

# Intro to DER

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# DER vs DG

- ▶  $DG = \text{Distributed Generation}$
- ▶  $DER = DG + \text{Storage}$

May seem like semantics but small storage grew in potential since 2005

# What is in DER

- ▶ Definitions vary but Small ( $< 49\text{MW}$ ) generation seems to count with  $< 1\text{MW}$  most common.
  - ▶ Plenty of renewable
  - ▶ Small turbine
  - ▶ Backup generators
  - ▶ Battery banks.
- ▶ Combined Heat and Power
  - ▶ Steam Generation
  - ▶ Chill Water
  - ▶ District Energy

# Why Would I (Private) Build It?

- ▶ Power Quality
  - ▶ Equipment is sensitive to voltage drops or spikes
  - ▶ Equipment is sensitive to frequency variation.
  - ▶ Wave shape and harmonics
  - ▶ High reactive power needs (Often avoids utility charge.)
- ▶ Reliability (Often combined with quality)
  - ▶ High cost of interrupted power, e.g., hospital
  - ▶ Two common measures
    - ▶ System Average Interruption Duration Index (SAIDI), average total time without power over a year.
    - ▶ Customer Average Interruption Duration Index (CAIDI), average time without given your power is out.
    - ▶ Many more relating to frequency and cost of lost service.
  - ▶ You could have lower rates if you have an interruptible tariff.

# Why Would I (Private) Build It? (Cont)

- ▶ Peak reduction
  - ▶ If you have demand (kW) charges, your maximum use.
  - ▶ If you have a coincident peak (kW) charge, you use at system peak.
- ▶ Cogeneration Opportunity
  - ▶ Already need Steam or Chill water
  - ▶ Electricity generation is a bonus
- ▶ Reduction in volumetric (kWh) charges
  - ▶ Net metering just a bit to shave off the high block charges
  - ▶ Peak Pricing Tariff
  - ▶ Real-time Prices.
  - ▶ Nice subsidy.
  - ▶ Actually, social cost, cheaper.
- ▶ The utility side is significantly more complicated.

# Three simple ways of thinking about costs

- ▶ The Make vs Buy trade-off (TC).
- ▶ The Minimum Efficient Scale (AC), i.e., volume such that AC is at a minimum.
- ▶ Investment Delay, a time value of money concept.

With all cost estimates the key conceptual problem is to only look at incremental costs.

- ▶ It is often unclear what those incremental costs are relative to.
- ▶ Cost does depend on your point of view.

# Example Make vs Buy

- ▶ Assume cost functions of  $C = F + \alpha q$  form.
  - ▶ Fixed cost
  - ▶ Constant average variable cost
- ▶ Make vs Buy: Given known  $q$ , Choose the least cost technology

# Example MES

- ▶ Several definitions of MES
  - ▶ Quantity such that  $MC = AC$ .
  - ▶ Quantity such that  $AC$  decreases very little as quantity increases.



# Example Investment Delay

- ▶ Pushing costs into the future can be valuable.
- ▶ Value of delay increases as interest rates increase.
- ▶ Exponential discounting  $P = \frac{F}{(1+i)^N}$ .
- ▶ Example: Maintenance expenditures of \$100 a year forever.  
What is the value of skipping a year?
  - ▶  $PW(Maintenance) = \frac{100}{i}$  At  $i = 10\%$  this is 1000.
  - ▶ Delay for 1 year is  $\frac{100}{1+i}$ . This is 909.09.
  - ▶ The difference is the savings.

# How Did We Get to the Current G-T-D Arrangement (MES Argument)

- ▶ Both large scale and small scale originally existed.
- ▶ Large scale developed
  - ▶ Lower AC
  - ▶ Higher MES
  - ▶ Speed of change up till 60s made this the dominate form.
- ▶ Small scale continued to develop
  - ▶ Right sized scale and MES
  - ▶ Decreasing AC
  - ▶ 1978 Qualifying Facilities Era was when they could sell power under some conditions.

# Private Choice of Technology (Make vs Buy Argument)

- ▶ Have access to utility power and DG.
- ▶ Several States of Opportunity Costs
  - ▶ If you have no special needs and need to pay full cost of fuel.
  - ▶ If you have 'Free' access to fuel, e.g., wood chips, AC of DG is lower.
  - ▶ If power quality or interruption is not what is desired, AC of utility power is higher.
  - ▶ More complicated diagrams can be made but this works.

# Utility Point of View (Make vs Buy Argument)

Please note that lots of power quality issues need to be solved on the D side, with capacitors and transformers. Power quality may actually get worse with new equipment and DG.

- ▶ Utility: Supply customer needs with T+G or with DG.
- ▶ Customer: Decide to take utility solution or provide with private DG.