Smart Grid to Provide Capacity Relief to Distribution Utilities

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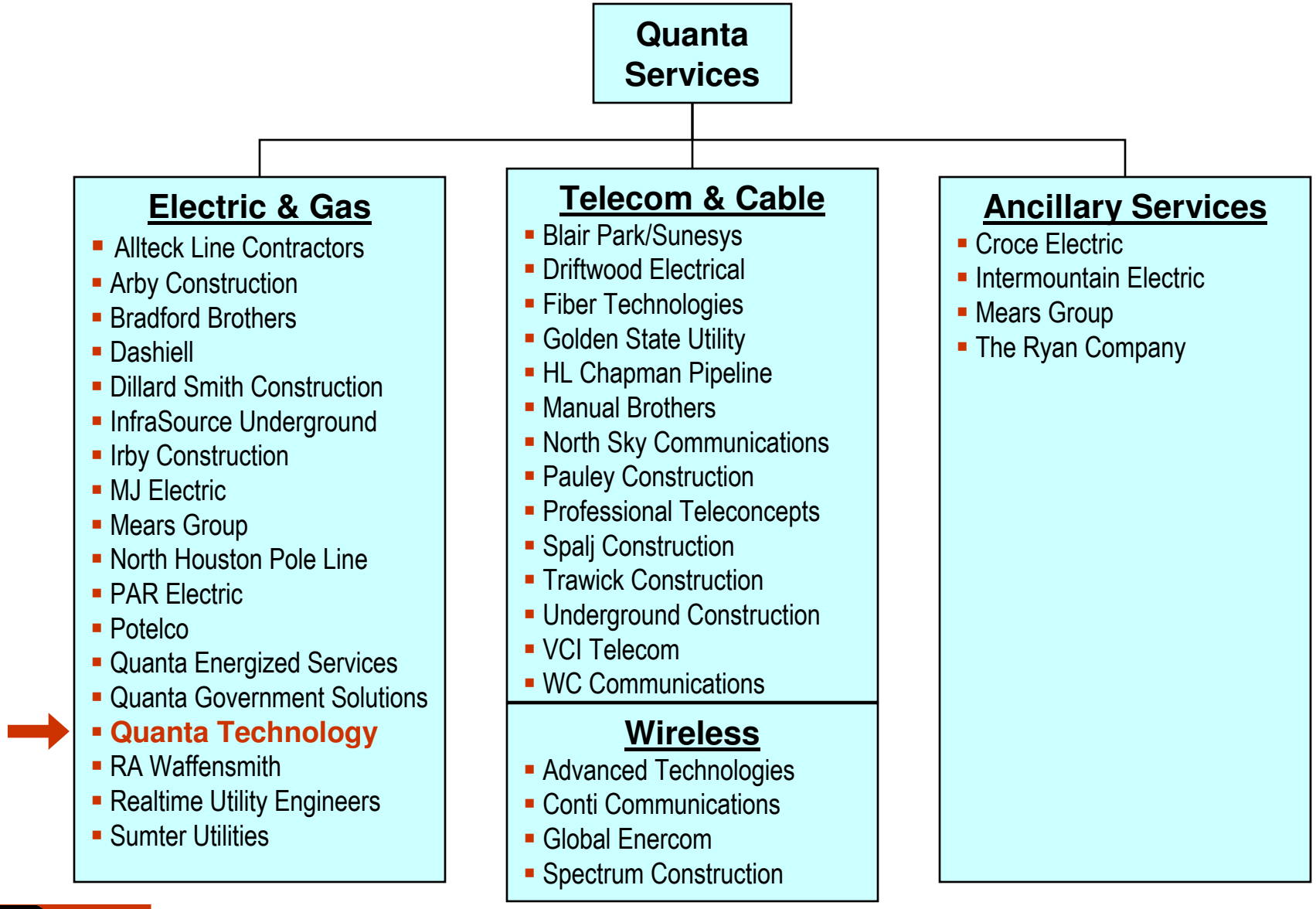
Agenda

- Introducing Quanta Services & Quanta Technology
- Smart Grid Overview
- Capacity-Relief Smart Grid Applications
  - Technology architecture
  - Functionalities
  - Benefits
  - Industry Experience
- Implementation Roadmap
- Discussion

Quanta Services

- The largest North American consulting, engineering, construction firm specialized in serving the energy and telecommunications industries
  - Over 16,000 employees and $3.1 B in 2007 revenue (annualized)
  - In Canada with Allteck (Vancouver) and EHV Underground (Toronto)
- T&D Primary Services:
  - Consulting, Planning, Design and Engineering
  - Construction and EPC Projects
  - Maintenance and Testing
  - Emergency Restoration
  - Outsourcing

Quanta Services - Organization



Quanta Technology's Services

- Strategic infrastructure planning and asset management
- Equipment condition, design and maintenance standards assessment
- System protection and automation
- "Smart Grid" development
- Enterprise systems integration
- Sustainable energy portfolio assessment
- Staff training

Quanta Technology Smart Grid Offerings

- Business Case studies
- Roadmap development
- Enterprise system design and acquisition consulting
- System acceptance testing & commissioning
- Process change analysis
- Implementation of Smart Grid applications
- Holding company, Quanta Services, provides EPC services

Quanta Technology Consultant Experience in Smart Grid

- PG&E
- SCE
- Puget Sound Energy
- BGE
- ConEd
- National Grid
- Dominion Energy
- PEPCO Holding
- Benton PUD
- Duke Energy
- ComEd
- Alinta (Australia)
- CLP (Hong Kong)
- ENMAX
- BC Hydro
- Manitoba Hydro
- METC

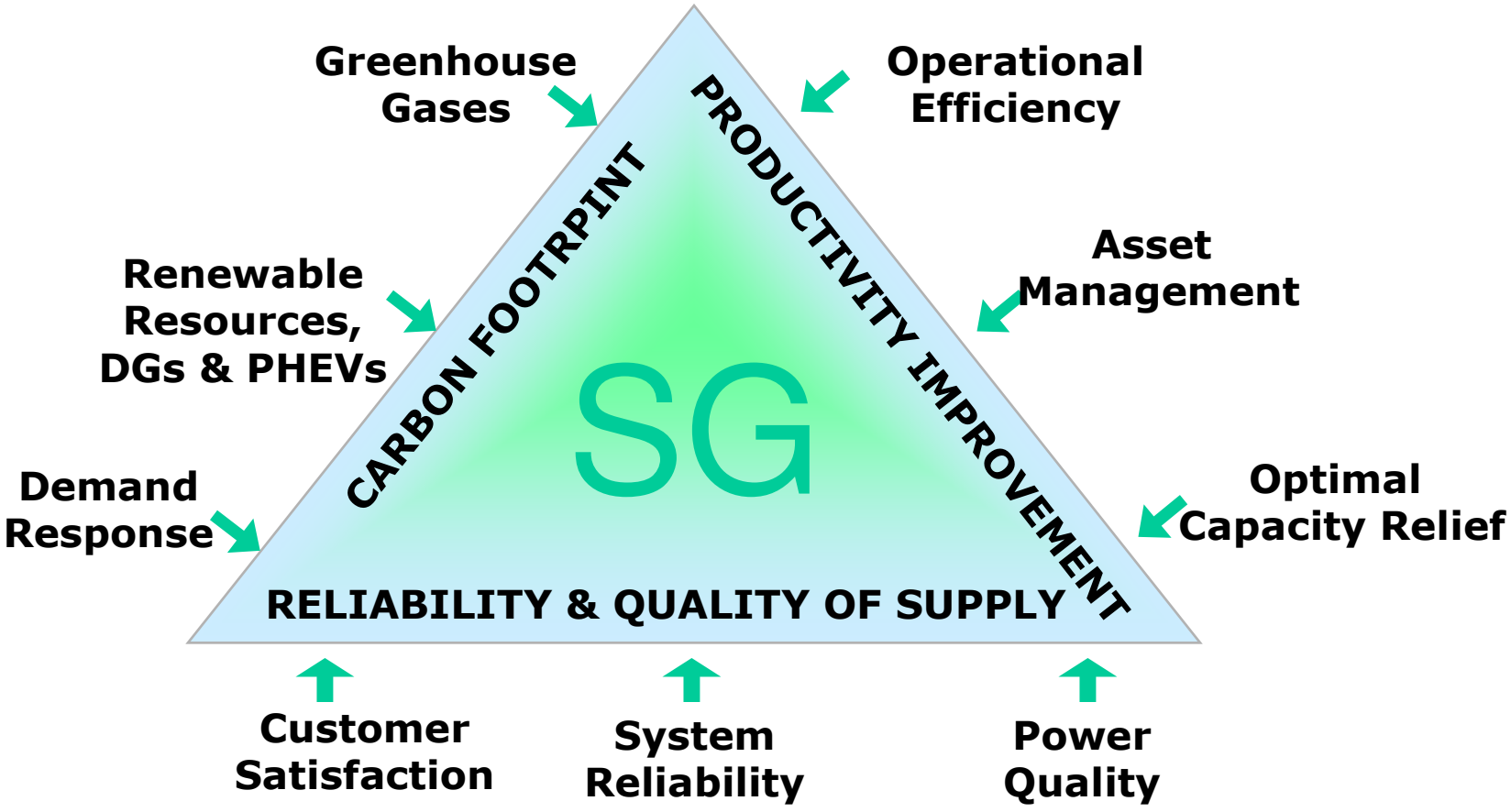
T&D System Planning & Technology Studies
Load Forecasting
AMI / Demand Side Management/Load Management
System Automation Planning & Implementation
Enterprise IT System
Knowledge Transfer

Consultant	Power System Planning & Load Forecasting	AMI and DSM/DR/LM	System Automation, EMS, SCADA & DMS	IEDs & System Protection	Power Electronics	Wind, Renewables & DG	Enterprise IT System	Regulatory Assistance
Richard Brown	X		X	X				X
Jim Burke	X		X	X				
ML Chan	X	X	X			X	X	X
Johan Enslin	X			X	X	X		X
Trevor Hall		X	X	X	X			
Yi Hu				X	X			
Farid Katiraei	X					X		
Damir Novosel	X		X	X	X			X
Edmund Philips	X		X					
John Spare	X		X		X			
Hahn Tram	X	X	X				X	X
Eric Udren	X	X	X	X	X			
Bob Uluski	X	X	X	X				X
Lee Willis	X	X				X		X
Bartosz Wojszczyk	X	X	X	X		X		X

What is Smart Grid?

- Smart Grid is a vision for electric utilities: Utilities and consumers will accrue values through the convergence of power delivery and information technologies
- Applied to G, T, D and customer sectors
- Not a set of shrink-wrapped solutions; the set and scope are unique to each utility, in the context of traditional capacity engineering and planning

Smart Grid Business Drivers: New Business Environment



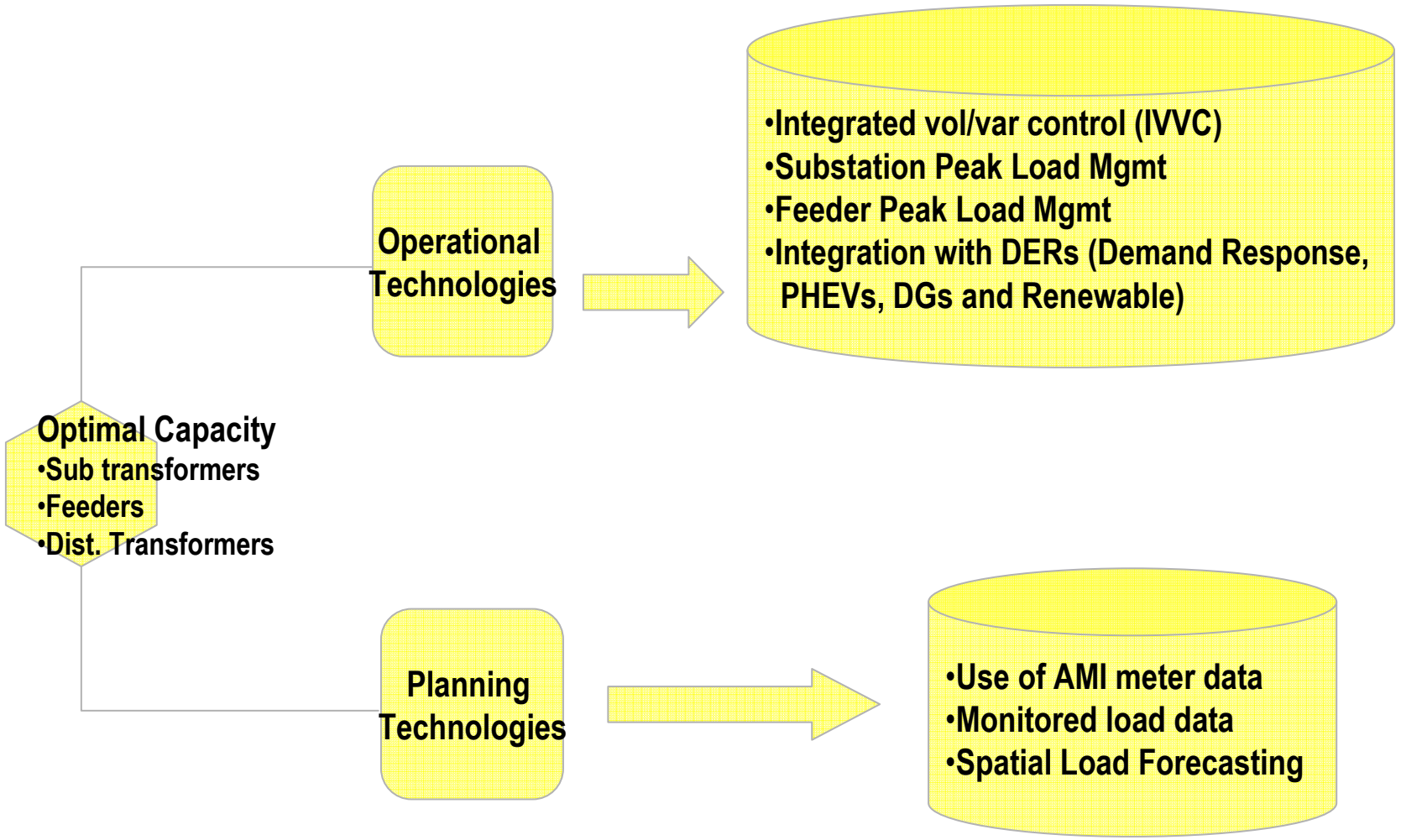
Smart Grid leverages on enablers

- "Sensors"
- Communications Infrastructure
- Enterprise Information Integration
- Regulatory Support
- Corporate Culture: A Holistic Approach

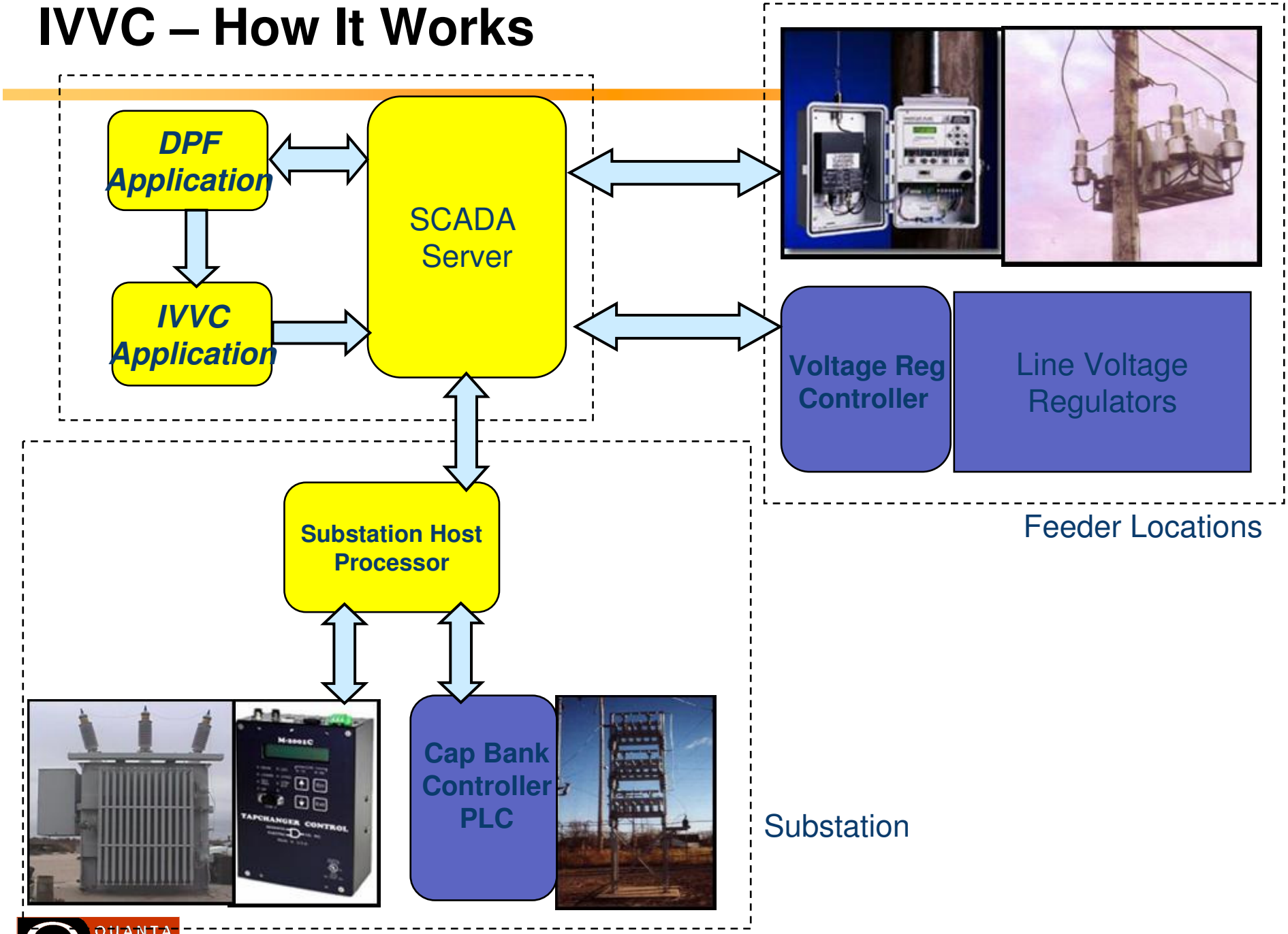
Capacity Relief Smart Grid Applications

- Value – Optimal capacity to meet the load
- Optimality
  - Lifecycle cost – investment and O&M
  - Service reliability
  - Carbon footprint
- Capacities of substation transformers, feeders, and distribution transformers (pole top & vaults)
- Realized through system planning & operations technologies

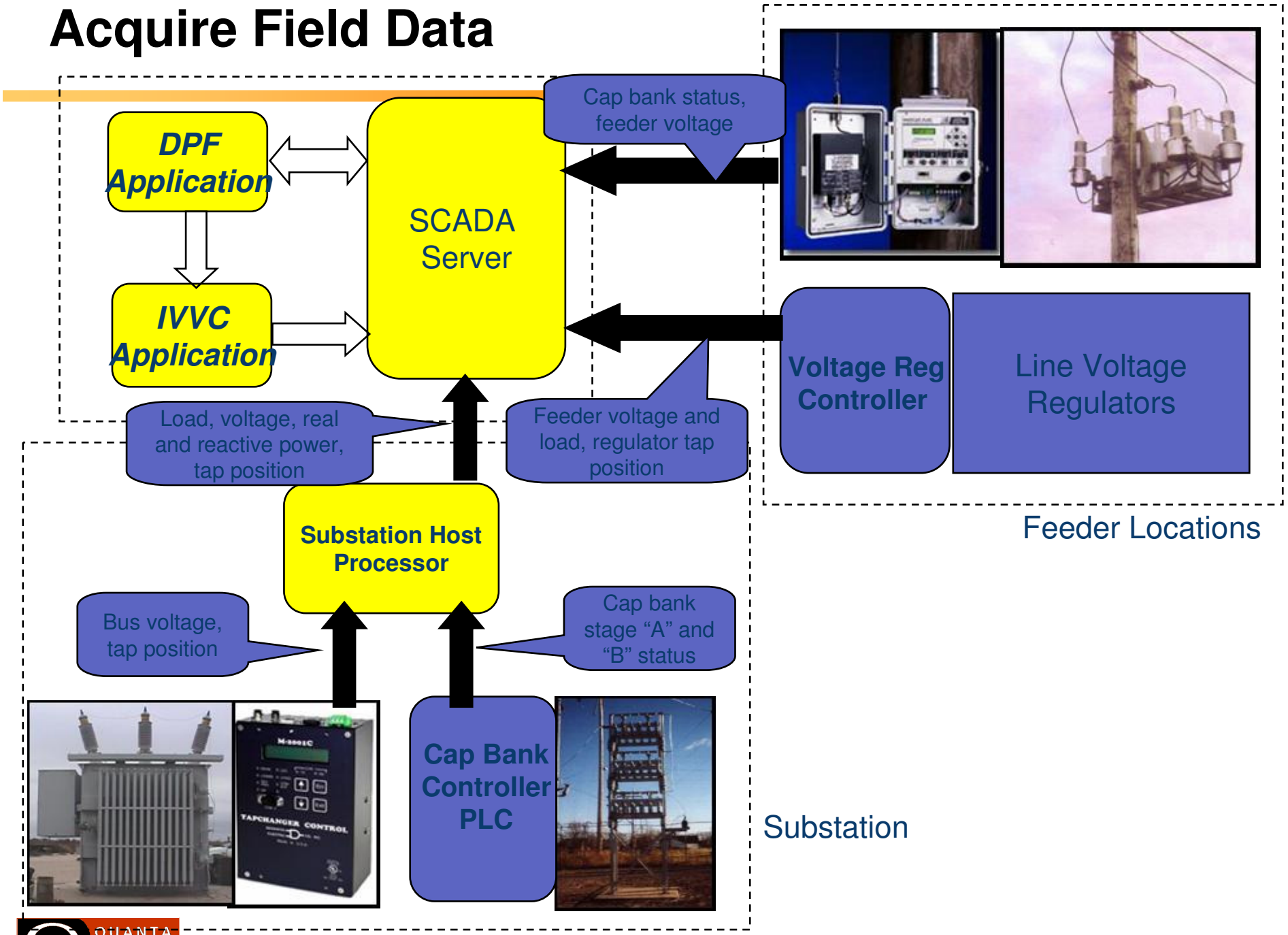
Smart Grid Capacity-Relief Technologies



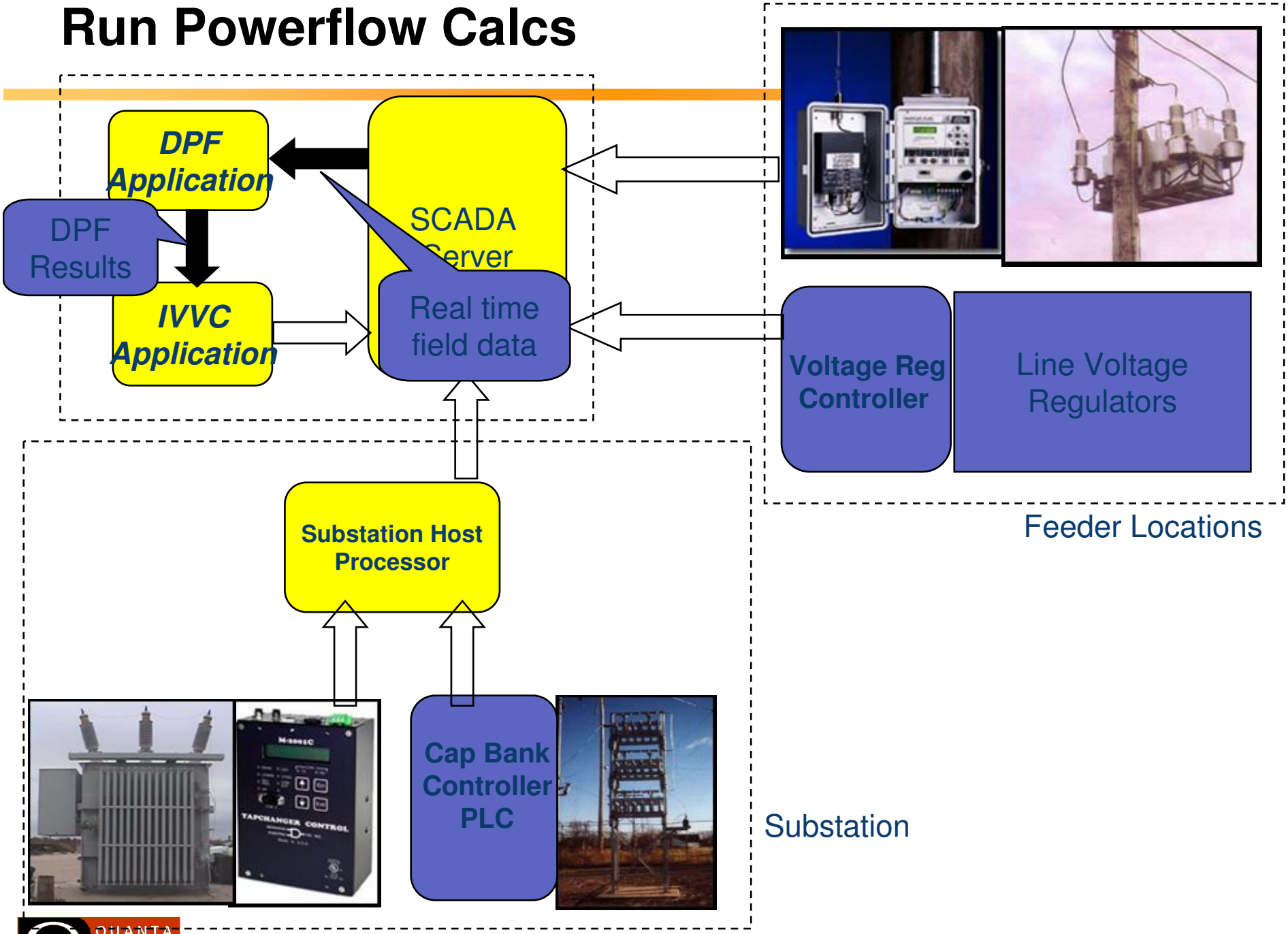
IVVC – How It Works



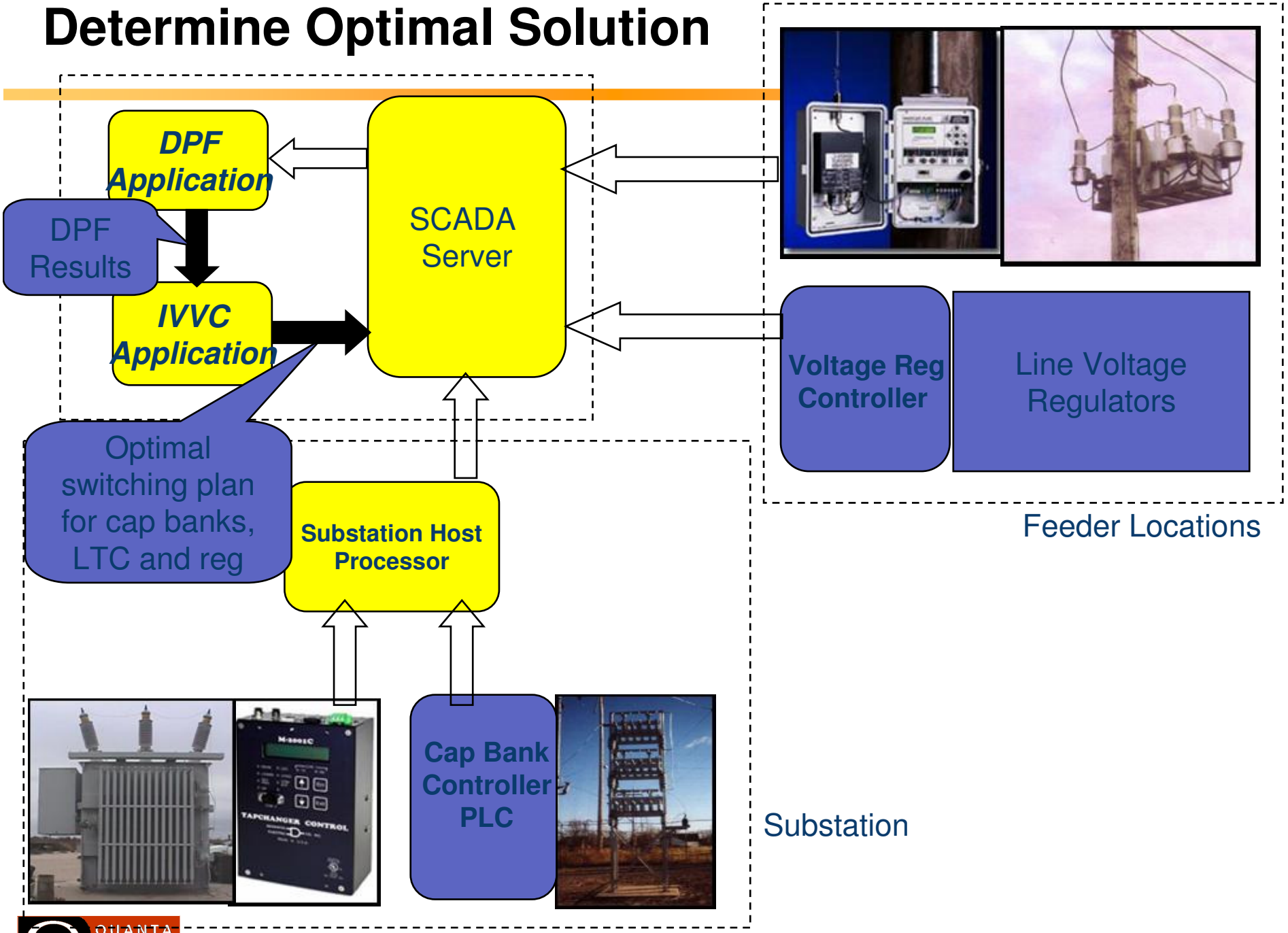
Acquire Field Data



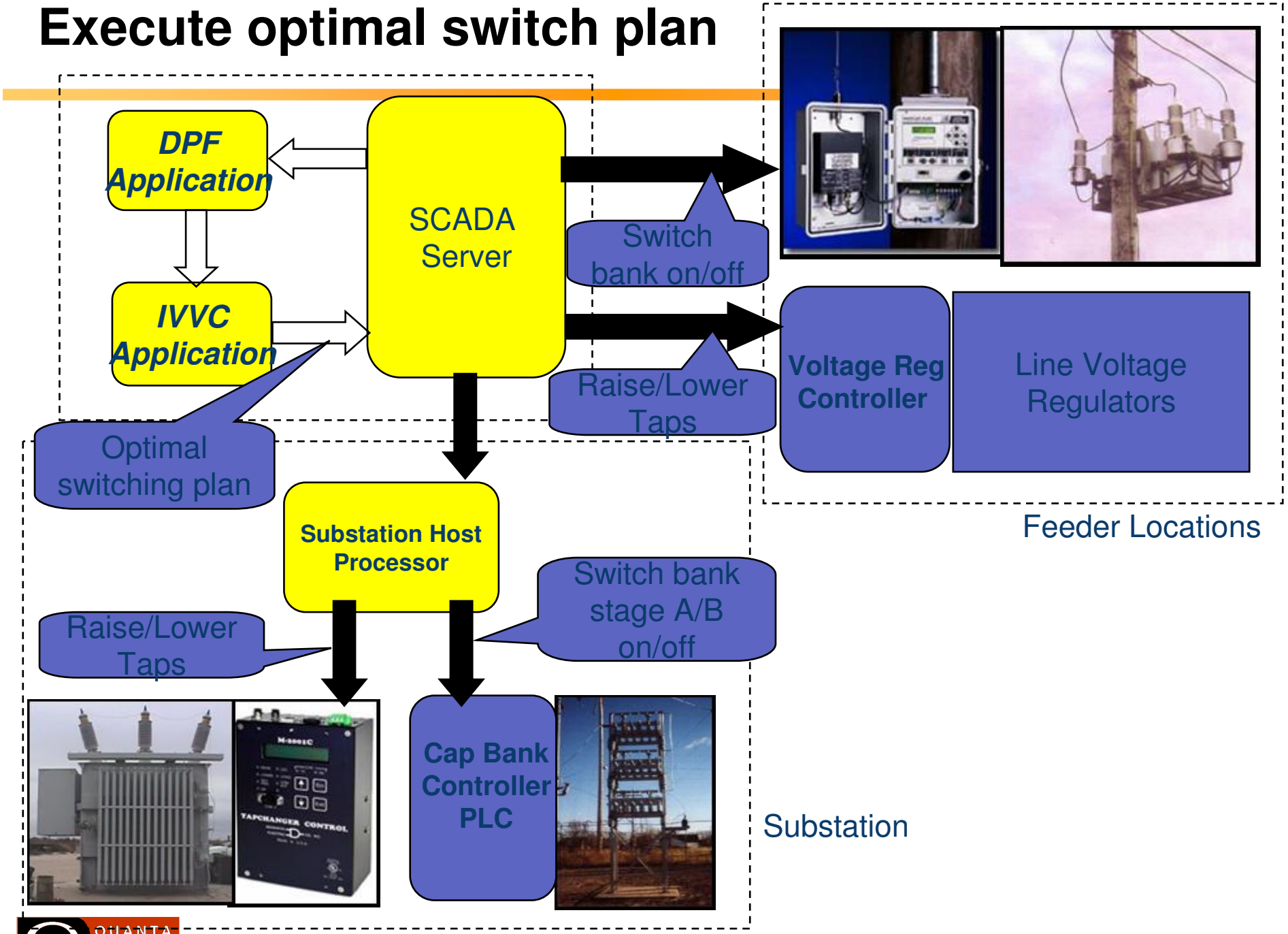
Run Powerflow Calcs



Determine Optimal Solution



Execute optimal switch plan



Benefits of IVVC

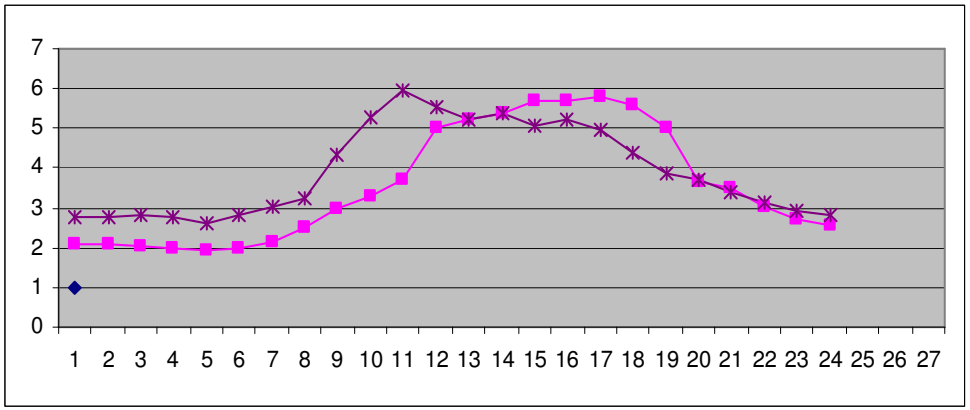
- Reduce line losses (energy kWh); carbon footprint benefits
- Reduce capacity needs (kW)
- Maintain satisfactory delivery voltage to customers
- Could be ~ 2% lower kWh losses; ~4% capacity reduction

Implementation Challenges/Opportunities

- Utilities in SE USA and West Canada
- Integrate DMS/SCADA system with GIS
- Communications with all field devices (feeder & substations)
- Can leverage AMI meters for End-of-Line voltage readings; has been a barrier for IVVC implementation

Feeder Peak Load Management

- **<u>Objective:</u> Reduce peak demand on feeders/substations by periodically shifting load between connected feeders to achieve better balance**
- **Must have significant load diversity between feeders**



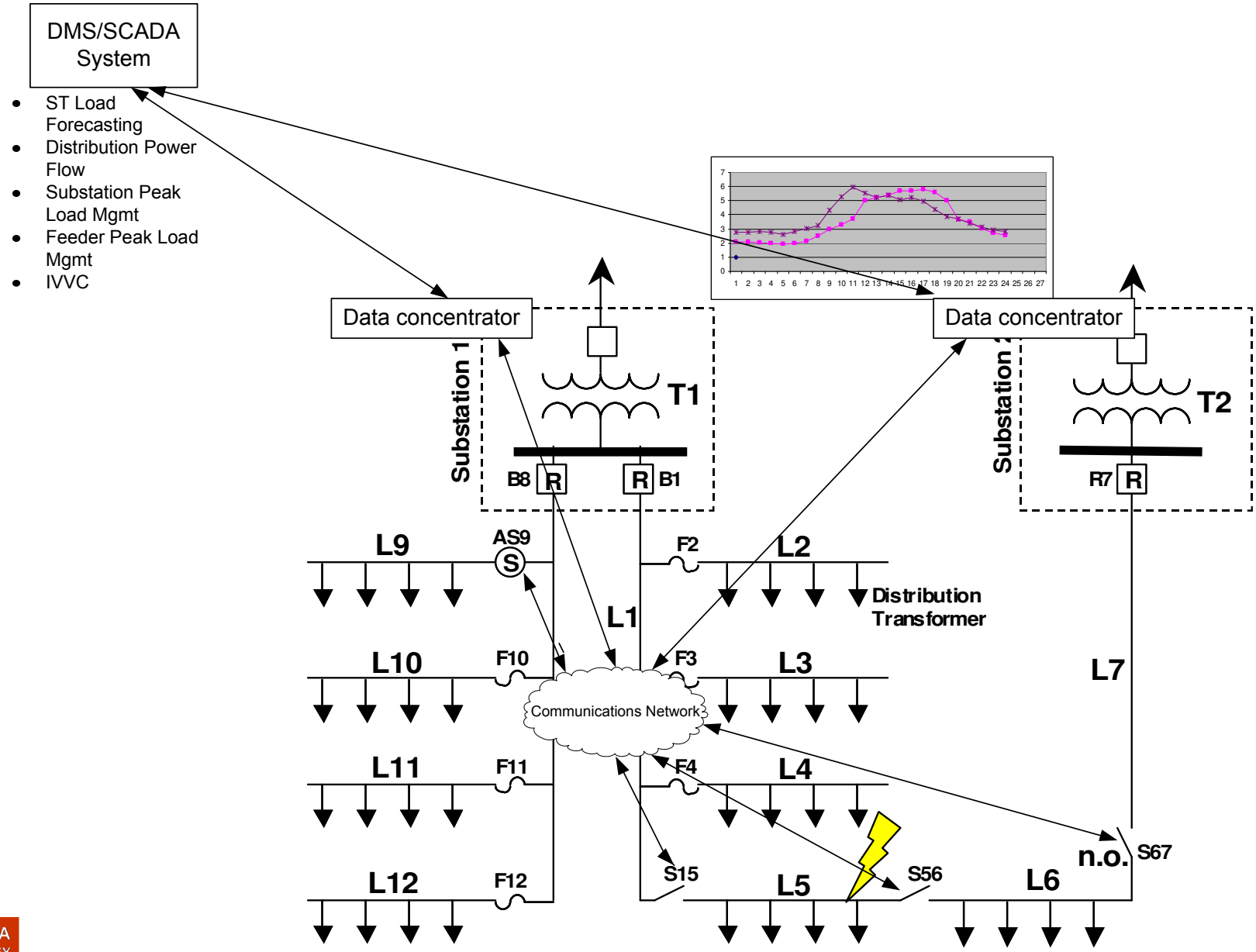
Feeder Peak Load Management - Benefits

- Reduction of peak demand on individual substations
  - Defer capacity addition
  - Reduce individual substation demand charges
- Reduction of peak demand on individual feeders; could be 5%, depending on customer mix
- Reduction of electrical losses
  - Total losses with balanced load < Total losses with one heavily loaded feeder and one lightly loaded feeder
  - Reduced kVA demand as a result

Substation Peak Load Management

- Similar technology solution as for Feeder Peak Load Management
- Takes advantage of load diversities among substation transformer banks
- Similar types of benefits
  - Defer substation capacity
  - Reduce demand charges at substations
- Benefits depend on the degree of load diversities; could be ~ 5% demand reduction

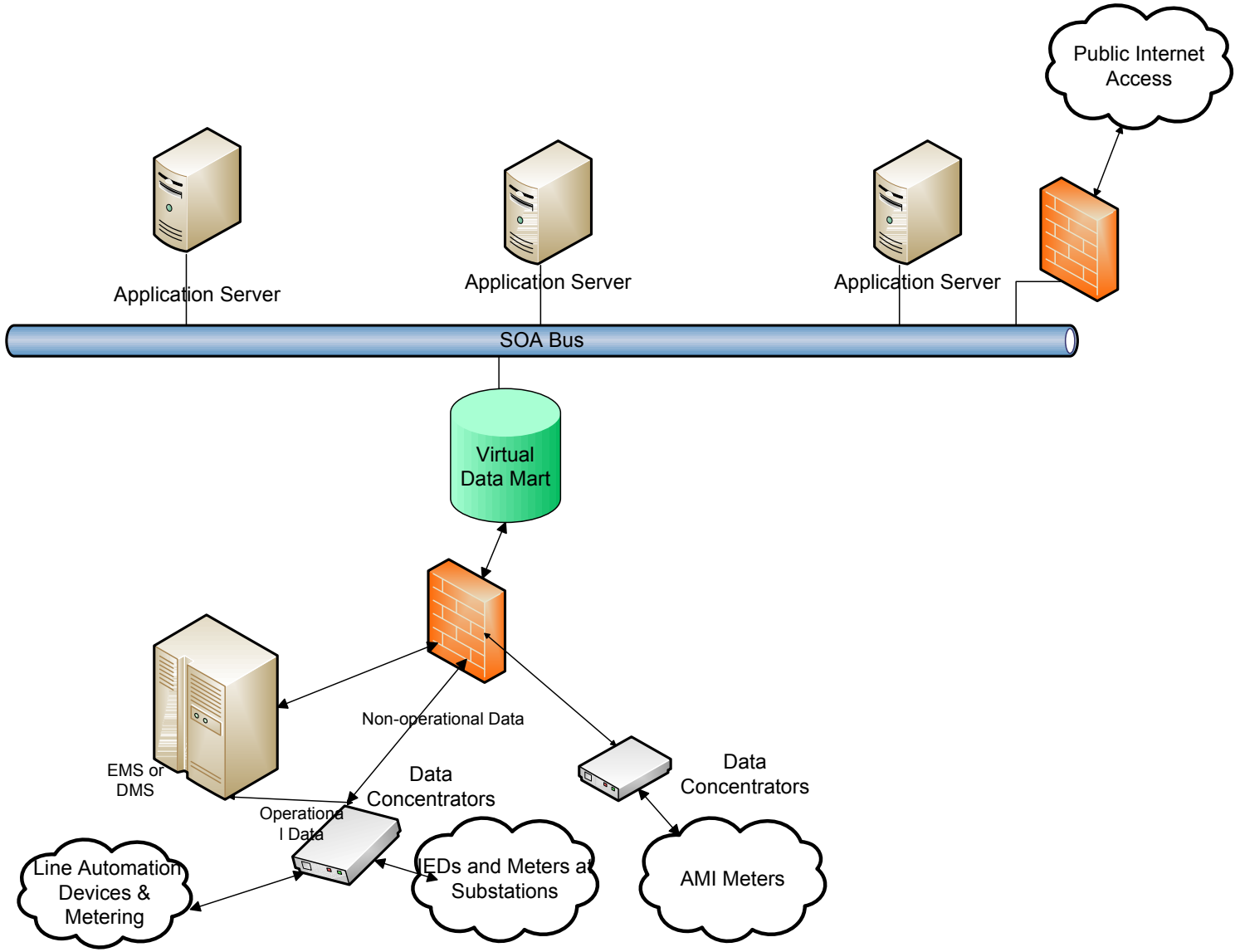
Feeder and Substation Peak Load Management



Implementation Challenges/Opportunities

- Western utility in USA
- Integrate DMS/SCADA system with GIS
- Communications with all field devices (feeder & substations)
- Lacking time-synchronized loading data for forecasting loading factors
- Feeder and Substation Peak Load Management need to be coordinated

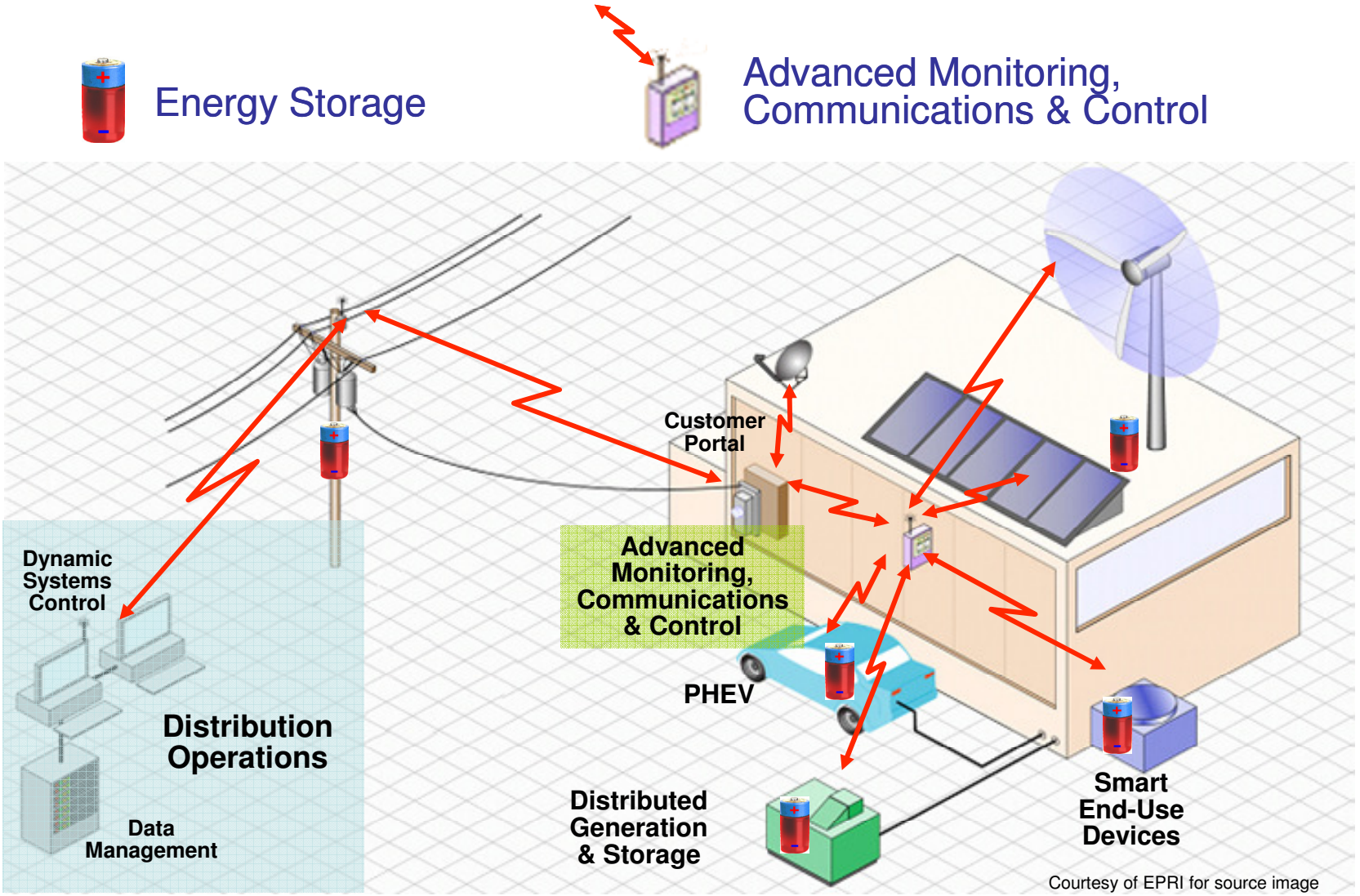
System Configuration for IVVC, Feeder & Substation Peak Load Management



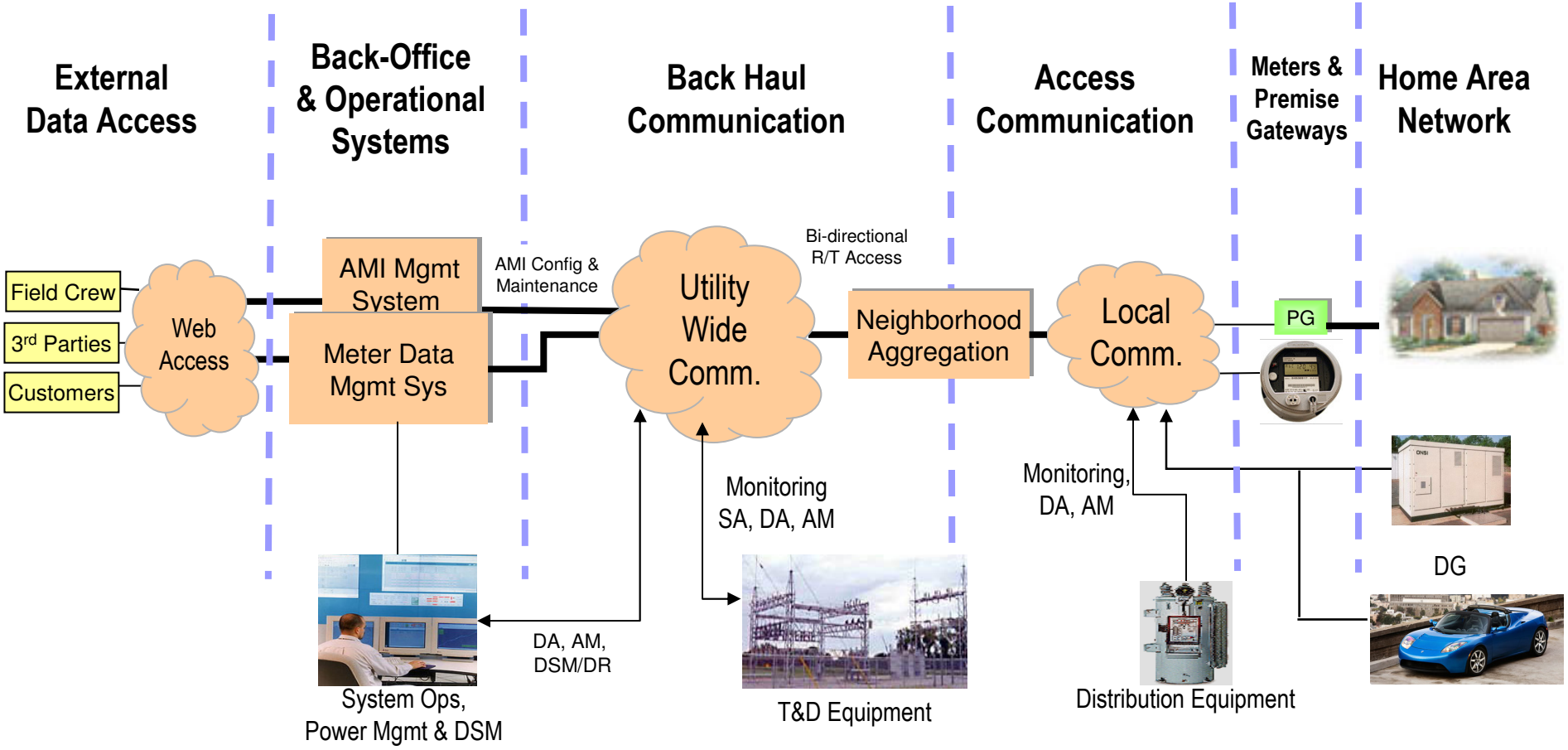
Integration with Distributed Energy Resources (DERs) - Demand Response, DGs, PHEVs & Renewable

- **Demand Response (DR) shifts peak load**
  - **Direct control of end-use loads (e.g., AC, WH)**
  - **Critical Peak Pricing/Real-Time Pricing/TOD Rates**
- **Renewable (wind, solar PV) & DGs with energy storage**
- **PHEVs as energy supply sources for customers**

Integrating DERs

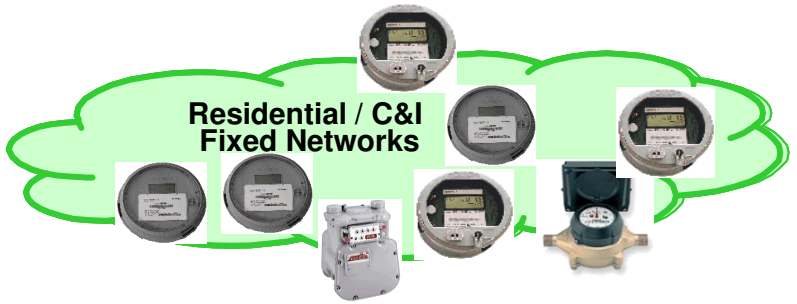


Communications Infrastructure for Integration of DERs



Smart Grid Technologies for Integrating DERs

- **AMI System**
  - AMI meters with HAN
  - Zigbee for communications
  - Home energy management system with smart charger system for PHEVs
  - Smart appliances & smart thermostats
  - Microgrid interface controller



- **Customer Portal Systems for energy management**

Benefits with DERs & Industry Experience

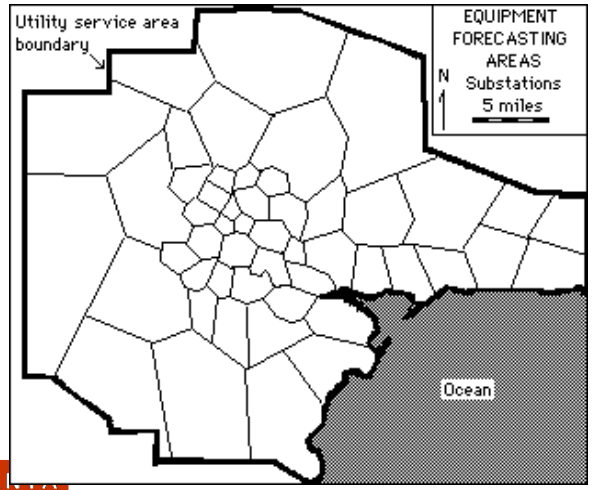
- **DR programs**
  - **~ 5-10% peak load reduction**
  - **<1% energy saving; minor reduction of carbon footprint**
  - **Hard to forecast the end-use load shapes with high certainty**
- **PHEVs, DG and Renewable**
  - **kW reduction depends on resource penetration & behavior**
  - **Smartness of controllers**
  - **Industry experience still limited**
- **Need accurate and robust load shape forecast by small areas**

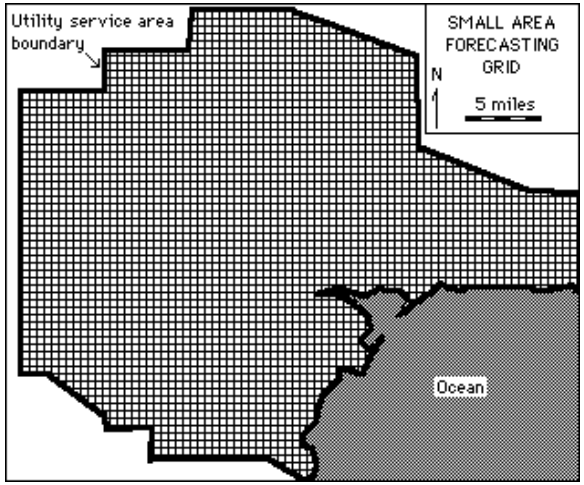
Spatial Load Forecasting

- With AMI metering
- With end-use load shape data

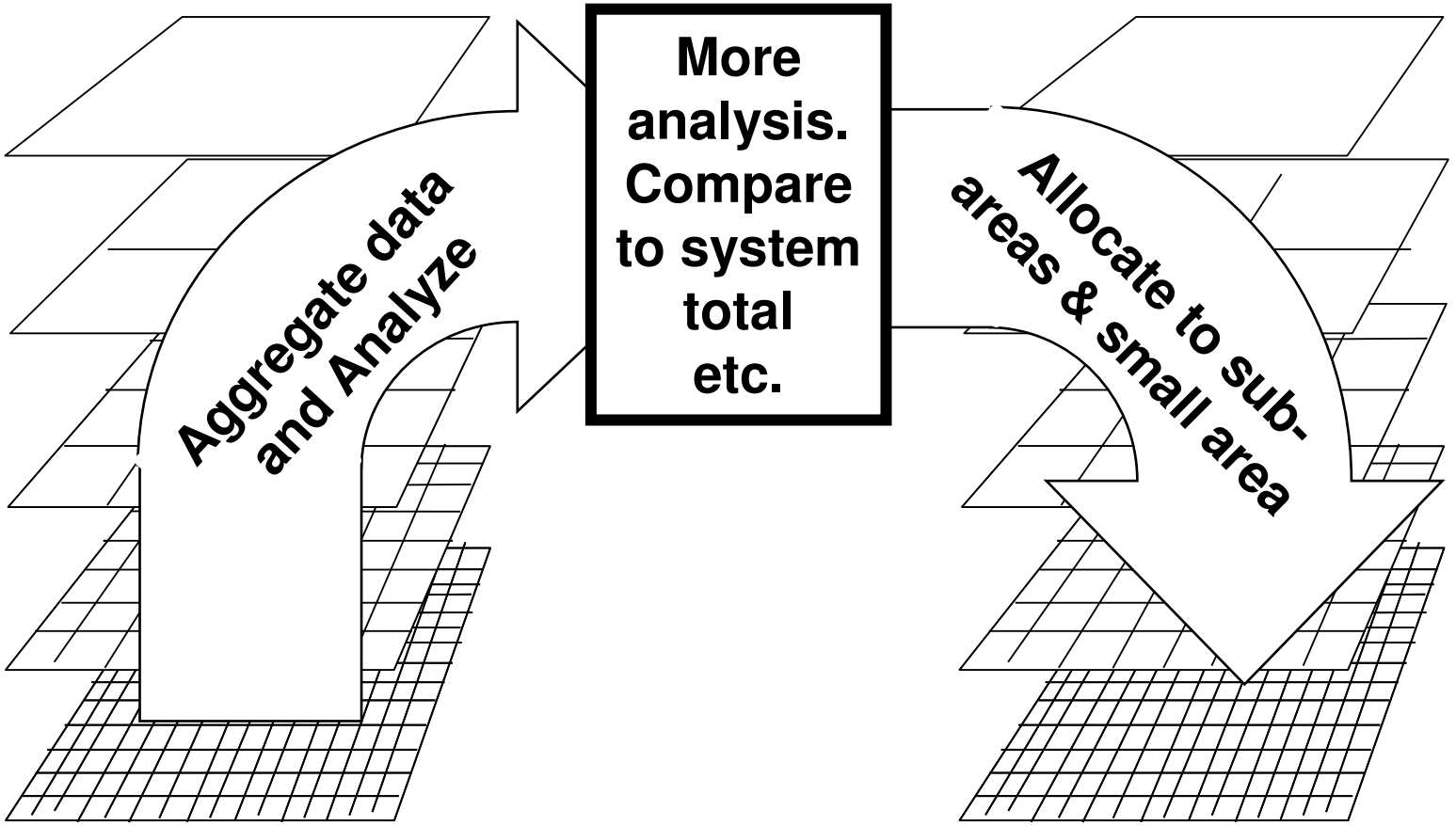
Spatial Load Forecasting Model

- Small area load forecast, taking into account neighboring area dynamics
- Top down hierarchical approach for forecasting – region, area, sub-area, sub-subarea, small area
- Bottom-up analysis to determine the curve fit for each area's forecast
- Geo-structure data; integrated with GIS





Summary: Bottom-Up Analysis: Top Down Forecast

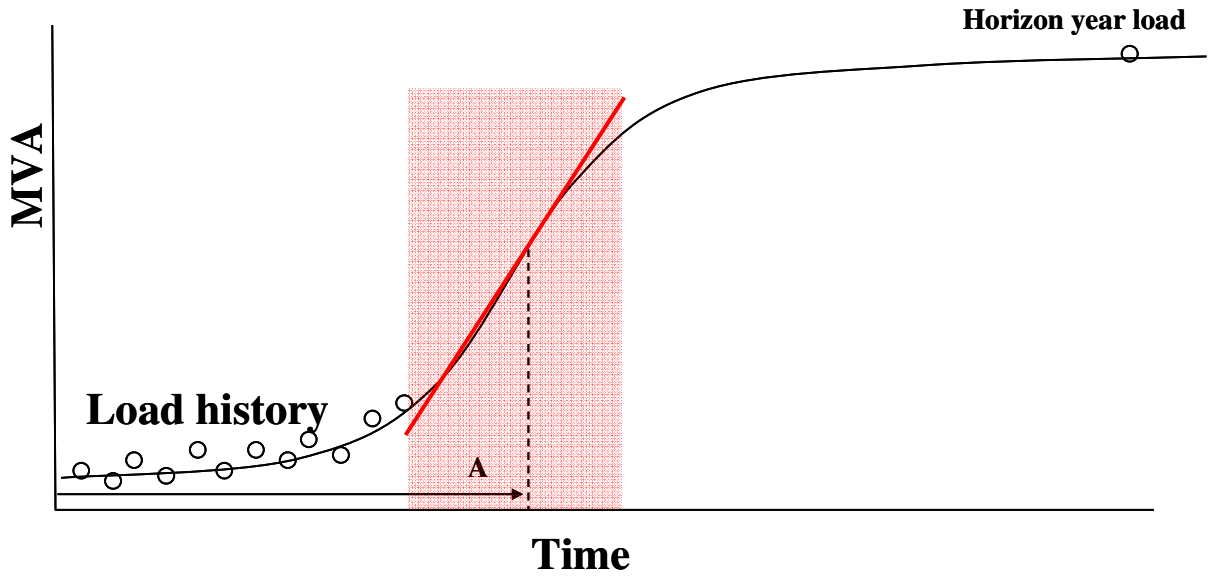


Start with Small Area Data

End with Small Area Forecast

Resulting Load Forecast for Each Area

- 20+ year planning horizon
- AMI meters provide excellent load database; even end-use based
- End-uses for PHEVs, rooftop PVs, DR programs, data centers



Benefits from Spatial Load Forecasting

- Reduce error margin (e.g., from about 6% to 3%); substantial capital investment savings
- Challenges
  - Appropriate input data gaps
  - Easy to use and properly designed tools
  - Utilities begin to appreciate the value of Spatial Load Forecasting

Harvesting Capacity Values from AMI Systems

- **AMI meter data allows for**
  - **Transformer load management system**
  - **More accurate loading data at various times for tighter margin load forecast**
  - **Major capacity benefits**
  - **Value of information**
- **AMI system infrastructure enables these Smart Grid capacity-related applications and other additional ones**

What should Ontario utilities do next?

- Conduct a Smart Grid business case study for each utility to establish a strategy
- Develop a Smart Grid roadmap
  - System specification, acquisition, development management, acceptance testing and commissioning for various systems
  - Field program deployment
  - Training and maintenance support
- Need to be integrated with other Smart Grid applications to implement the Smart Grid solutions; open system architecture and standard communications protocol

Challenges Facing Utilities in Smart Grid

- Confusing as to what Smart Grid is about; thus having difficulty to start
- Technology-focused; not value-driven
- Need to develop a business case, and then a roadmap
- Implement by integrating with legacy equipment and systems
- Open system standard and communications protocols
- Continue to plan for “dumb” capacity projects, and to harden the systems

QUANTA TECHNOLOGY

Thank You