U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

SOLAR ENERGY TECHNOLOGIES OFFICE

Unlocking Solar Thermochemical Potential:

Receivers, Reactors, and Heat Exchangers

R&D Virtual Workshop Series

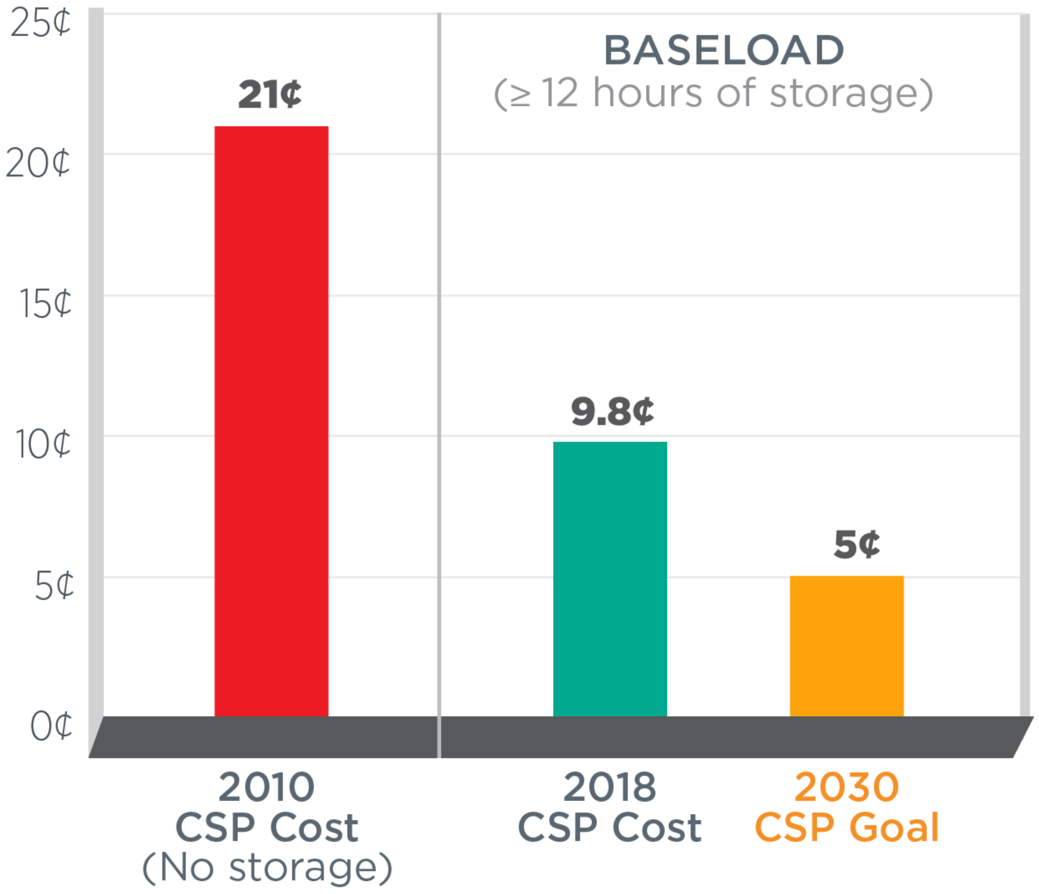
Concentrating Solar Power Program

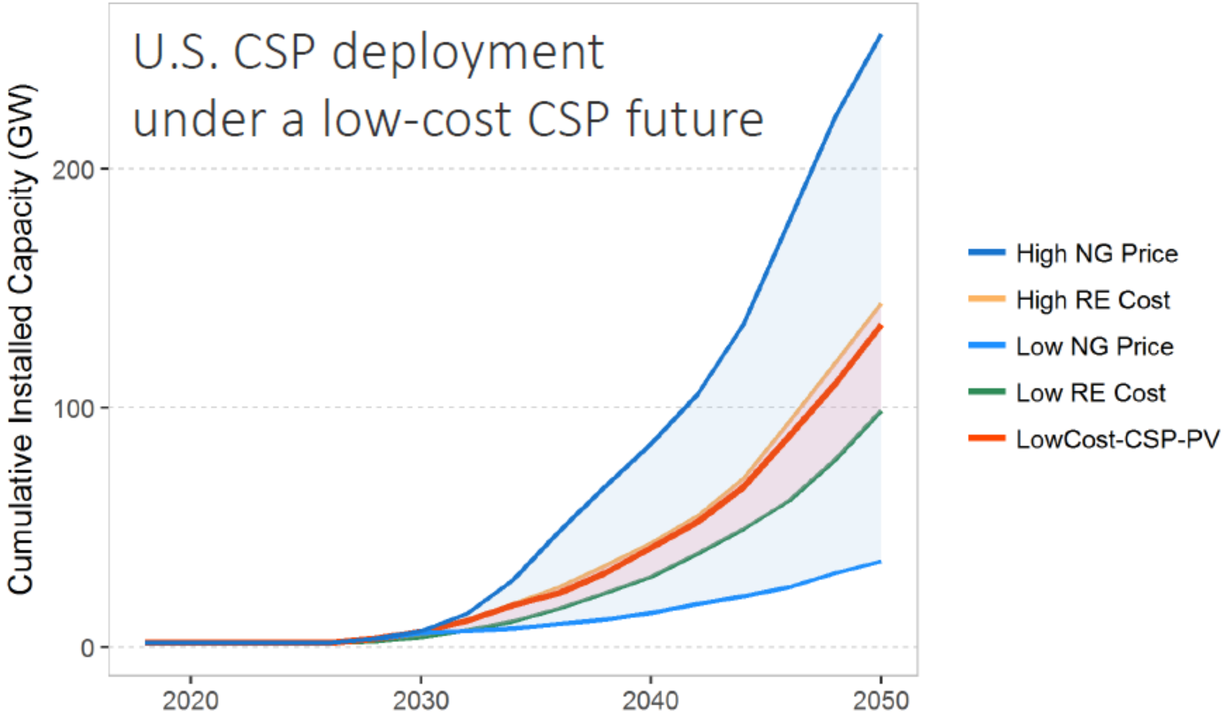
Avi Shultz, CSP Program Manager, US DOE

Levi Irwin, CSP Technology Manager, Contractor to US DOE

Levi.Irwin@ee.doe.gov

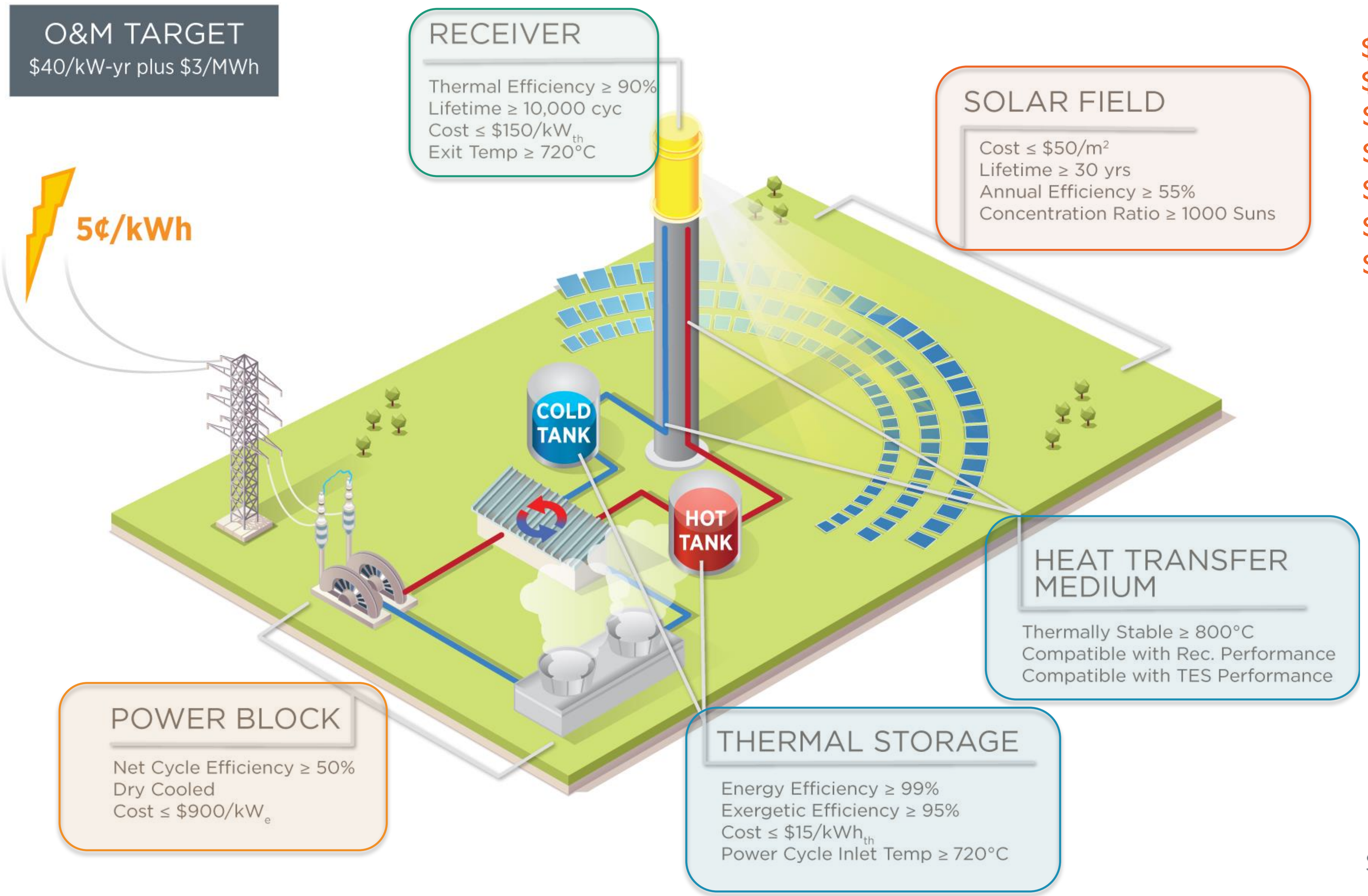
Progress and Goals: 2030 LCOE Goals





Murphy, et al. **2019**, NREL/TP-6A20-71912

CSP Technical Targets

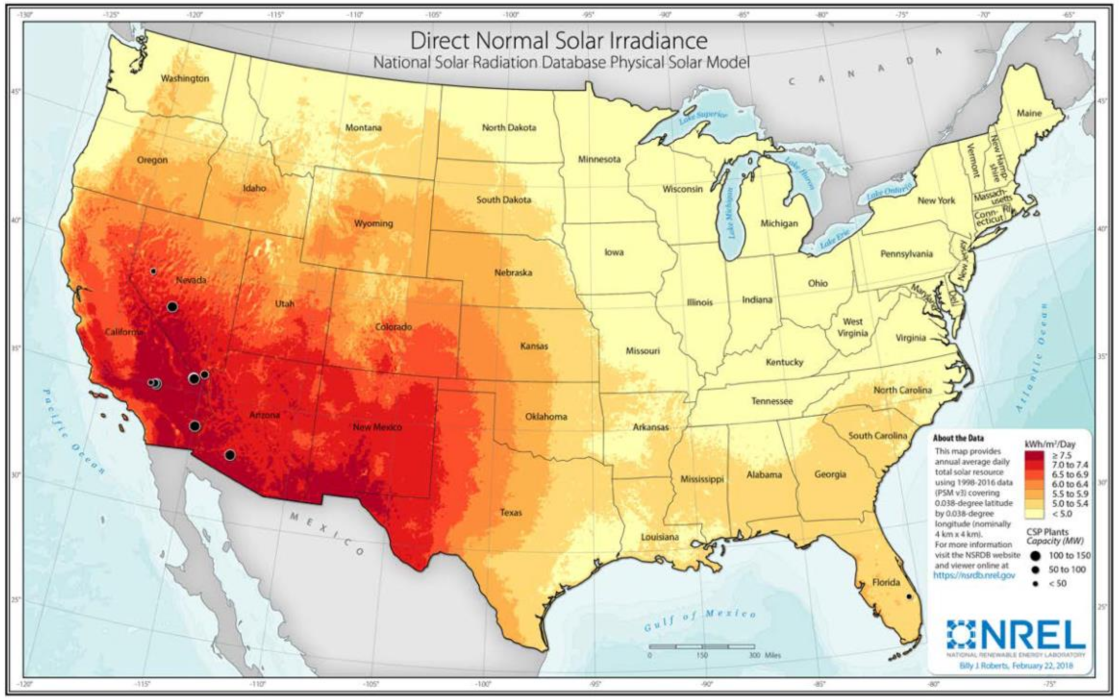


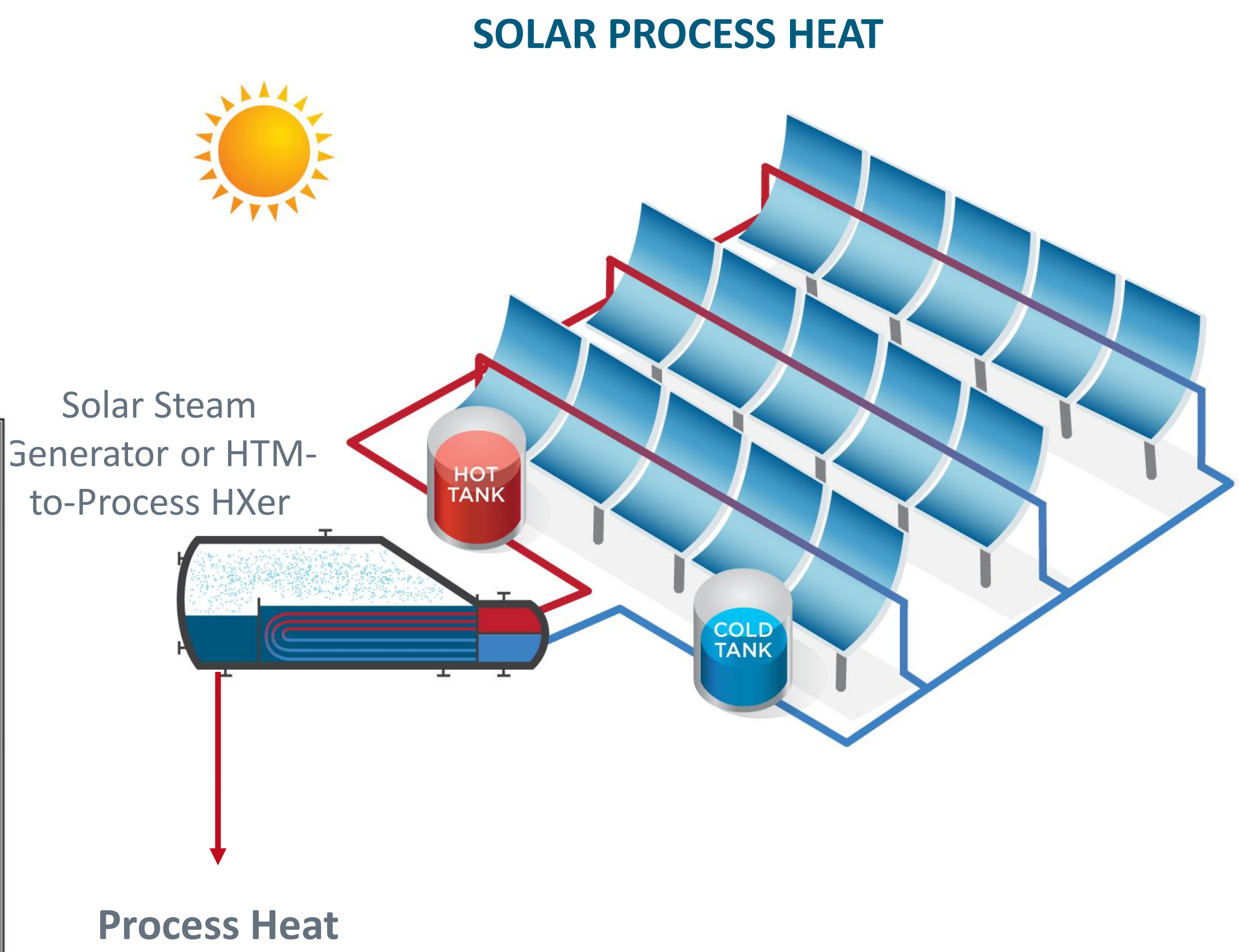
Competitive Programs

- $43M FY 2020 SETO FOA (2020)
- $30M FY 2019 SETO FOA (2019)
- $22M FY 2018 SETO FOA (2019)
- $21M Solar Desalination (2018)
- $22M FY19-21 National Lab Call (2018)
- $70M Gen3 CSP Systems (2018)
- $15M Gen3 CSP Lab Support (2018)
- $9M COLLECTS (2016)
- $32M CSP: APOLLO (2015)
- $29M CSP SuNLaMP (2015)
- $1.4M SolarMat II (2014)
- $10M CSP: ELEMENTS (2014)
- $1.1M SunShot Incubator (Recurring)
- $4M PREDICTS (2013)
- $2M SolarMat (2013)
- $10M CSP-HIBRED (2013)
- $27M National Lab R&D (2012)
- $10M SunShot MURI (2012)
- $56M CSP SunShot R&D (2012)
- $0.5M BRIDGE (2012)
- $62M CSP Baseload (2010)

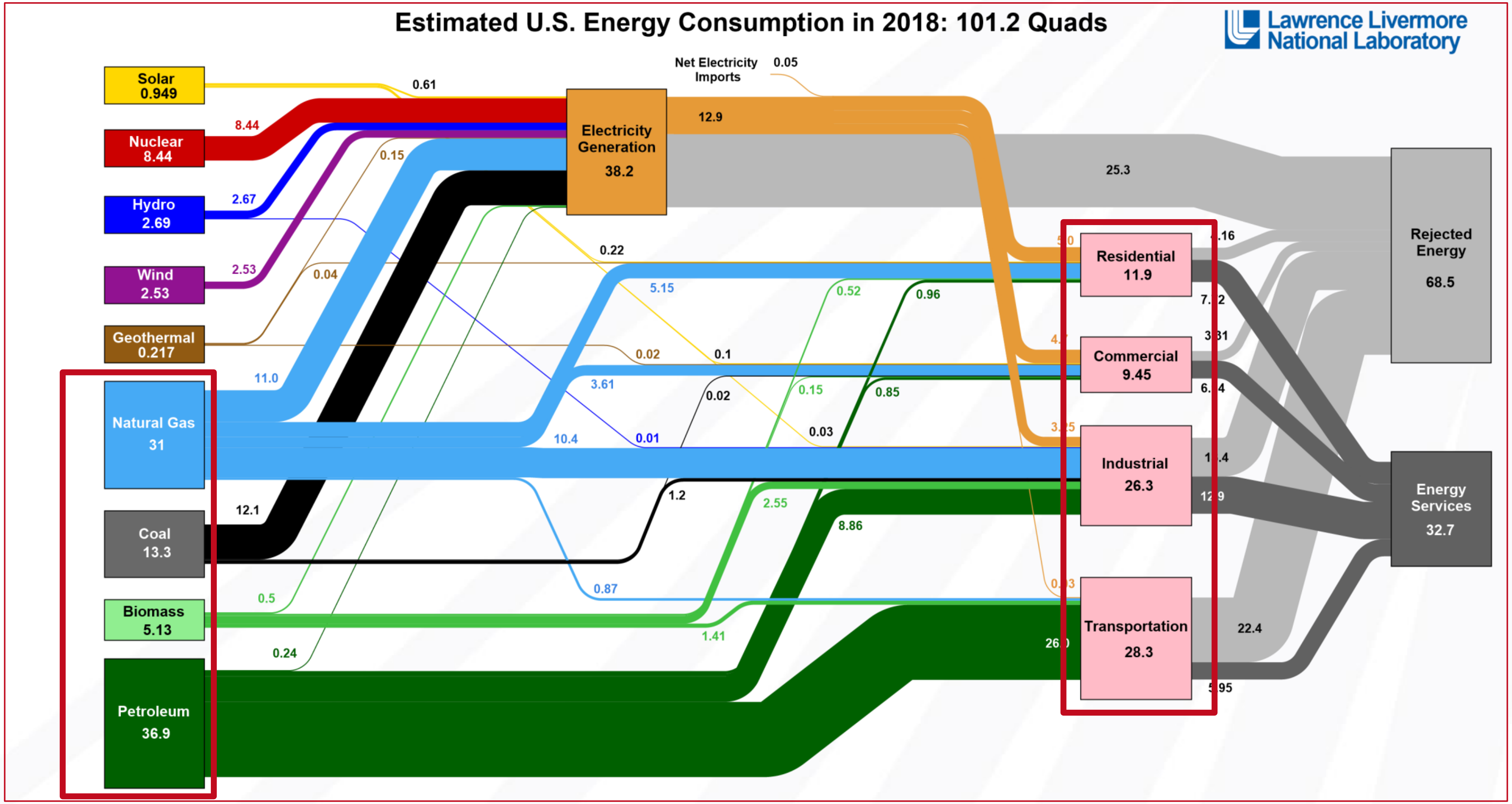
Solar Thermal Industrial Process Heat

Thermally-Driven Industrial Processes:
- Desalination
- Enhanced Oil Recovery
- Agriculture and Food Processing
- Fuel and Chemicals Production
- Mining and Metals Processing





Solar Thermal can Integrate with the Existing Energy System



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UPCOMING WEBINARS:

- CSP Performance and Reliability Innovations
  December 10 | 11:00 a.m. to 2:00 p.m. ET

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energy.gov/solar-office

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Agenda

Time	Session
11:00AM–11:30AM	**Introduction and Workshop Overview** Avi Shultz, *DOE Program Manager, Concentrating Solar Power* **Levi Irwin**, *Technology Manager, Concentrating Solar Power*
11:30AM–12:45PM	**Panel – Receivers, Reactors, and Heat Exchangers** Tony McDaniel, *Sandia National Laboratory* Peter Loutzenhiser, *Georgia Institute of Technology* Jonathan Scheffe, *University of Florida* Bob Wegeng, *STARS Technology Corporation* Rigaiy Zidan, *Savannah River National Laboratory*
12:45PM–1:45PM	**Panel Discussion, Question and Answer**
1:45 PM	**Closing Remarks** Avi Shultz, *Department of Energy*

Solar Thermochemical Systems – What Are They?

- Being a Concentrating Solar Thermal Facility and a Chemical Processing Facility
  - May or may not also produce power (electricity)
- The chemical may be stored and re-used on site or shipped off-site as a finished product
  - Includes the preparation of fuels, commodity chemicals
- Green field or brown field?
  - New infrastructure; new process
  - Append to existing infrastructure; (slight) mod to process

Thinking through Risk within Tiers of Technology Maturity

Integrated Pilot Scale Demonstration

Pilot Demo

- 10 MW +
- System level Risk Retirement

Pilot Scale Prototype Operation

- 1-10 MW
- Prove well understood models at commercial relevant scale

Design Refinement, Respond to identified Challenges

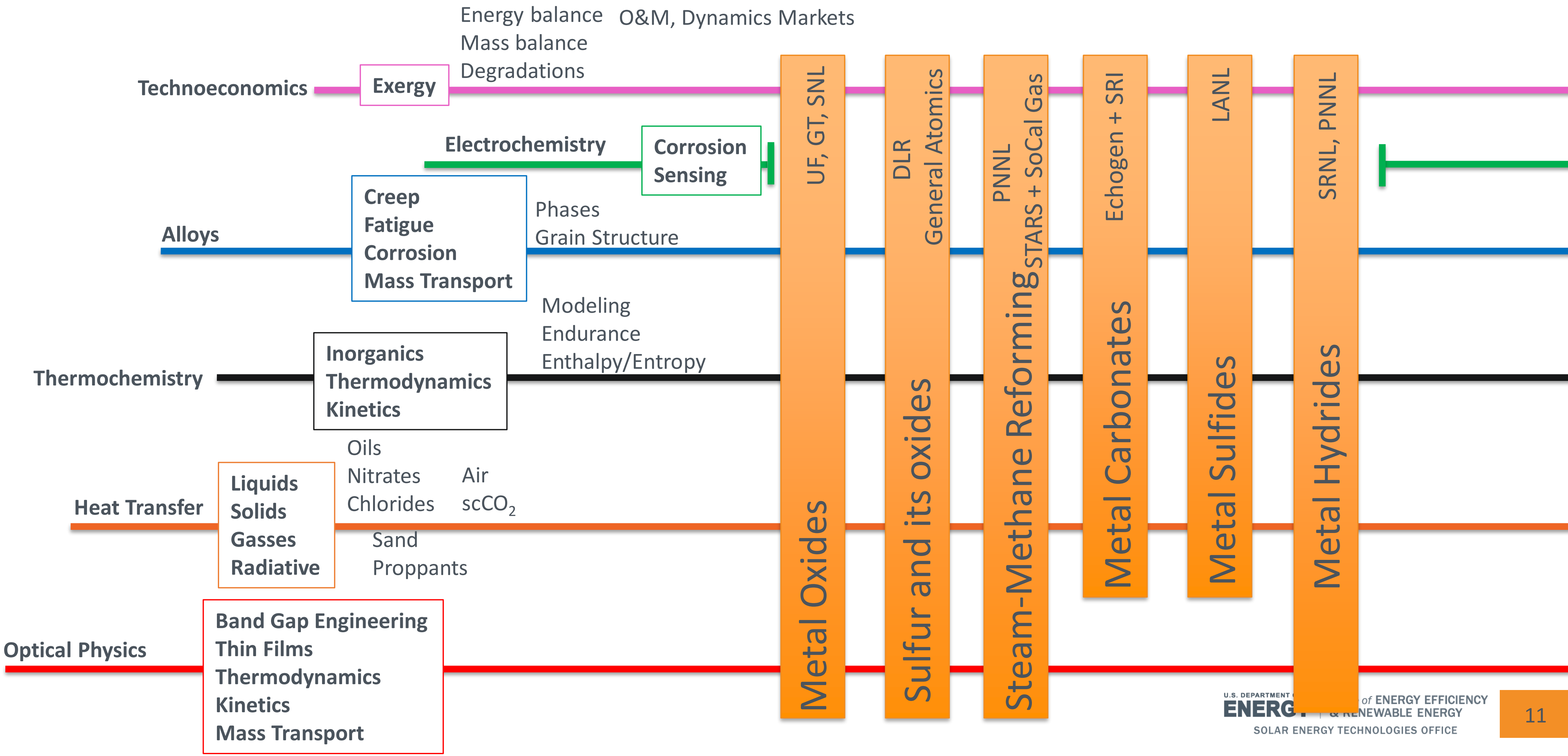
- 100-1,000 kW
- Validation and Isolated Risk Retirement

Innovation Discovery, Viability Realization

- 10-100 kW
- Conclusion Driven Research

A Little Bit of History

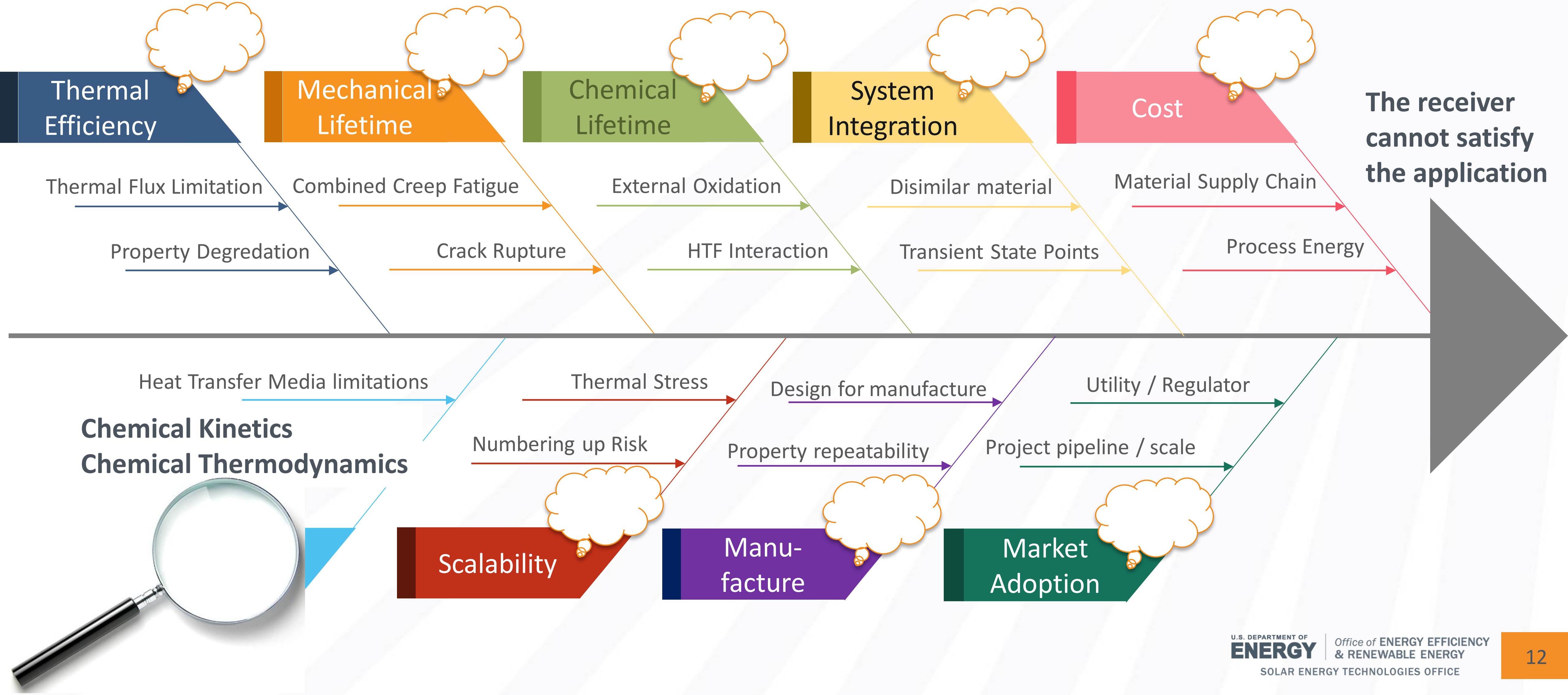
Innovation Discovery, Viability Realization



Thermochemical Concerns Compound with Innovative Receivers

Ishikawa diagram approach

Be thinking about how thermochemical nests into all these…



Workshop Goals

For the Panel and the Audience:

How comes a *chemical reaction* to be a part of a solar thermal system?

- Highlight the pure, applied science; the thermodynamics; the kinetics; the *product* of these two
- How the needs of a chemical reaction must be satisfied to access the full, useful 'band' of these two (thermodynamics and kinetics)
- Lab-scale research to on-sun demonstration
  - Emphasize what it means for the chemical reaction to extract heat from sun
  - Balancing constraints of the solar component and the remainder of the system
- What are the key risks that *Chemists* often overlook early in the development
  - How should testing campaigns be designed to manage those risks?
  - What are overlooked chemistry-based technical metrics/objectives?

How should research outcomes be packaged to draw attention from industry and private sponsors?

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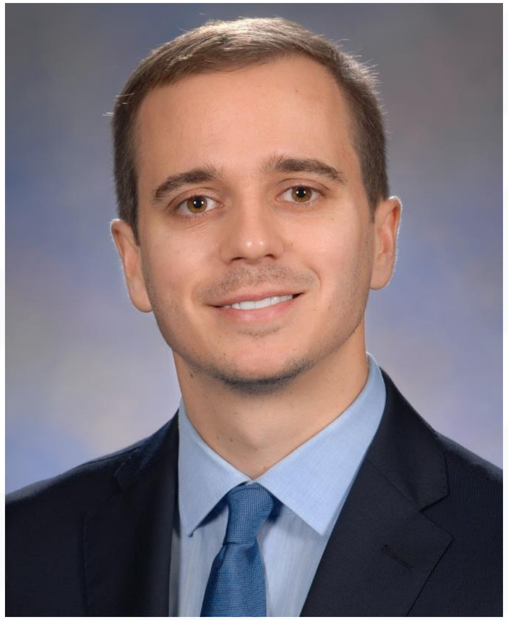
Receivers, Reactors, and Heat Exchangers

~Our Panelists~

Tony McDaniel
Sandia National Laboratory

Peter Loutzenhiser
Georgia Institute of Technology



Jonathan Scheffe
University of Florida

Robert (Bob) Wegeng
STARS Technology Corp.

Ragaiy Zidan
Savannah River National Laboratory

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