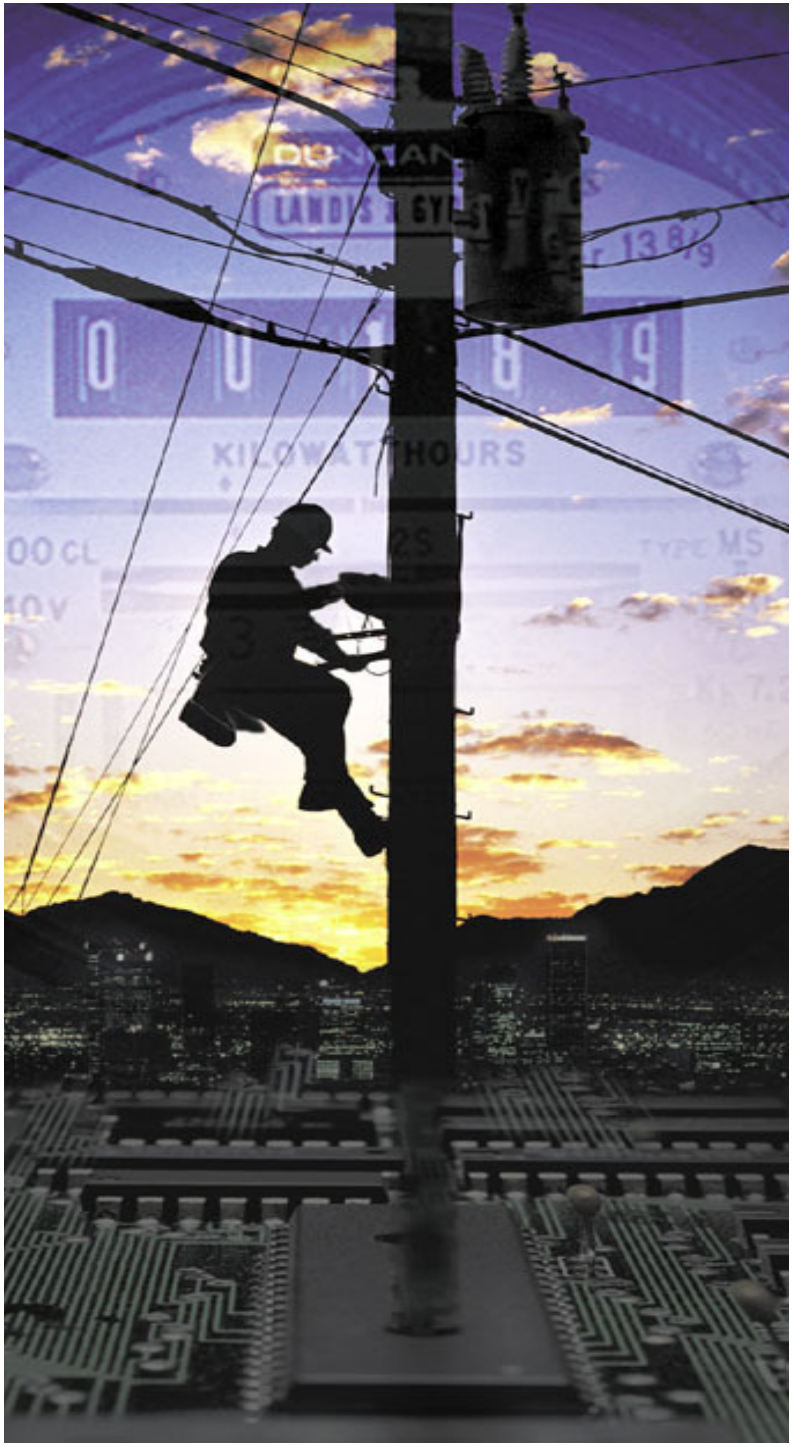

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Functions of a Local Controller to Coordinate Distributed Resources in a Smart Grid

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IEEE PES Panel
"Planning and Operation of DG in Smart Grid"

Outline

- Background
- Microgrids
- Requirements for a Local Controller
- Smart Grid Demonstrations Initiative

Background

Galvin Electricity Initiative

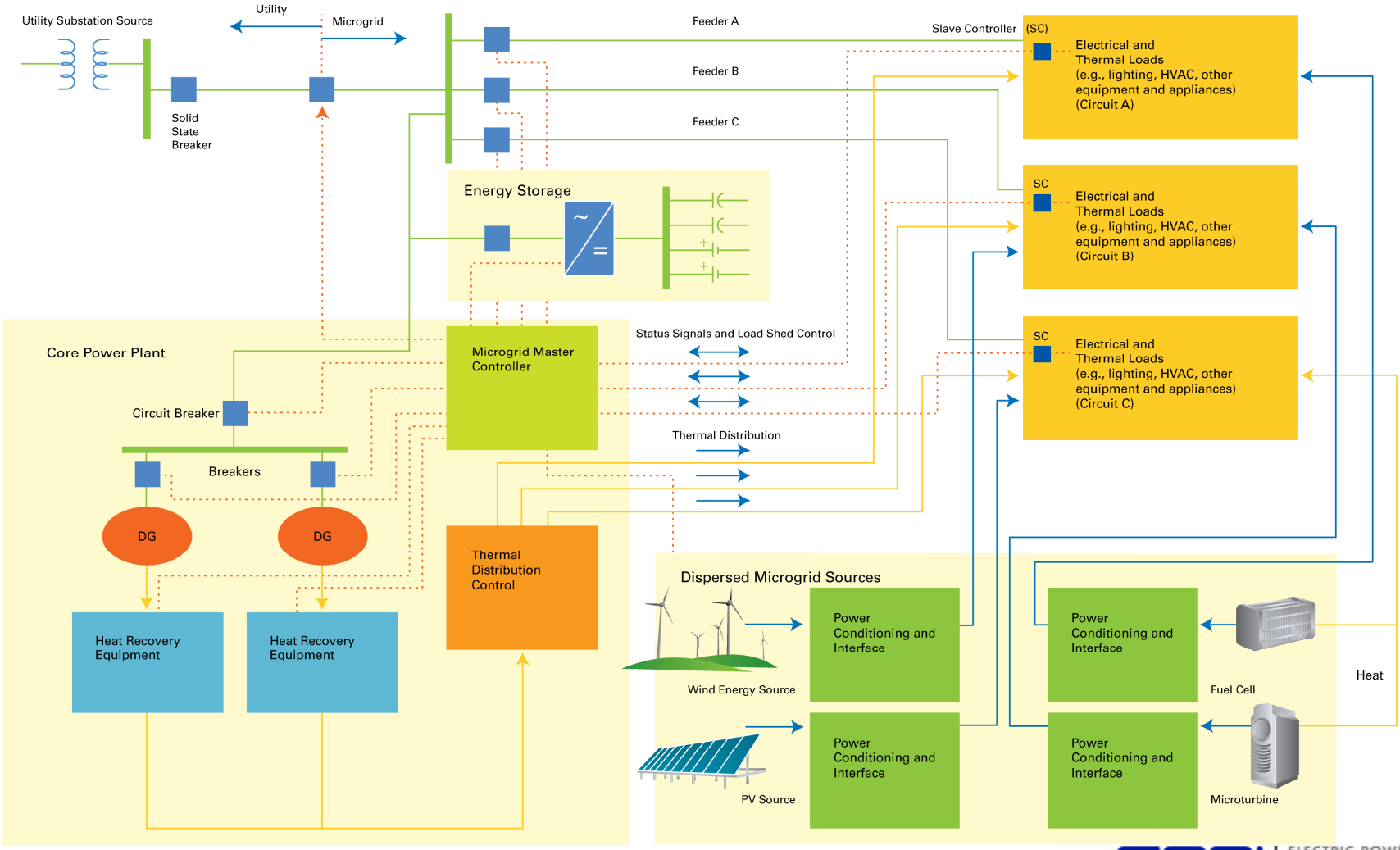
- "Perfect Power" from end-use customer perspective
  - Concept of Levels of Service to customer (i.e., electric service reliability and power quality)
  - Economics of a perfect power system
- Microgrid identified as configuration that can help enable the perfect power system
- Requirements specification for a master controller developed

Related Activities

- EPRI IntelliGrid program
  - Review of commercially available master controller offerings
- "Perfect Power" Demonstration
  - IIT, Exelon/ComEd, Galvin Electricity, S&C

Local Controller Concept

Example Microgrid with Master Controller



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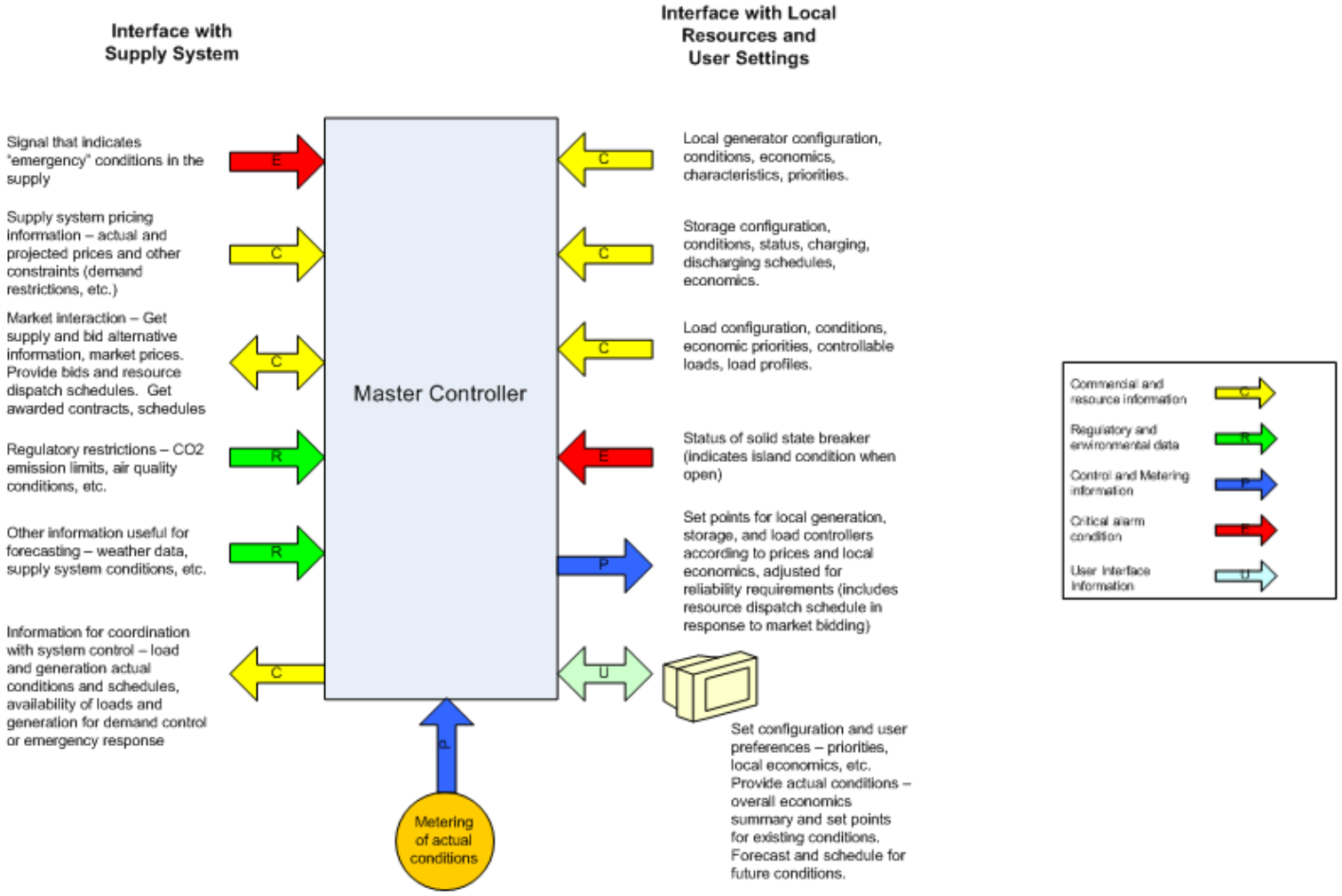
Modes of Operation

- Operating Modes
  - Normal mode
  - Emergency mode
  - Island mode

- Classes of Functions
  - Local grid configuration functions
  - Functions related to economic, environmental, and customer comfort considerations

Information Exchange



Source: "Master Controller Requirements Specification for Perfect Power Systems", Report prepared for Gavin Initiative, December, 2006.

Functional Requirements

- Optimization functions (collection of functions under each mode)
- System Configuration (configure controller to process information flows)
- Information Processing (support controller decision-making)
  - Electricity Price Forecasting and Processing (from supply)
  - Electricity Cost Forecasting and Processing (local sources)
  - Load management functions (demand management in response to prices and other factors)
  - Storage management functions (optimize use of storage along with load management and supply system requirements)
  - Market bidding functions
- Information Presentation (display and selection of user preferences & settings)

Other Requirements

- Communication and Software Interfaces
  - Support a common information model representation of the microgrid system
  - Standard communication protocols
- Data Management and Processing Requirements
  - Local optimization functions
  - Participation in markets and supply system requirements
  - User information about energy use and costs

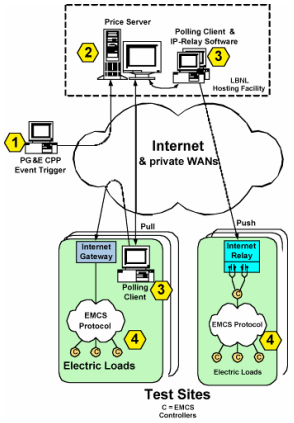
Next Steps: Smart Grid Demonstrations

Communication Media: BPL, WI-Max, Satellite, Fiber, DSL, WI-FI, RF Mesh, etc.

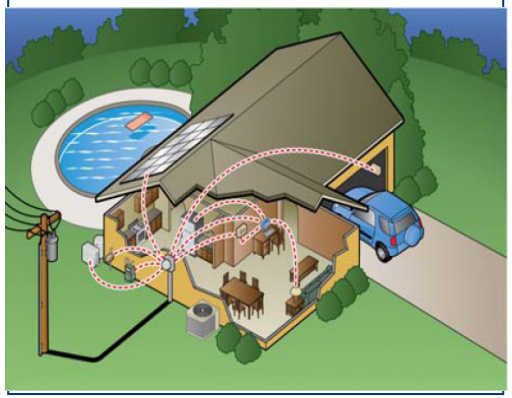
Smart Grid Infrastructure: Software/database, network communication and monitoring and control architecture

Substation/Feeder DER Integration

C&I Customer Demand Response & DER Integration



Residential Customer Demand Response & DER Integration



Integrating Distributed Power Generation, Storage and Demand Response Technology into a Demand-Side Virtual Power Plant

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Objectives of the Demonstration Initiative

- Define roles and required systems for distributed resource integration in different market and system environments.
- Define open interface models and interoperability requirements.
- Develop application guidelines, integration requirements, and standards for distributed resource integration.
- Verify business cases associated with smart grids and distributed resource integration.

Important Concepts

- Storage enables demand management and renewable integration
- Taking full advantage of distributed resources
  - Local grid benefits
  - Transmission benefits
  - Market integration
- Demand response as important component of distributed resources
- Coordination and integration with distribution management systems
- Microgrids enable improved reliability

Project Participants

EPRI BoD Initiative & IntelliGrid Program
Department of Energy (Office of Energy Efficiency & Renewable Energy & Office of Electricity Delivery and Energy Reliability)
California Energy Commission
NYSERDA
Others

EPRI/Utility Team
UCA International User's Group
FREEDM Center
GridWise Alliance
European Smart Grid Initiatives
Manufacturers

Standard Development Organizations (SDO)

ANSI
IEC
IEEE Intelligent Grid Coordinating Committee
AHAM
NIST
NEMA
Others

DOE Distribution Integration Awards

- Allegheny Power, WVU, NC State, Research & Development Solutions, Augusta Systems, Tollgrade – **West Virginia Super Circuit**
- ATK Launch Systems, Rocky Mountain Power, P&E Automation – **integration of renewables, DG, and storage (compressed air).**
- Chevron Energy Solutions, Alameda County, PG&E, VRN Power Systems, SatCon, Univ of Wisc., NREL, LBNL, E3 – **Solar, fuel cell and storage microgrid**.
- City of Fort Collins, Colorado State Univ, InteGrid Lab, Comm Found of Northern Col, Governor's Energy Office, Advanced Energy, Woodward Spirae, Eaton – **3.5 MW mixed distributed resources for peak load reduction**.
- IIT, Exelon/ComEd, Galvin Electricity, S&C – **"perfect Power" demonstration**
- Con Edison, Verizon, Innovative power, Infotility, Enernex – **Interoperability between utility and end use customers for DG aggregation.**
- SDG&E, Horizon Energy Group, Advanced Control Systems, PNNL, Univ of San Diego, Motorola, Lockheed Martin – **Integrating multiple distributed resources with advanced controls.**
- Univ of Hawaii, GE, HECO, MECO, Columbus Electric Coop, NM Inst of Mining and Tech, Sentech, UPC Wind – **Mgt of distributed resources for improved quality and reliability, grid support, and transmission relief**.
- Univ of Nevada, Pulte Homes, Nevada Power, GE Ecomagination – **Integrated PV, battery storage, and consumer products with advanced metering**.

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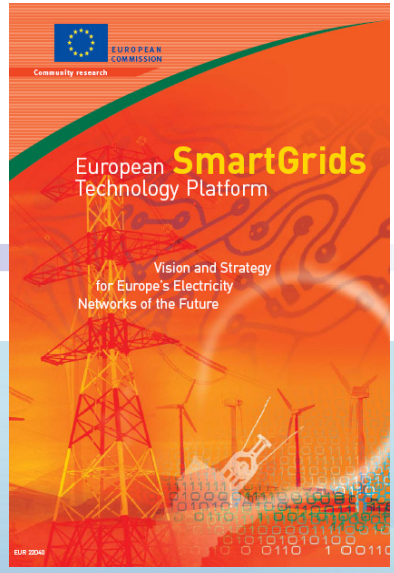
Alignment with European SmartGrids Vision



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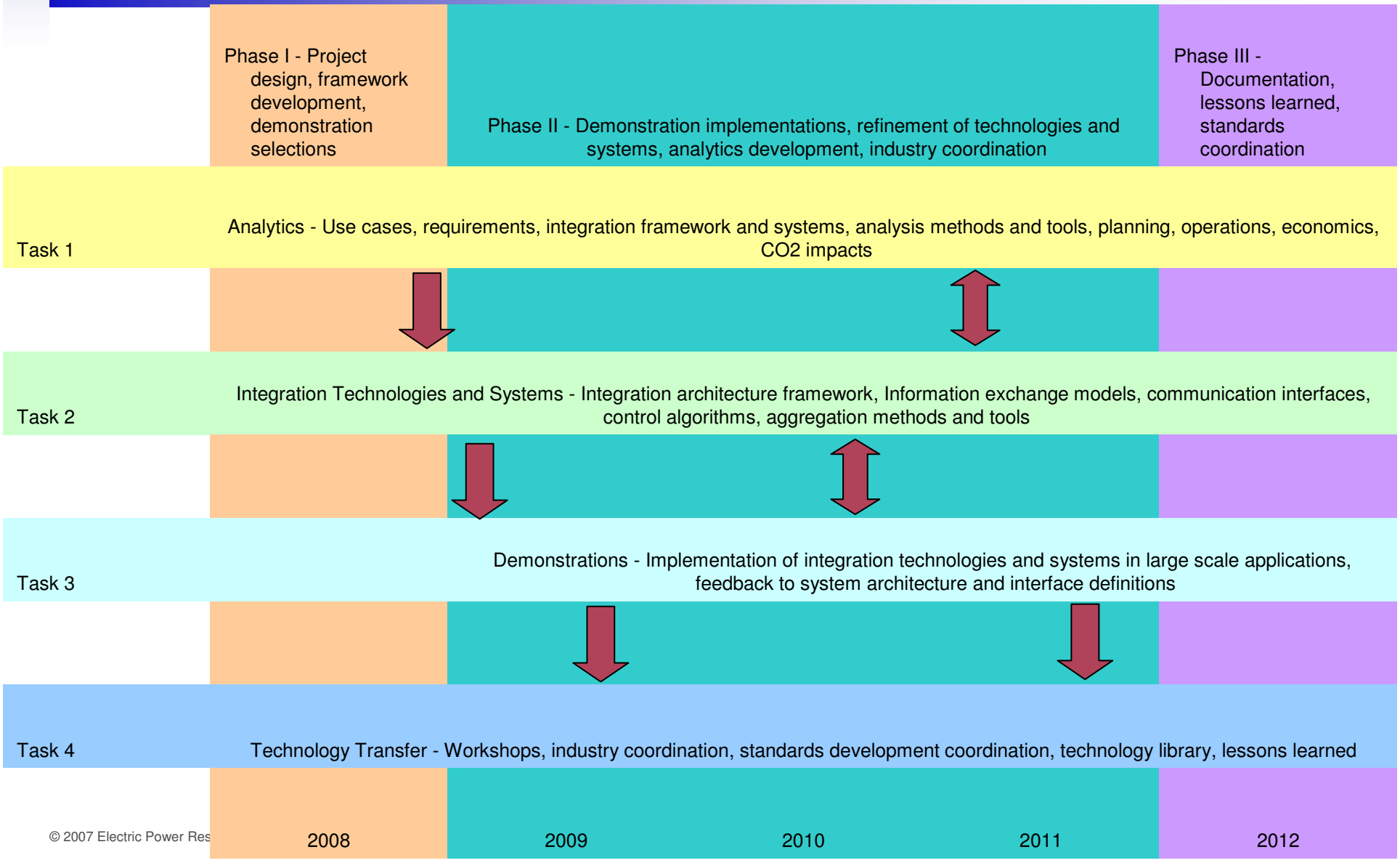
Project Overview



Next Steps: Critical Integration Technologies

- Develop reference designs and define open interfaces for integration of distributed resources
- Develop and apply technologies and systems for integration of distributed resources using the open interfaces
- Develop and implement systems for management of distributed resources as part of transmission and distribution operation (DMS, EMS)
- Integrate distributed resources at the market level to demonstrate the “demand-side virtual power plant” concept

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