



Basics & Beyond: ON-SITE ENERGY SOLUTIONS

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OVERVIEW & TRENDS



Fundamental needs

Data centers need energy and power:

- 1. Accessibility**

- XYZ MW , XYZ Date

- 2. Reliability**

- 99.9XX %

- 3. Sustainability**

- XYZ gCO2/kWh, ...

- 4. Affordability**

- XYZ \$/MWh

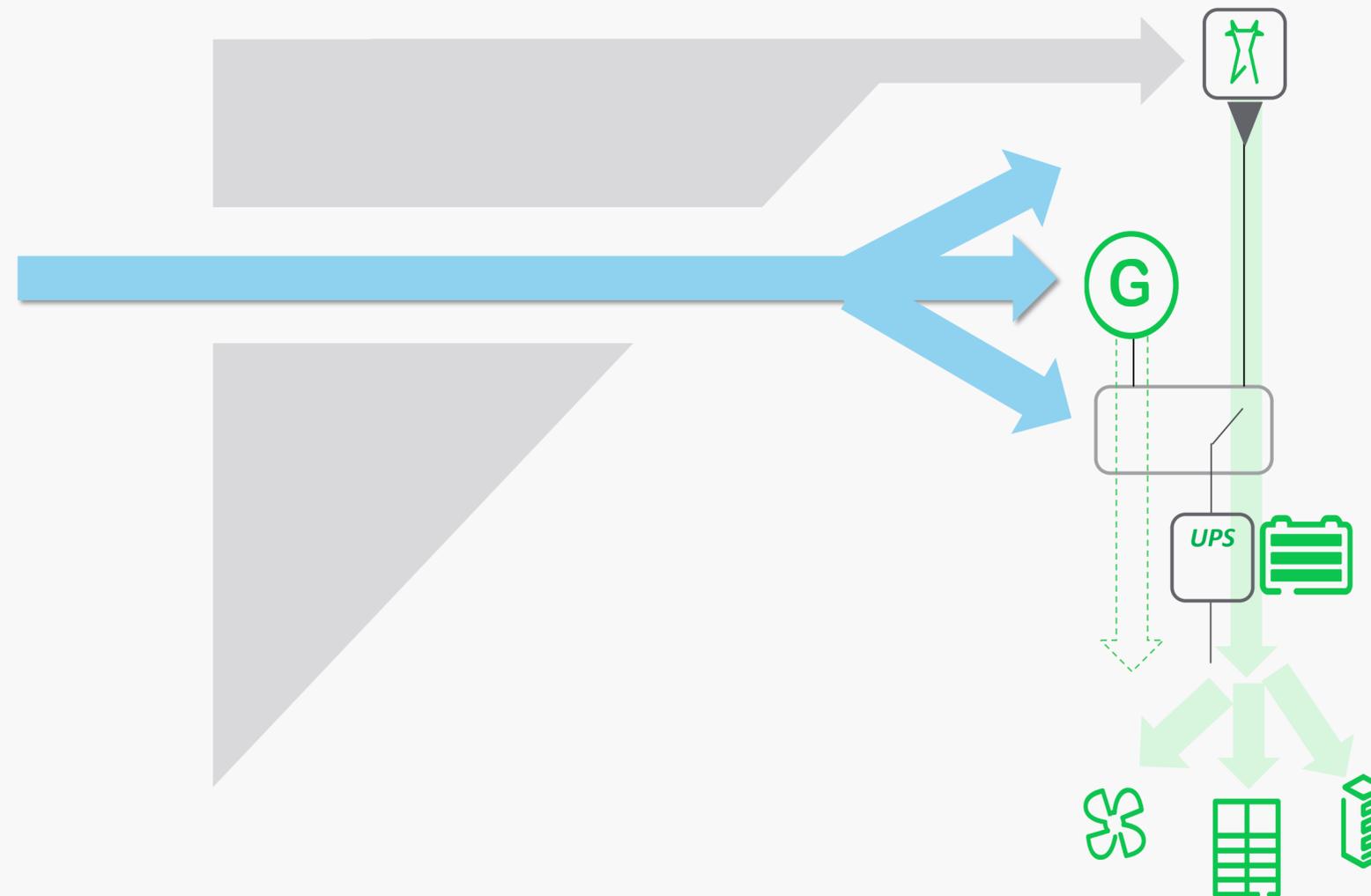
OVERVIEW & TRENDS

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Traditional Data Center Powertrain



OVERVIEW & TRENDS



Accessibility

Large data center grid interconnection is becoming more challenging

-  Data center scale and increasing electrification can challenge regional generation/transmission capacity
-  Substation build and interconnection timelines can be longer than the business requires
-  Large AI workloads may complexify interconnection

Impact: Onsite energy is playing an increasing role in providing energy and power accessibility

OVERVIEW & TRENDS

Reliability

Onsite energy needs for reliability are becoming more variable

More Onsite Energy

-  Regional reliability challenges increasing
 -  Destabilizing centralized infrastructure
 -  Climate/weather and geopolitical exposure
 -  Expanding into new markets? Exposure at the edge/distribution levels

Less Onsite Energy

-  Transmission connections in mature grids relatively stable?
-  Recloser and short duration disruption can be the majority of events
-  Workloads with less real-time power criticality?
 - AI Training/ batch processes
 - Application-level redundancy

Impact: One size may not fit all for on-site reliability solutions

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Sustainability and affordability

Sustainability and grid-interactive influences becoming more prominent

-  Diesel permitting/acceptance can burden deployments in some geographies- regulatory risk increasing
-  Grid operators increasingly looking for data center operators to utilize on-site assets for coincident peaks, balancing services, etc
-  More active use of existing diesel generators generally at odds with sustainability goals
-  General alignment between electricity market cost and sustainability opportunities

Impact: A push towards cleaner onsite sources and more active use

OVERVIEW & TRENDS

Discussions

How do we meet the business needs of today in a sustainable and future proof manner?



Long-life prime power assets mostly operating on natural gas? Is a transition strategy necessary?

2040 is within the lifetime of today's infrastructure designs and assets? What might change between now and then?

What is the role of data center on-site energy in greater grid/regional sustainability?

IMPROVING THE ENGINE GENSET

What changes can we make to the existing fleet of on-site power solutions? What is the role of engine gensets in the sustainable transition?

ALTERNATIVE FUELS

- HVO – Hydrotreated Vegetable Oil
- Fossil Free: Produced from various vegetable and animal fat waste streams
- Production process similar in grade and quality to diesel
- Completely compatible with the standard mix of petroleum-derived diesel fuels
- HVO does not oxidate or absorb water, resilient in cold weather and safe in warm conditions too

MAINTENANCE & TESTING

- Increased duration between required exercises and reduced run time lowers fuel consumption and GHG emissions
- Advances in engine technology allows diesel engines to exercise at no load

IMPROVE SUSTAINABILITY TODAY WITH RENEWABLE HVO FUEL



EVERYONE IS CONCERNED ABOUT CLIMATE CHANGE— WE ARE AT A TURNING POINT

[72% of people worldwide are concerned climate change will impact them personally

BUT WHEN IT COMES TO MISSION-CRITICAL POWER, WE HAVE THE TECHNOLOGY IN THE FORM OF NEW FUELS TO MAKE A DIFFERENCE TODAY

HVO IS A SUSTAINABLE ALTERNATIVE TO DIESEL THAT IS AVAILABLE RIGHT NOW



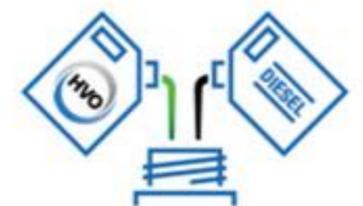
- Simple and efficient
- 90% carbon reduction
- Genuinely renewable energy
- Can be flexibly blended with diesel
- Suitable for extended storage



A NEW FUEL FROM THE WASTE STREAM



WITH MAJOR REFINERIES IN THE U.S. AND EUROPE



MEETS REGULATIONS, IMPROVES SUSTAINABILITY, SIMPLE, RISK-FREE

ALTERNATIVE POWER SOLUTIONS

Trialing new sustainable options for power on-site

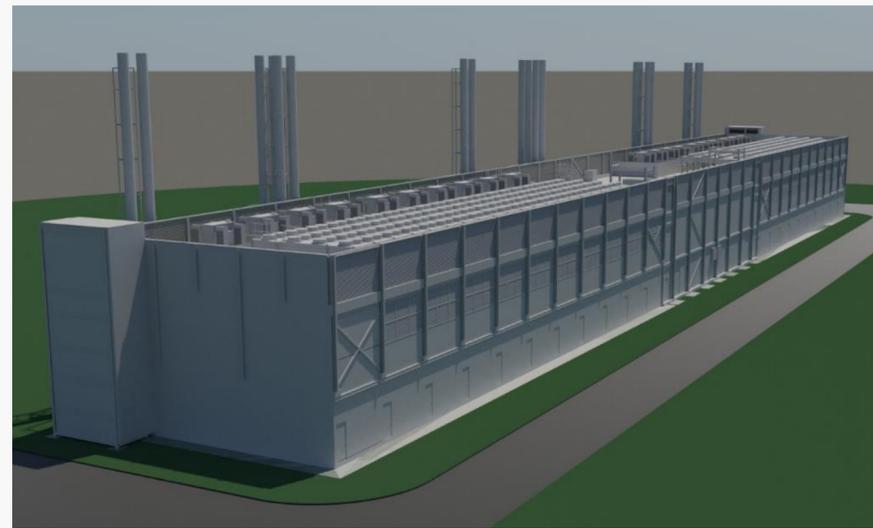


Dublin 1 – Back-Up Power

60MW gas-fired, high-transient back-up power solution, to a hyperscale data centre

Each 3MW node can achieve full load in 45s.

Entering commissioning phase

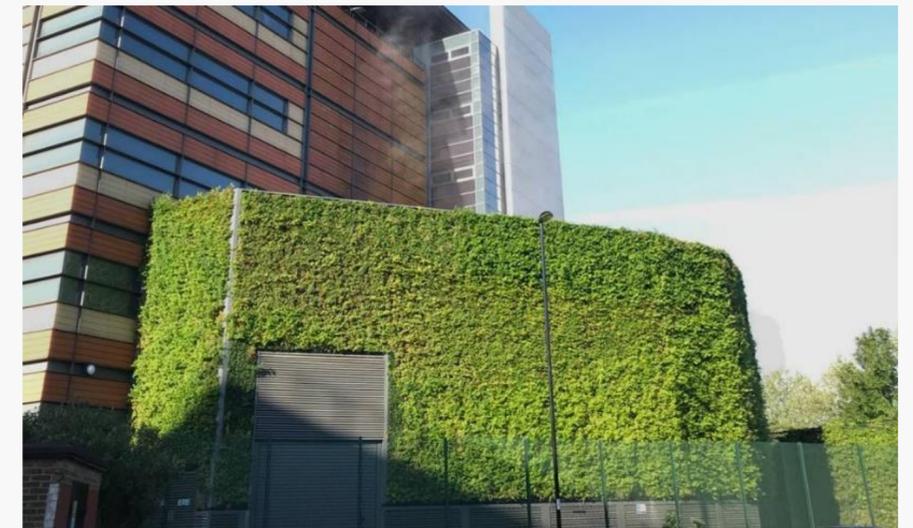


Dublin 2 – Baseload Gen

80MW gas-fired island mode energy centre providing base load generation to a hyperscale colocation provider

Scalability built around 4.5MW nodes

In construction



London 1 - Trigeneration

3MW gas-fired trigeneration solution providing base load generation and chilled water to a global bank's data centre operations

In operation since 2015

What is an Advanced Microgrid?

And what can we learn from them?

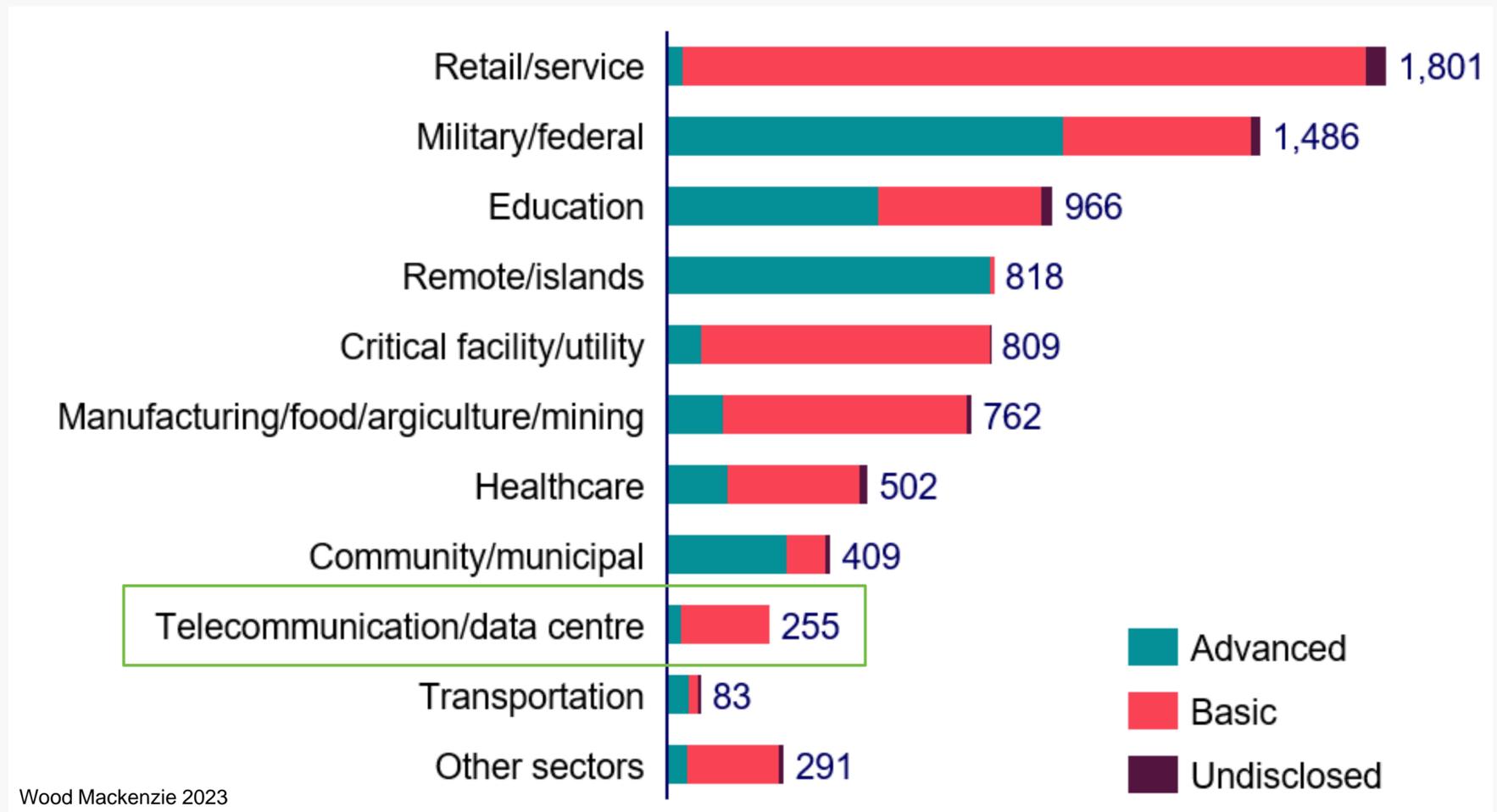
Definition

On-site energy system formed by diverse set of energy resources and equipped with intelligent control and optimization capabilities to provide backup and participate in value stacking opportunities.

Characteristics of an *Advanced Microgrids*

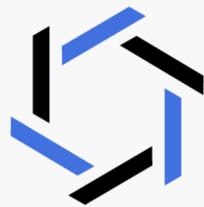
- Capability to seamlessly island from and reconnect to the grid.
- Autonomous multi-objective optimization (Cost, Resiliency, Sustainability).
- Real time market participation and grid support.
- Adaptability to internal and external requirements/constraints.

Microgrid capacity (MW) installed across different sectors through 2023E



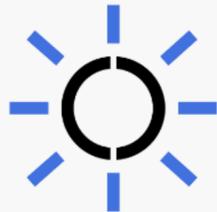
Finding the Right Energy Mix

Maximizing the value of your on-site energy resources



Enhance resilience

Build additional layers of resilience to protect against short- and long-term utility outages.



Reduce GHG and NOx emissions

Progress toward ESG goals by reducing emissions for both back-up and primary power.



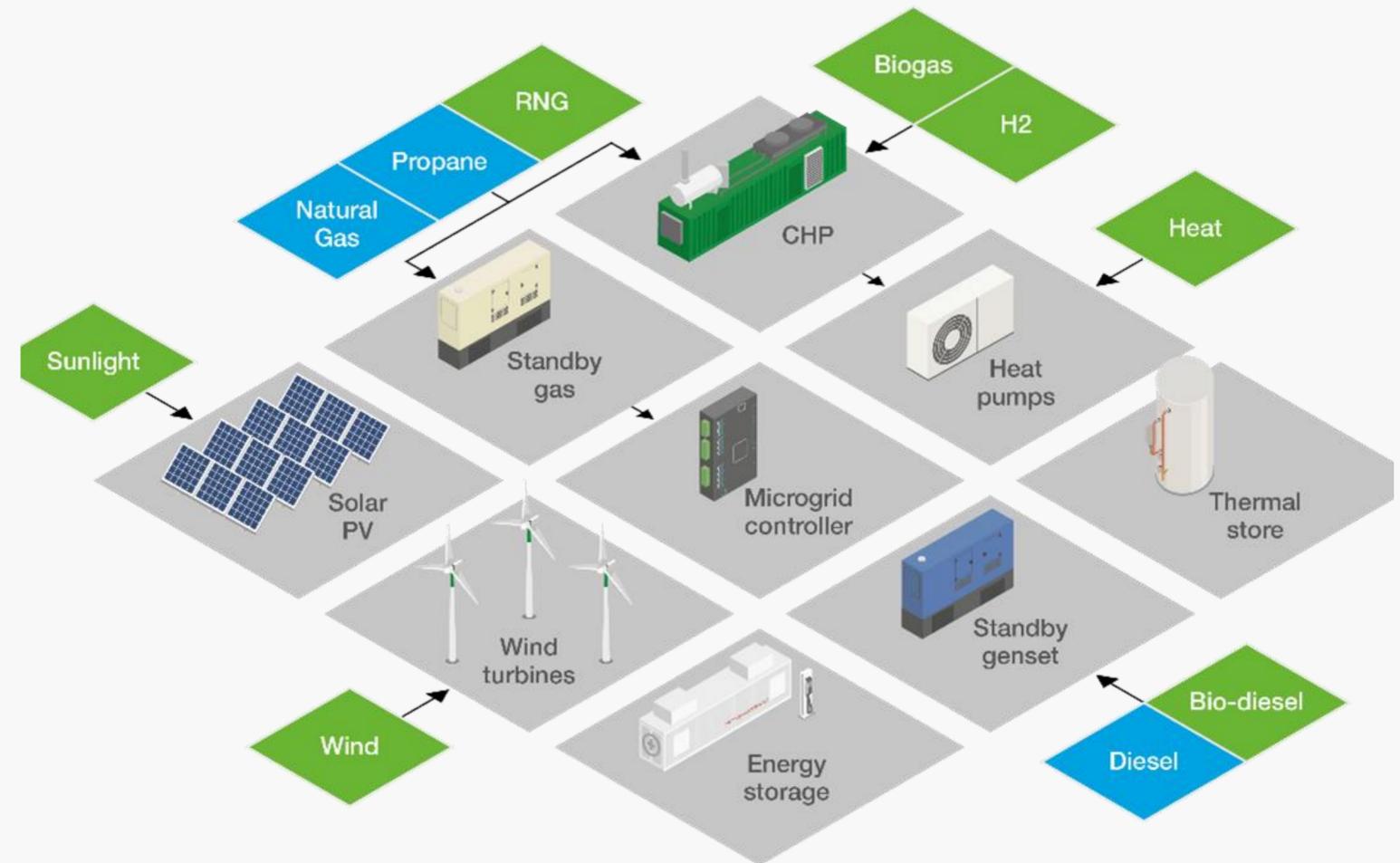
Drive energy savings and stabilize the grid

Optimized dispatch and market participation enable significant savings while contributing to grid stability.



Efficiently scale your systems

Adapt to changing site needs through flexible, modular microgrids that grow along with you.

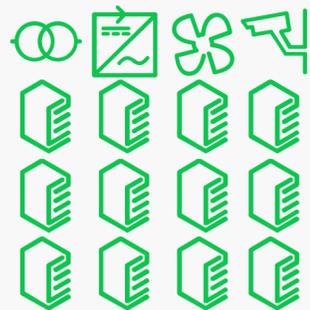


Energy Density Challenge

Data centers present a practical energy & power density challenge

Room for innovation

6 MW data hall



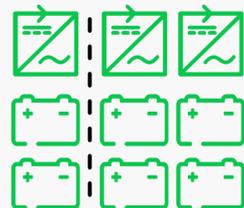
~16000 sq. ft

8 MW ICE Gen



~1000 sq. ft

8 MW LiB BESS



~3000 sq. ft

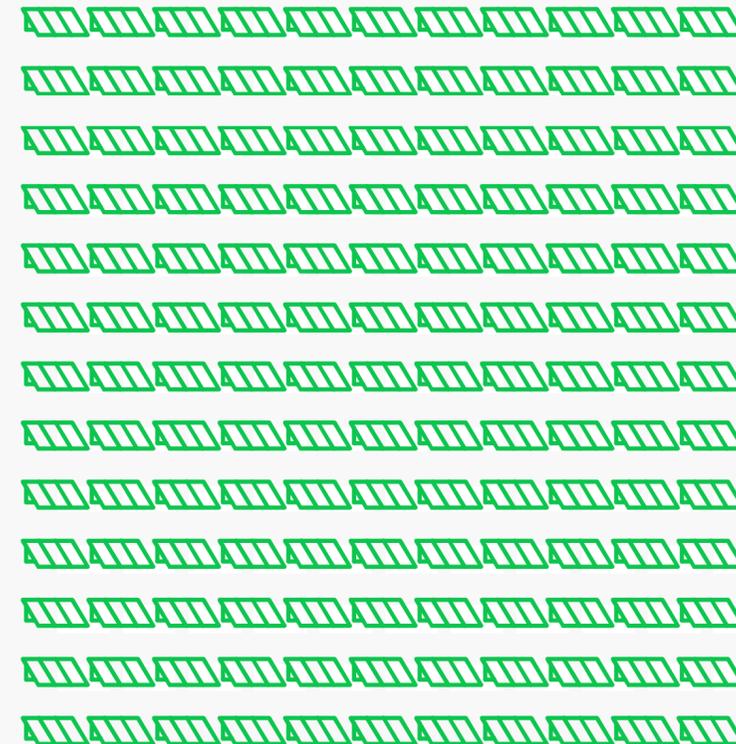
~9000 sq. ft
12 hours

8 MW PEM FC



~9000 sq. ft
24 hours H2

1 MW PV



~100000 sq. ft

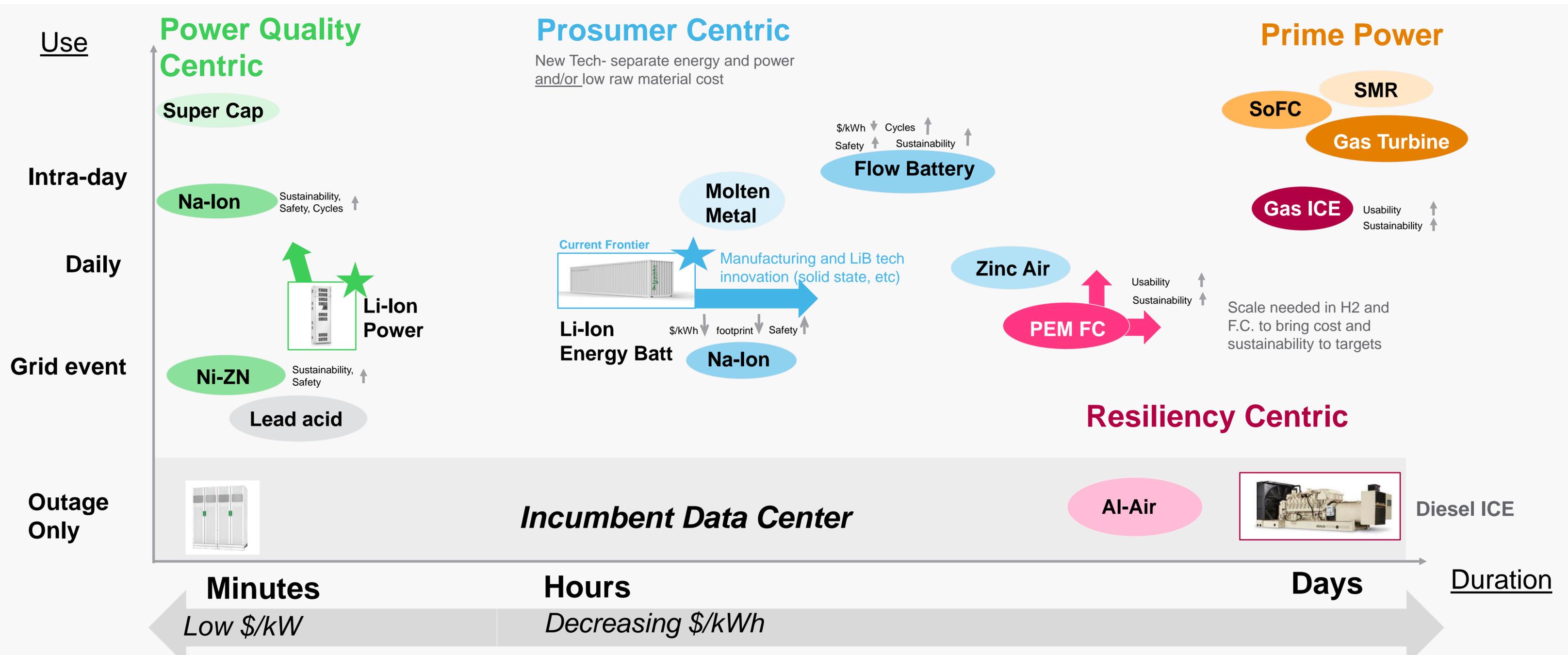
Data hall +



DERs

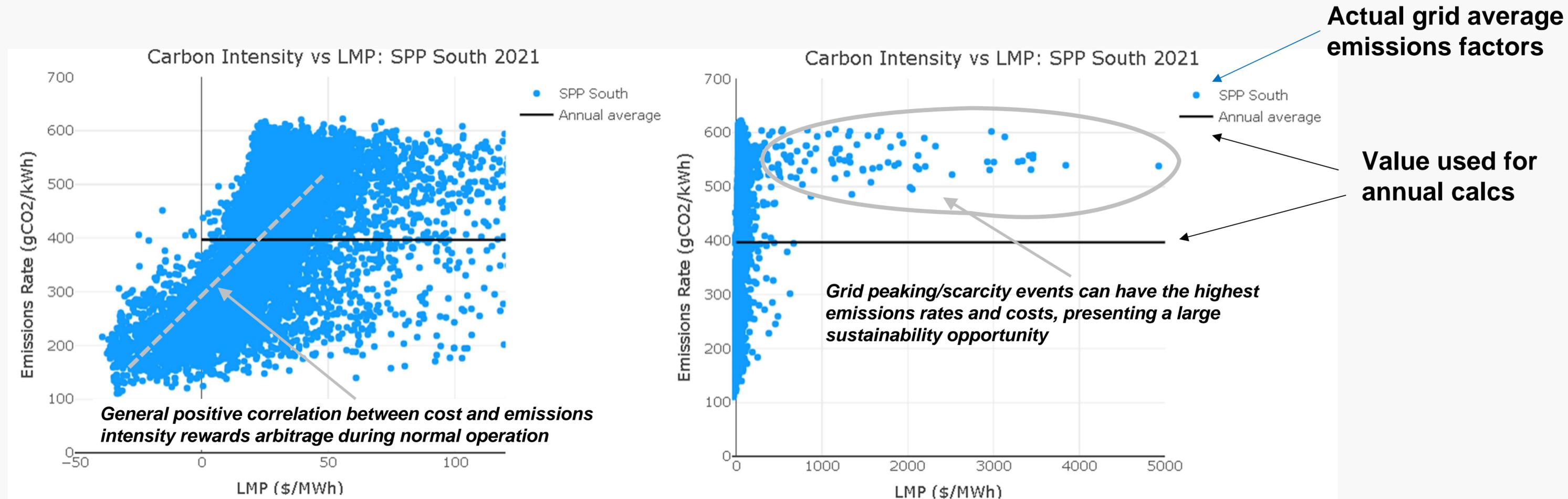
Evolving DER Landscape

Emerging technologies across the application space



Grid interactive use supporting grid decarbonization

General analysis supports enhanced benefits not accounted for by GHG annual average/net accounting



*Hourly system averages shown. Marginal rates likely accentuate the bifurcation of emissions rates during generation surplus and constraint.

+ How to measure impact of balancing services that support inertia & renewables integration