Planning and Operating a System in Transition to IBR – Engineers Unite!

ESIG Webinar

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ELECTRANIX
SPECIALISTS IN POWER SYSTEM STUDIES

Note about us…

-40C to +40C

- Electranix is a Canadian independent consulting company focused on power systems modelling and simulation
- I am fortunate to be able to count as my customers:
  - Developers/GOs
  - OEMs
  - TOs/ISOs (mostly planning, sometimes operations, sometimes other groups)
  - Research entities
- I'm out of my wheelhouse here!!!

Warning!! Unfair caricatures to follow!!

Viewing renewable energy through whose eyes?

Your teenager, neighbors, environmental activists, school teachers, etc:

- "Climate change is happening, fossil fuel is the problem, renewables are the solution"
- **"We're moving too slow"**
- **"blah blah blah"**
- Turn off all the fossil fuels now!

Image credit: Great Plains Institute

Viewing renewable energy through whose eyes?

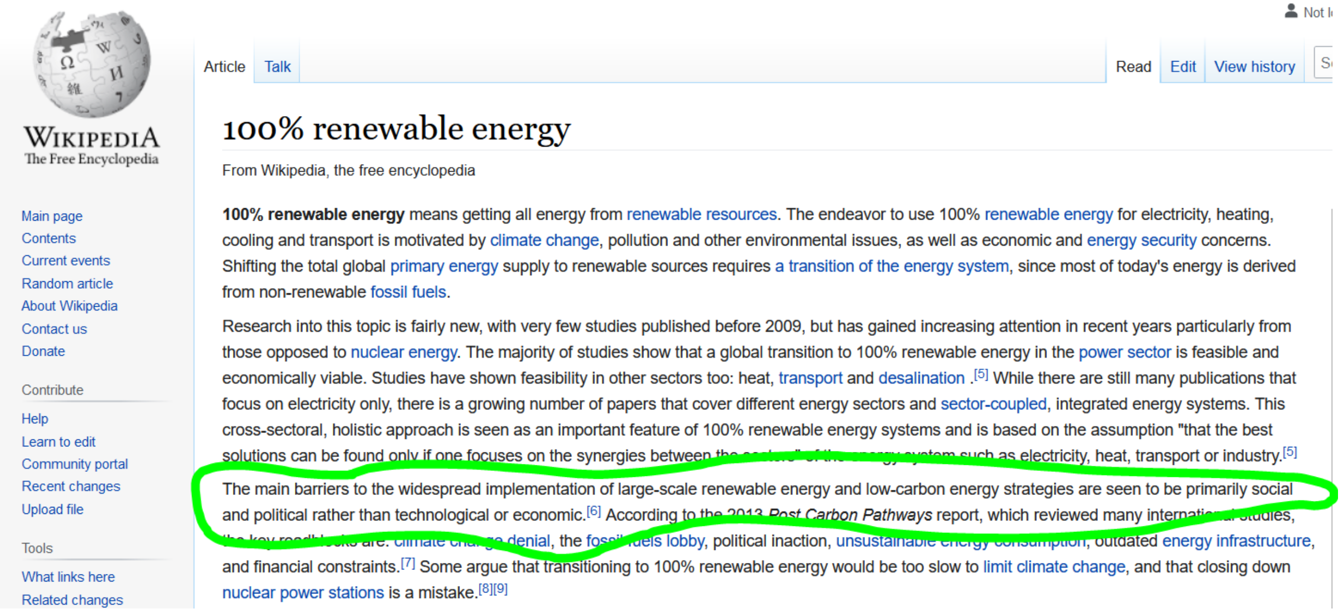
Commercial, political:

- "How can I profit or benefit from renewable energy?"

Viewing renewable energy through whose eyes?

Renewable Energy Policy Thinkers:

- 100% renewable is economic and feasible!
- “barriers are social, not technical”
- Hydro=solar=wind, etc
- The only problems are:
  - Climate change denial
  - Fossil fuels lobby
  - Old infrastructure
  - High energy consumption
  - Financial constraints



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100% renewable energy

From Wikipedia, the free encyclopedia

100% renewable energy means getting all energy from renewable resources. The endeavor to use 100% renewable energy for electricity, heating, cooling and transport is motivated by climate change, pollution and other environmental issues, as well as economic and energy security concerns. Shifting the total global primary energy supply to renewable sources requires a transition of the energy system, since most of today's energy is derived from non-renewable fossil fuels.

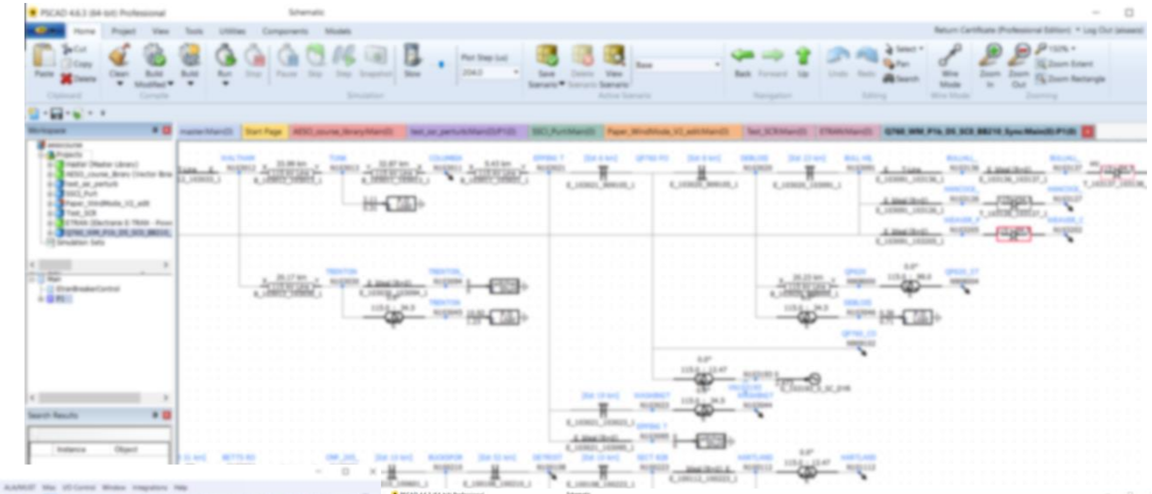
Research into this topic is fairly new, with very few studies published before 2009, but has gained increasing attention in recent years particularly from those opposed to nuclear energy. The majority of studies show that a global transition to 100% renewable energy in the power sector is feasible and economically viable. Studies have shown feasibility in other sectors too: heat, transport and desalination .[5] While there are still many publications that focus on electricity only, there is a growing number of papers that cover different energy sectors and sector-coupled, integrated energy systems. This cross-sectoral, holistic approach is seen as an important feature of 100% renewable energy systems and is based on the assumption "that the best solutions can be found only if one focuses on the synergies between the sectors" of the energy system such as electricity, heat, transport or industry.[5]

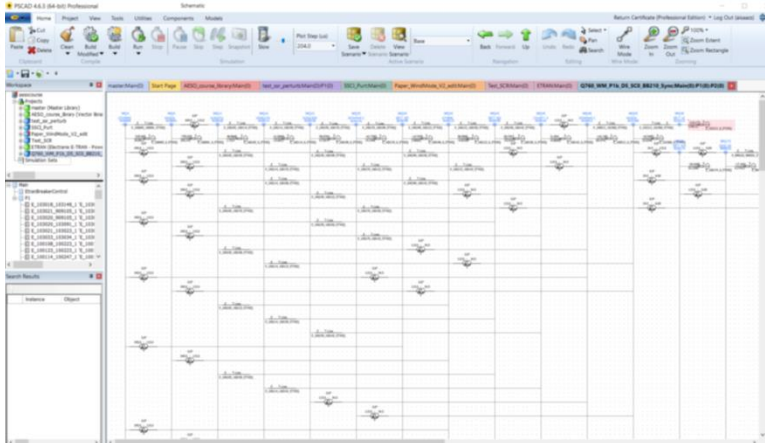
The main barriers to the widespread implementation of large-scale renewable energy and low-carbon energy strategies are seen to be primarily social and political rather than technological or economic.[6] According to the 2013 *Post Carbon Pathways* report, which reviewed many international studies, the key roadblocks are: climate change denial, the fossil fuels lobby, political inaction, unsustainable energy consumption, outdated energy infrastructure, and financial constraints.[7] Some argue that transitioning to 100% renewable energy would be too slow to limit climate change, and that closing down nuclear power stations is a mistake.[8][9]

Viewing renewable energy through whose eyes?

Power Systems Engineer:

- “Uh oh…”
- “um… inertia? Protection? Spin? Reliability?”
- “Technically feasible, maybe,
  but my study dept. is 3 people!”
- **“Will that work? Is it safe?”**
- **“Show me the Study!”**





Power System Engineer's perspective

- Our lens is ***usually invisible and irrelevant*** to outside, unless it delays political initiatives, or impacts the light switch functionality. If the political mandate isn't met, heads roll. If the power goes out, all the heads at the dinner table swing towards you!! (And heads roll!)
- It's okay, we are busy with our own problems. We have lots of groups and perspectives, and we also have a little trouble sometimes seeing the world through other internal lenses:

Operator vs. Planner

Researcher vs Researcher

Region vs. Region

TO vs GO

Distribution vs. Transmission

Subcultures: Consultants, Protection groups,
Research labs, OEMs, Academia, EPCs, software vendors, etc…

Issues in common as renewables increase:

- Declining inertia and increased generation variability
  - We know that conventional IBRs in isolation do not work. We suspect (and in some cases know) that 100% conventional IBRs also do not work, at least not the way we expect.
- Increasing system complexity and corresponding **study burden**
  - The combinations and permutations of generation and load is quickly rising, especially with the advent of IBRs, battery systems, and distributed energy.
- Demand for more accurate **models** and simulations
  - We can’t easily predict how generator or load resources will behave alone and together. Conventional and historical modelling approaches are likely to miss at least some reliability impacts.

Issues in common as renewables increase:

- Increased demand for expert **human resources**
  - Perpetual squeeze on technical staff… experts moving around
- Increased **speed** of interconnection
  - Renewables connecting faster than anyone guessed, and not fast enough!
- Increased **speed** of technology shift
  - IBR is high tech, and correspondingly has a very short product lifecycle
- Increased regulatory pressure
  - Etc. etc. etc.

Everyone is having trouble keeping up!

Example problems:

- Communication: Transmission planning study examining POW breakers showed a clear trade-off between "Voltage peak" (mitigates current zero miss) and "Voltage zero" (mitigates TOV), and recommended "voltage peak". Several weeks later, several 500kV breakers exploded due to a zero miss failure.
- Operators had never seen the study, closed on voltage zero, immediately opened again…   Debris field several hundred meters wide!

Example problems:

- TO is aware of NERC and other recommendations, and is worried about high renewable interconnection levels. (Good!)
- TO adopts new technology, new processes to try and address it. (Good!)
- TO retains old fashioned ideas (Bad!)
  - “us vs. them”
  - “we are the experts”
  - “renewables are a pain”
  - “100% reliability at all costs”
  - “rules are rules” (True but dangerous if you are making up the rules as you go!)
- Developers are stuck in a loop of trying submit projects, but face unfriendly, inflexible attitudes and are held rigidly to quickly changing rules that may be ill considered or non-sensical.
- Demoralizing and ineffective!!!!

Example problems:

- Manufacturers of equipment may refuse to release accurate models in an attempt to protect commercial advantage or IP. They release the minimum required and hold back key functions until pressed by either regulatory pressure or system event investigations.
- GOs sometimes deliberately "phone in" models to get across a milestone.
- Key functions are missing from the models, randomly parameterized, or models are missing altogether, ultimately resulting in inaccurate simulations, reliability risk, and further distrust by TO.
- (more innocent) good PPC model, good inverter model, no communication model. Literally insufficient communication.

Examples of collaboration:

- ATC engineers:
  - Facing huge clusters of renewables under MISO process.
  - Inventing EMT study and interconnection processes in the absence of industry standards
- Approach:
  - Weekly meetings between transmission planning, operations, and study consultants to review interconnection study progress
  - For interconnection projects with technical issues, make operations and planning engineers available to GOs for discussions (regular if needed).

Examples of collaboration:

- HECO engineers:
  - Facing 90-100% renewables in island systems.
  - Facing public pressure to retire synchronous machines and increase use of DER.
  - Facing uncertainty in protection systems
  - Facing high cost of fuel, inadequate models, human resource constraints
- Approach:
  - Form Technical Advisory Panel of industry experts
  - Involve protection, operation, distribution planning, and transmission planning engineers and management in regular technical update meetings
  - Procure cutting edge tech (GFM) but humbly accept that you may have to adjust your expectations and be flexible.
  - Make yourself available to interconnection customer teams to help with technical obstacles
  - Reach out to OEMs, research labs, and consultants directly for help with technical challenges
  - Invest in software and training
  - Communicate technical challenges to regulators

Examples of collaboration:

- Model and Software Mess:
  - Software vendors struggling to keep up with support for many different models
  - OEMs struggling to keep up accurate models for many different software vendors
  - Utilities struggling to adapt custom models into their processes
  - Research groups struggling to keep up with model accuracy in generic models as equipment is changing
- Approach: Collaboration between software vendors and model programmers to define a new standard .dll based interface (Cigre/IEEE joint standard). **This should be prioritized and adopted!!**

Examples of collaboration:

- Standards:
  - IEEE 2800 was an amazing confluence of interests
  - Massive scope, accomplished in a short time with many industry leaders participating across different groups
- ESIG:
  - Continues to look for ways to connect and educate disparate parts of industry
- NERC:
  - IRPS efforts have been instrumental in bringing people together and educating the industry.
- G-PST:
  - Six large system operators investing heavily in power systems engineering geared towards renewable transition

Specific Recommendation – Increase technical interface between groups

- Routine technical meetings between operations and planning groups. On the agenda could be:
  - (planning) Summary of new interconnections being studied
  - (planning) Key infrastructure assumptions
  - (planning and/or ops) Key study results from planning or operating
  - (ops) Report recent events in operation domain,
  - (planning and/or ops) Examine oscillography of key events
  - Concerns, request for advice, technical presentations

Specific Recommendation – Increase technical interface between groups

- Routine technical meetings between GO and TO groups. On the agenda could be:
  - Technical education points for GO
  - Updates on ongoing studies, tools, assumptions, and results
  - Look for avenues to allow GOs to help with technical issues
    - Note that GOs are quickly up-skilling (poaching? ☺) and are expected to have much higher level of technical mastery in coming years. **Opportunity!!?**

Specific Recommendation – Increase technical interface between groups

- Routine technical meetings between Transmission and Distribution planning groups. On the agenda could be:
  - Education regarding current concerns. Learn each other's language!
    - DER Voltage control (why, why not?)
    - DER Frequency response (how?)
    - DER Momentary cessation (why, why not?)
    - DER TOV tripping (why, why not?)
    - UFLS approaches
  - Planning assumptions going forward, modelling
  - Desired changes!

Specific Recommendation – Advisory Panels

- Form technical advisory panels to periodically review study scopes and assumptions and review study results. Members should be outside the direct technical circle… such as:
  - Engineers from neighbor utilities
  - Engineers from different departments within your utility (eg. Protection, resource planning, distribution planning)
  - Third party independent consultants
  - Research lab or academic representatives
  - GO/OEM technical experts
- Need to be accepting of uncomfortable questions!

What to do?!

- Garth Irwin: "Andrew, you can't solve all this stuff!"
- He is right. I can't personally change *any* of the complex systemic barriers that cause conflict and sticking points. (I know what trying to argue with an IT or legal dept. is like) My alternative is rather to appeal to engineers directly and personally.

General Recommendations!

- Patience, Kindness, Goodness, Gentleness
  - Engineering as a profession has an advantage here! Lean into it within our community!
  - Reject and resist sub-cultural enmity. We don't have time for that! Your mother told you not to talk badly about people behind their backs, we don't get a pass for groups of people!
- Humility
  - Each of our sub-cultural silos is missing information. *You and I are both definitely wrong about something. What is it?*
- Work to avoid "transferring liability".
  - Neighbors problems will eventually become our problems.
- Share your knowledge
  - Lessons learned, technical solutions, resist hoarding knowledge (it can be done even considering IP! There are good examples among OEMs and Consultants who have IP to protect!)
- Be brave and creative!
  - YOLO!! The industry is changing really quickly and many things are not going to be the same. We will need to try new technology, invent new processes and adapt. Make some mistakes!

What are your collaboration success stories?

Questions?

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