

### Innovative Cross-Sector Clean Energy Integration and Management in South Asia

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Sector coupling and Power to X are fundamentally reshaping the energy landscape, breaking down silos of industry, mobility, agriculture and urban landscape



By electrifying everything from mobility, manufacturing to fuel production—especially through renewables—these innovations are shaping a smarter, more resilient, and sustainable energy future



### **Power to Transport – direct and indirect electrification of transport**

Pathway		Description	Use cases	
	Electric Mobility (EVs)	Direct use of electricity via batteries in 2/3/4-W, buses & trucks	Urban mobility, fleet decarbonization	
	Green Hydrogen (FCEVs)	Hydrogen produced from RE used in fuel cell vehicles	Heavy-duty trucks, rail, shipping	
<b>1</b>	e-Fuels / Synthetic Fuels	Liquid fuels like e-diesel, e-kerosene, SAF, ethanol blending	4W, Aviation, maritime	
	Electrified Railways	Electrification of train networks	Intercity and metro rail systems	

- NEA through ADB support launched 62 charging stations in FY24 (first large scale installation)
- In 2025, 750 charging stations approved (majority under Pvt. sector) - 238 under construction
- Integration provides new revenue stream to NEA, clean air to Nepal & clean and affordable mobility to citizens





Many more regional examples have started to emerge in India, Bhutan and other countries ....



# Power to Industry, empowers Industry with energy efficient usage and sustainable fuels for deep decarbonisation

Pathway	Description	Use cases	
Heat Pumps	High-efficiency electric systems for low-to-medium temperature heating	Paper, textile, and food industries	
Electric Arc Furnaces (EAF)	Use of electricity to melt scrap metal or direct reduced iron	Steel production	
Waste Heat Recovery	Capturing waste heat for power generation	Cement production, glass and metal processing	
Battery & Thermal Energy Storage	Deploying battery systems and thermal storage for flexible energy use in industrial operations	Load balancing, peak demand management, process stability	





The trials have shown potential to reduce about 7-10% of CO2 emissions per ton of crude steel produced



Gunung Steel Group in Indonesia is expanding its use of Electric Arc Furnace for recycling of scrap metal, reducing its emissions.



Multiple programs are being designed to promote use of hydrogen in hard to abate industries like cement, steel, aluminum etc. and support deep decarbonization .



# Power to Agriculture, brings clean energy solutions to agriculture, driving sustainable food and fuel production

Pathway	Description	Use cases	
Solar-Power ed Irrigation	Solar PV systems driving water pumps for irrigation	Enhancing water access for small and marginal farmers	
Electric Farm Machinery	Battery-powered tractors, harvesters, and irrigation pumps replacing diesel-based equipment	Sustainable crop cultivation, reducing emissions in farming	
Biogas-to-P ower	Agricultural waste converted into biogas for electricity generation	Rural electrification, waste mgt., decentralized power	
Electrified Food Processing	Transitioning food & agro-processing industries from fossil-fuel-powered systems to electric alternatives	Cold storage, drying, milling, processing efficiency	



Bangladesh's IDCOL program financed by ADB has replaced diesel with over 2,500 solar irrigation pumps, cutting 12 million liters of diesel use annually and driving a cleaner, more sustainable farming future. Aim is to replace 2 mn diesel pumps. ADB's Uttar Pradesh Power Distribution Network Rehabilitation Project – Focused on feeder segregation for agriculture and rural supply; upgrades of low voltage rural network and facilitating use of solar energy for agriculture demand.

Similar program exist in Madhya Pradesh and Maharashtra also.





### A fragmented energy system leads to inefficiencies and missed opportunities for decarbonization



#### Planning gap

Not easy! Too many systems and sub-systems

Autonomous agents (Agentic AI) excel at decomposing complex, multi constraint problems & iterating plans in real time – provides ways to do it.

Analysts already see one third of enterprise apps embedding agentic AI by 2028

#### Why integrated planning matters

#### System wide optimization

· Balance demand-supply across sectors & time

**Complexity spike** 

Co-ordinating infra invest (GH grid, electricity grid)

#### Policy & Market Coordination

Cross-sectoral policies (carbon, RE) that align incentives Regulatory frameworks that support new business models (aggregators, storage etc.)

#### **Digitalization & Data Integration**

•Smart meters, IoT & AI capture sectoral interactions in real time and provide the required decision support

Framework - Integrated planning need to shift from traditional siloed planning/forecasting to an integrated, adaptive, and intelligence-augmented model



# In summary, it is a conscious choice of shifting towards a more integrated technology oriented dynamic planning that encompasses multiple sectors, fuels and stakeholders

	Old Approach	New Approach	"Sector coupling and Power-to-X are two sides of the same coin: one connects the sectors, the other provides the technologies to transfer energy between them."
Time Horizon	Static 10– 20 years plan	Rolling, adaptive cycles	— Fraunhofer Institute for Systems & Innovation Research ISI
Energy Vectors	Power-only or gas-only	Electricity, hydrogen, CO2, e-fuels, thermal	"By linking Power-to-X with sector coupling, we turn variable renewable energy into a stable pillar for mobility, manufacturing, and buildings — unlocking true system-wide decarbonization."
Sector Scope	Supply-side focus	Cross-sectoral: heat, mobility, industry	— World Economic Forum, Energy Transition Framework
Tooling	Linear programs, spreadsheets	Digital twins, agentic AI, generative insights	"Power-to-X enables sector coupling by using renewable electricity to produce green hydrogen, synthetic fuels, and heat — forming the backbone of a deeply integrated energy system."
Governance	Utility-Centric	Multi-agency, cross-sector coordination	— European Commission, Energy System Integration Strategy



Thank You

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"In a decarbonized future, electrons start the journey – but through Power-to-X, they become fuels, heat, and feedstocks that travel across every sector.

Electricity alone cannot decarbonize the World – it needs smarter connections. Integrated planning turns these trends into a shared solution that benefits all"