

DC technology as a smart and efficient distribution platform

Bruce Nordman

Lawrence Berkeley National Laboratory

April 24, 2015

Grid Terminology

- **Microgrid** **Capability**
“... a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode” (US Dept. of Energy)
- **Nanogrid** **Complexity**
“A single domain of power; single voltage, frequency (if AC), reliability, quality, capacity (power), price, and administration. Storage is internal to a nanogrid. Generation forms its own nanogrid.” (Nordman, 2010)
- **Picogrid** **XXX**
An individual device with its own internal battery for operation when external sources are not available or not preferred (paraphrased from S. Ghai et al. in *e-energy 2013*)

Grid Terminology, cont.

- **Local Grid**

A microgrid or nanogrid (or picogrid)

- **Minigrid**

A power distribution system with customers, some local generation, and peak capacity < **XX** kW

- **Power Distribution**

Technology between generation and end-use devices;
includes storage

– Can include or not include communication about power

Traditional power distribution

- Grid is a single undifferentiated “pool” of power



- Enormous complexity suggests difficult to manage
 - Only works because it is NOT managed

Fails to meet specified needs

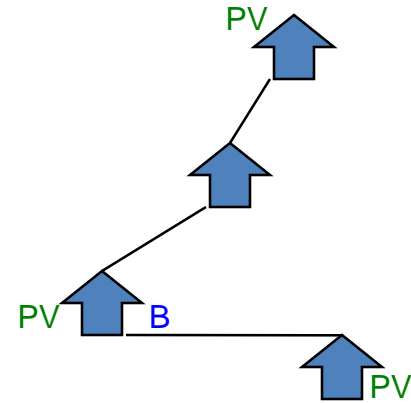
Village example

- **Start with single house** – car battery recharged every few days
 - Light, phone charger, TV, ...
 - Add local generation – PV, wind, ...



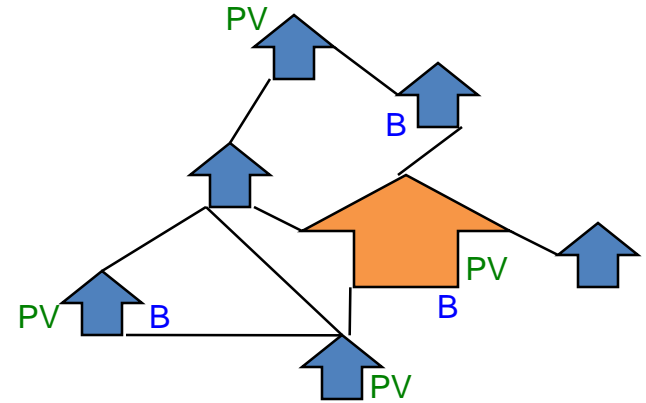
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 - Interconnect several houses



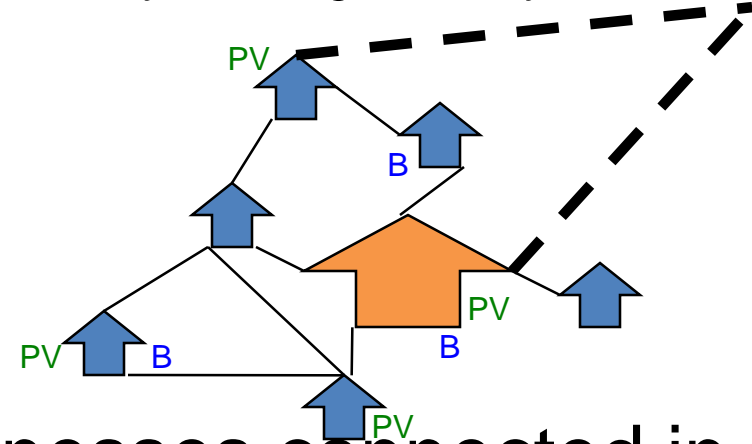
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 - More variable demand
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 - Can consider when topology should be changed
- **Existence of generation, storage, households, and connections all dynamic**



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- **Can later add grid connection(s)**

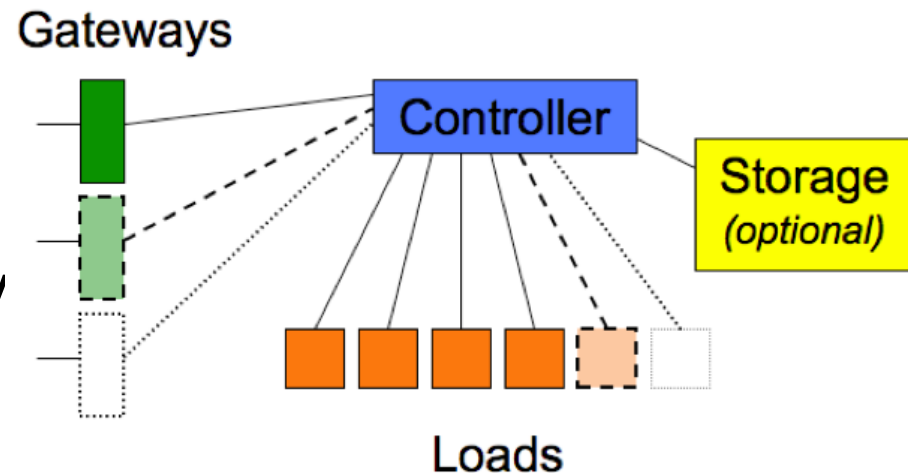


From no electricity to distributed power – skip traditional grid;
Similar to no phone to mobile phone – skip landline system

What is a Nanogrid?

“A (very) small electricity domain”

- Like a microgrid, only (much) smaller
- Has a single physical layer (voltage; usually DC)
- Is a single administrative, reliability, quality, and price domain
- Can interoperate with other (nano, micro) grids and generation through gateways
- Wide range in technology capability, capacity



Principles – All Countries

- Power distribution technology should be independent of grid context
- Grid context should be able to change dynamically
- Most generation should be local
- Reliability should be guaranteed locally
 - ➔ Utility grids can be much smaller and less reliable than otherwise – much less expensive

Thank you

