# ASSESSMENTS OF TECHNOLOGIES DEVELOPED UNDER FUTURE ENERGY SYSTEMS

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## BACKGROUND

It is critical for FES to assess the environmental, economic and social impacts of future energy technologies through considering their entire life cycle. In doing so, the theme aims to answer the following questions related to system characterization:

- Which primary energy sources do we have in a particular jurisdiction?
- How much primary and secondary energy do we use, and where?
- What are the pathways to convert each primary energy to secondary energy?
- What are the costs of producing each form of energy?
- How much energy and other resources are consumed in converting from one to another form of energy?
- What are environmental footprints over the life cycle of an energy form in terms of greenhouse gas emissions (GHG), water consumption, and land footprint?
- What are the socio-economic impacts of these energy pathways?
- What are their impacts over the short, medium and long term?

## SHORT-TERM OBJECTIVES

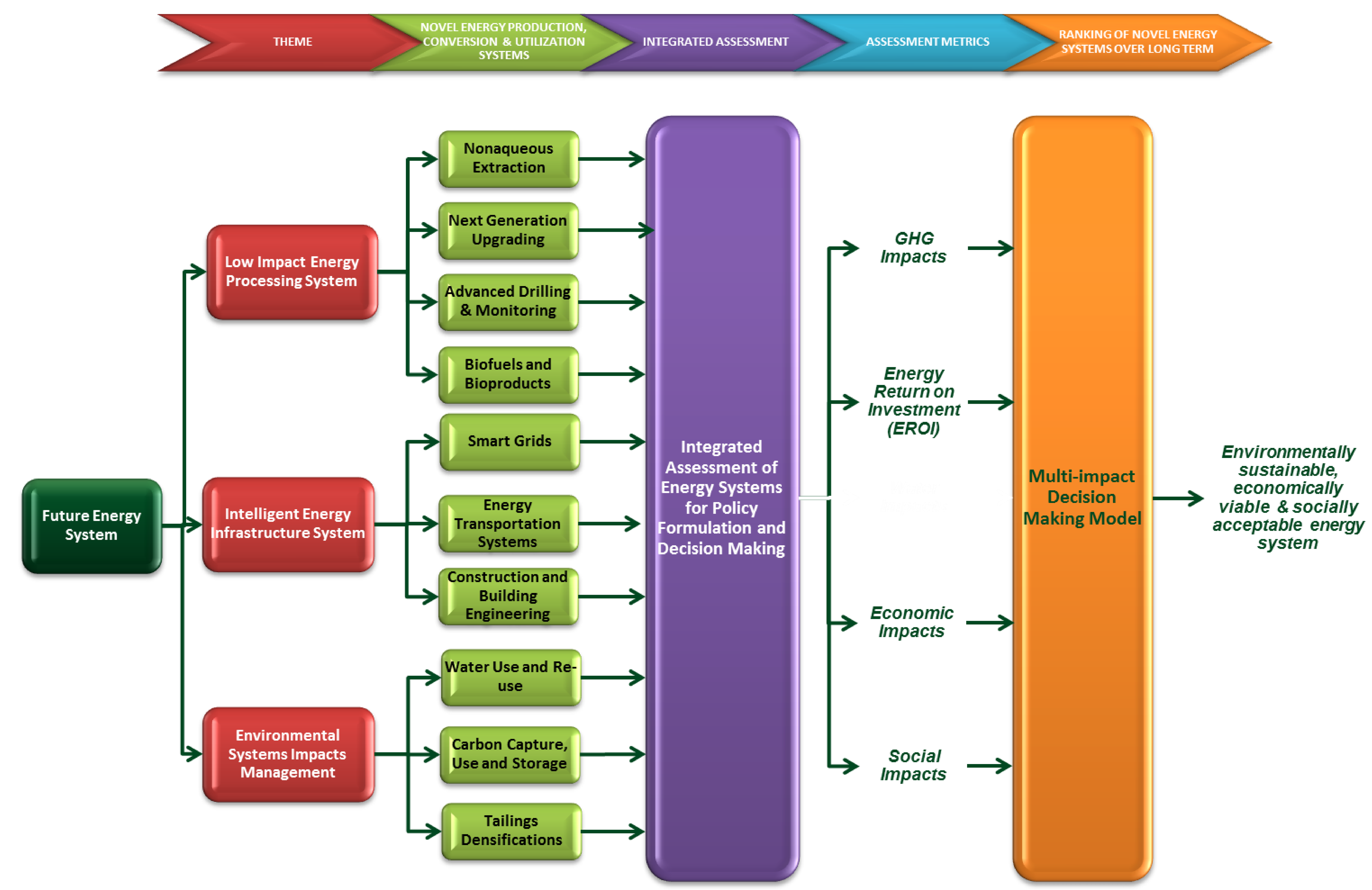
The ultimate objective of the project is to identify the technologies, which have the potential of being economically viable, environmentally sustainable and socially acceptable. The following are the short-term objectives:

- Identify the technologies being developed under FES
- Classify technologies under categories:
  - for direct energy production
  - for materials/products contributing for development of technologies for direct energy production;
  - for reducing the environmental impacts of energy technologies
- Select at least one of the technologies from each category for LCA and TEA
- Conduct LCA and TEA of these selected technologies
- Assess the future potential of the technologies

## PROJECT OVERVIEW

The project aspires to assess the Future Energy Systems (FES) both from renewable and non-renewable sources. It is based on a life cycle thinking that considers the whole life cycle: from the extraction, processing, conversion, transportation and utilization of different energy forms. Life cycle assessment (LCA) and techno-economic assessment (TEA) will be used as methodological approaches to identify and evaluate environmental sustainability, economical viability and social acceptability of technologies developed under FES. Solar, wind, geothermal, biomass, carbon capture utilization & storage, heavy oil, smart grids, non-electric infrastructure and land & water would be the key focus of this project. Fig. 1 below shows the overall approach of the theme.

The LCA would help in measuring GHG emissions and energy return on investment (EROI, while the TEA would help in estimating the cost of energy/products from these technologies.




## THEME OVERVIEW

System-Wide

Understanding energy systems at a system-wide level means recognizing the countless ways that they integrate into our daily lives. From the instant when an energy source is first captured, to the moment you access it by flipping a light switch or starting your engine, it has traveled through a system to reach you. Systems modeling allows us to identify and quantify each step along the way, to simulate the impact of alternative systems, and to predict the potential consequences of change. System-wide analysis and modeling will never provide a guaranteed forecast of the future, but it can identify possible benefits and disadvantages to change, highlight areas requiring additional study, and help us to consider the viability of an entirely new energy future.

## EXPECTED OUTCOMES

**MULTI-IMPACT DECISION MAKING MODEL**

- Considers the full life cycle of future energy systems
- Evaluates their environmental, economic and social performance
- Develops information for decision makers in industry and government in making investment decisions and policy formulation
- Helps decision making based on the economically and environmentally sustainable technologies


## EXTERNAL PARTNERS

This project will be complementary to NSERC/Cenovus/Alberta Innovates Associate Industrial Research Chair Program in Energy and Environmental Systems Engineering (IRC) and Cenovus Energy Endowed Chair in Environmental Engineering (Endowed Chair). These programs have contributed significantly to the system level research on energy processes.

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