Distributed Generation Integration Tool (DiGIT)

Donald Fournier/Roch Ducey

BRC-UIUC/ERDC

Mission Essential Load Determination

- Determination of applicable technology depends upon:
  - Load size and type.
  - Available renewable resources.
  - Available fuel resources.
  - Technology status and viability.
  - Installation preferences.
  - Load duration and reliability requirements.
- Determination of the loads first step to solution matrix.

Assessment of Technologies to Meet Mission Essential Loads

- Focus on electrical power provided by clean, distributed generation.
- By clean we mean:
  - Biomass
  - Solar
  - Wind
  - Geothermal
  - Hydrogen/Natural Gas
  - Hydro (low head)
- Technologies under review:
  - Microturbines
  - Fuel Cells
  - Photovoltaics
  - Wind Power

DiGIT Application Matrix

Technology		Application					
		Standby Power	Low-cost Energy	Stand-alone System	Combined Heat & Power	Peak Shaving	Power Quality
Energy Generation	Diesel Engine	✓	✓	✓	✓	✓	
	Natural Gas Engine	✓	✓	✓	✓	✓	
	Dual Fuel Engine	✓	✓	✓	✓	✓	
	Microturbine	✓		✓	✓	✓	
	Combustion Turbine	✓	✓	✓	✓	✓	
	Fuel Cell		(1)	✓	✓		
	Photovoltaics		(1)	✓		✓	
	Wind Turbine		(1)	✓			
Energy Storage	Uninterruptible Power Supply (UPS)	✓					✓
	Battery System	✓					✓
	Flywheel	✓					✓
	Superconducting Magnetic Energy Storage (SMES)						✓
	Hybrid Systems (2)	✓	✓	✓	✓	✓	✓

(1) Although fuel cells, photovoltaics, and wind turbines may not offer the lowest cost power option, their low environmental impacts greatly enhance the value of the power they provide.
(2) Hybrid systems are any combination of the technologies listed above.

More DiGIT Technologies

- existing diesel engine generator
- existing natural gas engine generator
- convert diesel to 80/20 NG/diesel (or replace with dual-fuel)
- clean diesel generator (custom sized)
- NG IC engine - 4 stroke lean burn (custom sized)
- 30-kW microturbine
- 70-kW microturbine
- 100-kW microturbine
- 150-kW microturbine
- 250-kW microturbine
- H_2 1-kW proton exchange membrane fuel cell (PEMFC)
- NG 5-kW PEMFC
- 200-kW phosphoric acid fuel cell (PAFC)
- 250-kW solid oxide fuel cell (SOFC)
- 250-kW direct fuel cell
- 600-kW grid-connected wind turbine
- 750-kW grid-connected wind turbine
- 950-kW grid-connected wind turbine
- 1500-kW grid-connected wind turbine
- grid-connected PV (custom sized)
- stand-alone PV with battery bank (custom sized)
- 30-MW CFB combined cycle gasifier
- 3-MW biogasifier steam turbine
- 1-MW biomass crop gasifier - ICE
- 55-kW STM PowerUnit (Stirling cycle)
- 2-MW microgrid

DiGIT Technologies - Miroturbines

- Sizes:
  - 30kW
  - 70kW
  - 250kW
- Fuel Options:
  - Hydrogen
  - Natural Gas
  - Propane
  - Diesel
  - Kerosene
  - Biogas
  - Landfill Gas
- Applications:
  - Prime power
  - Running backup
  - Cogeneration

PowerWorks 250 SM

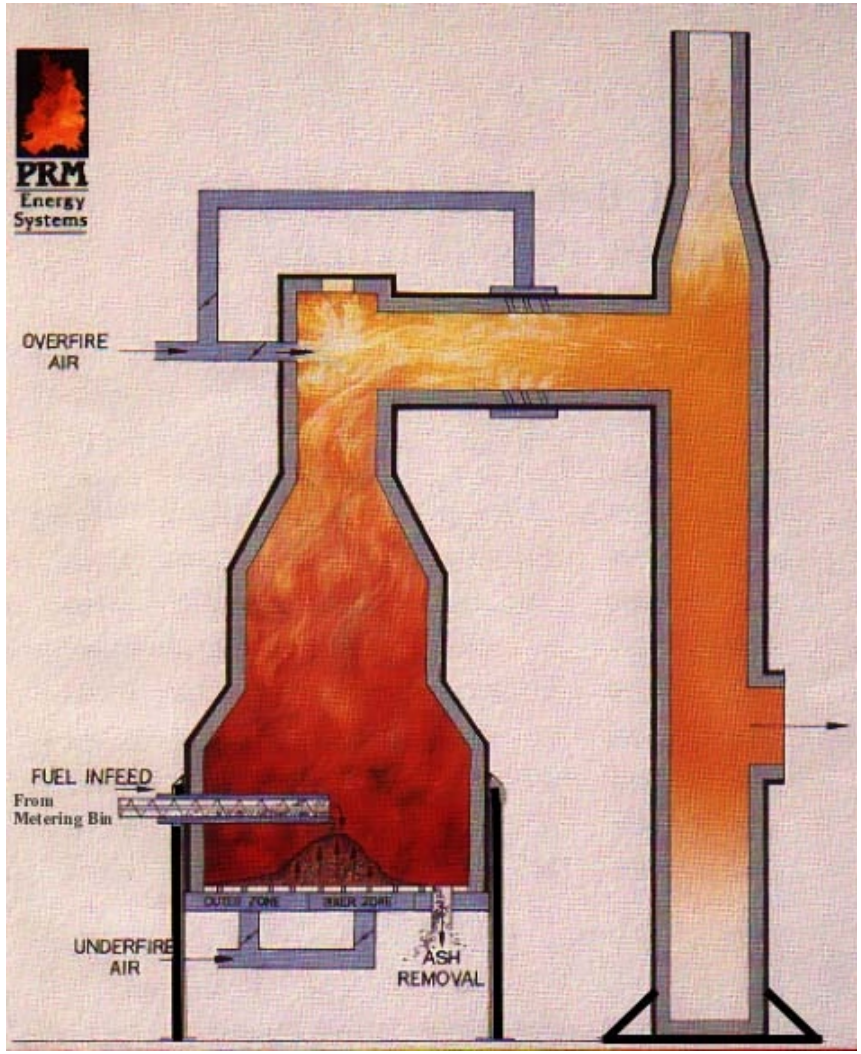
DiGIT Technologies – Fuel Cells

- Sizes:
  - 5 kW PEMFC
  - 200 kW PAFC
  - 250 kW Direct FC
  - 250 kW SOFC
  - 1 MW Direct FC
  - 2 MW Direct FC
- Fuel Options:
  - Hydrogen
  - Natural Gas
  - Propane
  - Diesel
  - Kerosene
  - Biogas
  - Landfill Gas
- Applications:
  - Prime power
  - Cogeneration

Fuel Cell Energy's 1MW Direct Fuel Cell 1500

Ancillary Technologies – Wood Biogas

- Biomass gasifier fuels: rice hulls, rice straw, chicken litter, green bark, sawdust and chips, peat, wheat straw, corn cobs and stubble, peanut hulls, RDF, petroleum coke, cotton gin waste, cotton seed hulls and low grade coal.
- Single gasifier input capacities range from 5 million to 110 million Btu/hr. Systems are modular and several gasifiers can be coupled for large applications.
  - Biomass Fired Engine Generator Systems
  - Biomass Fired Turbine Generator Systems



Fort Carson Area
Renewable Energy Potential

- Fuelwood – Good

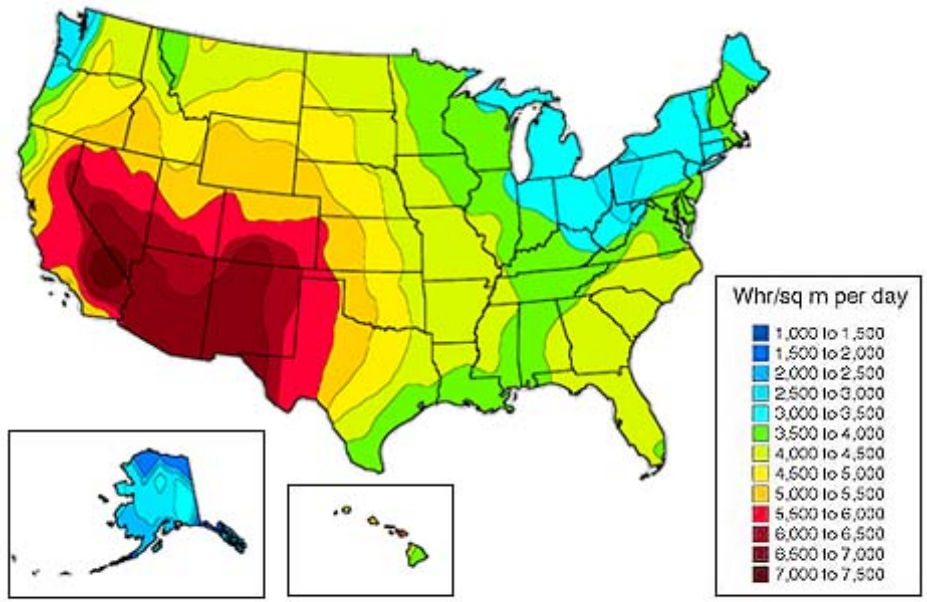
DiGIT Technologies – Photovoltaics

- Size:
  - 5 kW
  - 50 kW
  - 500 kW
  - 1 MW
- Fuel: None
- Application: Prime Power
- Issue:
  - Availability
  - Energy Storage

This 15-kilowatt photovoltaic system in Virginia feeds clean energy into the utility grid that supplies the Pentagon with electricity. *Credit: John Thorn*

Fort Carson Area
Renewable Energy Potential

- Fuelwood – Good
- Solar – Good to Excellent



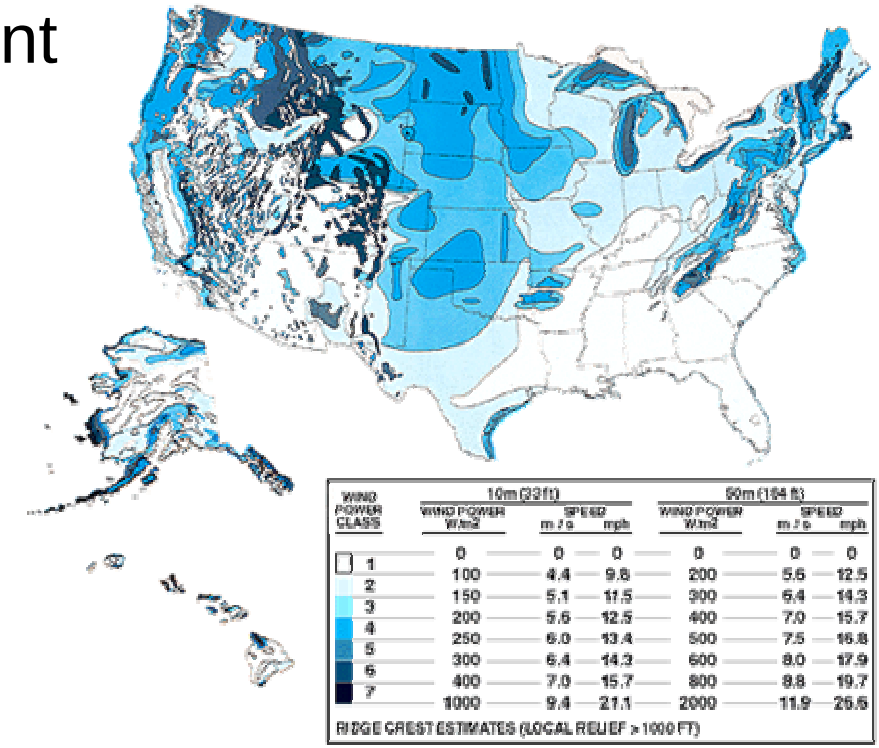
Solar resource for a concentrating collector

DiGIT Technologies – Wind Power

- Size:
  - 500 kW
  - 750 kW
  - 1 MW
  - 1.5 MW
- Fuel: None
- Application: Prime power
- Issues:
  - Availability
  - Energy Storage

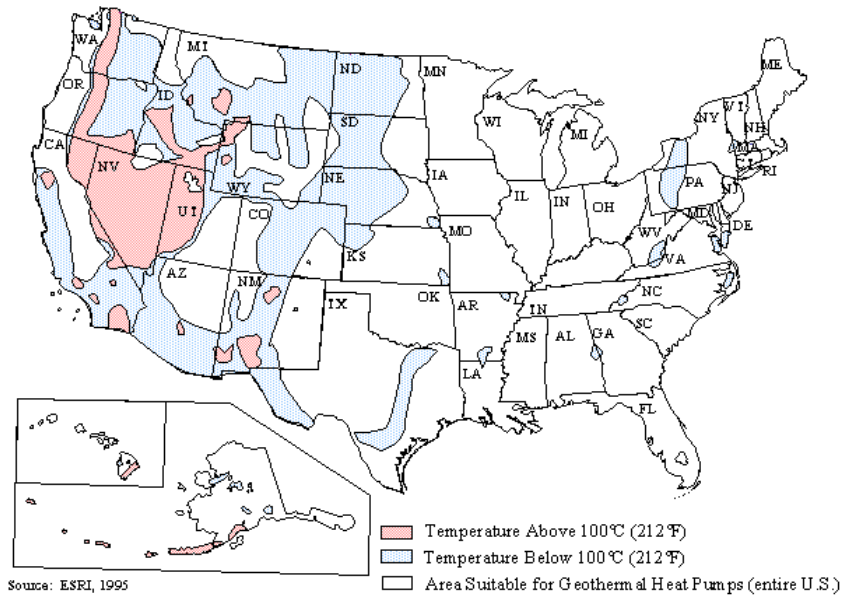
Fort Carson Area
Renewable Energy Potential

- Fuelwood – Good
- Solar – Good to Excellent
- Wind – Good to Excellent



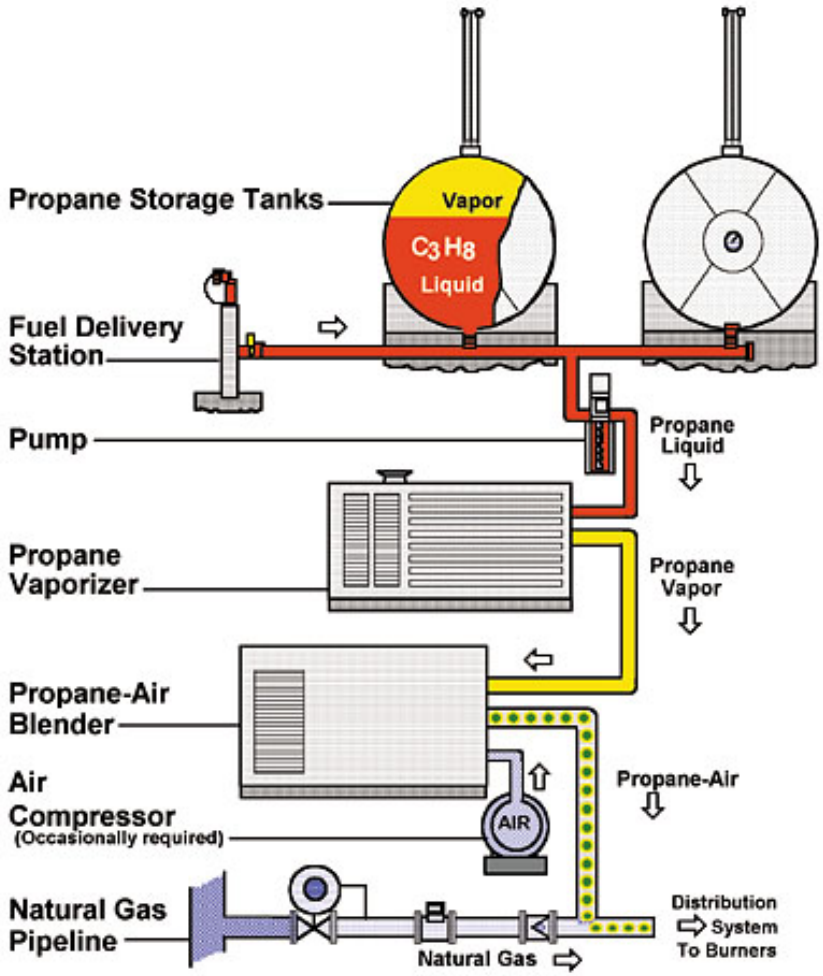
Fort Carson Area
Renewable Energy Potential

- Fuelwood – Good
- Solar – Good to Excellent
- Wind – Good to Excellent
- Geothermal – Poor



Propane/Air Storage Systems

- Propane-air can be burned with no change in equipment and operations.
- Propane-air standby systems bring unique advantages to the equation.
- Storage amount can be tailored to the situation.
- Additional advantages accrue from peak load control.



Propane-Air Storage System

Analyzing the Options

- Analyses somewhat economic driven, but the main issues are viability of the technologies.
- The solution set will change over time as technologies are commercialized and become available.
- Combinations of technologies will be developed based on the surveys.
- Evolution towards a more sustainable posture will guide the process.