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Managing the Atom Project

A Darkening Horizon: Nuclear Challenges Around the World

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Effect of a single nuclear weapon

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Source: Time-Life

The nuclear horizon has darkened in the last 10 years

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- ❑ Radically increased U.S.-Russian and U.S.-Chinese hostility
 - ⌘ Dramatic worsening from the war in Ukraine
 - ⌘ Repeated Russian nuclear threats
- ❑ Substantially increased doubts over U.S. leadership
 - ⌘ Increased anxieties among U.S. allies
- ❑ Major advances in evolving technologies that complicate nuclear balances
 - ⌘ Missile defenses, AI, cyber, counter-space, precision conventional...
- ❑ Large expansion of Chinese nuclear forces underway
- ❑ Arms control + risk reduction measures greatly weakened
 - ⌘ INF Treaty, U.S. + Russian participation in Open Skies treaty gone
 - ⌘ Almost all U.S.-Russian gov-gov communication cut off, much U.S.-Chinese gov-gov communication
 - ⌘ New START expires 2/26, modest prospects for replacement in treaty form

The nuclear horizon has darkened in the last 10 years (II)

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- ❑ Major expansion in North Korean nuclear + missile arsenal
- ❑ Dramatic increase in Iranian nuclear capabilities (and expanded missile force, ongoing support for armed groups)
- ❑ Ongoing arms competition in South Asia
- ❑ Ongoing nuclear terrorist threats
 - ⌘ Reduced capabilities of global terrorist groups (al Qaeda, Islamic State)
 - ⌘ Expanded insider threats from violent domestic extremists in many countries
 - ⌘ Reduced global focus on the danger – nuclear security summits long over
- ❑ Increased tensions between nuclear haves and have-nots
 - ⌘ Symbolized by the nuclear weapons ban treaty, now in force
 - ⌘ Makes nonproliferation progress more difficult
- ❑ Ongoing (expanding?) obstacles to progress toward disarmament

Russia's war on Ukraine has upended much of the international order

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- ❑ A founding member of the United Nations – charged with ensuring international peace and security – is waging large-scale aggressive war
 - ⌘ Using nuclear threats as shield to protect its offensive war
- ❑ A state that gave up the nuclear weapons on its soil for security assurances is being torn apart
- ❑ Impacts on security, food, energy are reverberating around the world
- ❑ U.S.-Russian talks cut off



Source: Reuters

The war in Ukraine requires rethinking most aspects of nuclear policy

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- ❑ With a more aggrieved Russia, more willing to use military force, and more willing to rattle the nuclear saber, nuclear deterrence needs new thinking
 - ⌘ With weakened conventional forces, Russia will be more dependent on nuclear weapons than before
 - ⌘ U.S. allies seeking still stronger assurances
- ❑ The future of nuclear arms control is in doubt
 - ⌘ Intense U.S.-Russian hostility means more nuclear danger, fewer chances to take steps to reduce it
- ❑ The future of nuclear nonproliferation is uncertain
 - ⌘ Ukraine's fate may lead other countries to reconsider nuclear options
- ❑ Requires rethinking nuclear energy, nuclear safety, and nuclear security with the possibilities of wars, political unrest, state collapse in mind

Cuban Missile Crisis: The tale of sub B-59

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- ❑ Diesel sub, designed for northern waters, not the Caribbean
 - ⌘ $>110^{\circ}$ on board – carbon dioxide high, sailors passing out
- ❑ Sub armed with a nuclear torpedo – physical capability to fire
 - ⌘ U.S. Navy did not know it was nuclear-armed
- ❑ U.S. Navy using “practice depth charges” to force it to the surface
 - ⌘ Those on sub believed war had begun, they were under attack
- ❑ Captain reportedly ordered nuclear torpedo prepared for firing
- ❑ Differing accounts of details – but agreement that Capt. Vasily Arkhipov – also on the sub by sheer chance – prevented use

The fog of crisis can lead to disaster

How might a nuclear war start?

- ❑ Nuclear deterrence makes a rational decision to begin a nuclear war hard to imagine...
- ❑ But Cold War crises, and pre-nuclear wars, highlight the dangers of unintended escalation, miscalculation in the heat of the moment, accidents, unauthorized use, decisions based on wrong information...
- ❑ Leaders might believe a limited use of nuclear weapons could avoid devastating defeat – and they could deter further response



Source: Department of Energy

Evolving technologies may be reducing deterrent stability

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- ❑ BMD, cyber, counter-space, precision conventional, autonomy create new complexities → greater escalation risks
 - ⌘ Cyber blurs lines between peace and conflict, difficult to control
 - ⌘ Counter-space and cyber may both create incentives to hit first, early
 - ⌘ Missile defenses complicate strategic planning
 - ⌘ “Entanglement” of nuclear and conventional forces, command and control create incentives to escalate
 - ⌘ AI-enabled decisions may shorten decision time, change decision environment



Hypersonic weapon concept. *Source:* space.com

Dateline: Russia

10

- ❑ Aggressive war in Ukraine; nuclear threats, modernization, novel weapons, exercises; cyberattacks; election interference...
- ❑ Intense U.S.-Russian tensions
 - ⌘ Almost all communication cut off – risk of escalation to direct conflict
- ❑ Russian forces, command and control vulnerable; arms control in crisis; potential for launch on false alarm or unintended crisis escalation



Source: ITAR-TASS

Will Russia use nuclear weapons during the Ukraine war?

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- ❑ Russian leaders might think could break “hurting stalemate,” stop a Ukrainian breakthrough, or end NATO support with nuclear use
 - ⌘ Destroy armored formations
 - ⌘ Threaten cities and demand surrender (Putin has referred to “precedent” of Hiroshima and Nagasaki)
 - ⌘ Use against NATO countries
- ❑ US has threatened “catastrophic” response
 - ⌘ Might Russia conclude it could deter substantial retaliation?



Loading an Iskander missile, 2015 *Source: Reuters*

Dateline: China

- ❑ Much smaller nuclear force, but major modernization underway
 - ⌘ ~400 weapons, but increasing
 - ⌘ 100s of nuclear missile silos under construction – possibly a goal of parity with the United States
- ❑ Heightened U.S.-China tensions – Taiwan, South and East China seas, trade, cyber, other issues
- ❑ No arms control, verification, or dialogue on strategic issues in place
 - ⌘ China (and Russia) concerned over U.S. missile defenses, conventional strike capabilities, nuclear forces



Source: AP, Li Gang

Dateline: North Korea

- ❑ Unpredictable dictator armed with dozens of nuclear weapons, ballistic missiles
 - ⌘ Flurry of missile testing, nuclear test any day, HEU, Pu production unabated
 - ⌘ Has threatened to rain “nuclear fire” on ROK, Japan, United States
- ❑ History of provocations against ROK – could lead to conflict
- ❑ Agreements, sanctions, threats have all failed
- ❑ No clear prospects for “denuclearization”



Source: KCNA

From Kim's perspective: A potential conflict scenario

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- ❑ Imagine:
 - ⌘ A major North Korean provocation – e.g., shelling an island again
 - ⌘ South Korea insists on striking back harder, to reestablish deterrence
 - ⌘ North Korea uses ~6 conventional missiles against a U.S. airbase
 - ⌘ ROK, U.S., begin an air campaign to destroy the DPRK's missiles
- ❑ DPRK faces “use them or lose them” pressures
- ❑ Can they tell the air campaign is not intended as a prelude to an all-out regime-change attack?



Source: Reuters

Dateline: South Asia

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- ❑ Ongoing nuclear arms race between Pakistan and India – who have fought 4 wars
- ❑ Military doctrines with unclear redlines; terrorists might provoke conflict; could blunder into war
 - ∞ But have managed recent crises successfully
- ❑ Pakistan has a growing nuclear arsenal, and some of the world's most capable terrorists
- ❑ Some modeling suggests even Indo-Pakistani nuclear war could cause “nuclear fall”



Source: Wikimedia Commons

Dateline: Iran

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- ❑ Nuclear agreement reduced risk – but attempts to rebuild it have failed
- ❑ Iran now has ability to produce several bombs' worth of HEU in days
- ❑ Iran continues to support terrorist groups, undermine countries in the region, threaten Israel, test longer-range ballistic missiles – and has never given an honest declaration of its past nuclear weapons efforts
- ❑ Where next?



Source: khamenei.ir

The surprising success of nonproliferation

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- ❑ No net increase in nuclear-armed states in 35 years
- ❑ All but 5 states are parties to the nuclear Nonproliferation Treaty (NPT)
 - ⌘ Obligated not to get nuclear weapons, and to accept inspections
 - ⌘ Many other accords, initiatives, support the overall regime
 - ⌘ Never in human history has the most powerful weapon available to our species been so widely forsworn
- ❑ What explains success?
 - ⌘ Most states realize they are better off if they and their neighbors don't have nuclear weapons
 - ⌘ Treaty changes states' decision-making: Foreign Minister, Finance Minister now more likely to be at the table, and nuclear weapons advocates need to reverse a decision already made
 - ⌘ NPT creates norms – easier to build coalitions against programs

But growing challenges to the global regime

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- ❑ Many states unhappy with the NPT – no consensus at reviews in 2015, 2022
- ❑ More states reconsidering security options
- ❑ Ongoing challenges controlling sensitive technologies – new tech. such as additive manufacturing makes more difficult
- ❑ Possible spread of ostensibly civilian enrichment and reprocessing as nuclear energy grows and spreads
- ❑ Ban Treaty manifests frictions



Source: AFP

Some good news about nuclear weapons

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- ❑ 78 years with no nuclear attacks – amazing success
- ❑ >80% of the world's nuclear weapons have been dismantled
- ❑ <5% of world's states have nuclear weapons – same as 35 years ago
 - ⌘ No net increase in 3.5 turbulent decades – amazing success
- ❑ >50% of the states that started nuclear weapons programs gave them up
 - ⌘ Efforts to prevent proliferation succeed more often than they fail
- ❑ >50% of the states that once had potential nuclear bomb material on their soil have eliminated it
- ❑ Nuclear material around the world is far more secure than it was 25 years ago – much harder for terrorists to get
 - ⌘ Most egregious weaknesses fixed – but more to be done

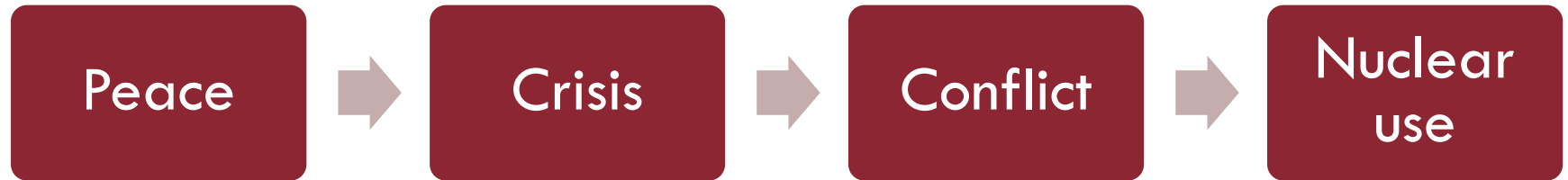
May still be options for reducing dangers

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- ❑ Both the United States and Russia have reasons to want to avoid an unrestrained arms competition
- ❑ When the Ukraine war ends, new opportunities may open
- ❑ Even if treaties are difficult to reach, may be able to use executive agreements, political commitments, unilateral-reciprocal initiatives to make progress
- ❑ Though China rejects arms control for now, also good reasons for it to want to avoid unregulated race for the long haul
- ❑ Variety of risk-reduction proposals still being put forward
- ❑ "Track II" (non-government) dialogues are developing, stockpiling ideas for when governments are ready
 - ⌘ Have explored most of the key ideas needed for the next round of nuclear arms control – and some novel risk-reduction approaches

We need risk-reduction action on each step on the pathway to nuclear war

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- ❑ Key step: preventing crises. Any militarized crisis between nuclear-armed states is dangerous – “fog of crisis” raises risks
 - ⌘ Avoiding crises is partly deterrence – but mainly foreign policy
 - ⌘ A more modest foreign policy for a dangerous nuclear era?
- ❑ Preventing escalation from crisis to conflict
 - ⌘ Partly deterrence – partly de-escalation, reassurance
- ❑ Preventing escalation to nuclear use
 - ⌘ Similar issues – but heavier emphasis on deterrence
- ❑ How to reassure, reach resolutions, in atmosphere of hatred, fear, misperception, disinformation, time pressure?

“Rethinking Nuclear Deterrence”: A global research network

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- ❑ Harvard-led research network launched in 2022, with support from the MacArthur Foundation
- ❑ Why rethink nuclear deterrence?
 - ⌘ Terrible dangers and serious moral ambiguities of nuclear deterrence have always been there
 - ⌘ Changing geopolitics, changing technologies raise complex issues
 - ⌘ Need ideas to address changing dangers
- ❑ Scores of scholars and practitioners from ~25 countries involved, in four working groups:
 - ⌘ Preventing nuclear war
 - ⌘ Legal, ethical aspects of nuclear deterrence
 - ⌘ Evolving technologies and arms control
 - ⌘ Beyond nuclear deterrence
 - ⌘ Other projects, outreach efforts, beyond the working groups

The importance of presidential judgment

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- ❑ Cuban Missile Crisis:
 - ⌘ Initially, Kennedy's advisors called for air strikes followed by an invasion
 - ⌘ Kennedy pushed back, asking for another option
 - ⌘ The recommended course might well have led to nuclear war
- ❑ Kennedy: Key lesson was always to give the adversary a choice between humiliating defeat and nuclear war
- ❑ The world relies on sober judgment by the leaders of nuclear states



Source: JFK Library

Further reading...

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- ❑ Full text of Managing the Atom publications:
<http://belfercenter.org/mta>
- ❑ Full text of Bunn publications and presentations, by topic:
https://scholar.harvard.edu/matthew_bunn
- ❑ “Pathways to Disaster: How Might a Nuclear War Start?”
presentation, Oak Ridge National Laboratory, 2022
<https://tinyurl.com/ypz7osd8>
- ❑ *The Iran Nuclear Archive: Impressions and Implications*, 2019
<https://tinyurl.com/2o7gqcm3>
- ❑ *Revitalizing Nuclear Security in an Era of Uncertainty*, 2019
<https://www.belfercenter.org/NuclearSecurity2019>
- ❑ “For Security’s Sake: Saving U.S.-Russian Arms Control,”
presentation, Oak Ridge National Laboratory, 2018
<https://tinyurl.com/y5u4p7xh>

Back-up slides

Some key takeaways

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- ❑ Nuclear weapons continue to pose real risks to U.S. and global security, requiring constant attention to minimize
- ❑ Evolving technologies may reduce deterrent stability – but there is likely to be more continuity than change
- ❑ Nuclear arms control has had real benefits for U.S. and global security, and is worth trying to continue
- ❑ The global effort to stem the spread of nuclear weapons has been surprisingly successful, and serves almost everyone's interests
 - ⌘ But requires constant effort for continued success
- ❑ Nuclear and radiological terrorism remain real dangers
- ❑ Good policy has managed to reduce nuclear dangers in multiple areas – and can do so again in the future

Taking the “security dilemma” seriously

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- ❑ What U.S. actions for defense and deterrence might provoke adversary responses that undermine U.S. security?
- ❑ Are U.S. missile defenses:
 - ⌘ Part of the cause of Russia’s new types of strategic nuclear weapons?
 - ⌘ Part of the cause of China’s buildup?
- ❑ Are U.S. counterforce capabilities a major reason why Russia relies on a “launch on warning” strategy?
- ❑ Do U.S.-ROK “kill chain” and decapitation strategies increase North Korean incentives for limited use of nuclear weapons early in a conflict?
- ❑ Do U.S. and Israeli threats, operations, increase Iran’s desire for a nuclear weapons option?

Need to think through long-term net effect of U.S. actions

From Putin's perspective: next steps in arms control

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- ❑ Imagine: it's 2024, talks on a new arms control agreement are beginning
- ❑ The U.S. wants
 - ⌘ Significantly lower numbers
 - ⌘ An accord that limits all warheads — including Russian tactical weapons
 - ⌘ On-site inspections at warhead sites
 - ⌘ Inclusion of new Russian weapon types in the treaty's limits
 - ⌘ But the U.S. refuses any serious limits on missile defenses (including space-based ones) or precision conventional strike capabilities, Ukraine unresolved
- ❑ Should Russia agree?

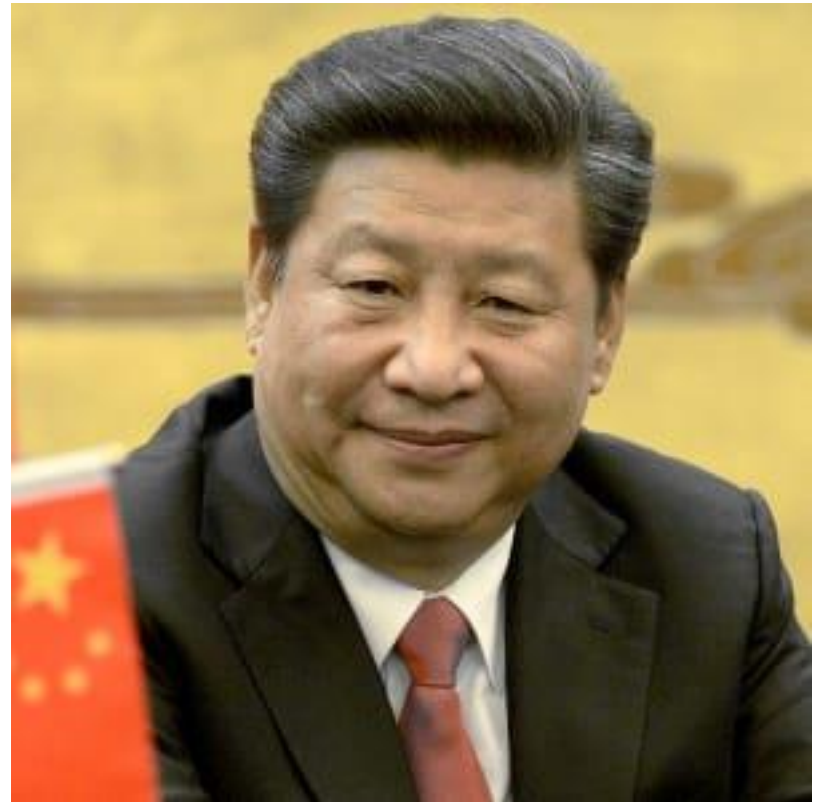


Source: kremlin.ru

From Xi's perspective: participate in arms control?

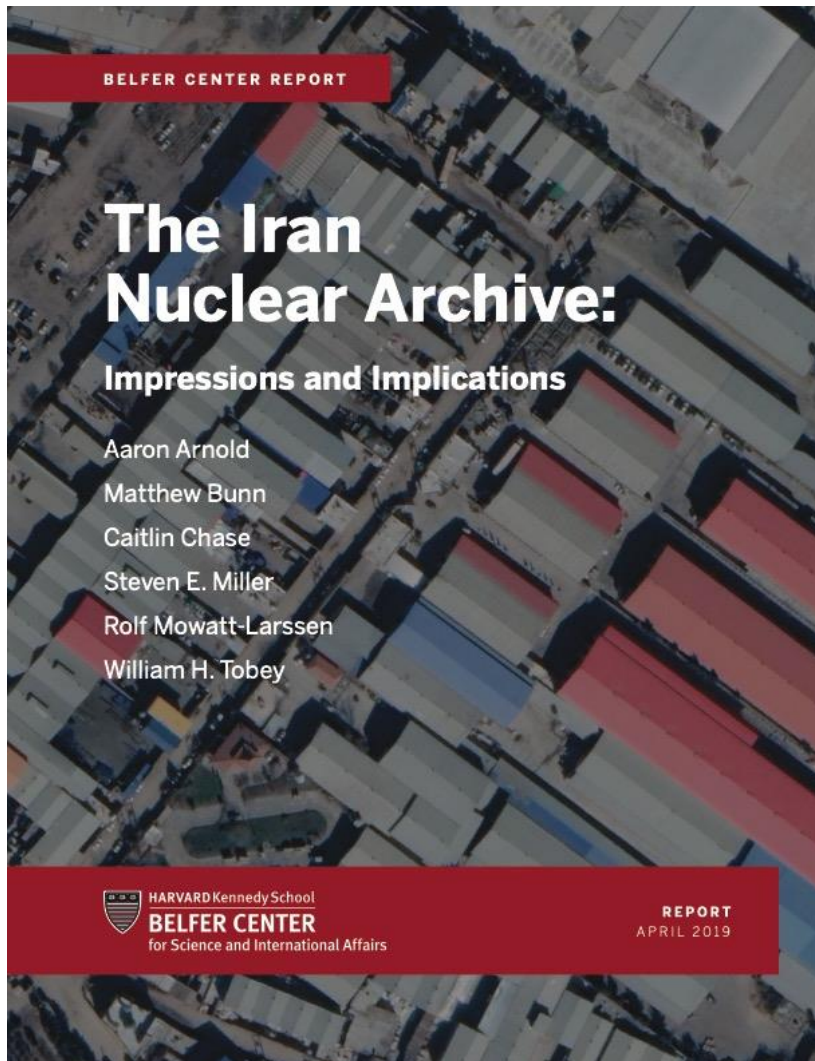
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- ❑ Imagine: it's 2024
- ❑ The U.S., concerned about China's growing (but still small) arsenal, wants China to agree to limits
 - ⌘ China doesn't want to be formally locked into an inferior position
 - ⌘ But China wants to be seen as an advocate of disarmament
 - ⌘ U.S. is unwilling to constrain missile defenses that China sees as threatening its deterrent
- ❑ What limits, if any, should China agree to?
 - ⌘ Formal, informal possibilities



Source: Muneyoshi Someya/Getty Images

The Iran nuclear archive



❑ 6 key conclusions:

- ⌘ Iran had focused program to produce, test nuclear weapons
- ⌘ Made more technical progress than had previously been known
- ⌘ Has ability to reconstitute
- ⌘ Much more foreign assistance than previously understood
- ⌘ Some facilities, activities went undetected
- ⌘ Issues will have to be addressed in future deals

❑ Many mysteries remain...

From Khamenei's perspective: what to agree to, for what price?

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- ❑ Imagine: it's 2023, all sides have returned to the JCPOA
- ❑ U.S. is asking for new accord – longer timelines, limits on long-range missiles...
- ❑ U.S. is offering broader sanctions relief in return
- ❑ What should Iran be prepared to offer, for what concessions from the United States or others?
 - ⌘ What would make U.S. promises credible to you this time?
 - ⌘ Should you authorize a new deal?



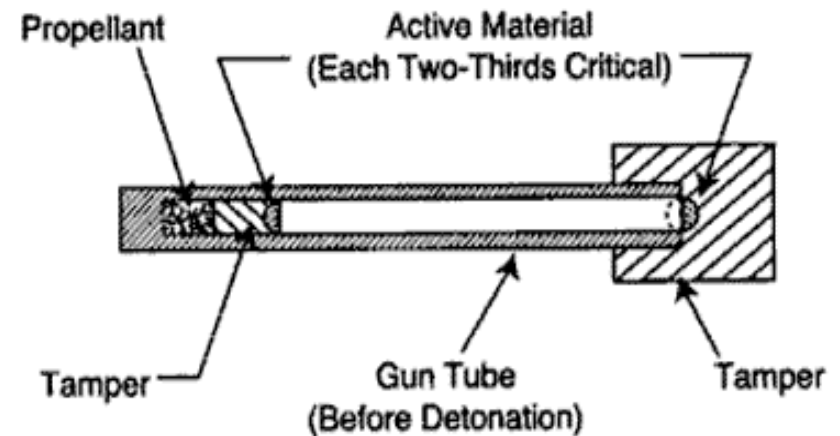
Source: Anadolu Agency via Getty Images

Dateline: Unknown

Nuclear and radiological terrorism

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- ❑ Numerous gov't studies: terrorist group *could* plausibly make a crude bomb if it got material
- ❑ ~20 cases of seizure of stolen HEU or plutonium
- ❑ Aum Shinrikyo, al Qaeda both pursued nuclear weapons
- ❑ ISIS intent unclear, but had more money, people, territory under control, ability to recruit globally than al Qaeda ever had



Source: NATO

Dateline: Unknown

Nuclear and radiological terrorism (II)

33

- ❑ Terrorists could also sabotage nuclear facilities (potentially cause Fukushima-scale accident), or use radioactive material in “dirty bomb”
- ❑ Policy options
 - ⌘ Improve security for nuclear and radiological materials, facilities (How to sustain momentum with the summit process years in the past?)
 - ⌘ Block nuclear smuggling (How to find the needles in the haystacks?)
 - ⌘ Counter high-capability terrorist groups (How can we do better?)
 - ⌘ Prepare to respond (How much can this mitigate the harm?)

One U.S.-Russian nuclear arms control agreement left – what's next?

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- ❑ ABM Treaty, INF Treaty, both terminated
- ❑ Presidents Biden and Putin extended New START for 5 years – but what comes then?
- ❑ New START is working
 - ∞ Both sides have met key limits
 - ∞ Inspections on hold as a result of pandemic
 - ∞ Expires 2/2026
- ❑ Intense U.S.-Russian hostility, Russian treaty violations, make it very difficult to reach, ratify new treaty
- ❑ What about China? What about non-strategic nuclear weapons? What about missile defenses, counter-space weaponry, other factors affecting strategic stability?

Why should we care?

Benefits of nuclear arms control

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❑ Benefits of the agreements themselves:

- ⌘ Reduced mutual perceptions of threat
- ⌘ Force structure stability
- ⌘ Predictability (important for planning)
- ⌘ Transparency
- ⌘ Reduced cost of maintaining forces

❑ Benefits of the arms control process:

- ⌘ Discussions allow greater mutual understanding of nuclear policies, plans, perceived dangers
- ⌘ Build relationships, habits of cooperation that spill over to other areas
- ⌘ Offers arena in which Russia is treated as an equal – helps assuage prestige, humiliation concerns

Dateline: United States

Strategic modernization

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- ❑ U.S. strategic weapons are aging
- ❑ Obama administration laid out a plan for new ICBMs, SLBMs, submarines, bombers, and cruise missiles, with “life extended” (upgraded) warheads
- ❑ Trump endorsed, expanded with new low-yield SLBM, nuclear SLCM, new warhead – Biden budget continues
- ❑ >>\$1 trillion cost over 30 years
- ❑ Bipartisan support – especially with Ukraine war
 - ⌘ But we need a broader debate over deterrence needs, costs, risks, arms control
 - ⌘ Some say further weapons needed



Source: DOD

The rest of the Middle East – and East Asia

37

- ❑ Iran's program has given other countries in the region incentives to explore nuclear options
 - ⌘ Saudi Arabia – statements threatening to get nuclear weapons if Iran does; possible deal with US for both reactors and enrichment
 - ⌘ Egypt – past safeguards violation never fully resolved; expanded civilian nuclear energy plans
 - ⌘ Turkey – new statements calling NPT commitment into question, expanded civilian nuclear energy plans
- ❑ North Korea's program gives its neighbors incentives to worry – especially if extended deterrence weakened
 - ⌘ Japan (full fuel cycle in place), ROK (majority support for nuclear weapons), Taiwan (faces growing threats, weaker U.S. commitment)
- ❑ Few apparent risks in other regions

Dateline: Global

Chemical and biological threats

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- ❑ Current pandemic shows the impact contagious disease can have
 - ⌘ Imagine if more contagious, more deadly
- ❑ Widespread chemical use by Syria – even after alleged disarmament
- ❑ North Korea and Russia apparently used chemical weapons for assassinations—may indicate other stocks
- ❑ Terrorists have pursued chemical, biological weapons
 - ⌘ Islamic State produced, used its own mustard gas
 - ⌘ Aum Shinrikyo conducted nerve gas attacks in Tokyo subways
 - ⌘ Aum Shinrikyo, al Qaeda pursued anthrax, other biological agents
 - ⌘ New gene editing technology (e.g., CRISPR) could increase risks
- ❑ Some state biological weapons programs persist
- ❑ Deep dual-use dilemmas, verification challenges

Group assignment:

allocate effort to reduce nuclear risks

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- ❑ What percent of total nuclear risk reduction effort (high-level political attention, \$, other resources) should be allocated to reducing risks posed by:
 - ⌘ U.S.-Russian conflict
 - ⌘ U.S.-China conflict
 - ⌘ North Korea
 - ⌘ Iran
 - ⌘ South Asia conflict
 - ⌘ Nuclear/radiological terrorists
 - ⌘ Other?
- ❑ Base allocations on:
 - ⌘ Scale of risk to U.S. or global security (probability x consequences)
 - ⌘ Degree to which U.S. or global policies could reduce the risk

A risk-informed approach

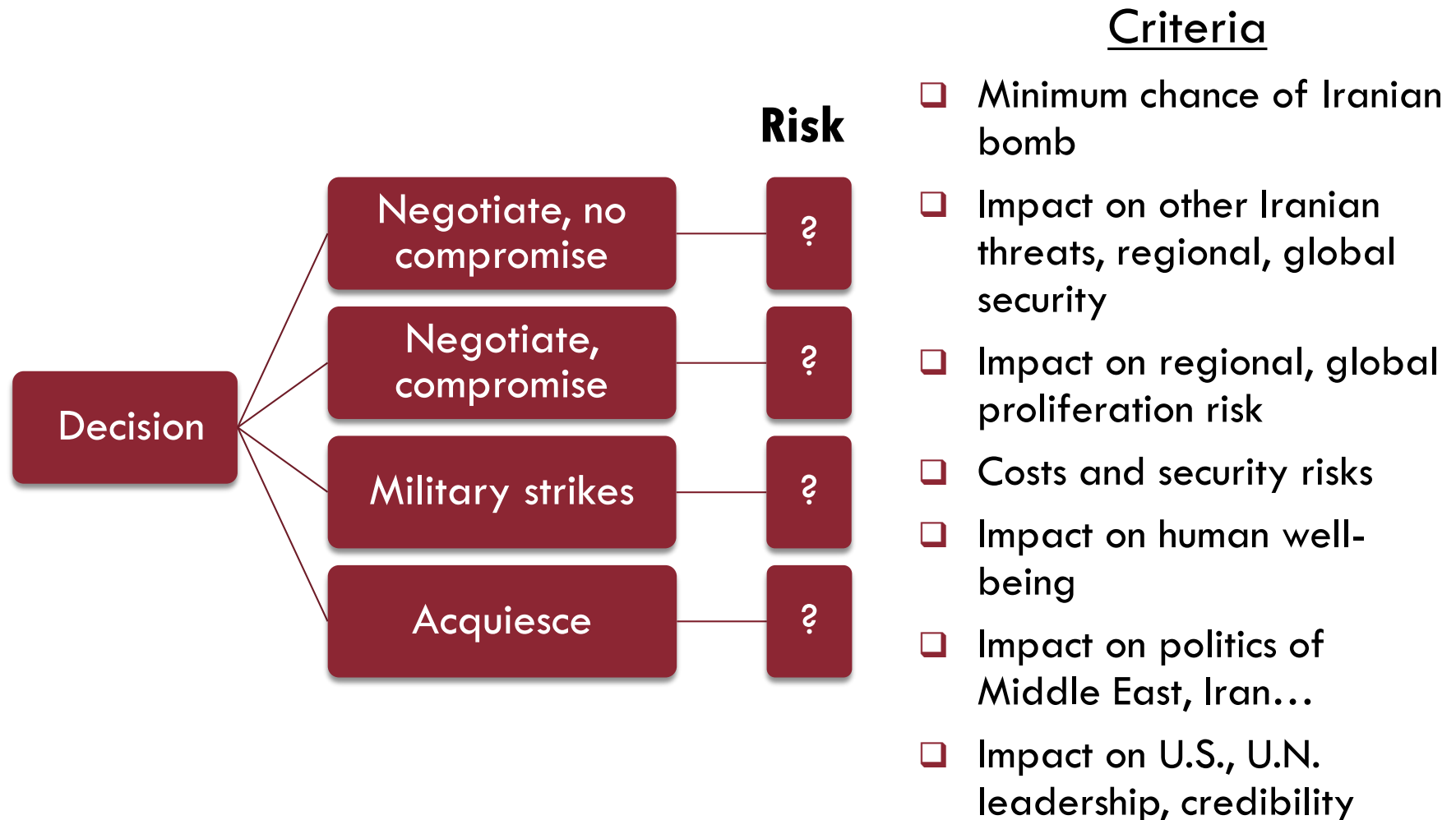
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- ❑ Risk: probability x consequences
- ❑ What's the problem?
 - ⌘ Identify, prioritize, risks and objectives
- ❑ What are the options to address it?
 - ⌘ Start with broad categories – get specific later
- ❑ What are the plausible outcomes of each option?
 - ⌘ Estimate probability, consequences of each outcome
- ❑ Choose the option that offers lowest risk/most benefit

In real life, these judgments are highly uncertain, debatable – but this approach offers a structure for thinking and choice

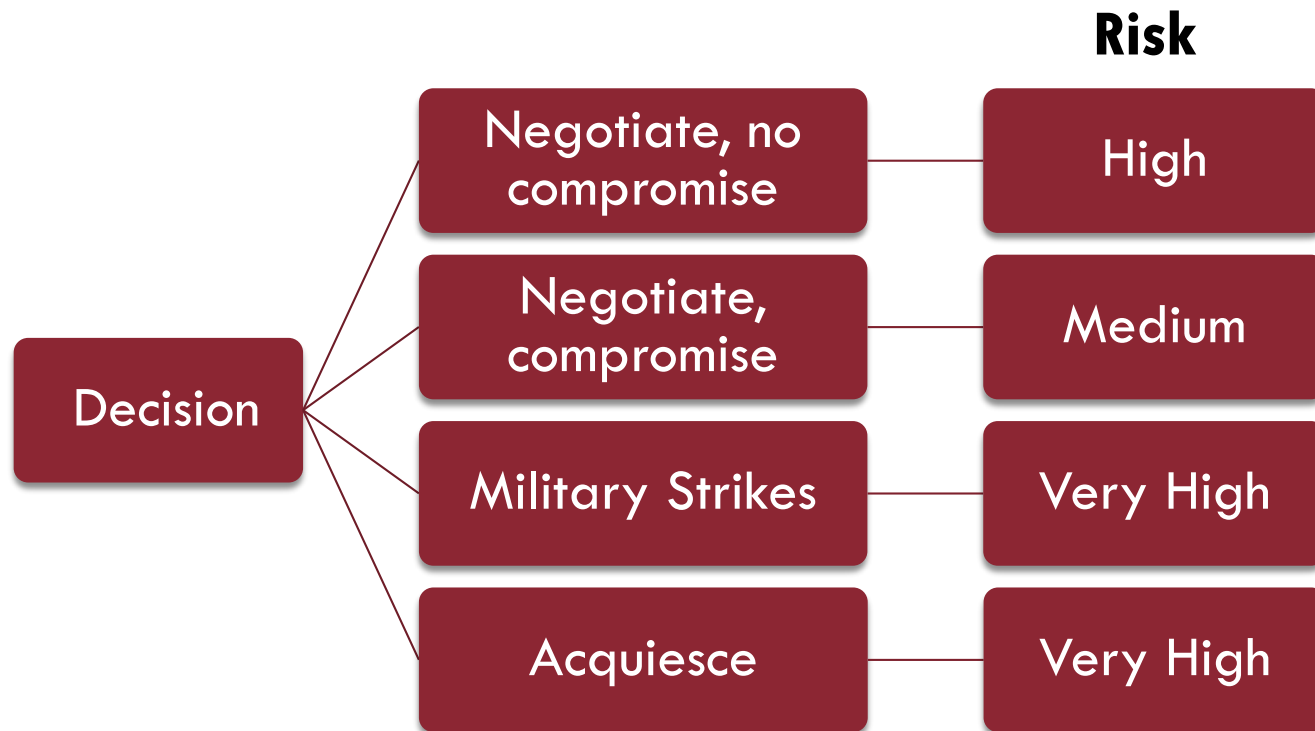
Iran: should Obama have cut a deal?

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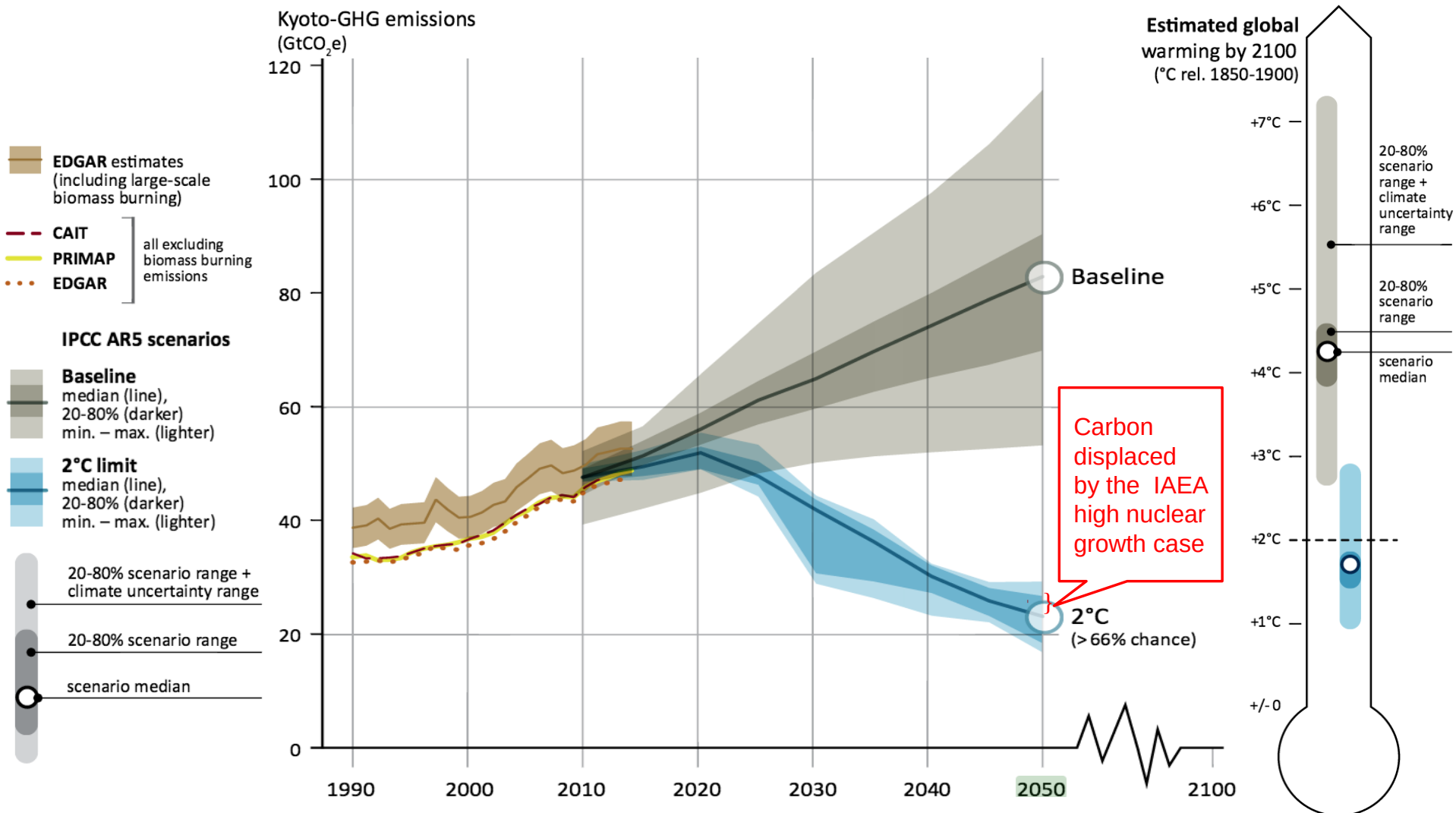
Comparing the alternatives

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Huge, transformational nuclear growth needed for substantial climate role

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Particulates may be even more important than climate in driving clean energy

44



Smog in Beijing. Source: inhabitat.com

❑ **>3 million deaths/yr globally from fine particulates**

Key constraints on large-scale nuclear energy growth – can they be loosened?

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- ❑ Economics
- ❑ Safety risks – real and perceived
- ❑ Security risks – real and perceived
- ❑ Nuclear waste management – mostly politics
- ❑ Siting and public acceptance
- ❑ Limited government and industry capacity
- ❑ Stringent regulation
- ❑ Proliferation risks – mainly from the nuclear fuel cycle
- ❑ U supply: Not likely to be a constraint this century

In each area, both new policies and new technologies have the potential to loosen past constraints on growth

Maintaining U.S. nuclear influence

- ❑ U.S. role in the nuclear market is now greatly reduced
- ❑ But the United States offers world-leading innovation, and approaches to safety, security, and nonproliferation
- ❑ Both economic and security benefits to maintaining a significant U.S. position in nuclear markets
 - ⌘ Important to U.S. influence over other countries' nuclear choices
- ❑ President Biden has to grapple with:
 - ⌘ How to avoid losing nuclear's domestic low-carbon contribution
 - ⌘ How to ease the path to commercializing new technologies
 - ⌘ How to help U.S. firms compete against state-owned (or assisted) firms from other countries
 - ⌘ How best to advance U.S. nuclear safety, security, nonproliferation objectives