

VISION OF A DISTRIBUTED ENERGY RESOURCES ECOSYSTEM

A CUSTOMERS' PERSPECTIVE

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PERSONAL BACKGROUND

- **Education**

- Electro-Mechanical Engineer & Master in International Development

- **Professional Experience**

- President of "Price Waterhouse Canada International"
- Founding Partner and President of "Strategic Governance Group International"
- Retired from Active Professional Activities since 2006

- **Expertise**

- Unbundling of Power Utilities, Negotiation of Power Purchase Agreement
- Audit of Power Rate Setting and Adjustment Cases Processes
- Design of Power Exchanges and Transmission Rights Booking Mechanisms
- Member of the Grand Rapids Chapter of Citizen Climate Lobby

QUESTIONS

Both the current “Law” and the “Proposed Distributed Generation Program” do not make any reference to:

- Any other “behind-the-meter” equipment located downstream of customers’ solar generation (Batteries & Smart Inverters)
- The potential benefits which can be derived from increasingly performing “behind-the-meter” automated energy management systems

In its current description the proposed Program seems to be aimed more at limiting the growth of “Distributed Generation” and “Distributed Energy Resources”, rather than supporting it.

PURPOSE OF THE PRESENTATION

- The question utilities must answer is whether they see customers' evolving needs as a threat or whether they will find ways to benefit from serving those needs.
- If they choose to participate, they could discover both new supply-side and demand-side ways to recover what otherwise would be stranded costs when new technologies are introduced
- “DER” Customers, as contributors to savings benefiting all consumers, should be entitled to reasonable compensation to support the debt contracted to acquire behind-the-meter equipment
- My objective is to present the significant gains of operational efficiency and costs reduction which could result from the introduction of new distributed technologies and increased cooperation between Utilities and their Customers.

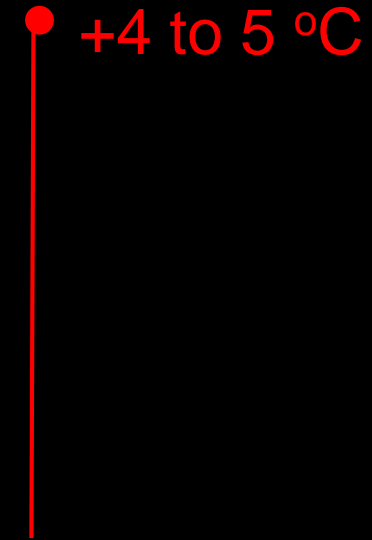
EVOLVING ELECTRIC POWER SYSTEM TRENDS

1. Electricity is used far more efficiently (Stagnant demand growth).
2. The system is currently shaped by the variable output of wind and solar resources. (This will be less true when more energy storage is introduced into the system)
3. Demand management becomes as important as supply management in balancing the system
4. Electric services will be increasingly decentralized (Distributed resources)
5. Collaboration between stakeholders supports efficient grid operations
6. Transportation energy use is progressively switching toward electric service
7. Push toward enabling **everyone** to contribute to, and benefit from, the transition away from fossil-fuels

THE MAGNITUDE OF FUTURE WARMING

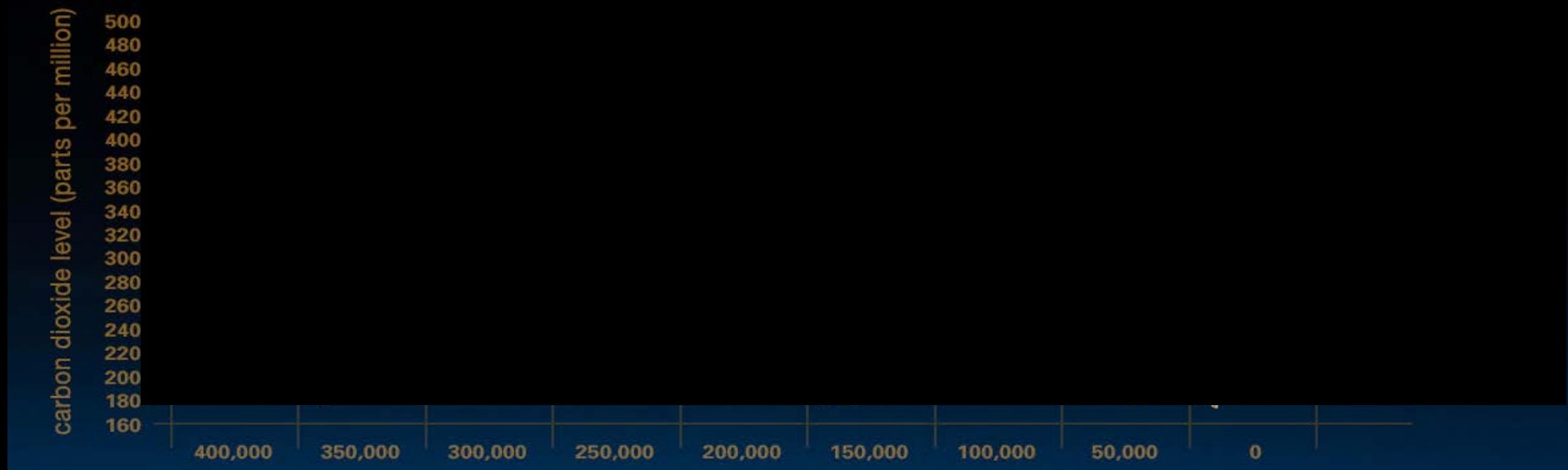
Depends on our choices made today

“Business as Usual”
950 ppm (in 2050)

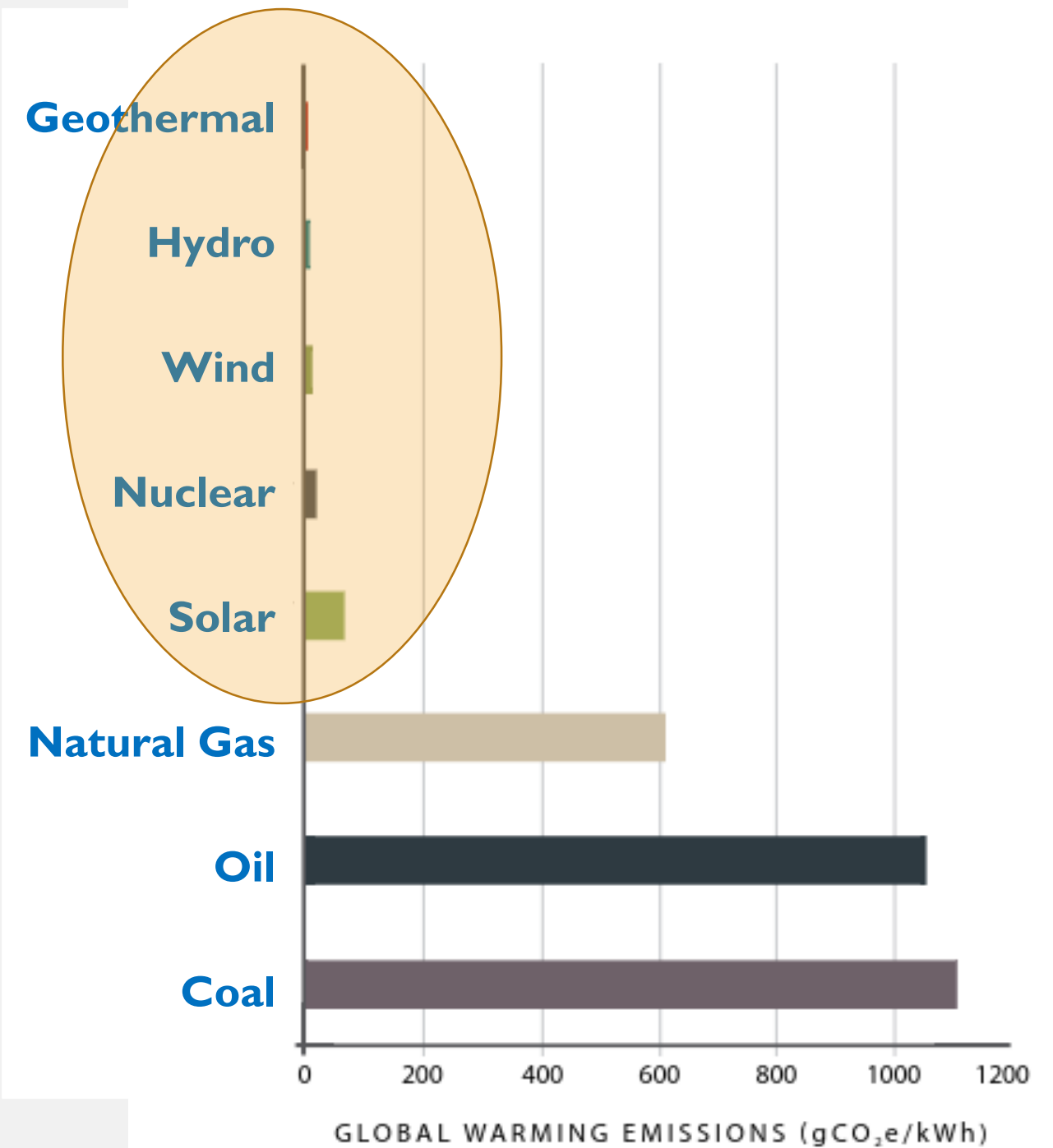



<http://Climate.nasa.gov>

**THIS IS THE MOST
CRITICAL ISSUE FACING
HUMANITY**



**GLOBAL
WARMING
POLLUTION
INTENSITY OF
ELECTRICITY
GENERATION**





If we continue on this trend Utilities will soon be less involved in providing reliable energy services and more on rebuilding power infrastructures destroyed by severe climatic events.

- The federal government has spent more than \$350 billion over the last decade. (\$205 billion directly on disaster relief, \$90 billion for crop and flood insurance, \$34 billion for wildland fire management and \$28 billion for repairs to federal facilities).
- This does not take into consideration private insurance payments
- It is estimated that this year alone climatic events recovery costs will cost \$350 to \$400 billion

**THESE COSTS ARE VERY REAL BUT ARE NOT
REFLECTED IN THE COST OF ENERGY
BILLED TO CUSTOMERS FOR BOTH
ELECTRICITY & TRANSPORTATION**

As mature, educated and socially responsible citizens we need to do, **right now**, what is required and technically feasible to stabilize and reverse the current trend

Despite the implied costs

NEW EMERGING TECHNOLOGIES

- Distributed generation assets, energy storage, smart switches, and self-learning optimization controls form the core of a meshed technology structure similar to what has already been successfully implemented in the field of computer technologies over the past 20 years.
- They are the real enablers for materializing the full potential benefits of “Distributed Energy Resources”

“FIELD-TESTED” TECHNOLOGIES

- Higher performance **“Solar-Panels”** (now close to Economic parity)
- Lower cost customer size **“Energy Storage Batteries”**
- **“Smart-Inverters”**, in customer compatible sizes and multiple capacities and capabilities
- **“Networked interfaces”** between customers and their Utility
- Increasingly performing “Behind-the-meter” **Automated Energy Management Systems**
- High energy capacity **“Plug-in Hybrids”** and **“Full Electric”** cars, with increasing supporting networks of charging stations

FACTS ABOUT IN-HOUSE ENERGY STORAGE

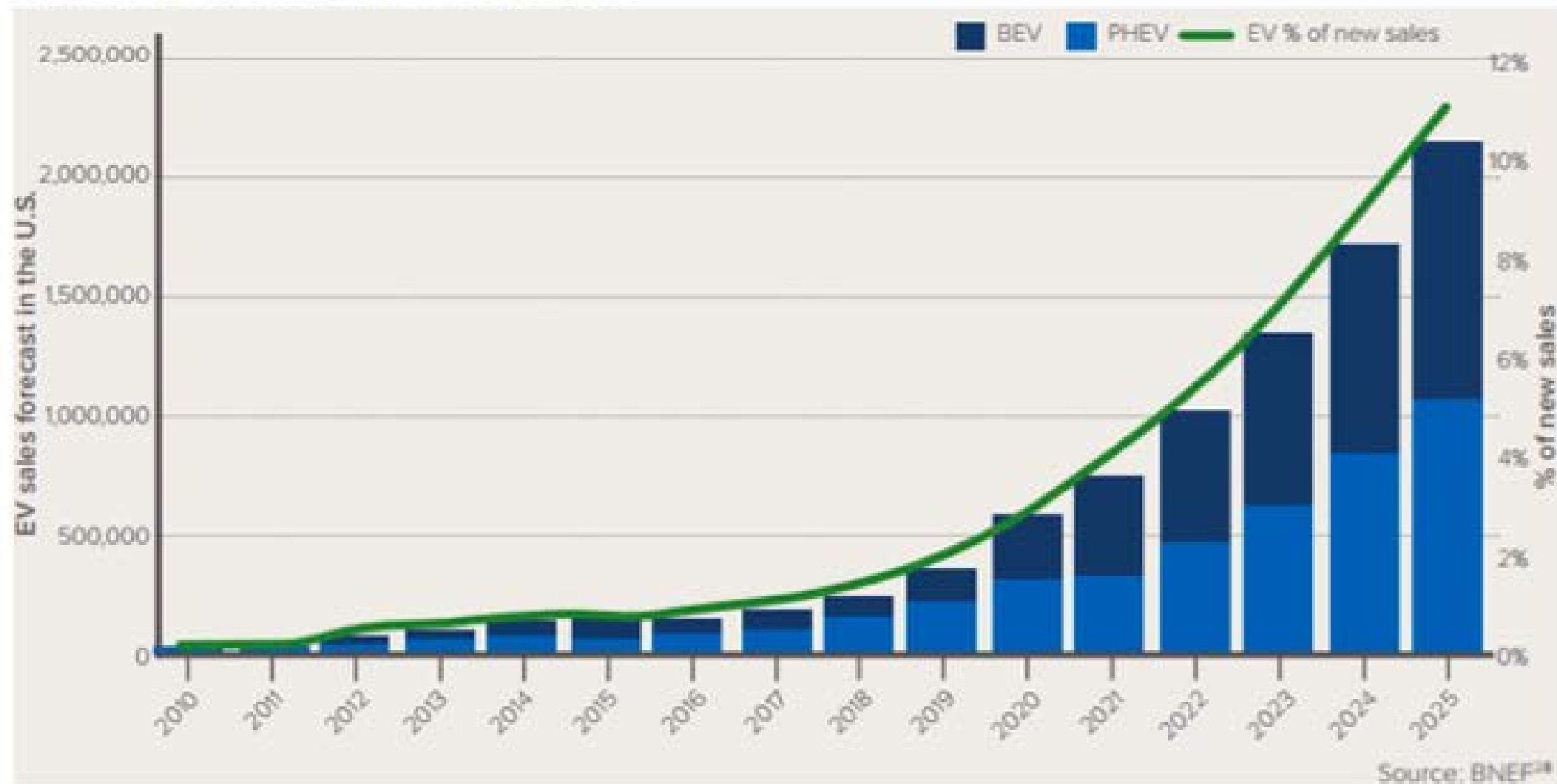
- Customer sized “Energy Storage” are now commercially available at reasonable price and are reliable
- DC-coupled battery systems are more efficient in applications where Solar energy is stored and used later
- Amount of energy that a battery can store is determined by its energy capacity (kWh), whereas the rate at which it charges or discharges is determined by its power rating (kW)
- Both factors have an impact on credits for surplus “OUTFLOWS” of energy to the grid. (Energy credit versus Capacity credit or a combination of both).
- Current total installed price for a 7-kW/14-kWh battery is around **\$7,000** in 2017, with \$5,500 for the battery and \$1,500 for installation. **These costs continue to drop rapidly**

FACTS ABOUT ELECTRIC CARS

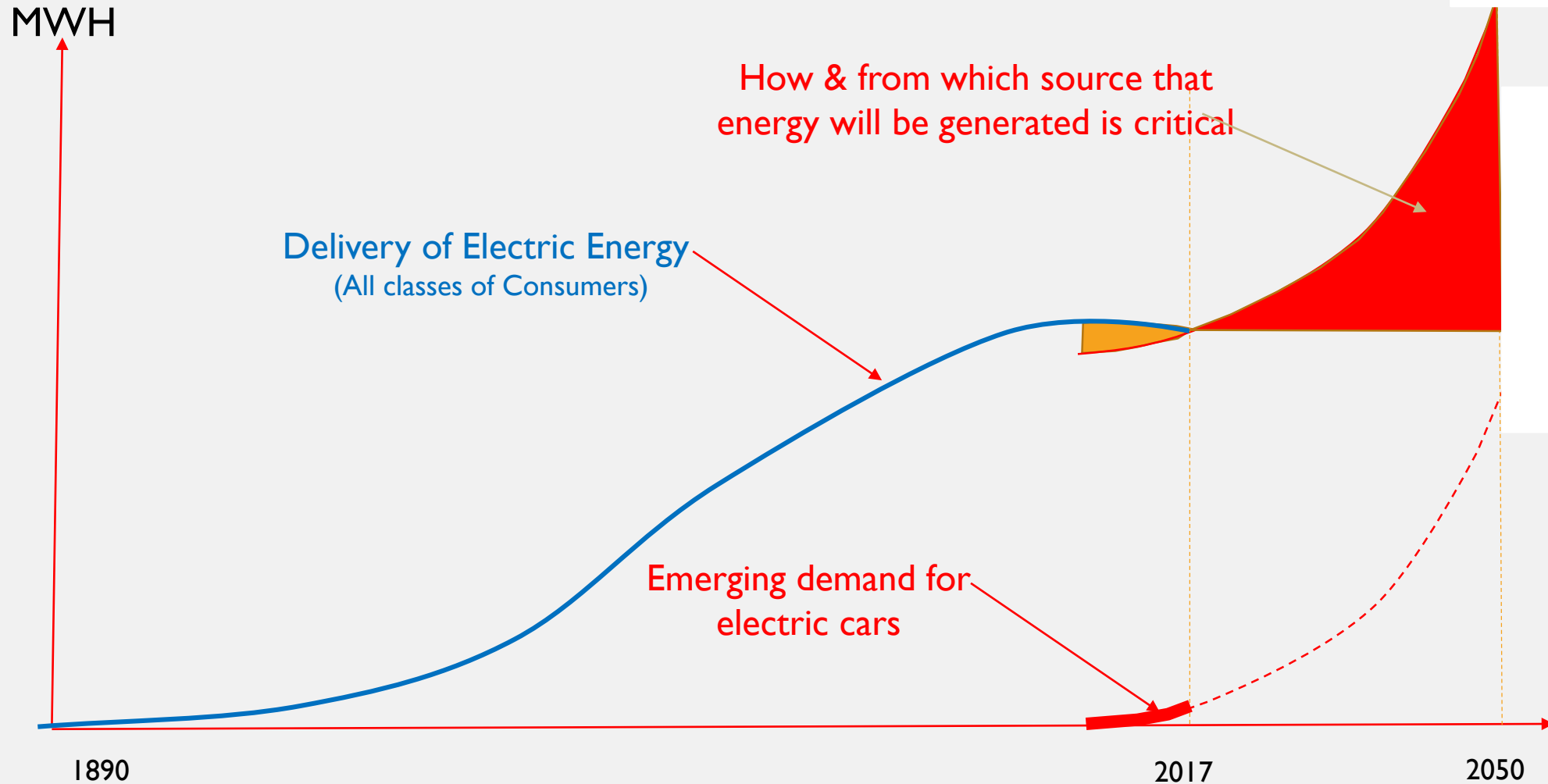
- The emergence of electric vehicles, **together** with the restructuring of the electric power generation and distribution system **present an unmatched convergence of opportunity for de-carbonizing the global energy ecosystem.**
- Penetration of electric cars will contribute to greatly increase “Off Peak” load demand when car batteries are charged at home during the night.
- Under reasonable assumptions, there could be 2.9 million EVs on the road in the U.S. within five years. They could add “over **11,000 GWh** of new load to the U.S. power grids, by 2025.
- This is about **\$1.5 billion in annual electricity sales** that utilities will need to accommodate within their current planning horizons.

PROJECTION FOR ELECTRIC CARS MARKET PENETRATION

BNEF EV SALES FORECAST THROUGH 2025



GROWING STRANDED "GENERATION-ASSETS" BECAUSE OF "GREEN-ENERGY" DEVELOPMENT MAY NEVER MATERIALIZE



**NOT ALL “DISTRIBUTED
ENERGY CUSTOMERS” ARE
CREATED EQUAL**

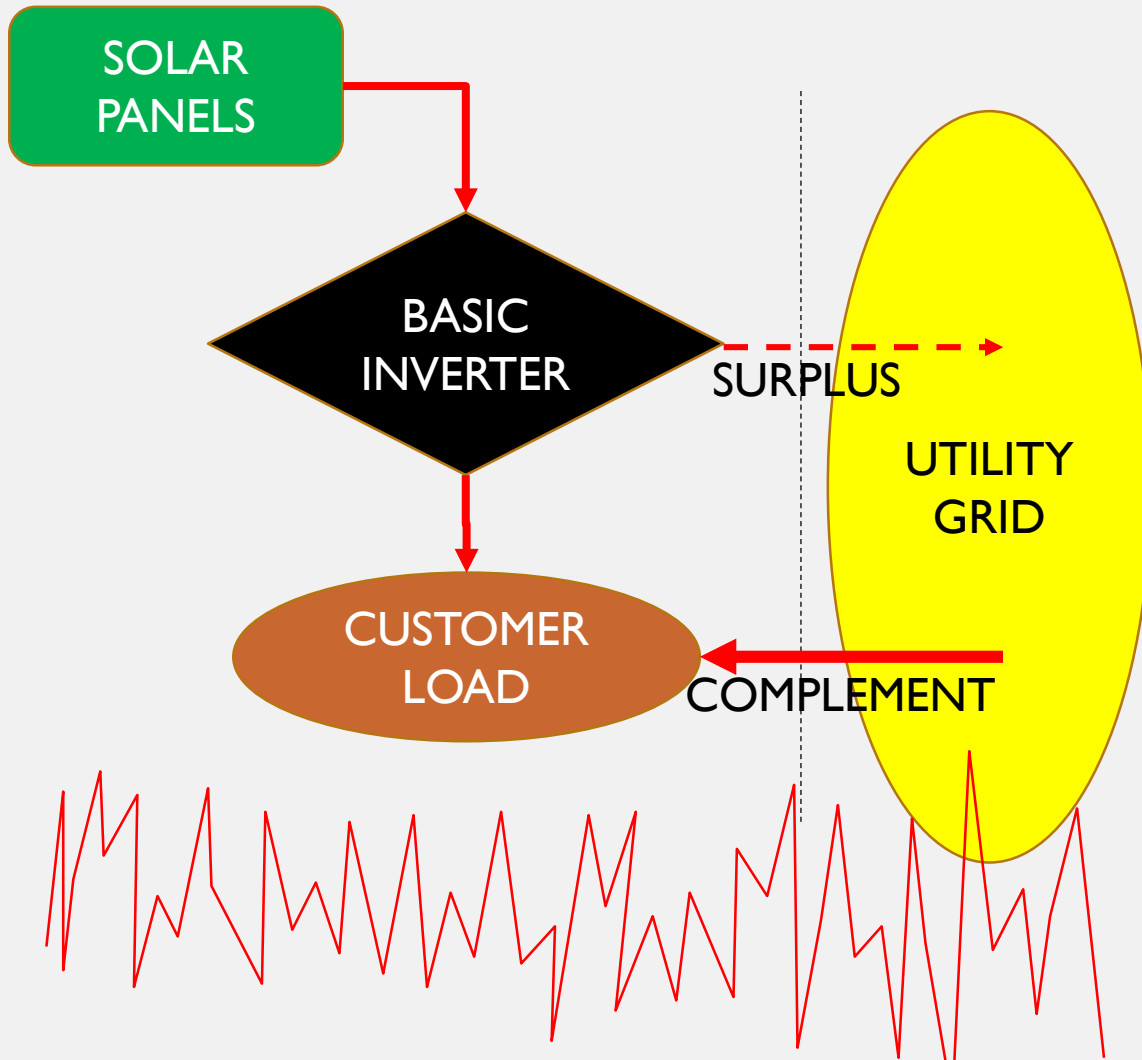
**This Implies a “Ranked Customers
Accreditation System” and the creation of a
specific “Customer Class” for them**

**“DISTRIBUTED GENERATION”
IS A SUBSET OF
“DISTRIBUTED ENERGY
RESOURCES”**

They address different issues and potential benefits

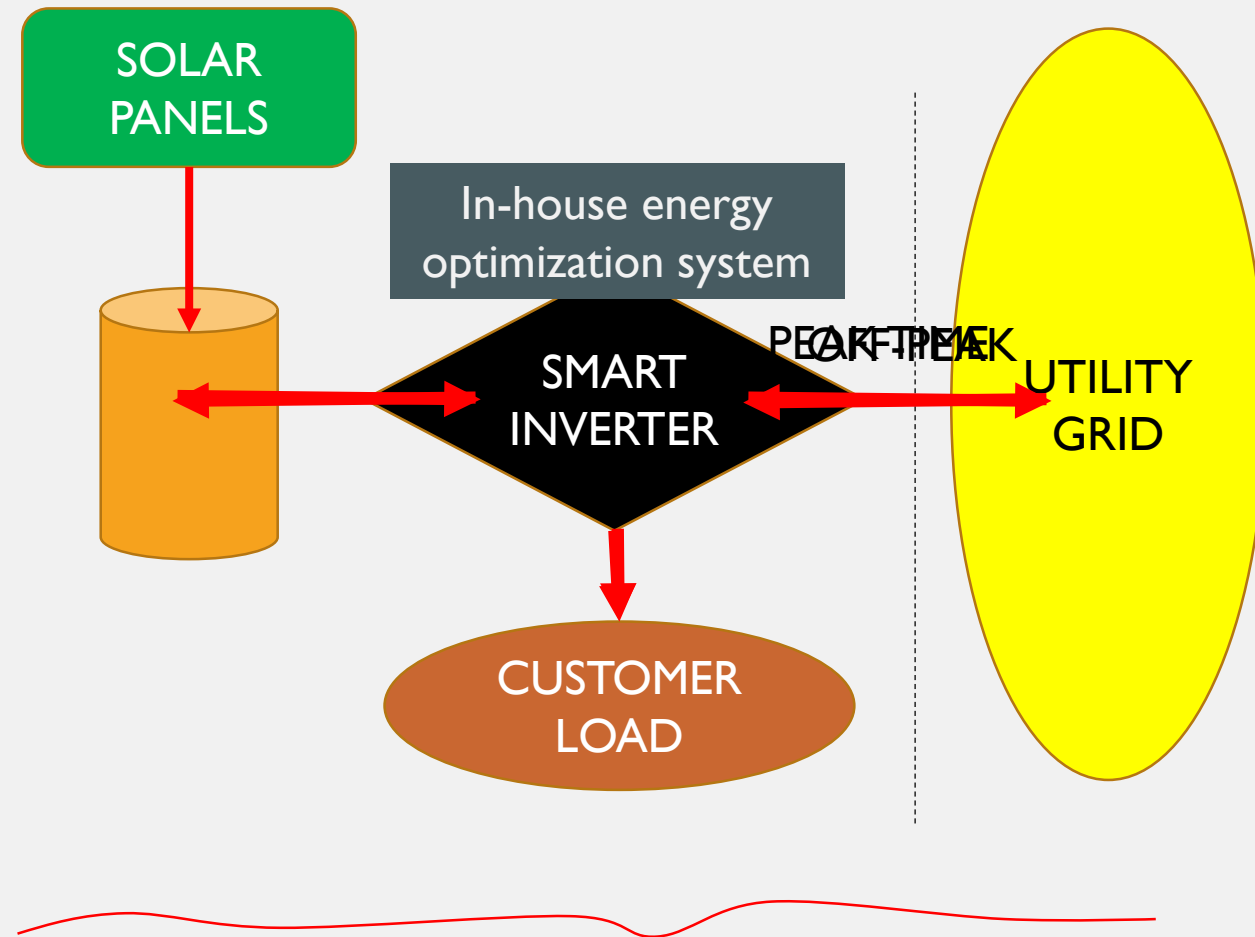
The biggest potential benefits for Customers, Utilities and Society derives from **“Distributed Energy Resources”**, not from **“Distributed Generation”**

DISTRIBUTED GENERATION



Flows of Energy are in real-time

DISTRIBUTED ENERGY RESOURCES



Flows of Energy are switched from "Peak" to "Off-Peak"

RANKING OF POTENTIAL BENEFITS TO THE GRID

- A large range of customer investment options in “behind-the-meter” equipment is possible.
- They provide both grid and customer-sited energy services, and they can serve as system loads, peaking resources, demand response assets, contributors to grid stability or renewable energy enablers.
- Potential benefits to Customers and the Grid are proportional to the **type**, **capacity** and **capabilities** of equipment installed “behind-the-meter”
- The same applies to potential indirect benefits to the distribution grid, society at large and all other classes of customers

THIS IMPLIES A NEED FOR:

**A MECHANISM OF ACCREDITATION OF EACH CUSTOMER'S EQUIPMENT
INSTALLATION BEHIND THE METER**

AND

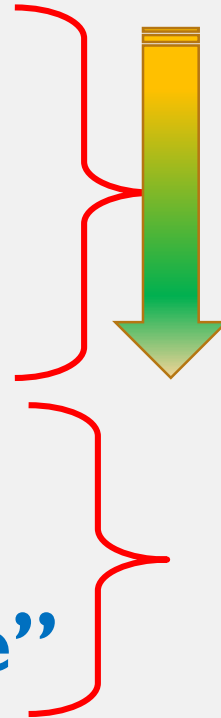
**THE RANKING OF “DISTRIBUTED ENERGY CUSTOMERS” ACCORDING TO
THE CAPABILITIES AND CAPACITY OF THEIR IN-HOUSE INSTALLATION**

AND

**CREDITS TO “DISTRIBUTED CUSTOMERS” CORRESPONDING TO THE
FAIR VALUE OF OUTFLOWS OF ENERGY & SERVICES BACK TO THE GRID.
THIS SHOULD BE PROPORTIONAL TO THE ACCREDITATION LEVEL**

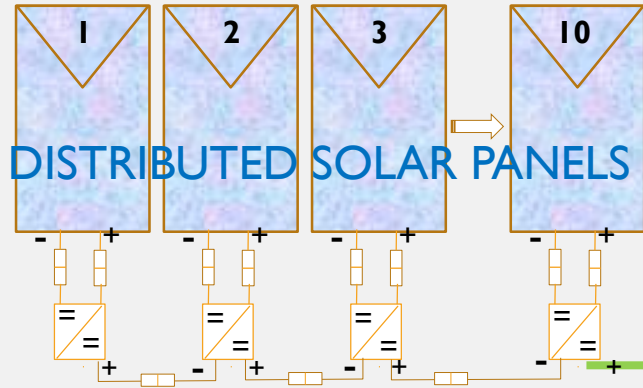
RANKING OF DISTRIBUTED ENERGY RESOURCES CUSTOMERS

- “Entry level”
- “Accredited Silver”
- “Accredited Gold”
- “Accredited Platinum”
- “Accredited Super Elite”



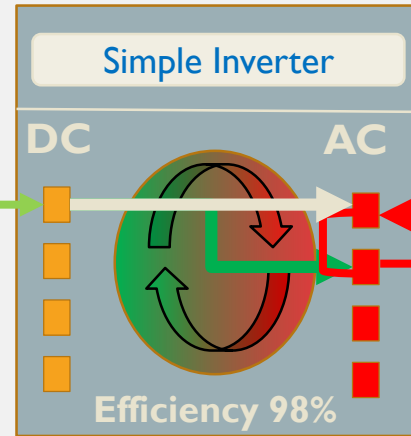
customers who contribute to grid operations BUT are still more Customers than Partners
Increasing compensation from the “Utility” for services provided by the “Customer” in support of grid operations
Investment in Partners” with the Utility to optimize grid operations & quality of services

DISTRIBUTED ENERGY RESOURCES "ENTRY LEVEL"



Solar Generation used on site in priority

Inflows of Energy from Grid when Required to Complement Solar Generation and when no sun



Sporadic "Outflows" of energy when Solar Generation exceeds house load



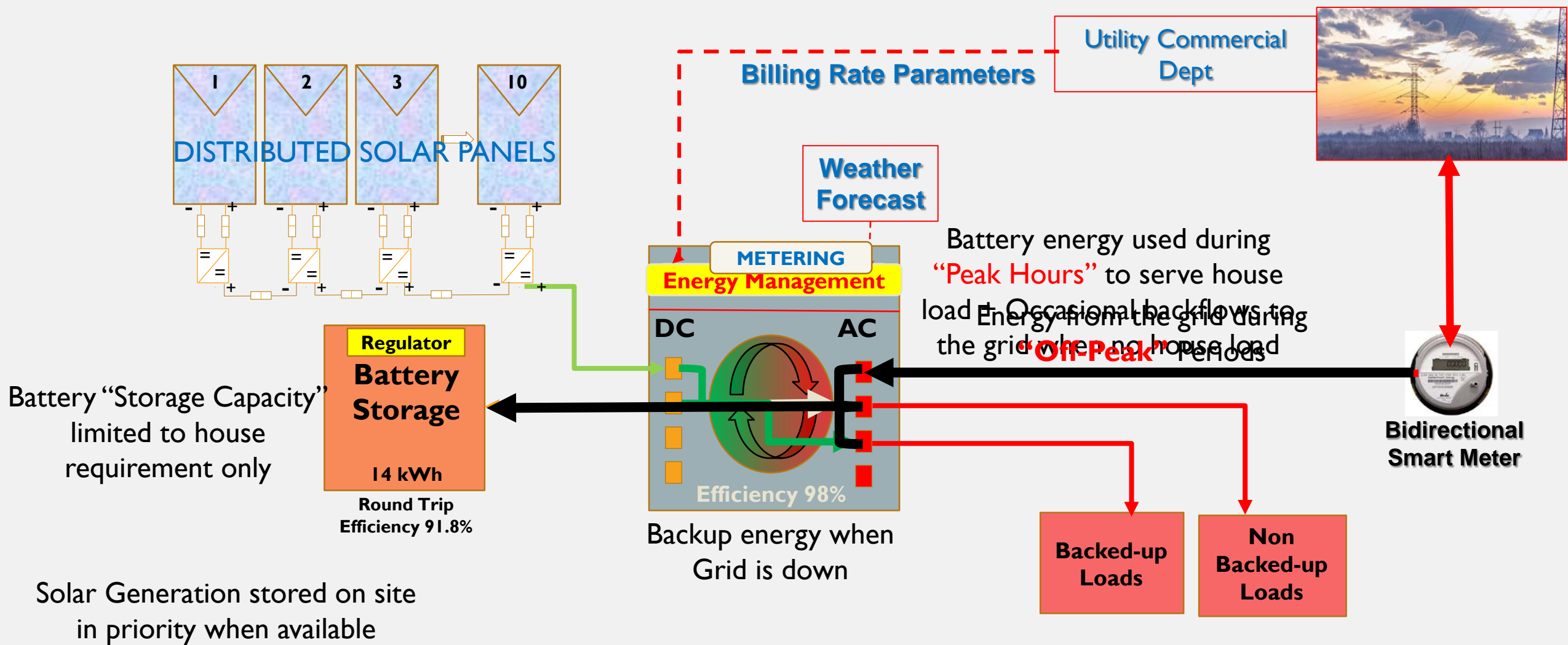
Bidirectional Smart Meter

HOUSE LOAD

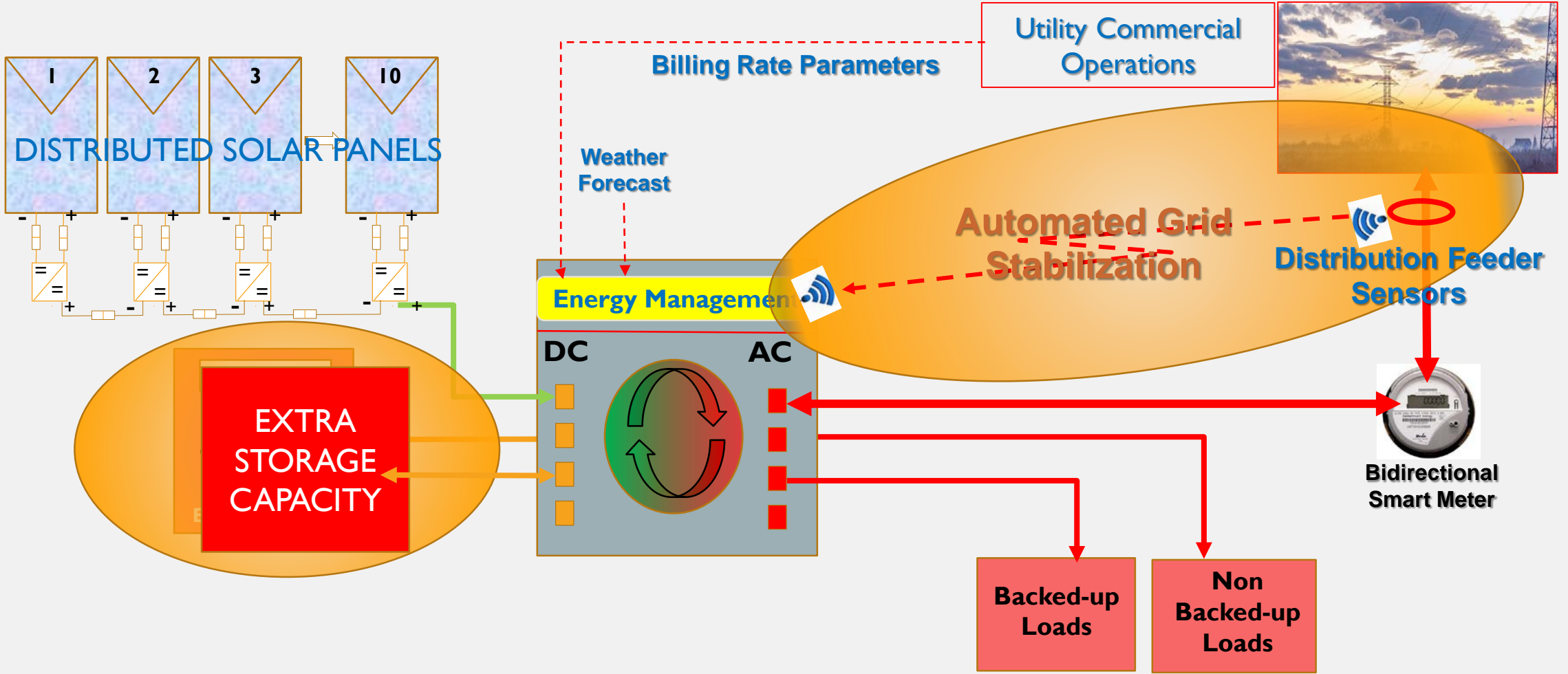


Wi Fi Programmable Switches & Outlets

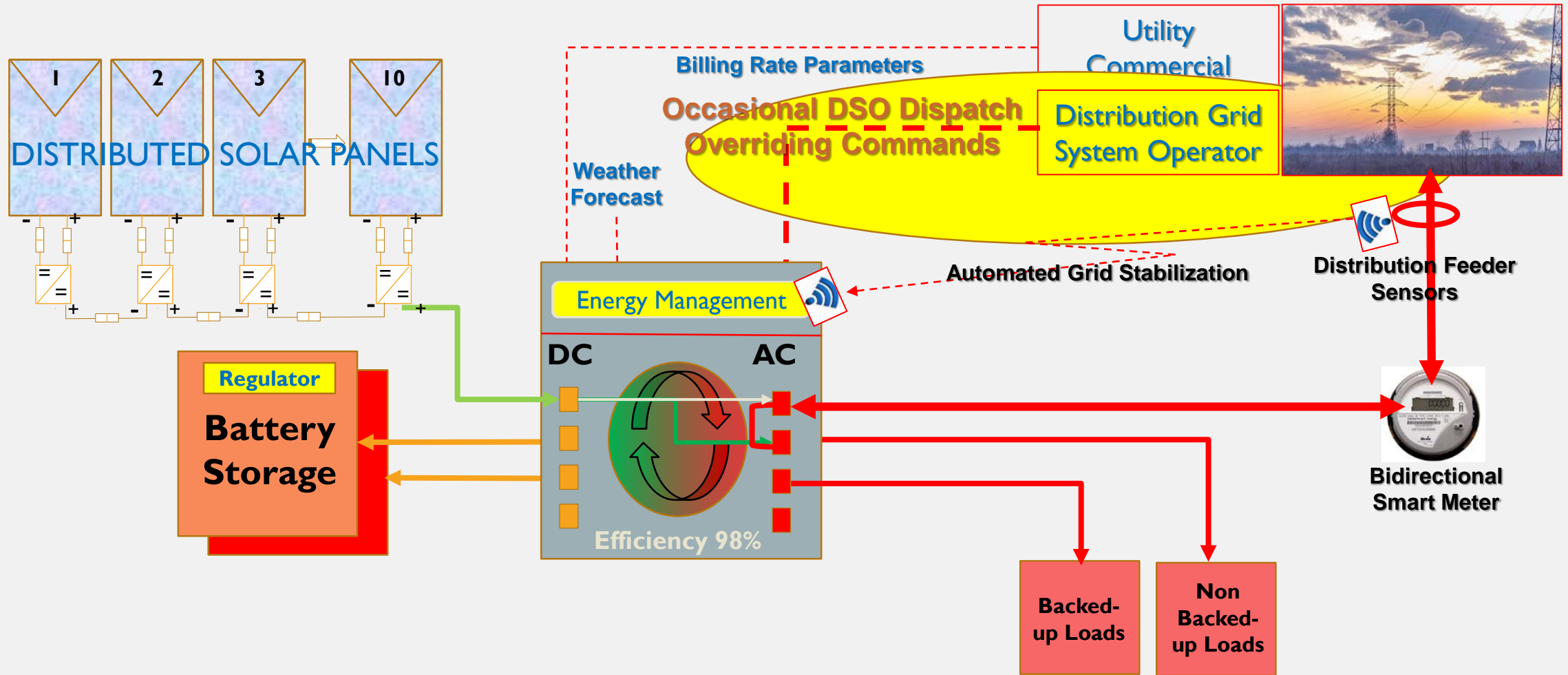
DISTRIBUTED ENERGY RESOURCES "ACCREDITED SILVER"



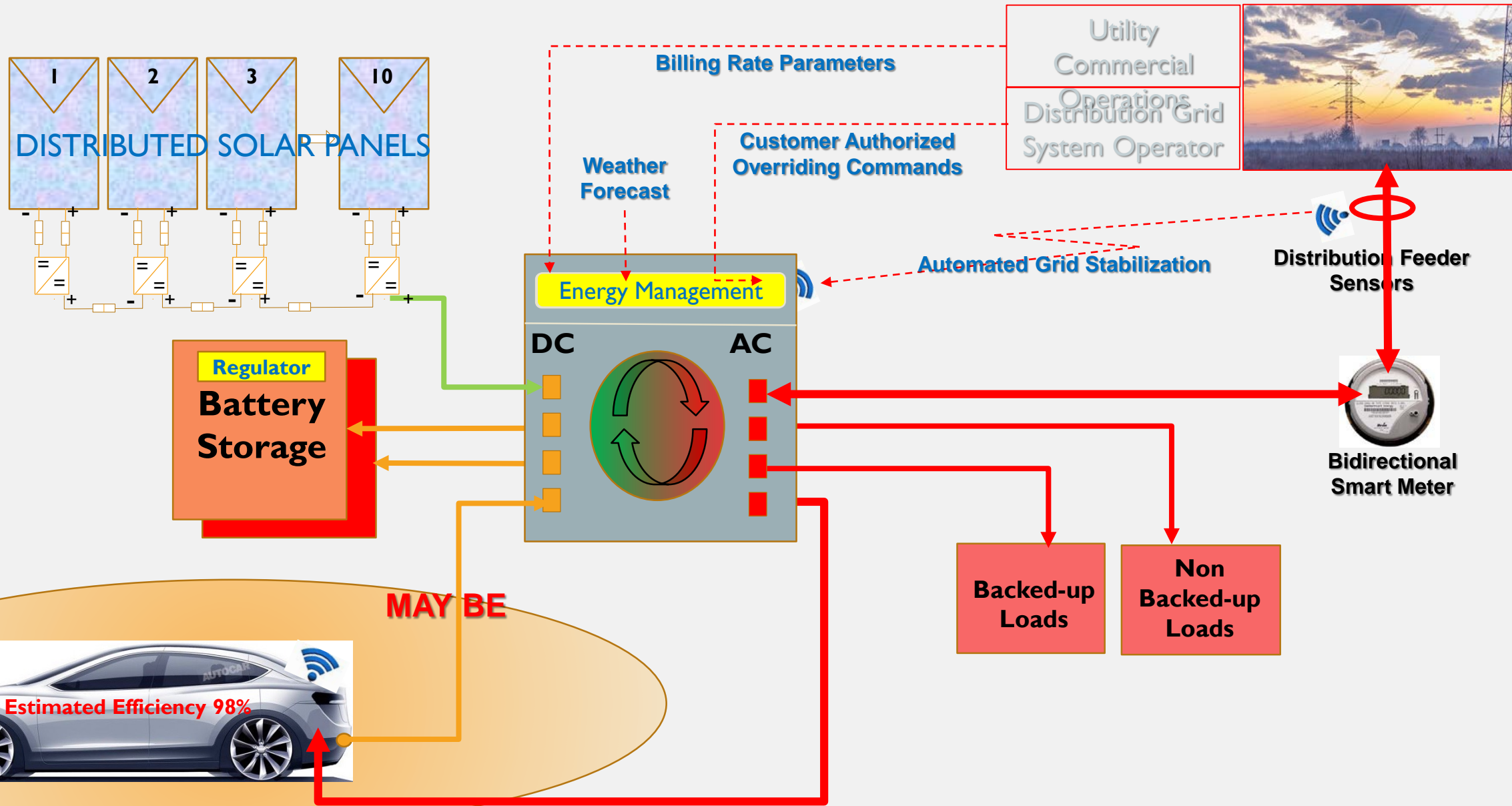
DISTRIBUTED ENERGY RESOURCES "ACCREDITED GOLD"



DISTRIBUTED ENERGY RESOURCES "ACCREDITED PLATINUM"



DISTRIBUTED ENERGY RESOURCES "ACCREDITED SUPER-ELITE"



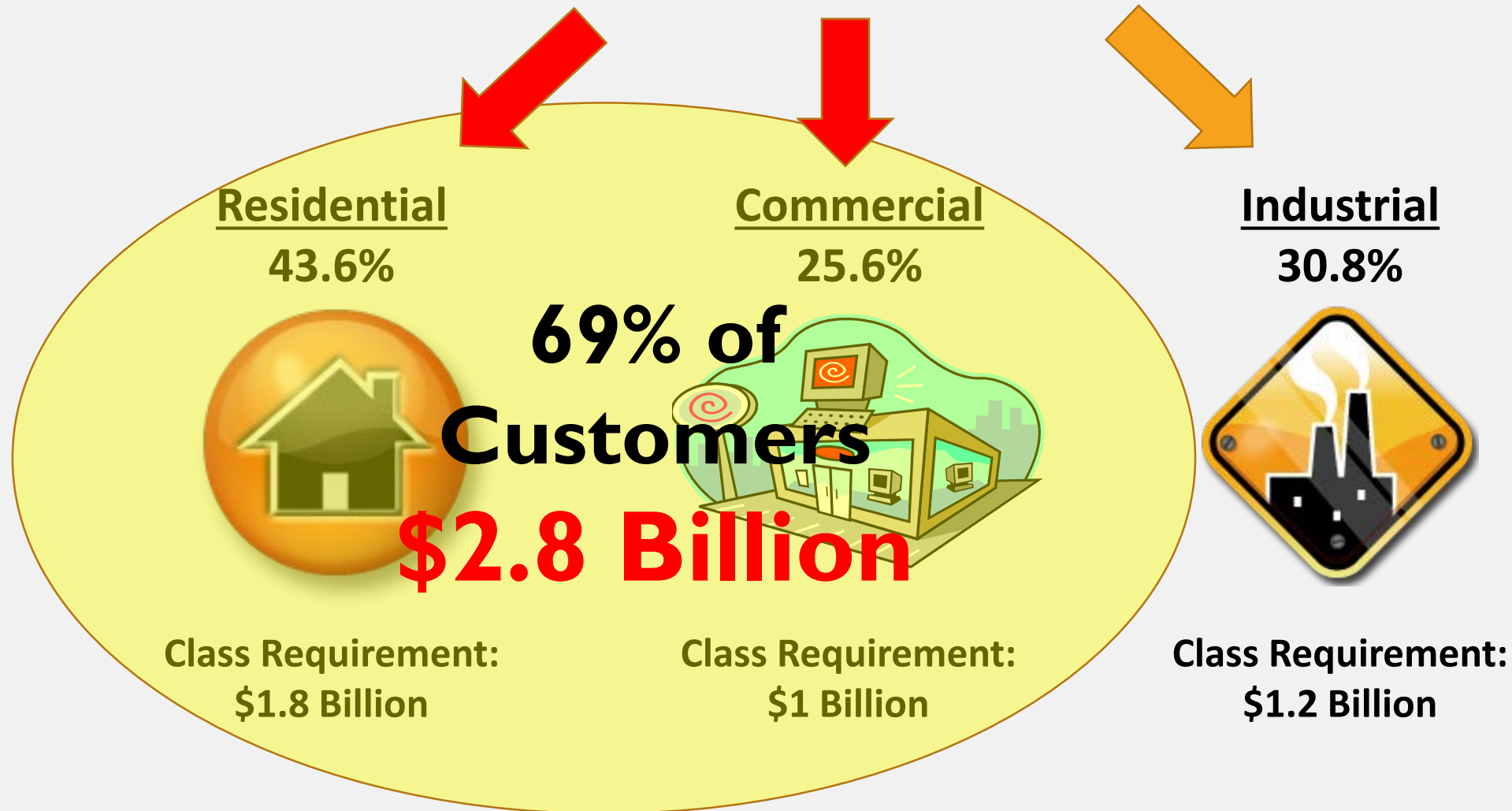
COST REDUCTION POTENTIAL OF “RELIABLE LOAD-SHIFTING”

Reliable Load-Shifting can result in reduced energy rates for **All** Classes of Customers

RELATIVE WEIGHT OF “RESIDENTIAL” AND “COMMERCIAL”

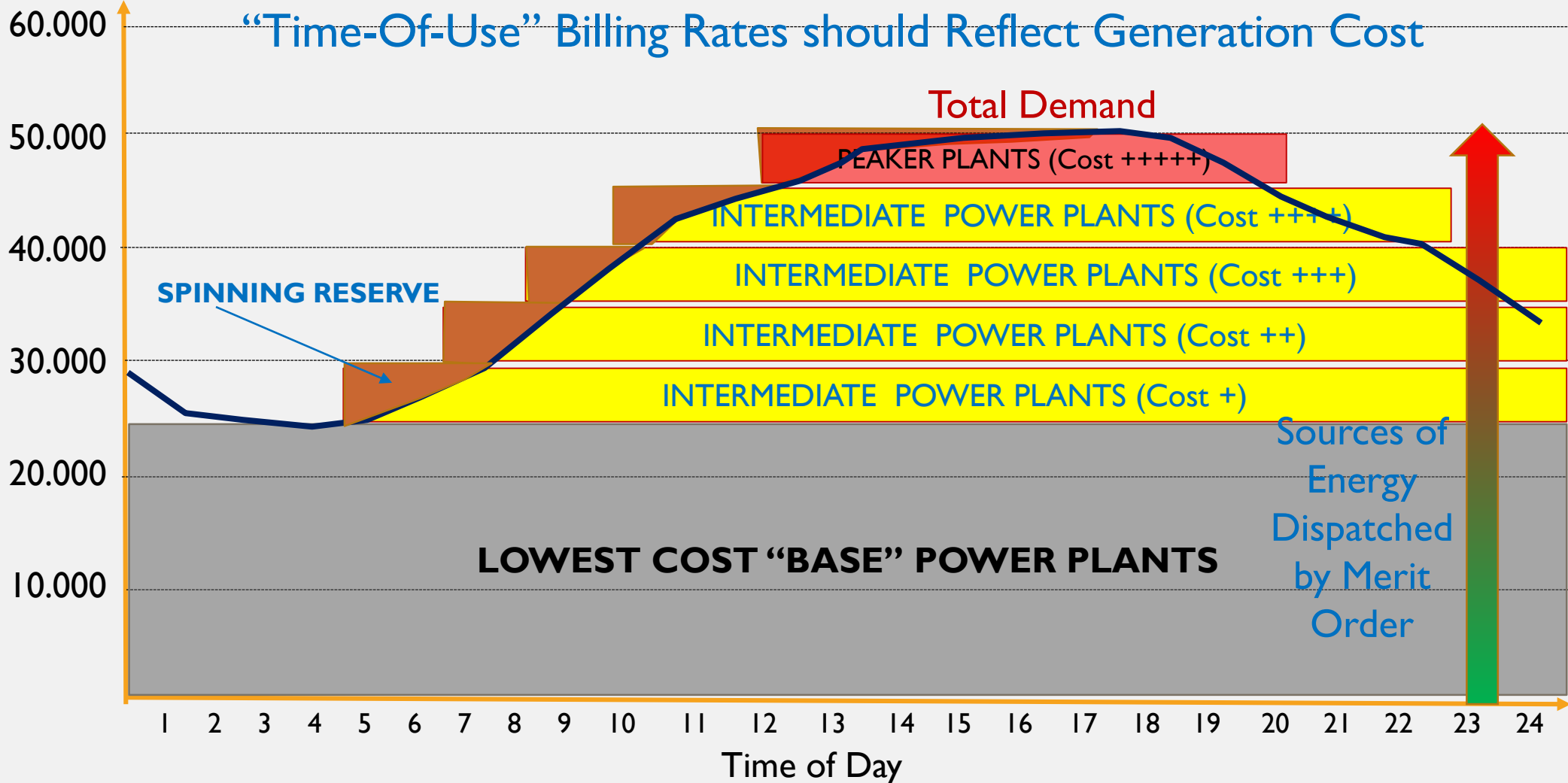
Consumers Energy Total Revenue Requirement: \$4 Billion

Cost Allocation Across 3 Rate Classes

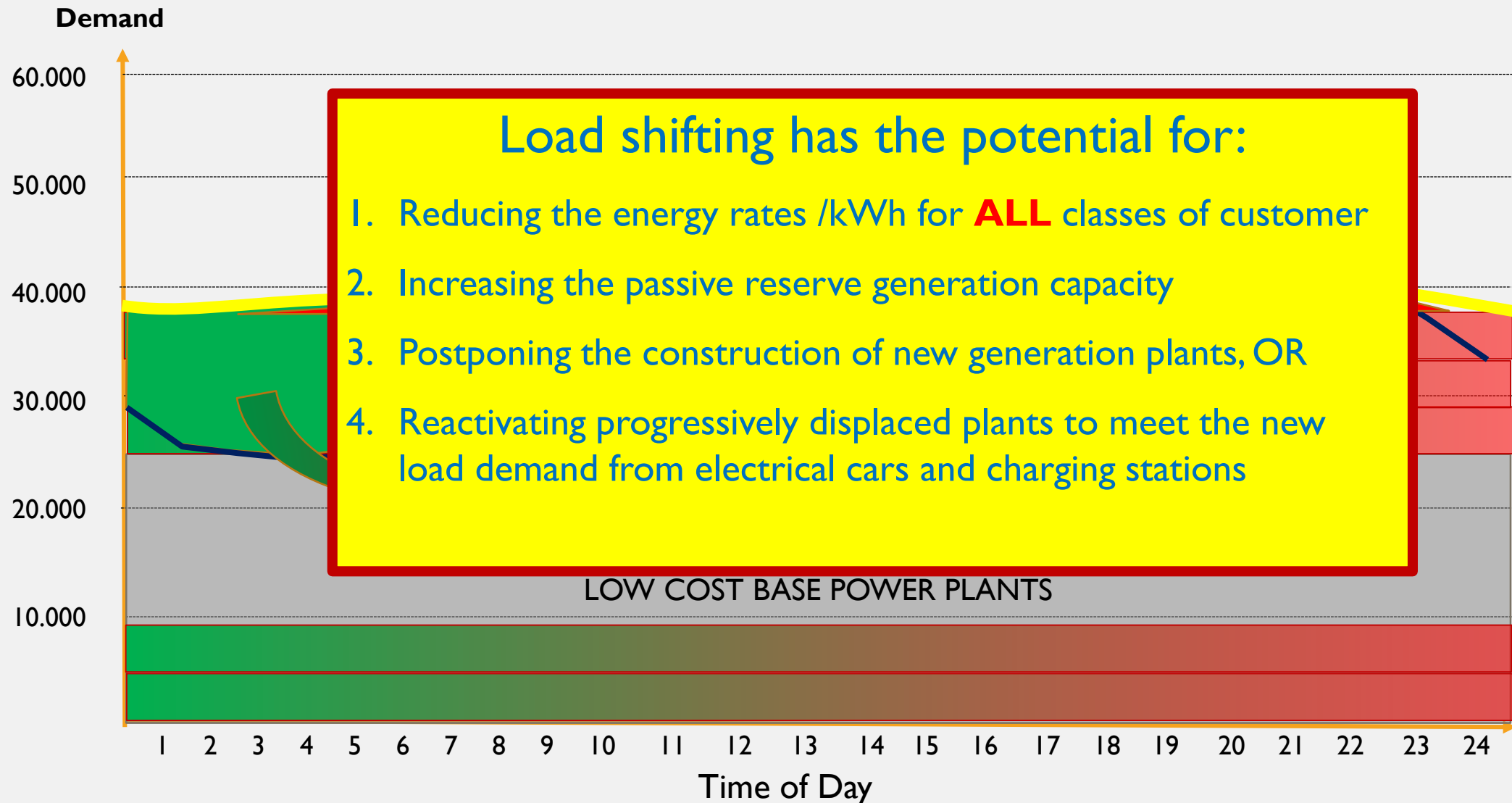


“MERIT-ORDER” DISPATCHING OF GENERATION

Demand (Megawatts)

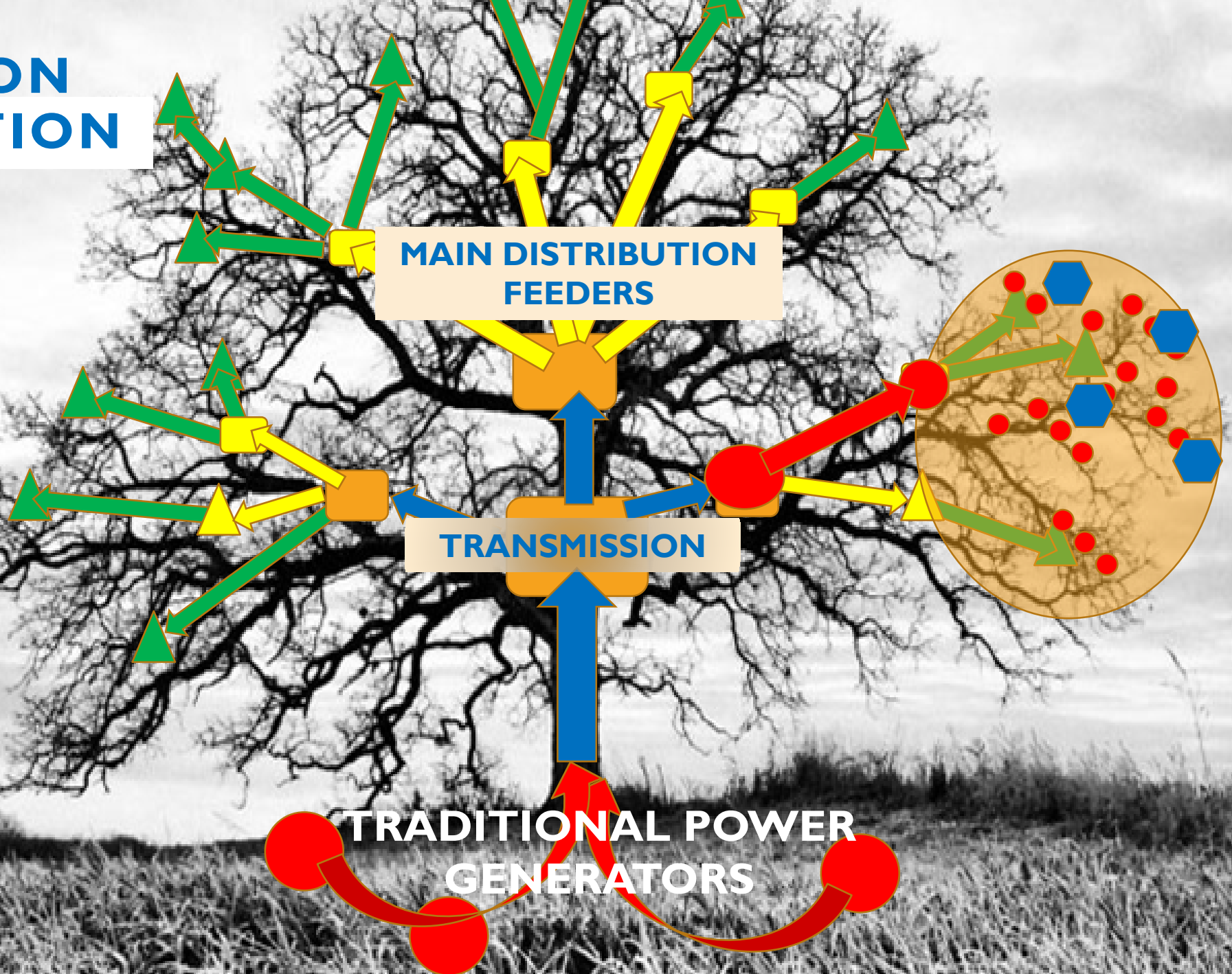


FLATTENING THE LOAD DEMAND CURVE (LOAD SHIFTING)



**COST REDUCTION POTENTIAL ON
THE “GRID INFRASTRUCTURES”**

IMPACT ON DISTRIBUTION GRID



**SUGGESTED BILLING
MECHANISMS
FOR
“INFLOWS”
AND
“OUTFLOWS”**

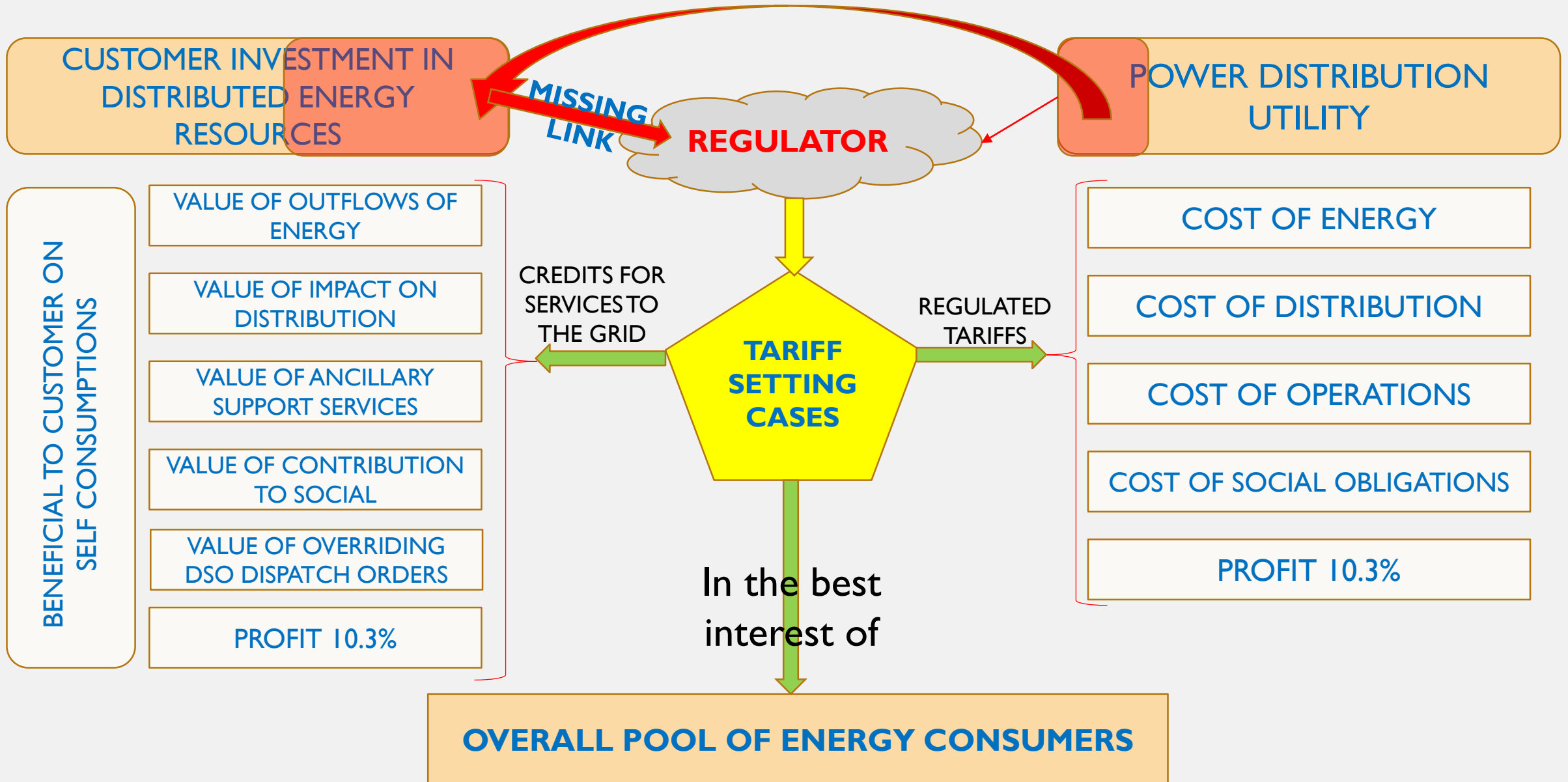
KEY BILLING/CREDITING GUIDING PRINCIPLES

- Both **“Energy”** and **“Distribution”** costs are billed or credited based on the volumetric amount of kWh flows
- **“Inflows”** of energy from the grid to the customer are billed on a standard regulated **“Time-Of-Use”** tariff with fair cost allocation
- Cost of customer self-generated clean-energy **is what it is** and the sole responsibility of the customer
- Each customer-specific equipment-installation is rated by the Utility and allocated an **“accreditation corrective-factor”** proportional to the nature, capacity and capabilities of equipment to provide reliable support services to the grid
- **“Automated Outflows”** of energy, from the customer back to the grid, are credited based on the standard **“Time-Of-Use”** rates factored with the **“accreditation corrective-factor”**

KEY BILLING/CREDITING GUIDING PRINCIPLES

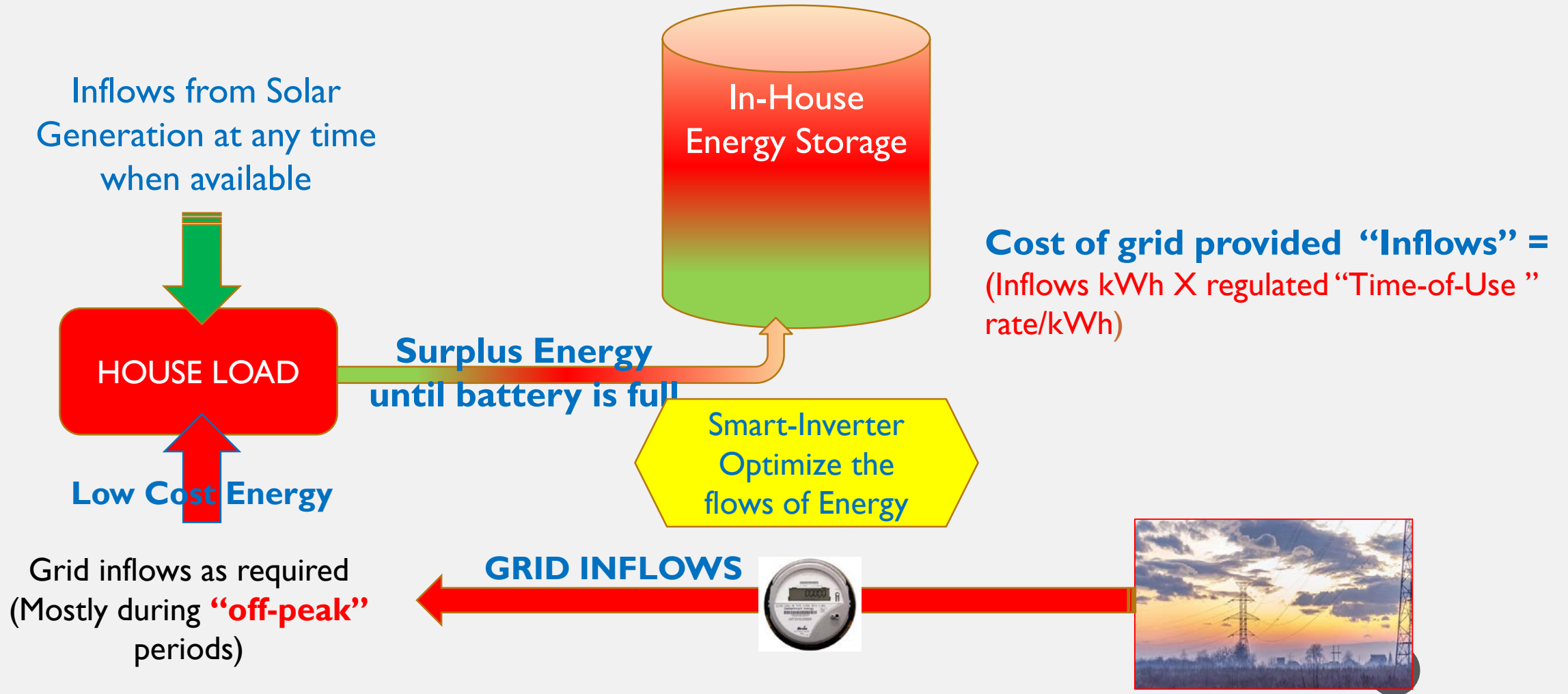
- Customer stored energy ordered by the DSO through an **“Overriding-Dispatching-Requests”** sent to the Smart-inverter is credited at an exceptional rate applicable for the whole number of time-blocks during which the DSO order is in force
- Customers applying for a DER accreditation, which are located in an area downstream of a congested distribution feeder or substation, are offered an **“Investment financing facility”** and a **“Discounted-loan-interest-rate”** by the Utility to encourage accelerated DER development in grid stressed areas

FAIRNESS OF TREATMENT & RECIPROCITY



**BILLING OF
“INFLOWS” OF ENERGY
FROM THE GRID**

FLOWS OF ENERGY DURING “OFF-PEAK” PERIODS



TIME-OF-USE RATES FOR INFLOWS

MONTHLY COST OF INFLOWS

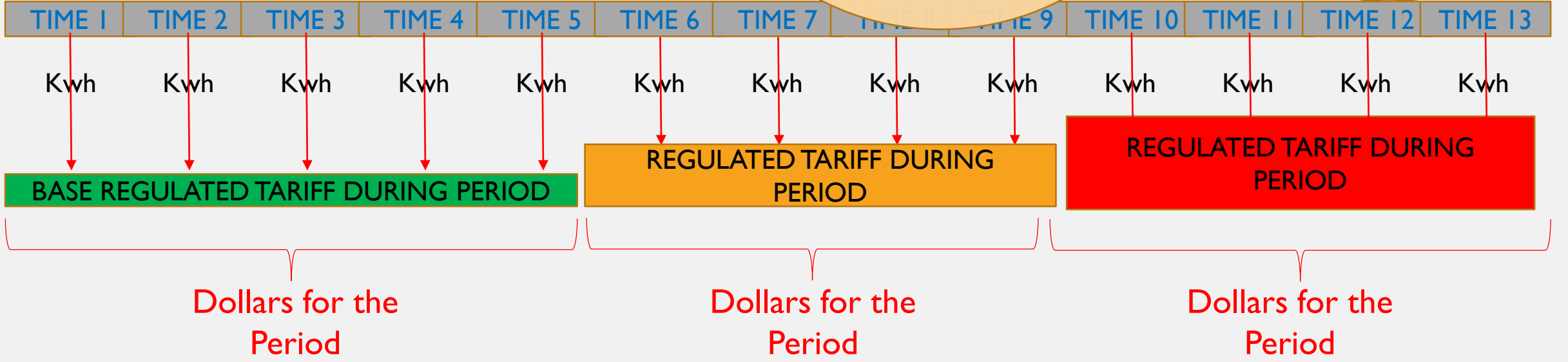
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COST OF ENERGY

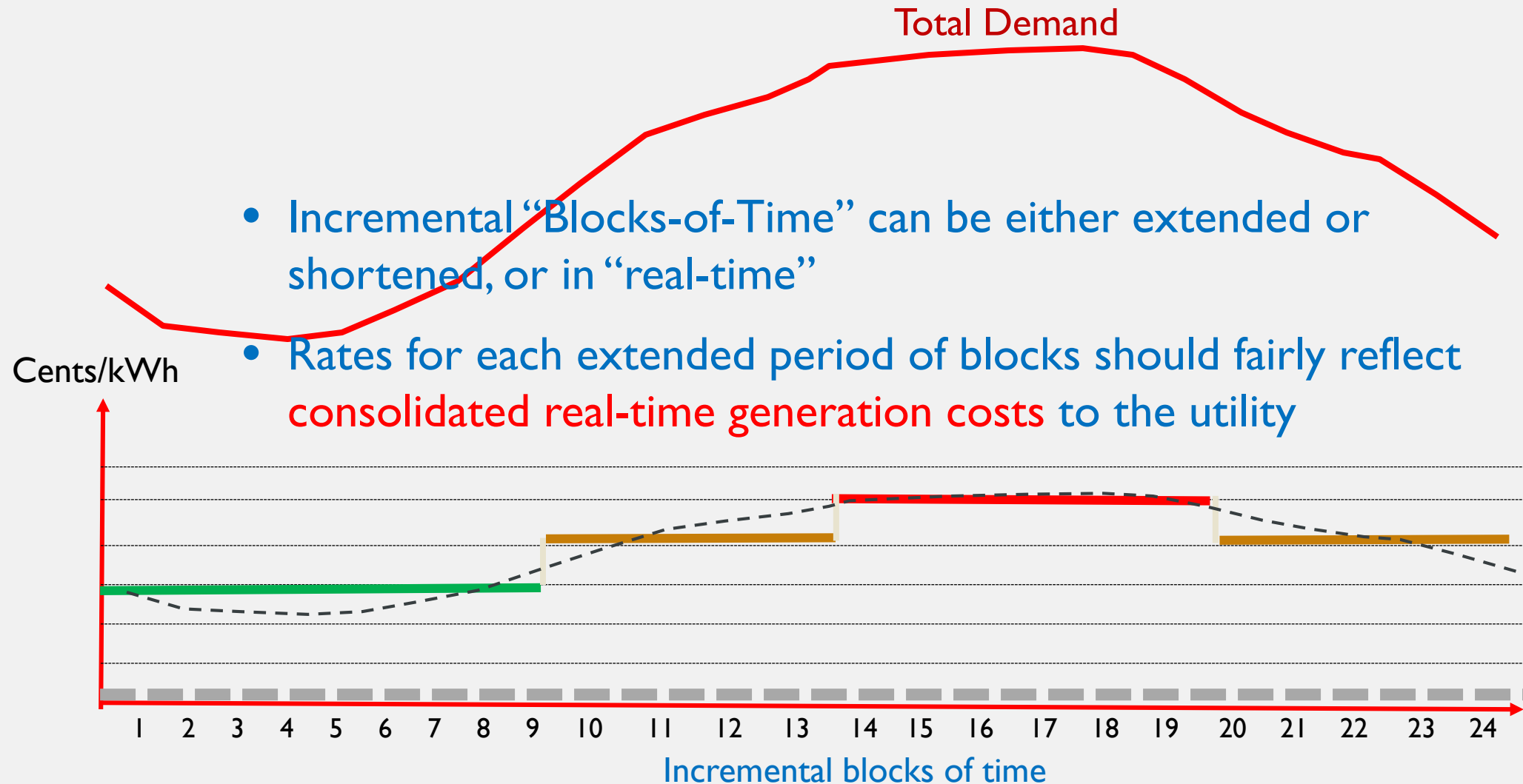
Monthly Sum of (Kwh per incremental block of time X **Energy** tariff in force during each Block)

For the "DER" a time-of-use rate base might be more appropriate to fairly account for contribution to reducing grid congestion

Billing mechanisms for this component may benefit from a net charge per kWh

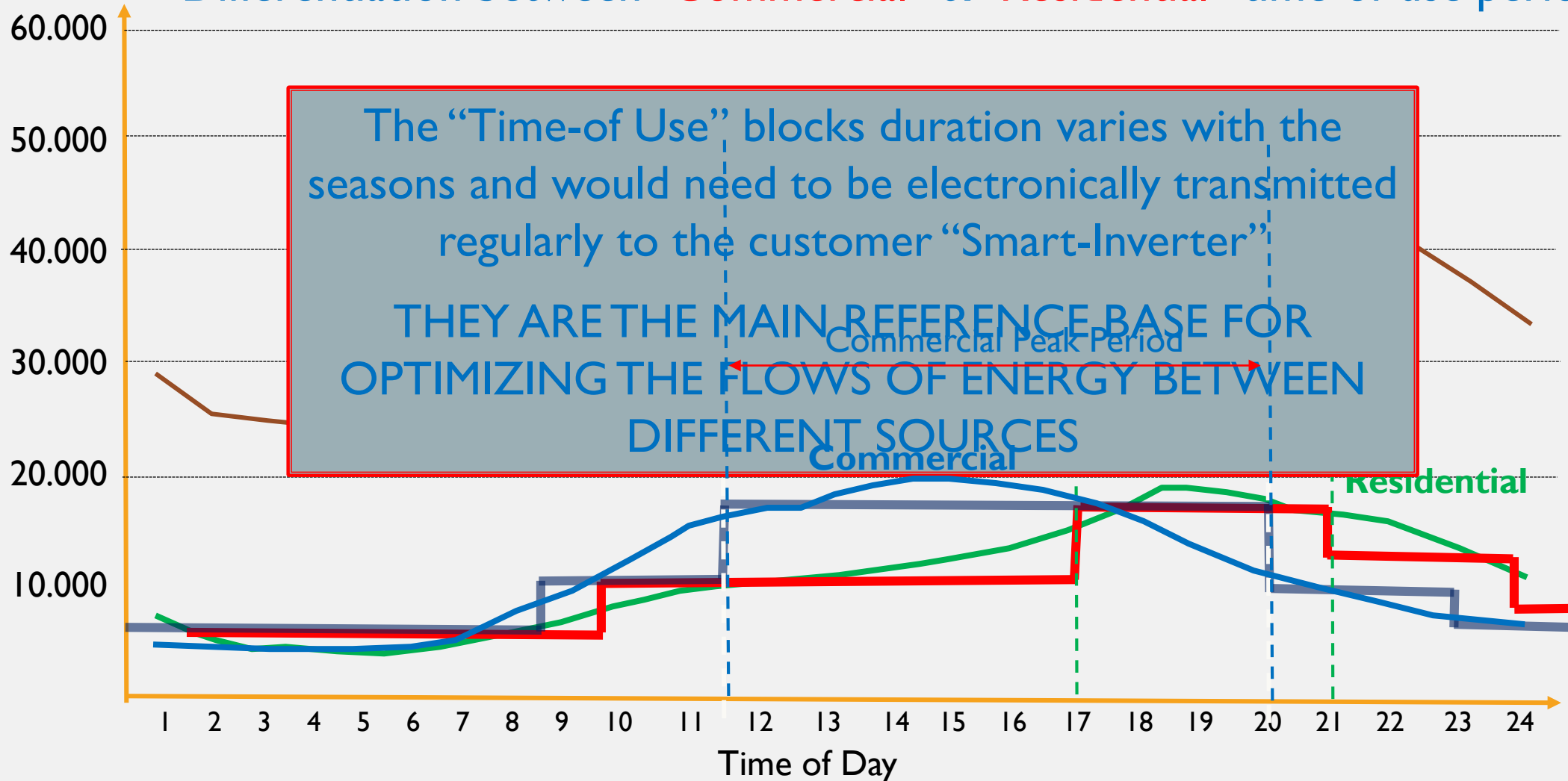


COST ALLOCATION TO “TIME-OF-USE” BILLING RATES



“TIME-OF-USE” RATES NEED TO BE FAIRLY DISTRIBUTED FOR EACH CUSTOMER CLASS

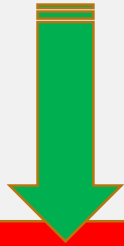
Differentiation between “Commercial” & “Residential” time-of-use periods



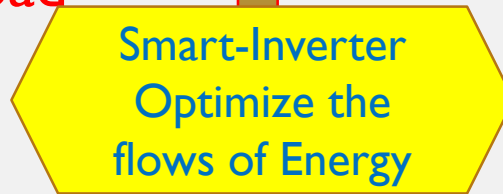
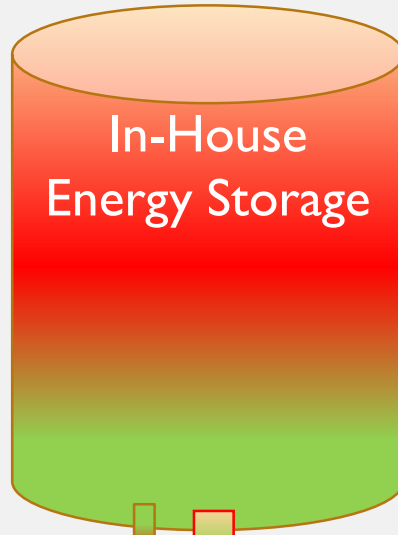
**CREDITING OF
“OUTFLOWS” OF ENERGY
TO THE GRID**

FLOWS OF ENERGY DURING “PEAK” PERIODS

Inflows from Solar at any time if still available



Use of Stored Energy to meet House Load



Surplus of stored energy exported to the grid during peak-time

THE ISSUE IS HOW THE VALUE OF OUTFLOWS AND RELATED SERVICES TO THE GRID SHOULD BE CREDITED TO THE CUSTOMER



OUTFLOWS



KEY DRIVING DER INVESTMENT-COST VARIABLES

- Cost of DER Customer's global investment in behind-the-meter equipment (**It**)
- Portion of investment cost incurred for the exclusive benefit of the customer (**Ic**)

$$\text{Portion of Customer's investment benefiting the Grid} = \mathbf{It} - \mathbf{Ic}$$

This portion of investment should be subject to a discounted Utility-sponsored "Investment-Facility-Program"

AND

Should be entitled to a contractual guaranteed return on the investment, equivalent to the legally guaranteed Utility ROI

KEY VOLUMETRIC ENERGY-COST VARIABLES

- kWh of customer self-generated (or acquired) **“Clean-Energy”**



- kWh of Grid provided **“Inflows”** of Energy

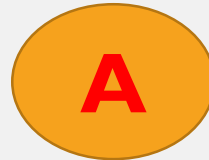


- kWh of **“Outflows”** of Energy returned to the Grid

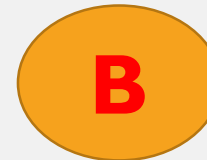


**In-House Energy
Consumption (kWh)**

=



+

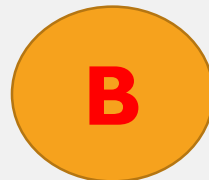


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**Net Grid provided
Energy (kWh)**

=



−



All billed/credited based on “Time-Of-Use” rates

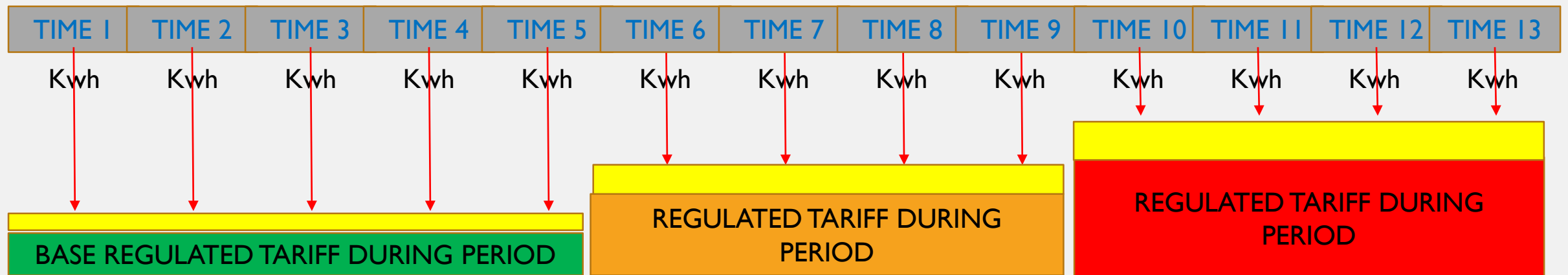
UTILITY-PROVIDED RATE REFERENCES

- Incremental **“Time-Blocks”** duration
- Regulated **“Time-Of-Use”** energy-cost-rates in force during each time-block
- **Months of the calendar-year** during which the “Time-Of-Use” rates are applicable
- The Customer’s equipment installation accredited **“Rate-Adjustment-Factor”**
- The exception energy-rate applicable for the duration of **“DOS-Overriding-Dispatching-Orders”**

All these reference billing parameters are stored in the “Energy Management Module” of the Smart-Inverter and are used for optimizing the routing of the flows of energy and billing/crediting purpose

IMPACT OF ACCREDITATION “RATE-ADJUSTMENT-FACTOR”

- The Proposed accredited “Rate-Adjustment-Factor” would be calculated by the Utility when it approve the Customer in-house installation capacity, capability and anticipated reliability.
- It would be proportional to the nature and degree of grid support services the customer will be able to provide
- The “Rate-Adjustment-Factor” would be a multiplier applied on the standard regulated “time-of-use” used for billing “inflows” of energy to the customer



CALCULATION OF THE ACCREDITED “RATE-ADJUSTMENT-FACTOR”

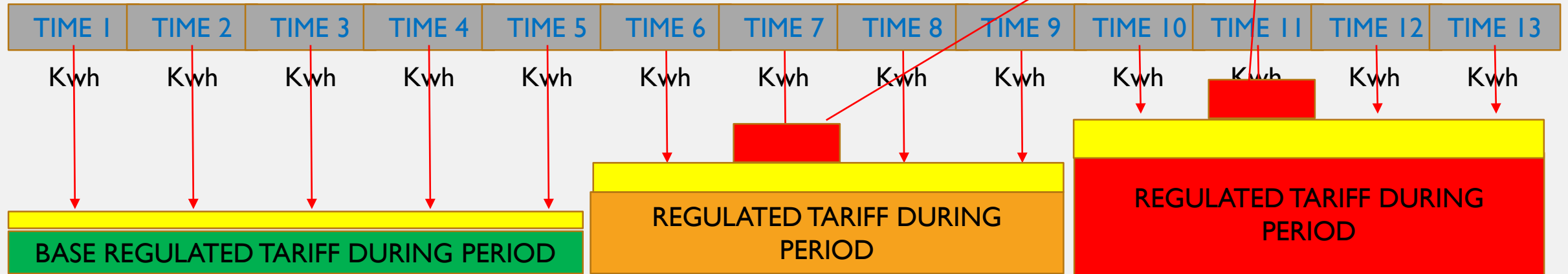
- “Entry Level”
- “Accredited Silver”
- “Accredited Gold”
- “Accredited Platinum”
- “Accredited Super-Elite”

NATURE OF SUPPORT SERVICES TO THE GRID									
A	B	C	D	E	F	G	H		
⚡	→								F1
⚡	⚡	→							F2
⚡	⚡	⚡	⚡	→					F3
⚡	⚡	⚡	⚡	⚡	⚡	⚡	→	F4	
⚡	⚡	⚡	⚡	⚡	⚡	⚡	⚡	F5	

Rate-adjustment-factors ↗

CREDIT FOR DSO OVERRIDING DISPATCHING OF STORED CUSTOMER ENERGY

Temporary **“Rate-Premium-Credit”** applicable only when a DSO stored energy dispatch order is activated



CONCEPTUAL CREDIT STRUCTURE (FOR DISCUSSION PURPOSE ONLY)

