



CARIBBEAN
EXAMINATIONS
COUNCIL

UNIT 1: INTRODUCTION TO GREEN ENGINEERING

**Module 2: The Theoretical Framework of Green
Engineering – Presenter: *Churchill Norbert***

The Theoretical Framework of Green Engineering



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General Objectives

On completion of this Module, students should:

1. Understand the principles of Green Engineering and the supporting mechanisms/technologies and guidelines;
2. Understand the principles of Industrial Ecology;
3. Appreciate the interrelationship between Green Engineering and Industrial Ecology; and,
4. Be aware of technologies, guidelines and mechanisms for collaborative design and product lifecycle management.

The Theoretical Framework of Green Engineering



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➤ The Impact of Engineering

Engineering has broad (sustainability) environmental, social and economic impacts. In fact, every day engineers and scientists make technical decisions which have significant impact on the environment. These decisions can either move us in the direction of sustainability or contribute to the growing problems.

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✓ Application Green Engineering Principles

Application of the principles of **Green Engineering** is considered a new paradigm that allows for the **incorporation** of the concept of **sustainability** and the application of **science** and **design solutions** to problems created by **conventional engineering**.

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- ✓ Green Engineering can be defined as environmentally conscious attitudes, values, and principles, **combined** with science, technology and innovation directed towards improving **local** and **global** environmental quality.

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Green Engineering

□ It is the **design** of materials, processes, systems and devices with the objective of **minimising** overall environmental impact over the entire life cycle whilst meeting **required performance**, **economic** and **societal constraints**.

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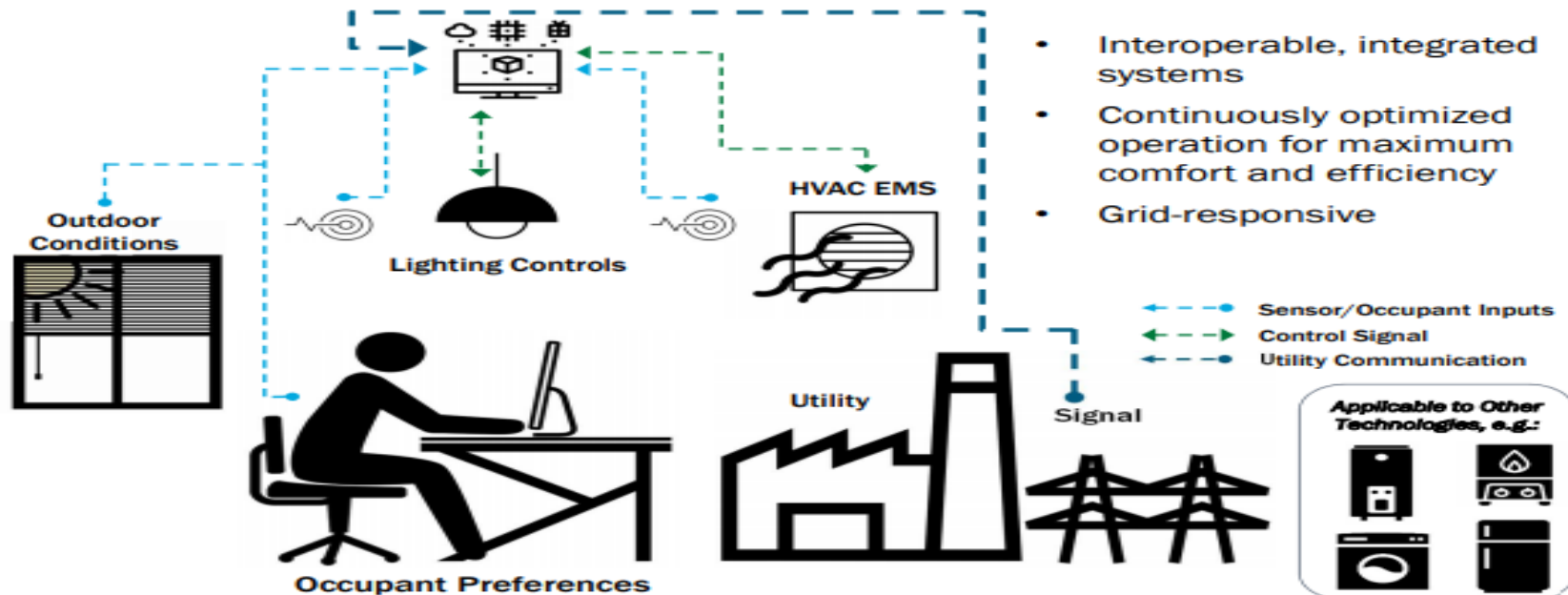


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Supporting mechanisms, technologies and guidelines

- **Environmental Management Systems (EMS)** – ISO 14001
- **Technologies** – Information and Communications Technology – ICT (shift from IT – ICT)
 - Internet of Things – IoT (Digitalization/wireless devices)
- **Guidelines**
 - ISO 14000 and 50000 family of standards particularly 14040, 14044 & 50001
 - American Standard for Testing Materials (ASTM)
 - 2018 CARICOM Regional Energy Efficiency Building Code
- **Certification**
 - Leadership in Energy and Environmental Designs (LEED) Certification for all building types
 - Building Research Establishment Environmental Assessment Method (BREEAM) Certification
 - Eco-Management and Audit Scheme (EMAS) Premium management instrument
 - ENERGY STAR – A symbol for energy efficient products and appliances used in buildings

Interactions with Building Occupants



- Interoperable, integrated systems
- Continuously optimized operation for maximum comfort and efficiency
- Grid-responsive

SELF-ASSEMBLY

Computers without Carcinogens



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➤ The Industrial Ecology

Sustainable development is defined as being more than a specific "end-point", but a dynamic and continuous process which encompassed a myriad of separate decisions spread over both time and space.

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- ✓ Industrial ecology is defined as the means by which a state of sustainable development is approached and maintained; it requires a systems view of human activity and its interrelationship with the fundamental biological, chemical and physical cycles which constitutes the industrial ecosystem.

Allenby, B. R. (1992). Achieving sustainable development through industrial ecology. *International Environmental Affairs*, 4(1), 56-68.

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The Industrial Ecology

- The **exchange** of wastes, by-products, and energy among **closely** situated firms is one of the **distinctive features** of the applications of **industrial ecological principles**.

Industrial Ecology in Practice: The Evolution of Interdependence at Kalundborg'. *Journal of Industrial Ecology* (1997) 1(1): 67-79.

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• The Industrial Ecology

- Industrial ecology is a new concept emerging in the evolution of environmental management paradigms (Ehrenfeld 1995), and springs from interests in integrating notions of sustainability into environmental and economic systems (Allenby 1992; Jelinski et al. 1992; Allen and Behmanish 1994; Ehrenfeld 1995).
- Environmental thinking has recently focused on a consciousness of the intimate and critical relationships between human actions and the natural world, and reflects limits in the current reliance on command-and-control regulation in much of the industrialized world.
- The critical problem is that, for the most part, the economy operates as an open system, drawing raw materials from the environment and returning vast amounts of unused by-products in the form of pollution and waste.

Industrial Ecology in Practice: The Evolution of Interdependence at Kalundborg'. *Journal of Industrial Ecology* (1997) 1(1): 67-79.

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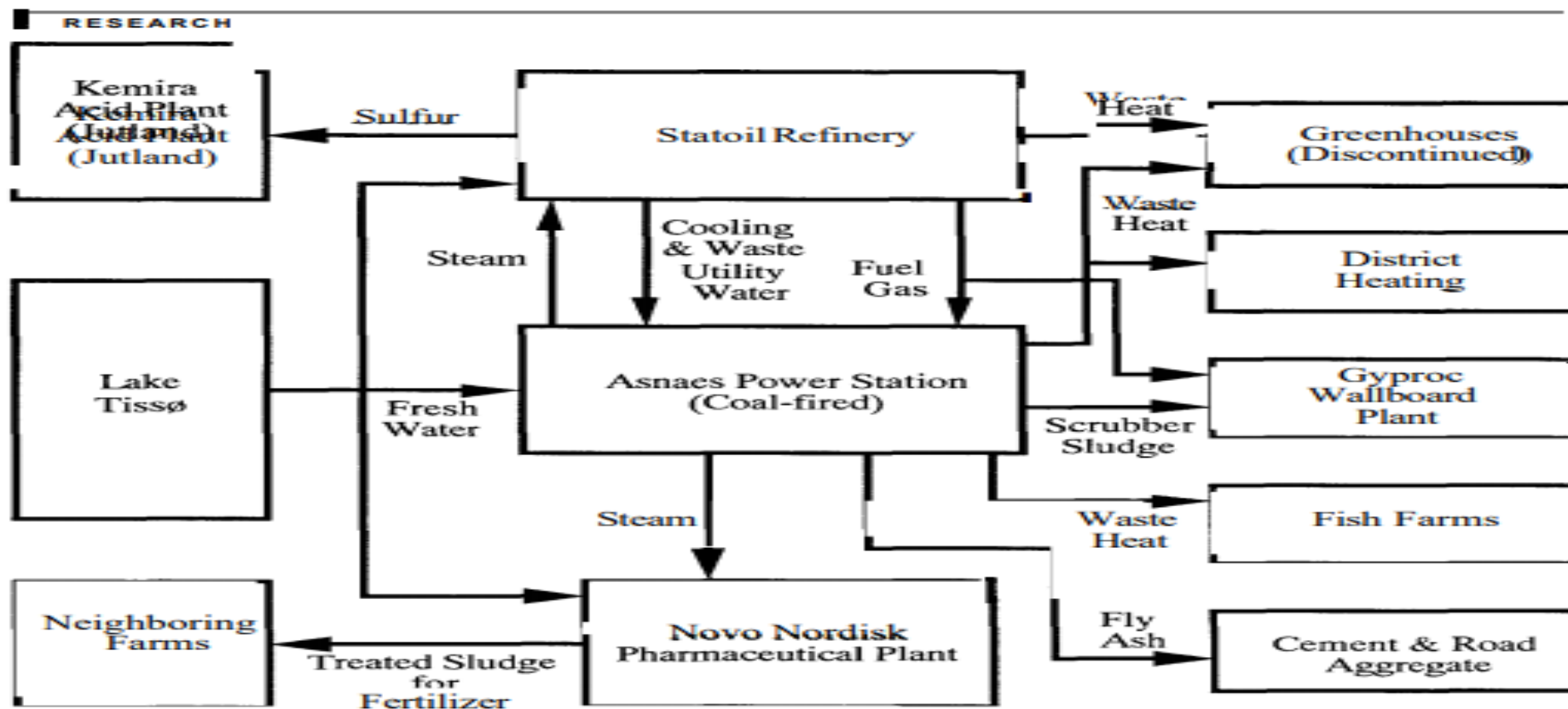
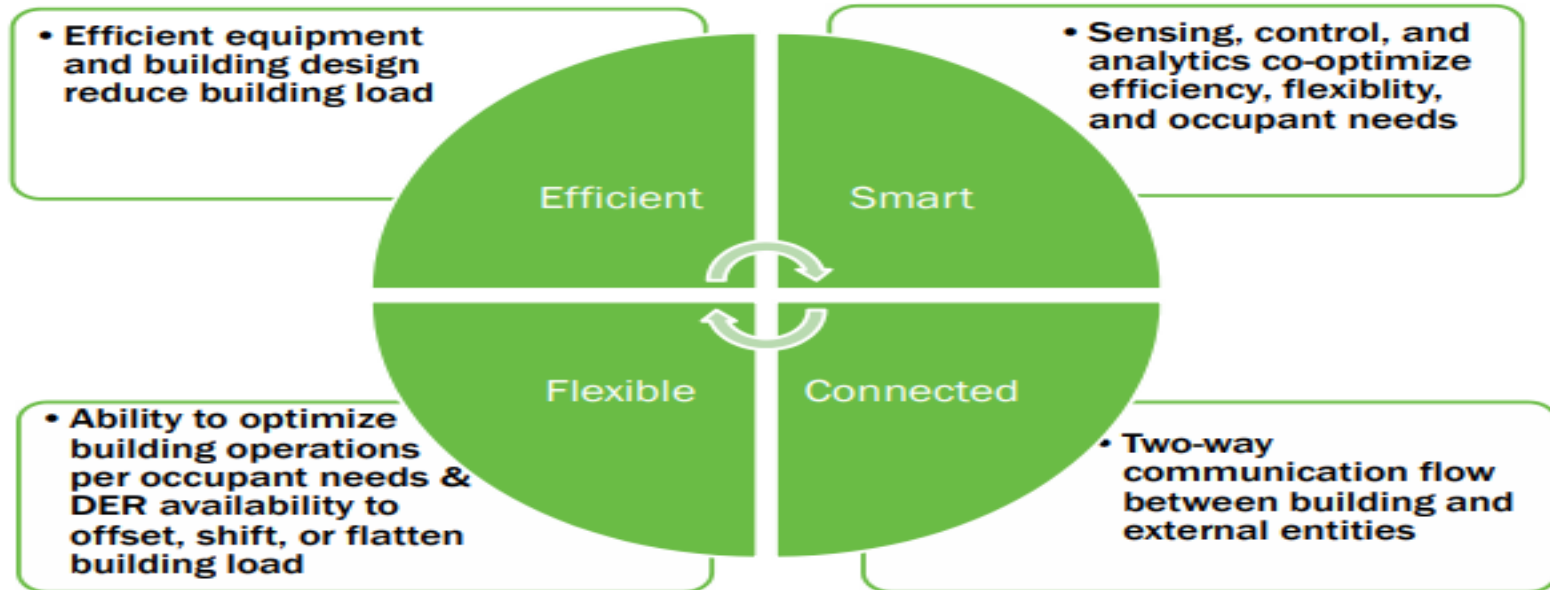


Figure 1 The industrial ecosystem at Kalundborg, Denmark

Grid-interactive Efficient Buildings



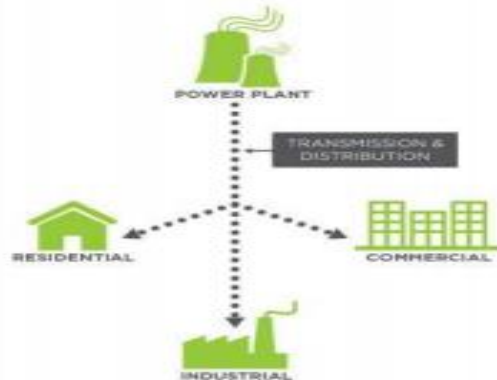
Electricity Grid of the Future



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Moving toward the Grid of the Future

TODAY: ONE-WAY POWER SYSTEM
Central, One-Way Power Systems



EMERGING: THE ENERGY CLOUD
Distributed, Two-Way Power Flows



(Source: Navigant)

U.S. DEPARTMENT OF ENERGY

OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY

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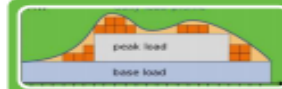
BENEFITS



Potential Benefits of Flexible Building Loads



✓ Energy Affordability



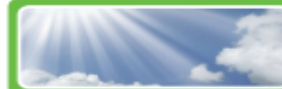
✓ Improved reliability



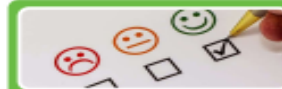
✓ Reduced grid congestion



✓ Enhanced services



✓ Environmental benefits



✓ Customer choice

Class Discussions



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- Define guiding Principles for Green Engineering
- Define guiding Principles for Industrial Ecology
- Describe the interrelationship between Green Engineering and the Industrial Ecology
- Explain your understanding of building regulations
- What are some benefits of smart buildings?
- What is the role ICT and IoT in Green Engineering



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The End!