TOU Tariff Analysis and Program Development

A project of USAID's Energy Efficiency for Clean Development Program (EECDP)

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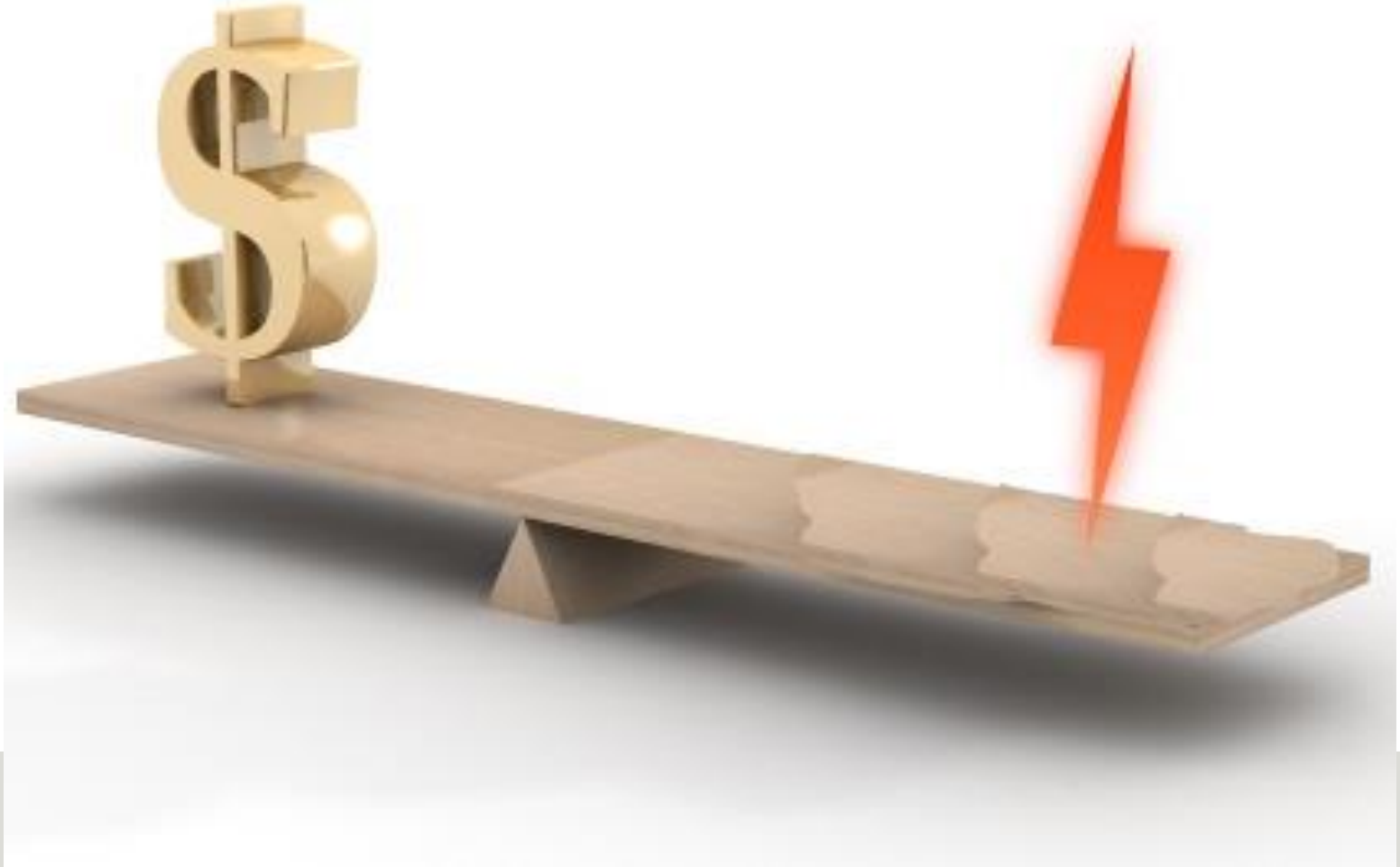
Introduction



DSM - Energy Efficiency

- Permanent reduction in consumption
- Reduction occurs across most hours of the load curve
- May or may not reduce system peak demand
- Provides same or better energy service with fewer kWh

DSM - Demand Response

- Temporary reduction in consumption
- Reductions targeted at specific hours, typically coincident with system peak
- May be associated with curtailment of service
  - But may not be perceived as curtailment

Demand Response

- Load Curtailment
  - Direct load control
  - Interruptible load control
- Dynamic Pricing
  - Real time Pricing
  - **Time of Use (TOU)**
  - Critical Peak Pricing (CPP)

Demand Response

- Utility-controlled switches on specific devices, e.g. AC units, water heaters
  - Pro
    - Quick demand reductions
  - Cons
    - Requires large number participation
    - Generally not applicable to industrial customers. Can be applied to most smaller customers with at least one appropriate load

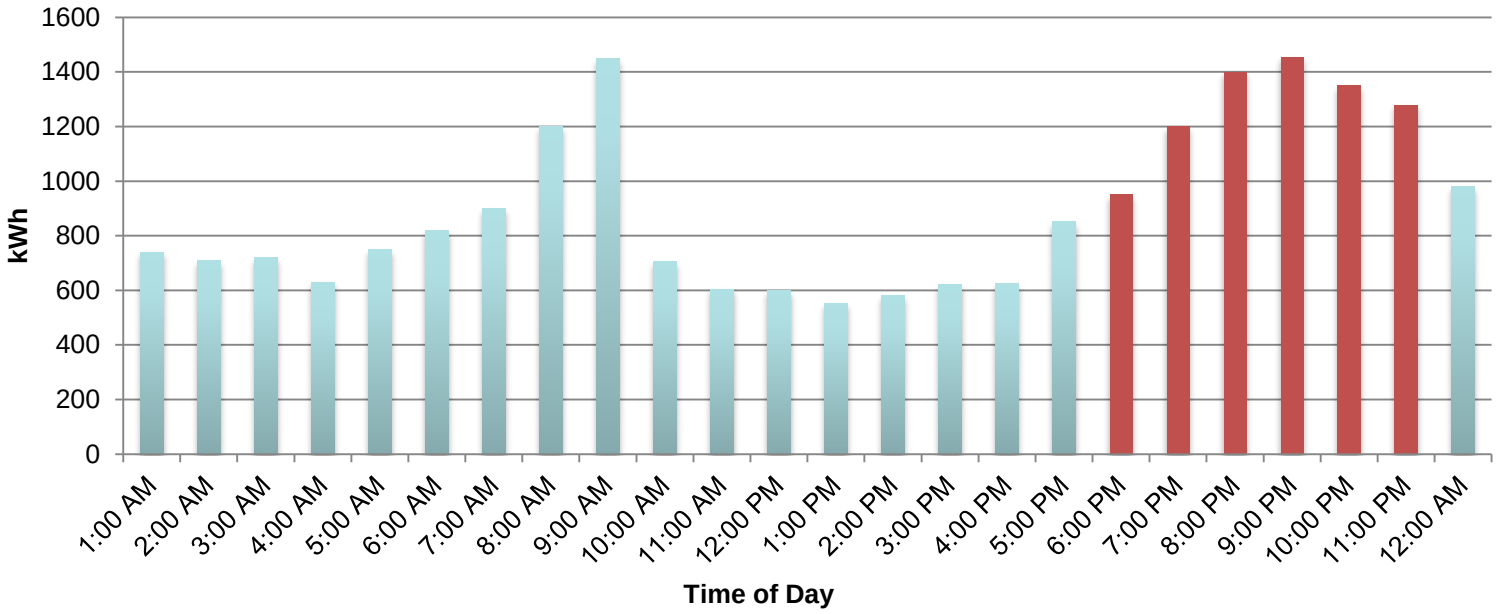
Types of Demand Response Programs - Interruptible Load

- Contract with customers to reduce demand as needed to stabilize grid
  - Pro
    - Applicable to industrial customers
    - Large demand reduction potential
  - Cons
    - Requires lead time – good forecasting tools

Types of Demand Response Programs - Time Based Programs

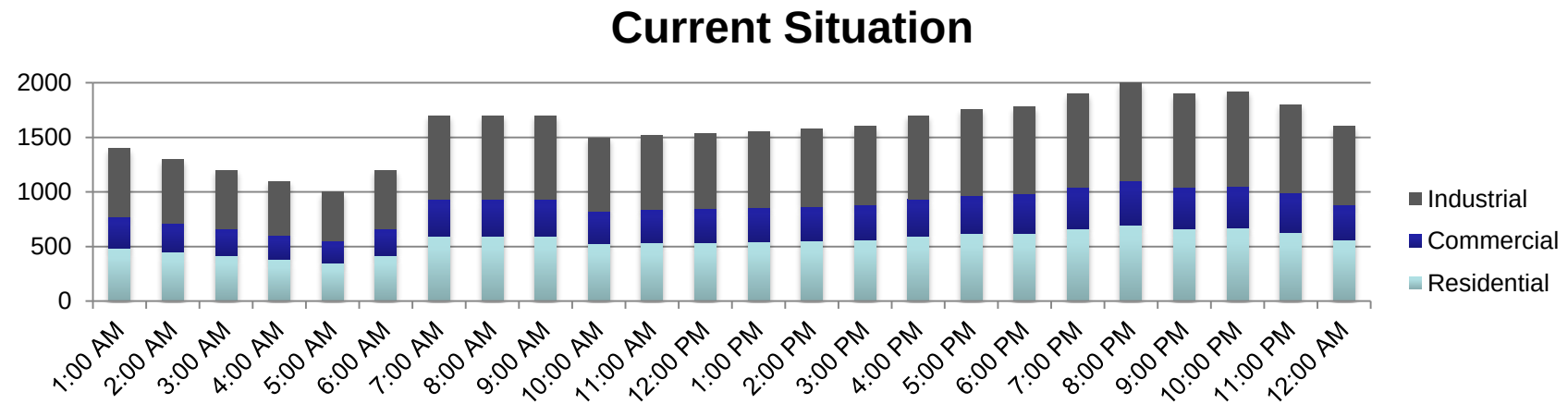
- Time of Use: Price electricity higher in peak periods
  - Can be applied to any customer class
- Critical peak pricing: for the highest peak hours
  - Difficult to implement as require advanced forecasting models
- Real time pricing: changes by hour
  - Complex to implement

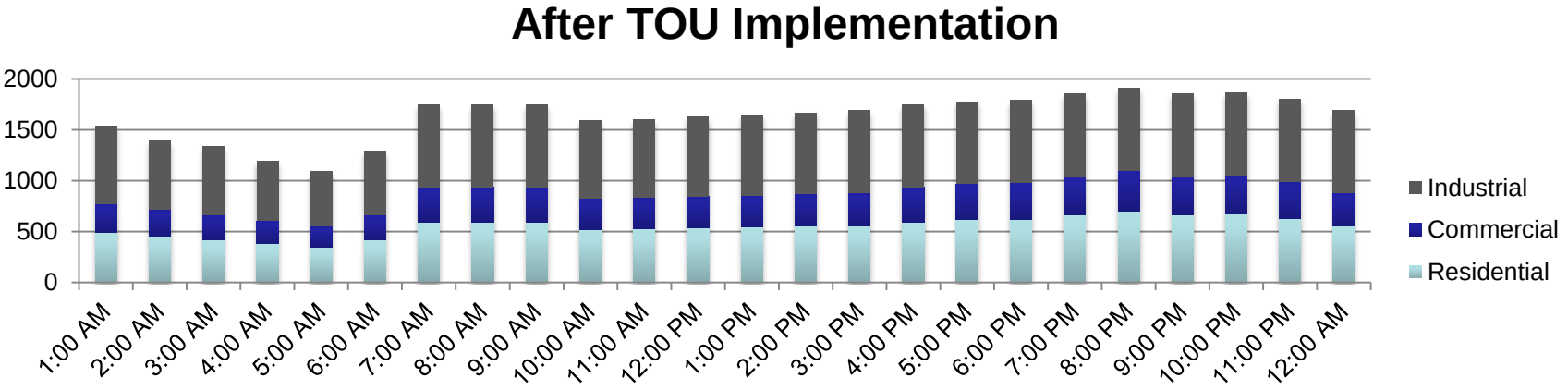
Time of Use Rate Structure



- Energy used in the blue shading is charged at off-peak rates
- Energy used in the red shading is charged at on-peak rates
- On-peak times are for non-holiday weekdays.
- Weekends / holidays are always off-peak.

Potential Impact of TOU Rate Structure





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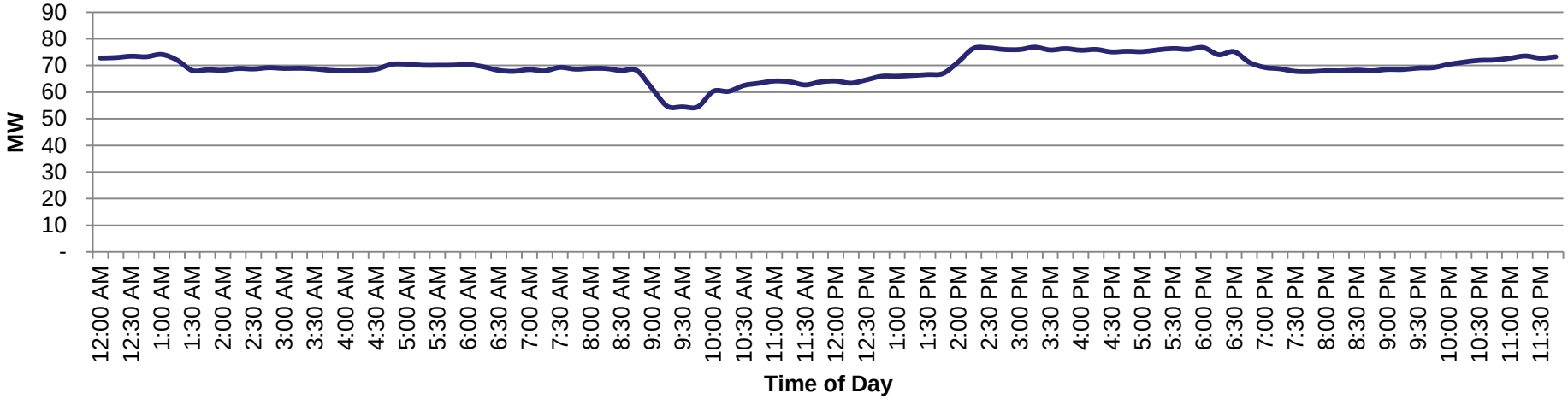
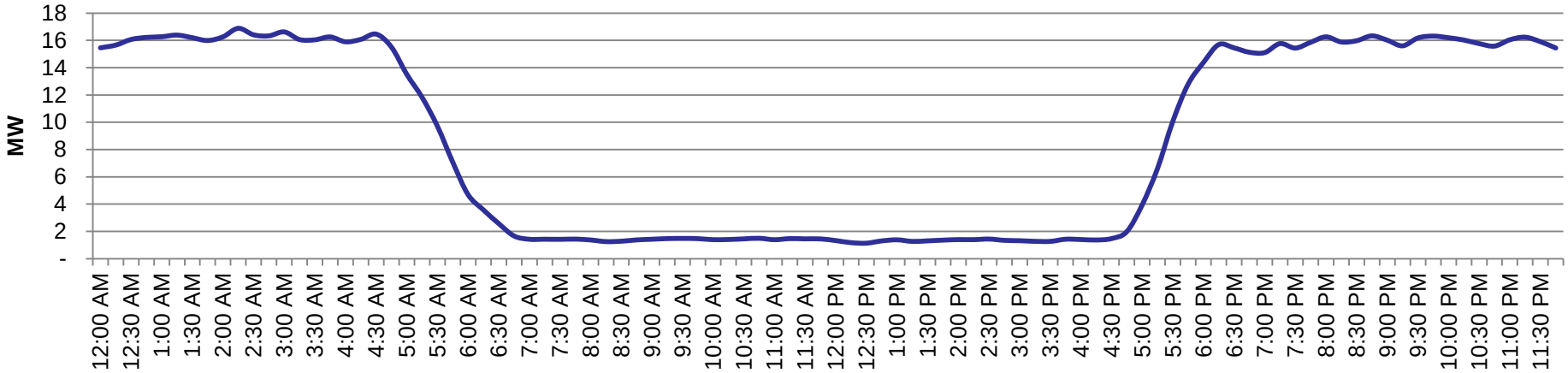
Why ECG Needs to Implement TOU Rate Structure

- Industrial customers are using high demand end loads during peak hours that can easily be shifted to off-peak hours
- Smart Meters provide ECG the ability
- Cost of generation varies with demand
- It will help stabilize the electricity supply resulting in less voltage fluctuation
- It will help reduce electricity outage

Sample Industrial Customer Load Review





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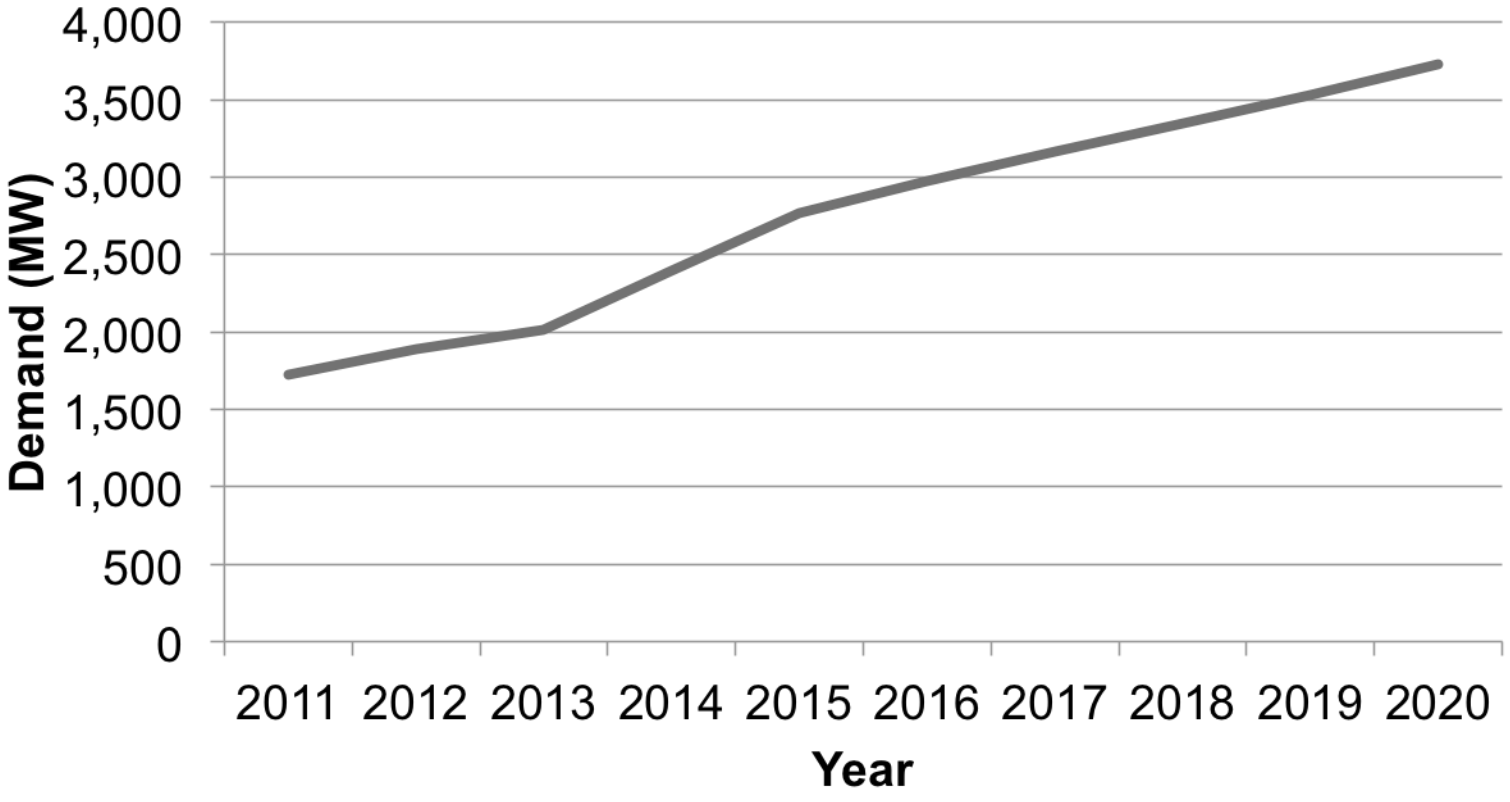
How Will ECG's Customers Benefit From TOU Rate Structure

- System reliability improvement
- The targeted industrial sector will be able to save money

Approach

- **Activity 1: Document Review**
- **Activity 2: Conduct Metering Data Analysis.**
- **Activity 3: Determine Utility Costing Periods and Develop TOU Tariff Strategies**
- **Activity 4: Create Marketing Plan and Support Pilot Rollout**

Baseline Energy Use



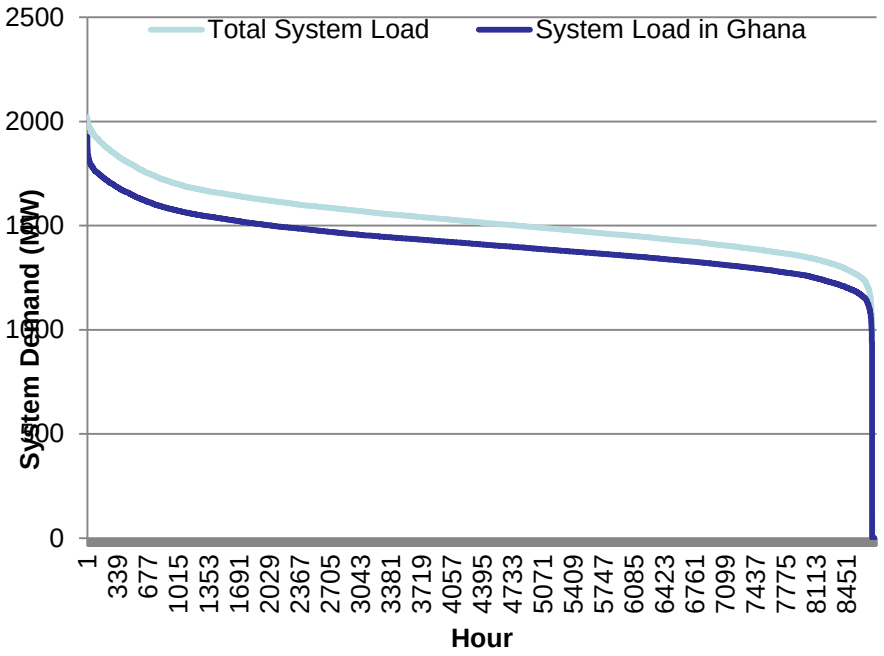
Electricity Use by Tariff Class

Tariff Class	Customers in Tariff Class	% Total Cust.	Total Sales (GWh)	% Sales	Total Demand (MW)
Residential	2,160,000	99 %	3,228	35%	1008
Non-Residential			1,525	16%	
Industrial	1,645	< .01%	4,224	45%	1008
Street Lighting	N/A	N/A	377	4%	N/A
Total	2,161,645		9354	100%	2,016

Electricity Sector Revenue Shortfall

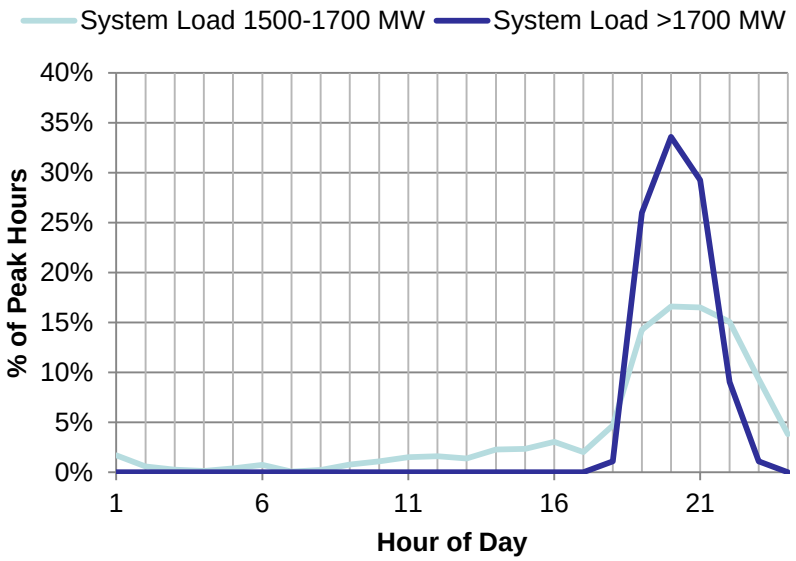
Year	Generation COS (million US$)	Transmission COS (million US$)	Distribution COS (million US$)	ECG Revenue Requirements, COS study (million US$)	ECG Revenue Requirements, ECG (million GHc [million US$])
2014	764	96.4	433	442	3,389.3 [1,118.5]

System Load Review



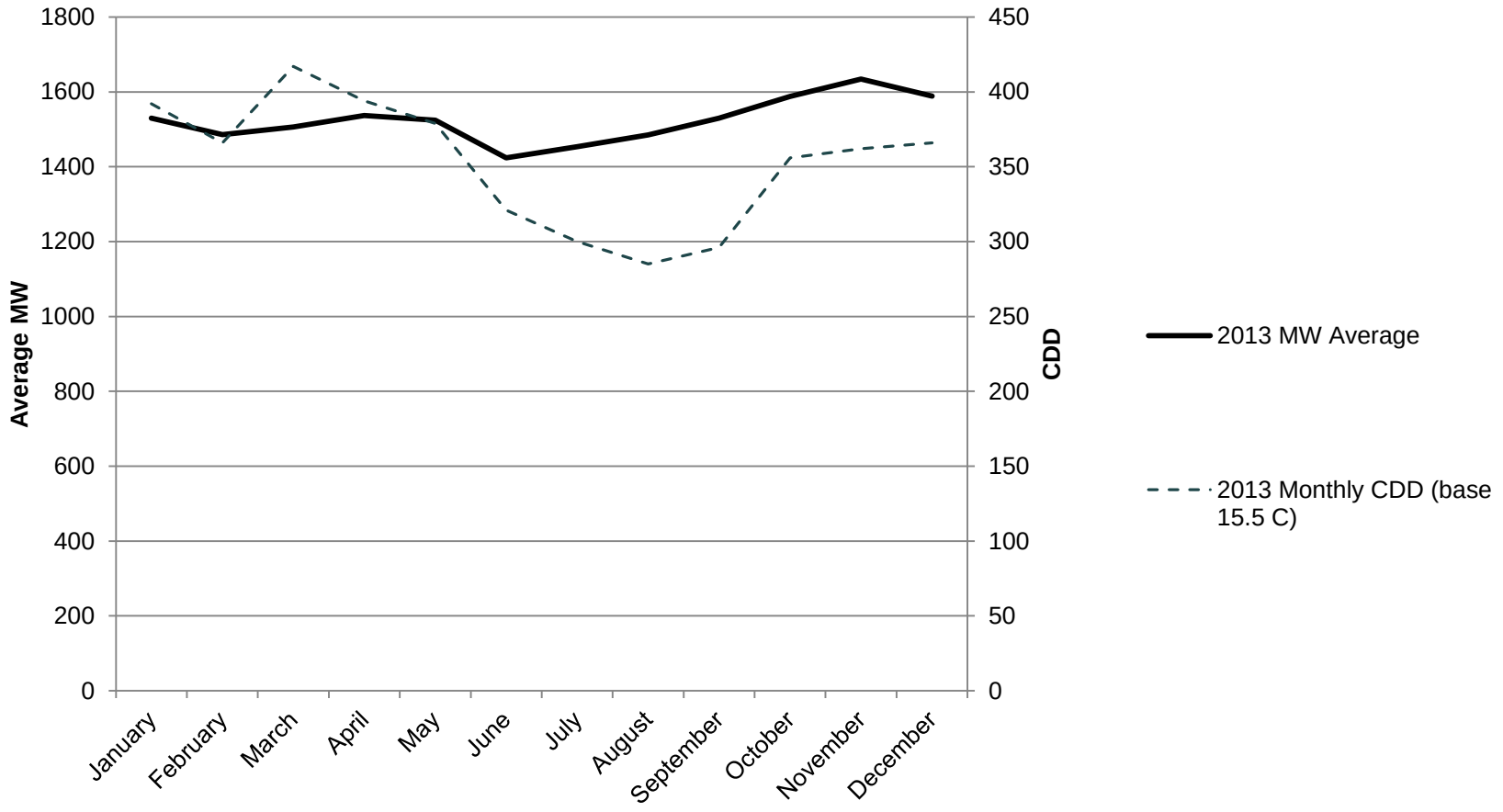
System Demand Bin	% 2013 Hours	% Cumulative Hours
0<MW<=1000	0%	0%
1000<=MW<1100	0%	0%
1100<=MW<1200	0%	1%
1200<=MW<1300	3%	4%
1300<=MW<1400	14%	18%
1400<=MW<1500	27%	45%
1500<=MW<1600	28%	73%
1600<=MW<1700	16%	89%
1700<=MW<1800	6%	95%
1800<=MW<1900	4%	98%
>1900	2%	100%

System Load Review



Time	System Load 1500-1700 MW	System Load >1700 MW
12-1 am	2%	0%
1-2 am	1%	0%
2-3 am	0%	0%
3-4 am	0%	0%
4-5 am	0%	0%
5-6 am	1%	0%
6-7 am	0%	0%
7-8 am	0%	0%
8-9 am	1%	0%
9-10 am	1%	0%
10-11 am	1%	0%
11 am -12 pm	2%	0%
12-1 pm	1%	0%
1-2 pm	2%	0%
2-3 pm	2%	0%
3-4 pm	3%	0%
4-5 pm	2%	0%
5-6 pm	5%	1%
6-7 pm	14%	26%
7-8 pm	17%	34%
8-9 pm	17%	29%
9-10 pm	15%	9%
10-11 pm	9%	1%
11 pm -12 am	4%	0%

System Load Review



Literature Review

Country	Ratio of on-peak to off-Peak rates	Pricing Periods
Algeria	8.2	3
Iran	5.4	3
Israel	21.13	3
Egypt	4.12	2
Jordan	9.2	2
Lebanon	21.2	3
Morocco	13.8	3
Syria	6.5	3
Tunisia	10.1	4
China (Jiangsu)	3.8	3
Korea	3.58	3
South Africa	7.3	3
Taiwan	2.67	3
Thailand	2	2
Turkey	2.59	3
Vietnam	3.12	3

Snapshot of Industrial Electricity Price Elasticity

Market	Date of Study	Own-price Elasticity	Substitution Elasticity
Ontario, Canada	1997	-0.07 to -0.09	0.7 to 0.11
CA, NY, and Midwest	1984	-0.014 to -0.02	
California, US	1983	-0.03	
Ontario, Canada	1986	N/A	
Texas, US	1984	-1.1	0.21
California, US	1983	-0.15 to -.27	N/A
California, US	1984	-0.02 to -0.09	
California, US	1991	-0.04 to -0.09	
Ontario, Canada	1983	0 to -0.24	
US	1978	-0.41	
US	1978	-0.78	
US	1978	-1.01	

Analysis

		Substitution Elasticity		
		0.02	0.15	0.27
Own Price Elasticity	-0.41	**Calculation for Each Combination:** On-Peak Consumption Change Off-Peak Consumption Change Revenue Impact		
	-0.78			
	-1.01			

Scenario Analysis

	Scenario 1 (Recommended)	Scenario 2	Scenario 3
Ratio of On-Peak to Off-peak	2	4	8
TOU Off-peak discount	15%	35%	55%
Estimated On-Peak Consumption Change	-8%	-13%	-18%
Estimated Off-Peak Consumption Change	-1%	-2%	-6%
Estimated Revenue Impact	0%	-2%	-4%
Potential System Peak Load Reduction (MW)	73	121	167

Proposed Tariff

	LV	MV	HV	HV Mines	Time Period	Hours per Day	Total Hours per Year	% Total Annual Hours
Current Energy Charge (Ghp/kWh)	51.71	40.02	36.80	58.41	All Hours	24	8760	N/A
Proposed Off-Peak Energy Charge (Ghp/kWh)	43.95	34.02	31.28	49.65	11 PM to 6 PM	19	6935	79%
Proposed On-Peak Energy Charge (Ghp/kWh)	87.90	68.04	62.56	99.3	6 PM to 11 PM	5	1825	21%

Industrial TOU Program Savings & Costs

Program Metric	2015	2016	2017	2018	2019
Incremental MW Savings	0	31	36	50	56
Cumulative MW Savings	0	31	36	50	56
Annual Program Costs ($Millions, USD)	$0.45	$0.3	$0.3	$0.3	$0.3
Annual Program Costs (Millions GHc)	GHC 0	GHc 717	GHc 478	GHc 478	GHc 478

Industrial TOU Program Cost-Effectiveness

Utility Cost Test (UCT) Ratio	**4.7**
Net UCT Benefits ($Millions)	$36.6
Net UCT Benefits (Millions GHc)	GHS 110.9
Levelized cost per kWh ($)	$2.25
Levelized cost per kWh (GHc)	GHS 6.8
Levelized cost per kW ($)	$10
Levelized cost per kW (1000 GHc)	GHS 33.30

Goals/Program Alternatives

Achievable MW Savings Potential (Cumulative, 2019)	Market Transformation Potential	Equity	Political Feasibility	Program Complexity	Implementation Risk	Net Utility Benefits ($Millions)
56	Not applicable.	Equity within the industrial sector will be determined by the regulatory requirements of the tariff (e.g., whether it is opt-in or opt-out). Overall, the tariff increases system-wide equity by reducing cross-subsidies and outages caused in part by energy charges being misaligned with energy costs.	High. Required by policy. Some industrials may initially object due to inflexibility in system operation.	Low. Start-up could be complex. Ongoing implementation involves low complexity.	Low. Requires minimal infrastructure investment with potentially high system benefits.	$36.6

Recommended Next Steps

- Create marketing brochures to clearly communicate the program details. Implement a voluntary pilot with a small set of industrial customers.
- Revise the program based on the findings of the pilot and launch ‘opt-in’ TOU program to build momentum. (3-6 months from program start date).
- Conduct evaluation, measurement and verification (EM&V) activities. Revise the program requirements and launch a mandatory program with exemptions for certain industries e.g. continuous process petrochemicals. (12-18 months from program start date).

Customer Messaging for TOU pricing

- Shift the energy intensive end-use to off-peak hours to save money
- If your facility has on-site generation use it during on-peak hours
- Manage electricity use for all end-uses; e.g. Charge batteries and fill compressed air tanks at night
- Implement an energy conservation plan and upgrade inefficient equipment

Motivation

- Chronic capacity and energy shortages
- The recent tariff increase to about US $0.20/kWh can cause an adverse impact on the competitiveness of Ghanaian industries

Goal

- Provide technical assistance to address load management by developing a Time of Use (TOU) tariff analysis and program design targeted at the industrial sector

Why Industrial Sector

- Customers already have the necessary infrastructure in the form of smart meters
- Customers electricity demand holds the greatest potential for load modification,
- Customers accounts for a high share of the total electricity usage

Potential

- Various scenarios were analyzed resulting in *economic* potential demand reduction ranging from 73MW to 167MW.
  - Due to the already high electricity prices, the scenario that results in the least aggressive pricing is recommended to ensure widespread acceptability.
- The recommended tariff is estimated to result in 56MW *achievable* potential which is around 5% of the industrial load or 2% of the system load by 2019.

Proposed Rate Structure

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Program Recommendations

- It is recommended the program be launched as a voluntary pilot for a period of 3-6 months.
  - The program should be revised based on the outcome of the pilot,
- ‘Opt-in’ program should be launched for a period of 12-18 months.
  - This will give sufficient time for the program to mature,
- Launch a mandatory TOU tariff program
  - (With necessary exemptions)