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University-Utility Partnerships: Best Practices for Water Innovation and Collaboration

by

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1 Abstract

University-utility partnerships (UUPs) are mutually beneficial collaborations that promote and accelerate innovation in the water sector. The Leaders Innovation Forum for Technology (LIFT) program worked with representatives from universities and utilities to define successful methods and strategies for establishing strong university-utility collaborative partnerships. Overall, partners in a successful university-utility collaboration need to be honest and realistic to match university capabilities and utility needs. In order to manage expectations at both organizations, utilities and universities must understand their respective points of view. Building and maintaining strong relationships should be a primary concern. Successful UUPs are built upon strong relationships between organizations rather than just strong research ideas. Different implementation structures should be considered for UUPs depending on what works best for both organizations. Common hurdles to overcome when implementing UUPs include working across distances and managing risks related to financing, intellectual property, and public outreach.

Key Words: University-Utility Partnerships, Collaboration, Research

2 Practitioner Points

- University-Utility collaborative partnerships are mutually beneficial and promote innovation throughout the water sector as a whole
- Establishing successful partnerships can be challenging, but difficulties can be mitigated by following the described best practices

- Partnerships can be structured and implemented in a variety of ways depending on the specific needs of each organization involved

3 Introduction

In a 2007 editorial in *Water Environment Research*, Dr. Krishna Pagilla succinctly summarized the benefits of university-utility collaborations:

*Applied research in water and wastewater conveyance and treatment is critical to address many short-term problems encountered by utilities and identify longer-term research needs and fundamental issues. Universities local to utilities have a great role to play in conducting such applied research and developing site-specific solutions to technical problems. **A university-utility collaboration is a win-win combination for both** and has synergistic benefits in terms of technical problem solving directly applicable to utility operations and training future professionals for the same utility. (Pagilla 2007)*

The Leaders Innovation Forum for Technology (LIFT) program, jointly administered by the Water Environment Federation (WEF) and The Water Research Foundation (WRF), has a focus area on encouraging university – utility partnerships (UUP). To communicate the best practices, challenges, and successes of university – utility collaboration, the LIFT team is working with influential stakeholders including the WEF Research & Innovation Committee, the Association of Environmental Engineering and Science Professors (AEESP), the International Water Association (IWA) USA National Committee (USANC), the IWA Canadian National Committee, and a research team working on a Grant Opportunities for Academic Liaison with Industry (GOALI) project funded by the National Science Foundation (NSF).

Leaders from WEF, WRF, LIFT, universities and utilities defined successful methods and strategies to establish strong utility-university collaborative partnerships (WEF, 2017), which are summarized in this paper.

4 Success Factors

In general, partnerships are more difficult for utilities than for universities. This is often because of the fundamental nature of utilities, whose job is to protect public health on a daily basis. A failed project in academia is a lesson learned and opportunity for future research. A failure at a utility can lead to non-compliance, fines, and public health and environmental consequences. Thus, utilities seem to be more interested in technical solutions than laying the groundwork for research. In addition, in some cases, professors and students do not fully understand the “on the ground” reality at a working, full-scale

utility. Therefore, the partners in a successful university-utility collaboration need to be honest and realistic to match university capabilities and utility needs. In order to manage expectations at both organizations, utilities and universities must understand their respective points of view.

While not confining themselves to local schools, utilities should support local institutions to build research infrastructure locally. Partnerships can strengthen local institutions to leverage support in obtaining research projects from larger funding sources, which utilities could leverage as they encourage researchers to conduct pilot- and full-scale research on-site to generate results most applicable to the facility. Because partnerships are focused on applied research, utilities should understand that a Professional Engineer (PE) is not always needed for a research project. However, the utility can facilitate the partnership of a university with a consultant when a cost estimate or business case analysis is needed to go along with a research or pilot project.

Utilities should also be open to the investigation of unexpected outcomes or fundamental issues through longer-term research, especially for high-risk projects, where universities can handle when projects don't work out. Utility staff can better understand the academic environment by designating a specific liaison to the project that works with the students, including serving on graduate student advisory committees, where appropriate. This integration will also help the utility recognize the degree requirements of university graduate students in terms of research, including project schedules, timelines, and publications.

With respect to publishing, utilities should minimize the requirements for separate reports, but encourage timely publication and presentation of results at conferences and in peer-reviewed journals as a substitution for traditional final reports. In fact, looking at the proceedings from WEFTEC 2014 to 2018, innovative utilities have been jointly publishing with universities on a consistent basis, as shown in Table 1. Figure 1 shows that UUP related presentations have consistently ranged from between 5.5 percent and 7.5 percent of the total number of presentations in the WEFTEC technical sessions (Water Environment Federation, 2014, 2015, 2016, 2017a, 2018).

The academic community members, both professors and students, should understand that there may be competing interest types, such as academic research versus practical projects needed by a utility. In fact, when starting a UUP, researchers should consider an initial project that is practical and immediately relevant, as a first step in the establishment of a long-term relationships with the utility. When provided

the opportunity to use the utility's facility for real world applications, researchers should understand that when they are on utility property, utility critical operations take precedence.

Utilities are generally used to working with consulting engineers and construction projects. Therefore, researchers need to develop communication protocols that will be successful in the utility environment. Researchers should provide deliverables (both interim and final) that have significant value and use for the utility. The goal of these frequent deliverables is to keep the utility informed of the work progress in a timely manner and keep the utility actively engaged in the research direction.

5 Structure for Implementation

There are myriad alternatives in which utilities and universities can partner. Utilities, funded by ratepayers, often have funding available for applied research and development efforts in support of specific issues they face. In smaller utilities, there are more opportunities for in-kind support and less money. Collaborations may be centered around faculty, students, curriculum, or a defined research project.

From a faculty perspective, utility professionals have been successfully used as adjunct professors in both undergraduate and graduate coursework, providing authentic engagement for students before they enter the profession. Correspondingly, having research faculty take a sabbatical at a utility enables the professor to obtain direct industry exposure, provides valuable scientific and technical expertise to the utility, and allows both entities to keep current on technological and market advances.

Graduate and undergraduate students hired at utilities for short-term internships are relatively inexpensive and not a long-term commitment. An internship program identifies potential future employees for the utility or other areas of the water sector, such as manufacturers. Students can get enough experience to obtain operator licenses (depending on their role and how many hours worked), which is a benefit to the student that would give them an advantage with many employers (utilities, consultants, etc.). The characteristics most identified as being beneficial to a partnership with utilities were students who are inquisitive and can develop good rapport with their utility counterparts, are interested in an industry job in future career, and can balance fundamental research with applied projects.

One example of such a partnership is in Brookings, South Dakota, between South Dakota State University and Brookings Municipal Utilities. For over 30 years, Brookings Municipal Utility has executed

yearly contracts with South Dakota State University to hire graduate and undergraduate students to operate a wastewater treatment facility in the evening and overnight hours. The benefit for Brookings Municipal Utilities is getting skilled workers to operate the facility without the cost of full-time employees, as well as training potential future employees in the wastewater profession. South Dakota State University is able to provide students with paid opportunities to get hands on experience (WEF, 2017).

Utilities can have representatives on academic departments' industry advisory boards, which keep the curriculum current, develop internship programs, and strengthen the link between academia and industry. Utility professionals can advise an undergrad student team for senior design or capstone class, which can begin as an informal transaction.

The approach can also expand to graduate students. For example, in St. Louis, MO, the Metropolitan St. Louis Sewer District (MSD) has worked with Washington University in St. Louis on independent studies courses with engineering graduate students to help them gain practical knowledge and hands-on experience with real utility challenges. The topics assigned to students are current and long-term areas of interest to MSD, including corrosion control in large force mains, digester optimization for energy recovery, struvite control and iron fouling of UV disinfection tubes, and non-incineration/landfill options for sludge disposal. MSD provided background information and operating data to the students, who then developed problem statements and offered practical resolution options to MSD for consideration. This partnership structure allows both the utility and university to benefit without a contract or funding (WEF, 2017).

Finally, lab facilities can be integrated into the curriculum. If a utility has analytical needs but doesn't have the equipment, the local university might have the high-end lab equipment to perform the testing. The reverse can also be true, the utility may have lab equipment that the university does not have.

Collaboration around a specific research project is a very common approach to UUPs. A professor, or utility R&D team member, serves as Principal Investigator (PI) on an externally funded study with a student team performing pilot or demonstration work of technologies or processes at utility facility in conjunction with utility staff. Utilities are often challenged by the mechanics of a long-term project, including things like having to find living arrangements for students. This approach could also involve equipment manufacturers and the utility's consulting engineers in the collaboration. On a smaller scale,

the utility can fund smaller research projects where utility data is provided to researchers to perform data analysis or other paper studies in order to help solve a specific problem.

The joint team on an externally funded research project is very common. The Water Research Foundation (WRF) is an organization dedicated to applied water research, primarily in support of water, wastewater, water reuse, and stormwater utilities. WRF is the combined foundation resulting from the 2018 merger of the Water Research Foundation (WaterRF) and Water Environment & Reuse Foundation, a previous merger between the Water Environment Research Foundation (WERF) and the WaterReuse Research Foundation. As shown in Figure 2, between 2014 and 2018, WRF began 106 research projects, of which 28 had both utilities and universities on the project teams. The wastewater research program from the legacy WERF initiatives accounted for 15 of the 28, or more than half of the UUP projects. The drinking water focused projects from legacy WaterRF represented eight projects, or roughly 30 percent, while the WaterReuse legacy research program had five projects, or about 18 percent (The Water Research Foundation, 2019).

The joint project teams were present at major North American water sector conferences between 2014 and 2018. Figure 3 shows that the teams had 37 presentations at WEFTEC, 24 presentations at AWWA ACE, and 2 at the Water Quality Technology Conference (WQTC). These teams delivered an average of 7 presentations at WEFTEC every year. Because WEFTEC has averaged 41 presentations per year by joint utility university collaborations, the WRF projects only represent about 17 percent of the total UUP presentations. The fact that over 80 percent of the UUP presentations were non-research foundation projects implies that collaborations are prevalent based on partnerships that started organically to address shared issues.

6 Distance

Distance is relative. A one-hour drive may be as large a barrier as a several hour flight, depending on the nature of the research or working relationships. Partnerships are often locally or regionally based, but there are interstate and international UUPs. Geographically related UUPs are convenient because students can work directly with or at the utility while taking classes. Furthermore, utilities and universities located nearby generally face the same issues with respect to climate and natural resources, which means project interests are often aligned. It is often easier to have meetings in person, especially when you are in the “getting to know the project” phase where lengthy discussions are needed. When working at a distance, the researchers and utilities tend to have one or two main contacts and miss the

opportunity to collaborate more broadly with many different types of people in a shorter timeframe as is often the case with local partnerships. Although co-location provides opportunities to strengthen critical interpersonal relationships, ready access to webinar tools makes it very easy to establish strong interpersonal relationships over distances in ways that can overcome some of the barriers noted.

For some public utilities, there are structural constraints to working with universities outside their regions. These organizations may specifically prohibit working out of state, or might not encourage it if a local university is perceived as having adequate capabilities to do the intended research. This leads to the “perception of plenty” that might be a barrier if the research interests or expertise of the local universities don’t match what the utility needs or vice versa. Another challenge in expanding collaboration is university loyalties – people tend to reach out to and collaborate more with their network of alumni, which can create a barrier for others, especially the smaller universities.

While utilities should definitely support their local academic community, if they have the resources they should also pursue strategic collaborations that make sense based on the expertise needed by the university research team rather than just accepting the expertise available nearby. Utility research often benefits from advanced state-of-the-art analytical methods that are only available at a small number of universities and it is more productive to work directly with these experts. Furthermore, universities are increasingly encouraging students to gain practical experience away from campus and graduate student summer internships are becoming popular and accommodated by university enrollment rules. Finally, the strongest sustained U-U relationships require interpersonal chemistry between those involved and proximity does not guarantee those relationships will exist. A committed partnership between individuals who have a strong mutual working relationship is going to be more sustained than a forced partnership between individuals who may be in close proximity but do not develop a functional working relationship.

Opening to others around the world can lead to alignment of needs. One is more likely to find matching interests when looking at a larger potential group. This concept is continually covered in the scientific press as well: Scientific American recently had a feature editorial discussing how partnering across borders means faster discovery (Scientific American, 2018). Specific examples in the water sector include professors who had partnerships with utilities in other countries, including Michigan-Ethiopia, North Carolina-Zambia, and Virginia-China (WEF, 2017).

7 Risk Management

The level of acceptable risk is different at the university than the utility, since utilities are very risk averse. In order to manage expectations for UUPs, the three most important aspects of risk management in a UUP are finance, intellectual property (IP), and public outreach.

7.1 Finance

From a utility perspective, with public procurement laws, it can be a challenge to work with a university and meet procurement rules. One participant even made the comment that “procurement is the enemy of innovation.” To develop a contract by sole sourcing (going into an agreement without a competitive bid) is difficult: approval can take several months, and sometimes the maximum threshold is \$10,000 or lower. Some utilities that have their own boards (not a city department who have to answer to an elected mayor) have more flexibility to fund research.

A contract offers more flexibility than a purchase order. An overall master agreement between the utility and a university means that the utility can then sole source. The master agreement can often be amended for additional work. In the master agreement at Metropolitan Water Reclamation District of Greater Chicago, a project can be initiated either by the utility approaching the university with a problem and need to build expertise, or by the university approaching the utility with a proposed technology. Another example of an effective contract is Grand Rapids’ program with Grand Valley State University, where the utility pays the university to get graduate or undergraduate students to come and do projects working full time. The department manager defines the needs for the utility. This arrangement has to be done via a contract, as the utility cannot give a grant. Procurement rules in some states may allow contracts with public universities without competition. In this case, only a scope and fees must be negotiated.

Coordinating with a consulting engineer or other third-party partner (may be part of a team initiating, or being brought in to assist) can be a benefit, but may also need to be managed. Since utilities are used to dealing with consulting engineers and contractors, they expect proposals and projects like consulting engineers would provide (includes deliverables, fee structure, etc.), which can be different than academic grant proposals.

The university can also have some flexibility to facilitate the financial agreement. If the research is performed at the utility (off campus), then a lower overhead rate may apply, increasing the amount of research that can be accomplished for the same money. Researchers can also seek support from higher

level in the administration. For example, Virginia Tech lowered overhead for help in fostering a partnership with multiple utilities for the Virginia Tech Center for Applied Water Research and Innovation (VT-CAWRI). Universities can also look at co-funding a project using discretionary funds from the academic department or college.

Equipment can be purchased and owned by the utility in order to avoid additional indirect costs. This was done for a project between the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) and Iowa State University to pilot revolving algae biofilm reactors or RABs (WEF, 2017). Universities should try to match funds or look for external funding outside of the utility in order to accelerate collaboration.

7.2 Intellectual Property

Historically, IP has been the domain of the universities, and utilities generally have not been interested. As the water sector moves towards a resource recovery paradigm and seeks sources for additional revenues, that model is changing. An example IP framework shows that if either partner exclusively develops some IP, then it is the property of the developing organization. Any IP developed as a joint effort must be shared equally. Any issues with a third party not part of the master agreement, such as a technology manufacturer, must be agreed to prior to their participation in the research program (WEF, 2017).

7.3 Public Outreach

Both researchers and utilities want to share the results of their research. Academics generally want to publish in peer-reviewed journals and utility professionals want to be seen as leaders by presenting at industry conferences like WEFTEC. The master agreement should specify publishing requirements. In general, best practices for publicizing the research results are that either partner can present or publish a technical paper, but must check with the partner for the opportunity to edit, comment and provide the right of first refusal for co-authorship. If a partner does not wish to participate, the other partner will be unnamed or sanitized in the publication or presentation. For example, "Utility A" instead of "Springfield Water Resource Recovery Facility." Data issues must be discussed at the beginning of the project. For example, if there is new analysis about emerging contaminants in solids, the partners need to come up with a common way to release information and everyone should agree to the same. Utilities don't want to hide the data, but also don't want data presented in a way that negatively portrays the utility in the public eye.

8 Building Relationships

Building and maintaining relationships are perhaps the most important aspect of UUPs. UUPs are not project based, they are based on relationships and the projects follow. Practices and issues are grouped below into three phases: Initiating the first connection, developing the first engagement, and maintaining relationships.

8.1 Initiating the First Connection

With their network of industry associations, such as the Water Environment Federation (WEF), the American Water Works Association (AWWA) and their regional affiliates, utilities can reach out by taking advantage of the associations' work engaging academics. Utilities can encourage regional professional organizations to highlight academics at the state-level conferences, creating opportunities for utilities and universities to network. The local organization could even host matchmaking events at a conference to match interests between utilities and universities. Utilities can also post their research and technology needs in the AEESP listserv, the "Projects" or the "Needs Forum" sections of the LIFT Link platform (LIFT 2018). In LIFT Link universities can see what types of projects utilities are currently working on and would like university participation, as well as follow various utility needs and connect to assemble partnerships for projects.

University professors can volunteer and participate in committees of applied professional organizations such as WEF or AWWA in order to build academic-utility networks and collaboration opportunities.

Academic involvement and participation in such organizations is essential not just for initiating relationships, but also for maintaining them. People interested in UUPs can participate in interdisciplinary workshops through organizations such as WEF and WRF, as well as through U.S. National Science Foundation, U.S. Department of Energy, water innovation clusters like the Water Council (Milwaukee, WI, USA) and The Water Alliance (Netherlands).

An easy way to make contact is for universities to arrange class tours of treatment plants and develop good relationship with plant managers. Utilities are proud of the work they do and their facilities and they run tours routinely.

8.2 Creating the First Engagement

In order to get the first project off the ground, academics must make sure their proposed research is relevant to the utility. If a university approaches a utility with a technology, the technology should have

strong potential to go into practice. If the university is coming to a utility for funding, the utility needs to be invested on the topic and technology in order to commit.

Setting up a lunch or other meeting to discuss the potential of a project without commitment is often used to help define the bounds of a proposed partnership. The goal of the introductory meeting is to have an information exchange to learn about each other's capabilities and needs/interests, as well as coordinate and come to an agreement on common questions that benefit the utility and the university for future investigation. Utilities can classify problems that need to go to consultants (mission critical, etc.) versus those that could go to university (feasibility studies, etc.).

Utilities generally prefer universities approaching them with a specific project proposal, so it is easier for utilities to say "yes" or "no." A one-page research proposal that includes a short literature review, proposed scope, timeline, and budget can be effective. Researchers should review the utility's master plan, capital improvement plan, budget, and facilities to prepare for an interview with the utility. An hour-long interview with the utility should help a university figure out opportunities to address utility needs. The researcher could steer the interview, knowing the capabilities of the students. Key questions that should be asked include "what are your problems?" and "where do you want to save money?"

8.3 Maintaining Relationships

Building the relationship helps to build the partnership. Longer term initiatives may work better as a wider collaboration. Recognize the scope that is inherent in how different groups work. For example, utilities know and understand the details of a particular situation they are facing (in-depth), while a consultant might know less detail but have many different angles from different clients (wide view). Multiple universities or academic departments can partner with a single utility.

Successful management of the long-term relationship includes communicating the value of the project through quarterly report-outs, a final report or journal publications, and a student presentation about the project to top utility management. UUP projects should demonstrate economic savings to utilities through applied projects – those projects the utility might not have time to investigate problems but know something is going on – such as doing basic research on which technologies perform the best.

From a staffing perspective, successful UUPs overlap new and long-standing faculty to inherit relationships and start to build new relationships. Utility and industry staff can have advisory roles at the university to help define and prioritize key research questions. Where possible, having multiple students

on research teams allows the senior student to help mentor the rising researchers, which will help create continuity on research teams.

Researchers can set up mutual learning benefits, such as leaving a piece of the lab work with the utility to help ensure buy-in and shared ownership of the research. However, researchers at utility labs need to ensure that they manage the lab needs so they are not taking utility staff away from their regular duties to assist with research sampling and analysis.

Both the university and utility staff should consider involvement in LIFT, WEF and AWWA committees. For larger efforts, the partners should engage with WRF subscribers or submit proposals for Subscriber Priority Research, Tailored Collaborative Research (TCR), Unsolicited Research, or one of WRF's other research programs. Following the best practices described in this paper will help ensure that University – Utility Partnerships meet their potential and ensure a true win-win combination.

9 References

- LIFT (2018)_Water Research Foundation & Water Environment Federation's LIFT Link, <http://liftlink.werf.org> accessed October 18, 2018
- Pagilla, Krishna. (2007). "University–Utility Collaborative Applied Research—A Win–Win Combination." *Water Environment Research* 79.6: 579-580.
- Science Without Walls (2017). *Scientific American*, 316(7), 7
- The Water Research Foundation (2019). [Project Management Database]. Unpublished raw data.
- Water Environment Federation (2014) Proceedings of the Water Environment Federation, WEFTEC 2014, New Orleans, LA
- Water Environment Federation (2015) Proceedings of the Water Environment Federation, WEFTEC 2015, Chicago, IL
- Water Environment Federation (2016) Proceedings of the Water Environment Federation, WEFTEC 2016, New Orleans, LA
- Water Environment Federation (2017a) Proceedings of the Water Environment Federation, WEFTEC 2017, Chicago, IL

Water Environment Federation (2017) Technical Report WSEC-2017-TR-005 University-Utility
Collaborative Partnerships

Water Environment Federation (2018) Proceedings of the Water Environment Federation, WEFTEC
2018, New Orleans, LA

10 Tables

Table 1: Utility University Partnerships Presentations at WEFTEC

WEFTEC Year	Number of UUP Papers	Total Number of WEFTEC Papers
2014	38	687
2015	44	630
2016	46	594
2017	33	612
2018	45	621
Total	206	3,144

11 Figures

Figure 1. Percentage of WEFTEC Technical Sessions Presentation with Utility University Partnerships,
2014-2018

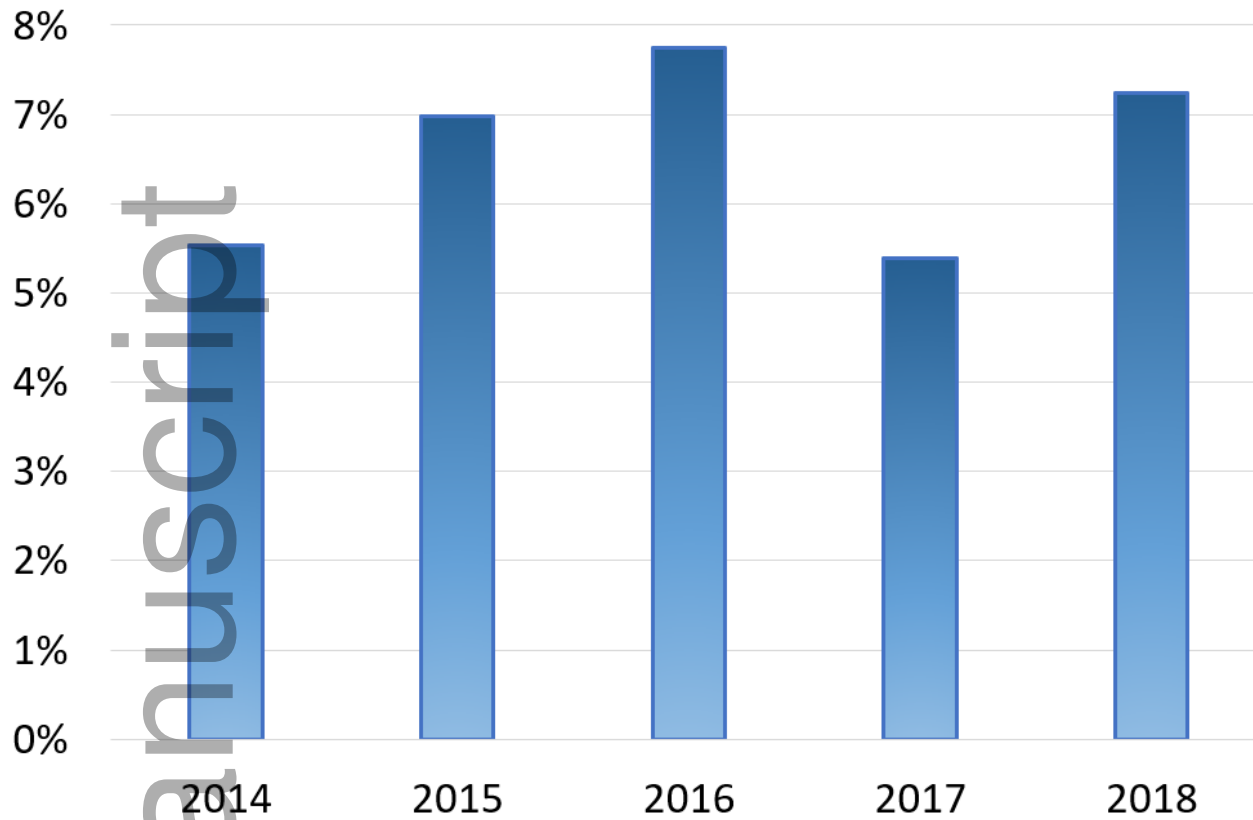


Figure 2. Research Teams with Utility – University Collaboration at The Water Research Foundation, 2014-2018

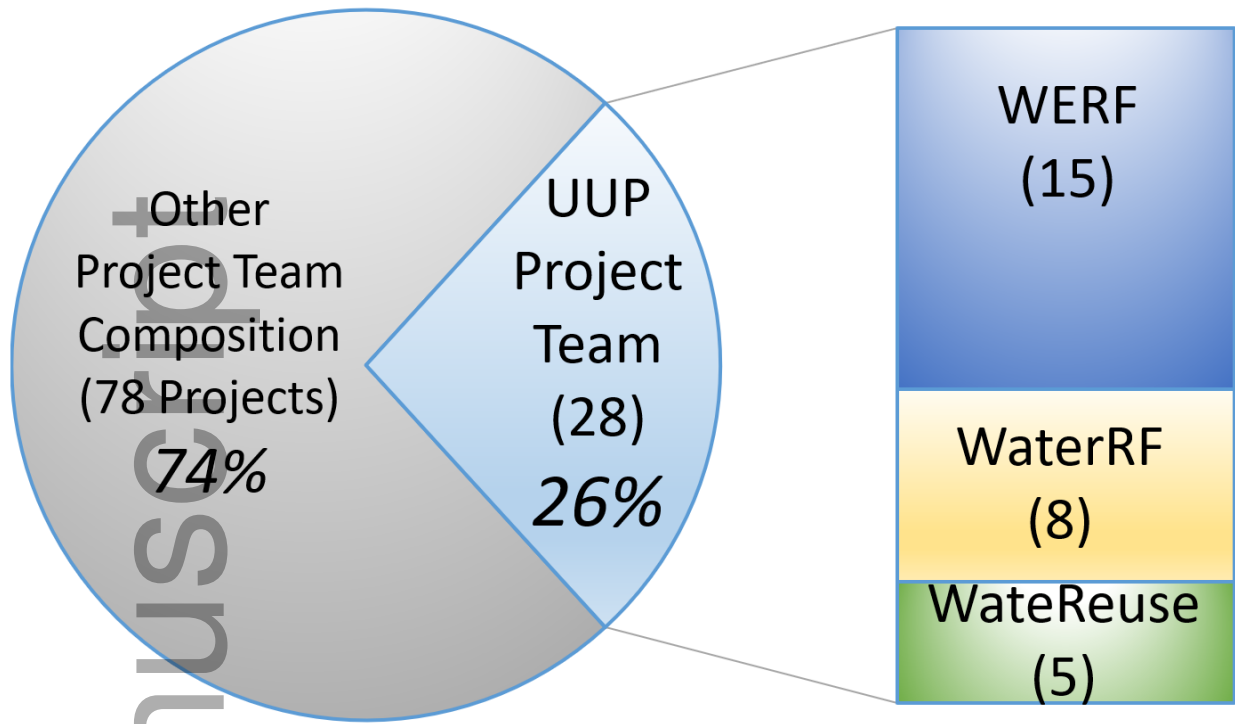
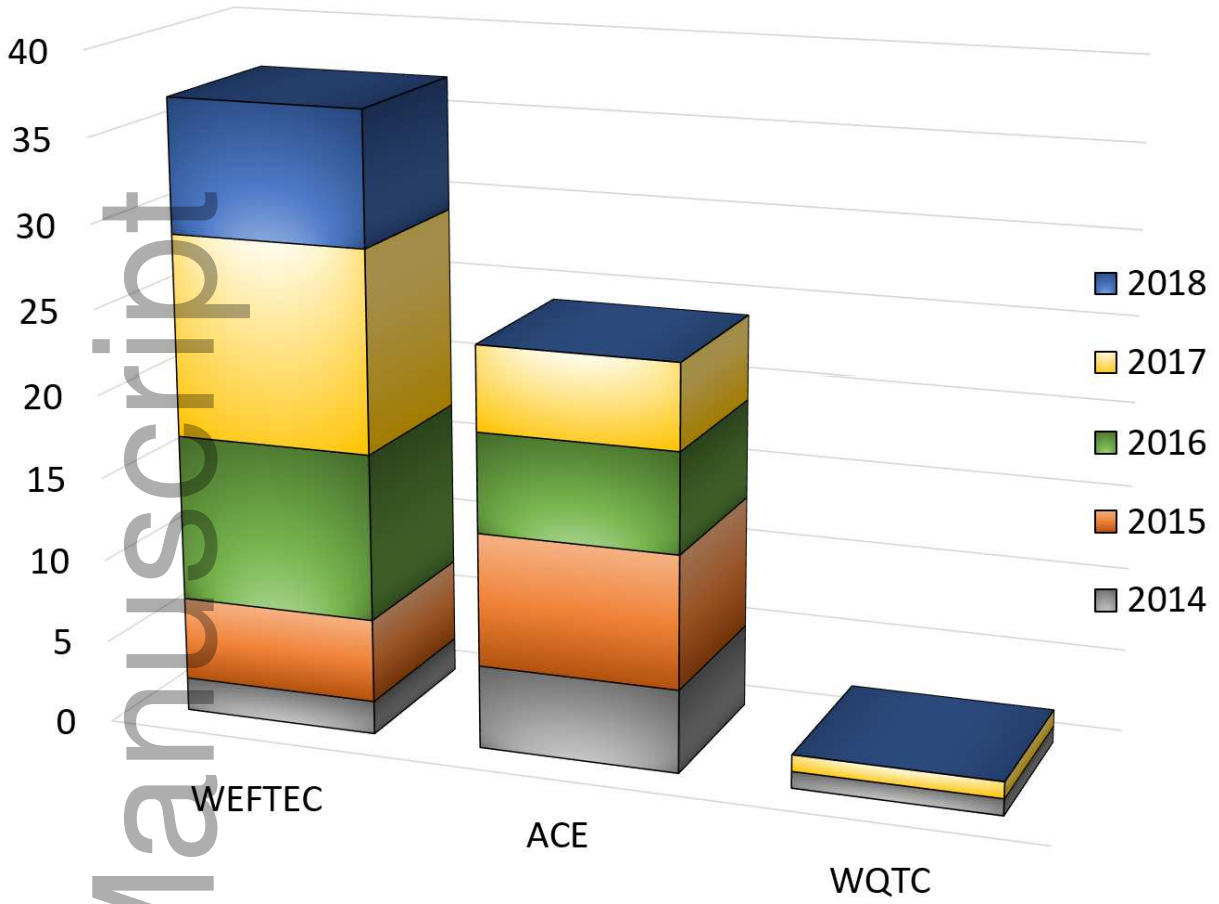
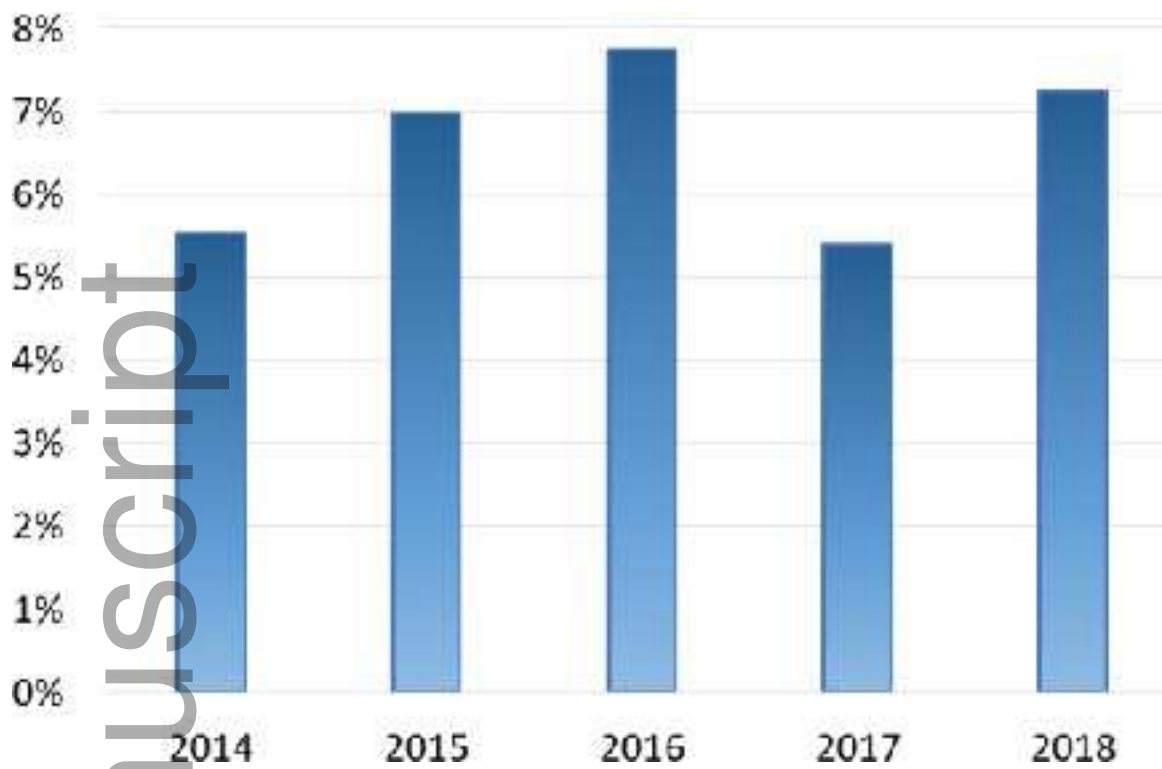


Figure 3. Presentations at Major Conferences by The Water Research Foundation UUP Project Teams, 2014-2018

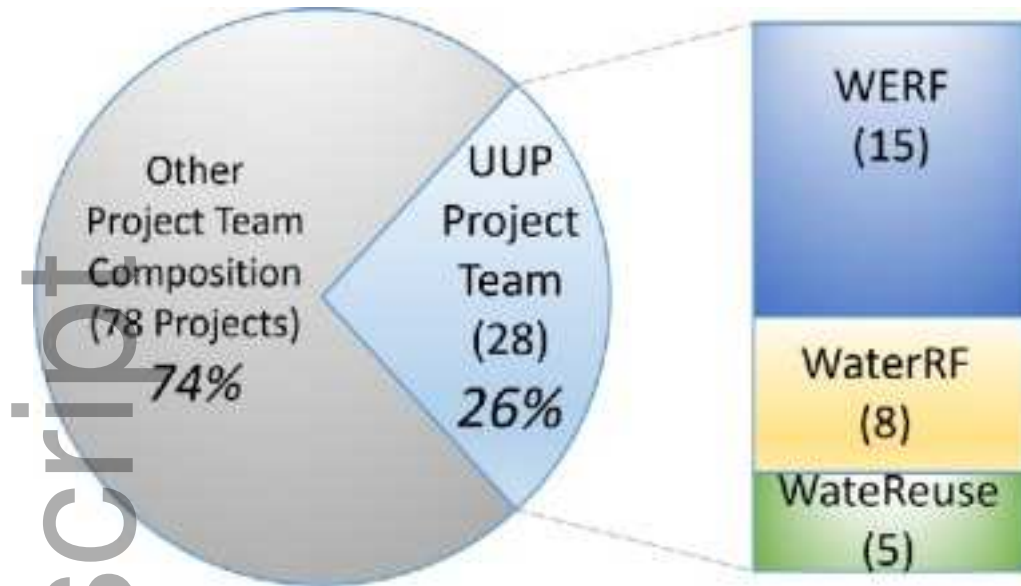
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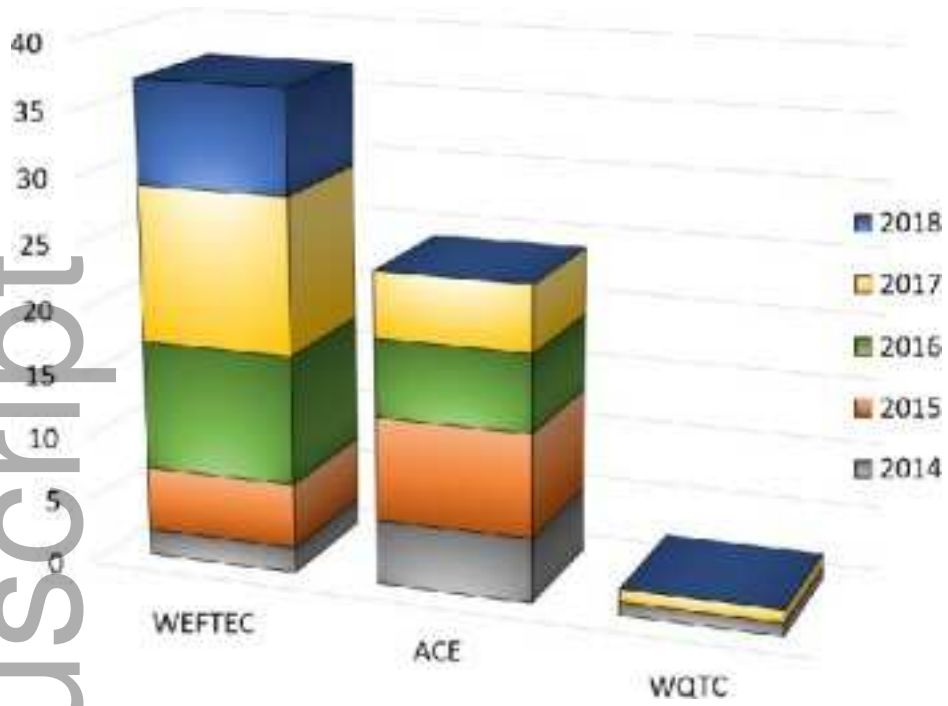
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