Evolution of Static & Dynamic UPS

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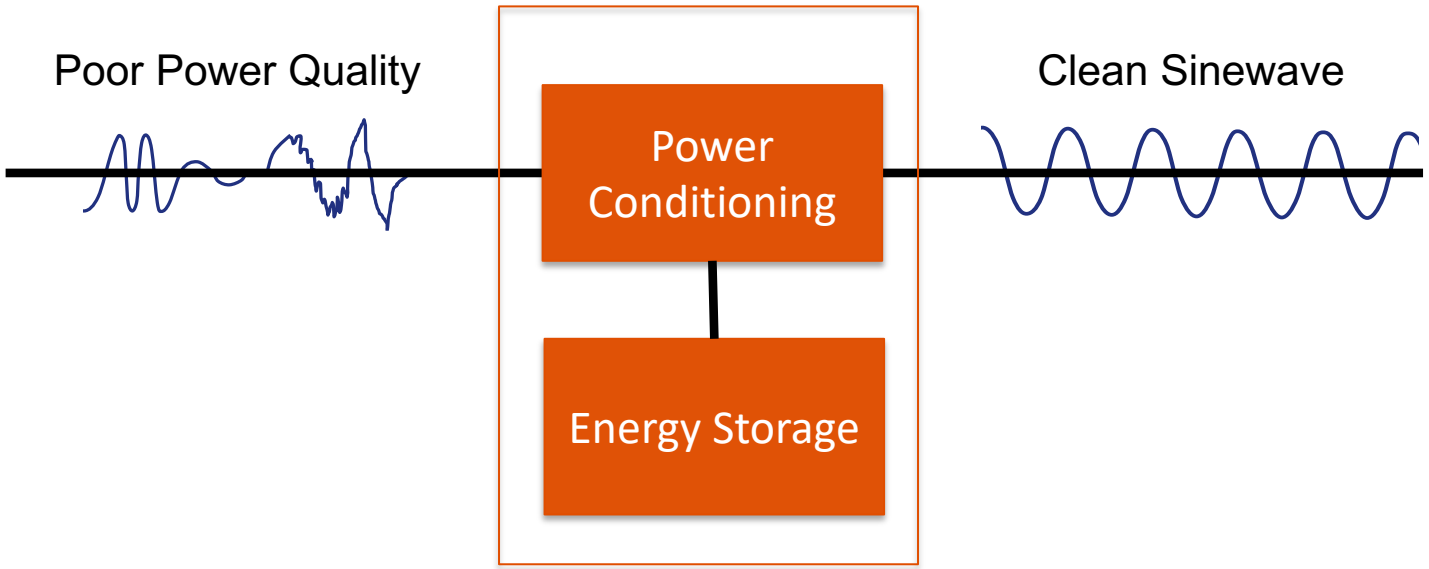
Introduction to UPS Technology

UPS Basics

An Uninterruptable Power Supply has two primary functions:

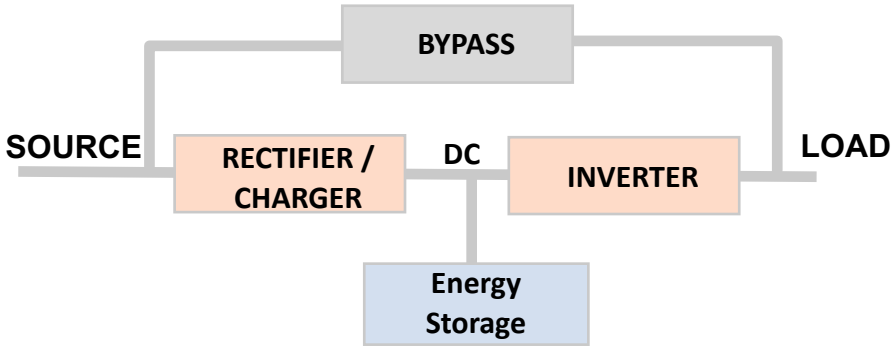
(1) Provide clean conditioned power within an accepted load tolerance regardless of input power quality

(2) Protect against total input failure ensuring a clean uninterrupted transfer of power to the UPS energy store.



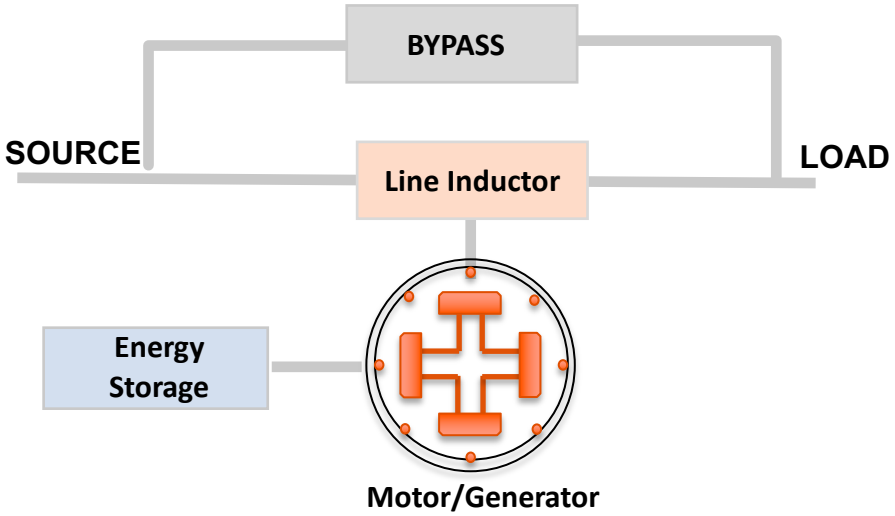
Introduction to Static & Dynamic (or Rotary) UPS

Static UPS System



- Double conversion (VFI) typical
- Available “Off the shelf” as a component within the critical power system
- Transformer vs Transformer-less
- Paralleling of transistors for increased power output; well suited for applications < 1000kVA
- Advancements in both rectifier and inverter power electronics.
- Eco/bypass mode vs Online.

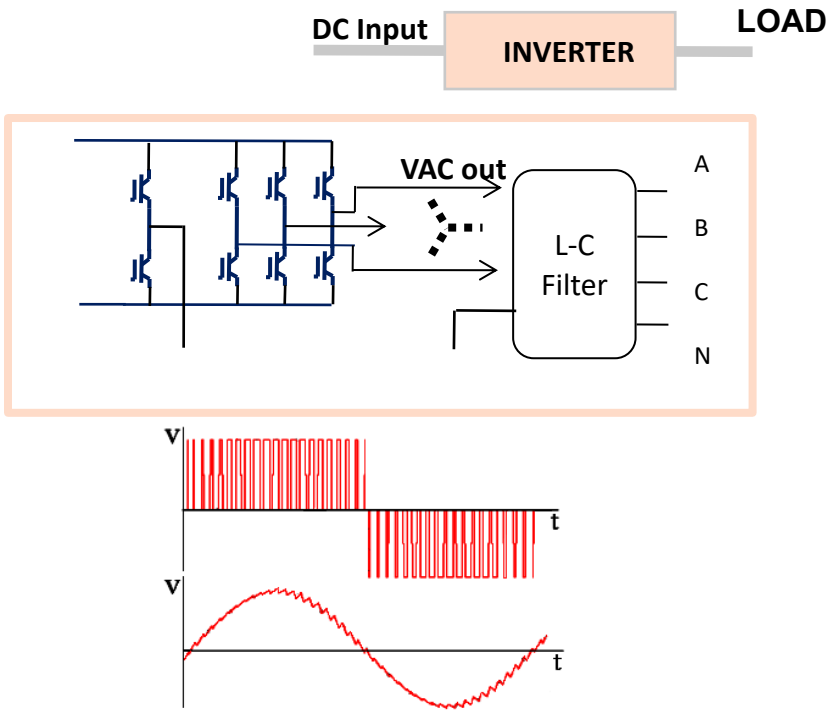
Dynamic UPS System



- Parallel Online (VI)
- Available custom built to order as an integrated system solution
- Well suited for applications > 1000kVA
- Advancements in integration and operational design of synchronous M/G and energy storage.
- Engine coupled Dynamic UPS vs electrically connected generator

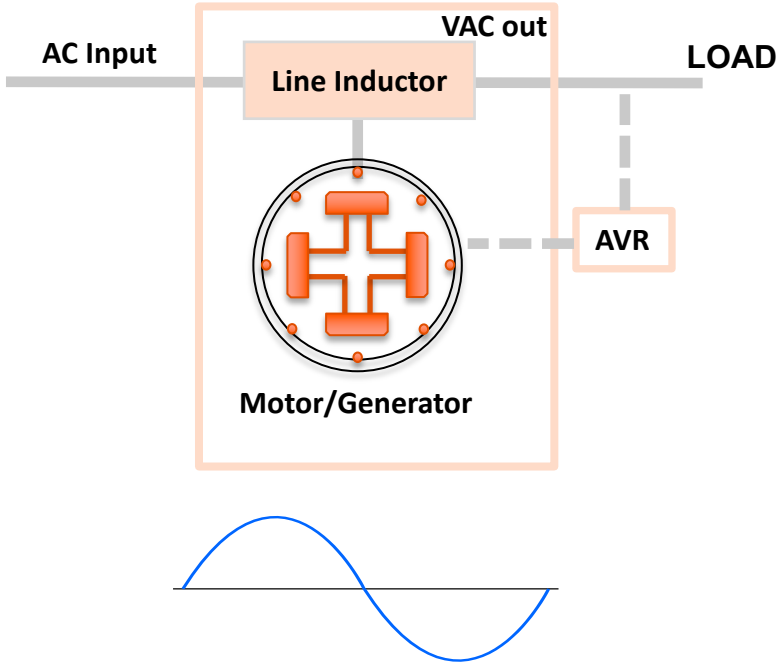
UPS Technologies: Power Conditioning

Static UPS System



- Pulse Width Modulation to re-create sinusoidal signal.
- LC filter to suppress harmonics generated from inverter.

Dynamic UPS System



- Regulated power provided by modern synchronous M/G.
- No harmonics produced. Line Inductor isolates load and utility harmonic propagation.

UPS Technologies: Energy Store

- Lead Acid Batteries
  - VRLA
  - Flooded
  - 2.0v per cell
  - 1, 2, 3, 4, 6 and soon 8 cells per container
  - Containers called jars or blocks

- Flywheels
  - High speed
  - Low speed

UPS Technologies: Energy Store Con't

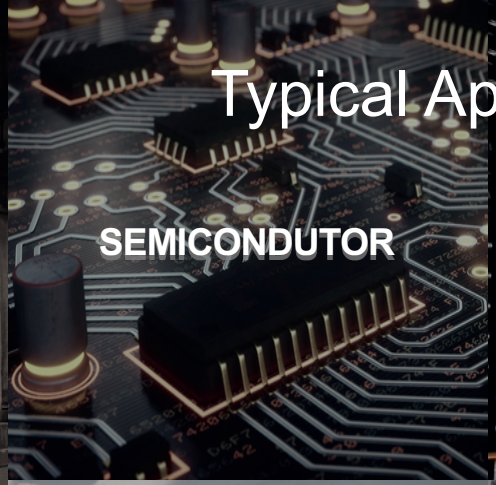
Battery (Chemical)

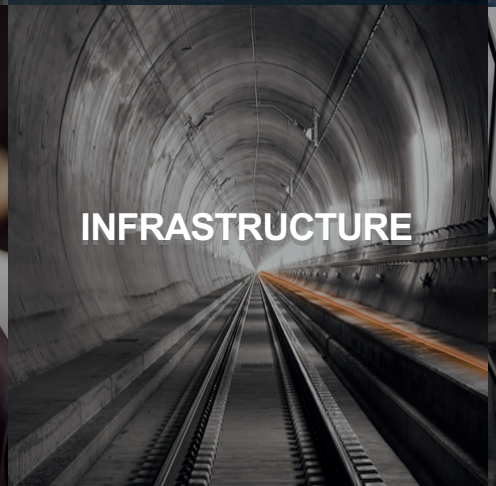
- High demand energy resource in transportation, consumer electronics, and bldg. infrastructure markets.
- Well suited for minutes of autonomy applications
- Duty cycle and recharge improvements
- Well suited for small power applications

Battery (Kinetic)

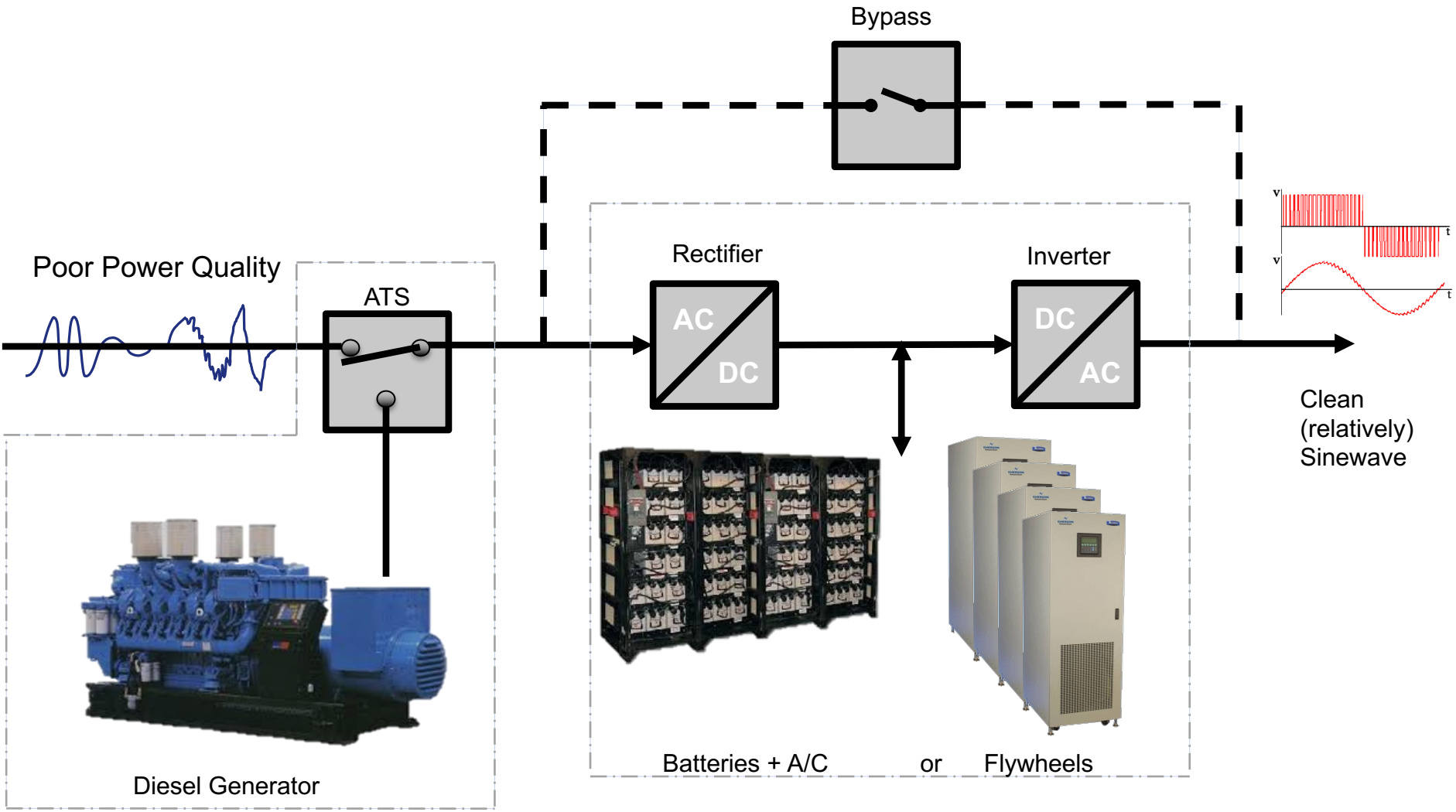
- Value engineered to bridge to an alternate long term energy source.
- 25+ year design life
- Nearly infinite duty cycle
- NFPA855 / UL9540A not applicable.
- 5.5ft x 14ft for 2.88MW; high power density
- MTBF / MTTR: 376.6k hrs / 48hrs (for just flywheel)

Typical Applications

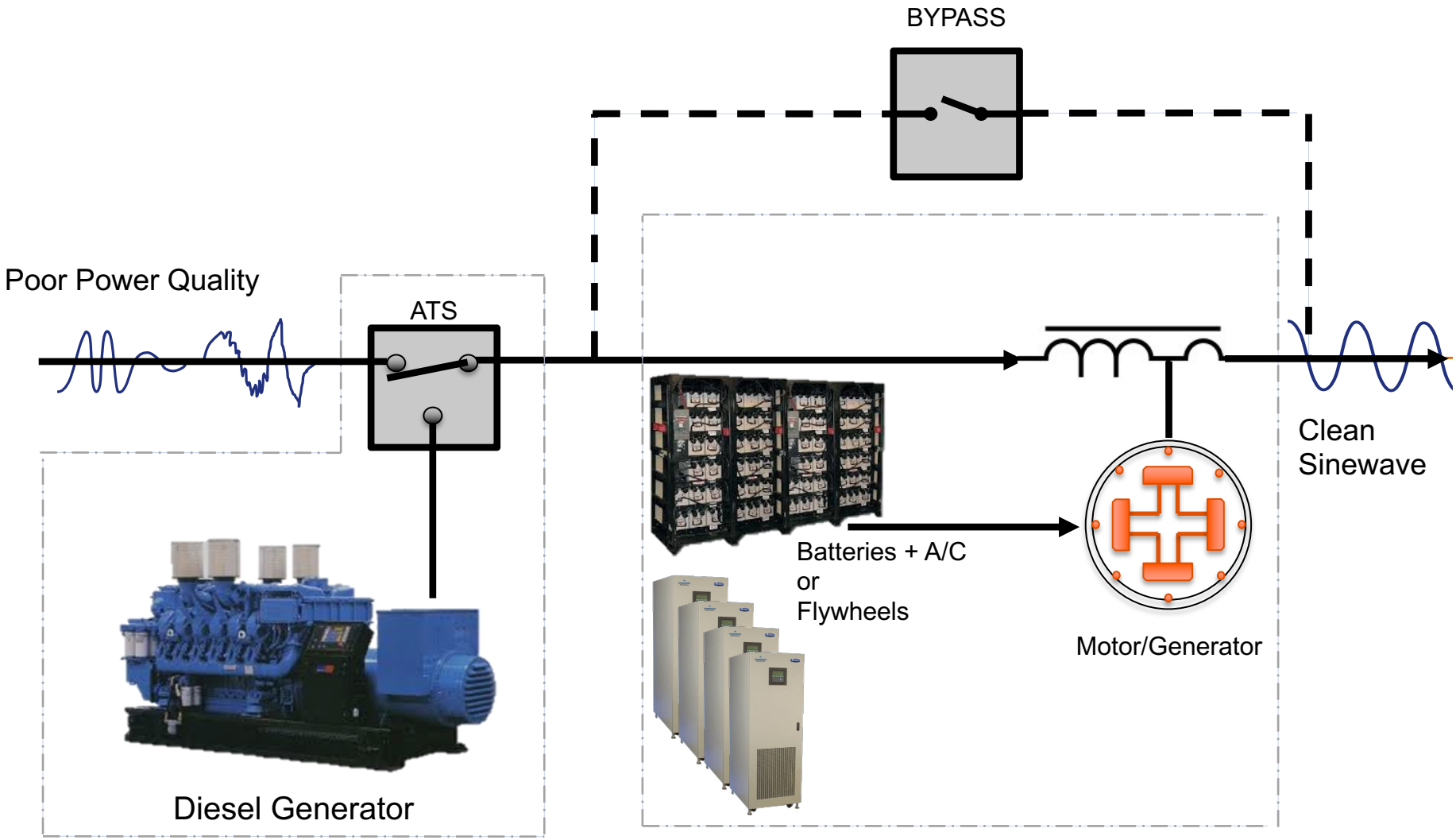




Adding Stand-by Power Infrastructure to Static UPS

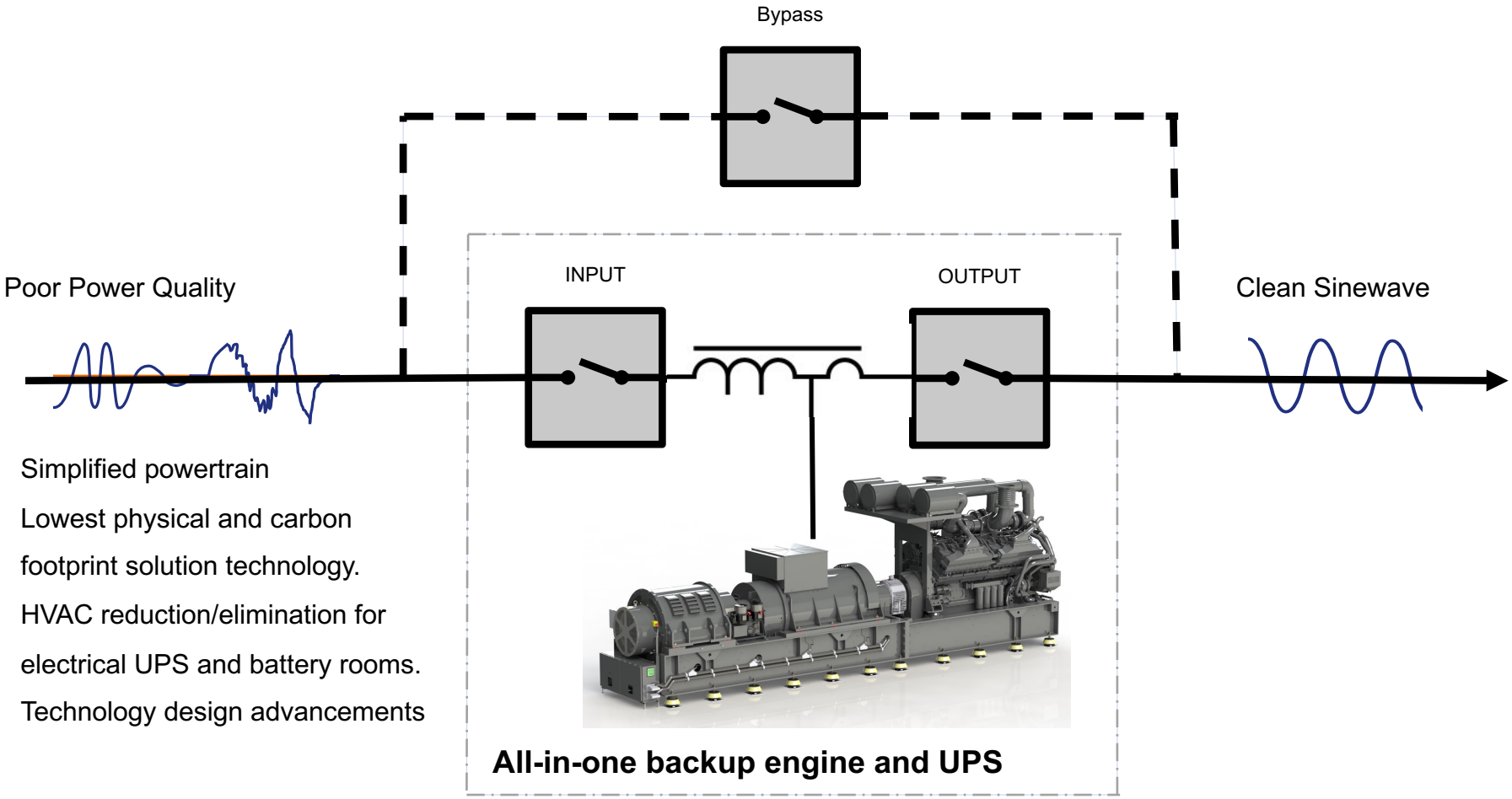


Adding Stand-by Power Infrastructure to Dynamic UPS



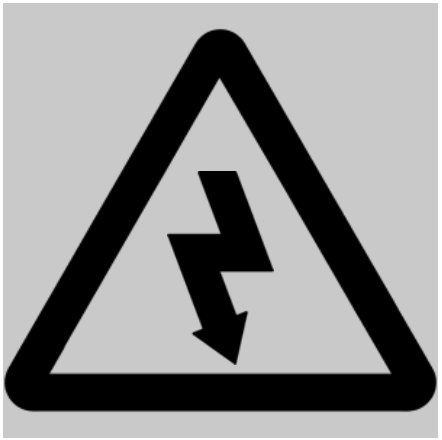
Adding Stand-by Power Infrastructure to Dynamic UPS

DRUPS or (Diesel Rotary UPS), also known as CPS (Continuous Power System)



- Simplified powertrain
- Lowest physical and carbon footprint solution technology.
- HVAC reduction/elimination for electrical UPS and battery rooms.
- Technology design advancements

Operational Voltage Capabilities



Low Voltage

400 – 600V

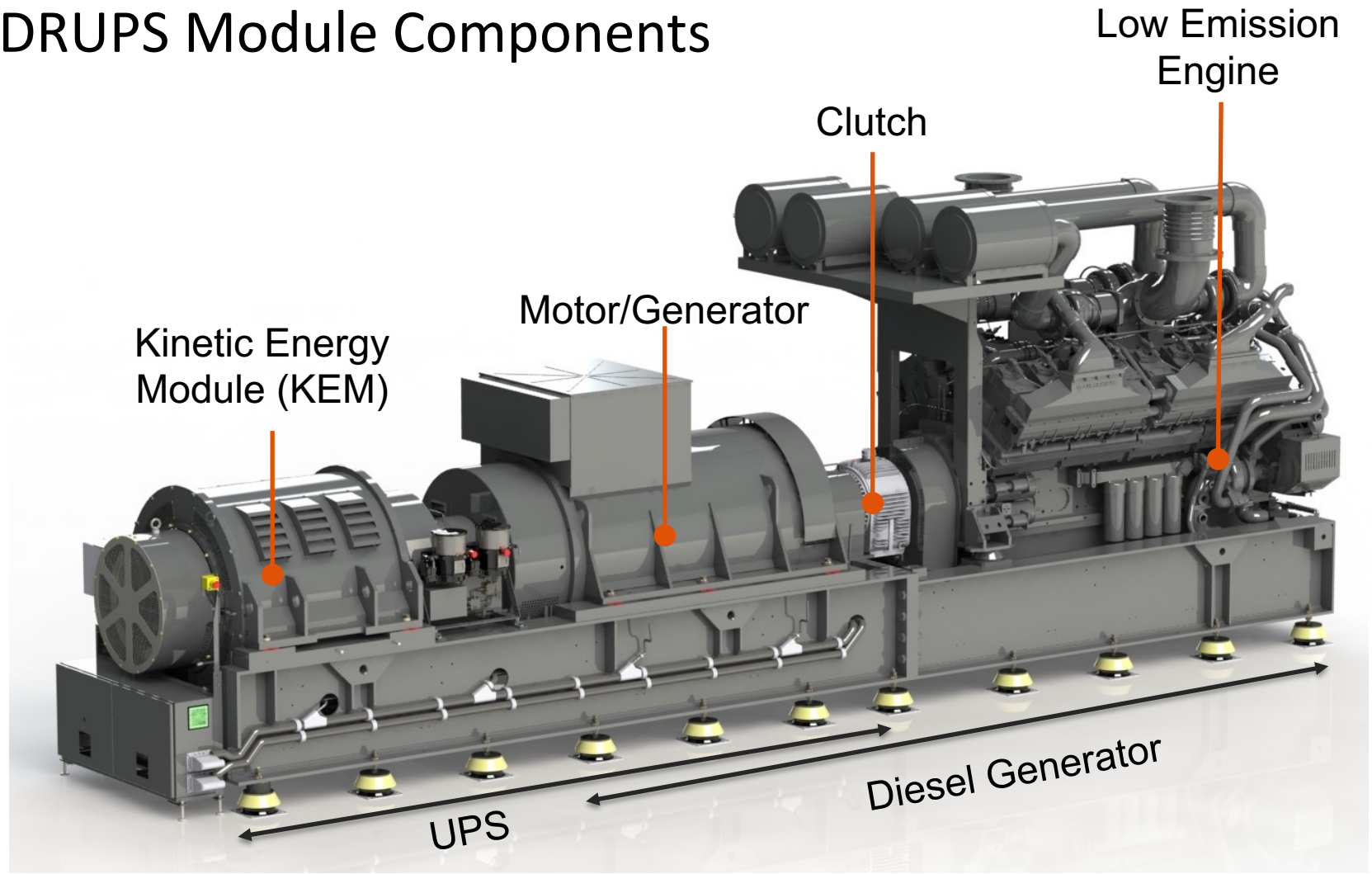
3 ph. 3 wire
3 ph. 4 wire

Medium Voltage

5 – 35kV

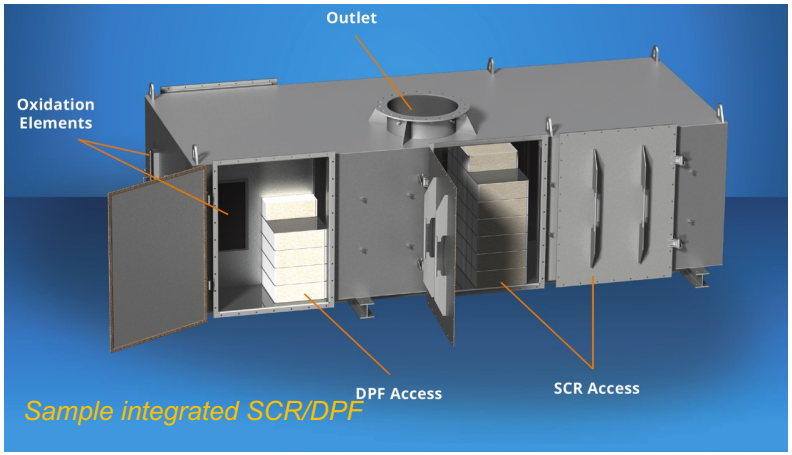
3 ph. 3 wire
3 ph. 4 wire

DRUPS Module Components



Model Ref: *PowerPRO*2700 (2700kVA)

Engine after treatment – Meeting EPA Tier IV final



Engine Cycle Data

Load	Speed	Power	Exhaust Flow	Exhaust Temp.	Fuel Cons.	NO_x	CO	NMNEHC	PM_{10}	O_2	H_2O
%		*bhp*	*acfm (cfm)*	*° F*		*g/bhp-hr*	*g/bhp-hr*	*g/bhp-hr*	*g/bhp-hr*	*%*	*%*
100	Rated	2,922	15,385	900		4.8	2.6	0.14	0.15	10	12.5

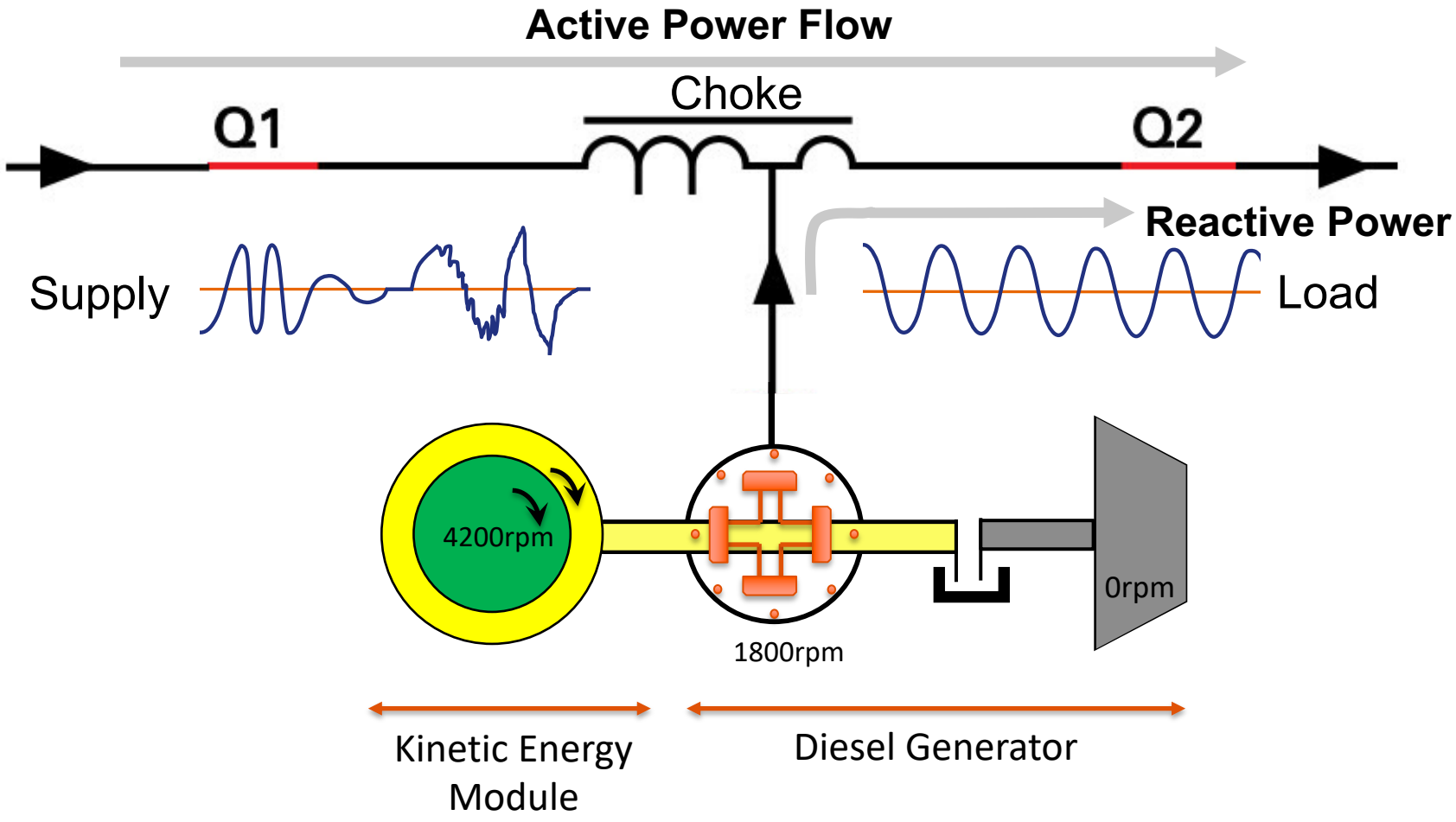
Emission Data (100% Load)

Emission	Raw Engine Emissions						Target Outlet Emissions						Calculated Reduction
	g/bhp-hr	*tons/yr*	*ppmvd @ 15% O_2*	*ppmvd*	*g/kW-hr*	*lb/MW-hr*	*g/bhp-hr*	*tons/yr*	*ppmvd @ 15% O_2*	*ppmvd*	*g/kW-hr*	*lb/MW-hr*	
NO_x*	4.8	15.46	447	826	6.437	14.19	0.5	1.61	47	86	0.671	1.48	89.6%
CO	2.6	8.37	398	735	3.487	7.69	2.6	8.37	398	735	3.487	7.69	
NMNEHC**	0.14	0.45	37	69	0.188	0.41	0.14	0.45	37	69	0.188	0.41	
PM_{10}	0.15	0.48	54	99	0.201	0.44	0.02	0.06	7	13	0.027	0.06	86.7%

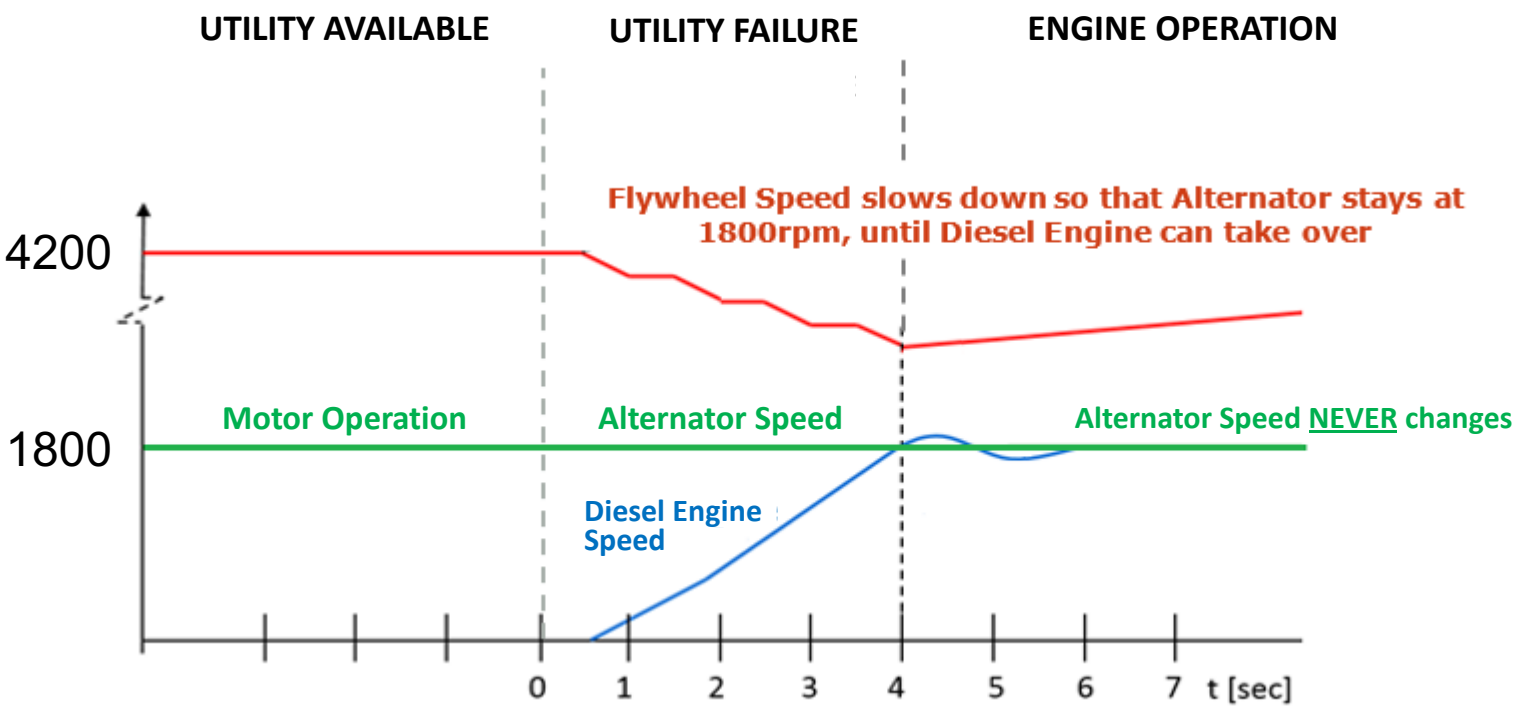
Sample GHG emission reduction data

Dynamic UPS (DRUPS) Operational Review

Power Conditioning Mode



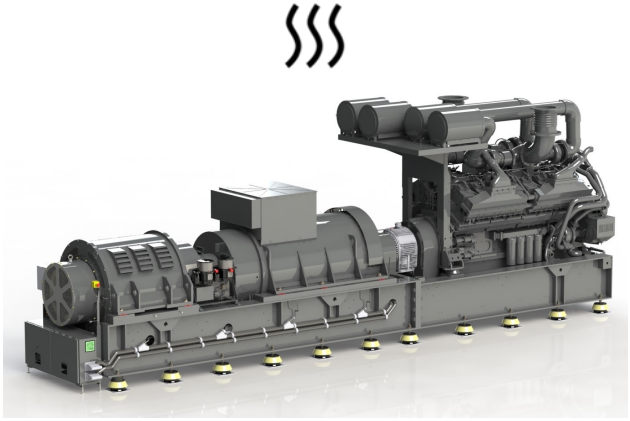
Seamless Transfer to Stand-by Engine



Modern DRUPS Design Advancements

Example SYSTEM Efficiency (100% Load @2MW)

100%



97%

100%

Battery
Inc. in UPS Losses

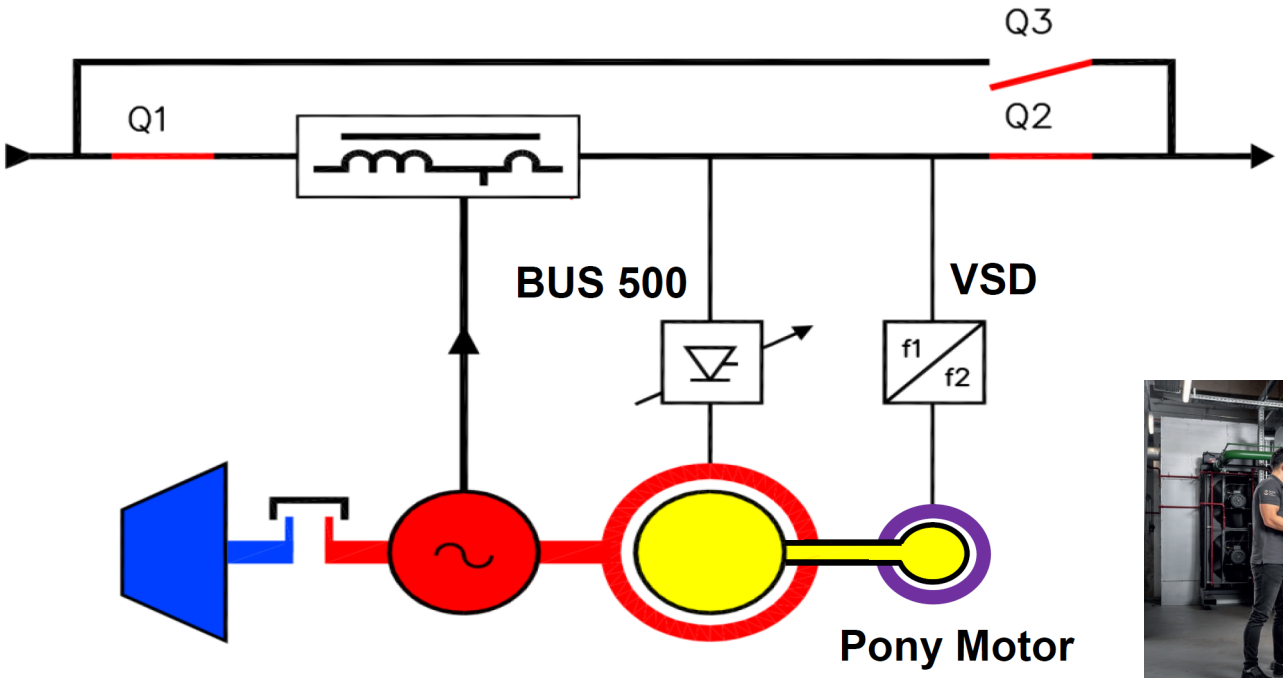
UPS
60kW (97%)

Air Conditioning
239000BTU/hr = 69.7kW

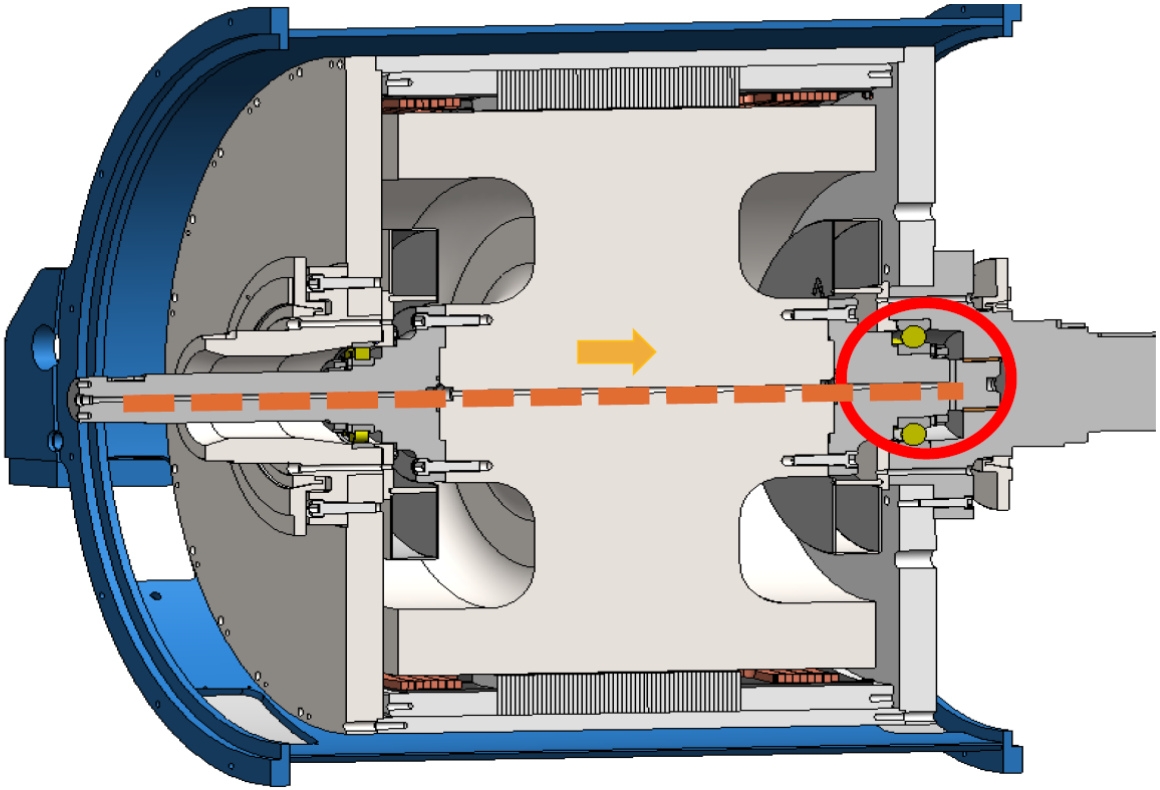
Diesel Genset
~5kW

93.2%

Efficiency Improvements with DRUPS



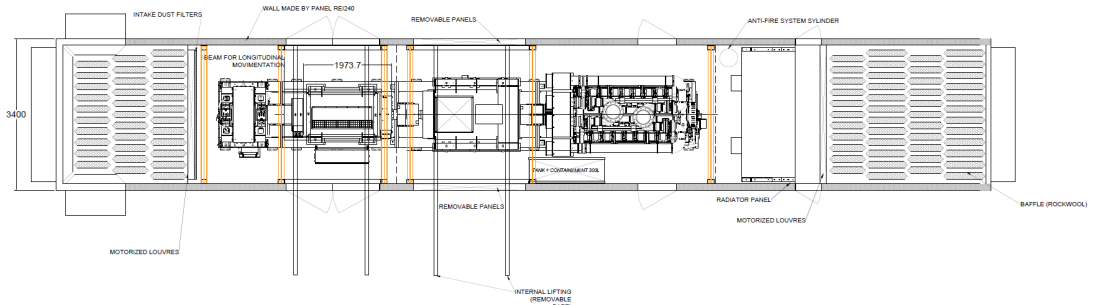
Kinetic Energy - Advancements in ventilation design



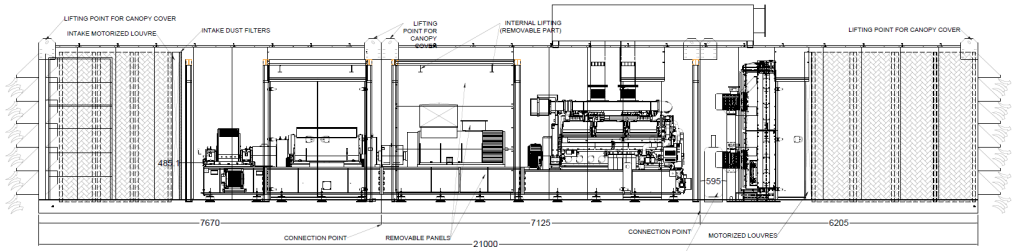

HITEC
Power
Protection
PowerPRO2700

No space indoor?

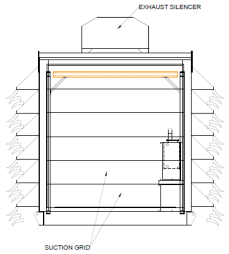
Example 2.5MW Power Block (70ft x 12ft), Smaller options Available



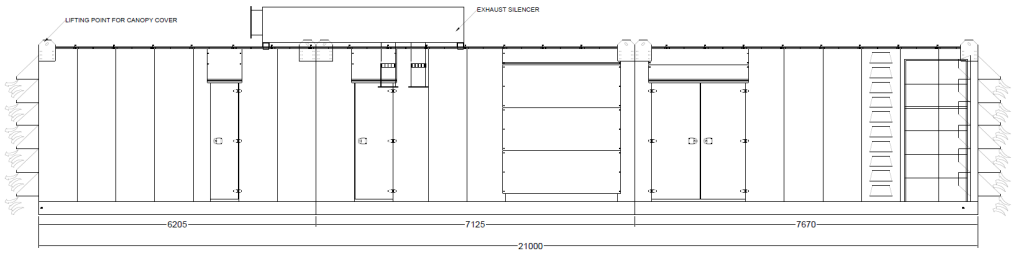
DRUPS CONTAINER - PLAN VIEW
N.T.S

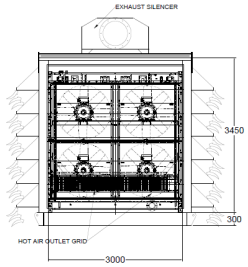


DRUPS CONTAINER - SECTION
N.T.S



RIGHT VIEW
N.T.S





Conclusion

Static UPS System

- Battery energy storage chemistries.
- Transformer-less 3-level IGBT market preferred.
- Online VFI emerged victorious over Eco mode
- Lack of silicon carbide cost / benefit.
- Participation in energy arbitrage to help offset CAPEX expenditure.

Dynamic UPS System

- Alternative lower carbon fuel source for engine.
- Interim period - expanded use of modern engine after-treatment systems.
- Dynamic UPS Debate: DRUPS/Engine coupled vs electrically coupled.
- New flex power applications – DRUPS integrated with BESS

Integrated systems provided as a solution will continue to rise

Thank you for your time..