



Implementing Dynamic Pricing

Technology & Implementation Aspects

Major Technology Aspects

- At the ISO
 - Day Ahead & Hour Ahead Market Process
- At the Middle
 - Calculating Uplifts & Arriving at a Retail Price
- Communicating Prices
 - AMI Communications vs Public Internet & 3 Party
- At the Consumer
 - Home Automation and Building Management Integration
 - Whose Data is It? - Open Access to Meter
- At the Electric Vehicle
 - Managing Required Charge State
 - Meter on the Vehicle vs the Cord vs the Charger

The Economics of Price Response

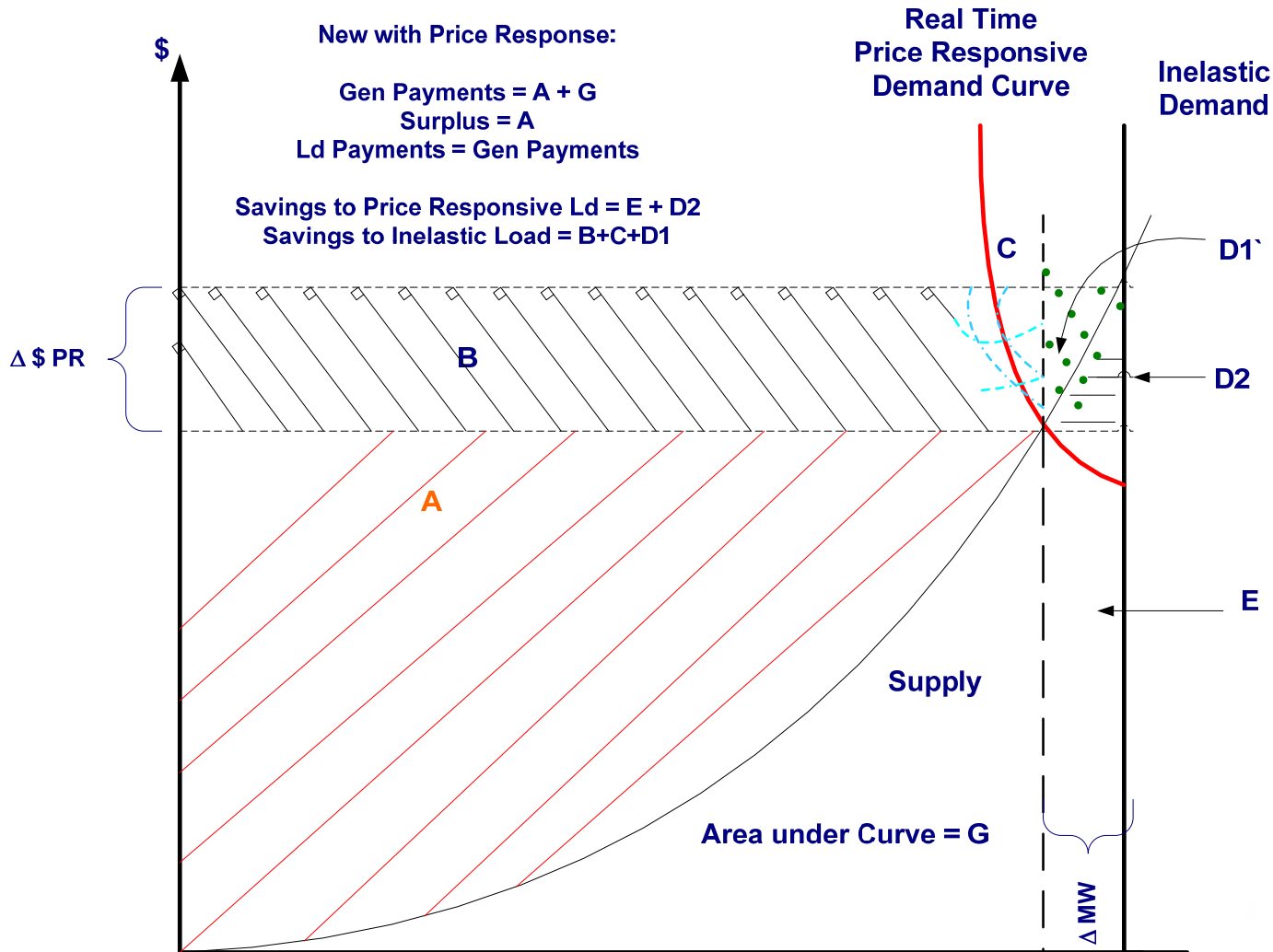
Original:

$$\begin{aligned} \text{Gen Payments} &= A+B+C+D1 +D2+E + G \\ \text{Gen Surplus} &= A+B-G+C+D1 \\ \text{Ld payments} &= \text{Gen Payments} \end{aligned}$$

New with Price Response:

$$\begin{aligned} \text{Gen Payments} &= A + G \\ \text{Surplus} &= A \\ \text{Ld Payments} &= \text{Gen Payments} \end{aligned}$$

$$\begin{aligned} \text{Savings to Price Responsive Ld} &= E + D2 \\ \text{Savings to Inelastic Load} &= B+C+D1 \end{aligned}$$



With Price Responsive Load the Cash Flows are Straightforward

And the Distribution of Savings is Also

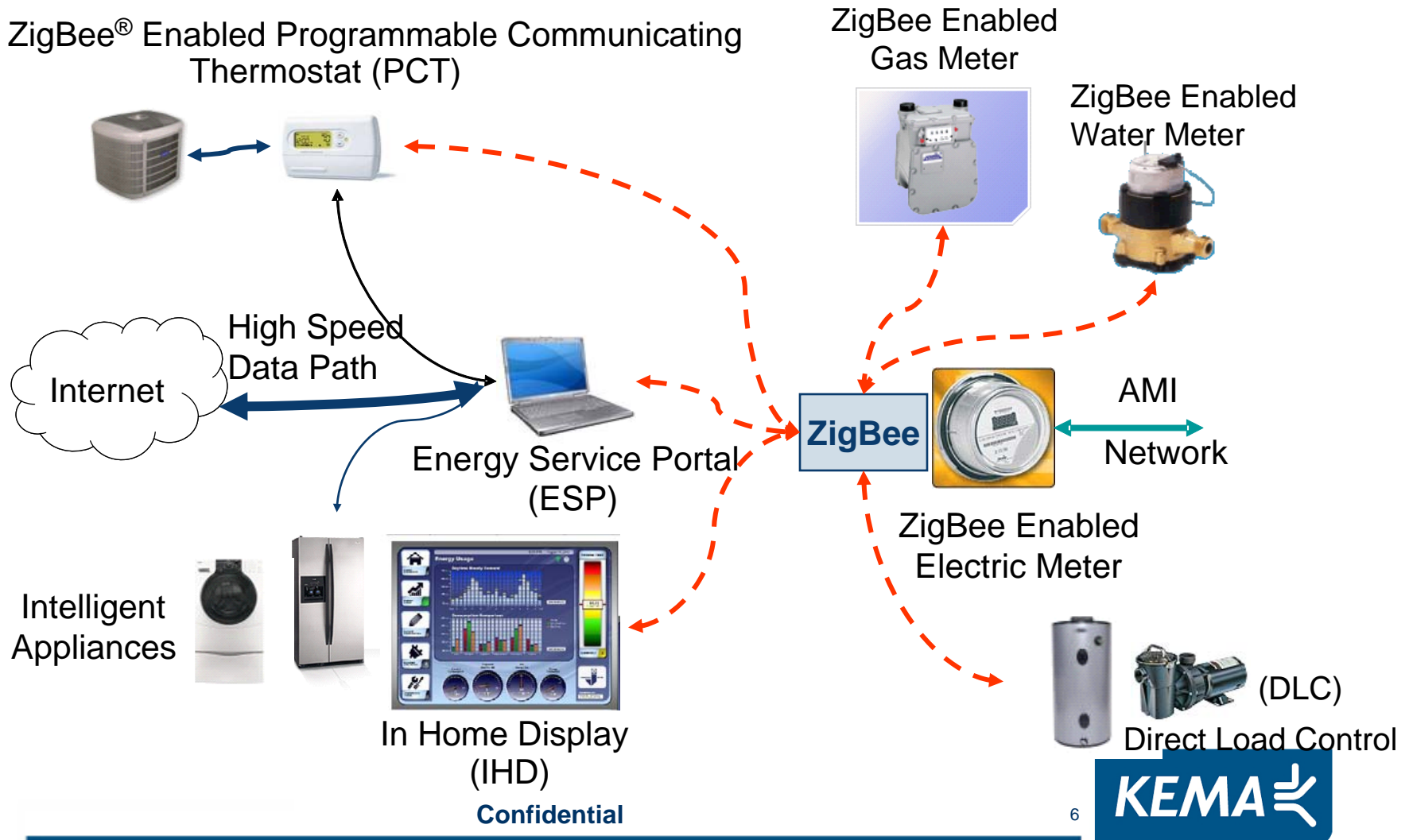
Dynamic Pricing and Wholesale Markets

- The Conundrum of a Single Auction
 - Complexity of aggregating consumer load “bids”
 - Forecasting impact of elasticity
 - Avoiding day ahead peak will reduce price response – under forecast
 - Publishing an inelastic clearing price will result in over-forecast
- Basis for Load Forecasting and Arriving at a Valid Day Ahead Clearing Price Just Got a Lot More Complicated !

Communicating Dynamic Prices

- Day Ahead - No challenge to AMI systems nor to use of public internet or 3 party
- Hour Ahead – Poses latency issues to reach all meters in narrow time window
- Collecting hour ahead demand information is futuristic today
- Use of Public Internet poses cyber security worries if anything more than price “push”
 - Operational data constraints

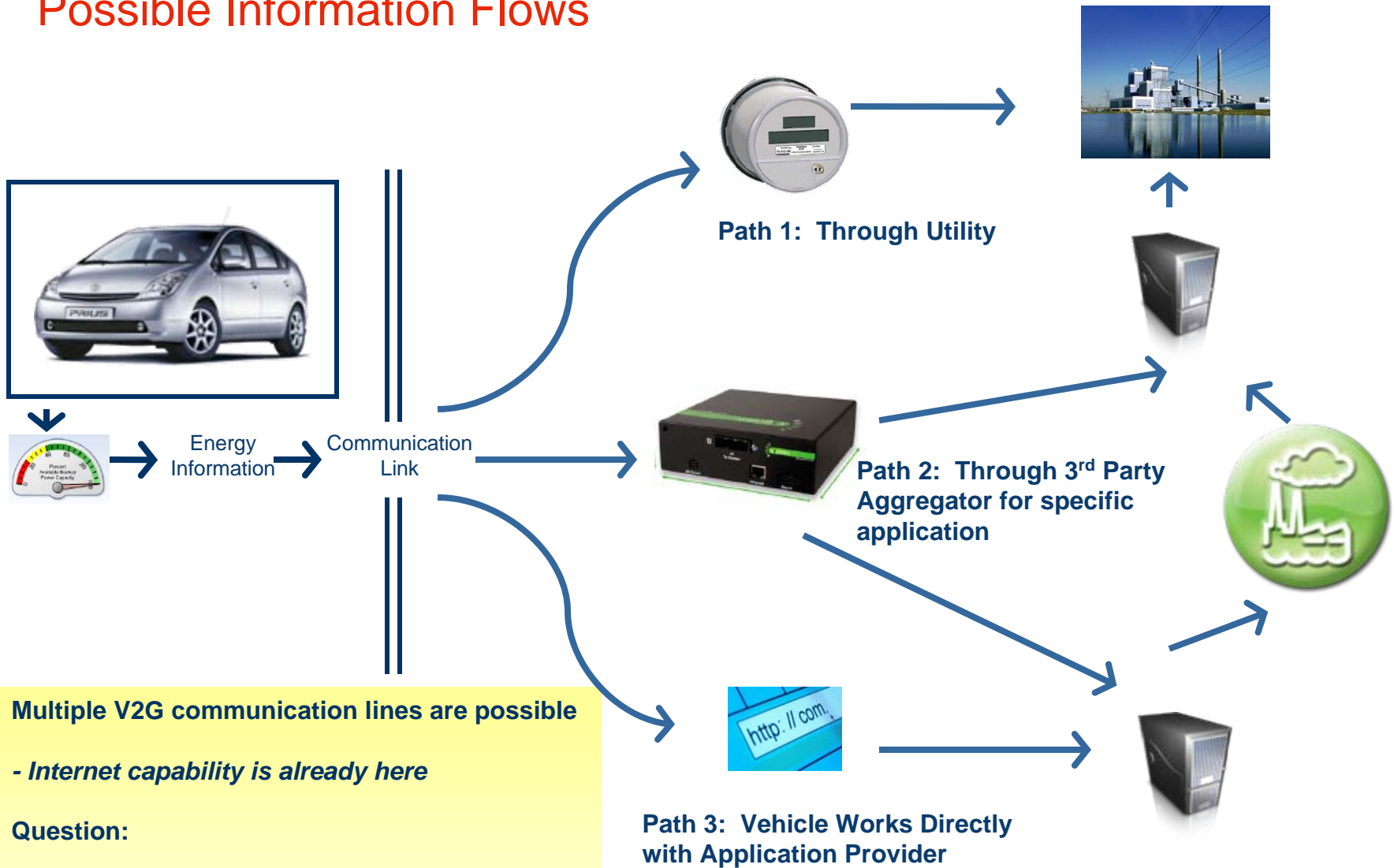
Robust HAN and available devices will make reliable and predictable demand response participation simple and automatic



Confidential

Vehicle To Electricity Grid Communications

Possible Information Flows



Multiple V2G communication lines are possible

- Internet capability is already here

Question:

- Who will 'own' vehicle interface and information?

Path 3: Vehicle Works Directly with Application Provider

What if all the information was on the vehicle?

EV Integration



Energy Information

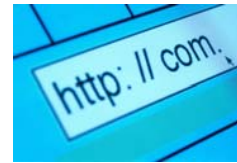


Should the meter be on the vehicle?

Software Application

Can a car be like a computer with wheels?

Internet



Server



Utility, Aggregator, Home Display, ...



Conclusions

- Hardware and Communications Technology is NOT the Issue
- Changing Business Models and a More Open Retail Business Process is Where the Fun Will Be