



# OPTIMIZING RENEWABLE ENERGY SOURCES FOR CAMPUS DISTRICT ENERGY

**Andrew Haden**

President, Wisewood Energy

IDEA 2019: The Energy for More Resilient Cities

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Pittsburg, Pennsylvania

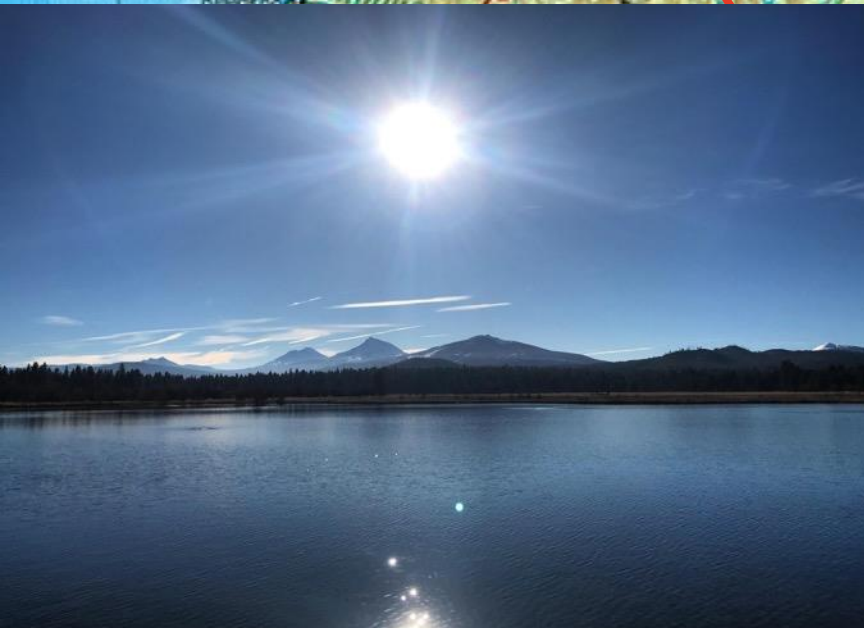




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# PROJECT BACKGROUND: INTEGRATION OF TECHNOLOGIES







# University wants to produce as much energy as it uses

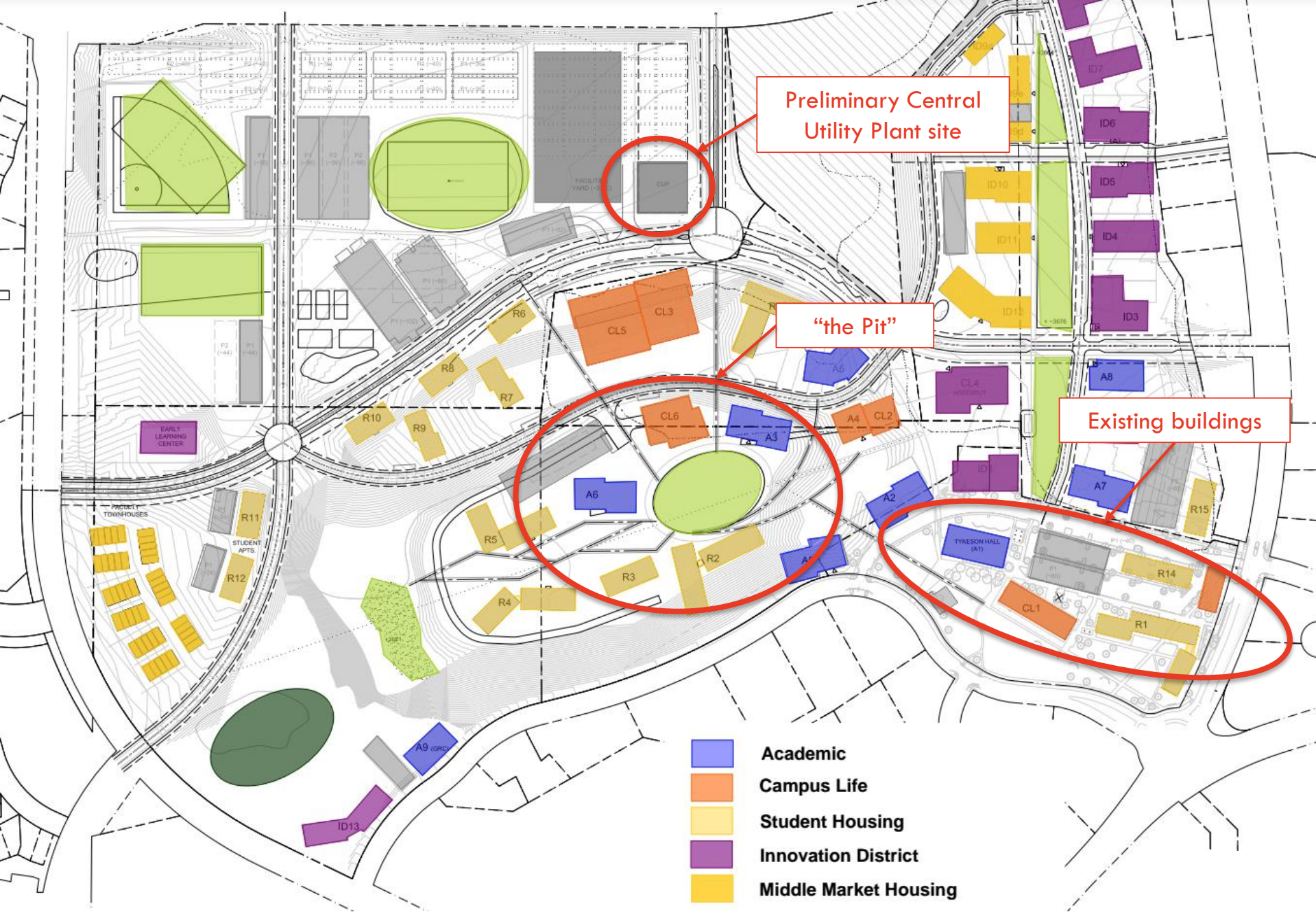
Campus has 'Net Zero' plan for expansion

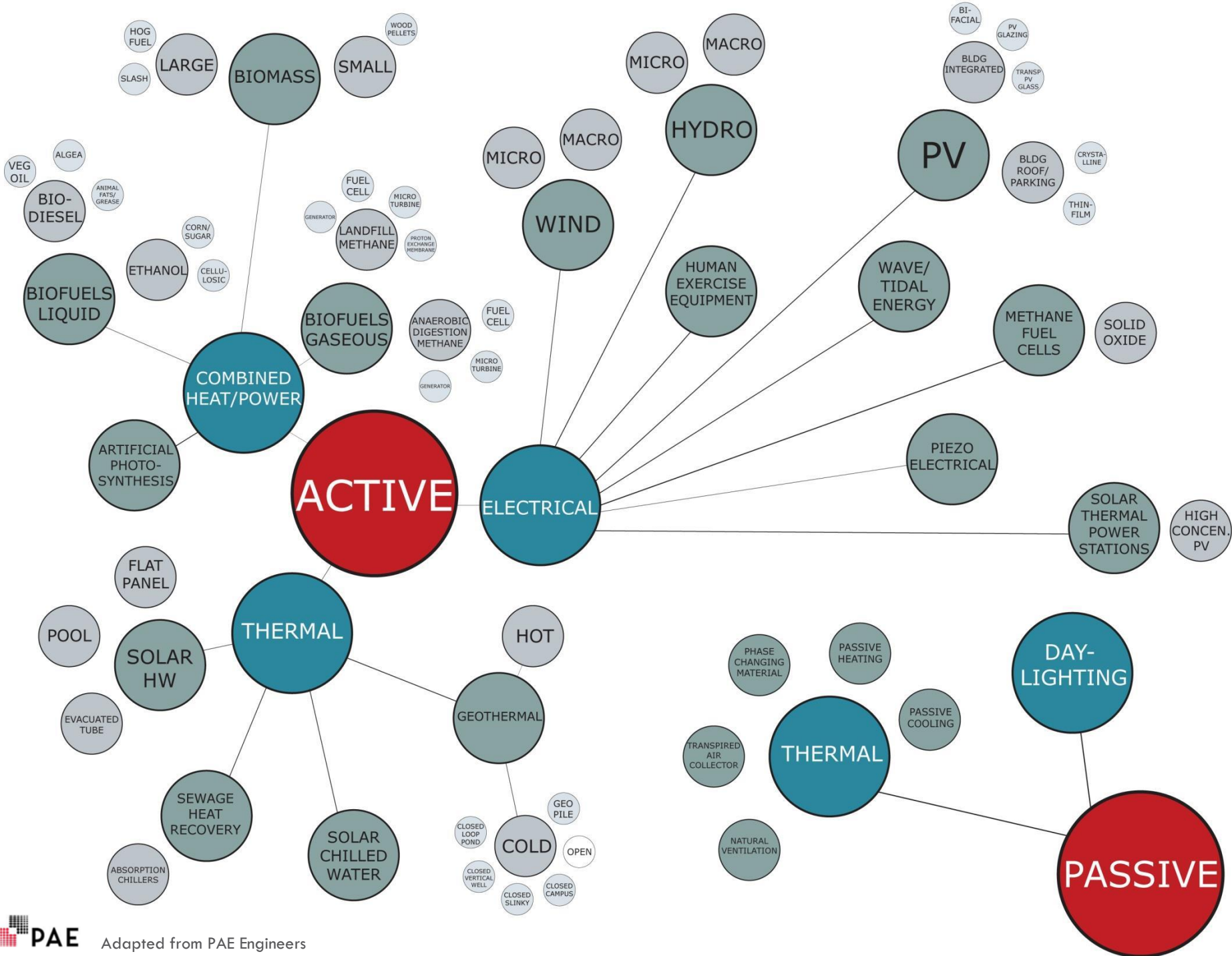


# FOCUS ON ENERGY

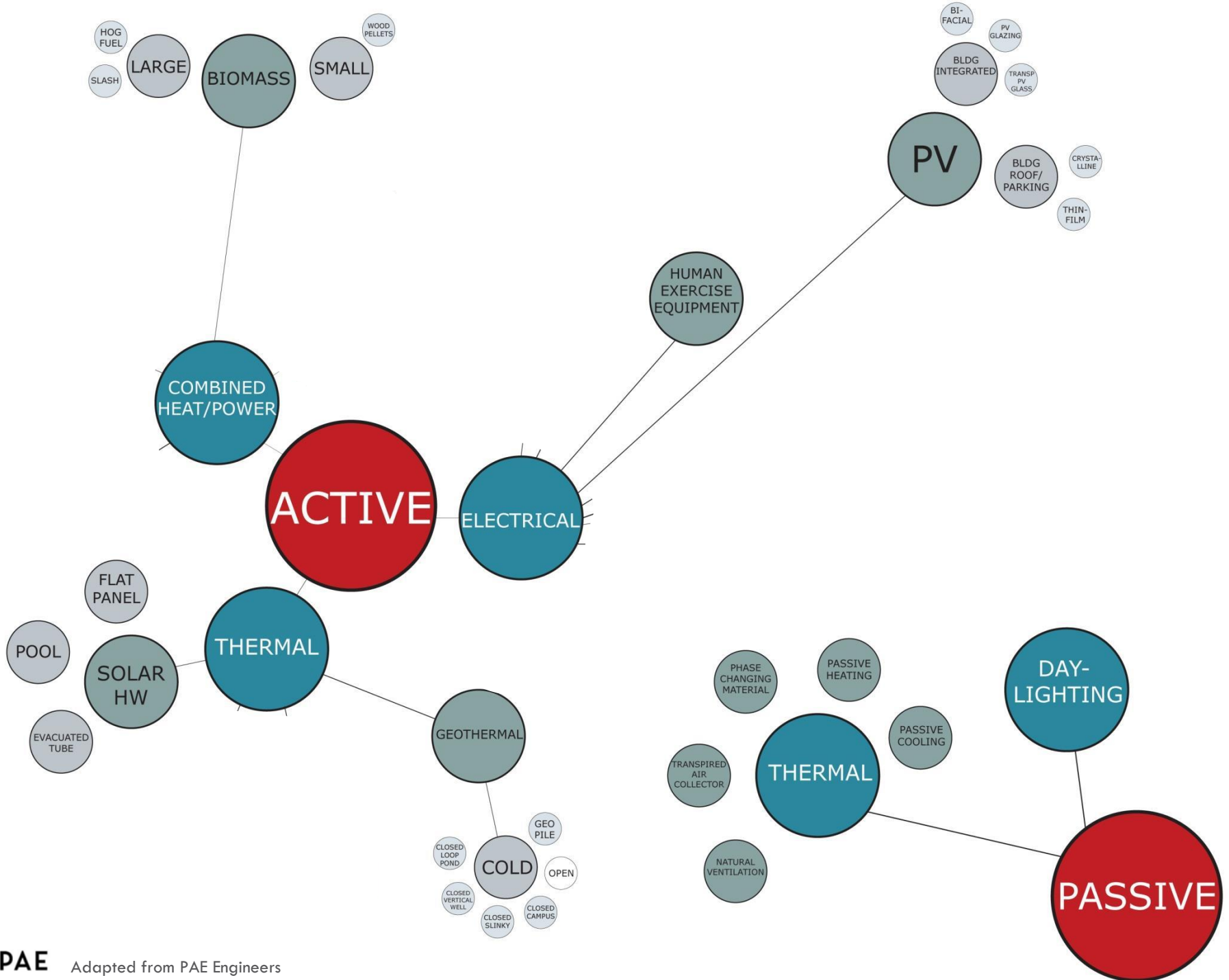
- **Master campus planning** begins with the Long Range Development Planning (LRDP) team
- **University receives funds from 2016 USDA Forest Service Wood Innovations Funding** to study biomass feasibility alongside master planning
- **Wisewood Energy retained** to provide biomass analysis for realistic campus scenarios
- **LRPD team develops five energy efficiency scenarios**, and recommends biomass central heating
- **Wisewood Energy uses LRPD data** to conduct biomass analysis













# THERMAL ENERGY TECHNOLOGIES CONSIDERED

OPTION	EVALUATED?



# ELECTRIC ENERGY TECHNOLOGIES CONSIDERED

OPTION	EVALUATED?



# LRDP ENERGY SCENARIOS

SCENARIO	DESCRIPTION	CAMPUS EUI (KBTU/SF/YR)	GEO THERMAL	PV FITS ON CAMPUS	ANNUAL HEAT DEMAND
<b>GOOD</b>	<ul style="list-style-type: none"> <li>➤ Biomass central heat</li> <li>➤ Distributed cooling</li> <li>➤ Buildings designed to code</li> </ul>	79	No	No	<b>62.7 MMBtu</b>
<b>BETTER</b>	<ul style="list-style-type: none"> <li>➤ Biomass central heat</li> <li>➤ Distributed cooling</li> <li>➤ Buildings exceed code</li> </ul>	56	No	Maybe	<b>48.0 MMBtu</b>
<b>BETTER +</b>	<ul style="list-style-type: none"> <li>➤ Biomass and geoexchange central heating and cooling</li> <li>➤ Buildings exceed code</li> </ul>	49	Yes	Maybe	<b>48.0 MMBtu</b>
<b>BEST</b>	<ul style="list-style-type: none"> <li>➤ Biomass central heat</li> <li>➤ Distributed cooling</li> <li>➤ Buildings passive as applicable</li> </ul>	38	No	Better + With and Without the Innovations District	
<b>BEST +</b>	<ul style="list-style-type: none"> <li>➤ Biomass and geoexchange central heating and cooling</li> <li>➤ Buildings passive as applicable</li> </ul>	33	Yes	Yes	<b>29.5 MMBtu</b>



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# ADVANCED WOOD ENERGY



# BIOMASS SYSTEM SIZING

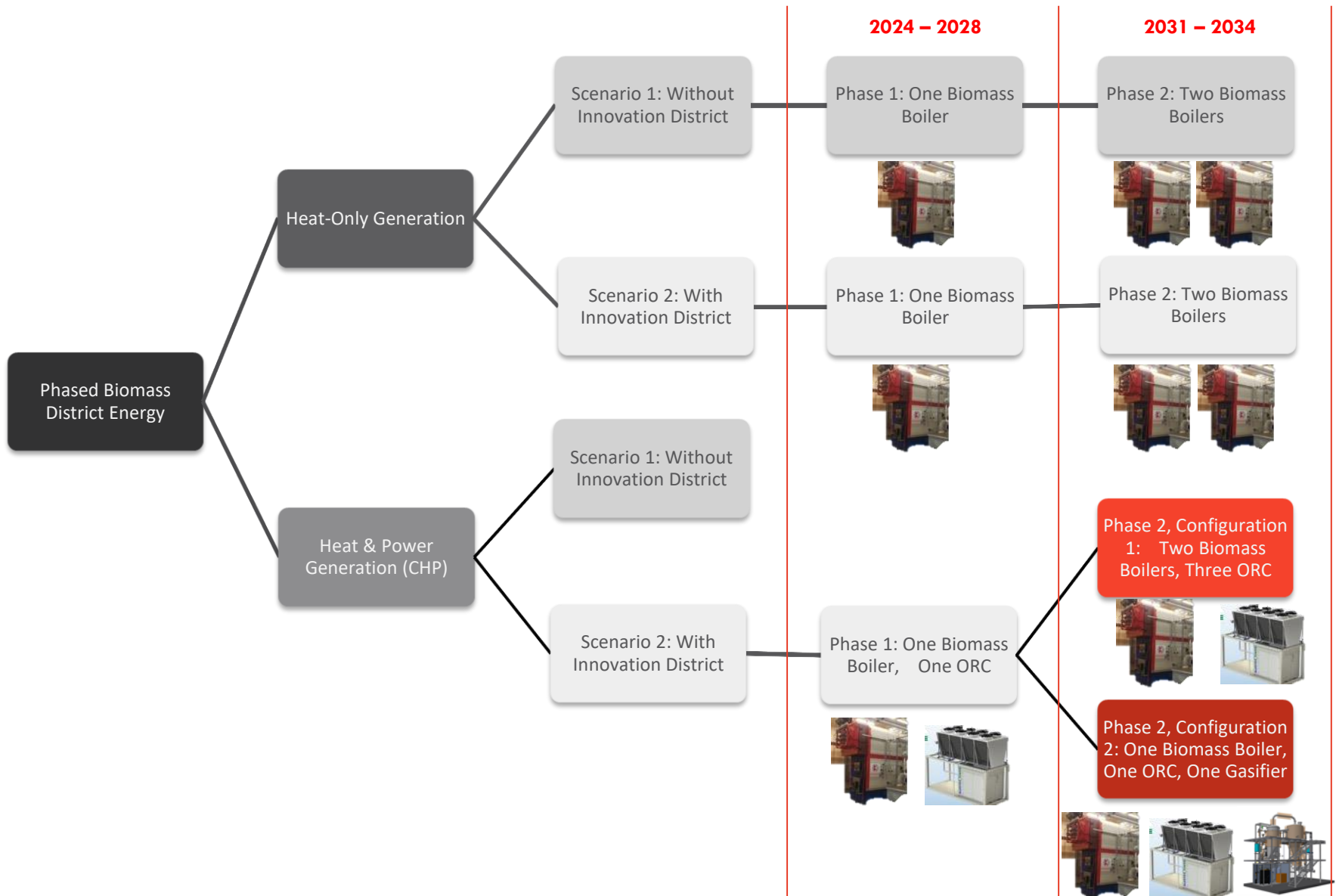
- **Determine optimum biomass boiler size for efficiency and effectiveness**
- **70% biomass heating, 30% geoexchange heating (100% geoexchange cooling)**
- **Design biomass for full campus buildout; realistic construction would be in phases**



WE



# BIOMASS ANALYSIS DIRECTIONS: BETTER +





# SHIFTING TO BIOMASS CHP

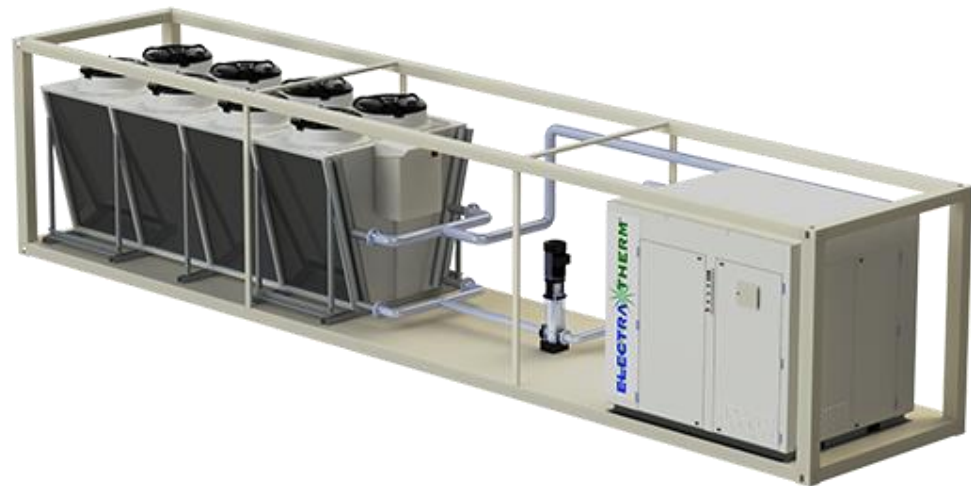
- **Financial incentives exist** when electricity is generated, unavailable if heat only
- **Reliable options** well suited to a campus scale
- **Existing Energy Systems Lab** that focuses on advanced internal combustion engines and unconventional fuels, but has no physical lab space on campus

## GASIFIER



- 200, 300, 400, 500kW modules
- 30% eff. electricity production
- 8,000+ operating hours
- Produces biochar, an organic agriculture amendment

## ORGANIC RANKINE CYCLE

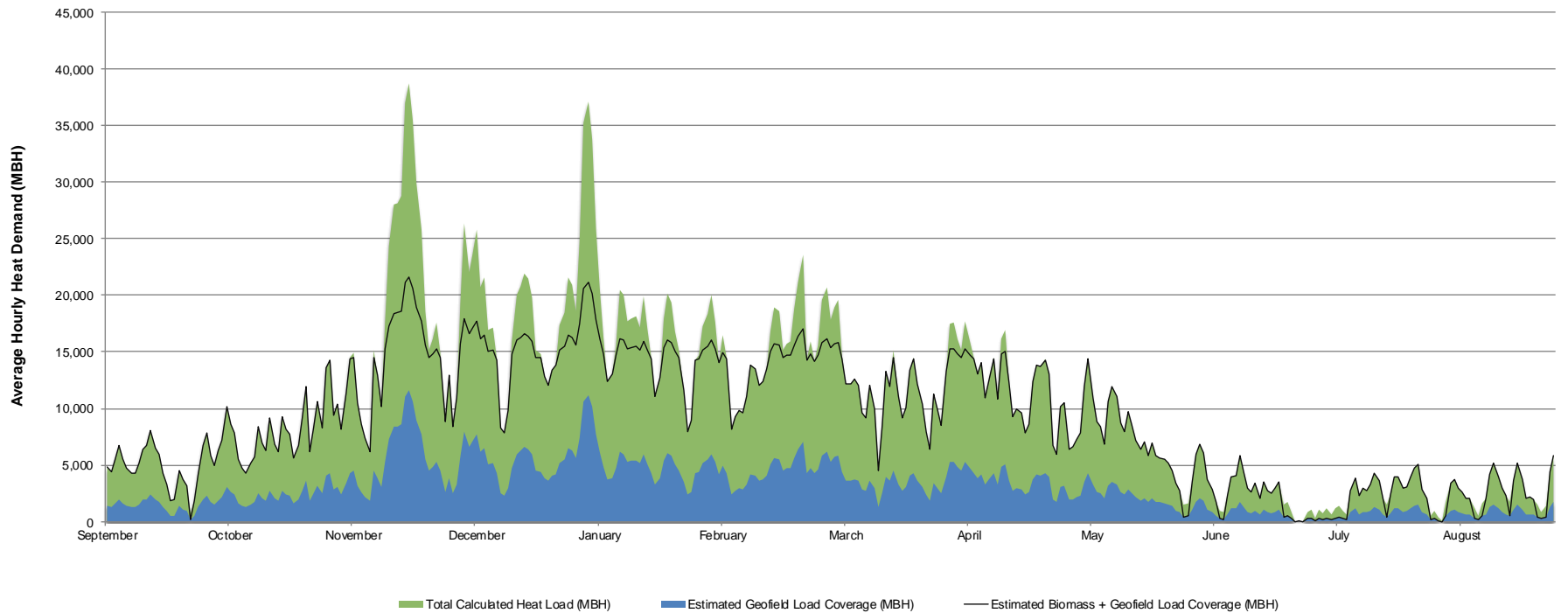


- 35, 100kW modules
- 8% eff. electricity production
- 8,000+ operating hours
- Produces low temp hot water



# BETTER + WITH INNOVATIONS DISTRICT (FULL BUILDOUT)

**Estimated Heat Load Coverage by New Biomass-Fired Boiler**



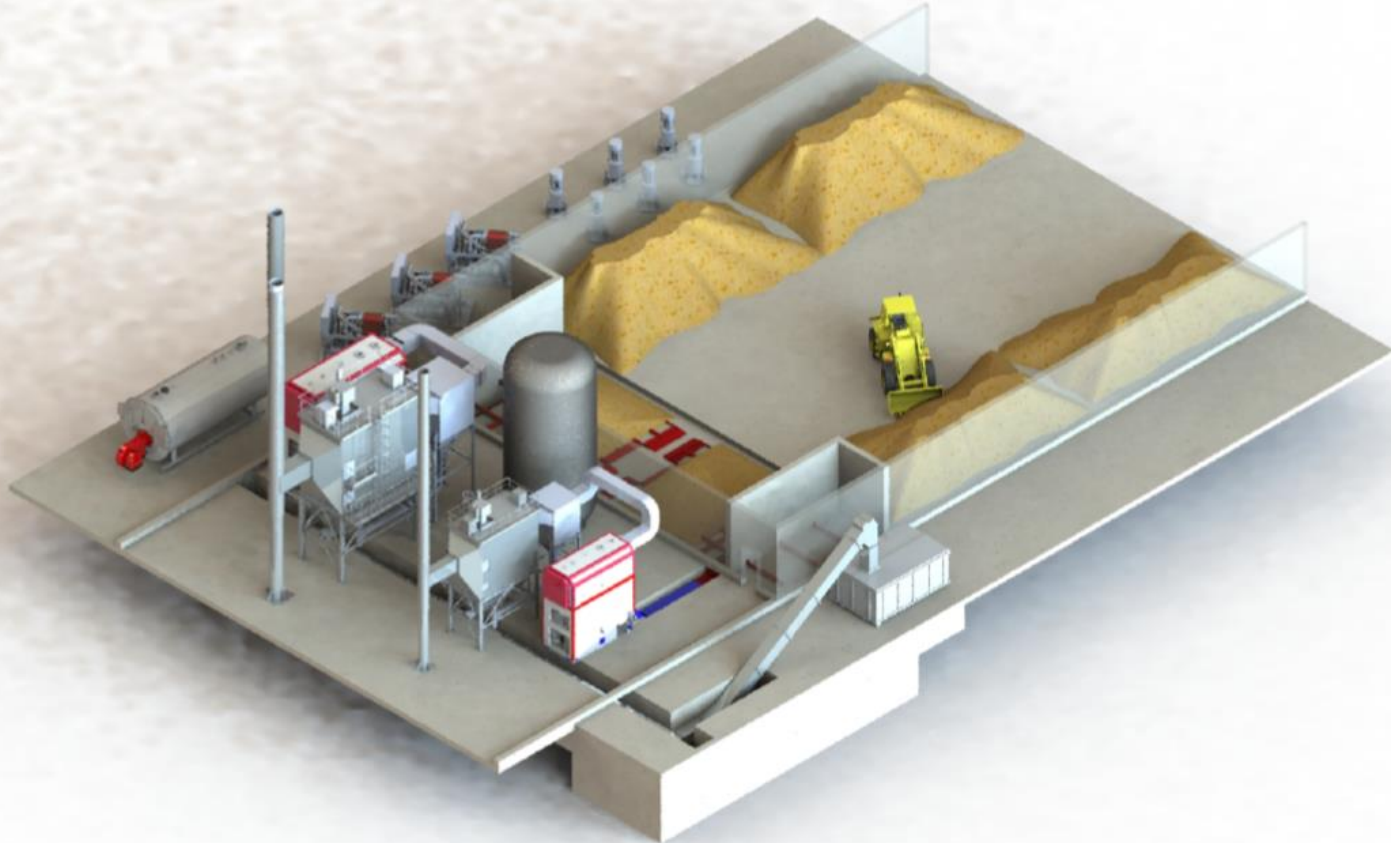
# BETTER + ANALYSIS

## (WITH INNOVATIONS DISTRICT)

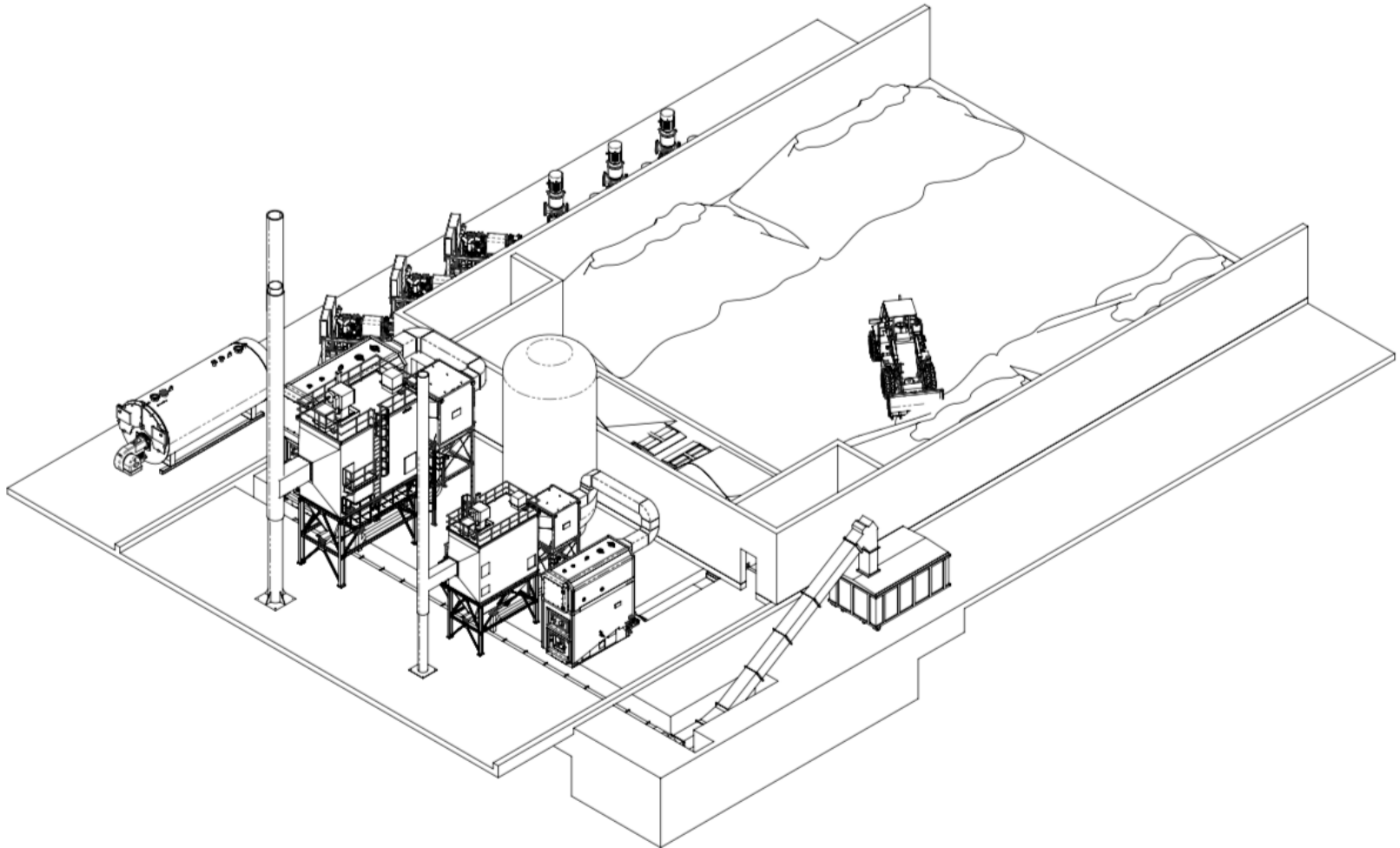
	PHASE 1		PHASE 2	
	HEAT ONLY	CHP	HEAT ONLY	CHP
TOTAL CAMPUS HEAT DEMAND	27,500 MMBtu/Yr	Same	70,500 MMBtu/Yr	Same



## PHASE 2 – ORC CHP ISO

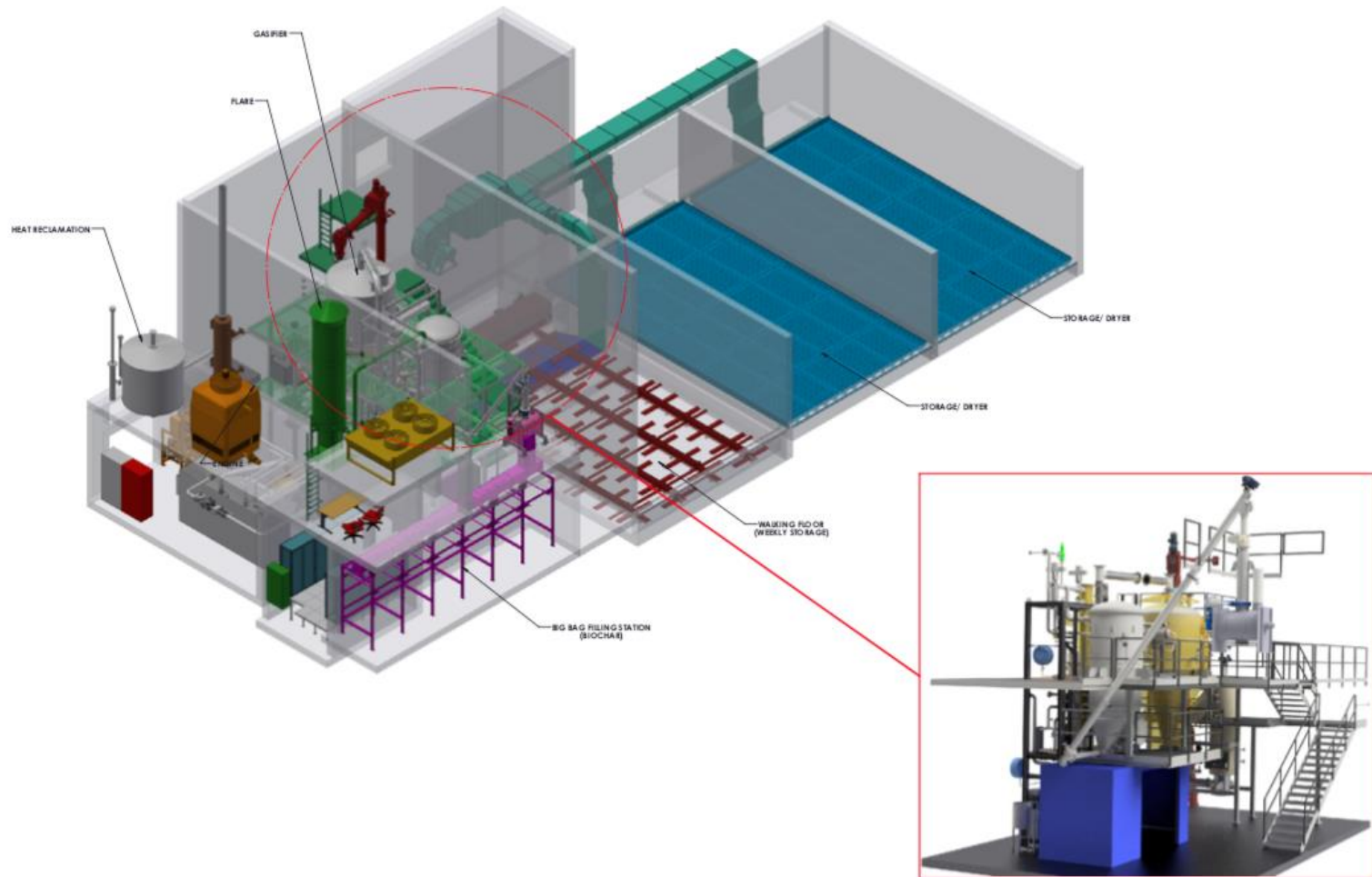


## PHASE 2 – ORC CHP ISO

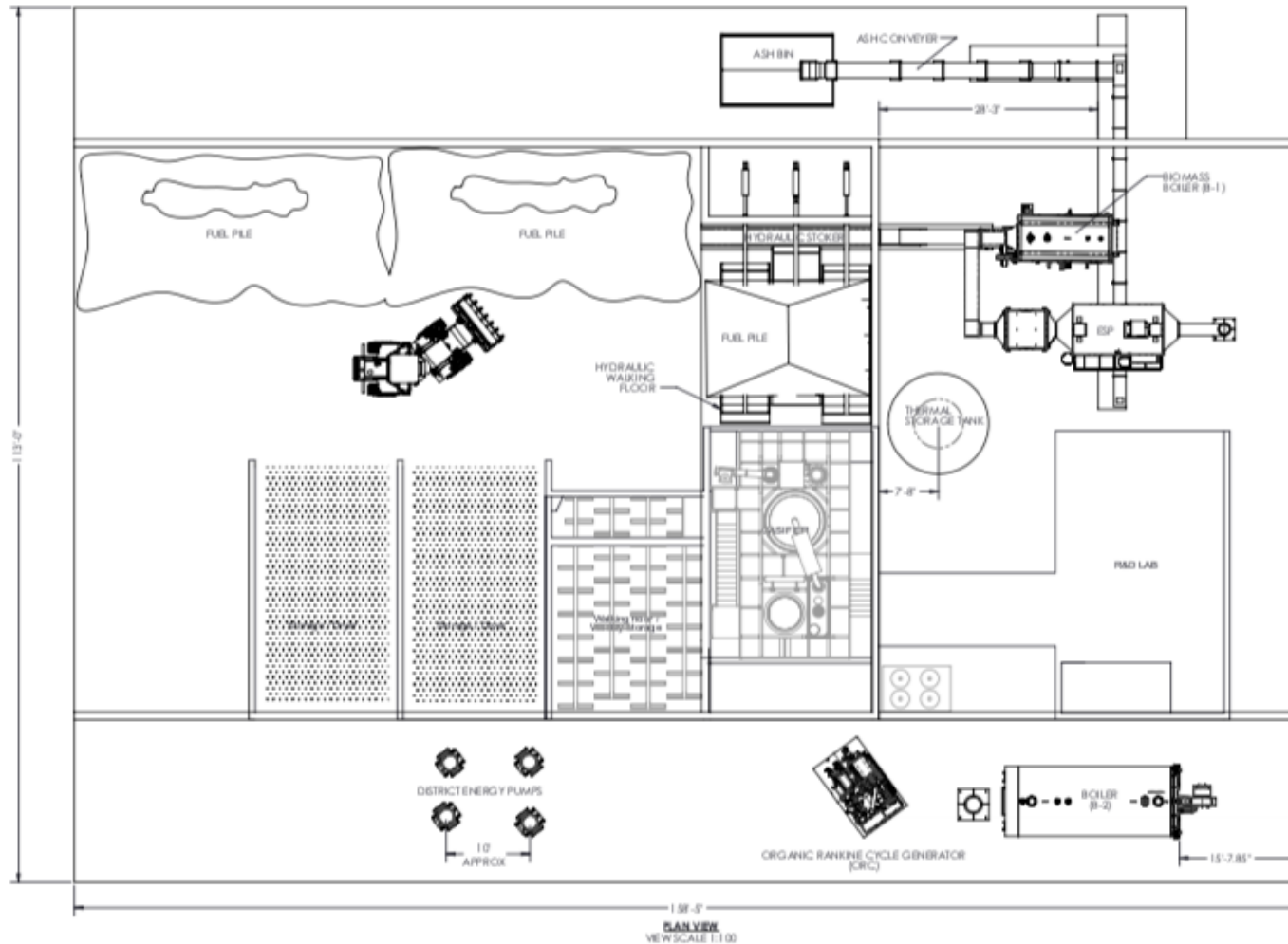




# PHASE 2 – GASIFIER PARTIAL ISO



# PHASE 2 – GASIFIER PLAN VIEW





## NEXT STEPS

- University is further developing conceptual design of geoexchange system options (ground vs water)
- University is undergoing internal process to determine whether to incorporate biomass into CUP
- If pursuing biomass, next step is to select heat-only or CHP, then refine system configuration and sizing



# WHAT DID WE LEARN?

- **Efficiencies and cross-team understanding** could have been improved if biomass option was incorporated more directly into LRDP process.
- Wood energy can be contentious – important to select **appropriate technology** and ground discussion in **realistic scenarios**.
- Optimizing across technologies is complex, but compelling! Takes **vision and leadership** to carry.



**THANK YOU!**  
**Technology in Service of  
Community and Environment**