
CampusEnergy2021
BRIDGE TO THE FUTURE
Feb. 16-18 | CONNECTING VIRTUALLY
WORKSHOPS | Thermal Distribution: March 2 | Microgrid: March 16

A Decision-Making Framework for a District Energy System Manager

Daniel C. Schuster

Schuster Consulting LLC

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INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Agenda

- Introduction
  - Problem Definition
  - District Energy
  - Motivation
- History
  - Decision-Making – Engineering Approach
  - District Energy Systems – System of Systems Engineering
- Methodology
  - Engineering Knowledge Map
  - Decision-Making Framework
  - Case Studies
- Summary, Benefits, and Conclusions
- Questions

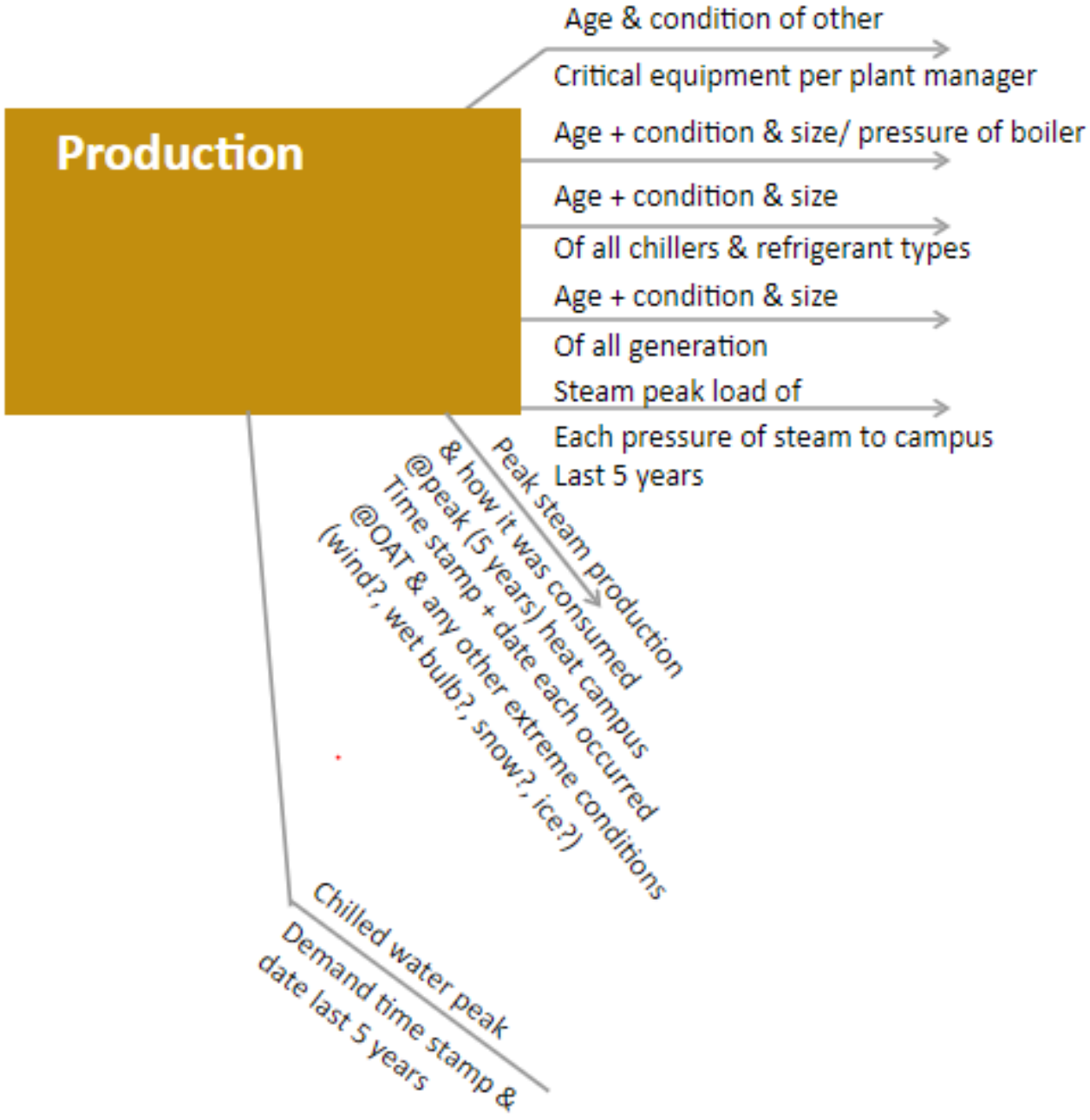
Introduction

- Problem Definition
  - Why develop a framework?
  - District Energy
    - Limited resources
    - Traditional solutions – Are there options?
  - Motivation
    - Incorporate district goals
    - Framework for sharing
    - Training tool

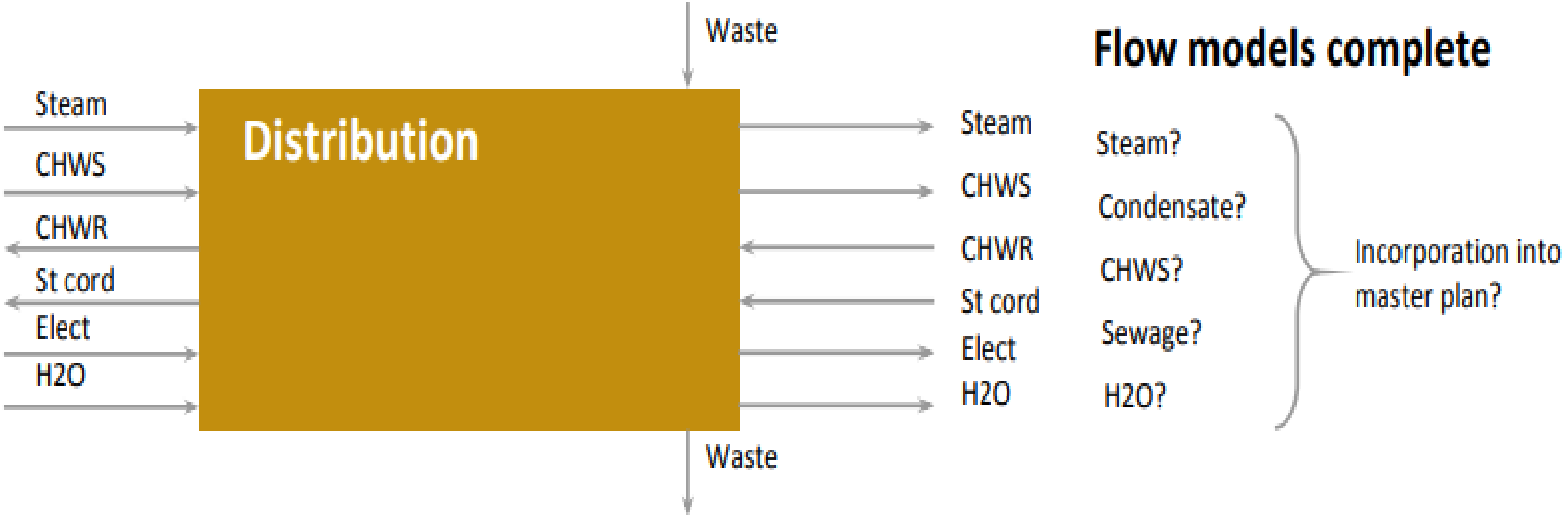
History and Background ©

- Optimization
- Multi-Criteria Decision-Making
- National Renewable Energy Lab - REopt
- Interviews
- Decision-Making (metacognition, skills based, instinctive, bias)
- Organizational Research to Systems Engineering
- System of Systems Engineering (SoSE)

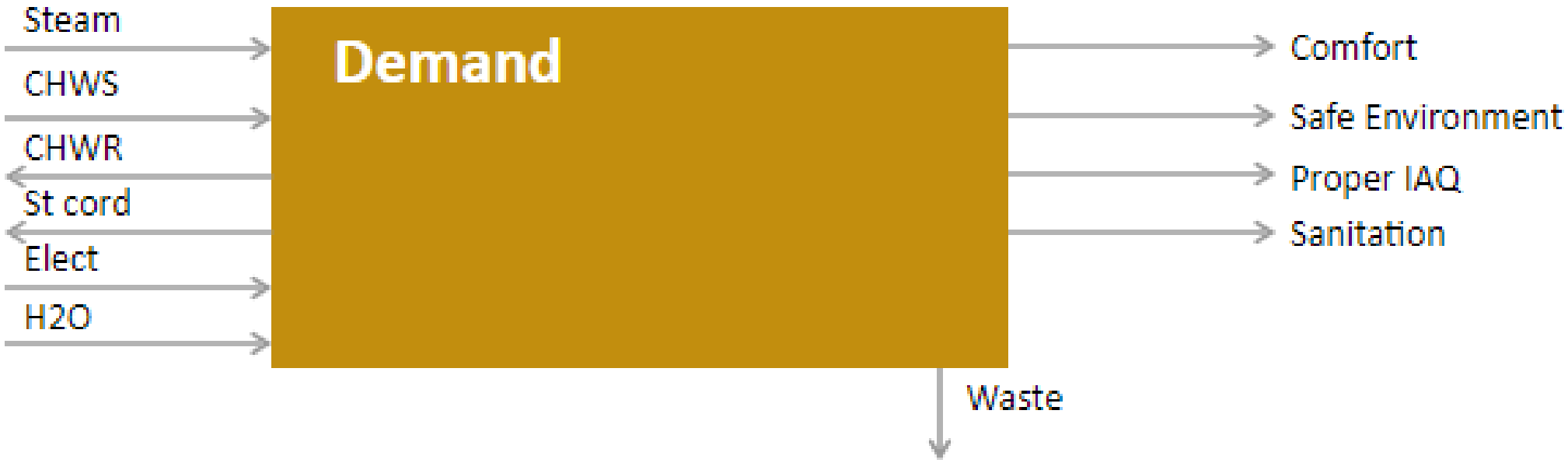
Production -SoSE



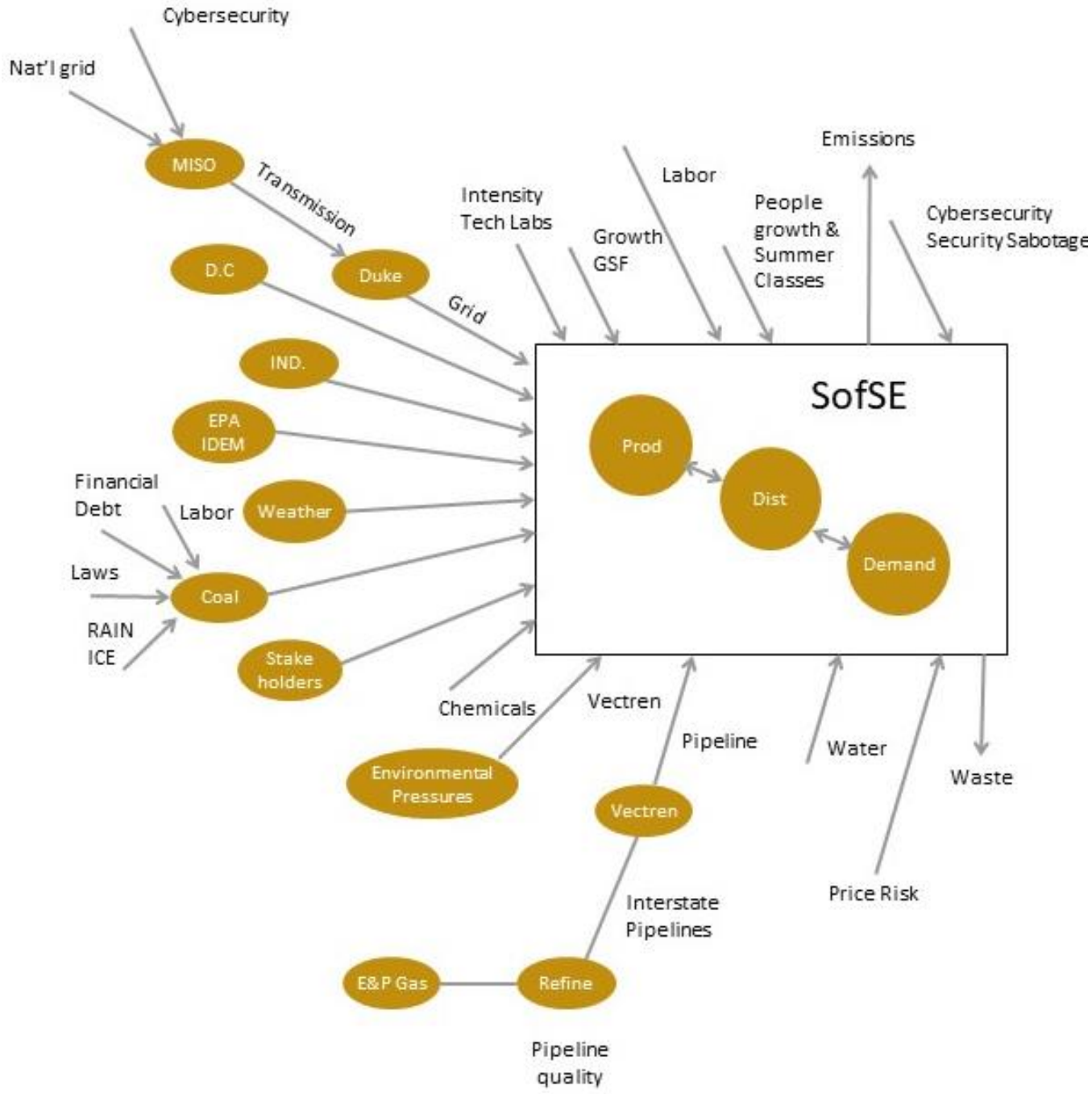
Distribution – SoSE



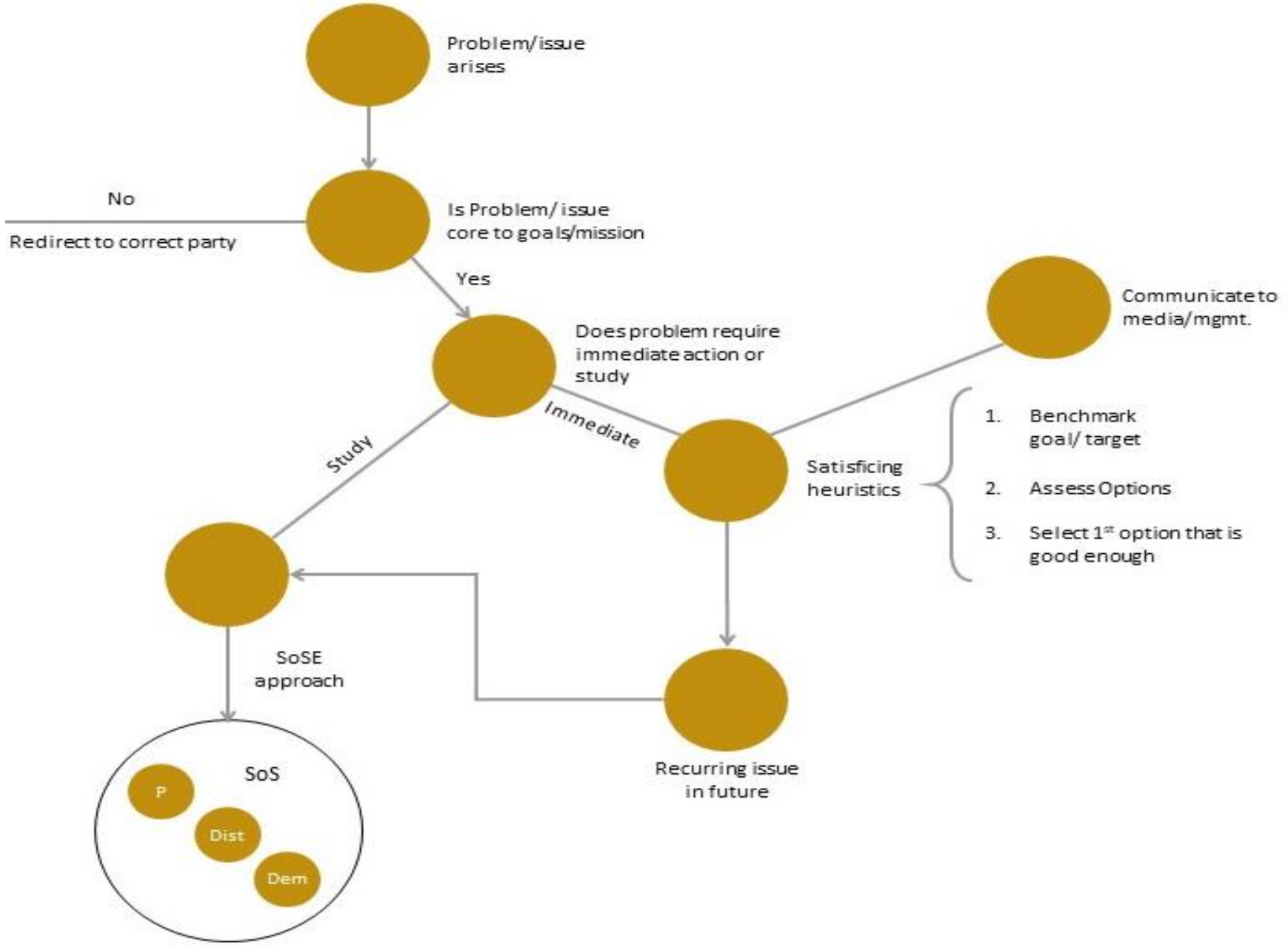
Demand – SoSE


Steam
CHWS
CHWR
St cord
Elect
H2O
Demand
Comfort
Safe Environment
Proper IAQ
Sanitation
Waste

Externalities © -SoSE



Decision-Making Framework (partial) ©



Attributes of SoSE for District Energy Systems

Citations are added on the next slide for these attributes to A.P. Sage and D. DeLaurentis

- Complex
- Independently Managed
- Interdependent with Each Other
- Dynamic Barriers
- Emergent Behavior
- Effectiveness
- Trans-domain (Engr + Econ + Policy + Ops + Env)

Citations

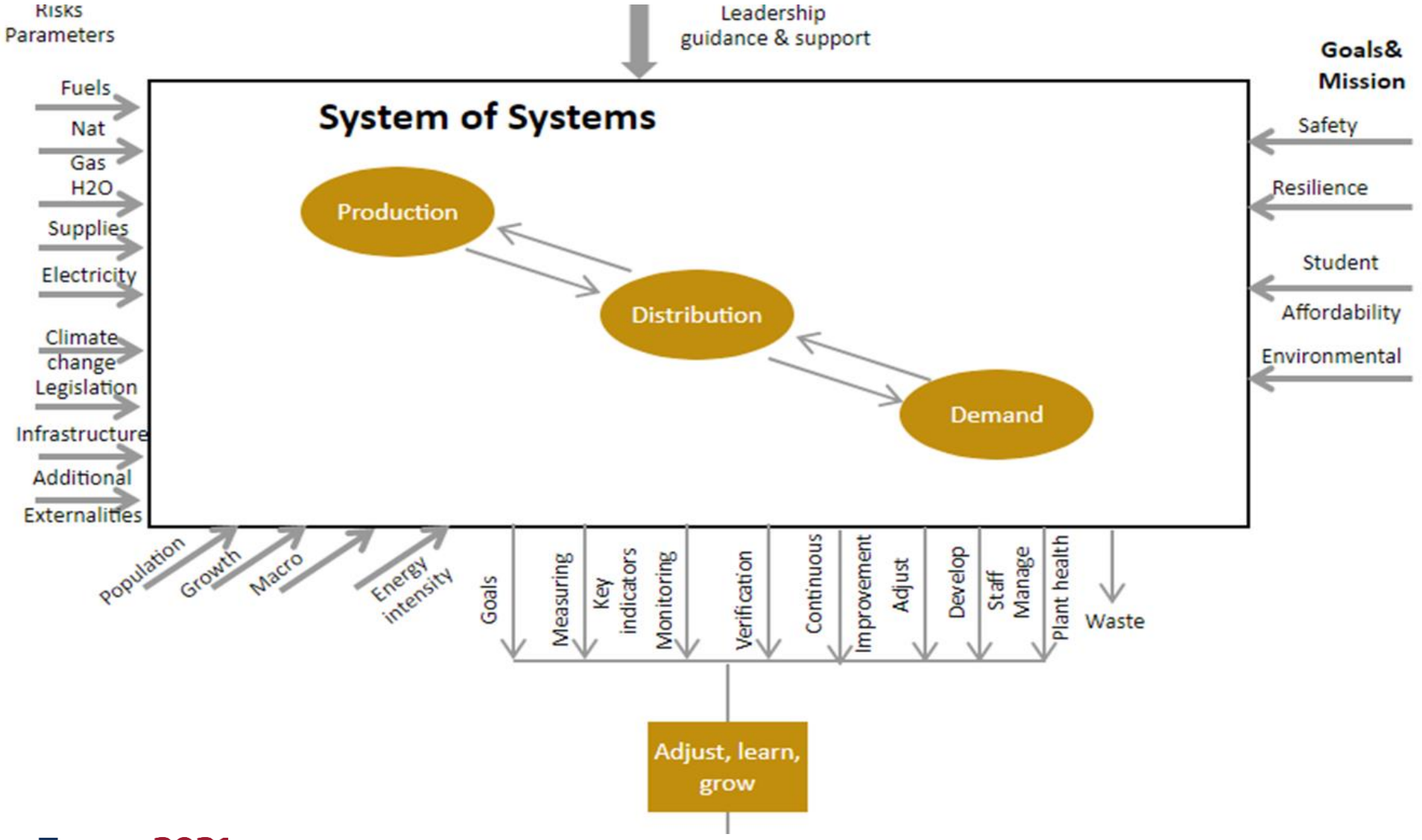
- A. P. Sage and S. M. Biemer, “Processes for System Family Architecting, Design, and Integration,” *IEEE Systems Journal*, vol. 1, no. 1, pp. 5–16, Sep. 2007, doi: 10.1109/JSYST.2007.900240.

- D. DeLaurentis, “Understanding Transportation as a System-of-Systems Design Problem,” presented at the 43rd AIAA Aerospace Sciences Meeting and Exhibit, Reno, Nevada, Jan. 2005, doi: 10.2514/6.2005-123.

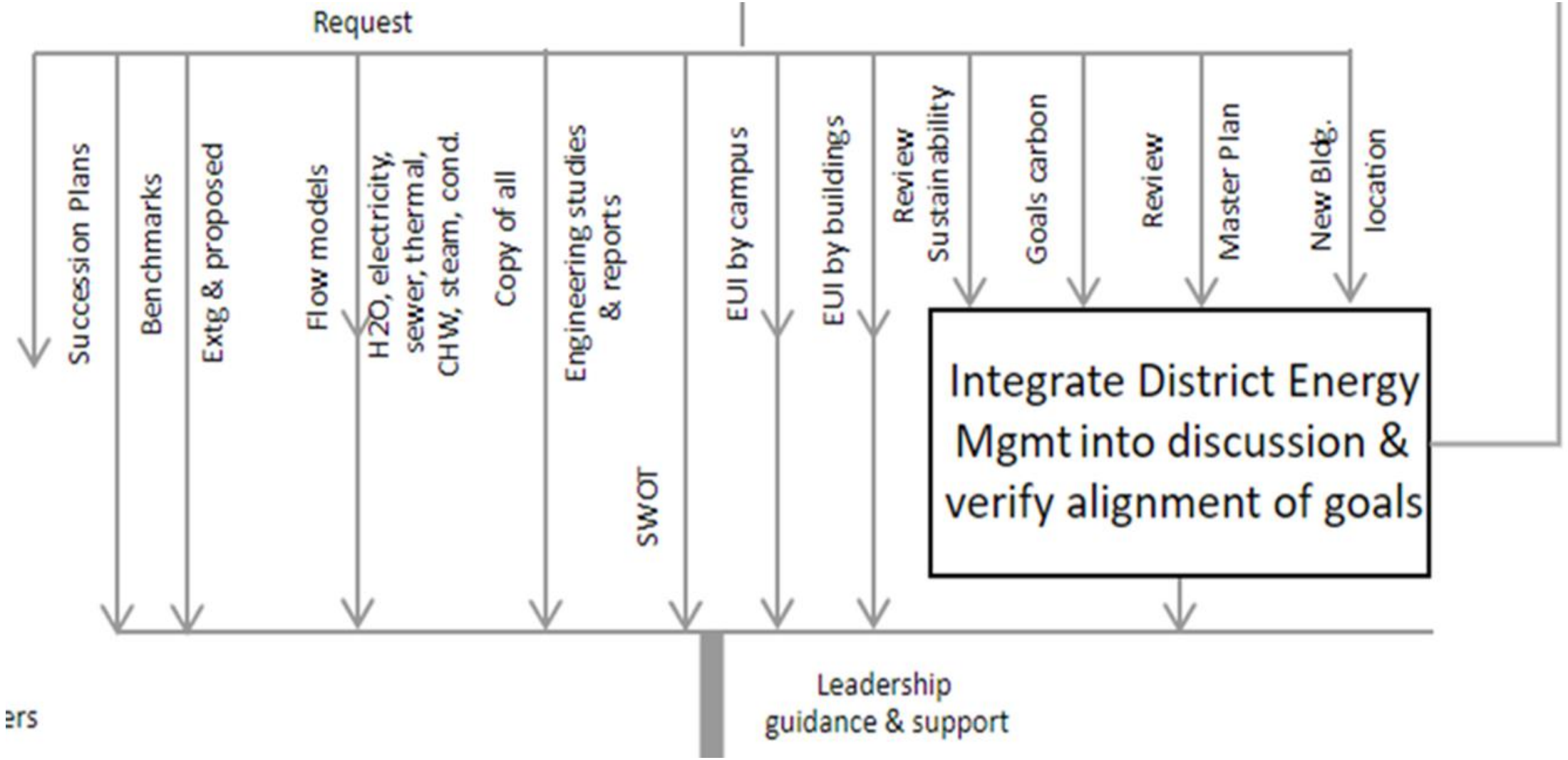
Tools

- An Engineering Knowledge Map for District Energy Managers
- A Decision-Making Framework for District Energy Managers
  - Utilizes a System of System Engineering Approach
    - Consideration of Immediacy of Solution
    - Consideration of Long-Term and Iterative Approach
    - Includes Benefit/Cost Analysis
    - Ability for Sensitivity Analysis

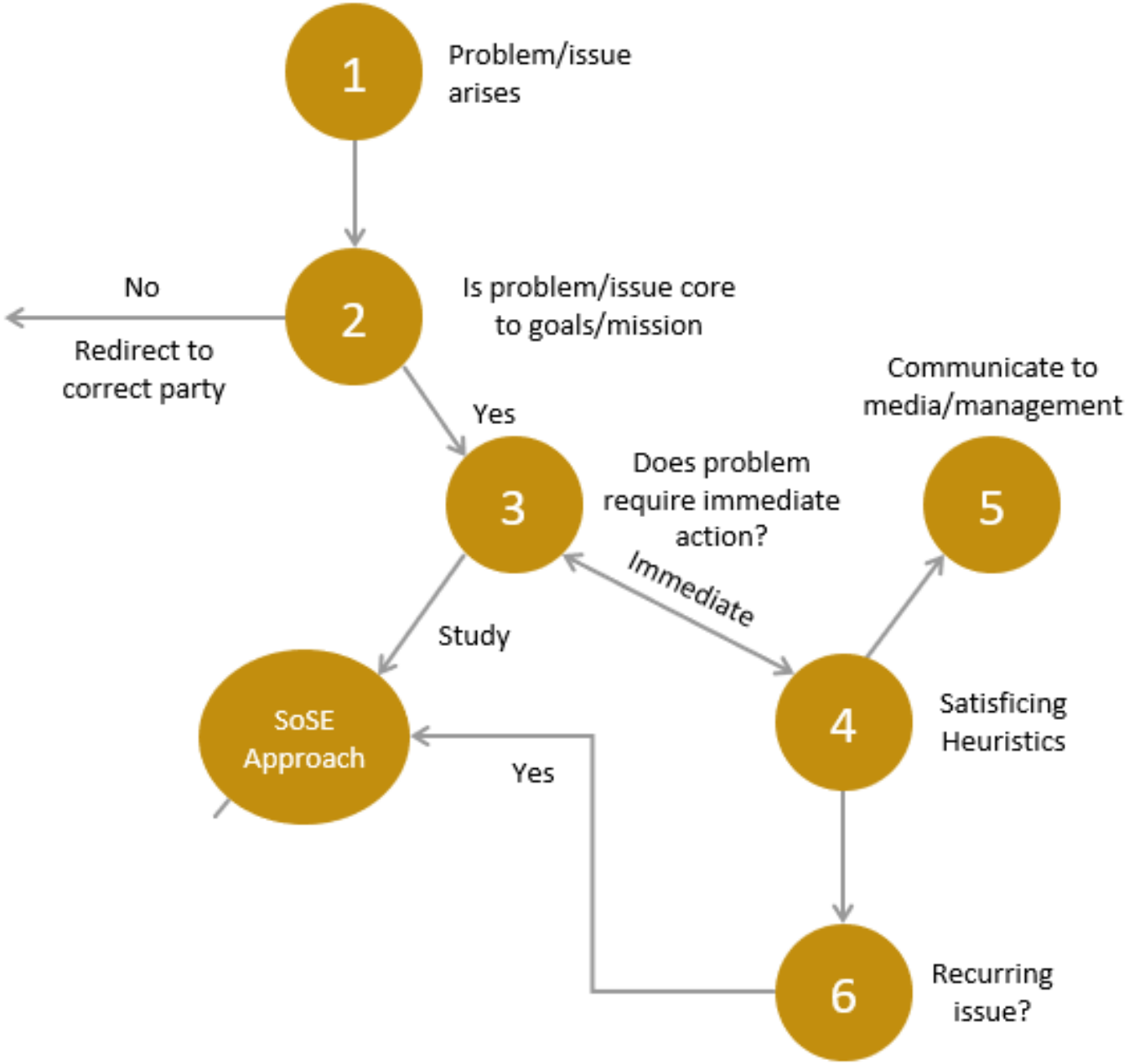
Knowledge Map Excerpt – SoSE & Externalities



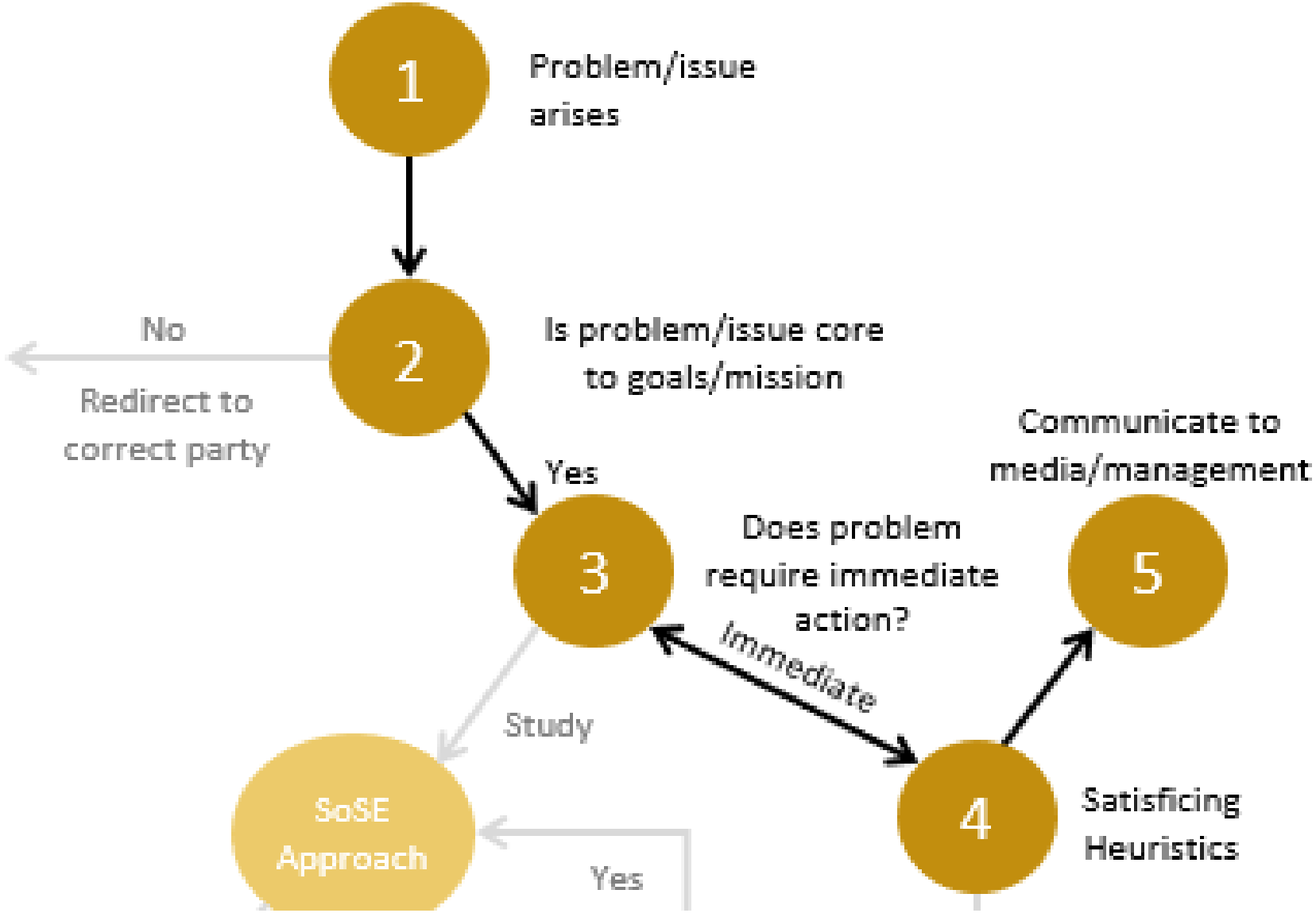
Knowledge Map Excerpt – Engineering



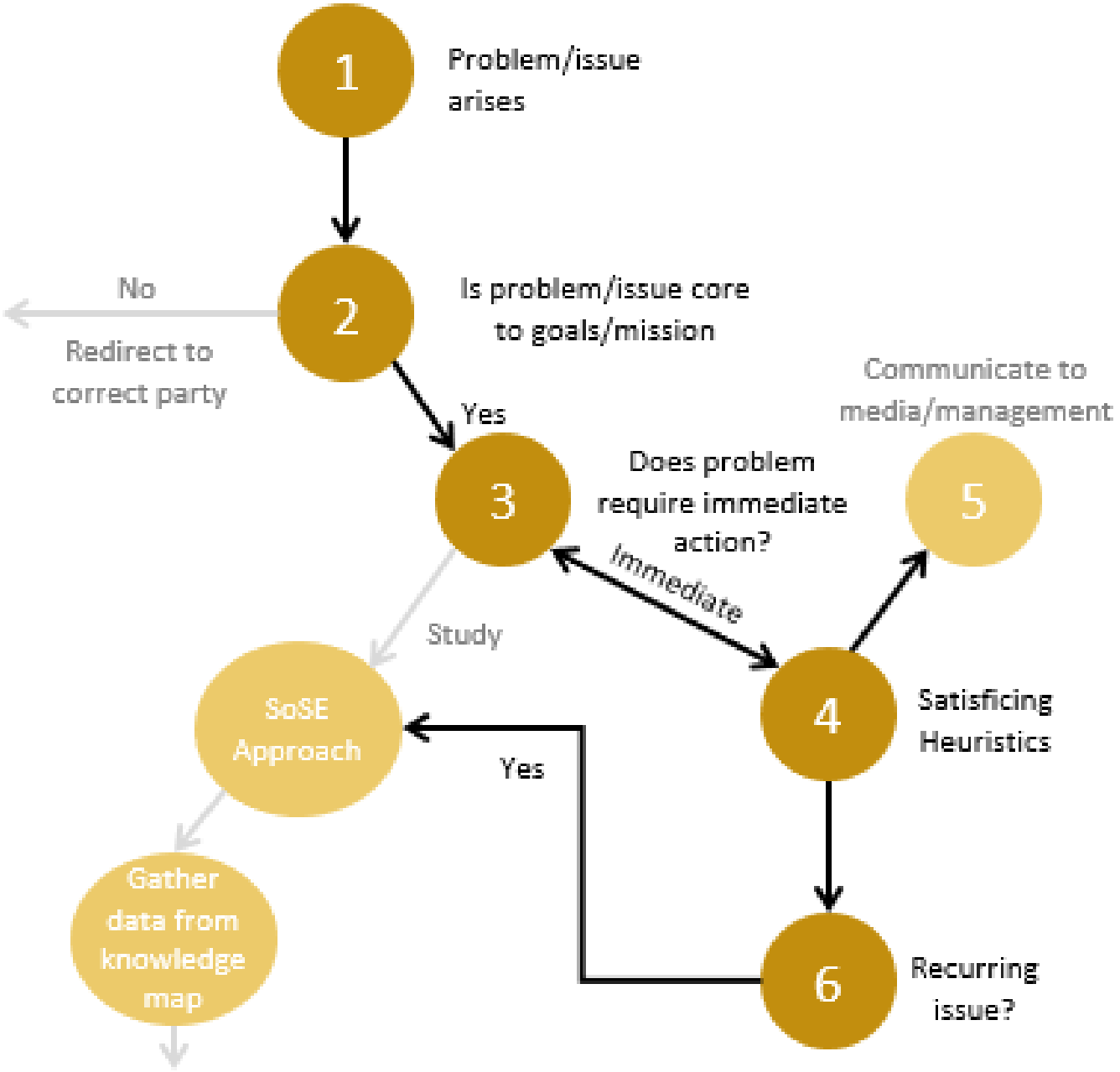
Framework (partial)



Case Study 1 – Unplanned Outage



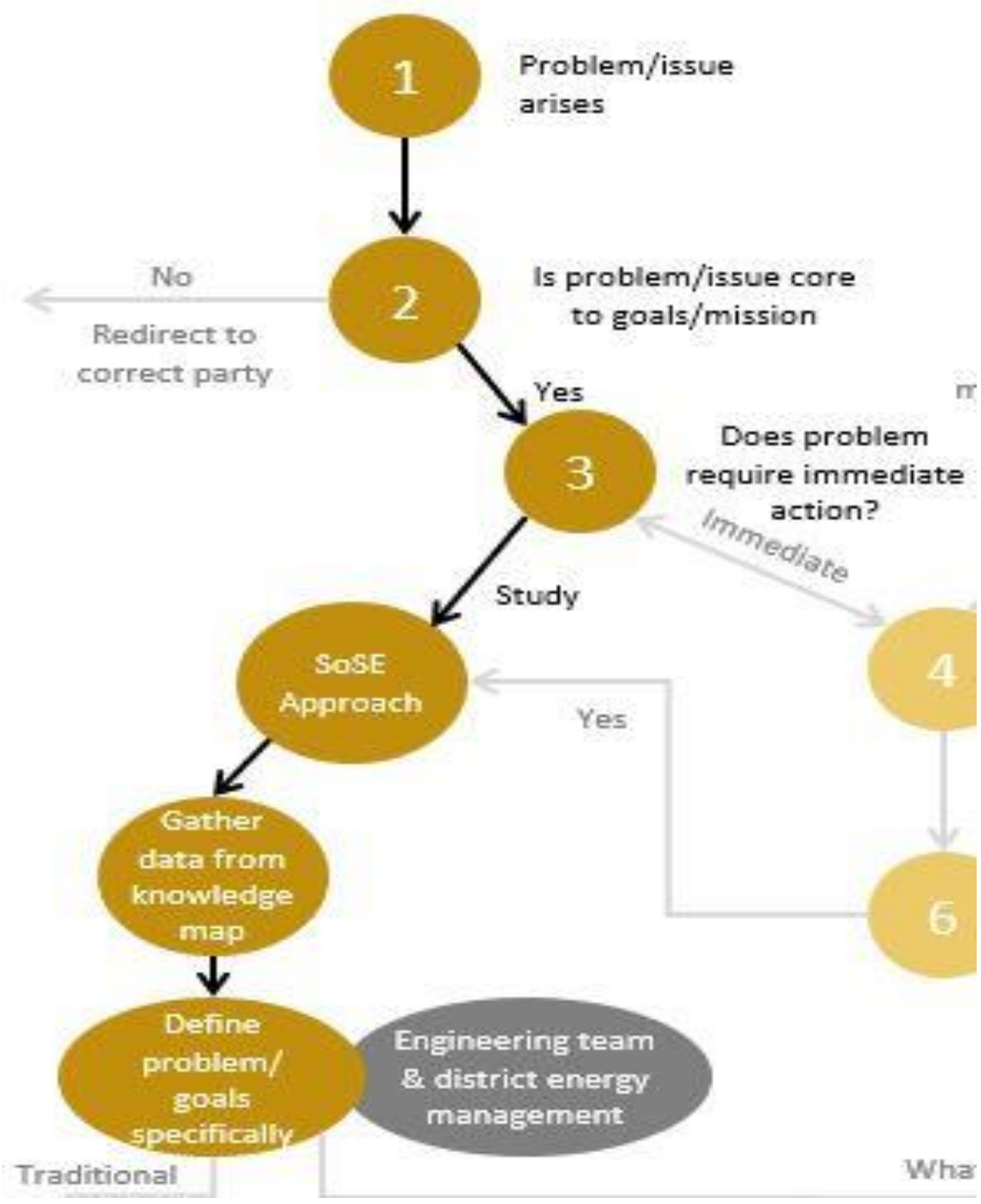
Case Study 2 – Steam Pressure Drops on Campus



Case Study 3 – Low Steam Pressure

- Specific Goal for this Case Study (2012 & 2018)
  - *Maintain the pressure of 75 psig at the north end of campus at all times*

Case Study 3 – Steam



Summary

- Introduction, Problem Definition, and Why
- Decision-Making– District Energy Systems
- Knowledge Map & Decision-Making Framework
- Case Studies –
  - Immediate
  - Iterative
  - Long-Term

Benefits

- Provides introduction and overview for district energy managers
- Benefit/cost analysis (including sensitivity analysis)
- Changing goals and timelines
- Time and resource availability
- Energy vs. peak demand
- Operations and maintenance impacts

Conclusions

- Traditional Solution is not always the best
- A set of tools for district energy managers
- Provides educational overview
- Benefits for interdisciplinary teams – operations, finance and management

Thank you for your attention

Daniel C. Schuster
Schuster Consulting LLC
Dcschust@gmail.com

Questions?