

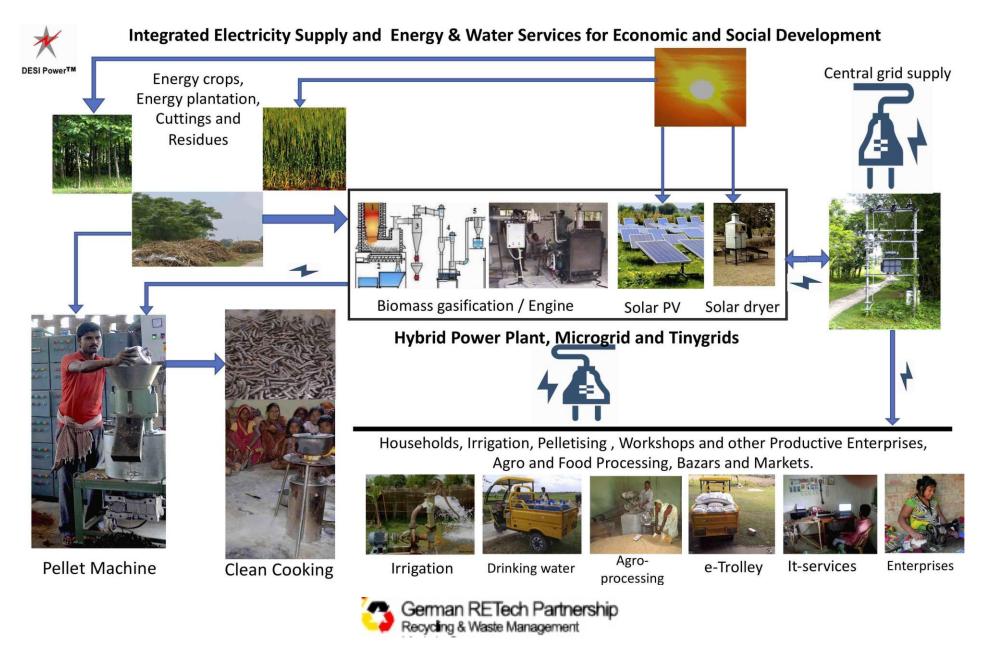
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Adequate quantities of agro-residues are available for meeting the needs of clean cooking of most of Indian villagers.

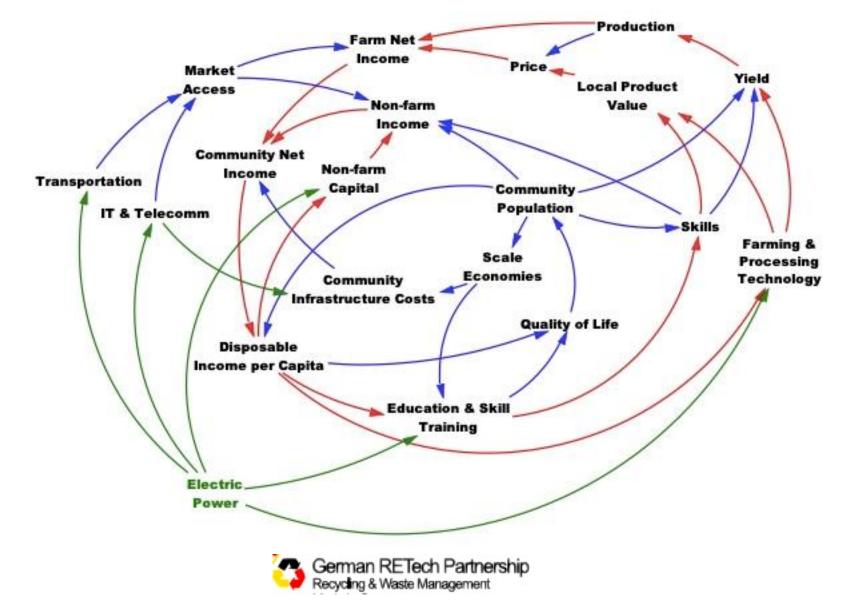
Agro-residues for producing pellets and using them for clean cooking	(For 164 million families livi	ing in villages in India)
Potential pellet production from total agro-	-residues	
Total agro-residues potentially available in India	mill.t/y	200
Argo-residues for making pellets	kg ar/kg p	1.1
Pellet production from total agro-residues	mill. t-p / y	182
Power generation potential using total available	agro residues	
Specific power consumption of agro-residues for producing pellets	kg-p/kWh	1.25
Annual hours of generation	h/y	5'000
Power potential using total available agro residues	kW	29'090'909
	MW	29'091
Demographic Data India. Source: Wikig	pedia	
Demographic Data India: Wikipedia	Year	2020
Total population	millions	1370
% in villages	%	60%
Pop. In villages	millions	82
Avg. per/family	No/fam	
No of families in villages	Millions	164
Average pop of villages (assumed)	No.	150
No. of villages	No.	548000
Pellets for cooking energy for all village families	(5 persons/family @ 0.5 k	g-p/person per day )
Daily consumption of pellets / fam	kg-p/d.fam.	2.5
No. of days / y	d/y	365
Annual consumption of pellets / fam	kg-p/y.fam	912.5
Annual consumption of pellets / fam	t/y.fam	0.9125
Total No. of families in Indian villages (as above)	million	164
Pellets needed for cooking by all families	mill.t-p/y	150
Pellets needed for generating power for produ	ucing pellets	
kWh needed to produce pellets (from pellet sheet)	kWh/kg-p	0.07
kWh needed to produce pellets	kWh/y	11'251'125'000
Running hours of m/c	h/y	2640
Power for Pelletising	MW	4'262
Power for Pelletising (% of total potential of power from agro-residues)	%	15%



In addition to clean cooking fuel, hybridising agroresidues and other suitable local renewable energy sources can provide power and energy services for social and economic development of villagers.



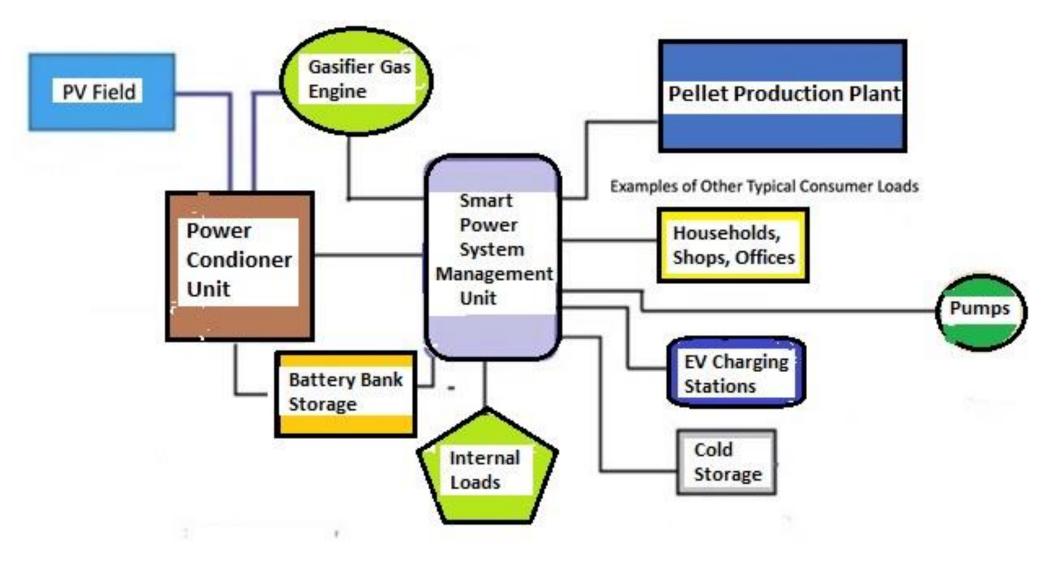
Example of the Modelling Process for Planning a Complex System using Vensim Software



An Example: Results of Simulation Modelling for the Planning of a Hybrid Power Plant for Integrated Village Projects **Real-Time Simulation Output for Key Variables Components of Metro Decision Options** Financials (2012-2026 cum) **Business** Investment **Quality of Life Energy Use** Population Revenue 300 2.5 14 **Positive Effect** Land Basic Infrastructure (annual target) Test run: 30.2 B 1.5 12 5 2 10 2.7 B 1 400 + Base run: 200 51.5 Skill 1 2 100 Smart Grid (annual target) Σ1 Financing Labor Force 200 + 0.5 Test run: 8.4 B 17.1 B Base run: 2001 2006 2011 2016 2021 2026 2001 2006 2011 2016 2021 2026 2001 2006 2011 2016 2021 2026 2001 2006 2011 2016 2021 2026 Transport New Mobility (annual target) **Ease of Commuting** Emissions (CO2 eq.) **Operational Spending** Jobs + 1.5 1.5 60 270 Taxes Net Cash Flow 12.6 B -0.5 Test run: 40 Operations -17.0 B **Building Upgrades (annual target)** Base run: 160 + -0.5 20.5 ō 20 Infrastructur 5 Repayment 5.9 B Building Technology (annual target) Test run: 1.5 **Negative Effect** 2001 2006 2011 2016 2021 2026 2001 2006 2011 2016 2021 2026 2001 2006 2011 2016 2021 2026 2001 2006 2011 2016 2021 2026 8.5 B -+ Base run: **Operational Adequacy** Population **Real Per-Capita Taxes** Unemployment Investment **Positive Effect** 1.5 4 Housing 10 Interest Rate % of Land t reted - 1.5 7.5 Test run: 4.0 % for Bu be 0.5 Jobs + 5.0 % Base run: 2.5 Transport 0.5 % of Budge ROI (after debt service) 11 2016 2021 2026 Taxes 2001 2006 2011 2016 2021 2026 2001 2006 2011 2016 2021 2026 2001 20 2001 2006 2011 2016 2021 2026 for by T 3.0 % Test run: 0 -44.8 % -93.0 + Base run: **Real GMP Per-Capita** Housing Density Assessed V **Real Debt Per-Capita** Operations 60 15 150 6000 -0.5 Infrastructure 40 p100 Reset to Ba Energy 8 20 m 50 2000 Reset to Test -1 Emissions 1.5 2001 2006 2011 2016 **Negative Effect** 2001 2006 2011 2016 2021 2026 2001 2006 2011 2016 2021 2026 2001 2006 2011 2016 2021 2026 Historical Data Business as Usual Investment aimed at Sustainability Attractiveness Chart Control Control Vary investment in Simulate as Test run port Data Simulate as Base run technology, energy, Compare alternate infrastructure, lear Data Clear Base **Clear All Runs** results, understand Clear Test run risks, improve the plan housing, ... Simulate 1000s of German RETech Partnership 5

Recycling & Waste Management

H. N. Sharan





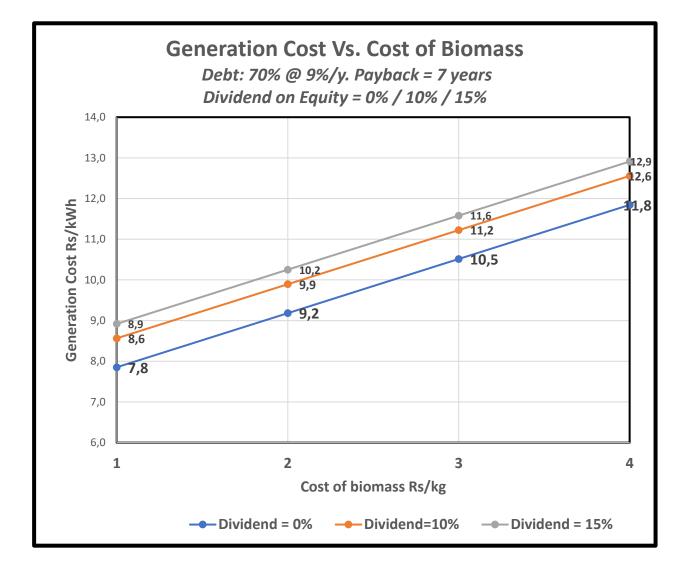
#### Total Cost (used in the example shown) Agricultural and Flantation Residues for Sustainable Social and Economic Progress of Villagers H. N. Sharan

The example given below is of a non-optimised Hybrid Power Plant and a Pelletising Unit for a Clean Cooking Fuel Business.

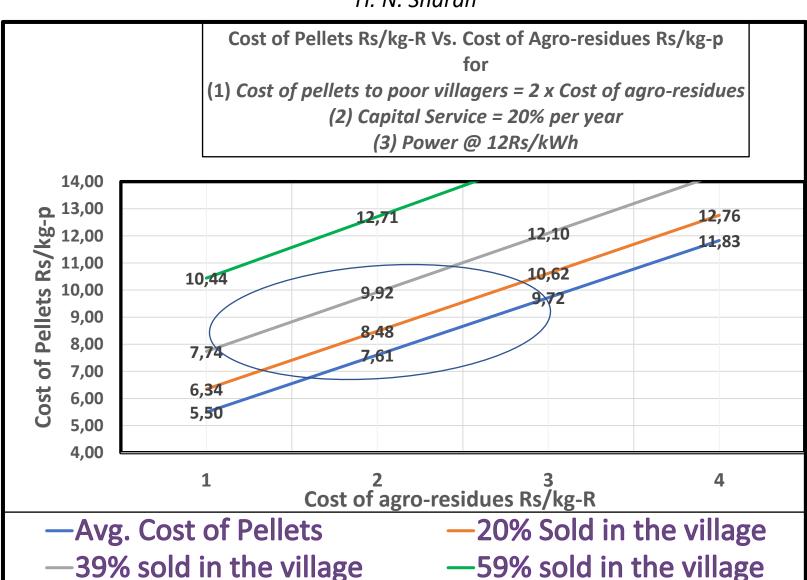
Biomass PV Hybrid Power Plant of (65 kW + 10 kWp) rating.
Consisting of:
Gasifier, PG Engine and Auxiliaries
PV Plant
Battery Bank
Auxiliary Systems
Microgrid Distribution Network
Not included:
Smart Control System
Pelletising Plant Complete: 500 kg-pellets/h

Total Project Cost (used in the example here): 9.5 million Rs / 106'000 Euro









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#### **Conclusion**s

The most effective, profitable and sustainable way of recycling of agroresidues is their commercialisation as pellets for clean cooking.

#### Our studies show that:

- Adequate quantities are available for meeting the needs of most of Indian villagers.
- Pellets used with energy efficient stoves can compete locally with other source of clean cooking (induction cooking, natural gas, LPG, clean biofuels and others under an equitable policy regime.
- Integrated with local power generation and micro grids, they will eliminate pollution and smoke-linked diseases, create local jobs, provide water services for farmers and electricity for households, shops and productive usage, e-transportation and IT services.



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#### **Conclusion**s

The most effective, profitable and sustainable way of recycling of agroresidues is their commercialisation as pellets for clean cooking.

# Our analysis shows that large-scale commercialisation will not be achieved unless:

- Integrated projects are planned and optimised for local conditions.
- Commercial-pilot projects are optimised, built and successfully operated in different regions of the country.
- The most promising locations for commercial-ilot projects are plantations and "Aspirational Villages" in agro-intensive parts of India where some of the poorest Indians live.
- Prospective owners, investors and equipment suppliers are convinced that policy frameworks, regulatory regimes and financing sources will be available for large scale commercialisation if commercial-pilot projects are successful.

