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India SMART UTILITY Week 2025

Session : 2

Future Trends and Challenges

Presented By

Mr. Subhadip Raychaudhuri, Additional General Manager, Tata Power-DDL

Performance in past 20 years

Parameter	Unit	July 2002	March 2024
OPERATIONAL PERFORMANCE			
AT&C Losses	%	53.1	5.92
System Reliability – ASAI -Availability Index	%	70	99.9
Transformer Failure Rate	%	11	0.68
Peak Load served	MW	930	2481 *(as on 18 June 2024)*
Length of Network	Ckt. km	6750	14250
Street Light Functionality	%	40	99.6
Smart Meters Installed	Lakh	0	4.99
CONSUMER RELATED PERFORMANCE			
New Connection Energisation Time	Days	51.8	3
Meter Replacement Time	Days	25	3
Mean Time to Repair Faults	Hours	11	0.67
Consumer Satisfaction Index	%	-	97.8

TATA POWER–DDL IS CERTIFIED WITH					
ISO 9001:2015	ISO 14001:2015	OHSAS 18001:2015	ISO 27001:2005	SA 8000 : 2008	EMS 50001:2018

Recent feathers in TPDDL Cap

1st Time for TPDDL

- Successful peak load management – All Time High load of 2481 MW
- All Time High Billing Efficiency @ 94.5%
- >5.3 Lakh Smart Meters installed
- Prestigious Deming Prize 2024
- Patent on Self Generating Breather
- Smart Grid Index 2024
- Customer Service Rating of Discom (CSRD) FY23-24
- Integrated Rating of Discoms FY23-24
- Distribution Utilities Ranking FY23-24

Smart Grid Index 2024 (by Singapore Power)

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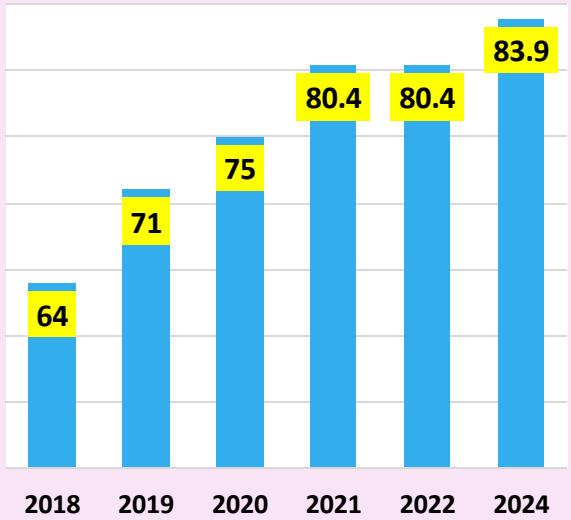
Benchmarks a total of 92 utilities across 36 countries / markets

Utilities	Country/Market	Score %	Best Practices
Enedis	FRA	98.2	
TaiPower	TWN	96.4	
UKPN	GBR	96.4	
CitiPower & Powercor	AUS	94.6	
DEWA	ARE	94.6	
State Grid Shanghai	CHN	94.6	
ConEd	USA	92.9	
SP Energy Networks	GBR	92.9	
State Grid Beijing	CHN	92.9	
WPD	GBR	92.9	
Guangzhou Power	CHN	91.1	
Shenzhen Power	CHN	91.1	
ENWL	GBR	89.3	
Northern Powergrid	GBR	89.3	
SDGE	USA	89.3	
TEPCO	JPN	89.3	
ComEd	USA	87.5	
SSEN	GBR	87.5	
Stedin	NLD	87.5	
Duke Energy	USA	85.7	
FPL	USA	85.7	
SCE	USA	85.7	
BGE	USA	83.9	
CLP	HKG	83.9	
Chubu	JPN	83.9	
e-distribuzione	ITA	83.9	
i-DE	ESP	83.9	
Jemena	AUS	83.9	
LADWP	USA	83.9	
PG&E	USA	83.9	
PEPCO	USA	83.9	
Tata power-DDL	IND	83.9	
United Energy	AUS	83.9	

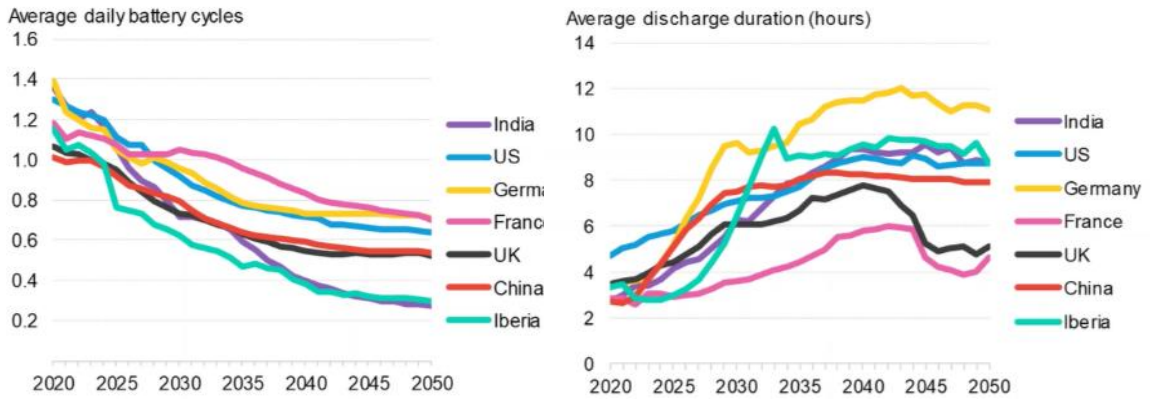
Tata Power-DDL- Smart Grid Index Score trend (↑)



- **Best Practice in 'Monitoring & Control' in 2018 rating**
- **Best Practices in 4 areas in 2024 - Monitoring & Control, Green Energy, Security, and Customer Empowerment & Satisfaction**

Key Technology Trends driving the Global Energy Transition

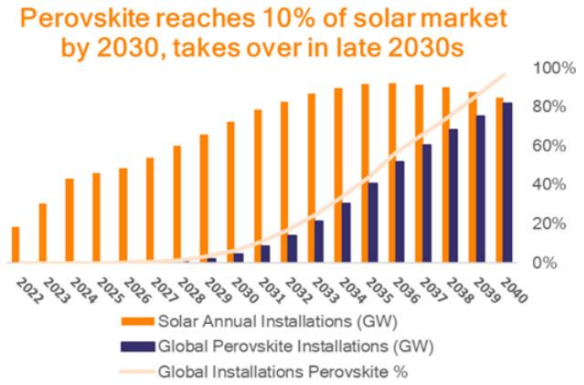
Long Duration Energy Storage (LDES) emerging as a key driver



Source: BNEF, 2024

LDES: CAES, Pumped Hydro, Flow Battery, Gravity, Liquid CO2

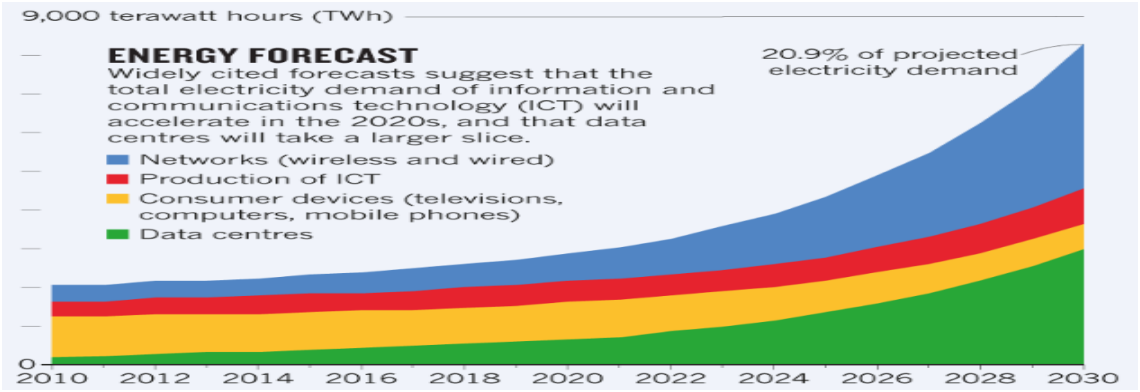
Perovskites & Hybrid Tandem emerging as new mfg opportunities



BIPV, tandem (TOPCOn + perovskites), Vehicular and Space Applications gaining interest

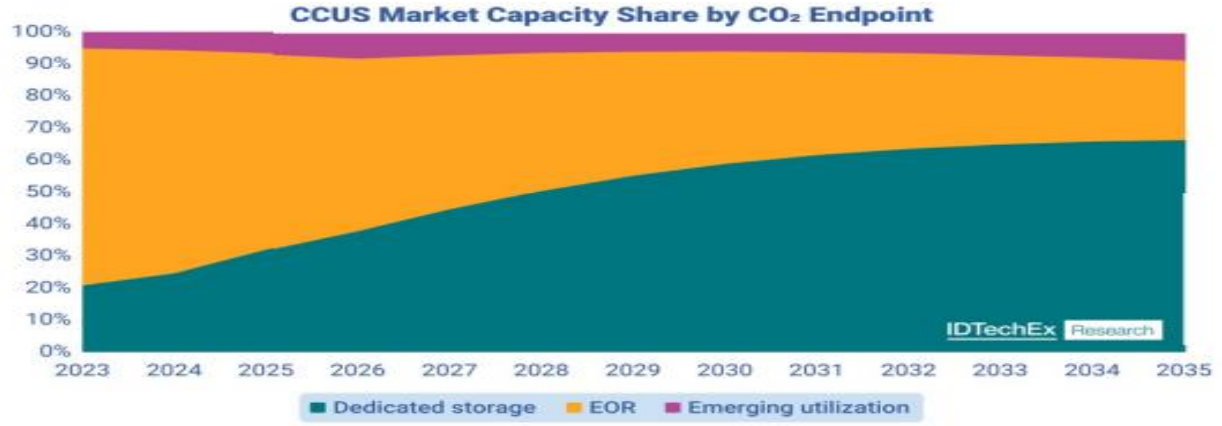
Source: Rethink Energy, 2024

Data Centers tying up with SMR's for 24x7 clean power



Microsoft, Amazon Web Services, Equinix, Oracle and **Google** tying up firm commitments with nuclear companies (SMRs)

CO2 Storage + conversion to chemicals expected to gain traction



Significant growth in demand for Sustainable Aviation fuels from Captured CO2 post 2030

Thematic Areas of Emerging Technologies

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Deep Technology

Solar PV		Thermal Generation		Distribution/RE	Transmission
Perovskite – Silicon Tandem Solar Cells	Organic PV Solar Cells	Carbon Capture Utilization & Storage	Nuclear – SMR/Fusion	Non-Lithium Battery Chemistry	Superconductors for Transmission

Efficiency, Quality, Safety & Yield Improvement

Solar PV			Transmission		Distribution		Thermal Generation
Anti-Soiling Coating	Atmospheric Dry Etching	Coatings for Solar Wavelength Absorption	Photonic Coatings	Advanced Conductors	Micro Substations	Fault Neutralization	Cooling Tower Optimization

New Product/Solution Development

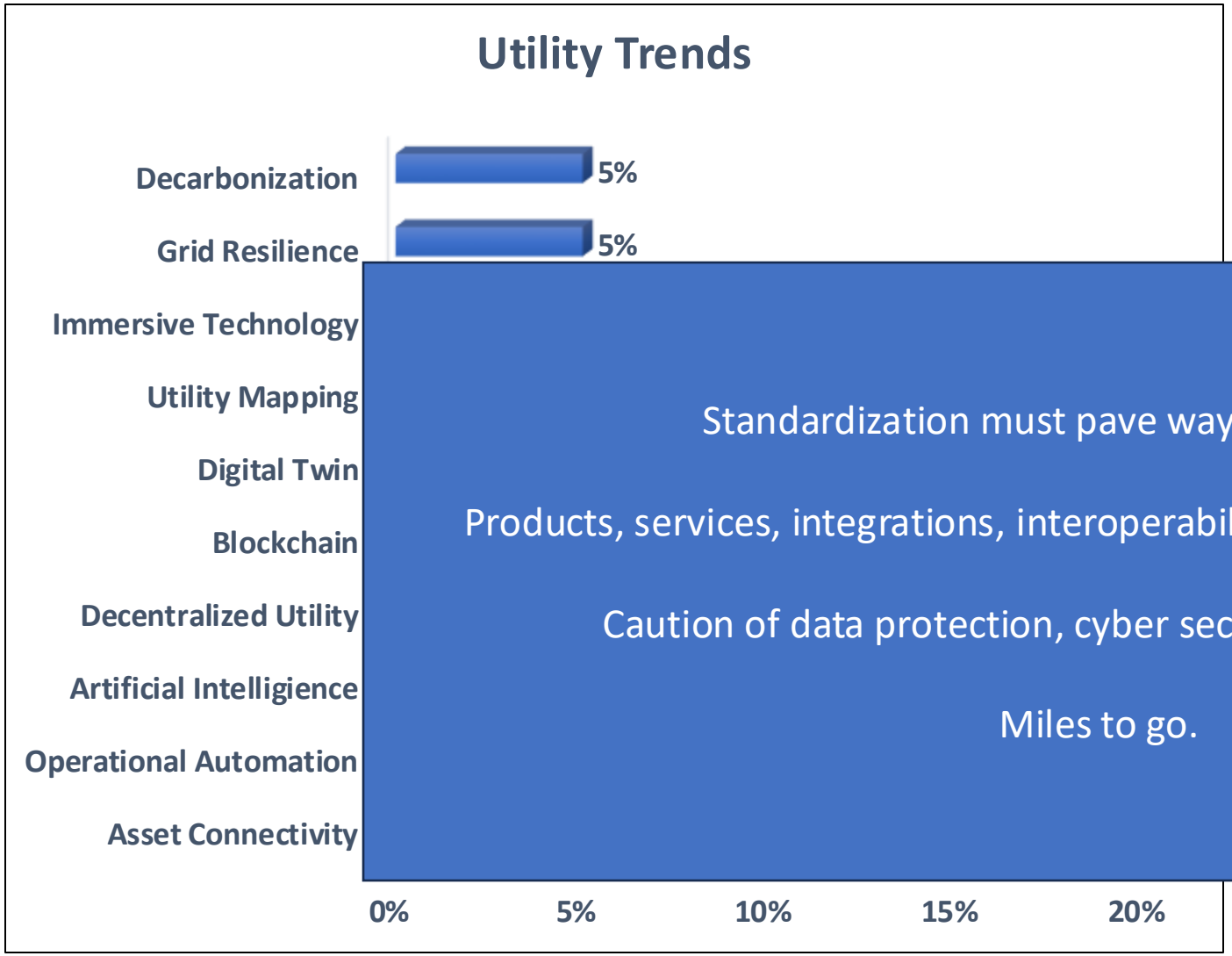
Solar PV		Microgrids	Distribution			EV Charging		
Floating Structures	Solar PV BOM	Biogas Generation	Alternative Materials	Feeder Pillar Leakage Current Detector	Localized Cyclone Detector	Smart Home Charger	Wireless Charger	V2G

- Carbon Net Zero by 2045
- Water Neutrality by 2030
- No Net Loss to Biodiversity by 2030

Digitalization Innovations

Hydro/Thermal Generation		Transmission	Distribution	
Inflow Forecasting and Scheduling	Digital Twin of Boiler	Satellite Imagery	Bottom Up Demand Forecasting	Digital Grids

Emerging Trends in the Utility Industry



Standardization must pave way for innovation.

Products, services, integrations, interoperabilites have to be worked upon.

Caution of data protection, cyber security are real threats.

Miles to go.

Source: Top 10 Utility Industry Trends in 2023-2024 | StartUs Insights (startus-insights.com)

Need for Innovations in Utility

- Variability in Fuel Prices
- netration in
- yberattacks
- ther/Natural
- f EVs in the
- ue to shift in

Source: Digital transformation and the utility of the future | Deloitte Insights

Quantum Technology in Energy Systems

Quantum Technology

- Field of science and engineering harnessing quantum mechanic principles (atoms & molecules) to develop new technologies with revolutionary capabilities.
- Utilizes quantum system properties like superposition and entanglement to perform challenging tasks.

Quantum Computing

Using quantum bits (qubits) to perform **high speed and complex computations**

Energy Sector Potential

- Hybrid Optimization DER Models
- Grid Safety and Resilience
- Cost-effective Grid Operation
- Accurate Weather Forecasting

Use Case

Gridsperstise – Quantum Computing for **Grid Resilience and Flexibility**

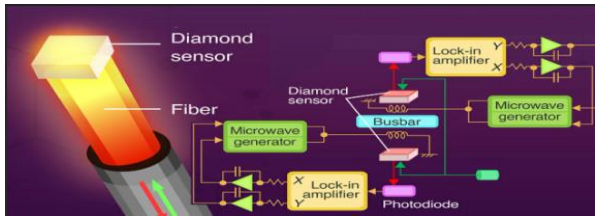
Quantum Sensors

Ultra-high precision measuring of physical quantities (Time, Magnetic fields, Temperature)

Energy Sector Potential

- Predictive Maintenance
- Automation for Smart Grids
- Nuclear Plant Safety and Efficiency
- EOR and GHG Emissions Detection

Use Case



Tokyo Tech – Diamond Quantum Sensor for **EV Battery Monitoring**

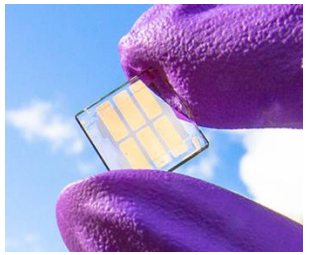
Quantum Materials

Materials with unique properties **enhancing performance** of **solar cells, energy storage devices,** etc.

Energy Sector Potential

- More Efficient Solar Cells
- Higher Capacity Batteries
- Superconductors for zero-loss energy transmission
- Catalysts for clean fuel production

Use Case



MIT – Low Cost **9%** Efficient **Quantum Dot Solar Cell**

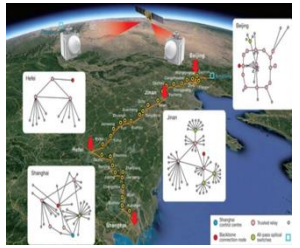
Quantum Communication

Secure data transmission in energy networks, protecting against **cyber threats**

Energy Sector Potential

- Secure data transfer in electricity grid
- Mitigation of grid failure
- Real Time Monitoring of Energy Systems

Use Case



China – World's 1st Integrated Quantum Communication Network

Emerging Technology – Few Field Experiences

- Under the Horizon 2020 Framework, the Indian and European Local Energy CommuniTies for Renewable Integration and the Energy Transition (IELECTRIX) project aimed towards increasing renewable energy integration into the distribution network.
- With an overall budget of 10.7 million euros, the project was coordinated by Enedis France of a duration of 42 months with 15 European Partners and 1 Indian Partner.

Indian Demonstration: SHAKTI

- Through a cooperation agreement between Enedis and TPDDL, the demonstration aimed at showcasing the implementation of Local Energy Communities (LEC) using local PV units and self-consumption approach through innovative solutions at a district level in New Delhi, India.

Key Objectives

- Maximise the penetration of local energy in the LV Grid.
- Increase the local consumption of Renewable Energy.
- Improve the resilience of the local energy system.

Implementation

- Mobile Storage System and Smart Substation.
- Adapted Demand Side Management.
- Islanding Capacity of Microgrid in case of outage.

Snapshot of the installed system

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THANK YOU

For discussions/suggestions/queries email: isuw@isuw.in

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Links/References (If any)