SOLAR Power Systems

Where To Start

Introduction

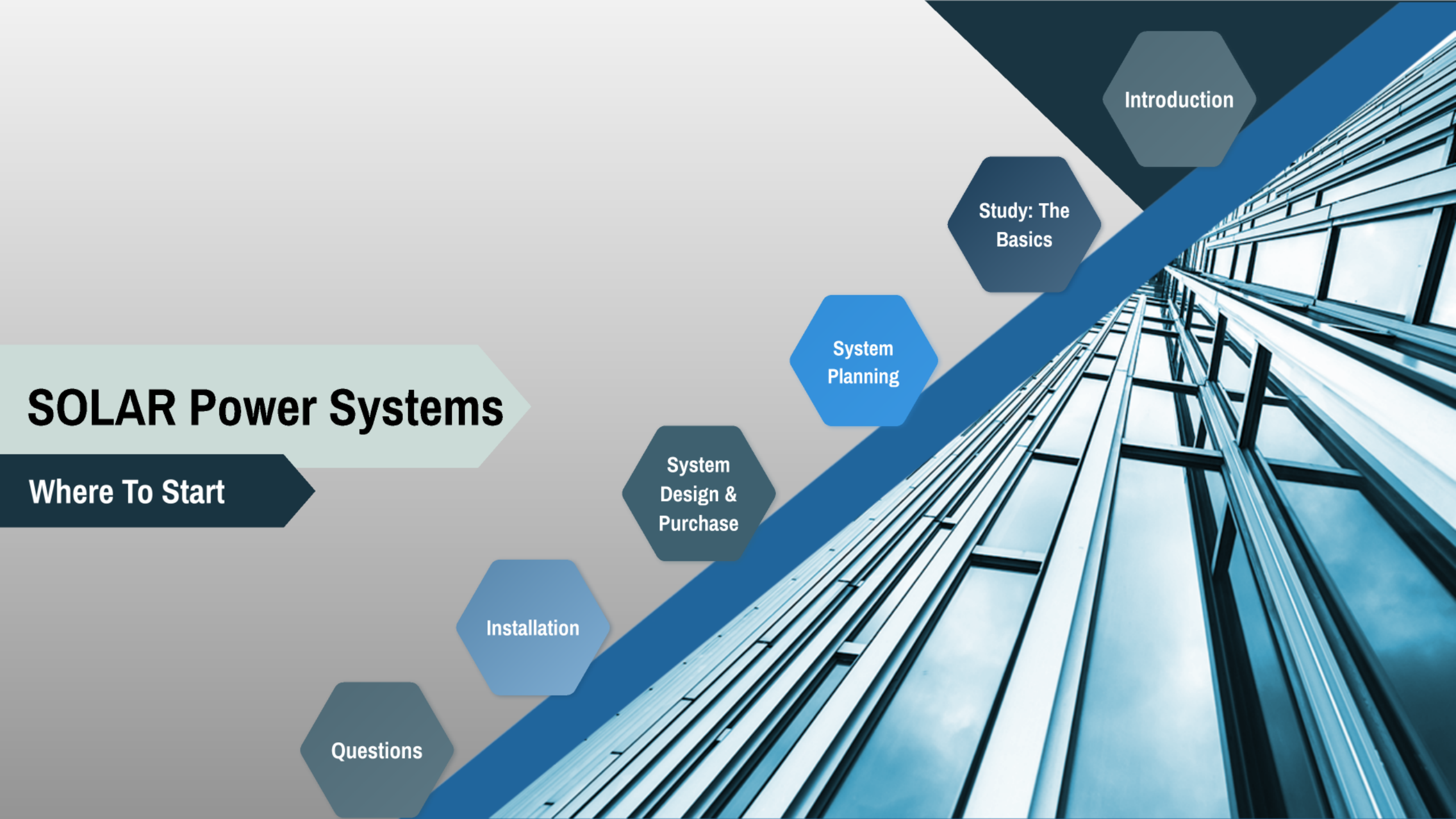
Study: The Basics

System Planning

System Design & Purchase

Installation

Questions



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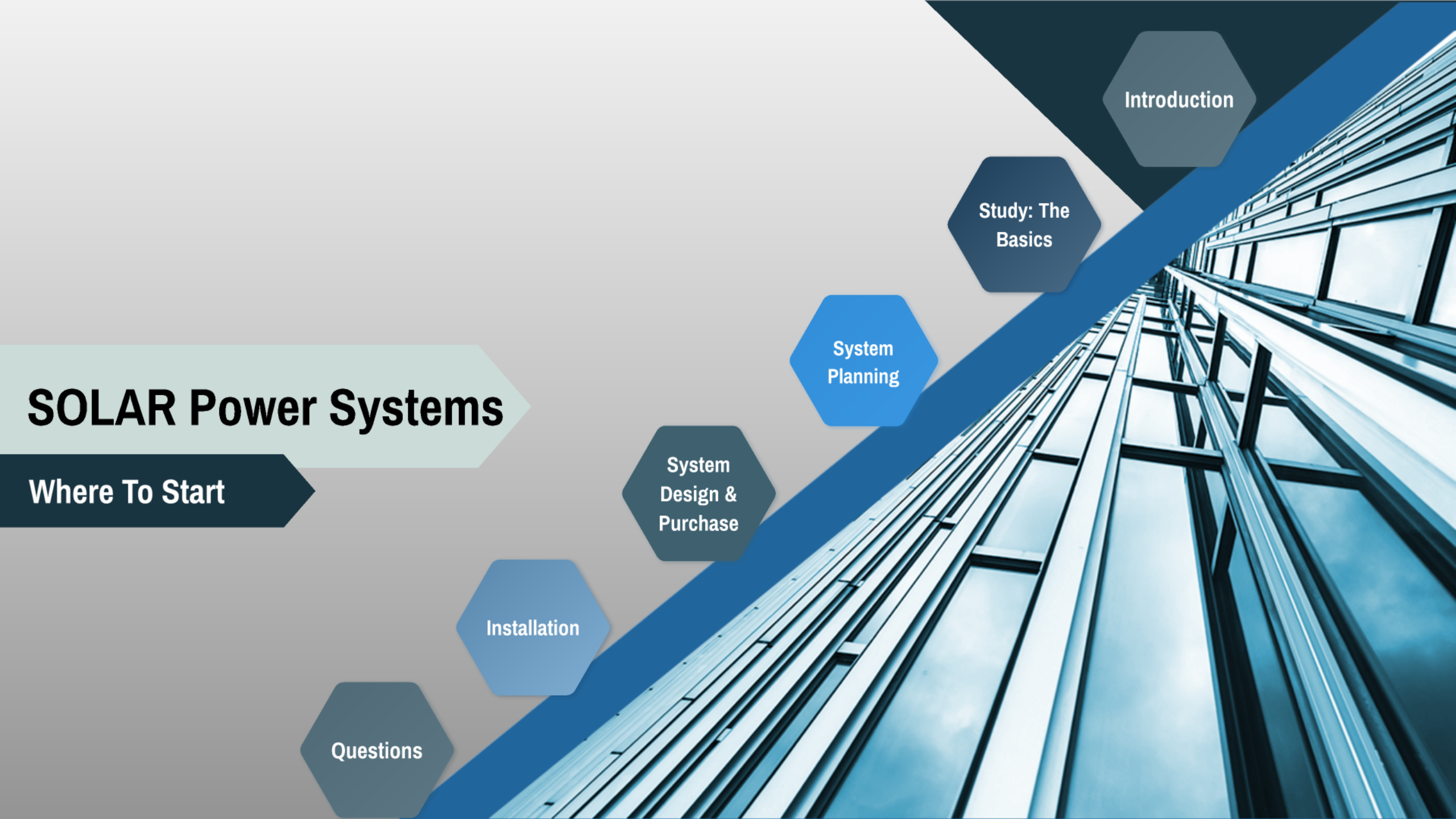

Who am I?

- Worked in Architecture profession for 17 years
- Left the city to persue country living after studying Sister White's and the Bible's direction on this topic
- Stayed at home and worked our land while homeschooling our two daughters
- Started a YouTube channel and internet marketing business for extra income
- Started investigating solar for my home and saw that the greatest expense was having it installed
- Researched how to install a solar system on my own, talked with friends who have systems, asked questions of a local solar equipment distributor, watched YouTube videos, talked to an electrician, and read a lot of articles.
- Purchased the equipment and installed my first system in November of 2021
- Have now installed 4 total systems and am a partner with the solar company the I originally purchased the equipment from
- Currently have 45 videos on those solar systems with over 3 million views if you need additional information and help

Presentation Parameters / Notes

- Assuming you will DIY your system
- Will not cover small portable solar generators
- Will not cover dealing with solar installation companies but this presentation will help you be more informed about what to ask them if you choose to hire one

- DIY still allows you to obtain the Federal Tax Credit! Current credit is 30%

Keep in mind....Solar is not for everyone!!

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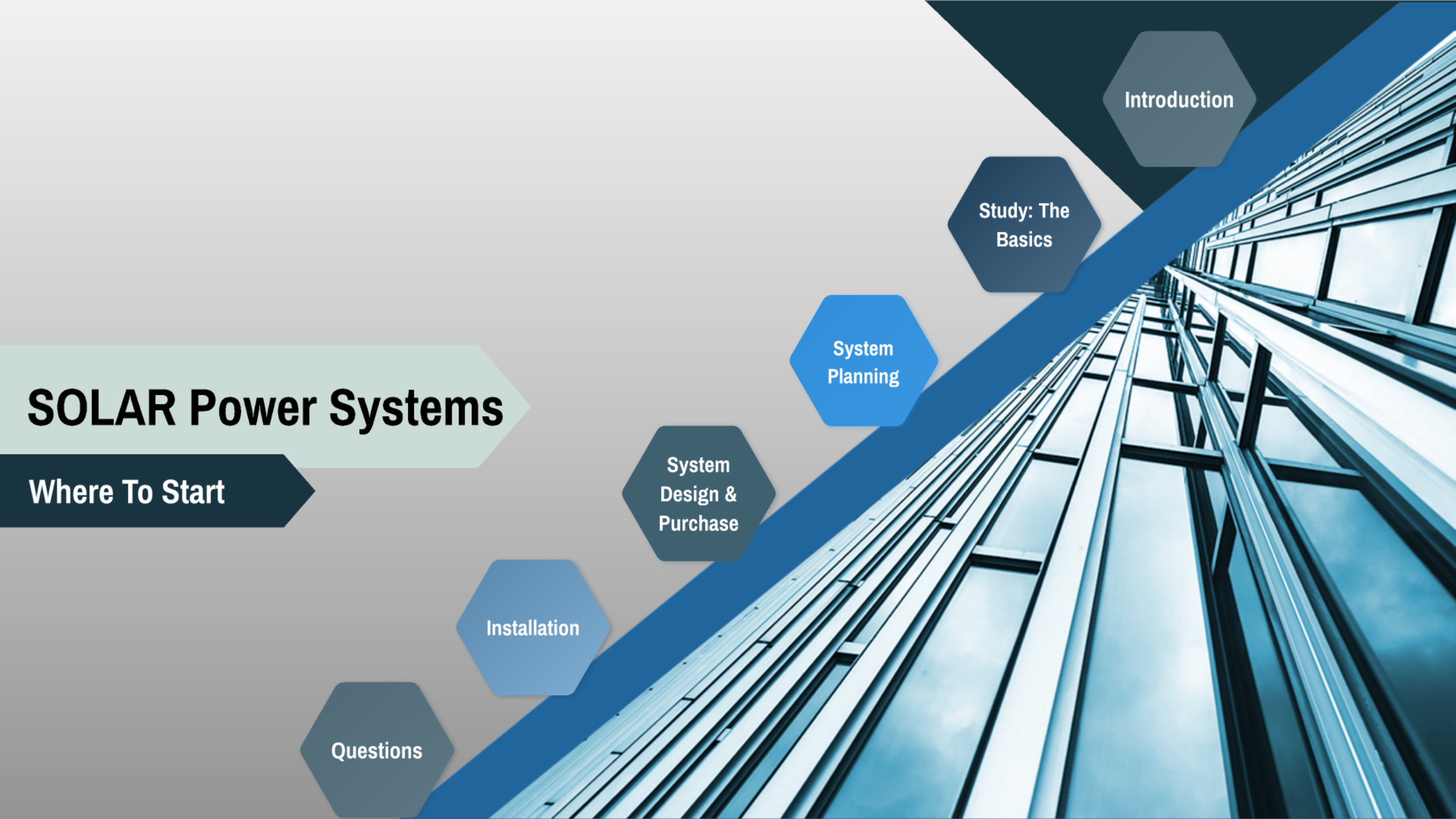

Genesis 1:16 God made the two great lights, the greater light to govern the day, and the lesser light to govern the night; He made the stars also. 17 God placed them in the expanse of the heavens to give light on the earth, 18 and to govern the day and the night, and to separate the light from the darkness; and God saw that it was good. 19 And there was evening and there was morning, a fourth day.

What To Study First?

What Are Your Needs?

How Do You Want To Live?

*It is very important to understand what your needs and limits are before purchasing the very first panel!

Do It Yourself?

What Do You Need?

Study Topics

Research & Study

If you are not comfortable doing your own electrical work, please consult with an electrician!!!

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Study Topics

Study and Ask First

1. **Familiarize yourself with basic electrical principles**

   AC vs. DC Power | Positive/Negative, Split Phase (240v L1 & L2), Single Phase (120v) , Neutral & Ground Conductors (Wires), Loads | What are Amps, Volts, Ohms, and Watts

2. **Safety, Safety, Safety**

   Checking connections, Not bridging connections, Short circuits, Power Off!, Where are the utilities buried?, How to work in an electrical panel, Overcurrent protection, Overvoltage protection

3. **Codes, Insurance, and Legal**

   Check to see what you can DIY in your jurisdiction

4. **Math**

   Amps x Volts = Watts, Watts/Volts = Amps, Etc.

5. **Where will I put the system?**

   Do I have the space for panels?, Do I have the space for batteries and inverters in my home or another structure?

6. **How much power do you need?**

   What does your house currently use?, What appliances do you have?, How big is your home?, Do you have other structures that need power?, Do you have other sources of energy like propane?, Etc.

Equipment Terminology

Study and Ask First

1

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What does your house currently use?, What appliances do you have?, How big is your home?, Do you have other structures that need power?, Do you have other sources of energy like propane?, Etc.

Inverter: device that converts direct current (DC) to alternating current (AC) which is what our homes use.

MPPT Solar Charge Controller: controls the incoming DC power from the panels to the batteries.

Solar panels: collect energy from the sun that is absorbed by the PV cells in the panel which creates electrical charges.

Battery: a device that stores chemical energy and converts it to electricity (DC).

- How big is your home?
- Do you have alternative heating?
- What appliances do you have/want to run?
- Do you have additional energy sources like propane?
- Get a kill-a-watt meter and an Emporia Vue (video) to monitor and calculate how much energy you are using.
- Look on your electric bill for total energy usage per month. (You still need to find peak demand)
- In 2023, we used 10300kWh of energy or an average of 28.2kWh/day.

What Are Your Needs?

Our Home

42 yrs old, 1800 sf, poorly insulated, wood stove

Solar is not like the Grid

- Living with solar is not like living on the grid 80% of the time
- If you have a small to medium sized system (2kw to 10kw), you must understand your house loads and not run all of them simultaneously
- Monitoring your system is important
- Explore adding alternate sources of energy like propane for your stove, etc.

Live a modern lifestyle or a "primitive" lifestyle?

We will have to live primitively one day but why not take advantage of technology now.

How To Live With Solar

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How To Live With Solar

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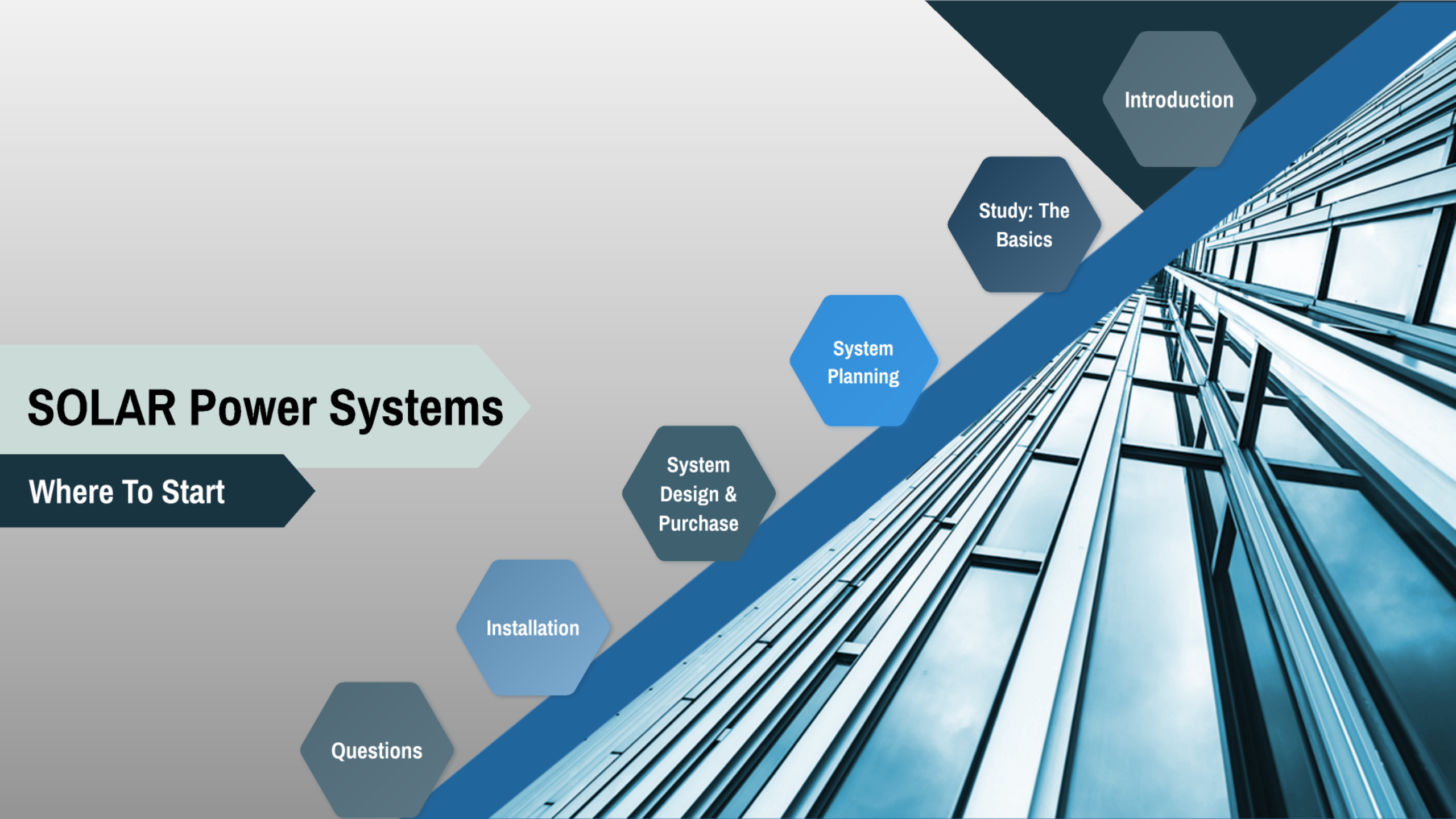

Solar System Types

System location

Budget

System Planning

System Types

1 Grid Tied System

- No battery backup.
- When the grid is down you don't have any electricity.
- You can sell back to the electric company for credit (usually not $1 to $1 and shrinking)

2 Hybrid System

- Battery backup
- Works when the grid is down
- You can sell electricity back to the grid

3 Off-Grid System

- Independent of the grid
- Battery for nightime and cloudy day use
- Cannot sell electricity back to the grid

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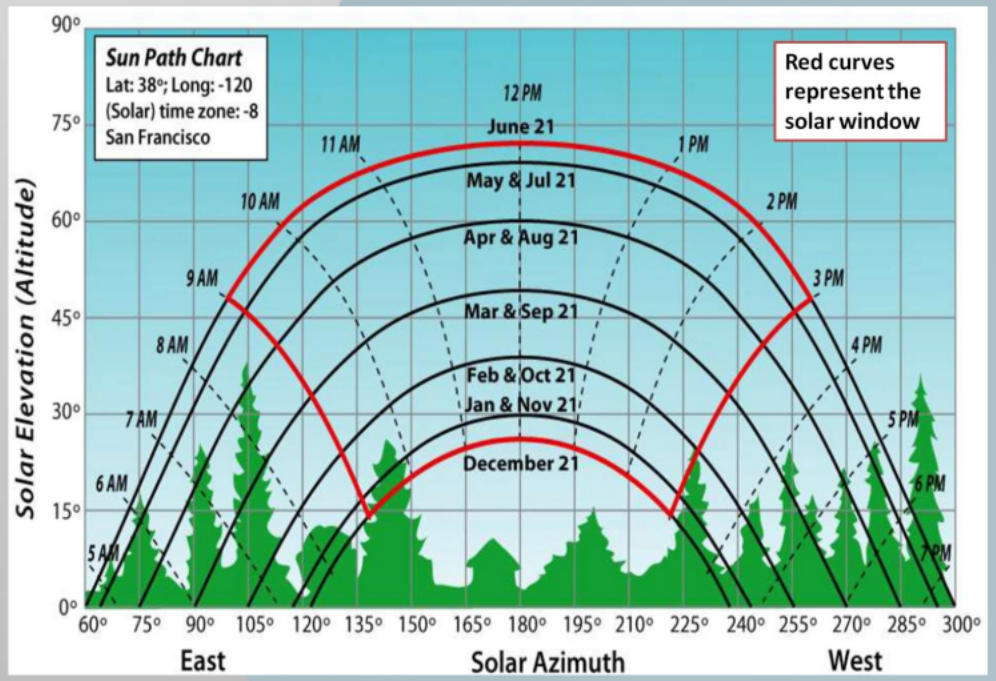
Locating panels

Locating Equipment

System Location

Observe your property!

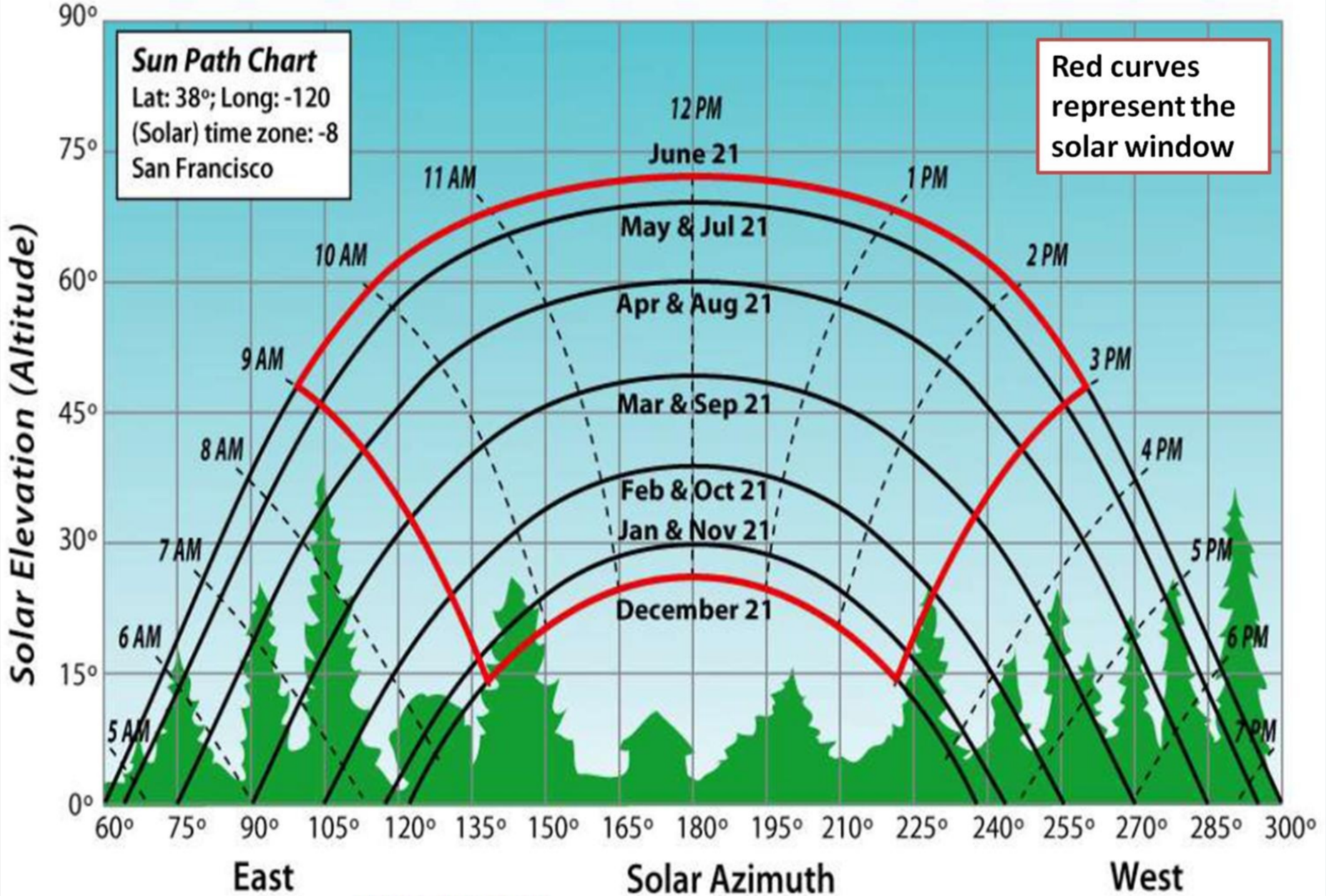


Sun Path

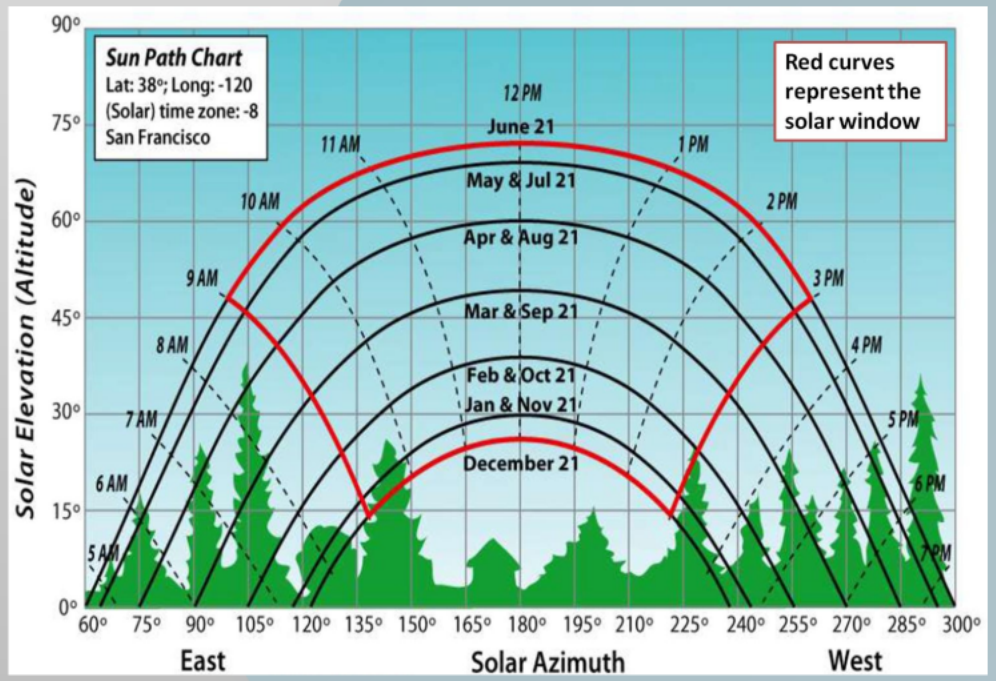
Careful Placement

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

This will give you your average number of sun hours per day for your location. It will also break it down by month. We average 5.37 in my area. In December it is only 3.71 and in July it is 6.37.


Sun Path Chart
Lat: 38°; Long: -120
(Solar) time zone: -8
San Francisco
Red curves represent the solar window
Solar Elevation (Altitude)
90°
75°
60°
45°
30°
15°
0°
12 PM
June 21
11 AM
1 PM
May & Jul 21
10 AM
2 PM
Apr & Aug 21
9 AM
3 PM
Mar & Sep 21
8 AM
4 PM
Feb & Oct 21
Jan & Nov 21
7 AM
5 PM
December 21
6 AM
6 PM
5 AM
7 PM
60° 75° 90° 105° 120° 135° 150° 165° 180° 195° 210° 225° 240° 255° 270° 285° 300°
East
Solar Azimuth
West

Observe your property!



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Where is the best place in your home?

- A closet?
- A garage?
- A utility room?
- A basement?

Where?

- Equipment gets hot - Needs a conditioned space. There are temperature operating parameters for inverters and batteries

- Ample space surrounding equipment is necessary

- Equipment must be mounted on non-flamable surfaces (concrete board, Hardie board)

- Must have a strong floor to support batteries

Dependent upon:

- How much power do you need?
- What are your electrical loads?
- How big is your house?
- Will you start small and scale up?

Cost can vary so much. It is hard to nail down!

$5k to $100k

Do what is appropriate and do not incure and debt!

Proverbs 22:7 The rich ruleth over the poor, and the borrower is servant to the lender.

System Budget

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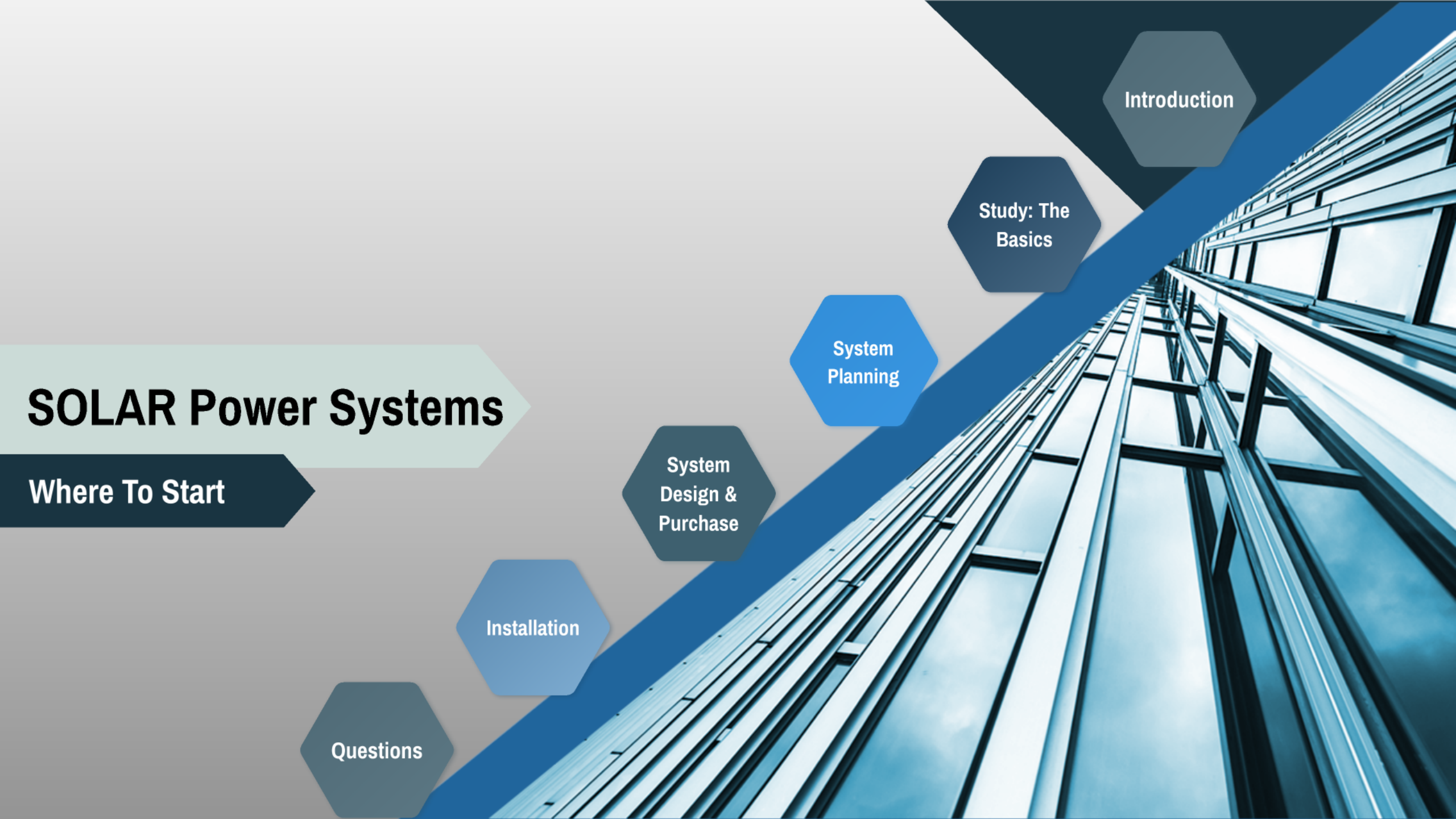


Design

Purchase

System Design & Purchase

Probable Parts

- Inverters
- Panels and a panel rack or mounting system
- Batteries
- Battery Rack - Optional
- Photovoltaic (PV) Disconnect Switch
- PV Combiner Box with DC Circuit Breakers
- MPPT Solar Charge Controller if not included in an All-In-One Inv.
- Breaker sub-panel (electrical panel)
- WIRE! PV wire, Battery cable, AC conductors
- Buss bars - for battery connections
- Wire connectors like ferules, lugs, ring connectors
- Roof mount rapid shutdown switches
- DC breakers for battery shutdown and protection
- Conduit

System Component Options

System Scaling

System Needs

System Design

Inverter Types:

- Split phase 120v/240v (or 2 phase) stackable (expandable)
- Single phase 120v stackable
- Single phase 240v stackable with a transformer to split
- All In One, Hybrid, Grid Tie, Off Grid
- Mostly all are 48v. Some are 24v and 12v

Battery Types:

- Lithium Iron Phosphate LiFePo4
- AGM (Absorbed Glass Matt)
- Lead Acid (sealed)
- 12 volt, 24 volt, 36 volt, or 48 volt

You can start with one inverter, a few panels, and a couple of batteries.

Inverters can be added (or paralleled) with each other. Single phase inverters (120v) must be added in pairs. Split phase inverters can be added in any combination (1, 3, 4, 7, 15).

Your battery bank can always be added to (up to 16 per inverter in most cases).

Panels of similar wattage can always be added (until the max voltage of an inverter mppt is achieved).

Just these two power my whole house! 12kw

System Scaling

Your house elec loads/ needs will determine:

- the number and size of inverters
- the number of panels
- size of wire, breakers, etc.

Your nighttime or inclement weather needs will determine:

- the number of batteries (if off-grid)
- battery cable size

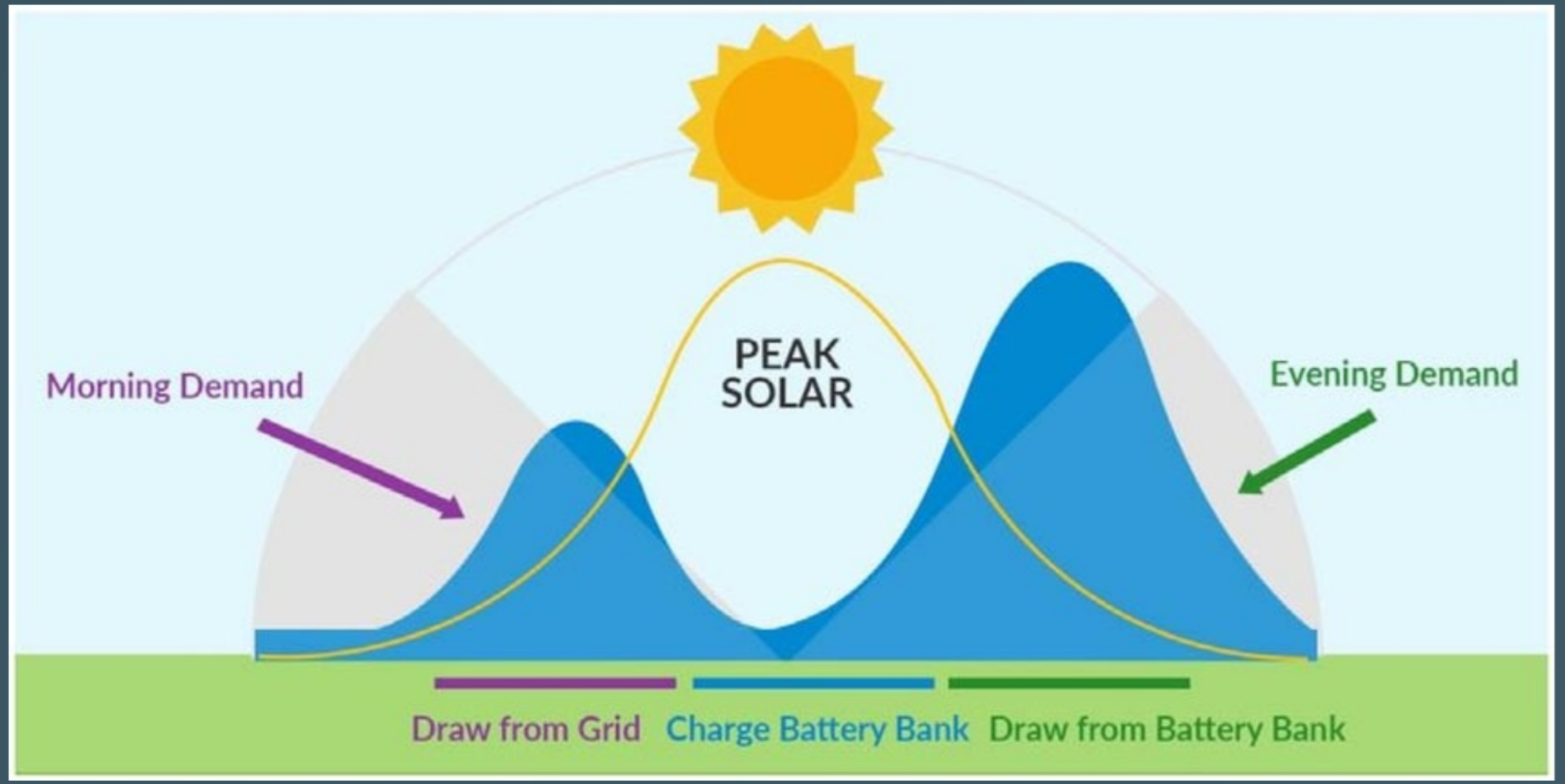
Your climate will determine:

- panel voltage fluctuations
- sun hours

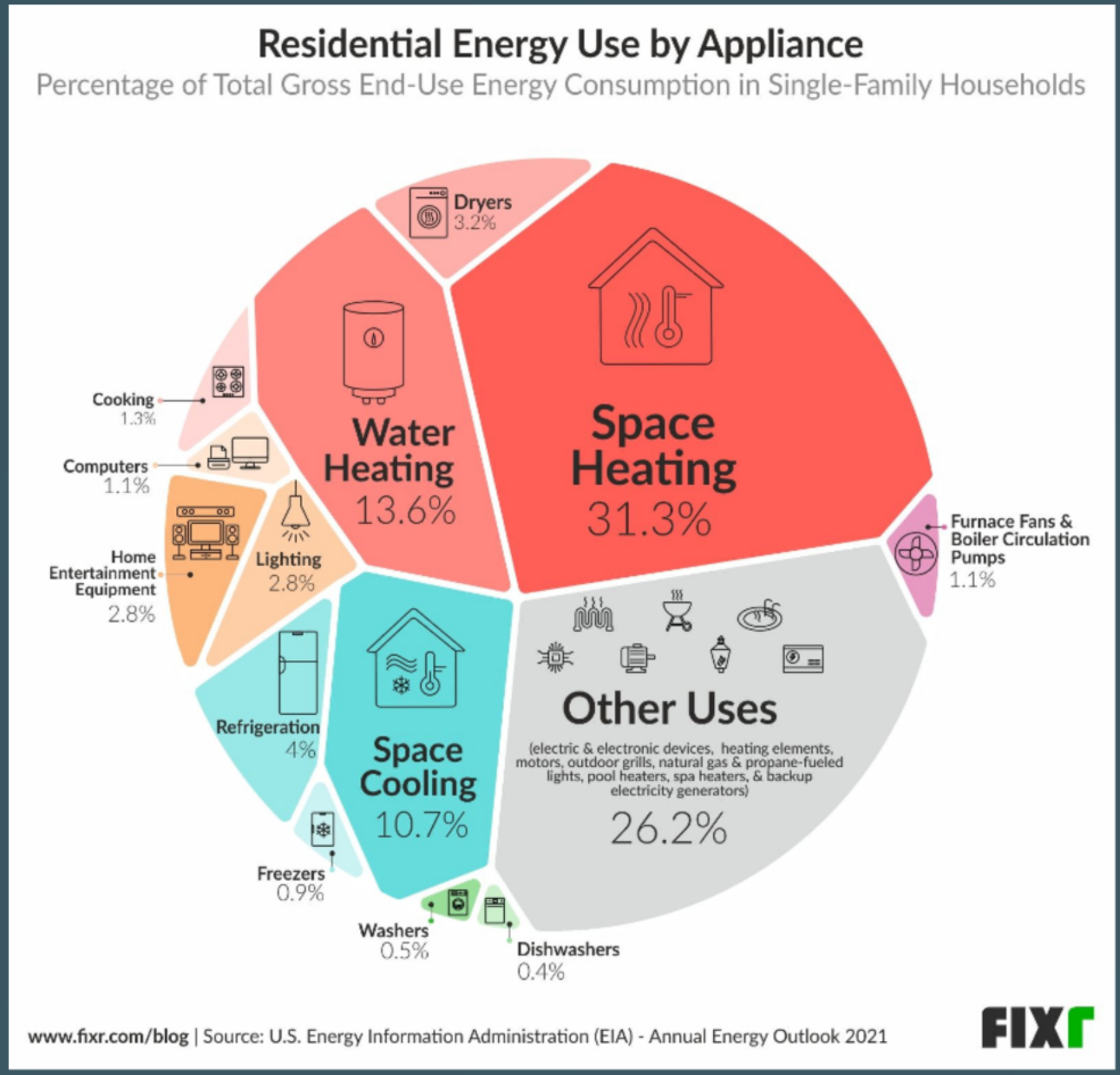
Sizing Considerations

System Needs

Typical Daily Home Load Demand



Typical Household Loads



Typical Household Appliance Loads

Table: Energy use by appliances, estimated usage based on a single person.

Item	Power (W)	Usage per year (h)	Energy use (kWh/ year)	Annual cost ($)	GHG emissions (kg CO_2)
Water heater	4000	450	1800	270.00	1260
Electric furnace (home heating)	6000	183	1098	164.70	769
Air Conditioner	3500	200	700	105.00	490
Space heater	1500	200	300	45.00	210
Fridge	180	1500	270	40.50	189
TV, 42", plasma	270	1000	270	40.50	189
Clothes dryer	3000	78	234	35.10	164
Cable TV box on standby	25	7700	193	28.88	135
Oven	2400	73	175	26.28	123
Stove top (hob)	1500	104	156	23.40	109
5 x CFL lightbulbs (18 W)	90	1700	153	22.95	107
TV, 42", LED	130	1000	130	19.50	91
Game console - PS4	115	1000	115	17.25	81
Desktop computer	100	1000	100	15.00	70
Game console - Xbox One	90	1000	90	13.50	63
Hair Dryer	1500	57	86	12.83	60
Kettle	1500	48	72	10.80	50
Toaster Oven	1200	60	72	10.80	50
Toaster	1200	57	68	10.26	48
WiFi router	6	8760	53	7.88	37
Game console - Wii U	30	1000	30	4.50	21
Vaccuum cleaner	1400	20	28	4.20	20
Rice Cooker, 1 cup	200	52	10	1.56	7
Laptop - 54 Wh battery*	54	180	10	1.46	7
Cell phone - 10 Wh battery*	10	365	4	0.55	3
Coffee Grinder	75	12	1	0.14	1

*Laptop and cell phone usage per year is expressed as number of charges rather than number of hours.

EX: Running the water heater, furnace, oven, and lights at the same time would require an inverter(s) that could handle an output of about 12500 watts or 12.5kw.

If you were doing these activites at night for 1 hour, it would drain 2.5 - 5.12kWh batteries.

If you were doing these activities in the day time, it will take away 12.5kw from charging your batteries.

They may not charge at all if you only have 12.5kw of potential panel output.

How To Purchase

- Search out reputable suppliers
- Find suppliers with the brands that you want
- Search out suppliers with all parts/ equipment in house
- Search out suppliers that are local to reduce shipping costs
- Search for the best prices on brands
- Search out suppliers that sell used equipment

Purchasing Solar

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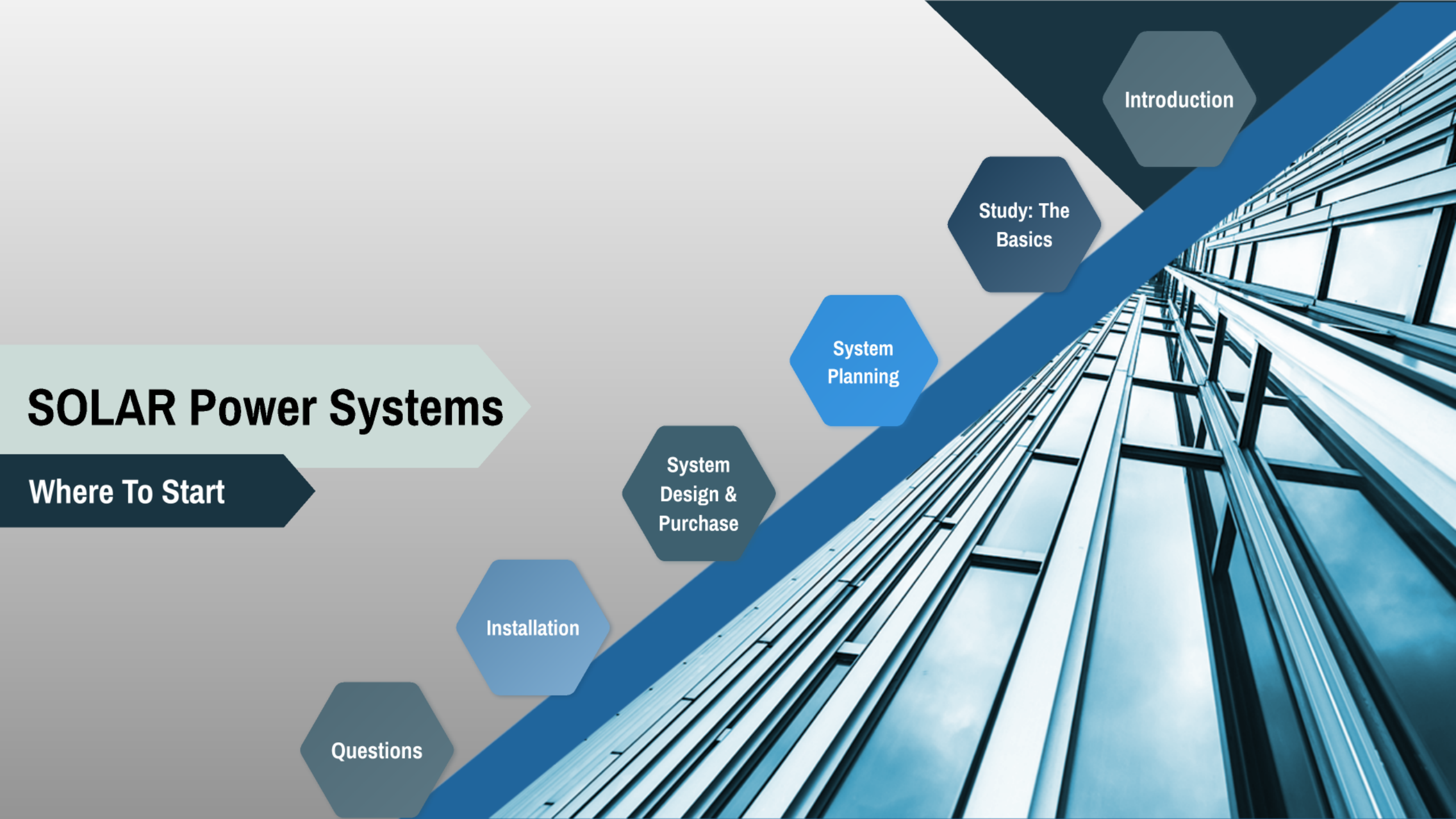

Steps (recommended order)

- Plan, Plan, Plan!
- (Gain permits if needed, check with insurance company)
- Orient panels in a Southerly or South-Westerly direction and at the optimal angle for your latitude
- Consult with an electrician if needed
- Build your racking then run conduit
- Calculate wire & buy 20% extra
- Mount equipment w/ proper spacing
- Connect wiring to all components
- Turn it on!!

Installation

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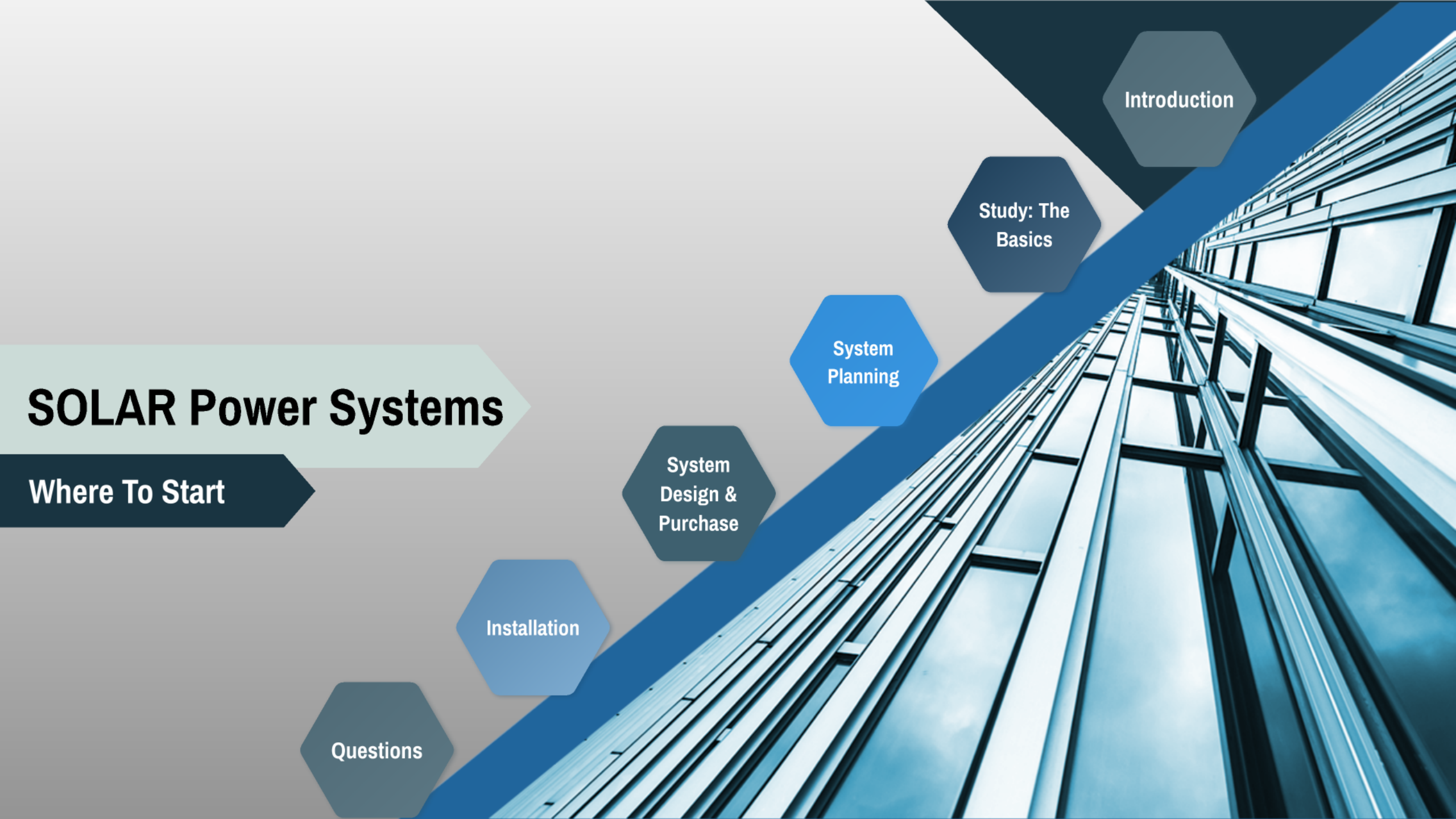

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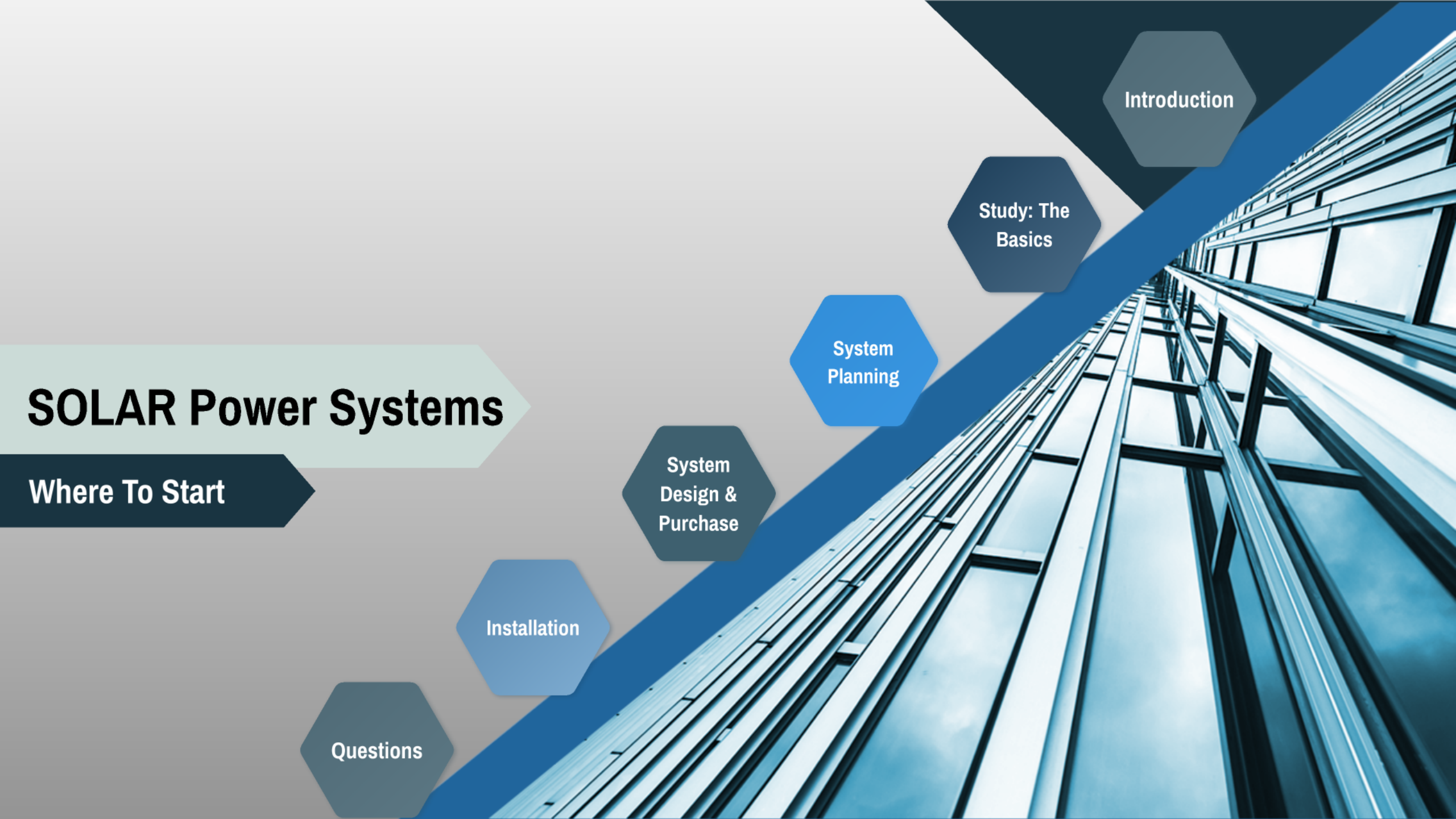

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