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Transactive Energy Valuation Issues Discussion

Developed for GWAC TE Systems Valuation Technical Meeting

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Why a Regional Business Case (RBC) for Smart Grid?

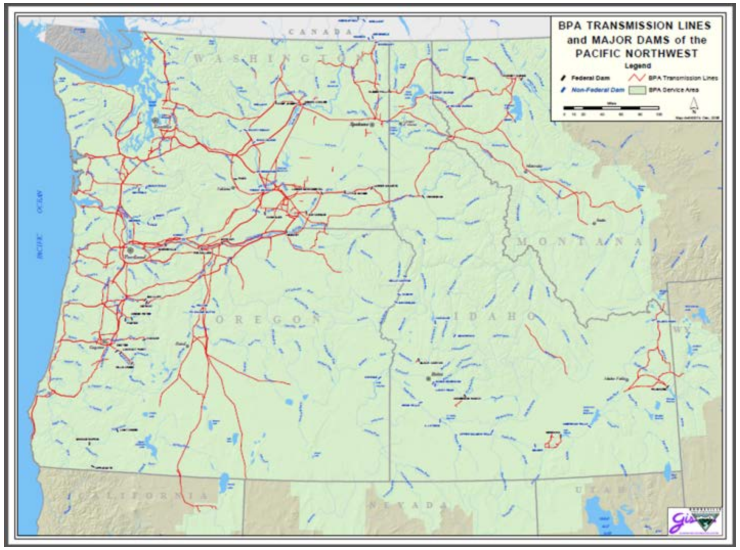
BPA is developing the RBC to:

- » Understand the ***potential*** for smart grid benefits
- » Understand the ***risks*** for regional stakeholders
- » Assist Regional stakeholders by providing information to help make ***appropriate investments*** in smart technologies.

Scope

- » SG definition

  Smart grid capabilities use *two-way communications* and some level of *automated intelligence*
- » Region
- » Time horizon of analysis
- » Incremental Benefits and Costs



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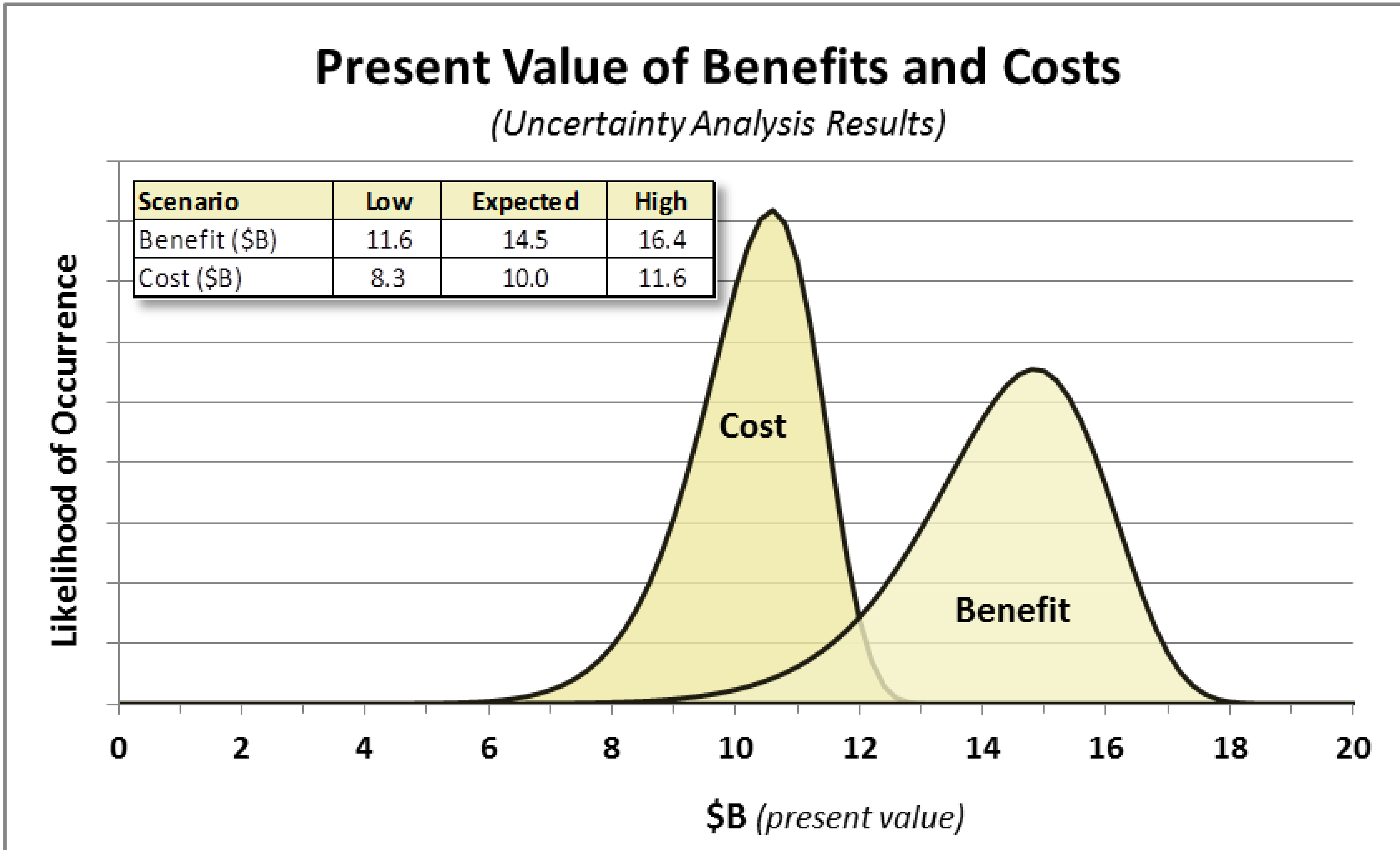
Overall Regional Benefits Very Likely to Outweigh Costs



Scenario	Low	Expected	High
Benefit ($B)	11.6	14.5	16.4
Cost ($B)	8.3	10.0	11.6

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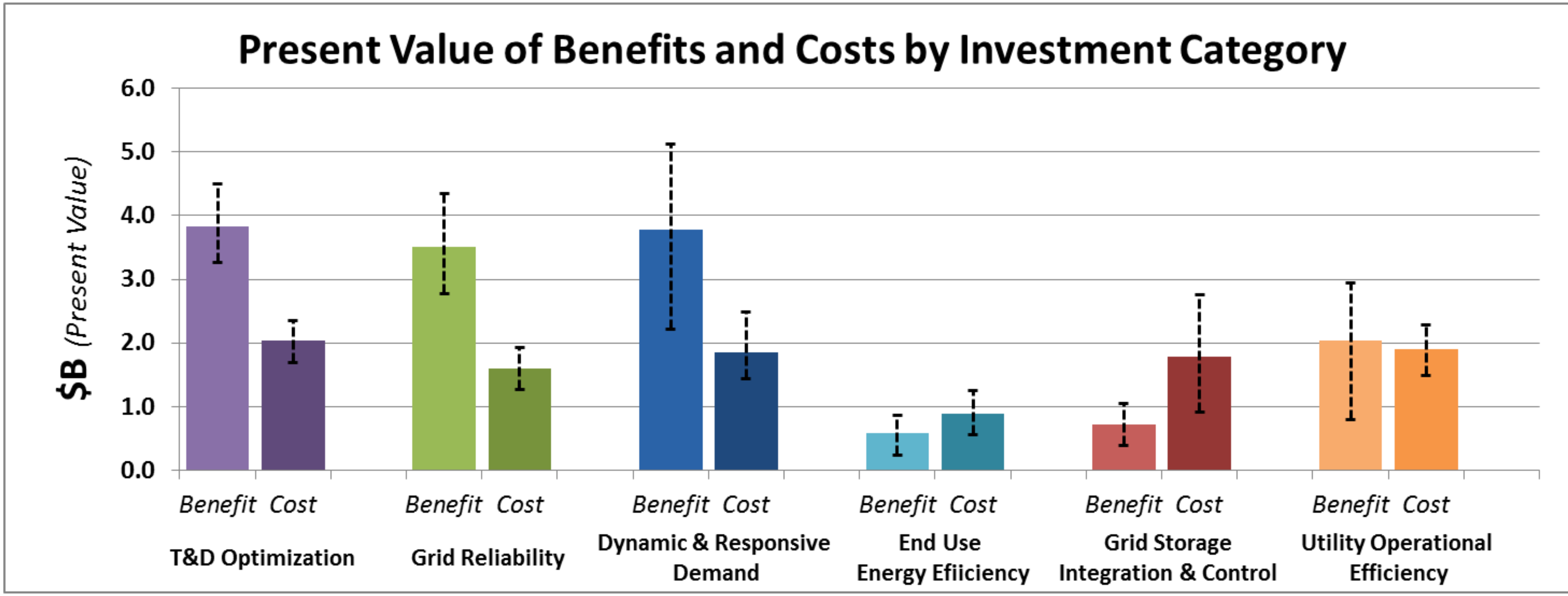
RBC: Six Investment Categories Show Different Returns and Risks



* Note: the RBC analysis addresses only those costs incurred, and those benefits provided, by the application of smart grid technology. It does not attempt to address the benefits and costs of traditional (not smart grid) capabilities. The benefits and costs of such traditional programs **are not included** in the RBC. In addition the energy efficiency costs shown above, for example, include a portion of the costs of AMI and other smart grid technologies, which are spread across the various capabilities. Thus, although the benefits are measurable and significant, the costs borne are also high.

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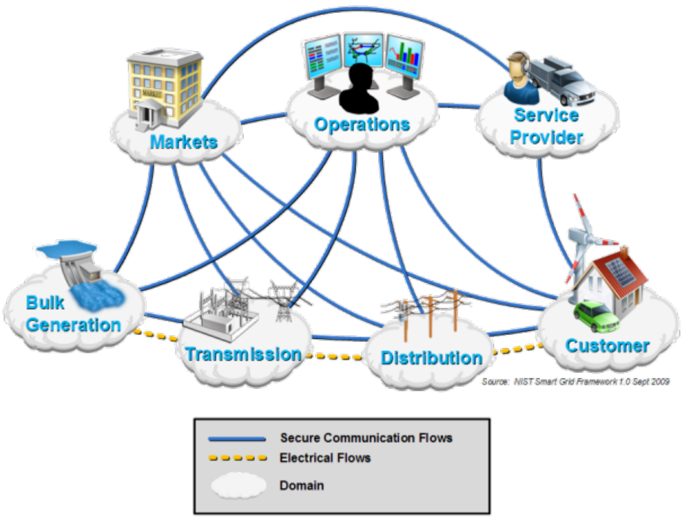
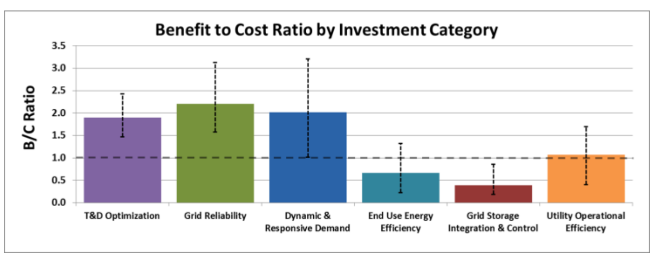
Overview of smart grid capabilities, grouped by investment category



Source: "NIST Framework and Roadmap for Smart Grid Interoperability Standards Release 1.0 (Draft)," Office of the National Coordinator for Smart Grid Interoperability, NIST (September 2009).



Investment Category	Capability Area (Function)
T&D Optimization	Automated VAR Control
	Conservation Voltage Reduction (CVR)
	Dynamic Capacity Rating
	Automated Power Flow Control for Transmission
	Automated Real Time Load Transfer for Distribution
	Notification of Distribution Equipment Condition
	Notification of Transmission Equipment Condition
	Fault Current Limiting for Distribution
	Fault Current Limiting for Transmission
	Distributed Energy Resource Monitoring & Control
	PMU-Based Centralized Renewable Resource Monitoring & Control
Grid Reliability	PMU-Based Wide Area Monitoring
	Automated Islanding & Reconnection (Microgrid Capability)
	Enhanced Fault Prevention for Distribution
	Enhanced Fault Prevention for Transmission
	Fault Location, Isolation & Service Restoration (FLISR)
Dynamic & Response Demand	Demand Response - Air Conditioning/Space Cooling
	Demand Response - Appliances & Plug Loads
	Demand Response - Lighting
	Demand Response - Refrigeration, Motors & Process Equipment
	Demand Response - Space Heating
	Demand Response - Water Heating
End Use Energy Efficiency	End Use Conservation
	End Use Equipment Efficiency Upgrade
	Notification of End Use Equipment Condition - HVAC
	Notification of End Use Equipment Condition - Refrigeration
Grid Storage Integration & Control	Transmission-Sited Grid Storage Integration & Control
	Distribution-Sited Grid Storage Integration & Control
	Electric Vehicle Battery Integration & Control
Utility Operational Efficiency	Automated AMI Meter Reading & Billing
	Improved DSM Program Execution (Marketing, Implementation, M&V)
	Improved Regional Planning & Forecasting
	Transactive Control

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Methodological considerations for valuation efforts.

A few of the complexities in establishing cost effectiveness for grid modernization efforts:

- **Construction of an *Investment Baseline* is critical issue (perhaps the most critical)**
- Sequencing of investments and synergies/interdependencies across investments
- Uncertainties in technology performance and customer behavior
- On-going evolution of technologies, applications, and operational practices
- Variation of pre-existing technologies, capabilities, and remaining useful life

Elements of a successful methodology and business case:

- **Applies a Bottom-up Framing/Architecture**: incorporates experimental and implementation results, rather than making overly broad assumptions about costs and benefits
- **Adequately Characterizes the Existing System:** incorporates key utility grid characteristics, selected technologies, avoided costs and relevant impacts
- **Avoids Double Counting of Benefits:** avoids double-counting of benefits
- **Allows Cost Sharing:** allows sharing of costs among various smart grid capabilities, and helps measure the benefits and costs of future, follow-on investments
- **Integrates Uncertainty and Risk Modeling:** integrating uncertainty modeling allows quantification of financial risks (e.g., Monte Carlo simulation, sensitivity analysis, etc.)
- **Enables Scenario Analysis:** allows examination of roll-out options to compare different asset deployment scenarios
- **Provides Transparency**: allows tracking of inputs and assumptions

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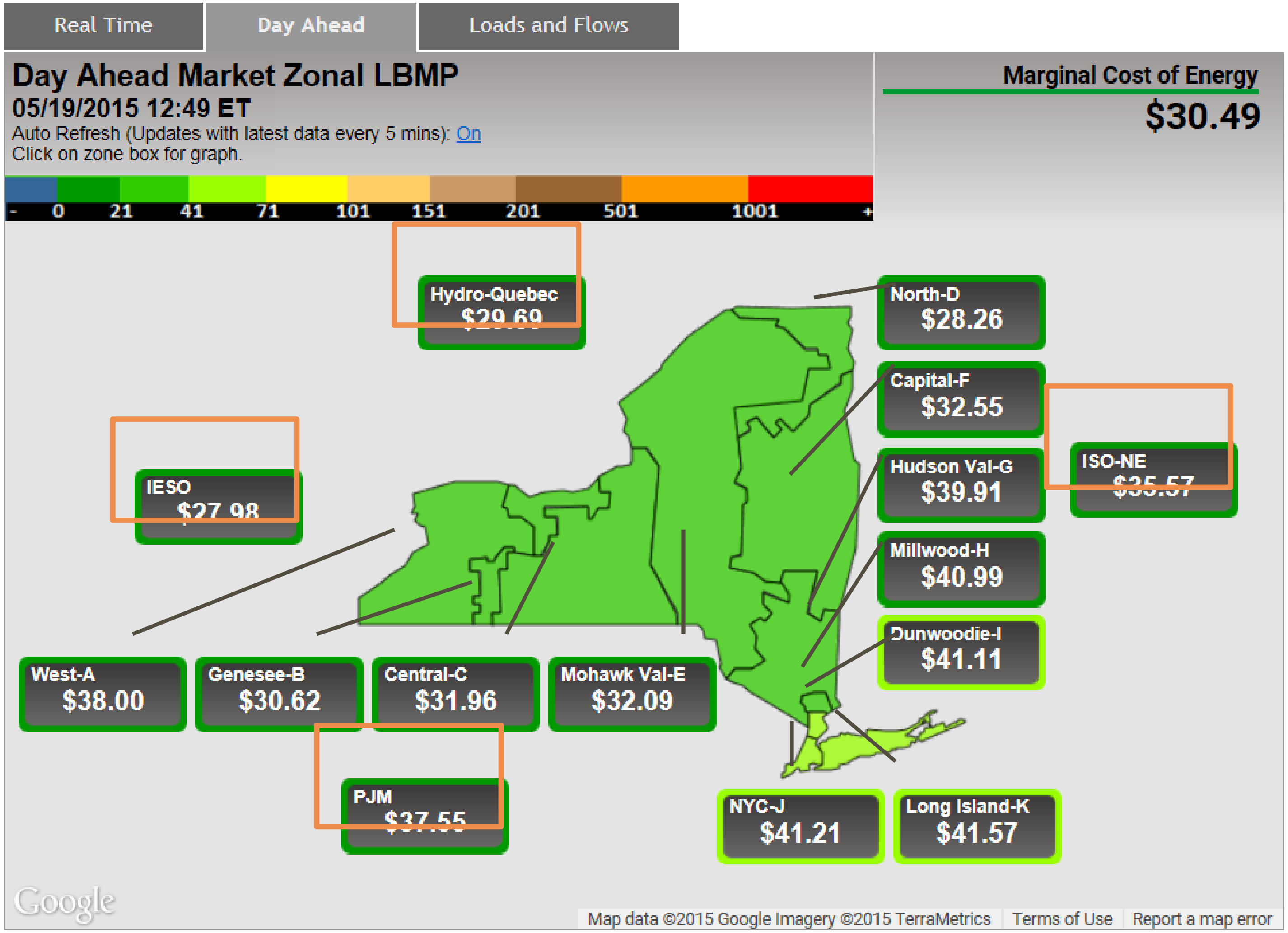
Are the ISOs already operating Transactive Energy markets? Energy, Capacity, Ancillary Services, Transmission Congestion



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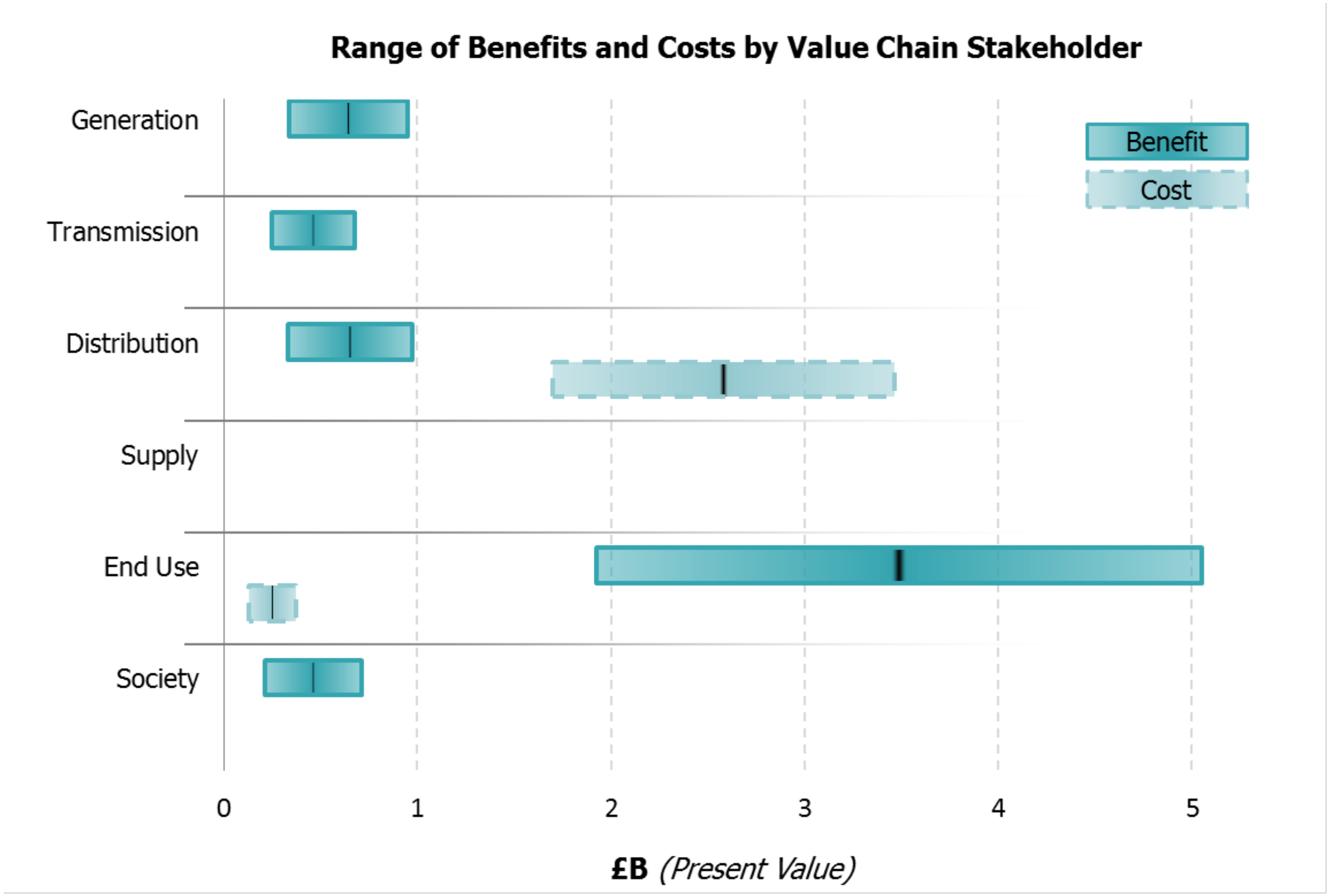
Investments in the distribution area yield benefits across the value chain (note these are where benefits and costs *originate*)



Source: http://www.smartgridgb.org/benefits-of-smart-grid/item/522-new-smartgrid-gb-report-shows-smart-grid-development-to-deliver-%C2%A32-8-billion-to-gb-economy-by-2030.html

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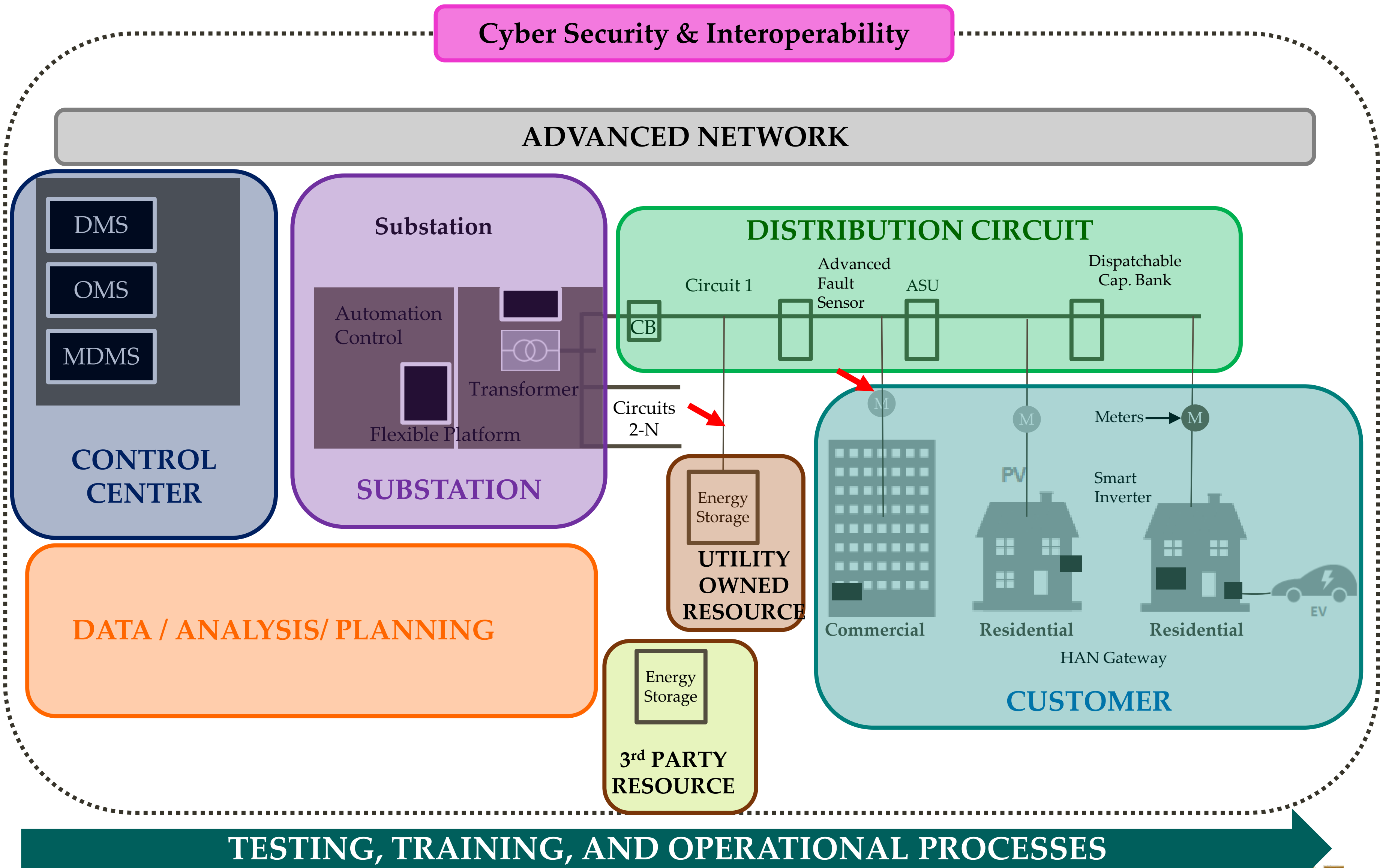

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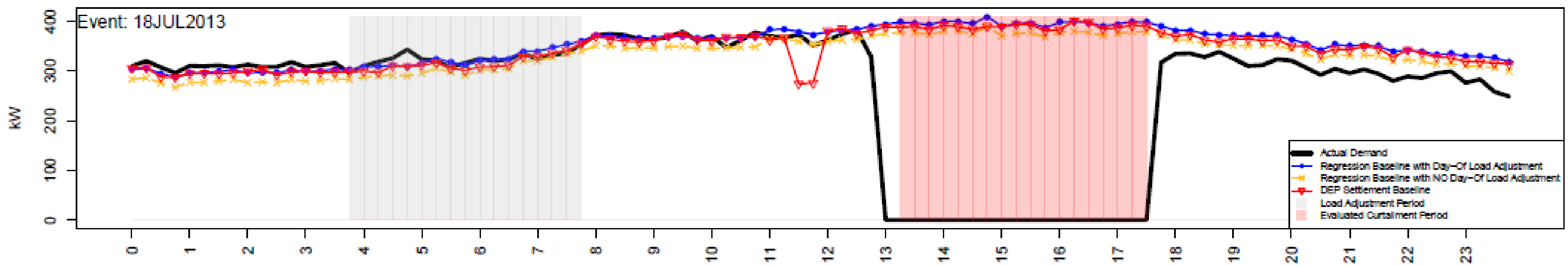
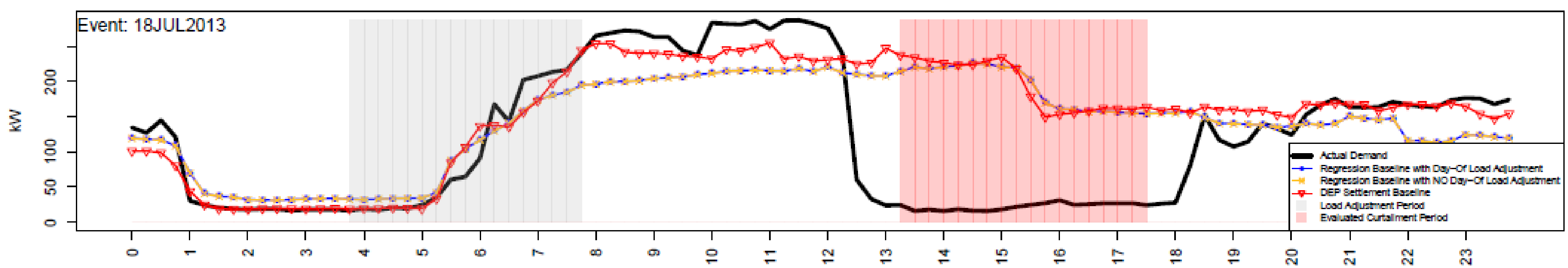
» Example output of baseline (with day-of adjustment) approach for building energy management systems curtailing in response to a critical peak price signal.

Meter ID : DRA0001
Segment : Grocery
Load Reduction Source : Generator



Meter ID : DRA0030
Segment : Manufacturing
Load Reduction Source : Process



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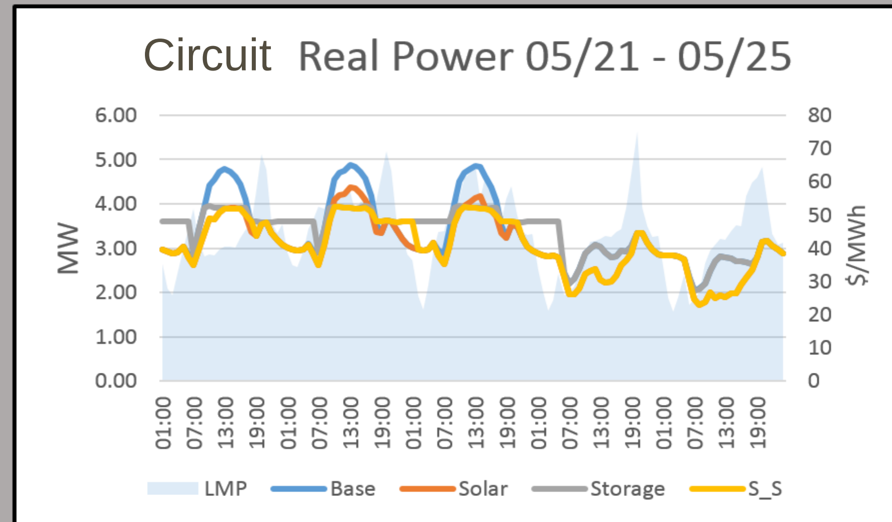
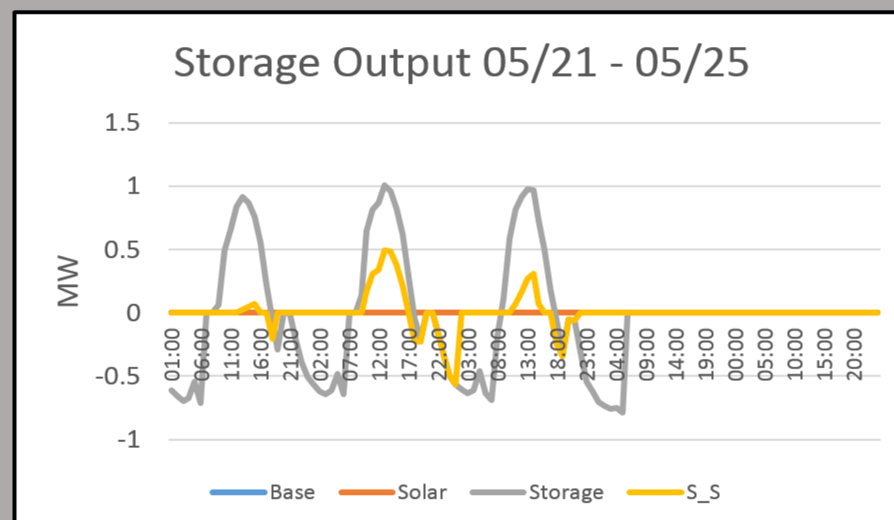
» *Implementation*
  - 2 MW Li-ion battery system + smart inverter
  - 1.5 MW commercial PV installation

» *Use Case*
  - Storage controlled primarily to reduce peak loading on its circuit, and secondarily to provide VAR support

» *Modeled Data*
  - The graphs to the right show a 5 day sample of the measured real power draw at the top of the P1 circuit
  - The locational marginal price (LMP) is shown on the light blue area graph, while demand in each of the four different cases (base circuit, only solar added, only storage added, and both solar and storage added) is shown on the line graph





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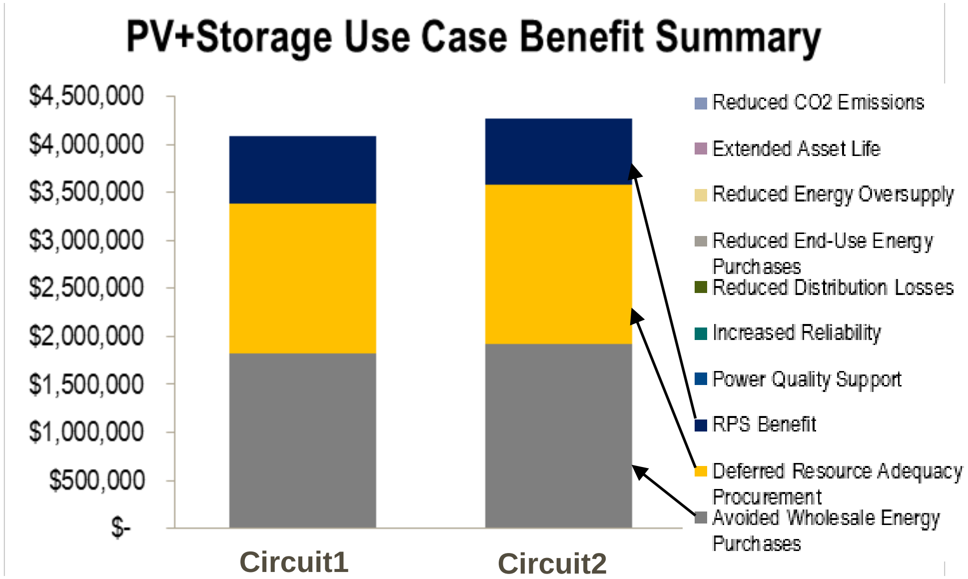

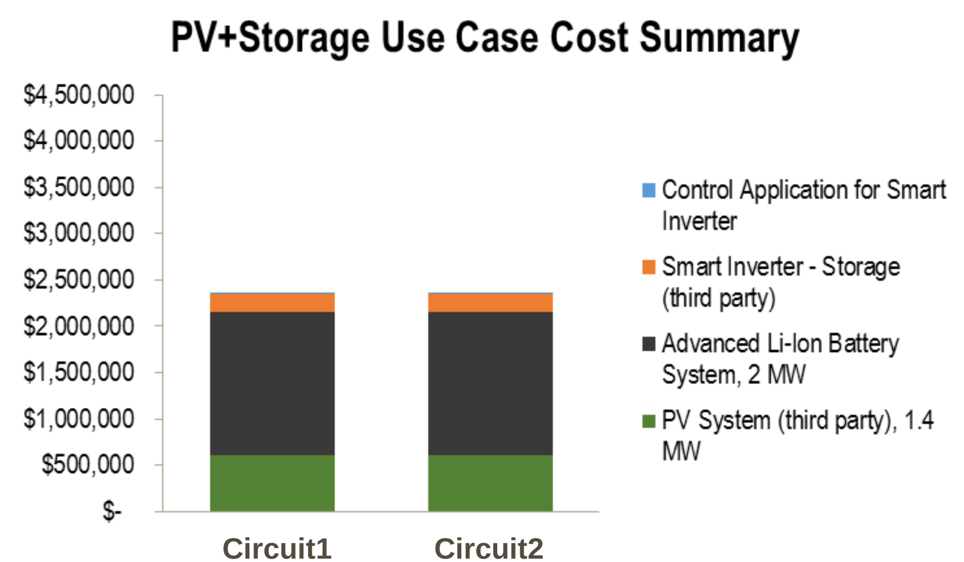

» *Wholesale energy purchases*[1]
  – The Circuit2 implementation avoids greater wholesale energy costs because its circuit peak aligns more closely with the pricing peak.

» *Resource adequacy*[2]
  – The storage control algorithm is able to reduce peak load more significantly on Circuit2 than on Circuit1 due to differences in their load shapes.

» *Distribution Investment Deferral*[3]

» *Feeder-level Cost Assumptions*
  – 1.4MW PV system @ $431/kW
    o NREL's Open PV Project
  – 2MW Li-Ion Battery System @ $500/kW
    o NavResearch ESGAS-14 Report
  – Smart Inverter – Storage
    o Assume $100/kW

[1]Wholesale price is 2014 historical LMP from CAISO OASIS database
[2]Resource adequacy price taken from internal 2014 RA Market and Forecast
[3] Distribution deferral and RPS benefits taken from CPUC Public Tool

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