AutoDrip Irrigation
Grow More With Less

2025

Auto Drip Irrigation Power Estimate Design Justification

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Introduction

To power our system, we chose to design an off-grid solar setup, eliminating the need for long power cables and ensuring the system remained self-sufficient. This approach also allowed us to place the unit anywhere on the farm with adequate sun exposure. The following document provides an analysis of the expected energy availability at our project site, along with an explanation of our current power system and how it differs from the ideal setup we would implement with additional resources.

Method

The daily electrical energy available from a solar panel can be estimated using:

$$E = H \times A \times \eta$$

Where:

- E = daily energy output (kWh/day)
- H = average daily solar insolation (kWh/m^2/day)
- A = Panel surface area (m^2)
- η = panel efficiency (decimal)

This method is often used for PV solar sizing estimates and is supported by data from Natural Resources Canada (NRCAN) [1].

Data and Assumptions

- Location: Central Saanich, BC
- Tilt: Latitude – 15°
- Panel area: 0.55m^2
- Panel efficiency: 20%
- Derating factor: 80% (to account for controller, wiring, temperature, and other losses)
- Time of use: May-September (main irrigation season)

Monthly averages were taken from NRCAN's *Photovoltaic potential and solar resource maps of Canada [1]*.

Results

Table 1 Solar Energy Output Estimates

Month	Insolation H ($kWh/m^2/day$)	Ideal Output (kWh/day)	Realistic Output (kWh/day, 80%)
May	5.41	0.487	0.390
Jun	5.74	0.517	0.414
Jul	6.08	0.547	0.438
Aug	5.78	0.520	0.416
Sep	5.36	0.482	0.386

Using the NRCAN monthly insolation values provided and a 10 W panel (assumed 20% efficiency → area = 0.12 m^2), the panel's ideal daily energy during May–September is ≈56.6 Wh/day. Applying a conservative system derating of 80% for real-world losses (wiring, controller, temperature, dust, etc.) yields a practical estimate of ≈ **45 Wh/day**, averaged over the irrigation season.

Actual System

The current system design is a prototype created under budget constraints. The client requested a working demonstration before investing in higher-quality components. We've selected the following parts to be used in our working demonstration of our power system. A wiring diagram of our actual system is shown in Appendix 2 below.

Battery

As such, a 7.2 Ah sealed lead-acid (SLA) 12V battery was selected [2]. This battery provides us with the required capacity for our system at an affordable price and sufficient charge to run for 24 hours without charge from the solar panel.

Solar Panel

For our solar panel we will be using a recycled 90 W solar panel [3]. This is a folding solar panel that can be split into two 45 W panels. For our purposes we will only use one 45 W panel which provides us with more than enough energy for our system. According to the calculations above, our 45 W panel provides us with ≈ 200Wh/day average over the irrigation season. If we were unable to reuse this recycled solar panel, we would only need to purchase a 10 W panel to reach our energy needs.

Charge Controller

This will be paired with a cost-effective charge controller shown in figure 1 [4]. This controller has an IP67 rating, a maximum current of 5 A, and supports up to 60 W input, which is suitable for the 45 W solar panel used in the prototype. The PowMr charge controller comes with 20 AWG wires connected to the device, this is much smaller than our suggested wire gauge of 14 AWG. However, it will work for our test system. It provides the basic functionality required while remaining affordable.

Figure 2 PowMr Solar Charge Controller [4]

Figure 1 Prototype battery [2]

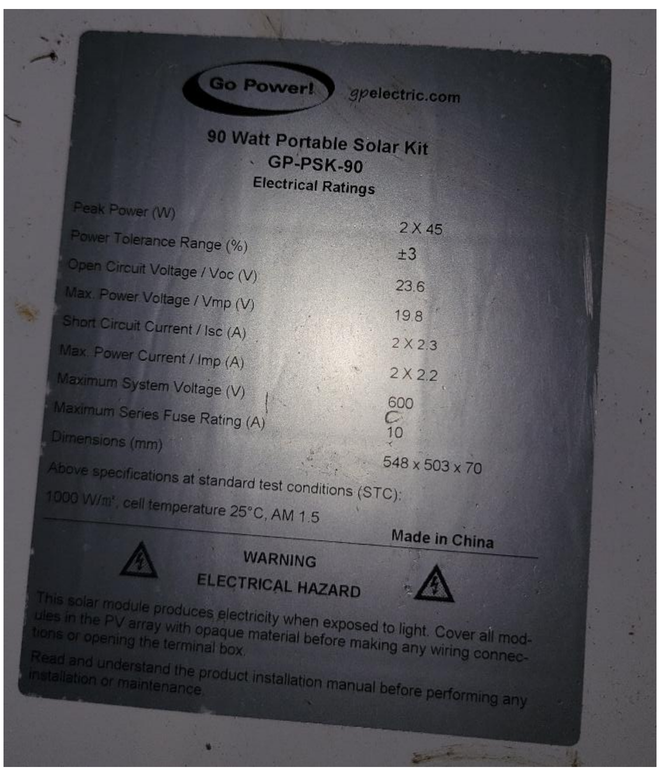


Figure 3 Solar panel ratings [3]

Ideal System

For long-term use, an upgraded battery and charge controller are recommended. The design is based on estimated energy consumption of 27 Wh per day, with an additional 25% headroom, bringing the total to 33.75 Wh. Allowing for two days of autonomy in cloudy conditions results in a required capacity of 67.6 Wh. A wiring diagram is shown in Appendix 3 below.

Battery

Using a 12 V, this equates to 5.6 Ah. Accounting for 80% depth of discharge (DoD), the required battery capacity is 7.0 Ah. A 10 Ah $LiFePO_4$ battery provides an appropriate safety margin and a longer lifespan making the higher upfront cost worthwhile. We choose a $LiFePO_4$ for it's longer lifespan, while it may have a higher upfront cost, its offers long term savings battery as An affordable option is shown in figure 5 [5].

Solar Panel

The solar panel sizing requirement is 7.2 W minimum (Table 4). As panels are not commonly available in this size, a 10 W panel is recommended, providing approximately 45 Wh/day during the irrigation season [1]. The solar panel must be rated for outdoor use with an IP67 waterproof rating. Affordable options can be found on Amazon.ca.

Charge Controller

A suitable solar charge controller must be IP67 rated or better, compatible with 12 V battery systems, supports $LiFePO_4$ batteries, and rated within the solar panels max output. An example is shown in Figure 4 [6].

3 Figure 4 Suggested MPPT solar charge controller [6]

Figure 5 Suggested LiFePO4 10Ah battery [5]

Appendices

Appendix 1: Power estimate tables

Table 2 Required battery capacity [7]

Usable Capacity Factor	Fraction	Required Battery Capacity (Ah)
90%	0.9	2.50
80%	0.8	2.81
75%	0.75	3.00
50%	0.5	4.50

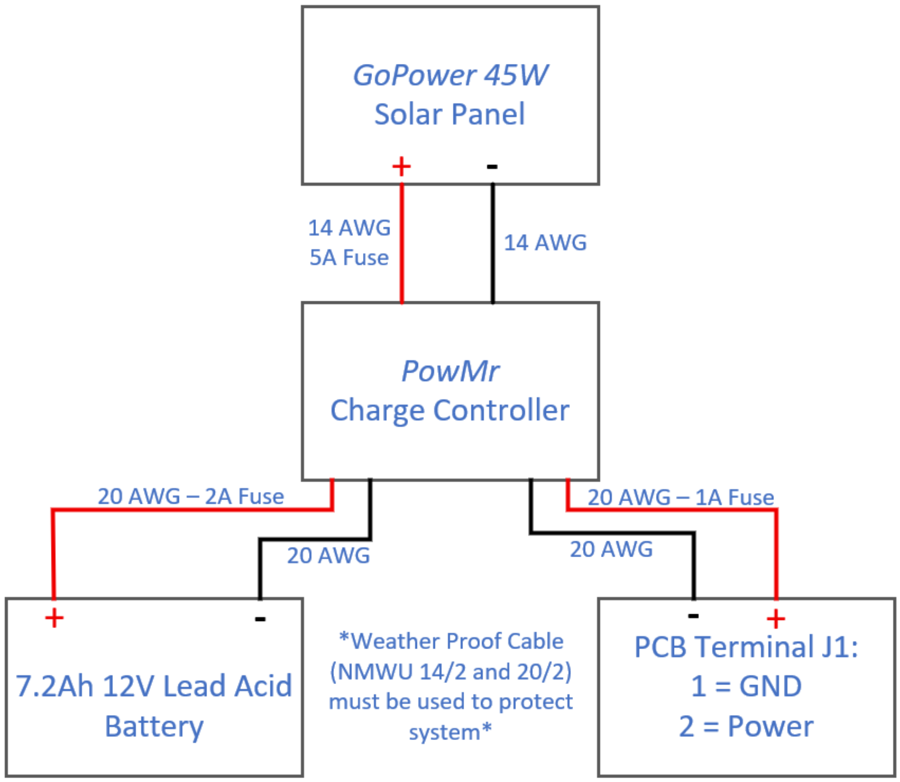
Table 3 Estimated energy consumption [7]

Device / Mode	Voltage (V)	Current (A)	Power (W)	Hours/day	Energy/day (Wh)	Battery-side Energy/day (Wh)
Solenoid valve	12.0 V	0.40	4.8	4	19.20 Wh	19.20 Wh
ESP32 - WiFi TX	3.3 V	0.60	1.98	1	1.98 Wh	
ESP32 - Active CPU	3.3 V	0.15	0.5	1	0.50 Wh	
ESP32 - Idle	3.3 V	0.005	0.0165	22	0.36 Wh	
ESP32 total (3.3 V)					2.84 Wh	3.69 Wh
Sensor	12.00 V	0.03	0.36	1	0.36 Wh	1.20 Wh
MOSFET/misc	12.0 V	-	0	-	0.10 Wh	0.01 Wh
Buck	12.0 V	0.010	0.12	24	2.88 Wh	2.88 Wh
TOTAL						26.98 Wh

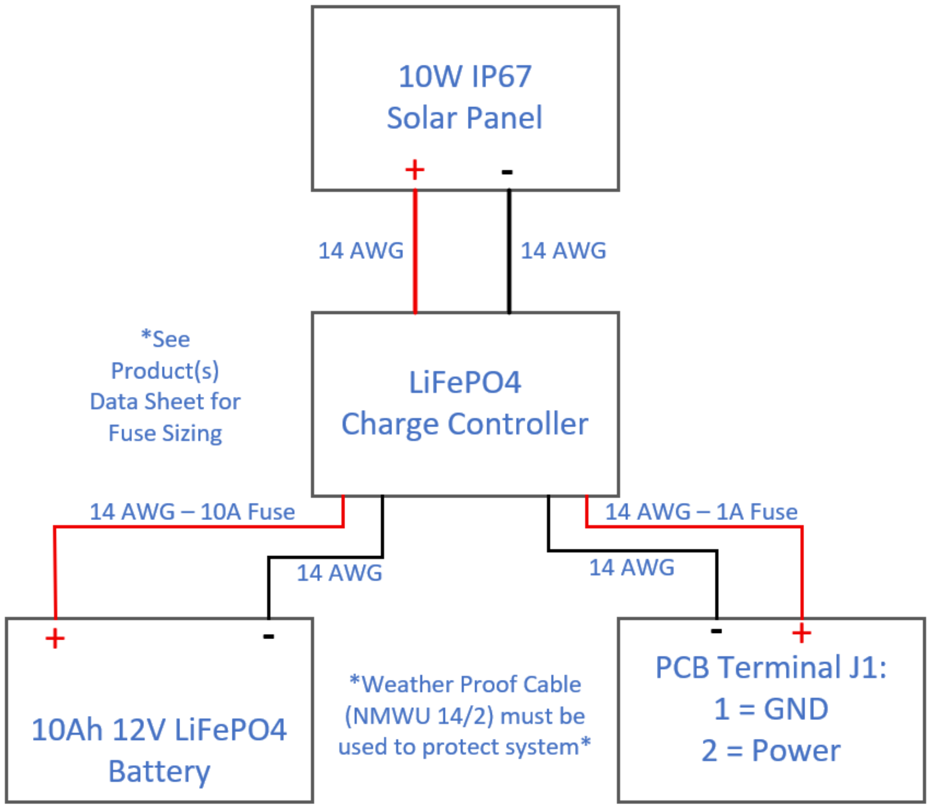
Table 4 Estimated Solar Panel Size [7]

Parameter	Value
Energy drawn from battery (Wh/day)	26.98
Average sun hours per day	5
Panel efficiency (fraction)	0.2
System derating factor (fraction)	0.75
Required panel power (W) — no derating	5.40
Required panel area (m^2) — no derating	0.03
Required panel power (W) — with derating	7.19
Required panel area (m^2) — with derating	0.04

Appendix 2: Wiring Schematic for Actual System



Appendix 3: Wiring Schematic for Ideal System



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