Network Energy Transformation

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Trend and Challenge

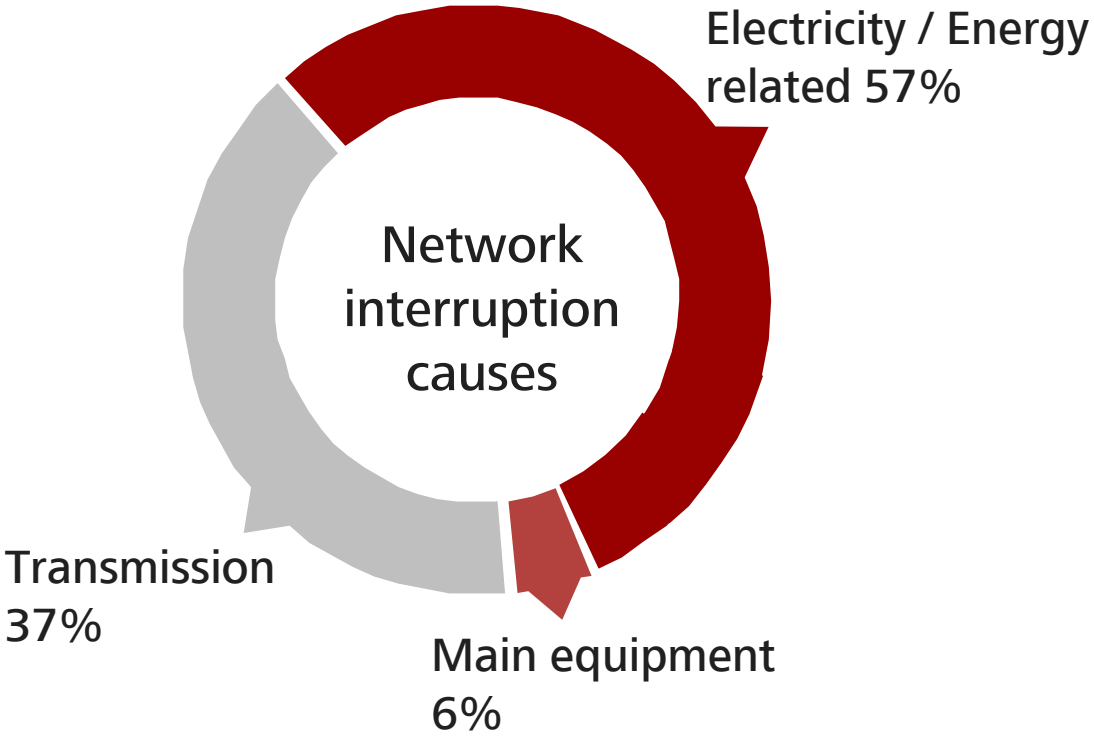
Better Connected World needs More Reliable Energy Supply

6.8B cell phone users

(average 1 set / person)

1 hour / day

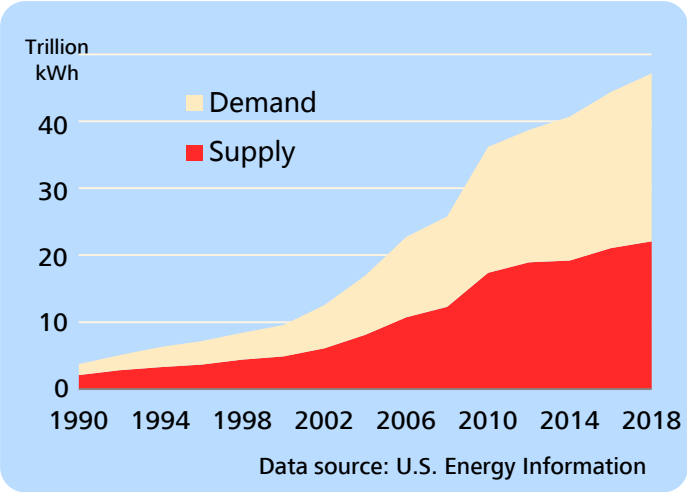
$74.45B /year



Data time: Jan, 2014

Reliability, the basic requirement of network energy users

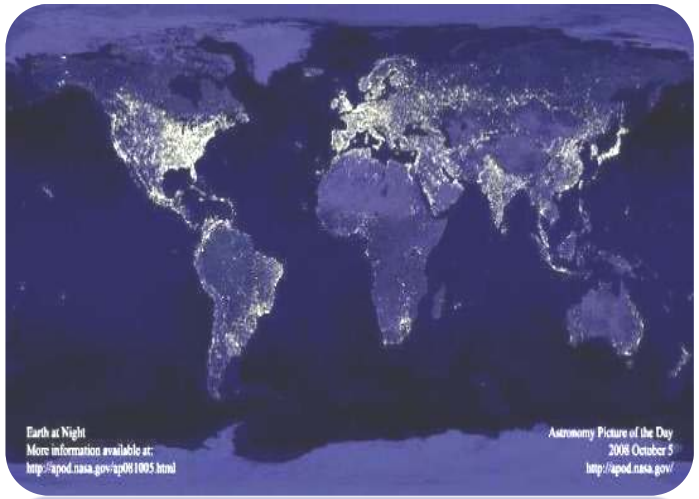
Energy Supply Shortage, Renewable Energy Trend



Growing gap of supply & demand

Gap in 2018

30 Trillion kWh



Data source: NASA

Lots off grid or poor grid area

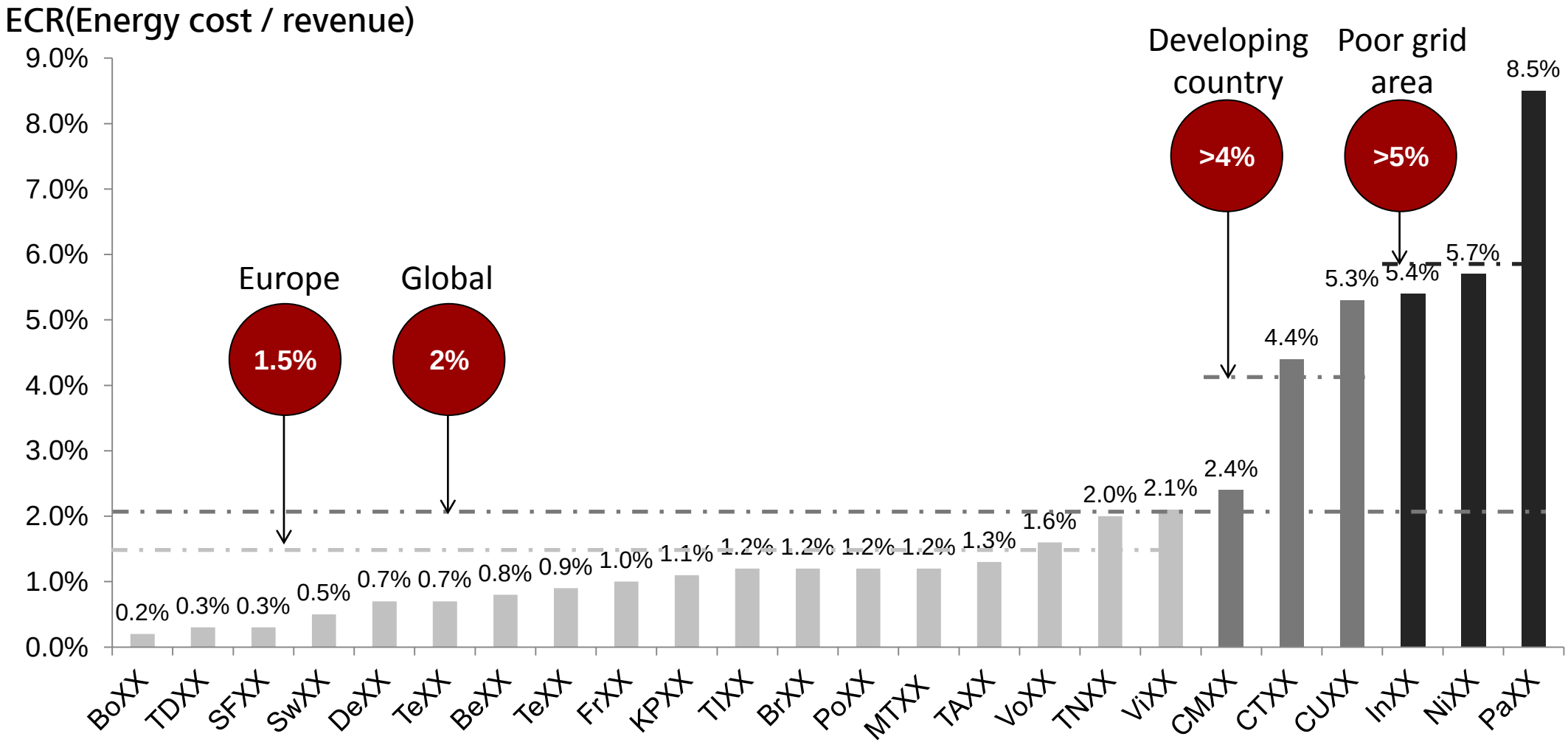
> 2 Billion population

> 0.6 Million sites

Renewable energy requirement increasing

> 30% /year

2% Revenue of Carriers is eroded by Energy Cost



Telecom Operators face Energy Saving Pressure

Operators	Saving commitment
Telefónica	2015 Vs 2008, reduce 30% network electricity consumption
Deutsche Telekom	2020 Vs1995, reduce 20% CO2 emission
telenor	2016 Vs 2007, reduce 40% CO2 emission
vodafone	2020 Vs 2006/07, reduce 50% CO2 emission
TELECOM ITALIA	2015 Vs 2008 , reduce 5% electricity consumption
BT	2020 Vs 1996 , reduce 80% CO2 emission
&	2020 Vs 2006, reduce 20% CO2 emission
verizon	2017Vs2007 , reduce 15% CO2 emission
Sprint	2017Vs2007 , reduce 15% CO2 emission

Other Operational Challenges
- besides reliability and energy efficiency

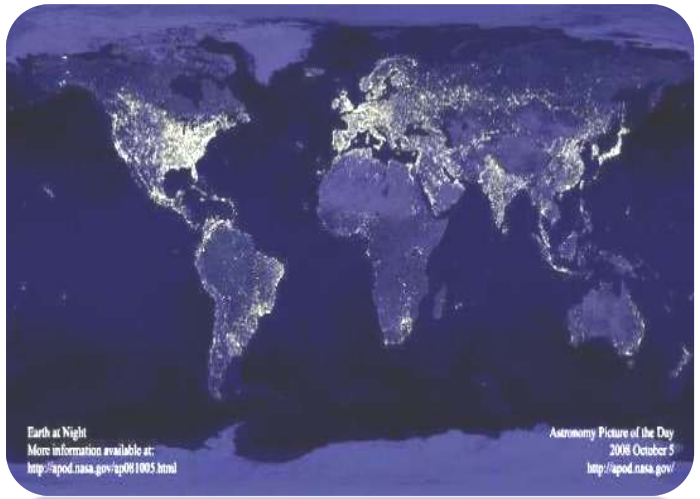
Site Acquisition

Difficult to find site, frequent loss

4.5M physical sites

300m LTE site distance

Energy Acquisition



Data source: NASA satellite

Poor grid, high power cost

> 2B population

> 600K sites

Energy Network Operation

Low visibility

Low resource utilization efficiency

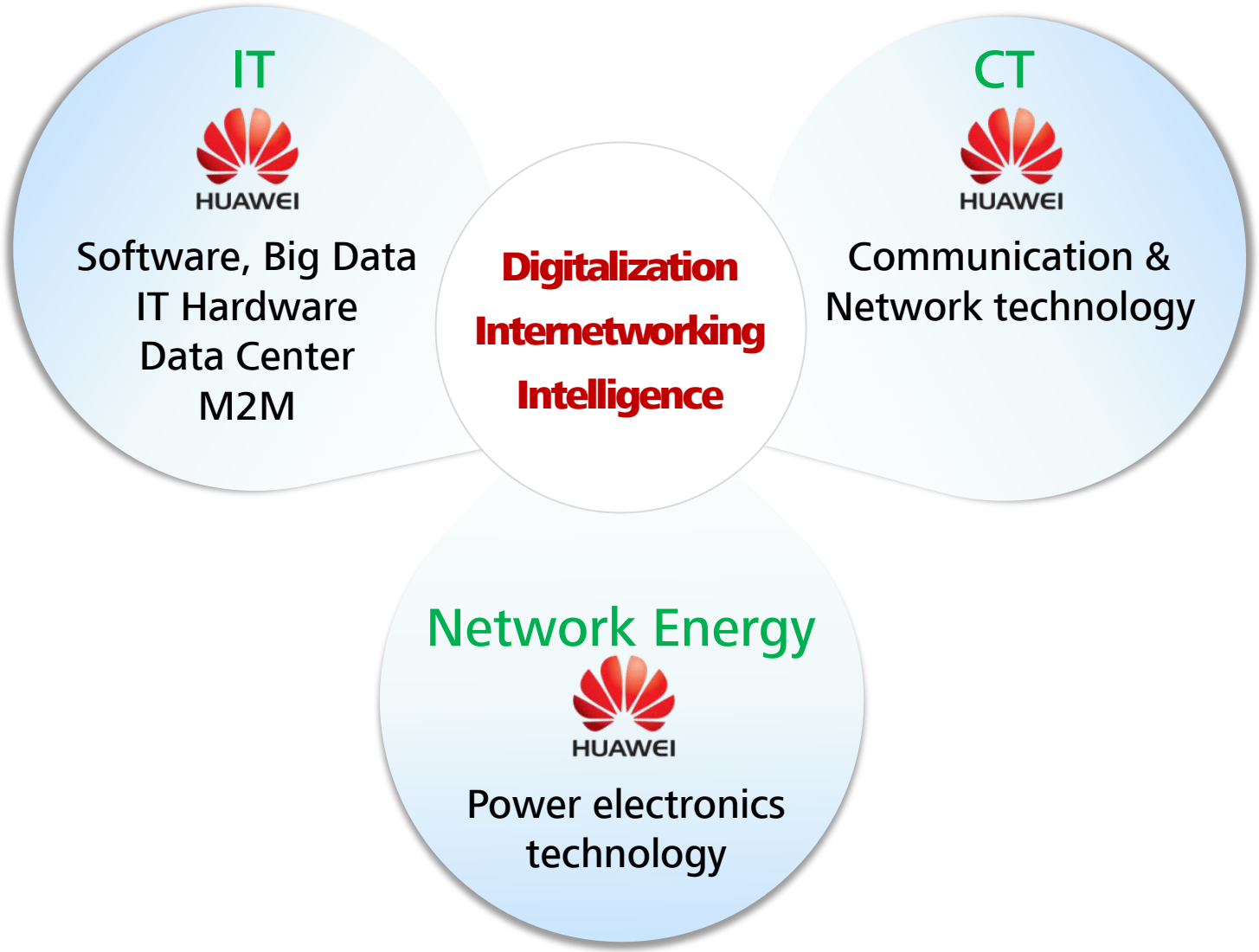
<2yrs average battery lifespan/outdoor site

>60% site without energy OSS

Data source: Huawei network energy research

HUAWEI Vision and Value Proposition

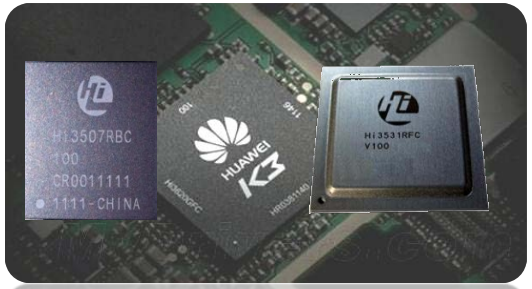
Cross-Industry Integration for a Better-Connected Green World



Digitalization:
Bit Managing Watt, Power Electronics + Chips = SDP

AC/DC, DC/DC, DC/AC

+



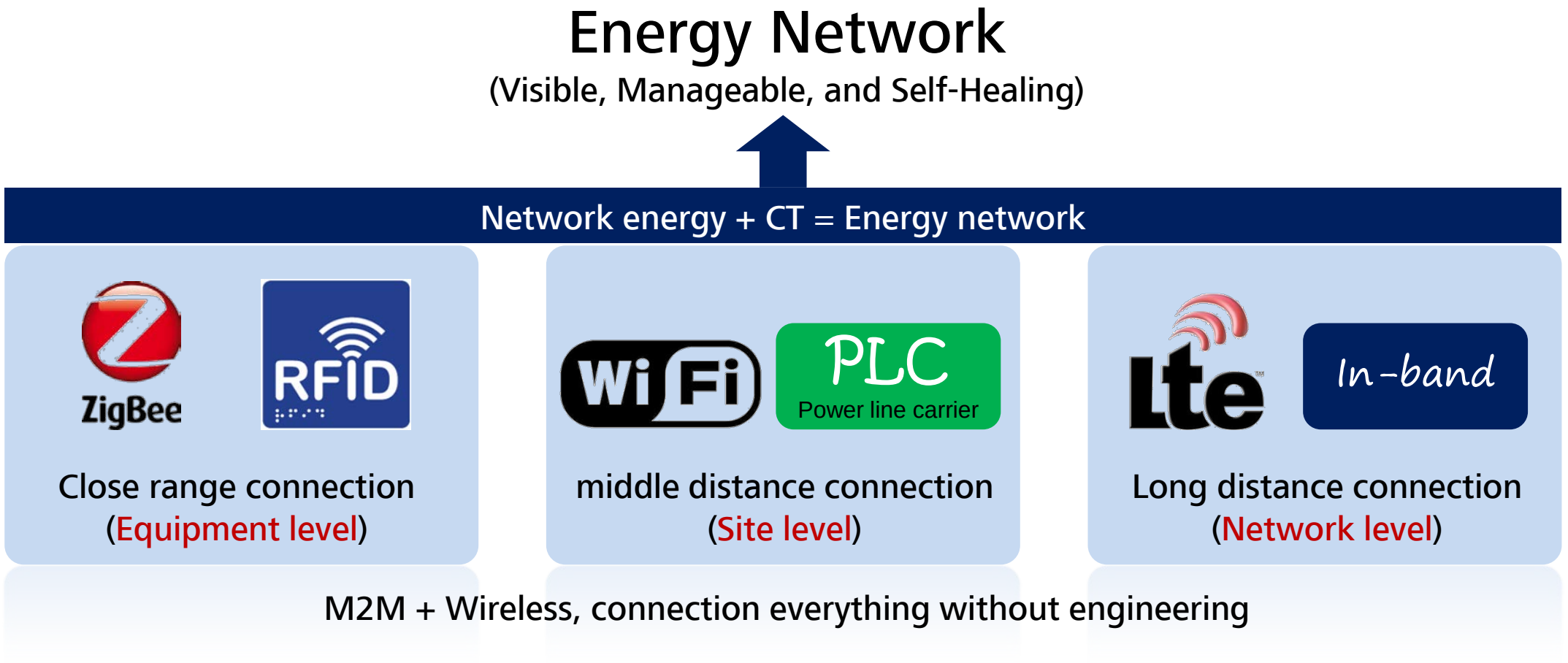
Specified digital control technology/chip

SDP
(Soft Defined Power)

- More silicon, less copper
- Software defined function

Higher energy efficiency, higher system reliability, fully scalable solution

Internetworking:
Connected Energy with Networking Technology Enablers



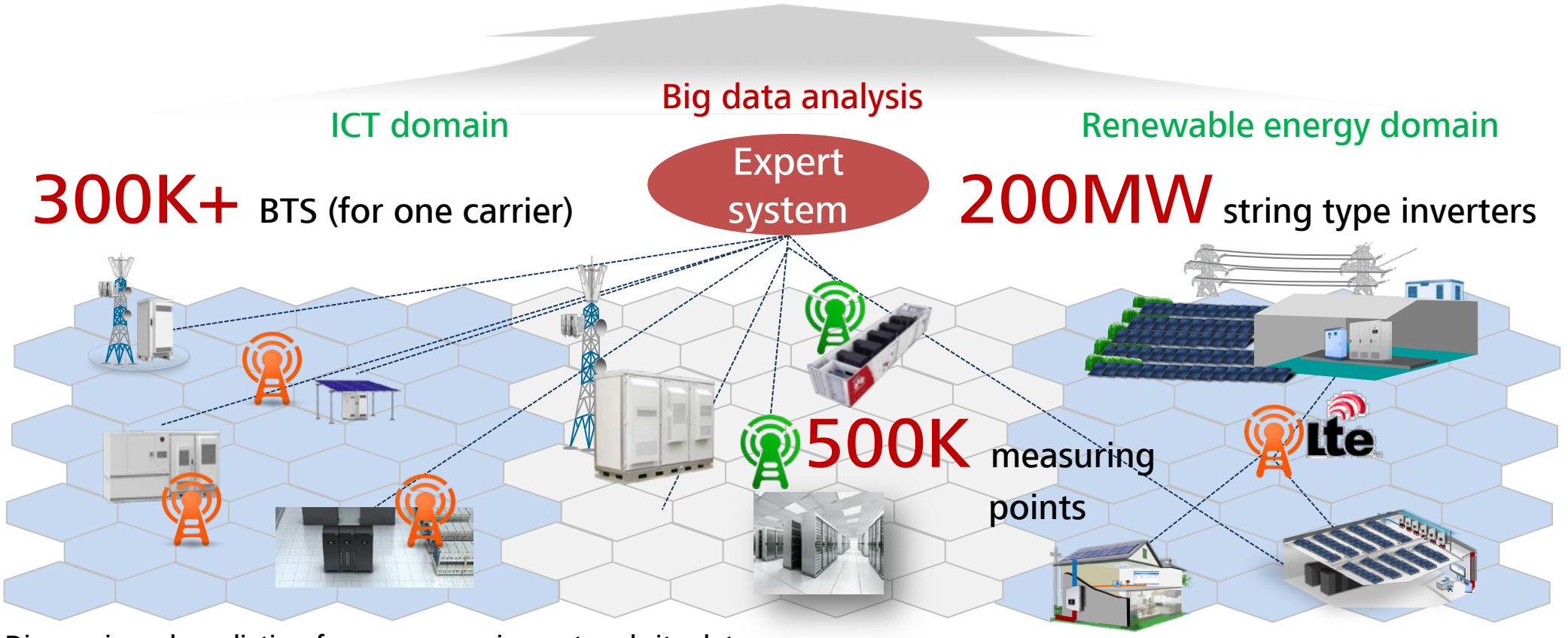
Intelligence:

Large-scale Real-time Energy Management System

Proactive Maintenance & Trouble shooting

Energy Network Operation

Intelligent Analysis & Report



Diagnosis and prediction from mass equipment and site data

HUAWEI Network Energy Solution

Telecom Power: Highest Efficiency Modular System

98%
Rectifier Unit

98.5%
Solar Supply Unit

97%
HVDC Unit

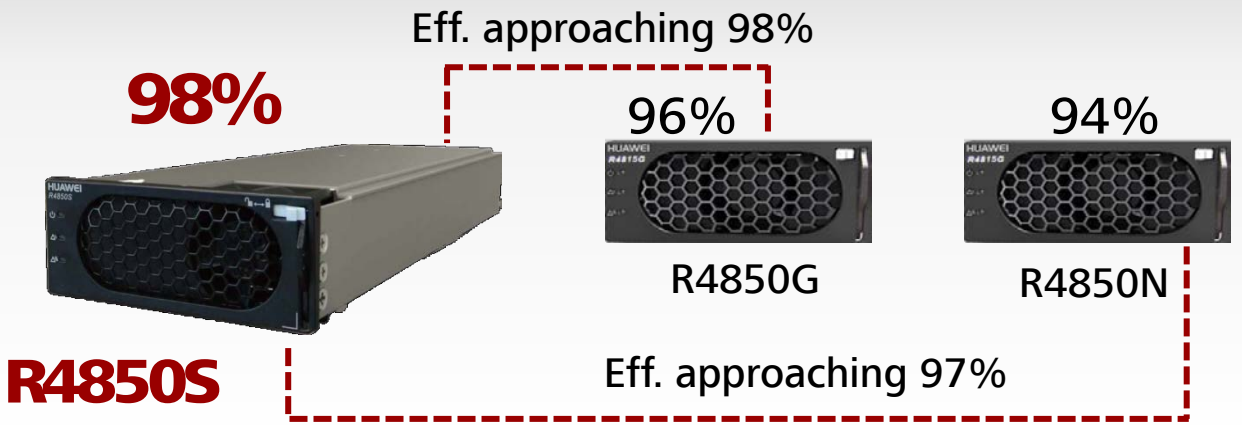
Functional mixing

- Plug and play
- Flexible and smooth evolution

Same form-factor, Same back-plate

Efficiency mixing

- Optimized efficiency
- Reduced CAPEX



3 Level Efficiency: Equipment Level, Site Level, Network Level

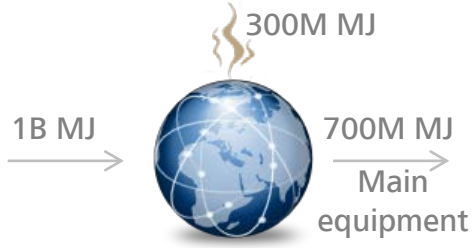
Improving equipment energy efficiency

EEE 98%

Improving site energy efficiency

SEE 95%

Improving network energy efficiency



NEE 80%

DC:CO:Site energy 5:20:75
Site indoor: outdoor 30:70

The best application in industry

Legacy power modernization	Site modernization / Site-level high efficiency	Network energy efficiency management
NEE 3~5%	NEE 10~20%	NEE 30%

High efficiency equipment ≠ high efficiency site; Network energy scheduling + KPI assessment, achieve high efficiency network.

- EEE: Equipment Energy Efficiency
- SEE: Site Energy Efficiency
- NEE: Network Energy Efficiency

NEE, KPI to Evaluate Efficiency of Network Energy

Domain: Data center

$$\mathbf{PUE} = \frac{\text{Total power consumption}}{\text{Load power consumption}}$$

PUE: Power Usage Effectiveness

Domain: Telecom network

$$\mathbf{NEE} = \frac{\text{Telecom Load power consumption}}{\text{Total energy consumption}}$$

NEE: Network Energy Efficiency

PUE can not differ the following scenarios, but NEE is different.

1 Power generating

1 hours/day vs **1 hours/month**

NEE 45% | NEE 50%

2 Site visit

1 time/week vs **1 time/season**

NEE 50% | NEE 51%

3 Solar

Grid vs **solar**

NEE 50% | NEE ∞

Improving NEE to save energy, the following items included at least:

- Energy consumed by generator
- Energy consumed by site visit

MTS (Migrate Towards Simplicity)
- New Generation Site Solution

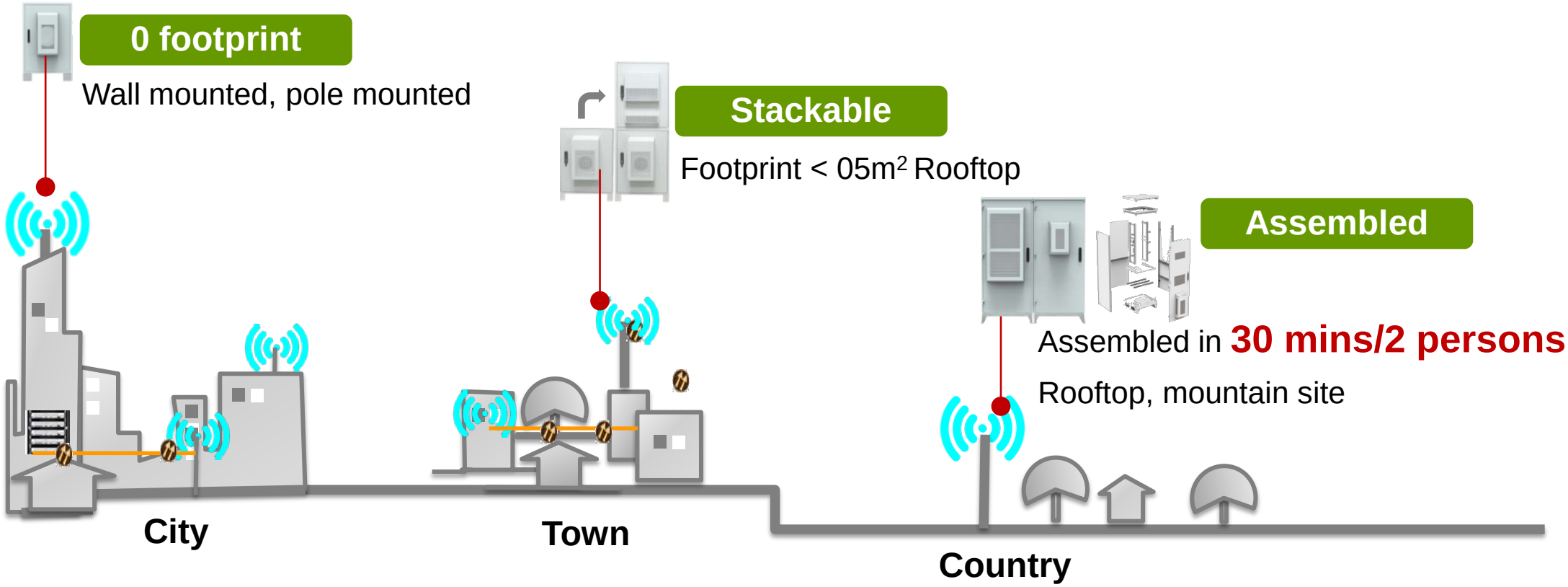
Simple

- MIMO technology, easy energy availability
- Modular design plus integrated design, simple expansion
- Unified OSS, Resource & Health Mgmt, Mobile APP

High Efficiency

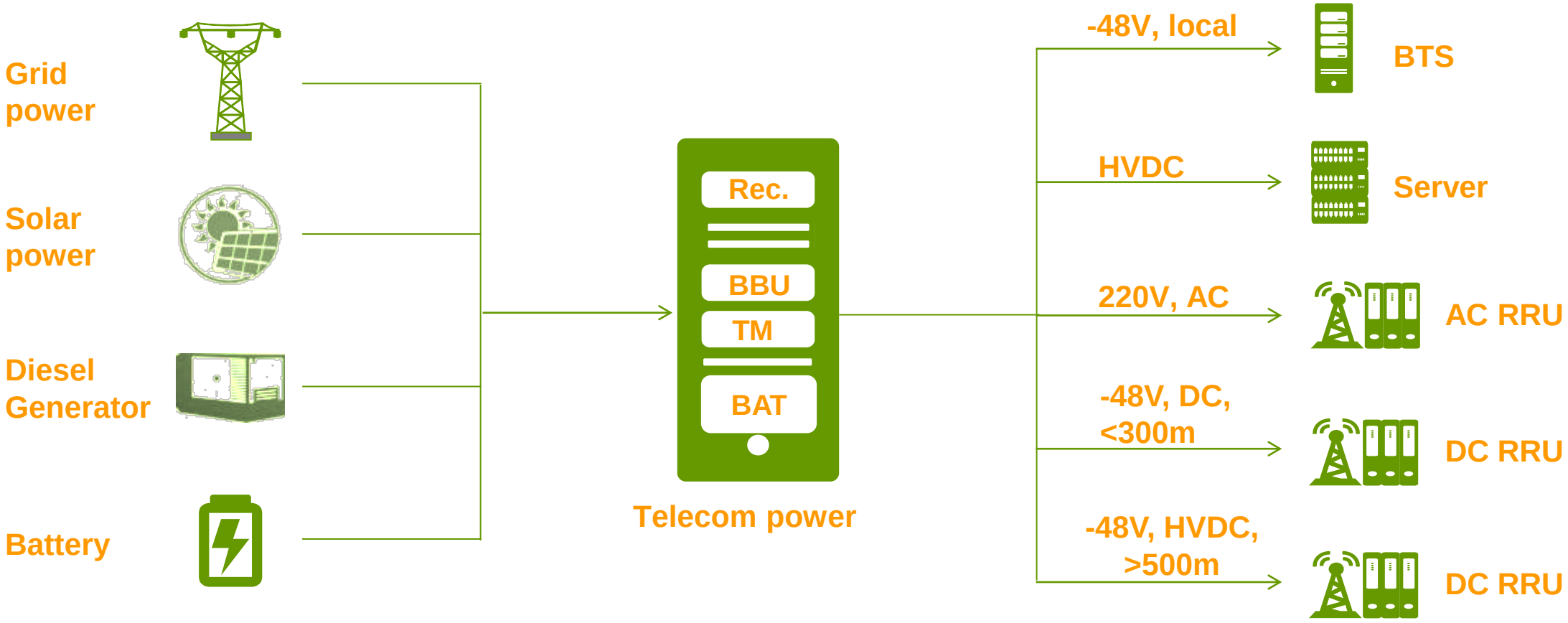
- Highest efficiency components
- SEE and NEE optimized integrated design

Ease Site Acquisition



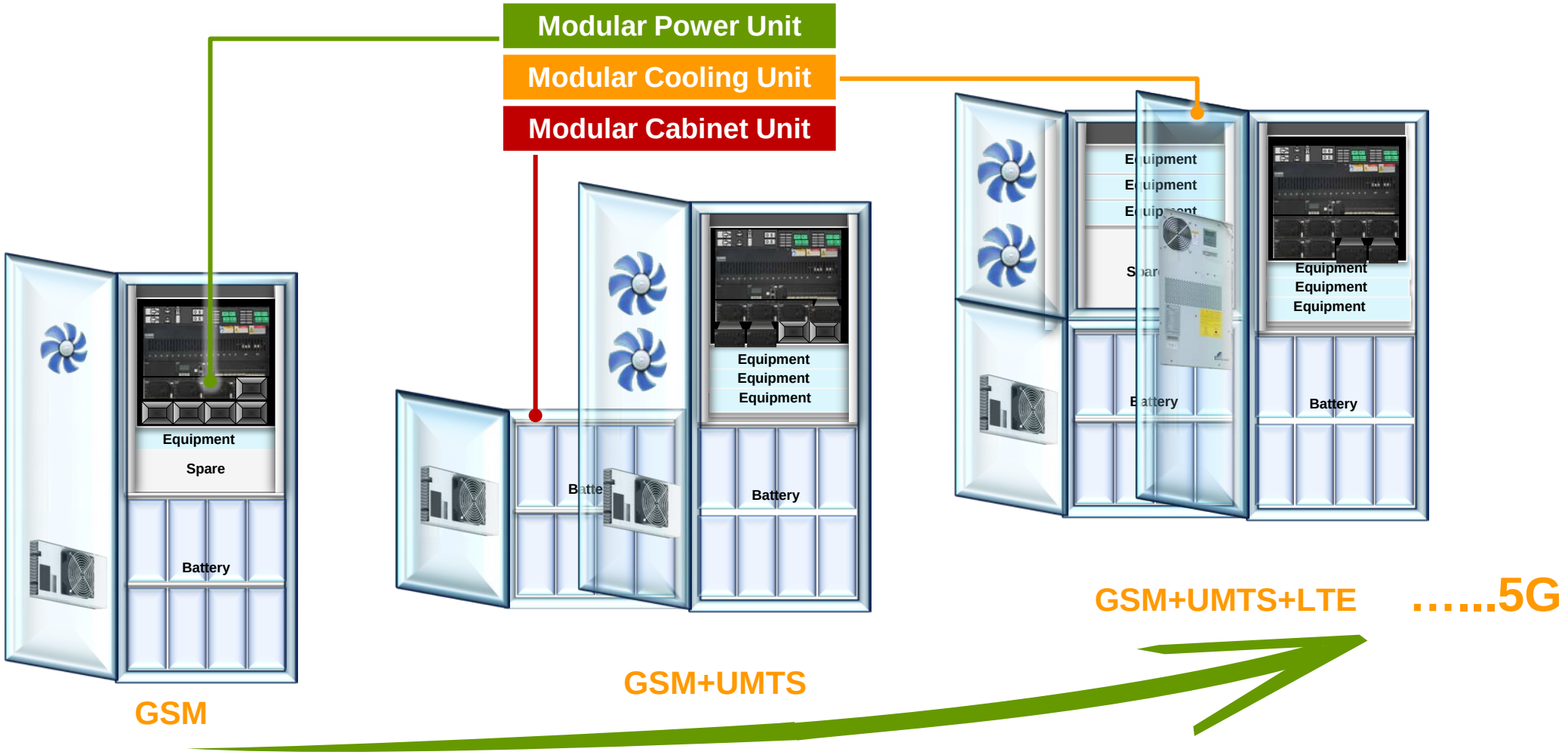
Series MTS outdoor solutions fit for various scenarios!

MIMO, Easy Energy Acquisition



Multiple energy input, multiple mode output, energy available @ anytime & anywhere !

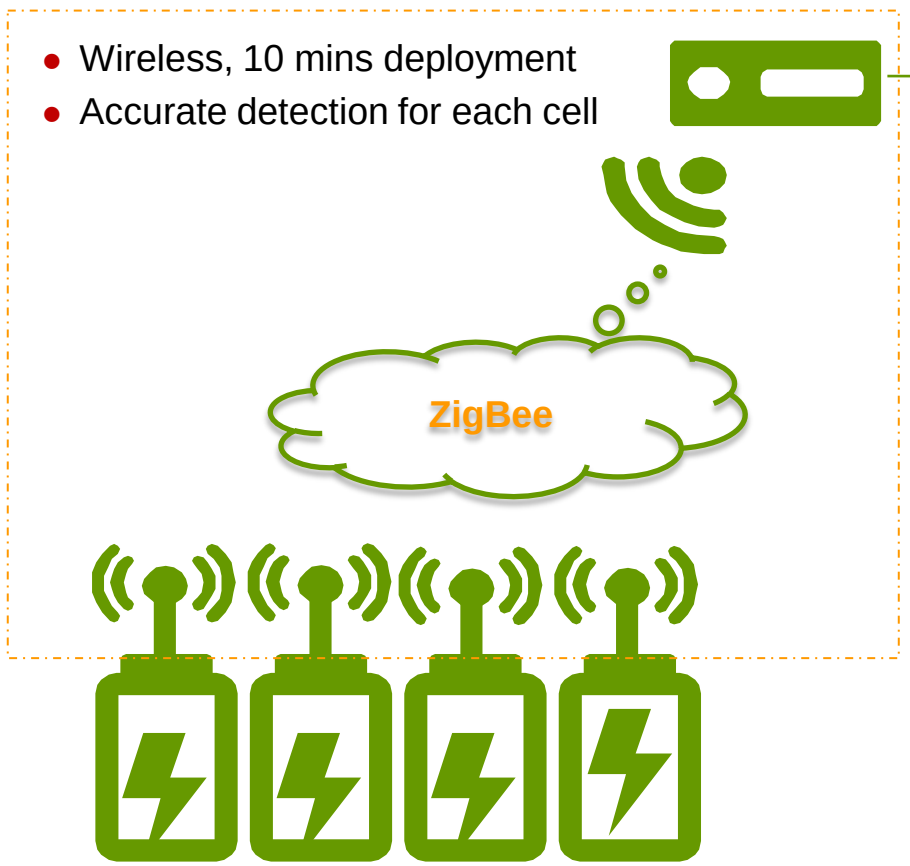
Modular Design, Smooth Expansion & Evolution

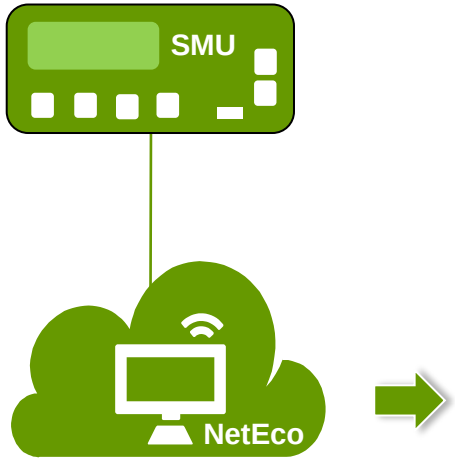


IBMS, Accurate SOH and SOC Management

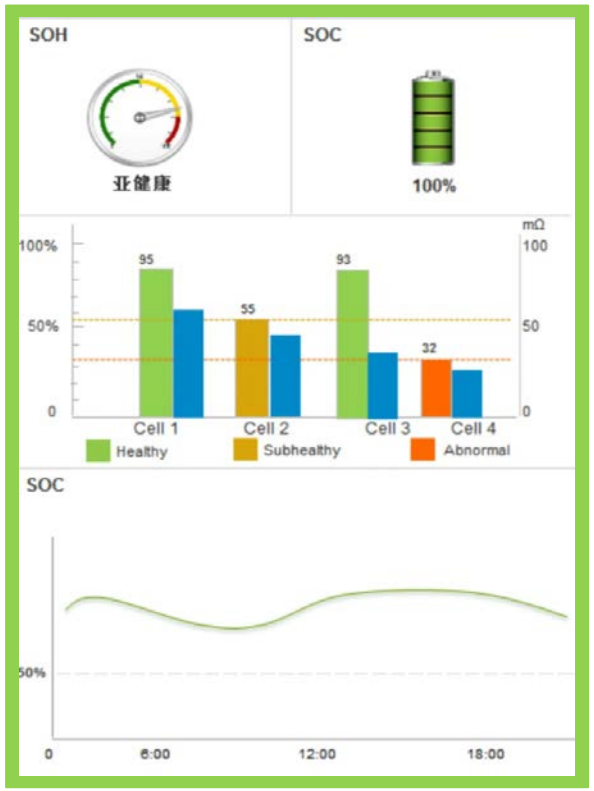
IBMS detect the battery operation status timely

- Wireless, 10 mins deployment
- Accurate detection for each cell





SOH diagnosis and capacity prediction for battery

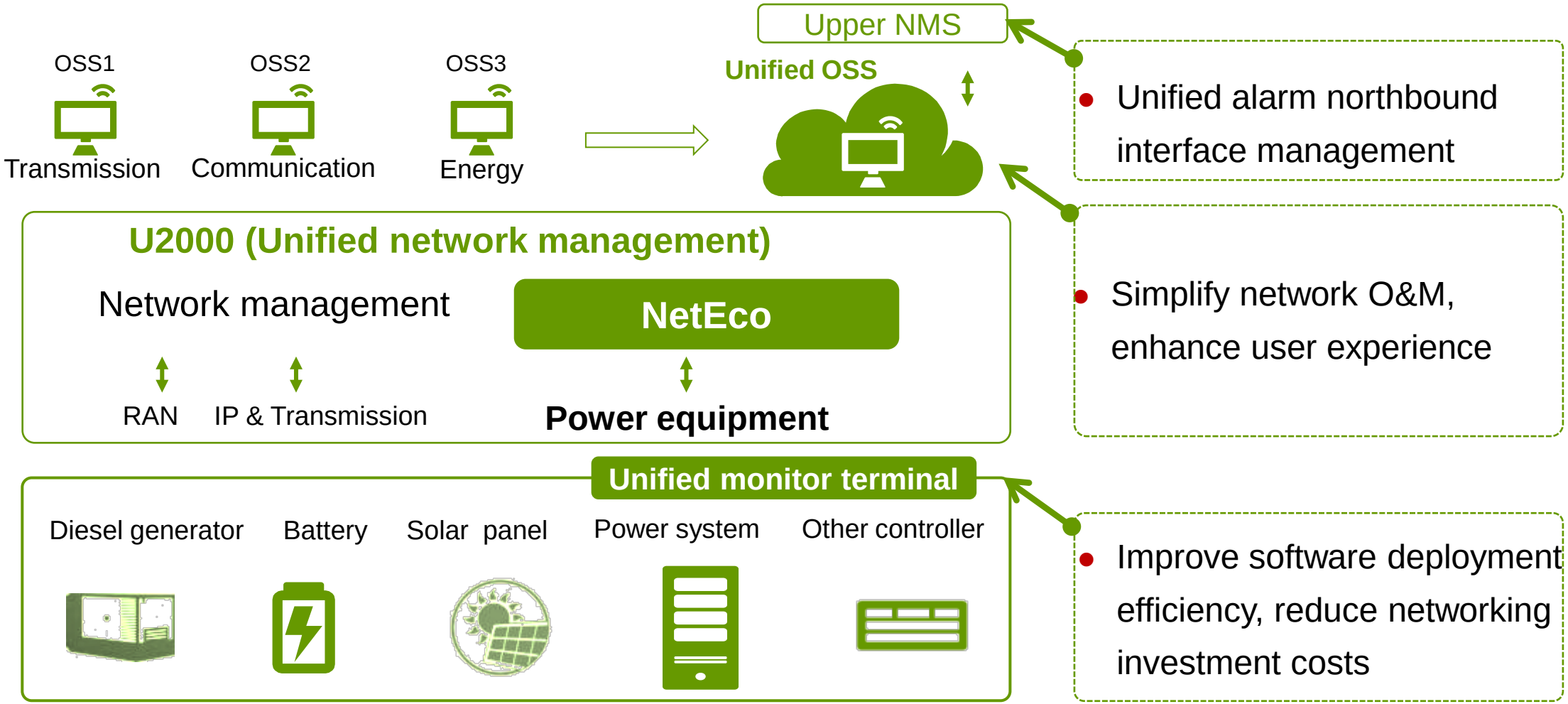


Benefits:

- R reduce **60%+** investment by replace weak battery timely
- Reduce **20%+** battery fault outage by remaining power detection

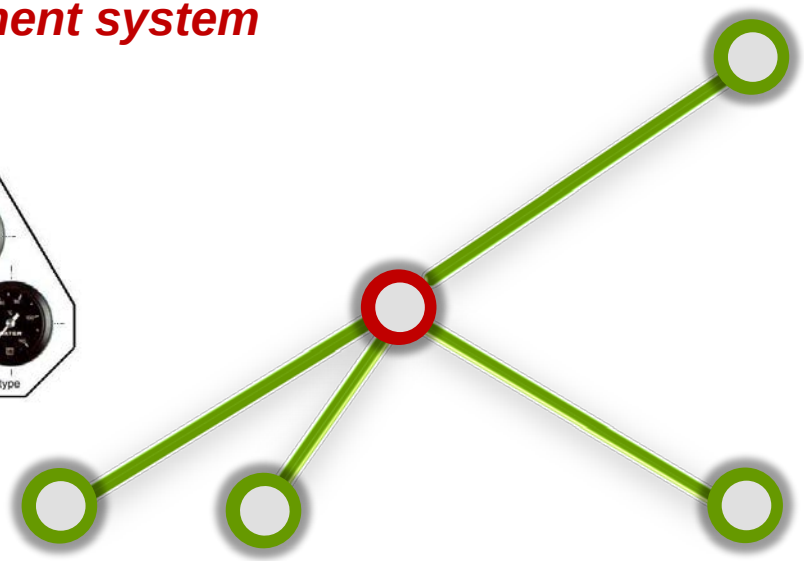
Note: IBMS=Intelligent battery management system

Unified OSS, Simplify Management



Visibility: Dash Board of Network Energy + Remote Control

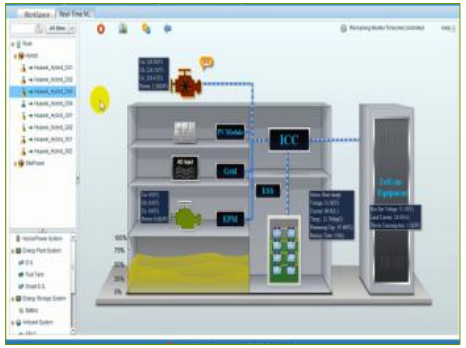
Network Energy Visibility & Insights
With NetEco Management system



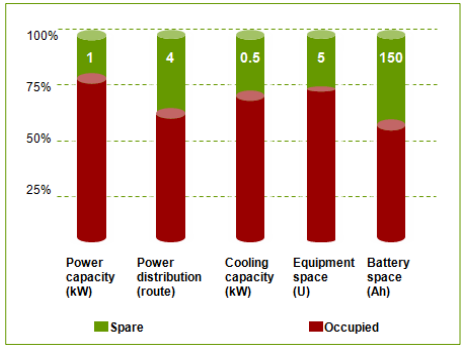
SOH (Battery, D.G., etc)

Notes: SOH, state of health

Real time status



Assets resource

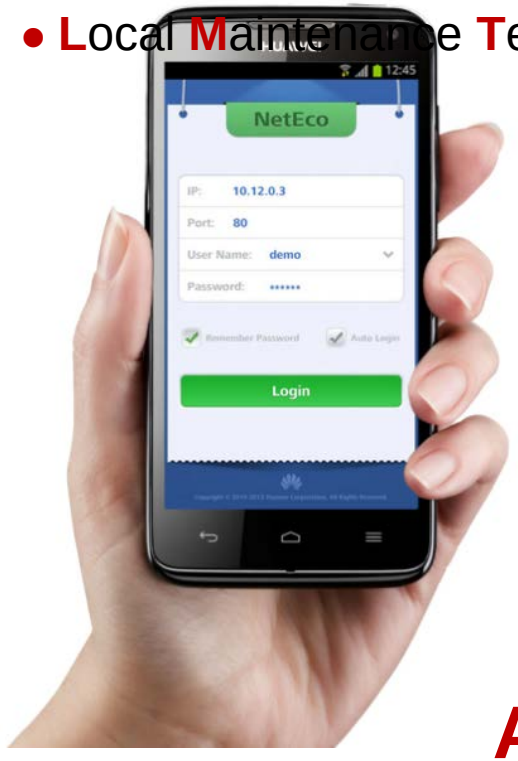


KPI report

Mobile APP Management, Anytime & Anywhere

Network Energy Management Expert in handset

- **OSS in hands** (at home, in office, on road)
- **L**ocal **M**aintenance **T**erminal (on site)



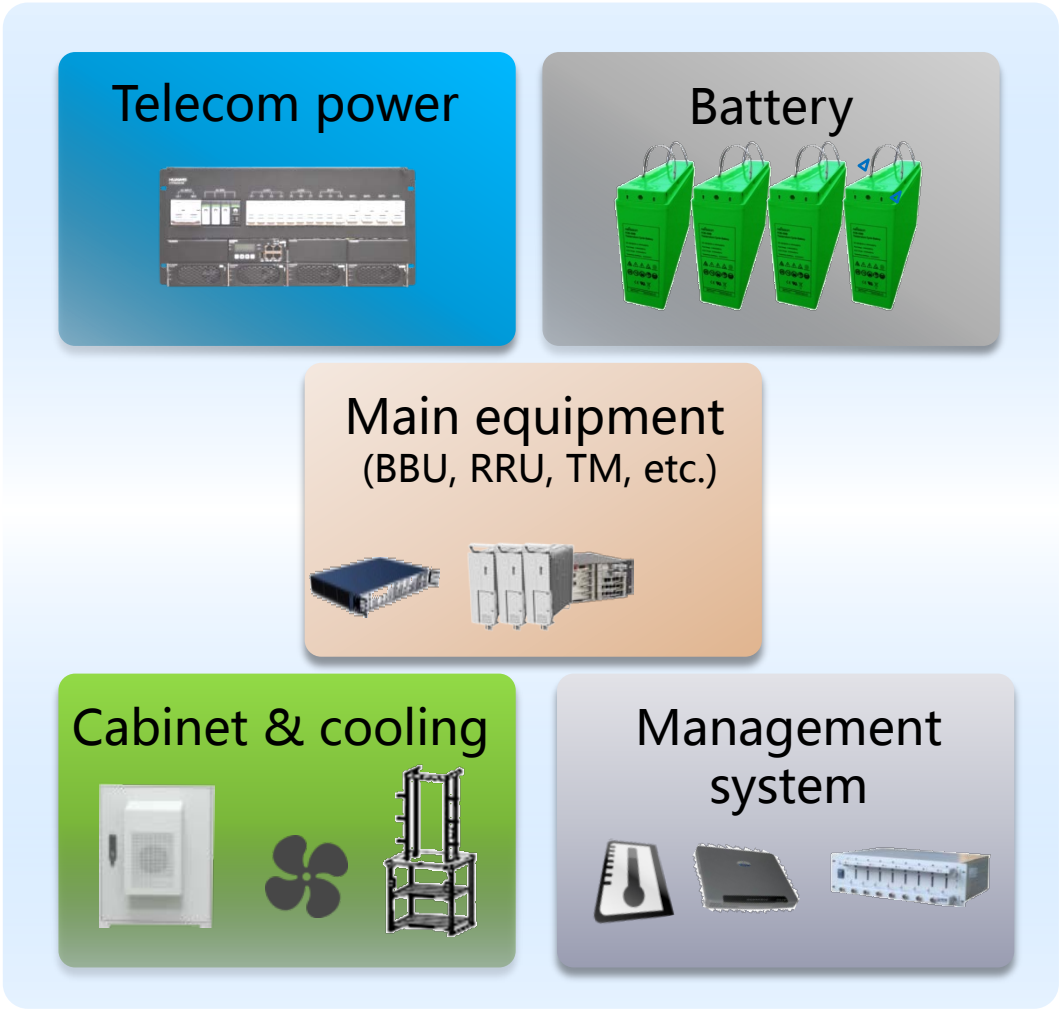
E-lock

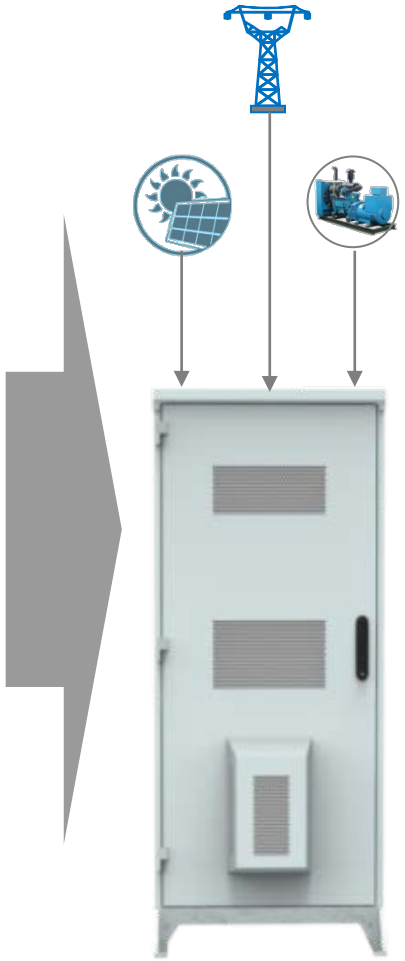
Battery management

……

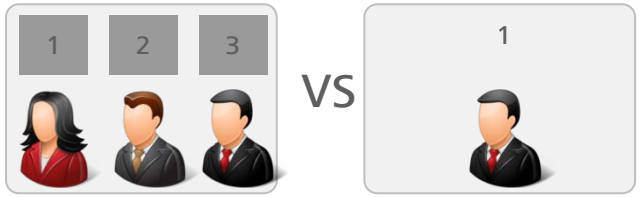
APP make the management simple!

MTS Integrated Design

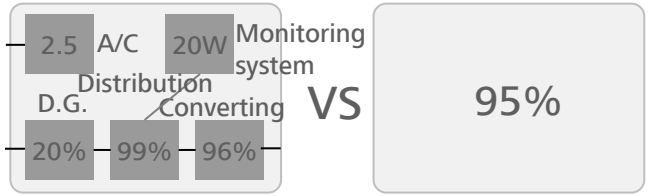




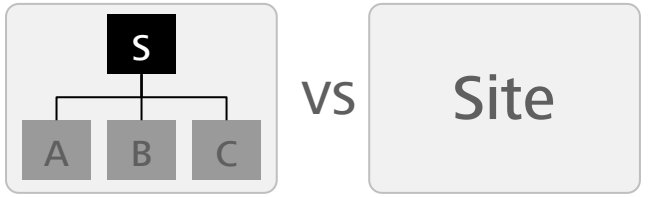
Single source design



Optimized E2E efficiency



Unified management

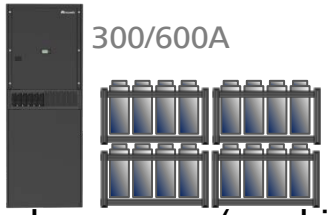


Energy-Friendly MTS Telecom Energy Solutions

Indoor site


1,200/2,000A

Large capacity power (combined)


300/600A

Indoor power (combined)


1

2,000/3,000A
Max: 24,000A

Large capacity power (distributed)


2

200/400/600A
0~32U equipment space
3~4 battery strings space

Indoor power (integrated)

Outdoor site


5

<3.5kW

Diesel hybrid


6

<3.5kW

Grid hybrid


7

<1.5kW

Solar hybrid


3

120/200/400A
0~2 battery strings
Main equipment space available

Outdoor power

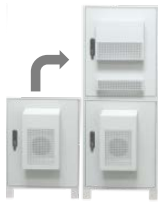

4

30/60A
20/40AH battery
Lithium battery compatible

Wall mounted power

Core | **Convergence** | **Access** | **End Node**

Deployment-Friendly MTS Telecom Energy Solutions



Stackable

- 200A outdoor power/battery cabinet
- Small volume, easy shipment
- Easy and fast expansion

Large housing capacity

- 1.4/2.0/2.3 sandwich panel cabinet
- 850~3,000W cooling for equipment
- 2 persons × 400 minutes disassemble and assemble

Salt corrosion proof

- 200/400A sandwich panel aluminum cabinet
- Large capacity, strong corrosion proof, stainless
- Can be used near the seashore

"0" footprint

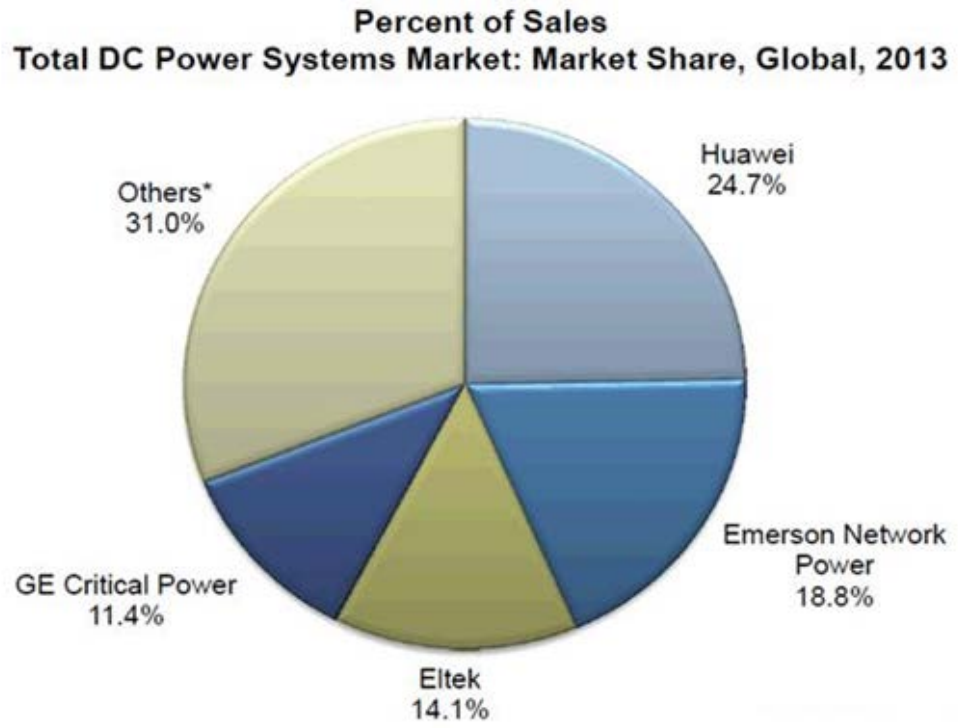
- 120/200A integrated power system
- Small volume, large housing capacity
- Wall or pole mounted

High integration

- 200/400A power system
- Street or roof standing, one site one cabinet
- Seamless expansion with additional battery cabinet

Global Recognition, Market Share No.1, Product Leadership

24.7% 2013 Global DC Power Market Share No.1



HE Large Capacity Power
The Industry's First Successf ully Application Award
People's post and Telecom munications

Mini-shelter
Green Technology Award
CommunicAsia

Solar hybrid
Global Power System Renovation Award
VDF

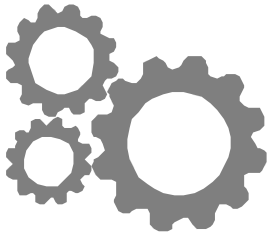
98% Efficiency Rectifier
Recommended Excellent Solution Award
CIC

Solar-Diesel hybrid
Green Mobile Award
GSMA

Integrated Site
The Best Site Design Award
Deutsche Telekom AG

Photo Caption: *Percentage of DC power systems global market share by vendor , Frost & Sullivan , 2014*

Data Center UPS: Digital, Intelligent, Connected



Availability Reliability

Tri-level reliability design , proactive precaution, ensuring business continuous

Efficiency

Intelligent management , networked synergy, making DC operation efficient

Easy OAM

Modular architecture, digital system, making DC easy to operate and scale

High Efficiency High Availability Modular UPS

Hot-swappable power module

Hot-swappable bypass module

Hot-swappable control unit

Efficiency **97%**

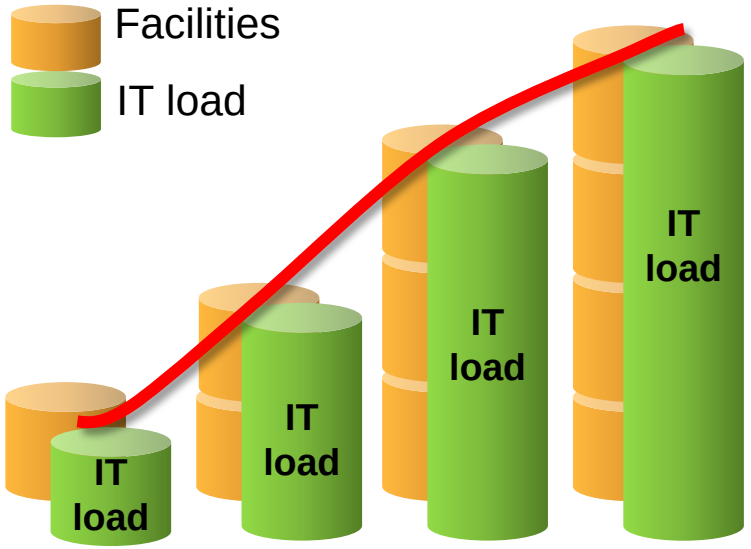
$$\text{Availability} = 1 - \frac{\text{MTTR} \downarrow}{\text{MTBF} \uparrow}$$

Full redundancy design improves MTBF

All Modular Design Improves Availability Efficiently

Modular structure, for both Availability and Scalability

Modular design, flexible expansion



Multi-level modularization, Capacity on demand

Modular components

DC module

Container DC

Initial invest ↓30%

Deployment time ↓50%

O&M staff ↓50%

Proactive Health Mgt，Active O&M，Reduce Failure Rate

Component health Mgt

Life prediction and failure pre-alarm

Fan(3-4 years)

Fan failure, equipment stop working because of high temp.

Capacitor(5-7 years)

China Telecom capacitor replacement costs is 30M RMB/year

Adopt the intelligent detection and prediction algorithm, realize failure pre-alarm, life evaluation, health Mgt.

Device health Mgt

State real-time monitoring, failure pre-alarm

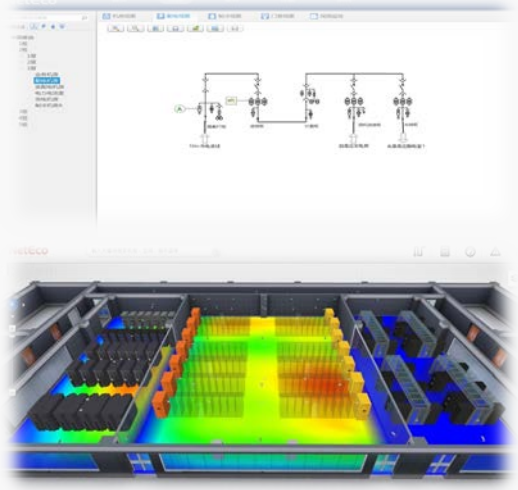
A/C pressure, flow real-time monitoring, evaluate device health

Battery(3-5years)
High replacement cost. Life is associated with the working environment

Key device health Mgt., Avoid device sudden stop to cause interruption of business

System health Mgt

Redundancy management and pre-alarm

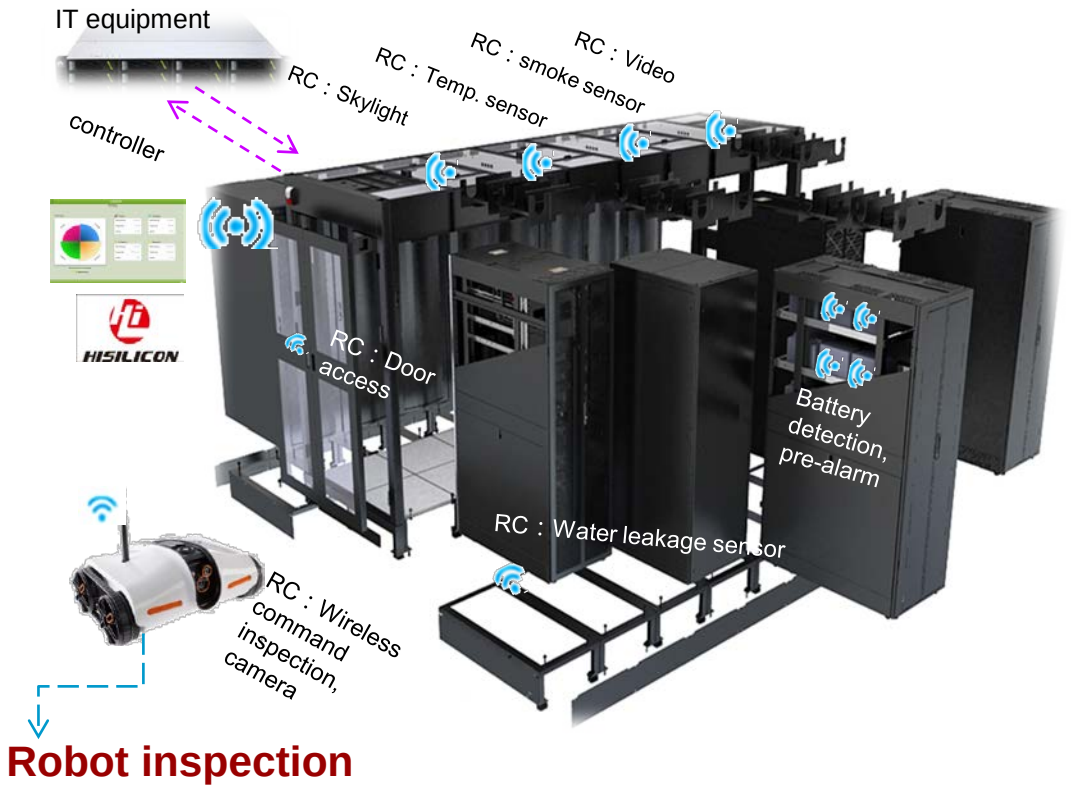


Detection and management of hot spot and the temperature rising point

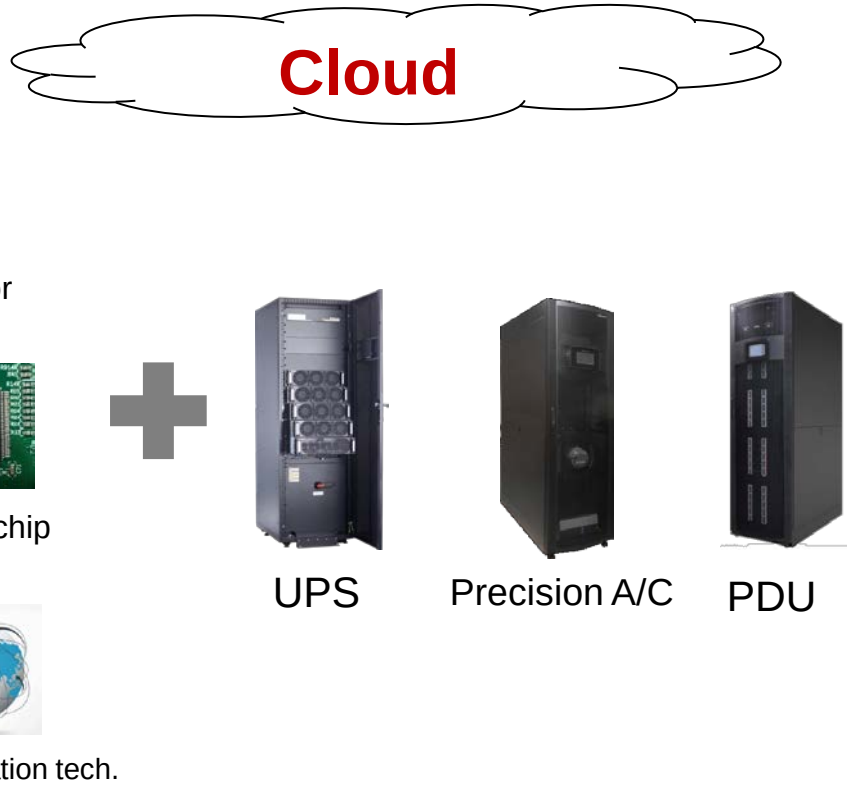
Cooling and power supply redundancy shortage warning

Connected DC, Easy O&M

Comprehensive DC monitoring



Sensor, Intelligence, and Communication technologies inside DC components



Thank you

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