Demand Side Management Option / Risk Evaluator

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Why DSMore Created

- Tool needed to capture true cost effectiveness of DSM/Load Control compared to other resources.
- Hourly analysis needed so that it compares to markets and plant dispatch
- Flexible to be used by measure or by program
- Help planners determine correct amounts for incentives and for other costs
- Help regulators use something consistent to compare DSM & Load Control Programs.
- Help assess risks of program

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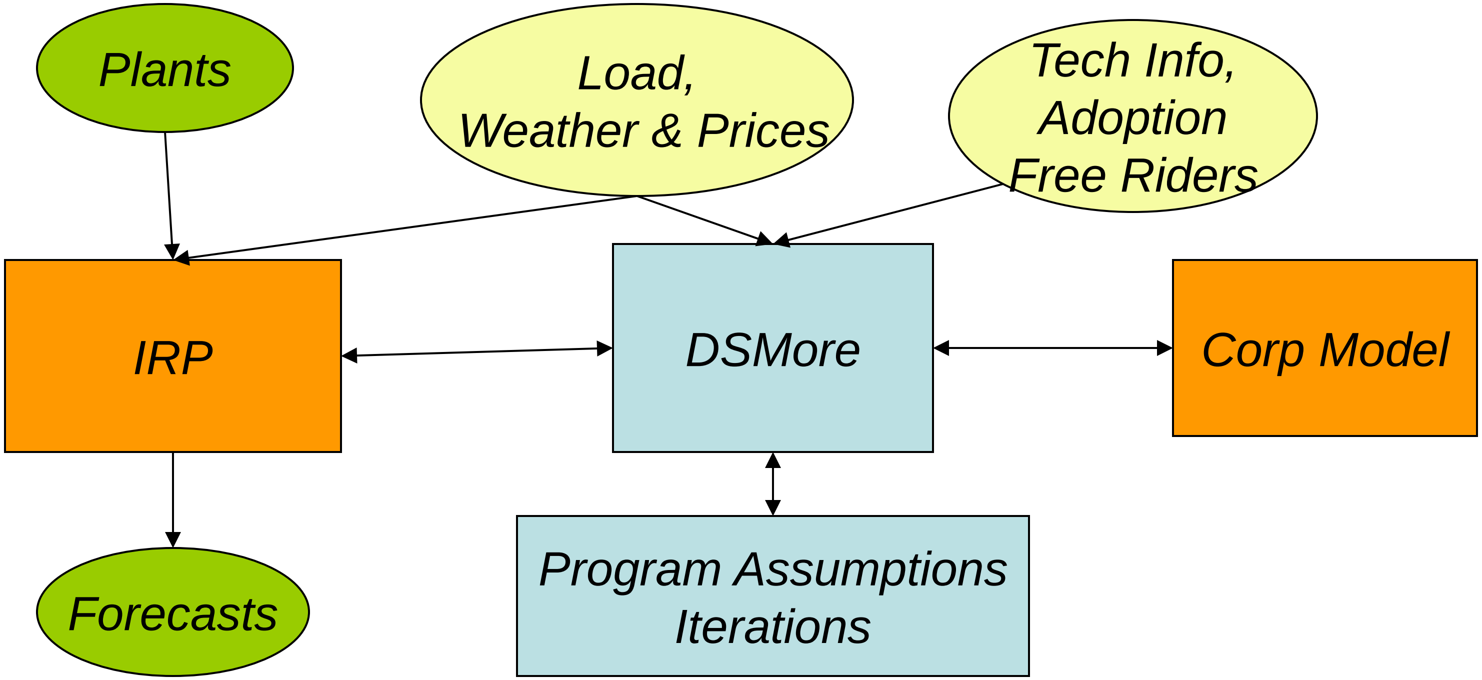
How the DSMore Model Fits In



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The DSMore Advantage

- Reflects more accurate valuations of DSM by including weather effects, and covariance of prices and loads, hourly by weather station.
- Both cost-based values and market-based valuations.
- Creates appropriate hourly end use load savings.
- Uses a familiar Excel user interface.
- Provides program planners the ability to value “low probability, high consequence events”

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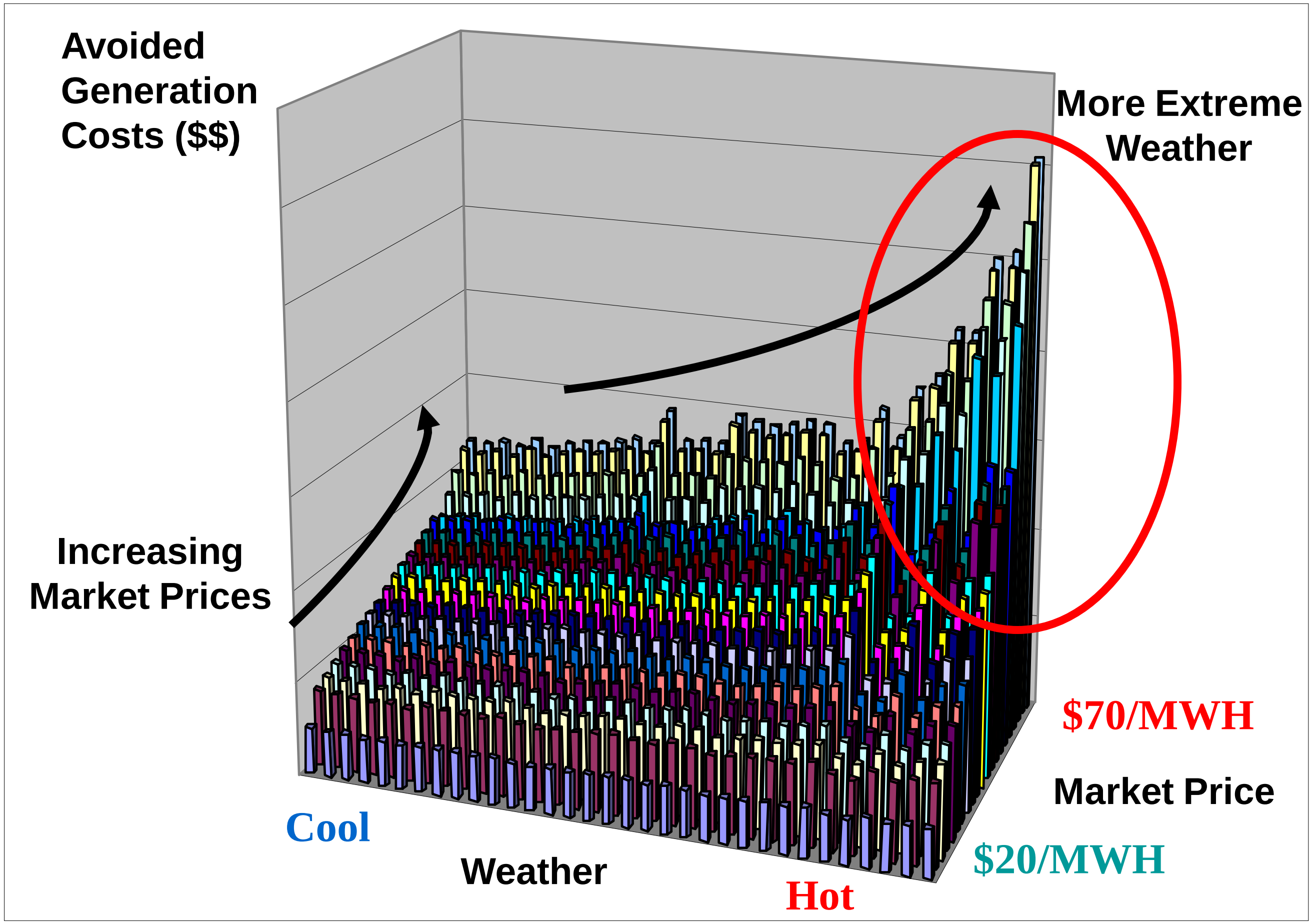
Distribution of Test Results

Loads **and** prices are **both** driven by weather covariance. If we use averages we loose the high end values.



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Introduction to DSMore

- DSMore is a unique software product that:
- uses causal simulation* to calculate accurate covariances,
- finds optimal regression fits for load forecasts by testing thousands of models, and
- uses Monte Carlo techniques to insure a full range of weather related cost benefit tests are provided, each time DSMore runs.

*IA Causal Simulation Model is copyright Integral Analytics

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Weather Affects DSM Reductions

Usage/Weather Scenarios	Test	Cost Based	Market Price Index Based Low	Median	High	kWh Savings
Mild Year	Utility	13.99	5.55	9.77	14.17	476.0
Normal Year	Utility	14.18	5.69	10.13	14.77	495.0
Extreme Year	Utility	14.36	5.83	10.47	15.33	515.4
Mild Year	TRC	7.02	2.78	4.90	7.11	476.0
Normal Year	TRC	7.12	2.85	5.09	7.41	495.0
Extreme Year	TRC	7.21	2.93	5.25	7.69	515.4

Annual Loads and Energy Saved Varies By Year
Typically
10% to 40%

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The DSMore Advantage

- Provides all Standard Practice Manual (SPM) cost effectiveness tests, plus long run option value test.
- Option value accurately values DSM the same way that asset planners value supply.
- Aligns prices and loads at hourly level, by day-type, month, leap years, holidays, etc., and by region
- Customizes avoided costs to specific customer load shapes and unique weather sensitivities.

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The DSMore Advantage

- Supports gas & electric programs, numerous rates and program types including conservation, demand response, and TOU.
- Provides summary financial reports, and aggregations, including accurate weather normal lost revenues and shared savings.
- Able to add numerous non-energy benefits.
- Extremely flexible and adaptive.
- Very fast processing of hourly calculations.

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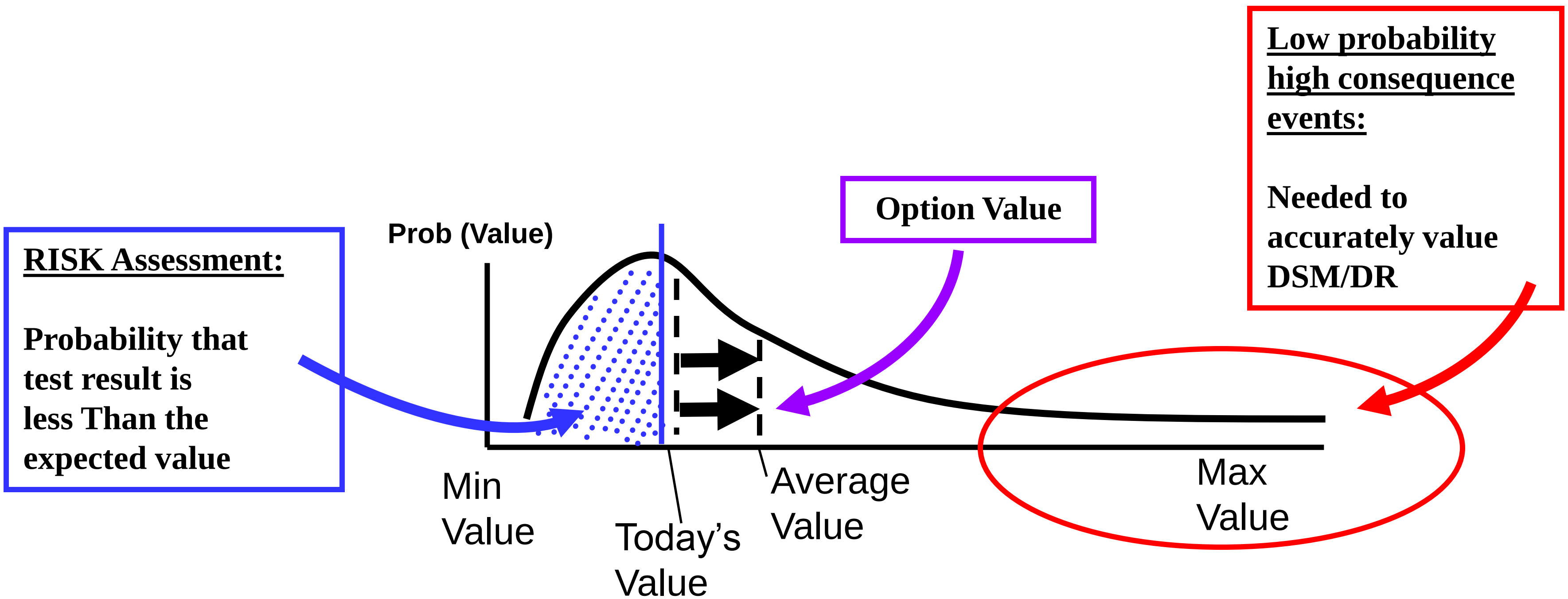
Test Distributions and Risk

Test results are in reality not just one point/number but a distribution of results based on potential future events. The distribution helps you assess risks. Capturing the extreme tail values also gives you a better view of the true value of DSM/DR. Enables the valuation of DSM/DR using supply-side option valuation techniques.



Test Values Based On Varied Market Price / Weather Scenarios

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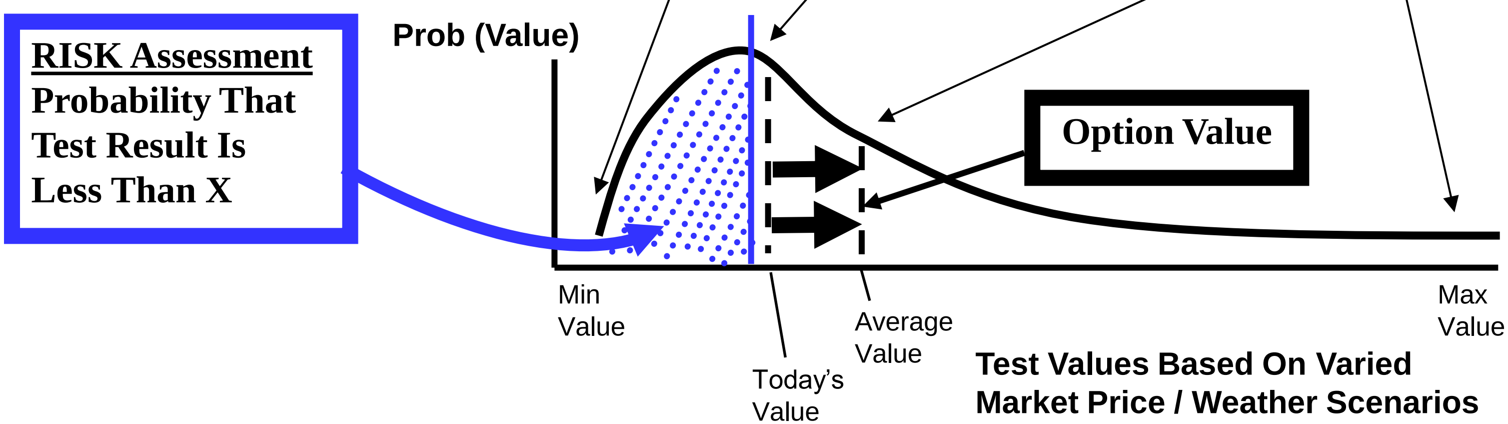
Test Distributions and Risk

Test results are driven (significantly) by market prices and weather

Min Value	**Lowest market prices, mildest weather**
Max Value	**Highest market prices, extreme weather**
Today's Value	**Today's market prices**
Alternative Value	**Alternative choice for Today's prices**
Option Value	**Long Run Value over many market prices, all weather**

Tests	Minimum Value	Today's Value	Alternate Value	Option Value	Maximum Value
Utility Test	1.17	2.53	2.74	3.25	8.36
TRC Test	1.49	3.23	3.51	4.15	10.68
RIM Test	0.52	1.36	1.47	1.74	4.52
RIM (Net Fuel)	0.63	1.73	1.87	2.21	5.91
Societal Test	1.77	3.51	3.78	4.43	23.51
Participant Test	2.15	2.24	2.24	2.24	3.03



Test Values Based On Varied Market Price / Weather Scenarios

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What Is Hourly Covariance ?

- Covariance is a key concept in supply-side asset planning. It is often ignored in DSM valuation, but quite consequential in determining risk and value.
- A simple example depicts what covariance is. Imagine serving a customer in a 5 hour day. Scenario 1 represents valuation using a *unrelated avoided cost and load profile*. In Scenario 2 the *load profile and avoided cost are co-varied*.

Both scenarios average 2 MW and $2 per MWH, but total costs differ when viewed hourly.

	Scenario 1			Scenario 2		
Hr	MW	$ / MWH	Total	MW	$ / MWH	Total
1	2	$2	$4	1	$1	$1
2	2	$2	$4	1	$1	$1
3	2	$2	$4	2	$2	$4
4	2	$2	$4	3	$3	$9
5	2	$2	$4	3	$3	$9
	2	**2**	**$20**	**2**	**2**	**$24**

This difference ($20 v. $24) is due to the co-varying of prices with loads, or covariance (akin to correlation). This covariance value (or risk) is what suppliers pay when they are caught short, and is value to DSM.

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- Wisconsin Focus on Energy
- Kansas City Power & Light
- Otter Tail Power
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- Jacksonville Elec.
- Springfield (MO) Utilities
- Black & Vetch
- PA Consulting
- ComED
- NIPSCO
- Others

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DSMore

More Accurate Valuations ………

1. More accurate valuations during "actual" high market prices (mark to market).
2. Longer run accuracy due to valuing of risk ("possibility") of high prices (option value).
3. More accuracy from the hourly measures of covariance of prices and load = volume risk.
4. Values for both prospective markets/ future supply AND retrospective/ embedded supply.

Ease Of Use For DSM Planners……

5. Easy to use.
6. Fast processing speeds.
7. Flexible across program types. Peak clip or conservation.
8. Tells you the range of risk (probability) of program passing or failing, due to weather or prices.
9. Several ways to adjust, or portray load savings.

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For more information about

DSMore

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What are these tests?

- **TRC** – Total Resource Cost Test looks at benefits of savings divided by program costs and participant costs
- **UCT** – Utility Cost Test looks from utility perspective with program benefits divided by program costs
- **RIM** – Rate Payer Impact tests looks at rate impacts of programs over life of program
- **Participant** – Participant Test is benefit from the participant perspective
- **Societal** – Societal Test includes non energy benefits

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Cost Effectiveness Tests

Source: AESP Principals of DSM	TRC/ Societal	Utility	Ratepayer	Participant
Avoided energy costs (fuel, O&M of power plants and T&D lines)	Benefit	Benefit	Benefit	
Avoided capacity costs (constructing power plants, T&D lines, pipelines)	Benefit	Benefit	Benefit	
Participants' incremental cost (above baseline) of efficient equipment	Cost			Cost
Incentives (rebates)	Transfer	Cost	Cost	Benefit
Program administration costs (staff, marketing, evaluation, etc.)	Cost	Cost	Cost	
Other benefits (fossil fuel savings, water savings, equipment O&M, etc.)	Benefit (Cost)			Benefit (Cost)
Externalities (e.g., environmental benefits like emissions reductions)	**Benefit**			
Lost utility revenue / lower energy bills (due to lower sales)	Transfer		Cost	Benefit

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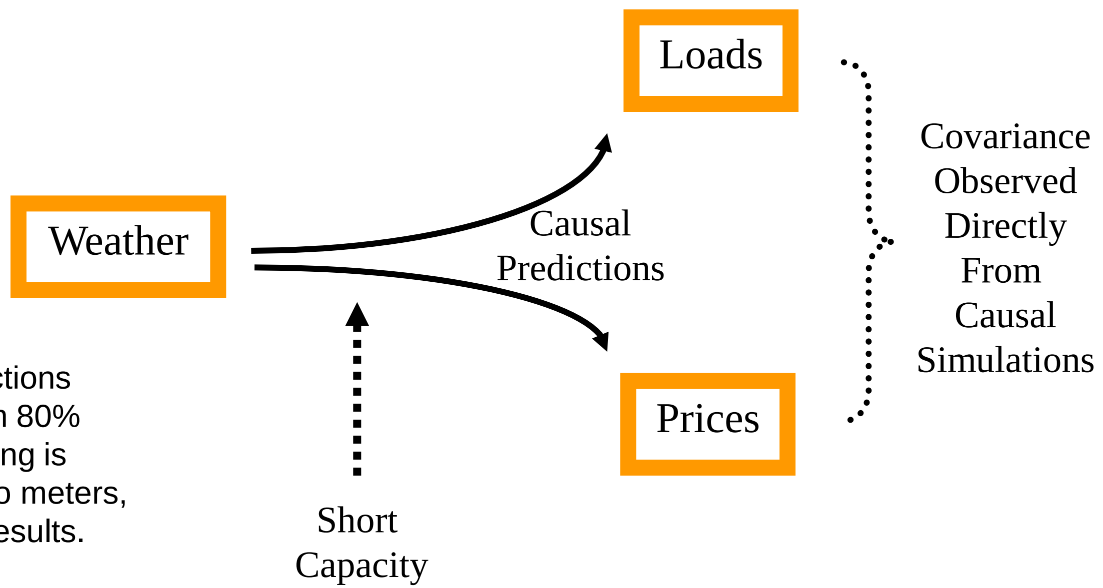
Causal Predictions and Monte Carlo Simulations

Because hourly covariances are so important, DSMore creates *causal* predictions of loads independently of prices, given weather, for over 30 years of weather.

DSMore generates reasonable causal predictions and forecasts to achieve this.

Monte Carlo simulations are applied to non-causal model aspects (error terms).



If DSMore regression predictions average 80% accuracy, then 80% of the value of hourly metering is achieved without resorting to meters, or waiting 30 years for the results.

Measuring the observed relationship between weather, load, and cost

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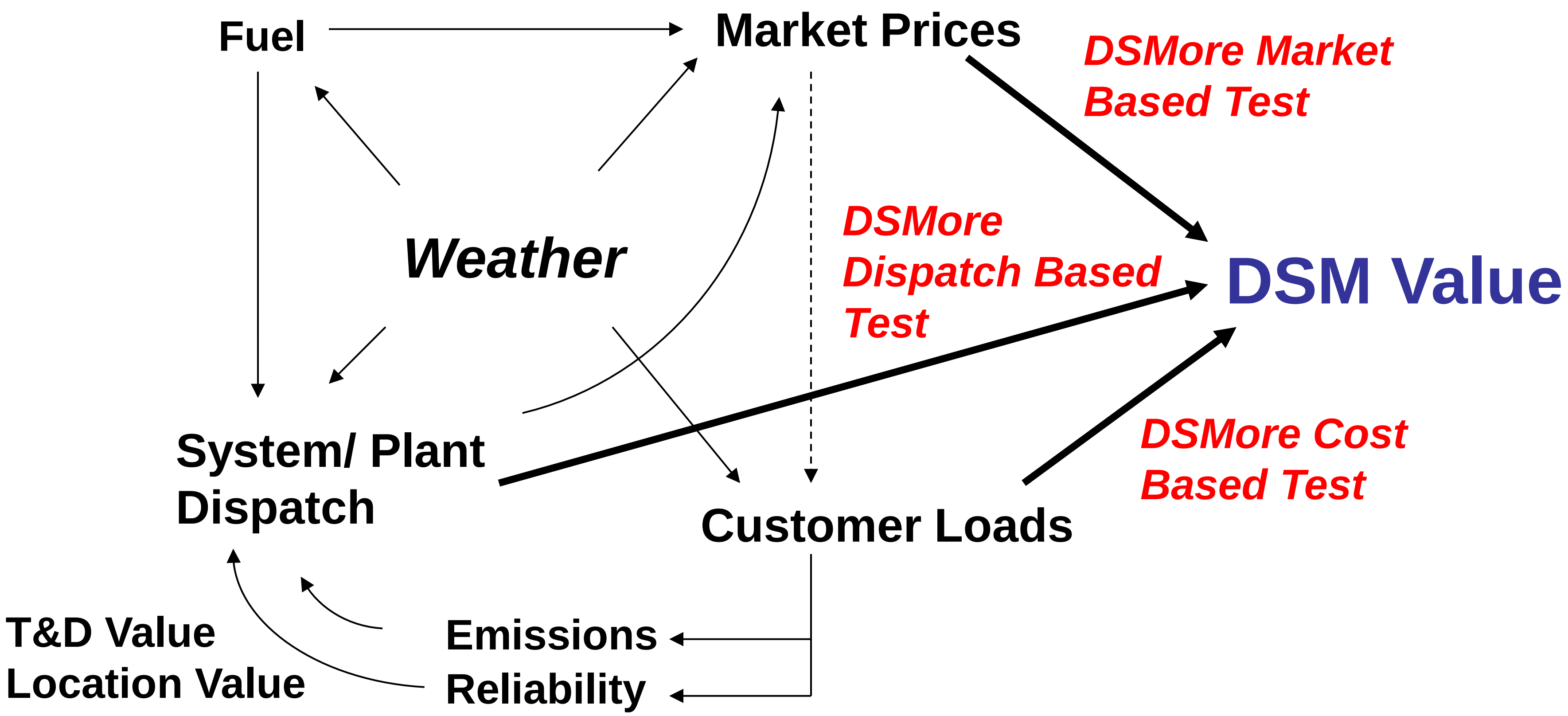
Causal Influences Of Supply Demand Balance



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Key Issues Related To Valuations: What Really Matters?

- Can choose which value to use (cost, market). Both important and matter.
- Avoided cost value is customized to the load savings from a customer, or class (vs. system average), with unique covariances. So, customer segments matter.
- DSM value increases with extreme weather, and varies with time and hours used or available. So, hourly valuation matters. And weather response modeling matters.
- Several avoided costs occur between plant and meter (transmission, distribution, losses, ancillary services, locational value due to bus LMPs, peak losses for DR). So, locational segments matter. Need to target.

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How Are Prices Evaluated ?

- In general, time series data is modeled using autoregressive error models which correct for serial, or time-based, correlation.
- Simple time series models (ARIMA, which stands for AutoRegressive Integrated Moving Average) do a good job correcting for this serial correlation, but do not allow the time series data to have different variances or errors at different times of the day or during different months.
- For this reason, **DSMore uses GARCH models**, which do allow for summer or winter price errors to be different from spring and fall. GARCH stands for generalized autoregressive conditional heteroscedasticity.
- As with load, DSMore uses IA Causal Simulation Models* to forecast electricity and fuel prices.

**IA Causal Simulation Model is copyright Integral Analytics*

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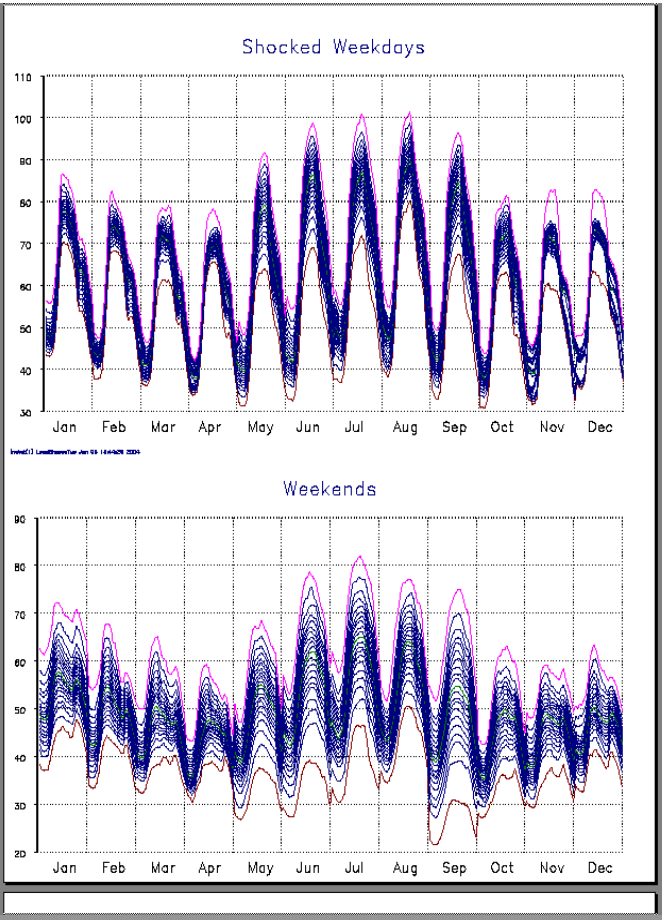
Example Load Shape Output

For each customer load or end use, 576 regressions are selected among several thousand possible combinations.

- **12 months x 24 hours x 2 day types.**
- **Each hour has its own distribution.**
- **Distributions are key to valuing extreme events, as with demand response.**
- **The middle "load shape" is the weather normal prediction of load or savings, and the upper load shape is the 99th percentile load forecast.**
- **5th percentile increments are provided.**



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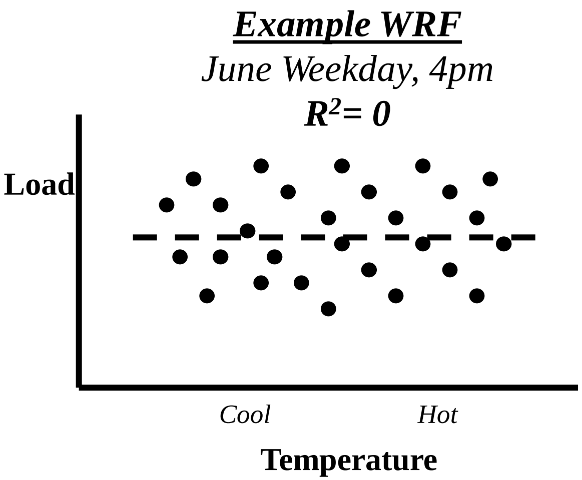
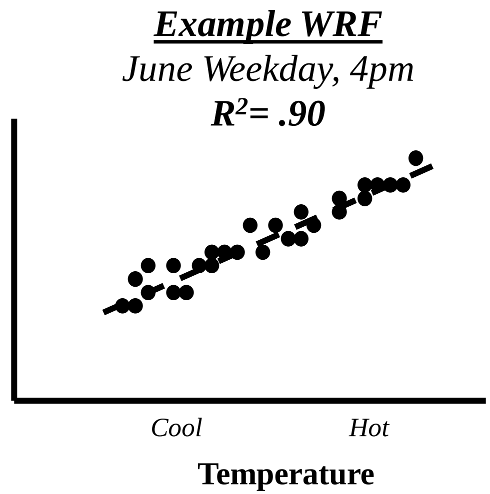
How Are Loads Evaluated ?

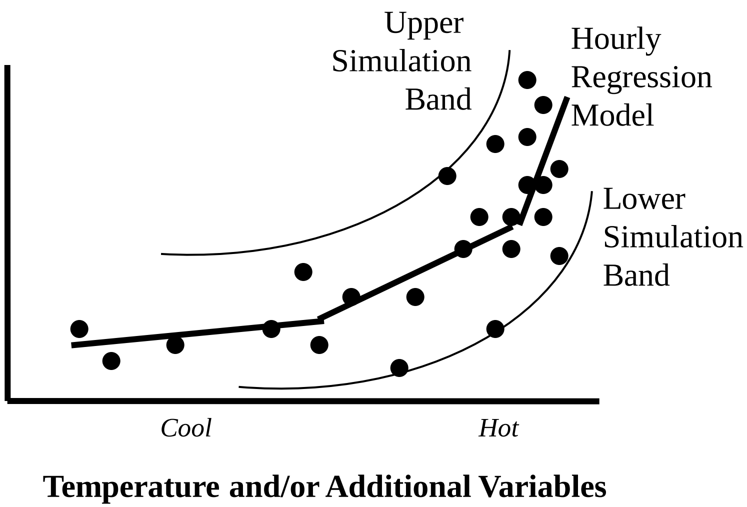
Random



Linear



Non-Linear



Several thousand non-linear regression models are created and evaluated.
The best model (R2, MAPE) is selected for each hour.
This model is used to simulate forecasted loads over 30+ years of weather.

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How Are Loads Evaluated ?

Example Regression Model

Apartment Building, About 700-800 KW
Summer Weekday. July 5pm

R-SQUARED: 0.92

Same modeling process applies to one customer or to a customer group

Coefficient	Variable	Knot
715.5	Constant	
- 252.7	YR2002	
15.61	TEMP	81.0
10.45	TEMP	81.0
2.38	HUMIDITY	36.0

Load = 715.5 - 252.7*YR1999
+ 15.61*(Temp-81, or 0) + 10.45*(81-Temp, or 0)
+ 2.39*Humidity*(Hum-36, or 0) + $\upsilon_{random\ error}$

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Green House Gas Calculator

Total Greenhouse Gas Impacts	
Total Per Participant Savings (Lbs)	4781
Total Cumulative Savings (Lbs)	4855001
Total Per Participant Savings ($)	$52.07
Total Cumulative Savings ($)	$52,867.55
Total Cumulative NPV Savings ($)	$36,105.93

Based on Your Plant Dispatch by Hour

Greenhouse Gas Impacts by Year

Year	Cumulative Participants	LBs CO2	$ CO2
1	500	183,902	2,003
2	1,100	404,583	4,406
3	1,100	404,583	4,406
4	1,100	404,583	4,406
5	1,100	404,583	4,406

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