CHANGING WHAT'S POSSIBLE

Solar Beyond Grid Parity Workshop

DESIGN GROUP BREAKOUT II

Friday, April 13

Format for Design Group Breakout II

Slides 2-6

- Each design team from Thursday afternoon reconvened to discuss some of the critical technology challenges associated with their specific design(s) by answering two questions:
  - What new component technology would have made your system easier to design yesterday? (be quantitative if possible)
  - What is the generic description of the problem that the component solves?

Slides 7-11

- Following the breakouts, all workshop participants gathered to compare each group's list of novel components and consolidate the list. All attendees then voted "yes/no" on the following questions with respect to each component in the consolidated list:
  - If successfully developed, would any of yesterday's system design problems have been significantly easier to solve?
  - Could the component technology actually work and eventually be manufactured at a low enough cost to make a difference?

(duplicative items across groups were marked red and not separately included in the vote)

Group 1: Top 5 Disruptive Component Technologies

#	What new component technology would have made your system easier to design yesterday? (be quantitative if possible)	What is the generic description of the problem that the component solves?
1a	50% efficient high temp H_2 (or CO) reactor with production of waste heat at useful temperature. Reactor properties– high absorption, low emissivity, temp > 1500°C, completely closed to contain atmosphere, continuous process – flowing reactor; Option – 1200°C makes different reactor tradeoffs.	Reactor
1b	Volume optic device, spectrally split into transmitted and reflected, both of which are focused; Flat surface some interactions with photons, gratings – **optically reconfigurable** surface, **nonmechanical** collector Low cost optics, 10% of total system cost Diffuse PV, spatially separated; Heliostat field greater than 75% efficiency at 3000 suns	Optics
1c	High temp PV	PV
1d	Need better heat exchangers, need effectiveness, 90% heat recovery at high temp (1500°C)	Heat Exchanger

Group 2: Top 5 Disruptive Component Technologies

#	What new component technology would have made your system easier to design yesterday? (be quantitative if possible)	What is the generic description of the problem that the component solves?
2a	High efficiency, high temperature photovoltaics at 6¢/kWh.	High temp PV
2b	Narrow band photovoltaics. (Handful of "tuned" high efficiency PV optimized for a single wavelength.) Per area equivalent that equates to 6¢/kWh. (Partial spectrum/partial area.)	Narrow band PV to be used with a spectrum splitter
2c	Spectrum splitter. Examples: (1) High efficiency partial spectrum, low cost coating for PV. (Reflects IR, transparent to visible. Large area coating technology (roll-to-roll)?). (2) Separate substrate, independent spectrum splitter component.	Efficient spectrum splitting
2d	Mild concentrator (integrated with PV?) (90% efficient concentration, 10X-200X, Must be consistent with 6c/kWh depending on concentration.)	Low cost, low concentration (light)
2e	Concentrator for heat (90%, 2000X, Cost consistent with 6c/kWh (much debate on cost $10-75/m2).	Low cost, high concentration (heat)

Group 2: Top 5 Disruptive Component Technologies (con't)

#	What new component technology would have made your system easier to design yesterday? (be quantitative if possible)	What is the generic description of the problem that the component solves?
2f	Embedded storage that integrates both heat and electrical storage. - Same physical component contributes to storage and generation? - $50/kWh - $500/kWh - roundtrip efficiency (need to calculate.) Must be very high electric to electric efficiency. - Storage that achieves even higher efficiency since it has both heat and electricity available. Quantify coupling between heat and electricity flows?	
	Optical Storage? Thermal to optical?	
	Phase change storage solution. Large delta Volume(?) need to be explored.	

Group 3: Top 5 Disruptive Component Technologies

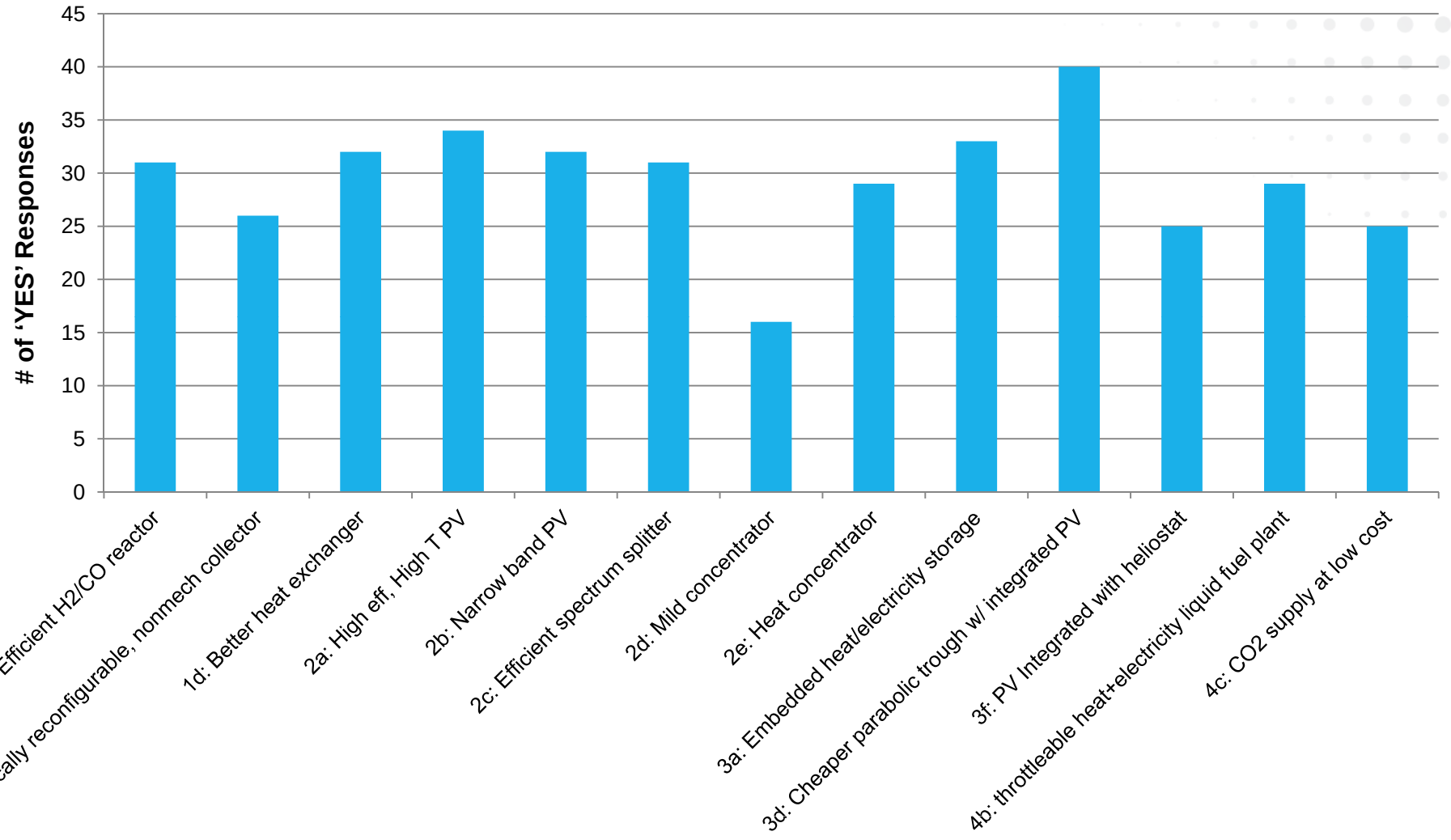
#	What new component technology would have made your system easier to design yesterday? (be quantitative if possible)	What is the generic description of the problem that the component solves?
3a	Embedded storage system that would store both heat and electricity (high (~80%) round trip efficiency), **similar to 2f**	Dispatchability (reaching the 50% target), can store electricity from anywhere else on the grid
3b	Integrated concentrator/spectrum splitter, combined with PV cells (cost of concentration + splitting << flat plate PV/m^2)	Cost, go to 2000+x concentration
3c	High T PV on the receiver tower: 300-400 deg C, approaching 20% efficiency (entire spectrum)	Cost
3d	Parabolic trough with integrated PV, adjustable diversion of light to thermal or PV components (50% PV efficiency from partial spectrum, inexpensive multijunction solar cell; 40% PV (full spectrum) < 2x cost of mirror), similar to 4d	
3d-2	New parabolic structure that's cheaper to get to a higher concentration ratio	Materials, manufacturing costs are too high
3f	Integrated PV on heliostats (for power tower), optimize PV design (comparable in price to today's heliostats, or slightly higher)	Can reach higher temperatures on thermal part, dispatchability

Group 4: Top 5 Disruptive Component Technologies

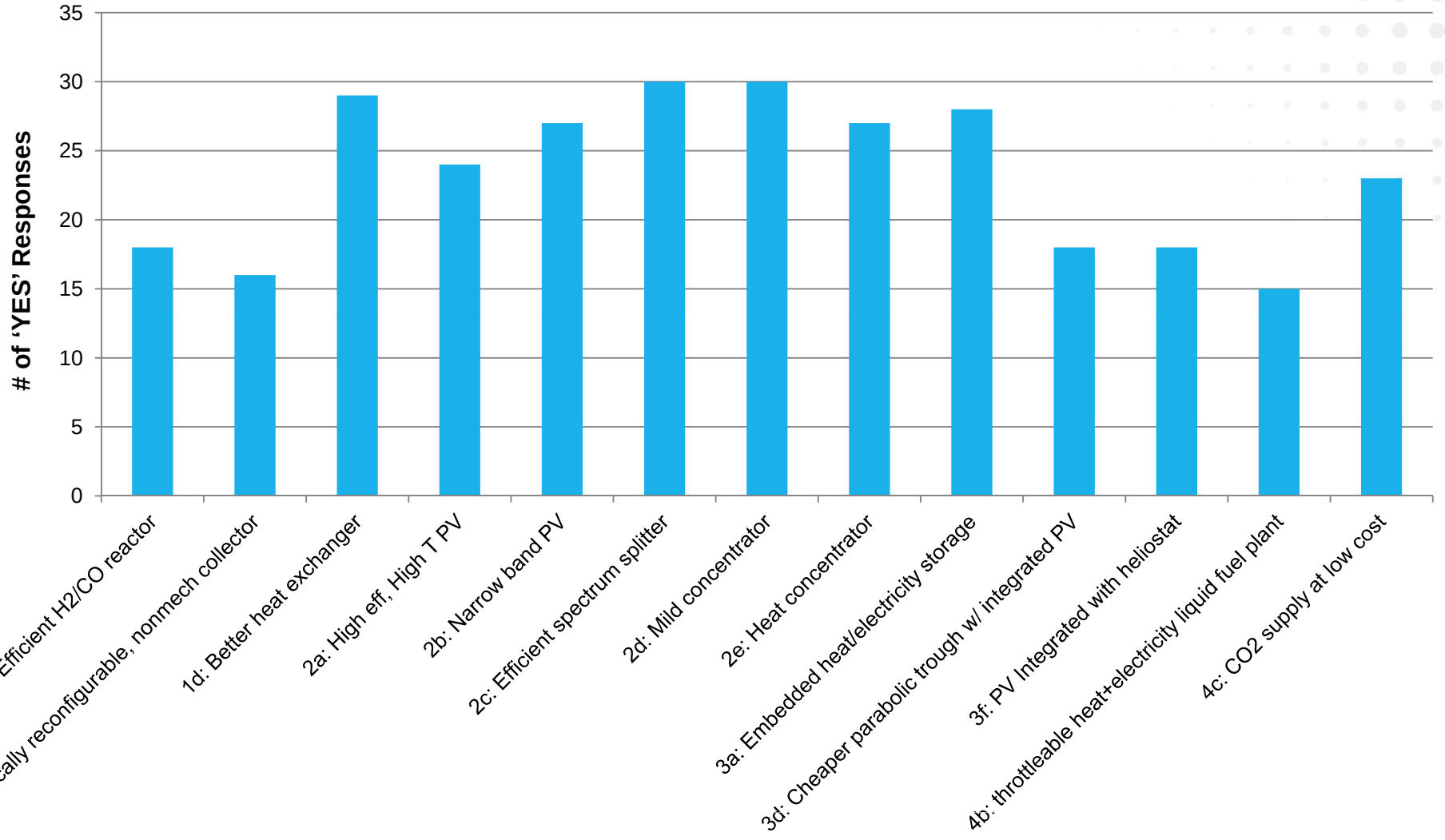
#	What new component technology would have made your system easier to design yesterday? (be quantitative if possible)	What is the generic description of the problem that the component solves?
4a	High temp PV at high efficiency & high stability	Added electricity to get rxns to drive electrolysis without loss of process heat
4b	A 95% efficient throttleable Liquid Fuel Plant that is optimized to take heat and electricity input, from combined system	Sets the requirements for electric and thermal inputs (a new level of integration needed). Quick on/off
4c	CO_2 supply at low cost	Reduced product cost to meet $3/gge, with no H_2 infrastructure
4d	Diffuse light capture @60% efficiency (indirect, small band) for electricity on same footprint (photon recycling, optical component separation)	Indirect light to electricity to increase system efficiency to 35%
4e	Thermal and electrical/H2 storage for 24 hour operation	Round-the-clock fuel production

RESULTS FROM VOTING

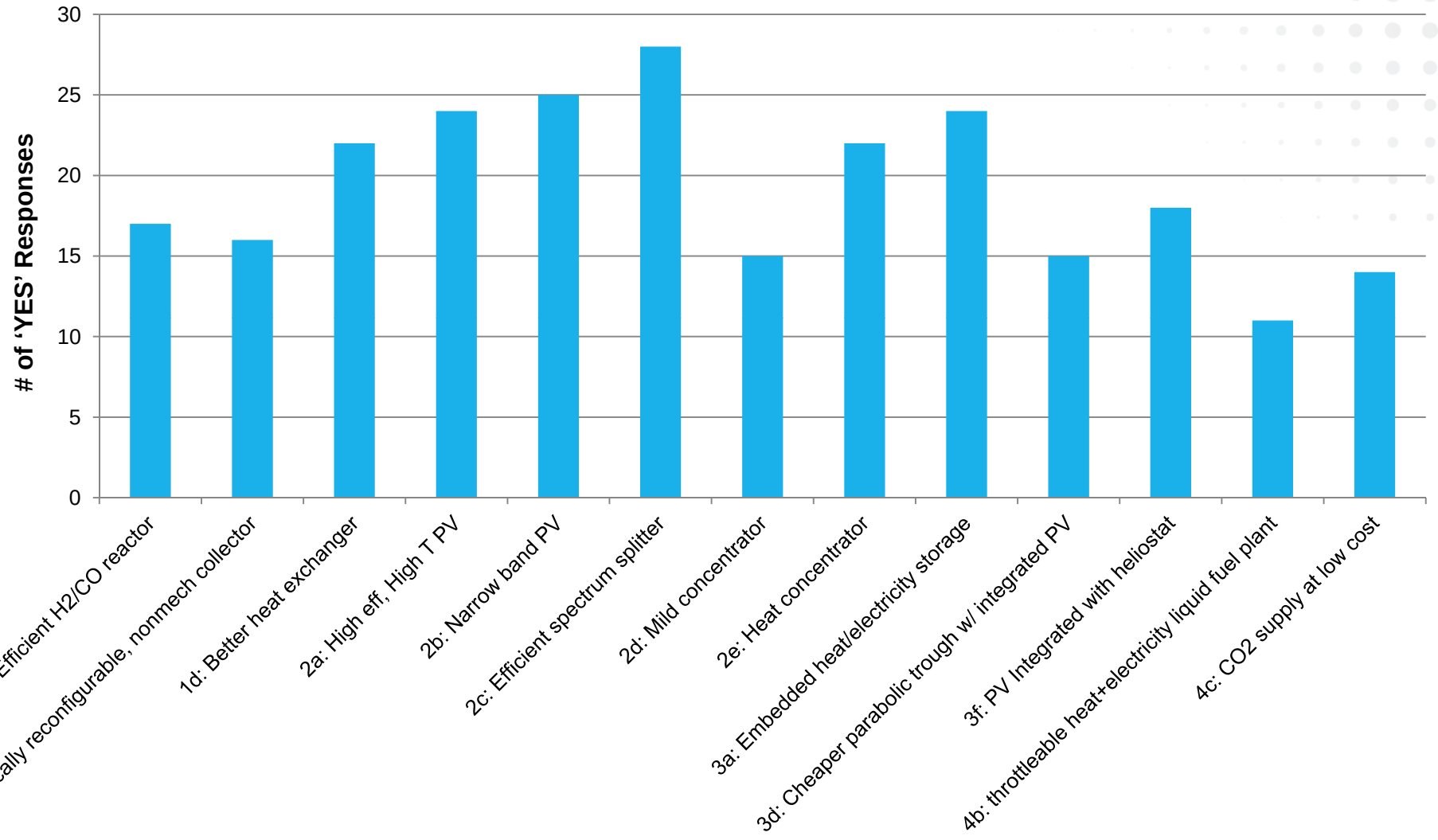
If developed, would the design problem have been easier to solve?



Could the component technology actually work and be manufactured at low cost?



Both questions voted ‘YES’



Overlay of Responses to Questions 1,2, and both "Yes"