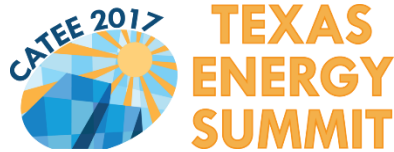


MICROGRIDS

Pathways to Sustainability & Resiliency



AN INTRODUCTION

Presented by Cliff Braddock

November 15 - Rio Grande Room - 1:15 PM to 2:30 PM

METC  **ENGINEERING**[®]

Sustainability

begins with
Energy

What is Sustainability?

[suh-stey-nuh-bil-i-tee]



1).



Standard Definition -

The ability to be sustained, supported, upheld or confirmed.



noun

2).



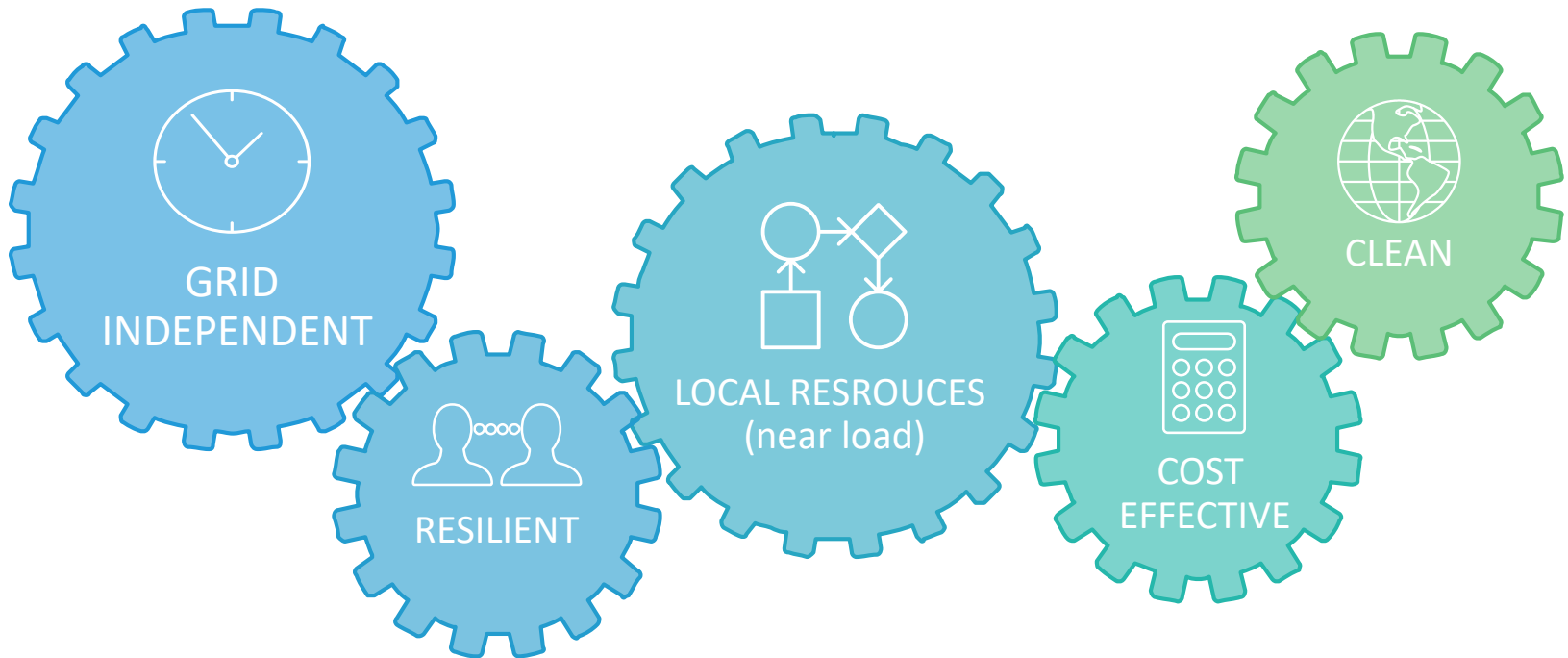
Environmental Science -

The quality of not being harmful to the environment or depleting natural resources and thereby supporting long-term ecological balance:



noun

What is a Microgrid?

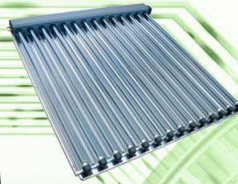


Multiple Resources Serve Multiple Loads

MICRO GRID

SYNERGY

SOLAR THERMAL



**SOLAR
CARPORT**



POWER GRID



**ELECTRIC
VEHICLE
CHARGING**



TRIGENERATION



**ENERGY
STORAGE**



**BUILDING +
PARKING**



**ENERGY EFFICIENT
EQUIPMENT**



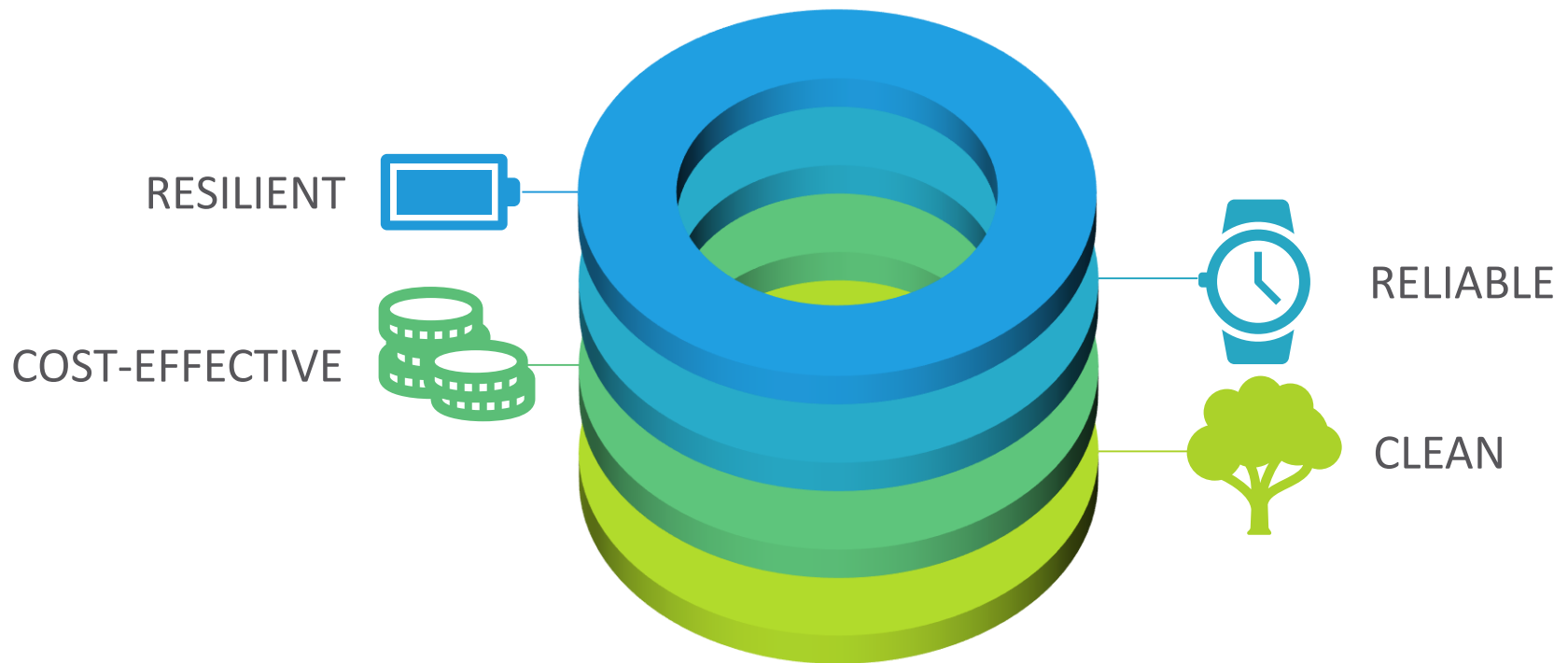
NATURAL GAS



**CITY WATER +
ON-SITE WELLS**

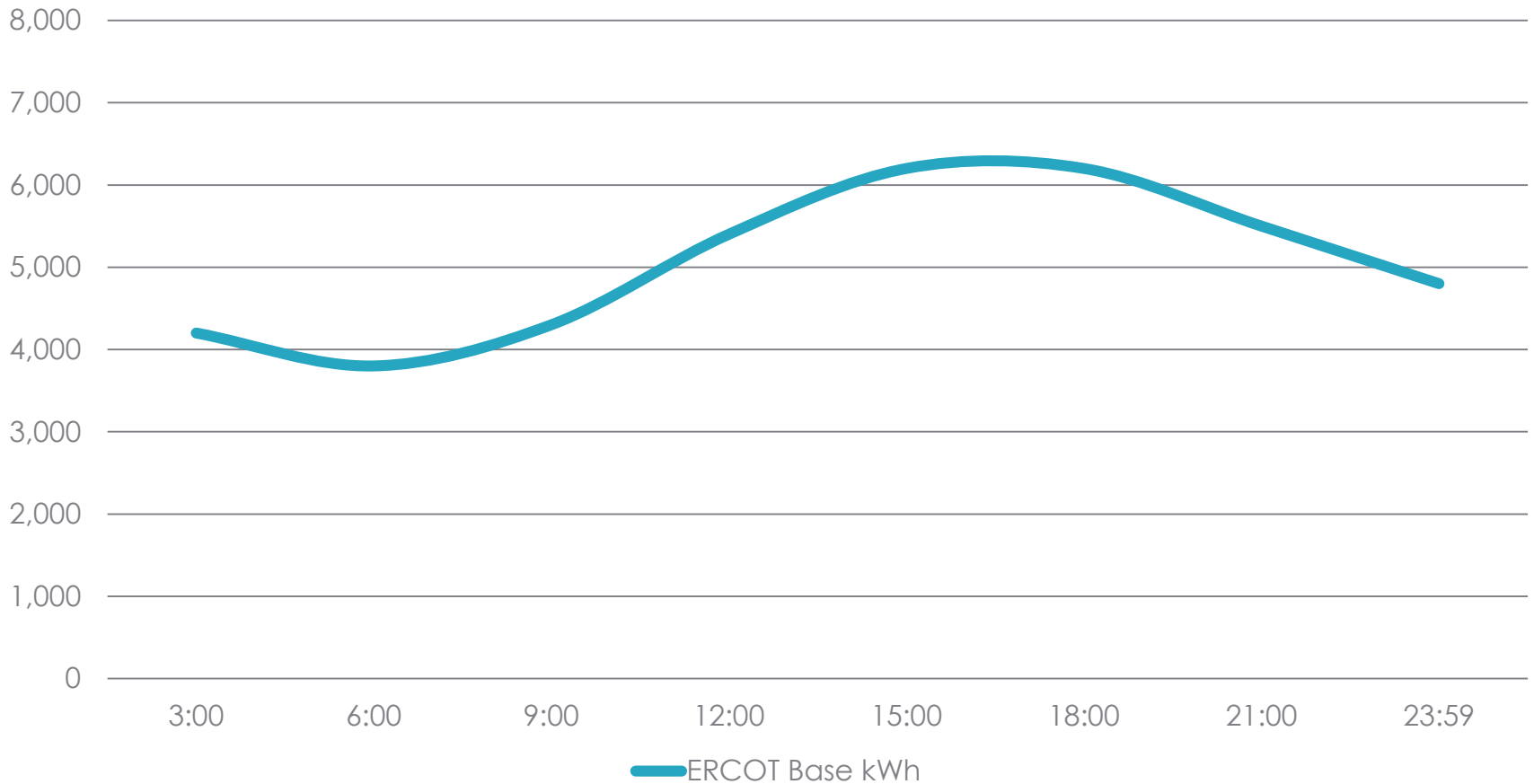


How Do We Grade Sustainability?



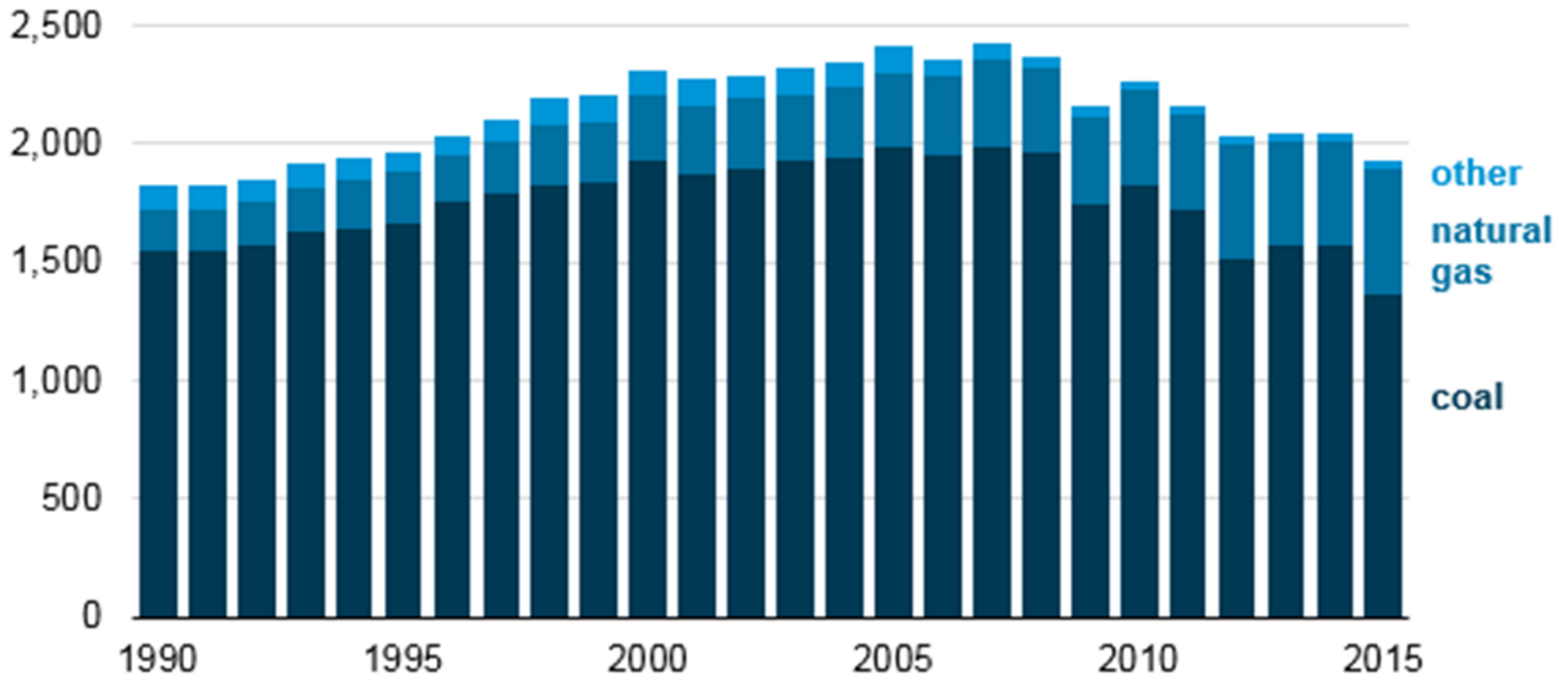
Our Benchmark is the Power Grid

ERCOT Electric Demand (typical summer day)



Not Clean!

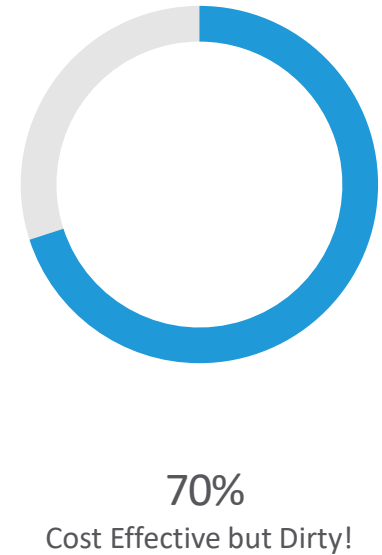
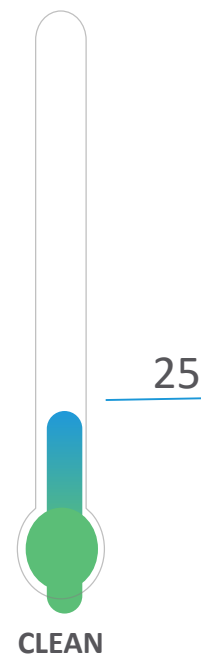
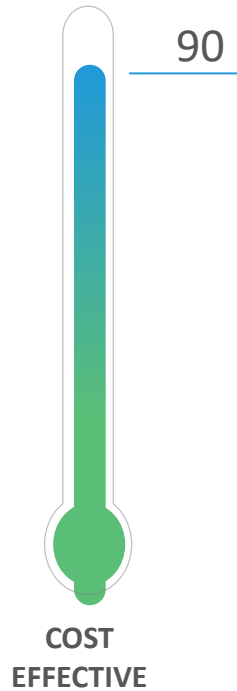
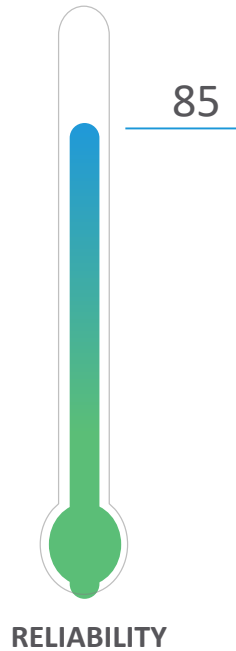
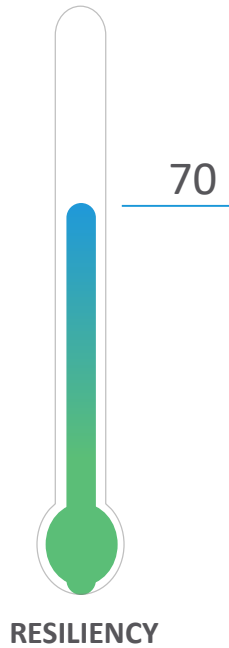
Carbon dioxide emissions from the electric power sector (1990-2015)
million metric tons



Reliability Trending the Wrong Way

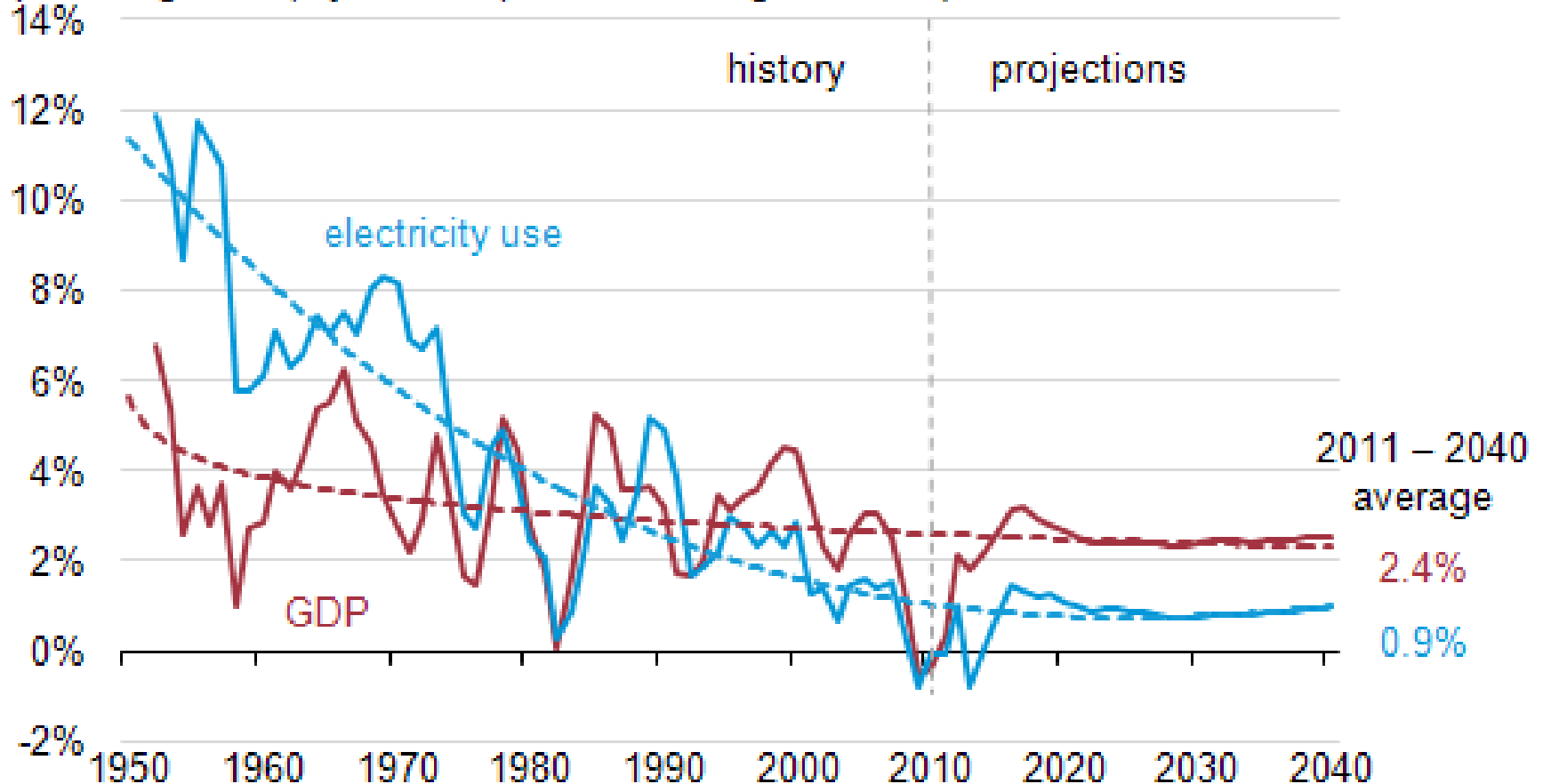
Measure	Target	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
System Average Interruption Frequency Index (SAIFI)	0.80	1.02	0.63	0.89	0.69	0.76	0.77
System Average Interruption Duration Index (SAIDI)	60.00	82.13	46.48	63.41	51.57	54.54	60.74
System Average Transmission Line Performance Index (SATLPI)	3.00	3.24	1.46	2.10	1.94	1.78	2.90

Grading the Grid

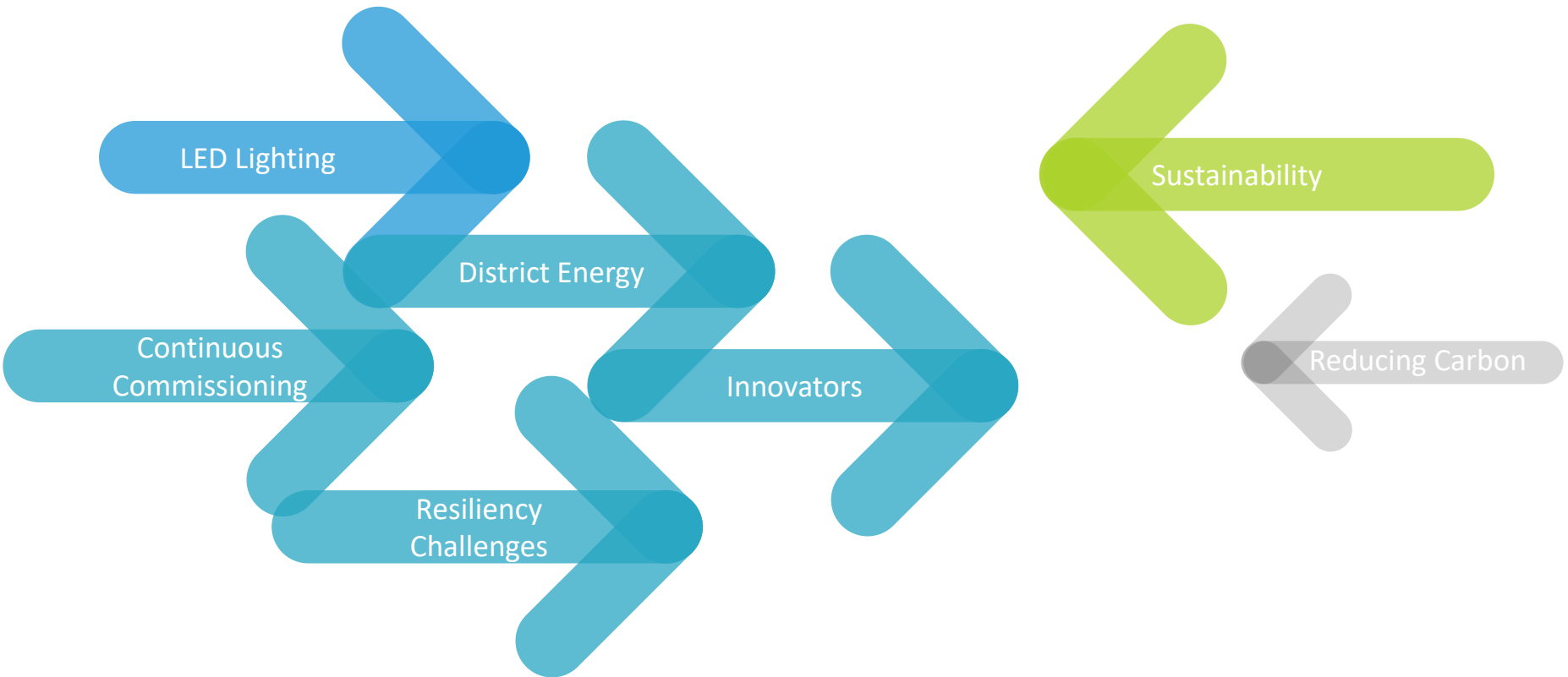


Efficiency is Delivering Results!

U.S. electricity use and economic growth, 1950 - 2040
percent growth (3-year compound annual growth rate) and trend lines

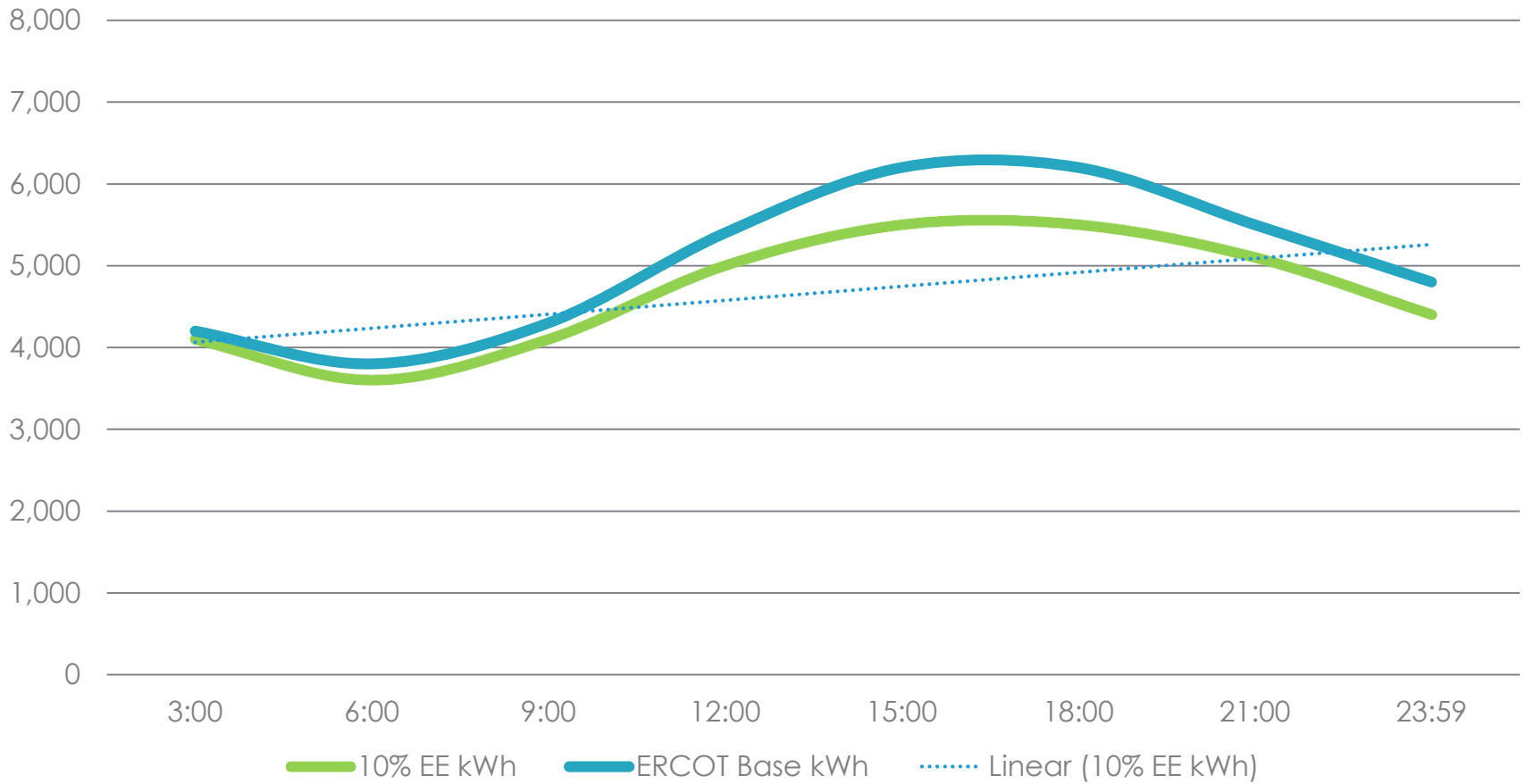


Drivers for Energy Efficiency

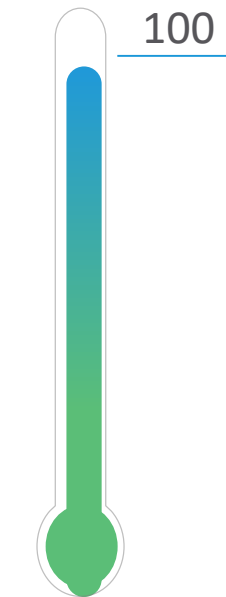


Efficiency Helps Flatten Demand Curve

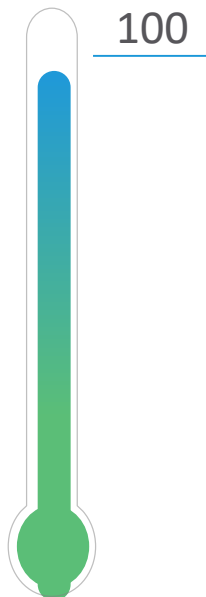
Demand Curve 10% Energy Efficiency



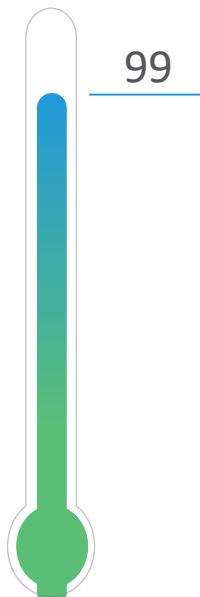
Grading Energy Efficiency



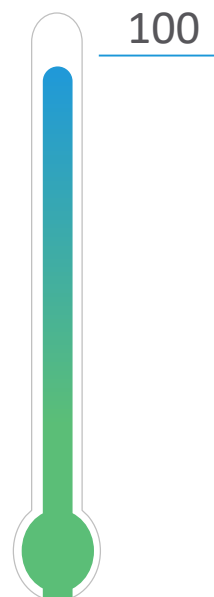
RESILIENCY



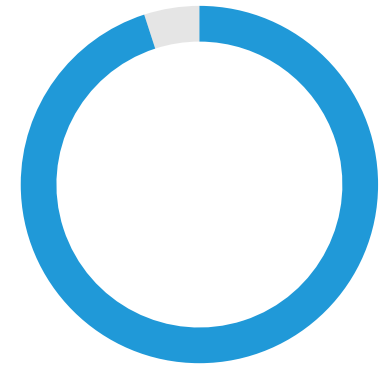
RELIABILITY



COST
EFFECTIVE



CLEAN

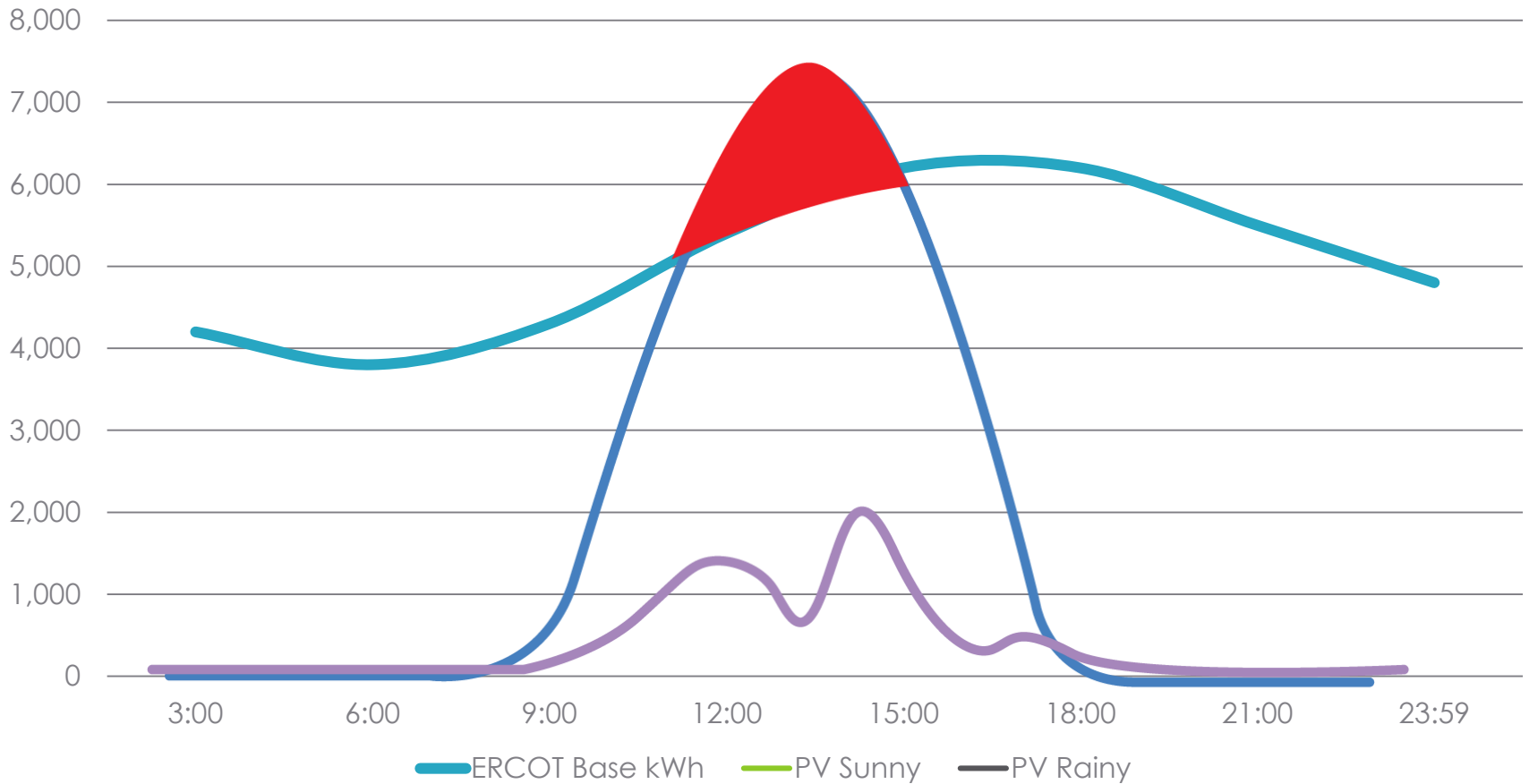


99.75%

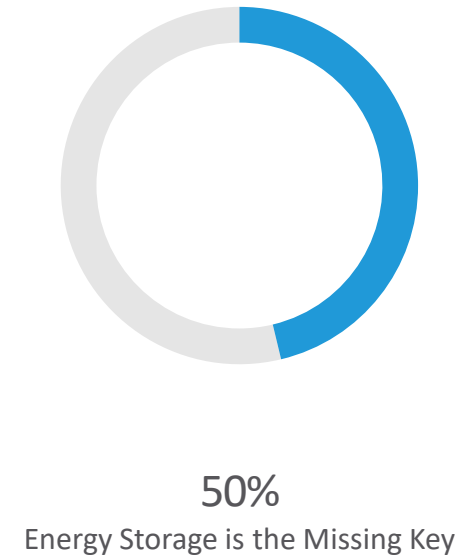
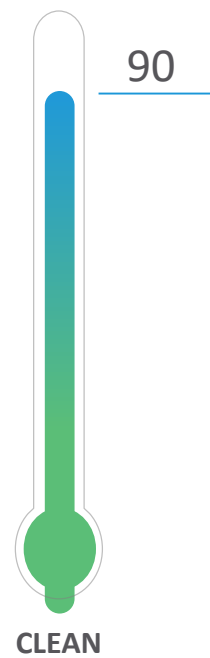
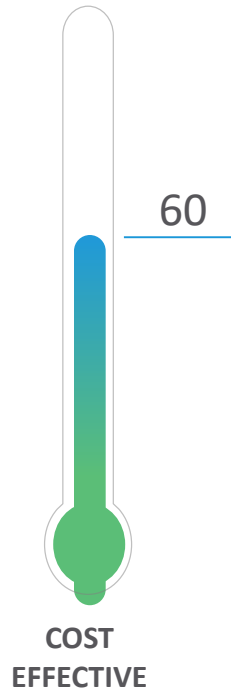
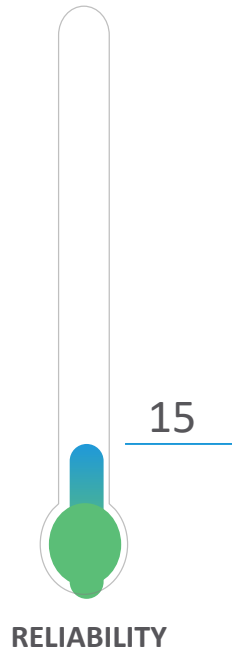
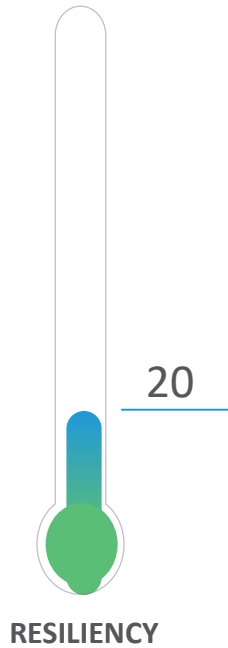
As an engineer, nothing is 100%

Opportunities and Limitations with PV

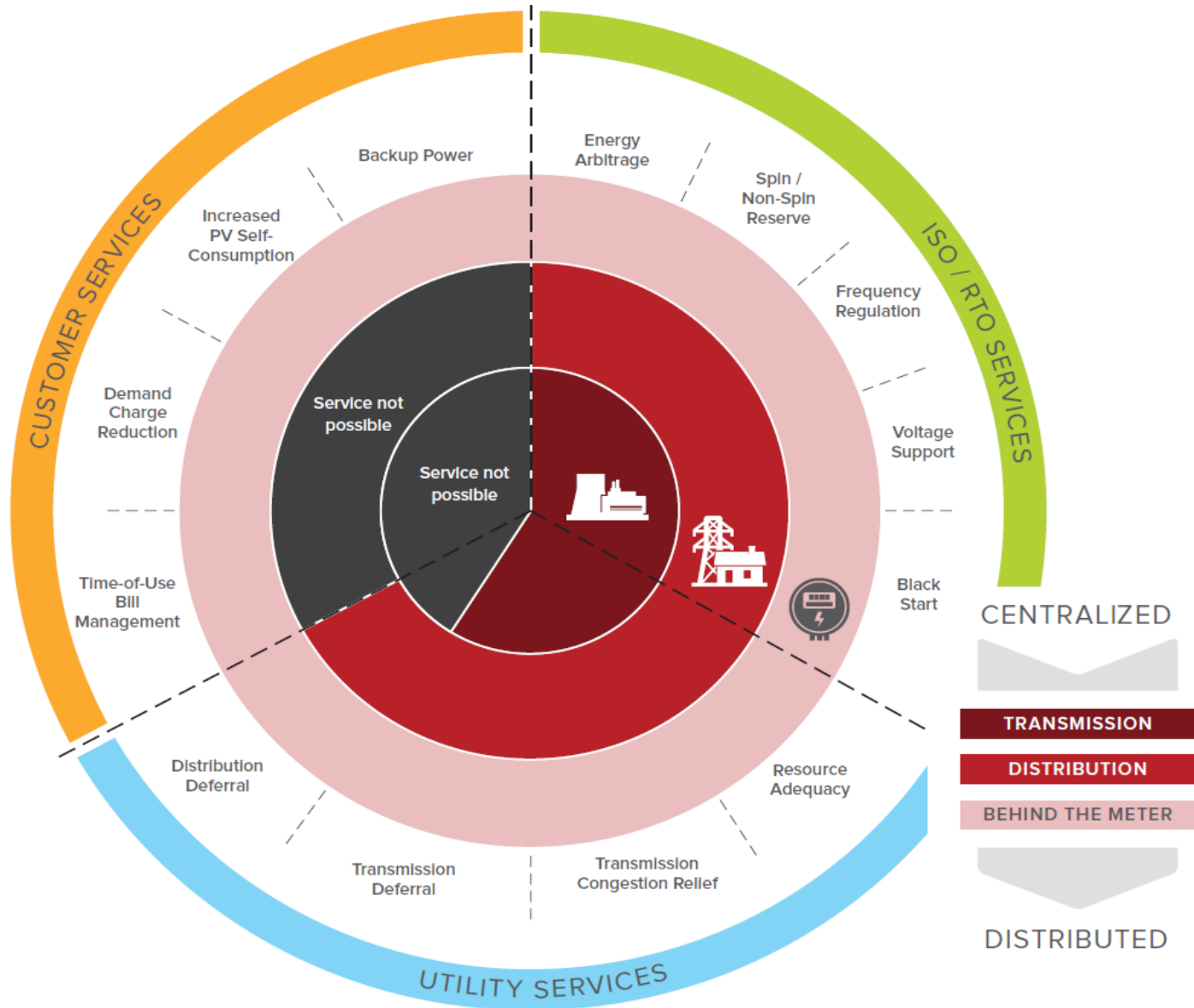
ERCOT Electric Demand (typical summer day)



Grading Solar Energy Sources



Multiple Benefits of Electric Storage



Solar Panel Array



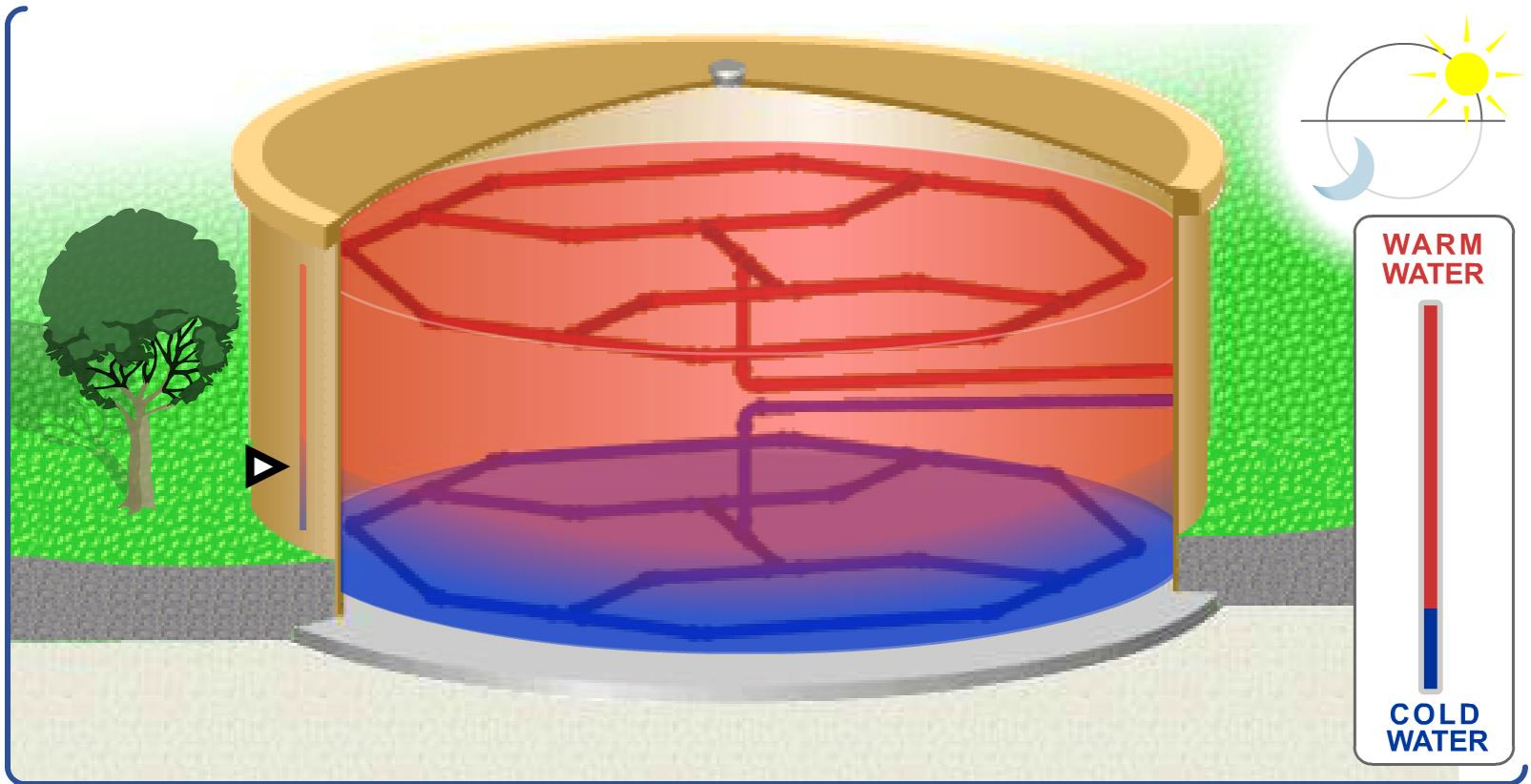
Why is it important?

The solar panel array can generate electricity and heat. It can also be used to power other systems such as lighting and heating. The solar panel array can also be used to power other systems such as lighting and heating. The solar panel array can also be used to power other systems such as lighting and heating.

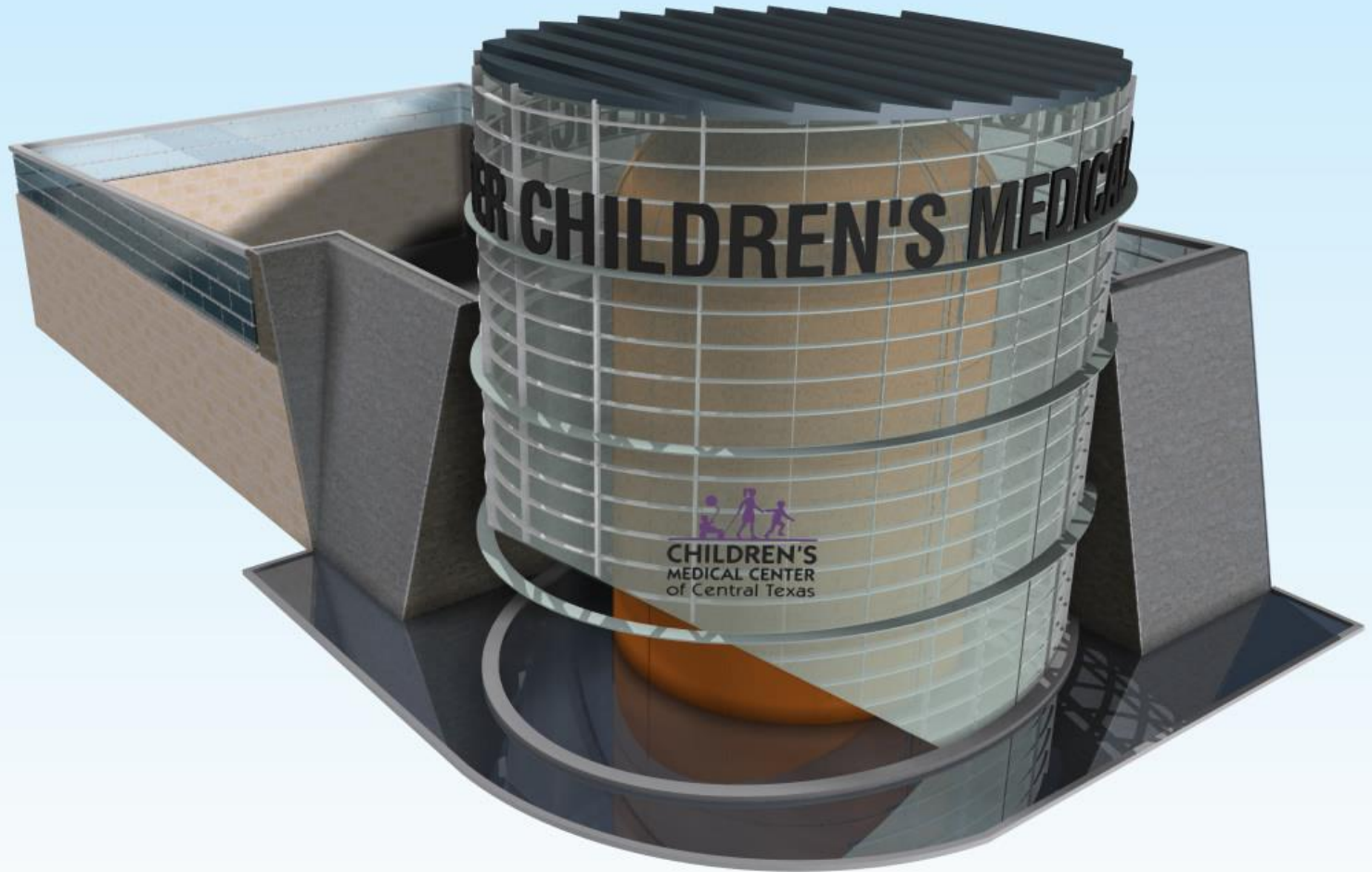
How do these systems work?

The solar panel array works by converting sunlight into electricity. The solar panel array works by converting sunlight into electricity. The solar panel array works by converting sunlight into electricity.

Daily Operations of Thermal Storage



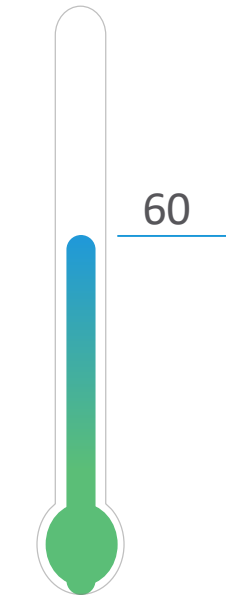
Thermal Storage Examples



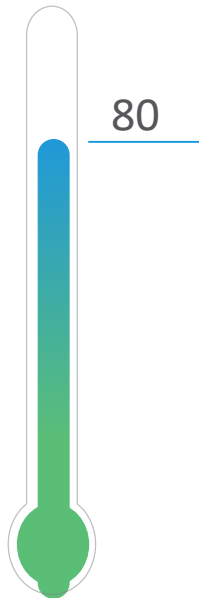
More Thermal!



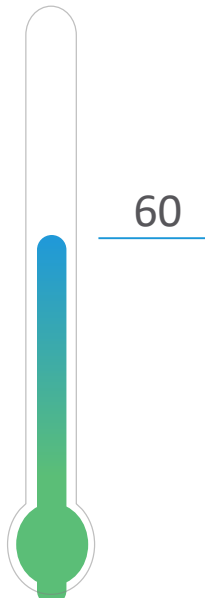
Grading Energy Storage



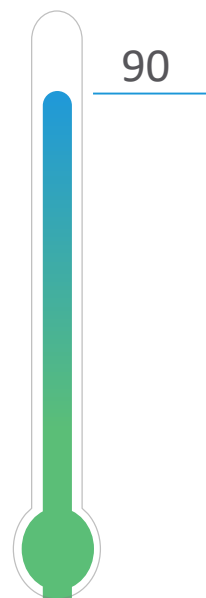
RESILIENCY



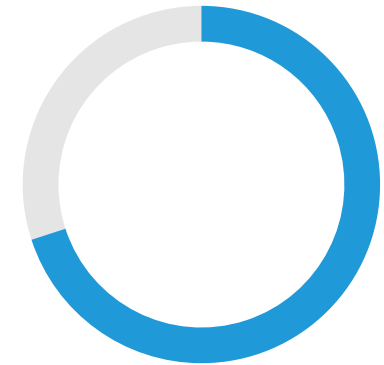
RELIABILITY



COST
EFFECTIVE



CLEAN



70%

Let's keep it moving forward!

Distributed Generation (DG)



Fuel Cells

Quiet, no moving parts, clean, can be efficient, but are expensive.



Microturbines

Clean, can be efficient in Cogen and Trigen. Reliable, cost effective in Cogen and Trigen modes.



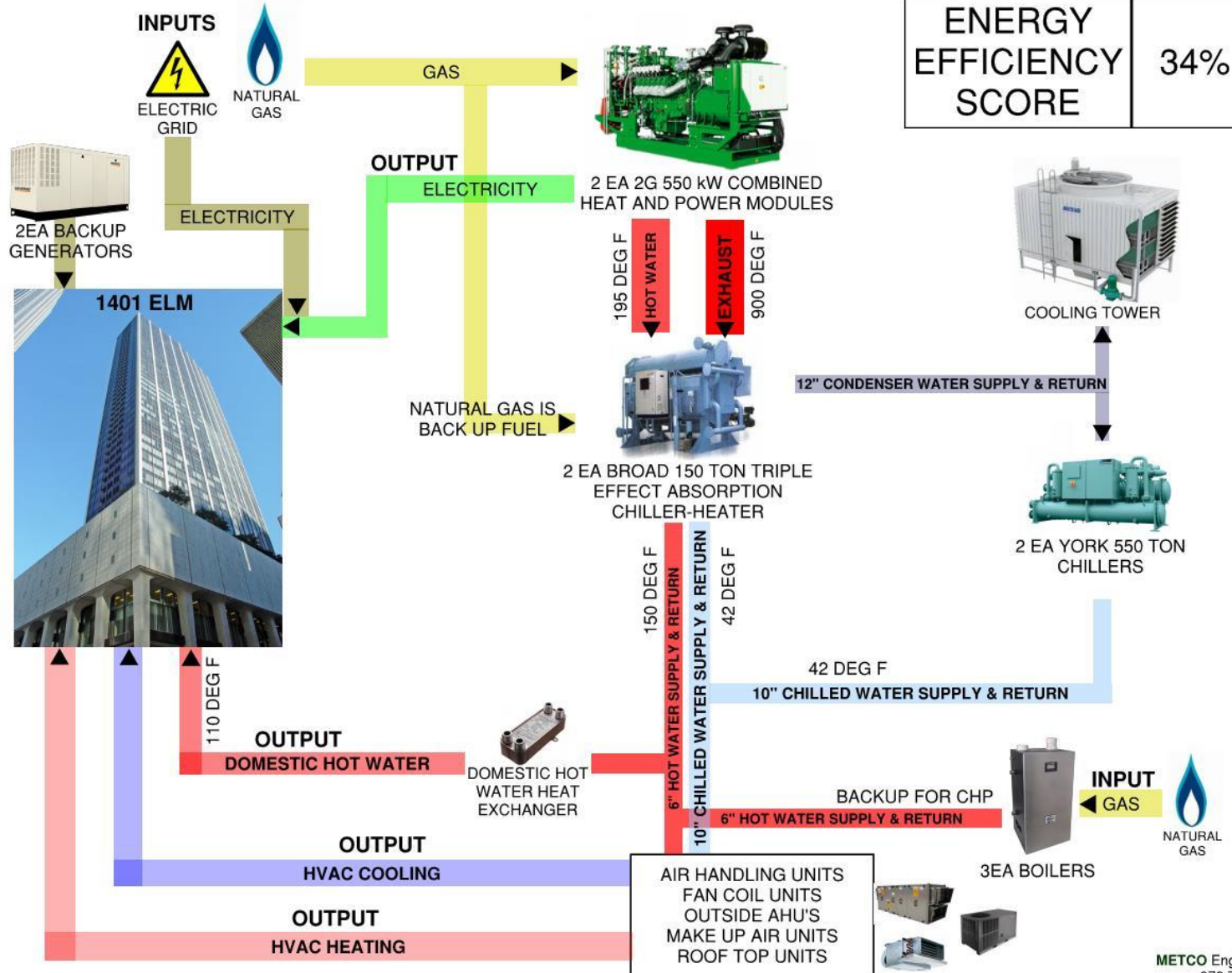
Waste Heat to Power - ORC

Quiet, no moving parts, clean, free fuel, but are expensive in the short term.



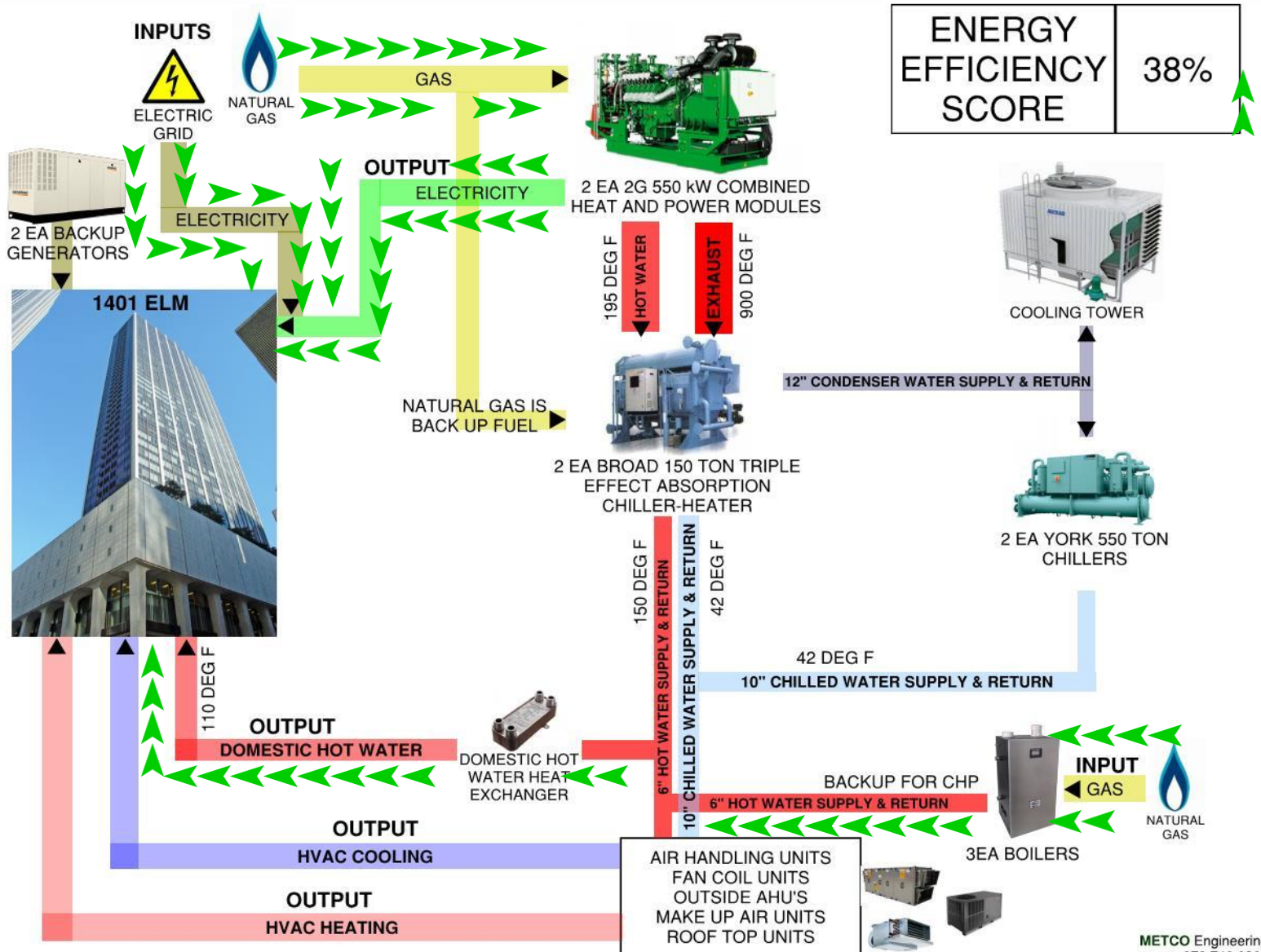
Grid Only (No DG)

ONCOR ELECTRIC GRID AND NATURAL GAS ACTIVATED



Grid + DG (No Thermal)

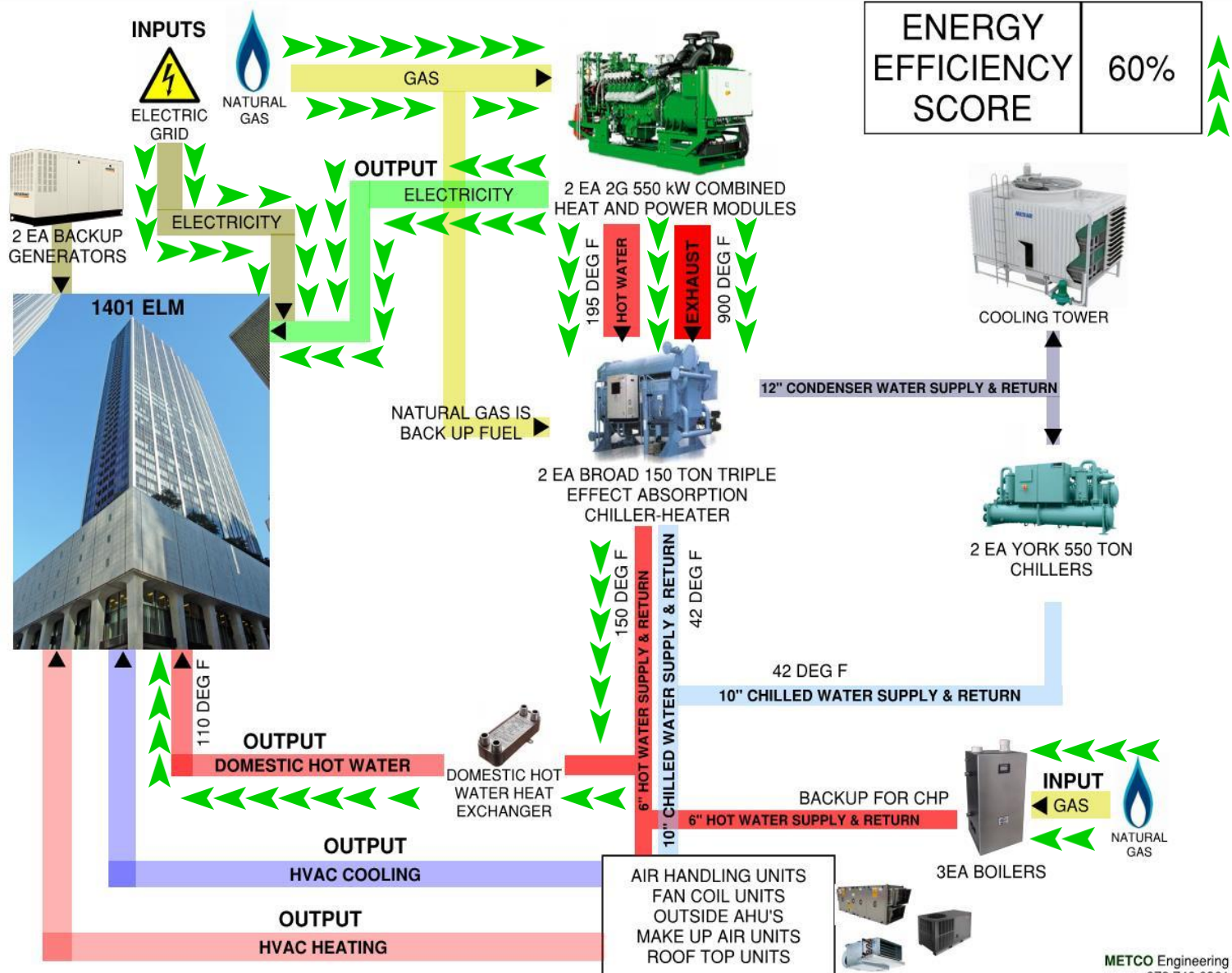
ONCOR ELECTRIC GRID AND NATURAL GAS ACTIVATED. CHP PRODUCES ELECTRICITY.





DG + Thermal

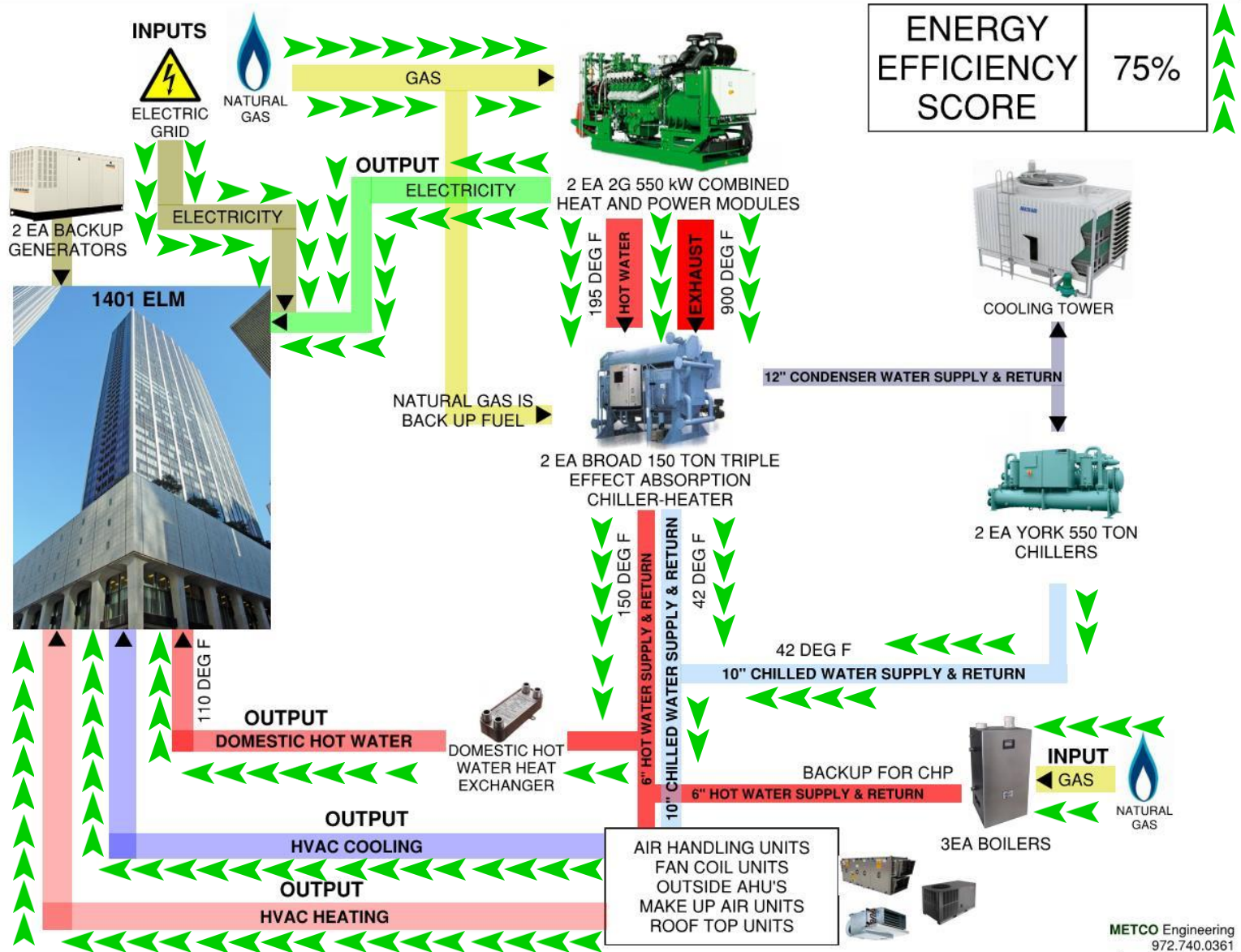
ONCOR ELECTRIC GRID AND NATURAL GAS ACTIVATED. CHP PRODUCES ELECTRICITY AND HEAT.



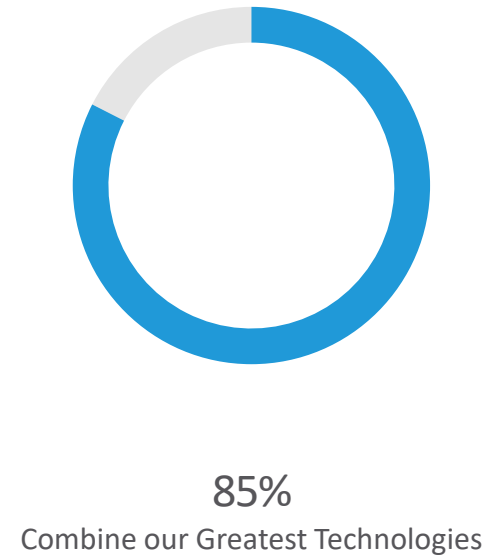
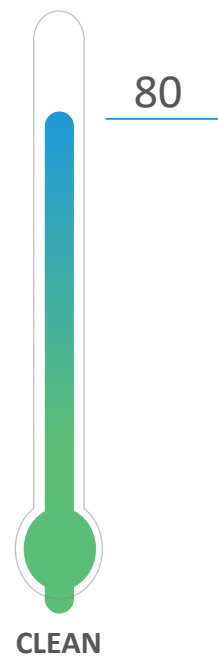
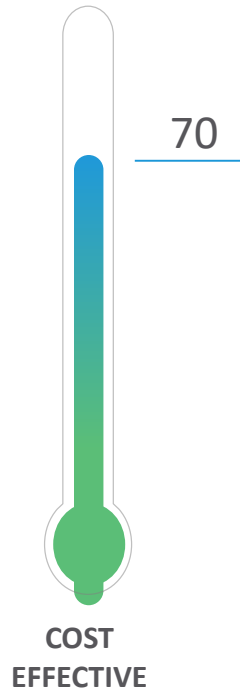
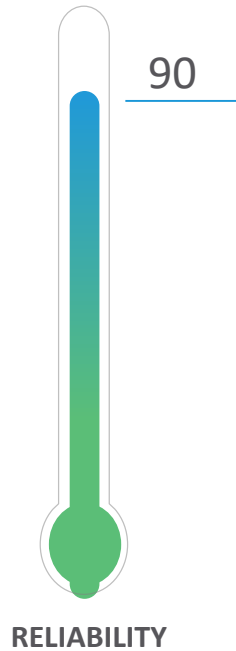
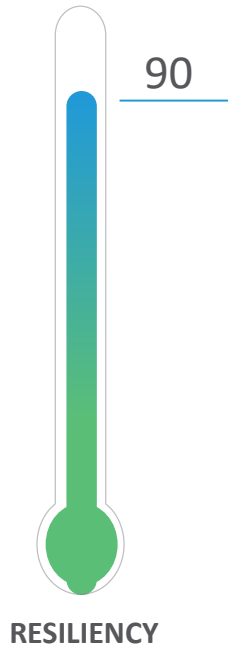
DG + Thermal + Cooling



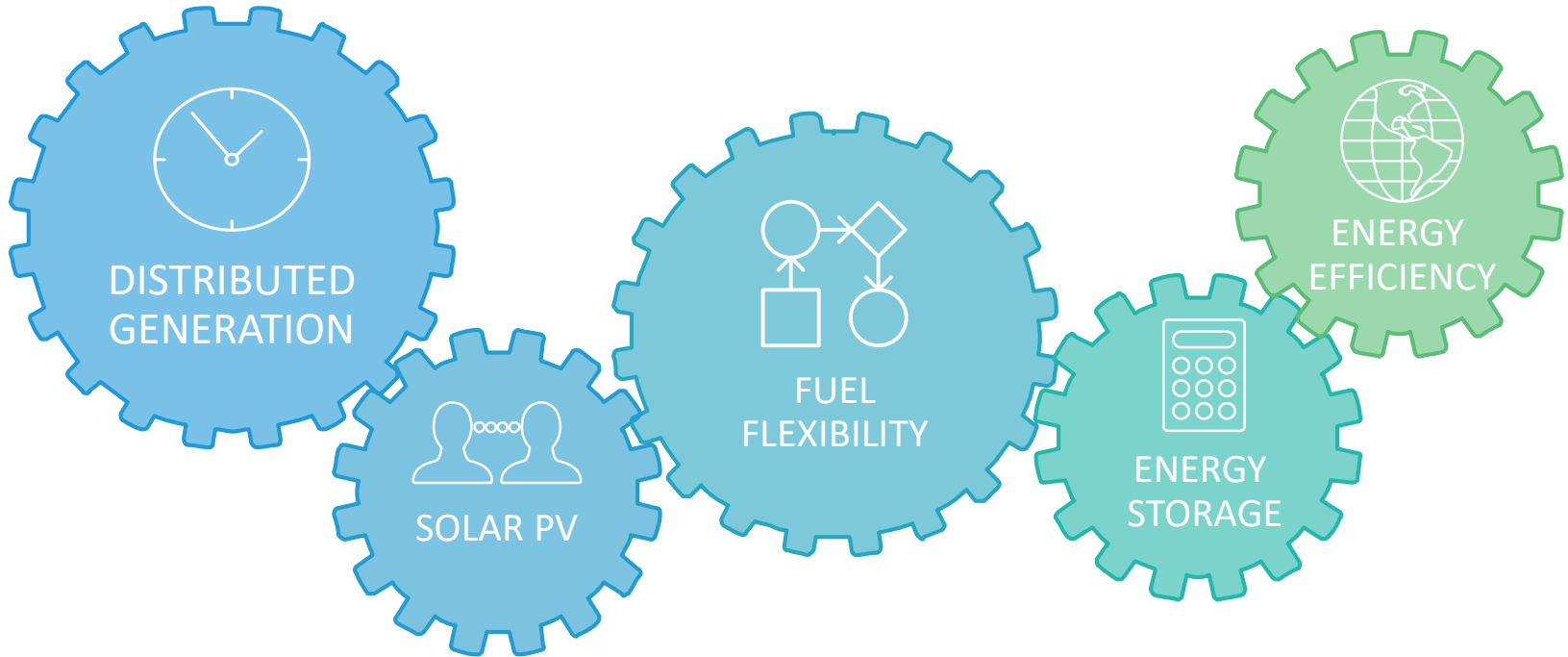
ONCOR ELECTRIC GRID AND NATURAL GAS ACTIVATED. CHP PRODUCES ELECTRICITY, HEAT AND COOLING.



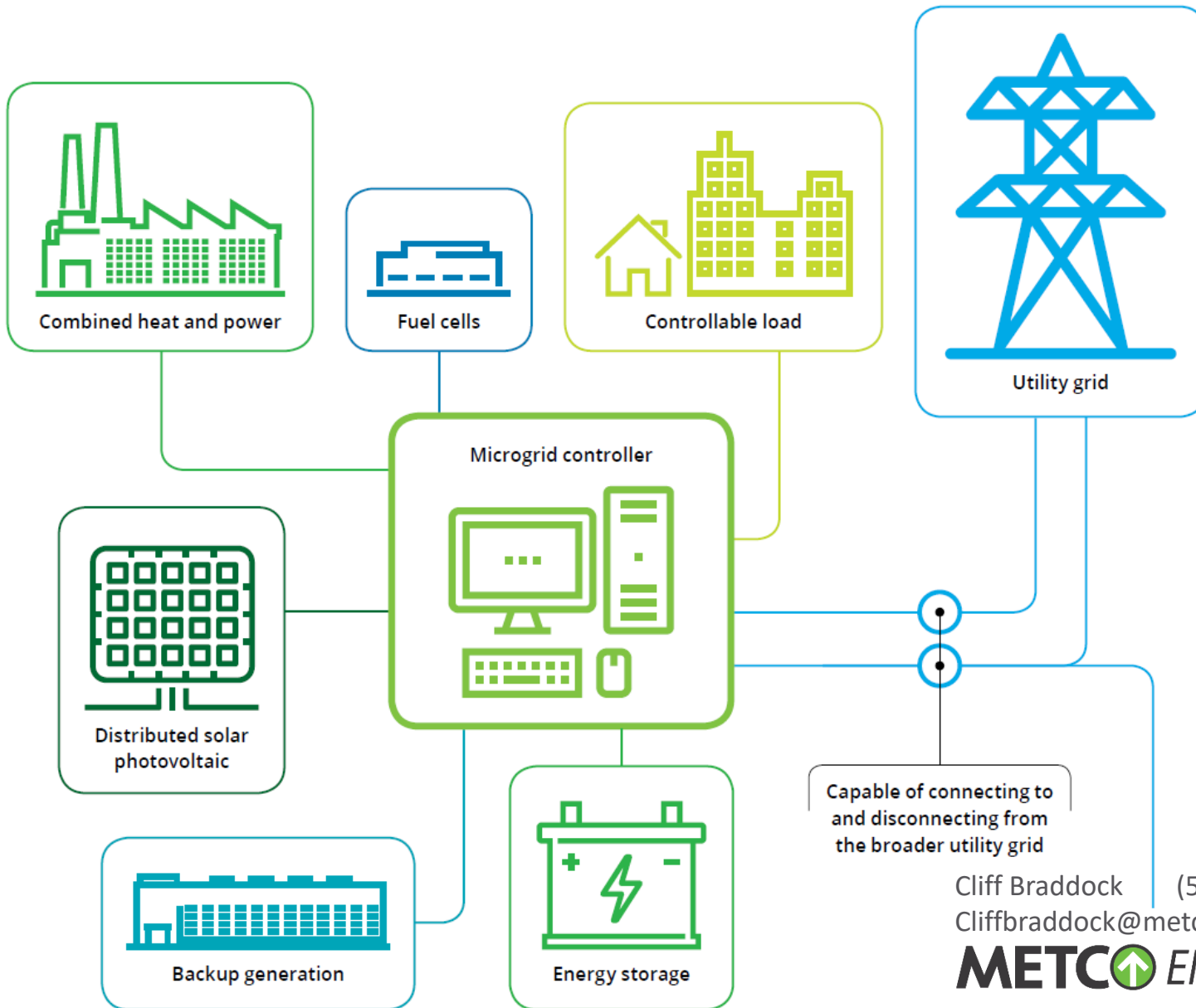
Grading DG + CHP



A Successful Microgrid



THANK YOU



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Cliffbraddock@metcoengineering.com
METCO ENGINEERING[®]