

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

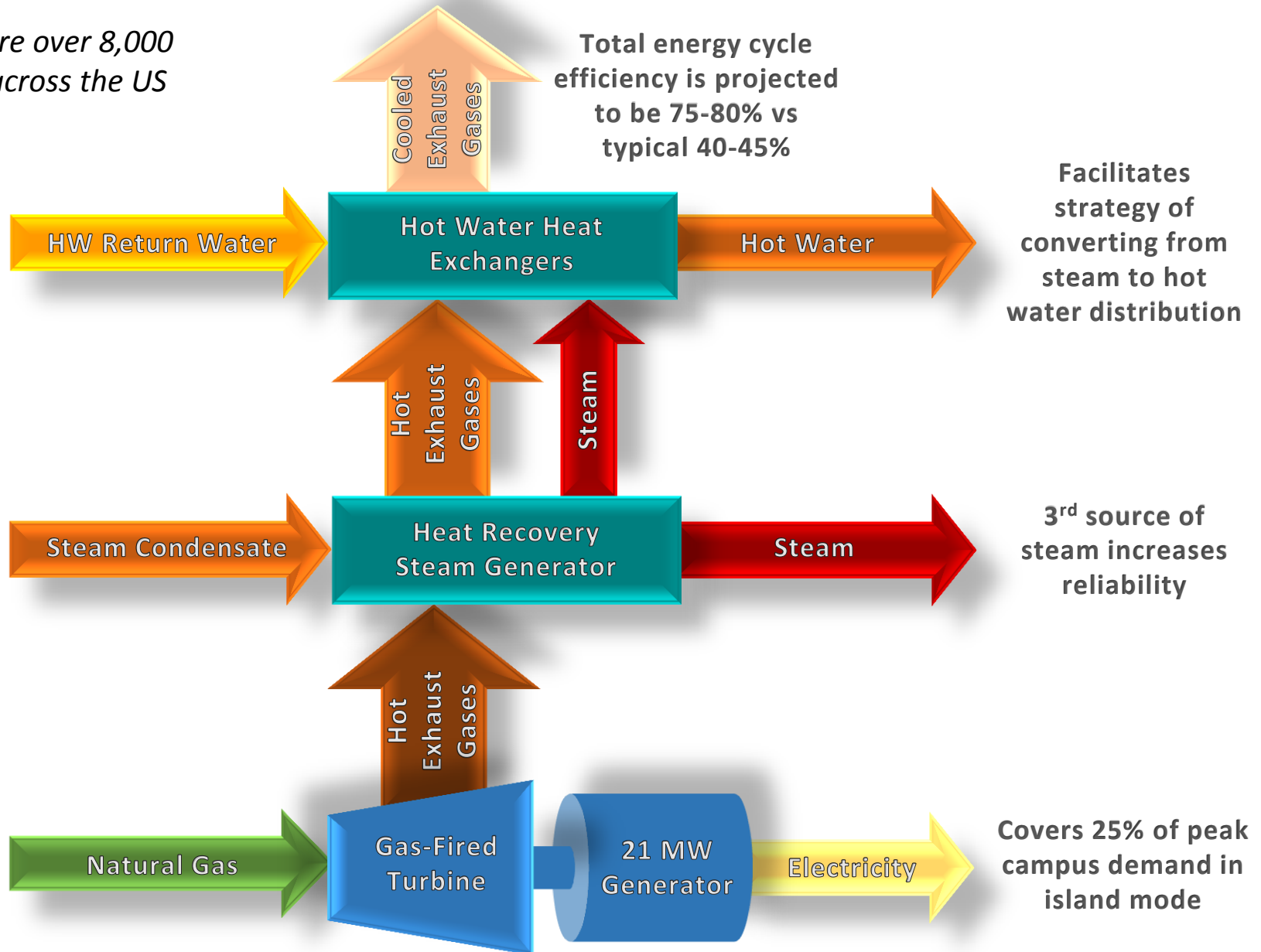
- ✦ Reliability:
 - Duke University electrical system total outage less than 6 seconds in 30 YEARS
- ✦ Rate:
 - Cost of electricity less than 8 cents per KWH
- ✦ Cost:
 - Large investment to build a CHP
- ✦ Skills:
 - No expertise to operate a large generating plant
- ✦ Legislation:
 - Change in the 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*



Benefits & Cost to Duke University

Benefits

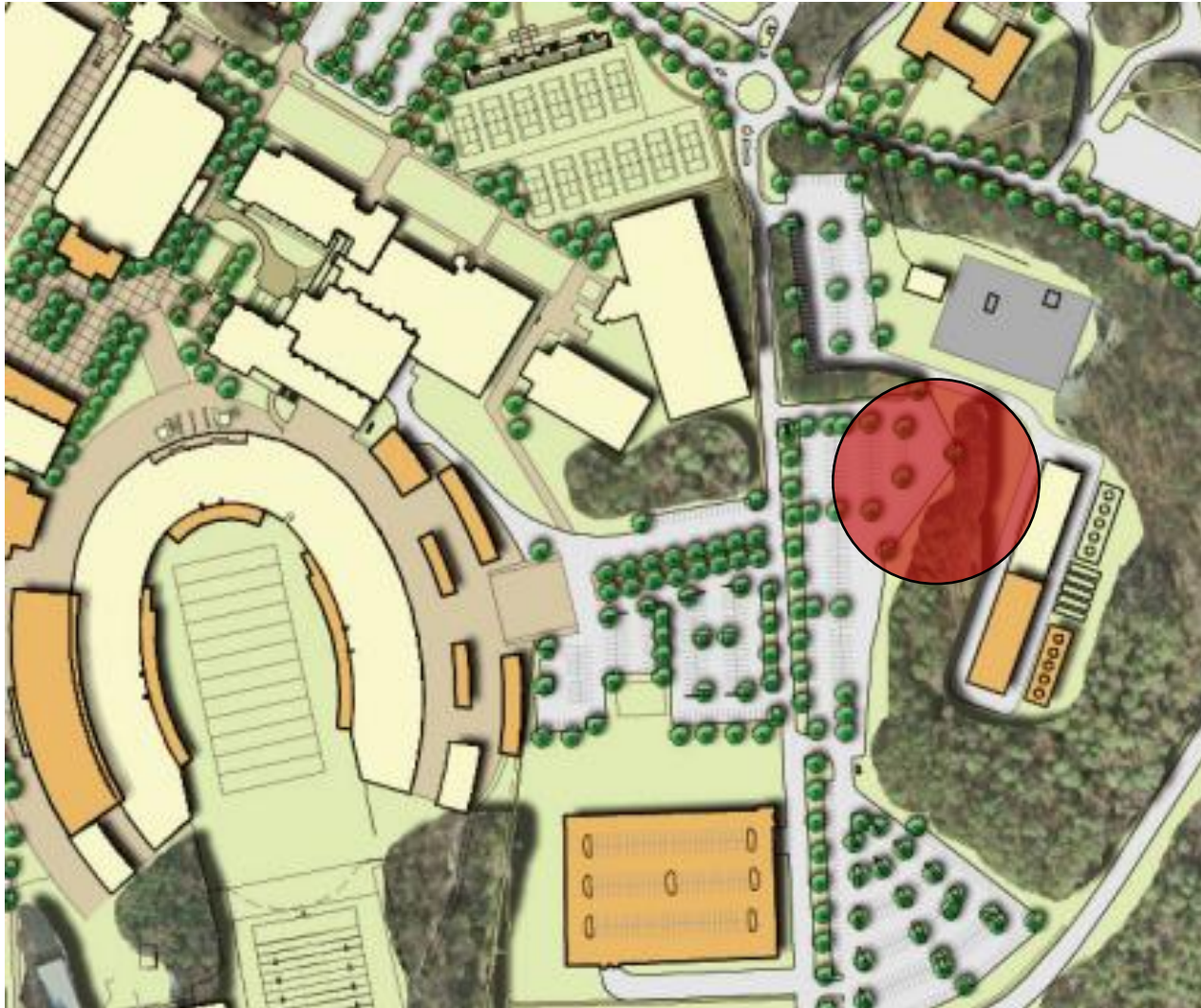
- ✦ Sustainability
 - 13% reduction of the 2015 CAP-reported carbon footprint (DU & SOM) (coal move was 12% of 2008 CAP)
 - 24% reduction in total University & Medical Center energy-related carbon
 - DU contributing to local and regional environmental sustainability
- ✦ Reliability
 - Increased energy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

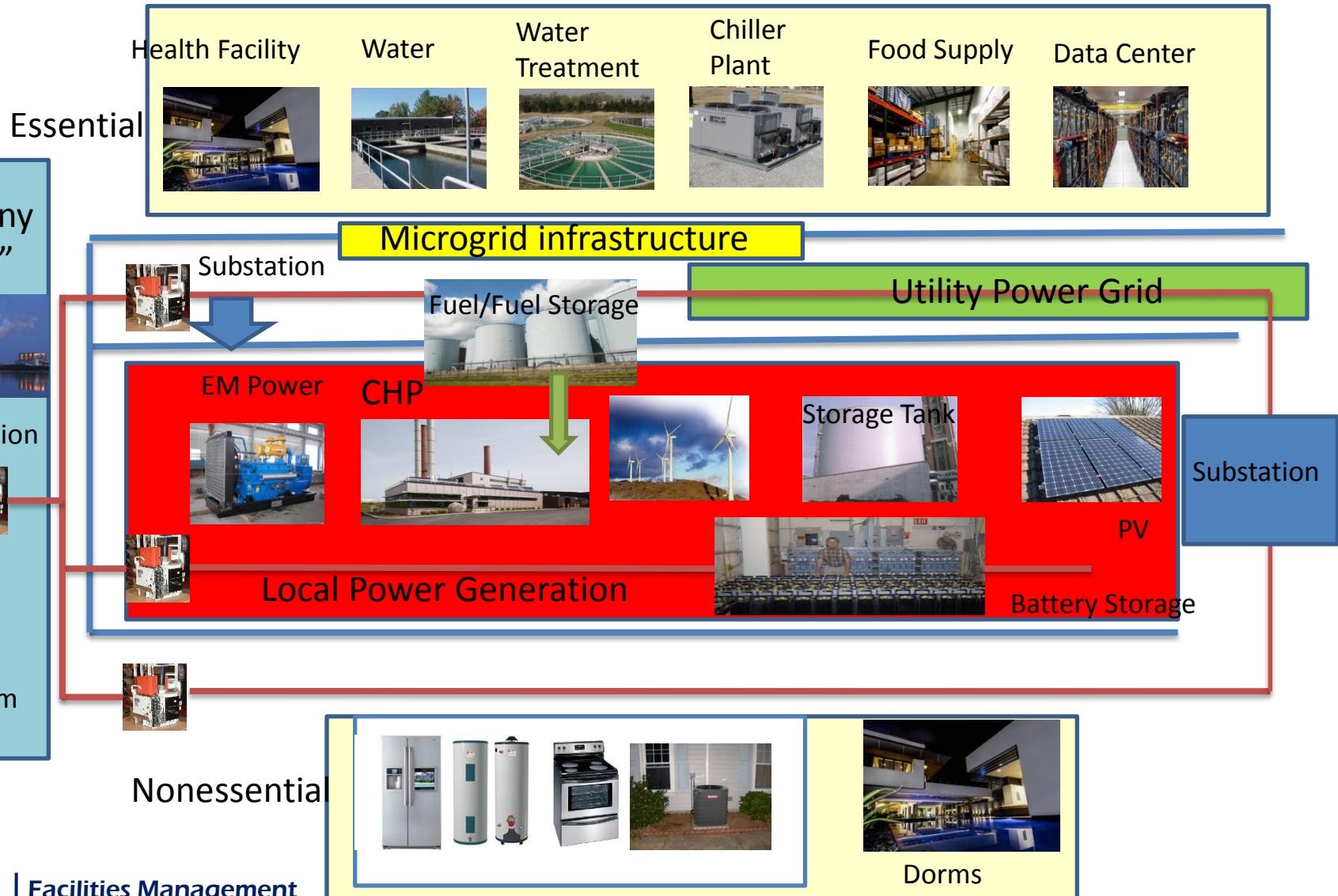
- ✦ Duke University would be leasing the land to Duke Energy for an extended period (35 years)
- ✦ In order to reliably operate our steam plants at a low load during summer, we would have to invest in modifications to the West Campus Steam Plant
- ✦ Project costs to connect the CHP plant to the campus 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

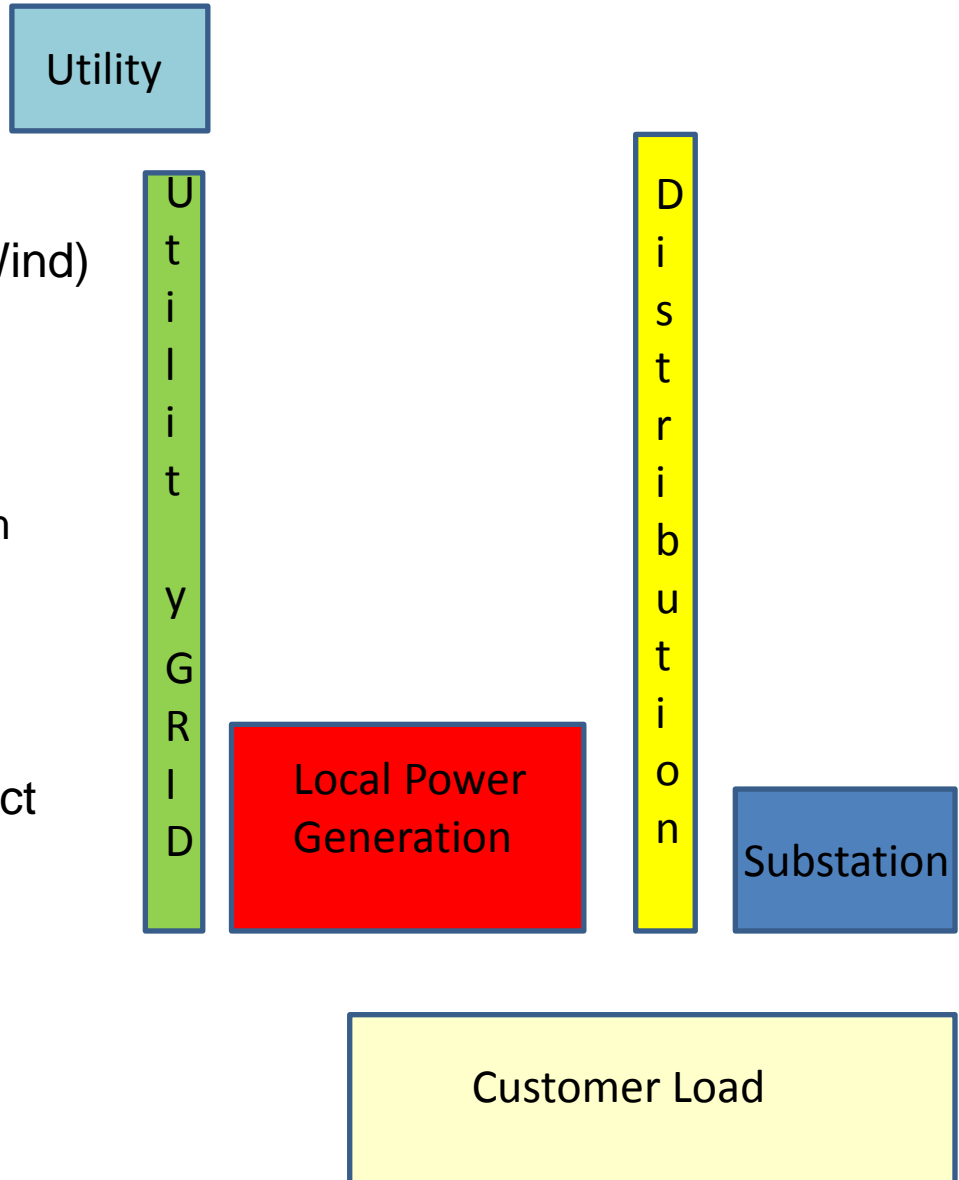


Microgrid Schematics

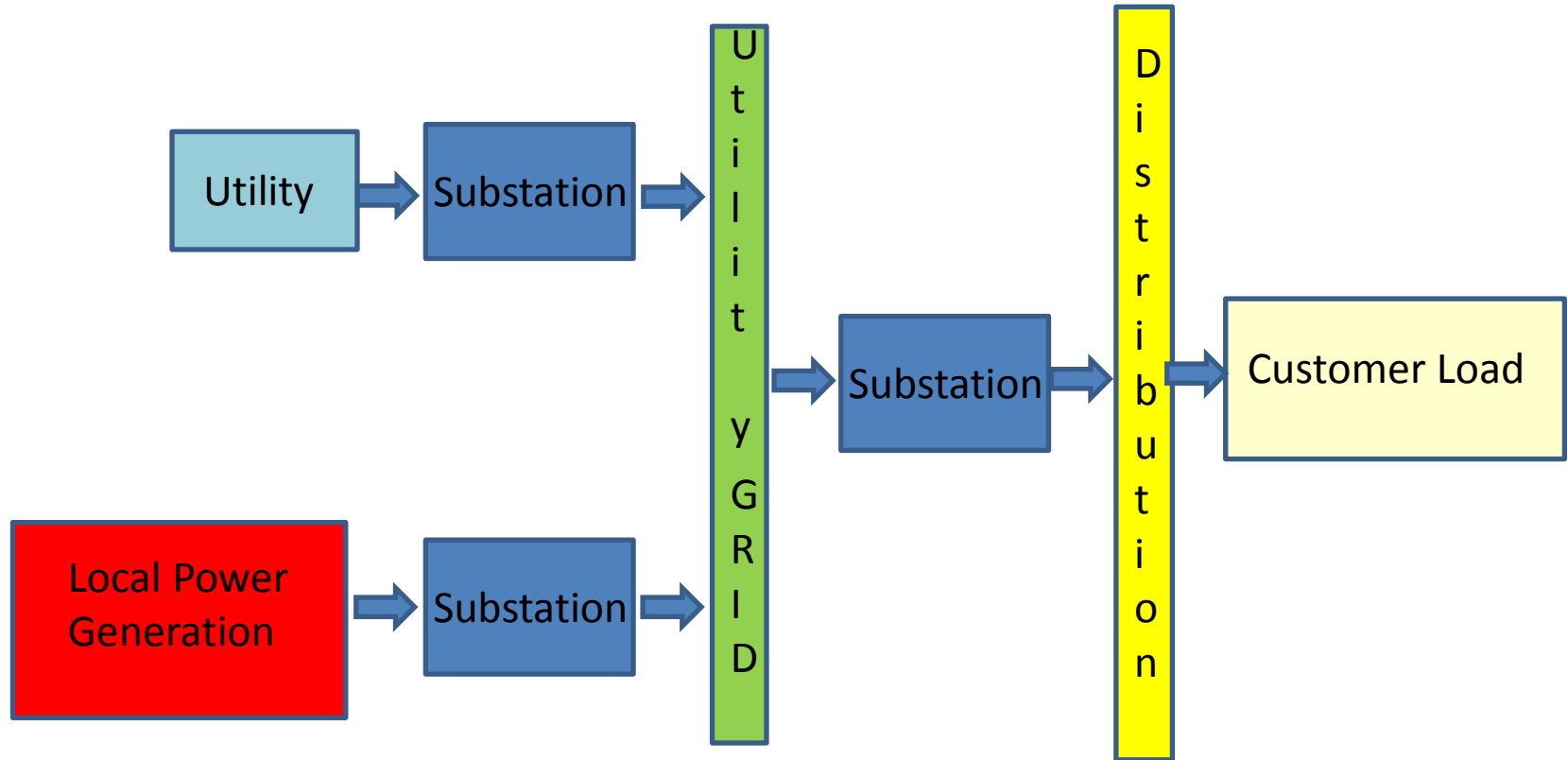


Microgrid Schematics

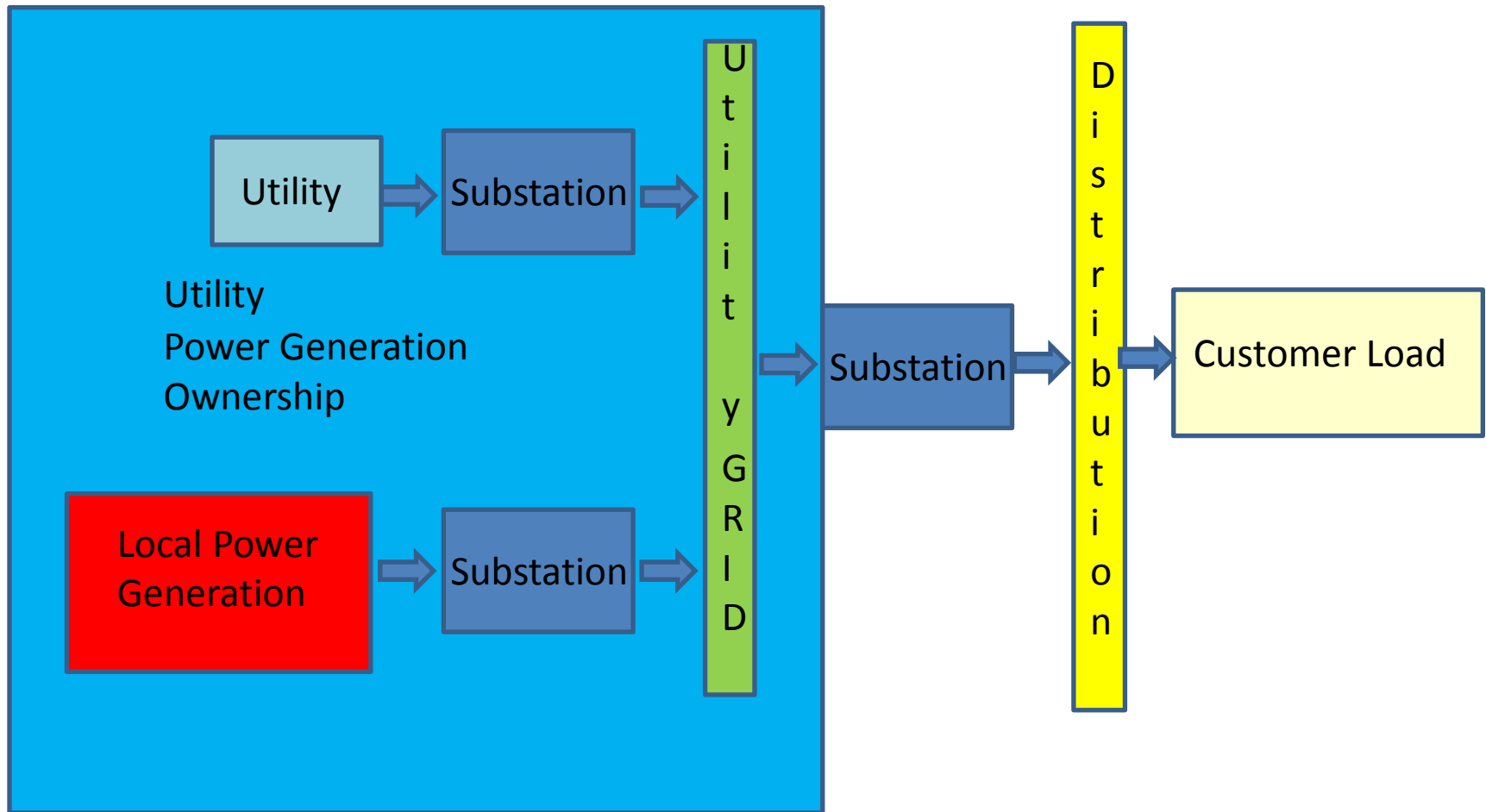
- ✦ Utility
- ✦ Local generating facility(CHP, PV, Wind)
- ✦ Distribution infrastructure
 - Utility Grid
 - Customer owned distribution system
- ✦ Connected load (customer load)
- ✦ Control Area / Substation/ Disconnect Location



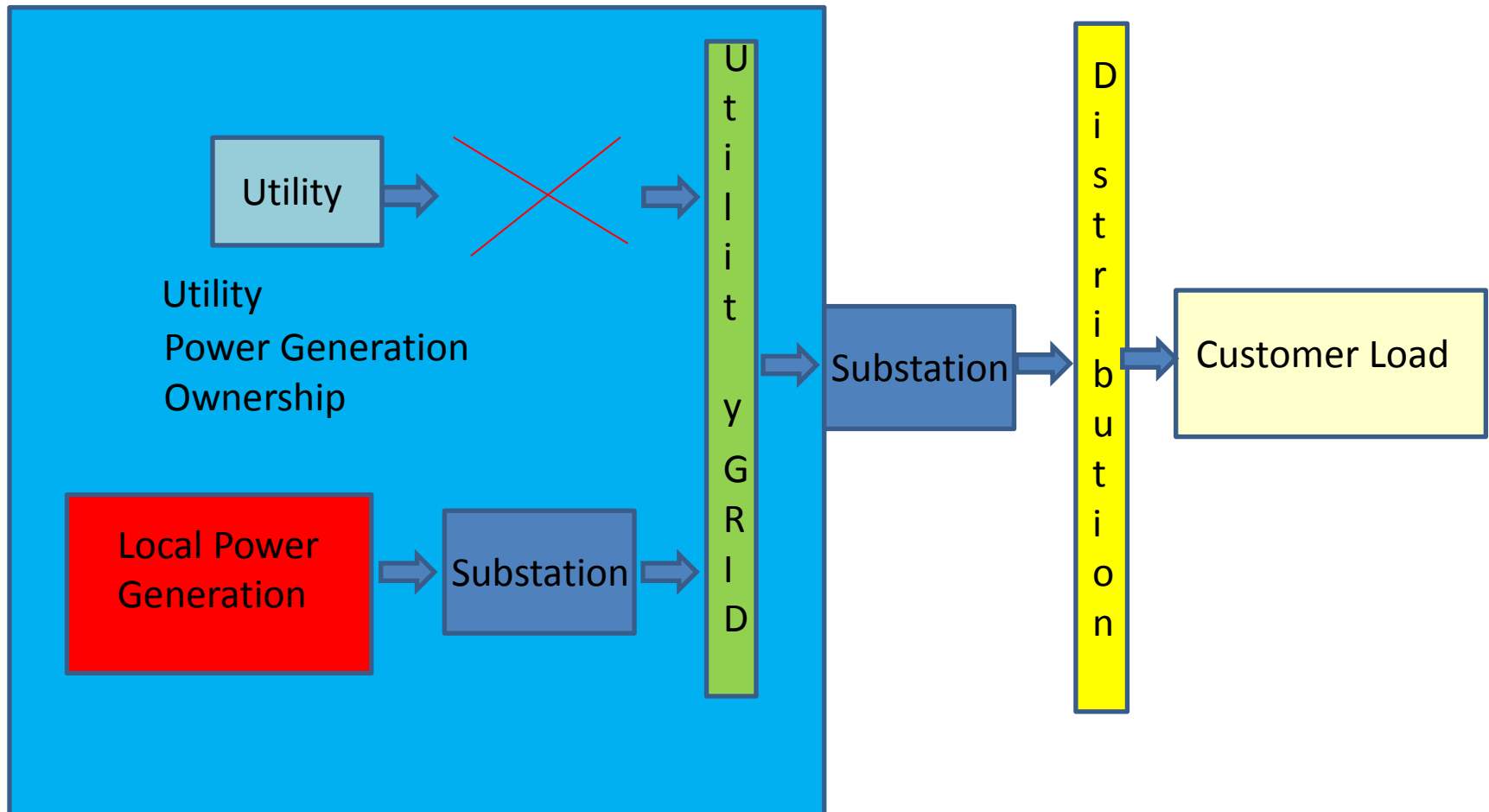
Duke University Microgrid Model



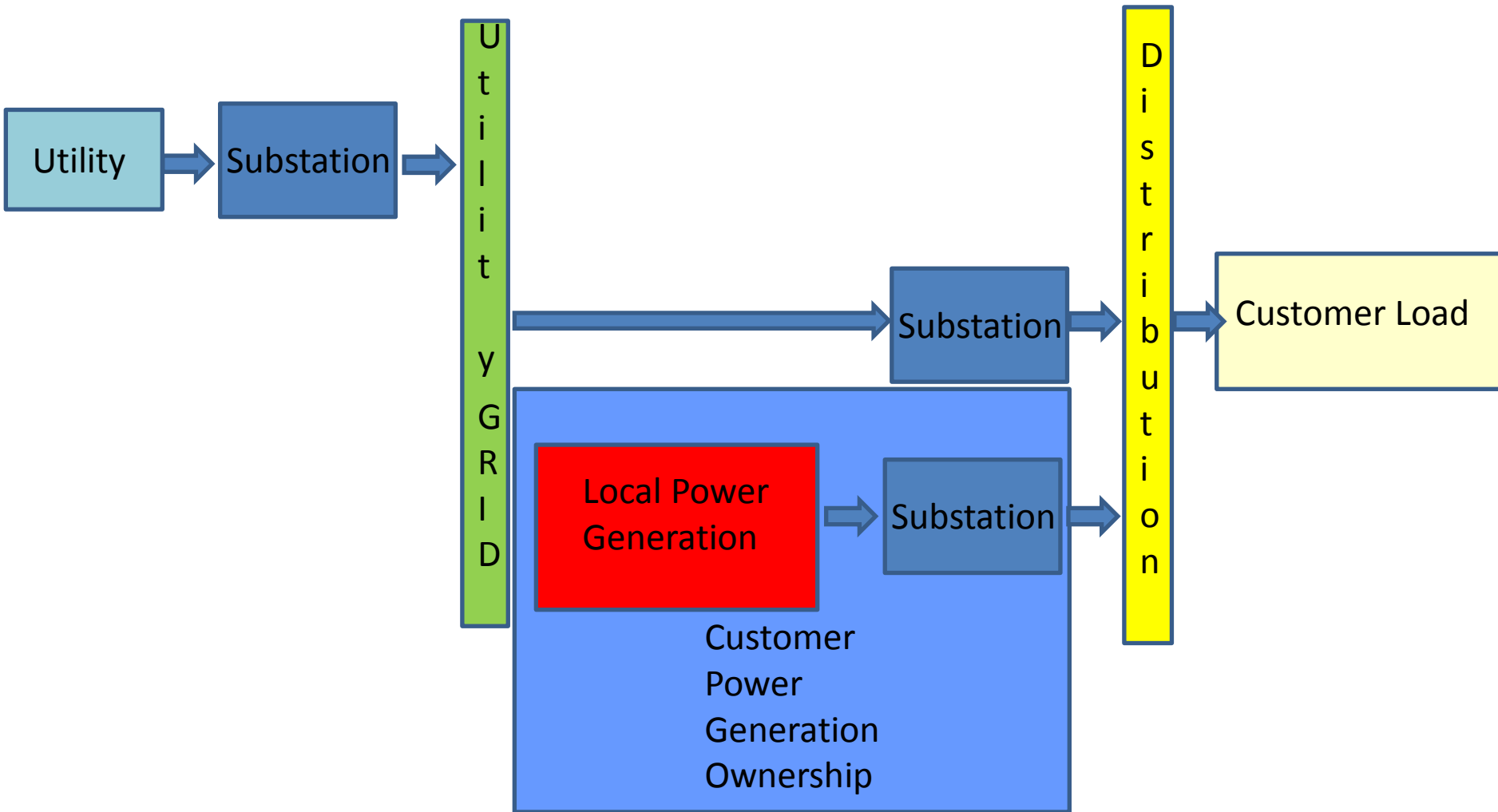
Duke University Microgrid Model



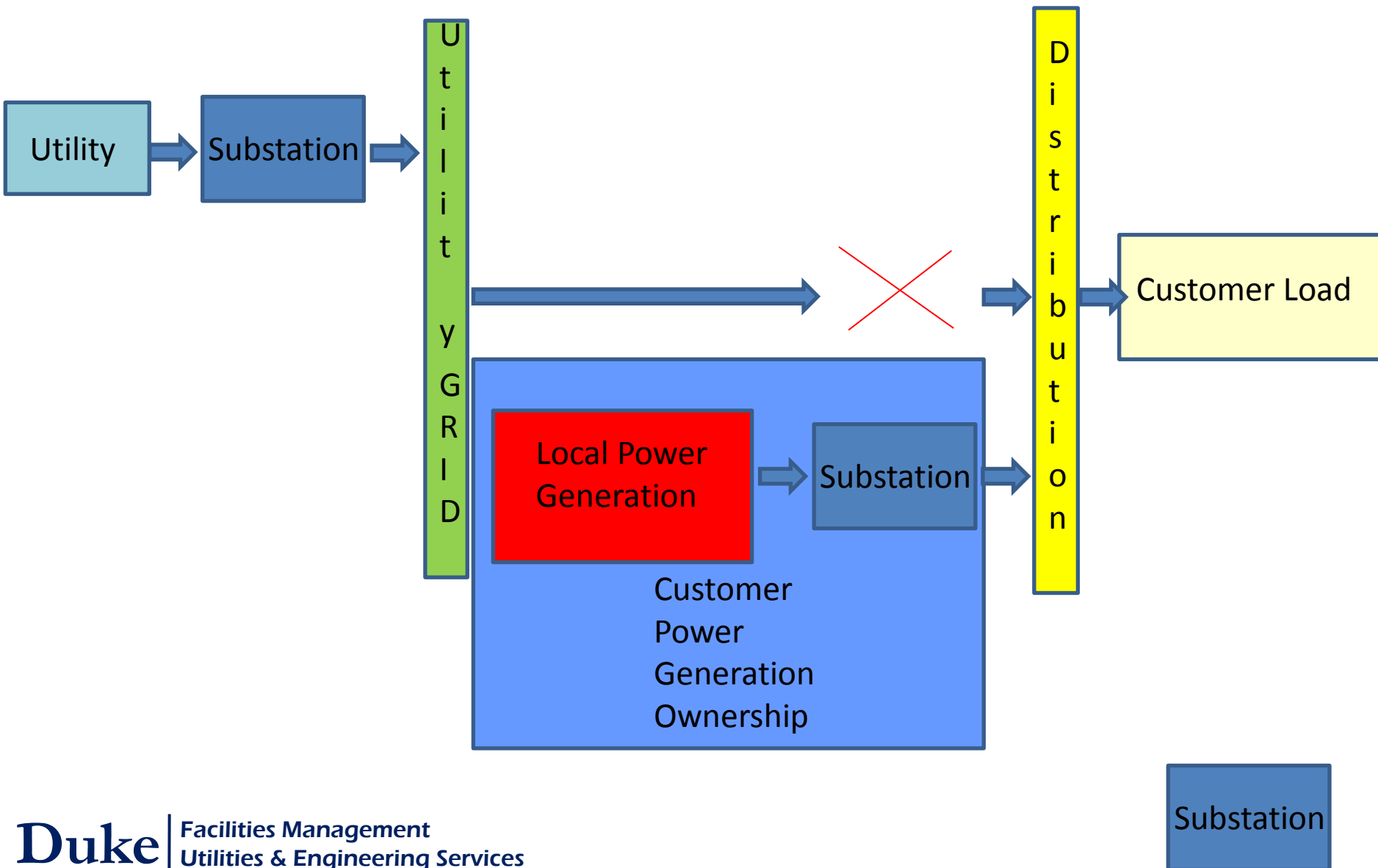
Duke University Microgrid Model – Island Mode



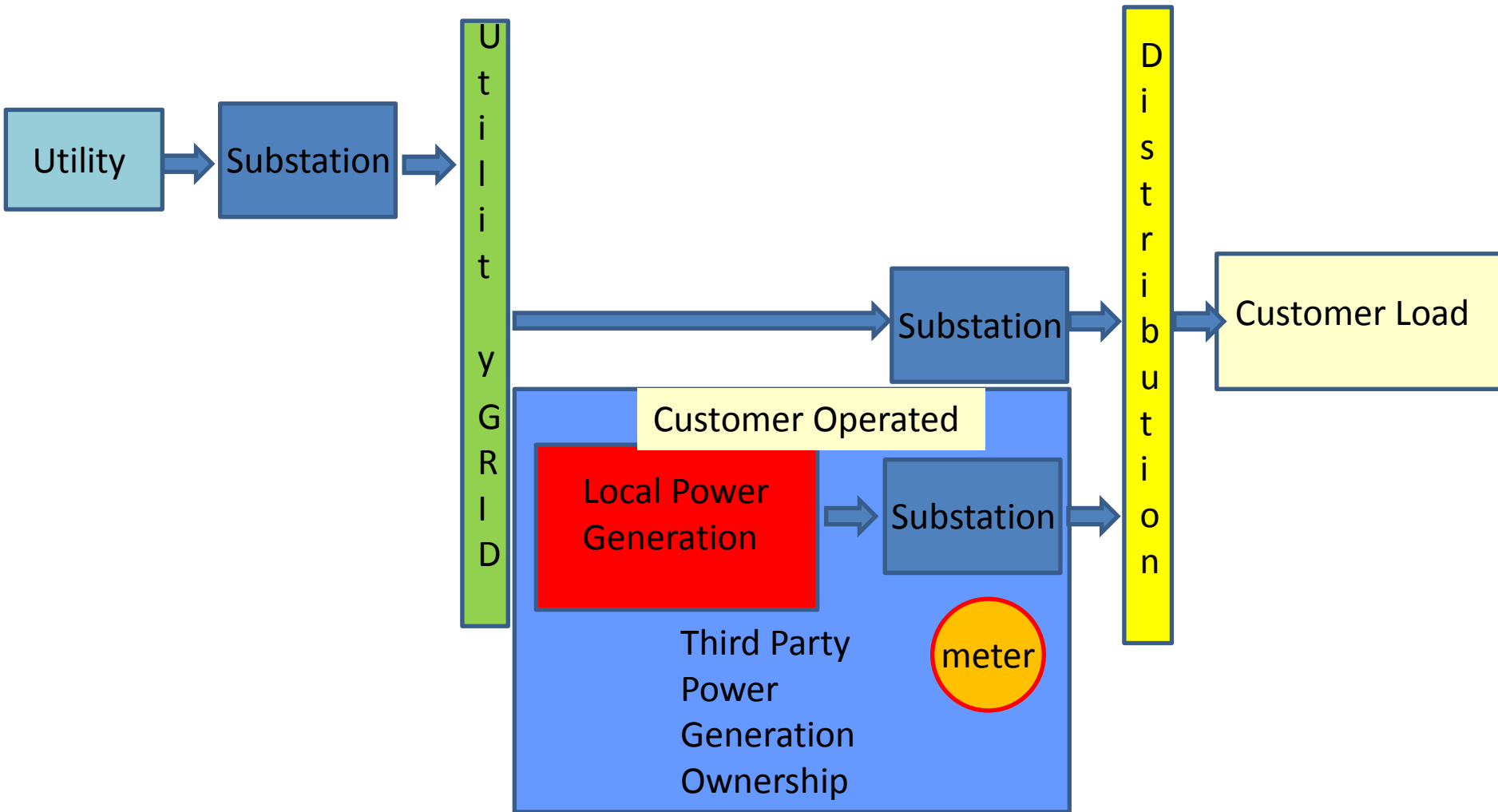
Single Owner / Single Operator - Microgrid Model



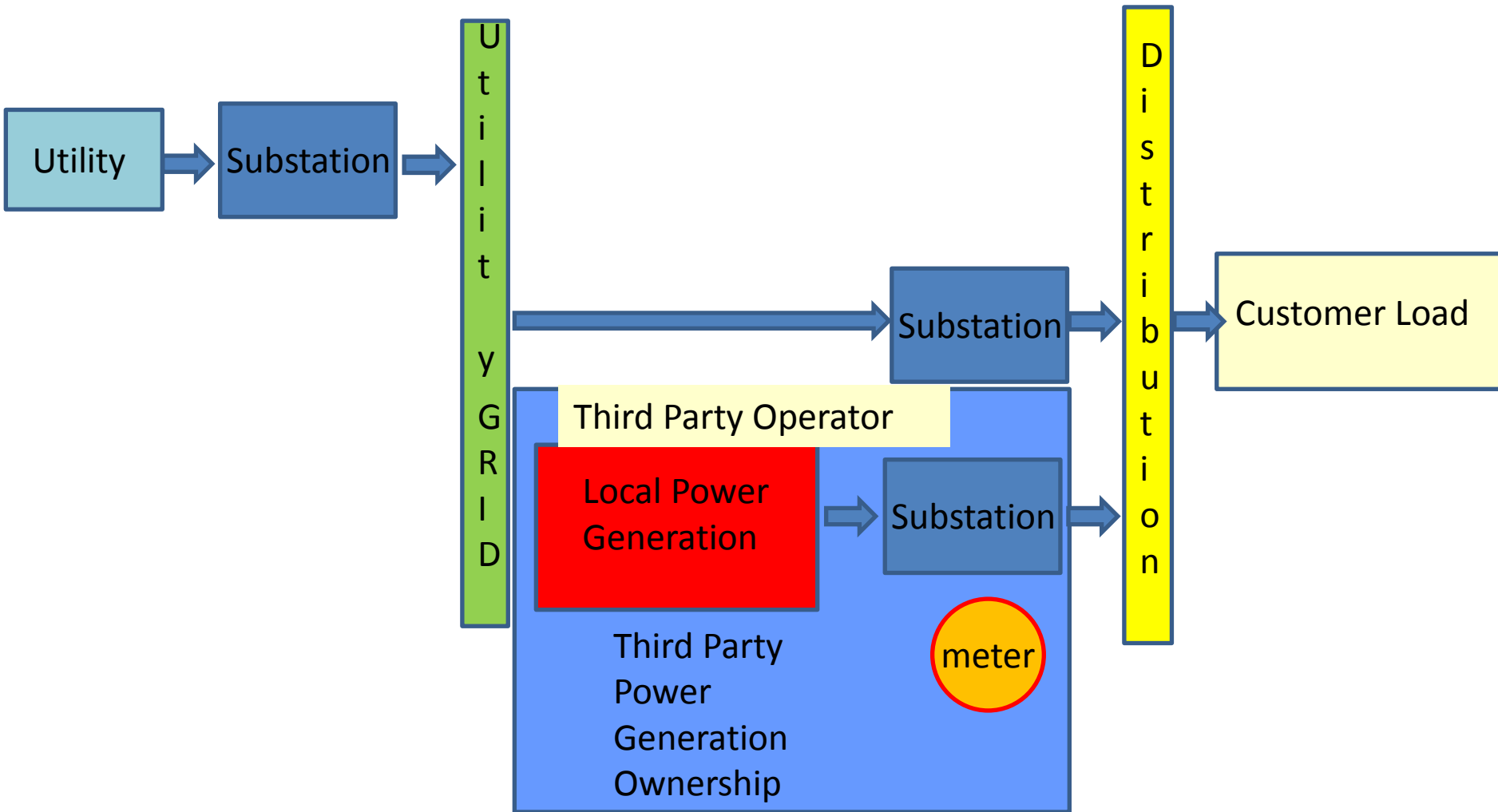
Single Owner / Single Operator - Microgrid Model Island Mode



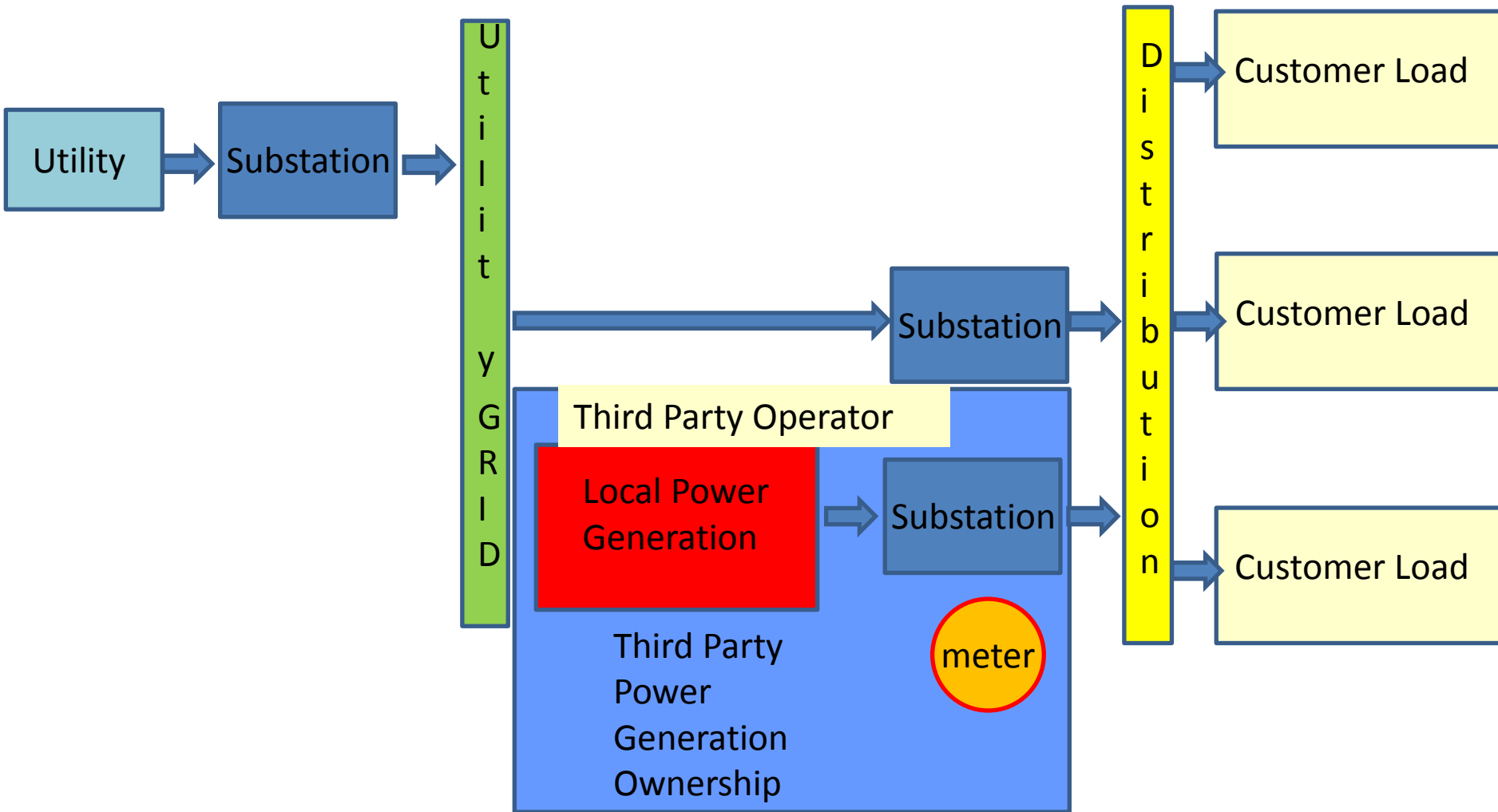
Third Party Owner / Single Operator - Microgrid Model



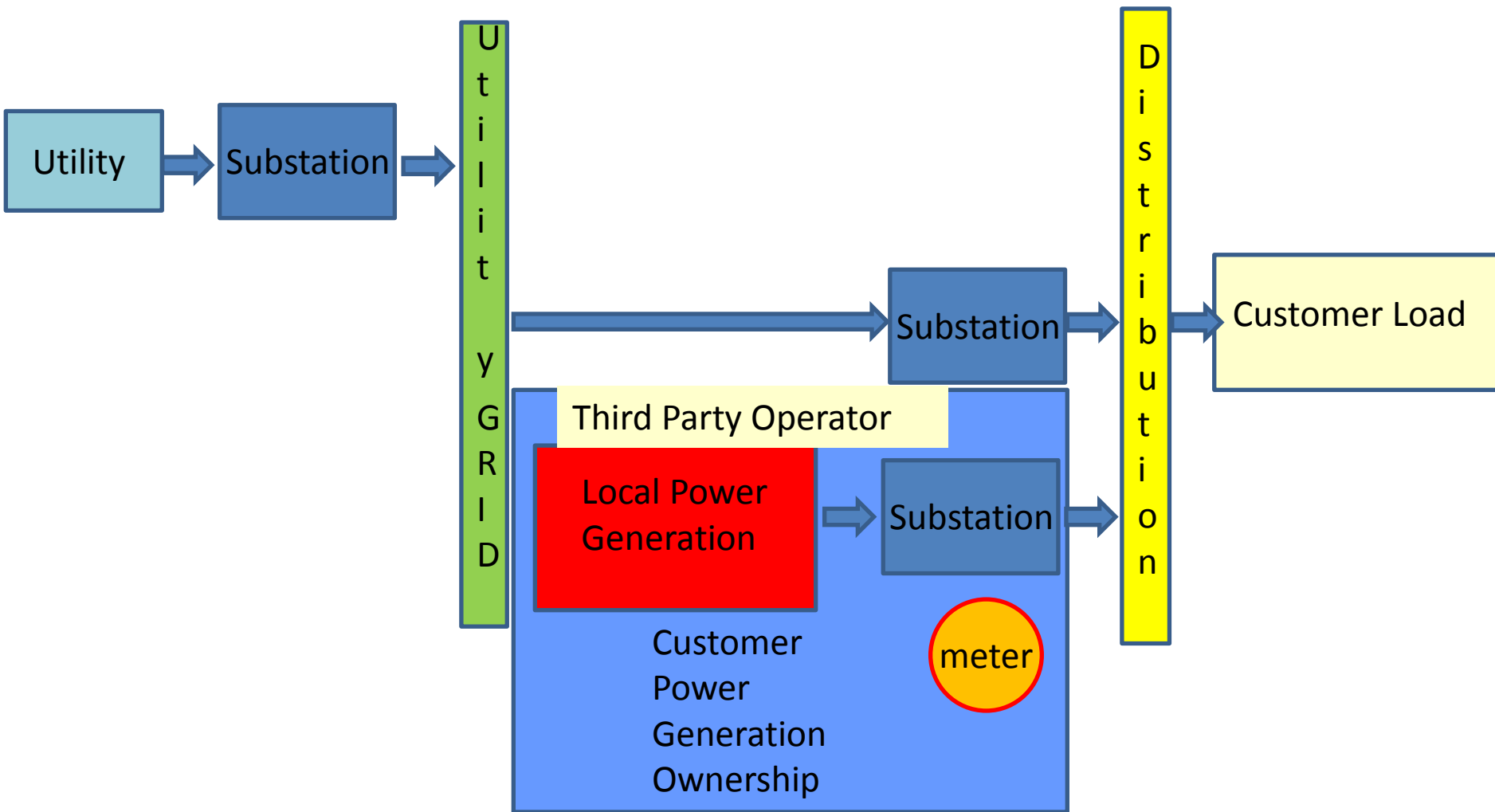
Third Party Owner / Third Party Operator - Microgrid Model



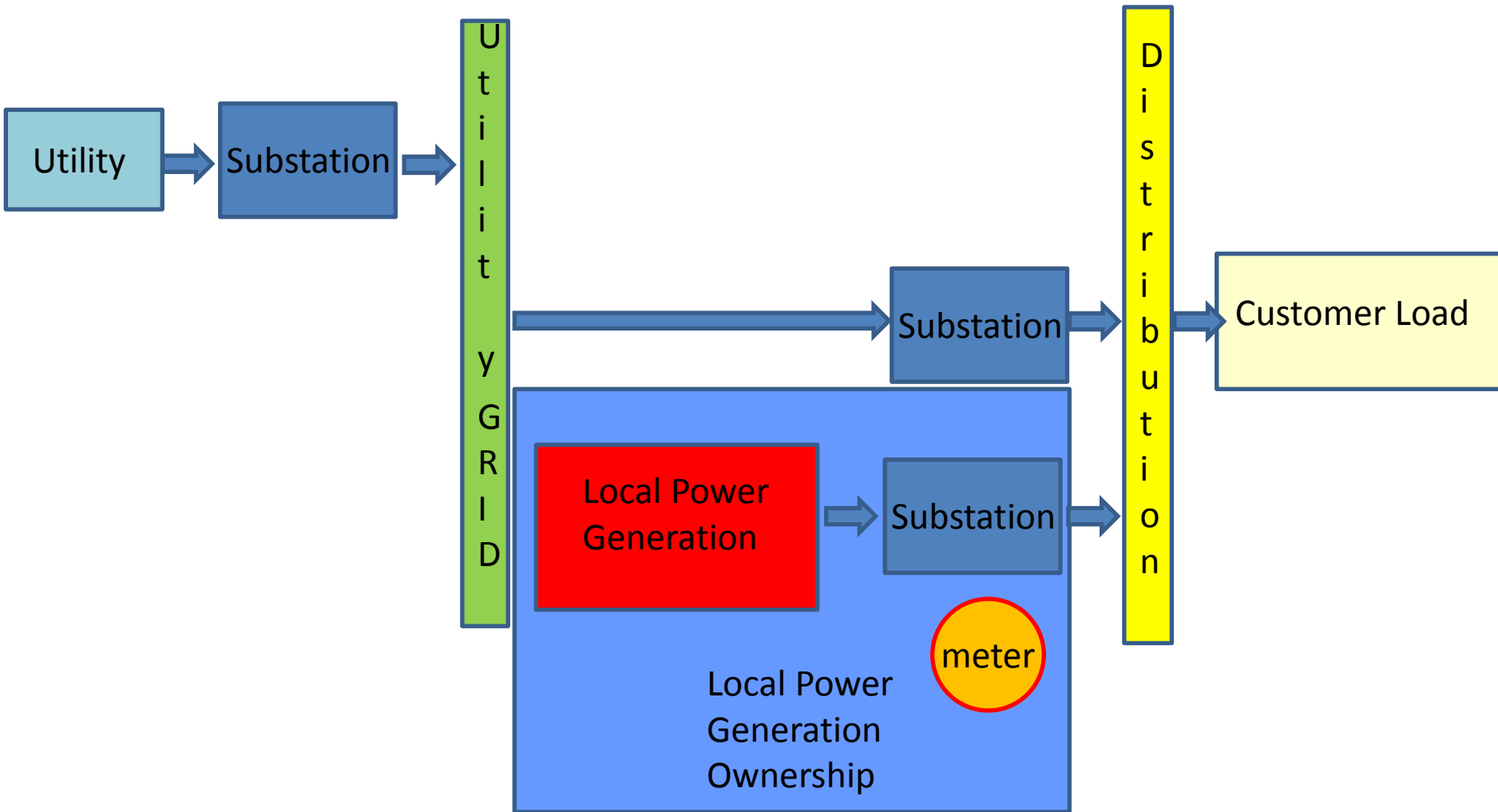
Third Party Owner / Third Party Operator – Multiple Customers



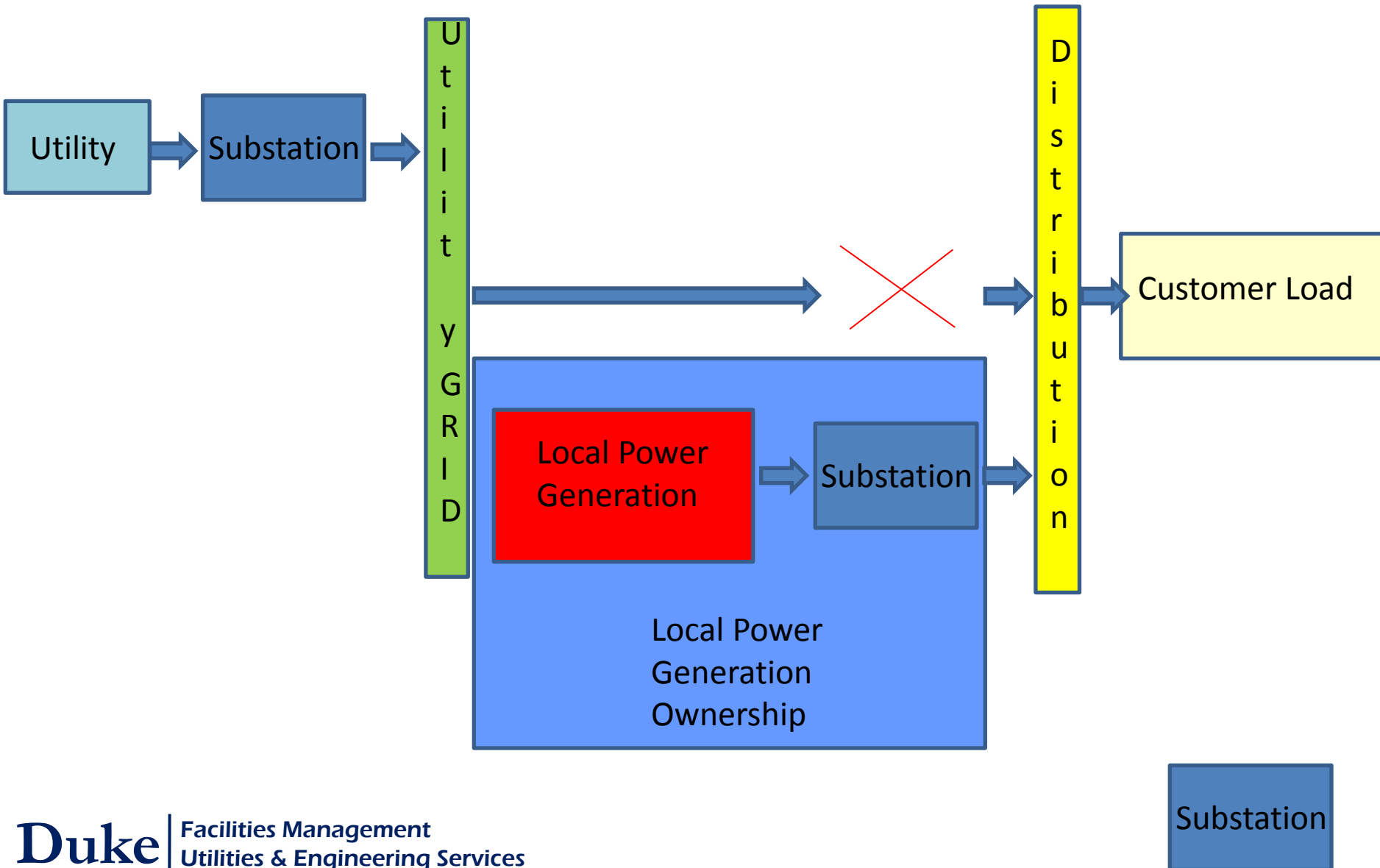
Single Owner / Third Party Operator - Microgrid Model



Third Party Owner / Third Party Operator - Microgrid Model



All Cases- Microgrid Model Island Mode



Questions