University of Sallahadin
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## Distributed Generation

### Chapter Three

# Microturbine Generator

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# Introduction

- Microturbine generator systems are considered as distributed energy resources which are interfaced with the electric power distribution system.
- They are most suitable for small to medium-sized commercial and industrial loads.
- The microturbine provides input mechanical energy for the generator system, which is converted by the generator to electrical energy.

# MTG Main Components

# Technical Background

- MTG‘s are small, high speed power plants that usually include the turbine, compressor, generator and power electronics to deliver the power to the grid.
- These small power plants typically operate on **natural gas**.
- In general MTG can be divided into three primary sub-systems: **Mechanical**, **Electrical and Control**, and **Fuel**.

# Mechanical System

- Mechanically the MTG is a single shaft, gas turbine with compressor, power turbine and permanent magnet alternator being mounted on the same shaft.
- The MTG incorporates centrifugal flow compressors and radial inflow turbine.
- During engine operation, engine air is drawn into the unit and passes through the recuperator where temperature is increased by hot exhaust gases.

# Mechanical System

- The air flows into the combustor where it is mixed with fuel, ignited and burnt.
- The ignitor is used only during start up and then the flame is self-sustaining.
- The combusted gas passes through the turbine nozzle and turbine wheel converting the thermal energy of the hot expanding gases to rotating mechanical energy of the turbine.

# Mechanical System

- The turbine drives the compressor and the generator.
- The gas exhausting from the turbine is directed back through the recuperator and then out of the stack.
- MTG‘s have a high speed gas turbine engine driving an integral electrical generator that produces 30-250 KW power while operating at a high speed generally in the range of 50,000-120,000 rpm.

# Electrical and Control System

Electrical and control system of MTG including:

1. Engine Controller.
2. Power Conditioning System.
3. Power Controller.

# Electrical and Control System

**Engine Controller**: It's features includes :

- Automated start sequence
- Battery or utility start
- Gas or liquid fuel algorithm
- Recuperated or simple cycle engines
- Fault detection and protection
- Advanced user interface

The design is fully digital to give it the flexibility of adaptation to different engine types and makes it more precise.

# Electrical and Control System

## Power Conditioning System

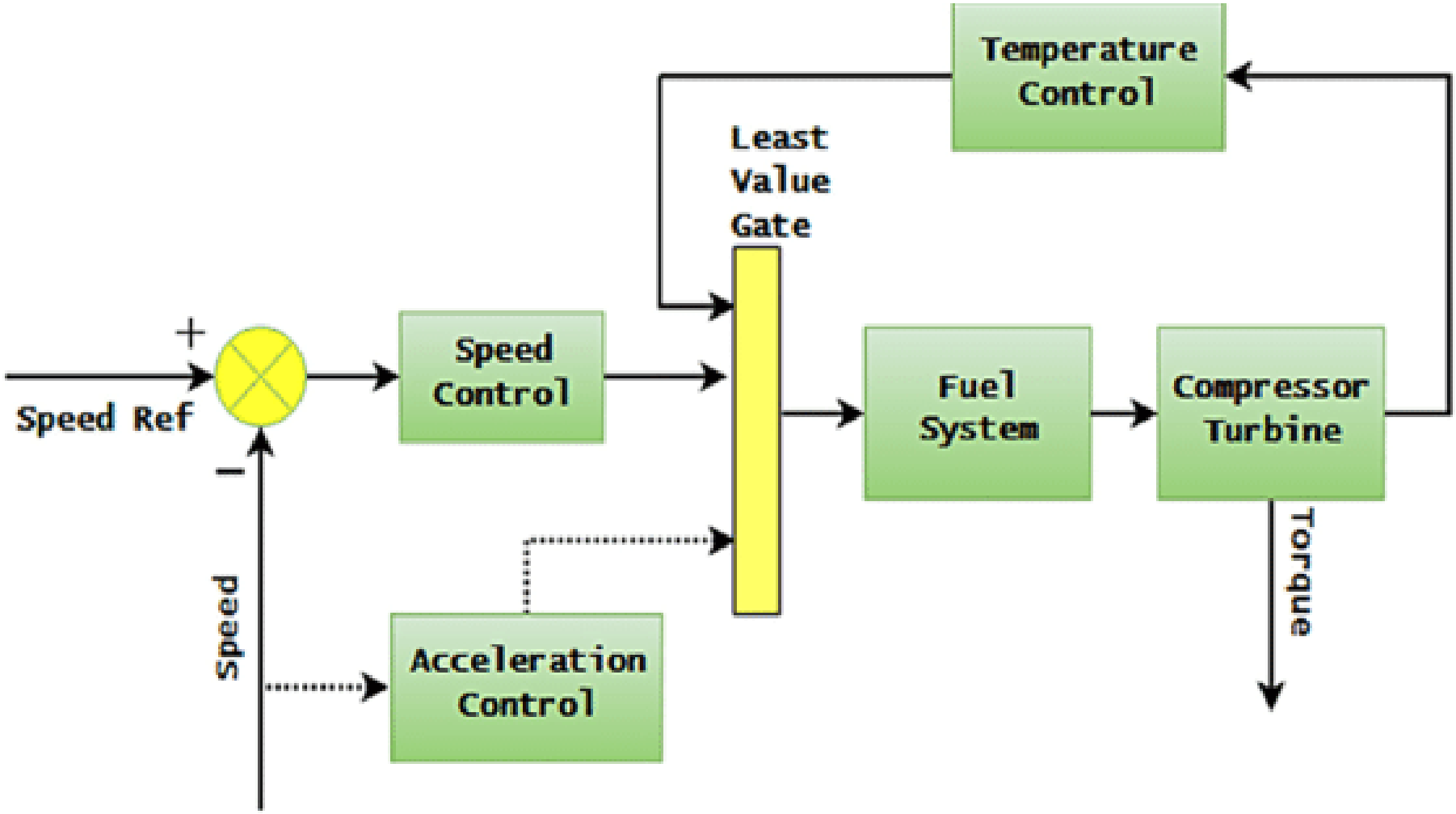
- Converts the unregulated, variable-frequency output of the alternator into a high quality, regulated waveform.
- The system can be selected to operate as a stand-alone power source [island mode] and in parallel with a site utility supply [utility mode].
- Manages the interaction with any applied load both in stand-alone and utility connect modes.

# Electrical and Control System

## Power Controller

- The overall power conversion process is managed by an advanced microprocessor-based control system.
- Control algorithms and filtering techniques allows the system to maintain under 3% voltage distortion level.
- Fault-clearing feature permits the supply of short duration overload current to operate a circuit breaker.
- This prevents interruption to the remaining site load in the event of localized load faults.

# MTG Block Diagram



# Operational Modes

There are two modes of operation: **Island** and **Utility.**

**Island mode operation** allows the generator system to supply a load without a site utility supply present.

- Typical applications include supply of electrical power in isolated locations, mobile applications and emergency power in the case of utility failure.

**Utility mode operation** allows the system to operate in parallel with the utility.

- This mode is cost effective.

# Operational Modes

- There are three modes under **Utility mode operation**:
- **Export mode**: the system can export power to the utility and meet current harmonic limits as specified.
- **Load following mode**: allows on-site power generation to be balanced with site demand resulting in zero power flow to the utility. This maximizes the benefit of embedded generation.
- **Peak demand mode**: the system can be operated just during times of peak demand which reduces the tariff.

# Advantage and Disadvantage

**ADVANTAGE**

- Cheap and easy installation and maintenance
- Less emission level and noise production
- Wide range of benefits in terms of operational and fuel flexibility, service performance and maintainability.

**DISADVANTAGE**

- Time-variable electrical and thermal demand distorts MTG' s energy balance sometimes leading to larger fuel requirement.

# Applications

- Distributed power generation
- Stand-alone power
- Backup/standby power
- Primary power with grid as backup
- Micro grid
- Resource recovery
- Combined heat and power (co-generation)
- Transportation applications

# Next Lecture

- Solar Energy

# Questions and Thank you