Demand and Time of Use Rates

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Factors Affecting Electric Rates

- Generation plant cost increases
- Fuel price increases and volatility
- Carbon and environmental regulations
- Cost of renewable portfolio standard
  - Generation cost of renewables
  - Intermittent nature of renewables
  - Location of renewables - new transmission to move power from renewable generators

Customer Response to Higher Prices Is Predictable

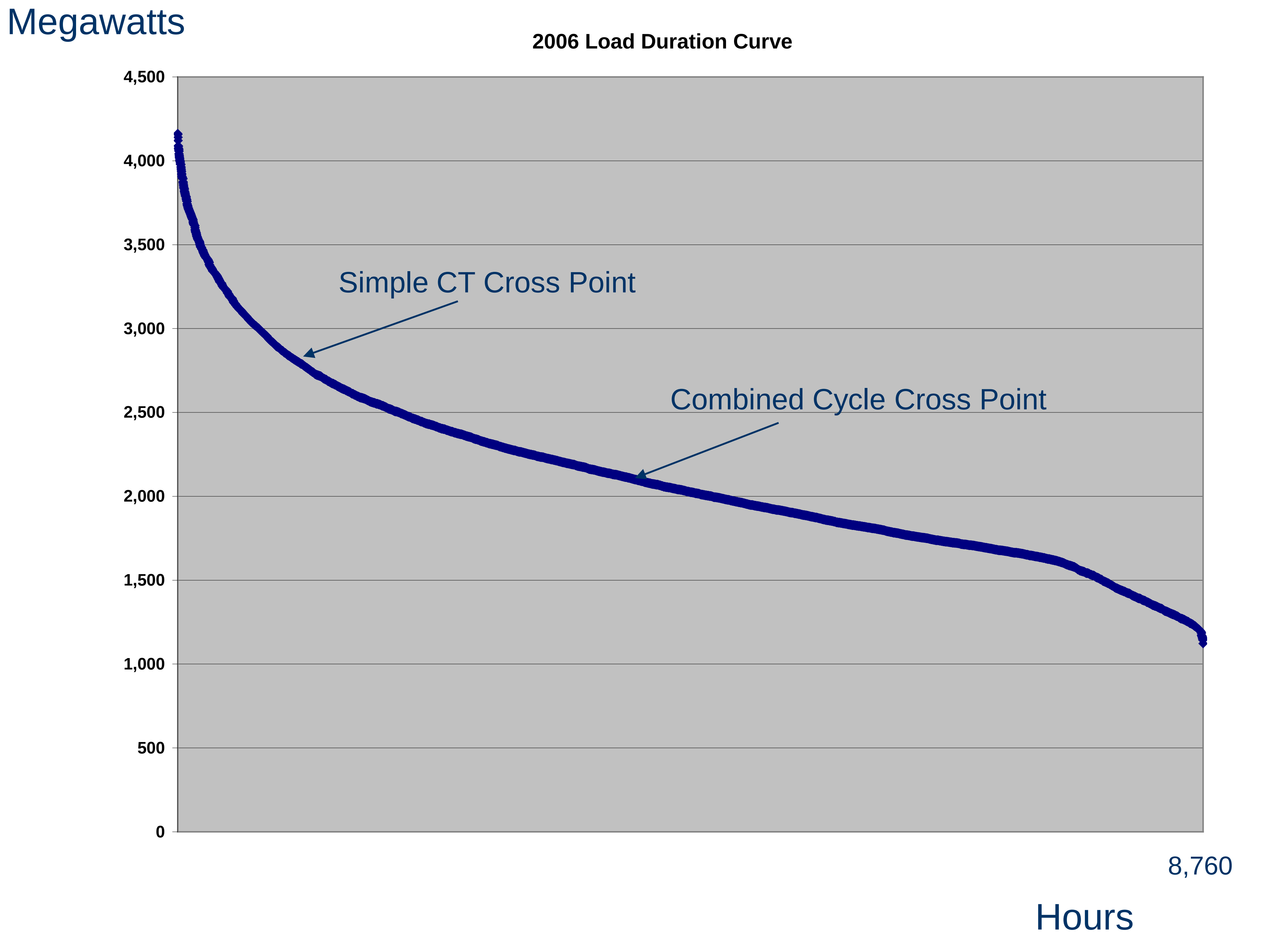
- Reduced customer usage and sales due to:
  - Energy efficiency
  - Conservation
  - Demand response
  - On-site generation and net metering
- Complaints and griping

The Two Big Issues

- Fixed cost recovery – assuring that G&T and distribution cooperatives recover their fixed costs as fairly as possible
- Deconstructing averages – empowering customers and giving them more control over their energy bills
  - Averages hide much of the underlying cost variability

Meeting Customer Needs

- A load duration curve provides a picture of the customer needs that the utility is trying to meet
- Address load variability on the supply side
  - Build capacity to meet the peaks
- Address load variability on the demand side by reducing peak demands
  - Demand side management programs (direct control)
  - Price signals (indirect control)



Megawatts
2006 Load Duration Curve
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Simple CT Cross Point
Combined Cycle Cross Point
8,760
Hours

Basis for Time Differentiated Rates

- The cost of serving load differs substantially over time
- Fixed cost per kWh varies over time as different generating units and technologies are required to meet customer needs
- Variable cost per kWh varies over time as different fuel sources are used to meet customer needs (coal, nuclear, gas)

Generating Cost Comparisons

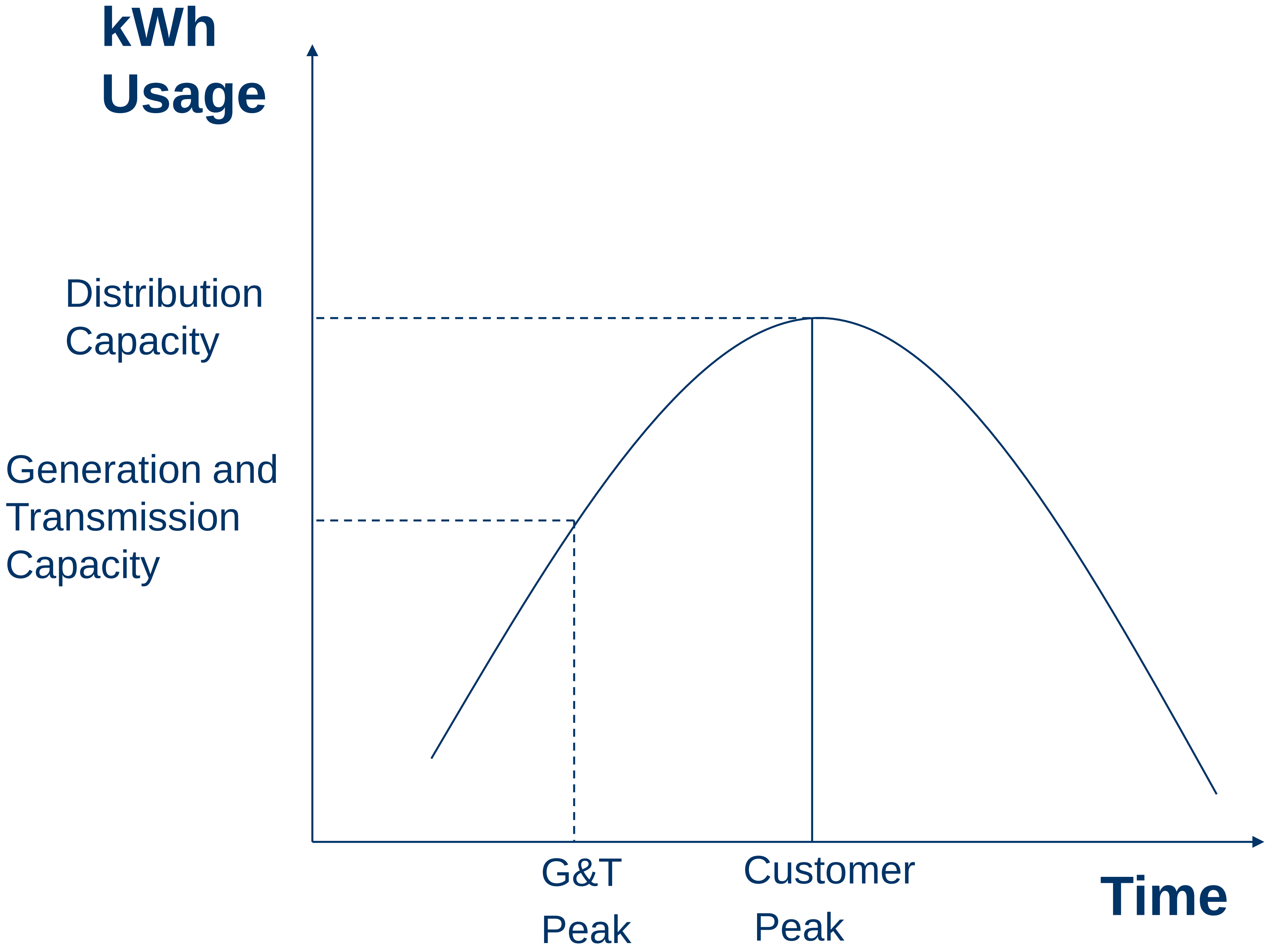
	Natural Gas Fired Simple CT	Combined Cycle	Conventional Coal Plant	Nuclear
Capacity (KW)	75,000	500,000	1,000,000	1,000,000
Cost per KW	$800	$1,600	$3,400	$6,000
Total Fixed Cost	$60,000,000	$800,000,000	$3,400,000,000	$6,000,000,000
Carrying charge	12.0%	12.0%	10.0%	10.0%
Fixed Cost/year	$7,200,000	$96,000,000	$340,000,000	$600,000,000
Hours of Operation	200	2,500	7,446	8,059
Fixed Cost /kWh	$0.480	$0.077	$0.046	$0.074
Fuel cost per kWh	$0.081	$0.058	$0.030	$0.008
Total Cost /kWh	$0.561	$0.135	$0.076	$0.082

Wholesale Rates from Meeting all Load with New Generation

Fixed Cost / kWh	$0.0681
Fuel Cost / kWh	$0.0342
Fixed cost /CP kW-mo.	$36.08
Undelivered Cost / kWh	$0.1023

Demand Related Costs

- Coincident peak demand - Customer’s use of capacity that is coincident with Utility’s peak demand
- Non-coincident peak demand - Capacity needed to meet the customer’s maximum use regardless of when it occurs


kWh
Usage
Distribution
Capacity
Generation and
Transmission
Capacity
G&T
Peak
Customer
Peak
Time

Time Differentiated Rates

- Time differentiated rate structures are used to recognize differences in costs relative to the time of the day
- Either demand or energy costs can be time differentiated
- Time differentiated rates can be developed using either average embedded costs or marginal costs

Cost Candidates for Time Differentiation

Likely

Production Demand

Transmission Demand

Somewhat Likely

Production Energy (Depends on the type of generation capacity)

Not Likely

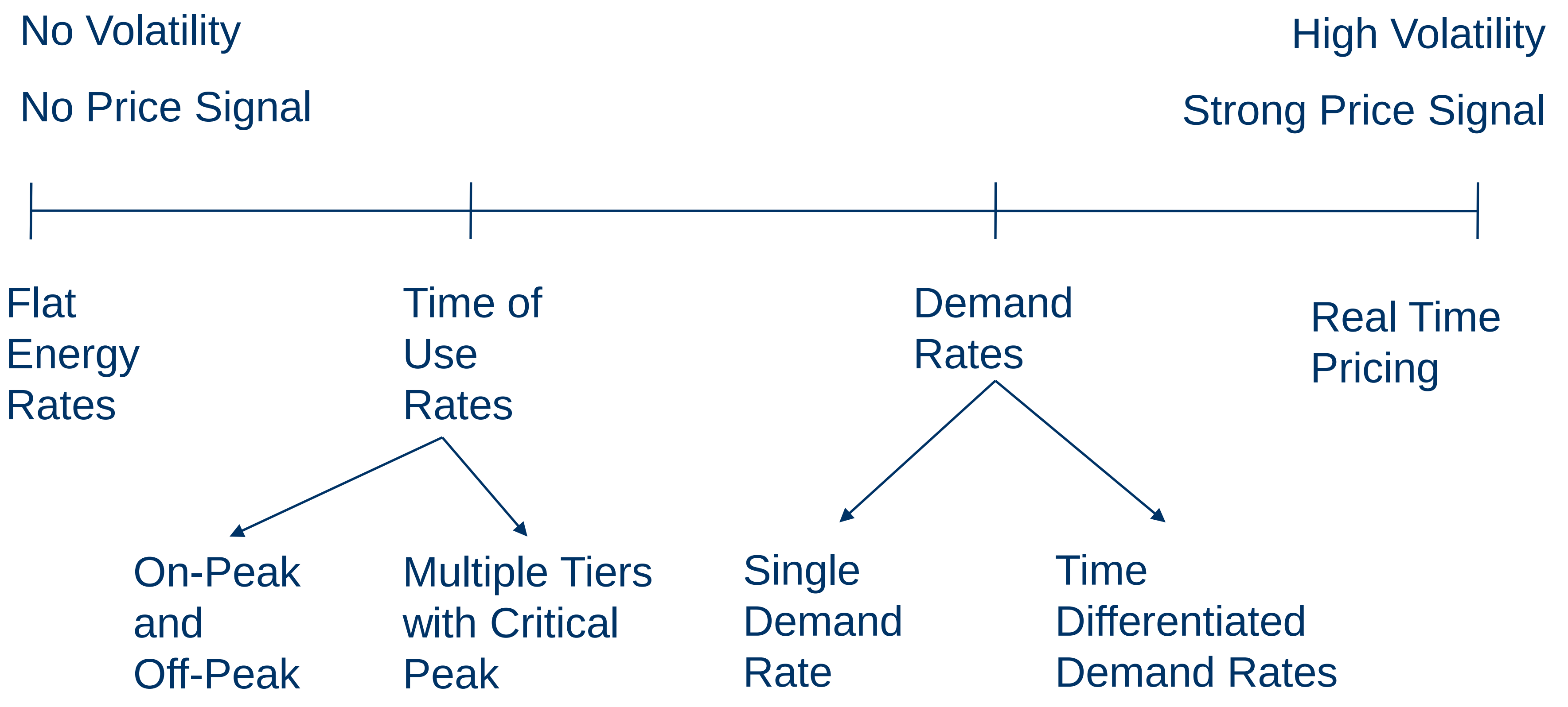
Customer-related Costs

Distribution Demand

Time Differentiated Rates

- Opportunities for time differentiating retail rates can be limited by the rate structure of the G&T provider:
  - NCP billing
  - “Tilted” demand charges (fixed costs shifted to energy charge for recovery)
  - Demand ratchets
  - Lack of a time differentiated energy charge

The Rate Continuum



Mechanics of Time Differentiation

- Opportunities for time differentiating distribution cooperatives retail rates
  - Turn CP demand charges into on-peak retail rate differentials
  - Time differentiated energy charges at the G&T level enhance distribution cooperative’s ability to offer on-peak and off-peak differentials
  - The cost of distribution substation equipment can also be time differentiated (these facilities are generally sized to meet peak demands)

Developing an On-Peak Adder

- Determination of peak periods
  - Likely to vary by season
  - May or may not include weekends
  - Needs to capture G&T’s peak
  - Shorter periods provide more opportunity for customers to shift loads and result in larger on-peak rate differential
- Recovery of enhanced metering costs

Data Requirements

- Monthly purchased power demand costs
- Time of day and day of the week when the G&T's monthly system peaks have occurred
- Load data that can be used to determine energy and demands during the peak periods
- Cost of enhanced metering equipment from vendors
- Recent cost of service study

Key Steps in Designing TOU Rates

- Step 1 – Develop TOU periods
  - Examine 5 to 10 years of G&T system peak demands
  - Determine whether weekend/holiday peaks are likely
  - Determine whether different time periods are appropriate by season
    - Summer peaks often occur in the evening
    - Winter and shoulder peaks can occur in the morning or evening

Key Steps in Designing TOU Rates

- Step 1 (cont.) – Develop TOU periods
  - Determine whether the peak period should be split up into two non-contiguous periods
  - If G&T has TOU or window rates, then those periods may be used unless they are overly broad

Peak Demand Analysis

Peaks Jan 2003 - Jun 2008		
Frequency	Weekday	
7	Sun	
16	Mon	
15	Tue	
5	Wed	
8	Thu	
9	Fri	
7	Sat	
67		

Frequency	Hour Ending		
12	700	(one in May)	
16	800		
4	900		
0	1000		
0	1100		
1	1200	Sat in Apr	
0	1300		
0	1400		
2	1500	Both Sat (Apr, Aug)	
2	1600		
21	1700		
4	1800		
1	1900	(Dec)	
4	2000	(Jan-Apr)	
67			

May-Sep all but two were 1500-1800	
(0700 in May and 1500 in Aug)	
(Both 1500 were on Saturday)	
All peaks after 1800 were Dec-Apr	
Oct-Apr all but one in 600-900 and 1600 to 2000	
(1200 Sat in Apr)	

Key Steps in Designing TOU Rates

- Step 2 – Determine billing units for the on-peak period
  - Determine kWh in the on-peak period for customer classes from load research data, AMI data or from borrowed profiles
  - Determine peak period demands (kW) for large power rates

Key Steps in Designing TOU Rates

- Step 3 – Calculate On-Peak Charge
  - On-peak charge includes:
    - On-peak differential - CP demand charges from G&T during the peak period divided by peak period kWh or kW billing demands
    - G&T on-peak energy charge
    - Distribution delivery charge
  - Off-peak charge includes:
    - G&T off-peak energy charge
    - Distribution delivery charge

Unbundled Cost Based Residential Rates

- Cost of service results:
  - Customer related costs are $20.84/cust/mo.
  - Margins on customer related $4.83/cust/mo.
  - Distribution demand costs are $0.012/kWh
  - Margins on dist demand are $0.008/kWh
  - Purchased power demand is $0.027/kWh
  - Purchased power energy is $0.024/kWh

Flat Energy Rate Example

- Customer charge = $25.67/customer/mo.
- Energy charge = 7.1¢/kWh
  - Distribution demand charge = 2¢/kWh
  - Purchased power demand = 2.7¢/kWh
  - Purchased power energy = 2.4¢/kWh

Time of Use Rate Example

Purchased power demand/peak period kWh = $772,791 / 5,770,947 hrs. = $0.134

On-peak rate = 2.4¢ + 13.4¢ + 2¢ = 17.8¢ / kWh

Off-peak rate = 2.4 ¢ + 2¢ = 4.4¢ / kWh

Customer charge = $25.67

G&T Time Differentiated Energy Charges

- Based on the average of system lambda data for on-peak and off-peak periods
- System lambda is the marginal cost of production in $/MWh
- Marginal cost is the cost in $/MWh of the most expensive unit that is dispatched in a least cost dispatch

Example with G&T Time Differentiated Energy Charges

- 3.0¢/kWh energy charge for on-peak period
- 2.0¢/kWh energy charge for off-peak period

Time of Use Rate Example with G&T Time Differentiated Energy

Purchased power demand/peak period kWh =

$772,791 / 5,770,947 hrs. = 13.4¢/kWh

On-peak rate = 3.0¢ + 13.4¢ + 2¢ = 18.4¢ / kWh

Off-peak rate = 2.0¢ + 2¢ = 4.0¢ / kWh

Customer charge = $25.67

Time of Use Rates

- Choosing the on-peak period as narrowly as possible is the key
- Broad peak period (e.g. 7 AM to 11 PM)
  - Not very useful to customers
  - Results is small differential between on-peak and off-peak because the denominator in the calculation of the on-peak adder is large
- Flat rate results if everything is on-peak

Problem With TOU Rates

- Once the on-peak period is selected and the rate is calculated, any usage during the on-peak period is billed at the on-peak rate, even if there is little or no chance of hitting a peak on that day
- Sends better price signals than flat rates
- A demand rate would send an even better price signal

Single Demand Rate Example

Customer charge = $25.67

Energy charge = $0.024/kWh

Distribution Demand charge =

$347,267 / 68,227 KW-mos. = $5.09/ NCP KW

Purchased power demand charge =

$772,791 / 59,527 KW-mos. = $12.98/ CP KW

Problem With Single Demand Rate

- May send the wrong price signal to high load factor customers that hit maximum demand in the off-peak period
- Load factor (LF) is the ratio of the average load that occurs over a period of time to the maximum load that occurs during that same time

$$LF = [kWh \div hrs] \div kW_{max}$$

Impact of Load Factor on Delivered Cost to Customers

		Demand Charge per kW	$10.00
		Energy Charge per kWh	$0.0300
	Customer A	Customer B	Customer C
kW	100	100	100
kWh	7,300	29,200	54,750
Demand Cost	$1,000.00	$1,000.00	$1,000.00
Energy Cost	$219.00	$876.00	$1,642.50
Total Bill	$1,219.00	$1,876.00	$2,642.50
Load Factor	10%	40%	75%
Cost per kWh	$0.1670	$0.0642	$0.0483

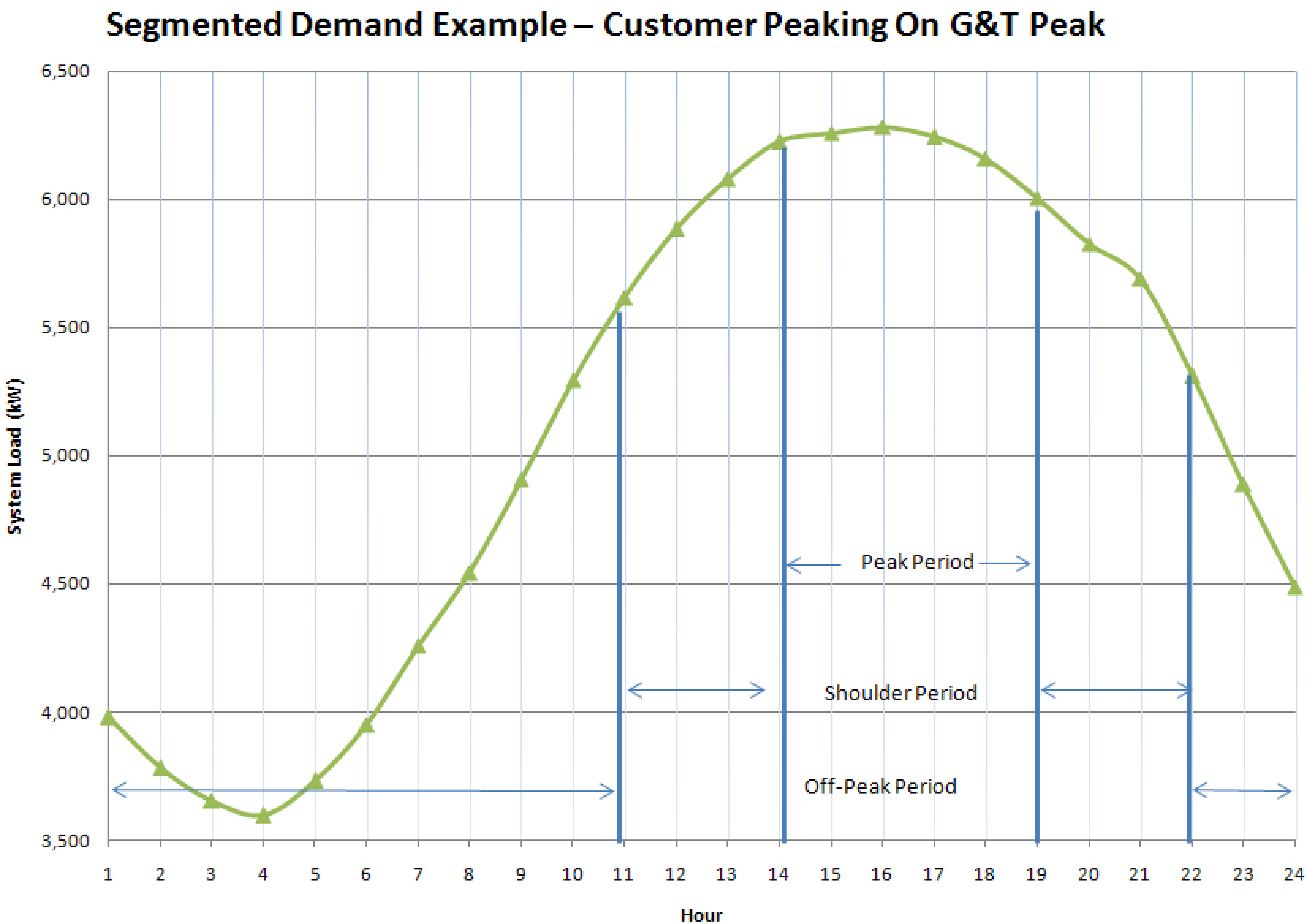
Time Differentiated Demand Options

TOU Rate Design Alternatives

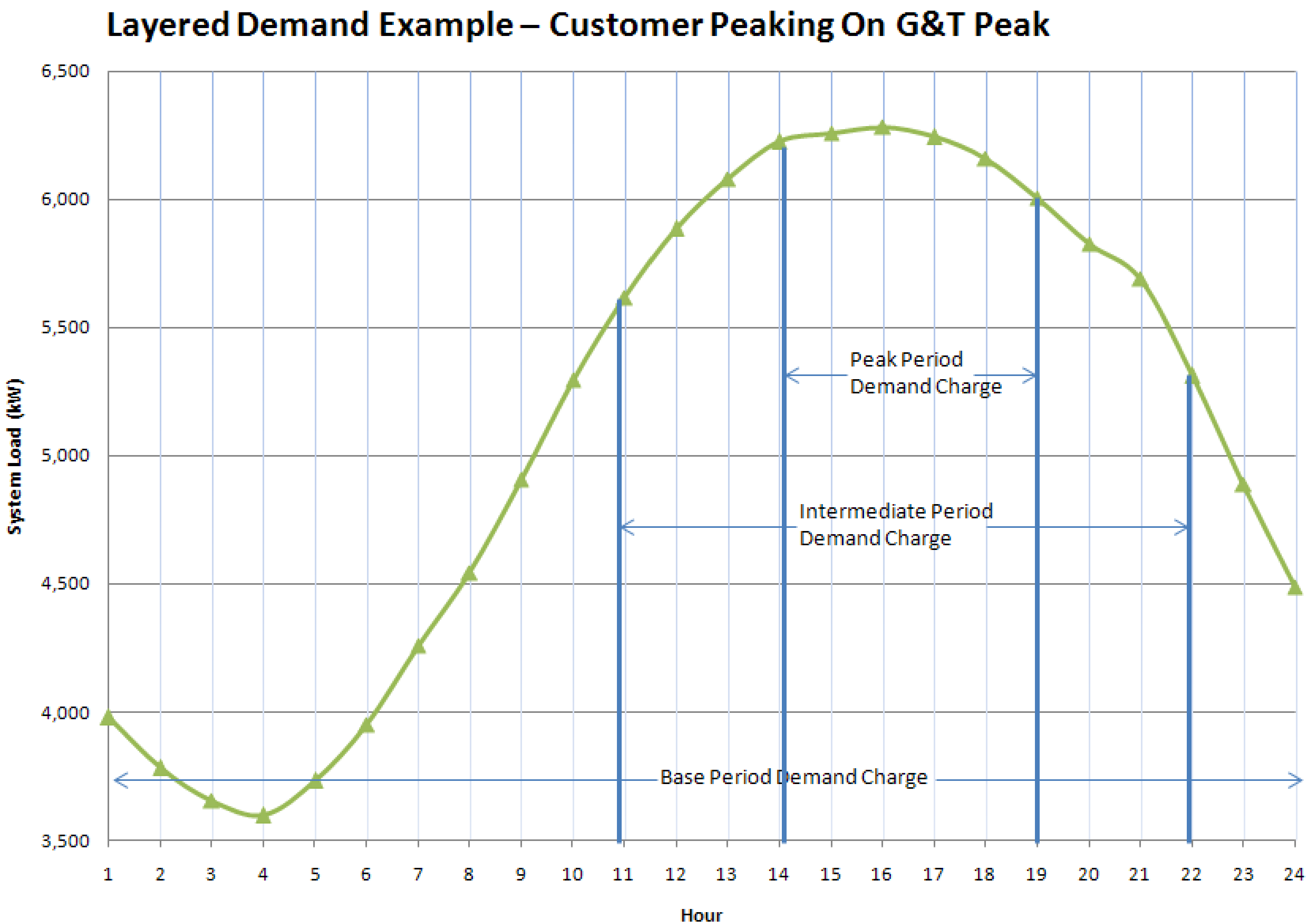
Single Demand Charge Option 1
NCP Demand Charge (Maximum demand during the month) or
CP Demand Charge (Maximum demand at time of system peak)

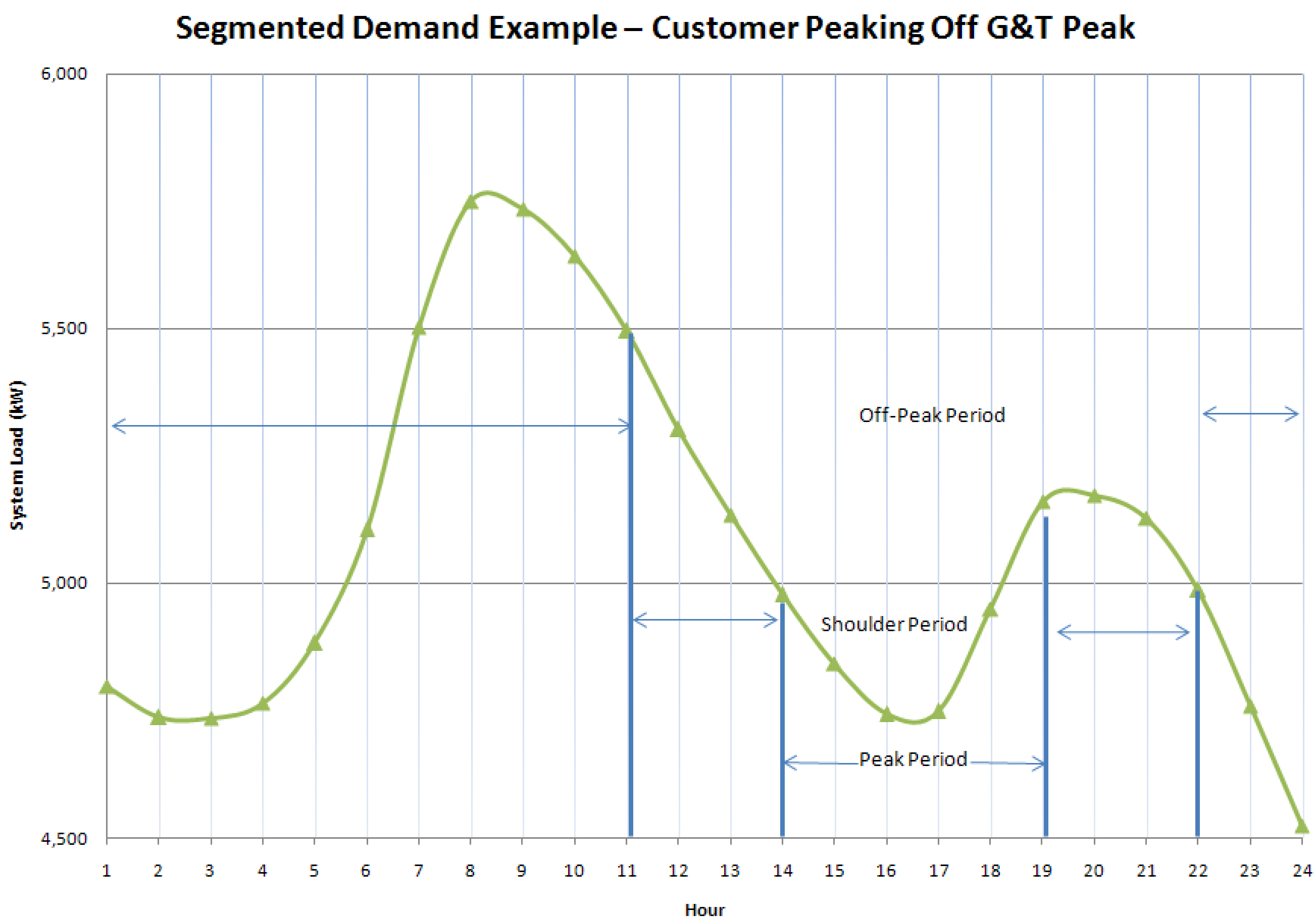
Segmented Demand Option 2
Off-Peak Period Demand Charge (Max demand during off-period)
Shoulder Period Demand Charge (Max demand during shoulder period)
Peak Period Demand Charge (Max demand during peak period)

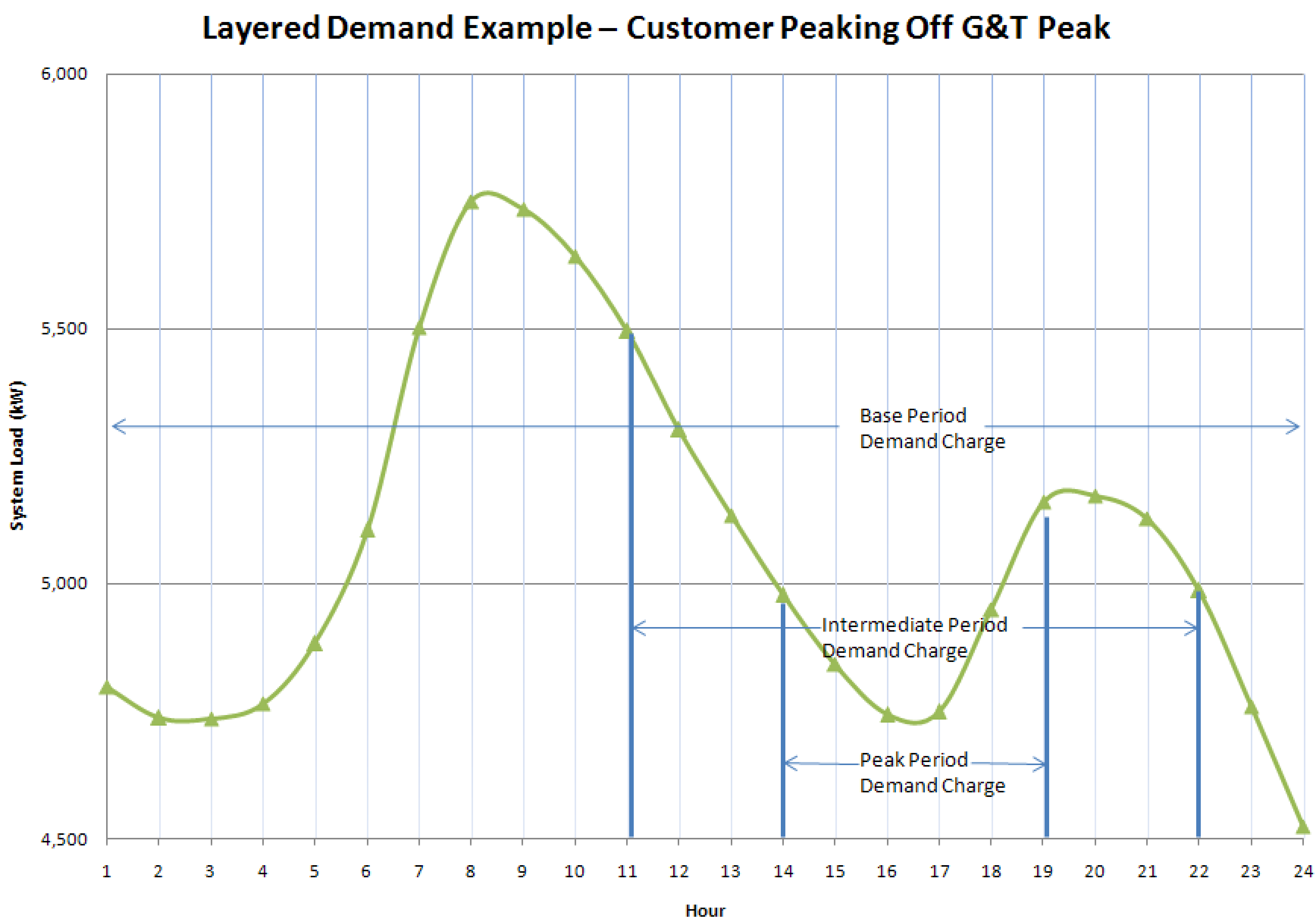
Layered Demand Option 3
Base Period Demand Charge (Max demand during month)
Intermediate Period Demand Charge (Max demand during both peak and intermediate periods)
Peak Period Demand Charge (Max demand during peak period)



Segmented Demand Example – Customer Peaking On G&T Peak
6,500
6,000
5,500
5,000
4,500
4,000
3,500
System Load (kW)
Peak Period
Shoulder Period
Off-Peak Period
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour


Layered Demand Example – Customer Peaking On G&T Peak
6,500
6,000
5,500
5,000
4,500
4,000
3,500
System Load (kW)
Peak Period Demand Charge
Intermediate Period Demand Charge
Base Period Demand Charge
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour


Segmented Demand Example – Customer Peaking Off G&T Peak
System Load (kW)
6,000
5,500
5,000
4,500
Off-Peak Period
Shoulder Period
Peak Period
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Hour


Layered Demand Example – Customer Peaking Off G&T Peak
6,000
5,500
5,000
4,500
System Load (kW)
Base Period
Demand Charge
Intermediate Period
Demand Charge
Peak Period
Demand Charge
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Hour

Customer's Max Demand Occurs during the Peak Period

Maximum Demand During Off-Peak Period	600	kW				
Maximum Demand During Shoulder Period	800	kW				
Maximum Demand During Peak Period	1,000	kW				
	Billing Units			**Demand Charge**		**Demand Billings**
Single NCP Demand Charge Option 1						
Demand Charge	1,000	kW	$	11.95	$	11,950
Segmented Demand Option 2						
Off-Peak Period Demand Charge	600	kW	$	2.00	$	1,200
Shoulder Period Demand Charge	800	kW	$	4.50	$	3,600
Peak Period Demand Charge	1,000	kW	$	7.15	$	7,150
					$	11,950
Layered Demand Option 3						
Base Period Demand Charge	1,000	kW	$	4.45	$	4,450
Intermediate Period Demand Charge	1,000	kW	$	3.00	$	3,000
Peak Period Demand Charge	1,000	kW	$	4.50	$	4,500
					$	11,950

Customer's Max Demand Occurs during the Peak Period ("Lower" Load Factor with Less Off-Peak Load)

	Billing Units		Demand Charge	Demand Billings
Maximum Demand During Off-Peak Period	200	kW		
Maximum Demand During Shoulder Period	600	kW		
Maximum Demand During Peak Period	1,000	kW		
Single NCP Demand Charge Option 1				
Demand Charge	1,000	kW	$ 11.95	$ 11,950
Segmented Demand Option 2				
Off-Peak Period Demand Charge	200	kW	$ 2.00	$ 400
Shoulder Period Demand Charge	600	kW	$ 4.50	$ 2,700
Peak Period Demand Charge	1,000	kW	$ 7.15	$ 7,150
				$ 10,250
Layered Demand Option 3				
Base Period Demand Charge	1,000	kW	$ 4.45	$ 4,450
Intermediate Period Demand Charge	1,000	kW	$ 3.00	$ 3,000
Peak Period Demand Charge	1,000	kW	$ 4.50	$ 4,500
				$ 11,950

Customer's Max Demand Occurs during the Peak Period ("Higher" Load Factor and Greater Off-Peak Load)

Maximum Demand During Off-Peak Period	900	kW				
Maximum Demand During Shoulder Period	900	kW				
Maximum Demand During Peak Period	1,000	kW				
	Billing Units			**Demand Charge**		**Demand Billings**
Single NCP Demand Charge Option 1						
Demand Charge	1,000	kW	$	11.95	$	11,950
Segmented Demand Option 2						
Off-Peak Period Demand Charge	900	kW	$	2.00	$	1,800
Shoulder Period Demand Charge	900	kW	$	4.50	$	4,050
Peak Period Demand Charge	1,000	kW	$	7.15	$	7,150
					$	13,000
Layered Demand Option 3						
Base Period Demand Charge	1,000	kW	$	4.45	$	4,450
Intermediate Period Demand Charge	1,000	kW	$	3.00	$	3,000
Peak Period Demand Charge	1,000	kW	$	4.50	$	4,500
					$	11,950

Customer's Max Demand Occurs during the Off-Peak Period

Maximum Demand During Off-Peak Period	1,000	kW				
Maximum Demand During Shoulder Period	800	kW				
Maximum Demand During Peak Period	600	kW				
	Billing Units			**Demand Charge**		**Demand Billings**
Single NCP Demand Charge Option 1						
Demand Charge	1,000	kW	$	11.95	$	11,950
Segmented Demand Option 2						
Off-Peak Period Demand Charge	1,000	kW	$	2.00	$	2,000
Shoulder Period Demand Charge	800	kW	$	4.50	$	3,600
Peak Period Demand Charge	600	kW	$	7.15	$	4,290
					$	9,890
Layered Demand Option 3						
Base Period Demand Charge	1,000	kW	$	4.45	$	4,450
Intermediate Period Demand Charge	800	kW	$	3.00	$	2,400
Peak Period Demand Charge	600	kW	$	4.50	$	2,700
					$	9,550

Customer's Max Demand Occurs during the Off-Peak Period

Maximum Demand During Off-Peak Period	1,000	kW		
Maximum Demand During Shoulder Period	800	kW		
Maximum Demand During Peak Period	600	kW		
	Billing Units		**Demand Charge**	**Demand Billings**
Single CP Demand Charge Option 1				
Demand Charge	600	kW	$ 11.95	$ 7,170
Segmented Demand Option 2				
Off-Peak Period Demand Charge	1,000	kW	$ 2.00	$ 2,000
Shoulder Period Demand Charge	800	kW	$ 4.50	$ 3,600
Peak Period Demand Charge	600	kW	$ 7.15	$ 4,290
				$ 9,890
Layered Demand Option 3				
Base Period Demand Charge	1,000	kW	$ 4.45	$ 4,450
Intermediate Period Demand Charge	800	kW	$ 3.00	$ 2,400
Peak Period Demand Charge	600	kW	$ 4.50	$ 2,700
				$ 9,550

Observations

- CP demand provides the strongest price signal to move usage to off-peak periods
  - Accurately recovers the cost of production demand
  - May under-recover for distribution demand, which can be corrected by billing an unbundled distribution component on an NCP basis
- Segmented demand sends perverse price signals with respect to load factor

Observations

- A layered demand approach sends better price signals than a segmented demand approach or either a single CP or NCP demand
  - Base period charge can be used to recover distribution demand costs (similar to NCP demand charge for these costs)
  - Intermediate and peaking charges can be used to more accurately recover the cost of production demand

Critical Peak Pricing

- Reflects cost of meeting customer needs during peak periods
- Example from Gulf States
  - Standard Residential Rate 11.3 cents
  - Time differentiated with a critical peak
    - LOW 9.2 cents (28% of time)
    - MEDIUM 10.4 cents (59% of time)
    - HIGH 15.0 cents (12% of time)
    - CRITICAL 35.9 cents (1% of time)

Critical Peak Pricing

- Critical peaks can be called 8 times a year for a maximum of 5 hours each time
- Resulted in a reduction of about 10 MW from a 3,000 customer pilot program

Seasonal Rate Structures

- Seasonal rate structures are used to recognize differences in costs relative to the time of year (i.e., seasons)
- Either demand or energy costs can be seasonally differentiated
- Accurately reflect cost but not much opportunity to shift usage
- Basically a flat rate by season

Seasonal Rate Structures

- Summer (June- Sept.)
  - Demand $12.00 / CP kW-month
  - Energy $0.05/kWh
- Winter (Dec.- Feb.)
  - Demand $10.00 / CP kW-month
  - Energy $0.045/kWh
- Shoulder (Mar. – May and Oct. – Nov.)
  - Demand $5.00 / CP kW-month
  - Energy $0.04/kWh

Seasonal Rate Structures

- Seasonal time of use provides more opportunities for customers
  - 20.025¢/kWh on-peak in summer (3 PM to 9 PM Monday through Friday in June, July, Aug)
  - 22.271¢/kWh on-peak in winter (7 AM to 10 AM and 6 PM to 9 PM Monday through Friday in Dec, Jan, Feb)
  - 7.327¢/kWh off-peak (all other hours of the year)

Real Time Pricing

- Reflect actual market price for electric energy to customer (hourly energy market price)
- Requires the infrastructure to transmit prices to customers and to measure customer consumption during appropriate time periods

Real Time Pricing

- Customers likely to need risk management tools to handle increased price volatility
- By having a strategy to deal with the high priced side of the market, the customer gets access to the low priced side of the market
- Opportunity to access the low priced side of the market is not available with average embedded cost pricing

Providing Customers Control of Their Energy Bills

- Provide the right retail rate environment for energy efficiency, conservation, demand response and net metering
- Provide retail rate menus
  - Provide incentives for customers to improve load factor and reduce delivered cost per kWh
  - Provide incentives for customers to shift usage to time periods that are less costly to serve
  - Give customers more control over their energy bills
  - Provide customers with “virtual choice”

Questions?

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