SMART ENERGY THE WORLD'S LARGEST AND MOST COMPLEX MACHINE

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EDF

EDF in brief : a global energy leader



EDF Group annual R&D investment: 500M€







SMART ENERGY: THE WORLD'S LARGEST AND MOST COMPLEX MACHINE

1.SMART ENERGY: WHAT ARE WE TALKING ABOUT? 2.THE MULTIPLE COMPLEXITY FACTORS 3.WHAT CONCRETELY THE INDUSTRY IS DOING 4.CONCLUSION



Smart Energy: «Connecting» many points of generation with many points of consumption end to end





The "Blind Men" and the.....Smart Grid/Smart Energy





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Laws of physics cannot be abolished !

Extreme complexity: one global physical system balanced 100 times/sec under fragmented responsibilities





Deregulation: market forces the best way to lower costs and foster innovation but....!





Renewable generation: a Blessingbut !





Nanogrid/Microgrids: buy, sell, use at the optimal time !



Customer-Grid Evolution

Customer DER driven by resilience, economics & environmental objectives



Utility Economics Are Changing





Vision for North Pole Energy Transmission





国家风光储输示范项目位置示意图







Zhangbei : prototype of a 600MW Renewable Power Plant ?

- Located in Hebei province (3 hours north of Beijing),
- project of Wind Farm/PV/BESS has been started since 2009

500MW Wind, 100MW PV and 100MW storage



Global Energy Interconnection / Global Energy Internet



Global Energy Interconnection Development and Cooperation Organization 全球能源互联网发展合作组织





Newly feasible very long distance delivery





Spatial & Temporal Changes

Operational systems are challenged by increased span of control and decreasing timing of information and decision and control responses



Who invests? Who benefits ?





Who invests? Who benefits ?



ululu cisco



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SYSTEM AND STANDARDS APPROACH



World market: what «investors» want





Make visible and traceable multi-dimensional system interdependencies





Uses Cases for a successful implementation of Smart Energy Systems



MODSARUS® = EDF Addin of EA (SPARX UML Tool)





Smart Grid Standards Map solution





Smart Energy planning: simulation to understand long term impact of today's decisions





Complex – system - modeling Multi scale, Interactions, non deterministic **Never ending evolution**

3D intelligence for smart actionable results

ntegrity . Service . Excellence

The oldest and largest Smart Grid in the World 40 years of Load Control in France : 10% peak reduction



Every night, 12 million water heaters store the electricity generated by 12 nuclear reactors

"If you can't solve a problem, enlarge it" (D.Eisenhower)



Conclusion

- Technical, Business, Regulatory decisions should be made keeping in mind the <u>physical nature of the</u> <u>unique overall system</u> they address (make sure to close the control loops)
- Wide scale deployments, require strategies to make appropriate <u>risk informed investment decisions</u>, taking into account the <u>legacy</u>, while enabling reasonable incremental <u>transitions towards dependable solutions</u>
- <u>Standardization</u> is a key to pre-resolve the extreme challenge of complexity !

Standards = complex systems "chromosomes"

IEC

Thank you