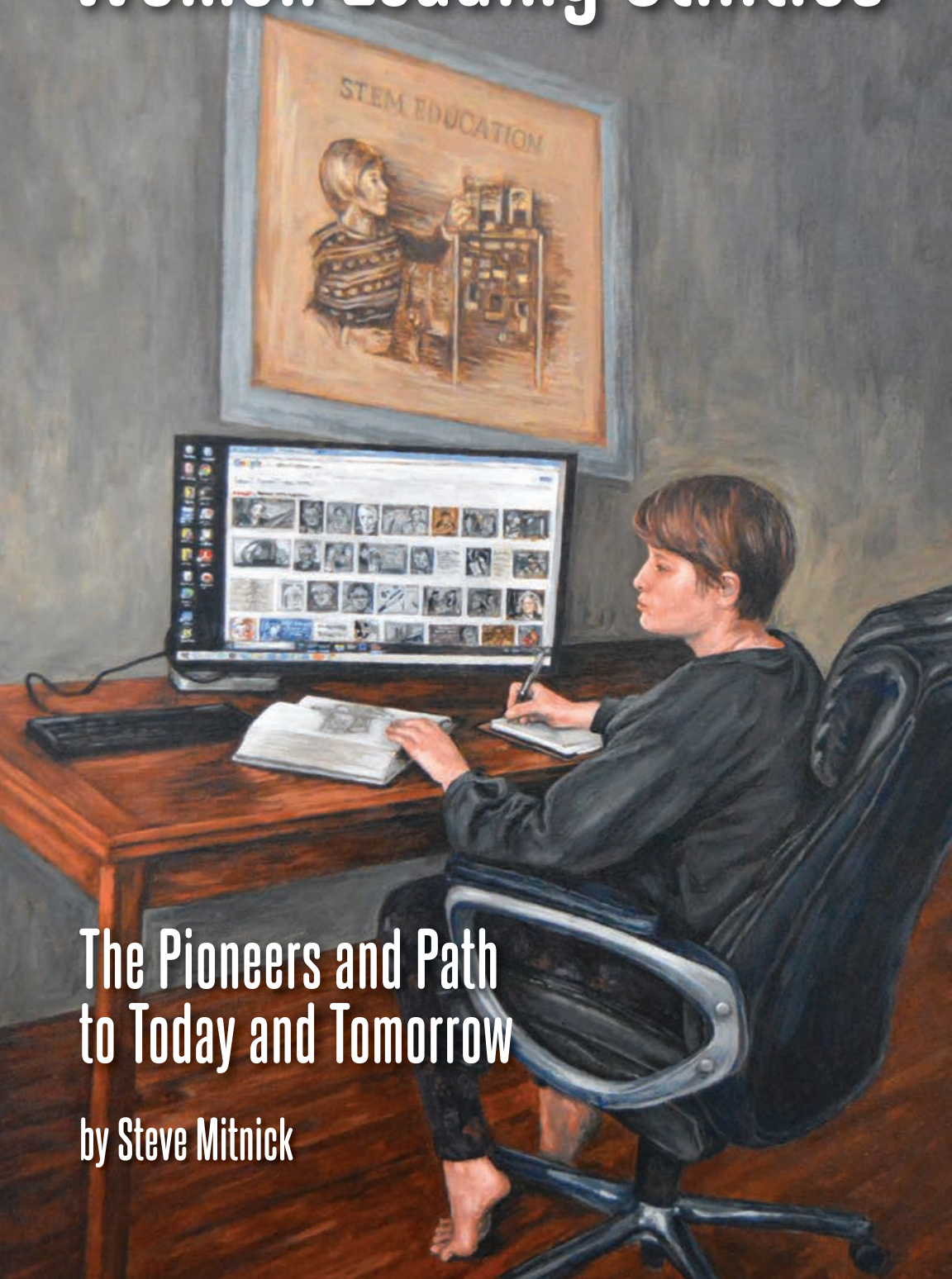


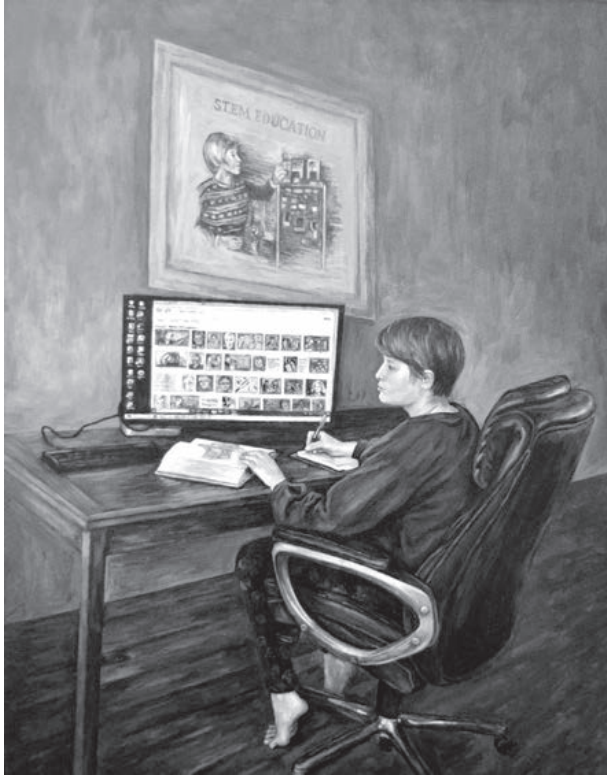
Women Leading Utilities



The Pioneers and Path
to Today and Tomorrow

by Steve Mitnick

Women Leading Utilities



The Pioneers and Path to Today and Tomorrow

by Steve Mitnick

Also by Steve Mitnick

Lines Down
How We Pay, Use, Value Grid Electricity Amid the Storm
2013

Lewis Latimer
The First Hidden Figure
2020

Women Leading Utilities

The Pioneers and Path to Today and Tomorrow

by Steve Mitnick

**PUBLIC UTILITIES
FORTNIGHTLY**

Impact the Debate

Public Utilities Fortnightly
Lines Up, Inc.
Arlington, Virginia

© 2021 Lines Up, Inc.

All rights reserved. Printed in the United States of America. Except as permitted under the United States Copyright Act of 1976, no part of this publication may be reproduced in any form or by any means without the prior written permission of the publisher.

The digital version of this publication may be freely shared in its full and final format.

Library of Congress Control Number: 2021909528

Author: Steve Mitnick

Editor: Lori Burkhart

Assistant Editors: Rachel Moore, Angela Hawkinson

Production: Mike Eacott

Cover Illustration: Paul Kjellander

Interior Illustrations: Dennis Auth

For information, contact:

Lines Up, Inc.
3033 Wilson Blvd
Suite 700
Arlington, VA 22201

First Printing, June 2021
ISBN 978-1-7360142-3-3
V. 1.01

Printed in the United States of America.

To my daughter

Leana Gayle Mitnick

who started her career in the utilities industry last year
at JERA, Japan's largest power generation company.

The cover painting entitled “Like Them I Can Be Anything”
is by Paul Kjellander, the President of the Idaho Public Utilities
Commission and President of the National Association of
Regulatory Utility Commissioners,
commonly referred to by its acronym NARUC.

Table of Contents

Table of Contents	vii
Table of Figures	ix
Sponsoring This Book	x
Moving Statements by the Sponsoring Organizations	xi
Acknowledgements	xvi
Foreword	xix
Introduction	1
Chapter 1. Women Who Made the Grid	5
Women of 1883	5
Bertha Lamme and More	6
Twentieth Century Women	10
Florence Fogler	11
The Roaring Twenties	13
Edith Clarke Addresses the Industry	14
Toward a Grid of Power	16
Chapter 2. Professor Clarke	18
Edith Clarke Substation	18
The Clarke Transform	19
Clarke in Texas	22
Smart Grid Looks to Clarke Again	23
Chapter 3. From Computer to Transformer	25
Where Clarke Came From	25
Clarke Becomes a GE Engineer	29
Take This Job and	34
Clarke Calculator Step To Modern Computing	36
Mabel MacFerran	37
Vivien Kellems	38

Chapter 4. Lost Decades of Role Restrictions	40
Female Jobs	40
They Navigated Challenging Time	42
Women and Engineering Education Mid-Century	44
The Seventies	45
Chapter 5. A Second Start — Women Leaders in the Eighties	49
Madame Dean	49
Joan Bok	50
Joy Tannian and More	52
A Woman's Place	54
Kay Stepp and Hazel O'Leary	56
Chapter 6. Glass Ceiling Cracks in the Nineties and Two Thousands . . .	59
The Early Nineties	59
Breakthroughs Elsewhere	61
The Late Nineties	63
New York, New York	64
Twenty-First Century Women	67
Chapter 7. To the Top, and Where Women Go From Here	69
Degrees	69
Fortune 500 CEOs	71
Fortune 1000 Firsts	72
Firsts in Two Thousand Tens	78
Keeping Score	80
Women COOs and CFOs	81
The General Counsel Route	82
Leading Utilities Not Quite Fortune 1000	84
Women Leading Public Power	89
Women Leading Co-op Power Too	94
Remaining Hurdles Not Yet Cleared	96
References	99
Index	103
About the Author	107

Table of Figures

Edith Clarke as a Young Woman	4
Bertha Lamme, Co-designer of First Large Power Plant	7
Florence Fogler, Grand Lady of Heat Transfer	12
Edith Clarke in the Lab	21
Edith Clarke at Her Desk	31
Edith Clarke Later in Life	35
Vivien Kellems, Power Cable Entrepreneur	38
Nancy Fitzroy, Nuclear Navy's and GE's Heat Transfer Expert	41
Maria Telkes, Sun Queen	43
Joan Bok, First Female Utility Chair	51
Hazel O'Leary, First African American Woman Energy Secretary	57
Jackalyne Pfannenstiel, First in California	62
Lynn Good, Duke Energy's CEO	73
Connie Lau, Hawaiian Electric Industries' CEO	75
Pat Vincent-Collawn, PNM Resources' CEO	77
Maria Pope, Portland General Electric's CEO	79
Bethany Owen, ALLETE's CEO	85
Lisa Grow, IDACORP's CEO	87
Paula Gold-Williams, CPS Energy's CEO	92
Debra Smith, Seattle City Light's CEO	93

Sponsoring This Book

Rather than for sale, this book is being distributed freely throughout the Public Utilities Fortnightly community due to the generous support of some highly-respected organizations of our community. These utilities and firms – American Public Power Association, Anterix, Edison International, Electric Power Research Institute, Guidehouse, PPL Corporation – believe as does this author that the history of women in leadership roles in the utilities industry over the last one hundred years inspires all of us to help support the industry’s female stars that are emerging so that our industry and society can benefit from the greatest talent whatever their gender, or for that matter their race, ethnicity, and personal preferences.

Moving Statements by the Sponsoring Organizations

“Women Leading Utilities” is an overdue recounting of women’s significant role in advancing the electric utility industry for over a century. As Steve Mitnick recounts in his compilation of the stories of women leaders since the industry’s infancy, through their brainpower, hard work, and determination, women have contributed to breakthroughs in technical and operational advancements with often little to no recognition. Until now.

What Steve’s research demonstrates is that these outstanding women leaders made incredible contributions despite the lack of societal or institutional support much less equitable promotional opportunities or pay. Women like Bertha Lamme, Edith Clarke and Florence Fogler paved the way for women leaders who came later and who forged into all aspects of the electric utility industry.

Modern utility leaders such as Paula Gold-Williams, Debra Smith, Jackie Flowers, Lena Wittler, Jessica Matlock and Maria Pope – to name only several – have made meaningful and long-lasting contributions to their utilities and regions as they position their utilities to maintain excellence and to meet the challenges of the future. I look forward to a time when gender isn’t a factor, and seeing the trajectory that Steve has cataloged in this book gives me hope that that day will come, maybe even in my lifetime.

– Joy Ditto, President and CEO,
American Public Power Association

In this heartfelt work, Steve Mitnick recognizes many remarkable women who overcame daunting obstacles and beat slim odds to become pioneers, innovators, and leaders in the electric utility industry. As he so plainly and empirically demonstrates, however, their numbers have been drastically limited by gender bias in industry, educational institutions, family roles, the media, and all the other elements of society reaching back before this chronology begins in 1883 with Emily Warren Roebling and the Brooklyn Bridge.

In each chapter, the reader cannot help but feel, almost tangibly, the author's love for the industry and a deep appreciation for the women (and men) through the decades that have enabled the electric utility industry to energize American growth. Even when viewing the industry in the book's revealing sunlight, one absorbs the author's unmistakable sense and pride that the people who operate our utilities form a community, complete with the imperfections of our times and cultures, but vibrant and strong in its talent and sense of public service.

Anterix is honored to sponsor this book. As a relative newcomer to this industry, we have witnessed the strength of its community firsthand. After six years working with and learning about utilities (and hiring some of their former staff), we are now part of that community, helping the industry continue to provide its customers—our family and neighbors—with nothing less than quality of life. This book highlights many of the remarkable women that have shaped the industry of yesterday and today; as the playing field levels and opportunities for women increase, there will be even more such stories to recount, until one day there is parity, and gender is no longer cause for remark at all. We plan to be a leader of that evolution within the utility community, as our success at Anterix is significantly driven by the large number of remarkable women with whom we work.

— Rob Schwartz, President and CEO, Anterix

We celebrate women leading utilities for their increasing success in an industry that has historically been run by men. More importantly, we celebrate these women leaders in our industry for their distinctive leadership on the most pressing issues of our time.

Women on our board of directors and in leadership positions across Edison International, Southern California Edison and Edison Energy are helping to address climate change, reimagine the electric power grid, improve resiliency, and enhance safety, reliability, and affordability. These women also lead operational, financial, legal and compliance activities and direct government and public affairs, marketing, corporate communications, and corporate philanthropy. I am proud that a few of our current and former Edison International and SCE leaders, Maria Rigatti, Jennifer Hasbrouck, and Carla Peterman, are mentioned in this book.

Fortunately, much has changed since the days of Edith Clarke, Bertha Lamme, Florence Fogler and Mabel MacFerran. They were trailblazers, and today our teams, our customers, and our communities are better off because of the women who followed in their substantial footsteps. All of us today – women and men alike – stand on their shoulders.

– Pedro J. Pizarro, President and CEO, Edison International

Women leaders in energy have not only made significant contributions to the continued growth and success of EPRI, but they have also created solutions for a better world. They are our colleagues, our advisors, our mentors, and our friends. And their consistent drive and forward thinking have helped us see beyond the horizon and make progress toward our public-purpose mission.

Women in energy have overcome all manner of challenges while still finding innovative ways to design, build, and operate energy systems that help serve customers affordably, reliably, and efficiently. As we take early steps in the clean energy transition, women leaders have paved the way for thinking differently, acting with purpose, and accomplishing more.

EPRI was built on a collaborative model that draws on individuals' strengths to serve the common good. When we come together as one team, there is no limit to what we can accomplish.

I am proud to work alongside the incredible women shaping the future of energy.

– Arshad Mansoor, President and CEO,
Electric Power Research Institute

At Guidehouse, we know the importance of diversity, and that's why we're proud to support this inspiring book that highlights the critical contributions from women who helped bring forth the development of today's electric utility industry.

From Edith Clarke— the first professional female electrical engineer in the United States— to today's women CEOs, who continue to break down barriers across the country's utilities, we hope you'll enjoy learning about how women have paved the way for progress over the last several decades.

Beyond that, we hope this book will continue to build momentum for a more inclusive and diverse future for our industry and its surrounding ecosystem. This includes the vendors and suppliers that provide products and services to utilities and the network of companies that provide equipment and services to utility customers on behalf of the utility. Diversity, including gender diversity, breeds innovation, and that's something we need more than ever as the pace of the energy transition accelerates.

According to the IEA, the energy sector is one of the least gender diverse parts of the economy, but also one of the fastest growing. Women's participation will be key in delivering a secure, affordable, and sustainable energy future — but unless we take action now, the gender divide has the potential to grow even larger.

While exciting progress is happening at the executive and board levels, we need to continue building and nurturing the pipeline of women we're bringing into the industry. As more women begin their careers or ascend to leadership roles, we must continue to work harder to close the gender gap, to give more women a seat— and a voice— at the table, and to transform the old constructs of who belongs in this space. This book is a powerful reminder of why, and we're glad to be a small part of sharing these women's stories with the world.

— Michelle Fay, Partner, Guidehouse

The heartbeat of the energy industry is its people, and at PPL we know our heartbeat is stronger when we create a culture of belonging. Our enduring commitment to embracing diversity and inclusion and advancing equity for all is the catalyst that fuels our innovation and growth – and drives us to deliver every day for the customers and communities we serve.

There is no doubt that women have revolutionized the energy industry and changed the very nature of how we think about power, introducing some of the most significant advances through time, including concepts like nuclear fission, nanotechnology, and solar heating. Today, women across our industry continue to lead our companies through significant times of change as we embrace a new energy future together.

PPL is a place where everyone can grow and succeed. We're proud of the many women in our ranks who put their talents and skills to work every day to promote positive change and push us forward on our path to success.

We thank Public Utilities Fortnightly for shining a long overdue spotlight on the amazing contributions of women in the utility industry.

– Vincent Sorgi, President and CEO, PPL Corporation

Acknowledgements

This book is a treasure that I have come upon after a long journey. Perhaps it was my destiny to write such a work given the lessons of life that I have found along my path, about the achievements of women which were too often in the background, unacknowledged and unrewarded, or insufficiently so.

I received my master's degree in business administration from the Wharton School, University of Pennsylvania, in 1976. My career began then and my first boss, at a major consulting firm, was Mary Proctor. She was an inspiring leader. But when she gave birth to twins, she left our project, which was assisting the United States Navy, and soon after the company, and I was reassigned to a male manager who was much less impressive. Before long I moved on to a startup consulting firm specializing in energy and environmental matters, and Proctor moved on to a key role at the Office of Technology Assessment of the United States Congress.

At that startup, my career really took off in the late nineteen seventies. I built a large and profitable division and hired a senior team of four managers, three of them women. This run ended after three years in 1980, when we were all disgusted by abusive behavior that was allowed to occur. One of those women, Therese Boisvert Varndell, suggested and then strongly lobbied me to start our own firm. Which we did, awakening the serial entrepreneur in me. Varndell later went to law school and then thrived in private practice focused on intellectual property law.

But over the next two decades of my career in the utilities industry, the nineteen eighties and nineties, though I enjoyed many successes as an economist and consultant, there were few women in professional roles to be found at the firms I worked for, or at our clients. One notable exception was Sandra Ringelstetter Ennis, a brilliant analyst on my team in the nineties who we promoted to be a vice president. Ringelstetter has gone on to a great career and is now the chief operating officer of the consultancy, NERA.

The first decade of the twenty-first century wasn't much different for me, as far as working in male-dominated environments. Though I'll note another outstanding exception. A former consulting client and now a member of the team at Dominion Energy that was funding my transmission development company was Diane Leopold. Her career has been phenomenal, and she's presently Dominion Energy's chief operating officer. More on Leopold in chapter seven of this book.

But in these last ten years, in this century's second decade, I have experienced an explosion of women in every environment of my work. I'm saddened that as I near the end of my career that it took this long. At the same time I feel blessed that I was able to experience a few years of the smartest women working with the smartest men. And it's thrilling for me, literally, that the next generation in utilities will be so enriched by a greater diversity than my generation could have ever imagined.

Allow me to mention just a few of the incredible women I've had the privilege to work with in some capacity. I risk of course leaving out the names of many of those greatly deserving. That said, these awesome friends have graciously helped me research this book: Morgan Stanley Managing Director Caren Byrd, former Alliant Energy CEO Pat Kampling, former American Public Power Association CEO Sue Kelly, Hawaiian Electric Industries CEO Connie Lau, Women's Council on Energy and the Environment President Barbara Tyran, and Edison Electric Institute Vice President Stephanie Voyda. Their guidance has meant so much to me.

A baker's dozen female leaders of the present and recent past allowed me to interview them for which I am grateful. The interviewees were ITC Holdings CEO Linda Apsey, former Con Ed Vice Chair Joan Freilich, CPS Energy's CEO Paula Gold-Williams, Duke Energy CEO Lynn Good, Idacorp CEO Lisa Grow, United States Energy Association Acting Executive Director Sheila Hollis, former Dairyland Electric Cooperative CEO Barbara Nick, ALLETE CEO Bethany Owen, Portland General Electric CEO Maria Pope, former Sacramento Municipal Utility District CEO Jan Schori, Seattle City Light CEO Debra Smith, American Municipal Power CEO Jolene Thompson, and PNM Resources CEO Pat Vincent-Collawn.

And may I add to this list these megastars that I cherish collaborating whenever their busy schedules allow. Alliance to Save Energy CEO Paula Glover, PG&E Executive Vice President of Corporate Affairs Carla Peterman, and Regina Davis and Michelle Malloy of the National

Association of Regulatory Utility Commissioners are just a few of the very many women at the state utility regulatory commissions, utilities, and other organizations that I have the special opportunity of working with in this great business of utility service to the public. While I didn't request their help on this book, I do fondly hope they will see it and enjoy the inspiring stories within.

Finally, it's an honor to heartily salute two women that have proven to be essential to me during these last few years of my career. The enormous success of our Public Utilities Fortnightly service to the utilities industry is largely due to them. I do mean the truly spectacular Lori Burkhart, PUF's Editor-in-Chief, and Alex Revel, who is a budding star on our team.

And also deserving of credit are PUF editor Angela Hawkinson and staff writer Rachel Moore. They consistently have an eagle's eye for spotting editing errors to be fixed.

Foreword

I attended an all-male four-year high school, starting at Brooklyn Tech a month after having turned fourteen. Within this massive monument to technical training were six thousand boys studying, for the most part, engineering, science, mathematics, and manufacturing methods. During my four years there in the late nineteen sixties, the only females in the building were a scattering of women teachers and cafeteria staff.

Graduating Brooklyn Tech with an electrical engineering diploma, after three summer months I went directly to the virtually all-male Rensselaer Polytechnic Institute. Originally aiming toward a bachelor's degree in electrical engineering, I finished up four years later with two other degrees instead, one in physics and one in history and political science.

On RPI's expansive upstate New York campus, Warren Hall was the small three-story freshman dorm that housed the sixty-five or so females in my class that first year. The more than nine hundred males in my class occupied the several other freshman dorms seemingly surrounding Warren.

Graduating RPI, again after three summer months, I went directly to another virtually all-male institution, the Wharton Graduate School of Business. I remember being shocked by the presence of so many female students on the University of Pennsylvania campus where Wharton is located, something I had never experienced, not even close.

I had spent four years at RPI but cannot recall a single time I talked with any of the few female students there about our studies. I spent the next two years at Wharton and do recall a time when a female classmate and I collaborated on a semester-long project. How awkward I felt working with a woman. I never had before. But how exhilarating it was to team up with this brilliant person who just so happened to be female.

I remember thinking at the time, how much more productive the U.S. economy would be if women were fully added to the men in our country's capitalistic competitive pool of entrepreneurs, execs, and employees at all

levels. The year when I first came to that conclusion was 1975, I believe. That was nearly a half century ago.

My first job out of Wharton was with a high-flying consulting firm in the Washington D.C. area. And my first boss there was, to my surprise, a woman. She was driven, quick-witted, and inspiring. But disaster struck for my career there, after just half a year. My boss gave birth to twins and she was replaced by a man who had little use for my obsessive ways of working. He even lectured me once for showing up the other guys, for coming to the office early and staying late when I was really on to something in a project.

Before long I joined a small consulting firm, and developed a division there doing studies about the electric utilities sector for the U.S. Department of Energy and Environmental Protection Agency. My group experienced explosive growth and I hired twenty or so people to keep it going, including women for three of my four top manager positions. I didn't plan to hire women. They were just the most impressive thinkers, writers, analysts, and communicators among the resumes we received and interviews we conducted.

It was now the late nineteen seventies. I was simultaneously completing my doctorate studies at Georgetown University's economics department. So I was busy, too busy really.

It's embarrassing to admit that I consistently brushed off the racist, antisemitic, and misogynist comments constantly coming out of the mouth of a man in a position of power. But then, on one fateful day, I caught him cornering and harassing one of my top managers. I couldn't believe this was happening in real life and was outraged. We were all shaken up. Though I can hardly equate my pain with those of the female members of my team.

These days, legal action would have surely followed. In those days, that course didn't seem open to us. I'm not proud to admit this too. So I almost immediately quit the firm, without any plan in mind, as did those three senior women. One of them suggested and then persuaded me to start our own firm. And so we did. It was 1980.

Why do I tell you all this? Because, perhaps, just perhaps, this will provide you, the dear readers of this book, some idea of where I'm coming from, of how I think about this subject, the history of women leading utilities.

Growing up, I don't believe I knew any women who attended college or held senior or mid-level positions in the workplace, with the exception

of school teachers. In my classes at school, I didn't encounter any women from the age of fourteen to twenty-one. I didn't collaborate with any woman as a colleague until my early twenties.

Yet, I somehow had within me an intuitive truth. It was evident on its face that working with the brightest and most ambitious women made as much sense as working with the brightest and most ambitious men. Why would anyone do otherwise?

This thought logically transports me to today and to the mission of this book. I do hope the book is a good read and that the stories herein are as inspiring to you all as they are to me. Fine, but this book poses a modern version of the question I conjured up a half century ago.

Why would the utilities industry not draw from the broadest and most diverse talent pool available to it including women and men, those of color and not, and without respect to other personal characteristics? Particularly when women have slam-dunked their roles at all levels of leadership responsibilities in our industry including as CEOs.

This book additionally demonstrates that the leadership capacity of women is hardly a new phenomenon. Edith Clarke, Bertha Lamme, Florence Fogler, and Mabel MacFerran Rockwell were giants in our industry's development. The male leaders of our industry in the first half of the twentieth century knew this. But somehow the gigantic contributions by women were soon forgotten.

Imagine if even a few more brilliant and dedicated women would have been given the opportunity to help build our industry. We will never know how much further we'd be by now. Then try to imagine if brilliant and dedicated women in our own day are given every opportunity to co-build the industry going forward. We will then see and know, I believe, how utilities can reach their greatest potential to serve the public good.

Introduction

This book started out as a story about the first and fabulous female electrical engineer, Edith Clarke. The more I learned about Clarke's transformational advances in the electrification of North America, the more passionate I became to write about her.

Then I discovered that Clarke was not alone. Even in the first half of the twentieth century, when it was so rare to find women in the leadership of the utilities industry, or any industry, and rarer still for them to be adequately recognized for their achievements, there were others. I was excited to learn about Bertha Lamme, Florence Fogler, and Mabel MacFerran Rockwell. Soon I was trying to learn all that could be learned about their accomplishments and the challenges they faced and faced down. It was then that this book expanded from Clarke's story to the story of Clarke's generation of women leaders.

Once I was going down that road, it was inevitable for me to ask, what happened next? What Clarke, Lamme, Fogler, and MacFerran did must have been well known by the men who led General Electric and Westinghouse, the utility industry's major vendors, and to the men who led the utilities themselves. The intellectual prowess of these women in the science, engineering, and mathematics of utility technologies couldn't have been doubted by any but the most obstinate of men.

It goes without saying that men knew then, in the middle decades of the twentieth century, from their mothers, sisters, daughters, and the other women in their lives, that women are comparable to men in the capacities they sought in their employees and managers. Intelligence, diligence, dedication and so forth, women excel in these traits in similar proportions as do men.

Yet, when men of the nineteen forties and fifties, and even of the sixties, were put to the test, to consider women as equals within their workplaces, the results had the opposite effect than one might have expected. The century's middle decades put a halt to the progress started by Clarke's generation.

During World War Two, women necessarily entered the workforce in large numbers as men went off to fight. Female employment outside the home grew fifty percent. By all reports women performed as capably as men in the nation's factories, shops, offices and yes, in its utilities. Though there's little evidence of women who were accorded supervisory or managerial responsibilities. In 1945, women were thirty-six percent of civilian workers though just four percent of skilled positions.

Could women manage men in the workplace? Apparently the sentiment of men was no. Just look at the newspapers, magazines, books, and movies of the period. Men generally felt that women didn't have the mental toughness to lead. That women were unable to require workers' compliance and insist upon success. It was inconceivable that a woman could direct a department of men to tackle a difficult task, in the same manner as male officers overseas were sending soldiers to take a hill or beach. Leadership then was considered a manly art. Men such as Generals Patton, Bradley, and MacArthur were admired for their skill ordering men into do-or-die missions without visible emotion.

When the war was done and men returned to the states, they had expectations to restore a peacetime of respect and privilege earned. The men returning also had their wartime experiences and relationships in common. Many men could and did take advantage of the GI Bill, enacted in the summer of 1944, to advance their careers through higher education, a door effectively closed to women. Labor unions were another door open to men and effectively closed to women. So there were few options for women aspiring to supervise or manage at utilities, or other types of businesses, in which the supervised or managed would be overwhelmingly men.

In his 1980 journal article "Working Women and World War II," Marc Miller writes: "While working through the war years, women were bombarded with propaganda extolling home life reminding them they would have to return to their homes when 'the boys came back.'" In the first twelve months after the war's conclusion, women as a percentage of civilian workers fell from thirty-six percent to twenty-nine percent.

Those were lean years and decades in the middle of the century for the women following the Clarke generation. Women were relegated to secretarial positions and the like for the most part. When they filled professional positions such as administrative, legal or technical, they usually had few or no men reporting to them. How might such a woman assess

her chances to fulfill an ambition to rise up to a leadership role when only men managed tens, hundreds, or thousands of men?

That's when I asked, when did the fever break? When did women again have opportunities to make major contributions to the utilities industry, and be recognized for their contributions? And how exactly did the progress of women leading utilities resume, in the nineteen seventies and eighties? It was then that this book expanded further from the story of Clarke's generation of women leaders to the story of the lean middle of the twentieth century decades and to the story of when women's progress resumed in the second half of the century.

I then found myself on a slippery slope. Shouldn't I tell the history of women leading utilities to the present day? That's when I started interviewing female leaders of the late twentieth century and this century too about their experiences. It was another exciting stage in this book's research. This generation of women leaders have themselves many inspiring stories to tell and sage advice to give to the next generation.

So it seemed that now I had a book worth publishing. At the beginning of my research I was writing a narrow book to be entitled "Edith Clarke, from Computer to Transformer." By the end of my research I was writing a broad book, a history of a hundred extraordinary years, when women helped lead the utilities industry, to when they were largely forgotten, to when they emerged again as leaders alongside men.



Edith Clarke as a Young Woman

Chapter One

Women Who Made the Grid

Women of 1883

It was so rare. Even if you were a very well-read citizen of the Gilded Age, you probably could not have named more than a handful of women who had earned a reputation in industry and science.

Suppose you're sitting down at your desk in the year 1883. It's a good reference point for us to begin this story, right in the middle of the Second Industrial Revolution, in order to gauge the recognition then of women's contributions to American commerce. And to assess their opportunities, as it would have been viewed nearly a hundred and forty years ago, to contribute as leaders.

The year 1883 is worth studying for another reason. Born that year was Edith Clarke, who would become our first female electrical engineer. She would ultimately command respect throughout the electricity sector for two groundbreaking patents. And more generally for applying advanced mathematics to some of the industry's most pressing practical problems during its growth spurt in the first half of the twentieth century.

If you were indeed composing a list of women who had earned a reputation in industry and science by 1883, the list couldn't have included Marie Curie. She was still a Polish teenager, a seventeen year old, in 1883. And she was unknown beyond her gymnasium for girls. Though at that school, Curie was already a star, earning a gold medal for academic excellence.

It would be twenty more years before the Nobel Prize in Physics was awarded to Curie for discovering radioactivity, along with her husband Pierre and Henri Becquerel. And twenty-eight more years before the Nobel Prize in Chemistry was awarded to her for discovering polonium and radium.

Your list couldn't have included Frances Perkins. In 1883, Perkins was merely a baby, a one-year old. And Eleanor Roosevelt wouldn't be born until the next year. Not until 1933, half a century later, would Perkins become the first member of a U.S. President's Cabinet. The President that appointed her was Roosevelt's husband, Franklin.

In 1883, Florence Bascom and Winifred Edgerton Merrill were both but twenty-one years old and still in school. So your list couldn't have included these two either. Bascom would become the second woman to earn a Ph.D. in geology from any university in the U.S.; in her case, from Johns Hopkins, at age thirty-one. Bascom advanced our understanding of volcanic rock structures and cycles of erosion. As for Merrill, she would become the first woman to earn a Ph.D. in mathematics from any university in the U.S.; in her case, from Columbia, at age twenty-four. She helped found Barnard College, at age twenty-seven.

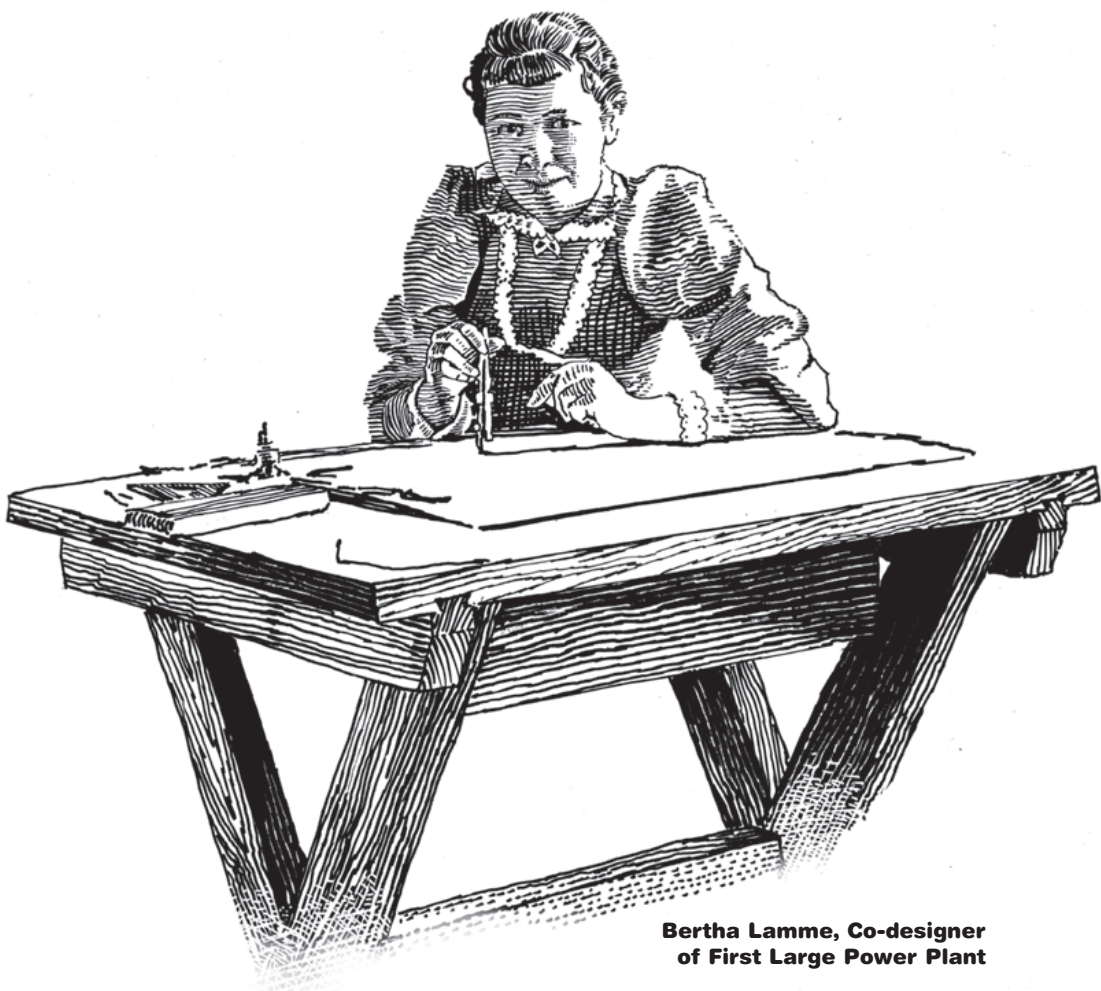
Bertha Lamme and More

In 1883, Bertha Lamme Feicht was a fourteen year-old teen. Ten years later, Lamme would be the first woman to earn an engineering degree in the U.S. in any discipline other than civil engineering; the sole engineering major that was considered female-appropriate. Ohio State awarded Lamme a degree in mechanical engineering in 1893, with a specialty in electricity.

That same year Bertha's older brother Benjamin had his first breakthrough. He would see his design for lighting the colossal Columbian Exposition in Chicago become a reality. More than twenty-seven million people visited the fair during its six month run. This was an astounding attendance considering the 1890 Census reported that the population of the entire country was sixty-three million.

Bertha became the first woman engineer at Westinghouse, joining Benjamin there and taking on his quantitative analyses. This must have seemed fitting to both of them. As children, Bertha and Benjamin made their own toys and talked about starting a toy company together.

Brother and sister, he as the electrical engineer and she as the mechanical engineer, worked together to design what was then considered the gigantic ten-unit, thirty-seven megawatt hydroelectric generating system housed in the Edward Dean Adams Power Plant at Niagara Falls.



**Bertha Lamme, Co-designer
of First Large Power Plant**

Initially just called Niagara Power Station No. 1, the plant was the first large-scale alternating current generator.

When this historic engineering feat began operations on August 25, 1895, and started transmitting power twenty-five miles away to Buffalo in 1896, it was the world's largest power plant. And it held that record for many years afterward. The Lamme generators actually operated until 1961.

A commentary on the times, Bertha married her supervisor Russell Feicht in 1905 and immediately retired. Though, some speculate, she continued to collaborate with her brother and her husband on Westinghouse engineering projects albeit behind the scenes. Lamme's daughter, born a few years later, went on to become a physicist for the U.S. Bureau of Mines.

Ellen Swallow Richards, who was forty-one in 1883, would probably make your list of women who earned a reputation in industry and science by that point in our history. She had already led the way as the first woman to enroll in a technical institution, the Massachusetts Institute of Technology, thirteen years earlier. She had received a degree in chemistry from Vassar College, the first American woman with a degree in that field. Richards, in her career, pioneered the analysis of drinking water quality. Her work led to the first water quality standards and the first modern sewage treatment plant.

We shouldn't forget Elizabeth Bragg Cummings. In 1883, she was thirty-five years old. Bragg had been the first American woman to earn a college degree in civil engineering (and perhaps the first woman to do so worldwide), which she had received seven years before, from the University of California at Berkeley.

From a wealthy San Francisco family, Bragg excelled in mathematics, like so many of the women we're discussing here. She attended a preparatory high school attached to Cal-Berkeley, and then went directly to its College of Civil Engineering. Though Bragg received her degree at the remarkably young age of eighteen, she never did work as an engineer. Instead she worked first as a teacher, for a dozen years, and then as a stay-at-home wife to a civil engineer for the Southern Pacific Railroad and as a mother to three sons.

Bragg's senior thesis at Cal-Berkeley had been entitled "A Solution to a Peculiar Problem of Surveying." But she wasn't able to survey, to supervise surveyors, or otherwise apply her highly quantitative mind to any aspect of civil engineering.

In 1883, Elizabeth Blackwell, the first woman physician, was sixty-two. She would make your list as well, as might the successful and wealthy investor, Hetty Green, who was forty-eight in 1883. As would the inventor, Mary Elizabeth Walton, who was fifty-four. Walton's two revolutionary patents of 1881 reduced the air emissions from smokestacks and chimneys, and reduced the noise from elevated railways.

That year, 1883, forty-year-old Emily Warren Roebling led the completion of one of the top engineering feats worldwide to that point in time, the construction of the Brooklyn Bridge. Her husband, Washington Roebling (son of the bridge's designer John Roebling), had been the chief engineer. But he became ill with decompression disease, that is, the bends. John had already died of tetanus following an accident at the construction site in 1869. So neither father nor son could complete this massive project.

Instead, for the final years of the work, Emily learned from her bedridden husband what was necessary, self-taught herself materials science, stress analysis, cable construction and catenary curve calculations, and took over the project's leadership. Including dealing with the politicians and the numerous other interested third parties. When the Brooklyn Bridge was successfully completed on May 24, 1883, Emily walked on the world's longest and tallest suspension water crossing first and was forever after famous within the U.S. and abroad. Outwardly modest amid the public acclaim, in a letter years later she wrote:

I am still feeling well enough to stoutly maintain against all critics (including my only son) that I have more brains, common sense, and know-how generally than any two engineers civil or uncivil that I have ever met, and but for me the Brooklyn Bridge would never have had the name of Roebling in any way connected to it!

At age fifty-five, two decades before women were finally allowed to vote, the renowned bridge builder argued this in her influential essay, "A Wife's Disabilities:"

[Women wished] to avail themselves of the possible rights given them under the fourteenth amendment to the Constitution [guaranteeing equal protection for all citizens] ... to have a voice in deciding questions of interest to them in laws made by the legislatures of different states ...

In that year, 1883, the anthropologist Margaret Mead, computer scientist Grace Hopper, physicist Maria Goeppert-Mayer, ecologist Rachel Carson, and obstetrician Virginia Apgar, all of whom would eventually have a huge impact in their fields, weren't yet born, not until the first decade of the twentieth century. Their impact would not come about until the nineteen-fifties and sixties.

Twentieth Century Women

Now let us turn to the year 1903, twenty years hence. This was such an important year for women in science. That's when the Nobel Prize for Physics was awarded to Marie Curie, along with two others. Just imagine what this momentous development must have meant for any woman at that time aspiring for a technical career. Admittedly there were a very small number of such women. But one was Edith Clarke, who in her twentieth year, was now enrolled at Vassar College. Her major was math and astronomy. Clarke really wanted to major in engineering. But Vassar didn't offer an engineering major to women students.

Clarke turned twenty-eight in 1911. That was the year Curie made history again, becoming the first person to win the Nobel Prize in two different scientific fields. Clarke had graduated Vassar three years earlier and became even more determined to become an engineer. She had been teaching college math since graduating Vassar. That year this very determined woman enrolled at the University of Wisconsin, majoring this time in civil engineering.

Each year from 1876 to 1900, Society of Women Engineers archivist Troy Eller English has found that it was rare for more than one woman to receive an engineering degree in the U.S. In several of these years, not one woman did so. And in each year from 1900 to 1917, typically only a handful received a degree in engineering.

English has written:

Subjects such as chemistry, botany, and astronomy were considered ladylike; physics was not... Engineering, the practical application of mathematics and science, was pretty much out of the equation.

In 1905, Nora Stanton Blatch did earn an engineering degree from Cornell University. Her achievement is especially noteworthy. Blatch was the granddaughter of Elizabeth Cady Stanton, the legendary women's rights leader and chief organizer of the historic Seneca Falls Convention in 1848.

When Blatch graduated as an engineer, Stanton could not share her granddaughter's joy. For the author of the Declaration of Rights and Sentiments, which launched the suffrage movement, had died three years earlier.

Florence Fogler

It's now 1923. The Roaring Twenties were taking over the country. A reporter from Schenectady Works News visited General Electric, to interview its expert on heat transfer. This field of research was one of the most important at GE. The company and its utility customers desperately wanted to increase the power output and efficiency (that is, the heat rate) of steam turbines.

After the expert's explanation of the thermodynamics of the problem, the reporter tired and moved the discussion to what he was really interested in. What was "a pleasant mannered girl," albeit with a degree in electrochemical engineering from the Massachusetts Institute of Technology, doing in such a job?

The so-called girl in this interview was Florence Fogler. She would eventually become known in professional circles as the Grand Lady of Heat Transfer. Fogler had already made her mark at GE after just two years at the company.

Fogler grew up in Billings, Montana. In 1916, as a seventeen year old, she crossed the country to begin her studies at MIT in electrical engineering. She was one of only thirteen female students at that time at MIT. And she was the sole female taking engineering classes.

The head of the electrical engineering department scoffed and told her:

Why, you can't do it. It can't be done. No woman ever became an electrical engineer.

As it turned out, it could be done, by Fogler at least. Despite further opposition by MIT's Dean, she excelled. She even won a letter of commendation from that skeptical Dean. A year later, while still at MIT, Fogler became the first woman elected to the American Institute of Electrical Engineers.

Fogler and Edith Clarke were colleagues at GE. There's an old photo of them together with friends from Albany Light and Power Company (now a part of National Grid US), and from GE. It must have been a rarity in the nineteen twenties for two accomplished and widely-respected women engineers to be working together at one company.

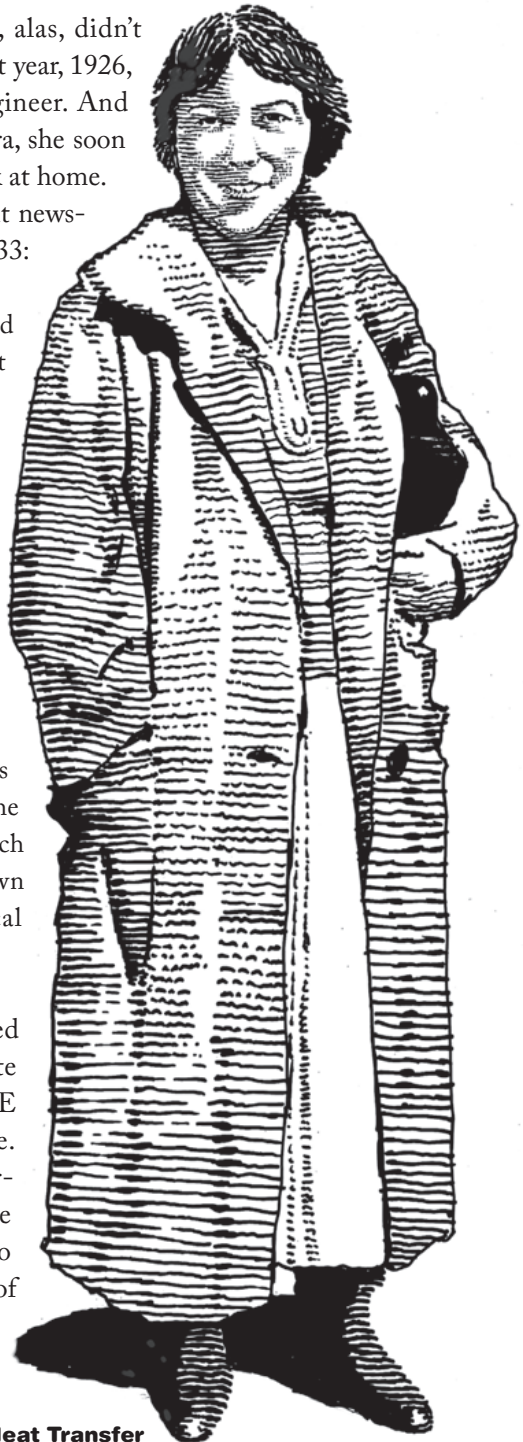
Two years later, in 1925, Fogler earned her master's degree in electrical engineering from Union College. Now both Fogler and Clarke had received their advanced electrical engineering degrees. It was another first for this extraordinary pair at GE's turbine engineering department.

This precedent-setting pair, alas, didn't stick together for long. In the next year, 1926, Fogler married a fellow GE engineer. And then, as was the custom in that era, she soon left work at the company for work at home.

As the Union College student newspaper wrote a few years later, in 1933:

Mrs. Buckland [her married name], one of the few great mathematicians, continued to hold her position with the company [after marrying]. When her first child was born, she resigned [from GE]. Since that time Mrs. Buckland has entirely given up her profession and has become an ardent housekeeper devoting herself to her son and daughter... and finds a great deal of enjoyment in the playing of contract bridge which she plays excellently as shown in her success in several local bridge tournaments.

Over the years, Fogler raised her two children. But then, quite remarkably, she returned to GE after sixteen years in the home. Restarting her career, at age forty-two, as the nation entered the second world war, she continued to contribute to our understanding of heat transfer all the way into the nineteen sixties.



Florence Fogler, Grand Lady of Heat Transfer

The Roaring Twenties

Back to 1926. Fifteen years have passed since Edith Clarke had enrolled in the engineering program at the University of Wisconsin. It is now the middle of the Roaring Twenties. Women have finally won the right to vote, after ratification of the nineteenth amendment on August 18, 1920.

The decade of the twenties saw a massive increase in the number of single women in the workplace, particularly as typists, filing clerks, stenographers, and secretaries, but also in creative fields. Yet, this was most definitely not the case for married women.

On these tendencies, we look to the outstanding research of Janet Yellen, the former Federal Reserve Bank Chair and the current Treasury Secretary. In particular, we look to Yellen's 2017 memorable speech at Brown University entitled "So We Can All Succeed: 125 Years of Women's Participation in the Economy."

The speech cited Census Bureau statistics that just twenty percent of all women in the early twentieth century worked outside the home. In other words, just one-in-five of them held paying jobs. But, Yellen emphasized, this was true of only five percent of married women. Just one-in-twenty of them held paying jobs.

As low as these percentages were, they actually underestimate the odds faced by many women who aspired to hold paying jobs. That's because African American women were far more likely than other women in the U.S. to work outside the home, as an economic necessity, whether they were single or married. So for white women with career aspirations, the odds against them were very long if they were single, and extremely long if they were married.

This situation then began to improve, significantly for single women but marginally for married women. Yellen, in her Brown University speech, tells us that by the end of the Roaring Twenties, in 1930, nearly fifty percent of all women worked outside the home, up from twenty percent. But for married women, the number of those working outside the home was now twelve percent, still fairly low, though up from five percent.

A scan through the newspapers and magazines of the period makes it clear that a women's place, a married women's place at least, was in the home, not in the workplace. Emblematic of this cultural mindset is an infamous quote by the auto industry magnate Henry Ford. He said at the time:

I pay our women well so they can dress attractively and get married.

This huge gap between the workforce participation of single women and the workforce participation of married women continued for much of the remainder of the twentieth century. That marriage often led to leaving the workplace had a pervasive effect on the career aspirations, opportunities, and achievements of the American woman.

Edith Clarke Addresses the Industry

In 1926, on the ninth of February of that year, the front page headline story of the New York Times was about how the federal government opposed the merger of baking companies, a “bread trust” conspiracy to control the nation’s bread. Other above-the-fold articles reported on the Swedish surgeon who sung operatic arias as an accomplished tenor while wielding the scalpel, Long Islanders welcoming home former President Theodore Roosevelt’s sons and their wives from a big game hunting expedition in Asia, and the outburst by Italy’s Fascist Premier Benito Mussolini about democratic Germany and that country’s threats against Austria.

If you turned to page fourteen of that day’s Times, an article entitled “Woman Addresses Electrical Institute” could be spotted. The article was just above a short piece on the sentencing to seven years in Sing Sing prison of a man who intended to bomb a Mussolini-supporting Italian newspaper, and below that, a Phillips Milk of Magnesia advertisement. The remainder of page fourteen was mostly taken up by ads for a society tailor, Chesterfield cigarettes (“men have learned they can depend on Chesterfield”), and New York Central’s and Southern Pacific Lines’ long-distance trains, in the latter case through the southwest (“California is still the paradise of the winter vacationist!”).

Elsewhere in that day’s Times was the report that a man named Charles Ponzi was indicted in a Florida real estate scheme to repay massive indebtedness to investors who lost money in his earlier schemes. And the report that the Delaware state militia, with machine guns in hand, hurled tear gas against protesters angry about a “negro” found guilty (a judgement the protesters believed wrongly decided), who will be hanged in a little over two weeks for attacking a twelve year old white girl.

Also in the paper that day, a story about the Racial Integrity Bill introduced in Virginia’s Legislature, which would broadly classify people as “coloreds” and forbid their marriage to whites. In an adjoining column, there was the story of five “Canadian beauties,” recent winners of a Montreal beauty

contest, who were touring Manhattan. Indicative of common conceptions in the Roaring Twenties about women's roles, the column said this:

Unaccustomed to express elevators, the young beauties became nervous while descending in the Woolworth Building, and were so affected that the [elevator] operator had to come down one floor at a time in easy stages.

Turning back to the page fourteen article, "Woman Addresses Electrical Institute," the article's subtitle announced, "Miss Edith Clarke the Only One of Her Sex to Read a Paper at Engineers' Meeting." And the lede said this:

Miss Edith Clarke, an electrical engineer at the General Electric Company, appeared yesterday [February 8, 1926] before the midwinter convention of the American Institute of Electrical Engineers at the Engineering Societies Building, 33 West Thirty-ninth Street, and read a paper on 'Steady-State Stability in Transmission Systems.'

Later in the article, we learn:

She was said to be the only woman who had ever addressed the institute, although she had a paper at a previous convention in Saratoga, N.Y. Her paper of yesterday, bristling with graphs and equations and complex mathematical formulae, was one of several in a technical discussion on the transmission of electric power over long distances.

Toward a Grid of Power

Edith Clarke, forty-three years old in 1926, had reached the pinnacle in her profession, though a woman in a sea of men. When she entered the historic Engineering Societies Building (a historic structure which still stands and serves engineering associations) on that momentous Monday to deliver her speech, Clarke was as famous among the leaders of the electric industry and her peer engineers for her pioneering and practical work as for the distinction of a woman in what was considered a man's role.

After Clarke's speech, several of the eminent engineers present such as Charles Fortescue and Robert Evans of Westinghouse Electric waxed enthusiastic in the discussion that ensued. And H.H. Spencer said that the industry should be grateful for how Clarke simplified to a slide rule and arithmetic such an important and difficult problem facing the electrical engineering community.

The Times account simplified the name of Clarke's paper that she read at the AIEE convention. While the title was indeed "Steady-State Stability in Transmission Systems," the Times may be forgiven for leaving out the even more technical subtitle, "Calculation of Equivalent Circuits or Circle Diagrams." Though perhaps the Times might have added that the paper, which was published in that month's A.I.E.E. Transactions, made quite an impression on the distinguished audience and that it was arguably of national importance.

The electric industry was rapidly growing in the nineteen twenties, the decade when Clarke gave her historic presentation. It was also a time when the industry was constantly constructing longer transmission lines. But as the mileage of the lines increased, and the electrical loads placed upon them increased too, more system instability problems and more acute problems arose.

Aristotle Tympas writes about this intractable challenge facing the industry of the twenties, in his 2003 paper entitled, "Perpetually Laborious: Computing Electric Power Transmission Before the Electronic Computer."

The step-up in computing complexity involved in the transformation from Edison's direct-current short-distance distribution to alternating-current long-distance transmission was considerable. As longer transmission schemes were tried and, accordingly, as transmission by alternating current and higher voltage were chosen, the labor of calculation was dramatically increased.

The existing mathematical models for power transmission had been built for shorter lines with lesser loads. By instead applying the method of symmetrical components, Clarke revolutionized how the industry could overcome the instability problems that were cropping up and construct lines that were greater in length and load.

Clarke's method of symmetrical components simplified the analysis of unbalanced three-phase systems, when there's unequal distribution of electrical loads between the three phases of these systems, under both normal and abnormal conditions. Her method was adopted by the two leading companies in the industry by far, her company General Electric and its rival Westinghouse, and became the accepted approach.

You can say that Clarke's method simplifies an engineer's analysis because it conceptually converts an unbalanced three-phase system into a balanced three-phase system. Since a balanced three-phase system is like a combination of three single-phase systems, we can figure out all the voltage, current, and power levels using basic single-phase equations.

Chapter Two

Professor Clarke

Edith Clarke Substation

At the base of the Texas Panhandle, in the north central plains bordering Oklahoma, sits a major electrical substation. It's an essential node in the high voltage grid of the area serving Dallas, Lubbock, Amarillo, and Abilene, Texas. And it's located right in the middle of one of the areas of the world with the greatest wind and solar energy potential. As you might have guessed, we're talking about Edith Clarke Substation, named after the extraordinary woman that is the subject of this chapter.

Edith Clarke is still having a powerful effect on the electric industry if only you consider that Edith Clarke Substation is connected with multiple three hundred and forty-five kilovolt transmission lines, two of these lines with Tesla Substation, from the northwest, and two more of these lines with Cottonwood Station, from the west. These four connections each have a line rating of approximately three thousand megavolt-amps. This means that they can, individually and in combination, transfer a whole lot of power.

Edith Clarke Substation is also connected with the three hundred and forty-five kilovolt Riley Substation, and Clear Crossing Substation as well at the same voltage. All these substations and transmission lines are owned by Electric Transmission Texas, which is a joint venture of American Electric Power and MidAmerican Energy Holdings (a Berkshire Hathaway Energy subsidiary).

It seems so fitting that Edith Clarke Substation should be situated in Texas. After all, Clarke became the first woman to be a professor of electrical engineering in the United States when she was appointed to that position at the University of Texas at Austin in 1947.

The Clarke Transform

Just four years earlier, in 1943, Edith Clarke introduced the Clarke Transformation (or Clarke Transform). This mathematical function, also known as the ab Transform, is the method that immediately became essential for the analysis of three-phase alternating-current power systems, the basis for all of the world's electric grids.

Nikola Tesla and some others virtually simultaneously invented this three-phase architecture for the electric industry in the eighteen eighties. Why? Because three-wire three-phase systems allow for a higher transmission of electric power at a lower level of electric current. Which is a very nice combination.

This lower level of electric current in the transmission of power means that three-phase can use less conducting wire material, thinner wires generally made of copper, to transmit a given amount of power. If instead we had to rely on single-phase, the wire would need to be thicker to handle a higher level of electric current. Three-phase is thus more economical, reducing both transmission material and construction costs. Three-phase systems also provide constant power, have less voltage drop, and accommodate smaller and simpler motors.

Yet, for all their advantages, three-phase systems are necessarily more complicated. This makes the Clarke Transform so valuable in planning and operating these systems.

Three-phase systems have three conductors, or if you prefer, three lines, or three wires. That's not the reason for the complexity, not directly. We'll explain.

Those three conductors carry an alternating current of the same exact frequency and voltage. In the United States, that frequency is sixty cycles per second. (Our home wiring is at this frequency too, but while it's single-phase, it taps the three-phase grid.) That's also not the reason for the complexity, again not directly.

But, importantly, there's a phase difference between the three conductors. Here's where three-phase (sometimes referred to as polyphase) gets a little sticky.

Each conductor operates, that is, varies its voltage and reverses the direction of its electric current, at one third of a cycle different and two thirds of a cycle different from the other two conductors, respectively. That's why we say that each conductor is out of phase, technically by 120 degrees of a 360 degree circle with one of the other conductors and by 240 degrees with the other.

When one conductor's voltage is peaking in a direction, for instance, from a power plant toward a city, the other two aren't, awaiting their turns to peak in that direction. The other two conductors will come to their peak voltage a third of a cycle later and two-thirds of a cycle later, respectively.

Remember, this is all happening rather quickly. For as noted, the frequency of the alternating current in the United States is sixty cycles per second. So a cycle lasts just a sixtieth of a second. If you think that's fast, try this. A third of a cycle, the difference between when each of the three conductors is peaking in a direction in our three-phase system lasts just a hundred and eightieth of a second. That is quick.

In simple terms, the Clarke Transform deals quite elegantly with this peculiar one-third, two-thirds, three-thirds behavior of our alternating current grid. Wielding the Clarke Transform, engineers deftly tackle three-phase planning and operating problems.

Let's dig deeper. What did Clarke really achieve when she devised her very handy function in the nineteen thirties and when she introduced it in the forties?

Alternating current can be thought to have, mathematically, three dimensions. Engineers represent this graphically. The graph has three axes, each of them at a right angle of the other axes. They're orthogonal, if you're a math whiz. There's an a-axis, b-axis and c-axis.

In this manner, we capture the dynamics of our three-phase systems visually, showing the sine wave-like variation within a cycle of each conductor's voltage. It's kind of like what you would see on an oscilloscope, that gently increasing and then decreasing curve of the sine wave.

There's a whole lot going on. So showing it graphically and mathematically too is essential.

First, within a cycle, a conductor has zero voltage. Then, its voltage rises to its peak in one direction. Then, its voltage falls back down to zero voltage. Then, its voltage falls further to its peak in the opposite direction. And then its voltage rises back down to zero voltage. This completes the cycle. And with three conductors going through this sine wave-like variation, each slightly out of phase with the others, it's clear it's complicated.

The Clarke Transform converts this graphical representation into two dimensions, with an a-axis and a b-axis. Doesn't seem like a big deal to most of us. But rest-assured, this ridiculously reduces the problems of planning and operating our electricity infrastructure.

Which is why electric engineers the world over relied upon Edith Clarke's two-volume textbook "Circuit Analysis of A-C Power Systems" for decades



Edith Clarke in the Lab

after volume one was published in 1943 while she was at General Electric's Central Station Engineering Department. And after volume two was published in 1950 while she was at the University of Texas.

Immediately after volume one was published, in the middle of the country's involvement in World War Two, Clarke's method using symmetrical components to simplify calculations for three-phase systems was adopted by the engineers at both GE and Westinghouse. After the war, this method of converting three unbalanced phases into three independent sources mathematically, building upon a 1918 paper by Westinghouse's Charles LeGeyt Fortescue, was universally adopted for asymmetric fault analysis.

Clarke in Texas

In 1947, Clarke joined the faculty of the electrical engineering department at the University of Texas at Austin. In doing so, she became the first female professor of electrical engineering in the U.S. She ended up teaching there for ten years, retiring in 1957.

When she first joined the UT faculty, the school paper *The Daily Texan* interviewed Clarke. One of the things she said at the time, which so aptly summarized the period, was:

There is no demand for women engineers, as such, as there are for women doctors; but there's always a demand for anyone who can do a good piece of work.

Let's take a look at Clarke's classic two-volume textbook. What did it accomplish and why did it become essential for every electrical engineer? In the preface to volume two, which Clarke published while at UT, she wrote:

In Volume II, as in Volume I, the endeavor has been to present methods of procedure in determining the performance of a-c power systems under normal and abnormal operating conditions. Special attention is also given to the development of equivalent circuits [theoretical circuits that retain all the electrical characteristics of given circuits but allows for simpler calculations] for use in the component networks.

Owing to space limitation in a book of this size, all types of equipment and all possible abnormal operating conditions have not been included. It is hoped, however, that the methods of analysis given here can be applied by the operating engineer to other types of equipment and to other abnormal operating conditions which may occur on *his* system {emphasis added}.

Also written during her time in Texas, Clarke's most-cited paper is a big hurdle for most of us, in trying to understanding how momentous her work was. It's filled to the brim with mathematical equations and symbols.

The paper, "Determination of Instantaneous Currents and Voltages by Means of Alpha, Beta, and Zero Components," was authored by a three-person

team, of W.C. Dueterhoeft, Max W. Schulz, Jr. and Edith Clarke. It was published in A.I.E.E. Transactions in 1951.

But the commentator Eric T.B. Gross breaks it down for us. About Clarke's 1951 paper, Gross said this in his comments which the American Institute of Electrical Engineers published right below the Clarke piece:

It has not been recognized until a few years ago that Clarke components are very useful in many unbalanced 3-phase problems [where at least one power source or load doesn't possess three-phase symmetry], and this paper indicates clearly some of the distinct advantages of Clarke components.

The complex operator a , so significant in symmetrical components sometimes introduces complications. Since the unbalances of great practical importance are the short circuit of 'one phase' alone or 'between two phases,' which are 'single axis' unbalances, they may be studied by replacing the 3-phase machine by a 2-phase machine...

In some cases, especially in connection with the application of the network analyzer, symmetrical components can not be used whereas Clarke components provide the basis for the solution. One such example concerns the study of transients in power systems [momentary bursts of energy] by means of the transient analyzer when single-phase circuits are used to reproduce 3-phase phenomena.

Smart Grid Looks to Clarke Again

Now in the twenty-first century, the Clarke Transform has become even more critical as we plan and build smart grids. This according to Danilo P. Mandic, Sithan Kanna, Yila Xia, Ahmad Moniri, Adrià Junyent-Ferré, and Anthony G. Constantinides, who wrote about the importance of the Clarke Transform today and going forward, in a March 2019 article in IEEE Signal Processing Magazine.

The article entitled "A Data Analytics Perspective of Power Grid Analysis – Part 1: The Clarke and Related Transforms" said:

Early in her career as a 'human computer' with General Electric, Edith Clarke routinely faced problems related to the simplification of analyses of three-phase circuits. Fast-Forward a century, and three-phase systems

pose another class of practical problems, essentially of a signal processing and machine-learning nature, including the following:

- 1) In smart grids, the effects arising from the on-off switching of various sub-grids and the dual roles of generators/loads will produce transients and spurious frequency/phasor estimates; the analysis thus requires modern signal processing and machine-learning techniques.

- 2) Accurate rate of change of frequency trackers are a prerequisite for the operation of smart grid, while rapid frequency trackers are envisaged to be part of many appliances, but their design is beyond the remit of power systems engineering.

... The operation of the future and almost permanently unbalanced smart grids requires close cooperation and convergence between the power systems and data analytics communities, especially those working in signal processing and machine learning...

To help bridge this gap, we have provided modern interpretations of the Clarke and related transforms ... We hope that this modern perspective of the Clarke and related transforms will help extend their legacy well into the Information Age ...

Chapter Three

From Computer to Transformer

Where Clarke Came From

It was the tenth day of February in the year 1883. In the issue of Scientific American published on that day, a first page article reported that a mine in Gloucestershire County, England had been able to transmit current for a distance of five hundred yards down into a mine to power an electric pump. On that same day, on a farm in Howard County, Maryland, in the United States, the woman who would a few decades later enable electric transmission for hundreds of miles, Edith Clarke, was born.

The Clarke family's prosperous four hundred acre farm named Arlington was situated three miles from the county seat, Ellicott City. Baltimore was just thirteen miles to the east. But thirteen miles greatly understated the difference between this nationally-important industrial center, Baltimore, and rural Howard County.

The nine children including Edith enjoyed an upper middle class life, with southern traditions. Howard County had mostly sided with the Confederacy during the Civil War, with twenty-eight hundred slaves and thirteen hundred free blacks in 1861 among its total population of thirteen thousand. About fifty of the County's young men joined the Confederacy's Company A of the First Maryland Cavalry though Maryland was one of the border states and didn't secede from the Union.

The Archives of Maryland, in their biography, write of her traditional upbringing:

[Edith] was expected to grow up to be a charming hostess, gracious wife, and loving mother. To that end, she was sent to Briarley Hall, a boarding school for girls in Montgomery County, Maryland. There,

for the most part, she received a typical education. Upon graduating at the age of sixteen, Edith could play a little piano, speak a little French, and knew a smattering of classic English literature, history and Latin.

Much later in her life, after becoming a celebrated engineer and inventor, Clarke said this to *The Dallas Morning News*.

I had always wanted to be an engineer, but felt that women were not supposed to be doing things like studying engineering.

Briarley Hall Female Academy in Poolesville, Maryland had been founded in 1874. It served as a boarding school for girls until 1907. As you might imagine, it was located far from any distractions for young ladies, in a remote area near the Potomac River and Virginia, and over forty miles west of her home and family. Poolesville's population in 1895, when Clarke was twelve years old, was a grand total of three hundred and fourteen. She graduated during the boarding school's twenty-fifth anniversary year, 1899.

Edith Clarke's father John Ridgely Clarke, a lawyer and gentleman farmer, had died in 1890 at age fifty-three, when Edith was seven years old. Her mother Susan Dorsey Clarke, ran the farm until she died too at age forty-five in 1895, when Edith was twelve. Edith was now an orphan, as a twelve year old, and that's when an uncle sent her to Briarley Hall.

Growing up on the farm, she had trouble with reading and spelling. But she was exceptional at math. And Edith was especially fond of the card game Whist. In his 1841 novel "Murders in the Rue Morgue," published four years before his most famous poem "The Raven," Edgar Allan Poe writes that excelling at the game requires an analytical mind:

Whist has long been known for its influence upon what is termed the calculating power; and men of the highest order of intellect have been known to take an apparently unaccountable delight in it, while eschewing chess as frivolous. Beyond doubt there is nothing of a similar nature so greatly tasking the faculty of analysis.

Clarke's favorite pastime was well known in her day. Whist plays a part in several of the works of Leo Tolstoy, Jane Austen, and Arthur Conan Doyle.

During Clarke's four years at Briarley Hall, it comes as no surprise that she excelled at arithmetic, algebra, and geometry. In 1901, when she turned eighteen, Clarke used a minor inheritance from her parents' estate to enroll at

Vassar College in upstate New York. She couldn't have known that she would spend much of her life and illustrious career in upstate.

Clarke graduated Vassar in 1908 at age twenty-five, with Phi Beta Kappa honors, after majoring in mathematics and astronomy. Vassar at that time didn't offer a major in engineering to its women, the field of study that Clarke preferred. Clarke then taught mathematics at a San Francisco private girls' school and afterward at Marshall College in Huntington, West Virginia.

Determined to become an engineer, she went to the University of Wisconsin at Madison, in the fall of 1911, enrolling as a sophomore to study civil engineering. But then she interrupted her studies in 1912, now at age twenty-nine. She went to work as a "computer," that is, a number-crunching analyst, typically female, at the American Telephone and Telegraph Company (the predecessor to AT&T).

This was arguably the turning point in Clarke's career. George Ashley Campbell, who had first hired her as a computer assistant for the summer of 1911, was applying mathematical methods at AT&T to analyze the long-distance transmission of electricity in the field of telephony. It was a crucial analysis. AT&T wanted to build the first transcontinental telephone line from New York to California.

Campbell had received a doctorate from Harvard after studying under two of the greatest mathematicians in history. He spent a year with Ludwig Boltzmann in Vienna and a year with Henri Poincaré in Paris. At AT&T, Clarke was Campbell's computer assistant, performing his mathematical calculations. She also trained and directed a group of computers. Not much more than a decade later, Clarke would do what Campbell did for the long-distance transmission of low-voltage telephone signals, but instead for the long-distance transmission of high-voltage power.

Her time with Campbell jump-started her interest in mathematics and electrical engineering. In his November 1985 paper, "From Computer to Electrical Engineer: The Remarkable Career of Edith Clarke," James Brittain, who was considered for decades to be the driver of IEEE's history committee, writes:

Clarke's time as assistant to Campbell provided her with an excellent apprenticeship in the mathematical theory of transmission lines and electric circuits. Campbell was [AT&T's] leading authority on these topics that involved the manipulation of hyperbolic functions, equivalent circuits, and graphical analysis, areas that Clarke pursued for the rest of her career.

While at AT&T, she studied electrical engineering at night at Columbia University. Then, Clarke enrolled at the Massachusetts Institute of Technology. In 1918, she became the first woman to receive an electrical engineering degree from MIT.

This was the second turning point in Clarke's career, not just because of her academic first. But because her faculty advisor, for her master's thesis entitled "Behavior of a Lumpy Artificial Transmission Line as the Frequency is Infinitely Increased," completed only a year later, was Arthur Edwin Kennelly.

Kennelly, a professor of electrical engineering at both MIT and Harvard University, simultaneously, who while in his twenties had worked for Thomas Edison, was still another highly mathematical electrical engineer who in his case pioneered the use of complex numbers and hyperbolic functions to the analysis of alternating current systems. It's thus not surprising that Kennelly and Clarke worked together as a rare team that could speak about the challenges of the rapidly growing electricity industry in mathematical terminology and concepts.

The director of MIT's electrical engineering department was Dugald Jackson. At one point, Jackson wrote a letter to Charles Proteus Steinmetz praising Clarke. Why do we bring up this letter? Because Steinmetz, called the Forger of Thunderbolts in his day, was the most renowned electrical engineering mind of that period, or arguably any period. It was Steinmetz who almost singlehandedly unlocked the mysteries of alternating current systems through advanced mathematics. And it was Clarke who, in the first half of the twentieth century, was one of no more than a handful who could interpret and apply Steinmetz's math despite its complexity.

In the letter, Jackson wrote:

Dr Kennelly tells me that Miss Clarke has been an uncommonly competent student in Mathematics and allied branches, and that she has done excellent research in connection with the characteristics of power transmission as represented by our artificial [experimental] transmission lines. She is proposing to communicate with you for the purpose of seeing whether there may not be a need for such a mind as hers in connection with your work.

After receiving her master's degree from MIT in June of 1919, notwithstanding this prestigious recommendation, she was unable to find a job as an engineer. In his 2003 paper, already cited, Tymphas concludes:

Unless we turn to the ideology that perpetuated women's inferiority, which contributed to the division-of-labor pyramidization [in the engineering of transmission systems], we cannot explain why Edith Clarke could not find any job as an electrical engineer.

While Clarke struggled in the job market, her peer Vannevar Bush thrived then and throughout his career with much acclaim and fortune. Bush, seven years younger than Clarke, completed his electrical engineering master's thesis at MIT in 1916, two years before Clarke had. Kennelly, the advisor for both Bush and Clarke, demanded that Bush do more work on his thesis. But Bush refused to do so. And he was then actually backed up by the department chairman, Jackson. Three years later, in 1919, while Clarke was in her job search, Jackson hired Bush, bringing him back to MIT.

How did Bush fare afterward? Pretty well. Bush went on to found the predecessor to Texas Instruments, then found Raytheon Company, and ultimately played important roles in research organizations during and after World War Two including the creation of the National Science Foundation. In contrast, notwithstanding Clarke's greater impact on the theory and application of electrical engineering, she ended up as a college professor.

Clarke Becomes a GE Engineer

Clarke finally settled for a position as a supervisor of computers at General Electric in Schenectady, New York, in its Turbine Engineering Department. Her focus there was on predicting the mechanical stresses in high-speed turbine rotors that could lead to turbine breakdowns.

It was universally believed, at least by the men at universities and in commerce, apparently, that women were naturally suited to the repetitive and monotonous work of the computers. In the early twentieth century, this kind of work had become increasingly important and then essential to the necessary calculations of science and technology in the decades before these calculations were taken on by electronic computers. Historians such as Katherine Stubbs and Lorraine Daston describe how the women who worked as human computers fit into the assembly line that male engineers created for their work and how the role of their female colleagues was devalued.

But it was at GE, as a supervisor of computers, that Clarke quickly rose to prominence and then became famous in her field. In less than two years at

GE, Clarke invented what was to become known almost immediately as the Clarke calculator.

She filed for the patent for the E. Clarke Calculator on June 8, 1921. This invention was nothing less than a forerunner to the slide rule of the mid-twentieth century. And to the modern graphing calculator and computer software of the late twentieth century. The patent was granted by the U.S. Patent and Trademark Office on September 1, 1925.

The application explains the purpose of the Clarke calculator quite elegantly:

My invention relates to a calculator, and more particularly to a calculator for investigating the electrical characteristics of long lines for the transmission of electrical energy.

In the ordinary methods of calculation employed for short transmission lines, such as miles or so, it is usually assumed that the capacity and inductance of the line are each concentrated at a single point or at a few isolated points along the line. Such assumptions however are not justifiable when the transmission line which is being investigated becomes comparatively long, say a few hundred miles.

Even for such distances as 200 miles, errors would result if such assumptions be made. If accuracy is desired in calculations for long lines, it is absolutely necessary to take into consideration the uniformly distributed inductance and capacity of the line.

Although formulas have been derived for such conditions, their application involves a great deal of work. Especially is this the case where it is necessary to investigate the behavior of transmission lines upon varying the conditions by small increments at the receiver end or at the generator end. It is the object of my invention to make it possible to investigate the characteristics of transmission lines of varying construction in a simple manner.

With my invention, laborious calculations are obviated for transmission lines of any length desired, and acceptably accurate results obtained. For example, the error obtained by using my calculator does not exceed a small fraction of one percent for lines of about five hundred miles. Lines of such length are being considered, and there is little doubt that in the future such long distance lines will be quite common.



Edith Clarke at Her Desk

The patent application goes on to explain how the Clarke calculator works. The mathematics are complicated for most readers. But the explanation starts off more simply:

The calculator is based upon the evaluations of infinite series to a sufficient degree of accuracy, which infinite series take into consideration the distributed inductance and capacity of the line. By making the assumption that certain of the elements involved in the calculations remain substantially constant, it is possible to perform the operations with the calculator by the aid of the combination of only a few pivoted

arms representing vectors. The infinite series chosen to represent the transmission line characteristics are those involving the hyperbolic sine's and cosine's.

In his 2017 book "Calculation and Computation in the Pre-Electronic Era," Tympas explains that the breakthrough of the so-called power-factor slide rule in 1922, which was publicized by Philip Alger and a male colleague, was actually invented by a woman in Alger's turbine engineering department at GE. Who was this woman you ask? Well, it was none other than Edith Clarke.

In her very first publication, in February of 1926, at the age of forty-three, Clarke succinctly summarizes in the synopsis the point of the paper. It was the first time a woman had authored, presented, and published in AIEE Transactions. This landmark paper, "Steady-State Stability in Transmission Systems, Calculation by Means of Equivalent Circuits of Circle Diagrams," can be summarized in these two paragraphs of its text:

The maximum load on a proposed transmission system must be within the steady-state power limit of the system for stability of operation. Two methods of calculating steady-state stability are given in detail and illustrated by examples. (1) The given transmission system is replaced by a simple equivalent system; then the steady-state power limit of this equivalent system is determined graphically. (2) By means of a circle diagram the system is tested for stability with the maximum proposed load on the system...

Formerly when a transmission system was proposed, it was customary to make the line calculations for voltage regulation and losses for the maximum load conditions, and to select the generators, transformers and synchronous condensers to fit these conditions. There was nothing in such calculations to indicate that the system would be stable, but fortunately the length of line and maximum load have been such that cases of instability have been rare. At the present time when the tendency is for longer lines and greater loads, it is necessary to consider the question of stability both for steady-state and transient conditions.

Tympas, in his book, explains for the layman what Clarke meant by calculation by means of equivalent circuits of circle diagrams, her paper's subtitle:

General Electric's Edith Clarke presented a paper on calculating the stability of transmission by circle diagrams or, alternatively, graphically or algebraically, by 'equivalent circuits,' that is, by replacing a complicated transmission structure by an equivalent simple one after applying connecting factors for correction.

In her breakthrough year of 1926, Clarke published a second paper just three months later. The May edition of the General Electric Review included Clarke's "Simplified Transmission Line Calculations." The journal's editor added this comment:

When we were young the multiplication table seemed most formidable, yet we eventually mastered it. But few of us have later been as completely successful in mastering some of the specialized branches of higher mathematics. Miss Clarke presents a simple medium for handling hyperbolic functions in a type of a problem frequently met.

Her method of symmetrical components revolutionized the analysis of long and higher-load transmission lines that were susceptible to system instability. Clarke's approach replaced the existing mathematical models that were only adequate for short and lower-load lines.

Take This Job and ...

Clarke was employed by General Electric for twenty-eight years, from 1919 to 1947. She worked at the extensive GE facilities in Schenectady, New York almost continuously during that period. Except for a brief time in, of all places, Istanbul, Turkey.

Clarke was understandably frustrated that GE classified her as a supervisor of computers rather than as an electrical engineer, even after her celebrated invention of the Clarke calculator. Her status and salary were lower than that of men doing the same work and she wasn't allowed to take on tasks reserved to engineers.

Tympas writes in his paper previously cited:

Had she not become an analyst [the lead engineer], Clarke might have also been unknown [as was the case for the highly-educated women who worked at that time as computers]. For more examples of women computers who worked to produce engineering computations in general and electric power transmission in particular, i.e., for computers who remain historiographically invisible [in the historical accounts of today], one would have to pay attention, literally, to the footnotes of computing treatises authorized by male analysts.

So, not being accorded the position as engineer at GE, she left the company in late 1921. Remarkably, she became a professor of physics at the Constantinople Women's College in Istanbul.

This apparently sent a very strong message to her GE managers. Soon thereafter, in 1922, Clarke was brought back to GE as a full-fledged electrical engineer in the Central Station Engineering Department. In so doing, GE gave her a contract that made Clarke the first female electrical engineer in the U.S., at the age of thirty-nine.



Edith Clarke Later in Life

Clarke Calculator Step To Modern Computing

Brittain recounts in his 1985 paper about Clarke that she was among the top scientists, engineers, and mathematicians that contributed to the development of electromechanical computers (replacing human computers, that is, women doing scientific, engineering, and business calculations). Including the famous ENIAC that was completed at the University of Pennsylvania's Moore School of Electrical Engineering in 1945.

Her involvement in the development of computers began in March of 1931 when she, for the first time, presented a paper using the method of symmetrical components. This paper was her second before the AIEE. Clarke then extended that work in her May 1932 paper, her third paper before the AIEE, again using the method of symmetrical components to analyze types of multi-conductor transmission lines.

The work was furthered in the January 1938 paper by Clarke, Moore School instructor Cornelius Weygandt, and a Clarke colleague from GE, Charles Concordia, on voltage surges from unbalanced faults in transmission lines, also presented before the AIEE. To prepare the paper, Clarke, Weygandt, and Concordia used the Moore School differential analyzer which was the predecessor to ENIAC.

Clarke was hardly done with her breakthroughs enabling the engineering of the modern electric grid. In a January 1941 paper, named as the AIEE paper of the year, Clarke and another GE colleague, Selden Crary, found that series capacitance was the most effective way to maintain system stability for transmission lines as long as seven hundred miles.

Electrical engineer and blogger Dr. Mohamad Koteich wrote in a recent blog post about Clarke:

Every electrical engineer who works in the field of alternating current (AC) systems should be familiar with the Clarke Transformation concept. It is a fundamental concept used for control, monitoring, and analysis of electric motors, generators, variable speed drives, electric grids, AC power converters, etc.

Mabel MacFerran

Some spots on the Internet mention Clarke's connection with the building of the Hoover Dam. Researching this has nonetheless led nowhere, in terms of original sources. The supposition seems unlikely to be true, though with one notable caveat. This unprecedented project, given how remote its location is, relative to cities, required long-distance power transmission. And long-distance transmission, if it was to be economical and reliable, required Clarke's work.

In the process of this research, on Clarke and the Hoover Dam, another amazing woman came to light. Mabel MacFerran Rockwell also broke down barriers in the electric industry. And MacFerran, who at age fifty-eight divorced the not nearly as successful engineer Stanley Rockwell, did indeed play a large part in this big project.

MacFerran graduated first in her class at the Massachusetts Institute of Technology in 1925, majoring in science, teaching, and mathematics, and earned another degree from Stanford University one year later, majoring in electrical engineering. After having helped design the power system for the Colorado River Aqueduct project, she was the only woman involved in the design and installation of the power generating machinery for Hoover Dam 1.

This massive hydroelectric facility was built on the Colorado River, on the border between Arizona and Nevada, during the first years of the Great Depression, from 1931 to its commissioning in 1936, when MacFerran was thirty-four years old. The two thousand and eighty megawatt behemoth actually wasn't called the Hoover Dam at first, receiving that name as an act of the Congress after World War Two (replacing its original name, the Boulder Dam).

Southern California Edison employed MacFerran during the construction of the dam with the job title of technical assistant. She later worked for the Metropolitan Water District and the U.S. Bureau of Reclamation, the Hoover Dam's operator.



Vivien Kellems, Power Cable Entrepreneur

Vivien Kellems

In 1940, of the seventeen thousand members of the American Institute of Electrical Engineers, only three were women. There was Clarke and MacFer-ran and one other woman, namely Vivien Kellems.

Kellems wasn't an engineer. She earned her undergraduate degree from the University of Oregon in economics in 1918, where she incidentally was the sole woman on the debate team. She later received her doctorate in economics from Columbia University. So, you ask, why was Kellems one of the three women in the nation's electric engineering association?

In 1927, she founded Kellems Cable Grips, Inc. in Connecticut to manufacture an endless-weave electrical cable grip invented by her brother Edgar that was better than the wire mesh grip in common use at the time. A year later she had their first orders with Queens Electric Light and Power Company and Brooklyn Edison Company. (Both companies eventually became a part of Consolidated Edison Company.)

It's odd that Kellems was better known in her day for her opposition to taxes. Talking about this topic, she was one of the first women to appear on the television show "Meet the Press" in 1948.

Chapter Four

Lost Decades of Role Restrictions

Female Jobs

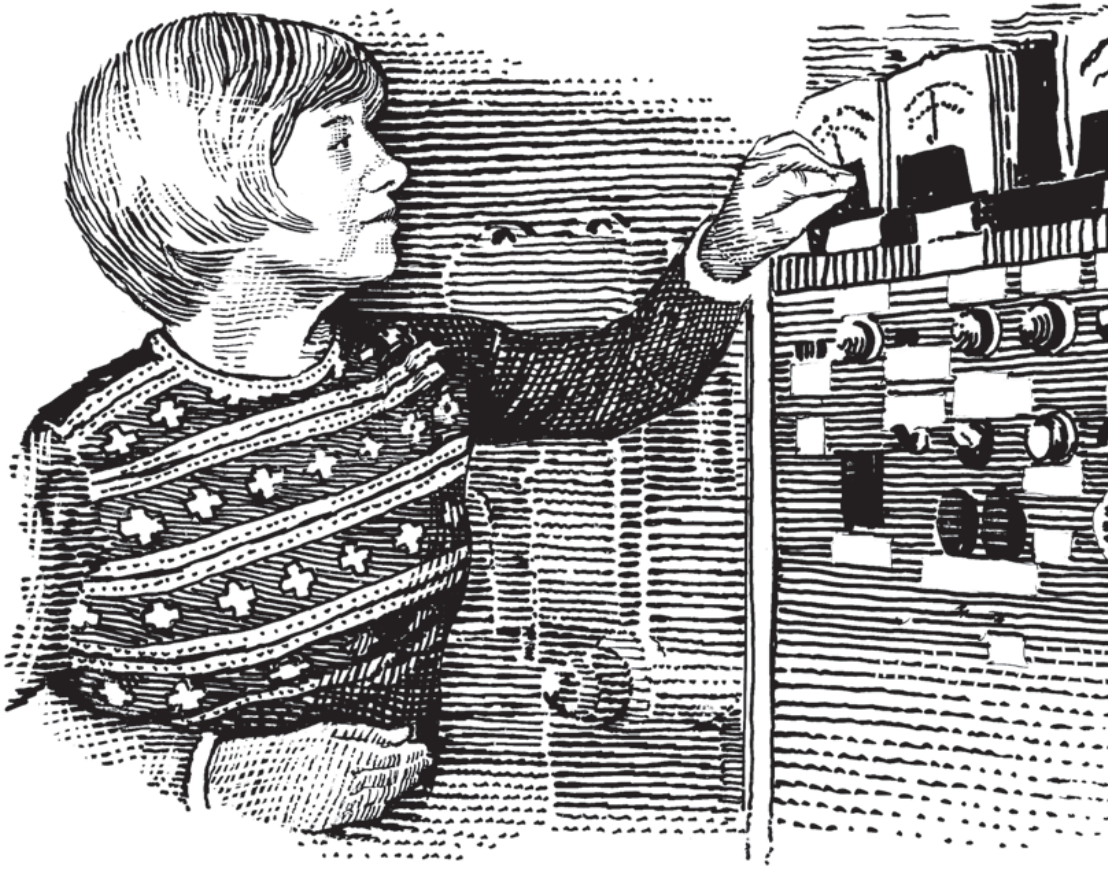
“When Women Were Computers” is the title of a 1999 article by historian Jennifer Light. In the article she writes:

Before World War II, women with college degrees in mathematics generally taught primary or secondary school. Occasionally they worked in clerical services as statistical clerks or human computers. The war [temporarily] changed job demands, and one women’s college reported that every mathematics major had her choice of twenty-five jobs in industry and government.

Yet, as [work sociologist Ruth] Milkman suggests, more women in the labor market did not necessarily mean more equality with men. Sexual divisions of labor persisted during wartime...

Occupational feminization in the sciences fostered long-term invisibility. For example, beginning in the 1940s, laboratories hired women to examine the nuclear and particle tracks on photographic emulsions. Until the 1950s, published copies of the photographs that each woman scanned bore her name.

Yet eventually the status of these women’s work eroded. Later publications were subsumed under the name of the lab leader, inevitably a man, and publicity photographs rarely showcased women’s contributions. Physicist Cecil Powell’s request for ‘three more microscopes and three girls’ suggests how invisibility and interchangeability went hand in hand.



Nancy Fitzroy, Nuclear Navy's and GE's Heat Transfer Expert

Into the late nineteen-fifties, highly-educated women were often relegated to secretarial positions. Many college women reported being asked how well they could type in their first job interview, according to a U.S. Department of Labor survey in 1957. Sandra Day O'Connor, the first woman to join the Supreme Court as an Associate Justice, often told the story of failing to get an offer from any California law firm, for the position of lawyer, and settling for that of a legal secretary, after graduating near the top of her class from Stanford Law School in 1952.

Eventually the tide turned. Janet Yellen added a particularly interesting footnote to her 2017 Brown University speech, which we have previously cited, "So We All Can Succeed: 125 Years of Women's Participation in the Economy." She pointed out that even though very many women were fired from their jobs when World War Two ended, opportunities for women rebounded back to those same levels during the Korean war of the early nineteen-fifties.

It appears that the wives of sons whose mothers worked during World War Two often worked outside the home.

They Navigated Challenging Time

Though there were very few opportunities in the mid-twentieth century for women to distinguish themselves professionally, some extraordinary women nevertheless succeeded. An example was Edith Boldebeck. Starting in 1945 at age thirty, after receiving her doctorate from the University of Chicago, she worked as a chemist at GE for thirty-five years, and was awarded thirty-one patents. That's almost one patent per year on average, mostly concerning plastics. Her work helped improve electric wires, specifically the quality of their insulating coatings.

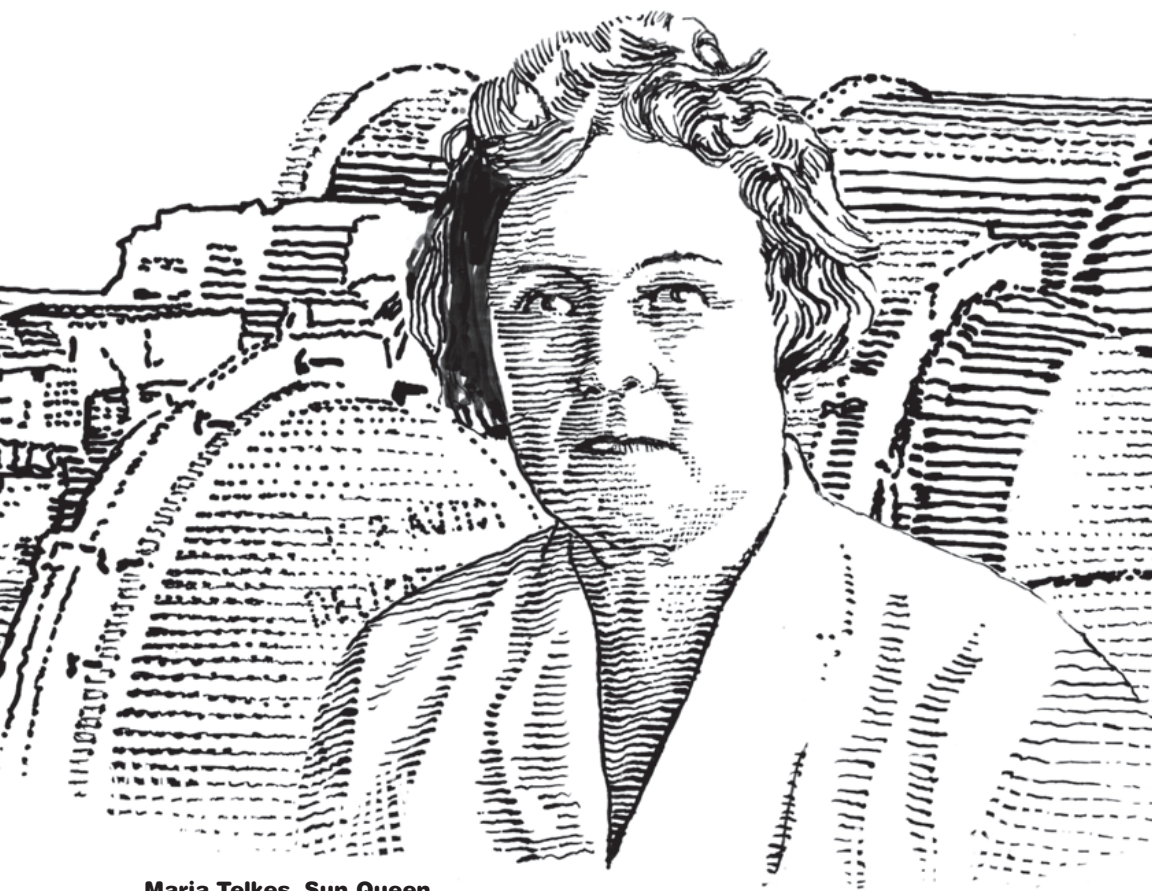
And there was Nancy Deloye Fitzroy. In 1949 at age twenty-two, she was the first woman to receive a bachelor's degree in chemical engineering from Rensselaer Polytechnic Institute. Fitzroy started working a year later at the Knolls Atomic Power Laboratory, assisting the U.S. Navy's development of nuclear-powered submarines under the legendary Hyman Rickover.

Then she went to GE in 1952 as a developmental engineer and helped design heat transfer surfaces for nuclear reactor cores and gas turbines. In 1979, she became GE's manager of energy and environmental programs for the company's turbine market and products division, and stayed with the company until her retirement in 1987. She has another important first. Fitzroy became the first woman president of a major national engineering society, by being named president of the American Society of Mechanical Engineers in 1986.

Fitzroy recalls why she chose to study chemical engineering in college after her application had been accepted by both RPI and MIT. She knew about the obstacles before her, what she called the big old man syndrome. Fitzroy figured that with a degree in chemical engineering if companies wouldn't hire her as an engineer, she could always get a job as a chemist. In those days there were plenty of women working as, in effect, chemists' bottle washers.

In an interview, Fitzroy was asked what's the main stumbling block for women in engineering and science. Her reply? She said the main stumbling block is in their own minds. They should do what they want to do with courage and conviction, and not wait for somebody else's approval.

If Fitzroy ever writes a book, she once said during the interview, she'd entitle it, "Little Girl, What Are You Doing Here?" That's the reaction she received throughout her career, since an interview on the RPI campus by a



Maria Telkes, Sun Queen

major oil company recruiter. It's what the recruiter said to her that day. But Fitzroy concluded, she's a good engineer and in the end that's what counted over her nearly four decades at GE.

Next comes the Sun Queen. Her real name was Maria Telkes. She was the founding mother of solar thermal energy systems.

After receiving a doctorate in chemistry at age twenty-four from the University of Budapest, she almost immediately moved to the U.S. Starting in 1939, and still fifteen years later to 1953, she did ground-breaking work at the Massachusetts Institute of Technology inventing practical thermal storage devices. Then in the nineteen seventies, Telkes helped several solar start-up companies as a consultant including what is now BP Solar. And she was still inventing into the nineteen eighties, when in her eighties, she helped the U.S. Department of Energy develop and build the first fully solar-powered home. Telkes ultimately earned more than twenty patents.

And there was also Emma Barth. She joined the Turbine Generator Division at Westinghouse during the second world war in 1944 as a draftsman. Many women were employed in that wartime role. But Barth was especially ambitious and aspired to become an engineer. She enrolled at the University of Pittsburgh, attended in the evening for seven years, and received her degree in general engineering in 1951, the sole female in her class.

Her work at Westinghouse as a mechanical engineer required her to evaluate whether the company's turbines and generators were a good fit at power plants around the country. However, many power plant managers wouldn't permit a woman inside their plants. So if a turbine or generator problem arose, Barth would send a male colleague to visit the plant, take photos of the equipment in question, and bring the pictures back to Westinghouse for evaluation.

There were other women during the period who had distinguished careers in the industry. In 1964, Radcliffe College's president Mary Bunting was appointed to the five-person Atomic Energy Commission. And the first woman to chair the AEC was Dixy Lee Ray, appointed to the job eight years later, in 1972.

Women and Engineering Education Mid-Century

As Amy Bix of Iowa State University wrote in her 2014 book "Girls Coming to Tech: A History of American Engineering Education for Women:"

Engineering education in the United States has a gendered history that until relatively recently prevented women from finding a comfortable place in the predominantly male technical world. Throughout the nineteenth century and most of the twentieth, American observers treated the professional study of technology as men's territory. For decades, women who studied or worked in engineering were popularly perceived as oddities at best and outcasts at worst because they defied traditional gender norms...

Up to World War II and beyond, some of the nation's foremost technical institutions refused to enroll female undergraduates. Many male students, faculty, and alumni at elite schools openly criticized or ridiculed the idea of women engineers...

Even after female students gained new opportunities to enroll in engineering, however, many were deterred, disheartened, or driven away by a cold or even antagonistic atmosphere. The debate over women's place in engineering served as a barometer of gender biases, displaying society's limits on what it accepted as masculine and feminine cognitive categories. Powerful cultural systems legitimated and facilitated 'proper' choices for college majors for men versus women.

Bix cites the dramatic numbers. Women were less than one percent of all college-level engineering students in the nineteen fifties, notwithstanding the increase in their number from seven hundred and sixty-three in 1949 to seventeen hundred and eighty-three in 1957. In sharp contrast, during the 2010 to 2011 academic year, women earned eighteen percent of engineering bachelor's degrees. According to Margaret Layne, who wrote the 2009 book "Women in Engineering: Pioneers and Trailblazers," women weren't as much as one percent of engineering students until 1972.

The Seventies

If you were reading the New York Times on the twelfth of April in 1970, you might have come across an in-depth article on the CEO of Con Ed. "Con Ed's Charles Luce All Power (Sometimes) To the People" reviewed the many challenges facing the City's electric utility company and quite thoroughly analyzed how Luce was coping with them.

Buried within the text is a discussion of Luce's programs to cut staff. Interestingly, for our purposes, the discussion touches upon the role of women at one of the nation's largest utilities:

Luce eased the removal of entrenched senior employees, executive and otherwise, by reducing the company retirement age from 68 to 65, man-aging to pare close to 2,000 workers from the payroll. (*The retirement age for women was lowered to 63, a fiat which caused a small uproar in the stenographic pool.* At last report, some of the women were intent upon bringing suit based on sex discrimination.)

Luce replaces the dismissed executives with *men* 20 to 30 years younger, whom he recruited across the nation from industry, government and other utilities. {emphasis added}

As at Con Ed, most women employed by utilities were in clerical positions. In her article "A Spontaneous Loss of Enthusiasm," Dorothy Sue Cobble discussed the frustrations of seventies women in the workplace, citing Karen Nussbaum, the co-founder of 9to5:

As Karen Nussbaum remembered it, the 'most powerful motivator [to form women's organizations for change] was the issue of respect. Women did not want to feel they were office wives. They were real workers with real jobs.' They also wanted their personhood acknowledged. Nussbaum recalled with chagrin her experience of being looked 'dead in the eye' and asked, 'Isn't anybody here?' Other clericals spoke bitterly of being 'invisible,' of having people not 'really look at you as a person,' and of the indignity of the 'servant role.' In short, clericals rejected being an 'office maid' as well as an 'office wife.'

In the same year as that New York Times article about Con Ed, the author of this book began attending the oldest and one of the largest engineering colleges in the U.S., Rensselaer Polytechnic Institute, and graduated four years later in 1974. In electrical engineering, all but two of the eighty graduates that year were male. In power and systems engineering, all fifteen graduates were male. In mechanical engineering, all thirty-one graduates were male. In nuclear engineering, all twelve graduates were male.

So, altogether, in these four fields that often led to careers in the utilities industries, there were but two women out of a total of a hundred and thirty-eight graduates. Civil engineering and environmental engineering sometimes led to utility careers as well. In civil engineering, there were two women that year that graduated alongside forty-seven men. In environmental engineering, there was one woman that graduated alongside eleven men.

Four years earlier in 1970, this author graduated from the largest engineering high school in the U.S., Brooklyn Technical High School. That spring, it graduated over thirteen hundred students, a majority of them with engineering diplomas. Every one of those who graduated were male, as Brooklyn Tech had never allowed females to attend, a policy that was to change months later that fall.

According to Janet Yellen, in that same year 1970, fifty percent of all women worked outside the home. This was about the same rate as in 1930, four decades earlier. Yet forty percent of married women worked outside the home, more than three times the rate in 1930. So the huge increase in workforce participation by women during the 1930 to 1970 period was by married women.

As Yellen said in her 2017 speech at Brown University:

By the 1970s, a dramatic change in women's work lives was under way. In the period after World War II, many women had not expected that they would spend as much of their adult lives working as turned out to be the case. By contrast, in the 1970s young women more commonly expected that they would spend a substantial portion of their lives in the labor force, and they prepared for it, increasing their educational attainment and taking courses and college majors that better equipped them for careers as opposed to just jobs.

This was true for the wife of this author, as one example, who received her bachelor's degree in business administration in 1977 and master's degree in that same field in 1981. She subsequently worked at a large water utility, in consulting, at a large hospital, and for an association for physicians.

In that same year, 1977, Sheila Hollis became the first director of the newly-established office of enforcement of the Federal Energy Regulatory Commission. She brought its first criminal referrals of energy law violations, and built the office to sixty-five lawyers, technical specialists, and investigators.

Hollis had earned her bachelor's degree from the University of Colorado at Boulder in 1971 and her law degree from the University of Denver in 1973. She then started her career at the Federal Power Commission, FERC's predecessor, and during her time there was lead counsel in the famous Pennzoil-United spinoff case.

After her government service and while in private practice, in 1992 Hollis was elected the first woman president of the Federal Energy Bar Association. Her advice to ambitious young women in energy is to prepare, be willing to make sacrifices, even difficult ones. She adds, don't be afraid to open the door in front of you and walk through to see what awaits. Be willing to give your intellect, time, heart, and soul to making a life in energy. And be prepared for sacrifice of personal time. Because, per her motto, energy never sleeps.

There was another first at the FERC in 1977. Georgiana Sheldon became the first female commissioner of the FERC that year. Including Sheldon, there have now been ten women to serve as commissioners there: Martha Hesse, who took her seat in 1986, Elizabeth Anne Moler, who started in 1988, Vicky Bailey, who started in 1993, Linda Breathitt, who started in 1977, Nora Brownell, who started in 2001, Suede Kelly, who started in 2003, Cheryl LaFleur, who started in 2010, Colette Honorable, who started in 2015, and Allison Clements, who started in 2020.

Of these ten commissioners, four have served as the FERC's chair, which is a powerful position at the Commission. Sheldon, Hesse, Moler, and LaFleur all have had stints as Chair. Sheldon's term as Chair was short-lived for five months in 1981 in an acting capacity. However, Hesse's term lasted for over three years in the late nineteen eighties, after her appointment by President Reagan. Moler's term lasted for well over four years in the mid-nineties, after her appointment by President Clinton. And LeFleur's three terms lasted over two years. Two of her terms were in an acting capacity but one was the result of an appointment by President Obama.

Thirty-two men have started their terms as FERC commissioners during this period since Sheldon started her term as the first of ten female commissioners on August 11, 1977. Fifteen men have started their terms as FERC's Chair during this period since Sheldon started her term as the first of four female Chairs of the Commission on January 2, 1981.

It would be an injustice to consider the federal regulators at FERC and not the regulators at the state public service commissions. As in the case of the utilities and the federal utility regulatory body, the state commissions were once male-dominated too. Just look at a 1965 brochure for a new program at Michigan State University, which grew to become its Institute of Public Utilities. The purpose of this program introduced in the mid-nineteen sixties was, according to the brochure, to educate state regulators for "top industry men."

It wasn't until the nineteen seventies that women were appointed or elected to state commissions in any numbers. Diane Munns, who was appointed to the Iowa Utilities Board in 1999, and who became the president of the association of state regulators, NARUC, in the mid-two thousands, has said that women started to be selected for the state commissions when it was realized that backgrounds in business, law, or government were as valuable for commissions as engineering.

One of the female pioneers in state utility regulation was Sharon Nelson, who chaired the Washington Utilities and Transportation Commission from 1985 to 1997. Nelson always made an effort to speak to young women about the opportunities at utilities and in utility regulation.

At the time of this book's writing, there were one hundred ninety-three filled commissioner positions at the states and the District of Columbia. Of these, sixty-eight were filled by women. This comes out to be thirty-five percent.

Chapter Five

A Second Start – Women Leaders in the Eighties

Madame Dean

Finally in 1984 a woman became the head of an engineering school in the U.S. At age forty-four, the electrical engineer Elizabeth K. Baum was named Dean of the School of Engineering of the Pratt Institute in New York. Three years later in 1987, she became Dean of the School of Engineering at Cooper Union, also in New York. During her twenty years at Cooper Union, the number of women among its students increased from five percent to forty percent.

An only child of parents who fled Europe during the Holocaust, Baum was destined to become a teacher. Her parents constantly drilled this into her and when her mathematics, physics, and chemistry proficiency became evident in her high school years, her mother and father allowed she could become a high school math teacher. When she told her mother about going down the path of electrical engineering, her mother responded like this, Baum recalled:

You can't do that. People will think you're weird, and no one will marry you.

Her high school teachers and the engineering colleges she applied to were similarly discouraging. One college wouldn't admit her because it said it didn't have a suitable ladies' room. But she was accepted by and attended the City College of New York, graduating in 1959, at age nineteen remarkably, and of course as the sole woman in her engineering class.

Baum said of her experience:

I felt very conspicuous... but I was stubborn enough to stick it out... Being the only girl in college classes was not wonderful ... you become all women. If I don't know something, then it's 'all women can't ...'

In 1964 she earned a doctorate from the School of Engineering of the Polytechnic Institute of New York (now New York University), notably by the time she was only twenty-four years old. This after completing her master's degree from the same institution.

One more recollection from Baum that was indicative of her breakthroughs amid challenges. She married a physicist, Paul Baum, and they somewhat uniquely for that period hired a nanny to help with their children for eighteen years. Her parents eventually embraced her as a successful engineer and leader but her in-laws never did.

Joan Bok

If you were reading the New York Times on May 23 of 1984, you would probably have been surprised by the headline of this article. "Woman Named to Lead New England Electric." It was truly a remarkable development for that time. Joan Toland Bok was the first woman by many years to become the Chair of a major utility in the U.S. In 1984 she was made the Chair of New England Electric System (now a part of National Grid US), a position she held until her retirement in 1998.

Bok very temporarily held the position of CEO as well, making her the first woman to have that title in the utilities industries, albeit for a few months only. CEO Samuel Huntington was killed in a lightning storm in July of 1988. The legendary John Rowe was selected by Bok and her Board of Directors to assume the CEO position that December.

Bok was born on the thirty-first of December in 1929, at the dawn of the Great Depression. She received her bachelor's degree from Radcliffe College twenty-two years later in 1951, and then her law degree four years later in 1955, from Harvard University.

Before joining NEES in 1968, she was an attorney with Ropes and Gray for her first six years out of law school and then had her own practice for the next seven years. She rose at the utility to become a vice president in 1977. This was three years before the first female U.S. Senator was elected in her own right (without following the footsteps of her father or husband) and four



Joan Bok, First Female Utility Chair

years before the first female Supreme Court Associate Justice was confirmed. In 1979, Bok was elevated to the position of Vice Chair.

At a time when having such an executive career was extremely rare for a woman, Bok brought up two children with her husband John Bok, who she married upon completing law school in 1955. In the next class at Harvard Law School, in 1956, future Supreme Court Justice Ruth Bader Ginsburg began her first year of classes there.

Joy Tannian and More

Take a close look at the 1986-1987 edition of the Electrical World Directory of Electric Utilities. For decades this reference book served as the Yellow Pages of utility executives and senior managers. In the years before the Internet, paging through the Electrical World Directory was the best way to see who sat atop the nation's investor-owned, public power, and rural cooperative electric utilities.

The 1986-1987 edition gives us a thirty-five year old picture of who ran the utilities of the mid-nineteen eighties. Though the reference book numbers nearly a thousand pages of small print, to spot the women who were included among the listed utility execs and senior managers isn't actually that difficult to do.

Because for the nearly hundred percent of execs and senior managers that were male, the Electrical World Directory generally shows them with their first name initial, middle name initial, last name, and job title. And for the tiny minority of them that were female, it shows them with their first names spelled out and sometimes their middle names spelled out as well. So the very few women at the exec and senior management levels stand out.

We've already discussed Joan Bok, who chaired the board of directors of New England Electric System in the mid-nineteen eighties and into the nineteen nineties. What other women were there at that time in the highest positions? It turns out there were virtually none.

One was Joy Tannian. Looking through this mid-eighties Electric World Directory, we can see that Tannian was the general counsel of Consolidated Edison. Was there anybody else? Were there any other women in the top positions? Joellyn Murphy's name is also easy to find among all the male execs with their first and middle name in initials rather than their first and middle names spelled out. In the mid-eighties, Murphy was the vice president for regulatory affairs at Public Service of New Mexico.

And there was also Duejean Garrett, who was at Public Service of Indiana. She was the only other general counsel within the pages of the 1985-1986 Electrical World Directory aside from Tannian. More on Garrett's career in the following chapter of this book.

Back to Tannian, she tragically passed away from cancer in 1988, when she was only fifty-six. Her death cut short an extraordinary career. Four years earlier, she had risen to the level of senior vice president and general counsel of Consolidated Edison.

She first joined Con Ed in 1957, at the age of twenty-five, after earning her law degree from the University of Michigan, where she also earned her bachelor's degree. Tannian ascended the ranks from a junior lawyer to become the company's first female vice president ever. And its first female general counsel in 1984. And, as far as we can tell, she was first female general counsel throughout the utilities industry.

Tannian said this in 1985, at an awards dinner honoring the nation's highest achieving businesswomen, a year after becoming Con Ed's general counsel:

I'm fortunate. The barriers are down in my organization and all I have to do is to see that they're not reconstructed while I'm not looking. A handful of the rest of you may be similarly placed. But most of you, given a world where fairness and justice are in short supply, have a heavy burden. You have to continue the assault on the remaining barriers.... Success is likely only in a nurturing environment created by an enterprise's commitment to excellence.

Tannian is remembered as someone who really encouraged other women at Con Ed. Though she held a senior position at the company, she organized lunches with them as part of her mentoring, and to sometimes steer them to less hierarchical departments that would likely provide more opportunities for women.

Now we turn to Joellyn Murphy. She joined Public Service of New Mexico in 1982, at the age of thirty-six. By 1989, her title was expanded from vice president for regulatory affairs, which it was in the 1985-1986 Electrical World Directory, to vice president for regulatory and business policy. But Murphy wasn't the only key officer of that company that was female.

While Murphy was the vice president for regulatory and business policy, Phyllis Bourque was the vice president for gas supply. Which was likely the first time a woman led a key utility operations division as a corporate officer.

Bourque had joined PS of New Mexico in 1987 at the age of thirty-nine. She earned her bachelor's degree in physics, with a minor in mathematics, from the University of Texas at El Paso in 1969. After graduation she went to work for Shell Oil, becoming its first female petroleum engineer. Excelling there, she also became the first female engineer qualified to testify before the state's regulatory body, the Texas Railroad Commission. After four years at Shell Oil, she moved to Chicago and then earned her master's in business administration from the University of Chicago in 1975.

At this point, Bourque's career gravitated toward the utilities industry. She soon developed a financial planning group at United Gas Pipeline, which after awhile named her vice president for marketing and then senior vice president for gas supply. Both were firsts for a woman in the natural gas sector.

She then found herself at PS of New Mexico. First she was vice president for gas supply but eventually she became senior vice president for both gas supply operations and electric generation as well. Undoubtedly this was another first for a woman.

Bourque has said that she was always in a man's world, in school, at Shell, and afterward. As a young woman she asked herself how she could work in a man's world and still be a woman? She admitted she failed miserably and ended up playing cards, golf, etc. with the men, but then also working harder and being smarter than her male colleagues.

A Woman's Place

Other than Bok, Tannian, Murphy, Bourque, and Garrett, women with any kind of senior responsibilities at utilities generally had certain job titles in common. In that period, they evidently could be a utility's treasurer, corporate secretary, assistant to the president, or assistant to the CEO. They could be, also, the vice president for administration, public affairs, or human resources.

Margot Kyd was the corporate treasurer of San Diego Gas and Electric, for example. Annette Savill was similarly the treasurer of Indianapolis Power and Light.

Kyd would go on to a nearly thirty-year career at SDG&E and its parent company Sempra Energy. She rose from treasurer to vice president for administrative services to vice president for marketing and customer service to vice president for human resources and ultimately to senior vice president and chief administrative and environmental officer for Sempra Energy, SDG&E, and Southern California Gas.

Astrid Pfeiffer was the corporate secretary of Florida Power and Light. And Batty Ann Splinter was similarly the corporate secretary of, in her case, Hawaiian Electric.

Pfeiffer is quoted in a 1988 Sun-Sentinel newspaper article on dressing for success in the corporate world. She talked about a young and ambitious executive on the fast track at FP&L, a man of course, who always wore a conservative three-piece suit:

... apparently trying to send a signal that he had what it took to manage the huge utility,

wrote the paper's business writer. Pfeiffer reportedly added:

There was a joke going around that he even took a shower in it.

And according to Pfeiffer, the man had indeed become one of FP&L's top execs.

A 1980 application by FP&L to the U.S. Nuclear regulatory Commission lists its twenty-seven officers at that time. Twenty-six of them were male. One was female, Pfeiffer, the corporate secretary.

Sharon Dixon was the vice president for public policy at Potomac Electric Power. Dixon became a vice president there in 1983. Her utility career, alas, was not long. In 1985 this Howard University educated woman, with both her bachelor's and law degrees from there, left to go to the Democratic National Committee as its treasurer, a position she held for four years before being elected as the first African American female to be the mayor of Washington, D.C. in 1990.

At this time in the mid-eighties, Sue Rozema was the treasurer of Iowa Power and Light. By the late nineties, Rozema had been promoted to vice president for financial services of MidAmerican Energy, the utility's post-merger name. Marlys Johnson was the treasurer of Iowa Public Service and Beverly Wharton was the vice president for staff services and corporate secretary at that same company. Rebecca Tilden was the corporate secretary of Kansas Power and Light, and Sue Dueitt was the vice president for corporate communications at that same company.

These five women were in somewhat senior positions in their organizations. But all these positions were in non-core areas of their Iowa and Kansas-based utilities, which was typical across the states. Of utilities' core areas, such as operations, engineering, construction, and power plant management, men were at the top almost without exception.

In the northeast, Lynn Goldfarb was the vice president for customer services of Central Maine Power. And Eleanor Daly was vice president and assistant to the CEO of Boston Edison.

Jane Kay was vice president for administration of Detroit Edison and Kathryn Westman was corporate secretary at that company. Harriet Rogge was the vice president for administration. This is the only instance we found in which there were more than two women in a utility's senior ranks.

So many utilities in the mid-eighties had women as their corporate secretaries. Gladys Powell was the corporate secretary of Central Hudson Gas and Electric. Patricia Kelly was the corporate secretary of Oklahoma Gas and Electric. Sally Nofziger was the corporate secretary of PacifiCorp. Diane Eismond was the corporate secretary of Duquesne Light. And Lucy Binder was the corporate secretary of Philadelphia Electric.

Here are more corporate secretaries. Emily Brown was the corporate secretary of Santee Cooper, a state government utility. Louise Kelley was the treasurer and corporate secretary of Black Hills Corp. Theta Fields was the corporate secretary of El Paso Electric. Leslie Cobb was the corporate secretary of Gulf States Utilities. And Olga Laird was the corporate secretary of Central Vermont Public Service.

Linda Winikow was the vice president for human resources and external affairs of Orange and Rockland Utilities. Cathy Novinger was senior vice president for administration of South Carolina Electric and Gas. There weren't too many women at that time that held the title of senior vice president. Though in Novinger's case, her portfolio was the traditional field of administration.

Irene Moszer was the vice president for administrative services of Virginia Electric and Power. Bernadene Dochnahl was the vice president for human resources of Puget Sound Power and Light. Administration and human resources were common landing spots for the highly-educated and talented women in utility workforces.

Shani Taha was the deputy superintendent for customer, community, and conservation services of Seattle City Light, a municipal utility. Nancy Noeske was the vice president for consumer affairs of Wisconsin Electric Power. Similarly, at some utilities, woman led departments in which interaction with customers was central to their mission.

Kay Stepp and Hazel O'Leary

There were over two hundred investor-owned utilities listed in that edition of the Electrical World Directory detailing their senior staffs. Among these senior staffs were approximately four thousand individuals at the level of vice president or above, or the equivalent. So, of these four thousand, we've found that just thirty-four were women, less than one percent of the total.

The thirty-four women excludes the two from public power utilities, Brown and Taha, but does include Kay Stepp, who was on her way on the fast track.

Ester Kay Stepp was the vice president for marketing and customer operations of Portland General Electric in 1986-1987. Though in later years she rose to become the company's chief operating officer.

Stepp received her bachelor's from Stanford University in 1967 at the age of twenty-two, and her master's from the University of Portland eleven years after that in 1978. She immediately joined Portland General Electric, and was promoted to be and served as its vice president for human resources for the first four years of the nineteen eighties. As noted above, she was moved to vice president for marketing and customer operations in the mid-eighties,



Hazel O'Leary, First African American Woman Energy Secretary

and then was promoted again to president and chief operating officer in 1989, serving in that position for three years until 1992. That's when she left the utilities industry, in a highly publicized departure, replaced by a man when the utility encountered financial challenges, including those from the construction of the Trojan nuclear power plant that was halted the following year.

A short time later, in early 1994, she was one of two finalists for the CEO spot at another utility but backed away in favor of her own business coaching practice and later the health care and financial industries. But that wasn't the end of her interest in the utilities industries. In 2005, Stepp joined with two other former utility execs in an ultimately unsuccessful attempt to take over Portland General Electric after the bankruptcy of its parent company, Enron. The winner of the competition to lead an independent PGE went to another woman, Peggy Fowler.

In the late eighties, Hazel O'Leary cracked the glass ceiling from another direction. In 1989, O'Leary became an executive vice president of Northern States Power (now a part of Xcel Energy). She remained there four years until 1993 when she was confirmed to become the first woman, as well as the first African American, to serve as the U.S. Secretary of Energy.

Hazel Reid O'Leary had earned her bachelor's degree from Fisk University and law degree from Rutgers University. At the Energy Department she had been preceded by Donna Fitzpatrick, who became the first female Undersecretary in 1988, and Linda Stuntz, who became the first Deputy Secretary in 1992.

Chapter Six

Glass Ceiling Cracks in the Nineties and Two Thousands

The Early Nineties

In the previous chapter, the 1985-86 Electrical World Directory of Electric Utilities was used to check on the trends in women leading utilities in the mid-nineteen eighties. Here, the 1991 Electrical World Directory is used to identify over two dozen women in utility leadership during the early nineteen nineties.

Shirley Richard was the executive vice president for customer services, corporate relations, and marketing at Arizona Public Service. Richard wasn't alone there, as far as women in the company's leadership. Also at APS was Nancy Loftin, who served as the company's general counsel and corporate secretary.

There were a number of female general counsels, even as early as 1991. Like Loftin at APS, Leah Manning Stetzner was the general counsel of Illinois Power. Christine Hansen was the general counsel and corporate secretary of Louisville Gas and Electric. And Edwyna Anderson was the general counsel of Duquesne Light.

Duejean Garrett, discussed in the previous chapter, was now the senior vice president for rates and regulatory affairs of Public Service of Indiana. Garrett had been promoted from the position of general counsel, a position that Cheryl Foley now assumed there.

Regulatory affairs was also a function at utilities that was somewhat broadly accepted for women to lead. Similar to Garrett's role at Public Service of Indiana, Patricia Smith was the vice president for rates, purchasing, and regulatory affairs at South Carolina Electric and Gas.

Lynn Goldfarb was the vice president for marketing and energy management services of Central Maine Power. This appears to be an increase

in her responsibilities from the mid-nineteen eighties, according to the Electrical World Directory for that period.

Jane Kay was the vice president for administration of Detroit Edison. That's the same position that she had in the mid-nineteen eighties.

Joellyn Murphy was the vice president for regulatory and business policy of Public Service of New Mexico. In her case, as noted, this appears to be an increase in her responsibilities from the mid-nineteen eighties.

By the early nineties, Darlene Kerr was the vice president for system electric operations of Niagara Mohawk Power. Kerr had joined the utility back in 1973 and worked all the way up from a junior analyst. More on this remarkable woman's career in the next section of this book.

Kerr's company, Niagara Mohawk, was one of the very few utilities in the early nineteen nineties with two women in key officer roles. Aside from Kerr, there was Theresa Flaim. She was, somewhat uniquely for leaders in the utilities industry, an economist. In 1977, she had earned her doctorate in energy resource economics from Cornell University. Six years before that, she had earned her bachelor's degree in history from the University of Missouri at Columbia.

In the early nineteen nineties, Flaim was Niagara Mohawk Power's manager for gas rates and integrated resource planning. The company didn't keep Flaim in that spot for long. By 1993, she was promoted to be the vice president for strategic planning. She remained at that position for nine years. In 2002, she moved to a higher level of responsibility at the Tennessee Valley Authority. At TVA, Flaim served as the senior vice president for pricing and strategic planning.

There were also a number of women leading those utility functions focused on customer and public relations. Shelley Faigle was the vice president for marketing of PacifiCorp. Linda Curry Bartholomew was the vice president for public affairs of Pennsylvania Power and Light. Hazel O'Leary was the executive vice president for corporate relations of Northern States Power, as was mentioned in the previous chapter of this book. And Eva Tieg was the vice president for government affairs of Virginia Electric and Power.

Nancy Noeske was the vice president for consumer relations of Wisconsin Electric Power, which was the same position that she held in the mid-eighties. Also there at Wisconsin Electric Power was LuAnn Killeen, who was the vice president for information services.

The prior chapter of this book highlighted the impressive career achievements of Kay Stepp. By the early nineteen nineties, Stepp had become the chief operating officer of Portland General Electric. Also there at PGE was

Peggy Fowler, who served as the company's vice president for power production. She was destined to go even further than this in her career.

Jackalyne Pfannenstiel received her bachelor's degree in economics from Clark University and her master's degree in economics as well from the University of Hartford. Before joining Pacific Gas and Electric in 1980, at age thirty-three, she worked as an economist at the utility regulatory commissions of Connecticut and then California. After seven years at PG&E, she was made the vice president for strategic planning. And after thirteen years in that position, she left the company, to become a consultant at first and then joining the California Energy Commission, becoming its Chair in 2006.

We've previously said a little about the illustrious career of Duejean Garrett. Her story is both extraordinary and ordinary for the period in which she lived. In a Fort Worth, Texas high school, in the nineteen fifties, Garrett had taken secretarial courses expecting to work as a secretary. But then, while still a teenager, she met a female lawyer who made a big impression.

Garrett was inspired to put herself through the University of Texas at Arlington. She did the same at the University of Texas at Austin law school, though she completed her law studies at Indiana University.

Garrett was frequently told that she had no future in law. Judges wouldn't accept a female attorney in their courts. Yet she was able to become an Indiana Deputy Attorney General and successfully argued cases before the Indiana Supreme Court and Circuit Court of Appeals.

She then joined Public Service of Indiana as its first female lawyer. After a few years she rose to become chief legal counsel and a vice president. And later rose again to become vice president for marketing.

Breakthroughs Elsewhere

It would be remiss to talk only of women in utility headquarters offices as opposed to in the field. Susan Blaser became a journeyman line worker with Kansas City Power and Light in 1992. Never before in the state of Missouri had a woman worked as a lineman.

Blaser had started as a meter reader for KCP&L and then in 1989 qualified to be an apprentice in line work. After ten years in the field she began training apprentices. She's now, at the time this book was being written, the lead instructor at a community college electric utility line technician program and encourages women to consider the profession. Women make up under ten percent of linemen. But Blaser's daughter is helping to change that. Her



**Jackalyne Pfannenstiel,
First in California**

daughter is a lineman for Ameren (as are her husband and her son), and earned a hundred thousand dollars in her first year.

Blaser's road wasn't always easy. She recalls that some of the old guys gave her grief. One in particular slipped a sexist letter into her personnel file, saying that she should instead be home cooking brownies and taking care of her kids. Since that time, men in the profession have become more accepting, but she

advises her female trainees: have a good attitude, roll with the punches, and don't take comments and jokes personally.

There were many breakthroughs for women in the nineteen nineties. In the middle of the nineties, in 1995, physicist Shirley Ann Jackson was appointed as chair of Nuclear Regulatory Commission, where she served in that role for four years. Before the decade was done, Jackson retired from the NRC to become president of Rensselaer Polytechnic Institute. That made her the first African American woman to head a top-ranked research university.

The Late Nineties

Look through the 1998 edition of the Electrical World Directory of Electric Power Producers. McGraw-Hill had tweaked the title of the Directory to reflect the industry's deregulation that was underway. In the 1998 edition, one can find a growing number of women that were having outstanding careers in utility leadership.

From the western U.S., there's Nancy Loftin, the chief legal counsel at Arizona Public Service, who had held this same position in the early nineteen nineties. There's Jackalyne Pfannenstiel, the vice president for corporate planning at Pacific Gas and Electric, who also held this same position in the early nineties.

And there's Patricia Smith, who was the general counsel of Public Service of Colorado. Jeanie Sell Latz held a similar position, chief legal officer, at Kansas City Power and Light.

At Commonwealth Edison, Pam Strobel was the general counsel. At Com Ed as well was Linda Manning, serving as the vice president for transmission systems. Also in Illinois, Leah Manning Stetzner was the general counsel of Illinova, the parent of Illinois Power. This was the same position that she held in the early nineties.

Strobel had been in private legal practice for sixteen years. But in 1993, she became the general counsel of Unicom and its principal utility subsidiary, Commonwealth Edison. This was the first time Com Ed had appointed a female officer of the company. Five years later, her responsibilities were considerably expanded when she was named an executive vice president. Two years after that, she played a key role in the merger with PECO Energy, forming Exelon.

She earned her bachelor's degree from the University of Illinois, where she also earned her law degree. Strobel was perhaps destined to go into law

as her grandfather had been the chief justice of Illinois' Supreme Court. Her grandmother was also extremely accomplished. She was the first woman to receive a bachelor's degree in physics from the University of Illinois and then she earned her master's degree in physics from U of I. And in 1919, her grandmother actually went to work for Commonwealth Edison.

An increasing number of women were rising at the utilities along the financial track. There's Dilek Samil, for example, who in the late nineties was the treasurer of Florida Power and Light. Samil later rose to become the vice president for finance at FP&L, then the chief operating officer at NV Energy. By 2004, she had moved to Cleco Power, where she started as its chief financial officer and then was its chief operating officer, starting in 2005, serving in that role for five years. Before beginning her career, Samil had earned her bachelor's degree from the City College of New York, and her master's degree in business administration from the University of Florida.

In the late nineties, Connie Lau was a treasurer as well, in her case of Hawaiian Electric Industries. Lau would go on to become the company's CEO. More on her later in this book. And there's Barbara Graham, who was the chief financial officer of Delmarva Power and Light.

In Indiana, Madeleine Ludlow was the chief financial officer of Cinergy. She was particularly well-prepared for this responsibility. She had earned her bachelor's degree from the University of Virginia in 1975 and three years later, her master's degree in business administration from there as well.

After a dozen years in the financial industry, she came to Public Service Enterprise Group in 1992 as its vice president for enterprise corporate development and treasurer. After five years of doing that, Ludlow moved to Cinergy. She was at first the president of its energy commodities business unit and then its chief financial officer until 2000.

Cheryl Foley was also in top management at Cinergy. In the early nineties, Foley was the general counsel there, which was the same position she held in the early nineties.

Barbara Barsky was the vice president for corporate strategies at Public Service of New Mexico. More on Barsky later in this book.

New York, New York

Consolidated Edison somewhat uniquely had two women in key spots within its senior ranks. There was Joan Freilich, serving as the chief financial officer. And there was Mary Jane McCartney, serving as senior vice president

for gas operations. Though in a mid-nineties list of Con Ed's officers thirty-four of them were male and two, Freilich and McCartney, were female.

Freilich is discussed below. As for McCartney, she led the extensive natural gas operations of her company from 1993, at age forty-four, to 2009. She had started at Con Ed just thirteen years before, in 1980, as the director for fuel oil supply. Soon she was promoted to be the assistant vice president for environmental affairs, then to be the vice president for Queens customer service, and then to be the vice president for gas supply. In every case, she was the first female to fill that position.

Prior to joining Con Ed, McCartney received her bachelor's degree in mathematics from Fordham University in 1969, then she did graduate studies in math and computer science at New York University. And she worked at Royal Dutch Shell in trading and analysis jobs over the course of eleven years.

Niagara Mohawk Power also had two women in key spots within its senior ranks. There was Theresa Flaim, serving as the vice president for corporate planning. And then there was Darlene Kerr, also at Niagara Mohawk. Kerr had one of the most extraordinary careers during this period for a woman leading utilities.

By the late nineteen nineties, Kerr's career had progressed to one of the utility's most critical leadership spots. She was serving at that point as the senior vice president for electric operations and customer service. This had been for her a promotion from the early nineties, as noted in the previous chapter, when she was the vice president for system electric operations.

By 2002, when her utility merged with another, Kerr had risen to be the president and chief operating officer. She was named chief operating officer in 1998. The title of president was added two years later in 2000. Following the merger, within the merged company she became a senior vice president of National Grid USA and headed National Grid USA Service Company for a year.

Kerr earned her bachelor's degree in mathematics and behavioral sciences from the State University of New York at Potsdam in 1973 and her master's degree in business administration from Syracuse University in 1984. She joined Niagara Mohawk right out of college as a junior analyst at the company. From there, she was promoted to be a systems analyst in engineering computer applications, and then to the supervisor for data administration, management systems and services, and then to budget coordinator, and then to strategic technical planning specialist, and then to the manager for corporate performance services. Now in management, she was then promoted to be the general manager for system electric operations, and then to an officer position as the vice president for system electric operations by the early nineties.

The promotions kept coming. In the nineteen nineties, she was promoted to be the vice president for gas marketing, account management and rates, and then to be the senior vice president for electric operations and customer service, and then to be the executive vice president for energy delivery, and then to be executive vice president and chief operating officer by the late nineties.

In the late nineteen nineties, Peggy Fowler was the senior vice president for energy services at Portland General Electric. Fowler would go on to become the company's CEO as discussed later in this book. Also in the Pacific Northwest, in the late nineties, Nancy Racicot was the senior vice president and general manager for energy delivery at Washington Water Power.

In Wisconsin, Kristine Krause was the vice president for fossil operations at Wisconsin Electric Power. Barbara Swan was the general counsel of Wisconsin Power and Light.

Let us turn now to another remarkable career of firsts. Joan Freilich had joined the central customer service department of Consolidated Edison, the electric utility for New York City and surrounding counties, and the natural gas utility for part of the City, back in 1978. From that point, Con Ed kept promoting her, to manager of accounting research and procedures, to general manager of resource planning and control in 1986, to vice president of corporate planning in 1990, to vice president and controller in 1992, and to chief accounting officer in 1994. In her eighteenth year at the company, in July of 1996, she was made chief financial officer. It appears this was a first, a woman as the CFO of a major utility in the U.S.

Freilich was added to the Board of Directors in April of the next year. The promotion to CFO wasn't her last. In 2005, after nine years as CFO, her position was again raised to Vice Chair of the company.

Freilich had earned her bachelor's degree from Barnard College. And her master's, doctorate (in French literature actually) and then another master's, this time in business administration, from Columbia University.

With her doctorate, Freilich started as a teacher and in college administration. With doubts that was what she wanted to do forever, as she recalls, Freilich entered an executives program at Columbia University. Which is where she encountered a woman in her class from Con Ed, notably one that held a senior position in the company's public affairs department. Con Ed was actually trying to hire capable women, which wasn't that usual for major corporations in the mid-nineteen seventies, and Freilich was invited to come in to talk about opportunities there.

She credits enlightened male leaders of Con Ed who recognized her contributions. There was CEO Chuck Luce when Freilich joined the company and there was Gene McGrath throughout her career there, who was the CEO from 1990 to 2006. McGrath would sometimes say to Freilich, that if he had a woman and a man applying for the same job, and they were equally-qualified, he would opt for the woman. Why? Because to McGrath, the woman would likely have worked harder to get to that level and recognition. And McGrath wanted the best people at Con Ed. His attitude was, if you're not hiring women, you're cutting out a slice of the very best. Which wasn't a common frame of mind for big company execs even in the nineteen nineties.

Freilich frequently advised young women and men to take risks and try different things in their careers. You never know where your opportunities will come from. At one critical point, she recalls, she took a position as controller after being in charge of corporate planning, which was almost a step down in the company's hierarchy. But she saw that the senior people on that side of the house weren't that far from retirement. The bet paid off for her career.

She also continued the tradition started by Joy Tannian, the first female General Counsel, of gathering up women at the company for group lunches. This was particularly important for women who were isolated in departments that were almost all-male such as at the power plants.

A few years ago at a Con Ed retirement party, a woman who was then an officer in environmental affairs approached Freilich. You don't know me, the younger woman said. But I just wanted to tell you, in the days when you were in the executive office, how important your role was to women in the company and how proud we were to have you in that position.

Twenty-First Century Women

The path that Mary Doswell took to utility leadership was a little different, as an economist. She first earned her bachelor's degree in physics at Mount Holyoke College in 1980, and then received her master's degree in materials engineering with a concentration in econometrics at MIT two years later, in 1982. That's when she started as an economist at Virginia Electric and Power, now known as Dominion Resources.

Five years later, Doswell was promoted to director for consumer research, and three years after that to director for demand side analysis, and five years after that to manager for energy efficiency. She was made an officer of the company in 2001, as vice president for billing and credit, and CEO of the

subsidiary Dominion Resources Services three years later in 2004. She was promoted to key senior vice president positions at the operating utility in 2007 and then in 2009.

Now let us turn to one of the utilities with the richest history of women in leadership, Public Service of New Mexico and its parent company PNM Resources. We've already noted the careers there of Joellyn Murphy, Phyllis Bourque, and Barbara Barsky. In the next chapter we highlight the career of its current CEO, Pat Vincent-Collawn.

If you look at the company's 2003 Annual Report, Barsky is still part of the leadership team. By then, she was the vice president for investor relations. But notably, Alice Cobb was the senior vice president for people services and development, Sarita Loehr was the vice president for operations and engineering, after a recent promotion from vice president for customer service and marketing, and Cindy McGill was the vice president for customer and market services.

Public power was changing as well in the nineteen nineties. Jan Schori joined Sacramento Municipal Utility District in 1979 straight out of law school. She rose to become SMUD's General Counsel and after five years in that job in 1994, she was named the general manager, in effect the CEO. When appointed, Schori was but forty years of age. She held that position for nearly fifteen years, retiring in 2009.

Her appointment to SMUD's leadership by the utility's board followed a national executive search. Though this is 1994 we're talking about here, the other finalist for the position was also a woman. While there weren't any other women in the senior ranks, a man on the board believed it was time to change that.

Schori thinks that her advancement was partly because she took every opportunity to join project teams on topics she often knew nothing about. That practice opened doors to new relationships and expertise. She advises young women and men as well, if you get those chances, say yes, and get that experience. Once in a while you'll fall on your face, which can be a little embarrassing. Most of the time, however, you will end up learning and making a contribution.

Chapter Seven

To the Top, and Where Women Go From Here

Degrees

Women have earned more bachelor's degrees in the United States than men each year ever since the 1981-1982 academic year. They have earned more master's degrees each year since 1986-1987. And they have earned more doctorates each year since 2005-2006.

Their relative numbers are now well over fifty percent. Women presently receive fifty-eight percent of all of the bachelor's degrees. They receive a truly remarkable sixty-one percent of all of the master's degrees. That means men now receive just thirty-nine percent of the master's degrees. And women receive fifty-four percent of all the doctorates.

This represents a huge increase particularly when measured against women's participation in postsecondary institutions in the first few decades of the twentieth century. For example, women received only thirty-four percent of the bachelor's degrees in the 1919-1920 academic year, about a hundred years ago. This percentage did steadily increase in the years leading up to the country's entry into World War Two. It was forty-one percent in 1939-1940, about eighty years ago.

But then women's participation fell sharply. It was as low as twenty-four percent in 1949-1950, after millions of men returned from military service and millions of women returned to the home.

Women's relative numbers did then inch up to thirty-five percent by 1959-1960. Which was roughly where this percentage had stood forty years earlier, in 1919-1920.

The number of women receiving bachelor's degrees rose from a hundred three thousand in 1949-1950 to a hundred thirty-eight thousand in

1959-1960, ten years later. This translates into a thirty-four percent increase during the decade of the fifties.

Then the number rocketed up to three hundred forty-one thousand in 1969-1970, ten more years later. This translates into an enormous one hundred and forty-seven percent increase during the decade of the sixties.

Then the number rose still further to four hundred fifty-six thousand in 1979-1980, ten more years later. This translates into another thirty-four percent increase during the decade of the seventies.

During the three decades altogether, the fifties, sixties, and seventies, the number of women receiving bachelor's degrees had risen by three hundred forty-three percent. This is a huge increase in both absolute and relative terms. The number of men receiving bachelor's degrees had risen by forty-five percent during those same three decades, a sizable growth, yes. But one that was far smaller than that for women.

Indeed, the number of women earning their bachelor's degrees is currently well over a million per year. Let's put this number into perspective. It's almost ten times as many as when John Kennedy was elected as President of the United States in 1960. And the number of women earning their master's degrees is presently over half a million per year. It's more than twenty times as many as in 1960.

The disparity in master's degrees, between men and women, is especially marked. About five hundred six thousand women are earning their master's degrees each and every year. While about three hundred twenty-seven thousand men are earning their master's degrees per year. That comes to three women getting their master's degrees for every two men doing so. The impact on workplace culture and roles is inevitable.

In 2019, women were forty-seven percent of the hundred forty-eight million employed in the U.S., though they were fifty-one percent of the population. This difference isn't surprising since fifty-seven percent of women participated in the labor force as compared to sixty-nine percent of men.

Women did hold fifty-two percent of management, professional, and related jobs in 2019. But they were just forty percent of management occupations and only twenty-nine percent of chief executives. Yet, women were fifty-three percent of financial managers and fifty-two percent of lawyers. These are, notably, two fields that often lead to leadership positions in the utilities industry.

In the 2017-2018 academic year, women received forty-two percent of the bachelor's degrees in mathematics and statistics and forty percent of the degrees in the physical sciences and science technologies. But they received just

twenty-one percent of degrees in engineering and engineering technologies and twenty percent of the degrees in computer and information sciences and support services. These STEM fields also lead to leadership positions in the utilities industry. Here the presence of women is significantly less.

Fortune 500 CEOs

The Fortune 500 list for 2020 broke a record for this annual reckoning of the largest U.S. corporations. Among the five hundred companies on the list were the greatest number of them in its history to have women at the helm.

Of the five hundred companies on the list, thirty-seven were led by women. That's seven percent. This may not seem to you like a particularly large proportion. Yet the percentage had never before reached even that.

Among these thirty-seven companies were two from the utilities industry. One of the two was Duke Energy, led by Lynn Good. She has been a regular on the list since 2014, for seven years straight. The second was CMS Energy, led by Patti Poppe. She has been on the list since 2017, for four years straight. Poppe has since left CMS Energy, but only to take the reins of another Fortune 500 company, PG&E.

Other women who have headed Fortune 500 utilities in recent years are Geisha Williams of PG&E, a predecessor of Poppe, and Debra Reed of Sempra Energy. Williams made the 2017 and 2018 lists. Reed made the 2012 through 2017 lists, for six years running.

Aside from Good, Poppe, Williams, and Reed, no other woman has ever been the CEO of a Fortune 500 utility. Good and Poppe remain in this exclusive club, and will no doubt show up again on the 2021 list. It will be the tenth consecutive year that the Fortune 500 has included a utility with a female CEO, ever since Reed broke the ice in 2012.

Good was named CEO of Duke Energy in July of 2013. She had joined a predecessor company, Cinergy, in 2002 as a senior vice president for accounting and finance. It was just three years later that she was made the CFO. When the company merged with Duke Energy the next year, Good became a senior vice president and the treasurer of the combined firm. And once again, after just three years she was made the CFO. Two years later, in 2011, the company grew even larger via merger, and two years later, Good was now the CEO.

Good had earned her bachelor's degree in systems analysis and accounting from Miami University in 1981. She began her career at Arthur Andersen

& Co. as an auditor and rose to supervise the audit of Cincinnati Gas and Electric and to partnership in 1992, at a point when there were still few women partners there.

She recalls that Arthur Andersen kept her on a steep learning curve with a fast pace, variety of experiences, and range of industries from which Good developed skills she's drawn upon throughout her career. And she recalls that the firm's demise from the Enron scandals was quite a detour, but adds that detours happen in every career, and these teach the importance of resilience, adjusting, and adapting with optimism and urgency.

When asked if there were times throughout her career when others were apparently underestimating her, Good replies that her answer wasn't to dwell on this but to work that much harder. As for now, she believes it's an extraordinary time to be in the utilities industry and that female leaders can flourish as leaders of change, bringing stakeholders together, listening to the voice of the customer, and embracing and engaging a diverse team to deliver solutions.

Good advises young women that success often takes a winding path and that three attributes are important, these being passion, resilience, and growth and development. On passion, you're going to be at your best if you are relentlessly curious about your work and your organization's purpose. With conviction, which will encourage you to take on bolder assignments and hard challenges that can stretch abilities and accelerate careers.

On resilience, every career will have detours and only you can control how to respond. Don't allow yourself to be afraid and give up. Instead, keep going to find the strength that will later serve you well. On growth and development, you never arrive. There is always something new to learn, a skill to be further developed, or a way to improve your leadership.

Fortune 1000 Firsts

Fortune began publishing a supplementary list twenty-five years ago. It includes the next five hundred largest companies, as well as the five hundred largest. On this broader list of a thousand companies, a utility with a female CEO appeared for the very first time in its 2005 edition. This was an absolute first, counting both the original Fortune 500, which had started as an annual feature in 1955, and the newer Fortune 1000 list, which started as an annual feature forty years later in 1995.

This first goes to Paula Rosput. She headed AGL Resources in 2005. Her company, which is now a part of Southern Company Gas, made the Fortune



1000 list only that one year. Notably, the current CEO of Southern Company Gas (a Southern Company subsidiary) is also a woman, Kim Greene.

It was actually much earlier that Rosput became the CEO of AGL Resources. Five years earlier, specifically, in August of 2000, she shattered the utilities industry's CEO glass ceiling, at the age of forty-four. And this was only a couple of years after her appointment as the chief operating officer of the company. Rosput did leave the utilities industry in 2007, following her great run at AGL, to become a CEO in the insurance industry.

As we've said in an earlier chapter, Joan Bok had technically and very temporarily cracked that glass ceiling a decade earlier. This was due however to the untimely death of the man who had been the CEO of her company, New England Electric System. And it was only months later that the CEO spot was filled by another man. Bok remained as the company's chair until 1998,

the same year that Rosput became AGL's chief operating officer and two years before she became its and the industry's first female CEO for good.

How did Rosput become the industry's first female CEO? Before AGL, she had been a CEO, but of a utility subsidiary, Duke Energy Power Services. Duke Energy happens to be the same company that Lynn Good has headed for the last seven years.

Previously, Rosput had been an officer at PG&E, a senior vice president of its Pacific Gas Transmission subsidiary. PG&E happens to be the same company that Patti Poppe now heads, and that Geisha Williams had headed. One wonders if it's more than a coincidence that Rosput had worked at Duke Energy and PG&E, the two large investor-owned utilities with particularly distinguished records of women in leadership over the last decade.

Rosput's academic training was not as an engineer or in a financial or business management field, which have traditionally been the most common paths for future utility chief executives. She instead received her bachelor's degree in economics from Wellesley College in 1978.

She credits her thesis advisor at Wellesley, a celebrated professor of economics there, Carolyn Shaw Bell, one of the first women in her field. The Bell Award has been given each year since 1998 by the American Economic Association to those who promote the success of women in economics. It was Bell who counseled Rosput to find a place she could rise. That's why Rosput chose an industry "where there were no women and I'd be unique."

Rosput has said that women have strong multi-tasking abilities, a breadth of understanding, and can touch every point with an inclusive style. At AGL Resources, she often broke tradition because of the "need to look outward, not inward."

Befitting the first female CEO in the utilities industries, Paula Rosput Reynolds was recently appointed, in September of 2020, to become the chair of National Grid. She will assume the company's chairmanship, of this international utility with extensive operations in both the U.S. and U.K., after a transition period.

Two years after Rosput made the Fortune 1000, a second female CEO showed up on this prestigious list. In 2007, Hawaiian Electric Industries (the parent of the utility Hawaiian Electric) was included in the Fortune 1000 and Connie Lau was noted as its CEO.

Lau had joined HEI in 1984, after having worked as a lawyer. She was promoted and promoted, to be the company's Treasurer in the late nineties, and ultimately was named as the company's chief exec in May of 2006. She is its CEO to this day, a fifteen-year span thus far.



Connie Lau, Hawaiian Electric Industries' CEO, fourth from the left.

Lau's academic training was also not as an engineer, but in law and business administration. She received her bachelor's degree in administrative sciences from Yale University, a law degree from the University of California three years later, and a master's degree in business administration from Stanford University twenty years hence. She had previously been the CEO of American Savings Bank, the banking subsidiary of Hawaiian Electric Industries.

The next year saw a third female CEO on the Fortune 1000 list. In 2008, Portland General Electric was included in the Fortune 1000 that one year and Peggy Fowler was noted as its CEO. There's much more to know about Fowler's story and her achievements.

Enron, the nineteen nineties energy giant that again proved the adage that the bigger they are, the harder they fall, had purchased Portland General Electric in 1997. The next year, Fowler was named PGE's chief operating officer. This was her position until April of 2000 when she was promoted to CEO. She was then forty-eight years old.

Now you might ask, if Fowler made CEO of her company in April of 2000 and Rosput made CEO of her company in August of 2000, four months later, why do we count Rosput as the industry's first female CEO? Good question. We accord Rosput this first because when they were named as their

company's CEO, Fowler's company was a subsidiary of a stock exchange-listed corporation, Enron, and Rospot's company was an independent stock exchange-listed corporation.

Enron infamously declared bankruptcy in December of 2001, commencing a period of turmoil for Portland General Electric. Finally, after nearly five years of legal wrangling, PGE freed itself of the bankrupt entity in 2006, to become an independent stock exchange-listed corporation. Fowler served as the newly-freed company's CEO until she retired in 2009.

She excelled in mathematics as a child and aspired to become a scientist, despite it being the nineteen fifties and despite her being legally blind in one eye. She received her bachelor's degrees in chemistry and mathematics from George Fox College in 1973 and then her master's degree from the University of Michigan and the University of Idaho.

She went to work for PGE a year after graduating George Fox College, at first as a chemist and soon after as the general manager for environmental and analytic services. Her career took a turn in the nineteen eighties when she became manager for customer services. She was the first woman to head that division of line repair crews, meter readers, and billing personnel. Fowler's career path accelerated from that point.

The next year saw a fourth female CEO on the list. In 2009, PNM Resources, the parent company of the utility Public Service of New Mexico, was included in the Fortune 1000 that one year, and Pat Vincent-Collawn was noted as its CEO. She is its CEO to this day.

Vincent-Collawn's academic training was also not as an engineer, but in business administration. She received her bachelor's degree in journalism and public relations from Drake University and her master's degree in business administration from Harvard University.

After business school, Vincent-Collawn worked at Quaker Oats and then at PwC as a consultant. This meant she was constantly traveling, and as she recalls, she was sometimes in California, Arizona, Chicago, and Detroit during a single week. So when a recruiter said a utility was looking for people with a marketing background, she said sure.

At that utility, Arizona Public Service, she came to love the utilities industry, because of what its reliable, affordable, and clean power means for our country. But there were frustrations too. She tells the story of a Friday when her team had committed to submit plans, and one of the team members said, around here, it's not what you actually deliver, it's what you sign up for that counts.



Pat Vincent-Collawn, PNM Resources' CEO.

She later became the president of the Public Service of Colorado subsidiary of Xcel Energy. Notably, the current president of that subsidiary, which is now called Xcel Energy – Colorado, is also a woman, Alice Jackson.

Vincent-Collawn subsequently rose to the top position at PNM Resources, but she hasn't stopped asking herself from time to time, did I learn anything over the last year? And is the money shareholders are putting into the company a wise investment for them?

Vincent-Collawn doesn't recall issues about her being female in a male dominated industry. Though she did encounter prejudice about her having a journalism degree in an engineer dominated industry. But she figured, one of the best things about being a journalist is that you learn to ask questions.

Her big break came from Wayne Brunetti, who rose through the ranks of Florida Power and Light, and then went to Public Service of Colorado (which begat New Century Energies, which begat Xcel Energy), to become its CEO. Brunetti offered Vincent-Collawn the opportunity to run transmission and

distribution across all of Xcel Energy. She had been running marketing and customer service, but this seemed like a big leap, to lead a large workforce of engineers and operational personnel. So she replied, Wayne, I'm not an engineer. Then Brunetti said, but you know how to ask questions, you know how to manage processes, and how to lead, so you'll be fine.

What advice does she dispense to young women starting out their careers in the utilities industry? Get operational experience. Get into non-traditional roles. Every utility is looking for females for roles in ops. If you're a woman or a minority, the opportunities for you are really boundless. And also, understand how the company makes money.

Vincent-Collawn observes that utility leaders need to compromise more than in the past, and women are generally good at that. And of course, she adds, some men are good at that too.

Firsts in Two Thousand Tens

Patricia Kampling of Alliant Energy became the fifth female CEO in the utilities industry, debuting on the Fortune 1000 list of 2012. You could say that Kampling tied with the aforementioned Debra Reed, who first appeared on that year's Fortune 500 list.

Then, in the next year, 2013, Kim Harris of Puget Energy joined the Fortune 1000 list. And then, in the following year, 2014, so did Susan Story of American Water Works.

Kampling joined Alliant Energy in 2005 as its vice president of finance. Four years later she was made the chief financial officer, and two years after that, the chief operating officer, and in the next year, the CEO. She was previously with Exelon, where she started her career as an engineer, and ultimately became the treasurer of Commonwealth Edison (a predecessor company), and then chief financial officer for Exelon Enterprises.

Kampling had received her bachelor's degrees in both economics and engineering from Swarthmore College. Then she received her master's degree in business administration from the University of Chicago in 1991. And she is a registered professional engineer, whereas the female CEOs who reached the top position before her were not.

That year when Kampling rose to chief financial officer, 2009, was a momentous one for the entire economy. That was the year when the financial crisis peaked. It was also when at least four women became the CFOs of their utilities. Aside from Kampling, Lynn Good became the CFO of Duke



Maria Pope, Portland General Electric's CEO

Energy, Maria Pope became the CFO of Portland General Electric, and Caroline Dorsa became the CFO of PSEG. Kampling, Good, and Pope later became their company's CEO.

Next comes Susan Story. She became CEO of the largest investor-owned water utility in the U.S., American Water Works, in 2014 and served in that role into 2020. Story had been the company's chief financial officer, following that typical career path for utility chief executives though for little more than a year. Previously, she had been at Southern Company, eventually becoming the CEO of its Southern Company Generation and Energy subsidiary.

Like Kampling, Story's academic training was as an engineer. She received her bachelor's degree in industrial engineering from Auburn University, and she earned her master's degree in business administration from the University of Alabama at Birmingham.

Now comes Maria Pope, a relatively recently appointed Fortune 1000 utility CEO. Pope started out by graduating from Georgetown University in 1987 with her bachelor's degree and from Stanford University five years later with her master's degree in business administration. She then worked in banking, natural resources, and high tech with increasingly senior financial and operating responsibilities. Pope served as chief financial officer for three

publicly-traded companies, including a software company for a couple of years before coming to the utilities industry in 2009.

She then started at Portland General Electric as its CFO and after four years moved to the key position of senior vice president for power supply, operations, and resource strategy. After five more years, in 2018, she was promoted to CEO.

Pope views her leadership experience overseeing operating divisions as invaluable in her career, enabling her to understand the business dynamics and drivers for growth and to identify key risks and opportunities. While she's mostly worked in male dominated industries, and found herself frequently as the only female in the room, she always felt accepted and valued for her capabilities and contributions. Pope has also seen firsthand the transformation of both corporate culture and our society and believes all of us are benefiting from the increase in diverse voices.

She advises young people to really think about their passions and where they want to have an impact. And to follow those passions to become experts but also to broaden, to understand the overall goals of their organizations, and look around the corner to what's next.

Keeping Score

Altogether, at the time of this book's writing, women have held the position of a Fortune 1000 utility CEO in thirteen cases. They are Paula Rosput, Connie Lau, Peggy Fowler, Pat Vincent-Collawn, Patricia Kampling, Debra Reed, Kim Harris, Susan Story, Lynn Good, Geisha Williams, Patti Poppe, Maria Pope, and Mary Kipp. Of these thirteen, as we've said, four have held the position of a Fortune 500 utility CEO, namely Reed, Good, Williams, and Poppe.

Five of the most recent Fortune 1000 list's utilities have female CEOs. Duke Energy, a hundred twenty-three on the list, is headed by Lynn Good. PG&E, a hundred eighty-nine on the list, is headed by Patti Poppe. Puget Energy, seven hundred ten on the list, is headed by Mary Kipp. Hawaiian Electric Industries, eight hundred ten on the list, is headed by Connie Lau. And Portland General Electric, nine hundred sixty-one on the list, is headed by Maria Pope.

Overall there are thirty-three Fortune 1000 utilities. So, five of thirty-three of the Fortune 1000 utility CEOs are women, or fifteen percent.

How does this percentage compare with other industries? In 2020, of the nine hundred sixty-seven Fortune 1000 companies that aren't utilities, sixty of them have female CEOs. That comes to six percent. The utilities sector at fifteen percent for female CEOs has therefore a considerably greater percentage.

The company led by Suzanne Sitherwood, Spire, didn't quite make it onto the Fortune 1000 list. Though it is the fifth largest investor-owned natural gas utility. Like Paula Rospot, Sitherwood was earlier a senior exec at AGL Resources. Like Susan Story, her career developed at an earlier stage at Southern Company. Sitherwood earned her bachelor's degree in industrial engineering technology from Southern College of Technology and master's degree in business administration from Brenau University.

Women COOs and CFOs

They're not utility CEOs. But Lisa Barton, Diane Leopold, and Bridget Reidy are presently the chief operating officers of their large investor-owned utilities, American Electric Power, Dominion Energy, and Exelon, respectively. This is likely the first time in history that women have the COO responsibility in as many as three of our largest utilities. Plus, a fourth woman should be mentioned in this group. Kim Hanemann is the COO of the very sizable electric and natural gas utility subsidiary of PSEG.

And there is an unprecedented number of women that are C-officers of the largest utilities. For instance, there are now female chief financial officers throughout the utilities industry.

Among the largest investor-owned electric utilities, Rebecca Kujawa is the CFO of NextEra Energy, Julie Sloat is the CFO of American Electric Power, and Maria Rigatti is the CFO of Edison International.

Among other fairly large investor-owned electrics, Xia Liu is the CFO of WEC Energy Group, Peggy Smyth is the CFO of National Grid US, and Kristie Colvin is the CFO of CenterPoint Energy. And Tayne Sekimura is the CFO of Hawaiian Electric, the principal utility of Hawaiian Electric Industries.

Among smaller investor-owned electrics, Crystal Lail is the CFO of NorthWestern Energy, Megan Mattern is the CFO of UGI Energy Services, and Jocelyn Perry is the CFO of Fortis. And Gretchen Holloway is the CFO of Fortis' subsidiary ITC Holdings.

And among other investor-owned utilities, Susan Hardwick is the CFO of American Water, Beth Cooper is the CFO of Chesapeake Utilities, and Mia DeMontigny is the CFO of Southern California Gas. That adds up to at least fifteen women in the CFO slot in the utilities industry. Let's take a closer look at this important development.

Of 2020's Fortune 500 companies, ninety of them had female chief financial officers. That works out to eighteen percent. This was a record high. And it can and should be expected to increase in future years.

However, it has been observed by several of those who monitor the trends in women in leadership that CFOs quite infrequently become CEOs. So the increasing numbers of female CFOs may not necessarily lead to increasing numbers of female CEOs.

This observation, however, doesn't necessarily apply to the utilities industry. Why? At utilities, CFOs actually do commonly become CEOs. This shouldn't seem surprising. Utilities are, in effect, companies that can efficiently attract and apply capital to the development and maintenance of critical infrastructure. So the increasing numbers of female CFOs at utilities is an especially meaningful trend for anyone predicting the potential for more female CEOs at utilities.

The General Counsel Route

The Minority Corporate Counsel Association published a survey of General Counsels of Fortune 1000 companies in 2013. On that list in the top 500 companies were eight female GCs, namely Julie Janson of Duke Energy, Leila Vespoli of FirstEnergy, Carter Reid of Dominion Energy, Elizabeth Moore of Consolidated Edison, Martha Wyrsh of Sempra Energy, Monica M. Gaudiosi of UGI, Stacey Doré of Energy Future Holdings (now the CEO of Sharyland Utilities, a Sempra Energy subsidiary), and Carrie Hightman of NiSource.

On that list in the 501 to 1000 companies were six more female GCs, namely Susan Martin of WEC Energy Group, Jodi Caro of Integrys Energy Group (now a part of WEC Energy Group), Mariellen Dugan of New Jersey Resources, Heather Humphrey of Great Plains Energy, Leslie Thornton of WGL Holdings (now a part of AltaGas), and Karen Haller of Southwest Gas.

There were thirty-nine Fortune 1000 utilities in 2013. And as listed above, fourteen of these thirty-nine companies had a female GC. That comes to thirty-six percent, which is a fairly strong proportion of the total.

Of the fourteen, in the eight years since this survey a couple of these females GCs have advanced in their careers. For instance, Julie Janson is now president of Duke Energy's large utility subsidiary in the Carolinas, as well as executive vice president for external affairs. Carter Reid is now executive vice president and chief of staff of Dominion Energy and president of its subsidiary Dominion Energy Services. Carrie Hightman remains GC at NiSource. Though a greater number of them have retired from the industry, such as Leila Vespoli, Elizabeth Moore, Martha Wyrsh, and Susan Martin. With the exception of Janson and Reid, none have approached C-officer level in their companies.

An example of today's general counsel is Chonda Nwamu, who is now the GC at Ameren. She had joined Ameren Services in 2016 as its deputy general counsel, was promoted to senior vice president three years later, and eight months after that to the top legal role at Ameren.

Nwamu earned her bachelor's degree in English at the University of Virginia in 1992 and her law degree from the University of Pennsylvania in 1995. She went into private practice and then to Pacific Gas and Electric, where she worked for sixteen years ultimately rising to become a managing counsel for her last two years there.

Another African American woman serving as a general counsel in the utilities industry is Andrianne Payson, who has been the GC at SUEZ North America since 2017. The company is one of the largest water utilities in the U.S.

Payson earned her bachelor's degree in public accounting from the City University of New York in 1993 and her law degree from Cornell University in 2000. She is a certified public accountant and was an auditor of utilities while working for a large accountancy for four years before attending law school. Later she was a partner of a major law firm and co-chair of its energy-power sector.

Two other general counsels serving the utilities industry at present are Margaret Thickens, the chief legal officer at ALLETE, where Bethany Owen is the CEO, and Natalie Hocken, the GC at Berkshire Hathaway Energy. Both of them graduated from law school in the same year, 1994.

Thickens joined her utility in 2008 as an attorney. She was soon after promoted to be a senior attorney, and by 2010 was named general counsel for a division of the company. Six years later Thickens was made the company's director of compliance, and three years after that, in 2019, she was made the company's chief legal officer as earlier noted. She received her law degree from the University of Minnesota in 1994.

Hocken joined one of the utilities of the Berkshire Hathaway Energy family in 2002, PacifiCorp. Five years later, she became the general counsel of a PacifiCorp operating utility, Pacific Power. Five more years and she became PacifiCorp's senior vice president for transmission. Three years after that, in 2015, was when she was promoted to be the GC for all of Berkshire Hathaway Energy. Hocken received her bachelor's degree from the University of Washington in 1991 and her law degree from the University of Oregon in 1994.

Among the largest investor-owned electric utilities, Tamara Linde is the GC of PSEG, Gayle Littleton is the GC of Exelon, Wendy Stark is the GC of PPL (succeeding Joanne Raphael), JoAnn Chavez is the GC of DTE Energy, Deneen Donnley is the GC of Consolidated Edison, Jennifer Hasbrouck is the GC of Southern California Edison, and Amanda Rome is the GC of Xcel Energy. Also, Carrie Hightman is the GC of NiSource. And Heather Humphrey is the GC of Evergy.

Peggy Kelsey is the GC of WEC Energy Group. Erin Kippen is the GC of Hawaiian Electric, as earlier noted, the principal utility of Hawaiian Electric Industries. So both the CFO and the GC at WEC Energy Group and Hawaiian Electric are women. And at Hawaiian Electric, the CEO of the parent company is a woman as well.

Leading Utilities Not Quite Fortune 1000

While their utilities aren't quite as large as those discussed above, and aren't large enough to be included in the Fortune 1000, one should note that there are other investor-owned electric utilities with female CEOs. Bethany Owen leads ALLETE. Lisa Grow leads IDACORP and its utility subsidiary Idaho Power. They are both the chief execs of independent stock exchange-listed corporations.

Owen was the equivalent of her company's GC previously. She has a bachelor's degree in international studies from Vanderbilt University and a law degree from the University of Minnesota.

After graduating Vanderbilt, Owen used all the money she had saved from a temp job and moved to Washington, D.C., living in a boarding house there, and hitting the pavement for work. She recalls the dorm-like facility charged her two hundred dollars per week including food. Before long, despite having zero connections, she landed a receptionist job for a U.S. Senator. Though he was defeated in a reelection bid three months later, her foot was now in the door.



Bethany Owen, ALLETE's CEO

After four more years, she had gone through law school and then afterward joined a law firm. With seven years under her belt there and in corporate law departments, including in the up and down telecom industry, she joined ALLETE as a senior attorney, drawn to its integrity and stability.

Owen never expected to end up in senior management let alone as the CEO. But in seven years she was a director and in another two years she was president of Superior Water, Light and Power, a utility subsidiary of the company. She found leadership to be a joy, helping employees see things in themselves they didn't before, and:

... clearing the brush out in front of really talented people and empowering them to be the best they can.

Owen points out that ALLETE has been a good environment for female employees for some time now. For instance, the company's board of directors

consists of five men including her predecessor and six women including her. And women hold and have held senior positions for many years. As far back as the first years of this century, Claudia Scott Welty was chief administrative officer and Laura Holquist was president of ALLETE Properties.

As for advice she freely dispenses to ambitious women at an early stage of their career, when they say their goal is to be in a senior role, she always asks why. Because in her view it has to be about other people, and to be the kind of person that others want to work with.

Next comes Grow. She became IDACORP's CEO in June of 2020. Grow was her company's chief operating officer previously, appointed to that position in 2017, after thirty years at the company. She had joined immediately after receiving her bachelor's degree in electrical engineering from the University of Idaho, in 1987. Twenty-one years later, she earned her master's degree in business administration from Boise State University, though she was undoubtedly quite busy working as the vice president for delivery engineering and operations.

Grow tells a story of how her career path was pointed out by a junior high school guidance counselor. Walking down a school hallway, the guidance counselor pulled her aside and asked, hey Lisa, what do you want to be when you grow up? She remembers thinking, I don't know. The guidance counselor then changed the course of her life, by saying, you know, Lisa, you are really good at math and science and you should think about engineering because as a woman, you can work in any industry you want in anywhere in the world and can make really good money. Recalling that conversation, Grow says she cannot overstate that kind of encouragement.

She does get asked all the time, how was she able to climb all the way to the top of her company? She attributes her success to curiosity and tenacity. Traits that were so important since she was only the second female engineer ever hired by the company, the first being Colleen Ramsey. And she credits supportive men, who would encourage her but sometimes give her hard-to-hear advice, such as, steamrolling people to get the job done wasn't going to work in her favor over the long-term.

Grow likes to say that, in the drive for a more diverse workforce, equity is about giving each person what they need and not giving everybody the same. For young women, she urges them to embrace challenge, to be tenacious, and to not be afraid to fail.

The next women highlighted here don't head stock exchange-listed corporations. But Linda Apsey is the CEO of ITC Holdings, Kelcey Brown is the CEO of MidAmerican Energy, and Caroline Winn is the CEO of San Diego



Gas and Electric. There's also Stephanie Raymond, who is the president of PPL Electric, Kelly Tomblin is the CEO of El Paso Electric, Mari McClure, the CEO of Green Mountain Power, Stacey Doré, the CEO of Sharyland Utilities, and Nancy Tower, the CEO of Tampa Electric. Let's take a closer look at the careers of Apsey, Brown and Winn.

Apsey earned both her bachelor's degree in public affairs management and master's degrees in business administration from Michigan State University. After joining Detroit Edison, now DTE Energy, Apsey rose to become the utility's manager for regulatory relations. Within DTE, in 2003, ITC was formed as a subsidiary and then divested to become the nation's first independent transmission company. Apsey transitioned from ITC's manager of transmission policy and business planning to vice president of business strategy at the new company. She rose there too, to chief business officer and eventually to CEO.

Four of the five most senior officers of ITC are women. Aside from Apsey, Gretchen Holloway is the chief financial officer. Christine Mason Soneral is the general counsel. Krista Tanner is the chief business unit officer.

Apsey says that while women can be more sensitive and take things personally, she encourages them to not do so, to not apologize, but to stand their ground. Every time a woman apologizes, Apsey says, it diminishes her stature and strength in the organization. Instead, demonstrate initiative, put up your hand, take the lead, don't be shy, and find ways to add incremental value or an incremental perspective.

Continuing with utilities in the midwest, Berkshire Hathaway Energy is a subsidiary of the stock exchange-listed corporation Berkshire Hathaway, founded by the legendary investor Warren Buffet. It has several large utilities operating under its wing including MidAmerican Energy. And who is CEO of that midwest utility but Kelcey Brown. She assumed that responsibility in January of 2021, at the age of forty-five. Brown's path is a remarkable story as well.

Ten years earlier, in 2011, Brown joined Berkshire Energy's northwest utility, PacifiCorp, having previously been a senior economist at the Oregon Public Utility Commission. She worked her way up at PacifiCorp in regulatory, commercial, and operational roles and eventually as the company's vice president for energy supply management.

Brown received her bachelor's degree in regulatory economics from the University of Wyoming. Notably, she served in the U.S. Navy for five years, mostly on board the aircraft carrier USS Nimitz.

Now to the west coast, San Diego Gas and Electric is a subsidiary of the stock exchange-listed corporation Sempra Energy. Its CEO as of August of 2020 is Caroline Winn.

Winn received her bachelor's degree in electrical engineering from California State University at Sacramento. She joined SDG&E in 1986 as an associate engineer. After a series of promotions, by 2007 she was the director for transmission and distribution asset management and smart grid, by 2009 the director for supply management, and by 2010 a vice president and chief customer privacy officer, transforming the utility's customer services organization while there. Five years later, she was promoted to be the chief energy delivery officer. A year and a half after that, in 2017, she was promoted to be the chief operating officer.

Then there's Lisa Krueger. Her title is not CEO, but she is president of AES US, which includes two major utilities, Indianapolis Power and Light and Dayton Power and Light. Earlier in her career, she served as CEO of

a merchant power generation company and held senior roles at First Solar, Dynegy, and Illinois Power. Krueger earned her bachelor's degree in chemical engineering from Missouri University of Science and Technology and her master's degree in business administration from Rice University.

Women Leading Public Power

The number of women leading public power utilities is actually higher, as a percentage, than among the investor-owned utilities. Presently, of the twenty-seven public power utilities in the Large Public Power Council, six of them have a female CEO. That comes to twenty-two percent.

In Ohio, American Municipal Power is led by Jolene Thompson, who was named its CEO in 2020, the first female to lead AMP in its history. Thompson has now been at AMP for thirty-one years, starting out in corporate communications in 1990. Thompson's bachelor's degree was in journalism, earned in 1988 from Otterbein University. Before being named the CEO, she served as the executive vice president of member services and external affairs.

Thompson's dad was an electrical engineer for over forty years in the distribution division of Dayton Power and Light (now a part of AES). Her mom was a telephone operator for Ohio Bell. Thompson jokes that the utility world is in her blood.

Finding herself at a utility with engineers all around her, she was fortunate to have a behind-the-scenes assist. If somebody was talking about a three-phase line, and she didn't know much about it, she'd phone up dad. Her dad's discussions about his work in the industry, at the dinner table when she was growing up, hadn't grabbed her attention then. But now she wanted to know everything from him. They literally drove around the lines he'd engineered and talked through the technicalities of electric distribution.

Early in her career, she was often the only woman and one of the youngest in the room at work. Occasionally, her coworkers would express their surprise at her understanding of the industry. Thompson not only listened attentively to her dad, to learn, but also to those same coworkers.

What does she say to young people looking for advice?

Work hard. Show up. Do the homework. Listen and learn from people who've been around for a while. You can pick up a lot by just listening and asking questions.

She worked her way up by representing AMP at Ohio's state house, again listening intently and learning the technicalities of utility regulation, tax, environmental and other policy, with the utility's general counsel as a mentor.

Thompson has been a member of the American Public Power Association board for nearly six years and currently serves as the chair of the board. During which time the CEOs of the organization have been two women, Sue Kelly and Joy Ditto. AMP similarly has women throughout its leadership. While Thompson is the CEO, Pamala Sullivan is the chief operating officer, Rachel Gerrick and Lisa McAlister are the general counsels, and Marcy Steckman is the chief financial officer.

Sue Kelly served as the CEO of the American Public Power Association, the first female in that position, from 2014 to 2019. Her successor is also a woman, Joy Ditto. There are about two thousand public power utilities, located in all of the states except Hawaii. Kelly points out that the member utilities generally have a lot of women in their workforce, most of whom work in traditional fields such as customer service, finance, accounting, legal, and public relations. The question is, to her, how do we expand the number of women who work in what have been male-dominated fields and ensure women and other underrepresented groups can advance into senior management?

Kelly graduated from law school in 1980 and joined a large corporate firm. There she first encountered energy law and liked it. But she left that firm after only a few years. It did have a number of women associates, but just one woman partner. She realized that the number of billable hours required of partners and senior associates seeking partnership was a hurdle to women who wanted to have both a family life and meaningful career there.

During Kelly's first year at the firm, a local law periodical's gossip column reported that the firm had instituted a rule. Its associates must bill nineteen hundred hours per year. The article added that some associates were upset and called the firm a sweatshop. All of the associates that next day found sweatbands in their office mail boxes.

A few months later, a partner admonished Kelly for her relatively low number of billable hours. But, Kelly responded, she was indeed on track to bill nineteen hundred hours that year. To which the partner made it clear that nineteen hundred hours was actually the floor and to advance, associates must bill at a faster pace.

After she moved to a smaller law firm, practicing energy law and doing administrative litigation before the Federal Energy Regulatory Commission, she often found herself the sole female in work environments. But in the nineteen nineties, that began to change. She was now in the company of more

women energy lawyers. And eventually, she was able to work with women counterparts at the utilities she represented.

Kelly has this advice for women in the utilities industry. Don't let the perfect be the enemy of the good. (She used to berate herself if she wasn't able to bring cupcakes to her daughter's school, even though she was in private law practice representing many clients.) You can try to be perfect both in the workplace and at home, she says, but that last five percent required to reach perfection takes a heavy toll. Rather, if you work hard, try your best and you're talented, your very good will likely be good enough.

There are a number of great examples of women in leadership roles within the industry's public power sector. Vera Claussen was a Grant County Public Utility District commissioner from 1982 to 2006. Claussen was Washington State's second female PUD commissioner. Jean Ludwick, who served as a Chelan County PUD commissioner from 1978 to 1990, was the first. And she also served as the president of the APPA.

Marcie Edwards had been utility general manager and then the overall city manager of the City of Anaheim, California from 2001 to 2014. The far larger public power utility, the Los Angeles Department of Water and Power, hired her away from Anaheim in 2014. She served as general manager of LADWP for two and a half years in the mid-two thousand tens.

So this is a good point to note a recent development at LADWP. Specifically concerning its board of water and power commissioners, essentially the utility's board of directors and its regulatory body wrapped as one. The board, at the time of this book's writing, consists of Mia Lehrer, Susana Reyes, Jill Banks Barad, Nicole Neeman Brady, and its chair, Cynthia McClain-Hill. Indeed, all five are women, so it's uniquely an all-female board.

Next comes Texas. In the Lone Star State, Austin Energy is led by Jackie Sargent. And CPS Energy is led by Paula Gold-Williams.

Gold-Williams joined CPS Energy, San Antonio's electric utility, in 2004 as its controller and assistant treasurer. After two years, she was promoted to its chief administrative officer. A year and a half later, she was promoted to serve as its chief financial officer. She kept taking on more responsibilities until, in 2015, she was appointed as its CEO.

Her bachelor's degree in business administration was from St. Mary's University, awarded in 1984. After college, she worked as an accountant and in finance. Her master's degree in business administration was from Regis University, awarded in 2006, while she was CPS Energy's controller.

The CEO before Gold-Williams had told her, you don't want this job, it's too hard. Because of the pressure. Another time he said, I realize now that



Paula Gold-Williams, CPS Energy's CEO

you're going to just do the job differently. You need to embrace it, he added, and find what you're passionate about.

As an African American woman, she surprised some people she met on Wall Street while serving as her utility's CFO. So it's important to her to respect everyone no matter their "pedigree." She also doesn't believe in striving for perfection, for those that do aren't continuing to learn.

When mentoring young people, she advises, when somebody taps you on the shoulder, for a new opportunity, give it a shot. Say yes. Some women and men too might obsess about the uncertainties around the assignment. But it'll make you a go-to person.

Gold-Williams actually wasn't the first woman to lead CPS Energy. Before her, Jamie Rochelle was its CEO.

Rochelle had started as a computer programmer way back in 1969. Over the course of nearly thirty years, she rose to become the CEO in 1999. She served in this position though 2002.



Debra Smith, Seattle City Light's CEO

After Texas comes Washington State. There, Clark Public Utilities is led by Lena Wittler, Seattle City Light is led by Debra Smith, and Tacoma Public Utilities is led by Jackie Flowers.

Smith earned her bachelor's degree in finance from Arizona State University in 1981. After a variety of financial jobs and while raising her three children, as she tells it, a "bus stop mom" suggested a part-time job share at Eugene Water and Electric Board. The opportunity had opened up then, in 1996, because a senior staff accountant there was going to have her first child. Smith ended up staying at EWEB for seventeen and a half years and serving during the last year as the utility's assistant general manager, the number two position.

When the top job opened up, Smith naturally applied. In the end, she was only the runner-up to become the next CEO because, she was told, she lacked operational experience. Which taught her going forward to develop close relationships with the engineering and operational leaders on her teams and rely on their advice.

At which point she moved over to nearby Central Lincoln Peoples Utility District as its general manager, that is, its CEO. It was now 2013 and Smith

had her first CEO job, albeit at a small public power utility. After nearly five and a half years at Central Lincoln, she moved over to the much larger Seattle City Light as its general manager, that is, again, its CEO.

At Seattle City Light, Smith has created a group, which she calls People Leaders, of the two hundred and fifty or so employees who supervise someone. The group focuses on developing leadership skills, and using best practice management skills to lead.

Smith believes that, while authentic leadership isn't gender-based, women often do lead with more nurturing. She mentors young women and men to be yourself, that everyone else is taken. And to challenge the status quo but respectfully. And, most of all, to deliver value to your utility which after all provides an essential service to the public, even by taking lateral assignments.

Women Leading Co-op Power Too

The third class of electric utilities in the U.S. are rural electric cooperatives, most of which are relatively small. However, if the membership on the board of directors of the National Rural Electric Cooperative Association is any indication of women leading cooperative utilities, of the forty-eight directors at present, three of them are women (Ingrid Kessler of Lane Electric Cooperative, Meera Kohler of Alaska Village Electric Cooperative, and Carolyn Turner of Nevada Rural Electric Cooperative).

There are other inspiring exceptions, of course, such as Jessica Matlock, who became the first female CEO of La Plata Electric Association in 2019. Matlock grew up on a Colorado horse farm and went on to receive her bachelor's degree in chemical oceanography from the University of Washington and master's degree in public administration from Portland State University. She began her career in the industry at Bonneville Power Administration and after three plus years went to Snohomish County Public Utility District No. 1, where she was ultimately promoted to assistant general manager.

Before Matlock, there was Barb Nick. Nick served as the CEO of Dairyland Electric Cooperative from 2014 to 2020. She was earlier at Wisconsin Public Service and Integrys (now WEC Energy Group) and rose to leadership roles. She served as the president of Michigan Gas Utilities and Minnesota Energy Resources at Integrys from 2012 to 2014, and the president of Upper Peninsula Power at WPS from 2006 to 2012.

Nick had started at WPS back in 1981, while still in college, receiving her bachelor's degree from the University of Wisconsin at Green Bay two years

later while raising two children. Her high school counselor had told her back in 1976 that she could be a nurse, secretary, or teacher. She wanted to be none of these, instead aspiring to be in professions partially open to women such as a lawyer or college professor.

One of Nick's first assignments was to write job and task descriptions at the Kewaunee nuclear power plant, a requirement of the Institute of Nuclear Power Operations (commonly referred to as INPO). When a machinist there told her how important it was to the region to keep the plant from tripping, that is, shutting down unexpectedly, she was sold on the utilities industry and making a difference in it.

Shortly after, she was promoted to division accountant, with forty-two employees, at the age of twenty-eight. She was probably the company's first woman with that title and one of the few female supervisors in any of the departments. One exception being Diane Ford, a vice president and the controller, who started at the company in 1975 right after receiving her bachelor's degree in accounting from the University of Wisconsin at Green Bay.

From that time Nick recalls the operations division manager, a former U.S. Army sergeant. He said to her:

One of these days we're going to need to have some women leaders around here. And by God, if we've got to do that, it might as well be you. And so you better learn about the damn business.

That's when the former sergeant put Nick on a two-year assignment as a district gas and electric supervisor. And when she joined the local Rotary, as he advised, one of two women there. Now in her early thirties, she was determined not to let him down. The gas and electric crews she now supervised were at first stunned and "maybe not so excited" but after two or three weeks became more welcoming of their female boss.

Nick's advice to young women early in their careers (and young men too)? Assimilate without compromising. That is, be yourself in a way that's authentic and also comfortable for others as well.

There have been other standouts, female CEOs, among the rural electric cooperatives. Three will be looked at here, Lisa Johnson, the CEO of Seminole Electric Cooperative, Patricia Richards, the CEO of Washington Electric Cooperative, and Rebecca Towne, the CEO of Vermont Electric Cooperative.

Johnson has led Seminole since 2013. Before that she was the chief operating officer of Old Dominion Electric Cooperative and earlier in her career she was a vice president of the power generation company Mirant and assistant

to the CEO of Southern Company. She received her bachelor's degree in mechanical engineering and materials science from Duke University in 1988.

Richards has led Washington Electric since 2013. Before that she was a consultant working with this utility and before that she was director of power supply and transmission at Vermont Public Power Supply Authority and also worked at Burlington Electric Department.

Towne has led VEC since 2018. Before that she was vice president for organizational strategy at Vermont Gas Systems for nearly four years and before that she was at Green Mountain Power for nearly a dozen years. She received her bachelor's degree in psychology from Swarthmore College and her master's degree in administration and management from St. Michael's College in 2004.

Remaining Hurdles Not Yet Cleared

In her 2017 Brown University speech, Janet Yellen attacks head-on one of the main impediments to further progress of women in leadership positions, whether in the utilities industries or anywhere else in the economy. Although women are well-represented in the professional schools of most fields, they remain poorly represented among corporate CEOs, law firm partners, and finance execs.

Yellen attributes this in large part to employers requiring, either explicitly or implicitly, long workweeks and then penalizing the taking of time off. She allows that this is frequently sensible from the perspective of the employer, so as to deepen client relationships or to most expeditiously complete a rush project.

But clearly this disadvantages women. It is they who, far more frequently than men, assume child and elder care and other household responsibilities.

What are the implications for the utilities industries? Certainly, the dedicated development of relationships with key people external to the organization as well as internally, and the relentless driving of projects to meet their deadlines, are imperatives at utilities as they are in other industries.

But many companies throughout the economy, not only utilities, are learning that there are real tradeoffs that must be considered. Attracting, retaining, and getting the most from the top talent can be a balancing act with legacy workstyles which reward the number of hours put into the job with pay and promotion.

This is a lesson that extends beyond attracting, retaining, and getting the most from the top female talent. Organizations of every type are increasingly understanding that if they tailor their approaches to the managing of their human resources to the humans within their workforce, a much more dynamic, motivated, and innovative work culture will result. And they are realizing that the top talent cuts across gender, race, ethnicity, personal preferences, etc.

This trend toward a more flexible workplace that accommodates individual differences seems like a perfectly American development. Those legacy workstyles celebrated uniformity and conformity, but those are traits of the old Soviet Union and not of the U.S. It is the diversity of America that is the petri dish for the most creative and inventive economy in history.

Some may fear the moving of the cheese. The world is a more competitive place than in the twentieth century. That seems so American too. The most talented and dedicated women and men, people of color and not, and native born and immigrant will rise to the top and lead our utilities to take new hills as we head to the middle of the twenty-first century.

References

Archives of Maryland, Biographical Series, “Edith Clarke (1883-1959),” March 9, 2006.

Belew, Ellie, “High Voltage Women, Breaking Barriers at Seattle City Light,” Red Letter Press, 2019.

Bix, Amy, “Girls Coming to Tech: A History of American Engineering Education for Women,” Iowa State University, January 2014.

Brittain, James E., “From Computer to Electrical Engineer: The Remarkable Career of Edith Clarke,” IEEE Transactions on Education, November 1985.

Catalyst, “Historical List of Women CEOs of the Fortune Lists: 1972-2020,” May 28, 2020.

Catalyst, “Women in STEM: the United States, 2017-2018,” 2020.

Clarke, Edith, “Circuit Analysis of A-C Power Systems, Volume I, Symmetrical and Related Components,” John Wiley & Sons, Inc., 1943.

Clarke, Edith, “Circuit Analysis of A-C Power Systems, Volume II,” John Wiley & Sons, Inc., 1950.

Clarke, Edith, W.C. Duesterhoeft, and Max W. Schulz, “Determination of Instantaneous Currents and Voltages by Means of Alpha, Beta, and Zero Components,” AIEE Transactions, 1951.

Clarke, Edith, “Steady-State Stability in Transmission Systems, Calculation by Means of Equivalent Circuits or Circle Diagrams,” Transactions of the American Institute of Electrical Engineers, February 1926.

Cobble, Dorothy Sue, “A Spontaneous Loss of Enthusiasm, Workplace Feminism and the Transformation of Women’s Service Jobs in the 1970s,” International Labor and Working-Class History, Cambridge University Press, Fall 1999.

Con Edison, “Con Edison Announces Executive Changes,” July 21, 2005.

Digest of Education Statistics, 2019 Tables and Figures, U.S. Department of Education, National Center for Education Statistics.

Dubois, Ellen Carol, “Suffrage, Women’s Long Battle for the Vote,” Simon & Schuster, 2020.

Edith Clarke Calculator, United States Patent Office, patented September 1, 1925.

Electric Reliability Council of Texas, "ERCOT Transmission Planning Overview," n.d.

Electrical World Directory of Electric Utilities, 1986-1987, 95th Edition, McGraw-Hill, 1986.

Electrical World Directory of Electric Utilities, 1991, 99th Edition, McGraw-Hill, 1990.

Electrical World Directory of Electric Power Producers, 1998, 106th Edition, McGraw-Hill, 1997.

Gaetano, Chris, "Number of Female Fortune 500 CFOs Reaches Record High," Next Gen, New York State Society of CPAs, October 7, 2020.

Garber, Megan, "When You Supervise a Woman: The 1940s Instructional Manual," The Atlantic, August 27, 2012.

Goldin, Claudia, "The Quiet Revolution That Transformed Women's Employment, Education, and Family," AEA Papers and Proceedings, May 2006.

Gilbert, Vedder M., "Maude Adams, Florence Fogler Are Only Women to Get Union Degrees," Concordensis, Union College, 1933.

Grier, David Alan, "When Computers Were Human," Princeton University Press, 2005.

Guilder, George, "Women in the Work Force," The Atlantic, September 1986.

Haw, Richard, "Engineering America, The Life and Times of John A. Roebling," Oxford University Press, 2020.

Hitchcock, Susan B., "Energy's Her Game – Inclusive Her Style, Paula G. Rosput, CEO, AGL Resources," AGE of SHEroes project, September 2000.

IEEE.org, "This Author's Publications: Edith Clarke."

IEEE History Center, History of Engineering and Technology website.

Kellner, Tomas, "Mother of Invention: This Barrier-Busting Electrical Engineer Joined Edison, Tesla in National Inventors," GE News, February 10, 2017.

Lamb, Vanessa Martins, "The 1950's and the 1960's and the American Woman: the Transition from the 'Housewife' to the Feminist," University of Toulon, June 2011.

Lazarick, Len, "Howard County Slavery: Born on the Fourth of July, It Wasn't Always a Free County," MarylandReporter.com, July 4, 2020.

Layne, Margaret E., Editor, "Women in Engineering, Pioneers and Trailblazers," ASCE Press, American Society of Civil Engineers, 2009.

Levins, Sandy, "The Electrifying Story of Engineer Edith Clarke," Wednesdays Women, July 1, 2020.

Light, Jennifer S., "When Computers Were Women," Technology and Culture, The Johns Hopkins University Press, July 1999.

Los Angeles Department of Water and Power, "Women Breaking Glass at LADWP, First Female Board President and V.P. Lead First All-Female Board," January 2021.

Lum, Lydia, "Diverse GCs Power Up," Diversity & The Bar, Minority Corporate Counsel Association, September/October 2013.

MacFerran, Mabel, "Parallel Operation of Transformers, Whose Ratios of Transformation are Unequal," AIEE Transactions, Transactions of the American Institute of Electrical Engineers, January 1930.

MacFerran, Mabel, and Alex A. Kroneberg, "Power Limits of 220-Kv Transmission Lines," Electrical Engineering, November 1933.

Mandic, Danilo P., Sithan Kanna, Yila Xia, Ahmad Moniri, *Adrià Junyent-Ferré*, and Anthony G. Constantinides, "A Data Analytics Perspective of Power Grid Analysis – Part 1: The Clarke and Related Transforms," IEEE Signal Processing Magazine, March 2019.

Maryland Commission for Women, Meeting Minutes, April 19, 2018.

McFadden, Christopher, "Edith Clarke: The First Female Electrical Engineer and Professor of Electrical Engineering," Interesting Engineering, March 25, 2018.

Miller, Marc, "Working Women and World War II," The New England Quarterly, March 1980.

Mohan, Pavithra, "Women CEOs May Be in Style – But What About the Rest of the C-Suite," Fast Company, February 15, 2019.

National Academy of Engineering, Engineer Girl website, "Trailblazers."

NBC Business News, "Women Gaining Among Utility Regulators," July 31, 2005.

New York Times, "A New Head for Oregon Utility," June 5, 1992.

New York Times, by Adelaide Handy, "Calculates Power Transmission for General Electric Company, Miss Edith Clarke Stands on a Plane With Men In Field of Electrical Engineering," October 27, 1940.

New York Times, by Susan Brownmiller, "Con Ed's Charles Luce All Power (Sometimes) To The People," April 12, 1970.

New York Times, "Woman Addresses Electrical Institute, Miss Edith Clarke the Only One of Her Sex to Read a Paper at Engineers' Meeting," February 9, 1926.

New York Times, "Woman Named to Lead New England Electric," May 23, 1984.

Oliver Wyman, "Making the Invisible Visible, What's Really Preventing Breakthrough Progress on Women in Leadership?" Women in Leadership Report 2021.

Public Service of New Mexico, Annual Report, 2003.

Scientific American, February 10, 1883.

Spectrum, Massachusetts Institute of Technology, "The Women of MIT," March 18, 2014.

The Atlantic, "Trouble With Women in the Workplace? This 1950s Film Is Here to Help," October 18, 2012.

The Daily Illini, University of Illinois, "Woman Engineer Directs Work, Mrs. Rockwell Heads Research Production," July 26, 1941.

The Ellicott City Bicentennial Journal, "The Civil War in Howard County," Summer-Fall 1972.

The Flathead Courier, "Achievement of Florence Fogler, Billings Girl is Elected to American Institute of Electrical Engineers" January 3, 1918.

Tympas, Aristotle, "Calculation and Computation in the Pre-electronic Era," Springer, 2017.

Tympas, Aristotle, "Perpetually Laborious: Computing Electric Power Transmission Before the Electronic Computer," International Review of Social History, Cambridge University Press, 2003.

University of Wisconsin-Green Bay, Inside, alumni article on Diane Ford, December 2007.

Waisman, Charlotte S., and Jill S. Tietjen, "Pioneering Engineers," Her Story: A Timeline of the Women Who Changed America, June 2013.

Washington Electric Co-op, "Richards Named New General Manager at Washington Electric Co-op," May 23, 2013.

Yellen, Janet L., "So We All Can Succeed: 125 Years of Women's Participation in the Economy," speech given at Brown University's "125 Years of Women at Brown Conference," May 5, 2017.

Yellen, Janet L., "The History of Women's Work and Wages and How It Has Created Success for Us All," The Brookings Gender Equality Series, May 2020.

Index

American Institute of Electrical Engineers, 11, 15, 23, 38
Apgar, Virginia, 9
Apsey, Linda, 86-88
Barsky, Barbara, 64, 68
Barth, Emma, 44
Bascom, Florence, 6
Baum, Elizabeth K., 49-50
Bell, Carolyn Shaw, 74
Bix, Amy, 44-45
Blackwell, Elizabeth, 8,
Blaser, Susan, 61-62
Blatch, Nora Stanton, 10
Bok, Joan Toland, 50-52, 54, 73
Boldebuck, Edith, 42
Bourque, Phyllis, 53-54, 68
Bragg Cummings, Elizabeth, 8
Brittain, James, 27, 36
Brooklyn Bridge, 8-9
Brown, Kelcey, 86-87, 88
Carson, Rachel, 9
Clarke, Edith, 1, 4-5, 10, 11, 13-21, 23-36
 AT&T, 27-28
 Briarley Hall, 23, 26
 Bush, Vannevar, 29
 Campbell, George Ashley, 27
 Clarke Calculator, 30-31, 34, 36
 Clarke Transformation (Transform), 19-20, 23
 Constantinople Women's College, 34
 Edith Clarke Substation, 18
 General Electric, 15, 17, 23, 29, 33-34
 Howard County, Maryland, 25
 Jackson, Dugald, 28-29
 Kennelly, Arthur Edwin, 28-29

Marshall College, 27
 Steinmetz, Charles Proteus, 28
 Smart grid, 23-24
 University of Texas at Austin, 18, 21-22
 University of Wisconsin, 10, 13, 27
 Vassar College, 10, 27
 Whist, 26
 Claussen, Vera, 91
 Curie, Marie, 5, 10
 Dixon, Sharon, 55
 Doré, Stacey, 82, 87
 Doswell, Mary, 67
 Edwards, Marcie, 91
 Electrical World Directory of Electric Utilities, 52-53, 56, 59-60, 63
 English, Troy Eller, 10
 Federal Energy Regulatory Commission, 47-48, 90
 Flaim, Theresa, 60, 65
 Fogler, Florence, 1, 11-12
 Foley, Cheryl, 59, 64
 Fortune, 71-76, 78-82, 84
 Fowler, Peggy, 58, 61, 66, 75-76, 80
 Freilich, Joan, 64-67
 Garrett, Duejean, 52, 54, 59, 61
 General Electric, 1, 11, 15, 17, 23, 29, 33-34
 Goeppert-Mayer, Maria, 9
 Gold-Williams, Paula, 91-92
 Goldfarb, Lynn, 55, 59
 Good, Lynn, 71-74, 78-80
 Green, Hetty, 8
 Grow, Lisa, 84, 87
 Harris, Kim, 78, 80
 Hightman, Carrie, 82-84
 Hocken, Natalie, 83-84
 Hollis, Sheila, 47
 Holloway, Gretchen, 81, 88
 Hoover Dam, 37
 Hopper, Grace, 9
 Humphrey, Heather, 82, 84
 Jackson, Shirley Ann, 63
 Janson, Julie, 82-83
 Johnson, Lisa, 95
 Kampling, Patricia, 78-80

Kay, Jane, 55, 60
Kellems, Vivien, 38-39
Kelly, Sue, 90-91
Kerr, Darlene, 60, 65
Koteich, Mohamad, 36
Krueger, Lisa, 88-89
Kyd, Margot, 54
Lamme Feicht, Bertha, 1, 6-7
Lau, Connie, 64, 74-75, 80
Layne, Margaret, 45
Leopold, Diane, 81
Light, Jennifer, 40
Loftin, Nancy, 59, 63
Ludlow, Madeleine, 64
Massachusetts Institute of Technology, 8, 11, 28-29, 37, 42-43, 67
Martin, Susan, 82-83
Matlock, Jessica, 94
McCartney, Mary Jane, 64-65
McClure, Mari, 87
Mead, Margaret, 9
Merrill, Winifred Edgerton, 6
Miller, Marc, 2
Munns, Diane, 48
Murphy, Joellyn, 52-54, 60, 68
Nelson, Sharon, 48
Nick, Barb, 94-95
Noeske, Nancy, 56, 60
Nwamu, Chonda, 83
O'Leary, Hazel Reid, 56-58, 60
Owen, Bethany, 83-85
Payson, Andrianne, 83
Perkins, Frances, 6
Pfannenstiel, Jackalyne, 61-63
Pfeiffer, Astrid, 54-55
Pope, Maria, 79-80
Poppe, Patti, 71, 74, 80
Reed, Debra, 71, 78, 80
Reid, Carter, 82-83
Reidy, Bridget, 81
Rensselaer Polytechnic Institute, 42, 46, 63
Richards, Ellen Swallow, 8
Richards, Patricia, 95-96

Rochelle, Jamie, 92
Rockwell, Mabel MacFerran, 1, 37-38
Roebeling, Emily Warren, 8-9
Roosevelt, Eleanor, 6
Rosput Reynolds, Paula, 72-76, 80-81
Samil, Dilek, 64
Sargent, Jackie, 91
Schori, Jan, 68
Scientific American, 25
Sitherwood, Suzanne, 81
Smith, Debra, 59, 63, 93-94
Society of Women Engineers, 10
Stanton, Elizabeth Cady, 10
Stepp, Ester Kay, 56-58, 60
Story, Susan, 78-81
Strobel, Pam, 63
Tannian, Joy, 52-54, 67
Telkes, Maria, 43
Thickens, Margaret, 83
Thompson, Jolene, 89-90
Towne, Rebecca, 95-96
Tympas, Aristotle, 16, 28, 32, 34
Vespoli, Leila, 82-83
Vincent-Collawn, Pat, 68, 76-78, 80
Walton, Mary Elizabeth, 8
Westinghouse, 1, 6-7, 16-17, 21, 44
Williams, Geisha, 71, 74, 80
Winn, Caroline, 86-88
World War Two, 2, 12, 21, 29, 37, 40-42, 44, 47, 69
Wyrsh, Martha, 82-83
Yellen, Janet, 13, 41, 46-47, 96

About the Author

Steve Mitnick is the executive editor of Public Utilities Fortnightly, the nearly hundred year old institution dedicated to serving as a platform for discussion about electric, natural gas, and water utility regulation and policy, in the public interest, and the principal owner of PUF's publisher, Lines Up, Inc., based in Arlington, Virginia. In this capacity, he writes, constantly actually, for PUF, the digital weekly This Half Fortnight and more recently books, as well as hosts and produces informative video programs for the industry.

Born in Brooklyn, New York in the summer of 1952, he came of age too late to mourn and resent the departure of the Dodgers but in time to embrace the Yankees of Mantle, Maris, Berra, and Ford. Prohibited from travelling to the Bronx, Yankee Stadium's borough, he attended scores of Mets games in the presumably safer borough of Queens, enabling him to see them transform from "can't anybody play this game" to their 1969 miracle. Now in Washington, D.C. he's come to love the Baby Shark song and the Nats as well.

Mitnick is an obsessive collector of artifacts and chronicler of utility history. Whether it's the strange journey of Reddy Kilowatt or the birth of the electricity industry in the late nineteenth century or the investor-owned versus public power fisticuffs of the nineteen thirties or the evolution of utility regulation throughout the twentieth century, Mitnick is researching and writing about the industry's stories seemingly without rest.

But most of all Mitnick is passionate about the people of the utilities industry, past, present, and future too. He loves highlighting and celebrating those that dedicate their careers to serving the public providing them with the essential elements of modern life safely, reliably, affordably, and cleanly.

