How To:
Marine Solar Panels for your Boat

Presented by:
Jeff Cote

Pacific Yacht Systems
marine electronics & electrical

design • installation • service • support

p| 604.284.5171 w| www.pysystems.ca a| 1641 Powell Street, Vancouver BC

Passion for Boating

- Systems Design Engineer
- Owner/operator of Pacific Yacht Systems
- NMEA & ABYC certifications
- Published monthly columns
  - Pacific Yachting Magazine: Tech Talk
  - Northwest Yachting Magazine: Hot Wire
- Favorite BC cruising grounds are Barkley Sound and the Broughton Archipelago

About Pacific Yacht Systems

- Specialize in marine electrical and electronics
- Servicing British Columbia and Western Canada
- Worldwide electrical design / consultation
- 2019 Recap:
  - Completed over 1000 boat projects
  - Designed / consulted on over 200 electrical projects
- Over 150 “How To” PYS Videos on YouTube
- www.pysystems.ca for schematics, design info, published articles, etc…

Different Charge Methods

- Ways to create power
  - Charger(s)
  - Alternator(s)
  - Solar
  - DC Genset
  - Wind

Conceptual Diagram – DC Overview

Fuse Block

Fuel Cell

Inverter

Service Disconnect

DC Panel

Solar Controller

Isolator

Combiner

Windlass, Thruster, Etc...

Alternator

DC Gen, Wind Turbine

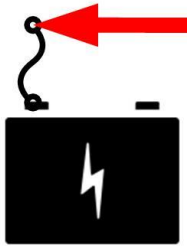
Charger

Fuse Block

Un-Switched Dist

House Switch

Switched Dist



House Battery

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Solar Panel Possibilities

- Staying an 1-2 day at anchor
- Offsetting the fridge loads
- Recharging the batteries
  - Without any noise, vibration, smoke
- Running a genset LESS or NOT at all
- Sailing between anchorages
  - Batteries recharging

Northwest Advantages: Better Solar Output

- Peak summer months:
  - 15 + hrs sunlight/day
- Relatively sunny days during summer

Solar Innovations

- Flexible panels: similar Wattage per area to rigid panels

Flexible Solar Panels

- Lightweight
- Mounted on:
  - cabin roof (no air gap needed)
  - canvas (bimini, dodger, cockpit enclosure)
- Zippers, grommets, velcro, snaps, adhesive, peel & stick

Prepping for Dodger Install

Hard Top:
Flexible Solar Installation

Flexible Solar: Dimension Examples

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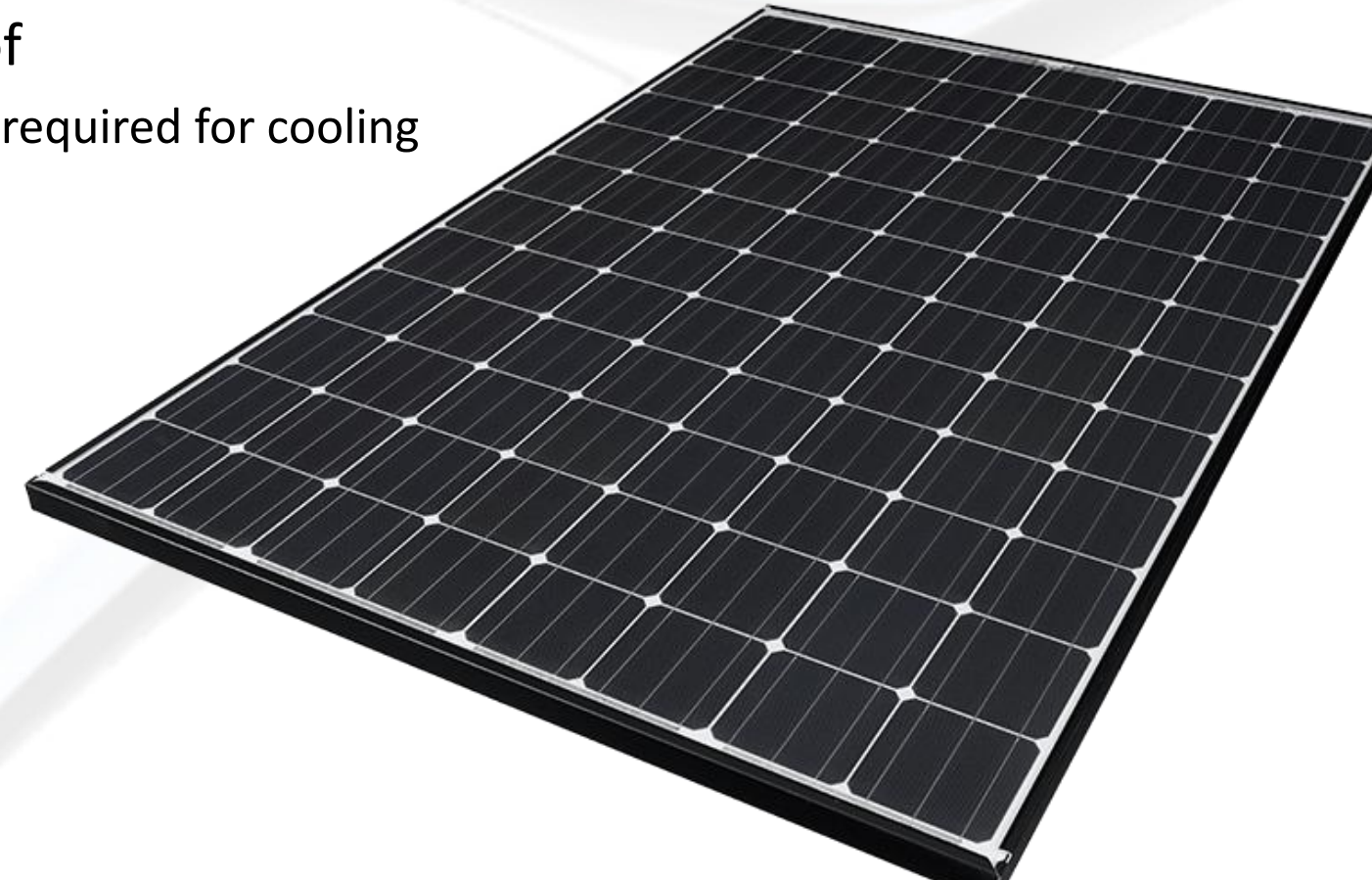
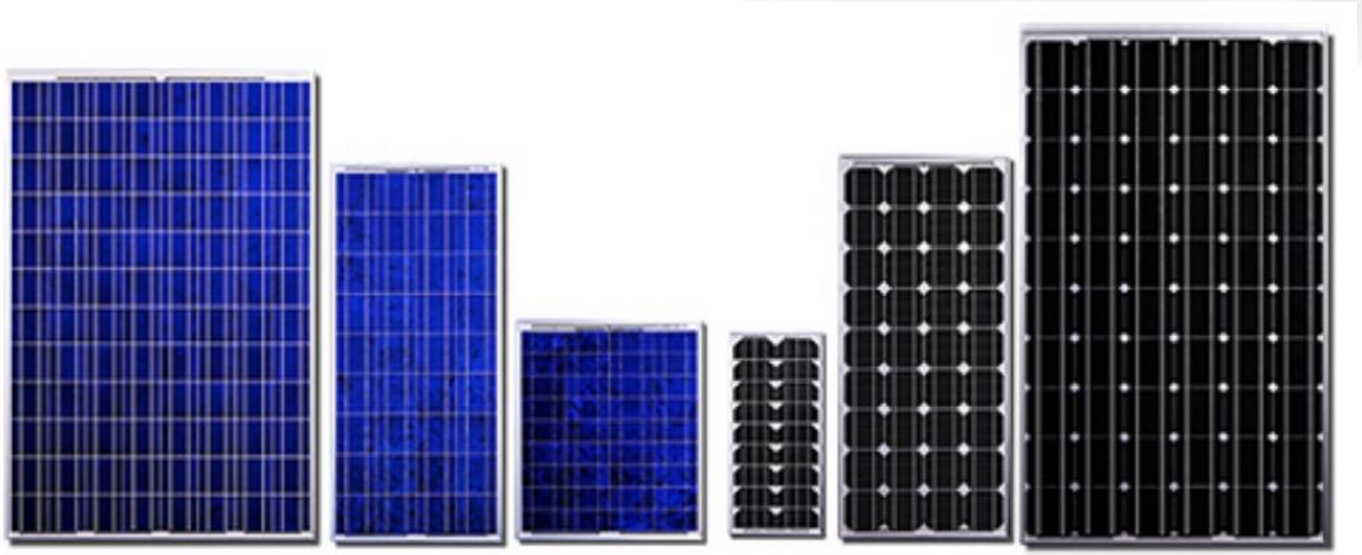
Rigid Solar Panels

- Mounted on:
  - Cabin roof
    - Air gap required for cooling
  - Arch
  - Railings



Rigid Solar:
Dimension Examples



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Solar Panel Choice: Mono or Poly?

- Monocrystalline cells
  - Highest efficiency
- Polycrystalline cells
  - Best value

Solar Power Efficiency Defined: Poly vs Mono

What do the different efficiencies mean?

- The efficiency of the panel is included in the wattage rating
  - a poly 100W panel **larger >** than a mono 100W panel
  - both will produce the same energy

Solar Trawler

What Makes a Great Panel?

- Quality of encapsulation: EVA (Ethylene vinyl acetate)
  - Prevents yellowing <- similar effect to shading
- Connections between cells: silver alloy
- Redundant pathways between cells
- High end solar cells
- Visual and tactile inspection
- Test individually (in-house) for 24 hr before shipping
  - Xenon Sun Lamp

Aft of Center Cockpit

How Many Watts Needed?

- Typical solar array goals:
  - Keep batteries top-off
  - Offset daily Ah (amp-hour) consumption
  - Offset refrigeration
  - Extend your time at anchorage:
    - e.g. 3 days instead of 2 days

Battery Monitor:
Know your Daily Ah Consumption

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Catamaran Installation

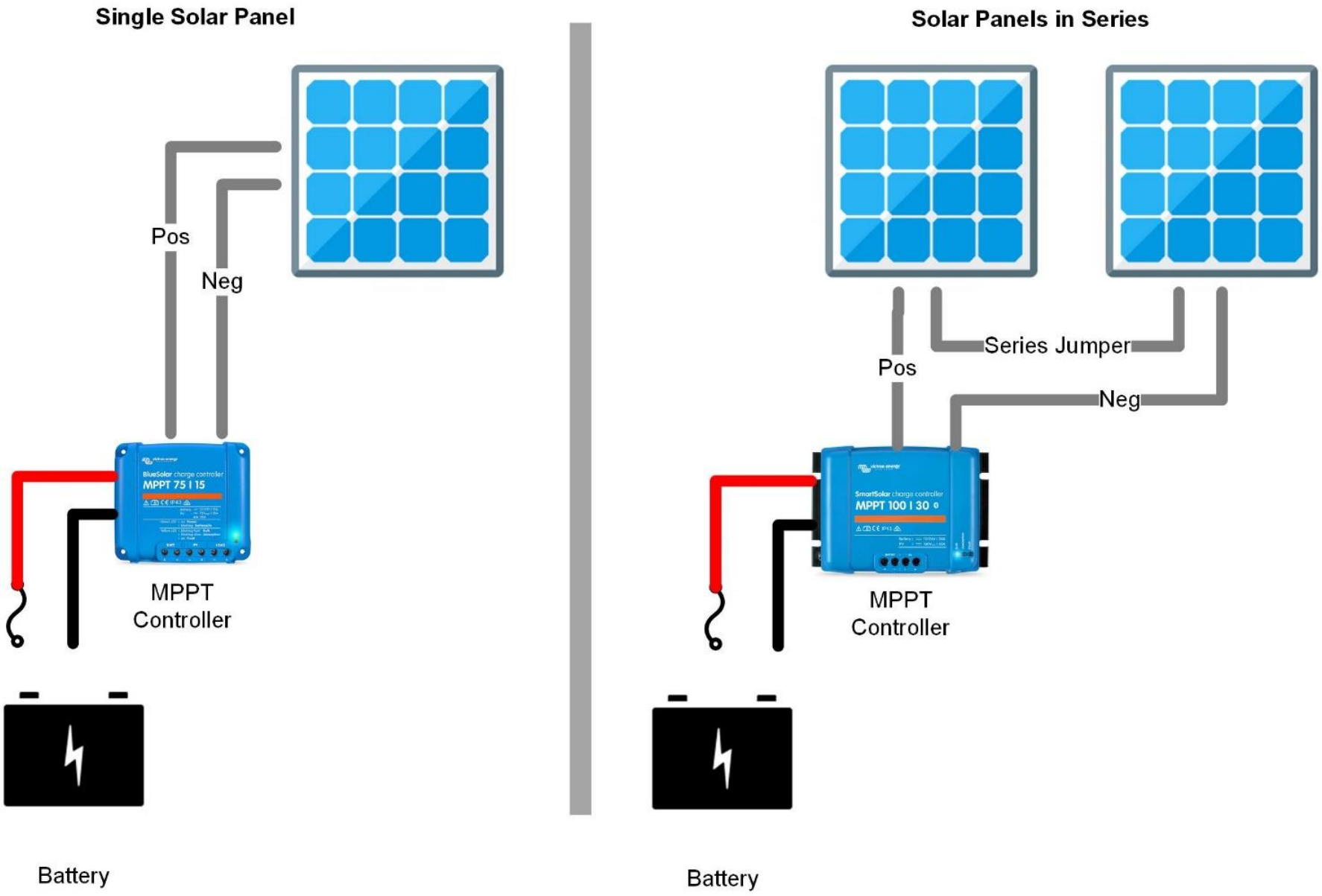
Sample - Quick Calculation

- Daily Solar Panel Output:
  - Watts X 25% or Watts / 4
  - E.g. A 100 Watt panel will produce 25 Ah/day
    - 100 X 25% = 25 Ah/day

- Optimistic: factor of 3 or 33 Ah/day
- Conservative: factor of 5 or 20 Ah/day

Surface Mount: Adhesive

Hardtop Installation: Peel & Stick



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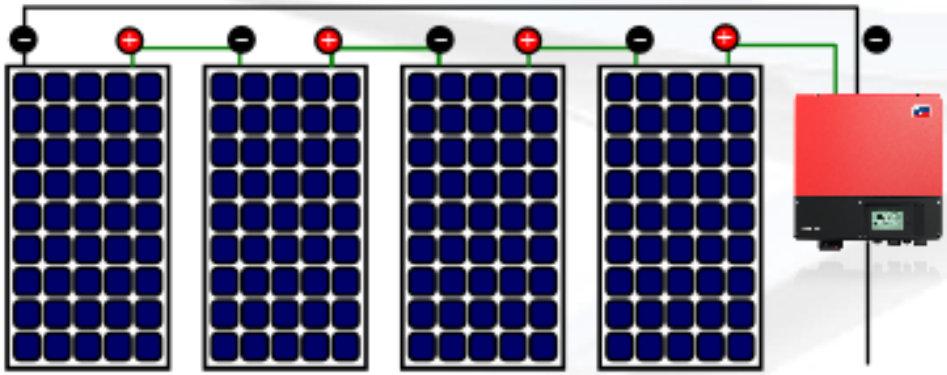
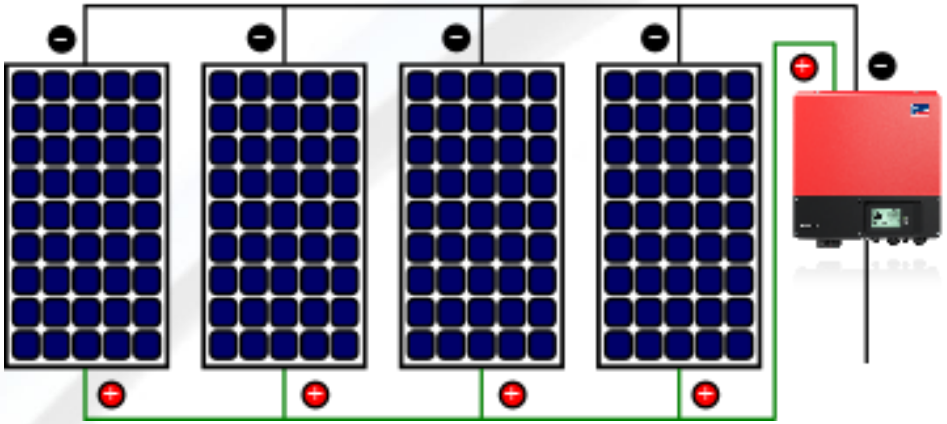
Solar Panel: Series vs Parallel

Wiring Solar Panels in a Series Circuit



Wiring Solar Panels in a Parallel Circuit



Make it Pretty: Wire Loom

Solar MC4 Connectors Disassembled

Solar MC4 Connectors

Cable Entry

Solar Panels Recap

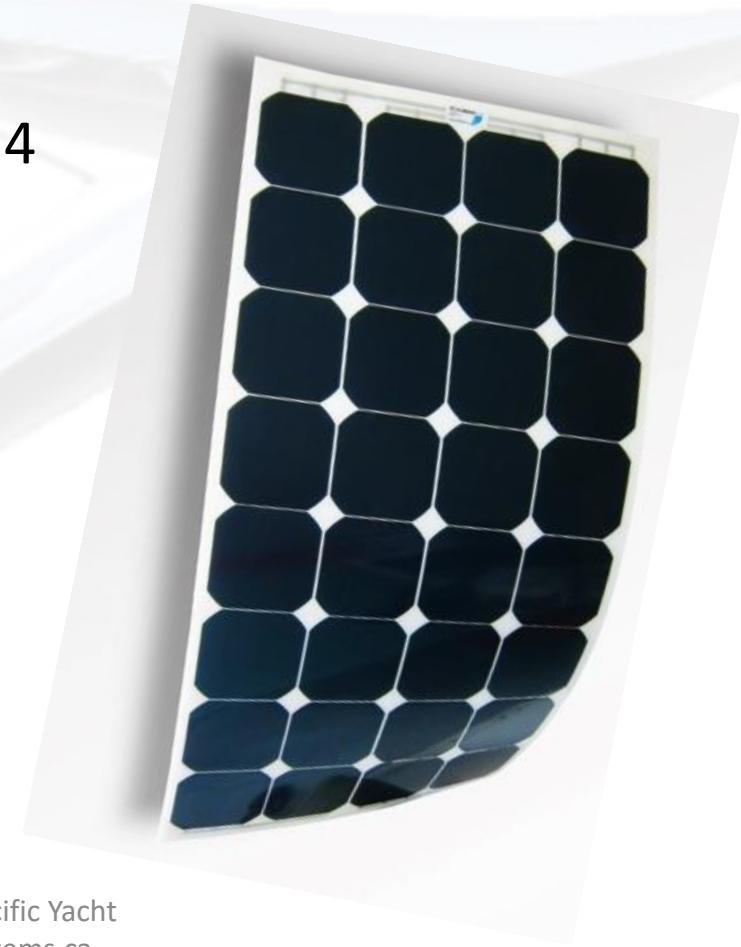
- Size solar panels for
  - Keep batteries topped-off
  - Offset refrigeration
  - An extra day at anchor
  - Daily Ah demand
- Mount options:
  - Flexible: canvas, hardtops
  - Rigid: arch, railing, stainless tubing
- Installation:
  - Use outdoor rated solar wiring
  - Use MC4 connectors

Selecting Solar Panels Tips

- Create templates (mock-up) to fit on your boat
  - E.g. 26” X 54”, 35” X 42”, etc…
- Give about 2” around all the edges for zippers
- Decide where the cabling will enter the boat

Solar Panels Purchasing Tips

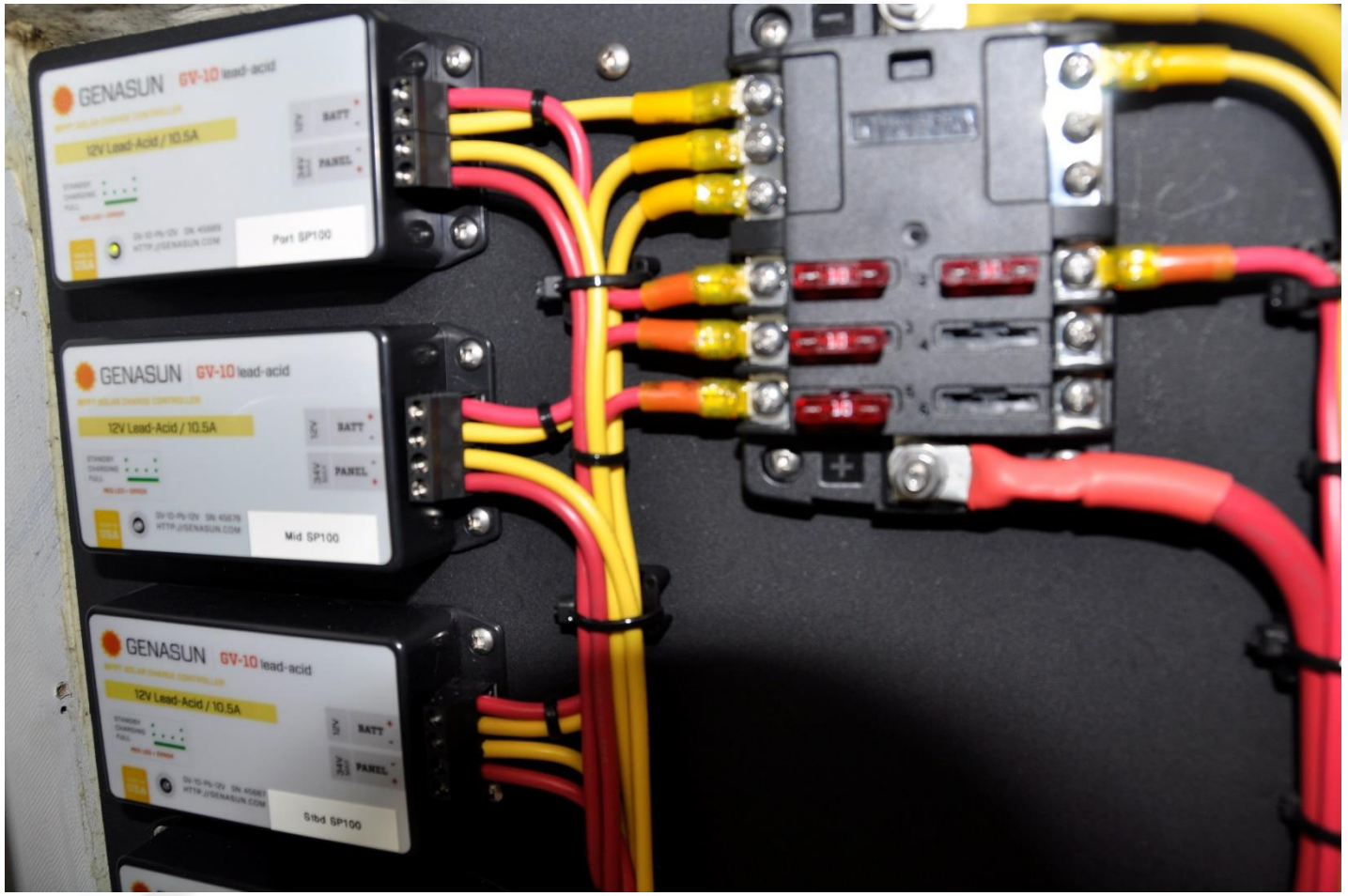
- Daily output estimate:
  - Short-hand formula: wattage / 4
- Quality
- Shading “by-pass diodes”
- Mono vs Poly
- Popular flexible models
  - Gioco, Solara, Solbian
- Rigid models
  - Lots of selections



Solar Controllers: PWM vs MPPT

- Definition:
  - PWM (Pulse Width Modulation)
  - MPPT (Multi Power Point Tracking)
- Differences
  - MPPT are more efficient (up to 30% more) then PWM
  - MPPT $$ vs PWN $
  - MPPT allows for higher input Voltage
    - series wiring
  - Some MPPT models provide boost Voltage

MPPT Wiring


GENASUN GV-10 lead-acid
12V Lead-Acid / 10.5A
BATT
PANEL
Port SP100
GENASUN GV-10 lead-acid
12V Lead-Acid / 10.5A
BATT
PANEL
Mid SP100
GENASUN GV-10 lead-acid
12V Lead-Acid / 10.5A
BATT
PANEL
Stbd SP100

Solar MPPT: Purchasing Tips

- Battery Voltage
- Maximum solar array Amperage
- Maximum solar array Voltage
- Battery chemistry
  - FLA, AGM, Lithium, custom

MPPT
75 Volts / 15 Amps

Genasun – GV-10 LA

MPPT
100 Volts / 30 Amps

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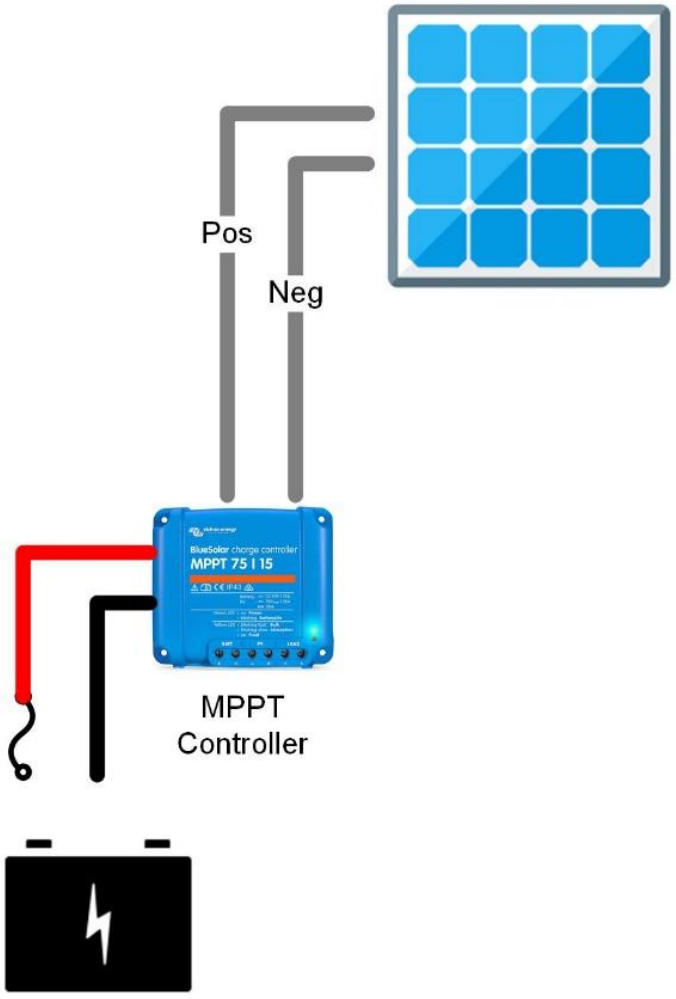
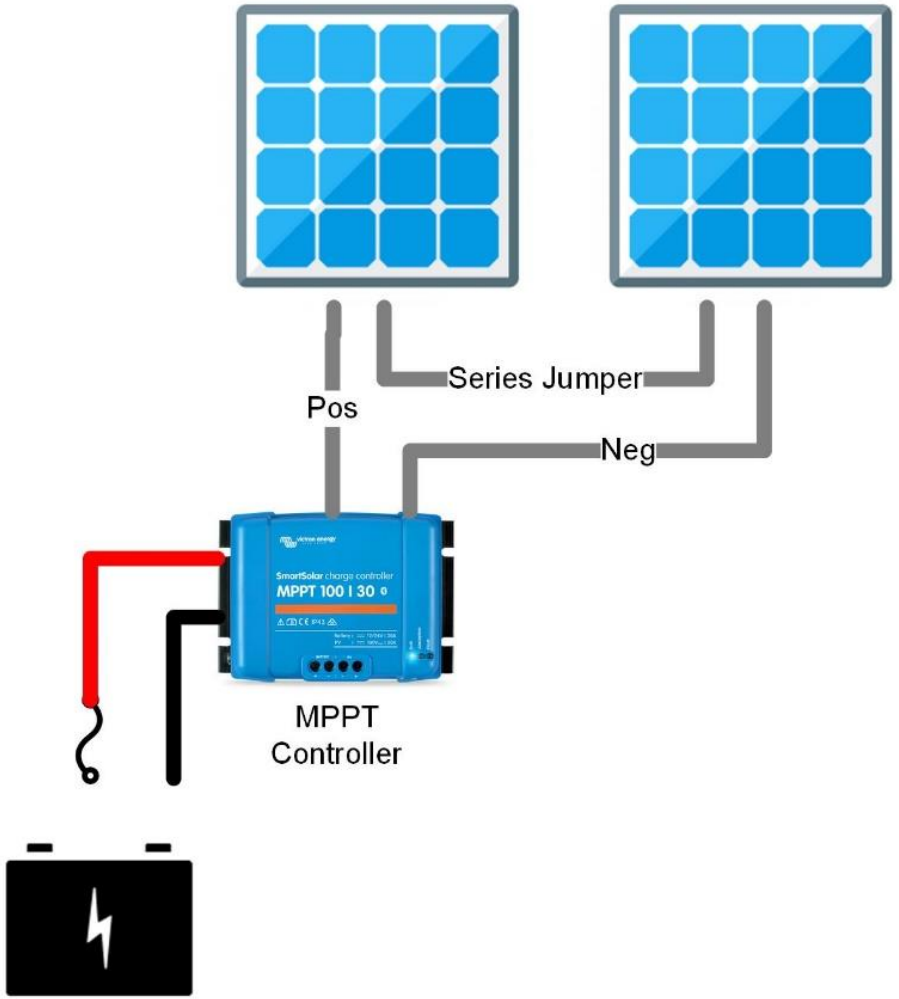
Solar MPPT: Installation Tips

- Shade potential
  - consider one MPPT controller per panel
- Bring 10 gauge wire from panel to MPPT
- Config MPPT for the right battery type:
  - Flooded, AGM, Gel, etc…
- Fuse each panel and each individual load
  - Properly label all fuses and wire runs

Single Solar Panel



Solar Panels in Series



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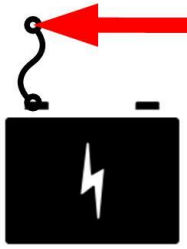

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#1: Catalina 36

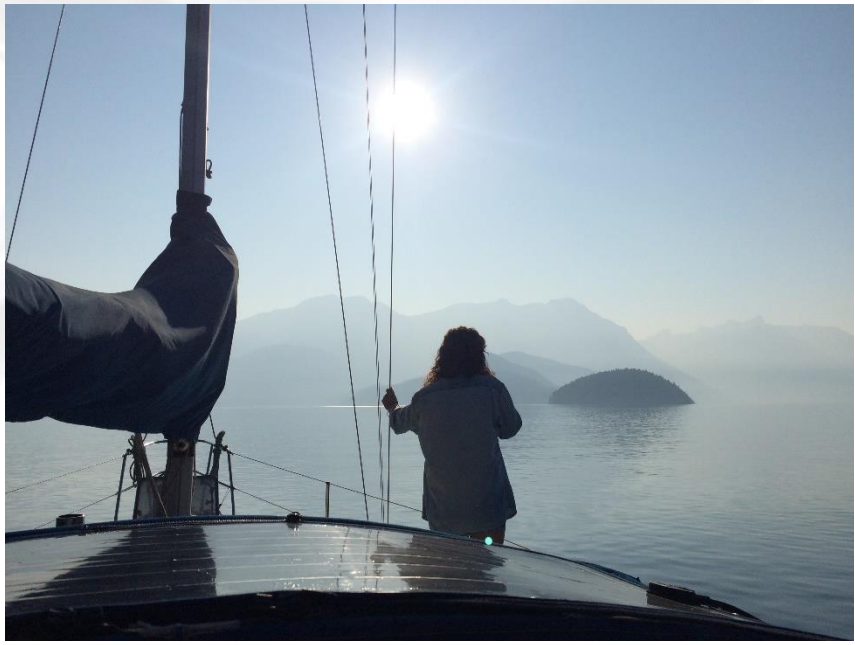
#2: Sea Ray

#3: Beneteau 51

#4: Camano 31

Closing Thoughts

- Recharging batteries
  - Without noise, vibration, smoke
- Costs are all front-loaded
- Secondary source for charging while at dock



Questions?

Connect with PYS

- PYS Electrical Orientation for your boat
  - 90 mins: Batteries, DC distribution, charger, alternator, inverter
- PYS Design Services for DIYers
  - Electrical system designed by PYS (collaborative and to marine code)
  - Installed by yourself or other outfit
- Pacific Yachting magazine - Monthly Tech Talk Column
- Northwest Yachting magazine – Monthly Hot Wire Column
- YouTube – 500K Views
- www.pysystems.ca 1000s of articles
- Monthly email newsletter

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