



Energy Master Planning for Resilient Communities

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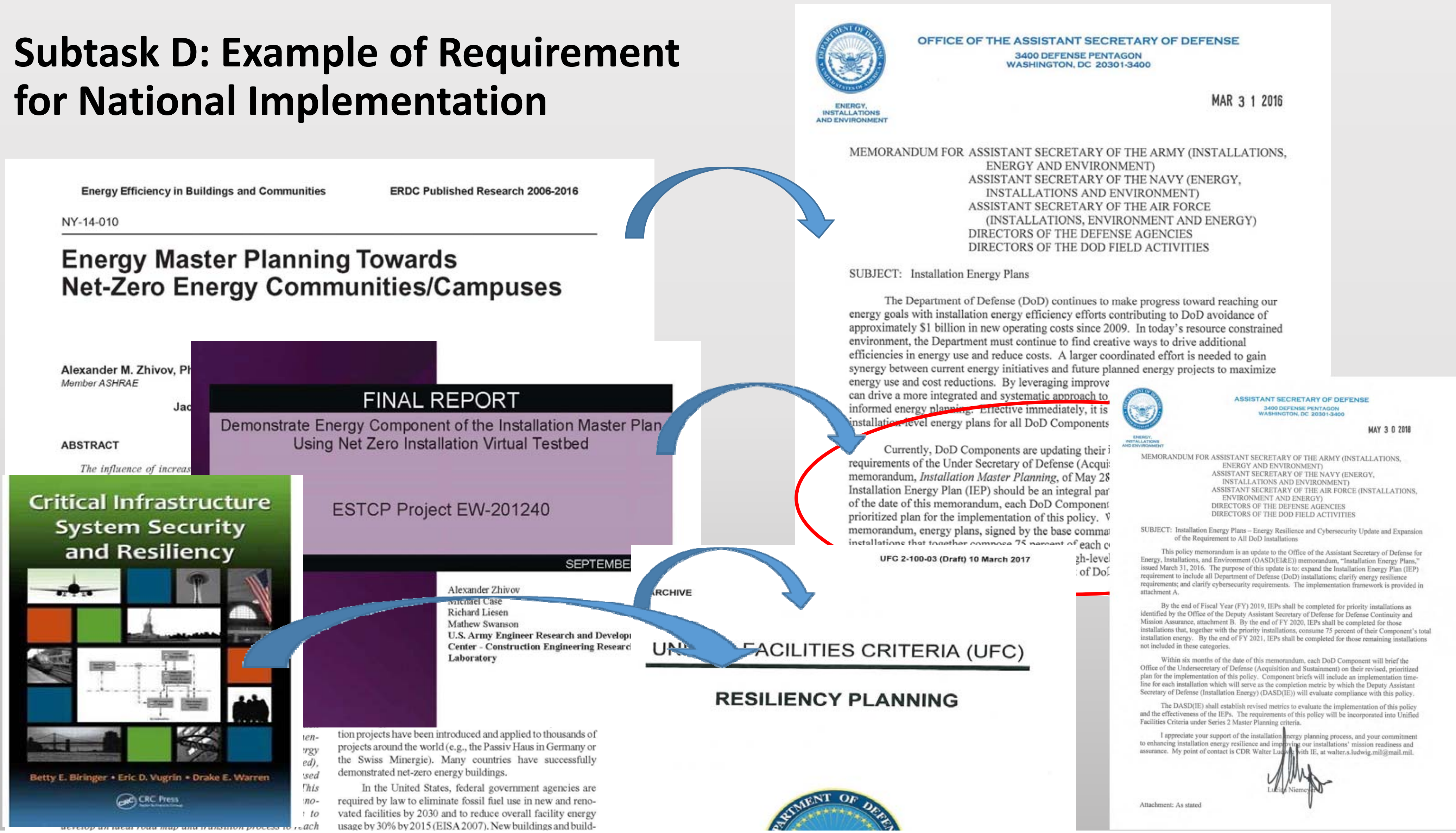
Outline

- Background
- Ongoing projects
- Some case studies

Why energy master planning and resiliency planning shall be an important part of the area development plan?

- Until recently, most planners of public communities (military garrisons, universities, etc.) addressed **energy systems for new facilities on an individual facility basis** without consideration of energy sources, renewables, storage, or future energy generation needs;
- Building retrofits of public buildings typically do not address **energy needs beyond the minimum code** requirements and are usually **not a part of the area development effort**;
- Energy demand reduction using **energy performance contracting models** typically address mechanical and lighting systems and their controls; and energy savings from these projects typically **range between 20% and 40% from the pre-renovation baseline**.
- The **frequency and duration of regional power outages** from weather, manmade events, and aging infrastructure **have increased**;
- Major **disruptions of electric and thermal energy degrade critical mission capabilities** and cause **significant economic impacts**;
- Significant additional **energy savings and increased energy security** can be realized by considering **holistic solutions for the heating, cooling and electrical energy needs** of the buildings;
- This includes consideration of **advanced energy supply, distribution, and storage systems** for district heating, cooling and CHP for the standalone campus or as an integrated part of a nearby city. .

Subtask D: Example of Requirement for National Implementation



ERDC Research Related to Energy and Resiliency Planning for Communities

"Technologies Integration to Achieve Resilient, Low-Energy Military Installations", sponsored by ESTCP

"Analysis of energy requirements and technical, resilience and economical evaluation of energy supply solutions to mission critical facilities," sponsored by OASA (IE&E)

"Towards Net Zero Energy Resilient Public Communities," IEA EBC Program Annex 73

IEA EBC Annex 73 Scope

Decision-making process and a computer based modeling tools for achieving low energy resilient publicly owned communities (military garrisons, universities, public housing, etc.)

Objectives

- Develop Energy Targets: definitions, matrix, monetary values
- Develop a Data-Base of Power and Thermal Energy Generation, Distribution and Storage Technologies and Energy Systems Architectures
- Develop Guidance for Energy Master Planning
- Integrate the targets, constraints, monetized values, enhanced technologies database and resiliency analysis into the modeling Tool
- Collect and describe business and financial aspects and legal requirements and constraints for NZE master planning for public communities in participating countries
- Provide dissemination and training in participating countries and the end users, mainly decision makers, community planners and energy managers and other market partners in the proceedings and work of the Annex subtasks.

Participating Countries and Organizations

Country	Contracting Party	Subtask Participant
Australia	University of Melbourne MOD	A,B,C, D. E, F
Austria	AEE INTEC B.I.G. (Bundesimmobiliengesellschaft)	B, C, E
Finland	VTT MOD	A, B, C, D
Denmark	Aalborg Technical University, Ramboll	A, B
	Danish MOD	A, B
	Danfos	C
Germany	KEA/Steinbeis Transfer Centre	A,B
	GEF Engineering,	C, E
	Stuttgart University of Applied Sciences,	B, C,
	Enisyst,	
	German Armed Forces Estate and Infrastructure Agency	A,B
	German ESCO association	F
	BPIE	
	Susi Funds, Solas Capital Funds	F

Country	Contracting Party	Subtask Participant
Norway	Norwegian Defense Estate Agency SINTEF	A, B, D, F
U.K.	UK MOD	A, B
U.S.A.	US. Army Engineer Research and Development Center	A, B, C, D, E, F
	USACE HQ/MP	D
	GSA	B
	Oak Ridge National Laboratory	
	Sandia National Laboratories	C, D
	National Renewable Energy Laboratory	A, B
	U.S. DOE BTO	A,B
	International District Energy Association	B, C
	Carnegie Mellon University	A, B, C
	Big Ladder Software Company	A,C
	Schneider Electric	B, C
	AECOM	A, D

Expected Deliverables

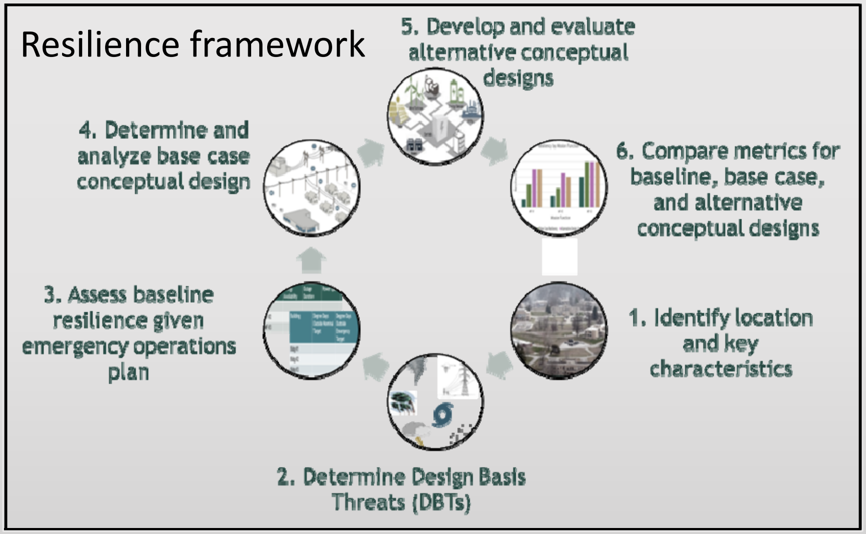
- A “Guide for Energy Master Planning in public building communities”
- Enhancements for Energy Master Planning Tools
- A Book of Case Studies and Pilot Projects (Examples of Energy Master Plans)

Subtask A. Establishing Energy Related Framing Goals

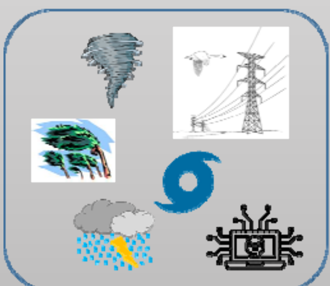
- Definition of specific decision making criteria, e.g.,
  - Site or end energy
  - Source or primary energy
  - Energy Efficiency
  - Energy Security
  - Energy Independence
  - Energy Resilience
  - Reliability of Energy Systems
- Definition of other non- energetic targets (environmental requirements for occupied and non-occupied/hibernating buildings)
- Decision making Matrix
- Monetary value of the energy and other targets

Energy Resilience

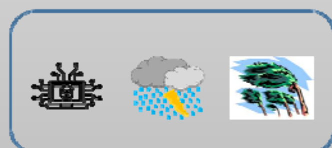
Resilience is defined by Ability to Prepare for, Withstand and Recover from disruptions caused by major Accidents, Attacks, or Natural Disasters.



Down-select threats to a list that is specific to location

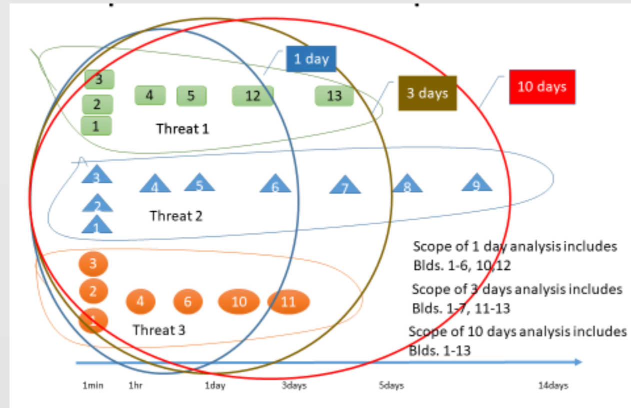


Master Threat List



Local Threat List

Define Mission Critical and Safety and Health related buildings/ operations for predominant threats over prescribed timeline



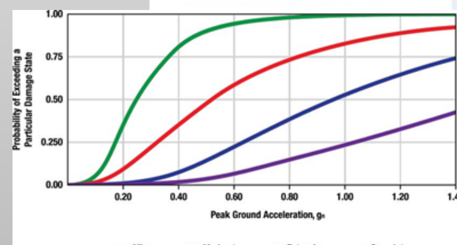
Resiliency Metrix for Mission Functions

Mission Function	Required Energy Availability	Max Allowable Outage Duration	Min Allowable Power Quality
MF #1			
MF #2			
MF #3			

Mission Resilience Matrix

Service Type	Max Allowable Person Hours w/o Service	Max Allowable Burden to Acquire Acceptable Level of Service
Service #1		
Service #2		
Service #3		

Community Resilience Matrix

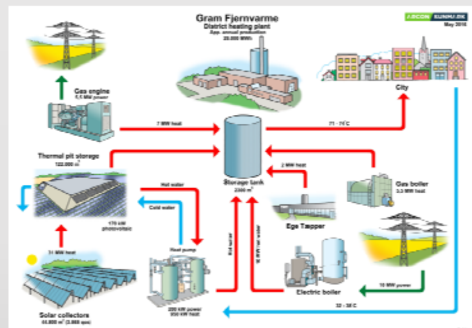


Fragility curves for different threats

Annex 73 Case Studies

25 Case studies of energy master plans for military installations, University campuses, Medical centers and public housing from USA (7), Austria (3), Australia (3) , Denmark (7), Finland (7), Germany (4)

University of Texas, Austin



Town of Gram, Denmark

“Ford Plant” area development
Minneapolis, MN

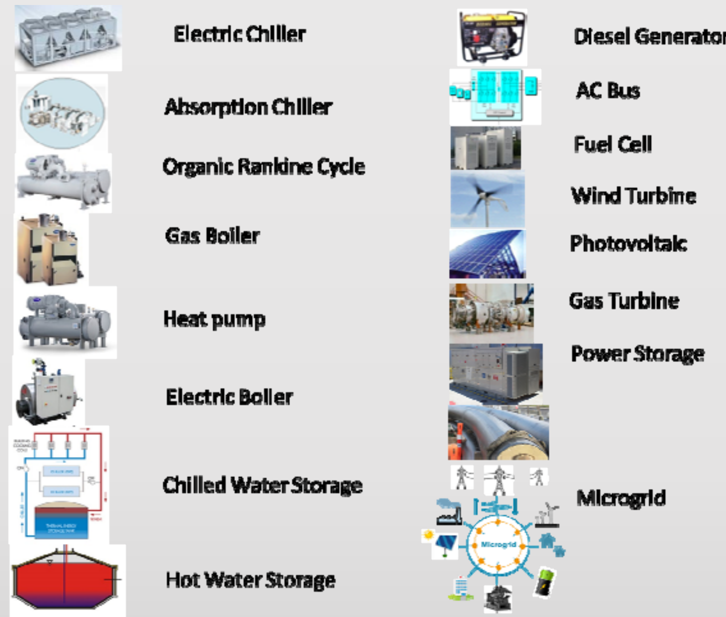
he Univ. of British Columbia, Canada

Volkswohnung KA Karlsruhe, Germany

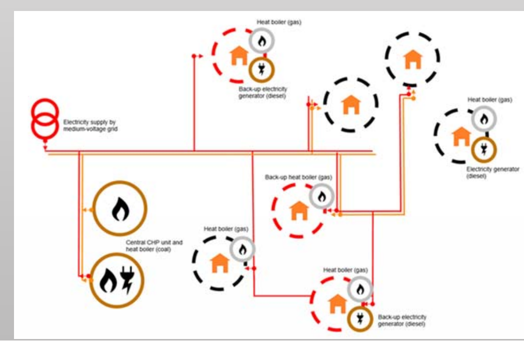
Nymindegab military campus, Denmark

Subtask C: Technology Database and Energy Systems Architecture

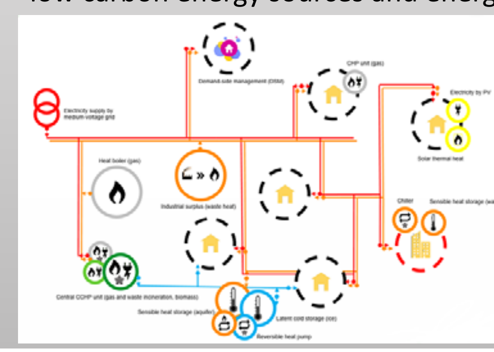
- Different energy supply technologies will be described by categories, and will include their technical and price data.
- Energy Supply Systems alternatives/architectures will be developed and presented by their application and appropriate climates



Baser Case: back-up generators and redundant boilers for electricity and heat supply



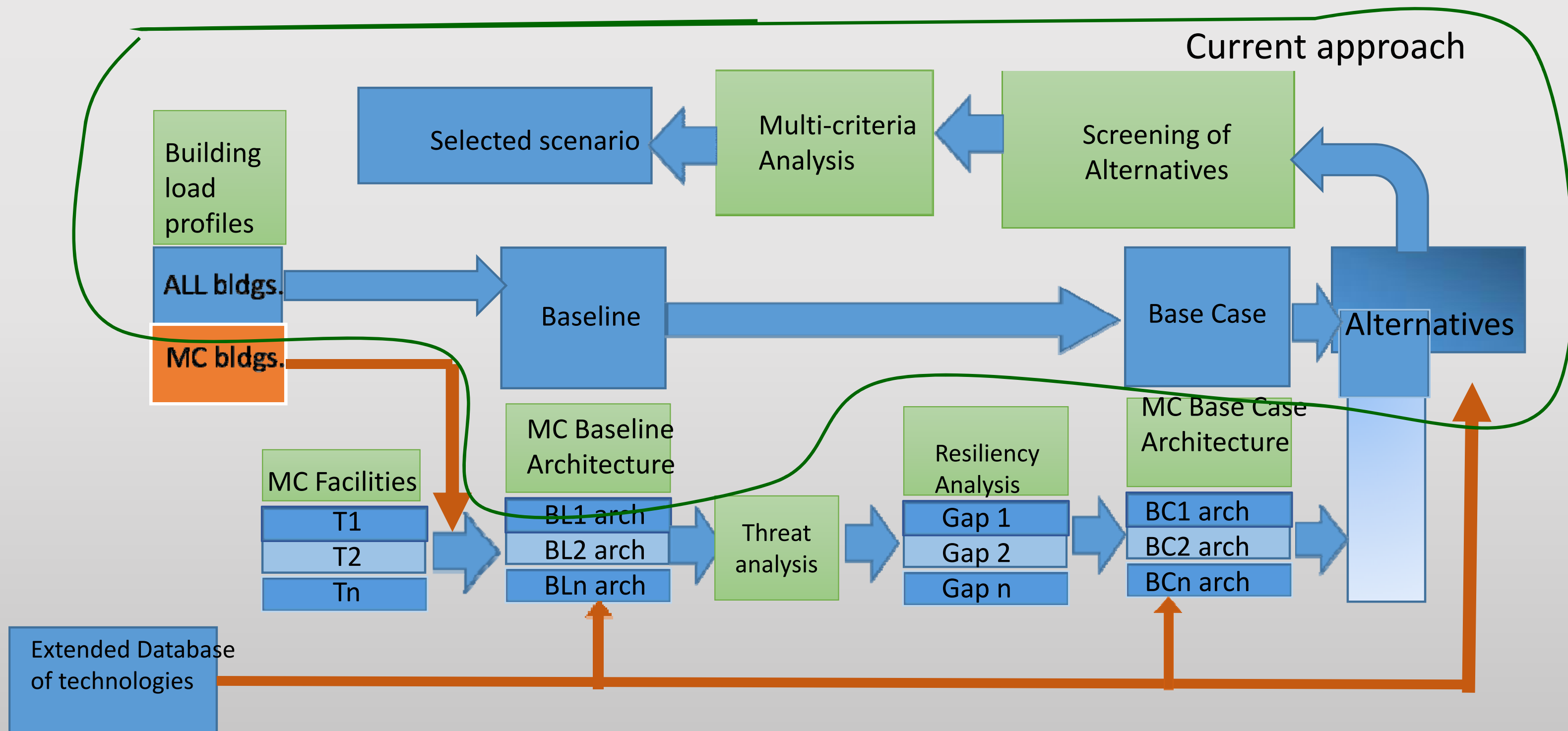
Alternative with advanced technologies for redundant heat and/or electricity supply, low carbon energy sources and energy storage



Subtask D: Develop Guidance for Net Zero Energy Master Planning

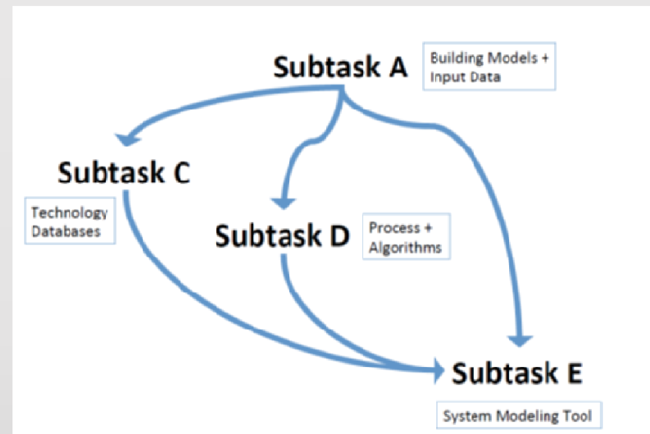
- The Guide will be targeted for decision makers, energy planners, and financiers.
- Started collecting existing energy master planning requirements and guidelines

Proposed Workflow for Integration of Resiliency Analysis into IEWP

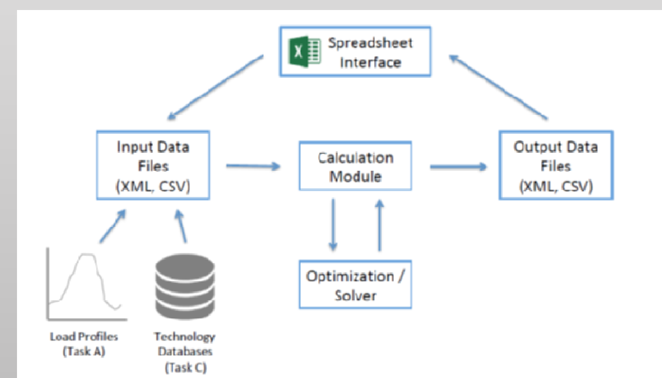


Subtask E: modeling tool to facilitate the Net Zero Energy Resilient Communities Master Planning Process.

- Review of existing modeling tools used for energy and resiliency planning, e.g., NZI-Opt / System Master Planning Tool (SMPL) developed by ERDC, Energy Resilience Analysis Tool (ERA) developed by MIT Lincoln Laboratory, Microgrid Design Toolkit (MDT)m developed by Sandia National Laboratory, energyPRO developed by EMD International.
- The tool will be a standalone module focusing on supply, distribution and storage technologies, addressing both thermal and electrical systems and providing performance and cost optimization and will integrate resiliency analysis and will integrate the result from Subtasks A, C and D.



Tool Architecture

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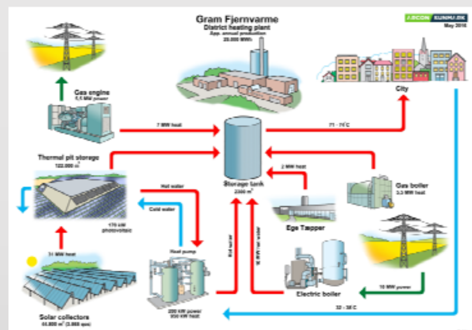

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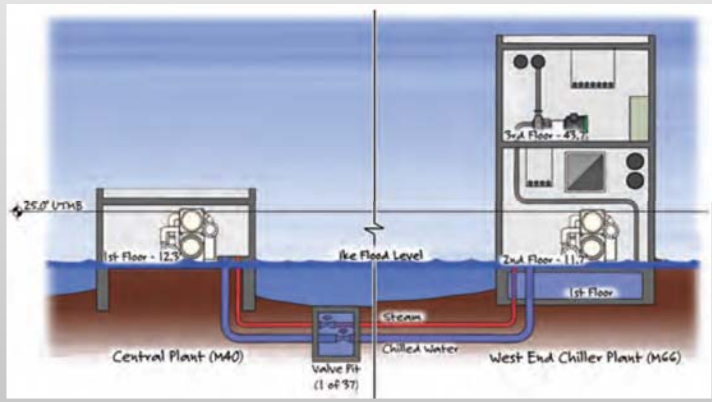
Nymindegab military campus, Denmark

The University of Texas Medical Branch at Galveston

Impact of Hurricane Ike, September 13, 2008



Cost of stabilization: $14,000,000
Unable to operate hospital: 90 Days
Lost business revenue: $2,000,000/day

Underground steam distribution system a complete loss
Lost research materials
Estimated over 1 billion dollars in damages

UTMB: A Three Step Plan

Step One: Go Away from Buried Steam Pipe

- Convert most buildings to heating with hot water.
- Distribute steam overhead to research buildings

Step Two Elevate the Boilers and Chillers

Step Two: West Plant Flood Walls

Step Three: Produce On-Site Electricity via Combined Heat & Power (CHP)

New Challenges: Hurricane Harvey (2017) vs. UTMB Galveston

- Local utility lost two electrical feeders due to a flooded transformer vault, *no problem*
  - The East Plant CHP system operated trouble free in “Island Mode”
- Heavy rainfall caused minor street flooding, *no problem*
  - For the new overhead steam and underground heating hot water distribution systems “It was just another day at the office”.
  - As a precaution, the gates in the new floodwall surrounding the older West Plant were secured.

For more information:
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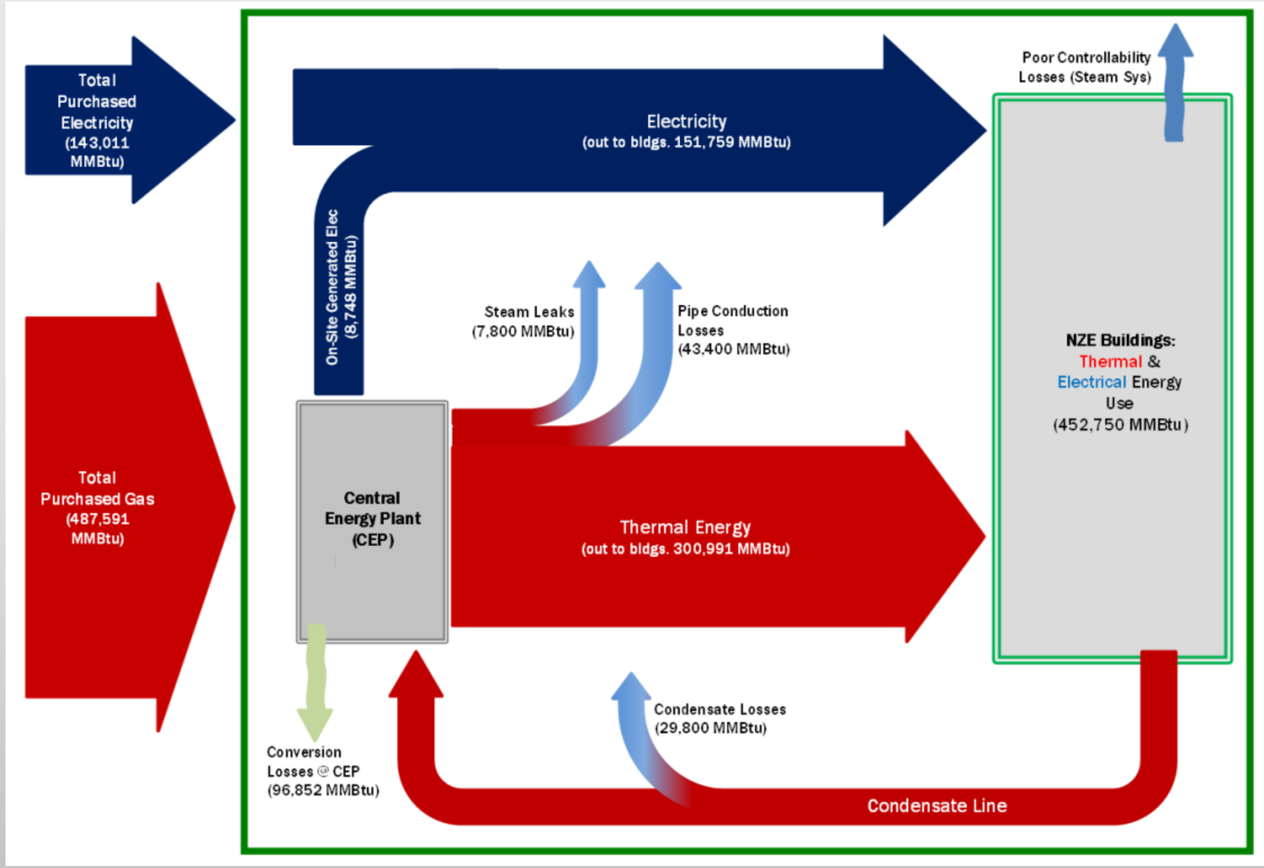
DOD Installation Baseline Energy Analysis

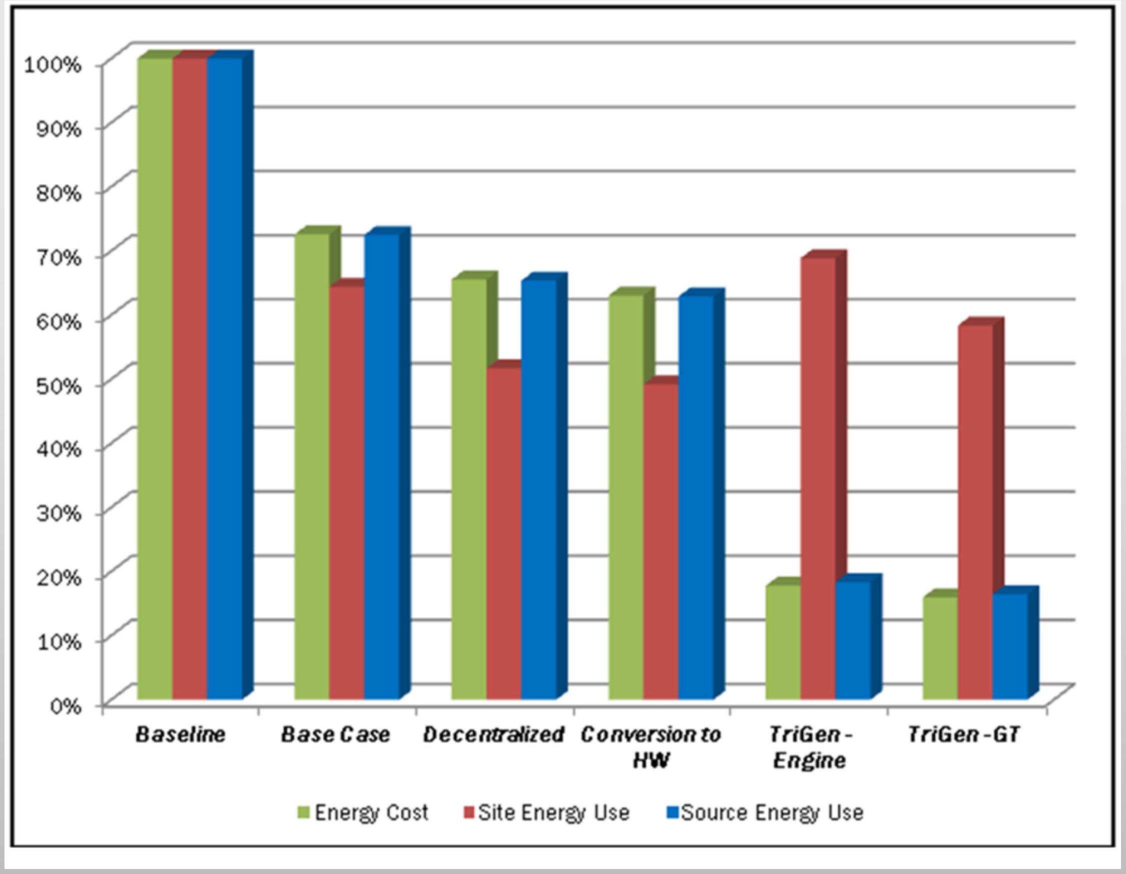
- end-uses,
- building functions,
- distribution losses on site,
- steam network losses,
- on-site electrical use,
- conversion losses on site (gas turbines, boilers and steam turbines),
- off-site conversion and distribution losses,
- purchased Natural Gas, and
- purchased electricity.



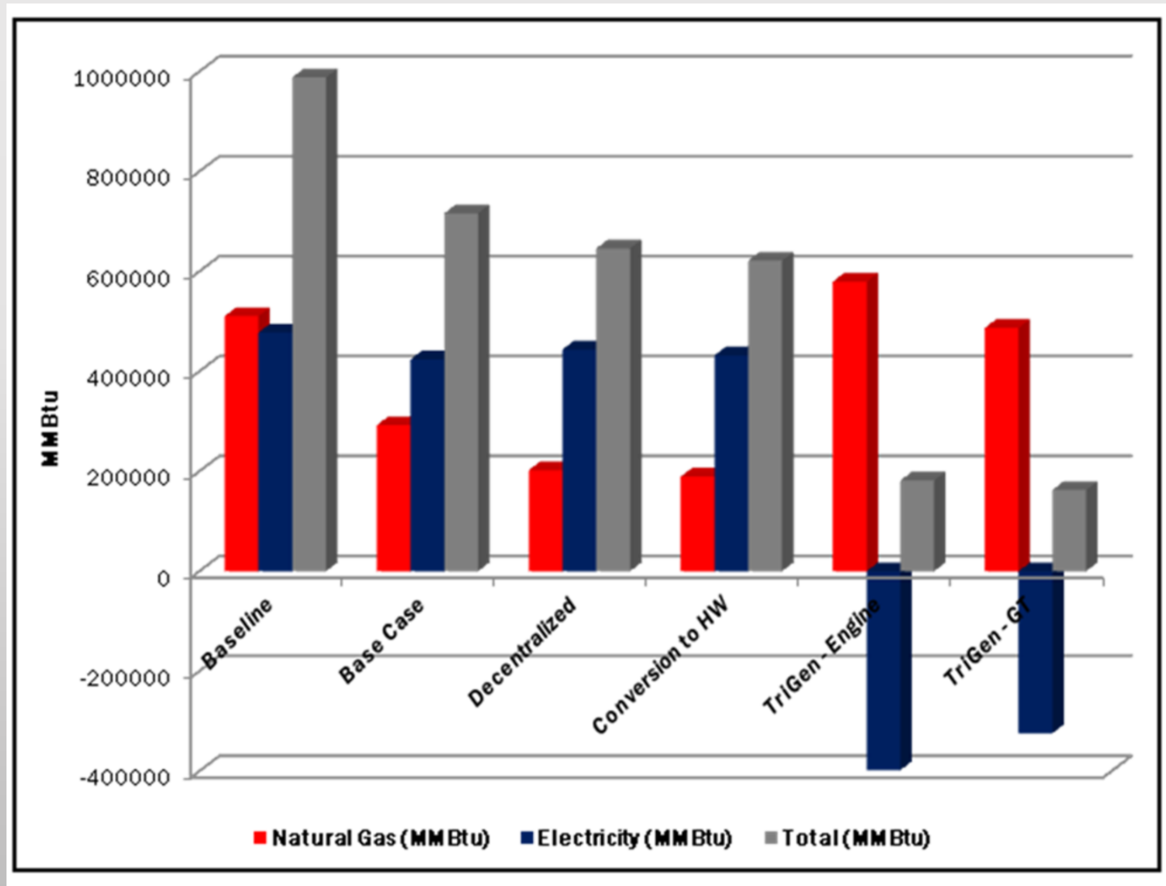
Study Alternatives

- Base Case
- Conversion of Steam systems to HW
- Decentralized
- Tri-generation using reciprocal engines
- Tri-generation using combine cycle (gas and steam turbine generators
- Tri-generation with syngas

Comparison of Alternatives to the Baseline: Site, Source, and Costs, %



Comparison of all Scenarios to the Baseline by Types of Energy Used



Comparison of All Alternatives

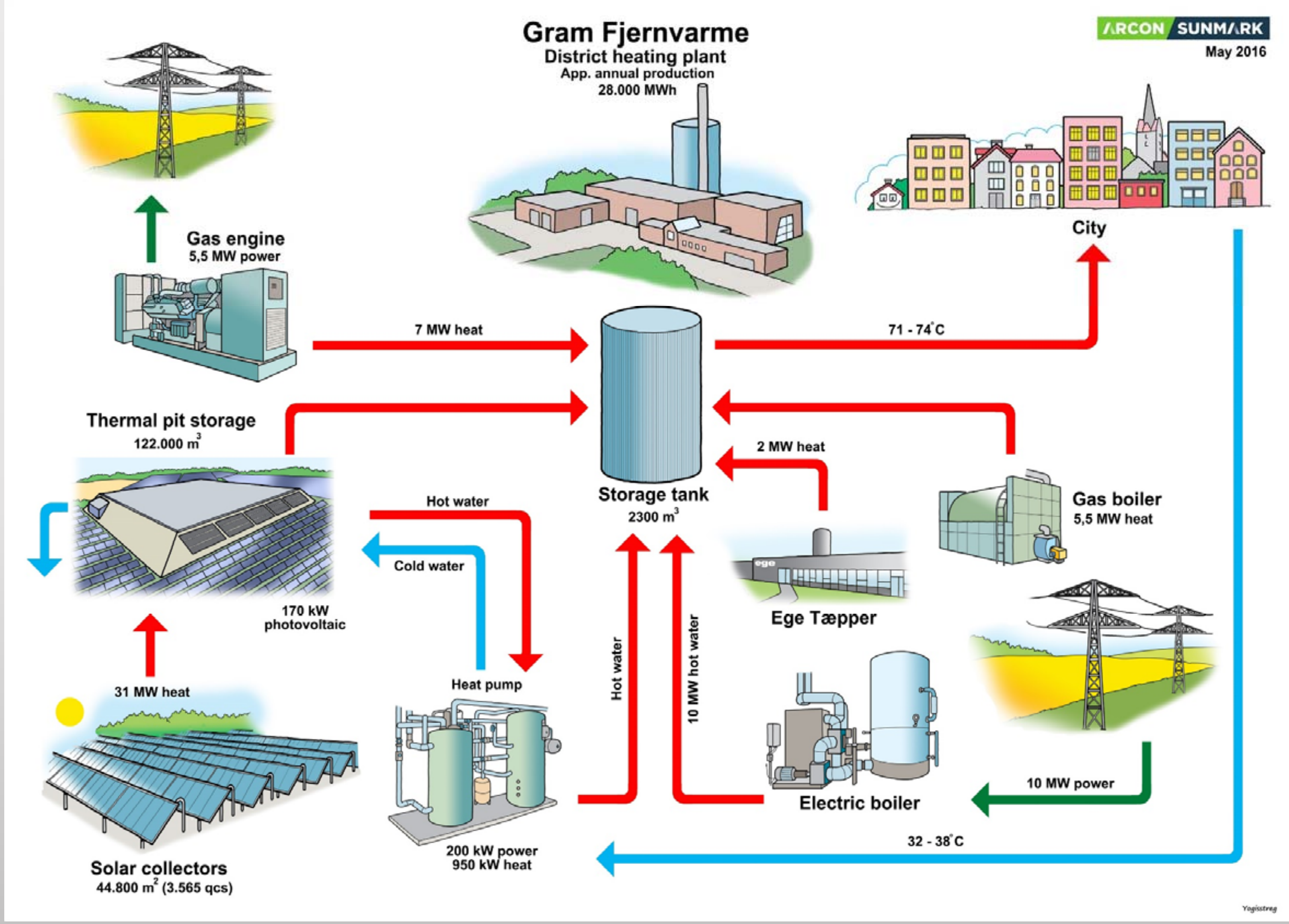
Scena-rio	Site Energy	Source Energy	Energy Cost	Maint. Costs	Capital Costs	% of Mission Critical Power Generated On-Site	Peak Power	Grid Capabi-lity to meet Peak Power, MW	LCC	SPB/DPV
	MMBtu %	**MMBtu**	**($)**	**$/yr (%)**	**($)**		**MMBtu/ hr**		**($)**	
TriGen with Engines	434,378 **(69%)**	181,457 **(18%)**	1,271,890 **(18%)**	2,198,667 **(89%)**	130,430,694 **(151%)**	100	41	18	232,125,392	**10/13**
TriGen with Turbines	367,992 **(58%)**	162,624 **(16%)**	1,142.647 **(16%)**	1,968,089 **(80%)**	158,430,694 **(183%)**	100	41	18	255,470,743	**16/20**
Baseline	630,602 **(100%)**	988,165 **(100%)**	7,151,497 **(100%)**	2,455,446 **(100%)**	-	0	47.1	18	NA	NA
Base Case	406,129 **(64%)**	716,339 **(72%)**	5,190,838 **(73%)**	1,872,823 **(76%)**	86,350,800 **(100%)**	100	57.3	18	306,942,547	NA

Conclusions

- In spite of additional loads: new construction, new requirement for building cooling, the Base Case and four alternatives significantly reduce energy use:
  - 31% to 51% site energy,
  - 27% to 84% source energy,
  - 27% to 84% energy cost
- All scenarios (excluding the Base Case) will resolve energy security issues:
  - Decentralized and Conversion-to-Hot-Water Alternatives will require purchase of additional generators
  - TriGen alternatives will reduce the total power demand for mission critical facilities from 18MW to 12MW (due to use of absorption chillers) and will provide 100% demand with on-site power generation.
- TriGen Engine scenario has the lowest life cycle cost with the simple payback of 10 years and a discounted payback of 13 years.

Town of Gram

- Established 1963
- 1170 consumers
- Annual turnover 2.400.000 €
- Annual heat sales 19.000 MWh
- Employees: 4



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Thank you for your attention!

Questions and Comments?

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