3RD INTERNATIONAL HYBRID POWER SYSTEMS WORKSHOP, MAY 9TH, 2018, TENERIFE, SPAIN

Microgrid for Commercial and Industrial (C&I) sites

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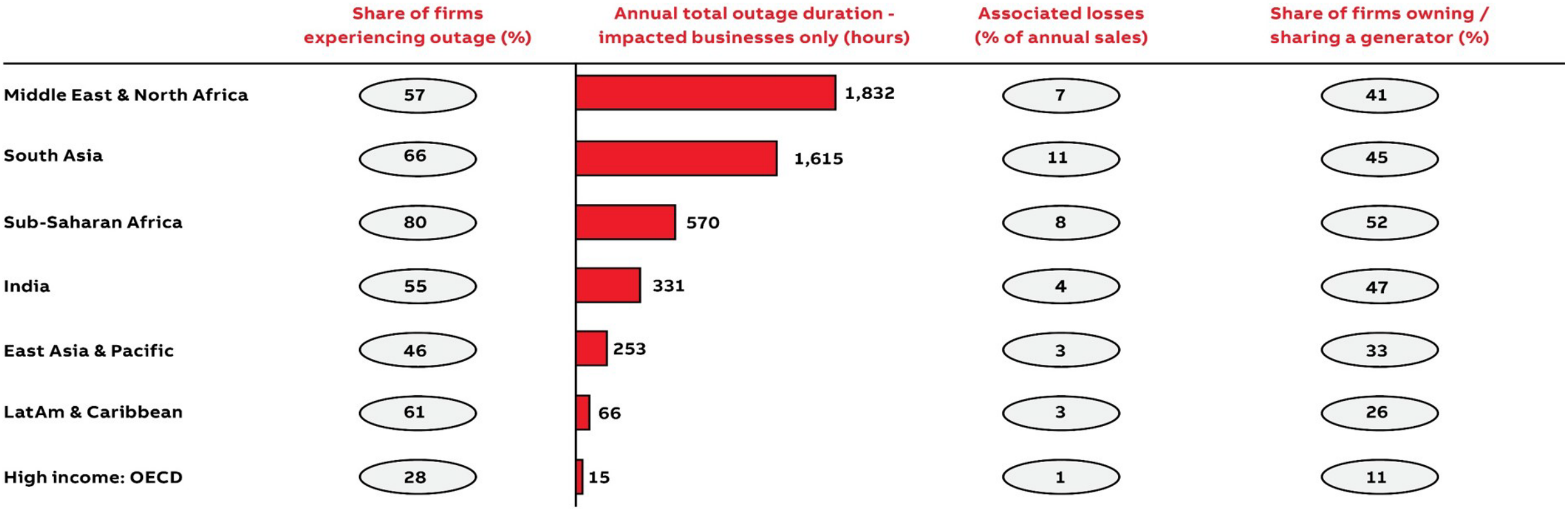
Agenda

- Overview of Commercial and Industrial sites
- How microgrids create value in C&I sites
- What ABB has to offer
- Microgrid for C&I business case
- Summary

Power Outage Issues for C&I plants

Outages, costs and generator ownership



Overview of business recorded power outages, associated costs, and backup generation

Source: Bloomberg/ World Bank (2010-2017)

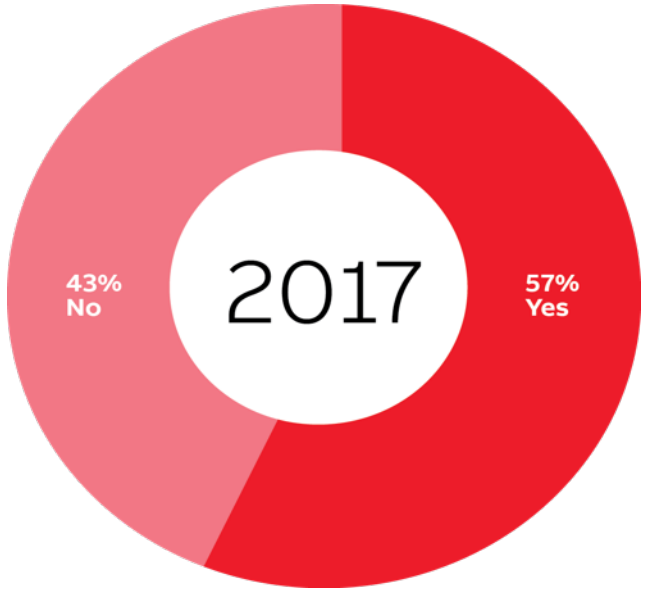
Businesses view on energy management

Reducing electricity cost and consumption

- Companies get more comfortable with **self-generating their electricity** supplies and procuring renewable energy from third parties
- 80 percent of businesses view **reducing electricity costs** as essential to staying competitive from an image perspective
- 84 percent of businesses view **reducing electricity consumption** as essential to staying competitive from a financial perspective

Businesses take control with renewables

Have on-site electricity generation



Source - Deloitte Resources 2017 Study - Energy management: Sustainability and progress

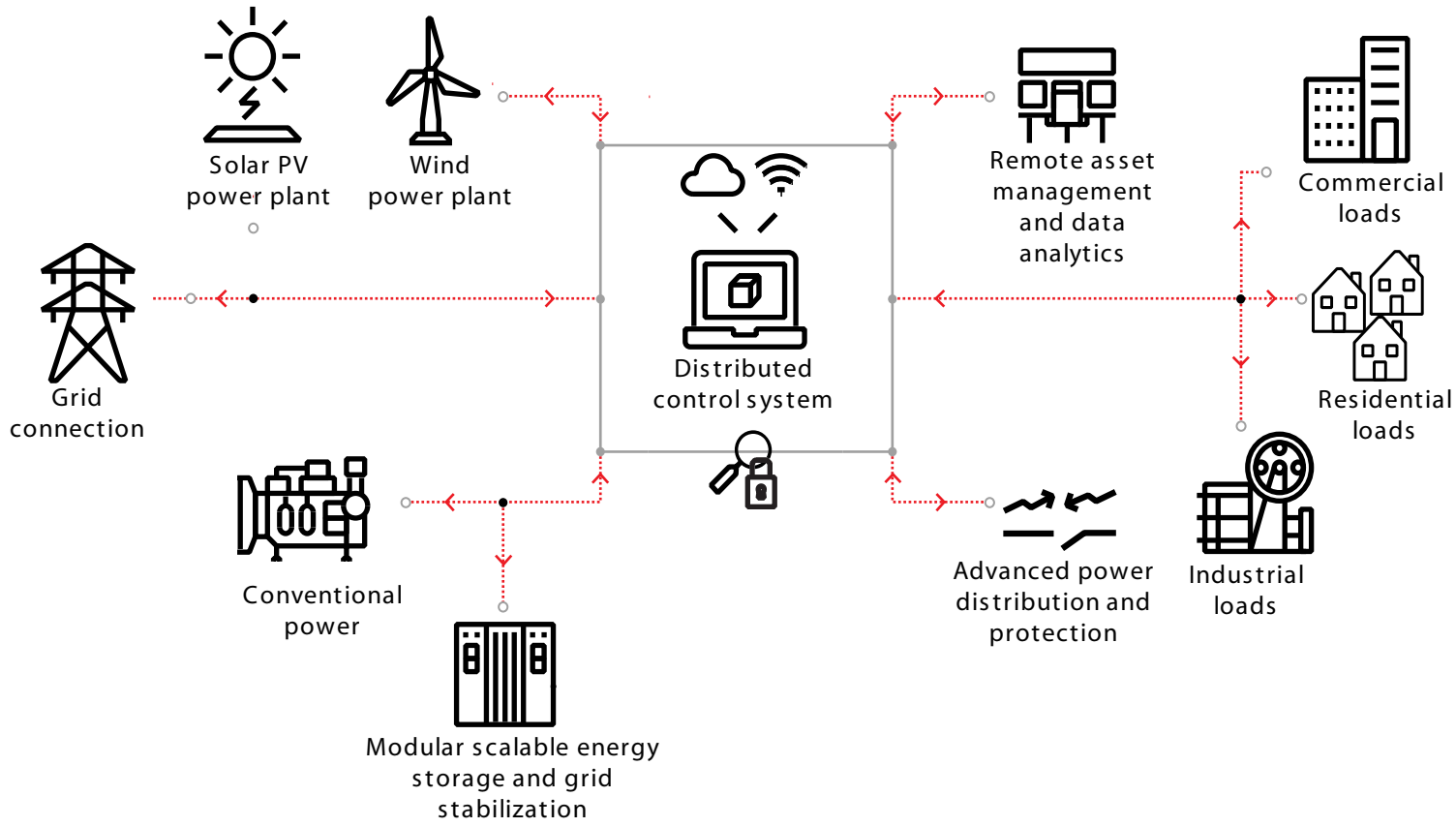
Microgrid

Generation at the point of consumption and always available

Microgrid definition

Distributed energy resources and loads that can be operated in a controlled, coordinated way either connected to the main power grid or in “islanded”* mode.

Microgrids are low or medium voltage grids without power transmission capabilities and are typically not geographically spread out.



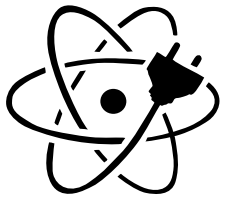
* Islanded mode: ability to provide power independently from the main power grid

What ABB has to offer

ABB - global microgrid solution partner

Leading global expertise

25+ 25+ years experience
40+ executed projects

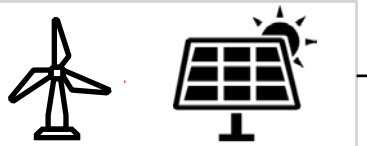


Innovation, technology & productization leadership

Global sales & service network

AND

Broad portfolio of products & services

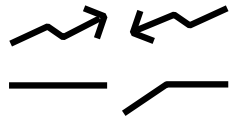


Renewable power

Conventional power

Microgrid control system

Energy storage and grid stabilization



Power distribution and protection

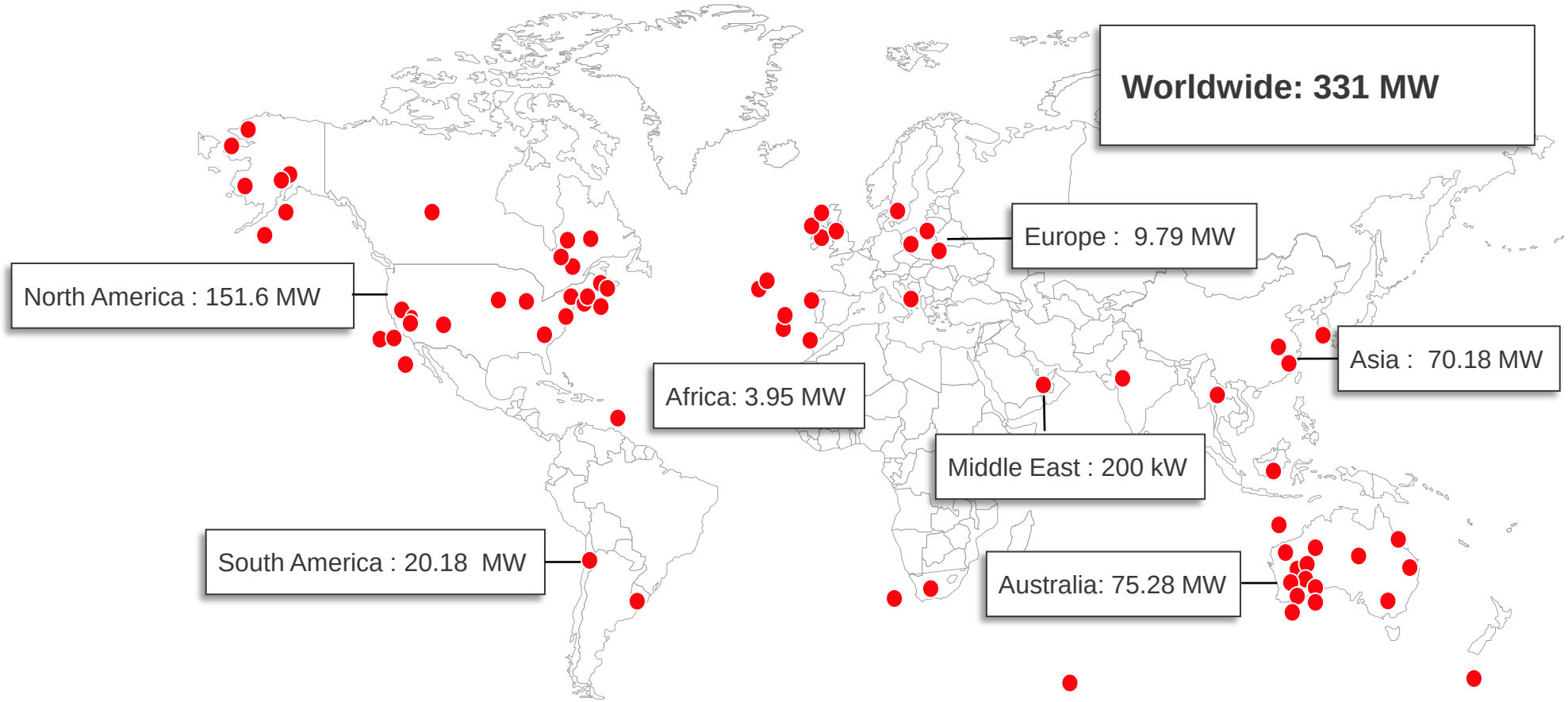
Consulting

Service

3rd party financing

Global installed base

Microgrids and BESS



Industrial and commercial sites

Longmeadow, PowerStore/ PV/ Diesel

About the Project

- **Project name:** Longmeadow
- **Location:** South Africa
- **Customer:** Longmeadow Business Estate
- **Completion date:** 2016

Solution

The resulting Microgrid system consists of:

- PowerStore Battery (1 MW/ 380 kWh)
- Microgrid Plus Control System
- Solar PV (1 x 750 kW_p)
- Diesel (2 x 600 kW)
- Remote Monitoring

Customer Benefits

- Stabilizing the grid for reliable and stable power supply
- Optimized renewable energy contribution to the facility
- Seamless transition from grid connection to islanding in case of an outage
- CO_2 reduction: over 1,000 tons/ year
- Up to 100% renewable energy penetration

LONGMEADOW Business Estate

Press Release
Infographic
Video
Data Sheet

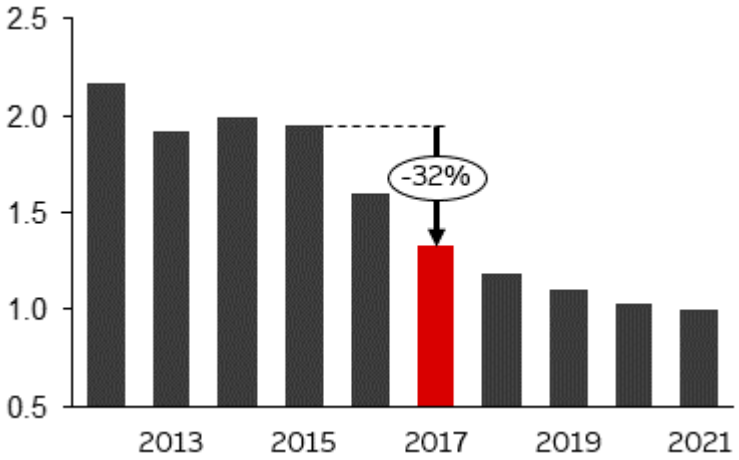
The microgrid solution is for the 96,000 sqm facility in Johannesburg that houses both ABB South Africa's headquarters, as well as a manufacturing facility employing close to 1,000 employees

ABB microgrids deliver ~30% fuel reduction

Future projects benefit from lower PV prices

Decreasing Solar PV costs to improve future business cases

Global Large Commercial PV system prices (1 to 5MW) USD/ Wp



- PV prices have reduced over 30% in past 2 years and continue to fall globally
- Commercial and utility scale systems reducing faster than household solar with the $1/ Wp already reached for utility scale[1]

ABB references already show ~30% fuel reduction possible with subsidies

Johannesburg, PowerStore/ PV/ Diesel

- **~30%** reduction in electricity bills and fossil fuel consumption

International Committee of the Red Cross (ICRC) Logistics Center, PowerStore/ PV/ Diesel

- Powering the largest logistics hub of the ICRC through a state-of-the-art microgrid, delivering reliable power for the first time in a region exposed to frequent outages and power quality issues

Source: IHS PV Demand Market Tracker - Q2 2017

[1] https://www.greentechmedia.com/articles/read/Sunshot-1-Per-Watt-Solar-Cost-Goal-Mission-Accomplished-Years-Ahead-of-S

Microgrid business case – C&I site connected to a weak grid

Various solar and storage scenarios tested using HOMER[1] optimization tool

Example: glass manufacturing in India

Power System

- 15 MW average load
- Critical load: 1 MW peak, 0.5 MW average
- 2 x 0.6 MW backup diesel generators
- Grid energy price: $0.15/ kWh

Outages

- 260 x 1hr power interruptions per year
- $800USD cost per outage

Business Case

- Delivered Fuel Cost: $1 USD/ l
- Solar installed cost: $1 USD/ Wp
- Average cost of capital: 11%
- Subsidies: none

Goal of the study

Determine when the Levelized Cost of Energy (LCOE) of 3 scenarios is lower than the diesel only base case

- Diesel & Storage
- Diesel & Solar PV
- Diesel & Solar PV & Storage

1 HOMER : http://www.homerenergy.com/, a simulation and optimization tool for energy systems

Power Outage Impacts on C&I Plants

Plant activities and operations have a big impact on outage costs

Power outage impacts

- Shutting off or malfunction of the machinery
- Damage to equipment and products
- Decrease in productivity

Modelled outage costs for C&I plant

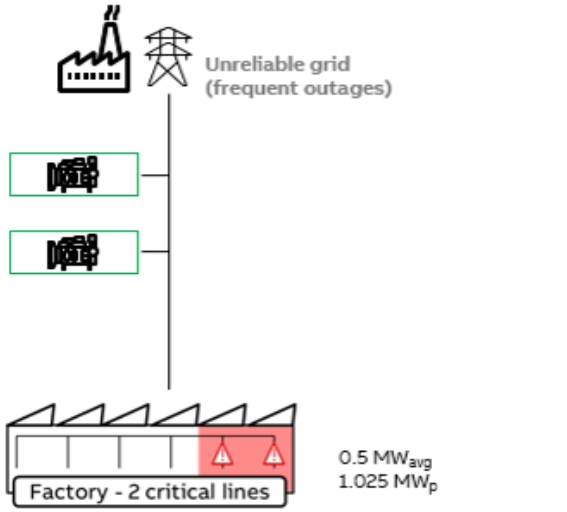
Hidden costs can add up for a manufacturer experiencing 260 outage events in a year

	Cost line item	Cost per event	Cost per year
Disrupted production line	Idle workers	$350	$91'000
	Lost product	$350	$91'000
	Lost efficiency	$100	$26'000
Annual total cost		$800	$208'000

Microgrid for C&I - Business Case

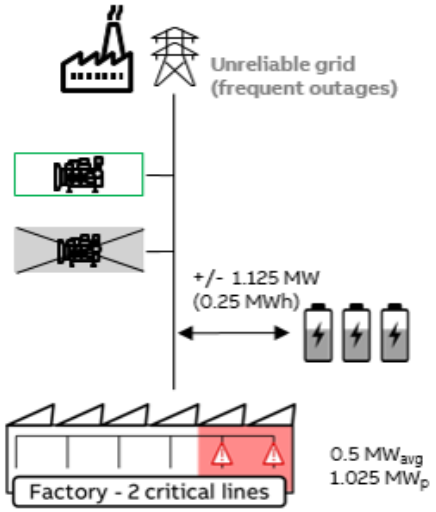
Incremental hybridization options analyzed

1. Base case – Diesel



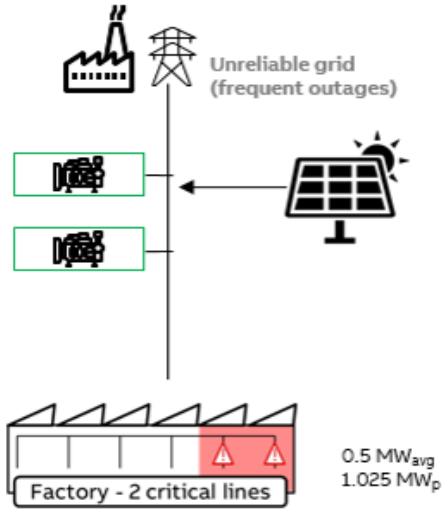
- 2 generator system (0.6 MW each), both required during power outage
- Generators kept off while grid-connected to save on fuel costs
- Facility undergoes outage every time the grid goes down

2. Diesel + BESS



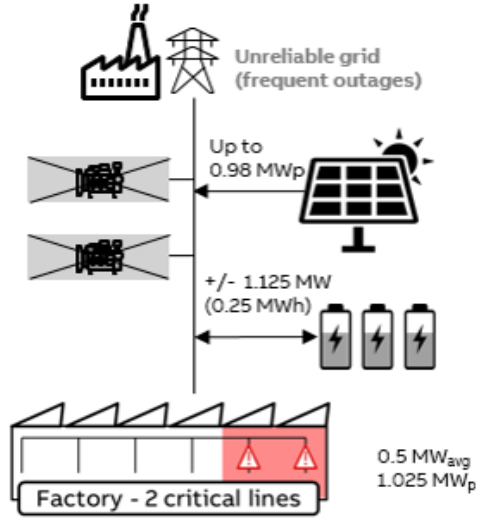
- BESS provides seamless transition to island state
- BESS provides required ramping and reduces need for generators
- BESS can delay or eliminate the need to start up a generator during short term outages

3. Diesel + Solar PV



- Requires generator spinning reserve equivalent to 75% of the maximum solar PV output to account for shading

4. Diesel + BESS + Solar PV

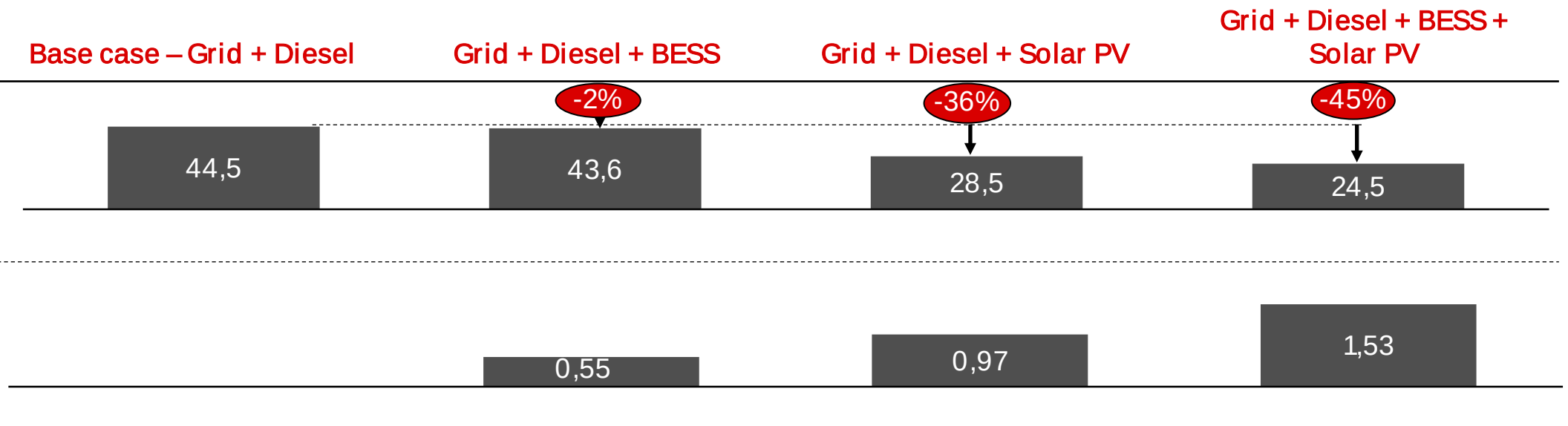


- All the benefits of Diesel + BESS case, as well as Diesel + Solar PV case
- BESS provides required ramping for solar and thus during daylight hours all generators can be shut down

Grid power | On-site generator | BESS | Solar PV | Critical lines | Demand covered by microgrid | Genset status | On | Off

Microgrid for C&I - Business Case

Up to 45% reduction in fuel possible when combining diesel with BESS and Solar PV

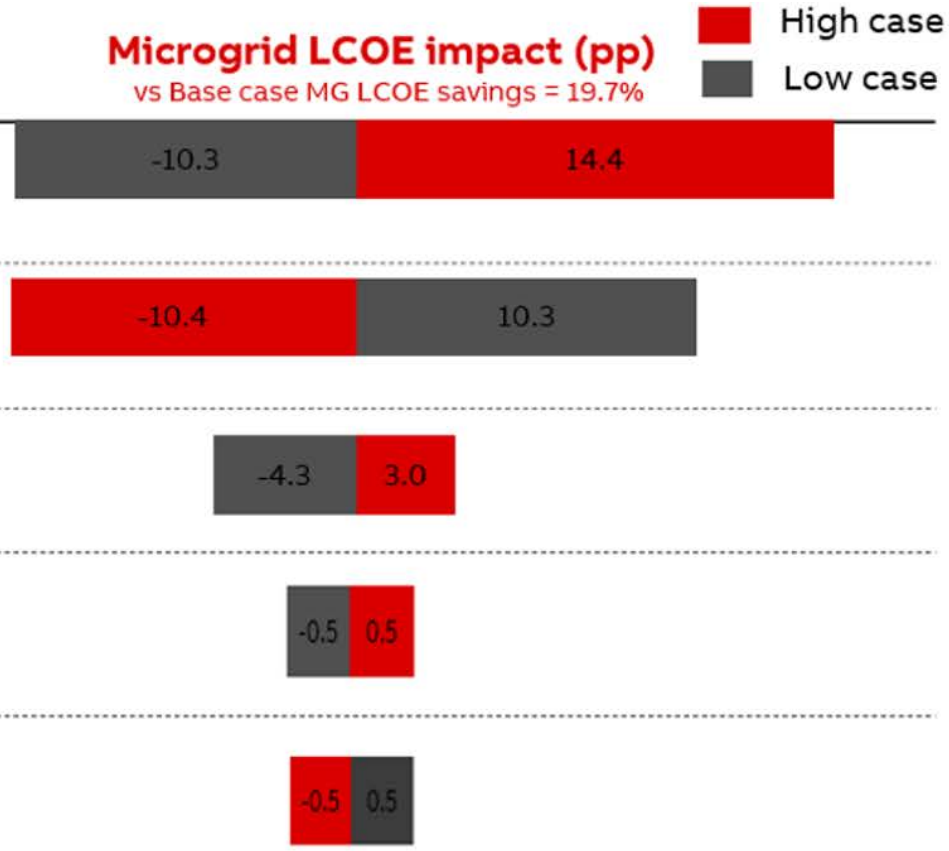


	Base case – Grid + Diesel	Grid + Diesel + BESS	Grid + Diesel + Solar PV	Grid + Diesel + BESS + Solar PV
Fuel consumption (kL)	44,5	43,6	28,5	24,5
Investment ($M)		0,55	0,97	1,53
IRR (%)	-	35%	20%	26%
LCOE ($/ MWh)	203	177 (-12.8%)	190 (-6.4%)	163 (-19.7%)
Payback (years)	-	2.7	4.5	3.6

Sensitivity analysis – Key driver of LCOE saving

Outage cost the largest single driver of LCOE savings, followed by PV price

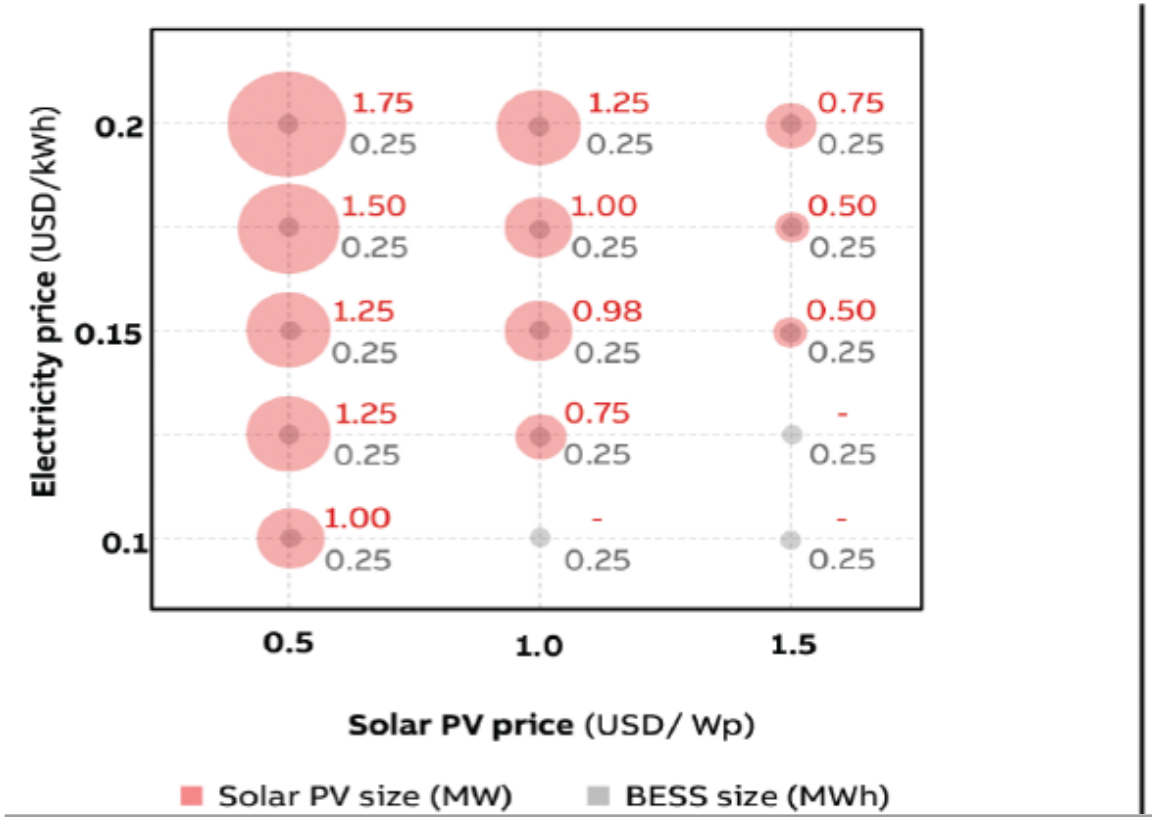
Sensitivity driver	Low case	Base case	High case
Outage Cost (k$/year)	104	208	416
Installed PV price (USD/Wp)	0.5	1	1.5
Grid energy price (USD/kWh)	0.1	0.15	0.2
Diesel price (USD/L)	0.5	1.0	1.5
Installed battery price excl. converter ($/kWh)	300	400	500



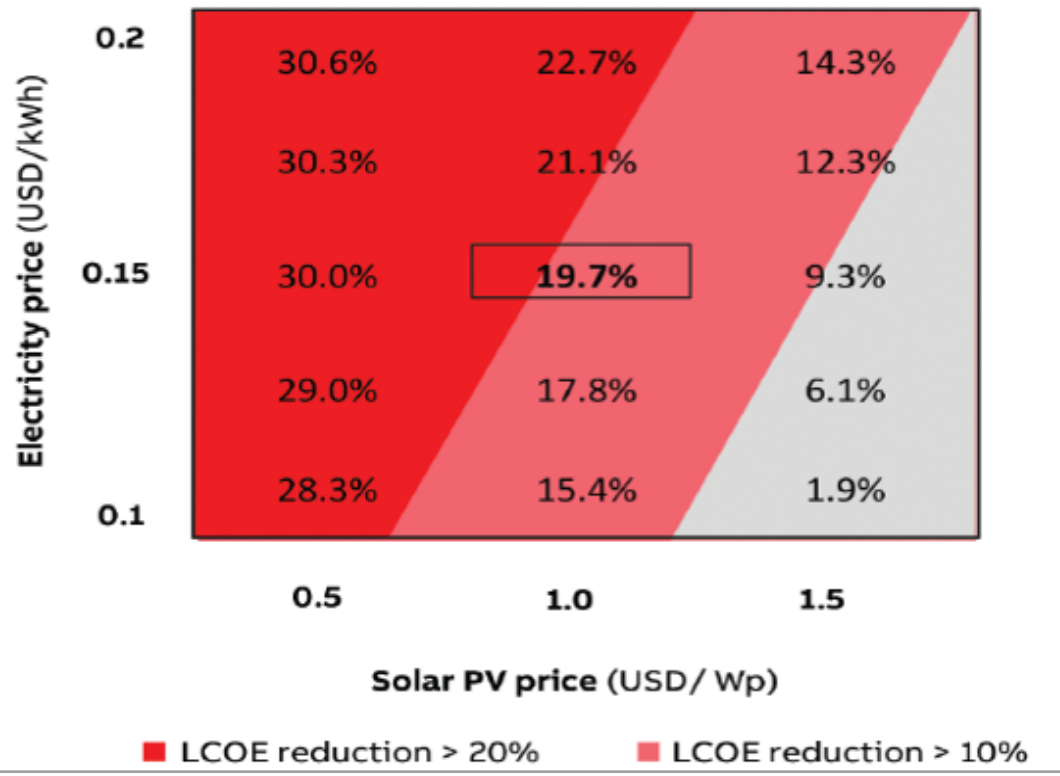
Microgrid for C&I - Business Case

Recommended microgrid system configuration and LCOE reduction

Configuration sensitivity to prices



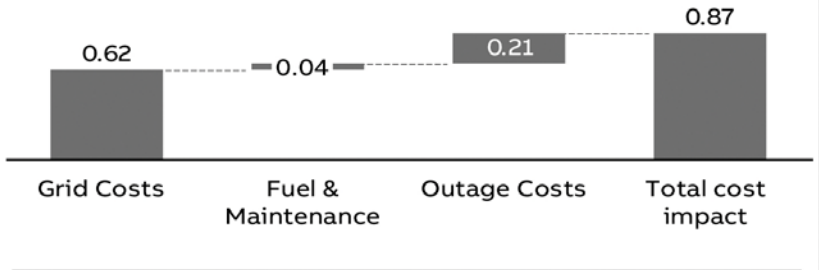
MG LCOE sensitivity to prices



Summary: 20 – 30 % energy related savings possible for C&I facilities

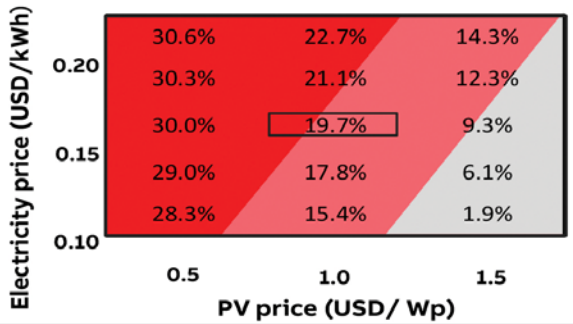
BESS + Solar PV benefits for a C&I facility with a weak grid

Base case annual electricity related cost build-up (MUSD)

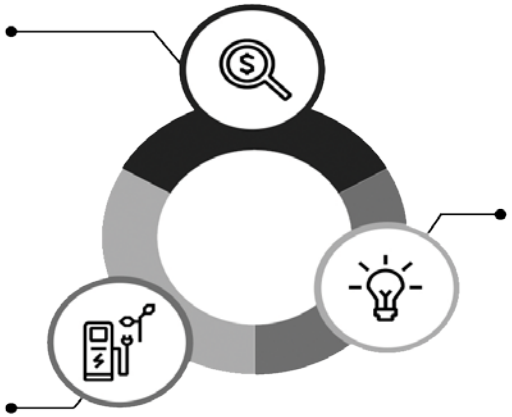


Outage costs a critical driver of total C&I energy related costs

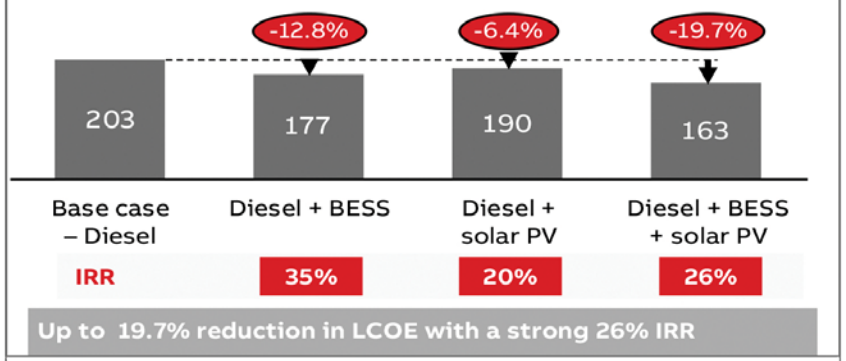
Microgrid LCOE impact - sensitivity to prices



20-30% LCOE savings possible across many scenarios



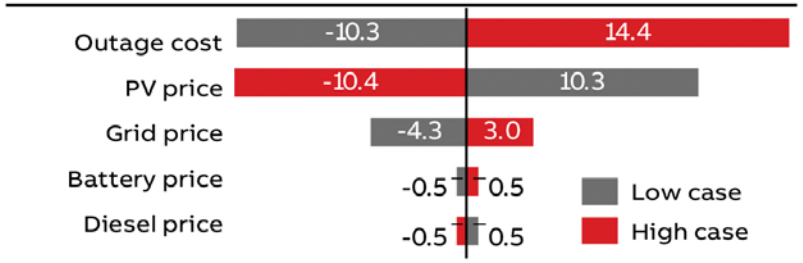
LCOE – including outage related costs (USD/MWh)



Up to 19.7% reduction in LCOE with a strong 26% IRR

Sensitivity analysis: Diesel + BESS + solar PV

Microgrid LCOE impact versus base assumptions (pp)



Outage costs and PV price the biggest drivers of LCOE saving

Microgrid for C&I sites

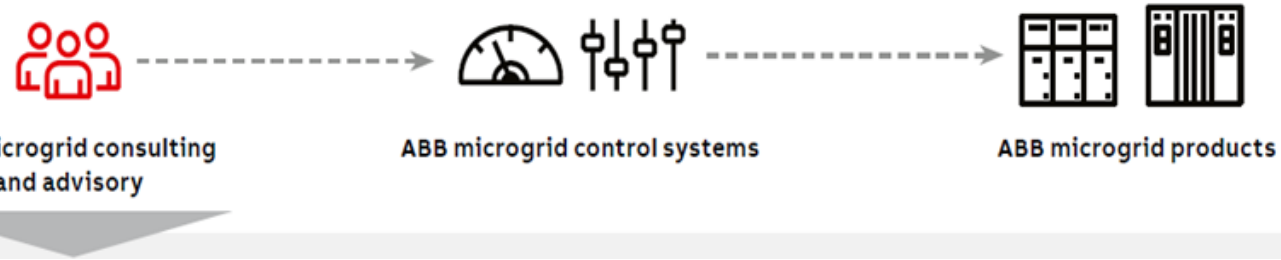
Key takeaways

How C&I sites will benefit from microgrids

- Fuel saving (and associated reduction in CO2 emissions & maintenance costs)
- Reduced Levelized Cost of Electricity (LCOE)
- Attractive Internal Rate of Return on investments (IRR)
- Improved power quality
- Increased energy independence

ABB Microgrid Advisory Services

Microgrid End-to-end Solution



Microgrid Market Analysis

- Trends in energy price, tariffs
- Drivers for energy storage as peak shaving, self-consumption vs feed-in, and energy arbitrage.
- Market participation revenues

Microgrid economic Analysis

- Optimum size and operation of DER
- Cost of energy, ROI, and payback
- Fuel savings and environmental impacts
- Sensitivity analysis on drivers
- Value stacking
- Ownership models

Microgrid technical Analysis

- Stability and dynamic studies
- Contingency analysis
- Power quality and reliability
- Frequency and voltage ride though

Contact Information

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