PASSIVE HOUSE AND STORAGE

AN ECONOMIC PERSPECTIVE

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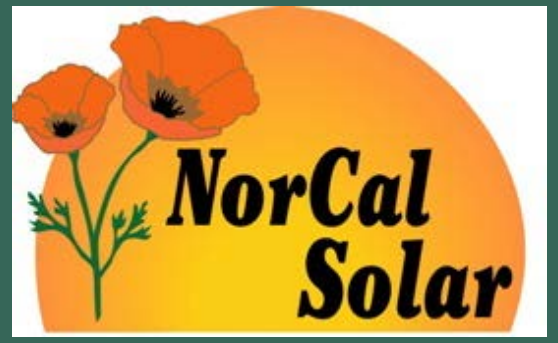
October 6, 2017



WHAT IS ENERGY STORAGE?

- **Generally accepted home energy storage devices are lithium nickel-manganese-cobalt oxide, lithium iron phosphate or lead-acid electromechanical devices that store energy. This energy is often provided by rooftop or co-located photovoltaic (PV) panels and supports distributed generation.**
- **Notably many manufacturers of home use battery storage devices started as manufacturers of mobile batteries – for example, Tesla, Panasonic, LG Chem, Nissan, BYD**
- **Increasingly these batteries are being manufactured in the US.**

A FEW YOU MAY HAVE HEARD ABOUT: SONNEN, TESLA, LG CHEM

Sonnen

Tesla

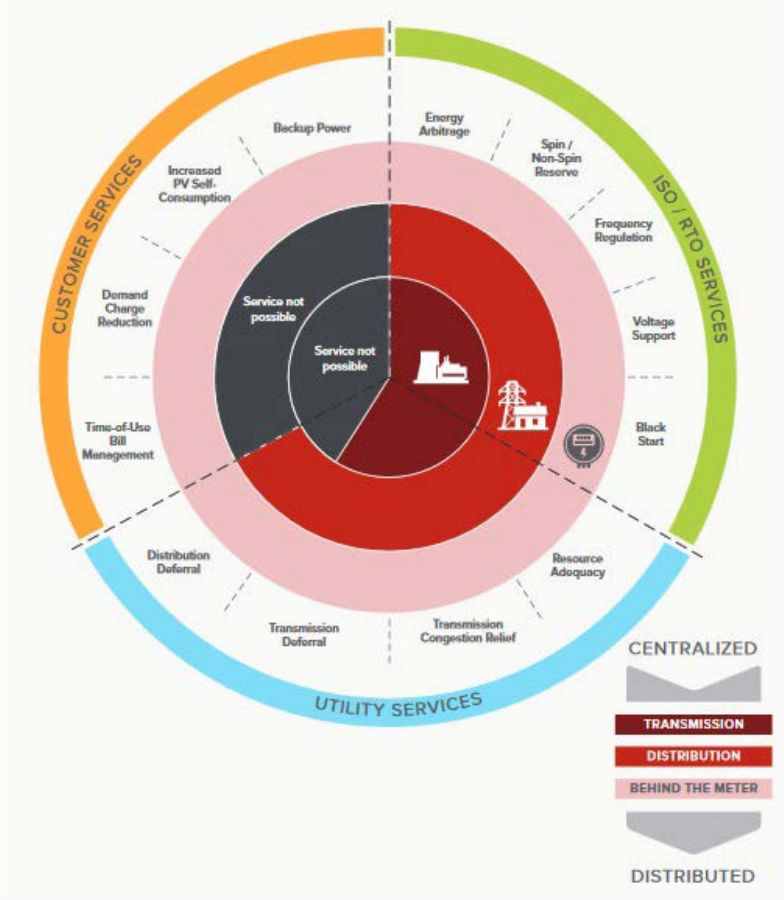
LG Chem

WHY SHOULD I CARE?
WHAT CAN THEY DO FOR ME?

"Energy storage can provide thirteen fundamental electricity services for three major stakeholder groups when deployed at a customer's premises (behind the meter)."

Rocky Mountain Institute, The Economics of Battery Storage, 2015

BATTERIES CAN SUPPLY UP TO 13 SERVICES TO STAKEHOLDER GROUPS



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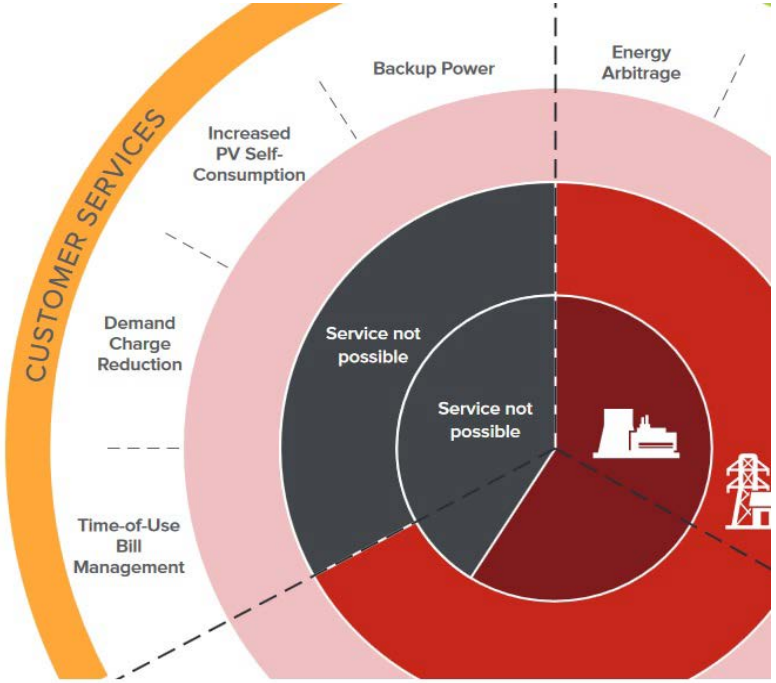
BATTERY SERVICES CAN INCLUDE CUSTOMERS, UTILITIES AND ISO/RTO WHOLESALE MARKET SERVICES



For Customers, this includes:

- Time-of-Use Bill Management
- Demand Charge Reduction
- Increased PV Self-Consumption
- Backup Power during Grid Outages

TIME-OF-USE BILL MANAGEMENT

- Time-of-Use Electricity Rates will be mandated for residential customers in all Investor-Owned Utility areas by 2019.
- Many areas are being transitioned to TOU rates as they:
  - Start new service in an IOU territory
  - Add or increase solar installations in an IOU territory
  - This means peak demand times are changing from 12 pm - 6 pm to 3pm to 9 pm or 4 pm to 10 pm depending on the area
  - Few areas have significant solar resources that late in the day

TIME OF USE BILL MANAGEMENT = ARBITRAGE

Time-of-Use Option A	TOU-A has a baseline rate i.e., it is a tiered rate	Peak – cost per kWh	Off-Peak – cost per kWh
Peak Hours are 3 pm to 8 pm year-round	Summer	0.39336	0.31778
	Winter	0.27539	0.26109

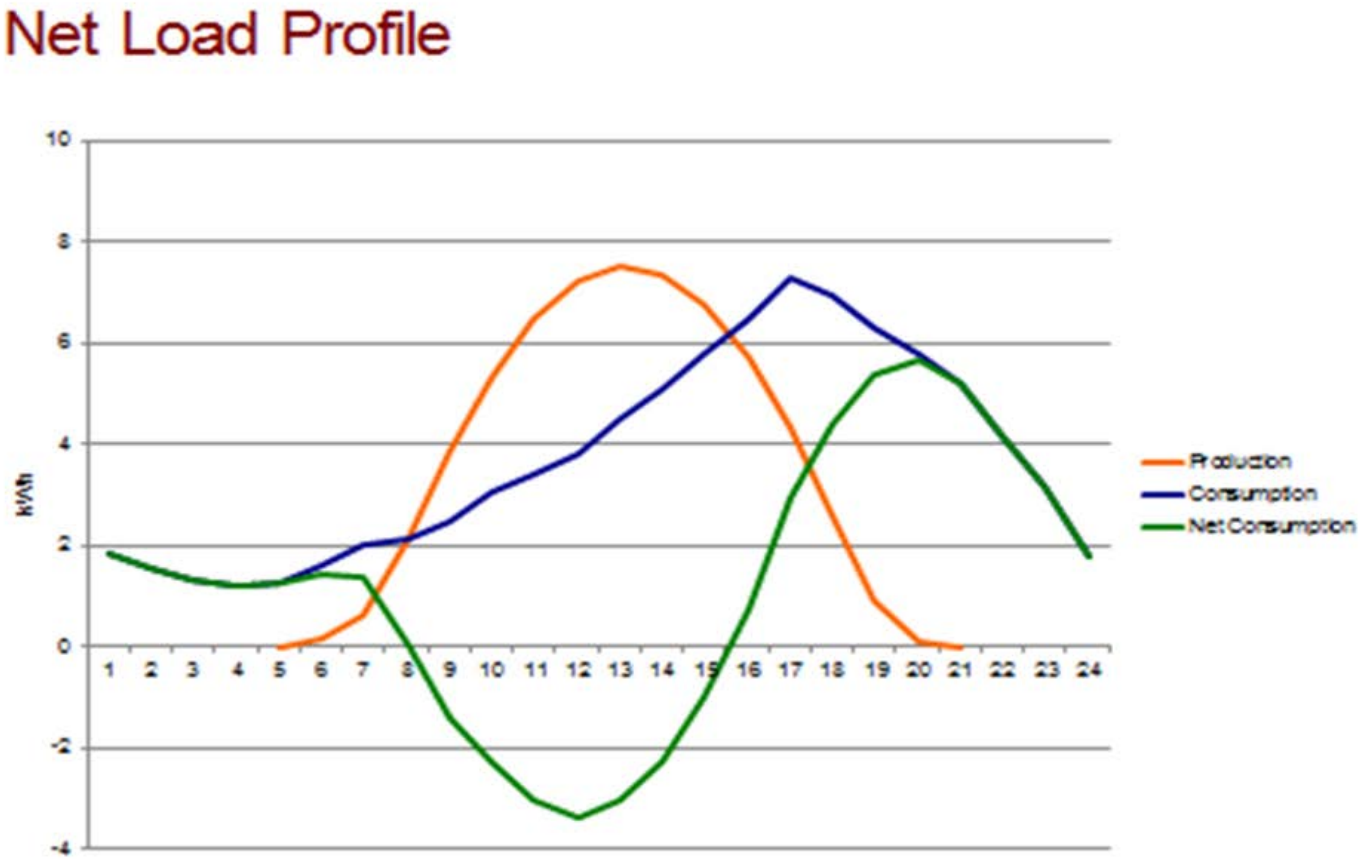
TIME OF USE BILL MANAGEMENT = ARBITRAGE

Time-of-Use Option B	TOU –B has no baseline rate	Peak – cost per kWh	Off-Peak – cost per kWh
Peak is from 4 pm to 9 pm year-round	Summer	0.36335	0.26029
	Winter	0.22588	0.20708

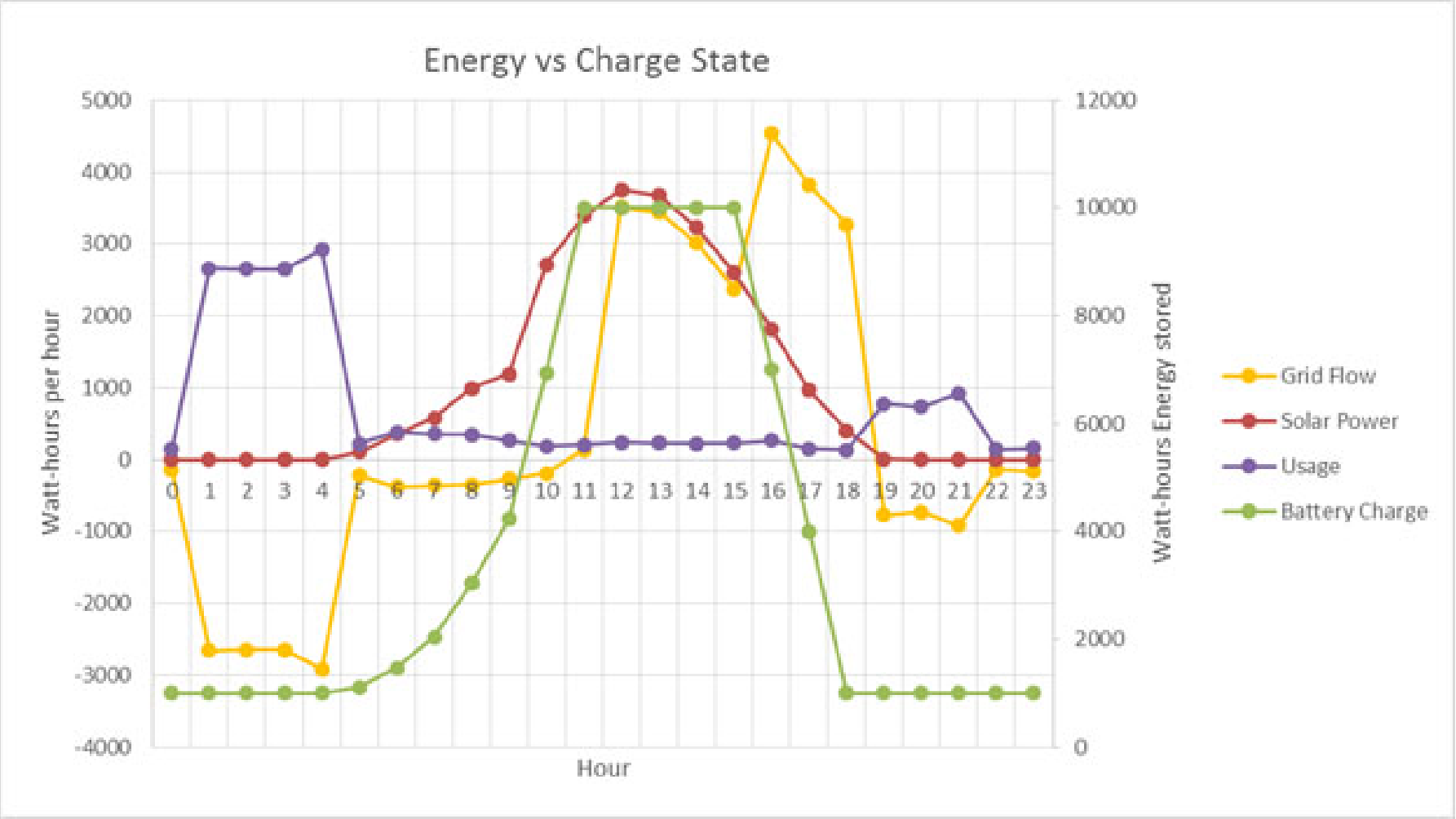
TIME OF USE BILL MANAGEMENT = ARBITRAGE

EV-A		Peak - - 2 pm to 9 pm M-F, 3 pm to 7 pm weekends and holidays	Part-Peak – 7 am to 2 pm and 9 pm to 11 pm M-F	Off-Peak – all other hours – 11 pm to 7 am M-F
Not a tiered rate	Summer	0.45389	0.24986	0.12225
	Winter	0.32018	0.19794	0.12503

TYPICAL SOLAR PRODUCTION AND CONSUMPTION



TYPICAL SOLAR PRODUCTION AND CONSUMPTION WITH BATTERY STORAGE



THE VALUE OF ARBITRAGE

Summary Cost No Solar No Storage				
	Annual			
	TOU-A	TOU-B	E-6	EV-A
Total	$1,745.90	$1,695.38	$2,100.62	$1,341.08
Summary Cost with Solar				
	Annual			
Total	$92.26	$128.80	-$79.53	-$441.41
Savings	$3,600.31	$3,513.24	$4,126.81	$3,729.16
Savings less EV	$1,653.64	$1,566.57	$2,180.14	$1,782.49
Summary Cost with Solar+Batteries				
	Annual			
Total	$17.68	$24.31	-$217.75	-$982.35
Savings	$3,674.89	$3,617.73	$4,265.03	$4,270.10
Savings less EV	$1,728.22	$1,671.07	$2,318.37	$2,323.44
Total usage	7373	kwh	$1,946.67	EV savings
Total solar	7249	kwh	4	kw AC Solar
Surplus	-125	kwh	10	kwh Battery
% of total	98.3%		40	mile/day EV

OTHER BATTERY SERVICES FOR CUSTOMERS

- Demand Charge Reduction – Not generally an issue with residential systems
- Increased PV Self-Consumption –
  - Using more of the energy you make with the solar
  - Necessary for areas like Hawaii with a large percentage of energy generation is solar
- Backup Power during grid outages – Rapid and automatic transfer
  - Can be configured for one or several days
  - Energy Security for natural or man-made disasters
  - Can utilize the solar plus storage to power an EV/hybrid plug-in vehicle in case of gasoline shortages
  - Alternatively can configure to use EV to power the load

REDUCTION IN GHG PRODUCTION

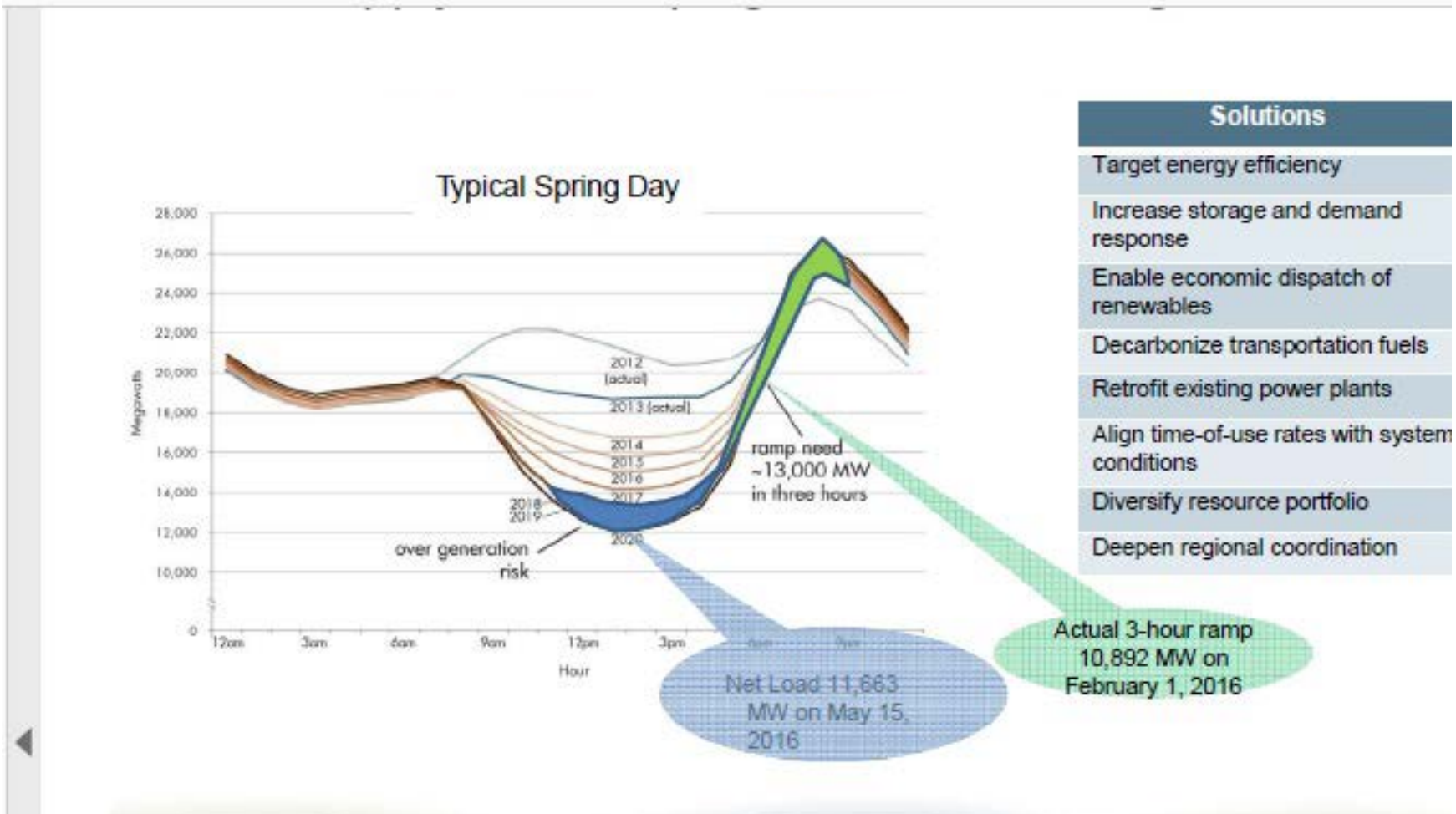
- Value of Reducing GHG Production
  - At the power plant as most peaker plants are running on natural gas
  - From the tailpipe if using an electric vehicle
  - Potential additional benefits for ZNE homes to reach true ZNE

EXAMPLE OF CONTRIBUTION OF SOLAR PV PLUS STORAGE TO GHG REDUCTIONS TO A ZNE HOME IN SACRAMENTO AREA*

2019 Projected Standards, 2700 sq ft home	Solar PV	Storage	GHG (MT/Yr)
Mixed Fuel Home	No	No	2.94
	3.1 kW Solar PV	No	2.52
	3.1 kW Solar PV	12 kWh Storage	2.2
All Electric Home	No	No	1.8
	6 kW Solar PV	No	1.32
	6 kW Solar PV	12 kWh Storage	0.67

* Courtesy Title 24 2019 ZNE Standards Group – These are preliminary numbers and subject to change. California Energy Commission

THE FAMOUS CALIFORNIA "DUCK CURVE"



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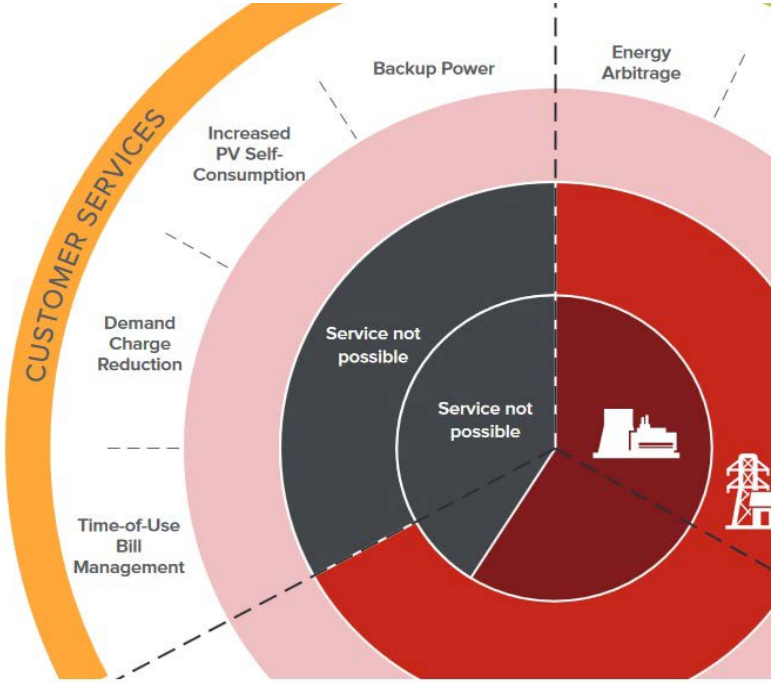

For Customers, this includes:

- Time-of-Use Bill Management
- Demand Charge Reduction
- Increased PV Self-Consumption
- Backup Power during Grid Outages
- GHG Reduction Strategy

THANK YOU!

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Questions?