



**BRENMILLER**  
THERMAL ENERGY STORAGE

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# CARBON-FREE HEAT

JUNE 2023

# ABOUT

We are a clean-tech company that develops, manufactures and sells our Thermal Energy Storage (“TES”) solutions to help decarbonize industrial process heat and power plants

**2012**

Founded

**\$100M**

Capital Investments

**60**

Employees

**BNRG**

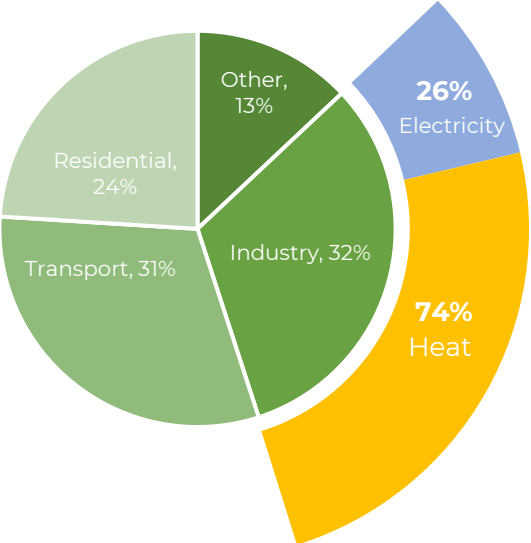
Nasdaq  
Tel Aviv





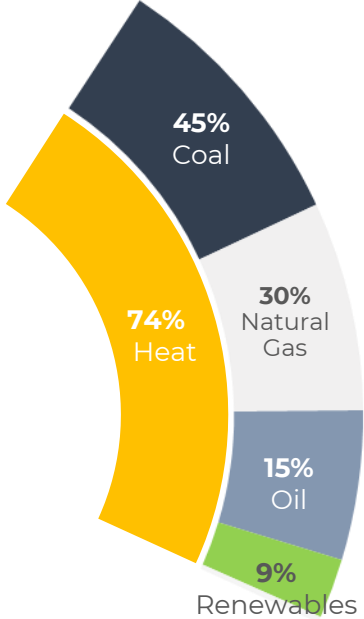
# RENEWABLE BASED HEAT IS CRUSIAL FOR NET-ZERO EMISSIONS

### GLOBAL FINAL ENERGY CONSUMPTION



Industrial Heat accounts for **1/4** of global energy consumption

### ENERGY SOURCES FOR INDUSTRIAL HEAT



Industrial Heat is heavily based on fossil fuels



# bGen™

## Thermal Energy Storage

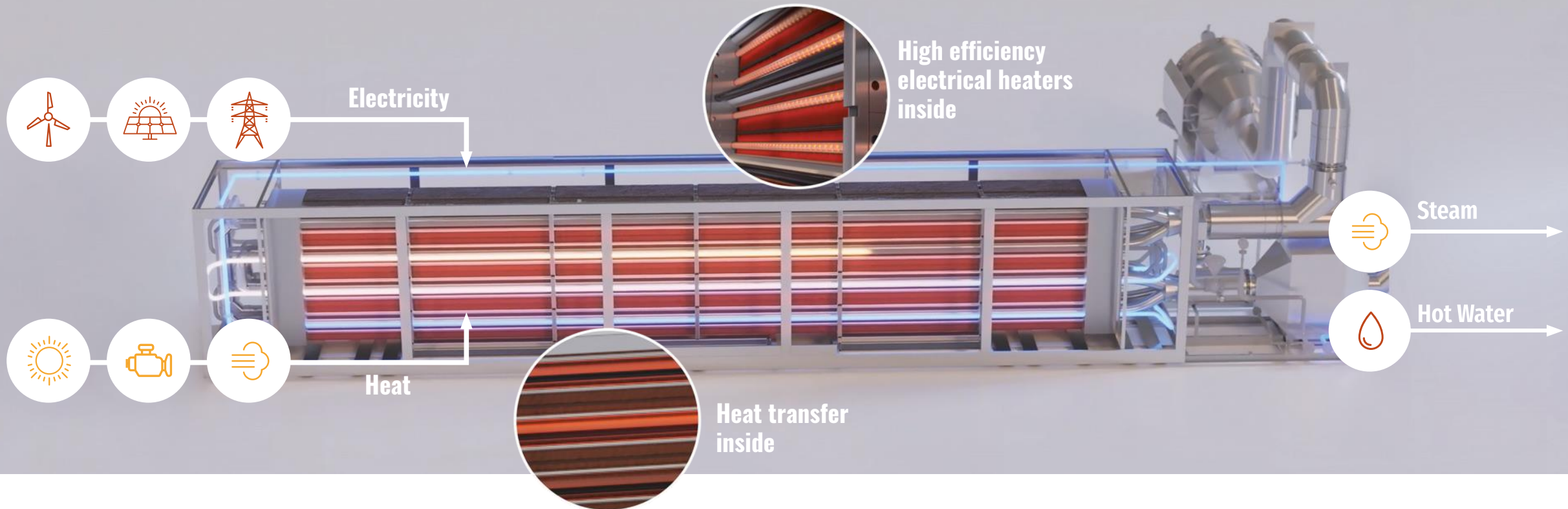
Heat battery based on crushed rocks enabling transition from fossil fuels to renewable energy

# FROM ROCKS TO THERMAL ENERGY STORAGE

- Rocks are crushed to small bits
- Thin metal cells (“bCells”) are filled with the crushed rocks
- bCells are stacked in to 12m modules
- Modules are assembled on-site to a structure
- Structure is insulated and connected to plant



# INNOVATION

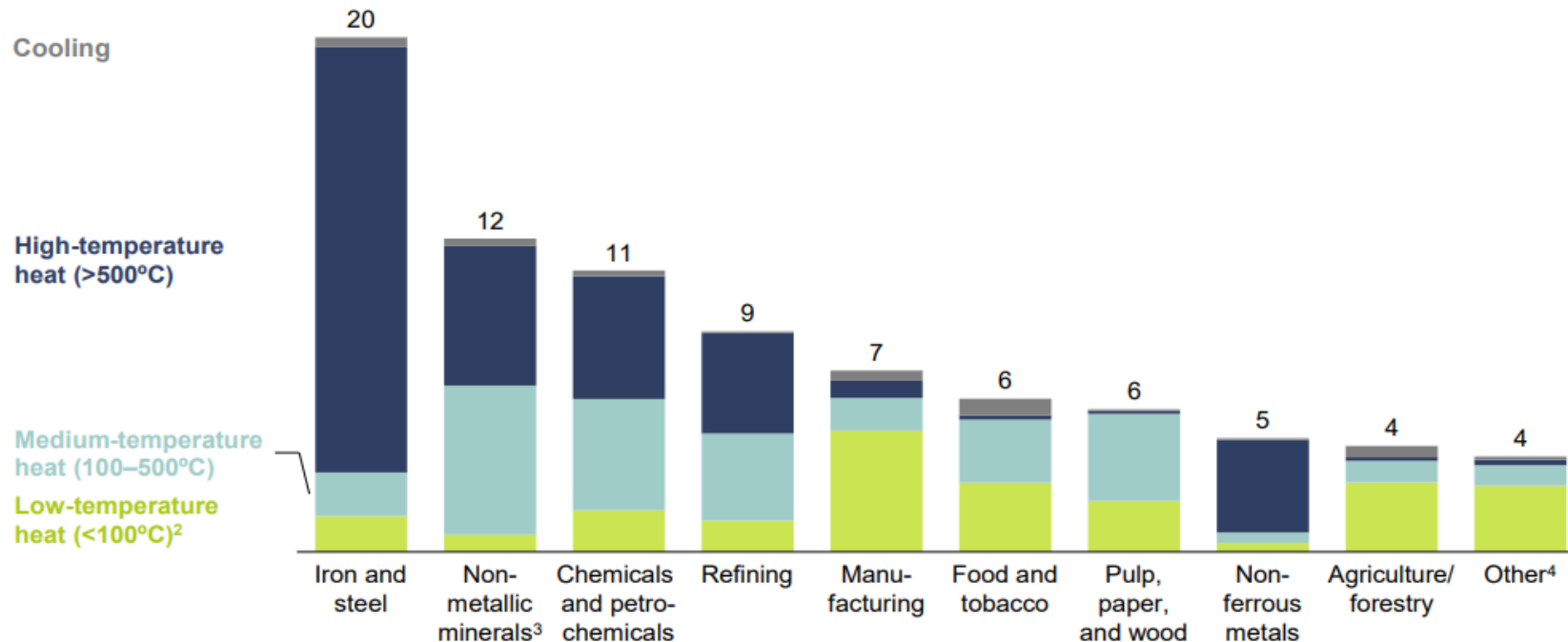


# DECARBONIZING INDUSTRIAL HEAT

# TES potential in mid-temperature process heat

bGen operation temperatures in the range of 100° - 500°c

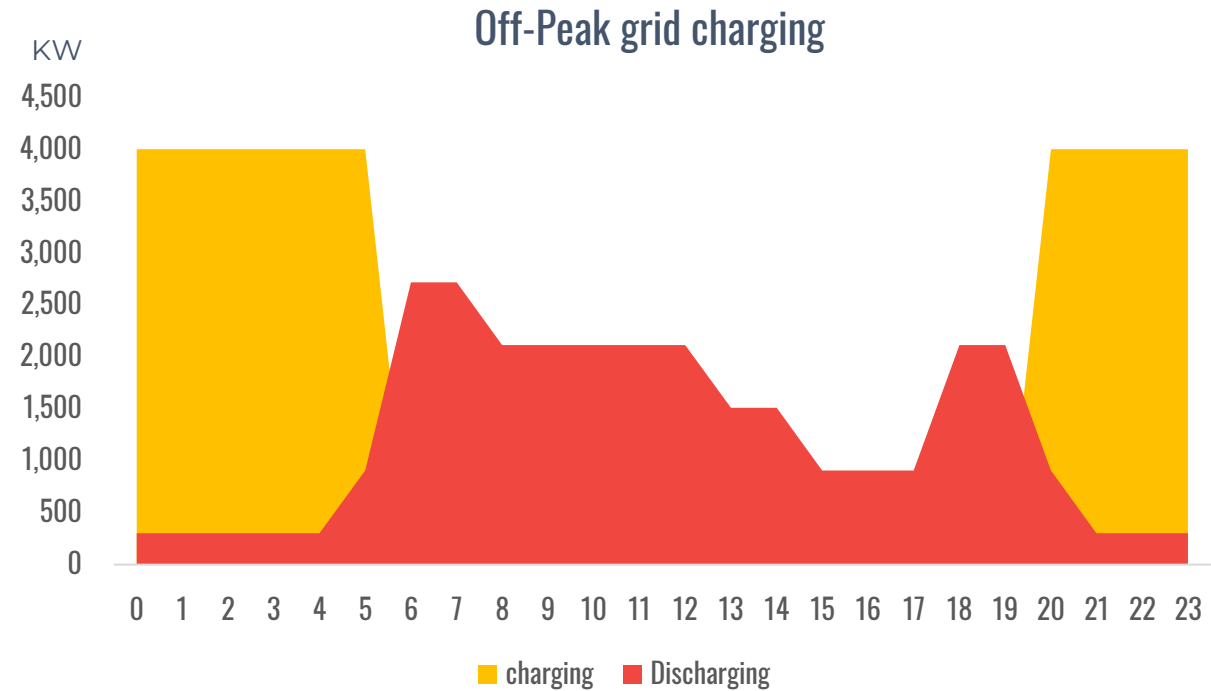
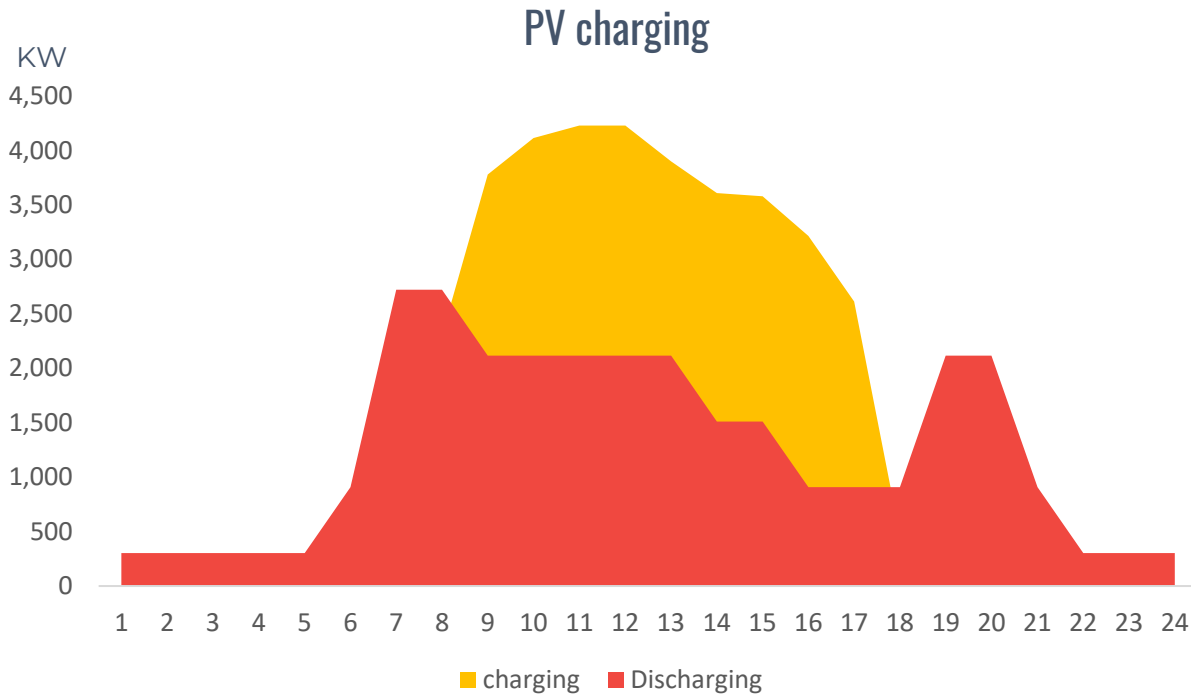
Global Industrial energy consumption by sector in Exajoules, 2019





# Integrating TES and renewables

Flexible operation allows replacing fossil-fuel based heat generation for 24/7 operation

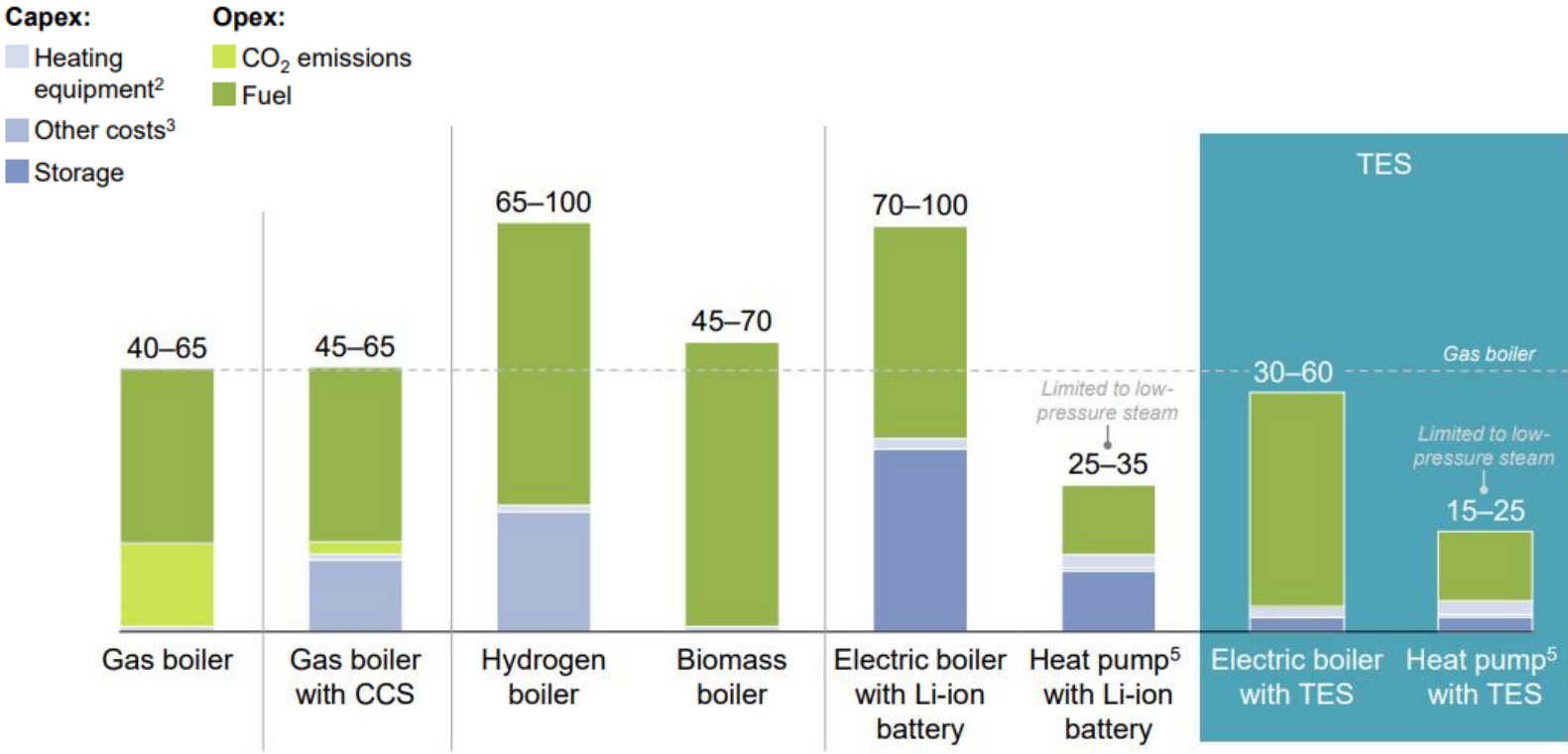


TES absorbs intermittency of renewables and delivers clean and stable steam

TES is programmed to charge during off-peak hours for minimum energy cost

# Renewables + TES is now competitive

Levelized cost of heat for selected technologies, \$/MWh



1. Ranges reflect representative fuel prices. Gas (USD 6–12/mmBTU), electricity (USD 25–50/MWh), biomass (USD 200–350/t). In the hydrogen boiler case, hydrogen production costs amount to USD 2.1–3.2/kg of hydrogen.
2. Boiler, heat pump, and charging equipment.
3. Electrolyzer, CCS.
4. Assumes on-site renewables.
5. High-temperature industrial heat pump. Maximum achievable steam temperature is ~160°C.

# Commercial & Industrial Projects

Thermal Storage based co-generation  
Hybrid charging: Exhaust gas and electricity



Biomass to heat storage system  
Continuous biomass combustion while delivering fluctuating output



# PV + Thermal energy storage

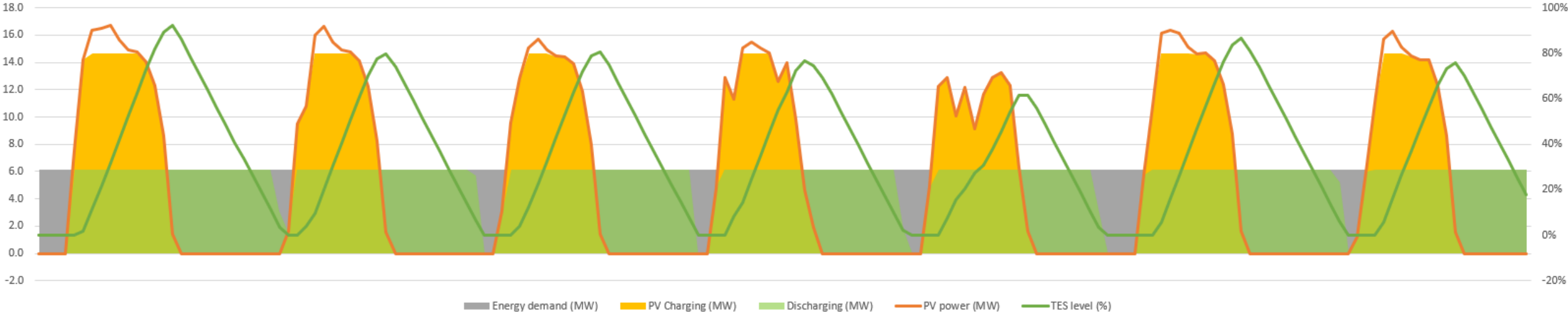
Food Manufacturing plant, Kenya



# Replacing HFO boiler with renewable heat

Configuration	20 MW PV + 83MWh TES
Steam consumption	8 ton/hr
Cost of HFO	\$1.20 / liter
Annual fuel savings	\$4.7m
Project cost	\$28.1m
ROI	6 years
Annual emission savings	9,400 ton CO2

83% of heat from renewables





## Anápolis (GO)

- **Input:** flue gas from burning biomass  
**Output:** hot air

**Customer's need:** to replace the burning of LPG with more economical and sustainable fuel - biomass,

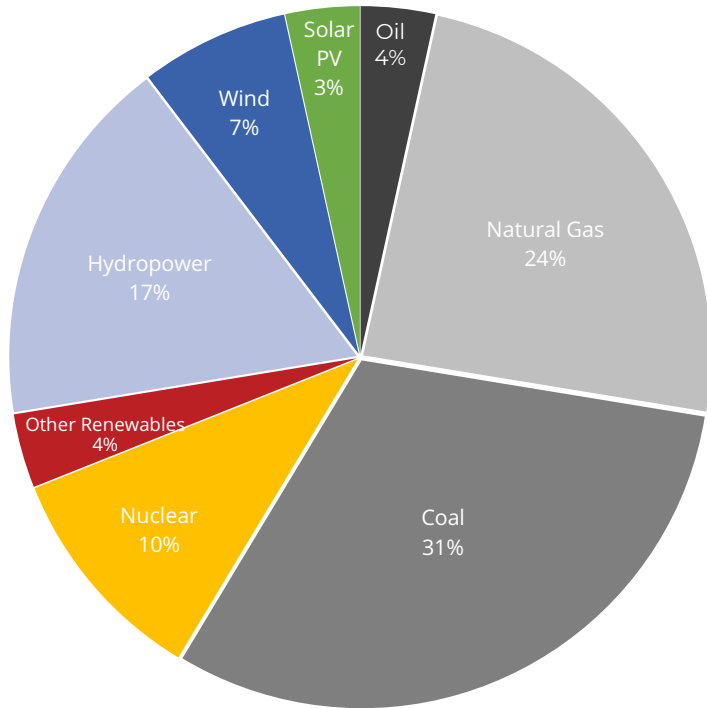
- **Storage Capacity - 1 MWh**
- **Charged capacity – 3 hours**
- **Operation Regime – 16h/day 5 day/week**
- **Energy Cost Reduction - 42%**
- **ROI – 3,38 years**



# THERMAL STORAGE FOR POWER PLANTS

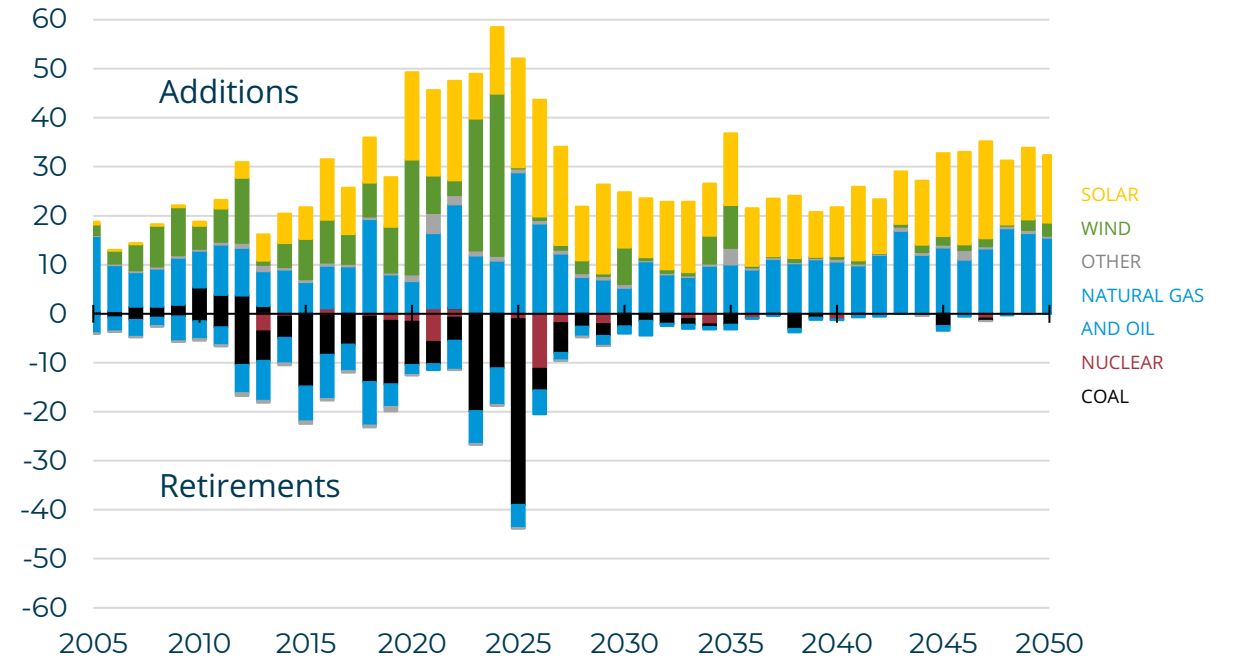
# Coal power plants are retiring, Gas will remain dominant

Global fuel sources for electricity generation in 2020



Source: International Energy Agency (2021), Net Zero by 2050

US electricity generating capacity additions (historic and expected)



Source: International Energy Agency, Annual energy Outlook 2021



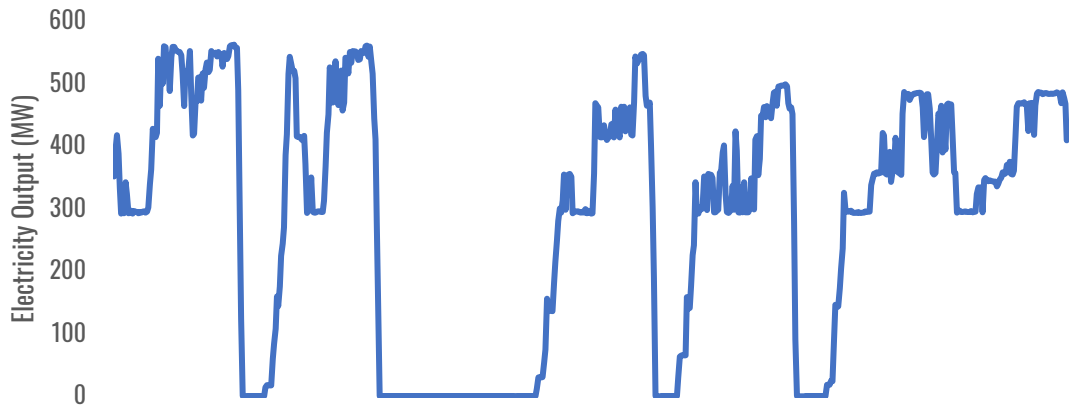
# THERMAL ENERGY STORAGE FOR POWER PLANTS



## GAS POWER PLANT

### Flexible operation for changing grid

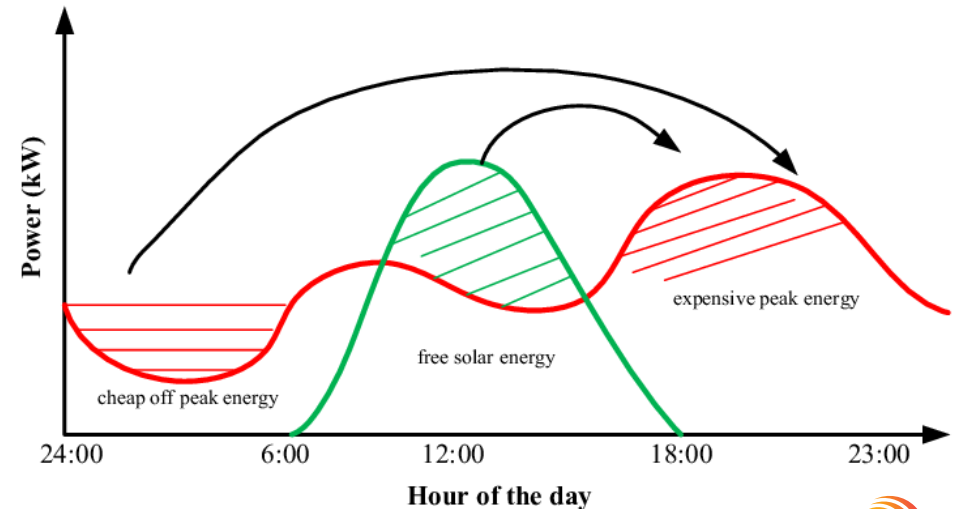
- Energy shifting
- Fast ramp-up for spot market
- Additional revenue stacking from capacity payments, grid balancing and frequency regulation



## COAL POWER PLANTS

### Converting retiring power plants to grid storage

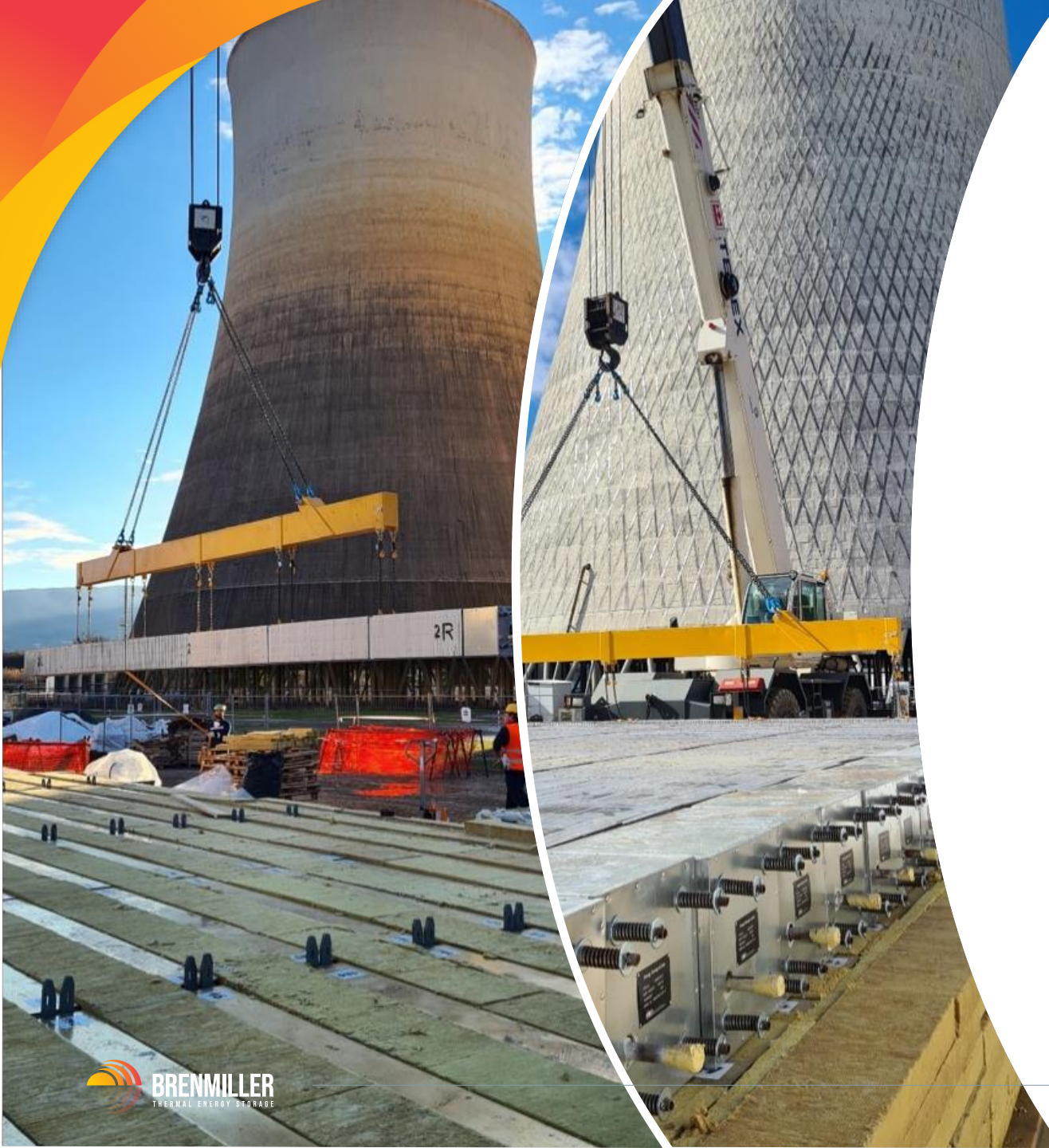
- Utilizing existing infrastructure allows reduction of Capex
- Highly efficient for long duration storage (4+ hours)
- Storing surplus renewable energy and supplying during peak hours



# enel Project Overview

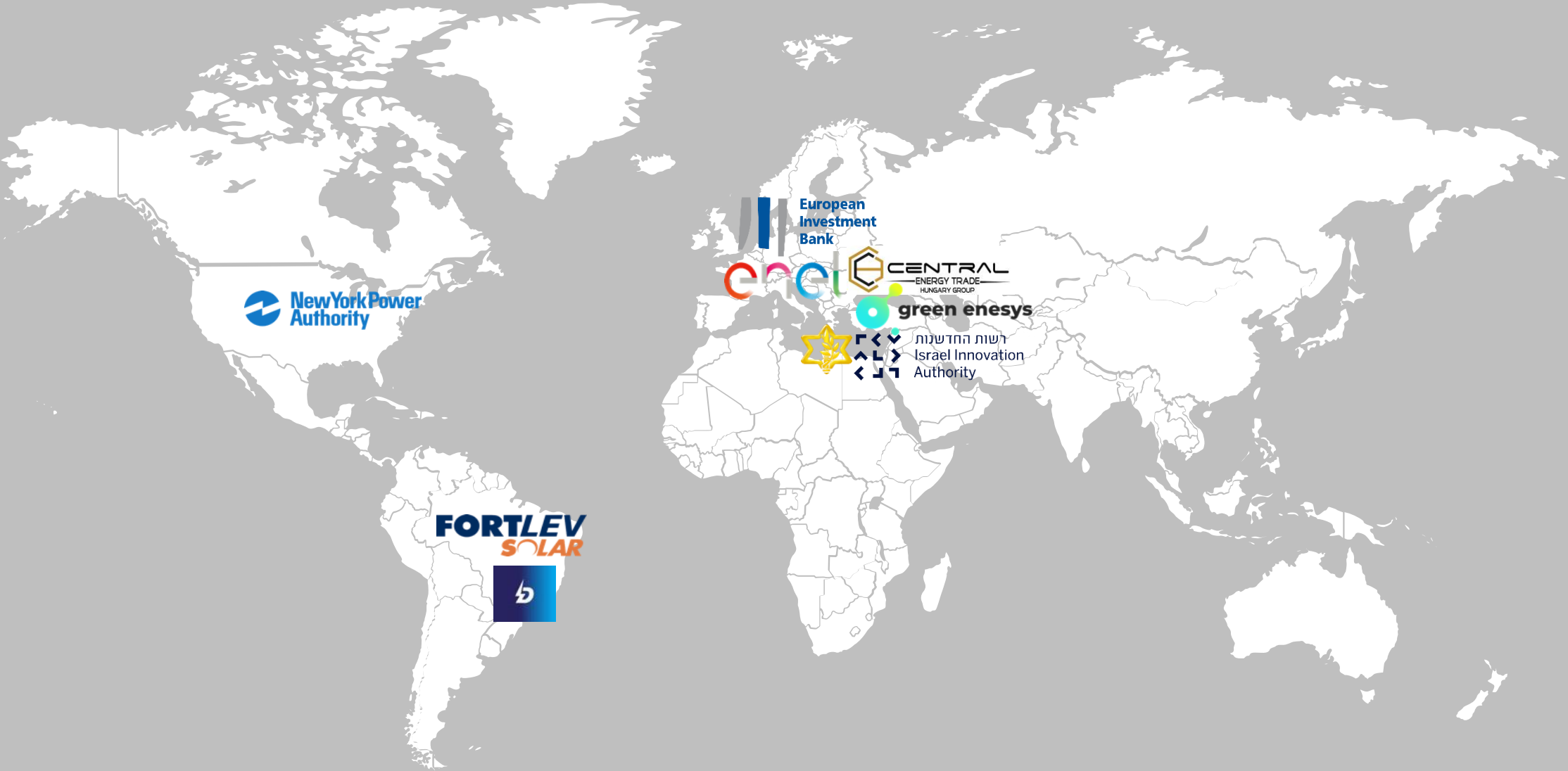
24MWh TES in a combined-cycle gas power plant

- Energy shifting from solar hours to evening peak
- Fast ramp-up to play in the spot market
- Additional capacity payments from increase maximum load & reducing minimum load



# GLOBAL FOOTPRINT

ISRAEL, EUROPE, US, BRAZIL



# NEW AUTOMATED PRODUCTION PLANT



- Production capacity of 4 GWh of storage modules
- European Investment Bank funding capital expenditure
- Support sales of up to \$200m per year
- Designed according to industry 4.0 standards





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**Thank You**