Secure Tomorrow Series Scenario Workshop Facilitator Guide

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SCENARIOS WORKSHOP FACILITATOR GUIDE

Secure Tomorrow Series

The Cybersecurity and Infrastructure Security Agency (CISA) has provided this toolkit as a starting point for your organization to address these critical issues. Please feel free to expand upon or adapt these exercises and tools to your needs. Please consult with your organization to consider what language or actions you will need to take in hosting a workshop session.

GOAL

This workshop uses hypothetical scenario narratives to help participants explore ways in which the operating environment for critical infrastructure (CI) owners and operators may evolve over the next 3 to7 years, and how this evolution may affect the security and resilience of CI systems. In particular, the workshop's three scenarios center on plausible future changes pertaining to the topics of (1) advanced manufacturing, (2) information and communications technology (ICT) supply chain resilience, and (3) water availability.

Participants will leave the workshop having identified a prioritized set of risk mitigation strategies that will increase CI resilience and security, regardless of future uncertainties.

KEY WORKSHOP OUTPUTS

- Identification of significant issues and questions—to address now and in the future—for the various strategic operating environments posed in each of the three scenarios.
- A prioritized set of risk mitigation strategies that would increase security and resilience in most, if not all, of the three scenarios.

BACKGROUND

In the context of this workshop, a scenario is a story with plausible cause and effect linkages that connect a future condition with the present while illustrating key decisions, events, and consequences throughout the narrative. By using a small set of carefully crafted scenarios, organizations can avoid focusing on just a single future (i.e., *the* future) and develop strategies and plans that are viable over a range of possible futures. This is the underlying premise behind the scenarios workshop sessions.

RECOMMENDED PARTICIPANTS

***[Please note:** Invitations to participate should focus on mid-to-senior career-level individuals who are interested in exploring longer-term risks to CI to enable effective risk mitigation. To provoke new lines of thinking about risks to CI systems (either directly or through cascading impacts), we recommend that you seek broad representation from regional CISA personnel; state, local, tribal, and territorial planners; fusion center and intelligence community representatives; and other private-sector, non-profit, think-tank, and academic stakeholders. In particular, individuals with interest and expertise in the topics, and individuals who are already familiar with strategic foresight, are encouraged to participate. Because the workshop divides participants into three groups, please consider how you will achieve mixing and balancing different perspectives and expertise.]*

[Once known, this section of the guide would list the workshop participants, their titles, and the agencies/organizations they represent. If the workshop sponsor permits, the facilitator should consider providing participant biographical information to all participants ahead of the workshop.]

WORKSHOP FORMAT

The workshop activities were designed to occur over 7 hours, either as a virtual event over two consecutive afternoons or as a one-day, in-person event. The remainder of this guide is built around a virtual execution of the workshop, which would use a virtual meeting platform.

FACILITATION STAFF

- One workshop coordinator[1]
- One lead facilitator
- Two scenario facilitators
- Three documentation leads

Note: Each facilitator is responsible for one scenario. The lead facilitator also serves as a scenario facilitator.

SUPPORT MATERIALS

- STS Scenarios Workshop: Introduction and Roadmap Slides
- STS Scenarios Workshop: Are We There Yet Results Slides

WORKSHOP PREPARATION

Hosting a virtual scenarios workshop is a major undertaking and can be considered a capstone activity that follows execution of matrix games or cross-impacts sessions. For additional details about the steps necessary to plan a virtual workshop, please see Appendix A: Workshop Planning Considerations.

Facilitators should review in detail the support materials that pertain to their assigned scenario. Although they should focus most of their attention on their assigned scenario, facilitators should also review the other scenarios.

[1] The workshop coordinator can also serve as one of the facilitators for the event.

Prior to the workshop, the workshop coordinator will assign participants (maximizing diversity of backgrounds in each group) to one of three groups. Each group will focus on one of the scenario narratives. Participants should receive their assigned scenario narrative at least one week before the workshop as a read ahead. Facilitators should review their list of assigned participants and familiarize themselves with the background and affiliation of each participant.

The lead facilitator/workshop coordinator should plan to hold at least one orientation meeting that requires attendance from all scenario facilitators and documentation leads. During this meeting, the lead facilitator/workshop coordinator should walk through the workshop agenda and sessions, allowing sufficient time for facilitation staff to ask questions about the workshop itself and detailed questions about the scenarios.

AGENDA

DAY ONE	
1–1:45 p.m.	Framing the workshop: Welcome, participant introductions, workshop objectives, and event roadmap (*plenary session*)
1:45–2:30 p.m.	Icebreaker exercise: Are we there yet? (*plenary session*)
2:30–2:45 p.m.	Break
2:45–5 p.m.	Scenario breakouts ▪ Participant introductions ▪ Scenario familiarization and build-out ▪ Identification of emerging and evolving risks and associated needs ▪ Identification and prioritization of risk mitigation strategies ▪ Preparation for Day Two stress-test rounds

DAY TWO	
1–1:10 p.m.	Welcome back and roadmap for the day's activities (*plenary session*)
1:10–1:55 p.m.	Alternative future stress-test: Round 1
1:55–2:40 p.m.	Alternative future stress-test: Round 2
2:40–2:55 p.m.	Break
2:55–3:45 p.m.	Synthesis and reflection (*plenary session*)
3:45–4 p.m.	Closing remarks (*plenary session*)

GENERAL INSTRUCTIONS

- **Foster and maintain a collaborative and respectful atmosphere.** Encourage different observations, opinions, and perspectives. The discussions will explore a variety of policies, actions, and issues, and participants will likely display different degrees of expertise on discussion topics. The breakouts are no-fault, not-for-attribution sessions focusing on the identification, analysis, and generation of solutions for upcoming issues of concern.
- **Encourage participants to speak from their perspective.** There may be strategic needs that are prominent for particular stakeholder groups. A participant's unique perspective can be used as a starting point for broadening the discussion as to how it might apply to other stakeholder groups. If a participant is speaking from the perspective of a particular stakeholder group, ask other stakeholder groups about how this might also apply to them.
- **Anchor participants in the scenarios.** Ask participants to refer to content from the scenario narrative whenever possible to make the discussion more concrete.
- **Reinforce the future context of discussions.** Include references to the time period when presenting materials and emphasize, when appropriate, the scenario time horizon of 3 to 7 years in discussions to prevent participants from lapsing into present-day concerns.
- **Focus on CI security and resilience.** Keep the group on topic. How does whatever is being discussed lead to a connection to risk for CI security and resilience? It can be connected indirectly, and facilitators can prompt discussion about any complexities and tradeoffs involved, but they should always return to CI security and resilience. In other words, as the group is identifying emerging or evolving threats, also have group members elaborate on the nexus to CI, if it is not obvious.

FRAMING THE WORKSHOP

DAY ONE: 1—1:45 P.M.	
Description	The workshop coordinator provides a brief introduction and welcome to all participants and introduces the lead facilitator (if necessary). The lead facilitator then explains the goal for the workshop and walks participants through how the various sessions will integrate to achieve this goal.
Session Objectives	State the goal of the workshop and discuss how the sessions in the workshop agenda fit together to achieve this goal
Outputs	Improved participant understanding of the workshop
Duration	45 minutes
Supporting Materials	Secure Tomorrow Series, Scenarios Workshop: Introduction and Roadmap Slides
Staffing Requirements	▪ Workshop coordinator ▪ Lead facilitator ▪ Senior leader representing the hosting organization
Breakdown	1. Welcome (workshop coordinator) 2. Thank you to participants (senior leader representing host organization) 3. Review of workshop objectives and desired outputs (lead facilitator) 4. Roadmap of workshop sessions (lead facilitator)
Facilitator Talking Points	Please work from the “Secure Tomorrow Series, Scenarios Workshop: Introduction and Roadmap Slides” and accompanying “Scenarios Workshop: Introduction and Roadmap Presentation Slide Notes”
Additional Notes	None

ICEBREAKER EXERCISE: ARE WE THERE YET?

DAY ONE: 1:45—2:30 P.M.	
Description	The lead facilitator will conduct an icebreaker exercise with participants. The exercise involves presenting participants with a series of topic areas (e.g., space travel). Participants will be polled on their perspectives about how far society will have progressed in each area by 2035. The facilitator will ask participants to select from a list of pre-established answers.
Session Objectives	▪ Orient participants' thinking toward the longer-term future ▪ Allow participants to see how their views about the future compare with those of others ▪ Familiarize participants with the concept of underlying drivers of change by exploring participants' rationale for their answer selections
Outputs	None
Duration	45 minutes
Supporting Materials	▪ Secure Tomorrow Series Scenarios Workshop: Are We There Yet Results Slides
Staffing Requirements	Lead facilitator
Breakdown	1. Relay exercise instructions (lead facilitator) 2. Walk through each of the topic areas, then facilitate discussion of the polling results (lead facilitator)
Facilitator Guidance	▪ Initial talking points: o Thinking about the future in longer-term timeframes can be difficult, so we didn't want to shock you by throwing you straightaway into deliberations about future states of the world. In this session, we're going to try and orient your thinking toward a longer-term time horizon. o This session is fairly short. Think of it as an icebreaker to the workshop and a chance for participants to stretch their thinking forward in time in order to see how their views of the future compare with other participants. *At this point, transition to using the Secure Tomorrow Series Scenarios Workshop Are We There Yet Results Slides.* ▪ Two slides address each topic in the slide deck (please refer to the slide deck). The first slide contains images that describe the topic to participants and lists the specific polling question with associated progress milestones as answer options. These milestones are topic specific and listed in order of increasing progress. The second slide presents the polling results. After showing the polling results, ask volunteers to provide their perspectives. Call attention to interesting features of the answer distribution (e.g., extremes, most popular, explanations for bimodal distributions).

	▪ The facilitator may want to devote additional time to the topic-related questions in the Icebreaker session to allow for more elaboration on these topics. Ask the topic subject matter experts participating to comment on key concepts, misconceptions, and current trends pertaining to the topic.
Additional Notes	▪ Some virtual platforms can execute live polling. If live polling is used, facilitators should work to pre-populate the polling questions (as listed in the slides) ahead of the workshop. Facilitators should also remember to delete the second slide associated with each of the topics in the slide deck. ▪ If you will not be obtaining polling results live during this activity, please coordinate with the workshop coordinator to ensure that participants receive a polling worksheet ahead of the workshop, and that their responses have been returned, tabulated, and inserted into the slide deck ahead of time. ▪ If you are unable to perform live polling or send out a polling worksheet ahead of time, you may use the existing charts shown in the Secure Tomorrow Series Scenarios Workshop: Are We There Yet Results Slides. The results in this deck are from an execution of this exercise held with a diverse group of representatives from government agencies, think tanks, academia, and private-sector companies. ▪ Given the technical nature of some of the topics, you may want to confer with the workshop sponsor and consider developing additional read-aheads that serve as primers on these topics.

SCENARIO BREAKOUTS

DAY ONE: 2:45—4:45 P.M.	
Description	Participants will break into three separate groups, each exploring an alternative future scenario. The facilitator assigned to the group will lead a discussion about the scenario, fleshing out elements of this future based on participant interests and subject matter expertise. Participants will identify and then prioritize a set of risk mitigation strategies that would better prepare CI stakeholders for any emerging or evolving risks (and opportunities) that may exist in this future scenario.
Session Objectives	▪ To engage participants with their scenario—that is, to create ties between components of the narrative and their particular backgrounds (e.g., industry, knowledge, experiences, perspectives) ▪ To understand how scenario conditions shape strategic needs and associated risk mitigation strategies necessary to address these needs ▪ To prioritize and identify a maximum of five risk mitigation strategies based on what was written or extrapolated from the scenario narrative. These will feed into sessions on Day Two that stress-test these risk mitigation strategies against alternative future scenarios
Outputs	A prioritized list of up to five recommended risk mitigation strategies to improve CI resilience and security in the world described by the scenario
Duration	2 hours
Supporting Materials	Scenario narratives: ▪ Secure Tomorrow Series Scenario Narrative 1: Water Woes ▪ Secure Tomorrow Series Scenario Narrative 2: Great Power Disruption ▪ Secure Tomorrow Series Scenario Narrative 3: Day Zero
Staffing Requirements	▪ Three facilitators (one for each scenario) ▪ Three documentation leads (one for each scenario)
Breakdown	Begin by assisting participants in discussing and fleshing out the scenario. During this discussion, you should encourage participants to identify ramifications associated with the various changes, trends, or events captured in the narrative; emerging and evolving risks (and opportunities); and other important drivers or concerns related to key elements of the scenario narrative (that were not captured). After immersing participants in their scenario, the facilitator will assist participants in identifying and then prioritizing a set of five risk mitigation strategies to address critical needs (to enhance CI resilience and security) arising from the scenario. Participants will discuss these risk mitigation strategies in the workshop's subsequent stress-testing sessions. These strategies should be prepared in slide presentation format for use in the stress-testing sessions.

Key steps during the session include the following:

1. Conduct participant introductions.
2. Allocate 10 minutes for participants to read through the scenario.
3. Assist the group with working through the scenario and highlight points of interest and how they tie potentially to concerns for CI resilience and security. For example, you may want to ask each participant—as they read through the scenario—to prepare answers to the following questions:
   - Name an element of the scenario that resonated with you—i.e., what did you find most interesting or compelling?
   - What is an emerging or evolving risk discussed or hinted at—either related to your previous answer or to another part of the scenario—that you are most concerned about?
   - What are the ramifications (direct or indirect) of this emerging and evolving risk for CI security and resilience?
   - What risk mitigation strategies might you employ to address this risk?

   If discussions stall, you may want to reference concerns and discussion points flagged in your scenario's Detailed Scenario Breakdown. You may also want to draw attention back to the identification of topic-specific risks and the development of topic-specific risk mitigation strategies. Please be aware to probe for both technical and nontechnical solutions. When relevant, please remind participants to tie their statements to the scenario write-up, so individuals can skim the narrative for context.
4. Roughly 1 hour and 15 minutes into the session, if any major issues of interest built into the scenario narrative have not been addressed, introduce them for group discussion. Please note that the facilitator, workshop coordinator, and other relevant workshop stakeholders should decide ahead of time which issues the facilitator should try to cover during the session, using the Detailed Scenario Breakdown as a starting point for such determinations.
5. If the group identifies more than five risk mitigation strategies, they will need to prioritize five of them to present during the stress-test sessions. Please allow sufficient time for prioritization. You may wish to insert a short break for participants; during the break, you can refine the participant inputs and develop a strawman list of the top risk mitigation strategies. Allocate at least 15 minutes after the break for participants to react to the strawman, select the top five risk mitigation strategies, and further refine the risk mitigation strategy statements.
6. Allocate at least 10 minutes at the conclusion of the session to discuss what will take place during the stress-test rounds in Day Two. Identify three to six members of the group (depending on the size of the group) to serve on the away team for Day Two (see Stress-Test Rounds). Discuss roles and responsibilities, including who among the home team members will brief the scenario (or if the facilitator should brief the scenario) and which away team members will be responsible for presenting which mitigation strategies. When determining who should serve on the away team, please make sure to retain at least a few strong participants for the home team. Emphasize the importance of Day Two attendance, especially for away team members.

Facilitator Guidance	▪ **State the desired output from this session.** At the end of this session, we would like to identify a prioritized set of five risk mitigation strategies. ▪ **Re-emphasize that the scenario narratives are meant to provide just enough structure and content for a productive discussion.** A three- to five-page narrative cannot fully describe a future state of the world, especially if the goal is to make the scenarios easy to read. We wanted to take advantage of the group's collective expertise to flesh out those parts of the narrative that are most pertinent to CI security and resilience. ▪ **Bend, do not break, the scenario.** If places exist where the narrative did not probe deeply enough, or where a portion of the narrative was intriguing but did not get a lot of space, we encourage participants to fill in these gaps or make refinements (as long as you feel the discussion is heading in a probative direction). However, 180-degree shifts from the proposed scenario are not permitted. ▪ **Focus on CI security and resilience.** How does whatever is being said connect to CI security and resilience? It can be indirectly connected, and we can certainly discuss any complexities and tradeoffs involved, but we always want to come back to CI security and resilience. ▪ **Encourage participants to speak from their perspectives.** Strategic needs may exist for particular CI stakeholder groups and communities. We can use this as a starting point for broadening the discussion to other CI stakeholder groups. ▪ **Engage participants with the scenario.** If a participant feels disconnected from the group, ask what resonated most for them. Was there a concern that was not explicitly addressed, but would have ramifications for their organization, industry, or mission? How might the risks mentioned translate to their circumstances? ▪ **Return them to the scenario.** Does the narrative already provide examples and evidence that a strategic need exists? Please also refer to the scenario as a means of making the discussion more concrete. ▪ **Foreshadow the other scenarios, as relevant.** Doing so should help participants orient to the upcoming stress-test sessions on Day Two. ▪ **Outline what will happen during the stress-test rounds.** The ultimate output of the workshop is a set of risk mitigation strategies that are robust against a multiplicity of futures. Thus, group members will be presenting their risk mitigation strategies to other scenario groups to discuss the relevance and efficacy of these strategies under different future operating environments. Participants need to have a firm understanding of the large role they will play in communicating the risk mitigation strategies to their peers on Day Two.
Facilitator Prompting Questions	For additional questions specific to content within the narrative, please refer to the appropriate scenario. Questions to assist with fleshing out and familiarizing participants with this future reality: ▪ What portions of the scenario resonated most with you? ▪ What emerging and evolving risks were discussed or hinted at in this scenario that you are most concerned about? ▪ What are the ramifications of these emerging and evolving risks for CI security and resilience (if not obvious)?

	▪ How might some of the issues, trends, and threats identified in the scenario affect your particular organization/industry (ask as appropriate)? Questions to assist with identifying risk mitigation strategies: ▪ What strategic needs or capabilities must be addressed by CI stakeholders as a result of the threats, as well as the prevailing conditions, that you have identified for this scenario? ▪ What risk mitigation strategies might you propose to address these needs or develop these capabilities? Are you aware of anyone who has already implemented this risk mitigation strategy successfully? ▪ Which risks do you feel your sector is currently least prepared to address? What risk mitigation strategies would you propose to address these risks? ▪ What would we wish to have done currently to be positioned better to address these challenges in the next three to seven years? ▪ How might CI stakeholder roles and missions need to change and evolve to address the threats of concern? ▪ Are changes to existing authorities, resources, and understanding necessary? Questions to assist with prioritization of risk mitigation strategies: ▪ Why would this be among your top five strategies? ▪ Are any of the risk mitigation strategies that you have identified too generic or implausible to implement? How feasible is this risk mitigation strategy to implement? What trade-offs might arise as a result of implementing this mitigation strategy? ▪ Does this risk mitigation strategy represent a radical departure from the status quo? Are current activities occurring within the CI stakeholder community likely to address the underlying strategic need that this strategy is meant to address? ▪ Are there any risk mitigation strategies that would help address multiple threats or strategic needs associated with the scenario?
Additional Notes	▪ Before the workshop, the workshop coordinator assigns participants (maximizing diversity of backgrounds in each group) into one of three groups. Each group will focus on one of the scenario narratives, and all participants should receive their assigned scenario narrative at least one week in advance of the workshop as a read ahead. ▪ Following the end of Day One, facilitators should review and make any final refinements to the risk mitigation strategies generated by their groups. Facilitators should send copies of all risk mitigation strategies (preferably mapped to the associated risks they are meant to address) and all scenario narratives to their group members to assist with preparation for Day Two.

STRESS-TEST ROUNDS

DAY TWO: 1:10—2:40 P.M.	
Description	The facilitator for each scenario group will divide their group into a home team and away team. The away team will rotate to another scenario group and present its risk mitigation strategies to that group's home team. The home team receiving this presentation will assess the relevance and utility of implementing these risk mitigation strategies under the different operating environment and circumstances of its own scenario, engaging in discussions with the presenting group. Two rounds of stress-tests will occur; by the end of these rounds, participants will have had their risk mitigation strategies assessed for robustness against the other workshop scenarios.
Session Objectives	To discuss and perform a basic assessment of how relevant the presenting group's risk mitigation strategies are for the receiving group's scenario.
Outputs	▪ Notes on which risk mitigation strategies were judged to be more relevant and useful to alternative futures. ▪ Notes on possible modifications to risk mitigation strategies that would make them more relevant and useful to alternative futures.
Duration	1.5 hours
Supporting Materials	▪ Facilitators should be prepared to share a slide on the virtual meeting platform with the risk mitigation strategies of each visiting group. ▪ Scenario synopses one-pager ("Secure Tomorrow Series Scenarios Workshop: Scenario Synopses").
Staffing Requirements	▪ Three facilitators (one for each scenario). ▪ Three documentation leads (one for each scenario).
Breakdown	1. Divide the group into a home team and away team. The away team will rotate to present the group's risk mitigation strategies to other groups. The home team will listen to other groups' presentations of their risk mitigation strategies and discuss the relevance of these strategies to the home team's scenario. Each round will run for 45 minutes. You can simply rotate the away teams in order of the scenario numbers. For example, the Scenario 2 away team will go to the Scenario 3 breakout during Round 1, and then on to the Scenario 1 breakout in Round 2. 2. During each round, both the visiting away team and the home team should begin by presenting brief reports on their scenarios. Presenters should feel free to refer to the summary of their scenario in the scenario synopses one-pager ("Secure Tomorrow Series Scenarios Workshop: Scenario Synopses"). The facilitator should be prepared to assist with or present the home team's scenario, as based on the assignment of responsibilities from Day One. 3. The away team will then go through its risk mitigation strategies one by one. The facilitator should share a slide on the virtual meeting platform with the risk mitigation strategies of the away team.

	4. For each risk mitigation strategy, the two teams will engage in a facilitated discussion about how well the risk mitigation strategy fits the alternative scenario and what modifications might improve the strategy's alignment to the scenario (if not initially a good fit). 5. Facilitators will lead participants in a final vote of the relevance of the risk mitigation strategy to the alternative scenario (e.g., not a fit, a partial fit, or an excellent fit). Facilitators should use the voting session to discuss differences of opinion among the participants and use these discussions to identify potential additional modifications to the risk mitigation strategies.
Facilitator Guidance	▪ **Balance the two teams in each group.** Use your best judgment to balance the strengths of both teams based on their insights and participation. For example, avoid assigning all your most active participants to the away team, as the home team will then be less capable of engaging with the groups in an active discussion about the relevance of their risk mitigation strategies. ▪ **Re-emphasize the purpose of stress-testing.** Before sending one team to another breakout room for the first round of stress-testing, facilitators should reiterate the purpose of the two stress-test rounds. Day Two focuses on stress-testing the risk mitigation strategies identified for the primary scenario against the other scenarios. A key concept in scenario-based planning is using multiple future scenarios to identify strategies that are robust against uncertainty. The underlying rationale is that because we cannot successfully predict the future, we should treat the future as a set of plausible alternatives against which our strategic planning efforts need to be robust. The two stress-test rounds are one way of executing this concept in practice.
Facilitator Prompting Questions	▪ If implemented, would this risk mitigation strategy be effective in your scenario? What concerns might you have about implementing this strategy? ▪ How would this risk mitigation strategy rank relative to the ones you identified for your scenario? ▪ Are there conditions in this alternative future that would make this strategy more difficult or easier to implement? ▪ How could you modify the existing risk mitigation strategy statement so that it is more relevant to your scenario, without destroying the intent of the team that originated it?
Additional Notes	None

SYNTHESIS AND REFLECTION

DAY TWO: 2:55—3:45 P.M.	
Description	In this plenary session, the lead facilitator asks participants to provide their perspectives on what they learned from the two rounds of stress-testing and solicits overall reactions to the concerns and ideas presented during the workshop.
Session Objectives	To provide an opportunity for participants to reflect more broadly on what they learned from the stress-test rounds and the overall workshop
Outputs	▪ Additional insight and detail on risk mitigation strategies ▪ A feeling of closure for participants, increasing their willingness to support future efforts
Duration	50 minutes
Supporting Materials	▪ None
Staffing Requirements	▪ Lead facilitator ▪ Senior leader representing the hosting organization ▪ Documentation lead
Breakdown	▪ Solicitation of remarks by scenario group (lead facilitator) ▪ Solicitation of final remarks or reactions to anything discussed at the workshop (lead facilitator)
Facilitator Prompting Questions	▪ What were your key takeaways from the workshop? ▪ Did you learn of any risk mitigation strategies from other scenario groups that surprised you or that you would like to comment on?
Additional Notes	If relevant, the lead facilitator may want to relay information about any products that will be generated from the workshop (e.g., a report) during this session.

SCENARIO #1: WATER WOES

Please note: The version of the narrative that the facilitator possesses has line numbers for ease of identifying key segments of the scenario narrative (as referenced in the table below). These segments are also labeled with reference numbers.

BRIEF DESCRIPTION

Different regions of the United States increasingly find themselves threatened by either too much or too little water. In 2029, extreme weather has come to feel like the norm; the country is a patchwork of regions either inundated with floods and hurricanes or parched by drought and choked by wildfires. Three issues have exacerbated the challenges that jurisdictions face with water: (1) the growing effects of climate change; (2) aging water infrastructure; and (3) breakdowns in public trust. To date, efforts to address these issues have proven insufficient. Transitioning to clean energy, for example, to reduce greenhouse gas emissions and address climate change has been hindered by slower-than-expected adoption of electric vehicles (EVs), challenges with workforce development and reskilling, and a failure for new materials and greener processes to be incorporated at scale. A more moderate future will require an immoderate effort to address these issues moving forward.

SCENARIO CONTEXT

- Set up as a blog post that tries to put the challenges that U.S. regions are facing with water into context. The blogger highlights three issues exacerbating the nation's water woes and frames the blog as a call to greater action.
- Depicts a future in which all-too-measured efforts to address issues such as greenhouse gas emissions and aging infrastructure contribute to extreme weather and water availability problems.
- Provides examples of stumbling blocks and challenges affecting the clean energy transition and the Water and Wastewater Sector's resilience and security over the past decade.
- Introduces various events that speak to heightening tensions and growing mistrust over access to water among different stakeholder groups and sectors.

FACILITATION QUESTIONS – TAILORED

Please note: Broader, more general facilitation questions—common to all three scenarios—are located in the Scenario Breakouts section of this facilitator's guide. Additional discussion points, tied to specific portions of the scenario narrative, are listed in each scenario's "Detailed Scenario Breakdown."

- The scenario identifies three major issues contributing to various water woes that the country faces. Are there other issues that warrant attention?
- In addition to the water and wastewater sector, which CI sectors do you see as potentially most disrupted as the various impacts of climate change become more pronounced?
- The scenario is broadly framed around a call to greater action to address the three issues. What adjustments or additional actions would you recommend to accelerate progress?
- Where else do you see tension and mistrust among different stakeholder groups affecting the trajectory of critical infrastructure system development? Of an emerging technology essential to critical infrastructure systems?

The Cybersecurity and Infrastructure Security Agency (CISA) has produced these scenarios to initiate and facilitate discussion. The situations described here are hypothetical and speculative and should not be considered the position of the U.S. government. All names, characters, organizations, and incidents portrayed in these scenarios are fictitious. Any positions expressed by fictional characters herein regarding any particular issues or technologies do not represent the positions of CISA or the federal government.

MY ISSUE WITH THE ISSUE

Water Woes

October 25, 2029 36 Comments

When I was growing up, my mom was a proponent of "everything in moderation," especially around the holidays. Those who follow this blog regularly might figure it had something to do with my dad's tendency to overindulge each December. Lately, the adage has been on my mind for entirely different reasons. We've been exposed to a constant barrage of news about extreme weather, most recently Hurricane Emily, which washed nearly a million people out of their homes. It has me wishing Mother Nature would show more moderation.

The United States increasingly seems unable to find the Goldilocks zone between too much water and too little. The weather map is a patchwork of regions either inundated with floods and hurricanes or parched by drought and choked by wildfires.

Meanwhile, global leaders have been all too moderate in addressing three issues that might have mitigated our water woes. Chief among these is our greenhouse gas emissions. With nations set to convene on climate on the 15-year anniversary of the Paris Agreement, I find myself frustrated that many nations, ours included, have taken a measured approach toward mitigating climate change. Another problem is our aging water infrastructure, which is ill-equipped for modern threats. And finally, breakdowns in public trust have eroded our social resilience, affecting our ability to address our water challenges. A more moderate future will require an immoderate effort in these areas today.

Atmospheric Extremes

Earlier this year, the Climate Change Panel of the League of Aligned Nations released a synthesis report of its Seventh Assessment on Climate Impacts. Unsurprisingly, a central theme of the report is how efforts have fallen well short of what's necessary to limit global warming to below 1.5◦C. **[1]** The panel called for drastic action to curb even more damaging effects from climate change.

To many, the Seventh Assessment doesn't really say anything new. As one climate expert put it to me, "We could have just relabeled 'Sixth' with 'Seventh,' then inserted 'very' everywhere to emphasize that things will be even worse and that we need to do even more." Nevertheless, for many Americans, the report comes at a time when they find it much easier to see the impacts of climate change in their own backyards. The term "extreme weather" feels more and more like a misnomer since extreme has become normalized. **[2]** To date this year, there have been more than 160 presidential disaster declarations. **[3]** The vast majority of these disasters are linked to problems with water:

- **Atmospheric rivers.** Ten years ago, few people knew what an "atmospheric river" was. [4] Today, it has become a dreaded phenomenon on the West Coast, releasing longer and more intense bursts of rain. The phenomena captured national headlines in 2025, when a sequence of atmospheric rivers triggered more than 800 landslides, forced tens of thousands to evacuate, and killed at least 40. [5] Since then, two additional winters of severe atmospheric rivers have assaulted the Pacific Coast. And some researchers worry the next "Big One" will be a megaflood that could unleash devastation three times as costly as a major San Andreas earthquake. [6]

- **Drought.** We are closing out our third decade of megadrought in the Southwest. [7] As crop yields and power generation have suffered, tensions over access to water are on the rise. The drought is undoubtedly at least partly responsible for increasing suicide rates among farmers. [8] Yet another shutdown of barge traffic on the Mississippi River last fall backed up thousands of barges and caused major delays in getting agricultural exports to market. [9]

- **Hurricanes.** Hurricanes pounded the United States this year, with Hurricane Emily being the fourth to make landfall. [10] The season literally left no port in the Southeast untouched, causing billions of dollars in damage and lost productivity.

- **Wildfire.** The annual fire season has all but disappeared, with tens of thousands of wildfires consuming millions of acres year-round. This decade has already claimed three of the top five years in terms of acreage burned. [11] Major fires in one North Central state in 2027 and the Adirondacks in 2028 shut down two major cities for days and ended any sense that forest fires were just a concern for Westerners.

The Difficult Path to Net Zero

It's no secret that the United States will fall short of its pledge to reduce greenhouse gas emissions by 50 percent to 52 percent below 2005 levels in 2030. [12] According to the most recent outlook, the United States is on track to achieve a 35 percent emissions reduction. Even this progress was partly unearned because of slower-than-projected economic growth. Some underlying factors in key sectors include the following:

- **Transportation sector.** Despite forecasts that EVs would overtake gasoline cars by 2030, they currently account for just 38 percent of sales. Resistant buyers cite cost constraints (sticker prices only reached parity with gasoline cars this year), supply constraints, and persistent concerns over access to fast charging stations. Building a national network of EV charging stations took longer than expected, slowed by supply chain shortages and the need for grid improvements. Although nearly a half-million charging stations have been built, vandalism, maintenance, and equitable access to charging have been persistent issues. [13]
- **Energy sector.** Progress has been uneven, with areas such as the Gulf Coast seeing slower progress toward renewables implementation at scale. Efforts to establish a Gulf-wide council to coordinate energy transition efforts never gained traction, hindering the ability to maximize federal incentives and resources. For example, workforce development and reskilling to support the energy transition has lagged, suffering from fragmented and duplicative efforts. As a result, carbon capture and geothermal companies complain of a skills shortage despite layoffs in oil exploration.
- **Industrial sector.** One bright spot has been the implementation of advanced manufacturing techniques to increase energy and operational efficiencies in manufacturing, chemicals, and

oil and gas. But new materials and greener processes haven't substantially moved the needle on greenhouse gas emissions yet.

Collectively, these and other challenges have led to a widening gap between projected versus realized emissions reductions.

Aging Infrastructure

Another key factor contributing to our country's water woes is the poor state of existing water infrastructure. Pumping equipment and pipes in more than half of our major cities are working well beyond their intended operational lifetimes. **[14]** Stressed by events such as extreme rainfall, they fail, pressure becomes intermittent, and water becomes undrinkable. In the past five years, 11 of the 25 largest U.S. cities left hundreds of thousands of residents without access to safe drinking water for weeks at a time. And water treatment plants have been challenged by new risks like cyberattacks and the "forever chemicals" perfluoroalkyl and polyfluoroalkyl substances, or PFAS. **[15]** Meanwhile, the increasing frequency of massive, harmful algae blooms **[16]** have made clogged infrastructure an almost annual problem for some water treatment plants.

This decade started on an optimistic note, with federal laws that included funding to upgrade water infrastructure. **[17]** But the billions allocated were not enough to spread around more than 148,000 public water systems. And later in the decade, facing an economic slowdown and fearful of foreign supply chain dependencies, Congress prioritized incentivizing investment in human and physical capital for manufacturing of critical technologies such as semiconductors. Federal support for water infrastructure once again slowed to a trickle, and usage fees—which experienced only modest increases nationwide on average—couldn't compensate. Those shortfalls also slowed the development of the water workforce, even as retirements drained water utilities of critical knowledge. **[18]** Water authorities reverted to the reactive status quo: operate until failure.

The 2028 shutdown of the XYZ semiconductor megaplant served as a reminder that advanced manufacturing still depends on investments in water infrastructure. The poster child for America's reemergence in semiconductor fabrication, producing some 60,000 wafers a month, XYZ was forced to shut down because of a cyberattack that targeted the standalone water treatment facility that provided essential, ultrapure water and water recycling. Like many water treatment facilities, it lacked sufficient cybersecurity, allowing criminal hackers to damage critical equipment in the water plant, which in turn crippled the factory.

An Absence of Trust

Access to water is considered a human right, and denial of water access has led to severe breakdowns in trust, particularly between underserved communities and government. Longstanding environmental injustice, punctuated by historic water crises created a legacy of mistrust. **[19]** In 2026, the Great Lakes city of Wirlingston was struck by a 500-year rainfall event that knocked out power and water. In the days that followed, a prolonged heatwave further stressed power restoration and led to large-scale sheltering and water distribution operations for more than a week. Civic leaders and environmental justice advocates angrily denounced the systemic failure to provide safe drinking water. Three years later, a utility payments boycott threatens the local utility with bankruptcy.

In the drier West, mistrust is further complicating problems with inaccurate accounting of water, groundwater overallocation, and water rights. Two recent incidents illustrate the rising tensions. In the first, a large-scale expansion of the JKLMNO manufacturing facility was met with strong protests about water consumption despite company promises to recycle nearly 100 percent of water used. [20] After malicious actors vandalized a water diversion system, officials admitted they could not guarantee the physical security of water infrastructure given the large networks involved in transporting water. [21] Instead, they focused on public education about the planned expansion. One CISA official commented, "Given the lack of trust that exists in the country about water rights, we're concerned that individuals may be more susceptible to influence by opportunistic foreign adversaries."

A second incident of mistrust shows rising tempers over the foreign acquisition of farmland and its associated water rights. Anger has led to recent bills attempting to broaden existing state prohibitions on foreign adversaries owning American farmland. [22] Much of this ire has focused on the export of "virtual water" in the form of water-intensive commodities. [23] Two people were even caught attempting to set nearly 100 hay bales of alfalfa for export on fire.

Final Thoughts

Climate change, aging infrastructure, and public trust all represent longstanding, tough-nut problems. They have been exacerbated by a lack of dedicated, well-resourced attention. The upcoming climate change meeting represents another opportunity to take bold steps toward addressing at least one of these problems. Moderate progress is no longer enough if we want to address our country's current problems with water. A colleague reminded me that my mother had left out a key part of the quote. It should be: "Everything in moderation, including moderation."

DETAILED SCENARIO BREAKDOWN: WATER WOES

Please note: The version of the narrative that the facilitator possesses has line numbers for ease of identifying key segments of the scenario narrative (as referenced in the table below). These segments are also labeled with reference numbers.

Ref No.	Line #	Narrative Reference Text	Additional Comments DP = Discussion Point INFO = Additional Information NOTE = Clarification/Rationale CONCERN = Potential issue, threat, or vulnerability
1	22	…what's necessary to limit global warming to below 1.5◦C.	**INFO:** Parties to the 2015 Paris Agreement agreed to "pursue efforts to limit the temperature increase to 1.5◦C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change."
2	29	The term "extreme weather" feels more and more like a misnomer since extreme has become normalized.	**INFO**: Although definitions vary, the 2016 study *Attribution of Extreme Weather Events in the Context of Climate Change* defines *extreme weather* events as events that are rare for a particular location (and sometimes for the time of year), in which "rare" refers to occurrences at the highest or lowest percentiles based on a historical distribution of measurements (e.g., 1st, 5th, 95th, 99th).
3	30	To date this year, there have been more than 160 presidential disaster declarations.	**INFO:** This number reflects an unusually large number of presidential disaster declarations. From fiscal year (FY) 2017 to 2022, for example, the number of presidential disaster declarations each year was 135, 132, 102, 315, 123, and 98, respectively. FY 2020 is an outlier, with counts surging because of separate disaster declarations issued for different states.
4	32	…what an "atmospheric river" was.	**INFO:** Atmospheric rivers are long, narrow regions in the atmosphere that transport moist air from the tropics to higher latitudes. A strong atmospheric river transports an amount of water vapor equivalent to 7.5 to 15 times the average flow of liquid water at the mouth of the Mississippi River. On average, atmospheric river events contribute to approximately 30–50 percent of annual precipitation in West Coast states.
5	36	The phenomena captured national headlines in 2025, when a sequence of atmospheric rivers triggered more than	**INFO:** Nine separate atmospheric rivers struck California from December 27, 2022, to January 16, 2023. More than 32 trillion gallons of water rained on the state, leading to significant flooding in areas of the Central Valley, Salinas Valley, and Santa Cruz Mountains and resulting in power outages and mudslides. The severe

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		800 landslides, forced tens of thousands to evacuate, and killed at least 40.	winter storms related to the atmospheric rivers led the governor to proclaim a state of emergency and to request both emergency and major disaster declarations.
6	39	And some researchers worry the next "Big One" will be a megaflood that could unleash devastation three times as costly as a major San Andreas earthquake.	**INFO:** The Great Flood of 1861–62 in California inundated the Central Valley and Los Angeles and Orange Counties, killing thousands and destroying one-third of the state's taxable properties. Six rainfall events of severity similar to or even greater than the Great Flood of 1861–62 have struck California in the past 2,000 years. A 2011 study applied a plausible hypothetical storm to model a potential great flood scenario. Based on the model, the storm could flood up to 25 percent of buildings in the state, breach 50 levees, and force the evacuation of 1.5 million people, resulting in $1.1 trillion in damages (when adjusted to 2023 dollars).
7	40	We are closing out our third decade of megadrought in the Southwest.	**INFO:** Since 2000, southwestern North America has been in a "megadrought" because of low precipitation totals and heat. A 2022 study published in *Nature Climate Change* ranked 2000–2021 as the driest 22-year period for the region since 800 CE. **DP:** ▪ What potential concerns could arise for critical infrastructure systems from "chronic" stressors such as megadrought (versus acute natural hazards)? ▪ What risks emerge or are exacerbated when a disaster takes place against the backdrop of a persisting hazard (e.g., prolonged heat wave, drought)?
8	43	…at least partly responsible for increasing suicide rates among farmers.	**INFO:** A December 2021 study published in *Science of the Total Environment* found a link between drought and increased occupational psychosocial stress among farmers.
9	44	Yet another shutdown of barge traffic on the Mississippi River last fall backed up thousands of barges and caused major delays in getting agricultural exports to market.	**INFO:** In 2022, drought led to low water levels in the Mississippi River, which backed up more than 2,000 barges and delayed transport of crops, fuel, coral, industrial materials, and building materials. **CONCERN:** Supply chain disruptions introduced by extreme weather and climate change effects **DP:** What other connections between extreme weather and supply chains are you concerned about?

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10	46	…with Hurricane Emily being the fourth to make landfall.	**NOTE:** This reflects an unusually large number of hurricane landfalls. Between 2011 and 2020, for example, 19 hurricanes made landfall. **DP:** ▪ What additional challenges and risks arise for critical infrastructure systems as the frequency of natural hazards (e.g., wildfire, hurricanes) increases and affects the ability of communities to recover before the next incident? ▪ How does this alter the approach to mitigation?
11	50	This decade has already claimed three of the top five years in terms of acreage burned.	**NOTE:** This is meant to continue a trend of increasing wildfire risk associated with climate change. Three of the top five years for acreage burned by wildfire (since 1960) have been in recent years (2015, 2017, and 2020).
12	55	…the United States will fall short of its pledge to reduce greenhouse gas emissions by 50 percent to 52 percent below 2005 levels in 2030.	**INFO:** This reflects a target announced by the Administration in April 2021.
13	65	Although nearly a half-million charging stations have been built, vandalism, maintenance, and equitable access to charging have been persistent issues.	**INFO:** This reflects a target announced by the Administration. The Bipartisan Infrastructure Law includes $7.5 billion for EV charging. In a 2021 survey by Plug In America, the most commonly identified challenge with public charging networks was finding chargers that were nonfunctional or broken. **DP:** What physical and cybersecurity risks do you see potentially emerging with the massive deployment of interoperable EV chargers? **CONCERN:** Cybersecurity vulnerabilities associated with EV charging infrastructure.
14	82	Pumping equipment and pipes in more than half of our major cities are working well beyond their intended operational lifetimes.	**INFO:** Most of the nation's water infrastructure was built before the 1950s. Cast iron pipes represent the largest pipe material inventory in North America, and 82 percent of all cast iron pipes were over 50 years old as of 2018. **CONCERN:** Increasing incidents of failure, resulting in disruptions to water delivery and cascading impacts on other sectors
15	86	…the "forever chemicals" perfluoroalkyl and polyfluoroalkyl, or PFAS.	**CONCERN:** As noted in the narrative, a common characteristic of these chemicals is that they break down very slowly. As a result, they can build up in people, animals,

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			and the environment over time. The Centers for Disease Control and Prevention (CDC) recognizes increased risk of severe and chronic diseases from PFAS exposure. The health implications of both high-level acute and low-level chronic exposure to many chemicals are poorly understood or underestimated.
16	87	…harmful algae blooms…	**CONCERN:** Harmful algal blooms (HABs) are overgrowths of algae in marine or freshwater that can result in dangerous toxins and depletion of dissolved oxygen, making the aquatic system uninhabitable. HABs affect water quality and can clog infrastructure. If not detected and treated, the toxins can lead to sickness and even death.
17	90	…with federal laws that included funding to upgrade water infrastructure.	**INFO:** The 2021 Bipartisan Infrastructure Law authorized $55 billion for water initiatives over five years.
18	97	…even as retirements drained water utilities of critical knowledge.	**CONCERN:** The Water and Wastewater Sector is dealing with a rapidly aging workforce, creating major labor shortages in some areas and risking the loss of institutional knowledge across the sector. Between 2016 and 2026, an estimated 10.6 percent of Water and Wastewater Sector workers will retire or transfer each year, with some utilities expecting as much as half of their staff to retire in the next 5 to 10 years.
19	108	…historic water crises created a legacy of mistrust.	**INFO:** ▪ In 2014, the city of Flint, Michigan, switched its water supply. The supply pipes suffered major corrosion and lead leached into the water, resulting in widespread lead exposure for the local community. In January 2016, the President issued an emergency declaration to provide federal support for the water crisis response and recovery. ▪ Budgetary constraints prevented Jackson, Mississippi, from performing necessary water utility repairs, which has resulted in frequent water system failures and boil water notifications. In August 2022, flooding from severe storms led to a weeks-long failure of the OB Curtis Water Plant, leaving approximately 150,000 residents without access to safe drinking water and leading the President to issue an emergency declaration.

Ref No.	Line #	Narrative Reference Text	Additional Comments DP = Discussion Point INFO = Additional Information NOTE = Clarification/Rationale CONCERN = Potential issue, threat, or vulnerability
20	119	…despite company promises to recycle nearly 100 percent of water used.	**NOTE:** Some semiconductor manufacturing facilities in the United States already claim to capture and restore the majority of their water for reuse.
21	121	After malicious actors vandalized a water diversion system, officials admitted they could not guarantee the physical security of water infrastructure given the large networks involved in transporting water.	**CONCERN:** Because of the large number of water resources and because they are often geographically widespread, water systems are extremely difficult to protect from theft, intentional contamination, or intentional damage. For example, water thieves dug an illegal diversion canal from one city's water source to irrigate illegal marijuana farms, diverting roughly one-fifth of the city's water and causing a major drop in pressure that led to boil water advisories for the entire water system.
22	127	…to broaden existing state prohibitions on foreign adversaries owning American farmland.	**NOTE:** Numerous states specifically forbid or limit foreign ownership of farmland within their state. As of July 2023, no federal law exists that restricts foreign persons, entities, or governments from acquiring or holding U.S. agricultural land. However, legislation has been proposed, for example, that would prevent select countries from acquiring U.S. farmland.
23	128	…export of "virtual water" in the form of water-intensive commodities.	**INFO:** Virtual water transfer is water embodied in the production and trade of commodities. On a macro scale, this can result in large amounts of water being consumed for the production of goods that leave an area as exports.

SCENARIO #2: GREAT POWER DISRUPTION

Please note: The version of the narrative that the facilitator possesses has line numbers for ease of identifying key segments of the scenario narrative (as referenced in the table below). These segments are also labeled with reference numbers.

BRIEF DESCRIPTION

In the 2020s, the United States finds itself in a new chapter of great power competition, this time driven by competition for technological leadership. Efforts to control key technologies such as semiconductors leads to partial decoupling internationally, onshoring of production for critical sectors, and tensions over supply chains. By 2030, despite achieving considerable gains in onshoring the manufacture of critical technologies, the United States faces an uncertain future about whether its policies and investments over the past decade will be sustainable absent permanent government subsidies and continued protectionism. Furthermore, protectionist trade and investment policies have limited U.S. access to several international markets. Meanwhile, the emergence of artificial intelligence (AI) has reshaped the landscape for both cyber offense and defense.

SCENARIO CONTEXT

- Set up as the first class of the semester for a course on great power disruption that emphasizes the role of key technologies (e.g., semiconductors) and their associated supply chains in competition among great powers. The professor outlines the course, which consists of five modules, each highlighting a different risk.
- Depicts a future in which some nations, including the United States, have favored increasing protectionism and decoupling of critical technologies in the interests of national security. Through this policy shift, the United States and many allied nations have succeeded in onshoring production of many critical resources. However, the United States faces an uncertain future regarding the sustainability of these gains.
- Explains how the global protectionist policy shift has delivered some negative side effects. Most notably, nations have elected to detach from the global internet partially or even fully, resulting in its fragmentation. In addition, trade balances and foreign direct investment flows have become siloed among geopolitically aligned nations. In other words, the United States has significantly reduced trade with all nations except for its closest allies. This has resulted in diminished U.S. access to emerging markets and led to reduced economic opportunity, and thus greater instability, in developing nations.
- Describes three key trends in cyber conflict: (1) the shift from ransomware to espionage, including intellectual property theft; (2) a beneficial reduction in the volume of compromised computer components in the ICT supply chain; and (3) the evolution of cyber conflict as driven by maturing AI capabilities.

FACILITATION QUESTIONS – TAILORED

Please note: Broader, more general facilitation questions—common to all three scenarios—are located in the Scenario Breakouts section of this facilitator's guide. Additional discussion points, tied to specific portions of the scenario narrative, are listed in the scenario's "Detailed Scenario Breakdown."

- Besides semiconductors, what other critical technologies would be focal points in this era of great power disruption? Which critical intermediate goods (i.e., manufacturing inputs) would be the focal point of this era?
- Aside from decoupling critical technologies, what other policies do you believe the United States should have pursued in the 2020s? What actions might enhance the sustainability of domestic manufacturing efforts and avoid the need for permanent government subsidies?
- How should the United States balance the need to onshore the production of critical technologies with the desire to maintain access to international markets that provide valuable resources for U.S. critical infrastructure?
- What additional risks and opportunities do you see arising from decoupling efforts?
- What do you see as the key accelerators and derailers to AI's maturation and use in cyber conflict? What aspects of AI warrant greater attention to ensure future cybersecurity and resilience?
- The professor notes that regulatory progress almost always lags behind technological change. What actions can technology stakeholders take to mitigate the potential risks that may arise as a result?

The Cybersecurity and Infrastructure Security Agency (CISA) has produced these scenarios to initiate and facilitate discussion. The situations described here are hypothetical and speculative and should not be considered the position of the U.S. government. All names, characters, organizations, and incidents portrayed in these scenarios are fictitious. Any positions expressed by fictional characters herein regarding any particular issues or technologies do not represent the positions of CISA or the federal government.

September 2030

Course: CSTS-200/IR-300: Great Power Disruption: How Technological Innovation Defined a Decade of Cold Conflict

Lecture 1

As a service to students, I upload real-time transcripts of all lectures to the course site. The transcriptions are by XYZ v.23.0, and I take no responsibility for any transcription errors.

Professor Miller:

Good morning, everyone. I'm Professor Miller, and welcome to Great Power Disruption. This is a graduate seminar exploring the intersection of technological change and great power competition during the past decade.

So, who am I and why should I be teaching this class? After studying computer science as an undergraduate, I began my career as an analyst with the U.S. intelligence community. Several years later, I returned to academia to obtain my Ph.D. in history. Since then, my academic work examines how wars have influenced technological progress throughout history.

Enough about me. The name of this course, Great Power Disruption, blends two concepts: great power competition and technological disruption. **[1]** *Great power competition* refers to rivalry among the most powerful nations in the world. The best-known historical example is the 20th-century Cold War. Throughout history, we have experienced numerous chapters of great power competition, often driven by some mix of religion, politics, or imperial aspirations. Great power competition in the most recent decade has been propelled by several factors, but the most significant driving force is competition for technological leadership. You can see that, in the course name, I've replaced the word *competition* with *disruption* to reference both the inherently disruptive nature of technological innovation and the emergence of technology as a core driver of great power competition.

I've divided the course into five modules, and I'd like to begin today by reviewing the syllabus so you know what to expect this semester. Stop me at any point if you have questions. If there's time at the end of class, we'll dive into the first module.

In module 1, we'll begin by looking at the early 2020s. Washington was increasingly concerned that the United States was losing its edge in the design and manufacture of key technologies, most notably semiconductors **[2]**, memory chips, and other components in everyday electronics and dual-use—meaning military and civilian—technologies. Concern quickly evolved into competition, accelerating an international race for technological supremacy and control of key supply chains.

In module 2, we will discuss the geopolitical tensions that emerged from the decisions made in the early 2020s. For example, enhanced competition for control of critical minerals led to regional proxy conflicts among great powers that took place in developing nations. [3] These conflicts created domestic economic and political challenges in the United States that persist today. Global standard-setting organizations, particularly those involved in setting internet standards, also felt the strain of great power disruption. We've seen nations across the political spectrum choose to detach from the global internet partially or even fully. [4] This pivot away from a shared, online, global commons and toward internet fragmentation is emblematic of this historical moment of competition for control of technological progress.

In module 3, we will focus on the online battlefield. Cyber conflict, which became an expansive tool for shaping geopolitical outcomes during the early 21st century, continues to evolve. The ransomware threat has dissipated somewhat since its peak a few years ago. I would credit this progress to improved cross-sector cyber resilience and corporate resistance to paying ransoms. Companies are better prepared to maintain operational continuity during an attack and often see little value in paying a ransom that may not restore their systems anyway. Ransomware does remain a threat, particularly for organizations that possess sensitive personal data, such as hospitals. But the overall risk has diminished; the main battlefield of great power cyber conflict has been espionage, including intellectual property theft. This trend has reached all-time highs in recent years, enabled in part by significant advances in artificial intelligence [5], more commonly known as AI. Cyber threat actors have, for example, begun to leverage large language models (LLMs) to develop novel network penetration techniques. LLMs have essentially democratized access to advanced cyber toolkits because threat actors with minimal technical capability can leverage LLMs to build advanced cyber weapons in minutes.

You have a question?

Student 1:

Yes, excuse me, professor. In module 3, will we discuss last year's water cyberattack in Mittleridge? I'm from that area, and I read that they 3D-printed a component to get the water flowing again.

Professor Miller:

Thanks. That is a good example, and we'll certainly discuss it. For those who are not aware, last year there was a cyberattack on a SCADA system for a major water treatment facility just outside the city of Mittleridge in the Midwest.

Student 1:

SCADA?

Professor Miller:

That stands for supervisory control and data acquisition. SCADA is basically a network to control machines and processes. This attack is indicative of the trend I just mentioned about AI in cyber offense. The attackers leveraged AI in two ways. First, they leveraged an LLM to create spear phishing emails sent to employees. The emails enabled the attackers to gain initial access to the network. Second, once the perpetrators had access to the SCADA system, they deployed a strain of

polymorphic malware that leveraged AI code generative techniques to synthesize new malware variants autonomously. [6] In other words, after it was deployed, the malware adapted to the target environment to evade detection.

In addition to our discussion of the intersection between AI and cyber conflict, the Mittleridge plant example is also relevant to advanced manufacturing, which we'll discuss later in the course. The attack caused physical damage to several components of the plant, forcing the water treatment facility to halt operations for three days. Instead of waiting several weeks, or perhaps months, for replacement components from the original manufacturer, the water plant found a 3D printing company that was able to build replacements in less than two days. [7] Notably, the 3D printing company had formed just a few years earlier with the support of federal funding appropriated by Congress in 2025 to invest in domestic advanced manufacturing.

We'll get back on track with the syllabus in a minute, but while we're on this interesting example, I'll point out that it intersects with several key themes of this class:

- One, critical infrastructure remains at risk in the era of great power competition.
- Two, government-funded industrial policy has delivered proven domestic benefits (in this case, a strategic advantage in advanced manufacturing).
- Three, the proliferation of AI in cyber offense over the past decade has significantly lowered the barriers to entry for cyber intrusions. As a result, cyber resilience and rapid recovery are essential, particularly for critical infrastructure operators.

One more thought before we get back to the syllabus: regulatory progress almost always lags behind technological change. In this case, the urgent need to rapidly restore operations forced the water plant to adopt an untested technology for which no regulatory framework exists. There are no federal laws that regulate quality standards for 3D-printed components or whether critical infrastructure operators can use them. Think about what problems can arise from this. Should the plant have been permitted to use a 3D-printed component, even temporarily? What are the costs and benefits of such an approach? I see a lot of hands up. I'd like to postpone this discussion for a later class. It's an ongoing debate.

Student 1:

We'll be ready.

Professor Miller:

Let's get back to the course overview. As I have mentioned, generative AI has had a transformative effect on cyber offense over the past decade. As a result of improved efficiency in LLM training and expanded access to high-end graphics processing units, cyber threat actors can develop custom trained LLMs on a laptop in a matter of hours. [8] Attackers can leverage this to rapidly build and deploy new capabilities. In this way, AI development over the past decade has effectively raised the floor of cyber offense such that even the least technically capable adversaries can generate technically advanced attacks.

On a more positive note, AI has led to significant developments for cybersecurity defenders. Machine learning has proven to be a highly effective tool to augment network intrusion detection, helping to

mitigate some of the AI-supercharged advances in cyber offense. [9] However, AI can be a drag on security in the development phase. Software developers are increasingly leveraging LLMs to handle basic coding workloads. These LLMs often recommend insecure code that contain a myriad of vulnerabilities, further complicating the work of security professionals. Broadly speaking, the past decade of AI advancement has, despite some successes, proven challenging for security professionals.

In the final section of module 3, we will discuss the role of the information and communications technology supply chain, or the ICT supply chain, in cyber conflict. Specifically, we'll look at the history of cybersecurity risks from compromised computer components in the supply chain.

That leads us to module 4, where we will assess the policy responses adopted by the United States, its allies, and its rivals in the pursuit of great power disruption. In the early 2020s, U.S. political leaders in both parties identified key technologies where partial economic decoupling could be advantageous for national security. The United States has devoted significant resources over the past decade to industrial policies that subsidize the domestic development and production of critical technologies. [10] The federal government has also worked to reorient critical supply chains away from rival nations [11] and embraced initiatives to source materials from domestic or trusted international sources. This process has not been without its challenges, most notably those proxy conflicts in resource-rich regions. Finally, the United States has strengthened its export controls on American-designed innovations in an attempt to contain the benefits of technological progress within national borders.

There's a hand up.

Student 2:

Thanks. I'd like to know if you think these policies have been successful. Because I watched an ILuminate Talk that said they've failed.

Professor Miller:

That is one of the key questions each of you will be wrestling with in this class. But here are a few thoughts to get you started.

Has the United States succeeded in onshoring significant production capacity for critical technologies? Yes. That is a clearly measurable outcome of these policy initiatives. Has this onshoring effort led to a meaningful improvement in the nation's national security posture? Likely yes, but this is a tricky question that we will explore in depth throughout the course. Have there been negative side effects of this effort? Certainly, and we will talk about one economic side effect shortly. So, the answer to whether they've succeeded or failed depends on how you define success and for whom.

Regarding supply chains, the United States has not fully decoupled from major trading partners who are also geopolitical competitors. That's proven to be impractical, both economically and politically. But the United States has at least meaningfully reduced its dependence on imports of critical tech components from adversarial nations.

As for export controls, there is actually evidence that withholding tech exports from competing nations may have helped propel them to build the technologies themselves. That was certainly not the intent of the policy. This result cuts both ways, as it likely slowed down the competitors' progress in certain industries that relied on our products, but it also spurred the development of domestic industries in these countries that now compete with the United States globally. Further complicating this picture is the dramatic rise in intellectual property theft that may be a by-product of export controls. Overall, their impact has been mixed.

Broadly speaking, we can identify some wins today that have emerged from these policies, but the overall results are complex and sometimes ambiguous. This semester, you all will be analyzing specific case studies to determine the impact of these policies and gain insight into what might happen next.

Student 2:

Sounds great. Thanks.

Professor Miller:

For the last module in the class, module 5, we will look ahead to the 2030s. How sustainable will U.S. policies prove to be in this decade? For example, many of the government subsidies for advanced manufacturing of critical technologies are set to expire in 2032. [12] It is not clear whether these new domestic industries will be sustainable without permanent government support. There are many factors at play here, but does anyone know a key reason why this might be the case?

Student 3:

Maybe the cost of building new manufacturing plants, which is often cheaper in other countries.

Professor Miller:

Exactly! And these high-tech factories are not only costly to build, they are also very expensive to maintain. In the 20th century, factories could be easily retooled to manufacture the next generation of hardware. Today, a plant designed to build the current version of, let's say, smartphone touch screens might be largely obsolete in just a few years. To build the next generation, entirely new processes need to be built from the ground up. In short, progress in advanced manufacturing has led to highly specialized processes for each generation of technological components. Without ongoing incentives, producers will want to shift their operations to lower-cost nations to build their next generation of advanced manufacturing facilities.

I will also add an addendum here about AI—a topic that permeates nearly everything that we will discuss in this course. Advanced manufacturing plants have experimented with leveraging AI to improve efficiency and reduce costs. However, adoption remains sluggish due to several challenges, including a lack of a unified framework for implementing AI in advanced manufacturing and insufficient high-quality data to train AI models for certain aspects of the manufacturing process. Given some well-publicized failures, broader concerns about AI's disruption of the workplace, and the continued black-box nature of AI algorithms, operators in these plants have also expressed reluctance and a lack of trust in AI.

So that's module 5. Any final questions about the syllabus? If not, let's jump into module 1.

Why do we care so much about what happened in the early 2020s? Let's start by looking at two seminal moments in recent history and see how each ties back to precipitating events in the early 2020s. Last year, in 2029, two major announcements made headlines:

One, the International Monetary Reserve, or IMR, projected that global annualized real economic growth would remain below 3 percent per year for the next 5 to 10 years. [13]

And two, the United States announced plans to eliminate reliance on foreign produced semiconductors by 2035. [14]

Thinking about these two announcements, let's consider a few key questions: What trends or decisions visible in the early 2020s led to these two outcomes? What do they have in common?

Sorry, I haven't learned your names yet. Let's hear next from you, in the blue shirt.

Student 4:

Well, inflation in the early and mid-2020s led to less accommodative interest rates than we had in the 2010s. Interest rates remain economically neutral or slightly restrictive in most developed economies today. This could help to explain below-trend growth.

Professor Miller:

Absolutely, that is a key factor impacting the IMR projection. What else?

You, in the hoodie.

Student 5:

As you said when we were reviewing module 4, nations around the world have spent the past decade partially reorienting away from international free trade toward protectionism and government-funded onshoring of production for critical sectors. Wouldn't the United States eliminating reliance on foreign semiconductors be a continuation of that trend? And limiting free trade would definitely be a drag on global economic growth.

Professor Miller:

Correct on both counts. This is a critical point.

In the name of great power competition, the United States has embraced partial trade protectionism and domestic industrial policy. And this trend is global. While complete economic decoupling is not likely, partial decoupling in certain sectors has reshuffled multitrillion-dollar industries. The United States has succeeded in onshoring significant production capacity for a wide variety of critical components, including semiconductors. However, the global push to onshore production sacrifices economic efficiencies inherent in international free trade, contributing to slower growth and higher prices.

This is emblematic of great power disruption. Nations have brazenly competed to master the next technological age and harden domestic industrial resilience at the expense of global economic

cooperation. [15] We see the results of these decisions in our economic and international trade data today.

Unfortunately, that's all the time we have today. I hope you now have a sense of what to expect this semester as we look back at the past decade of great power disruption. Don't forgot to read Michelsontz chapters 4 and 5 for next class. And if you have questions, I will be in my office on Thursday. See you next week.

DETAILED SCENARIO BREAKDOWN: GREAT POWER DISRUPTION

Please note: The version of the narrative that the facilitator possesses has line numbers for ease of identifying key segments of the scenario narrative (as referenced in the table below). These segments are also labeled with reference numbers.

Ref No.	Line #	Narrative Reference Text	Additional Comments DP Discussion Point INFO Additional Information NOTE Clarification/Rationale CONCERN Potential issue, threat, or vulnerability
1	15	…Great Power Disruption, blends two concepts: great power competition and technological disruption.	**NOTE:** *Great power competition* refers to rivalry among the most powerful nations in the world. The best-known historical example is the 20th-century Cold War between the United States and the Soviet Union. As noted in the scenario narrative, great power competition in the most recent decade has been propelled by several factors, the most significant of which is competition for technological leadership. To reflect this current state, the word *competition* is replaced with *disruption* in the scenario title to reference both the inherently disruptive nature of technological innovation and the emergence of technology as a core driver of great power competition.
2	28	…[in] the early 2020s. Washington was increasingly concerned that the United States was losing its edge in the design and manufacture of key technologies, most notably semiconductors…	**INFO:** This is the backdrop that began a decade of great power disruption. Various factors in the late 2010s led to this moment, including expanding foreign dominance in advanced semiconductor manufacturing and supply-chain bottlenecks highlighted during the COVID-19 pandemic.
3	33	…enhanced competition for control of critical minerals led to regional proxy conflicts among great powers that took place in developing nations.	**NOTE:** Ongoing international competition in the technology sphere led to numerous challenging outcomes in the mid- to late-2020s. For example, manufacturing critical technologies requires natural resource inputs, many of which are either rare or are only abundant in certain regions of the world. This initially sparked fierce competition between businesses and governments and, in a few cases, devolved into regional proxy conflicts between great powers in the name of controlling access to critical resources overseas. This is great power disruption at work. **DP:** How should we balance the needs of the United States to maintain reliable access to critical natural resources with the interests of supporting stability and peace overseas?

Ref No.	Line #	Narrative Reference Text	Additional Comments DP Discussion Point INFO Additional Information NOTE Clarification/Rationale CONCERN Potential issue, threat, or vulnerability
4	37	…nations across the political spectrum are choosing to detach from the global internet partially or even fully.	**NOTE:** A second example of great power disruption at work in public policy is the ongoing push among nations to localize and insulate internet access, resisting the historical preference for a free and open internet. **INFO:** This is in reference to two key trends. First, authoritarian nations have chosen to develop bespoke versions of internet protocols (such as Domain Name System [DNS]) to build a closed-loop domestic internet environment. Second, democratic nations have taken targeted steps to limit their exposure to international internet traffic. These initiatives most often seek to screen out certain unlawful internet activity coming from overseas, as well as support data protection and data localization laws. **CONCERN:** The pivot away from a shared online global commons and toward internet fragmentation is emblematic of this historical moment of competition for control of technological progress. **DP:** What do we lose as a global society if we continue to shift away from a shared global internet? What might we gain?
5	49	…intellectual property theft….has reached all-time highs in recent years, enabled in part by significant advances in artificial intelligence…	**NOTE:** As competition among international businesses intensified through the mid- to late-2020s, intellectual property theft expanded to all-time highs. These threats most often originate from companies that operate in countries without laws protecting against Internet Protocol (IP) theft and cyber intrusion. As such, U.S. companies are the victims and not the perpetrators of such acts. **CONCERN:** Cyber threat actors have begun to leverage LLMs to develop novel network penetration techniques. This has essentially democratized access to advanced cyber toolkits as threat actors with minimal technical capability can leverage LLMs to build advanced cyber weapons in minutes. **DP:** What steps should U.S. companies take to mitigate this threat? What steps, if any, should the U.S. government take?

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6	71	…cyberattack on a SCADA system for a major water treatment facility….they deployed a strain of polymorphic malware that leveraged AI code generative techniques to synthesize new malware variants autonomously.	**CONCERN:** ▪ Critical infrastructure remains at risk in the era of great power competition. Industrial control system (ICS) SCADA, in particular, remains a weak point in the security posture of U.S. critical infrastructure. ▪ The proliferation of AI in cyber offense over the past decade has significantly lowered the barriers to entry for cyber intrusions. As a result, cyber resilience and rapid recovery is essential, particularly for critical infrastructure operators. **DP:** What steps can be taken today to limit the potential harms of AI when it is used for cyber offense? What steps can be taken to better protect ICS SCADA systems from attack, especially those operated by critical infrastructure providers?
7	78	…the water plant found a 3D printing company that was able to build replacements in less than two days.	**NOTE:** The SCADA system cyberattack caused damage to numerous components at the water treatment facility. One component in particular could not be replaced quickly from the original manufacturer. Instead, the plant contracted a 3D printing company to build a replacement much faster. **DP:** How should government agencies approach regulating the use of 3D-printed components in critical infrastructure?
8	103	As a result of improved efficiency in LLM training and expanded access to high-end graphics processing units, cyber threat actors can develop custom trained LLMs on a laptop in a matter of hours.	**CONCERN:** Attackers can leverage this capability to rapidly build and deploy new capabilities. In this way, AI development over the past decade has effectively raised the floor of cyber offense such that even the least technically capable adversaries can generate technically advanced attacks.
9	109	Machine learning has proven to be a highly effective tool to augment network intrusion detection, helping to mitigate some of the AI-supercharged advances in cyber offense.	**NOTE:** On the flip side of the AI cybersecurity story, cyber defenders have been able to leverage machine learning to enhance and automate certain cybersecurity activities, including network monitoring, malware analysis, and email traffic filtering. **DP:** On balance, will advances in AI present more of a threat or opportunity for cybersecurity?

Ref No.	Line #	Narrative Reference Text	Additional Comments DP Discussion Point INFO Additional Information NOTE Clarification/Rationale CONCERN Potential issue, threat, or vulnerability
10	123	…partial economic decoupling could be advantageous for national security. The United States has devoted significant resources…to industrial policies that subsidize the domestic development and production of critical technologies.	**NOTE:** This is in reference, primarily, to the CHIPS and Science Act of 2022, a bill that delivers $280 billion in subsidies and incentives over 10 years. The Inflation Reduction Act (IRA) of 2022 also provides significant incentives for onshoring manufacturing. Although the latter of these two legislative initiatives did not garner broad support in the U.S. Congress, the underlying theme of unwinding globalization maintains bipartisan momentum throughout the decade. **DP:** What are the economic and national security implications of the policy in the long run? How might it affect the global economy? U.S. critical infrastructure?
11	124	The federal government has also worked to reorient critical supply chains away from rival nations…	**NOTE:** ▪ Inherent in the ongoing U.S. strategy of limited globalization are limits on the expansion of trade relations with all but the most closely allied foreign nations. By the mid-2020s, nations with active free trade agreements with the United States have increased exports to the United States while those nations without such agreements in place have seen exports decline. ▪ U.S. policy-makers state that the rationale for this policy is twofold. First, shifting supply chains help the United States and its closest allies reduce their reliance on trade with rival nations. Second, expanding trade with only the most reliable and stable partners reduces the risk of future supply-chain bottlenecks. **CONCERN:** ▪ A retreat from foreign direct investment in emerging markets has led to uneven pockets of economic contraction around the world. By the late 2020s, an emerging markets debt crisis looks increasingly probable. ▪ Many of the nations that have been excluded from wealthy markets as a result of this policy shift have significant natural resources to offer that are critical for various manufacturing inputs but are struggling to bring their products to market in an increasingly economically divided world. **DP:** What are the costs and benefits to critical infrastructure of limiting globalization in this way?

Ref No.	Line #	Narrative Reference Text	Additional Comments DP Discussion Point INFO Additional Information NOTE Clarification/Rationale CONCERN Potential issue, threat, or vulnerability
12	163	…many of the government subsidies for advanced manufacturing of critical technologies are set to expire in 2032.	**NOTE:** This is in reference, primarily, to the CHIPS and Science Act of 2022, a bill that delivers $280 billion in subsidies and incentives over 10 years. The IRA of 2022 is also a 10-year plan, with a stated investment amount of $369 billion in domestic clean energy supply chains, although that cost could exceed $1 trillion. **CONCERN:** Tranches of CHIPS Act funding will expire between 5 and 10 years after the bill's passage, with full completion occurring in 2032. IRA subsidies will expire in 2032. **DP:** It is not yet clear whether the new domestic industries, created as a result of the CHIPS Act and the IRA, will be sustainable without permanent government support. **INFO:** In the 20th century, factories could be easily retooled to manufacture the next generation of hardware. Today, a plant designed to build the current version of, let's say, smartphone touch screens might be largely obsolete in just a few years. To build the next generation, entirely new processes need to be built from the ground up. In short, progress in advanced manufacturing has led to highly specialized processes for each generation of technological components. Without ongoing incentives, producers may want to shift their operations to lower-cost nations.
13	190	…projected that global annualized real economic growth would remain below 3 percent per year for the next 5 to 10 years.	**DP:** What are the likely causes of this persistent below-trend growth? What policies might be effective at improving the situation? Are these policies worth pursuing or do they come at too high of a cost?
14	192	…the United States announced plans to eliminate reliance on foreign produced semiconductors by 2035.	**INFO:** By 2029, the United States has succeeded in onshoring significant production capacity for a wide variety of critical components, including semiconductors. This shift is attributable to a government-funded effort to onshore production and purchase semiconductors from trusted nations in other parts of the world. **DP:** What level of decoupling is warranted to balance the benefits of free trade with the security needs of trusted supply chains for critical technologies?

Ref No.	Line #	Narrative Reference Text	Additional Comments DP Discussion Point INFO Additional Information NOTE Clarification/Rationale CONCERN Potential issue, threat, or vulnerability
15	220	Nations have brazenly competed to master the next technological age and harden domestic industrial resilience at the expense of global economic cooperation.	**NOTE:** Great power disruption has defined a decade of economic and foreign policy. While complete economic decoupling is not likely, partial decoupling in certain sectors has reshuffled multitrillion-dollar industries. The United States has succeeded in building more reliable supply chains and onshoring production of critical goods. **CONCERN:** In spite of the national security benefits, the global push to onshore production sacrifices economic efficiencies inherent in free trade, contributing to slower growth and higher prices. Protectionist trade policies also inherently de-emphasize the priority of international stability, particularly in emerging markets. **DP:** What are the implications of great power disruption for global stability? How has the policy shift to protectionism affected the United States' image and soft power overseas?

SCENARIO #3: DAY ZERO

Please note: The version of the narrative that the facilitator possesses has line numbers for ease of identifying key segments of the scenario narrative (as referenced in the table below). These segments are also labeled with reference numbers.

BRIEF DESCRIPTION

The city of Monroe has declared that it has less than six months of water supplies remaining and must make drastic cuts that will harshly impact both citizens and businesses. However, Monroe is just one of many cities in the United States facing a likely water crisis. There are many stresses on water systems, but one underappreciated one is the demand from the energy sector. As the United States pursues the clean energy transition (i.e., investing in alternative fuels, photovoltaics, electric batteries, etc. with the goal of reducing carbon emissions), demand for energy is increasing and, at least in the short term, this is causing increased dependence on traditional sources of energy. Energy production is a water-intensive process, as is the production of necessary equipment. The author of the scenario's fictitious essay advocates for approaching water resources more holistically: examining demand and exploring solutions across jurisdictions (where they draw from the same water sources) and across sectors, most critically the energy and agriculture sectors.

SCENARIO CONTEXT

- A news-catching water crisis serves as the hook for this scenario, which serves as an opportunity to describe a situation facing many cities in the United States: one of rapidly depleting water resources while demand continues to rise.
- The scenario quickly transitions to a discussion of national-level pressures on water resources, emphasizing the enhanced demand from the clean energy transition, and details several ways in which the energy transition may increase demand for water and lead to more contamination events.
- In this future, the United States has invested heavily in clean energy sources, but energy demand has continued to rise, and clean energy production has not kept pace. This has led to increased reliance on traditional forms of energy.
- The author concludes with a call to action, where the author describes the issues that will need to be addressed to solve the country's growing water crisis, and hints at possible solutions. Many more potential solutions exist but were not included to avoid biasing participants.
- Water resources are usually thought of in terms of quantity; however, participants should also be prompted to think about issues of quality that might affect water's usability.
- While this scenario does not directly address cyber risk to water and energy infrastructure, it is a chronic and severe risk across the United States. Participants may be encouraged to talk about potential cyber risk to water and energy infrastructure if it is relevant to their expertise.

FACILITATION QUESTIONS – TAILORED

Please note: Broader, more general facilitation questions—common to all three scenarios—are located in the Scenario Breakouts section of this facilitator's guide. Additional discussion points, tied to specific portions of the scenario narrative, are listed in the scenario's "Detailed Scenario Breakdown."

- Of the problems presented in this scenario, which one do you feel is most urgent? Based on your background and expertise, what steps would you recommend to address or mitigate that problem?
- How might jurisdictions best be encouraged to take action to preserve their long-term water security?
- How can regulations stay ahead of novel contaminants, particularly those where the human impact might not be well understood?
- Climate change is not a main driver of this scenario but will have an enormous impact on water quantity and quality. How can communities adapt to future climate conditions?
- What are the technological advancements, both positive and negative, that might impact water resources in the future?
- Water is critical for many supply chains; for example, semiconductor production is famously water-intensive. What risk does lack of water availability pose to the United States' supply chain security?
- Given the number of water systems in the United States, what is the best way to communicate with water stakeholders and encourage adoption of best practices?

The Cybersecurity and Infrastructure Security Agency (CISA) has produced these scenarios to initiate and facilitate discussion. The situations described here are hypothetical and speculative and should not be considered the position of the U.S. government. All names, characters, organizations, and incidents portrayed in these scenarios are fictitious. Any positions expressed by fictional characters herein regarding any particular issues or technologies do not represent the positions of CISA or the federal government.

OPINION

GUEST ESSAY

Day Zero

September 13, 2030

By Diana Green

Diana Green has served three presidential administrations as an expert on climate and water resources. She is the author of *The Thousand Year Problem: Draining the Nation's Groundwater*. She currently lectures on watershed management in the Department of Environmental Sciences and Engineering at Whyttle University and is the founder and CEO of Green Watershed Consulting.

One week ago, the city of Monroe made national headlines when its city manager announced that the community would reach "Day Zero" sometime in March 2031. When that day arrives, Monroe will run out of water completely. Taps will go dry.

Scientists had been sounding the alarm for years that the water supply was dangerously low. But decision makers didn't heed the warnings because the groundwater models they had relied on for decades gave significantly higher estimates. [1] After several of Monroe's wells went dry unexpectedly, the city was forced to reevaluate their models and ultimately conceded that they had vastly overestimated the supply of water in the aquifer below their feet. The city of 300,000 came to the startling conclusion that they were less than a year away from a massive water crisis.

Monroe is hardly the first city we've seen run out of water. [2] But Monroe is eye-opening for both its size and economic importance. A hub of manufacturing and energy, it is also the heart of a regional agricultural economy, where water-intensive crops like cotton and alfalfa are grown for export worldwide. [3] More important, Monroe will not be the last. Its story is a cautionary tale that U.S. policymakers should heed to protect an economy that is navigating multiple transitions. We are all but guaranteed to see an increasing trend of Day Zeros in our lifetime.

In Monroe and elsewhere, there are too many culprits to point a finger at just one. Decision makers in Monroe have grappled with persistent overallocation to a long list of stakeholders with decades-old legal claims on the city's water. [4] While the city undoubtedly mismanaged demand for water resources, overallocation meant that the deck was already stacked against it. Countless cities like Monroe are suffering from longstanding and exhaustively documented issues hurting water availability in this country. These include long-term nationwide trends like climate change and aging infrastructure [5] as well as more localized issues, such as poor resource management and contamination from increasingly common sources like saltwater inundation from sea level rise, algae blooms, and wildfires. [6] But Monroe's problems are also related to a more surprising water issue: the energy transition.

Water problems have actually been exacerbated by the energy transition in many U.S. regions where water demands from legacy energy sources overlap with new water impacts from the renewable energy economy. The importance of the relationship between water and energy cannot be overstated. [7] For example, water is essential to produce electricity in coal, gas, nuclear, and hydroelectric power plants. But newer energy sources, such as renewable biofuels, and even manufacturing of solar panels, also place demands on a shrinking water supply. I would highlight four issues in the energy-water nexus that deserve serious attention.

Oil and gas. Despite some significant growth in electric vehicles and renewable electricity generation, global demand for oil and gas has not yet fallen, and the United States remains the world leader in production. More important for our water concerns, the share of U.S. oil and gas production extracted by hydraulic fracturing, or fracking, has leaped from less than 66 percent to more than 95 percent in the past decade. [8] Fracking mixes water with toxic chemicals and other contaminants, then pumps the mixture deep into the ground to create cracks to release oil or gas. It also produces impressive amounts of wastewater containing salts, toxic elements, organic matter, and radioactive material, which presents contamination risks. We use almost 800 percent more water and create over 500 percent more wastewater for each well today than we did in 2010. [9]

Biofuels. Biofuels are a particularly risky source of energy from a water availability standpoint. Irrigation can result in biofuels having an even higher water footprint than fossil fuels. But that doesn't seem to have slowed their growth, as policymakers have desperately tried to increase renewable energy as quickly as possible. While irrigated agriculture already consumes 70 percent of the nation's water supply, biofuels are increasing that share and further depleting surface water and groundwater. In fact, several regions are now suffering from lower crop yields because water supplies are too low for growers to irrigate sufficiently. [10] Biofuels also add to the problem of water contamination from overuse of fertilizer. More than half of applied nitrogen and phosphorous leaches from farms into water resources, causing contaminated groundwater and surface water. When nitrogen and phosphorus contamination occur in surface water, it can lead to eutrophication and harmful algal blooms locally and downstream. The Gulf of Mexico set yet another record this year for the size of its "dead zone"—eutrophication caused by nutrients traveling down the Mississippi from the Corn Belt. High levels of nitrates and harmful algae can cause negative human health impacts. Last year, more than 100,000 wells tested in the Corn Belt had nitrates above the recommended health advisory level.

Mining. The United States has seen a mining resurgence in the past several years focused on rare earth elements used in solar photovoltaic (PV) panels and batteries. These mines create mountains of toxic waste and thousands of gallons of wastewater for every ton of rare earth produced. And the most productive mine in the country is located in a water-constrained area. [11] Mining also poses a significant risk of water contamination from tailings, erosion, sedimentation, and acid mine drainage. When the town of Grenery learned that its water supply was undrinkable because of the Mincorex cobalt mine 85 miles upstream, residents blocked roads to the mine and forced it to shut down for three days.

Advanced manufacturing. Compared to coal- and gas-fired steam turbines, wind turbines and PV panels use very little water to produce electricity. But manufacturing those clean energy technologies can have major local and regional effects on water. Manufacturing accounts for roughly 6 percent of total U.S. water use but more than 75 percent of water use in the 60 counties where manufacturing is most concentrated. [12] Semiconductor fabricating facilities for solar PV are particularly

demanding, exacerbating water scarcity issues in some places. In addition, recent contamination scares have focused attention on new risks in the energy transition: [13]

- In 2026, nanoparticles from a manufacturing facility that built wind turbines using 3D printing were identified in the Atlantic Ocean and several freshwater sources along the East Coast. The biological impact is still unknown.

- In 2027, a solar PV production facility in Calvertal City had an accidental spill of silicon tetrachloride that contaminated the nearby Ohio River and spread downstream as far as the Gulf of Mexico.

- In the mid-2020s, hundreds of old solar panels were illegally dumped into a landfill near the Maumee River, a tributary of Lake Erie. In 2029, cadmium telluride traced back to the panels in the landfill was identified as the cause of poisoning suffered by residents.

The communities and regions feeling the effects of the energy transition on water resources most acutely are located where these issues overlap. Many parts of the country have been performing double duty by supporting both legacy fossil fuel energy and clean energy production. [14] This is true for Monroe, which has a coal-powered thermoelectric plant and a production center for solar panels.

The number of places performing this double duty has risen because clean energy solutions have failed to keep pace with the increasing global demand for energy. [15] For example, the Permian Basin has accelerated its rates of water depletion and contamination for oil and gas production. But the region is also a top producer of wind and solar energy in the nation and today supports several manufacturing centers for solar and wind components, exacerbating water scarcity and contamination issues. The basin is well on its way to becoming the next Colorado River Basin—with ongoing, multistate battles over water rights—because of its combination of heavy fracking and solar panel production. [16]

As the effects of climate change accelerate—driving more communities toward Day Zero—I would be the last to suggest that progress on clean energy should be slowed. [17] But at all levels of government and across multiple sectors of the economy, we need to identify and implement synergistic solutions that have positive effects on food, energy, *and* water [18] or we will be doomed to watch these water crises unfold for the rest of our lifetimes. For example, the federal government could incentivize farmers to adopt water-efficient approaches and adaptation methods, such as precision irrigation or using solar panels to provide shade for crops during the hottest parts of the day, reducing the need for irrigation. The energy sector should also be incentivized to explore more water-efficient methods, including greater conservation and water reuse in energy sourcing and using fluids that can serve as alternatives to water, such as liquid carbon dioxide. [19]

Unsurprisingly, numerous water efficiency advances have come from the private sector, [20] which is increasingly aware of the need to cut water costs and avoid crippling water-related shutdowns. Many manufacturers, such as semiconductor foundries, are investing in water efficiency through the adoption of advanced manufacturing techniques. The most advanced manufacturers use sensors, water-efficient processes, and water recycling techniques that allow them to recycle about 70 percent of their water. [21]

However, we also need to solve long-standing water issues like the persistent and ubiquitous problem of overallocation. One proposed solution is the concept of “water bankruptcy.” [22] When a jurisdiction facing a looming water crisis is allowed to declare water bankruptcy, it’s given a fresh start to reallocate its water rights. The widely publicized water bankruptcy declaration by the City of Quinzy in 2026, though it faced legal challenges, caused decision makers from other regions to take note.

Finally, decision makers should leverage the interconnectedness between “gray” and “green” infrastructure, as well as the ways in which natural systems, including forests, floodplains, wetlands, and soils, can protect and support water quality and improve the resilience of water infrastructure. [23]

The water crises brewing across our country stem from the divergent and conflicting needs for water resources and the lack of multisectoral planning across the nation, as well as businesses, lawmakers, and citizens treating water supplies as if they are limitless. Despite decades of research and advocacy, water management often fails to consider the deep interconnections among all components of our country’s lifeline infrastructure. From county water boards to the halls of Congress, we must approach our food, energy, and water problems holistically or Day Zero will continue to creep closer.

DETAILED SCENARIO BREAKDOWN: DAY ZERO

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1	14	Scientists had been sounding the alarm for years that the water supply was dangerously low. But decision makers didn't heed the warnings because the groundwater models they had relied on for decades gave significantly higher estimates.	**INFO:** Groundwater models are computer models of groundwater flow systems and are used by hydrologists and hydrogeologists to simulate and predict conditions such as water quantity. There are many different groundwater models available, each with their own capabilities, operational characteristics, and limitations. **NOTE:** This scenario states that the city of Monroe favored a model that gave them more optimistic estimates of available groundwater. The implication is that Monroe's decision-makers made a conscious choice to disregard the differences between models.
2	18	Monroe is hardly the first city we've seen run out of water.	**INFO:** In 2017, Cape Town, South Africa, came within 90 days of running out of water, because of a combination of urbanization and drought. In 2022, the city of Coalinga, California, announced it had about 60 days of water left. In January 2023, decision makers in Scottsdale, Arizona, cut off the water supply to homes outside of Scottsdale's municipal boundaries to conserve water for its own residents. There are also multiple examples of smaller-scale wells serving a few hundred residents running dry. When cities run out of water, they usually end up paying to have water transported in from neighboring jurisdictions, sometimes at very high prices.

Ref No.	Line #	Narrative Reference Text	Additional Comments DP Discussion Point INFO Additional Information NOTE Clarification/Rationale CONCERN Potential issue, threat, or vulnerability
3	21	…where water-intensive crops like cotton and alfalfa are grown for export worldwide.	**NOTE:** This line refers to virtual water transfer, which is water embodied in the production and trade of commodities. On a macro scale, this can result in large amounts of water being consumed for the production of goods that leave an area as exports. Virtual water exports are particularly important for commodities such as water-intensive crops. Increased water consumption for the production and export of commodities from relatively dry areas can affect local ecosystems and communities, and can weaken local communities' control over water resources. **DP:** How might regions mitigate impacts on water availability from virtual water exports while accounting for the economic profits gained from those exports?
4	26	Decision makers in Monroe have grappled with persistent overallocation to a long list of stakeholders with decades-old legal claims on the city's water.	**INFO:** Overallocation of water can lead to the rapid depletion of water resources. It can also be nearly impossible to revoke a claim to water rights after it has been established. Overallocation is a chronic issue nationwide.

Ref No.	Line #	Narrative Reference Text	Additional Comments DP Discussion Point INFO Additional Information NOTE Clarification/Rationale CONCERN Potential issue, threat, or vulnerability
5	30	These include long-term nationwide trends like climate change and aging infrastructure…	**INFO:** Climate change impacts will alter the historical weather patterns that many areas depend on. ▪ Droughts are predicted to occur with more frequency and severity in the western United States. ▪ Increased heat will lead to greater demand for water for cooling and irrigation. ▪ More frequent and severe wildfires will lead to greater demand as well as greater water contamination. ▪ Sea level rise will lead to increasing instances of saltwater intrusion into freshwater sources. ▪ Storms are predicted to become more frequent and intense. Most water infrastructure is not designed to capture large quantities of water in short time periods, which leads to lower water supply levels, inundation of water infrastructure, and increased risk of contamination. ▪ Climate change will increasingly amplify ongoing habitat loss and degradation, overexploitation of natural resources, concentrations of existing pollution, and invasive alien species—all of which will adversely affect forests, fisheries, and wetlands that provide valuable filtering, replenishment, and natural protections for water resources. **INFO:** Aging infrastructure results in water loss and increasing water system failures. The construction of water and wastewater infrastructure is typically a major investment; as a result, it is built to last for decades. The majority of the nation's water infrastructure was built by the 1950s. **CONCERN:** Aging infrastructure and climate change are interrelated risks; older infrastructure has not been built to the standards of future climate conditions. Climate change—particularly increasingly severe weather—will strain aging infrastructure and lead to more instances of failure.

Ref No.	Line #	Narrative Reference Text	Additional Comments DP Discussion Point INFO Additional Information NOTE Clarification/Rationale CONCERN Potential issue, threat, or vulnerability
6	32	...more localized issues, such as poor resource management and contamination from increasingly common sources like saltwater inundation from sea level rise, algae blooms, and wildfires.	**INFO:** Several factors complicate the effective management of water resources to ensure water availability. One key complication is that water often has not been priced to reflect its value. Because it is critical to human health and well-being, water must be kept relatively cheap through a mix of cost-saving measures and government subsidies. As a result, water utilities are not profitable, which has led to underinvestment in water infrastructure. Another complication is that water availability is often not measured accurately, authoritatively, or holistically. Approaches to measure water availability are hindered by (1) insufficient data tracking of water supply and demand at smaller geographic scales (versus at the national level), (2) challenges in following a single standardized means of water accounting, and (3) difficulties in collecting data not only on water quantity but also water quality. **INFO:** Sea level rise, when combined with groundwater drawdown or lower river flow, can lead to saltwater intrusion that can contaminate drinking water. Numerous coastal cities struggle with saltwater intrusion, including Miami (the Biscayne Aquifer), Philadelphia (the Delaware River), and New Orleans (the Mississippi River). **INFO:** HABs are overgrowths of algae in marine or freshwater that can result in dangerous toxins and depletion of dissolved oxygen, making the aquatic system uninhabitable. HABs affect water quality and can clog infrastructure. If not detected and treated, the toxins can lead to sickness and even death. **CONCERN:** Hotspots of acute water stress will restrict profits, challenge governance, and may lead to conflict between citizens and industrial users. In the past 10 years, there have been increased instances of civil unrest related to water access, particularly in the western and southwestern United States.

Ref No.	Line #	Narrative Reference Text	Additional Comments DP Discussion Point INFO Additional Information NOTE Clarification/Rationale CONCERN Potential issue, threat, or vulnerability
7	37	The importance of the relationship between water and energy cannot be overstated.	**NOTE:** Water is a necessary input for energy production and can result in negative feedback loops, which is when the energy sector has such significant effects on water availability that there is no longer sufficient water to support energy production.
8	45	…the share of U.S. oil and gas production extracted by hydraulic fracturing, or fracking, has leaped from less than 66 percent to more than 95 percent in the past decade.	**NOTE:** Depleted conventional fossil fuels have led to a shift to unconventional fossil fuels. This is a significant transition as it relates to the water sector. Conventional fossil fuels were often found in discrete locations and were easily accessible. In contrast, unconventional fossil fuels are located in pore spaces throughout expansive geologic formations that require advanced, water-intensive extraction techniques, including hydraulic fracturing, which threaten water security.
9	49	We use almost 800 percent more water and create over 500 percent more wastewater for each well today than we did in 2010.	**NOTE:** Hydraulic fracturing to satisfy demand for unconventional fossil fuels has resulted in a rapid increase in water consumption and contamination. The values mentioned reflect research conducted from 2011 to 2016 and, therefore, may be conservative estimates of the effects by the year 2030.
10	56	…lower crop yields because water supplies are too low for growers to irrigate sufficiently.	**NOTE:** Water is often the limiting factor for agricultural production. Negative feedback loops result from water used for irrigation contributing to water scarcity which, in turn, limits the water available to irrigate crops and reduces yields. **INFO:** In addition to increasing competition for water between the food and energy sectors, biofuels can create competition for agricultural commodities between the food and energy sectors as edible crops are used to produce energy. **DP:** Which regions might experience the biggest effects on water availability because of biofuel production and increased competition for agricultural commodities? How might effects on those regions be mitigated?

Ref No.	Line #	Narrative Reference Text	Additional Comments DP Discussion Point INFO Additional Information NOTE Clarification/Rationale CONCERN Potential issue, threat, or vulnerability
11	68	…the most productive mine in the country is located in a water-constrained area.	**NOTE:** As of 2023, the only productive mine for rare earth elements in the United States is located in southeastern California. These rare earth elements are vital to the energy transition, representing necessary inputs for everything from wind turbines to EVs. **CONCERN:** Mining in a dry region that has little to no backup water resources increases risks to water availability, particularly from contamination of already scarce water resources.
12	77	Manufacturing accounts for roughly 6 percent of total U.S. water use but more than 75 percent of water use in the 60 counties where manufacturing is most concentrated.	**INFO:** The United States is the largest user in the world of water for manufacturing, directly withdrawing more than 18.2 billion gallons per day, roughly 6 percent of total U.S. water withdrawal. Because many factors drive manufacturing agglomeration and colocation, manufacturing sites tend to be concentrated in specific regions.
13	79	In addition, recent contamination scares have focused attention on new risks in the energy transition:	**NOTE:** ▪ This scenario specifically addresses issues of contamination as water resources are usually thought of in terms of quantity rather than quality. ▪ As the examples indicate, because of the flow of water, contamination of water sources often results in geographic dispersal of the contaminants and potential ecological and human health effects far from the source of the contamination. **DP:** How should regulators and water systems prepare for contaminants for which human health effects aren't well understood?

Ref No.	Line #	Narrative Reference Text	Additional Comments DP Discussion Point INFO Additional Information NOTE Clarification/Rationale CONCERN Potential issue, threat, or vulnerability
14	91	Many parts of the country have been performing double duty by supporting both legacy fossil fuel energy and clean energy production.	**NOTE:** This scenario focuses on solutions that reduce greenhouse gas emissions, such as clean energy sources. In racing to meet climate objectives, effects on the water sector are largely disregarded. The result is development of clean energy supply chains that affect water resources in the same regions that continue to depend on water resources for fossil fuel-sourced energy supply chains. This intersection of clean energy and fossil fuel–sourced energy reflects the projection that fossil fuel dependence will continue to increase in the near future. **DP:** What can be done to ensure an appropriate level of consideration is given to the effects on water resources when seeking to mitigate climate change through reductions in greenhouse gas emissions?
15	95	…clean energy solutions have failed to keep pace with the increasing global demand for energy.	**NOTE:** In this scenario, energy demand rises faster than clean energy can keep up, which follows current projections for U.S. energy demand.
16	101	The basin is well on its way to becoming the next Colorado River Basin—with ongoing, multistate battles over water rights—because of its combination of heavy fracking and solar panel production.	**INFO:** The Colorado River Basin is in crisis due to overallocation and a multi-decade drought. The Colorado River Basin covers approximately 250,000 square miles and provides water to seven states and Mexico, making renegotiation of water rights a highly difficult process. Between 35 and 40 million people depend on the Colorado River for all municipal water needs, although 70 percent of the water pumped from the river is used for agriculture.
17	103	As the effects of climate change accelerate—driving more communities toward Day Zero—I would be the last to suggest that progress on clean energy should be slowed.	**NOTE:** This scenario is not suggesting that clean energy should not be pursued; rather, it points out that overly focusing on reducing greenhouse gases can potentially lead to the detriment of other resources.

Ref No.	Line #	Narrative Reference Text	Additional Comments DP Discussion Point INFO Additional Information NOTE Clarification/Rationale CONCERN Potential issue, threat, or vulnerability
18	105	…to identify and implement synergistic solutions that have positive effects on food, energy, and water…	**NOTE:** Taking a single-sector approach to solve problems (e.g., using more fertilizers and irrigation to grow more crops) may improve resilience of one sector (e.g., produce higher yields to feed a growing population), but has the consequence of decreasing resilience of (an)other sector(s) (e.g., depleting and contaminating water resources and requiring more energy to produce, transport, and apply fertilizers and apply irrigation water). **DP:** What are some synergistic solutions that could have significant benefits to multiple sectors simultaneously?
19	111	…using fluids that can serve as alternatives to water, such as liquid carbon dioxide.	**INFO:** Historically, hydraulic fracturing has used liquid water as the working fluid to extract fossil fuels. However, supercritical CO_2 (CO_2 held in a liquid form) has been shown to be a better working fluid than water. Utilization of CO_2 has the added benefits of reducing effects on water resources while sequestering carbon.
20	112	Unsurprisingly, numerous water efficiency advances have come from the private sector…	**DP:** How should companies be encouraged to increase their water efficiency?
21	117	The most advanced manufacturers use sensors, water-efficient processes, and water recycling techniques that allow them to recycle about 70 percent of their water.	**INFO:** Many companies, particularly in water-scarce regions, are investing in water efficiency measures to help control costs and reduce the risk of water-related shutdowns. For example, one company that specializes in water recycling technology for semiconductor fabricators claims to be able to recycle 98 percent of the water used by fabricators.
22	119	One proposed solution is the concept of “water bankruptcy.”	**DP:** What are the pros and cons of declaring water bankruptcy? What alternative solutions exist?

Ref No.	Line #	Narrative Reference Text	Additional Comments DP Discussion Point INFO Additional Information NOTE Clarification/Rationale CONCERN Potential issue, threat, or vulnerability
23	127	…decision makers should leverage the interconnectedness between "gray" and "green" infrastructure, as well as the ways in which natural systems, including forests, floodplains, wetlands, and soils, can protect and support water quality and improve the resilience of water infrastructure.	**INFO:** Green infrastructure (natural systems, including forests, floodplains, wetlands, and soils) performs many of the functions that gray infrastructure (e.g., dams, pipes, water treatment plants) is designed to achieve, such as water storage, flood impact protection, and water purification. Green-gray infrastructure linkages can be leveraged to improve resilience of water critical infrastructure. **DP:** What examples of green infrastructure exist in your region? If it isn't being leveraged to support water resources, how might it be integrated?

APPENDIX A: WORKSHOP PLANNING CONSIDERATIONS

Step 1: Set a target date for the event at least three months in advance.

Step 2: Identify workshop staff.

Staffing the workshop requires a time commitment from at least six individuals—three facilitators and three document leads. Facilitators should expect to spend at least 30 hours on the workshop and document leads at least 15 hours. In addition, a workshop coordinator should expect to spend 10–15 percent of their time in the three months prior to the event on organizing the workshop and engaging with invitees. Workshop planning efforts may also require periodic input from a planning committee (e.g., to tailor the workshop goals).

Step 3: Identify potential invitees.

A scenarios workshop requires 40–50 participants. Thus, hosts may need a list of 55–70 candidates to secure the necessary number of participants. When identifying candidates, the workshop sponsor/planning committee/coordinator should target the following groups:

- Mid-to-senior career-level individuals interested in exploring longer-term risks to CI to enable effective risk mitigation
- A mix of representatives (e.g., CISA personnel; state and local planners; fusion center personnel; private sector representatives; subject matter experts from nonprofits, think tanks, and academia)
- Individuals with interest and expertise in advanced manufacturing, information and communications technology (ICT) supply chain resilience, and water availability
- Individuals familiar with strategic foresight

Because the virtual workshop divides participants into three breakout rooms (one for each scenario), consider the best way to achieve a mix of different perspectives and expertise among the groups when identifying candidates. The workshop coordinator should tap into the networks of the Regional Director, senior leaders, Protective Security Advisors, Cybersecurity Advisors, and members of the planning committee to identify participants. The workshop coordinator may also need to coordinate engagement efforts within the region to identify additional participants for the workshop. Thus, the workshop coordinator may want to develop and circulate a one-page flyer on the scenarios workshop. An example can be requested at SecureTomorrowSeries@cisa.dhs.gov.

As prospective participants are identified, it would be useful to record additional information about them in a spreadsheet to help prioritize invitations (and potential backup candidates). Possible data fields include the following:

- Name
- Position
- Organization
- Subject matter expertise in one or more of the topic areas (advanced manufacturing, ICT supply chain resilience, and water availability)

- Stakeholder group (e.g., private sector, public sector, nongovernmental organization, academia)
- Experience/expertise in strategic foresight
- Link to professional bio

Step 4: Start sending invitations and tracking responses.

Roughly two months before the workshop, the workshop coordinator should begin issuing invitations and tracking RSVPs. Invitations should come from a senior leader within the sponsoring organization. Invitation language may require leadership review and coordination with the leader's executive assistant on invitation rollout. Candidates should send RSVPs to the workshop coordinator, who should respond immediately with a save-the-date meeting invitation.

Step 5: Review scenarios and identify key discussion points.

Each of the topics addressed by the scenarios is broad, providing opportunities for hosts to tailor the workshop to their interests. Facilitators are unlikely to have time to address all the discussion points listed in the detailed scenario breakdowns. The workshop sponsor, planning committee, and coordinator should review the scenarios and select the key discussion points that facilitators should prioritize for the participants in their group. It may be useful to invite facilitators to participate in or observe these deliberations so they can gain a better idea of leadership intent and begin familiarizing themselves with the scenarios.

Step 6: Train the facilitators and document leads.

Five weeks prior to the workshop, the workshop coordinator should hold a meeting with all workshop personnel to walk through the agenda and train them on specific responsibilities and desired outputs for each session (using this facilitation guide as a reference). The coordinator should introduce each of the facilitator-document lead pairings at this time and give them their assigned scenarios (if they have not yet received them).

A second, follow-on meeting should be held for the facilitators to talk through their scenarios with one another and to receive additional training on workshop priorities. This meeting will help the facilitators to gain a more holistic understanding of the scenarios to help with stress-test rounds and to discern the distinctions between different directions explored by each scenario.

Step 7: Determine scenario assignments.

Three weeks prior to the workshop, the workshop coordinator should finalize the assignment of attendees to scenarios. As noted earlier, because the workshop divides participants into three groups, consideration should be given to the mix and balance of different perspectives and expertise among the groups when making group assignments.

Step 8: Send out participant information.

Two weeks before the event, each participant should receive the following:

- Assigned scenario narrative

- One-page brief describing the three scenarios
- Workshop feedback form (optional)
- Are We There Yet? Participant Form (if receiving polling information beforehand)
- Participant biographical information

If participants receive a polling form, remind them to complete and return the form one week before the workshop to allow sufficient time for compiling and analyzing the results and updating the "Are We There Yet?" results slides.

Step 9: Make final preparations.

A few days before the event, conduct a final review of the slides, emphasizing transitions between speakers and between plenary and breakout sessions, and selecting files to share on the virtual meeting platform. During this review, the workshop coordinator should confirm assignments for supporting workshop sessions (e.g., who will be presenting/manipulating the slides, providing technical support, monitoring chat).

Facilitators should review in detail the support materials that pertain to their assigned scenario. Although they should focus most of their attention on their assigned scenario, facilitators should also review the remaining scenarios.

APPENDIX B: IN-PERSON WORKSHOP AGENDA

The scenarios workshop facilitation guide is written for a two-afternoon, virtual execution of the workshop. However, the workshop can also be configured as a one-day, in-person event (see below for alternative agenda). Unless otherwise indicated as plenary, the sessions occur in breakout groups.

TIME	ACTIVITY
8–8:30 a.m.	Registration
8:30–9:15 a.m.	Framing the workshop: welcome, participant introductions, workshop objectives, and roadmap for the day's activities (*plenary session*)
9:15–10 a.m.	Icebreaker exercise: Are we there yet? (*plenary session*)
10–10:15 a.m.	Break
10:15–12:15 p.m.	Scenario breakouts • Scenario familiarization and build out • Identification of emerging and evolving risks and associated needs • Risk mitigation strategies
12:15–1 p.m.	Lunch
1–1:10 p.m.	Divide breakout group and prepare for stress-test rounds
1:10–1:55 p.m.	Alternative future stress-test: Round 1
1:55–2:40 p.m.	Alternative future stress-test: Round 2
2:40–2:55 p.m.	Break
2:55–3:45 p.m.	Synthesis and reflection (*plenary session*)
3:45–4 p.m.	Closing remarks (*plenary session*)