AGENDA, June 25/July 1 2024 HVDC-Learn PAB Meeting

1. List of PAB members, introductions
2. Project team
3. Project website
4. What we are asking of PAB members
5. Project overview
    - Objective
    - What is a module
    - Module groupings
    - Module list and completion schedule
    - Module development principles and process
    - Other project features
    - Project milestones
6. Next steps for PAB

List of PAB Members

Project board:

- 17 US industry organizations
- 3 European industry organizations
- 1 international organization

- 4 US community/vocational colleges
- 1 US university;
- 1 US vocational school;
- 4 European universities;

- 1 DEIA expert
- 1 envrnmntl justice advocacy grp

INDUSTRY

Hitachi Energy, Jiuping Pan
GE Vernova, Carl Barker
Nexans in Charleston, Gregory M. Smith
HVDC Centre Scotland, Simon Marshall. Ben Gomersall
Electric Power Research Institute (EPRI), Ram Adapa
Duke Energy
Dominion, Kevin Jones
Mitsubishi, David Roop Jr
Energy System Integration Group (ESIG), James Okullo
National Grid, Jim McGrath
Eversource, Oluwaseyi Olatujoye
Southern Company, Jason Autrey, Glenn Wilson
National Renewable Energy Lab (NREL), Ben Kropowski
ISONE, Xiaochuan Luo
WindGrid, Ervin Spahic. Dennis De Decker
Global Power System Transformation (G-PST) Mark O'Malley
New York Power Authority (NYPA), Bruce Fardenesh
Midcontinent Independent System Operator (MISO), Armando Figueroa
American Electric Power (AEP), Kamran Ali
PJM, Paul McGlynn, Kenneth S. Seiler
Southwest Power Pool (SPP), Antoine Lucas

EDUCATIONAL INSTITUTIONS

Bristol Community College, MA, Yashwant Sinha
Trident Technical Community College, Tom Fulford
Northern Virginia Community College, John Sound
Centura College, Joel English
Mid-Atlantic Maritime Academy, Raymond Blanchet
Farmingdale State College, Jeff Hung
KU Leuven, Dirk Van Hertem
Strathclyde, Lie Xu
KTH, Lina Bertling
Imperial College, London, Balarko Chaudhuri
Tufts University, Samantha Fried

DEIA & env justice

Salem Alliance for the Environment (SAFE) Betsy Frederick, Bonnie Bain

Project team

Power Systems

Hantao Cui, Assist. Prof., Oklahoma State
Xin Fang, Asst. Prof., Mississippi State
Eric Hines, Prof. of Practice, Tufts
Fran Li, Chaired Prof., U. Tenn.-Knox.
Per-Anders Lof, Lecturer, Tufts;
    Principal Engr, National Grid
James McCalley, Chaired Prof., Iowa State

Power Electronics

Leon Tolbert, Chaired Prof., U. Tenn-Knox.
Alex Stankovic, Chaired Prof., Tufts
Ali Mehrizi-Sani, Assoc. Prof., Virginia Tech
Johan Enslin, Chaired Prof., Clemson
Moazzam Nazir, Rsrch Scientist, Clemson

High Voltage Engineering

David Wallace, Asst. Clin. Prof. Miss. State

Logistical - Project Website (not module website)

home.engineering.iastate.edu/~jdm/hvdclearn/index.htm

Note: this website is for storing project logistical information (it is not where modules will reside).

Contains slides of all meetings (team, PAB, & Bridgeport)
Bookmark it.

Home Page for the
HVDC-LEARN project
3 year project (2024-2027)
Funded by the US Department of Energy
(Office of Energy Efficiency and Renewable Energy)

HVDC LEARN
Modules for Maturing HVDC Electric Transmission Knowledge

Project information;
- ►Short project description
- ►One slide summary
- ►Module WORD template
- ►Slide decks from project team meeting:
  - May 31, 2024: Project Slides
  - June18, 2024: DOE Slides, Project Slides
- ►Slides from Project Advisory Board Meetings:
  - June 25 & July 1, 2024: Slides
- ►Slides from Bridgeport Meetings:

What we are asking of PAB

1. Project oversight;
   - Assess project health; ask questions, suggest changes.
   - I will provide a list of project milestones
2. Abstract review: will provide module summary table & abstracts of all 35 modules; request to review abstracts; give feedback directly on them.
3. Full module review: 1-3 per yr per PAB member. Criteria to be given.
4. Module co-author (optional): we welcome this but do not require it. You will not be asked to review a module you co-author.

The US DOE EERE management team is highly interested in the extent to which PAB participates. We are too, because PAB participation will heavily enrich module content.

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HVDC-LEARN Project objective

HVDC-LEARN: Develop/deploy 35 modules to elevate community's awareness/understanding of HVDC domain & increase HVDC presence as a transmission solution, for both onshore and offshore applications.

- Extend/enrich HVDC expertise in electric energy community: engineering, regulatory, policy
- Enable *ongoing* resource development
- Reflect integrated academic & industry expertise

What is a module?

➔A "mini-textbook"

- Self-contained
- 5-30 pages
- Address an HVDC feature/issue
- Clear learning objectives
- Both on/offshore applications
- Targets
  - university engineering courses
  - industry-focused short courses
  - community colleges
  - Regulatory & policy groups
  - individual learning.

HVDC LEARN

Modules for Maturing HVDC Electric Transmission Knowledge

Module 7a
Point-to-Point HVDC Configurations

Primary Author: James D. McCalley, Iowa State University
Email Address: jdm@iastate.edu
Co-author:
Last Update: March 31, 2024

Prerequisite Competencies:
1. Motivating needs for high-capacity electric transmission
2. HVDC converter types and operations as found in Modules 1a, 1b, 1c.

Module Objectives:
1. Identify features of point-to-point HVDC transmission
2. Distinguish from multi-terminal HVDC systems.
3. Identify point-to-point applications and describe implementations of each

7a.1 Introduction

High voltage direct current (HVDC) transmission has seen applications since the early 1950s. The first such line for commercial purposes was installed in 1954 to interconnect the Swedish mainland 98 km (61 miles) to the island of Gotland in the Baltic Sea; a monopole design employing mercury-arc valves, its capacity was 20 MW at a voltage level of 100 kV [1]. The

■ ■ ■

Module grouping: 12 areas, 35 modules

(1) Introductory/Overview Coverage;
(2) Station components;
(3) Converters;
(4) Control;
(5) HVDC Protection;
(6) HVDC Line and Cable Technologies;
(7) Point-to-Point HVDC Configurations;
(8) Multi-Terminal HVDC Networks;
(9) Planning and Design;
(10) HVDC System Simulation and Analysis;
(11) Regulatory Permitting Processes/Procedures;
(12) Energy Equity and Environmental Justice.

3. CONVERTERS, Enslin				
3a	Nazir/ Enslin	Interoperability between different HVDC converter technologies/vendors	3	Q12
3b	Mehrizi-Sani/ Fang	Power electronics 101: Fundamentals of switching pwr conv+EMT	3	Q5
3c	Fang/ Tolbert	Operation of thyristors & IGBTs in converters	4	Q7
3d	Tolbert/ Fang	Modular multilevel converter as HVDC cnvrtr interface and its control	3	Q3

6. HVDC LINE & CABLE TECHNOLOGIES, Wallace				
6a	Wallace /Enslin	Insulation - HVDC cables	5	Q10
7. POINT-TO-POINT HVDC CONFIGURATIONS, McCalley				
7a	McCalley /Li	Onshore & offshore apps	2	Q3
8. MULTI-TERMINAL HVDC NETWORKS, Tolbert				
8a	Tolbert/ Cui	Design/operation of multiterminal HVDC grids	3	Q12
9. PLANNING AND DESIGN, McCalley				
9a	Lof/ Hines	HVDC in pwr sys.; meshed HVDC systems	3	Q7
9b	McCalley /Hines	Processes for planning & building offshore HVDC	3	Q2

MODULE COMPLETION SCHEDULE

Prjct team member	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
O1, H. Cui				Mod 2b				Mod 4c				Mod 10a
M1, X. Fang		Mod 1c					Mod 3c				Mod 10d	
C1, J. Enslin							Mod 5c					
T1, E. Hines					Mod 11a				Mod 1d		Mod 12a	
UT1, F. Li		Mod 1b						Mod 9e				
T2, P. Lof				Mod 1a				Mod 9a				
I1, J. McCalley		Mod 9b	Mod 7a			Mod 9c		Mod 9d		Mod 10b		Mod 11b
V1, A. Mehrizi-Sani			Mod 2a		Mod 3b			Mod 4b	Mod 5b		Mod 5e	Mod 10c
C2, M. Nazir				Mod 4d								Mod 3a
T3, A. Stankovic								Mod 10e				
UT2, L. Tolbert			Mod 3d			Mod 4a			Mod 5d			Mod 8a
M2, D. Wallace				Mod 5a						Mod 6a		

MODULE LIST

(yellow to be completed year 1; blue in year 2; white in year 3)

Mod #	Lead-auth /Lead-rvwr	Module title	# of 1-h lectures	Comp date
1. INTRODUCTORY/OVERVIEW COVERAGE, Li				
1a	T2/UT1	Intro to HVDC technology	3	Q4
1b	UT1/T2	Application Guide for HVDC Transmission	3	Q2
1c	M1/T1	Intro to HVDC for offshore wind	3	Q2
1d	T1/C1	HVDC for executives	2	Q9
2. STATION COMPONENTS, Cui				
2a	V1/O1	HVDC reactive power, EMI, and filter design	4	Q3
2b	O1/C1	VSC-HVDC converter station technologies	3	Q4
3. CONVERTERS, Enslin				
3a	C2/C1	Interoperability between different HVDC converter technologies/vendors	3	Q12
3b	V1/M1	Power electronics 101: Fundamentals of switching pwr conv+EMT	3	Q5
3c	M1/UT2	Operation of thyristors & IGBTs in converters	4	Q7
3d	UT2/M1	Modular multilevel converter as HVDC cnvrtr interface and its control	3	Q3
4. CONTROL, Mehrizi-Sani				
4a	UT2/O1	Cnvtr cntrl fundamentals	4	Q6
4b	V1/C2	Dynamic modeling/cntrl of HVDC converters and grid-forming functions	4	Q8
4c	O1/V1	Control of multiterminal HVDC networks	4	Q8
4d	C2/C1	Offshore HVDC cnvrtr grid forming controller design for black start capability	3	Q4
5. HVDC PROTECTION, Nazir				
5a	M2/UT2	HVDC fault management & protection systems	6	Q4
5b	V1/UT1	HVDC measurements, faults, and misoperation	3	Q9
5c	C1/C2	Protection for multi-terminal HVDC networks	3	Q7

Mod #	Lead-auth /Lead-rvwr	Module title	# of 1-h lectures	Comp date
5d	UT2/M2	Protection: ability to ride through faults in HVDC	3	Q9
5e	V1/UT1	Cybersecurity in HVDC systems	3	Q11
6. HVDC LINE & CABLE TECHNOLOGIES, Wallace				
6a	M2/C1	Insulation - HVDC cables	5	Q10
7. POINT-TO-POINT HVDC CONFIGURATIONS, McCalley				
7a	I1/UT1	Onshore & offshore apps	2	Q3
8. MULTI-TERMINAL HVDC NETWORKS, Tolbert				
8a	UT2/O1	Design/operation of multiterminal HVDC grids	3	Q12
9. PLANNING AND DESIGN, McCalley				
9a	T2/O1	HVDC in pwr sys.; meshed HVDC systems	3	Q8
9b	I1/T1	Processes for planning & building offshore HVDC	3	Q2
9c	I1/T1	Expansion planning for offshore HVDC, topology/ capacity design for HVDC interregional transmission	5	Q6
9d	I1/M1	Macrogrid & HVDC offshore networks	4	Q8
9f	UT1/T2	A long-term planning study of offshore HVDC	4	Q8
10. HVDC SYSTEM SIMULATION & ANALYSIS, Fang				
10a	O1/C2	Hardware-in-the-loop electromag transient sim	3	Q12
10b	I1/T3	Large-sys analysis of multiterminal HVDC grids	4	Q10
10c	V1/M1	Frequency-dependent representation of AC syst	4	Q12
10d	M1/O1	Modeling of HVDC grids	6	Q11
10e	T3/I1	Reactive power & harmonics	6	Q8
11. REGULATORY/PERMITTING PROCESSES & PROC, McCalley				
11a	T1/T2	Offshore transmission development processes	3	Q5
11b	I1/UT1	HVDC right-of-way	3	Q12
12. ENERGY EQUITY & ENVIRONMENTAL JUSTICE, Hines				
12a	T1/V1	Effects of HVDC on enrgy equity & env. justice.	3	Q11

Module development principles

1. Team-aware: The design/content of a module, though led by one team member, is influenced by all 12 team members. This occurs in four ways:
    a. We develop and share abstracts with bulleted contents for all modules, early in the project.
    b. We maintain a project topical index that identifies for all topics, occurrences in all modules.
    c. Although we do not restrict overlap/redundancy, we try to be aware of it and reference treatments of the same topic in other modules.
    d. The review process enables that all project team members see what is in every module.
2. Multi-stage review process: (i) lead-reviewer, (ii) team, (iii) formal review (lead reviewer + 3 others), (iv) course testing and feedback. This process results in modules having substantive and applicable content.
3. Common themes to employ:
    a. Treat both onshore (first) & offshore (last) applications in each module.
    b. Compare/contrast with (generally more familiar) AC transmission.
    c. Illustrate using a common test system.
    d. Make it accessible to people of various expertise levels.
    e. Include section in each module: how module topic relates to energy equity/justice.

Module development <u>process</u>

STEP	DESCRIPTION	TIME
1	Develop abstracts and bulleted list of content for all modules.	3 wks (now)
2	Project advisory board (PAB) considers table of modules together with abstracts. Some PAB members may volunteer to serve as co-authors of certain modules.	By end of Q1
3	Development process:	
3a	Lead author develops V1a (competencies & objectives identified; fairly well-developed intro, section headers, some writing in sections, some figures/tables).	0.5 months
3b	Share w/ lead reviewer (& any co-author); develop V1b (fairly mature) based on comments.	3 months
3c	Share w/ team, address comments from team, authors complete module; this is V2.	1 month
4	Review & testing process:	
4a	Submit V2 for review by 4 reviewers: lead reviewer (coordinates), at least 1 PAB member, & 2 more.	1 month
4b	Develop V3 based on reviewer comments and post for general PAB comments.	1.5 months
4c	Post V3 to publicly available website.	
5	Course-test (in short course and/or other course).	
5a	Develop V4.	
5b	Repost to publicly available website (with periodic revision).	

- We will develop & communicate review logistics (criteria & mechanics) at a later time.
- Most important feature as reviewer is to lend your expertise. We will identify your role as reviewer if you give permission to do so.

Project Milestones

Quarter	Milestone	Description	Evaluation/assessment method
1	1.1	Complete one module all but course testing and review.	Module will be under review
2	1.2	Yr 1 project board meeting.	Have ≥90% participation.
3	1.3	Complete planning for yr 1 short course.	Scheduled to occur before end of yr 1.
4	Go/NG 1	10 modules completed; 6 modules tested; 2 Bridgeport meetings.	All tested modules have review scores ≥ 90%. 75% project team participation in Bridgeport meetings.
5	2.1	Yr 2 project board meeting.	Have ≥90% participation.
6	2.2	Implement communication outreach.	Sent 3 times since project initiation.
7	2.3	Complete planning for yr 2 short course.	Scheduled to occur before end of yr 2.
8	Go/NG 2	12 new modules completed (total of 22) each with "applications to energy equity." 11 modules tested (total of 18). Workforce using modules. 2 Bridgeport meetings.	All tested modules have review scores ≥90%. 50% of people in workforce exposed to modules have used one or more of them. 75% project team participation in Bridgeport meetings.
9	3.1	Implement communication outreach.	Sent 6 times since project initiation.
10	3.2	Use modules in 4 certificate program courses.	Two programs are existing; two are new.
11	3.3	Complete course testing.	All 35 modules used in instruction.
12	Final	13 new modules completed (total of 35). Workforce using modules. 2 Bridgeport meetings.	All modules have review scores ≥90%. 50% of people in workforce exposed to modules use 1 or more. 75% project team participation in Bridgeport meetings.

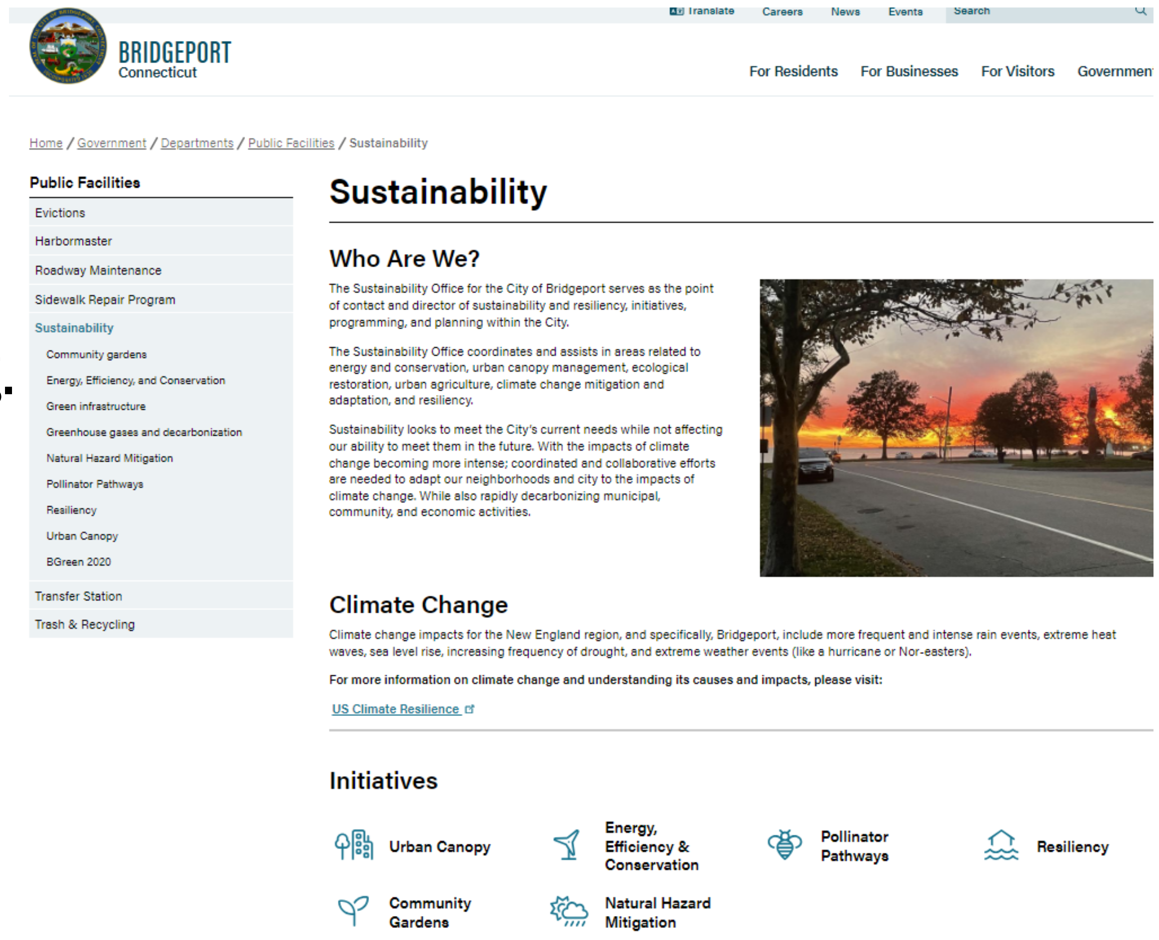
Other project features

- Short courses: 1 per year, using modules.
- Multi-school design development:
  - Includes 7 universities comprising project team
  - Hope to include 10 institutions on PAB (6 US, 4 European)
  - Organize a high-level project with multiple tasks
  - Teams at each school develop and host websites that characterize their sub-project and corresponding progress, so students at other schools can benefit from the information posted by both current and past student teams

Example: Have these teams focus on the design of a ±525 kV HVDC offshore backbone transmission system, capable of handling 85 GW of offshore wind. Different features of this design, each of which is appropriate for a single team, include (i) identification of landfalls; (ii) design of onshore HVDC circuits from a landfall to points of interconnection (POI) substations; (iii) POI substation modification and converter design; (iv) identification of onshore grid expansion needs; (v) remedial action design for loss of a landfall station; (vi) HVDC protection design; (vii) offshore submarine cable routing; and (viii) regulatory and permitting processes associated with the offshore transmission plan.

Other project features: Bridgeport CT

1. Contact is Chadwick Schroeder, Bridgeport Sustainability Manager.→
2. To meet him July 11, 2:30-4:00pmCDT.
   a. 1 hr discussion where I present team & project basics & availability of our team to work with Bridgeport in other ways as well.
   b. Chadwick to present/characterize Bridgeport current sustainability needs.
   c. Will be virtual; need 75% of us participating.
3. Objective: In partnership w/ Bridgeport, identify ways to decrease energy burden (energy cost/income) while enhancing sustnblty & mitigating envrnmntl impacts.
   - Characterize existing conditions
   - Identify choices
   - Understand community concerns
   - Develop useful materials



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Home / Government / Departments / Public Facilities / Sustainability

Public Facilities

- Evictions
- Harbormaster
- Roadway Maintenance
- Sidewalk Repair Program
- Sustainability
  - Community gardens
  - Energy, Efficiency, and Conservation
  - Green infrastructure
  - Greenhouse gases and decarbonization
  - Natural Hazard Mitigation
  - Pollinator Pathways
  - Resiliency
  - Urban Canopy
  - BGreen 2020
- Transfer Station
- Trash & Recycling

Sustainability

Who Are We?

The Sustainability Office for the City of Bridgeport serves as the point of contact and director of sustainability and resiliency, initiatives, programming, and planning within the City.

The Sustainability Office coordinates and assists in areas related to energy and conservation, urban canopy management, ecological restoration, urban agriculture, climate change mitigation and adaptation, and resiliency.

Sustainability looks to meet the City's current needs while not affecting our ability to meet them in the future. With the impacts of climate change becoming more intense; coordinated and collaborative efforts are needed to adapt our neighborhoods and city to the impacts of climate change. While also rapidly decarbonizing municipal, community, and economic activities.

Climate Change

Climate change impacts for the New England region, and specifically, Bridgeport, include more frequent and intense rain events, extreme heat waves, sea level rise, increasing frequency of drought, and extreme weather events (like a hurricane or Nor-easters).

For more information on climate change and understanding its causes and impacts, please visit:

US Climate Resilience

Initiatives

Urban Canopy
Energy, Efficiency & Conservation
Pollinator Pathways
Resiliency
Community Gardens
Natural Hazard Mitigation

Next Steps for PAB

ABSTRACTS:

- Will be making half-page abstracts available to you by July 31.
- Communicate individual modules for which you have review interest or co-author interest.
- Consider overall project scope and substance
- Provide short written feedback to me.
- I will disseminate to all project team members and DOE.

REVIEWS:

- Some of you will get review requests in quarters 2-4 of this year.

NEXT PAB MEETING:

- We are likely to organize one more PAB meeting in Sept/Oct ’24.

Current priorities for project team

1. All modules: Develop half-page abstract with major sections identified and send to me by 7/10 (all).
2. Start on year 1 modules:
   - McCalley, 7a – Pt 2 pt onshore & offshore apps, Q1←EARLY COMPLETION OF THIS (AND DISTRIBUTE!!!)
   - Fang, 1c - Intro to HVDC for offshore wind, Q2
   - Li, 1b - Application Guide for HVDC Transmission, Q2
   - Lof, 1a - Intro to HVDC technology, Q4.
   - Mehrizi-Sani, 2a - HVDC reactive power, EMI, and filter design, Q3
   - Tolbert, 3d - Modular multilevel converter as HVDC cnvrtr interface and its control, Q3.
   - Wallace, 5a - HVDC fault management & protection systems, Q4.
   - Cui, 2b - VSC-HVDC converter station technologies, Q4
   - Nazir, 4d - Offshore HVDC cnvrtr grid forming controller design for black start capability, Q4.
3. Comment on project logo and module summary table per slide 7 by 7/10 (all).
4. Submit project logo and module summary table to DOE by 7/10 (McCalley).
5. Develop website (Cui/McCalley).
6. Begin developing short course (Fang).
7. First PAB meeting: Tuesday June 25 11am-12 CT and July 1 11am-12 CT (McCalley).
8. Organize visit to/meeting with Bridgeport (McCalley/Hines).
9. Initiate multischool HVDC offshore design projects (Nazir).
10. Tell me if you are hiring student – 3 need to be hired by end of Q2, 1 of them female, w/div-search (have heard only from Hines on this).

PAB member comments from 6/25/2024 meeting

1. How to develop module content so that it can be used by the various targeted groups (university education, community college education, regulators, industry engineers, policy groups)?
2. To address the issue of prerequisite material, consider to develop three or four basic “lead” modules on which other modules could depend.
3. The Energy Justice/Equity work proposed for Bridgeport could also include Salem, Massachusetts.
4. Address in each module a connection to energy justice/equity issues, even if its just a paragraph.
5. There are several national labs addressing energy justice/equity issues (PNNL, NREL, LBNL, Livermore). Contact them to see if they have material that could be leveraged.
6. How to address “hands-on” lab-related activities? One way is by reporting on laboratory activities within the module. Another way is to set up virtual activities.
7. How do control room operators think about HVDC? Do they have adequate training?
8. How do formal LMP markets include HVDC?
9. 95% of existing HVDC is LCC. 95% of future HVDC will be VSC. There was strong consensus from the PAB members that HVDC-Learn team should focus less on LCC-based HVDC and more on VSC-based HVDC. One approach here would be that each module could address both but LCC gets much less attention/emphasis. Another perspective on this issue was communicated by email and is given on the next slide.

PAB member comments from 6/25/2024 meeting

10. Just one comment with regards to LCC vs VSC. The general global trend is moving towards VSC based HVDC for new projects except for a few very high-power long transmission links. That said, as noted in your slide (18/18) there is a lot of LCC based HVDC in the world today, including in the USA. In the majority of cases, it is likely that these HVDC links will be refurbished rather than completely replaced with VSC due to the cost of a complete replacement; noting that a VSC converter would be too large to fit in an LCC “Valve Hall”. Through refurbishment it can be expected that LCC HVDC will be around and operating within the power grid for many years to come. I make this point because the global knowledge of LCC HVDC is declining, making it more difficult for the complete chain, owner, consultants, regulator, to keep these systems in operation. There is, therefore, a case to teach the next generation of engineers about LCC HVDC as well as VSC so that they are prepared for the systems they may be faced with. (Also, worth considering that new graduates today who’ve been taught about VSC at university are usually shocked at how much more complicated LCC HVDC is! – less degrees of freedom). I’m not trying to persuade you to include more on LCC, I just thought it was worth making the point that LCC will be around for a long time to come, hence both LCC and VSC are equally valid topics. Not sure if you are aware of it but we do have a number of educational resources on our website including a book on HVDC transmission. Whilst based on LCC, ~80% of the book is still highly relevant to what you are trying to achieve. The web page is https://resources.grid.gevernova.com/hvdc.

PAB member comments from 7/1/2024 meeting

1. The PAB members attending this meeting very much agreed with the point made in the first meeting related to emphasizing VSC over LCC, but they qualified it to recognize that LCC is heavily present in Asia where they need high capacity; VSC is heavily present in Europe where smaller capacity projects are being planned and built. One PAB member indicated he could provide graphical content on this issue.
2. Consider that module content should span from basic information to advanced “breakthrough” concepts.
3. We should enable the possibility of publishing module (or module content) in technical journals and conference proceedings. It is assumed all modules will be copyrighted to the authors; then authors (but no one else) may utilize that material for other publications. It may be possible to publish entire modules (or multiple modules) in that form but seems doing so would need to be orchestrated with a book publisher.
4. There should be a list of vocabulary, acronyms, and symbols that are consistent throughout all modules.
5. Modules should have more than just readable materials; they should also have example problems and homework problems. It may be interesting to sidebar descriptions of “Illustrations” or “Industry scenarios.”
6. You indicate on one slide titled “Module development principles” (slide #11 in this deck) the intent to “include section in each module: how module topic relates to energy equity/justice.” That may be more challenging for some modules than for others (how does energy equity/justice relate to IGBT operation?). One thought here is that perhaps the relation between module topic and energy equity/justice (EEJ) need not be direct; maybe the EEJ issue can be indirect, indeed, maybe it can be simply consistent with an overall EEJ “sidebar presence” in all of the modules and need not connect directly. Perhaps our two EEJ experts can help us consider this further.