Analysis of potato value chain in West Bengal

Roadmap for retrofitting-cum-modernizing existing cold storages

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Alliance for an™ Energy Efficient Economy

Overview of cold-chain in India

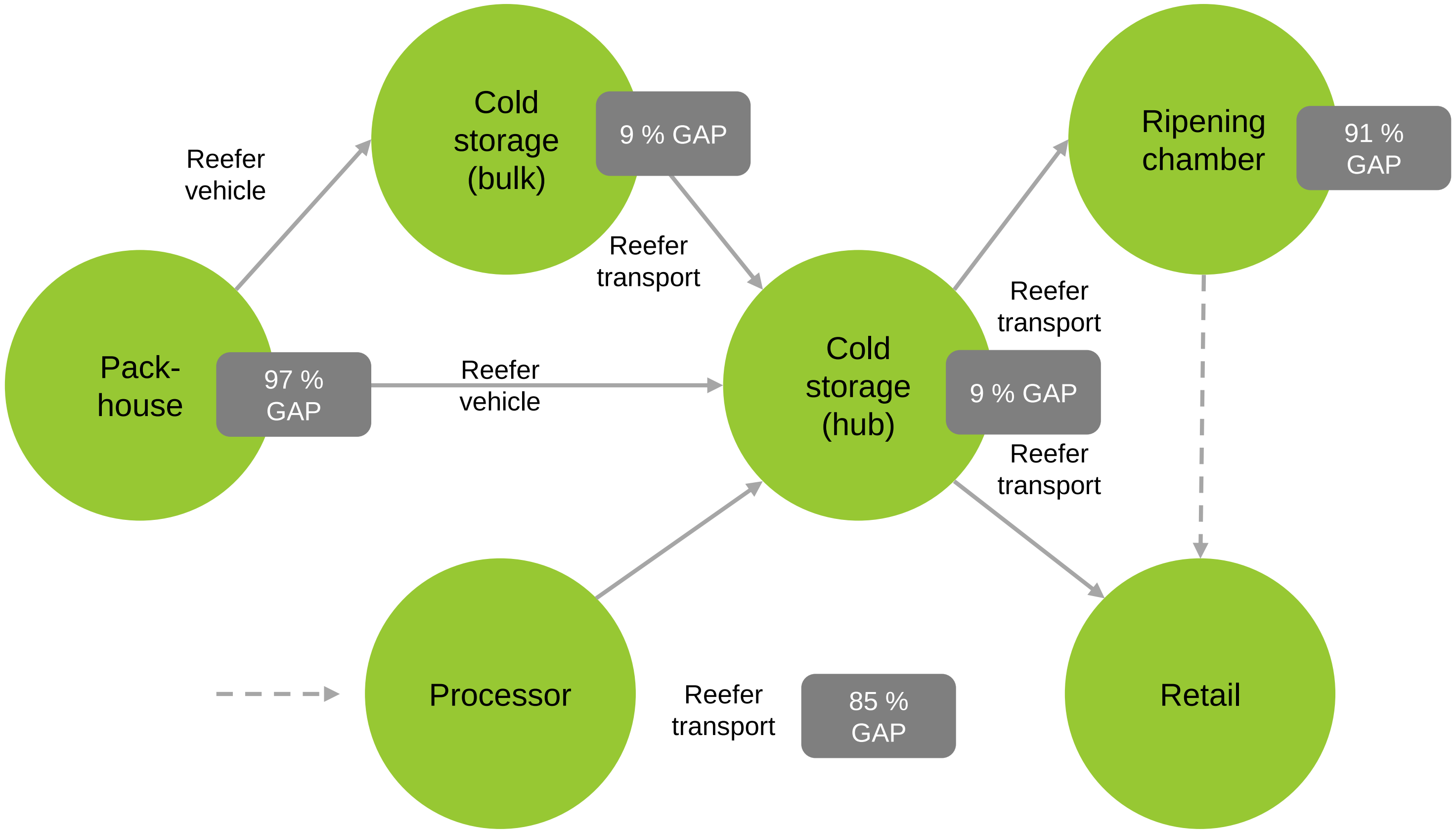
A typical cold chain consists of

In India, the cold chain infrastructure is understood as mostly cold storages

Overview

- Agriculture contributes ~16% of GDP and employs at least 42% of people in India
- India is the second-largest producer of fruits and third-largest producer of vegetables in the world
- Most farmers are small-scale **(~126 million)**, accounting for **86% of all farmers in India, owning about half the arable land**
- Limited (mostly no) access to cold chain infrastructure because of the **absence of affordable cold chain logistics**
- fruits and vegetable losses is 4.58% to 15.88%
- fruits and vegetables wastage is around 30%

Cold chain infrastructure overview



A **twin-approach** to cater to the gap in cold chain infrastructure:

- Uninterrupted modern super-speciality cold-chain catering to the export-oriented and supermarket-oriented produce
- Cold-chain infrastructure tailored to the needs of the smallholder farmers

The gap presents an opportunity to frame policies and regulations to develop more climate friendly cold-chain infrastructure

Agricultural and Cold Storage landscape in West Bengal

- Dominated by small and marginal landholdings
- Agricultural households' income- INR 11,750 i.e. 1/3 of all India avg- INR 36,950
- Second largest horticultural producing state
- Potato is a major horticulture crop. Stands 2nd with 1/4 of India's total potato production
- 90% of 500+ cold storages in the state are used for potato

West Bengal stands 5th in terms of no. of cold storages in India and 2nd in terms of share of storage capacity

32% of the West Bengal cold storages are more than 30 years old (Hansa Research Group 2014)

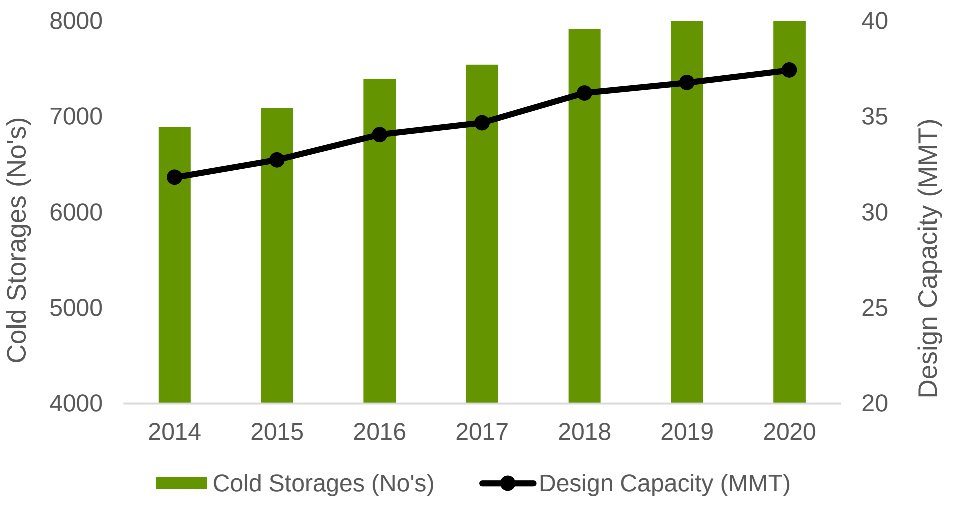
Improving the agricultural supply cold chain in West Bengal will have significant positive impact on the state's economy and rural livelihoods

Cold Storage industry in India and West Bengal

West Bengal stands 5th in terms of no. of cold storages in India and 2nd in terms of share of storage capacity (as on 31st August 2020)

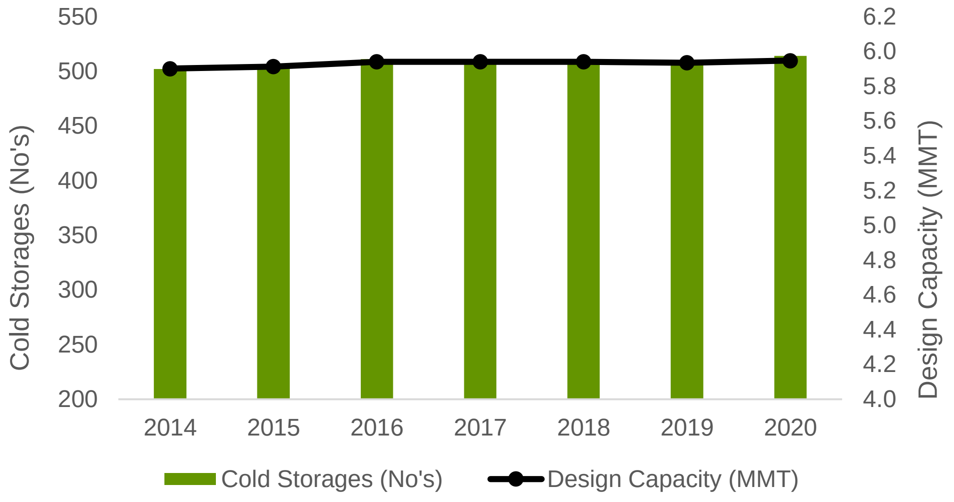
India

CAGR- (No’s: 2.9%; MMT: 2.7%)



West Bengal

CAGR- (No’s: 0.4%; MMT: 0.1%)

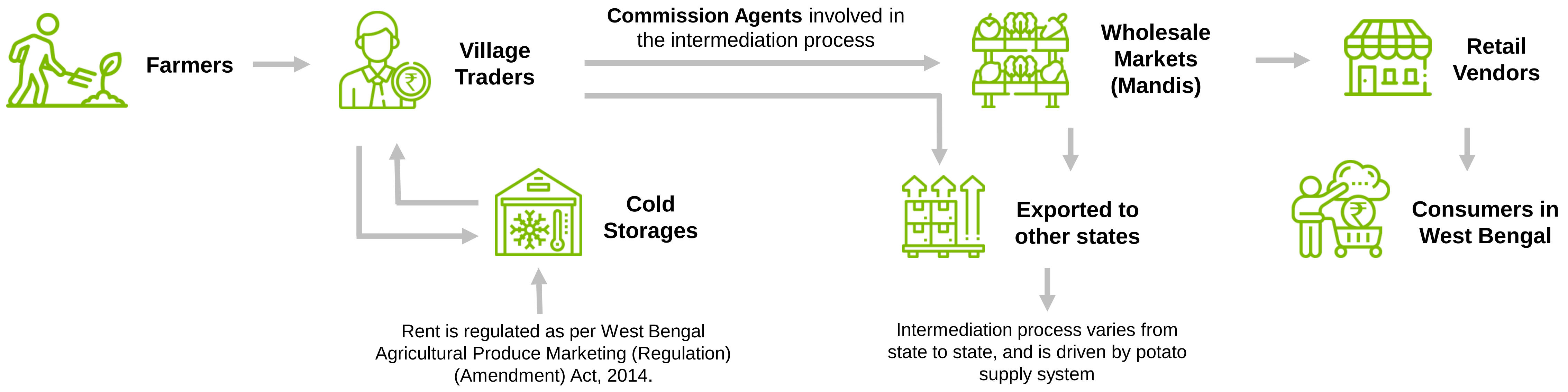


Source: Agriculture Statistics at a glance (various years), NCCD (2014)
Note: Data for the year 2020 is as on 31st August 2020

- Rate of growth of Cold Storages in West Bengal is much slower than the all India growth
- **514 cold storage units (5.9 MMT storage capacity) in West Bengal**; 465 (90%) are used to store potatoes
- 32% of the West Bengal cold storages are more than 30 years old (Hansa Research Group 2014)

Losses reported in supply chain of potatoes in West Bengal

Cold storages are an essential link in potato supply chain as they act as service providers



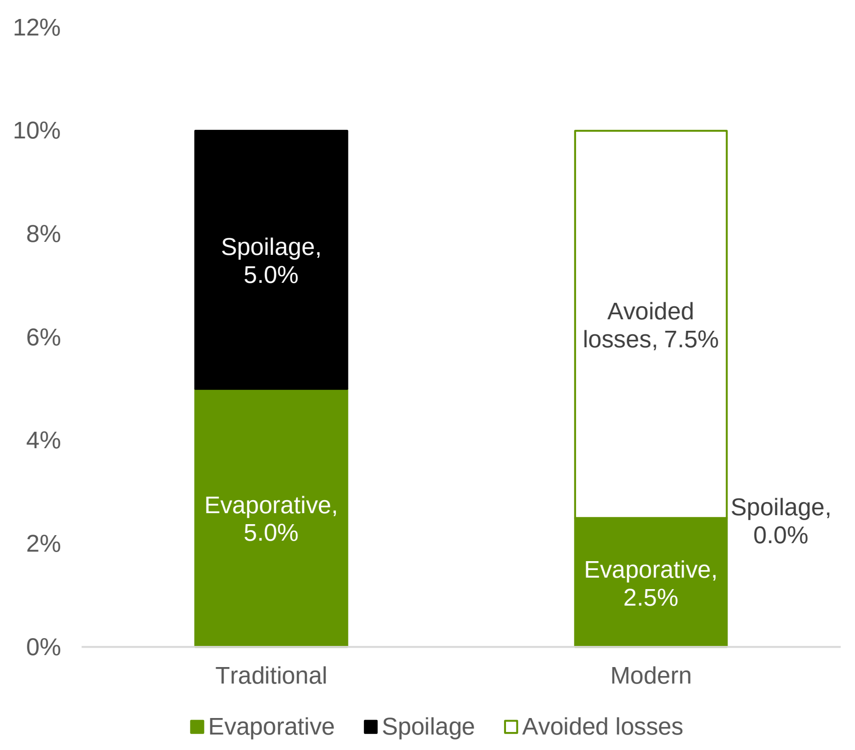
>25% overall value losses are reported in the supply chain of potatoes in West Bengal

Production losses [5%] → **Storage losses [10%]** → **Wholesale markets (*Mandis*) losses [5%]** → **Retail markets losses [10%]** → **Consumption**

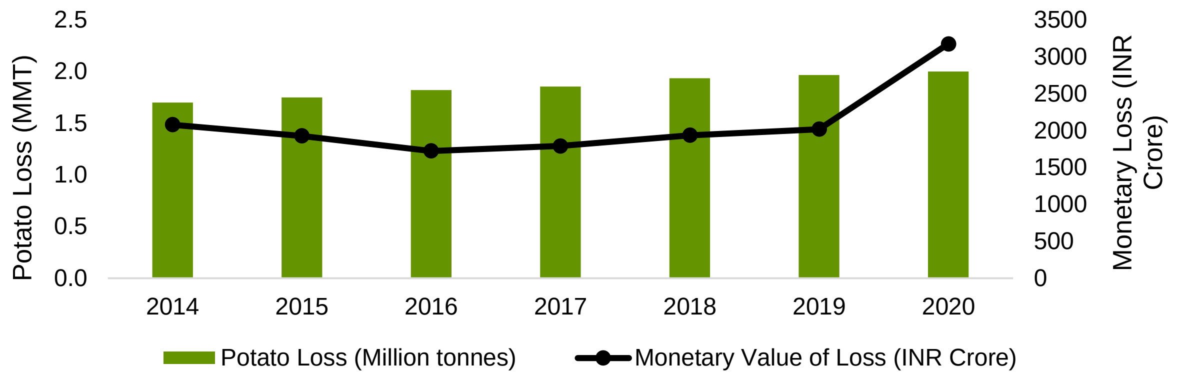
Source: AEEE estimation

Potato Losses in Cold Storages Avoided through Modernization

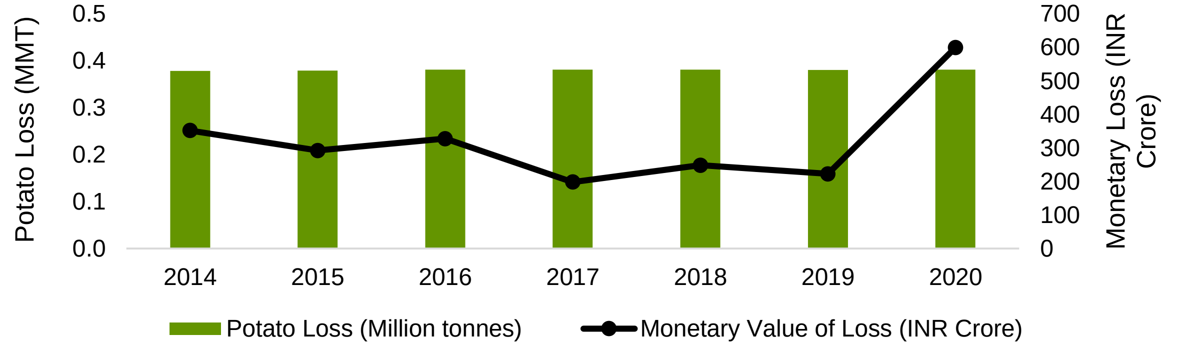
Losses avoided through modernization at storage level



India (avoided potato loss)



West Bengal (avoided potato loss)



75% of the total potato losses happening in West Bengal (i.e. 0.38 MMT of the total 0.51 MMT loss) can be avoided if traditional cold storages are retrofitted to modern ones, thereby yielding monetary benefits of INR ~600 Crores in 2020

Source: AEEE estimation
Note: The variation in monetary loss is also due to the annual variation in potato wholesale prices

Key findings from field assessment

Basic details of the three cold storages in the Hooghly district of West Bengal, where the energy audits were conducted

	Facility #1	Facility #2	Facility #3
Year of establishment (age in 2020)	1987 (33 years)	1986 (34 years)	2010 (10 years)
Location (Climatic Zone)	Hooghly district of West Bengal (Warm and Humid)		
Cold storage capacity	9,500 MT*	15,673 MT	16,200 MT
Commodity stored	Single commodity: Table Potatoes (Jyoti and Chandramukhi)	Multi-commodity: Table Potatoes (Jyoti and Chandramukhi), Processing Potatoes (for chips manufacturing), Maize, Chilli and Ground-nut	Multi-commodity: Table Potatoes (Jyoti and Chandramukhi), Processing Potatoes (for chips manufacturing), Chilli and Dhania
No. of chambers	2	14	14
Refrigeration plant	Reciprocating Ammonia compressors with gravity flooded system	Reciprocating Ammonia compressors with gravity flooded system	Reciprocating Ammonia compressors with gravity flooded system
No. of compressors (capacity)	7 (110TR X 2,100TR X 2, 80TR X 2, 65 TR)	7 (110TR X 2,100TR, 80TR X 2, 65 TR, NA)	5 (110TR X 2, 80TR X 2, 60 TR)
Evaporator	Traditional bunker coil	Hybrid of traditional bunker coil and modern ACUs	Modern ACUs
Ammonia flow control	Manual	Manual	Manual
Condenser	Atmospheric	Atmospheric	Atmospheric
Diesel Generator (DG) sets	2 Nos. (70 kVA and 110 kVA)	3 Nos. (63 kVA, 110 kVA and 250 kVA)	3 Nos. (15 kVA, 110 kVA and 250 kVA)
On-site PV	None	Rooftop PV of capacity 300 kWp with net metering	None
Automated material handling system	None	None	None
Strip curtain and/or Air curtain	None	None	None
Wall insulation	Chamber 1: Fibre Glass; Chamber 2: Thermocol (EPS**)	Varies from chamber to chamber: Thermocol (EPS) or PUF**	Varies from chamber to chamber: Thermocol (EPS) or Fibreglass or PUF
Roof insulation	Thermocol (EPS)	Fibre Glass	Fibre Glass
Door insulation	PUF	Thermocol (EPS)	Thermocol (EPS)

** MT: Metric Ton; ** EPS: Expanded Polystyrene; *** PUF: Polyurethane Foam*

Field Observations

Traditional design and operation of cold storages is the leading cause for

food loss (evaporative weight losses and spoilage)

energy wastage

- Majority of Cold Storages in West Bengal are **traditionally designed, constructed and operated**
- **Improper manual handling practices** damages the potatoes due to physical shocks and compression
- The **thermal integrity of the building envelope** is not appropriately maintained
  - Poor quality of insulation for roof, walls, and doors
  - Leakages and infiltration are common place from frequent opening of doors and cracks on walls/roof
- **Inadequate fresh air ventilation** leading to CO_2 built up suffocating the stored produce
- The **refrigeration plant is designed with non-standard, non-tested equipment, leading** to energy wastage and safety hazards (toxicity of Ammonia)
  - Traditional bunker coil design leads to poor air circulation, vertical temperature asymmetry, low humidity, and poor cold storage space utilization- upto 20% of the available space is occupied by bunker coils
  - No refrigeration system controls- manual throttling of ammonia flow valves for cooling control
  - Non standard atmospheric condensers leading to energy wastage and high drift (water) losses

Annual energy consumption and expenditure for 3 facilities for 2018-19 and 2019-20

S. No	Particulars	Unit	Facility #1		Facility #2		Facility #3	
			2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Energy Consumption								
1	Annual Energy Purchased & Consumed from Grid	kWh	5,85,712	4,41,249	8,15,685	7,62,920	4,74,255	6,46,150
2	Annual Energy Generated (by DG Sets) & Consumed	kWh	16,933	12,687	16,236	5,904	4,360	12,644
3	Annual Energy Consumed from Solar PV System	kWh	NA	NA	1,13,575	1,81,441	NA	NA
4	Total Annual Energy Consumption	kWh	6,02,645	4,53,937	9,45,496	9,50,265	4,78,615	6,58,794
Energy Expenditure								
5	Cost of Electricity Purchased from Grid	Lakh INR	40.6	32.1	62.2	55.0	34.7	48.3
6	Unit Rate of Electricity Purchased from Grid	INR/kWh	6.9	7.3	7.6	7.2	7.3	7.5
7	HSD Purchased & Consumed	Litre	5,799	4,345	4,400	1,600	2,000	5,800
8	Cost of HSD purchased & Consumed	Lakh INR	4.0	2.9	3.0	1.2	1.4	4.2
9	Unit Rate of HSD Purchased & Consumed	INR/Litre	68.1	67.8	68.0	73.0	68.0	73.0
		INR/kWh	23	23	18	20	31	33
10	Total Annual Energy Expenditure	Lakh INR	44.6	35.0	65.2	56.2	36.1	52.6
11		Euro (@ INR 86/Euro)	51,803	40,750	75,756	65,337	41,977	61,105
Energy Use Intensity								
12	Design Capacity	MT	9,500	9,500	15,673	15,673	16,200	16,200
13	Energy Use Intensity	kWh/MT	63	48	60	61	30	41

Standardized Energy Efficiency Measures (EEMs)

EEMs will lead to reduced energy expenditure, better air circulation, better product quality and lower ammonia leakages

Improving the thermal performance of the building envelope

- PUF insulation panels for wall/roof
- Airtight horizontal insulated doors with air-curtains

Optimizing the overall refrigeration system performance

- VFD drive for compressor
- Evaporative condenser
- Fin coil evaporator with VFD fan and pressure control valves
- Pump recirculation (over feed) system
- PLC controller for the refrigeration plant
- Economizer for subcooling
- Suction line insulation
- CO_2 scrubber*

** Cost-benefit analysis for CO_2 scrubber has not been included*

Overall Scenario for Modernizing Potato Cold Storages in West Bengal

S. No.	Parameter	Unit	Value
1	Avg. energy consumption per CS per year	kWh/year	7,50,000
2	Avg. energy expenditure per CS (@Rs 8/kWh)	INR/year	60,00,000
3	Statewide energy consumption for potato cold storages per year	GWh/year	347
4	Statewide energy expenditure for potato cold storages per year	Crore INR/year	278
5	Investment potential for modernization per CS (of 11000 MT)	Crore INR/year	3.75
6	Avg. energy cost-saving potential per CS through modernization (@20-25%)	INR/year	13,50,000
7	Statewide investment potential for modernizing potato cold storages	Crore INR/year	1736
8	Statewide energy cost-saving potential through modernization	Crore INR/year	63
9	Statewide potato losses avoided through modernization	MMT/year	0.38
10	Statewide monetary benefit from avoided potato losses (@wholesale price of Rs 15,711/MT for 2020)	Crore INR/year	599

Return on investment through energy savings alone is not viable

Total investment potential
INR ~1750 crores

Simple Payback factoring avoided food loss:
2.6 years

Simple Payback factoring additional MIDH subsidy support (~40%):
1.6 years

Source: AEEE estimation based on energy audit data

Possible options for recovery of EESL's investment

Modernization -cum-retrofitting

Recovery of Investment

Energy Savings

Very well established. Though energy efficiency gains are much smaller than non-energy benefits

Monetizing Avoided Food Losses

M&V framework to be established by EESL in coordination with West Bengal State Government

MIDH Subsidy

Can be directly transferred to EESL; facilitated through a tripartite agreement between MIDH, Cold Storage Owners' and EESL

Better Space Utilization

The net capacity of modern cold storage can be increased by upto 20% through replacing the traditional bunker coil system. The capacity expansion will lead to additional revenue for the cold storages

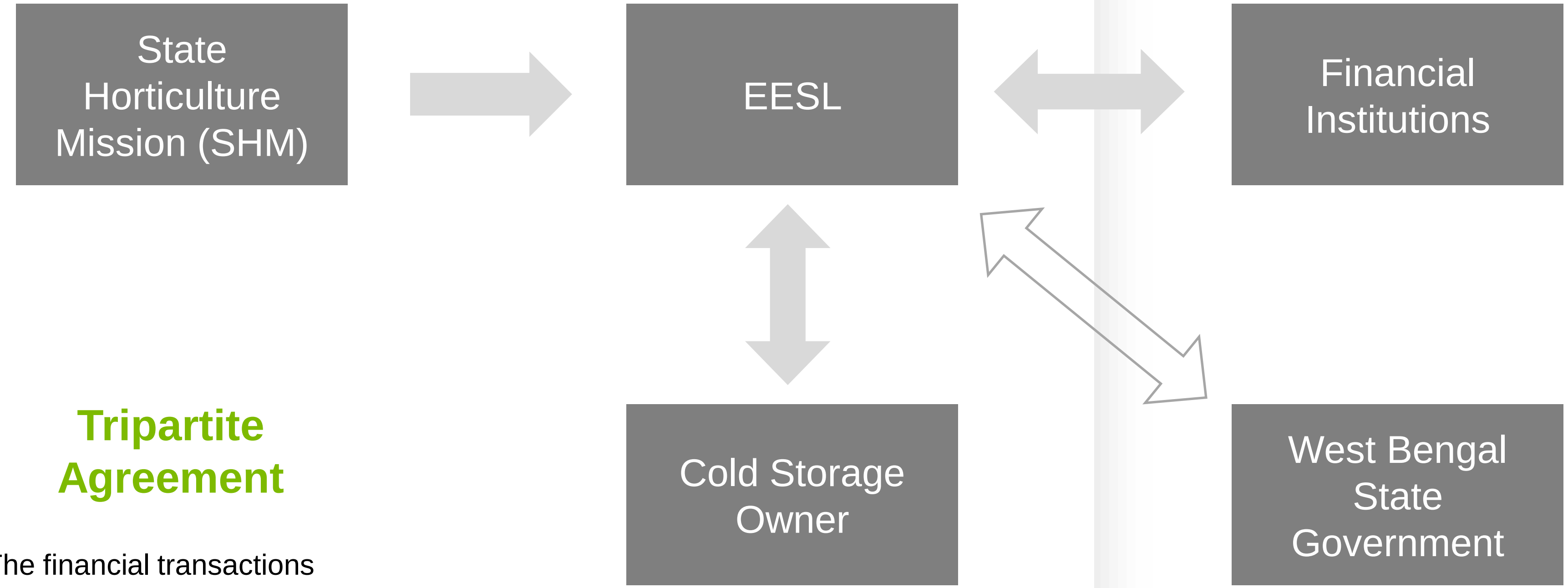
Business Expansion

Modern multi-commodity cold storages will open up new revenue streams through the ability to store other high value horticulture produce. Assured market linkages, will in turn incentivize farmers to diversify their cropping patters

Proposed business model to monetize MIDH subsidy and multiple benefits from modernizing existing cold storages

Project Monitoring Unit: provide guaranteed energy cost savings and food loss reduction

MIDH subsidy can be directly transferred to an ESCROW account by SHM which is the MIDH representative in states



Provide the upfront capital (SBI, SIDBI, NABARD, other development or international financial institutions)

Tripartite Agreement

The financial transactions could be facilitated through a tripartite agreement between MIDH, Cold Storage Owner and EESL

Repay EESL (upto 5 years) through energy cost savings and additional revenue from better capacity utilization and business expansion

Since the state govt will be a major beneficiary from the improvement in agricultural supply chain and farmers' livelihoods, they should also invest in the program

Key message

Field Observations

- Majority of cold storages in West Bengal are designed with non-standard, non-tested refrigeration systems
- The traditional design and operation leads to food loss, energy wastage and safety hazards
- Piecemeal upgradation of old cold storage facilities is prevalent

Challenges

- Restrictive policies and regulations by West Bengal's government
- Return on investment through energy savings alone is not viable
- High capital costs associated with setting up modern multi commodity cold storages

Solutions and Benefits

- Development of standardized EEMs package
- Retrofitting-cum-modernization into multi-commodity cold storages
- Better net-capacity utilization, lower operational expenditure, better storage quality (lower losses) and higher price realization

Recommendations

- Awareness programs on reducing post harvest potato losses
- Improvement in the policy environment governing cold storages in West Bengal
- Holistic assessment of the entire value chain is a must
- Synchronization of govt support (both centre and state) for making a business case for retrofitting-cum-modernization of cold storages
- Credible M&V for tracking avoided potato losses

Thank You