SunZia Economic Impact Analysis Review
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Introduction

This report addresses the economic impacts calculated by the University of Arizona and New Mexico State University for the two-line 500-kV AC configuration of the SunZia Southwest Transmission Project. As mentioned in my previous analysis (December 11, 2011), the fundamental problem with the job numbers released by SunZia is equating job-years of work with jobs, which greatly inflates SunZia's job potential. Dr. Charney and her associates consistently refer to job-years as jobs throughout their main report, and SunZia apparently accepted this without questioning it. In other economic impact studies that I have examined, all researchers explicitly differentiate between job-years and jobs, discussing them separately. Not doing this is a major oversight in this study.

The error that I note in the job numbers calculated for photovoltaic projects rests with SunZia and not with the modelers. A consultant presumably supplied the basic input for this study. The starting job numbers are so greatly in error that I suspect a typographical error is to blame. Because of this error, the job numbers and associated revenues are invalid, and this portion of the study must be completely redone to have any merit.

The following addresses additional weakness of the report. I intend this discussion to be taken as a peer review designed to make the report better and more worthy of public presentation, not an attack on the work that was done. It is something to use in revising the report, if this is done.

Additional Shortcomings of the Main Report

The Relative Importance of Job Numbers

I have two significant criticisms of the transmission project report itself. Most importantly, while projecting supply-related, indirect and induced job numbers helps assess the broader impact of a project, the single most important economic indicator for any project is how many people it will hire. When DOE references job numbers in project summaries, it is this number that is always given as a baseline measurement of economic potential. Nowhere in Dr. Charney and her associates' report or on SunZia's website is this number given. While one can derive it from the data provided, one cannot determine it without doing a series of computations. This, again, is a fundamental oversight.

The most important job figures to give, in the proper order, are (1) how many people the company will hire (both average and peak employment, or 482 and 780, respectively), (2) how many total jobs will be supported (again, both average and peak employment, or 1,550 and 2,459, respectively), and lastly, (3) how many job-years of work will result (6,200). Because only 30% of SunZia hirees will be from Arizona and New Mexico, SunZia will employ an average of 41 Arizona residents and 106 New Mexico residents. Peak employment will occur in

year 3 of construction, when SunZia will employ 65 Arizona residents and 169 New Mexico residents.

While SunZia, like any company, wants to make its job potential appear as large as possible, legislators and policy makers need an honest portrayal of actual jobs and their locations to make sound decisions. SunZia will generate some good jobs, but the misuse of the study's results makes it difficult to correct misconceptions now without embarrassing SunZia and harming the company's credibility.

Out-of-State Hirees and Induced Jobs

A major problem with these employment numbers is that published summaries do not make clear that not all construction jobs will go to workers in Arizona and New Mexico. The states where SunZia workers are hired and the location of spin-off jobs is critical information for policy makers and legislators, especially those in these states. Seventy percent of direct construction jobs would go to individuals from other states. In addition, while the report assumes that these people would spend 80% of their income in Arizona and New Mexico, this seems too high. This also applied to in-state hirees, who will supposedly spend 100% of their wages in state. These are high-quality jobs with food and lodging paid, and modelers assume that no one will save money or pay down existing debts, a rather unrealistic assumption given the nature of the jobs. Induced jobs, which rely on the spending of wages, could be significantly overestimated by assuming this, and these jobs represent the largest job category.

In addition, many people hired from outside Arizona and New Mexico will have families to support and mortgages to pay in their home states. Single individuals without these concerns are likely to save a higher proportion of their incomes as well. I thus expect the number of induced jobs resulting from the spending of wages in Arizona and New Mexico by non-residents to be less than 80% and by residents to be less than 100%. Both of these factors – the employment of outside individuals and the inclusion of savings and debt reduction in calculating induced jobs – diminish the job potential in these states.

Also, the number of induced jobs depends heavily on how concentrated the spending of wages is. Such spending must be concentrated in a fairly limited number of businesses or otherwise revenues will be insufficient to justify hiring additional workers. If such spending is very diffuse, it will not create jobs. Economic modeling calculations need to include a spending diffusivity index to more accurately predict job potential. Because SunZia employees will come from a widely dispersed area and because a significant portion of their income will likely be spent with more businesses, this should reduce induced job creation. I make no adjustment of this, however, in any of the job numbers that I calculate.

Assessment Problems Arising from the Location of Material Supply Jobs

A second very serious shortcoming of the main report is that nowhere does it give a breakdown of the primary materials needed to build the project, where these materials will be manufactured, and the number of jobs associated with each material. This is critical because many of the materials will be manufactured overseas or in other states, and the jobs associated with them will

not be in Arizona or New Mexico. The manner in which SunZia references job numbers on its website and in its brochures makes it appear that all of these jobs will occur within these two states.

As an example of this problem, Tom Wray of SunZia has stated that all of the steel for the transmission towers will be manufactured in India or China[1]. In addition, the transmission cable may be manufactured overseas, or at least in other states. These are the two main materials needed for the project, and many of the direct material-supply jobs given in the study are presumably associated with them. Lesser amounts of additional materials are undoubtedly needed also, some of which may be procured in Arizona and New Mexico.

This lack of clarification of job location and associated spending accentuates the difficulty in assessing the economic impact on Arizona and New Mexico because the additional indirect and induced jobs associated with these jobs will be elsewhere also. SunZia's summary of the reports suggests that all of these jobs would be created in Arizona and New Mexico when they will not be.

Adjusting for Jobs Created Elsewhere

Nowhere does the report state that these jobs may be created throughout the country or in foreign countries. The brochures on the SunZia give the impression that the project will create 3,900 jobs in New Mexico and 2,200 jobs in Arizona, although they contain a rather obscure footnote at the end that mentions that these are man-years of work. When one converts job-years to jobs, adjusts for people hired from other states, removes jobs associated with materials manufactured elsewhere (direct, indirect, and induced), and reduces induced jobs to accommodate savings and debt reduction, the average jobs/year summed together for all categories in New Mexico will be ~320 with peak employment of ~510; the average jobs/year summed together for all categories in Arizona will be ~180 with peak employment of ~285.

These numbers are derived by (1) reducing direct labor jobs by 70% to adjust for out-of-state hiring, (2) reducing the number of direct, indirect, and induced jobs associated with manufacturing of materials by 80%, (3) reducing the number of construction-related induced jobs created by in-state worker spending from 100% to 80%, and (4) reducing the number of construction-related induced jobs created by out-of-state worker spending from 80% to 60%. The reduction of jobs associated with materials is not based on known information, however, and the locations of the manufacture of needed materials are required to accurately derive this. Neither do I have a sound basis for reducing induced jobs. Thus the job numbers that I have calculated are only a rough approximation.

This required adjustment significantly affects the collection of local and state sales taxes, corporate taxes, and personal taxes in Arizona and New Mexico. Not adjusting for the location of material supply jobs and associated indirect and induced jobs produces revenue estimates that would be much too high for these states. Presumably modelers have compensated for this, but nowhere is this stated in the report.

[1] Tom Wray, public presentation, Cascabel, Arizona, January 13, 2010.

To fully assess the economic impact of SunZia on Arizona and New Mexico, it is essential to know where employees will be hired, where ancillary jobs will be created, and thus where money will be spent. How the report portrays job numbers does not make this possible.

Adjusting Photovoltaic Jobs Numbers

Review of Other Photovoltaic Projects

What initially alerted me that something was seriously wrong with the SunZia photovoltaic job numbers was the great imbalance between them and those for the Topaz and Desert Sunlight photovoltaic projects in California. These two projects total 1,100 MW in capacity compared with 800 MW for SunZia jobs projects. The total number of job-years of work, including indirect and induced jobs, for these two California projects was 3,619, yet for the SunZia projects, which had nearly one-third less capacity, the total job-years of work was 22,016. Part of the mismatch results from the lack of full inclusion of material supply jobs for the California projects, but this cannot explain such a large difference. When the California projects are proportionally sized to match the SunZia projects, the number of SunZia job-years is nearly an order of magnitude greater.

I compiled a list of the number of construction jobs associated with these and four other projects on the DOE website, and I give these in the table below. Excluding the number of jobs associated with the Mesquite Project, which gave peak employment rather than average employment, the number of construction jobs/100 MW of capacity averages ~120. Had the 890 jobs/100 MW of capacity given in the SunZia study been merely 89, the job numbers would have been more accurate. This suggests that this initial number is a typographical error.

Photovoltaic Projects

Project	Location	Capacity (Megawatts)	Construction Jobs	Jobs per 100 MW
Agua Caliente	Yuma Co., AZ	290	up to 400	up to 138
Antelope Valley Solar Ranch	Los Angeles Co., CA	230	350	152
California Valley Solar Ranch	San Luis Obisbo Co. CA	250	350	140
Desert Sunlight	Riverside Co., CA	550	550	80
Mesquite Solar 1	Phoenix, AZ	150	up to 300	up to 200
Topaz Solar Project	San Luis Obisbo Co., CA	550	400	73

I obtained three economic impact studies that calculated actual construction (labor) job-years of work associated with photovoltaic projects (California Valley[2], Desert Sunlight[3], and Topaz[4]), and scaling them proportionally to 100 MW of capacity gives 272, 173, and 218 job-years of work, respectively, again far below the 890 figure given in the SunZia report. While it is

[2] Available from http://www.californiavalleysolarranch.com/pdfs/Economic_Impact_to_SLO__Final.pdf. Accessed January 15, 2012.
[3] Available from http://www.desertsunlight.com/~/media/WWW/Files/Microsites/Desert-Sunlight/Report_EconomicImpactReport.ashx. Accessed January 15, 2012.
[4] Available from http://www.topazsolar.com/~/media/WWW/Files/Microsites/Topaz/TopazEconomicStudy.ashx. Accessed January 15, 2012.

somewhat difficult to determine an appropriate number for recalculating all photovoltaic job and revenue numbers, this must be done for the study to have any validity. These other reports suggest that a reasonable number for construction jobs would be ~150 with a construction time of 1.5 years, which gives 225 job-years of work/100 MW. The number of years required to build these other projects suggests that 1 year is too short to construct a 100-MW facility. I cannot determine whether the direct jobs associated with material supplies should be adjusted by the same amount. I did so in my original analysis.

When these adjustments are made, the total number of job-years associated with the eight photovoltaic projects is approximately 5,500, with actual employment being about 3,700. This compares with the 22,016 job-years (equivalent to jobs in this case) given in the report.

Problem with the Location of Photovoltaic Material Supply Manufacturers

Again, a major problem with assessing the actual economic impact of these projects on Arizona and New Mexico is the lack of locations for manufactured materials. SunZia's presentation of these job numbers gives the impression that all of these jobs and any associated indirect and induced jobs will occur in Arizona or New Mexico. No solar panel manufacturers are located in New Mexico, although First Solar is a major manufacturer in Arizona. The largest manufacturers of solar panels reside in China and Taiwan.

The principal components of a PV system include the solar modules, mounts, electrical wiring and AC/DC inverters. While mounts can be manufactured locally and wiring can be purchased locally, the modules and inverters will be built outside New Mexico. Thus the majority of associated supply, indirect, and induced jobs will occur outside New Mexico. Whether this situation accrues to Arizona's advantage depends upon whether PV installers use First Solar for their panels or whether they use one of the larger standard PV manufacturers located elsewhere in the country or world.

Additional Ramifications of Photovoltaic Job Errors

Because the jobs numbers for photovoltaic projects are so greatly in error, this affects all of the revenue calculations derived from them for county and state income. Thus all of these revenues must be recalculated. In addition, because the mix of possible projects proposed for all 18 counties contain photovoltaic projects, all of the potential economic impacts of renewable generation on these counties must be recalculated. Some attempt must be made to determine the manufacturing location of the PV components in order to adjust material supply jobs and associated indirect and induced jobs. This is likely to sharply reduce employment numbers for at least New Mexico.

Other Renewable Generation Projects

Error in Solar-Thermal Job Numbers

While I have not found actual construction job numbers for other geothermal and wind-energy projects, I did find numbers for several solar-thermal projects on the Department of Energy's

website. Project summaries listed there indicate that the numbers used in the SunZia study are too low. Construction job numbers for the Genesis Solar Project, Ivanpah Solar Complex, and Mojave Solar Project suggest that a 160-MW solar thermal plant should support ~500 jobs for 2 years, resulting in 1,000 job-years of work. Tables 2.1.2 and 2.1.3 in the SunZia study list 500 job-years of work for this amount of capacity, suggesting that construction jobs were not converted to job-years in computing economic impacts.

It is unclear whether the associated supply, indirect, and induced jobs need adjustment also. Comparing the relative abundances of job numbers in all job categories for other project types does provide solid guidance in determining this. It is possible that merely the construction job-years are in error, which could partially affect the number of induced jobs calculated. SunZia and the modelers need to further examine this to determine if additional corrections are needed.

Hiring Location and Material Supply Problems for Other Project Types

Again, hiring location and the location of material supplies greatly affects job numbers and related revenue streams for Arizona and New Mexico. As mentioned in my original analysis, 80% of the construction jobs associated with New Mexico wind turbine installation will go to workers outside New Mexico. Because no manufacturers of wind turbine components are located in New Mexico, most of the associated material supply jobs will be located outside New Mexico, as will most of the related indirect and induced jobs.

Again, SunZia's manner of referencing these numbers makes it appear that these jobs will be in New Mexico, which significantly inflates job expectations. The total number of jobs associated with wind installations was given as 5,632 (derived from 8,448 job-years). After adjusting for out-of-state workers and out-of-state material supply jobs, the number of jobs available to New Mexico workers would be ~1,100. If wind project size were 200 MW instead of 100 MW, this would reduce employment to 550, but workers would work twice as long to complete all projects, conserving job years of work.

This problem of manufacturer location affects solar-thermal and undoubtedly geothermal projects also. For the Mojave Solar Project, 20% of the materials will come from overseas, while the remaining supply manufacturers are located in six states. Again, this affects the location of indirect and induced jobs and tax revenues associated with them. While I did not research geothermal installations, I assume that components will be widely distributed as well.

Comments on Renewable Project Mix

The mix of renewable generation projects given in the SunZia study is hypothetical and as such is unrealistic in light of what is feasible. SunZia references these job numbers as though they are concrete and that all of these jobs will materialize if SunZia is built. This will not occur and is misleading. Several factors make construction of the proposed mix of renewable generation unlikely. The SunZia project itself is extremely vulnerable economically because these projects cannot be built with certainty. While other companies may have expressed interest in building renewable generation to use SunZia, obtaining the hundreds of millions of dollars in loans to build that generation and committing the money to these projects is difficult and risky. The

following lists several factors that make the full build-out of the proposed renewable generation mix unlikely.

- *Low Capacity Factors and Inefficient System Utilization*. A major problem with this mix is the low capacity factors of solar PV and wind, which are ~20% and ~33%, respectively. This means that for 800 MW of installed PV capacity, only 160 MW of power is generated on average, and for 1,200 MW of wind generation capacity, only 400 MW of power is generated on average. This translates to an average capacity factor of 28%, which translates to a system utilization of the same percentage. Solar thermal, geothermal, and natural gas have capacity factors of ~65%, which would raise the overall system utilization to between 30% and 40%, but this would still be very low for a system of this regional significance. The less power that a system carries, the less economically viable it is. A system utilization of 75% for a large-scale transmission project would be optimum both physically and financially and requires a different energy mix.
- *The Need for Large Amounts of Nonrenewable Energy to Stabilize Power Output*. The use of highly variable generation such as solar and wind requires that such generation be coupled to an equivalent amount of nonrenewable generation. The system cannot function effectively without this. Conceiving of SunZia without taking this into account leaves an important component out of the system, although nonrenewable generation located outside the system will partially compensate for this. This nonrenewable generation is needed to support the system physically and financially.
- *The Time Required to Build Generation Facilities*. The modeled scenario assumes that most of this renewable generation will be built quickly during or following construction of SunZia, when it will most likely be built over time if the project is built. It would not be unrealistic to expect a construction period of 20 years for this much generation. If this capacity is not built quickly, however, SunZia will fail financially, and investors cannot justify building the project. A 500-kV line costing up to $1 billion cannot sit unused for 10-15 years. This is the prospect that SunZia faces, which makes a full, initial build-out of the project extremely risky financially.
- *The Lack of a Need for the Power*. This project is predicated on the basis that states such as Arizona and California will require additional renewable power to meet their renewable portfolio standards (RPSs), yet Arizona is well on its way to meeting its RPS with its own solar energy[5], and California has warned the Western Electricity Coordinating Council against building long interstate lines to deliver renewable energy to the state because it believes that it can meet its RPS with its own renewable sources[6]. This weakens the need for New Mexico power and the justification for SunZia.
- *The Need for Federal Loan Guarantees and Subsidies*. While wind facilities can be built profitably by private investors without federal support, both solar PV and solar thermal facilities require hundreds of millions of dollars in federal aid to be built. The proposed 800 MW of solar PV capacity would require $2–3 billion in federal loan guarantees, and the 320 MW of solar thermal capacity would require ~$1.5 billion in federal loan guarantees. The

[5] Susan Whittington, "Arizona Solar: Victim of Success?", *Energy Prospects West*, December 6, 2011. Available at http://www.roselawgroup.com/blog/wordpress/?p=40326. Accessed January 16, 2012.
[6] John Farrell, "California Governor Tells Western Grid: No Renewable Energy Imports Needed," *Renewable Energy World.com*, November 3, 2011, http://www.renewableenergyworld.com/rea/blog/post/2011/11/california-governor-tells-western-grid-no-renewable-energy-imports-needed. Accessed January 12, 2012.

federal government has already spent enormous sums on such facilities. It is uncertain whether the federal government allocate additional funds for these new projects.

- *System Use by Natural Gas Generation*. SunZia has no control over what type of generation will use its system. The transmission system must be open to all operators. SunZia traverses prime natural gas generation territory, and owners of existing natural gas generation will unquestionably expand it at some time and request use of SunZia. While SunZia's transmission capacity is rated at 3,000 MW, approximately 10% of this capacity cannot be sold in order to maintain system reliability in case of grid failure elsewhere. Thus only 2,700 MW of capacity is available for sale, leaving just 280 MW of system capacity for nonrenewable generation in the modeled scenario. This is unrealistically small. In addition, the SouthWestern Power Group initially proposed SunZia to serve its 1,000-MW Bowie, Arizona, natural gas-fired power plant. SWPG needs 500 MW or more of this capacity to fully build its plant, and the magnitude of renewable energy generation in this scenario is insufficient for SWPG's own needs.
- *Utilities Need Reliable Power*. While public utilities are legally mandated to increase their usage of renewable energy, they must have enough nonrenewable generation online to meet their full power needs in case solar and wind facilities are not producing power. These utilities ***must*** provide power when it is needed, and they will always be seeking additional nonrenewable generation to maintain full system reliability. Not using SunZia to meet some of these additional power requirements greatly limits the system's usefulness and robustness.
- *Transmission Capacity Dependent Upon Generation Capacity*. Lastly, while renewable generation needs transmission capacity to be utilized, a transmission system needs generation capacity in order to be built. If that generation capacity does not materialize, the project will fail. While some companies have expressed interest in building generation facilities near SunZia, the magnitude of generation required to support the system will accrue only in small increments. The generation proposed to support this system is nothing like that of a 2,000-MW coal-fired power plant. This uncertainty places SunZia at great financial risk.

All of these factors indicate the need for a more realistic generation mix for SunZia. Such a mix would need to include far more wind and natural gas generation. These factors also suggest the need to be very cautious in building this system and not to overbuild it to start with.

Summary

This discussion highlights several problems with the presentation of results from the SunZia economic impact study and with assumptions used in calculating jobs associated with renewable generation facilities. Equating job-years of work with jobs has greatly exaggerated the job potential of the project and created confusion. While the number of job-years of work is an important economic indicator, what is most important is how many people can have jobs.

SunZia employment will average ~482 people/year over the project's four-year construction period, with a peak employment of 780 in year 3. For all categories of employment combined, employment will average 1,550 people/year with a peak employment of 2,459. Lastly, the total number of job-years of work will be 6,200. SunZia itself will employ an average of 41 Arizona residents and 106 New Mexico residents, with peak employment being 65 and 169, respectively.

An additional problem with the study is determining how many Arizona and New Mexico residents will have jobs. The study states that only 30% of the people hired for construction will be from these states (job numbers given above), and the locations of jobs associated with the manufacture of materials are not given. Most of these materials are likely to be manufactured outside these two states, and thus the jobs associated with them will be elsewhere.

A general adjustment for these factors indicates that the average number of people employed in Arizona for all categories will be ~180 with a peak employment of ~285, and the average number of people employed in New Mexico will be ~320 with a peak employment of ~510. Average employment in these states will be somewhat less than 10% of the number that SunZia promotional brochures suggest (2,200 and 3,900, respectively). These new numbers are derived by (1) converting job-years of work to jobs, (2) removing people hired from out of state, (3) adjusting for jobs associated with materials manufactured out of state, and (4) reducing the number of induced jobs somewhat to compensate for the saving of wages and payment of debts.

A major revision of the jobs and revenue associated with photovoltaic (PV) projects is required for renewable generation modeling to be valid. The error in jobs for solar-thermal projects is also significant, requiring additional recalculations. Actual PV jobs are approximately 17% of that of the number given in the current study, and the number of solar-thermal construction jobs should be approximately twice that in the current study.

Using 150 construction jobs/solar PV project gives 1,200 construction jobs rather than 7,120, as derived in the study. Total solar PV job-years of work would be ~5,500 rather than 22,016. It is uncertain how material supply, indirect, and induced jobs should scale. If the other jobs scale in the same way that construction jobs do, then total average employment/year for all photovoltaic projects combined would be ~3,700. This underscores the magnitude of the error in model input parameters, which translates into gross miscalculations of job numbers and tax revenues.

For solar-thermal projects, total construction employment for both states combined should be ~1,000 rather than 500. Total job-years of construction work should be 2,000 rather than 1,000. It is unclear whether the other employment categories should be similarly scaled, and modelers must research this before redoing job and revenue projections.

A problem, again, with total renewable job projections for Arizona and New Mexico is the hiring of workers from out of state and the location of manufacturing facilities for needed materials. Fifty percent of construction jobs for solar PV, solar-thermal, and geothermal projects will go to outside workers. For New Mexico wind projects, 80% of workers will be hired from out of state, and nearly all materials for the installations will be manufactured out of state. Thus of the 5,632 jobs (derived from 8,448 job-years of work) projected for wind installations in New Mexico, approximately 1,100 of them would go to New Mexico workers if 90% of the materials are manufactured elsewhere. Manufacturing location would sharply reduce jobs related to solar-PV projects in at least New Mexico.

Lastly, a variety of factors make the mix of renewable generation projects used in modeling unrealistic. A more reasonable mix would include a higher number of wind projects and significant natural gas generation. Solar installations would need to be rather sharply reduced in

number. And again, all generation projects in the supplemental study are hypothetical, and the jobs projected from them are thus very uncertain. Because of the time needed to permit and construct these projects and because of the great uncertainty in whether they will actually be built, investors must be very cautious about committing to SunZia and overbuilding the project at the beginning.