BOOTCAMP INSIGHTS

Key takeaways from the workshop:

From knowledge to action

AI workshop outcomes & expert insights

USE CASE 3

FORECASTING FOR DEMAND MANAGEMENT USING DYNAMIC PRICING

This summary reviews what was produced by the participants during the workshop, complemented by the analyses and recommendations of our AI experts.

THE WORKING GROUP'S PERSPECTIVE

Target users

- **Utilities** responsible for operating and balancing electricity networks
- **Distributors** managing energy flows and customer supply

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Who Benefits from This Use Case

This use case is designed for **utilities and energy distributors** operating **AMI/IoT-enabled networks** and serving **mixed customer segments**, including residential, commercial, and industrial customers. These actors face increasing complexity in balancing demand, pricing, and grid stability across very different usage profiles.

Segmenting Customers for More Effective Signals

A key principle of this approach is **segmentation**. Agentic AI is used to tailor signals and actions for each customer cohort, based on their **consumption profiles** and their **observed responsiveness to price signals**. Instead of applying uniform messages or incentives, the system adapts its recommendations to how different segments actually behave.

Adjusting Forecasts and Pricing to Segment Criticality

The solution also introduces **variable forecast granularity**. Forecast horizons can be adjusted to different time scales—15 minutes, hourly, or daily—depending on the criticality of the segment. For example, industrial customers may require finer-grained forecasts and more cautious pricing signals than residential users. This flexibility improves both operational accuracy and customer relevance.

Orchestrating Decisions Through a Multi-Agent Loop

At the core of the solution is a **multi-agent loop** that structures decision-making across the system. A Forecast Agent predicts demand, an Elasticity Agent evaluates customer responsiveness, a Pricing Agent defines appropriate pricing signals, an Engagement Agent manages customer communication, and a Compliance/Risk Agent ensures regulatory and operational constraints are respected. These agents continuously share context and state through an **event bus and a feature store**, enabling coordinated, consistent, and scalable demand management.

THE WORKING GROUP'S PERSPECTIVE

Objective

- **Reduce peak demand** by influencing consumption behaviors
- Enable **better pricing for customers** through optimized demand management

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Defining Clear and Measurable Objectives

When deploying an AI-driven demand management solution, it is essential to define **focused and measurable objectives**. Clear targets help align teams, guide technical choices, and ensure that the solution delivers tangible value rather than fragmented initiatives. Using a SMART approach makes objectives concrete, time-bound, and actionable.

Examples of SMART Objectives

One objective is to **increase customer participation in demand response programs by 20% within the next quarter**. This can be achieved through personalized, AI-driven engagement that delivers the right message to the right customer at the right time.

Another objective is to **reduce peak demand by 10% during critical periods within 6 months**. This relies on applying dynamic pricing mechanisms combined with automated customer notifications to influence consumption behavior when the grid is under stress.

A third objective focuses on operational accuracy: **improving short-term forecast accuracy to a MAPE below 5% within 9 months**. This is achieved by deploying hybrid AI forecasting models and integrating anomaly detection safeguards to improve reliability and robustness.

THE WORKING GROUP'S PERSPECTIVE

Benefits

- **Lower investment in infrastructure** by avoiding over-dimensioning driven by peak demand
- **Reduced outages and system failures** thanks to better load balancing
- **More frequent and effective regulation** of the grid through continuous monitoring and adjustment

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Improving Grid Reliability

The solution improves **grid reliability** by delivering more accurate demand forecasts, enabling smoother peak management, and reducing the likelihood of outages. Better anticipation of stress periods allows operators to act earlier and maintain system stability.

Driving Economic Efficiency

By optimizing demand management and pricing, the approach leads to **lower operational costs**. Transparent pricing mechanisms and personalized guidance help customers better understand and adjust their consumption, resulting in improved customer satisfaction and more efficient system-wide outcomes.

Creating Value Across Multiple Use Cases

Beyond demand management, the solution strengthens the **data foundation** of the organization. This improved data quality and structure can be leveraged across adjacent use cases, such as predictive maintenance and investment planning, extending the value of the solution well beyond its initial scope.

THE WORKING GROUP'S PERSPECTIVE

Pain points

- **Lack of data visibility**, making it difficult to anticipate demand and act proactively
- Challenges related to **grid resilience**, especially during peak periods
- **Limited operational resources** available to monitor and manage demand in real time

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Limits in Real-Time Data Processing

Without AI, processing **real-time smart meter and weather data** becomes extremely challenging. The volume, velocity, and variety of these data streams slow down analysis and delay responses to sudden demand spikes, limiting the ability to act proactively during critical periods.

Constraints of Manual Pricing Approaches

Traditional pricing mechanisms rely on **manual and generic adjustments**. These approaches are often slow to deploy and lack personalization across different customer groups, reducing their effectiveness in influencing consumption behavior when it matters most.

Gaps in Visibility, Data Quality, and Compliance

Limited **real-time visibility**, combined with heterogeneous data quality, makes it difficult to maintain control during peak periods. At the same time, regulatory and compliance expectations increase during these moments, putting additional pressure on operators to justify decisions and actions.

Need for End-to-End Data Pipelines and Explainability

To address these challenges, there is a clear need to **orchestrate streaming data pipelines** end to end. This includes ingestion, schema validation, data cleaning, enrichment, and event labeling for peaks, anomalies, and customer responses. In parallel, the use of **explainable AI (XAI)** is essential to surface clear rationales behind decisions, enabling operators and regulators to understand, trust, and act on AI-driven recommendations.

THE WORKING GROUP'S PERSPECTIVE

Prerequisites

- **Regulatory frameworks** that allow dynamic demand management and customer interaction
- **Data protection mechanisms** to ensure privacy and compliance
- **Smart metering infrastructure** to collect granular and timely consumption data

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Aligning Prerequisites with the Level of Ambition

The prerequisites required to deploy this solution depend on the **ambition of the initiative** and the **value expected**. A pragmatic approach is to progressively strengthen technical, organizational, and governance foundations as the solution matures.

Basic Value: Starting with Minimal Requirements

At a foundational level, the solution can be deployed with **limited prerequisites**. Smart meters and basic digital infrastructure are sufficient to collect consumption data. Simple communication channels such as mobile applications, SMS, or email allow utilities to send notifications and engage customers. This level enables early value creation with low complexity.

Higher Value: Enabling Advanced Capabilities

To unlock more advanced optimization, additional prerequisites are required. From a **teams and compliance** perspective, staff must be trained to oversee AI operations, manage exceptions, and ensure privacy and regulatory compliance in line with data sensitivity.

Strong **data readiness and governance** are also essential. This includes regular audits to ensure data completeness and freshness, as well as clear documentation of workflows, models, and trigger criteria to support transparency and trust.

Scaling Through a Structured Rollout Strategy

For advanced deployment, a structured **rollout strategy** is critical. This involves running pilots on feeders with high volatility, conducting A/B testing (comparing "agentic ON" scenarios with baseline operations), tracking key performance indicators such as forecast accuracy (MAPE/RMSE), reaction time, peak reduction, and participation rates. Insights from these pilots are then used to iterate and progressively scale the solution.

THE WORKING GROUP'S PERSPECTIVE

Detailed description

- **Data agent** that collects, processes, and analyzes energy consumption data
- Computes data to **produce insights and forecasts** on demand and usage
- Supports **energy dispatch decisions** to better balance supply and demand
- Sends **personalized messages to customers** to guide them toward more appropriate energy usage

How it works in practice:

The AI agent acts as a central data orchestrator. It aggregates and analyzes consumption data, generates insights to support operational decisions, and helps utilities decide when and how to dispatch energy. Based on this analysis, the agent also communicates with customers, providing guidance on the best way to use energy at specific moments, especially during peak periods.

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Understanding Elasticity Through Segmentation

The approach starts with **segmenting customers into cohorts** based on shared characteristics. For each cohort, the system models **price elasticity**, fitting elasticity curves that describe how consumption responds to price signals. These models are **updated regularly**, using observed customer responses, to continuously refine targeting and focus on the groups with the highest potential impact.

Optimizing Pricing While Preserving Customer Utility

Pricing decisions are optimized to **minimize peak demand and imbalance costs** while still maintaining customer utility. This optimization operates within clearly defined constraints, such as limits on how fast prices can change, equity considerations across customer groups, and **human-in-the-loop approvals** for exceptional or sensitive pricing adjustments. This ensures both effectiveness and fairness.

Executing Actions Through Agentic Workflows

Once pricing and demand strategies are defined, **agentic execution** takes over. The system automatically triggers actions across devices and communication channels, including apps, SMS, and email. It continuously learns from customer response rates and adjusts policies and messages to improve effectiveness over time.

Enriching Engagement with RAG and Generative AI

The solution leverages **Retrieval-Augmented Generation (RAG)** to retrieve relevant context such as tariff clauses, regulatory caps, incident notes, and past demand response outcomes. **Generative AI** then uses this information to produce clear, segment-specific explanations and calls to action, with source references visible in operator consoles. Integration with engagement platforms allows teams to measure customer responses in real time.

A Hybrid Forecasting Stack

At the core of the system is a **hybrid forecasting stack**. Multiple AI models work together: some specialize in detecting temporal patterns, others focus on structured data, and additional models capture regular trends and seasonality. This combination improves forecast accuracy and robustness across different time horizons and operating conditions.

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