An Overview of the Practical Application of Renewable Energy Technologies to the Pumping of Ground Water for Agricultural Purposes in New Mexico

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Water and Energy

Needs Statement

- **Constituencies of NMSU have indicated that *water* and *energy* are two areas of pressing concern.**
- **With this in mind, NMSU College of Engineering teamed with the College of Agriculture Extension Services to provide information related to a specific area of both water *and* energy – *pumping of water* in remote or semi-remote locations.**

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Overall Objectives

- A *manual* to provide essential, basic information about various energy sources and their implementation in water pumping
- An easy-to-use *interactive spreadsheet* to lead users through an example design process for a PV-powered water pumping system. Wind and diesel are covered in other documentation
- A simple, *portable demonstration unit*

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Manual for Designers/Users

"SOLAR-POWERED LIVE STOCK WATER PUMPING SYSTEMS", Prof. Thomas Jenkins *et al.*
available via the NMSU web site

- Provide basic analysis for three energy sources: Solar, Wind, and Fossil Fuels for pumping water
- List the primary advantages and disadvantages
- Furnish a simple economical comparison
- Investigate Tracker vs. Fixed-rack analysis for solar systems

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Solar PV Pumping System

Source: http://www.wdmoore.com.au

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Overview:
Solar PV System Advantages

- Renewable and sustainable energy source:
  - Low environmental impact and low noise
- Very low operation and maintenance requirements with high reliability and long life cycle
- Can be installed in remote locations
- Decreasing capital cost trends and no fuel costs
- Federal and state incentives (positive tax benefits)

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Solar System Disadvantages

- Limited to daylight operation (most of NM is gifted with excellent and predictable solar energy). Efficiency depends on sun intensity
- Low volume flows - low gallons per minute pump capacities and therefore extended time to meet demand & storage requirements
- Supplemental storage of water is often needed (similar to wind)

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Solar Mounting Options

- PV panels may be mounted with:
  - Fixed rack: pointed south with tilt angle around 34° (about the latitude)
  - Single-axis tracker (follows sun east-to-west during day)
  - Two axis tracker (follows sun all year)
- Trackers capture more sun energy which may decrease equipment sizes and cost, but add additional cost for tracking hardware and complexity/maintenance

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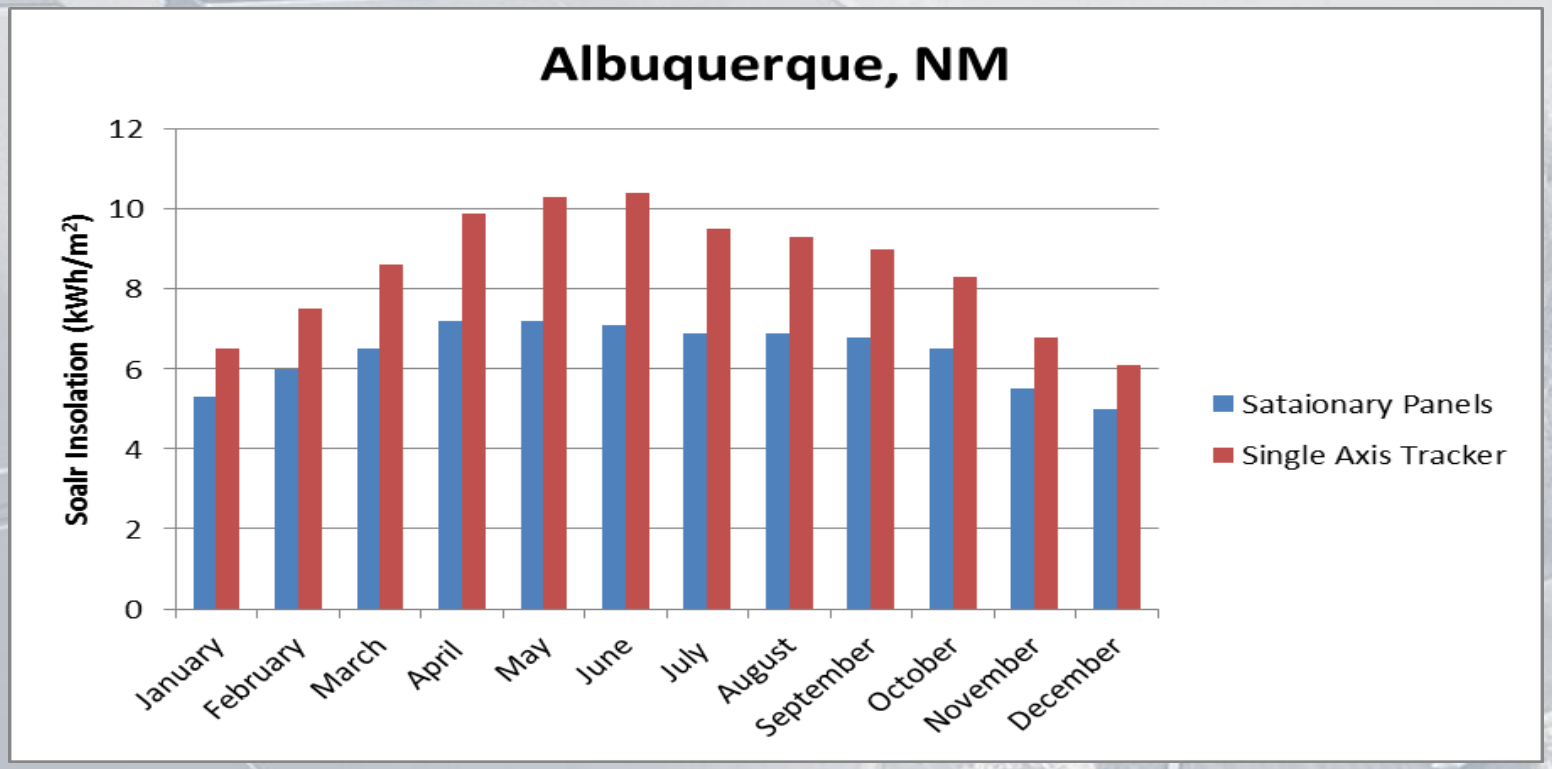
Tracker System vs. Fixed Panels



A solar tracker increases solar energy collected, results in fewer panels and smaller pumps: must be weighed against the additional cost of tracker and complexity/maintenance

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Windmill Systems

Wind Publications:
http://solar.nmsu.edu/
http://aces.nmsu.edu/ces/windmill/windmill-publications.html

NMSU Wind Technology Center
http://aces.nmsu.edu/ces/windmill/

Source: http://www.wdmoore.com.au

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Windmill System Advantages

- Renewable: Low environmental impact
- Remote area installations
- Proven technology – has been around a long time with good results – extensive experience and knowledge sets
- Federal and state incentives
- No fuel costs

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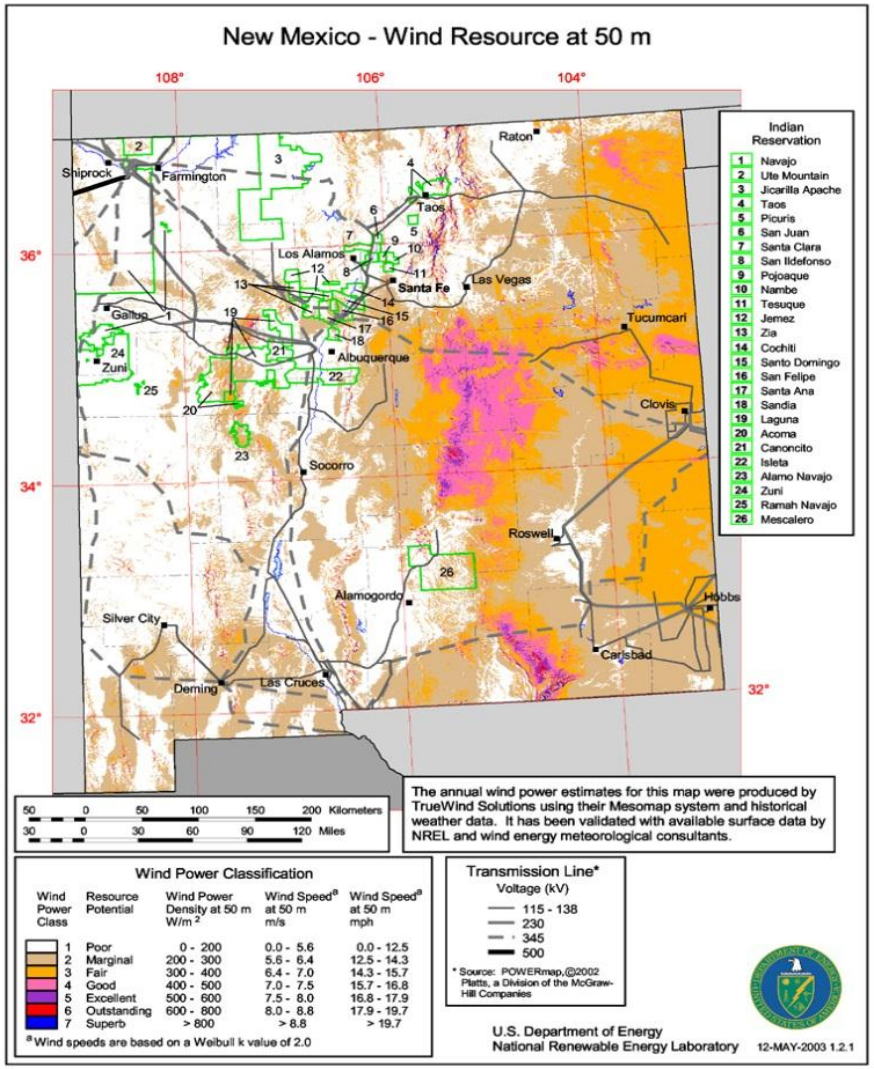
Wind Energy in New Mexico



Map of wind potential in NM: wind is best in Eastern NM and along ridge lines and mountains; often limited areas for livestock grazing and agriculture

Source: www.eia.gov

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Wind Energy Disadvantages

- Only works under adequate wind conditions
  - Efficiency achieved depends on manufacturer's specifications and site conditions
- Manual operation occasionally needed
  - High wind velocity can damage windmill and user intervention may be required
- Low flow rates
  - Long time to meet water & storage requirements
- Periodic maintenance required

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Fossil Fuel (Diesel) Advantages

- High water volume flow rates possible
- Meets higher demand/storage requirements faster (often no storage may be needed)

Source: Wikipedia

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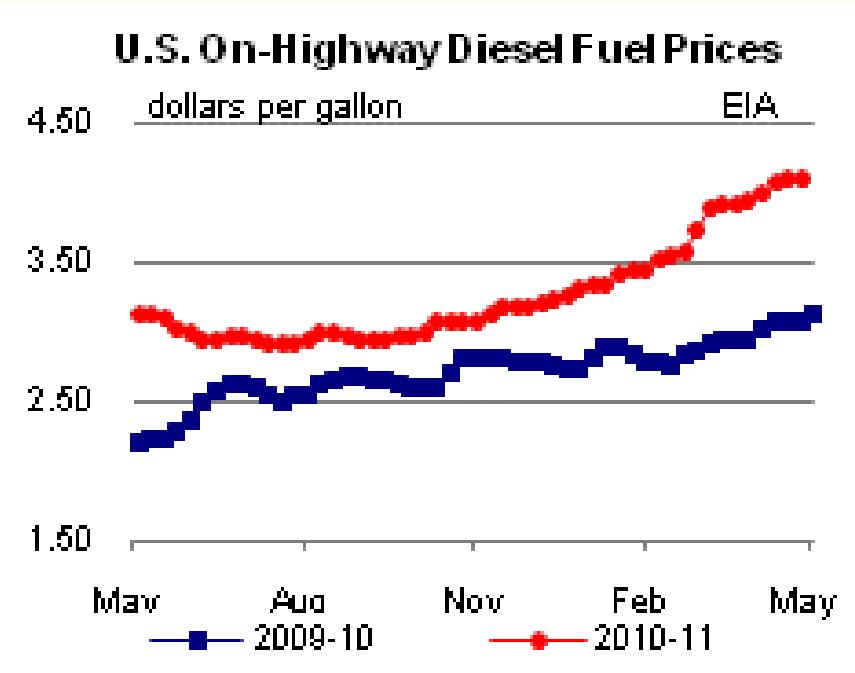
Diesel Fuel Disadvantages

- Manually operated and requires accessibility for operation and maintenance
- Fuel costs (trends are increasing), and fuel storage and transportation costs
- Environmental impacts

Source: www.eia.gov



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Diesel Pumps: Examples

Model CA-5581-96

Model CA-16D60-F3L

The AMT 6" engine driven pump is designed for applications requiring high volume flow and solid/debris handling capabilities. Pump is constructed of heavy-duty sand cast aluminum with cast iron and stainless steel internal parts for wear resistance and durability. Patent pending built-in slide mechanism features nylon and powder coated steel components that permit servicing, repairing and cleaning entire pump without removing hoses or pump components from trailer. Digital tachometer/hour meter. AMT Engine Driven Trash pumps are reliable, cost effective and low maintenance. Many are readily available "Off-the-Shelf" for fast 24 hour shipment. For use with non-flammable liquids which are compatible with pump component materials.

On the model CA-16D60-F3L, the simple front cleanout design permits easy removal of trash and debris without disconnecting hoses. Pumps are available with Honda, Kohler, or Wisconsin gasoline engines or Lombardini, John Deere or Deutz diesel engines. All are furnished with suction strainers and 90 degree discharge elbows.

- **Max Head**: 100 FT
- **Max Flow**: 1200 GPM
- **Max Pressure:** 58 PSI
- **Materials: Cast Aluminum / Cast Iron**
- **Seal**: Silicon Carbide
- Buna O-Rings and Flapper/Check Valve

- **Dimensions** *Model CA-5581-96*: 93 "L x 52 "W x 50 "H
- **Dimensions** *Model CA-16D60-F3L*: 126"L x 62"W x 81"H

Ordering Information - **Free Shipping**

MODEL	SIZE	ENGINE	TANK SIZE	RUN TIME	WEIGHT	PRICE
CA-5581-96	6"	**Honda** V-Twin	12 gal.	6 hrs.	1000 lbs	$11,475.85 Add to
CA-16D60-F3L	6"	57 HP Deutz **Diesel**	61 gal.	31 hrs.	2850 lbs	$28,737.35 Add to

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COST PERSPECTIVES

SYSTEM TYPE	CAPITAL COST	MAINTENANCE ASPECTS	OPERATION REQUIREMENTS	CREDITS & INCENTIVES	WARRANTY (TYP)
SOLAR PV	$2,500	None or very low	None, or very infrequent	30% of installation cost	+20 years
WIND	$5,200	Lubrication and corrosion maintenance	Manual brake in case of undesired wind	30% of installation cost	5 years
DIESEL	$10 to +$30K	Oil/filter(s) changes, tune ups, and fuel refills	Operator, depending on diesel prices	None	1 year

Assumptions: 100 ft. of Dynamic head
Storage tanks not include in any of the costs

Cost sources: Solar www.sunpumps.com
Wind http://www.ironmanwindmill.com/
Diesel http://www.ultimatewasher.com/water pumps/

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Spreadsheet Tool

- A user-friendly, *Microsoft Excel*© Spreadsheet and User's Manual has been developed to demonstrate the design method and introduce the terminology of PV solar pump system design. Version I is now available from NMSU COE, or Ag Extension.

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Spreadsheet Objectives

- Provide basic PV design method concepts, terminology, and information
- Easily understood and interactive
- Illustrate the required components
  - PV Panels, pump size, etc.
- Provide estimated system costs

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Spreadsheet Assumptions

- Prices may vary with time (current trend is lower). Tax and other incentives may also change.
- Spreadsheet does not take into account any elevation factor for the calculation of the system solar insolation. Its influence on the final result is negligible.

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Spreadsheet Assumptions

- Data for products utilized to obtain the final solar system design are taken from commercial websites only as basis for example calculations – no endorsements are implied
- Spread sheet based cost is accurate for the brands of pumps and solar panels at the time of development. Users may make decisions to buy different brands from other suppliers. Costs given within the spread sheet serves only as a baseline reference.

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Spreadsheet Assumptions - *Caveats*

- Costs do not take into account the drilling of the well or its components, including any storage units (earthen, concrete, plastic tanks)
- Although care has been taken for accuracy, the material is a "*work-in-progress*" and no guarantee is either expressed or implied.
- Some of the material draws from various manufacturers' and equipment suppliers' data, purely as examples: no endorsement of these is intended.

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Spreadsheet Calculations

- The spreadsheet uses some mathematical calculations (total dynamic head, flow rates, etc.) which are explained in its accompanying documentation.
- The calculations are based on sound engineering principles, but may have been simplified whenever possible and when results do not impact the final system

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Demonstration Modules

- NMSU has developed two portable solar PV water pumping systems which can be used to provide users with a visual display of the concepts and major system components.
- http://www.youtube.com/watch?v=4gFbCdHle0w&list=PL89870B418A514D27&index=10&feature=plpp_video

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Conclusions

For an increasing set of remotely located applications, such as surface capture (ponds, catch tanks, streams, etc.), and well pumping to provide drinking water (human, livestock, etc.), or to support some forms of agriculture (drip irrigation, etc.), solar PV power offers economical solutions that are attractive, compared to traditional wind or fossil-fuel choices.

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Web Links

- ***Engineering NM:***

  http://engr.nmsu.edu/outreach.shtml

- ***College of Agricultural, Consumer and Environmental Sciences:***

  http://extension.nmsu.edu/energy_water.html/

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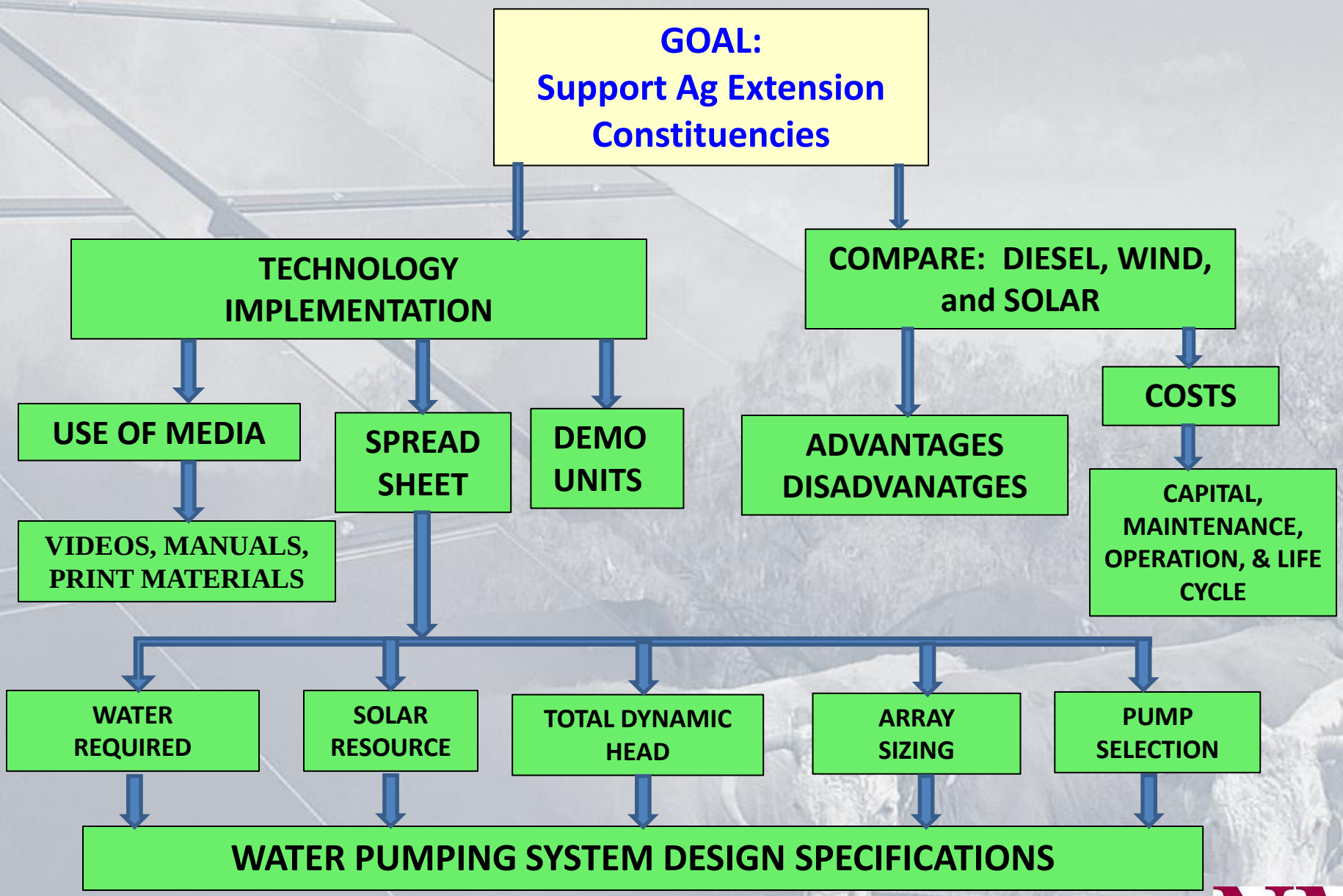

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