

A Future History of the Grid

PG&E Employee Resource Group Talk

Paul De Martini

Executive Director, Pacific Energy Institute

Adjunct Professor, University of San Francisco

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***“The future has arrived —
it’s just not evenly distributed yet.”***

William Gibson

Electricity Industry in Transition

Convergence of Environment, Policy, Customer, Innovation, & Communities are Shaping the Future of the Electric Industry

Environment

Profound changes in our environment are creating catastrophic weather related events in addition to other naturally occurring disasters, such as earthquakes.

Policy

Federal & state policy have progressively institutionalized Customers' "right to choose"

Customer Expectations

Always-on, Anywhere, Internet of Things & Personalization expectation is the new reality

Innovation

Technology advancements are accelerating! Business models derived from the internet are reshaping traditional businesses

Sustainable & Resilient Communities

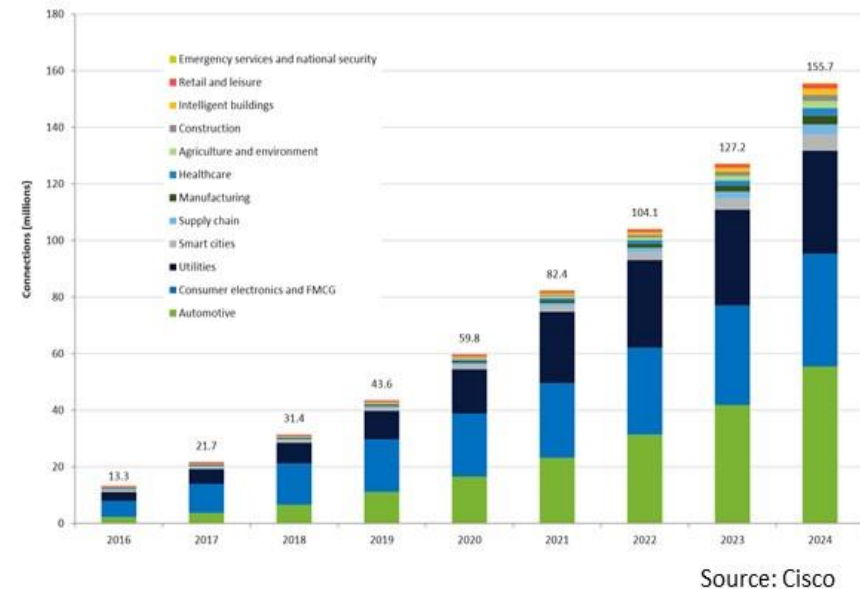
Communities are taking control of their futures through proactive steps to achieve sustainability and resilience relying more on the electric grid



BYOD – Energy Internet of Things (eIoT)

Will Alexa, Siri, Google Assistant and others effectively become DER aggregators later this decade?

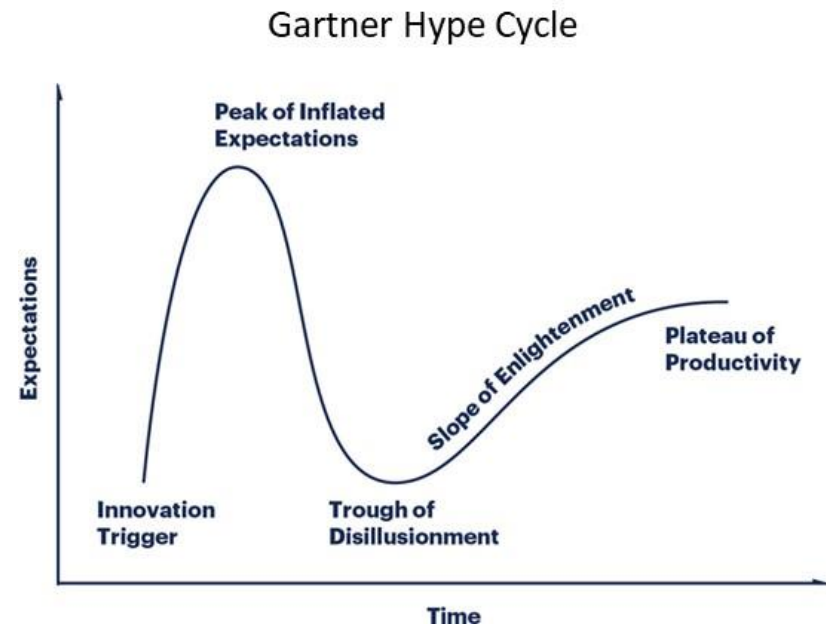
- 50 billion IoT devices globally by 2020
- 5.8 billion enterprise & automotive IoT devices globally in 2020
- Energy IoT - all customer devices that consume or produce electricity are internet-enabled & can coordinate their energy production & consumption with the rest of the grid in real time or near real time
- Grid energy interactive buildings become reality potentially sooner & at lower cost



Value of DER

Beautiful Theory Evolving into Practical Reality

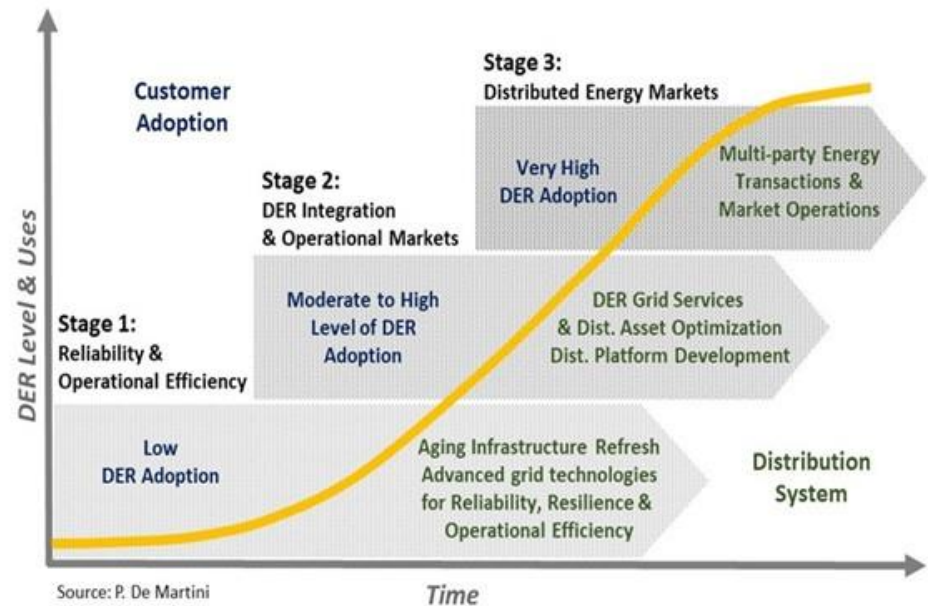
- DER Value Stack has been studied and tested for over 10 years
- True value potential and methods to extract this value remains unclear
 - Procurements, Programs and/or Pricing (Tariff/Market)?
 - A la Carte or Bundled?
- Post-NEM Rates and operational performance requirements may drive resolution



Distributed Market Evolution

NEM Rates Key Barrier to Transactive Energy

- Customer Solar PV & Storage are treated as load modifiers under NEM rates
- No ability to schedule export energy as NEM rates are customer self-supply tariffs
- CCAs may change this as they pursue options to address resource adequacy through customers' solar+storage assets
- If this happens, then like in Texas today, the transaction may be a sale to an energy retailer for resale – not Peer-to-Peer



Sustainable & Resilient Cities

89% of US Population Living in Cities by 2045 (Statista)

DEADLINE 2020

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100 RESILIENT CITIES

Determining Resilience Solutions

- **Policymakers, regulators, utilities, communities and customers are considering and implementing various point & community solutions**
 - **Community:** Cyber-Physical Grid Hardening, Mini-grids, Multi-user Microgrids, etc.
 - **Point Solutions:** Back-up generation, energy storage, customer microgrid, etc.
- **Specific solutions don't necessarily solve all the needs – a portfolio is needed**
 - Solutions usually address specific functional resilience needs
 - Solutions have different potential societal benefits based on type of event and severity



Societal Value of Clean, Electrified & Resilient Communities

Clean, resilient electricity is the lifeblood of 21st century societies & economies

- Societal value from the creation of Sustainable & Resilient Communities accrues in significant part based on the efficient use of clean, resilient electricity
- Sustainable communities cannot be developed without *a node-friendly distribution network that is open, visible, flexible, reliable, resilient and safe**

*More Than Smart principle adopted by CPUC

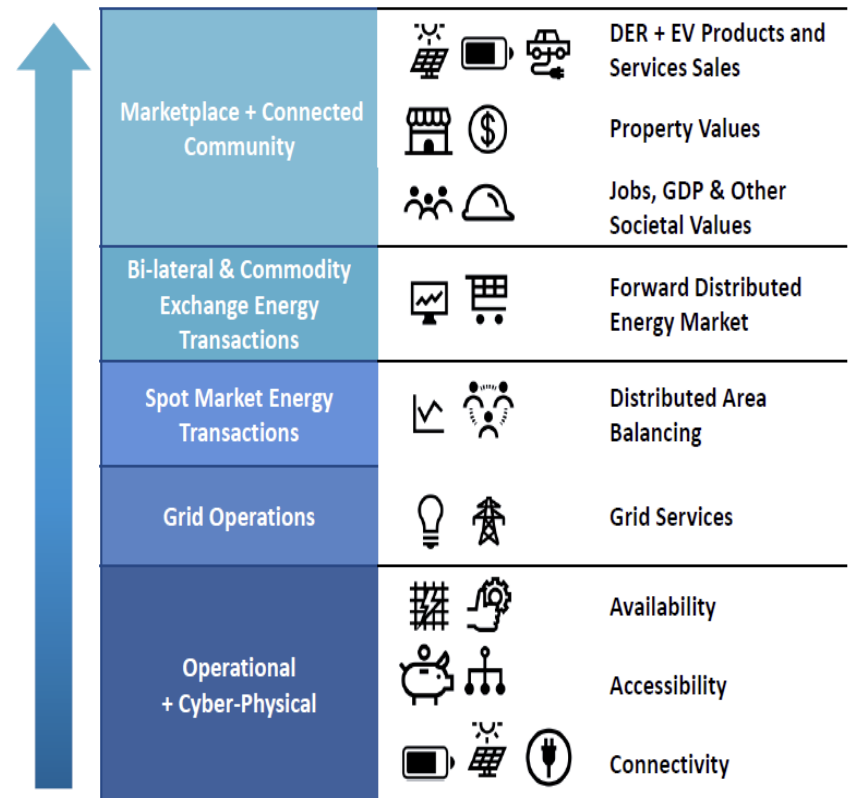


Source: Energy Innovation Technology & Policy, LLC

Distribution Network Value Potential

DER's societal value potential is wholly dependent on a robust modern grid that enables all customers to benefit

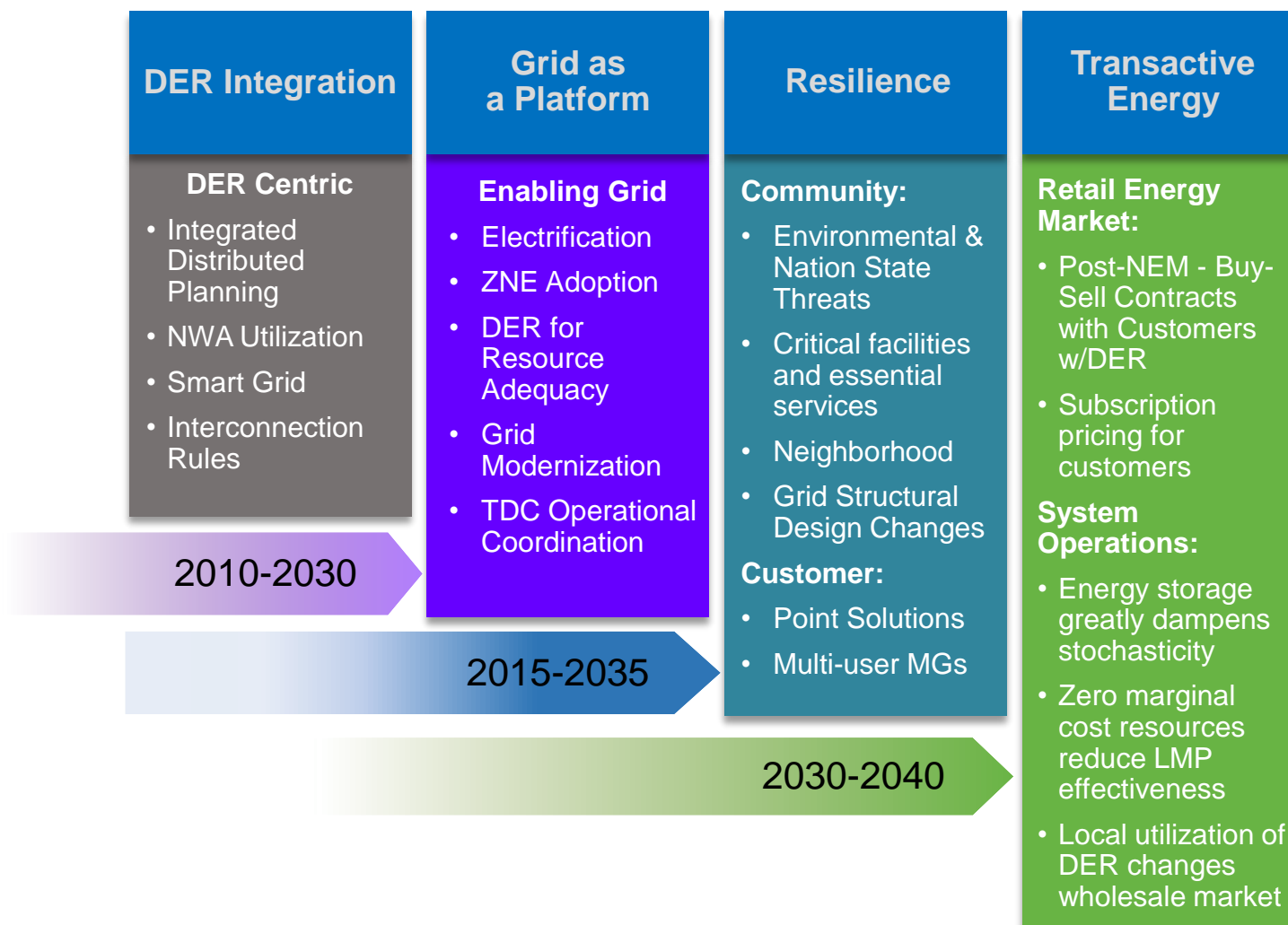
- The cyber-physical grid infrastructure can provide the foundation for network value creation
- Total value increases through the interdependent capabilities of each value layer
- Capturing benefits requires a broader view of the solution set and deliberate alternative grid designs & investment to support value realization



Source: De Martini & ICF

A Future History of the Grid

Many possible futures – essential to consider the potential implications



Considerations for the Future

- **Electrification of transportation can have tremendous benefits for communities and utilities, but needs to be thoughtfully planned and coordinated**
- **Technological advancement is accelerating and there will be new and larger societal impacts from emergent technologies over the next decade as seen over the past 10+ years**
- **Large scale use of DER for Resource Adequacy (post-NEM) will fundamentally change the design requirements for distribution grid**
- **Role and value of electric grid to enable clean, electrified & resilient communities is not fully understood by all stakeholders**
- **Shift from scarcity thinking to abundance thinking regarding the significant value potential created from grid investment?**

***“The future belongs to those who
prepare for it today.”***

Malcolm X

<https://pacificenergyinstitute.org/>