Is Electric Utility Ownership of CHP Good for Ratepayers and the Environment?

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FVB Energy Inc.

International District Energy Association

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45 Years of Experience in Sustainable District Energy Systems

Agenda

- Drivers
- Case study: Duke University
- CHP role in the dispatch order
- Calculating GHG reductions
- Economic impact on ratepayers
- Why not use renewable energy instead?
- Resiliency benefits

Drivers

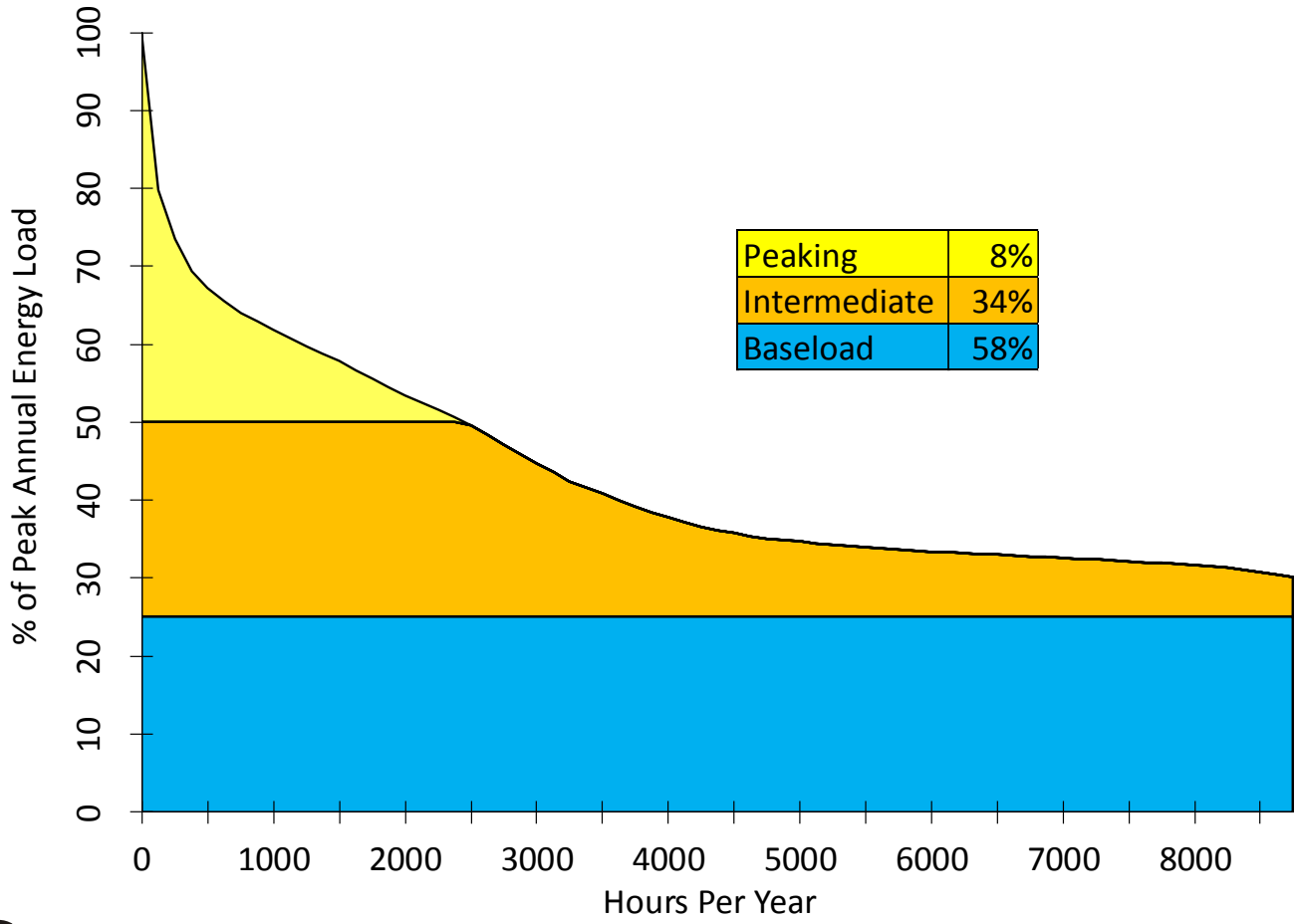
- Policy-makers
- Electric utilities
- Thermal hosts
- Environmental advocacy groups

Case study: Duke University

- Duke Energy and Duke University have planned a 20 MW natural gas turbine CHP facility located at the University
- Financed, owned and operated by Duke Energy as a rate base generating asset
- Opposition from student and outside advocacy groups

CHP role in the power grid dispatch order

CHP must compete with marginal costs of grid generating capacity



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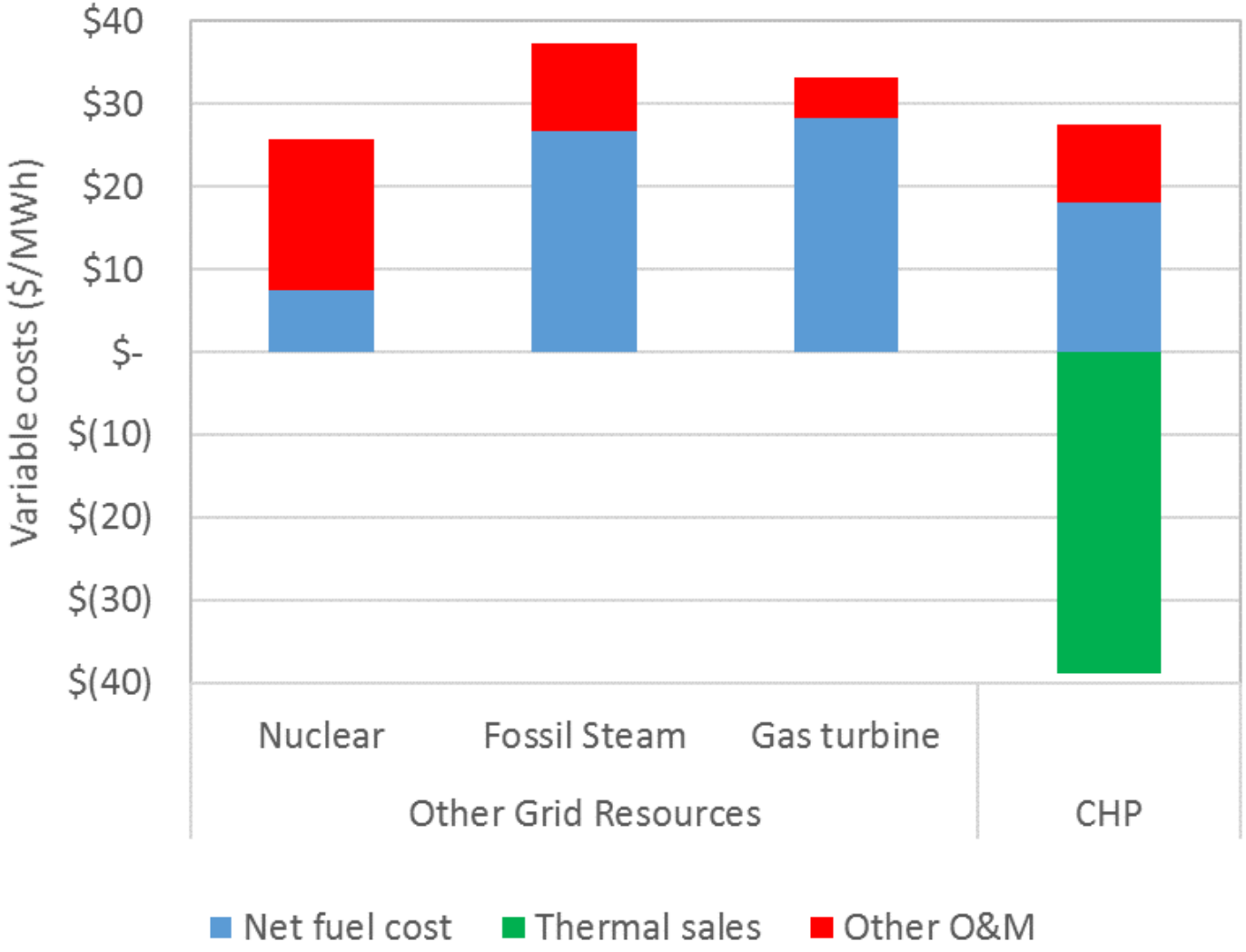
CHP role in the power grid dispatch order



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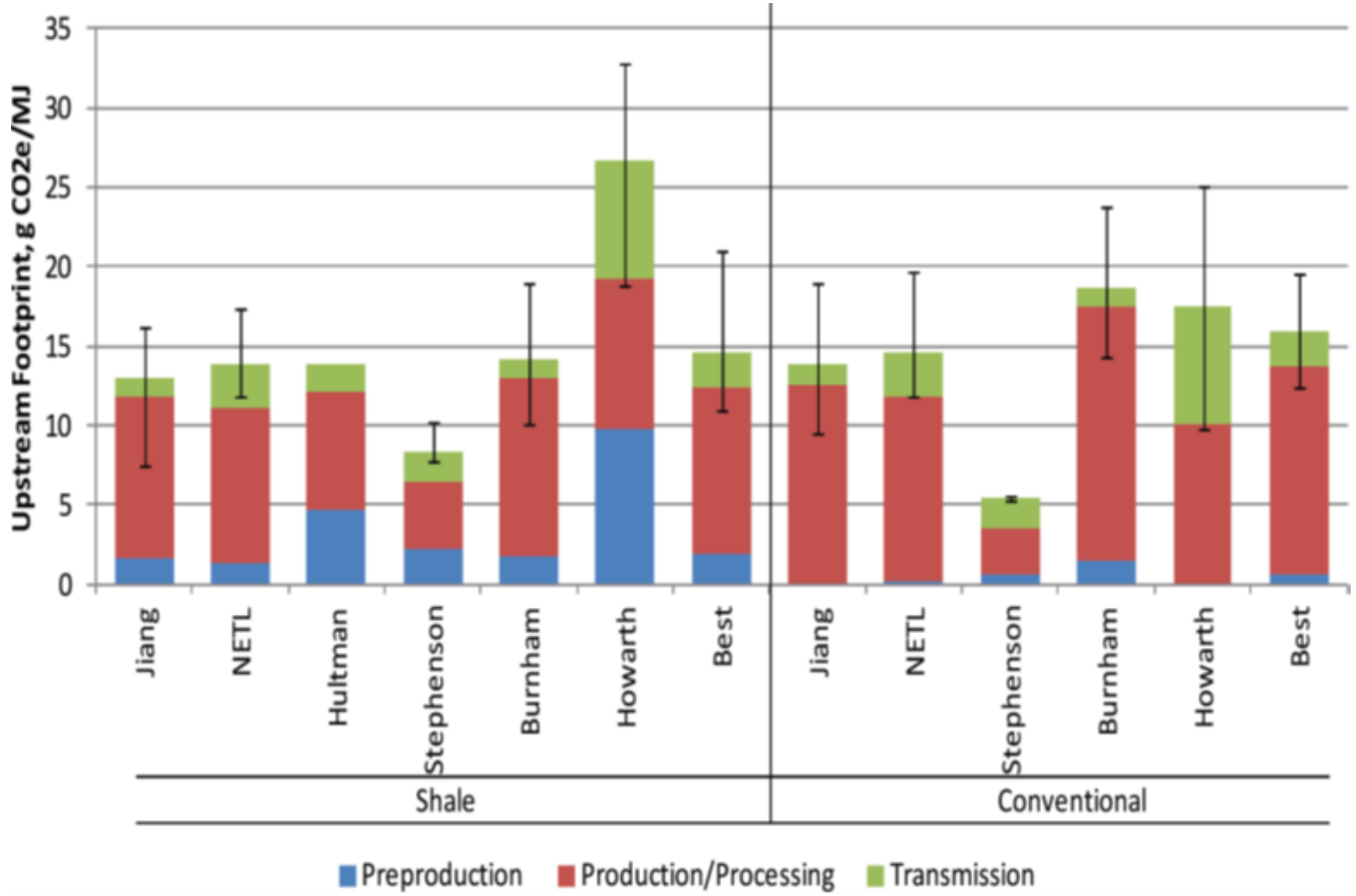
Calculating GHG reductions

- What are the lifecycle GHG impacts of natural gas, including not only combustion but also the extraction, processing, transportation and delivery of the fuel?



Source: Christopher L. Weber and Christopher Clavin, "Life Cycle Carbon Footprint of Shale Gas: Review of Evidence and Implications", Environmental Science & Technology 2012, 46 (11), 5688-5695.

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Calculating GHG reductions

- Best estimate values of natural gas life cycle GHG impacts from Weber and Clavin analysis (lbs CO2e/million Btu HHV):

	Shale Gas	Conventional Gas
Combustion	117.0	117.0
Upstream	30.6	33.5
Total	147.6	150.5

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Source: Christopher L. Weber and Christopher Clavin, "Life Cycle Carbon Footprint of Shale Gas: Review of Evidence and Implications", Environmental Science & Technology 2012, 46 (11), 5688-5695.

Calculating GHG reductions

What are the GHG emissions of separate heat and power?

- GHG emissions at the CHP plant

Heat rate (Btu/kWh)	10,265
Thermal output (Btu/kWh)	4,255
Avoided boiler fuel (Btu/kWh)	(5,319)
Net natural gas consumption (Btu/kWh)	4,946
GHG emissions rate (lbs CO2e/MMBtu)	150.5
GHG emissions (lbs/kWh)	0.74

- GHG avoided from offset grid power is more complex
  - Depends on the type of generation avoided, which varies depending on the dispatch of the CHP plant and GHG emissions of the power plants displaced by CHP

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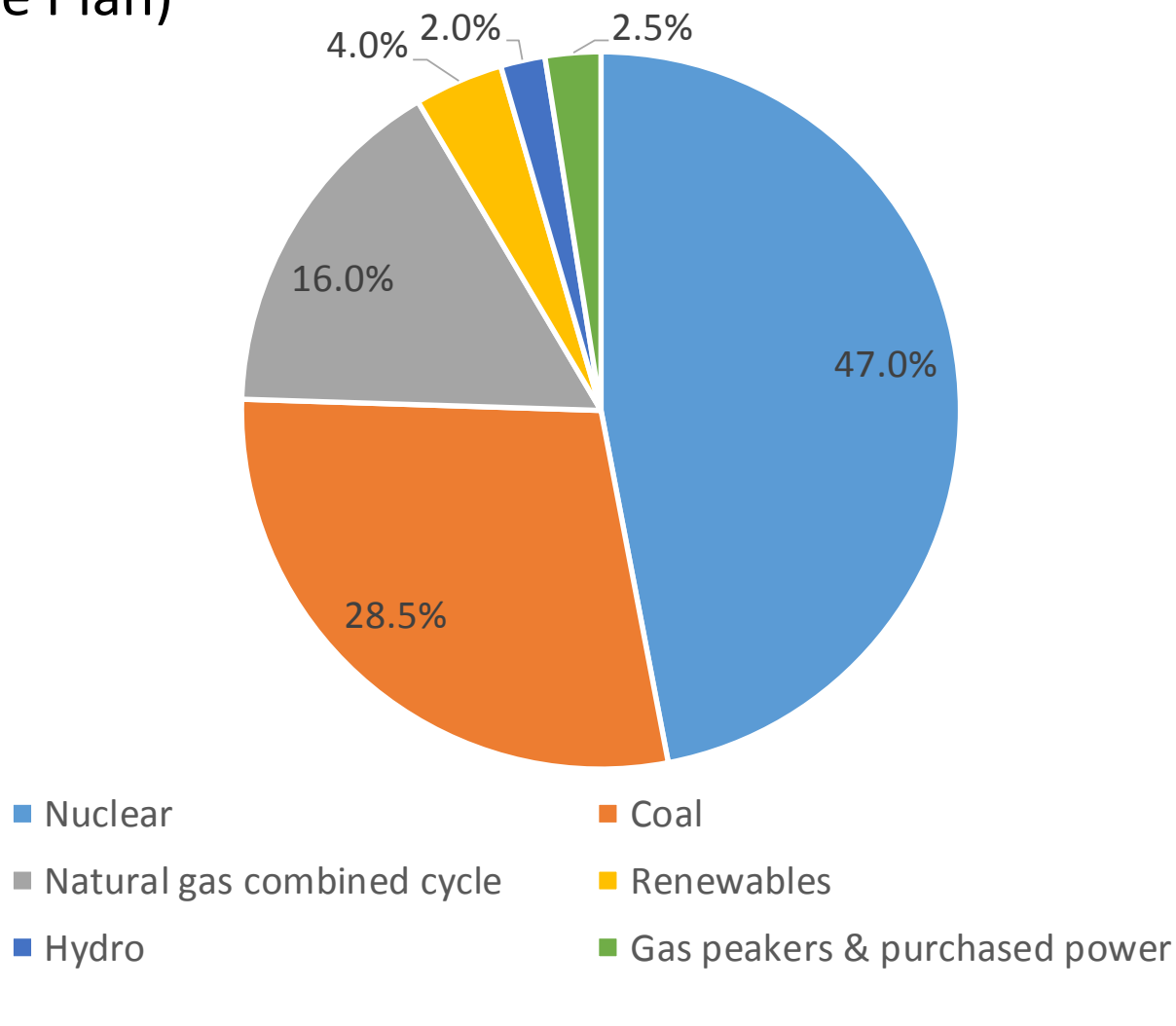
Calculating GHG reductions

Duke Energy projected electricity sources (2016 Integrated Resource Plan)



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Calculating GHG reductions

- *CHP does not displace the "average MWh"!*
- Duke University CHP would displace coal and gas
  - Duke Energy nuclear capacity is about equal to minimum grid load
  - CHP can't compete with nuclear, but does compete with coal and natural gas
- GHG reductions for three scenarios for displaced grid generation:
  - Weighted Duke Energy capacity mix (coal and gas)
  - Existing Duke Energy natural gas capacity
  - New natural gas combined cycle plant

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Calculating GHG reductions

CHP GHG emissions (lbs/kWh)	0.74	
Avoided power grid emissions		
Current Duke Energy capacity mix	(1.87)	
Existing Duke Energy natural gas	(1.20)	
New natural gas combined cycle	(0.99)	
Net GHG emissions impact of CHP		***% Reduction***
Current Duke Energy capacity mix	(1.13)	***60%***
Existing Duke Energy natural gas	(0.46)	***38%***
New natural gas combined cycle	(0.25)	***25%***

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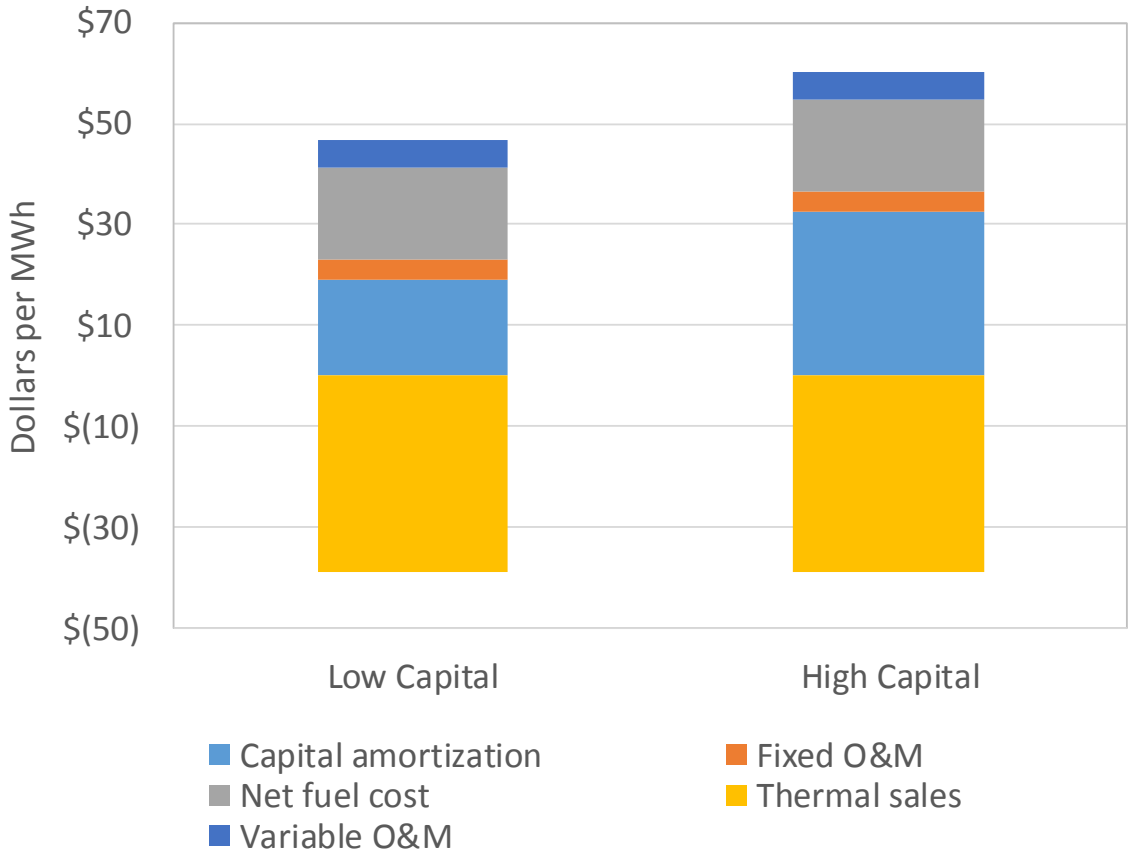
Economic impact on ratepayers

- Highly case-specific
- Duke case:
  - 20.3 MW gas turbine CHP with a high capacity factor
  - In utility service area requiring additional power generation capacity



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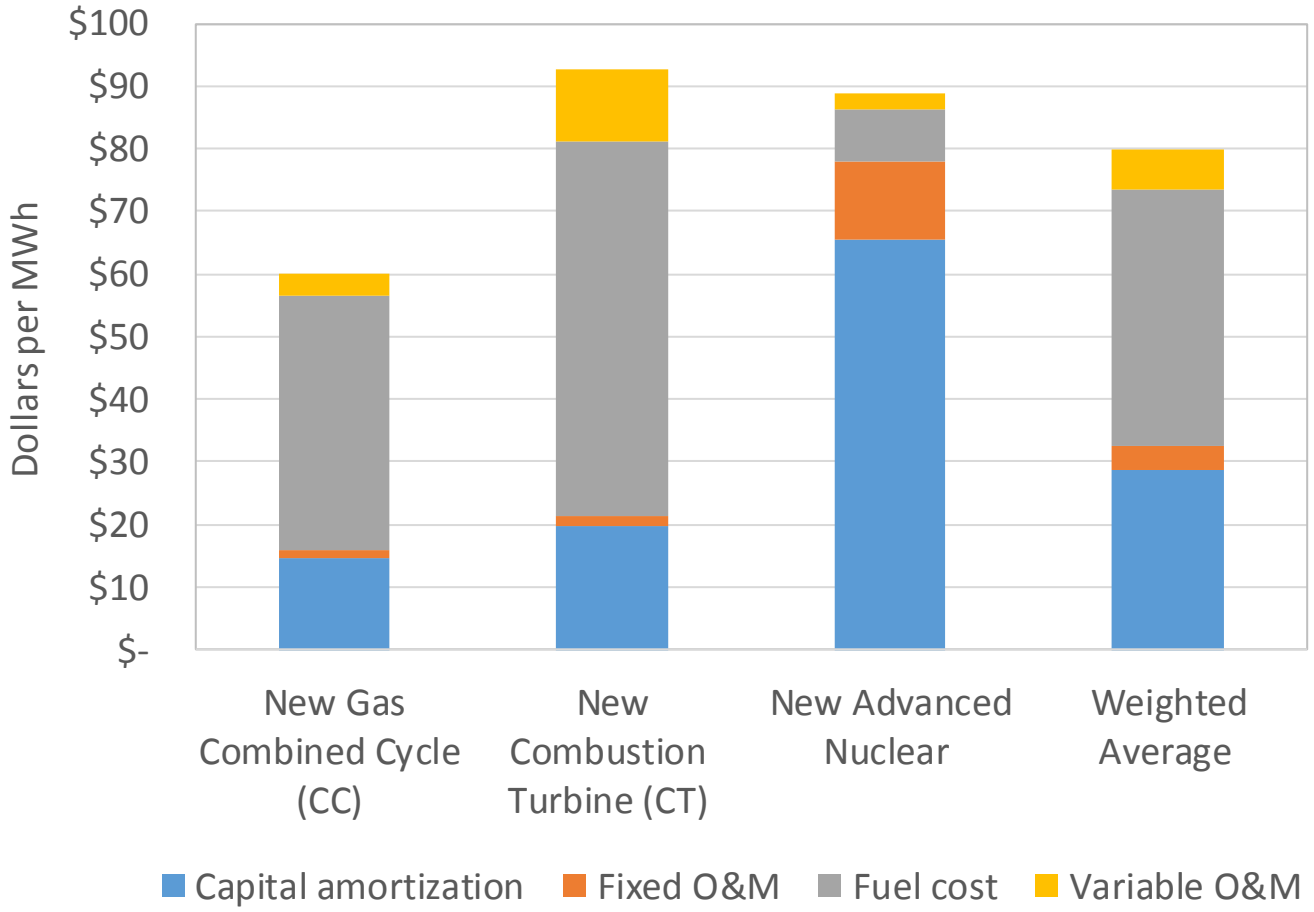
Economic impact on ratepayers

- Well-sized gas turbine CHP competes well with other options for new grid capacity



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Why not use renewable energy instead?

- Renewable power can play an important role in campus and grid power mix
- Intermittent renewables are a not a substitute for baseloaded CHP
- Battery storage is advancing but is still not cost-effective in making solar an effectively reliable source
- Solar is space-intensive

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Resiliency benefits of CHP

- *Wilma, Katrina, Ike, Gustave, Irene, Sandy……who's next?*
- On-campus CHP is inherently more resilient to disruption from natural disasters or other events that interrupt energy supply from complex and interconnected grids
- CHP systems can be designed to operate in island mode during a grid outage
- CHP and district energy systems have demonstrated that they can keep the power on and continue to keep people warm in the winter and cool in the summer even when the power grid is down

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Thanks for your attention!

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