Geothermal Heat Pump (GHP) & “Building the Case”

May 12, 2017

Ingersoll Rand

Agenda

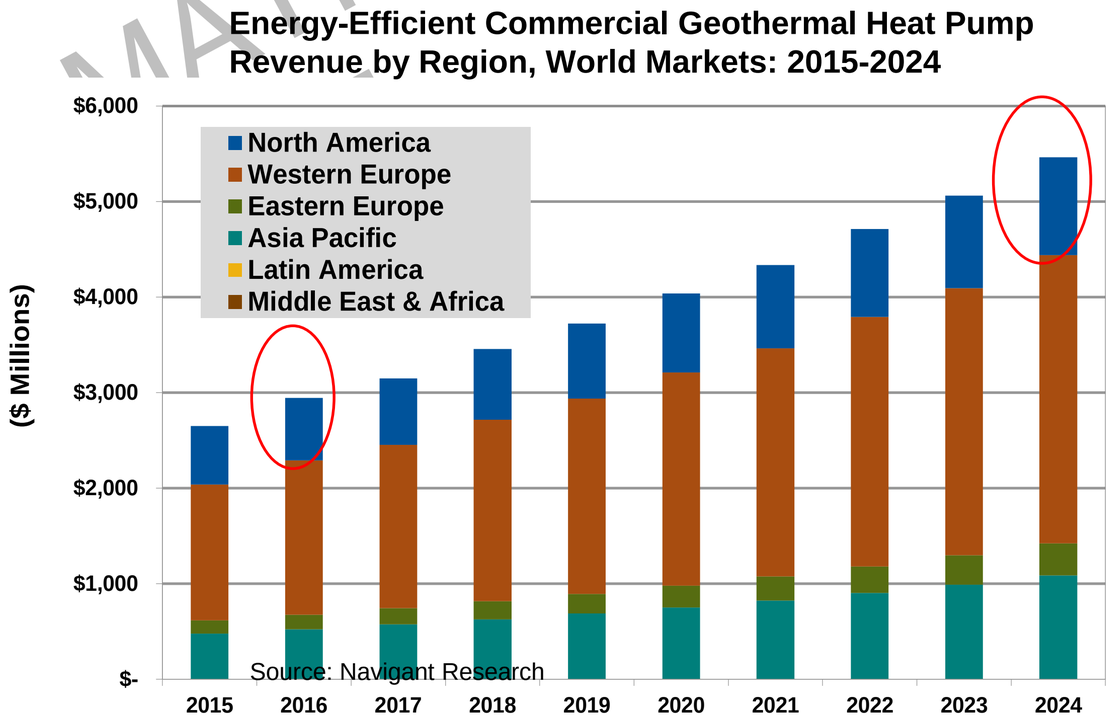
- Introductions
- Overview and History
  - What, why, when
- A sample in NW – Keyport Navel Base
- Financing
  - Incentives
  - Tax Benefits
  - Ownership Structures
- Other Considerations
  - Utility pressures
  - Distributed Energy Resources (DERs)
  - Smart or Micro Grid

Introductions

- Alex Banks
  - Roughly 20 years in energy efficiency and renewable energy, building systems, construction, and lifecycle cost analysis, development, and finance
  - Pacific NW native
  - North America, Trane Renewable Energy and Power Solutions (TREPS)
  - BSME, MBA, LEED AP….
- Your focus?
- Your history with Geothermal Heat Pump applications / projects?

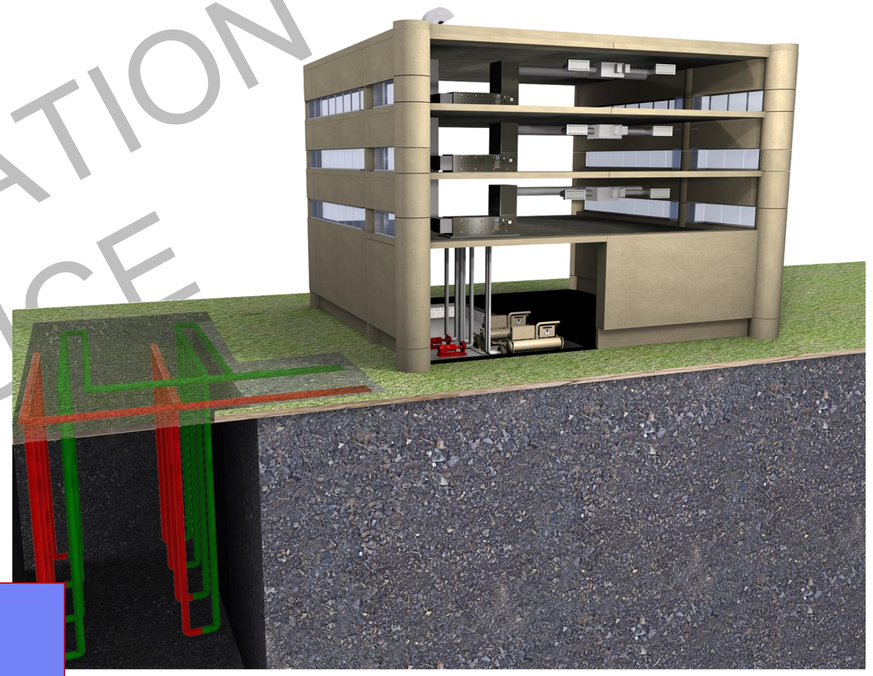
Geothermal (Ground Coupled) Heat Pumps – History and Market Data

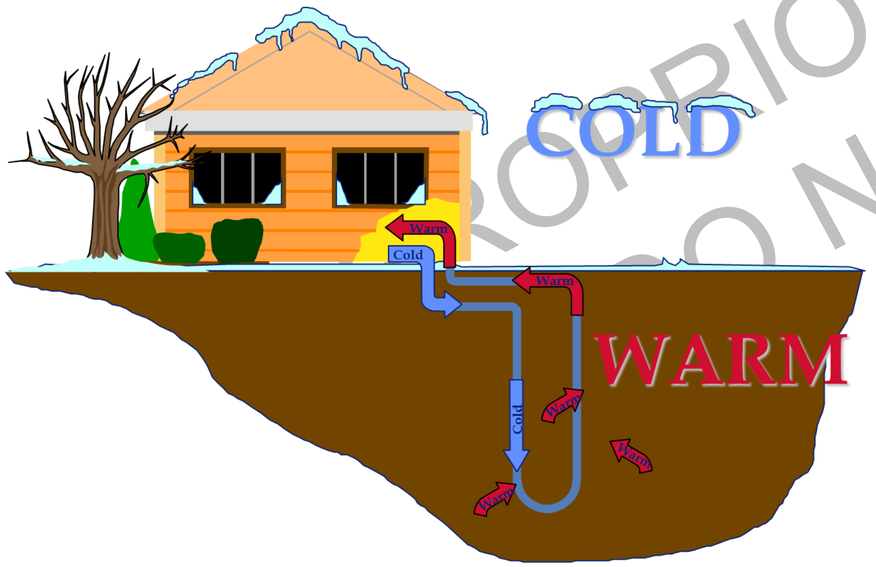
- First commercial application – The Common Wealth Building
  - Portland, Oregon in the year 1948
  - 14 stories, 200k+ sqft
  - Now on the historic register - American Society of Mechanical Engineers (ASME)
- According to Navigant Research
  - Emerging from stagnate growth stemming from late 2000's economic downturn
  - Strong growth (10% compound annual growth rate) through 2024 in areas such as Asia Pacific
  - Moderate growth (< 5%) in North America – Currently $600+MM

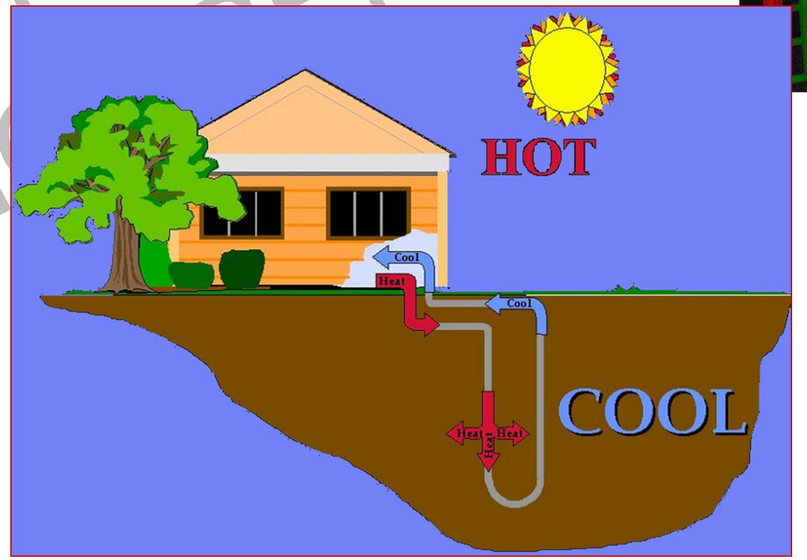


Geothermal (Ground Coupled) Heat Pump (GHP) - Overview

- Use of Earth’s temperature's (ground or water) as a heat sink or source
  - In heating – gain heat from the earth (vs a boiler)
  - In cooling – reject heat to the earth (vs a cooling tower)
- Not referring to steam or hot water from the ground in this case

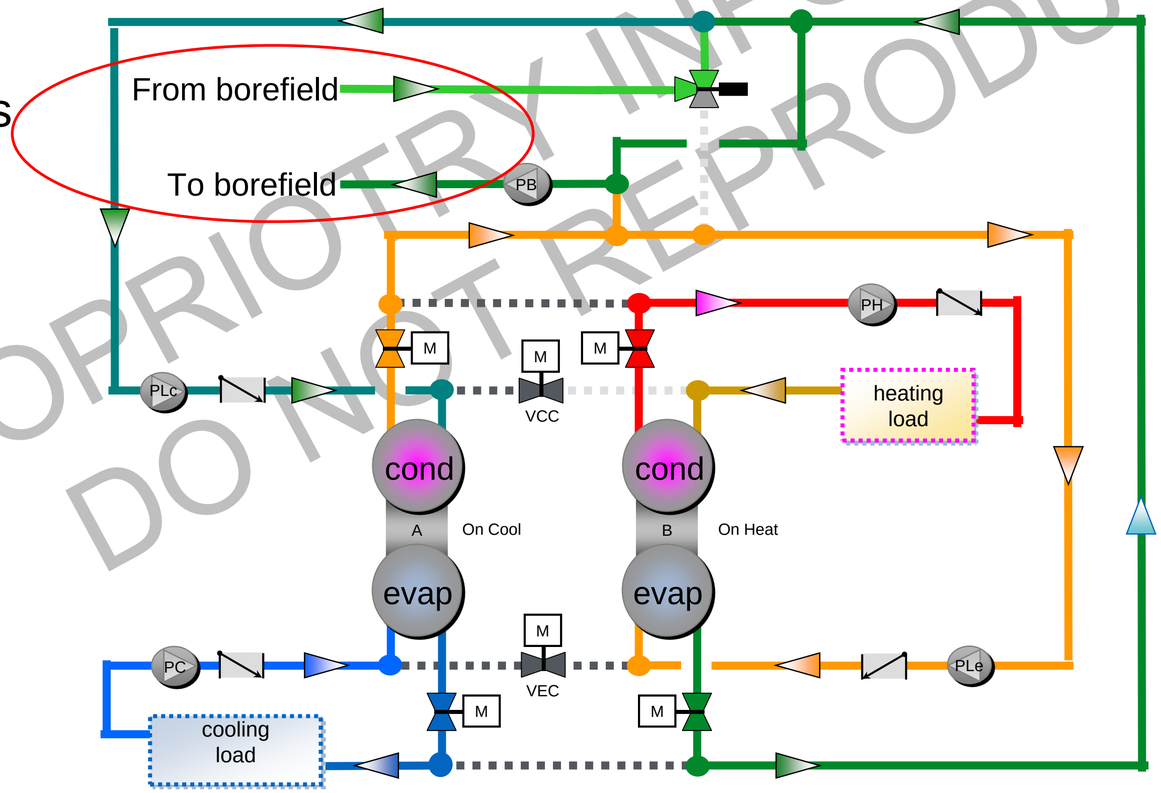


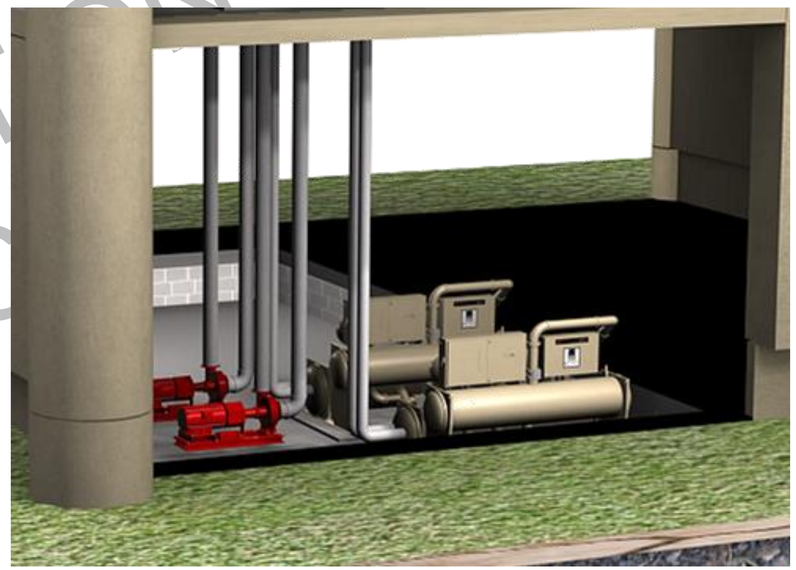




Many Variations

- Central or distributed
- Ground or water coupled
- Example - Heat recovery chillers (chiller/heaters) provide heating and cooling
  - Hydronic four pipe
    - Central air handlers
    - VAV terminals
    - Auxiliary boilers
    - Water pumps

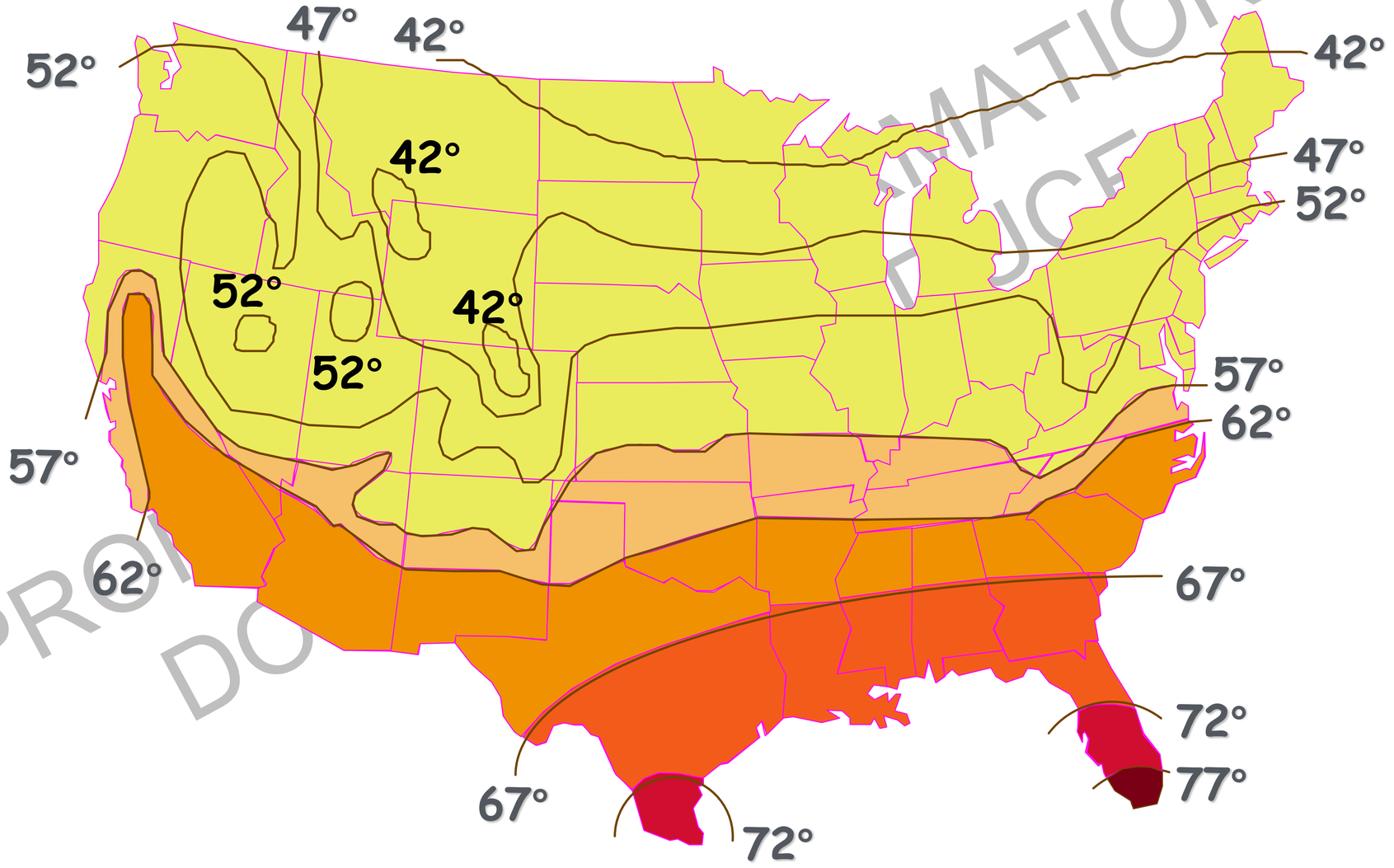




Wells Field Options

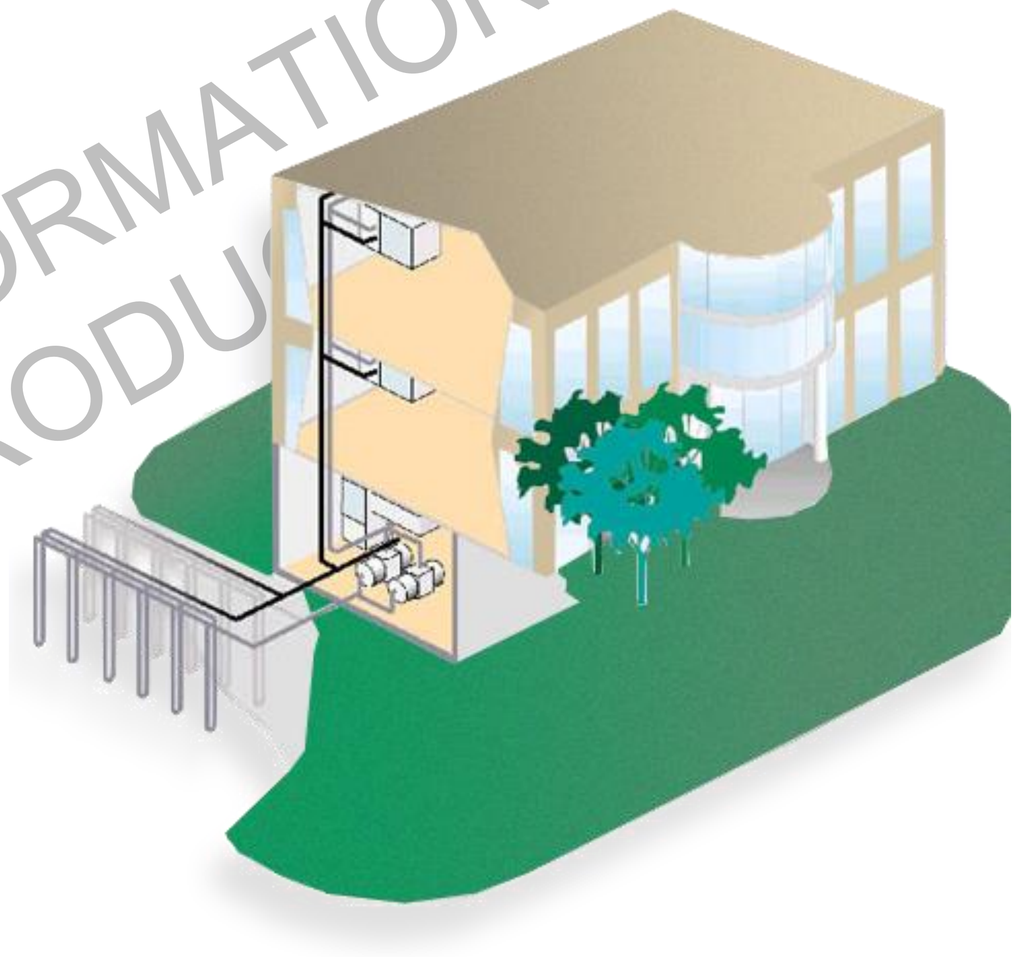
- Vertical
  - 200+ ft deep
  - Protected
  - Less temp variation
- Horizontal
  - More land
  - Less protection
  - May be less cost

Water Temperature in Wells
30 to 60 Feet Deep



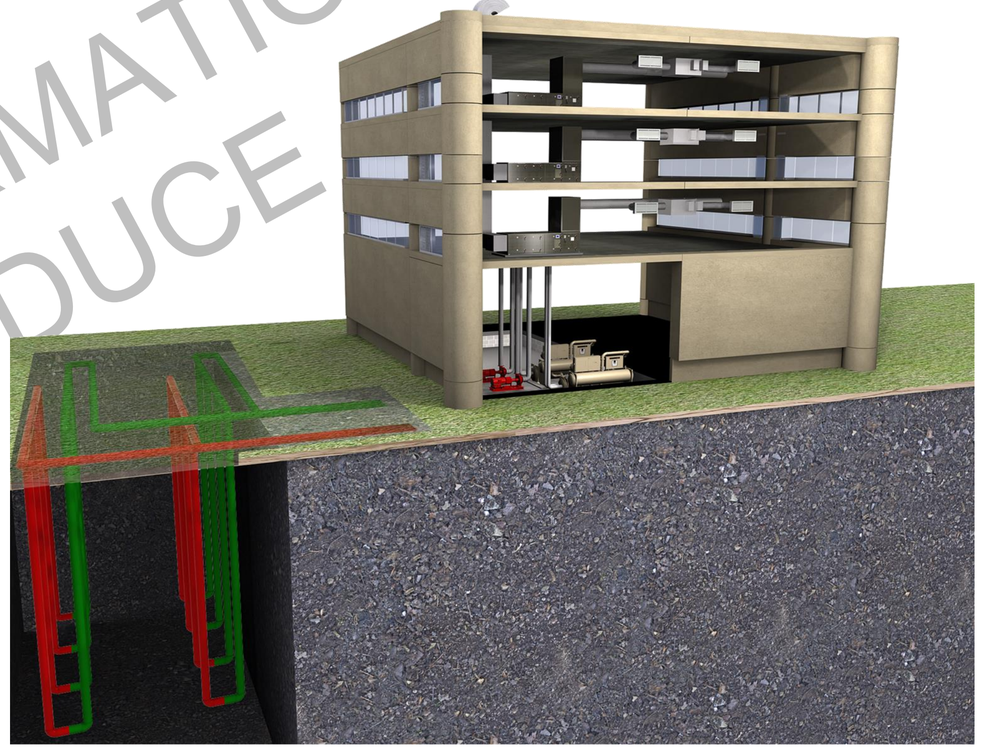
Why a Geothermal System?

- High system energy efficiency
- **Low carbon emissions**
- Lifecycle cost considerations
- LEED® energy credits
- Potential attractive financial return
  - Tax incentives – Federal
    - **if structured correctly**



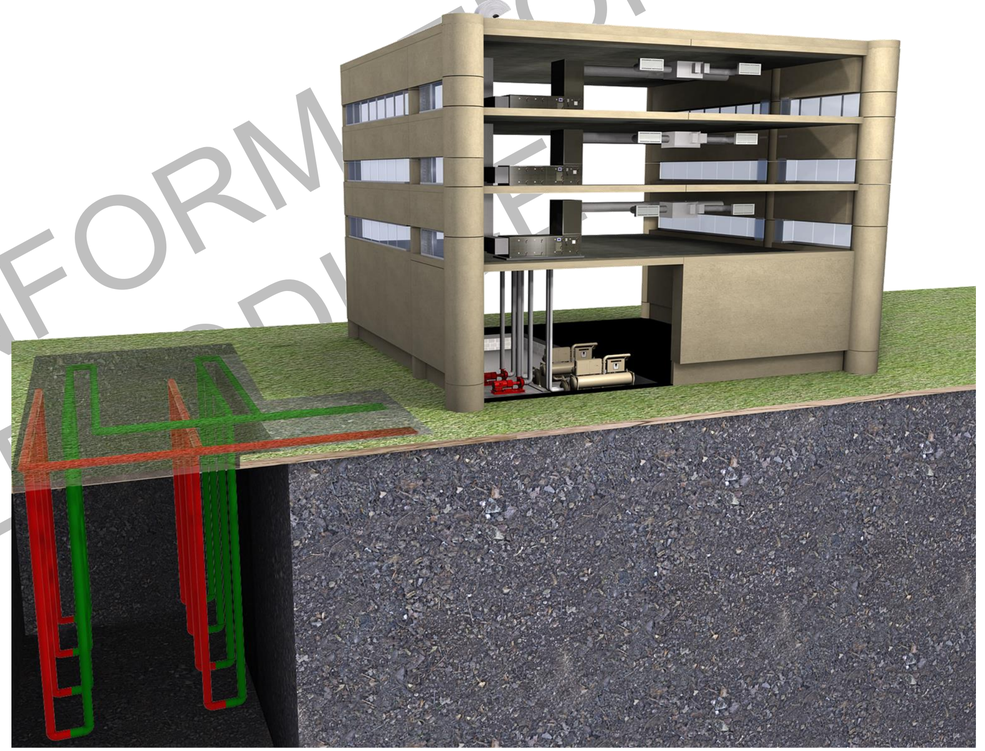
System Benefits & Best Fit

- Best when replacing both heating and cooling systems
- Lower space requirements
- Keeps you out of the building space
- Best for simultaneous heating and cooling needs
- Potential decreased maintenance
  - Coastal areas - less exposure to corrosive environment
  - Little to no exterior equipment
- Well field guaranteed for 50 years
- Long equipment life



System Challenges

- Higher first cost
- Hard to model
- Need a specialized team
- Slightly “less standard”
- Need available land
  - Needs to be protected



Case Study –
Navel Undersea Warfare Center (NUWC)
Keyport

- Keyport, Washington
- US Depart of Energy
- Decentralized aged steam plant
  - Failing systems
  - Very inefficient
- Roughly $15MM in improvements
  - Financed over 18 yr term

Finance - Financing Structures

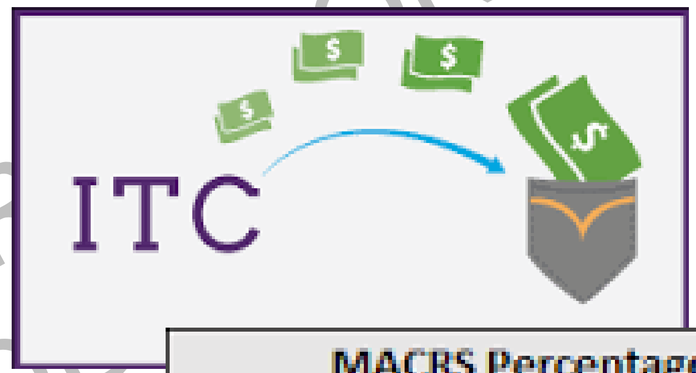
	Traditional Lease/Bond	Energy Services Agreement (ESA) (Public Entity)	PPA/ESA (Third Party Ownership)	PACE
Ownership of Project Assets	Customer/Lessor	Customer	Tax Equity/FMV Purchase Option	Customer
Cash Upfront	No	No	No	No
Off Credit	No	Yes	Yes	No
Operation & Maintenance	Flexible	Flexible	ESA Provider	Flexible
Able to Monetize Tax Benefits	No	No	Yes	Yes (for discussion)
Payment Contingent on Performance	No/Performance Guarantee from Trane	Yes	Yes	No

Incentives

- Puget Sound Energy (PSE)
  - $.030 / kWh
  - $5 / therm
  - Up to 70%?
  - Based on year 1 savings
- Seattle City Light
  - Custom - $0.27 / kWh
- Others
  - Department of Commerce
  - Various research grants

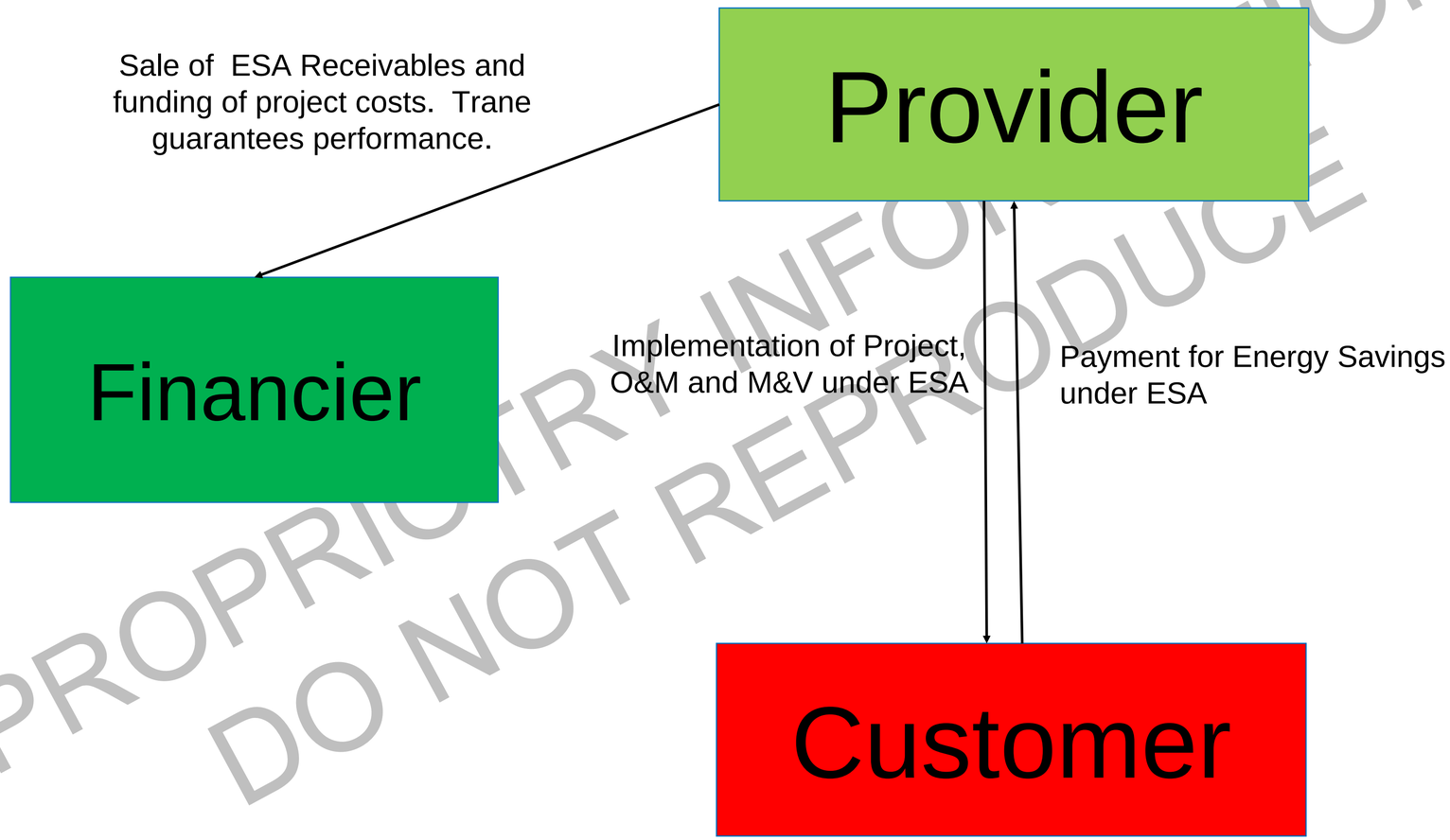
Financing / Ownership Alternatives – Tax Benefit

- Requires Tax Equity Investor
- Can reduce your effective finance rate by more than 1%
- Modified Accelerated Cost Recovery System (MARCS)
  - Depreciation
  - Over 5+ year period
  - 50% bonus if in use by end of 2018
  - Yr 1 = 20%, Yr 2= 32%, 19.2%, 11.52%, 11.52%, Yr 6 = 5.72%
- Business Energy Investment Tax Credit (ITC)
  - 10% of a geothermal project cost – gone in 2016
  - Taken at the completion of construction
  - Always revising

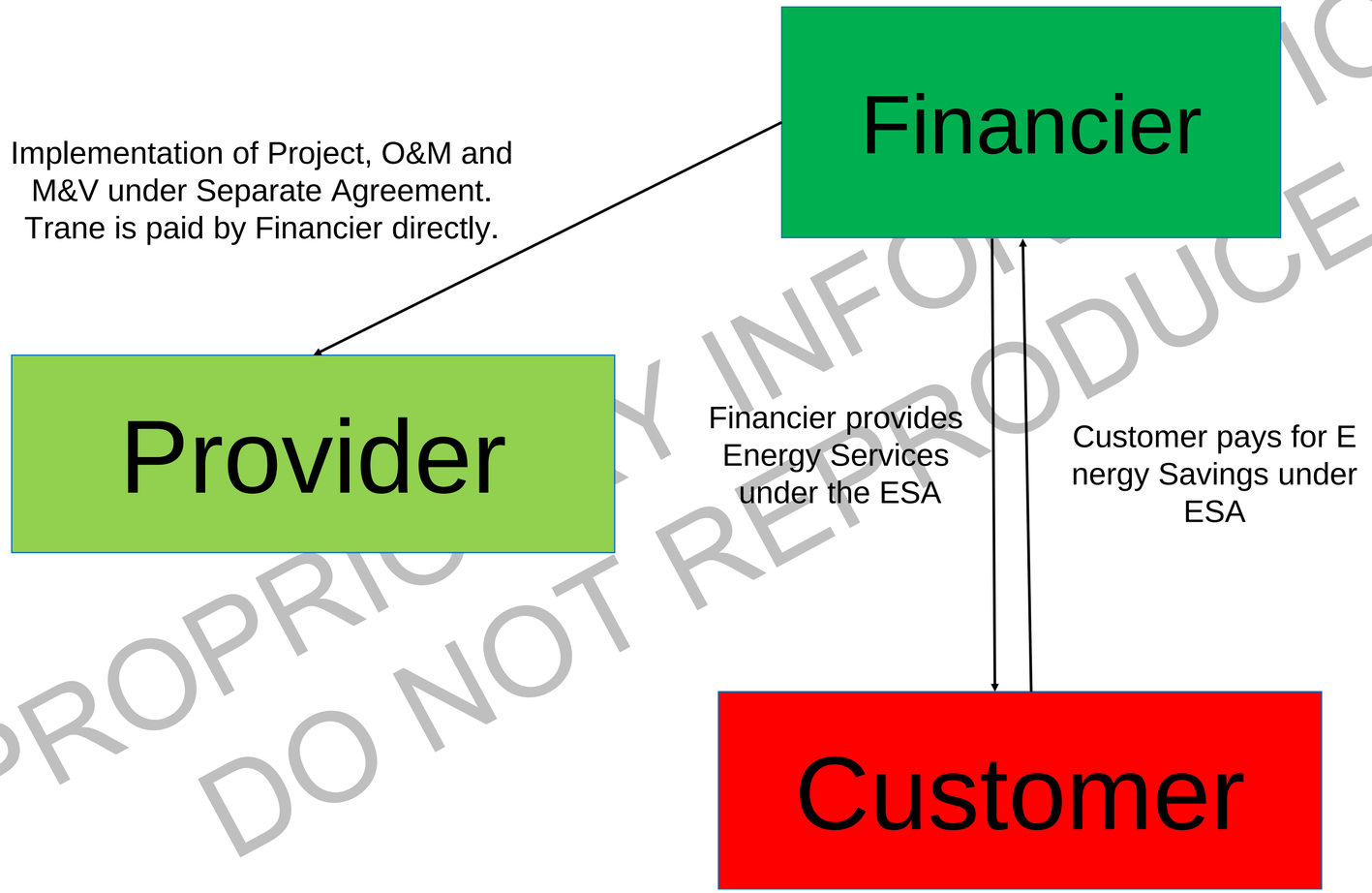


MACRS Percentage Table			
Year	3 Year	5 Year	7 Year
1/2 year	33.33%	20.00%	14.29%
1	44.45%	32.00%	24.49%
2	14.81%	19.20%	17.49%
3	7.41%	11.52%	12.49%
4		11.52%	8.93%
5		5.76%	8.92%
6			8.93%
7			4.46%

Finance - PPA/ESA Structure (Public Entity)



Finance - ESA/PPA (Third Party Ownership)

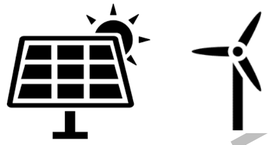


Building as a Resource - Opportunity

Resource Options

1 Traditional resources historically effective but facing increasing challenges

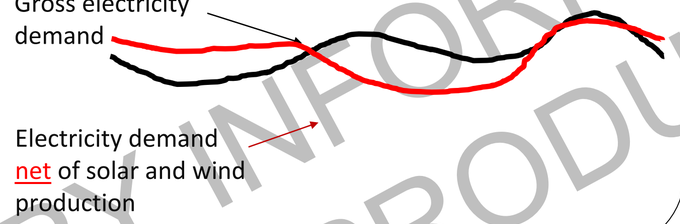
2 Non-Dispatchable Resources change the generation needs from other resources (red line)



3 BaaR can be dispatched to follow or help flatten the needed profile. Also can address localized needs.

Control Room Operations

The utility control room balances system resources with load requirements



Also manages localized congestion & power quality issues

Buildings as a Resource "BaaR": Buildings outfitted with appropriate equipment, controls, and utility control room interface that can enable a utility to schedule and control a fleet of buildings like a power plant

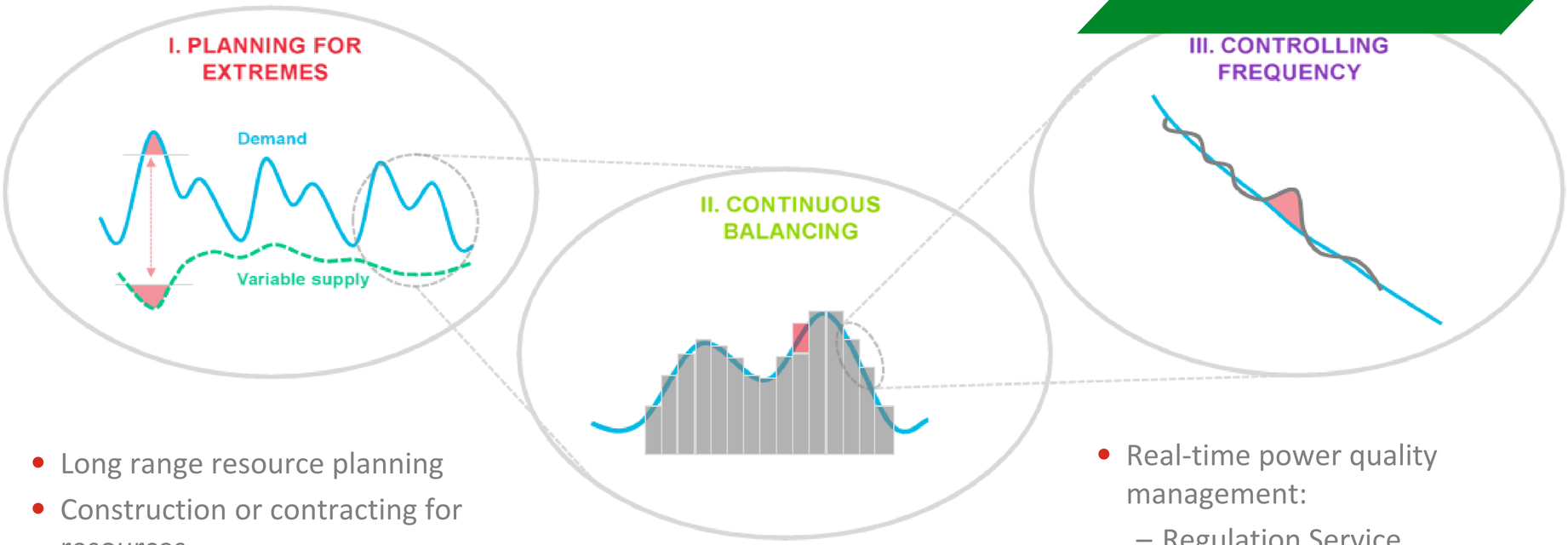
BaaR Solutions (what's in the building)
HVAC
BEMS & Controls
Thermal Storage
Batteries
Refrigeration
Compressed Air
Pumping / Flow Storage

BaaR Solutions configured to deliver "sacrifice" or "non-sacrifice" based outcomes to building occupants

Utility Markets & Operations

Utilities use defined grid products and processes to maintain reliable power supply over short and long time scales

Years to Months | Days to Minutes | Minutes to Seconds

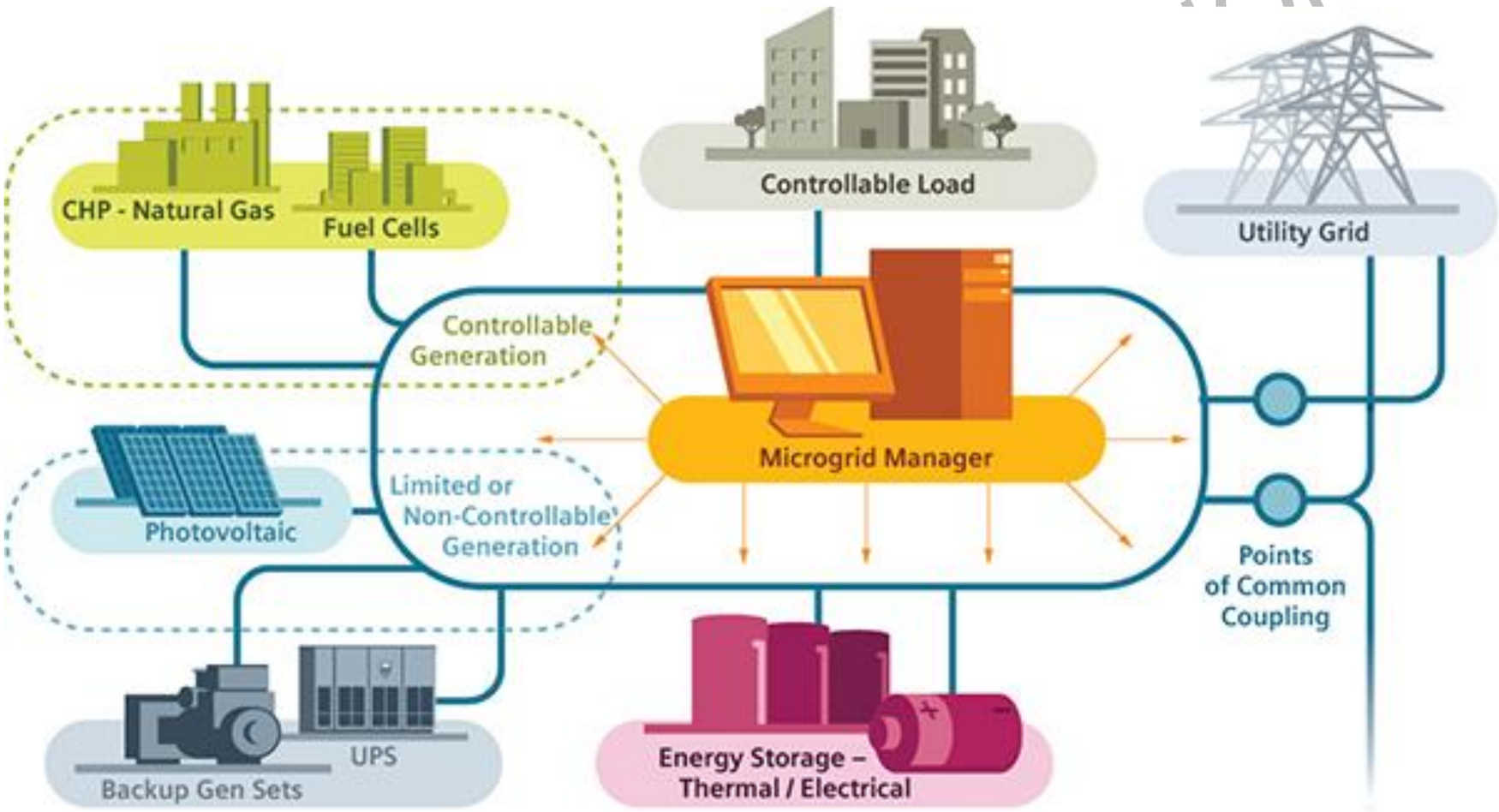


- Long range resource planning
- Construction or contracting for resources

- Dispatch operations & markets:
  - Energy
  - Capacity
  - Load Following Service

- Real-time power quality management:
  - Regulation Service
  - Frequency Control

Micro Grid
What is it?



Electric Energy Storage - Battery Storage
What is it?

Electricity Energy Storage devices can manage the amount of power required to supply customers at times when need is greatest, which is during peak load.

- Issue: The amount of electricity that can be generated is relatively fixed over short periods of time, but demand for electricity fluctuates throughout the day. This is particularly true with solar and wind resources.
- Benefits:
  - Renewable Energy: reliable and dispatchable
  - Micro Grid Balance
  - Provides Frequency Regulation
  - Improves Reliability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