

Community Energy and Microgrid Ownership Models

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Agenda

- ✦ Duke University Model
- ✦ Other Models Overview
- ✦ Benefits & Costs

What to Look For

- ✦ Funding
- ✦ Fuel availability
- ✦ Inside expertise - Operation
- ✦ Grid reliability needs
- ✦ Cost of power
- ✦ Legislation
- ✦ Environmental Impact

Proposed Combined Heat & Power (CHP) Plant

Duke University Model

CHP Ownership Challenge

- ✦ Reliability:
 - Duke University electrical system total outage less than 6 seconds in 30 YEARS
- ✦ Rate:
 - Cost of electricity less than 8 cents per KWH
- ✦ Cost:
 - Large investment to build a CHP
- ✦ Skills:
 - No expertise to operate a large generating plant
- ✦ Legislation:
 - Change in the Power Company Rate Plan
- ✦ Environmental Impact:
 - Reduce carbon footprint
- ✦ Island mode challenge:
 - No reliability gain in “island mode” without using Duke Energy distribution system

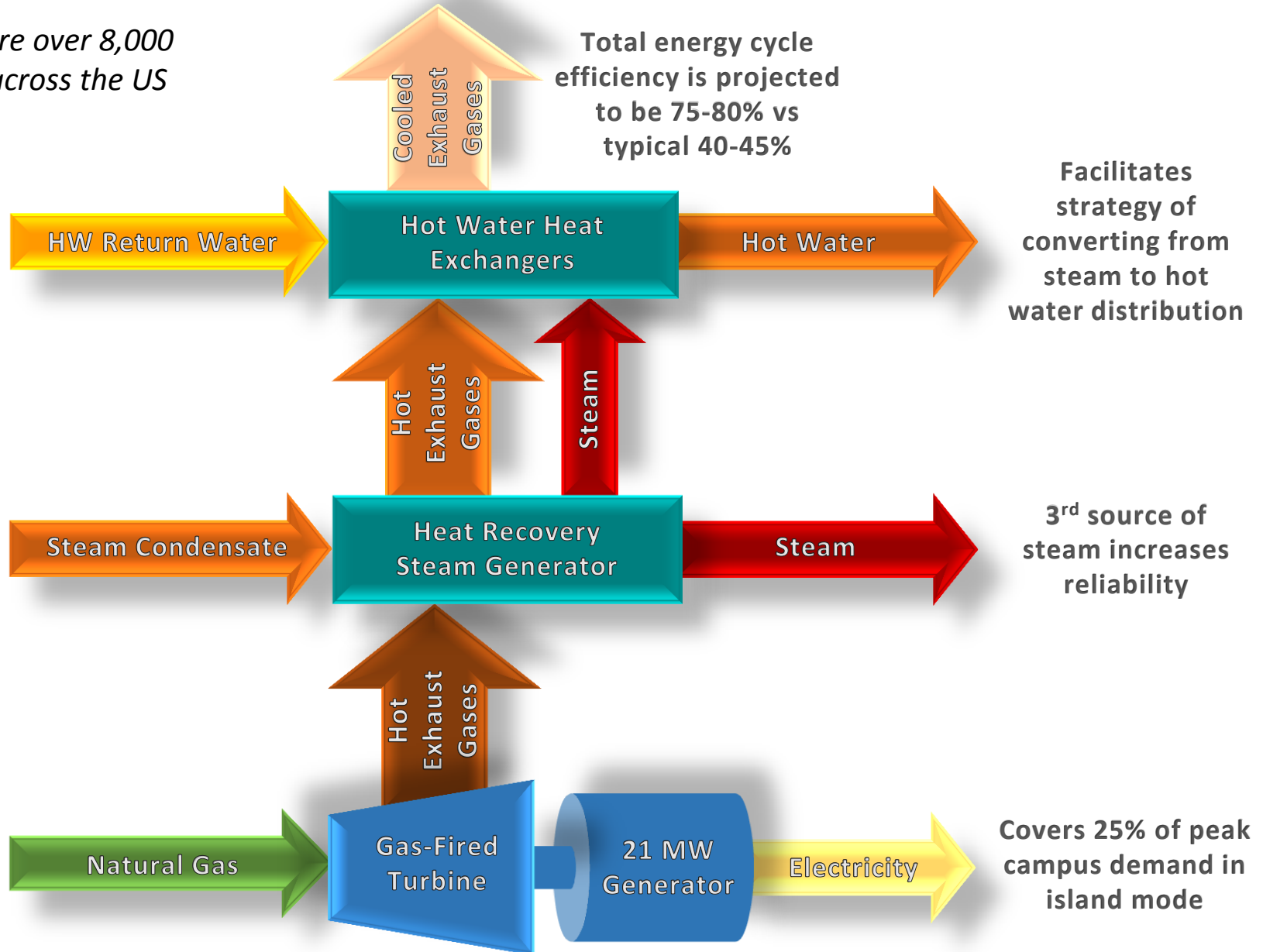
Proposal Overview

- ✦ Duke Energy will build, own and operate a Combined Heat and Power (CHP) plant on property leased from Duke University
- ✦ Duke Energy will send electricity back onto NC grid and we will continue to purchase electricity as we always have
- ✦ Duke University will buy the “waste” steam generated in the process at a rate that is significantly less than it costs us at our steam plants. The discounted steam rate would float with cost of natural gas.
- ✦ The system will be constructed to allow Duke University to “island” in cases of emergency (power grid outage).

Combined Heat and Power Plant System Diagram

There are over 8,000
CHP's across the US

Total energy cycle
efficiency is projected
to be 75-80% vs
typical 40-45%



Benefits & Cost to Duke University

Benefits

- ★ Sustainability
 - 13% reduction of the 2015 CAP-reported carbon footprint (DU & SOM) (coal move was 12% of 2008 CAP)
 - 24% reduction in total University & Medical Center energy-related carbon
 - DU contributing to local and regional environmental sustainability

- ★ Reliability
 - Increased energy security for Duke campus
 - Additional generation on campus for emergencies (Island Mode)
 - Improved ability to continue operating during regional emergencies (hurricane, ice, etc.)

- ★ Savings
 - Significant natural gas cost savings to the university (\$2.5-\$3.0M / yr)
 - Simple payback of 2-3 years

Costs

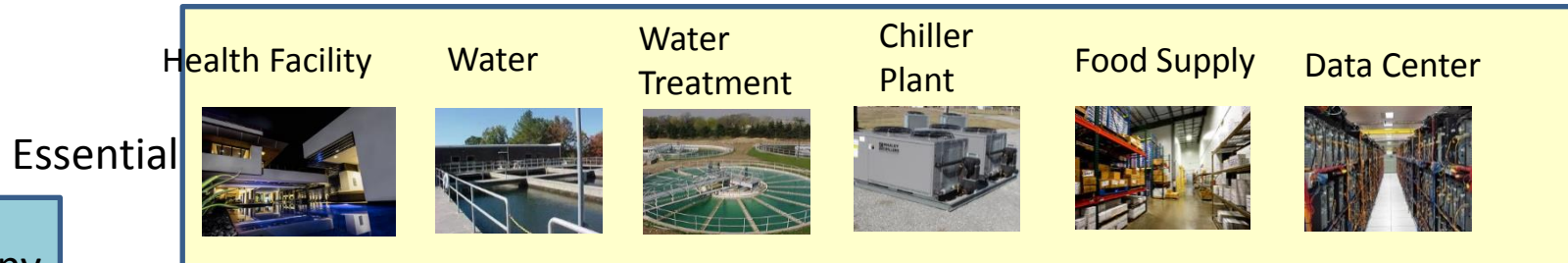
- ★ Duke University would be leasing the land to Duke Energy for an extended period (35 years)
- ★ In order to reliably operate our steam plants at a low load during summer, we would have to invest in modifications to the West Campus Steam Plant
- ★ Project costs to connect the CHP plant to the campus utility infrastructure
- ★ Total investment in plant modifications and infrastructure could range up to \$7M

Site Location on Duke Master Plan

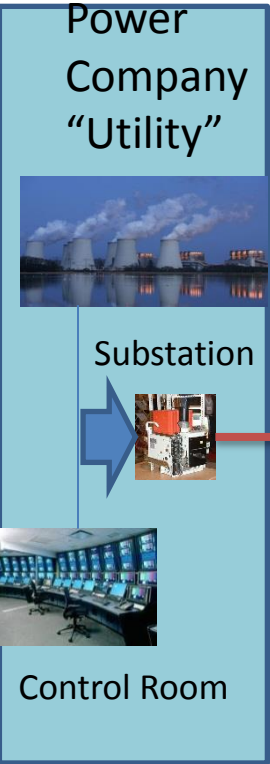
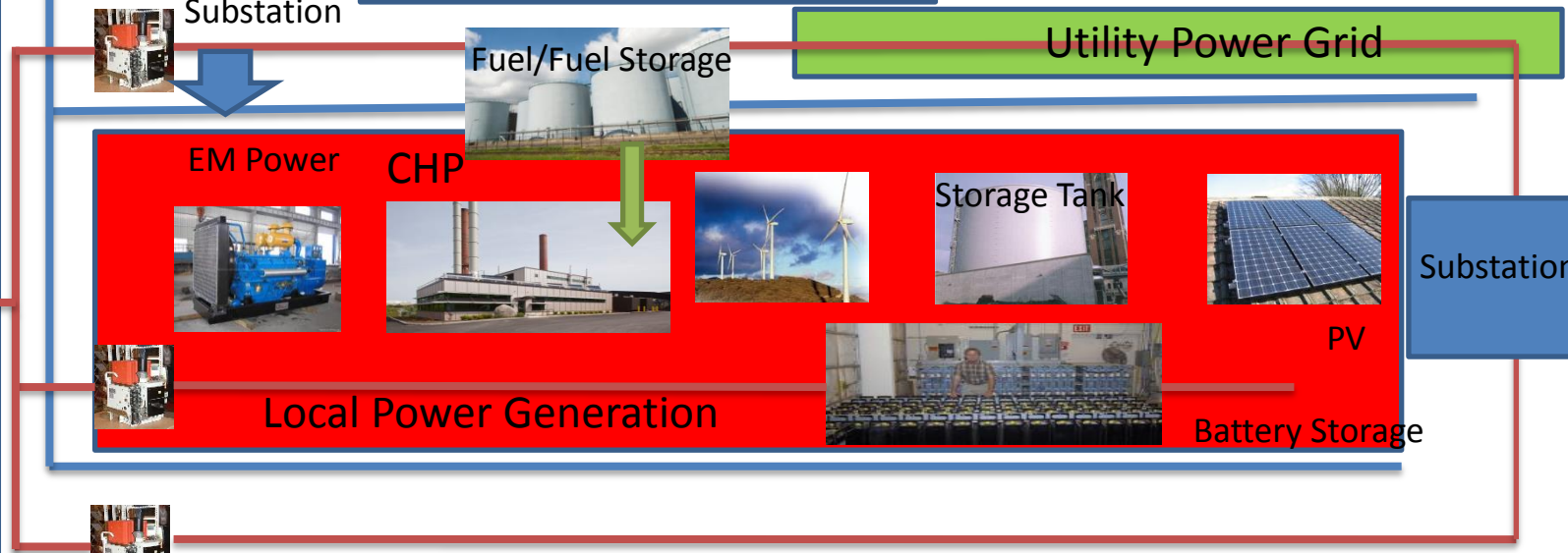
Proposed site next to Chilled Water Plant #1 and Substation #4



Microgrid Schematics

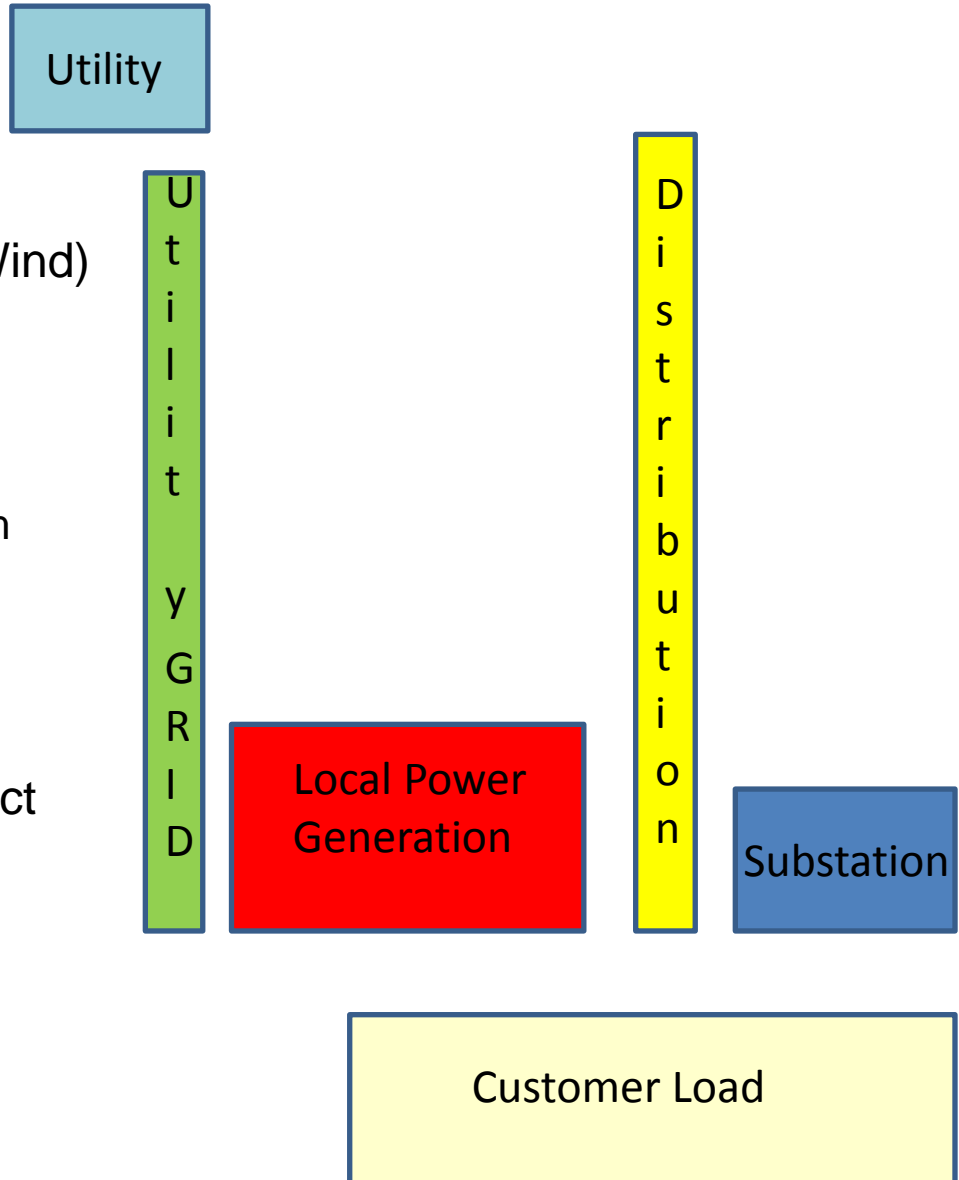


Microgrid infrastructure

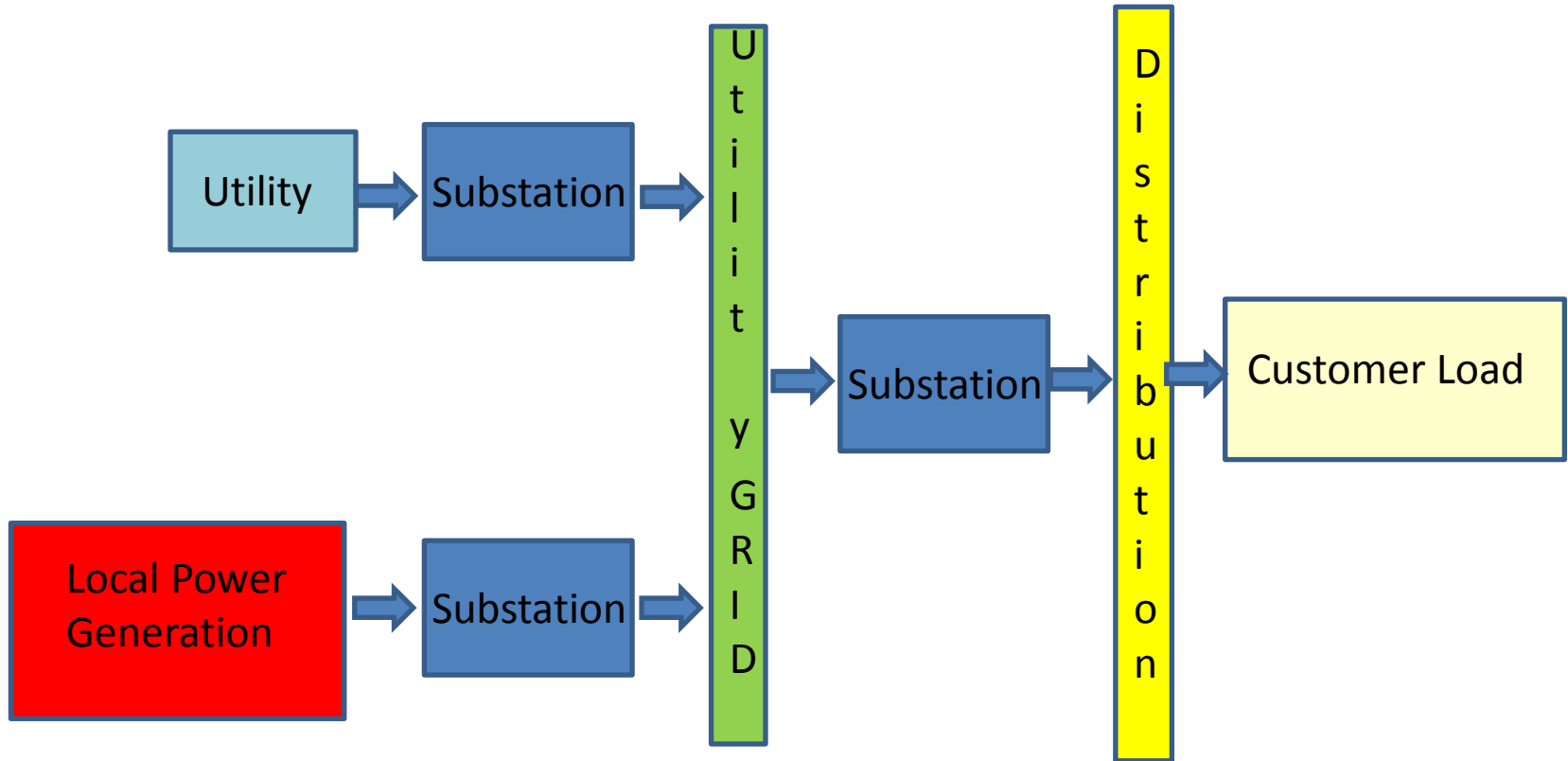


Microgrid Schematics

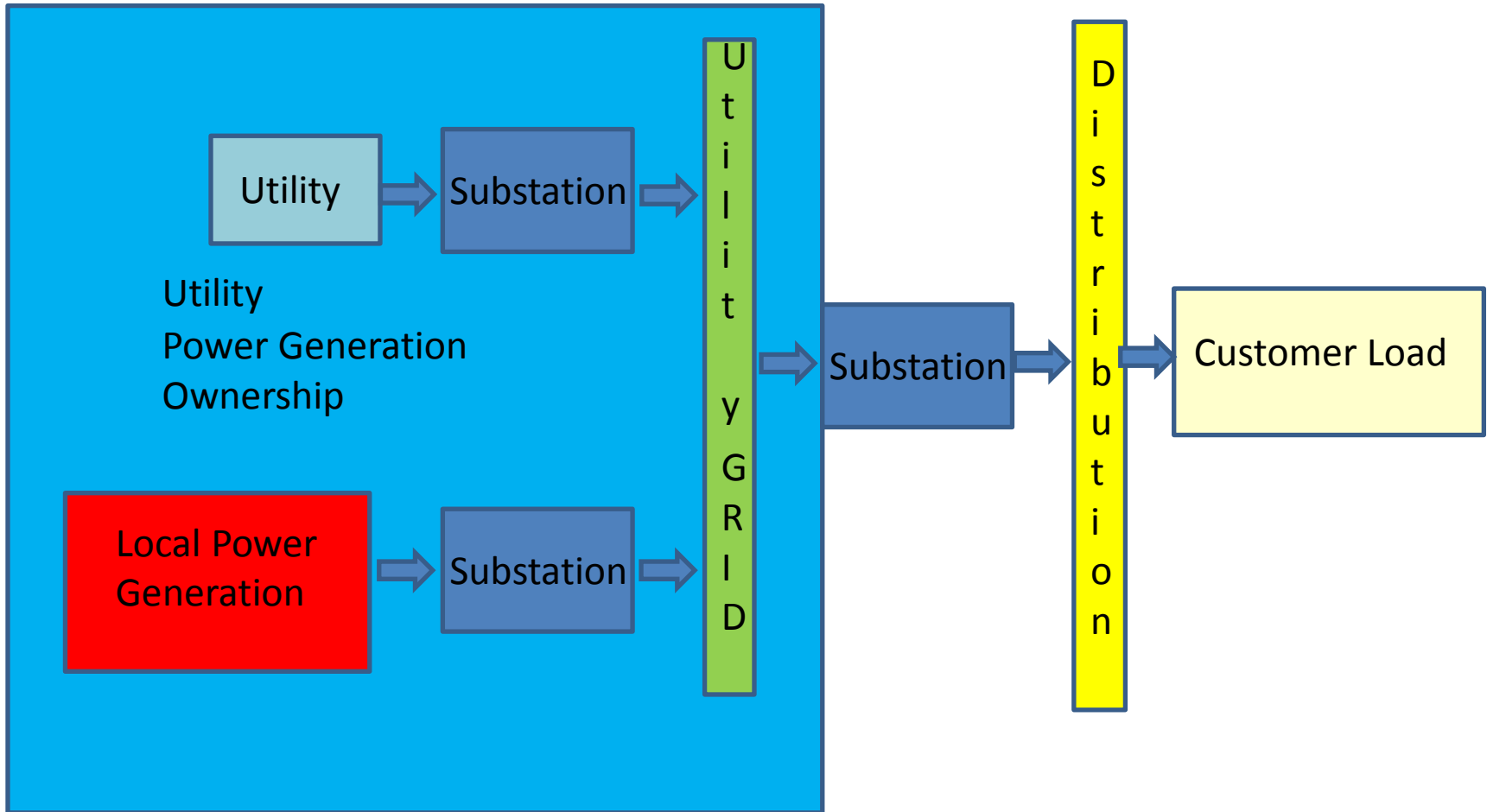
- ✦ Utility
- ✦ Local generating facility(CHP, PV, Wind)
- ✦ Distribution infrastructure
 - Utility Grid
 - Customer owned distribution system
- ✦ Connected load (customer load)
- ✦ Control Area / Substation/ Disconnect Location



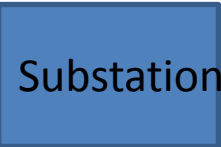
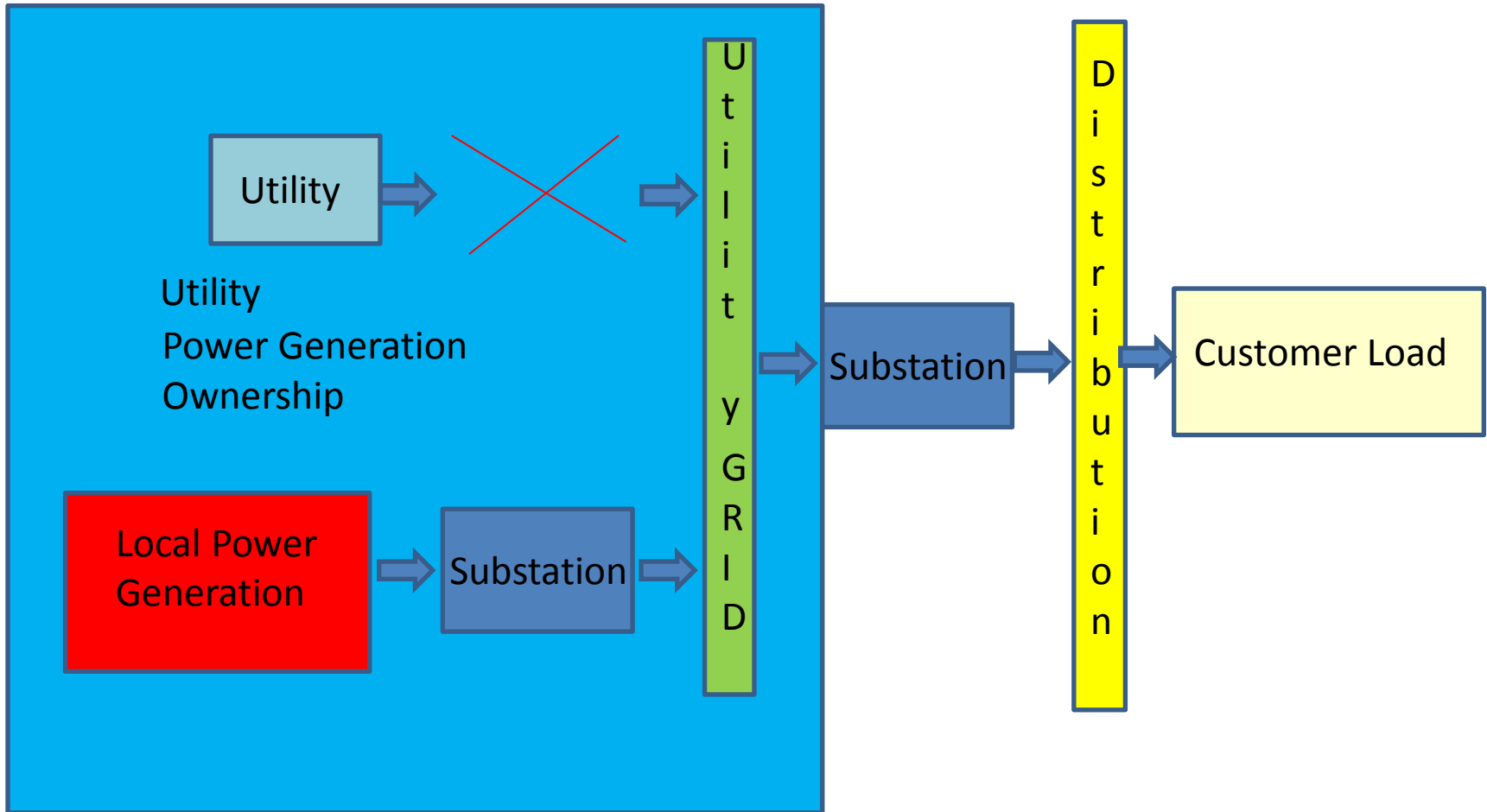
Duke University Microgrid Model



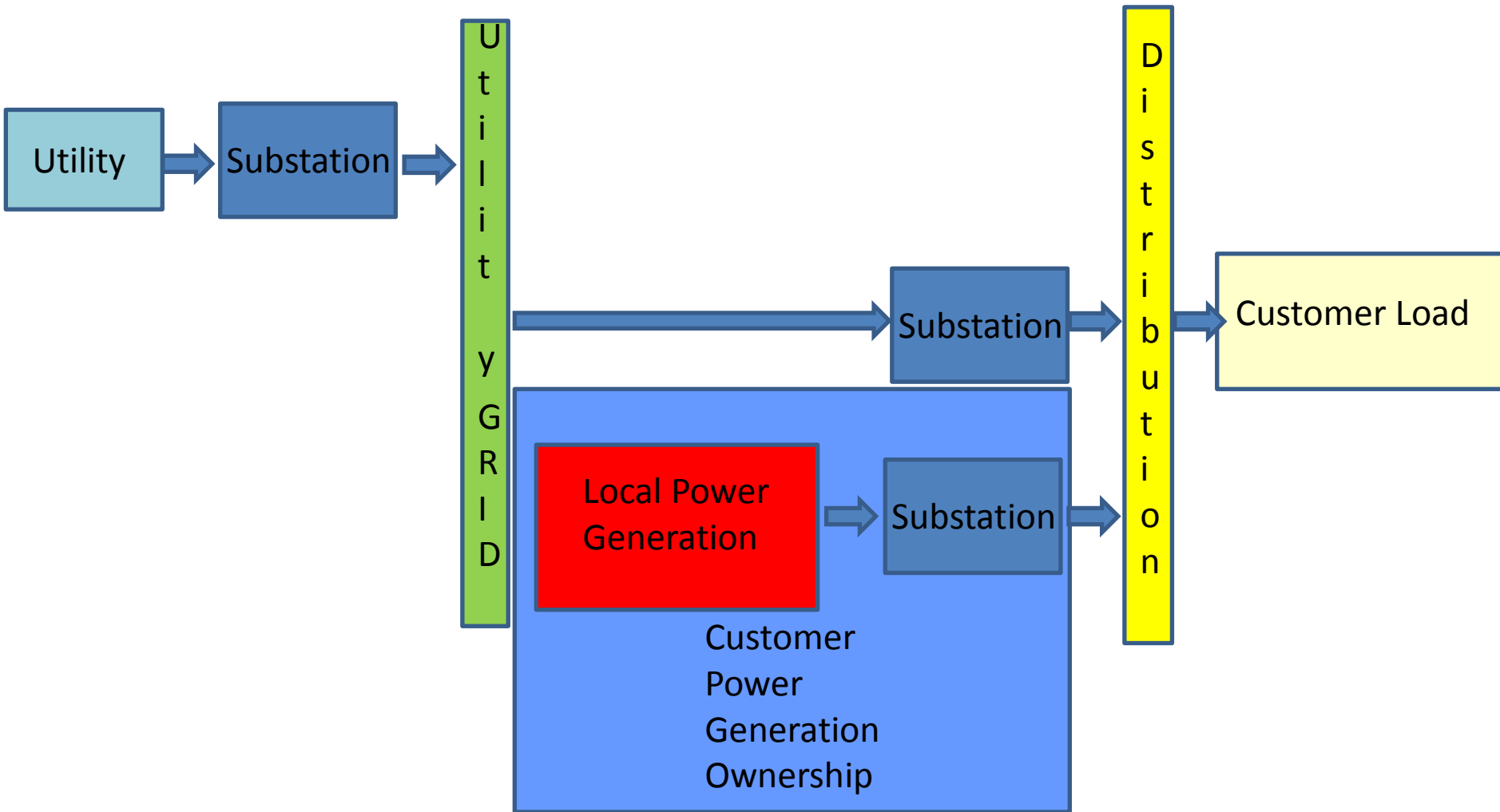
Duke University Microgrid Model



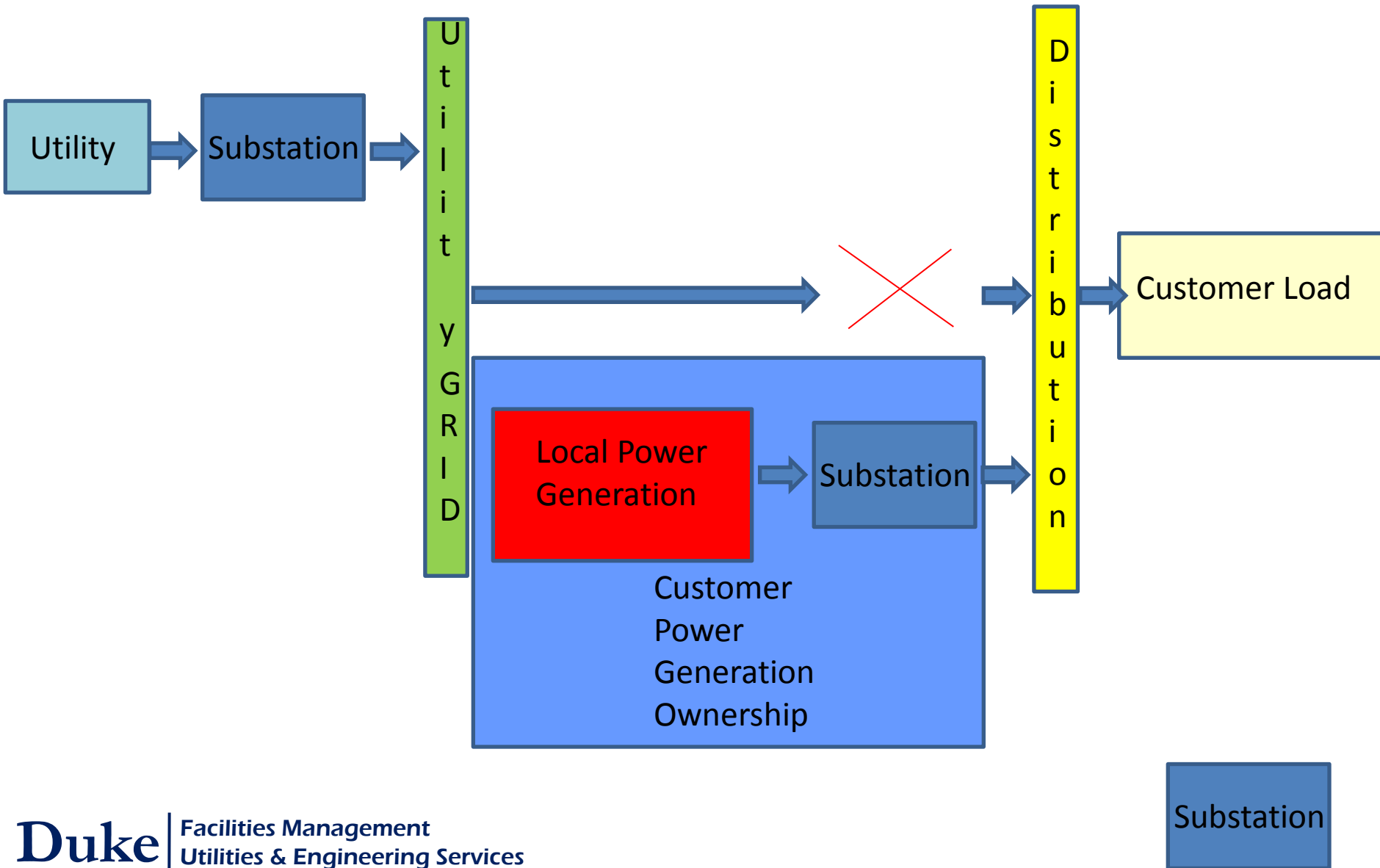
Duke University Microgrid Model – Island Mode



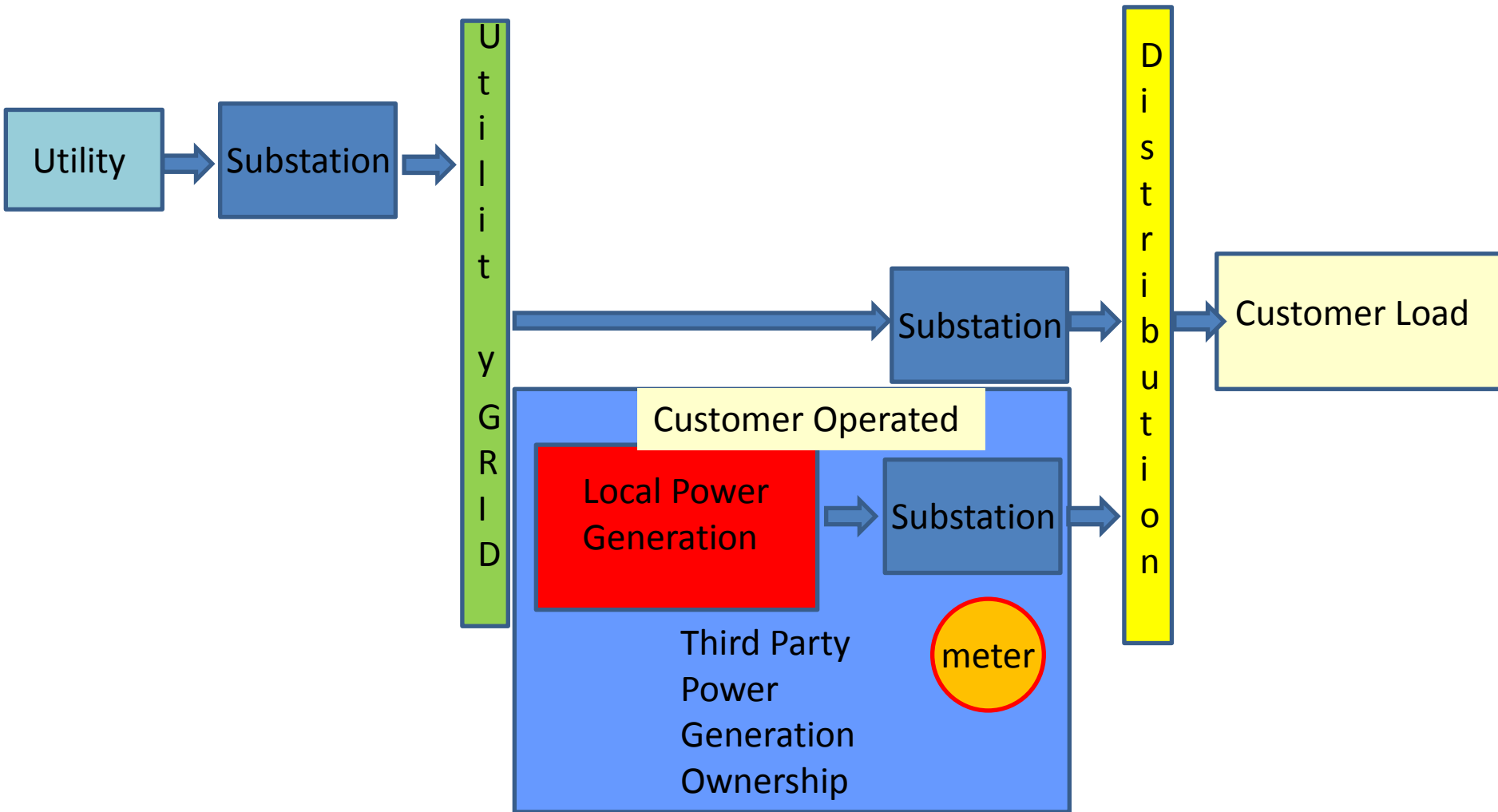
Single Owner / Single Operator - Microgrid Model



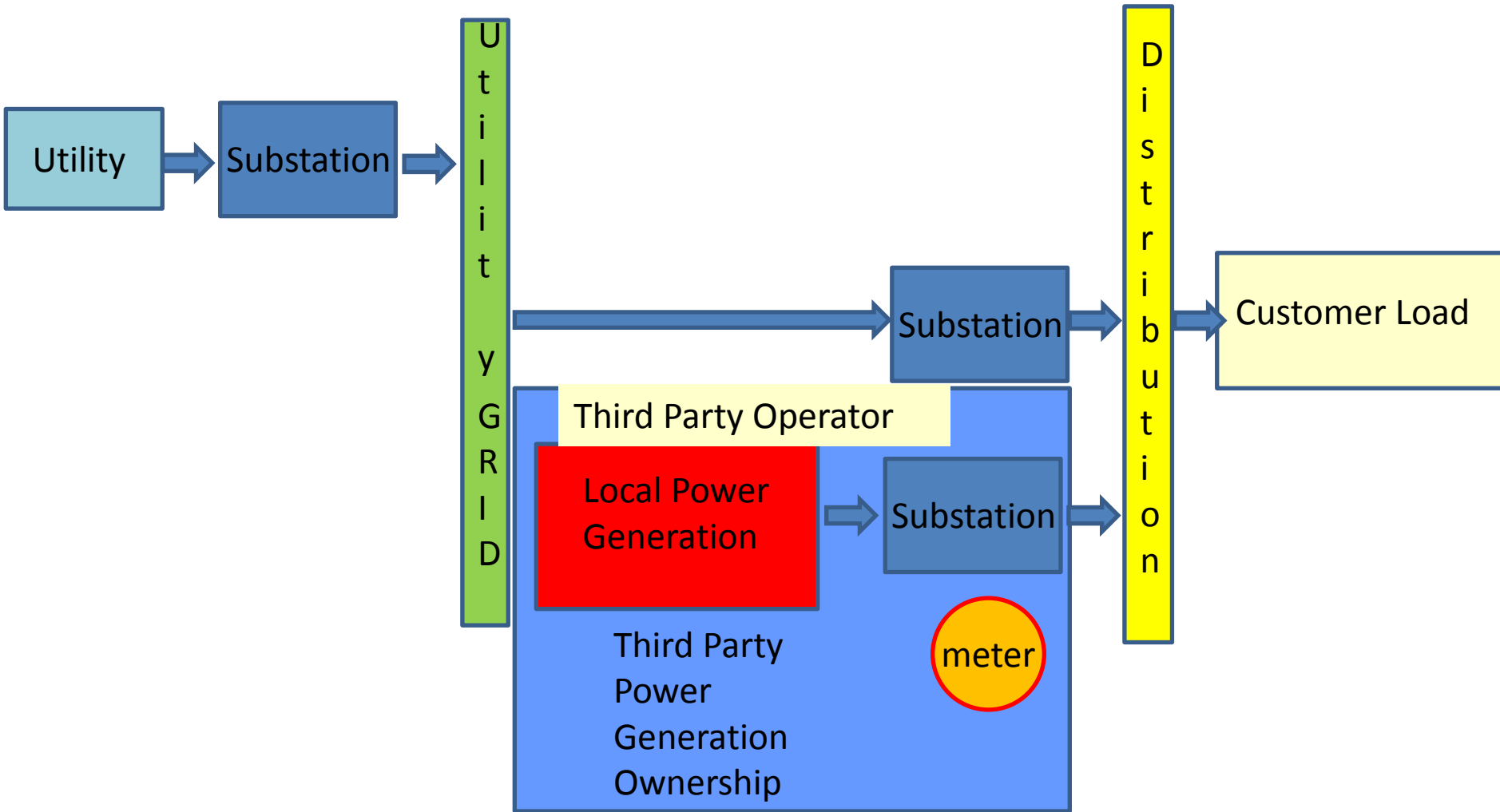
Single Owner / Single Operator - Microgrid Model Island Mode



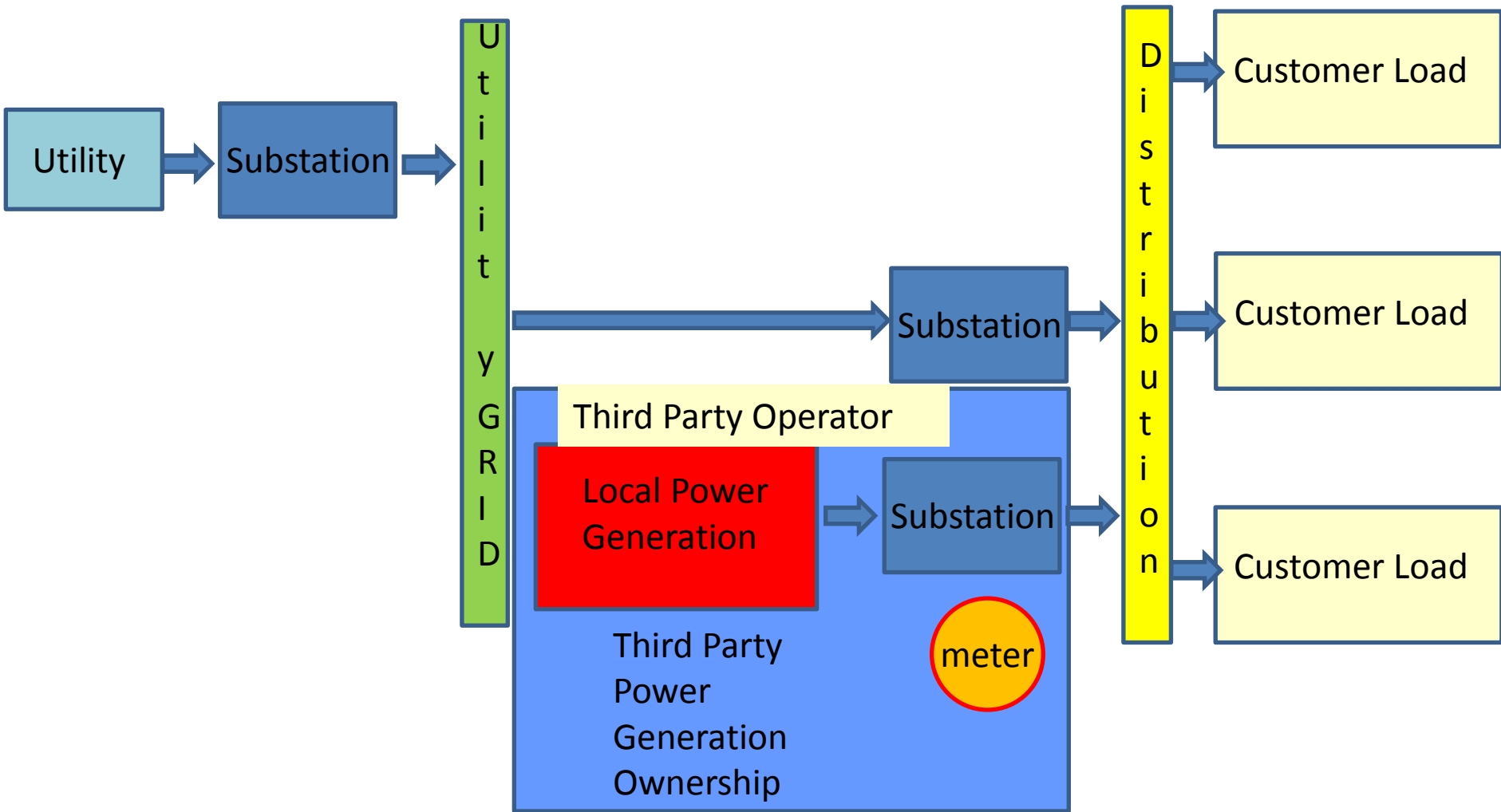
Third Party Owner / Single Operator - Microgrid Model



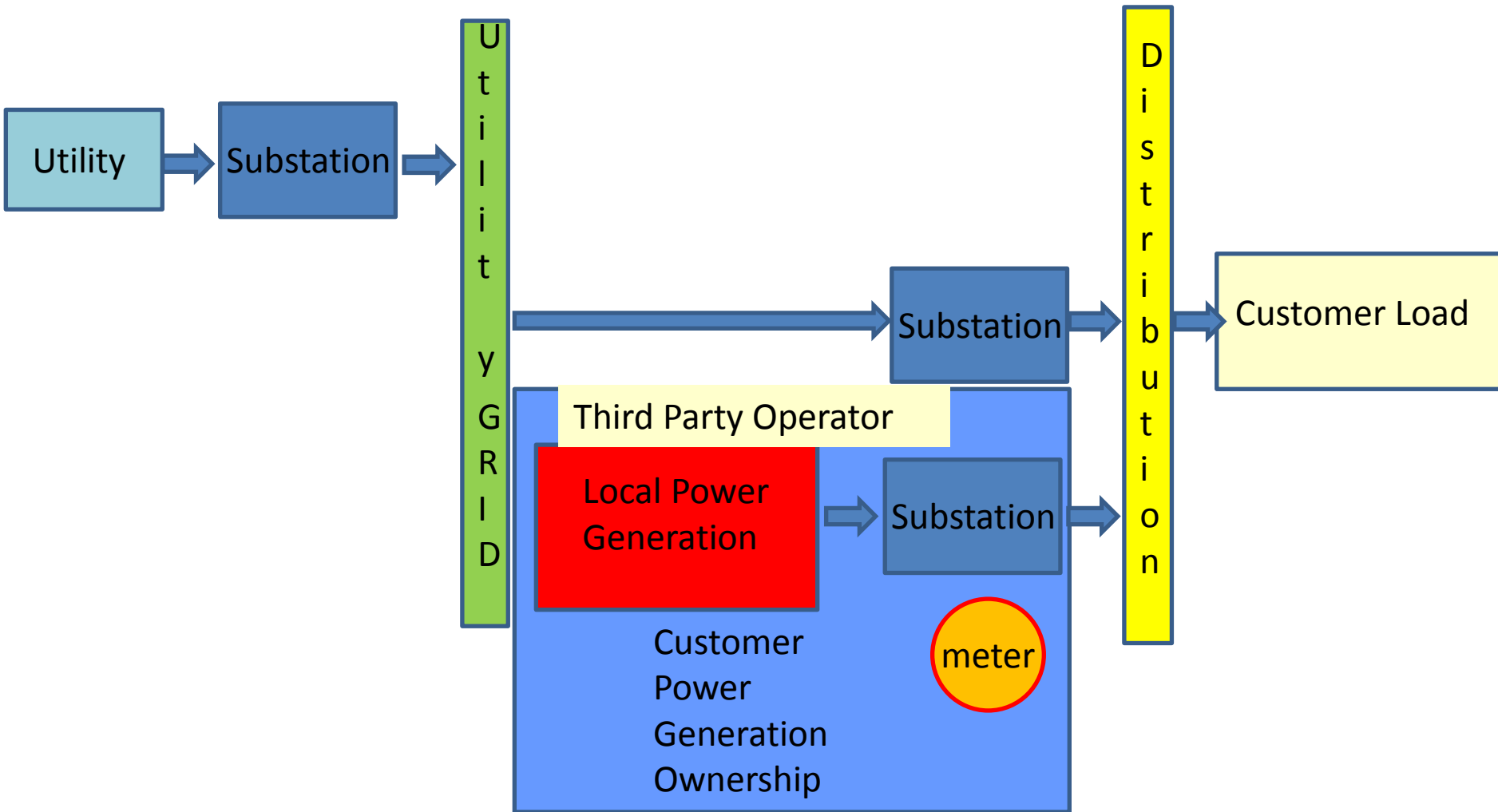
Third Party Owner / Third Party Operator - Microgrid Model



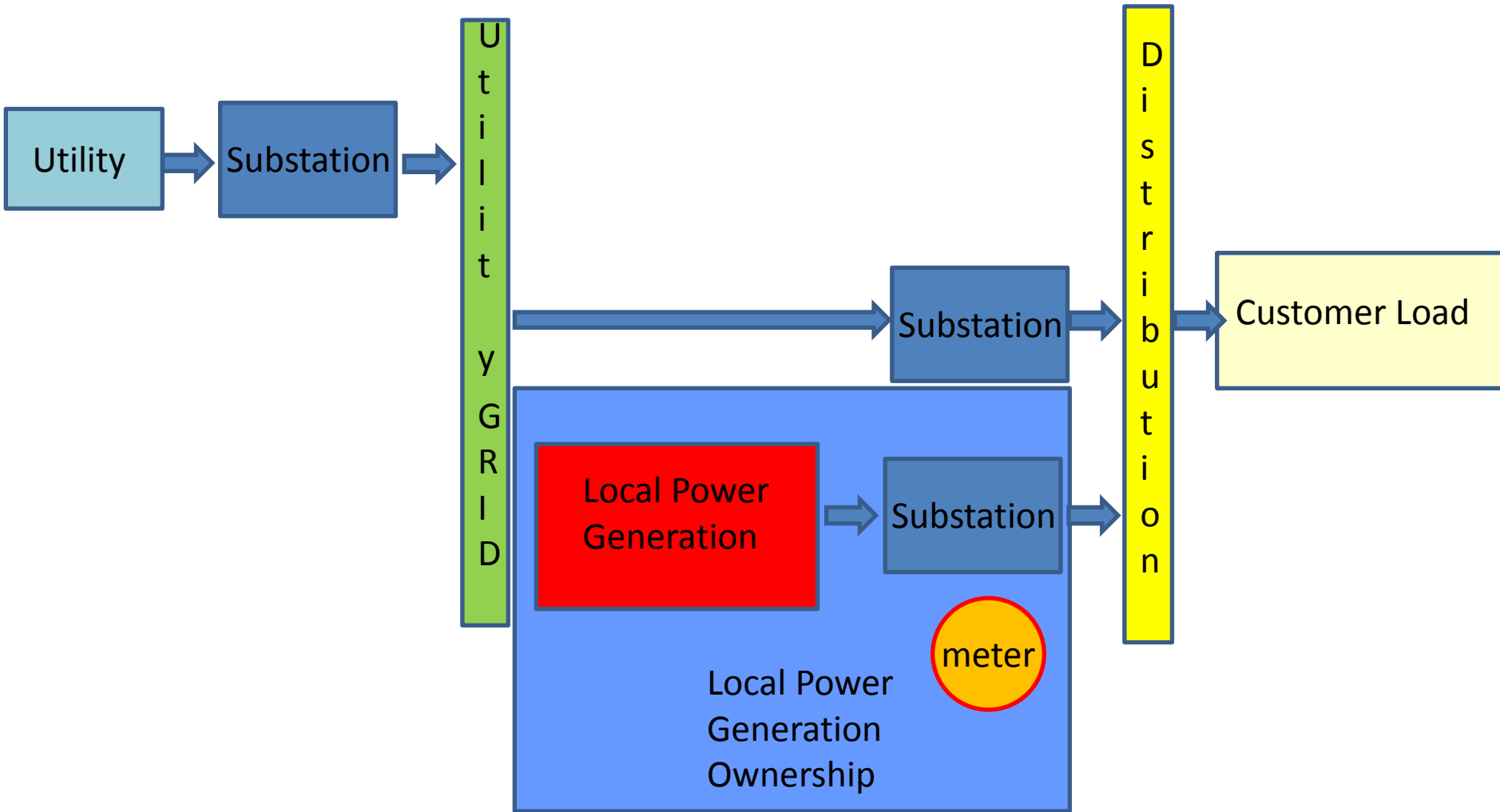
Third Party Owner / Third Party Operator – Multiple Customers



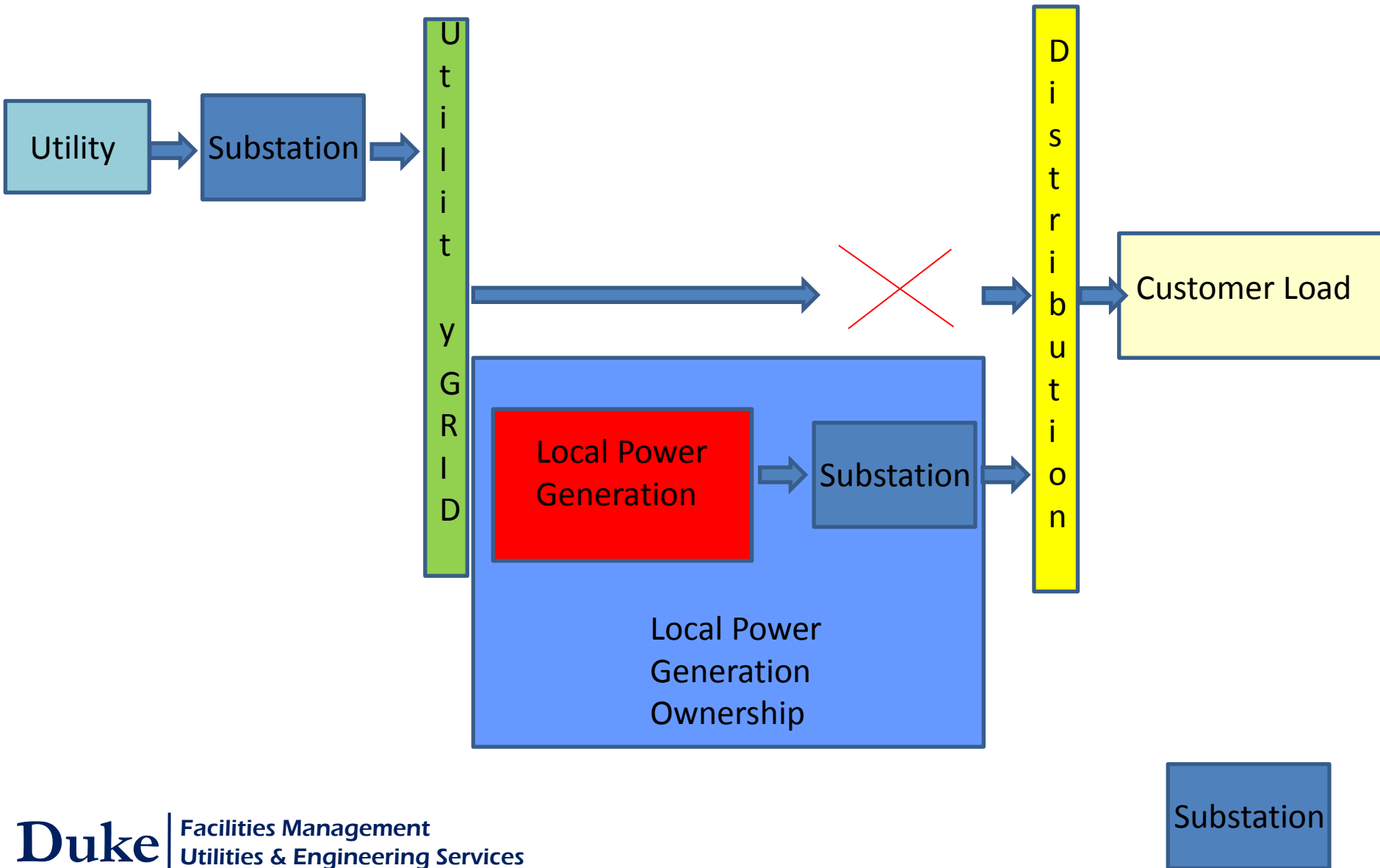
Single Owner / Third Party Operator - Microgrid Model



Third Party Owner / Third Party Operator - Microgrid Model



All Cases- Microgrid Model Island Mode



Questions