

Scenarios for Nuclear Power

--Post Fukushima



Roundtable / Dinner



*Nuclear Energy Insider
Supply Chain Conference*
--June 14, 2011

Linton Consulting

Scenarios for Nuclear Power

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Why Are We Here?



- ◆ Knowledge exchange
 - Status of nuclear revival
 - Discuss challenges
- ◆ Share insights / perspectives
 - Utilities (demand side)
 - Vendors & suppliers (supply side)
 - Advisors, associations & advocacy groups
- ◆ Timely issues with a lot of associated questions
 - Growing electricity demand
 - Natural gas prices
 - Financing issues
 - Fukushima

Situation Analysis



- ◆ “Nuclear renaissance” in the news nearly a decade
 - Growing L.T. demand for baseload, low carbon electricity
 - Growing public support for nuclear
 - Maturing reactor technologies
 - Active construction in Japan, China, Korea, India, U.S.
- ◆ Policy / Regulatory trends more favorable
 - Yet financing problems in U.S.
- ◆ Globalization and change in Energy
 - Shifting global growth & demand: Asia
 - Energy dynamics & competition: oil, gas, coal, nuclear
- ◆ Nuclear already facing several challenges
 - **Then Fukushima...!**

Situation Analysis – Post Fukushima



- ◆ Reactions to Fukushima Event:
 - Germany: Exit nuclear by 2022; Switzerland also
 - Italy?
 - Slower development : UK (Urgent need)
 - Pause in Nuclear development : Malaysia, Thailand, ...
 - Continue forward with additional safety controls: U.S., China, France, India, Russia, ...
 - Continue plans: UAE, Vietnam, Turkey, Indonesia, ...
 - Saudi's announce huge vision of 16 reactors
- ◆ Energy demand growth worldwide continues

Key Questions



- ◆ What are the new challenges for the nuclear revival?
- ◆ Which countries will decide to phase out of nuclear and which will go forward? What will occur in the U.S.?
- ◆ Will demand on the supply chain be reduced, delayed or merely changed?
- ◆ What will be the new regulatory – imposed design requirements and what retrofits will be required?
- ◆ How will these changes impact demand patterns?
- ◆ How will these changes impact major nuclear suppliers: vendors, EPCs, component manufacturers?
- ◆ Others (list)

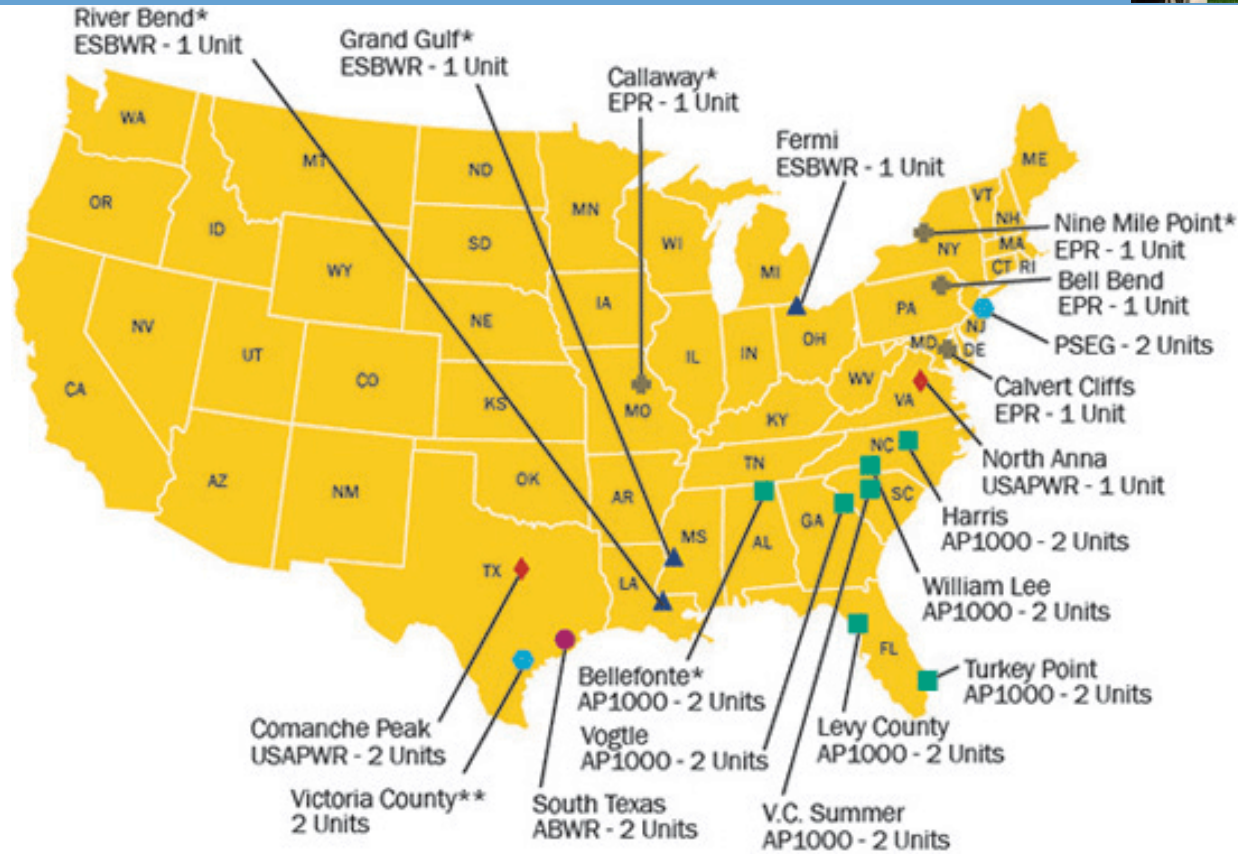
Key Areas of Impact



- ◆ Japan and worldwide
 - Electricity shortages
 - Decommissioning and clean up expense (Japan)
 - TEPCO financial crisis
 - Investment in gas generation, short term
- ◆ Regulators, peer review groups
 - Japanese regulator, US-NRC, European Commission and local regulators will study and update regulations
 - IAEA, INPO, WANO, will grow stronger
 - Expect increased harmonization and stronger oversight
 - US-NRC highly respected

Scenarios for Nuclear Power

Proposed Reactors – How Many?



*Review Suspended by Applicant

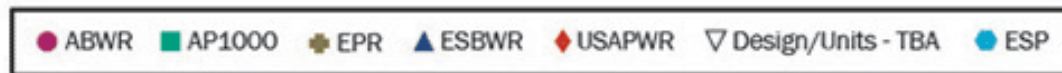
** COL Application Amended by Applicant to ESP on 03/25/2010

Scenarios for Nuclear Power

Proposed Reactors – How Many Likely 5 Years?



X = Significant Postponement (Linton Assessment)



*Review Suspended by Applicant

** COL Application Amended by Applicant to ESP on 03/25/2010

Scenarios for Nuclear Power

Operating Reactors - 104



U.S. Commercial Nuclear Power Reactors—Years of Operation



Years of Commercial Operation

- △ 0-9
- ▲ 10-19
- ▲ 20-29
- ▲ 30-39

Number of Reactors

- 0
- 10
- 42
- 52

Source: U.S. Nuclear Regulatory Commission

Scenarios for Nuclear Power

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“Recent events in Japan are likely to result in changes at existing U.S. nuclear plants and possibly impact plans for new nuclear plants...”

--NRC Commissioner Gregory Jaczko

U.S. Electricity Markets



- ◆ Regulated (especially in Southeast)
 - Traditional utilities, regulated monopolies
 - Southern, SCANA, DTE, Dominion, Duke, Progress, FPL
 - Exelon, Entergy (have both)
 - PUCs closely monitor & control
 - Can get LGs and CWIP (in favorable states)
- ◆ Unregulated, competitive (NE, MW, Texas)
 - Merchant companies, no guaranteed returns
 - Constellation
 - NRG
 - Exelon, Entergy (Have both)
 - Can't get CWIP; must have LGs

**“Are we seeing the merchant market leading to short term decisions that are not in the public’s best interest?”
--Utility Financial Officer**

Most Active Projects – (Nov 2010)

(Challenge Priority)



- ◆ Tier 1 – “Happening”
 - Southern & Partners’ Plant Vogtle
- ◆ Tier 2 – “Imminent”
 - SCANA and Partners’ V.C. Summer 2 & 3
 - NRG & Partners’ ~~South Texas Nuclear Plant~~
- ◆ Tier 3 – “Trying”
 - EDF/Constellation’s ~~Calvert Cliffs 3~~
 - TVA’s Bellefont (board decision 2011)
- ◆ Tier 4 – “Actively Planning, but future”
 - Luminant
 - Progress’ Levy County, FL
 - Duke’s Lee Station, SC

“After these two,
there is nothing else I
have confidence in”
--Financier

Key Areas of Impact



◆ Operating Reactors

- Assessments, stress tests, safety and back up system evaluations
- Possible shutdown of coastal reactors?
 - Build seawall or decommission?
 - Some temporarily shut down (Chubu Electric - Hamaoka)
 - What about San Onofre, Diablo Canyon, Brunswick?
- Possible shutdown of reactors in seismically active areas?
- Increased flood control in higher risk areas
- Investment in additional equipment to assure back up power, emergency cooling water and fire protection systems

“The future of nuclear will be driven more by existing plants than new builds”

Key Areas of Impact



◆ New Reactors

- More stringent design requirements?
 - Recent NRC challenge to AP 1000
 - How will different vendors' designs be impacted?
 - What about BWR vs. PWR?
- Certification delays?
- Licensing delays?

**“We are anticipating a 1-2
year delay in the U.S.
market due to Fukushima“
-- Supplier**

What About SMRs?



- ◆ Small Modular Reactors could provide
 - Electricity in remote areas (global interest)
 - Lower capital cost (\$1-2 bil) & economies of mass production
 - Scalability / incremental capacity additions (6-, 12-pack)
 - Shorter construction/financing duration
 - Energy in non-electric markets
 - Water desalination
 - Unconventional oil recovery
 - Chemicals, metals processing industries
- ◆ But...
 - Higher cost per Kw (unfavorable economies of scale)
 - Still long term: 5-10 years to develop technology & licensing
- ◆ Will they be disruptive to the market?
 - “Nobody has made the math work”

SMRs can be built underground
“which should improve their
security...and seismic safety”
– DOE official

Key Areas of Impact



- ◆ Regions for potential development delays
 - Asia / Japan
 - Europe
 - U.S.?
- ◆ Fuel Cycle – Backend
 - Review of spent fuel pools; reconfigurations
 - Faster transition to dry cast storage and increased demand
 - Push for recycling, long term waste repositories

Scenarios



Country examples for each:

1. Exit nuclear, build gas, alternatives
2. Maintain, but no new build; pause or stop development
3. Slower development
4. Continue with additional safety controls
5. No change – continue pace of development

Scenarios – Changing Demand



- ◆ Increasing demand, interest
 - Consulting, evaluations, assessments, stress tests
 - Peer reviews, monitoring
 - Rulemaking, harmonization/standardization, legal
 - Safety retrofits (& associated EPC); backup power systems, fuel storage ponds, flood control/seawalls, etc.
 - Power uprates
 - Dry cask storage systems
 - Small reactors?
- ◆ Slowing/reduced or postponed demand
 - New Build - Engineering & Construction (globally and selected countries)

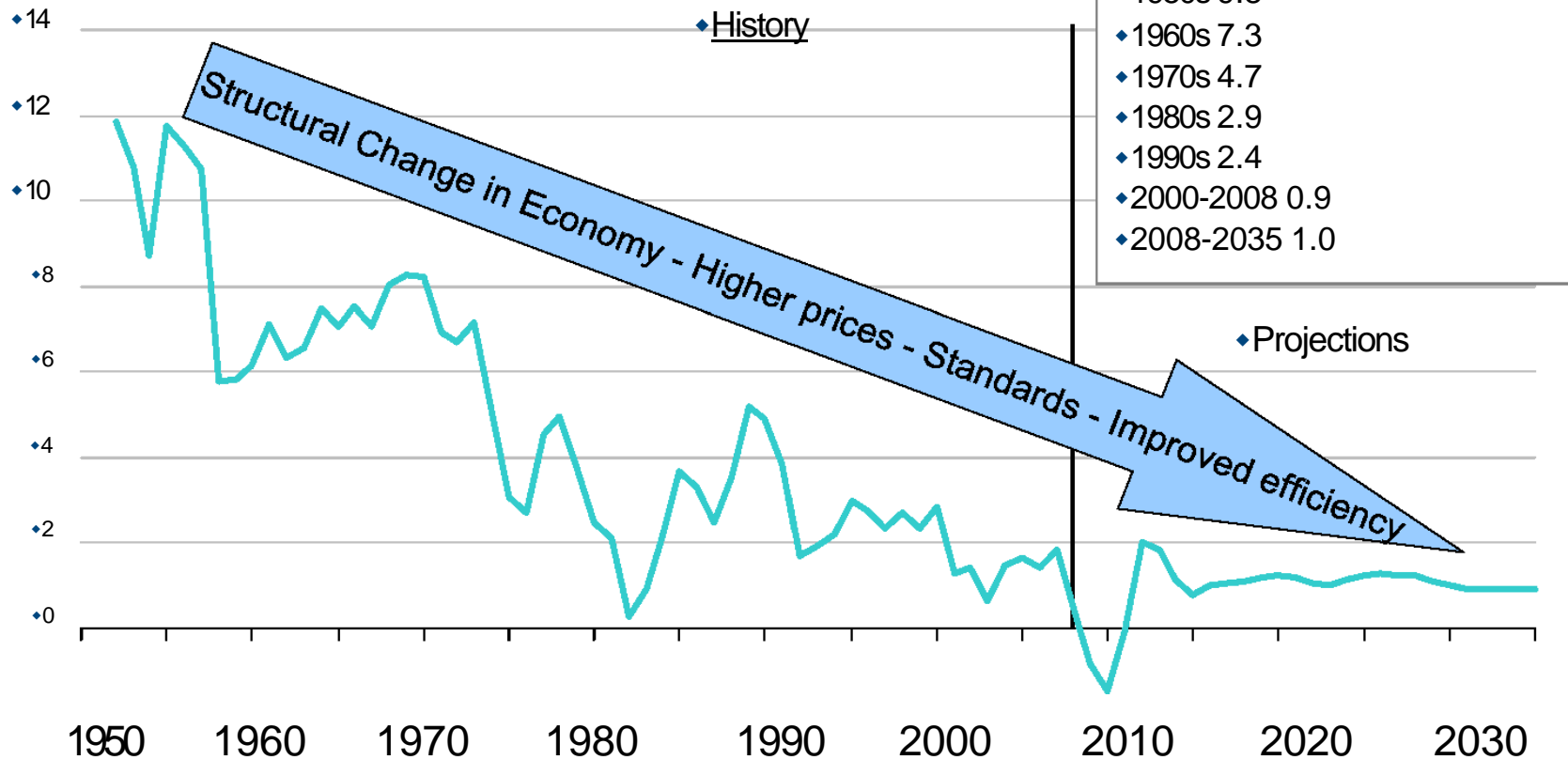


Appendix

U.S. Electricity Use Growth – Slowing



◆ 3-year rolling average percent growth



John Conti, USDOE, April 6th, 2010 Source: Annual Energy Outlook 2010

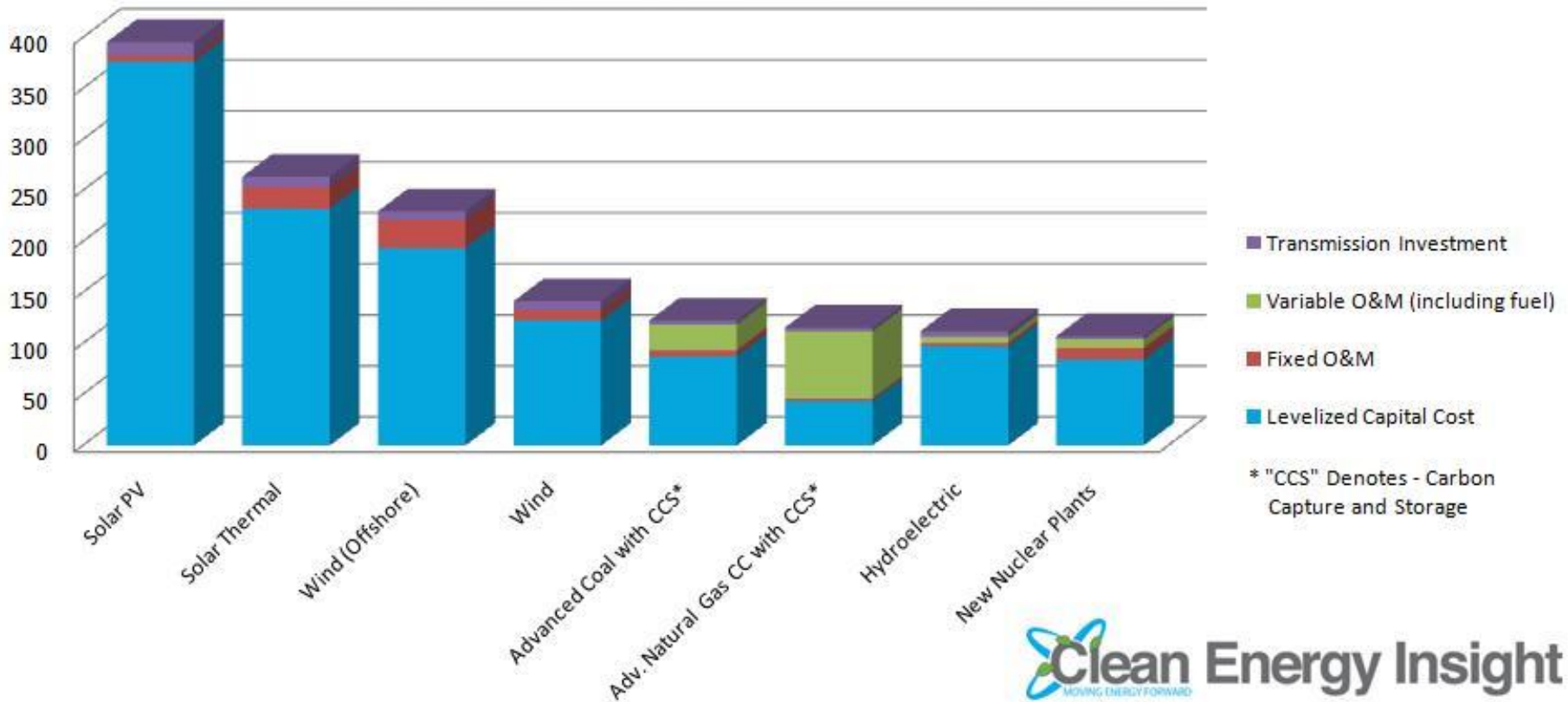
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Comparing Generation Costs



Comparing Clean Energy Costs

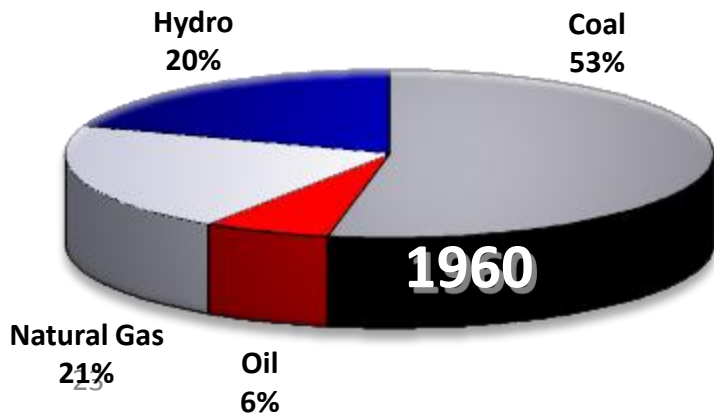
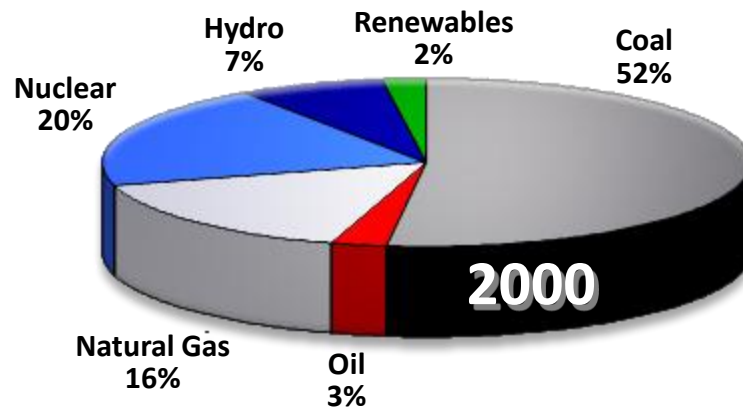
Total System Levelized Cost per Energy Source (2007 Dollars per MWh)



Energy Dynamics



- ◆ U.S. Generation mix changes over time
- ◆ Nuclear share from zero to 20%
- ◆ Global growth expected



Global Growth is Likely



WNA NUCLEAR CENTURY OUTLOOK

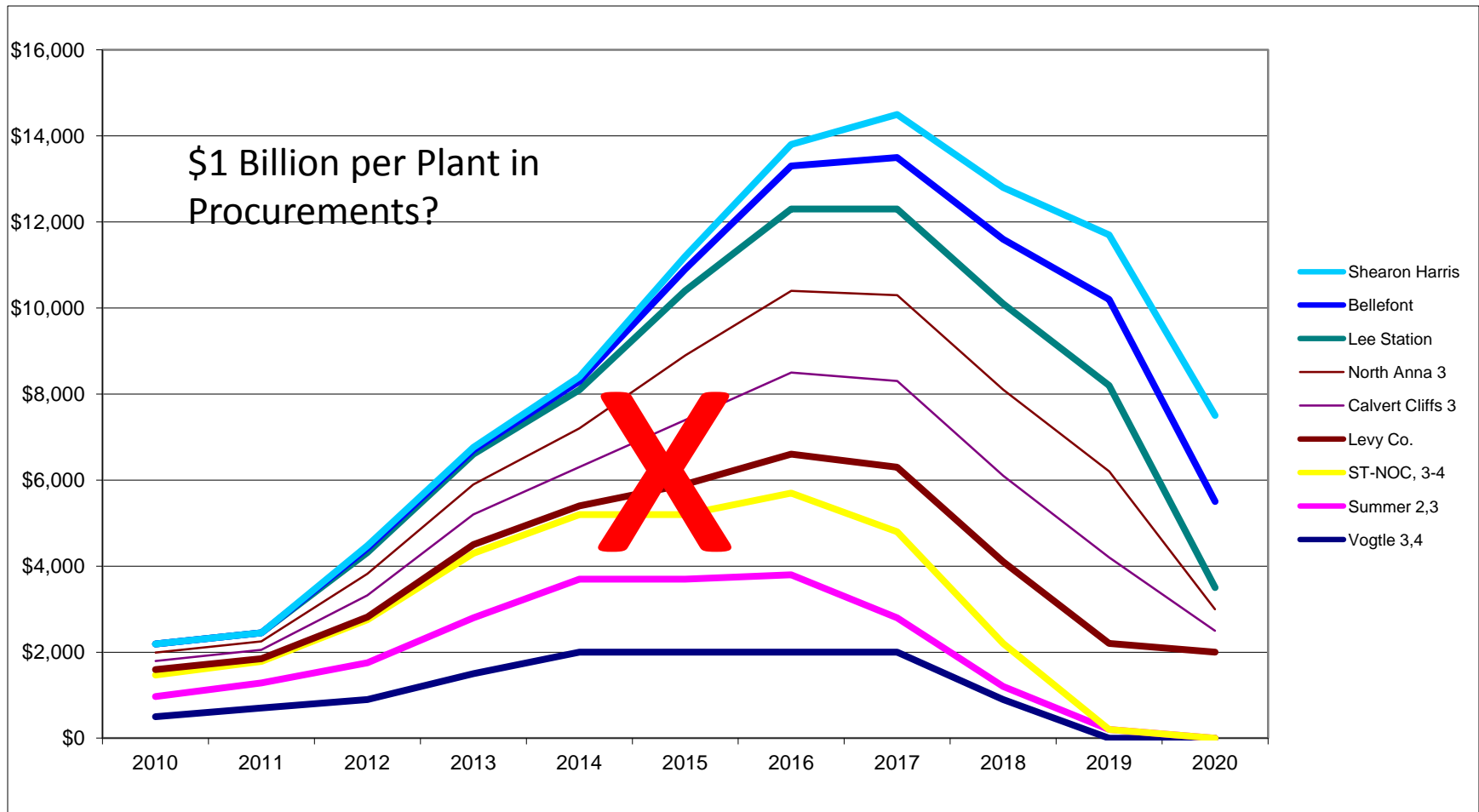
MAJOR NUCLEAR PROGRAMMES*	2008	2030 Low	2030 High	2060 Low	2060 High	2100 Low	2100 High
<i>Units - 1GWe</i>							
Belarus	0	2	5	5	8	5	10
Belgium	6	6	8	8	10	8	22
Brazil	2	10	30	40	100	70	330
Bulgaria	2	4	7	5	7	5	7
Canada	13	20	30	25	40	30	85
China	9	35	100	150	750	500	2800
Czech Republic	3	5	7	5	12	5	15
Finland	3	5	7	8	10	8	11
France	63	65	75	80	110	80	130
Germany	20	20	50	40	80	80	175
Hungary	2	4	5	4	8	5	12
India	4	20	70	60	350	200	2750
Japan	48	55	70	80	140	80	200
Lithuania/ Latvia/ Estonia	1	4	6	5	8	5	8
Netherlands	1	1	5	7	20	10	35
Romania	1	4	10	5	20	10	25
Russia	22	30	70	75	180	100	200
Slovakia	2	3	4	4	5	5	7
Slovenia	1	1	1	1	2	1	2
South Korea (and North Korea)	18	25	50	45	80	70	145
Spain	7	8	20	20	50	25	60
Sweden	9	10	15	10	18	10	18
Switzerland				5	10	5	11

Source: World Nuclear Association Website

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Nuclear Plant Capital Spending

\$8 - 10B Supplier Market to 2020 ?



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Insights for Industry and Government



Linton Consulting

Who Is Linton Consulting?



- ◆ A professional practice providing independent insights and advisory services to industry and government, focused in energy
- ◆ Help with business strategy, market development, trend analyses, scenarios and futuristic market/industry visioning
- ◆ Strategic View – process that provides high level insights on the future state of industries and markets; developed through ongoing analyses and executive interviews
- ◆ Services leading to sound business decisions, plans and actions

Who is Linton Consulting?



- ◆ Independent practice providing strategic development and market development services in Energy and Manufacturing
 - Over 30 years experience with large engineering and construction firms: CH2M HILL, Lockwood Greene, Fluor
 - Over a decade of consulting experience
 - Extensive industry contacts & ongoing interviews

Strategic View Industry Studies

- 2010 Energy Challenges/ Energy Parks
- 2008 Nuclear Renaissance
- 2007 Oil, Gas, Chemicals
- 2006 Energy
- 2005 Mfg./Industrial
- 2004 Food & Beverage
- 2003 Pharmaceutical
- 2002 Power
- 2001 Infrastructure Life Cycle, Others

Past *Linton* Industry Studies

- Oil & Gas
- Electric Power
- Engineering and Construction
- Water/Wastewater
- Environmental
- Asia/Pacific
- *Market Reports* - Series

2010 Research Conducted – For SRNS



115 Interviews, Discussions, and Meetings*

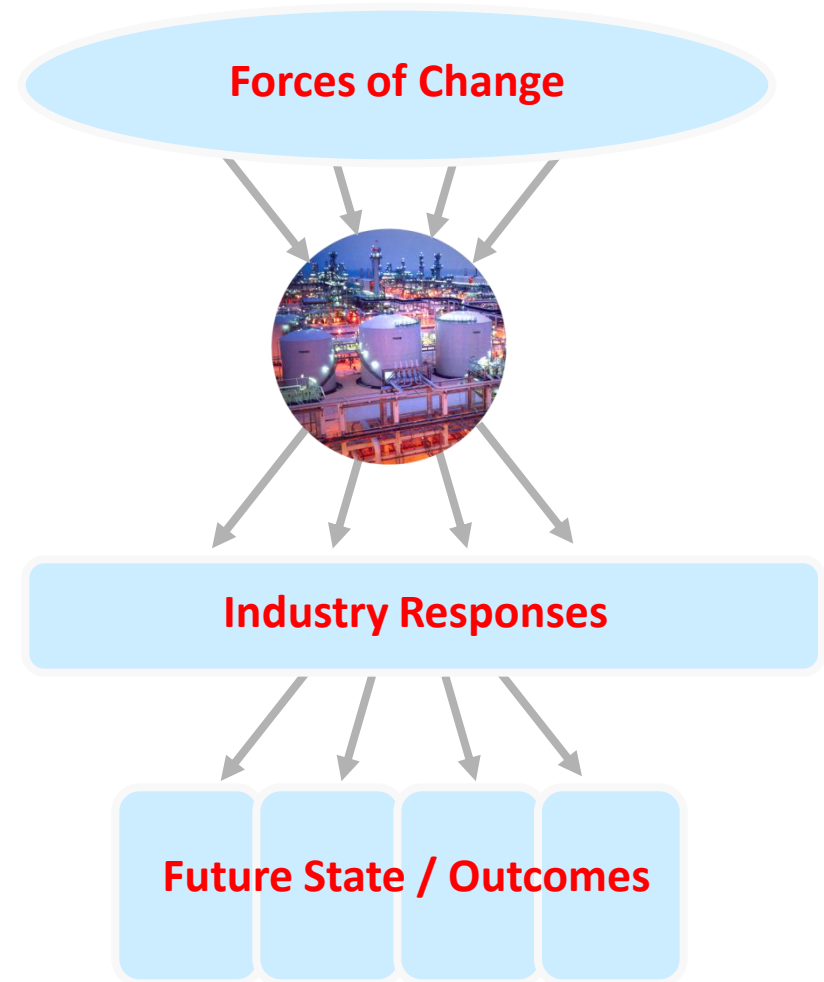
Ameresco	Dow Chemical	Marathon	Shaw Group
American Nuclear Society	Eastman Chemical	Marston Consulting	Siemens-America
Arizona Clean Fuels	Economic Development Partnership	MIT	Southern Company
B&W	EIA	NEI	SRNL
BetterPlace	EPRI	New Carolina	SRNS
BP	Exelon Corporation	NNSA	SRNS- Honeywell
Building Construction Trades Dept. (AFL-CIO)	Fluor	NRC	SRNS- Northrup Grumman
Canup & Associates	Gasification Technologies Council	Peabody Coal	SRS-CRO
Carolinas' Nuclear Cluster	General Atomics	PJM Interconnection	TerraPower
CH2M Hill	General Electric	Progress Energy	Technology Ventures
ConocoPhillips	GE- Hitachi	Rentech	Three Rivers Solid Waste Authority
CSIS	George Mason University	S-4 Energy Solutions	University of South Carolina
Duke Energy	Honeywell	SCANA	UOP - Honeywell
DOE	Hyperion Power	SC Regional Development	USEA
DOE- EM		Senator Graham's Office	Westinghouse
		Senator DeMint's Office	

*Some organizations had multiple interviews

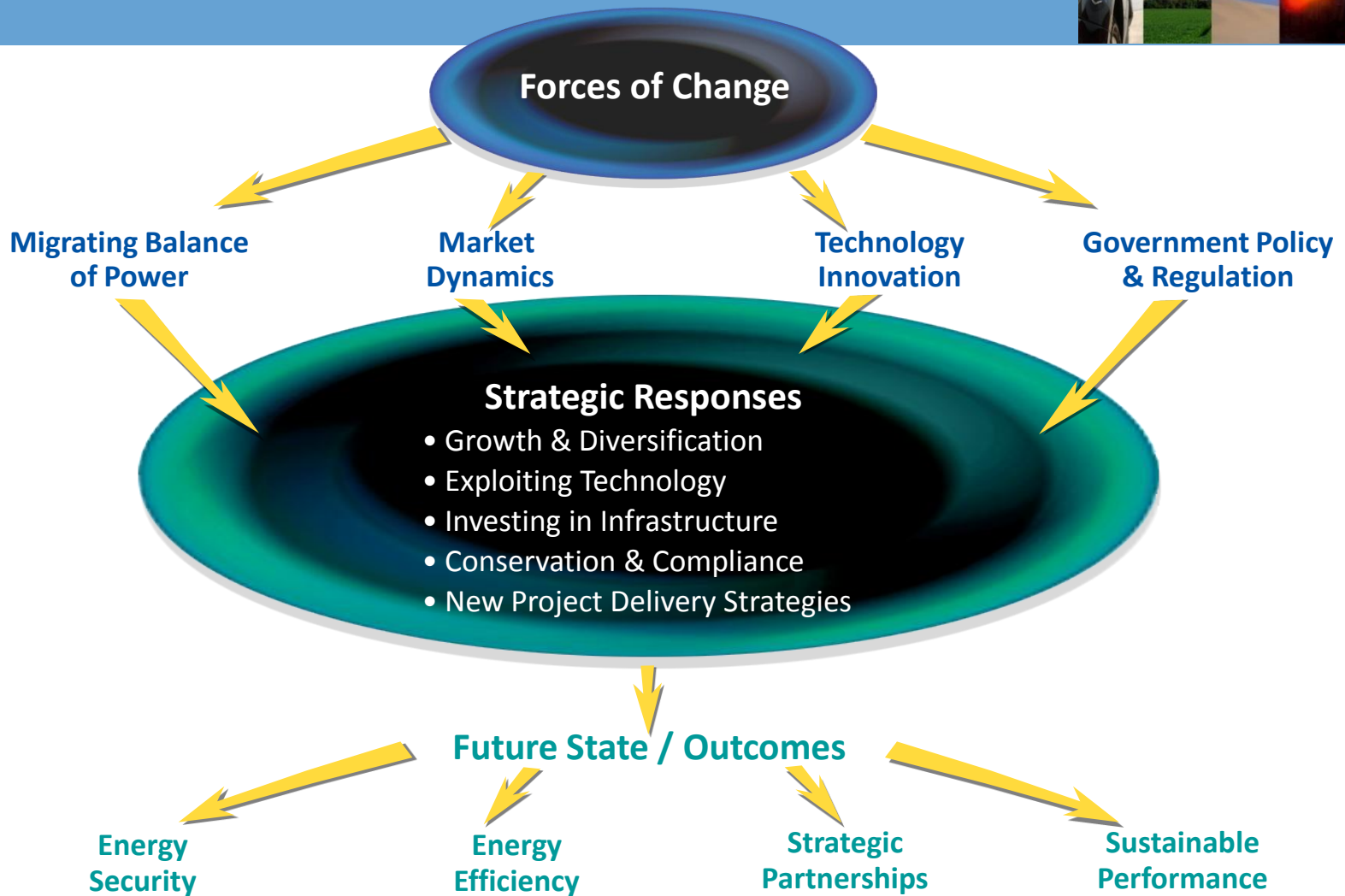
What is *Strategic View*?



- ◆ Research model
 - Used 14 years; 5 in energy
 - Forces affecting the future of the energy industry
 - Industry responses
 - Where it is leading – the future state/outcomes
- ◆ Process
 - Interviews with executives and thought leaders
 - Research & analysis
 - Executive Roundtable
 - Follow up & plan integration



Strategic View – Energy (Example)



Executive Roundtables



◆ Common purpose

- Convene executives and thought leaders for knowledge exchange
- Expand understanding
- Share perspectives
- Confirm/challenge paradigms
- Advise leadership
- Uncover ideas and opportunities for your organization
- Explore Future – trends and challenges
- Establish practical, realistic path forward