Microgrids

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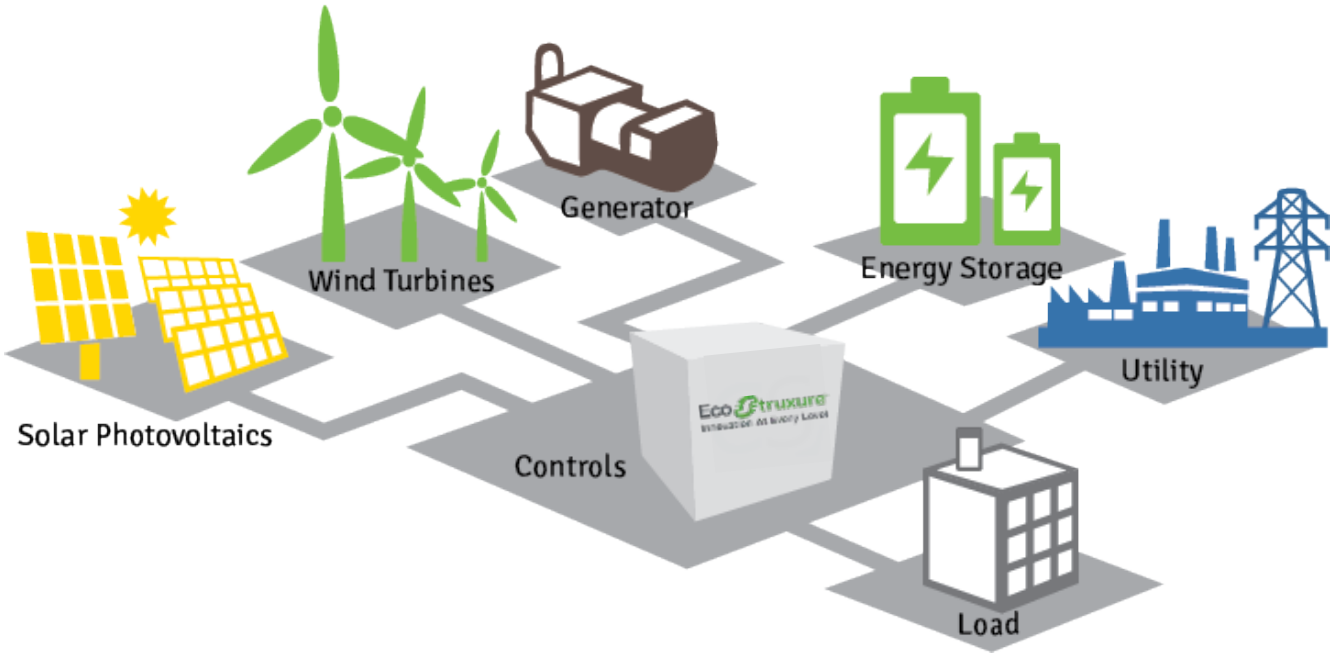
Agenda – 27 November 2018

1	Overview
2	Drivers
3	Potential Applications
4	Impact of Digitisation
5	Case Study
6	Questions

Overview

What is a Microgrid?

An integrated energy system consisting of interconnected loads and distributed energy resources…



…which as an integrated system can be controlled as a single entity and operate in parallel with the grid or in an intentional *islanded* mode.

Types of Microgrids

On-site renewables, energy storage and power generation facilities utilized in parallel with grid

Grid-tied

Microgrid will generate energy from local sources in the case of a grid outage OR other external event which makes local energy more desirable

Island-mode

Microgrid will generate energy from local source

Off-grid

Drivers

Energy Transition – Global Electricity Demand

40% increase by 2030 – IEA

18% population growth by 2030 – 7.1b

Global urbanization

Access to energy for developing countries

Increasing electrical appliances

Increased electrical usage –cars/heating

Energy Transition – CO2 Emissions & Fossil Fuel Reduction

CO2 emissions from electricity generation account for 45% of world energy related emissions

Depends on quantity of electricity produced and mix of generation

Quantity – expected to increase as related to demand

Mix – move to cleaner sources

Energy Transition – Resiliency

Developed countries

Aging power grid/infrastructure

Little resilience for disruption/instability

Power outages >1h increasing

US blackouts -$100b p.a. – 68% - 73% weather related disruptions

Energy Transition – Access to Energy

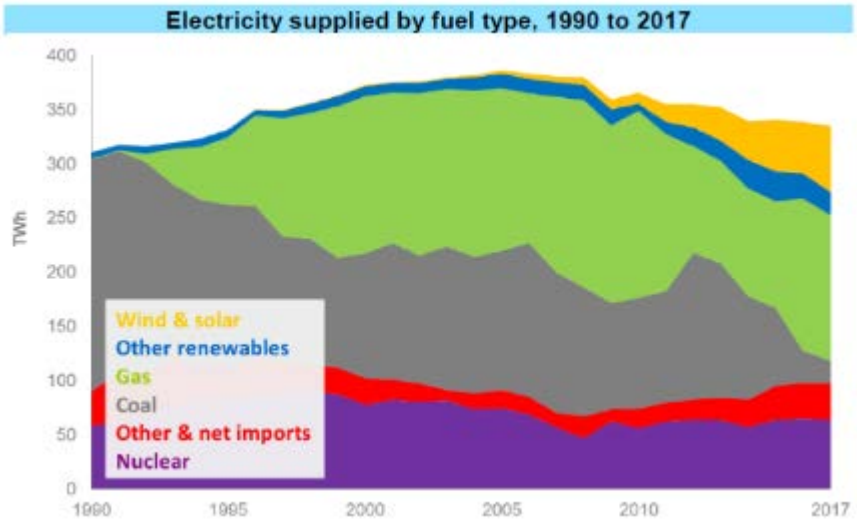
17% global population do not have access to electricity (2013)

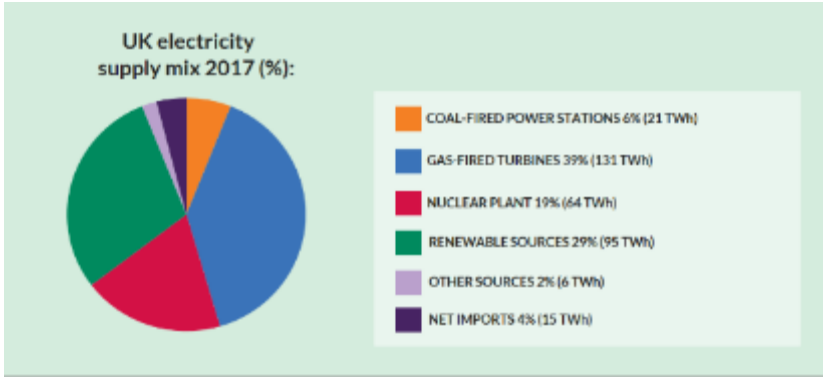
Unreliable/poor supply

95% sub-Saharan Africa and developing Asian countries – rural areas

UN Millennium Development Goal – productive use of energy leading to improvement in living conditions

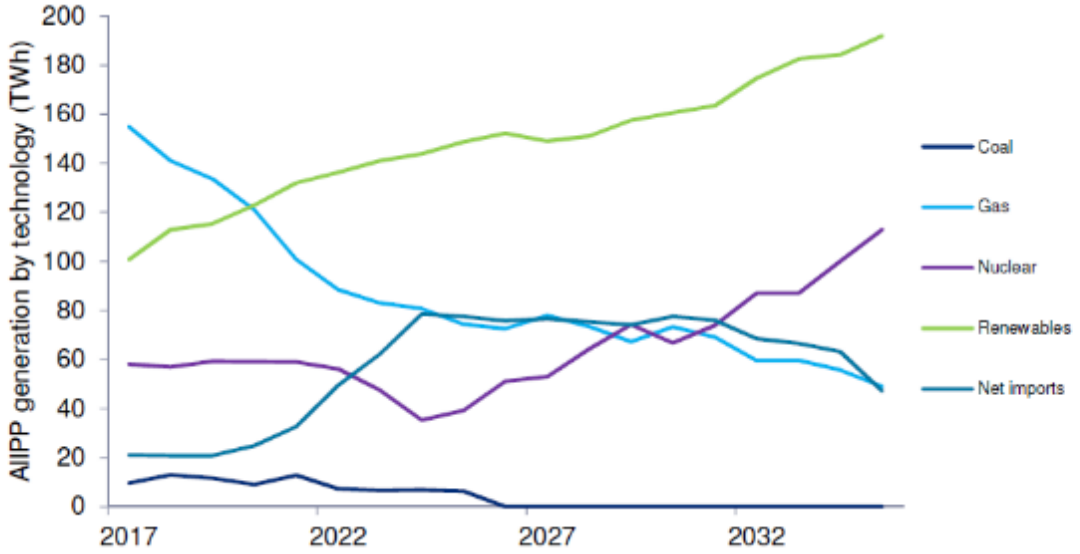
UK Energy 2017





Ref:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/728374/UK_Energy_in_Brief_2018.pdf
https://www.ofgem.gov.uk/publications-and-updates/infographic-promoting-sustainable-energy-future

Projected UK Energy Mix



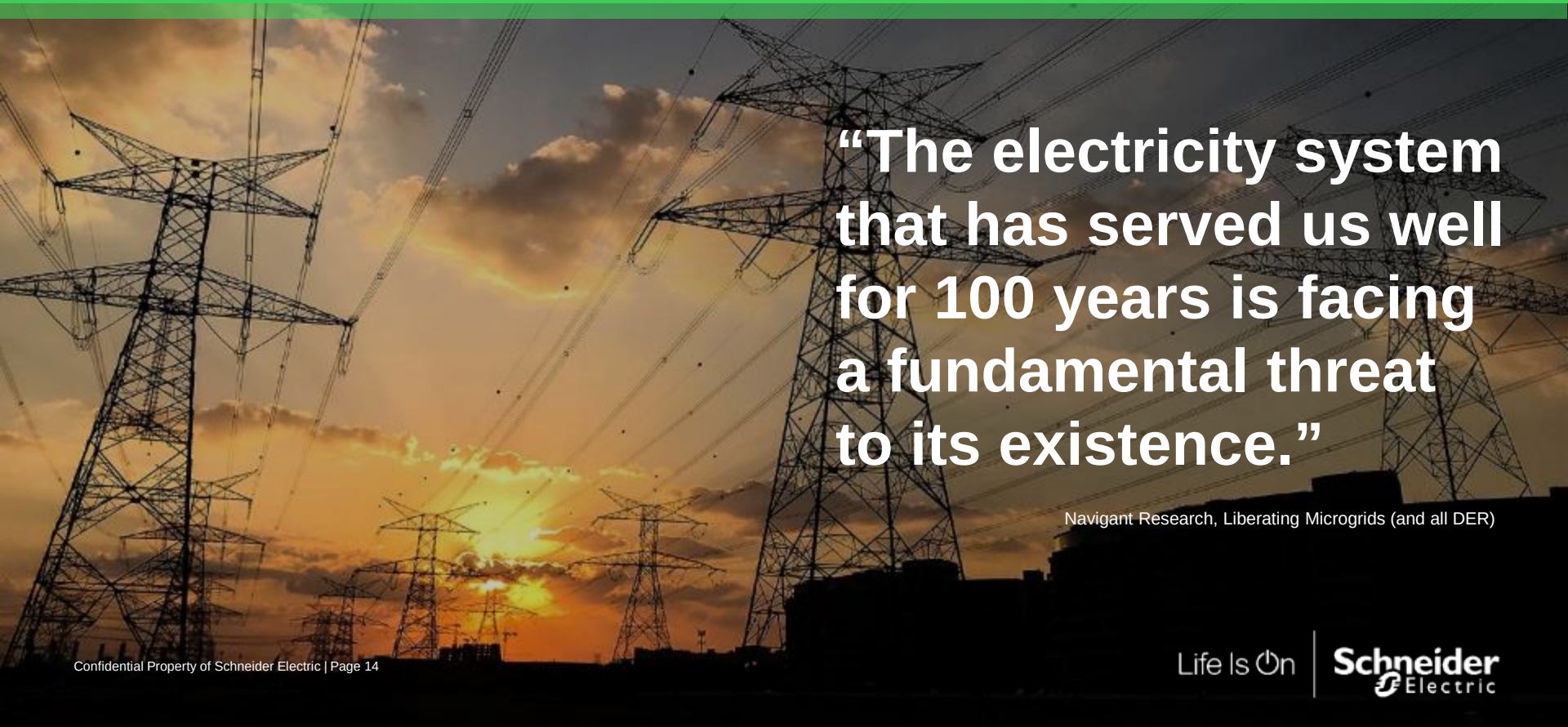
Ref: Updated Energy and Emissions projections 2017, BEIS, January 2018

Declining cost of Renewables and Storage

solar cost has decreased by 80% in the past 7 years

Solar and Storage costs are diving as we speak – both dropping by a factor of 5 in the past 4-5 years.

On the brink of disruption



“The electricity system that has served us well for 100 years is facing a fundamental threat to its existence.”

Navigant Research, Liberating Microgrids (and all DER)

Changing Landscape

2017

Saturday 25 March - The transmissions system demand in Great Britain was for the first time ever lower during the afternoon than it was overnight due to high solar PV generation.

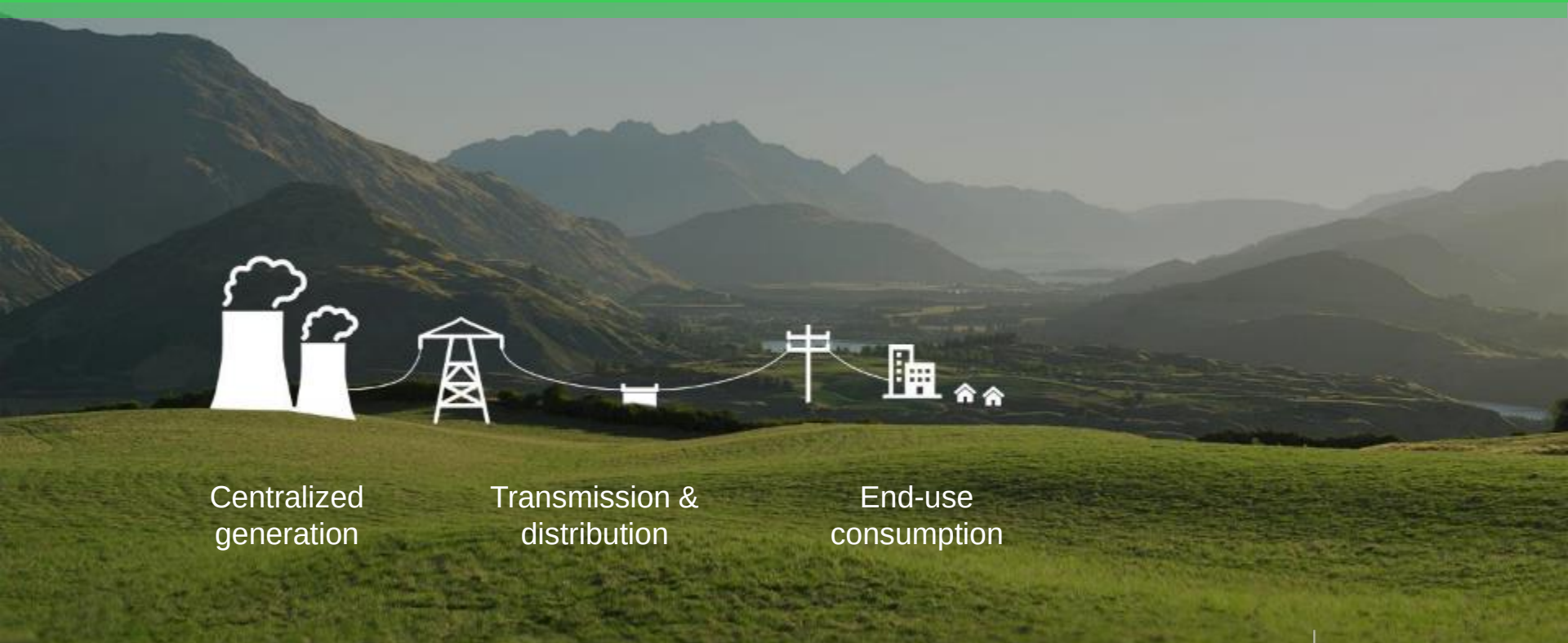
Friday 21 April - Britain went a full day without using coal power for the first time since the industrial revolution.

48% electricity generated from fossil fuel – 75% in 2010

Q2 2018

Renewable energy generation - 31.7% total generation capacity.

From simple and linear



Added distributed energy resources

To increasingly complex and multidirectional

Centralized generation

Transmission & distribution

End-use consumption

Distributed energy resources

Potential Applications

Different applications, customers, geographies and market dynamics

Working around the same value proposition to different market categories

Prosumers

- Commercial buildings
- Research/business campus
- Hospital
- Data Centre

- Minimize energy bills
- Higher integration of renewable energy
- Greater resiliency

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Different applications, customers, geographies and market dynamics

Working around the same value proposition to different market categories

Smart Districts

- City campuses
- Eco districts
- Small municipalities
- Green villages

- Minimize energy bills
- Higher integration of renewable energy
- Greater resiliency

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Different applications, customers, geographies and market dynamics

Working around the same value proposition to different market categories

Remote Communities

- Islands
- Remote villages
- Communities

- High integration of renewable energy to minimize fuel dependency
- Minimizing environmental and energy costs
- Can benefit from microgrid optimization and management technologies

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Different applications, customers, geographies and market dynamics

Working around the same value proposition to different market categories

Remote Sites

- Military bases
- Mines
- Industrial sites
- Resorts
- Isolated buildings

- High reliability for energy
- Integration of low carbon renewable energy
- Optimisation of both cost and environmental benefit

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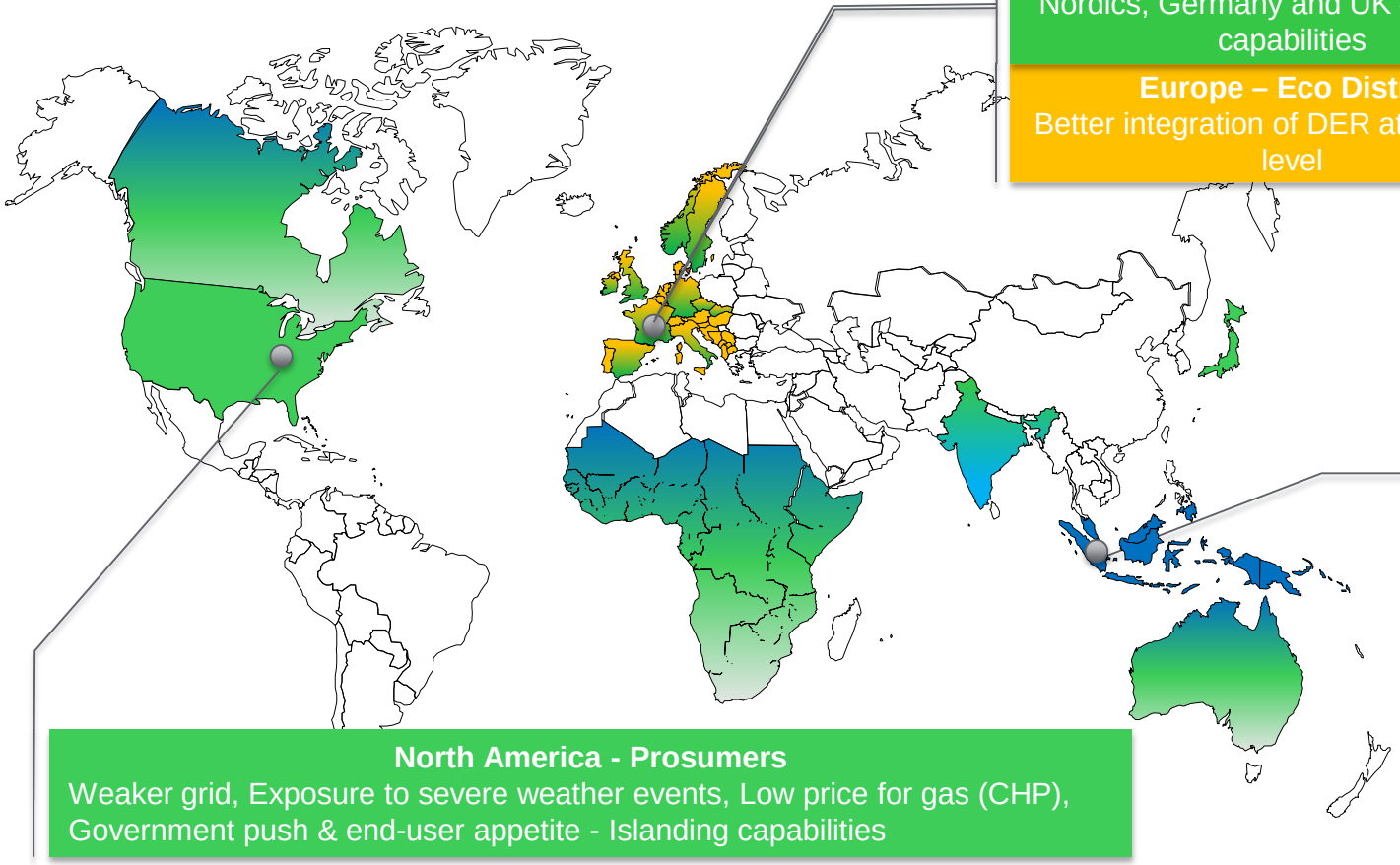
Geographical dynamics & priority

Europe – Prosumers
Strong grid, more and more DER to integrate, looking for new services
Nordics, Germany and UK – Islanding capabilities

Europe – Eco District
Better integration of DER at the district level



Asia & Pacific – Remote Microgrid
Access to Energy, Alternative to diesel generation, weak or no grid

North America - Prosumers
Weaker grid, Exposure to severe weather events, Low price for gas (CHP), Government push & end-user appetite - Islanding capabilities

Prosumers

Remote Microgrids

Eco District

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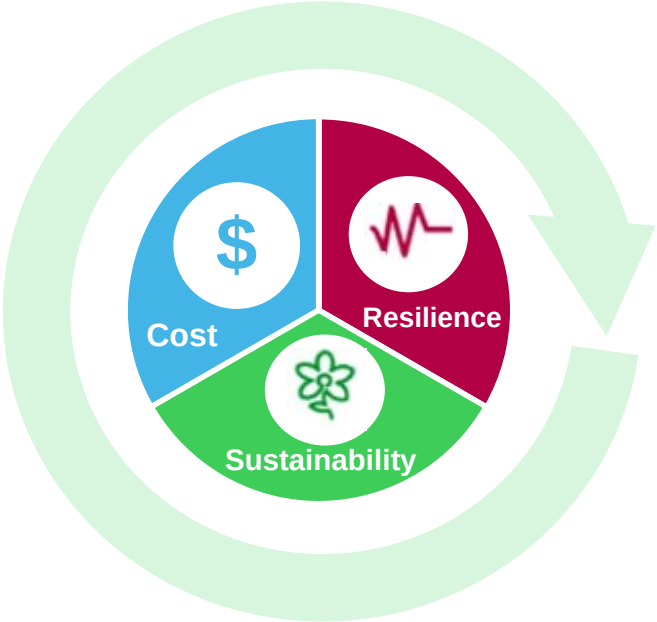
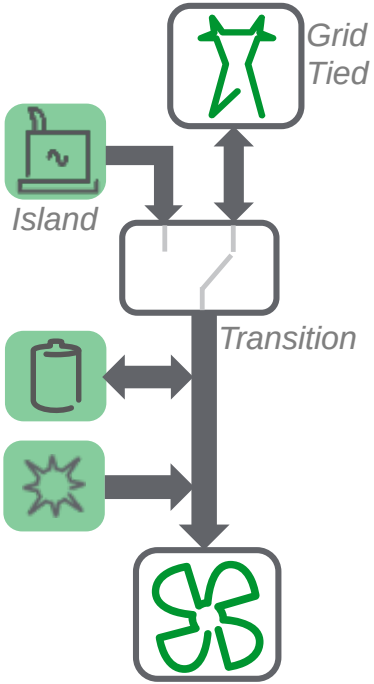
Microgrids “Treble Triplet”

“Its about making wise choices at the intersection between energy smartly acquired, locally produced and efficiently consumed!”

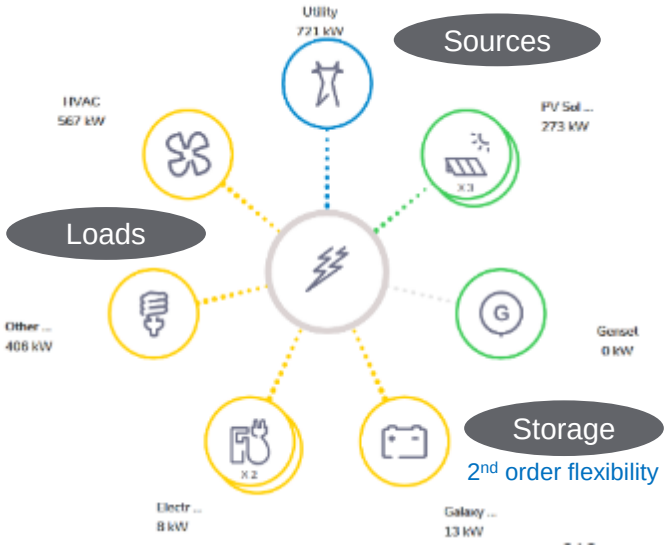
Prosumer Outcomes



Power System Architecture & Operating Modes



Energy Flexibilities & Optimization



2nd order flexibility

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Microgrid Advisor and Onsite Controls

>**Predictive** DER management
>Forecast when to **produce, store or sell energy**
>Data storage and **reporting**
>**Cloud-based Accessible** from anywhere
>Interfaces with energy markets
>Weather forecasts (DTN)

Cloud

EcoStruxure Microgrid Advisor

Client Constraints

Weather forecast

Energy market pricing

Demand response requests

EcoStruxure Microgrid Operation

Energy Control Center

>Reactive DER management
>Ensures microgrid real time stability & reliability
>Manage of connect/disconnect from the grid
>Optimize energy production & use

Edge / Client site

Microgrid Requirements

Cloud services

- Ancillary services
- Optimization Services

Supervision, HMI & Data Management

- Data Management
- Communication
- Remote and local Interfaces

Microgrid control

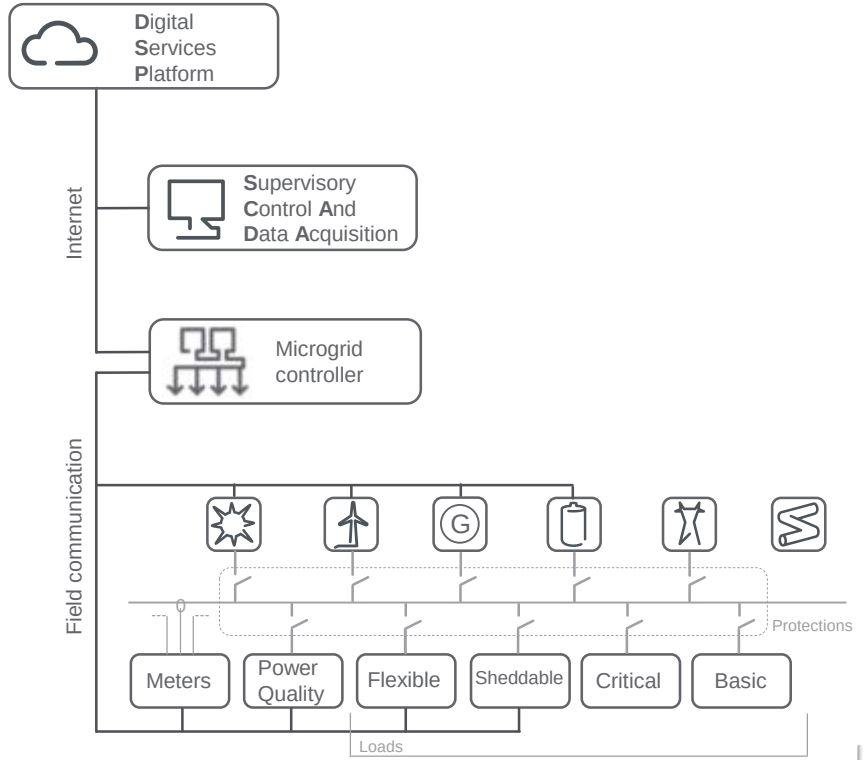
- Energy Management execution
- Power Management

Distributed Energy Resources

- Gensets, CHP, inverters for storage, PV or wind

Protections & Metering

- Protection schemes
- Loads flexibility management
- Power Quality & Metering



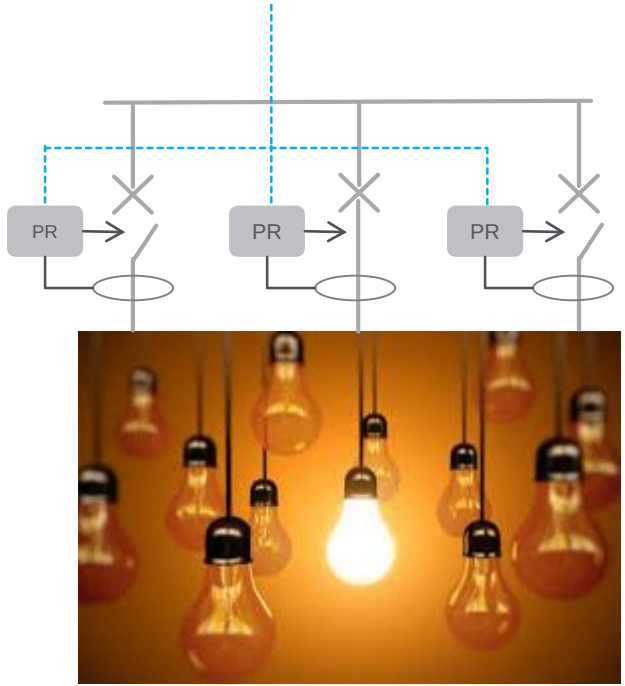
Sheddable loads

Load preservation system = load shedding

Microgrid Controller

In case of islanded mode from the utility, local generation is usually not sufficient to feed the total loads site.

- This is the purpose of the Load Preservation System (LPS) or Load shedding system to maintain the critical loads up and running.
- This functionality is implemented as part of the MicroGrid controller.
- Critical and non critical loads have to be determined
- Switches have to be replaced with circuit breaker for faster reaction to load preservation orders
- The LPS System usually only open breakers. Reclosure of breakers is usually a manual operation.



Engineering studies

Microgrid technical & economic sizing

- Bidirectional energy flow – protection relays for grid/island mode
- Local flexible loads sizing, power supplies, including renewable sources and storage according to the Microgrid power requirements
- Goal is to define the best configuration (Genset, PV, storage, biomass,etc) in order to minimise the LCOE (Levelized Cost of Electricity) – installed cost/lifetime energy generated
- Fault levels
- Harmonics – battery/PV inverters
- Switching speeds – battery UPS
- Protection and discrimination modelling
- Load shedding - critical and non critical loads have to be determined

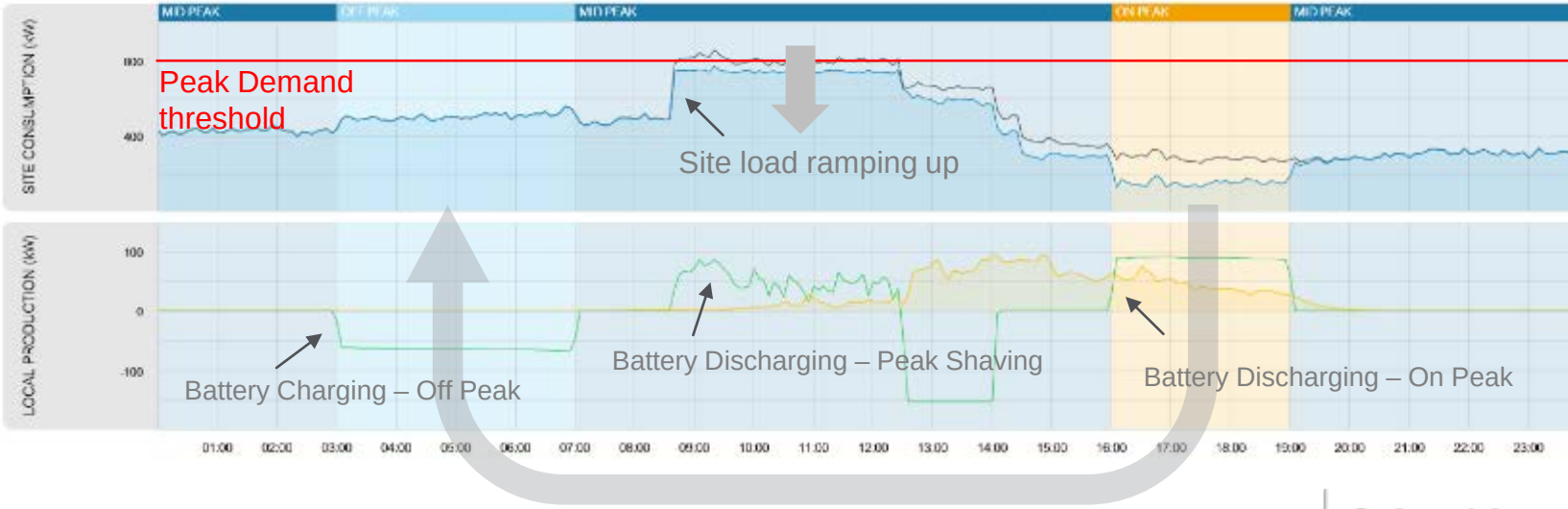
Forecasting and Optimisation

When to consume, produce, store, or sell energy

- Remote Monitoring of DER
- Tariff Management
- Demand Control
- Self Consumption
- Demand Response
- Island Mode

Example 1: Charge an energy storage system during “off peak” period and discharge during “on peak” period

Example 2: Discharge energy storage to avoid Peak Demand Charges



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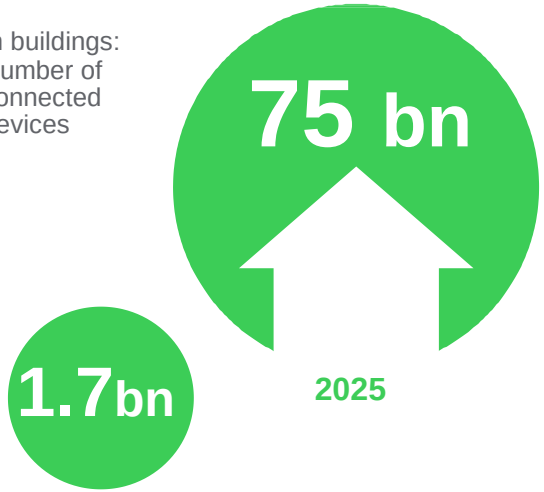
Digitisation

Accelerating the transformation

Digitization
of data

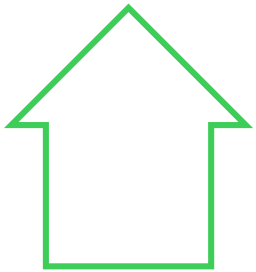
In buildings:
Number of connected devices



IHS "IoT Platforms: Enabling the Internet of Things", 2016

Decentralization
of assets

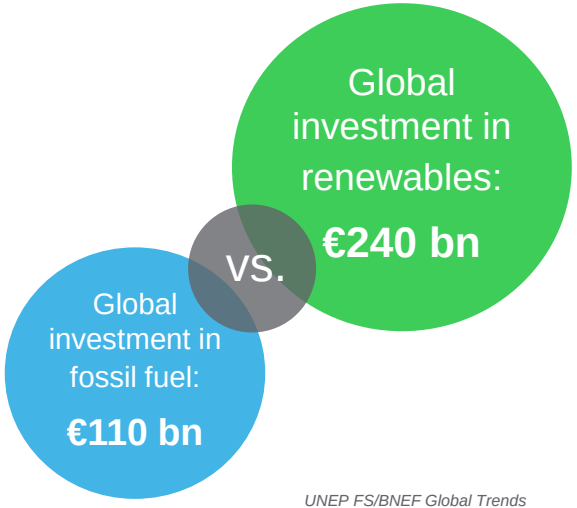
Corporate investment



Over **55%** of companies now have on-site generation

Bloomberg New Energy Finance

Decarbonization
of grid



UNEP FS/BNEF Global Trends in Renewable Energy Investment 2016

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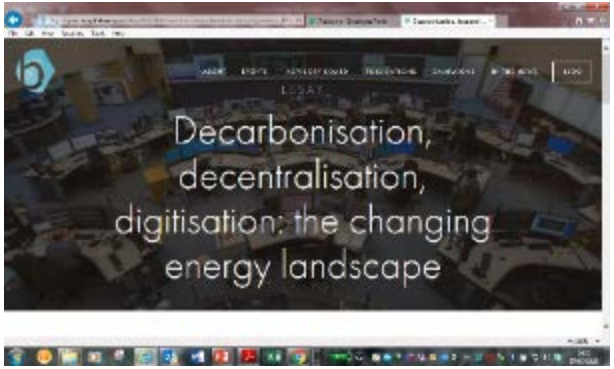
The 3Ds – A Common Theme



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Technology is the solution.

Technology Dimension

Biotech

Neurotech

Nanotech

\+

Human Factor

Decentralisation

Demographics.

Social connection

Democratisation

=

Computing Power.	-	Cheaper Faster more powerful.
Sensors.	-	Cheaper smaller more powerful.
Communications	-	5G Wireless – Fiber
Renewable Energy.	-	Clean, Cheap Energy
Energy Storage	-	Clean, Cheap reliable Energy
Robotics & Drones	-	Automation of physical work
Mixed Reality	-	Simulation, Modeling
Simulation	-	Digital Twin, Modeling
Blockchain	-	Speed & security of transaction,
3 D Printing	-	Fast, Flexble Manufacturing
Data – Insights.	-	Making the unknown known.

Case Study

Boston One Campus

Type: Schneider Electric NAM HQ, R&D center, islandable
Location: Boston, USA
Size: 1 MW
Completed: 2017

Customer pain point

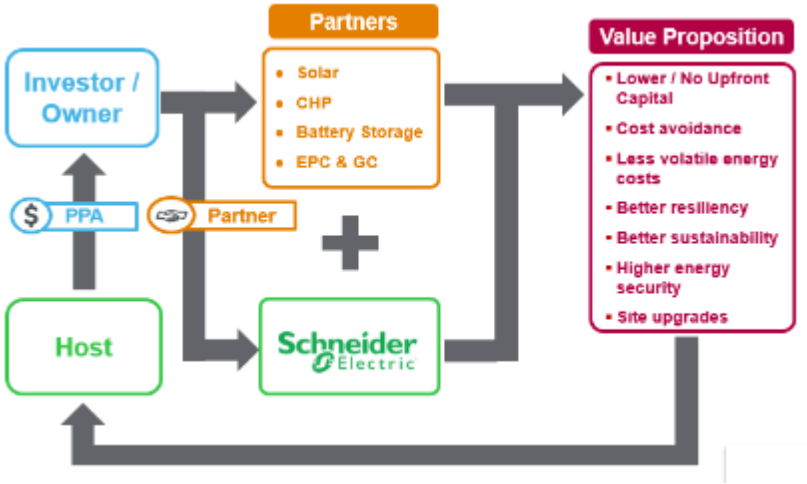
Energy reliability, renewable integration, willingness to demonstrate microgrid technologies, to develop and test them + creating new business model

Solution

Microgrid as a service business model with Duke energy, delivering advance microgrid solutions with no upfront cost

Scope

- EcoStruxure™ Microgrid Operation and EcoStruxure™ Microgrid Advisor provided by Schneider Electric
- DER: PV from REC solar, Energy Storage, EV charging Stations



Summary

Summary

Microgrid - A local, interconnected energy system within clearly defined electrical boundaries

- Incorporates loads and decentralized energy resources, including storage
- Multiple energy sources
- Grid connected or off grid mode
- A single entity with its own independent control in both modes
- Power range from several kW to multiple MW, voltage range up to MV