PNE2050
PLANO NACIONAL DE ENERGIA

Energia Nuclear

Perspectivas para o Brasil no horizonte 2050

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Presidente

06 de julho de 2020

Empresa de Pesquisa Energética
Ministério de Minas e Energia

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PNE**2050**

Elementos Principais

Não há um cenário de referência, mas **trajetórias exploratórias** que permitam, em seu conjunto, orientar melhor estratégia em um cenário de grande incerteza

Apoiar as escolhas de política energética a partir das **diversas alternativas** (caminhos) para atendimento dos objetivos estratégicos

Evitar **arrependimentos** posteriores: apostas que terminem em trancamento tecnológico ou elevado custo de saída

Visão de futuro

...guardando coerência nas interações complexas entre os condicionadores da produção e uso de energia

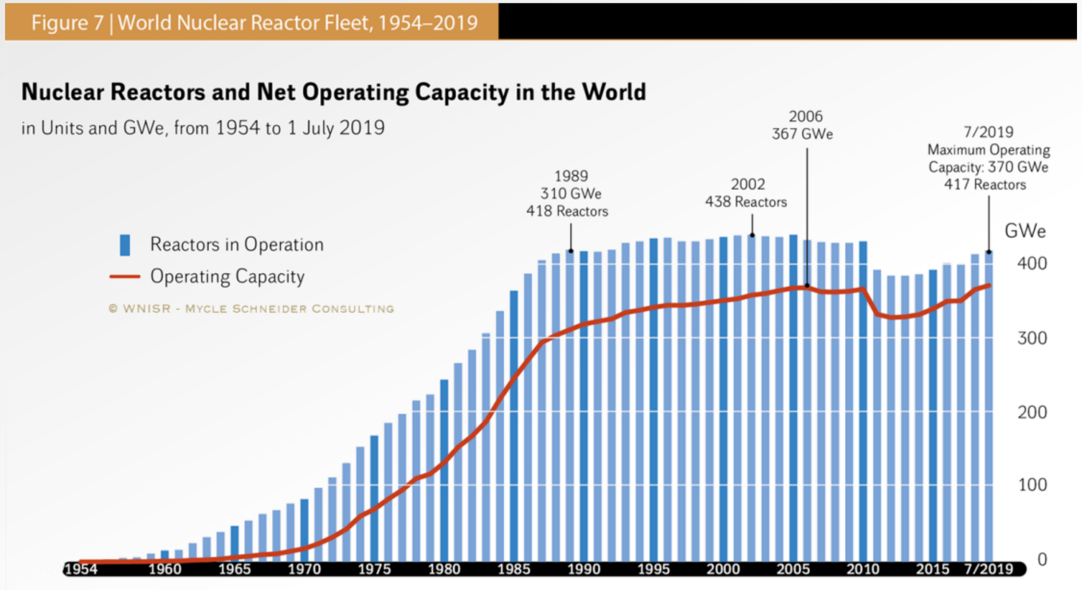
Estratégia

...reconhecendo a variedade de possibilidades e evitar escolhas que levem a arrependimentos e trancamentos tecnológicos (elevado custo de saída)

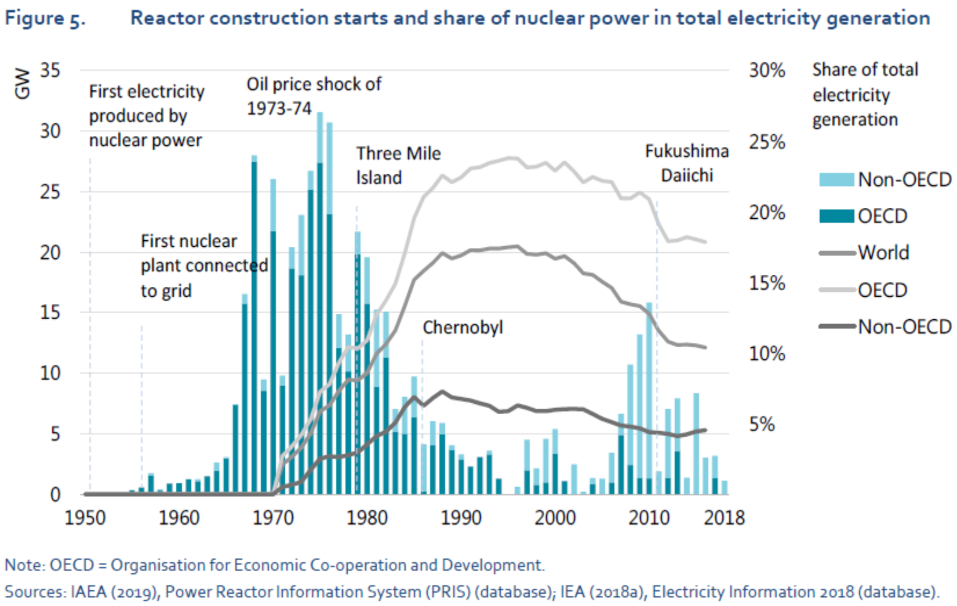
Energia Nuclear

Contexto

Impactos no desenvolvimento da indústria nuclear da percepção de risco e da perda de competitividade



https://www.worldnuclearreport.org/The-World-Nuclear-Industry-Status-Report-2019-HTML.html#_idTextAnchor024



https://www.iea.org/reports/nuclear-power-in-a-clean-energy-system

Regulações de segurança mais restritivas e piora na aceitabilidade social (plebiscitos, protestos, etc.) após acidentes

Nuclear

Aumento do tempo de construção de usinas nucleares

Figure 9 | Average Annual Construction Times in the World

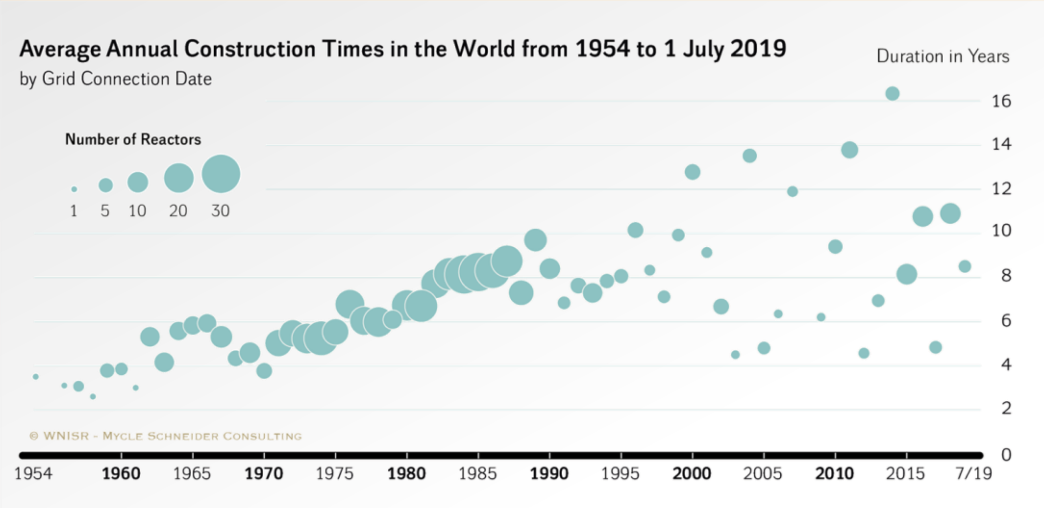
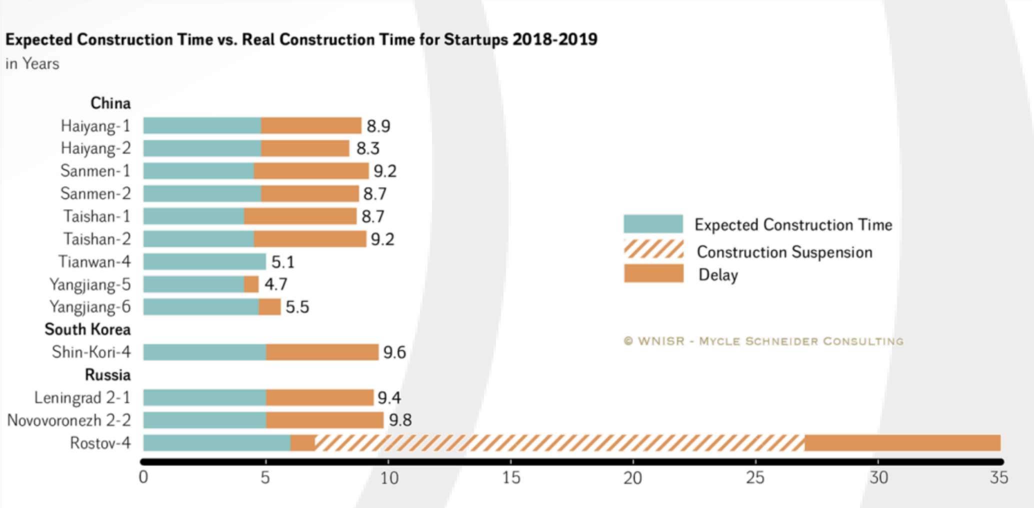


Figure 10 | Delays for Units Started Up 2018-2019



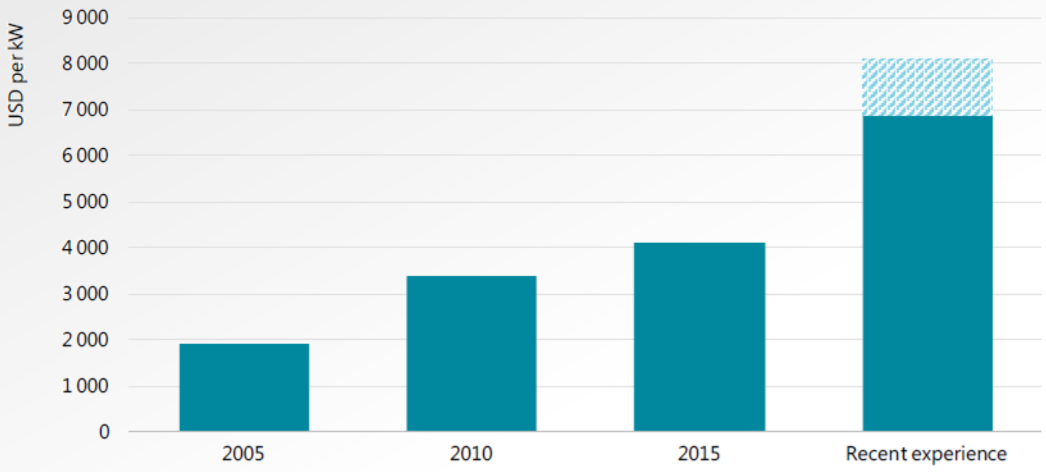
https://www.worldnuclearreport.org/The-World-Nuclear-Industry-Status-Report-2019-HTML.html#_idTextAnchor024

Complexidade e diversidade de projetos e regressão na curva de aprendizagem afetam cronogramas de construção

Nuclear

Aumento de custo e do custo efetivo de construção *(cost escalation and cost overrun)*

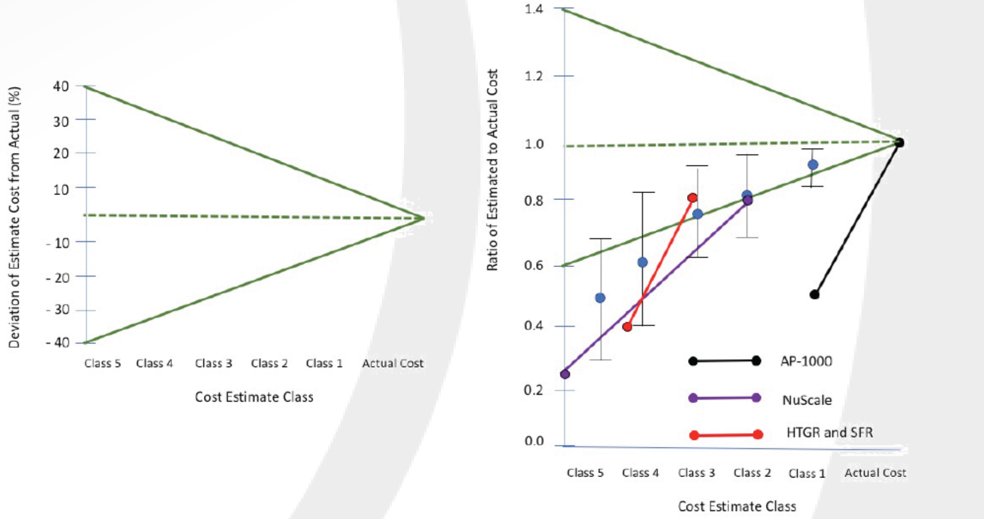
Figure 9. Projected overnight construction cost of nuclear power capacity and recent United States and Western European experience



Source: IEA analysis based on IEA/NEA (2005, 2010 and 2015 editions), Projected Costs of Generating Electricity.

https://www.iea.org/reports/nuclear-power-in-a-clean-energy-system

Figure 3.4: Cost estimation in large complex projects showing that as designs mature and incorporate more detail, cost uncertainty decreases but (more importantly) actual cost increases significantly



http://energy.mit.edu/research/future-nuclear-energy-carbon-constrained-world

Complexidade e diversidade de projetos, regressão na curva de aprendizagem, atrasos nos cronogramas de construção afetam os custos efetivos de construção

Nuclear

Aumento de custo e do custo efetivo de construção *(cost escalation and cost overrun)*

Nuclear

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Cost overruns and financial risk in the construction of nuclear power reactors: A critical appraisal

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ABSTRACT

Lovering and colleagues attempt to advance understanding of construction cost escalation risks inherent in building nuclear reactors and power plants, a laudable goal. Although we appreciate their focus on capital cost increases and overruns, we maintain in this critical appraisal that their study conceptualizes cost issues in a limiting way. Methodological choices in treating different cost categories by the authors mean that their conclusions are more narrowly applicable than they describe. We also argue that their study is factually incorrect in its criticism of the previous peer-reviewed literature. Earlier work, for instance, has compared historical construction costs for nuclear reactors with other energy sources, in many countries, and extending over several decades. Lastly, in failing to be transparent about the limitations of their own work, Lovering et al. have recourse to a selective choice of data, unbalanced analysis, and biased interpretation.

It is a capital mistake to theorize before one has data. Insensibly one begins to twist facts to suite theories, instead of theories to suite facts.

Sherlock Holmes, in Arthur Conan Doyle's *A Scandal in Bohemia*, 1891, p. 78.

1. Introduction

Despite sounding a bit dry, there can be little doubt that the topic of construction cost overruns is of central importance to energy and electricity planning, investment, policy, and regulation. As Bacon and Besant-Jones (1998, p. 317) wrote in the present journal almost two decades ago:

The economic impact of a construction cost overrun is the possible loss of the economic justification for the project. A cost overrun can also be critical to policies for pricing electricity on the basis of economic costs, because such overruns would lead to underpricing. The financial impact of a cost overrun is the strain on the power utility and on national financing capacity in terms of foreign borrowings and domestic credit.

In other words, evaluations of construction cost escalation and overruns have much to tell regarding inefficiencies in the allocation of resources, and can assist with estimating likelihoods of future infrastructure risks.

It is in this regard that we appreciate and understand the interest in this topic shown by Lovering et al. (2016a), in their effort at analyzing new global data on overnight nuclear construction costs. However, we disagree with their conclusion that there is "no inherent cost escalation trend associated nuclear technology."

In this response, we critique Lovering et al. on three grounds. First, we argue that a series of methodological choices undermine their conclusions and limit the applicability of their results in respect of both historical and future nuclear construction costs. Second, we question the reliability of the data underlying Lovering et al. by discussing three recent studies that are global in scope and focus on trends including the past few decades of nuclear construction. Third, we express concerns that recent public declarations made by the authors when discussing their article are not based on their actual data or on reliable results. The first criticism refutes the piece's methodology; the second questions its comparative novelty; the third challenges the objectivity of the overall framing and interpretation.

2. Worrying methodological assumptions

Our first criticism is that the narrow definition of construction costs used by Lovering et al. (2016a), overnight capital costs (OCC), is not an appropriate metric to judge nuclear construction costs. This cost is notionally what it would take to build a reactor "overnight", with financing and other time-related costs omitted. We raise three issues with this methodology:

- OCC are an inappropriate measure of power plant construction costs
- OCC and the author's definition of cost escalation do not include the full impacts of cost overruns

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Table 1
Summary construction cost overrun data for electricity supply projects.

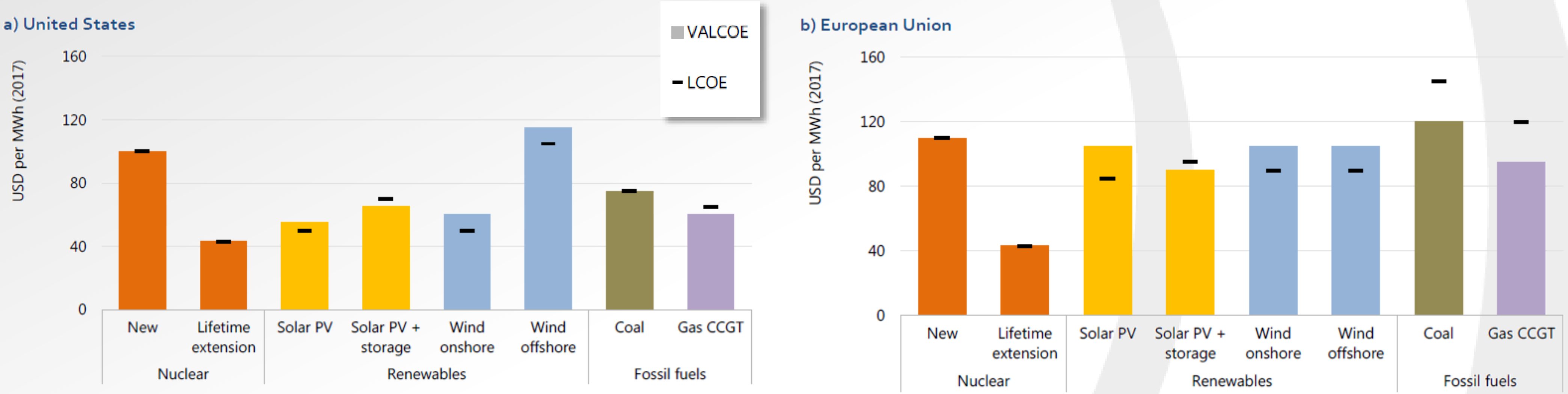
Description		Hydroelectric dams	Nuclear reactors	Thermal plants	Wind farms	Solar facilities
Number of projects (N)		61	180	36	35	39
N with cost overrun		47	175	24	20	16
N with cost overrun (%)		77	92.2	66.7	57.1	41
Cost escalation (%)	Mean	70.6	117.3	12.6	7.7	1.3
	Min	−50.6	−7.9	−50	−9.1	−40.8
	Max	512.7	1279.7	120	44.4	50
	Median	30.1	64.8	9.6	1.7	0
	Mode	–	189.4	75	0	0
	Standard deviation	111.7	152.1	33.5	13.1	17.8
Cost overrun (millions US$)	Mean	2437	1282	168.5	32.8	−4.2
	Min	−671.4	−298.8	−1272.7	−158.5	−266.6
	Max	47,630	16,589	2000	526.4	102.3
	Median	99.5	503.1	51.5	0.96	0
	Mode	–	41.9	–	0	0
	Standard deviation	7054.7	1965.8	579.6	112.9	62.1
Time overrun (%)*	Mean	63.7	64	10.4	9.5	−0.2
	Min	−28.6	−15	−10.7	−19	−11.2
	Max	401.7	261.9	66.7	60	25
	Median	32.7	40	0	0	0
	Mode	30.9	35.4	0	0	0
	Standard deviation	89.8	53.1	19.0	22.6	8.0
Time overrun (months)*	Mean	43.2	35.7	4.8	0.22	−0.2
	Min	−24	−9	24	−4	−5
	Max	241	149	−9	6	5
	Median	19.5	24	0	0	0
	Mode	12	17	0	0	0
	Standard deviation	58.4	30.6	8.9	2.4	2.1
Cost per installed kW (US$)	Mean	3093.2	2427	1943.9	2808	8311.6
	Min	146.8	190.7	279	405.6	1773.5
	Max	10,359.5	13,260.1	5606.8	5793.7	27,180
	Median	2278.4	1776	1787.9	2459	7199.4
	Mode	–	960.2	–	2645.5	–
	Standard deviation	2516.1	1888.5	1163.9	1147.4	5099.7

* Applies only to a smaller subsample N=33 for hydro, 175 for nuclear, 24 for thermal, 18 for wind, 23 for solar. Source: Modified from Sovacool et al. (2014b).

https://www.sciencedirect.com/science/article/pii/S0301421516301690/pdfft?md5=215e9af8a66c1ea415522340598cbae1&pid=1-s2.0-S0301421516301690-main.pdf

Nuclear

Custos nivelados de expansão de geração elétrica: competitividade das tecnologias



Notes: VALCOE = value-adjusted levelised cost of electricity; LCOE = levelised cost of electricity; PV = photovoltaics; coal = coal supercritical; CCGT = combined-cycle gas turbines. Nuclear lifetime extension LCOE is based on 1.1 billion USD investment to extend operations for 20 years. Storage paired with solar PV is scaled to 20% of the solar capacity and 4-hours duration. LCOEs are calculated based on an 8% weighted-average cost of capital for all technologies. Other cost assumptions are from the World Energy Outlook 2018 and are available at https://www.iea.org/weo/weomodel/.

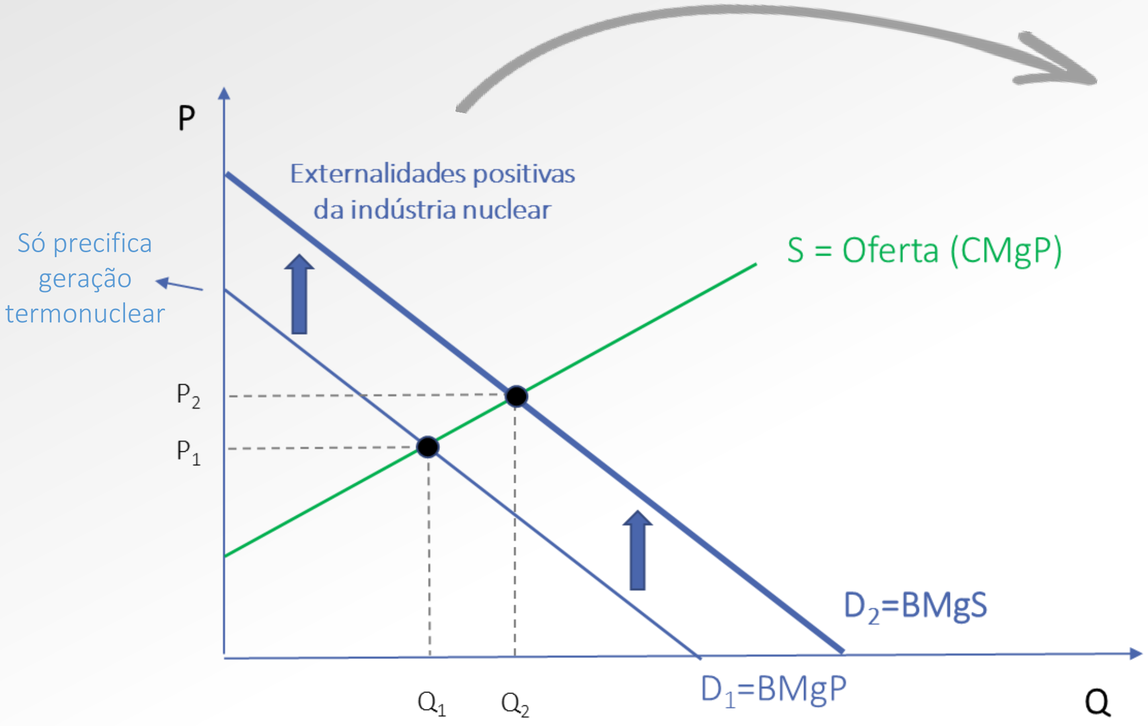
https://www.iea.org/reports/nuclear-power-in-a-clean-energy-system

VALCOE builds on the foundation of LCOE that incorporates all cost elements, but also adds three categories of value in power systems: energy, flexibility and capacity

Energia Nuclear

Desafios

Efeitos econômicos das externalidades da indústria nuclear: benefícios não precificados no mercado



Notas: BMgP = Benefício Marginal Privado; BMgS = Benefício Marginal Social

- Abatimento de carbono
- Impactos socioeconômicos da cadeia industrial de fornecedores de bens e serviços (alto valor agregado, empregos qualificados, etc.)
- Medicina nuclear/radiofármacos
- Usos na Agricultura: irradiação de alimentos, controle de insetos, mutação da germinação de plantas, etc.
- Usos industriais: marcadores industriais, inspeção e instrumentação, datação de carbono, dessalinização, vapor residual, produção de hidrogênio, etc.
- Propulsão de navios e embarcações
- Defesa (submarino de propulsão nuclear)

Fonte: baseado em: https://www.world-nuclear.org/information-library/non-power-nuclear-applications/overview/the-many-uses-of-nuclear-technology.aspx; http://energy.mit.edu/research/future-nuclear-energy-carbon-constrained-world

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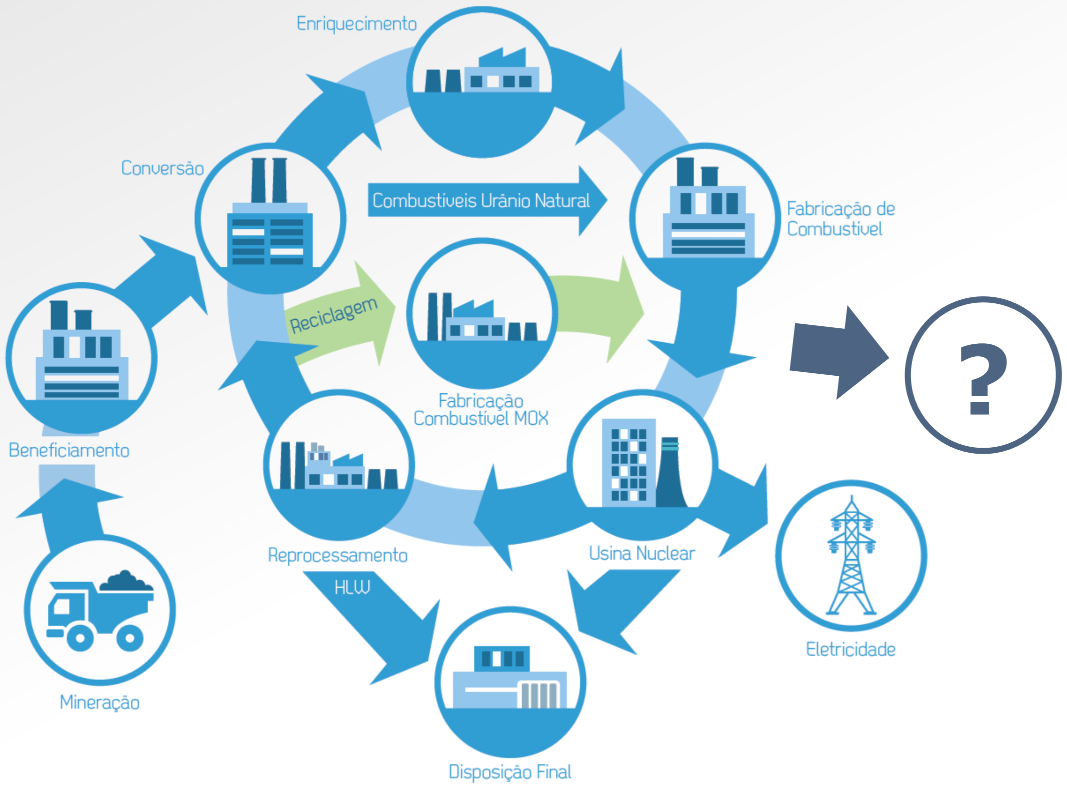
Cadeia da indústria nuclear: economia de escopo



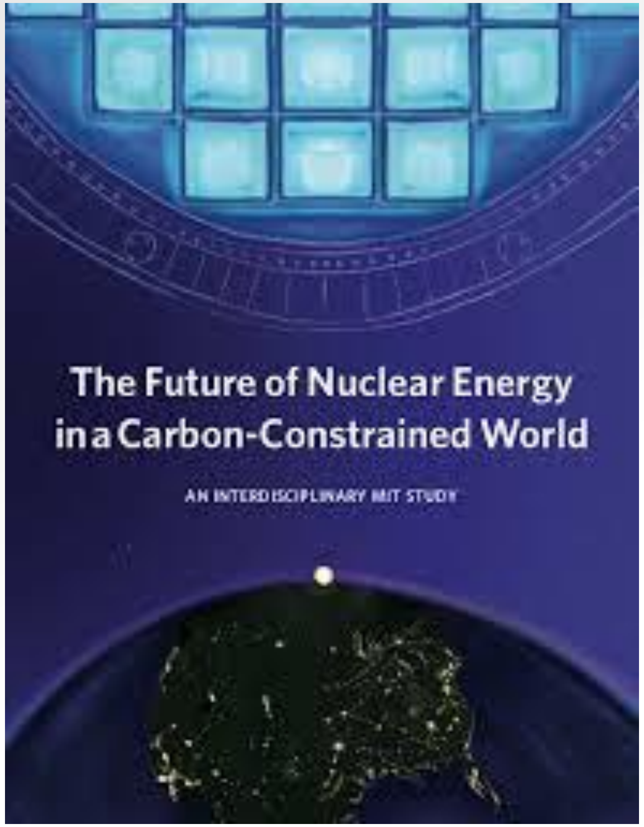
Fonte: Elaboração própria

HLW: resíduo altamente radioativo

- Abatimento de carbono
- Impactos socioeconômicos da cadeia industrial de fornecedores de bens e serviços (alto valor agregado, empregos qualificados, etc.)
- Medicina nuclear/radiofármacos
- Usos na Agricultura: irradiação de alimentos, controle de insetos, mutação da germinação de plantas, etc.
- Usos industriais: marcadores industriais, inspeção e instrumentação, datação de carbono, dessalinização, vapor residual, produção de hidrogênio, etc.
- Propulsão de navios e embarcações
- Defesa (submarino nuclear)

https://fgvenergia.fgv.br/sites/fgvenergia.fgv.br/files/pdf_fgv-energia_web.pdf

Racionalidade para renascimento da nuclear: abatimento de emissões de carbono



Findings:

The cost of new nuclear plants is high, and this significantly constrains the growth of nuclear power under scenarios that assume 'business as usual' and modest carbon emission constraints. In those parts of the world where a carbon constraint is not a primary factor, fossil fuels, whether coal or natural gas, are generally a lower cost alternative for electricity generation. Under a modest carbon emission constraint, renewable generation usually offers a lower cost alternative.

As the world seeks deeper reductions in electricity sector carbon emissions, the cost of incremental power from renewables increases dramatically. At the levels of 'deep decarbonization' that have been widely discussed in international policy deliberations—for example, a 2050 emissions target for the electric sector that is well below 50 grams carbon dioxide per kilowatt hour of electricity generation (gCO_2/kWh)—including nuclear in the mix of capacity options helps to minimize or constrain rising system costs, which makes attaining stringent emissions goals more realistic (worldwide, electricity sector emissions currently average approximately 500 gCO_2/kWh).

Lowering the cost of nuclear technology can help reduce the cost of meeting even more modest decarbonization targets (such as a 100 gCO_2/kWh emissions target).

http://energy.mit.edu/research/future-nuclear-energy-carbon-constrained-world

Racionalidade para renascimento da nuclear:
aumento do pool de receitas

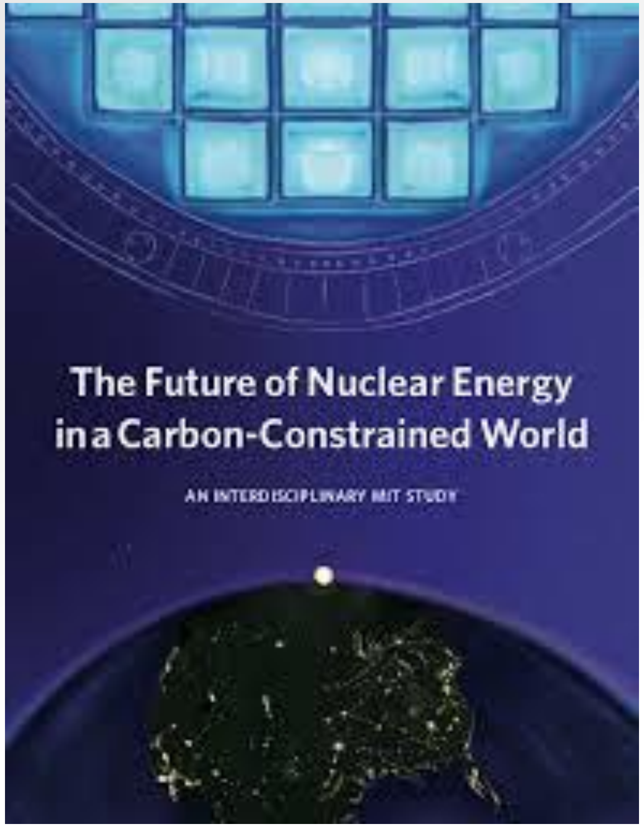
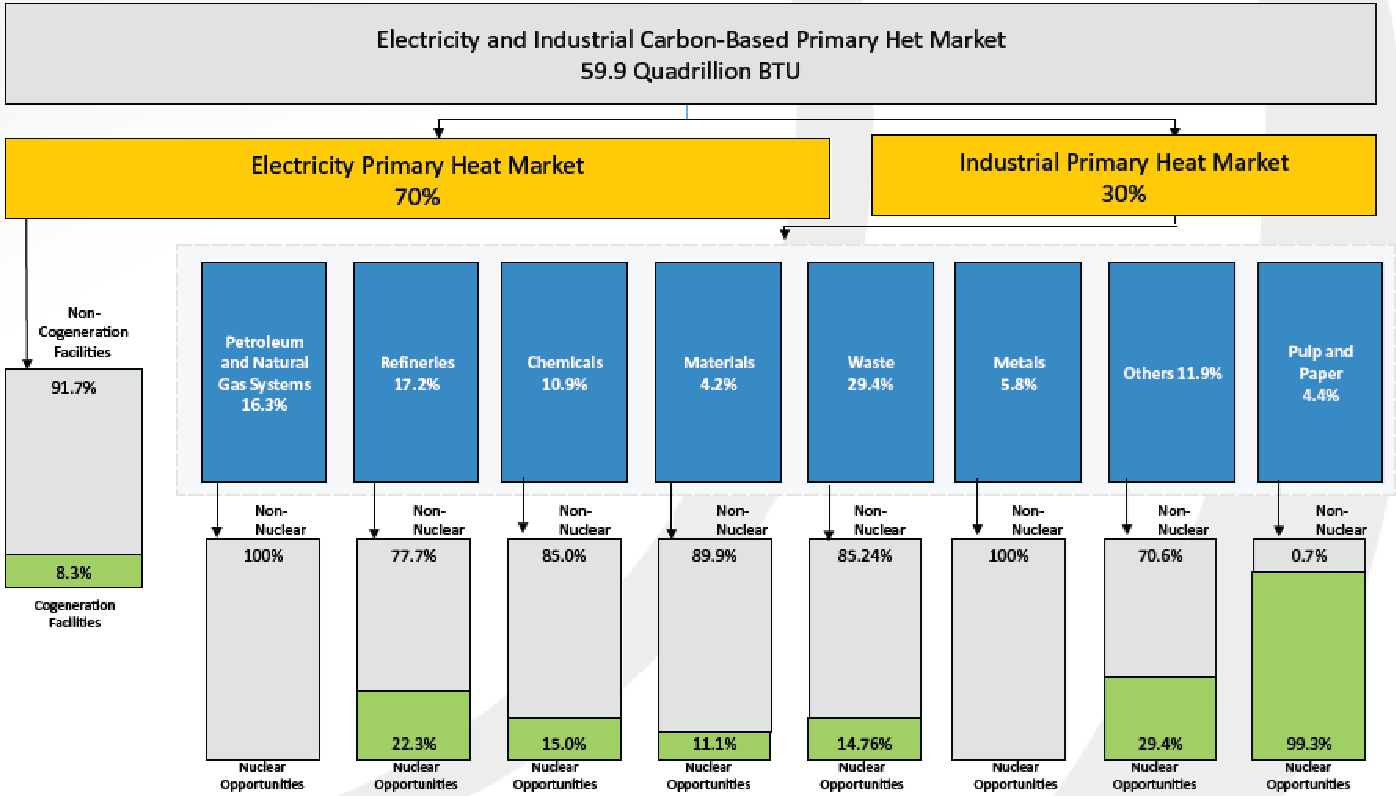


Figure 1.15: Nuclear process heat potential



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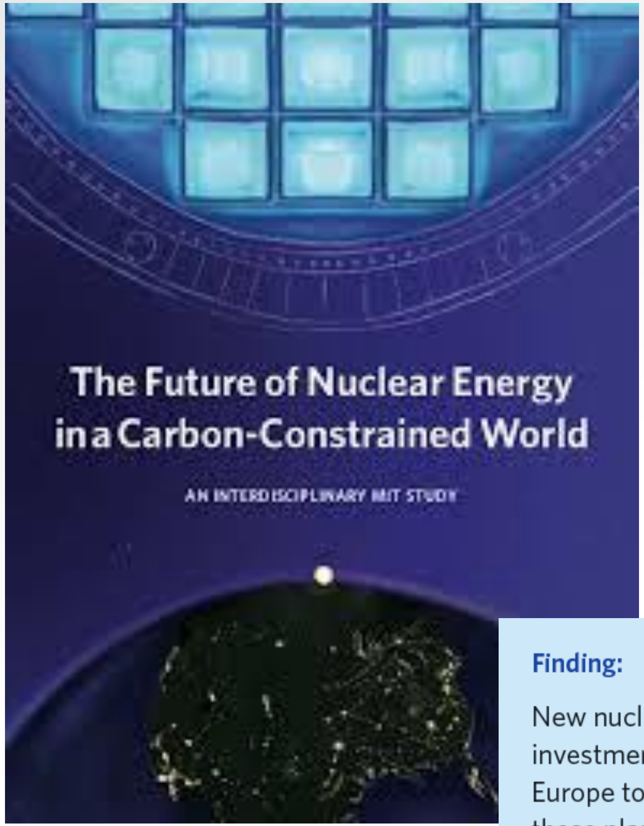
Nuclear

Racionalidade para renascimento da nuclear: redução de custos



Finding:

New nuclear plants are not a profitable investment in the United States and Western Europe today. The capital cost of building these plants is too high.

Figure 2.2: LWR construction costs around the world

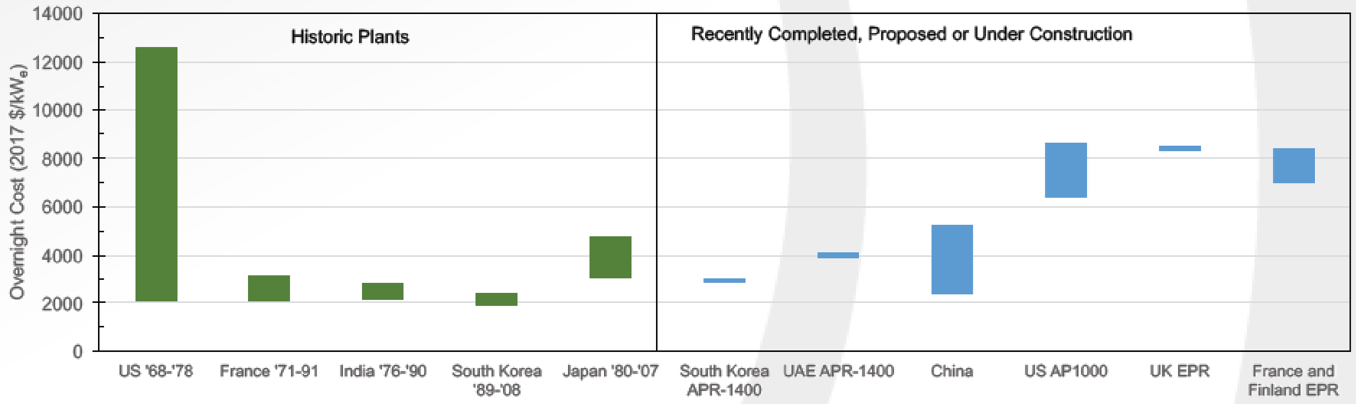
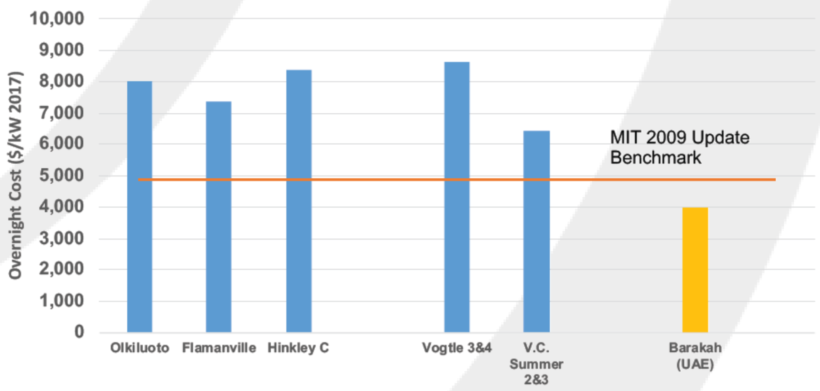


Figure 2.3: Overnight cost of recent Gen-III+ builds versus benchmark



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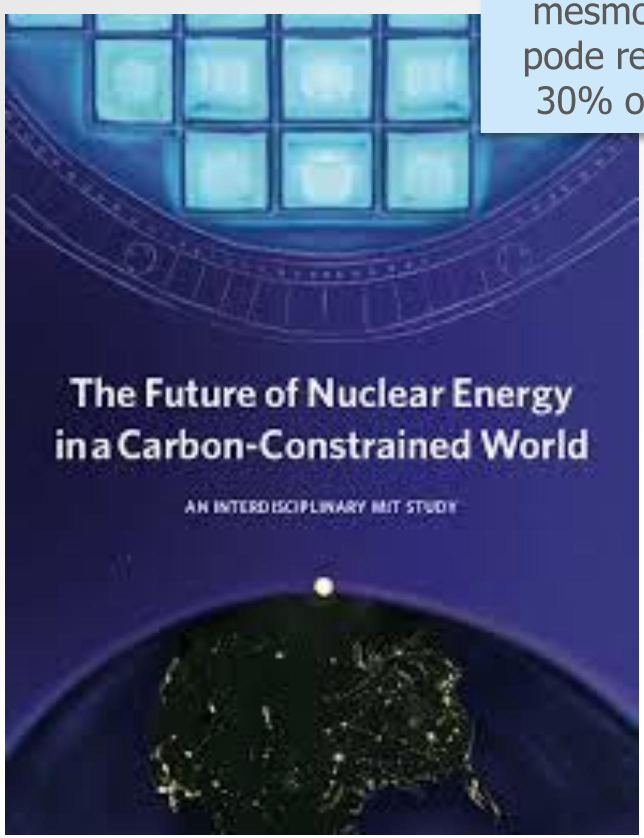
Racionalidade para renascimento da nuclear: redução de custos

1 → 2 planta do mesmo projeto pode reduzir em 30% os custos



Finding:

Successful nuclear builds tend to have the following attributes:

a) Completion of needed portions of the design prior to start of construction,*

b) Development of a proven supply chain for nuclear steam supply system (NSSS) components and a skilled labor workforce,*

c) Inclusion of fabricators and constructors in the design team to ensure that components can be manufactured and structures can be built to relevant standards,

d) Appointment of a single primary contract manager with proven expertise in managing multiple independent subcontractors,

e) Establishment of a contracting structure in which all contractors (and subcontractors) have a vested interest in the success of the project,

f) Adoption of contract administrative processes that allow for rapid and non-litigious adjustments to unanticipated changes in requirements or subcontractor performance, and

g) Operation in a flexible regulatory environment that can accommodate small, unanticipated changes in design and construction in a timely fashion.

1. A ***No Nuclear*** case where nuclear is not an allowed option.
2. A ***Nuclear—Nominal Cost*** case in which nuclear technology can be selected at the currently projected 'nth-of-a-kind' (NOAK) overnight cost of \$5,500/kW_e in 2050 (National Renewable Energy Laboratory, 2016).
3. A ***Nuclear—Low Cost*** case in which nuclear technology can be selected at a cost that is 25% lower than currently projected for 2050. This estimate is based on our analysis of opportunities to reduce the overnight cost of nuclear by employing innovations in enabling technologies (see Chapter 2).
4. A ***Nuclear—Extremely Low Cost*** case in which nuclear technology can be selected at a cost that is 50% that of the currently projected cost for 2050. This is a long-term cost goal for many advanced reactor technologies (U.S. Department of Energy 2016).
5. ***Nuclear—High Cost*** case where the nuclear cost is 25% higher than the currently projected cost for 2050 based on current first-of-a-kind (FOAK) costs.

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Racionalidade para renascimento da nuclear:
redução de custos

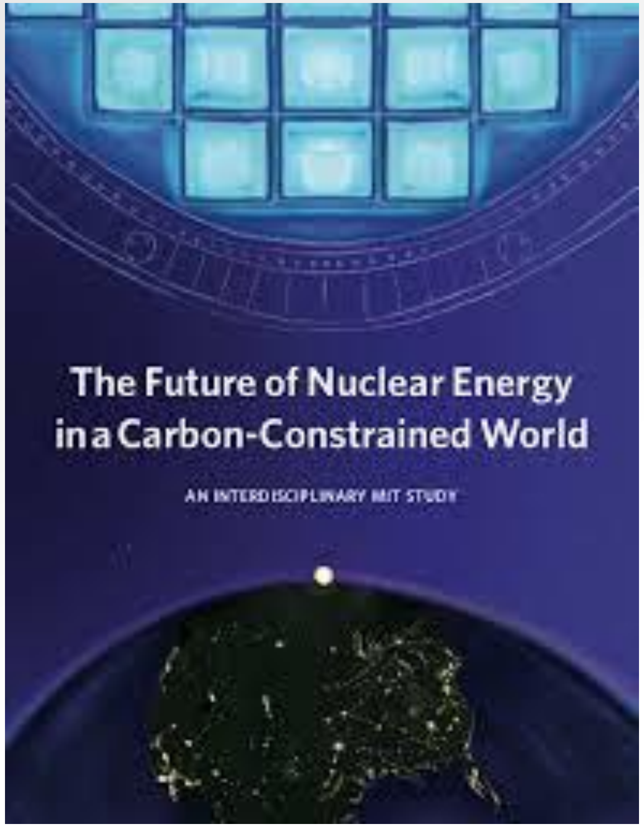
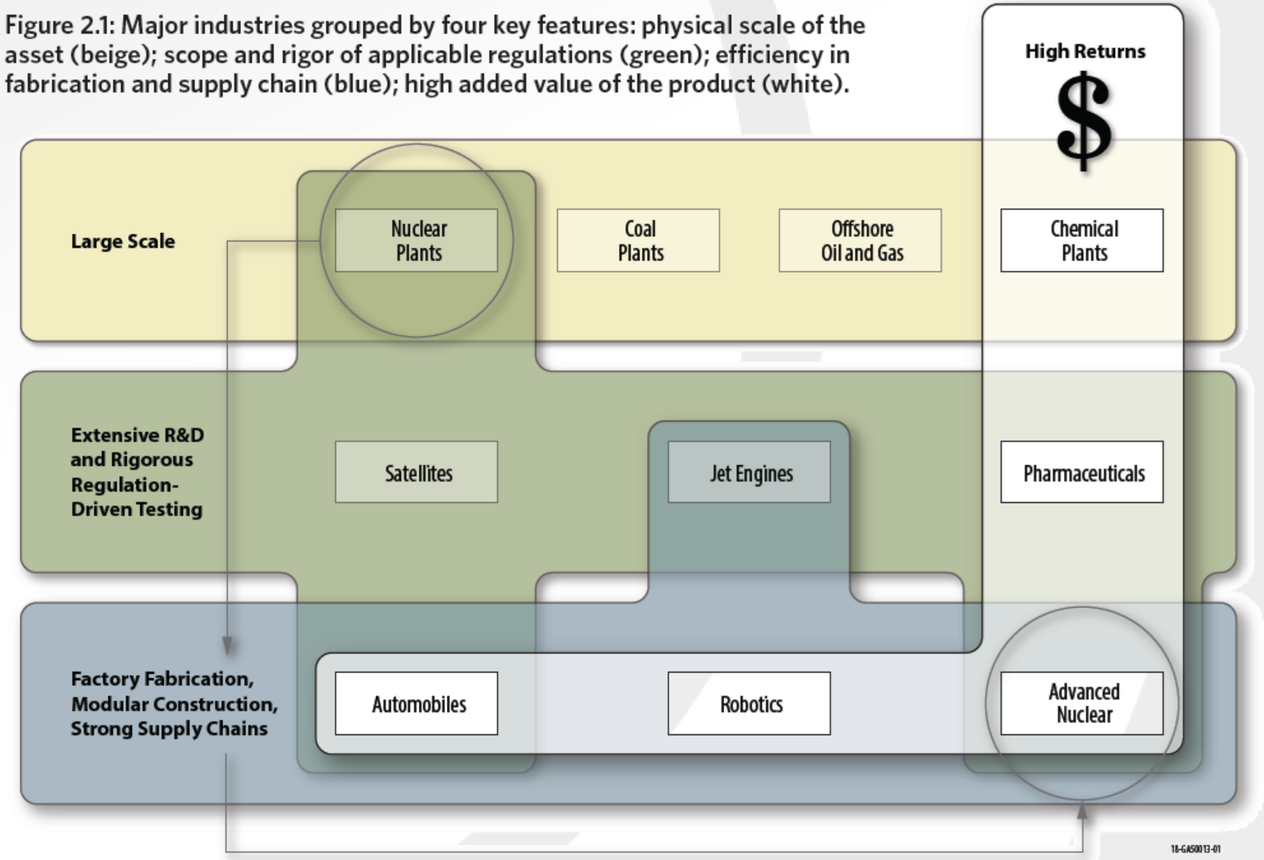


Figure 2.1: Major industries grouped by four key features: physical scale of the asset (beige); scope and rigor of applicable regulations (green); efficiency in fabrication and supply chain (blue); high added value of the product (white).



Nuclear power currently has a unique combination of features that adversely affect its cost and time to commercial deployment. The challenge for new nuclear systems is to move from the top left corner of this chart to the bottom right corner. Taking advantage of factory fabrication, modular construction, and a strong supply chain could help shorten the innovation cycle for nuclear technology and improve the industry's economic returns. The introduction of a price on carbon emissions would make all non-carbon energy sources more competitive and create added value for nuclear power plants.

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Nuclear

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Racionalidade para renascimento da nuclear: inovação tecnológica

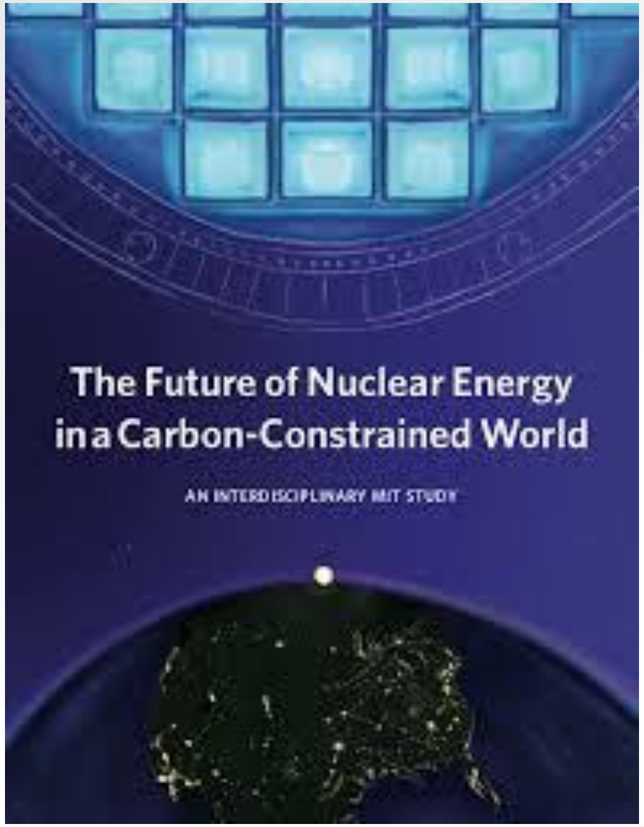
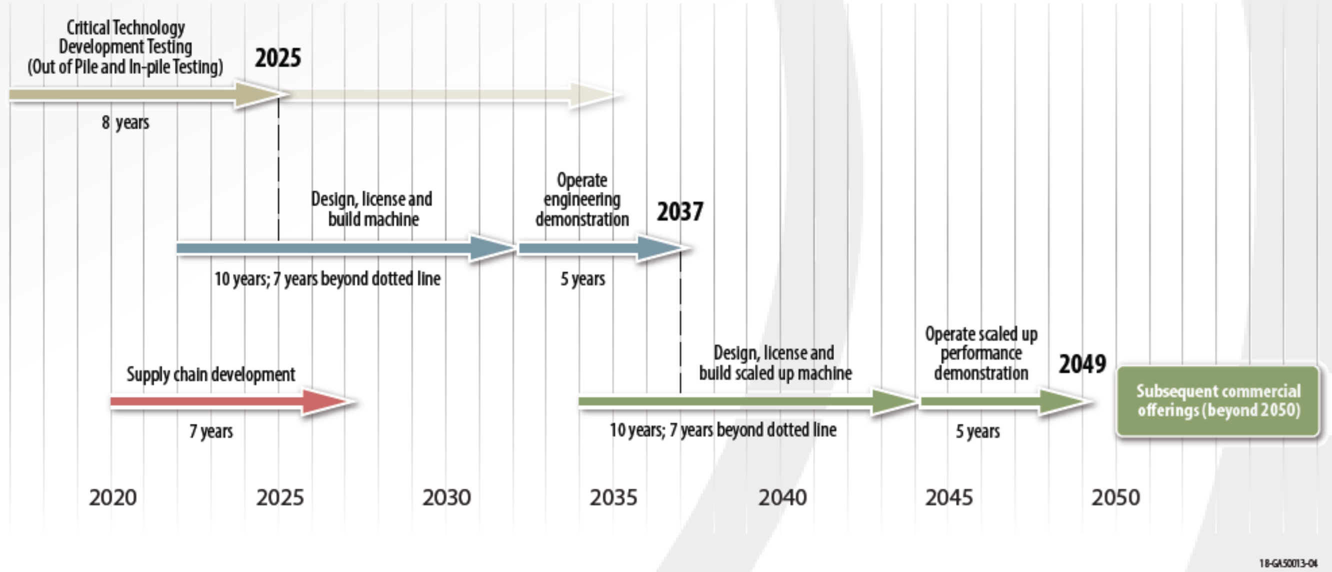


Figure 3.6: Notional advanced reactor development schedule for less mature technologies based on historical practice



Reactor Technology	Initial Commercial Deployment	Subsequent Commercial Units
NuScale and other LWR SMRs	Between now and 2030	Between 2030 and 2050
SFRs and HTGRs	2030	Between 2030 and 2050
FHRs, MSRs, LFRs, VHTRs, and advanced SFRs	Beyond 2050	Beyond 2050

Nuclear

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Racionalidade para renascimento da nuclear:
inovação tecnológica

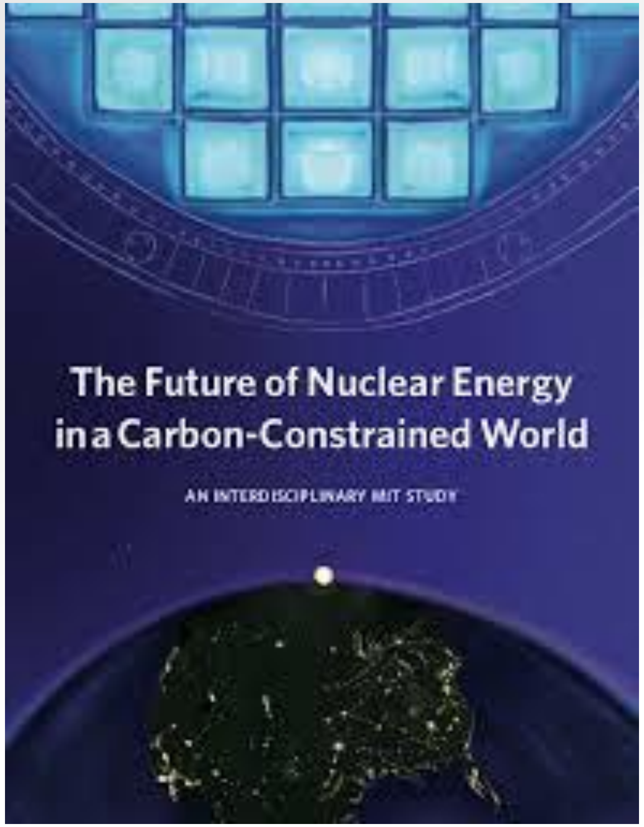
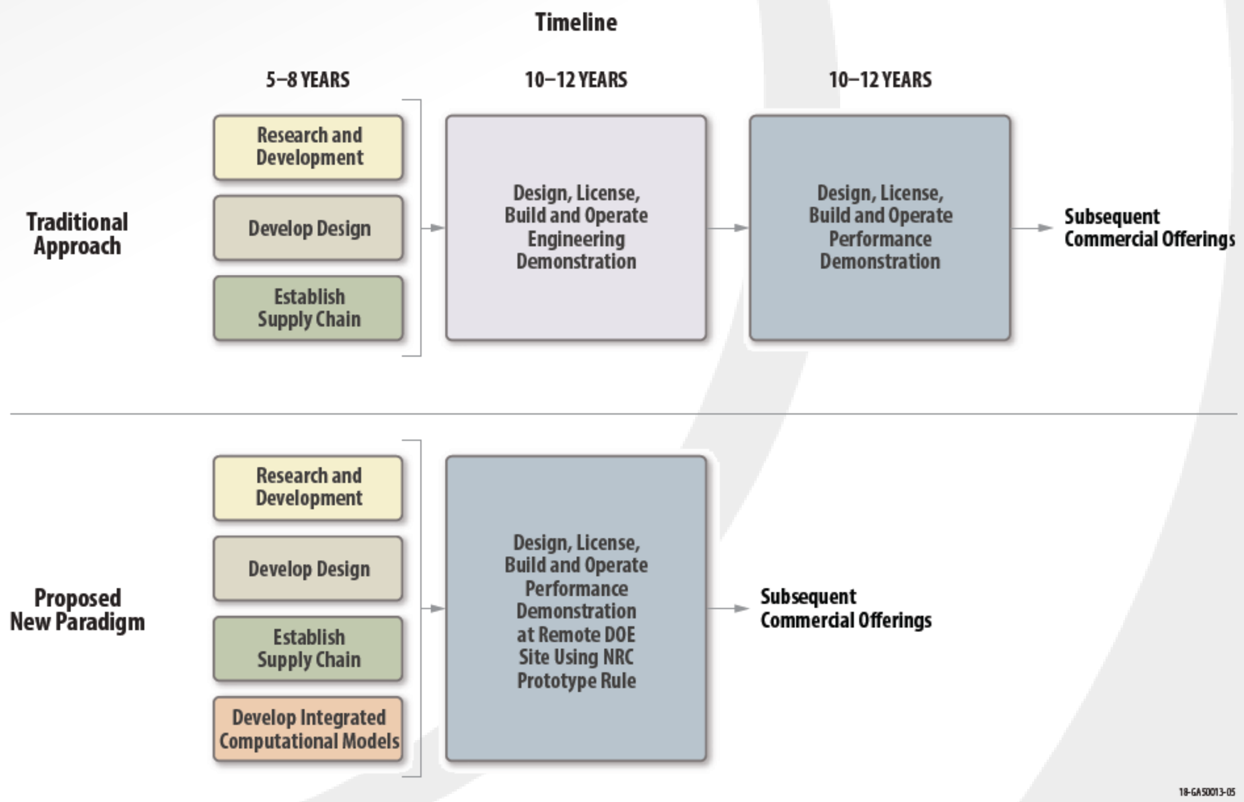


Figure 3.7: Comparison of timelines under the traditional and proposed new development and deployment paradigms for nuclear reactors



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Nuclear

Racionalidade para renascimento da nuclear: defesa

Atlantic Council
GLOBAL ENERGY CENTER

ISSUE BRIEF

The Value of the US Nuclear Power Complex to US National Security

OCTOBER 2019

DR. ROBERT F. ICHORD, JR.
BART OOSTERVELD

I. INTRODUCTION

In this analysis, the Atlantic Council has set out to estimate the value that the civilian nuclear power sector contributes to the United States' national security apparatus. Based on a series of inputs, this analysis and conservative estimation found that the nuclear power complex contributes an equivalent of more than $42.4 billion to US national security, as broadly defined. In other words, the lack of a civilian nuclear sector would present an immediate and significant economic shock (and impact on the labor force)—which, in turn, would have immediate and longer-term budgetary implications for the US government.

The definition of national security can be viewed narrowly or more broadly, in terms of both the scope of the institutional assets and providers of national security services and the types of functions or services they undertake. This analysis includes both nuclear utilities and nuclear generators, as well as US military and defense facilities, as providing critical national security functions. The utilities and generators provide secure and reliable electricity, accounting for 19.3 percent of total US electricity generation in 2018, and they contribute significantly to the diversified energy-generation mix that the United States enjoys.

There are three main reasons for public support of the civilian nuclear industry for national security purposes, which are identified in the analysis that follows. The reasons are

1. the civilian nuclear industry generates a vast investment in human capital, which is a necessary condition for all applications of nuclear energy in the national security apparatus;

The Global Energy Center promotes energy security by working alongside government, industry, civil society, and public stakeholders to devise pragmatic solutions to the geopolitical, sustainability, and economic challenges of the changing global energy landscape.

Figure 1. Summary Table of Issue Brief Findings

Area of Analysis	Terms Incorporated	Dollar Value Estimated
Human Capital	National labs, universities, civilian nuclear workforce	$26.1 billion
Baseload and Supply Chain	Gas capacity substitution, dependable baseload, supply chain companies	$2.9 billion
Environmental Benefits	Avoided emissions	$13.4 billion
Total		$42.4 billion

Source: Compiled from authors' own work, as presented in this issue brief.

https://atlanticcouncil.org/wp-content/uploads/2019/10/Nuclear-Power-Value-IB-final-web-version.pdf

Nuclear

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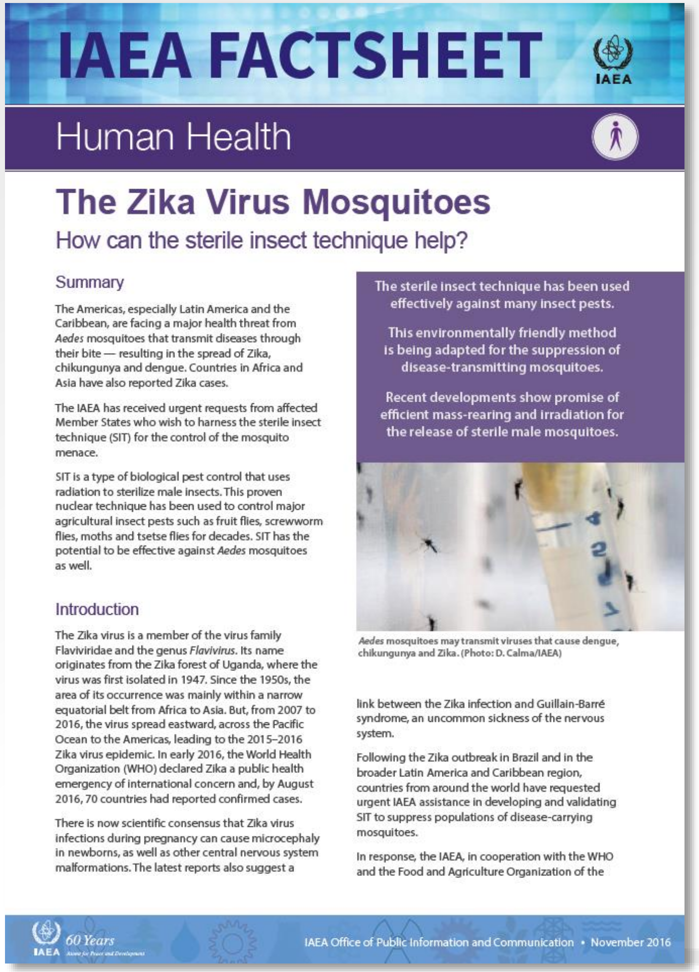
Racionalidade para renascimento da nuclear: saúde



IAEA FACTSHEET

IAEA

Human Health

The Zika Virus Mosquitoes

How can the sterile insect technique help?

Summary

The Americas, especially Latin America and the Caribbean, are facing a major health threat from *Aedes* mosquitoes that transmit diseases through their bite — resulting in the spread of Zika, chikungunya and dengue. Countries in Africa and Asia have also reported Zika cases.

The IAEA has received urgent requests from affected Member States who wish to harness the sterile insect technique (SIT) for the control of the mosquito menace.

SIT is a type of biological pest control that uses radiation to sterilize male insects. This proven nuclear technique has been used to control major agricultural insect pests such as fruit flies, screwworm flies, moths and tsetse flies for decades. SIT has the potential to be effective against *Aedes* mosquitoes as well.

The sterile insect technique has been used effectively against many insect pests.

This environmentally friendly method is being adapted for the suppression of disease-transmitting mosquitoes.

Recent developments show promise of efficient mass-rearing and irradiation for the release of sterile male mosquitoes.

Aedes mosquitoes may transmit viruses that cause dengue, chikungunya and Zika. (Photo: D. Calma/IAEA)

Introduction

The Zika virus is a member of the virus family Flaviviridae and the genus *Flavivirus*. Its name originates from the Zika forest of Uganda, where the virus was first isolated in 1947. Since the 1950s, the area of its occurrence was mainly within a narrow equatorial belt from Africa to Asia. But, from 2007 to 2016, the virus spread eastward, across the Pacific Ocean to the Americas, leading to the 2015–2016 Zika virus epidemic. In early 2016, the World Health Organization (WHO) declared Zika a public health emergency of international concern and, by August 2016, 70 countries had reported confirmed cases.

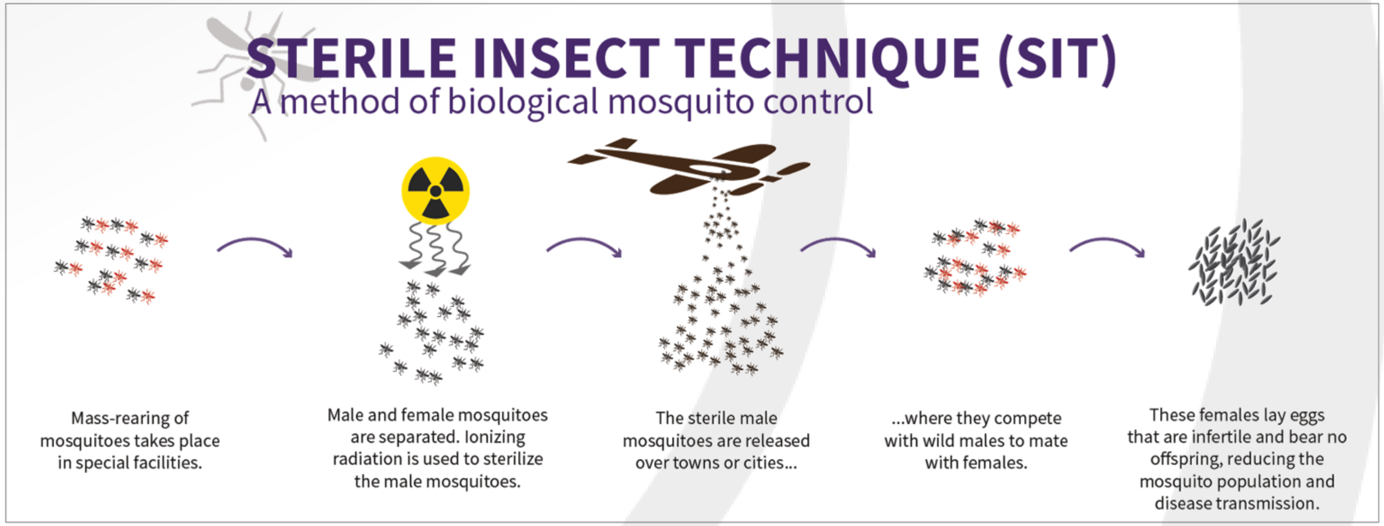
There is now scientific consensus that Zika virus infections during pregnancy can cause microcephaly in newborns, as well as other central nervous system malformations. The latest reports also suggest a link between the Zika infection and Guillain-Barré syndrome, an uncommon sickness of the nervous system.

Following the Zika outbreak in Brazil and in the broader Latin America and Caribbean region, countries from around the world have requested urgent IAEA assistance in developing and validating SIT to suppress populations of disease-carrying mosquitoes.

In response, the IAEA, in cooperation with the WHO and the Food and Agriculture Organization of the

60 Years IAEA

IAEA Office of Public Information and Communication • November 2016



https://www.iaea.org/sites/default/files/16/11/zika-virus-mosquitos-how-can-sterile-insect-technique-help.pdf

Nuclear

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Racionalidade para renascimento da nuclear: modelo de negócios

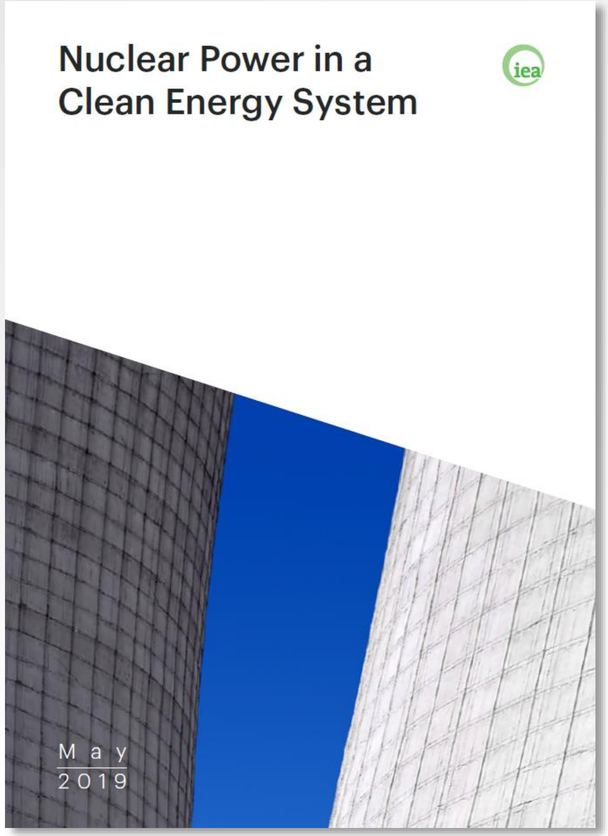
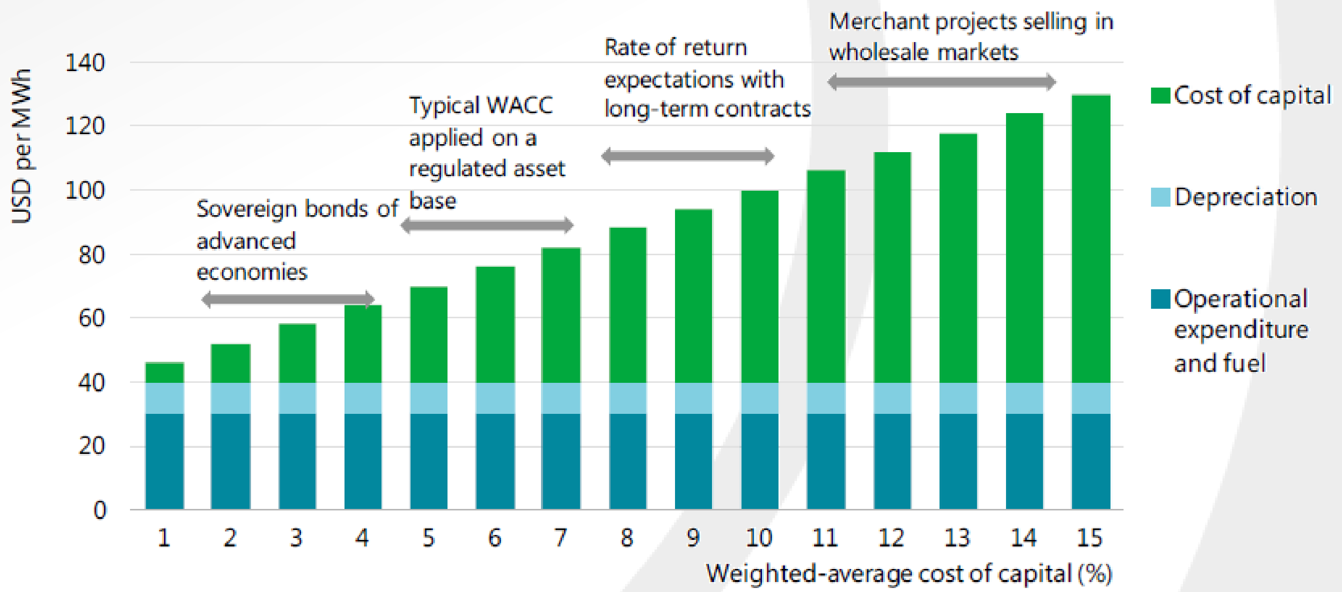


Figure 38. Illustrative LCOE of a new nuclear power plant project according to the cost of capital



Note: Based on a 1 GW plant with an investment cost of USD 4.5 billion.

https://www.iea.org/reports/nuclear-power-in-a-clean-energy-system

Nuclear

Racionalidade para renascimento da nuclear:
modelo de negócios e riscos

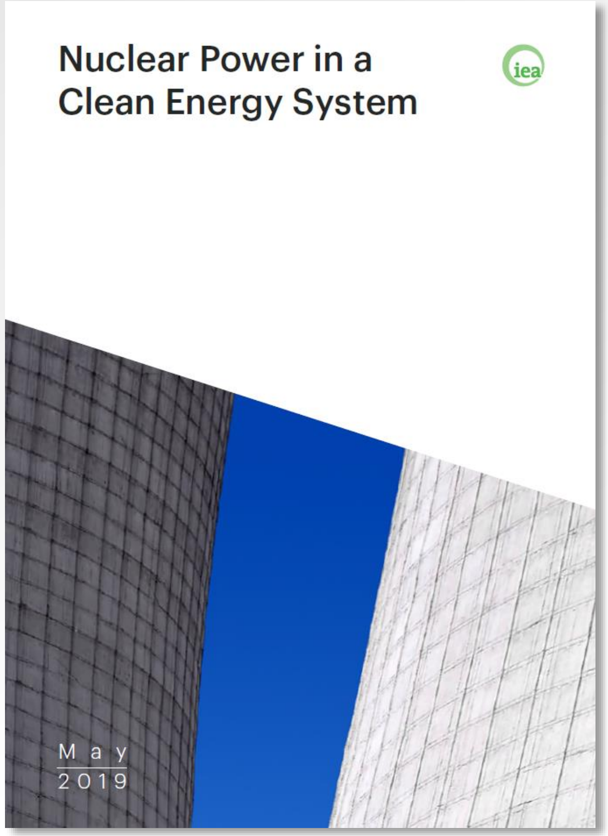


Figure 8. Impact of various risks on net present value of a 1 GW nuclear power project with guaranteed revenues to 2040

Note: All the sensitivities are compared with a "best-case" nuclear project, which assumes an investment cost of USD 4.5 billion per GW, a six year project construction time frame, a 60 year lifetime and a 7% cost of capital.

https://www.iea.org/reports/nuclear-power-in-a-clean-energy-system

Nuclear

Nuclear

Racionalidade para renascimento da nuclear: políticas públicas

HM Government

Industrial strategy: government and industry in partnership

The UK's Nuclear Future

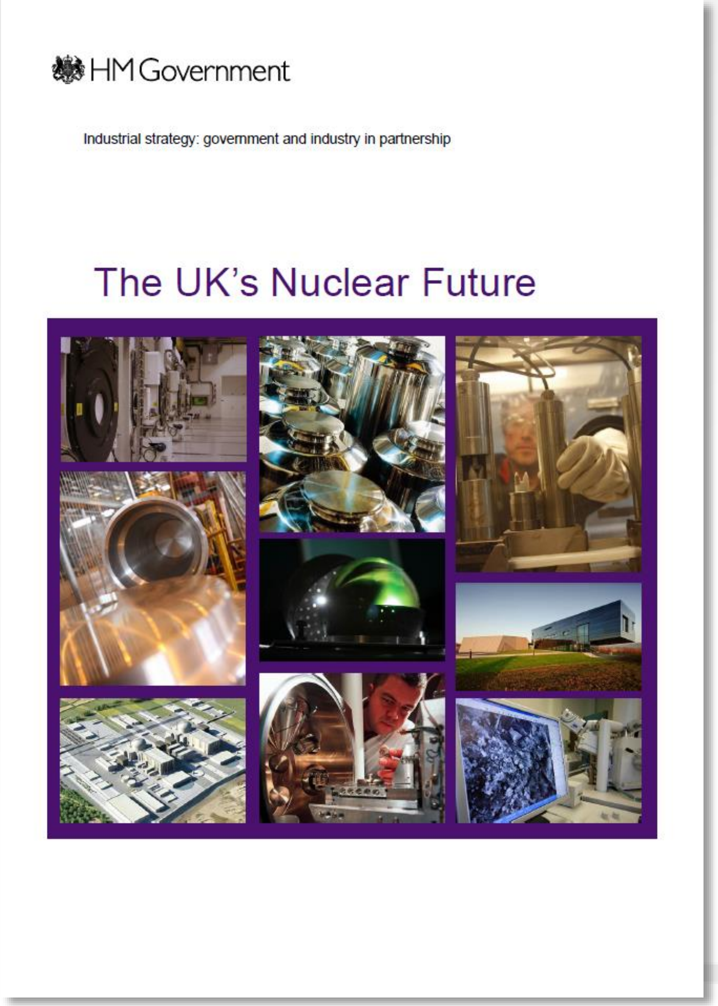
Together, Government and industry have a clear and ambitious vision to ensure the development of a vibrant UK nuclear industry that is an area of economic and strategic national strength, providing the UK with a safe, reliable and affordable supply of low-carbon electricity.

Objectives

- To have a domestic nuclear market that maximises UK commercial opportunities, delivering growth by providing a platform to build sustainable exports as well as a secure supply of energy in the long-term;
- To provide the long term infrastructure required to support both the public and private sector parts of industry in a safe, responsible and cost-effective manner;
- To have clear direction and co-ordination across public procurement, R&D, and skills development;
- For the home market to become the showcase that demonstrates UK's overall nuclear excellence to the international market.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/168048/bis-13-627-nuclear-industrial-strategy-the-uks-nuclear-future.pdf

Racionalidade para renascimento da nuclear: políticas públicas


HM Government

Industrial strategy: government and industry in partnership

The UK's Nuclear Future

Government has in recent years taken a number of steps and provided substantial funding to help industry take advantage of existing market opportunities. This has included:

- £66m funding for nuclear R&D (2010-11).[30] This includes R&D into nuclear fusion which attracts significant gearing funding from Europe and international programmes and where the UK is a global player.
- £9 billion spent by NDA in the supply chain dealing with decommissioning since 2005.
- Establishment of the Nuclear-AMRC in 2009 to provide a focal point for the UK civil nuclear manufacturing industry. The aim of the Nuclear-AMRC is to help companies access the domestic and global market, to develop capability and competitiveness through process manufacturing innovation and R&D, driving up quality and reducing cost. The initial support was followed by additional investment of £37.1m in 2012. This public funding has been matched with additional industry and European funding. The Nuclear-AMRC is also part of the Manufacturing Catapult attracting additional TSB funding and support.
- TSB Nuclear Feasibility and Near to Market Nuclear Innovation Support: £18m funding, including £3m from NDA's R&D portfolio for projects identified in 2012. This builds on £2m to industry through the Technology Strategy Board (TSB) for nuclear feasibility studies in 2010.
- Via the Skills Funding Agency , UK Commission for Employment and Skills (UKCES) and Research Councils, Government has made a number of investments in support of the nuclear skills agenda including:
  - National Skills Academy for Nuclear
    - £6.5m capital on flagship training centres
    - £3.5m Skills Academy set up and operational costs
    - £2m on 'Transformational Growth' programme in the Supply Chain
    - £1m Expansion into Manufacturing for Nuclear
  - Cogent SSC: £1m Employer Investment Fund including:
    - The Nuclear Workforce Tool being developed with the Nuclear Energy Skills Alliance
    - The Nuclear Island
    - Nuclear Industry Training Framework
  - £10.5M support from the Engineering and Physical Sciences Research Councils (EPSRC) for the training of nuclear PhDs through the Nuclear First Centre for Doctoral Training and the Nuclear Engineering Industrial Doctoral Centre.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/168048/bis-13-627-nuclear-industrial-strategy-the-uks-nuclear-future.pdf

Nuclear

Envolvimento e comunicação

**Making the Case for Nuclear Power:
Why Stakeholder Involvement Matters**

*Embarking on a nuclear power programme **requires years of preparatory work and long term national commitment throughout the development, construction, operation and, ultimately, decommissioning, of nuclear facilities**. To advance a strong case for nuclear power and to gain sustained public acceptance, **it is essential to engage all stakeholders at every stage of the planning process and during the life cycle of nuclear facilities**.*

https://www.iaea.org/newscenter/news/making-the-case-for-nuclear-power-why-stakeholder-involvement-matters

Nuclear

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Energia Nuclear

Exercícios quantitativos

Nuclear

Capacidade Instalada em 2050 nos casos com expansão de novas centrais nucleares

1 O efeito de reduções de custo (CAPEX e/ou OPEX) sobre as perspectivas de inserção de UTN

Em resumo, é possível a inserção competitiva de capacidade termonuclear desde que os custos de instalação (CAPEX) e/ou operação (OPEX) se reduzam de forma significativa em relação às perspectivas atuais de evolução de custo desta fonte no horizonte do PNE 2050.

Tal desafio requererá ações fundamentais na direção de padronização de projetos, redução de tempo de construção e avanço na curva de aprendizagem na construção de novos empreendimentos.

Capacidade Instalada em 2050 nos casos com expansão de novas centrais nucleares

2 Uma política energética definindo a inserção de 8 a 10 GW de UTN

Esta política energética, por sua vez, deve estar baseada em uma análise de custo-benefício mais geral não restrita apenas a seus serviços no setor elétrico (incluindo-se possíveis ganhos de escala), mas também às economias de escopo em atividades como defesa (submarino com propulsão nuclear), medicina nuclear (equipamentos de diagnósticos, radiofármacos, etc.), agricultura (controle de pragas, irradiação de alimentos, etc.), entre outros. Em outras palavras, é preciso estimar os efeitos de **transbordamentos econômicos e tecnológicos** (spillovers) e de compartilhamento de custos do complexo nuclear

Tratar-se-ia, nesse sentido, de uma lógica de **minimizar o máximo arrependimento** (um valor de opção, como um seguro), assegurando expertise e posicionamento estratégico nesse mercado de alto conteúdo tecnológico. Alguns países (EUA, Reino Unido e França, por exemplo) têm adotado essa estratégia, reconhecendo a relevância que a nuclear pode ter em um mundo com restrição de carbono.

Energia Nuclear

Reflexões

Reflexões

Obtenção de informações que permitam embasar externalidades positivas de outros negócios fora do setor energético que possam ampliar o pool de receitas e compartilhar os custos da cadeia da indústria nuclear

Qual o peso que outros negócios podem ter no compartilhamento dos custos com a geração termonuclear?

Definir programas que embasem a redução de custos da indústria nuclear

EUA, Reino Unido e outros países definiram políticas de P&D para redução dos custos da nuclear e políticas públicas para novos negócios e receitas (inclusive mercados de carbono)

Estratégias para viabilização do desenvolvimento da indústria nuclear

Aperfeiçoamentos institucionais, legais e regulatórios
Redução de custos
Estruturação de modelos de financiamento e de negócios
Políticas de segurança e contingência, C&TI e capacitação
Plano de Comunicação e Envolvimento de stakeholders

Obrigado!

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