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Agricultural Pump Market Research

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Table of Contents

Executive Summary

The Northwest Energy Efficiency Alliance (NEEA) is an alliance of more than 140 utilities and energy efficiency organizations working on behalf of more than 13 million energy consumers. NEEA is dedicated to accelerating both electric and natural gas energy efficiency, leveraging its regional partnerships to advance the adoption of energy-efficient products, services, and practices.

NEEA's Extended Motor Products (XMP) – Pumps Program aims to accelerate the adoption of energy efficient commercial and industrial pumps and circulators by mitigating or eliminating identified market barriers to adoption of such technologies through market transformation. The goal of this agricultural pump study is to support a potential expansion of the XMP program into the Northwest Region's (Idaho, Montana, Oregon, and Washington) agricultural sector by investigating current market actor knowledge and market equipment, support, and existing conditions.

Objectives

The objectives for this study were three-fold:

Objective 1: Identify and prioritize agricultural market barriers to uptake of highly efficient pumps for irrigation purposes.

Objective 2: Document market actor motivations and agricultural irrigation pump path-to-purchase.

Objective 3: Assess the accuracy of key market projections documented in NEEA's 2013 Agricultural Irrigation Market Characterization, specifically as pertaining to regional irrigated agricultural acreage and market actor technology usage.

Methodology

This study builds on NEEA's 2013 Agricultural Irrigation Market Characterization by updating the information already presented and adding Montana as a key state of focus (the previous study included Idaho, Oregon, and Washington). To achieve the research objectives, the team first conducted a comprehensive literature review, followed by interviews with nine Northwest farming end-users, four installers/specifiers, and three manufacturers in the agricultural pump market in the Northwest.

To complete the interviews, the following recruitment activities were conducted:

- Leveraging existing relationships with market actors in the agricultural market in the Northwest
- Emails, calls, and paper mail based on internet searches for contacts
- Dun and Bradstreet Business Look-up searches[1]
- Visiting farmers markets in Oregon and Washington
- Visting farms and manufacturing offices in Oregon

[1] https://www.dnb.com/business-directory.html

Findings

The study uncovered the following:

Objective 1: Market Barriers

1) Cost is the biggest barrier reported by all interviewees for adopting more efficient pumping technologies. Interviewees reported that the upfront cost of new, more efficient, technology will continue to be a barrier for them. Several interviewees mentioned that incentives from utilities or the government are and would continue to be useful to push more efficient technology.
2) While some farmers are very knowledgeable about smart technology, several farmers are not, or do not believe that there are enough knowledgeable contractors to maintain smart technology. This lack of market knowledge, whether actual or perceived, is a barrier for increasing efficiency on farms.
3) All barriers and market trends reported in 2013 remain relevant today in shaping decisions made on farms, including weighing the adoption of efficient irrigation pumps. The bolded barriers and market trends appear to have intensified since 2013, while the others remained constant:
    a. **Availability of – and competition for – suitable lands for agriculture purposes**
    b. **Availability of – and competition for – water for agricultural irrigation**
    c. **Crop value and demand for crops**
    d. **Cost of labor and production**
    e. Crop yield focus and capability of farmers
    f. Availability and demonstration of technologies and practices
    g. Pump buyer lack of awareness of efficient pump systems and the return on investment

Additionally, this study identified new barriers of (a) access to electricity and (b) reluctance among the aging farmer population to adopt new technology or change methods close to retirement.

Objective 2: Market Actor Motivations and General View of the Market

Generally, all interviewees prioritize efficiency, whether that be energy efficiency, water efficiency, or cost efficiency. End-users are focused on getting reliable equipment that 1) is energy efficient, and 2) meets their needs based on the crop types they grow and the geography of their farms. End-users, particularly those with lower levels of technology awareness, report relying heavily on manufacturers, distributors, and installers to recommend equipment. Specifiers are motivated in their recommendations by getting the highest efficiency products to customers for the best cost.

Market actors were asked about motivations for adopting smart technology. Across the interviews, variable-frequency drives (VFDs) were most commonly viewed as the primary "smart technology" available in the agricultural market. Estimates varied from 15-50% of the Northwest market using VFDs. According to interviews with market actors in the Northwest, adoption of VFDs seems to be increasing as prices of electricity and labor increase, as they and other smart technologies enable greater efficiency in energy usage and decreased labor needs on farms.

The project team also asked market actors to estimate the use of soft starters (equipment that gradually ramps up voltages and current to a motor) in the Northwest. Estimates ranged from 3-

10% of the market using soft starters, with their use becoming more common in Oregon and Washington due to the perception of state regulations requiring their use.

Objective 3: Updates Since 2013 Findings

1) As reported in 2013, efficiency is a large priority for the agricultural pump market, and everyone is moving towards energy efficiency.
2) There is a trend towards more smart technology and VFDs, but older generations of farmers are more hesitant to adopt new technology. The trend towards more smart technology was predicted in 2013; however, the project team found that the age of the farmer impacts willingness to adopt new technology.
3) There are about 8 million irrigated acres in the Northwest, with Idaho having the most irrigated acreage, according to USDA agricultural data. Irrigated acreage is down from the 2013 NEEA study, notably in Montana where prolonged drought was reported. (See Table 4, page 25, for state-by-state irrigated acreage estimates in 2008 and 2023.)
4) Specifiers are reluctant to specify new technology because of a perceived lack of contractor knowledge around maintaining systems and the perception that they are too difficult for users who are not tech savvy. This was a new finding since the 2013 report.
5) Education among end users on smart technology varies. The 2013 report highlighted that lack of awareness on new technology was going to be a barrier for new technology adoption.

Conclusions

With concerns about increasing prices, climate and weather challenges, and labor shortages, efficient pumping brings a great opportunity to lower costs, improve yield, and improve the quality of life for farmers across the Northwest. Efficient technology exists, but farmers, contractors, and specifiers need help understanding how the benefits of efficient pumping apply to their applications. Further, the cost of technology and electricity present barriers towards adoption. Incentives and rebates from utilities or co-ops, in conjunction with education on how best to use smart technology on farms, could help offset the high upfront cost and knowledge barriers and help farmers save time and energy.

More research would be required to better understand:

1. Differences in the path-to-purchase for irrigation pumps by size of farm.
2. Differences in the path-to-purchase by whether manufacturers stock or custom build pumps.
3. If there are installers who are not specifiers and vice versa, and where manufacturer representatives could play a role in the path-to-purchase journey.

Future research could also be conducted to confirm whether barriers change over time and whether projections for the market are accurate in the future. To ensure that the findings are as robust as possible, recruitment efforts should be focused on in-person events, such as trade shows and conferences, to build legitimacy and establish relationships. Further, recruitment should occur outside of the busy spring and summer harvesting season for farmers to increase the chance that they will have time to speak with interviewers. This will help to ensure larger, more representative samples to bolster the findings.

1 Introduction

The Northwest Energy Efficiency Alliance (NEEA) is a non-profit organization working to accelerate energy efficiency to meet the future energy needs of the Northwest. The Northwest Energy Efficiency Alliance (NEEA) is an alliance of more than 140 utilities and energy efficiency organizations working on behalf of more than 13 million energy consumers.

In 2013, NEEA contracted Navigant Consulting, Inc. (Navigant) to estimate the baseline for integrated decision-making irrigation systems in Idaho, Oregon, and Washington from 2012 and over the following 20 years. As part of that study, Navigant interviewed market actors to understand historic trends in the agricultural market, to estimate and forecast future trends, and capture qualitative information regarding the barriers and projected dynamics facing the irrigation market in the three-state region. The present study was contracted to extend this earlier research by assessing the accuracy and validity of forecasted trends and barriers and assessing path-to-purchase for agricultural pumps, while also incorporating the fourth state that NEEA serves, Montana, into the analysis. Additionally, market actors were asked about motivations for adopting smart technology such as smart pumps. For the purposes of this study, smart pump systems were defined as a pump system that combines a pump, drive, and integrated controller; however, it is important to note that there is no cohesive and agreed-upon definition of a smart pump in the agricultural pump market.

1.1 Research Objectives

The objectives for this study were three-fold:

- **Objective 1:** Identify and prioritize agricultural market barriers to uptake of highly efficient pumps for irrigation purposes.
- **Objective 2:** Document market actor motivations and agricultural irrigation pump path-to-purchase.
- **Objective 3:** Assess the accuracy of key market projections documented in NEEA's 2013 Agricultural Irrigation Market Characterization, specifically as pertaining to regional irrigated agricultural acreage and market actor technology usage.

The next section outlines the research activities and methodology for achieving the research objectives.

2 Research Activities and Methodology

To achieve the research objectives, a comprehensive literature review was conducted to obtain a solid base understanding of the existing research on the agricultural pump market in the Northwest. Interview guides were then developed to target topics that were not well-covered in the existing research, as well as topics that required primary thoughts from farmers, specifiers and contractors, and manufacturers. The following table summarizes the research objectives and the data collection activity that was conducted to ensure the objectives were addressed (see Table 1).

Table 1. Research objectives and data collection activity

Research Objective	Research Topic	Literature Review	End Users	Specifiers/ Contractors	Manufacturers
1	Confirm or update market barriers	X	X	X	
	Rate significance of barriers' risk, presence, persistence	X	X	X	
	Assess variance across market actor group, state, type, etc.		X	X	
2	Identify motivators, priorities, barriers across market actors	X	X	X	
	Assess degree of efficiency prioritization within market actors		X	X	X
	Assess seasonality of pump usage with regard to efficiency		X	X	
	Describe the role and influence of market actors in decision making process		X	X	
	Document motivations and perspectives		X	X	
	Identify factors of pumping options and specifications		X	X	X
	Relationship between market actors		X	X	X
	Purchasing decisions across new construction, planned retrofit, emergency replacement		X	X	
	Approximate the percentage of well/surface pumping	X	X	X	
	Prevalence and location of soft starters and VSDs			X	
3	Assess key market projections	X		X	X
	Estimate irrigated agricultural acreage	X		X	
	Assess market actor reluctance to adopt new technology	X	X	X	X

To complete the interviews, the following recruitment activities were conducted:

- Leveraging existing relationships with market actors in the agricultural market in the Northwest
- Emails, calls, and paper mail based on internet searches for contacts
- Dun and Bradstreet Business Look-up searches
- Visiting farmers markets in Oregon and Washington
- Visting farms and manufacturing offices in Oregon

Recruitment started with our subcontractor in Idaho leveraging existing relationships with farmers and specifiers in his region. Through this, we were able to interview two farmers and two specifiers. Next, we engaged phone and email recruitment to limited success. We then sent some paper mail, again, with limited success. Visiting farmers markets, farms, and manufacturing offices in person resulted in several informal conversations about the agricultural market, however, it was difficult to reach the correct contact through that method. We also engaged a farmers market organizer in Oregon who was able to help us recruit Oregon farmers by sending an email to her farmer contacts on our behalf. The greatest success came from snowball recruiting. Individuals we interviewed recommended other market actors to speak to and made the warm introduction on our behalf. This lent legitimacy to the study. Respondents were offering a $100 e-gift card as thanks for their time spent on the interview; however, as mentioned, recruitment proved difficult despite the varied efforts. This may be due to the timing of the study being during summer and harvest season, lack of market actor familiarity with Resource Innovations and NEEA, or a belief that the incentive was "too good to be true."

Table 2 outlines the interview targets as well as number of interviews completed.

Table 2. Interview targets and completes

Activity	Target	Complete
Manufacturer Interviews	Up to 5	3
Specifier and Contractor Interviews	Up to 10	4
End-User Interviews: Oregon	3	3
End-User Interviews: Washington	3	1
End-User Interviews: Idaho	3	2
End-User Interviews: Montana	3	3

This study builds on NEEA's 2013 Agricultural Irrigation Market Characterization by updating the information already presented and adding Montana as a key state of focus.

The following sections outline the findings from the literature review and interviews, organized by objective.

3 Objective 1 Findings

Objective 1: Identify and prioritize agricultural market barriers to the adoption of highly efficient pumps for irrigation purposes.

3.1 Top Barriers for Adopting Irrigation Technology

Several key barriers exist for market actors to adopt highly efficient pumps for irrigation. These are the top barriers reported across all market actors interviewed.

3.1.1 Cost

Cost was reported as the largest barrier by all groups interviewed across all states covered. New technology is costly, particularly if existing technology is still in working condition. The upfront cost of new technology proves to be prohibitive for adopting new technology. For farmers that do not already have electricity access on their farms, it is incredibly costly to run power lines to facilities, serving as another barrier for agricultural end users to switch from diesel generators to highly efficient electric pumps. It is unclear based on current research how common of an occurrence it is for farms to not already have electricity. For farms that already have electricity access, the cost of power has been increasing and is expected to continue to increase. During irrigation season, farmers run their pumps for up to 24 hours a day, which is a significant draw on power and adds cost. While a more efficient pump would lead to savings compared to running a less efficient pump, the upfront cost of switching to that pump remains a large barrier.

3.1.2 Lack of Awareness

Lack of awareness from end-users and contractors/specifiers is also a key barrier impacting the uptake of highly efficient pumps for irrigation. One farmer reported that they have no knowledge of smart technology. That same farmer reported that they also do not believe that there would be enough knowledgeable contractors to maintain efficient technology, such as variable-frequency drives (VFDs). One specifier reported that they do not recommend smart technology to customers due to this perception.

If customers are not knowledgeable about smart technology, they will rely on their specifiers and contractors to determine what technology is best suited for their needs. Therefore, if specifiers are not recommending or educating customers on more efficient technology, the highly efficient equipment will not be installed. Two manufacturers and three specifiers reported that many of their customers are not currently knowledgeable about smart technology, but that customers are willing to be educated and have conversations about smart technology.

Farmers reported that they gain knowledge and awareness about new technology or new ways to use technology from neighboring farmers who have tried smart technology and from their specifiers/contractors, as well as from farming newsletters and magazines, and conferences.

3.1.3 Age of Farmer

Age of the farmer impacts willingness to adopt new technology in all states. Though not universal, younger farmers tend to be more likely to adopt new technology, whereas older farmers are more reluctant to change their methods. One farmer in Oregon mentioned that being in their sixties and having established a system that works well for their farming over years, they do not feel the need to change the system. Younger farmers mentioned that they are willing to adopt new technology to keep up with crop demands, keep up their revenue, and minimize their labor. Older farmers who are later in their careers prioritize their comfort in their methods and see less reason to change their practices as they approach retirement.

3.1.4 Location and Age of Farm

Location and age of the farm also serve as important factors impacting whether or not farmers can irrigate. Location and age of the farm impacts the allotment of water the farm receives, and thus the ability to irrigate. With regard to location, due to a drought and resulting restricted water access in Montana, farms cannot irrigate as much and farmers are shifting crops across farms to crops that do not need extensive, if any, water input. This introduces barriers to farmers who have to shift their practices in response. Many farms in Northern Montana are no longer irrigated. With regard to age of the farm, older farms will already have established water rights that impact how farmers can access and use water. The elevation of the land on the farm also impacts the type of pumping and irrigation strategies used.

3.2 Significance of Irrigation Market Barriers and Trends

As part of this study, the Resource Innovations team set out to update the market barriers and trends reported on in the 2013 NEEA report on agricultural pumps (see Table 3). In the far-right column, the project team presents whether the trend demonstrates a true barrier for irrigation that is outside of the control of NEEA, or presents an opportunity for improvement.

Table 3. Significance of irrigation market barriers/trends reported in 2013

Barriers/Trends	Finding in 2013	Finding in 2025	Barrier, Context, or Opportunity
Availability of – and competition for – suitable lands for agricultural purposes	There is a continual competition of land between agriculture and urban sprawl.	This remains a key barrier. There is a need for local land trusts to set aside land for agricultural use and lower commodity price.	Barier: Uncertainties and changes due to factors such as land rights, water availability, and climate and weather challenges are affecting farmers ability to prioritize efficiency or to take on risks with new equipment. These barriers would be difficult, if not impossible, for NEEA to address, however they should be kept in mind.
Availability of – and competition for – water for agricultural irrigation	Respondents did not think that water scarcity was an issue on farms in the three-state region.	The amount of water that will be delivered in areas of Montana experiencing drought and those without water rights is uncertain. This results in reluctance to invest in costly pumps if farmers will have to change to non-irrigated crops.	
Demand for crops	Demand for crops are the key drivers of the disposition of agricultural land use.	Climate and weather challenges is changing the crops that can be grown in the Northwest, with farmers switching to less water-intensive crops due to drought in Montana and warming temperatures in all of the area stressing cool-season crops such as lettuce and spinach.	
Availability of labor	The cost of labor can be a determining factor in farm economics. In recent years, some areas of the three-state region have had a shortage of field labor.	Cost and availability of labor remains prohibitive. All farmers mentioned that the cost of labor is increasing and good labor is difficult to find. Three farmers mentioned that automating irrigation using smart technology decreases the need for labor.	Opportunity for distributors, contractors, and NEEA to market smart technology as a solution to rising costs and labor shortages.
Crop value	Commodity prices tend to be volatile. Periods of relatively high commodity prices coincide with periods of higher capital investment and slower rates of land loss to urban sprawl.	Commodity prices remain volatile; however, the main focus seems to be the impact of climate and weather challenges on the types of crops that can be grown across the Northwest due to droughts in Montana and warming temperatures across the Northwest as a whole.	Opportunity to encourage farmers to increase their yields, and thus their ability to sell more crops, through smart technology or energy efficient solutions.
Cost of production	The component costs of crop production, such as equipment capital, labor, water, energy, fertilizers, and pesticides, influence	Cost of equipment, electricity, electricity hookups, water, labor and farming inputs such as seeds and fertilizers are all increasing. This contributed to younger farmers adopting smart technology to decrease labor and increase yield. One farmer	Opportunity for distributors, contractors, and NEEA to market smart technology as a solution to rising costs and labor shortages.

	farmers' motivations to adopt tools and strategies that shift costs.	mentioned that refurbished equipment is purchased to keep costs down.	
Crop yield	Most farmers in the three-state region use crop yield, rather than profit, as an explicit objective.	Crop yield remains the highest priority for farmers. Crops are relatively low margin; therefore, they need to produce as much as possible.	Opportunity for farmers to increase their yields with more energy efficient technology, leading to more crops to sell.
Capability of farmers	The trend towards larger farms means that a farmer's already-limited time and effort must be spread over a larger area. This is driving farmers to use automated irrigation systems.	Three farmers reported that they use automated irrigation systems to decrease their labor and effort. Instead of manually adjusting pumps, farmers are able to control the pumps from their phones.	Opportunity for distributors, contractors, and NEEA to market smart technology as a solution to rising costs and labor shortages.
Availability and demonstration of technologies and practices	While the limited bandwidth of farmers suggests a captive market for decision support technologies, most growers are skeptical of relying on a computer to manage their farm and prefer traditional methods of irrigation.	All farmers believe that they have the appropriate technologies for their farms, regardless of whether smart technology is used. Older farmers and contractors continue to be more skeptical about new technology, however they are open to conversations about new technology.	Opportunity for NEEA to support education to farmers about new technologies.

3.3 Objective 1 Conclusions

The following conclusions were made based on the research for Objective 1:

1) Cost is the biggest barrier reported by all interviewees for adopting more efficient pumping technologies. Interviewees reported that the upfront cost of new, more efficient, technology, will continue to be a barrier for them. Several interviewees mentioned that incentives from utilities or the government are and would continue to be useful to push more efficient technology.
2) While some farmers are very knowledgeable about smart technology, several farmers are not, or do not believe that there are enough knowledgeable contractors to maintain smart technology. This lack of knowledge, whether perceived or actual, is a barrier for increasing efficiency on farms.
3) All barriers and market trends reported in 2013 remain relevant now, with the added barriers of access to electricity and the aging population being more reluctant to adopt new technology or change their methods close to retirement. The bolded barriers and market trends appear to have intensified since 2013, while the others remained constant.
    a. **Availability of – and competition for – suitable lands for agriculture purposes.**
    b. **Availability of – and competition for – water for agricultural irrigation.**
    c. **Crop value and demand for crops.**
    d. **Cost of labor and production.**
    e. Crop yield focus and capability of farmers.
    f. Availability and demonstration of technologies and practices.
    g. Pump buyer lack of awareness of efficient pump systems and the return on investment

4 Objective 2 Findings

Objective 2: Document market actor motivations and agricultural irrigation path-to-purchase.

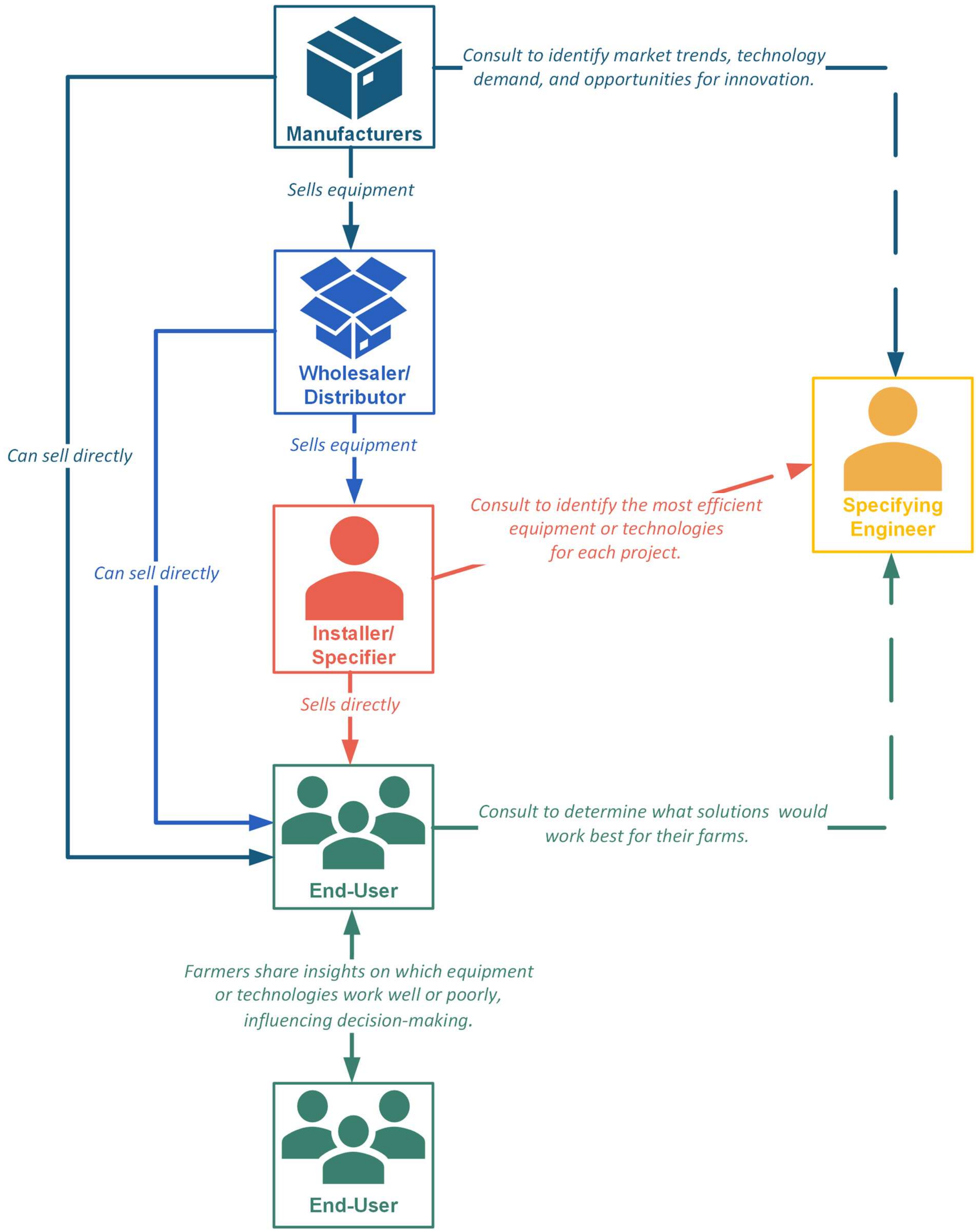
4.1 Path-to-Purchase Journey Map – Relationship Between Market Actors

Figure 1 demonstrates the path-to-purchase journey that outlines how irrigation pumps are selected, purchased, and installed in agricultural settings in the Northwest, and where different market actors have influence on what ends up installed in the market. It is also important to note that the path-to-purchase journey map may vary depending on the size of farms or whether the manufacturer or distributor stocks pumps or employ custom builds for each application. Further research, with larger samples, is required to make those distinctions. The presented journey map is a generalization based on the input from all interviewees and findings from the literature.

In the current sample, wholesalers and distributors played the same role and all installers also acted in a specifier role. More research is required to determine if there are installers who are not specifiers and vice versa, and where manufacturer representatives could play a role in the path-to-purchase.

The interviews uncovered that specifying engineers play a consulting role in calculating energy savings, flow rates, depths needed, and more to assist manufacturers, installers/specifiers, and end-users to determine what systems would work best for their applications and needs. They may come to farms directly for site visits, but they do not install the equipment.

Figure 1. Path-to-purchase journey



4.2 Decision-Making for Choosing Pumps

Selecting pumping equipment requires different considerations depending on whether the project is a new construction, retrofit, or an emergency replacement and varies between market actors. The next sections outline the different factors prioritized by type of replacement, and by market actor group, respectively.

Throughout the sections, efficiency is emphasized as an important consideration. It is important to note, however, that "efficiency" means something different to each person within the industry. Some individuals will use efficiency to mean reliability or durability, while others will use it to mean saving energy or water. At the time of reporting, there is no common definition of "efficiency" within the agricultural market in the Northwest.

4.2.1 Purchasing Decisions

The following sections outline the differences in purchasing decisions by new construction and retrofit applications and emergency replacements.

New Construction and Retrofit

For decisions regarding a new installation for a pump, end-users all reported that they will purchase based on efficiency and cost. Whereas, retrofits will most likely do a like-for-like replacement. For the most part, all market actors rely on recommendations from their specifier/contractor on what system offers the best efficiency for the cost for their specific application (crop, water source, and land geography). Those who are performing planned retrofits or are replacing end-of-useful-life equipment in a non-emergency situation most commonly do a like-for-like replacement since they are already used to the equipment and value the reliability and the comfort in knowing that the system will work for their land. In contrast, new construction installs offer a better chance for efficiency because there are no preconceived notions of what will work for the land and allows efficiency to become the top priority.

Further, market actors in Idaho reported that as their population has increased, the need to produce more crop, and to do so more efficiently, has increased as well. The need for higher yields has necessitated a push towards greater pump efficiency in Idaho to produce more crops without drastically increasing costs. As a result, there is more openness in Idaho towards replacing pumps with more efficient technology, whether that be in a retrofit or a new construction opportunity.

Emergency Replacement

For emergency replacements, the biggest priority for end-users is to get a pump back up and running as quickly as possible. End-users will install whatever is available immediately to preserve their crop, which may often not be the most efficient pump. Spending more on electricity is considered acceptable to avoid losing the crop. Refurbished equipment is often available quickly and there is a large market for refurbished pumps for emergency replacements, and as a lower cost option.

4.2.2 Top Priorities When Choosing Pumps

End-users, specifiers/contractors, and manufacturers vary slightly in their priorities when choosing, recommending, or developing pumps. The following sections outline these priorities and motivations by market actor group.

End-Users

End-users have three main priorities when selecting pumps.

1. That the pump flow and pressure work for the use and topography of the farm,
2. That the pump is efficient in terms of energy or water usage, and
3. That the brand has a good reputation for maintenance.

The focus when choosing a pump is that it will help meet their needs for crop yield. Most of the time, this means that efficiency and dependability are prioritized, as this increases output while lowering energy costs and labor needed. Modern pumps with VFDs and controls are able to support multiple fields with different crops, and as a result can support different watering needs. This configuration provides flexibility in agriculture to change crops over time. Farmers who have more than one crop or have seasonal crops often opt for this solution due to the flexibility despite the higher upfront cost. Younger farmers are motivated to use smart technology and remote monitoring to lower their labor costs. For example, one farmer reported using soil moisture sensors to help measure the soil's water content to determine when and how much to water his fields.

Further, the pump company's reputation and warranty on the equipment gives end-users comfort that their equipment will be reliable and that should any issues arise, the manufacturer will stand behind the product and provide maintenance assistance. Farmers will speak to other farmers about their experiences with different pumps and pump companies, and these conversations can meaningfully impact their decision-making.

Specifiers/Contractors

Specifiers and contractors prioritize offering their customers the most efficient system that meets their needs for the best price possible. Since there are higher upfront costs associated with updating to efficient pumps and customers are price-sensitive, specifiers/contractors are motivated to recommend equipment that is covered by rebates or incentives to help cover upfront costs for customers. Due to the price sensitivity of customers, specifiers reported that they will only recommend VFDs if the efficiency and maintenance savings will outweigh the upfront costs of installing the system. One respondent reported that an ideal return on investment would be about two to three years.

Manufacturers

When developing pumps, manufacturers consider the following:

1. Federal or state standards for manufacturing motors and pumps,

2. Reliability and performance of the pump,
3. How to provide more efficient options than their competitors, and
4. How to sell technology as a solution to common problems faced by farmers, such as labor and crop yields

Manufacturers and end-users also mentioned that a warranty on the product builds confidence that the manufacturer stands by and believes in their product and that support would be available should the system stop functioning as required. Warranties on products vary by manufacturer, with some providing up to a 5-year warranty on new pump installations, whereas others provide 1-3 years as the standard for the irrigation industry. Warranties tend to be closer to the 1-year mark for full agricultural use, but manufacturers can increase their warranty to stay competitive.

4.3 Efficiency Prioritization

Market actors were asked to describe the extent to which they prioritize efficiency in their decision-making. The next sections discuss the responses by market actor group.

End-Users

All end-users, except for one in Washington who claimed not to be knowledgeable on efficiency, highly prioritize efficiency because of rising costs of electricity and power. End-users can run their pumps anywhere from 50%-100% of the time during irrigation season; thus, having efficient pumps is key to ensuring that they are not spending more money and using more energy than they must. It is important to note, however, that “energy efficiency” means something different to each person. The end-users in Montana in particular focus on water efficiency, preserving water due to drought, and using less water for their farming overall. One end-user reported working with the local college on a research project looking at increasing yields with less water usage. This saves both money and water, leading to greater efficiency as defined by these farmers.

Specifiers/Contractors

All specifiers/contractors interviewed reported that efficiency is their main priority in specifying/installing systems. They will all provide the most efficient system that they can to meet the needs of the farmer. What the “most efficient system” is depends on the geography of the land, the type of crop grown, and what level of efficiency the budget of the farmer allows, but often comprises of control systems, VFDs, or meeting 90% efficiency thresholds. The farmers will prioritize efficiency, but they will not generally increase the budgets of their projects to be able to reach maximum efficiencies. The sample for the current study is too small to be able to make specific claims on what the most efficient system is for different use cases; however, the specifier will keep efficiency top-of-mind as they make recommendations.

Manufacturers

Manufacturers reported that at this time in the market, everything that gets manufactured will be energy-efficient due to codes and standards in their states, as well as a focus on hydraulic efficiency. For example, there are standards in Oregon and Washington related to needing to use soft starters on pump motors. The main priority when it comes to energy efficiency for manufacturers, then, is to develop products and solutions (with remote monitoring and controls) that are more efficient than their competitors. All manufacturers interviewed manufacture VFDs and lines of controls to ensure their competitiveness in the market.

4.4 Pumping Factors and Specifications

According to interviewees and the literature review, pumps are selected based on the following factors:

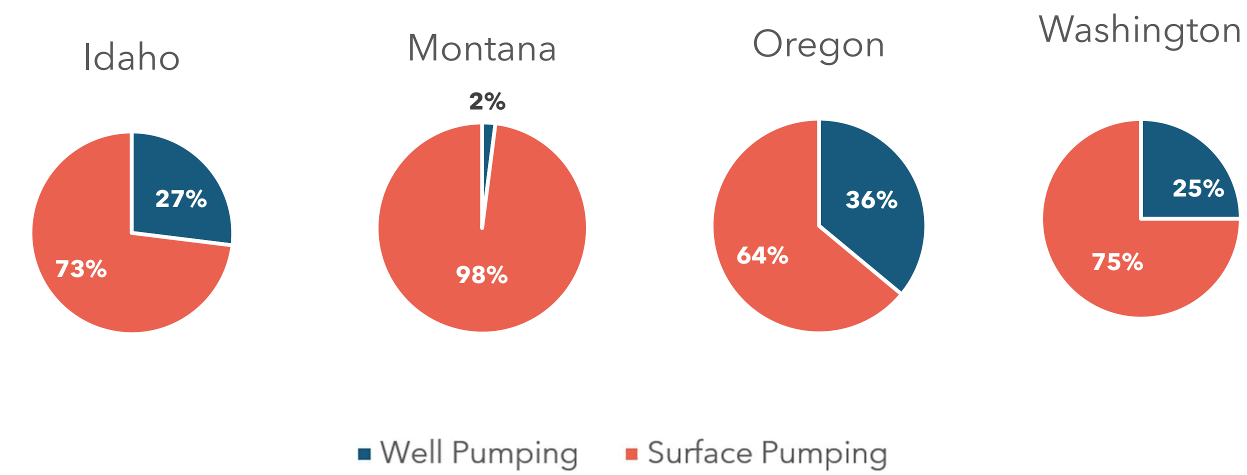
- Pumping water depth needed for the application
- Horsepower needed for the application
- Gallons of water needed per minute
- Pressure needed
- Elevation change of the field
- Crop types grown at a given time dictates water needs

Elevation of the field determines how water moves and how it can be distributed. As water will naturally flow downhill, fields with high elevation or sloping land make it harder to control water distribution. If there is too much of a slope, there is the risk of runoff, erosion, and uneven watering. In sloping fields, pumps such as submersible or centrifugal pumps can be used to lift water uphill and maintain even distribution.

4.5 Well Pumping Vs. Surface Water Pumping

According to data from the U.S. Geological Survey, surface water pumping is more common in the Northwest (see Figure 2). In Montana, almost all pumping is surface water pumping. Market actors all have different beliefs on whether surface water pumping or well pumping is more common. These differing beliefs likely relate to their own practices and the geography of their immediate surroundings.

Figure 2. Well pumping vs. surface pumping by state



Note: The percentages represent the proportion of total irrigation water withdrawals.
Source: U.S. Geological Survey, 2014, Estimated Use of Water in the United States in 2010.

4.6 Prevalence and Location of Smart Technology

Interviewees were asked to estimate the prevalence and location of smart technology in their states. The following sections outline the responses by market actor for 1) soft starters, and 2) variable speed drives (VSDs)/VFDs.

4.6.1 Soft Starters

A soft starter is a type of motor starter that uses voltage reduction techniques to reduce the voltage during the start of the motor. Soft starters allow for a gradual increase in the voltage, allowing the motor to slowly accelerate and gain speed without overburdening the electrical line. Soft starters are not energy-saving technology per se, but rather a demand-reduction technology to be used at start-up of the motor. Overall, soft starters are not that common in the agricultural pump market in the Northwest, but are becoming more common due to state regulations in Oregon[2], Washington[3], and increasingly in Idaho[4] that require soft starters on pumps. The regulation as written, however, is ambiguous and general, not stating whether the regulation applies to new pumps or retrofit applications, or specific horsepower levels. However, those interviewed believed that there was a horsepower requirement for new pump applications.

End-Users

Only one end-user interviewed reported using a soft starter on their farm. The remaining end-users do not use soft starters. One end-user in Montana reported that they did not use the technology because of the

[2] 2023 OESC Table of amendments
[3] WAC 296 -307 -36848.pdf
[4] Microsoft Word - Pressure Irrigation Stnds _5-13-03_.doc

perception that too much electrical service would be required to get one installed on the motor, making it a costly addition to the farm.

Specifiers/Contractors

Specifiers in Idaho reported that soft starters are quite expensive and do not save any energy to make the cost worthwhile. Further, there is controversy in the market about whether soft starters actually save energy or whether it drags the higher current for longer which is harder on the motor. One specifier believes that only about 5% of the market in the Northwest would have a soft starter at the time of the interview. They reported that soft starters are very costly to install and run on the panel and as a result, only those who are required by their utility will have one installed. This is in line with the estimates in Idaho that about 3-10% of the Idaho market is using soft starters.

Manufacturers

The manufacturers reported that soft starters are required in Oregon once you get to a certain horsepower. As mentioned above, however, research into the state requirement showed that the regulation as written provides more flexibility and less prescriptive requirements for adding a soft starter. Research shows that Oregon has a reactive demand charge on their large irrigation pump tariff, which may encourage soft starters, but does not require them. However, due to the perception that they are required, manufacturers believe that about 90% of new construction of pumps on farms in that region will have a soft starter. To support this requirement co-ops or utilities should provide an incentive to help offset the cost for farmers of running a soft starter on their panels.

4.6.2 Variable Frequency Drives (VFDs)/Variable Speed Drives (VSDs)

Variable frequency drives (VFDs) are electric controllers that vary the speed of the pump motor, allowing the pump to operate efficiently in response to fluctuations in flow and pressure demands. VFDs reduce energy costs, act as a soft starter (which decreases stress on the electrical system), and extend the life of a pump. With the market focusing more on efficiency, the use of VFDs is increasing in the Northwest market. However, there is still a long way to go on achieving widespread adoption due to reluctance to adopt new technology and high upfront costs for the technology and installation.

End-Users

The one end-user in Washington was unaware of VFDs and smart pumps. Two end-users in Montana and one end-user in Oregon were aware of VFDs and smart pumps but do not use them due to the expense and the belief that their existing systems function well for their needs. Both Idaho end-users interviewed have VFDs on their farms. Those who do not have VFDs were self-proclaimed “older generation” farmers who did not feel the need to change their methods that are already working. The Oregon farmer reported that since they are able to keep up with the yield required and are not concerned about making more money, they do not need to increase their yield further.

According to manufacturers and specifiers, if incentives were available to help offset the initial cost of adding VFDs, as well as additional education on the value and the uses for VFDs, uptake may increase.

Specifiers/Contractors

Two specifiers, operating mainly in Idaho, reported that they will recommend VFDs to farmers in Idaho if the farmer is running multiple pivots. They believe that about 15-20% of farms in Idaho have VFDs. This number is relatively low due to the majority of farmers in Idaho only running one pump with one pivot, and as a result, not needing a VFD, as well as the high cost of VFDs in Idaho to meet a harmonic standard. Further, VFDs typically work better on well pump systems that usually have higher pressure changes as flow rates change as compared to surface water pumping. While this does happen with surface water pumping occasionally as well, it is more common with well pumping. Since the proportion of well pumping in the Northwest is lower than surface water pumping, this may explain why they are less adopted in the region.

One specifier corroborated the finding from end-users that younger farmers are more likely to use VFDs as they are earlier in their career and thus more focused on expanding their practices and making them more sustainable for years to come.

Manufacturers

All manufacturers interviewed offer a line of VFDs to the Northwest. Manufacturer estimates for presence of VFDs in the market are significantly higher than that of specifiers. One manufacturer believes that 50% of the Northwest market uses VFDs, while another believes that it is as high as 70% of the market. This view may be impacted by the fact that the manufacturers all offer VFDs, and are thus driven to sell them, which may not be reflective of the offerings of other manufacturers.

One manufacturer mentioned that there is more knowledge surrounding smart pumps and new technology in Idaho due to a recent building boom in the area encouraging a bigger focus on efficiency to be able to feed a growing population on less space. While the sample was small, this is true in this current sample with both Idaho end-users having VFDs on their farms, while the other state end-users did not report VFDs.

4.7 Objective 2 Conclusions

Generally, all interviewees prioritize efficiency, whether that be energy efficiency, water efficiency, or saving money. End-users are focused on getting reliable equipment that 1) is energy efficient, and 2) meets their needs based on the crop types they grow and the geography of their farms. End-users report relying heavily on manufacturers, distributors, and installers to recommend equipment, especially those who do not have much awareness of technology. When giving recommendations, specifiers are motivated by getting the highest efficiency products to customers for the best cost.

Market actors were asked about motivations for adopting smart technology. For the purposes of this study, smart pump systems were defined as a pump system that combines a pump, drive, and integrated controller. However, it is important to note that there is no cohesive and agreed-upon definition of a smart pump in the agricultural pump market. Across the interviews, VFDs were most commonly viewed as the "smart technology" that is available in the agricultural market. Estimates varied from 15-50% of the Northwest market using VFDs. Adoption of VFDs seems to be increasing as prices of electricity and labor increase. VFDs and other smart technologies allow for greater efficiency in energy usage as well as decreases labor needs on farms.

Finally, the project team asked market actors to estimate the use of soft starters in the Northwest. Estimates ranged from 3-10% of the market using soft starters, with their use becoming more common in Oregon and Washington due to the perception of state regulations requiring their use.

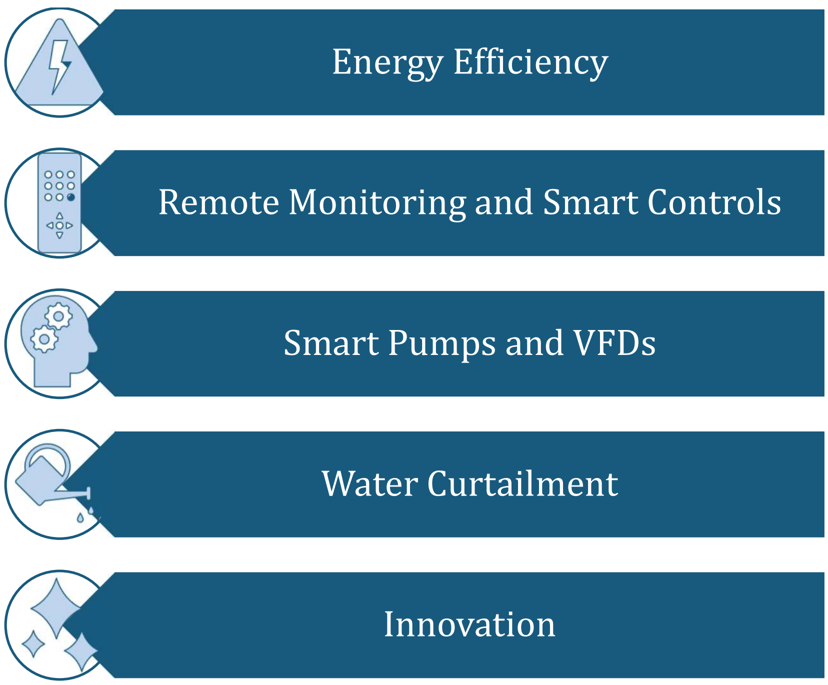
5 Objective 3 Findings

Objective 3: Assess the accuracy of key market projections documented in NEEA's 2013 Agricultural Irrigation Market Characterization, specifically as pertaining to regional irrigated agricultural acreage and market actor technology usage.

5.1 Key Market Projections

Interviewees were asked where they see the agricultural pump market going in the future. Five key topics for projections stood out (see Figure 3). This section serves as a summary of the previous sections, with additional detail relevant to the key market projections documented by NEEA in 2013.

Figure 3. Themes for key projections



5.1.1 Energy Efficiency

All interviewees believe that energy efficiency will continue to be a priority in the future due to rising costs of power and labor. As noted above, however, "energy efficiency" means something different to each person. For example, energy efficiency could mean water conservation, as is the case in Montana where there is significant drought. Energy efficiency may also mean using smarter technology to decrease the labor burden on farmers. To others, energy efficiency means using the least amount of power possible to obtain the same crop yield. To manufacturers, energy efficiency is mainly important inasmuch as they can offer more efficient technology than their competitors.

As costs of power, labor, and technology rise, all market actors, regardless of role and state, believe that energy efficiency (as they individually define it) will continue to drive decision-making in the agricultural pump market. This aligns with the projection in NEEA's 2013 Agricultural Irrigation Market Characterization.

5.1.2 Remote Monitoring and Smart Controls

All manufacturers, specifiers, and all but one farmer reported that there is a trend in agriculture towards remote monitoring and smart controls. As labor costs increase, manual processes for irrigating, troubleshooting pumps, and manually adjusting the irrigation schedule become burdensome. Two farmers reported using remote monitoring and smart controls in their farming practices. While the remaining farmers did not use this technology themselves, they believe that younger generations of farmers are moving in that direction.

This aligns with the 2013 report predictions that irrigation practices will change as labor prices increase; however, it seems to depend on the demographics of the farmer.

5.1.3 Smart Pumps and VFDs

While one farmer reported being unaware of VFDs, the remaining five farmers perceived themselves to be highly knowledgeable. Two farmers reported using VFDs in their farming practices. The three farmers who do not use VFDs do not use them due to the belief that they do not need them due to the elevation of their land and only growing one or two different types of crops at a time. However, the five farmers reported that they are seeing a trend towards an increase in pivots and VFDs because they are efficient and require less labor. Three specifiers also reported recommending VFDs more often as the application requires. All manufacturers reported that they are seeing market demand for VFDs increase, with all manufacturers reporting that they have a line of VFDs. The technology, however, remains costly, and has thus not fully permeated the market.

This aligns with the 2013 project that as demands increase on farmers' time, farmers are moving towards pivots to reduce hands-on effort required as well as decreasing water usage.

5.1.4 Water Curtailment

Montana is experiencing a sustained drought which impacts irrigation practices and crops produced. As a result, crops are shifting in Montana to less water intensive crops. At the time of the 2013 report, water was already fully allocated, and no expansion of irrigated agricultural lands was expected. Section 5.2 outlines the change in irrigated agricultural acreage which demonstrates that since the 2013 report, irrigated agricultural acreage has decreased over time.

5.1.5 Innovation

All market actors reported that there have been no notable advancements in pump design since the 2013 report was released. They all reported that there has been an increase in smart monitoring and use of VFDs and pivots, but the design of pumps themselves have stayed relatively constant as they are already highly efficient. No advancements are anticipated for pump technology itself in the next five years. However, manufacturers are trying to sell controls and automation as a solution in the agricultural space. As the usage of smart controls increases, there could be more innovation in what is possible for farmers to automate on their farms, as well as creative usages for existing technology. For example, one farmer in Idaho uses his VFD to spread fertilizer more thoroughly on his fields.

5.2 Irrigated Agricultural Acreage

According to 2023 USDA Agricultural data, there are just under 8 million irrigated acres in the Northwest across almost 42,000 farms. This is 9.3% less overall acreage than reported from 2008,[5] which does not align with the prediction from the 2013 report that irrigated acreage will only decline by less than 6% between then and 2032. Most notably, the number of farms (17.6% decrease) and irrigated acres (19.8% decrease) has significantly declined over time in Montana, which corroborates the impacts of drought that were discussed by all Montana farmers.

Table 4. Number of farms and irrigated acreage by states

State	Number of Farms (2008)	Number of Farms (2023)	Number of Irrigated Acres (2008)	Number of Irrigated Acres (2023)
Idaho	13,834	11,952	3,319,827	3,180,948
Montana	8,507	7,013	1,947,159	1,561,373
Oregon	12,156	12,692	1,758,602	1,447,429
Washington	12,712	9,988	1,675,898	1,706,118
TOTAL	**47,209**	**41,645**	**8,701,486**	**7,895,868**

Note: Farms are included in the Census of Agriculture if $1,000 or more of products were raised and sold, or normally would have been sold, during the census year.

5.3 New Technology Adoption

All interviewees were asked about their openness to adopting new technology. The following sections outline responses by market actor type.

5.3.1 End-Users

One end-user reported that they do not know about new technology and are concerned that there are not enough knowledgeable contractors to conduct maintenance. As a result, they would be reluctant to adopt new technology. The remaining four end-users mentioned that they are not reluctant to adopt new technology; however, they did not believe that they needed the technology. They all reported that increasing efficiency is a priority as costs rise and they recognize that new technology is key in increasing

[5] As reported in the 2013 NEEA report

efficiency and lowering costs. As crop yield is the main priority for end-users, novel approaches to farming that lowers costs while maintaining crop yield are important.

5.3.2 Specifiers/Contractors

One interviewee reported that they do not specify smart pumps or controls because they are "of an older generation." However, they believe that newer generations will be more willing to recommend new technology. The manufacturers interviewed corroborate this by saying that they believe that younger specifiers are willing to specify new technology to build and maintain market competitiveness.

One specifier reported that they are reluctant to specify new technology for farmers that are not tech-savvy because they may be more complicated for end-users to operate and maintain. Two other specifiers agreed with this by saying that older farmers are more reluctant to adopt new technology but would be open to conversations about how upgrades could save them energy and money. More support and articulation of benefits would be required when specifying newer technology to older generations of farmers. However, the specifiers believe that younger farmers are open to new technology.

5.3.3 Manufacturers

All manufacturers believe that the agricultural pump market is going in the direction of smart pump technology. One manufacturer believes, however, that the market overall is hesitant to adopt new technology as new technology invites uncertainty and thus potential risk. Despite this, there is a general openness in the market to be educated about the value of new technology for increasing efficiency, saving money, and maintaining the desired crop yield.

5.4 Objective 3 Conclusions

The following conclusions were made based on the research for Objective 3:

1) As reported in 2013, efficiency is a large priority for the agricultural pump market, and everyone is moving towards energy efficiency.
2) There is a trend towards more smart technology and VFDs, but older generations of farmers are more hesitant to adopt new technology. The trend towards more smart technology was predicted in 2013; however, the project team found that the age of the farmer impacts willingness to adopt new technology.
3) There are about 8 million irrigated acres in the Northwest, with Idaho having the most irrigated acreage, and Montana with the greatest reduction. Irrigated acreage is down from the 2013 NEEA study.
4) Specifiers are reluctant to specify new technology because of a perceived lack of contractor knowledge around maintaining systems and the perception that they are too difficult for users who are not tech-savvy. This was a new finding since the 2013 report.
5) Education among end users on smart technology varies. The 2013 report highlighted that lack of awareness on new technology was going to be a barrier for new technology adoption.

6 Summary Conclusion

With concerns about increasing prices, drought, and labor shortages, efficient pumping brings a great opportunity to lower costs, improve yield, and improve the quality of life for farmers across the Northwest region. Efficient technology exists, but farmers, contractors, and specifiers need help understanding how the benefits of efficient pumping apply to their applications. Further, the cost of technology and electricity present systemic barriers to adoption. Incentives and rebates from utilities or co-ops, in conjunction with education on how best to use smart technology on farms, could help offset the high upfront cost and knowledge barriers and help farmers save time and energy.

7 Recommended Future Research

More research would be required to better understand:

1. Differences in the path-to-purchase journey map by size of farm.
2. Differences in the path-to-purchase journey map by whether manufacturers stock or custom build pumps.
3. If there are installers who are not specifiers and vice versa, and where manufacturer representatives could play a role in the path-to-purchase journey.

Future research could also be conducted to confirm whether barriers change over time and whether projections for the market are accurate in the future. To ensure that the findings are as robust as possible, recruitment efforts should be focused on in-person events, such as trade shows and conferences to build legitimacy and build relationships. Further, recruitment should occur outside of the busy spring and summer harvesting season for farmers to increase the chance that they will have time to speak with interviewers. This will help to ensure larger, more representative samples to bolster the findings.