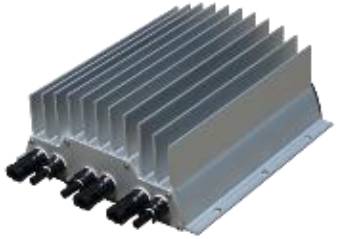
Case Study:
Utility-Scale System Upgrade with Ampt String Optimizers

HDPV ALLIANCE MEMBER

Executive Summary:
Ampt upgrade delivered superior solution

ampt



Ampt String Optimizer

Background

- 6-year-old, utility-scale system
- Mismatch from degradation and component failures
- Some strings, combiners, and inverters dropping power
- Losing energy and revenue
- High O&M cost

Customer Need

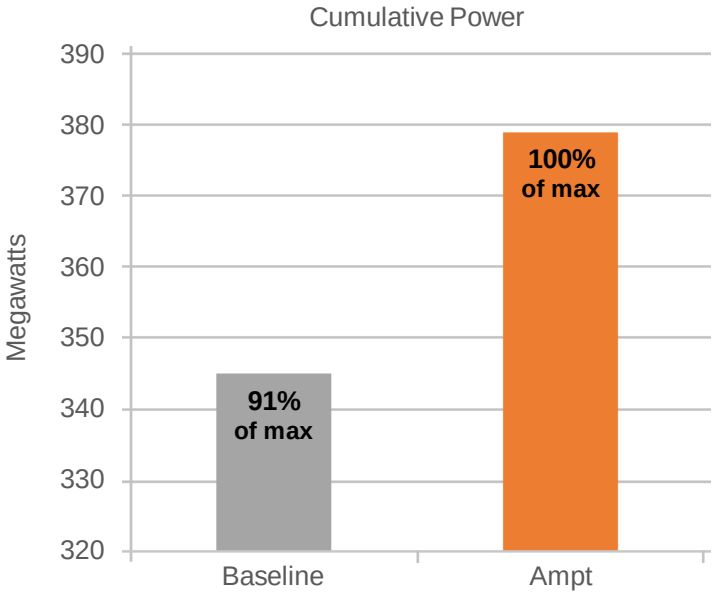
- Upgrade to revitalize aging system
- Maximize system production
- Reduce annual O&M cost
- Meet cost/benefit requirements

Solution and Results

- Ampt string optimizers selected as upgrade solution
- Ampt improved performance on each inverter system-wide
- String-level monitoring included for enhanced O&M
- Investment payback ~6 months

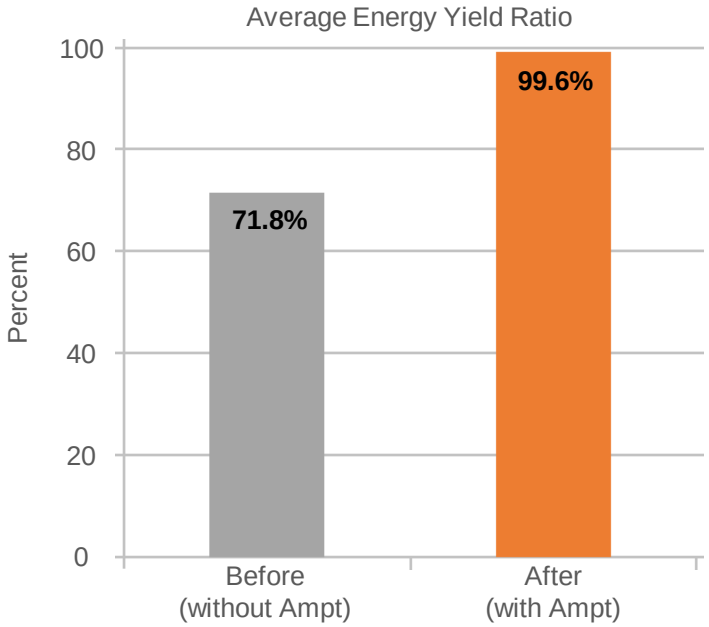
Summary of performance results

Phase 1:
Single Inverter Upgrade



- Ampt outperformed baseline system in side-by-side comparison
- Ampt generated 10% more energy

Phase 2:
Full System Upgrade

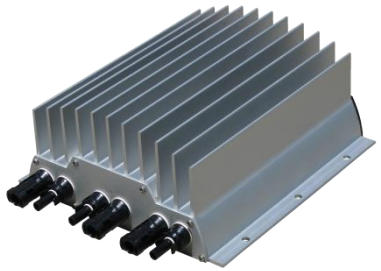


- Ampt improved average site performance ~39%
- Each inverter with Ampt showed significant performance improvement
- Even the best performing inverter block improved with Ampt by 2.2%
- 50%+ increase in annual site production projected

Solution Overview

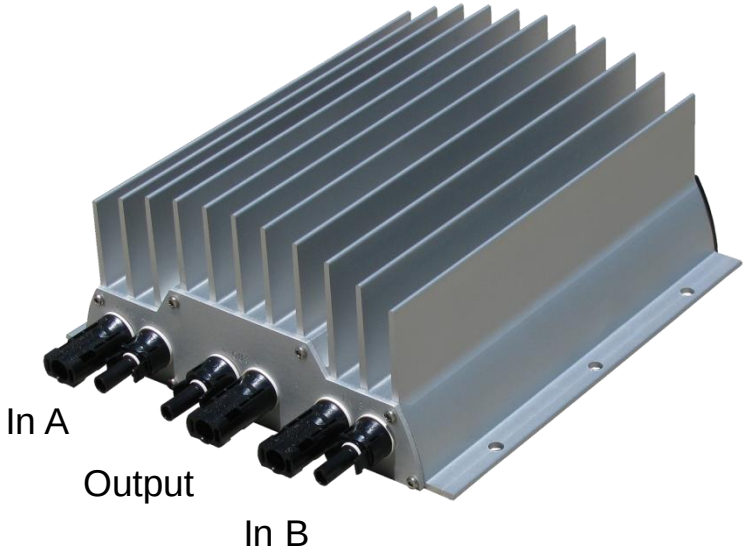
Ampt upgrade improves system performance

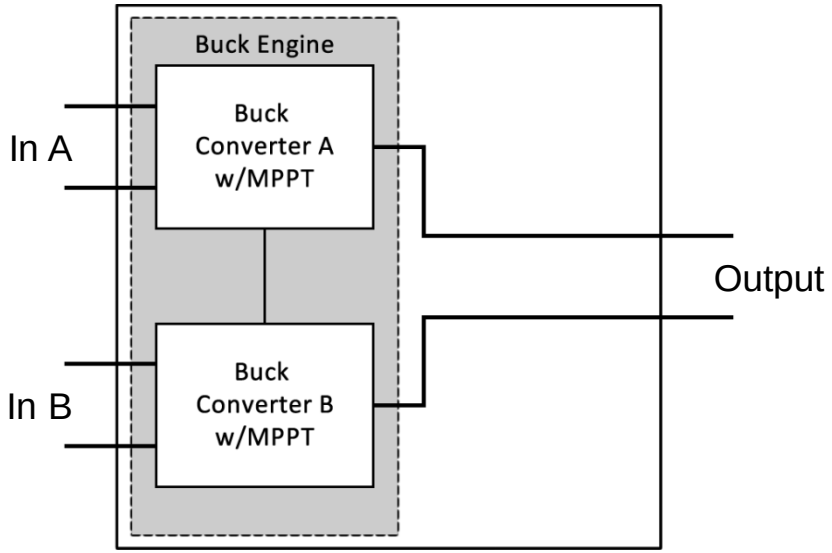
Ampt String Optimizer



Lowest cost option that corrects system aging issues
to increase production revenues

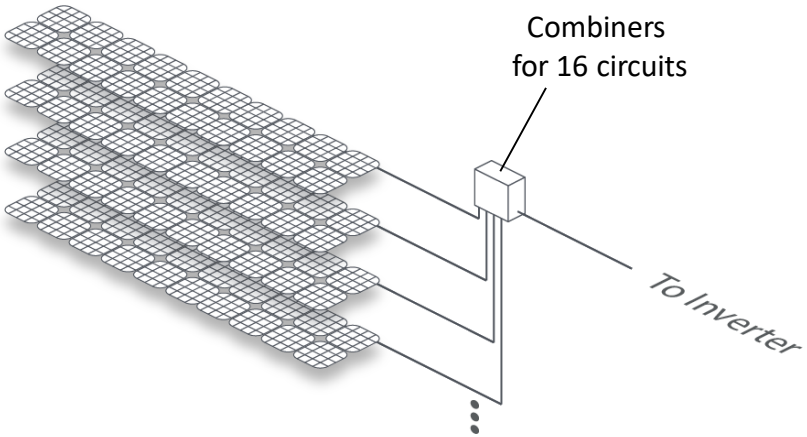
Ampt String Optimizers put 2 MPPTs as well as output voltage and current limits on each string



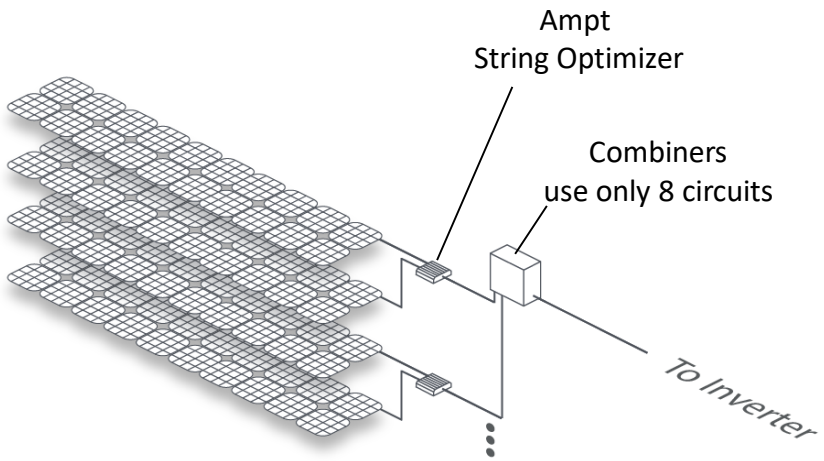


Ampt tracks voltage set by inverter – no communication required

Upgrading with Ampt String Optimizers



Baseline System Configuration
(original)



Ampt String Optimizer Configuration
(after upgrade)

Simple drop-in using existing wiring, combiners, and other components

Phase 1: Single Inverter Upgrade with Ampt

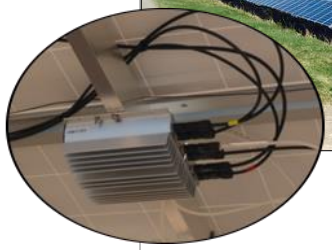
Single inverter upgrade with Ampt String Optimizers

Phase 1 comparison set

Baseline

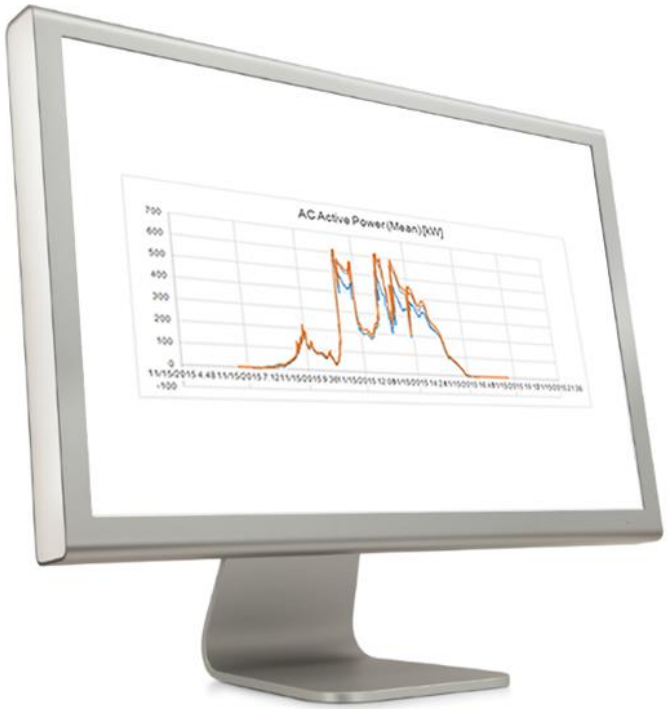
- Customer's best performing inverter
- Fully functional during evaluation
- 20 modules per string
- Mismatch from six years of degradation

Ampt



- Use Ampt String Optimizer
- 40 modules per string
- 2 MPPTs per optimizer
- Half combiner inputs used

Ampt outperformed system in side-by-side comparison

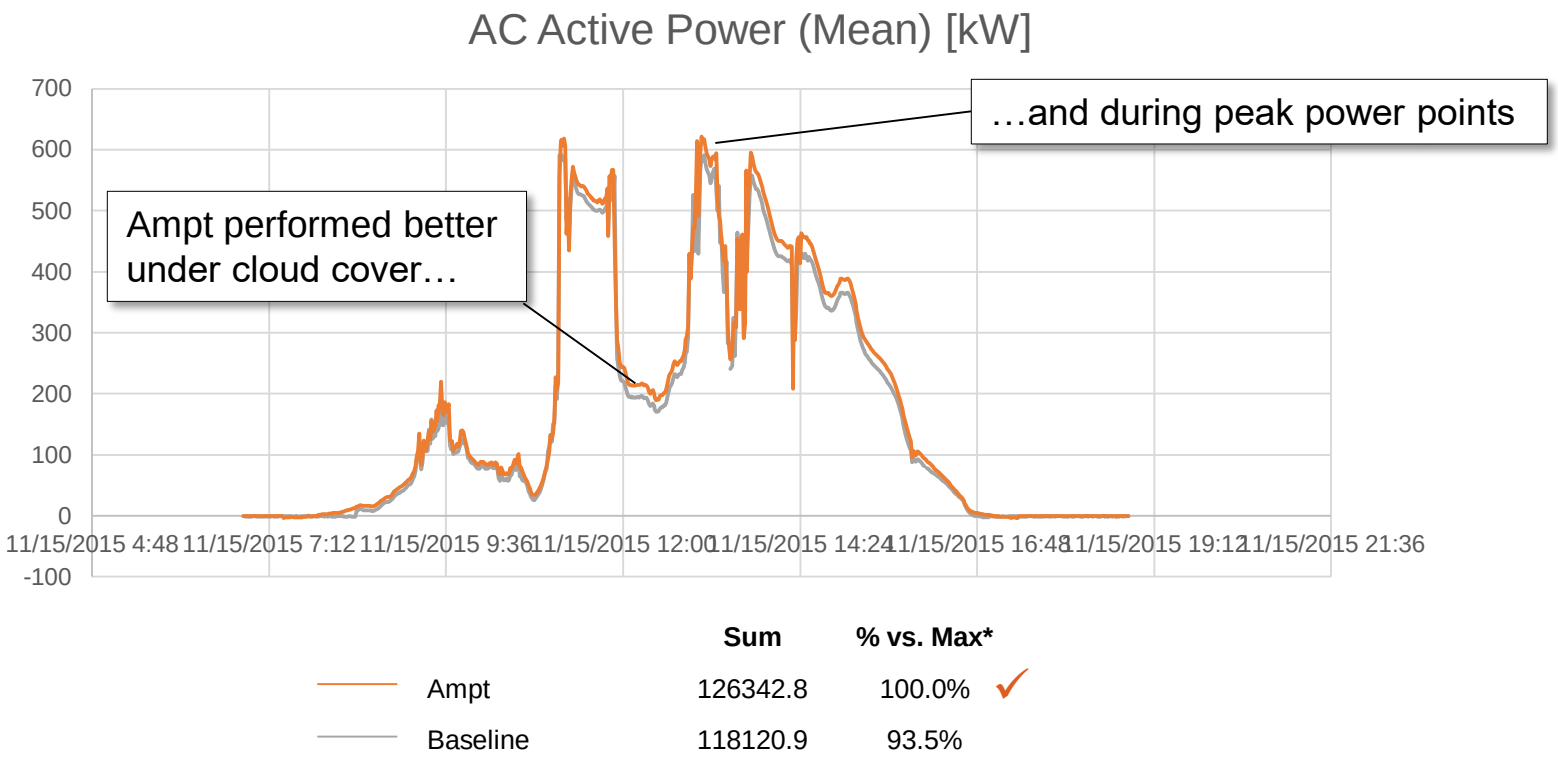


Ampt delivered more energy during:

- High irradiance days
- Medium irradiance days
- Low irradiance days
- Sporadic cloud cover
- Fast changing conditions

Ampt generated more energy overall and under diverse conditions

Ampt outperformed throughout high irradiance days

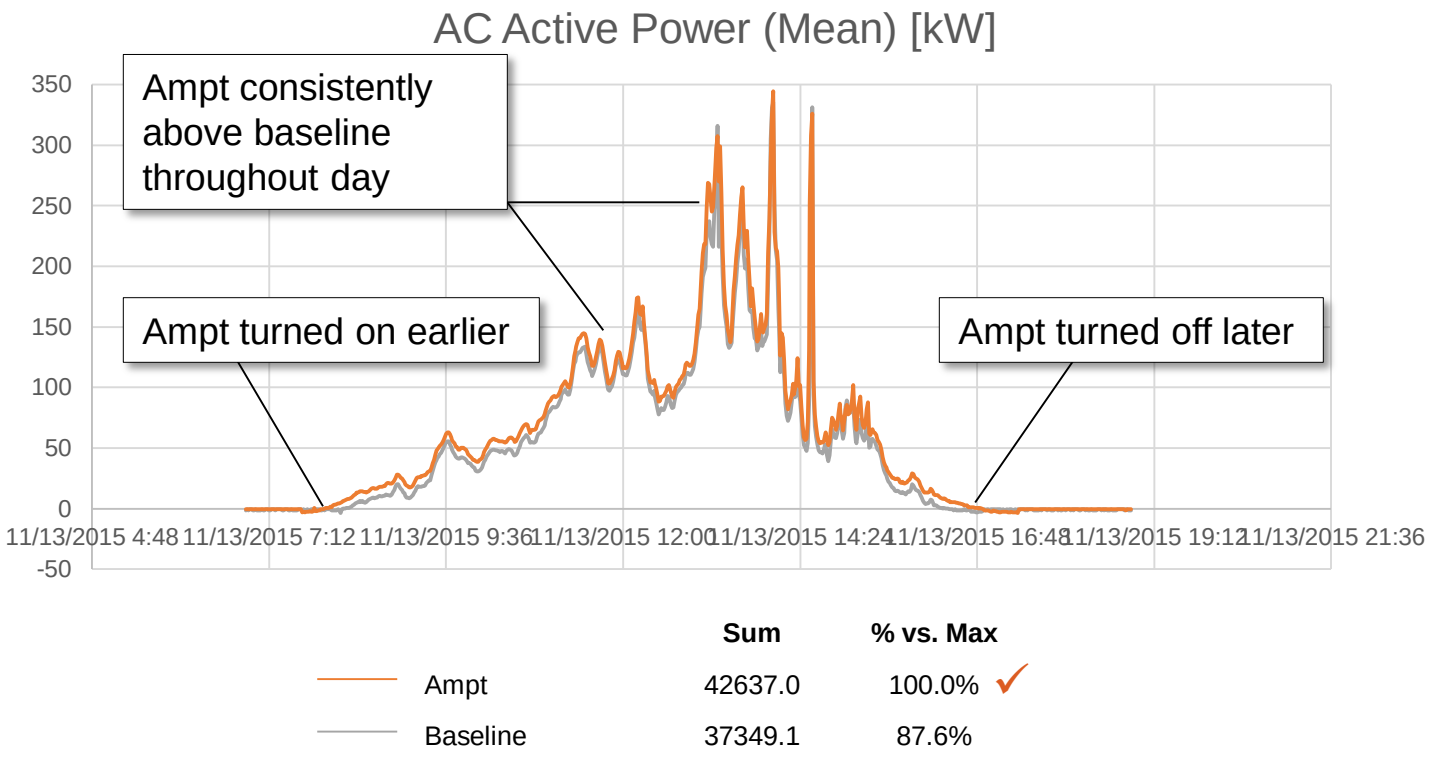


	Sum	% vs. Max*
Ampt	126342.8	100.0% ✓
Baseline	118120.9	93.5%

Ampt increased performance when most kWh are being generated

*The inverter with Ampt optimizers is the highest performing compared to the customer's other inverters on the system. Therefore, Ampt is 100% vs. Max.

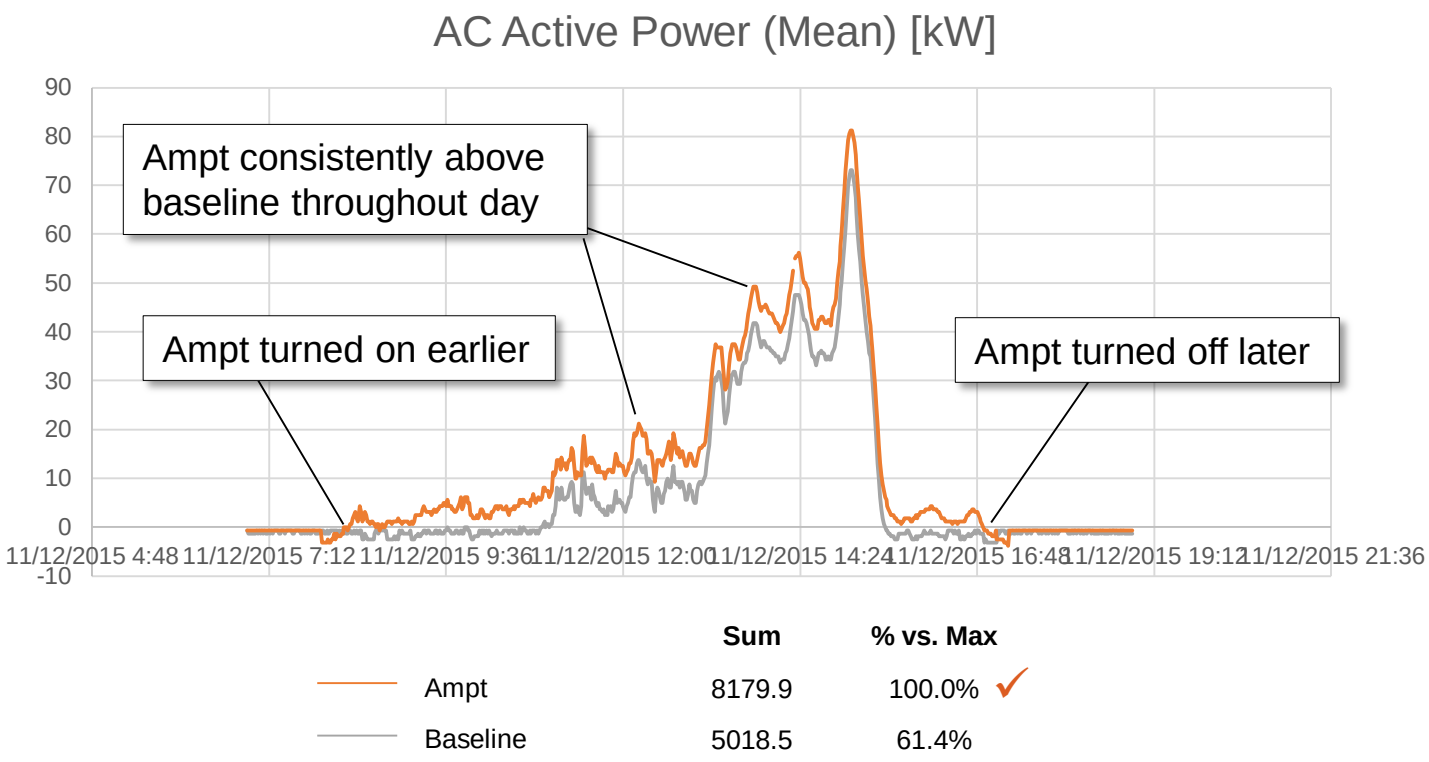
Ampt outperformed throughout medium irradiance days



	Sum	% vs. Max
Ampt	42637.0	100.0% ✓
Baseline	37349.1	87.6%

Ampt's longer strings supply the voltage needed to turn the inverter on earlier and keep it on later

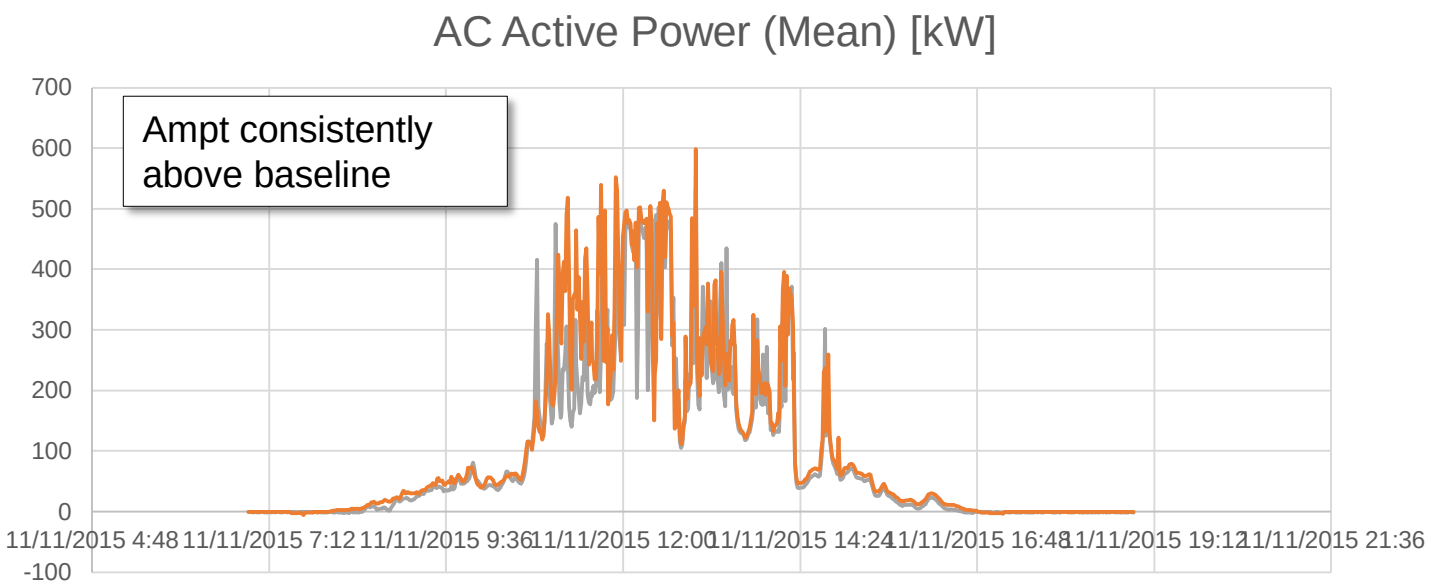
Ampt outperformed throughout a low irradiance days



	Sum	% vs. Max
Ampt	8179.9	100.0% ✓
Baseline	5018.5	61.4%

Ampt captured more energy – even under low light conditions

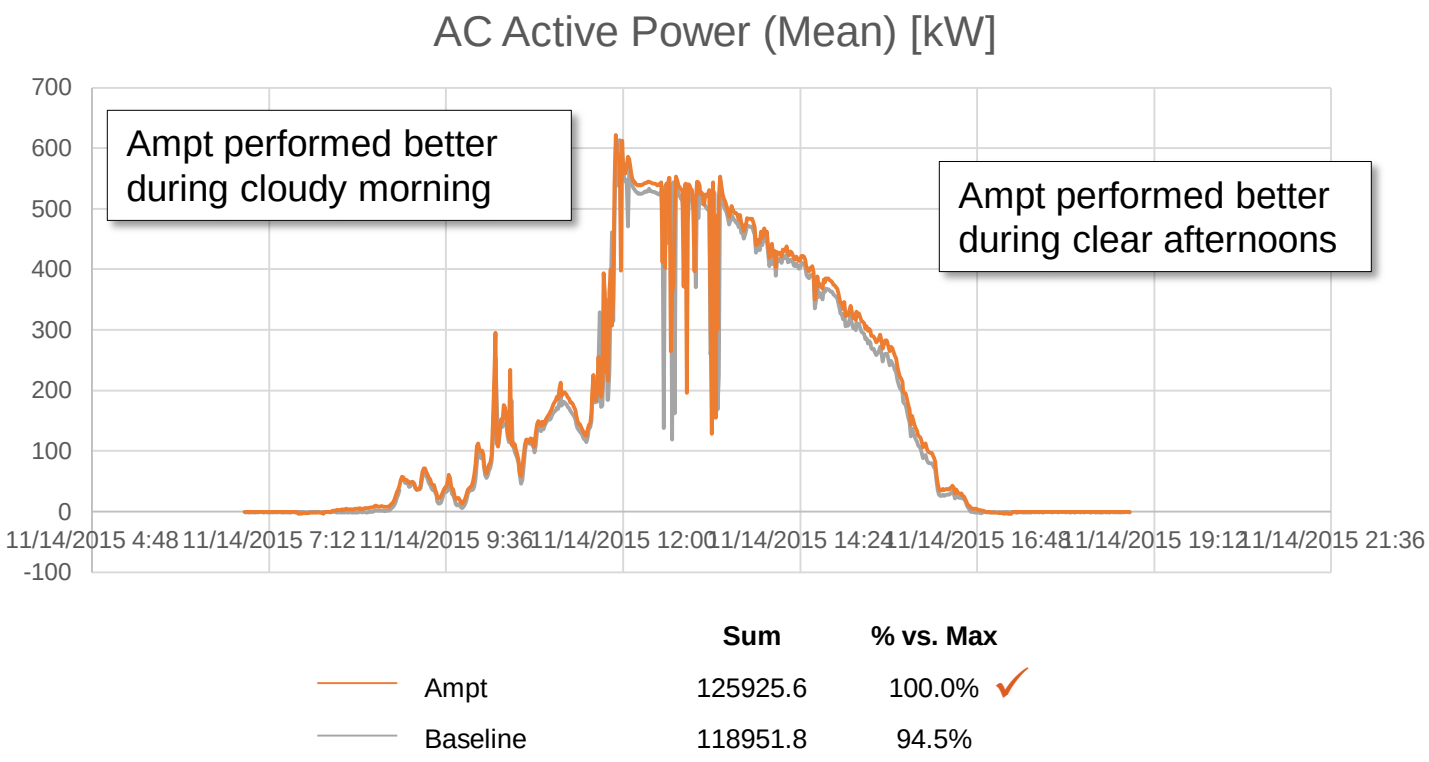
Ampt generated more energy under sporadic cloud cover



	Sum	% vs. Max
Ampt	75368.8	100.0% ✓
Baseline	65477.2	86.9%

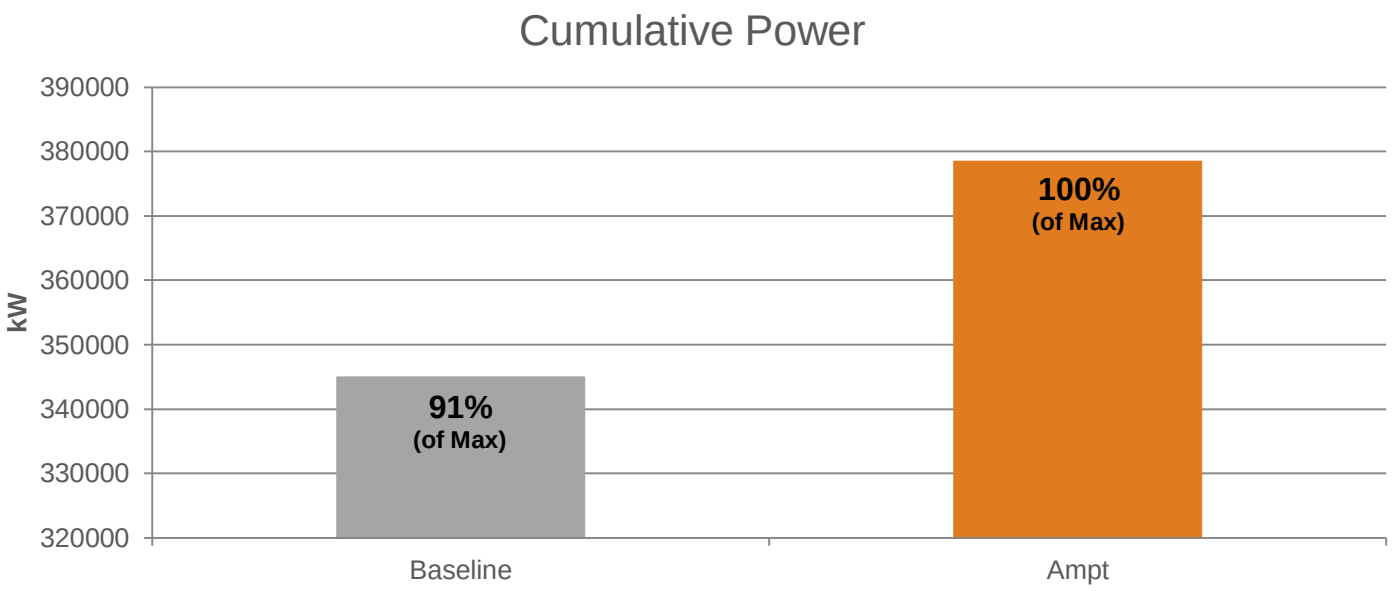
Under fast changing conditions, Ampt responded faster to deliver more power

Ampt outperformed in varying conditions



Ampt has a performance advantage in high, medium, and low light

Phase 1 performance summary: Ampt achieved highest cumulative production

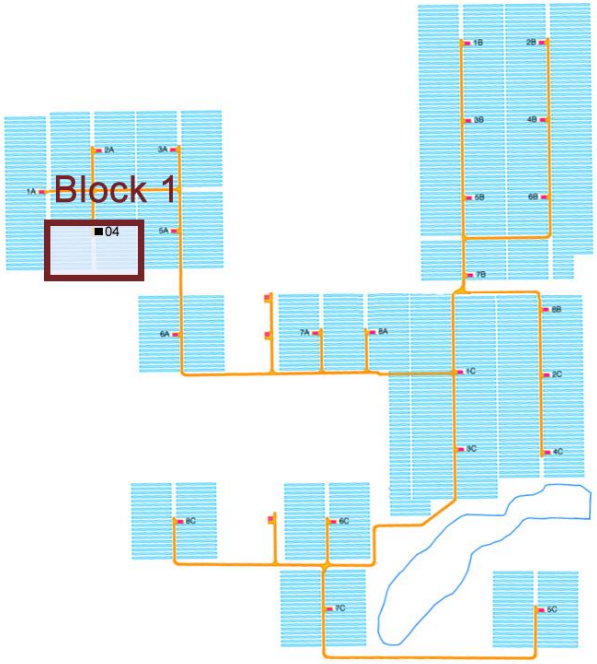


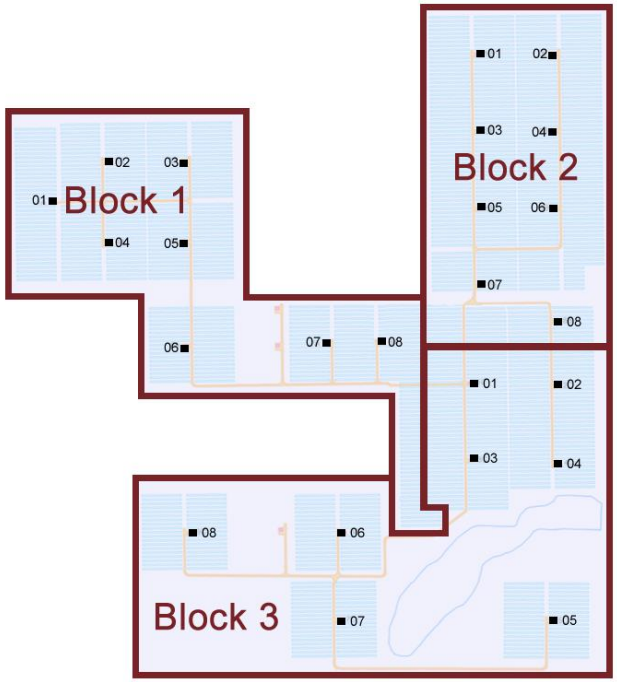
Ampt generated 10% more energy to increase revenue

Phase 2: Full system upgrade with Ampt

Full system upgrade with Ampt String Optimizers

Phase 1: Single Inverter Upgrade	Phase 2: Full System Upgrade
1 inverter	48 inverters
75 optimizers	3624 optimizers



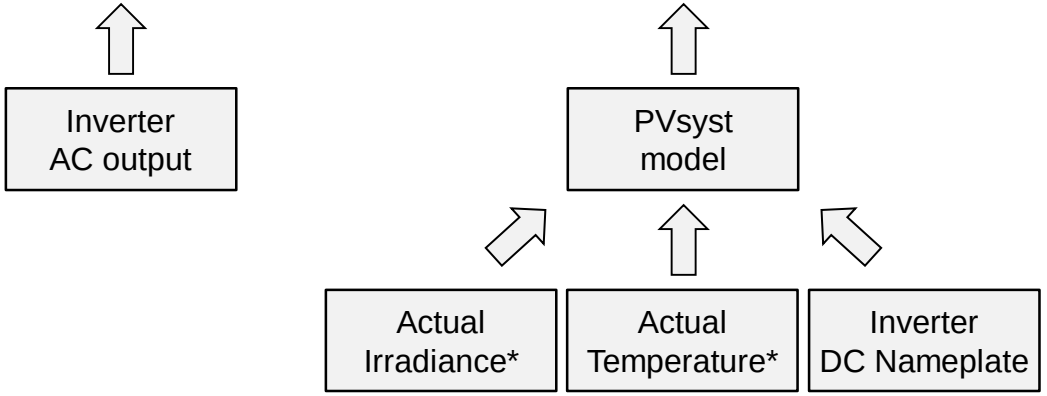


Ampt on-site

Phase 2 performance analysis method

Energy Yield Ratio = Actual Energy Yield ÷ Expected Energy Yield

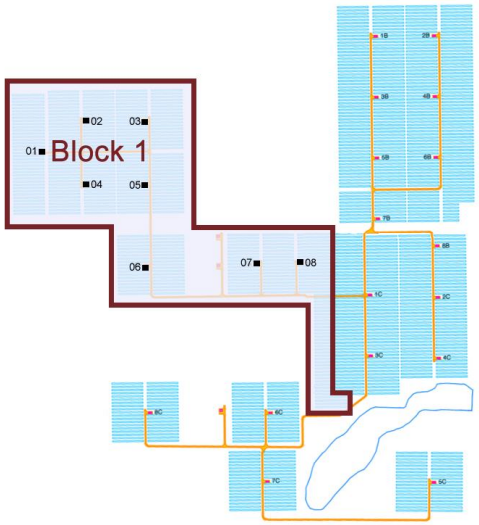
Metric used to compare performance before and after system upgrade with Ampt

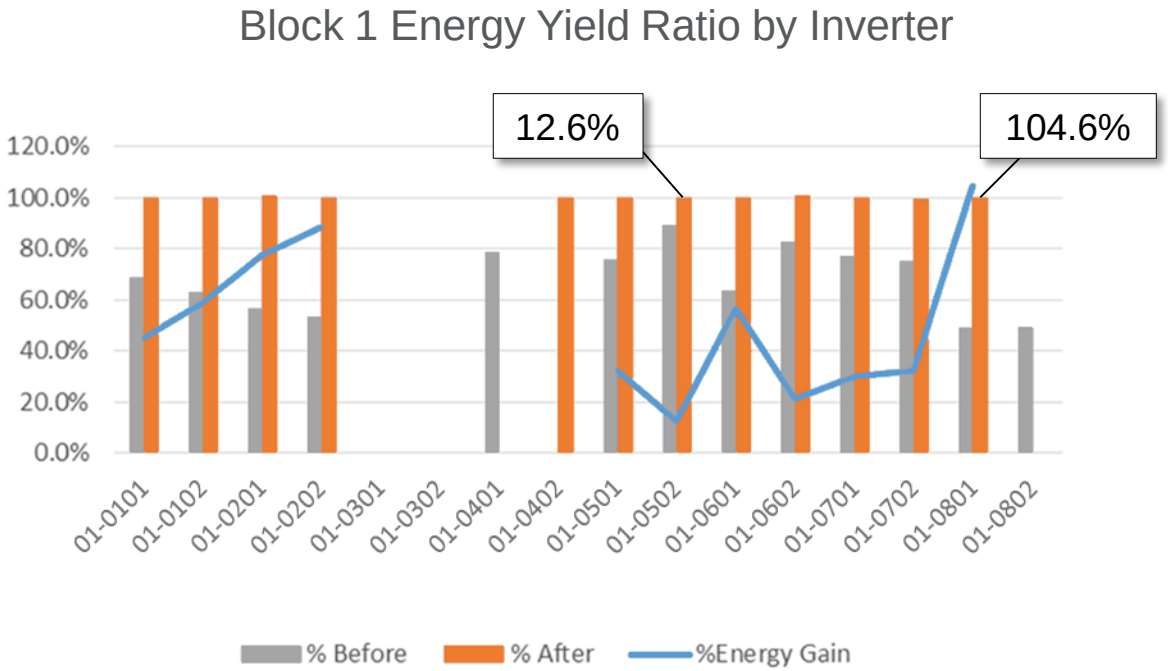


* Measured at the site

Highly accurate PVsyst model - perfected using data from single inverter upgrade with Ampt

Block 1 produced between 12.6% and 104.6% more energy with Ampt

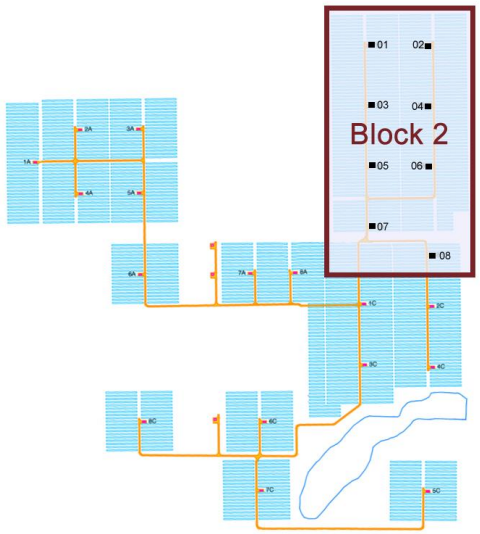


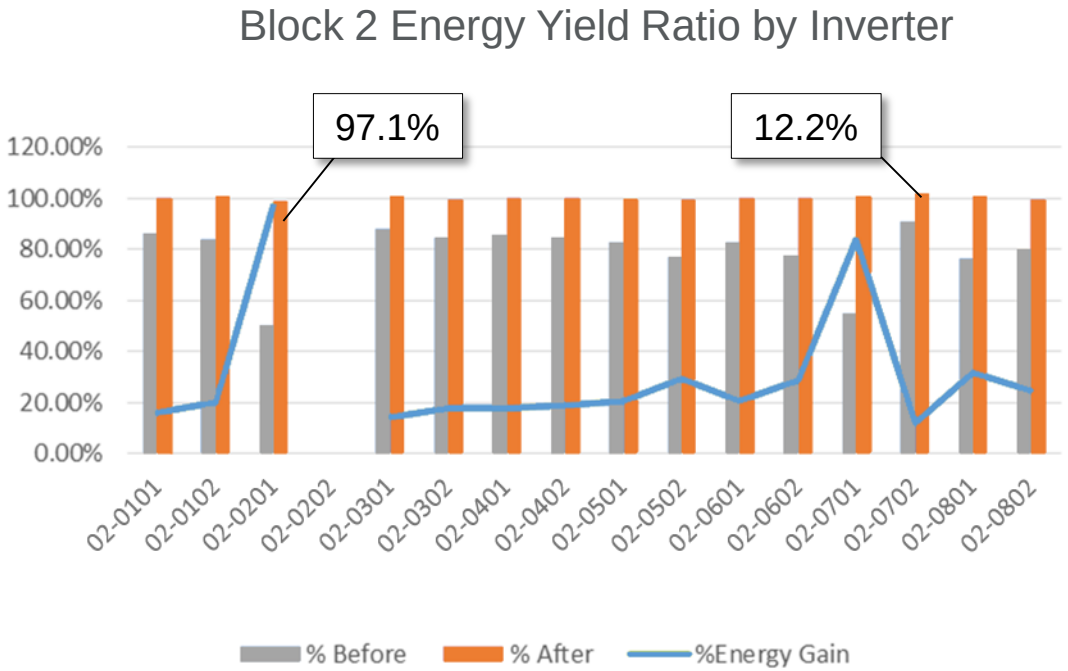


Inverters in Block 1 showed significant energy yield improvement with Ampt

Note: Some of the inverter upgrades were not complete when the analysis was done.
Inverter 01-0402 was upgraded with Ampt during Phase 1 so there is no “before” data available. This inverter showed a 10% improvement compared to its neighboring inverter during the Phase 1 analysis.

Block 2 produced between 12.2% and 97.1% more energy with Ampt

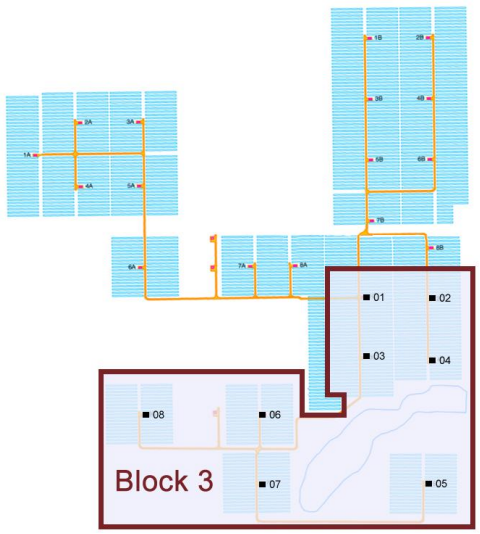


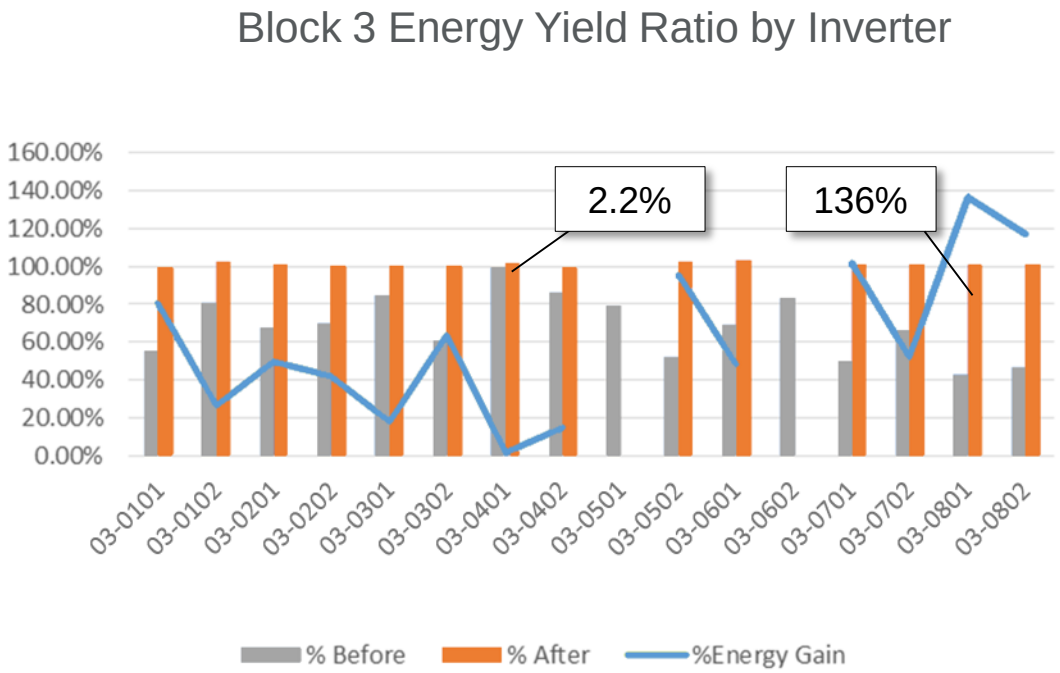


Inverters in Block 2 showed significant energy yield improvement with Ampt

Note: Some of the inverter upgrades were not complete when the analysis was done.

Block 3 produced between 2.2% and 136% more energy with Ampt

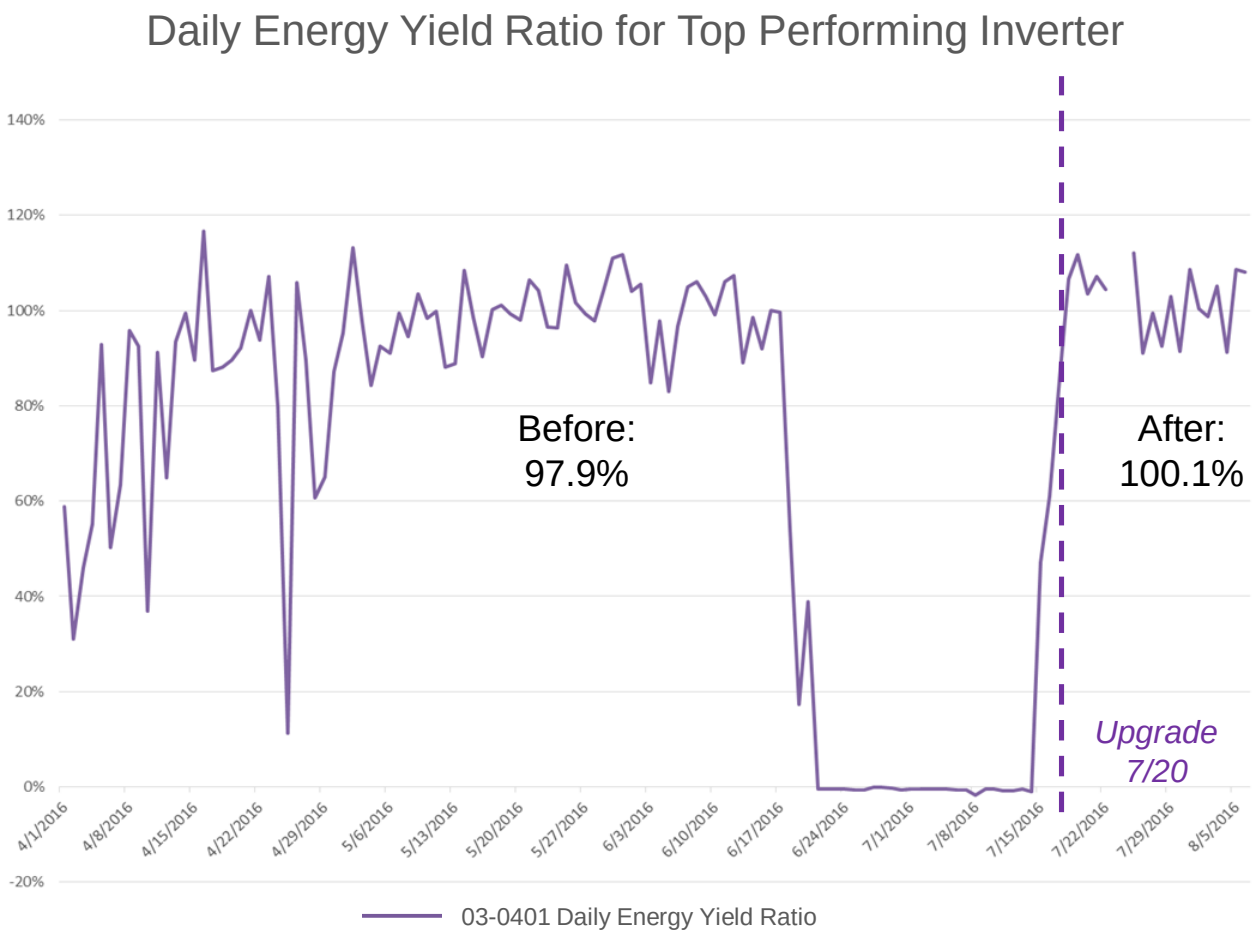




Block3-04.01: the best performing inverter before upgrade gained ~2.2% in performance with Ampt

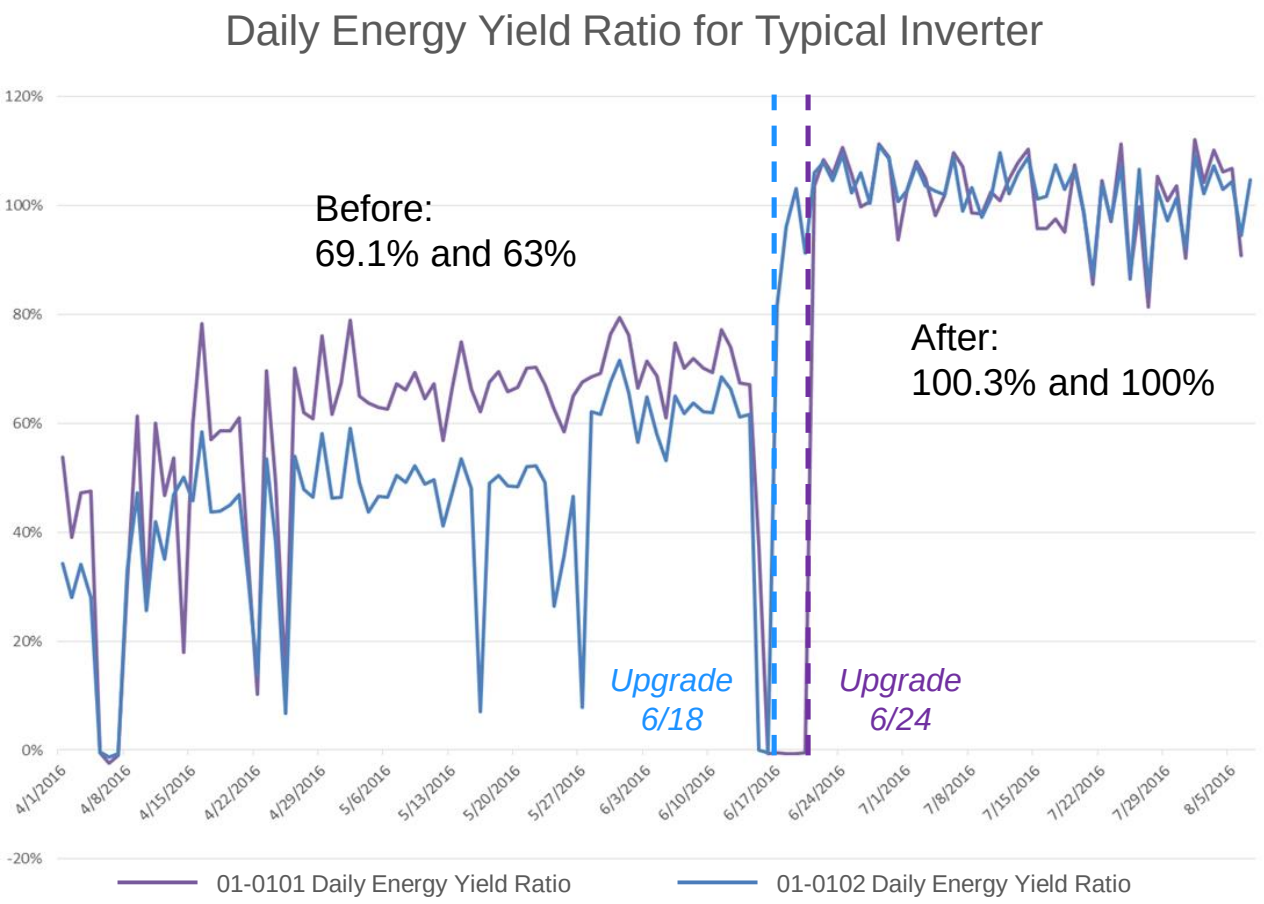
Note: Some of the inverter upgrades were not complete when the analysis was done.

Highest performing inverter before upgrade (Block3-04.01) showed 2.2% improvement with Ampt



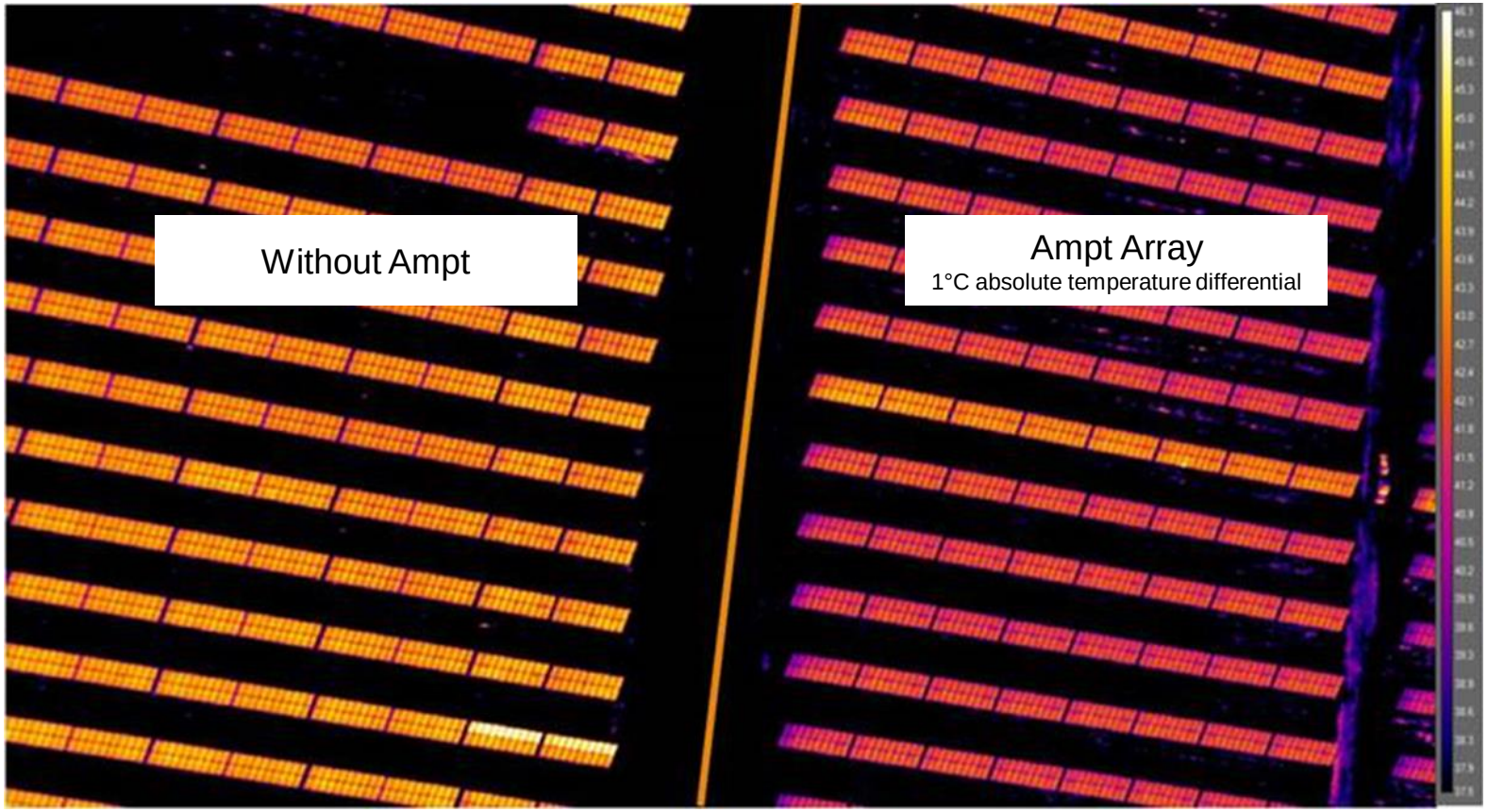
Ampt improvement of the top performing block likely due to elimination of mismatch

Ampt performance improvement on typical inverter block



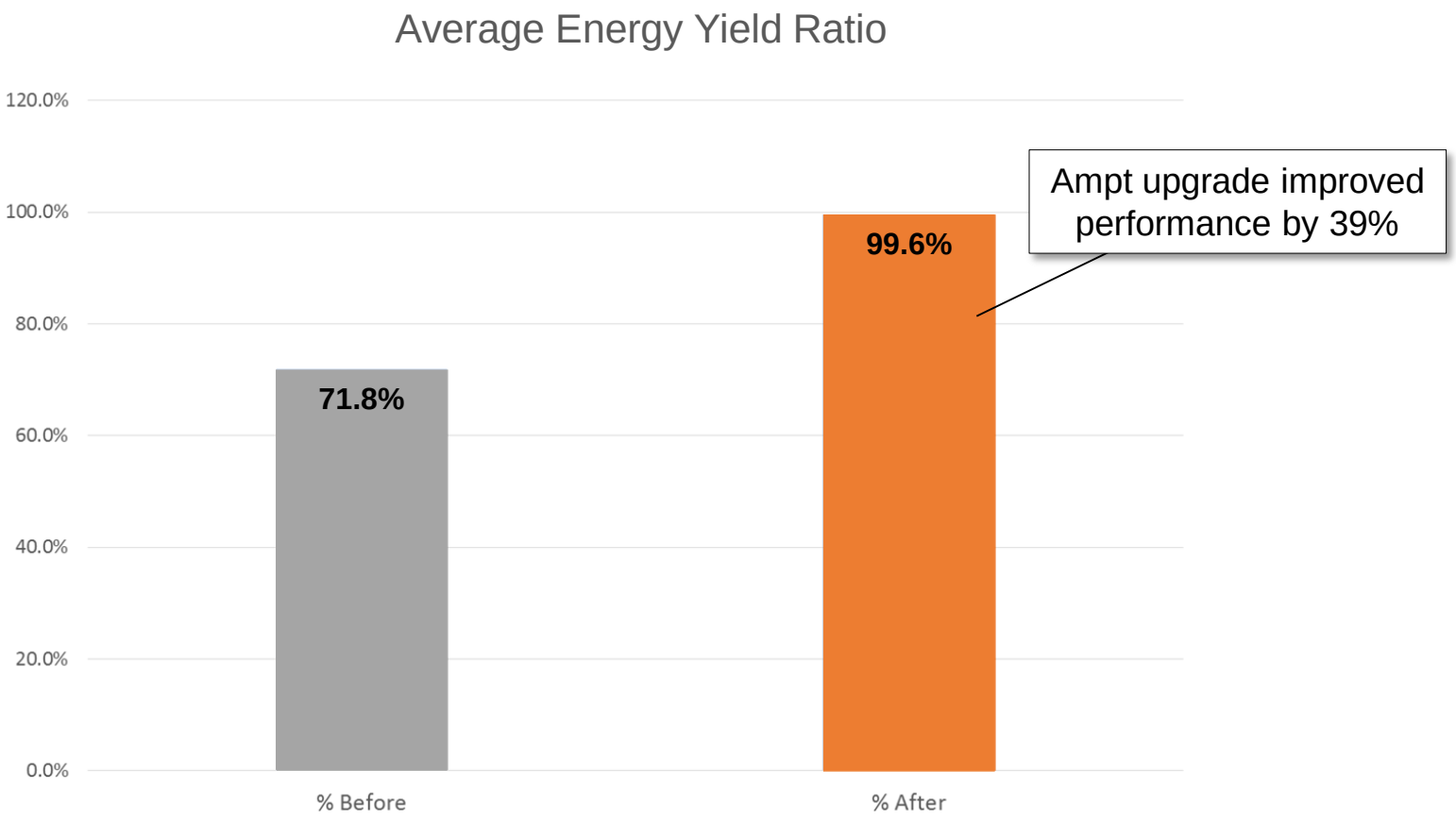
Inverter performance increased 45% to 59% after the Ampt upgrade
by addressing components dropping power and recovering mismatch losses

Ampt array benefits from cooler operating temperature



PV modules have higher efficiency and
reduced lifetime degradation at cooler temperature

Phase 2 performance summary:



This increase in production is projected to be over 50% annually due to seasonal effects

Conclusion: Ampt delivered superior solution

- Fastest Return on Investment
  - 6 months for this project
- Maximized annual project revenue
  - Generated more energy on each inverter
  - Addressed reliability issues of legacy components
  - Provided string-level data monitoring to simplify O&M
- Lowest cost upgrade option
  - Operated seamlessly with existing system components
  - Ampt Optimizers cost a fraction of string inverters
  - Leveraged existing wires and combiners
  - Avoided costly rewiring / retrenching

ampt.com

hdpv.org