An Evolutionary Solution for High-Density Solar Integration on the Distribution Grid

Presented by **Heart Akerson**

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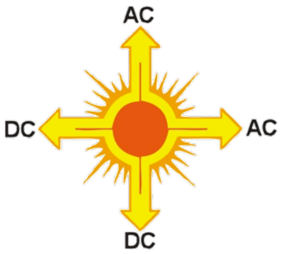
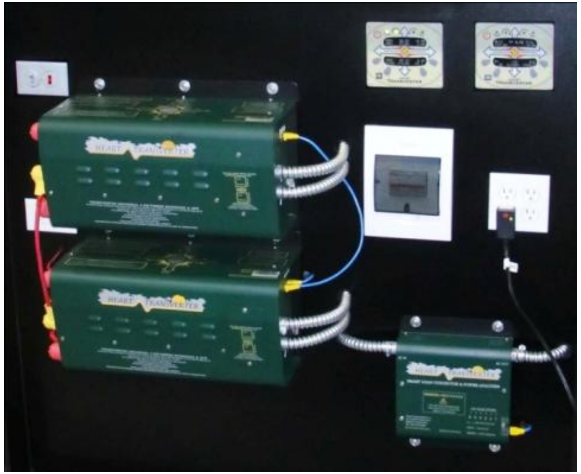
Redesigning the Bee rather than the Beehive

Often, we can perceive big problems and then envision big solutions but sometimes, if we just open our eyes a little wider, we can see that most of the elements of the big solution are already there, but in small pieces. We have designed the Transverter to connect all of those small pieces together so that we can have a realistic effective restructuring of the electrical energy sector that can be deployed immediately.





Business Challenge

- High Integration Solar is forcing the Grid to implement Peaker Plants.
- Smart Grid data is overwhelming the communication structure and data processors.
- Most consumers want solar energy yet there is public resistance to the Smart Grid.
- No one wants to increase budgets.

Solution

- Thousands of small smart autonomous systems integrating energy storage, solar & demand response.
- Aggregate data and control parameters into a hierarchy of larger, easy to perceive & control, blocks.
- Super fast response times enable new levels of stability.

Results and Benefits

- Infinitely Scalable in small increments for comparable cost.
- Higher quality precision deep data with vastly less data burden.
- Autonomous operation enables microgrids which increases security.
- Practically eliminates transmission loss.

PV Integration Issues

Utility Issues

- Voltage Regulation
- PV Intermittency Mitigation
- Real and reactive power support
- Dynamic VAR injection
- Protection Coordination
- Phantom Generation Management
- Communications capability

Consumer Issues

- Under-frequency trip out
- Low voltage ride through
- KWh Generation missed opportunities
- End of Feeder Voltage Regulation
- Use of Solar during Blackout

THE CONSUMER DATA SHEET

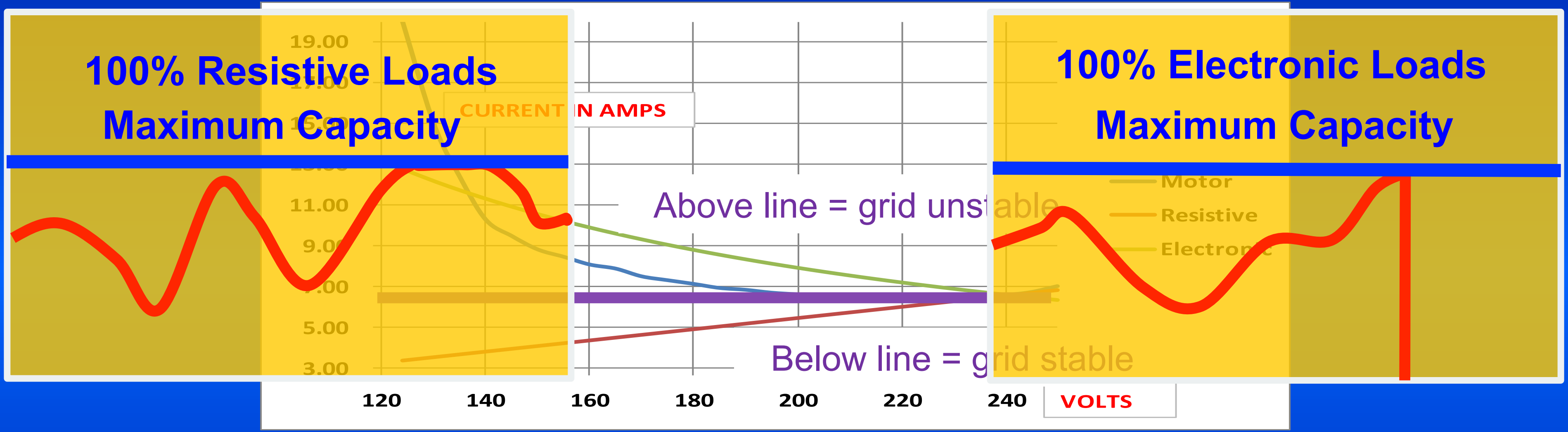
1. Most consumers want green solar energy.
2. They are suspicious of privacy and control issues with the Smart Grid.
3. They value autonomous backup power.
4. Nobody wants to pay for anything.
5. Some consumers, like Cell Towers, are very sophisticated and <u>will</u> pay.

The Utility Companies can easily be the Hero here if they play their technological cards right.

Anatomy of Grid Stress

When grid capacity is reached the voltage drops.

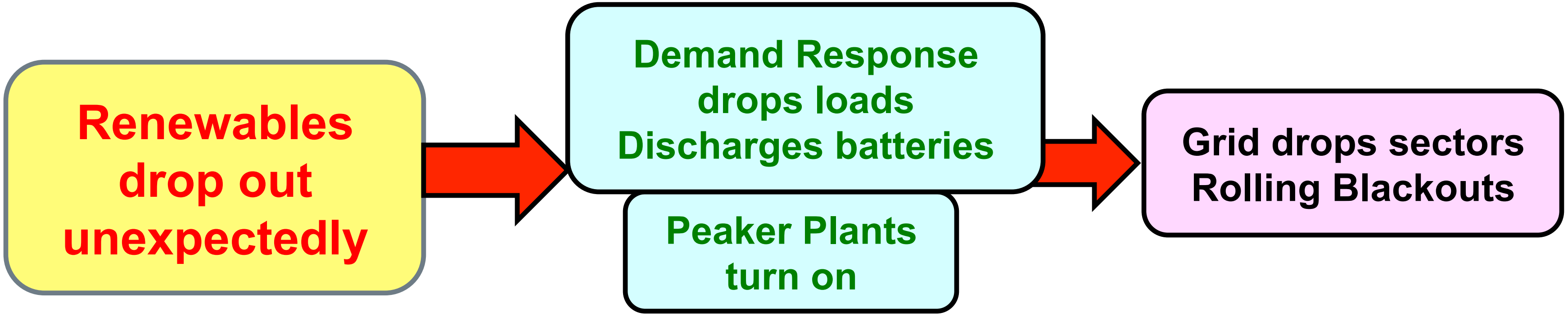
Different types of loads respond differently.



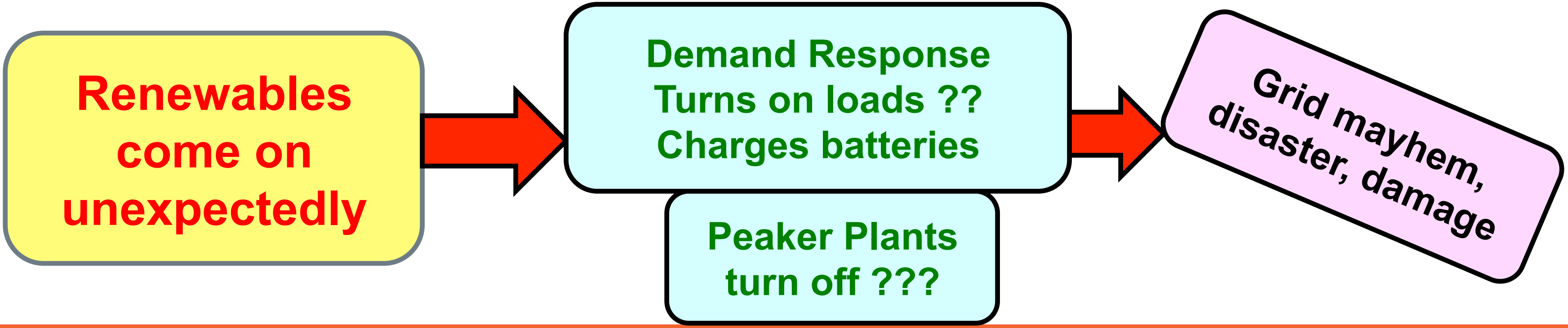
Resistive loads are the most stable because the current drops and relieves grid stress.

Electronic loads have internal regulation which keeps the power constant which increases the current and increases grid stress.

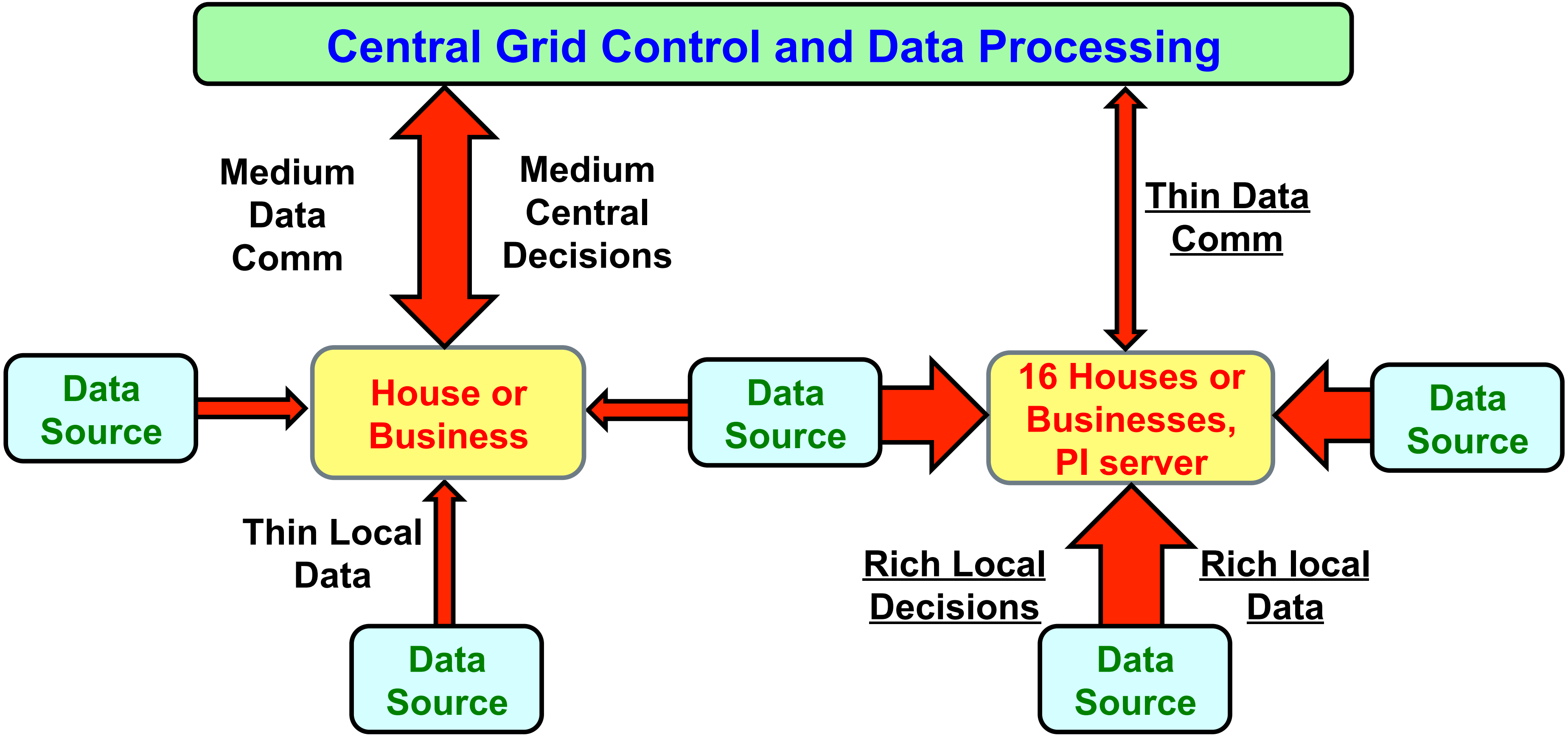
Intermittent RE Based Grid Stress



These things work in two directions.



The Real Cost of Central Processing



T13X Smart Solar Peaker Plant

PHEV

Heater

Freezer

Hot Water

HVAC

Well Pump

6 Relays with Current Sensing (30 amp)

T13X AMI & Load Management

4 Line Voltage & Current Sensing (100 amp)

AC Grid

AC Generator

4 kW Power Modules
AC in
AC out Data

1,840 watts solar expands to 4 kW

6 kWh Battery Bank
Lead, Gel or Li-ion

4 kW critical loads, lights, electronics, frig., UPS

Remote Panel

USB

Plug Computer with Wi-Fi & Ethernet
PI data Translator

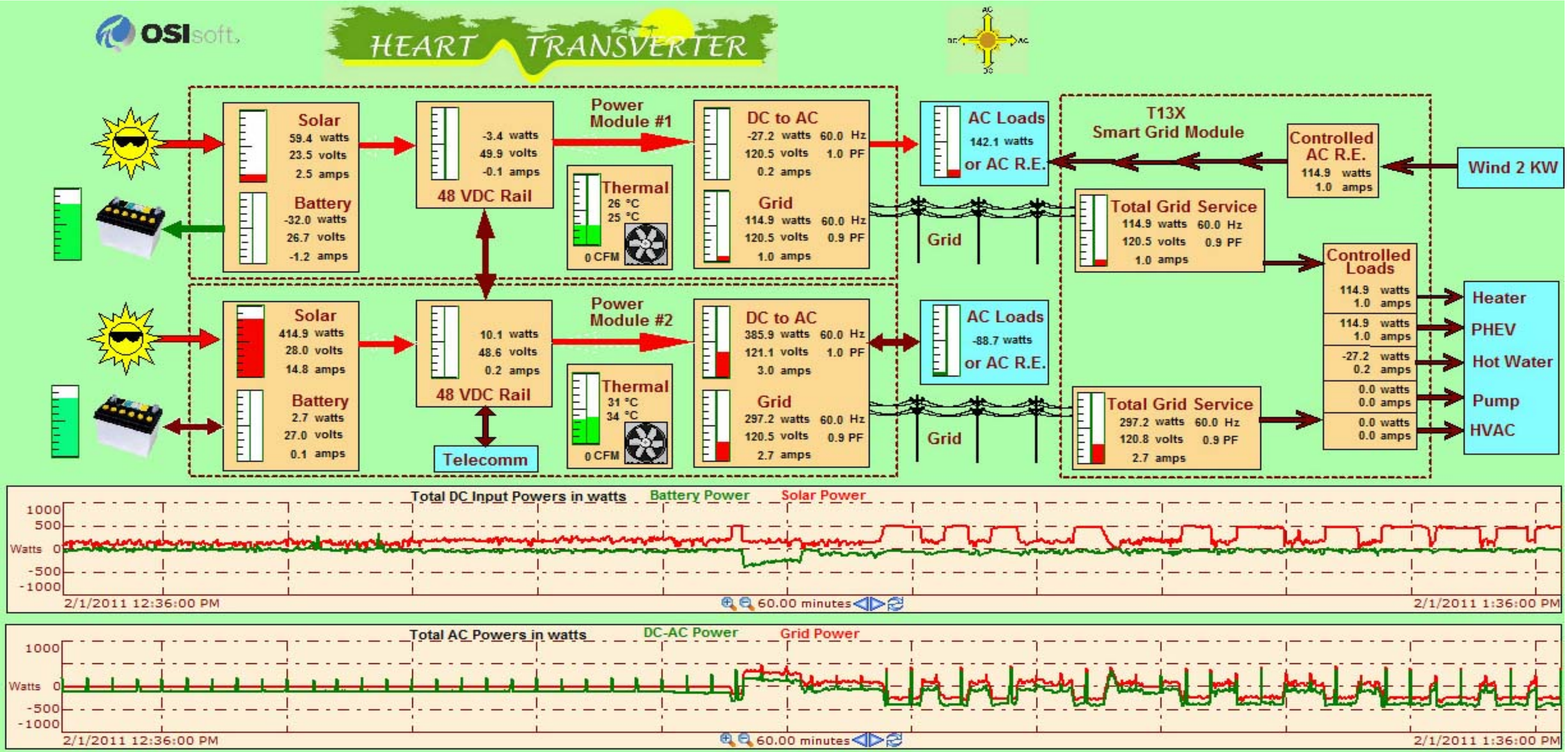
TYPICAL HOUSE SYSTEM

Boulder 4 kW UPS, 1,840 w Solar, 276 kWh solar per month	QUANTITY	COST	EXTENDED
CS6P-230-P 230 Watt Solar Panel	8	$ 464	$ 3,712
TRANSVERTER POWER MODULE 2000W	2	$ 2,000	$ 4,000
TRANSVERTER REMOTE PANEL	1	$ 200	$ 200
TRANSVERTER T13X (Smart Grid in a Box)	1	$ 600	$ 600
MK S31-SLD-G 12 V 108AH BATTERIES GEL	6	$ -	$ 1,572
Hardware, wires and other B.O.S.			$ 1,494
		TOTAL	$ 11,578

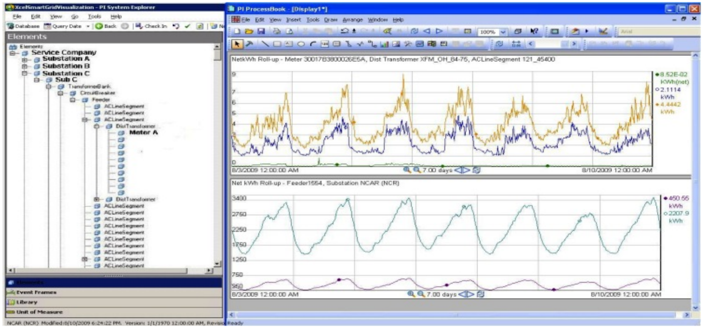
IMPACT OF 1,000 HOUSE PROJECT

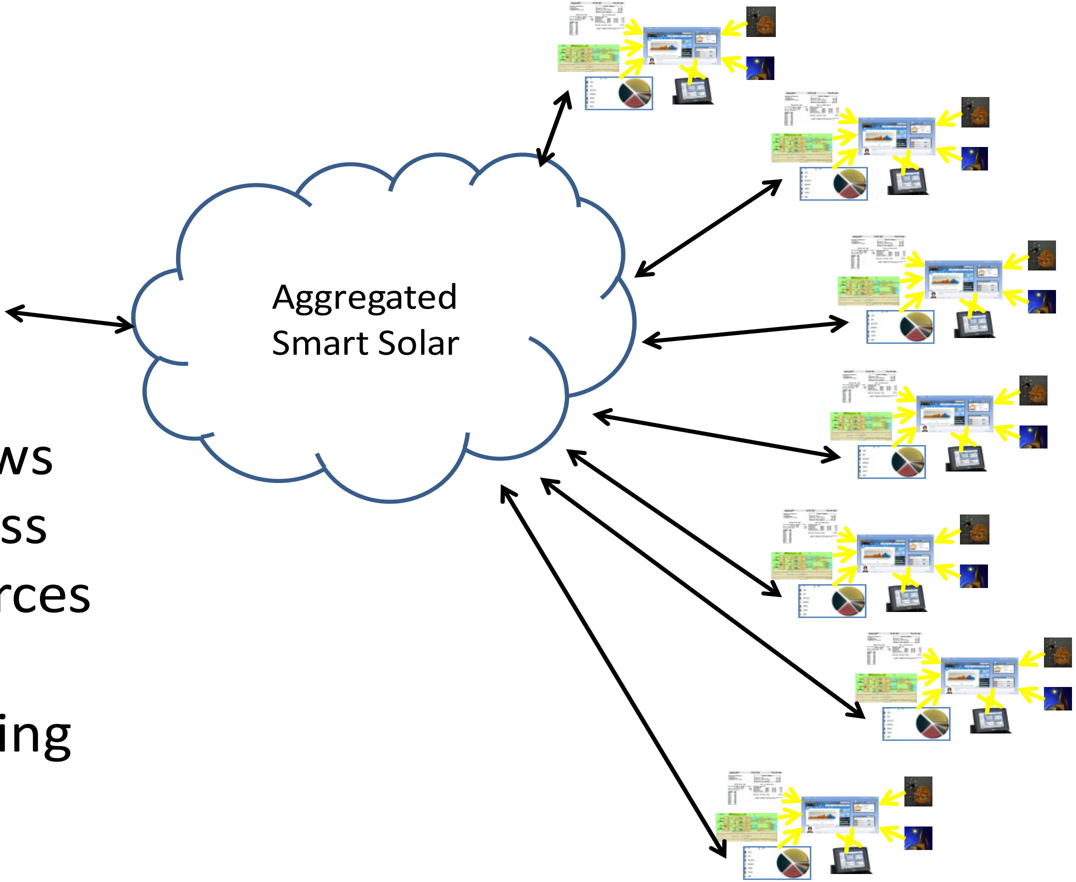
- INSTALLED COST $11.3M, RAW MATERIALS $7.8M, LOCAL INSTALLERS $3.5M
- REDUCED ENERGY CONSUMPTION, FROM SMART AUTO-DR, BY 20% SAVING OVER 230 MWH / MONTH
- PRODUCING 276 MWH SOLAR / MONTH AND REDUCING GRID BT 506 MWH/MONTH
- SOLAR CAN BE EXPANDED UP TO 600 MWH / MONTH AT CUSTOMERS OPTION
- AUTOMATIC SURGE ASSIST TO GRID OF 4 MW
- AUTOMATIC POWER FACTOR COMPENSATION TO GRID OF 4 MW
- DISTRIBUTED DEEP DATALOGGING, AUTONOMOUS REAL TIME OPERATION, AGGREGATED DATA & CONTROL
- 100 AMP SERVICE → 50 AMP SERVICE BY AUTOMATIC LOAD SEQUENCING - CUTS THE COST OF THE ELECTRICAL INFRASTRUCTURE IN HALF
- COMMUNITY ENERGY STORAGE CAPABILITY IN PLACE (SET THE RULES)

ProcessBook, WebPart & CoreSight Displays



Secure Backhaul to the Utility, Detail Privacy Stays in the Home





- PI System-based views
- Situational Awareness
- Integrated Data Sources
- Distributed Control
- Centralized Monitoring

Steering the Grid

Quick Response
Light Weight
Low Inertia

Home
Small Office
Cell Tower

How fast do you respond when you drive?
4 minutes
4 seconds
17 ms

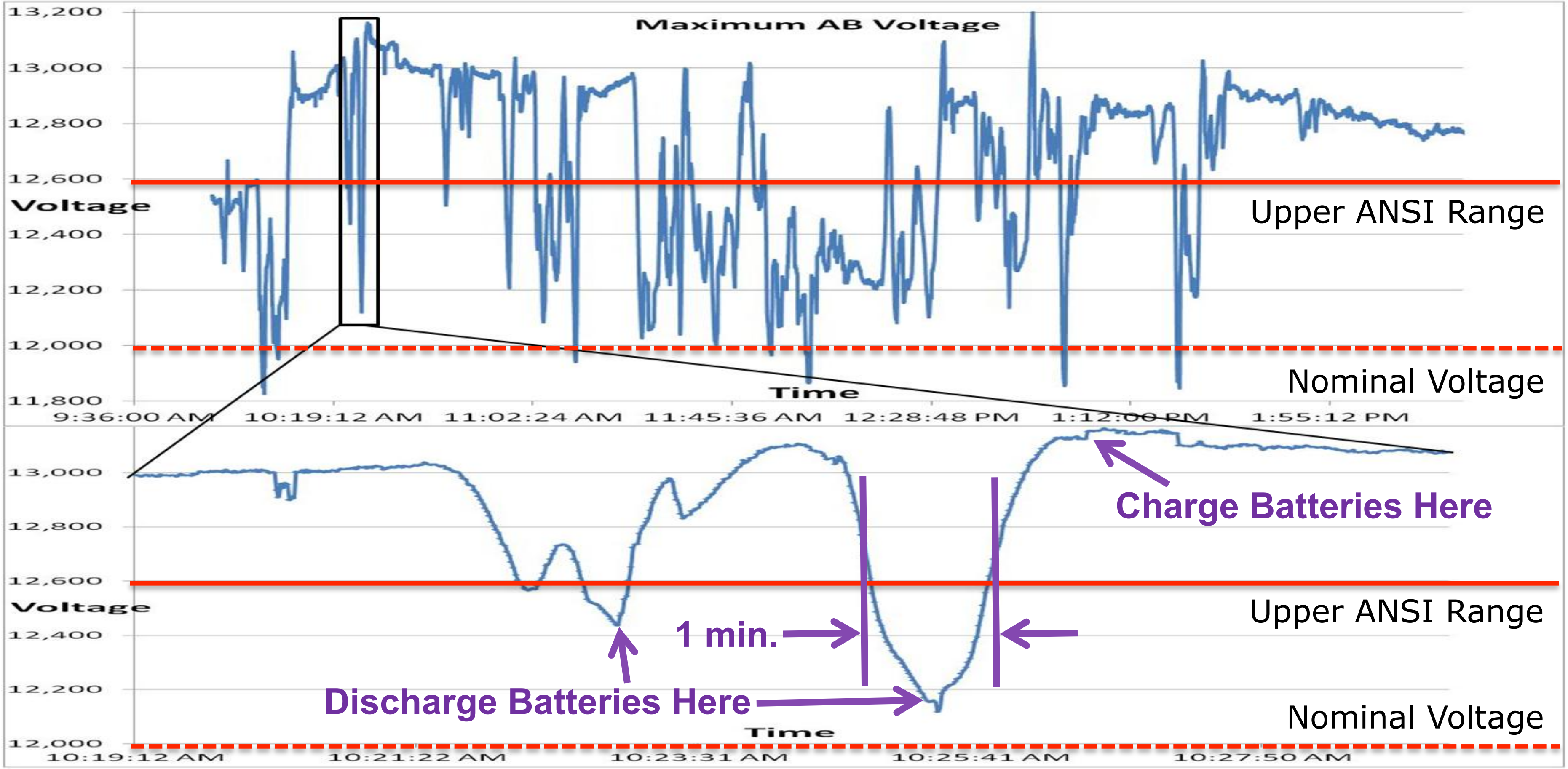
The faster the response, the smaller the size of the response.

The size of the response (battery bank) is where the money is.

Slow Response
Heavy Weight
High Inertia

Large Industrial Facility
Sub Station
Peaker Plant
Large Energy Storage Facility

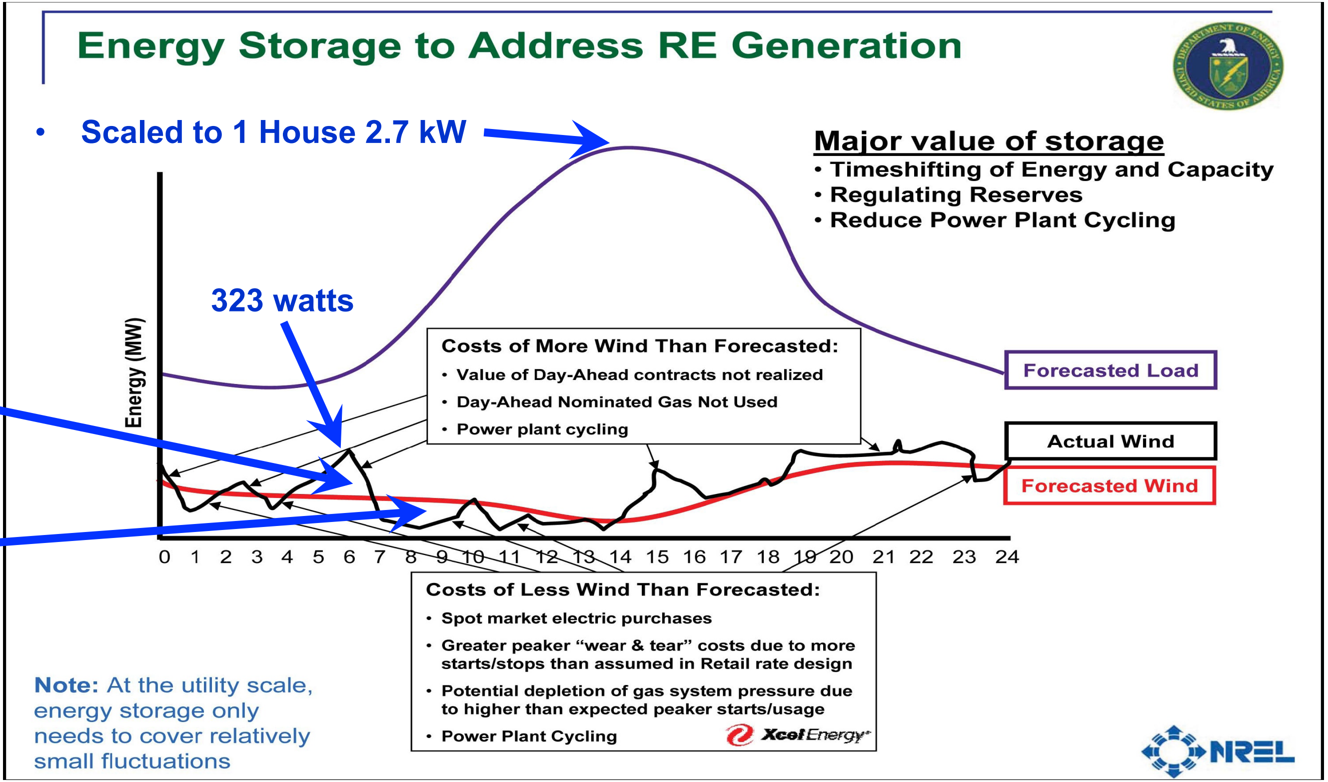
How Fast Do We Have to Respond?



Making Renewable Energy Real (One House at a Time)

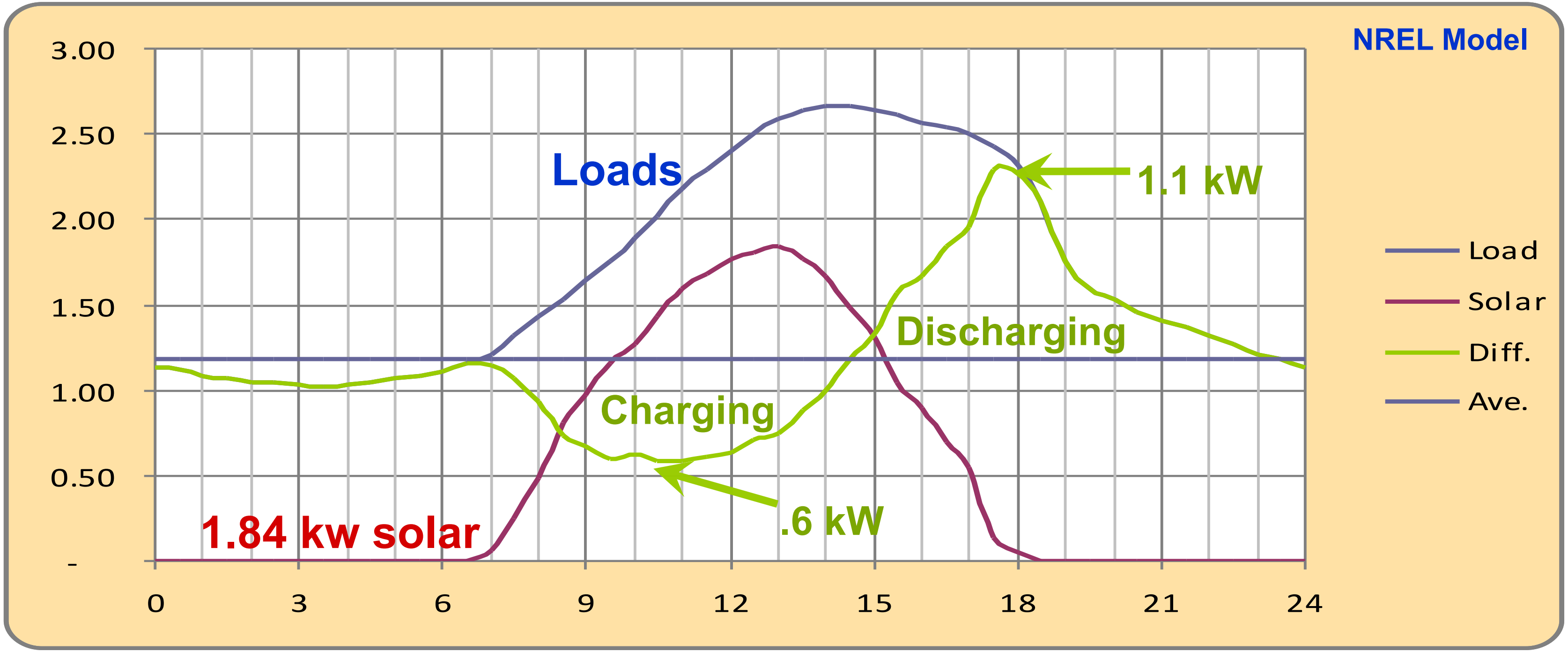
Charging .485 kWh 8% battery capacity @ C/19

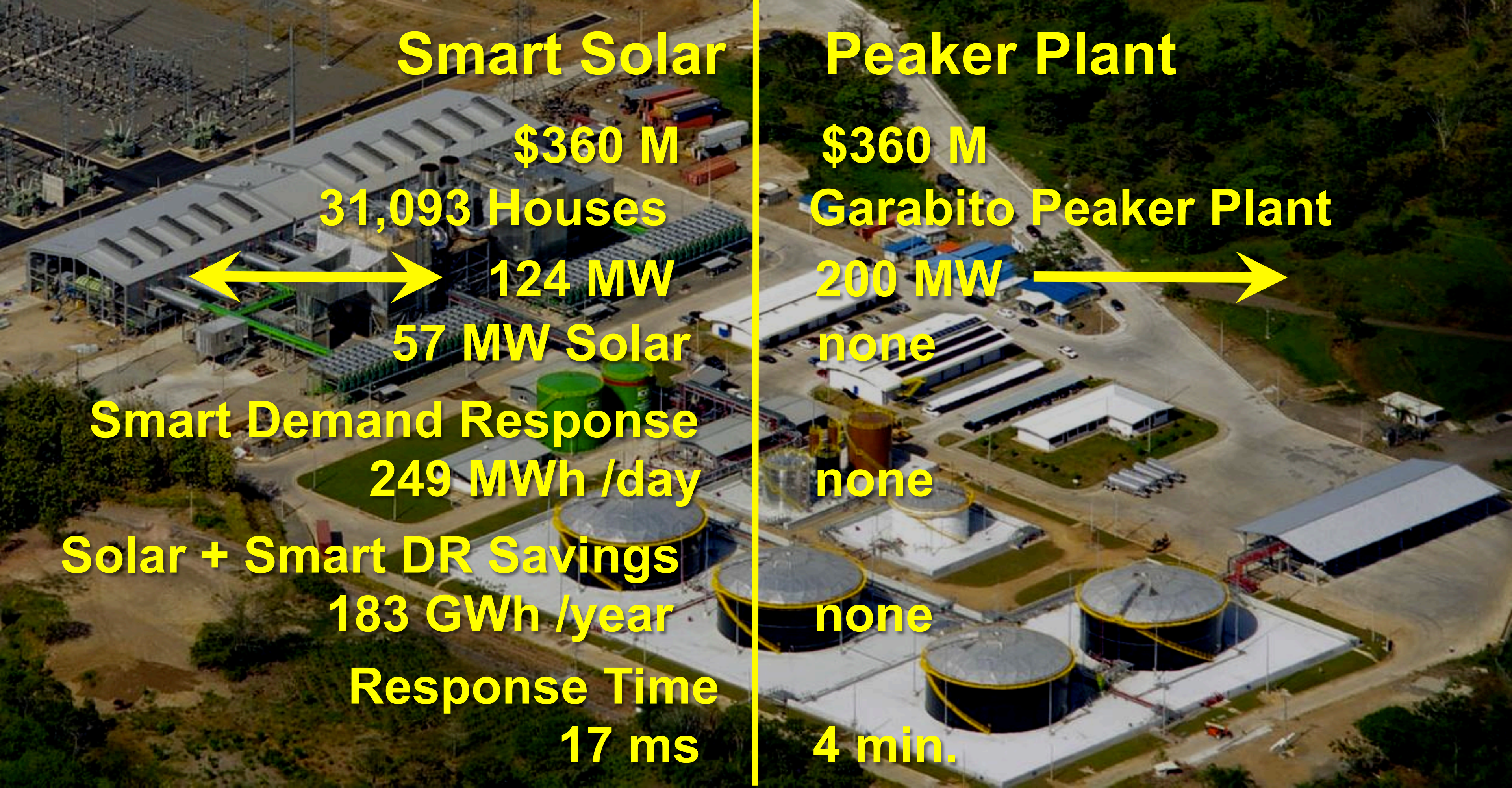
Discharging .474 kWh 8% battery capacity @ C/28



Balancing Loads with Solar, One House at a Time

Daily Charge-Discharge 3.9 kWh = 65% of 6 kWh battery Charge @ C/10   Discharge @ C/5





Smart Solar	Peaker Plant
$360 M	$360 M
31,093 Houses	Garabito Peaker Plant
124 MW	200 MW
57 MW Solar	none
Smart Demand Response 249 MWh /day	none
Solar + Smart DR Savings 183 GWh /year	none
Response Time 17 ms	4 min.

GAS PEAKER PLANT v.s. SMART SOLAR DISTRIBUTED PEAKER

GAS FIRED	PEAKER PLANT	SMART SOLAR	12,500 HOUSES OR BUSINESSES
PEAK POWER	50 MW	50 MW	PEAK POWER
		23 MW	SOLAR POWER
		98 MWh	ENERGY STORAGE
		50 MW	DEMAND RESPONSE
PRODUCTION @ 5%	22 GWh/year	74 GWh/year	SOLAR + SMART AUTO-DR SAVINGS
		61%	BATTERY DISCHARGE @ 5% ONCE/DAY
DIRECTION	SOURCE ONLY	SOURCE & SINK	DIRECTION
RESPONSE TIME	4 min.	17 ms	BIDIRECTIONAL RESPONSE TIME
		YES	ELECTRONIC PFC
INSTALLATION COST	$75M	$145M	INSTALLATION COST
FUEL COST	($1.00M/year)	$3.78M/year	SOLAR REVENUE
OPERATING COST	($1.25M/year)	$3.65M/year	SMART AUTO-DR REVENUE
TOTAL RUNNING COST	($2.25M/year)	$7.43M/year	TOTAL ENERGY REVENUE
		9 YEARS	SIMPLE DELTA R.O.I.

PEAKER PLANT v.s. SMART SOLAR with = INSTALLATION COST

GAS FIRED	PEAKER PLANT	SMART SOLAR	6,478 HOUSES OR BUSINESSES
PEAK POWER	50 MW	26 MW	PEAK POWER
		12 MW	SOLAR POWER
		51 MWh	ENERGY STORAGE
		26 MW	DEMAND RESPONSE
PRODUCTION @ 5%	22 GWh/year	38 GWh/year	SOLAR + SMART AUTO-DR SAVINGS
		61%	BATTERY DISCHARGE @ 5% ONCE/DAY
DIRECTION	SOURCE ONLY	SOURCE & SINK	DIRECTION
RESPONSE TIME	4 min.	17 ms	BIDIRECTIONAL RESPONSE TIME
		YES	ELECTRONIC PFC
INSTALLATION COST	$75M	$75M	INSTALLATION COST
FUEL COST	($1.00M/year)	$1.96M/year	SOLAR REVENUE
OPERATING COST	($1.25M/year)	$1.89M/year	SMART AUTO-DR REVENUE
TOTAL RUNNING COST	($2.25M/year)	$3.85M/year	TOTAL ENERGY REVENUE
		1 DAY	SIMPLE DELTA R.O.I.

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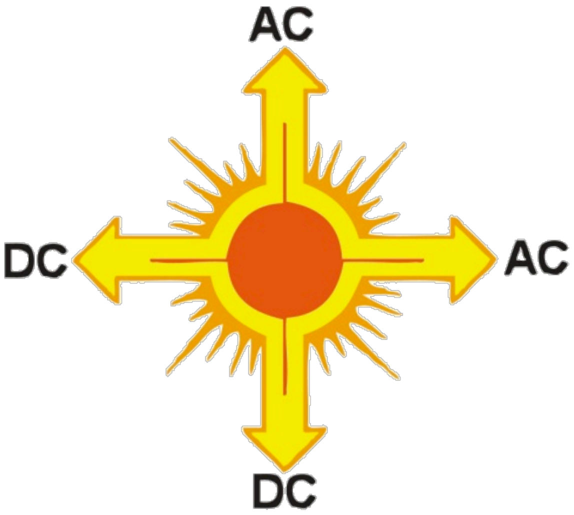

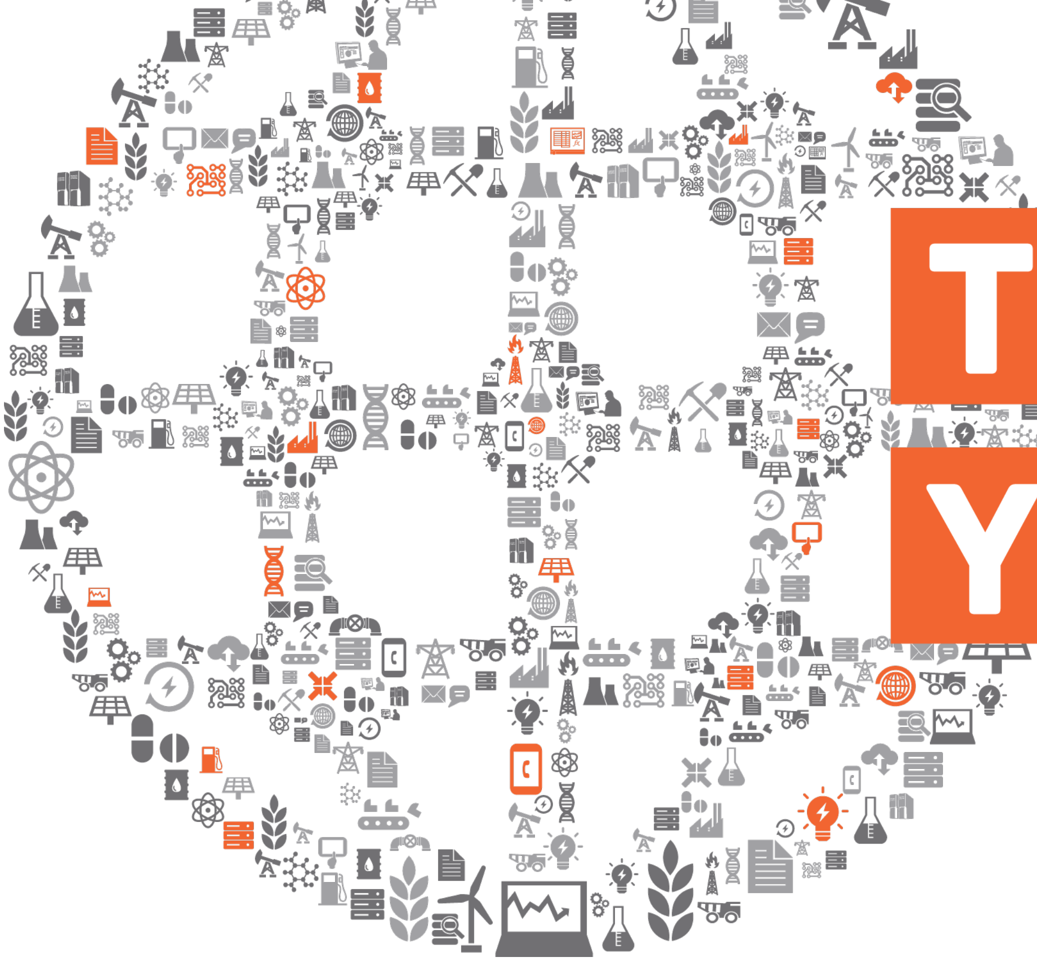

THANK YOU

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