



# Water Reclamation System For Electrolux Fabric Care Reliability Lab



Chandler Horton, Gabe Martinez, Samuel Norvell, Tyler Salisbury, Alex Senneville, Jeremie Tuzizila  
 Facility Mentor: Steve Kiser | Industry Supporters: Anthony Lufkin, Richard Hudson, Rajesh Patel

## Description of Problem

The Industry Supporter for the ELEC\_FABRIC project is Electrolux, a premier global appliance manufacturer. Electrolux is a socially responsible company, committed to both consumer satisfaction and sustainability. Electrolux tasked the team with developing a greywater reuse system for the washing machine testing performed at their Fabric Care and Reliability Lab.

Specification	Application	
	Prototype	Large Scale
Description		
At least 50% water reuse*		✓
Remove target contaminants**	✓	✓
Total hardness of 20-40 ppm	✓	✓
Provide flux rate data	✓	

Designed for variable capacity demands ✓  
 \* This is the minimum reclamation requirements; however the system is designed for a 100% theoretical rate of return with minor losses in operation  
 \*\* Target contaminants differ between RO and UF systems

## Design Assumptions

### Initial Greywater Testing

- TDS (salts and detergents), and TSS (lint, soil, and other debris) were found to be the primary parameters of concern.
- Total Water Hardness within acceptable limits before treatment.
- Normal pH level (6-9).

### Facility Water Demand:

- 64 washers operating at approximately 60% capacity.
- Variable flow=variable demand.
- Based on utility data facility demand an estimated annual water consumption of 3.75 million gallons.

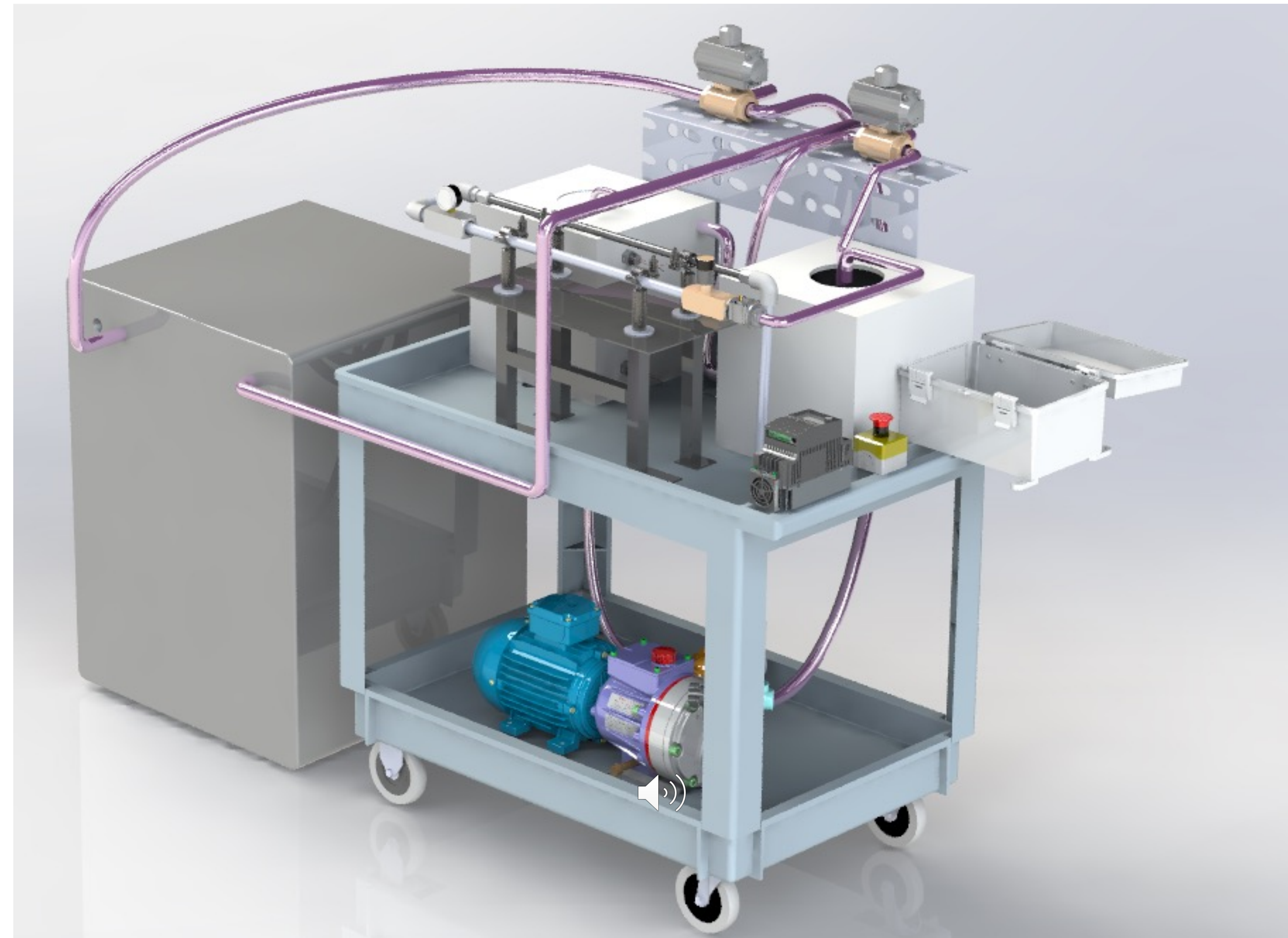
## Filtration Techniques

### Reverse Osmosis

- Pressure driven
- Greater removal efficiency (TDS and Turbidity)
- Produces nearly pure water
- Lower flux rate
- More membrane are required
- More expensive

### Ultrafiltration

- Flow driven
- Passes detergent
- Greater flux rate
- Less membrane are required
- Smaller pump
- Cheaper system
- Removes TSS
- Membrane based
- Crossflow tubular membranes
- CIP



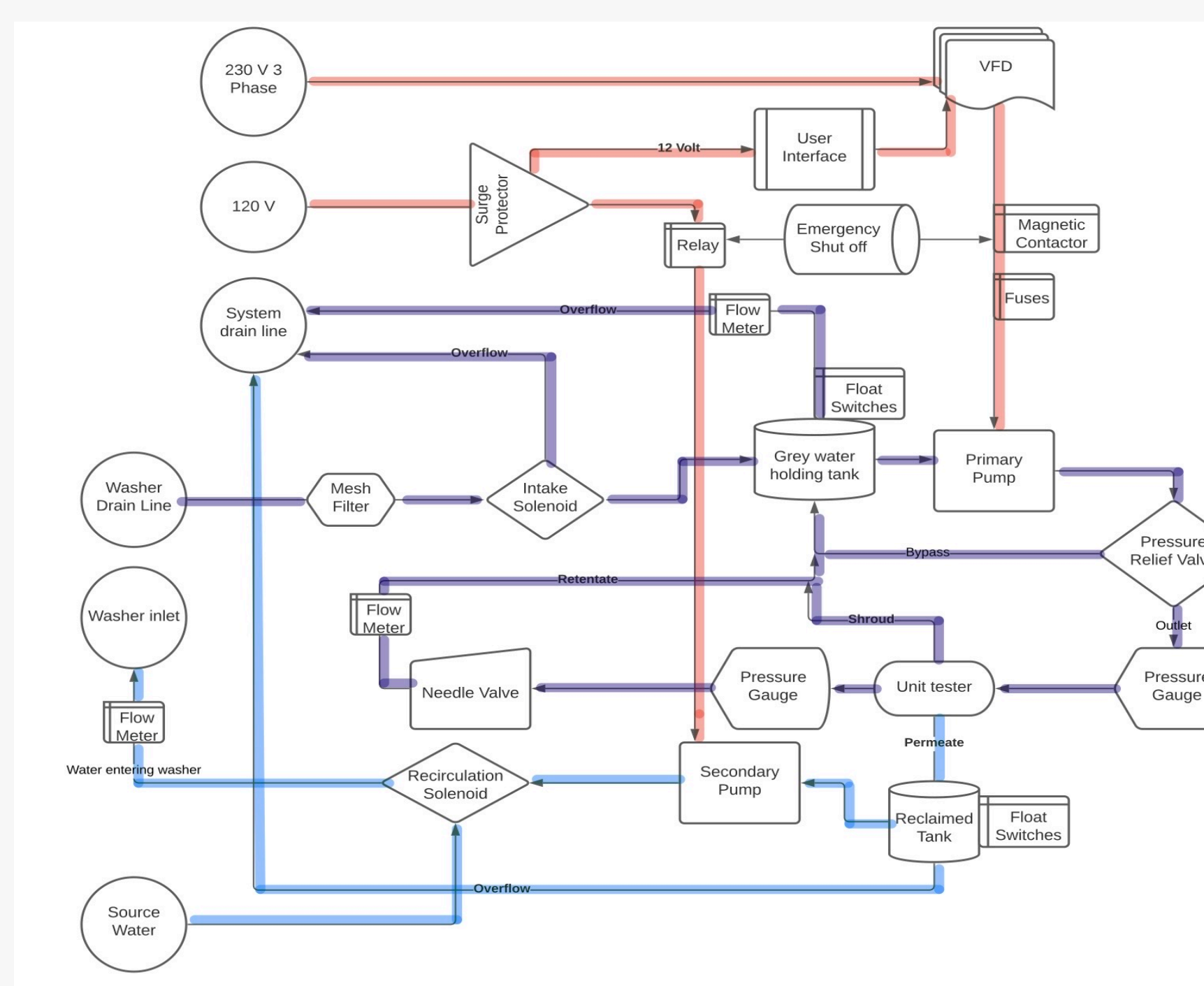
System Details

### Electrical Specifications

- 230 Volt 3 Phase 60 Hz AC input primary pump
- 120 Volt AC input for secondary pump
- 12 Volt DC input for microcontroller
- 4 PLS-092A-3PPH Float sensors
- 2 BVB6TV-XR33-J Solenoids
- 4 Digen Flow meter sensors
- Teco Westinghouse E510 VFD
- Protection circuit from wall to VFD
- Custom built controller using the STM32F411Re MCU Dev. Board
- Simulink Embedded Coder used to generate C/C++ code
- Informative user interface
- Autonomous functionality

### Mechanical Specifications

- 3/4" Stainless Steel NPT Plumbing
- 2HP Motor
- 300+ PSI
- Pressure Relief Valve
- Needle Valve
- Pressure Gauges



## Large-Scale Payback Analysis

Reverse Osmosis			Ultrafiltration		
	Net Yearly	Cumulative		Net Yearly	Cumulative
Year 0	\$(322,000.00)	\$(322,000.00)	Year 0	\$(161,000.00)	\$(161,000.00)
Year 1	\$19,408.16	\$(302,591.84)	Year 1	\$19,408.16	\$(141,591.84)
Year 2	\$20,873.97	\$(281,717.87)	Year 2	\$20,873.97	\$(120,717.87)
Year 3	\$22,398.71	\$(259,319.17)	Year 3	\$22,398.71	\$(98,319.17)
Year 4	\$23,984.72	\$(235,334.45)	Year 4	\$23,984.72	\$(74,334.45)
Year 5	\$25,634.48	\$(209,699.97)	Year 5	\$25,634.48	\$(48,699.97)
Year 6	\$27,350.54	\$(182,349.43)	Year 6	\$27,350.54	\$(21,349.43)
Year 7	\$29,135.56	\$(153,213.86)	Year 7	\$29,135.56	\$7,786.14
Year 8	\$30,992.32	\$(122,221.54)			
Year 9	\$32,923.68	\$(89,297.86)			
Year 10	\$34,932.65	\$(54,365.21)			
Year 11	\$37,022.34	\$(17,342.87)			
Year 12	\$39,195.99	\$21,853.11			

## Sustainability Benefits

Category	Economic Savings	Ecological	Community	Certifications
Water Reuse	\$15,000- \$20,000/yr	Drought prevention, water conservation, groundwater/surface water preservation	More water availability, setting sustainability precedent for industry	LEED BD+C NSF/ANSI 350
Detergent Savings (UF)	50% reduction	Reduced chemical loading, less production and less depletion of resources, less plastic being disposed of (packaging)	Model of a semi-closed loop system, demonstrates commitment to sustainability	NSF U.S. Green Building Council LEED CERTIFIED VEGRO
Reduced Sewage Load	\$23,000- \$36,000/yr	Less potential for chemicals and high nutrient water contaminating waterways	Less waste in community systems	

## Testing Results

PARAMETER	UF	RO
TDS (ppm)	127.7	6.3
Turbidity (NTU)	7.5	1.15
pH	7.1	6.8
Detergent Removal (%)	39%	98%
Turbidity Removal (%)	87%	95%
Flux Rate (GFD)	138	32.4

- 4x higher flux rate for UF
- Greater removal efficiency for RO
- Acceptable pH found in all samples
- Meets NSF/ANSI 350 requirements\*

\*For tests performed, more extensive testing required for certification.



- Over 50 years of experience
- Tubular Crossflow Technology