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Nannochloropsis salina, 1776 sp. *(Doug Lynn's Nanno)*
Photo courtesy of CEHMM and Sapphire Energy, Inc.

Economic Impacts of an Algal Industry on New Mexico

Testimony to the New Mexico State Legislature: Science, Technology, and Telecommunications Committee

State Capitol, RM 311 Santa Fe, NM

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Note: All results presented herein are preliminary and the sole responsibility of the author.

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Introduction

- We need a reliable, safe source of liquid transportation fuels
  - 46% of our crude oil comes from Venezuela, the Middle East, North Africa, and Russia (US Energy Information Administration, 2007).
- We need an environmentally preferential source of critical fuel supplies
  - A fuel that produces at least 50% fewer greenhouse gas emissions relative to the fossil fuel equivalent;
  - A fuel that does not compete with agricultural resources (land, water, nutrients); and
  - That minimizes the use of environmental resources.
- New Mexico is at the forefront of algal fuel innovation because of the availability of resources -- non-arable land, sun light, CO_2, non-potable water, energy and agricultural infrastructure.
- Algae can be grown on non-arable land using non-potable water and non-competing nutrient and economic input sources.

*Source: Photo and Concept from Sapphire Energy Incorporated, 2009; US DOE EIA.

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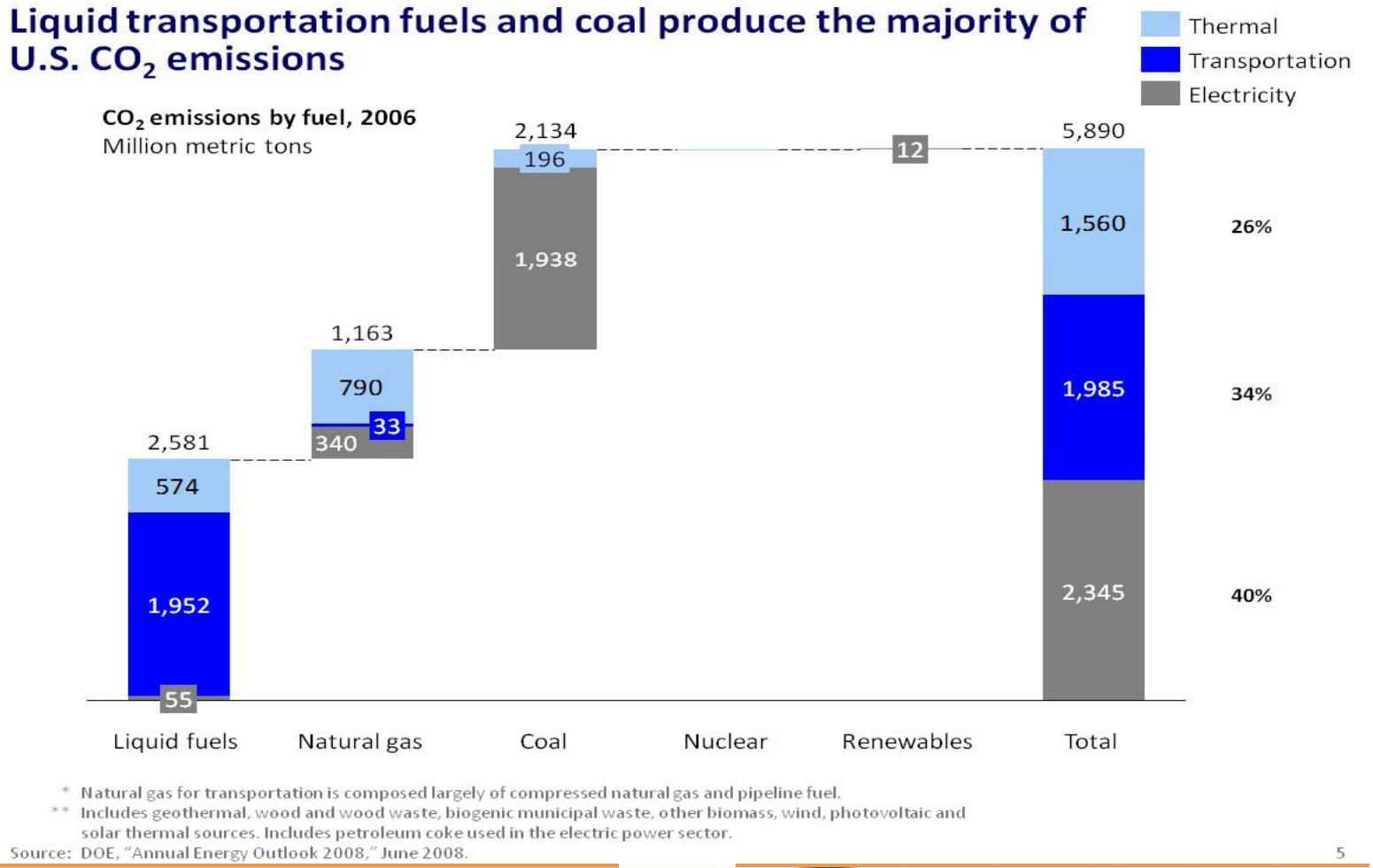
Sustainable Economic Development means reducing our Carbon Footprint while producing the critical energy supplies needed for our economy. It also means using our domestic resources (i.e., labor) instead of importing critical economic inputs.



Source: Sapphire Energy, Inc. 2009

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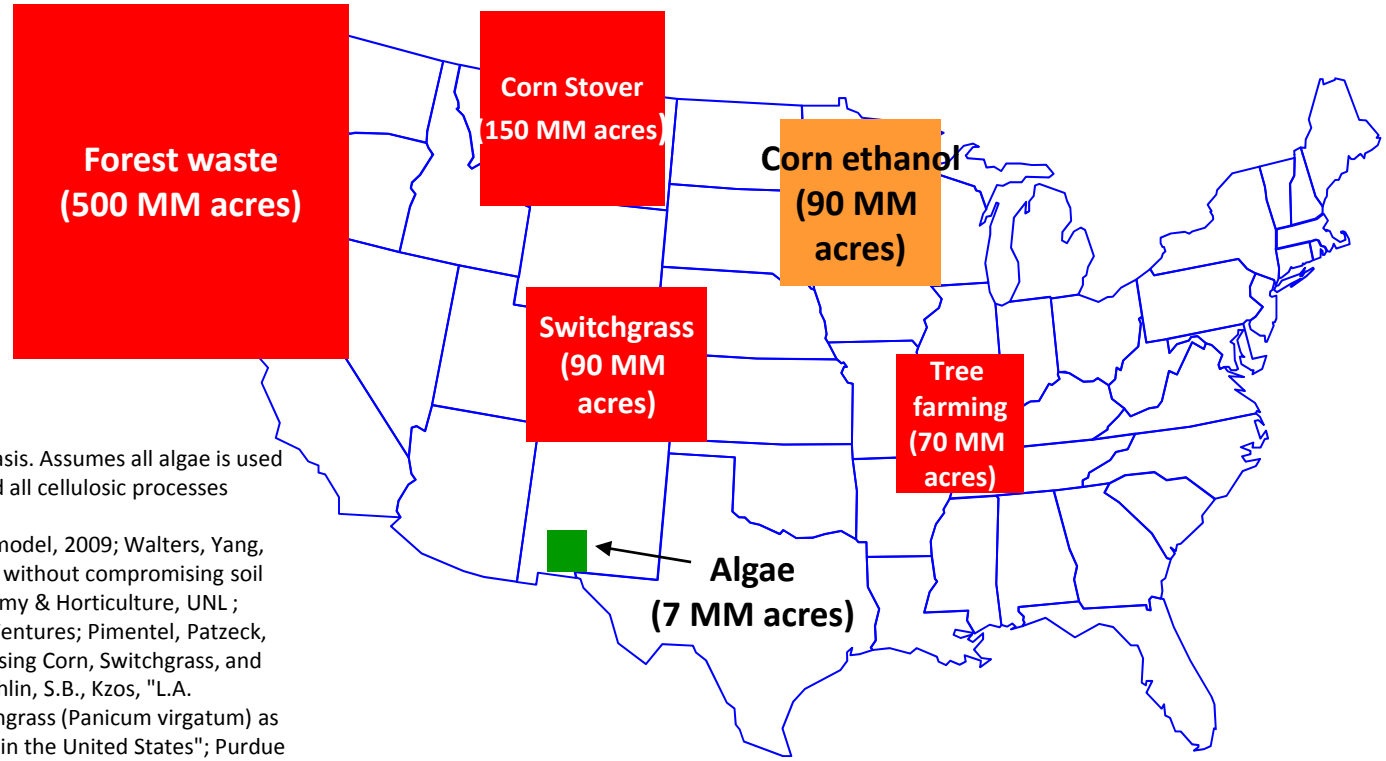
The land required for algae to displace 15% of US transportation fuel usage is a fraction of that of other feedstocks



Note: Calculated on a BTU basis. Assumes all algae is used to produced diesel and all cellulosic processes produce ethanol.

CA Air Resources Board, GREET model, 2009; Walters, Yang, "Corn Stover removed without compromising soil quality", Dept. Agronomy & Horticulture, UNL ; Vinod Khosla, Khosla Ventures; Pimentel, Patzeck, "Ethanol Production Using Corn, Switchgrass, and Wood", 2005; McLaughlin, S.B., Kzos, "L.A. Development of switchgrass (Panicum virgatum) as a bioenergy feedstock in the United States"; Purdue University, "Fast-Growing Trees Could Take Root as Future Energy Source"

Source: Sapphire Energy Incorporated, 2009.

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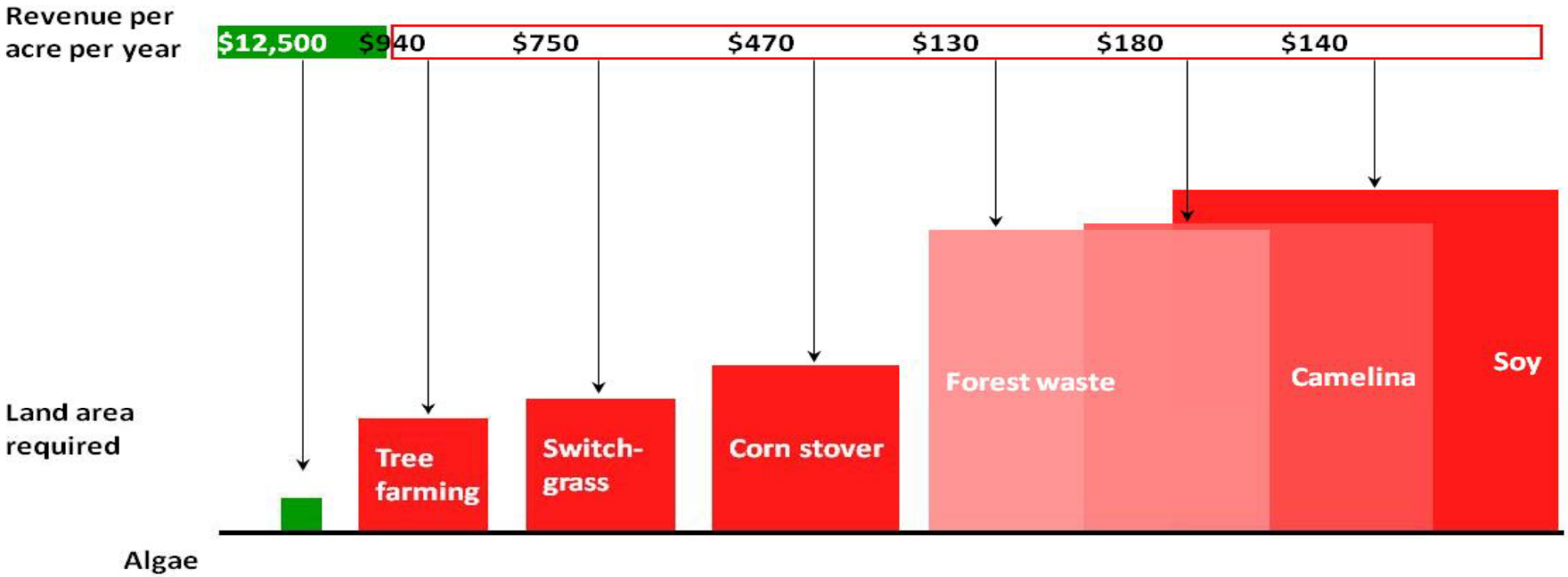
Introduction



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Source: Sapphire Energy Incorporated, 2009.

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Introduction

- The development of an algal biofuels industry in New Mexico has the potential to create significant economic opportunities.
- The magnitude of these impacts is highly uncertain since the industry does not yet exist.
- Using information from numerous sources, the potential economic impact from a 100 million gallon per year facility has been estimated using the REMI economic modeling platform.
- REMI allows users to estimate the effect on employment, taxes, output, and other key economic and demographic variables from policy and industry changes.
- *Under US DOE funded work, NAABB is conducting a complete economic impact analysis of algal fuels. The results here are first stage preliminary results.*

Methodology

- Information from CEHMM, Sapphire, and NAABB was incorporated with information from US Energy Information Administration and the US Department of Agriculture to predict impacts in REMI PI+.

- NMSU Arrowhead Center has a 169 sector model for New Mexico from Regional Economic Models, Inc (REMI). This dynamic simulation I-O software was used to estimate the employment, value added, and state tax revenue impacts from an advanced biofuel sector in New Mexico between 2008 and 2020.

Assumptions

•Employment information from the two operational Integrated Biorefineries in New Mexico was entered into REMI for years 2008 through 2020 into the Oil and Gas Extraction Sector.

•The Oil and Gas Extraction sector was used because it is the most similar to the end product and labor distribution type of algal crude production.

•Algal crude production will be a mix of agriculture and crude oil production, support, refining, and distribution.

•Current National Input-Output tables do not contain an algal industry and a baseline approximation must be used.

•Under NAABB funded efforts work will be conducted to modify the Oil and Gas Extraction industry to reflect the agricultural aspects of algal crude production.

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Inputs

Renewable Fuel Standard 2 (Energy Independence and Security act 2007)						
	Volume Requirement (billions of gallons)		Volume Requirement (Gallons)		Volume Requirement (Barrels)	
	Advanced Biofuel	Total RF	Advanced Biofuel	Total RF	Advanced Biofuel	Total RF
2008	-	9	-	9,000,000,000	-	214,285,714
2009	1	11	600,000,000	11,100,000,000	14,285,714	264,285,714
2010	1	13	950,000,000	12,950,000,000	22,619,048	308,333,333
2011	1	14	1,350,000,000	13,950,000,000	32,142,857	332,142,857
2012	2	15	2,000,000,000	15,200,000,000	47,619,048	361,904,762
2013	3	17	2,750,000,000	16,550,000,000	65,476,190	394,047,619
2014	4	18	3,750,000,000	18,150,000,000	89,285,714	432,142,857
2015	6	21	5,500,000,000	20,500,000,000	130,952,381	488,095,238
2016	7	22	7,250,000,000	22,250,000,000	172,619,048	529,761,905
2017	9	24	9,000,000,000	24,000,000,000	214,285,714	571,428,571
2018	11	26	11,000,000,000	26,000,000,000	261,904,762	619,047,619
2019	13	28	13,000,000,000	28,000,000,000	309,523,810	666,666,667
2020	15	30	15,000,000,000	30,000,000,000	357,142,857	714,285,714
2021	18	33	18,000,000,000	33,000,000,000	428,571,429	785,714,286
2022	21	36	21,000,000,000	36,000,000,000	500,000,000	857,142,857

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Inputs

Algal Industry Assumptions (Scaling to 100 Million Gallon per Year Firm) *							
	gallons/year	barrels/year	acres needed	Employees Needed	Algal Crude Oil Product Sales	Producers Tax Credit (HR4168)	Total Firm Revenues
2012	1,000,000	23,810	200	44	$ 934,487	$ 1,010,000	$ 1,944,487
2013	13,500,000	321,429	2,700	47	$ 12,615,580	$ 13,635,000	$ 26,250,580
2014	26,000,000	619,048	5,200	51	$ 24,296,672	$ 26,260,000	$ 50,556,672
2015	38,500,000	916,667	7,700	55	$ 35,977,764	$ 38,885,000	$ 74,862,764
2016	51,000,000	1,214,286	10,200	59	$ 47,658,857	$ 51,510,000	$ 99,168,857
2017	63,500,000	1,511,905	12,700	63	$ 59,339,949	$ 64,135,000	$ 123,474,949
2018	76,000,000	1,809,524	15,200	68	$ 71,021,041	$ 76,760,000	$ 147,781,041
2019	88,500,000	2,107,143	17,700	72	$ 82,702,134	$ 89,385,000	$ 172,087,134
2020	100,000,000	2,380,952	20,000	76	$ 93,448,739	$ 101,000,000	$ 194,448,739

- Based on information from Sapphire and CEHMM, the number of employees per scale of production was estimated. This labor distribution was then aggregated to provide total needed employees per unit of production.

- This is then scaled to an Nth scale facility of 100 million gallons per year to predict the number of employees in New Mexico engaged in algal crude oil production.

- Additional information from NAABB, US EIA, USDA, and House Resolution 4168 were used to estimate the key model variables.

*Note: (1) productivity is assumed at 5,000 gal/acre/yr; (2) 10 year average real price of WTI (1989-2009) was used for the per barrel cost of algal crude; (3) $1.01/gal producer credit.

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Results

First 100 Million Gallons of Algal Crude Oil			
Year	Employment	Value Added	State Revenue
2008	109	$ 6,000,000	$ 1,000,000
2009	177	$ 9,000,000	$ 2,000,000
2010	220	$ 12,000,000	$ 3,000,000
2011	973	$ 44,000,000	$ 10,000,000
2012	1,005	$ 46,000,000	$ 11,000,000
2013	880	$ 40,000,000	$ 10,000,000
2014	369	$ 21,000,000	$ 7,000,000
2015	351	$ 20,000,000	$ 7,000,000
2016	354	$ 21,000,000	$ 7,000,000
2017	369	$ 22,000,000	$ 7,000,000
2018	393	$ 24,000,000	$ 8,000,000
2019	422	$ 26,000,000	$ 8,000,000
2020	452	$ 28,000,000	$ 8,000,000

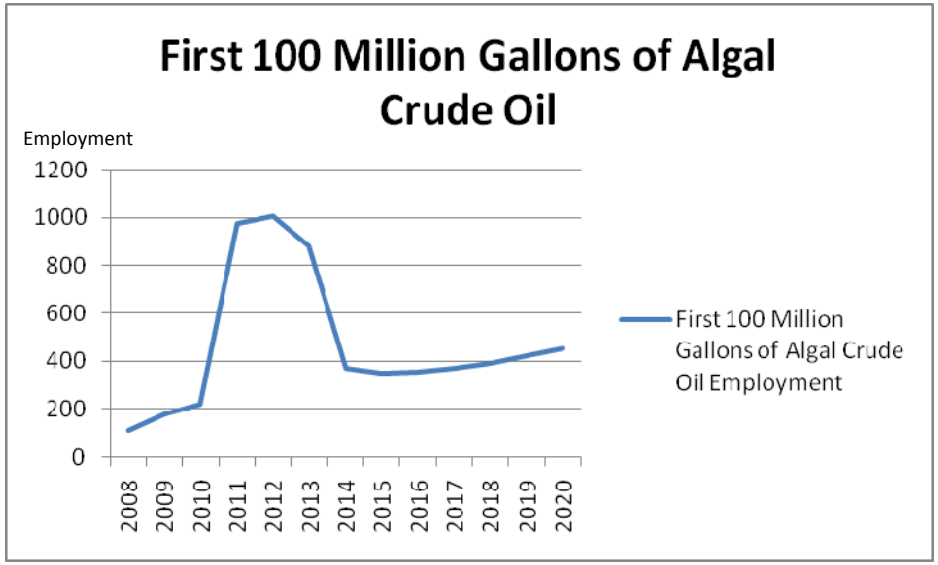
- Assuming the scale up of employment for the first 100 million gallon/year (MGY) and construction spending in 2011-2012 for the first large scale facility.

- These are totals (direct + indirect + induced) impacts on the New Mexico economy from one 100 million gallon per year firm.

Note: These values are *CHANGES* to the current baseline as predicted by REMI. They are additions to the predicted *LEVELS*.

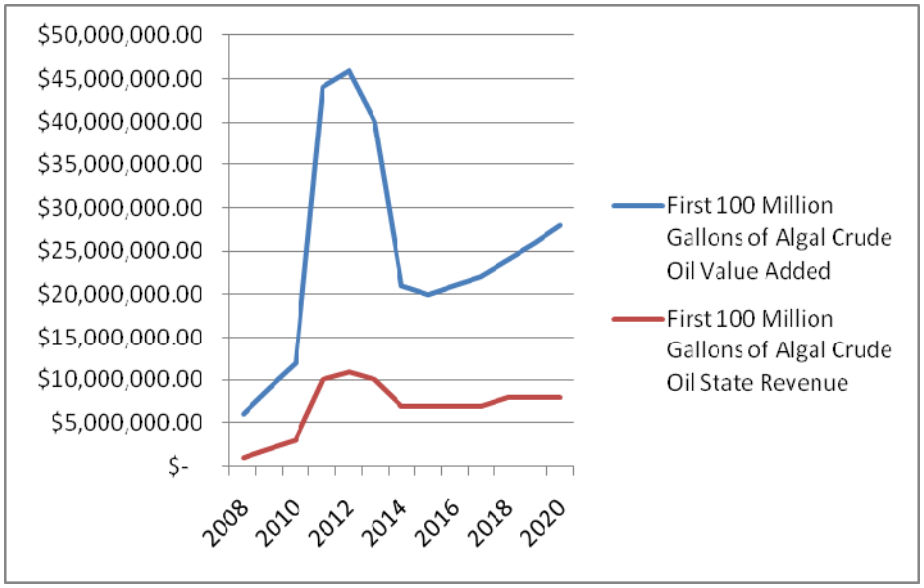
Note: Value Added is in 2000 USD

Results



Based on current estimates, the first 100 MGY production facility will result in a peak of employment in 2012 as construction peaks, then levels out to 452 total jobs in the state associated with 100 million gallons of algal crude.

For every 100 million gallons, it is currently estimated that total state revenues will increase by $8,000,000 due to increases in economic activity in the energy sectors and the multiplier effects derived from this activity.



Note: Value Added is in 2000 USD

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Results

Impacts from Scaling Up to Meet the Renewable Fuel Standard 2					
Meeting X% of Standard	**10%**	**15%**	**20%**	**25%**	**30%**
Number of 100 mgy units	21	32	42	53	63
Direct Employment	1,596	2,394	3,192	3,990	4,787
Total Employment	12,729	14,417	18,865	20,087	27,769
Value Added (2000 USD)	483,000,000	804,000,000	895,000,000	1,191,000,000	1,267,000,000
State Revenue	91,000,000	156,000,000	184,000,000	248,000,000	277,000,000

Good Baseline for New Mexico Advanced Biofuel Production over the next 10 years

Note:
Oil and Gas Extraction Total Employment in REMI (2007) is 7,934.

Highly UNLIKELY that New Mexico would capture 30% of the advanced biofuel market.

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Conclusion

- Algal fuel production has the potential to create significant employment and economic activity in New Mexico.
- Employment is likely to be a mix of agriculture, biology, chemistry, and engineering disciplines.
- Training will be required to meet the demands of this new industry. NMSU and our other academic institutions will play a vital role in helping to create this industry by providing tangible commercialization breakthroughs and by providing a trained workforce for the industry.
- Green energy is similar to existing energy sectors, but not identical and changes to the base economic sectoring will be required to accurately capture and predict the economic impacts from this developing industry.

Additional information, including a spreadsheet containing the assumptions and calculations is available upon request from the author.

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