Deep Energy Retrofits
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1. What is a deep retrofit?
2. How are deep retrofits being applied at the Federal level?
3. Deep retrofit best practices
   - GSA’s National Deep Energy Retrofit Program
   - Army’s Deep Retrofit ESPC Program
   - DOE’s Facilities Infrastructure Restoration and Modernization Program
4. Conclusion and discussion

Lessons learned, tools and insights from multiple perspectives
WHAT IS DEEP RETROFIT?

Achieve ≥ 40% energy savings

Integrative Design Process

Whole Systems Perspective
  Building, site/campus and lifecycle

Improved project economics

Positive impacts to site and grid
BENEFITS OF DEEP ENERGY RETROFITS

- Infrastructure improvements
- Job creation
- Public private partnerships
- Cost savings
- Increased energy security and resiliency
- Reduced exposure to utility price volatility
- Attract and retain quality staff
- Energy efficiency is the cheapest fuel source
- Bipartisan support

Bottom Line: In line with administration priorities and provides best overall value.
Federal Investment in Facility Efficiency


Funding Type
- UESC
- ESPC
- Direct Obligations

Investment (2016$)
- 2007: $0.7B
- 2008: $0.9B
- 2009: $1.2B
- 2010: $4.0B
- 2011: $2.9B
- 2012: $1.2B
- 2013: $1.5B
- 2014: $1.8B
- 2015: $2.0B
- 2016: $1.7B
Cost of energy saved: $25 / million Btu

Return on Investment 2007-2030: 2.3 years

Meets even very conservative payback calculations, also shows perhaps we could be doing more!


GSA’s National Deep Energy Retrofit Program

- 73 facilities, 40 million square feet
- 26 task orders awarded (2014 – 2016)
- 34% average energy reduction
- $541 million implementation cost
- $21.5 million annual savings
- 905 billion Btus annual energy reduction
- One Net Zero ESPC project

Goals:
- Increase use of PPP
- Retrofit plans that move a building towards net-zero energy use
- Use of innovative technologies
- Achieve deep(er) energy savings than in past projects
GSA’s keys to success

- Emphasis on deep retrofits in the notice of opportunity
- Design charrettes reinforced the need for ESCOs to dig deeper and propose ECMs with longer simple paybacks
- Central Program Management Office provided central source of information for GSA regional managers
The World of the Army

• Army Real Property Portfolio ~ 1 Billion Square Feet (approximately 30% of all Federal SF)

• Campus Approach – Our “Facilities” are small cities, not just individual buildings

• Largest Single Facility Energy User in USA

• Energy Security & Sustainability (ES²) Strategy

• Net-Zero Philosophy
  • Energy
  • Water
  • Waste

• Everything we do is for Mission Readiness
Army’s ESPC/UESC Portfolio

• Started UESC program in 1992 and ESPC program in 1996, longtime champion
• Third Party Investment of over $2.5B
• Over $1B investment just in last 5 years
• Over 245 ESPC Task Orders/modifications
• Over 375 UESC Task Orders/modifications
• Largest ESPC program in Federal Gov’t
• Second Largest UESC program in Federal Gov’t
Army’s Keys to success

- Senior Leader support
- HQ Dept of Army provides guidance and framework for program support, but installations generate and champion projects at the local level.
- Quasi-centralized contracting, maintains expertise in specialized contracting.
- Phased approach allows execution in manageable pieces.
- Not overly prescriptive RFPs/NOO.
- Open, Early, honest communication, including charrettes with all stakeholders
- Longer terms and bundled projects
DOE’s Facilities Infrastructure Restoration and Modernization (FIRM) Program

• Overview

• Focused effort to deliver necessary improvements to DOE’s facilities and infrastructure using public-private partnerships.
Objective

DOE has used public-private partnerships to install more $520 million in infrastructure improvements across the complex since 1999.

Given the limited availability of appropriated funding, ESPC and UESC projects are an ideal vehicle for upgrading energy performance and resolving the backlog of deferred maintenance issues in our facilities.
DOE’s Facilities Infrastructure Restoration and Modernization (FIRM) Program

• Participant Benefits
• Meet goals and demonstrate leadership
• Mobilize capital to address long-standing issues or site needs
• Enhance mission effectiveness
• Boost employee productivity and recruitment:
GSA-RMI Report: Summary of Deep ESPC Savings

Energy Cost Savings

- GSA - New Carrollton: 60%
- Navy - NAS Oceana: 40%
- GSA - Almeric Christian: 100%
- Army - Fort Buchanan: 53%
- DOS - Nicaragua Embassy: 54%
- GSA - King Brickell: 43%
- City of Boulder: 68%
- Nat'l Archives and Records Adm. - NARA: 45%

Average Federal ESPC Savings
### Case Study Overview

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Location</th>
<th>ESCO</th>
<th>Energy Savings</th>
<th>Investment Value and % Appropriated</th>
<th>Contract Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Carrollton Federal Building</td>
<td>New Carrollton, MD</td>
<td>Ameresco, Inc.</td>
<td>60%</td>
<td>$44.6M (1%)</td>
<td>22 years</td>
</tr>
<tr>
<td>NAS Oceana</td>
<td>Virginia Beach, VA</td>
<td>Trane U.S., Inc.</td>
<td>40%</td>
<td>$89.6M (0%)</td>
<td>17 years</td>
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<tr>
<td>Almeric Christian</td>
<td>Saint Croix, USVI</td>
<td>Schneider Electric</td>
<td>100%</td>
<td>$6.4M (0%)</td>
<td>19 years</td>
</tr>
<tr>
<td>Fort Buchanan</td>
<td>San Juan, Puerto Rico</td>
<td>Johnson Controls, Inc.</td>
<td>53%</td>
<td>$71.1M (0%)</td>
<td>18.5 years</td>
</tr>
<tr>
<td>Nicaragua Embassy</td>
<td>Managua, Nicaragua</td>
<td>Lockheed Martin</td>
<td>54%</td>
<td>$15.0M (0%)</td>
<td>25 years</td>
</tr>
<tr>
<td>King Brickell</td>
<td>Miami, FL</td>
<td>FPL Energy Services, Inc.</td>
<td>43%</td>
<td>$4.4M (51%)</td>
<td>15 years</td>
</tr>
<tr>
<td>City of Boulder</td>
<td>Boulder, CO</td>
<td>McKinstry Essention, LLC</td>
<td>68%</td>
<td>$16.2M (29%)</td>
<td>15 years</td>
</tr>
<tr>
<td>NARA</td>
<td>(Multiple)</td>
<td>Honeywell ESG</td>
<td>45%</td>
<td>$11.1M (0%)</td>
<td>16 years</td>
</tr>
</tbody>
</table>
What is Required to Achieve Deep Retrofits

- Buildings that have not undergone recent energy retrofit projects
- Emphasis from agency
- Thorough audit process to identify ECMs
- Integrated design approach
- Realization that deep retrofits cost more
  (in terms of energy savings per dollar invested)
Deep Retrofit Best Practices

1. Set Aggressive Goals

2. Collaborate with Diverse Stakeholders

3. Use Iterative, Holistic Design Processes

4. Incorporate Ongoing Involvement
Best Practice #1. Set Aggressive Goals

1. Establish long-term goals that align with facility masterplan

2. Clearly state desired outcomes and constraints

3. Push for longer contract terms to achieve deep, bundled savings
FULLY LEVERAGE APPROPRIATED FUNDING

- Inevitably, appropriations will fall short of ‘cost effective’ upgrade needs
- Plan B should include combined private ESPC/UESC funding
- Longer payback measures should be funded through appropriations and shorter term measures financed through ESPC/UESC.
  - Timing is key – ESPC work must align with appropriated funding.
  - Legal understanding and engagement

Visit Track 14 Session 5: ‘Public Private Partnerships’ 10:30-12:00 for additional info

Deep retrofit over time

**Load Reduction ECM’s:**
- Lighting
- Sealing and weatherization
- Window replacement or films
- Roof or wall insulation
- Shading
- Daylighting
- Plug load reduction
- Controls (i.e. DCV, programmable Tstats)
- Passive strategies (i.e. night flush w/ thermal mass)

Do load reduction ECM’s with or before equipment replacement
Almeric Christian Federal Building
First Net Zero ESPC

- GSA Region 2
- Schneider Electric selected in 2012, through NDER, to implement ESPC
- TO awarded September, 2013
- Construction completed September, 2014
- Project parameters
  - $6.4 million investment
  - $0.5 million/year guaranteed savings
  - 19 year finance term
Key Facts

Building Characteristics:
- **Location:** St. Croix, Virgin Islands
- **Floor Area:** 57,872 ft²
- **Original Construction:** 1989
- **Tenant:** Federal Courts
- **Baseline EUI:** 57 kBtu/ft²
- **Local Utility Rate:** $0.52/kWh

Project Details:
- **Project Duration:** Approx. 24 months, 12 each for development & construction
- **Investment Value:** $6.4 million
- **Projected Energy Reduction:** 100%
- **Projected Savings:** $500,000/year
- **Contract Term:** 19 years
Keys to Success

- Well-structured communication plan
- Building tenant buy-in
  - Proactively addressed tenant concerns
- Consideration of unique project characteristics
  - Utility rates
  - Security requirements
- Information collection and dissemination processes could be improved
  - More existing asset data needed
  - Standardized central location for all project information
Fort Buchanan ESPC

The Fort Buchanan ESPC

- Stemmed from Army’s Net Zero Initiative
- Utilized comprehensive, long-payback measures balanced by shorter-term ECMs
- Helped the base achieve 53% energy and 70% water savings
Key Facts

**Building Characteristics:**
- **Location:** Guaynabo, Puerto Rico
- **Number of Buildings:** 73
- **Total Floor Area:** 1.7 million ft²
- **Original Construction:** 1940-present
- **Baseline EUI:** 55 kBtu/ft²
- **Utility Rate:** $0.22/kWh

**Project Details:**
- **ESCO:** Johnson Controls, Inc.
- **Managing Agency:** U.S. Army
- **# Task Orders:** 2*
- **Project Duration:** 38 months
- **Investment Value:** $71.1M
- **Projected Energy Reduction:** 53%
- **Projected Savings:** $4.8M per year
- **Contract Term:** 17-20 years
Technical Specifications

- **Key ECMs**
  - Lighting replacements and controls
  - HVAC improvements
- **Water Conservation**
  - Rainwater harvesting
  - Smart irrigation system
  - 70% reduction, 52 Mgal/yr saved
- **Renewables**
  - 5.4 MW solar PV
  - 875 kW wind turbines
  - 106 MmBtu/yr solar thermal
- **M&V**
  - Option B: renewable systems
  - Option A: all other ECMs

<table>
<thead>
<tr>
<th>Description</th>
<th>Invested</th>
<th>First-Year Savings</th>
<th>Simple Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV Generation</td>
<td>$28.43M</td>
<td>$1.53M</td>
<td>19 yrs</td>
</tr>
<tr>
<td>Lights &amp; Occupancy Sensors</td>
<td>$7.38M</td>
<td>$1.1M</td>
<td>7 yrs</td>
</tr>
<tr>
<td>HVAC</td>
<td>$7.04M</td>
<td>$613k</td>
<td>12 yrs</td>
</tr>
<tr>
<td>Wind Generation</td>
<td>$5.10M</td>
<td>$179k</td>
<td>29 yrs</td>
</tr>
<tr>
<td>Water Solutions</td>
<td>$4.35M</td>
<td>$590k</td>
<td>7 yrs</td>
</tr>
<tr>
<td>Air Cooled Chiller</td>
<td>$4.26M</td>
<td>$236k</td>
<td>18 yrs</td>
</tr>
<tr>
<td>EMCS</td>
<td>$3.29M</td>
<td>$445k</td>
<td>7 yrs</td>
</tr>
<tr>
<td>LED Street Lights</td>
<td>$890k</td>
<td>$85k</td>
<td>11 yrs</td>
</tr>
<tr>
<td>Roof Insulation &amp; Reflective Membrane</td>
<td>$660k</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Retro-Commissioning</td>
<td>$570k</td>
<td>$5k</td>
<td>11 yrs</td>
</tr>
<tr>
<td>Solar Water Heating</td>
<td>$180k</td>
<td>$5k</td>
<td>33 yrs</td>
</tr>
</tbody>
</table>
Key to Success

- ECM Bundling
  - $23.5M shorter-payback ECMs (7-12 years)
  - $38.0M longer-payback ECMS (18-33 years)

- Aggressive Goals
  - Specified Net Zero Water pilot site
  - Program supported by Army goals (e.g. security)
  - Program established project philosophy for water and energy

- Value Beyond Energy Savings
  - Projected O&M savings: $268k/year
  - O&M and water contribute 18% of total savings

- Project Champion and Interdisciplinary Project Team
NNSA Flow of Contracting Authority

Administrator
NNSA Act
Gives Authority

Procurement Executive
(NA-APM-10)

Full Delegation

Head of the
Contracting Activity

Limited Delegation

Acquisition
Management
Contracting Officers

Formal
Contracting Officer
Warrant Appointment

Site Office
Contracting Officers

Subject to Appointment Limitations and
NNSA Coordination and Approval Process (CAP)

HQ or Site Office
Contracting Officer
Representatives

Formal Contracting Officer
Representative
Delegation Letters

HQ or Site Office M&O
Contracting Officer
Representatives

Formal Contracting Officer
Representative
Delegation Letters
Acquisition Personnel Roles and Responsibilities

- Contracting Officer (CO): A person with the authority to enter into, administer, and/or terminate contracts. The only Federal position, 1102, who has the authority to contractually bind the Government.

- Contracting Officer’s Representative (COR): Authorized representative of the CO
  - Can issue technical direction per written delegation, and accept performance
  - Cannot change scope, schedule, price or terms
  - Must be a Federal employee
  - Appointed in writing by a Contracting Officer
  - No Conflicts of Interest

- Federal Project Director (FPD): An individual responsible for planning, organizing, directing, controlling, and reporting on the status of a capital asset project.
Flow of Contractual Relationships

NNSA CO/COR

Direct Relationship

Direct Relationship

Contractors

Subcontractors

No Direct Relationship
Suddenly, a heated exchange took place between the king and the moat contractor.
Lessons Learned

- Involve the site contracting personnel early in the acquisition process if the site will be responsible for contract administration.
- Appoint a qualified, experienced Contracting Officer Representative Federal Project Director
- Revisit, review Tri-Party Agreement continuously. Revise as necessary.
- Ensure that the Tri-Party Agreement is executed and that roles and responsibilities for all phases of the contract are clearly documented.
- Ensure understanding that privity of contract (ESPC) lies between NNSA and the ESCO
- Clearly understand safety and security requirements and how they will impact all phases of the contract.
- Understand that the M&O contractor can change (site management) during any phase of the ESPC process, thereby requiring a mod to incorporate procedural changes, etc.
- Construction & design appears to be the most vulnerable phase of the process.
- Ensure that communication lines and methods are clearly understood by all parties involved.
Pantex Wind Farm
Best Practice #2. Collaborate with Diverse Stakeholders

1. Map out key decision makers and influencers

2. Maintain stakeholder engagement

3. Mitigate the effects of personnel turnover

4. Quantify the benefits beyond energy cost savings

1x : 10x : 100x
Diverse and broad Stakeholder team
As we move toward more efficient and net zero energy buildings, plug loads play a big role in energy use, between 30% - 60% of a building's energy use. 

7.4% reduction in energy use due to behavioral strategies. ²
• Energy kiosk and educational signage
• Certifications and awards
• Training programs and fact sheets
• Energy competitions

GSA – ESPC Program Management Office

• In Support of the GSA ESPC Effort:
  – Created a Program Management Office (PMO) March 2012:
    • Provide Guidance and Capture Best Practices
    • Provide Subject Matter Experts to Support Regions During ESPC Development
    • Provides Quality Assurance to Regional ESPC Contracting
    • Develop System to Ensure Essential EPSC Administration During Contract Performance Period

• PMO Membership Includes Portfolio, Budget, Finance, Energy Team, Contracting, and Regional Representatives and Subject Matter Experts
PMO Best Practices

• PMO/Dedicated Contracting Personnel
• A Preset Agenda for Weekly Meetings
• Provided More Information at the PA Kick Off
• Provide the Utility Escalators at PA Kick Off
• Reasonable Number of Task Orders to Match Resources
• Schedule a Baseline and M&V Meeting Outside of Regular Meetings
• Keep a Cohesive Comment Form Throughout All Reviews.
• Independent Cost Estimator
• Centralized Contracting Reviews Equate to Quicker Reviews
• Adding Appropriated Funds, if Possible, into the Planning Process
• M&V – If a Larger Retrofit, Utilize 3-year Option C M&V
Rock Island Arsenal ESPC

- Collaboration between major mission tenant and the host installation
- Maintained engagement through multiple phases
- Enhanced mission by modernizing WWII era industrial processes
- Solved emissions issues by decentralizing coal-fired heating plant
Project Facts

- **ESCO**: Honeywell
- **Managing Command**: Installation Management Command (IMCOM)
- **Mission Command**: Army Materiel Command
- **# Task Orders**: 3 T.O.s plus 3 modifications
- **Project Duration**: phases executed over 2 years
- **Investment Value**: $86.2M
- **Projected Energy Reduction**: 46%
- **Projected Savings**: $6.2M per year
- **Contract Term**: 16-17 years
Main ECMs

- **Facilities Improvements:** HVAC, Water and Sewer conservation
- **Industrial Modernization:** Industrial process improvements to Finishing Line & Painting Line, Compressed Air Optimization
- **Central Plant:** Decentralization of Coal-Fired Central Plant and conversion to decentralized Natural Gas

FY15 ESPC – New Boilers, Rock Island Arsenal, IL
Keys to Success

• Multiple stakeholders collaborated to enhance mission readiness.
• Solved problems other than energy issues that were critical to the success of the mission.
• Not only phased, but Task Orders grouped by area of focus: facility, process, central plant
DOE’s Keys to success

• Multifunctional Team hold weekly meetings
• Adopt a “get it done” Attitude
• Empower a project champion
• Accountability
• Buy in from the M&O
• Solid communication plan
• Well vetted scope
Best Practice #3. Use a Holistic Design Processes

1. Master integrative design
2. Whole building energy modeling
Integrative Design Process

Optimize the WHOLE, not the parts
1. Better buildings, lower energy costs

2. Downsizing or eliminating mechanical and other systems - and therefore avoiding capital costs
   - Central plant expansion, nat gas, lighting, chillers, perimeter heating

3. Reclaim square footage or roof space due to reduced mechanical space

4. Allowing for more cost-effective measures to “finance” longer payback measures
New Carrollton Federal Building

Building Characteristics:
- **Location:** Near Washington, DC
- **Floor Area:** 1.2 million ft²
- **Original Construction:** 1994
- **Tenant:** IRS
- **Baseline EUI:** 121 kBtu/ft²

Project Details:
- **ESCO:** Ameresco
- **Managing Agency:** GSA
- **Project Duration:** 38 months
- **Investment Value:** $40M
- **Projected Energy Reduction:** 60%
- **Projected Savings:** $2.5M per year
- **Contract Term:** 22 years
Keys to Success

• Integrative Design and Focus on End-Use
• Project Champions
  • National GSA office
  • Building Facility Manager
  • Project facilitator
• ECMs Saved with Design
  Compromises
  • PV array and rain gardens
  • Window films and roof replacement
• Well-Structured Communication Plan
• NDER Program
  • Standardization of processes
  • Streamlining of legal and logistical hurdles
  • Potential for improvements in commissioning of integrative design
Adelphi Research Lab

- ECMs for demand reduction linked with generation projects that can cover half of load.
- Multiple phases executed in 3 Task Orders achieved 48% energy savings.

FY14 ESPC, Adelphi, MD 2.1 MW PV
Key Measures

1,729 kW Solar PV Carports

331 kW Solar PV Rooftop

All PV includes revenue grade metering and monitoring

Rain Water Harvesting

For Cooling Tower Make-Up

5 New High Efficiency Rooftop Units

New High Efficiency Dry-Type Transformers

Multiple low-efficient transformers consolidated into new right-sized efficient transformers

DDC Automation

New Controllers

Integration to Garrison’s controls front-end with Sequence Optimization

New Valves

Occupancy Sensors for Room Lighting & HVAC

Base-wide Application

Data Center HVAC Upgrades

Five computer server rooms

Combined Heat & Power

2.2 MW at Central Plant

1,729 kW Solar PV Carports

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2.2 MW at Central Plant
Lessons Learned

• Look for systems integration
• O&M issues reveal energy-saving opportunities
  - 84% of equipment past expected service life
• Team: Management, Contracting, O&M, ESCO, Higher Headquarters, Customer, and Installation Sub-Contractor
Maximizing Infrastructure Improvements Through Deep Retrofits

• Performance based contracts transform current energy use into infrastructure improvements by monetizing energy savings

• The value of these energy savings is maximized when
  – They are augmented with energy-related savings (i.e., maintenance savings)
  – They are derived from projects with longer simple paybacks, as through deep energy retrofits

• Deeper energy savings enable deeper improvements in infrastructure
• Goal to award $125 million in new ESPC, UESC, PPA, etc. annually beginning in 2018
• NREL expertise available to sites to jump start the project development process
• Coordination of DOE/NNSA program offices to streamline project award/implementation process
• Series of three DOE-wide design charrettes to ensure DOE/NNSA program offices, individual sites, contracting staff, ESCOs and utilities are trained in the integrative design process necessary to achieve deep retrofits and maximize infrastructure improvements
4. Incorporate Ongoing Involvement

1. Select ‘Ripe’ projects
2. Multiple Modifications to a task order
3. More involved and continuous M&V
4. Include BAS installation or upgrades
5. Incorporate an occupant engagement program
• Identifying projects with potential for a deep retrofit

• Deep Retrofit technical triggers:
  1. Older HVAC equipment at the end of its useful life or failing, poorly designed or implemented building systems.
  2. Poor Occupant Satisfaction Thermal Comfort Ratings.
  3. Old or failing major building envelope components.
  4. Older/inefficient lighting systems.
  5. Occupant turnover or change of use
Utilize Existing Building Data

- gBUILD, FMIS, REXUS, and EUAS
- ARRA Project Overview
- Building Expenses, Mechanical Expenses/GSF
- Energy Consumption, EUI % difference
- OCS comfort rating
Narrow the list of buildings to a more manageable number

Methods to further investigate options:
1. Projects can either be disqualified due to recent major HVAC, envelope, controls upgrades or prioritized due to no recent work in this area.
2. If a building has potential performance issue and the lease is about to end, this impending change of use is a big potential for accessing the space and adding work to existing retrofit plans.
3. Integrate OCS data for all buildings. By adding this data, an analysis of low overall occupant satisfaction ratings by building could suggest a need to use a DER to address this problem.

The Project Selection Workbook search tool will help automate and expand the search process to make the process more manageable and data driven.
Fort Knox UESC and ESPC

- Long term strategic plan with multiple phases.
- Load reduction paired with onsite generation provides energy security for mission readiness.
- EMCS/Building Operations Control Center (BOCC) for majority of installation.
- Building Energy Monitor Program
Project Facts

• Just under $300M investment value over 100 UESC task orders and an ESPC awarded over a 20 year period.

• Achieved 57% savings with another 8% reduction currently in construction for 65% reduction overall.

• Large District Ground Source Heat Pump Loop

• Combined UESC, ESPC, and Utilities Privatization efforts enable installation to completely island from the grid.
In conclusion...

- The keys to successful deep ESPC projects are **communication**, deliberate **goal setting**, and **integrative design**

- Deep ESPCs are a **responsible investment** of taxpayer money

- Investing in efficiency today increases **resiliency**, improves **health and productivity** and supports goals like **net-zero energy**
Thoughts?

With your neighbor, discuss:

1. What resonated?
2. What do you still have questions on?
3. What are you doing currently?
4. What else could you do to get to deeper savings?

Questions for our panel? Comments to share?
**Additional Resources**

- **Deep Retrofit Value Guide:** [https://rmi.org/insights/reports/calculate-present-deep-retrofit-value-investors/?preview=true](https://rmi.org/insights/reports/calculate-present-deep-retrofit-value-investors/?preview=true)
- **Integrative Design Principles:** [https://www.rmi.org/our-work/areas-of-innovation/office-chief-scientist/10xe-factor-ten-engineering/](https://www.rmi.org/our-work/areas-of-innovation/office-chief-scientist/10xe-factor-ten-engineering/)
Thank you!

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