

APPTI Net Zero Workshop – Decarbonizing the Pulp & Paper Sector – August 13&14, 2024

Agenda:

Day 1:

- 7:30 Registration Opens and Breakfast
- 8:00 Introductions and Purpose/Products – Role of APPTI and Anti-trust Reminder Dr. Chris Luetgen, APPTI
- 8:35 Introduce the IEDO Office of the DOE and Identify Pulp & Paper Priorities Mr. David Turpin, Nexight & Dr. Barclay Satterfield, IEDO
- 8:55 WinGEMS/FisherSolve Information and NCSU Approach to Decarbonization via Two IEDO-funded projects Dr. Sunkyu Park, NCSU
- 9:35 Oxy-Kraft Project Dr. Markus Engblom, Abo Akademi
- 10:05 Break

Carbon Capture Technology

- 10:35 CC Opportunities in the US Pulping Industry Dr. Joe Sagues, NCSU, and Taylor Sugg, CO280
- 11:20 Life Cycle Assessment: Meeting Policy Benchmarks for Decarbonization Dr. Valerie Thomas, GT

12:00 Lunch

1:00 Breakouts – What would be breakthrough technologies in CC for the forest products industry that could lead to defined APPTI RFPs ALL

Biogas Generation Opportunities

2:00	Experience with Anaerobic Digestion of Pulp and Paper Mill Effluents	Mr. Jack Kuhar, Veolia
2:30	AI-enabled Smart Recovery and Upcycling of Non-recycled Papers and Other Waster in Bioproducts	Dr. Lokendra Pal, NCSU
2:50	Anaerobic Digestion Research	Dr. Niko DeMartini, University of Toronto
3:15	Discussion of current relevancy to mill operations with aerobic activated sludge systems and lagoons and CH ₄ and CO ₂ emissions	Luetngen to lead
3:30	Breakouts – What would be breakthrough technologies in Biogas Generation for the forest products industry that could lead to defined APPTI RFPs	ALL
4:30	Wrap-up	

Day 2:

7:30 Registration Opens and Breakfast

Lime Kiln Carbon Emissions

8:00	Introductions to Day 2	Dr. Chris Luetgen
8:10	Lime Kiln Developments with Alternative Fuels	Mr. Matthew Sparks and Carsten Jensen, Valmet
8:40	Forest Products Decarbonization via Electrification and Energy Efficient Processes	Dr. Lokendra Pal, NCSU
9:20	Kinetic Assessment of Pulp Mill-derived Lime Mud Calcination in High CO ₂ Atmosphere	Dr. Joe Sagues, NCSU
10:00	The Untapped Potential for Firing Non-Fossil Fuels in Rotary Kilns	Glenn Hanson, Metso
10:35	Break	
10:55	Assessing Current Operations and Targets for State-of-the-art Operations	Dr. Peter Gorog, Houghton Cascades, and Victor Padilla, FPInnovations
11:40	Lunch	
12:30	Borate Auto-causticizing Research	Dr. Honghi Tran, University of Toronto

1:00 Breakouts – What would be breakthrough technologies in Lime Kiln Operations for the forest products industry that could lead to defined APPTI RFPs ALL

2:00 Break

Drier Web Committee: Co-Chairs, Lindsey Clifton, Domtar and Gary Nyman, IP on the current active/funded and tracked projects of the committee

2:20	Introduction of the Committee	Ms. Lindsey Clifton
2:30	LEAD Project	Dr. Lokendra Pal, NCSU
2:45	Ultrasonic Dewatering	Dr. Shri Ramaswamy, U Minn
3:00	Felt Design to Prevent Re-wet	Dr. Carson Meredith, GT
3:15	Dispersed Laser Drying	Dr. Jamal Yagoobi, WPI
3:30	Displacement Pressing	Mr. David Beck and Mr. John Neun, Beck & Associates
3:45	Multi-Phase Forming	Dr. Cyrus Aidun, GT
4:00	Asking the Question: What is next for the Drier Web Committee?	ALL, led by Co-Chairs
4:15	Black Liquor Committee – Idled – Celebrating Success?	ALL
4:25	Workshop is Adjourned	

4:35 Net Zero Committee holds a business meeting: discuss key takeaways from the Workshop; discuss potential for an LCA on the paper industry. Net Zero Committee

5:00 Wrap-up

Speaker Bios:

DAVE BECK graduated from the University of Wisconsin with a degree in Chemical Engineering and an interest in fluid mechanics. He started working in the paper industry in 1978 at Appleton Mills, now called Voith Fabrics. There he did fundamental research in papermaking using their pilot paper machine to improve felt designs and develop pressing models. One of his models was used in development of Voith's Flexonip. His work measuring hydraulic pressures within the nip along with work done at the Institute of Paper Chemistry led to his intense interest in displacement pressing. Dave went on to work at Georgia Pacific as a research fellow at their Neenah Innovation Center. He retired from that position and has rekindled his interest in displacement pressing which led to applying for a DOE grant to build a pilot displacement press. DOE accepted this project along with 48 other projects for funding out of 700 applications due to the high ranking for saving energy and resources. Dave holds 31 patents with 20 being related to displacement pressing.

LINDSEY CLIFTON works for Domtar as an Engineer in their Research & Development group. She has worked for Domtar for 9 years – 5 years as a process engineer at their Kingsport, TN mill and 4 years in R&D. Lindsey focuses on research in fiber development, new product development, and cost and quality improvements. She is APPTI's Reduce Drying Energy Team's Co-Leader.

DR. NIKOLAI DEMARTINI is Associate Professor Department of Chemical Engineering and Applied Chemistry, University of Toronto and Director of the Pulp and Paper Centre at UofT. He is the Lead for industrial consortium "Effective Energy and Chemical Recover in Pulp and Paper Mills"

CARSTEN JENSEN, Sales Manager Lime Kilns Valmet. Located in Copenhagen, Denmark where we have our world wide technology center for lime kilns. I have been working at Valmet for 7 years. Before that I worked 15 years in the US.

JACK KUCHAR, P.E., PMP, is Director of Industrial Operations and Engineering at Veolia. He has 17 years of experience in water and petrochemical industries in a variety of roles and has been with Veolia for 13 years. He has been instrumental in the design, engineering, procurement, construction and checkout of aerobic and anaerobic processes since joining Veolia. In his career, he has completed the design, procurement, supply and construction of numerous DAF, MBBR, Disc Filter, EGSB, UASB, CSTR, Anaerobic Membrane and Biogas Handling systems for industrial clients. Mr. Kuhar has held the following positions at Veolia.

DR. CHRIS LUETTGEN is the Executive Director and CEO of the Alliance for Pulp & Paper Technology Innovation (APPTI) and a Professor of the Practice in the School of Chemical and Biomolecular Engineering at Georgia Tech. He also serves as the Strategic Initiative Lead for Pulp, Paper, Packaging and Tissue at the Renewable Bioproducts Institute at GT, the Director of the Undergraduate Pulp & Paper Engineering Program, and the External Advisory Board Chair of the ReWOOD Center at GT.

He has 25 plus years of industry experience, with Scott Paper and Kimberly-Clark Corp., where he most recently served as head of North American Innovation for the Professional business sector. He has held positions in product development and innovation, capital project management and manufacturing facility leadership. Luetgen has served as the Chairman of the Board of the Technical Association of the Pulp & Paper Industry (TAPPI) and is a TAPPI Fellow. He earned his BS degree in Paper Engineering at Western Michigan University ('85), his MS degree at the Institute of Paper Chemistry, Appleton, WI ('87), and his PhD at the Institute of Paper Science and Technology - now RBI ('91).

DR. CARSON MEREDITH currently serves as the Executive Director, *Renewable Bioproducts Institute*; Professor and James Harris Faculty Fellow in the *School of Chemical & Biomolecular Engineering (ChBE)* at Georgia Institute of Technology. He has received a BS degree in Chemical

Engineering from Georgia Tech (1993); PhD in Chemical Engineering from the University of Texas, Austin (1998); and a Postdoc at NIST Polymers Division from 1998 to 2000, after which he joined the faculty in the School of Chemical & Biomolecular Engineering at Georgia Tech in 2000. His research interests include:

- Biomass-derived renewable and sustainable polymers. Pioneered in the area of using chitin and cellulose to derive alternative packaging materials as substitutes for plastics.
- Decarbonization of water-intensive processes in forest products
- High-throughput materials discovery and characterization.

Other activities include:

- AIChE Fellow and co-winner of AIChE Himmelblau Award for Innovations in Computer-Based Chemical Engineering Education
- Started the GT-EQUAL program, the first ACS Bridge Program in a chemical engineering school, for advancing the number of underrepresented student that earn PhDs.
- Advisory Board of the *Bioproducts Institute* (University of British Columbia)
- Advisory Board of the *Joint Bioenergy Institute* (JBEI).
- Editorial Board of the journal *Green Materials*

JOHN NEUN, P.E., - John's career in the paper industry spans over four decades, beginning in 1979. He has held a diverse array of technical and management roles, giving him a wide range of insights into the intricacies of paper machines. His tenure with Albany International and Kadant, Inc. has seen him conduct measurements and evaluations on most US paper machines and many more internationally.

Over the past decade, John has focused his expertise on identifying energy-saving opportunities, particularly within forming and pressing processes. His dedication to innovation and efficiency has resulted in numerous publications, primarily through TAPPI, where he is recognized as a Fellow. Notably, John has been honored with leadership awards from both TAPPI Engineering and Paper and Board Divisions, as well as the TAPPI Engineering Division Technical Award. In 2021, he was awarded the Herman Joachim TAPPI Distinguished Service Award, a testament to his global contributions in paper and tissue research. Throughout his career, John has played pivotal roles within TAPPI, serving as the past chairman of both the Water Removal and Papermaker's Committees, and the Paper and Board Division. His academic foundation includes B.S. and M. Eng. Degrees in Mechanical Engineering from Rensselaer Polytechnic Institute. He is a retired registered Professional Engineer in New York State.

DR. SUNKYU PARK is a Jordan Family Distinguished Professor and University Faculty Scholar at the Department of Forest Biomaterials, North Carolina State University. Before joining NCSU in 2009 as a faculty member, he received his Ph.D. in the same department, followed by postdoctoral training at UT-Knoxville and DOE-NREL. His department is dedicated to Pulp and Paper education, and he teaches process simulation for Pulp and Paper and Biorefinery operations. His research covers a broad spectrum of biorefinery development to produce biofuels, biochemicals, and biomaterials from lignocellulosic biomass, funded mainly by the US Department of Energy (DOE). He has over 130 publications and is currently working on 7 DOE projects and 4 of them as a lead PI.

DR. SHRI RAMASWAMY is Professor, Department of Bioproducts and Biosystems Engineering, University of Minnesota. He was the head of the department for 14 years. He has degrees in chemical engineering and paper science and engineering and over nine years of pulp and paper and chemical industry experience in process and products engineering, process research and development, and chemical applications technology development. Prof. Ramaswamy has extensive experience in research, development and deployment of biomass conversion, separation and purification technologies. He has made important contributions in separations and purification processes in biorefineries and fundamental understanding of the relationship between the three-dimensional structure of biomaterials and their transport properties. His current areas of research interests include transport processes in porous media and their applications to decarbonization of process industries.

DR. JOE SAGUES is an Assistant Professor in the Biological & Agricultural Engineering Department and the Principal Investigator of the Biocarbon Utilization & Sequestration Lab at North Carolina State University. He has experience in research, development, and demonstration of innovative bioprocessing technologies at corporations, startup companies, universities, and national labs. His research program takes an integrated approach to innovate technologies that utilize and sequester atmospheric carbon via industrial biomass processing. He recently played a prominent role in the DOE-funded Roads to Removal project, which conducted a granular assessment of various methods of carbon removal across the US. He is also co-founder of Flip Biosystems, a carbon removal startup that is spinning out intellectual property from NC State University.

BARCLAY SATTERFIELD is a Senior Technology Manager in the Industrial Efficiency and Decarbonization Office (IEDO) at the Department of Energy. Barclay is a member of IEDO's Energy- and Emissions-Intensive Industries pillar, which advances efficiency and emission-reduction technologies for industries such as chemicals, iron and steel, food and beverage, cement, and paper and forest products.

Prior to joining DOE in 2024, Barclay worked for Eastman Chemical Company as a group leader and technology manager, administering Eastman's US university research collaborations. Barclay is a former ACS Science Policy Fellow and has performed environmental life cycle assessments for Eastman and for retail and consumer goods companies as a consultant. She earned her PhD from Princeton University and Bachelor of Science from Yale University – both in chemical engineering.

TAYLOR SUGG, Vice President, Project Development for CO280, is an industry leader in carbon capture and storage (CCS) business development and project execution. Prior to joining the CO280 team, Taylor worked to advance the CCUS business at Denbury Low Carbon Solutions. This included the execution of CO₂ commercial offtake agreements with industrial emission sources and supporting a host of storage site and CO₂ pipeline evaluation and business development activities. Prior to Denbury, Taylor held progressing roles in the oil and gas industry for several exploration and production companies including operations, reservoir engineering, business development, and, most recently, investor relations. Taylor holds a BS from Texas A&M University in Chemical Engineering.

DR. HONGHI TRAN obtained his B.Sc. and M.Eng. in Ceramic Engineering from Shizuoka University, Japan, and his PhD in Chemical Engineering from University of Toronto (UofT), Canada in 1982. Honghi has been with the Department of Chemical Engineering and Applied Chemistry, UofT since 1987, where he was professor from 1994 to 2019 and director of the Pulp & Paper from 2003 to 2022, and is currently a professor emeritus. During his nearly 4 decades of research tenure at UofT, Honghi established and directed 11 large industrial research consortia, focusing on issues related to fouling/corrosion in recovery boilers, causticizing/lime kiln chemistry, Na and S balances, borate auto-causticizing, combustion and ash related problems in biomass boilers as well as mill waste disposal and utilization. He supervised/co-supervised over 100 graduate students and postdoctoral fellows; authored/co-authored over 320 refereed papers and book chapters and had 8 patents. Honghi has been the program chair of the TAPPI Kraft Recovery Course since 2006. He received numerous prestigious awards including the 2013 PAPTAC John S. Bates Gold Medal and the 2017 TAPPI Gunnar Nicholson Gold Medal. Honghi was inducted to the Paper Industry International Hall of Fame in 2017, the UofT Engineering Alumni Hall of Distinction in 2021, and the Pulp & Paper Canada's Inaugural Hall of Fame in 2022. Honghi is a TAPPI fellow, a PAPTAC fellow, a Canadian Academy of Engineering Fellow and a registered professional engineer of Ontario.

DAVID TURPIN is a Principal Consultant with Nexight Group. He was previously the President & Executive Director of the Alliance for Pulp & Paper Technology Innovation (APPTI), a non-profit organization, focused on high priority, pre-competitive technology challenges for the pulp and paper industry. Prior to joining APPTI he worked for Mead and MeadWestvaco for 26 years. During this time, he had a variety of roles in Corporate Engineering, Manufacturing, Information Technology and Research & Development, where he served as Vice President, Innovation Systems and Vice President, Packaging

Materials. Prior to joining Mead, he worked for P.H. Glatfelter. He is a graduate of North Carolina State with a degree in Paper Science.

DR. JAMAL YAGOObI is the George F. Fuller Professor in the Department of Mechanical and Materials Engineering at Worcester Polytechnic Institute (WPI). Yagoobi's research expertise includes enhancement of heat and mass transfer with electrohydrodynamics in small and large scales in the presence and absence of gravity, heat and mass transfer in porous media (drying), and enhancement of heat transfer with phase-change materials. He has over 350 peer reviewed journal and conference publications and book chapters, ten patents (plus 3 provisional patents), a licensed technology, and a licensed software program. Yagoobi is the founding director of the NSF Industry University Cooperative Research Center entitled, "Center for Advanced Research in Drying (CARD)". He had an experiment onboard the International Space Station from 2018 to 2019. Yagoobi is a fellow ASME, a fellow IEEE, and has received several national and international awards for his research and teaching activities. Yagoobi is currently the associate editor of IEEE-IAS Transactions and previously was the associate editor for the ASME Journal of Heat and Mass Transfer.