



***Is It Time To Take A Serious Look At
Convection Cooled Switched Mode
Rectifier/Chargers Again?***

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Rectifier/Charger Types

Circa.

1910's Magnetic Amplifier (Mag Amp)

1960's. Controlled Ferroresonant (Controlled Ferro)

1960's Silicone Controlled Rectifier (SCR)

1970's Switched Mode Rectifier (SMR) – Convection Cooled

1980's Switched Mode Rectifier (SMR) – Fan Cooled

Early Rectifier/Chargers

Typical Mag Amp



Typical Controlled Ferro





SCR Chargers

Typical Modern SCR Chargers



Switched Mode Rectifier/Chargers



Early Convection cooled



Modular Fan Cooled System



Fan Cooled



Modern Convection Cooled



Modular Convection Cooled System



SCR Chargers

SCR Chargers which convert the ac to dc at the frequency of the electrical utility (50/60 Hz), are the most popular way of providing dc power for almost all industrial and utility battery backed power systems. There are many reasons for this and a few are:

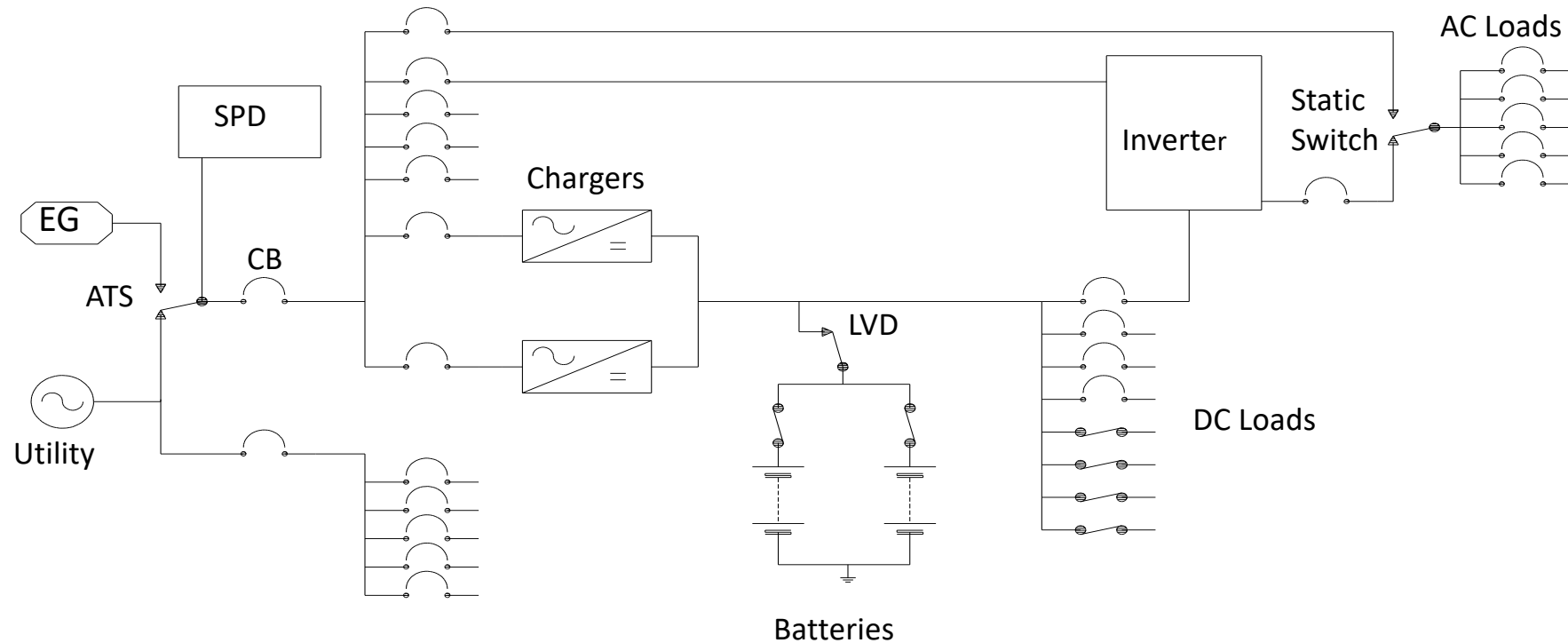
- **It is a tried and true reliable technology.**
- **Why change if it is not broken?**
- **Convection cooling is preferred. Forced air cooling was an issue.**
- **Space was not an issue.**
- **The load equipment was not changing at the same pace as other market sectors such as communications and IT.**
- **Skilled technicians were available to maintain and service power equipment.**

But there were, and are, problems.



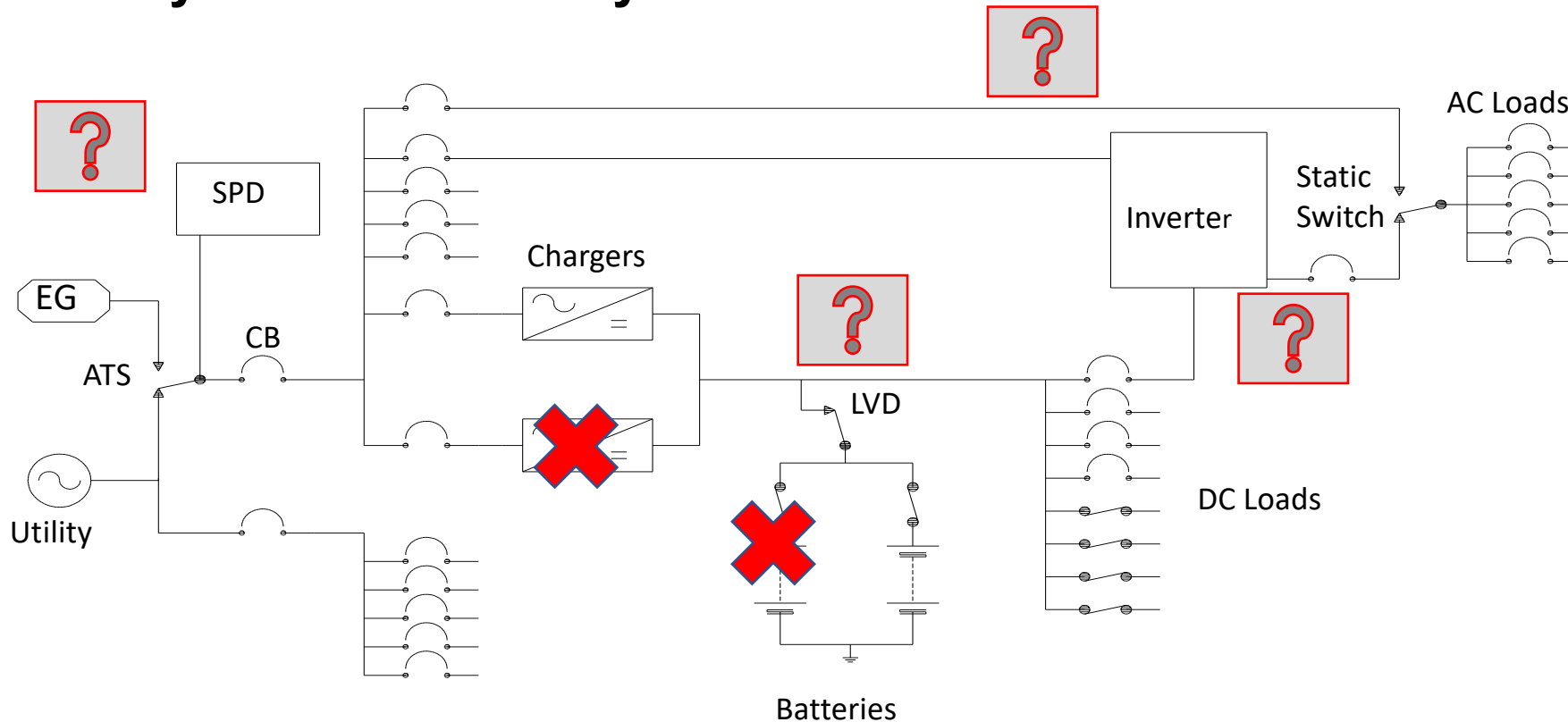
So what are the problems?

Typical Communications DC Power System. Highly Redundant.



So what are the problems?

**Typical Industrial/Utility DC Power System.
No Redundancy and Several Gray Areas**



So what are the problems?

Maintainability.

Say this SCR charger fails.
Your options are:

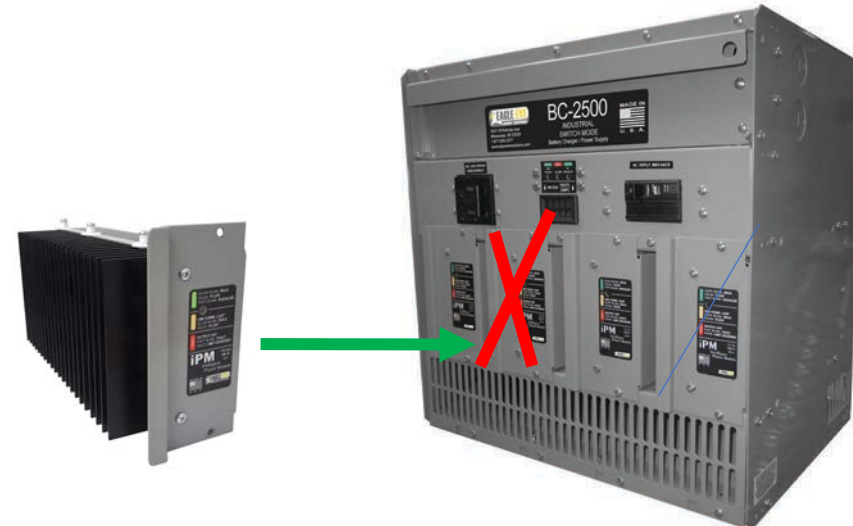
- Attempt a field repair, or
- Replace the unit.



130 lbs.

Say this modular SMR charger fails. Just change the charger hot. System remains on-line.

So easy even a sales guy could do it!



6 lbs.

65 lbs.



So what are the problems?

So you're smart and want redundancy

You can do this.



With a modular approach you've already got it.





So what are the problems?

Need to grow more?

You can do this.



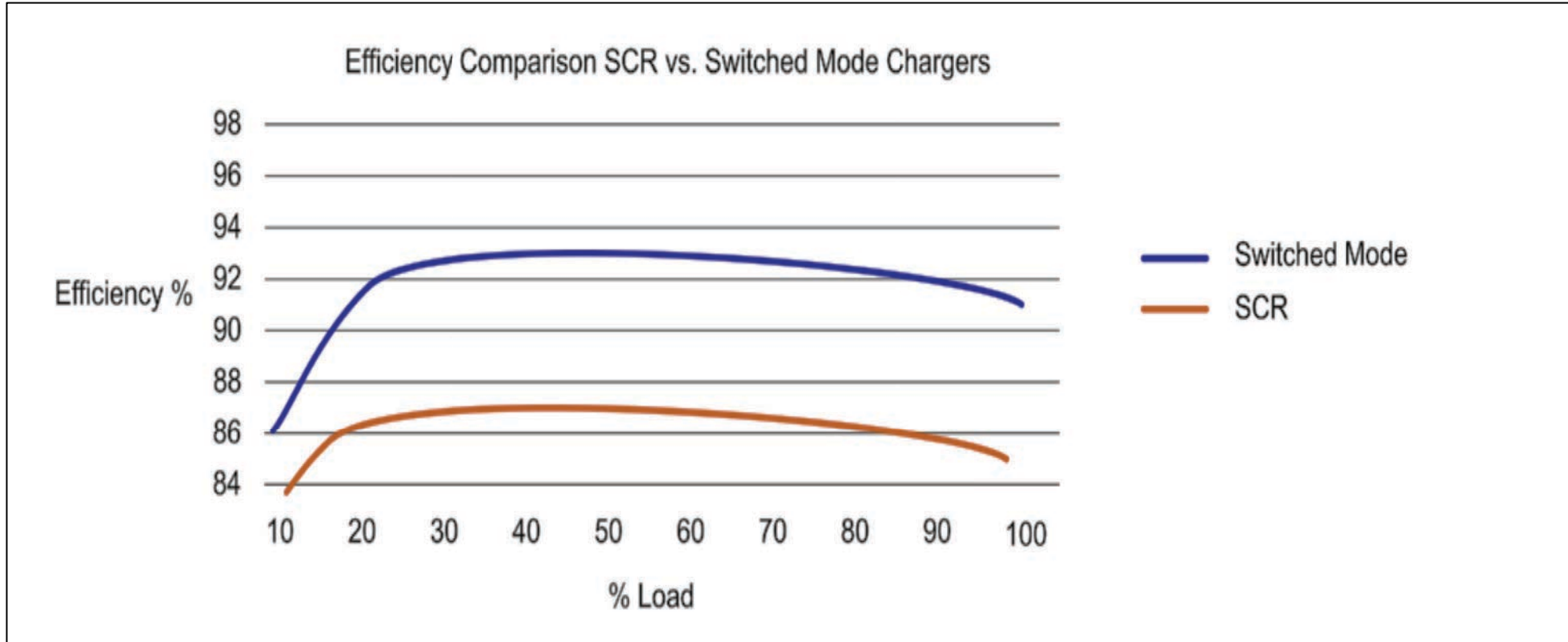
No problem





So what are the problems?

Efficiency.





So what are the problems?

Actual lab test results of a SCR charger compared to a SMR charger

	SCR Measured Values		Switch Mode Measured Values	
	25A Full Load	4A Float Load	25A Full Load	4A Float Load
Output DCV	130.00	130.80	130.00	130.88
Output DCI	24.46	4.02	24.40	3.98
Output Wattage	3179.80	525.82	3172.00	520.90
Input Voltage	240.00	240.50	240.10	240.00
Input current	26.27	6.21	14.40	3.14
VA	6290.00	1493.00	3445.00	753.00
VAR	3590.00	753.00	-904.00	-500.00
Power Factor (DPF)	0.73	0.67	-0.965	-0.74
Power Factor (TPF)	0.588	0.45	-0.960	-0.74
Input Wattage	3709.00	672.00	3309.00	556.00
Efficiency	0.86	0.78	0.96	0.94



So what are the problems?

Efficiency = ~~\$\$\$~~ ~~€€€~~ ~~₹₹₹~~ ~~WWRsRsNNPP~~

As shown in the previous table of the laboratory test:

- **At a full load of 25 Amps the efficiency difference is 400 Watts.**
- **This translates to 3,504 kWhr/year. (400 x 24 x 365).**
- **At a more realistic load of 4 Amps the difference is 116 Watts.**
- **This translates to 1,016 kWhr/year. (116 x 24 x 365).**

Even at a modest cost of 10 cents per kWhr, this would mean these cost savings:

- **At a 25 amp load, \$350.40 per year or \$3,504.00 over 10 years.**
- **At a 4 amp load, \$101.60 per year or \$1,016.00 over 10 years.**



So what are the problems?

Efficiency and the Environmental Regulators.

This is just the beginning folks!

One example is that the State of California, in 2011 mandated that the “California Energy Commission reduce the wasteful, uneconomic, inefficient, or unnecessary consumption of energy by prescribing standards for minimum levels of operating efficiency of appliances whose use, as determined by the Commission, requires a significant amount of energy on a statewide basis.”

At this point in time, the mandate only applies to devices under 2kW but watch for this to change. Almost all modern SMR’s would meet this mandate and that is not to say SCR’s would not, but the fact is that SMR’s are more efficient.

The Electric Power Research Institute (EPRI) states “Switch mode chargers of any topology are generally more efficient than the other types of charger.”



Summary

Given all of the above and other issues that time does not permit but are covered in the proceedings, it is time to take a serious look at using convection cooled SMR chargers in the industrial and utility industries.

I would like to thank Lester Electrical and Eagle Eye Power Solutions for their assistance with some data contained within this presentation.



Thank you for your attention.

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