ENERGY STORAGE, A MARKET FOR POWER ELECTRONICS

IMRE GYUK, DOE

POWER ELECTRONICS

ARE ESSENTIAL

FOR STORAGE AND DG

REPRESENTING ABOUT

30% OF SYSTEM COST

ENERGY STORAGE

REPRESENTS A POTENTIAL

MULTIBILLION DOLLAR

BUSINESS

ENERGY STORAGE

MEDIATES BETWEEN

VARIABLE SOURCES

AND VARIABLE LOADS

LOAD VARIABILITY

RESULTS IN

LOW CAPACITY FACTORS

AND INEFFICIENT

RESOURCE UTILIZATION

CURRENTLY

GENERATION: 60-70%

TRANSMISSION: 40-50%

DISTRIBUTION: 35-45%

EPRI: BY 2025 ENERGY STORAGE WILL INCREASE CAPACITY FACTORS FOR

GENERATION: 5%

TRANSMISSION: 10%

DISTRIBUTION: 15%

ENERGY STORAGE

WILL BE A KEY TECHNOLOGY

FOR THE FUTURE GRID

WITH HUGE ECONOMIC POTENTIAL

BUT SUCCESS OF

ENERGY STORAGE

DEPENDS CRUCIALLY

ON IMPROVEMENTS

OF INVERTER TECHNOLOGY

ENERGY STORAGE

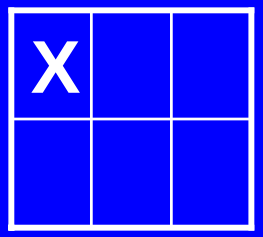
FINDS APPLICATIONS

ON BOTH CUSTOMER SIDE

AND UTILITY SIDE

	POWER Seconds	minutes – hours	*ENERGY* diurnal
LOAD	PQ, Digital Reliability	DER Support for Load Following	Peak Shaving to Avoid Demand Charges
GRID	Voltage Support, Transients	Dispatchability for Renewables, Village Power	Mitigation of Transmission Congestion, Arbitrage

APPLICATIONS FOR ENERGY STORAGE



RELIABILITY

HAS BECOME

A NECESSITY FOR THE

DIGITAL SOCIETY

HIGH-TECH DEMANDS

NINE NINES

THE GRID PROVIDES

THREE NINES

98% OF FATAL

POWER QUALITY EVENTS

LAST LESS THAN 15 secs.

BUT OUTAGES

LASTING A FEW CYCLES

CAN CAUSE

HOURS OF DOWNTIME

COSTING U.S. INDUSTRY

$35 - $150 BILLION

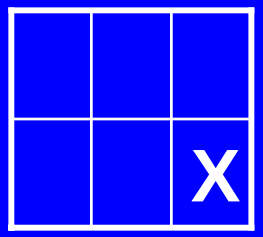
ONLY ENERGY STORAGE

CAN PROVIDE

SEAMLESS CONTINUITY

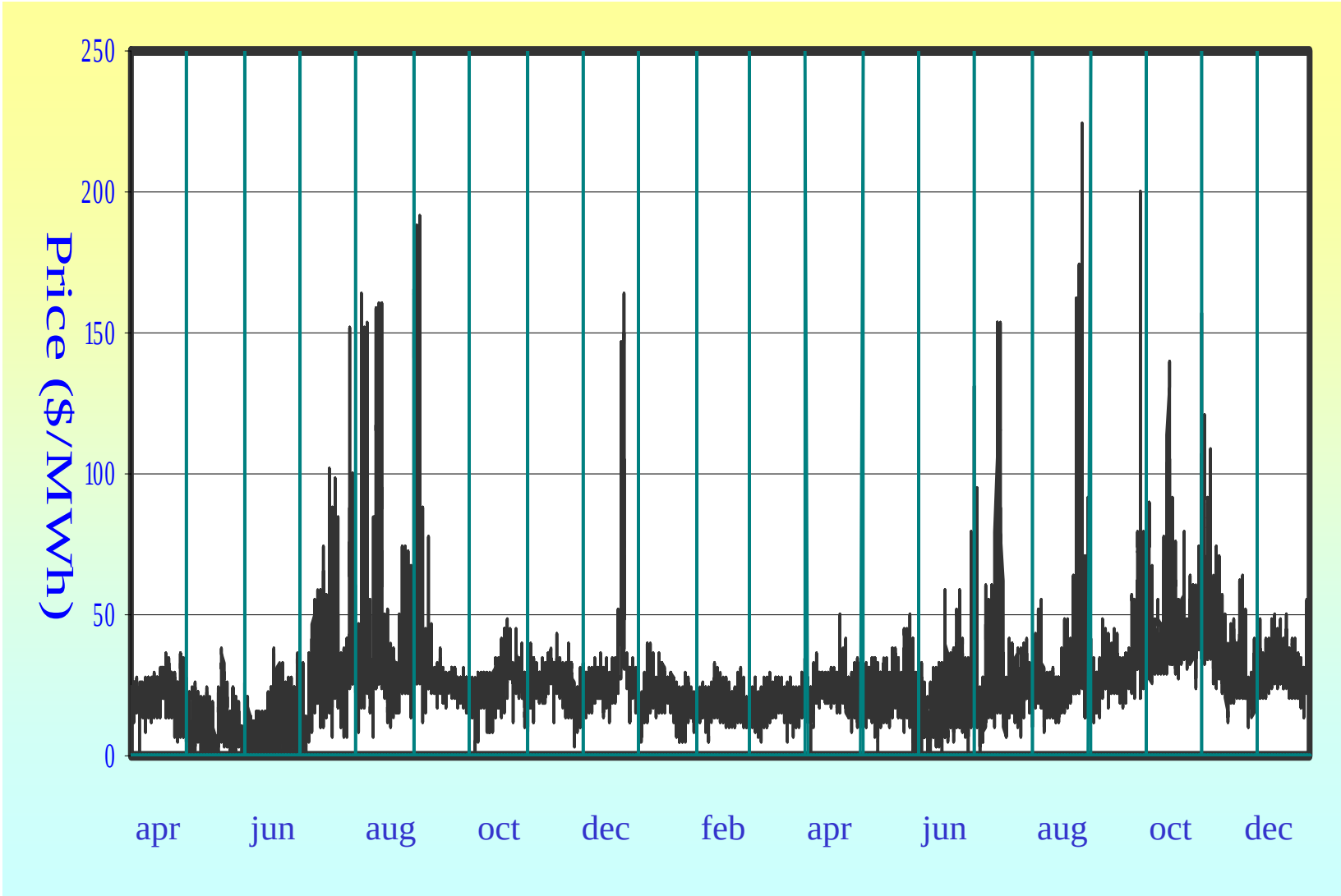
OF POWER SUPPLY

10 MW - 15 sec System at Microchip Plant



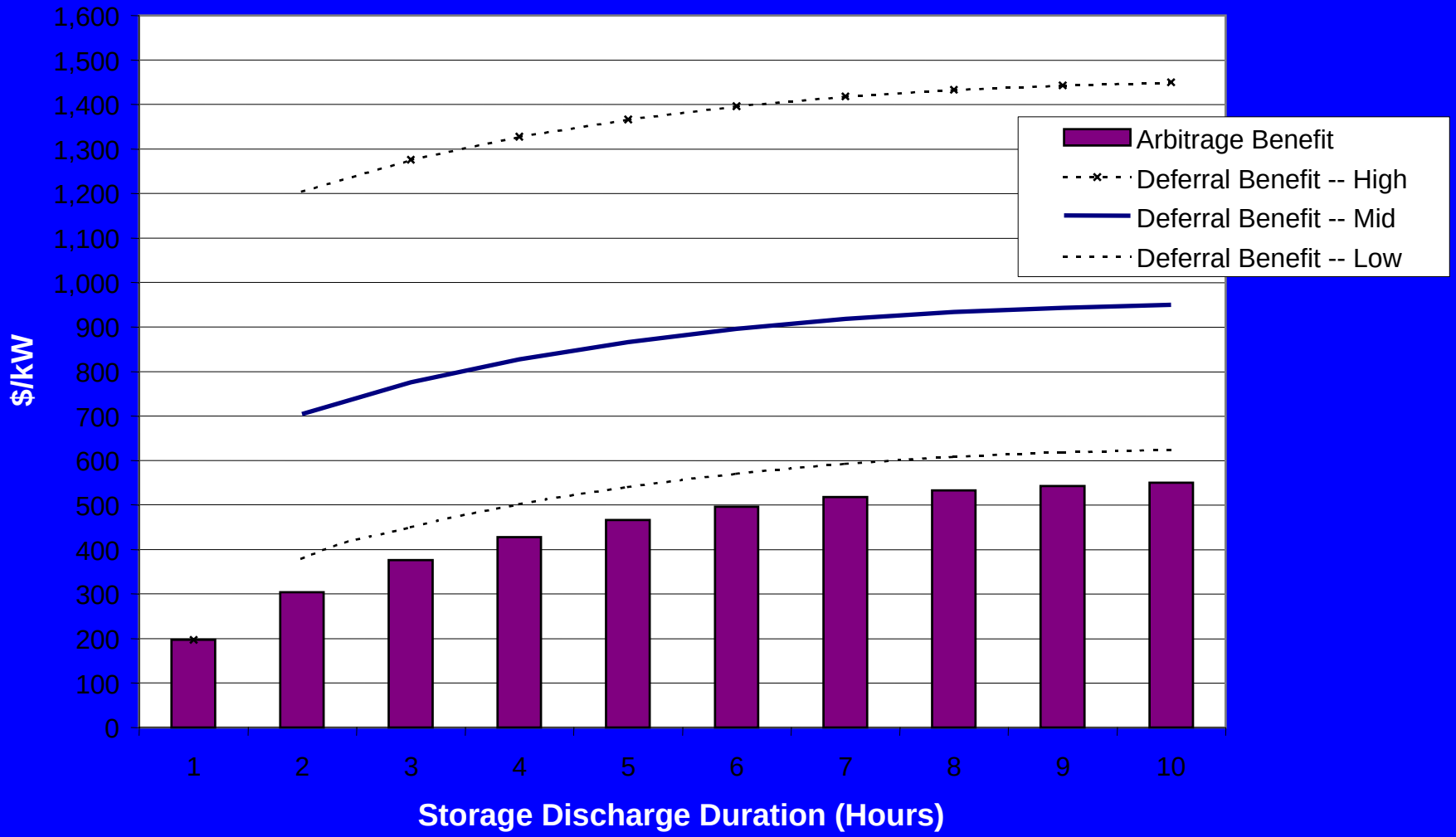
ARBITRAGE AND RELIEF OF TRANSMISSION CONGESTION

California Spotmarket 1998-1999

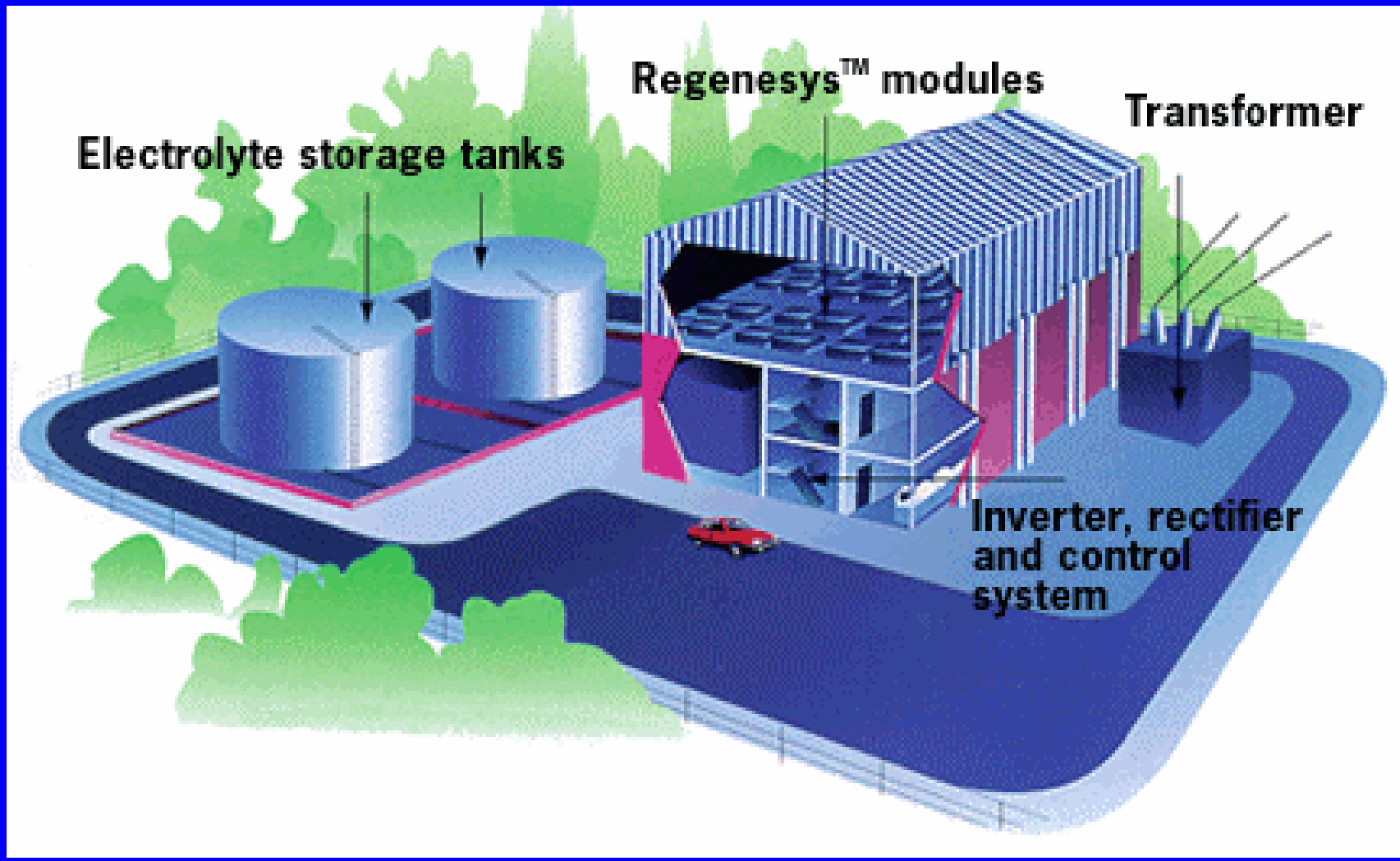


CONSIDERABLE BENEFITS CAN BE DERIVED FROM TRANSMISSION DEFERRAL

Benefits: Lifecycle Arbitrage Plus Deferral, Storage: 90% Efficiency, 1.0 ¢/kWh (DUA Results)

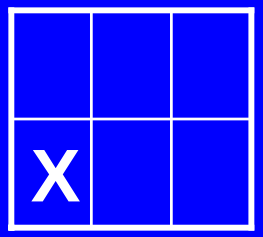


6 MW / 8hrs Sodium-Sulfur at Ohito



View of 12 MW / 8 hour Flow Battery Facility

200 kw / 2 hr ZnBr Batteries at Lum, MI Substation



VOLTAGE SUPPORT,

TRANSIENTS,

GRID STABILITY

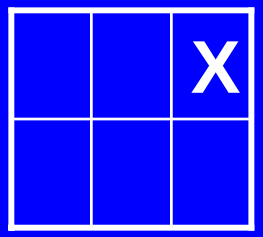
EXAMPLES:

D-SMES in WISCONSIN

40 MW NiCd in ALASKA

20 MW LA in PUERTO RICO

20 MW / 14 MWhr Puerto Rico



PEAK SHAVING FOR

PROFIT AND RELIABILITY

ENERGY STORAGE

TO RIDE OUT PRICE PEAKS

AND AVOID DEMAND CHARGES

POTENTIAL MARKET: 460 GW

REPRESENTS A HUGE

AVAILABLE RESOURCE

OF UNUSED LOAD

FOR THE ISO

WITH DEVELOPMENT OF

AGGREGATION MECHANISMS

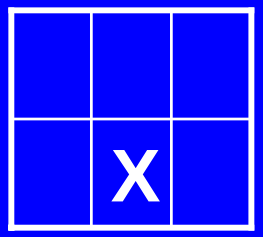
AND APPROPRIATE

CONTRACTUAL TOOLS

CUSTOMERS COULD

BID UNUSED LOAD

AT SPOT MARKET PRICES



MAKING RENEWABLES DISPATCHABLE

VILLAGE POWER

STORAGE CAN MAKE

WIND FARMS DISPATCHABLE

TO BID ON THE SPOT MARKET

WHERE BIDS TYPICALLY

REQUIRE 24 HOUR ADVANCE

WITH 250% PENALTY

FOR NON-DELIVERY

ONE THIRD OF THE WORLD POPULATION IS NOT GRID CONNECTED

STORAGE IMPROVES EFFICIENCY & RELIABILITY OF A VILLAGE GRID

DOE PROGRAM GOAL:

DEVELOP A BROAD PORTFOLIO OF STORAGE TECHNOLOGIES FOR A WIDE SPECTRUM OF APPLICATIONS

DOE POWER ELECTRONICS

RESEARCH:

EMITTER TURN-OFF (ETO) SWITCH:

DEVELOPMENT OF A SWITCH

FASTER THAN GTO,
MORE POWERFUL THAN IGBT,
AND CHEAPER AS WELL

ETO BASED MULTI LEVEL INVERTER

DEVELOPED BY TVA

TEAMED WITH ULTRACAPACITORS

FOR CURRENT INJECTION

TO MAINTAIN GRID STABILITY

OPTICALLY ISOLATED INVERTER

FACTS WITH ENERGY STORAGE

DEVELOPMENT OF RELIABLE MODULAR INVERTER

ENERGY STORAGE HAS HUGE ECONOMIC POTENTIAL

BUT IT WON'T HAPPEN WITHOUT BETTER INVERTERS !!

(DITTO FOR DG)