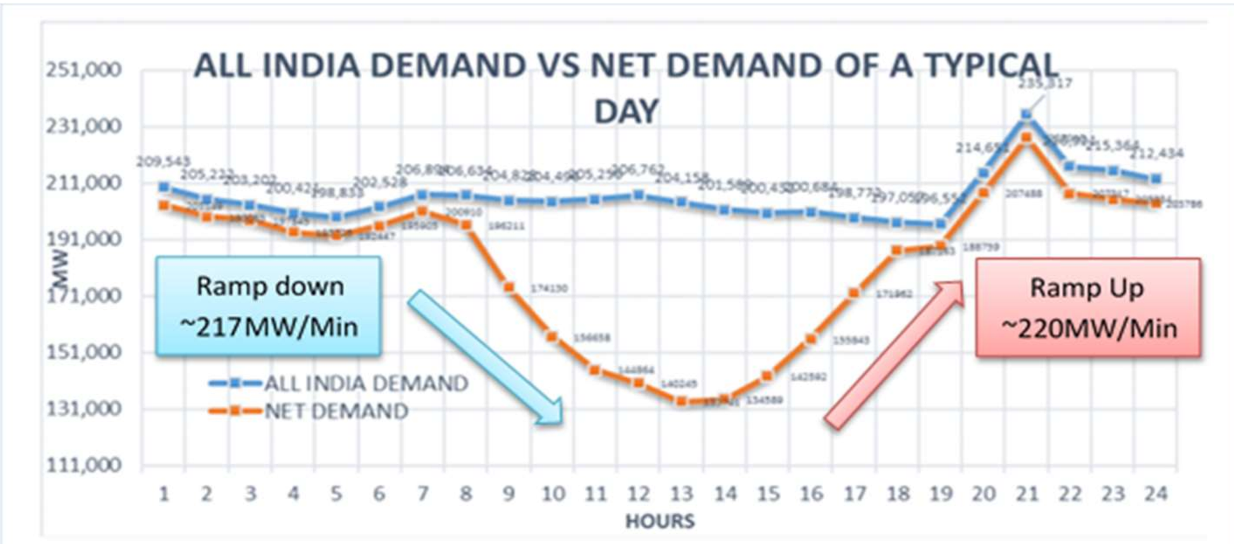
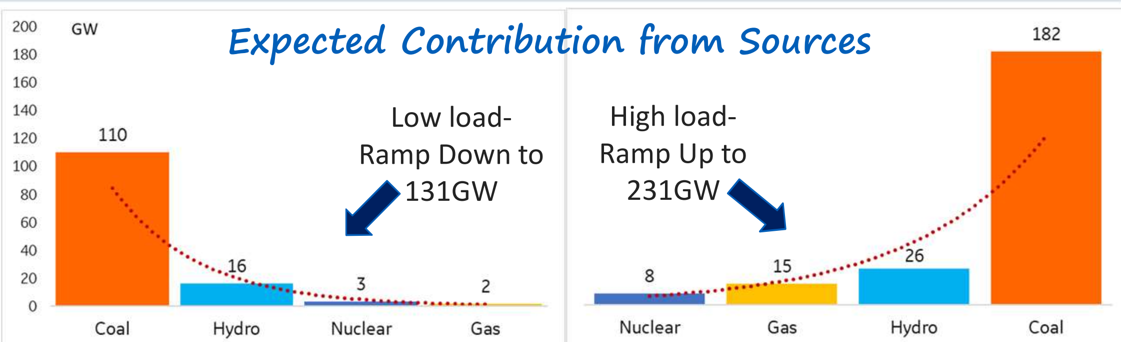
Suggestions- IEGC

July 22, 2019

Grid Stability - Using existing coal units for flexible operation

Flexible Power Projected Net Load Curve -2022 & Options





Options to support flexibility

- ***Gas*** - Low fuel gas availability; potential use of ~14GW of stranded asset for RE integration
- ***Hydro***-Limited Pump Storage <5GW. Constraints of water availability, downstream constraints & Agriculture needs etc.
- ***Nuclear*** - Limited capacities
- ***Coal*** - Expected & need to support ~70% of flex needs and most economical option
- ***Battery*** - Good source, however no short term scale and economic viability

Limited & inadequate flex support Options – Coal must support max. flexibility needs

Estimates of LCOE of battery storage

Please enter values in "BLUE" only

Battery Details		
Battery Capacity	MW	100
Service Hours per cycle	Hrs/Day	4
Battery Capacity	MWh	400
Battery Capacity	kWh	400000
Battery Efficiency	%	88%
Chargin Units Required	MWh/Day	455
Chargin Units Required	MWh/Year	165909
Battery Operational Summary		
Battery Discharge Units	MWh/Day	800
Battery Discharge Units	MWh/Year	292000
Battery Charging Units	MWh/Day	909
Battery Charging Units	MWh/Year	331818
No. of cycles in a day	#	2
Battery Discharge Duration	Hrs/Year	2920
Battery Utilization Factor	%	33.3%
Battery Charging		
Charging Source		Solar PV
Charging Tariff	Rs/kWh	3.00
Charging Tariff	Rs/MWh	3000
Charging Tariff Escalation	%/Year	0%
Battery Capex		
Battery Cost	$/kWh	250
Battery Cost	Rs/kWh	16250
Battery Capital Cost	$ MM	100.0
Battery Capital Cost	**Rs Crores**	**650.00**
Battery O&M		
O&M Cost	% of Capex	1.50%
1st Year O&M Cost	Rs Crores	9.75
O&M Escalation	%/Year	5%
Battery Replacement Year	Year	5
Battery Replacement Cost	% of Capex	30%
Replacement Cost	Rs Crores	195

Results		
Project Deliverable	**Unit**	**Battery Storage**
Levelized Cost of Electricity (LCoE)		
Levelised Tariff for Fixed Charges	Rs/kWh	3.22
Levelised Tariff for Charging Costs	Rs/KWh	3.41
Levelised Tariff for O&m Charges	Rs/kWh	0.49
Levelised Tariff for replacement	Rs/kWh	1.05
Levelised Tariff	**Rs/kWh**	**8.17**
Project Cost		
Project Cost	Rs Crores	650
Project Cost	Rs Crores/MW	6.50
Battery Summary	**MW**	**100**
	MWh	**400**

Financing Assumptions		
Parameter	**Unit**	**Battery Storage**
Capital Structuring		
Debt	%	70.00%
Equity	%	30%
Debt (Loan) Details		
Domestic Loan	Rs Crores	455
Tenor	Years	10
Interest Rate	%	11.50%
Moratorium	Years	0
Financing Details		
Discounting Rate	%	12.0%
Required Return on Equity (RoE)	%	20%
Currency Conversion		
USD to INR		65

Batteries economically costlier option than using coal for flex support

Economic Impact Assessment- Battery Vs. Coal flex.

Assumptions

- Capacity-38GW (4 hrs cycles -2 cycles/day)
- Battery-Cost 250$/Kwh
- Coal units flex conversion- 20 lakh/Mw

For 40GW Rs Crore	Battery	Coal Flexing Retrofit	Saving Cr
CAPEX (Rs Cr)	243,750	12,400	231,350
OPEX	2,925	17,825	-14,900
Cost of Electricity Rs/Unit	Rs 8 to 8.5	Rs 4.7 to 6.5	
MU Generated	109,500		
Total Cost	**87,600**	**71,175**	**16,425**

Coal units flexing is cheaper than battery storage.
All India Savings of ~16,000 Cr./year

Recommendation

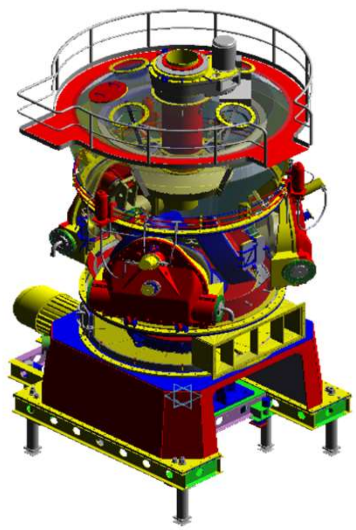
- Flexing coal plants one of the most economical option to integrate renewable
- Avoid coal plant closure and use them for flexible operations
  - Identify 50-60GW of coal plants & retrofit for flexible operations
- Flex coal plant to minimum load of 30%
- Ramp rate – 2% minimum for all plants
- Support implementation of AGC

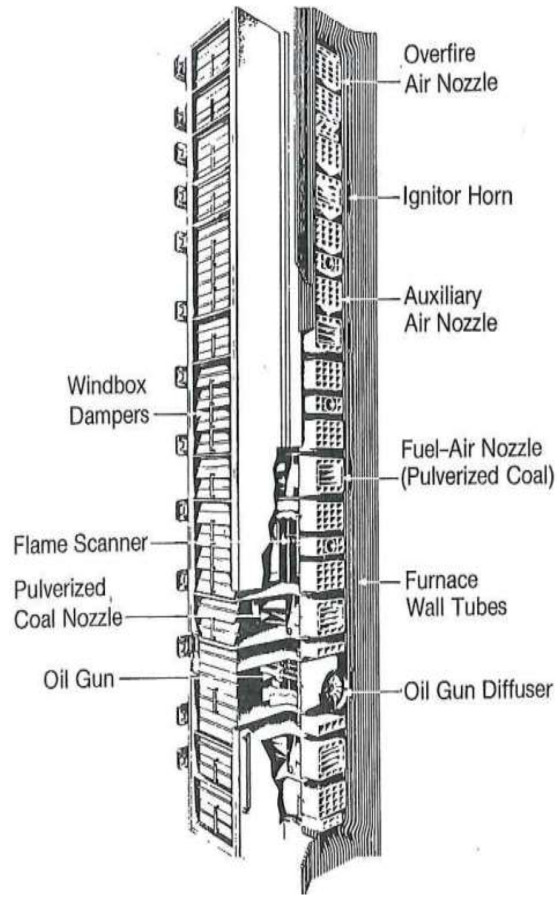
Boiler flexibility features – Low load

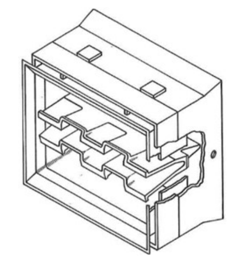
Firing System
- Wind Box
- Coal & Air Nozzles
- Control Philosophy-SA & PA
- Mill Upgrades
- Advanced Flame Scanners
- Mill O/L Temp.
- Two Mill Operation
- Advance Tilt Mechanism

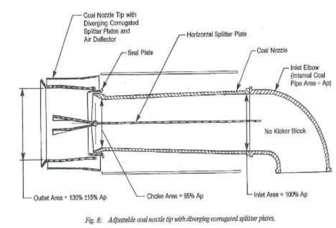
Pressure Parts
- RH / SH Modification
- Second Pass Modification

Boiler Operation
- Modify to Sliding Pressure
- Excess air level and burner tilts
- Preferential selection of burner elevation(s)



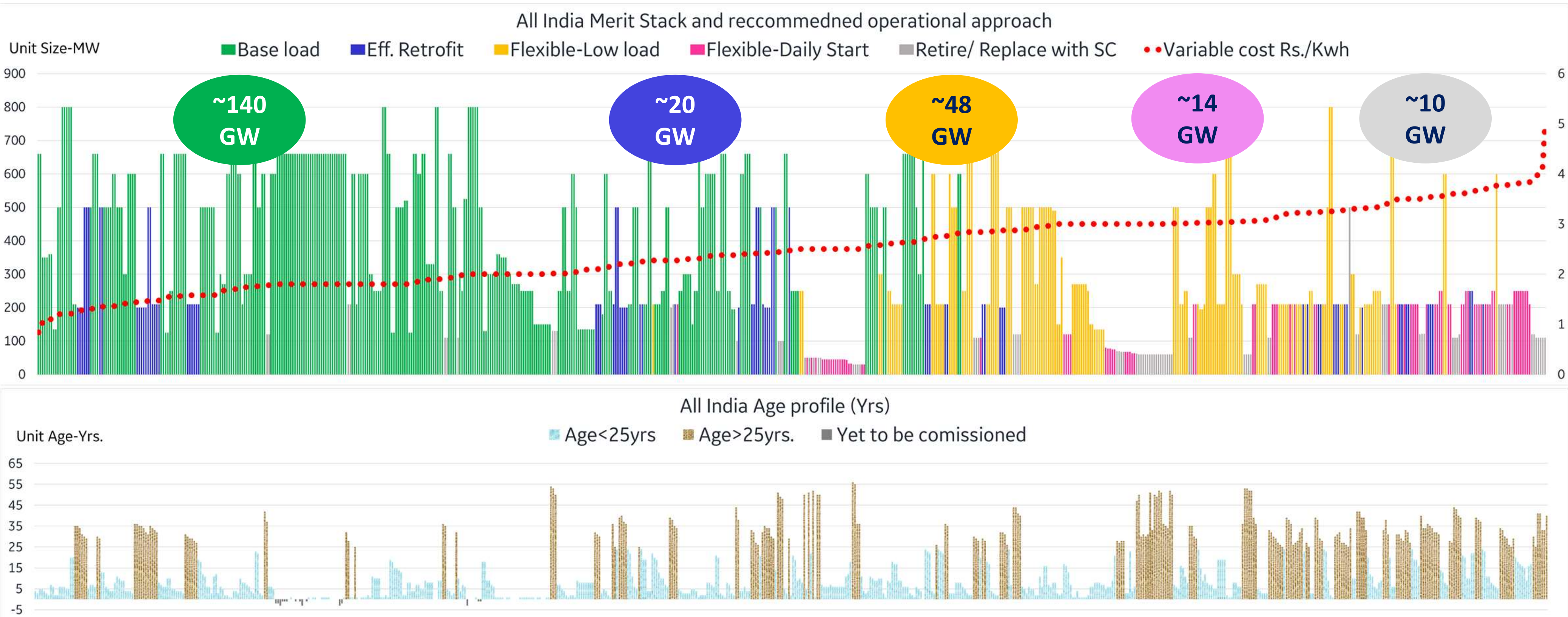






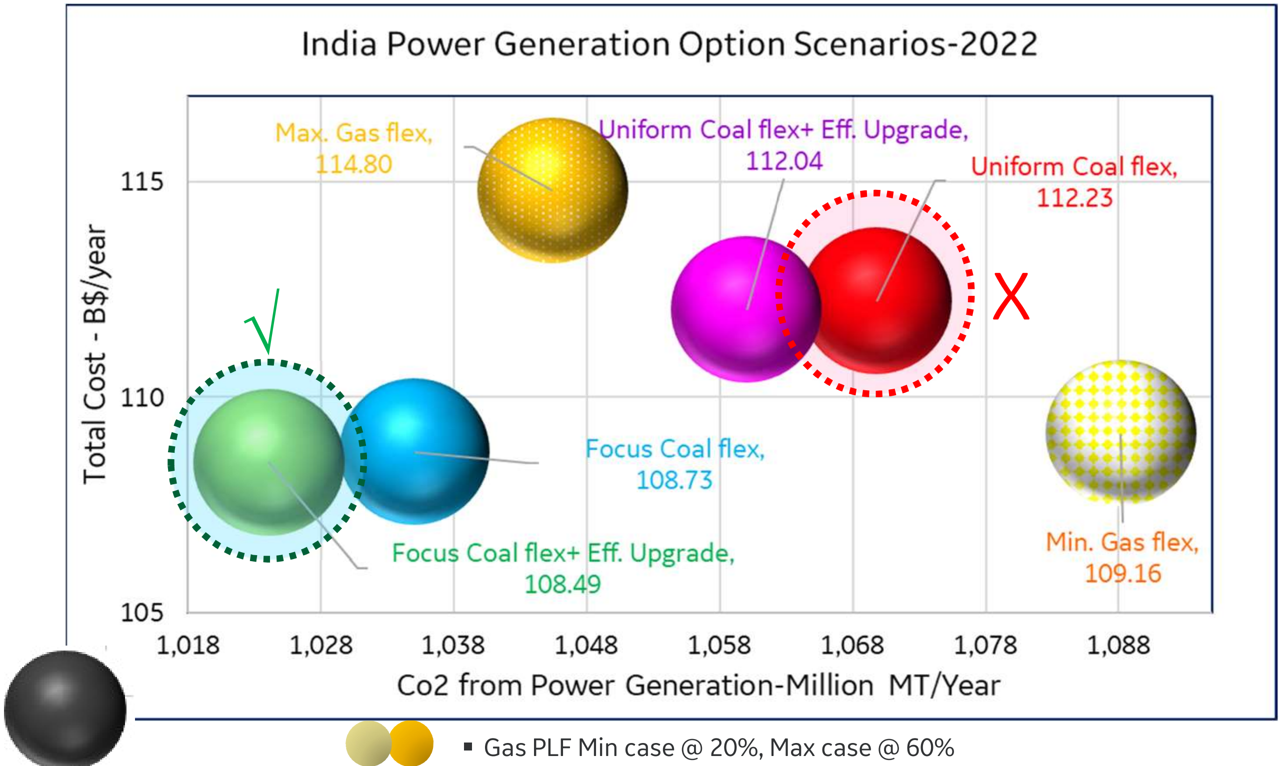
Boiler modifications for low load and cyclic operations

Adopting Single National Merit order Approach & with flexing only focused selected coal units-2022



Economics to define merit order; Flexing only selected coal units.
One nation one merit order to optimize cost & operations

Flexibility Support - 2022 All India Cost & Carbon scenarios



Current
Cost-88.5 $B/year
Co2-937 MMT/year

- Gas PLF Min case @ 20%, Max case @ 60%
- Uniform coal flex: All coal units flexing
- Efficiency Upgrade: HR benefits from 8% (500MW) to 13% (for 210MW)
- Focus flex: Flex Sub-critical <500MW; higher size/SC used for base load
- Focus Flex + Efficiency Upgrade

Notes & Assumptions

- IB: 479GW per National Electricity Plan (NEP)
- Generation: 1698 BU per NEP
- Coal Retirement: 23GW per NEP
- Analysis of generation cost; no T&D costs
- Co2 Emissions: using CEA references

Generation Mix Base Case

- Constant generation from RE/NUC/Hydro
- Gas IB in NEP is 25GW, 38% PLF
- Coal generation 1072BU, per NEP; IB of 212GW

Coal Upgrades

- Efficiency Upgrade of 18GW at $72MM/GW
- Flex Upgrade of 55GW at $36MM/GW
- Impact on Flex O&M/Efficiency is factored in

Focus Flex~3.7 B$/yr. savings ..~45 MMT Co2/yr. reduction in comparison with uniform flex

Successful Global References

Low Load-Reference: 800 MW in Germany (Heilbronn)

- Coal fired unit, COD in 1985
- Tower type

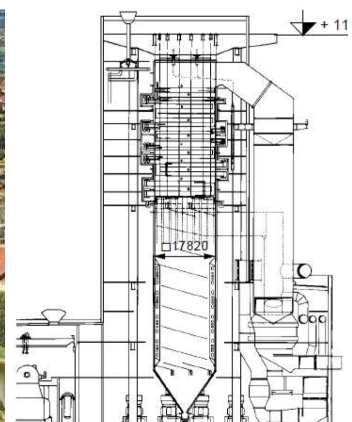
Design Low load operation: 30%.

- 2012/13: *Target Low Load operation: 15%;*

Achieved: 10% (net) equivalent to ~15% (gross)

Main Modifications

- Mills: Upto One mill operation
- Boiler: Additional flame scanners per burner elevation
- Modification of unit I&C system

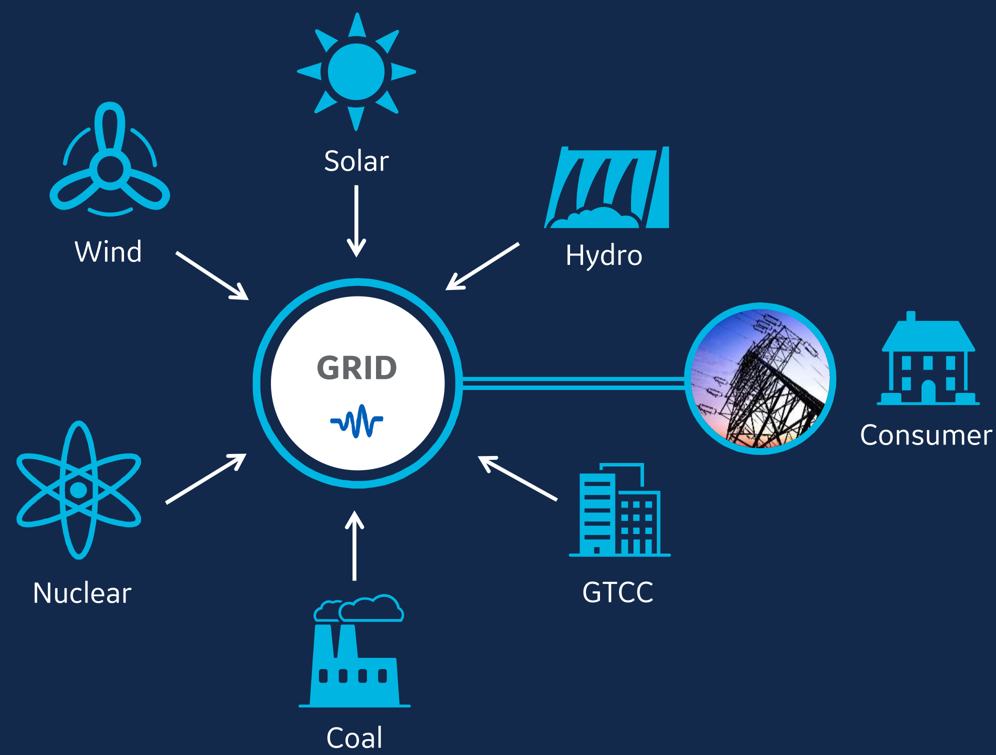


Summary Post Modifications	Full Load	Min. Load
Main steam temperature	540	505
Reheat steam temperature	540	467
Heat input	100%	14%
Boiler efficiency	94%	92%
W/S cycle efficiency	45.7%	38%
Generator power output [MW]	812	105
Auxiliary power consumption [MW]	38	27
Net power output [MW]	**774 (100%)**	**78** (10%)
Net efficiency	41%	26%

Reactive Power Management –

Utilizing Retired / Retiring units by converting to Synchronous Condenser

Addressing rising needs for grid performance enhancement



Synchronous Condensers addressing market needs

Evolving electricity mix

- Increasing renewable share
- Thermal plant retirements
- Long HVDC transmission lines
- Transit markets

▼

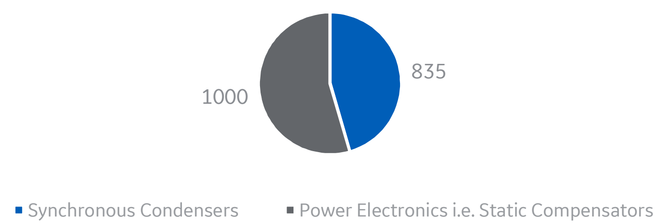
- Shrinking inertia
- Reduced short circuit strength
- Decreased dynamic reactive power reserves
- Grid System instability

▼

Market Requirements

- Reactive power and voltage support
- Short circuit strength
- System inertia

Product Demand for Grid Performance enhancement reaching $1.8b+ by 2020 (Global)



Synchronous Condenser Conversion Benefits

Significant VAR capacity for reduced cost
Re-use of existing generator, auxiliaries, facility, step-up transformer,…

Quickest overall cycle to implement
Disconnect turbine, modify auxiliaries, install & integrate starter system

Increased return on original plant investment
Avoid or delay mothball/demolition costs
Use available operation and maintenance expertese

Superior power system response
- Dynamic VARs
- mass inertia (add flywheel as needed)

Short circuit support
- SC mechanical inertia provides increased short circuit capacity and thus improves grid stability where static capacitors and power electronics cannot

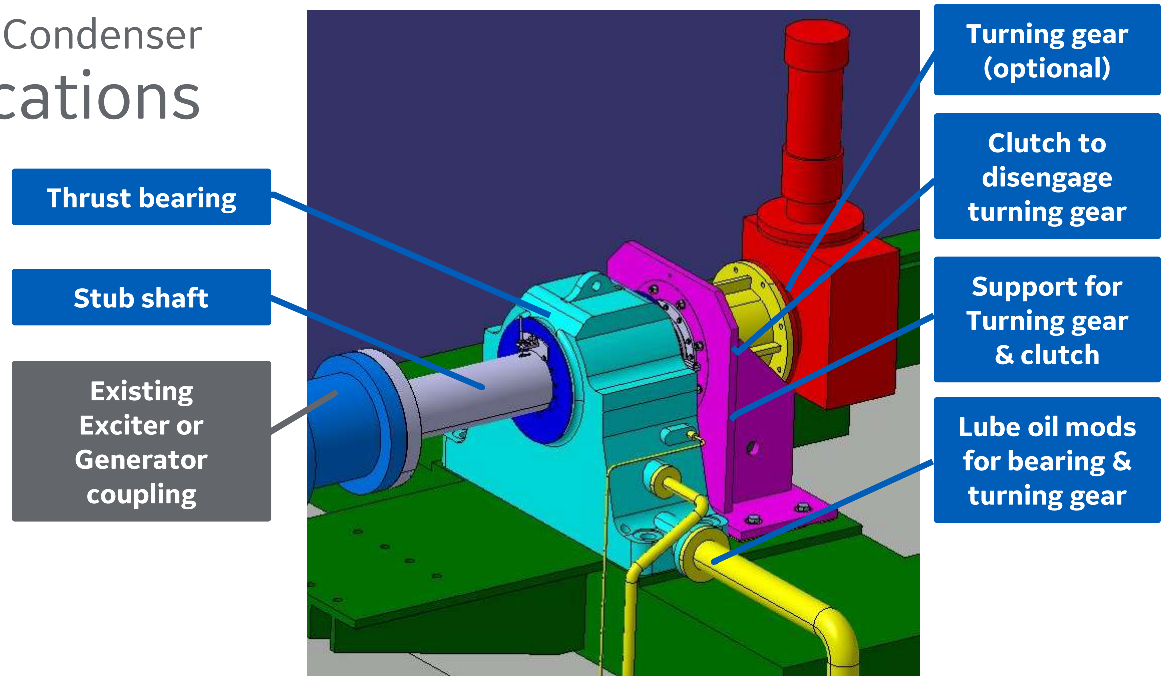
Investigate demand for grid stabilization where Steam Turbine trains are retired

Conversion of Thermal Unit to Synchronous Condenser

Generator shaft line modifications

Mechanical modifications required

- Break turbine coupling.
  Move turbine coupling away from Generator coupling to allow for thermal expansion.
- Install thrust bearing
  as previous turbine thrust bearing is disconnected
- Optional LS turning gear incl. self synchronizing clutch
  depending on starting method and forecasted operational profile



Considerations

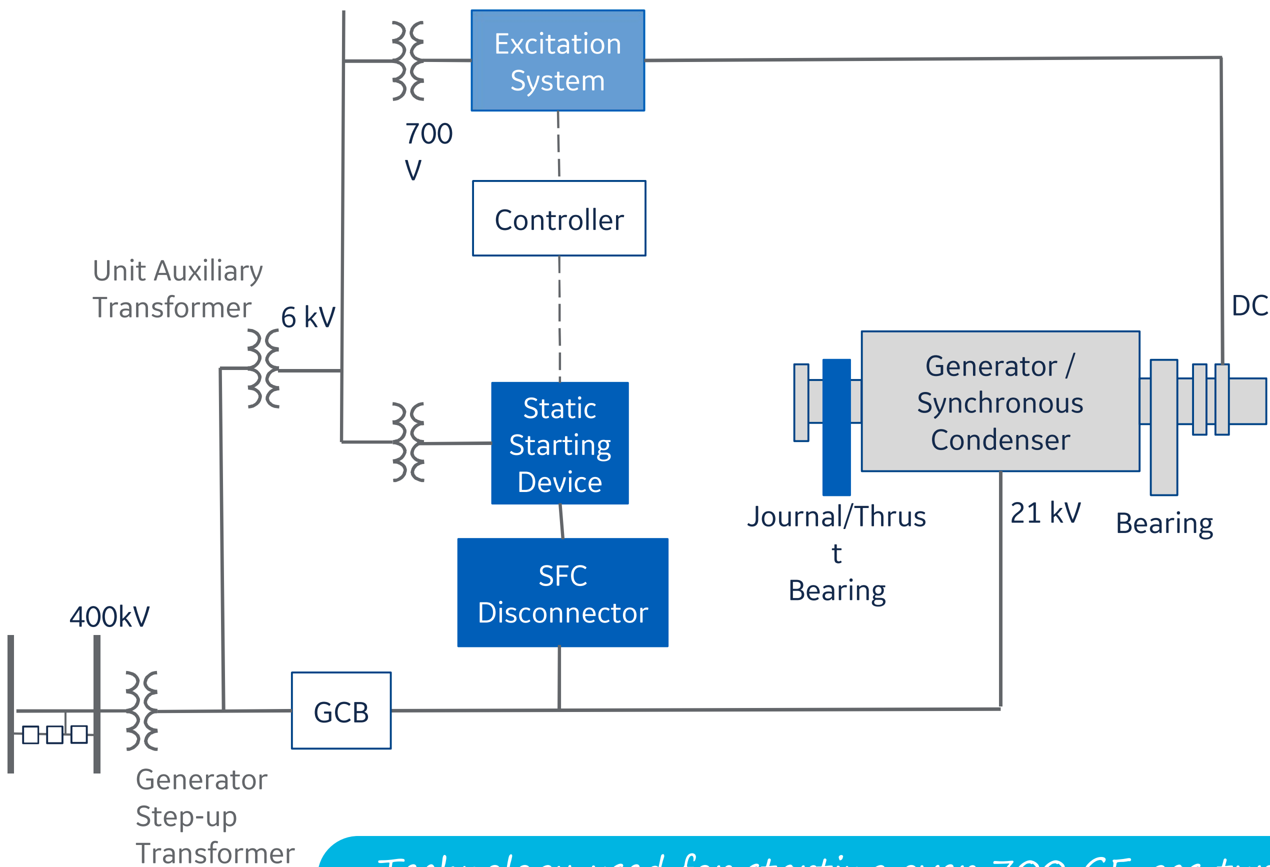
- Rotor dynamics assessment
- High pressure lift oil required?
- Add thrust bearing on NDE side (or alternatively modify existing Generator journal and bearing) Regulations for seismic loading

Key benefits

- External thrust bearing minimizes modification on Generator
- Modified Generator journal and bearing serves to minimizes losses and modifications on exciter end
- Low speed turning gear omits start-up vibration issues at low power consumption during stand-by

Conversion of Thermal Unit to Synchronous Condenser

Static Start



Synchronous condenser functions as motor for startup

Modifications

- Turbine disconnected
- Modify or upgrade excitation system
- Re-use existing auxiliary systems
- Mechanical modifications
  - add thrust bearing
  - add turning gear option
  - Oil system modifications

Considerations

- Generator rotor must be equipped with slip rings
- SFC might be used barring
- One SFC can start multiple units

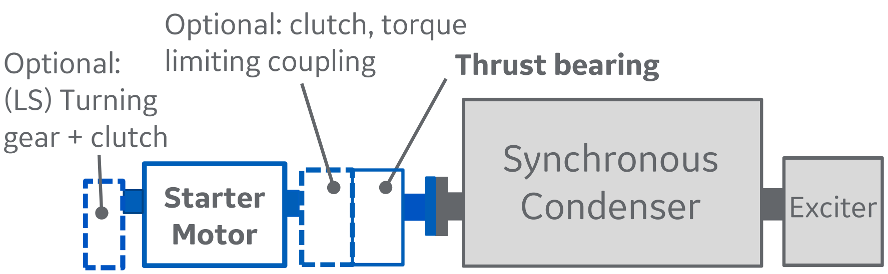
Technology used for starting over 700 GE gas turbine generators

Motor start

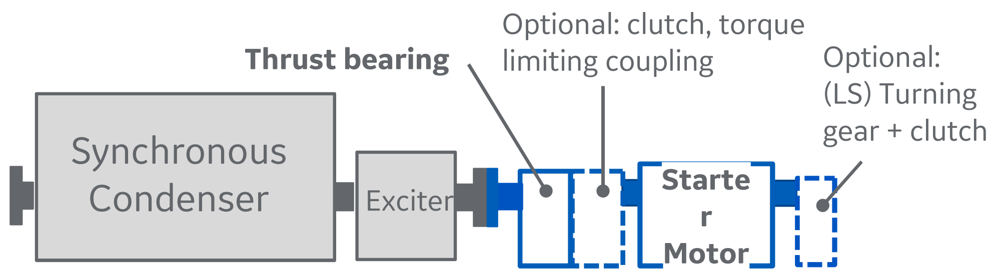
Maximize use of existing systems

- Motor ramps up Synchronous Condenser rotor to rated speed
- Re-use or upgrade existing excitation system
- Re-use existing plant auxiliary systems

Motor on DE



Motor on NDE



Considerations

- Rotor dynamic analysis required
- Space availability and foundation properties
- Motor on DE needs turbine to be removed
- Motor on NDE requires capability of exciter shaft joint
- For units with static excitation a static start configuration is likely less expensive

Key benefits

- Can be realized with static and brushless exciters
- Can possibly be integrated at DE and NDE side

Syncon Installed Capacity, Conversion potential & savings

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@7 GW Syn-Con capacity already installed

Hydro Stations having Synchronous Condenser Facility						
Region	Hydro Station	Utility	#Units	Rating MW	Total MW	
NR	Pong	BBMB	6	66	396	**1893**
NR	Larji	HPSEB	3	42	126	
NR	Ranjit Sagar	PSEB	4	150	600	
NR	Ratna Pratap	RRVUNL	4	43	172	
NR	Jawahar Sagar	RRVUNL	3	33	99	
NR	Tehari	THDC	2	250	500	
WR	RHBH-Sarovar	NCA	6	200	1200	**2450**
WR	Koyan	MSPGCL	4	250	1000	
WR	Ghatghar	MSPGCL	2	125	250	
SR	Sagar	APGENCO	7	100.8	705.6	**2770.6**
SR	Sagar	APGENCO	1	110	110	
SR	Srisailam LB	APGENCO	6	150	900	
SR	Varahi	KPCL	2	115	230	
SR	Idukki	Kerla	3	130	390	
SR	Kuttiadi	Kerla	3	25	75	
SR	Lower Periyar	Kerla	3	60	180	
SR	Nasin Bridge	TANGEDCO	4	30	120	
SR	Aliyar	TANGEDCO	1	60	60	
					Total MW	**7113.6**

Substantions having Synchronous condenser installed						
Region	Substation	State	#Units	Rating -MVAR	Total MVAR	
NR	Heerapura 220KV *	Rajasthan	2	20	40	**40**
* Installed on 33KV us- SynCon make- Siemens						

Potential to convert only retired units

Relatively High load states-More Potential

Relatively Low load states-Less Potential

@6.2 GW (#52 Units)

Total Syncon Conversion Cost- @Rs. 2300/Kvar ~1600 Cr.

If other options like STATCOM etc. ~ 2600 Cr.

Total Savings ~1000 Cr.

Reactive Power –Present Availability

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As on 31-12-2013

ALL INDIA REACTIVE POWER COMPENSATION DETAILS

Sl. No	Region (A)	NO of 400 & above lines (B)	CIRCUIT. KMS (C)	Total Mvar Generated by the line @ 1.0 p.u voltage (D)	No of line Reactors (E)	line Reactors Mvar (F)	No of Bus Reactors (G)	Bus Reactors Mvar (H)	% Compensation Line Raectors (F/D)	% Compensation Bus Reactors (H/D)	Total Compensation Mvar (F+H)	% Compensation Line + Bus reactor (F+H) *
1	Inter Regional	28	6234	6836.4	22	2328.00			34.05	0.00	2328	34
2	Northern	285	35269	25113.2	130	9955.00	95	9963	39.64	39.67	19918	79
3	Western	308	47742	35471.6	170	12609.00	92	7163	35.55	20.19	19772	56
4	Southern	167	21898	12171.8	66	3749.00	38	2379	30.80	19.55	6128	50
5	Eastern	121	15374	9202.9	48	3063.00	46	3974	33.28	43.18	7037	76
6	North Eastern	15	2582	1433.1	13	802.00	34	1125	55.96	78.50	1927	134
	TOTAL	**924**	**129098**	**90228.9**	**449**	**32506.00**	**305**	**24604**	**36.03**	**27.27**	**57110**	**63**

@90GVAR Generation & 57 GVAR compensation capacity available

Reactive Power-Additional Investments Planned-2022

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Static

Summary of Under Implementation Bus Reactors in India till 2021-22

Region	Plan	MVAr Compensation		Cost (in Cr)	
		765kV	400kV	765kV	400kV

Summary of Under Implementation Bus Reactors in India till 2021-22

Region	Plan	MVAr Compensation		Cost (in Cr)	
ER	12th	0	1580	0	222
	13th	1320	2455	150	350
NER	12th	0	320	0	58
	13th	0	1820	0	273
NR	12th	0	955	0	165
	13th	720	1375	118	232
SR	12th	810	80	106	17
	13th	3360	1813	436	292
WR	12th	240	125	39	21
	13th	2700	1063	399	184
ALL INDIA	12th	1050	3060	146	483
	13th	8100	8526	1102	1332
Total till 13th Plan end (Voltage-wise)		9150	11586	1248	1815
Total MVAr & Cost Figures by end of 13th Plan		20736		3063	

Static

Summary of Under Implementation Line Reactors in India till 2021-22

Region	Plan	MVAr Compensation		Cost (in Cr)	
		765kV	400kV	765kV	400kV
ER	12th	0	760	0	69
	13th	4020	1266	340	115
NER	12th	0	0	0	0
	13th	0	412	0	37
NR	12th	0	200	0	18
	13th	1200	886	101	81
SR	12th	2744	0	232	0
	13th	6846	852	578	78
WR	12th	2100	1452	177	132
	13th	14280	446	1207	41
ALL INDIA	12th	4844	2412	409	219
	13th	26346	3862	2226	351
Total till 13th Plan end (Voltage-wise)		31190	6274	2636	571
Total MVAr & Cost Figures by end of 13th Plan		37464		3206	

Dynamic

Sl. No.	Location	Dynamic Compensation (STATCOM) (MVAr)	Dynamic Compensation (SVC) (MVAr)	Mechanically Switched Compensation (MVAR) Reactor	Capacitor	Plan	Estimated Cost (Cr. Rs)
	Northern Region						
1.	Nalagarh	± 200		2 x 125	2 x 125	13th	431.89
2.	New Lucknow	± 300		2 x 125	1 x 125		
3	New Wanpoh		(+)300/(-)200			12th	829.98
4	Kankroli		(+)400/(-)300				
5	Ludhiana		(+)600/(-)400				
	Western Region						
3.	Solapur	± 300		2 x 125	1 x 125	13th	1071.24
4.	Gwalior	± 200		2 x 125	1 x 125		
5.	Satna	± 300		2 x 125	1 x 125		
6.	Aurangabad (PG)	± 300		2 x 125	1 x 125		
	Southern Region						
7.	Hyderabad (PG)	± 200		2 x 125	1 x 125	13th	562.25
8.	Udumalpet	± 200		2 x 125	1 x 125		
9.	Trichy	± 200		2 x 125	1 x 125		
	Eastern Region						
10.	Rourkela	± 300		2 x 125	-	13th	766.21
11.	Kishanganj	± 200		2 x 125	-		
12.	Ranchi (New)	± 300		2 x 125	-		
13.	Jeypore	± 200		2 x 125	2 x 125		
					Total	12th	829.98
						13th	2831.59
					Grand Total		3661.57

Planned till 2021-22

Compensation Type	Planned to be achieved by	MVAR	Total MVAR	% Share	Cost -Cr.	Cr./MVAR
Static Support	Bus Reactors	20736	20736	29%	3063	0.15
	Line Reactors	37464	37464	52%	3206	0.09
Dynamic Support	STATCOM	6400	13350	19%	3662	0.57
	SVC	2200				
	Mech. Switched Reactor	3250				
	Mech. Shwitched Capacitor	1500				

Competing Tech. to Synchronous Condenser- 0.26 Cr./MVAR*

@72 GVAR addition compensation capacity planned ~1.4 B$ Investments

Practical transmission- Comparing Competing solutions

Cost $ → $$$$$

	AUTO SWCH. CAP REAC.	LOAD SHED	SERIES CAP.	SYNC COND. CONV.	SVC	NEW SYNC COND.
LONG LINES						
Transient stability	+		+++	++	+	++
Power oscillations			++	+	+	+
Voltage regulation	++		++	+++	+++	+++
LOAD AREAS						
Voltage regulation			++	+++	+++	+++
Voltage collapse	++	+++	++	+++	++	+++
FEATURES						
Short term overload response				+++		+++
Harmonics				**Negl.**		**Negl.**
Op mode flexibility				**Yes**	**No**	**No**
Increase short circuit strength				**Yes**	**No**	**Yes**
LVRT				+++	+	+++
Inertia for stability				**Yes**	**No**	**Yes**

Competing Tech. & Economics

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Comparison of Various Reactive Power Support Options

Equipment*	Ability to support Voltage*	Capital cost (per KVAr)*	Operating cost*	Opportunity Cost*	Category of Reactive power Support devices	Applications
STATCOM	Fair, drops with V	$50-55	Moderate	NO	**Dynamic Reactive Sources** *Merits and Demerits:* • These are fast, continuous & controllable reactive support devices. • Dynamic reactive devices can, on demand, increase their output above the normal rating for short periods of time. • Synchronous machines can produce several multiples of their normal reactive power rating for short periods.	Dynamic reactive resources are typically used to adapt to rapidly changing conditions on the transmission system, such as sudden loss of generators or transmission facilities.
Static VAr compensator	Poor, above its rated value it drops with V^2	$45-50	Moderate	NO		
Synchronous condenser	Excellent, additional short- term capacity	$30-35	High	NO		
Generator	Excellent, additional short- term capacity	Difficult to separate	High	Yes		
Capacitor	Poor, drops with V^2	$8-10	Very low	NO	Static devices are typically used to adapt to slowly changing system conditions such as daily and seasonal load cycles and changes to scheduled transactions.	

Converting retired unit to work as Synchronous Condenser is Economical

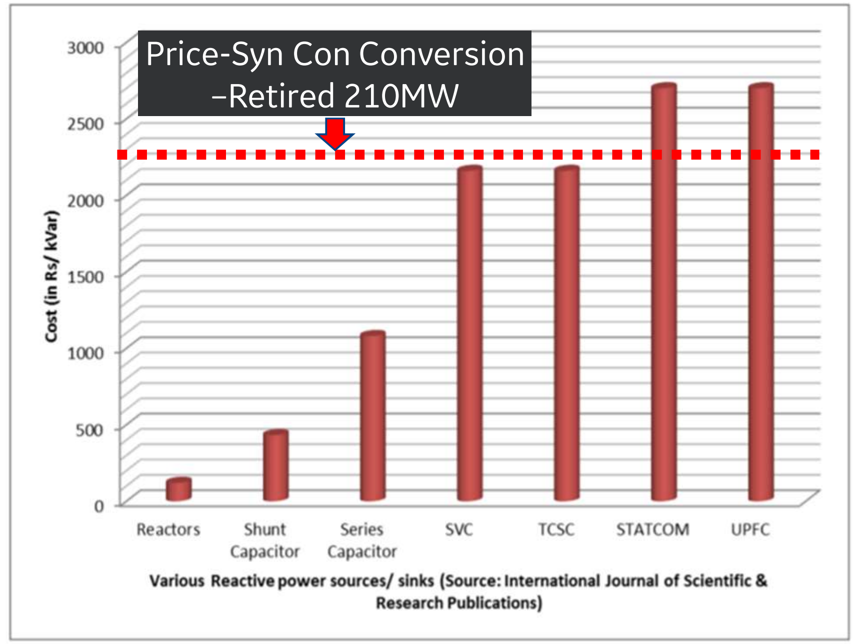

Figure 10 Average cost of Reactive power technologies

Recommendation

- Synchronous condenser- Best suited to provide Dynamic reactive support.
- Better than SVC's, STATCOM in – Inertial stability, LVRT, Short Crt. Strength etc.
- For cheaper & faster support- Utilize retired/ retiring units & convert to Sycon
- Forecast of Reactive needs- Study & analyze
- Mechanism of valuation of reactive power support.
- Develop & implement compensation/ incentive mechanism.

Explore Other Options– Thermal Energy Storage

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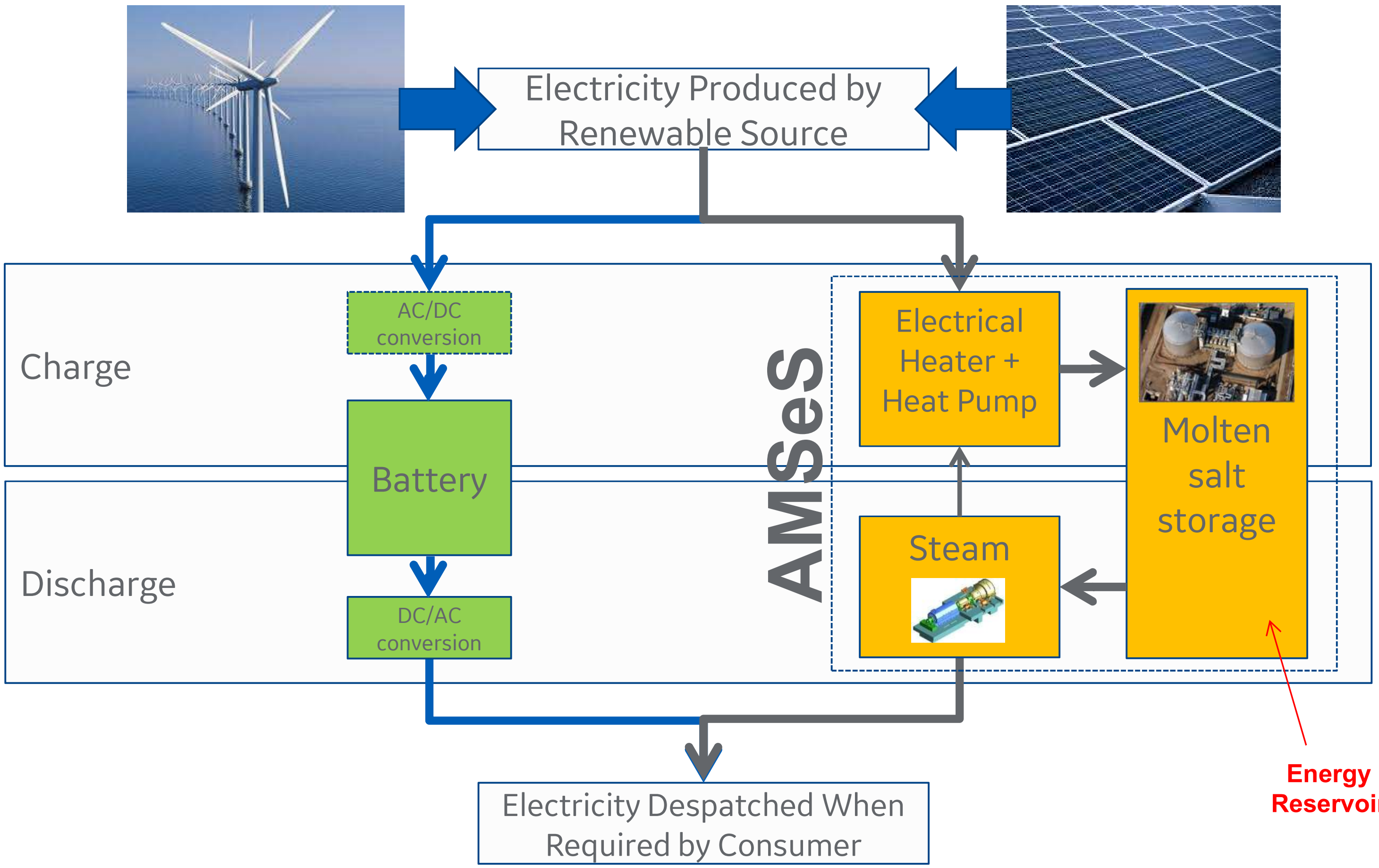
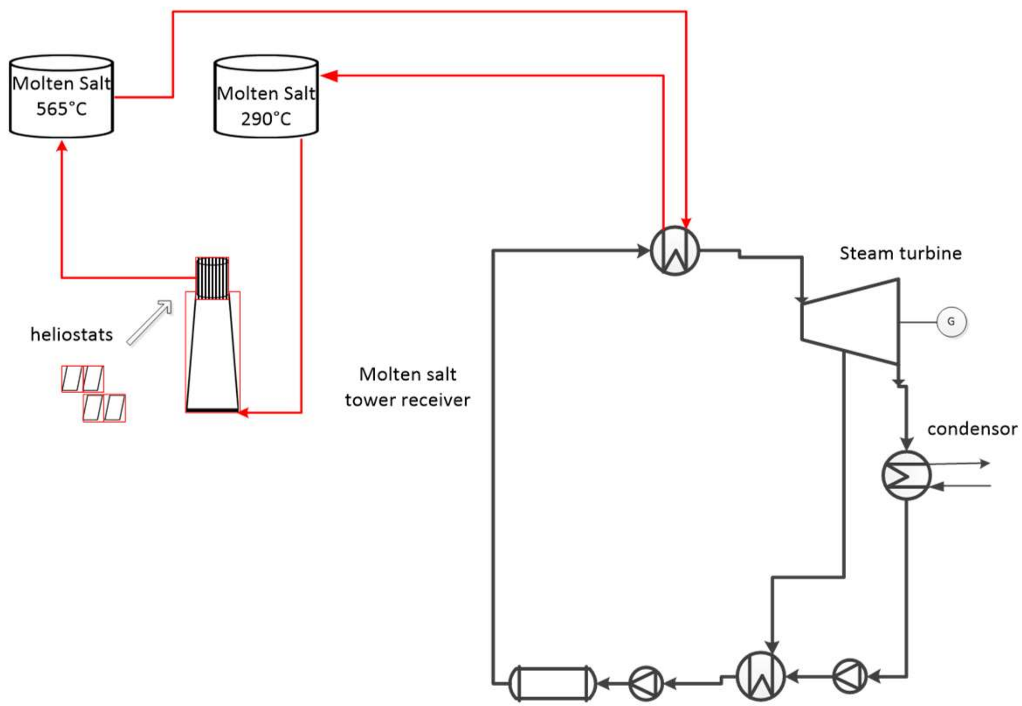
Electricity Storage – The Thermal Option



Molten Salt Storage and power cycle well known from tower based CSP

Molten Salt - experience, references, low cost - industrially well known ($NaNO_3$ + KNO_3)

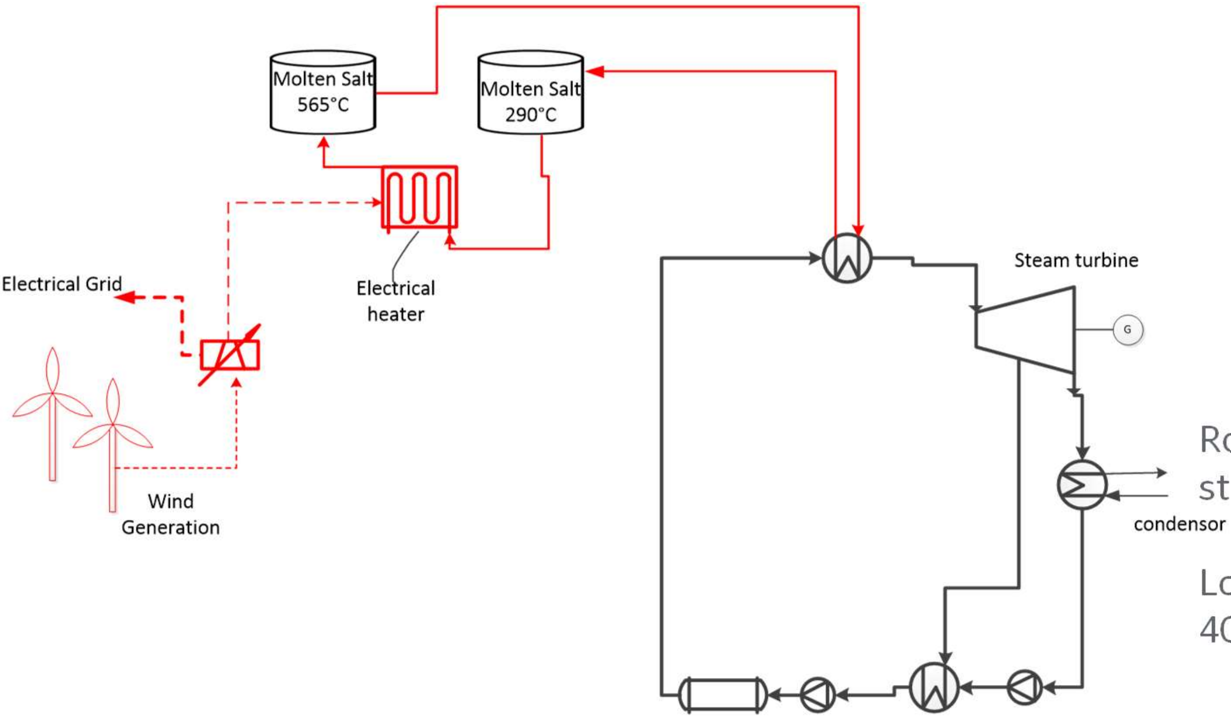


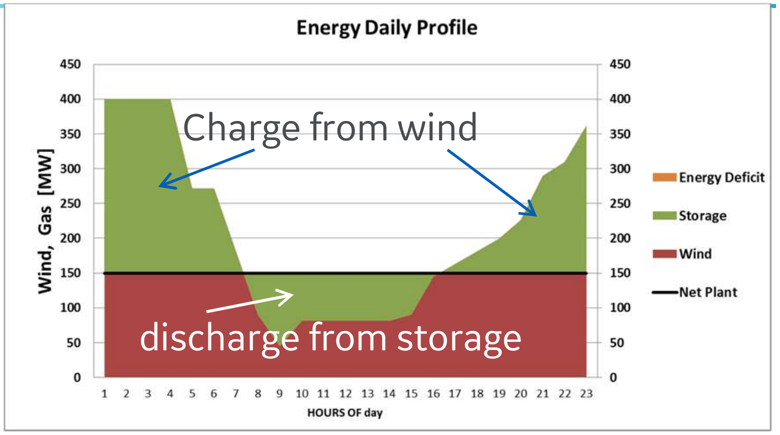
Well known 2-tank solution

60% $NaNO_3$ + 40% KNO_3
Non-toxic, used as fertilizer and in heat treatment for industry
Stable upto 565°C, freezes at 240°C

Direct electrical heating of molten salt from wind / Solar/ Grid

Electrical heater integration for 100 - 400 MW possible



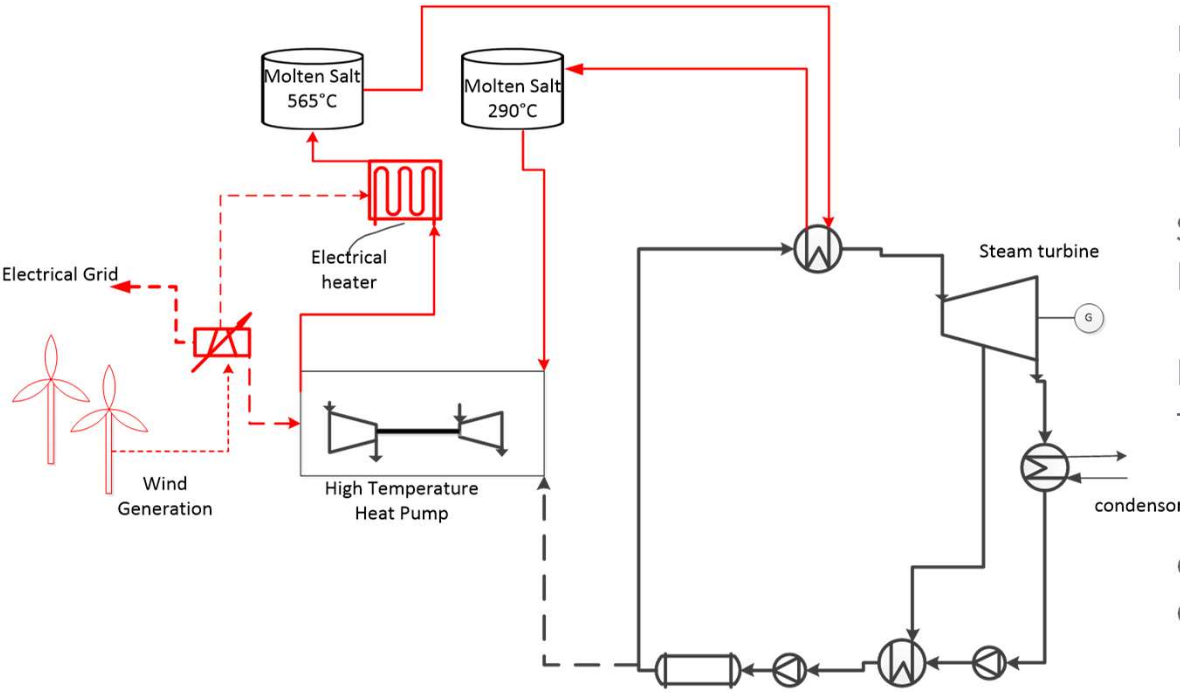


Round trip efficiency ~ Heat to electricity efficiency of steam cycle ~ 42%

Low cost integration: Molten salt equipment costs 40-60 €/kWhe

If business case demands -> better efficiency

High temperature heat pump based on GE equipment



Round trip efficiency ~ Coefficicent of Performance of Heat pump x efficiency of steam cycle ~ 50%-52% net

Supercritical carbon dioxide used as working fluid for heat pump - equipment known in oil and gas industry

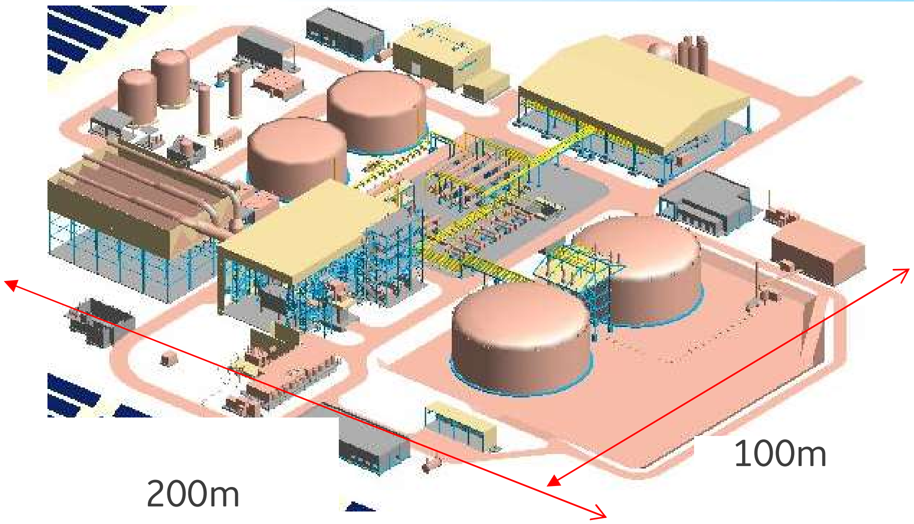
High temperature compressor is key enabling technology

Water tanks store hot water - extracted from steam cycle during discharge - increase heat pump efficiency during charge

GE patent: EP15153755

Advantages and Features

No site dependance, lower footprint compared to Li-ion (for comparable size)



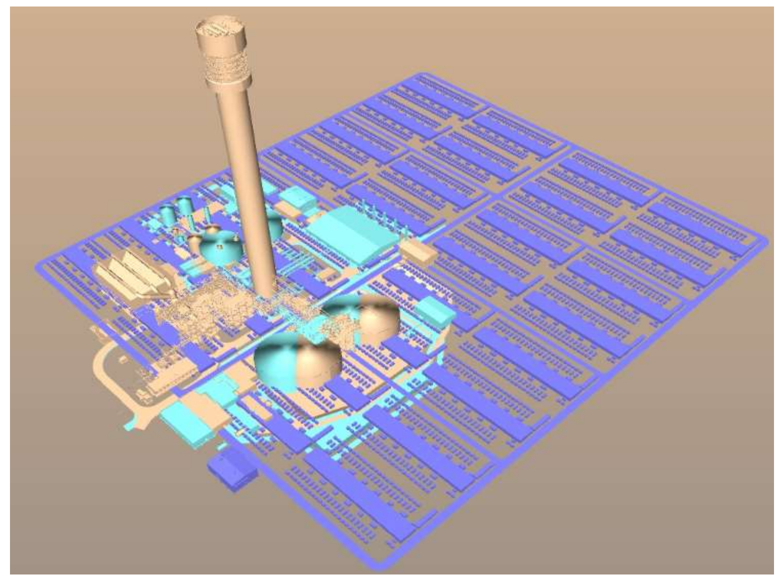
100 MWe - 8 -12 hours storage

- Limited space requirement (20 m2/ MWh) . Higher capacity up to 4-5 GWh possible by increasing tank size or simply more tanks
- No geographical constraint, no major earth moving
- Better lifetime than Li-ion batteries - effectively no replacement during a 25-30 year lifetime
- Roundtrip efficiency in the range of 50% - But low cost and scalability renders competitive
- Typical storage capacity from 4 to 24 hours

AMSES – Advanced Molten Salt Electricity Storage

Energy and power density for large sizes is higher for AMSES than Li-ion

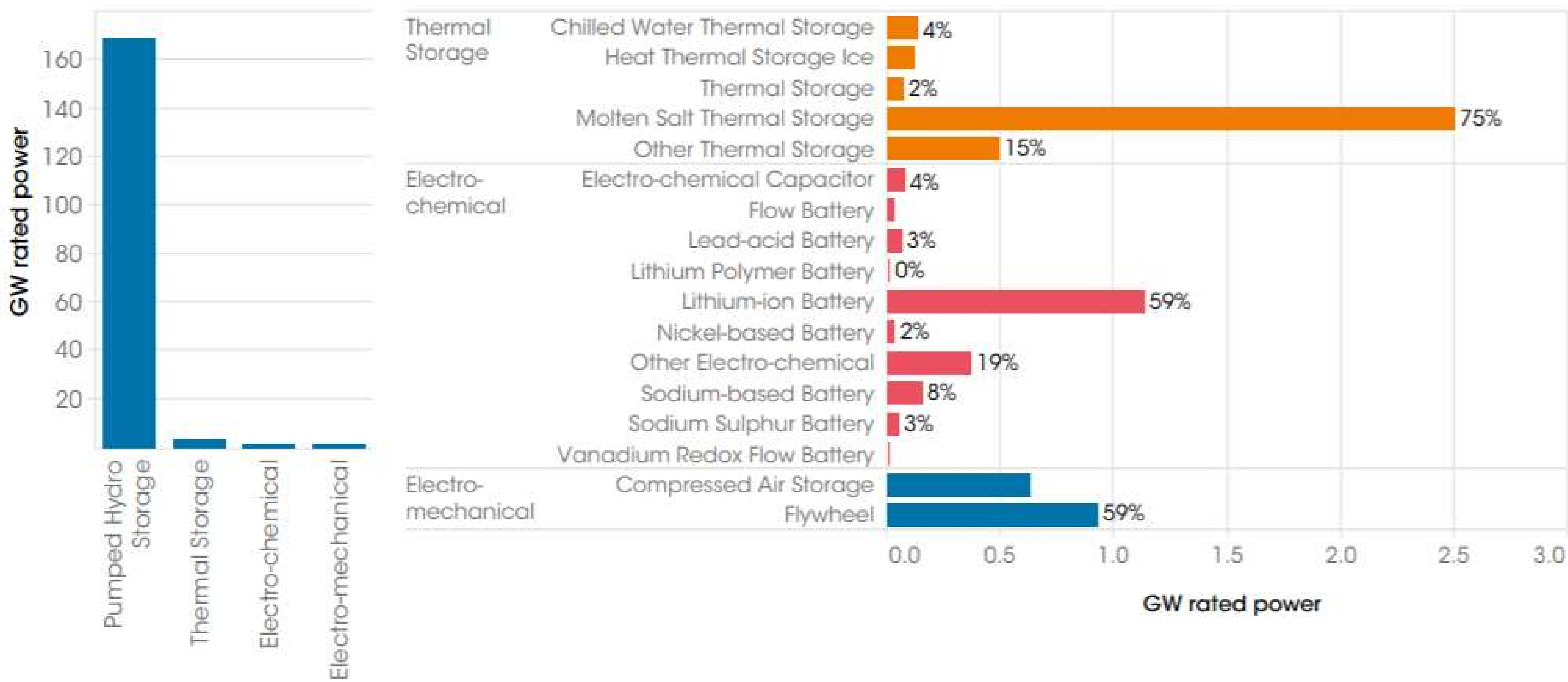
100 MW, 8 hrs storage with
CO_2 heat pumps and electrical heater



Comparison of footprint for a 800 MWhe storage
Cyan = AMSES   Dark Blue = Li –ion Battery
Brown= CSP tower

Global Scenario

Operational Power Storage Capacity by technology –mid 2017



Recommendation

- Thermal Storage- Effective for long term storage / discharge cycles than battery
- May also be used for partial coal flexibility support.
- Utilization of existing assets. Low space requirements- TG cycle reuse.
- Guidelines for evaluating new technologies & implementing a pilot scheme

Ensure Cyber Security

Attack Surface

INFORMATION TECHNOLOGY

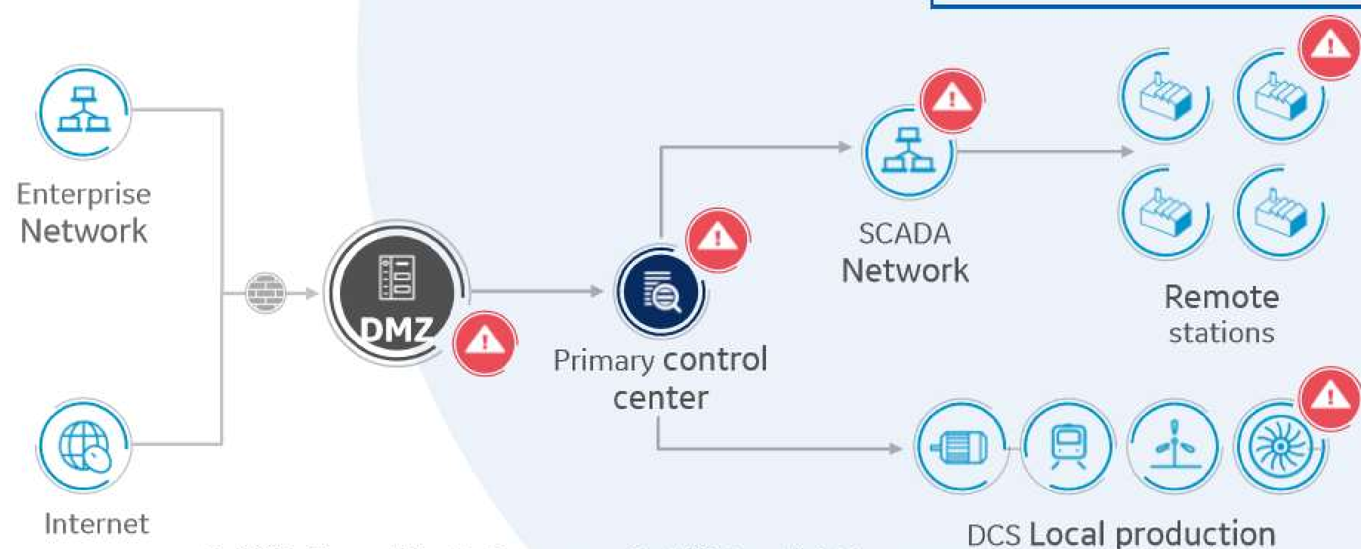
IT includes virtual/online work and computer networks.

IT stores, retrieves, transmits, and manipulates data, mostly in the virtual world, using computer networks.

OPERATIONAL TECHNOLOGY

OT includes hardware and software.

It is focused on moving and controlling devices and processes to keep systems working as intended, safely and efficiently.



DMZ: Demilitarized Zone; SCADA: Supervisory control and data acquisition

500,000,000,000$

$500 Billion total potential cost of cyber crime to the global community

146 days

Median number of days an attacker resides within a network **before detection**

3,800,000$

$3.8 Million average cost of a data breach to a company

1,000,000$

Up to $1 Million per day fine for NERC **compliance violation**

data src: Microsoft

Ukraine Grid cyber attack

225K people lost power in the Ukraine from cyber attack (December 2015)

The attackers appear to have gained access more than **six months prior** the power outage occurred

+30 Substation, 3 utilities companies attacked

Impacted stations worked in **operationally constrained mode** after electrical service was restored

src: Analysis of the cyber attack on Ukreainian Power grid

Why should **YOU** care about cyber security?

There is a growing trend of using cyber attacks to target critical infrastructure and industrial systems...

TRITON Saudi Arabia cyber attack

Attack goals was to **sabotage** the firm's operations and **trigger an explosion**

Within minutes of the attacks, hard drives inside the company's computers were destroyed and their **data wiped clean**

First insertion without interrupting normal operation
First **compromise of safety control system** (SIS)

src: SANS Webinar - Anatomy of TRITON ICS Cyberattack

NERC Enforcement: Duke Energy fined $10M

NERC fined Duke Energy $10 Million for **security violations** between 2015 and 2018 regarding critical infrastructure assets

The 127 security violations, including critical cyber assets, were largely self-reported by the utility and caused by:

- Lack of managerial oversight,
- Process deficiencies,
- Inadequate training
- Lack of internal controls.

src: https://www.utilitydive.com/news/duke-fined-10m-for-cybersecurity-lapses-since-2015/547528

Why should YOU care about cyber security?

...cyber security related policies have been established around the world and national entities are getting more and more serious into enforcing security standards!

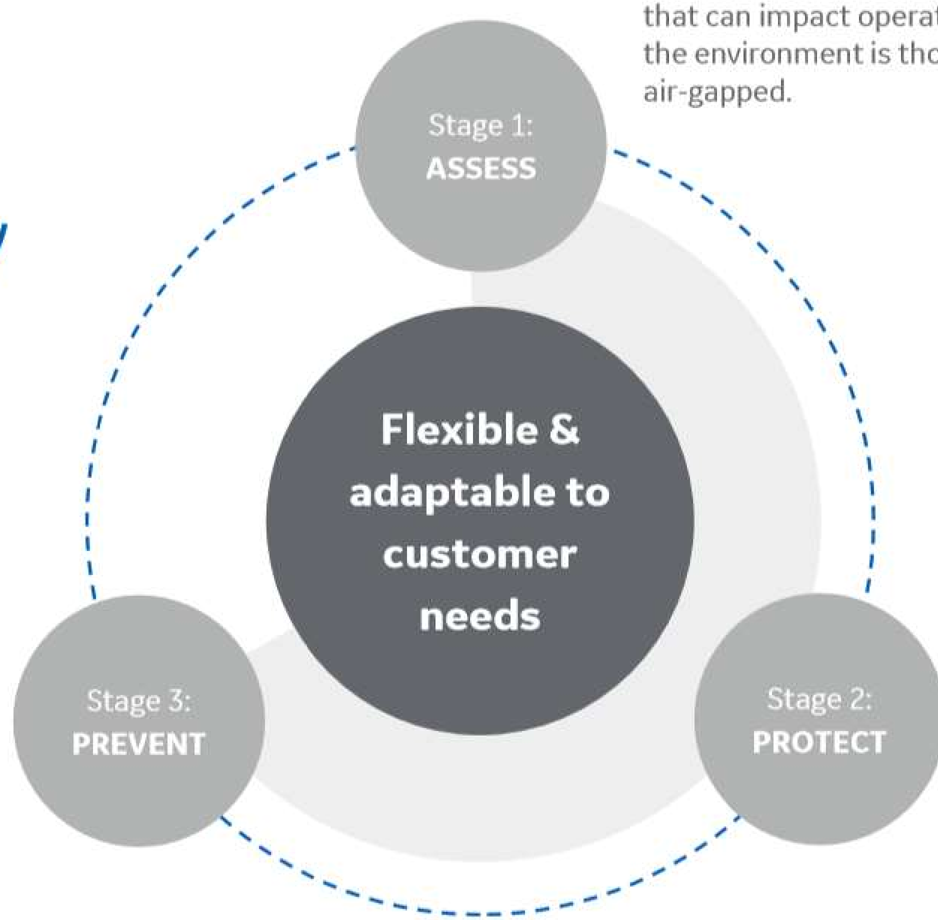
United Kingdom latest announcement

New fines for essential services operators with poor cybersecurity as much as £17 million or 4 per cent of global turnover

NIS Directive will help make UK most secure place to live and do business online

src https://www.gov.uk/government/news/new-fines-for-essential-service-operators-with-poor-cyber-security

GE Cyber Security defense strategy



Identify immediate security issues that can impact operations even if the environment is thought to be air-gapped.

Implement security monitoring and defensive layers to comply with standards and strengthen the security posture of a company.

For sophisticated organizations, pursue proactive and predictive security measures such as have a response plan & trained personnel to execute it during or after cyber events

Recommendation

- Guidelines for protecting the generation & transmission assets by implementing -cyber security
- Develop & Implement Cyber security standards/ grid codes