DOOSAN GridTech

END-TO-END FLEXIBLE & SCALABLE ENERGY STORAGE SYSTEMS

01
DOOSAN GROUP OVERVIEW

Doosan Group

Oldest Company Incorporated in Korea

- One of top 10 conglomerates in Korea, active in engineering and manufacturing of power plants, construction equipment, industrial facilities, engines, construction
- Doosan is the oldest conglomerate in Korea with over 126 years of history but one of the fastest growing company, achieving 10% average annual growth in Sales over the last 17 years.
- Strong aspiration for accelerated global-scale growth, with focus on Infrastructure Support Businesses (ISB) reaching total sales of $16.3 billion in 2017

Doosan Corporation

- Electro-Materials
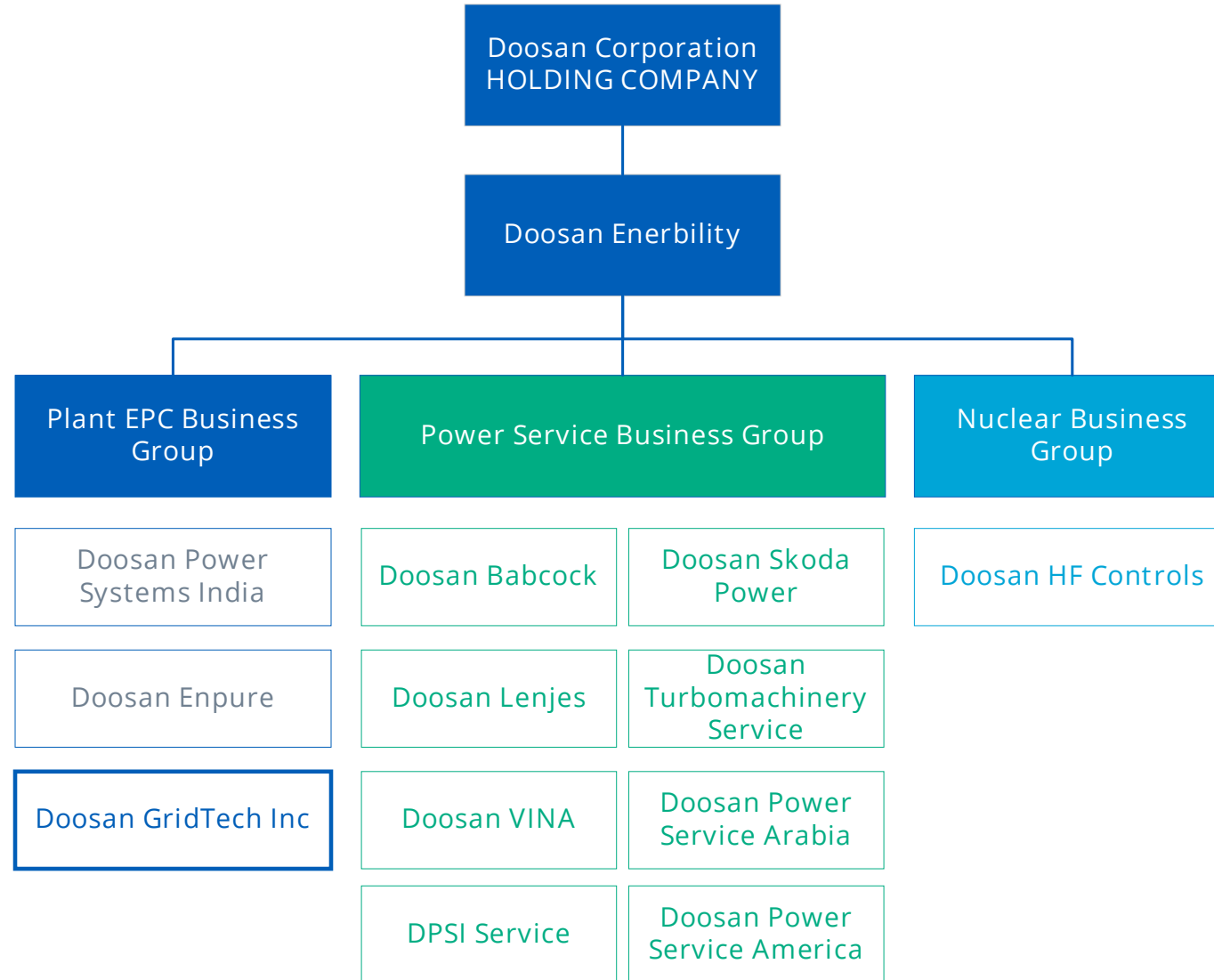- Fuel Cell Power
- Digital Innovation
- Retail

Affiliates

- Doosan Enerbility
  - New energy solutions
  - Power plant equipment / Services
  - Plant EPC / Construction
  - Material manufacturing
- Doosan Bobcat
- Doosan Industrial Vehicle
- Doosan Fuel Cell
- Doosan Mecatec
- Doosan Robotics
- Doosan Mobility Innovation
- Doosan Logistics Solutions
- Oricom
- Hancomm
- Doosan Magazines
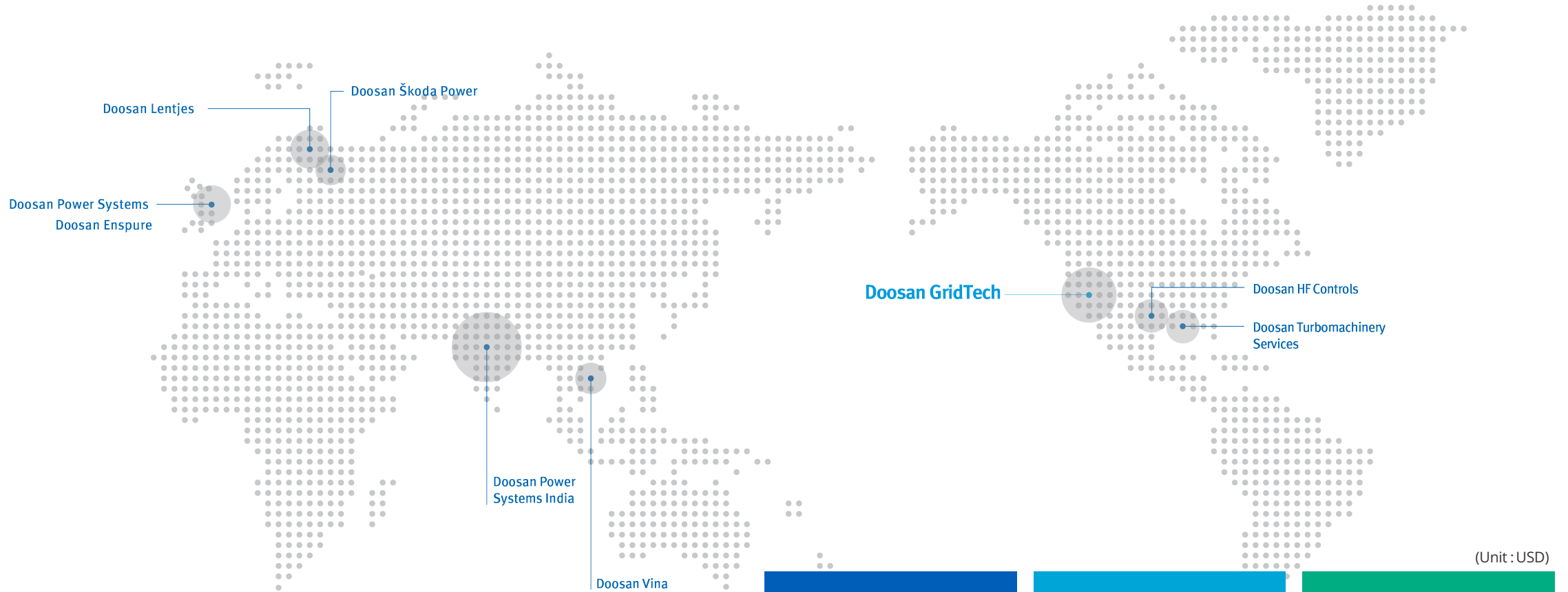- Doosan Bears
- Doosan Cuvex

Doosan Enerbility

Core Business Organization

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Doosan Corporation
HOLDING COMPANY
        │
   Doosan Enerbility
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Plant EPC Business Group | **Power Service Business Group** | **Nuclear Business Group**

Plant EPC Business Group	Power Service Business Group		Nuclear Business Group
Doosan Power Systems India	Doosan Babcock	Doosan Skoda Power	Doosan HF Controls
Doosan Enpure	Doosan Lenjes	Doosan Turbomachinery Service	
Doosan GridTech Inc	Doosan VINA	Doosan Power Service Arabia	
	DPSI Service	Doosan Power Service America	

Extensive Global Operation

Doosan Enerbility has strategically organized global networks of engineering, manufacturing, and service to be a global leader in the power & water business.

DOOSAN GRIDTECH

Doosan Lentjes

Doosan Škoda Power

Doosan Power Systems
Doosan Enspure

Doosan GridTech

Doosan HF Controls

Doosan Turbomachinery Services

Doosan Power Systems India

Doosan Vina

(Unit : USD)

Global Offices
35

Q2 22 Orders
$2.3B
Backlog $10.5B

Q2 22 Revenue
$2.1B

02
ABOUT US

Doosan GridTech

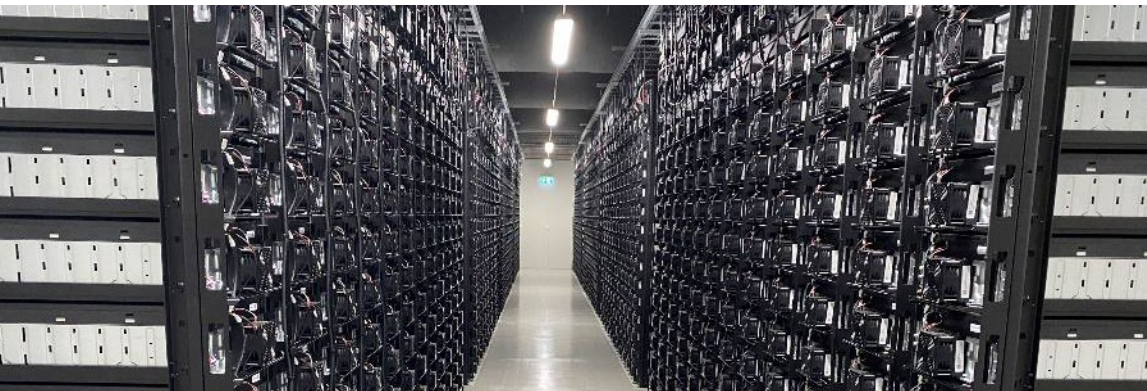Delivering sustainable power where and when it is required.

Our Vision

Our vision is to deliver flexible and scalable energy storage systems through the design of intelligent, award-winning software built on open standards for the delivery of renewable and sustainable power where and when it is required.
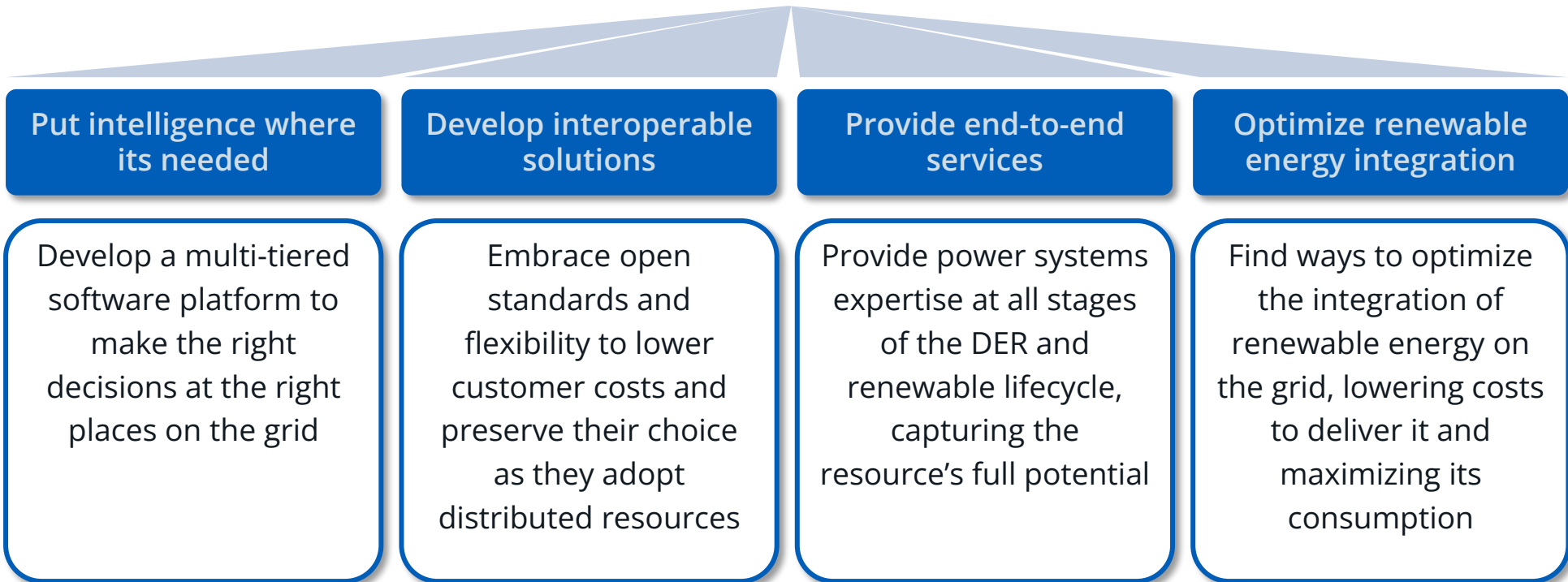
Our Mission

Our mission is to enable a safe, reliable, and sustainable low-carbon power grid to withstand the energy demands of the future. With environmental stewardship and economic growth at the forefront, our intelligent software and energy storage systems are bankable, scalable, and reliable. Our state-of-the-art end-to-end energy storage solutions are key to the longevity of energy distribution. We bring flexibility at all project execution levels from Design and Delivery, Control & Optimization Software, System Integration, and Operations and Maintenance.

DOOSAN GRIDTECH

Creating the **flexible, low-carbon, digital grid** of the future

DOOSAN GridTech

Put intelligence where its needed	Develop interoperable solutions	Provide end-to-end services	Optimize renewable energy integration
Develop a multi-tiered software platform to make the right decisions at the right places on the grid	Embrace open standards and flexibility to lower customer costs and preserve their choice as they adopt distributed resources	Provide power systems expertise at all stages of the DER and renewable lifecycle, capturing the resource's full potential	Find ways to optimize the integration of renewable energy on the grid, lowering costs to deliver it and maximizing its consumption

Executive Leadership Team

Our dedicated leadership team possesses a depth and breadth of knowledge and experiences that are unmatched in the battery storage and clean energy industry.

- Seasoned leadership team with decades of experience in the software and energy space
- Leadership experience at technology, energy, and industrial companies
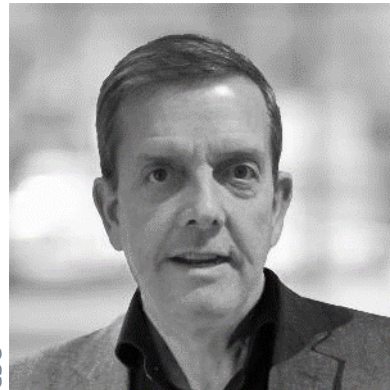- 75 employees

Ingrid Lehnert
Secretary, General Counsel

Jen Young
CHRO

David Jackson
CSO

Richard Janssen
Managing Director, Australia

Christopher Sanderson
Director, Bids & Proposals

Andreas Fornwald
CEO

Wonyoung Ahn
COO

Ilmo Kim
CFO

Steve Hummel
CTO
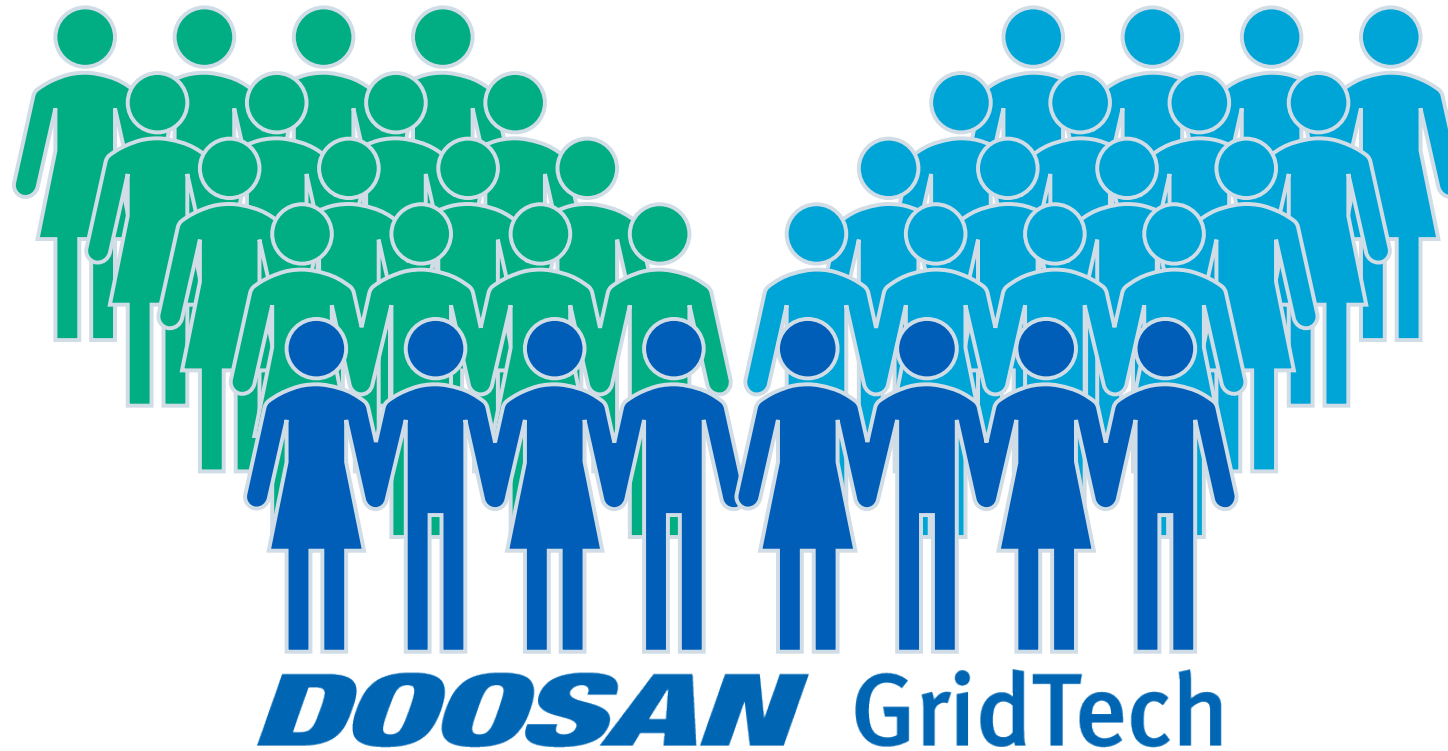
1Energy Systems
founded in
Seattle, WA

1st MESA-based
ESS installed at
Snohomish PUD

Austin Energy
receives DOE
SHINES Award

1Energy acquired by
Doosan Enerbility,
Doosan GridTech formed

| 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |

1st DG-IC
installed at a
utility substation
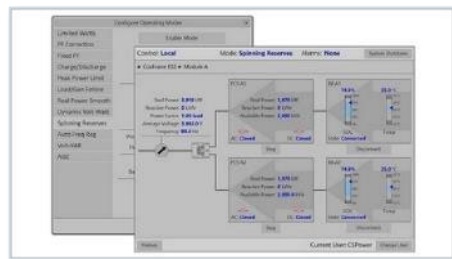
DG-DERO®
Announced

1Energy wins
2016 Grid
Edge Award

Doosan GridTech wins
2018 Grid Edge
Innovation Award

Vena Energy selects Doosan
GridTech as EPC for 100MW
Wandoan South BESS

Vena Energy selects Doosan
GridTech as EPC for 41MW
Tailem Bend 2 BESS

2017 — **2018** — **2019** — **2020** — **2021** — **2022**

Doosan GridTech
chosen to install
LADWP's first ESS

Doosan GridTech
opens office in
Australia

Doosan GridTech
chosen to install
Neoen's Capital BESS

03
END-TO-END ENERGY STORAGE SOLUTIONS

Grid-Scale Energy Storage Solutions

DESIGN
BESS Design & Delivery
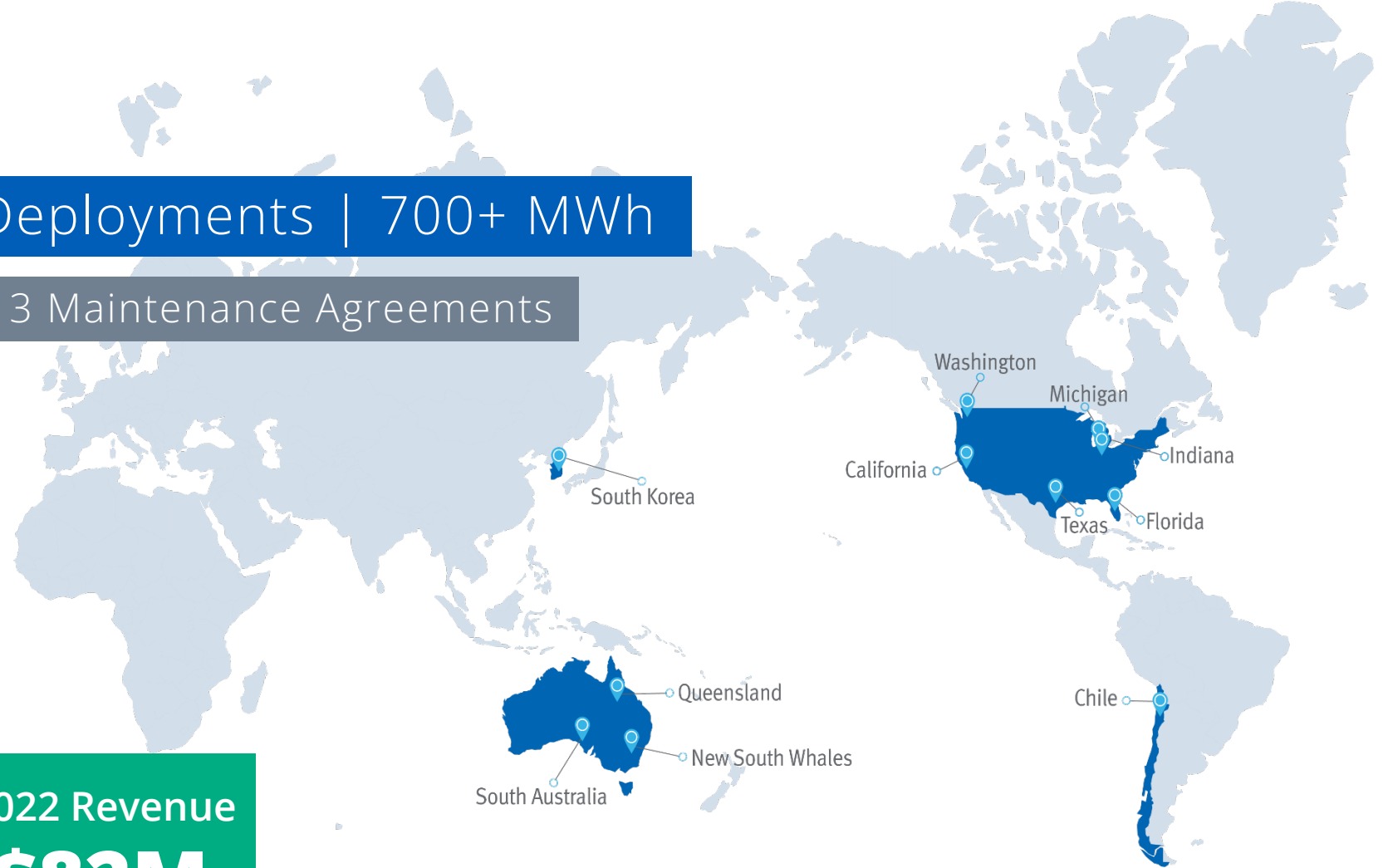
CONTROL
Control & Optimization Software

DEPLOY
System Integration | O&M

Global Battery Energy Storage Deployments

Over 35 ESS Deployments | 700+ MWh

5 O&M Contracts, 3 Maintenance Agreements

Washington

Michigan

Indiana

California

Texas

Florida

South Korea

Queensland

New South Whales

South Australia

Chile

2022 Orders
$121M

2022 Revenue
$82M

Our Client Partnerships

Trusted to be BESS and EMS provider on series of first BESS's for early market progressive utilities.

04
ENERGY MANAGEMENT SYSTEM

Doosan GridTech's fully-optimized, market-leading control platform **places decision making intelligence where it is most effective**

Flexible, Autonomous, Scalable, Reliable, and Safe

DG-IC®
Intelligent Controller

Extensible artificial intelligence amplifies energy management performance for battery energy storage and hybrid power systems.

PERFORMANCE ANALYZER

Maintain the health and forecast performance of system

DG-DERO®
Distributed Energy Resource Optimizer

Works to maximize the value of Distributed Energy Resources through a flexible, modular, and configurable set of applications.

BESS Applications

We created this control platform to be able to serve any ESS use-case.

From bulk power system applications to remote community backup support and reliability to integrating renewable power on a circuit using multiple ESSs.

DOOSAN GRIDTECH
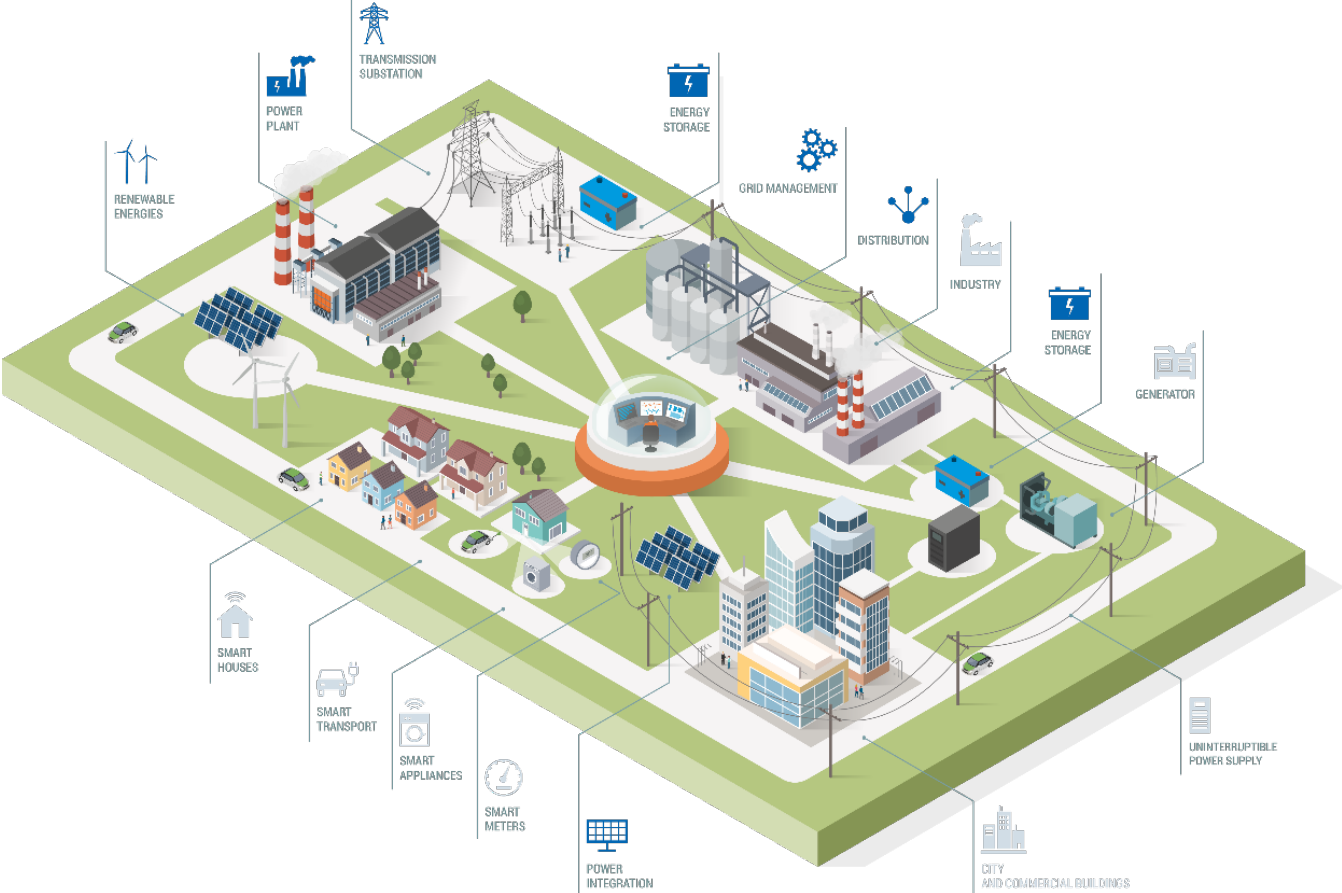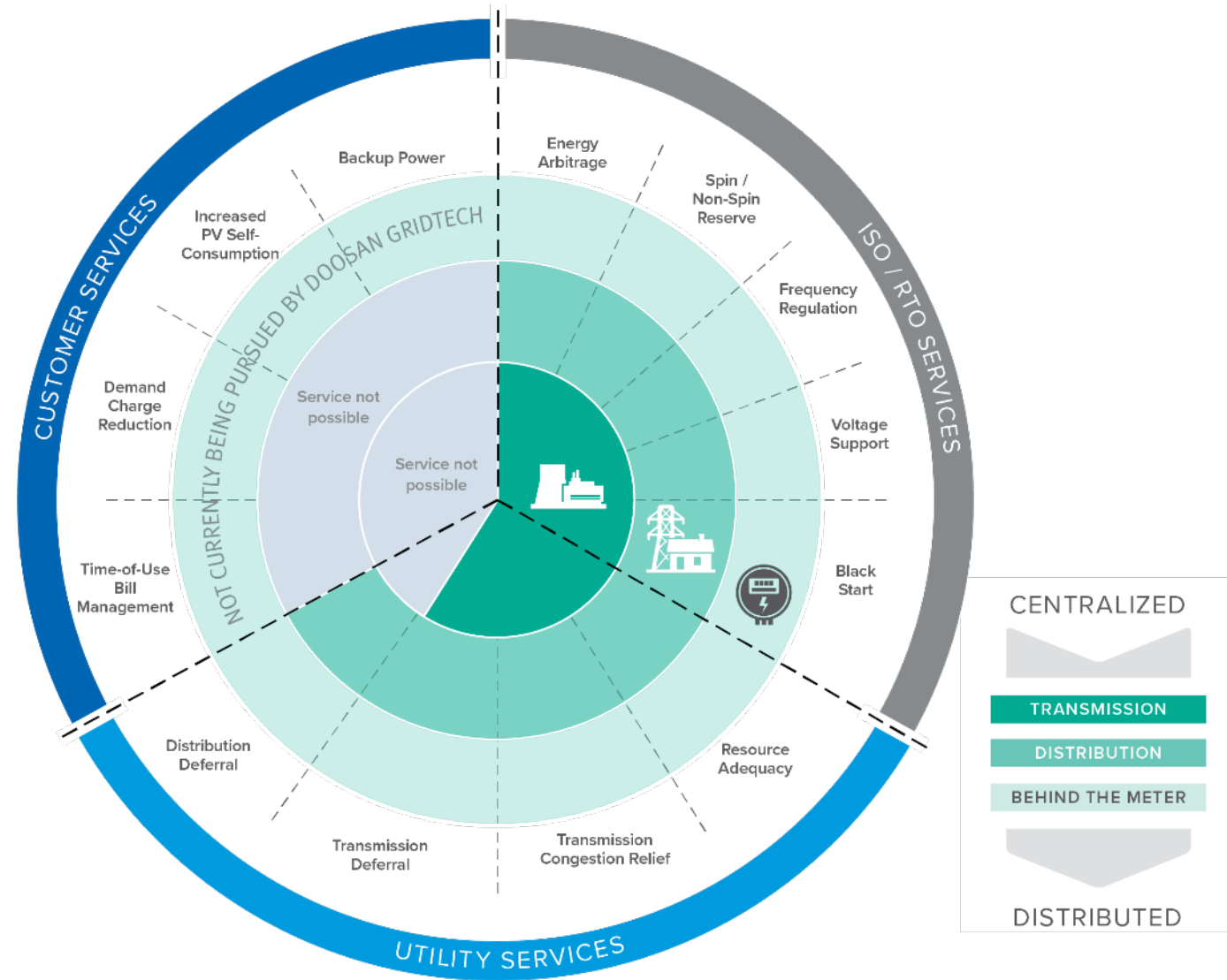
Battery storage can provide up to 13 services to three stakeholder groups

Each value stream can be categorized as either an avoided cost/loss or as direct income.

Doosan currently offers 9 out of 13 identified energy storage value streams with our AI-driven platform.

DOOSAN GRIDTECH

Value Creation Mechanism

*Not exhaustive, VCMs depend on customer objectives and specific environment.

| Category		Application	Value Creation Mechanism (VCM)
Distribution Ops Support	1	Back-up Power (islanding)	Benefit reliability factors (SAIDI/SAIFI) and continue to sell energy during outages.
	2	Volt/VAR optimization	Improve voltage profile and defer investment in other voltage control equipment.
	3	Power Factor Correction	Reduce system losses by operating the distribution circuit closer to unity power factor.
Transmission Ops Support	4	Peak Loss Avoidance	Reduce technical losses on transmission by transmitting less energy across transmission during peak times (I^2R losses)
	5	VAR support for transmission	Increase generation revenue by relieving generators of VAR loading.
Direct ISO Market Participation	6	Regulating reserve	Create revenue via participation in ISO regulating reserve market.
	7	Spinning Reserve	Create revenue via participation in ISO spinning reserve market.
	8	Supplemental Reserve	Create revenue via participation in ISO supplemental reserve market.
	9	Capacity	Create revenue via participation in ISO capacity market.
	10	Energy	Create revenue via participation in ISO energy market.
	11	Ramp product	Create revenue via participation in ISO ramp product market.
Bulk System Benefits	12	Energy procurement cost reduction	Buy more energy from the market when prices are low; buy less energy from the market when prices are high.
	13	Load forecast error mitigation	Compensate for differences between forecasted load bid and actual load, reducing exposure to real-time market and to load forecast error penalties.
	14	Generation offer error mitigation	Compensate for unforeseen deviations between generation offer and available generation, reducing load forecast error exposure.
	15	Black start	Participate in process to energize system after an outage.
	16	Primary frequency response	Respond to locally-measured deviations in frequency to contribute to NERC BAL-003 requirements.
Asset Deferral	17	Generation capacity deferral	Avoid the need for generation asset upgrades to meet future generation capacity needs.
	18	Transmission capacity deferral	Avoid the need for transmission asset upgrades by reliably shifting peak consumption to off-peak times.
	19	Distribution capacity deferral	Avoid the need for distribution asset upgrades by reliably shifting peak consumption to off-peak times.
Customer Revenue	20	Customer back-up power program revenue	Create revenue from customers for providing a battery that provides back-up power during an outage.
	21	Customer bill reduction program revenue	Create revenue from customers for providing a battery that enables customers to reduce their energy bill.

DG-IC®

Doosan GridTech Intelligent Controller®

Extensible artificial intelligence energy management for battery energy storage and hybrid power systems. Fully flexible, precision programming delivers safe, reliable control, and optimization with rapid response to changing conditions in real-time. The DG-IC® provides the interface for communications between the devices in the system and remote operators and other data collection systems, such as SCADA.

Cost-effectively integrate renewable energy while maintaining high power quality and reliability

DOOSAN GRIDTECH

DG-IC®

Benefits at a Glance
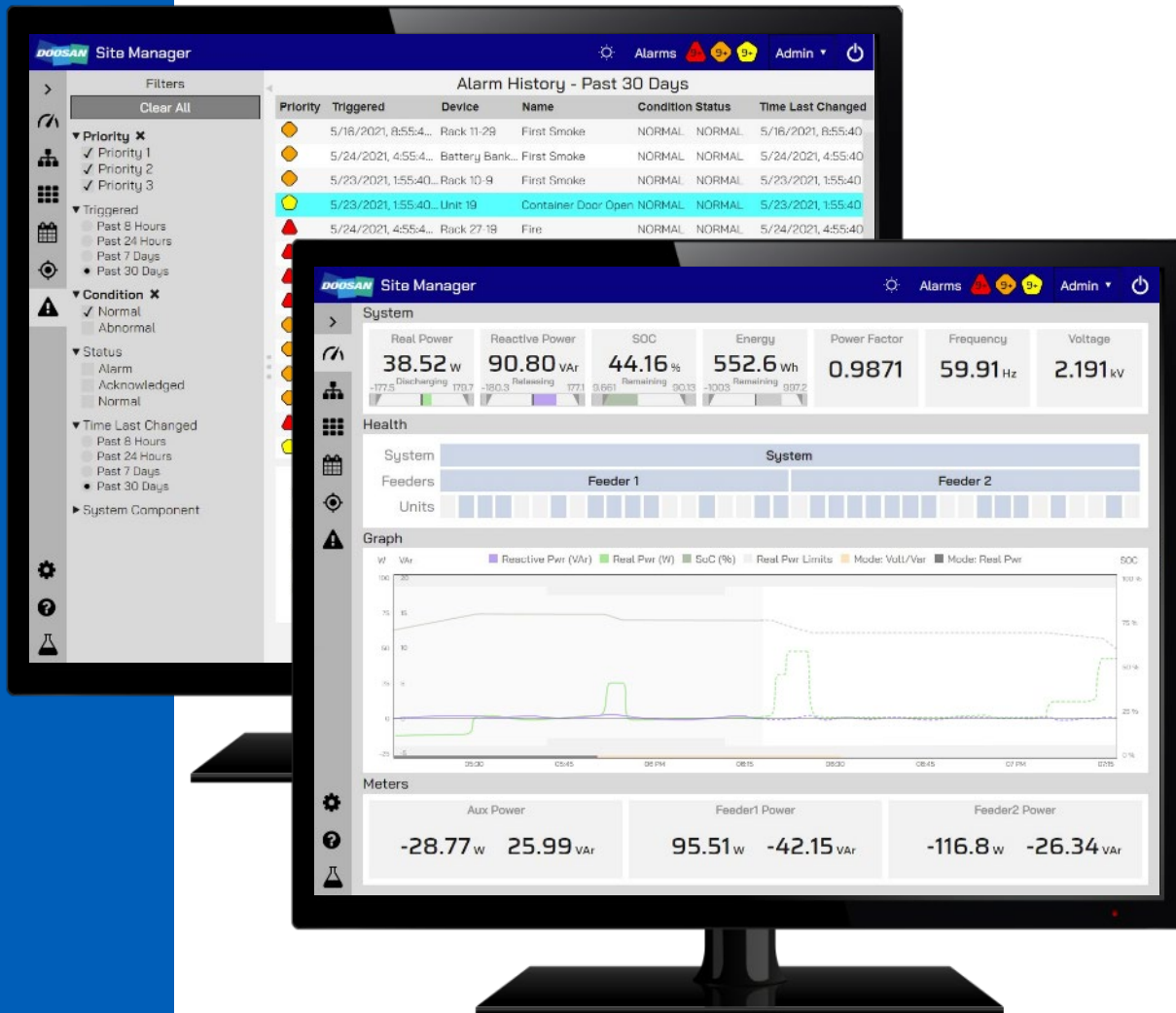
01 Responds Quickly

Prioritized operating modes with sub-second response to variations in real or reactive power, voltage, and frequency mean a quick response to your most pressing needs.

02 Adapts Readily

Configurable parameters, constraints, and settings and a commitment to open standards-based communications ensure the systems can meet your specifications in AC and DC coupled applications.

03 Delivers Safely & Reliably

Built-in features - maintenance mode, three-tier alarm system, failsafe shutdown – ensures personnel, the grid, and the system are safe.

Operating Modes Align with Value Streams

DG-IC® covers multiple use cases

The DG-IC® provides opportunities to avoid costs and losses as well as opportunities for income.

ESS Real / Reactive Power	ESS Power Limit	ESS Power Factor
SOC Management	Power Following	Load Following
Generation Following	Power Factor Correction	Power Smoothing
Peak Power Limiting	Volt/VAr	Volt/Watt
Frequency/ Watt	AGC	Spinning Reserves
Voltage Smoothing		

Optimizing Value

Optimizing value across the power and energy application spectrum
for new systems and retrofits.

POWER ↑ ↓ **ENERGY**

APPLICATION	USE CASES	DG-IC OPERATING MODES
Voltage Regulation	• Renewable Power Integration • Remote community support	• Voltage Smoothing • Dynamic Volt/VAr • Dynamic Volt/Watt
Frequency Regulation	• Ancillary services • Contingency reserves	• Automatic Generation Control (AGC) • Frequency/Watt • Spinning Reserves
Islanding	• Outage Management • Non-wires Alternatives	• SOC Management
Solar + Storage	• Power Firming • Energy Shifting	• Generation Following • ESS Real Power
Peak Management	• Demand Charge Management • Peak Shaving	• Demand Charge Management • Real Power Response
Energy Arbitrage	• Energy Market Participation	• ESS Real Power

DOOSAN GRIDTECH

DG-PAN℮

Doosan GridTech Performance Analyzer™

- Using historical data and sophisticated models underscored by artificial intelligence, provides meaningful predictions to assist operational decision-making
- Allows automated reporting that sends customized reports to various stakeholders
- Allows system operators to create custom key performance indicators, benchmarks, and visualizations

Secure visibility into the current and expected status of assets in real-time

DG-DERO®

Distributed Energy Resource Optimizer®

A field-proven distributed energy resource management system, providing control, monitoring and optimization of distributed energy resources. Be it a single energy storage system or a fleet of thousands of devices, DG-DERO® works to maximize the value of DERs through a flexible, modular, and configurable set of applications.
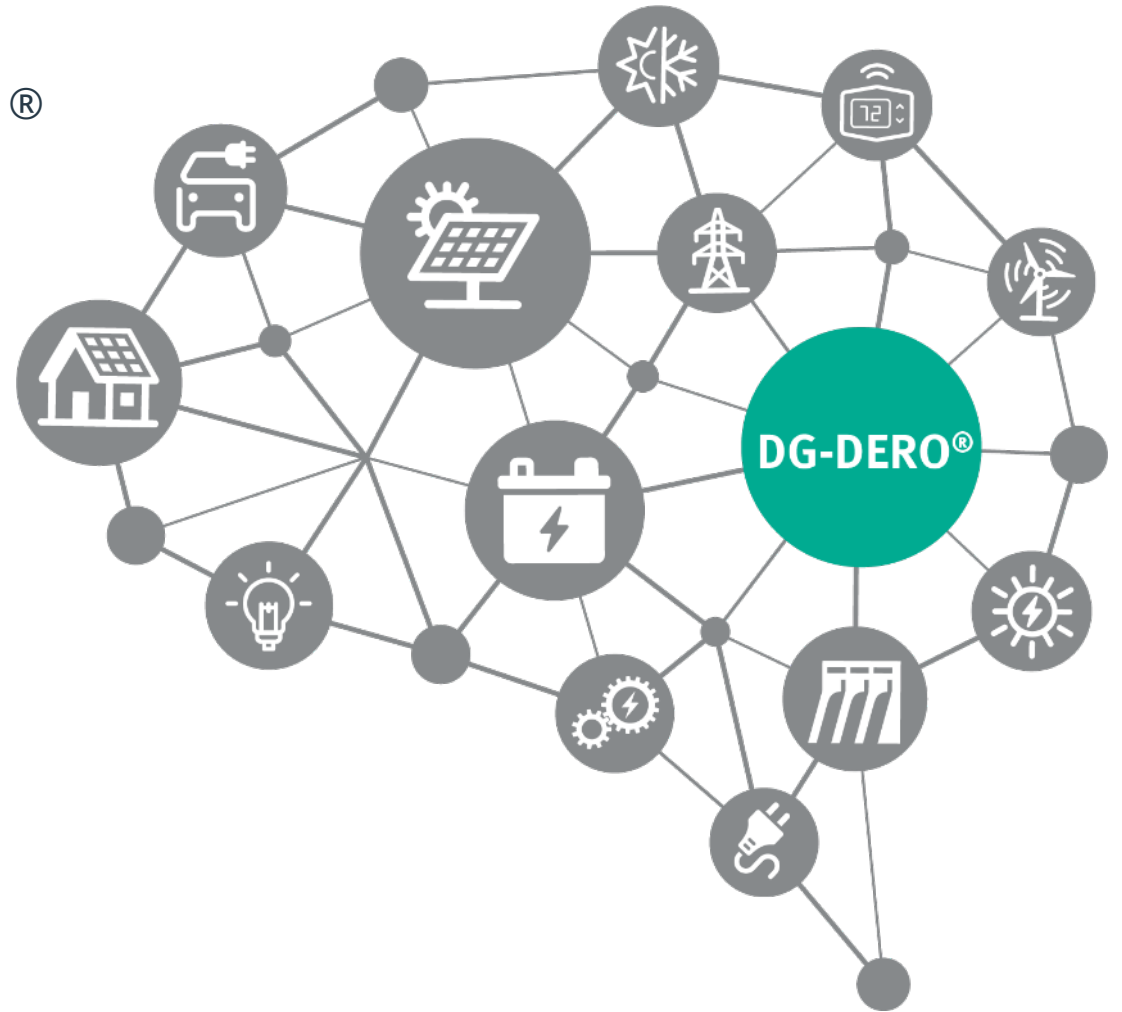
Better management of the grid and less electricity wastage

DG-DERO®

DOOSAN GRIDTECH

DG-DERO®

Benefits at a Glance

01 Optimizes Value

Multiple applications are optimized on intra-hour, hourly, or daily time horizons as conditions change.

02 Simplifies Fleet Management

Serves as a central hub for all DERs – no need for multiple custom portals as DERs proliferate.

03 Scales as the Fleet Grows

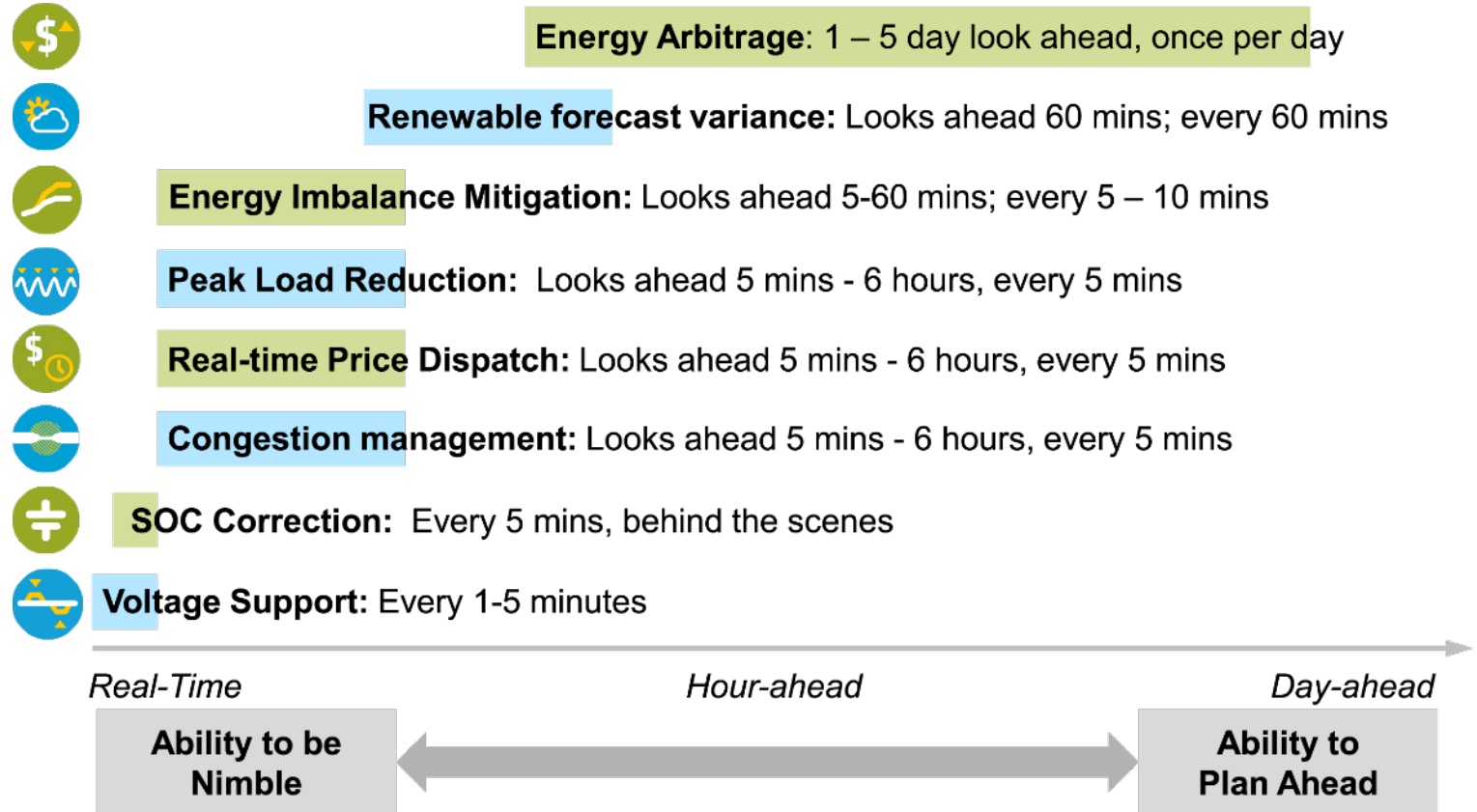Modular, flexible architecture allows for scaling to 1,000's of devices.

04 Lowers Risk

Embrace of open-standards both lowers the cost and time for DER integration and preserves flexibility to add or swap components in the future.

Applications Focused on Value Creation

DG-DERO® applications cover multiple use cases

DG-DERO® has an ever-expanding suite of value creating applications. Applications are optimized according to the relevant time-horizons. Value creation is maximized with optimization occurring every five minutes in response to changing conditions. Applications can be configured to meet each customers' unique needs.

Energy Arbitrage: 1 – 5 day look ahead, once per day

Renewable forecast variance: Looks ahead 60 mins; every 60 mins

Energy Imbalance Mitigation: Looks ahead 5-60 mins; every 5 – 10 mins

Peak Load Reduction: Looks ahead 5 mins - 6 hours, every 5 mins

Real-time Price Dispatch: Looks ahead 5 mins - 6 hours, every 5 mins

Congestion management: Looks ahead 5 mins - 6 hours, every 5 mins

SOC Correction: Every 5 mins, behind the scenes

Voltage Support: Every 1-5 minutes

Real-Time   *Hour-ahead*   *Day-ahead*

Ability to be Nimble   ⟷   **Ability to Plan Ahead**

How We Cybersecure Your Investment

Our "Defense in Depth" Pledge

We will uphold these layers of protection — each working to contribute to the overall security of your digital assets

Information integrity and access controls

Employee policy, practices, and procedures

Internal and perimeter network-level protections

Server and client-based logical and physical protections

Application logic, error checking, and data validation controls

05
KEY EPC EXPERIENCE

Wandoan South 100MW BESS – Standalone

Vena Energy

Location: Western Downs Region – Australia
Utility Offtaker: AGL Energy
Battery: Samsung SDI (AC-coupled)
Inverter: Power Electronics
Control Software: DG-IC®

MESA
Open Standards for Energy Storage

Purpose:

To play a major role in improving grid stability and support the state's shift to renewable energy. Part of Wandoan South Project, approved to generate 1GW of solar energy and 450MW of energy storage

Challenge:

Frequency and voltage support in under 100ms

First registration of ESS into the Australian "National Electricity Market"

Doosan Role:

EPC Contractor, System Integrator & EMS Provider. O&M included.

Complete

Tailem Bend 2 41MW BESS – Hybrid

Vena Energy

Location: Tailem Bend, Australia
Utility Offtaker: ElectraNet
Battery: CATL
Inverter: Power Electronics
Control Software: DG-IC®

MESA
Open Standards for Energy Storage

Purpose:

To counter the intermittent nature of solar generation and maximize the solar plant's profit while providing ancillary services to the National Electricity Market.

Challenge:

Frequency and voltage support in 250ms

Doosan Role:

EPC Contractor, System Integrator & EMS Provider. O&M included.

In Progress

Capital 100MW BESS – Standalone

Neoen

Location: Australian Capital Territory – Australia
Utility Offtaker: Neoen
Battery: CATL
Inverter: Power Electronics
Control Software: DG-IC®

Purpose:

Support and stabilize ACT's electricity grid by providing power to help avoid blackouts during periods of high demand and when large fossil fuel generators fail in heatwave conditions

Challenge:

Respond to frequency changes to prevent voltage and frequency collapse

Doosan Role:

EPC Contractor, System Integrator & EMS Provider. O&M included.

DOOSAN GRIDTECH

MESA
Open Standards for Energy Storage

In Progress

Chisholm Grid 100MW BESS – Standalone

Able Grid / Eolian

Location: Fort Worth, TX
Utility Offtaker: 100% Merchant
Battery: Samsung SDI
Inverter: Sungrow
Control Software: DG-IC®

MESA
Open Standards for Energy Storage

Purpose:

Control, monitor, and dispatch BESS in ERCOT market services including fast frequency response, regulation services, reserve services, energy arbitrage, and voltage support service

Challenge:

Provide 150ms response time for fast frequency response (FFR)

Doosan Role:

System Integrator & EMS Provider

Complete

Beacon Solar Plant 20MW BESS – Co-located with Solar

Los Angeles Department of Water & Power

Location: Kern County, CA
Utility Offtaker: LADWP
Battery: Samsung SDI (AC-coupled)
Inverter: SMA
Control Software: DG-IC®

Purpose:

To allow greater use of solar and wind generation in the area as well as helping maintain grid reliability and lowering use of LADWP's natural gas generators

Challenge:

Deliver modular turnkey design to confront harsh desert conditions at an availability of over 99% for 10 years

Doosan Role:

EPC Contractor, System Integrator & EMS Provider. Maintenance agreement included.

DOOSAN GRIDTECH

MESA Open Standards for Energy Storage

Complete

Kingsbury 1.5MW BESS – Co-located with Solar

Austin Energy

Location: Austin, TX

Utility Offtaker: Austin Energy

Battery: LG Chemical

Inverter: Parker

Control Software: DG-IC® and DG-DERO®

Purpose:

- Kingsbery ESS is co-located with the La Loma community solar array (2.6 MW). It will provide voltage support services on the local circuit and perform energy arbitrage within ERCOT market to maximize local use of solar production

Challenge:

- Integrate high levels of renewable energy on distribution level circuit

Doosan Role:

- System Integrator & EMS provider

Complete

MESA 1 & 2 BESS – Standalone

Snohomish County Public Utilities District

Location: Everett, WA

Utility Offtaker: Snohomish County PUD

Battery: Mitsubishi, LG Chemical, and UET

Inverter: Parker and Siemens
Control Software: DG-IC® and DG-DERO®

MESA
Open Standards for Energy Storage

Purpose:

- Two ESSs were deployed at the same substation and demonstrated the capability of the DG-IC® to manage more than one ESS at the substation. The third ESS is an energy dense vanadium redox flow battery, with another DG-IC® control system. All ESSs were deployed using the MESA standards, ensuring that SnoPUD has standardized communication interfaces, uniform scheduling capability, and reliable security parameters. Doosan GridTech's DG-DERO® is the keystone of SnoPUD's program.

Challenge:

- Holistically design, grid integrate and optimize a set of energy storage systems

Doosan Role:

- System Integrator & EMS provider

Complete

Atterbury 5MW BESS + 2MW PV – Hybrid

Duke Energy

Location: National Guard – Camp Atterbury, IN
Utility Offtaker: Duke Energy
Battery: Samsung SDI
Inverter: SMA
Control Software: DG-IC®

MESA
Open Standards for Energy Storage

Purpose:

Improves customer reliability and ensures power supply to mission critical military operations, accesses the fast frequency regulation market, and integrates with distribution operations to provide grid support services as needed

Challenge:

Deliver microgrid for large National Guard base as a utility resiliency service

Doosan Role:

EPC Contractor, System Integrator & EMS Provider. O&M included.

Complete

Jennings 5.5MW BESS – Standalone

Duke Energy

Location: Jennings, FL
Utility Offtaker: Duke Energy
Battery: Samsung SDI
Inverter: SMA

MESA
Open Standards for Energy Storage

Purpose:

Improves customer reliability and ensures power supply to mission critical military operations, accesses the fast frequency regulation market, and integrates with distribution operations to provide grid support services as needed

Challenge:

Capture revenue from the MISO Frequency Regulation market to improve economics for investment.

Doosan Role:

EPC Contractor

Complete

Micanopy 8.25MW BESS – Standalone

Duke Energy

Purpose:

Provides a cost-effective solution for focused power quality and reliability for the town of Micanopy and nearby neighbors.

Challenge:

Capture revenue from the MISO Frequency Regulation market to improve economics for investment.

Doosan Role:

EPC Contractor

Location: Micanopy, FL
Utility Offtaker: Duke Energy
Battery: Samsung SDI
Inverter: SMA

MESA
Open Standards for Energy Storage

In Progress

John Hopkins 2.5MW BESS + 1MW PV – Standalone

Duke Energy

Location: John Hopkins Middle School, St. Petersburg, FL
Utility Offtaker: Duke Energy
Battery: CATL
Inverter: Dynapower

MESA Open Standards for Energy Storage

Purpose:

The microgrid consists of a 1-megawatt solar parking canopy array and a 2.5-megawatt battery and controls, which will store and deploy clean, renewable energy to the school and grid. The project enhances electric service and grid operations for customers.

Challenge:

Support grid operations and provide backup electric power to the school when it must operate as a special need's hurricane evacuation shelter.
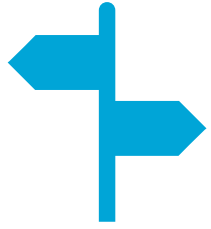
Doosan Role:

EPC Contractor

In Progress

06
O&M SERVICE EXPERIENCE

O&M Experience

Operating 700+Gwh of capacity

10 yrs ⊕

JFB BESS
.2MW/.8MWh

Maintenance and performance guarantees

10 yrs ⊕

Beacon BESS
10MW/20MWh

Maintenance and performance guarantees

25 yrs ⊕

Horn Rapids BESS
1MW/4MWh

Maintenance and performance guarantees

12 yrs ←

Atterbury BESS
5MW/5MWh

Operations & Maintenance

12 yrs →

NABB BESS
5MW/5MWh

Operations & Maintenance

20 yrs ⭳

Tailem Bend 2
41MW/45MWh

Operations & Maintenance

15 yrs ⭱

Wandoan South
100MW/150MWh

Operations & Maintenance

20 yrs ⭱

Capital BESS
100MW/200MWh

Operations & Maintenance
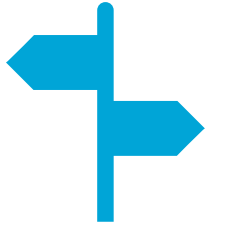
O&M Experience
Operating 700+GWh of capacity

DOOSAN
GRIDTECH

THANK
YOU