September 2018

FUTURE ENERGY SYSTEMS:
Theme Overview

T01 Biomass

We already know how to create fuels from certain types of biomass, but many other feedstocks can potentially be transformed in a similar manner. In order to identify new viable sources, we must develop more a sophisticated understanding of the technological processes that might be used to convert biomass to fuel, and assess the potential business cases for adopting certain sources that might have other economic uses, or compete with established cash crops. We can also explore the potential for tailor-made fuels for the transportation sector, developed from biological sources.

T02 Carbon CUS

Hydrocarbons will continue to serve as an essential energy source while the world transitions to a lower-carbon energy economy, but can we prevent the use of those fuels from contributing to the accumulation of CO2 in the atmosphere?

Existing technologies can capture carbon, but these methods can be costly and energy-intensive. Extracting energy without burning fuels, improving CO2 capture efficiencies if they are burned, and finding effective ways to store or reuse captured carbon may be essential to ensuring it does not enter the atmosphere.

T03 Communities and Aboriginal

New technologies enable us to exploit renewable energy resources, but truly harnessing their energy requires the ability to control and adapt to the complex interaction between multiple sources and users.

Smart grid technology will enable systems that can adapt to the variation in supply that is common from renewable sources, while new storage technologies will make it possible to retain energy generated at during peak times to be withheld for later use.

Developing hybrid grids that can accommodate both AC and DC power, accommodating distributed generation, and effectively interfacing with legacy grid systems will be essential to our energy future.

T04 Energy Humanities

Throughout history, human society has been profoundly changed by the integration of new energy systems. From the adoption of fire as a means of gaining warmth to industrialization reshaping settlement patterns and changing social norms, energy's impact has been far-reaching, and has required us to reimagine the ways we interact with each other and our environment.

Employing a full spectrum of disciplines from the arts and humanities, we can try to better envision what the next iteration of this evolution will look like, and to communicate about the challenges and opportunities that lie ahead.

T05 Geothermal

Canada's geoscape possesses more potential geothermal energy than hydrocarbon energy, but numerous challenges must be overcome if this renewable resource is to be effectively harnessed. Reservoirs of geothermal energy must be located, characterized, and modeled.

The nature of the interaction between rock at reservoir sites and geothermal fluids must be understood, and the potential costs of exploiting them in real-world scenarios must be understood. At the same, new engine technologies must be developed to enable generation of power from geothermal heat sources with non-ideal temperatures.

T06 Grids and Storage

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T07 Heavy Oil - In-Situ

According to the 2015-2016 factbook published by Natural Resources Canada, Canada is ranked third and fifth in crude oil reserves and production in the world. Also, fossil (oil, gas, coal) energy production comprises 85% of total energy production in Canada today and nearly half of it is crude oil (42%).

Extensive experience has been accumulated in this area at UAlberta. Problems have been well identified and solutions have been proposed through intensive research and service projects over decades with close relationship to industry. This also attracted companies from outside of Canada seeking solutions to their problems on in-situ recovery of heavy-oil. Being familiar with the problems in the area, and future needs, UAlberta can provide long-term solutions.

T08 Heavy Oil - Non-Aqueous Recovery

Excessive freshwater use and its eventual capture in tailings ponds represent some of the most concerning elements of the oil sands industry. The requirement for water to be heated as part of

the process is also a serious concern, as it demands the use of considerable energy as part of the extraction process.

Developing a Non-Aqueous Extraction (NAE) method for recovering oil from the oilsands without the use of water could significantly reduce the environmental and carbon footprint of extracting these resources, and the fundamental science developed to support this process could enable significantly improved cleanup of oilsands sites.

T10 Land / Water

As the world moves towards a low-carbon energy future, the legacies of past energy technologies remain a serious concern. Reclamation and restoration of land and water after previous generations of exploitation will be important for our future, and many issues must be addressed. Standards for restoration — set across decades and based on varying levels of understanding — must be assessed, while the technologies and methods for land and water reclamation are investigated and refined.

True reclamation might take generations, so it is essential to begin broadening and enhancing our knowledge now. We must also begin to foresee potential issues related to new, sustainable energy technologies, so that future generations are not left with the consequences of questions left unasked.

T11 Non-Electric Infrastructure

Whether for hydrocarbons or new fuels derived from renewable resources, effective methods for storing, handling and transport are essential to the harnessing of energy sources. Infrastructure for movement and storage of these resources must be developed with an understanding of its social, economic, and environmental impacts — including potential unintended consequences, such as the creation of locked-in emissions, or the stranding of assets.

A base of knowledge related to these questions must be developed, and distributed to planners, users, and decision-makers whose choices can shape our energy future for generations to come.

T12 Solar

The sun powers the entire world, providing warmth, light, and sustenance for countless forms of life. Technologies have made it possible to use some of the sun's energy to produce electricity and fuels, but new refinements may allow us to diversify the ways in which solar energy can be generated, stored, and utilized.

By identifying lower-cost materials for use in the construction of solar cells, finding new catalysts to enable different types of production, identifying more efficient methods for market integration, and considering the possibility of solar-derived hydrogen fuels, it may be possible to develop vast energy resources from the most abundant source in our lives.

T13 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.

T14 Wind

Wind has powered human societies for centuries, milling grain, pumping water, and driving ships around the globe. In recent years, maturing technologies have enabled the same resource to generate electricity, and contribute significantly to the energy needs of numerous countries. However, the challenges of harnessing wind remain: it is an ever-changing force, and its cycles often do not align with our demands.

Effectively integrating wind into our grids and markets requires both technologies and an economic system that can accommodate these variations in supply. Understanding the special challenges of harnessing wind power in the Canadian north will be a specific priority.