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Renewables-Based Microgrids: An Emerging Urban Energy Solution for Developing Asia

By Recca Liem

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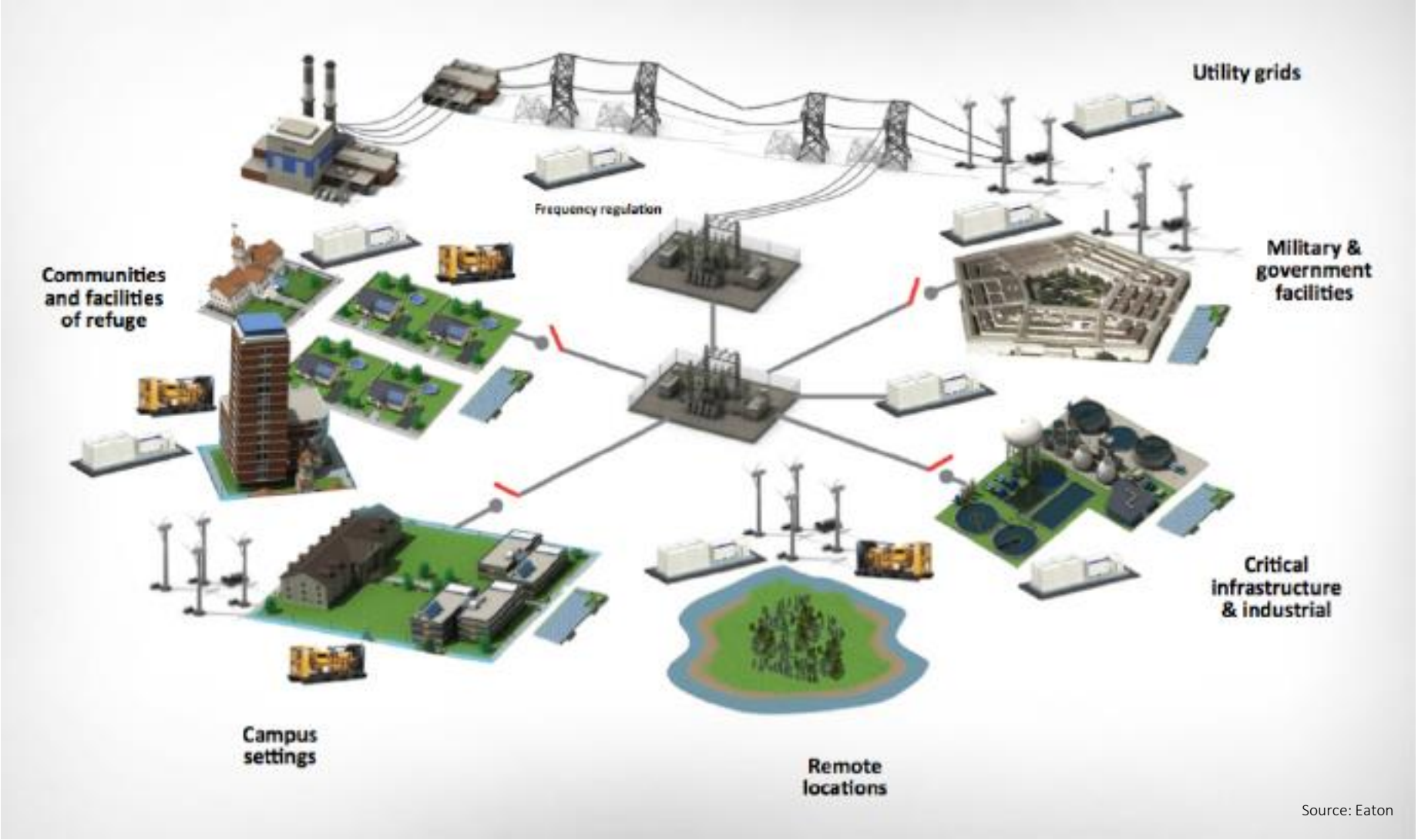
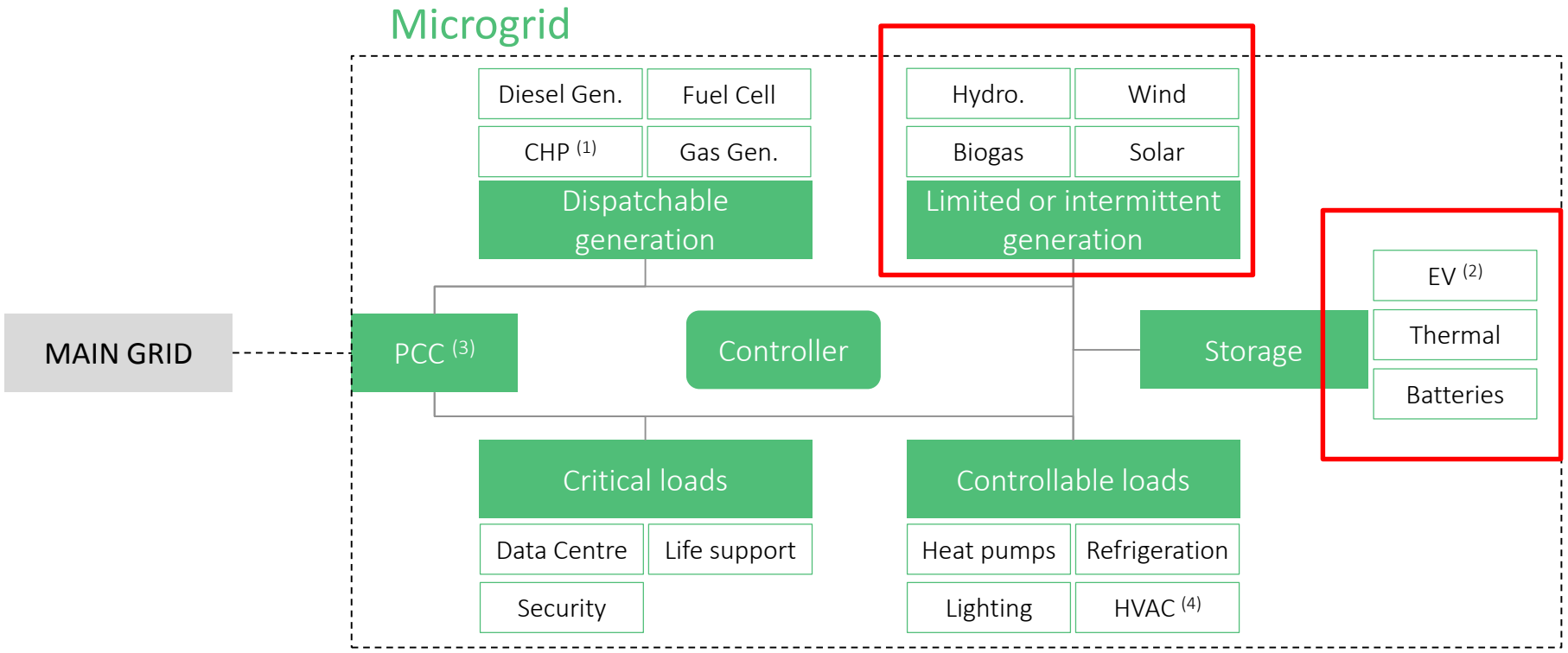
A microgrid is a set of energy resources that can operate independently from the electricity grid.



Source: Eaton

Microgrids include various components: generation, loads and back-up facilities that are optimized by a controller and an EMS



(1) CHP: Combined Heat and Power plant
(2) EV: Electric Vehicles
(3) PCC: Point of Common Coupling
(4) HVAC: Heating, Ventilation and Air Conditioning

Traditional microgrids relied on fossil fuels, but now low-carbon microgrids are emerging which run with predominantly renewable power.

Embedding renewables could improve the economic, operational and environmental benefits of microgrids

Challenge	Objectives	Urban Applications
 Energy security	• Diversify the energy supply resources by onsite production • Reduce the risks for fuel supply of fossil fuel	• Data centres • Critical industries • Hospitals • Military camp • Research labs
 Sustainability	• Reduce carbon emissions • Reduce the health and environmental impact to local communities	• Industries • Tertiary • Commercial zones • Municipalities • Eco-districts • Universities
 Costs reduction	• Decreasing costs of rooftop solar and storage can lower the overall costs of microgrid • Could generate extra revenue through selling green certificate	• Industries • Tertiary • Commercial zones • Municipalities • Universities

Stafford Hill

Assets

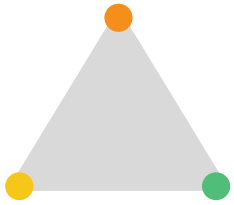
EXISTING

Only distribution network at the school

2015 UPGRADE

- 2 MW solar
- 2 MW li-ion battery (0.9 MWh capacity)
- 2MW lead-acid battery (2.4 MWh capacity)

Drivers



	EXPECTATIONS	RESULTS
Energy security	Back-up power for Rutland high school, that would become the city emergency shelter	No natural disasters (or other grid outages) happened so far
Costs reduction: Reduce transmission and capacity payments	Reduce capacity payment for GMP with peak shaving ($0.3 to $0.5 Mn/MW)	$2 million saved per year: 2 MW peak shaving, and frequency regulation, solar energy generation, RECs (1)
Sustainability: In 2017, 55% of GMP electricity sales must be renewable	With Stafford Hill, GMP solar capacity went from 0.5 to 2.5 MW	Based on 2015 data, renewable energy will represent 18% of GMP production, and solar 2% in 2016.

(1) Renewable Energy Credits

Source: Dan Borneo, Scientist at Sandia National Laboratories

Princeton University

Assets

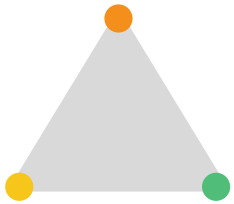
EXISTING

- Distribution network has been continuously improved since the 1880's
- Thermal storage

1996 AND 2012 UPGRADES

- 15 MW Combined Heat and Power (CHP) engine (since 1996)
- 4.5 MW solar (since 2012)

Drivers



Energy security:
Power reliability for research facilities

Costs reduction:
Cut electricity bills

Sustainability:
Carbon emissions reduction for university image

EXPECTATIONS	RESULTS
• Protect research facilities from any grid flickering and/or short time outage • Microgrid not initially planned for resiliency	Achieved islanded operation 3 to 4 days during Sandy hurricane
Reduce overall costs thanks to internal operation of electric infrastructure	• $4.5 million/year saved on transmission/capacity bills • $2 million/year saved with arbitrage • $450 000/year gained with grid services
Carbon reductions from CHP and solar	Carbon reductions on solar can be claimed when solar RECs sale stops at the end of lease contract in 2020

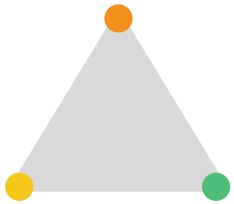
Sources : Edward Borer, Princeton's energy plant manager | Tom Nyquist, executive director of engineering and campus energy in Princeton's Facilities Organization

Santa Rita Jail

Assets

EXISTING	2012 UPGRADE
1.2 MW solar 1.2 MW fuel cell 2.4 MW back up diesel generators	0.2775 MW solar 2 MW Li-Ion battery (4 MWh storage capacity)

Drivers



	EXPECTATIONS	RESULTS
Energy security: Increase prison security	Before 2012, twice outages a year with existing on-site generation (fuel cell and fixed PV)	After 2012, no other grid failures happened.
Costs reduction: Avoid peak-hour electricity consumption	Zero net consumption at peak hours	1 MW consumption from the grid at peak hour $100 000 saved per year
Sustainability: Test bed for the DoE program on renewable energy	Increase know-how on distributed and renewable energy sources management	• Choice of innovative technologies (fuel cell, switch) • Lessons learnt on batteries management

Sources : Robert Lasseter, Professor at the University of Wisconsin | Douglas Ledbetter, Project Developer, Opterra Energy Services

Renewable-based microgrids could offer attractive solutions to developing Asia

In areas that power / fuel supply is not stable

- Improve reliability

In areas that power supply is expensive

- Reduce energy losses and costs

In areas that power supply is based on fossil fuels mainly

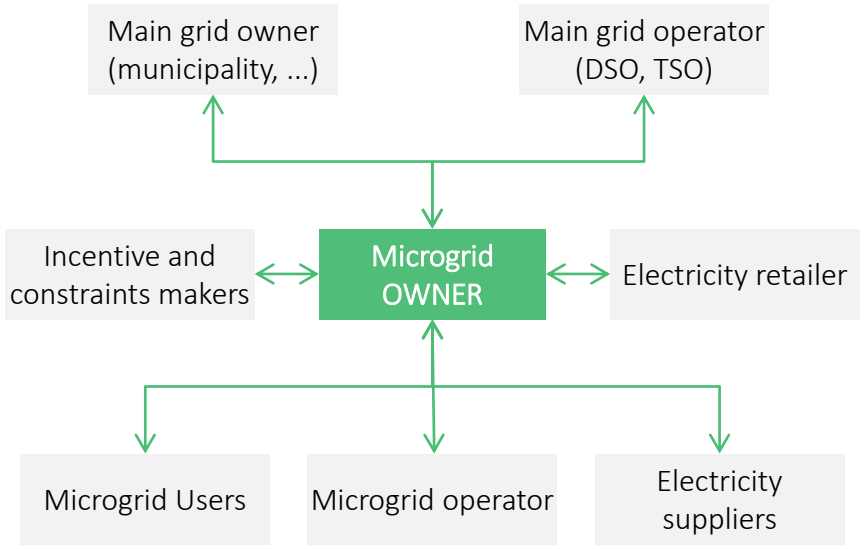
- Reduce emissions

But the business case of these solutions would still depend on many other factors, including:

- Accessibility of revenue streams, business models, financing schemes etc.

Accessibility to various value streams will determine the project viability

Man stakeholders may be involved in the microgrid ecosystem



Numerous value streams could be captured

Services to the system operator (national)

- Frequency and voltage regulation
- Spin / non-spin reserves
- Black start
- Demand-response

Public subsidies

- Feed-in-tariffs, green certificates, etc.
- Direct grant, tax credit, public loans etc.

Energy arbitrage

- Energy injected into and taken from the main grid

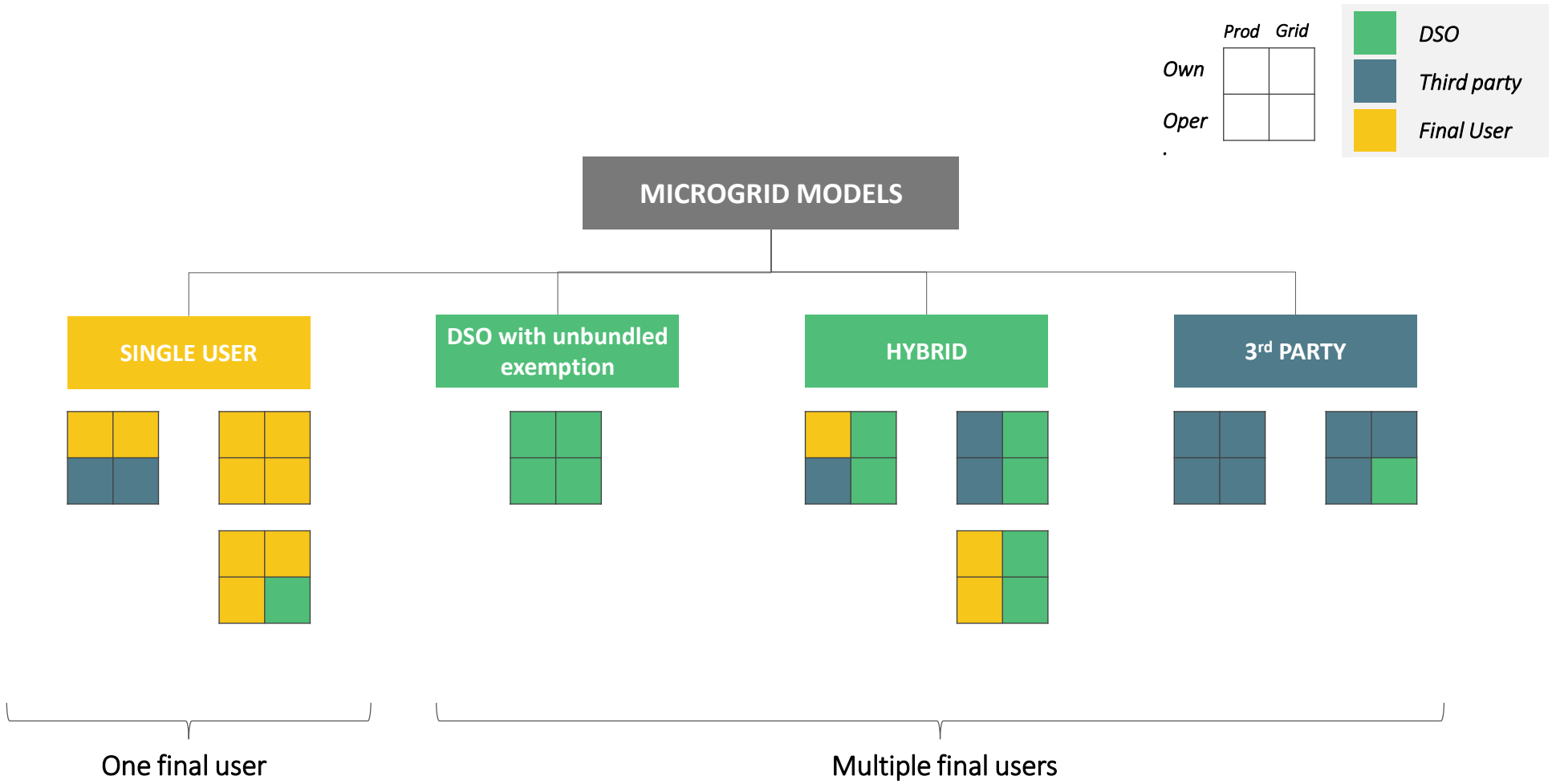
Local services to the DSO

- investment deferrals
- Voltage regulation

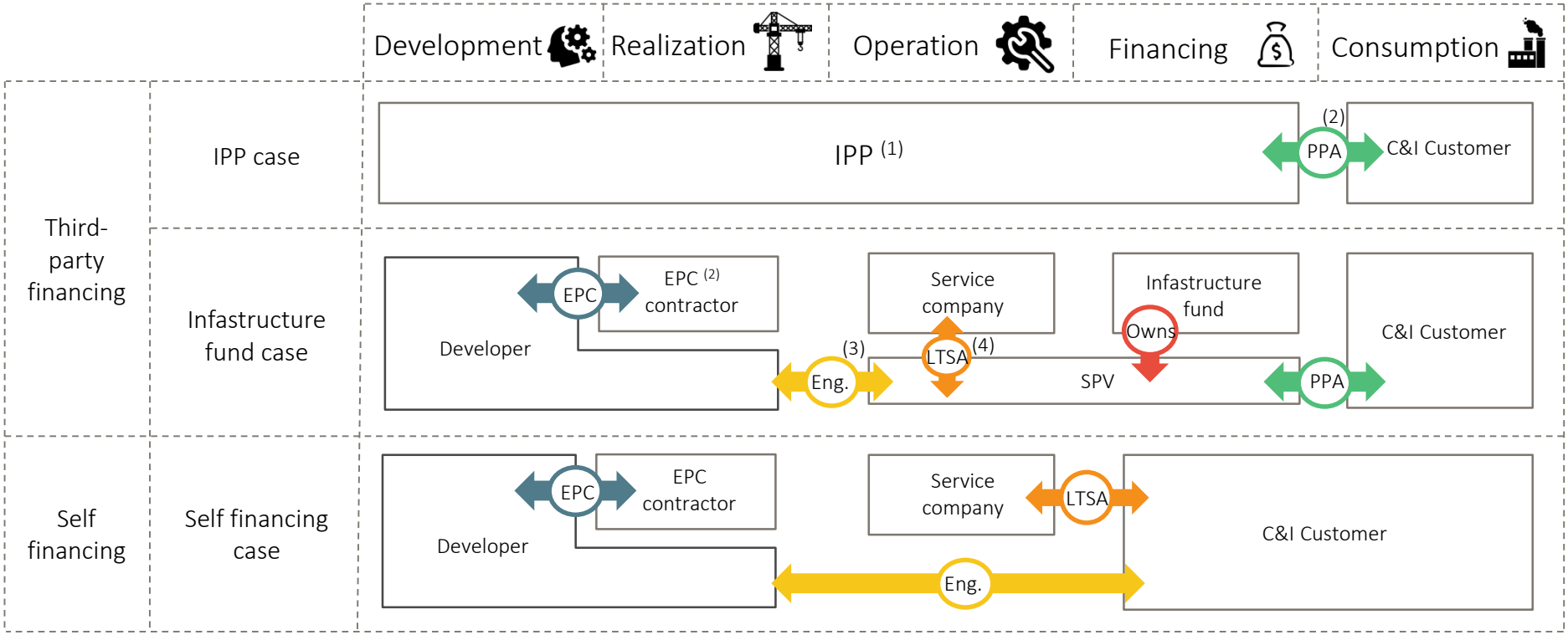
Quality of supply

- Higher rates
- Power sale contract

New business models emerge according to regulations and capabilities/interests of stakeholders



Innovative financing schemes allow companies to benefit from microgrids without significant upfront investment



(1) IPP: Independent Power Producer
(2) PPA: Power Purchase Agreement
(3) Eng: Engineering services
(4) LTSA: Long-Term Services Agreement

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