Towards Net Zero Energy Resilient Public Communities

IEA ECB Annex 73

Working Phase Experts Meeting

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Scope

Decision-making process and a computer based modeling tools for achieving net zero energy resilient publicly owned (1) communities (military garrisons, universities, public housing, etc.)

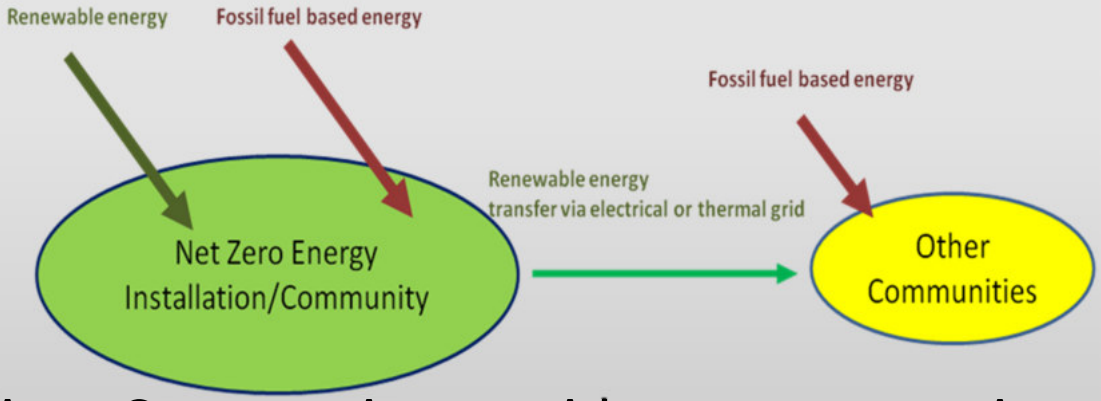
(1)- assumption: multiple ownership should not add complexity

Objectives

- Energy Targets on building and community level: definitions, matrix, monetary values
- summarize, develop and catalog representative building models by building use type, applicable to national public communities/military garrisons building stocks
- Data-Base of Power and Thermal Energy Generation, Distribution and Storage Scenarios
- Guidance for Net Zero Energy Master Planning
- Generate integrative NZP Tool to effectively model and identify optimum energy-support infrastructures that ensure sustainment of mission critical functions for neighborhoods
- Generate implementation models considering business, financial and legal aspects for NZE master planning for public communities
- 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.

Important Definitions

- “The Net Zero energy community term denotes an energy configuration in which the amount of fossil fuel-based energy used over the course of a year is equal to the amount of energy from renewable energy sources that are exported from this community to a power or thermal grid for external users’ consumption. Under this definition, net zero balance includes a combination of thermal and electrical energies presented in terms of primary (source) energy used;”



- “An Energy Resilient Community provides energy services required for mission-critical facilities (e.g., hospitals, datacenters, shelters, dining facilities, etc.) by planning for, withstanding, adapting to, and recovering from disruptions, both natural and manmade. The prioritization of energy services under limited resources is based on a multi-scenario, all-hazards view of how energy services lead to mission achievement for these facilities.

Receptors

- Decision makers, planners, building owners, architects, engineers, energy managers and mission operators of public-owned and operated communities e.g.:
  - National Armed Forces through their Infrastructure Components, military garrisons,
  - University and high school campuses,
  - Hospitals and public housing which are responsible for all costs related to new construction, renovation and O&M.
  - Neigborhoods, quartiers
- Industry, energy service companies, architects, engineers and financiers supporting public communities

Annex Structure

Subtask A	Collect and Evaluate Input Data for Energy Master Plan (EMP)
Subtask B	Collect Existing Case Studies and implement Pilot Studies
Subtask C	Describe existing and innovative technologies, architecture and calculation tools for performance analysis (including resilience) of central energy systems (power and thermal)
Subtask D	Develop Guidance for Net Zero Energy Master Planning
Subtask E	Develop a functional modeling tool to facilitate the Net Zero Energy Resilient Communities Master Planning Process
Subtask F	Business, legal and financial aspects of Net Zero Energy Master Planning.

Subtask A: Energy Targets

- 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 (comfort, functionality)
- Decision making Matrix
- Monetary value of the energy and other targets

Subtask A: Example of energy targets (EUI) based on building activities and climate

Table 1 – Energy Use Intensity (EUI) Targets for New & Existing Facilities (Post-2008)

10% reduction below pre-2008 for DFAC and UEPH (Dining & Lodging); 20% reduction for all other building types

EUIs by Building Type by Climate Zone (kBtu/ft2-yr)																		
ASHRAE 100 #	Commercial Building Type	Army Building Type	ASHRAE Climate Zone															
			1A	2A	2B	3A	3B Coast	3B Other	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
1	Admin/professional office		31	32	31	34	26	31	26	37	32	32	38	34	31	43	38	46	65
1A	Company Operations Facility	14185	28	31	29	33	22	29	23	41	32	33	47	34	35	57	48	63	76
3	Government Office		39	40	39	42	33	38	34	46	39	40	48	42	39	54	47	58	81
3A	Brigade Headquarters	14182	59	58	55	57	50	54	50	61	55	53	66	58	53	74	65	79	90
3B	Battalion Headquarters	14183	36	37	36	38	30	35	31	42	36	37	44	38	36	50	44	53	76
5	Mixed-use office		36	37	36	38	30	36	31	42	37	38	45	38	36	50	44	54	75
6	Other Office		30	31	30	32	26	30	26	35	30	31	38	32	30	42	37	45	62
7	Laboratory		142	141	137	140	118	132	127	155	138	143	167	150	145	186	169	199	265
8	Distribution / shipping center		10	13	13	16	9	14	11	22	18	18	29	24	19	39	32	48	90
9	Non-refrigerated warehouse		5	6	6	8	4	7	6	10	9	9	14	11	10	19	15	23	43
29	Other classroom education		20	20	20	20	14	19	17	23	20	21	26	22	22	30	26	32	48
30	Fast Food		235	241	237	249	213	239	228	275	252	256	299	271	266	328	300	354	447
30A	Dining Facility	72210	351	361	351	362	311	350	321	384	361	354	410	365	362	452	417	492	571
31	Restaurant/cafeteria		127	131	127	135	113	129	123	149	136	140	161	147	149	176	163	192	241
32	Other food services		69	71	69	74	62	70	68	82	75	77	88	80	82	96	89	104	131
34	Dormitory/fraternity/sorority		36	39	38	42	28	39	36	52	43	49	59	50	47	68	59	77	107
35A	Unaccompanied Enlisted Personnel Housing	72111	59	61	63	61	48	58	49	61	56	52	65	62	53	74	67	80	97
36	Hotel		45	46	43	47	42	44	43	50	47	47	51	50	48	55	53	59	68
37	Motel or inn		50	48	47	46	43	45	41	47	45	43	48	45	44	50	47	51	62
38	Other lodging		48	45	45	44	41	43	40	44	43	41	45	43	42	48	45	50	59
46	Other Service		48	48	46	47	40	45	43	52	47	48	57	50	49	62	57	67	90
46A	Tactical Equipment Maintenance Facility	21410	37	41	44	64	37	54	39	92	68	74	119	99	79	158	128	180	239
43	Repair shop		22	22	22	22	18	21	20	25	22	22	26	24	23	30	27	32	42
44	Vehicle service/repair shop		26	26	26	26	22	25	23	29	26	26	31	28	26	34	31	37	49
45	Vehicle storage/maintenance		11	11	11	11	10	10	10	13	11	11	14	12	12	15	14	16	22
50	Single family, detached		22	24	24	26	18	24	22	32	27	30	37	30	29	42	37	48	66
51	Single family, attached		26	27	27	30	20	28	26	37	31	34	42	35	34	48	42	54	77
52	Apartment, 2-4 units		38	40	40	45	30	41	38	54	46	51	62	52	49	71	62	81	112
53	Apartment, 5 or more units		26	27	27	30	20	28	26	37	31	34	42	35	34	48	42	54	77

Subtask A. Resiliency Matrix and Energy System Attributes

Mission Critical Facility Energy Requirements

- Uptime,
- % of energy delivered,
- Power/thermal energy quality requirements,
- fuel storage requirements/ minimum operation time

Energy System Attributes

- Robustness,
- Redundancy,
- Reliability,
- Responsiveness,
- Resourcefulness/efficiency

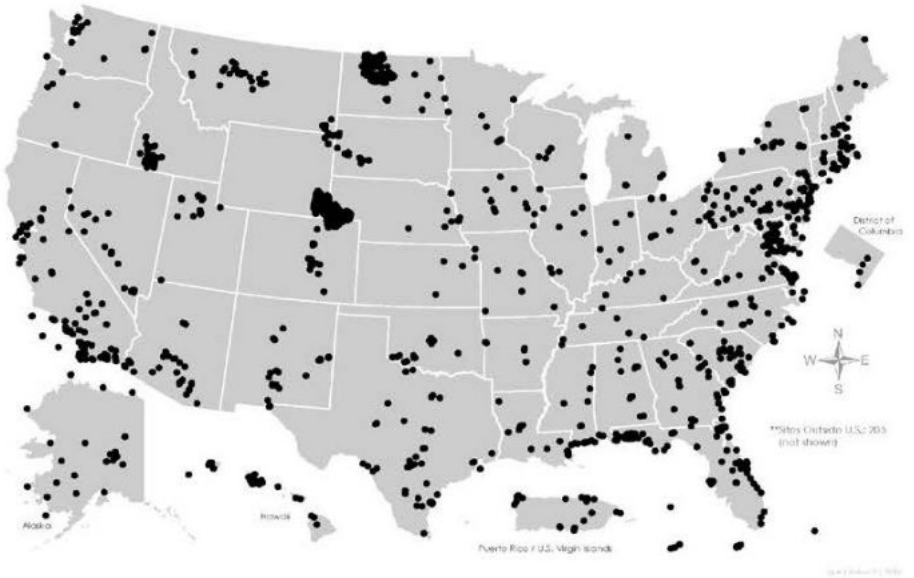
Subtask A. Types of Threats

- Abnormal Threats:
  - Fire,
  - Strong Winds,
  - Hurricane,
  - Tornado
  - Extreme Heat.
  - Seismic,
  - Flood
- Normal Threat
  - Physical Accident
- Malevolent Threat
  - Physical attack,
  - Cyber Attack

Subtask A. Maps of Areas with Predominant Threats
(Climate-Related Risk to Initial Vulnerability Assessment Survey)

Map 5 - Sites that Indicated Effects from Wildfire

Map 7 - Sites that Indicated Effects from Multiple Vulnerability Areas (Flooding, Extreme Temperatures, Wind, Drought, Wildfire)



Subtask B. Case Studies

"Ford Plant" are development, Minneapolis, MN

The University of Texas Austin

City of Gram, Denmark

City of Graz, Austria

West Point USMA, NY

Subtask C. Database of Thermal and Power Technologies

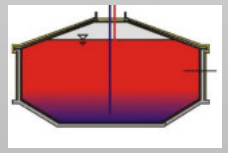
Electric Chiller

Photovoltaic

Absorption Chiller

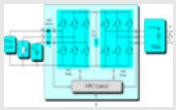
Gas Boiler

Organic Rankine Cycle



Thermal Storage

Diesel Generator



AC Bus

Fuel Cell

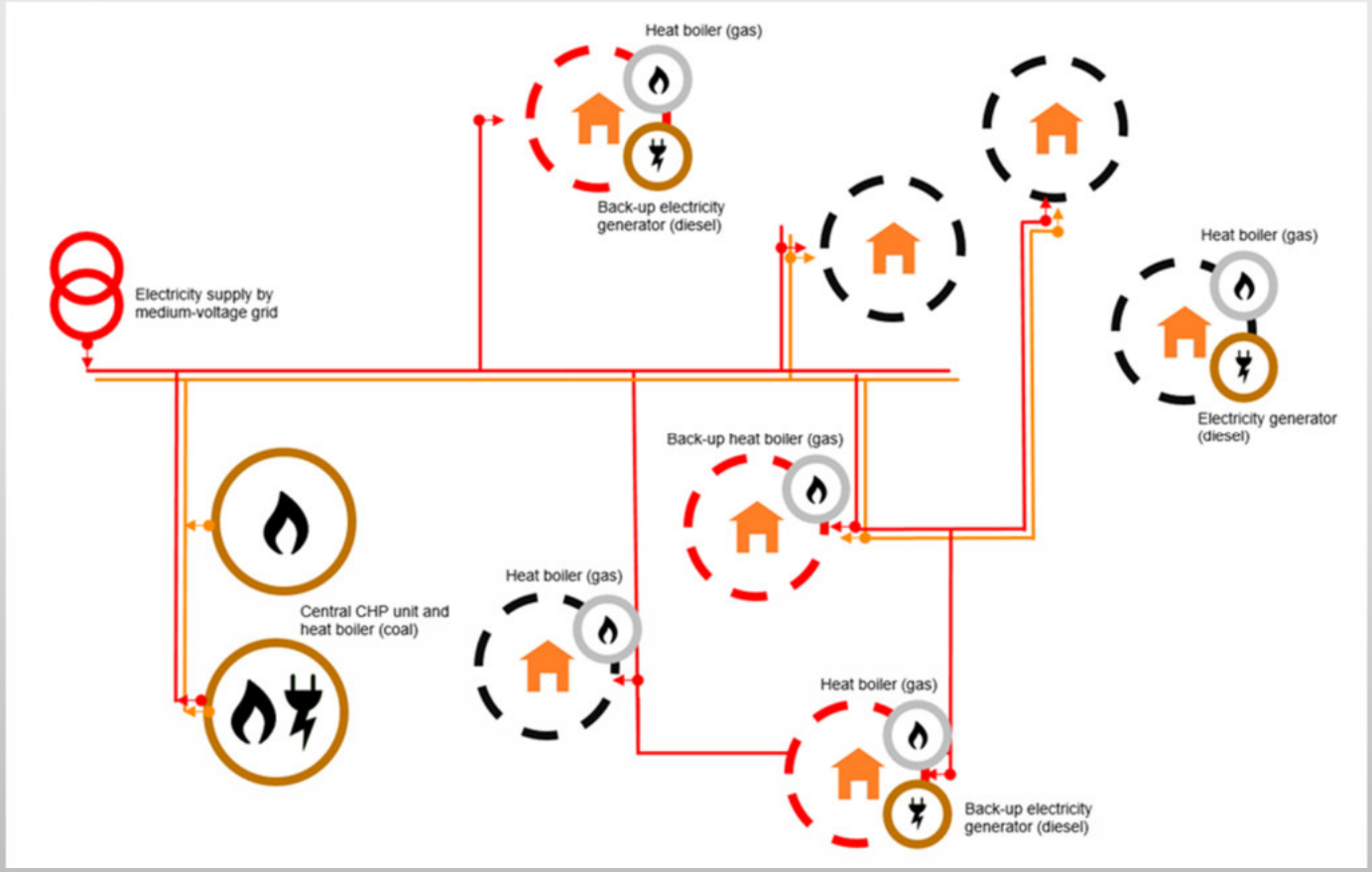
Wind Turbine

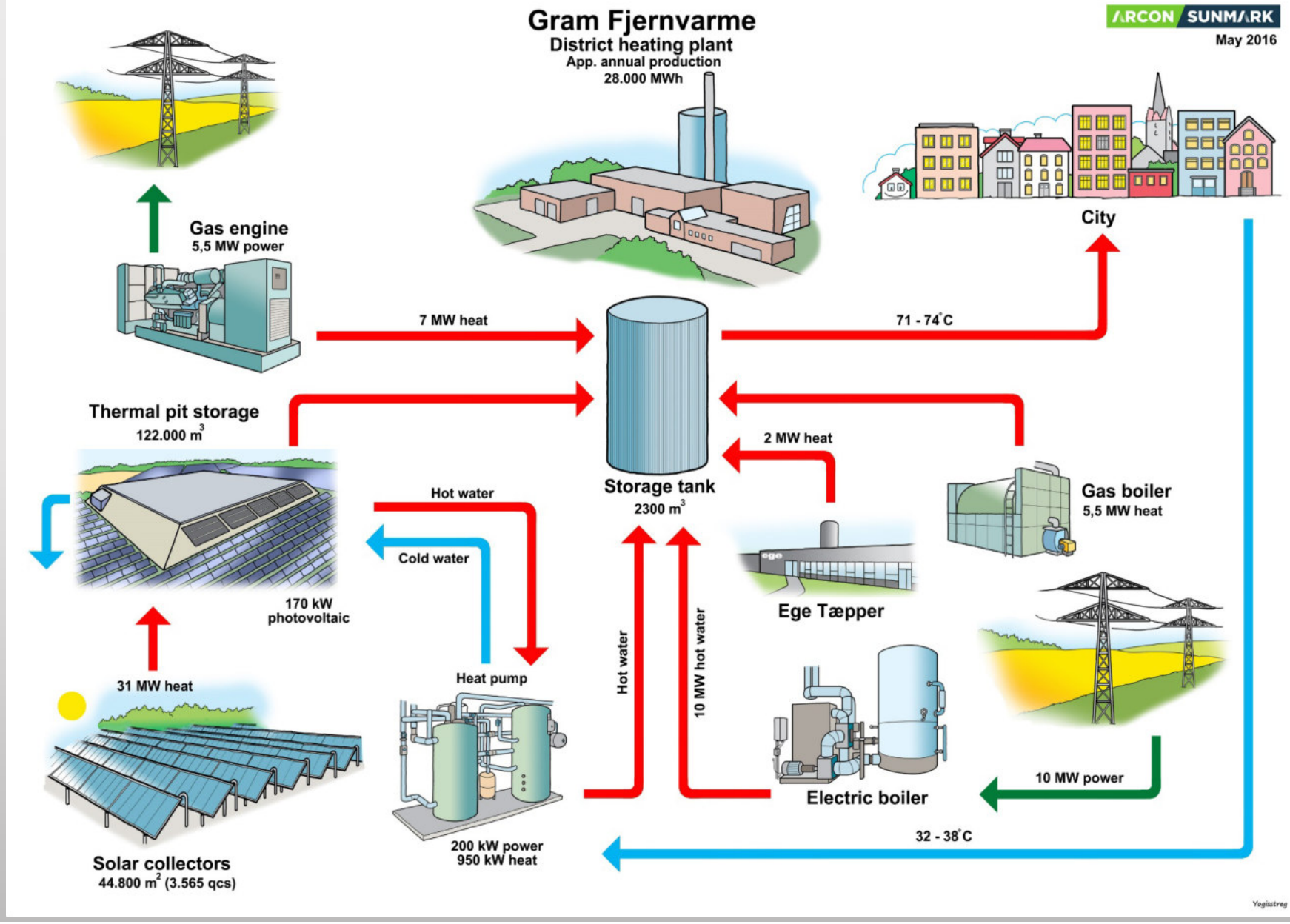
Gas Turbine

Electric Heater

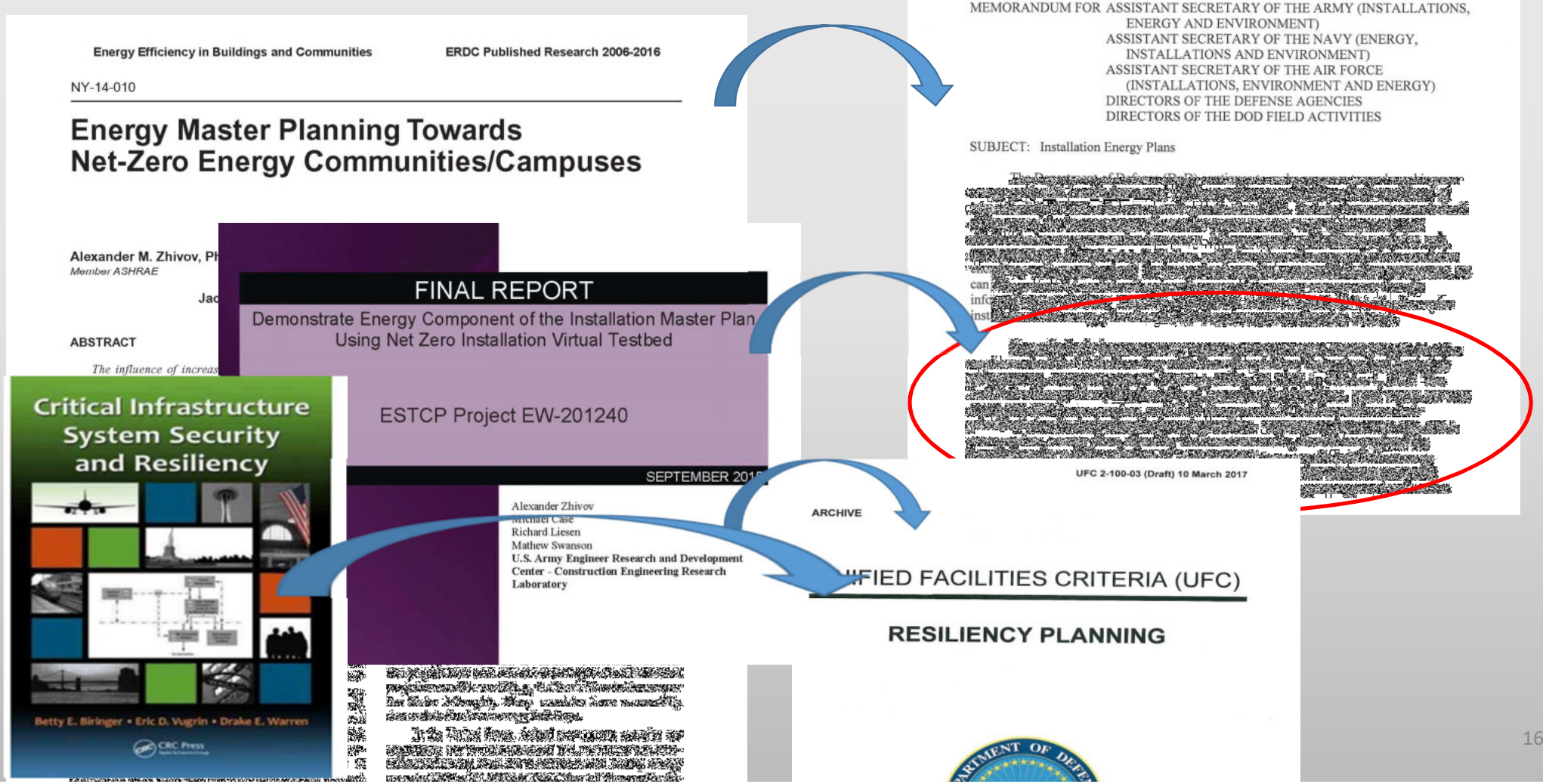
Power Storage

Subtask C. Example of energy supply system in a military garrison with mission-critical facilities including redundant heat and/or electricity supply (marked in red).

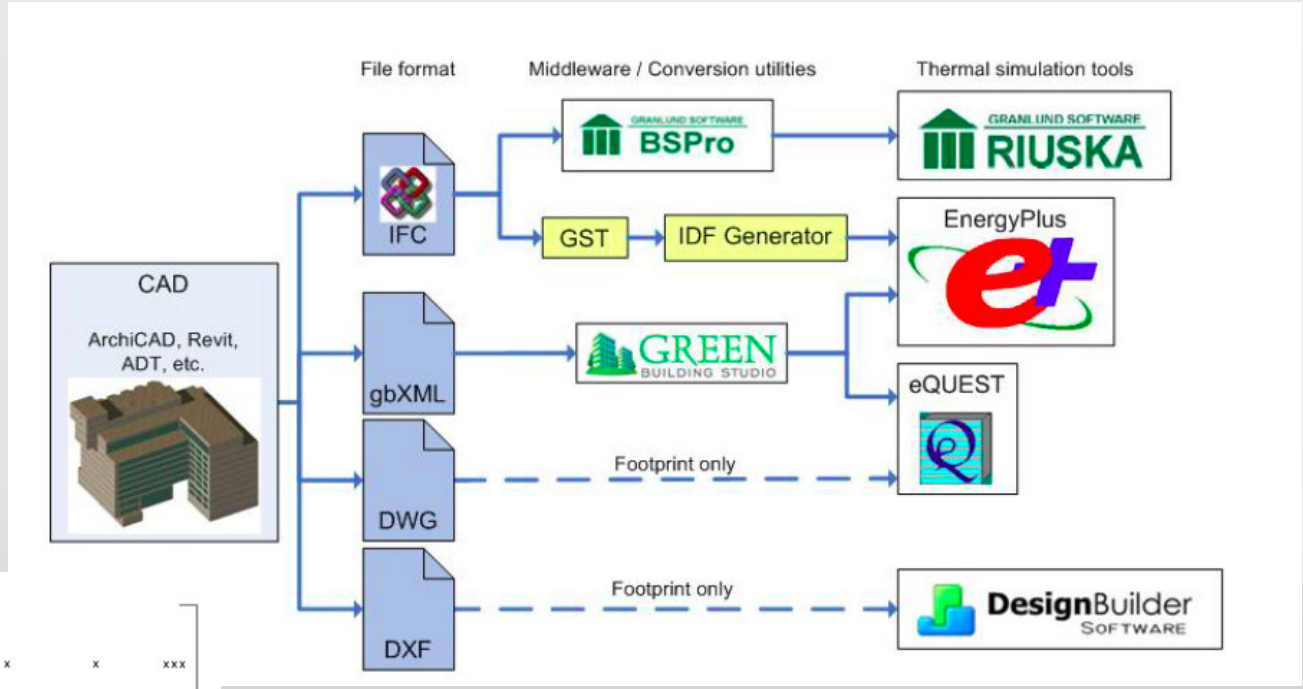



Gram Fjernvarme
District heating plant
App. annual production
28.000 MWh
ARCON SUNMARK
May 2016
City
Gas engine
5,5 MW power
7 MW heat
71 - 74°C
Thermal pit storage
122.000 m3
Storage tank
2300 m3
2 MW heat
Gas boiler
5,5 MW heat
Hot water
Cold water
170 kW
photovoltaic
Ege Tæpper
Hot water
10 MW hot water
31 MW heat
Heat pump
Electric boiler
10 MW power
200 kW power
950 kW heat
32 - 38°C
Solar collectors
44.800 m2 (3.565 qcs)
Yogisstreg

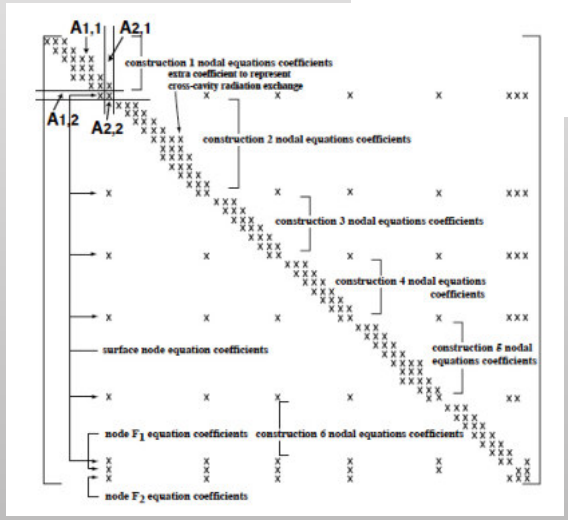
Subtask D: Example of Requirement for National Implementation



Subtask E: German Building Community Simulation Model

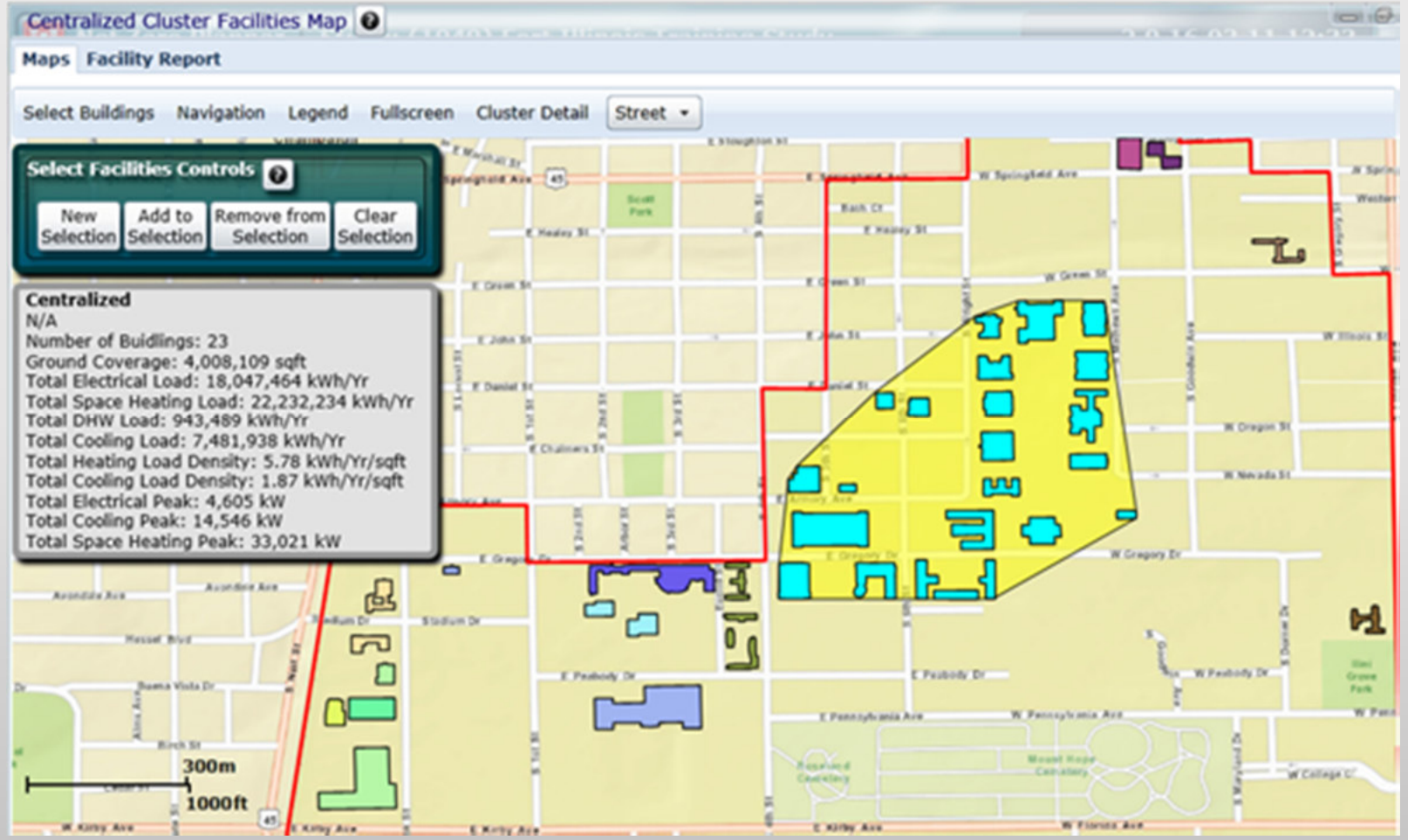


Maile, Fischer, Bazjanak, Stanford University 2007

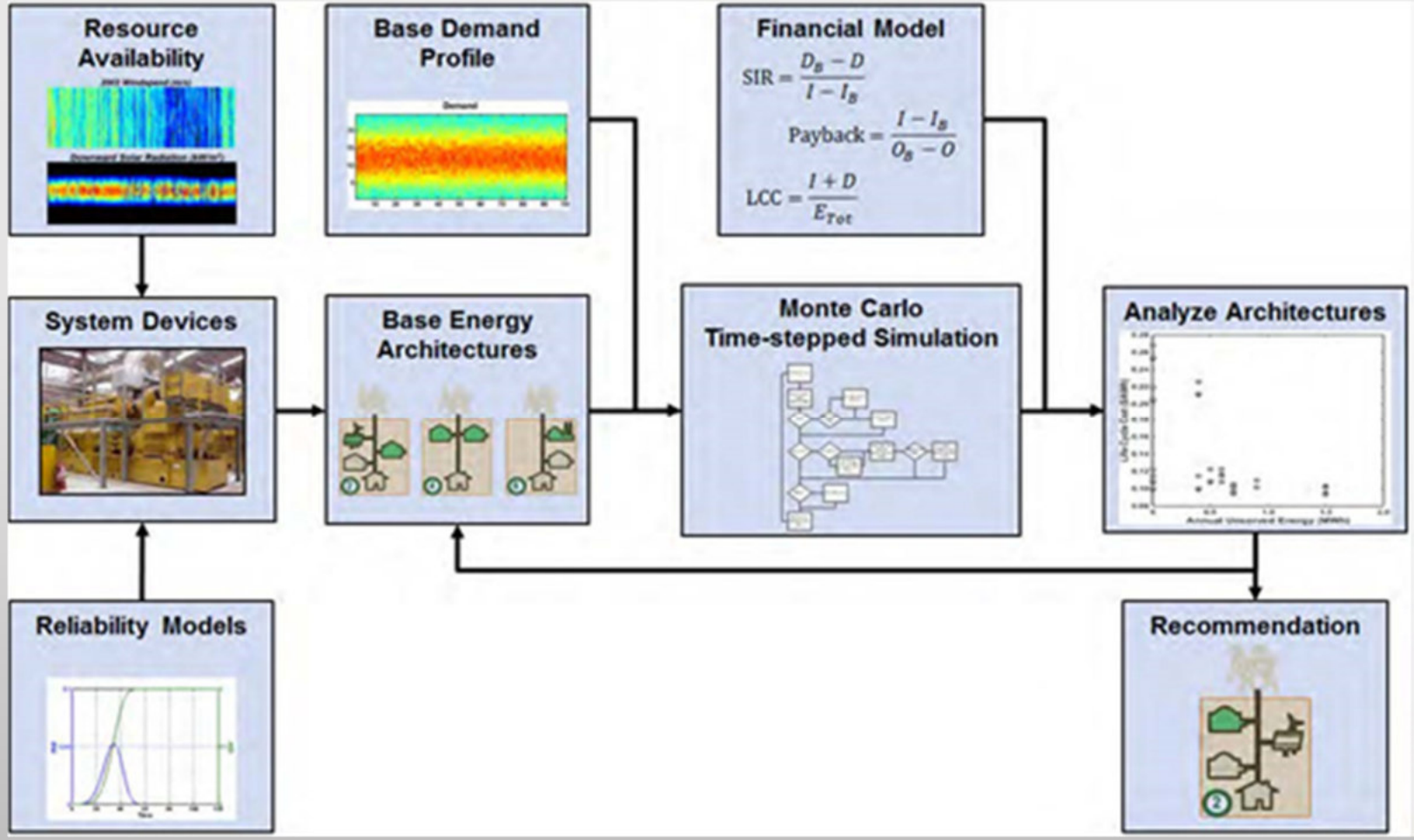


Joe Clark, Strathclyde University

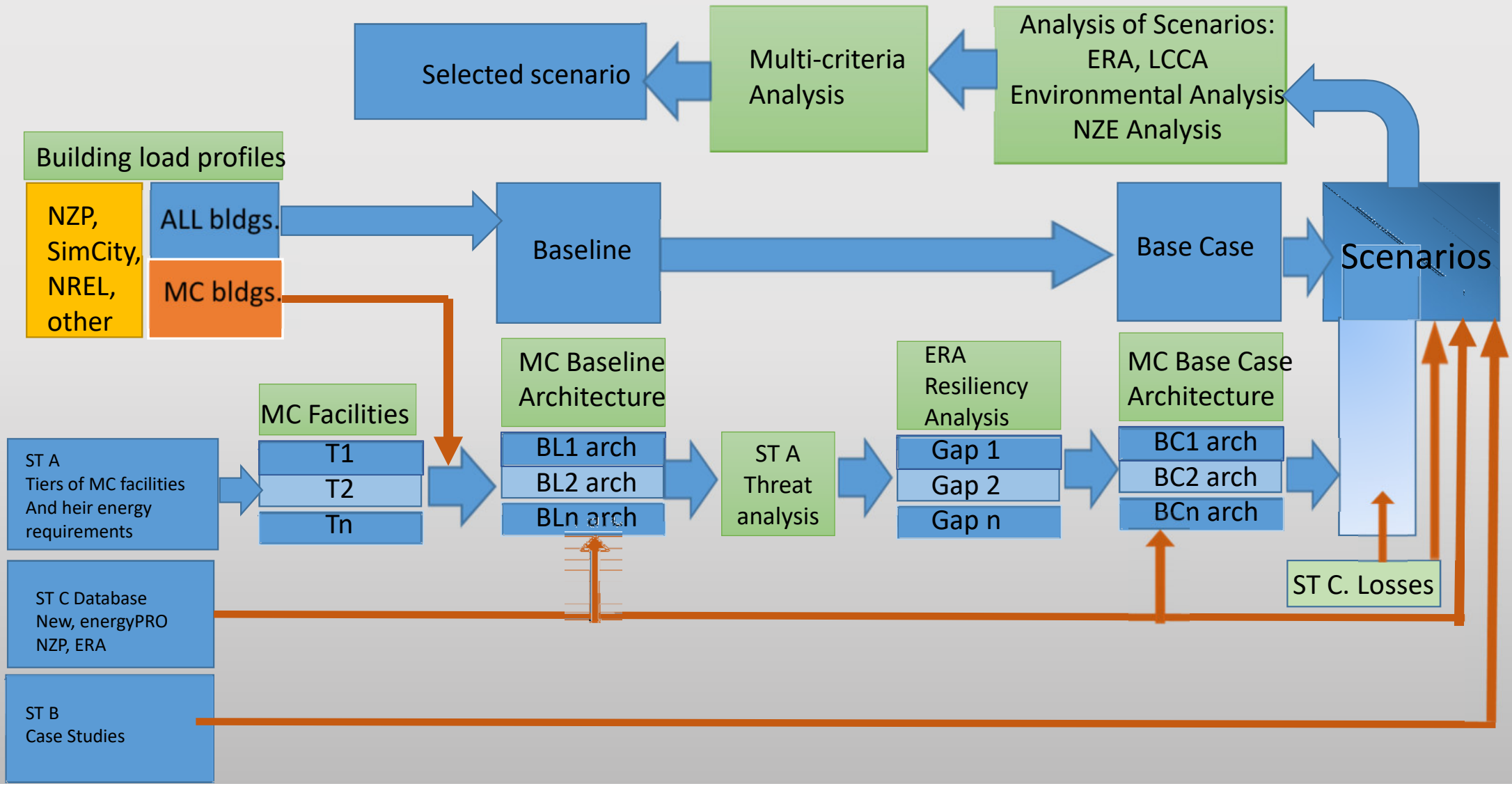
Subtask E: US Army NZP-tool: Selection of Facilities to be Included in the Study



Subtask E. MIT Lincoln Laboratories Energy Resilience Analysis Tool

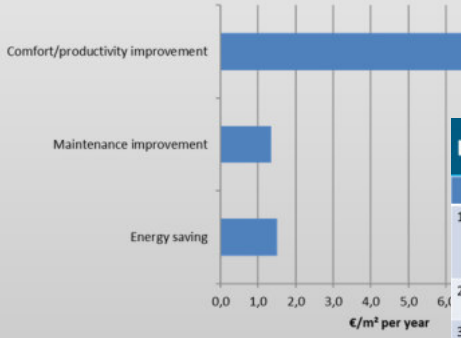


Subtask E. Workflow for the Annex 73 EMP and Resiliency analysis



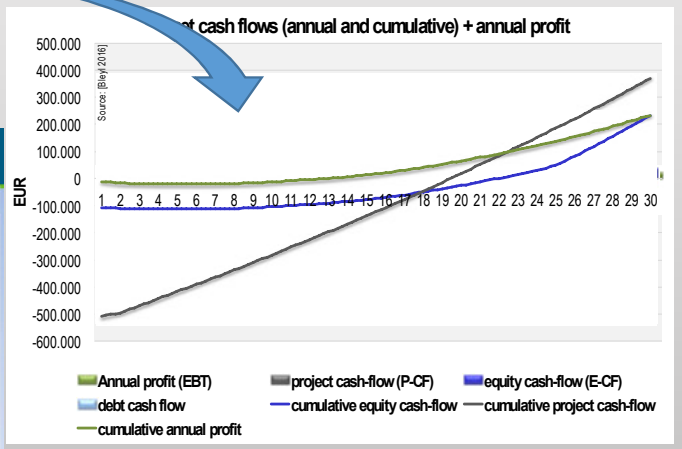
Subtask F. Business, Legal and Financial Aspects- Missions and Goals

- Overall: Generating reliable implementation models which allow to yield more ambitious energy efficiency standards for NZE Quartiers
- 1: Evaluation of implementation models for NearZE Quartiers
- 2: Evaluation of Life Cycle Cost and Benefits of NZE Quartiers
- 3: Practical implementation of results



LCC- considerable cost benefits of DER

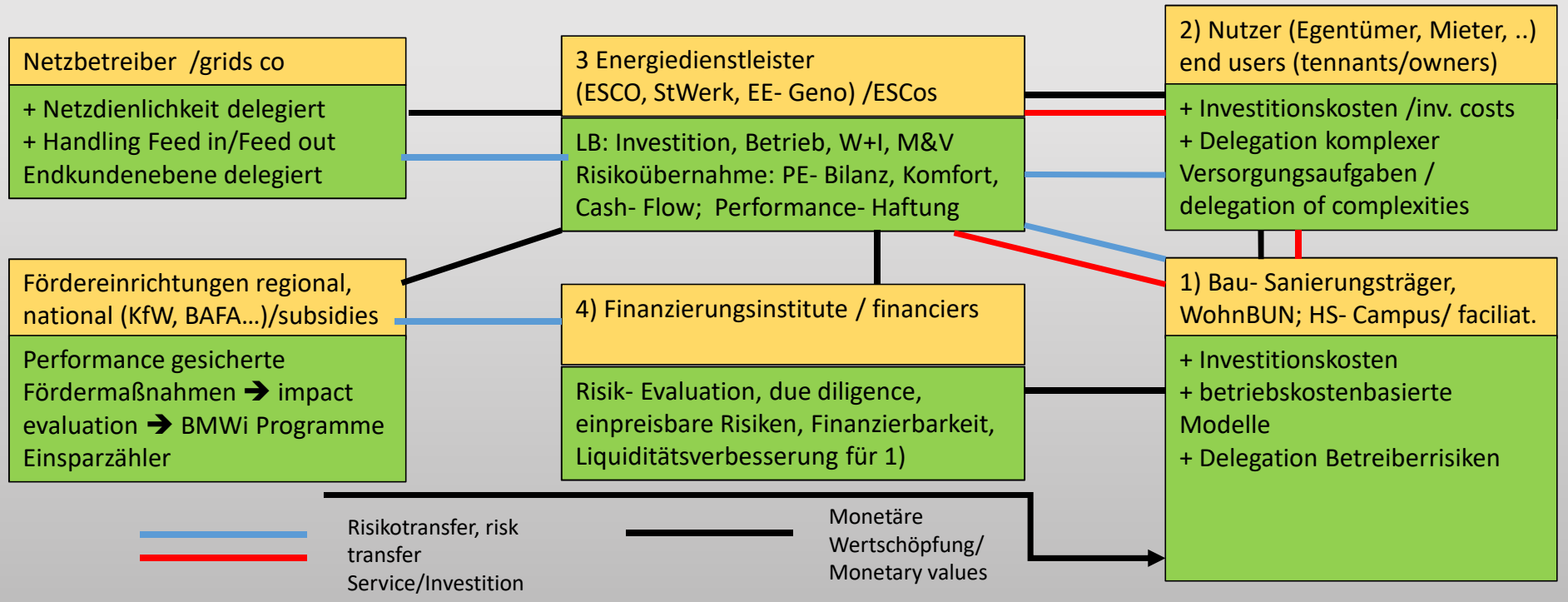
	Life Cycle Cost	Calculation	Variations and Values
1	Energy savings: effects from improving the e- performance of equipment by maintenance or replacement	kWh savings x energy price	Fixed or flexible energy price; in DER it is expected to at least reduce by 50% Values: Germany office building stock 7-14€/m²yr
2	Energy savings II	kWh *RE replacing fossile* x energy price *(RE- fossile)*	kWh replaced by RE; fixed or flexible energy prices;
3	Reduced maintenance I	Maintenance costs for replaced, worn down equipment at the end of its life cycle as a percentage of the new investment value	Average percentage value or end of life cycle value (➔ graph LCC maintenance) Values applied at the market: - 0,25$/ft² in US; EU: - 2 to -4 €/m²
4	Reduced maintenance II	Downsizing of investment in a DER bundle means reduction of investment cost related maintenance	A component downsized by 30% reduces maintenance costs by 30%
5	Reduced operation costs I	Building automation reduce operation workloads	Consider workplans and operation schedules individually



Financing of demanding NZE By considering enhanced LCC based cash flows

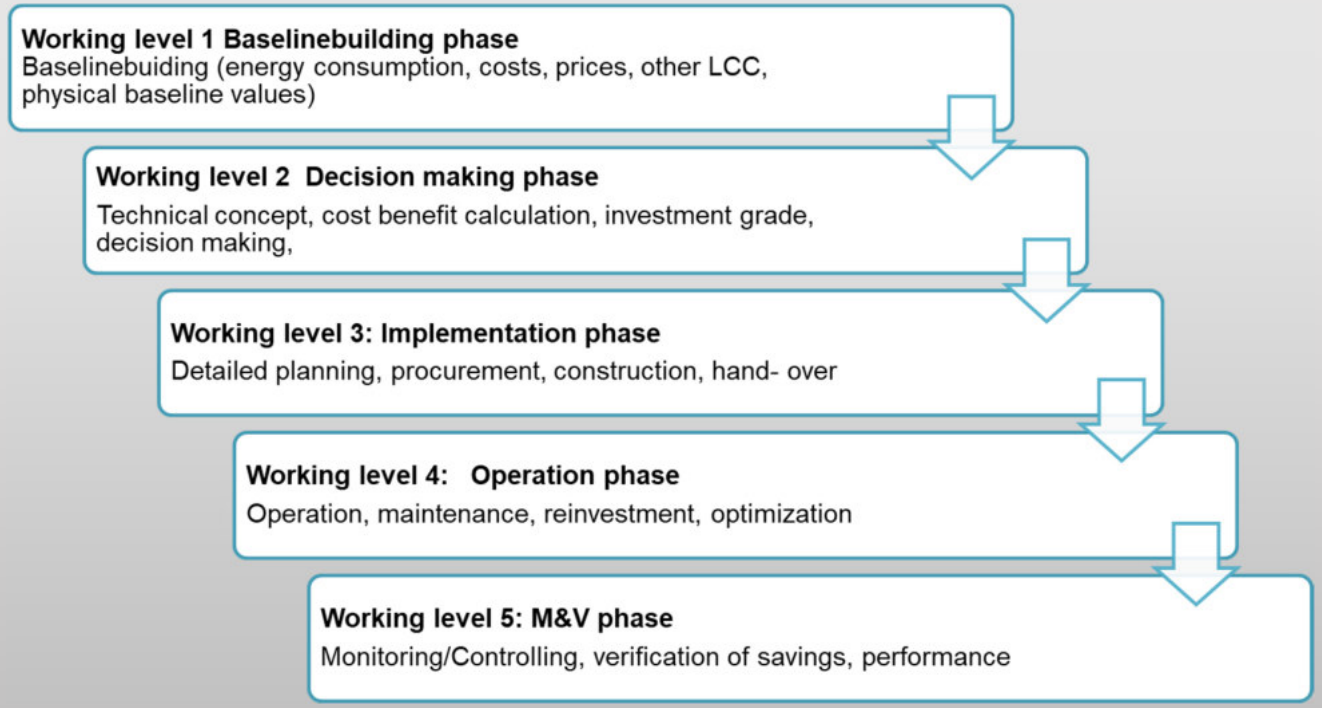
Subtask F. Business, Legal and Financial Aspects- Mission and Goals

- 4 technical- organizational structure for implementation models based on the results of A 61 which allows the cash flow based interaction between consumers, storage, production and grids

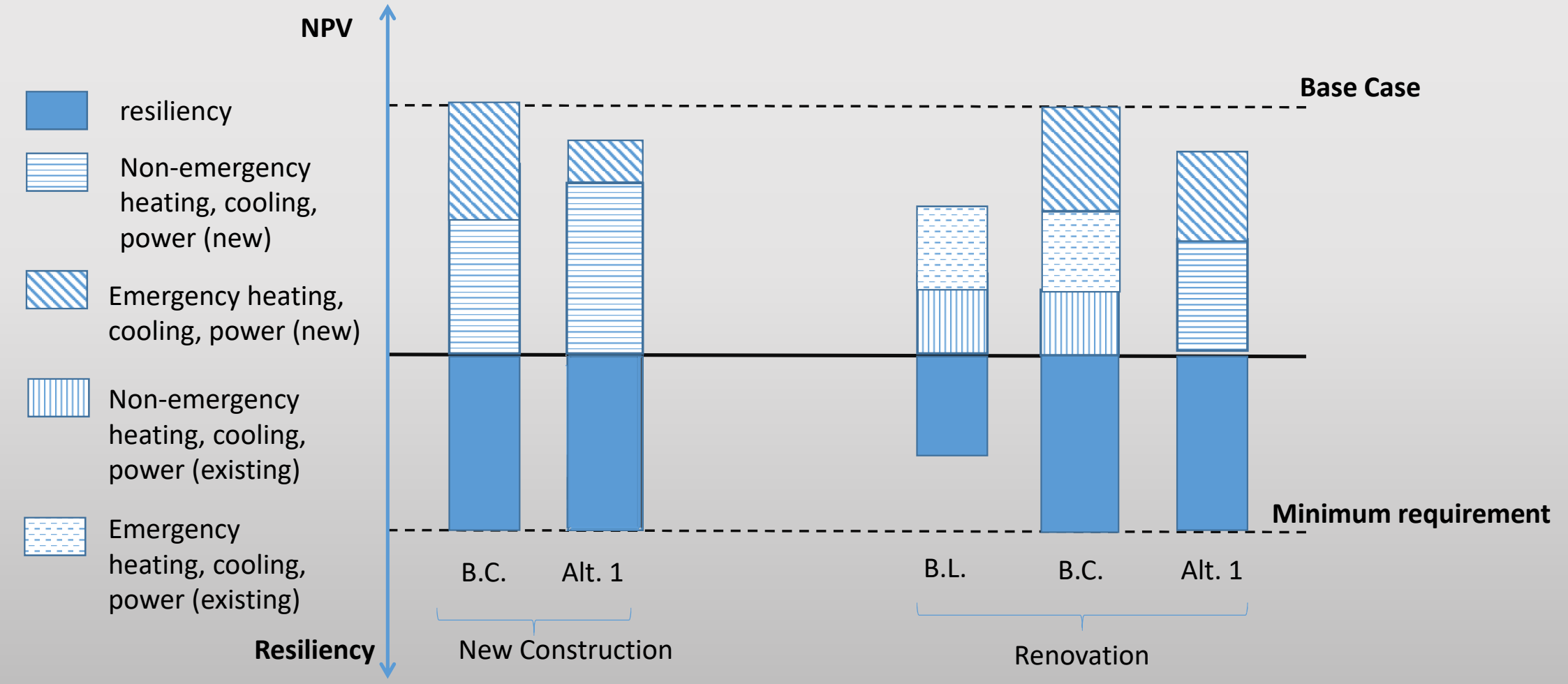


Subtask F. : Businsess, Legal and Financial Aspects- Mission and Goals

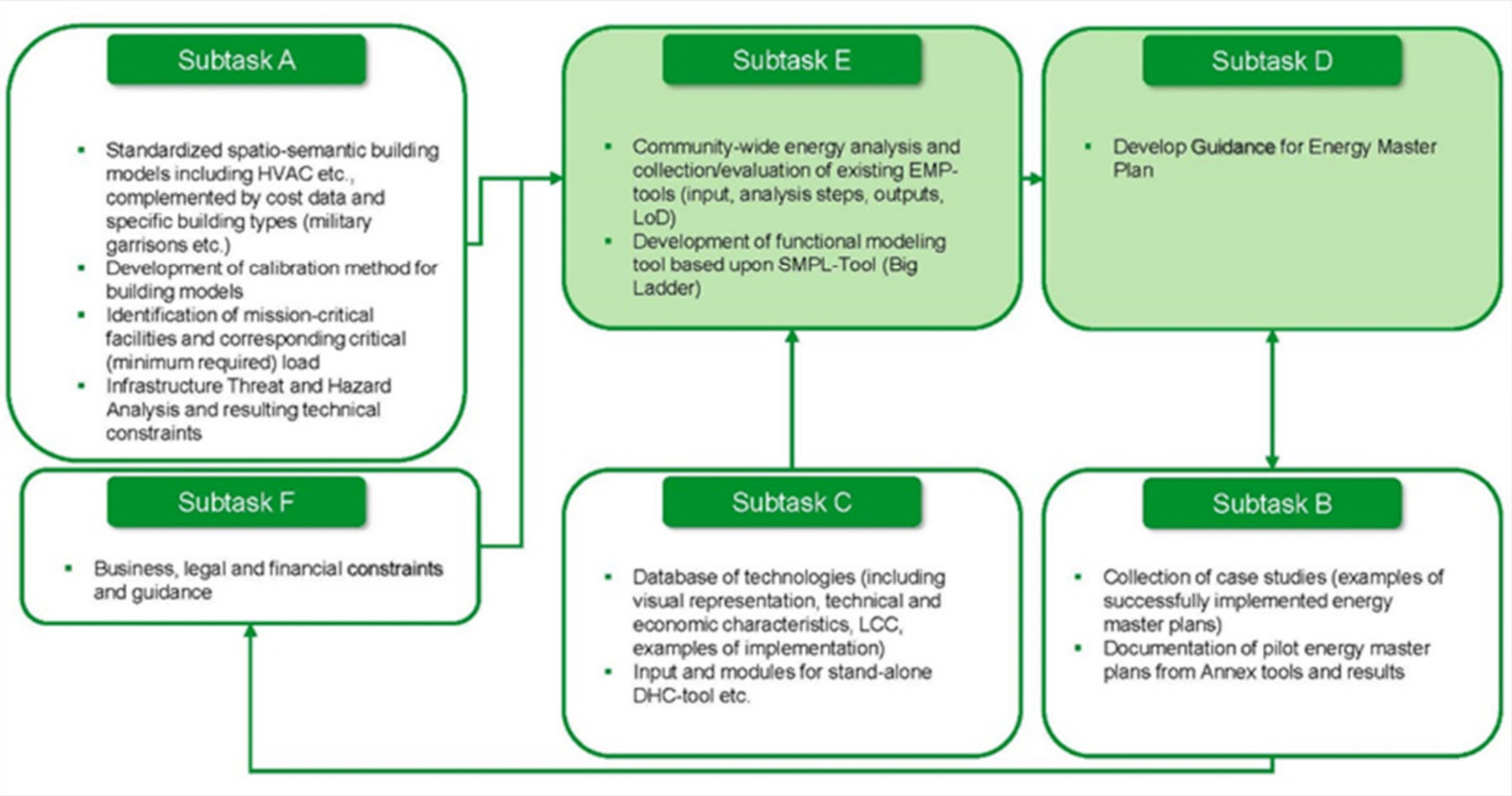
- 5 Risik analysis, quality assurance- exemplary calculation of default risk values for NZE project facilitation based on a five stage work flow



Subtask F. How to approach LCCA of energy system with requirements to resiliency



Information Flow for Subtasks A-F



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)

Participating Countries and Organizations

Country	Contracting Party	Subtask Participant	Subtask Co-lead	Letter of Nat. Participation
Australia	University of Melbourne MOD	A,B,C, D. E, F		X
Austria	AEE INTEC B.I.G. (Bundesimmobiliengesellschaft)		F	X
Canada	Carleton University DND???		A	X
Denmark	Aalborg Technical University, Ramboll Danish MOD	A, B A, B	C	
Germany	KEA/Steinbeis Transfer Centre	A,B	OA, F	
	GEF Engineering,	C, E	C	
	Stuttgart University of Applied Sciences,	B, C,	E	
	Enisyst,		F	
	German Armed Forces Estate and Infrastructure Agency	A,B		
	German ESCO association	F		
	BPIE		F	
	Susi Funds, Solas Capital Funds	F		

Country	Contracting Party	Subtask Participant	Subtask Co-lead	Letter of Nat. Participation
Norway	Norwegian Defence Estate Agency SINTEF	A, B, D, F		
U.K.	UK MOD	A, B		X
U.S.A.	US. Army Engineer Research and Development Center	A, B, C, D, E, F	OA, B, D	X
	USACE HQ/MP	D		
	GSA	B		
	Oak Ridge National Laboratory		A	
	Sandia National Laboratory	C, D	A	
	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	E	

Operating Agents and Subtasks Co-Leads

Operating Agents	Alexander Zhivov (ERDC, USA) and Rüdiger Lohse (KEA, Germany)
Subtask A:	Scott Bucking (Carleton University, Canada) and Robert Jeffers (Sandia National Lab, USA)
Subtask B:	Ingo Leusbrock (AEE, Austria), Michael Case, (ERDC, USA)
Subtask C:	Anders Dyrelund (Ramboll, Denmark) and Domenik Hering (GEF, Germany)
Subtask D:	Reinhardt Jank (Germany) and Alexander Zhivov (ERDC, USA)
Subtask E:	Peter Ellis (Big Ladder, USA) and Ursula Eckert (HFT-Stuttgart, Germany)
Subtask F:	Rüdiger Lohse, Oliver Rapf, (Building Performance Institute, Germany)

Time Schedule

- Preparation phase - one year (through November 2017)
- Working phase - 3 years (starting February 1, 2018)
- Reporting phase – 1 year

Thank you. Questions??