



# 2011, SmartGrid, Taking Control of our Future

**A Basic Primer To SmartGrid in the Year 2011**

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# OK, What Am I About Anyway

- ❖ Smart Grid Concept
- ❖ Smart Grid: Utility and Consumer Side
- ❖ Provide a big picture view of the data management and infrastructure challenges
- ❖ Provide a look at the architecture challenges
  
- ❖ Have a little fun

# What are you doing for the next generation?

## A STUNNING SENIOR MOMENT

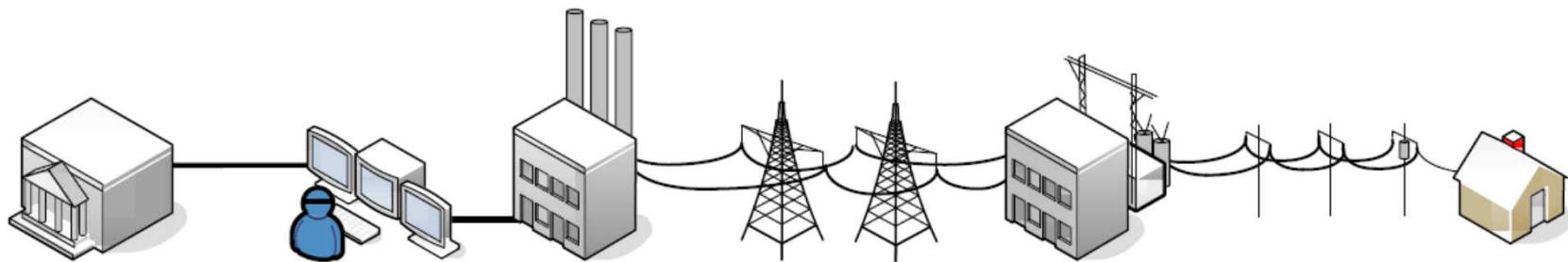


*A self-important college freshman walking along the beach took it upon himself to explain to a senior citizen resting on the steps why it was impossible for the older generation to understand his generation. "You grew up in a different world, actually an almost primitive one" the student said loud enough for others to hear. "The young people of today grew up with television, jet planes, space travel, man walking on the moon. We have nuclear energy, ships and cell phones, computers with light speed....and many more." After a brief silence, the senior citizen responded as follows.*

*"You're right son. We didn't have those things when we were young....so we invented them. Now, you arrogant little sh\*t what are you doing for the next generation? The applause was amazing!"*

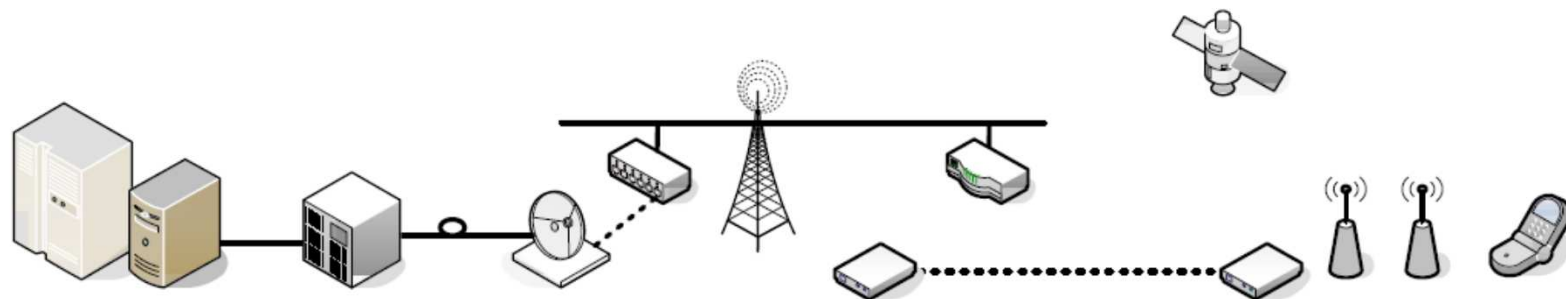
# Smart Grid Concept

Smart Grid is modernization of transmission and distribution networks by merging



**Electrical Infrastructure**

AND



**“Intelligence” Infrastructure**

# Smart Grid – Why We Need It

- ❖ Increased demand for power puts more pressure on infrastructure
- ❖ Ageing infrastructure needs upgrades
- ❖ Lack of real-time communication delays repair decreasing reliability (e.g. outages)
- ❖ NIMBY syndrome; strong opposition to new power lines in communities
- ❖ Regulators demand increased efficiency and Demand Side Management (DSM)
- ❖ Society and legislators expect increased use of renewable power, hence

Let's modernize infrastructure by fixing all above

# Smart Grid Overview

- ❖ Smart Grid is not a formula or scheme, but a concept, a vision, which realization differs by industry participants
- ❖ Different utilities/jurisdictions apply various technologies and management programs
- ❖ Smart Grid architecture and management are addressed in the context of the overall enterprise and extend to the vendor space
- ❖ Incremental deployment and integration of intelligent systems will proceed over many years

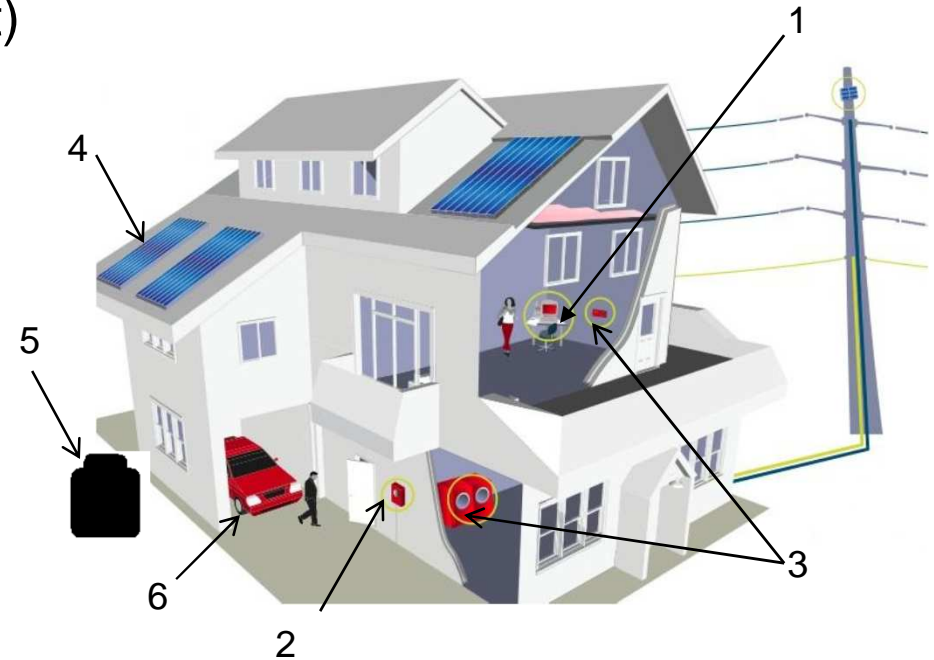
# Smart Grid - Consumer Side

## 1. High-speed connections (internet)

- a) to monitor the consumption and price
- b) to program smart devices in response to price changes and generation type

## 2. Two-way connected digital meters record real-time data and provide communication between generators and smart devices

- a) Usage data
- b) Price data
- c) Alerts (electric system characteristics, weather forecast, smart devices condition)



## 3. Using information from smart meters, sockets, devices (thermostat, AC, TV, washing machines) allows for auto adjustment to respond price signals

## 4. Distributed generation (solar, wind) is the source of energy supply allowing to sell excess to the grid

## 5. Energy storage devices facilitate the use of distributed generation

## 6. Plug-in hybrid electric car can store energy, act as backup generator and supply the grid during peak demand

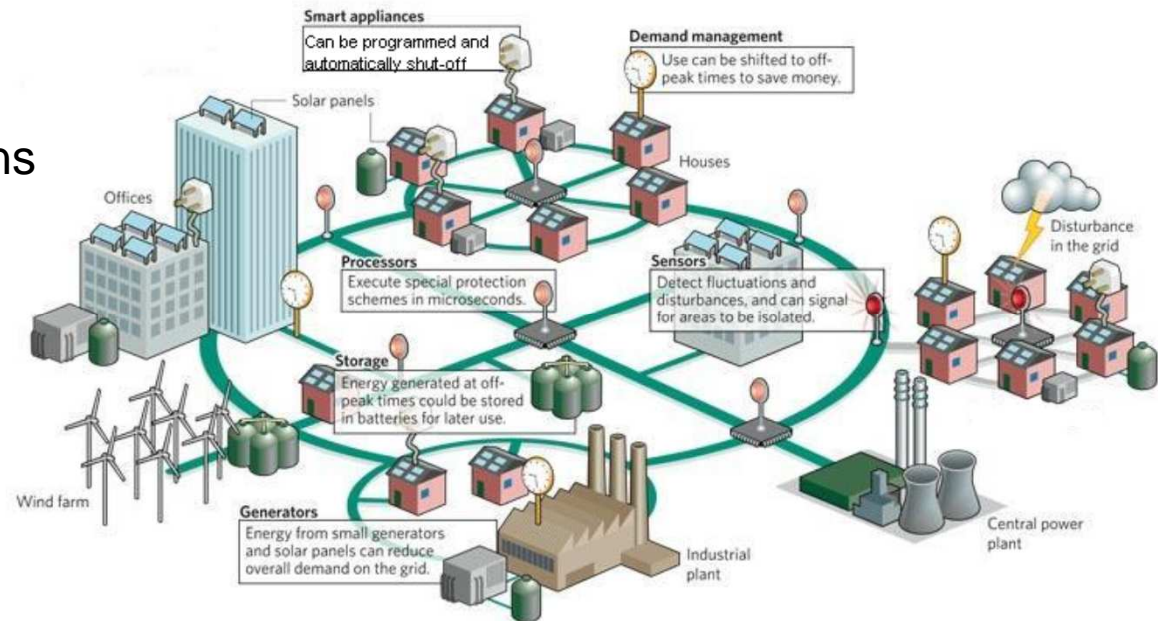
# Smart Grid – Utility Side

Smart Grid is automation and optimization of the power delivery system that can monitor and heal itself

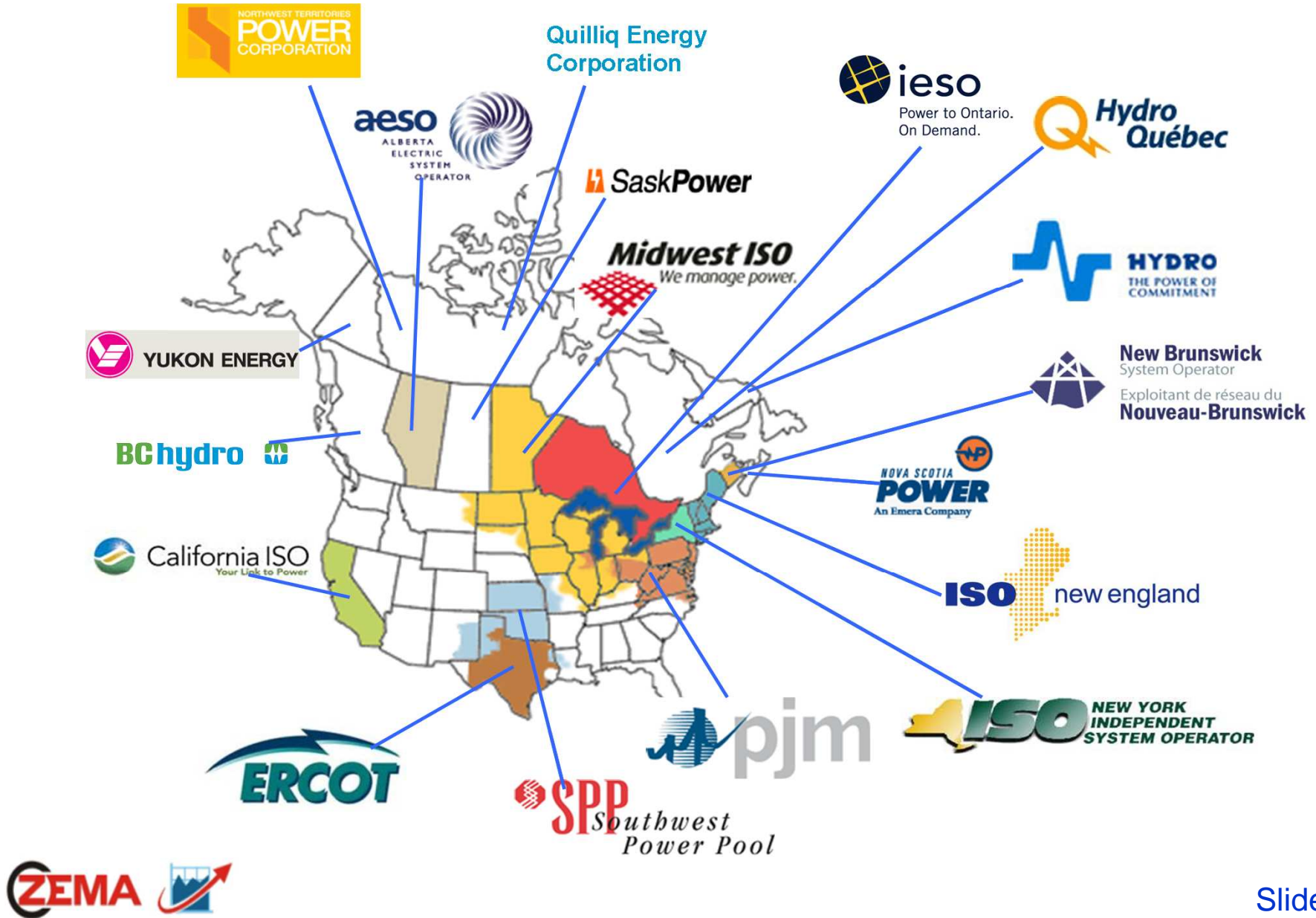
- ❖ digital real-time monitoring and control of the system and power flow by intelligent electrical devices

- sensors monitor power flow and quality (voltage, current, real power, reactive power, etc.), the condition of equipment, outages
- synchrophasors and digital relays remotely detect faults and adjust them

- ❖ smart meters ensure integrated communications between generators and consumers



# Not One Market

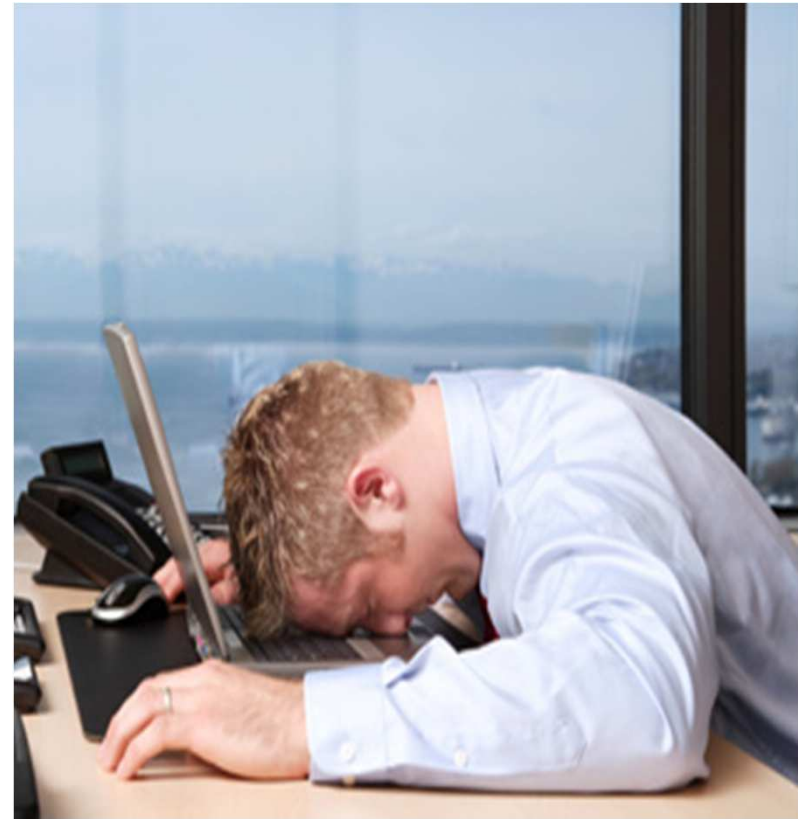
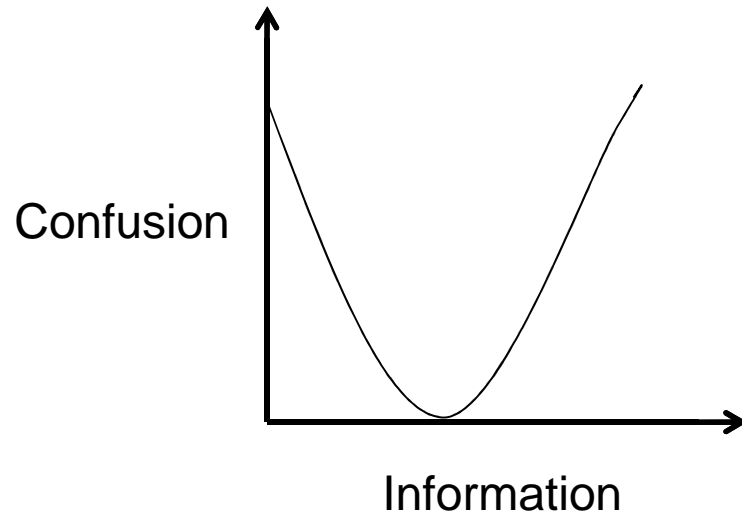


# Snapshot of Data from Nodal Market – MISO

Location	Hourly Day Ahead			5-Minute Real Time			Delta			Last Hour Estimated			
	HE 19			18:35			HE 18			HE 18			
	LMP	MCC	MCC	LMP	MCC	MCC	LMP	MCC	MCC	LMP	MCC	MCC	
DUIHESK1	47.51	-6.43	3.41	25.96	-2.86	0	21.55	-3.57	3.41	75	-9.59	0.07	
MDULLEWIS1	45.59	-6.55	1.61	26.2	-2.62	0	19.39	-3.93	1.61	75.54	-9.04	0.07	
MEC.GDMEC_2_3	37.9	-4.54	-8.09	26.82	-2	0	11.08	-2.54	-8.09	77.93	-6.65	0.07	
MEC.LOUISA_1	36.45	-3.39	-10.69	26.76	-2.06	0	9.69	-1.33	-10.69	78.12	-6.46	0.07	
MEC.MECB	39.01	-3.69	-7.83	27.24	-1.58	0	11.77	-2.11	-7.83	79.03	-5.56	0.07	
MEC.NEALS_4	33.71	-6.39	-10.43	26.01	-2.81	0	7.7	-3.58	-10.43	75.49	-9.1	0.07	
MEC.WSEC4	35.88	-6.1	-8.55	26	-2.82	0	9.88	-3.28	-8.55	75.58	-9	0.07	
MHEB	52.66	-6.55	8.68	26.03	-2.79	0	26.63	-3.76	8.68	75.2	-9.38	0.07	
MICHIGAN.HUB	52.45	2.79	-0.87	30.42	1.6	0	22.03	1.19	-0.87	91.01	6.43	0.07	
MIDW	39.58	-4.21	-7.74	26.81	-2.01	0	12.77	-2.2	-7.74	78.34	-6.24	0.07	
MINN.HUB	58.97	-3.99	12.43	28.35	-0.47	0	30.62	-3.52	12.43	80.36	-4.22	0.07	
MOWR	42.67	-3.12	-4.74	27.27	-1.55	0	15.4	-1.57	-4.74	88.96	-4.61	9.05	
MP.BOS233	53.25	-5.85	8.57	26.41	-2.41	0	26.84	-3.44	8.57	75.68	-8.9	0.07	
MP.HIBBAR3	54.99	-2.93	7.39	27.77	-1.05	0	27.22	-1.88	7.39	79.23	-5.36	0.07	
MP.TACHB2	48.53	-1.08	3.06	22.81	-0.61	0	25.72	-4.17	3.06	81.88	66.16	-18.43	0.07
MPS	39.85	-4.14	-6.54	26.78	-2.04	0	13.07	-2.1	-6.54	78.24	-6.35	0.07	
MPW.MPW	35.8	-2.58	-12.15	27.06	-1.76	0	8.74	-0.82	-12.15	78.9	-5.69	0.07	
MPW.UNIT_7	35.73	-2.69	-12.11	27.01	-1.81	0	8.72	-0.88	-12.11	78.76	-5.83	0.07	
MPW.UNIT_8A	35.73	-2.69	-12.11	27.01	-1.81	0	8.72	-0.88	-12.11	78.76	-5.83	0.07	
MPW.UNIT_9	35.63	-2.92	-11.98	26.91	-1.91	0	8.72	-1.01	-11.98	78.47	-6.11	0.07	
NIPS.BALLP7	46.54	-1.27	-2.72	27.77	-1.05	0	18.77	-0.22	-2.72	81.31	-3.27	0.07	
NIPS.MICHCP12	46.76	-1.05	-2.72	27.77	-1.05	0	18.99	0	-2.72	81.56	-3.03	0.07	
NIPS.MITCHP5	47.09	-0.72	-2.72	27.96	-0.86	0	19.13	0.14	-2.72	81.89	-2.7	0.07	
NIPS.SCHAHP15	46.74	-1.05	-2.72	27.77	-1.05	0	18.99	0	-2.72	81.56	-3.03	0.07	
NPPD	37.37	-5.45	-7.71	26.38	-2.44	0	10.99	-3.01	-7.71	76.68	-7.9	0.07	
NSB	46.81	-0.84	-2.88	28.13	-0.69	0	18.68	-0.15	-2.88	84.16	-1.21	0.85	
NSP.ANCON3	40.64	-5.99	-3.9	26.3	-2.52	0	14.34	-3.47	-3.9	76.04	-8.54	0.07	
NSP.BUKD03	60.02	-3.74	13.23	28.63	-0.19	0	31.39	-3.55	13.23	81.16	-3.42	0.07	
NSP.MITCHEL1	57.42	-1.41	2.86	28.63	-1.19	0	29.79	-4.26	2.86	78.38	-6.2	0.07	
NSP.PRISL1	61.4	-4.05	14.92	28.19	-0.63	0	33.21	-3.42	14.92	80.02	-4.56	0.07	
NSP.REDWIN1	61.91	-3.21	14.59	28.77	-0.05	0	33.14	-3.16	14.59	81.71	-2.88	0.07	
NSP.SHERCO1	57.25	-5.55	12.27	27.61	-1.21	0	29.64	-4.34	12.27	78.33	-6.25	0.07	
NSP.TATANKA1	48.69	-5.16	3.32	26.7	-2.12	0	21.99	-3.04	3.32	81.16	-3.42	0.07	
NSP.WHEATO3	61.12	-0.96	11.55	29.03	0.21	0	32.09	-0.17	11.55	81.16	-3.42	0.07	
NSP.WILMAR1	62.11	-4.49	16.07	27.24	-1.58	0	34.87	-2.91	16.07	81.16	-3.42	0.07	
NYISO	47.56	0.98	-3.95	28.86	0.04	0	18.7	0.94	-3.95	81.16	-3.42	0.07	
OKGE	42.93	-3.06	-4.54	27.27	-1.55	0	15.66	-1.51	-4.54	81.16	-3.42	0.07	
OMPA	42.6	-3.32	-4.61	27.17	-1.65	0	15.43	-1.67	-4.61	81.16	-3.42	0.07	
ONT	46.44	-0.64	-4.73	28.89	0.07	0	17.55	0.57	-4.73	81.16	-3.42	0.07	
ONT.W	49.2	-5.59	4.26	26.27	-2.55	0	22.93	-3.04	4.26	81.16	-3.42	0.07	
OPPD	36.23	-5.79	-8.51	26.15	-2.67	0	10.08	-3.12	-8.51	81.16	-3.42	0.07	
OTP.BIGSTON1	44.14	-8.29	1.9	25	-3.82	0	19.14	-4.47	1.9	81.16	-3.42	0.07	
OTP.COYOT1	47.44	-8.79	3.91	26.06	-2.76	0	21.38	-4.24	3.91	81.16	-3.42	0.07	
OTP.HOOTL2	54.83	-3.45	6.74	27.7	-1.2	0	25.04	-2.33	6.74	81.16	-3.42	0.07	
OVEC	47.41	-0.29	-2.83	28.23	-0.59	0	19.18	0.3	-2.83	81.16	-3.42	0.07	
PJMC	47.44	0.18	-3.27	28.4	-0.42	0	19.04	0.6	-3.27	81.16	-3.42	0.07	
PSCO	40.28	-3.93	-6.32	26.89	-1.93	0	13.39	-2	-6.32	81.16	-3.42	0.07	
PSEG	47.44	0.18	-3.27	28.4	-0.42	0	19.04	0.6	-3.27	81.16	-3.42	0.07	
RC	46.81	-0.84	-2.88	28.13	-0.69	0	18.68	-0.15	-2.88	81.16	-3.42	0.07	
SC	46.81	-0.84	-2.88	28.13	-0.69	0	18.68	-0.15	-2.88	81.16	-3.42	0.07	
SCGE	46.96	-0.66	-2.91	28.18	-0.64	0	18.78	-0.02	-2.91	81.16	-3.42	0.07	
SEC	46.81	-0.84	-2.88	28.13	-0.69	0	18.68	-0.15	-2.88	81.16	-3.42	0.07	
SECI	39.85	-4.04	-6.64	26.87	-1.95	0	12.98	-2.09	-6.64	81.16	-3.42	0.07	
SEMA	46.81	-0.84	-2.88	28.13	-0.69	0	18.68	-0.15	-2.88	81.16	-3.42	0.07	
SERU	47.06	-0.57	-2.9	28.21	-0.61	0	18.85	0.04	-2.9	81.16	-3.42	0.07	
SIGE.10CULGN3	45.53	-2.19	-2.81	27.64	-1.18	0	17.89	-1.01	-2.81	81.16	-3.42	0.07	
SIGE.10NEG11	47.1	-0.62	-2.81	28.32	-0.5	0	18.78	-0.12	-2.81	81.16	-3.42	0.07	
SIGE.ABBROW1M4	47.15	-0.57	-2.81	28.23	-0.59	0	18.92	0.02	-2.81	81.16	-3.42	0.07	
SIGE.WARRASIGE	45.52	-2.2	-2.81	27.63	-1.19	0	17.89	-1.01	-2.81	81.16	-3.42	0.07	
SJPC.MARJGEN5	47.31	-0.4	-2.82	28.27	-0.55	0	19.04	0.15	-2.82	81.16	-3.42	0.07	
SME	46.42	-1.25	-2.86	27.99	-0.83	0	18.43	-0.42	-2.86	81.16	-3.42	0.07	
SMP.MMPA.CCRK1	66.11	-2.35	17.93	28.72	-0.1	0	37.39	-2.25	17.93	81.16	-3.42	0.07	
SMP.MMPA.CCRK2	66.11	-2.35	17.93	28.72	-0.1	0	37.39	-2.25	17.93	81.16	-3.42	0.07	
SOCO	46.81	-0.84	-2.88	28.13	-0.69	0	18.68	-0.15	-2.88	81.16	-3.42	0.07	
SPA	43.91	-2.67	-3.95	27.43	-1.39	0	16.48	-1.28	-3.95	81.16	-3.42	0.07	
SPC	51.06	-6.54	7.07	26.1	-2.72	0	24.96	-3.82	7.07	81.16	-3.42	0.07	
SPS	41.51	-3.48	-5.54	27.1	-1.72	0	14.41	-1.76	-5.54	81.16	-3.42	0.07	
TAL	46.81	-0.84	-2.88	28.13	-0.69	0	18.68	-0.15	-2.88	81.16	-3.42	0.07	
TEC	46.81	-0.84	-2.88	28.13	-0.69	0	18.68	-0.15	-2.88	81.16	-3.42	0.07	
TVA	47.11	-0.89	-2.53	28.15	-0.67	0	18.96	-0.22	-2.53	81.16	-3.42	0.07	
UPPC.ESCC1	62.04	10.63	0.88	32.21	3.39	0	29.83	7.24	0.88	81.16	-3.42	0.07	
UPPC.GLADSTONE	63.27	11.86	0.88	32.69	3.87	0	30.58	7.99	0.88	81.16	-3.42	0.07	
UPPC.INTEGRATD	68.82	8.34	0.95	31.8	2.99	0	37.02	5.36	0.95	81.16	-3.42	0.07	
UPPC.VICTORIA1	75	4.59	19.88	29.94	1.12	0	45.06	3.47	19.88	81.16	-3.42	0.07	
UPPC.VICTORIA2	75	4.59	19.88	29.94	1.12	0	45.06	3.47	19.88	81.16	-3.42	0.07	
VAP	47.44	0.18	-3.27	28.4	-0.42	0	19.04	0.6	-3.27	81.16	-3.42	0.07	
WAUE	42.85	-5.78	-1.9	26.48	-2.34	0	16.37	-3.44	-1.9	81.16	-3.42	0.07	
WEC.GERMANOT1	50.71	2.6	-2.42	29.41	0.59	0	21.3	2.01	-2.42	81.16	-3.42	0.07	
WEC.MAGAZESH	96.52	16.59	29.4	35.46	6.64	0	61.06	9.95	29.4	81.16	-3.42	0.07	
WEC.PARIS01S1	49.11	0.82	-2.24	28.77	-0.05	0	20.34	0.87	-2.24	81.16	-3.42	0.07	
WEC.PLRG41	47.71	-0.26	-2.56	28.1	-0.72	0	19.61	0.46	-2.56	81.16	-3.42	0.07	
WEC.PS0IGIS	51.87	4.72	-3.38	29.84	1.02	0	22.03	3.7	-3.38	81.16	-3.42	0.07	
WEC.PTMBG2	49.69	1.64	-2.48	28.51	-0.31	0	21.18	1.95	-2.48	81.16	-3.42	0.07	
WEC.WP.MWPN	74.38	3.97	18.88	29.77	0.95	0	44.61	3.02	18.88	81.16	-3.42	0.07	
WFEC	43.01	-3.01	-4.51	27.31	-1.51	0	15.7	-1.5	-4.51	81.16	-3.42	0.07	
WPS.EDGEWTR4	48.69	0.58	-2.42	28.33	-0.49	0	20.36	1.07	-2.42	81.16	-3.42	0.07	
WPS.GRFATHER	59.41	4.33	4.55	30.7	1.88	0	28.71	2.45	4.55	81.16	-3.42	0.07	
WPS.WESTON3	56.07	1.55	3.99	29.25	0.43	0	26.82	1.12	3.99	81.16	-3.42	0.07	
WY2	49.28	-3.29	2.62	26.89	-1.93	0	13.39	-2	2.62	81.16	-3.42	0.07	
YAD	47.25	-0.35	-2.93	28.26	-0.56	0	18.99	0.21	-2.93	81.16	-3.42	0.07	

Location	Hourly Day Ahead			5-Minute Real Time			Delta			Last Hour Estimated		
	HE 19			18:35			HE 18			HE 18		
	LMP	MCC	MCC	LMP	MCC	MCC	LMP	MCC	MCC	LMP	MCC	MCC
AEC	46.12	-1.56	-2.85	27.89	-0.93	0	18.23	-0.63	-2.85	84.25	-2.16	1.89
AECI	42.43	-3.15	-4.95	27.22	-1.6	0	15.21	-1.55	-4.95	80.44	-4.75	0.67
AEP	47.44	0.18	-3.27	28.4	-0.42	0	19.04	0.6	-3.27	84.45	-0.14	0.07
ALTE.COLUMBAL1	49.3	0.98	-2.21	28.58	-0.24	0	20.72	1.22	-2.21	82.96	-1.63	0.07
ALTE.EDGE5G5	48.7	0.59	-2.42	28.33	-0.49	0	20.37	1.08	-2.42	82.6	-1.98	0.07
ALTW.DAEC	51	-3.78	4.25	27.77	-1.05	0	23.23	-2.73	4.25	79.3	-5.29	0.07
ALTW.EMERY31												

# AND FURTHER....



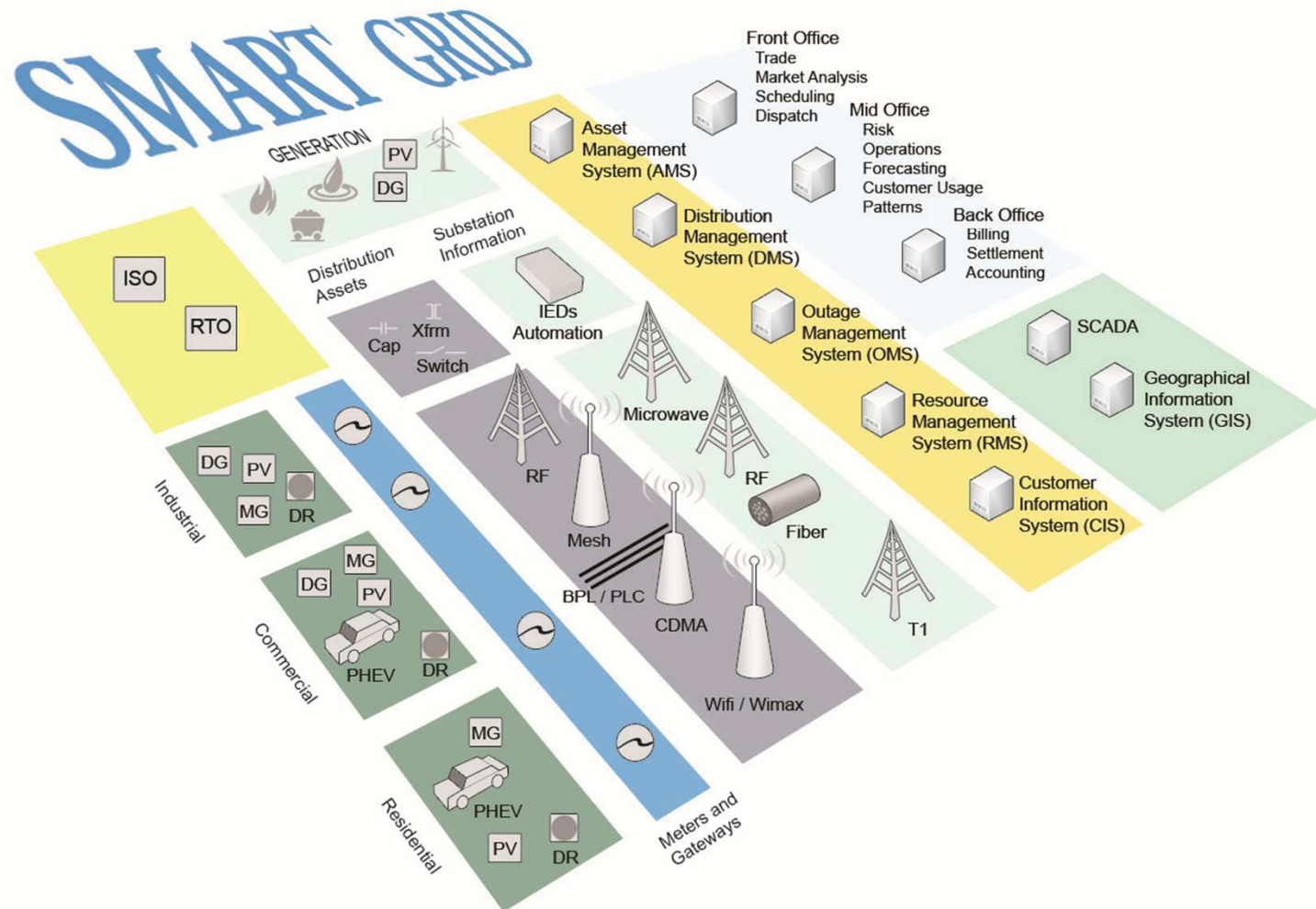
# Utilities Challenges

- ❖ Requires timely access to market data (as available when available)
- ❖ Requires the logical storage of larger volumes of data
- ❖ Data needs to be not only collected but needs to be:
  - Clean
  - Correct
  - Timely
- ❖ Needs to be centralized and highly available
- ❖ Needs to be systematically available to downstream business intelligence tools, trade and risk systems and other decision support products.
- ❖ It needs advanced technology, flexible integration capabilities and robust analytical capabilities

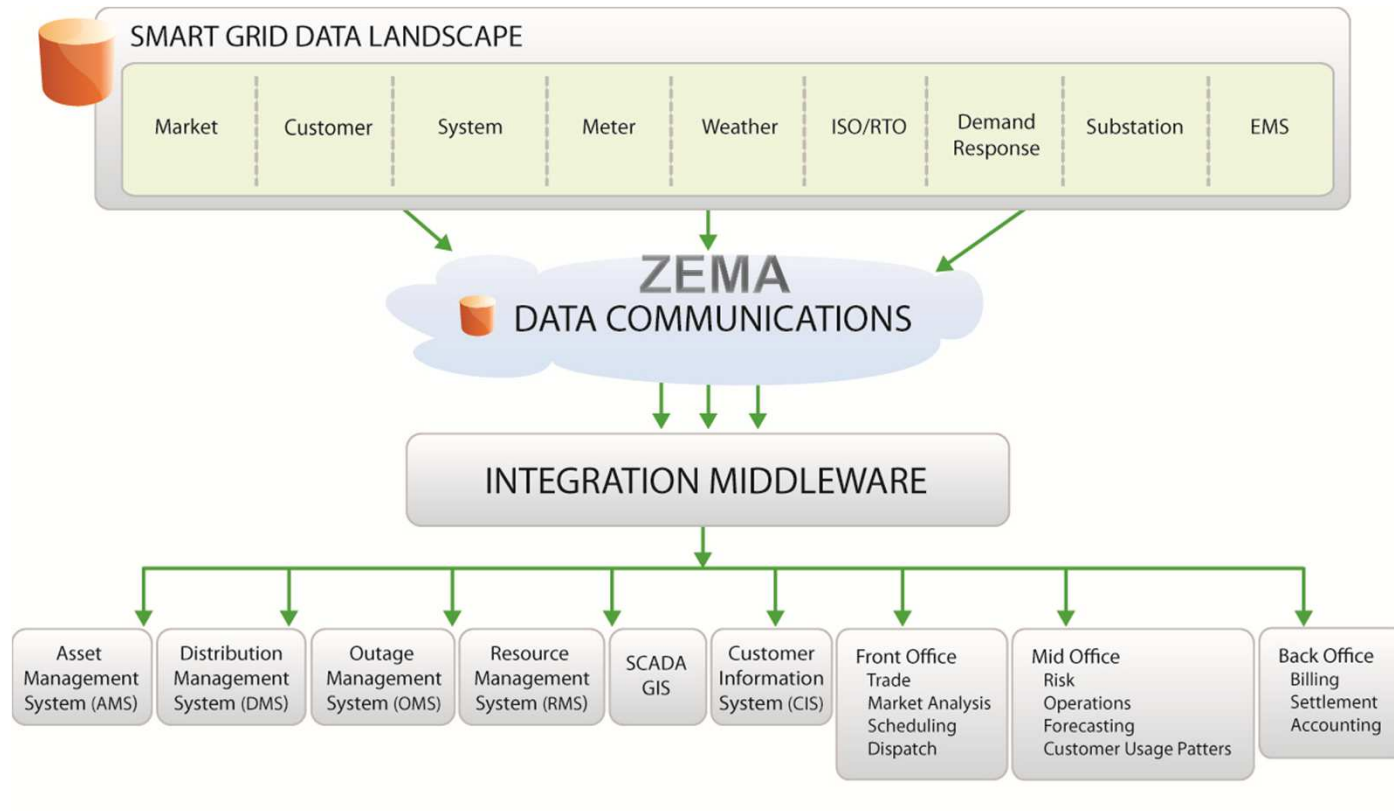
# What Does the Future Hold For Us?



# How it comes together...



# Smart Grid Data Flow



# What Has Been Done

Different aspects of Smart Grid are on different stages of development and implementation

- ❖ distributed generation is becoming an important part of infrastructure
- ❖ demand response programs, Demand Side Management (DSM), have been applied by utilities for years
  - Time-of-Use rates
  - Curtailment
- ❖ smart meters have already been introduced by utilities (76 million worldwide)

# SmartGrid Efforts around Carolina

- ❖ Wake EMC partners with Consert, Inc. of Raleigh to test new "smart grid" technology based on a home energy management system accessed through the Internet.
  - The company said the pilot project will involve 100 customers primarily in the Wake Forest, Rolesville, and Youngsville areas.
  - Wake Electric said the 6 to 8-month pilot project is a first step toward creating a more efficient, environmentally responsible electricity grid.
- ❖ Duke Energy program launched end-to-end pilot program leveraging smart grid technologies to gain energy efficiencies in commercial buildings
  - Early participants have averaged 27% annual savings and payback periods of two to four years

# SmartGrid Initiatives around the States

**Puget Sound Energy** – 1.5 million wireless gas and electricity meters – Completed in 2000

**Tacoma Power** – 9000 muNet meters based on IP and Fibre for homes and businesses.

**Portland General Electric Company** – Project to install meters for all 850,000 customers by 2010. Using Sensus solution. For demand response and web access.

**PG&E** – Installing 5.1 million electricity and 4.2 million gas meters – Uses wireless (gas) and PLC (electricity) for last mile concentrators. Using Esco for wireless and powerline network. Using Oracle for back office.

**Burbank Water and Power** – Using Smartsynch to install up to 45000 residential and 6000 business smart meters using municipal wi-fi

**SCE** – 5.3 million meters. Requires Zigbee for every meter. Have selected Itron's Openway for the communications backbone.

**SDG&E** – 1.4 million electricity and 900,000 gas meters.

**Arizona Public Service** – 2006 – 45,000 smart meters. 800,000 to be installed by 2014.

**SRP (Phoenix)** – Deploying a low power radio(900MHz) to concentrator solution based on Elster's electricity AMR infrastructure. Installing 10,000 per month.

**Lower Colorado River Authority** – Using Meter Smart.

**Heber (Salt Lake City)** – Using Sensus Flexnet for 9000 customers. Will grow to 16,000.

**Spanish Fork (Salt Lake City)** – Sensus Flexnet AMI for 10,000 electricity and 16,000 water customers.

**Xcel energy (Boulder Colorado)** – 100,000 customers using Landis + Gyr to create a smart grid city.

**Sulphur Springs Valley Electric** – 30,000 homes using Landis + Gyr TS2 solution. Looking to implement TOU programs.

**San Marcos City Council (Austin Texas)** – EKA systems to install 10,000 water and 20,000 electricity meters by 2009.

**Austin Energy** - Using Landis+Gyr two way mesh AMI system to deploy 234,000 meters.

**OnCor (Dallas, TXU)** – Landis + Gyr to install 3 million meters.

**Centerpoint Energy (Houston)** – Using Itron Openway and Zigbee RF network. 2 million electricity and 1 million gas meters.

**Xcel energy (Minneapolis)** – 1.4 million wireless gas and electricity meters.

**Wisconsin Public Service** – 200,000 wireless gas and 650,000 PLC electricity meters. Completed in 2004.

# What Has Been Done - Smart Metering

**Consumers Energy** – 1.8 million electricity and 1.7 million gas meters planned for rollout in 2008-9. Working with SAP to implement AMI software.

**Alliant Energy** (Madison) – working with Sensus Flexnet for 450,000 electricity and 176,000 gas customers.

**DTE Energy** (Michigan) – Using Itron to install 2.7 million meters. Completed by 2012.

**Duke Energy** – 800,000 customers in Indiana. PLC based solution. Using Echelon.

**American Electric Power** (Columbus) – 5 million customers by 2015.

**LG&E** - \$1.9 million trial.

**Clarksville Department of Electricity** – muNet meters for 54,000 customers. Using Zigbee.

**EFB** (Chattanooga) – 500,000 to be on smart grid.

**TVA** – EnerNOC has signed a contract with the Tennessee Valley Authority (TVA) to provide a minimum of 110 megawatts (MW) of demand response capacity.

**Alabama Power** (Southern Company) – AMI for 1.4 million customers. Completed by 2011. Using Sensus.

**Georgia Power** (Atlanta) – Using Itron. 2 million meters by 2012.

**Tallahassee** – Elster to provide 220,000 electricity, gas and water meters. Using Elsters EnergyAxis solution.

**Tampa Electric Co.** – Tested EKA Systems's AMI.

**FPL** – Using Itron smart meters for 4.5 million business and residential customers. Using Silver Spring Networks.

**Southern Company** – Using Sensus Flexnet system for 4.3 million customers.

**Baltimore Gas and Electric** (Constellation) – Using Esco system for 1.2 million electricity and 640,000 gas customers. Starting 2009.

**Atlantic City Electric** – 4 to 5 year program to install over 500,000 meters.

**PSE&G** (New York) – Testing phase.

**Con Ed** (New York) – 500,000 smart meters pilot. Plans \$713 million for AMI for all 5 million customers by 2011.

**Horizon Utilities** (Hamilton Ont.) - Using Elter's EnergyAxis AMI for 140,000 customers by 2010.

**Independent Electricity System Operator** (Ontario) – 4.5 million meters by 2010. Using Sensus, Elster, Trilliant and Tantalus.

**Toronto Hydro Electric System** – 450,000 smart meters installed by 2008.

# It is Not Fantasy, But Reality

We will build our SmartGrid for future generations together



# For More Information

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# ZE PowerGroup Inc. (ZE)

ZE PowerGroup is a best of breed software development firm that provides comprehensive technical solutions, strategic positioning and consulting for participants in the energy markets.

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# Recent Recognition



Energy Risk Data Management House of the Year 2009 & 2010

2010/2011 Energy Risk Magazine Annual Software Survey

Data Management Category:

- #1 Preferred System
- #1 Ease of System Integration
- #1 Customer Service

Gartner Inc. Report: Cool Vendors in Energy and Utilities, 2010