Metropolitan Water Reclamation District of Greater Chicago

Welcome to the May Edition of the 2026 M&R Seminar Series

NOTES FOR SEMINAR ATTENDEES

- Remote attendees' microphones are muted at entry to minimize background noise. For attendees in the auditorium, please silence your phones.
- A question and answer (Q/A) session will follow the presentation.
- For remote attendees, please use "**Chat**" only to type questions for the presenter. For other issues, please send emails to MnRseminars@mwrd.org.
  For attendees in the auditorium, please raise your hand and wait for the microphone to ask a verbal question during the Q/A session.
- The presentation slides will be posted on the MWRD website after the seminar.
- This seminar has been approved by the Engineering Society of Illinois (ESI) for one PDH and approved by the IEPA for one TCH. Certificates will be issued only to participants who attend the entire presentation. For PDH certificate seekers, **completing a brief course evaluation and submitting it are required**.

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Water/Wastewater Process Engineer
Jacobs, Denver, Colorado

Maddy Fairley-Wax, P.E. is a Wastewater Process Engineer and Technology Specialist focused on anaerobic digestion and biogas utilization design and optimization. She received her B.S. in Civil Engineering from Northeastern University and her M.S. in Environmental Engineer from the University of Michigan. She has been with Jacobs for 8 years and leads the research, development, and implementation of Jacobs' Microbial Hydrolysis Process (MHP), an innovative technology enhancing digester performance. Her expertise extends to comprehensive solids process evaluations, feasibility studies for cogeneration, and permitting for complex wastewater infrastructure projects.

For PDH Certificate seekers,

The link to the new on-line course evaluation form has been posted in the Chat. The link is also available on the District website. The form will only be available online until the start of next month's seminar. Please be sure to fill it out and submit promptly.

Jacobs

Challenging today.
Reinventing tomorrow.

Full-Scale Enhancement of Anaerobic Digestion with the Microbial Hydrolysis Process

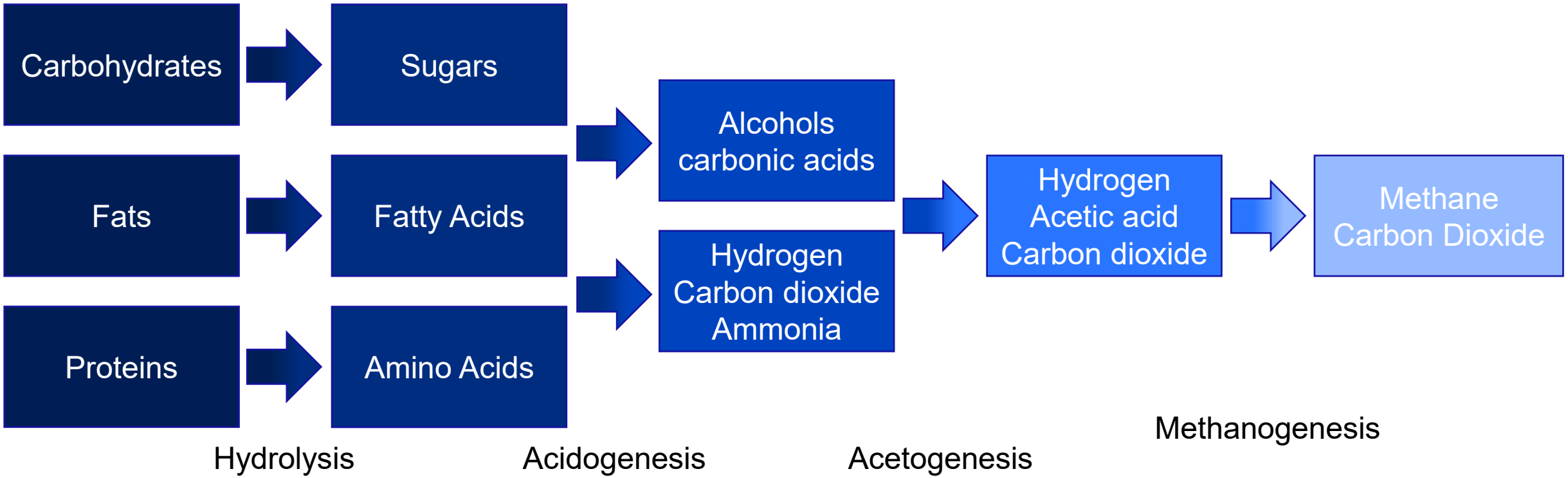
May 29, 2026

Agenda

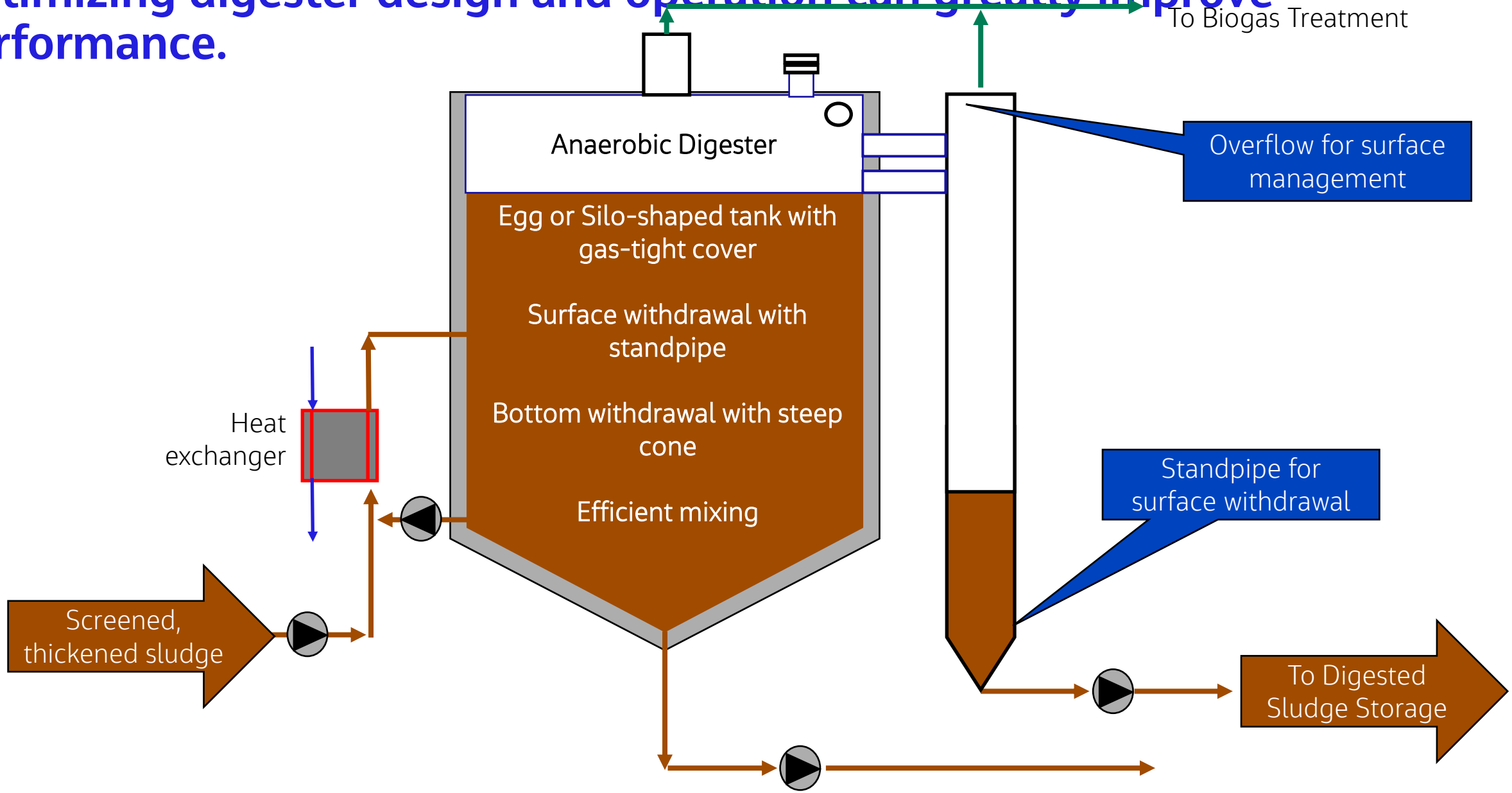
- Optimizing Anaerobic Digestion
- Overview of the Microbial Hydrolysis Process (MHP) using *C. bescii*
- Research approaches and results
- Implementation

Optimizing Anaerobic Digestion

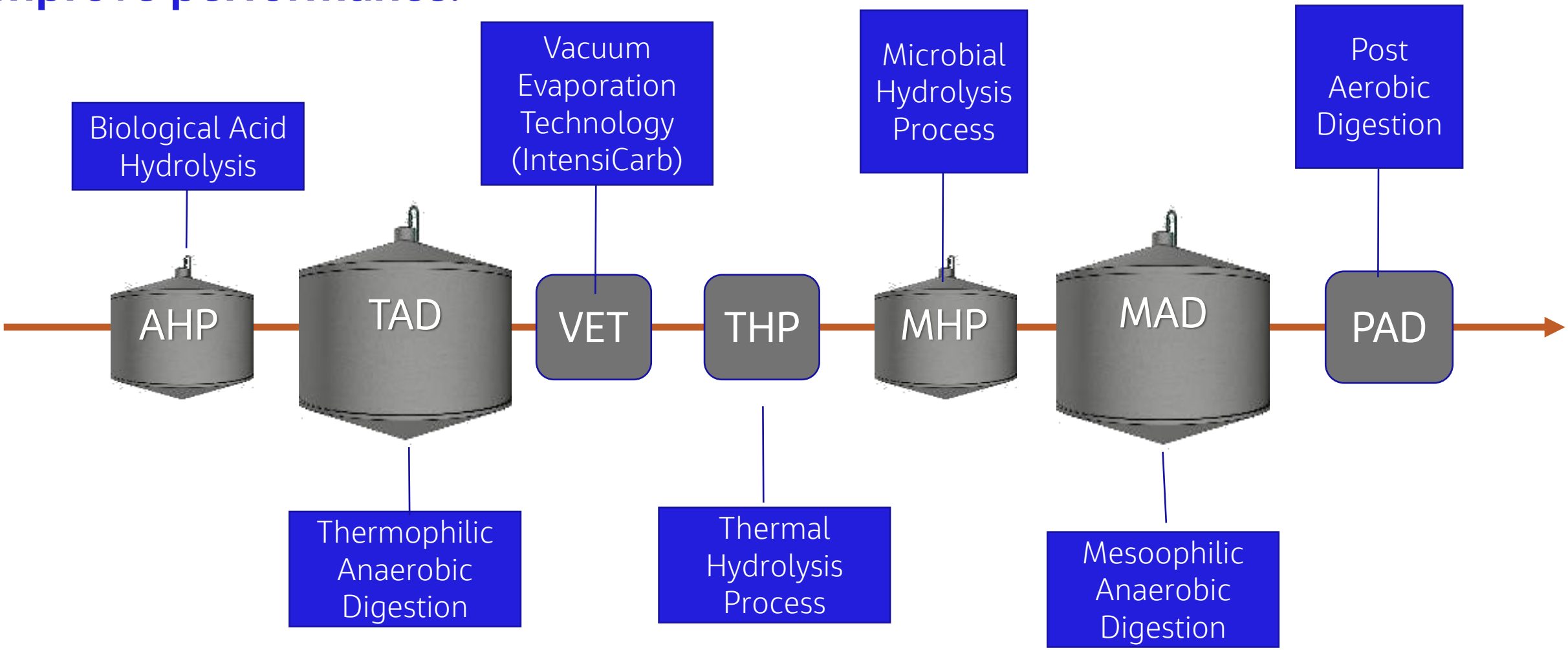
Digestion involves four main steps to convert complex organics to biogas.



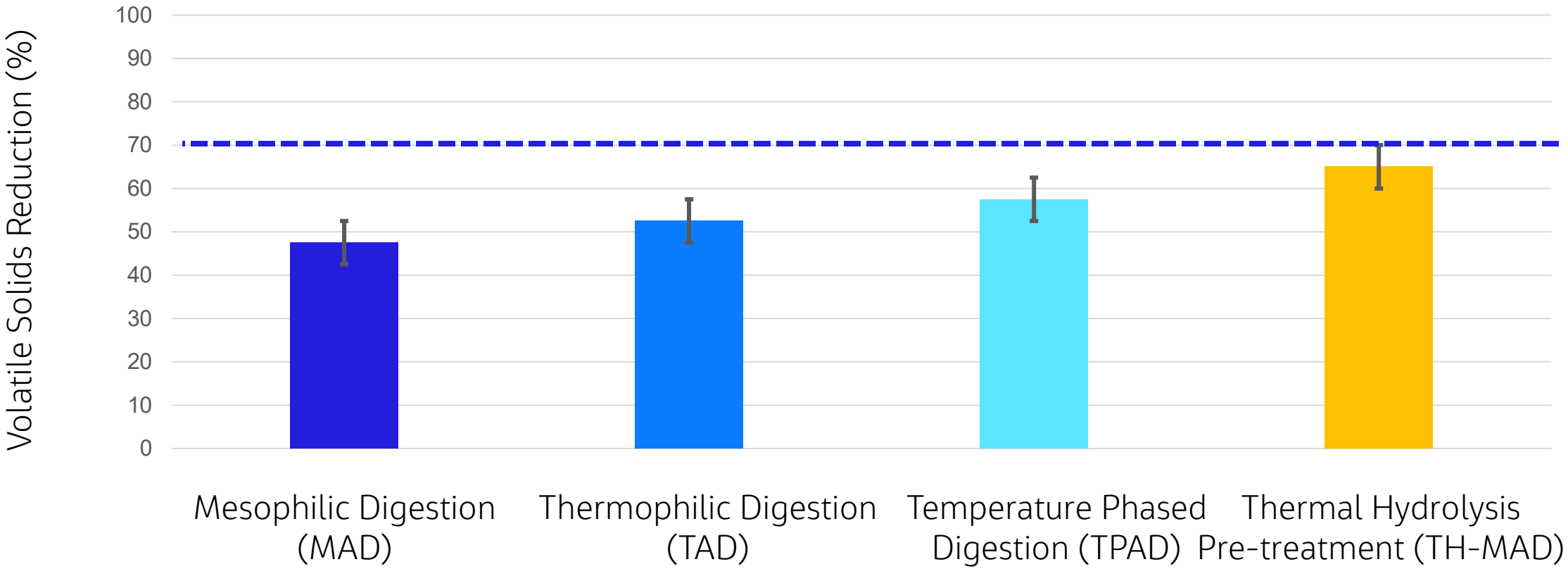
Optimizing digester design and operation can greatly improve performance.



Advanced treatment and complimentary operations can further improve performance.



Even with optimized operations and advanced treatment, VSR rarely exceeds 70%.



Source: Wilson, Christopher et al (2009)

Undigested organics contribute to final biosolids volume and hold significant untapped energy potential.

The Challenge

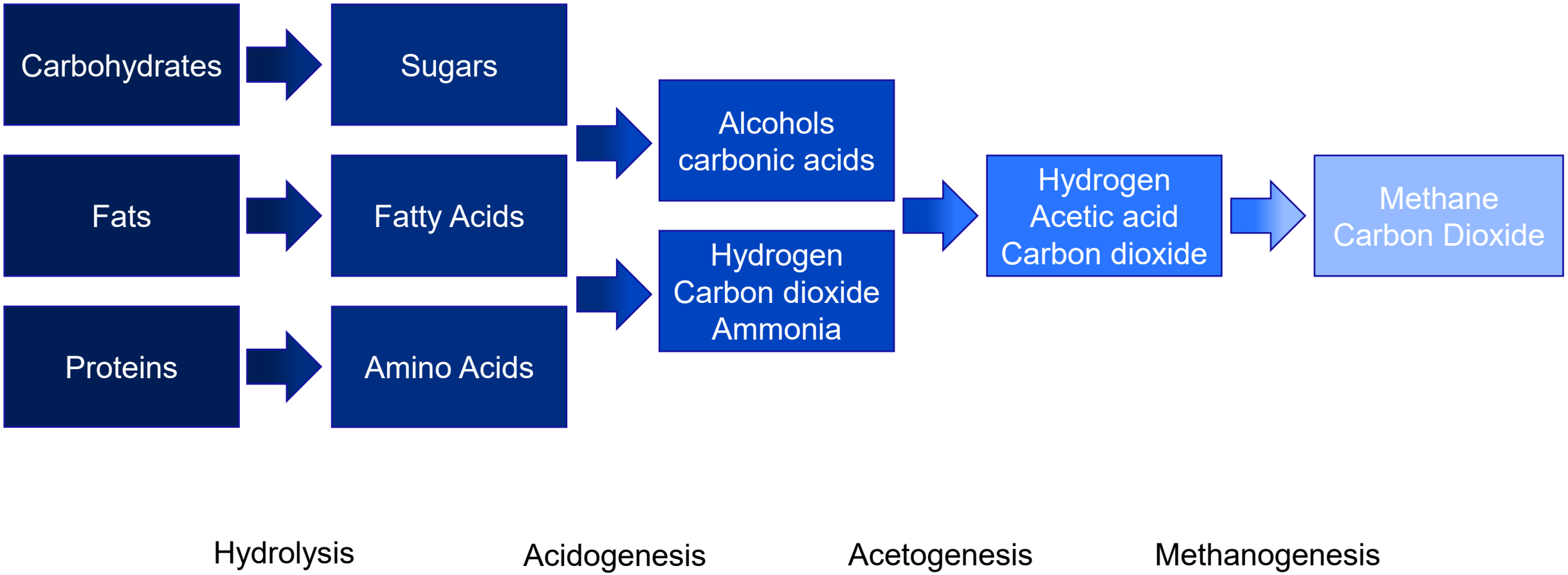
- Complex organics like cellulose (i.e. toilet paper) are resistant to digestion and require additional processing to be bioavailable

The Solution

- MHP breaks down cellulose, enabling its digestion and increasing total VSR
- Greater VSR means:
  - Less biosolids
  - More biogas

Overview of MHP using *C. bescii*

Hydrolysis of complex organics is often what limits AD performance to below 70%.



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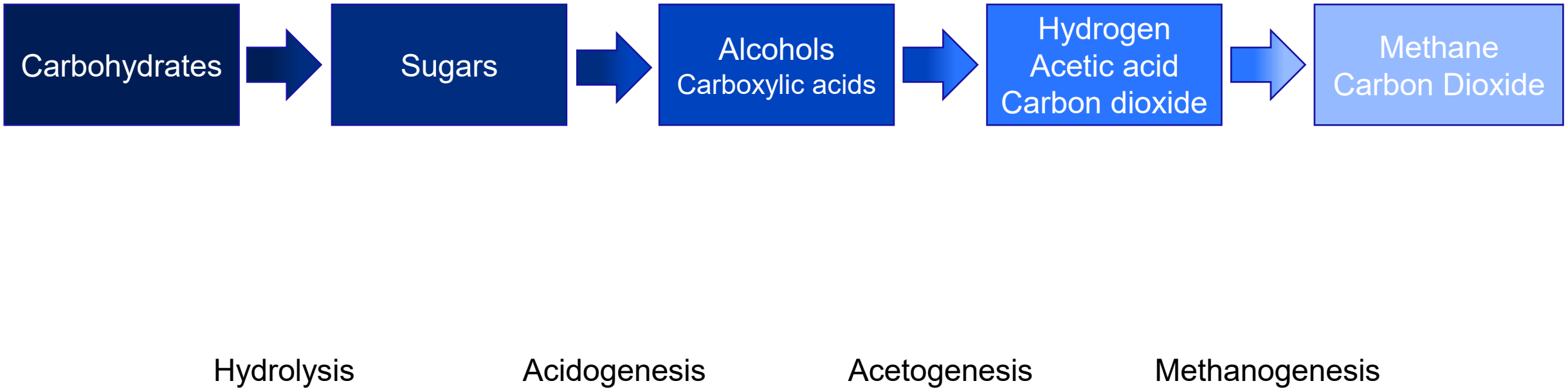
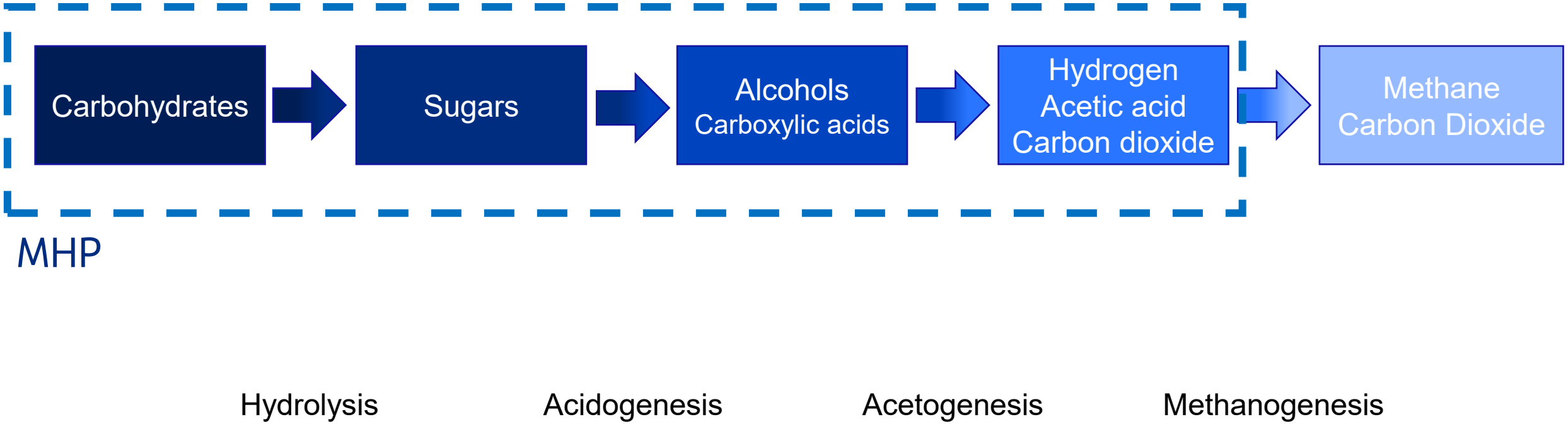
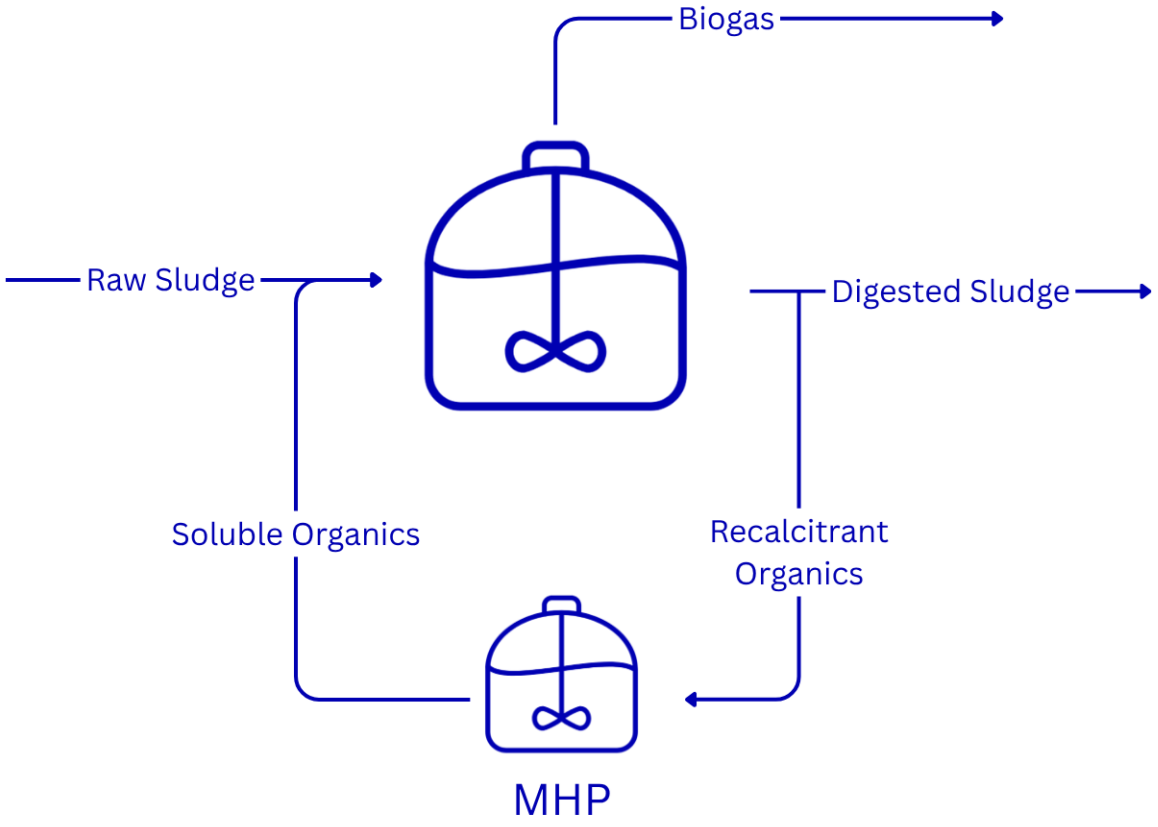


MHP hydrolyzes and ferments cellulose and other complex carbohydrates.



MHP requires equipment similar to conventional digesters and has a short SRT.

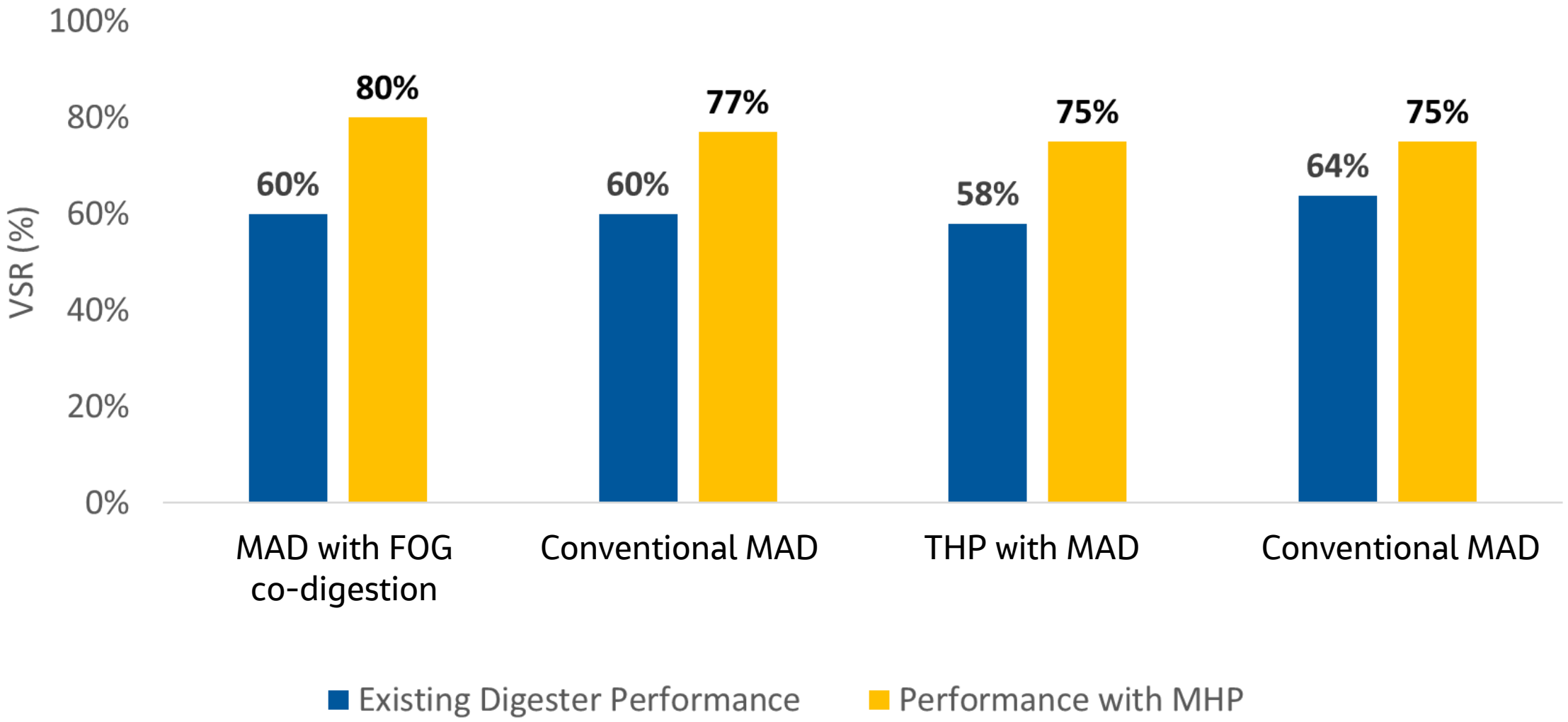
- 2-day SRT at 2-day SRT at 75°C (167°F)
- Small footprint
- Low-complexity
- Familiar operation



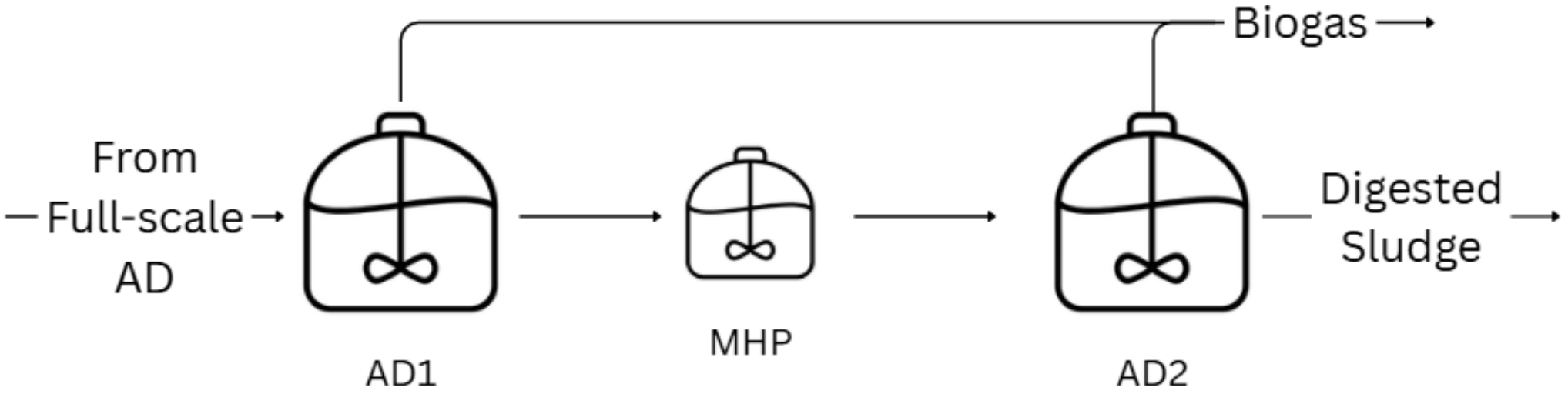
Research Approaches and Results

Since 2020, we studied MHP at lab-scale and at pilot-scale.

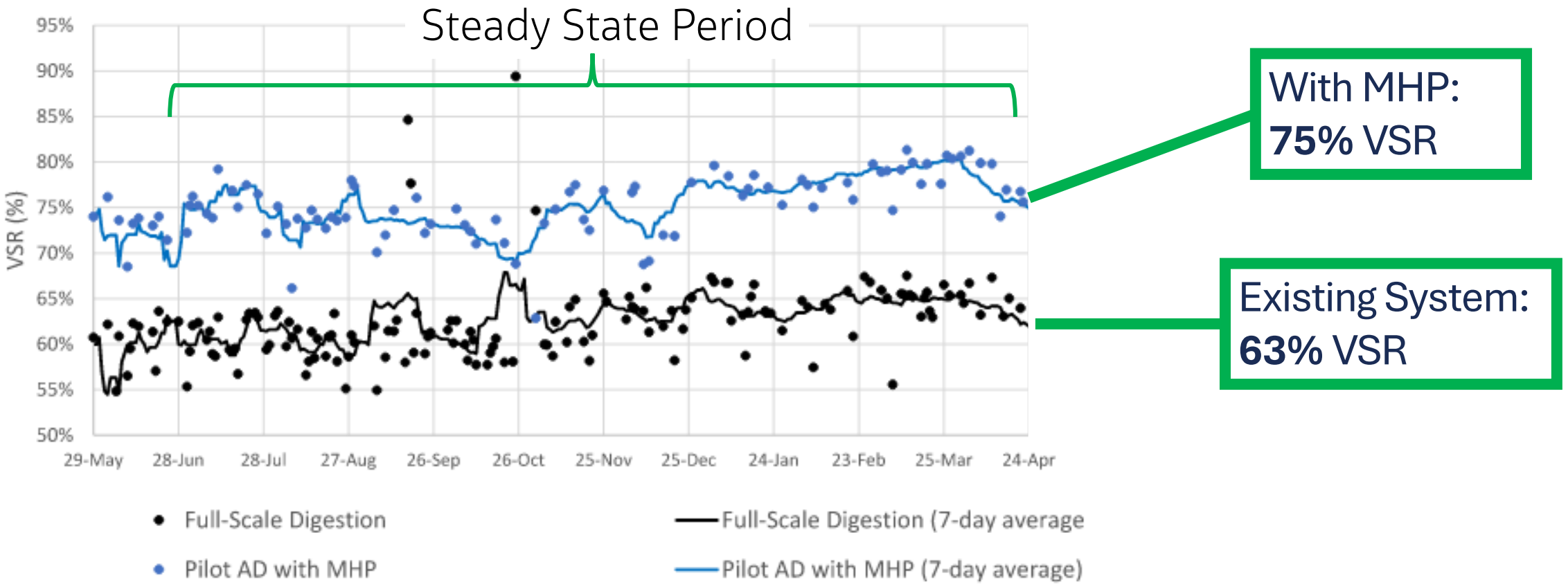
MHP has consistently demonstrated improved digestion performance.



Recently, a one-year pilot study was completed and supplemented with lab-scale tests.



A recent one-year pilot study demonstrated an consistent VSR of 75% during steady state operation.

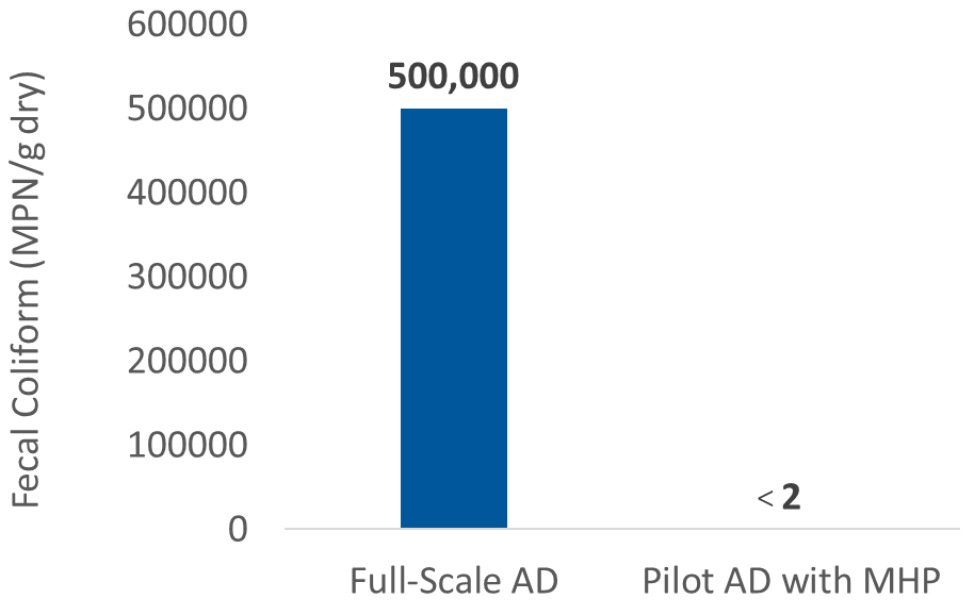


With MHP:
75% VSR

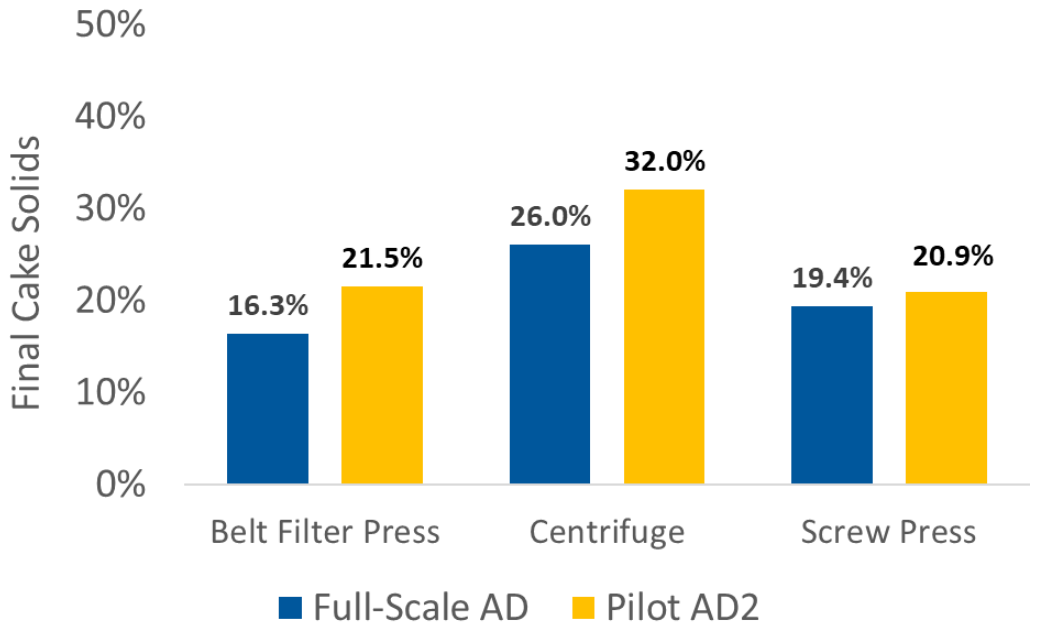
Existing System:
63% VSR

Addition of MHP met Class A pathogen reduction requirements and produced dryer cake after dewatering.

Pathogen Reduction

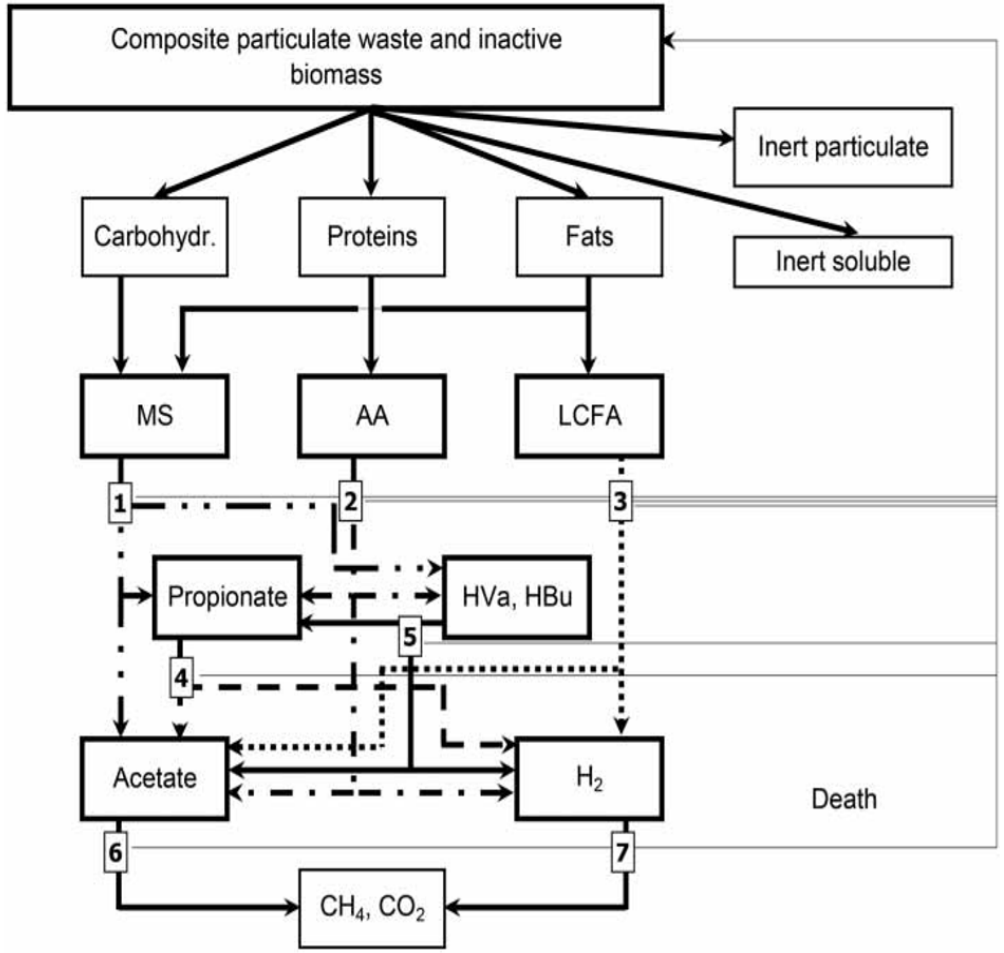


Dewaterability



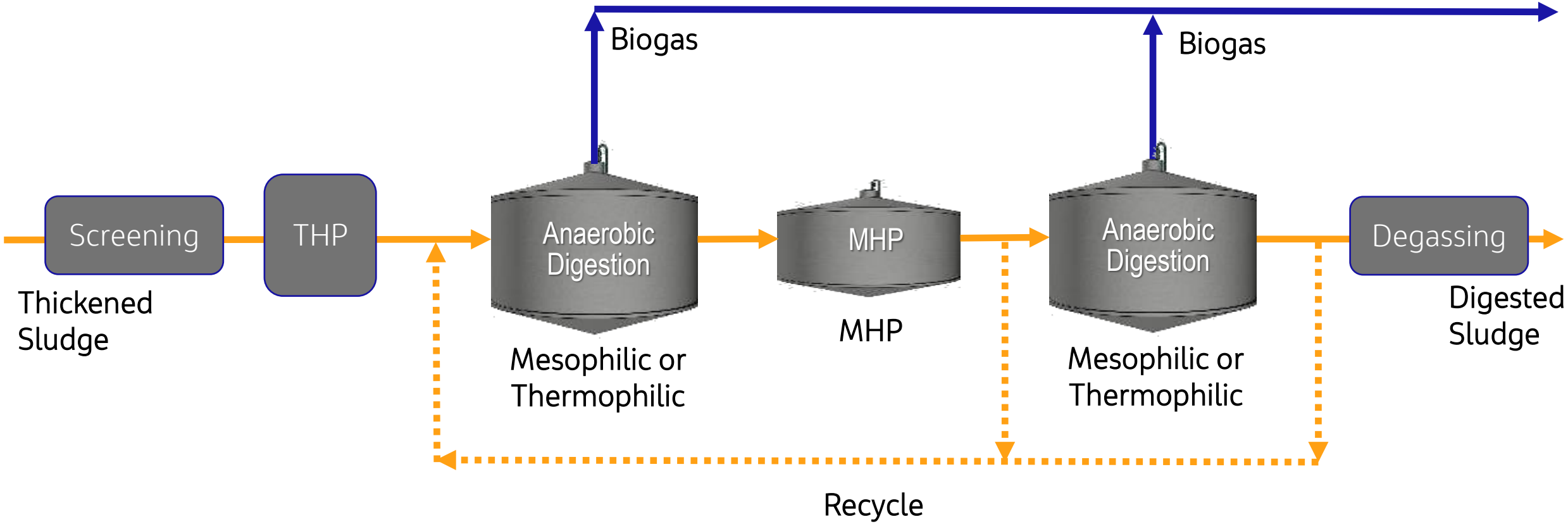
Using pilot-scale data, a predictive process model has been developed using SUMO and ADM1.

- Modeling MHP helps:
  - Capture knowledge
  - Inform future research
  - Predict MHP performance without pilot studies
  - Simulate MHP performance in varying process configurations

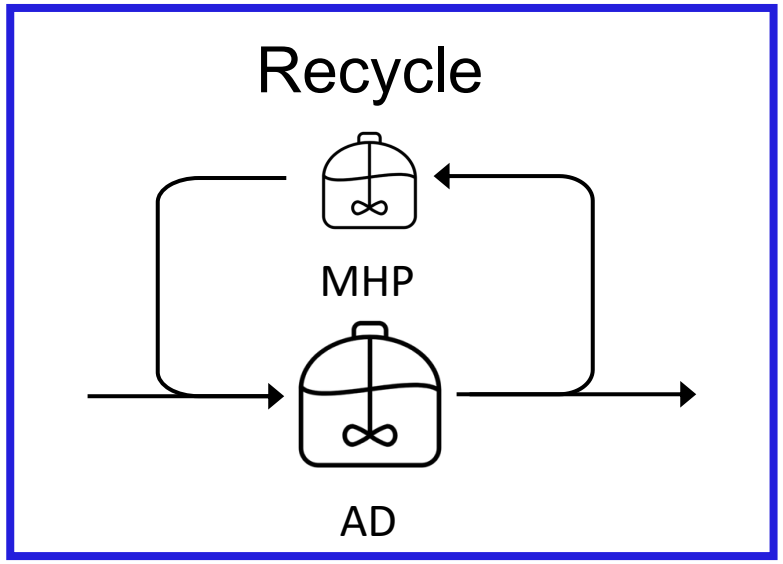


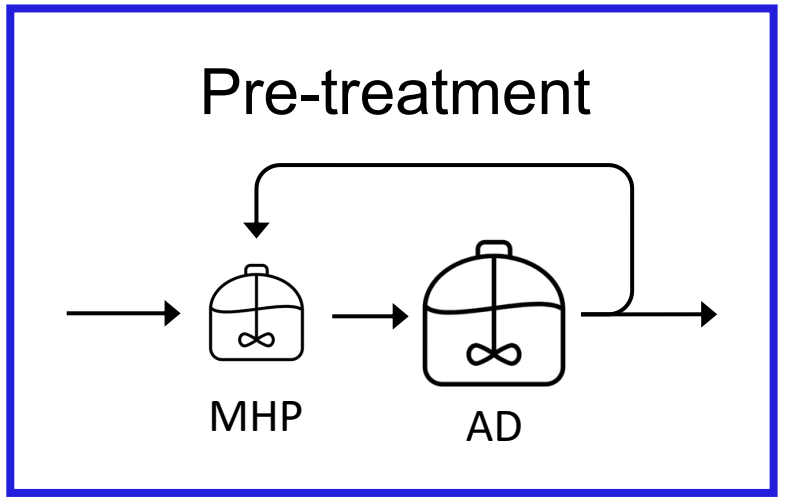
Design and Implementation

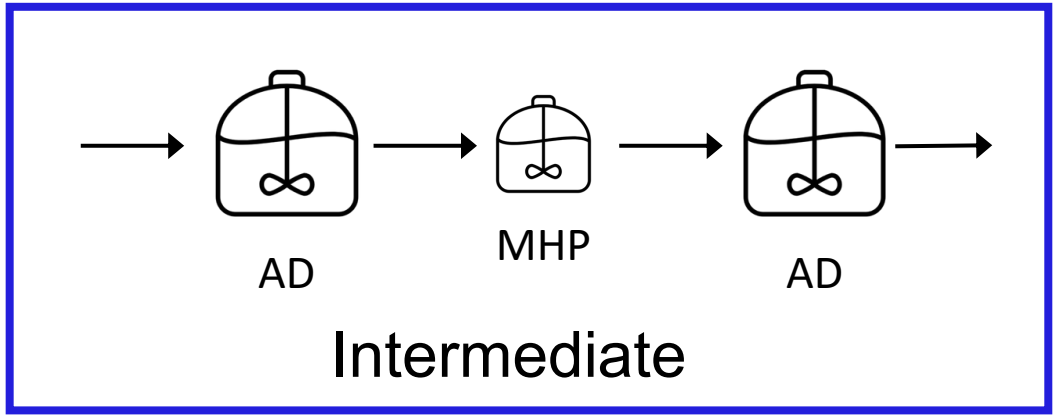
MHP can be implemented into existing digestion systems with a range of different solids processes.



Jacobs continues to develop new configurations and opportunities to implement MHP







Example Configuration: Treatment plant with TPAD, designed to meet N+1 redundancy requirements.

Thermophilic AD

Mesophilic AD

The redundant digesters can be modified to operate as MHP tank, thermophilic digester or mesophilic digester.

Thermophilic AD

Mesophilic AD

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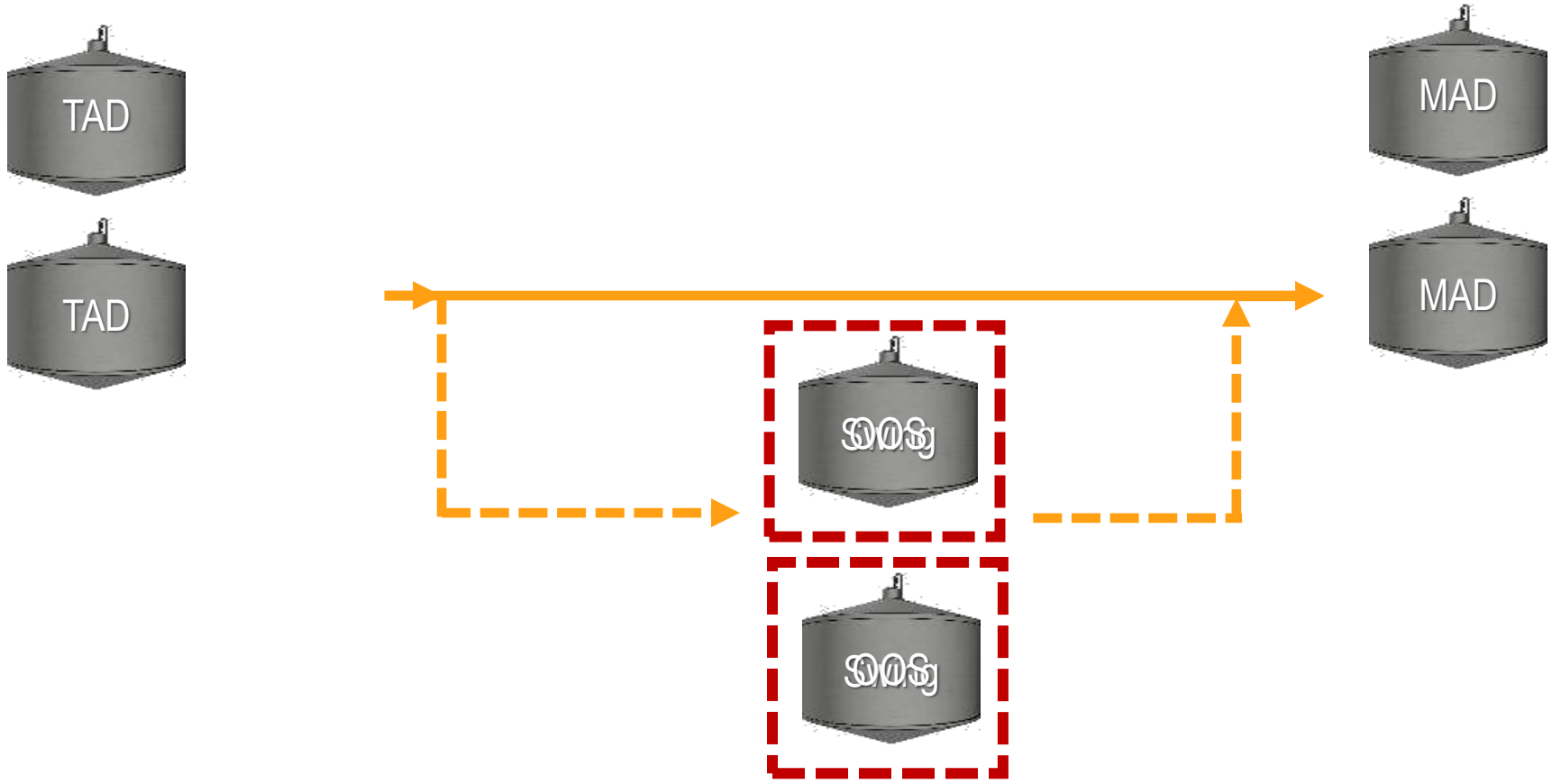
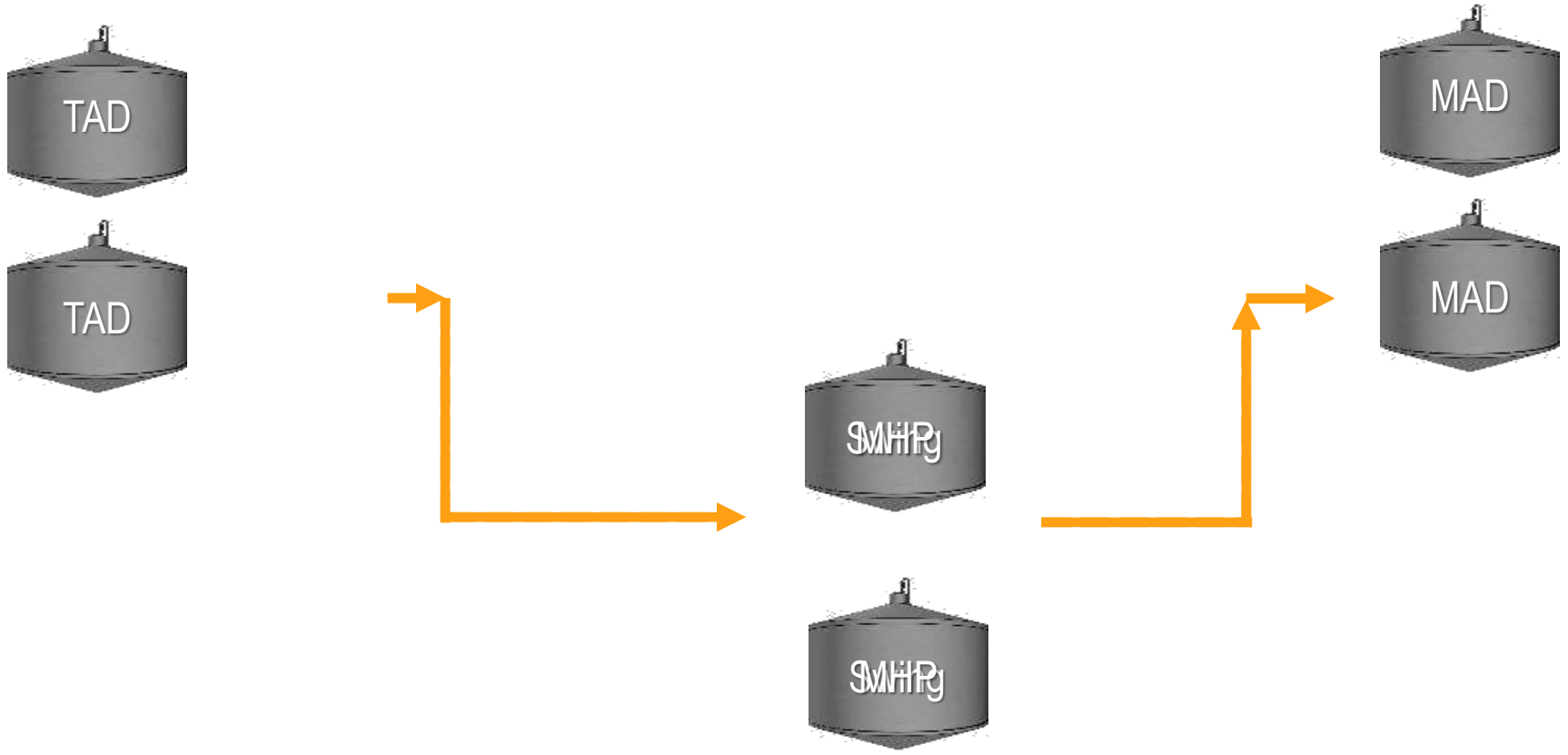
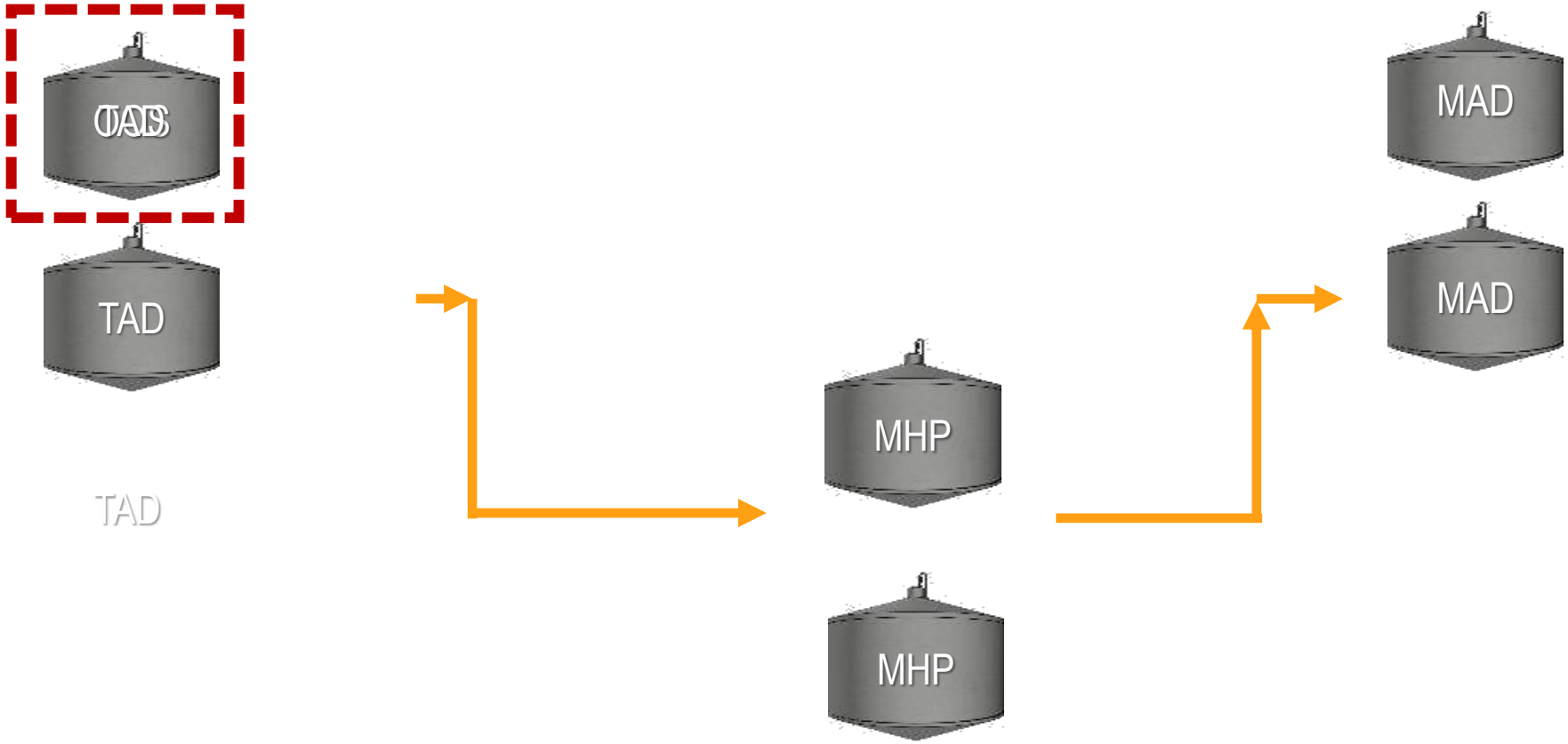


During normal operation, both swing digesters can operate as MHP tanks.



Thermophilic AD MHP Mesophilic AD

A swing digester can replace a first-stage digester when one is out of service (OOS).



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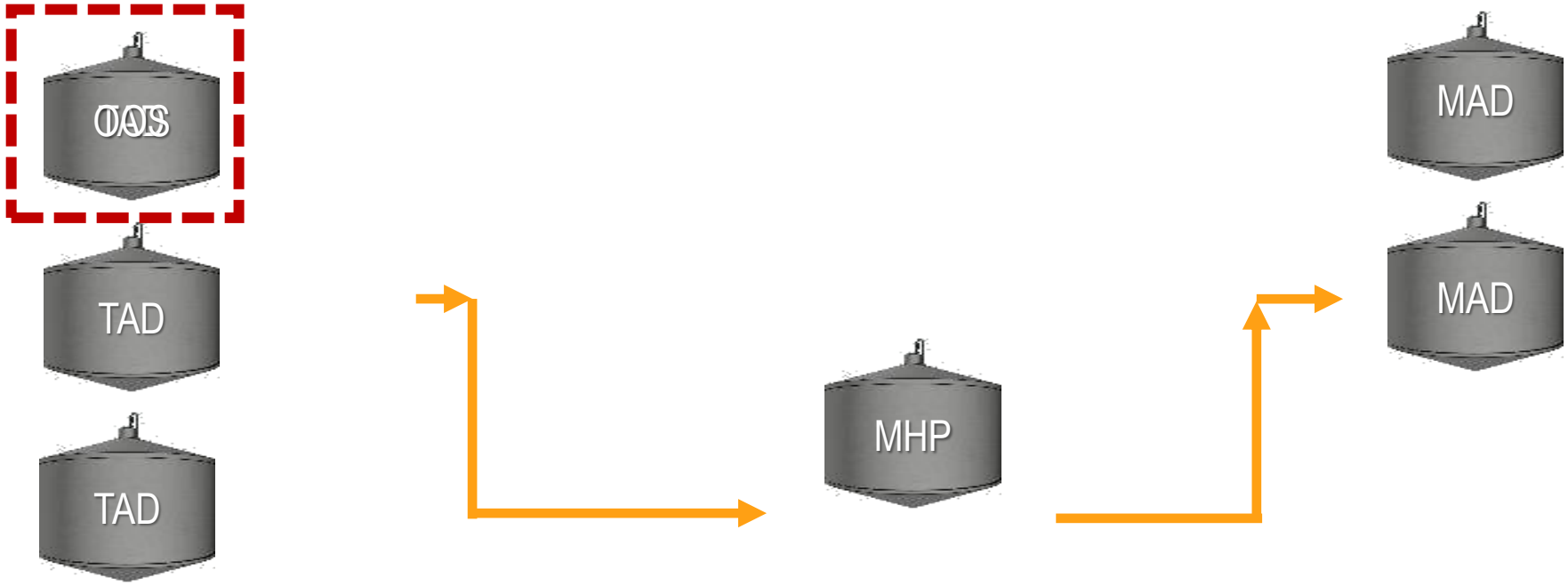
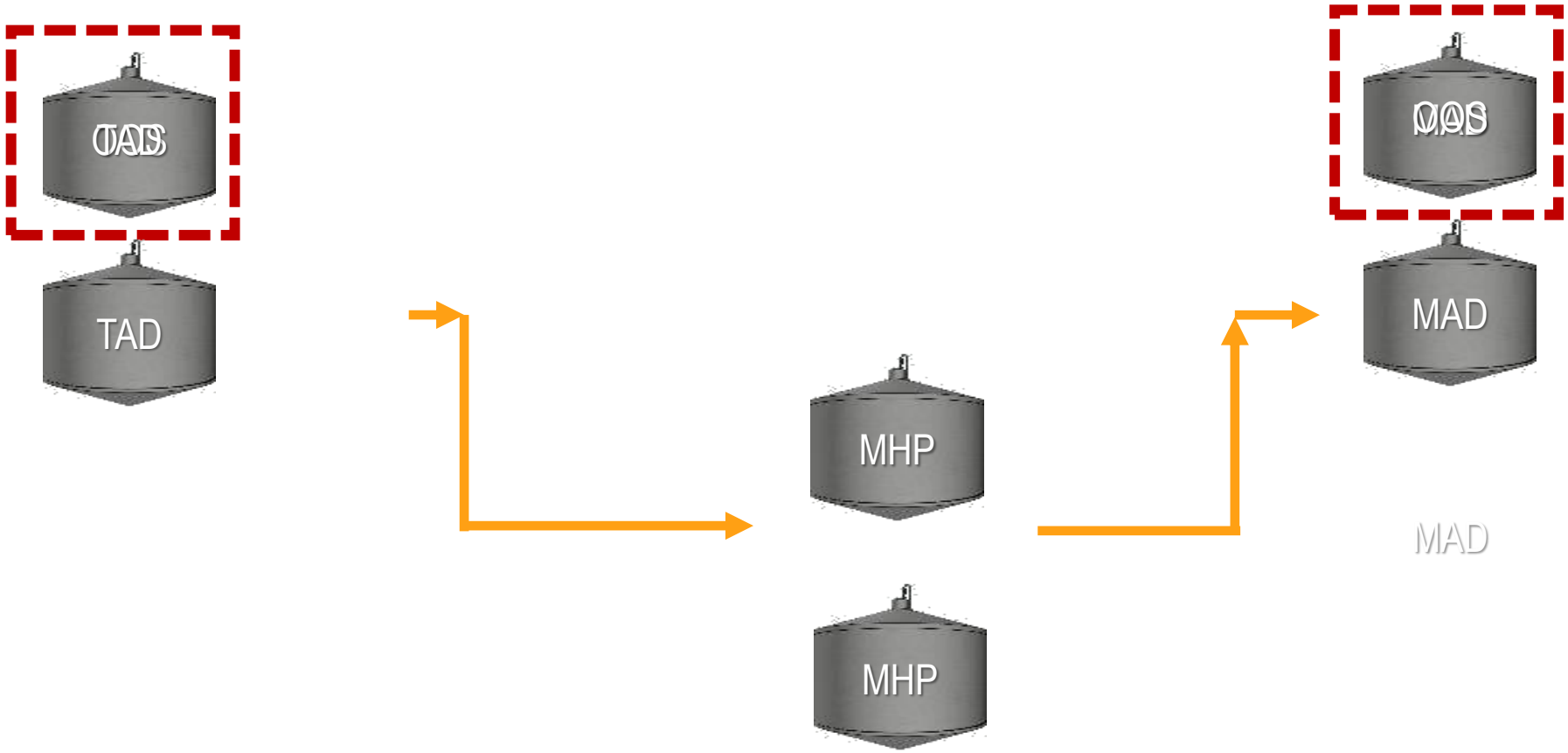


MHP

Thermophilic AD MHP Mesophilic AD

Similarly, a swing digester can replace a second-stage digester when one is out of service (OOS).



Thermophilic AD MHP Mesophilic AD

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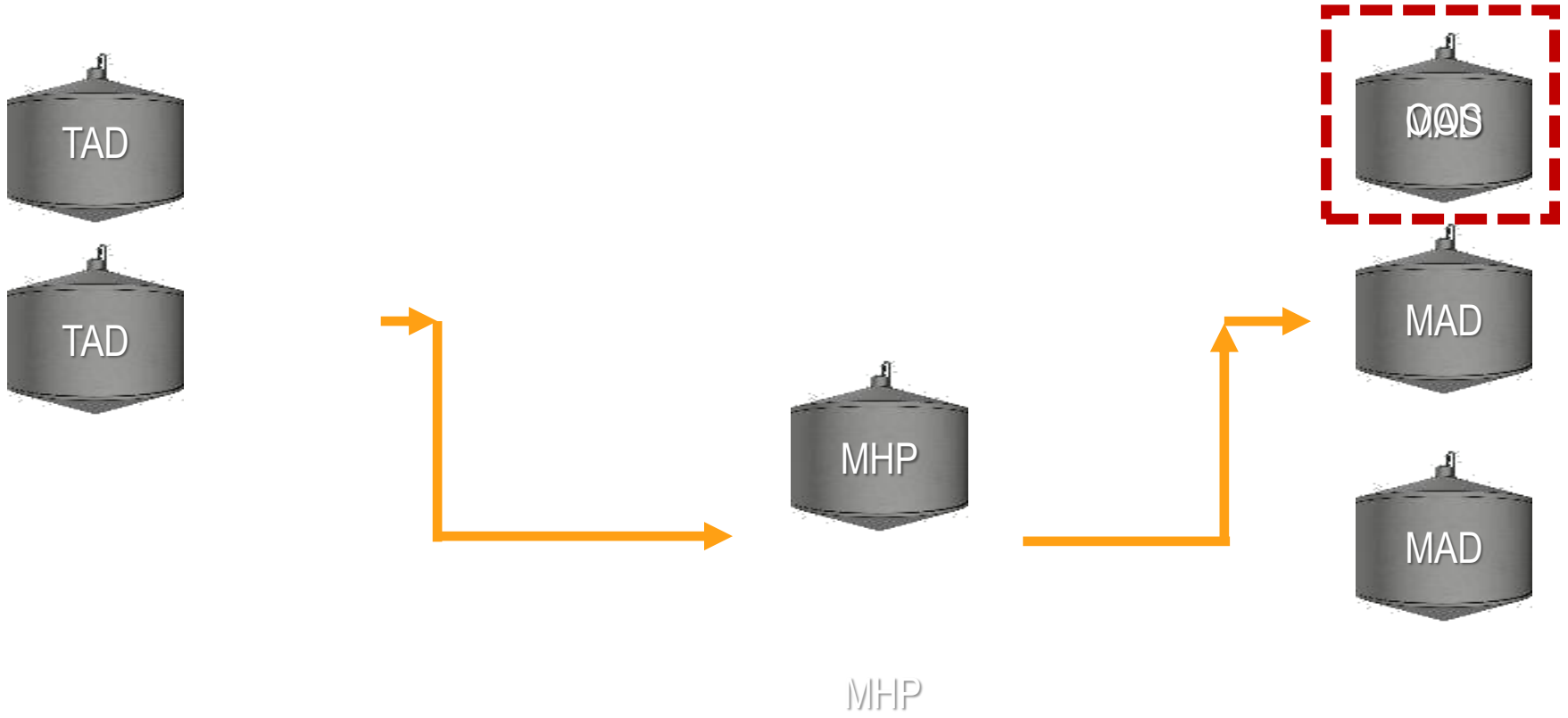
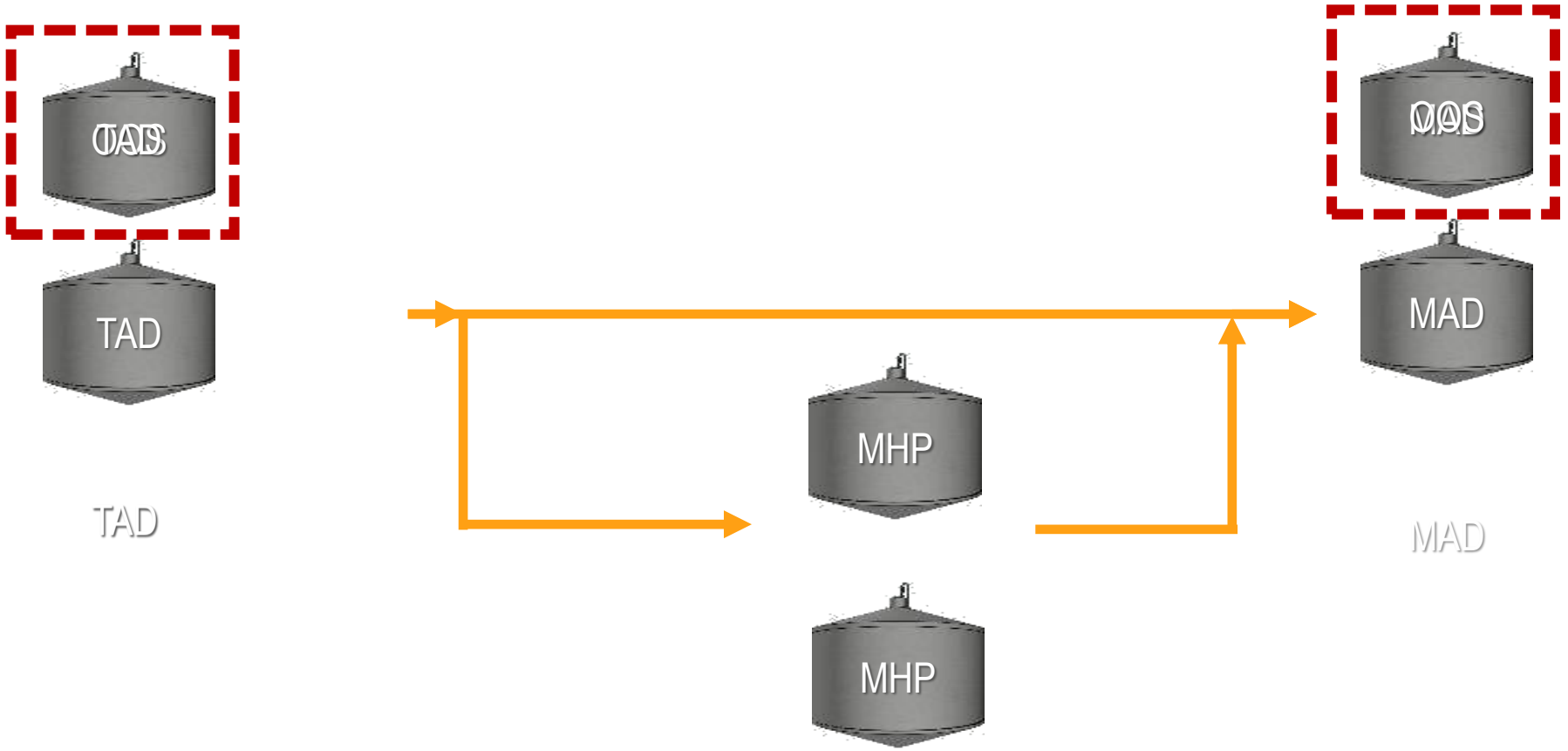


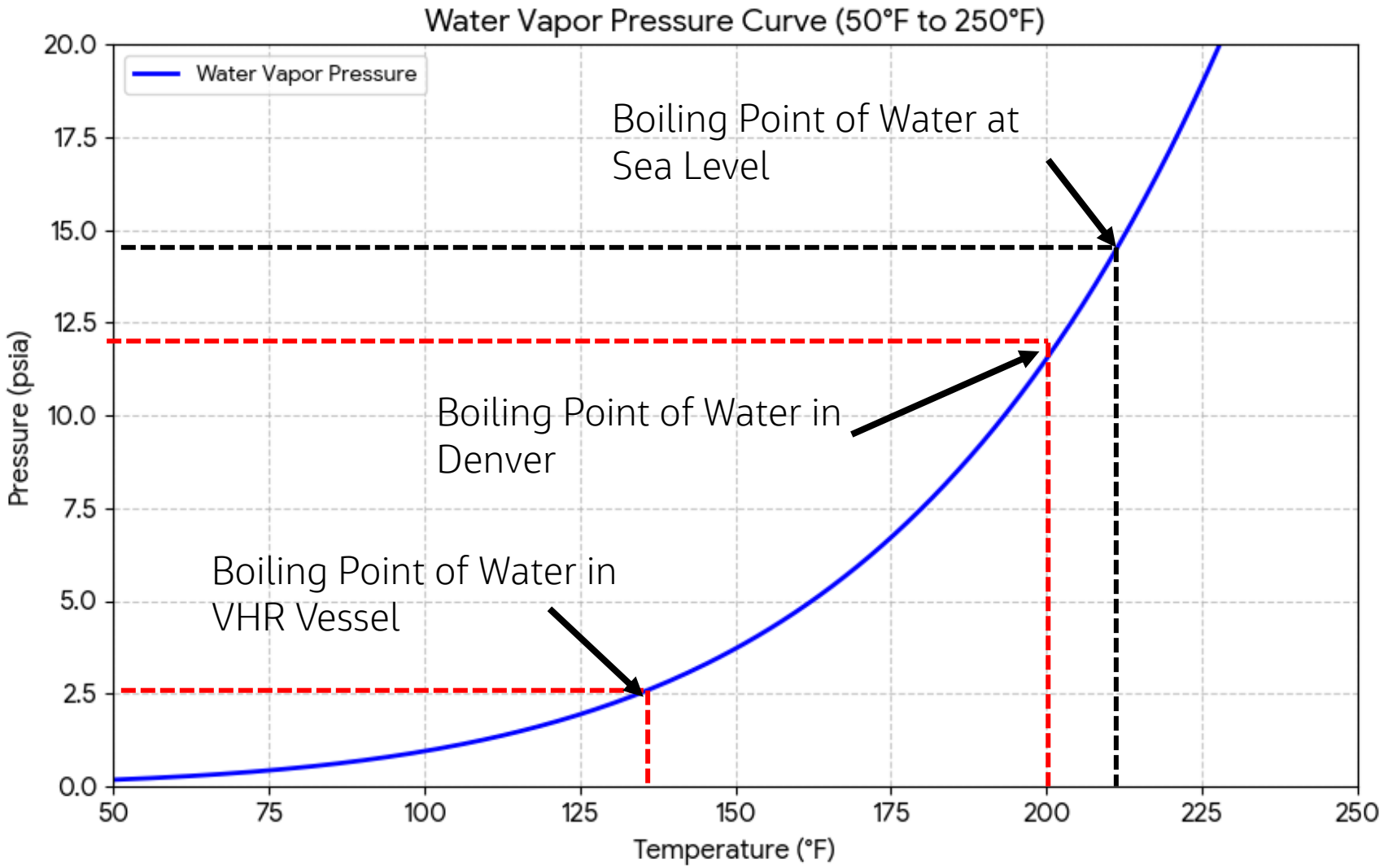
Thermophilic AD → MHP → Mesophilic AD

If one digester is OOS in each stage, both swing digesters can be used for redundancy, and MHP can be taken off-line.



Thermophilic AD MHP Mesophilic AD

A novel heat recovery system uses vacuum conditions to efficiently recover and reuse heat required for MHP.

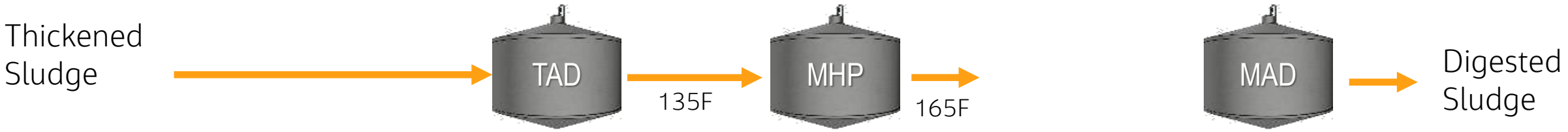


A novel vacuum heat recovery system can efficiently recover and reuse heat required for MHP.

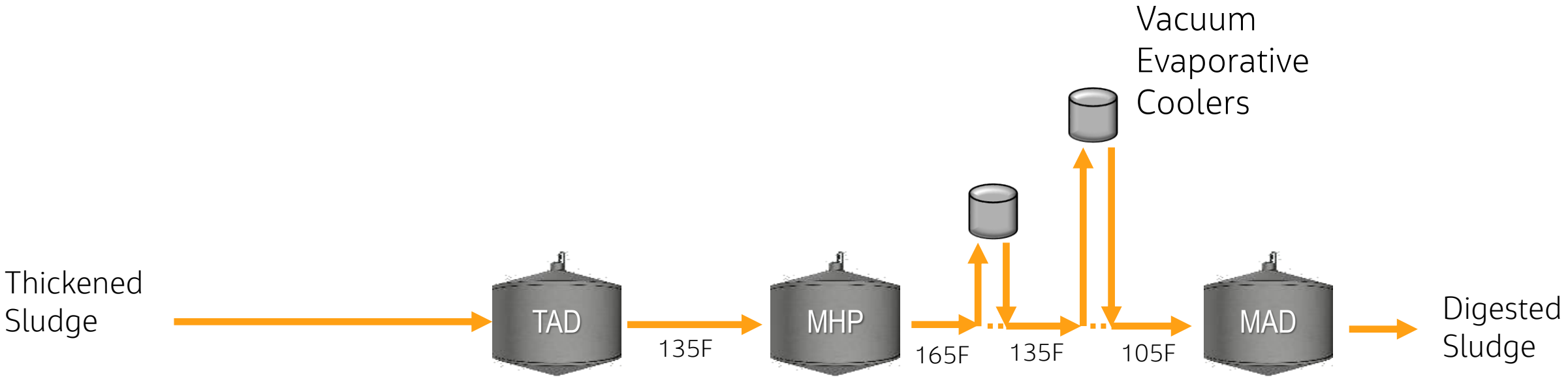
- Under vacuum conditions, water evaporates at lower temperatures.
- The bulk liquid is instantaneously cooled and steam is removed from vacuum cooling vessel.
- Steam can be injected into sludge line for direct heat transfer, or used in a steam-to-sludge or steam-to-water heat exchanger for indirect heat transfer.

The following configuration shows how MHP and VHR can be implemented into an existing TPAD system.

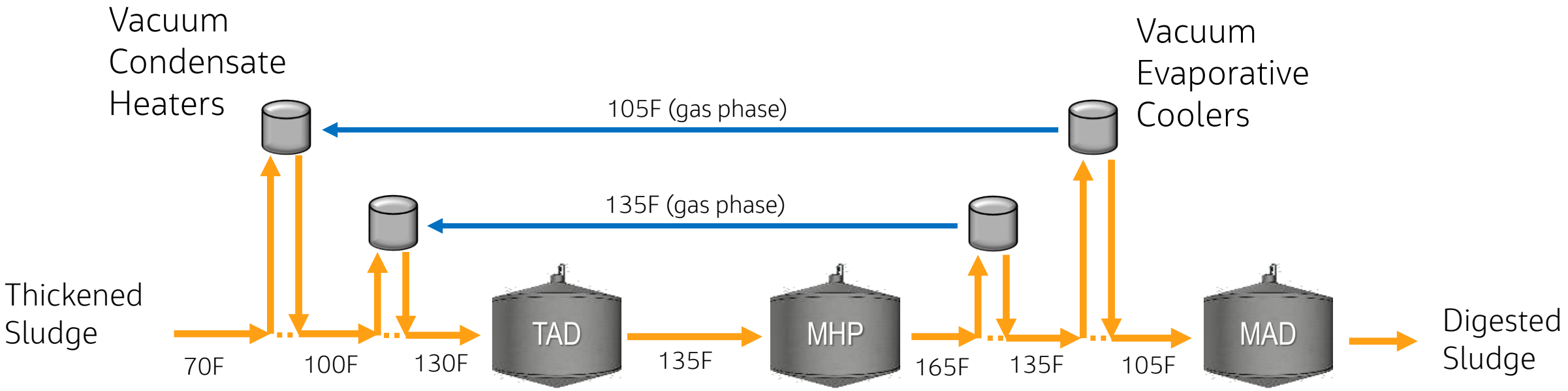
Primary digested sludge is heated to 165-167F using heat exchangers or steam injection.



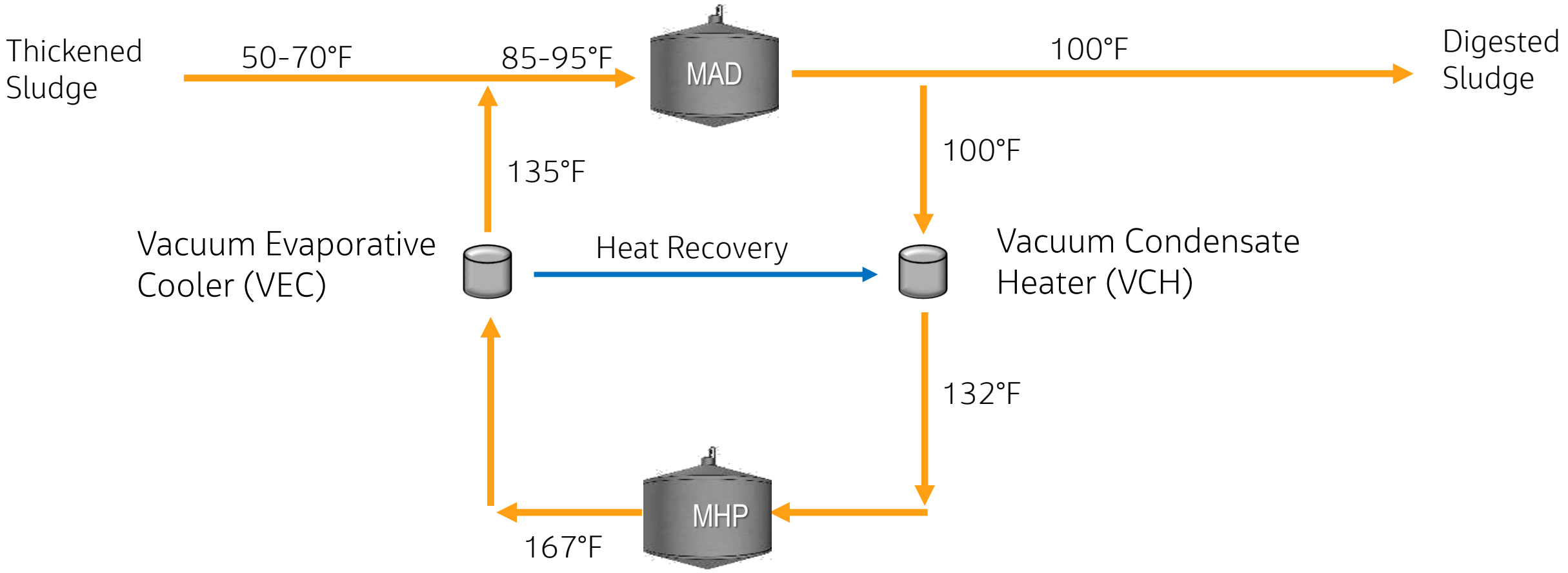
Hydrolyzed sludge is transferred to two in-line VECs to reduce sludge to mesophilic temperatures.



Vapor produced is pulled into the in-line VCHs, pre-heating raw sludge prior to thermophilic digestion.



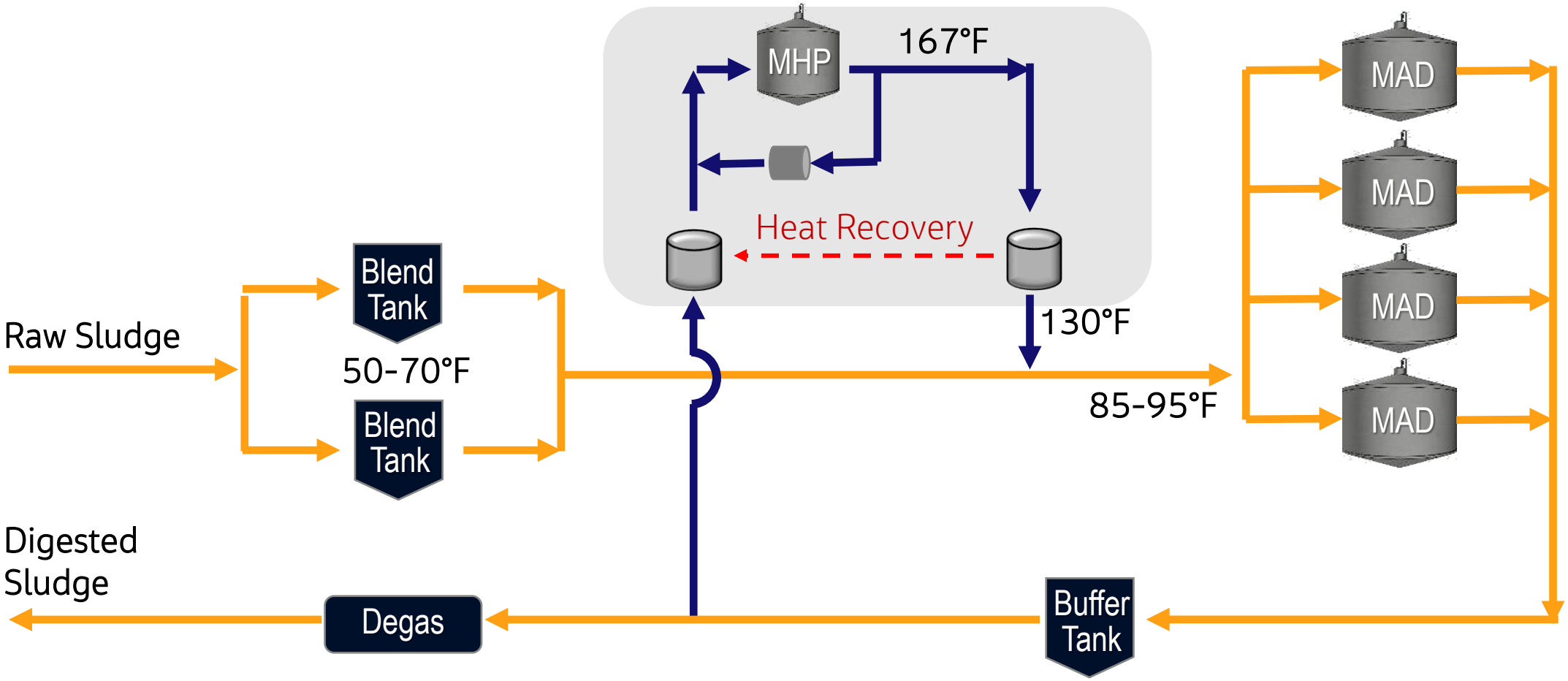
A similar approach can be used to recover heat in the recycle configuration.



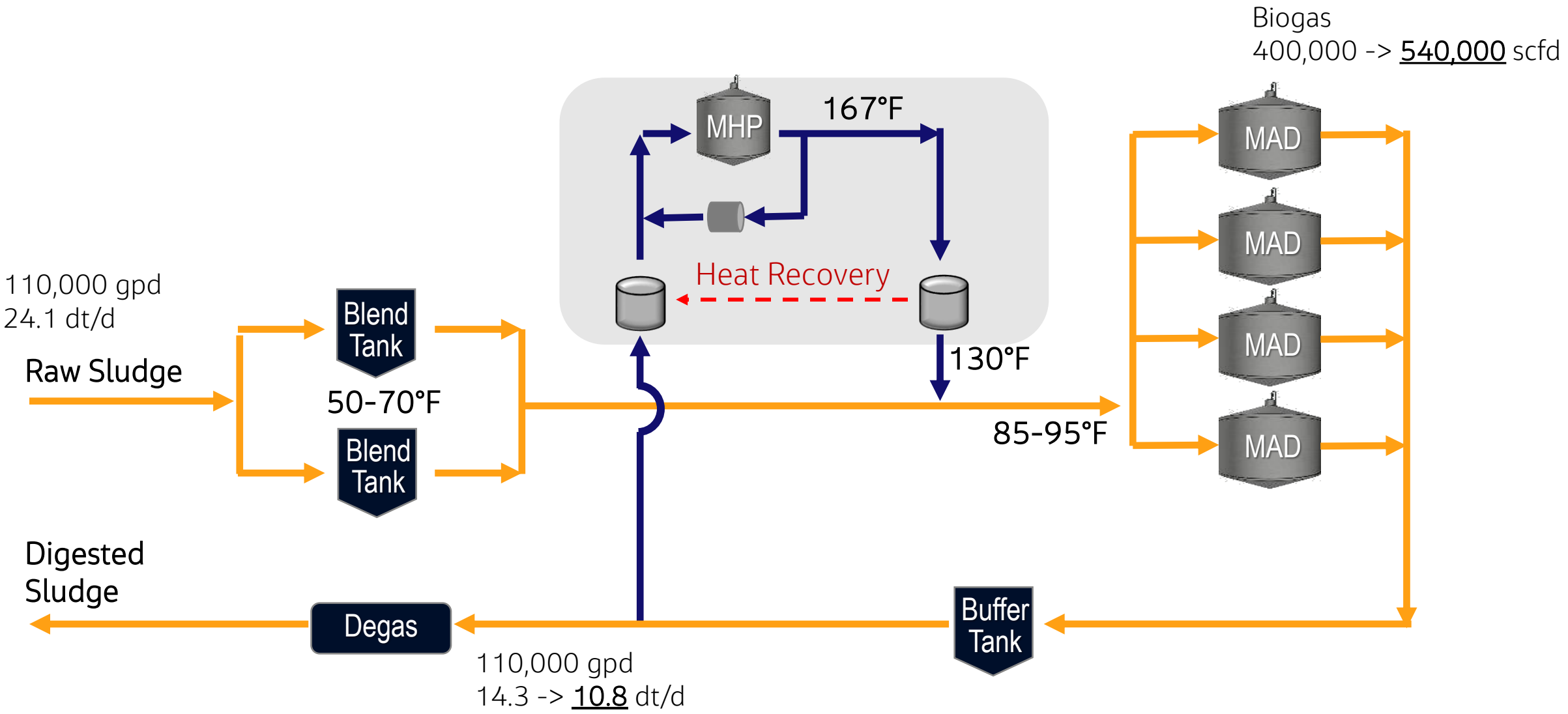
MHP is being implemented at full-scale at the Ejby Molle WRRF in Denmark.

Design-build led by VCS. Construction begins this month and substantial completion is expected in 2027.

MHP will be implemented as a side-stream process with vacuum heat recovery to minimize overall energy requirements.

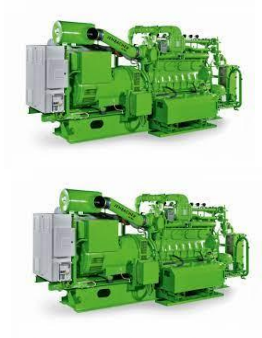


The addition of MHP is expected to reduce final cake production by 37%.



Increased biogas production will provide enough heat for MHP and increase energy revenue streams

Boiler



CHP
Heat: 4.4 -> 6.5 MMBTU/hr
Power: 1,350 -> 1,950 kWe

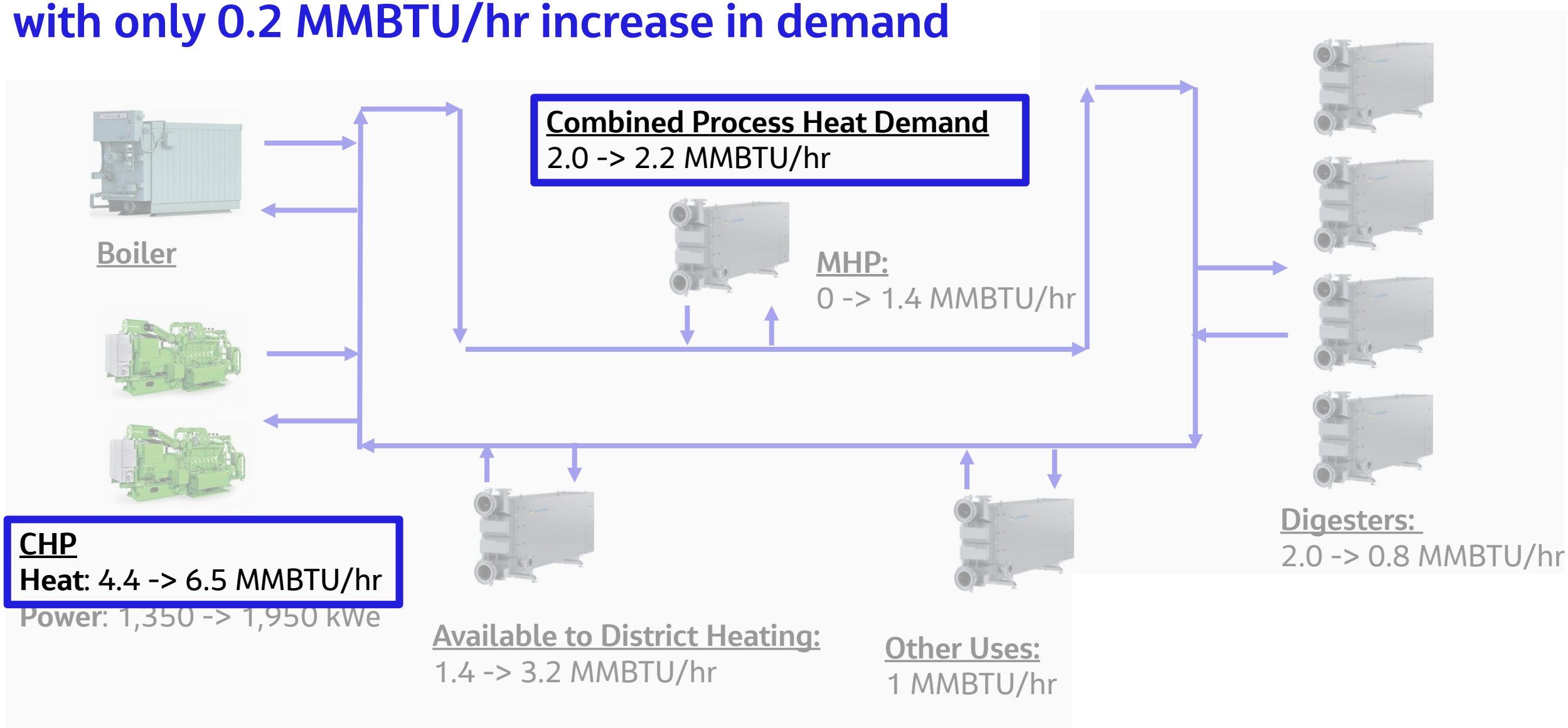
MHP:
0 -> 1.4 MMBTU/hr

Available to District Heating:
1.4 -> 3.2 MMBTU/hr

Other Uses:
1 MMBTU/hr

Digesters:
2.0 -> 0.8 MMBTU/hr

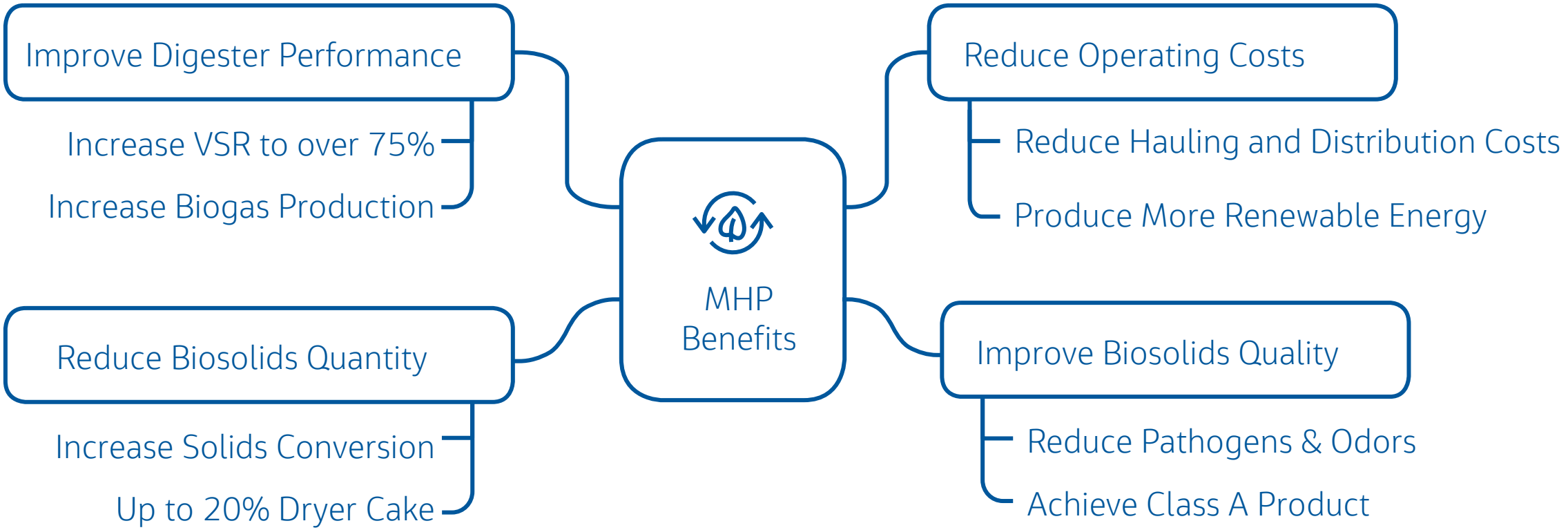
Additional biogas will result in 2.1 MMBTU/hr increase in heat produced with only 0.2 MMBTU/hr increase in demand



Denmark estimates a 4-7 year return on investment.

- Adding MHP will significantly improve the performance of digestion facilities in terms of VSR and biogas generation.
  - Savings from reduced sludge disposal costs
  - Additional revenue from increased biogas production

In summary, MHP offers a high-impact enhancement for anaerobic digestion and can result in significant operational cost savings with minimal added complexity.



This would not be possible without the support of our partners.

- The Hansen Lab at Brigham Young University for providing inoculum
- Dr. Matthew Scarborough at University of Vermont for microbial population analysis
- Dr. Matthew Higgins for rheology and dewaterability analysis
- The Gresham WWTP lab staff for research space and support
- Our client partners for continued support in research and design development.

Thank you

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Challenging today.
Reinventing tomorrow.