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# Distribution Cost Structure – Methodology and Generic Data

TR-109178

Final Report, February 1998

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# REPORT SUMMARY

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In response to the breakup of traditional utility business structures, distribution utilities face increasing pressure to better understand their costs in order to remain competitive. The Distribution Cost Structure Analysis project is one step in both providing better cost information for management planning and control as well as setting the stage for future efforts in distribution system redesign.

## **Background**

One barrier to determining effective changes in distribution systems is the lack of cost structure data in a useful form for a standalone distribution business. Current cost information, often driven by regulatory accounting requirements, often masks major distribution drivers. Application of business process redesign and activity-based costing can be one means of providing a better understanding of ways to improve distribution system profitability. The studies took place at five cosponsoring utilities: Duke Power, San Diego Gas & Electric, Omaha Public Power District, Duquesne Light, and Public Service Electric & Gas.

## **Objectives**

- To identify costs for key processes within the distribution system.
- To identify and characterize cost drivers.
- To identify opportunities where costs can be reduced primarily through application of technology.
- To direct distribution redesign efforts to the most appropriate areas.

## **Approach**

Participants agreed to limit the study to costs needed to plan, construct, operate, and maintain distribution equipment from the low side of the 69-kV transformer to the meter socket. Extensive interviews were conducted with personnel from each utility, representing all sectors of the distribution business. Analysts developed a cost study model linking activities and resources (including capital, labor, supplies, equipment, and services), and costs were calculated for each activity. Cost drivers also were identified.

## **Results**

The study identified seven processes and 31 associated activities making up the bulk of costs associated with the distribution business. These major processes were (1) new construction, (2) new customer hook-ups, (3) feeder and line maintenance, (4) substation maintenance, (5) service restoration, (6) road and bridge relocation, and (7) tree trimming.

## **EPRI Perspective**

Distribution companies (DISCO) face new challenges as deregulation decouples the traditional vertically-integrated utility structure and forces the DISCO to generate its own return on investment. Changing relationships with both customers and regulators necessitate distribution companies having an even better understanding of their own cost structures. Application of nontraditional utility costing techniques such as activity-based costing can help utilities better position themselves for success in a competitive marketplace.

## **TR-109178**

### **Interest Categories**

Distribution reliability  
Distribution cost control  
Distribution O&M

### **Keywords**

Distribution costing  
Activity-based costing  
Process redesign  
Distribution system redesign  
Distribution accounting  
Standalone DISCO

## Organization

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- Introduction to cost study project
- Primary objectives in undertaking the project

### Introduction & Objectives

- An overview of the U.S. electric industry
- Impact of changing environment on overall industry dynamics
- Impact of changing environment on electric distribution business

### Setting the Stage

- Scope of the project
- Approach and work plan

### Project Overview

- Cost breakdown of key distribution processes
- List of critical cost drivers
- List of improvement opportunities within each process

### Cost Study Results

- Introduction to cost study project
- Primary objectives in undertaking the project

### Introduction & Objectives

Setting the Stage

Project Overview

Cost Study Results

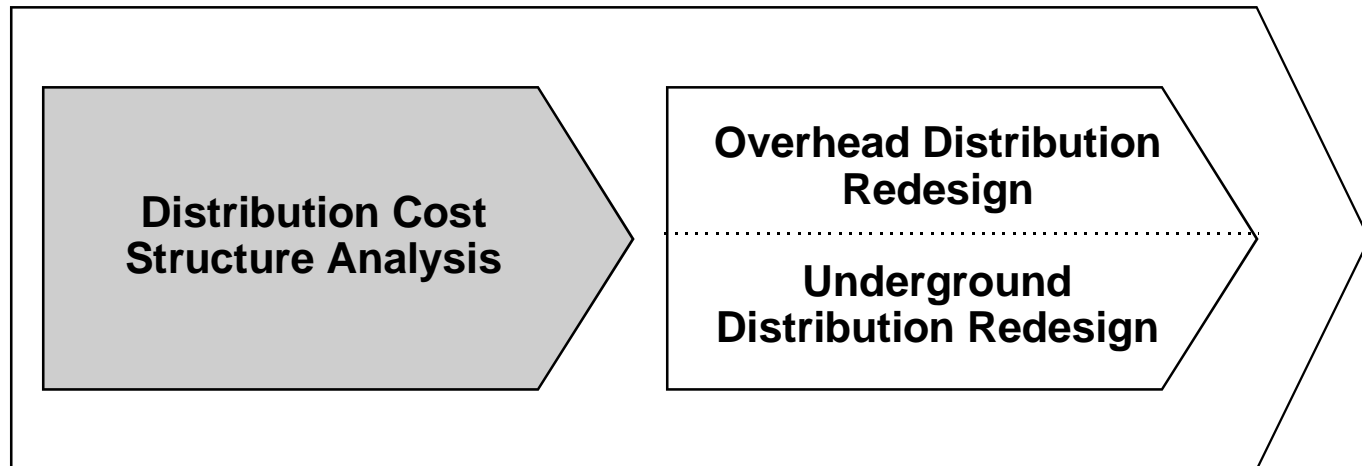
## Introduction & Objectives

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**The distribution cost structure project identifies cost data on key distribution processes and provides insight into potential improvement opportunities.**

### Introduction

The Distribution Cost Structure Analysis was the first step towards preparing for two distribution redesign projects: Overhead Distribution System Redesign and Underground Distribution System Redesign. This first phase sets the stage for the distribution system redesign from a cost perspective and by identifying where cost-based improvement opportunities lie.



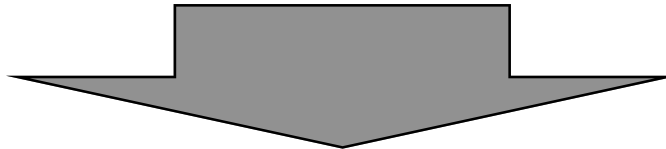
## Introduction & Objectives

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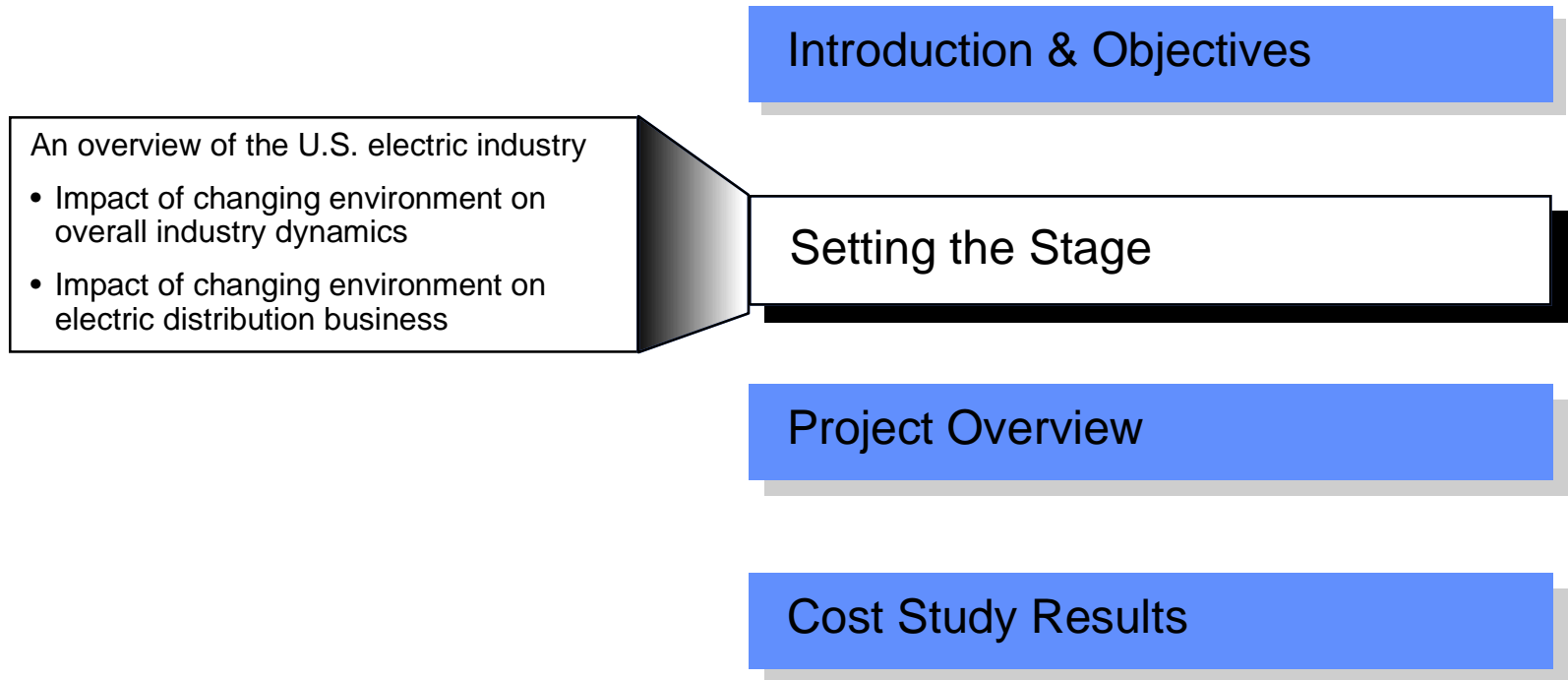
**Results from the cost structure analysis phase will help the redesign team focus their efforts on issues that could potentially have the biggest impact on distribution costs.**

### Primary Objective

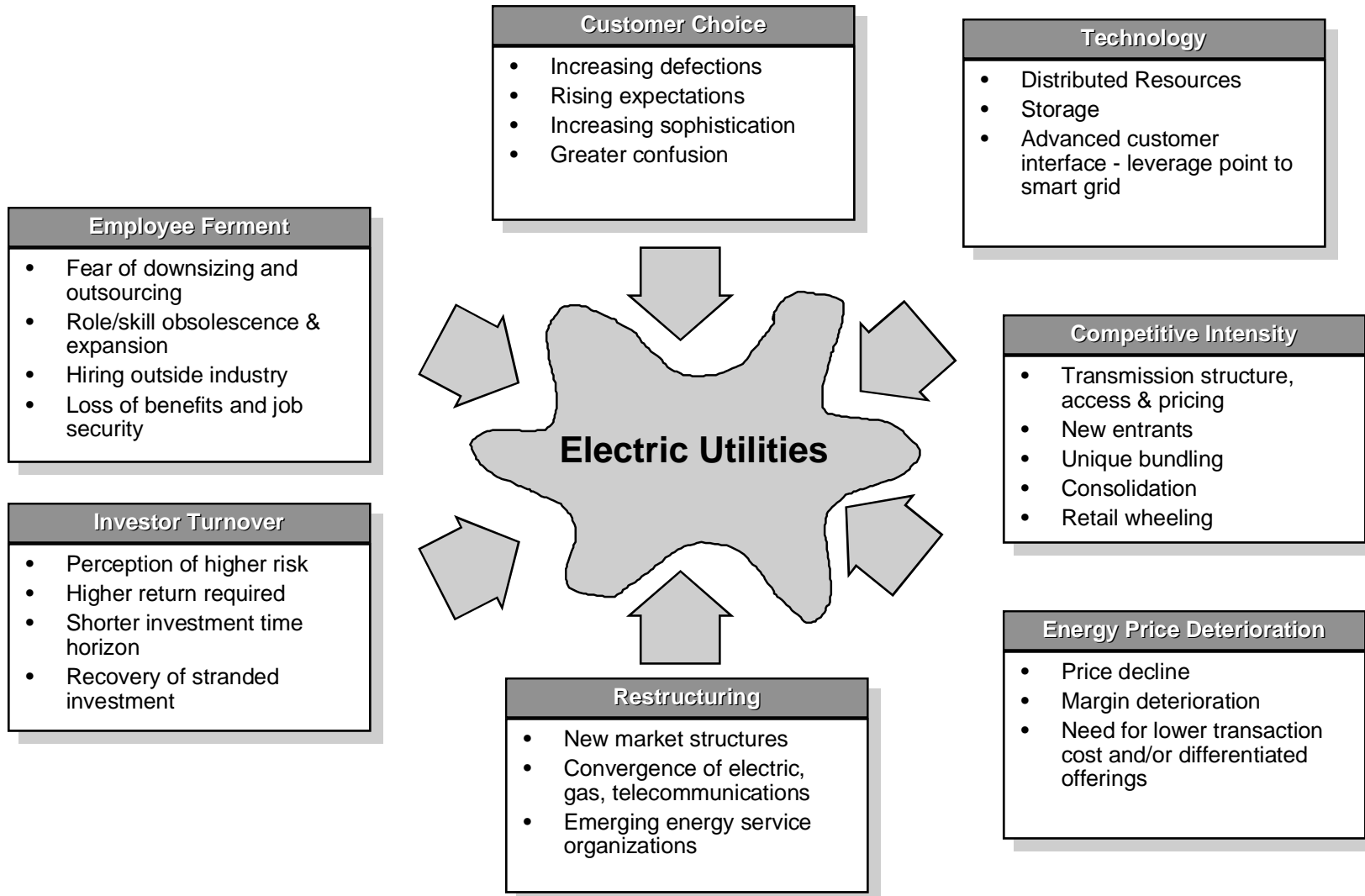
The primary objective of the Cost Structure Analysis phase is to develop an understanding of where utilities are currently spending their distribution dollars, and in-turn direct efforts of the redesign team to appropriate areas



- Identify costs for key processes within the distribution system
- Identify and characterize cost drivers
- Identify opportunities where costs can be reduced primarily through application of technology



**The electric industry is experiencing unprecedented change driven by trends and characteristics within the business environment.**




**High level of uncertainty driven by changes in the business environment generate key challenges for the utilities.**

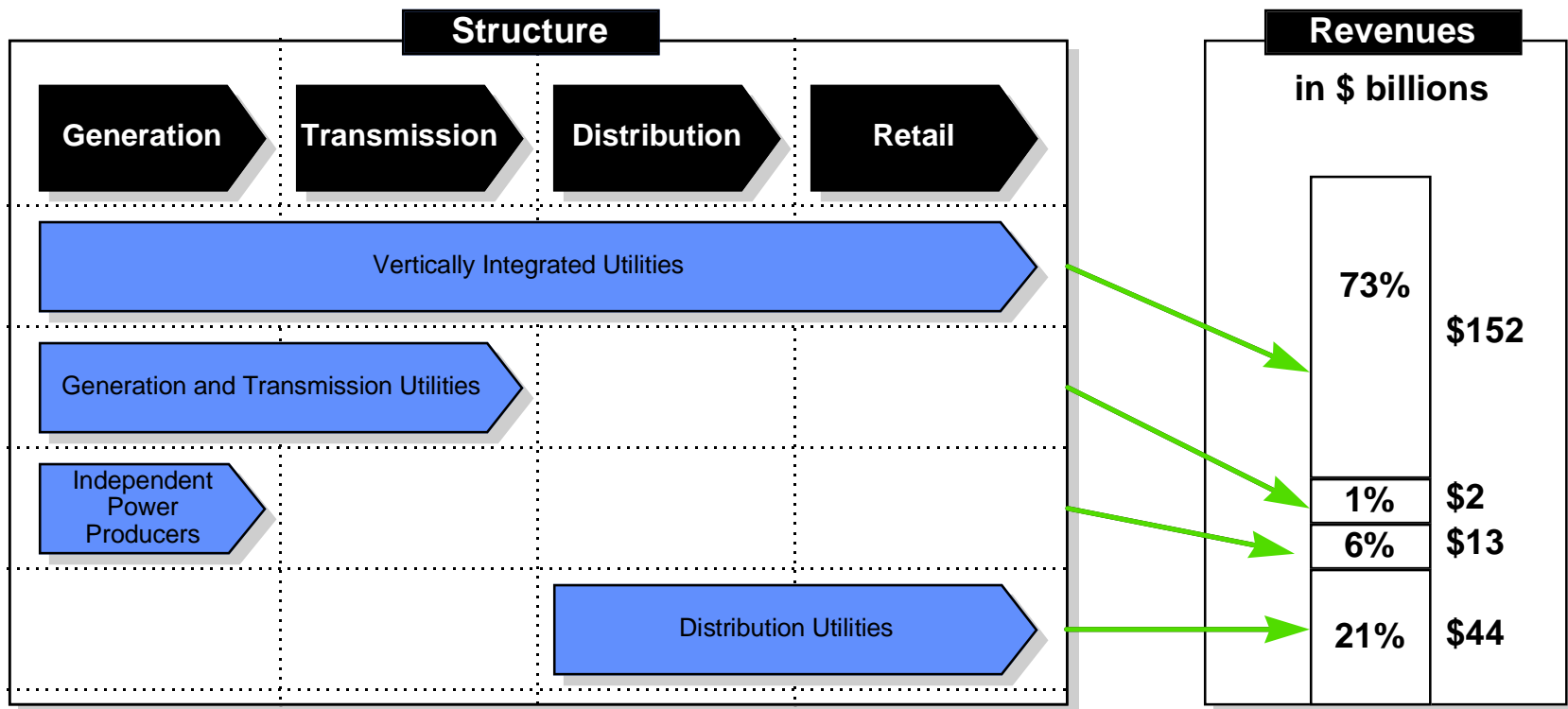
### **Key Challenges**

- Price declines - The competitive power market will force a reduction in utility rates, severely impacting future utility earnings
- Margin reductions - Margins on wholesale and retail energy sales will be reduced
- Loss of monopoly protection - Monopoly protections will be eliminated in wholesale and retail power markets, but will largely remain in transmission and distribution
- New competitors - Competitors will enter at all levels and from many industries in the energy market place to cherry pick a utility's best customers
- New technologies - Super efficient gas generation technologies as well as storage capability pose significant new threats

**To address industry challenges, utilities are implementing a broad array of initiatives focused on retaining and growing earnings.**

	<b>Significant cost reduction</b>	Reducing labor force, decreasing dividend payout ratios, and implementing strategic sourcing
	<b>Reorganization</b>	Forming strategic business units primarily around Genco, Disco and Retailco businesses
	<b>New hires</b>	Expanding outside hiring to acquire competitive market skills, drawing on telecommunications, computers and consumer goods companies
	<b>Mergers &amp; acquisitions</b>	Creating value through regional expansion, gas and electric convergence, and global growth opportunities
	<b>Entering downstream markets</b>	Seeking customer driven service and product enhancements to achieve customer retention objectives
	<b>Entering new businesses</b>	Examples include wholesale and retail energy marketing, telecommunications, energy services, security, and independent power production

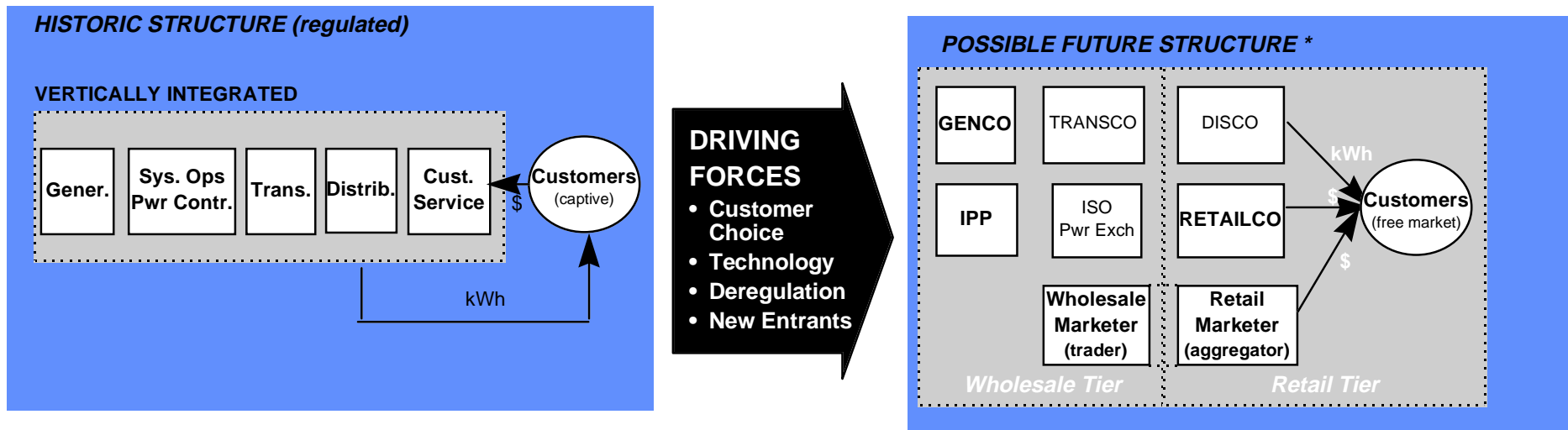
**Future visions and strategies will vary among utilities. Currently vertically integrated utilities and distribution utilities dominate the U.S. electric industry.**



NB: Figures do not add to 100% due to rounding

Source: DOE/EIA Statistics

Implications of pressures from deregulation and competition are expected to replace the current vertically integrated utility with more competitive models.

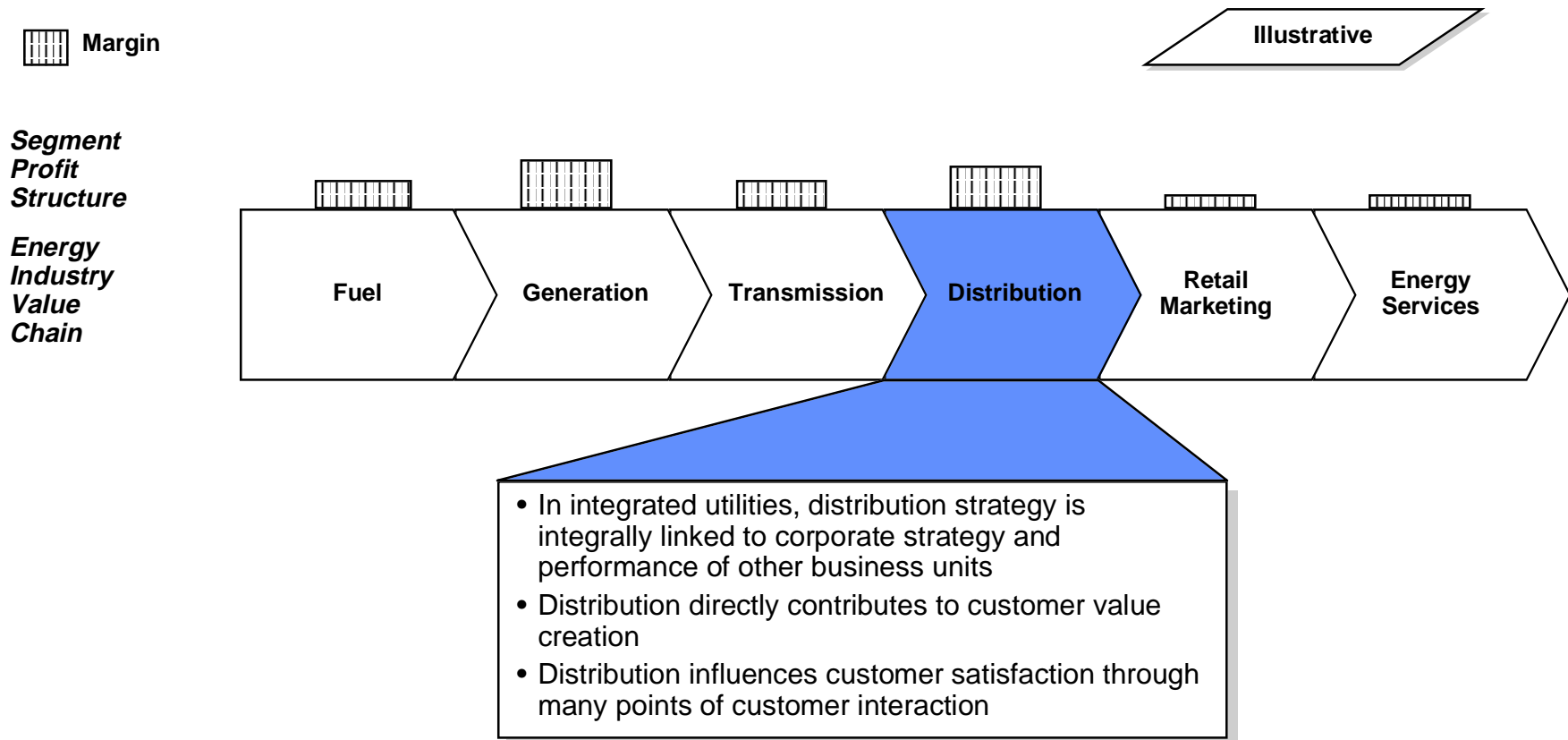


\*Bold connotes unregulated entities (restructured incumbents, new entrants) in future industry.

**Utilities are learning from lessons of other industry restructuring efforts and are taking dramatic measures to position themselves for success in the competitive markets.**

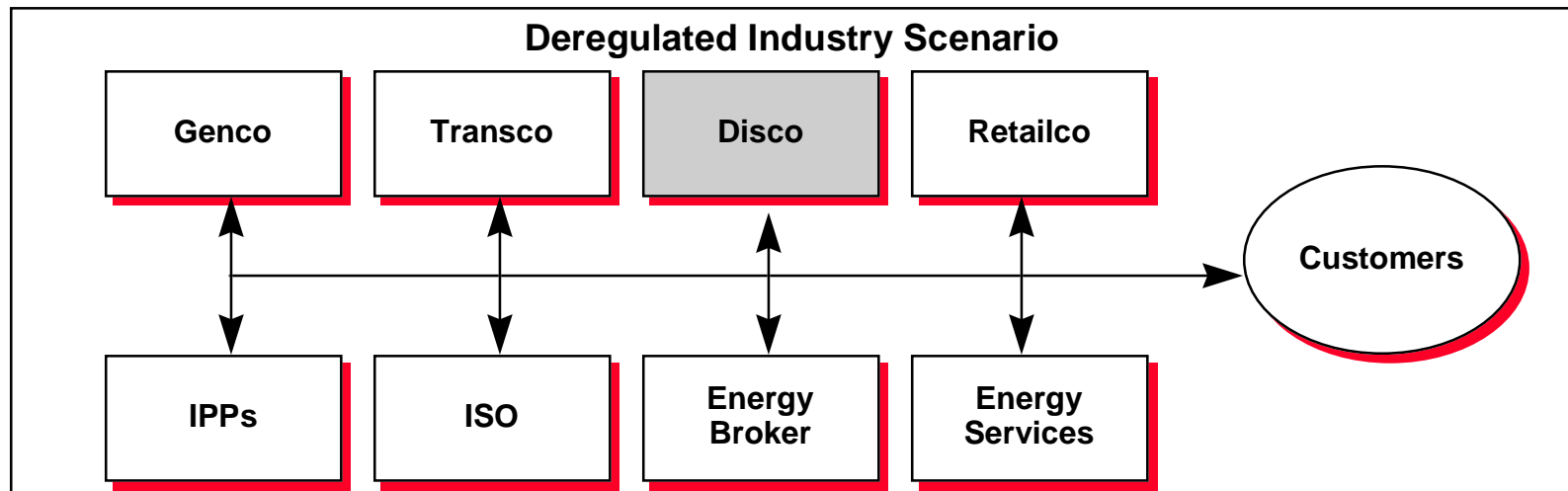
		<i>Key Transition Patterns and Characteristics</i>				
<i>Key Players:</i>		<b>Monopolistic Market</b>	<b>Emergence of Choice</b>	<b>Snowballing Effect</b>	<b>Focused Growth</b>	<b>Competitive Market</b>
<b>Customers</b>	<ul style="list-style-type: none"> <li>• Full reliability</li> <li>• No sticker shock</li> <li>• Invisibility</li> </ul>	<ul style="list-style-type: none"> <li>• Few customers with choice</li> <li>• Initial confusion</li> </ul>	<ul style="list-style-type: none"> <li>• Rising expectations</li> <li>• Price driver</li> <li>• Customer defection</li> </ul>	<ul style="list-style-type: none"> <li>• Loyalty to companies decline, rises to new products and services</li> </ul>	<ul style="list-style-type: none"> <li>• Competitive price</li> <li>• Enhanced services</li> </ul>	
<b>Regulators</b>	<ul style="list-style-type: none"> <li>• Prudence</li> <li>• Documented Cost</li> <li>• Social cost allocation</li> </ul>	<ul style="list-style-type: none"> <li>• Growing customer sympathy</li> <li>• Proactive regulation</li> <li>• Open to niche</li> </ul>	<ul style="list-style-type: none"> <li>• Adversarial relations</li> <li>• Bias to new entrants but worried about stranded cost</li> </ul>	<ul style="list-style-type: none"> <li>• Support competition</li> <li>• Regulate price not cost</li> <li>• Look for new roles</li> </ul>	<ul style="list-style-type: none"> <li>• Customer protection</li> <li>• Re-enforce competition</li> </ul>	
<b>Shareholders</b>	<ul style="list-style-type: none"> <li>• Secure dividend</li> <li>• Low risk</li> </ul>	<ul style="list-style-type: none"> <li>• Believe traditional performance will hold</li> </ul>	<ul style="list-style-type: none"> <li>• Growing concern</li> <li>• Increased activism</li> <li>• Fund Diversification</li> </ul>	<ul style="list-style-type: none"> <li>• Focus on cash flow and risk management</li> <li>• Seek related growth</li> </ul>	<ul style="list-style-type: none"> <li>• Seek growth in shareholder value</li> <li>• Acceptable risk</li> </ul>	
<b>Employees</b>	<ul style="list-style-type: none"> <li>• Job security</li> <li>• Fair compensation</li> <li>• Stable workforce</li> </ul>	<ul style="list-style-type: none"> <li>• Believe traditional rules will hold</li> </ul>	<ul style="list-style-type: none"> <li>• Mismatch of skills and needs</li> <li>• Downsizing</li> <li>• Outside hires</li> </ul>	<ul style="list-style-type: none"> <li>• Match performance and pay</li> <li>• Marketing and finance</li> <li>• Work rule changes</li> </ul>	<ul style="list-style-type: none"> <li>• Career growth</li> <li>• Competitive pay for performance</li> </ul>	
<b>Competitors</b>	<ul style="list-style-type: none"> <li>• Nonexistent</li> </ul>	<ul style="list-style-type: none"> <li>• New entrants</li> <li>• Falling prices</li> </ul>	<ul style="list-style-type: none"> <li>• Falling margins</li> <li>• Gradual specialization</li> <li>• Cost reduction</li> </ul>	<ul style="list-style-type: none"> <li>• Consolidation</li> <li>• Sophistication of offer</li> <li>• Optimization of operations</li> </ul>	<ul style="list-style-type: none"> <li>• Many and dynamic</li> <li>• Brand equity builders</li> </ul>	

**Impact of changes to the vertically integrated utility will have an effect on the current industry value chain.**



**Distribution systems occupy a pivotal position within the value chain from a profit and strategic perspective.**

**Role of the distribution entity is expected to significantly change and distribution companies will embrace a range of strategies: from commodity transporter to enhanced energy and services distributor.**



#### Possible Scenario's

- Distribution will be regulated via Performance Based Ratemaking (PBR) mechanisms
- Smart grid utilities may retain connection to the retail end of the business - by enabling delivery of power and other consumer services (e.g., information, security, telephony)
- Some utilities will bundle distribution with transmission and focus on wires common carriage as the core purpose of the future company
- Some merger activity is possible even with unconventional entities (CATV, Teleco, etc.) as rights of way, field operations, customer connection and telecommunications assets are leveraged

**The selection of business strategies and investment decisions are likely to be based on how individual companies see visions of future business scenarios.**

**Future Scenarios**

**“Business as usual”**

Market demands drive deregulation and the average price of electricity declines. However, the pace of liberalization is curbed by unresolved issues such as open transmission access, stranded cost recovery, and Public Utilities Holding Company Act (PUHCA) reform.

**“Market”**

Electric industry is robust with market opportunities. Regulators accommodate structural change, facilitate the transition to competitive power markets, and encourage new entrants into an entrepreneurial marketplace.

**“Commodity”**

The electric industry is suffering effects of global economic slowdown. Utilities are implementing extreme cost cutting as business failures mount. Excessive capacity leads to cost wars where deep pockets provide staying power.

**Illustrative Distribution Visions**

**“Business as usual”**

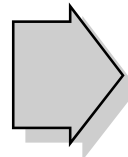
- **Rate-of-return regulation**
- **Focus on safety and social equity**
- **Vertically integrated**

**“Market”**

- **Incentive regulation (PBR/Caps)**
- **Value added services**
- **Integrated offerings (telecom/gas/electric/service/smart grid)**

**“Commodity”**

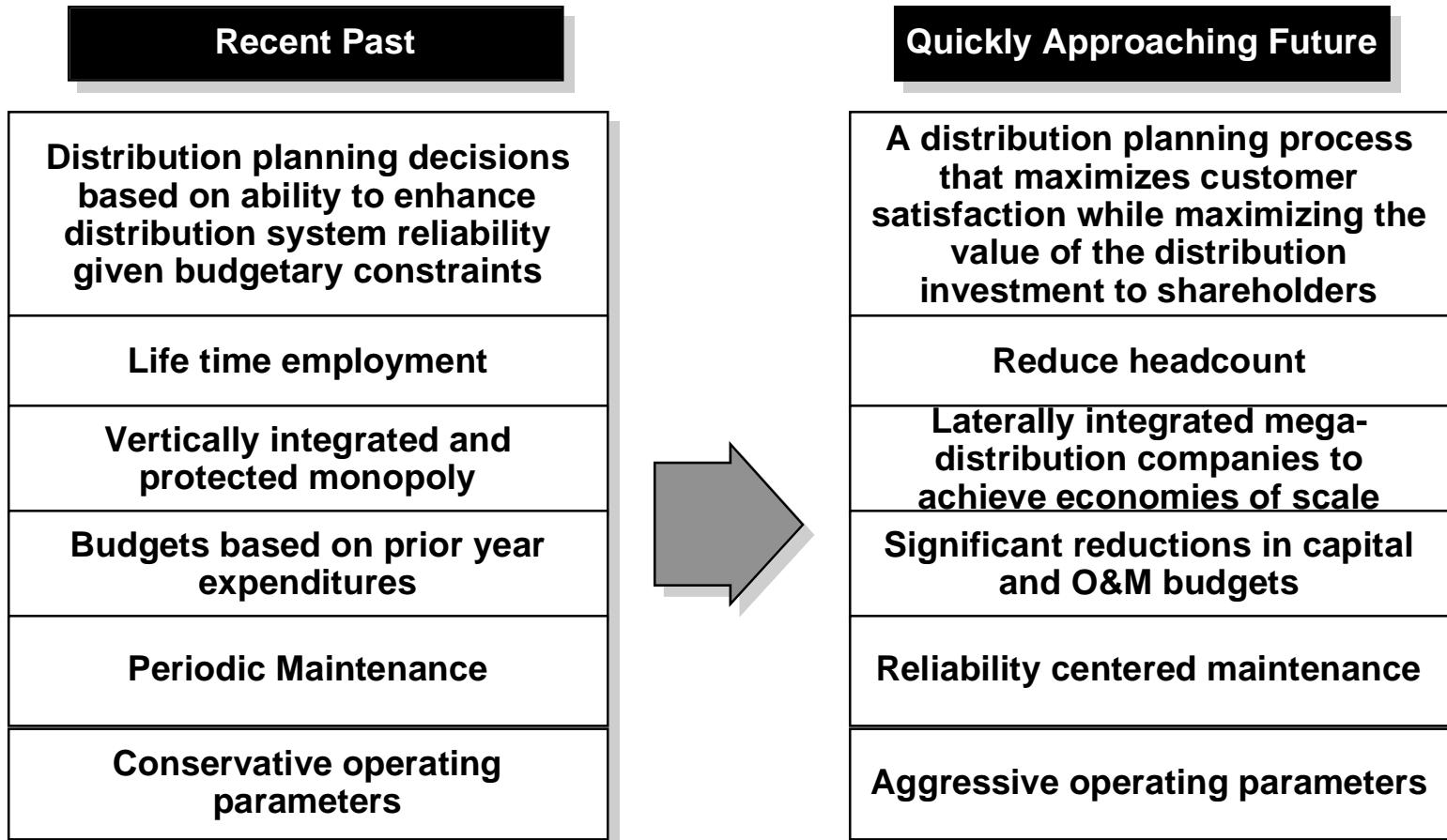
- **Low cost strategies win**
- **Differentiated reliability and quality**
- **Laterally integrated mega-distribution companies (dumb grid)**



**Irrespective of the future business scenarios, distribution system managers are being given very clear objectives to meet the needs of the changing environment.**

- Increase shareholder returns
- Reduce costs
- Enhance customer loyalty and retention
- Manage risk
- Maximize asset utilization
- Implement and use individual performance measurement systems
- Move from subjective to objective distribution performance goals and metrics (i.e.; PBR)

**Consequently, distribution managers are seeking new tools and implementing new policies to achieve corporate objectives.**



## Setting the Stage

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**To address the needs of distribution managers, DBA has launched the current project to examine utility's distribution cost structure, and conceivably redesign the distribution system.**

### Cost Structure Analysis Phase Objectives

- Identify costs for key processes within the distribution system
- Identify and characterize cost drivers
- Identify opportunities where costs can be reduced primarily through application of technology
- Provide analytical results to DBAC for 1997-98 R&D brainstorming.

### "Rethink" Phase Objectives

- Provide clean sheet redesign models for both overhead and underground infrastructures
- Focus application of technology on those areas of the distribution system that are likely to yield the most dramatic gains in performance or reductions in cost
- Focus on technology enabled redesign opportunities within the distribution system as opposed to management/process/strategy opportunities
- Quantitatively assess the magnitude of potential impacts of technology
- Provide analytical results to DBAC for 1997-98 R&D brainstorming

Introduction & Objectives

Setting the Stage

- Scope of the project
- Approach and work plan

Project Overview

Cost Study Results

**It was important to build consensus among participants regarding the scope of the study, and clarify which costs were to be included in the study.**

**Scope**

Costs associated with activities required to plan, construct, operate and maintain distribution equipment from the low side of the 69KV distribution transformer to the meter socket.

**Includes:**

- Planning, construction, operation, maintenance of the distribution system such as:
- Distribution transformers
  - All equipment on the low side of the 69KV distribution transformers
  - Above ground and underground distribution feeders
  - All service restoration, tree trimming, customer hook-up and government related work

**Does not include:**

- The project did not include costs for:
- Meter installation
  - Meter reading
  - Billing
  - Credit and collections
  - Transmission related costs
  - Street Lighting

**One of the primary advantages to the methodology used in this study was that distribution cost data was not based on FERC data.**

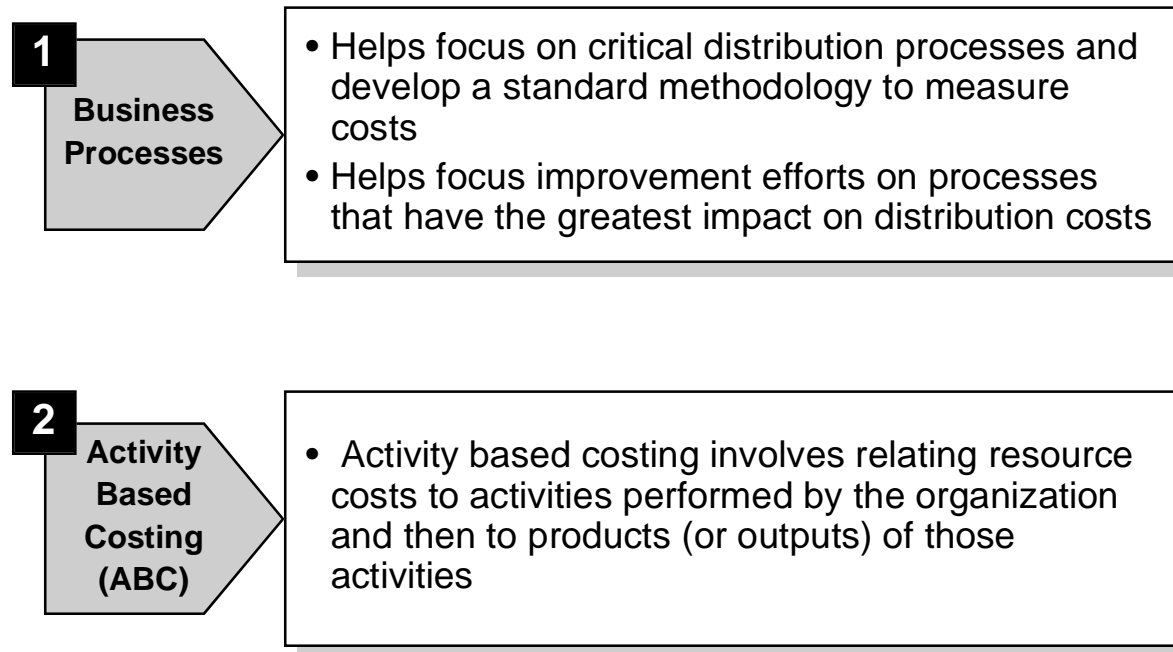
**EPRI Study**

- Process based comparisons
- Activity cost calculated from resource usage
- Consistent definitions of processes
- Data useful in evaluating process performance
- Data helpful in evaluating improvement opportunities

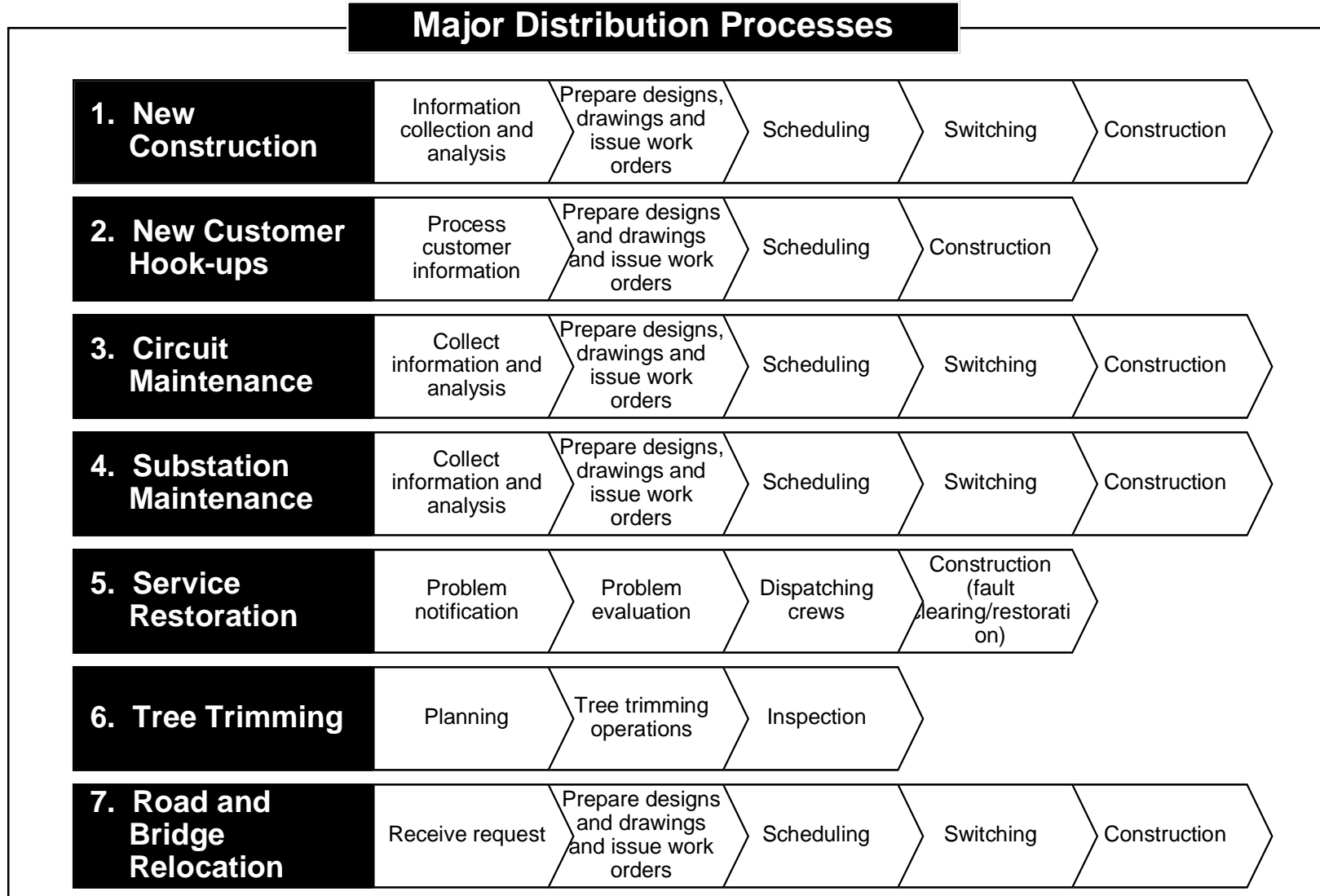
**FERC Based Comparison**

- Calculation based on FERC accounting definitions
- Inconsistent definitions across utilities
- Data not comparable
- Costs are allocated to the activities based on assumptions

**Cost study methodology was developed using concepts from business process redesign and activity based costing.**



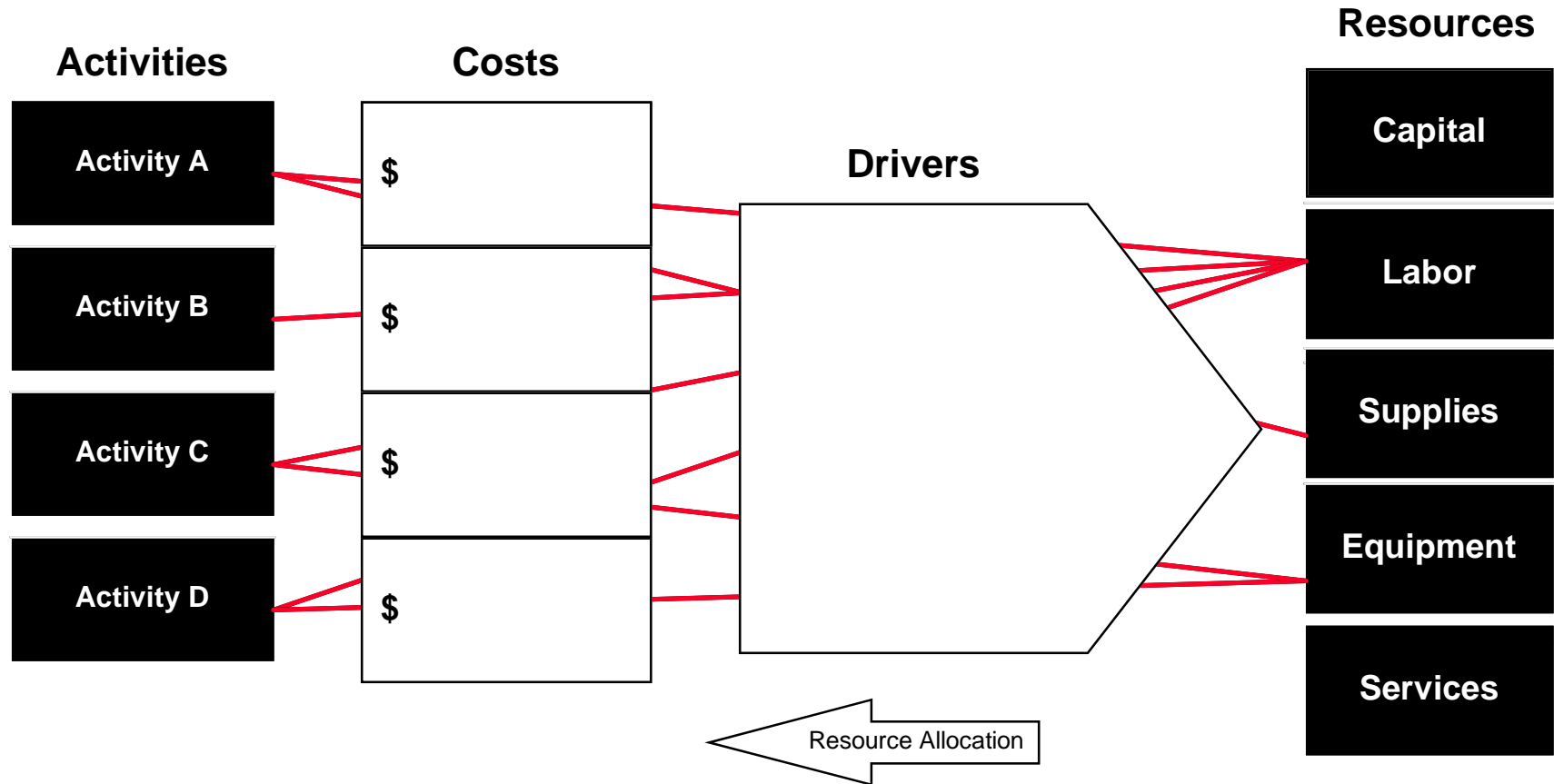
**Seven major processes and 31 associated activities were identified to evaluate distribution costs.**



**Costs within the distribution system were separated into the seven processes based on evaluating the initiating event that resulted in the expenditure.**

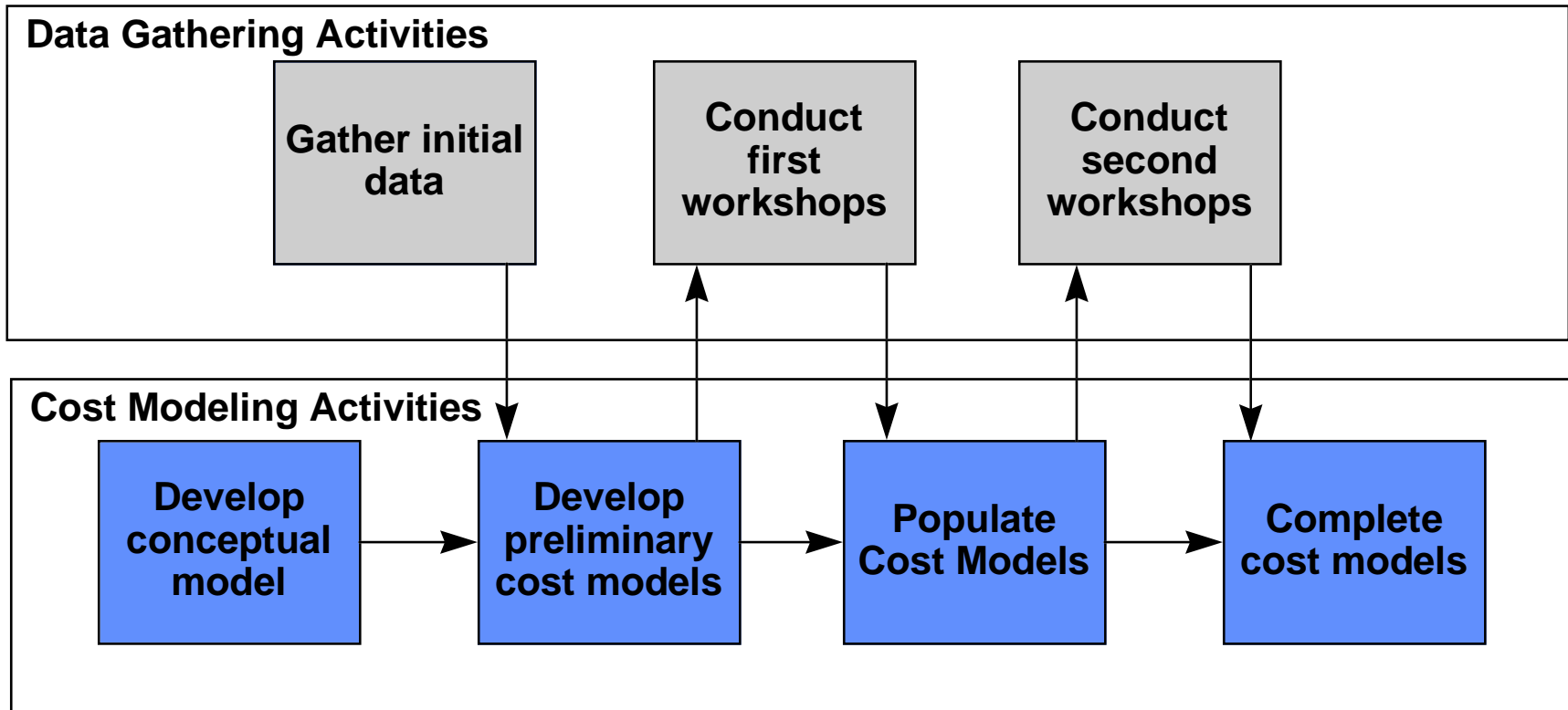
<b>Major Process</b>	<b>Description</b>
<b>1. New Construction</b>	<b>Activities initiated by need to relieve system constraints due to area load growth (i.e.; activities initiated by planning department)</b>
<b>2. New Customer Hook-ups</b>	<b>Activities initiated by customer requests for new service (i.e.; activities initiated by customer)</b>
<b>3. Feeder &amp; Line Maintenance</b>	<b>Line and cable (overhead and underground) activities necessary to maintain system's ability to perform as designed</b>
<b>4. Substation Maintenance</b>	<b>Substation activities necessary to maintain system's ability to perform as designed</b>
<b>5. Service Restoration</b>	<b>Activities necessary to locate and clear unplanned outages and faults</b>
<b>6. Tree Trimming</b>	<b>Foliage management activities</b>
<b>7. Road and Bridge Relocation</b>	<b>Government initiated activities to relocate electric facilities</b>

The cost model was developed using concepts from Activity Based costing.



Costs for activities were calculated based on linking all resources applicable to individual activities.

The overall project comprised of key milestones which could be grouped into two distinct tasks - data gathering and cost modeling. Data gathering involved session with key individuals across each utility's distribution business. Over 300 individuals were interviewed during the project.



Introduction & Objectives

Setting the Stage

Project Overview

- Total Distribution Budget
- Distribution Costs by Resource
- Distribution Costs by Process

Cost Study Results

**The cost study results are presented in three sections:**

- 1** **Total Distribution Budget**
- 2** **Distribution Costs by Resource**
- 3** **Distribution Costs by Process**

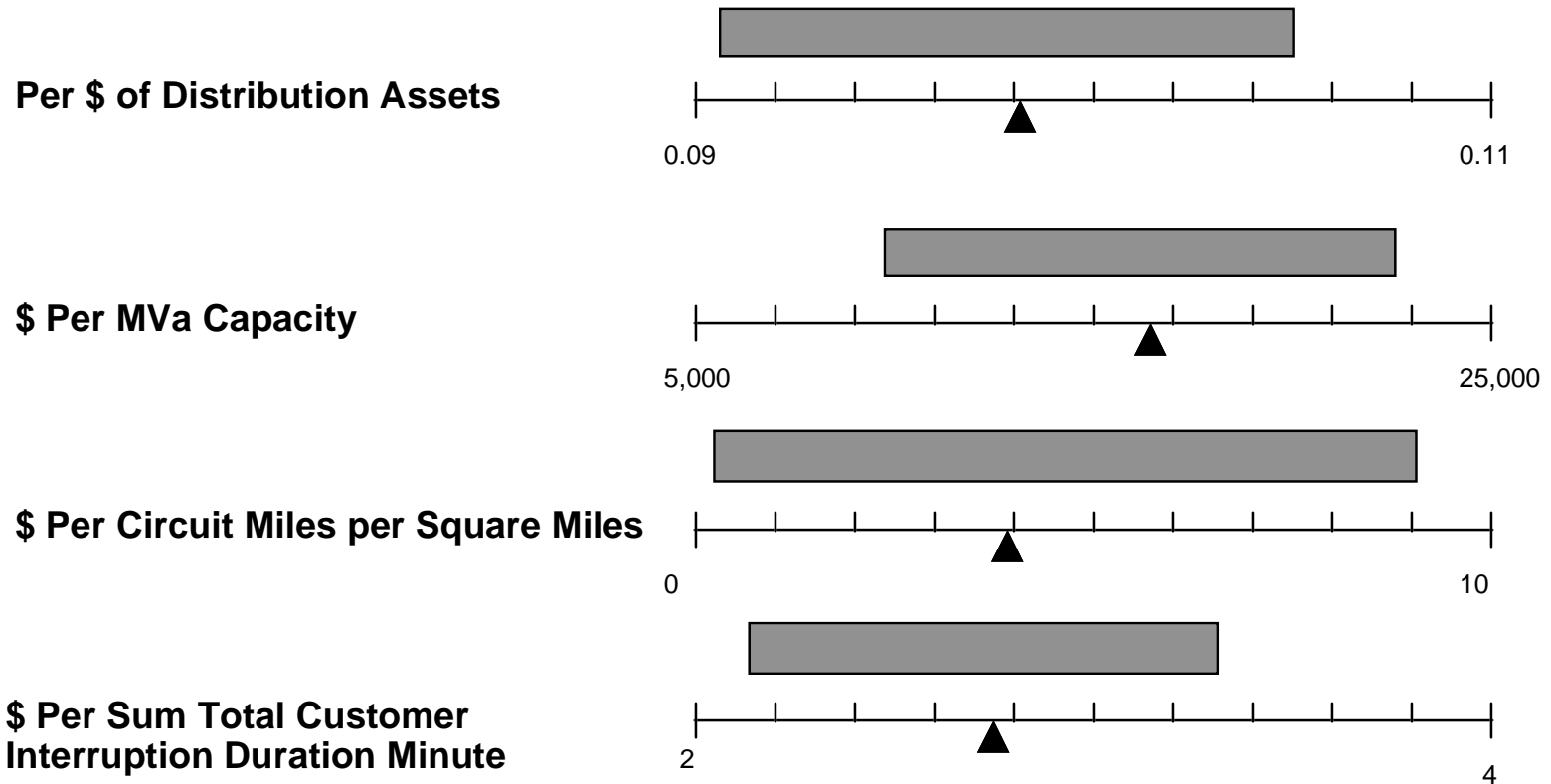
Cost Study Results Total Distribution Budget

The average total distribution budget per circuit mile for the study participants is \$9,285.



Cost Study Results Total Distribution Budget

The average total distribution budget per MVa of installed capacity for the study participants is \$16,397.



**We identified and collected data for six major resources in distribution.**

**Resources**

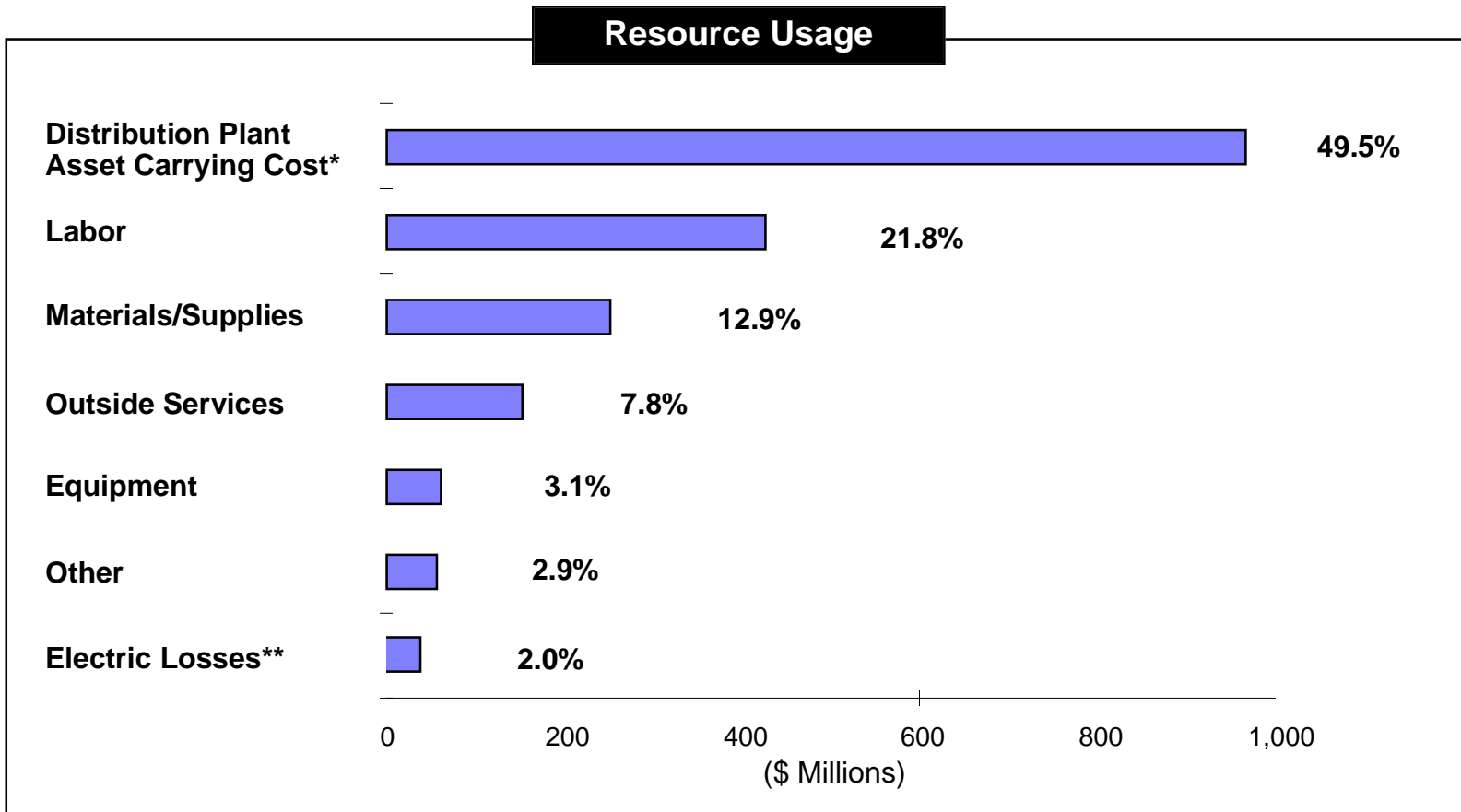
- Distribution Resources:
  - Internal Labor
  - Materials and Supplies
  - Contractors
  - Equipment
  - Asset Carrying Costs
  - Electric Line Losses

**The resources are defined as follows:**

<b>Major Resource</b>	<b>Description</b>
<b>1. Asset Carrying Costs</b>	<b>Annual financial cost of carrying the distribution assets</b>
<b>2. Internal Labor Costs</b>	<b>Utility's labor costs associated with all distribution activities</b>
<b>3. Materials and Supplies</b>	<b>Materials and supplies such as transformers and conductors which are installed on the system</b>
<b>4. Electric Line Losses</b>	<b>Electric line losses</b>
<b>5. Services</b>	<b>Services procured from outside the utility, such as contractor services for tree trimming</b>
<b>6. Equipment</b>	<b>Annual equipment costs for trucks and tools necessary for distribution</b>

## Cost Study Results Resources

**Asset carrying cost accounts for 49.5% of the total distribution resource usage.**



note: n=5

\* Distribution Plant asset carrying cost based on applying cost of capital to distribution assets

\*\* Electric losses based on participant input

**We identified seven major processes in distribution.**

### **Distribution Processes**

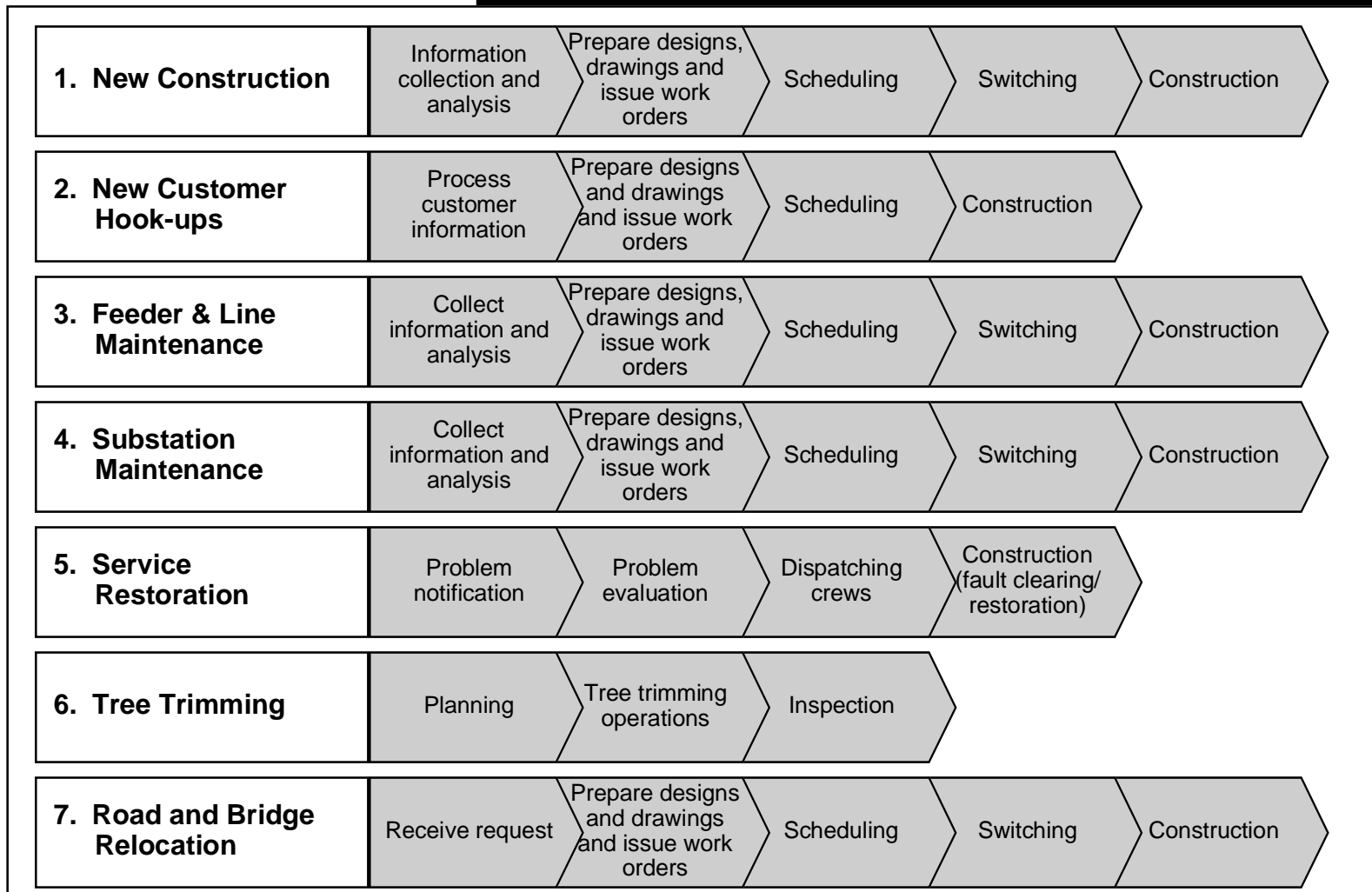
1. New Construction
2. Customer Hookups
3. Feeder and Line Maintenance
4. Substation Maintenance
5. Service Restoration
6. Tree Trimming
7. Road and Bridge Relocation

**Distribution's major processes are defined as follows:**

<b>Major Process</b>	<b>Description</b>
<b>1. New Construction</b>	<b>Activities initiated by need to relieve system constraints due to area load growth</b>
<b>2. New Customer Hook-ups</b>	<b>Activities initiated by customer requests for new service</b>
<b>3. Feeder &amp; Line Maintenance</b>	<b>Line and cable (overhead and underground) activities necessary to maintain system's ability to perform as designed</b>
<b>4. Substation Maintenance</b>	<b>Substation activities necessary to maintain system's ability to perform as designed</b>
<b>5. Service Restoration</b>	<b>Activities necessary to locate and clear unplanned outages and faults</b>
<b>6. Tree Trimming</b>	<b>Foliage management activities</b>
<b>7. Road and Bridge Relocation</b>	<b>Government initiated activities to relocate electric facilities</b>

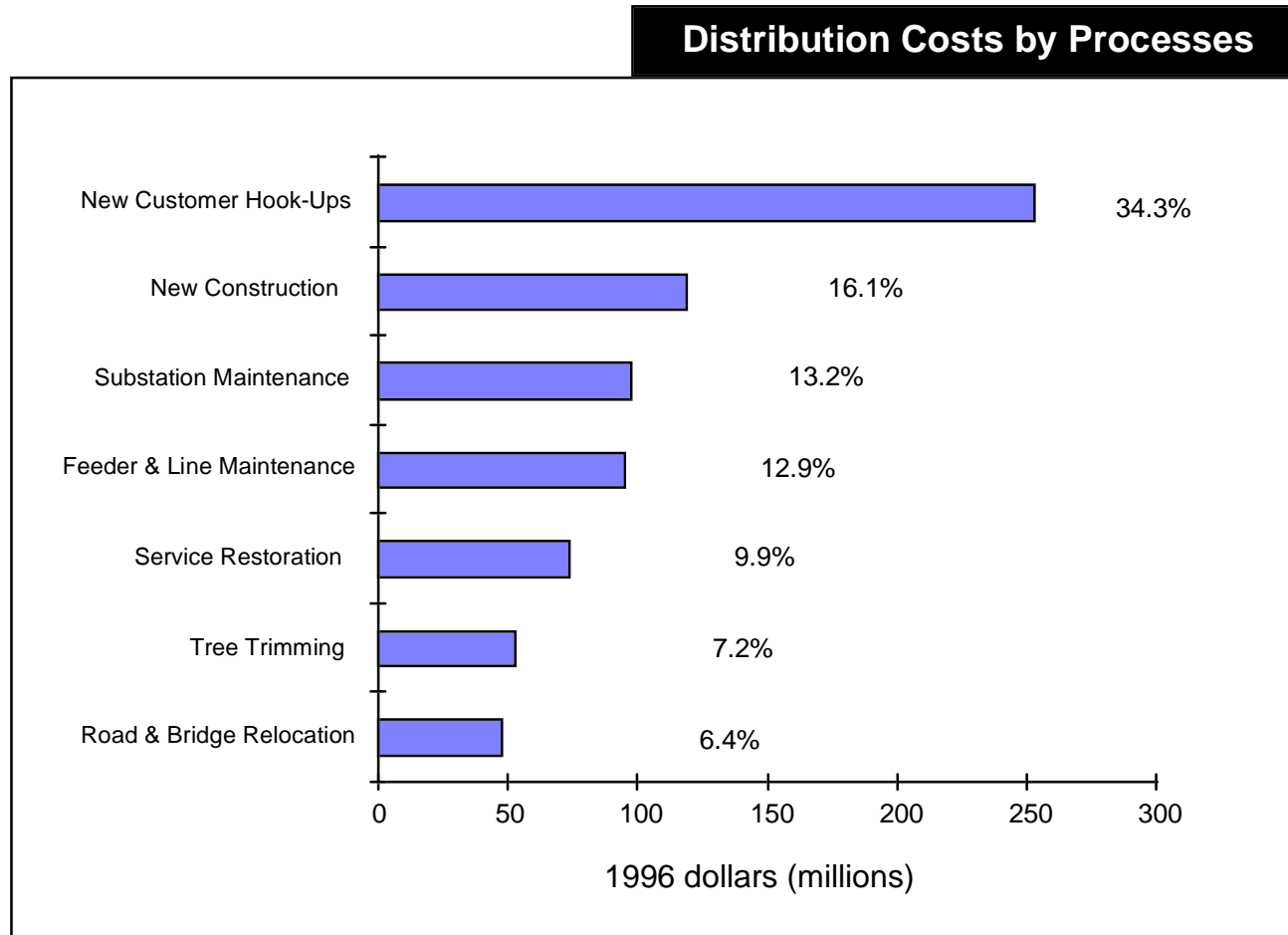
For each major process we identified additional subprocesses.

### Major Distribution Processes and Subprocesses



## Cost Study Results Processes

**The combined cost for new customer hook-ups and new construction accounts for 50.4% of the total distribution costs.**



**Results of the distribution process analysis is organized into four sections.**

- 1** **Scope of Activities**
- 2** **Process and Resource Costs**
- 3** **Cost Drivers**
- 4** **Improvement Opportunities**

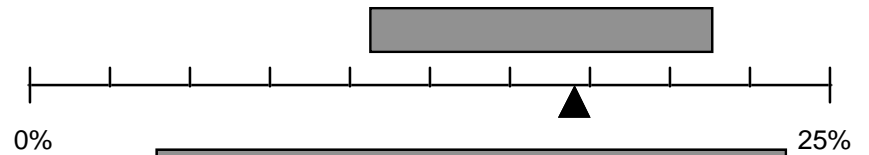
**New construction activities focus on activities such as voltage upgrades, load balancing and other incremental enhancements.**

**Scope of Activities**

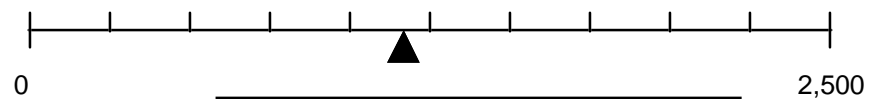
- Distribution circuits
  - Install new aerial cable
  - Install larger capacity carrying cable
  - Conversions to meet capacity constraints (e.g., 4kV to 12kV conversions)
  - Tie line enhancements (e.g., new switches)
  - Load balancing
- Substations
  - Install/relocate substation
  - Add/upgrade transformers
  - Add remote switching capabilities

**The average new construction cost for the study participants measured per circuit mile is \$1,158.**

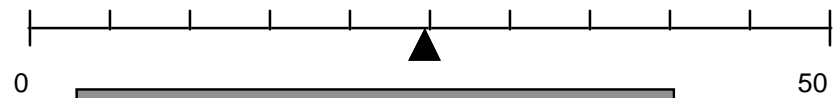
**Percentage of Total Distribution Cost**



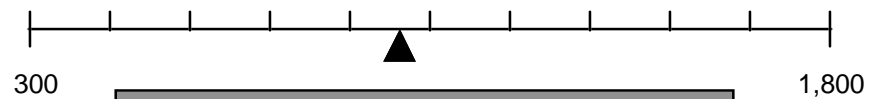
**\$ Per Circuit Mile**



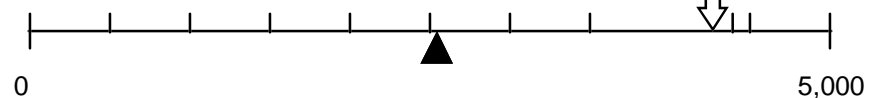
**\$ Per Customer**



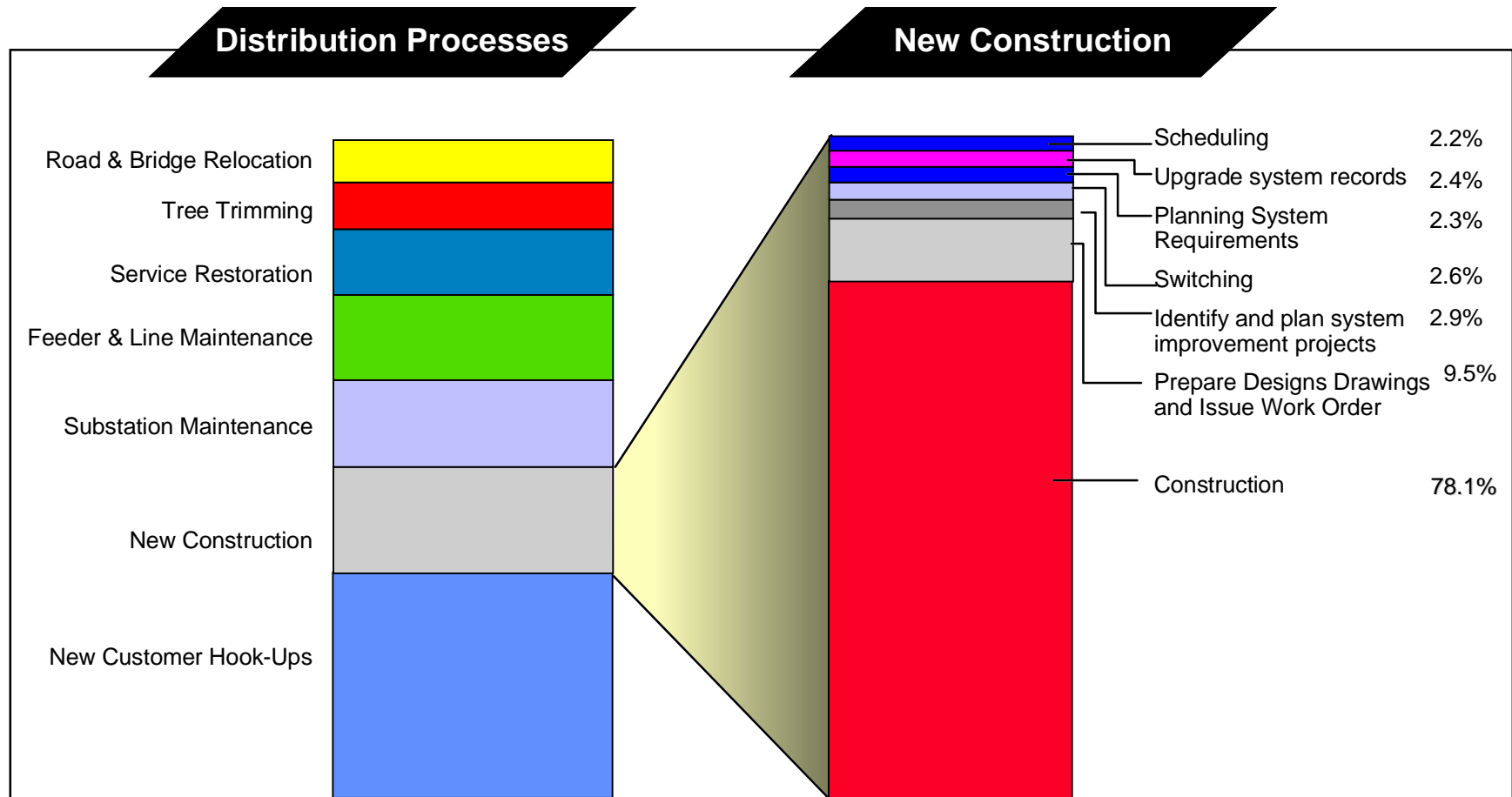
**\$ Per Million kWh**



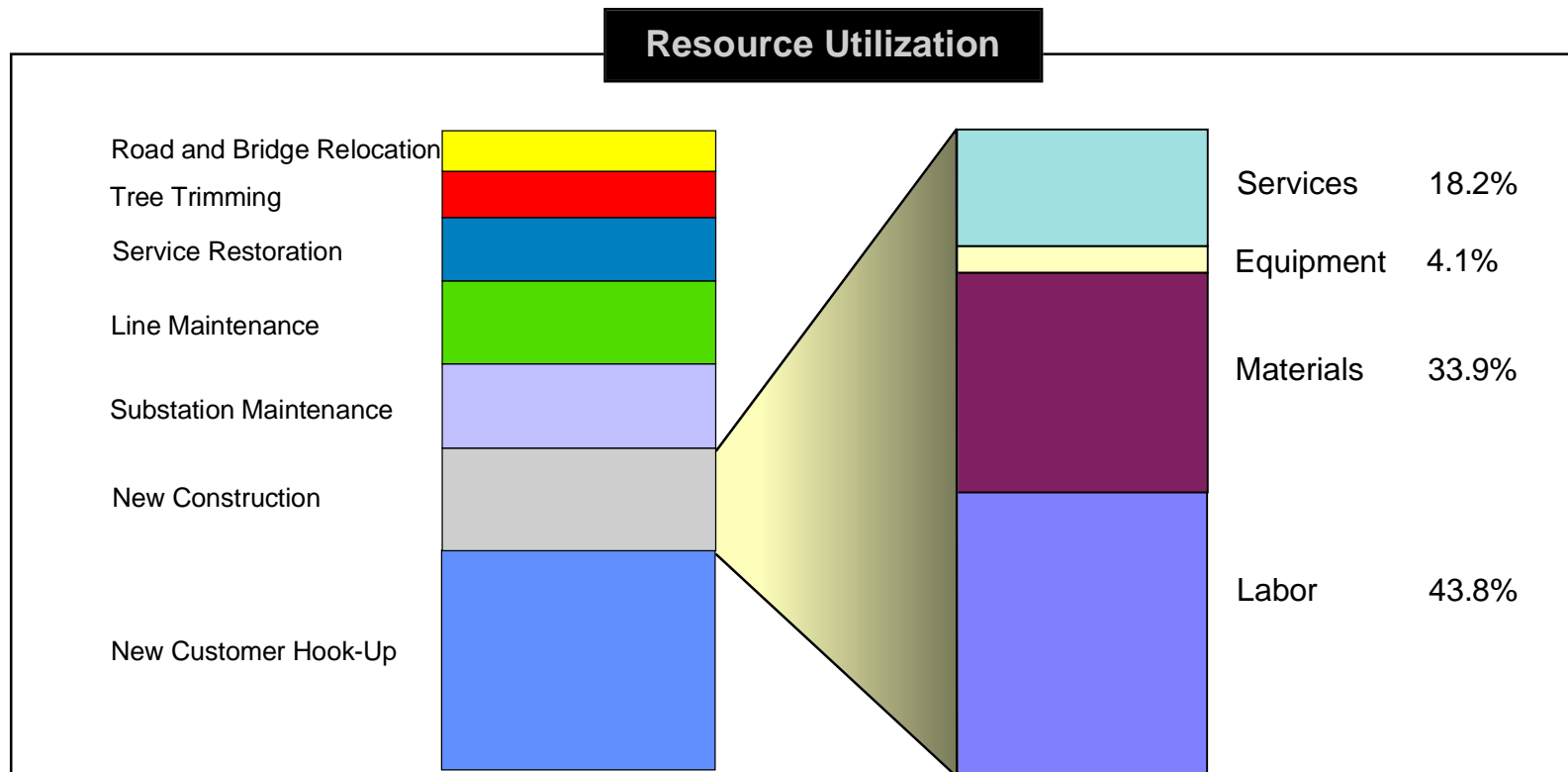
**\$ Per New Customer**



**Resources expended during construction activity in the field account for 78.1% of the total cost of new construction.**

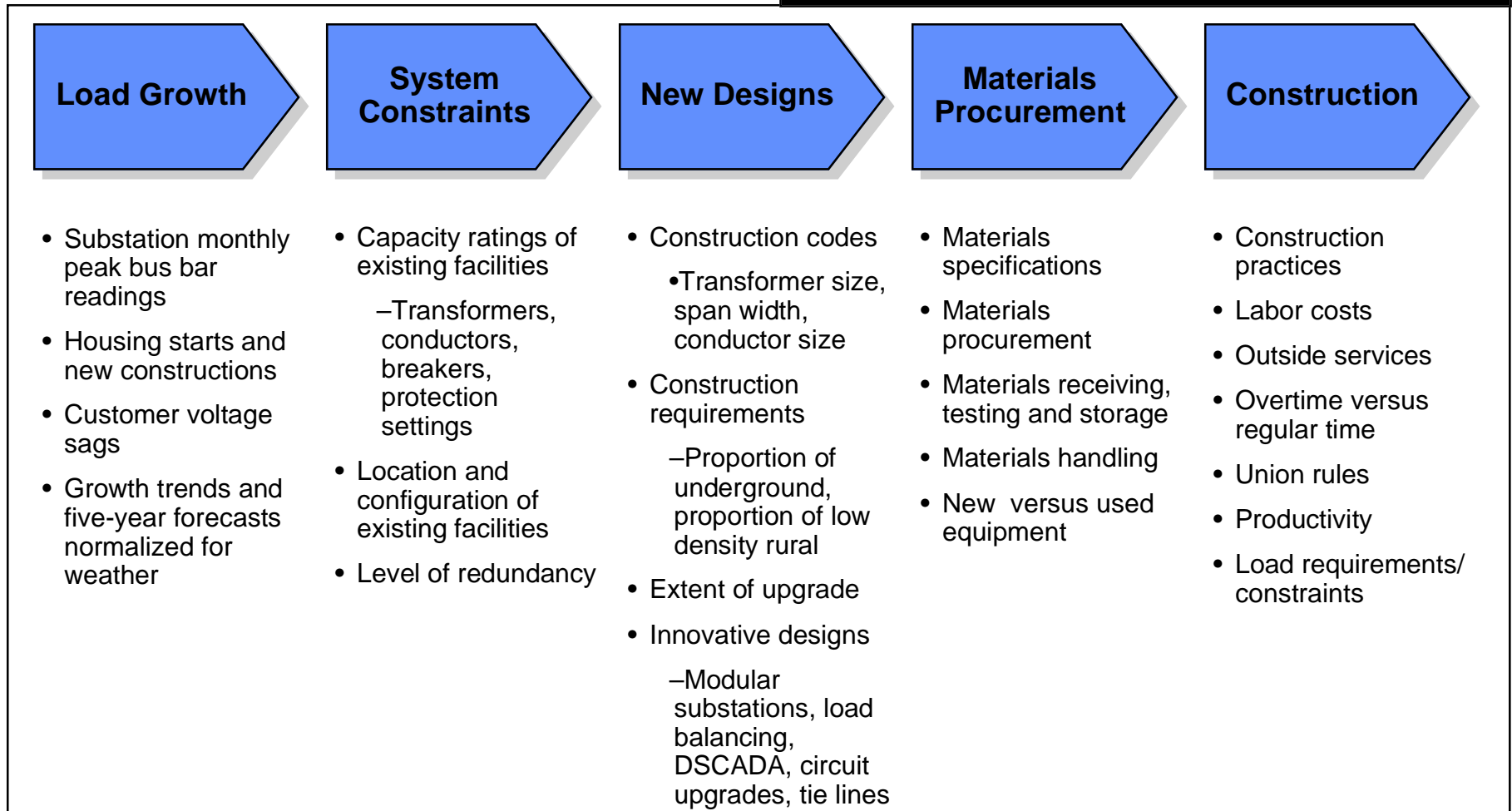


**The combined cost of in house labor and material used during construction accounts for 77.7% of the total new construction cost.**



For each major process, we identified principal cost drivers. New construction costs can be most significantly impacted by changing equipment loading practices and applying innovative approaches to system design.

**New Construction Cost Drivers**



**New construction to relieve capacity constraints can be offset by increasing asset utilization factors on the installed capacity.**

<b>Key Improvement Category</b>	<b>Possible Options</b>
<b>Increase Asset Utilization</b>	<p>Evaluate possibilities to increase current asset utilization to defer or eliminate capital expenditures. Options might include:</p> <ul style="list-style-type: none"> <li>• Aggresively loading of transformers and circuits</li> <li>• Increasing the number of transfer ties</li> <li>• Making decision to selectively refurbish equipment rather than incur expenditures to rebuild</li> </ul>
<b>Reduce labor costs</b>	<p>Labor costs are a significant component of the total costs. Evaluate potential cost reduction opportunities such as:</p> <ul style="list-style-type: none"> <li>• Review the current union rules and work practices</li> <li>• Evaluate the possibility of using combination crews</li> <li>• Review current practices of selecting work teams based on seniority</li> </ul>
<b>Review current work practices</b>	<p>Review current work methods and incorporate potential changes based on best practices in the industry. Some examples include:</p> <ul style="list-style-type: none"> <li>• Integrating AM/FM into work flow</li> <li>• Installing computers in vans and having the capability to transmit real time data on work orders and maps from central offices to field crews</li> <li>• Developing standards for key substation equipment. Establishing automated systems to track inventory levels and minimize stock out situations</li> </ul>

**Scope of Activities**

Underground Residential Development

- Trenching, conduit and cabling
- Pad mount transformer installation
- Terminations and energizing

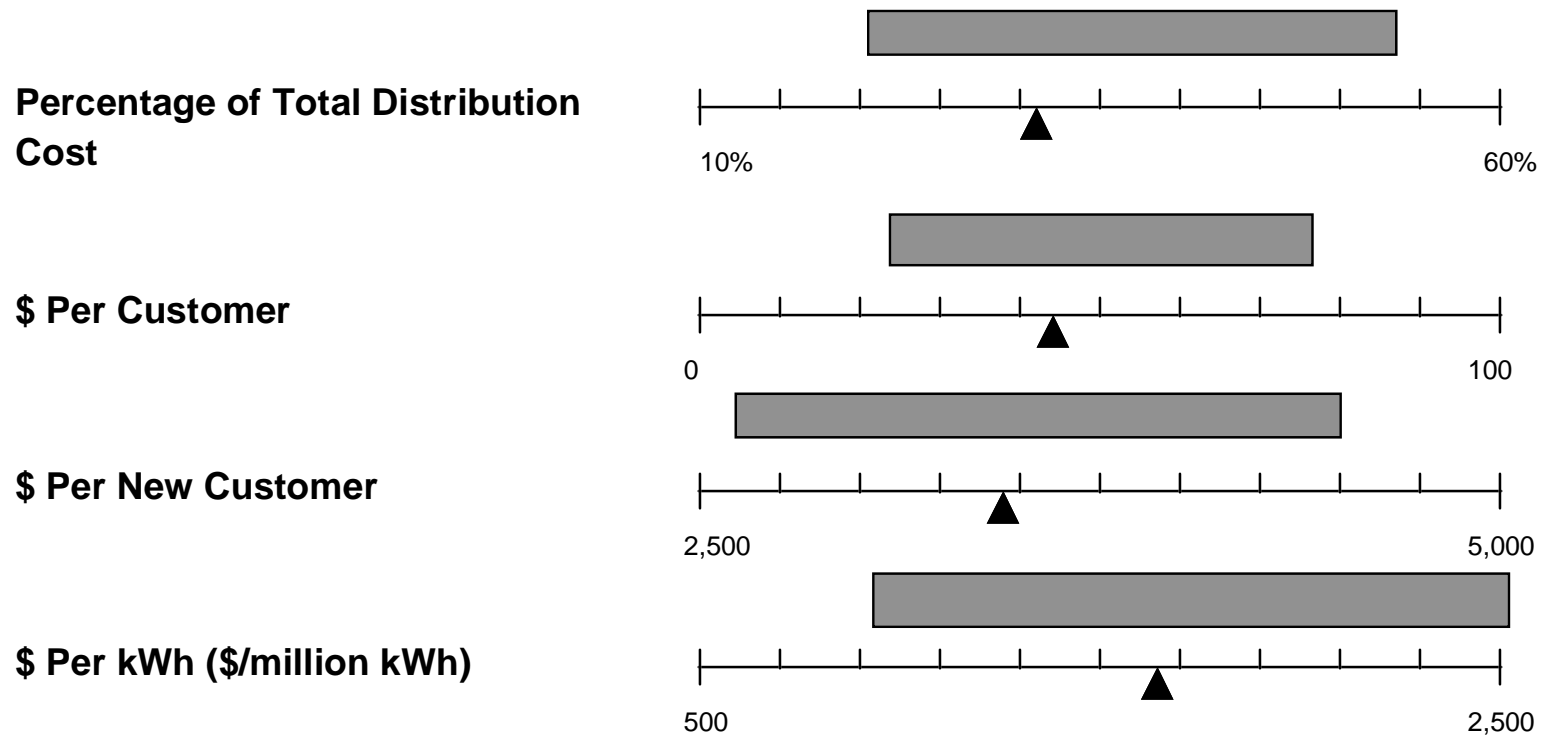
Downtown Metropolitan Installations

- Install vault transformers
- Install cable termination

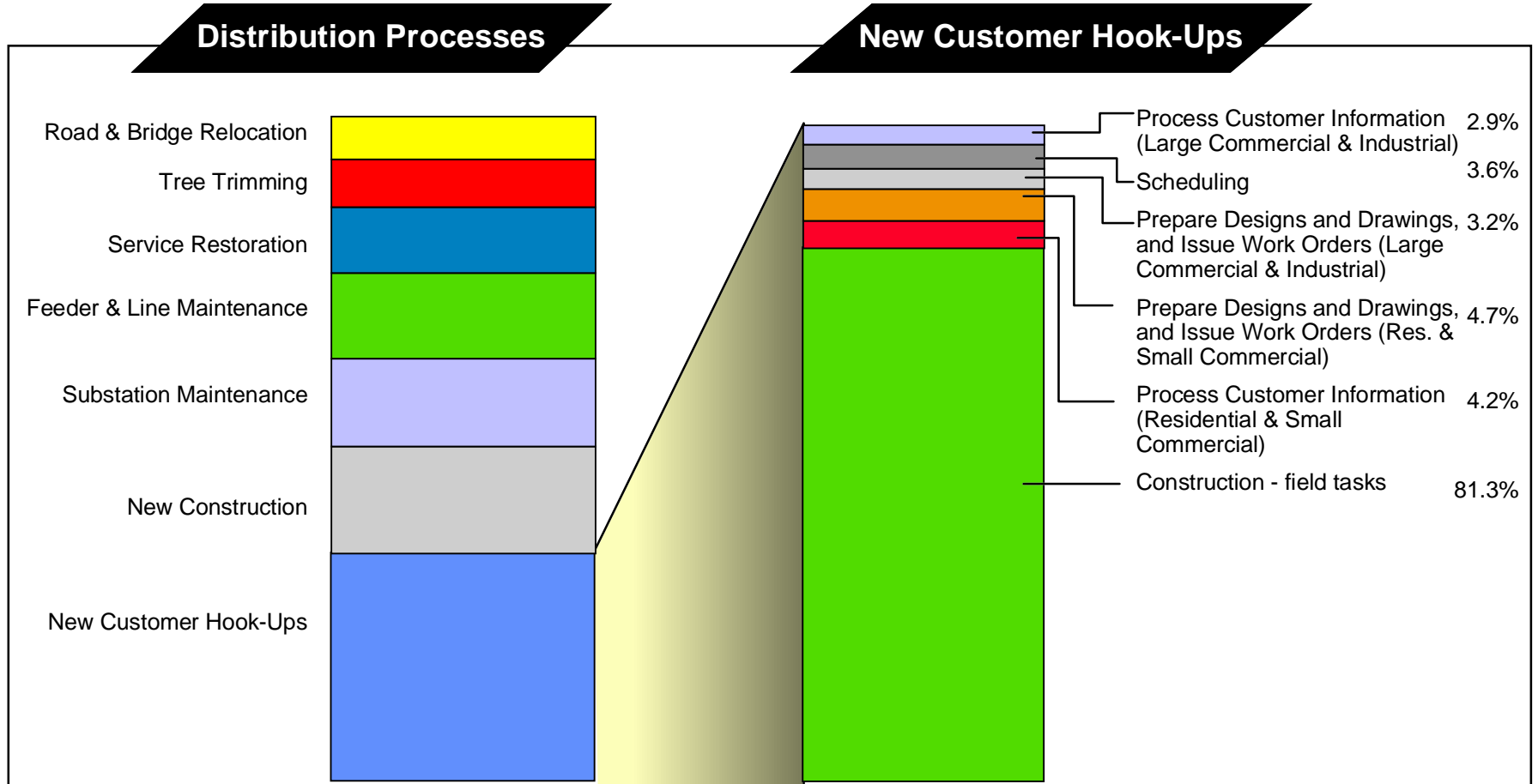
Overhead Primary and Secondary Hook-Ups

- Line extensions
- Pad mount transformer installations
- Pole top transformer installation
- Service drop and energizing

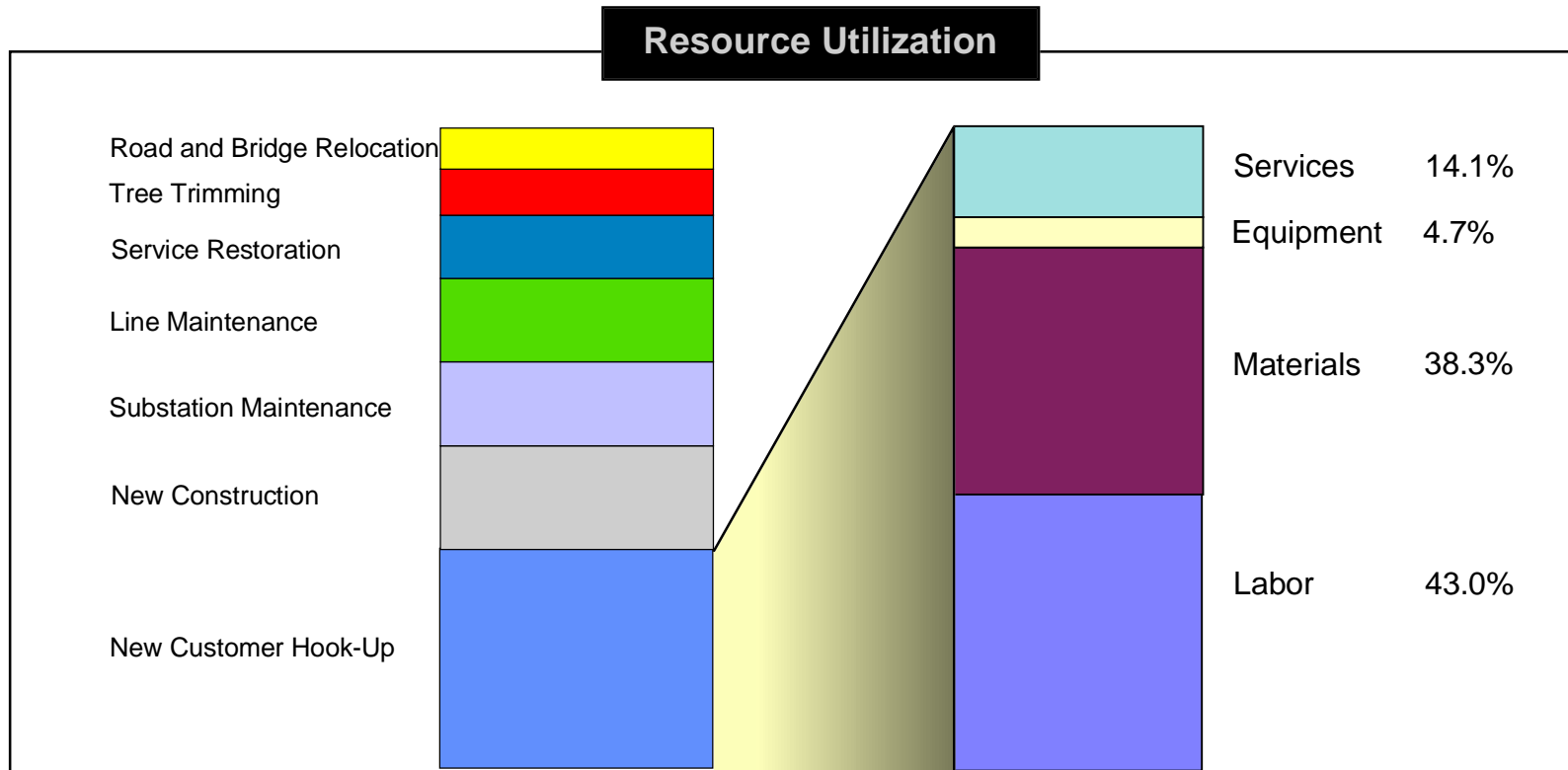
The average cost to hook-up a new customer for the study participants is \$3,622.



**Resources used in the field to connect new customers account for 81.3% of the total resources.**

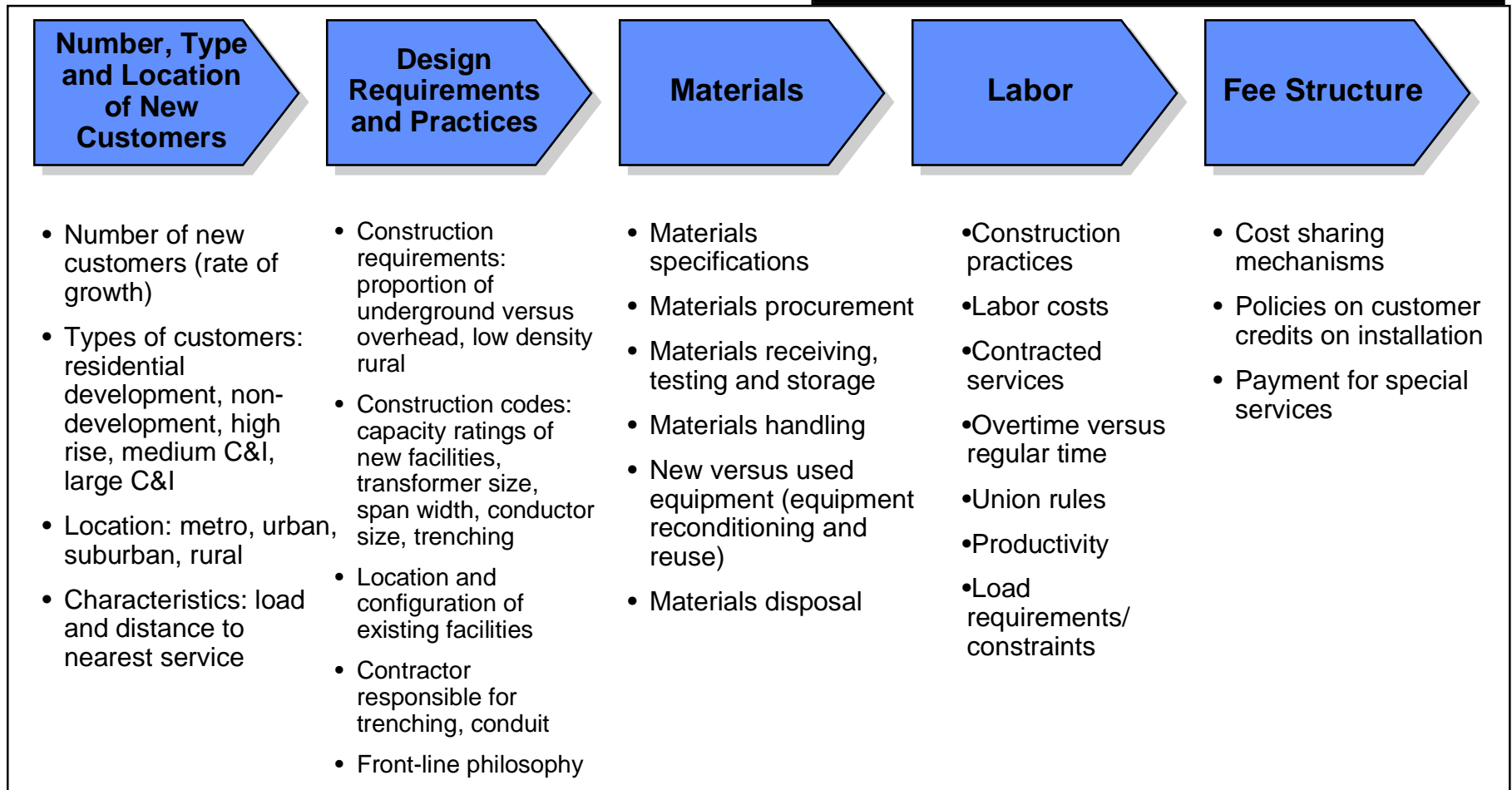


**The cost of providing new service to customers is primarily driven by labor costs, which accounts for 43% of the total costs.**



New customer hook-up costs can be most significantly impacted by developing better methods of load forecasting and applying innovative approaches to standardizing the hook-up process.

**New Customer Hook-Up Cost Drivers**



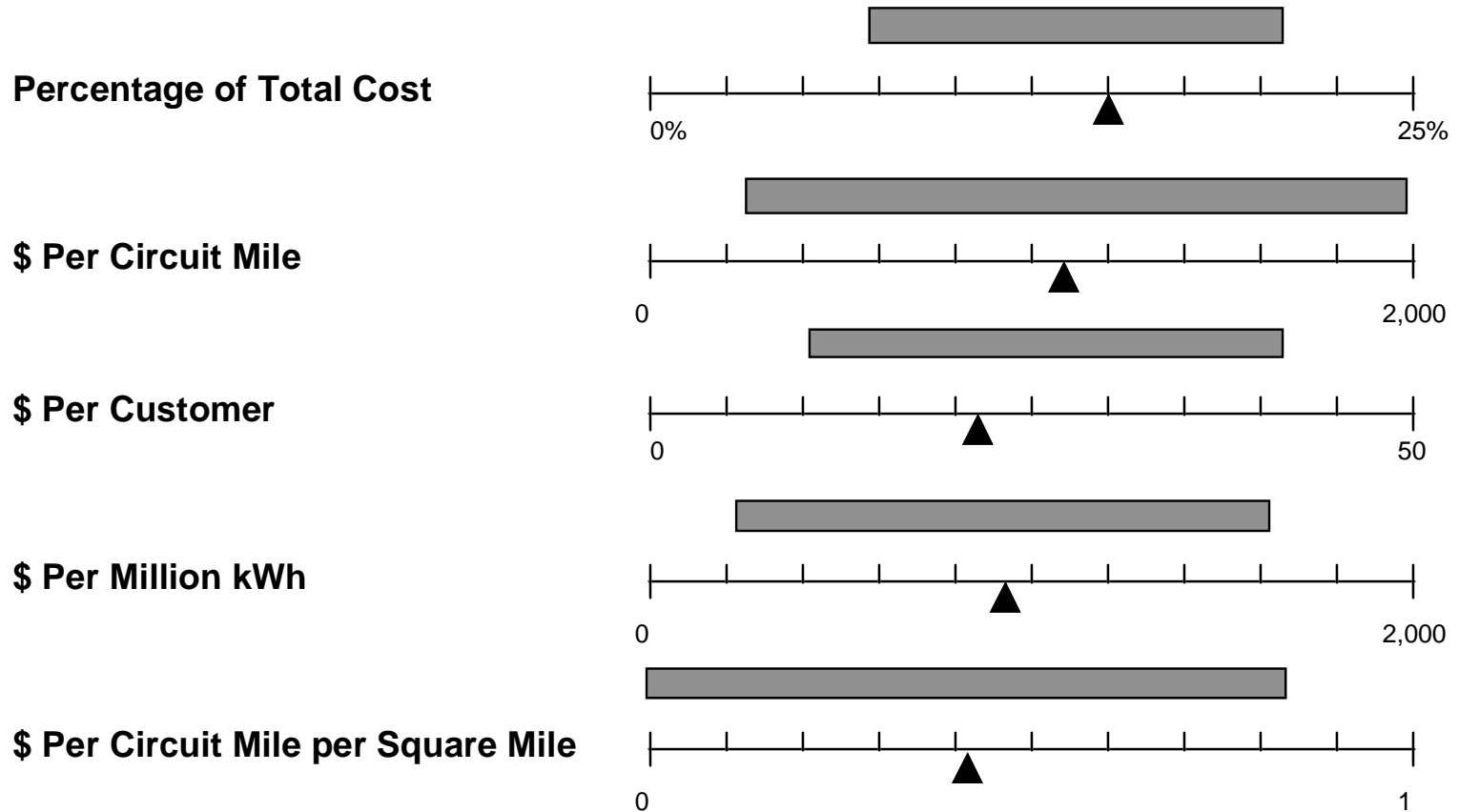
**Putting in place controls to ensure that crews work minimal overtime can significantly reduce labor costs.**

Key Improvement Category	Possible Options
<p><b>Reduce labor costs</b></p>	<p>Labor costs are a significant component of the total costs. Evaluate potential cost reduction opportunities such as:</p> <ul style="list-style-type: none"> <li>• Increase the flexibility of activities such as crew scheduling, dispatching and assignment of work</li> <li>• Evaluate policies that result in crews having to work on weekends and evenings to meet special customer requests</li> </ul>
<p><b>Review current work practices</b></p>	<p>Review current work methods and incorporate potential changes based on best practices in the industry.</p> <ul style="list-style-type: none"> <li>• Develop standard processes for new service installations. For example, reducing hook-up costs by having the customer bring out the meter to the property line</li> <li>• Evaluate contractor rules and responsibilities at sub-divisions. Clearly define work site responsibilities of contractors and company personnel</li> <li>• Develop more accurate methods for forecasting load. Current system of estimating loads could result in increased costs due to overdesigning new installations</li> <li>• Having the option to use differentiated grades of construction to recognize the difference between the varying needs of customers</li> <li>• Provide Customer Service Representative (CSR) personal with automation tools to locate and dispatch crews in the field</li> </ul>

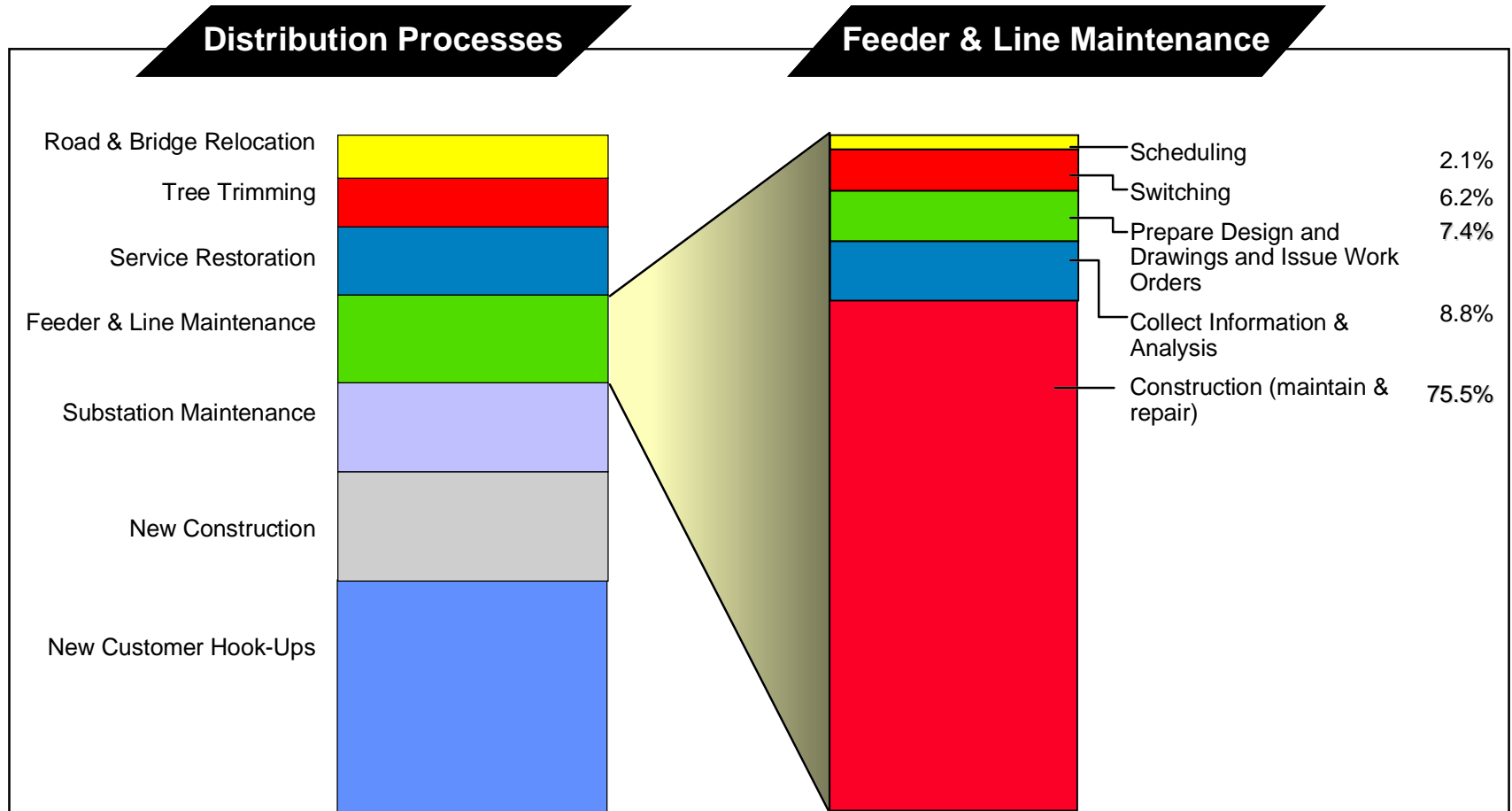
**Scope of Activities**

- Maintenance of OH lines
- Maintenance of Poles
- Maintenance of Capacitors and Regulators
- Maintenance of OH Transformers
- Maintenance of Sectionalizing Devices
- Maintenance of UG Cable
- Maintenance of Manhole, Vault, Conduit
- URD Plant Maintenance

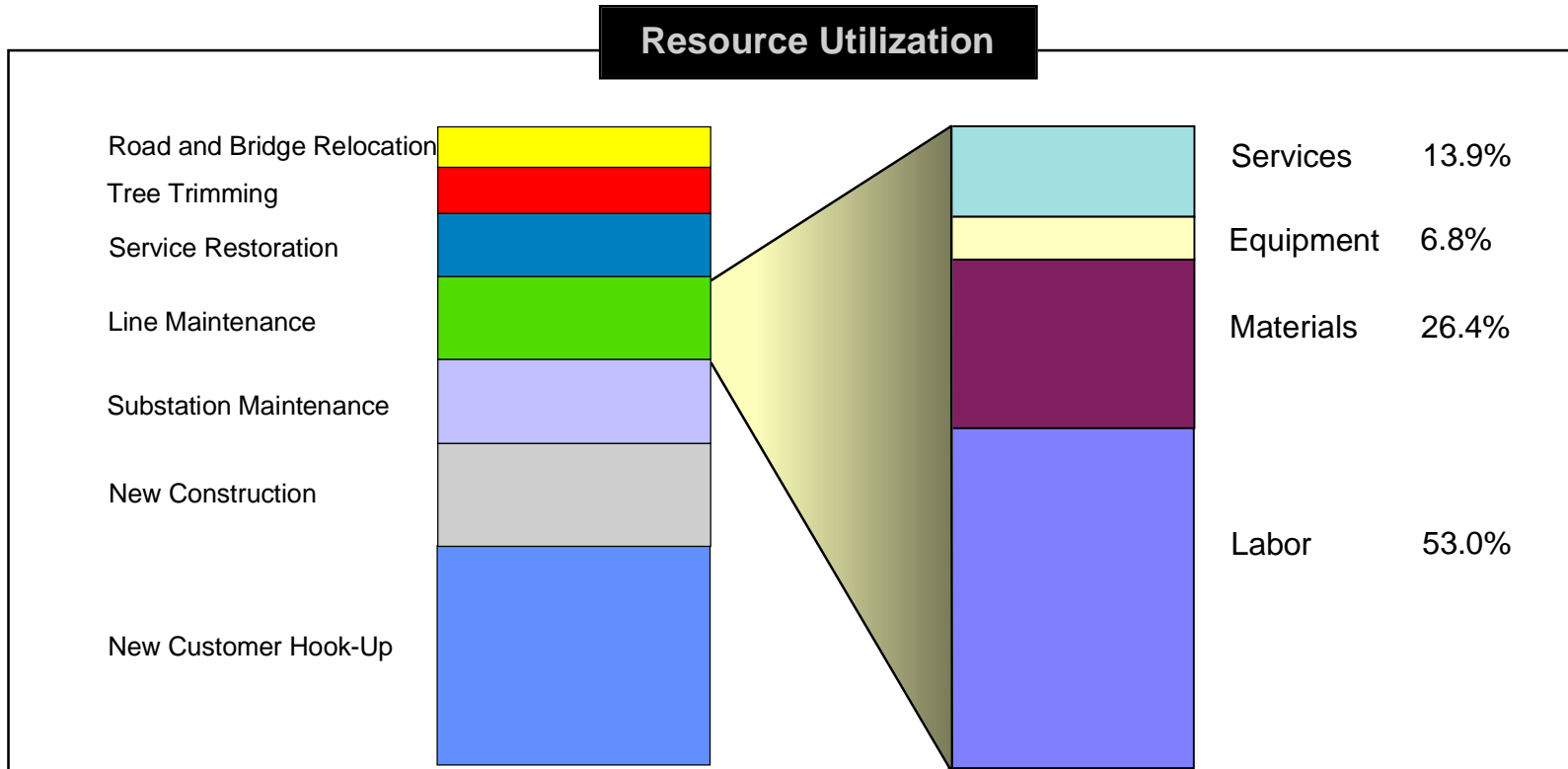
**The average feeder and line maintenance cost for the study participants measured per circuit mile is \$1,059.**



**Maintenance and repair activity accounts for 75.5% of the total costs incurred.**

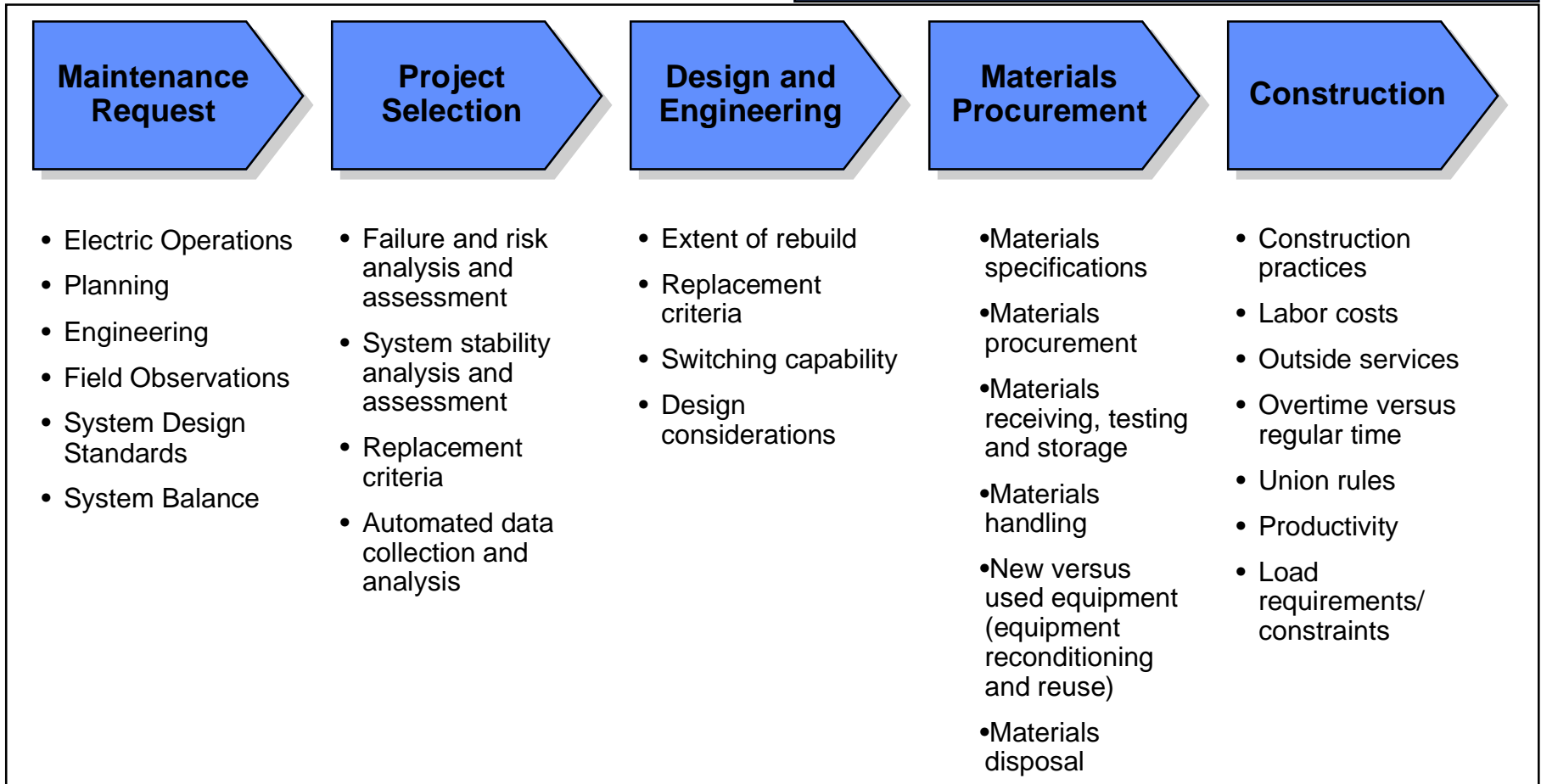


**The cost of maintaining feeders and lines is primarily driven by labor, which accounts for 53% of the total costs.**



**Feeder & Line Maintenance costs can be most significantly impacted by using automated systems to track data on individual components and make informed maintenance decisions.**

**Feeder & Line Maintenance Cost Drivers**



**Implementing information systems to monitor and track equipment performance can lead to better more effective maintenance decisions.**

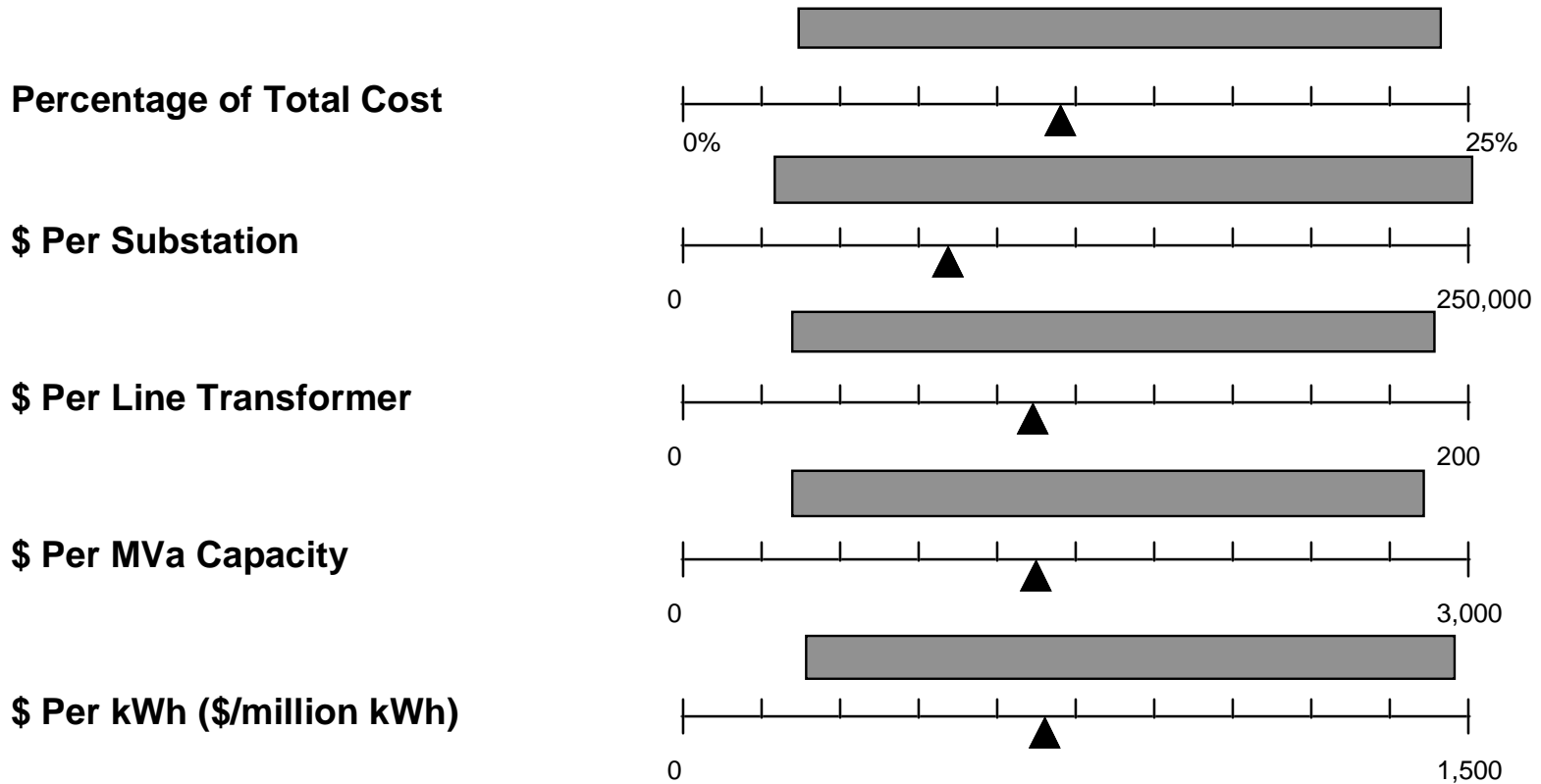
Key Improvement Category	Possible Options
<p><b>Reduce labor costs</b></p>	<ul style="list-style-type: none"> <li>• Review union rules and policies</li> <li>• Develop training programs that ensure that crews are continually kept abreast of new work methods and procedures</li> <li>• Evaluate the use of combination crews. For example, crews that can work on OH lines and UG cables</li> <li>• Balance the use of company personnel and contractors to perform inspections in the field</li> </ul>
<p><b>Review current work practices</b></p>	<ul style="list-style-type: none"> <li>• Review maintenance practices - For example;                             <ul style="list-style-type: none"> <li>• review the practice of replacing entire sections of lines with a program to selectively refurbish sections that need immediate repair</li> <li>• Implementing programs that replace individual components, not the entire piece of equipment</li> </ul> </li> <li>• Reduce the level of preventative maintenance and shift to a program that relies on predictive maintenance</li> <li>• Implement systems that monitor real time performance data on equipment and provide the ability to make more cost effective maintenance decisions. Selectively identify components to be maintained based on overall system impact</li> <li>• Use higher proportion of standard distribution equipment</li> </ul>

**Scope of Activities**

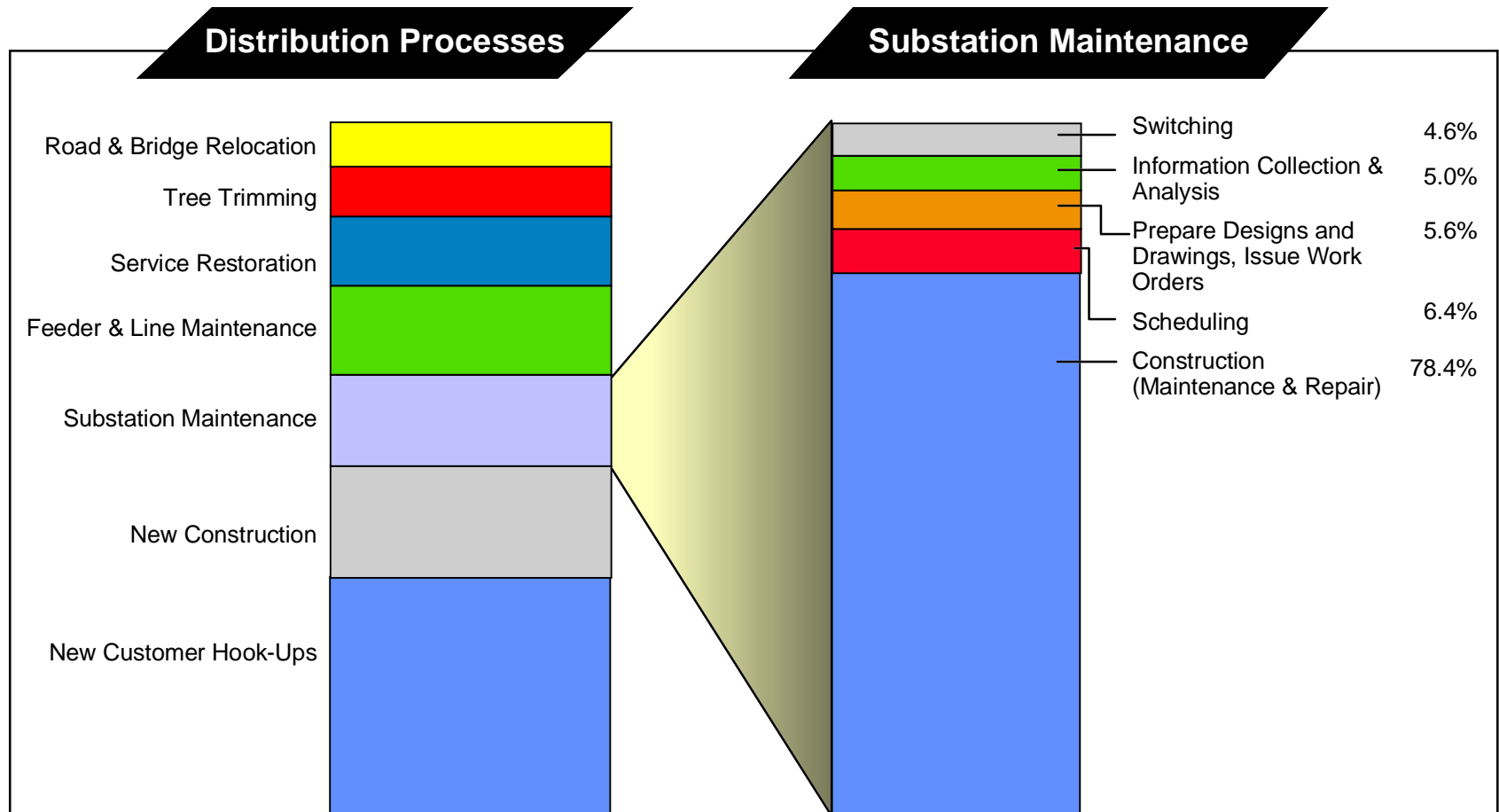
Maintenance of Substation Equipment

- Regulators
- Breakers
- Transformers
- Switches
- Batteries
- Protection and Control
  - Relay
  - Controls
  - Fault Recorders
  - Sequence and Event Recorders
- Maintenance of UG Transformers

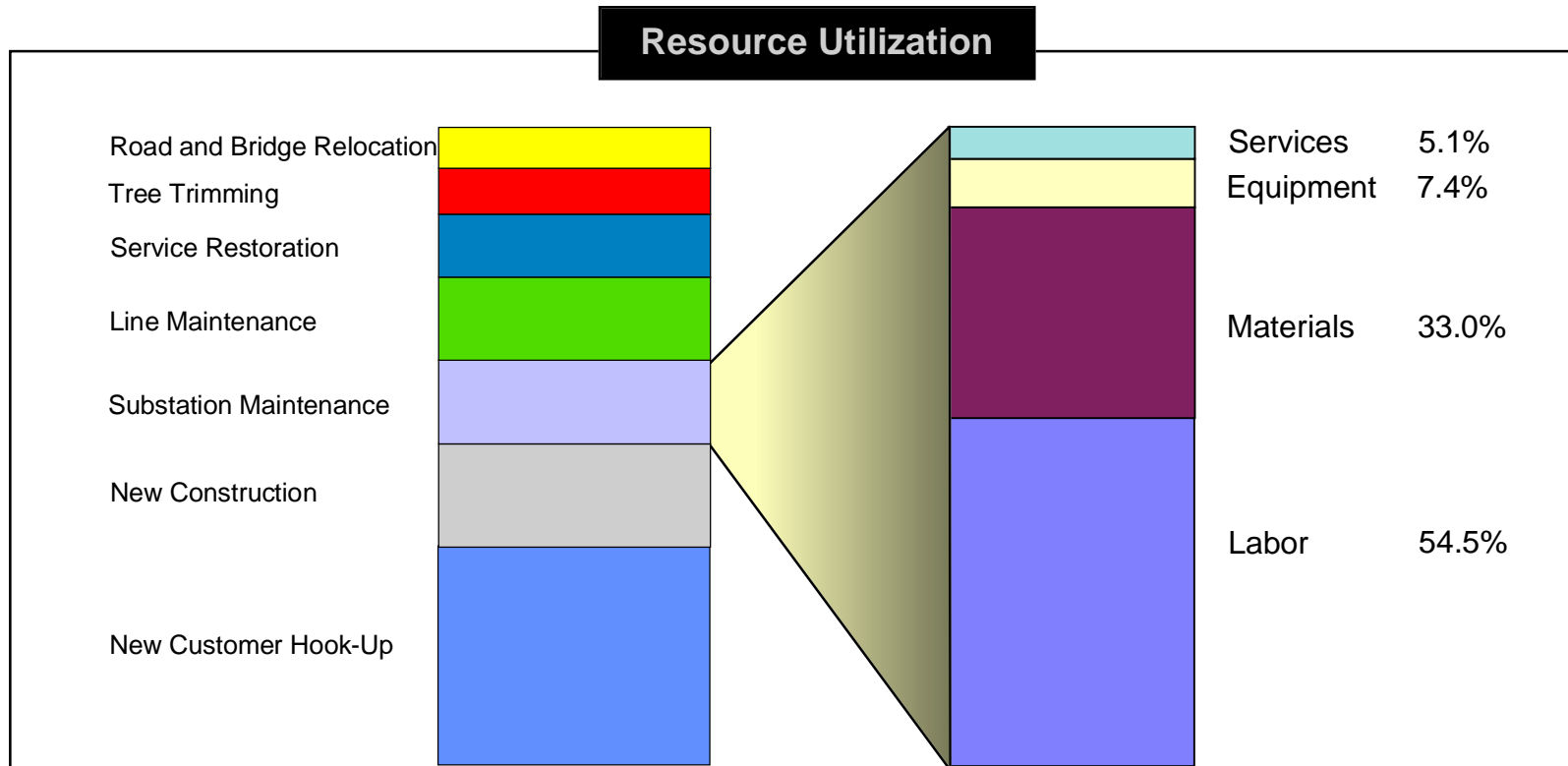
**The average substation maintenance cost for the study participants measured per substation is \$86,557.**



**Maintenance and repair activity accounts for 78.4% of the total cost of substation maintenance.**

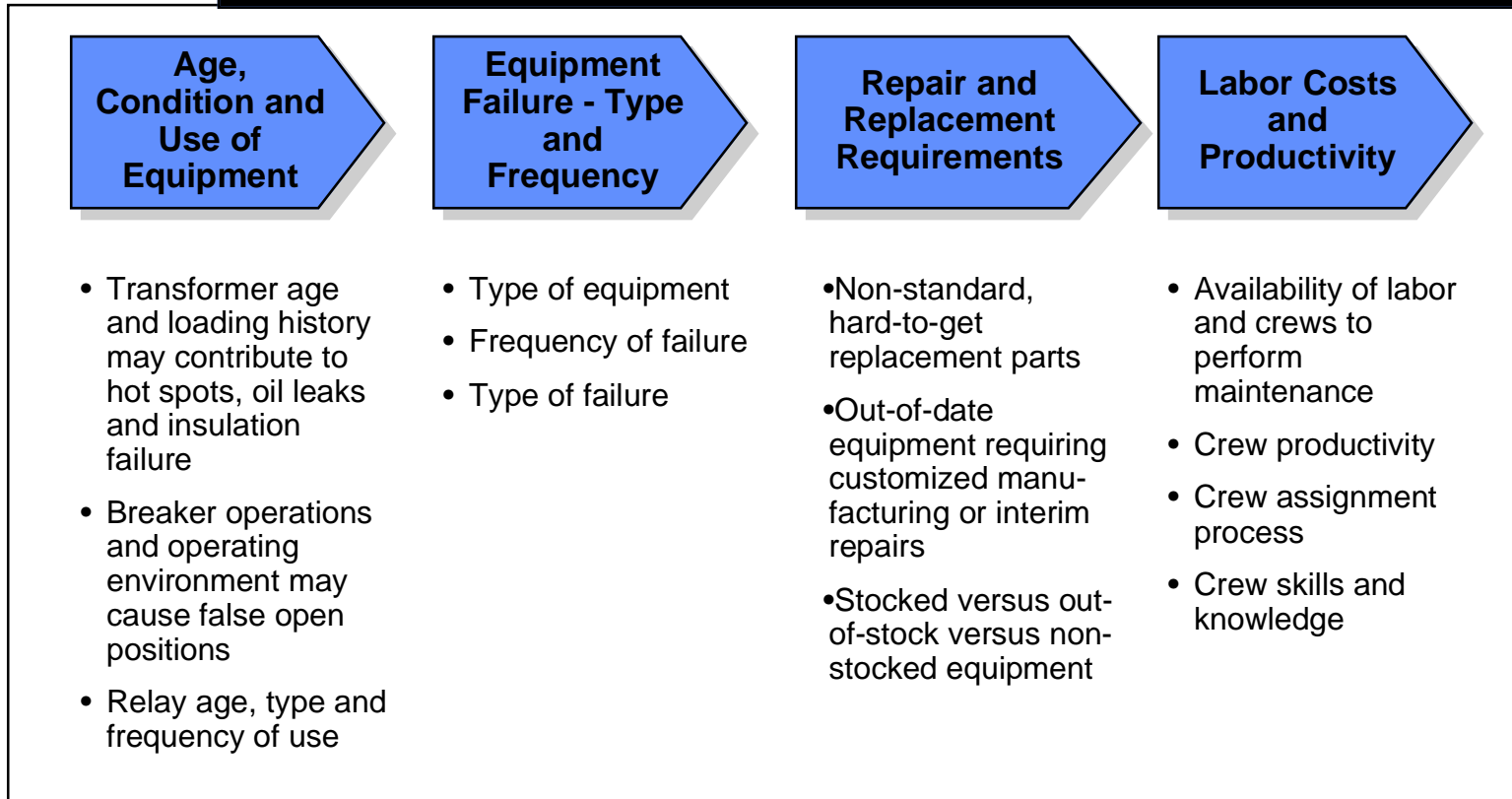


**Labor accounts for 54.5% of the total substation maintenance cost.**



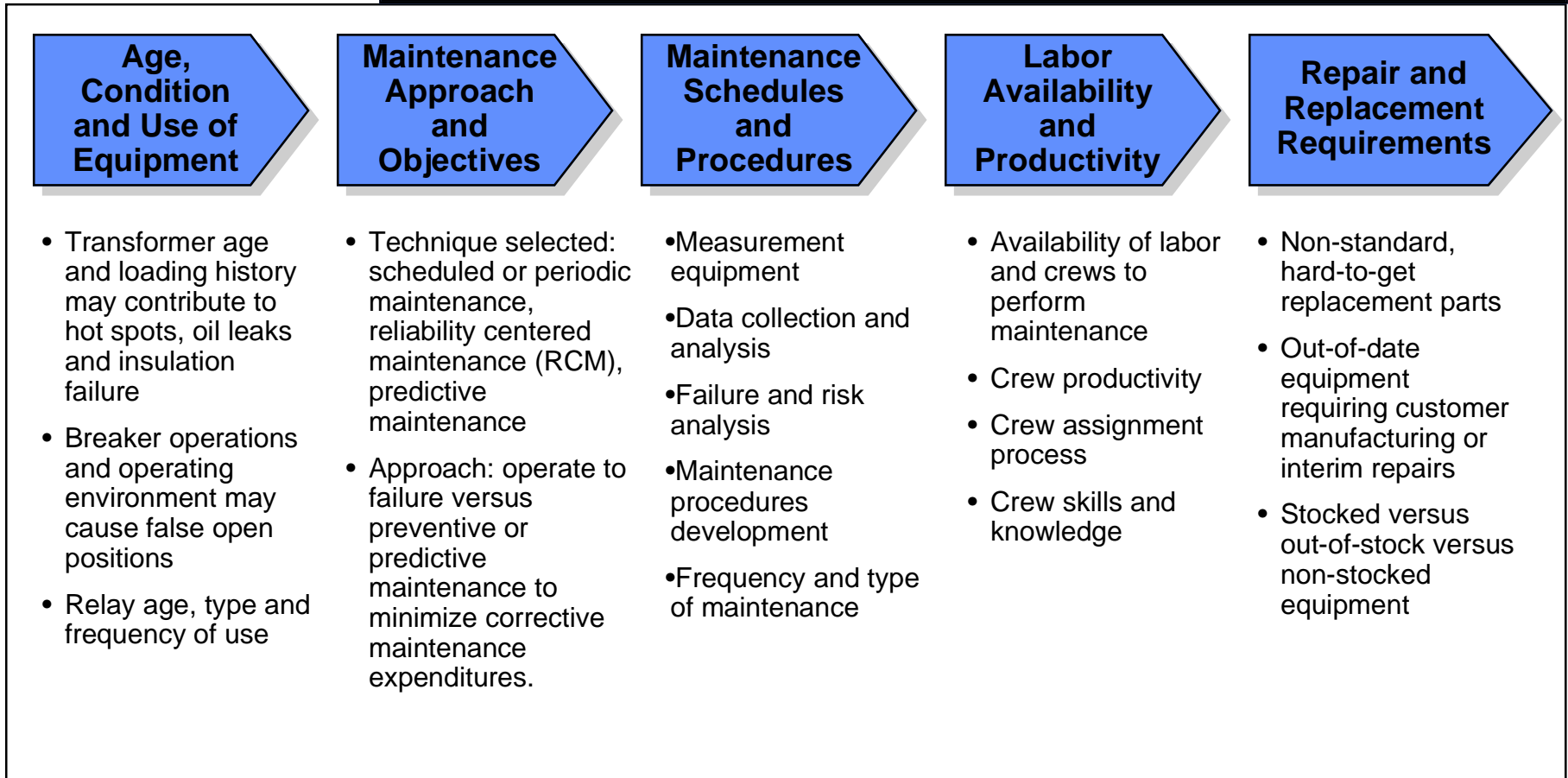
**Substation corrective maintenance costs are significantly impacted by the age and condition of installed equipment.**

**Substation Maintenance Cost Drivers - Corrective Maintenance**



**Substation maintenance costs could be impacted by applying RCM techniques and shifting from a preventative maintenance program to predictive maintenance program.**

**Substation Maintenance Cost Drivers - Predictive and Preventive**



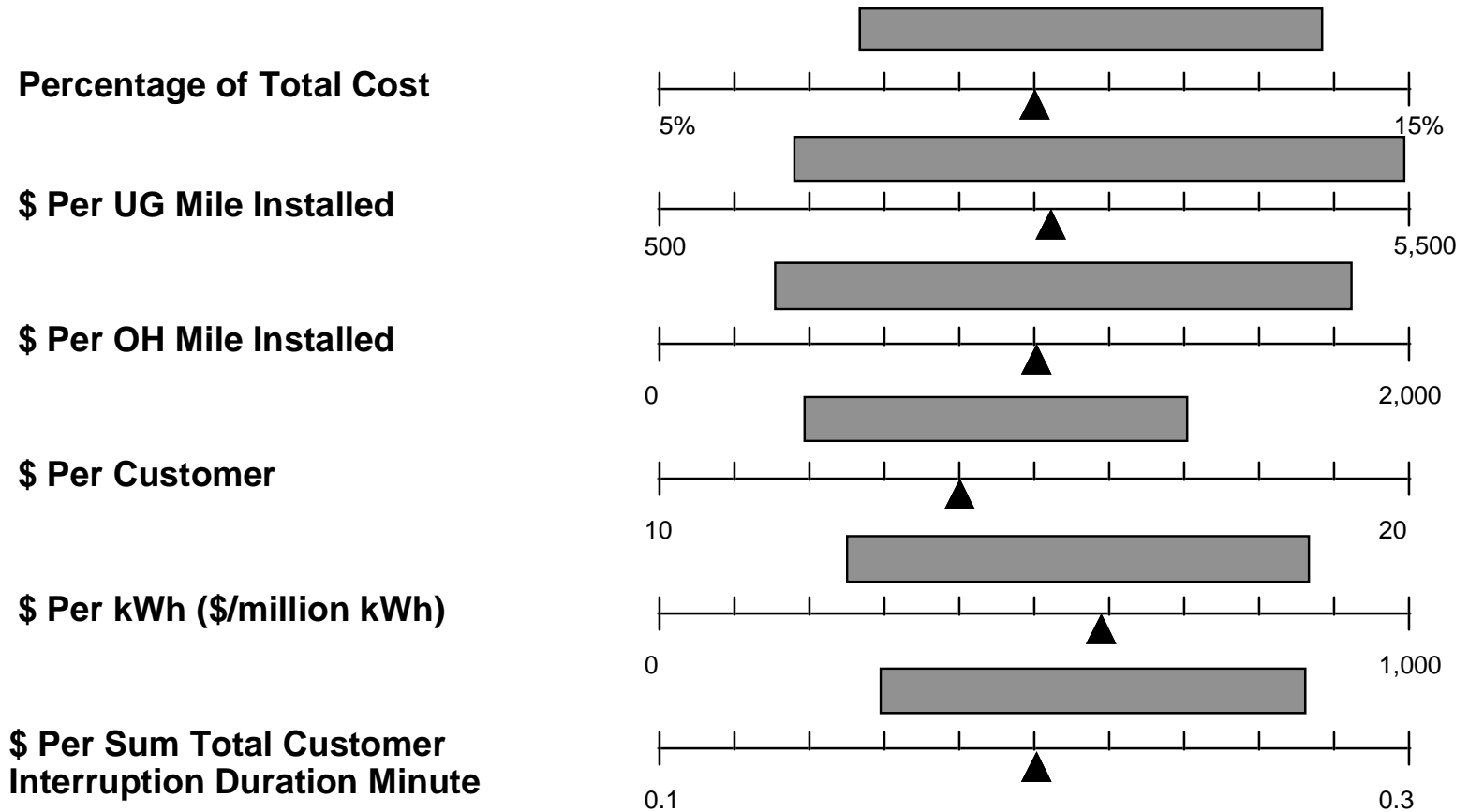
**Developing the ability to collect accurate performance data on substation equipment will lead to more effective maintenance decisions.**

Key Improvement Category	Possible Options
<p><b>Data Collection</b></p>	<ul style="list-style-type: none"> <li>• Install systems to monitor and track real time data on substation equipment performance</li> <li>• Integrate system for data collection - presently companies have multiple systems that do not effectively communicate with each other</li> <li>• Use unobtrusive methods for station monitoring</li> </ul>
<p><b>Review current work practices</b></p>	<ul style="list-style-type: none"> <li>• Engineer substations to more standard designs. The costs for constructing and maintaining substation equipment is increased due to low enforcement of standards</li> <li>• Achieve increased flexibility at a lower cost using modular design concepts at substations</li> <li>• Shift to Reliability Centered Maintenance. Prioritize maintenance work based on probability of failure and its impact on customers</li> <li>• Use information systems to monitor transformers - add sensors to transformer and breakers to collect real time performance data to make decisions on maintenance schedules and operating parameters</li> <li>• Use historical data collected on transformers and regulators to perform life cycle costing analysis. Make more accurate buy vs. maintain decisions.</li> </ul>

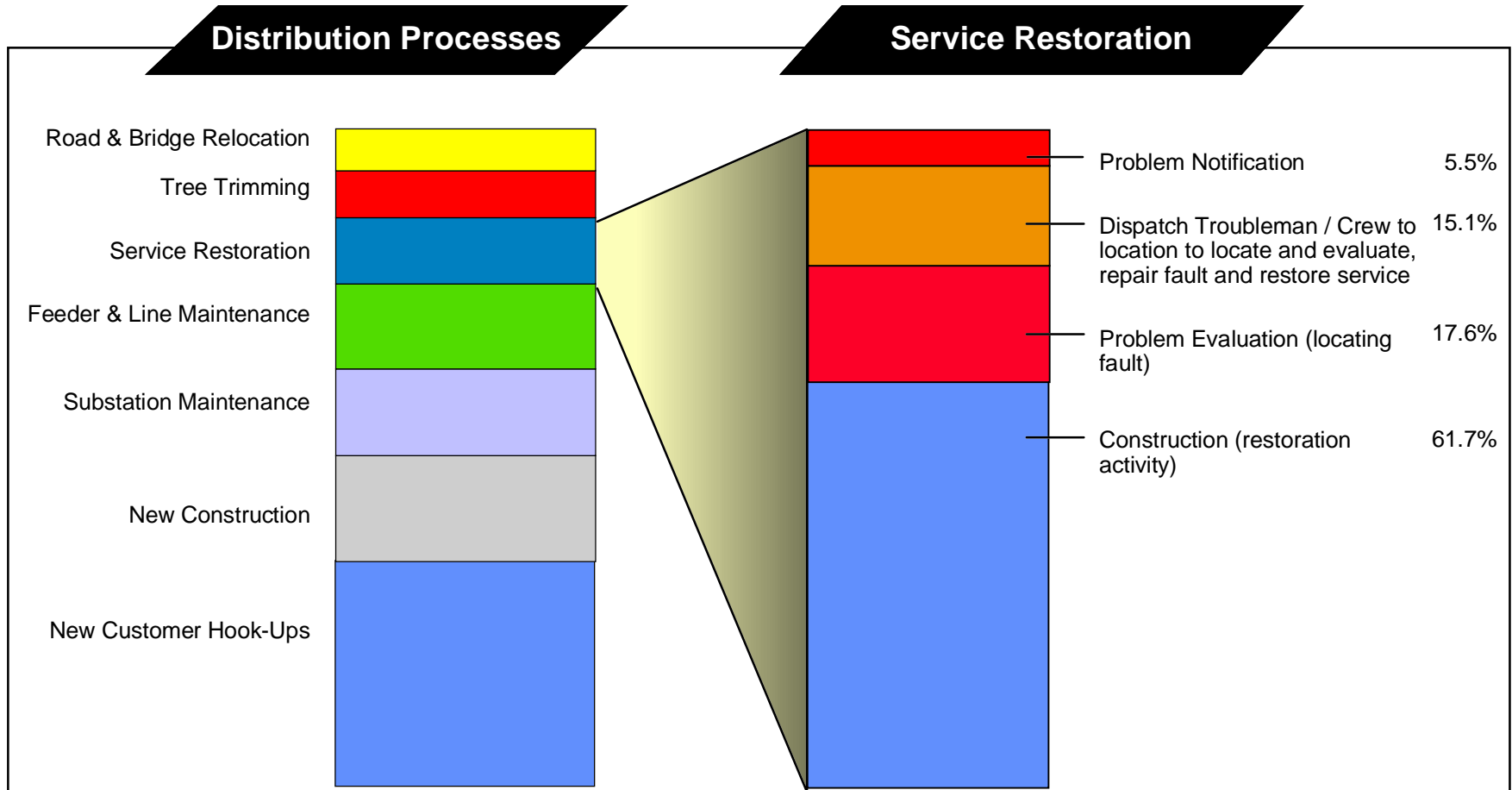
### **Scope of Activities**

- Repair of damaged OH facilities
- Repair of damaged UG facilities
- Emergency breakdown
  - Resetting reclosers and sectionalizers
  - Replacement of line fuses
  - Restore downed conductors
  - Restore distribution service
- No lights -- other customer complaints
- Storm restoration

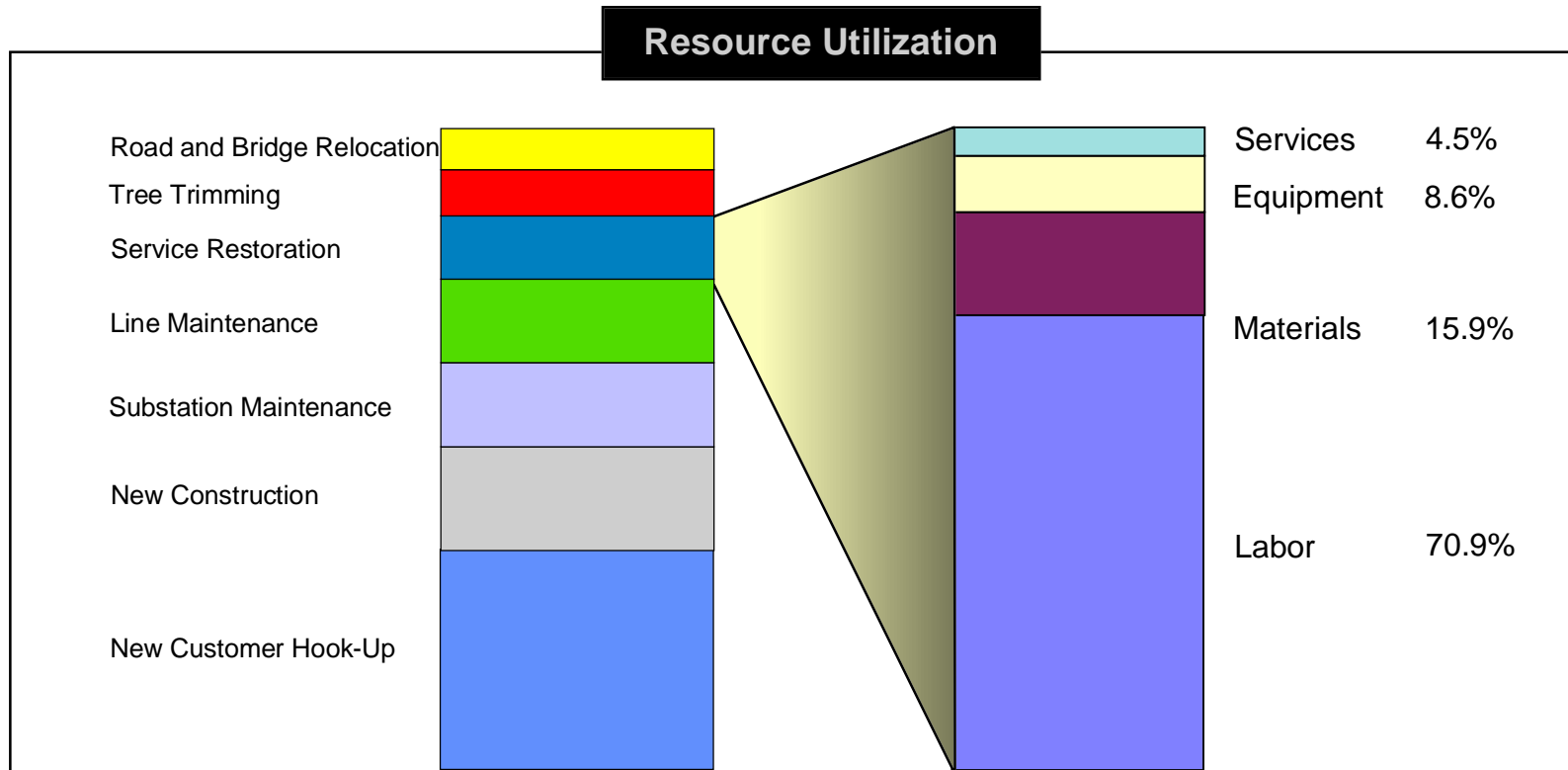
The average cost of service restoration for the study participants measured per customer is \$14.



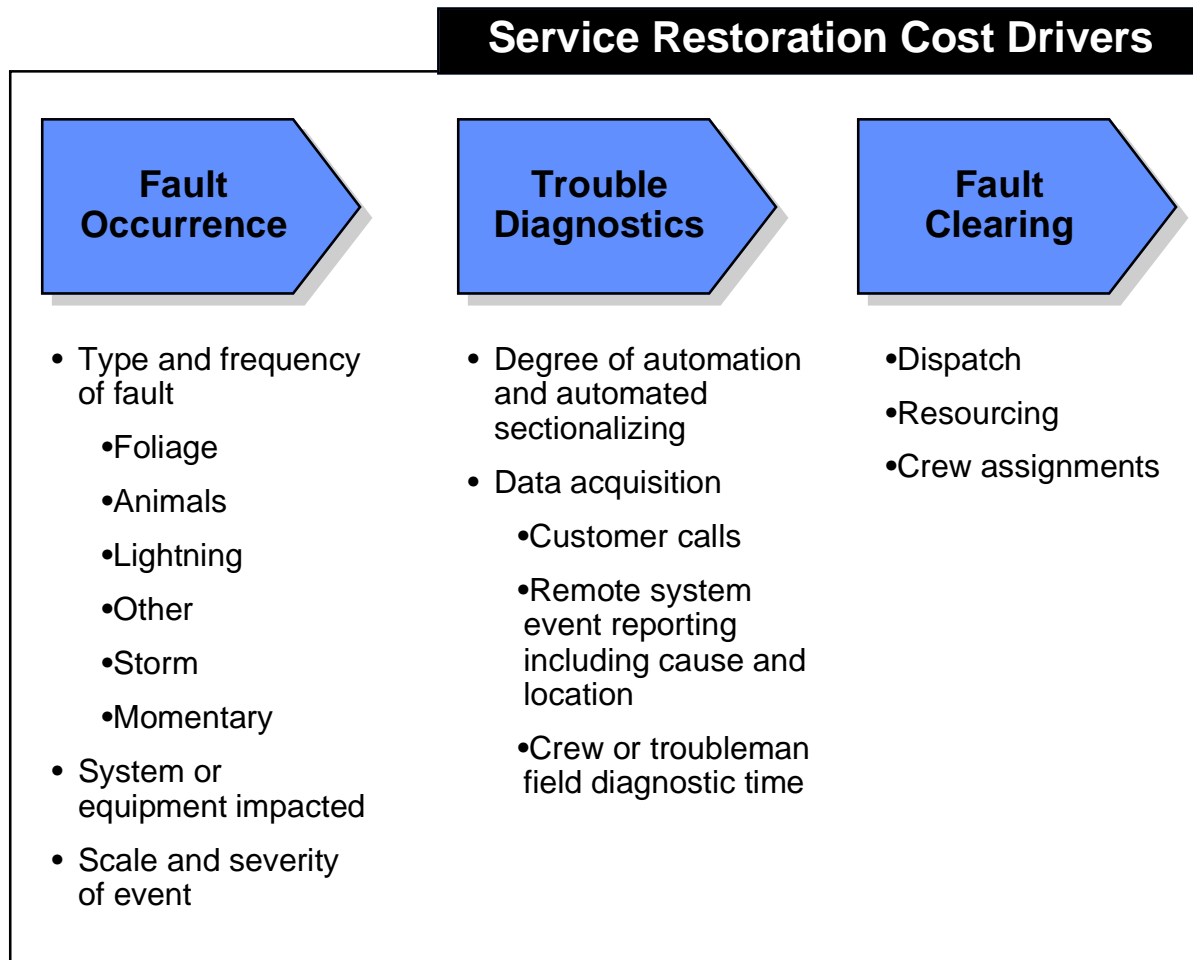
The cost to restore service after the problem has been located accounts for 61.7% of the total cost.



**Labor accounts for 70.9% of the total cost of service restoration.**



**Service restoration costs can be significantly impacted by increasing the level of automation and remote sectionalizing capability using switches and d-SCADA on circuits and substations.**



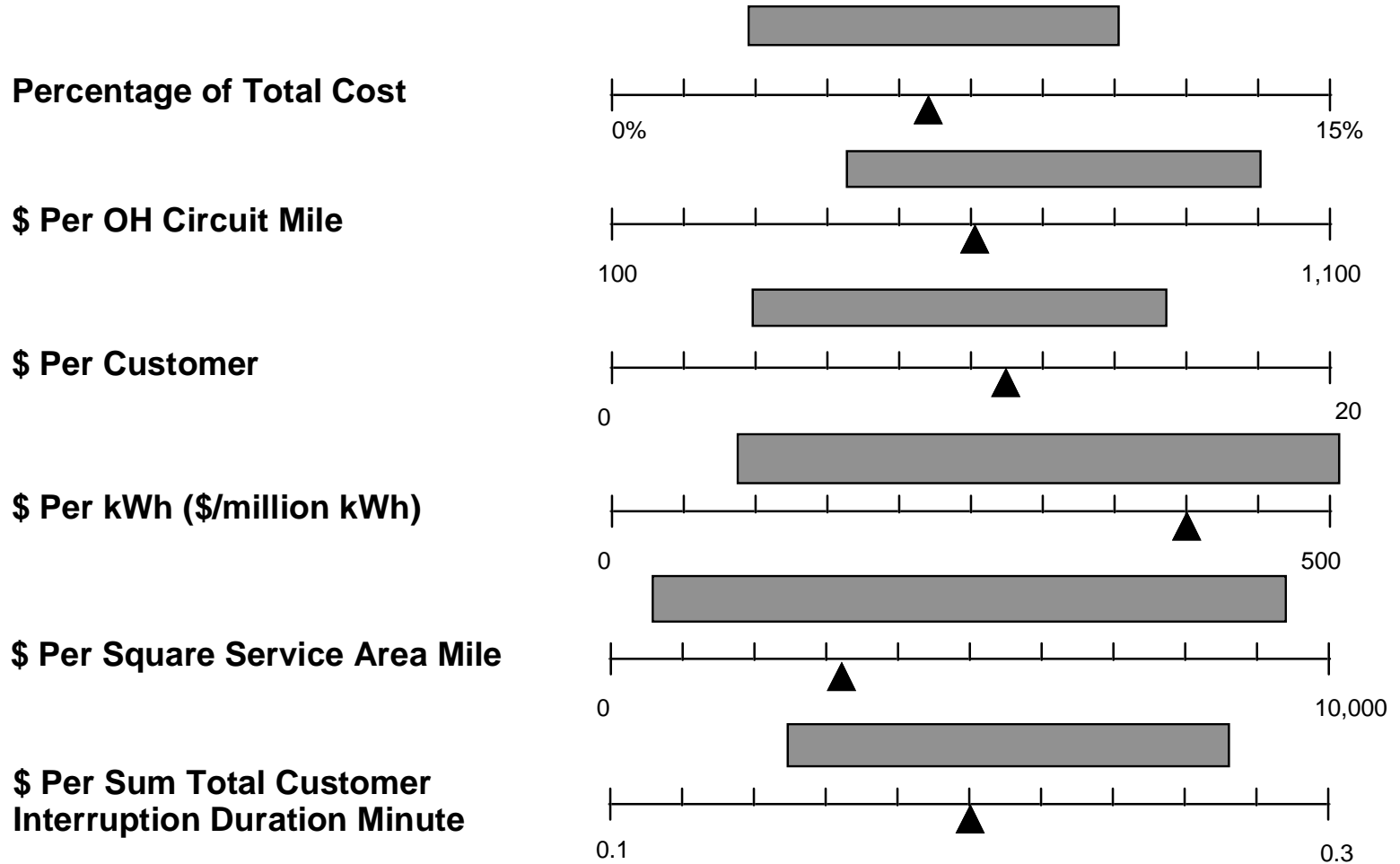
**The cost of service restoration could be reduced by applying technology to various aspects of the restoration process.**

Key Improvement Category	Possible Options
<p><b>Review current work practices</b></p>	<ul style="list-style-type: none"> <li>• Develop a system to capture information on trouble circuits and station equipment. Analyze the data to evaluate the need for a more long term solution to the outage problem</li> <li>• Design circuits and relay schemes to minimize the impact of outages on customers</li> <li>• Distribution automation to provide the ability to switch load between circuits and minimize the occurrence of an outage on the system</li> <li>• Field Inventory System - outage analysis system for automatic dispatching. Provide the ability to determine where lights are out and identify which customer are out.</li> <li>• Computer automated call distribution system to effectively capture customer calls during an outage and collect data necessary to locate and isolate the fault</li> <li>• Forecast scheduling of customer representatives to ensure that an optimal level of representatives are present at all times</li> <li>• Technology to efficiently collect information during an outage using “Computer telephone integration” and “Automated numeric indication”</li> <li>• Wireless Communications to transmit trouble ticket information directly to the crews in the vans</li> <li>• Ability to transmit maps/records wireless. Ensures that the crew has the most updated maps at all times and all the concerned parties are viewing the same version of the map</li> <li>• Develop an emergency service restoration plan with clear responsibilities</li> </ul>

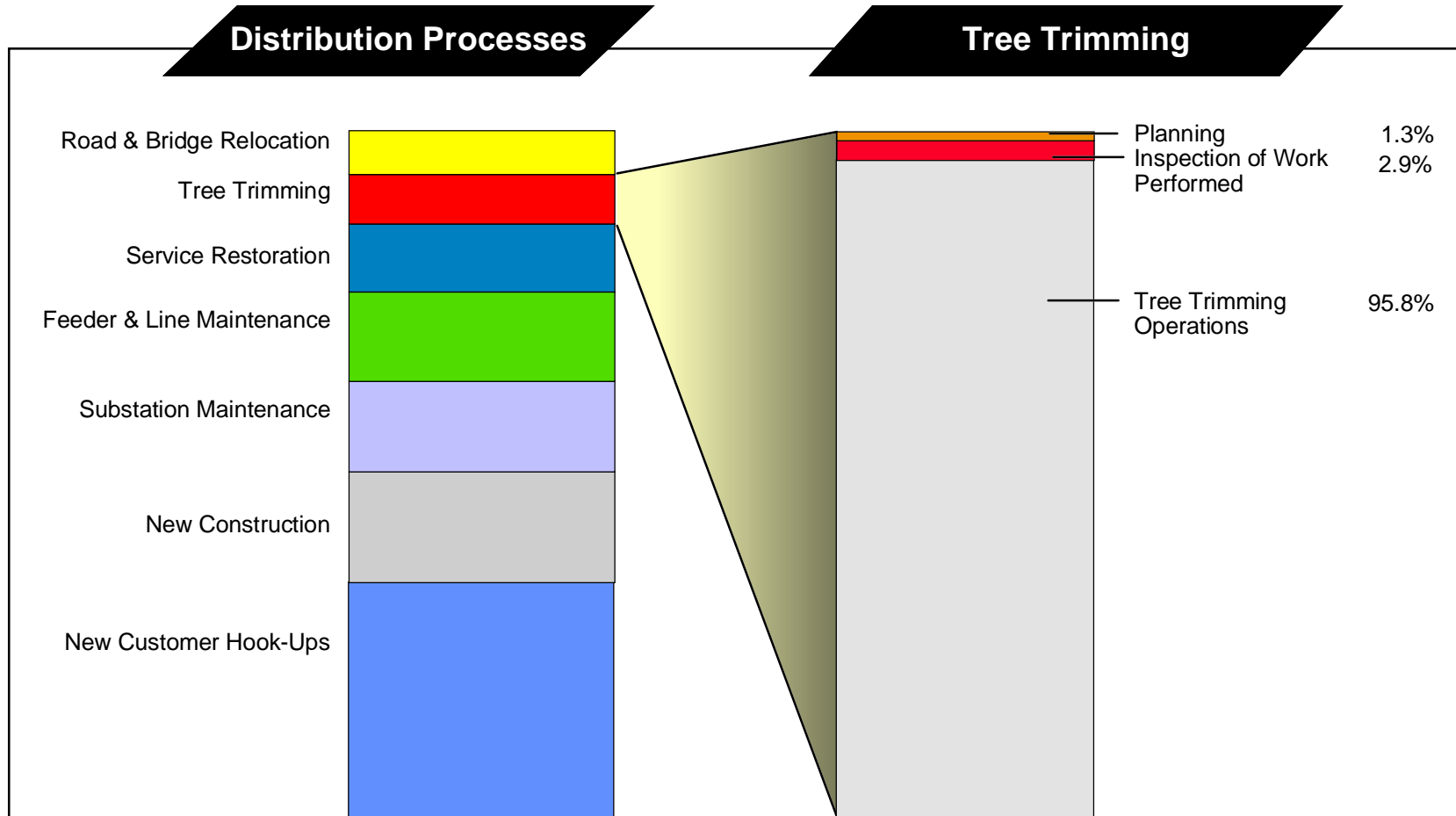
**Scope of Activities**

- Planned tree trimming operation
- Unplanned trimming/removal operation

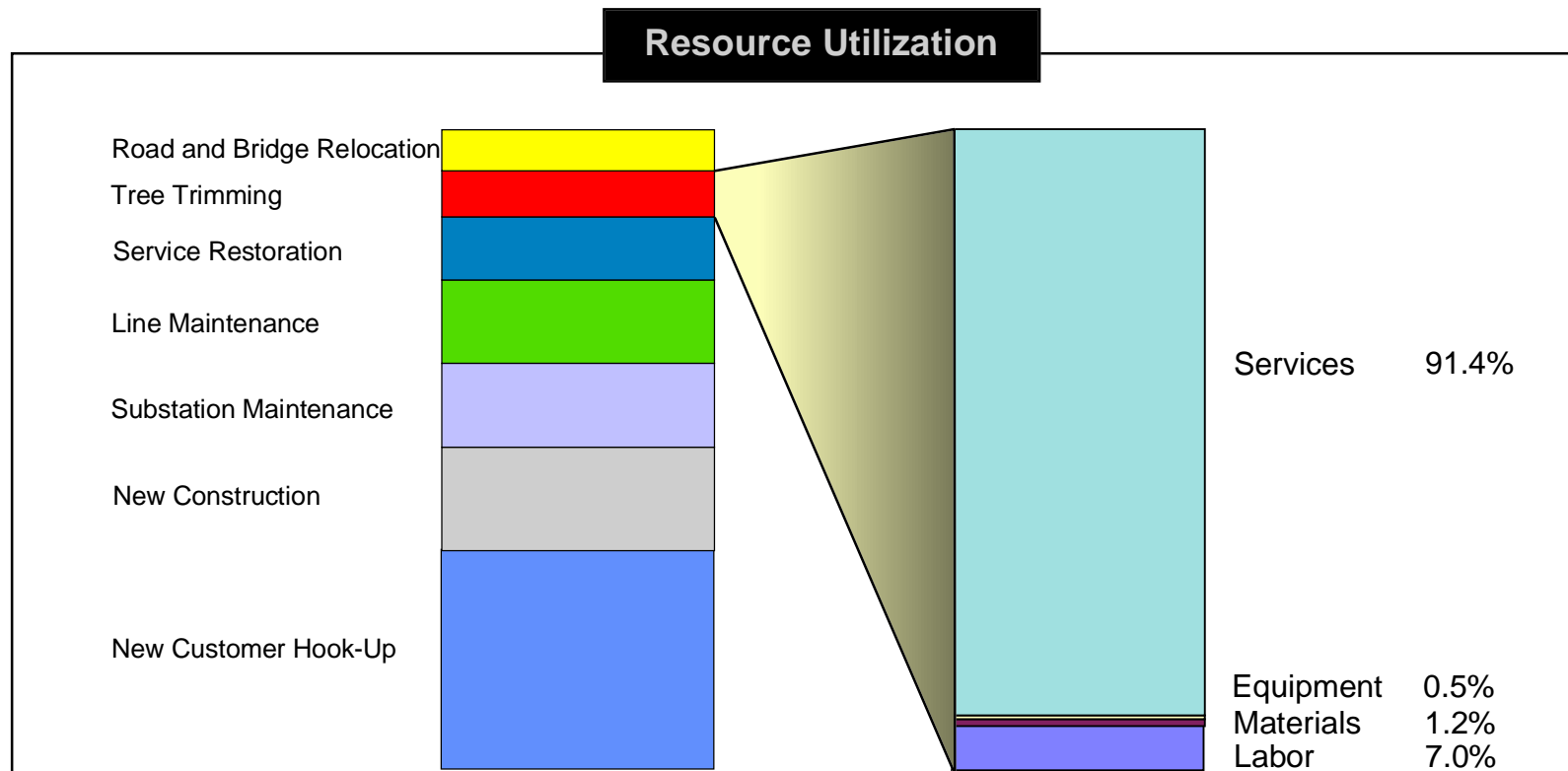
The average cost of tree trimming for the study participants measured per square service area mile is \$3,244.



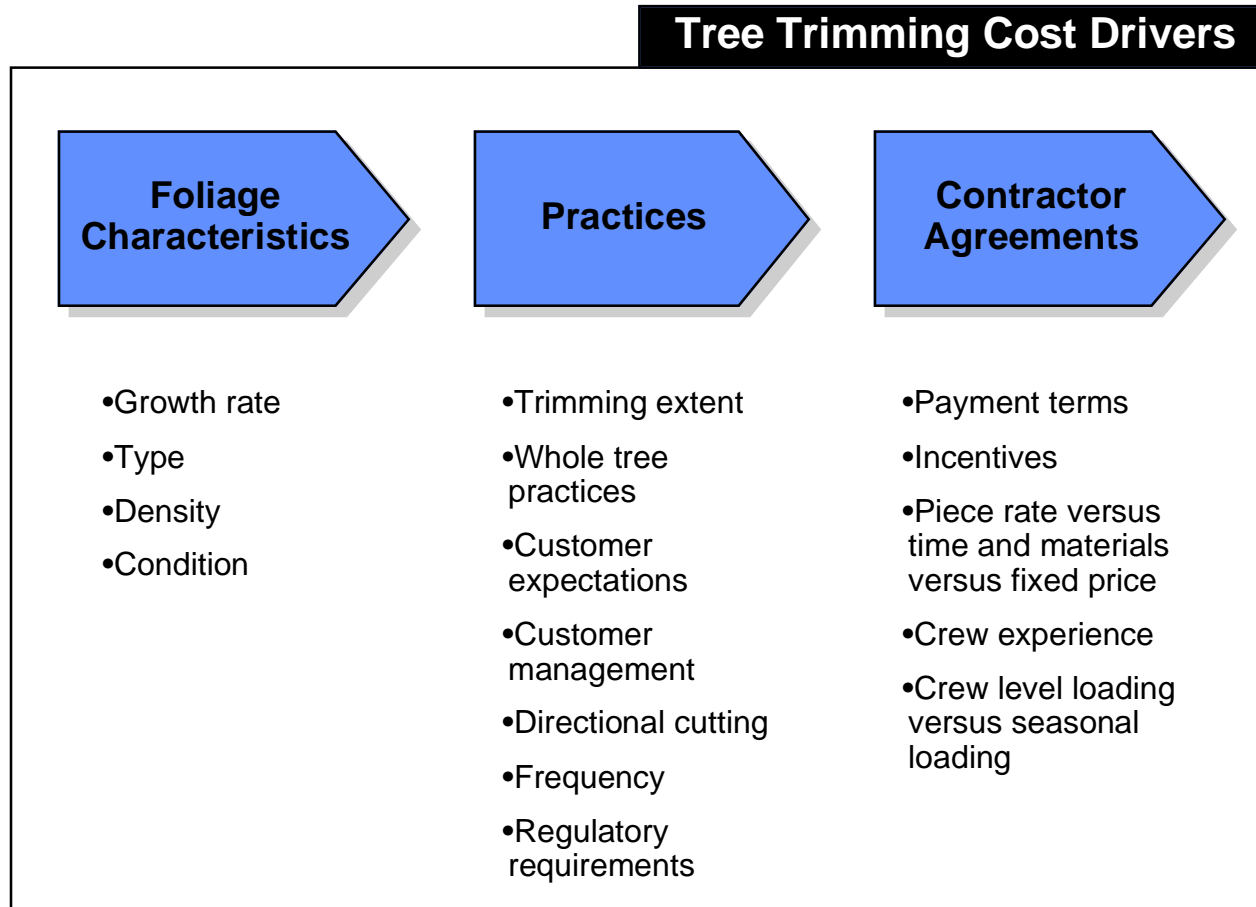
**Tree Trimming operations accounts for 95.8% of total cost of tree trimming.**



**Outside services account for 91.4% of the tree trimming costs.**



**Tree trimming costs are significantly impacted by innovative contractor agreements that incorporate performance-based incentive systems.**



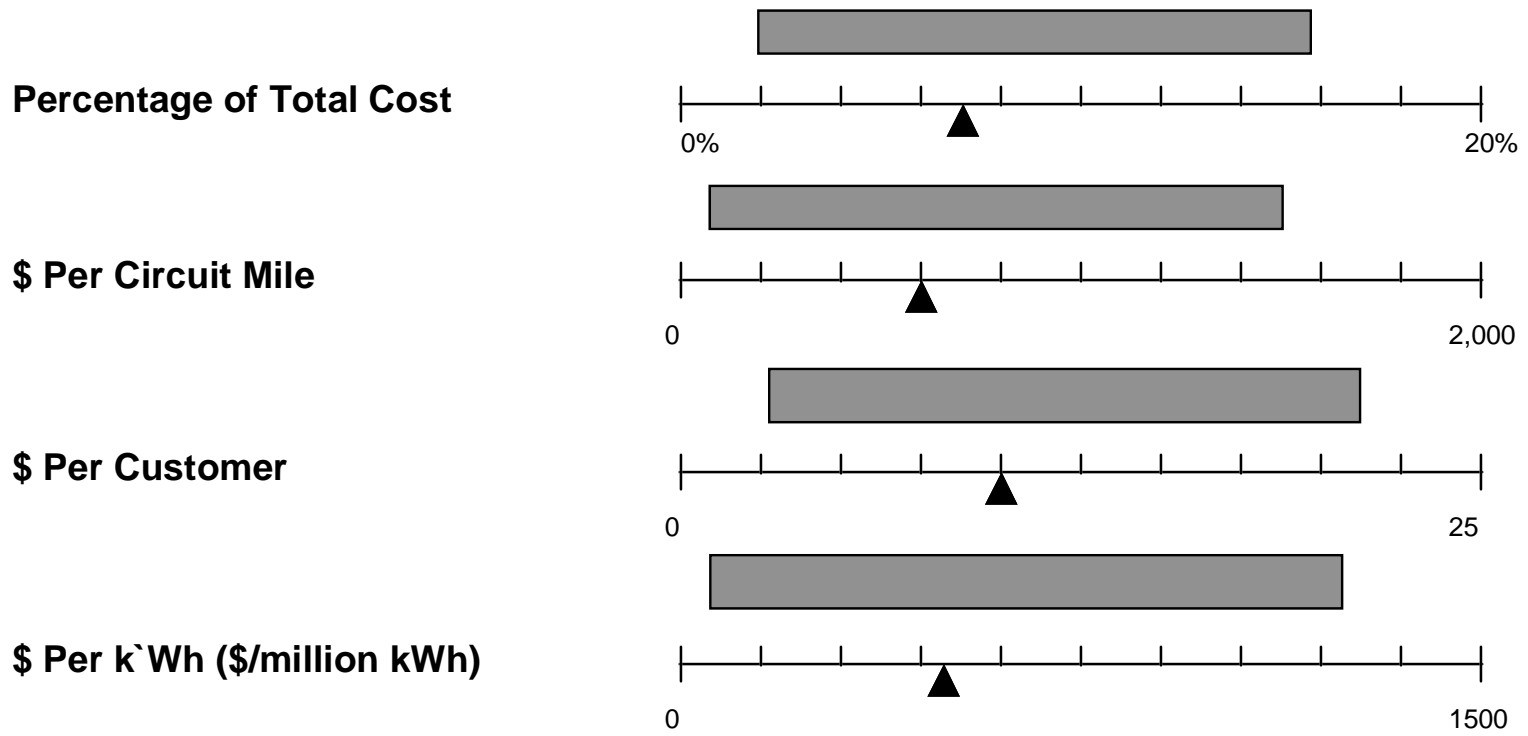
**Tree trimming operation is predominantly outsourced and hence the process of contract management is critical to managing tree trimming costs, beginning with competitive bidding. Nearly all of the tree trimming costs are for contractor services**

Key Improvement Category	Possible Options
<p><b>Contract Management</b></p>	<ul style="list-style-type: none"> <li>• Maximize crew utilization through advanced planning of tree trimming operations. Prioritize circuits that need trimming based on impact on customer outages</li> <li>• Enhance crew performance with setting up performance contracts, periodically rebidding the job, and closely monitoring contractor performance</li> </ul>
<p><b>Review current work practices</b></p>	<ul style="list-style-type: none"> <li>• Develop enhanced processes for planning tree trimming and circuit prioritization</li> <li>• Introduce growth retardants</li> <li>• Introduce selective use of herbicides</li> <li>• Reduce the number of unplanned/disruptive work created by customer demands</li> <li>• Evaluate the possibility of introducing standard clearances for lines and ROW specifications.</li> <li>•</li> </ul>

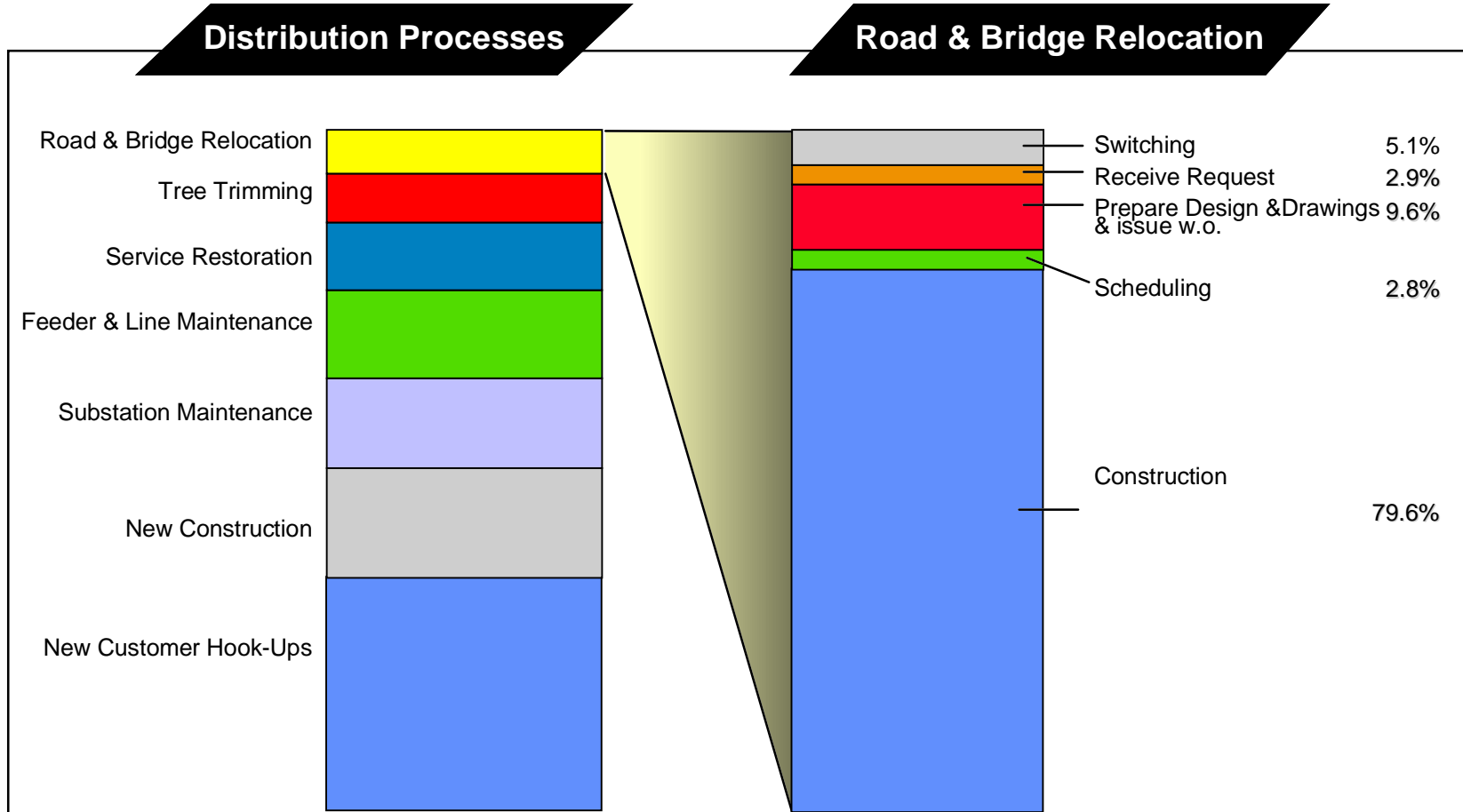
### Scope of Activities

- Relocating Overhead and Underground facilities
- Municipal improvement resulting in conversion of OH facilities to UG

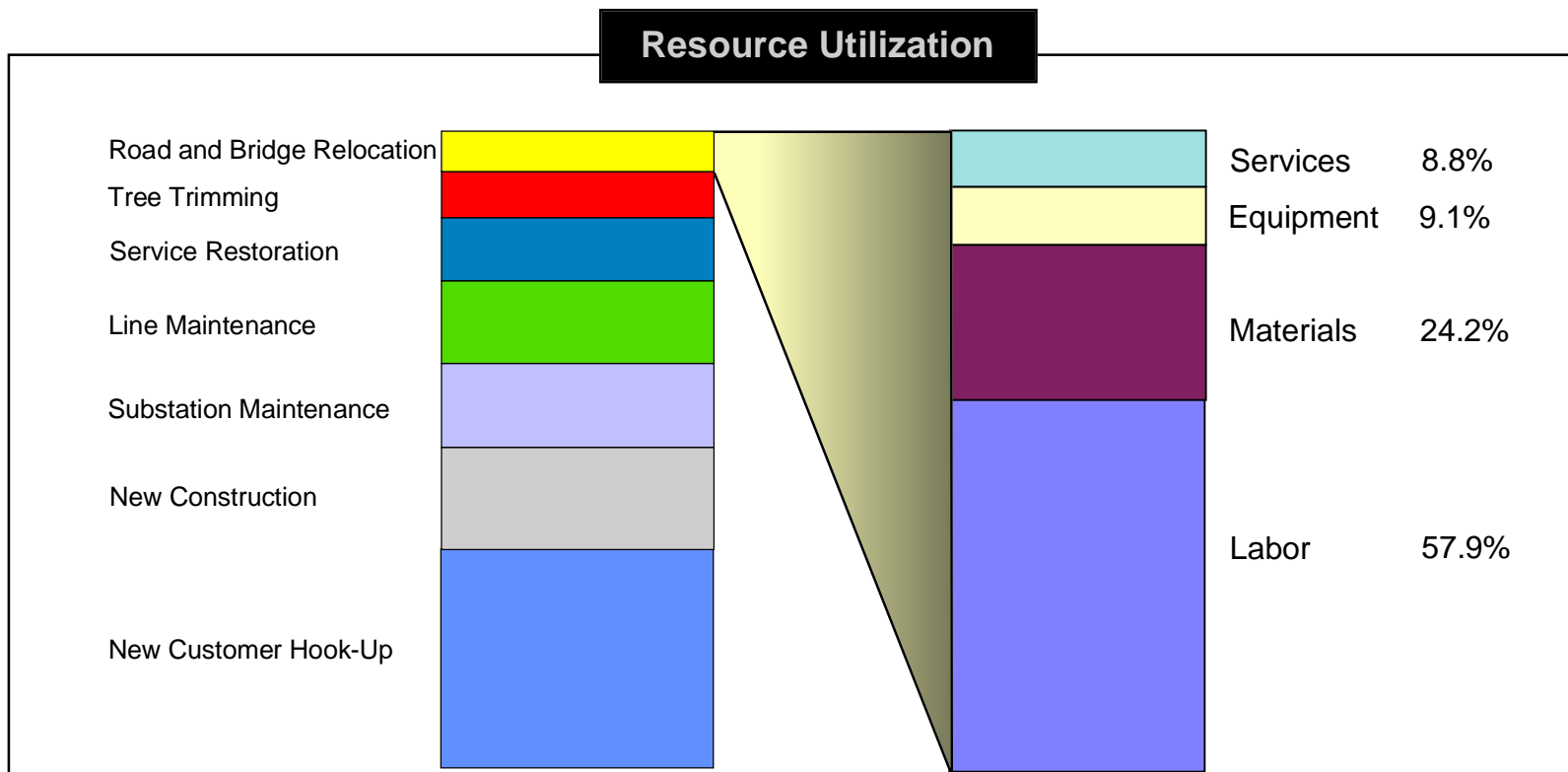
The average cost of road and bridge relocation for the study participants measured per circuit mile is \$587.



Once the work has been scheduled, the construction activity accounts for 79.6% of the total cost.



**Labor costs for road & bridge relocation accounts for 57.9% of the total cost.**



**Road & Bridge Relocation costs can be significantly impacted by increasing the level of coordination with state agencies and managing expectations.**

**Road and Bridge Relocation Cost Drivers**

**Service Requests**

- Short lead time work notices
- Inefficient work requirements
- Type and size of projects
- Regional growth levels
- Government expectations and relationship
- Number, sequence and location of projects
- Coordination levels

**Materials Procurement**

- Materials specifications
- Materials procurement
- Materials receiving, testing and storage
- Materials handling
- New versus used equipment

**Construction**

- Construction practices
- Labor costs
- Outside services
- Overtime versus regular time
- Union rules
- Productivity
- Load requirements/ constraints

**Increased coordination between the government agencies and utilities could significantly improve efficiency and reduce cost.**

Key Improvement Category	Possible Options
<p><b>Review current work practices</b></p>	<p>Improved coordination among the government agencies and utilities during the project identification and scope development phase. Knowledge of proposed work would help optimize resources during the construction phase of the project</p> <ul style="list-style-type: none"> <li>•</li> </ul>