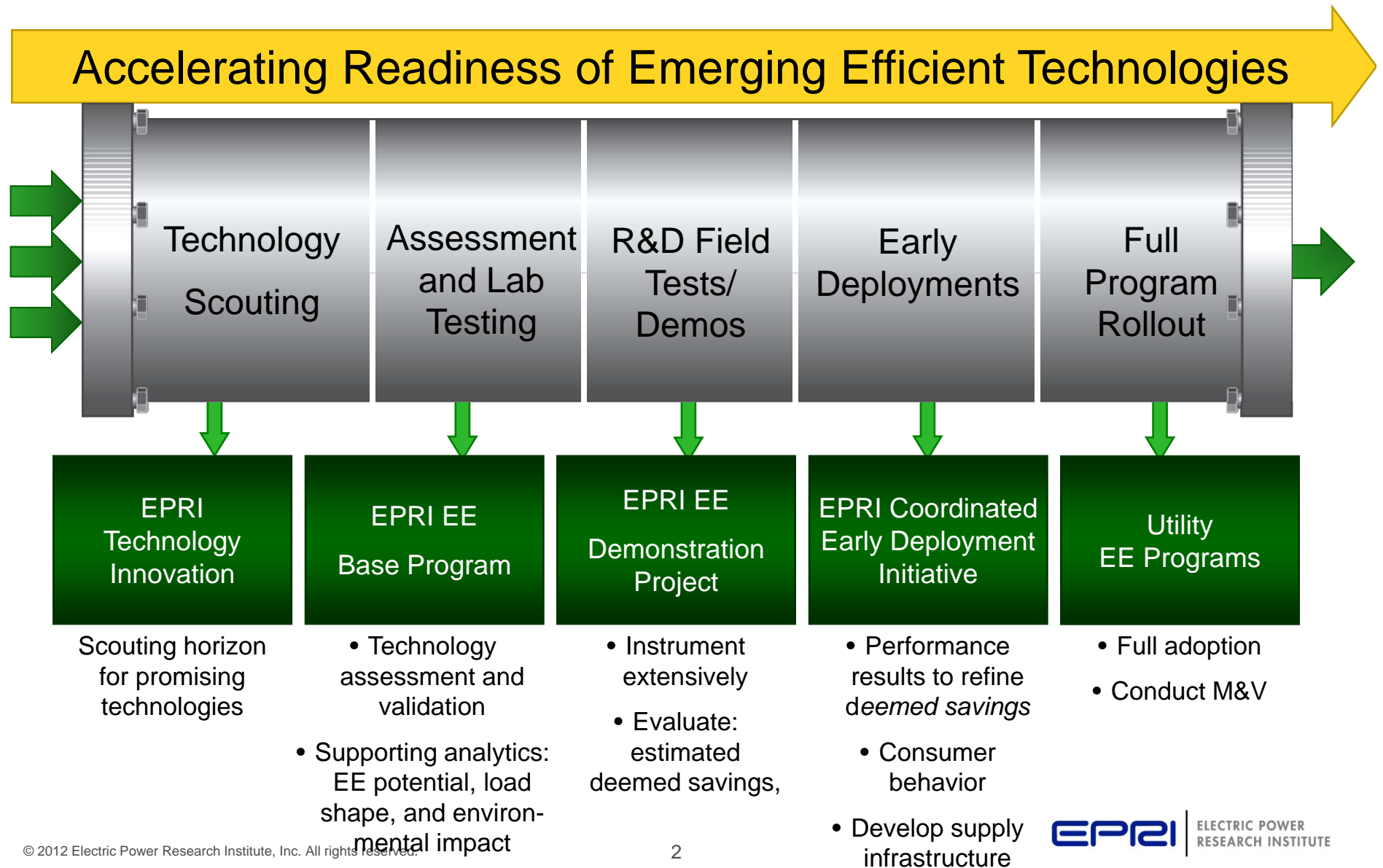# Evaluation of NILMs Technologies for Electric Load Disaggregation

Krish Gomatom, Senior Engineer (EPRI)

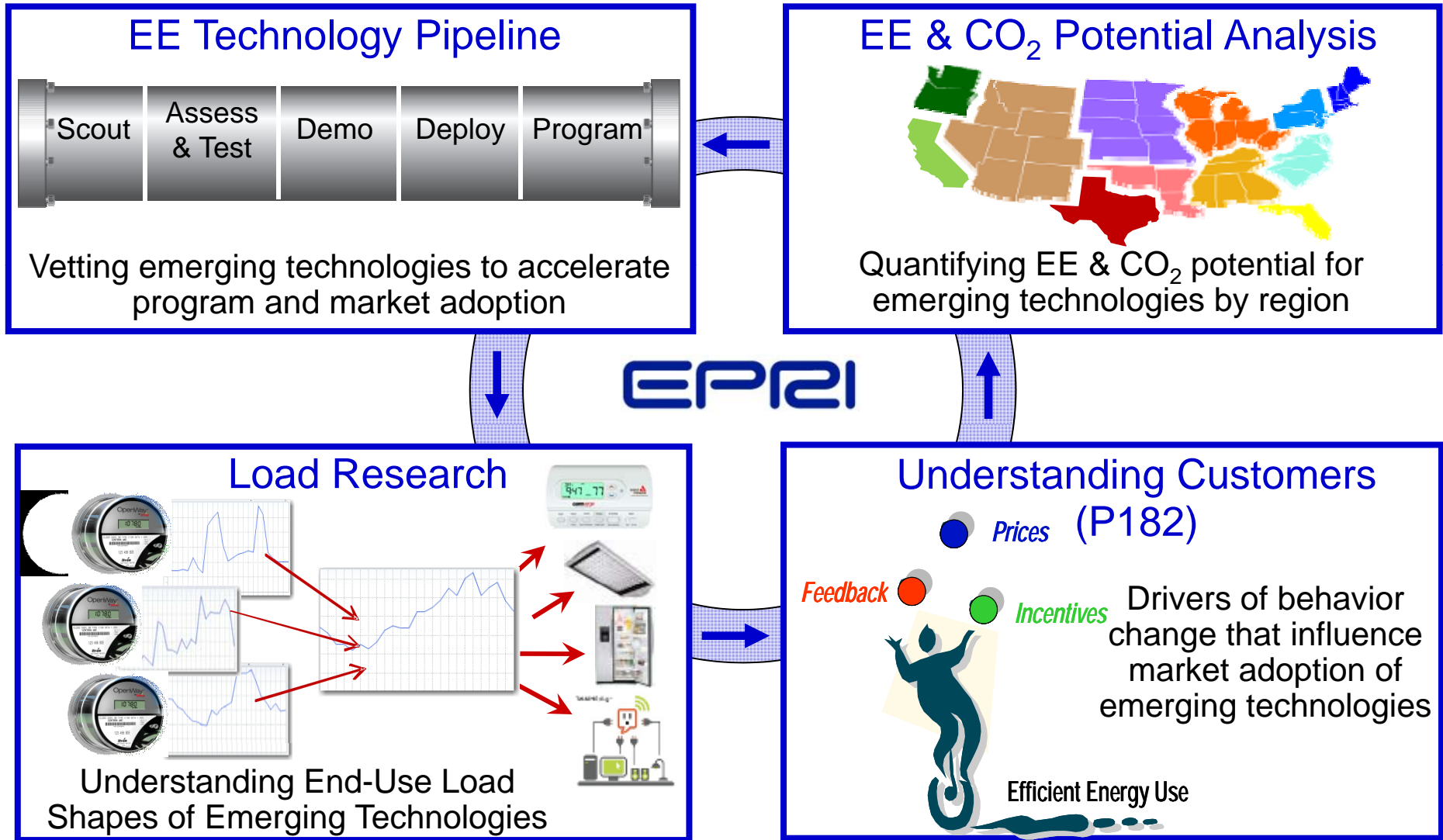**Chris Holmes, Senior Project Manager (EPRI)**

1st International Workshop on Non-Intrusive Load Monitoring

Carnegie Mellon University, Pittsburgh, PA

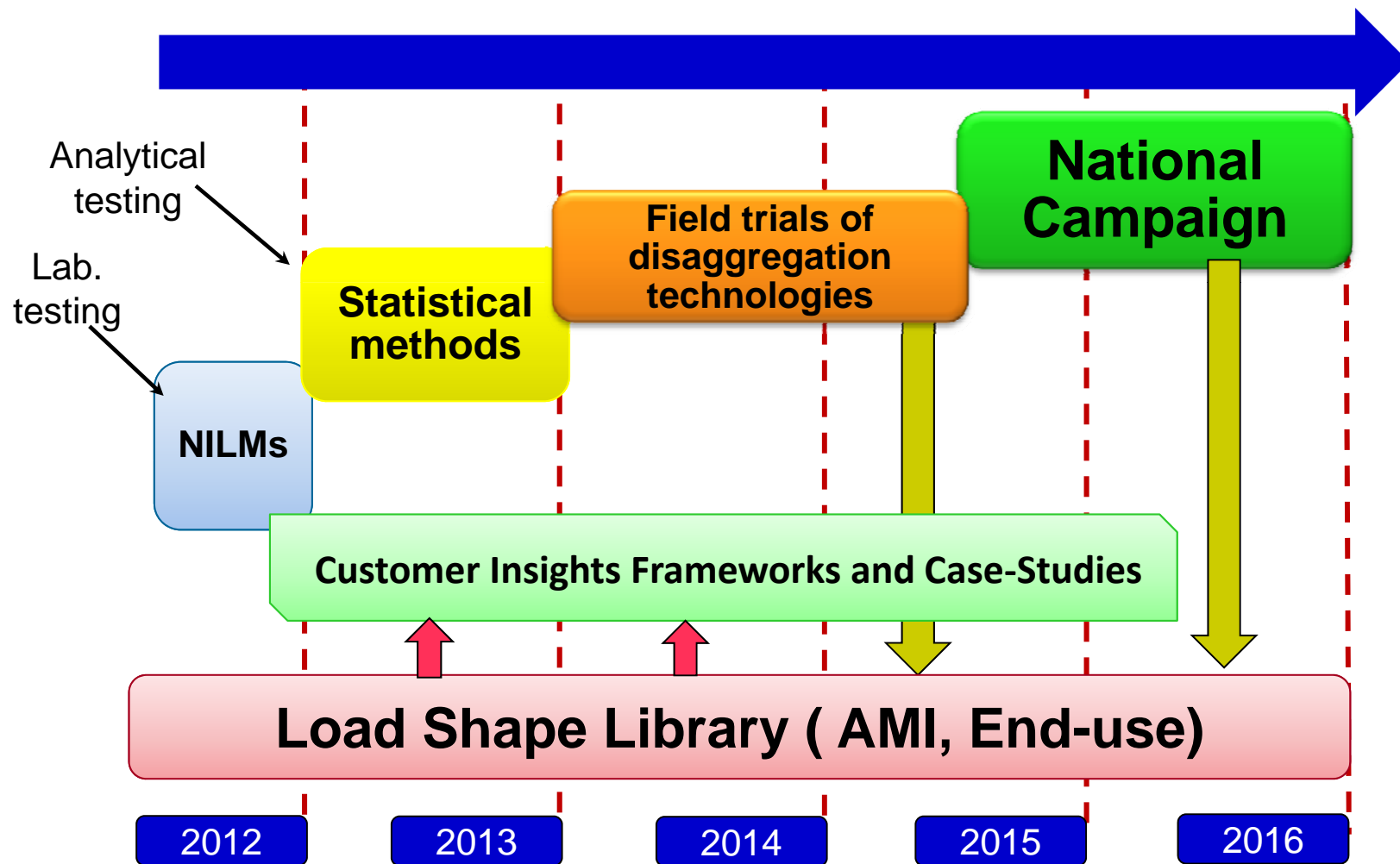May 7, 2012

EPRI Energy Efficiency Technology Pipeline

Accelerating Readiness of Emerging Efficient Technologies

Technology Scouting	Assessment and Lab Testing	R&D Field Tests/ Demos	Early Deployments	Full Program Rollout
EPRI Technology Innovation	EPRI EE Base Program	EPRI EE Demonstration Project	EPRI Coordinated Early Deployment Initiative	Utility EE Programs
Scouting horizon for promising technologies	• Technology assessment and validation • Supporting analytics: EE potential, load shape, and environ-mental impact	• Instrument extensively • Evaluate: estimated deemed savings,	• Performance results to refine *deemed savings* • Consumer behavior • Develop supply infrastructure	• Full adoption • Conduct M&V

2

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Analytics Complements Technology Research

EE Technology Pipeline

| Scout | Assess & Test | Demo | Deploy | Program |

Vetting emerging technologies to accelerate program and market adoption

EE & CO_2 Potential Analysis

Quantifying EE & CO_2 potential for emerging technologies by region

EPRI

Load Research

Understanding End-Use Load Shapes of Emerging Technologies

Understanding Customers (P182)

Prices

Feedback   *Incentives*

Drivers of behavior change that influence market adoption of emerging technologies

Efficient Energy Use

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

EPRI Load Research Objectives (2012)

- **Develop, investigate and test alternative methods of cost-effective collection of end-use electric load data to assess the accuracy and applicability of such data for utility load research activities.**

- Develop a framework (database) for creating a load shape repository of electric load end-uses with secure web access to member funders.

- Establish a "Load Data Working Group " comprising of member funders, utilities and other entities interested in collecting and utilizing electric meter data for customer and utility benefit.

- Create a "sharing" platform to facilitate and solicit participation of electric utilities and other interested organizations in the development of analytical frameworks/methods to translate whole-premise load data collected through smart meters into customer and business insights.

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Load Research Activity Map (2012-1016)

Analytical testing

Lab. testing

Statistical methods

Field trials of disaggregation technologies

National Campaign

NILMs

Customer Insights Frameworks and Case-Studies

Load Shape Library (AMI, End-use)

| 2012 | 2013 | 2014 | 2015 | 2016 |

5

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Analytics Supplemental Project Opportunities: Load Research

Phase I - Controlled Pilot Experiment of Alternative End-Use Data Collection approaches

- Test accuracy
- Survey of available devices (e.g., NILMs)
- Laboratory testing of devices
- Priced at $40k per host with three host utilities (currently have two host utilities)

Phase II – Testing of Conditional Demand Analysis (CDA) methods for Smart Meters

- Sample of end-uses using results from Phase I.
- Administration of general and detailed household survey instruments to reduce variance
- Perform regression analysis
- Assess cost versus accuracy tradeoff between Nilms and CDA methods
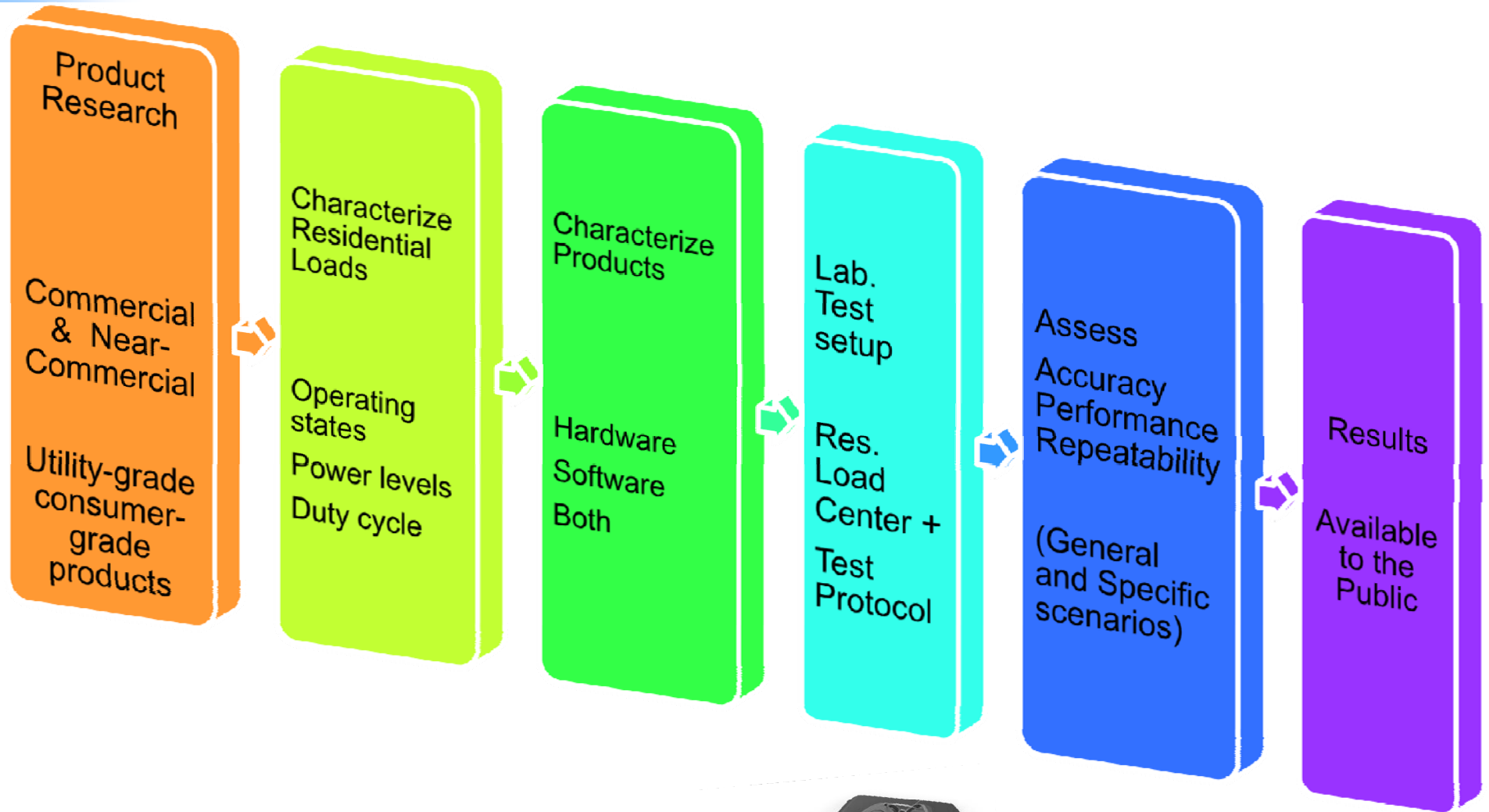- Total price anticipated to be $350k

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

NILMs Device Testing

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

NILMs Testing : Objectives

- Part of the multi-year effort to ultimately collect end-use load data cost-effectively and accurately.

- Entails evaluation of commercial and near-commercial Non-Intrusive technologies capable of measuring end-use electric loads

- Laboratory evaluation using a Residential Load Bank(RLB) and A standardized EPRI test protocol.

- RLB allows connection, individual metering and operation of loads in any combination for any duration, using programmed scripts

- Assess three key factors
  - Accuracy of measurement relative to metered value
  - Disaggregation performance
  - Repeatability of disaggregation
  - Cost

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Tasks Planned for the NILMs Lab. Evaluation

Product Research

Commercial & Near-Commercial

Utility-grade consumer-grade products

Characterize Residential Loads

Operating states
Power levels
Duty cycle

Characterize Products

Hardware
Software
Both

Lab. Test setup

Res. Load Center + Test Protocol

Assess Accuracy Performance Repeatability

(General and Specific scenarios)

Results

Available to the Public

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

EPRI's Interest in NILMs Testing

- The interest of EPRI's member utilities is the accuracy and repeatable disaggregation-capability of NILMs technologies

- Devices must be able to perform on the field for deployment and collection of accurate data.

- EPRI testing is only intended to measure the accuracy of disaggregated load values.

- Testing WILL NOT evaluate or publish technologies and methods used , WILL NOT publish vendor names or product details, WILL NOT compare or publish - design philosophy, functional features, algorithms, hardware and software specs.

- Testing SHALL NOT tamper with the device

- Non-disclosure agreements with product vendors

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Conclusions

- Utility interest in the technology is the cost-effective and (hopefully) the accurate nature of disaggregation for collecting end-use load data.

- NILMs could be a potential candidate for EPRI's national end-use load data collection campaign activities starting late 2013.

- EPRI is interested to work with vendors and the NILMs community to test, evaluate and encourage participation in the national campaign.

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Questions?

Contact

Krish Gomatom
kgomatom@epri.com
Phone: 865-218-8070

Chris Holmes
cholmes@epri.com
Phone: 865-218-8116

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Together…Shaping the Future of Electricity

EPRI | ELECTRIC POWER RESEARCH INSTITUTE