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# Electrical Energy in the Future ...or, the future is now...

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# Generation and Distribution

Once upon a time, generation, distribution, and local service were a vertical monopoly. Everybody complained, so Congress decided to fix all this for us...

Enter the age of deregulation (aka Enron and friends)

- Generation and Distribution are separated

- The price consumers pay for electricity is fixed

- The cost distribution pays for electricity is not controlled

- The power producers are only responsible for what they ship

But, who's left holding the strings for the major distribution infrastructure??

In reality, no one has made any significant investment in the backbone distribution network for over 20 years, and what we have left is not ageing gracefully.



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# What does this mean to us?

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Most people think the way to tell a third-world country from a first-world country is to use the light switch test:

Flick the light switch, and if the lights come on **all the time**, you're in a first-world country.

But due to all the issues we're talking about, the quality and availability of power in the US is getting steadily worse

Who makes up the difference?

It's up to the user - if you care about the reliability of power you need to take measures at your own expense, because the privatized network isn't able to support you at 100% up-time.



# Static Energy Storage

The US Department of Energy has embarked on a major program under the Office of Transmission and Distribution: The Static Energy Storage Initiative

The basic premise is the desire to Time Shift electricity generation

- Peak shaving

- VARs support

- Lowering peak demand on overworked distribution feeders

- Postponing an upgrade

But who's going to pay for all this?



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# The value stream

Buy low, sell high:

The marginal cost of generation today is 3c - 4c/kWH at 2AM, and 16c - 18c/kWH at 2PM here in the US

Especially in the summer, there is substantial excess spinning capacity at night - why not store it at night, and sell it during the day?

16 - 4 -> +12c/kWH price delta. A 100kWH storage battery could generate \$12/day

Unfortunately, the inverter and battery pack costs >\$50,000 NOT a good Return on Investment

There's not enough margin here to make an economic case for storage - so "Where's the beef"



# The Value Stream

What really happens to a regional provider?

Mesa Power and Light in Mesa, AZ is a typical regional provider.

They are the only available power source for the residents and businesses of the City of Mesa.

Mesa has a contract, an obligation, and an expectation to provide power to its clients at all times

Mesa has long term contracts for power from a variety of generation sources at various long term rates, averaging in the range of 8c - 12c/kWH

During those long hot days of summer, the growing population of Mesa regularly exceeds the peak demand setaside in these long term contracts

Where does the excess power come from? The utility has 2 choices:

Rolling brownouts to reduce demand, or

Purchase power on the spot market



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# The Value Stream

The spot market is an ongoing arbitrage, brokering power on a 10-minute horizon to those who need it,

AND can pay the price:

When Enron was active, prices got up to \$1600/kWH

Even today, peaking power can cost Mesa Power \$200 - \$400/kWH

4c - \$400 for the same item, depending on how badly or when you need it - how could you ever run this business?

Yet another miracle of deregulation...

It may sound terribly unfair, but I smell an opportunity!

And so does the DOE



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# RMS Activities

RMS is funded by DOE to investigate approaches to reduce the cost of inverters in the 100kW - 1,000kW power range

Inverter systems in this range today typically sell for \$800/kW

It is estimated that for market penetration the power electronics system must sell for \$100 - 200/kW

Our focus is on reducing size and cost, and improving reliability of:

the power semiconductor package

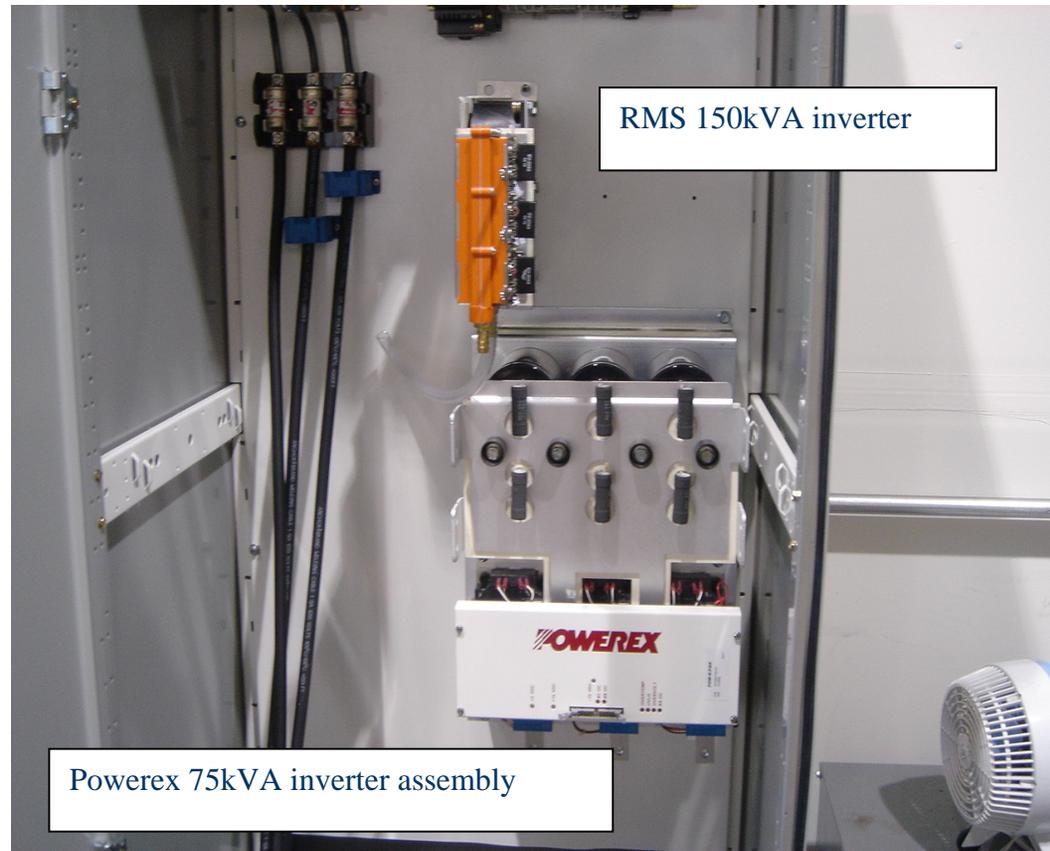
The capacitors, inductors and transformers

Novel cooling approaches to better utilize the Si devices



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# RMS Activities



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# The stuff they never told you about

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The unintended consequences of what we do... And are we really responsible?

Things to think about:

Cardiac Hill and the luckiest man I've ever met...

Above a hard rock mine in Tennessee in the spring...

Really, Only you can decide who's fault it will be when the inevitable happens

What will YOU have to say, not just in court, but when you're in your own warm bed, all alone, drifting off to sleep?

