

Net Social Benefit of Developing Energy from Biomass in Argentina: An input-output analysis for the province of Misiones.

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Introduction

Argentina Energy Sector Situation

Figure 1: GHG emissions by sector in Argentina

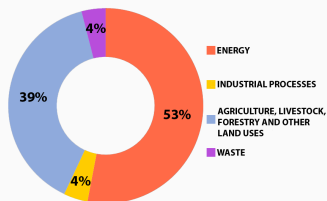
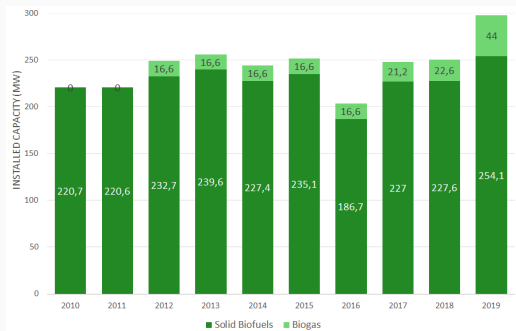


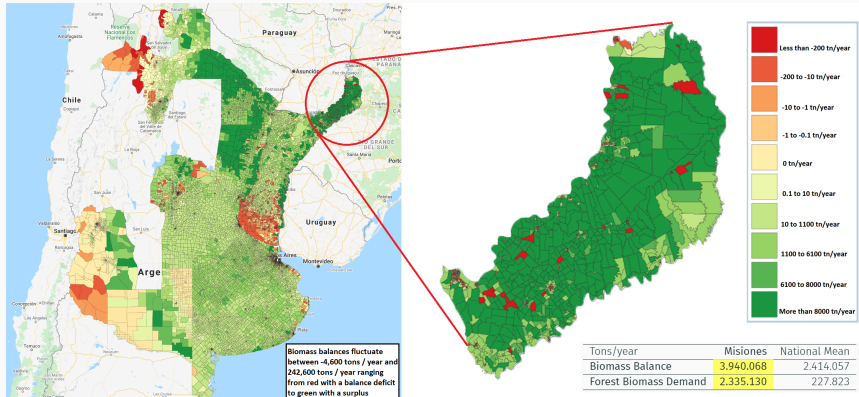
Figure 2: Installed capacity of bioenergies in Argentina



- **UN-SDG 7:** "Ensure access to affordable, reliable, sustainable and modern energy for all"

- **Law 27,191 (2015):** Renewable Energies reaching 20% by December 2025.
- **Law 27,424 (2017):** Distributed Generation of Renewable Energies integrated into the public grid.

Misiones Situation



- Misiones Total Installed Capacity: 323MW.
Biomass Installed Capacity: 83MW.
- Laws XVI-106, XVI-104, XVI-97 and the Net Balance Law.

Main objectives:

1. Evaluate the net social benefit of the development and the investment on bioenergy from biomass in Misiones.
2. Study and estimate characteristics of the forest biomass sector and its value chain in Misiones, due to lack of information in official statistics.
3. Using an Input-Output Model simulate production and investment scenarios and extract lessons for sectoral public policies and possible modifications of the current regulations.

Methodological Approach

1. **Regional Input-Output Matrix**
2. Regional Input-Output Model

Regional Input-Output Matrix

Data Sources

- Argentina Input-Output Matrix of 1997
- Economic census data for 2004.
- Supply and use tables for 2004.
- Level of occupation by activity sector of Misiones from the 2010 census.
- Crop data from Ministry of Agriculture, Livestock and Fisheries.
- WISDOM reports 2015-2018.
- Surveys to companies in the biomass sector.

Treatment

1. Transformation from the national matrix into regional matrix for Misiones, using *Flegg Location Quotients*, **indirect method**.
2. Information from surveys added on technologies, consumption and intermediate sales of the biomass sector, **direct method**.
3. Matrix balancing method: **RAS/** bi-proportional balancing technique.

Methodological insights

Regional Input-Output Matrix

MIS	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11	s12	s13	s14	s15	s16	s17	s18	s19	s20	s21	s22	s23	s24	s25	C_grov	X_grov	Df_resto	Total
s1	177.5	70.8	-	2310.5	17.9	123.3	0.3	27.1	121.3	0.0	0.0	0.0	0.3	-	-	-	-	0.2	1.4	116.9	-	-	2.0	5.4	1.4	1.683.0	-	535.1	5.175
s2	-	-	1484.0	-	-	-	-	24.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0	4.4	-	-	-	785.5	2.298
s3	-	-	2.7	2.6	0.3	0.3	0.3	-	-	18.0	0.3	0.0	0.2	0.2	0.0	0.2	44.0	-	-	0.9	-	-	7.5	1.3	0.0	3.3	-	111.5	1.94
s4	111.6	0.1	0.7	940.1	8.9	11.6	5.6	24.6	-	3.2	0.7	2.7	0.3	3.4	0.4	0.0	0.1	2.0	13.6	918.4	3.5	6.4	22.6	60.8	104.8	11.914	-	-	13.437
s5	1.6	0.4	0.0	7.3	6.2	1.3	2.8	-	-	0.3	0.3	1.0	0.2	1.4	0.0	0.0	0.0	0.3	4.8	3.0	0.9	0.9	3.6	4.3	11.9	250.7	-	-	303
s6	19.9	1.2	2.0	134.5	0.9	1.349.5	5.9	16.0	70.1	4.7	3.0	4.6	0.2	44.0	1.1	0.2	0.5	158.4	326.5	13.6	6.8	21.2	152.0	39.6	52.4	159.7	-	-	10.373.8
s7	5.2	3.7	0.3	57.5	2.2	9.8	10.4	0.3	0.2	1.2	1.3	11.8	2.7	7.2	0.2	0.0	0.2	10.8	15.9	5.9	25.7	0.3	11.3	3.8	16.5	180.2	-	-	170.8
s8	58.8	161.9	-	164.1	-	2.9	-	-	-	-	-	-	-	-	-	71.3	-	-	-	-	-	-	-	-	-	-	-	-	118.4
s9	-	-	-	-	-	407.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	59.3
s10	1.1	-	0.1	21.6	0.0	0.8	1.2	-	-	5.6	1.0	2.4	0.6	0.5	0.0	0.0	0.1	118.6	4.4	0.1	0.1	0.2	25.3	0.8	3.4	41.4	-	-	137.2
s11	0.7	-	0.1	6.8	0.1	2.1	1.5	-	-	0.6	2.5	20.1	3.9	2.2	0.6	0.0	0.2	36.3	1.1	0.2	0.8	2.6	4.2	0.6	2.3	32.7	-	-	196.7
s12	0.4	-	0.1	0.5	0.1	0.5	0.1	-	-	0.1	0.9	9.4	1.5	0.3	0.2	0.3	0.1	8.8	2.2	0.1	1.0	7.5	4.1	0.8	4.0	135.4	-	-	301.1
s13	0.1	-	0.0	0.1	0.0	0.0	0.0	-	-	0.0	0.1	0.8	0.4	0.0	0.0	0.0	0.0	0.8	0.7	0.0	2.3	0.1	0.1	0.1	0.3	15.7	-	-	81.4
s14	0.6	-	0.1	2.7	0.5	2.0	1.0	-	-	0.3	1.0	1.1	2.0	10.2	0.1	0.1	0.0	23.7	7.3	2.2	0.3	0.5	11.2	4.4	39.8	559.2	-	-	289.6
s15	1.7	-	0.5	2.4	0.1	1.2	0.5	-	-	0.3	0.3	0.4	0.2	0.2	0.2	0.1	0.3	1.4	2.0	0.8	9.3	2.4	6.5	4.0	7.2	4.5	-	-	64.7
s16	1.5	-	2.3	34.0	0.5	25.6	3.0	0.0	0.0	3.3	1.1	0.9	0.2	1.9	0.1	29.2	6.4	26.6	143.9	24.3	19.8	10.8	16.2	18.7	21.8	96.0	-	-	1170.3
s17	0.2	-	0.1	3.8	0.0	0.3	0.3	-	-	0.1	0.1	0.1	0.0	0.2	0.0	0.0	0.0	-	2.5	4.7	0.2	1.7	8.3	5.8	114.4	-	-	104.2	
s18	2.2	-	0.2	-	-	-	-	0.0	0.0	0.1	0.2	0.0	-	-	0.0	2.6	4.9	-	55.2	2.6	26.6	7.8	400.8	91.7	57.9	-	-	-	11.612.0
s19	171.2	37.6	8.2	880.6	17.0	174.6	46.2	0.0	0.0	15.1	22.6	51.7	10.4	55.7	5.5	9.1	11.1	819.3	832.3	354.0	208.2	75.8	459.2	205.5	584.4	1.903.6	-	-	24.280.5
s20	20.8	0.3	0.3	116.5	1.9	27.2	12.5	-	-	6.2	9.1	13.9	2.3	13.0	4.1	1.1	0.2	1.1	40.1	98.8	26.1	26.4	85.8	105.7	109.9	1.153.6	-	-	2.991.9
s21	138.4	30.0	7.8	143.4	3.1	21.2	16.3	-	-	8.0	7.6	11.4	2.6	9.8	1.6	0.2	29.4	44.5	84.7	53.8	230.7	63.3	76.4	43.0	47.4	2.758.1	-	-	4.465
s22	0.9	-	0.9	26.9	0.8	4.2	3.3	-	-	1.4	1.7	3.7	0.4	1.3	0.3	0.2	1.0	2.4	59.5	6.3	28.7	74.4	120.1	37.1	48.0	845.9	-	-	340.4
s23	43.8	1.1	16.4	175.1	4.7	42.4	20.3	-	-	8.9	12.5	18.8	2.1	16.9	4.4	5.1	11.3	54.9	827.0	277.6	320.5	189.6	1079.6	345.4	632.1	4.160.3	-	-	8.777.9
s24	3.4	-	2.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23.6	0.0	-	-	9.4	7.4	0.5	782.9	0.0	-	-	14.857.9
s25	16.4	0.3	1.1	10.4	0.1	4.0	0.8	-	-	0.3	0.4	0.7	0.1	0.3	0.2	0.1	0.1	18.8	44.3	4.7	29.2	38.1	135.5	208.5	986.3	4.317.9	-	-	4.775.2
CL_ARG	685.3	370.1	25.2	1.117.9	24.3	2.892.6	138.8	139.7	81.7	48.0	59.3	43.9	7.8	-	12.1	489.3	43.3	2.902.4	4.659.1	932.5	206.0	1362.1	2060	1260.1	1.291.8	1.542.7	-	-	-
CL_M	128.8	55.9	3.9	203.9	12.9	779.7	53.0	-	-	14.0	21.5	48.7	14.8	-	8.5	177.7	6.6	954.6	645.8	84.2	231.4	71.8	337.5	-	-	-	-	-	-
T	374.6	165.2	2.8	2.295.7	47.8	876.1	45.2	54.3	30.4	18.4	12.8	46.2	16.7	115.5	4.8	-807.4	21.9	191.9	256.0	579.4	283.7	162.3	1.506.3	18.9	774.1	-	-	-	-
L	924.0	354.1	9.8	970.6	74.3	1.529.4	41.7	80.2	45.0	46.2	66.4	49.7	15.9	495.2	9.1	369.2	29.8	3.514.0	11.643.0	431.9	1.322.5	88.2	3.225.8	10.817.4	3.534.5	-	-	-	-
K	1.932.6	896.2	97.6	1.411.6	47.1	2.876.9	91.7	164.2	92.1	1031.9	49.7	80.4	5.9	89.0	40.2	787.8	51.6	2.138.7	6.142.0	810.8	253.5	434.1	6.094.8	64.71	1.332.3	-	-	-	-
TL	156.9	56.2	3.6	480.9	23.2	669.1	24.9	19.2	10.8	72.2	23.6	20.0	9.2	44.5	7.7	290.0	23.4	648.2	2.440.5	113.4	379.3	43.1	1.040.3	1.498.7	561.9	-	-	-	-
TK	194.7	90.3	6.3	511.2	36.4	1.128.3	24.8	27.6	15.5	26.4	19.0	35.1	2.3	46.5	9.8	232.2	4.3	544.2	2.959.9	32.2	37.3	75.6	946.8	17.2	105.6	-	-	-	-
Total	5.375	2.298	194	13.437	303	12.962	555.5	577	467	367	319	480	103	960	111	1.658	247	12.265	31.239	4.869	4.647	1.610	17.049	15.488	10.594	30.370	0	82.750	137.975

- We obtain a 25 sector I-O Matrix including the **Forest Biomass sector**.
- The sectors important to disaggregate it were Agriculture, forestry and fishing, Paper and Wood, Chemical products.
- The industrial forestry sector consumes more than 80% of the total biomass demanded.
- Crops that contribute the most to obtain biomass are forest cultivation, yerba mate and tea plantations.

1. Regional Input-Output Matrix
2. **Regional Input-Output Model**

Regional Input-Output Model

- **Closed and Open Input-Output Models** based on Miller & Blair (2009).
- Use of **output and employment multipliers** to capture the difference between the initial effect of an exogenous change and the total effects of that change.
- **Simple or Type I multipliers**: direct and indirect effects. Open Models.
- **Total or Type II multipliers**: direct, indirect and induced effects. Closed Models.

Simulation Results

1. Scenarios
2. Results and Discussions

Scenarios

Table 1: Scenarios

Scenario	Shock	Justification
Scenario A	15% increase in production	Possible underestimation of installed capacity.
Scenario B	Increased investment to double production capacity 1) equipment locally produced in Misiones 2) imported equipment	Double the installed capacity.
Scenario C	WISDOM biomass potential impact	Make use of the 3,940,068 tons per year biomass surplus.

- Increases in final demand resulting from increases in final consumption of bioenergy and investment in the expansion of productive capacity are simulated.

1. Scenarios
2. **Results and Discussions**

Simulation Results

Scenario	ΔX						ΔL					
	Direct	Indirect	Induced	Total	mult 1	mult 2	Direct	Indirect	Induced	Total	mult 1	mult 2
A Production increase 15%	70	34	11	115	1,49	1,64	45	174	27	246	4,90	5,52
TOTAL	70	34	11	115	1,49	1,64	45	174	27	246	4,90	5,52

ΔX : increase in production in millions of \$ of 2015; ΔL : increase in employment; Total: direct, indirect and induced impacts; mult 1 and mult 2: type I and type II multipliers.

- A) • Total impact of 115 million pesos on provincial gross value of production (GVP).
- Total job creation of 246 new positions: **45 direct, 174 indirect** and **27 induced**.
- Multiplier effects on employment disaggregated by contribution by gender:
Female participation of 6% (open model) and 9% (closed model).

Simulation Results

Scenario	ΔX							ΔL					
	Direct	Indirect	Induced	Total	mult 1	mult 2	Direct	Indirect	Induced	Total	mult 1	mult 2	
A													
Production increase	15%	70	34	11	115	1,49	1,64	45	174	27	246	4,90	5,52
TOTAL		70	34	11	115	1,49	1,64	45	174	27	246	4,90	5,52
B.1													
Investment	83 MW	1.923	582	888	3.393	1,30	1,76	3.169	1.314	2.310	6.793	1,41	2,14
Production		985	484	148	1.617	1,49	1,64	628	2.448	385	3.461	4,90	5,52
TOTAL		2.908	1.066	1.036	5.010	1,37	1,72	3.796	3.762	2.695	10.254	1,99	2,70
B.2													
Investment	83 MW	846	149	489	1.484	1,18	1,75	2.121	311	1.270	3.702	1,15	1,75
Production		985	484	148	1.617	1,49	1,64	628	2.448	385	3.461	4,90	5,52
TOTAL		1.831	633	637	3.100	1,35	1,69	2.749	5.508	1.655	7.163	2,00	2,61

ΔX : increase in production in millions of \$ of 2015; ΔL : increase in employment; Total: direct, indirect and induced impacts; mult 1 and mult 2: type I and type II multipliers.

Investment

- B.1) • Total impact of 3.393 million on GVP.
 - Total job creation of 6.793 new jobs.
 - Female participation of 13% (open model) and 19% (closed model).
- B.2) • Total impact of 1.484 million on GVP.
 - Total job creation of 3.702 new jobs.
 - Female participation of 11% (open model) and 17% (closed model).

Production

- B) • Total impact of 1.617 million on GVP.
 - Total job creation of 3.461 new jobs.
 - Female participation of 6% (open model) and 9% (closed model).

Simulation Results

Scenario	ΔX						ΔL							
	Direct	Indirect	Induced	Total	mult 1	mult 2	Direct	Indirect	Induced	Total	mult 1	mult 2		
A	Production increase	15%	70	34	11	115	1,49	1,64	45	174	27	246	4,90	5,52
	TOTAL		70	34	11	115	1,49	1,64	45	174	27	246	4,90	5,52
B.1	Power increase	83 MW	1.923	582	888	3.393	1,30	1,76	3.169	1.314	2.310	6.793	1,41	2,14
	Production		985	484	148	1.617	1,49	1,64	628	2.448	385	3.461	4,90	5,52
	TOTAL		2.908	1.066	1.036	5.010	1,37	1,72	3.796	3.762	2.695	10.254	1,99	2,70
B.2	Power increase	83 MW	846	149	489	1.484	1,18	1,75	2.121	311	1.270	3.702	1,15	1,75
	Production		985	484	148	1.617	1,49	1,64	628	2.448	385	3.461	4,90	5,52
	TOTAL		1.831	633	637	3.100	1,35	1,69	2.749	5.508	1.655	7.163	2,00	2,61
C	Investment	215 MW	4.980	1.506	2.300	8.786	1,30	1,76	8.204	3.404	5.982	17.590	1,41	2,14
	Production		2.550	1.253	383	4.186	1,49	1,64	1.625	6.340	997	8.962	4,90	5,52
	TOTAL		7.530	2.758	2.684	12.972	1,37	1,72	9.829	9.744	6.979	26.552	1,91	2,58

ΔX : increase in production in millions of \$ of 2015; ΔL : increase in employment; Total: direct, indirect and induced impacts; mult 1 and mult 2: type I and type II multipliers.

- C) • Total impact of 12.972 million on GVP.
- Total job creation of 26.552 new jobs: 66% from installation of plants (17.590). Job creation of 8.962 positions during plants' lifespan.
 - Female participation of 13% (open model) and 19% (closed model) in the **investment phase**. Female participation 6% (open model) and 9% (closed model) female participation in the **production phase**.

Variant in the calculation of direct jobs

	Phase	ΔL					
		Direct	Indirect	Induced	Total	mult 1	mult 2
Scenario B	Production	88	2446	384	2.918	28,84	33,22
Scenario C	Production	227	6333	997	7.557	28,84	33,22

Total: direct, indirect and induced impacts; mult 1 and mult 2: type I and type II multipliers.

Sensitivity Scenario

- Previous simulations considered large scale biomass plants.
- Now we consider increase in installed capacity through small and medium-sized plants (lower direct employment requirements).
- Considerable **increase in employment multipliers** in both the open and closed models, from 4,9 to 28,44 (type I) and from 5,52 to 33,22 (type II).
- **Direct employment** generation **decreases** from 628 new positions to 88 (B) and from 1.625 to 227 (C). **Indirect and induced employment** almost unchanged.

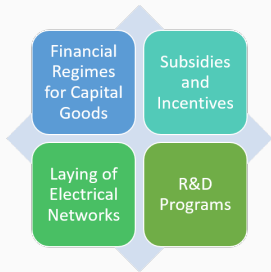
Conclusions

Conclusions

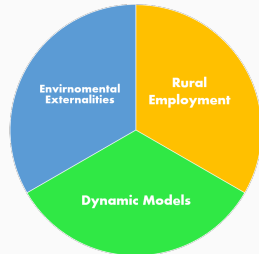
Summary

- We developed a Regional I-O Matrix for Misiones, a province which displays a great biomass potential.
- Using both the open and closed I-O Model we evaluated the impact on production and employment of different production and investment scenarios.
- Main findings: Impacts on production and job creation increased notably when considering locally produced machinery and equipment. Complementary with gender agenda to increase female participation in new jobs created.

Policy Suggestions



Extensions



Thank you for your attention
Questions, comments and suggestions are
welcome!