"Integrating Sustainable Technology to Solve Tomorrow's Energy Needs Today"

Wayne Bliesner- Founder and CEO

ADI Solar Power Corporation
ADI Strategic Metals Corporation

Meet the Founder & Lead Scientist

Wayne Bliesner
ADI founder and CEO

- 20+ years with Boeing in Aerodynamics Engineering Research
- Head of $100 Million NASA Research Program
- 7 In-Use Patents for Airplane Systems
- Inventor of Wing Configuration valued over $50 million for Boeing

ADI Solar Power Corporation

- Solar Energy Storage
- Solar Fuels
- Stirling engines
- High efficiency LED lighting systems

- BSCE & MSCE- Aeronautical Engineering
  University of Washington
- Patents for Chemical Reactor Storage System and High-Efficiency Dual Shell Stirling Engine
- Expert in Complex System Design and Chemical Reactions

ADI Advisory Team

Dr. Robert Bowman
Jet Propulsion Laboratory
Hydride Expert & Consultant

Dr. Robert Reed
Los Alamos National Laboratory
Heat Transfer Consultant
Heat Pipe Designer

Dr. Allan Organ
Cambridge University
Stirling Engines
world expert

Dr. Jianliang Lin
SwRI
High Power Impulse Magnetron
Sputtering US Expert

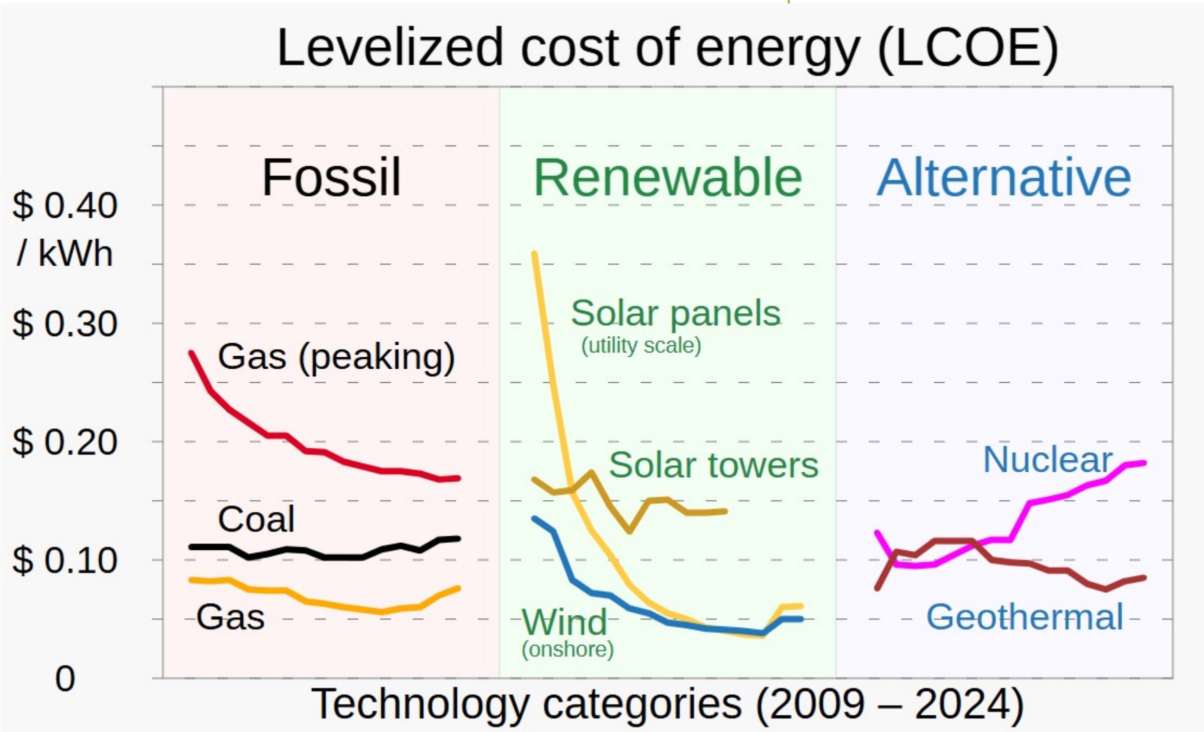
Dr. Jacob Bertrand
CEO Maxima Sciences
Atomic Layer Deposition
Research Scientist

Mike McDowell
GTI Energy
Supercritical CO_2 Power System
Nuclear and CSP experience

Dr. Matthew Muller
NREL
Heliostat Coating and Structure
Research Scientist

Glenn Reynolds
CEO Gossamer Space Frames
Research Scientist

Increasing Cost Benefits of Renewable Energy

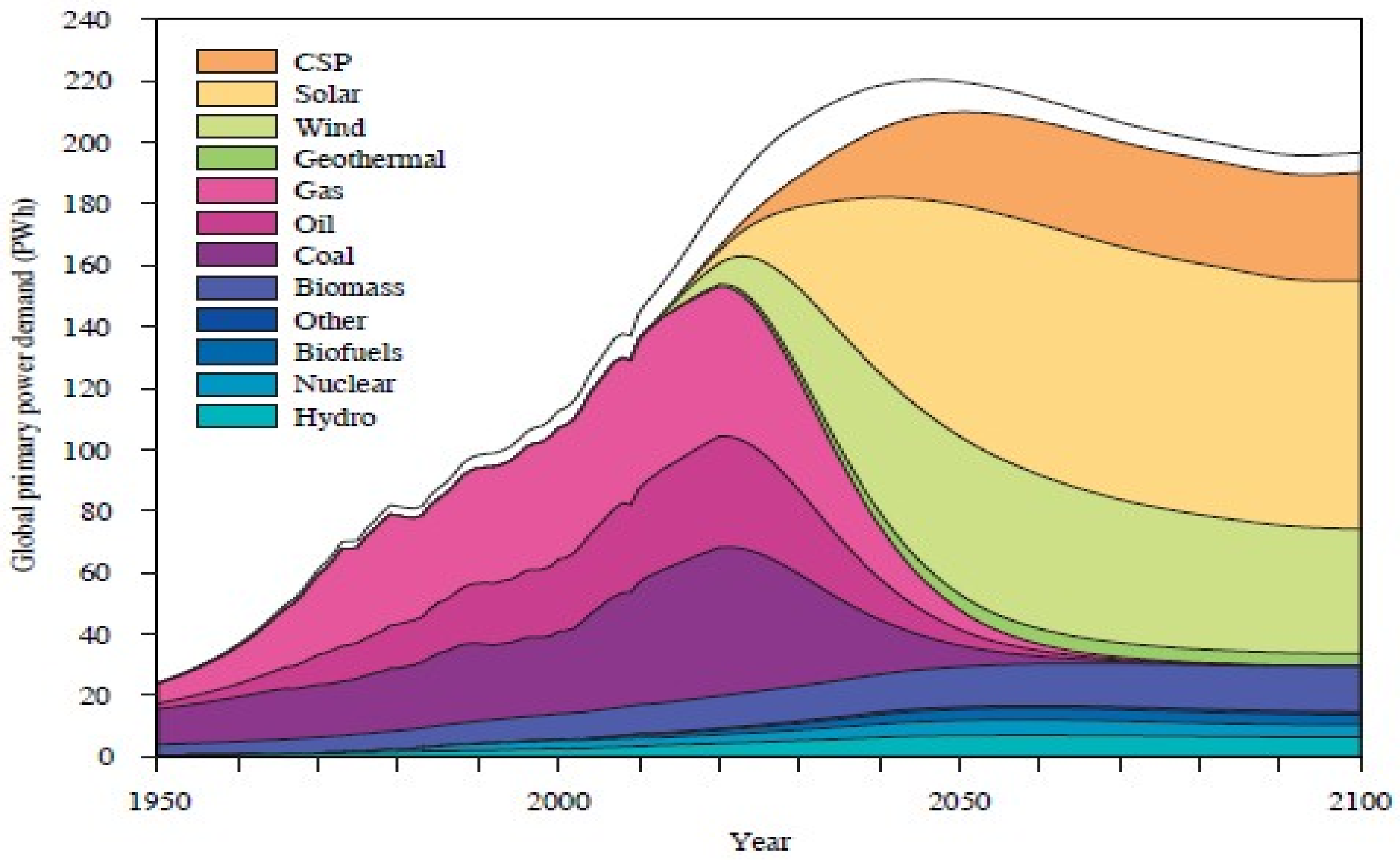


Reference 2024: [Lazard LCOE Levelized Cost Of Energy]

Practical Issues Maintaining Baseload Power with Solar

- Depending on location in the world direct solar is available 70 to 90% which requires a fuel to maintain baseload power
- Integration of the supercritical CO_2 turbine allows fuel versatility for input heat source
- With the ADI LCOE of $0.025/kWh for solar: integration of natural gas provides a viable solution
- DME fuel can be generated and stored on site using HTE of steam and CO_2

Solving Issues of Energy Growth & Storage

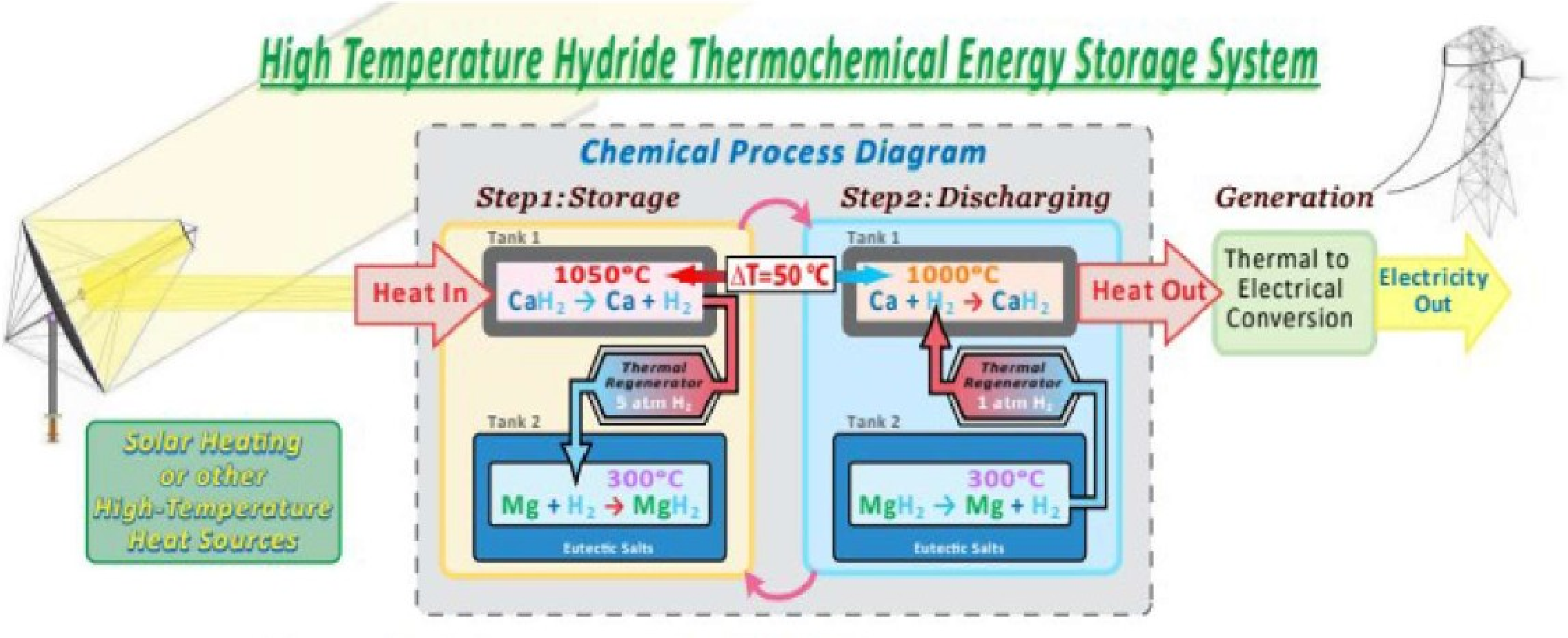


Sgouris Sgouridis, Denes Csala and Ugo Bardi: Masdar UAE

- There is no mention of the requirement of long duration / large capacity storage with high renewable fraction

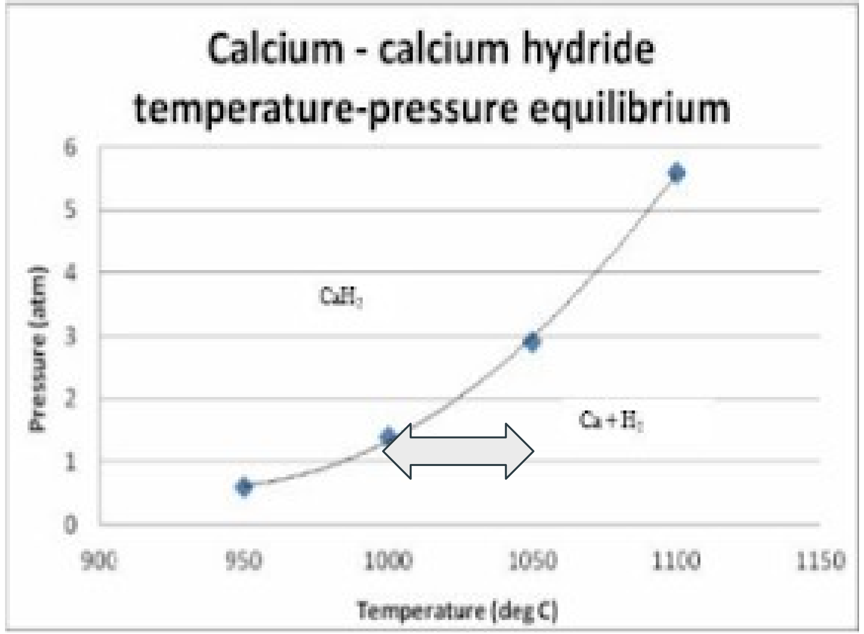
- There is no growth of nuclear and no mention of fusion
- The high up ramp of renewables that starts now, has no precedent
- The quick phase out of fossil, specialty gas, has no economic basis. Gas will remain the low-cost option for years

HYTES Energy Storage Process



Levelized Cost of Energy: $0.025/KWhre
No Moving Parts: H_2 moves due to Thermal Input-Output

ADI Solar Sub-scale Reactor

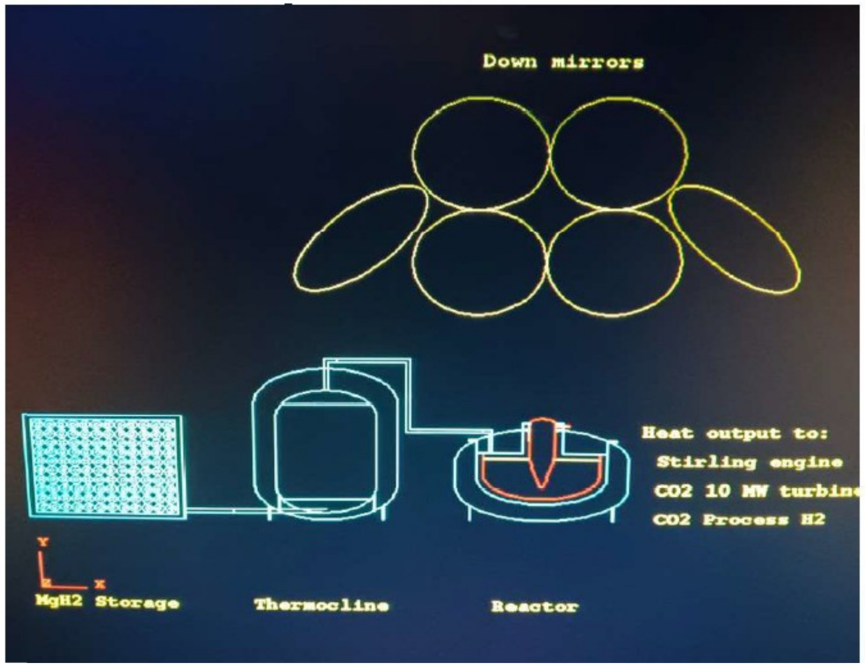


$0.87Ca + H_2 + 0.02Ca_8Al_3 \leftrightarrow CaH_2 + 0.03CaAl_2$

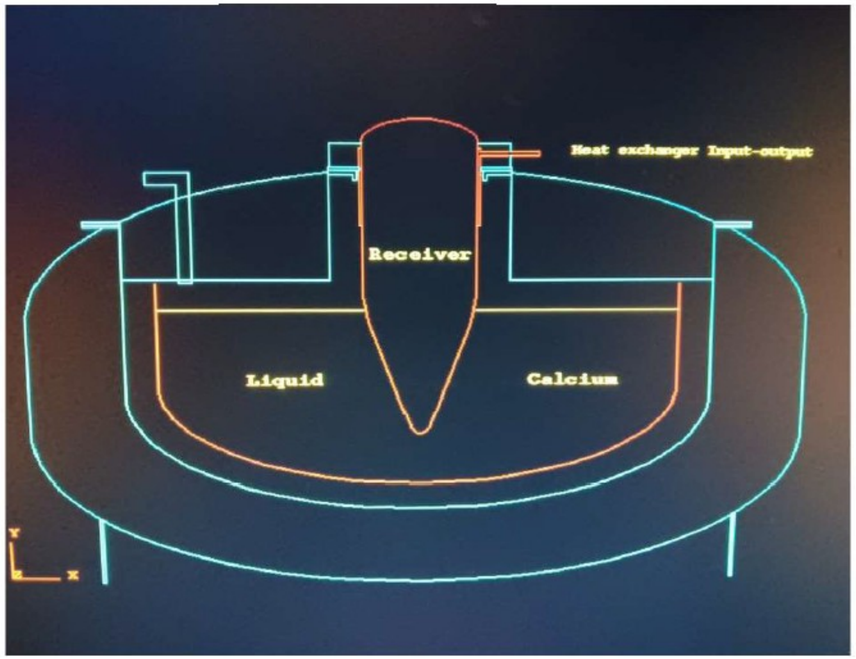
Ca-Al alloy liquid to 545 C

Storage System Hardware & Solar Focusing

CaH_2: 20X energy density of molten salt storage



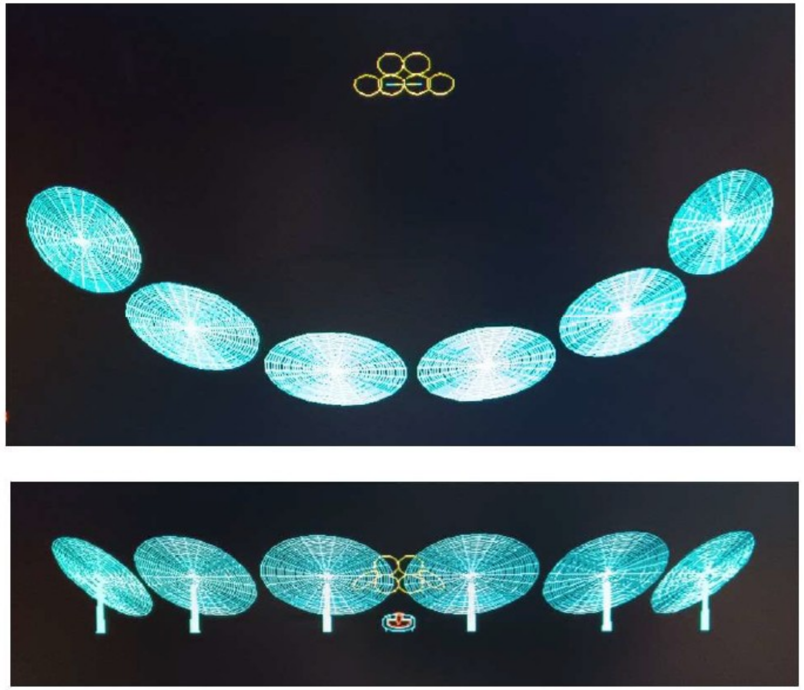
100 kW Dual Hydride System



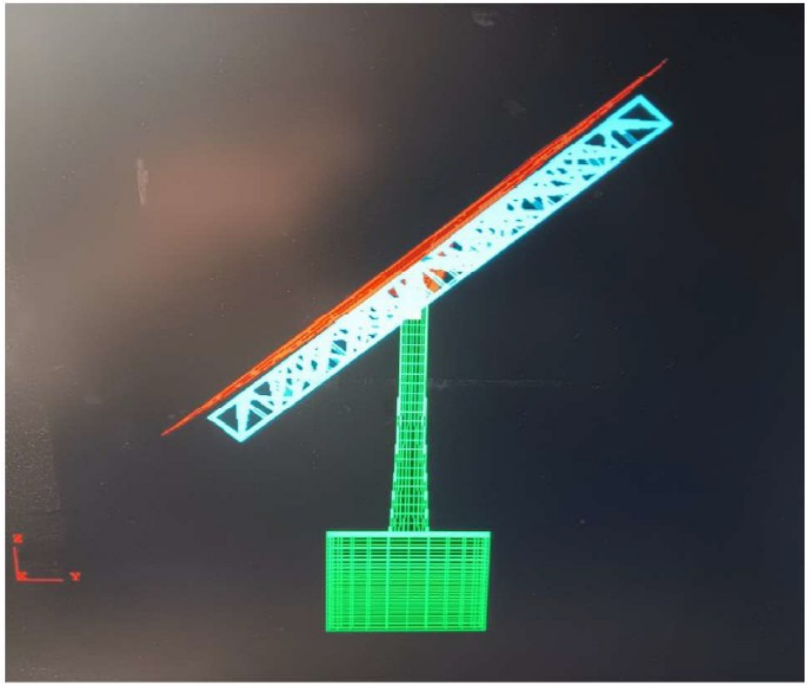
Receiver/Reactor Detail: 100 kW

ADI 25 kW Dual Shell Stirling Engine

100 KW Heliostat Array and Reactor



Top and Back View of Six Heliostats, Six Down-Mirrors, and 100 kW Reactor

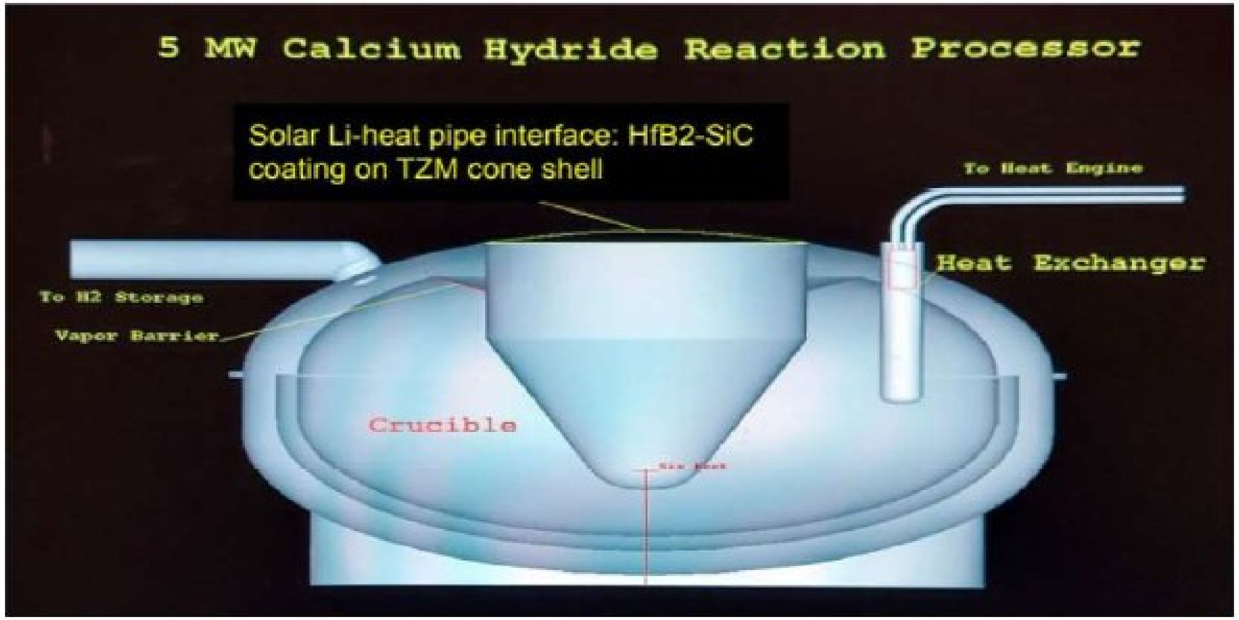


Fifty Foot Heliostat

Tank (below ground)

Calcium Hydride Reactor for 10 MW System

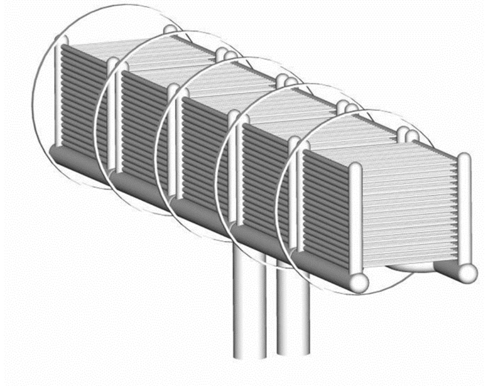
Liquid Sodium metaborate at air TZM interface mp: 1000 C
TZM temperature top: Day 5000 suns 1300 C, Night 1000 C covered



Nano Coatings on Haynes 230 Crucible:
Diffusion layer: Metal nitride 100 nm
Full Heusler Coating: Tantalum refractory mix 1000 nm
Air resistant coating: Metal Boride 100 nm
(H_2 diffusion coating on TZM lower surface: Metal nitride 1000 nm)

DOE: Materials Processing Code

- Interface Module
- Enthalpy Diagrams
- Alloy Structure and Stability

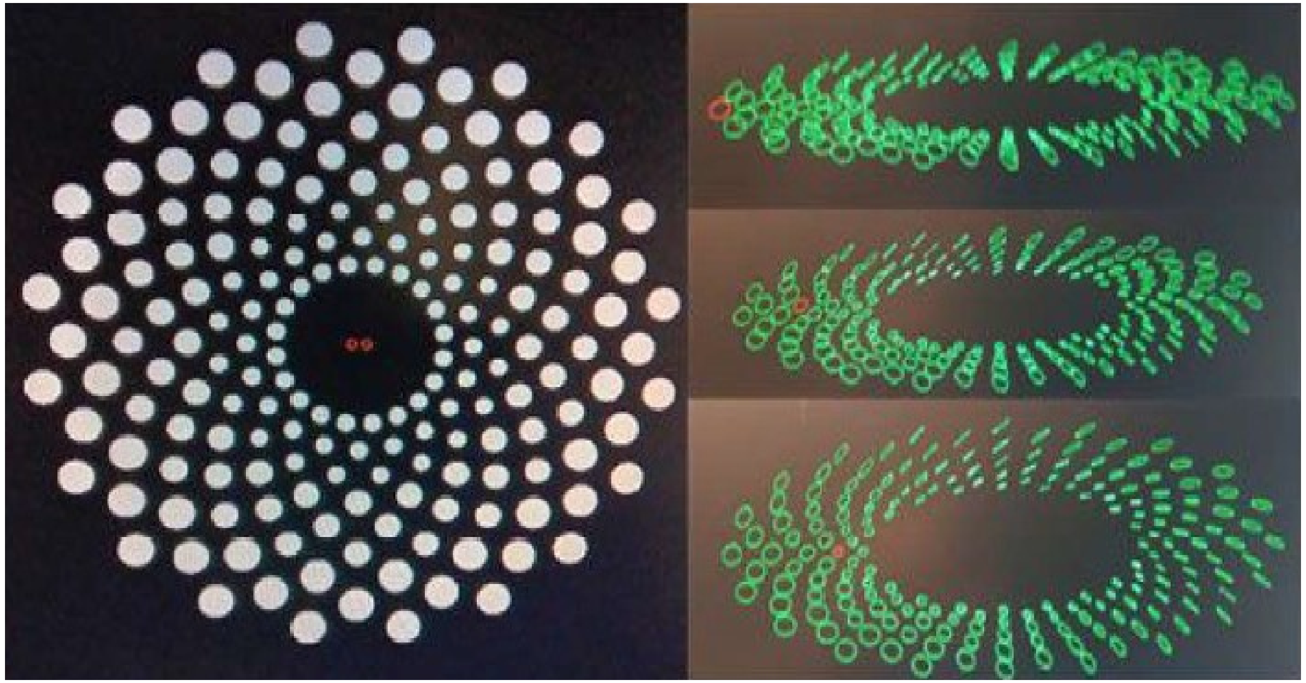


TZM: TiC/ ZrC → TiN/ ZrN
Stepped diffusion heating raises
Recrystallization: 1400 C to 1800 C

Braze: Titanium Full Heusler mix
Excess Titanium diffuses through
TiN layer into TZM: 1700 C braze
2000 C final melting temperature

10 MW Down Beam Reflection Design

10 MW solar heliostat field: 25% Cost || Solar Field cost: $50/ sq meter DOE target



2200 ft Diameter Primary Mirrors 500 ft Inner Diameter
Down-Mirror Ring: 300 ft Diameter 300 ft Above 5 MW Reactors

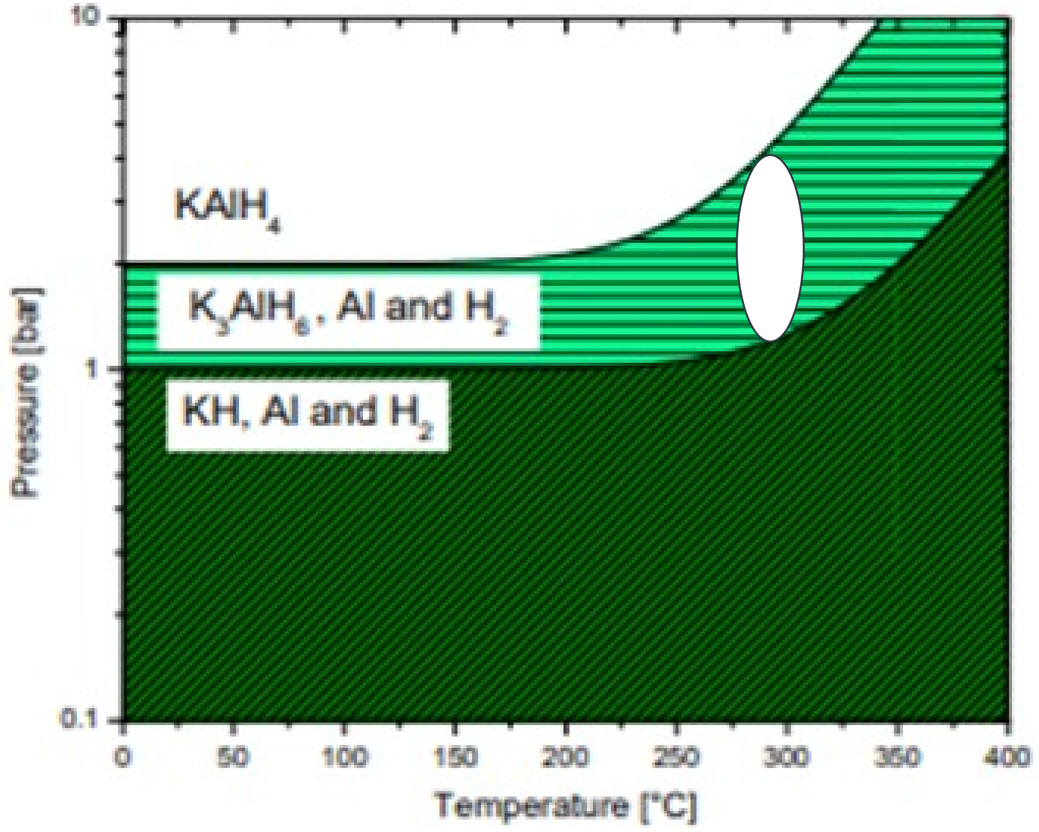
Nano hard coating on mirrors for erosion protection: Al_2O_3-ZrO_2

Back surface reflective coatings on primary mirrors

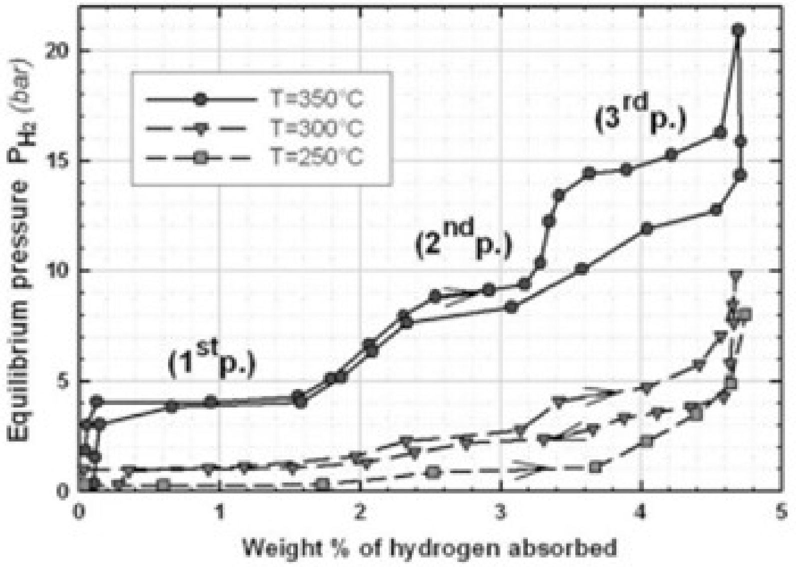
Front surface reflective coatings on secondary mirrors

Primary mirrors: 60, 90, 120 ft diameter, Down-mirrors: 6, 9, 12 ft diameter

Mid Temperature Hydride Solution



Magnesium Aluminum Intermetallic



	Mole percent	kJ / Kg heat of fusion	Melting pt C	Max Temp C
Sodium nitrate	87.0%	182.4	308	510
Sodium chloride	8%	478.3	800.7	1465
Sodium fluoride	5%	776.4	993	1704
$NaNO_3$-NaCl-NaF		224	288	510 est

Note: salt mixture cycles from 275 C to 325 C, 10% est volume change solid to liquid

<u>Temperature Balancing: 288 C to 300 C, 1-3 atm</u>

Annular Tank Array: 316-L: Inner hydride, outer salt

Nano Coatings: Hydrides: Metal nitrides, Eutectic salt: Metal glass mix

Mid-Temperature Hydride Solution Formula

Magnesium Aluminum intermetallic

- Between 1 to 3 atmospheres and 275 C to 300 C all materials remain dry powder form

  Reaction: $Mg_{17}Al_{12} + 17H_2 \rightarrow 17MgH_2 + 12Al$

- Mg-Al intermetallic improves reversibility relative to Mg only (4.41 H_2)
- Mixing required to create nano size particles for kinetics (liquid mixing at 50 atm hydrogen with up to Mg.7Al.3 ratio is a potential solution where the Mg-Al alloy and the MgH2 are liquids)
- Combined equation:

  $17MgH_2 + 12KAlH_4 + 3.3Al \rightarrow 12KH + Mg_{17}Al_{12} + 35H_2 + 3.3Al$ (5.08% H_2)

  $28MgH_2 + 12KAlH_4 + 3.3Al \rightarrow 12KH + Mg_{17}Al_{12} + 11Mg + 46H_2 + 3.3Al$ (5.52% H_2)

- Added aluminum enhances thermal conductivity, added magnesium enhances hydrogen %
- Chemical components self-mix under high pressure hydrogen, requiring no ball milling

Vertically Integrated Factories

- Low cost environmentally efficient Mid stream metals production
- Hydride production and storage
- Forging equipment for TZM heat pipe and HDPE injection solar panels
- TZM heat exchanger integration and production
- TZM nitriding and production brazing at 1700 C
- Extrusion processing for aluminum and Stainless tubing
- Low cost glass processing for mirror production
- Atomic layer deposition and Nano HPIMS/ PEMS production
- E-beam welding for large tank assemblies
- Fiberglass spin processing for primary heliostat towers
- Heat pipe mesh screen weaving

ADI Strategic Metals Corporation

10 MW Hydride System Details: 18 hours of chemical storage

Metals and Salts used	kg	Volume (in3)	$/kg	Total Cost
Calcium metal:	401,000	17,743,363	0.48	192,480
Magnesium metal:	206,729	7,253,649	0.48	99,230
Potassium hydride:	21,889	935,427	0.80	17,511
Aluminum	14,593	330,158	2.00	29,186
Hydrogen	20,050	-----	2.00	40,100
			Total:	**378,407**
Thermo-cline				
Magnesium oxide	1,625,000	27,542,373	0.12	195,000
Calcium oxide	1,625,000	29,707,496	0.12	195,000
			Total:	**390,000**
Eutectic Salt				
Sodium nitrate	2,489,210	67,275,946	0.40	995,684
Sodium chloride	157,400	4,421,348	0.04	6,296
Sodium fluoride	70,680	1,686,874	0.80	56,544
			Total:	**1,058,524**

total Cost: **$1,826,931**

Vertically Integrated Mid stream metal production facility

Calcium	Scandium
Magnesium	Yttrium
Potassium	Tantalum
Aluminum	Tungsten
Titanium	Molybdenum
Zirconium	

10 Megawatt Reactor System

Mg-Al-KH Volme:	**8,519,234 in3**
Eutectic Salt Volume:	**73,384,168 in3**
Thermo-cline Volume:	**57,249,869 in3**

Reactor	Diameter (in)	Wall Thickness (in)	Alloy	Wt (kg)	Cost ($)
Outer shell	360	0.50	316-L	17,945	35,589
Mid shell	324	0.25	I-230	5,048	116,104
Inner shell	312	0.1875	I-230	2,712	62,376
		Total 2 tank assemblies:			**$428,138**

Thermocline	Diameter (in)	Wall Thickness	Alloy	Wt(kg)	Cost($)
Outer shell	324	0.375	316-L	26,400	52,800
Inner shell	288	0.250	I-230	10,945	251,735
		Total 2 tank assemblies:			**$609,070**

H2 Storage	Diameter (in)	Wall Thickness (in)	Alloy	Wt (kg)	Cost($)
Outer shell	9.5	0.035	316-L	6.01	18.03
Inner shell	3.0	0.035	316-L	1.88	5.63
		Total 28,800 tank assemblies:			**$681,696**

Techno-Economic Analysis Summary

Techno-Economic Analysis Summary Results Achieving DOE Targets by 2030

	Current Tech-nology	2030 Vision	2030 ADI Solar Vision
	Molten Salt	Ceramic Bricks	Liquid Calcium Dual Hydride
	Steam	sCO2	sCO2
	550°C TiT	700°C TiT	700°C TiT
Net Capacity / MWe	100	100	100
Operating Mode	Baseload	Baseload	Baseload
Receiver HTF	Molten Salt	Liquid Sodium	Lithium Vapor
LCOE / $/kWeh	0.081	0.048	0.025
Solar Multiple	2.75	2.75	3.5
TES Storage / hours	14	14	18
DNI / W/m2	850	850	850
Cycle Efficiency	41%	52%	52%
TES Round-Trip Efficiency	90%	95%	95%
Receiver Efficiency	85%	92%	92%
Field Efficiency	55%	70%	70%
Site Preparation / $/m2	10	10	10
Collector Field / $/m2	75	50	50
Power Block / $/kWe	900	694	694
Tower and Receiver / $/kWth	150	60	25
TES System / $/kWthh	26	30	15.28
Construction/ Contingency Cost Factor	21%	20%	5%
Financing	7%	7%	7%
Lifetime / years	30	30	30
Capacity Factor	70.30%	70.30%	70.30%
O&M Factor / $/kWe-year	40	40	40

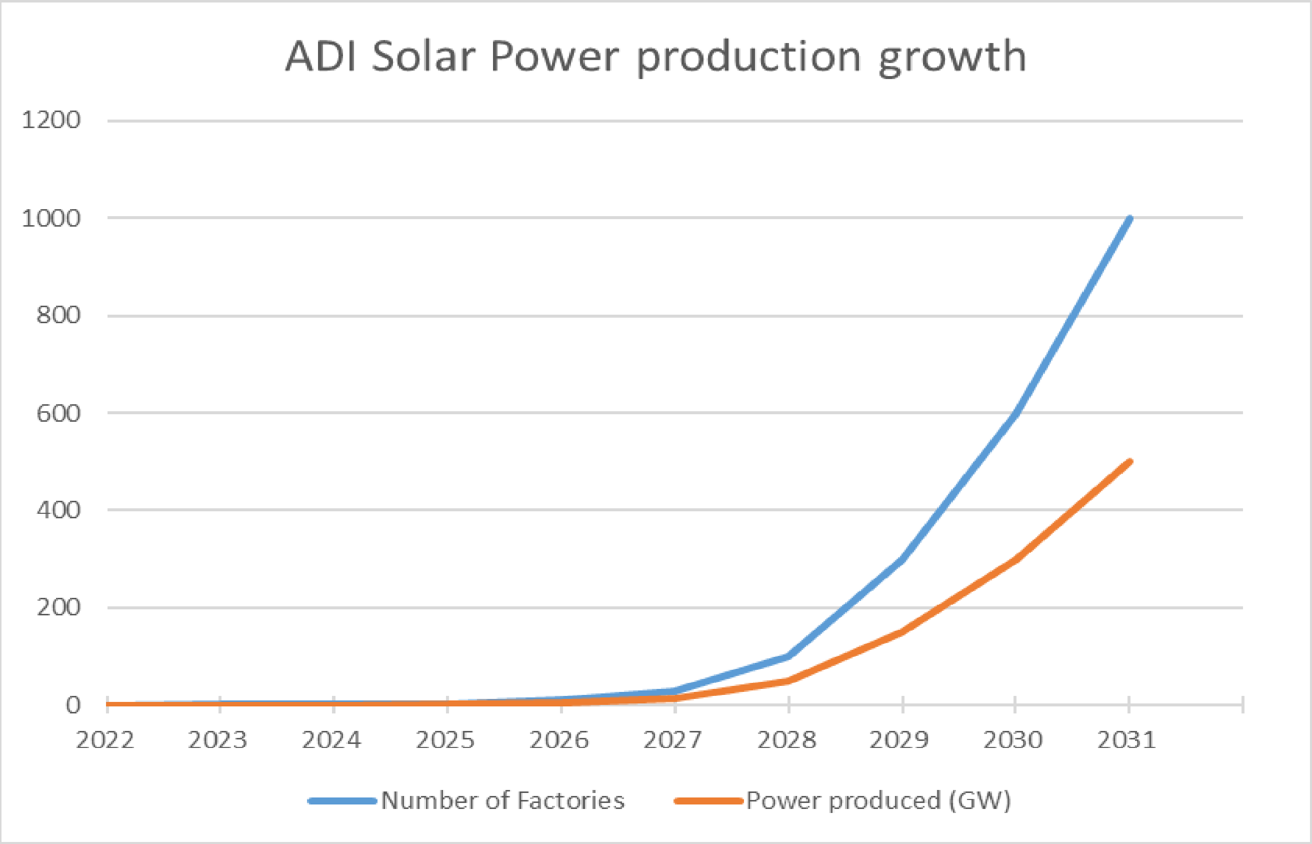
A Detailed Techno-Economic Analysis was completed for the ADI Solar 10MW system relative to competing storage systems projected to 2030 AvailabilityAll the system trades use the supercritical turbine and a similar solar field cost per square meter

The Liquid calcium dual hydride shows ½ the LCOE relative to the ceramic bricks baseload power of $.025/kw-hr vs $.048/kw-hr.

This significant benefit was the result of three factors:

1. A 29% System Cost Reduction
   - ½ Tower and Receiver Cost
   - ½ Storage System Cost
   - ¼ Site Construction Cost
2. A 12.5% Increase in Kwhr delivered
   - Increase in Solar Multiple from 2.75 to 3.5
   - Allowing 15 MW Power Output during 6-Hour Daytime Interval Relative to 10MW Baseload
3. A 20% increase in storage duration
   - Higher Energy Storage Density from Liquid Calcium Hydride
   - Allowing 18 Hours instead of 14 Hours

10 Megawatt Production Growth



Revenue Forecast

Commercialization Revenue Forcast Detail for 10 MW

Income Statement (thousands)

Sales Assumptions	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Sales	0	1	5	50	200	500	1000	2000	6000	20000	50000
Sales Price		-	50,000	50,000	47,500	40,000	35,000	30,000	27,500	25,000	24,000
Production cost	0.0	80,000	50,000	40,000	35,000	30,000	25,000	22,000	21,000	20,000	20,000
Price per KW (in $)	0	0	5,000	5,000	4,750	4,000	3,500	3,000	2,750	2,500	2,400
Factories				1	4	10	20	40	120	400	1000
Revenue			250,000	2,500,000	9,500,000	20,000,000	35,000,000	60,000,000	165,000,000	500,000,000	1,200,000,000
Profit			50,000	5,000,000	1,900,000	4,000,000	7,000,000	12,000,000	33,000,000	100,000,000	240,000,000

Note: *First 6 turbines projecting a 2X cost for initial production with $10M each added from profit in 2028-2029*

2037 Full Production: 500 GW per year

Storage System Summary

- Storage System will operate with multiple fuel sources providing baseload power 365 days a year 24 hours a day
- 10 MW system integrates with 10 MW supercritical CO_2 turbine
- 100 KW system integrates with ADI Solar 100 KW Stirling engine
- System provides load following for intermittent energy sources
- System can be integrated with co-electrolysis system developed at Idaho National Lab to produce H_2, DME and Kerosene Jet fuels from Solar energy, H_2O and CO_2
- 1000 C storage temperature provides 95% of thermal processing temperature requirements for industry
- Storage system uses abundant materials allowing sustainable production growth requirements