Desert Dreams of Drinking the Sea, Consumed by the Cold War: Transnational Flows of Desalination and Energy from the Pacific to the Persian Gulf

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In the present era of global climate change, academics, government officials, and the media have all begun to grapple with the prospect that anthropogenic drought is likely a permanent condition in California. In 2015, drought forced Governor Jerry Brown and the State Water Resources Control Board to adopt California's first mandatory water restrictions, imposing a 25-percent reduction in urban water use. As California's water crisis deepens, average Americans are becoming accustomed to hearing about the state's controversial turn to desalination technology. In December 2015, the San Diego County Water Authority and Poseidon Water opened the Claude 'Bud' Lewis Carlsbad Desalination Plant, the largest seawater desalination plant in the Western Hemisphere. With a price tag of a billion US dollars, the reverse-osmosis plant is projected to produce 50 million gallons of drinking water per day, providing nearly 10 percent of San Diego County's supply by 2020.[1]

Despite enthusiastic visions of climate and water independence, safeguarding California's urban areas from future drought, desalination in California and United States has a checkered history. After decades of sporadic interest, converted seawater has struggled to make a sizeable contribution to the nation's water supply. Previous projects in California and Florida have struggled. In Tampa Bay, a plant with half of the proposed capacity of the Carlsbad project, opened in 2007 after a string of costly setbacks. However, engineering

[1] William DeBuys, *A Great Aridness: Climate Change and the Future of the American Southwest* (New York: Oxford University Press, 2013); Amir AghaKouchak et al., 'Recognize Anthropogenic Drought', *Nature* 534, 7566 (27 Aug. 2015): 409-11; Bradley J. Fikes, 'State's biggest desal plant to open: What it means', *The San Diego Union-Tribune*, 13 Dec. 2015, http://www.sandiegouniontribune.com/news/environment/sdut-poseidon-water-desalination-carlsbad-opening-2015dec13-htmlstory.html; Adam Nagourney, 'California Imposes First Mandatory Water Restrictions to Deal With Drought', *The New York Times*, 1 Apr. 2015, https://www.nytimes.com/2015/04/02/us/california-imposes-first-ever-water-restrictions-to-deal-with-drought.html.

problems reduced the plant's operating capacity by some 80 percent for years. Key investors were forced to declare bankruptcy, costing the city millions more than projected. Similarly, Santa Barbara's desalination plant has been offline for over two decades. Originally built to address the drought conditions of the 1980s, almost immediately after its completion in 1992, the Santa Barbara plant became too expensive to operate after rainfall returned and local reservoirs were replenished. Part of the plant was eventually sold off to Saudi Arabia and the remaining fragment of the decommissioned plant is held as an 'insurance policy' against future drought. With the United States' extremely low average water prices, even in drought-stricken regions desalination has struggled to prove its economic viability.[2]

Desalination has also faced withering opposition from environmental activists voicing concerns that utilities and consumers will be lured away from conservation if they believe that drinking seawater is a panacea. Environmental groups filed numerous challenges to the Carlsbad plant, citing concerns that fish larvae will get sucked into the plant's intake system or that fish will get pinned against the screens designed to prevent them from entering the plant's intake. Activists worry about the impact of increased salinity produced by the plant's reject brine on marine ecosystems. There also remain concerns that the energy-intensive nature of desalination merely perpetuates the vicious cycle of fossil-fuel dependency driving global climate. And yet, with some fifteen proposed projects dotting its coastline, California seems poised to normalize the idea of drinking the sea.[3]

Although the debate on desalination is unfamiliar to most Americans, the technology itself is neither new, nor untested. Since the 1970s, desalination technology has gained

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[2] Ruth Morgan, 'The Allure of Climate and Water Independence: Desalination Projects in Perth and San Diego', *Journal of Urban History*, OnlineFirst (2017): 1-16; David Sedlak, *Water 4.0: The Past, Present, and Future of the World's Most Vital Resource* (New Haven: Yale University Press, 2014), 231-7.

[3] Amanda Little, 'Can Desalination Counter the Drought?", *The New Yorker*, 22 July 2015, http://www.newyorker.com/tech/elements/can-desalination-counter-the-drought.

traction in locations as disparate as Australia, China, India, Israel, Japan, Kuwait, Saudi Arabia, Singapore, Spain, and the United Arab Emirates (UAE). However, the Middle East stands out as home to both the most advanced desalination expertise and its most mature market. Of the approximately 17,500 desalination plants worldwide, 43 percent are located in Saudi Arabia, Bahrain, Kuwait, Oman, Qatar, and the UAE alone. Worldwide 14 billion gallons of water are produced each day, but roughly 70 percent of that total capacity comes from the Arabian Peninsula. In Saudi Arabia about 60 percent of the kingdom's water supply comes from desalination. Meanwhile, desalination accounts for some 75 percent of Israel's household drinking water.[4]

Given the Middle East's deep investment in desalination, it is unsurprising that the new San Diego facility was designed by an Israeli firm, IDE Technologies. While enormous by American standards, Carlsbad barely makes the International Desalination Association's list of the 50 largest seawater plants, most of which are in the Middle East. It has less than a third the capacity of Tel Aviv's Soreq plant, which it was modeled after, and less than one-fifth that of the world's largest, Saudi Arabia's 273 million-gallon-per-day (MGD) Ras al-Khair plant.[5]

The great irony is that the US, now a relative laggard in the field, was once its greatest pioneer. At the height of the Cold War, from the 1952 to 1974, the US government's Office of Saline Water (OSW) was instrumental in spearheading the basic research and development that incubated the desalting techniques seen today. American technical assistance programs were fundamental to the growth of desalination capacity in the Middle

[4] Gökçe Günel, 'The Infinity of Water: Climate Change Adaptation in the Arabian Peninsula', *Public Culture* 28, 2 (2016): 295; Ubaid al-Suhaimy, 'Saudi Arabia: The Desalination Nation', English Edition of *Asharq al-Awsat*, 2 July 2013, http://english.aawsat.com/abeedalsuhaimy/features/the-desalination-nation; Alon Tal, 'Addressing Desalination's Carbon Footprint: The Israeli Experience', *Water* 10, 2 (2018): 197-210.
[5] Little, 'Can Desalination Counter the Drought?'.

East and its eventual globalization. However, the federal government's original target region was southern California, not Israel or Arabia.

This essay examines the rise and fall of American domestic desalination ambitions and their metamorphosis and rebirth as a tool of Cold War foreign policy. The first half of this essay traces the domestic side of OSW's transnational career. In the 1950s, desalination was first proposed as an infrastructural safeguard to relieve the stress that California's unquenchable thirst had placed on the Colorado River basin. To borrow a phrase from Erik Swyngedouw, desalination was supposed to provide the ultimate 'hydro-social fix.' It was imagined that desalination would allow California to escape from, or at least mitigate the costs of, its seemingly endless cycle of dam building and increasingly costly and controversial battles over water transfers. As Swyngedouw argues, while 'terrestrial' inter-basin water transfers are typically plagued by 'complex property rights, inserted in dense regulatory and institutional arrangements, infused with all manner of social, cultural, and ecological conflict,' desalination proponents have lauded seawater as virtually free of the 'highly charged meanings, claims, and practices' associated with more conventional land-based hydraulic systems. Whereas transfers tend to imply top-down, even authoritarian, bureaucratic decision making with clear winners and losers, 'the incorporation of the sea into the politics of produced water' has generally been positioned as a 'scalar fix,' a win-win proposition for all involved. Ideally, this adjustment would have alleviated the American West's intractable regional conflicts 'by including the sea as an integral component of national water management strategies.'[6]

[6] Erik Swyngedouw, 'Into the Sea: Desalination as Hydro-Social Fix in Spain,' *Annals of the Association of American Geographers* 103, 2 (2013): 261-70; idem, ''Not a Drop of Water…': State, Modernity and the Production of Nature in Spain, 1898-2010,' *Environment and History* 20 (2014): 67-92.

In practice, the OSW's domestic plans failed to overcome two challenges. First, desalination never proved itself as an economically competitive alternative to the arid West's existing system of dams and long-distance water transfers. Second, the success of domestic desalination was fundamentally a question of energy efficiency and pricing. On the one hand, fossil-fueled desalination proved too expensive to scale up. Indeed, in the 1970s, rising oil prices would eventually play a decisive role in eroding federal support for desalination research. On the other hand, the OSW's flirtation with nuclear-powered desalination produced a chain reaction of technical and fiscal challenges, compounded by local opposition to the construction of nuclear power plants along California's densely-populated and seismically-vulnerable coastline.

A third set of challenges emerged from desalination's potential as an instrument of Cold War strategy. While superpower rivalry and humanitarian modernization initially helped inform the rationale needed to secure funding and advance desalination research and development, those same forces also wound up altering, even hampering, the basic design and viability of domestic desalination. Gradually, the promise of domestic desalination was coopted and consumed by the technopolitics of Cold War foreign policy. This story of ambition, setbacks, and unintended consequences traces the transnational flows and bottlenecks that channeled desalination technology from California to Cuba, Israel, and Saudi Arabia. Thus, the latter half of this article unravels the intertwined stories of how the OSW's original plans for saving California were repackaged and exported to the Middle East. Simultaneously mirroring and exacerbating the dilemmas encountered in California, the divergent fortunes of American technical assistance in Israel and Saudi Arabia would also be defined by the question of whether desalination would be powered by hydrocarbons or atoms.

As Americans contemplate a return to desalination, this essay considers how and why the US slipped from the vanguard of desalination research while the Middle East emerged as its global leader. By reconnecting and comparing the divergent, yet symbiotic, fortunes of Cold War desalination in the American West and the Middle East, this essay sheds new light on the nexus between the production of desalinated water and its key ingredient, energy.

**WHEN THE RIVERS OF EMPIRE RUN DRY:
CALIFORNIA, THE COLORADO RIVER, AND THE OFFICE OF SALINE WATER**

The origins of American desalination cannot be understood without the wider context of the US Bureau of Reclamation's role in the development of the American West's hydraulic infrastructures. From Donald Worster's *Rivers of Empire* to Marc Reisner's *Cadillac Desert*, the classic environmental historiography of the American West has been narrated as the story of the big dams, reservoirs, canals, and hydro-electric projects needed to fuel southern California and the desert Southwest's ever-expanding population and insatiable quest for sprawling suburban development.[7]

In 1982, Worster dubbed California as 'the most elaborate hydraulic system in world history, overshadowing even the grandiose works of the Sassanians and the Pharaohs.' By 1976, at the end of the Bureau of Reclamation's multi-decade dam-building spree, Worster tallied the massive scale of California's hydro-electric infrastructure. This liquid empire included 320 water-storage reservoirs, 344 diversion dams, 14,400 miles of canals, 900 miles of pipelines, 205 miles of tunnels, 145 pumping plants, 50 power plants, and 16,240 circuit miles of transmission lines. This infrastructural spine supported both California's booming cities and the world's most powerful agricultural region. For Worster, this enormous

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7 Donald Worster, *Rivers of Empire: Water, Aridity, and the Growth of the American West* (New York: Oxford University Press, 1985); Marc Reisner, *Cadillac Desert: The American West and Its Disappearing Water* (New York: Penguin Books, 1993); Norris Hundley Jr., *The Great Thirst: Californians and Water, 1770s-1990s* (Berkeley: University of California Press, 1992); Donald Pisani, *Water and American Government: The Reclamation Bureau, Water Policy, and the West* (Berkeley: University of California Press, 2002).

hydraulic empire was nothing to celebrate. He predicted that its scale and complexity represented a long-term infrastructural 'trap.'[8]

Worster's gloomy warnings mirrored the federal government's own predictions dating back to the 1950s. Inspired by growing concerns over the arid Southwest's population boom, New Mexico Senator Clinton P. Anderson spearheaded the bill that led to the Office of Saline Water's creation. On 3 July 1952, the Truman administration signed the Saline Water Conversion Act. Housed in the Department of the Interior, the OSW grew out of, and functioned as a kind of 'sister agency' to the Bureau of Reclamation.[9] Together, their experts repeatedly framed the American West's water supply as a looming Malthusian crisis. As Fred Seaton, Secretary of the Interior, explained in 1959:

> We all know the population of the United States has now passed 177 million. What sometimes escapes our notice is that barring the catastrophe of a nuclear war or some unprecedented natural calamity, there will be 275 million of us by 1980—only a generation away. By the turn of the next century, only 40 years away, we will have doubled our present population to 350 million souls.[10]

In order to meet increased demand, the OSW warned that the US would need to develop new water sources 'equal to the daily flow of 25 Colorado Rivers.'[11] According to their calculations, only about a third of the US had an average annual rainfall of more than 30 inches. In the two-thirds of the nation west of the Mississippi River, rainfall varied from 30 to as little as 10 inches in desert areas. However, those same arid regions, most notably California and Arizona, had seen population increases of more than 50 percent in the

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[8] Donald Worster, 'Hydraulic Society in California: An Ecological Interpretation', *Agricultural History* 56, 3 (1982): 506, 514.
[9] On the Bureau of Reclamation's role in the creation and staffing of the OSW, see J. W. Pat O'Meara, 'The OSW 20 Years Later: Part 1', *Desalination and Water Reuse* 2, 2 (1992): 31-8.
[10] Fred A. Seaton, 14 July 1959, National Archives and Research Administration, College Park, Maryland (hereafter NARA), Record Group (RG) 380.1: Records of the Office of Saline Water, Press Releases, 1958-1972, Box 1, Folder 1.
[11] A. L. Miller, Director of the Office of Saline Water, 7 Oct. 1959, NARA RG 380.1, Box 1, Folder 1.

previous 20 years.[12] Between 1945 and 1960, Los Angeles grew from approximately 1.5 to 2.5 million residents, with more than 6.75 million in the metropolitan area. San Diego's population went from just over 200,00 to 573,000, with over a million in its greater metropolitan area.[13] Phoenix grew from little more than an irrigated village of 65,000 to a Sun Belt metropolis of 440,000.[14] America's westward expansion was concentrating more and more people in the nation's most water insecure region.

As the region's urban centers expanded, their hydraulic demands gradually choked the Colorado River. The Colorado's strangulation began in earnest with the completion of Hoover Dam (1935) and continued with the subsequent additions of the Parker (1938), Davis (1951), Navajo (1962), Glen Canyon (1963), Flaming Gorge (1964), and Blue Mesa (1966) dams. By the 1960s, these and other diversion projects had reduced the lowest reaches of the river to little more than a 'drainage ditch.' Bottled up into reservoirs, the Colorado no longer even reached the sea.[15] With every dam built, the Bureau of Reclamation had begun to realize the limits of this approach. Thus, the OSW was imagined as the back-up plan, a last line of defense when these giant dams eventually cease to slake California's unquenchable thirst.

In the midst of the bitter fight over California's highly controversial Feather River project, Fred Seaton invoked the infamous William Mulholland, the longtime superintendent of Los Angeles's water system and the Metropolitan Water District of Southern California, to drive home his point about California's narrowing options.[16] As Seaton mused, 'When

[12] Seaton, 25 May 1959, NARA, RG 380.1, Box 1, Folder 1.
[13] Sean P. Cunningham, *American Politics in the Postwar Sunbelt: Conservative Growth in a Battleground Region* (Cambridge: Cambridge University Press, 2014), 28.
[14] Andrew Needham, *Power Lines: Phoenix and the Making of the Modern Southwest* (Princeton: Princeton University Press, 2014), 28; Reisner, *Cadillac Desert*, 259-60.
[15] Worster, *Rivers of Empire*, 272-4; Reisner, *Cadillac Desert*, 255-305.
[16] Catherine Mulholland, *William Mulholland and the Rise of Los Angeles* (Berkeley: University of California Press, 2000); Steven P. Erie, *Beyond Chinatown: The Metropolitan Water District, Growth, and the*

asked what in the world Los Angeles would do with all the water he was going to bring down from the Owens River, Mulholland is reported to have replied: 'If you don't get it, you won't need it.' For Seaton, California's repeated raids on freshwater supplies from northern California and the Great Basin were necessary evils. Nevertheless, he feared that if development trends held steady, these diversion projects would prove inadequate in less than a decade. As Seaton warned, 'today the people of southern California are looking toward another answer for their problem, a $1.5 billion project which would bring them water from the Feather River—more than 500 miles away—water far more expensive than that now obtained from the Colorado.'[17] In reality, the Feather River Project, what ultimately resulted in the Oroville Dam and California Water Project (1968), diverting water from northern California to the San Joaquin Valley and the municipal and industrial water systems of southern California, would actually cost more like $3 billion. Adjusted for inflation that roughly equals $25 billion in 2017 dollars.[18]

The Feather River controversies illustrated the urgent need for alternatives to the increasingly expensive and politically unpopular cycle of dam construction and water transfers. By ramping up the pace and scale of desalination research, Seaton and his colleagues earnestly believed that by as early as 1975 they could bring down the cost of desalination to levels that would make it competitive with conventional sources of transferred water.[19] Despite the grim predictions about California's empire of dams, they proved more difficult to supplant than the OSW's leaders assumed. While extracting water from the ocean ostensibly alleviated the social, political, and ecological conflicts associated

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Environment in Southern California (Palo Alto: Stanford University Press, 2006).

[17] Seaton, 25 May 1959, NARA, RG 380.1, Box 1, Folder 1.

[18] Reisner, *Cadillac Desert*, 349-57.

[19] Seaton, 30 Aug. 1960, NARA, RG 380.1, Box 1, Folder 2.

with terrestrial water transfers, this 'scalar fix' depended on its potential to achieve price parity with conventional water.[20]

The need to compete with existing infrastructures also faced challenges related to energy costs. However, desalination inverted the 'normal' relationship between water and electricity established by the Bureau of Reclamation's existing infrastructures. En route to its final point of consumption in irrigation systems and household faucets, water transferred from the Great Basin had the obvious benefit of generating hydro-electric power along its journey.[21] By contrast, the most obvious drawback to desalinated water was its energy-intensive nature. While dams produced energy, desalination plants were voracious consumers.

DIVERGENT DREAMS: COLD WAR TECHNOPOLITICS AT HOME AND ABROAD

From the 1940s through the 1970s, the Bureau of Reclamation's big dams were exported across the globe from Jordan and Lebanon to Ethiopia, China, and the Mekong Delta as part of an American vision of Cold War modernization. Much like the story of the Bureau of Reclamation's large dam and hydro-electric projects, American desalination also found its way into Cold War development schemes abroad. In this respect, desalination technology was like a shadow trailing behind the dams of the Colorado River and their global offspring.[22]

Unlike big dams, however, desalination technology was drafted into the service of Cold War well before it had been perfected at home. As a result, arguably the biggest

[20] Swyngedouw, 'Into the Sea', 262.
[21] Worster, 'Hydraulic Society', 506-7.
[22] Christopher Sneddon, *Concrete Revolution: Large Dams, Cold War Geopolitics, and the US Bureau of Reclamation* (Chicago: University of Chicago Press, 2015). On Cold War technopolitics, modernization, and development, see also Gabrielle Hecht, *Entangled Geographies: Empire and Technopolitics in the Global Cold War* (Cambridge: MIT Press, 2011); Michael E. Latham, *The Right Kind of Revolution: Modernization, Development, and U.S. Foreign Policy from the Cold War to the Present* (Ithaca: Cornell University Press, 2011).

obstacle facing the rise of desalination in California was the federal government's divergent visions for the technology's utility. At various points, desalination was imagined as both a civilian and military technology. Clearly, it was first imagined as a domestic project. However, in an attempt to show the project's relevance to wider Cold War competitions between American and Soviet science, proponents of desalination were quick to advertise its potential as a strategic tool of modernizing foreign aid. At times, these goals overlapped and coexisted. At other critical junctures, however, the OSW's domestic plans were repurposed and appropriated in service of seemingly more pressing foreign policy objectives.

In 1960, OSW Director Dr. A. L. Miller addressed the American Institute of Chemical Engineers, delivering a shrill Cold War rallying cry. As Miller warned, 'I can assure you that the most important of all our natural resources is not gold, not oil, not uranium, but plain ordinary water.' He implored his audience to imagine water security as a critical front in the Cold War.

> The United States and the Soviet Union are locked in a titanic struggle to demonstrate to the world which system, our type of freedom or Communist slavery can provide the economic growth and technological progress that can break the bonds of disease, undernourishment, illiteracy, and impoverishment that shackle the under-developed Nations of the world. If we run out of water we will lose the battle, for our economy would be damaged beyond repair.[23]

Having found its place in the strategic logic of the Cold War, under the presidency of John F. Kennedy desalination research would receive its biggest break. For Kennedy, desalination was well suited to the technological futurism of the era: 'like the space race, it involved a concerted government effort to advance a technology that could provide a military advantage in the Cold War, and like the Peace Corps, its success would lead to the betterment of mankind.'[24]

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[23] Miller, 6 Sept.1960, NARA, RG 380.1, Box 1, Folder 2.
[24] Sedlak, *Water 4.0*, 221.

Even if winning the Cold War was the overarching goal, desalination was more than 'politics by another name.' Desalination was *technopolitical*. As Gabrielle Hecht defines it, 'technopolitics is the strategic practice of designing or using technology to constitute, embody, or enact political goals.'[25] This brand of modernist hubris fostered the illusion that human intellect and technological infrastructures can control and organize nature.[26] However, when politicians, bureaucrats, and engineers (also political actors in their own right) work together to solve a technopolitical problem, the final results can be unpredictable. As they interact, 'emerging technical capabilities both create and constrain political possibilities.' The seemingly indispensable nature of technical expertise can create 'obligatory passage points.'[27] In those bottlenecks, political aims can either support or suffocate technical progress. Technical expertise can reshape, redirect, or even undermine the original political objectives. Politicians and technical experts may also 'orient each other to particular solutions.' New technologies may 'expand and take on directionality to the extent that they acquire political support and effectiveness.' Some designs come to seem unworkable or impractical, even if they are not. Likewise, less efficient or even deeply flawed designs can become dominant if enough political and technical resources are assembled behind them. And frequently, neither politicians nor engineers are able to anticipate the wide-ranging implications of their 'mutual orientation' toward particular kinds of usages and solutions.[28]

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[25] Gabrielle Hecht, *The Radiance of France: Nuclear Power and National Identity after World War II* (Cambridge: MIT Press, 2009), 91.

[26] Sara B. Pritchard, 'Water, Technology, and Western Hubris', *Pacific Standard*, 7 Apr. 2015, http://www.psmag.com/nature-and-technology/water-technology-and-western-hubris.

[27] Bruno Latour, *Pandora's Hope: Essays on the Reality of Science Studies* (Cambridge: Harvard University Press, 1999), 191-2.

[28] Gabrielle Hecht and Paul N. Edwards, 'The Technopolitics of the Cold War: Toward a Transregional Perspective', in Michael Adas (ed.), *Essays on Twentieth Century History*, pp. 274-5 (Philadelphia: Temple University Press, 2010).

In the case of American desalination, this 'mutual orientation' manifested itself as a Cold War confusion over whether desalination was primarily a civilian-domestic project or a military-foreign policy tool. This indecision had two consequences. First, successfully-tested fossil-fueled plant designs in California were rapidly appropriated for military and foreign policy uses. Second, technopolitical enthusiasms for the multiple civilian, military, and foreign policy potentials of desalination led politicians and experts to gravitate toward more complex nuclear plans with clearer military and foreign policy applications, eschewing more gradual progress being made on fossil-fueled designs. These nuclear plans, despite their potential domestic limitations, had ideological and strategic values that fit the Cold War narratives underpinning the rationale for desalination. Thus, at several pivotal moments, desalination research and development in southern California ended up trapped between basic questions surrounding the cost and efficiency of fossil-fueled desalination plants, the socio-technical complexities of nuclear-powered alternatives, and the intrusion of international pressures introduced by Cold War considerations ranging from Cuba and the Soviet Union to Israel and the Arab world.

RESEARCH AND DEVELOPMENT: CIVILIAN TEST PLANTS AND MILITARY TRANSPLANTS

Desalination is the artificial process of removing salt from seawater, miniaturizing nature's hydrologic cycle. In nature, heat from the sun acts as an evaporator. As water vapor rises in the atmosphere, it cools and condenses, and falls back to Earth's surface as precipitation. The mechanical process of desalination does the same thing, but unlike rain, which occurs at irregular intervals and is unevenly distributed across the globe, a desalination plant allows its operator to determine the regularity and location of the water produced. Rudimentary knowledge of this basic science stretches back to antiquity.

However, attempts to industrialize this process began to gain traction with the dawn of steam technology between the 1830s and World I.[29]

The basic principle of thermal distillation is to heat saline water in order to create water vapor. While water boils under normal atmospheric pressure at 100º C, by reducing atmospheric pressure in the system, the temperature required to boil the saline solution decreases. By processing water through multiple boiling steps in vessels operating at successively lower temperatures and pressures, more vapor can be produced and condensed with the same amount of energy. The concept of distilling water in multiple reduced-pressure vessels or 'effects' was not a new technology. The technique was first developed for cane sugar production in the American South and Caribbean in the 1830s. By the end of the century, multi-effect systems had been adapted for use on steamships and eventually for land-based condenser plants in parched locations from the Florida Keys and the Caribbean to the Red Sea and Persian Gulf. [30]

The US government's first experiments with desalination emerged during World War Two. With hundreds of thousands of servicemen fighting on Saipan, Iwo Jima, and countless other islands across the Pacific, the Navy outfitted submarines and ships with portable vapor compression systems, allowing crews to distill potable water from the sea.[31] In the 1950s, Forrestal Class aircraft carriers came equipped with 50,000-gallon systems. When the first nuclear-powered submarine, the *USS Nautilus*, was launched in 1954, it was equipped with a

[29] Philip Sporn, *Fresh Water from Saline Waters: The Political, Social, Engineering and Economic Aspects of Desalination* (Oxford: Pergamon Press, 1966), 7-8.
[30] National Research Council of the National Academies, Committee on Advancing Desalination Technology, *Desalination: A National Perspective* (Washington, DC: The National Academies Press, 2008), 71-3; James D. Birkett, 'A Brief History of Desalination from the Bible to 1940', *Desalination* 50 (1984): 33-40.
[31] James D. Birkett, 'The History of Desalination Before Large-Scale Use", in *Desalination and Water Resources: History Development, and Management of Water Resources*, vol. 1, 424-5 (United Kingdom: UNESCO-EOLSS Publishers, 2010).

distillation unit harnessing heat from atomic energy.[32] This burst of military development led to major advances in the efficiency and variety of desalination techniques, suggesting new potential for broader civilian uses.

By the 1950s and 1960s, multi-effect distillation was being supplanted by a newer method called multi-stage flash (MSF). MSF distillation employs a similar approach. The steam vapor created by successive 'flash' stages is converted to freshwater as it condenses on the tubes of the heat exchangers running through each stage. Freshwater is recovered by cooling some of the steam that collects on the surfaces of the tubes that transport saline water into the plant. The tubes are cooled by incoming water fed from the sea to the brine heater. In turn, this heats the feed water so that the amount of thermal energy required to operate the brine heater is lowered. By operating at higher temperatures than multi-effect plants, MSF techniques dramatically reduced the risk of salt precipitation or scale formation on heating elements. This adjustment decelerated metal corrosion and dramatically improved the efficiency of heat transfer. By the 1960s, MSF represented the cutting edge of desalination research, paving the way for the development and further commercialization of thermal processes and newer membrane-based reverse-osmosis methods, which became increasingly viable from the late 1970s onward.

In 1955, Congress reauthorized the OSW, extending the fledgling program through 1963 and increasing its funding from $2 million to $10 million. In 1958, Congress approved a further $10 million for the construction and operation of five demonstration plants. Having piqued the interest of the Kennedy administration, in 1961, the OSW achieved its greatest legislative victory. Kennedy signed the Anderson-Aspinall Act, increasing research and development funds to $75 million from 1963 to 1967. The act extended the authorizations

[32] Miller, 16 Sept. 1960, NARA, RG 380.1, Box 1, Folder 2.

for the demonstration plants for another decade. Between 1966 and 1973, federal investment in desalination research hovered around 150 million present-day dollars per year (2017). To put this in perspective, that is about ten times higher than current federal investments in desalination research.[33]

Constructed between 1961 and 1963, the five demonstration plants were distributed across the country. Three were dedicated to seawater desalination and two for converting brackish water in inland sites. Each site was designed to test a desalting technique appropriate to its local environment. The first plant was located on the Gulf coast in Freeport, Texas and tested multi-effect long-tube vertical distillation. Webster, South Dakota received a plant specializing in electrodialysis and plastic membranes. Roswell, New Mexico tested vapor compression. Wrightsville Beach, North Carolina explored freeze separation. However, the OSW's crown jewel was San Diego's million-gallon MSF plant.[34]

In March 1962, the Westinghouse-designed Point Loma plant began production.[35] In just under two years in operation, the plant processed over 500 million gallons of freshwater from the Pacific Ocean. It was a critical proving ground, advancing research on corrosion-resistant construction materials, heater-transfer efficiency, energy consumption, and virtually every technical feature of desalination. Shortly after the plant's dedication, it reached its design specifications. However, by increasing operating temperatures from 190˚F to 250˚F (87.78˚C to 121.1˚C), output was raised to as much as 1.4 MGD. With negligible cost increases, the plant produced 40 percent more water per day. Prior to 1952, the OSW estimated the average cost of converted saline water at four to five dollars per 1,000 gallons.

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[33] Sporn, *Fresh Water from Saline Waters*, 9-10, 35; Sedlak*, Water 4.0*, 221.
[34] James K. Carr, Under Secretary of the Interior, 11 Feb. 1963, NARA, RG 380.2, Box 1.
[35] *Proceedings of the First International Symposium on Water Desalination: Washington, D.C. October 3-9, 1965* (Washington, DC: U.S. Department of the Interior, Office of Saline Water, 1967), 224.

Point Loma was producing at a cost of $1.18 per thousand gallons.[36] But even this remarkable figure remained nowhere close to competing with average national water costs of roughly 30 to 35 cents per thousand gallons.[37]

San Diego's experiment with MSF desalination was a smashing success, perhaps too successful. Having proved its utility, the Point Loma plant, originally designed for domestic civilian-use, was re-militarized and drafted into the Cold War. In February 1964, in the wake of the Bay of Pigs and the Cuban Missile Crisis in 1961-1962, Fidel Castro completely cut off all water to the US Navy's base at Guantanamo Bay. The Department of the Interior recommended that the Navy could address the base's water crisis through desalination and suggested the transfer of the Point Loma plant to Cuba to ensure the base's self-sufficiency. On 26 February 1964, the plant was dismantled and shipped to Guantanamo Bay. In the blink of an eye, California's first desalination plant became a Cold War casualty, altering the overall trajectory of desalination research both at home and abroad.[38]

FROM ATOMIC AMBITION TO NUCLEAR SUICIDE: A SEISMIC SHIFT ON BOLSA ISLAND

Despite this setback, San Diego, Los Angeles, and the wider Metropolitan Water District of Southern California remained central to the OSW's mission. In July 1964, President Lyndon B. Johnson asked the Department of the Interior to partner with the Atomic Energy Commission (AEC) to develop a more aggressive strategy to advance large-scale desalination. The resulting report called for the creation of a new West Coast test facility. When the OSW broke ground on the new facility in 1966, it was supposed to push MSF technology to new levels of efficiency and scale. The South Bay test site, made available to the Department of the Interior by the San Diego Gas and Electric Company, was

[36] Frank C. Di Luzio, Director, Office of Saline Water, 20 May 1965, NARA, RG 380.2, Box 1.
[37] Miller, 7 Oct. 1959, NARA, RG 380.1, Box 1, Folder 1.
[38] Stewart L. Udall, Secretary of the Interior, 10 Aug. 1966, NARA, RG 380.1, Box 1, Folder 2.

envisioned as the first step in an ambitious plan to rapidly scale up from the original million-gallon Point Loma plant to larger dual-purpose desalting and electric power plants capable of producing 50 million gallons and 150 megawatts per day by 1968-1971 and 150 million-gallon/750 megawatt-capacity plants by 1972-1975.[39] Combined with the first breakthroughs in reverse-osmosis membranes by researchers at UCLA and the San Diego-based defense contractor, General Atomics, southern California seemed positioned to launch a desalination revolution.[40]

In a feasibility study, Bechtel Corporation argued that a dual-purpose plant with a 150-MGD capacity could bring the cost of converted seawater below 25 cents per thousand gallons. However, this would require a leap from fossil fuels to nuclear energy. Nuclear power was the only way to dramatically increase capacity and reduce fuel costs. A dual-purpose plant with an electrical output of 125 megawatts powered by fossil fuels was projected to produce 38.3 MGD with annual fuel costs of $7.2 million, while a 125-megawatt plant fueled by a nuclear reactor was projected to produce 69 MGD with an annual fuel cost of only $5.42 million.[41] As the Bechtel study underscored, the future of desalination in California was morphing from a question of the theoretical viability of desalination technology itself to one of electricity costs, moving desalination to the center of a wider debate on nuclear energy.

In 1953, President Dwight Eisenhower had launched a campaign to benignly repackage the terrifying violence of nuclear bombs as 'Atoms for Peace.' Walt Disney's cartoons encouraged American children to think of nuclear power as 'Our Friend the Atom.'

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[39] Di Luzio, 20 May 1965, NARA, RG 380.2, Box 1.
[40] Seth M. Siegel, *Let There Be Water: Israel's Solution for a Water-Starved World* (New York: Thomas Dunne Books, 2015), 119-21.
[41] Grace M. Urrows, *Nuclear Energy for Desalting* (Washington, DC: U.S. Atomic Energy Commission, Division of Technical Information, 1966), 37-8.

From the halls of power to popular culture, Americans were encouraged to vernacularize and tame nuclear energy through what came to be called 'nukespeak.' At the heart of this effort to popularize peaceful nuclear technology was its potential as a source of electricity. Speaking in 1954, then AEC Chairman Lewis Strauss famously promised a near future with 'electrical energy too cheap to meter.'[42] Not surprisingly, as this imagined future of infinite electricity became entangled with nuclear power, its experts, institutions, and international implications, desalination followed. In turn, promoters of peaceful nuclear energy like Eisenhower and Strauss also emerged as enthusiastic advocates for desalination.

Desalination's 'nuclearity' was a clear indicator of the power that it had accumulated. Just as 'nuclear scientists and engineers gained prestige, power, and funding far beyond their colleagues in conventional research,' desalination achieved a similar kind of gravitational pull on Washington's Cold War imagination by the 1960s. However, nuclear exceptionalism was always a double-edged sword. As nuclear energy gained traction in California and elsewhere, by the late 1960s anti-nuclear groups also sprang up, brandishing their own 'exceptionalist claims by highlighting the unprecedented qualitative and quantitative dangers posed by exposure to radioactive substances.'[43]

The biggest challenge for southern California's proposed nuclear desalting plant was finding an appropriate site. Due to the obvious safety concerns surrounding any nuclear project, not to mention the political pull of real estate and coastal development interests, official consensus gravitated toward an offshore island concept. This proposal led to the

[42] John Wills, 'Talking Atoms: Anti-Nuclear Protest at Diablo Canyon, California, 1977-1984', *Oral History* 28, 2 (2000): 44-5.
[43] Gabrielle Hecht, 'The Power of Nuclear Things', *Technology and Culture* 51, 1 (210): 3-4.

construction of the 43-acre man-made Bolsa Island, located some 3,500 feet off the coast of Orange County near Huntington Beach.[44]

Whatever the supposed advantages of its quarantine-like offshore design, Bolsa Island would not have been a 'closed' technical system.[45] There were no stable borders between nature and technology, between the seismic and the nuclear. Despite optimistic claims that its designers had accounted for the site's seismicity, as Charles Perrow and Sara Pritchard explain, complex nuclear sites like the proposed Bolsa Island site (or more famous examples like Three Mile Island or Japan's Fukushima Daiichi nuclear power station), inherently produce systemic risks. While we might describe incidents at nuclear facilities as natural disasters, accidents produced by human error, or technical glitches, it is dangerously misleading to imagine these events as unusual or unlikely. In reality, so-called 'accidents' are 'normal and systemic, not extraordinary and inadvertent.' As Perrow warns, 'eco-system' accidents are the inevitable result of the 'tight coupling human-made systems and natural systems.' Even when their designers believe that they have created sufficient buffers between the technical and the natural, systems envisioned as 'independent' are unable to escape the 'larger ecology' in which they are embedded.[46]

Despite its theoretical advantages, the real-world marriage of desalination and nuclear energy was an unhappy one. With the backing of the Johnson administration and then Governor Ronald Reagan, the Bolsa Island project was formalized in November 1967. The Metropolitan Water District was slated to operate the facility with the support of the Los Angeles Department of Water and Power, Southern California Edison, and San Diego Gas

[44] Kenneth Holum, Assistant Secretary of the Interior and Power Development, 31 Mar. 1966, NARA, RG 380.1, Box 1, Folder 8.
[45] Thomas P. Hughes, *Networks of Power: Electrification in Western Society, 1880-1930* (Baltimore: Johns Hopkins University Press, 1983), 6.
[46] Sara Pritchard, 'An Envirotechnical Disaster: Nature, Technology, and Politics at Fukushima', *Environmental History* 17, 2 (2012): 219-43; Charles Perrow, *Normal Accidents: Living with High-Risk Technologies* (Princeton: Princeton University, 1991).

and Electric. From the start, the project was plagued by rivalries between various federal, municipal, and industry partners, leading several stakeholders searching for any excuse to make 'a graceful exit.' And while optimism surrounding nuclear power had soared in the 1950s and early 1960s, the latter half of that decade was marked by increasing environmental opposition. Although nuclear facilities at Rancho Seco, San Onofre, and Diablo Canyon were completed, this group was dwarfed by a much longer list of abandoned projects like Bodega Bay, Davenport, Malibu, Point Arena, and Point Conception. As in the case of Malibu and Bodega Bay, the Joint Commission on Atomic Energy warned that Bolsa Island presented serious safety risks due to its seismic instability and proximity to a large population center. In light of these concerns, it would need significant modifications to withstand earthquakes and tsunamis. In early 1968, revised cost estimates soared from $444 million to $765 million. As a result, Southern California Edison pulled out of the agreement, guaranteeing the project's demise.[47]

Even as the project's seismic risk became clearer, in June 1968, former President Eisenhower penned a pro-nuclear endorsement of desalination for *Reader's Digest* touting the Bolsa Island project. For Eisenhower, it was a perfect vehicle for his long-held dream of popularizing peaceful nuclear power. On the other hand, as we shall see, both the timing and underlying motivations behind Eisenhower's public embrace of Bolsa Island show that it was actually a pawn in service of his promotion of an Arab-Israeli peace proposal built around nuclear desalination assistance in Egypt, Israel, and Jordan.[48]

Despite Eisenhower's advocacy, the toxic mix of seismic risk, anti-nuclear opposition, and environmental activism had already doomed the project. Bolsa Island's

[47] Thomas Raymond Wellock, *Critical Masses: Opposition to Nuclear Power in California, 1958-1978* (Madison: University of Wisconsin Press, 1998), 125-8.
[48] Dwight Eisenhower, 'A Proposal for Our Time,' *Reader's Digest* (June, 1968): 71-4.

defeat triggered a virtual moratorium on the development of new nuclear plants in California. By 1976, California's nuclear flirtation came to decisive close. Voters approved a state referendum banning all new orders for nuclear reactors.[49] For the OSW, its failed partnership with nuclear energy squandered more than a decade of momentum. Although the OSW reached its fiscal peak in the late 1960s, its window of opportunity was about to slam shut.

MOONSHOT IN THE NEGEV: NUCLEAR DESALINATION DIPLOMACY

Even as America's domestic ambitions imploded, desalination as a tool of Cold War diplomacy and foreign aid had already taken on a life of its own. In 1961, OSW Director Charles F. MacGowan addressed the fourth annual Conference on Science and Technology in Israel and the Middle East in New York City. He began by praising the Israeli government for its visionary promotion of desalination technology and then turned to make his pitch: 'How, you may ask, can the OSW contribute to the Israeli program?' Channeling President Kennedy's rhetoric, he framed desalination in the wider context of the Cold War and the Space Race:

> At the first news conference President Kennedy held after Yuri Gagarin's spectacular space shot, the questions of the reporters reflected the dismay and disappointment of our Nation in this unaccustomed defeat. They naturally asked what we could do to restore our somewhat tarnished prestige, expecting him to say "put a man on the moon." He said, instead, that if U.S. scientists could find a way to get fresh water from the seas that this would "really dwarf" any other scientific accomplishment.[50]

By the early 1960s, the Soviet Union had developed their own desalination program. While desalination was certainly a source of competition, it also opened a rare opportunity for US-Soviet cooperation. In February 1964, Soviet Premier Nikita Khrushchev proposed the idea of sharing desalination research in a message dealing with nuclear arms reduction.[51]

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[49] Joseph Mangano, *Mad Science: The Nuclear Power Experiment* (New York: OR Books, 2012), 87.
[50] C. F. MacGowan, 14 Oct. 1961, NARA, RG 380.1, Box 1, Folder 3.
[51] *Foreign Relations of the United States* (*FRUS*), 1964-1968, vol. 34, Energy Diplomacy and Global Issues (Washington, DC: United States Government Printing Office, 1999), 235-6.

While it was unclear whether the Soviets were really interested in desalination itself or whether their proposal was merely an attempt to glean intelligence on American nuclear reactor technology, the US felt obliged to play along. With the escalation of the war in Vietnam, President Johnson was keenly aware that America's image in the developing world was plummeting. Thus, the Johnson administration was looking for ways to conspicuously signal its openness to international cooperation for the global public good.[52]

The superpowers signed an agreement to share their desalination findings, including advances in nuclear desalination. It provided a framework for the exchange of scientific data and visits mediated by the International Atomic Energy Agency (IAEA). By 1966, the Soviet Union was operating a 1.5 MGD plant for converting brackish water at Shevchenko on the eastern shores of the Caspian Sea. The construction of a dual-purpose nuclear plant was also underway at Shevchenko, with similar plants planned in the Donets River Basin and central Kazakhstan. Between 1964 and 1968, news of these projects only increased pressure on the Johnson administration to push forward with the ill-fated Bolsa Island project and to collaborate with Israel.[53]

As desalination emerged as another Cold War battlefield, its global potential came into sharper focus. From its inception, the OSW had imagined turning the world's desert 'wastelands' into 'gardens.' The agency dreamed of bringing desalination to barren lands from Africa, Australia, Brazil, and Mexico to Pakistan, Saudi Arabia, and Israel's Negev

[52] For the parallel example of US-Soviet cooperation on smallpox eradication, see Erez Manela, 'A Pox on Your Narrative: Writing Disease Control into Cold War History', *Diplomatic History* 34, no. 2 (2010): 299-323.
[53] Urrows, *Nuclear Energy for Desalting*, 42; John Walsh, 'Desalination: Emphasis Is on Dual-Purpose Nuclear Power and Desalting Plants', *Science* 147, 3662 (5 Mar. 1965): 1117-9.

Desert.[54] Among these potential targets, Israel and Saudi Arabia emerged as the OSW's primary international partners.

In 1963, the Kennedy administration began negotiations on a proposal, coordinated by the IAEA, for cooperation on the construction of nuclear-powered desalination plants in water-poor regions. Following those talks, in February 1964, Johnson announced that the US and Israel had begun negotiations on collaborative nuclear desalination research.[55] In June 1964, Israeli Prime Minister Levi Eshkol was welcomed to Washington for the first official state visit by an Israeli national leader. They agreed to undertake a joint feasibility study for a dual-purpose desalination facility in Israel. The joint US-Israeli study was framed as the companion to Bechtel's feasibility study on nuclear-powered desalination for the Metropolitan Water District of Southern California. It proposed a 200-megawatt nuclear-powered plant capable of producing 100 MGD.[56]

The study assumed that capital costs for the project could reach $200 million, a figure that Israel simply could not afford without American assistance. The other major concern was energy. Countries like Kuwait or Saudi Arabia, blessed with seemingly infinite energy supplies and budget surpluses, could shoulder the capital costs of huge plants. Not only could these energy-rich states afford the initial costs, they could also spare enough oil to operate less-efficient fossil-fueled plants. Conversely, Israel had practically no energy resources and would be dependent on expensive coal, oil, or gas imports.[57]

Like Israel, the OSW was desperate to solve the puzzle of energy costs associated with fossil fuels. However, Johnson's interest in nuclear desalination was never just a matter

[54] Seaton, 25 May 1959, NARA, RG 380.1, Box 1, Folder 1.
[55] *FRUS*, 1964-1968, vol. 34, 235.
[56] 'Feasibility Study of Combination Power-Desalting Plant for Israel Completed', 7 Mar. 1966, NARA, RG 380.1, Box 1, Folder 8.
[57] Siegel, *Let There Be Water*, 108.

of fuel efficiency. It was a prestige project, allowing the US to simultaneously compete and cooperate with the Soviets, while balancing conflicting interests in the Middle East. Even after plans for California's Bolsa Island nuclear desalination plant imploded in 1967-1968, the OSW's domestic goals remained shackled to the president's ambitious international agenda. As the Bureau of the Budget warned, collaboration with Israel threatened to completely invert the OSW's priorities. In preparation for the First International Symposium on Water Desalination in 1965 the Department of the Interior and the AEC sought authorization for a $300-500 million fund to finance desalination projects abroad, figures which dwarfed the OSW's domestic budget. The proposal threatened to commit the US to support the construction of large plants abroad in the absence of a similar investments at home.[58]

In retrospect, Johnson's leap toward giant dual-purpose nuclear designs probably slowed Israel's desalination ambitions too. In 1964, Johnson had considered a 100-million-dollar loan for the proposed Israeli nuclear plant, a figure more than double what the US government had spent on the OSW during the entire Eisenhower administration. In addition to the prohibitive cost of the proposed project, the failure of the Bolsa Island project, the Vietnam War, and Israel's Six-Day War in 1967, presented an overwhelming cascade of distractions and obstacles to US-Israeli collaboration, culminating in Richard Nixon's eventual termination of the project.[59]

US-Israeli cooperation also had wider repercussions, setting off a firestorm in the Arab world. The Arab press hurled epithets like 'Johnson the Jew,' decrying the president's support for Zionism.[60] Even within the Whitehouse and the State Department there were

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[58] *FRUS*, 1964-1968, vol. 34, 255-8.
[59] Siegel, *Let There Be Water*, 109-13.
[60] Ibid., 103.

concerns that overt nuclear cooperation would inflame Arab sensitivities and further destabilize the region. It also raised serious questions about nuclear proliferation. The amount of plutonium generated by a 200-megawatt plant would have produced enough fissile material for a substantial nuclear arsenal. The US government candidly conceded that Israel could easily weaponize the program against its Arab enemies in the region.[61]

Concerns over Arab anger over nuclear collaboration with Israel prompted a variety of plans to broaden American desalination aid to the region, ranging from the cynical to the truly earnest. Among the more blatantly pro-Israel suggestions was the attempt to cloak assistance to Israel in a joint-financing scheme, theoretically available to other nations. As Bob Horning, the President's Special Assistant for Science and Technology argued: 'As a program not specifically addressed to Israel, it helps protect our Arab flank (though we'd have to build an Arab plant too sooner or later). Ergo, it seems to me that we might be able to have our cake and eat it too on this one.'[62]

On the other end of the spectrum, nuclear desalination was imagined as a potential cornerstone for Arab-Israeli water cooperation in the Jordan Valley, the West Bank, or for a Gaza plant in collaboration with Egypt. Within days of the Six-Day War's ceasefire, Eisenhower presented a peace plan, 'A Proposal for Our Time,' to President Johnson. By August, the proposal was approved as Senate Resolution 155. The resolution called on the President to pursue 'the prompt design, construction, and operation of nuclear desalting plants' to provide freshwater for Arab and Israel territories. It called for the establishment of

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[61] Zach Levey, 'The United States, Israel, and Nuclear Desalination, 1964-1968', *Diplomatic History* 39, 5 (2015): 904-25.
[62] *FRUS*, 1964-1968, vol. 34, 237-8.

an international body to oversee the construction of three nuclear desalination plants. The provision of fissile material and nuclear operations were delegated to the AEC.[63]

As Eisenhower explained, the purpose of 'atomic desalting' in the Middle East was not just 'to bring large arid regions into production and supply useful work for hundreds of thousands of people, but also, hopefully, to promote peace in a deeply troubled area of the world through a new cooperative venture among nations.' Eisenhower genuinely believed that nuclear desalination could ensure 'development across 1,750 square miles (4,500 square kilometers) of barren land,' forming what he hoped would become 'the centerpiece of a scheme to settle more than a million Palestinian refugees.'[64]

The wildly ambitious Eisenhower-Strauss plan also raised the prospect of using desalination cooperation as 'leverage' to move the Israelis toward broader regional objectives of water management, refugee settlement, and ultimately peace. The Johnson administration hoped to use nuclear desalination to inhibit Israel's pursuit of nuclear weapons. US officials wanted to require Israel to accept IAEA safeguards and inspections at Dimona and all future reactors as 'the prince for going ahead with a nuclear plant.'[65] After the Six-Day War, however, desalination for nuclear non-proliferation was not a bargain that Israel was prepared to consider.

THE PETRO-KINGDOM AND THE WATER PRINCE

In October 1965, 2,400 participants representing 65 nations attended the First International Symposium on Water Desalination. There, President Johnson announced a massive American effort to bring the latest water technologies to arid nations. Johnson envisioned the Water for Peace program, a nod to Eisenhower's Atoms for Peace, as a

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[63] *FRUS*, 1969-1976, vol. 24, Middle East Region and Arabian Peninsula, 1969-1972, 21-2.
[64] Eisenhower, 'A Proposal for Our Time,' 171-4.
[65] *FRUS*, 1964-1968, vol. 34, 275-276, 298-302.

vehicle to spread American desalination technology, as well as more conventional hydraulic expertise like dam-building and hydroelectric power, from the Middle East to the Mekong Delta. It also provided a measure of camouflage for the administration's signature desalination collaboration with Israel.[66]

During the symposium, the Office of Science and Technology, the Department of the Interior, and the AEC fielded meetings with representatives from the Soviet Union, Israel, Italy, Greece, Egypt, Kuwait, and Saudi Arabia. In the symposium's closing remarks, Secretary of the Interior Stewart Udall touted what seemed like a rather modest accomplishment at the time, a preliminary US-Saudi agreement for the construction of a non-nuclear dual-purpose plant capable of producing five million gallons and 36 megawatts of electricity per day for the Red Sea port of Jeddah.[67] Although it paled in comparison with the massive nuclear designs offered to Israel, in the long run the Jeddah plant wound up being the most impactful facility designed by the OSW. Unlike the twin nuclear plans for California and Israel, Jeddah's plant was a more realistic improvement on the earlier Point Loma demonstration plant.

Saudi Arabia had both the oil reserves and the capital to build and maintain the plant. Equally importantly, Saudi subjects brought a much deeper level of day-to-day experience with desalination than either the US or Israel. The rise of more primitive condenser technologies in the Arabian Peninsula long predated both American involvement in the region and the discovery of petroleum. The first era of desalination in Arabia emerged from late-nineteenth-century infrastructures of steam-powered empire. Early advances in desalination methods went hand in hand with the rise of oceangoing steamships. Between the 1830s and 1860s, the development of surface condensers and seawater evaporators made it

[66] Ibid., 258-60.
[67] Ibid.

possible for steamship crews to convert seawater into freshwater for both the ship's boilers and for the crew's consumption. However, the condenser did not remain stranded at sea. From the 1850s and 1860s, the British Empire began to experiment with the installation of coal-fired condenser units in Eastern Mediterranean and Red Sea ports like Malta, Suez, and Aden, where local water supplies were unable to keep up with the new demands of industrial steamship traffic. In the 1880s and 1890s, lengthy military engagements in Egypt and Sudan tested Britain's ability to supply water to its troops. Over time, these emergency security operations became permanent features of the region's infrastructure, creating an archipelago of land-based condensers from Suez to the Persian Gulf.[68]

At the same time, a different kind of battle was being waged in the Red Sea. From the 1860s through World War One, the pilgrimage to Mecca emerged as a global public health crisis. As the steamship opened the floodgates of transoceanic transport, it also had the unintended consequence of forging faster pathways for the globalization of epidemic cholera. At the international conferences held to address this threat, oceangoing pilgrims from India were singled out as the primary carriers of cholera. As a result, an international quarantine system was erected to process potential victims before they could reach Mecca and spread the disease across the Middle East and Europe.[69]

This brought an unprecedented level of scrutiny to the Muslim holy land's water supplies. Ottoman officials and public health experts scrambling to grapple with a deadly combination of crumbling conventional water infrastructures, drought, and cholera, also turned to desalination. In 1894, Istanbul ordered a small condenser from the Glasgow-based

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[68] James D. Birkett and D. Radcliffe, 'Normandy's Patent Marine Aërated Fresh Water Company: a family business for 60 years, 1851-1910', *IDA Journal of Desalination and Water Reuse* 6, 1 (2014): 25-6; On Barak, *Coalonialism: Energy and Empire before the Age of Oil*, forthcoming.
[69] Michael Christopher Low, 'Empire and the Hajj: Pilgrims, Plagues, and Pan-Islam under British Surveillance, 1865-1908', *International Journal of Middle East Studies* 40, 2 (2008): 269-290.

Mirless-Watson Company to filter brackish well water for the Kamaran Island quarantine station just off the coast of Yemen. And in 1911, the Ottoman state built Jeddah's first desalination plant, capable of filtering 100 tons per day.[70]

When the Saudis conquered the short-lived Hashemite Kingdom of the Hijaz in 1925, they inherited Jeddah's chronic water problems. By then, the Ottoman condenser facility, taken over by British engineers during World War One, had become a central part of daily life for locals and pilgrims alike. The plant had become known to locals as *al-Kandāsa* (the condenser). Although the supply of distilled water was expensive, barely palatable, and notoriously unreliable, it provided an indispensable safety net, supplementing Jeddah's meager rain and groundwater resources. In an attempt to keep pace with rising demand, in the late 1920s, King ʻAbd al-ʻAziz ibn Saʻud imported two new desalination. Thus, even before the discovery of oil in Saudi Arabia in 1930s, imperial infrastructures of coal, steam, and pilgrimage had already started Arabia's transition toward fossil-fueled seawater.[71]

In 1933, Saudi Arabia granted the Standard Oil Company of California a concession for the exclusive rights to explore for and extract oil in the kingdom, leading to the creation of the Arabian American Oil Company (Aramco). In the wake of the Aramco concession, commercial interests led to increasingly intimate diplomatic relations between Saudi Arabia and the US. This relationship was built on a simple exchange, the US would have access to Saudi oil and Saudi Arabia would have access to the American technical expertise and military hardware needed to build up the infrastructures of a modern state.[72]

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[70] Gülden Sarıyıldız, *Hicaz Karantina Teşkilatı, 1865-1914* (Ankara: Türk Tarih Kurumu, 1996), 55, 87-94, 102-11; Ömer Faruk Yılmaz, *Hicaz'da Deniz Suyu Arıtma Tesisleri Projesi* (İstanbul: Çamlıca, 2012).

[71] Michael Christopher Low, 'Ottoman Infrastructures of the Saudi Hydro-State: The Technopolitics of Pilgrimage and Potable Water in the Hijaz', *Comparative Studies in Society and History* 57, 4 (2015): 942-974; Abdul Qaddous al-Ansari, *History of Aziziah Water Supply, Juddah and Glimpses on Water Sources in the Kingdom of Saudi Arabia* (Jeddah: Administration of the Aziziah Water Supply, 1972).

[72] Toby Craig Jones, *Desert Kingdom: How Oil and Water Forged Modern Saudi Arabia* (Cambridge: Harvard University Press, 2010).

In 1942, the US Agricultural Mission to Saudi Arabia drew up recommendations to bring new groundwater sources to Jeddah. During World War Two, these plans would gain new urgency. Owing to the sharp decline in international maritime trade during the war, the kingdom was unable to acquire spare parts to service Jeddah's condensers. In an attempt to recover this lost capacity, in 1947 the kingdom commissioned the construction of a pipeline project, bringing a new stream of freshwater from Wadi Fatima to Jeddah. However, Jeddah's respite would prove brief. Prior to World War Two, the city's population had been estimated at no more than 40,000. By 1963, the population had exploded to nearly 150,000. By the 1960s, population pressure was draining the region's aquifer, prompting the kingdom's permanent shift from groundwater exploration to harvesting water from the sea.[73]

Born in 1937, Muhammad al-Faisal (d. 2017), the second son of King Faisal (r. 1964-1975), was destined to become Saudi Arabia's 'Water Prince.' While al-Faisal has often been mocked for his ill-fated schemes to tow icebergs from Antarctica to the Red Sea or to build water pipelines from Turkey, some of his aquatic dreams actually did come true. Between 1963 and 1976, he built the foundations of what would grow into the world's leading producer of desalinated water. As al-Faisal recounted in 2015, his first interest in desalination was sparked as a child drinking condenser water from Jeddah's *al-Kandāsa* plant. Two decades later, while studying at Menlo College near San Francisco, the prince found himself at the epicenter of America's turn to desalination. During his studies, al-Faisal visited an MSF desalination unit built by Aqua-Chem for Southern California Edison's Ventura power plant. Impressed by these advances, he was armed with the idea that would

[73] 'Preliminary Appraisal on a Combination Sea Water Desalting and Electric Power Plant for Jidda, Saudi Arabia', June 1964, NARA, RG 380.2, Box 2.

become his legacy.[74]

After graduating in 1963, al-Faisal joined the Saudi diplomatic mission to the United Nations and acted as a special representative to the Kennedy administration. The prince's ties to Washington would prove invaluable. Between 1963 and 1964, he had begun examining a number of small water purification units being installed in luxury hotels in Cairo and Amman, royal palaces, as well as those servicing oceangoing passenger ships. He became convinced that Saudi Arabia needed to adopt a centralized strategy for large-scale desalination. In 1964, the prince convinced King Faisal to commit more serious budgetary resources to the development of a national desalination program. In 1964, the Prince assembled a small technical working group to examine the feasibility of large-scale seawater conversion units. At first, al-Faisal started small. He reached out to two American firms, Aqua-Chem and Conam Services, and negotiated the purchase of two 100,000-gallon-per-day MSF units for the Red Sea towns of al-Wajh and Duba.[75]

As word of the prince's efforts spread, al-Faisal was invited to Washington by the State Department. Although Westinghouse had demonstrated the potential of its MSF technology at the defunct Point Loma plant, once that unit had been commandeered by the Navy and shipped to Cuba subsequent plans for a southern California test site had opted for nuclear desalting. However, Westinghouse and its partners in the OSW still wanted a site where they could improve their technology on a larger, but still non-nuclear, scale. Seizing the initiative, al-Faisal offered Jeddah as the site for this scaled-up experiment, complete with funding from the Saudi treasury. In March 1964, the OSW and the Department of the

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[74] Khaled M. Batarfi, 'M. Al-Faisal: The Water Prince', *Saudi-US Relations Information Service*, 20 March 2015, http://susris.com/2015/03/20/commentary-m-al-faisal-the-water-prince-batarfi/; 'Muhammad al-Faisal is not dead!', *Saudi Gazette*, 17 January 2017, http://saudigazette.com.sa/opinion/muhammad-al-faisal-not-dead/.
[75] Andrea H. Pampanini, *Desalinated Water in the Kingdom of Saudi Arabia: The History of the Saline Water Conversion Corporation* (New York: Turnaround Associates, 2010), 9-10, 25-6.

Interior conducted a survey of Jeddah's water needs. By June, the Department of the Interior had drawn up preliminary plans for a dual-purpose desalting and electric power plant.[76] This laid the groundwork for the US-Saudi agreement reached in October 1965. Construction began in 1969 and was completed in 1970.[77]

While the OSW's proposed plants in California and Israel both fell victim to the environmental, technical, fiscal, and foreign policy complexities introduced by their overly ambitious nuclear designs, Saudi Arabia's desalination program became the OSW's most successful fossil-fueled heir. The Jeddah plant's completion came at a fortuitous moment, during a brief window, just before the opening of a yawning divergence between the fortunes of desalination in Saudi Arabia and the US.

Since the 1930s, the US and the Kingdom of Saudi Arabia had developed increasingly intimate ties. In the decades since the discovery of oil and the creation of Aramco, Americans had rightly come to regard Saudi Arabia as the Western world's primary oil supplier. Equally importantly, the Saudis were viewed as a bulwark against Communist penetration into Arabia. On the other hand, American support for Israel was an omnipresent threat to US-Arab relations.[78]

In 1967, tensions in the region reached a boiling point. In the wake of its victory in the Six-Day War, Israel had occupied the Sinai Desert, the Golan Heights, the West Bank, and East Jerusalem. While United Nations Resolution 242 had provided a mechanism for Israel's withdrawal in exchange for Arab diplomatic recognition, between 1967 and 1973 any hope of a lasting peace had slipped away. In August 1973, King Faisal made a secret pact with Egyptian President Anwar Sadat to cut oil production if Egypt went to war with

[76] 'Preliminary Appraisal', June 1964, NARA, RG 380.2, Box 2.
[77] Pampanini, *Desalinated Water*, 26.
[78] *FRUS*, 1969-1976, vol. 24, 546-52.

Israel. When Egypt and Syria attacked Israel, initiating the Yom Kippur War of October 1973, Saudi Arabia and the rest of the Organization of Petroleum Exporting Countries (OPEC) imposed an embargo on oil exports to the US and threatened an overall production cut of 25 percent. By December, the price of oil had quadrupled. Americans were stunned by what they considered an ambush, tantamount to 'an Energy Pearl Harbor.' Although the US was still the world's largest oil producer, the post-World War Two proliferation of big cars and sprawling suburbs had outstripped domestic supplies. By 1970, US oil fields had already reached their peak production of 9.6 million barrels per day. As American demand outpaced domestic supply, foreign imports doubled between 1970 and 1973, accounting for 36 percent of US oil consumption. As the oil shock of 1973-1974 unfolded, 'panic at the pump' ushered in a new era of economic and national insecurity.[79]

In a bitterly ironic twist, just as American-designed desalination was taking off in Saudi Arabia, the Arab oil embargo struck a death knell to American desalination ambitions. With oil prices soaring and a growing recognition that desalination was going to continue to guzzle energy, Congress slashed federal desalination funding by roughly 90 percent. Exploding oil prices also coincided with wider shifts in American politics and budgetary priorities. With Richard Nixon's founding of the Environmental Protection Agency in 1970 and the flowering of environmental consciousness across the country, especially in the West, the Bureau of Reclamation's multi-decade dam-building spree came under increasing scrutiny. As Vietnam-induced inflation deepened during the OPEC crisis, 'pork barrel' spending on massive, often environmentally dubious, water infrastructure projects came under a sustained assault. This bipartisan trend intensified through the Carter and Reagan

[79] Meg Jacobs, *Panic at the Pump: The Energy Crisis and the Transformation of American Politics in the 1970s* (New York: Hill and Wang, 2016), 3-5, 49-85.

administrations.[80]

Desalination suffered collateral damage on multiple fronts. In 1974, the OSW was merged with the Office of Water Resources Research and renamed the Office of Water Research and Technology. By 1982, this office was also abolished and federal desalination research was discontinued. As a result, subsequent advances in seawater desalination, especially reverse osmosis, moved to better-funded government and university labs of Europe, the Middle East, and Asia. Without a coherent national strategy, the heavy burden of planning and financing new desalination infrastructures has fallen to American coastal municipalities.[81]

The embargo had the opposite effect on Saudi Arabia. Between 1971 and 1974, as energy prices soared, the oil boom bloated Saudi coffers. The modernization of Saudi Arabia's hydraulic infrastructure was no longer an unattainable dream. The immediate success of al-Faisal's American-designed plant in Jeddah opened new horizons for Saudi desalination. In 1971, a new Saline Water Conversion Department branched off from the Ministry of Agriculture and Water. In 1974, a royal decree created an independent government body, headed by al-Faisal. The Saline Water Conversion Corporation was given sweeping authority to exploit desalination technology. In 1977, the Saudi government allocated a staggering $15 billion to build 20 massive desalination plants supplying billions of gallons of water. In 1978, the kingdom brought the world's largest reverse-osmosis system into production, adding another 40 percent to its existing capacity. Four decades later, Saudi Arabia remains the world's leading producer of desalinated water, accounting for 22

[80] Reisner, *Cadillac Desert*, 306-31, 393.
[81] Sedlak, *Water 4.0*, 223-5, 231-7.

percent of global capacity.[82]

CONCLUSION: INFINITE WATER OR PEAK SALT?

Saudi Arabia and its Gulf neighbors have all embraced fossil-fueled solutions to address their acute water problems. Desalination has become a defining material feature of life on the Arabian Peninsula, arguably second only to oil. The Gulf's transition toward total dependency on desalination has ushered in an era from which there is no escape. Since the 1970s, oil and water production have become inextricably linked. Not only have oil revenues subsidized impossibly low water prices and high levels of consumption for Gulf state subjects; oil itself has become the key ingredient in the manufacture of the peninsula's water. As of 2010, Saudi desalination operations consumed a mind-boggling 1.5 million barrels of oil per day, representing something like 15 percent of the kingdom's daily production. This energy-intensive solution depends on the conceit that oil production will indefinitely keep pace with the development that they have enabled. But, unlike the technopolitical alchemy of turning crude oil into government revenue or private wealth, the production and consumption of desalinated water has fostered an even deeper material dependency. Through the 'black magic' of transforming oil into water, Gulf monarchies have cast an unbreakable spell over their subjects.[83]

Mirroring the Arabian Peninsula's petroleum-based ethos of endless energy, the large-scale adoption of desalination technology has given rise to an equally problematic environmental imaginary of 'infinite water.' With renewable capacities of less than 500 cubic meters per capita, states like Saudi Arabia, Kuwait, and the UAE suffer from absolute

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[82] Jones, *Desert Kingdom*, 6-7; Pampanini, *Desalinated Water*, 10-11, 26-7; Saline Water Conversion Corporation, http://www.swcc.gov.sa/english/AboutSWCC/Pages/About.aspx.

[83] Low, 'Ottoman Infrastructures of the Saudi Hydro-State', 971-3; Timothy Mitchell, *Carbon Democracy: Political Power in the Age of Oil* (London, 2011), 1-2; Fernando Coronil, *The Magical State: Nature, Money and Modernity in Venezuela* (Chicago: University of Chicago Press, 1997), 5-6.

water scarcity. And yet, their fossil-fueled hydro-imaginaries have rendered renewable water resources virtually obsolete. Desalination has allowed these states to imagine their water supplies as infinitely expandable. If there is no more rain or groundwater to be tapped, more can simply be extracted and produced. The potential for harvesting the sea has been decoupled from the realities of existing groundwater scarcity. Decades of subsidized desalination have lulled Gulf populations into the false belief that water is a 'free resource.' Desalination has nurtured expectations of luxury lifestyles kept afloat by cheap water. From the promotion of water parks and indoor ski slopes to golf courses and lavish fountains, the Gulf monarchies encourage their residents to continue deeply unsustainable habits of consumption. Despite their growing recognition of a looming post-oil future, through the free flow of subsidized water Gulf monarchs offer constant reassurances that their 'carbon-intensive lifestyles' will endure for the foreseeable future.[84]

Erasing the natural limits of the Colorado River once lay at the heart of America's Cold War dreams of tapping the infinite supplies of the Pacific Ocean. Visions of a never-ending housing boom, Sun Belt highways filled with gas-guzzling sedans, connecting 'infinite suburbs' spilling out across the Mojave and Sonoran deserts from Los Angeles, San Diego, Las Vegas, and Phoenix fueled decades of dam building and sparked America's pursuit of a desalinated future for the arid Southwest. In many respects, the fantasy of infinite water for infinite suburbs emerged from a symbiotic ethos of resource infinity that American expertise and Arabian oil built together.[85]

For both California and the Arabian Peninsula, desalination was never just about water. Rather, the quest for desalination was always a question of energy. For the Office of Saline Water, the challenge of lowering the cost of desalination to a level that could compete

[84] Günel, 'The Infinity of Water', 291-315.
[85] Mike Davis, 'Water Pirates and the Infinite Suburb', *Capitalism, Nature, Socialism* 7, 2 (1996): 81-4.

with more conventional water infrastructures was always at the mercy of energy prices. In the 1950s and 1960s, the OSW fantasized that their research would lead to greater efficiencies in desalination. As it turned out, those dreams did come true. By the late 1970s, their pioneering research on multi-stage flash and reverse osmosis/membrane technologies dramatically improved the efficiency of desalination. Unfortunately, the increasing viability of the technologies that they helped introduce—as witnessed by their rapid adoption abroad—came just *after* the energy crisis of the early 1970s sparked a massive federal divestment from desalination research. In addition to the unfortunate timing of America's retreat from desalination, the price of desalinated water never came remotely to achieving parity with the cost of conventional sources. A half century later, the cost of desalinated water in California is still more than double that of water transferred from the dams of the Colorado River. As it turned out, the OSW's dire predictions of the Colorado River's demise were greatly exaggerated.

Having determined that a desirable price point could not be achieved rapidly enough with fossil fuels, politicians and engineers gravitated toward nuclear energy. Once American desalination planning became entangled in the complexities of nuclear power, environmental activism, competition with the Soviet Union, and the morass of the Arab-Israeli conflict, the program's core goal of watering the arid West was overwhelmed by a cluster of overlapping foreign policy crises. Through a series of unpredictable techopolitical accidents and false starts, technologies designed to liberate California from its dependency on the Colorado River found their home in the oil-rich Middle East.

While thermal desalination and even more advanced reverse-osmosis plants still consume staggering amounts of energy, this was a tradeoff that Gulf petro-states could afford. Similarly, despite Israel's lack of energy resources, by the late 1990s, advances in the efficiency of reserve-osmosis technologies combined with absolute national necessity would override questions of cost. Beginning in 1997, Israel began building a network of coastal desalination plants in order to pump water into a giant distribution canal, the National Water Carrier, linking the country's major cities.[86]

Thus, while the OSW's research gradually took root across the Middle East, after the oil shocks of 1973 and 1979, American desalination quite literally ran out of gas. As California contemplates a return to desalination, it is worth considering why it failed the first time. A better understanding of desalination's incestuous relationship with energy will help to inform the difficult choices that lay ahead.

If fossil-fueled desalination does become a larger piece of the arid West's hydraulic puzzle, in the age of anthropogenic climate change, it will entail environmental consequences that might seem acceptable in the short term, but accumulate in the long run. The intensification of desalination activities in the Persian Gulf over past four decades has begun to take its toll. Measuring 250,000 square kilometers and an average depth of just 35 meters, the Gulf is 'more like a salt-water lake than a sea.' The few rivers that feed the Gulf have been dammed or diverted, raising its salinity. Each day dozens of the world's largest desalination plants pump some 70 cubic meters of super-salty reject brine back into its waters. As a result, the Gulf is now 25 percent saltier than normal seawater. With the Arabian Peninsula's groundwater sources decimated and climate change bringing ever higher temperatures, Gulf states are projected to double their desalination capacity by 2030. But unless something can be done to address the problem of brine disposal, the water will

[86] Sedlak, *Water 4.0*, 225-7.

eventually become 'so saline that it will be too expensive to desalinate,' raising the prospect that the Gulf is headed for 'peak salt.'[87]

Mirroring the theory of peak oil, the point at which the maximum rate of oil extraction might be reached, peak salt predicts a future when desalination becomes environmentally and economically unfeasible. Not so long ago, the prospect of peak oil seemed like the greatest threat to the economic stability of both the US and the Middle East.[88] As human-made climate change looms ever larger on the horizon, however, the fear of running out of oil is gradually being overshadowed by the consequences of the carbon that humans have already pumped into the atmosphere. In this sense, peak salt and peak oil are not so different. Desalination has always been a child of fossil fuels, rooted in the same hubris and drive for infinite resources and economic development.

As Americans return to their dreams of a desalinated future, this basic equation is worth reconsidering: Even if desalination is fiscally viable, are the energy requirements and environmental impacts sustainable? Will fossil-fueled desalination save us from a drier world or merely become another driver of man-made climate change? While it is comforting to imagine desalination as a kind of enviro-technical panacea, we forget the limitations of this infrastructure at our peril. After all, oil already killed American desalination once; it seems entirely reasonable to guess that it might do so again, particularly as humans become ever more aware of relationship between their energy consumption and carbon-driven climate change.

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[87] Stephen Leahy and Katherine Purvis, 'Peak salt: is the desalination dream over for the Gulf states?', *The Guardian*, 29 Sept. 2016, https://www.theguardian.com/global-development-professionals-network/2016/sep/29/peak-salt-is-the-desalination-dream-over-for-the-gulf-states.

[88] On peak oil, see Matthew Schneider-Mayerson, *Peak Oil: Apocalyptic Environmentalism and Libertarian Political Culture* (Chicago: University of Chicago Press, 2015); Kenneth S. Deffeyes, *Hubbert's Peak: The Impending World Oil Shortage* (Princeton: Princeton University Press, 2001).