## **NURENEW**

## Hybrid Nuclear(LSCR)-Renewable(CSP) Energy Park

#### **Bojan Petrovic**

http://petrovic.gatech.edu

Nuclear and Radiological Engineering Georgia Institute of Technology, Atlanta, GA, USA



HES-2012 Salt Lake City, UT April 3-4, 2012

## Vision / Objective



Issue:

- >\$1T stranded in coal infrastructure
- Large coal resources
- Cannot just stop using (economically NOT acceptable)
- Cannot continue using (environmentally NOT acceptable)

#### **VISION / OBJECTIVE**

Transition to sustainable energy production by facilitating economical deployment of a non-fossil energy source, synergistic nuclear-solar power system ("NuRenew") and phasing out of coal-fired power plants, while enabling continued (but cleaner) use of large US coal resources and coal-related infrastructure for transportation





Combines several promising technologies

- Molten salt cooled nuclear power plant (LSCR)
- Molten salt based concentrated solar power plant (CSP)
- Molten salt based thermal energy storage (TES)
- → Molten salt technology synergy direct integration hybrid energy system
- → NuRenew energy park (Georgia Tech, NREL)
- Electricity, transportation fuel, high-temperature (HT) process heat
- TES simultaneous multiple use reduces cost, improves reliability Firewalls nuclear safety-wise Isolates users from perturbations
  NuRenew Energy Park Multiple, Modular, Redundantly Connected CSP-TES-LSCR-HTS

Objective: Hybrid – Synergy – 2+2=5 (Cost: 2+2=3)





#### **NuRenew**

Georgia

Tech



- Expands nuclear generation into transportation (CTL, H) and HT processes
- CTL, fossil plants sites repurposing continues using coal resources/infrastructure
- Promotes accelerated CSP deployment (reduces effective TES cost)
- Dual layer energy storage: (TES) + (H, HT processes) optimizes supply-demand balancing and stability

Industrial processes integrated in NuRenew Energy Park:

(High) capital cost? Technology (Al,..)? need low capital cost & flexible in the mix

• Potential use of thorium fuel to address nuclear resources/waste



## High temperature technology(ies)

MSNS NFC Georgia Tech Nuticity NEC Secorgia NEC Secorg

- Material issues, potentially significant-to-showstopper?
- What fraction of energy needs we can cover with realistic/limited temperatures?
- Based on temperatures needed and current use differential and cumulative fraction may be determined
- ~600 C covers ~70%
- Limited temperature enhancement economically feasible







### Summary



- Concentrated Solar Power (CSP) promising technology, but requires massive/expensive energy storage to meet energy demand during evening/night hours, and periods of reduced solar radiation.
- Molten salt harbors huge potential for thermal energy storage (TES) for CSP as well as for liquid salt (molten salt) cooled nuclear power plants (LSCR). It is suitable for operation at high temperatures thereby achieving higher efficiency and reduced water use compared to current power plants.
- Such storage has been so far considered for solar and nuclear separately, but the cost is then a significant issue, in particular for solar power.
- Using it in synergy for a directly coupled nuclear-solar system (NuRenew), as proposed here, will significantly reduce the TES cost (enabling earlier deployment of CSP) and increase the energy supply reliability, creating a consistent, low-CO2-emitting, energy supply.
- High-temperature high efficiency, reduced reject heat (and water use)
- On the nuclear power side, one option is to use thorium, which is about four times more abundant than uranium, and generates wastes of significantly more benign characteristics than the currently used nuclear fuel cycle.
- Technical characteristics of NuRenew facilitate using it for high-temperature processes, and in particular for coal liquefaction (coal-to-liquid or CTL), and synfuel in general, enabling its expansion and positive environmental impact into transportation.
- It will also permit economically-acceptable accelerated phasing out of fossil-fired power plants, while enabling continued (but cleaner) use of large US coal resources and infrastructure.
- NuRenew may be considered as a platform to examine possible energy policies in promoting this innovative energy supply technology to cut down carbon emissions and mitigate climate change.



# Thank you for your attention! Questions?

