Innovating to ZERO

The imperative for smarter grids
Towards ZERO waste with smarter grids

1. DIMENSIONS OF TECHNOLOGY INNOVATION

2. THE POWER TO TRANSFORM – WANT TO CHANGE

3. DESIRED RATE OF INNOVATION – NEED TO CHANGE FASTER

4. ENERGY MARKETS EVOLUTION – IMPERATIE TO CHANGE

5. NEW REALITIES – CHALLENGES TO CHANGE

6. MANAGE THE TRANSITION – CHANGE YOUR THINKING FIRST
Dimensions of technology innovation and the rate of change

- Mechanical / Chemical
- Information
- Augmenting Human Performance
- Zero Incidence
- Zero Emissions
- Energy
- Zero Delay
- Zero Emissions
Digital is impacting the world at an exponential rate.

**Value drivers**
- Technology
- Stages

**Augmented behavior**
- Tiny, Low Power, Cheap, Fast, DSP
- Billions IoT, Embedded logic

**Augmented intelligence**
- Power Line Communication
- Super fast, Fiber
- High bandwidth
- Mobility, 5D
- Cyber Security

**Digital components**
- AI the new UI
- 3D and nD
- Gamification
- Augmented Reality
- Ultrafast switches

**Edge & Cloud Computing**
- Quantum Computing
- Machine Learning
- AI, Algorithms
- Simulation, Context

**Analyzing**
- Cloud Storage,
  Data Lakes, BlockChain
- Data Historians

**Acting**
- Standards

**Creating**
- Network

**Communicating**
- Sensors
Electrification: The Power to transform – Want to change

- Cost of DER is declining exponentially - $0.45/kWh solar PV with storage
- Zero emissions (DPM + GHG) at load – Reduce ventilation requirements
- Improved energy conversion – Reduce consumption and cooling requirements
- Improved in “power to weight” ratio – Improve payload ratio
- Lower maintenance requirement – Fewer parts, inherently more reliable
- Greater level of control with electricity – Instant response
- Reduced noise – Improve working conditions

Broad positive stakeholder impact
Value creation: Desired rate of innovation – Need to change faster

- Commodity prices are set by the marginal supply
- Marginal suppliers have the greatest incentive to innovate
- Innovation by marginal suppliers can depress industry margins
- Mass adoption of energy innovations by everyone leaves relative positioning the same, commodity prices fall and margins do not improve
- Earlier and successful adoption of energy innovations translate into value creation
  - Lower cost drives higher margins
  - Resource to reserve conversion expands LOM
  - New ore bodies become viable to drive profitable growth
Changing context: Energy market evolution – Imperative to change

- Decarbonize, Digitize, Decentralize
- High penetration of renewable resources and the “duck curve”
- Falling cost of renewables favor shorter PPAs
- Market structure is changing with new players emerging
- Alignment to new tariff structures
- New opportunities for tariff management emerge
- New opportunities for revenue from ancillary services emerge
- Utilization of all energy assets can improve
New realities: Old paradigms – **Challenges to change**

- **New realities:**
  - Intermittent supply: Need to manage variation in real-time
  - Greater mobile loads: More stochastic demand
  - More reactive loads and THD: More capacity and energy waste in the grid

- **Unintended consequences:**
  - Energy efficiency VS power quality
  - Hidden costs and consequences

- **Combinatory and dynamic complexity**
  - Multiple agents, multiple time domains
  - Multiple models, dynamic simulations
Managing the transition: Do differently – Change your thinking first

- Less brawn, more brain: Greater power measurement, quality and control
- Small rather than big: Super fast modular iPEDs rather than large slow EMDs
- Enhanced safety and resilience: Millisecond fault detection and response
- Goldilocks Value Zone: Focus on the true grid edge, bottom-up solutions
- Exploit differences: Develop details characteristics of all loads, unique load IDs
- Small can be big: Manage individual loads in aggregate, dynamically in real time
- Work storage VS energy storage: Value optimized energy/work synchronization
- Multiply the value: AI based predictive maintenance from electricity signatures
- Partner for success: PSAs with IPSPs for maximum success