

Cogeneration: An ELECTRICAL PERSPECTIVE

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RENEWABLE DISTRIBUTED ENERGY SOURCES (DER)

- ❑ WIND
- ❑ WATER (HYDRO POWER)
- ❑ SUN
- ❑ GEOTHERMAL
- ❑ BIOMASS



WIND TURBINES IN LIVERMORE, CA



300KW HYDROTURBINES AT ACWD

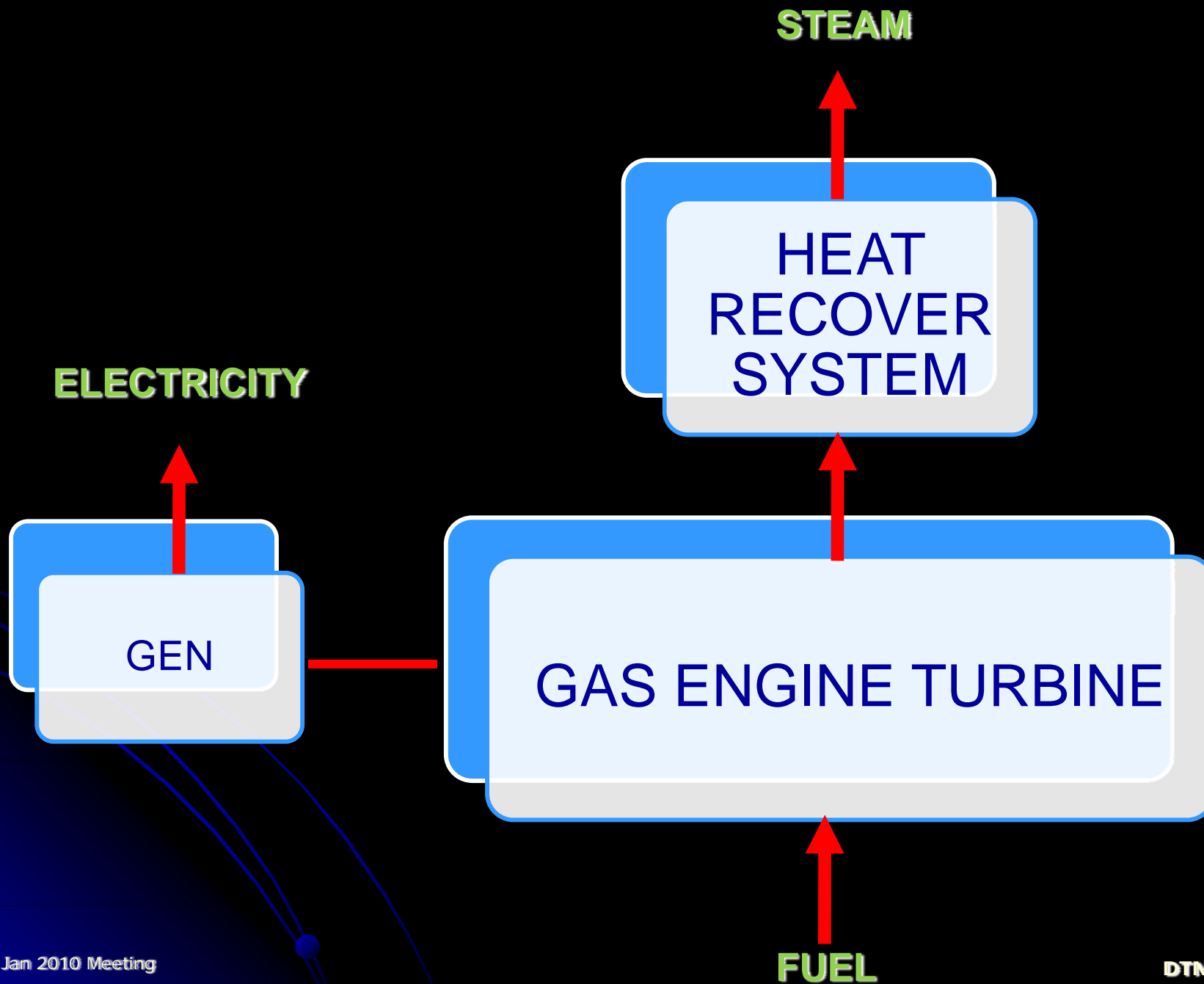


DUAL-AXIS SOLAR TRACKER AT WEST COUNTY WPCP RICHMOND CA



MANTRIA BIOFUEL POWER PLANT KNOXVILLE TN.

TRADITIONAL COGEN PLANT



7.5MW DIGESTER GAS COGEN PLANT



COGEN SWITCHGEAR



5MW DIGESTER GAS COGEN PLANT

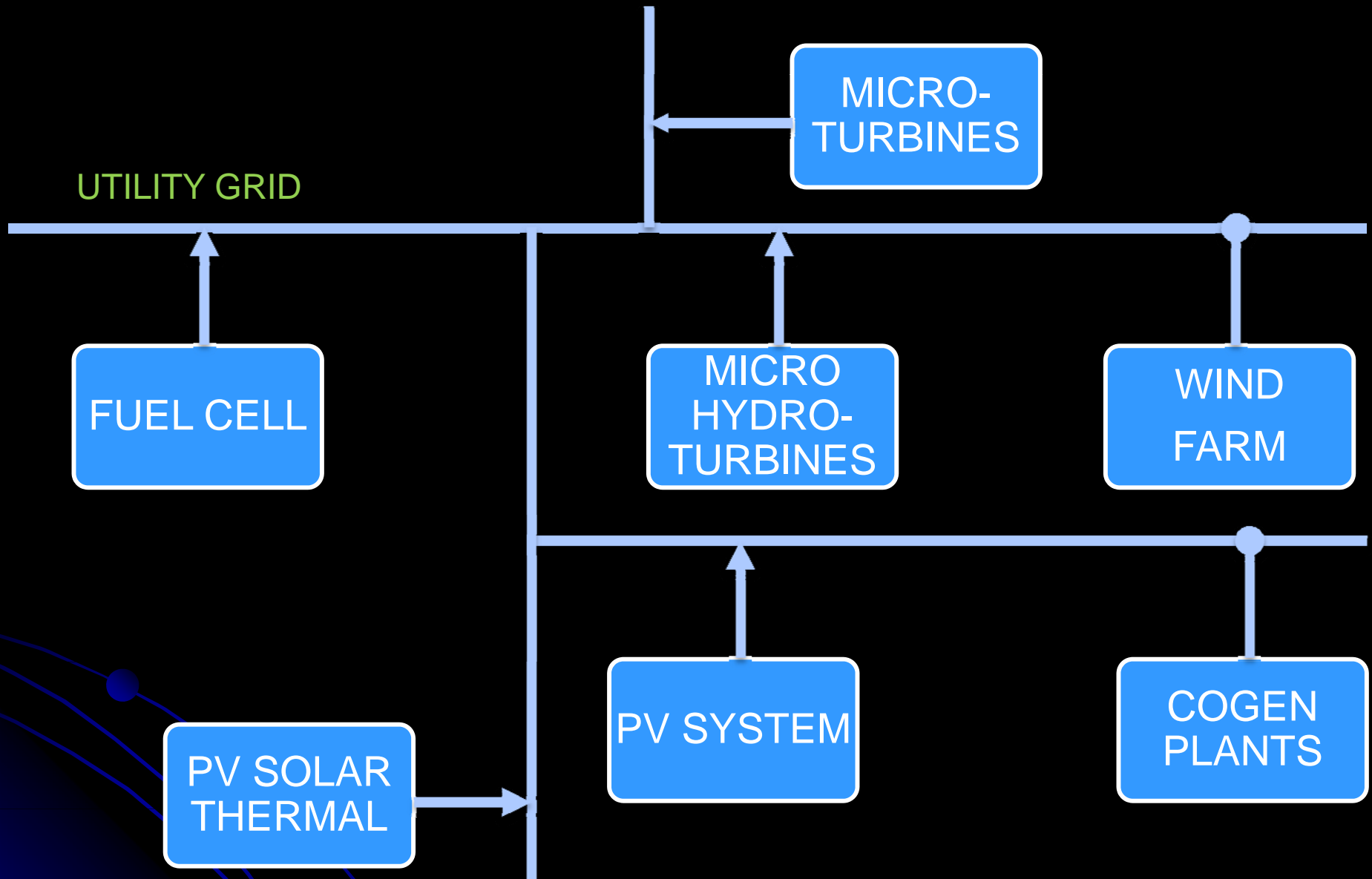


100KW DIGESTER GAS MICROTURBINE



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DISTRIBUTED GENERATION/MICROGRIDS



TWO IMPORTANT PG&E RULES

□ **RULE NO. 2**

□ **RULE NO. 21**

PG&E ELECTRIC RULE 2

DESCRIPTION OF SERVICES

- VOLTAGE
- SERVICE CONFIGURATION
- LOAD LIMITATIONS
- INTERFERENCES

PG&E ELECTRIC RULE 21

GENERAL FACILITY INTERCONNECTIONS

- ❑ Application Process
- ❑ Interconnection Requirements
- ❑ Protection Relays
- ❑ System Performance
- ❑ Metering, monitoring and Telemetry
- ❑ System Certification and Testing

PG&E INTERCONNECTION HANDBOOK (updated 2009)

IEEE 1547

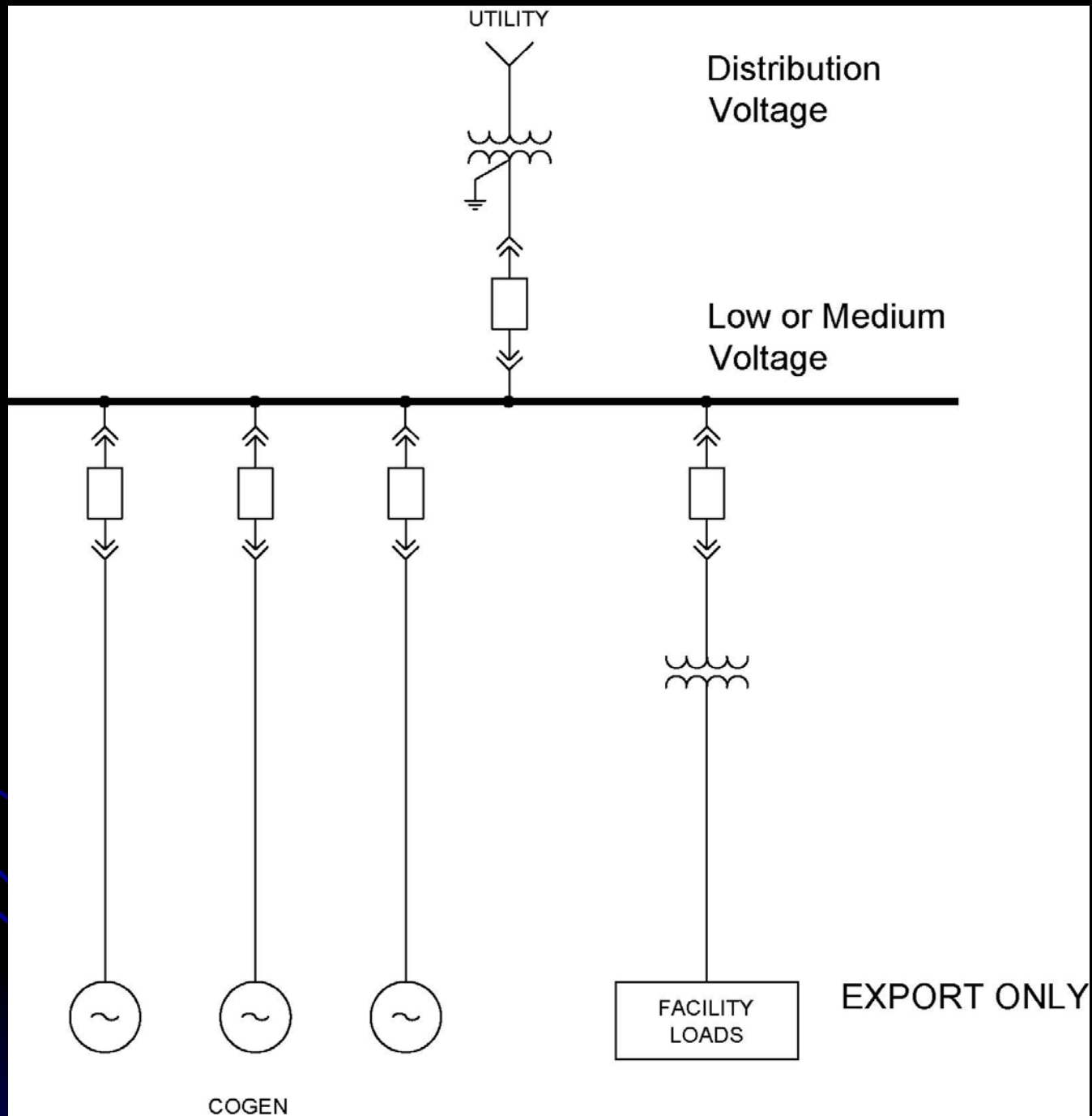
IEEE Standard for Interconnecting Distributed Energy Resources (DER) with Electric Power System

- Functional Requirements for interconnections. Not a design handbook or application guide
- Section 2 – Guide for interconnection
- Section 3 – Guide for monitoring, information exchange and control
- Section 4 – Guide for design, operation and integration of island system
- Section 5 – Guide for interconnection of sources larger than 10 MVA
- Section 6 – Recommended practice for interconnection w/secondary Network

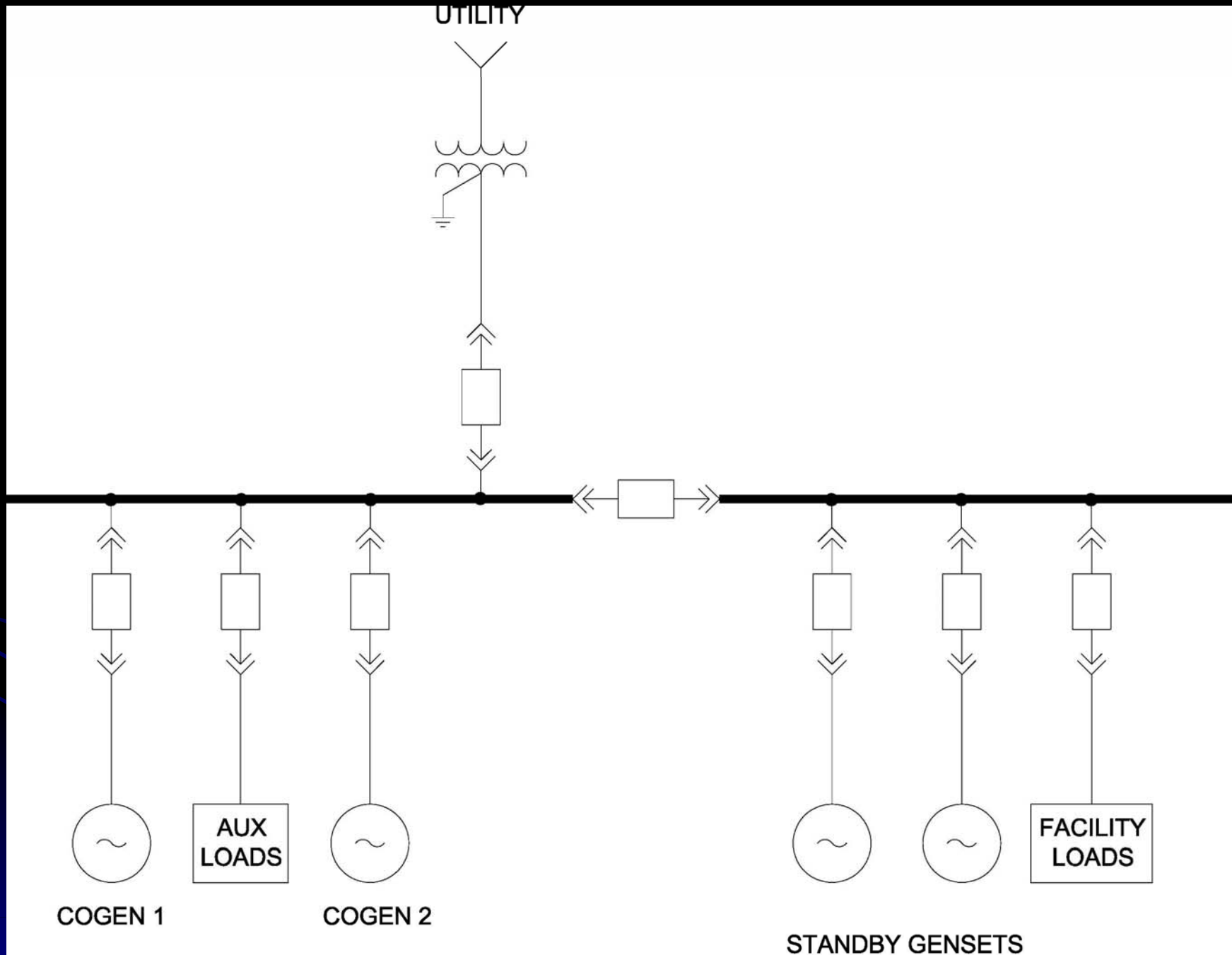
MAIN CONSIDERATIONS IN COGEN FACILITY DESIGN:

1. RELIABILITY
2. EQUIPMENT QUALITY
3. COSTS
4. REGULATION COMPLIANCE

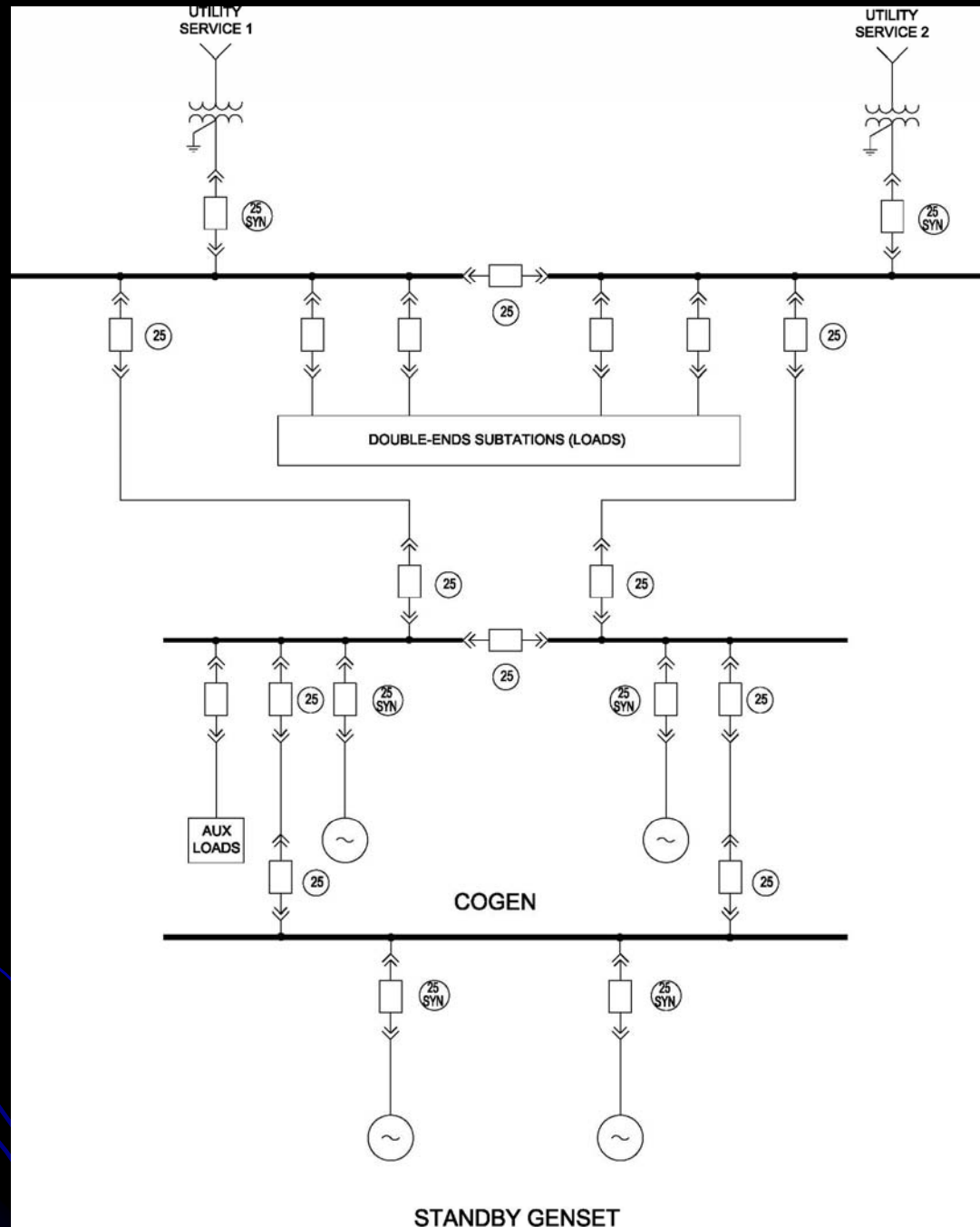
TYPICAL SINGLE-LINE DIAGRAM



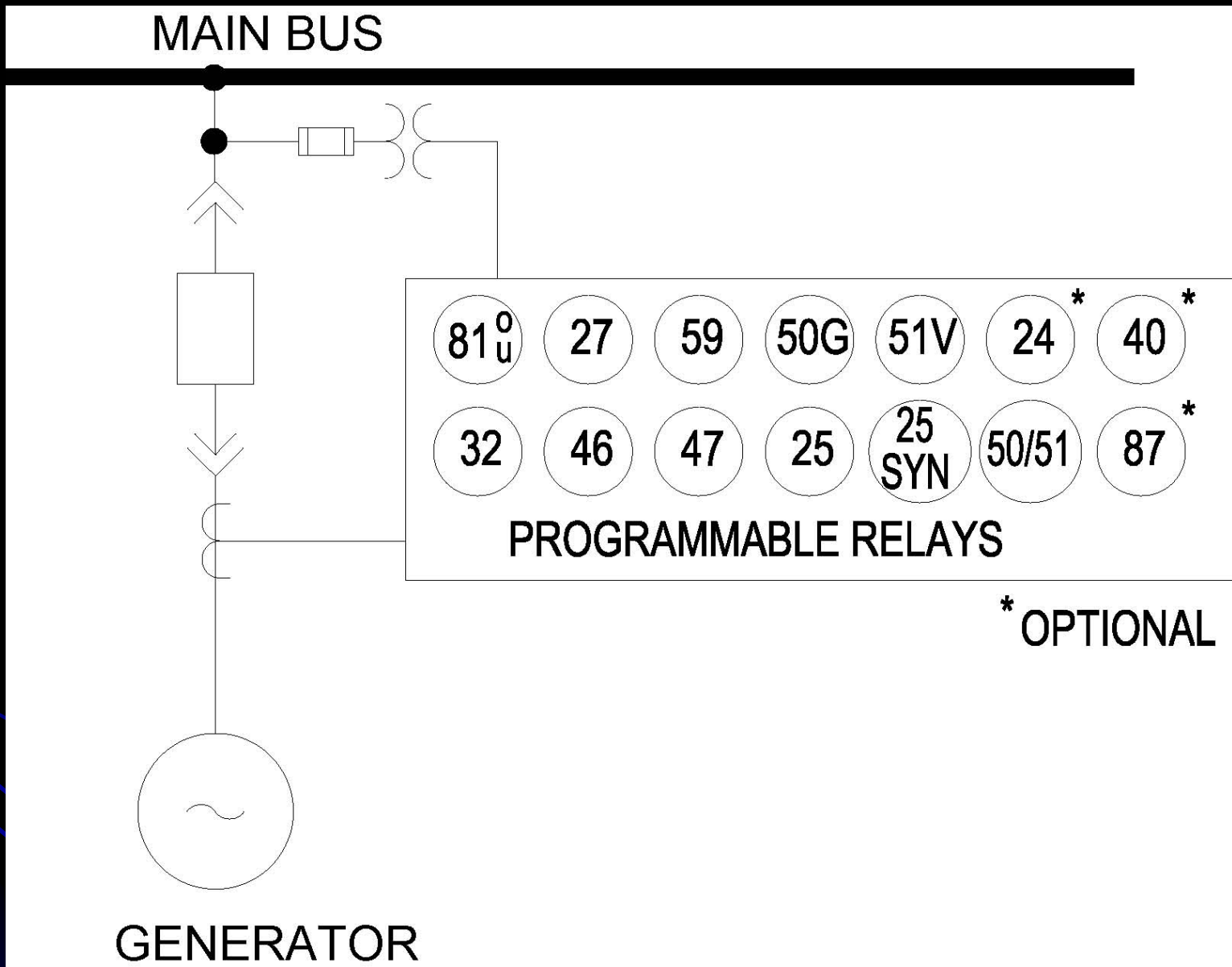
COGEN SYSTEM – SINGLE UTILITY SERVICE



COGEN SYSTEM – DUAL UTILITY SERVICE



BASIC PARALLELING PROTECTION



ELECTRICAL SWITCHGEAR STANDARD RATINGS

**Short
Circuits**

**Circuits
Breakers**

UL

250 MVA

1200A

ANSI/IEEE C37.20.2

350 MVA

2000A

500 MVA

3000A

(Formerly UL-1670

750 MVA

4000A

Metal-Clad SWGR)

1000 MVA

1500 MVA

(UL-891
UL-1558

Switchboards
Metal-enclosed SWGR
Low voltage)

LOAD SHEDDING SYSTEM:

- A. FREQUENCY-BASED (Hz)
- B. LOAD -BASED (KW)

LOAD INHIBITING SYSTEM

- A. ESSENTIAL LOADS
- B. NON-ESSENTIAL LOADS

COGEN FACILITY AUXILIARY SYSTEMS

- 1. FUEL SUPPLY**
- 2. CONTROL SYSTEM (SCADA)**
- 3. STANDBY POWER (BLACK START)**
- 4. FIRE PROTECTION SYSTEM**
- 5. COMMUNICATIONS**

QUESTIONS

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