

**Use of Renewable Energies in Urban, Agricultural and Industrial Activities to Improve Efficiency and Ensure Sustainability**

• TEGREMED International Workshop •

*“Future Green Engineering: A Civil & Energy Workshop for Young People and Students”*

Co-funded by the European Union

**URBAN**

- Solar Energy
- Wind Energy
- Energy Efficient Buildings
- Sustainable Mobility

**AGRICULTURAL**

- Solar Irrigation and Pumping
- Biomass & Biogas from Agro-residues
- Efficient Water Use
- Sustainable Food Production

**INDUSTRIAL**

- Renewable Electricity
- Renewable Heat
- Process Efficiency
- Circular Economy & Resource Use

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

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## Slide 1. Title slide

### Use of Renewable Energies in Urban, Agricultural and Industrial Activities to Improve Efficiency and Ensure Sustainability

Good morning/afternoon everyone. It is a pleasure to participate in the TEGREMED International Workshop, *Future Green Engineering: A Civil & Energy Workshop for Young People and Students*.

Today we will discuss how renewable energies can be integrated into three major activity sectors: cities, agriculture, and industry. These sectors are responsible for a large share of energy consumption, greenhouse gas emissions, water demand, and material use. Therefore, they also offer significant opportunities for improving efficiency and sustainability.

The main message of this presentation is simple: renewable energy is not only about producing clean electricity. It is about redesigning how we plan cities, manage water and food systems, operate industries, and use technology to reduce environmental impacts while maintaining social and economic development.

**UNIVERSITAT POLITÈCNICA DE VALÈNCIA** **Why Renewable Energies Matter Today** **TEGREMED**

*The energy transition is driven by converging challenges and integrated solutions*

**1 THREE KEY CHALLENGES**

**1. CLIMATE CHANGE**  
Fossil fuels generate greenhouse gas emissions that drive climate change.

**2. ENERGY SECURITY & PRICE VOLATILITY**  
Many regions face volatile energy prices and dependence on imported fuels.

**3. GROWING ENERGY DEMAND**  
Cities, food production and industrial development continue to increase energy demand.

**2 RENEWABLE SOLUTIONS**  
*Lower-impact alternatives for a cleaner energy future.*

Solar | Wind | Biomass | Geothermal | Hydropower | Renewable Hydrogen

**3 MAXIMUM VALUE THROUGH INTEGRATION**

ENERGY EFFICIENCY → SMART MANAGEMENT SYSTEMS → STORAGE → CIRCULAR ECONOMY

Integration improves reliability, resilience and sustainability.

**4 A CHALLENGE FOR ENGINEERS**

The energy transition is not only a technological challenge. It is also a planning, design, management and governance challenge.

CIVIL ENGINEERS | ENVIRONMENTAL ENGINEERS | AGRICULTURAL ENGINEERS | INDUSTRIAL ENGINEERS

ALL ENGINEERS HAVE A ROLE TO PLAY.


**CLEANER ENERGY • STRONGER ECONOMIES • HEALTHIER PLANET • BETTER FUTURE**

## Slide 2. Why renewable energies matter today


The current energy transition is driven by several converging challenges. First, conventional fossil fuels generate greenhouse gas emissions that contribute to climate change. Second, many regions are exposed to energy price volatility and dependence on imported fuels. Third, urban growth, food production, and industrial development continue to increase energy demand.

Renewable energy sources such as solar, wind, biomass, geothermal, hydropower, and renewable hydrogen provide alternatives with lower environmental impact. However, their value is maximized when they are combined with energy efficiency, smart management systems, storage, and circular economy strategies.

For engineers, this means that the energy transition is not only a technological challenge. It is also a planning, design, management, and governance challenge. Civil, environmental, agricultural, and industrial engineers all have a role to play.










# Main Renewable Energy Sources










*Key technologies, how they work, and the need to choose the right energy mix*




1 MOST COMMON RENEWABLE ENERGY SOURCES



 <b>SOLAR PHOTOVOLTAIC</b> Converts sunlight directly into electricity	 <b>SOLAR THERMAL</b> Produces heat for hot water, industry, or drying	 <b>WIND ENERGY</b> Converts kinetic energy from air movement into electricity	 <b>BIOMASS &amp; BIOGAS</b> Uses organic matter and residues to produce heat, electricity, or fuel	 <b>GEOTHERMAL ENERGY</b> Uses heat stored in the ground	 <b>HYDROPOWER</b> Uses the energy of moving water	 <b>GREEN HYDROGEN</b> Emerging renewable fuel produced using renewable electricity
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2 APPLICATIONS AND RESOURCE USE

 Buildings and hot water	 Industrial processes	 Agricultural drying	 Crop residues and manure	 Wastewater sludge and municipal waste	 Electricity generation	 Clean fuels and storage
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3 ADVANTAGES, LIMITATIONS AND ENGINEERING CHALLENGE

 <p><b>ADVANTAGES</b></p> <ul style="list-style-type: none"> <li>• Low environmental impact</li> <li>• Diverse technologies and uses</li> <li>• Can support electricity, heat, and fuel needs</li> </ul>	 <p><b>LIMITATIONS</b></p> <ul style="list-style-type: none"> <li>• Solar and wind are variable</li> <li>• Biomass requires sustainable feedstock management</li> <li>• Hydropower depends on water availability and ecological constraints</li> </ul>	 <p><b>ENGINEERING CHALLENGE / FINAL MESSAGE</b></p> <p>The right combination depends on local resources, demand patterns, environmental conditions, and economic feasibility.</p>
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Sustainable energy planning means selecting the best mix for each territory.


### Slide 3. Main renewable energy sources

The most common renewable energy sources include solar photovoltaic energy, solar thermal energy, wind energy, biomass and biogas, geothermal energy, hydropower, and emerging renewable fuels such as green hydrogen.

Solar photovoltaic systems convert sunlight directly into electricity. Solar thermal systems produce heat, which can be used for domestic hot water, industrial processes, or agricultural drying. Wind energy converts kinetic energy from air movement into electricity. Biomass and biogas use organic matter, agricultural residues, wastewater sludge, or municipal waste to produce heat, electricity, or fuel. Geothermal energy uses heat stored in the ground, and hydropower uses the energy of moving water.

Each source has advantages and limitations. Solar and wind are variable. Biomass requires sustainable feedstock management. Hydropower depends on water availability and ecological constraints. The engineering challenge is to select the right combination according to local resources, demand patterns, environmental conditions, and economic feasibility.

UNIVERSITAT POLITÈCNICA DE VALÈNCIA **Energy Efficiency Before Energy Generation** 

*The cleanest and cheapest energy is the energy that does not need to be consumed.*

**1. URBAN BUILDINGS**


- Better insulation
- Efficient lighting
- Passive design
- Natural ventilation
- High-efficiency heating and cooling systems

**2. AGRICULTURE**

- Efficient irrigation
- Optimized pumping
- Reduced fertilizer losses
- Better machinery use and maintenance

**3. INDUSTRY**

- Heat recovery and reuse
- High-efficiency motors and drives
- Process optimization
- Energy monitoring and data-driven decisions

**EFFICIENCY FIRST** Use less energy by doing more with less. → **THEN RENEWABLE ENERGY** Supply remaining needs with clean, renewable energy. → **HIGHER SUSTAINABILITY** Lower costs, lower emissions, and greater resilience.  Efficiency and renewable energy must be designed together, not separately.

**LESS EFFICIENT OPTION** High energy waste despite solar installation.


- Poor insulation → High cooling load
- Air leaks → Energy wasted all year
- Inefficient equipment → High energy bills and emissions

⊗ **High demand = High cost = Higher emissions**


**BETTER INTEGRATED OPTION** Efficiency first, then clean energy.


- Highly insulated building → Low energy demand
- Efficient systems and appliances → Renewables supply remaining needs
- Smart controls and automation → Near zero-energy performance


✓ **Low demand + Renewables = Lower cost = Lower emissions**


**EFFICIENCY AND RENEWABLE ENERGY ARE COMPLEMENTARY SOLUTIONS.** 

*Save energy first. Add renewables second. Build a sustainable future together!*

 **USE LESS**  
Do more with less energy.

 **CLEAN ENERGY**  
Use what is clean and renewable.

 **SMARTER CHOICES**  
Data, design and discipline.

 **STRONGER FUTURE**  
For people and our planet.

#### Slide 4. Energy efficiency before energy generation

Before installing renewable energy systems, the first principle should always be energy efficiency. The cleanest and cheapest energy is often the energy that does not need to be consumed.

In urban buildings, this means better insulation, efficient lighting, passive design, natural ventilation, and high-efficiency heating and cooling systems. In agriculture, it means efficient irrigation, optimized pumping, reduced fertilizer losses, and better machinery use. In industry, it means heat recovery, improved motors, process optimization, and energy monitoring.

Renewable energy and efficiency should not be treated as separate solutions. They must be designed together. For example, a poorly insulated building with solar panels may still waste large amounts of energy. An efficient building with renewable energy integration can approach nearly zero-energy performance.

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# Renewable Energies in Urban Environments

*Integrating clean energy into buildings, districts, infrastructure and mobility systems*

**1. CITIES AS COMPLEX ENERGY SYSTEMS**

Urban areas are complex systems with high demand for energy, mobility and water services.

- Electricity
- Heating
- Cooling
- Transport
- Water

**2. WHERE RENEWABLES CAN BE INTEGRATED**

- Rooftops and facades
- Car parks and public buildings
- Schools and sports facilities
- Solar thermal for hot water
- District heating & cooling

**DISTRICT-ENERGY SOURCES**

- Biomass
- Geothermal
- Waste heat
- Large-scale solar thermal

**3. SMART URBAN SOLUTIONS**

- Electric mobility**: EVs, charging networks and clean public transport.
- Smart street lighting**: Adaptive LED lighting saves energy and improves safety.
- Energy-positive buildings**: Efficient design, renewables and storage produce more energy than they use.
- Local energy communities**: Neighborhoods produce, share and manage clean energy together.

**4. THE OBJECTIVE**

The goal is not only to generate energy in the city, but to build urban systems that are:

- Resilient**: Prepared for shocks and disruptions.
- Efficient**: Use less energy and reduce operating costs.
- Less dependent on fossil fuels**: Cleaner air, healthier cities, sustainable future.

**Clean urban energy supports resilience, efficiency and sustainability.**

LOWER EMISSIONS • SMARTER CITIES • BETTER MOBILITY • STRONGER COMMUNITIES

## Slide 5. Renewable energies in urban environments

Cities are complex energy systems. They consume electricity, heat, cooling, transport fuels, and water. Renewable energy can be introduced at multiple scales: individual buildings, districts, public infrastructure, and urban mobility systems.

Solar photovoltaic panels can be installed on rooftops, facades, car parks, schools, sports facilities, and public buildings. Solar thermal systems can supply domestic hot water in residential buildings. District heating and cooling networks can integrate biomass, geothermal energy, waste heat, or large-scale solar thermal systems.

Urban renewable energy also includes electric mobility powered by renewable electricity, smart street lighting, energy-positive buildings, and local energy communities. The objective is not only to produce energy in the city, but to make the city more resilient, efficient, and less dependent on external fossil energy sources.

UNIVERSITAT POLITÈCNICA DE VALÈNCIA **Smart Buildings and Nearly Zero-Energy Buildings** 

*Designing buildings as integrated energy systems with efficiency, digital control and renewable energy.*

### 1. WHAT IS A NEARLY ZERO-ENERGY BUILDING?



- Very low energy demand
- High efficiency
- Renewable energy contribution

### 2. PASSIVE DESIGN FIRST



- Orientation
- Shading
- Insulation
- Airtightness
- Natural lighting
- Ventilation

### 3. EFFICIENT ACTIVE SYSTEMS

 <b>Heat pumps</b> High performance for heating, cooling and hot water.	 <b>LED lighting</b> High efficiency lighting with smart controls.
 <b>Smart control systems</b> Automated control for comfort and energy savings.	 <b>Efficient heating and cooling</b> High-efficiency equipment and zoned operation.

### 4. RENEWABLE ENERGY INTEGRATION

Supply the remaining energy needs with clean, renewable sources.

 <b>Photovoltaic panels</b> Generate clean electricity on-site.	 <b>Solar thermal collectors</b> Produce hot water sustainably.	 <b>Geothermal heat pumps</b> Stable, efficient heating and cooling from the ground.	 <b>Biomass systems</b> Renewable heat from sustainable biomass.
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### 5. DIGITAL TECHNOLOGIES



- Sensors**: Collect data across the building.
- Building management systems**: Integrate and manage building operations.
- Smart meters**: Measure energy use accurately.
- Real-time monitoring**: See performance as it happens.
- Detect inefficiencies**: Identify issues and anomalies early.
- Adjust operation**: Optimize systems for efficiency and comfort.
- Responsible user behaviour**: Engage occupants for lasting impact.

**KEY IDEA FOR YOUNG ENGINEERS**

 Buildings should be designed as integrated energy systems, not as isolated structures.


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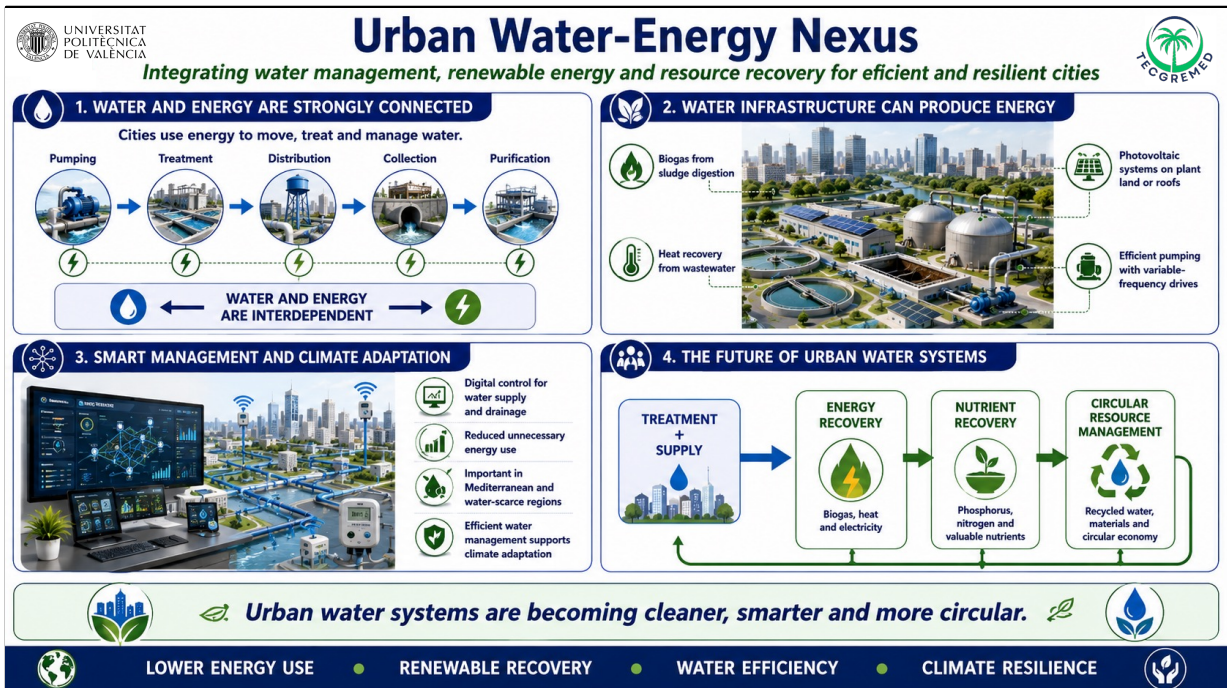
**Efficiency, innovation and renewable energy together create smarter buildings.**

## Slide 6. Smart buildings and nearly zero-energy buildings

Buildings are one of the most important targets for renewable energy integration. A nearly zero-energy building combines very low energy demand with a significant contribution from renewable sources.

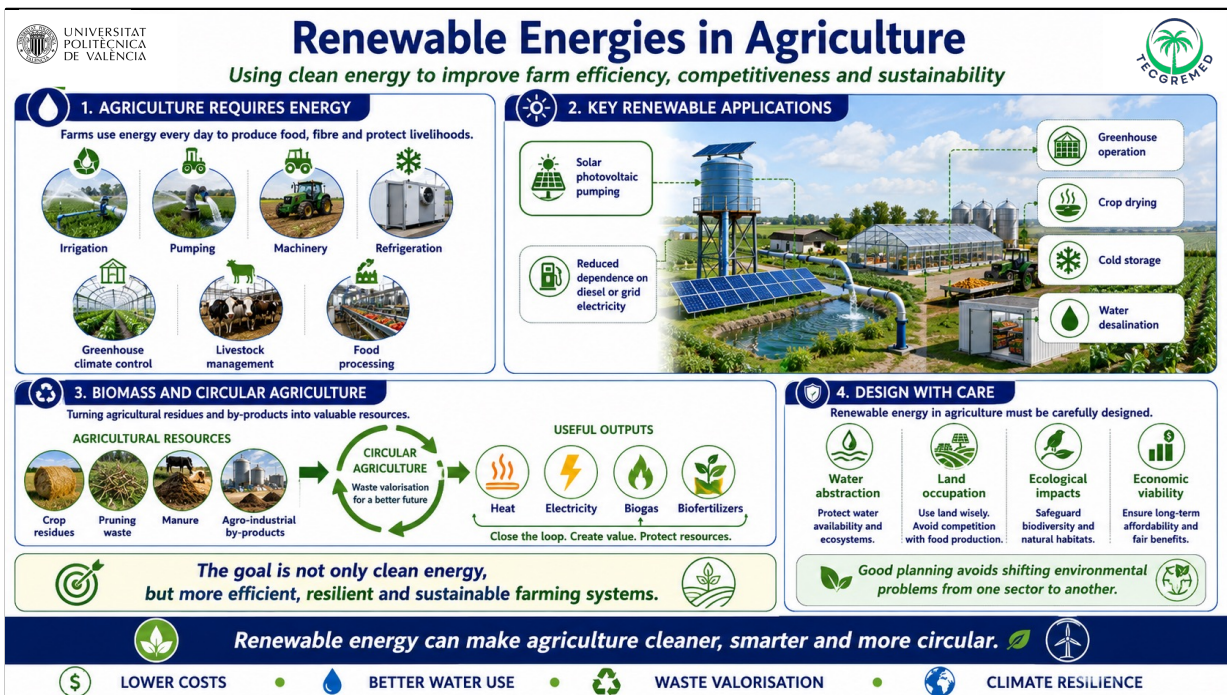
The design process starts with passive strategies: orientation, shading, insulation, airtightness, natural lighting, and ventilation. Then, efficient active systems are selected, such as heat pumps, LED lighting, and smart control systems. Finally, renewable generation is incorporated through photovoltaic panels, solar thermal collectors, geothermal heat pumps, or biomass systems. Digital technologies are also essential. Sensors, building management systems, and smart meters allow real-time monitoring of energy consumption. This helps detect inefficiencies, adjust operation, and involve users in responsible energy behaviour.

For young engineers, the key idea is that buildings should be designed as integrated energy systems, not as isolated structures.



**Slide 7. Urban water-energy nexus**

In cities, water and energy are strongly connected. Energy is required to pump, treat, distribute, collect, and purify water. At the same time, water infrastructure can support renewable energy generation and resource recovery. Wastewater treatment plants are a good example. They can produce biogas from sludge digestion, recover heat from wastewater, and install photovoltaic systems on available land or structures. Pumping stations can be optimized using variable-frequency drives and powered partly by renewable electricity. Urban drainage and water supply systems can also be managed using digital control tools to reduce unnecessary energy consumption. This is particularly relevant in Mediterranean regions and other areas facing water scarcity, where efficient water management is directly linked to climate adaptation. The future of urban water systems is not only treatment and supply. It is energy recovery, nutrient recovery, and circular resource management.



## Slide 8. Renewable energies in agriculture

Agriculture requires energy for irrigation, pumping, machinery, refrigeration, greenhouse climate control, livestock management, and food processing. Renewable energy can improve both environmental performance and farm competitiveness.

Solar photovoltaic pumping is one of the most attractive applications, especially in areas with high solar radiation. It can reduce dependence on diesel pumps or grid electricity. Solar energy can also be used for greenhouse operation, crop drying, cold storage, and water desalination.


Biomass from crop residues, pruning waste, manure, and agro-industrial by-products can be converted into heat, electricity, biogas, or biofertilizers. In this context, renewable energy is closely connected with waste valorisation and circular agriculture.

However, renewable energy in agriculture must be carefully designed. Water abstraction, land occupation, ecological impacts, and economic viability must be assessed to avoid shifting environmental problems from one sector to another.


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# Solar Irrigation and Efficient Water Use

Combining photovoltaic pumping, efficient irrigation and water governance for efficient and sustainable agriculture




### 1. HOW SOLAR IRRIGATION WORKS



Sunlight → PV panels generate electricity → Controller / Inverter → Pumps extract or distribute water → Water source (river, well, tank) → Irrigation network (pressurized) → Water reaches crops efficiently

### 2. MAIN BENEFITS

- Lower fuel costs
- Lower emissions
- Useful in remote areas
- Reduced dependence on diesel or the electric grid



### 3. THE RISK: CHEAPER PUMPING CAN INCREASE WATER USE

Lower energy costs can encourage overpumping and lead to unsustainable water use.

#### SUSTAINABLE USE

Balanced abstraction  
Protects aquifers and ecosystems

#### OVERPUMPING RISK

More pumping may lower water levels and harm ecosystems

- More pumping may increase water abstraction
- Water savings are not automatic
- Technology must be linked to governance

### 4. EFFICIENT WATER USE AND GOOD MANAGEMENT

Use the right amount of water, at the right time, for the right crop.

- Drip irrigation
- Soil moisture sensors
- Irrigation scheduling
- Pressure control
- Crop water requirement calculations
- Water governance

The goal is efficient use of water, not simply more pumping.

**For engineers:** technology must be integrated with environmental management and policy.

Solar irrigation is most sustainable when renewable energy, efficient irrigation and water governance work together.

LOWER COSTS • WATER EFFICIENCY • SMART IRRIGATION • CLIMATE RESILIENCE

## Slide 9. Solar irrigation and efficient water use

Solar irrigation is a powerful example of the link between renewable energy and resource efficiency. Photovoltaic panels generate electricity to power pumps that extract or distribute water for crops.

This technology can reduce fuel costs and emissions. It is particularly useful in remote areas where grid access is limited. However, there is an important risk: if pumping becomes cheaper, water use may increase. Therefore, solar irrigation must always be combined with efficient irrigation systems and water governance.

Drip irrigation, soil moisture sensors, irrigation scheduling, pressure control, and crop water requirement calculations are essential. The objective is not simply to pump water with solar energy, but to use water more efficiently.

For engineers, this is a clear example of why technological solutions must be integrated with environmental management and policy.

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# Renewable Energy in Greenhouses and Controlled Agriculture

*Integrating clean energy, smart climate control and precision agriculture for efficient and resilient food production*

**1. WHY GREENHOUSES NEED ENERGY**  
Controlled agriculture needs energy to maintain optimal growing conditions.

- Heating
- Cooling
- Lighting
- Ventilation
- Humidity control
- CO<sub>2</sub> management

**2. RENEWABLE ENERGY OPTIONS**

- PV electricity
- Solar thermal heat
- Geothermal systems
- Biomass boilers
- Heat pumps
- Thermal screens, passive ventilation and climate-responsive controls reduce energy demand.

**3. PRECISION AGRICULTURE + SMART CONTROL**

Sensors + control systems optimize climate, irrigation and energy use in real time.

**GREENHOUSE DASHBOARD**

Temperature: 25.4°C	Humidity: 62%	SSR: 34%
Nutrients: 1.8 mS/cm	Plant Growth: Good	

**4. WHY THIS APPROACH MATTERS**

- Lower environmental footprint:** Uses clean energy and fewer resources to grow more food sustainably.
- Better energy efficiency:** Reduces energy costs and increases efficiency of operations.
- Improved water management:** Smart irrigation and monitoring reduce water use and waste.
- Climate resilience:** Systems are more resilient to heat stress, drought and extreme events.
- Reliable food production:** Ensures year-round, high-quality food for growing populations.

Especially relevant in regions affected by water scarcity, heat stress, and unstable climate conditions.

**Renewable energy and precision agriculture help create smarter, cleaner and more resilient greenhouse systems.**

LOWER EMISSIONS • BETTER WATER USE • SMARTER CONTROL • CLIMATE RESILIENCE • SUSTAINABLE FOOD PRODUCTION

## Slide 10. Renewable energy in greenhouses and controlled agriculture

Greenhouses and controlled-environment agriculture require energy for heating, cooling, lighting, ventilation, humidity control, and sometimes carbon dioxide management. Renewable energy can significantly reduce their environmental footprint.

Solar photovoltaic systems can supply electricity for fans, pumps, sensors, and control systems. Solar thermal collectors, geothermal systems, biomass boilers, and heat pumps can provide heating. Thermal screens, passive ventilation, and climate-responsive control systems can reduce energy demand.

In advanced systems, renewable energy can be combined with precision agriculture. Sensors monitor temperature, humidity, soil moisture, nutrient concentration, and plant growth. Control systems then optimize energy and water use.

This approach is highly relevant for future food production, especially in regions affected by water scarcity, heat stress, or unstable climate conditions.

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# Renewable Energies in Industrial Activities

Combining clean energy, efficiency and digital innovation to decarbonise industrial production

**1. INDUSTRY HAS HIGH ENERGY DEMAND**

Industrial processes often require continuous supply, high temperatures, and strict reliability.

**2. RENEWABLE OPTIONS FOR INDUSTRY**

Photovoltaic and wind for electricity  
 Biomass and biogas for process heat  
 Solar thermal energy  
 Geothermal energy  
 H<sub>2</sub> Renewable hydrogen  
 Waste heat recovery (Improves efficiency not a renewable source itself)

**3. THE INDUSTRIAL DECARBONISATION TOOLBOX**

Energy audits → Process optimization → Electrification → Renewable heat → Storage → Digital monitoring → Circular use of materials

Integrated approach for continuous improvement

**4. THE BEST STRATEGY DEPENDS ON CONTEXT**

Type of industry (e.g., steel, cement, chemicals, food)  
 Energy intensity (Low, medium or high)  
 Temperature requirements (Low, medium or high)  
 Location (Resource availability, climate, grid access)

No single solution fits all industries. The best mix depends on local and process-specific conditions.

**Industrial decarbonisation requires integrated solutions: efficiency, renewable energy, storage, monitoring and circular production.**

LOWER EMISSIONS • HIGHER EFFICIENCY • GREATER RESILIENCE • CLEANER PRODUCTION • SUSTAINABLE INDUSTRY

## Slide 11. Renewable energies in industrial activities

Industry consumes large amounts of energy, especially for heat, steam, motors, compressed air, refrigeration, and chemical processes. Renewable energy integration in industry is more complex than in buildings because industrial processes often require continuous supply, high temperatures, and strict reliability.

Photovoltaic and wind systems can supply part of the electricity demand. Biomass, biogas, solar thermal energy, geothermal energy, and renewable hydrogen can contribute to process heat. Waste heat recovery is also essential, even if it is not a renewable source, because it improves global energy efficiency. Industrial decarbonisation requires a combination of measures: energy audits, process optimization, electrification, renewable heat, storage, digital monitoring, and circular use of materials. The most effective strategy depends on the type of industry, energy intensity, temperature requirements, and location.

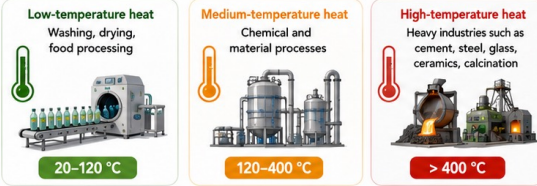
# Renewable Heat and Industrial Process Efficiency



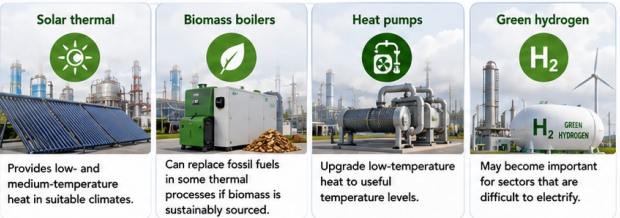
Matching energy quality with process needs is essential for sustainable industry.

## 1 Why Heat Matters in Industry

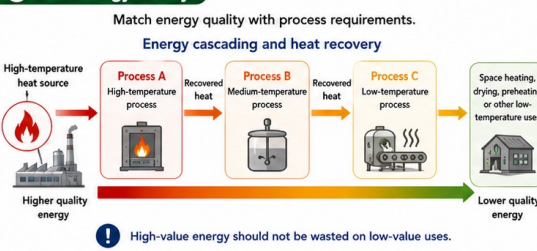
A large share of industrial energy demand is heat, not only electricity.



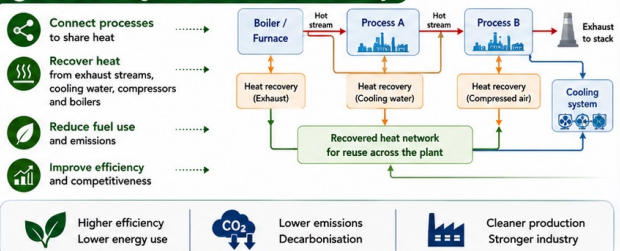
## 2 Renewable Heat Solutions



## 3 Use Energy Wisely



## 4 Process Integration in Sustainable Industry



Energy cascading, heat recovery, and process integration are fundamental concepts in sustainable industry.

### Slide 12. Renewable heat and industrial process efficiency

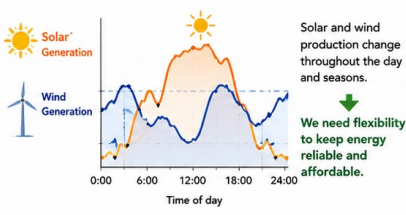
When people think about renewable energy, they often think first about electricity. However, a large part of industrial energy demand is heat. This includes low-temperature heat for washing, drying, and food processing; medium-temperature heat for chemical and material processes; and high-temperature heat for heavy industries.

Solar thermal systems can provide low- and medium-temperature heat in suitable climates. Biomass boilers can replace fossil fuels in some thermal processes, provided biomass is sustainably sourced. Heat pumps can upgrade low-temperature heat to useful levels. Green hydrogen may become important for sectors that are difficult to electrify.

The engineering priority is to match energy quality with process requirements. High-value energy should not be wasted on low-value uses. This is why energy cascading, heat recovery, and process integration are fundamental concepts in sustainable industry.

*Flexibility is essential for integrating variable renewable energy*


### 1 WHY FLEXIBILITY MATTERS



### 2 MAIN STORAGE SOLUTIONS

#### BATTERY STORAGE


Short-term balancing



- Responds in seconds to balance supply and demand.
- Ideal for minutes to hours.

#### THERMAL STORAGE


Heat or cold on demand



- Stores heat or cold for buildings, greenhouses and industrial processes.
- From hours to days.

#### HYDROPOWER RESERVOIRS (PUMPED STORAGE)


Water-based energy storage



- Stores energy by pumping water uphill and generating when needed.
- Large capacity, long life.

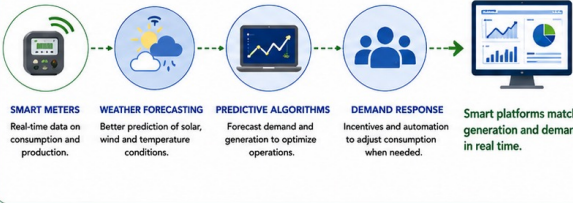
#### GREEN HYDROGEN

Long-duration storage

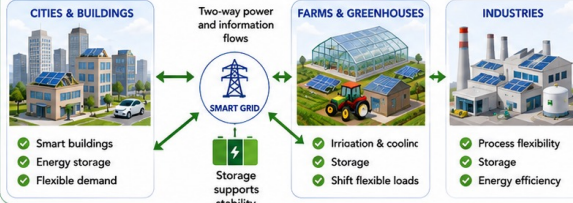


- Converts renewable electricity to hydrogen for storage and future use.
- Efficiency and cost remain key challenges.

### 3 DIGITAL MANAGEMENT TOOLS



### 4 A DISTRIBUTED AND INTERACTIVE ENERGY SYSTEM



### 5 The future energy system will be distributed, digital, flexible and interactive.

## Slide 13. Storage, grids and digital management

Renewable energy systems need flexibility because solar and wind generation vary over time. Storage and smart management are therefore essential.

Battery storage can balance short-term electricity fluctuations. Thermal storage can store heat or cold for buildings, greenhouses, or industrial processes. Water reservoirs, where environmentally acceptable, can provide energy storage through hydropower systems. Green hydrogen can store renewable electricity over longer periods, although efficiency and cost remain important challenges. Digital tools such as smart meters, predictive algorithms, weather forecasting, and demand-response systems help match energy generation with consumption. In cities, farms, and industries, these tools allow users to shift flexible demand to periods of high renewable production.

The future energy system will not be based only on large power plants. It will be distributed, digital, flexible, and interactive.

**14 Environmental, Social and Economic Benefits**  
 Renewable energy creates value for people, the planet and the economy.

**ENVIRONMENTAL BENEFITS**

- Reduces greenhouse gas emissions
- Lowers air pollution and improves health
- Conserves natural resources and ecosystems
- Reduces dependence on fossil fuels

**SOCIAL BENEFITS**

- Supports rural development
- Improves energy access and reliability
- Encourages community participation
- Creates jobs and enhances skills

**ECONOMIC BENEFITS**

- Reduces operating costs over time
- Improves energy security and price stability
- Attracts investment and innovation
- Creates local jobs and strengthens economies

**SUSTAINABILITY REQUIRES FULL LIFE-CYCLE THINKING**

Renewable technologies require materials, land, water, infrastructure, operation, maintenance and end-of-life management. Every stage matters.

- 1. RAW MATERIALS**  
Responsible sourcing of materials
- 2. MANUFACTURING**  
Efficient production and lower emissions
- 3. INSTALLATION**  
Careful use of land and resources
- 4. OPERATION**  
Efficient use, maintenance and performance
- 5. END-OF-LIFE**  
Reuse, repair, recycle and recover

**EXAMPLES OF RESPONSIBLE MANAGEMENT**

- Recycling of solar panels and batteries
- Repowering and recycling of wind blades
- Second life for batteries
- Circular economy and resource efficiency

**ENGINEERS EVALUATE RENEWABLE ENERGY PROJECTS USING:**

- ENVIRONMENTAL IMPACT**  
Assess emissions, biodiversity, water, land use and ecosystems
- LIFE-CYCLE ASSESSMENT**  
Evaluate impacts from cradle to grave
- COST-BENEFIT ANALYSIS**  
Consider costs, benefits and economic viability
- SOCIAL ACCEPTANCE**  
Engage stakeholders and communities
- RESILIENCE AND RISK**  
Ensure adaptability, reliability and climate resilience

**A PROJECT IS SUSTAINABLE ONLY WHEN IT PERFORMS WELL ACROSS TECHNICAL, ENVIRONMENTAL, SOCIAL AND ECONOMIC DIMENSIONS.**

Good engineering integrates technology, people, economy and the planet for a better and sustainable future.

Renewable energy delivers real and lasting benefits when planned, designed and managed sustainably.

Better for the planet. Better for people. Better for economies.

### Slide 14. Environmental, social and economic benefits

Renewable energies can provide multiple benefits. Environmentally, they reduce greenhouse gas emissions, air pollution, and dependence on fossil fuels.

Economically, they can reduce operating costs, improve energy security, and create local employment. Socially, they can support rural development, energy access, and community participation.

However, sustainability requires full life-cycle thinking. Renewable systems also need materials, land, water, infrastructure, maintenance, and end-of-life management. Solar panels, batteries, wind turbine blades, and electronic components must be produced, used, and recycled responsibly.

Therefore, engineers should evaluate renewable energy projects using environmental impact assessment, life-cycle assessment, cost-benefit analysis, social acceptance, and resilience criteria. A project is sustainable only when it performs well across technical, environmental, social, and economic dimensions.

# Final Message: The Role of Young Engineers



Renewable energy is a key part of future green engineering, but its full value comes from integration, innovation and responsible planning.

### 1 INTEGRATED SOLUTIONS FOR A SUSTAINABLE FUTURE

Renewables are not a magic solution by themselves. Their real potential appears when they work together with these complementary strategies.

### 2 IMPACT ACROSS KEY SECTORS

#### URBAN

- Efficient buildings
- Sustainable mobility
- Smarter water infrastructure

#### AGRICULTURE

- Efficient irrigation
- Resilient food production
- Waste valorisation

#### INDUSTRY

- Decarbonisation
- Process optimization
- Cleaner production

### 3 WHAT YOUNG ENGINEERS MUST DO

**Understand systems**  
See the big picture and connections.

**Quantify impacts**  
Use data to measure and evaluate.

**Design efficient technologies**  
Innovate for performance and resource savings.

**Collaborate across disciplines**  
Work together for better solutions.

**Use practical solutions**  
Apply knowledge in real-world contexts.

**Balance development and environmental protection**  
Build today, protect tomorrow.

### 4 FINAL CALL TO ACTION

The energy transition needs new ideas, interdisciplinary collaboration and practical engineering solutions.

Future engineers will help build a cleaner, more efficient and more sustainable world.

**YOUNG ENGINEERS CAN TURN SUSTAINABILITY INTO REAL-WORLD ACTION**

## Slide 15. Final message: the role of young engineers

To conclude, renewable energies are a central component of future green engineering. But they are not a magic solution by themselves. Their real potential appears when they are integrated with efficiency, digital technologies, circular economy, water management, sustainable design, and responsible planning. In urban areas, renewable energy can transform buildings, mobility, and water infrastructure. In agriculture, it can support efficient irrigation, resilient food production, and waste valorisation. In industry, it can contribute to decarbonisation, process optimization, and cleaner production. For young people and students, the challenge is exciting. The energy transition requires new ideas, interdisciplinary collaboration, and practical engineering solutions. Future engineers must be able to understand systems, quantify impacts, design efficient technologies, and make decisions that balance development with environmental protection.

**Use of Renewable Energies in Urban, Agricultural and Industrial Activities to Improve Efficiency and Ensure Sustainability**

• TEGREMED International Workshop •

*“Future Green Engineering: A Civil & Energy Workshop for Young People and Students”*

**URBAN**

- Solar Energy
- Wind Energy
- Energy Efficient Buildings
- Sustainable Mobility

**AGRICULTURAL**

- Solar Irrigation and Pumping
- Biomass & Biogas from Agro-residues
- Efficient Water Use
- Sustainable Food Production

**INDUSTRIAL**

- Renewable Electricity
- Renewable Heat
- Process Efficiency
- Circular Economy & Resource Use

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### Slide 1. Title slide

## Use of Renewable Energies in Urban, Agricultural and Industrial Activities to Improve Efficiency and Ensure Sustainability

Good morning/afternoon everyone. It is a pleasure to participate in the TEGREMED International Workshop, *Future Green Engineering: A Civil & Energy Workshop for Young People and Students*.

Today we will discuss how renewable energies can be integrated into three major activity sectors: cities, agriculture, and industry. These sectors are responsible for a large share of energy consumption, greenhouse gas emissions, water demand, and material use. Therefore, they also offer significant opportunities for improving efficiency and sustainability.

The main message of this presentation is simple: renewable energy is not only about producing clean electricity. It is about redesigning how we plan cities, manage water and food systems, operate industries, and use technology to reduce environmental impacts while maintaining social and economic development.