Reviewer #1: Comments to SE-D-17-00390R1  
  
The authors give a review about the special technical field of thermo photovoltaics, solar thermo photovoltaics and solar thermal with a focus on absorbers at high temperature. The modified manuscript distinguishes these fields being on focus from other moderate temperature systems as classical photovoltaic and solar thermal use.   
  
The manuscript gives a good overview about the endeavour to manage the efforts at solar and infra-red spectral range to get high efficiency. Theoretical work, software solutions for simulation and experimental performance were likewise approached.  
As I have already mentioned I have an uncomfortable feeling about many referenced work and the status of the technical field in general. However the authors present a review of the scientific area and reference the theses well. Insofar I have to accept it as scientist even I does not agree with the theory of some referenced relevant studies. Finally I am very grateful for this review and hope it will either initialize a constructive discussion about efficiency limits, if my objections are eligible, or initialize strong efforts in the field to overcome technical challenges in the other case.

Comment 1: The usually referenced Shockley-Queisser limit just above 40% is based on irradiation of one sun without concentration, ideal absorption above the band gap energy, ideal charge capture, optimized band gap energy and radiation recombination as sole recombination mechanism. If any of these assumptions is not fulfilled the efficiency limit may be higher (in cases of sun concentration or tandem solar cells) or lower (in cases of silicon instead of ideal band gap semiconductor or Auger and non-radiative recombination). The essential idea of Shockley and Queisser is the thermodynamic detailed balance of radiation and charge densities, respectively splitting of quasi-Fermi levels or internal photo-voltage. Therefore Shockley-Queisser efficiency limit rises up with light intensity and exceeds 40% with sun concentration in a large extent, too. STPV systems base on sun concentration (factor C), an absorbing area (A) and an emitting area (E). Because solar cell area is of the order of the emitting area (E) the effective sun concentration factor for the PV cell in a STPV system is C\*A/E.   
So it would be adequate when the theoretical efficiency of STPV systems with effective concentration factor C\*A/E is compared with the Shockley-Queisser limit in case of irradiation with the same concentration factor C\*A/E but not with factor 1. I have the urgent appeal, do not use wording as "exceeding Shockley Queisser limit" - even it might be common - because it is a thermodynamic limit which depends on the boundary conditions as Carnot efficiency too, which one could not exceed. In this manner I do not agree with the sentence "This configuration allows STPV systems to operate with an efficiency approaching Carnot limit in theory" (page 5, line 97). The theoretical efficiencies presented in Fig. 3 (please give the reference if it is not your own) seem to be Carnot limited at the steep rising part, too. To my opinion the photovoltaic cell is limited to Shockley Queisser detailed balance concept, however for special boundary conditions.

**Response (Jay):** We agree with the referee that the S-Q limit is a fundamental thermodynamic limit, and rather than exceed this limit, STPV systems change the boundary conditions leading to conversion efficiencies beyond 40%. We also agree with the referee’s assessment of Figure 3 that the steep rise is Carnot limited, but there is a different limiting behavior that causes the decline in the high-temperature limit due to necessary radiative losses as the BB distribution of the system has increased overlap with incident (solar) spectrum. We note that Figure 3 is our own figure.

**Change:**

1. We have removed reference to “exceeding the Schockley-Queisser limit” in our discussion in this paper. We have revised the discussion on page 31, line 750 to reference specific limiting efficiencies with the particular boundary conditions corresponding to their current implementation.
2. We have removed the sentence on page 5, line 97, suggesting that only the Carnot limit bounds STPV performance.
3. We added the expression for the two temperature-dependent limiting efficiencies used to generate Figure 3 in the caption.

As review article for STPV and TPV systems I am missing more detailed information about the technical challenges hold for PV cells. At page 35 line 827 and following corresponding references are given. However some technical challenges are worth to mention explicitly: The high current density and the high associated resistance losses  at the PV cell [11] and the high cooling power being necessary to hold the PV cell at an adequate temperature.  
  
**Response (Craig):** These are indeed important technical challenges regarding STPV and TPV systems, and deserve explicit mention in our review.

**Change:** We added a discussion of these technical challenges on page 35, starting around line 832.

Minor Comments  
Page 2 line 22: Missing blank between "nanostructures. Some"

**Response (Jay):**

**Change:** Added space between the sentences.

Page 13 Capture text for Fig. 5 line 36: doubled "is"

**Response (Jay):**

**Change:** We have deleted the second “is” in the caption of Figure 5.

Page 13 Capture text for Fig. 5 c and d seems to be changed

**Response (Jay):** The only updates to the caption of Figure 5 are in the reference numbers since more references were added during the revisions.

Page 14 line 285: Please clarify the notation: Either "material properties (refraction index, n, and extinction coefficient, k)" or "material properties (complex refraction index, ñ = n +ik)". The choice influences also line 296 on the same page: Complex valued angels are used. My suggestion is using real valued terms only for readers, which are not familiar with the complex valued Fresnel equations. However EL+ and EL- are electric field inside of layer. Insofar t is related to the transmission from the source to the Lth layer and not through all layers. For reader it is simpler one presents t for transmittance through all layers. In this case beam angle is real valued. And only in this case El- is zero. Finally it is not necessary to set E1+ = 1 because t and r are already related to E1+ (line 294 and 295)

**Response (Jay):**

**Change:** We have adopted the notation “material properties (complex refractive index, ñ = n +ik)". We have removed the Re() in the expression for the Transmission. We have also removed the phrase that E1+=1.

Page 28 line 668: With the new text just before the word "such" in "Operating at such high temperature" is odd.

**Response (Jay):**

**Change:** This sentence on line 668 has been revised.

Page 31 line 748. "For example, there" is a free hanging text.

**Response (Jay):** This appears to be a sentence that was partially, but not completely removed, during the last revision, and we appreciate the referee for catching this for us!

**Change:** The hanging text was removed.

Page 31 line 751. In principle correct. But I suggest that Shockley-Queisser limit should always be related to an optimised band gap to get an unit value in this manuscript (efficiency > 40%).

**Response (Craig):** We agree that this is an important point for the audience to appreciate.

**Change:** We have revised the text on page 31 starting around line 751 to include both the efficiency limit for Si PV cells and one for an optimized single junction cell for clarity.

Page 31 line 34/35: Reference [116] is not valid. Reference [127] might be the correct reference. However, to my opinion the calculation is based on false conditions.  
  
**Response (Craig):** We thank the referee for suggesting this clarification.

**Change:** Reference changes to [127] for clarity. Caption for Table 1 has been altered as suggested to help increase clarity.

Page 32 Capture text for Table 1: "Efficiency" should be denoted more precise as "absorber efficiency corresponding to eq. (3)" for a concentration factor C = 2500.

**Response:** We agree this would enhance the clarity of the data presented in Table 1.

**Change:** We have updated the caption for Table 1 to indicate that it is absorber efficiency, and indicated that the figures are for concentration factor 2500.

Page 33 line 776: The sense of references [42, 49] is not clear at this position.

**Response (Craig):** The references were meant to be additional examples of nanotextured surfaces, but upon re-examining the sentence, it’s clear that their positioning was confusing and caused them to appear to reference a non-sensical point. They have been removed.

**Change:** References removed from that sentence.

Page 33 equation (4): A composited factor C is more convincing. A term as solar concentration efficiency seems to be arbitrary or redundant.

**Response (Craig):** The equation was changed to use a composited C, and the solar concentration efficiency term was removed. The text was updated to reflect this change.

**Change:**  \textcolor{red}{ $C$ is the concentration factor of incoming sunlight, including concentrator ratio and concentrator efficiency,} Equation also changed.

Page 34 line 9: Equation (5) holds for so called ultimate efficiency (not spectral, because integration eliminates wavelength dependence). A more general equation including angle dependence one finds in [11] eq. 9.

**Response (Jay):** We agree the terminology *ultimate efficiency* can be found in the literature for Equation (5), and also that in general, it will have explicit angle dependence.

**Change:** We refer to the quantity defined by Equation (5) as the emitter efficiency throughout. We have noted the angle dependence of the emissivity on realistic structures, and therefore the need to include angle of emission in the definition of Eq. (5) and refer the reader to Ref. 11 for further information.

Page 34 line 816 and page 35, Table 2: Please unify (or clarify) the used term "spectral efficiency". If it is related to eq. (5), the term is denoted as ultimate efficiency. However in case of ultimate efficiency  table 2 is unclear because ultimate efficiency depend on band gap and temperature. Both parameters are not given.

**Response (Craig):** The table was indeed referring to ultimate efficiency. The terms have been unified, and table 2 has been updated to better reflect both bandgap and temperature.

**Change:** Terms changed in text. Table 2 changed as well.

Page 37 table 3: As key factors concentration factor and area relation of emitter and pv cell are missing for assessment overall efficiency and absorber temperature.

**Response (Craig):** They have been added to the table.

**Change:** They have been added to table 3

Page 37 table 3, Simulated systems: Absorber temperature of reference [11] is not 6000 K (temperature of the sun) but about 2200 K (or 2130 K, see manuscript page 38, line 880) for concentration factor of 20000 (see Fig. 6a in [11].

**Response (Craig):** This has been fixed to reflect the paper.

**Change:** Table 3 has been changed

Page 38, lines 880-882: The efficiency of reference  [89] does not agree with the value referenced in table 3 (8% and 2% respectively) Page 40, reference [80]: D.M. Bierman Page 43, line 1021: PbS Page 51, line 1223, reference [121] L.T. Berghaus, A. Djahanbakhsh, L.K. Thomas Page 52, reference [135]: An erratum is published at Nat. Nanothechnol. 10 (2015) 563-

**Response (Craig):** This has been fixed to reflect the paper.

**Change:** Table 3 has been changed