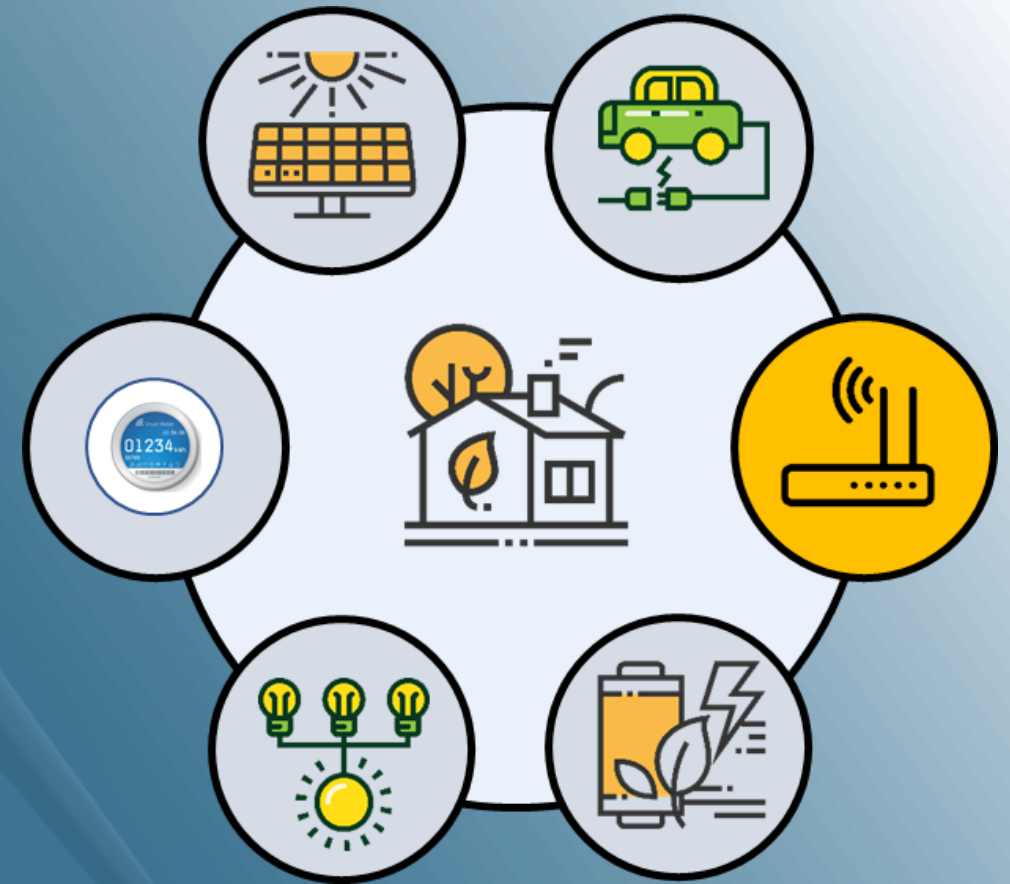



Standardizing, Replicating and Scaling Hybrid Energy Systems: Lessons from Commercial Project Deployments

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Evolution of Distributed Energy


Spirae's mission is to accelerate the world's transition to renewable energy through the deployment of microgrids – everywhere.




1900s
Centrally Based
Fossil Generation



2000s
Large Scale
Renewables



2010s
Distributed Energy
Resources



2020s
IoT Managed and
Optimized Microgrids

\$150 Billion in Revenue by 2025¹

1. Navigant Research

Why Renewable Energy Microgrids

- **Power** anything (clean, low-cost energy for whatever, whenever, wherever)
- **Harness** abundance (use ubiquitous energy instead of mining, transporting and burning finite resources from fragile ecosystems)
- **Localize** (maximize use of local resources for massive efficiency gains)
- **Personalize** energy (tailor to individual preferences)
- **Decarbonize** personal energy footprint (contribute measurably to mitigating and reversing human-caused environmental impacts)
- **Network** microgrids (diversify, share, and optimize resources)



Microgrids enable Energy Service Providers to deliver customized, DER-based, energy solutions to customers

Renewable Energy Microgrids Benefit:

- Facility Energy Managers
- Microgrid Project Developers/EPCs
- Solar + Storage Developers/Contractors/Installers
- DER Manufacturers
- Electric Utilities

Leverage solar, storage, power-gen, demand management, and EVSC solutions and deliver value-added energy services to your customers!



Microgrid Deployments



Location: Africa
Type: Mine (off grid)
Driver: Economic (diesel offset)

Location: Caribbean
Type: Island
Driver: Resilience, Renewables



Location: Fort Collins
Type: Energy Storage Fleet
Driver: Climate action plan

Location: San Diego
Type: Microgrid and Storage
Driver: Resilience, Economic

Microgrid Deployments



Location: San Diego
Type: Utility Microgrid
Driver: Resilience



Location: San Diego
Type: Storage Fleet
Driver: AB 2868

Location: Liberia
Type: Off-grid Community
Driver: Rural Electrification

Integrid Lab

Test and Validate Equipment, Control Software and Use Cases



Major Challenges

Ever Increasing DER Options

- Solar Inverters, Battery Energy Storage Systems
- Building Management Systems, EVSCs
- Genset and Switchgear Controls
- Meters, Breakers, Synchronizers, Protection Relays

Communications and Networking

- Field Networking (Between DERs)
- Facility Operations and Integration with Customer IT Systems
- Remote Access, Uptime, Technical Support
- Security, Privacy, Resilience

Engineering Knowhow and Costs

- Analyzing opportunities, costs and benefits
- Equipment selection, sizing and interconnection
- Specialized systems integration
- Data Management, Analytics and Optimization

Opportunities

Standardize

- Microgrid Types
- Asset Libraries
- Control Algorithms and Value Equations
- Interfaces and Protocols

Software-Defined

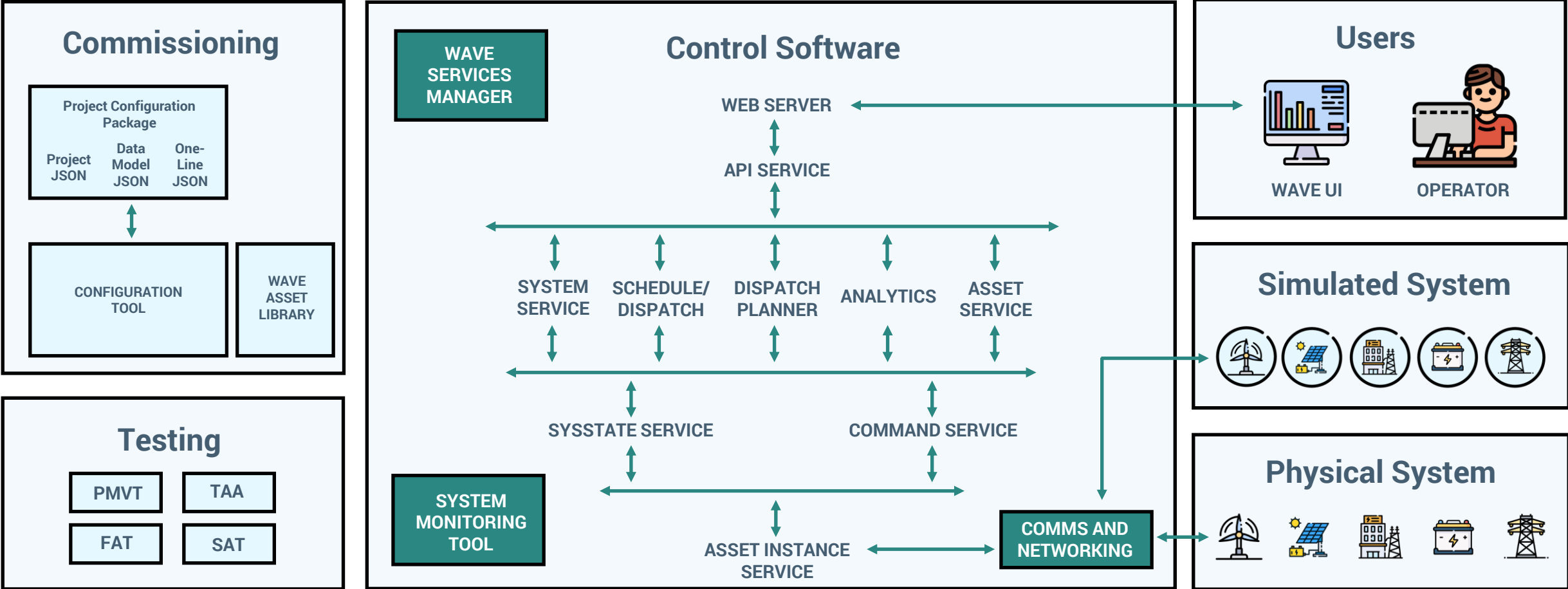
- Configurable
- Modular
- Data-Driven
- Model-Based

Process Driven

- Cloud Platform for Managing Every Stage of Deployment
- Standard Procedure for Configuring Systems
- Standardized Site Readiness Tests
- Standardized Site Acceptance Tests

Wave Microgrid Control Software Architecture

CONFIGURE | SIMULATE | DEPLOY | OPERATE



Manage Renewable Energy Microgrid Projects from Concept to Operations

PLUG AND PLAY DERs LIBRARY

The screenshot displays the 'Wave Library' interface. The top navigation bar includes the Spirae logo, 'Wave Library | OUR COLLECTION', and 'TOUR CONTACT US'. A sidebar on the left lists navigation options: Overview, Quotes, Proposals, Projects, Dashboard, Library (selected), Support, Config Tool, Controllers, and Demo. The main content area is divided into three sections: 'Breaker' with items like JQ L1000, Tesla Powerpack 2.5, and Aggreko Y Cube; 'Generator Controller' with items like Controllable Breaker, Schneider Masterpact NW, and Virtual Breaker; and a bottom row with DEF AGC-4, CAT EMCP 4.2, CAT EMCP 4.4, and Generic Switchgear. The bottom left corner notes 'Powered by Spirae Wave'.

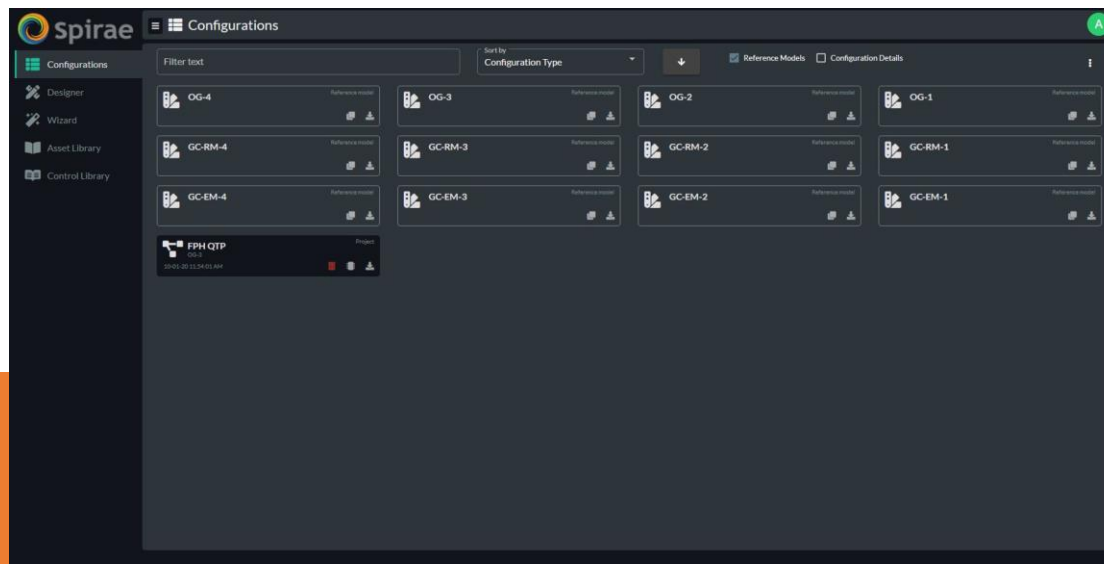
LIFECYCLE MANAGEMENT PLATFORM

The screenshot shows the 'Spirae | YOUR PERSONAL DASHBOARD' interface. The top navigation bar includes the Spirae logo, 'Spirae | YOUR PERSONAL DASHBOARD', and 'QUICK START'. A sidebar on the left lists navigation options: Overview (selected), Quotes, Proposals, Projects, Dashboard, Library, Support, Config Tool, Controllers, and Demo. The main content area features several widgets: 'Explore' with a grid of colored squares and a 'DEMO' button; 'Support Tickets' with a large orange donut chart and a legend for Submitted (0), InProgress (1), Solved (0), Done (0), and Cancelled (0); 'Proposals' with progress bars for InProgress, Generated, Submitted, and Accepted, and a 'PROPOSAL BUILDER' button; and 'My Projects' with a search bar and a table of project progress.

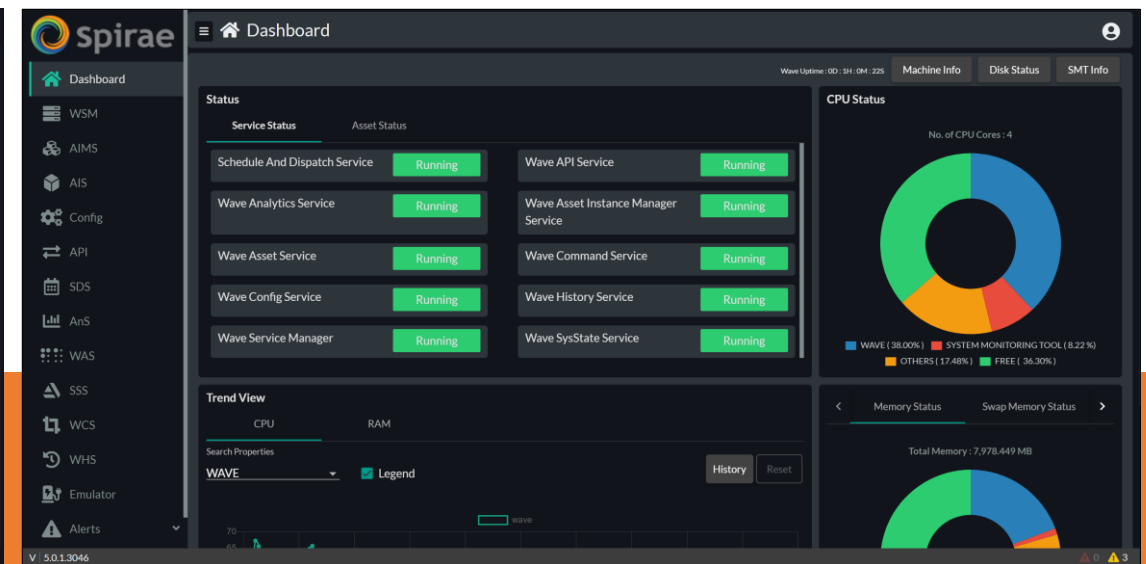
PROJECT	INITIATE	DESIGN	CONFIGURE	COMMISSION	SUPPORT
Archos Project Manager	2 of 3	1 of 1	2 of 5	2 of 4	0 of 2
Dream Line Project Manager CAT	2 of 2	0 of 1	0 of 5	0 of 4	0 of 2
GGe Project Manager	2 of 2	1 of 1	2 of 5	2 of 4	0 of 2
Green Tree Project Manager: Spirae Admin	1 of 2	0 of 1	0 of 5	0 of 4	0 of 2
Rams Project Manager: Sull Christian	2 of 2	1 of 1	1 of 5	0 of 4	0 of 2

Rapidly Configure, Emulate and Deploy Microgrids

CONFIGURE

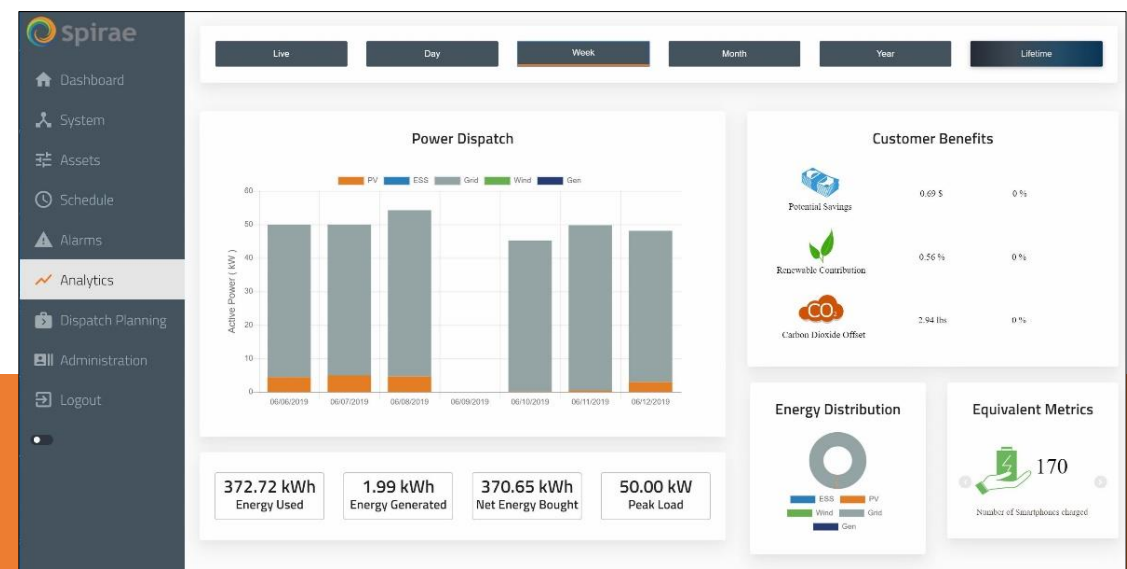
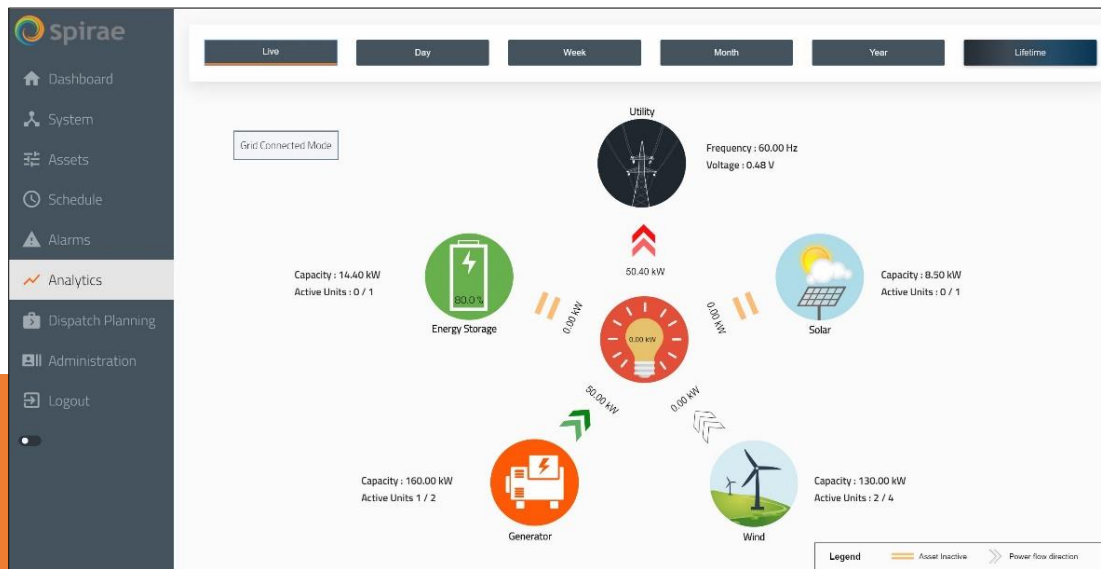


DEPLOY and MANAGE



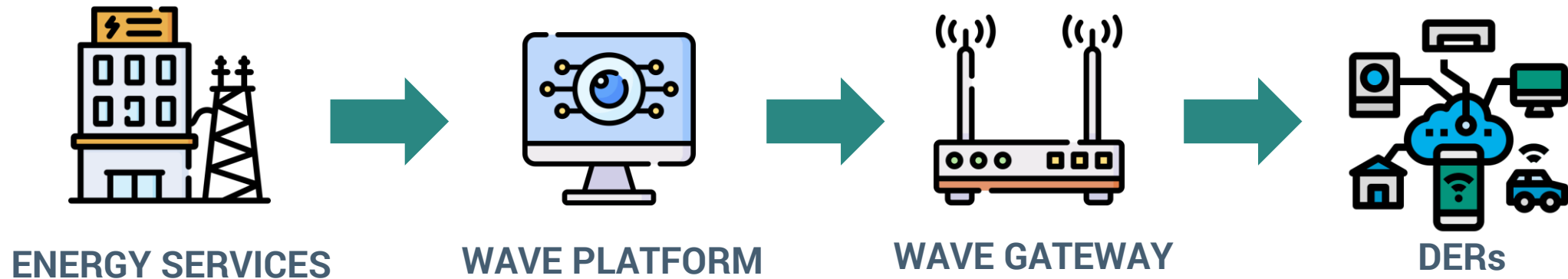
Access Client UI through Browser from Anywhere

MONITOR AND CONTROL



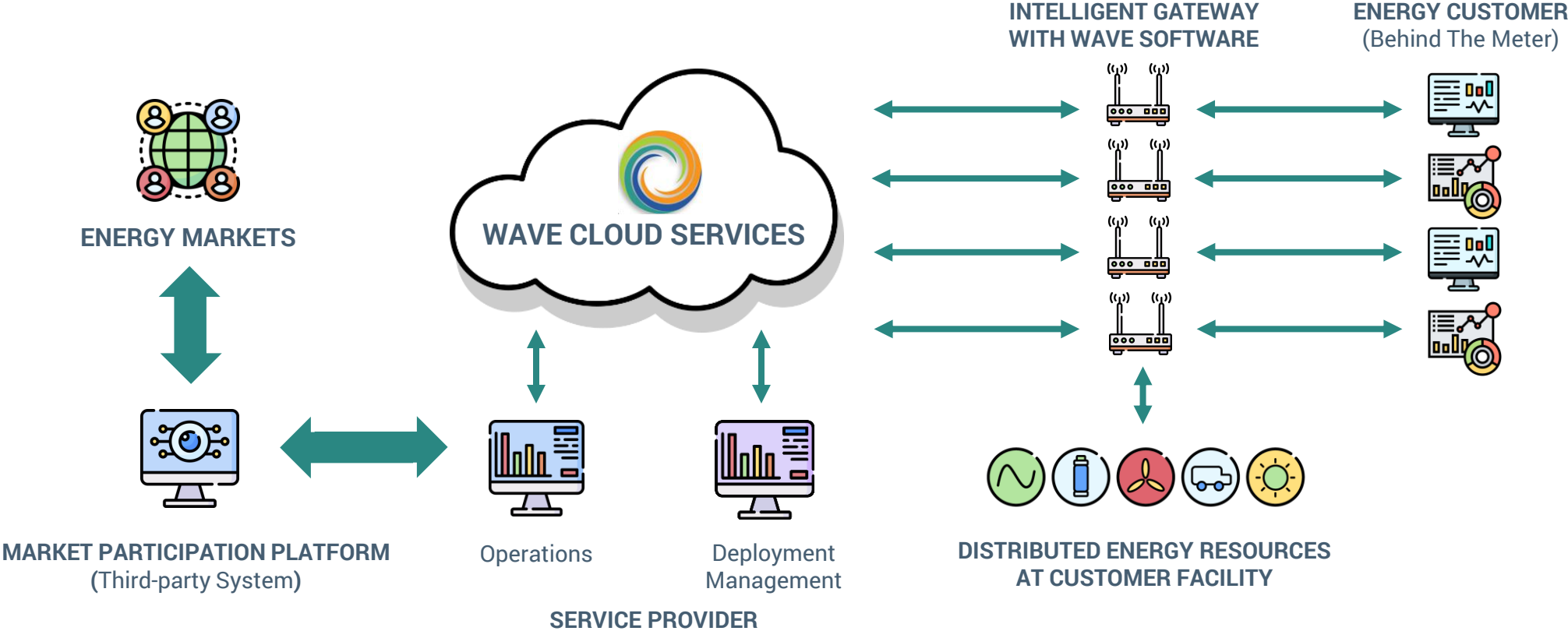
Transform Business Models: Activate Energy Services with Microgrids

Seamlessly integrate DERs from many manufacturers using native interfaces, protocols and field networks, use edge-intelligence for control, connect microgrids to cloud platform, and enable service providers to activate and manage energy services for their customers.



Connect Service Providers with Customers

CONFIGURE | SIMULATE | DEPLOY | OPERATE



Summary

- Engineering Costs to Design, Develop, Commission and Operate Microgrids will decrease substantially
- Microgrids will enable the delivery of differentiated energy services to customers
- Energy as a Service (EaaS) models will become pervasive underpinned by software-defined microgrids
- Microgrids will accelerate the Localization, Personalization and Decarbonization of Energy Systems

Thank You!

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