



#### STRATEGIC VALUE PROPOSITION: THE ACCUENERGY ADVANTAGE

While Dynamic Load Management (DLM) is a software logic, its safety and efficiency are entirely dependent on the hardware layer. Standard utility meters, with 15-minute latency, and generic low accuracy submeters cannot support safe dynamic control.

Accuenergy overcomes these physical constraints through three specific engineering advantages:

- 1. Sub-Second Latency for Safety:** Unlike utility meters that report historical averages, the Acuvim II Series delivers 100ms update rates, enabling the controller to detect and react to load spikes before the breakers trip.
- 2. Revenue-Grade Precision for ROI:** By offering Class 0.1 accuracy, we minimize the required safety guard band, which allows facilities to utilize more than 99% of available capacity rather than the standard 80%.
- 3. Deployment Scalability:** The AcuPanel 9104X eliminates field wiring variability, providing a pre-validated, NEMA 4X turnkey solution that ensures data integrity from day one.

#### Trademark

This resource document may not be altered or reproduced in whole or in part by any means without the expressed written consent of Accuenergy.

All product names, trademarks, and registered trademarks are the property of their respective owners. References to third-party products are for identification purposes only and do not imply affiliation, endorsement, or sponsorship.

#### EXECUTIVE SUMMARY

The rapid electrification of transportation presents a critical challenge to Commercial and Industrial (C&I) facility infrastructure which is the finite capacity of existing electrical service entrances. Traditional capacity planning leads to significant underutilization of power assets. This white paper explores the engineering principles of Dynamic Load Management (DLM) and demonstrates how revenue-grade metering infrastructure, specifically high-precision sampling and sub-second telemetry, is essential for safely maximizing charger density without capital-intensive transformer upgrades.

#### 1. THE CAPACITY PARADOX IN EV INFRASTRUCTURE

An electrical design requires sizing infrastructure based on the theoretical worst-case scenarios. For EV charging, this means assuming a maximum full output load to all connected chargers simultaneously. Installing a Level 2 or DC Fast Chargers into an

existing system introduces a unique constraint to the electrical grid. While a facility may have a rated capacity of 2000A, its peak demand rarely utilizes 100% of this limit continuously. An example of capacity paradox is a scenario where ten 11kW chargers require reserving 110kW of capacity 24/7, regardless of actual usage. Consequently, facilities reach the provisional limit of allowable chargers, even if the demand for load peaks only at certain time of the day and will not be able to add new chargers. DLM resolves this paradox by shifting from fixed allocations to real-time available capacity. Figure 1 is an illustration of dynamic capacity allocation, where load can be adjusted as per time of day and demand.

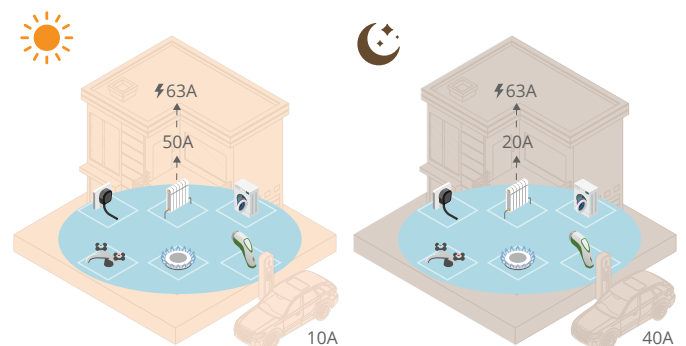


Figure 1: Dynamic Load Allocation During Peak and Off-Peak Hours

As depicted in Figure 1, the dynamic capacity allocation system optimizes power distribution based on real-time demand. During peak daylight hours the building's main load is high at 50A, which safely

# Precision Metering as the Enabler of Dynamic Load Management

## Overcoming Infrastructure Constraints in High-Density EV Charging

limits the available EV charging current to 10A. Conversely, during off-peak night hours, the building's power demand decreases to 20A. The system automatically detects this drop and reallocates the unused capacity, providing up to 40A to the EV chargers. This ensures maximum utilization of the 63A total capacity without overloading the electrical panel. This is the main advantage of dynamic load management as compared to static load management. Figure 2 indicates the percentage allocation of electrical capacity in a static and dynamic load in a graphical form for easier comprehension.

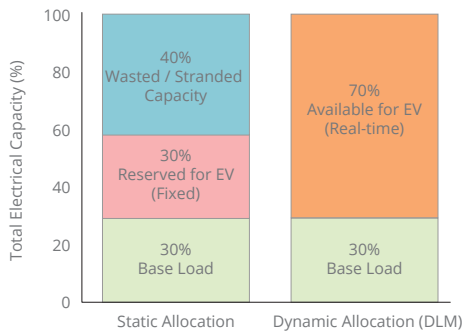


Figure 2: Static vs. Dynamic Load Management

Dynamic Load Management (DLM) resolves this paradox by shifting the control paradigm from static provisioned capacity to real-time available capacity.

## 2. THEORETICAL FRAMEWORK

The fundamental logic of DLM can be expressed as a dynamic equation for available power calculated by:

$$P_{EV\_Available}(t) = P_{Transformer\_Max} - P_{Building\_Base\_Load}(t) - P_{Guard\_Band}$$

Where:

$P_{EV\_Available}$  is the available power.

$P_{Transformer\_Max}$  is the rated kVA capacity of the transformer.

$P_{Building\_Base\_Load}$  is the base load of the building.

$P_{Guard\_Band}$  is the measurement uncertainty and transient risk.

To maximize  $P_{EV\_Available}(t)$  the control system must minimize the uncertainty in measuring  $P_{Building\_Base\_Load}$ . The magnitude of the  $P_{Guard\_Band}$  is inversely proportional to the accuracy and speed of the metering infrastructure.

Figure 3 and 4 depicts the impact of different class meters using the previously considered 2000A scenario on system capacity.

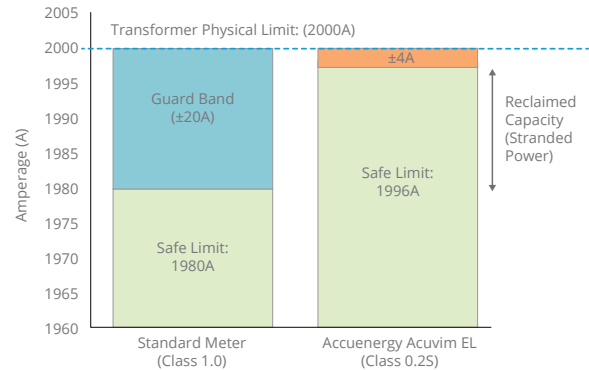


Figure 3: Impact of Accuenergy Acuvim EL Class 0.2S on Usable System Capacity

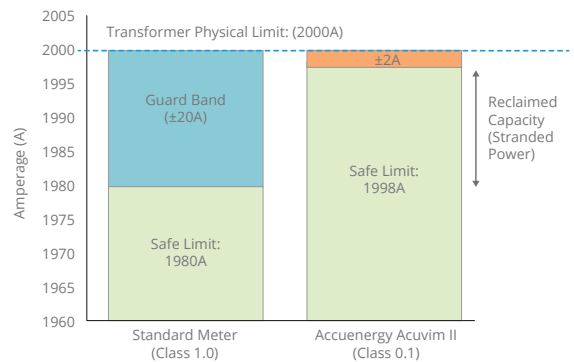


Figure 4: Impact of Accuenergy Acuvim II Class 0.1 on Usable System Capacity

Figures 3 and 4 illustrate the mandatory guard band required by control logic to account for measurement uncertainty. A standard Class 1.0 meter forces the system to reserve a  $\pm 20A$  buffer, capping usable capacity at 1980A to prevent false breaker trips. While Acuvim L with class 0.2, reduces this buffer to just  $\pm 4A$ , safely extending the operational limit to 1996A and Acuvim II has class 0.1, reduces it to  $\pm 2A$  and increases the safety limit to 1998A. The reclaimed capacity represents the stranded power that can now be utilized for EV charging without infrastructure upgrades.

## 3. THE CONTROL LOOP MECHANISM (MEASURE - CALCULATE - CONTROL)

The Electric Vehicle Supply Equipment (EVSE) controller operates as a closed-loop feedback system. It requires real-time telemetry from the main service meter to dynamically adjust the output of the chargers.

### Step 1: Telemetry Input (Telemetry Acquisition)

The meter (e.g. Acuvim II) polls the main service entrance via Modbus TCP/IP. It measures and provides two critical data points. The total apparent power ( $P_{Grid}$ ) to ensure the total load stays below the transformer limit (e.g. 2000kVA) and current per phase ( $I_A, I_B, I_C$ ) to prevent phase imbalance and protect individual breakers.

# Precision Metering as the Enabler of Dynamic Load Management

## Overcoming Infrastructure Constraints in High-Density EV Charging

### Step 2: Capacity Calculation (Logic Processing)

The EVSE controller calculates the available headroom in real-time using the ratings and measured demand as stated below.

$$I_{Available} = I_{Breaker\_Limit} - I_{Building\_Load\_Measured} - I_{Safety\_Buffer}$$

### Step 3: Load Throttling (Command Execution)

Based on the calculated headroom, the controller sends commands to the EV chargers via Open Charge Point Protocol (OCPP) or Modbus to adjust their charging rate.

For example, if a sudden building load spike occurs like an HVAC startup, it reduces the available headroom, and the controller instantly commands all EVs to drop from 40A to 6A. The entire cycle of measure, calculate and control cycle must happen in sub-seconds to prevent the main breaker from tripping during the spike. This is the main reason that fast metering is mandatory.

## 4. CRITICAL TECHNICAL ENABLERS

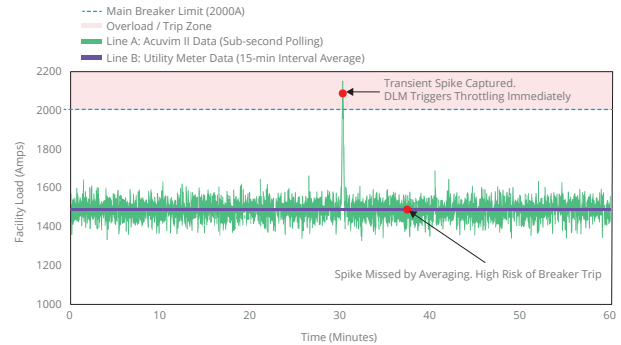
For a DLM system to operate safely near the transformer's physical limit, the metering infrastructure must address three challenges. They are measurement accuracy, latency to response, and circuit density.

### 4.1 Minimizing the Guard Band via Accuracy

In control theory, measurement uncertainty necessitates a guard band to prevent overshoot. If a main service meter has a 1.0% error margin (Class 1.0) on a 2000A service, the controller must reserve  $\pm 20A$  as a buffer zone. Accuenergy provides two tiers of precision metering to minimize this waste. The premium tier, Acuvim II Series, meets ANSI C12.20 Class 0.1 standards which reduces the guard band to negligible levels of less than 2A error on 2000A service. The standard tier, Acuvim-EL model of the Acuvim L series, offers a cost-effective alternative while maintaining IEC 62053-22 Class 0.2S and ANSI C12.20 Class 0.2 accuracy, reducing the guard band to  $\pm 4A$  on a 2000A service. Both platforms allow DLM algorithms to safely utilize more than 99% of the transformer's capacity. The choice between them depends on the specific dynamic requirements of the load and not a compromise on steady-state accuracy.

### 4.2 Transient Response and Sub-Second Polling

Building loads are static but elevators, HVAC systems, and process equipment create sudden demand spikes. A DLM controller relying on standard 15-minute integrated demand data which is standard for utility billing intervals is blind to these transients, creating a high risk of main breaker trips. The Acuvim II and AcuRev 4100 support sub-second polling via Modbus TCP/IP. They have fast response which allows the DLM controller to detect a building load spike and throttle EV chargers within milliseconds, maintaining system stability even in dynamic environments. Standard Load Balancing (Acuvim-EL model): For commercial facilities with predictable load profiles, the sampling rate of 512 samples/cycle in the Acuvim-EL model provides a high-resolution waveform capture, with a 1-second Modbus data update rate to the DLM controller. This makes the Acuvim-EL model a robust and economical solution for environments where building loads change gradually and sub-second throttling response is not required.

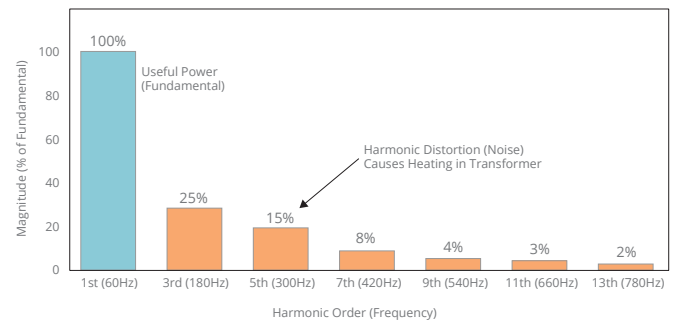


**Figure 5: Impact of Meter Sampling Rate on Transient Load Detection (Sub-Second Polling vs. 15-Minute Interval Data)**

The graph in Figure 5 illustrates a transient load spike lasting approximately 30 seconds (e.g. simultaneous EV charger start-up) that exceeds the 2000A main breaker limit. The line A, or the green trace represents Acuvim II's sub-second data which accurately captures the magnitude and duration of the spike, allowing the DLM controller to trigger protective throttling immediately. The Line B, or the grey step line represents a standard utility billing meter's 15-minute average data. Due to averaging, the spike is completely invisible to the control logic, resulting in a high probability of a breaker trip.

### 4.3 Power Quality and Harmonic Mitigation

EV chargers utilize power electronics such as rectifiers that act as non-linear loads and introducing Total Harmonic Distortion (THD) into the distribution grid. High THD causes transformers to overheat even when operating below their rated kW load which leads to K-Factor derating as depicted in Figure 6.



**Figure 6: Typical Current Harmonic Spectrum Generated by EV Rectifiers**

The chart in Figure 6 illustrates the non-linear load characteristics of EV chargers. The blue bar represents the fundamental frequency at 60Hz, which delivers useful power and the red bars represent harmonic distortion (3rd, 5th, 7th orders) generated by the switching electronics. These harmonic currents cause additional heating in transformers and conductors without contributing to active power delivery. Unlike basic energy loggers, the Acuvim II provides real-time monitoring of power quality parameters, including THD and individual harmonics which allows facility managers to implement thermal protection strategies, preventing premature transformer aging.

# Precision Metering as the Enabler of Dynamic Load Management

## Overcoming Infrastructure Constraints in High-Density EV Charging

### 5. DEPLOYMENT SCALABILITY WITH THE TURNKEY

#### APPROACH

As EV charging networks expand from single pilots to multi-site rollouts, engineering consistency and environmental protection become major challenges.

#### 5.1 Standardized Infrastructure using the AcuPanel 9104X

Field variability introduces commissioning risk. Wiring inconsistencies, improper shorting blocks, or environmental exposure can compromise data integrity which can be resolved with AcuPanel 9104X.



Figure 7: AcuPanel 9104X

To mitigate installation risks, Accuenergy introduces the AcuPanel 9104X, a pre-configured metering enclosure designed for rapid deployment.

- Standardizing Field Deployment: By pre-wiring voltage fuses, shorting blocks, and terminals in a factory-controlled environment, the AcuPanel 9104X reduces on-site wiring errors and commissioning time by up to 70%.
- Environmental Resilience: The NEMA 4X rated polycarbonate enclosure allows the metering node to be deployed directly in harsh environments, such as outdoor parking lots or exposed transformer pads, without requiring additional cabinetry.
- Scalability: Whether using the Acuvim II for a main distribution panel or an Acuvim L for a sub-panel, the standardized form factor ensures a consistent maintenance experience across all sites.

#### 5.2 High-Density Branch Monitoring with AcuRev 4100 Series

The AcuRev 4100 series transforms DLM from a bulk throttling system into a granular optimization platform.



Figure 8: AcuRev 4100 Series

For the charging circuits themselves, the AcuRev 4100 series offers high-density integration. The key capabilities are:

- Density: Monitors up to 24 single-phase circuits in a single device, replacing banks of individual meters.
- Retrofit Viability: Supports flexible Rogowski coils, enabling installation on existing busbars without power shutdowns.

### 6. SYSTEM ARCHITECTURE & TOPOLOGY

An effective DLM architecture requires a hierarchical metering topology to ensure granular control and scalability as depicted in Figure 9.

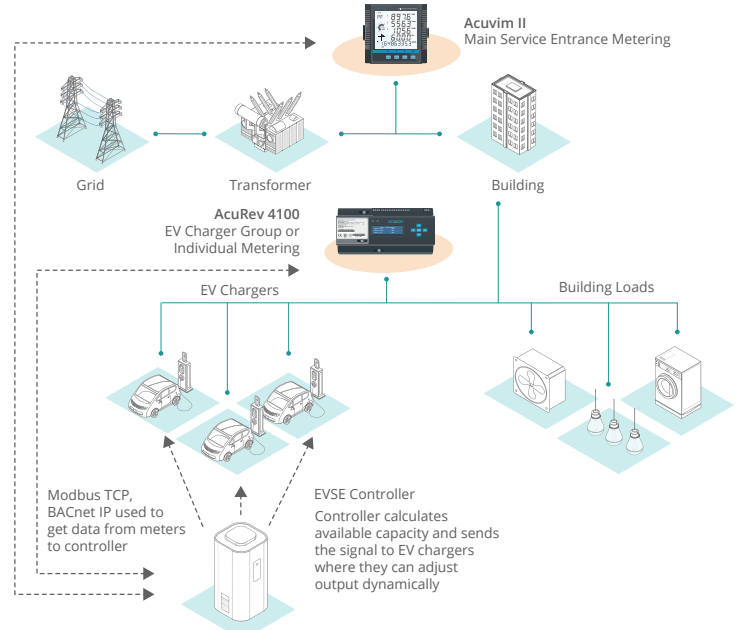


Figure 9: System Architecture

As depicted in Figure 9, in the main service entrance the Acuvim II serves as the primary telemetry node at the main switchboard. It continuously monitors the total facility demand ( $kW_{Total}$ ) and transmits this data to the EVSE Controller or Energy Management System (EMS) via Modbus TCP/IP or BACnet IP.

As charger density increases in the EV distribution and branch circuits, the distribution panel space becomes a premium. The AcuRev 4100 Series addresses this through high-density integration as it monitors up to 24 single-phase circuits or 8 three-phase chargers within a single device enclosure, significantly reducing the installation footprint compared to individual meters. It also provides retrofit viability by supporting flexible Rogowski coils, allowing installation on existing busbars or cables without requiring disconnection or power shutdowns for rapid retrofit installation in space-constrained panels.



Figure 10: AcuRev 4100 Multi-Circuit Meter Paired with Flexible Rogowski Coils

Another advantage is data aggregation as it consolidates 24 measurement channels into a contiguous Modbus register map, allowing the controller to fetch all charger states in a single query cycle.

# Precision Metering as the Enabler of Dynamic Load Management

## Overcoming Infrastructure Constraints in High-Density EV Charging

---

### 7. CONCLUSION

Dynamic Load Management (DLM) enables high-density EV charging without transformer updates when supported by precise metering infrastructure. It is not merely a software application; it is a hardware-dependent control strategy. The safety and efficiency of DLM deployment are directly correlated to the fidelity of its telemetry. Safe operation near service limit requires revenue-grade accuracy to minimize guard bands. Sub-second telemetry is required to manage transient events and granular branch monitoring to optimize distribution across multiple chargers to ensure long-term system integrity.

By integrating the Accuenergy flexible ecosystem—selecting the Acuvim II for high-speed precision at Class 0.1 precision and sub-second telemetry; the Acuvim L for Class 0.2S accuracy which provides cost effective monitoring data. Incorporating the AcuRev 4100 for high density branch-level monitoring and utilizing the AcuPanel 9104X for standardized deployment—facility managers can confidently operate their electrical infrastructure closer to its physical limits. This approach maximizes EV charger availability while strictly enforcing electrical code compliance with safety margins.

### Important Notice and Disclaimer

This resource document is provided for informational purposes only and is subject to change without notice. While every effort has been made to ensure accuracy, no representation or warranty, express or implied, is made regarding the completeness or reliability of the information contained here in. The user is solely responsible for the proper installation, configuration, and use of the products described in this resource document. The manufacturer assumes no liability for damages resulting from the use or application of the information provided.

### Connect with Our Experts

Please consult the Accuenergy Technical Support team for any technical queries or the Sales team to discuss your project requirements at [marketing@accuenergy.com](mailto:marketing@accuenergy.com)

TF: 1-877-721-8908  
INT: +1-416-497-4100  
440 Comstock Road  
Toronto, ON M1L 2H6, Canada

