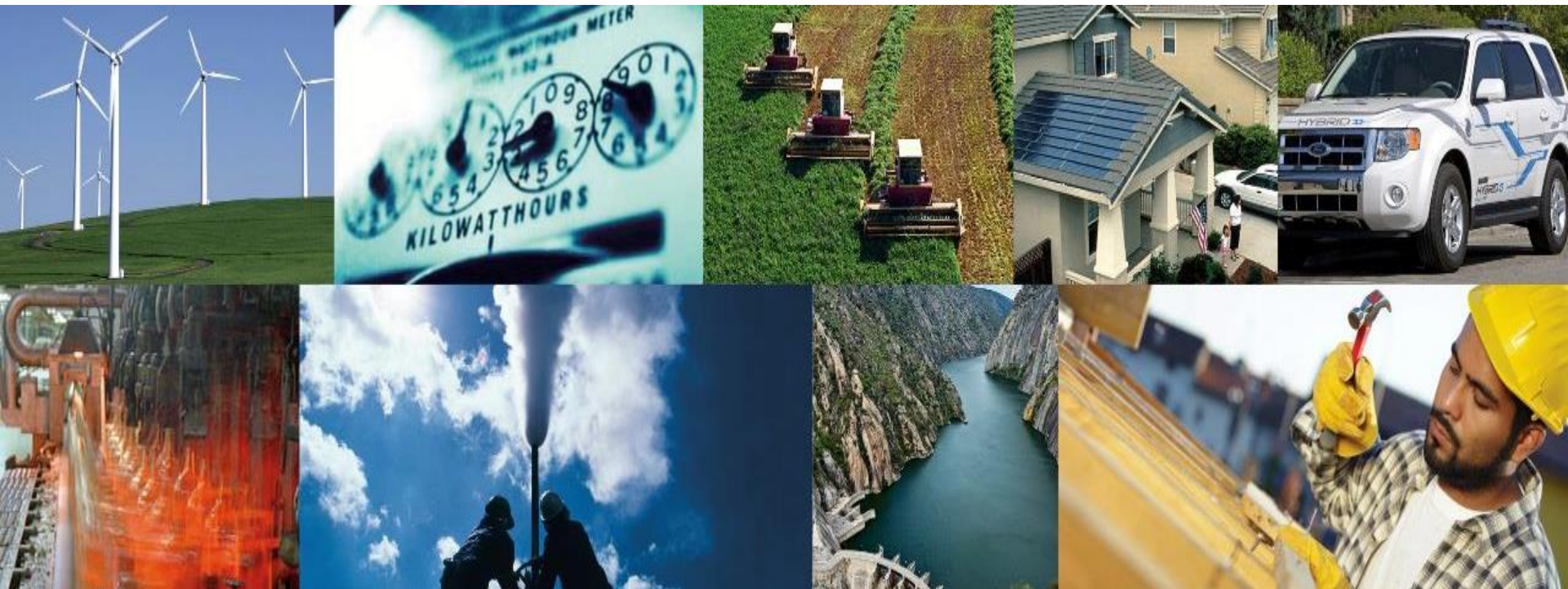


# Net Zero Energy, Water, and Waste for Campuses, and New and Existing Buildings



Rachel Shepherd, Federal Energy Management Program

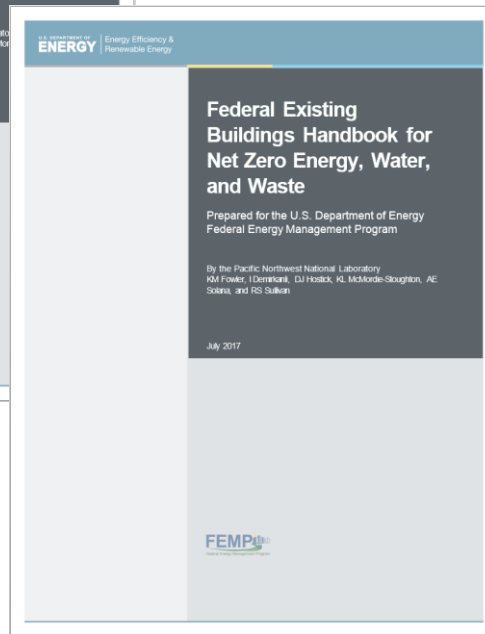
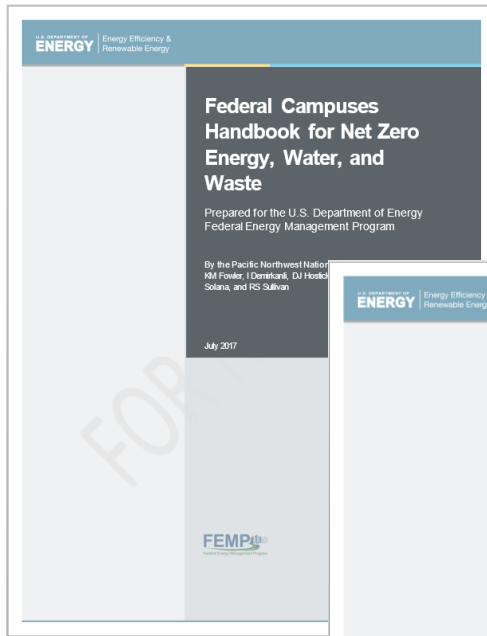
Kim M. Fowler, Pacific Northwest National Laboratory

# Outline

---

- **Net Zero Energy, Water, Waste Definitions**
- **Setting Net Zero Project Boundaries**
  - Fence-to-fence Campus
  - Designated sub-campus
  - Building
- **Net Zero Implementation for Energy, Water, and Waste**
  - Connect & Coordinate
  - Design
  - Construction
  - Operations

# Net Zero Handbooks



<https://energy.gov/eere/femp/net-zero-energy-water-and-waste-federal-buildings-and-campuses>

# Net Zero Energy Implementation

- A net zero energy Federal building (constructed, renovated, or existing) is operated to maximize energy efficiency, implement energy recovery opportunities where feasible, and balance the actual annual source energy consumption with on-site renewable energy generation.
- A net zero energy Federal campus reduces overall energy use, maximizes efficiency, implements energy recovery and cogeneration opportunities, and then offsets the remaining demand with the production of renewable energy from on-site sources, such that the campus produces as much renewable energy as it uses over the course of a year.



# Net Zero Water Implementation

- A net zero water Federal building (constructed, renovated, or existing) is operated to minimize total water consumption, maximize alternative water sources, minimize wastewater discharge from the building, and return water to the original water source such that the annual water consumption is equivalent to the alternative water use plus water returned to the original source over the course of a year.
- A net zero water Federal campus minimizes total water consumption, maximizes alternative water sources, minimizes wastewater discharge, and returns water to the original water source such that the annual water consumption is equivalent to the alternative water use plus the water returned to the original water source over the course of a year.

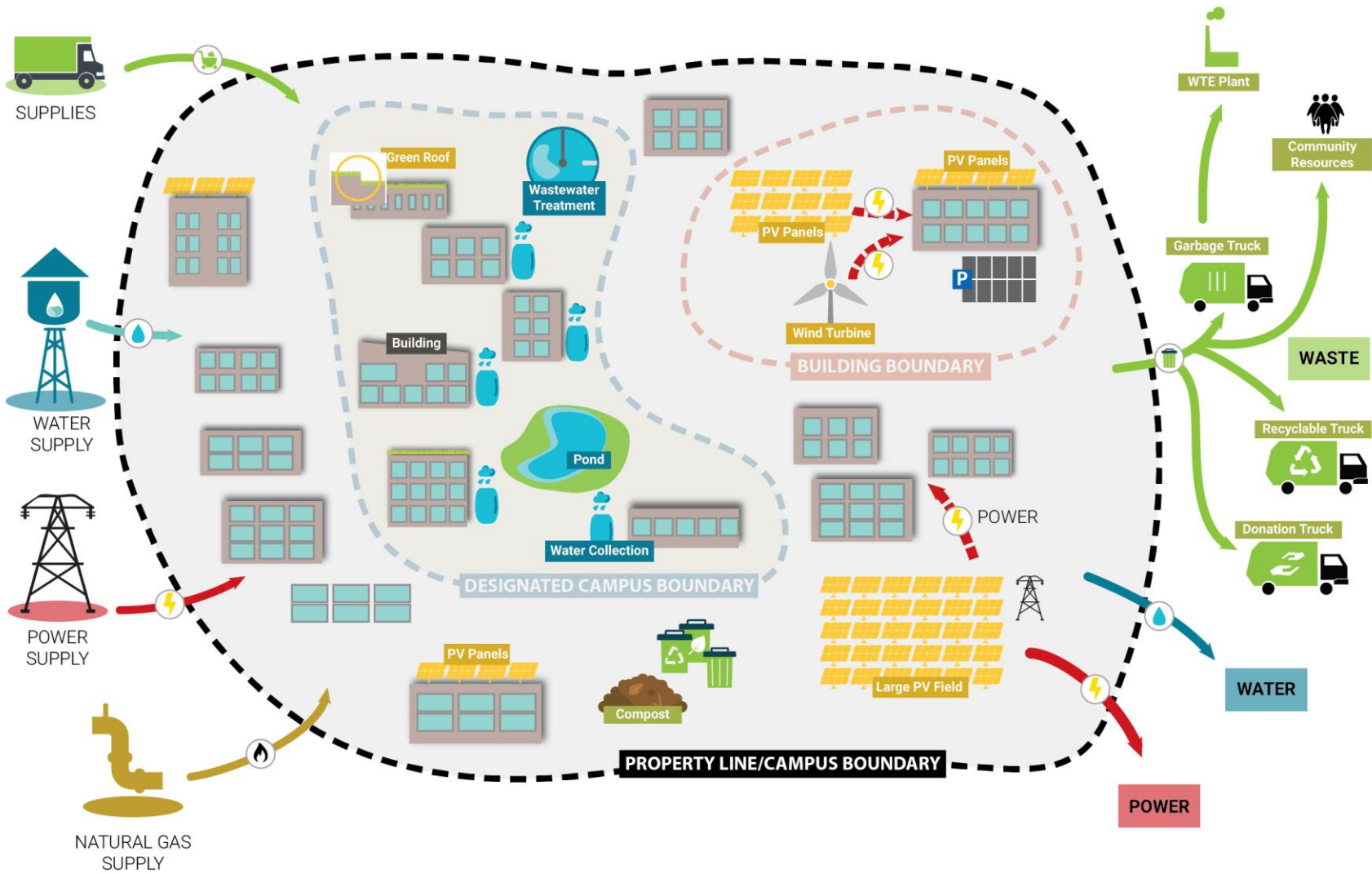


# Net Zero Waste Implementation

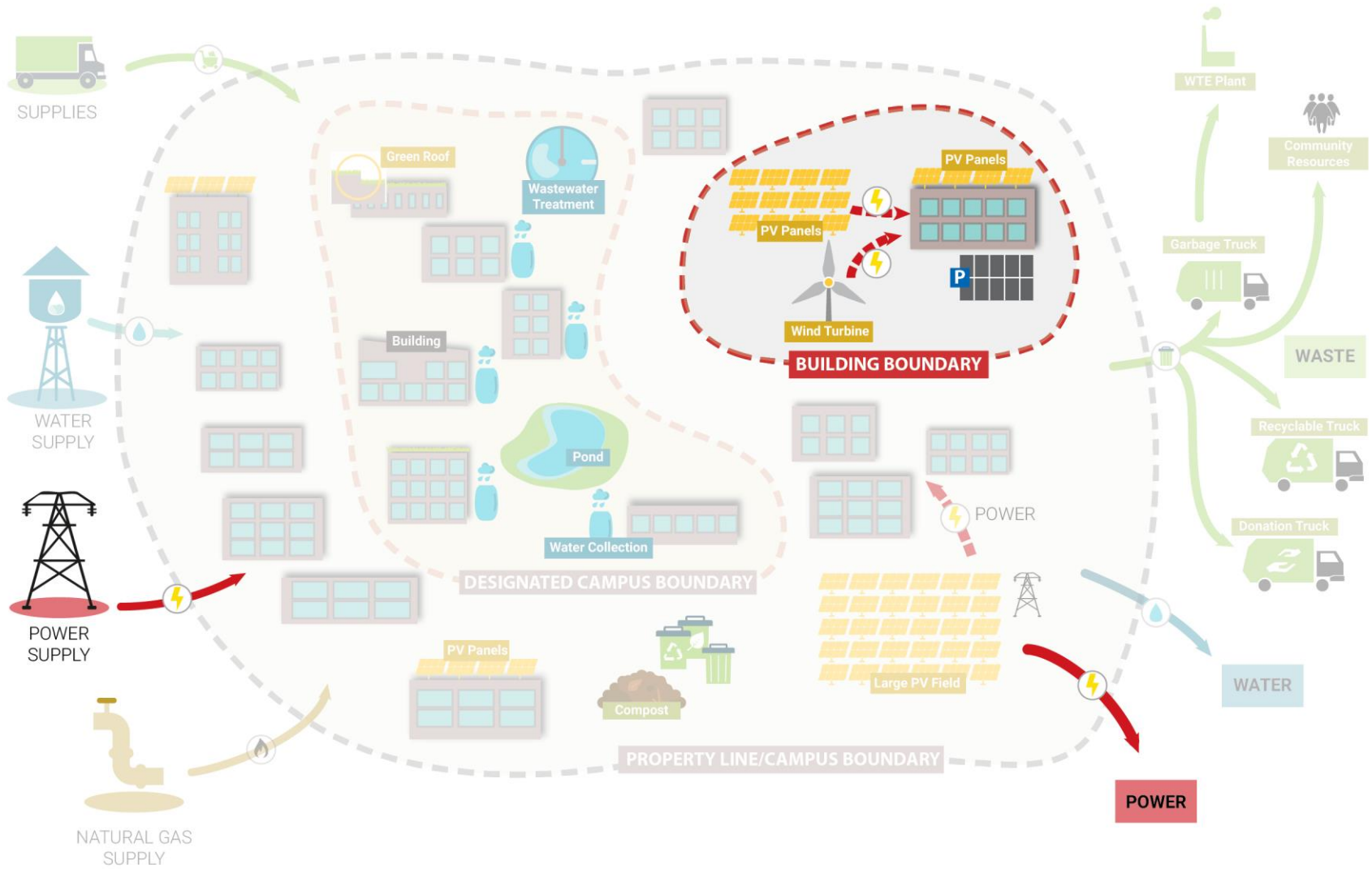
- A net zero waste Federal building is operated to reduce, reuse, recycle, compost, or recover solid waste streams (with the exception of hazardous and medical waste) thereby resulting in no waste disposal to landfills or incinerators.
- A net zero waste Federal campus reduces, reuses, recycles/composts, and recovers solid waste streams (with the exception of hazardous and medical waste), converting them to resource values, resulting in no waste disposal to landfills or incinerators.



# Defining Net Zero Boundaries

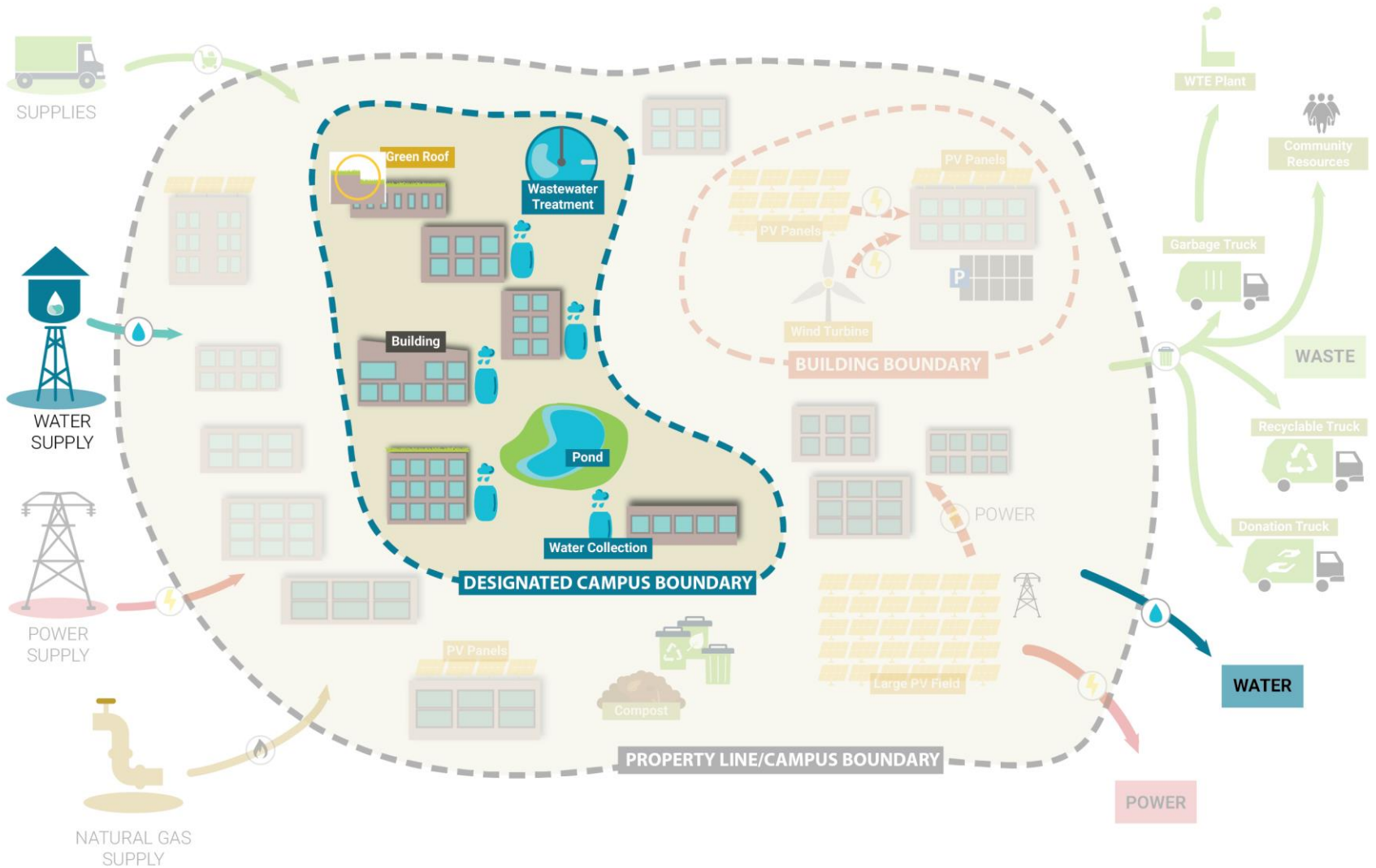


# Net Zero Boundaries: Building

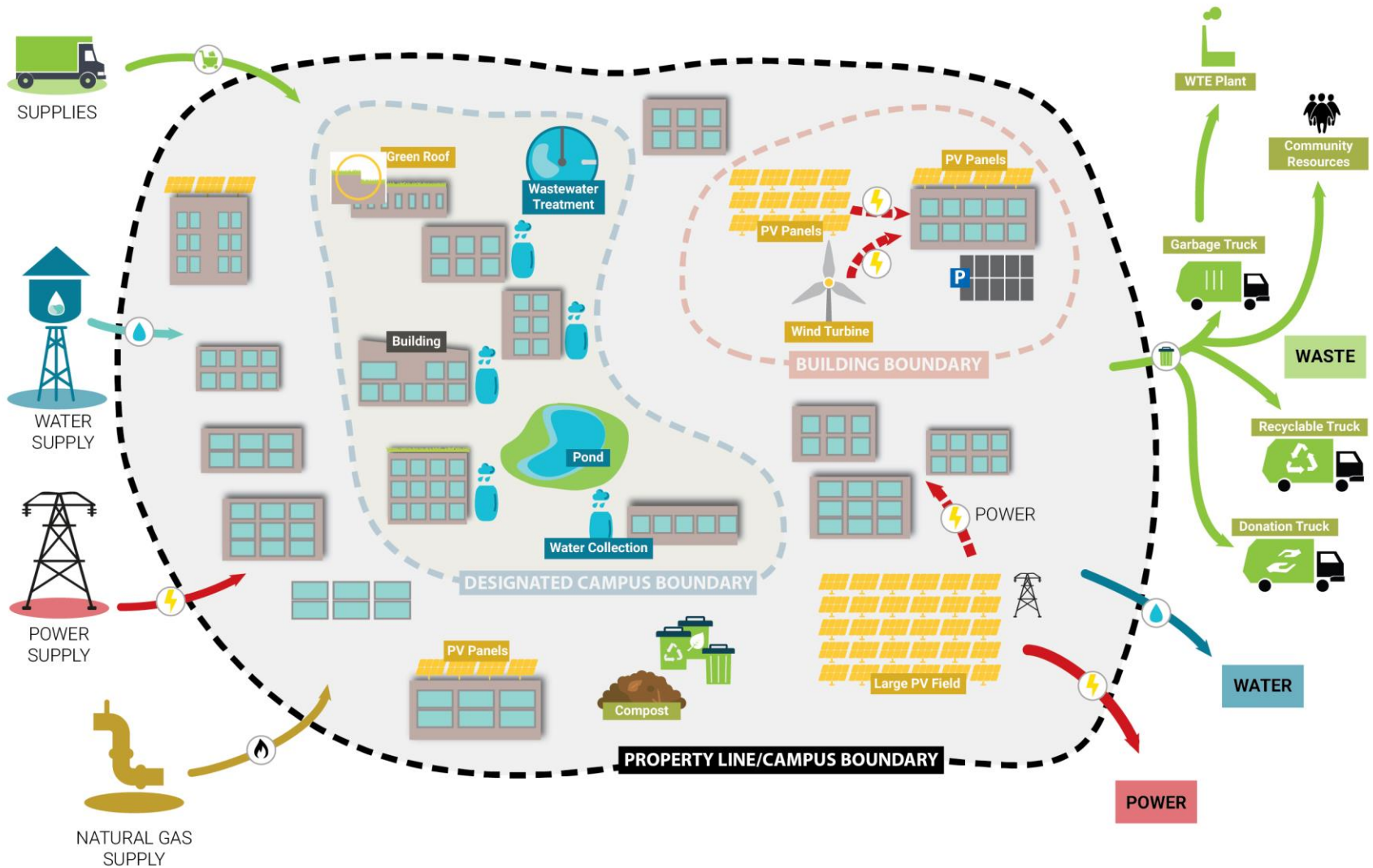




# Net Zero Boundaries: Designated Campus



# Net Zero Boundaries: Fence-to-Fence Campus

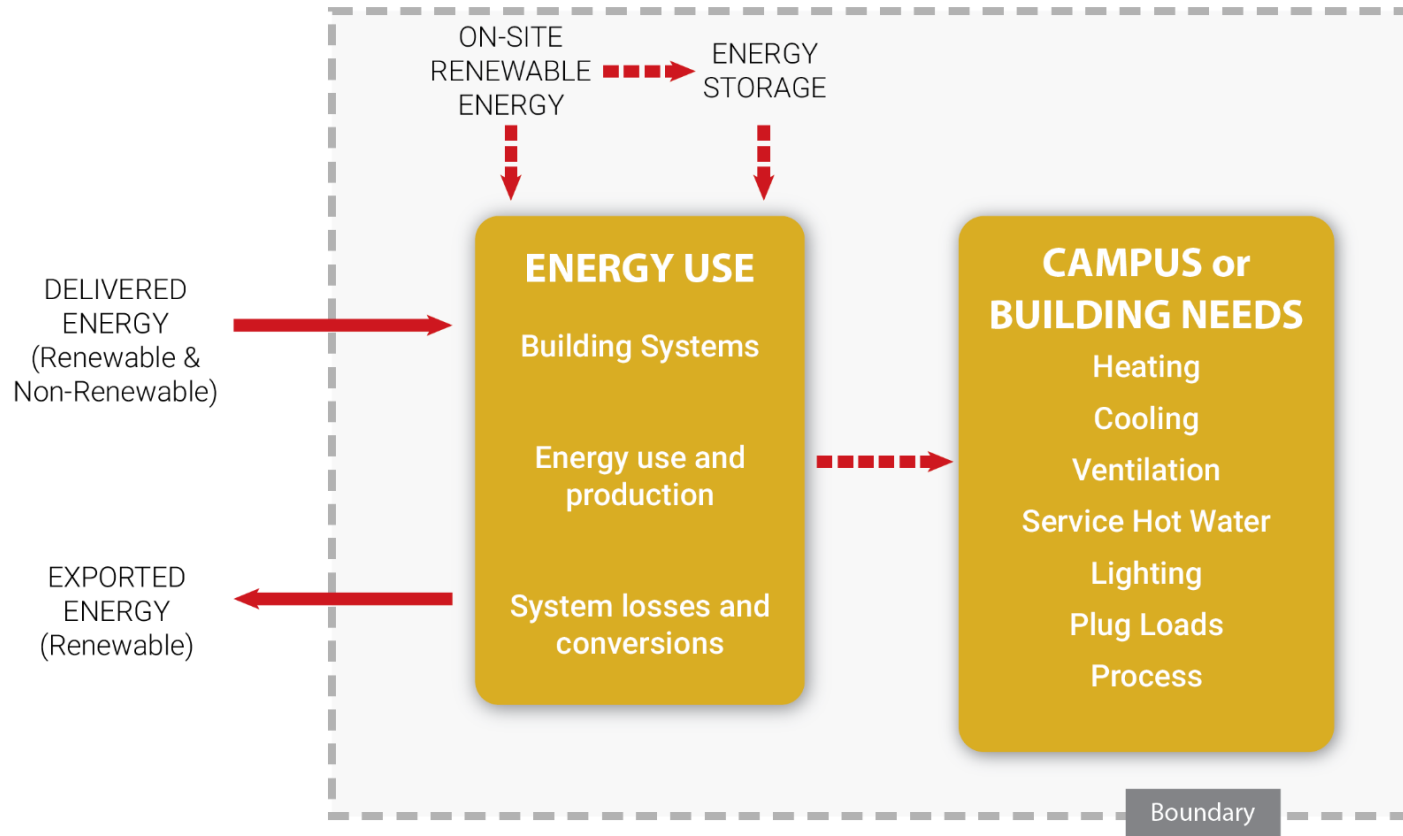


# Drivers for Net Zero



---

- Requirements
- Capital and operations cost avoidance
- Reduced energy and water use
- Reduced waste generation
- On-site access to energy and water

# Net Zero Energy



## Legend

-  Energy transfer within the building or campus boundary
-  Energy transfer leaving or entering the building or campus boundary

# Net Zero Energy Implementation for Campuses

## Connect & Coordinate

Consolidate functions to reduce building footprint

Review / develop Campus Master Plan

Consider Central Heating / Cooling plants & Cogeneration

Implement campus-wide energy management systems

Coordinate with utility providers

## Design

Design buildings to meet or exceed Campus Master Plan expectations

Measure campus annual energy use

Design renewable energy system(s) to meet calculated campus annual energy use

## Construction

Contract language for net zero related features

Commission, recommission, or retrocommission energy systems

## Operation

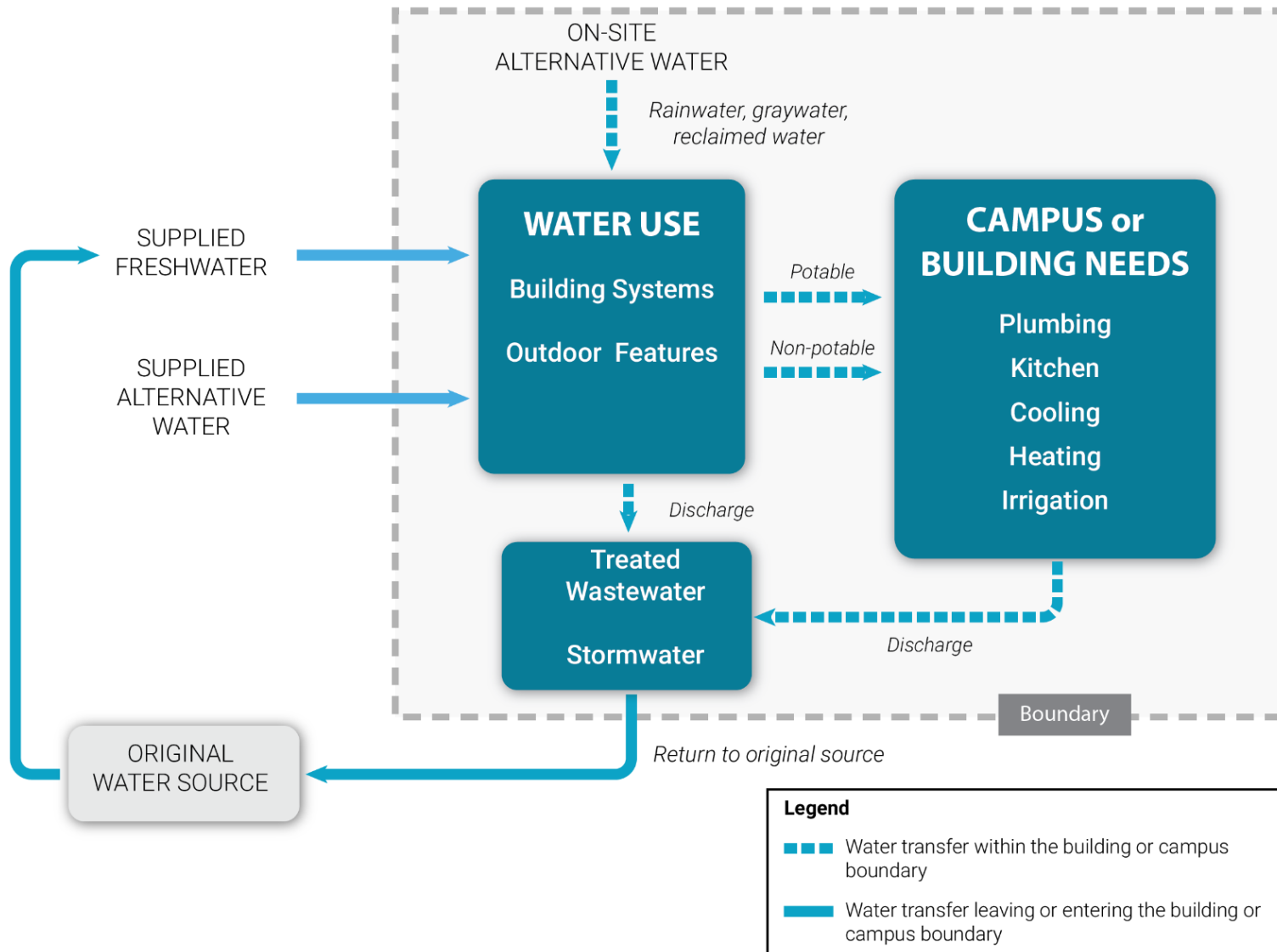
Campus Operation Plan addresses O&M of energy efficiency design features and renewable energy systems

Meter energy use and benchmark performance

Occupants are engaged with achieving the expected energy performance

Measure and verify the campus is operating at net zero over a one-year timeframe

# Net Zero Water



# Net Zero Water Implementation

## Connect & Coordinate

Identify opportunities to consolidate functions and reduce footprint

Develop a campus operation plan focused on synergies of water-related systems

Improve utility infrastructure

Develop campus master plans and related plans to establish design and performance expectations

## Design

Design buildings to meet or exceed Campus Master Plan expectations

Determine campus annual water use and water balance

Design alternative water systems & systems to return water to the original water source to meet estimated Campus annual water use

Treat wastewater on-site and return to the original source

Design green infrastructure features to return water to its original water source

Minimize the impact of design reviews or value engineering on the net zero target

## Construction

Develop contract language for net zero related features

Commission, recommission, or retrocommission water and wastewater systems

## Operation

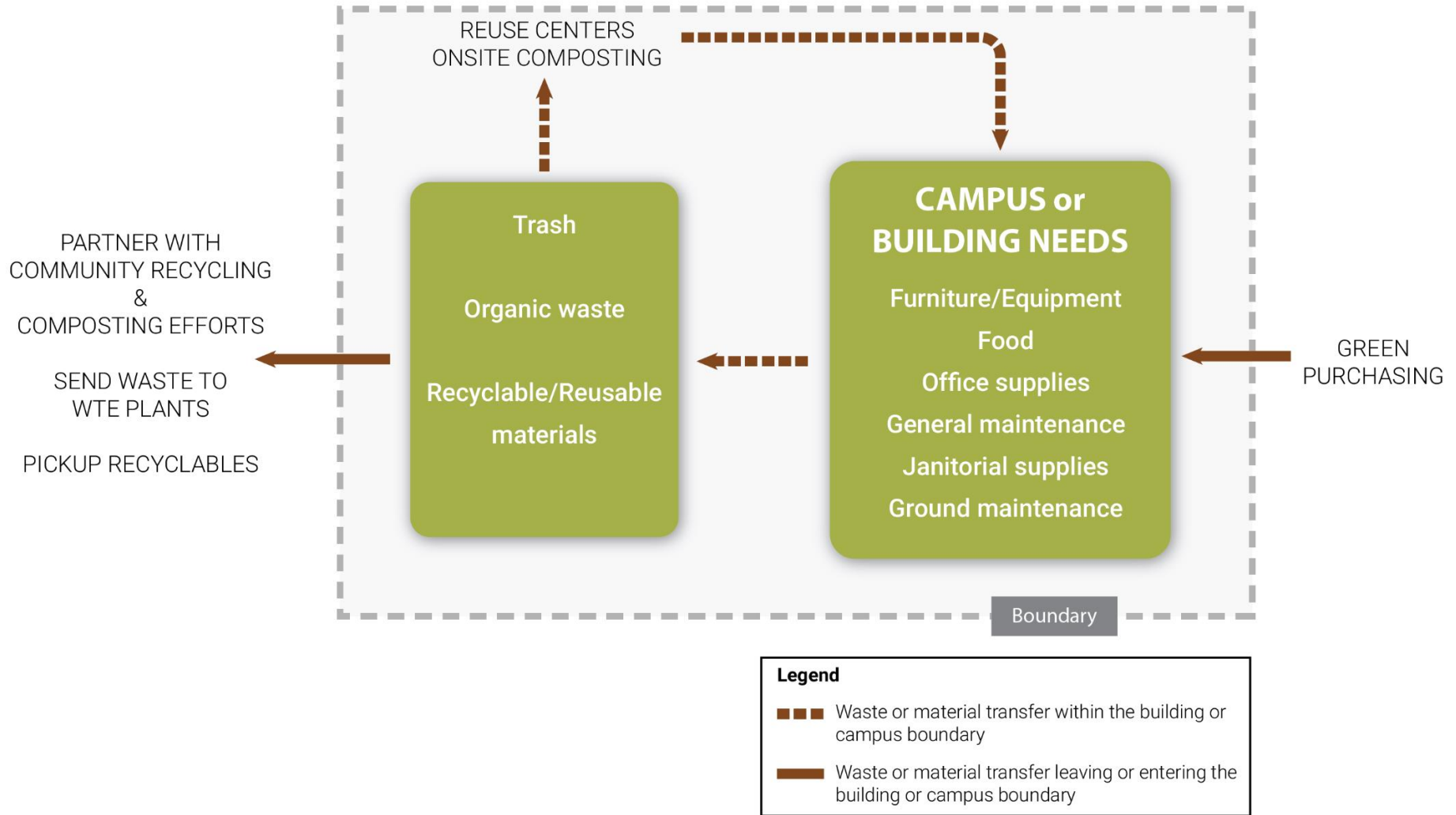
Develop Campus operation plan covering O&M of water features

Meter water use and monitor for leaks & operational issues

Engage occupants with the net zero water program

Measure and verify the campus is operating at net zero over a one-year timeframe

# Net Zero Waste





# Net Zero Waste Implementation

## Connect & Coordinate

Identify and build building waste manager team

Review/Develop campus operation plan to address campus-level waste minimization & waste management systems

Establish agreements with waste and recycling haulers

Review / Develop green procurement policies & procedures

## Design

Assess waste stream composition

Green procurement programs that minimizes waste

Reuse, recycling, & compost programs to minimize waste

Design appropriate space to manage these programs

Identify alternative paths for remaining waste streams (including WTE)

## Construction

Establish contracts with local entities

Systems to enforce green procurement & waste management

Make reuse, recycling, compost containers available

## Operation

Operation plan addresses O&M of waste conversion programs, such as waste-to-energy, and O&M of reuse, recycling, compost and other waste diversion programs

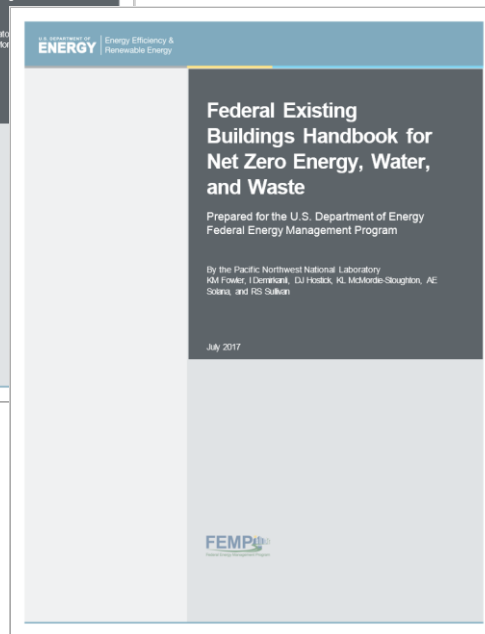
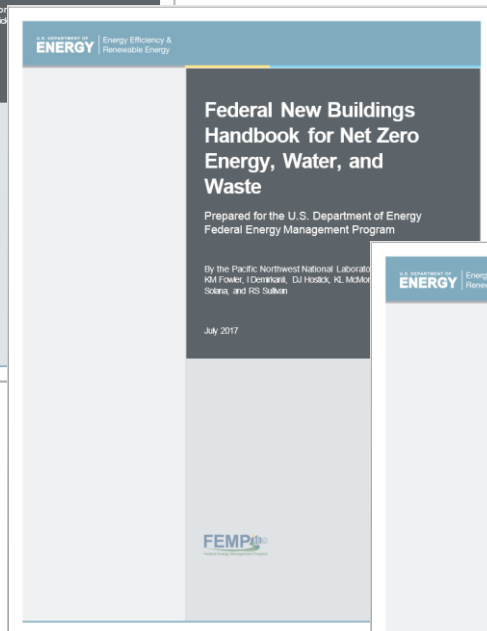
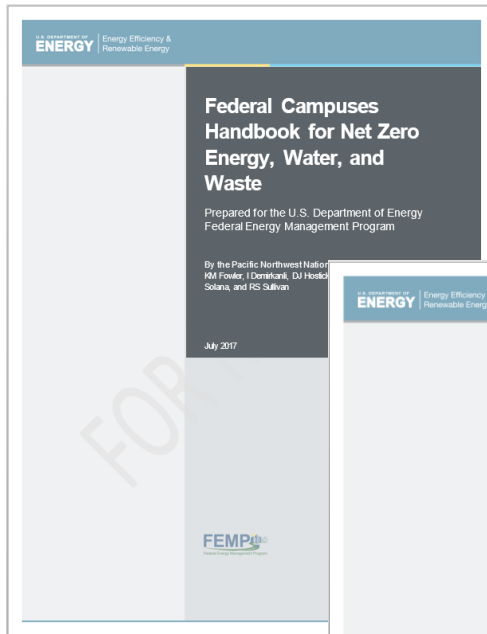
Implement Reuse/Recycle Program

Green procurement requirements and waste diversion options are enforced

Occupants are actively engaged in achieving the net zero waste targets

Measure and verify building is operating at net zero over a one-year timeframe

# Net Zero Handbooks



<https://energy.gov/eere/femp/net-zero-energy-water-and-waste-federal-buildings-and-campuses>

## For more information, contact:

Rachel Shepherd  
RE Program Manager  
FEMP

[rachel.shepherd@ee.doe.gov](mailto:rachel.shepherd@ee.doe.gov)

202-586-9209

Kim M. Fowler  
Chief Research Engineer  
PNNL

[kim.fowler@pnnl.gov](mailto:kim.fowler@pnnl.gov)

509-372-4233