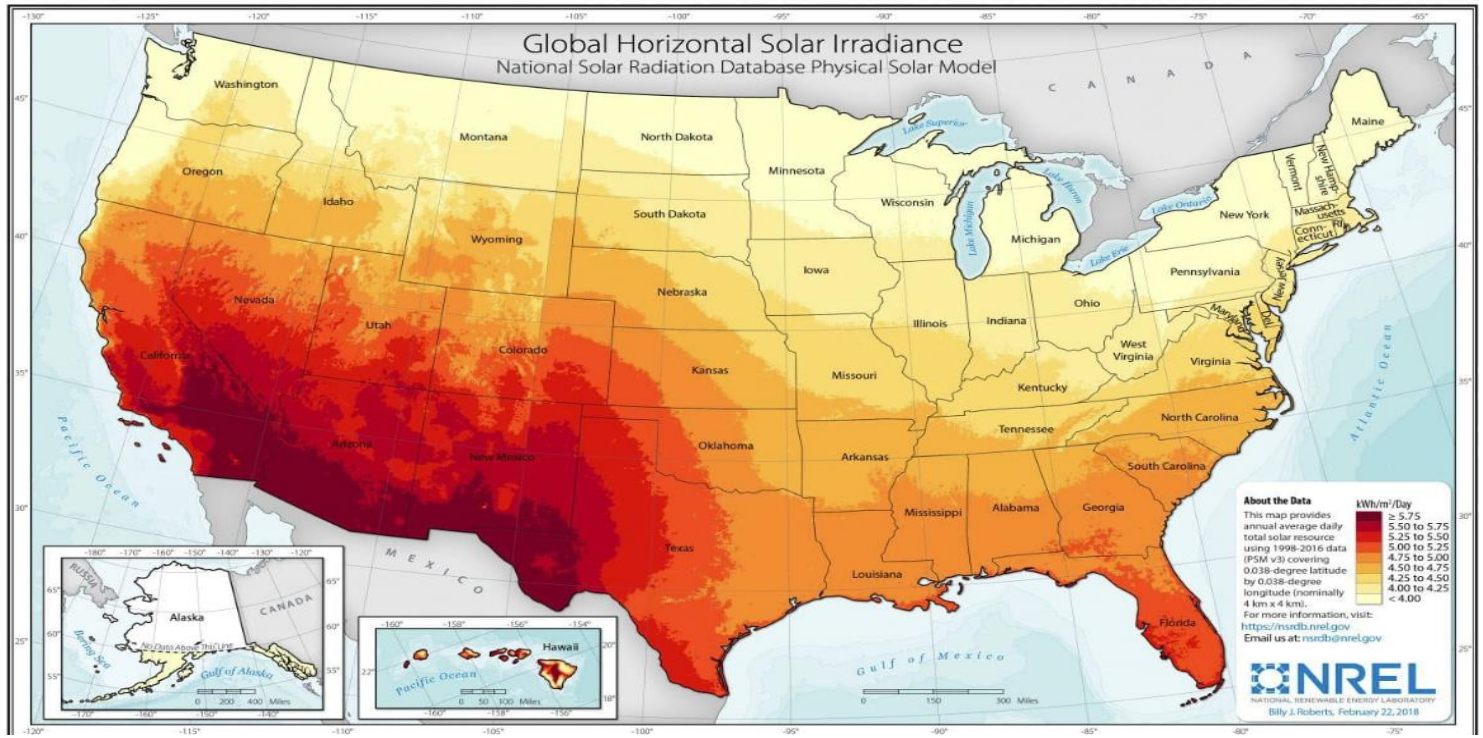
Strong Public Support and Growing Adoption: A recent survey in Iowa revealed a significant portion of the public is interested in adopting solar energy. Although only 7-8% of respondents have installed rooftop solar, 18-27% expressed willingness to do so in the near future (Agricultural Policy Review). This indicates a growing awareness and acceptance of solar energy, particularly at the residential level, which could support the expansion of distributed solar projects.



Cons:

- **Weather Challenges**: Iowa has harsh weather in winters, which include long periods of cloud cover and snow, can significantly reduce solar panel efficiency during colder months. Additionally, snowfall on panels can block sunlight, reducing energy production even further (Environment).



https://footprinthero.com/peak-sun-hours-calculator

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Buying land in Ames IA Vs New Mexico

New Mexico:

Pros:

- **Renewable Energy Policies:** New Mexico's **Energy Transition Act (2019)** sets a clear path for carbon-free electricity by 2045. This progressive policy creates a strong environment for renewable energy projects (Home)(NRDC).
- **Land Cost:** New Mexico generally offers **lower land prices** compared to other states, making it cost-effective for large solar projects (Wide land opportunities).
- **Terrain:** state offers vast open land with plenty of **flat, arid regions**, perfect for large-scale solar installations. High solar irradiance levels contribute to optimal solar energy production (Home).

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Buying land in Ames IA Vs New Mexico

New Mexico:

Cons:

- **Weather Challenges:** New Mexico's **extreme weather**, including dust storms and high summer temperatures, can pose challenges to maintaining solar equipment efficiency and worker safety (Hail) (NRDC).

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Array Parameter Tool

- Began Experimenting with the Array Parameter Tool and understanding how it works
- Took values from random data sheet to get an experimental array

		String Size			Electrical Rack Size			CB capacity			Array Design			Array Size	
				Designer Choice		portrait or Landscape									
	Location Dependent	Min Temp	4.44 C	Datasheet	Module width	3.2875 ft	Datasheet (STC)	mod/string Isc	8.38 A	Designer Choice	Racks per row	20	Designer Choice	tilt	0
				Datasheet	module height	6.5883333 ft	NEC sectic	multiplier	1.25						
	Datasheet (STC)	Voc	45.6 V					nom Isc	10.475	Designer Choice	rows per Array	20		table height proj	13.17667 ft
	Datasheet (STC)	Ref temp	20 C	Designer Choice	Rack width	20 modules	Irr.	multiplier	1.25						
				Designer Choice	Rack height	2 modules		max Isc	13.09375 A	Designer Choice	Racks removed	2	Designer Choice	row space	30 ft
	Datasheet	Temp Coeff of Voc	-0.0029 /C		Modules per rack	40									
		Temp delta	-15.56		Rack width	65.75 ft	Designer Choice: 200, 400A etc.	allowed current	530 A		Total Racks/Array	398		pitch	43.17667 ft
		temp correction	1.05		Rack height	13.176667 ft		is this disconnect A?						Space for Inverter Maintenance	ft
		V0c corrected	47.65765					strings per CB	40.47733		Total modules	15920		Array height	863.5333 ft
								Round down:	40						
Confirm possible with Panel type chosen		string voltage	1000 V					racks per CB	20	Datasheet (STC)	module capacity	385 W		Array width	1315 ft
	Designer Choice: 600, 1000, 1500, 2000V	String size	20.98299											Ground Coverage Ratio	0.30518
		string size	20								dc capacity	6129.2 kW			
		Actual String Voltage	953.2							Designer Choice	inverter capacity	4400 kW			
												MVA			
										Provided: Industry standard 1.3	ILR	1.393			
		Input Information =													

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THANK YOU

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