

ECE 528 – Understanding Power Quality

<https://webpages.uidaho.edu/ECE/power/ECE528/>

Paul Ortmann
portmann@uidaho.edu
208-316-1520 (voice)

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Today:

- The future of power and power quality
 - Observations and emerging trends and technologies
- Future jobs in power and power quality
 - Where the jobs will be
 - Skills to consider

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Electric Power industry – where we’re going:

Vertically-integrated (legacy) model

- Power company role: own and operate generation, transmission, and distribution
- Large Utility-operated generating stations
 - Some “base load”
 - Some “dispatchable”
 - No “storage” apart from saved fuels
- Radial distribution systems with unidirectional power flow
- Simple, autonomous, distribution protection (reclosers, fuses)
- Clear supplier/consumer roles

Emerging model

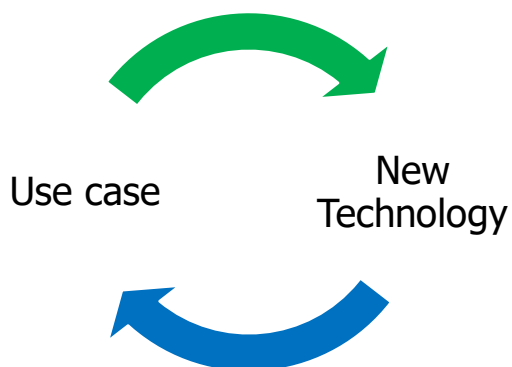
- Power company role: system integrator
- Widespread use of Distributed Resources
- Independently owned and operated DG/DR of all sizes
- Rapidly growing use of storage (batteries)
- Distribution systems have bi-directional power flow
- Complex, integrated distribution protection systems (relays with communications)
- Blended supplier/consumer roles

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Technology Cycle



- We develop technology to address a need.
- Once we have the new technology, we realize we can do other new things with it, but perhaps not perfectly.
- The technology is then refined based on the new use case.
- **This cycle will continue to create opportunities for engineers.**

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Some other predictions about power and energy

- More integration of heating/cooling for improved efficiency
 - Present model:
 - Refrigerators dump heat to living space and AC moves heat outdoors while water heaters consume (other) energy to heat water
 - Heating/cooling integration:
 - Move heat from refrigerators/freezers/spaces to water heating

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Energy storage

- Early use cases:
 - Store low-cost energy
 - Run off-grid or through outages
- Newer use cases:
 - Can make renewables (solar, wind) dispatchable
 - Flatten demand profile
 - Increase existing system capacity
 - Power quality – sag mitigation, etc.
 - Reduces need for multiple “fuels”

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Power System Data

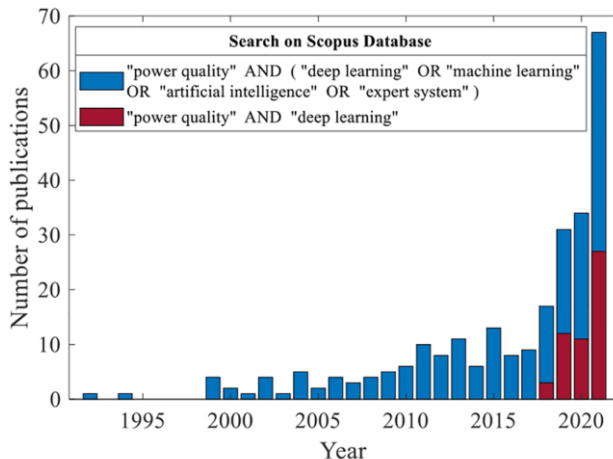
- Past:
 - Customer level:
 - most only had a single monthly kWh value
 - Distribution system:
 - Voltage, current, and basic power values on feeders at substations
- Now:
 - Customer level:
 - kWh, Voltage, etc. hourly or more frequently
 - Revenue meters can report interruptions and operators can “ping” meters to check for service.
 - Distribution system:
 - Voltage, current, events, waveforms, etc. from revenue meters or other monitors dispersed across the distribution system, delivered in near-real time.
- This trend is continuing...

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Artificial Intelligence in power and power quality



Some driving factors:

- Advancements in AI
- More data
- More processing power

Figure from:

Deep learning for power quality, by Roger Alves de Oliveira, Math H.J. Bolen, Published in *Electric Power Systems Research*, 17 October 2022

<https://doi.org/10.1016/j.epsr.2022.108887>

Fig. 2. The number of publications related to PQ and AI from 1992 to 2021.

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Some applications of Artificial Intelligence in power and power quality

- System operation
 - Fault location
 - Capacitor, regulator, tap-changer control for maximum efficiency
 - Dynamic system ratings using weather data and other data
- Power Quality/Reliability
 - Automatic event classification
 - Fault location
 - Pre-failure event identification (transients, etc.)
 - Autonomous patrol with UAVs

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Power Quality Jobs

- Where are the jobs?
 - Electric power companies
 - Manufacturers of power system equipment
 - Engineering research/consulting providers
- Side jobs
 - Teaching
 - Expert witness work
- Trends:
 - Increasing complexity and specialization
 - Increasing use of AI, data analytics

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Engineering work

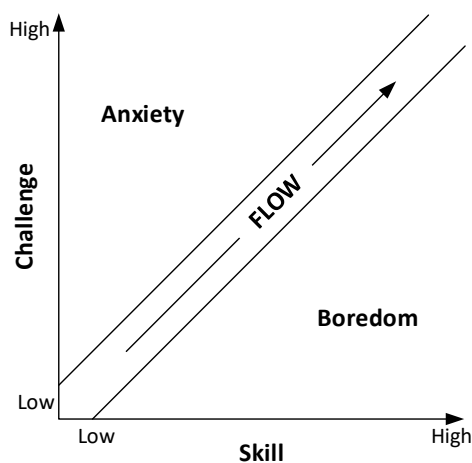
- Always do your best work, but if you do something well, you'll be asked to do it again, even if it's work you don't enjoy.
- It's up to you to find what you like and let others know.
- You'll spend much of your life at work. You can be paid well to do fun, challenging, stimulating work. Finding or creating those opportunities is worth the effort.
- A simple test: Do you lose track of time, or are you watching the clock?
 - Pay attention to the work you are doing when this happens

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"Flow" theory – from Mihaly Csikszentmihalyi



- Pay attention to how you respond to your work.
 - Are you anxious, bored, or in a "flow" state?
 - Are your skills and challenges growing together?
 - Are there clear goals and immediate feedback?
- Sometimes you may need more training.
- Sometimes you may need new challenges.
- Sometimes you may need to modify the work.
- It may be up to you to identify and address these issues.

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Some skills to consider

- More data and new technologies will create new needs in the Electric Power industry:
 - Data analytics
 - Coding
 - Artificial Intelligence expertise
- Skills in multiple domains will become more important:
 - electrical power engineering PLUS data analytics
 - Coding PLUS power quality

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Engineering Resumes/Interviews/Internships

(Your instructor reviews resumes and interviews candidates regularly)

- Overcoming the experience paradox
 - Use a skills-based resume
 - Academic experience counts
- Adjust resume and cover letter to the posting
- Proofread...
- Interviews
 - practice
 - “Interview” the employer too
- Internships
 - Provide valuable work experience
 - Can lead to a full-time job

<i>Technical Software Skills</i>	Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat.
<i>Programming Skills</i>	Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.
<i>Power System Analysis Skills</i>	Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat.

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Diversity of experience

- Focusing on a single specialty can be risky
- A broader base of experience may make it easier to move, and may make you more valuable to your employer
- Temporary or cross-training assignments may allow you to “test drive” different jobs within a company
- No temporary or cross-training opportunities? – Try job shadowing
- As skills grow, you can specialize, if

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Next time...

- Engineering
 - Responsibilities
 - Useful skills

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