Industrial Technology Innovation Advisory Committee (ITIAC) Mural Board Commentary

March 21-22, 2024

Day One

Figure 1 provides a screenshot of the Mural, a collaborative online platform, that committee members used for note taking during the first day of the first ITIAC meeting. On the left is an overview of the tools for use within Mural and on the right are boxes where committee members added color-coded notes, questions, and discussion points. Comments from committee members in the Mural are provided below.

Figure 1. Screen Capture of ITIAC March 2024 Meeting, Day one, Mural Board Overview of Committee Duties

Session: Opening Remarks

Notes

- Learning of new technology to impact on commercial workflow to enhance commercialization and sustained new technology adoptions

Questions

- Does heavy duty transportation include mining, marine, construction, and agriculture?

- Should high performance computing be treated as an application for industrial decarbonization or, more deeply, as a sector to also be decarbonized?

Discussion Points for Day 2:

- We also need to focus on recycling of post-consumer scrap (low carbon and low-cost domestic resource) as opposed to exporting and, worst case, landfilling.
- Revisit the charge and the guard rails around the charge
- "Few eggs in the right baskets" – well said! How do we make this happen in the context of ITIAC?

Session: Innovation Pipeline for Industrial Decarbonization

Notes

- No notes

Questions

- Loan Program Office's connections with TIEReD projects?
- Is there a way for ITIAC to easily understand and track the different funding programs in play and their roles?
- How public is the sorting of which office certain technologies belong in? The various offices can be difficult to navigate, especially for smaller manufacturers.
- Loan Program Office has innovation requirements but can't take much technology risk. With the technology risk more likely for industrial projects, how can this be rectified to enable more LPO financing in this space?

Discussion Points for Day 2:

- It would be great to have a diagram showing the ecosystem of offices (both within and outside of DOE) relevant to industrial decarbonization for use by ITIAC

Session: DOE Industrial Decarbonization Strategy

Notes

- We can't always go industry-by-industry due to the long tail of emissions from many industries, so considering cross-cutting technologies that can help all industries will be needed to address the dozens of industries in the long tail.
- Efficiency accounts for 1/3 the needed mitigation by 2050; the ITIAC should not lose sight of this; what is needed to double down on efficiency while we wait for the emerging technologies to become available?
    - This comment received one "thumbs up" reaction emoji

Questions

- Would like to learn about the low carbon cements work from the Loan Program Office
- Can we have a presentation on DOE's work on non-manufacturing industrial sources?
- The challenge is getting industry to buy in on new tech. There are some industries that have tech available now to improve energy efficiency and CO_2 emissions, but many don't invest.
- Can we ask the Energy Information Administration to conduct the Manufacturing Energy Consumption Survey more often than every 4 years and to break out more industrial end uses (not just boilers, process heating, cooling, machine drive, etc. as they do today in table 5.2)? Also, can they break out more fuel types – too much energy is in the "other" fuel type category in table 5.2.
- The IEDO roadmap focuses on 5 key heavy industries; the ITIAC should consider how decarbonizing the light industries can lead to technology learning and economies of scale for cross-cutting technologies like solar thermal, heat pumps, etc. that will also benefit the heavy industries. Need to think broadly here.
- In the food sector, are the activities for the Office of Manufacturing and Energy Supply Chains (MESC) and the Office of Clean Energy Demonstration (OCED) and LPO coordinated with USDA?
- Has there been an effort to compare technologies and abatement potential between the industrial decarbonization roadmap vs. the Liftoff Reports? Do they match, if not, why not?

- In Liftoff Reports, how are you thinking about pushing/maximizing adoption of existing decarbonization solution and the tradeoffs with locking in technology at the expense of deeper decarbonization opportunities? What do you see as the role of policy in smoothing that glidepath? But also, where do you see the unavailable bumps in that path that need to be recognized/accepted?
- It would be great to hear from the IEDO analysis team about critical data gaps on industrial energy use and emissions installed technologies, etc.; the ITIAC has the chance to elevate the needs for data collection to improve the evidence base for this sector.
- Is IEDO's further analysis going to identify the few eggs and baskets or is that something the ITIAC would be informing?
- To Joe Cresko: Can we have more insight/discussion about how to prioritize the "few eggs in the few baskets"? This seems pivotal.
- The Energy Information Administration is great, but more data would enable greater evaluation. I know this has been a perennial problem. Funding for an enhanced Manufacturing Energy Consumption Survey (MECS) would be great.
- For MESC and OCCE do you require or encourage partnerships along a supply chain? I.e. say utilities & manufacturer & original equipment manufacturers (OEM). This kind of coalition seems to be working in Sweden.
- To Sam Goldman: Given the assessment of commercial viability of clean energy technology, how much attention, if any, is being put into attendant increased revenue associated with "customers" being willing to pay more for lower-GHG industrial products? The high-level analogy is how there's a growing sector of clientele being willing to pay more for "clean food" (e.g. organic, sustainably sourced food). Likewise, what's the assessing/account of customers being willing to pay for "clean energy"?
- To Joe Cresko and/or Lisa Guay: Are the energy shots being optimally leveraged/" fed" into each other (e.g., H_2 shot "feeding" options/insights into (1) heat; (2) fuels and products shots; fuels and products shots feeding into the heat shot)?
- To an extent the economics will depend on the availability and cost of carbon both of which are evolving. Based on the anticipated extent of grid decarbonization with time can we set expectations on deployment of electrification of hydrogen-based technologies?

Discussion Points for Day 2

- Decarbonizing low-temp heat (used in industries such as food processing) is a near-term opportunity that can be done efficiently with heat pumps, etc. It cuts across many different industries that need low-to-med temperature heat.
- Where does mining fit in? It can be a hurdle to upstream adoption of technologies and can by itself cause emissions
- Challenge of transition from CHP to electrification and/or decarbonization
- Incremental vs transformational.

Session: Industrial Efficiency and Decarbonization Office (IEDO) Overview

Notes

- Better Climate allowed energy intensives to have 25% reduction goals, not 50%

Questions

- Some solutions post demonstration may be limited by supply chain of components say power electronics for high voltage systems
- Does DOE produce reporting on the practical challenges with implementing a new tech once it is fully developed? For example, industry reluctance to pay for it, etc.?
- Are you working with leading states to identify cohorts of facilities that might be candidates for investments in cross-cutting techs?

- How do the Energy and Emissions Intensive Industries (EEII) and Cross Sector Technology subprograms coordinate on overlapping technologies? (e.g., molten ore electrolysis for steel as part of broader industrial electrification approach and increased clean electricity infrastructure needs)
- For iron and steel consider post iron smelting technology. This is a limitation for scaling up decarbonized iron from say H2DRI to actually produce steel
- Technical Assistance and Workforce Development (TAWD) programs seem much more deployment focused compared to other applied R&D programs in IEDO. How do these overlap or not with the Office of Manufacturing and Energy Supply Chains? Is TAWD also working with connecting industry to help pilot/demo the R&D-stage technologies?
- FY24 EEII FOA (and others) have included collaboration with other applied energy offices. How much flexibility is there to do more of this, what's the appetite among offices/department for doing this to facilitate multi-technology solutions for single facilities?
- Expect "light" manufacturing to grow.
- In terms of EWD how is DOE coordinating with Department of Labor (DoL) or Department of Energy (DoE)
- How is EPA and/or ENERGY STAR involved in the energy intensive pilot?
- Are the participants in the Better Plants program publicly listed somewhere?
    - Link provided: Partner List - Better Plants Program | Better Buildings Initiative (energy.gov)

Discussion Points for Day 2

- Analysis of actual thermal demand, quality for industrial thermal processes.
- How much should ITIAC recommendations focus on DOE existing authority vs. changes that may need to be made that would require new authority/funding (Congress)? (Broader than IEDO, but IEDO example re: FOA timelines/lack of feedback that may discourage applications)

Session: TIEReD Lightning Talks – EERE Offices

Notes

- It seems to me for H2 use in reduction there may be other metals to be considered e.g. CoO, NiO, even maybe SiO2
- It seems like there is a major opportunity to coordinate with BTO regarding how buy clean requirements in the building sector (which are happening) could accelerate industrial technology take-up, particularly efficiency in the near-term as embodied carbon limits push BATs in the near term

Questions

- For CTS is line gas the right comparison? Perhaps RNG would be a better comparison?
- How has the effectiveness of "prizes" emerged in contrast to "FOAs"?
- How do the EERE Offices handle hybrid system concepts that cross more than one EERE Office (e.g., solar-driven/assisted water electrolysis touching SETO and HFTO)?
- Are storage/transport emissions considerations being considered in the emissions reductions considerations (e.g., the GHG footprint associated with transport of "explicitly decarbonized" fuels --- e.g., the impact of the "color" of H2 upon comprehensive emissions analysis)?
- Does BETO see algae to products as a potential area or is it considered too early?
- Are goals realistic? How do you know if you are on track for ambitious goals?
- General question: explain differences in hubs, consortiums, centers, etc.
- Is there any research related to how to discover natural source of H2?
- The critical materials portfolio in AMMTO seemed to limit to consumer waste. Is anyone in DOE looking at other sources e.g. mine tailings, smelter slags and even sustainable mining?

Discussion Points for Day 2

- No discussion points

Session: TIEReD Lightning Talks – Offices outside EERE

Notes

- No notes

Questions

- How does IEDO coordinate with FECM on realistic scenarios and programs for which industrial plants can adopt CCS based on local geological storage resources? Does the IEDO roadmap take plant locations into account in its CCS wedge?
- can DOE build a cross office platform where say for a given geography, different solutions can be compared TEA wise? Say H2 vs CCUS vs direct electrification etc.?
    - This comment received a “thumbs up” emoji
    - This comment received the follow-up message:
      And include options for combining technologies, not just vs. (e.g., cement kiln electrification + CCUS for process emissions)
- Heat (such as steam) cannot be transported over long distances. This seems like it would greatly limit the use of nuclear heat for industry, given that it would require industries to cluster near nuclear plants. SMRs would have their own challenges around security, locating them in urbanized areas, etc.
- Given Technical Readiness Level overlap between ARPA-E and applied offices, how does coordination work between the two on technology topic/focus areas?
- Do we have the appropriate focus on Direct Air Capture - from a cost standpoint, would carbon tax make more sense?

Discussion Points for Day 2

- How can the "dataverse" that is generated across all of these offices be leveraged by ITIAC to get pictures of the status, performance, costs, etc. of all of these various solutions? And, more importantly, by IEDO.

Session: Demo & Deployment Lightning Talks

Notes

- For OCED, I’d suggest prioritizing viability/scalability before timeliness and moving fast

Questions

- What is the strategy for manufacturers of less than 20 workers? These are hard to support.
- For the MESC program for workforce development in coal country. There are many e.g. tribal groups interested in this. But may not have grant writing support. It would be great if DOE has say a workshop on the application.

Discussion Points for Day 2

- No discussion points

Session: Closing Remarks

No comments gathered

Day Two

Session: Overview of Committee Duties

Figure 2 provides a screenshot of a quadrant of the Mural, a collaborative online platform, that committee members used for note taking during the second day of the first ITIAC meeting labelled "Overview of Committee Duties" and shows a flow diagram outlining a Summary of Duties from 42 U.S. Code § 17114. Committee members had a blue box to the right where a comment was added that reads "How to assure a feedback loop around technical gaps back to applied [research, development, and demonstration] RD&D to address the gaps."

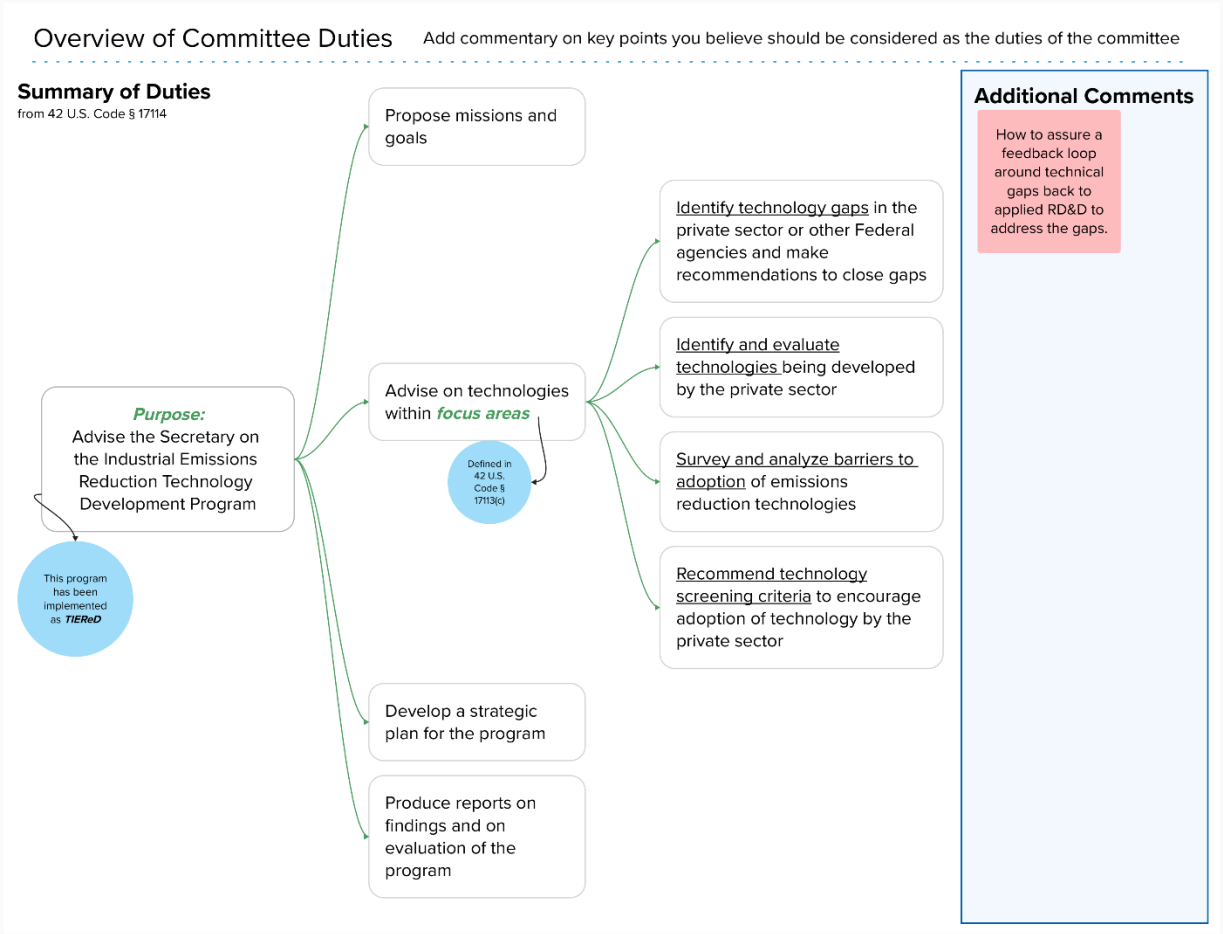

Figure 2. Screen Capture of ITIAC March 2024 Meeting, Day two, Mural Board Overview of Committee Duties

Session: Report Development

Figure 3 provides a screenshot of the Mural, a collaborative online platform, that committee members used for note taking during the first second of the first ITIAC meeting on "Report Development". Committee members were provided with a diagram of the Proposed Report Outline document with space to add annotations. To the right, an alternative report section structure is listed based on commentary from a committee member during the meeting. Transcription of these comments are provided below.

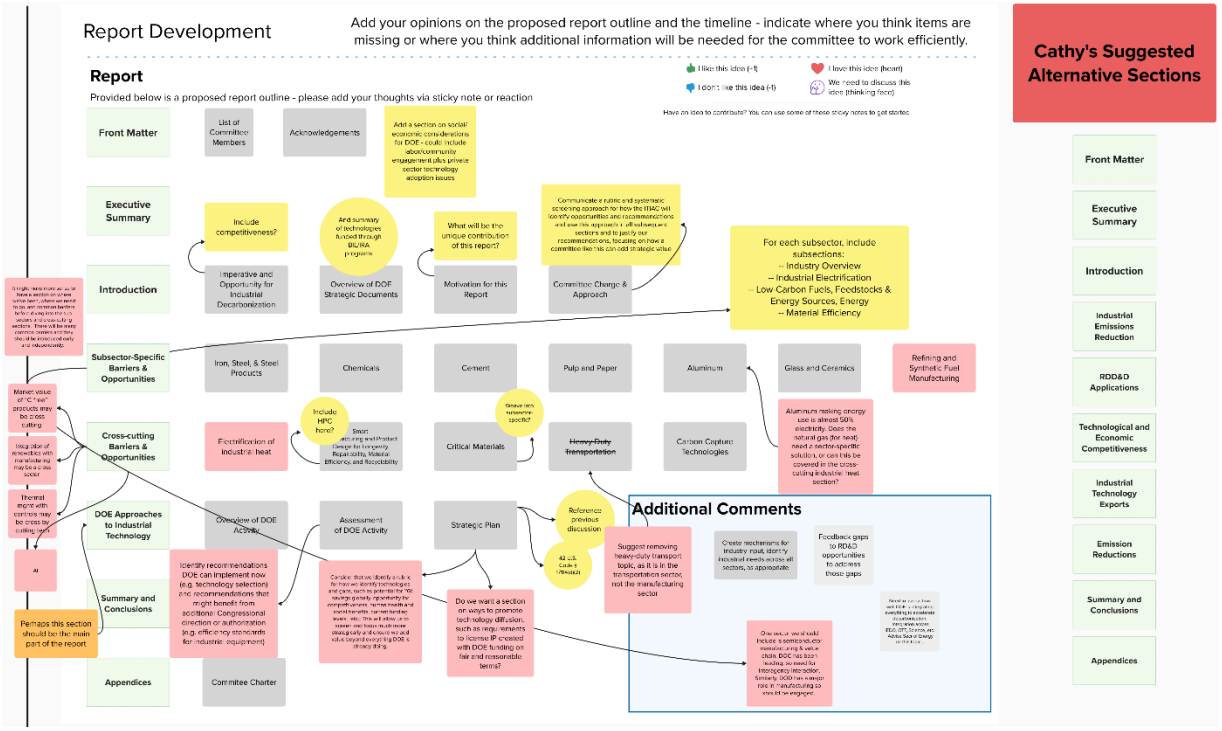

Figure 3. Screen Capture of ITIAC March 2024 Meeting, Day two, Mural Board on Report Development

Report

General comment: Add a section on social/economic considerations for DOE – could include labor/community engagement plus private section technology adoption issues

1. **Front Matter**
   No comments added
   - 1.1. List of Committee Members
     No comments added
   - 1.2. Acknowledgements
     No comments added
2. **Executive Summary**
   No comments added
3. **Introduction**
   - 3.1. The Imperative and Opportunity for Industrial Decarbonization
     Pre-added comment for initial discussion: Include competitiveness?
   - 3.2. Overview of DOE Strategic Documents
     Comment added: and summary of technologies funded through BIL/IRA programs
   - 3.3. Motivation for this Report
     Pre-added comment for initial discussion: What will be the unique contribution of this report?
   - 3.4. Committee Charge & Approach
     Comment added: Communicate a rubric and systematic screening approach for how the ITIAC will identify opportunities and recommendations and use this approach in all subsequent sections and to justify our recommendations, focusing on how a committee like this can add strategic value

Comment added between these two sections: It might make more sense to have a section on where we've been, where we need to go, and common barriers before diving into the sub-sectors and cross-cutting sections. There will be many common barriers and they should be introduced early and independently.

4. **Subsector-specific Barriers & Opportunities**

Pre-added comment for initial discussion: For each subsector, include subsections: Industry Overview, Industrial Electrification, Low-Carbon Fuels, Feedstocks & Energy Sources, Energy, Material Efficiency

4.1. Iron, Steel, & Steel Mill Products

4.2. Chemicals

4.3. Cement

4.4. Pulp & Paper

4.5. Aluminum

Comment added: Aluminum-making energy use is almost 50% electricity. Does the natural gas (for heat) need a sector-specific solution, or can this be covered in the cross-cutting industrial heat section?

4.6. Glass & Ceramics

4.7. *Additional Industries?*

Comment added: Refining and Synthetic Fuel Manufacturing

Comment added: One sector we should include is semiconductor manufacturing & value chain. DOC has been leading, so need for interagency interaction. Similarly, DOD has a major role in manufacturing so should be engaged.

5. Cross-cutting Barriers & Opportunities

5.1. Carbon Capture Technologies

5.2. Smart Manufacturing

Pre-added comment for initial discussion: Include high-performance computing here?

Title changed to: Smart Manufacturing and Product Design for Longevity, Repairability, Material Efficiency, and Recyclability

5.3. Critical Materials

Pre-added comment for initial discussion: Weave into subsector-specific?

5.4. Heavy-Duty Transportation

Title was reformatting to have text struck out

Comment added: Suggest removing heavy-duty topic, as it is in the transportation sector, not the manufacturing sector.

5.5. *Additional Topics?*

Comments added:

- Electrification of industrial heat

Sub-comment: Electrification: heat is only one aspect

- Market value of “C free” products may be cross cutting
- Integration of renewables with manufacturing may be a cross sector
- Thermal management with controls may be cross cutting technology
- Artificial Intelligence

6. **Department of Energy Approaches to Industrial Technology**

Comment added: Perhaps this section should be the main part of the report

6.1. Overview of DOE Activity

No comments added

6.2. Assessment of DOE Activity

Comment added: Identify recommendations DOE can implement now (e.g. technology selection) and recommendations that might benefit from additional Congressional direction or authorization (e.g. efficiency standards for industrial equipment)

6.3. Strategic Plan

Pre-added comment for initial discussion: Reference previous discussion

Pre-added comment for initial discussion: 42 U.S. Code § 17114(d)(2)

Comment added: Consider that we identify a rubric for how we identify technologies and gaps,

such as potential for ~Gt savings globally, opportunity for competitiveness, human health and social benefits, current funding levels. etc.; This will allow us to screen and focus much more strategically and ensure we add value beyond everything DOE is already doing.
Comment added: Do we want a section on ways to promote technology diffusion, such as requirements to license IP created with DOE funding on fair and reasonable terms?

7. **Summary and Conclusions**
   No comments added
8. **Appendices**
   No comments added
   8.1. Committee Charter
   No comments added

Suggested Alternative Sections

1. Front Matter
2. Executive Summary
3. Introduction
4. Industrial Emission Reduction
5. RDD&D Applications
6. Technological and Economic Competitiveness
7. Industrial Technology Exports
8. Emission Reductions
9. Summary and Conclusions
10. Appendices

Additional Comments

- Create mechanisms for industry input, identify industrial needs across all sectors, as appropriate
- Feedback gaps to RD&D opportunities to address those gaps
- Need to assess how well DOE is integrating everything to accelerate decarbonization. Integration across IEDO, OTT, Science, etc. Advise Secretary of Energy on this topic.

Session: Subcommittees

Figure 4 provides a screenshot of the Mural, a collaborative online platform, that committee members used for note taking during the first second of the first ITIAC meeting on “Subcommittees”. Committee members were provided a list of the proposed subcommittees with space to add their names as members and space to propose additional subcommittees. To the left is a list of new committees that were proposed, discussed, and decided on during the meeting. A transcription of the comments on the initial proposal and the agreed upon committees is provided below.

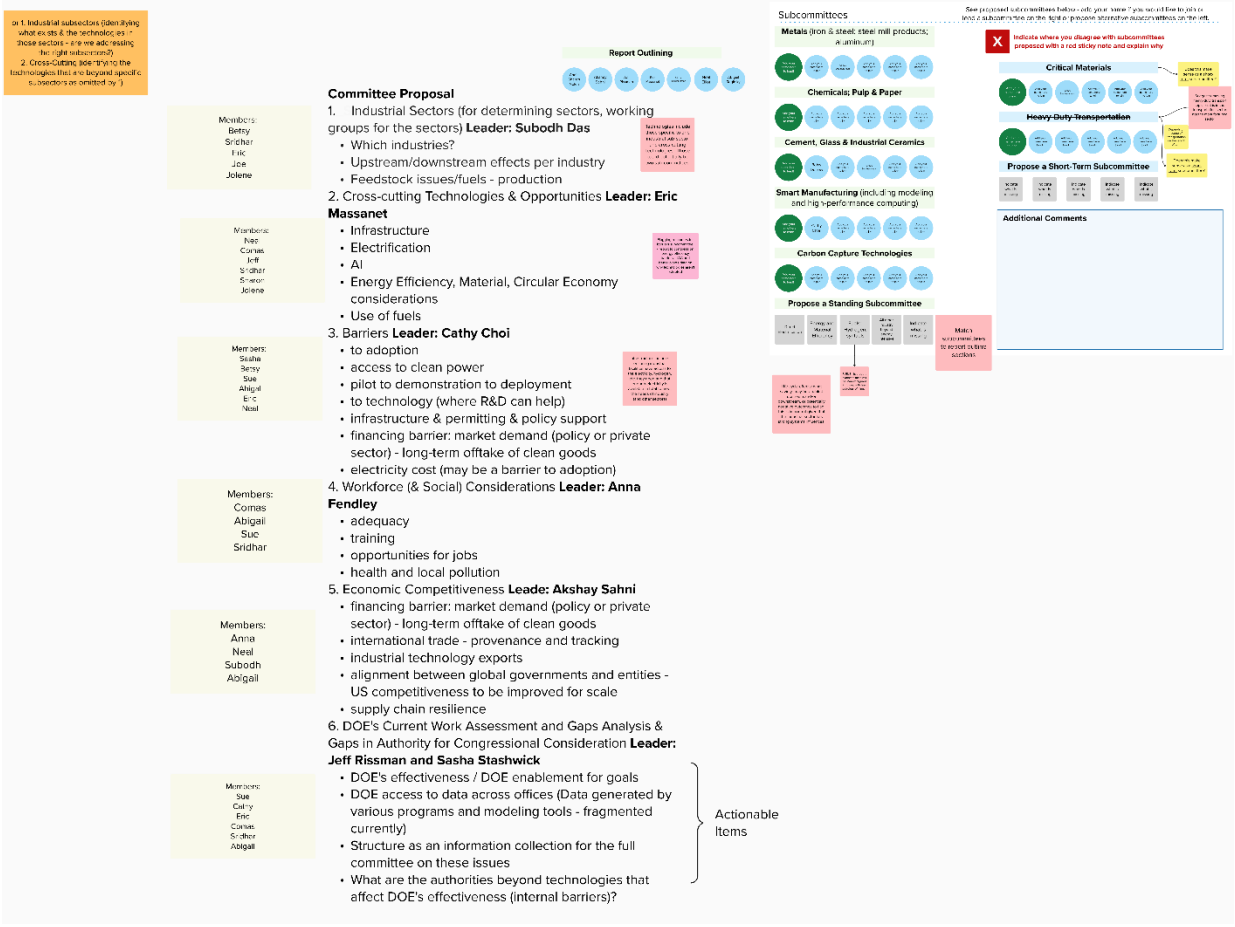

Figure 4. Screen Capture of ITIAC March 2024 Meeting, Day two, Mural Board on Subcommittees

Initial Committee Proposal Commentary

Proposals for standing subcommittees added:

- direct electrification
- energy and material efficiency
- fuels: hydrogen, synfuels
    - Sub-comment: FUELS: hydrogen, synthetic fuels will be manufactured in future, with less petroleum refining
- all other industry beyond energy intensive
- Life-cycle effects: what savings may be enabled upstream and/or downstream, or potentially negative outcomes to flag; this is important given that the industrial sector has strong systems influences!
- Match subcommittees to report outline sections

Comments added to the proposed "Heavy-Duty Transportation" subcommittee

- Suggest removing heavy-duty transport topic, as it is in the transportation sector, not the manufacturing sector
- Depends on scope of transportation on the length of term

Final Committees and Commentary

Report Outlining

Members: Sharon Nolen (Chair), Akshay Sahni, Jeff Risman, Eric Massanet, Sridhar Seetharaman, Neal Elliot, Abigail Registky

Comment from initial discussion: or 1. Industrial subsectors (identifying what exists & the technologies in those sectors - are we addressing the right subsectors?) 2. Cross-Cutting (identifying the technologies that are beyond specific subsectors as omitted by 1)

Committee Proposal

1. **Industrial Sectors (for determining sectors, working groups for the sectors)**
   Leader: Subodh Das
   - Which industries?
   - Upstream/downstream effects per industry
   - Feedstock issues/fuels - production

   Members: Betsy, Sridhar, Eric, Joe, Jolene

   Comment added: Technologies include those specific to one industrial sub-sector and cross-cutting technologies. Those could potentially be two sub-committees.
2. **Cross-cutting Technologies & Opportunities**
   Leader: Eric Massanet
   - Infrastructure
   - Electrification
   - AI
   - Energy Efficiency, Material, Circular Economy considerations
   - Use of fuels

   Members: Neal, Comas, Jeff, Sridhar, Sharon, Jolene

   Comment added: Flagging resources for barriers subcommittee: - report to congress on energy efficiency barriers; - IAC and better plants data on why technologies aren't adopted
3. **Barriers**
   Leader: Cathy Choi
   - to adoption
   - access to clean power
   - pilot to demonstration to deployment
   - to technology (where R&D can help)
   - infrastructure & permitting & policy support
   - financing barrier: market demand (policy or private sector) - long-term offtake of clean goods
   - electricity cost (may be a barrier to adoption)

   Members: Sasha, Betsy, Sue, Abigal, Eric, Neal

   Comment added: Infrastructure includes ensuring industrial facilities have access to the electricity, hydrogen, etc. they need, and that enough electricity is available in total to meet the needs of industry (and other sectors)
4. **Workforce (& Social) Considerations**
   Leader: Anna Fendley
   - adequacy
   - training
   - opportunities for jobs
   - health and local pollution

   Members: Comas, Abigail, Sue, Sridhar

5. **Economic Competitiveness**
   Leader: Akshay Sahni
   - financing barrier: market demand (policy or private sector) - long-term offtake of clean goods
   - international trade - provenance and tracking
   - industrial technology exports
   - alignment between global governments and entities - US competitiveness to be improved for scale
   - supply chain resilience

   Members: Anna, Neal, Subodh, Abigail
6. **DOE's Current Work Assessment and Gaps Analysis & Gaps in Authority for Congressional Consideration**
   Leaders: Jeff Rissman and Sasha Stashwick
   - DOE's effectiveness / DOE enablement for goals
   - DOE access to data across offices (Data generated by various programs and modeling tools - fragmented currently)
   - Structure as an information collection for the full committee on these issues
   - What are the authorities beyond technologies that affect DOE's effectiveness (internal barriers)?

   Members: Sue, Cathy, Eric, Comas, Sridhar, Abigail
   Comment added: Actionable items

Session: Timeline

Figure 5 provides a screenshot of the Mural, a collaborative online platform, that committee members used for note taking during the first second of the first ITIAC meeting on “Timeline”. Committee members were provided a timeline and given the opportunity to add additional time points, indicate future meeting topics, and desired cadence. A meeting was added to the timeline “Mid-Summer, Virtual, Subcommittee Updates & Mural Request Follow-up" by staff during the discussions. No committee commentary was added.

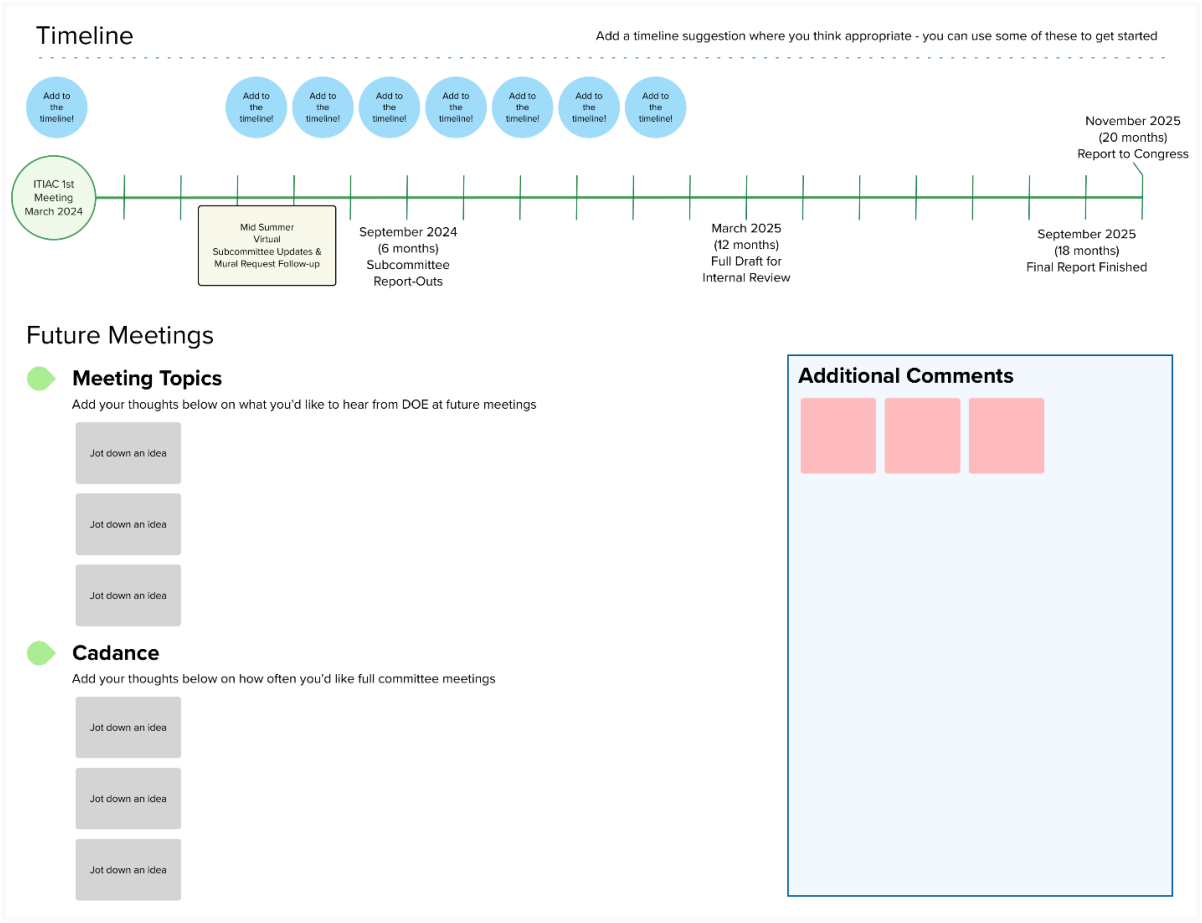

Figure 5. Screen Capture of ITIAC March 2024 Meeting, Day two, Mural Board on Timelines