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## **Integrated Solar & Nuclear Cogeneration of Electricity & Water using the sCO<sub>2</sub> Cycle**

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**Program:** NE-2 Integrated Energy Systems Design and Modeling

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### **ABSTRACT:**

We will design and model a nuclear + renewable Integrated Energy System (IES) for co-generation of cost competitive electricity and clean water. We will also develop modeling tools that will allow IES to be simulated, hence providing a crucial toolset for present and future studies of this type. A conceptual design of IES is proposed, comprising the following components.

- **Concentrated Solar Power (CSP)** – compatible with thermal energy storage for dispatchability.
- **The supercritical CO<sub>2</sub> (sCO<sub>2</sub>) cycle** – utilizes temperatures compatible with cogeneration of electricity and clean water as the outlet temperature is compatible with desalination
- **Multi effect distillation (MED)** – for desalination as cogeneration application while providing heat rejection from the sCO<sub>2</sub> cycle without being a parasitic load on the power station.
- **Lead-cooled Fast Reactor (LFR)** – leading US advanced reactor technology which uses sCO<sub>2</sub> cycle so can be combined with the rest of the system efficiently.

The proposed IES has improved dispatchability compared to CSP and nuclear in isolation. The molten salt thermal energy storage system connected to the CSP provides the capability to meet short term changes in demand and frequency control, while the LFR is suitable for longer term load follow. Synergies between the technologies may also allow for reduction in component requirements. A reference configuration for the IES will be defined, considering technical and lifecycle aspects (Cyber Informed Engineering [CIE], regulatory environment) and likely system cost. RAVEN/Modelica will be interfaced to the freely available and open-source System Adviser Model, developed at NREL. This capability will then be applied to the analysis of the proposed concept.

The project consists of the following tasks:

1. Develop the overall system concept, following a CIE Approach
2. System modeling including integration of RAVEN/Modelica with NREL models
3. System analysis including optimized operational dispatch, CIE
4. Market and market competitiveness analysis
5. Sensitivity analysis. The analyses will be guided by the output of Task 4.
6. Conclusions and reporting

This deliverables and outcomes of this project are:

1. Report on the feasibility and viability of the proposed IES. This supports wider deployment markets due to improved dispatchability and cogeneration capabilities.
2. An analysis framework and computational models, compatible with the existing RAVEN/Modelica ecosystem, which can be used for future studies.