

Integrated Energy Network

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Electric Power Research Institute



A Look Back: The Last 25 Years

Electronics: Smaller with Increased Performance and Decreased Cost

Communication: Increased Speed; Globally Connected Networks and Devices

Information: Explosion of Digital Data and Searchable



Smaller

Faster

Cheaper

A Look Ahead: Technology Innovation

Storage: Bulk to Micro



Energy Efficiency and Automation



24x7 Quality & Capacity



Cleaner Energy



Microgrids



Resiliency



Electrification



Analytics

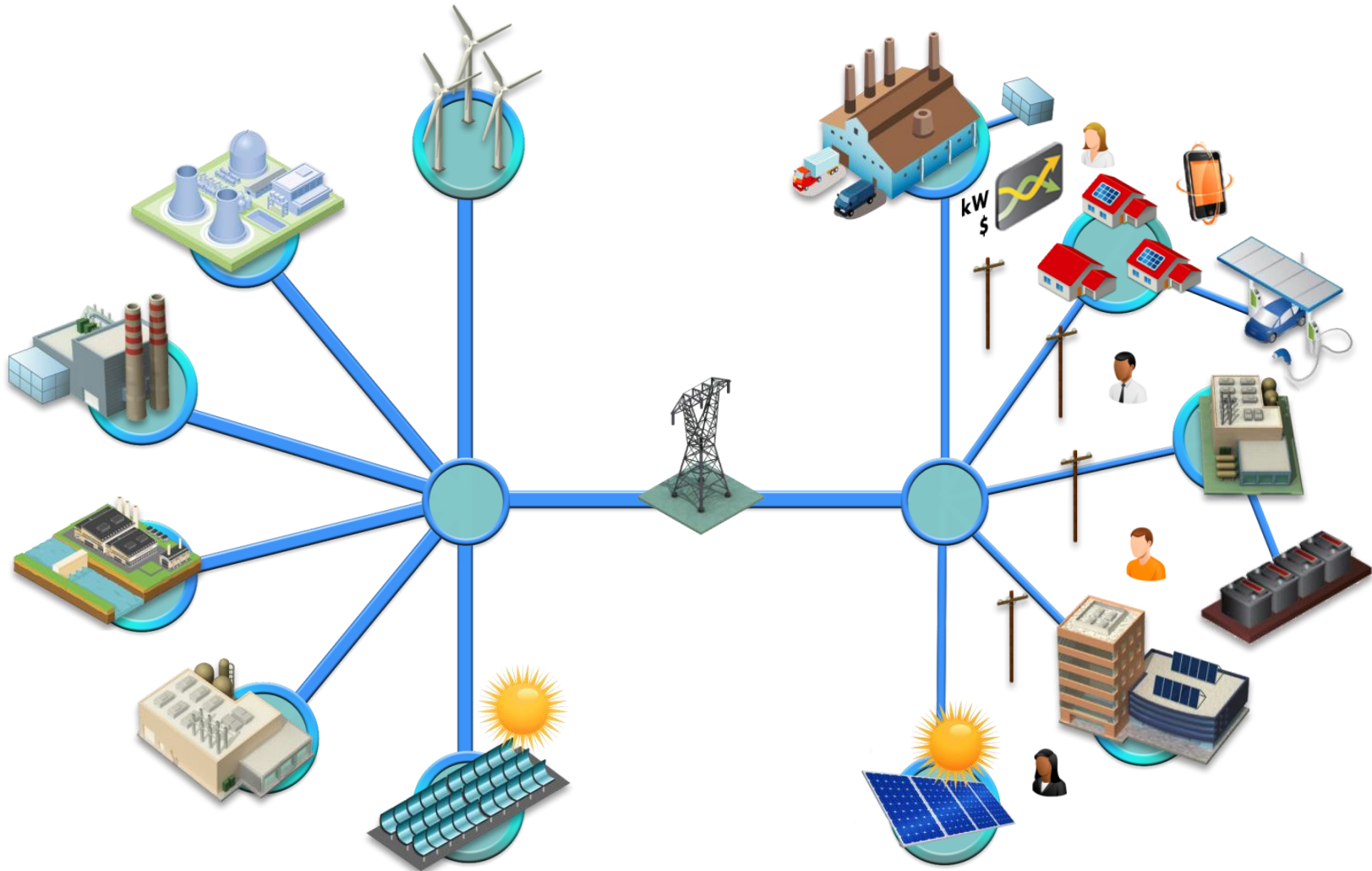


Acceleration 25:8

Breadth & Depth

Integration

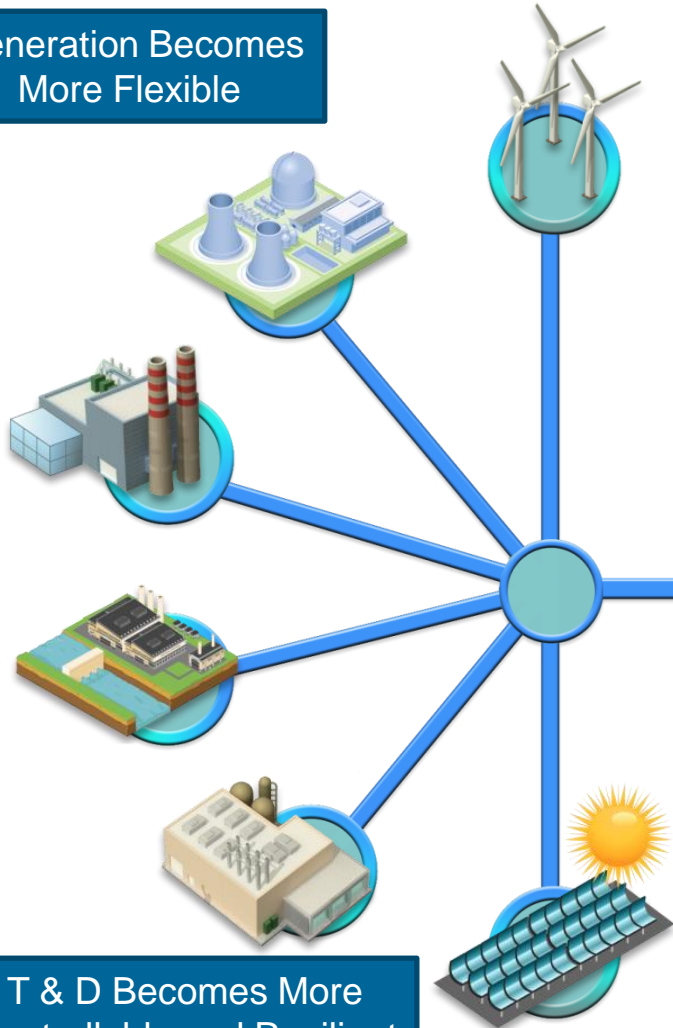
A Look Ahead: The Power System



Less Dispatchable, Less Forecastable, More Dynamic, More Interactive

A Look Ahead: The Integrated Grid

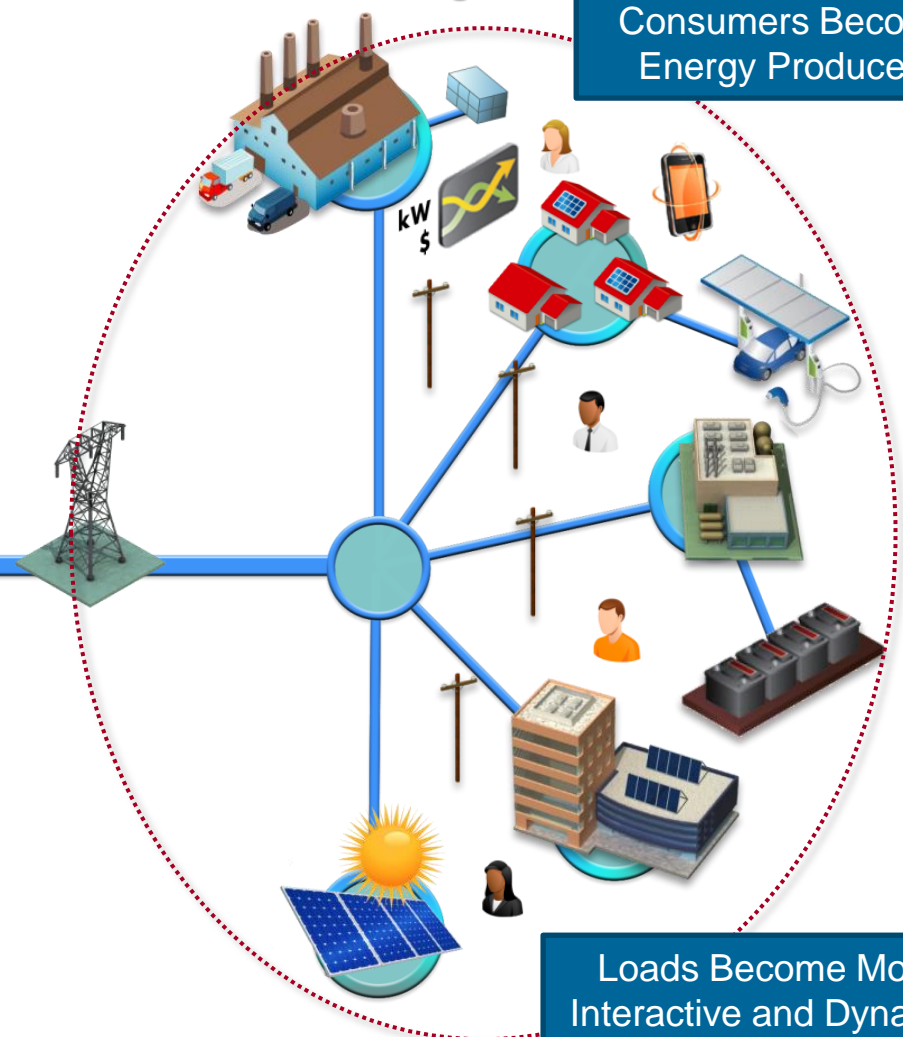
Generation Becomes More Flexible



T & D Becomes More Controllable and Resilient

The Edge

Consumers Become Energy Producers



Loads Become More Interactive and Dynamic

Enables Optimization of Local & Central Resources with Customer Needs

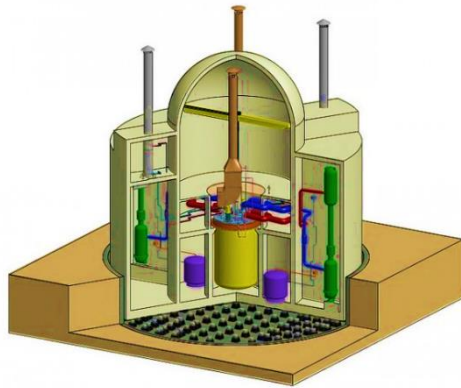
A Look Ahead: Integrated Energy Network



Integrated Energy Network

A Network of Infrastructures that connects customers with clean energy production and use

Cleaner Generation: Economy-wide Emission Reduction



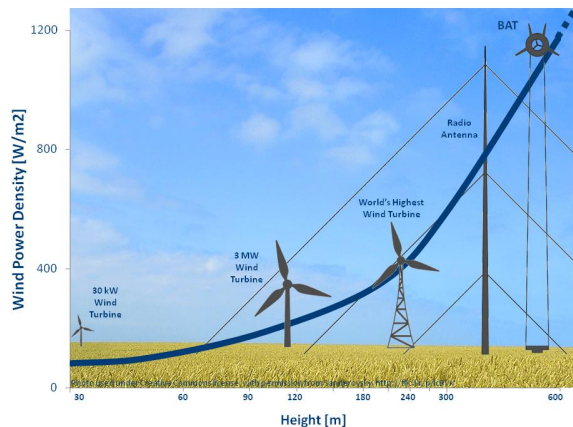
Generation IV Nuclear
(co-production – electricity, hydrogen steam)



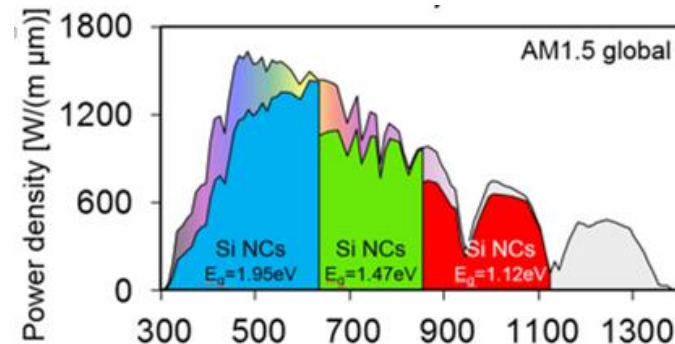
Large-Scale Storage
(e.g., Regenesys Flow Battery)



Coal and Gas Carbon Capture and Sequestration



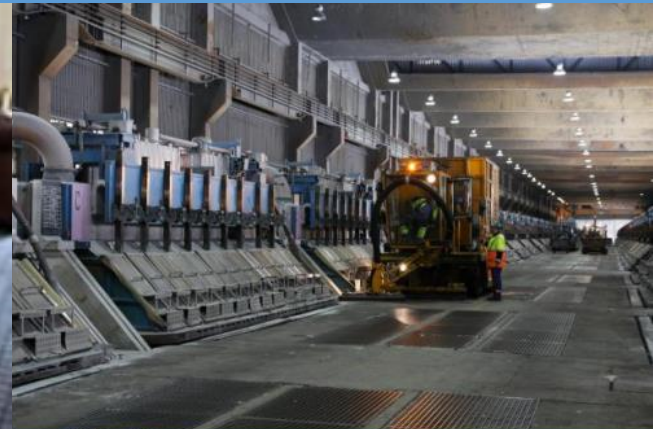
High-Altitude Wind



Gen III Photovoltaic (PV)
(e.g., High power density PV cells)

Source: Carbon Capture Image – htcco2systems.com; Gen IV Image – KAERI

Electrification: Economy-wide Emission Reduction



Integration: Consumer Energy Resource

Distributed Generation
(Inverters, control systems, active distribution component, etc.)

Energy Storage

Advanced Technology
(Inverters, control systems, active distribution component, etc.)

Behavioral Initiatives
(TOU rates, etc.)

Demand Response

Energy Efficiency

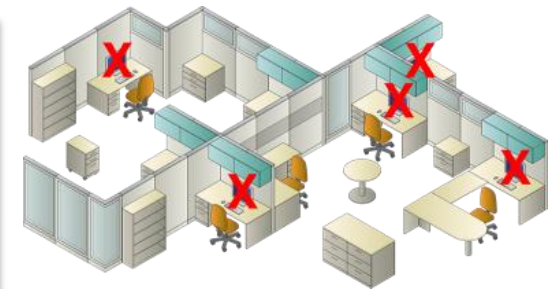


A Network of Local Energy Networks

Cyber Security: *Defense in Depth* – From OT to IT

Prevention

Cannot be the primary strategy

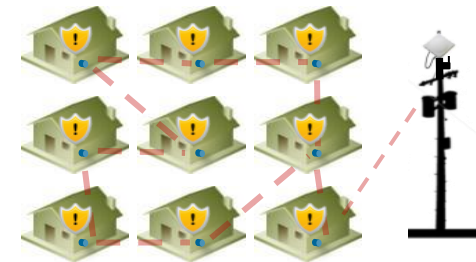


Sleeper Agent

Support Systems Disabled

Detect, Respond and Recover

Assume breach will happen



Malicious Remote Operations

Malicious Mass Disconnects

Survivability

Can the grid operate while recovering?

Can the Network Operation During Isolation & Recovery?

