BIOGAS ENERGY

ENHANCING LIVELIHOOD OF BASE OF ECONOMIC PYRAMID (BOP): SARI/ENERGY PROJECT IN NEPAL

July 11 – 13, 2011, Male, Maldives

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HIGHLIGHTS

- HISTORY
- POTENTIAL
- BENEFITS
- HIGHLIGHTS OF NBPA SARI/E PROJECT
- HIGHLIGHTS OF BASELINE STUDY
- ACTIVITIES

HISTORY

Year	Events
1955	Father B.R Saubolle built the first biogas system demonstrative system at St. Xavier's School, Godavari, Lalitpur Nepal, 20 Km East South of Kathmandu
1968	KVIC (Khadi and Village Industries Commission of India demonstrated 250 cft biogas system at an exhibition tion in Kathmandu (floating drum type biogas)
1974/75	Energy Research and Development Group formed at Tribhuvan University, Nepal, this research wing promoted Gobar Gas Development Committee
1975/76	GON Nepal launched first official Biogas program, ADBNepal authorized to channel interest free loan. Butuwal Engineering works, Balaju Yantra Sala, and Agricultural Tool Factory involved fabricating appliances required to the biogas
1977	GoN established GGC (Gobar Gas Company) in joint venture with United Mission to Nepal, Agriculture Development Bank, Nepal provided soft loan at 6 % Interest rate

HISTORY CONTI....

Year	Events
1979	GON and American Peace Corps jointly implemented Biogas program under USAID financial assistance
1980	ADB Manila provided financial assistance under Fourth Agriculture Credit Project to promote biogas
1992	SNV Nepal entered biogas program under biogas support program, SNV supported upto 2010
1994	Nepal Biogas Promotion Group, established as an umbrella organization to promote biogas program. Now it was restructured as Nepal Biogas Promotion Association (NBPA)

POTENTIAL

- Nepal has total 1.9 million biogas plant potenail and economical feasible plants are1 million.
- Total 201,000 biogas plants are installed (WECS, 2010)
- Installed capacity of plants are: 2, 4,6,8, 10, 15 and 20 M3
- But installation of institutional plants are becoming popular in Army, poultry firms and school

SOCIO ECONOMIC BENEFIT

- ✓ Reduction of the women workload by 3hrs/day/hh
- ✓ Saved time utilize education, income generation and other social functions
- ✓ Increasing productivity
- ✓ Reduce use of chemical use of fertilizer
- ✓ Generate employments opportunities

ENVIRONMENTAL BENEFIT

- ✓Cooking fuel wood saving upto 2 tons/plant
- ✓Agriculture waste 0.35 ton/plant
- ✓Dung cake 0.6 ton/plant
- ✓Annual kerosene saving 3.5 million lits, 25lits/plant
- ✓Annual reduction of GHG (Co2): 7 ton/plant
- ✓Slurry production 1.75/plant
- ✓Improve health and sanitation (toilet connection)

REDUCE GASES

Combustible gas produced by anaerobic fermentation of organic material by action of methanogenic bactoria. Biogas is composed of methane and carbondioside

Substance	Symbol	Percentage
Methane	CH_4	50-70
Carbon dioxide	CO_2	30-40
hydrogen	H_2	5-10
Nitrogen	H_2	1-2
Water Vapour	H_2O	0.3
Hydrogen Sulphide	H_2S	Traces

Source: Karki, et. al. ed (2009)Biogas: As Renewal Sources of Energy in Nepal

PUBLIC HEALTH BENEFIT

- ✓ Reduce indoor pollution in the house
- ✓ Reduce incidence of illness and expenses of medical bill
- ✓ Improve rural sanitation (WASH- water sanitation and hygiene) by connecting toilets to biogas
- ✓ Increase human efficiency

HIGHLIGHTS OF SARI/E SMALL GRANT PROGRAM IN BIOGAS

NBPA in collaboration with SARI/E successfully implemented Biogas project in Dang. Target beneficiaries were socially and economically backward women group

The components of the projects were:

A. **Capacity building of:**

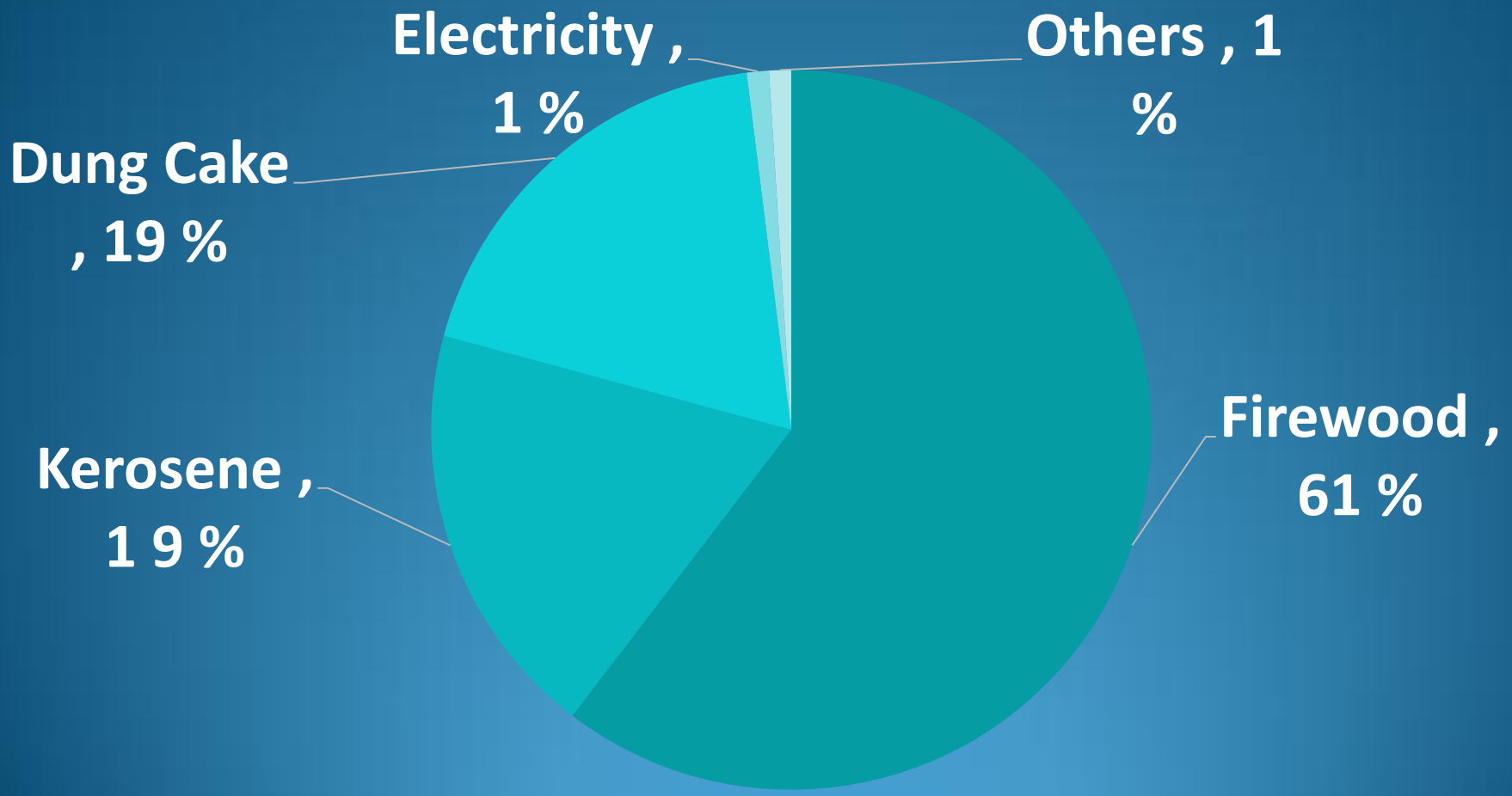
- ✓ Access to Market (A2M)
- ✓ Access to Finance- group saving and credit, cooperative (A2F)
- ✓ Access to Technology- operation, maintenance and installation (A2T)
- ✓ Public Health and nutrition- water sanitation and hygiene
- ✓ Organic Farming- vegetables

B. Household biogas construction

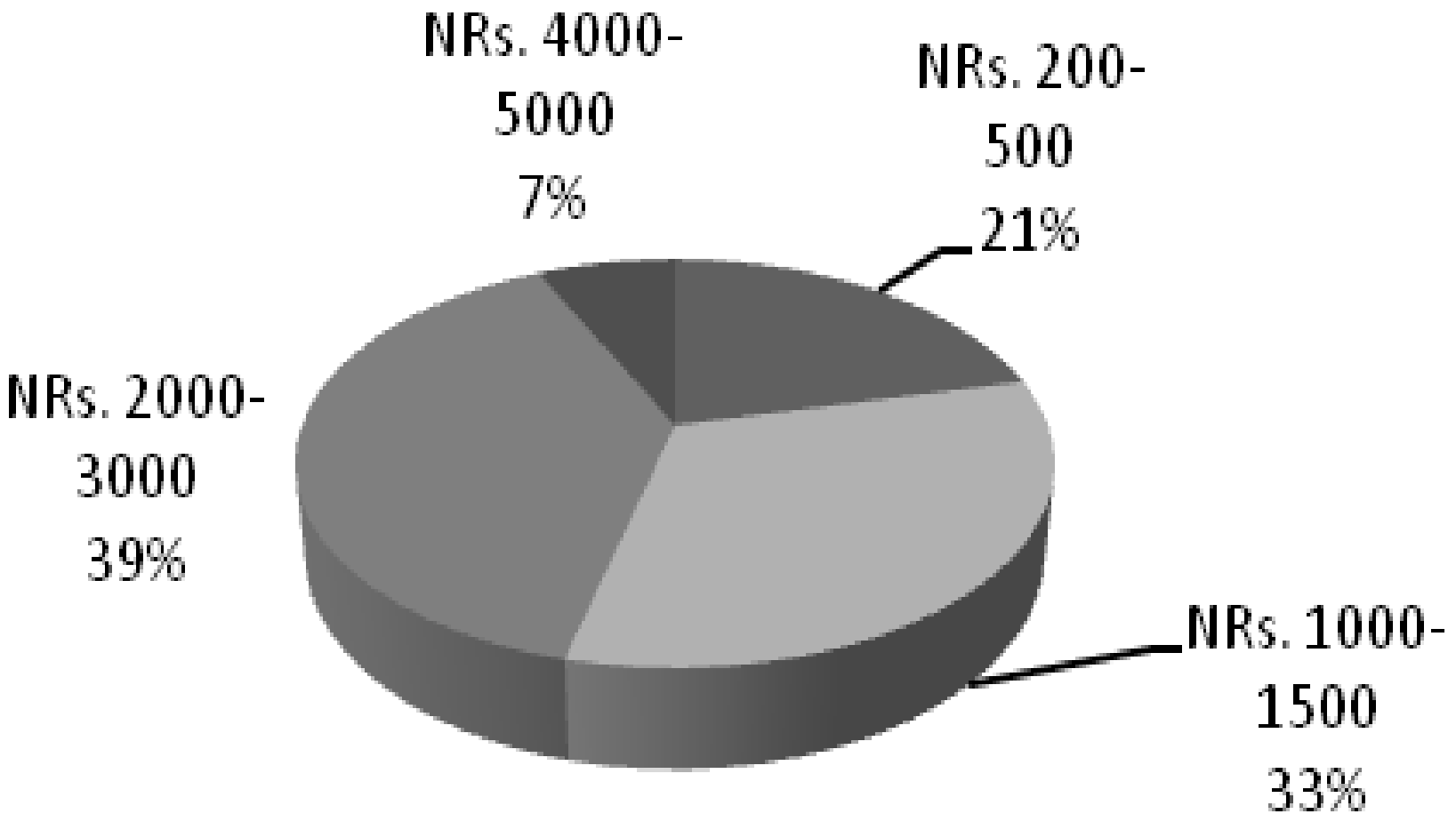
C. Toilet construction and connecting to the biogas plant

Highlights of baseline study

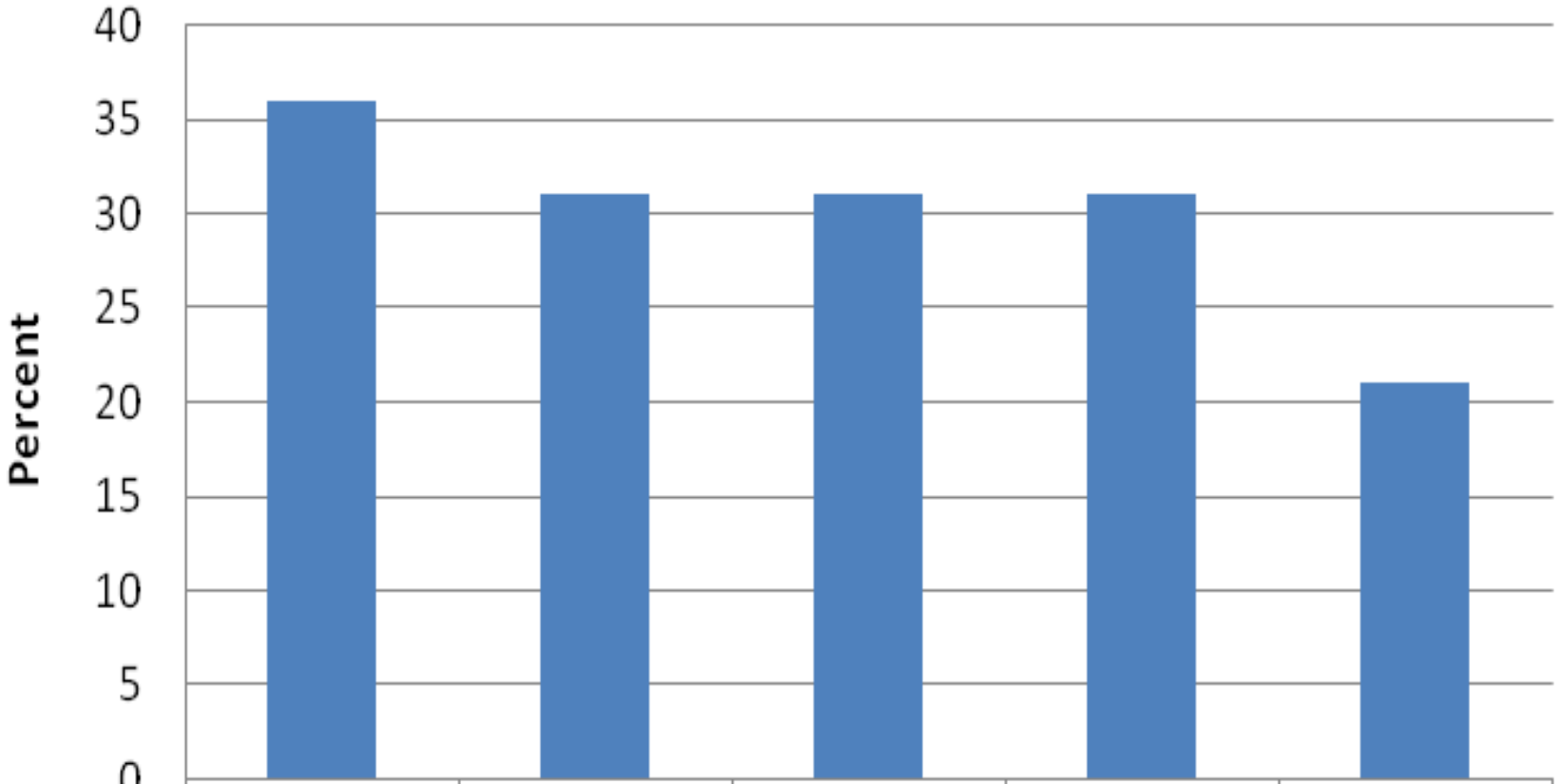
1. Source of Energy of the project beneficiaries



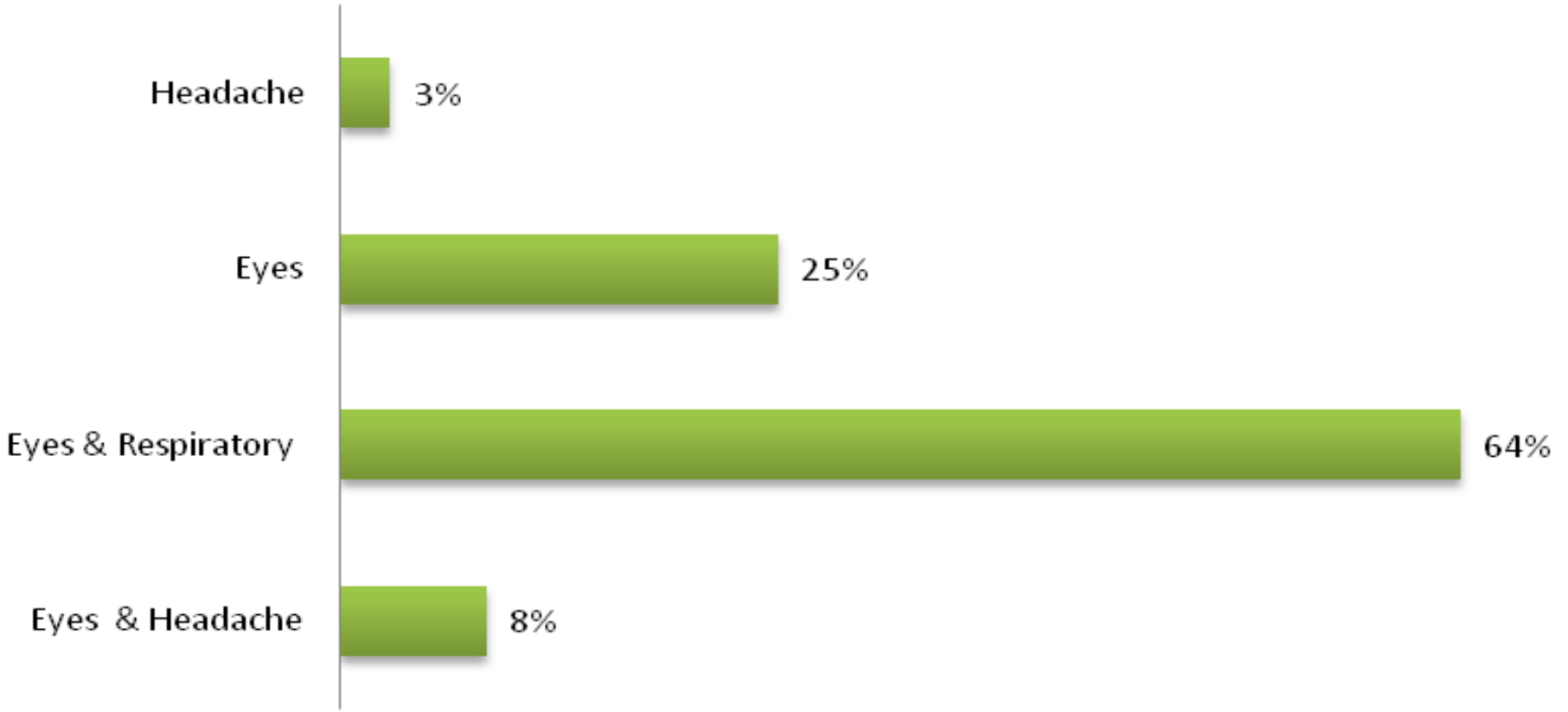
1. Monthly Expenditure on firewood



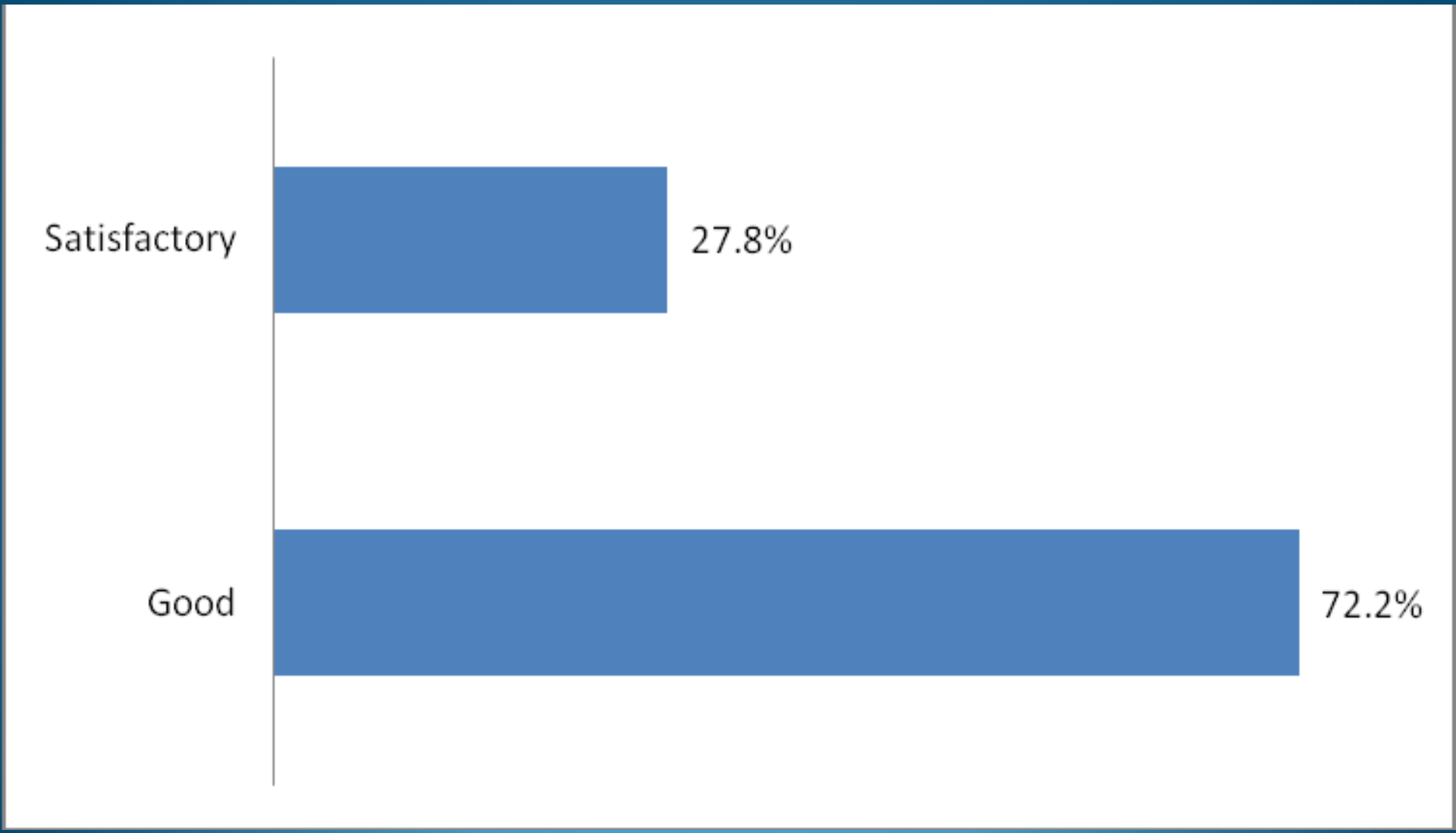
1. Source of firewood



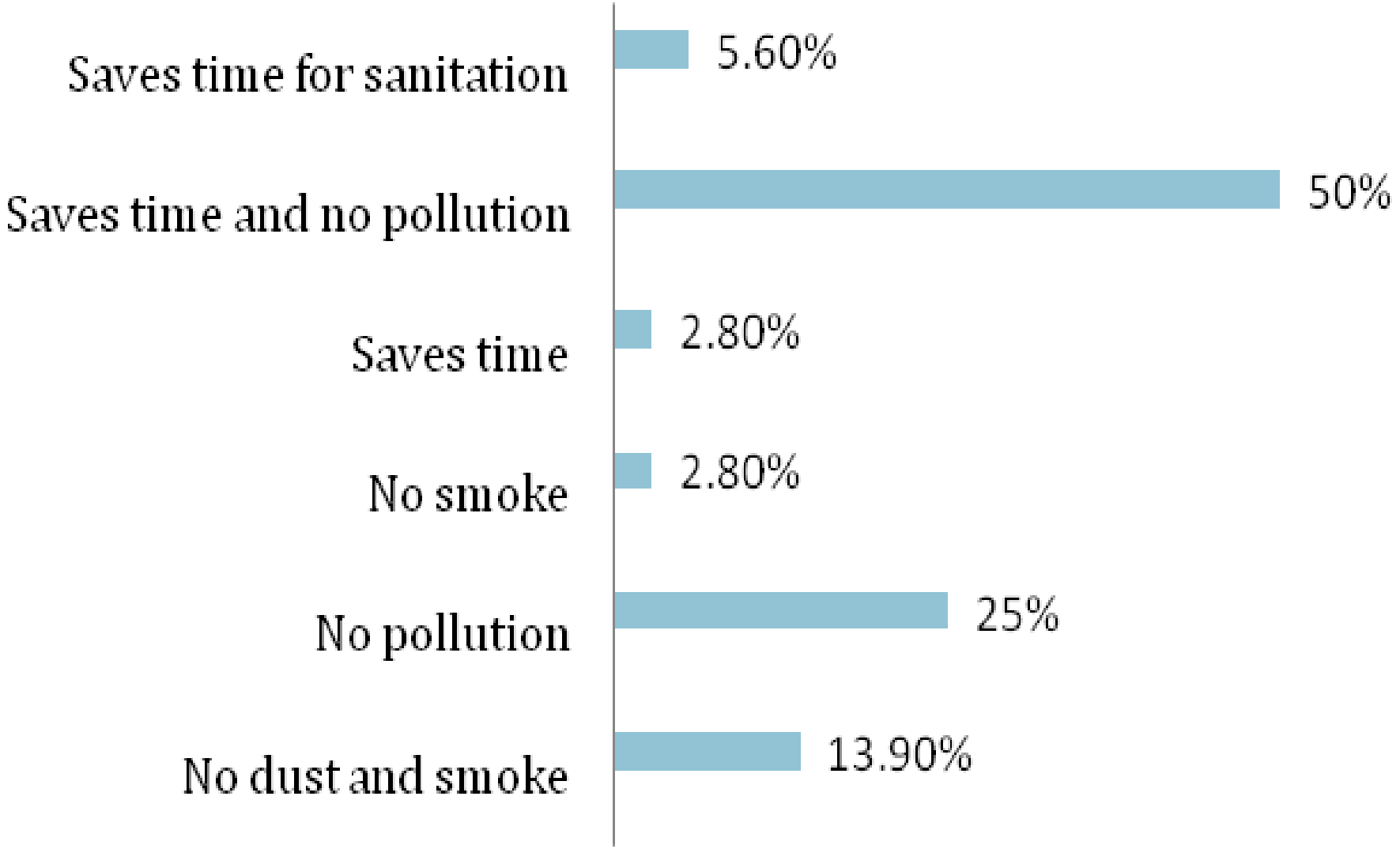
1. Major health problem



1. Perception of beneficiaries on Biogas (health and Sanitation)



1. Biogas helping women



Improve Water, sanitation and Hygiene

Access to Clean energy and No indoor air pollution

Productive human resource

Organic Vegetables

Namaste !

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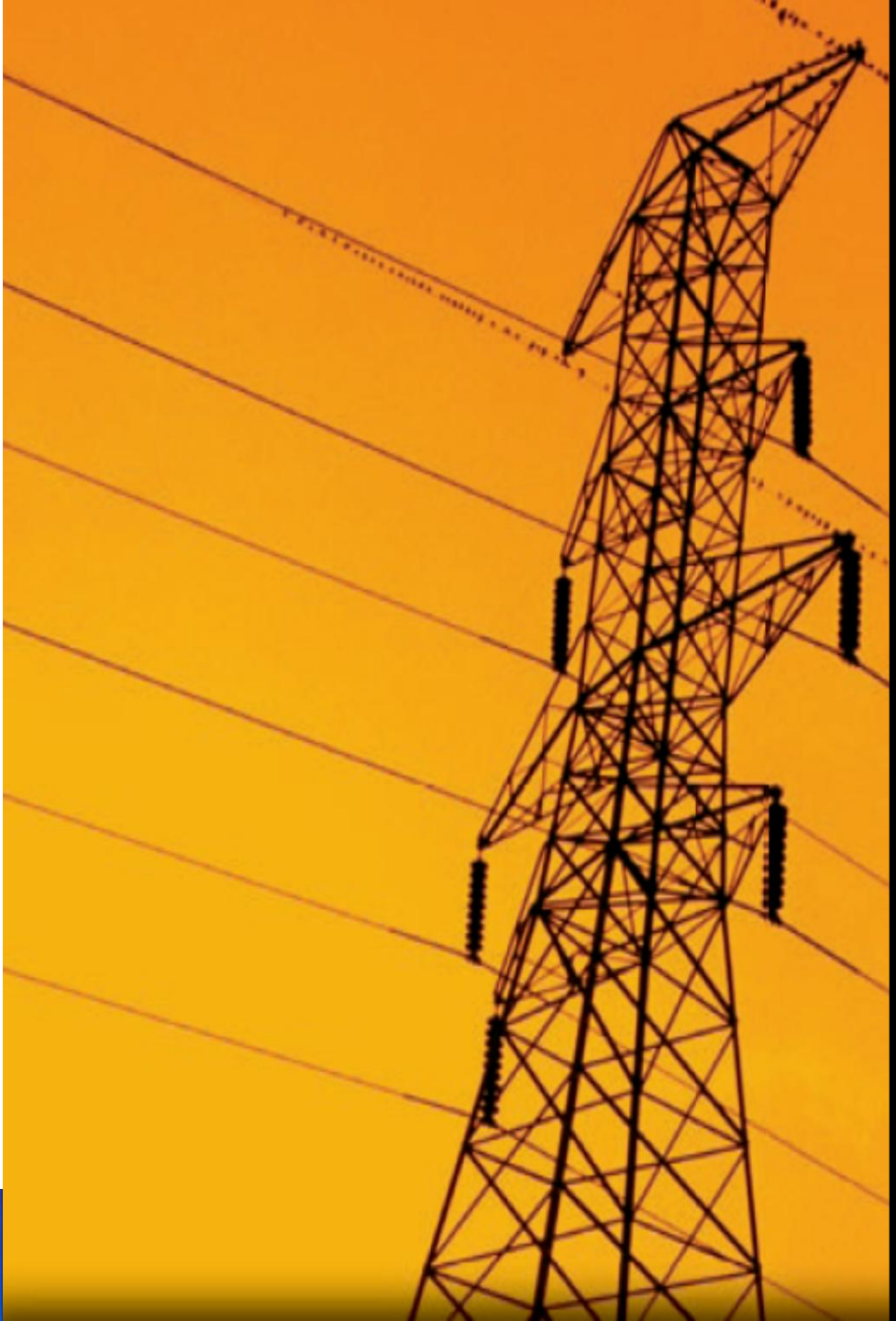
Introduction to IEX

A true marketplace…

INDIAN ENERGY EXCHANGE
India's No. 1 Power Exchange



IEX is

"***one stop shop***"

to buy and sell electricity for

Any hour of the day

Any day of the week

Any week of the month

Who are we ?

Promoters

Financial Technologies
Creating Markets. Unlocking Value.

PTC India

Joint Equity Partners:

TATA

BESSEMER VENTURE PARTNERS

TATA POWER

RELIANCE Energy
Anil Dhirubhai Ambani Group

ADANI

LANCO
INSPIRING GROWTH

LIGHTSPEED VENTURE PARTNERS

JINDAL POWER LIMITED

REC
Endless energy. Infinite possibilities.

IDFC
Think Infrastructure. Think IDFC.

Technology :

Financial Technologies
Creating Markets. Unlocking Value.

NASDAQ OMX

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Products at IEX

Spot Market	***Day-Ahead -*** *Hourly for Next Day* ***Intraday-*** *For the same day (last 6 Hours)* ***Day-ahead Contingency -*** *Hourly for Next day*
Forward Market	***Daily-*** *for rolling seven days (starting after 5 days)* ***Weekly-*** *for Next 2 weeks*
REC	***National market for RE*** ***RE generators sell certificates*** ***Obligated entities purchase to fulfill RPO.***

Way forward… Escerts

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IEX: Market Segments…

Day-Ahead Market (Since June,2008)	Term-Ahead Market (Since Sep,2009)	REC Market (Since February,11)
Hourly Contracts Matching through Close Auction* • *Market splitting feature*	• **Intra Day** • **Day-Ahead Contingency** • **Daily** Matching through Continuous Trade Session **Weekly Contracts** Matching through Open Auction * *Without Market split feature*	**REC Contracts** Matching through Auction*

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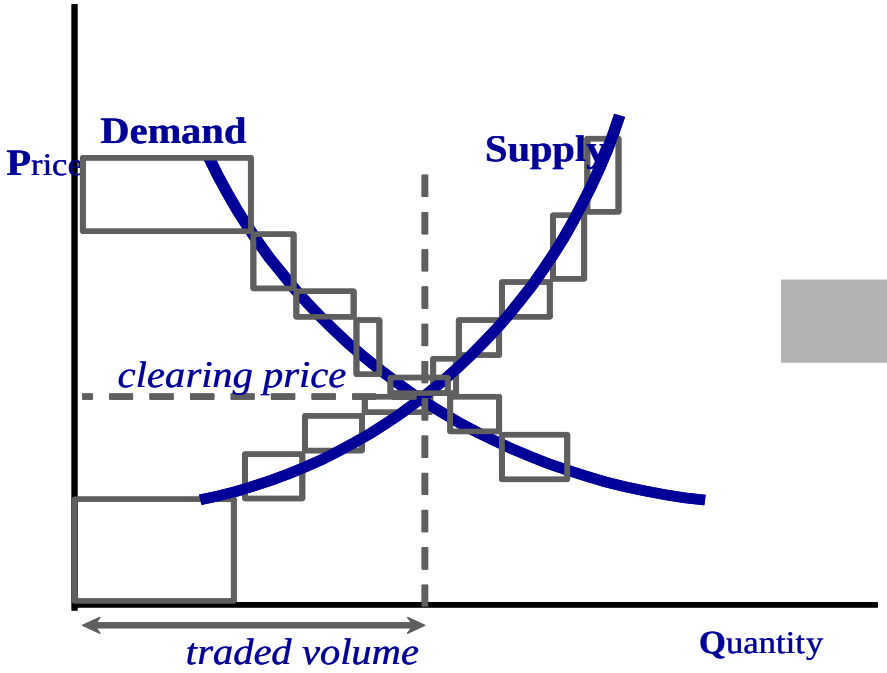
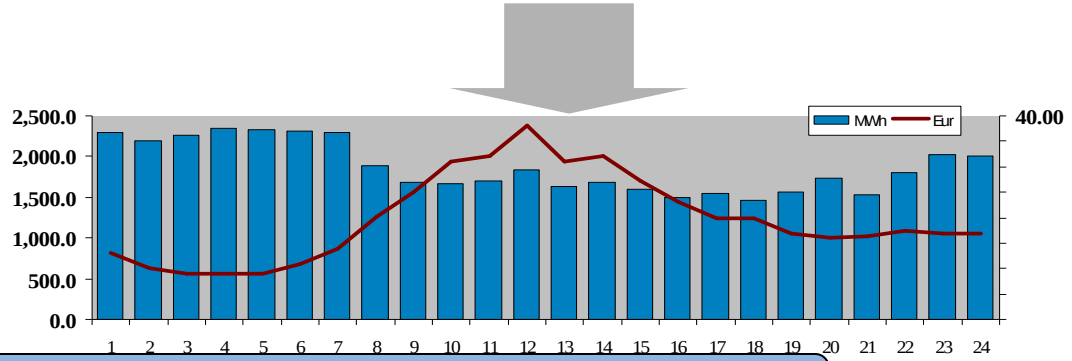
Auctioned day-ahead market(DAM)



- Double-sided auction system
- Hourly day-ahead contracts (MWh)
- Physical delivery
- Central counter party: IEX
- Equilibrium price for each hour (Rs./MWh)
- Hourly volumes/prices published



For scheduling, coordination with NLDC -> SLDCs. Settlement @Regional Periphery

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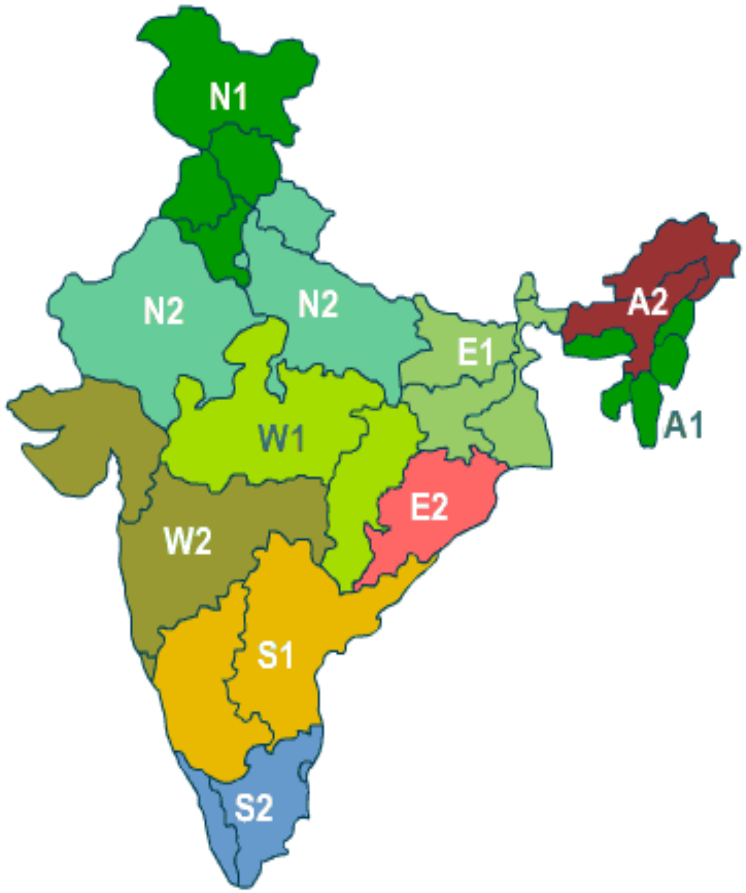
IEX Bid Areas



Sr. No.	Bid Area	Region	States covered under Bid Area
1.	N1	North Region	Jammu and Kashmir, Himachal Pradesh, Punjab, Chandigarh, Haryana
2.	N2	North Region	Uttar Pradesh , Uttaranchal, Rajasthan, Delhi
3.	E1	East Region	West Bengal, Sikkim, Bihar, Jharkhand
4.	E2	East Region	Orissa
5.	W1	West Region	Madhaya Pradesh, Chhattisgarh
6.	W2	West Region	Maharashtra, Gujarat, Goa, Daman and Diu-1, Daman and Diu-2, Dadar and Nagar Haveli, North Goa
7.	S1	South Region	Andhra Pradesh, Karnataka, Pondicherry (Yanam), South Goa
8.	S2	South Region	Tamil Nadu, Kerala, Pondicherry (Puducherry), Pondicherry (Karaikal), Pondicherry (Mahe)
9.	A1	North East Region	Tripura, Meghalaya, Manipur, Mizoram, Nagaland
10.	A2	North East Region	Assam, Arunachal Pradesh

Performance so far…

IEX won India Power Award for

" Best e-enabled consumer platform"

17th November,2009

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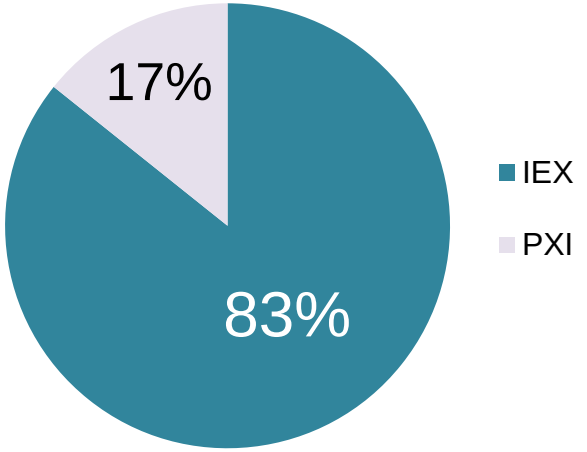
3 years of Adequate Liquidity

- **29 State Utility**
- **990+ Portfolios**
- **777 Direct consumers**
- ***570+*** *participants on single day*
- **Cleared Volume : 22 Billion Units**
- **DAM Volume Record**
  - ***59.98 MUs constrained*** *(23rd September ' 10)*
  - ***61.58 MUs unconstrained*** *(23rd September 10)*

IEX Market Share (as on May 31, 2011)



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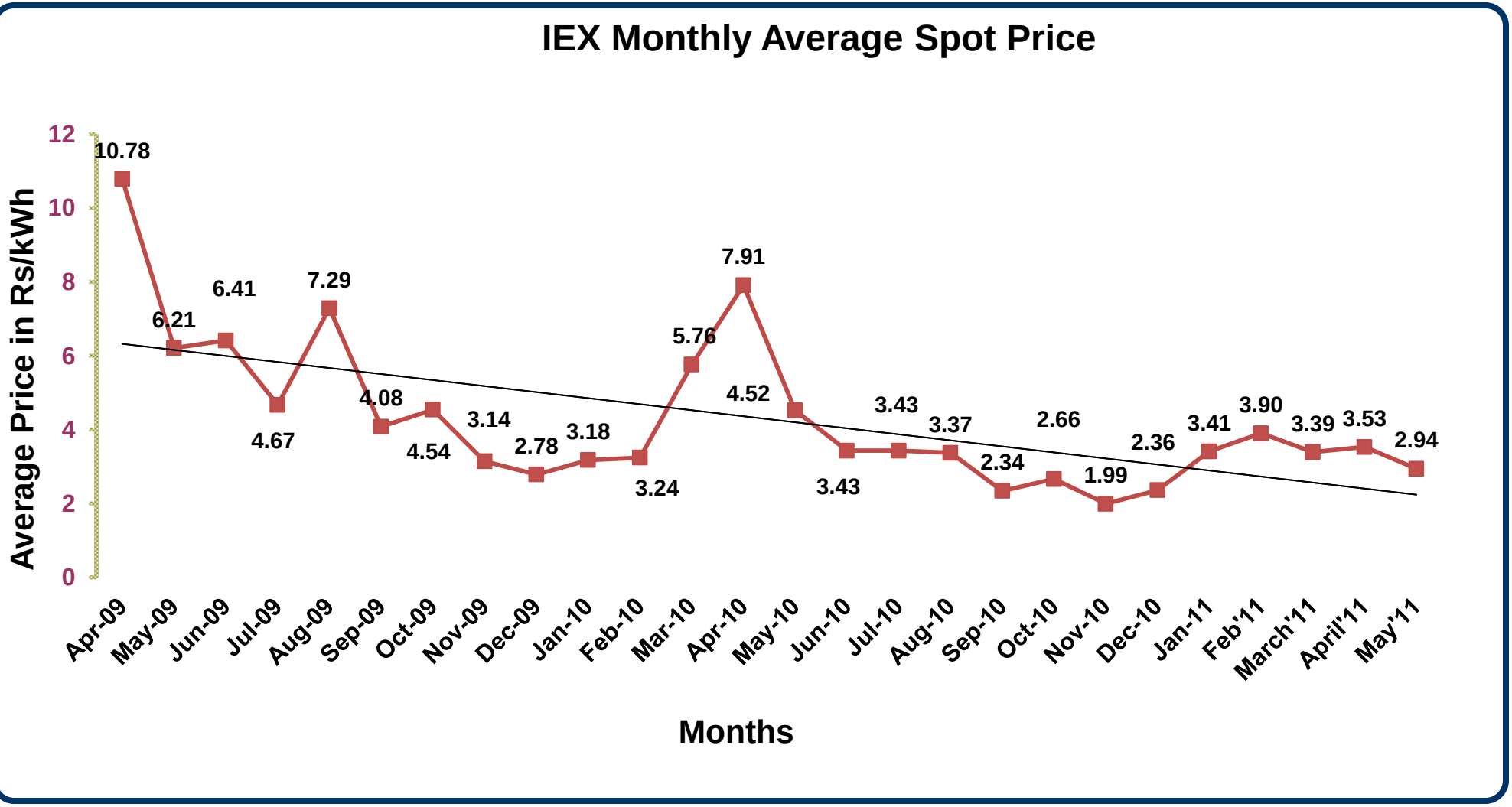
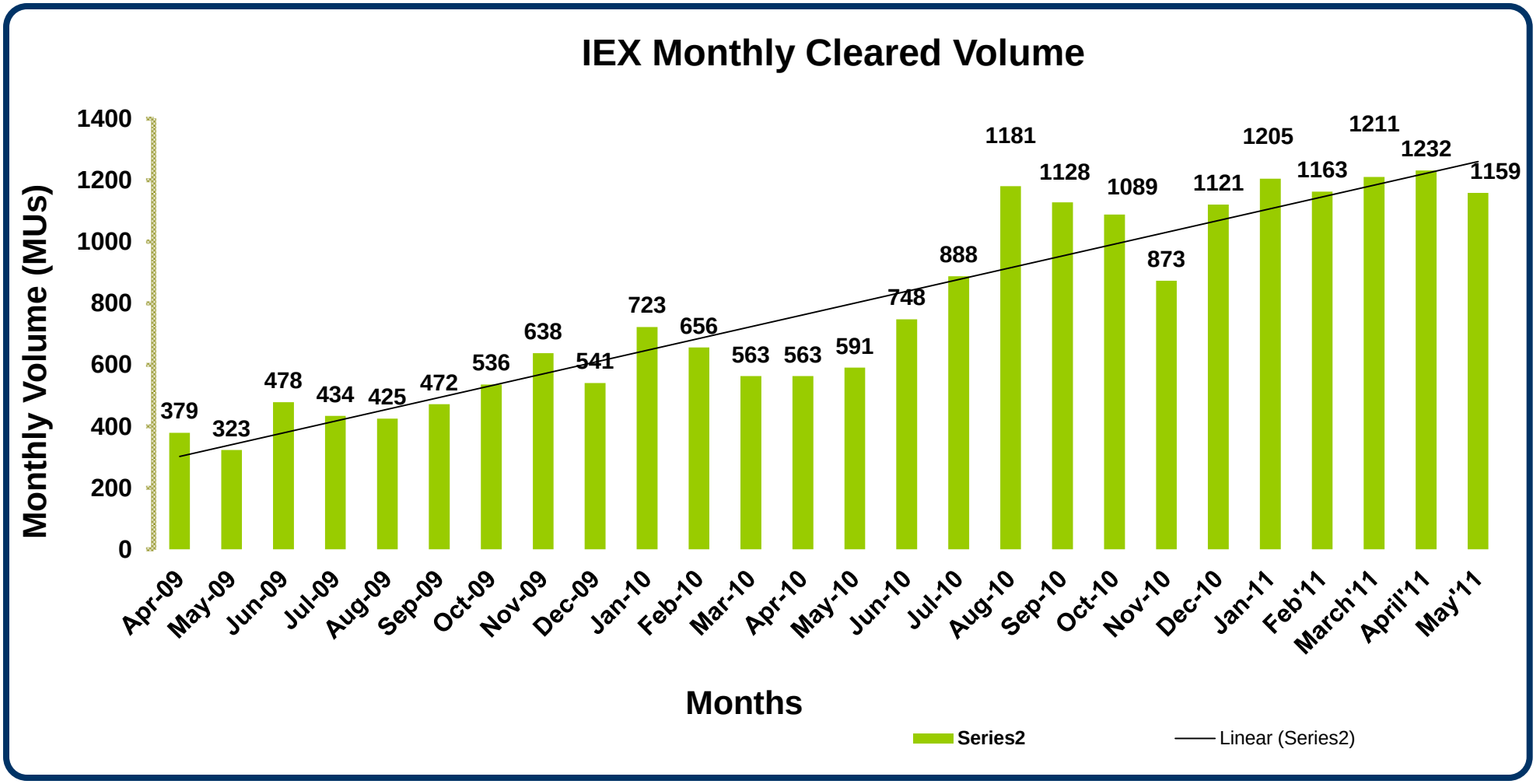
Participation at IEX

STATE	No. of Private Generator	Open Access Industrial Consumers
Maharashtra	8	0
Rajasthan	10	54
Karnataka	9	0
Andhra Pradesh	7	6
Punjab	**3**	**257**
Orissa	**1**	2
Madhya Pradesh	**9**	4
Chhattisgarh	**29**	0
Haryana	1	31
Tamil Nadu	0	**402**
Gujarat	**11**	7
Uttarakhand	0	10
Arunachal Pradesh	0	3
Others	14	1
Total	**102**	**777**

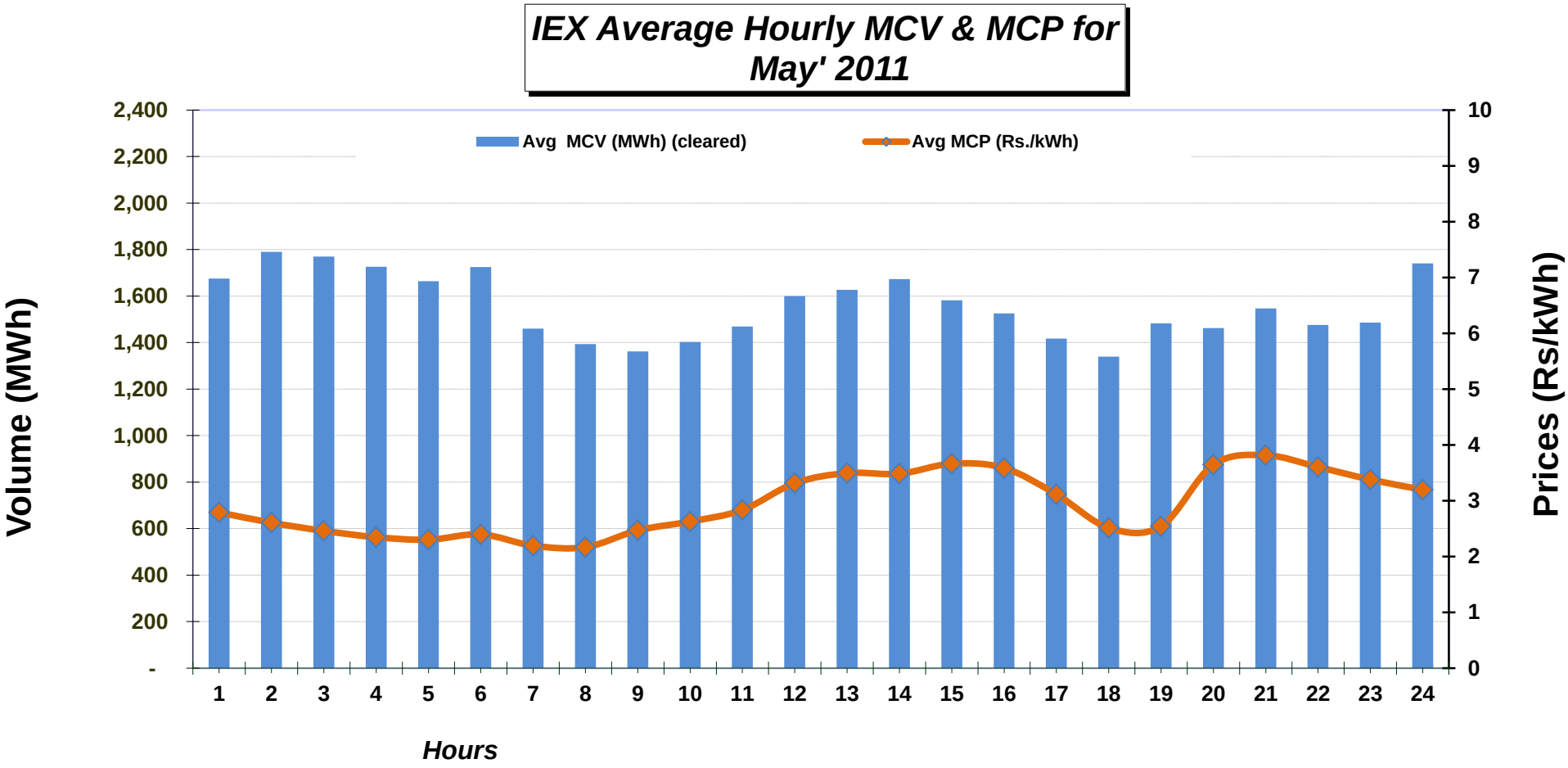
IEX monthly Average Price



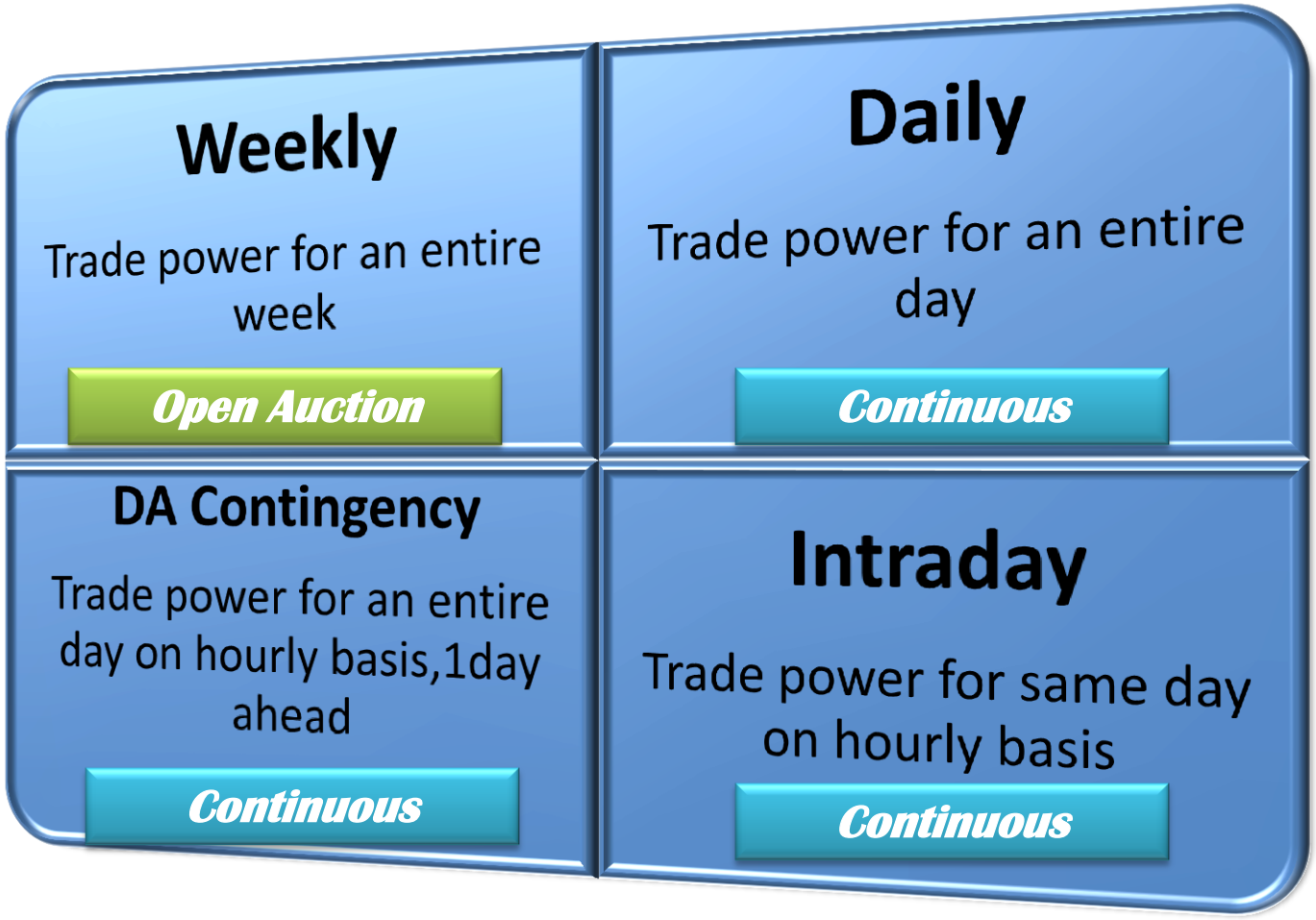
IEX Monthly Volume



IEX Hourly Price and Volume Average in May' 2011



TAM Market Segments



TAM: *Performance so far…*

Weekly	Day-ahead Contingency
1,255,366 MWh	33,746 MWh

Total Volume traded
1,337 MUs

Intraday	Daily
17,308 MWh	30,192 MWh

INDIAN ENERGY EXCHANGE
India's No. 1 Power Exchange

IEX Initiatives

Continuous communication with Users

IEX Daily SMS Service for Trade Details

sms@iexindia.com

IEX Monthly Bulletin

bulletin@iexindia.com

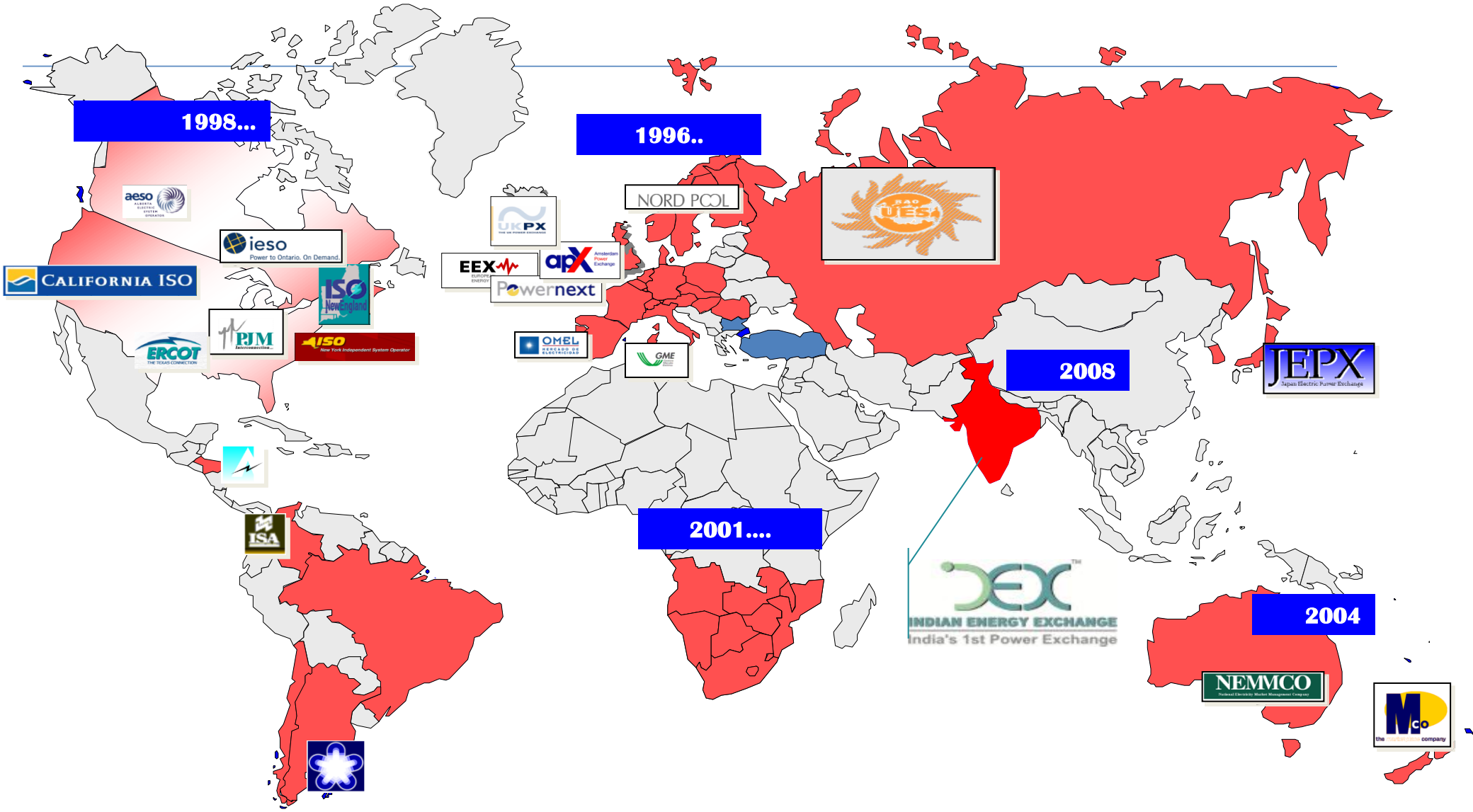
IEX hourly Trade Prices displayed on its website

For any other information

iex-bd@iexindia.com

INDIAN ENERGY EXCHANGE
India's No. 1 Power Exchange

Evolution of Electricity Market

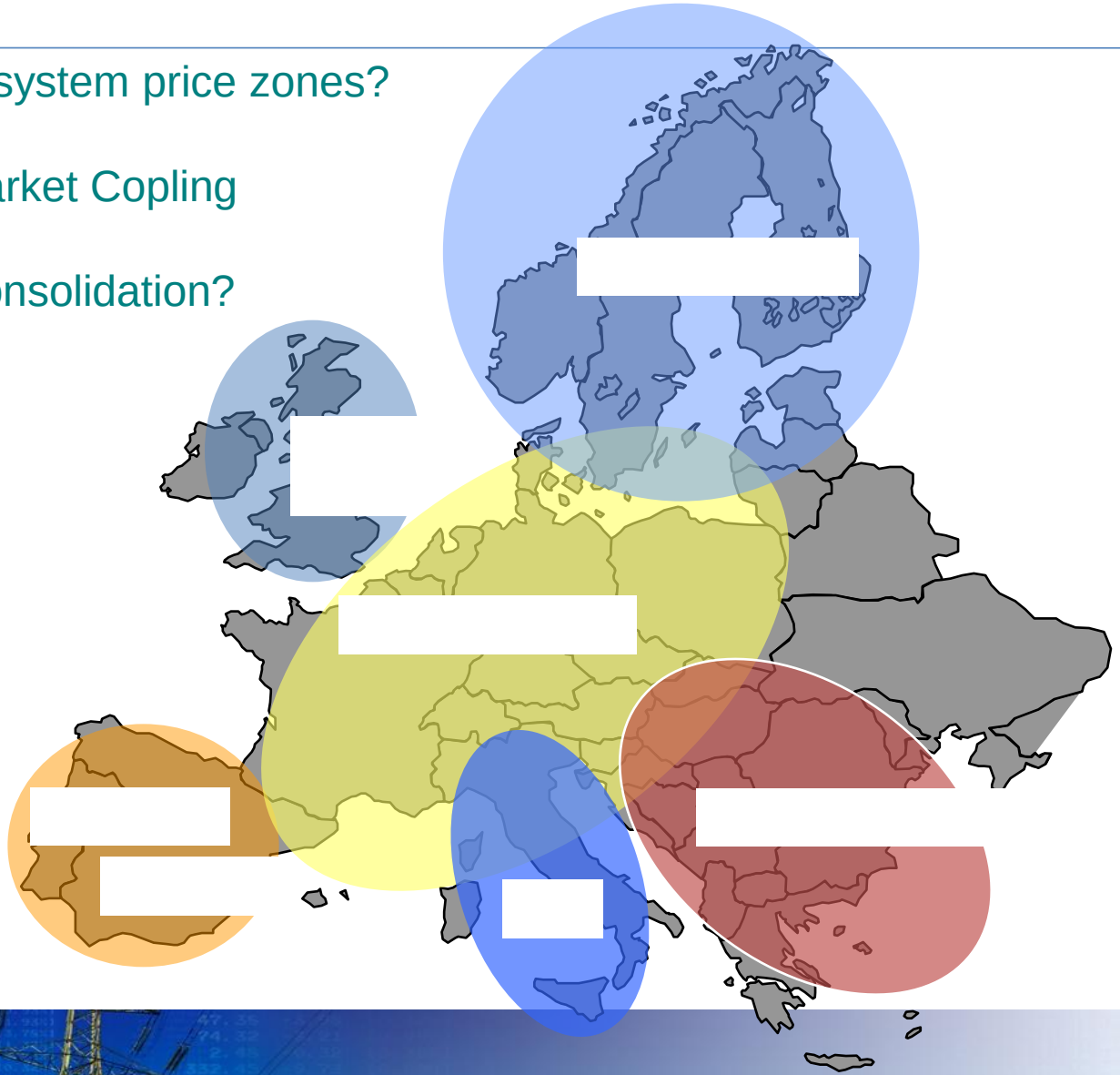


European Power Exchanges Future?

Emerging system price zones?

Market Copling

Consolidation?



Thank You

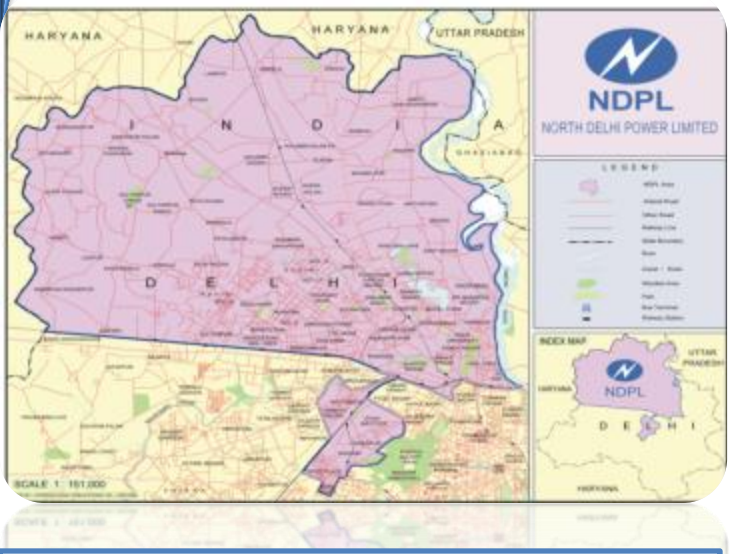
www.iexindia.com

NDPL's Experience in Outage Management & Demand Side Management

Arunabha Basu
Vice President & Head (Technology)
North Delhi Power Limited, India

Traders Hotel, Male, Maldives
11 to 13-July'2011

NDPL Profile



Joint Venture of Tata Power Company and Govt. of NCT of Delhi (51: 49)

Licensed for distribution of power in North and North West Delhi

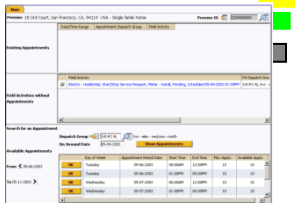
Parameter	2011-12 (as on date)
Turnover	USD 652 Mn
Peak Load	1401 MW
Annual energy requirement	7700 Mn. Units
Total registered consumers	1.2Mn
Number of employees	3500
Area	510 Sq Kms
Population serviced in Network area (approx)	5 Mn.
Number of consumers per Sq.Kms	2353
Employees per `000 consumers	2.9
Employees per Mn. Unit input	0.45

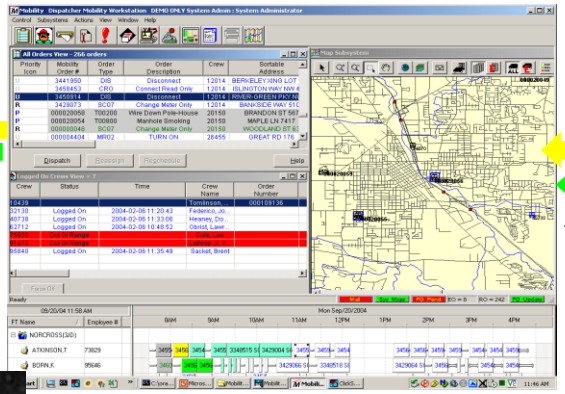
Outage Management System - Concept

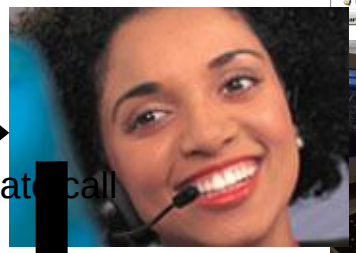
NDPL

PROPOSED
IN FUTURE

Customer calls
with service request

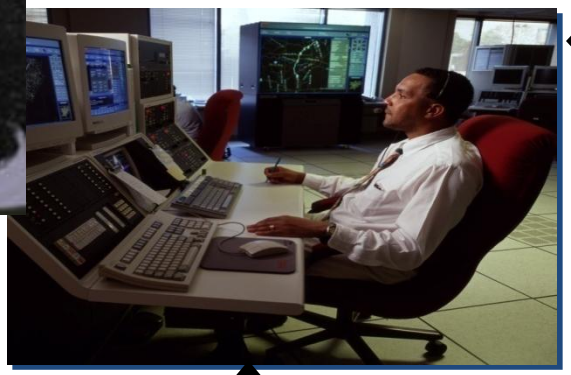






Call center generates call
tickets in
SAP-ISU

Outage Management System

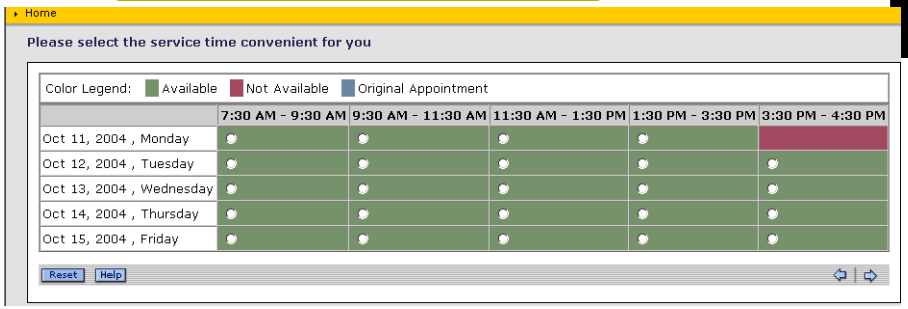


Enroute

MWM FSR Module

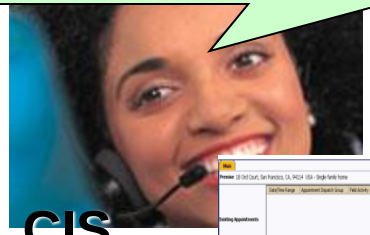
Onsite

Worked

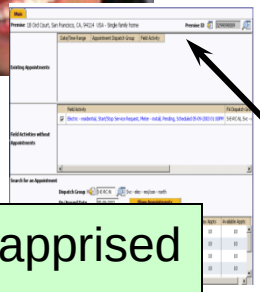


System Interfaces

- Takes trouble calls
- Informs customers of restoration status



CIS
SAP-ISU

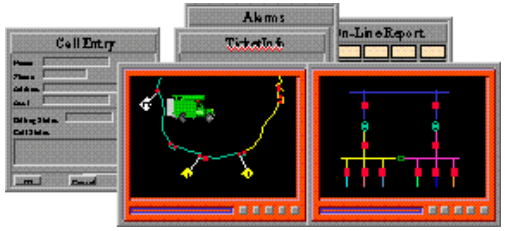


- Keeps OMS apprised of status on monitored devices

SCADA/DMS

- Call assignment
- Trouble prediction
- Switching
- Dispatching

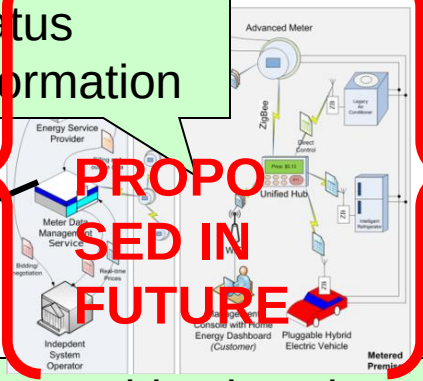
Control Centre



Outage Management System – for 1.8 million Customers

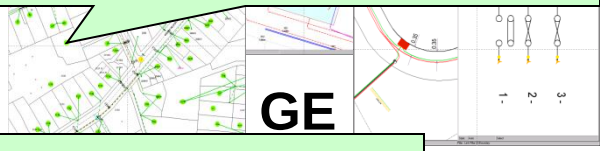
AMI

- Meter status information



PROPOSED IN FUTURE

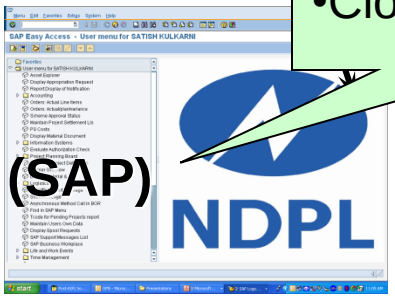
- Provides location
- Provides circuit data
- Provides routing



GE

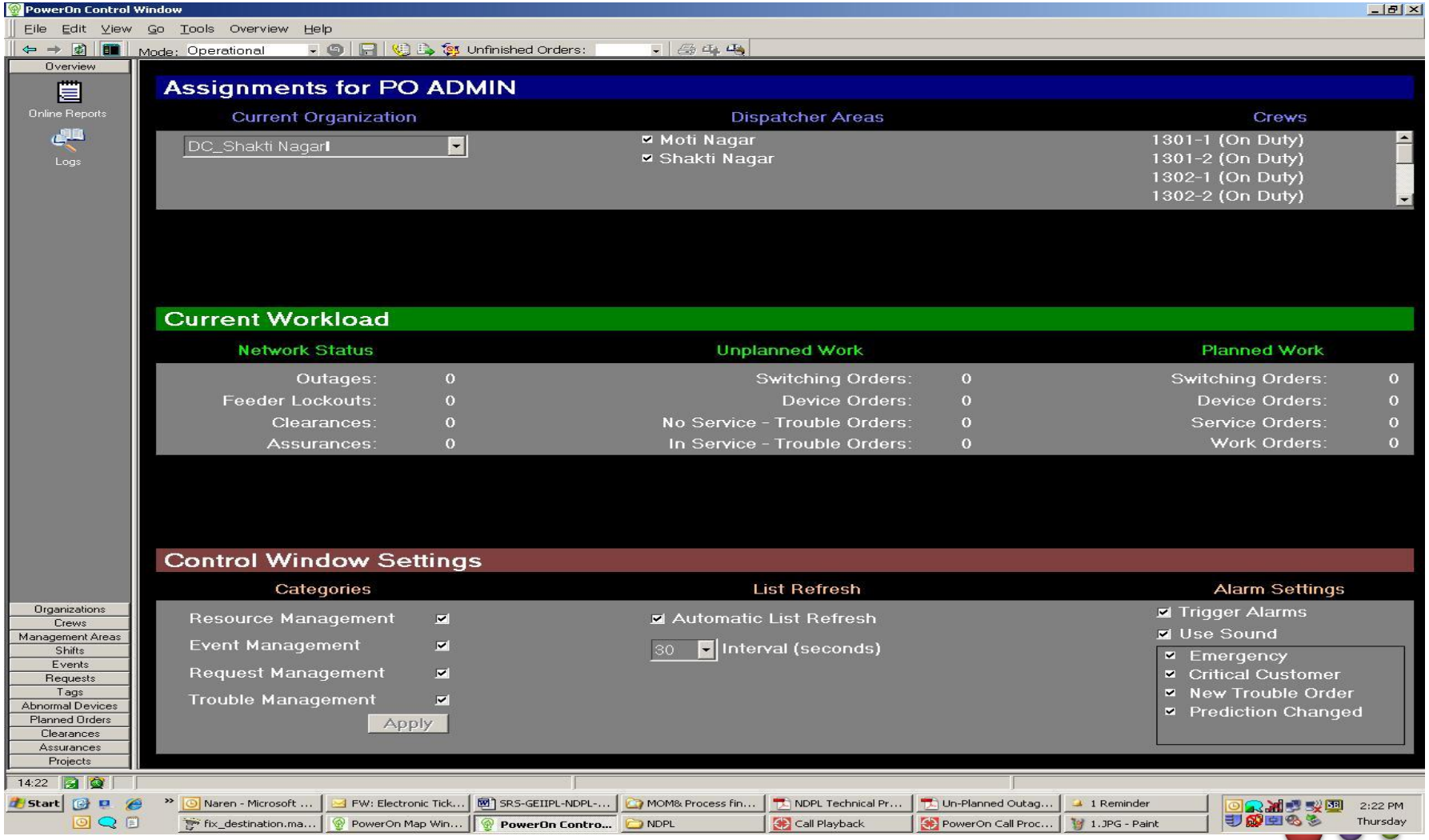
- Initiates work
- Tracks work status
- Closes jobs

WMS (SAP)



NDPL

GIS OMS interface-Work flow.



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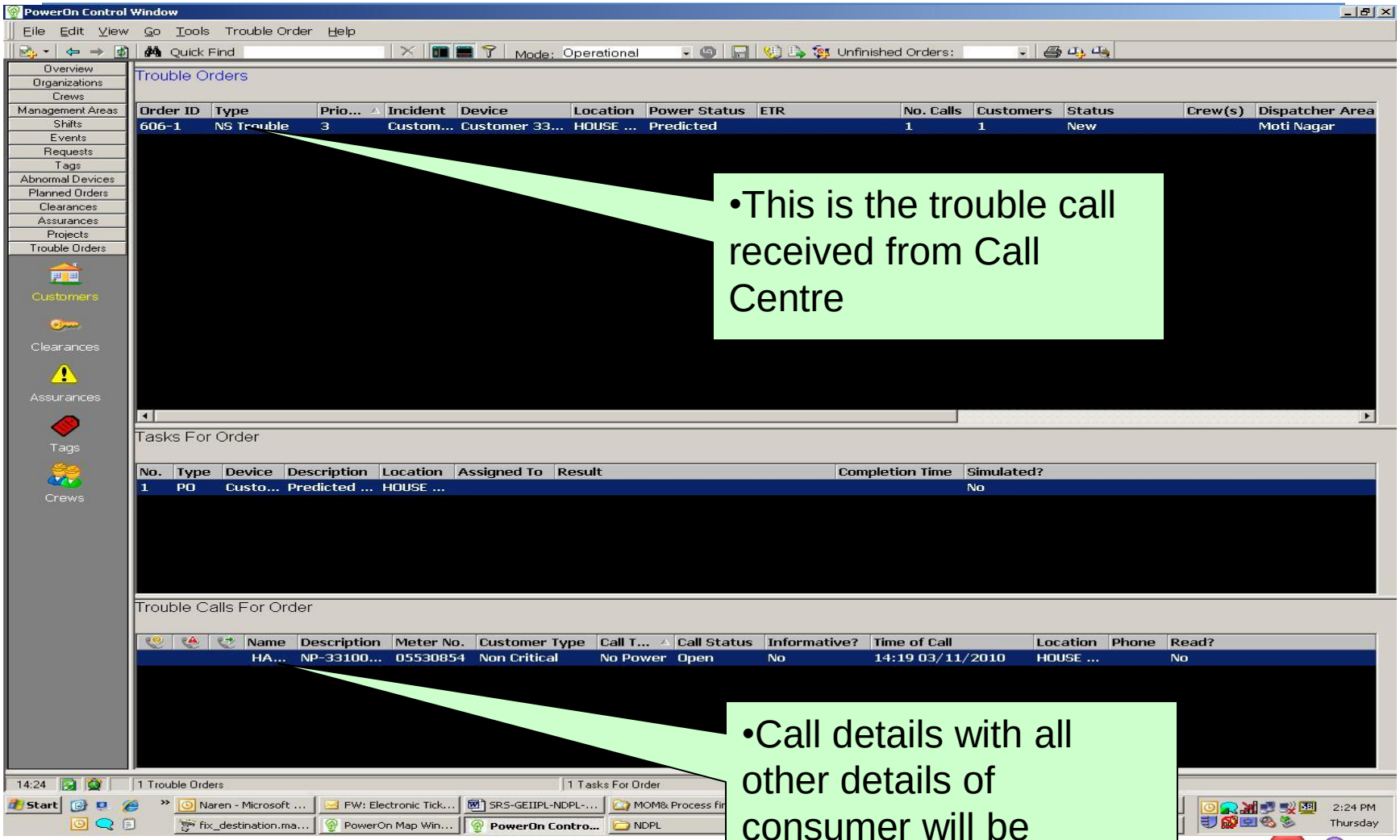

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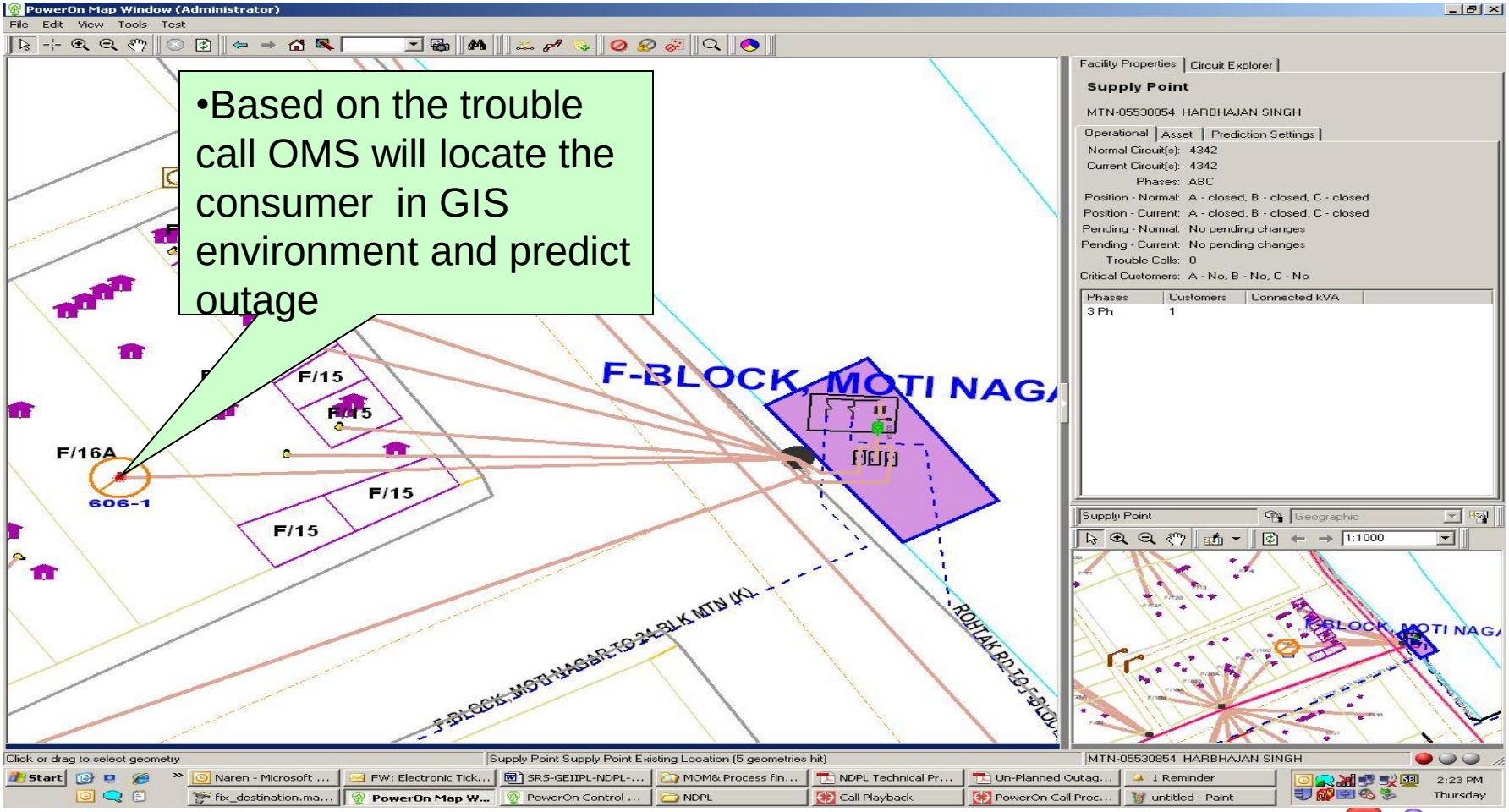

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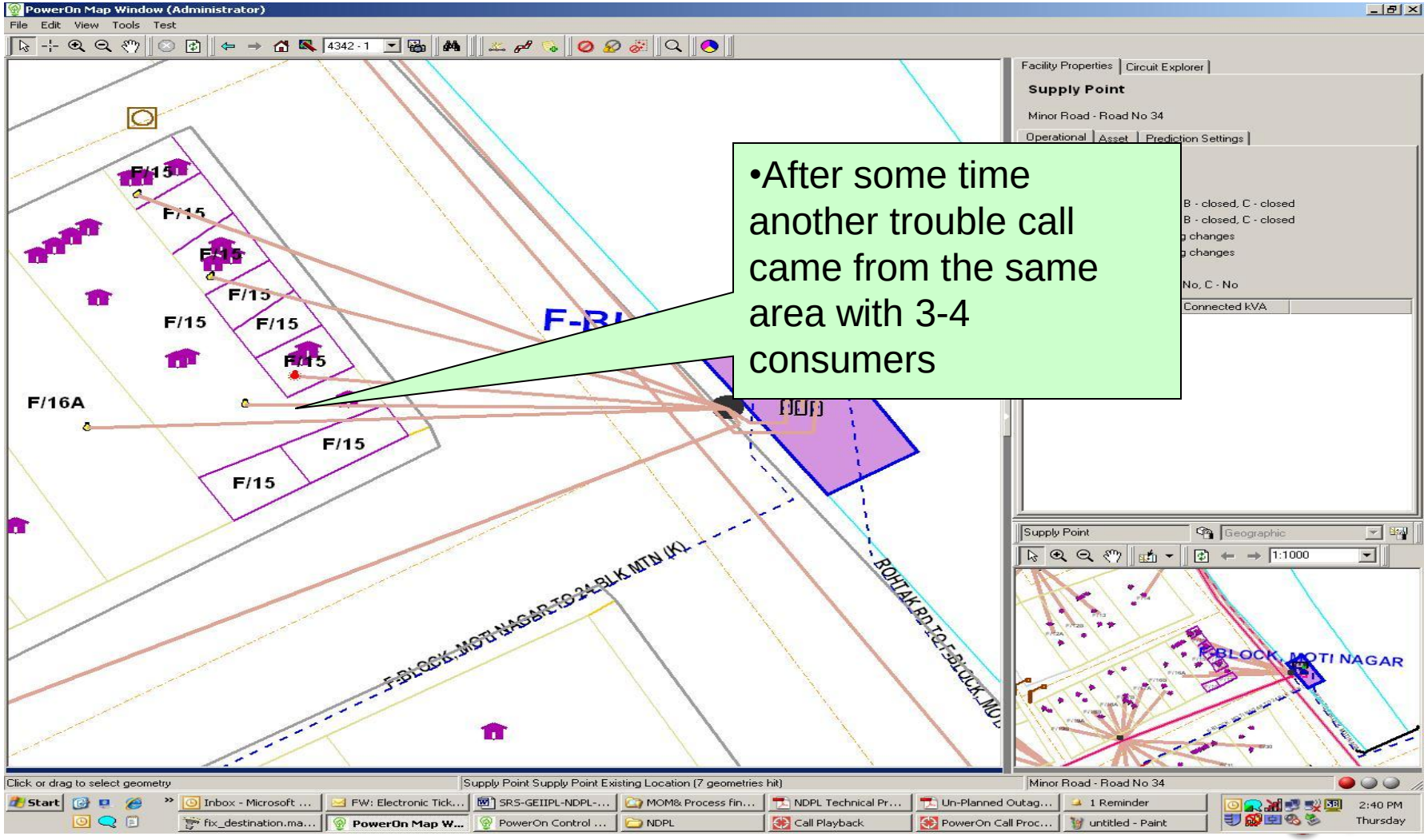

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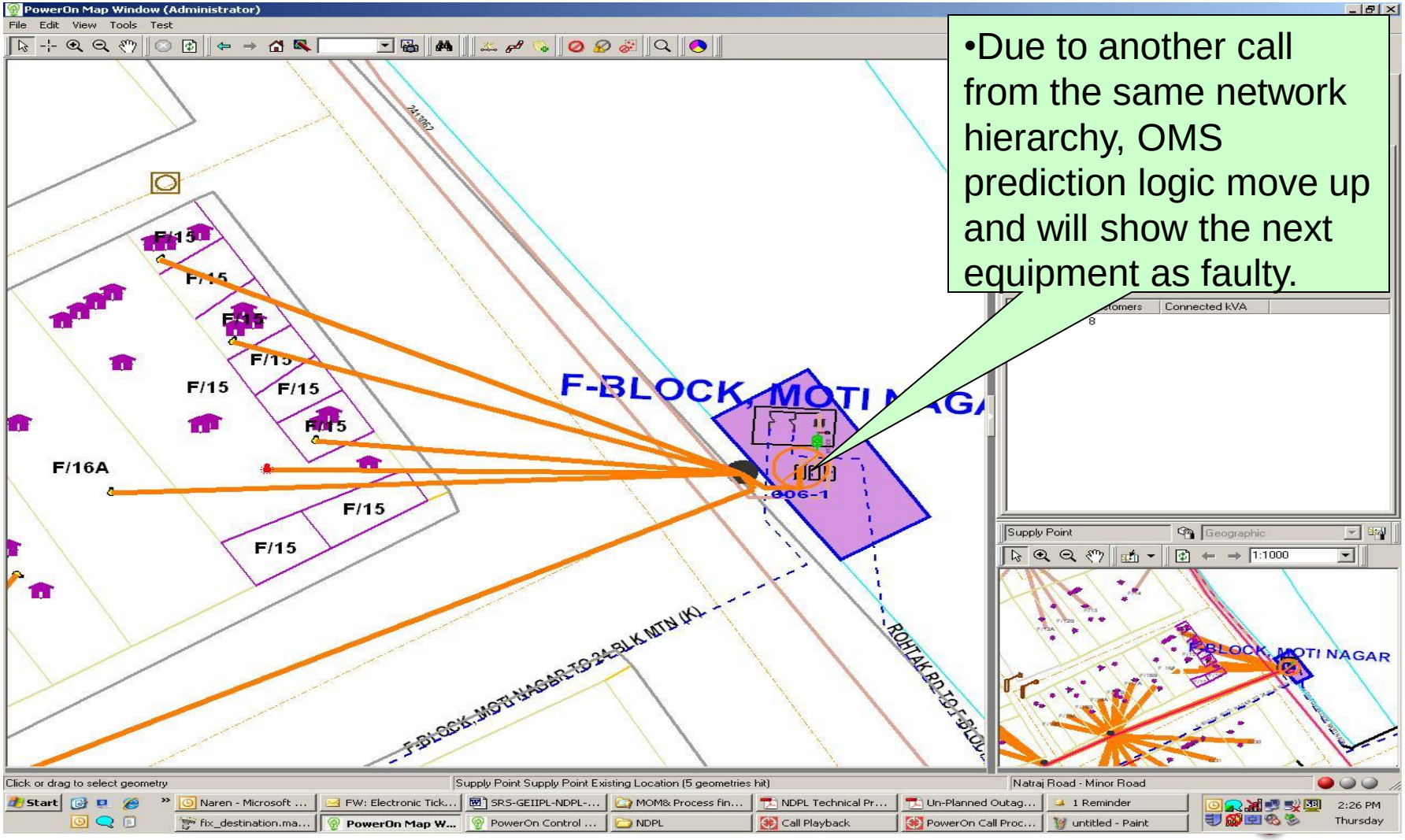
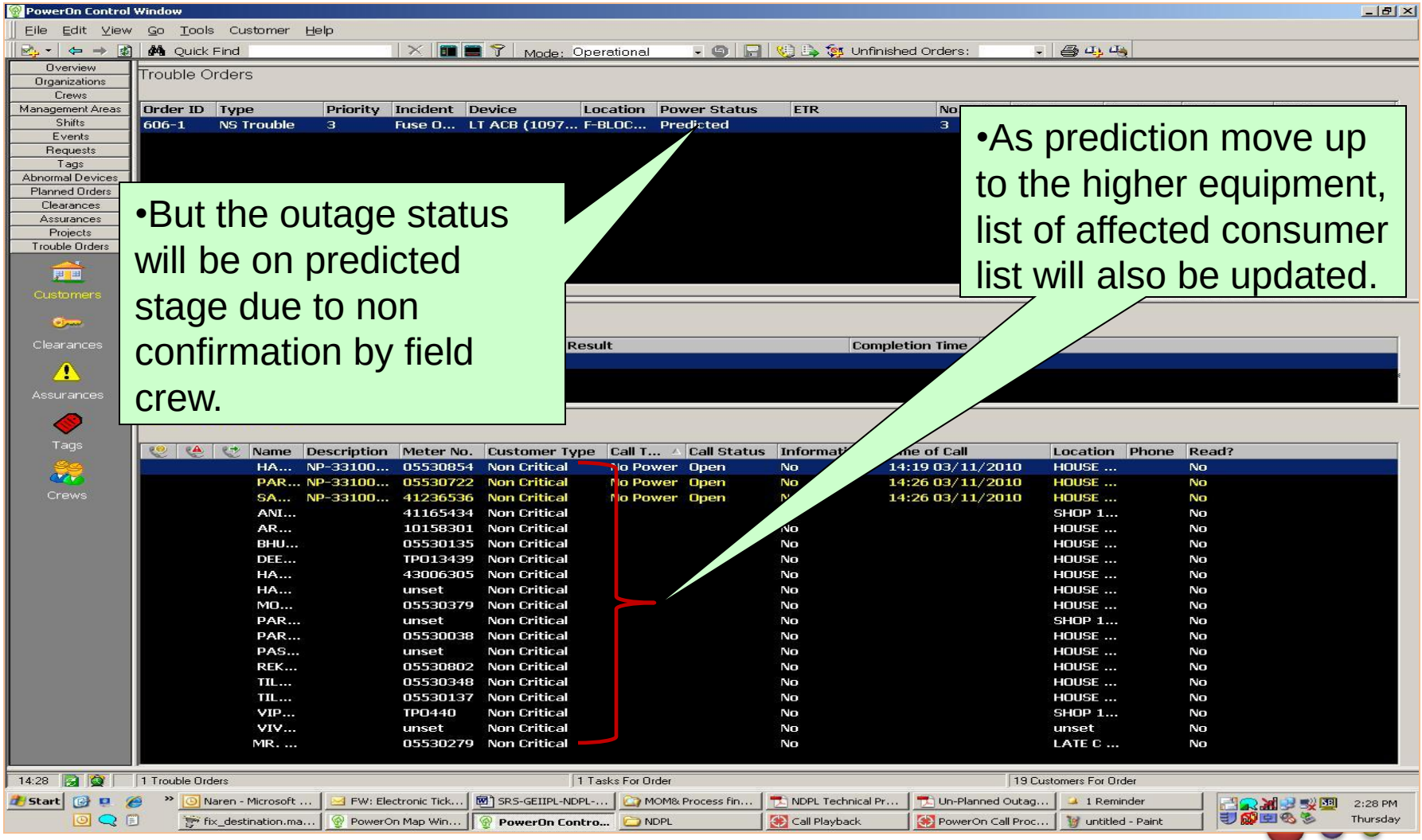


•Due to another call from the same network hierarchy, OMS prediction logic move up and will show the next equipment as faulty.

GIS OMS interface-Work flow

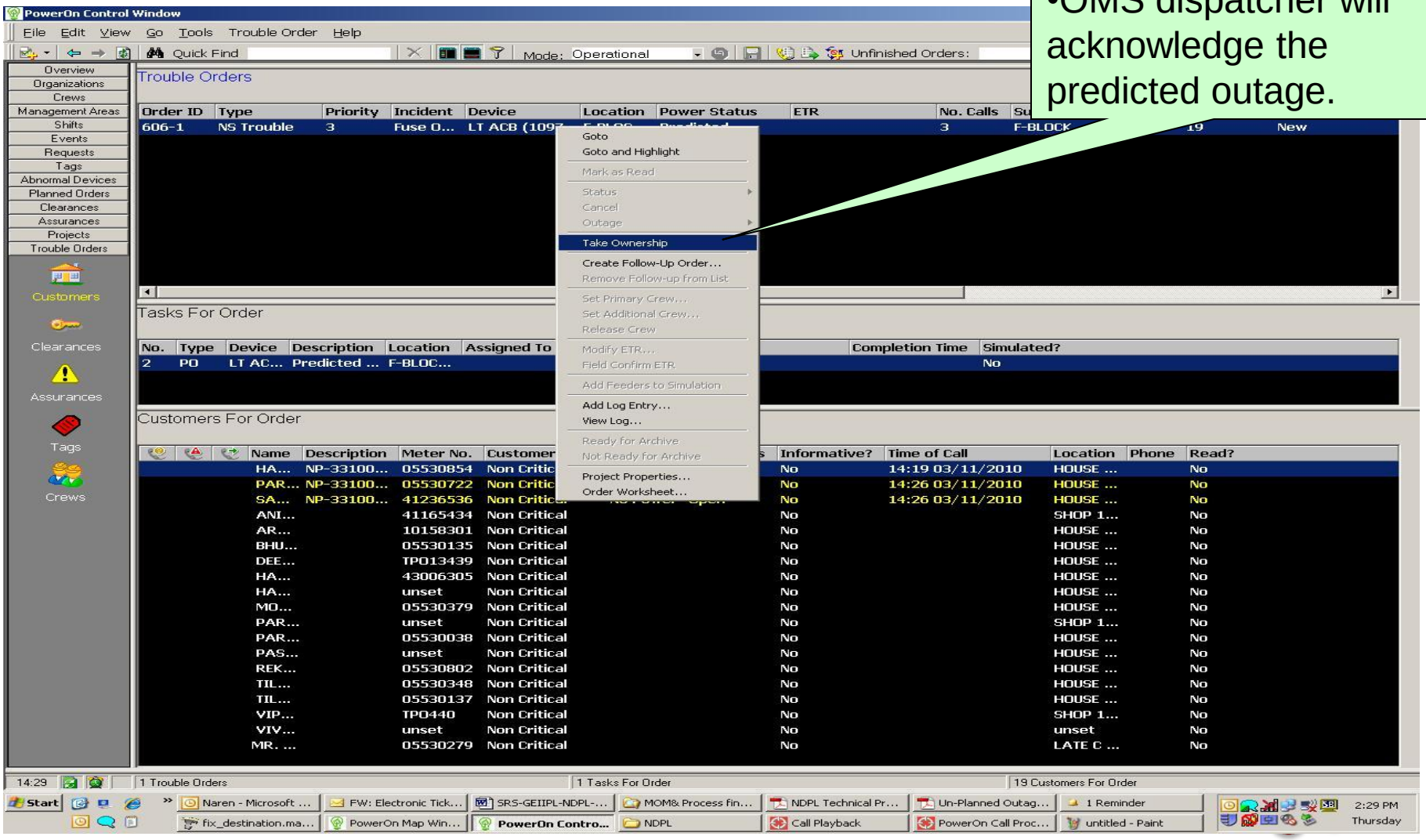


•But the outage status will be on predicted stage due to non confirmation by field crew.

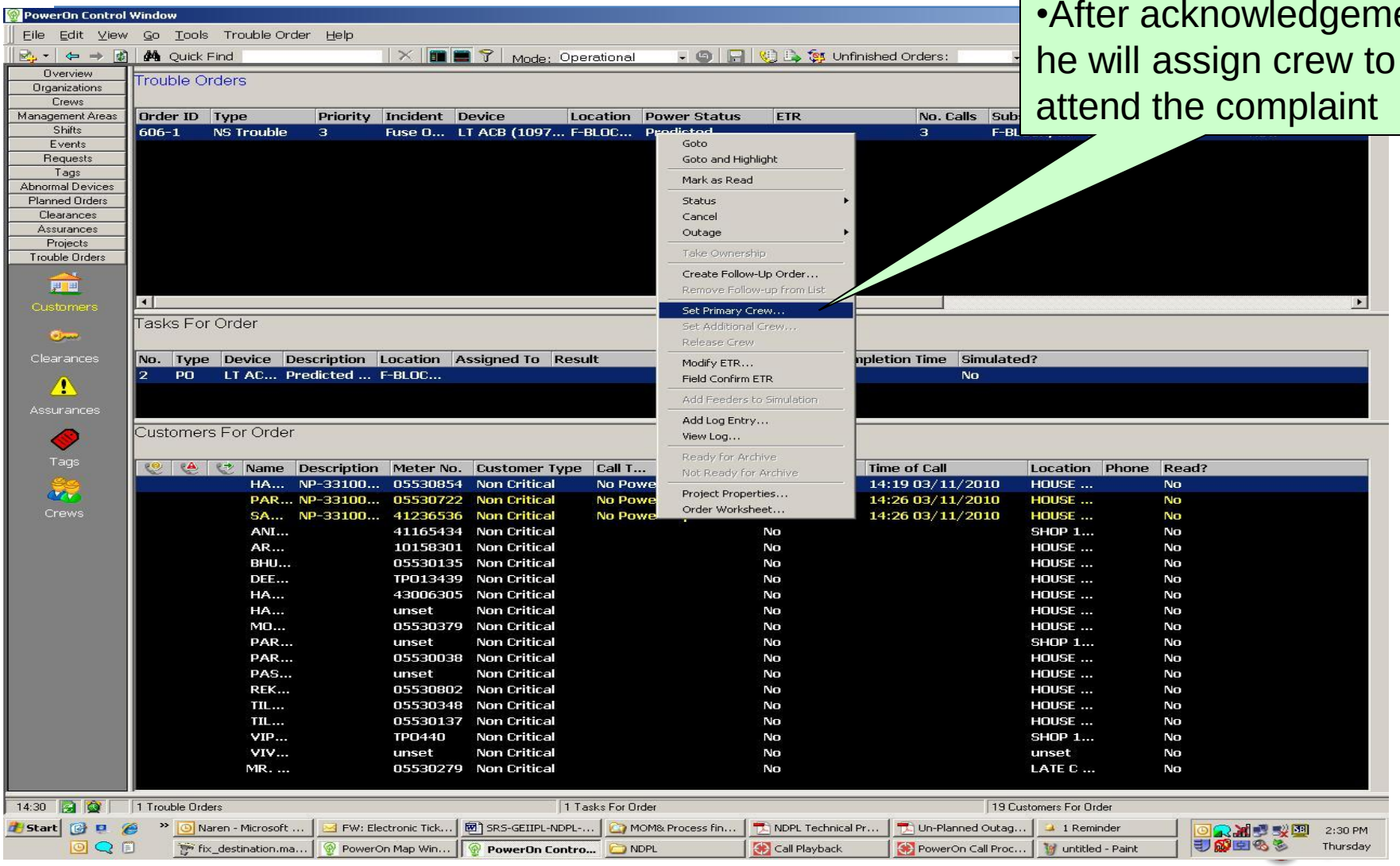
•As prediction move up to the higher equipment, list of affected consumer list will also be updated.

GIS OMS interface-Work flow-Crew assigning

•OMS dispatcher will acknowledge the predicted outage.

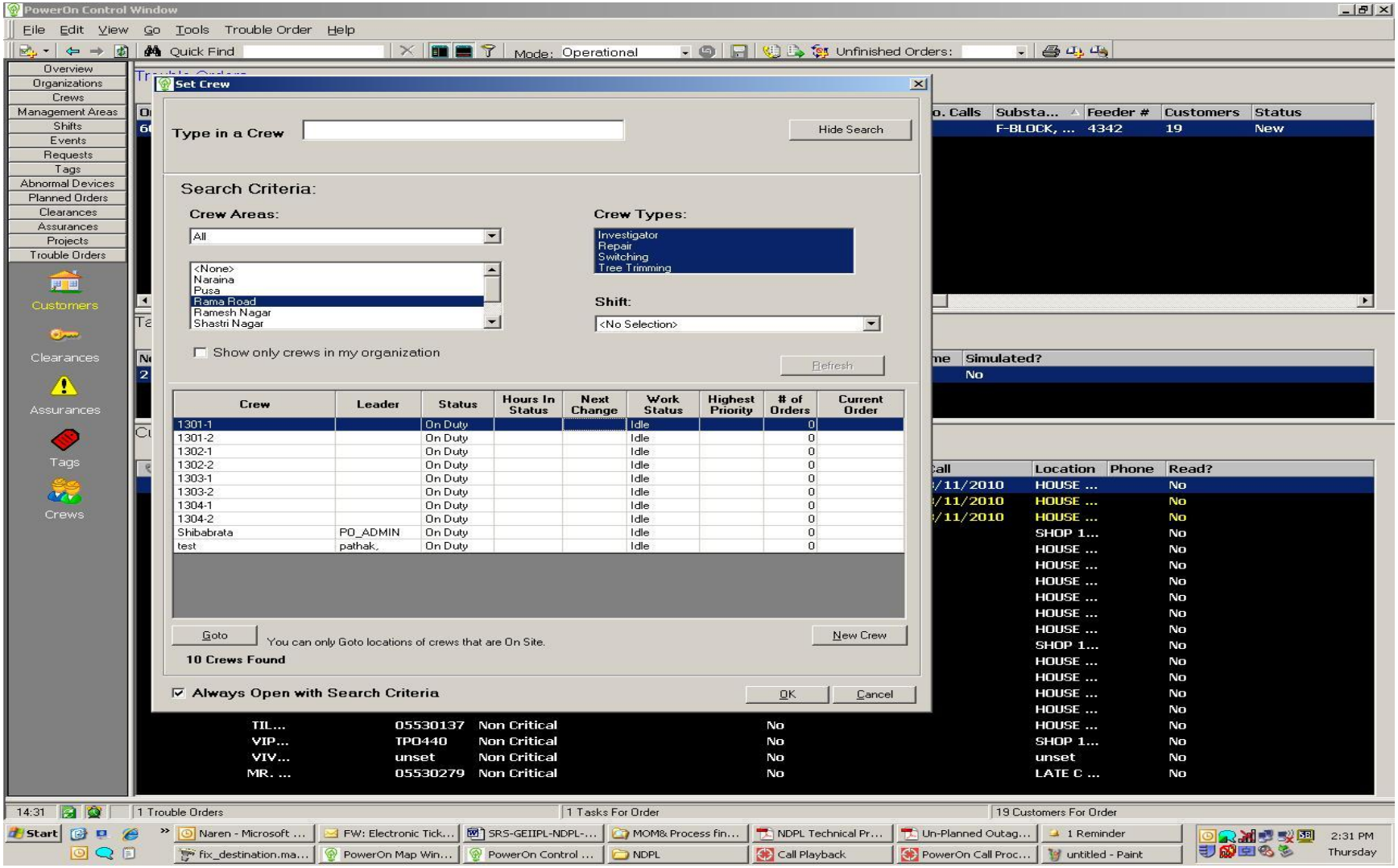


GIS OMS interface-Work flow-Crew assigning



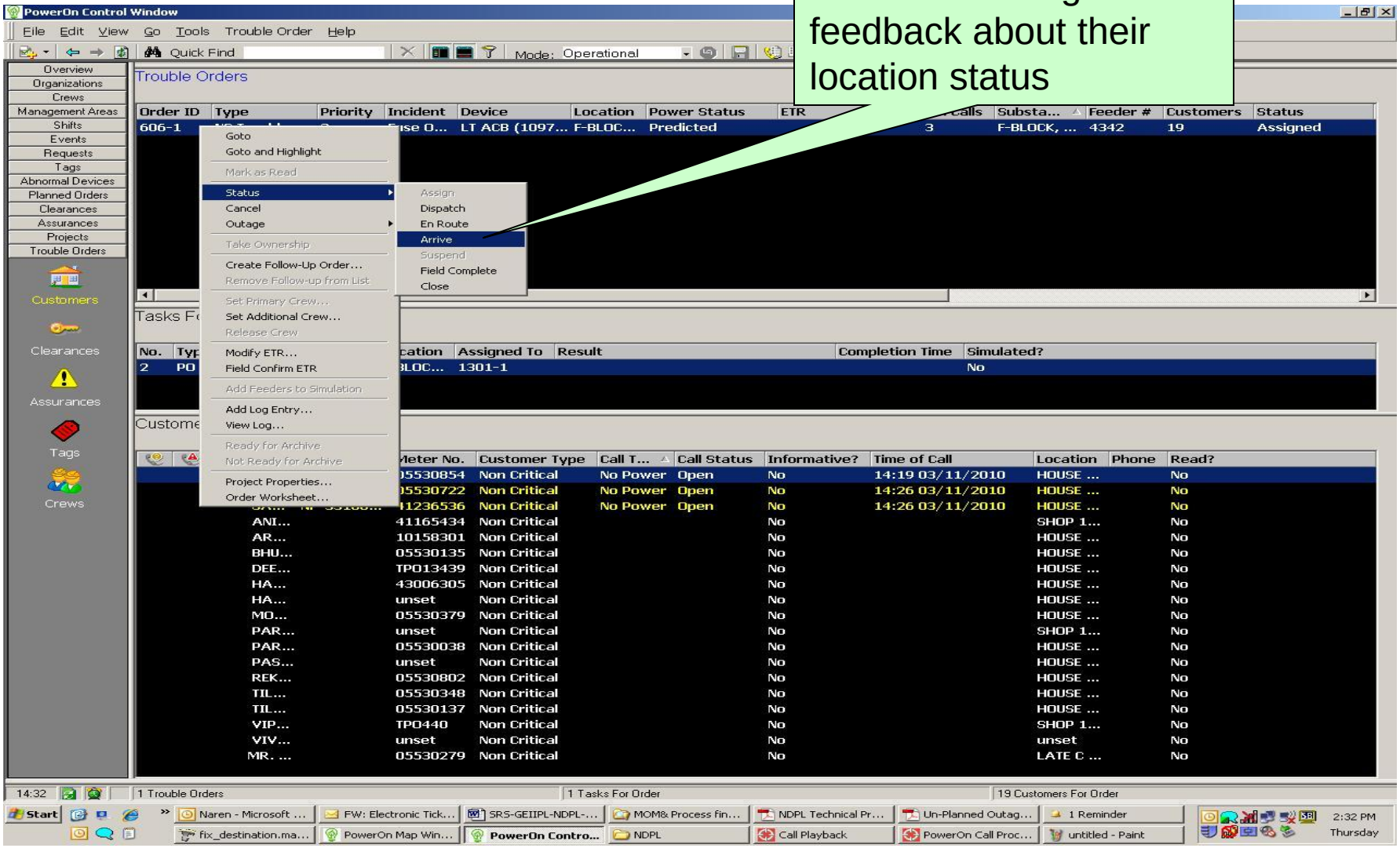
•After acknowledgement he will assign crew to attend the complaint

GIS OMS interface-Work flow-Crew assigning



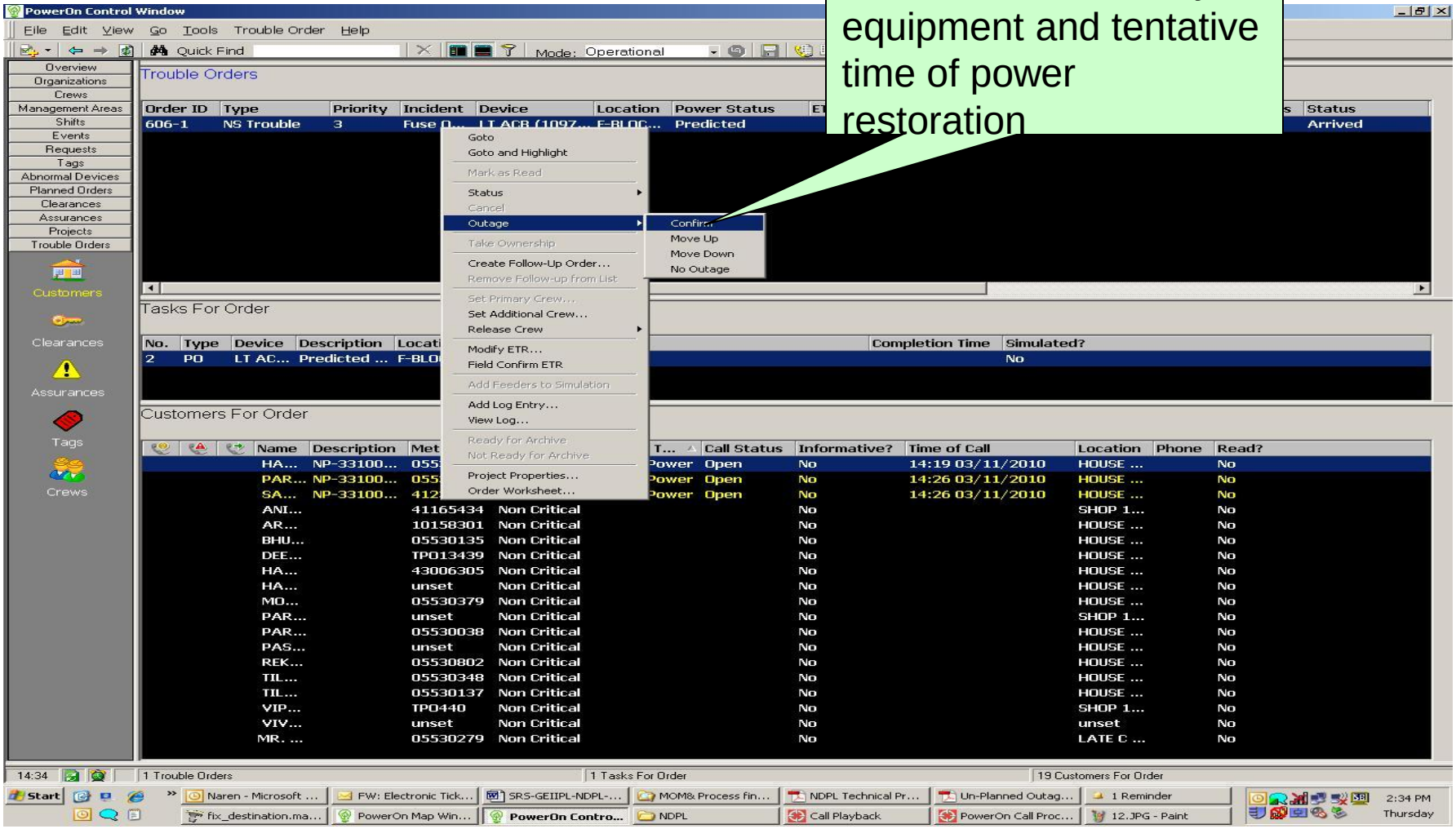
GIS OMS interface-Work flow-Crew feedback

•Now crew will give feedback about their location status

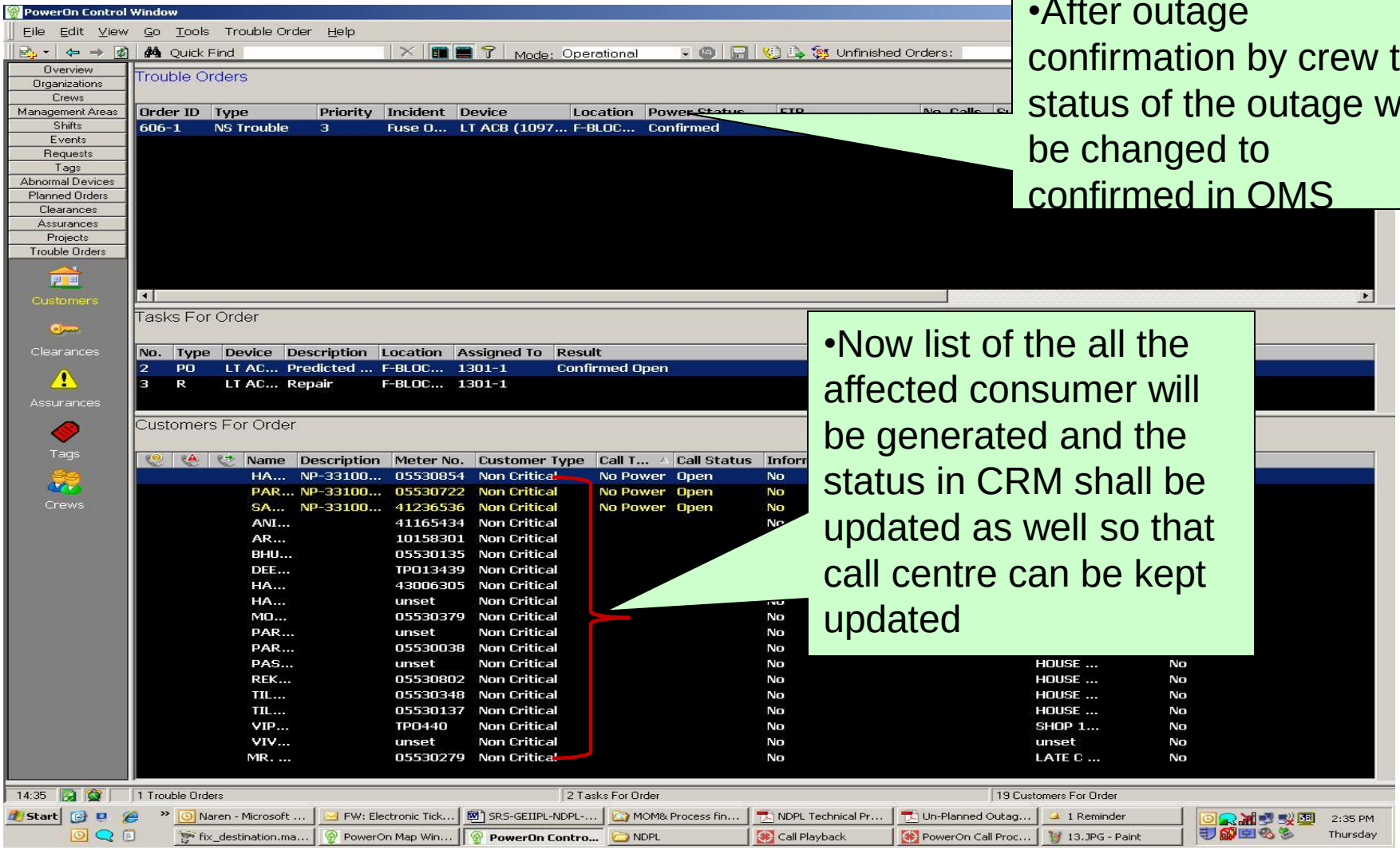


GIS OMS interface-Work flow-Crew feedback

•Now crew will confirm about the exact faulty equipment and tentative time of power restoration



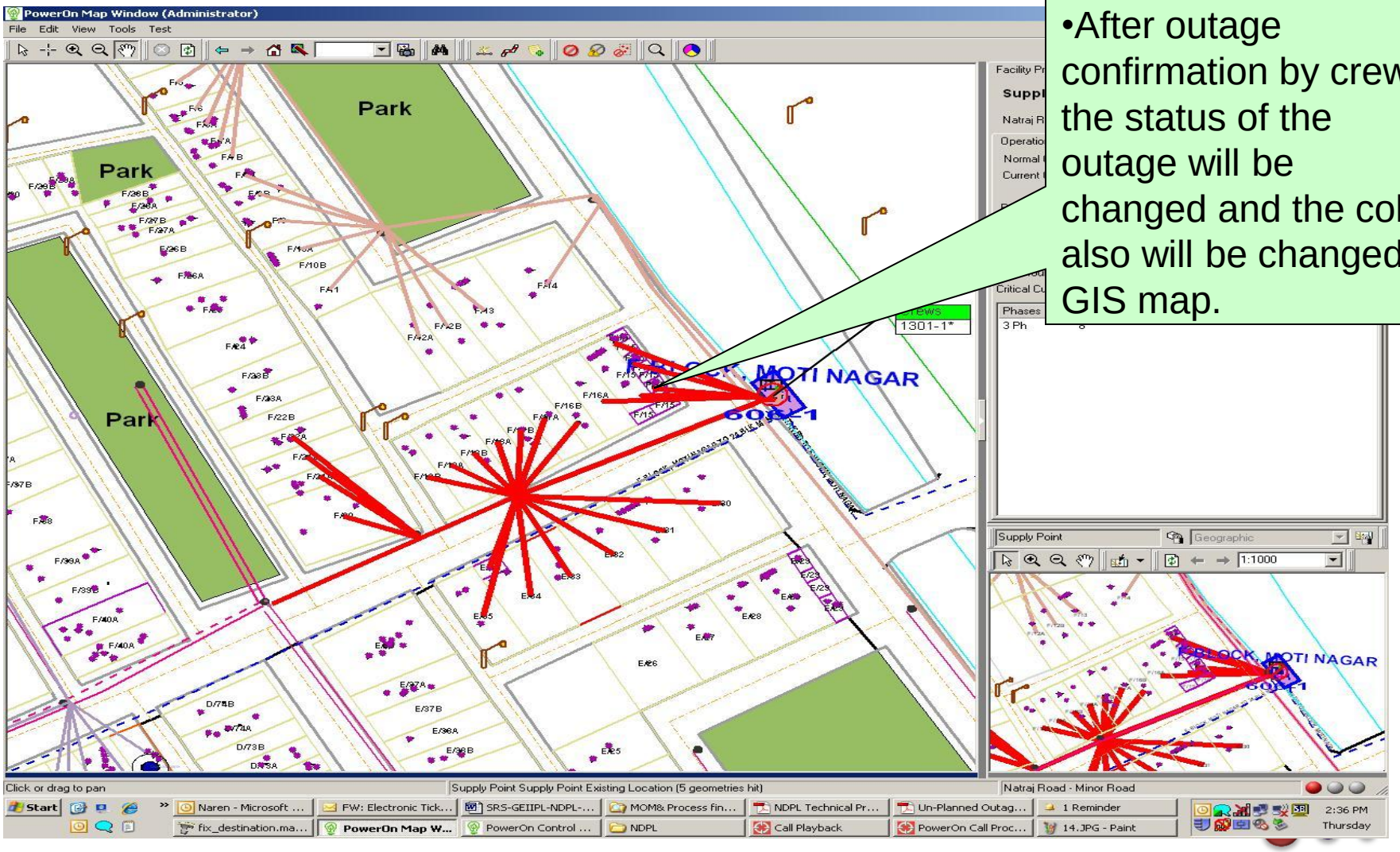
GIS OMS interface-Work flow-Crew feedback



•After outage confirmation by crew the status of the outage will be changed to confirmed in OMS

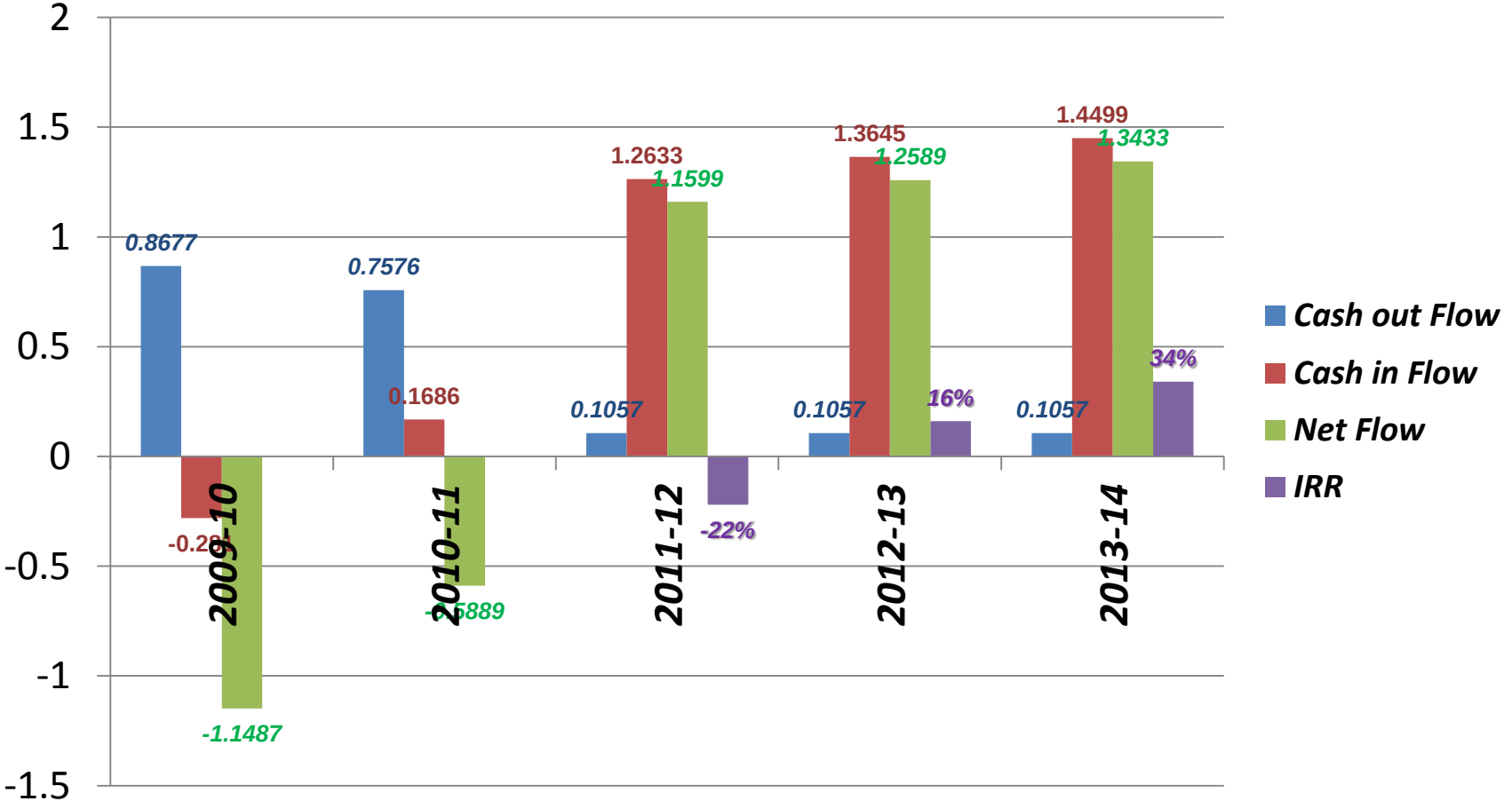
•Now list of the all the affected consumer will be generated and the status in CRM shall be updated as well so that call centre can be kept updated

GIS OMS interface-Work flow-Crew feedback



•After outage confirmation by crew the status of the outage will be changed and the color also will be changed in GIS map.

Estimated Investment Benefits (in Million USD)



Demand Side Management (DSM)

In current scenario, the focus is exclusively on new supply (Ultra Mega Power Plants) and on improving the supply efficiency and reducing T&D losses (Restructured Accelerated Power Development & Reforms Program), there is need for major focus on ***Demand Side Management (DSM)***, like *energy efficiency (base load) and demand response (peak demand).*

In India, the key drivers for DSM are identified as:

- Overall energy saving
- Improved service (eg., through improving the voltage / frequency profiles)
- Increased revenue (eg., through reducing power theft), or decrease cost (eg., through reducing peak demand)
- Ability to manage tariff subsidy

Demand Response (DR)

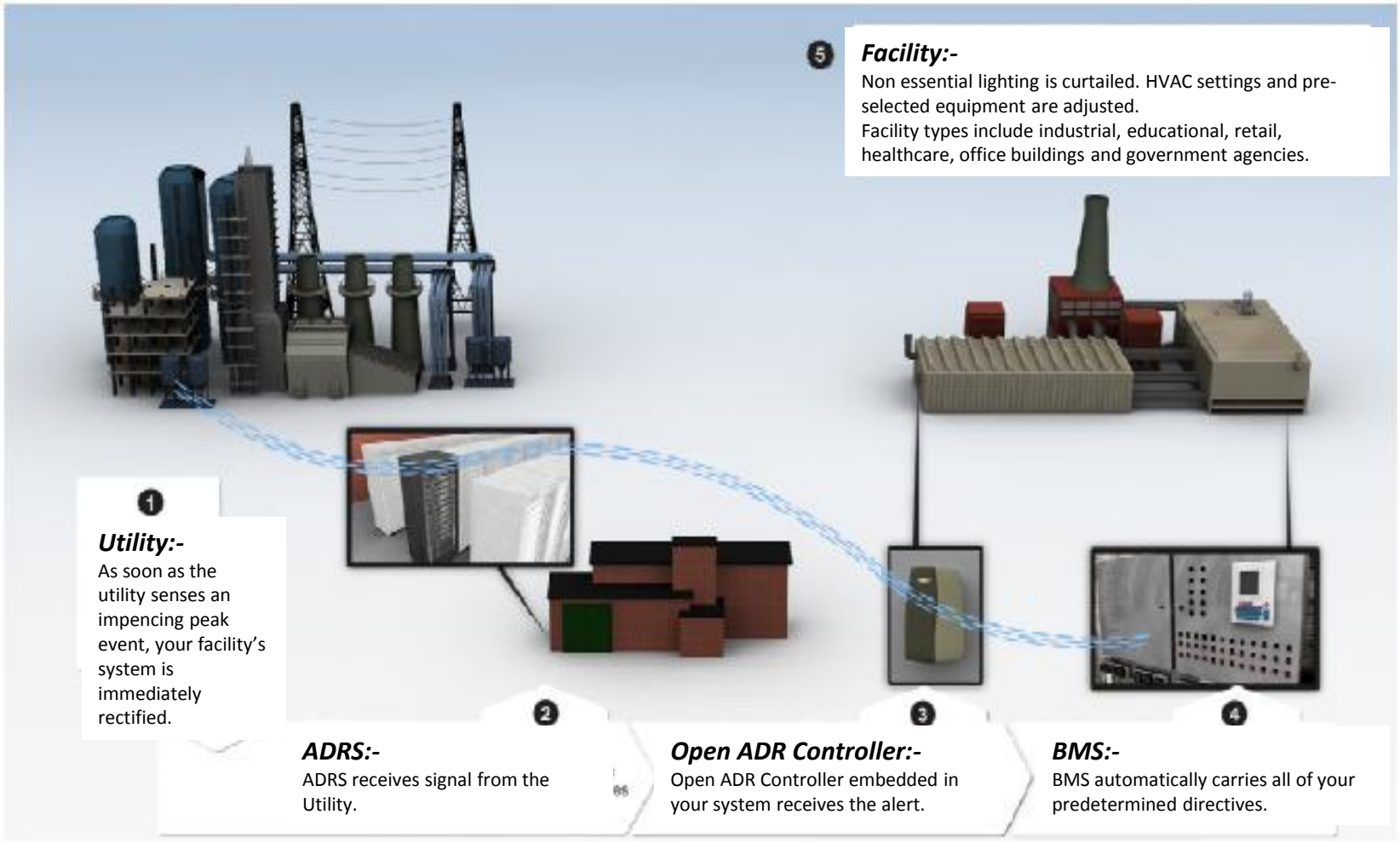
Demand Response (DR) is ***Peak Electric Load Reduction,*** *an historical perspective and business model for load control*

Demand Response explicitly refers to all those activities that involve utility action in the marketplace to modify the consumer's load profile. Demand Response is a potent tool to address the peak energy and power deficit in India which stands at 12.7% and 10.1% respectively.

Actual Power Supply Position

	Energy (MU)	Peak (MU)
Requirement	*830594*	*119166*
Availability	*746644*	*104009*
Shortage	*83950*	*15157*
Percentage	**10.1%**	**12.7%**

DR System Architecture



Typical Demand Response (DR) Event

GRID STRESS → Notification → Client Actions

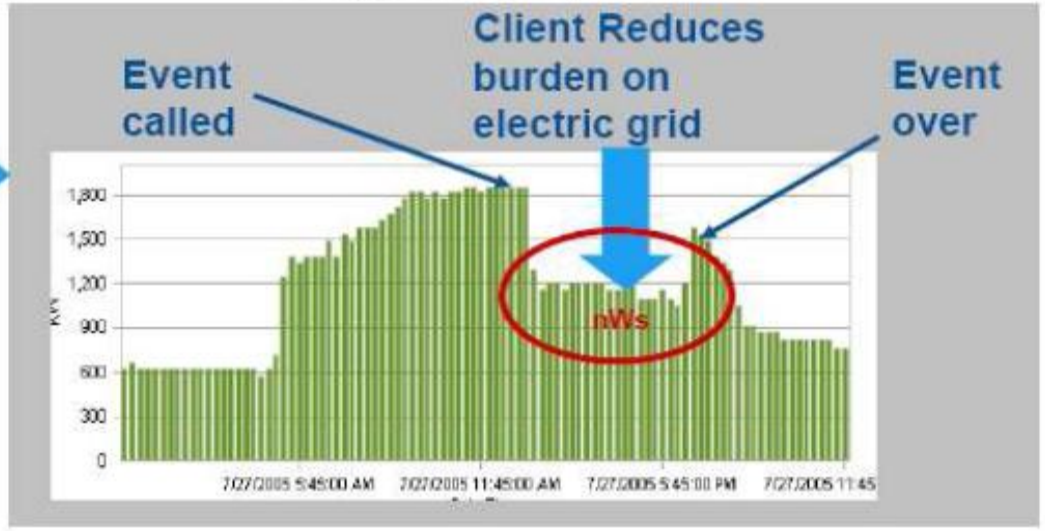
Turn off 1 of 4 elevators

Pre-cool building in early morning hours

Turn on emergency generator (can use as monthly generator test)

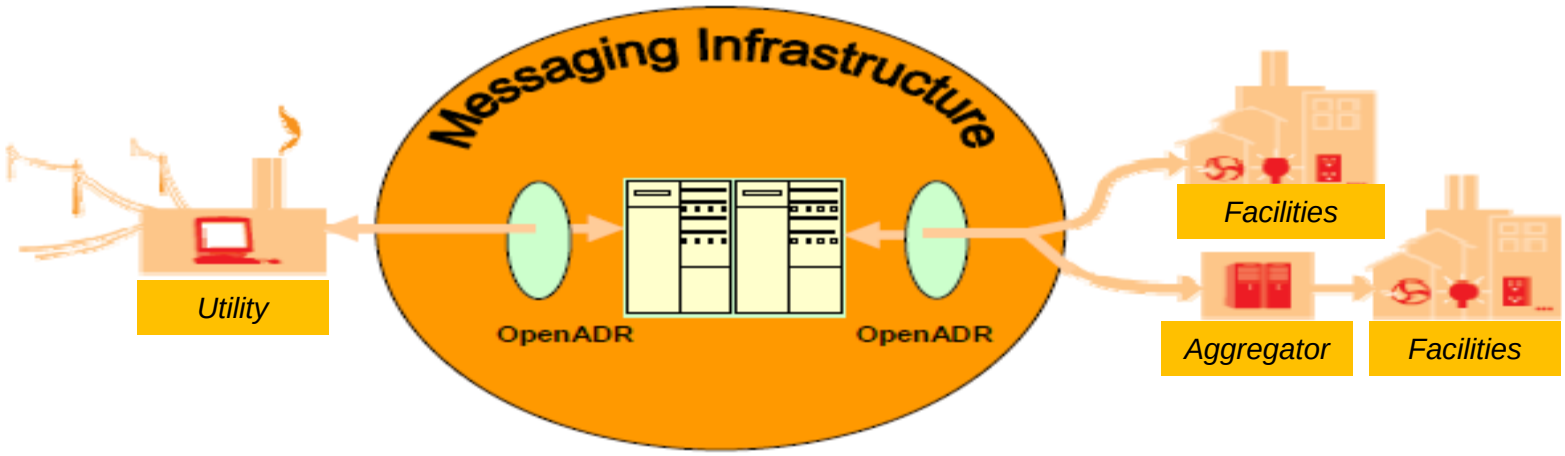
Turn off non-essential lighting

Grid Relief



Automatic Demand Response (ADR)

Automatic Demand Response (ADR) is a communication infrastructure with energy management control systems to initiate customer approved actions to curtail loads automatically. An Auto-DR event can be triggered by either real-time prices or system reliability triggers. The communication is based on open standards like Internet protocols – Open ADR protocol.



Automatic Demand Response (ADR)

- Open ADR is a set of data models and interaction specifications that provide a means for utilities to publish grid condition information such as electricity prices, shed levels and grid reliability signals.
- The purpose of publishing the information using Open ADR is to affect certain automated change in end use load profiles. This information is published using a standardized Open ADR message that is transmitted from the utility to participating end-use customers for better load management through pre-programming in the system.

- *Open ADR protocol is suitable for Indian market conditions considering it is a protocol based on open standards, network neutral and inter-operable with existing systems.*

Typical ADR Strategy and its Impact

HVAC Systems

- Zone Control
  - Global Temperature Adjustment
  - Passive Thermal Mass Storage
- Air Distribution
  - Duct Static Pressure Decrease
  - Fan VFD Limit
  - Supply Air Temperature Increase
  - Fan Quantity Reduction
  - Cooling Valve Limit
  - CO_2 Set point
- Central Plant
  - Chilled Water Temperature Increase
  - Chiller Demand Limit
  - Chiller Quantity Reduction
- Rebound Avoidance
  - Slow Recovery
  - Sequential Equipment Recovery
  - Extended DR Control Period
- Other HVAC
  - Duty-cycling of Electric Heaters

15~20%

Lighting Systems

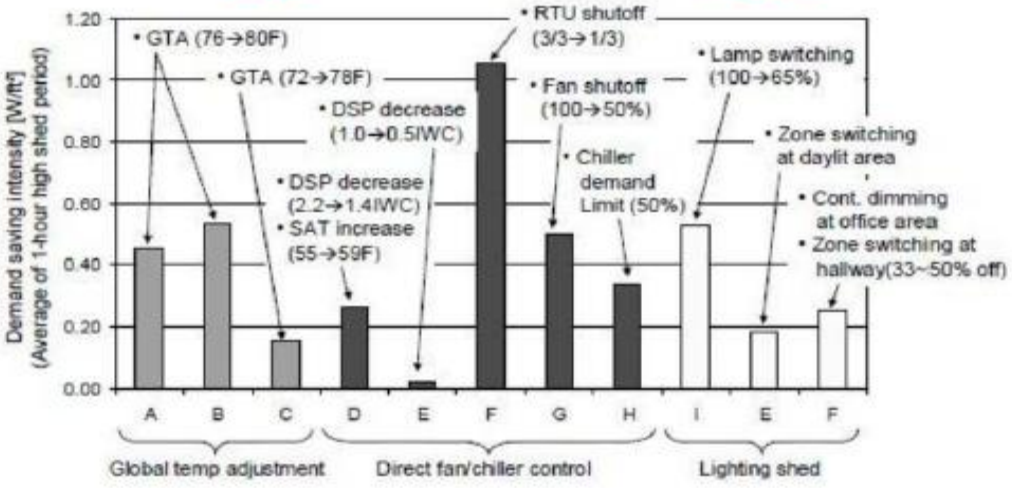
- Demand Limiting
- Lighting Sweep
- Central Dimming
- Bi-level/Zonal Switching
- Overrides

5~10%

Other Equipment

- Elevators
- Water Treatment Systems
- Water Fountain Pumps

10~15%



ADR for Commercial and Industrial Loads

A typical DR Implementation would consist of three main entities:

- An entity at the utility which stores the program information, generates and communicates the DR signal to the participant.
- An entity at the participant site capable of receiving the utility DR signal and controlling the load accordingly.
- An entity for measurement and verification.

ADR for Commercial and Industrial Loads

A typical DR Implementation consists of following steps :

- Perform energy audit of the facility and identify shed strategy.
- Installation of control box, capable of receiving the utility DR signal.
- Programming of the shed strategy in the Building Management System (BMS).
- Connection of control box to the meters for obtaining meter data
- Running a test event – utility sends a test signal, control box receives it, engages pre-programmed shed strategy, collects meter data during the DR event and transmits it back to the utility.

Automated C&I Demand Response Solution

UTILITY NEEDS

- Maintain system integrity
- Maintain program control
- Drive energy conservation
- Promote dynamic pricing
- Enable behavior change
- Real time reporting

DR Aggregation Server

- Event Control
- Utility Dashboard

DR Program Management

- Program development
- Customer enrollment
- Customer site optimization
- Program management
- Monitoring and reporting

Site Controller

- Compatible with 99+% of BAS systems
- Customer Dashboard

CUSTOMER NEEDS

- Turnkey energy cost savings
- Automated participation
- Self funding opportunities
- Monitoring / reporting of results

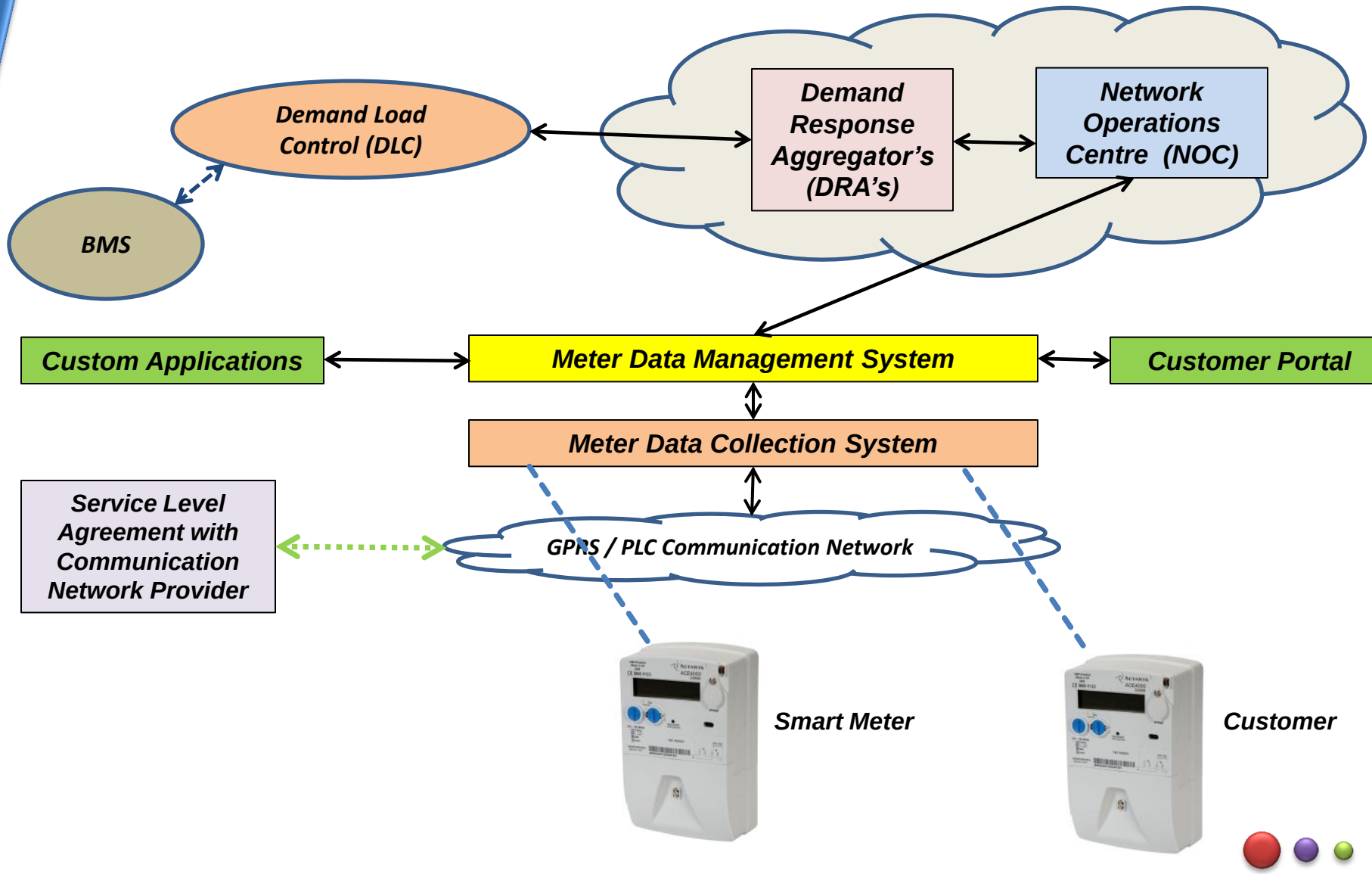
Proven standards based DR technology for C&I sector

Savings through DR (in Million USD)

Savings	1 year	3 year	5 year
a. Energy saving through DR *	*0.191*	*0.571*	*0.951*
b. Deviation from sanctioned load *	*1.260*	*3.778*	*6.296*
c. Monthly meter reading for billing and analysis *	*0.022*	*0.067*	*0.133*
Total d = (a + b + c) *	***1.473***	***4.416***	***7.380***

* ***Considering top 100 C&I consumers***

Smart Grid Pilot Architecture



NDPL

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questions and queries to

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Outage Management and Demand Side Management

T. M. Shakya
General Manager
Transmission and System Operation
Project Coordinator
Energy Access and Efficiency Improvement Project

Outline of Presentation

- **Status of Power System in Nepal**
  - **Generation System**
  - **Transmission System**
  - **Distribution System**

- **Integrated Nepal Power System**

- **System Load Curve**
- **Supply Side Management**
- **Demand Side Management**
- **Benefits of Demand Side Management**

Status of Power System in Nepal

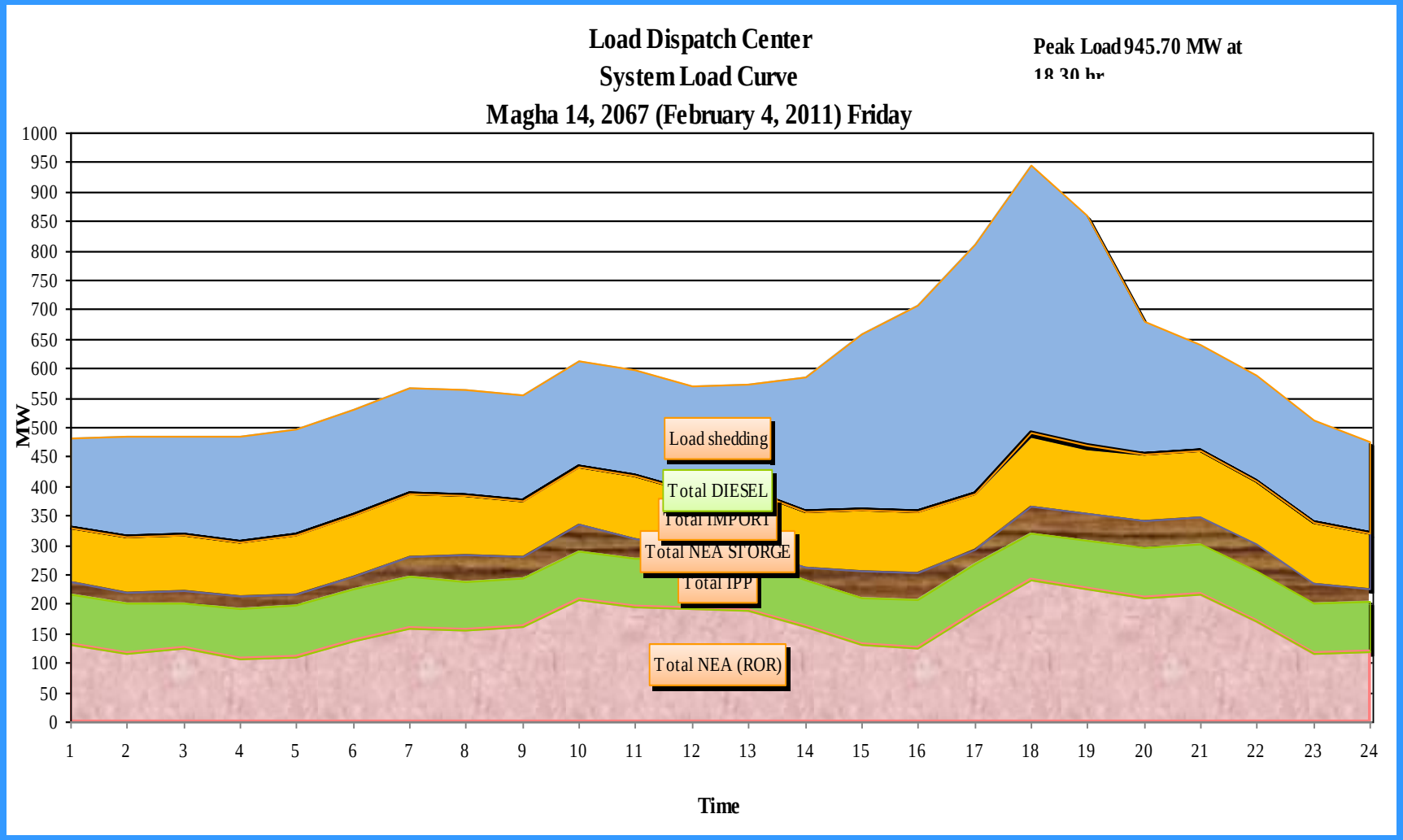
- **Generation System**
  - **Predominantly Hydropower Based**

Total Installed Capacity:	**644 MW**
Run of River:	**552 MW**
Storage:	**92 MW**
Thermal (Diesel/Multifuel)	**53 MW**
Total Generation Capacity	**697 MW**
Peak Demand (2011)	**945 MW**

Problems of Power System in Nepal

- Low Power Generation Capability in Dry Season because of ROR Plants
- Maximum Demand in Winter Dry Season
- Power and Energy Deficit in the System
- Load Shedding Almost Round the Year, Extensively in Dry Season
- High Power System Losses
- Sharp Peak and Low System Load Factor
- Need for Supply Side and Demand Side Management

System Load Curve of Peak Day
February 4, 2011



Supply Side Management

- Construction of New Power Stations
- Rehabilitation of Existing Power Plants
- Supply Side Efficiency Programs
  - Transmission and Distribution System Reinforcements
  - Power Factor Improvement
  - Loss Reduction Programs
- System Voltage Control
- System Frequency Control
- Load Staggering
- Load Shedding

Load Shedding

- **Round the Year. Continuing from Last 4 Years and will Continue for at least for Next 4 Years**
- **As High as 14 hrs a Day in Dry Season and 2 hrs in Wet Season this Year**
- **Load Shedding Mostly in the Central Region. Less Severe and almost None in the Areas Supplied from Power Imported from India**
- **Load Shedding in 2 Shifts**
- **Load Shedding Different for Different Categories of Consumers**
- **No Load Shedding for Hospitals**
- **All the Distribution Feeders are Divided into 7 Different Groups and Have Load Shedding in Rotation**
- **Load Shedding Managed by Load Dispatch Center**

Demand Side Management

- **Promotion of Energy Efficient Lamps and Equipments**
  - **Use of CFL Lamps**
  - **Use of LED Lamps**
  - **Use of Thin Tube Lights**
  - **Use of Electronic Chokes**
  - **Use of Energy Efficient Equipments and Appliances**

Demand Side Management

- **NEA's CFL Program**
  - **Distribution of more than 756,000 CFL Lamps in Pilot Areas**
  - **Buy 1 Get 1 Free, Buy 2 Get 2 Free**
  - **Use of High Power Factor CFL Lamps**
  - **Supply from 2 Vendors Selected on Competitive Basis**
  - **Distribution Through Retail Shops**
  - **Public Awareness Programs**

Demand Side Management

- **Energy Efficiency in Lighting Program under ADB Grant**
  - **About US$ 2 million Grant from ADB (Clean Energy Fund)**
  - **Distribution of About One Million CFL Lamps to the Consumers**
  - **Workshops, Training and Awareness Programs**
  - **Waste Management**

Demand Side Management

- **Time of Day (TOD) Tariff and Metering**
  - NEA Introduced TOD Tariff in 2001

  - Three Time Zones (T1, T2 and T3)
    - T1: 18:00 Hrs to 23:00 Hrs (Peak Time)
    - T2: 23:00 Hrs to 06:00 Hrs (Off Peak Time)
    - T3: 06:00 Hrs to 18:00 Hrs (Normal Time)

  - Highest Tariff for Peak Time and Lowest Tariff for Off Peak Time

  - TOD Energy Meter Mandatory for 11kV and Higher Voltage Consumers

  - NEA Planning to Introduce TOD Tariff for Low Voltage Consumers Also

Benefits of Demand Side Management

- **Benefits to Consumers**
  - Less Electricity Bill
  - Long Life of CFL and LED Lamps and Hence Low Replacement Costs
  - More Reliable Power Supply

- **Benefits to Utility**
  - Less Investment in Generation, Transmission and Distribution System
  - Low Cost of Service
  - More Manageable Power System Operation
  - Better Consumer Service and Increased Consumer Satisfaction

Benefits of Demand Side Management

- **Benefits to the Nation and World**
  - **Conservation of Scarce Non- Renewable Natural Resources**
  - **Less Investment in the Power Sector Development**
  - **Increase in Production of Goods and Services due to More Reliable Power Supply**
  - **Better Quality of Life**
  - **Better Environmental Protection**
  - **Slow Down Global Warming and Climate Change**

Conclusion

- **Urgent Need to Mitigate Power Crisis in Nepal**
- **Supply Side Management is More Capital Intensive and Costlier than Demand Side Management**
- **Demand Side Management Is Cost Effective and Need to be Pursued Widely**
- **Need for Public Awareness Program and Government Support**
- **Demand Side Management Needed Not Only in Nepal but also All Over the World Specially in the Countries with Thermal Power Generation from Fossil Fuels to Protect the Environment and Mankind in the Years Ahead and Save the Good Earth for the Future Generations**

Thanks for Your Attention

TRUNZ

Water Systems

Swiss Made

Turning Ideas into Action!

Experiences with Wind- and Solarpowered Watertreatment

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It started with a need…

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… became an idea and then a prototype …

TRUNZ Water Systems Swiss Made

… and finally a solution

About Trunz Water Systems

Development, Production and Sales of

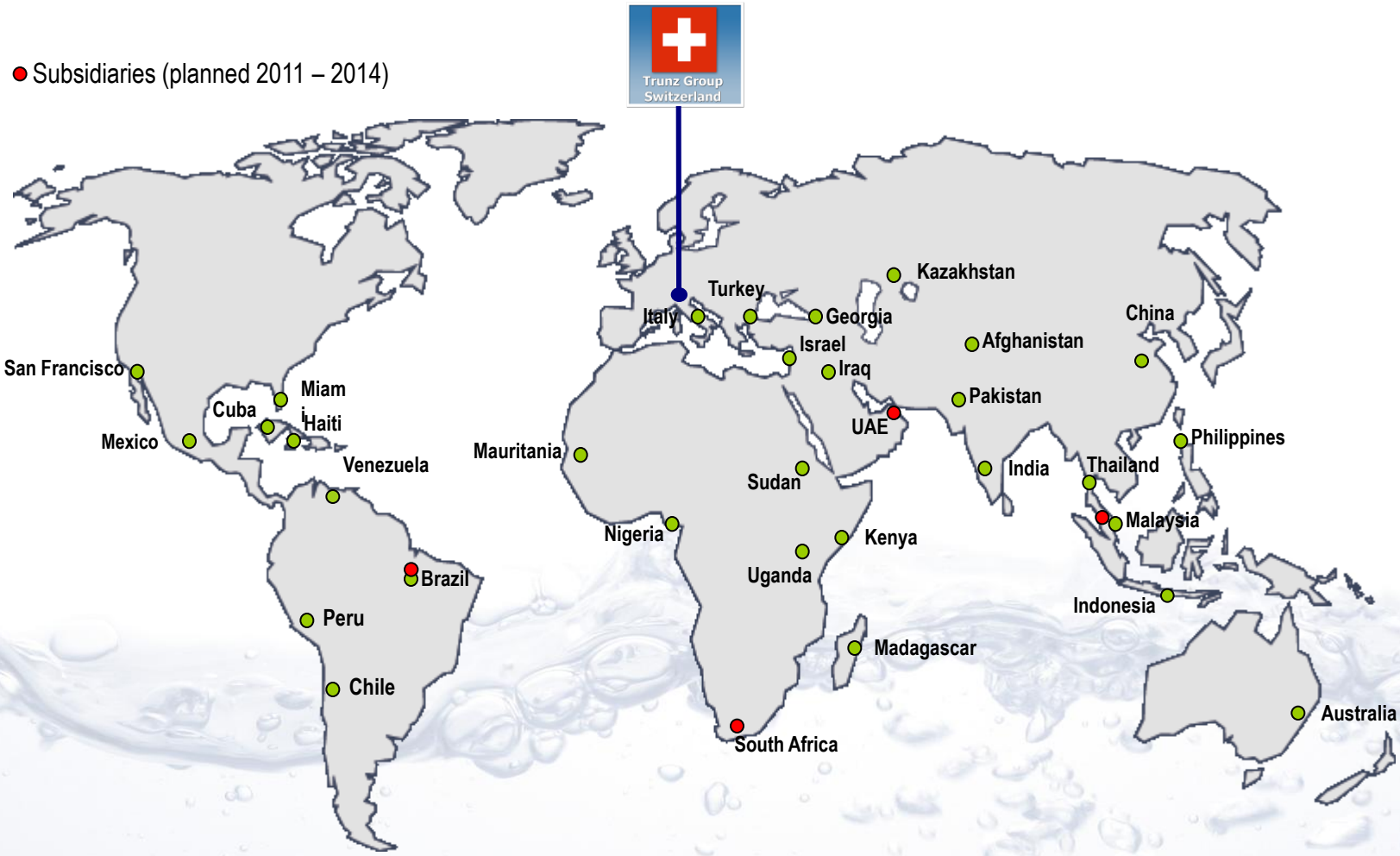
→Drinking Water Treatment Solutions

→Renewable Energy Solutions

Distribution through worldwide dealer network

Focus on remote locations with no electricity and no access to safe drinking water

Worldwide applications



What makes the Trunz Water Systems unique?

- Independent, thanks to renewable energy sources
- Exceptionally energy efficient
- Only top quality components
- Able to treat highly contaminated water due to advanced treatment technology (Ultrafiltration and Reverse Osmosis)
- Easy to operate also by local people due to high automation
- Low maintenance and service requirements
- Long life expectancy
- Compact and modular product portoflio

➢ Designed for the usage under harsh conditions in remote areas without power and safe drinking water!

Is renewable Energy economically efficient?

Let me show you a few examples:

Comparison of Solar and Diesel (quantitative)

Solar

- Cost for 1Wp Solarpower:
  approx. 1.20 USD
- Operation time to produce 3kWh
  3‘750h or 680 days
- Capacity losses due to cabling etc.:
  25%

Diesel

- Cost for 1l Diesel:
  approx. 1.20 USD
- Energy capacity per liter Diesel:
  10kWh (theoretical)
  3kWh in Generator

As soon as a Solarsystem is installed for longer than 1.9 years, it will have a cost saving effect related to Diesel powered systems!

Comparison of Solar and Diesel (qualitative)

Solar

- No logistic costs
- Supply security
- Low service costs
- Long lifetime expectation (+20y)
- Green Technology
- Production of CO2:
  None!

Diesel

- Costs for transportation and infrastructure
- Supply can not always be guaranteed
- High service costs
- Limited lifetime expectation (5y)
- Generation of Noise and Smell
- Production of CO2:
  2,6kg/l

The tendency of the cost development an efficiency is in favour of the renewabl
Energy ressources too.

Example 1: Telecommunication Tower

Solar

Requirement: 2kW or 48kWh per day

Solar Powersystem:	10‘900Wp
Price per installed Wp:	5.- USD
Total Investment:	50‘000.- USD

Diesel

Requirement: 2kW or 48kWh per day

Diesel Vol. per 10kWh:	3,3l
Requirement per day:	16l
Costs at USD 1.20/l:	19.20 USD
Net Costs at USD 3.-/l:	48.- USD

With a planned operation time of more than 1‘000 days or 2.8 years, it makes more sense to invest into a solarpowered supply system.

Example 2: Desalination Plant (45‘000l clean water per day)

Solar

Requirement: 4,5kW or 100kWh per day

Solar Powersystem:	19‘980Wp
Price per installed Wp:	5.- USD
Total Investment:	100‘000.- USD

Diesel

Requirement: 10kW or 227,5kWh per day

Diesel Vol. per 10kW:	3,3l
Requirement per day:	75l
Costs at USD 1.20/l:	90.- USD
Net Costs at USD 3.-/l:	225.- USD

By using optimised seawater desalination systems, the investment
In solar energy will pay off after 444 days or 1.33 years already!

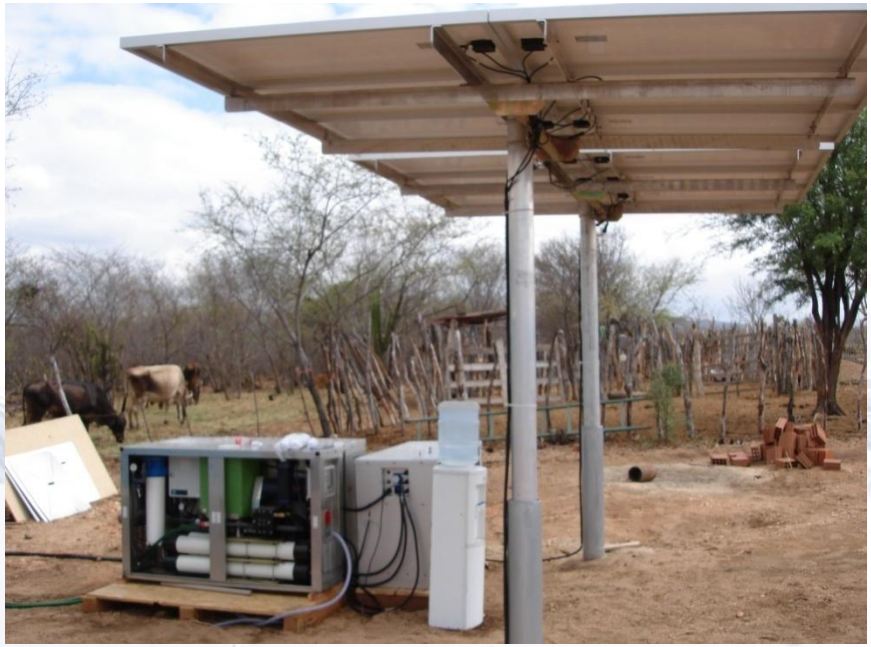
Examples of Solar Installations

Solarpumping system, Malaysia

Solarpower in Haiti

Examples of Desalination Plants

North East of Brasil



Desert of Abu Dhabi

Is renewable Energy economically efficient?

We clearly believe, that under the right circumstances and with the right technology, renewable energy supply can already today replace traditional sources. Especially by starting with remote areas and growing into a connected system, green technologies have a good potential.

The cheapest way to solve the energy problem, is energy saving. New technologies can reduce the amount of energy we use daily. Products like solar heating systems, solar airconditioning etc. can be used to reduce the load.

But, these technologies have to proof profitable for everybody involved!

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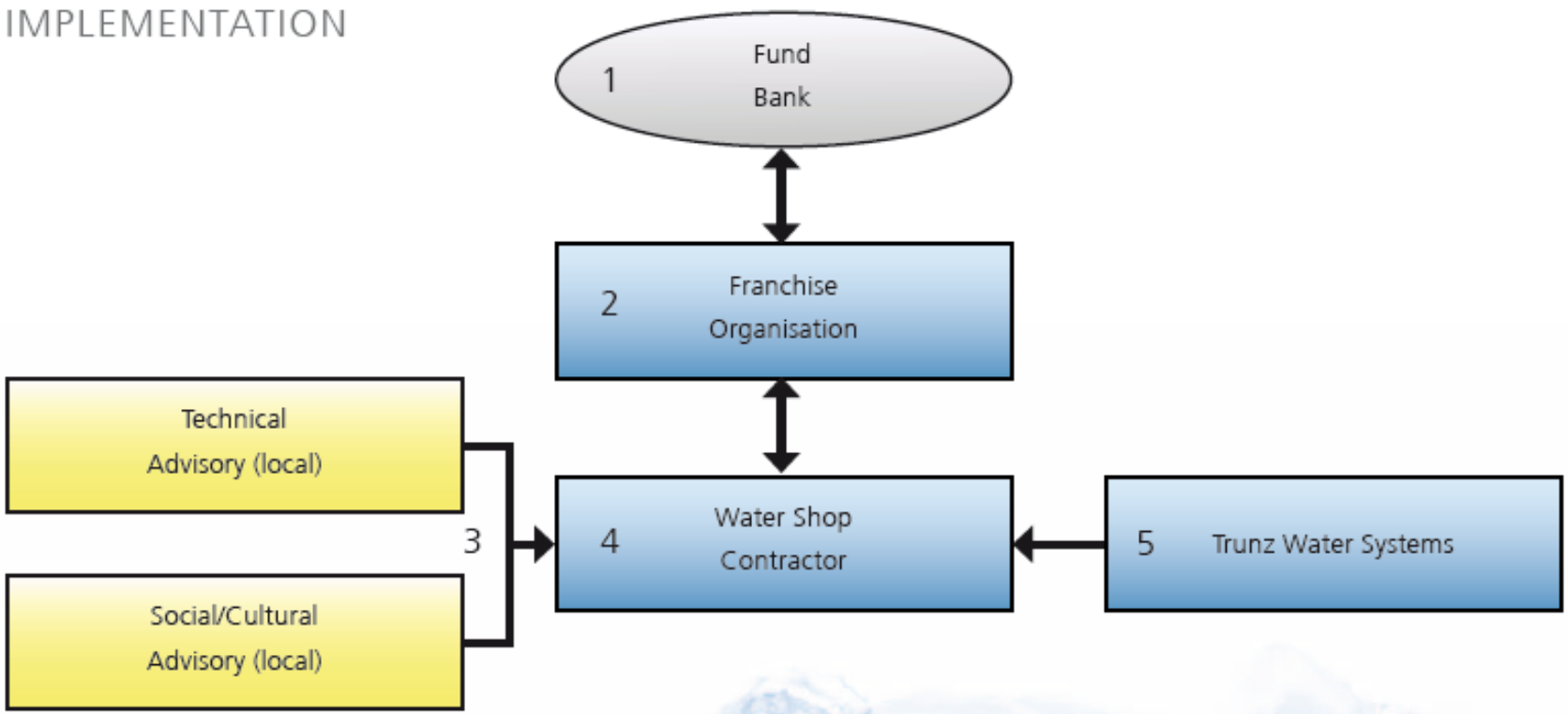
A new, triple bottom line approach: Social, Ecological & Economical

A new, triple bottom line approach: Social, Ecological & Economical



TRUNZ Water Systems Swiss Made

What is key to make this concept successful?

- An affordable Sales Price
- The demand needs to be high enough to break even
- A local partner with good contacts and good knowledge (technical and economical)
- Reliable Technology
- A financing partner who is not looking for a high rentability only
- The government needs to agree

- **The Endusers need to support the concept.** They need to understand the importance of clean water and energy and why they have to pay for it. They need to see the obvious benefits for their Health, their social Life but also for their economical situation. For this reason, they must be included from the beginning!

TRUNZ Water Systems Swiss Made

The Water & Energy Shop Concept

- Selling clean and safe drinking water and energy
- For an affordable price
- To the poorest of the poor,
- With green technology,
- By creating local job opportunities,
- Introduced by a regional partner,
- Financially at least sustainable or even profitable,
- For all stakeholders involved!

TRUNZ
Water Systems
Swiss Made

Philippines

Rotary Watershop Installation in Santa Barbara, Ilo Ilo City

Kenya

Diani Children Orphanage and School – the unit is used as a Watershop as well

Pakistan

Karachi City water house, water treatment unit

The Maledives want to become carbon neutral until 2020?
Then it is time to start acting and invest in renewable energy supply and energy saving equipment.
The solutions are ready and with a longterm focus, they can even save money!

Let us work together to solve two of the most important problems in the world with natural ressources and for everybodys benefit!

Get involved!

Let us save the environment for the generations to come!

Technology Driven Initiatives for Green Energy and Livelihood Security in Remote Villages

Dr. S. P. Gon Chaudhuri
Advisor (Renewable Energy)
Department of Power & NES
Government of West Bengal

Critical Issues in Rural Areas :~

- ✓ Non availability of Quality Energy, Infrastructure and Potable Water
- ✓ Environmental Degradation due to cutting of Trees for firewood
- ✓ Unemployment problem in Rural Areas due to non availability of Electricity
- ✓ Inefficient use of local resources and significant contribution to Green House Gas Emission

Barrier towards Electrification of Rural Areas :~

- ✓ High transmission and distribution losses
- ✓ Financial un viability of extending grid to remote and inaccessible areas
- ✓ Dispersed population in small villages resulting in low peak demand
- ✓ Poor financial condition of Power Utility Company
- ✓ Low density of electrical service connection (Average one connection in three poles)
- ✓ Non availability of Industrial or Commercial demand
- ✓ Difficulties in maintaining long distribution line through difficult terrain, forest areas or desert areas

Renewable Energy Sources which are decentralized in character and available all most all parts of the World could be good option to provide low quantum limited hours electric supply to Rural Areas. Indian experience says Solar Photovoltaic and Biomass based Small Power Generation Programmes are most suitable to supply of reliable and more or less affordable electricity to the Rural Mass. However, providing of capital subsidy from the Government is an important issue to make such programme sustainable. In today's context Low Carbon Fund is also available from donar agencies.

Solar Energy :~

Solar Energy is the most widely distributed Renewable Energy sources in the World and used by mankind since time immemorial. In practical terms, Solar Energy consists of Two Components – Heat and Light. In the modern era, the two main routes of utilizing Solar Energy are based on these Two Components –

- ✓ Solar Thermal
- ✓Solar Photovoltaic

Solar Thermal: For direct use of the Heat Energy for purpose such as Water Heating, Cooking and Drying and for conversion into mechanical energy and electrical power.

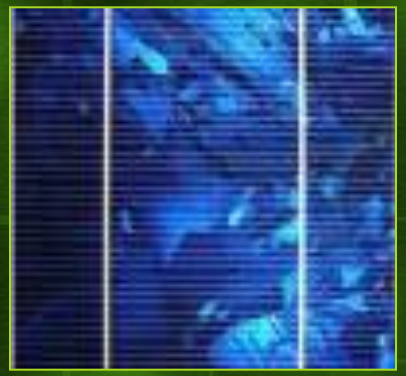
Solar Photovoltaic: For direct conversion of light into electricity.

Solar Water Heater

Solar PV Power Plant

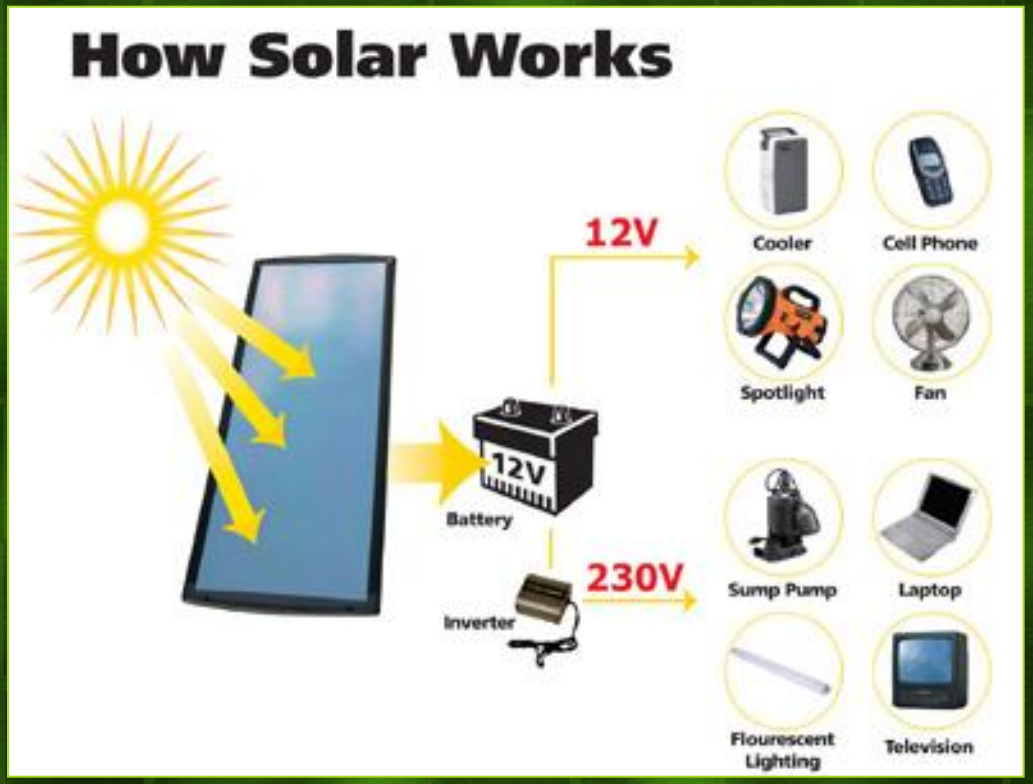
Solar Street Light

Solar Photovoltaic technology enables the direct conversion of Sunlight into electricity using devices known as Solar Cells.



The most common type of Solar Cell is made from a wafer of high purity Silicon. A typical Silicon Solar Cell generates 3.5 – 4 watts or more of electric power. A combination of Solar Cells makes a Module. The Capacity of Module varies from 1 watt to 300 watts. There are different types of Solar Cells : Multi Crystal Solar Cells or Thin Film Solar Cells.

Once we generate electricity from Solar Cells or Modules the same may be utilized for any purpose like Lighting, Water Pumping, Street Lights and Running of Television even running of Small Motors.



Such systems are stand alone system.

Advantages

- ✓ May be set up in any location
- ✓ Easy to operate and maintain
- ✓ Reliable
- ✓ Environment Friendly
- ✓ Installation time is low
- ✓ Fuel Cost is Nil

Limitations

- ✓ Climate dependent
- ✓ Still expensive
- ✓ Weak storage system
- ✓ 24 X 7 electricity is not ensured
- ✓ Capacity limited

The Capacity of the Power Plant varies from 1 kw to 150 kw.

Bio Energy based power generation in Rural Areas :~

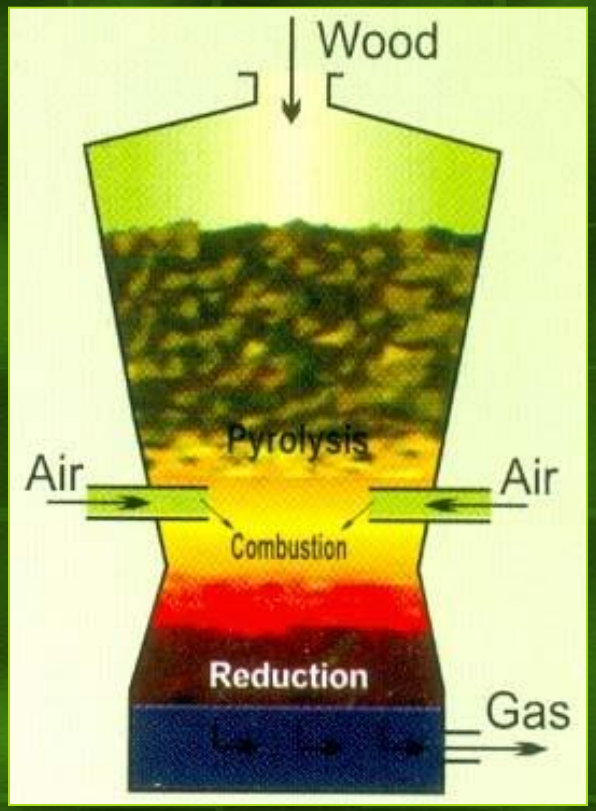
Electricity can be generated from wet or dry biomass.

Simplest way to get energy from Biomass is burning of the Biomass. However, the process is highly inefficient. The best way to produce energy from Biomass is Gasification Process. Biomass Gasification is a process of converting solid biomass fuel into a gaseous combustible gas (Called Producer Gas) through a sequence of thermo – chemical reactions. The gas is of Low Calorific Value. CV of Producer Gas varies between 1000 – 1200 kcal / Nm^3. Almost 2.5 – 3 Nm^3 of gas can be obtained through Gasification of about 1 kg. of air-dried biomass.

Typical Composition of Producer Gas (%) :~

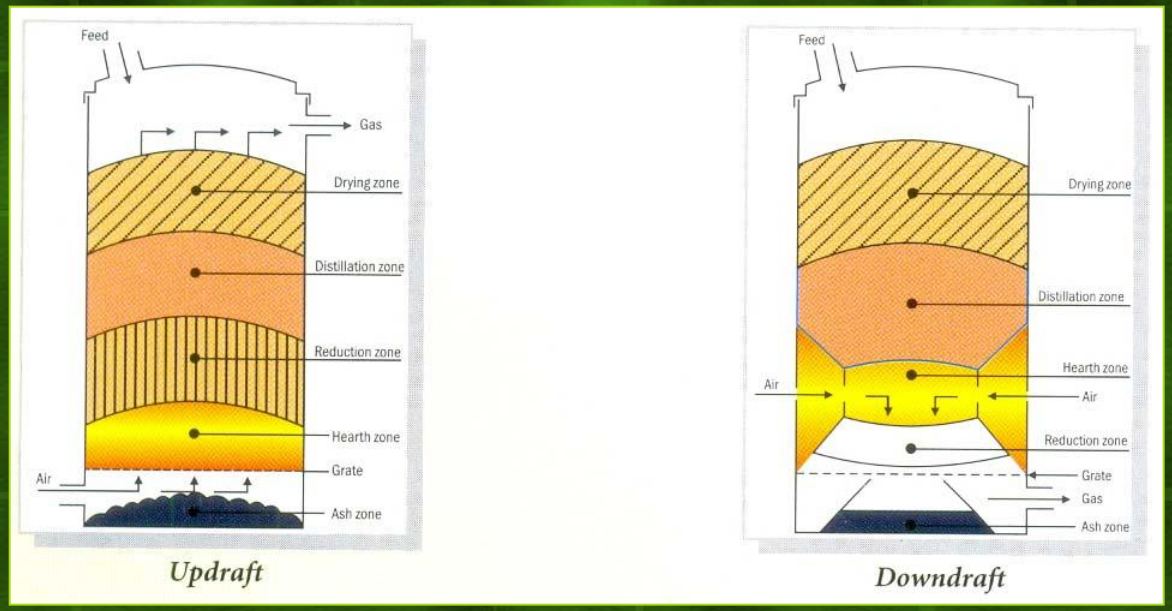
Carbon Monoxide (CO)	20 – 22
Hydrogen (H_2)	15 – 20
Methane (CH_4)	2 – 3
Carbon Dioxide (CO_2)	9 – 11
Nitrogen (N_2)	45 – 54
Water Vapour (H_2O)	10 – 15
Heavy Hydrocarbon	0.2 – 0.4

The gas can be cooled, cleaned and fed into an engine to operate either on dual fuel or in a 100 % Producer Gas mode to generate electricity.



Types of Biomass Gasifier :~

- ✓ Updraft or Counter-current Gasifier
- ✓ Downdraft or Co-current Gasifier



Normally, Updraft Gasifier is less sensitive to fuel size and moisture content compared to Downdraft Gasifier gives relatively cleaner gas (low tar content) and hence, is preferred for engine applications.

Capacity :~

100 % Producer Gas engines are available from 10 kw range to 500 kw range. The engine runs an alternator which finally supplies electricity to the village.

Operational Biomass plant at Sundarbans, West Bengal

Types of fuel and requirement of fuel :~

- ✓ Primary lops and tops of trees etc.
- ✓ Wood Waste, Saw Dust
- ✓ Rice Husk
- ✓ Coconut shells, Cashew nut shells, Lantana etc.
- ✓ Briquettes of agricultural residue

All the above mentioned materials are available in the village. However, captive energy plantation may also be taken up with quick growing plants like Subabul or Acacia etc.

In order to generate 1 kwh of electricity 1.5 kg Dry Biomass is required.

Biomass Gasifier based electricity is cheaper than Solar Electricity.

Comparison of Price

Type	Cost / kwh
Solar PV based electricity (Stand alone type)	40 US cents
Wind Battery Charger	25 US cents
Biomass Gasifier	20 US cents

Capital Cost of Biomass Gasifier Plant (100 % Producer Gas based) - $ 2500 / kw (Inclusive Civil Works)

Operation and Maintenance :~

Biomass Gasifier needs operator as well as regular maintenance. Routine maintenance include checking of all pipes, cleaning of the filters, use of dry Biomass is an important issue to get better life of Gasifier. With proper maintenance a Biomass Gasifier can run for 7 – 10 Years.

Entrepreneurship development in the Rural Energy Sector :~

Biogas Based Power Generation :~

SVO Based Power Generation :~

Electricity can be generated by using SVO (Straight Vegetable Oil). The Engines are now available in India up to the level of 25 kw.

Participation of Local people in operating off grid power plant is an important issue. Without participation of local people an off grid power plant may not sustain.

Task of the Local Energy Society

- ✓ Tariff fixing
- ✓ Penalty for non payment of electricity bill
- ✓ Linkages with the Local Government
- ✓ Use of electricity for income generation

Provision for future connectivity with the main grid is also important for an off grid power plant.

THANK YOU

MSW/BioWaste Solution

Treatment; Recycling; Energy production

2011

Waste Busters – About Us

- Mission statement - Develop and implement waste treatment solutions transforming waste from liability into a resource
- Every solution developed by Waste Busters, must be based on the following guidelines:
  - **Minimal ecological footprint**
  - **Highly economic solution**
  - **Highest operational reliability**
- Solutions are based on Waste-to-Energy technologies

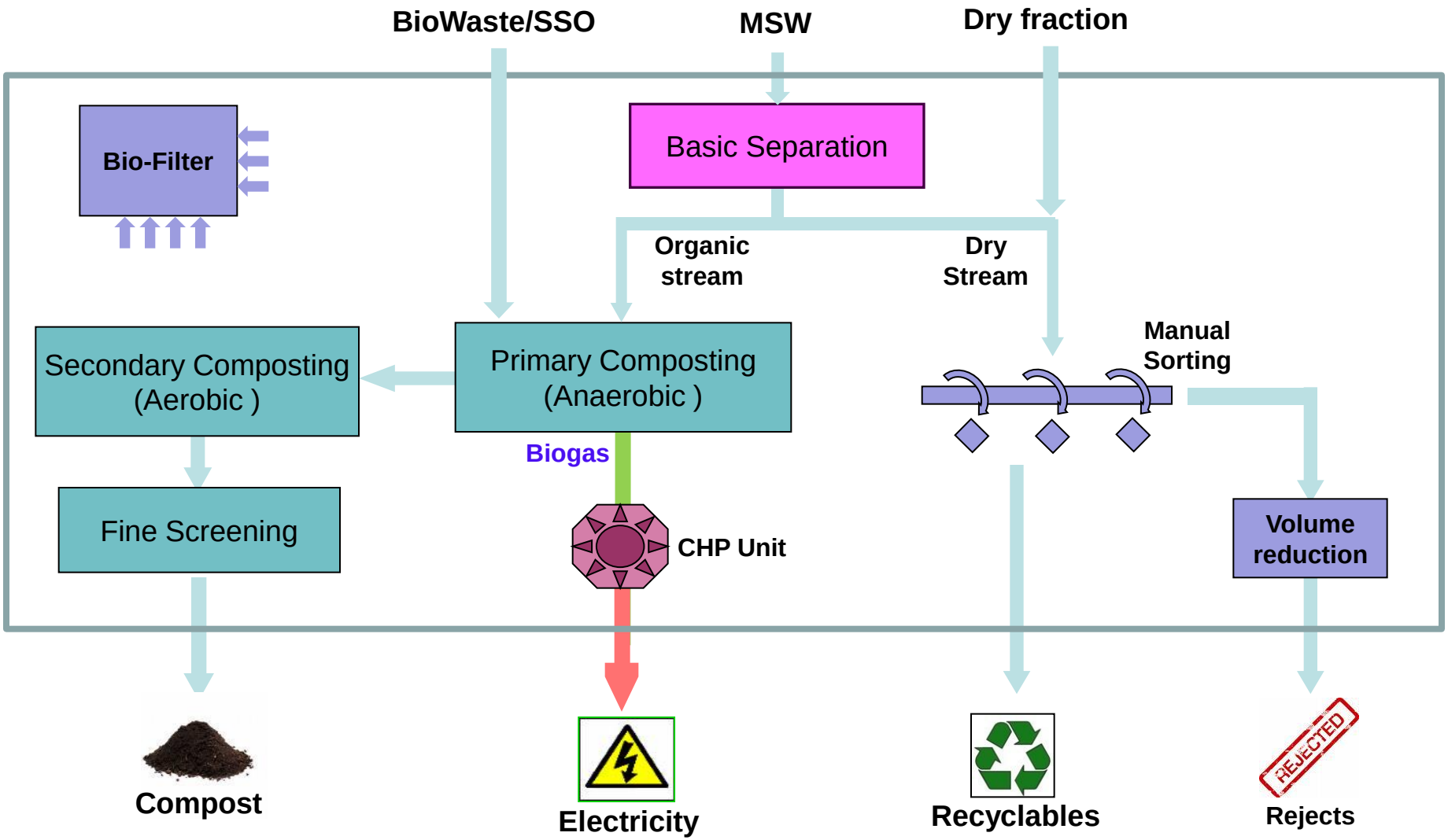
MSW/BioWaste treatment – what is required

- **Minimal waste treatment costs**
  - Lowest possible treatment facility gate-fee
- **Treatment of all MSW fractions**
  - Mixed MSW; OFMSW, Source-separated Waste/BioWaste
- **“Peace-of-mind”**
  - Highly reliable solution; operational simplicity, robustness
- **Cost-effective scalability**
  - Easily and economically expand to meet growing needs
- **Ecological solution**
  - No emissions; minimal residues to landfill; minimal water consumption
- **Minimal land footprint**
  - High utilization of waste treatment site ground

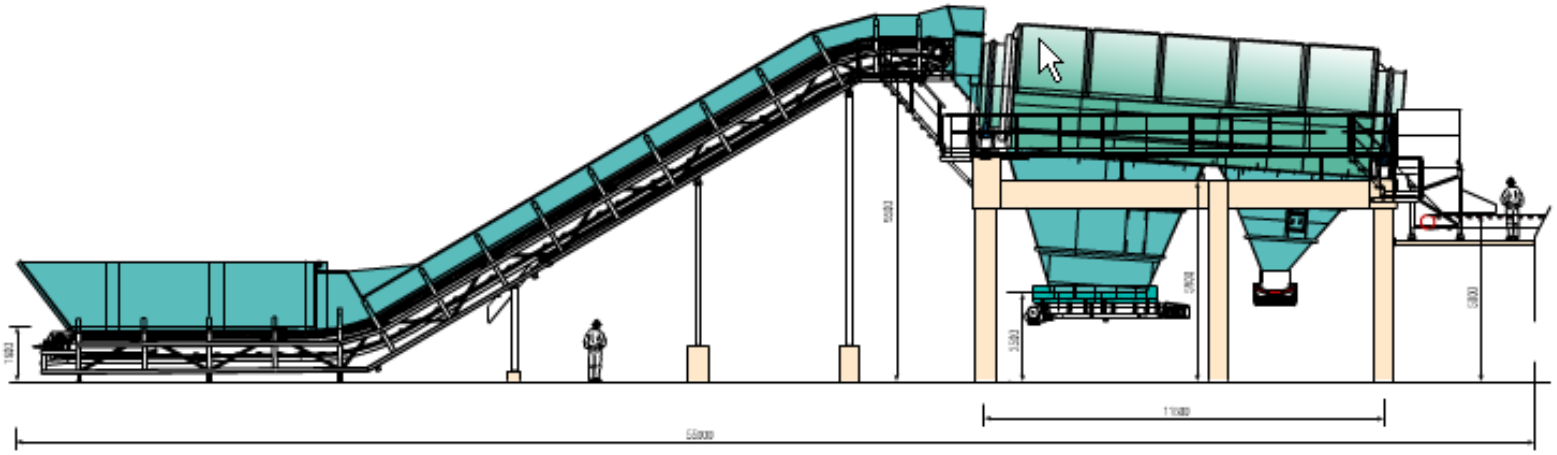
Solution Principles

- Unique Batch Dry Fermentation – Anaerobic Digestion technology generating renewable energy as part of the waste treatment procedure
    - Minimal sensitivity to waste fraction structure – suitable to both source separated waste and mixed waste
- Biodegradable fraction treatment based on 2 phase – anaerobic followed by aerobic phases – ensuring organic decomposition and stabilization
- Complete isolation from facility environment – odors and leachate control
- Fine separation as process final phase – ensuring high quality compost production, economically

Full Process Flow



Basic Separation - Simple, cost-effective



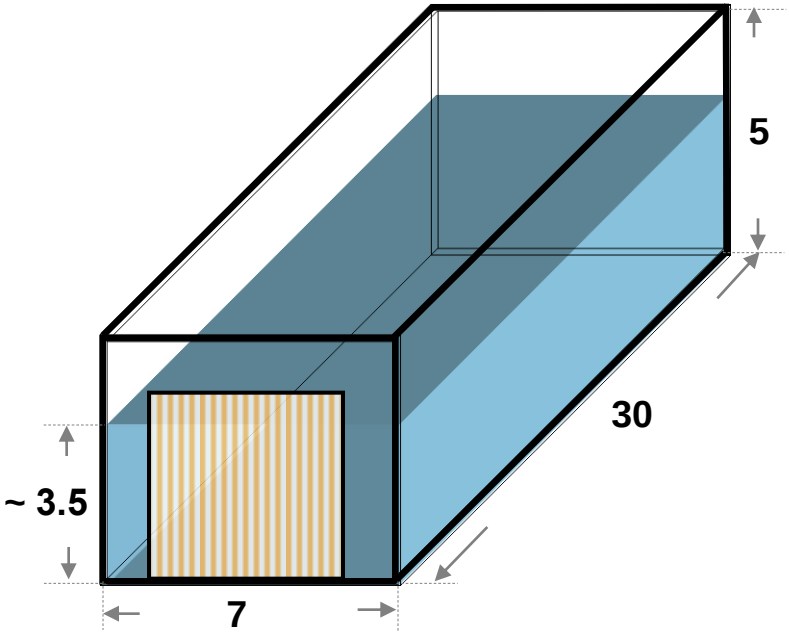
Organic fraction of MSW, after basic separation

Anaerobic Digestion – Dry Fermentation

- Anaerobic Digestion (AD)
  - Biodegradable biomass is digested by bio-organisms into soil fertilizer and methane-rich Biogas, in an oxygen-free environment
  - The Biogas is converted into electricity & heat
- Wet Fermentation vs. Dry Fermentation
  - Until early 2000s most of AD facilities were based on wet fermentation (WF) – solids content lower then 10% (liquid)
  - Late 90s dry fermentation (DF) became commercially mature – solids content 20% and more (stackable)
- Dry fermentation has several key advantages:
  - High solids content biomass → Higher energy potential per fermentation chamber volume
  - Minimal environmental footprint → Low water consumption, no emissions
  - Insensitivity to biomass 'purity', low machinery level → Extremely attractive Capex & Opex

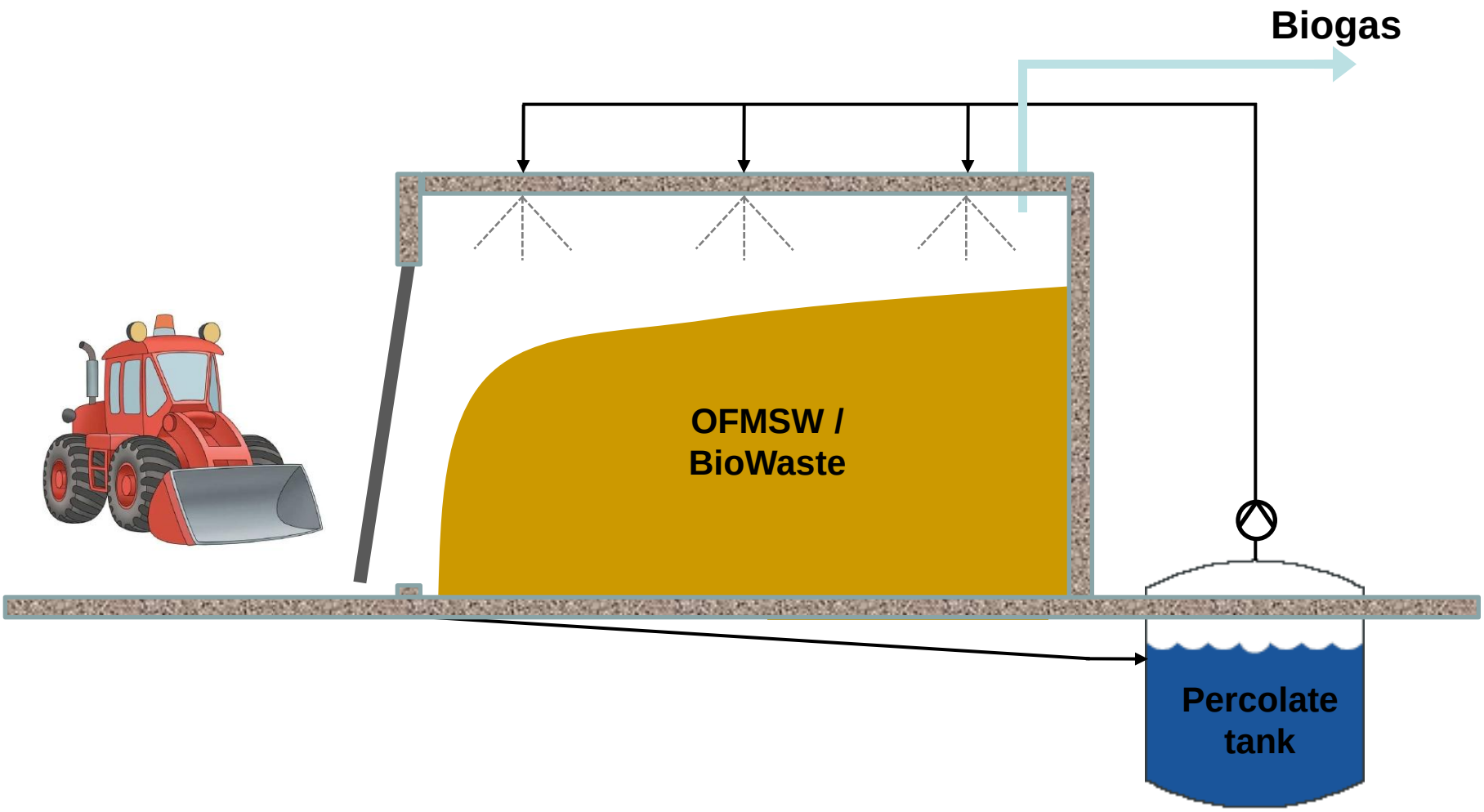
Single Fermentation Module

Organic Biomass

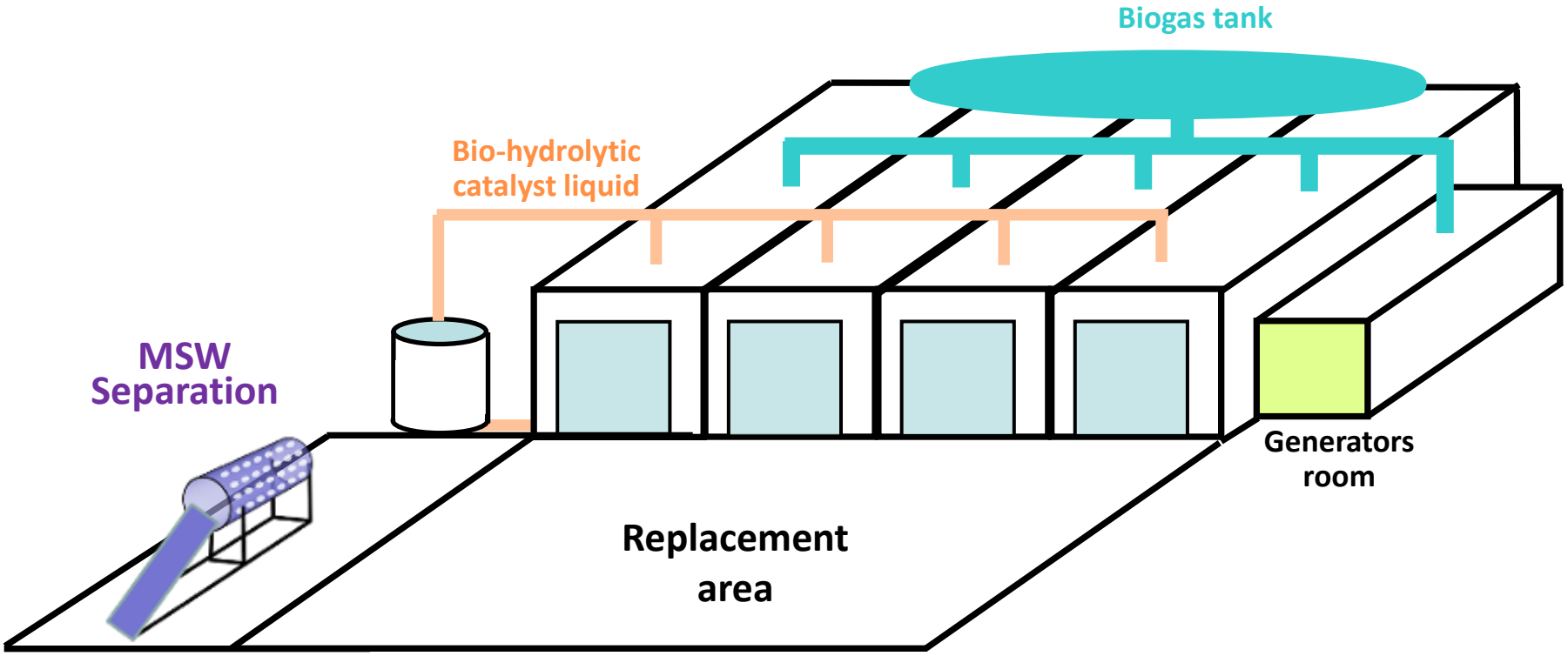


- Organic biomass: ~400 ton
- Typ. operational procedure : Replenishment of ½ every 21 days
- Biomass consumption rate: ~9 ton/day

Inside the Fermentation Module



General layout of a 4 Fermentation modules plant



- Organic waste consumption rate: ~ 36 ton/day

The replacement area

The replacement area

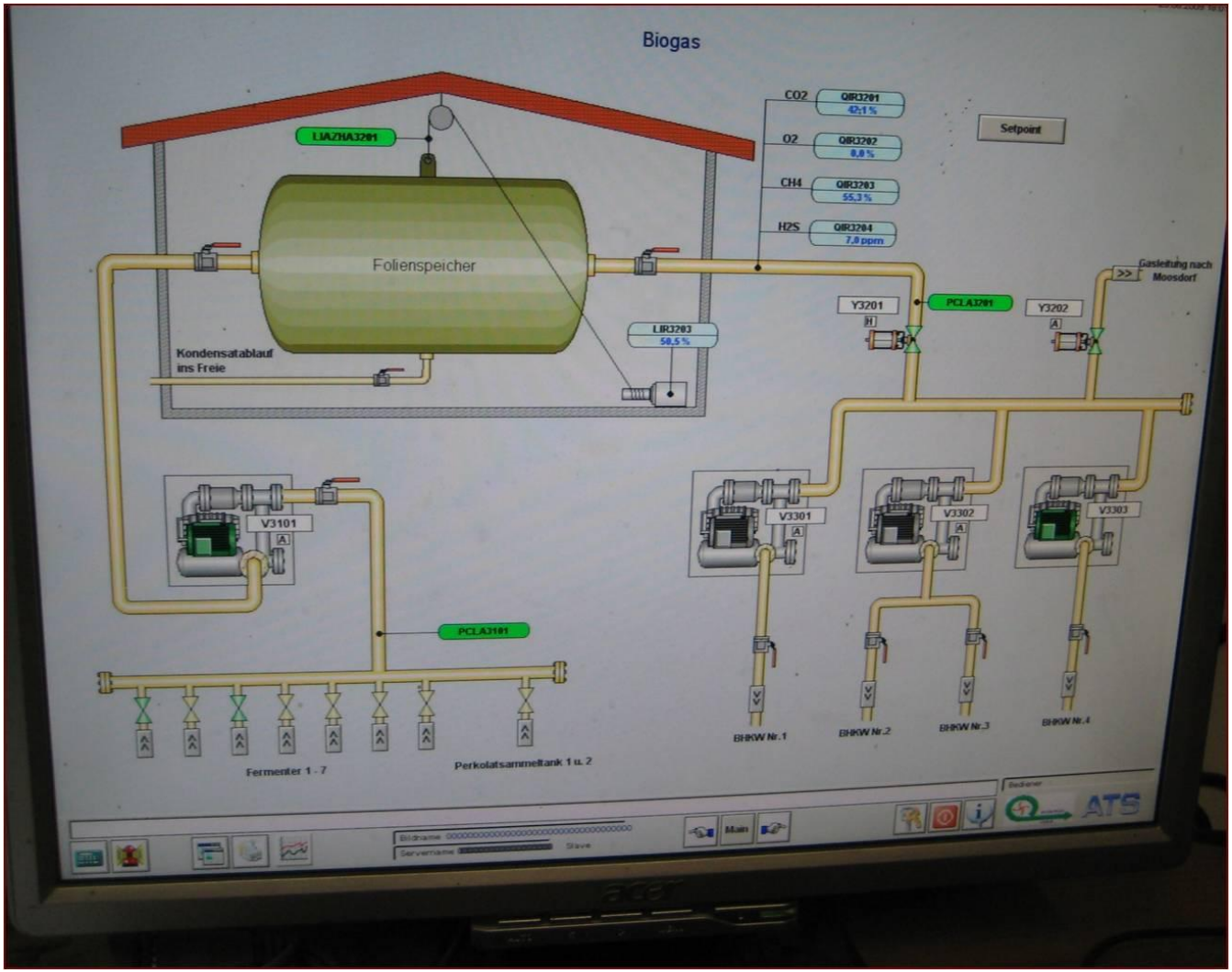
Refilling the Fermentation Module

Inside the Fermentation Module

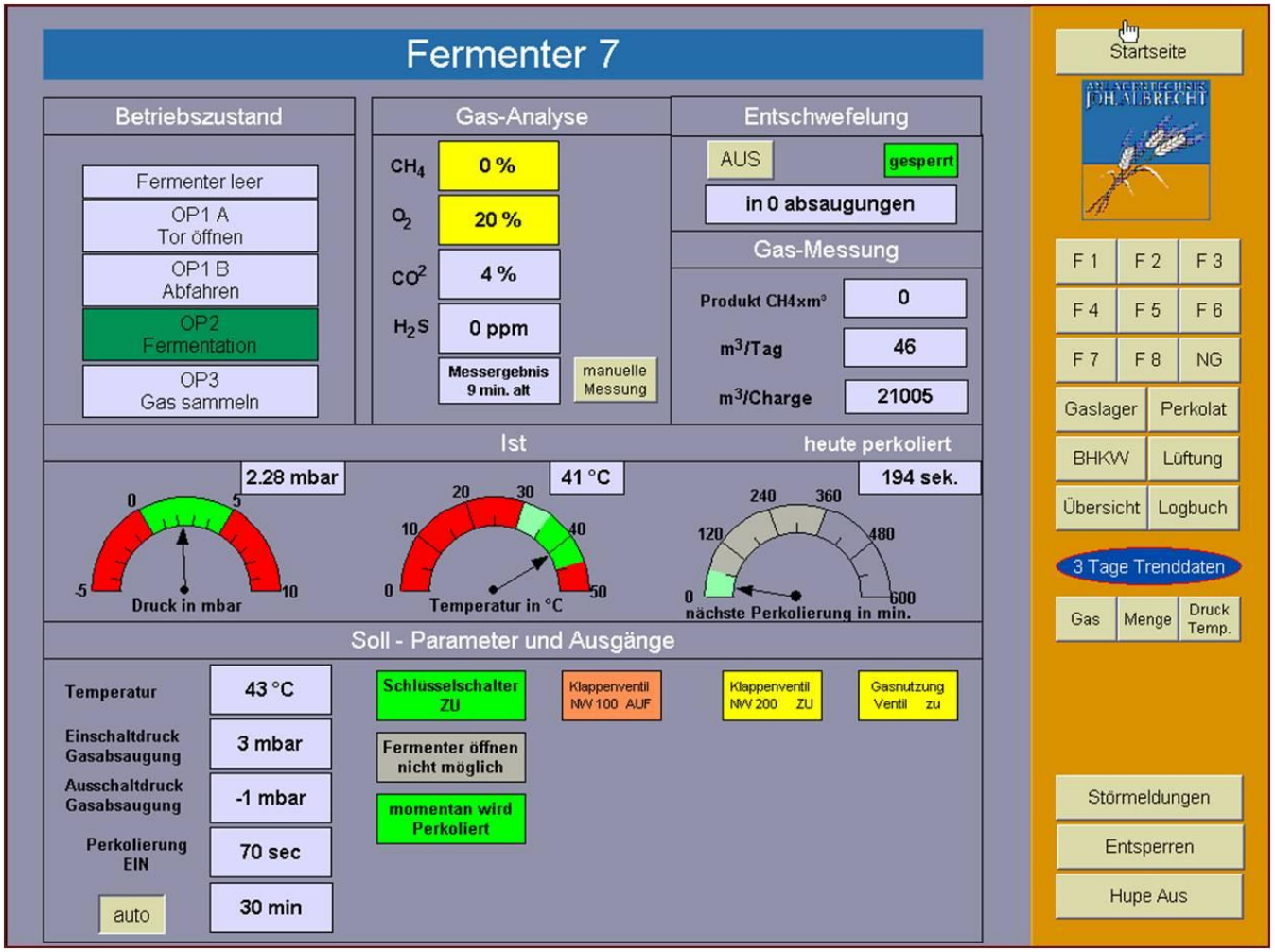
Biogas pipes above the Fermentation Module

Generators room (CHP Units)

Computerized monitoring system

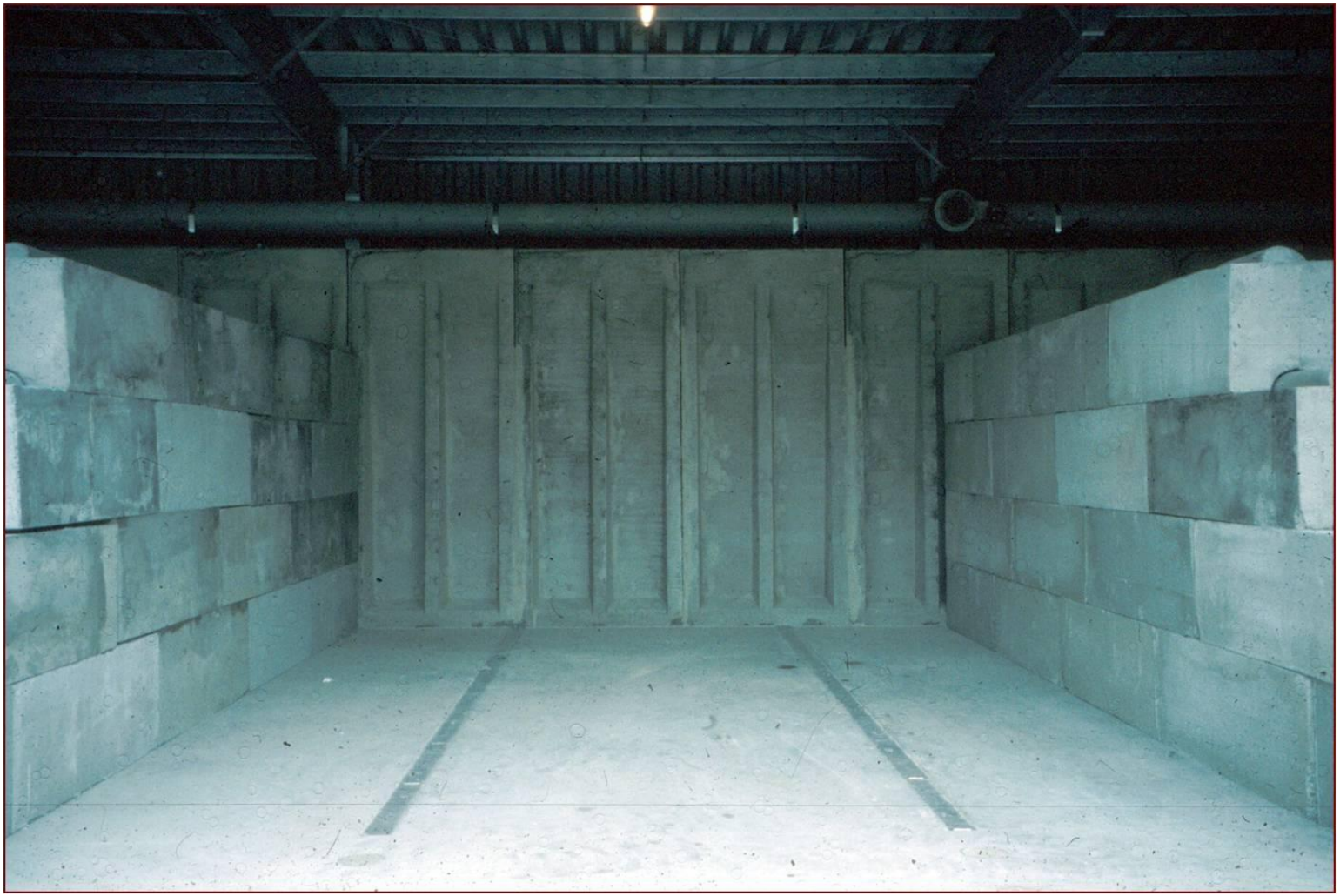


Computerized monitoring system



Post anaerobic composting biomass (Digestate)

Accelerated aerobic composting – aerated floors



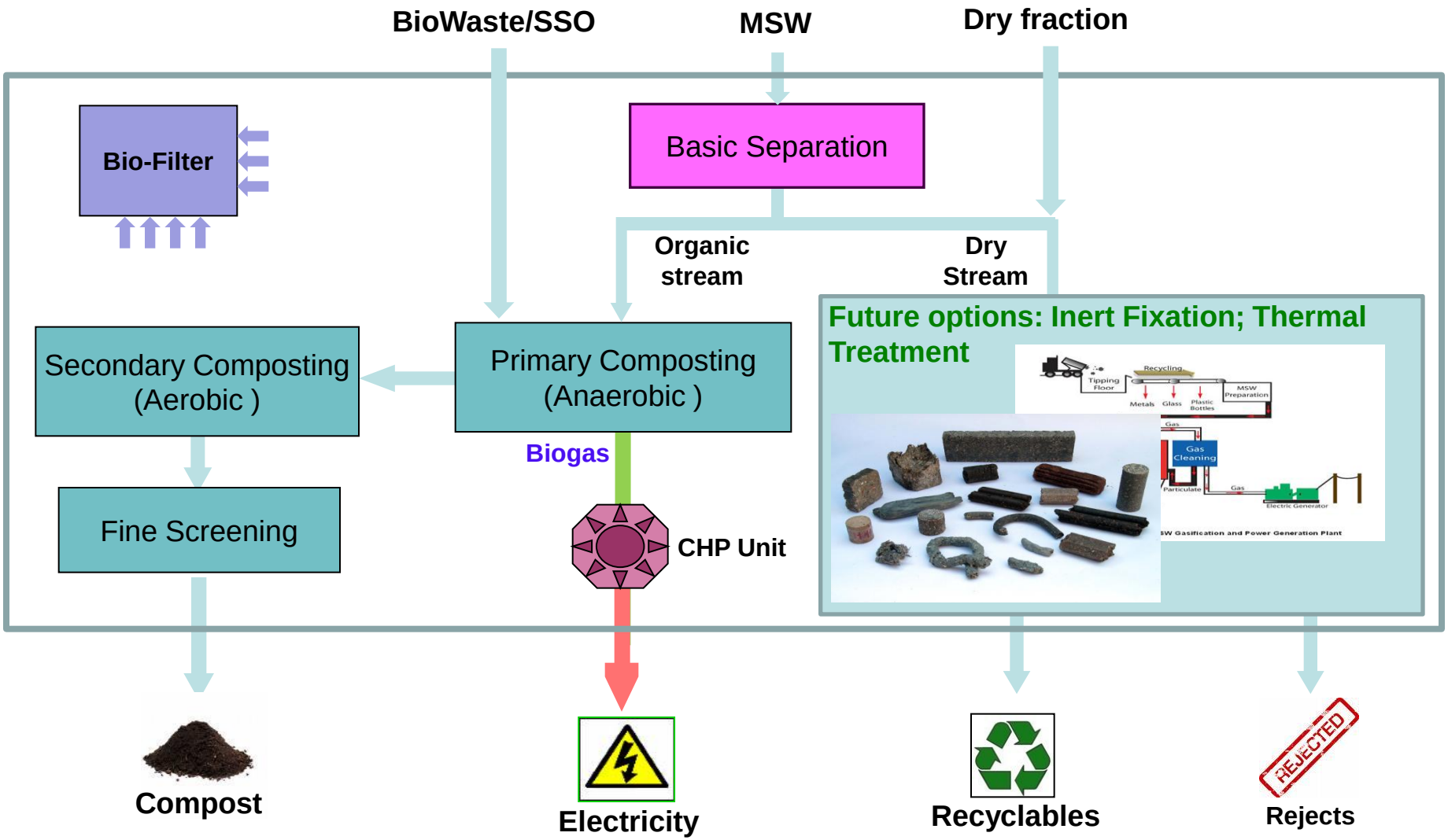
Accelerated aerobic composting – aerated floors

Final phase – Fine Screening

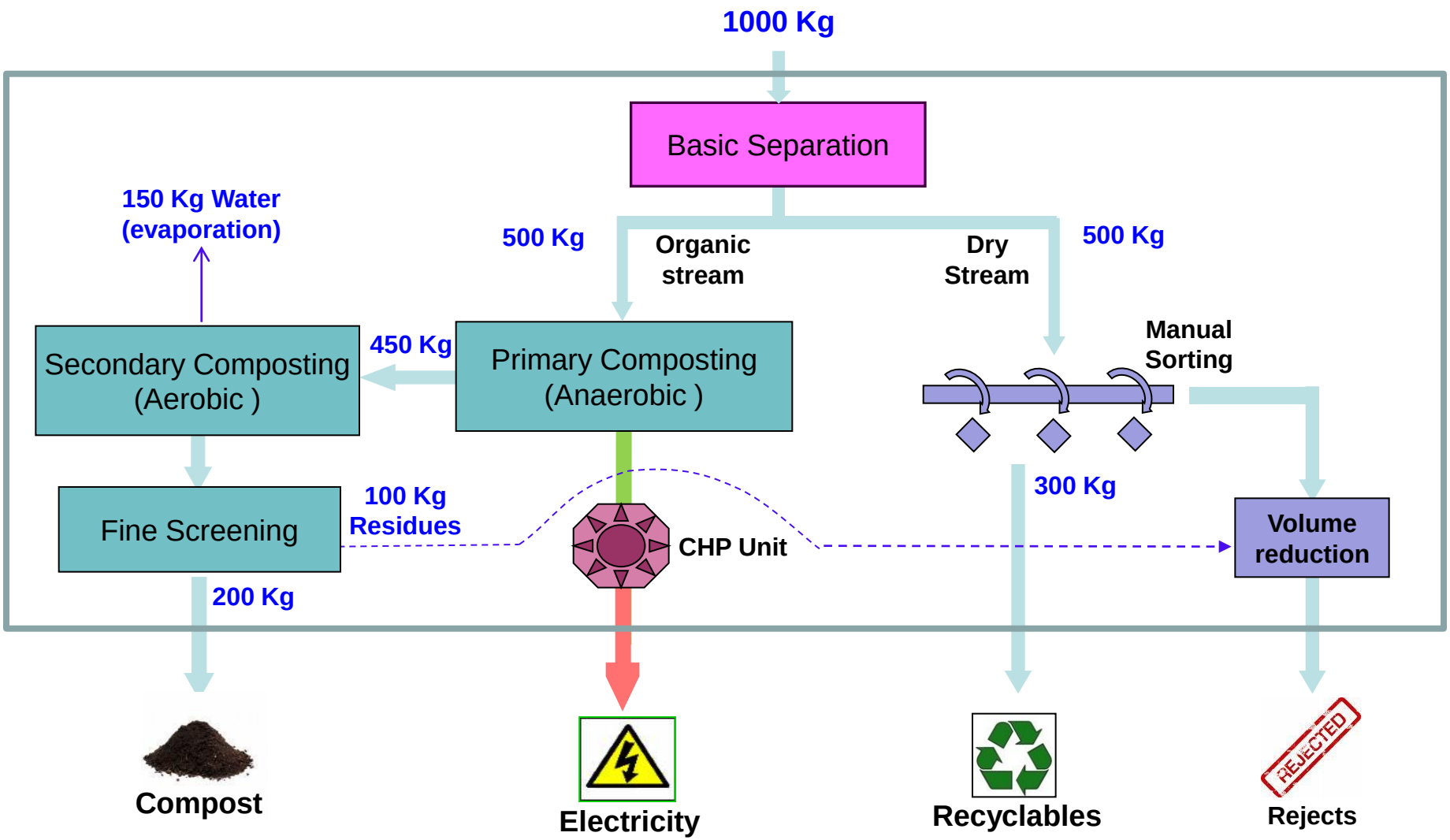
Aerated floors – fans array

Bio-Filter

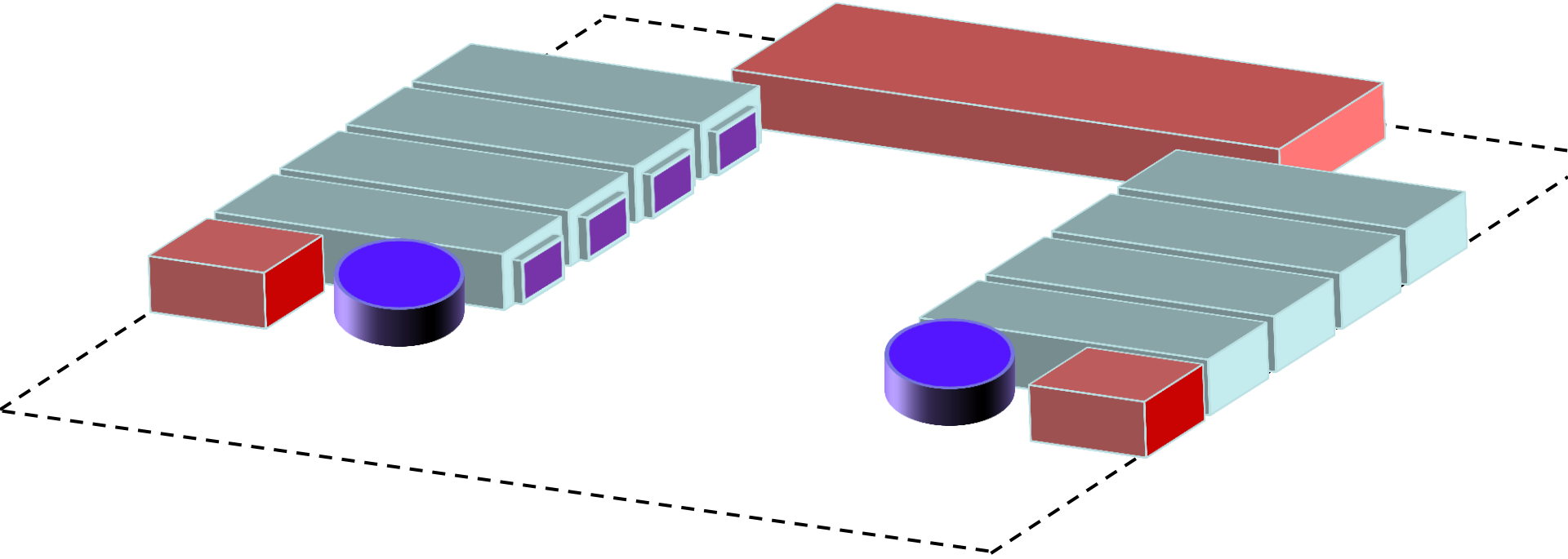
Future Dry Fraction treatment technologies



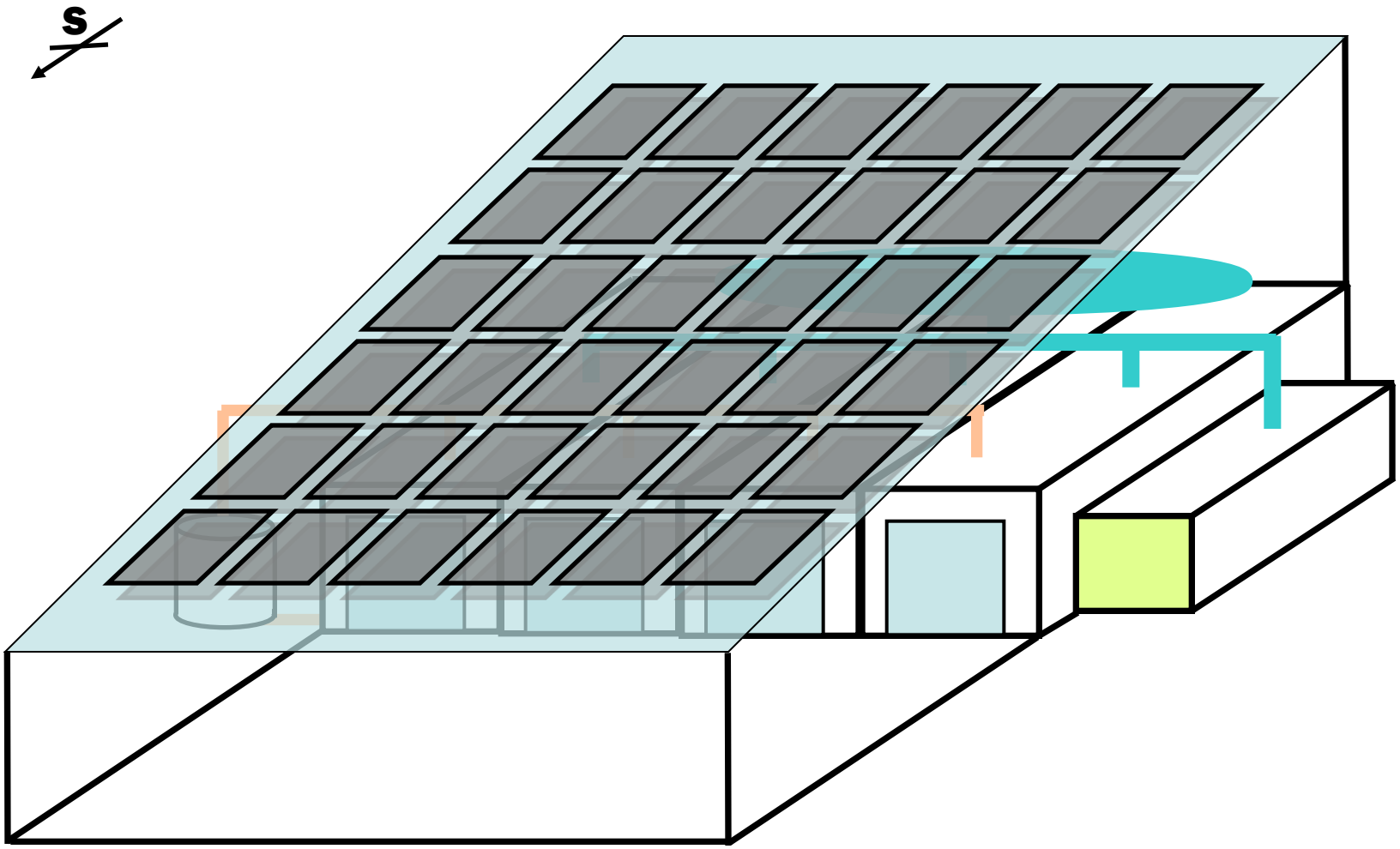
MSW Mass Flow Example



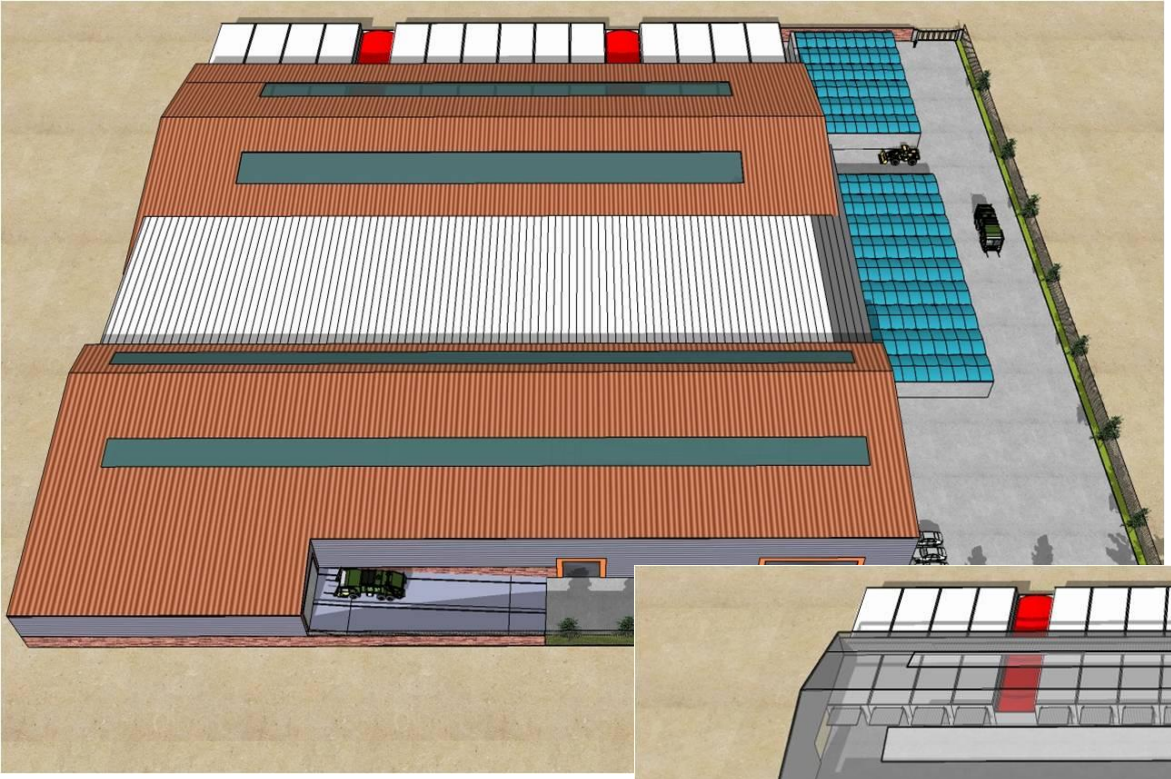
Modular Architecture

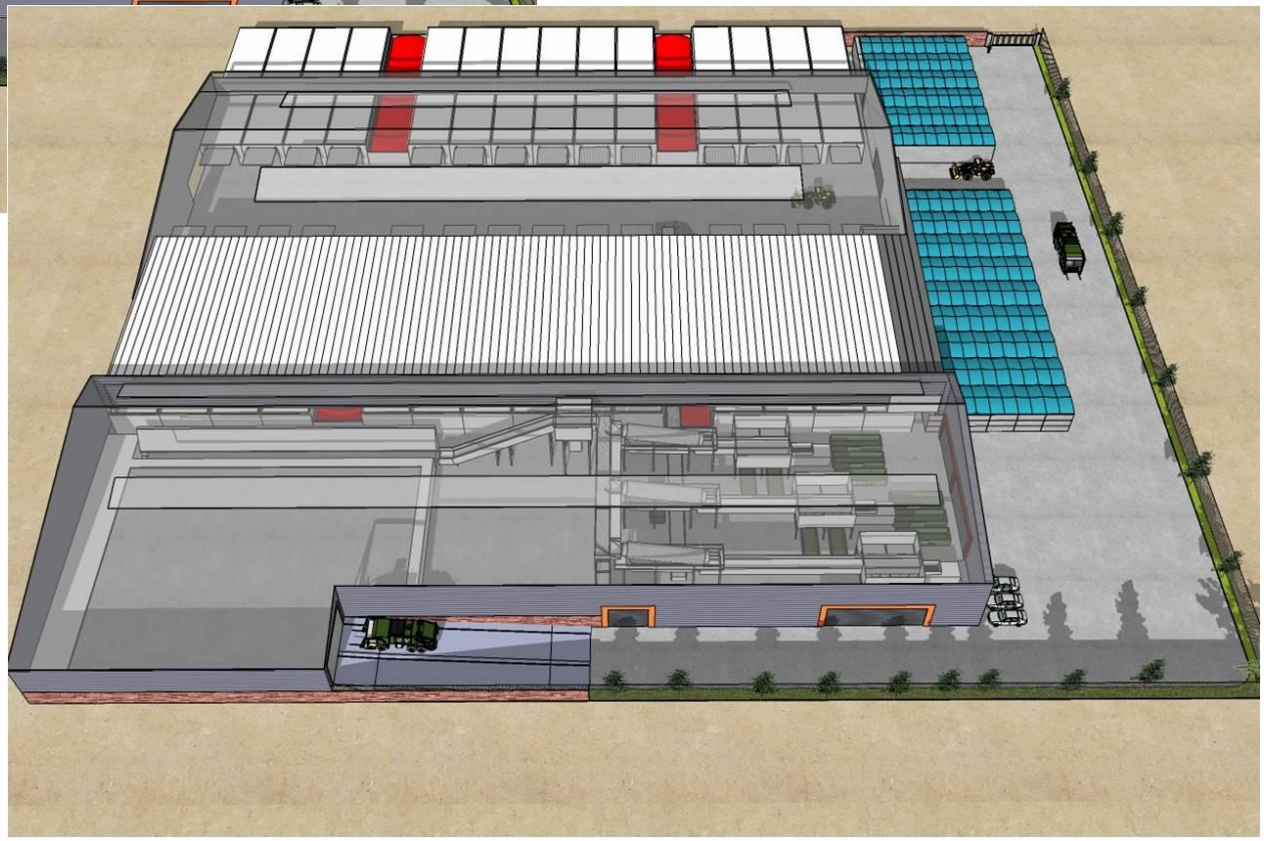


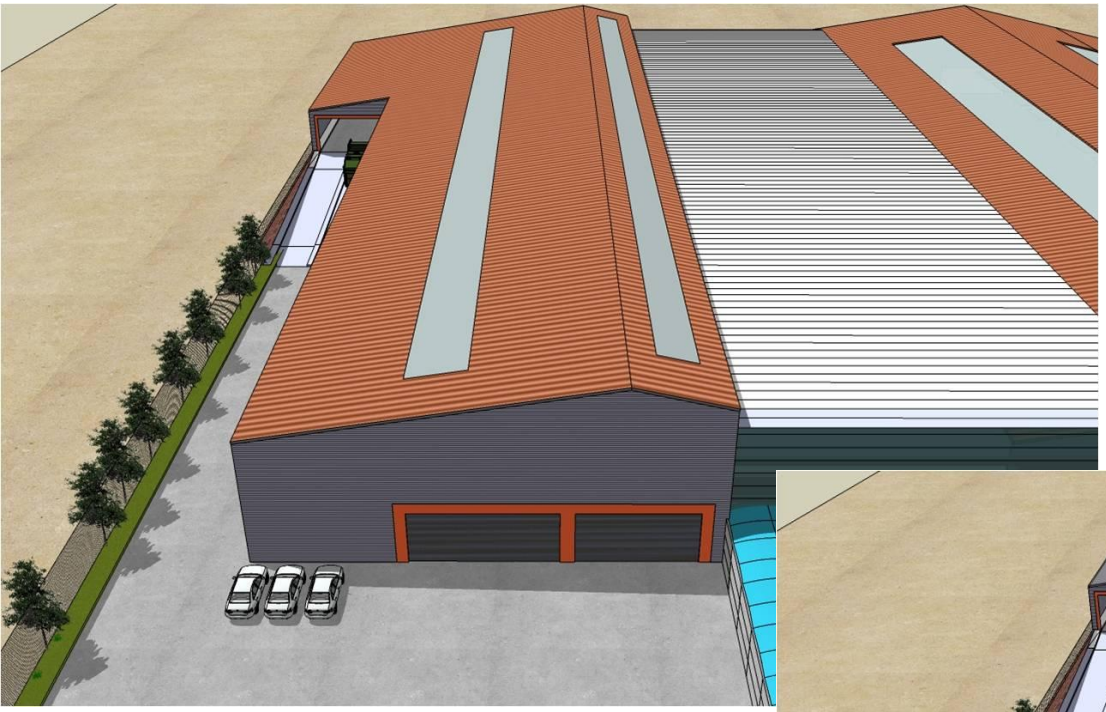
Synergy with Solar Technology

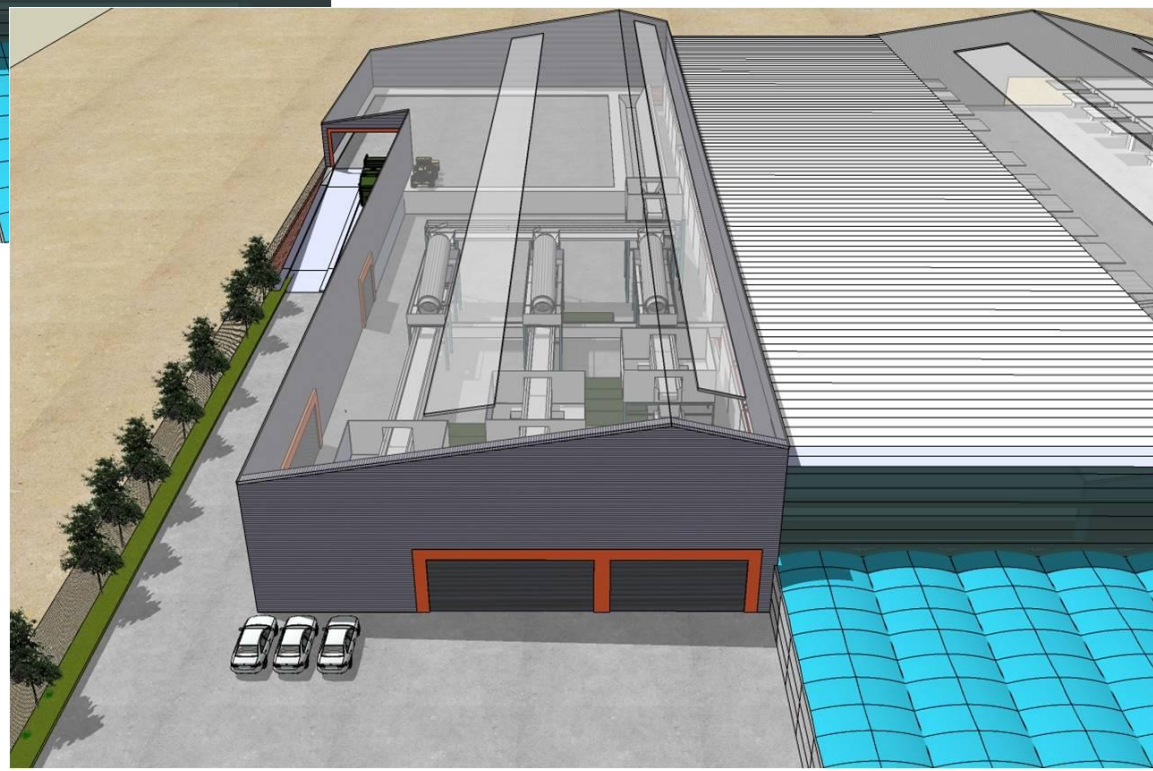


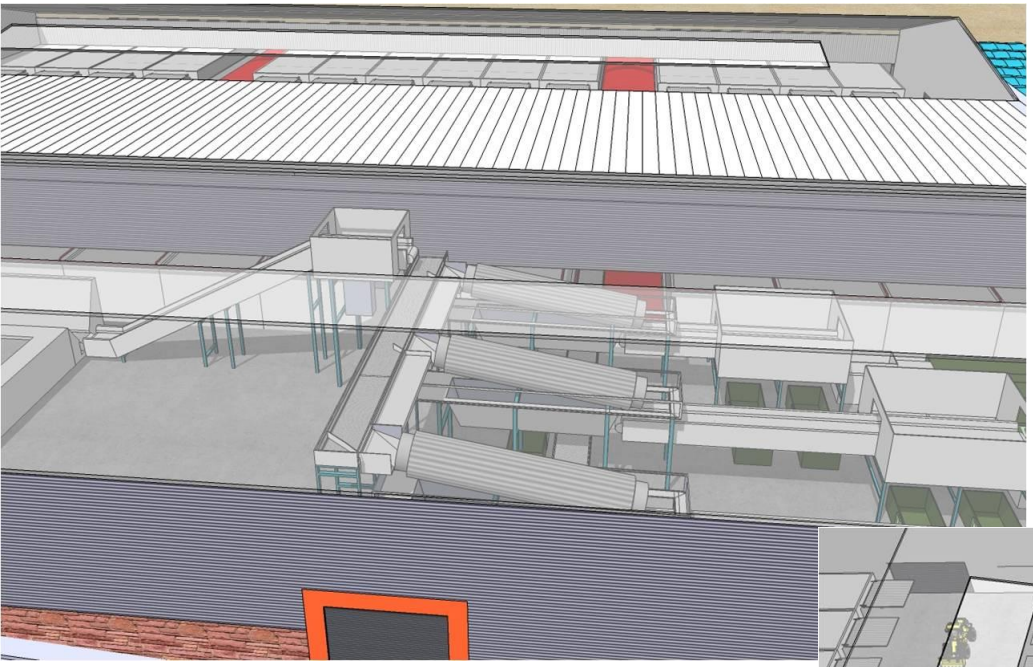
Preliminary facility design example

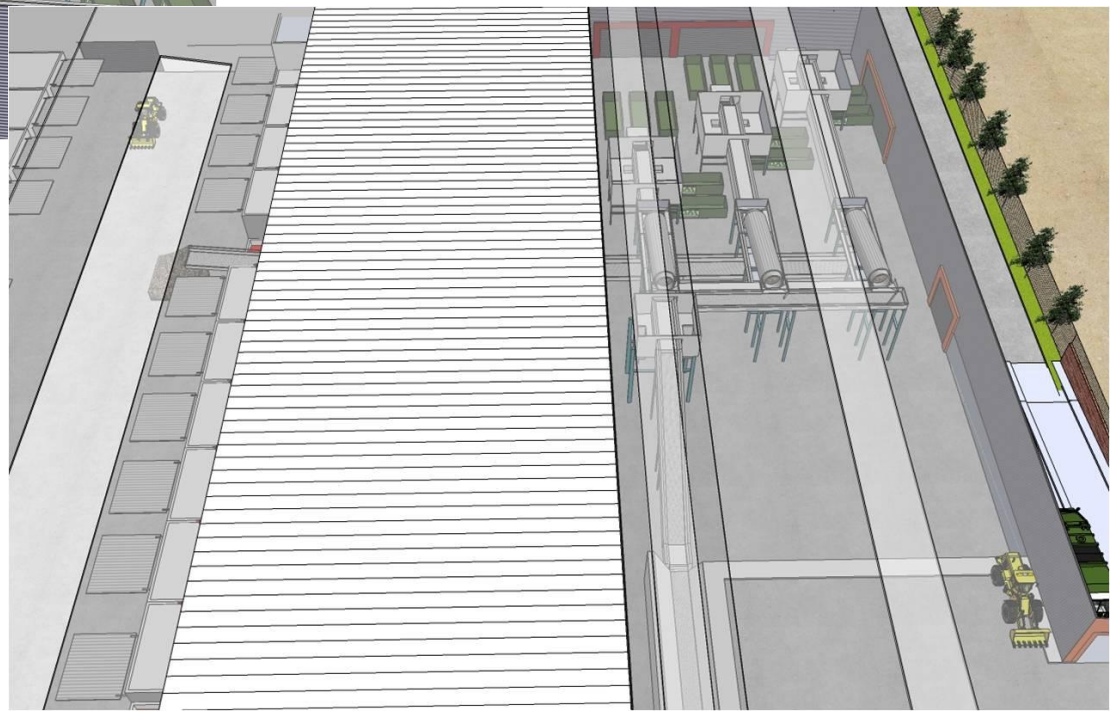












Key Advantages of UVP Solution

- Highly economic and cost effective solution
  - Simple to construct
  - Low-level pre-sorting requirement
  - Minimal operational costs
- High reliability and stability
- Simple up-scaling due to the modular design
- Minimal ecological footprint
- Synergy with other renewable energy solutions

Thank you

BIO-DIESEL YIELDS FROM DIFFERENT SOURCES

S. #	PLANT	AREA	NO. OF SEASONS PER YEAR	NO. OF TREES *	SEED YIELD PER SEASON (kg) **	CRUDE OIL YIELD ***		BIO-DIESEL TRANSESTERIFIED FROM CRUDE OIL ****		GLYCERINE YIELD FROM CRUDE OIL *****		SOAP YIELD FROM CRUDE OIL ******		OIL CAKE YIELD *******	
						Liters	As % of seed quantity	Liters	As % of crude oil	kg	As % of crude oil	kg	As % of crude oil	kg	As % of seed quantity
1	PONGAMIA PINNATA	PER ACRE @ 20kg seed per tree	1	96	1,920	672	35%	591	88%	60	9%	20	3%	1,248	65%
		PER HECTARE @20kg seed per tree	1	240	4,800	1,680	35%	1,478	88%	151	9%	50	3%	3,120	65%
		PER ACRE @ 50kg seed per tree	1	96	4,800	1,680	35%	1,478	88%	151	9%	50	3%	3,120	65%
		PER HECTARE @ 50kg seed per tree	1	240	12,000	4,200	35%	3,696	88%	378	9%	126	3%	7,800	65%
2	CASTOR BEAN	PER ACRE	2	800	5,600	2,072	37%	1,782	86%	249	12%	41	2%	3,528	63%
		PER HECTARE	2	2,000	14,000	5,180	37%	4,455	86%	622	12%	104	2%	8,820	63%
3	JATROPHA	PER ACRE	1	896	3,584	538	15%	462	86%	65	12%	11	2%	3,046	85%
		PER HECTARE	1	2,240	8,960	1,344	15%	1,156	86%	161	12%	27	2%	7,616	85%

*** NO. OF TREES**

(a) Pongame

No. of kanals in 1 acre:	8
No. of trees in 1 kanal:	12
No.of trees in 1 acre:	*12 x 8 = 96*
No. of kanals in 1 hectare:	20
No. of acres in 1 hectare:	20/8 = 2.5
No. of trees in 1 hectare:	*2.5 x 96 = 240*

(b) Castor Bean

No. of Castor Bean shrubs in 1 kanal	100
No. of Castor Bean shrubs in 1 acre	*100 x 8 = 800*
No.of Castor Bean shrubs in 1 hectare:	*800 x 2.5 = 2,000*

(c) Jatropha

No. of Jatropha bushes in 1 kanal	112
No. of Jatropha bushes in 1 acre	*112 x 8 = 896*
No.of Jatropha bushes in 1 hectare:	*896 x 2.5 = 2,240*

**** SEED YIELD PER SEASON**

(a) Pongame

Seed yield by weight for 5-yr old tree:	20 kg
Seed yield by weight for mature tree (10-15 yrs old):	40-60 kg
	Avg 50 kg

Yield calculated on the basis of average seed yield for 5-yr old as well as mature tree

(b) Castor Bean

Seed yield by weight	6-8 kg
Average	7kg

Yield calculated on the basis of average seed yield

(c) Jatropha

Seed yield by weight	4-5 kg
Average	4 kg

Yield calculated on the basis of average seed yield

***** CRUDE OIL YIELD FROM SEED**

(a) Pongame

Maximum:	37% by weight of seed
Average:	35% by weight of seed

Crude oil yield calculated on the basis of average %age yield

(b) Castor Bean

%age oil yield:	37% by weight of seed

(c) Jatropha

%age oil yield:	10-15% by weight of seed

Crude oil yield calculated on the basis of maximum %age yield

****** BIO-DIESEL TRANSESTERIFIED FROM CRUDE OIL**

(a) Pongame

% yield of Bio-diesel: 88% of crude oil

(b) Castor Bean

% yield of Bio-diesel: 86% of crude oil

(c) Jatropha

% yield of Bio-diesel: 86% of crude oil

******* GLYCERINE YIELD FROM CRUDE OIL**

(a) Pongame

% yield of Glycerine: 9% of crude oil

(b) Castor Bean

% yield of Glycerine: 12% of crude oil

******** SOAP YIELD FROM CRUDE OIL**

(a) Pongame

% yield of soap: 3% of crude oil
(88% Bio-diesel, 9% glycerine, 3% soap)

(b) Castor Bean

% yield of soap: 2% of crude oil

********* OIL CAKE YIELD FROM SEED**

(a) Pongame

Crude oil yield from seed:	35% (average)
Oil cake yield from seed:	65%

(b) Castor Bean

Crude oil yield from seed:	37% (average)
Oil cake yield from seed:	63%

			(86% Bio-diesel, 12% glycerine, 2% soap)		
(c) Jatropha		**(c) Jatropha**		**(c) Jatropha**	
% yield of Glycerine:	12% of crude oil	% yield of soap:	2% of crude oil	Crude oil yield from seed:	15% (maximum)
			(86% Bio-diesel, 12% glycerine, 2% soap)	Oil cake yield from seed:	85%

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PAKISTAN'S PROGRESS IN THE USE OF BIOFUELS AS AN ENERGY SOURCE

SEQUENCE

- Global Biofuels production / sources
- Rationale for Pakistan
  - Rationale for Pakistan
- Ethanol as an energy source for Pakistan
  - Facts about Gasoline
  - Pakistan’s sugar industry & ethanol production
  - Major players
  - Progress
  - Barriers & Potential

SEQUENCE

- Bio-Diesel as an energy source for Pakistan
  - Facts about Diesel
  - Importance / suitability of Bio-Diesel for Pakistan
  - Bio-Diesel as a rural development tool
  - Worldwide challenges
  - Progress
- Collaboration opportunities

Contd..

GLOBAL BIOFUELS PRODUCTION & SOURCES

BIOFUELS

- World biofuels production 2009: **93 Bn liters**

- World biofuels production to reach more than 1 million barrels per day in 2010

SOURCES: RENEWABLE GLOBAL STATUS REPORT 2010

GLOBAL RENEWABLE FUELS ALLIANCE (GRFA)

ETHANOL

- World production
  - World production of fuel ethanol in 2009: **76 Bn liters** – increase of 10% over 2008
    - 2010 (forecast): **86 billion liters** (increase of 13% over 2009)
    - In 2011, ethanol production will displace the need for 370 million equivalent barrels of oil globally

Contd..

SOURCE: RENEWABLE GLOBAL STATUS REPORT 2010

ETHANOL

- World production
  - Major producers
    - USA: > **45 billion liters** production predicted for 2011 – world's largest ethanol producer
    - Brazil: **26 Bn liters** in 2009
      - Ethanol from sugarcane replaces 50% of gasoline for transport
    - USA & Brazil together accounted for 88% of world ethanol production in 2009

SOURCE: RENEWABLE GLOBAL STATUS REPORT 2010

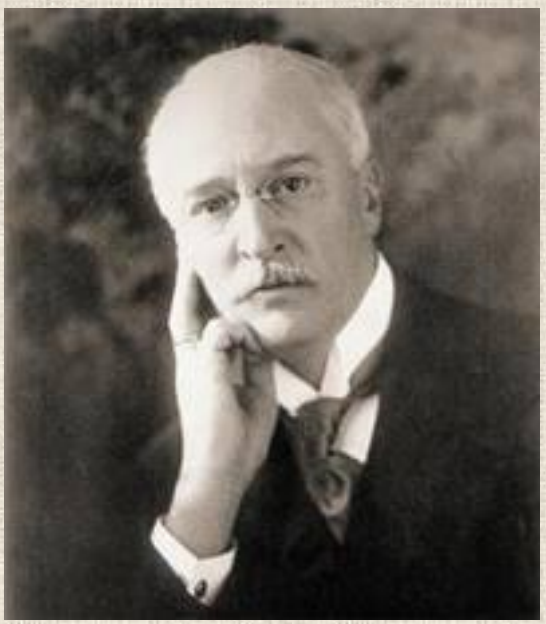
ETHANOL

- Biofuels are making small but growing contributions to fuel usage in several countries
  - In Brazil, Ethanol from sugarcane replaces 50% of gasoline for transport

- Corn is the source of more than half of world ethanol production

SOURCE: RENEWABLE GLOBAL STATUS REPORT 2010

BIO-DIESEL



RUDOLF DIESEL – Inventor of the compression-ignition engine

"The use of vegetable oils for engine fuels may seem insignificant today. But such oils may become, in the course of time, as important as the petroleum & coal tar products of the present time"

RUDOLF DIESEL – 1912

"The diesel engine can be fed with vegetable oils & would help considerably in the development of agriculture of the countries which use it."

RUDOLF DIESEL – 1911

Rudolf's diesel engine ran on peanut oil in the World Exhibition in Paris in 1900

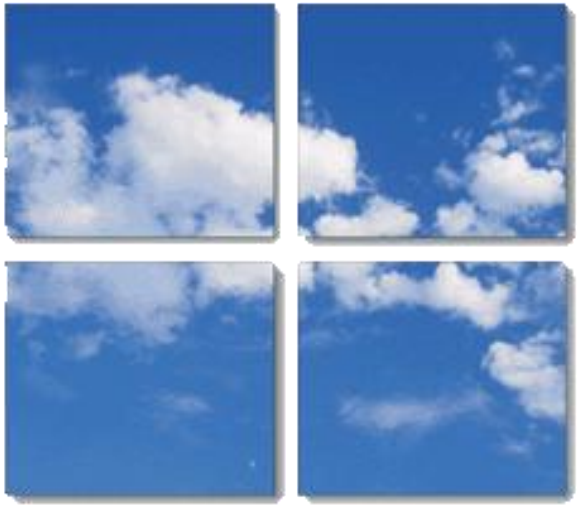
BIO-DIESEL

- World production
  - 2009: **16.6 Bn liters** – increase of 9% over 2008 *
  - Estimated to reach **20 Bn liters** in 2010
  - The world Bio-Diesel market is expected to be worth **USD 12.6 Bn** by 2014

- Major producers
  - The EU produces more than half of the world's Bio-Diesel
    - Other producers include USA, Brazil, China, Malaysia, Thailand, Argentina, Indonesia, Columbia, India, etc.

*** SOURCE: RENEWABLE GLOBAL STATUS REPORT 2010**

BIOFUELS – THE RATIONALE FOR PAKISTAN



RATIONALE FOR PAKISTAN

- An agriculture-dependent economy
  - Suitable climate for agriculture
  - Effective irrigation system
  - Sizeable cultivated area in Punjab, NWFP, Sindh, & parts of Balochistan
  - Rich in raw material for biofuels
    - Bio-Diesel
      - Numerous indigenous species of Bio-Diesel producing crops & plants exist in Pakistan
    - Sugarcane for Ethanol *
      - Pakistan is the world's 7th largest sugarcane producer – **49.37 M tons** in 2009-10
      - Area with sugarcane plantation: **942,870 hectares**

* SOURCE: PAKISTAN SUGAR MILLS ASSOCIATION (PSMA) ANNUAL REPORT 2010

RATIONALE FOR PAKISTAN

- Need to reduce oil imports for sake of national economy & energy security
  - Oil import 2009-10
    - Crude oil: **6.89 M tonnes** **USD 3.85 Bn**
      (down by 14.5% from 2008-09)
    - POL products: **11.178 M tonnes** **USD 6.14 Bn**
      (up by 12% from 2008-09)

TOTAL **18.086 M tons** **USD 9.99 Bn**

  - *ADB* estimates Pakistan's oil import bill for 2015 to be **USD 38 billion**

*** SOURCE: PAKISTAN ENERGY YEARBOOK 2010**

RATIONALE FOR PAKISTAN

- Poverty-alleviation / rural development
  - Good portion of population lives below the poverty line
    - Per capita income in 2009-10 = USD 1,051
    - Poverty alleviation / rural development possible through use of Biofuels – particularly Bio-Diesel

RATIONALE FOR PAKISTAN

- Cultivate – *"engreen"* - build
  - Vast pieces of uncultivated land exist in Pakistan
  - Growing Bio-diesel & Ethanol producing plants on them will:
    - Improve forestation
    - Build resource for commercial production in years to come
    - Enhance Non-Timber Forest Products (NTFPs) (gums, resins, tanins, honey, spices, medicines, dyes) – commercialization of NTFPs

RATIONALE FOR PAKISTAN

- Energy balance
  - Ethanol from sugarcane has positive energy balance in Pakistan
  - Cultivation in Pakistan not as heavily dependent on use of machinery as in developed world

ETHANOL AS AN ENERGY SOURCE FOR PAKISTAN

SOME FACTS ABOUT GASOLINE IN PAKISTAN

- Pakistan's gasoline consumption in 2009- 10: **1.924 M tons**
  - Up by 33% from 2007-08 & 26% from 2008-09
  - Major reasons:
    - Increase in prices of HSD
    - Increase in prices of CNG
    - Shortage of CNG

SOURCE: PAKISTAN ENERGY YEARBOOK 2010

SOME FACTS ABOUT GASOLINE IN PAKISTAN

- Gasoline consumption by sector
  - Transport sector: **1.892 M tons** (98%)
  - Industry: **0.019 M tons**
  - Other Govt.: **0.012 M tons**

SOURCE: PAKISTAN ENERGY YEARBOOK 2010

SOME FACTS ABOUT GASOLINE IN PAKISTAN

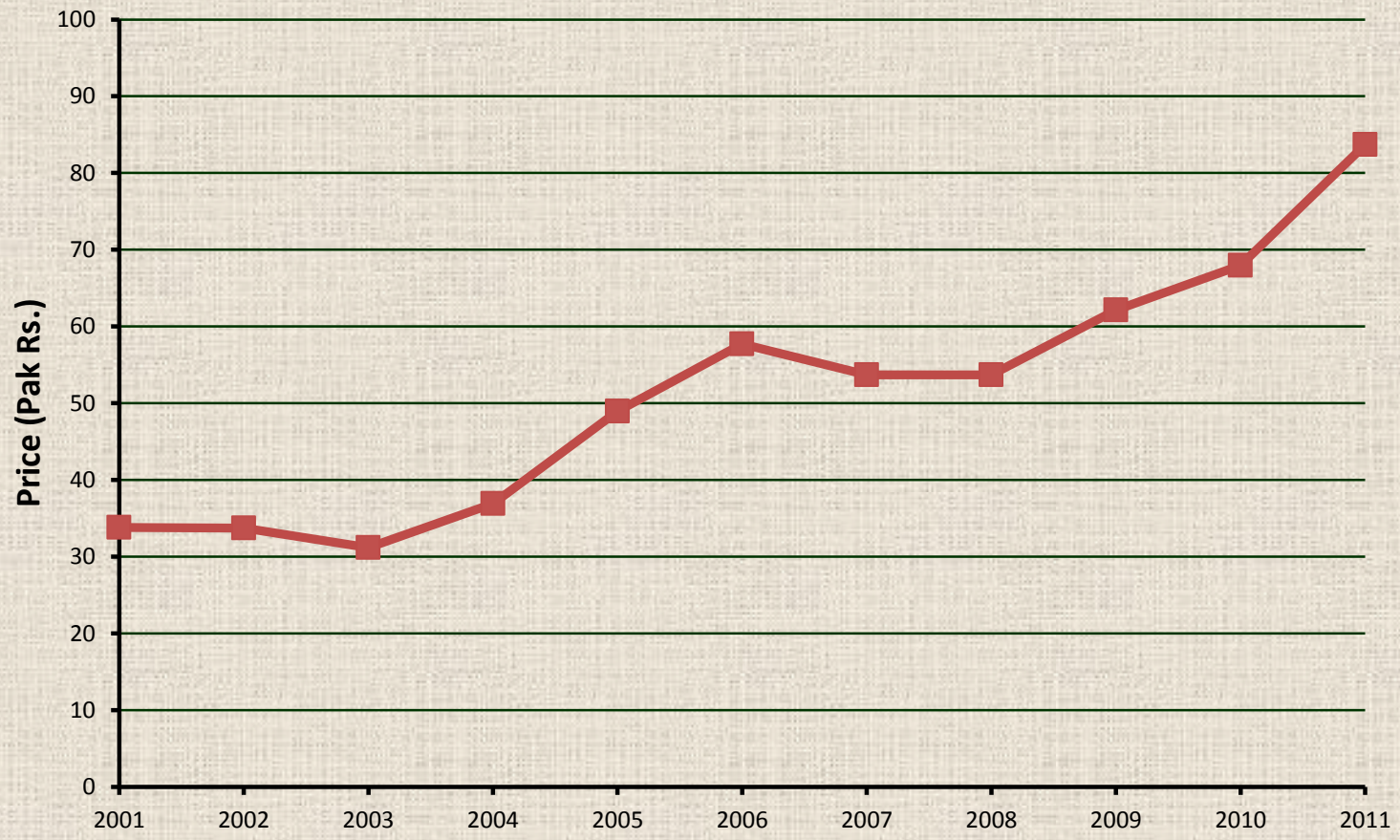
- Pakistan oil refineries production of gasoline in 2009-10: **1.337 Million tons**
  - Up by 4% from 2008-09

- Import of gasoline in 2009-10: **0.58 M tons**
  - Up by 132% from 2008-09
  - Import bill: **USD 422 M**

SOURCE: PAKISTAN ENERGY YEARBOOK 2010

SOME FACTS ABOUT GASOLINE IN PAKISTAN

- Trend in gasoline prices over the decade (Pak Rs. per liter)



SOURCE: PAKISTAN ENERGY YEARBOOK 2010

SOME FACTS ABOUT GASOLINE IN PAKISTAN

- Rise in gasoline prices over the paste decade has been mainly due to rising oil prices

- Gasoline becoming too expensive to afford

SUGAR – MOLASSES – ETHANOL

- The 2nd largest industry in Pakistan after the textile industry
  - Contributes 2% to GDP & 13% to manufacturing sector

- 81 sugar mills in Pakistan:
  - Crushing capacity of sugarcane: **300 tons per day**
  - The industry crushes **30- 40 M tons per year** of sugarcane

SUGAR – MOLASSES – ETHANOL

- Cane molasses is the main by-product of sugar manufacturing
- To maximize returns, the sugar industry processes molasses to produce anhydrous & hydrous ethanol
- Ethanol is a value-added by-product of Pakistan's sugar industry

ETHANOL PRODUCTION

- Pakistan has 21 ethanol distilleries
  - Capacity to process **2 M tons** of molasses per year
  - Ethanol production capacity: **400,000 tons per year**

- Fuel-grade ethanol (99.7% anhydrous)
  - 10% of transport petrol substituted with ethanol = approx. **189,000 tons** of fuel-grade ethanol per year is required
  - Annual savings in import (estimated): **USD 100-130 M**

ETHANOL PRODUCTION

- 6 ethanol distilleries have the capacity to produce ethanol fit for 10% blending
  - Ethanol needs to have 99.7% octane for blending with gasoline
  - Most distilleries produce ethanol with 95% octane

- Uses of ethanol produced in Pakistan
  - Export
  - Industrial chemicals (denatured ethanol)
  - Beverages

ETHANOL PRODUCTION

- In 2006, Pakistan produced & exported:
  - **36,500 tons** of fuel-grade ethanol
    - Mostly to USA
    - Limited quantity used locally
  - **165,406 tons** of ethanol
- 2007 exports: **234,000 tons**

MAJOR PLAYERS

- Oil refineries & OMCs
  - Have a negative bias towards fuel ethanol
  - State-owned OMC *PAKISTAN STATE OIL (PSO)* is the first in Pakistan to start a project on fuel ethanol
- Sugar mills – *PAKISTAN SUGAR MILLS ASSOCIATION (PSMA)*
  - Main business not ethanol production
  - Need incentives for increasing capacity to produce fuel-grade ethanol

MAJOR PLAYERS

- Ministries
  - Industries, Production & Special Initiatives
  - Petroleum & Natural Resources
  - Environment
  - Food, Agriculture & Livestock
    - Pro-oil lobbies very strong
    - Bureaucracy is a major hurdle
- Consumers & Environmental Activists
  - Want cheaper & environmentally friendly alternatives

PROGRESS

- Government sector
  - Policy recommendations by *AEDB*
    - *AEDB* created in May 2003 as the central national body on RE in Pakistan – works under the *MINISTRY FOR WATER & POWER*
    - Developed Policy Recommendations for Biofuels for GoP – 2005

Contd..

PROGRESS

- Government sector
  - Policy recommendations by *AEDB*
    - Covered areas like:
      - Supply chain
      - Industry & public awareness
      - Production permits & other licenses
      - Blending issues
      - Storage, handling, & distribution issues
      - Quality standards for various stages of the chain
      - Stakeholders' involved
      - Development of HR

Contd..

PROGRESS

- Government sector
  - Project by *PSO*
    - Government approved pilot project in 2006
    - *PSO* initiated sale of E10 on experimental basis in 2007
    - 03 petrol stations in Karachi, Lahore, & Islamabad
    - Enthusiastically accepted by consumers
    - Project being expanded

Contd..

PROGRESS

- Government sector
  - *HYDROCARBON DEVELOPMENT INSTITUTE OF PAKISTAN (HDIP)* conducted road tests for fuel ethanol
    - Testing for Pakistani conditions
      - 1,000 km test run in highway & city conditions
      - Blends used: E10 & E20
      - Different speeds
    - Positive results were realized
    - *PSO's* ethanol project was launched on the basis of the study's success

BARRIERS

- Pro-oil lobbies
- Surplus petrol refining capacity in Pakistan
- Supply line & infrastructure need to be developed

POTENTIAL

- Sale of ethanol in remote areas where:
  - OMCs do not have sale points
  - Access to fuel is difficult
- Ethanol producers to use ethanol for their own electricity generation
- Start with use of E5 / E10 as transport fuel
  - Gradually build infrastructure & feedstock supply
- Ethanol mixed with Diesel = Diesahol – 3% to 10% diesel mixed with ethanol

BIO-DIESEL AS AN ENERGY SOURCE FOR PAKISTAN

SOME FACTS ABOUT DIESEL IN PAKISTAN

- Pakistan's HSD consumption in 2009- 10: **7.27 M tons**

  - Down by 11% from 2007-08 & 4% from 2008-09

  - Consumption by sector:
    - Transport sector: **6.47 M tons** (89%)
    - Industry: **0.445 M tons** (6%)
    - Power generation: **0.25 M tons** (3.4%)
    - Other Govt.: **0.104 M tons** (1.4%)

SOURCE: PAKISTAN ENERGY YEARBOOK 2010

SOME FACTS ABOUT DIESEL IN PAKISTAN

- Pakistan oil refineries production of HSD in 2009-10: **3.14 M tons**
  - Down by 3.5% from 2008-09

- Import of HSD in 2009-10: **4.39 M tons**
  - Down slightly from 2007-08 (2.5%) & 2008-09
  - Import bill: **USD 2.724 Bn**

SOURCE: PAKISTAN ENERGY YEARBOOK 2010

SOME FACTS ABOUT DIESEL IN PAKISTAN

- Pakistan's FO consumption in 2009-10: **9.039 M tons**
  - Up by 14% from 2008-09
  - Power generation: **8.56 M tons** (94.7%)
  - Industry: **0.46 M tons** (5%)
  - Marginal quantities being used for transport, domestic & other govt. consumption

SOURCE: PAKISTAN ENERGY YEARBOOK 2010

SOME FACTS ABOUT DIESEL IN PAKISTAN

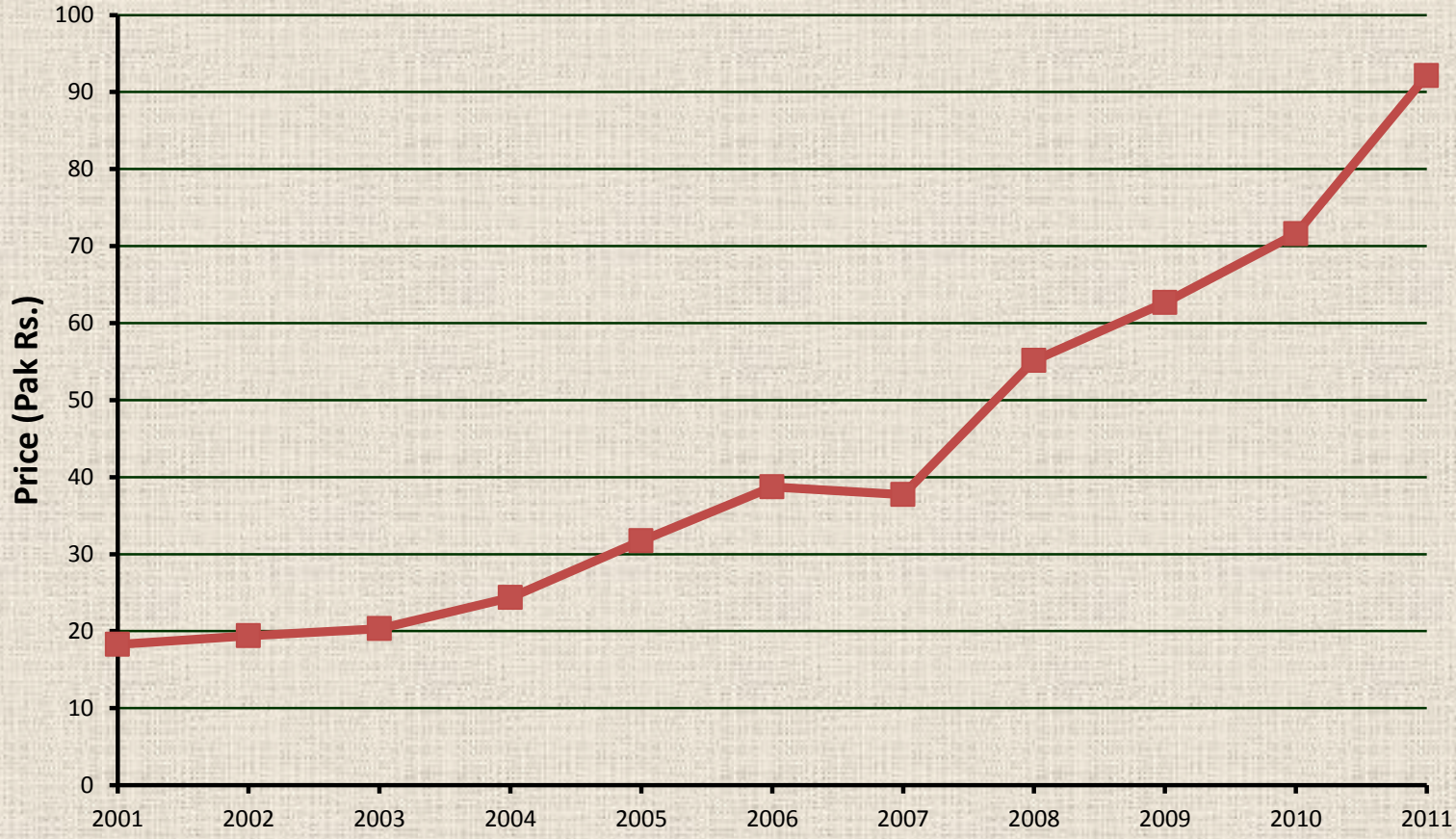
- Pakistan oil refineries production of FO in 2009-10: **2.497 M tons**
  - Down by 19% from 2008-09

- Import of FO in 2009-10: **5.6 M tons**
  - High-Sulfur FO (HSFO)
  - Import bill: **USD 2.579 Bn**

SOURCE: PAKISTAN ENERGY YEARBOOK 2010

SOME FACTS ABOUT DIESEL IN PAKISTAN

- Trend in HSD prices over the decade (Pak Rs. per liter)



SOURCE: PAKISTAN ENERGY YEARBOOK 2010

SOME FACTS ABOUT DIESEL IN PAKISTAN

- In 2008, price of HSD surpassed the price of gasoline

- Diesel shortage + high price have created an *"energy nightmare"* for Pakistanis

SOURCE: PAKISTAN ENERGY YEARBOOK 2010

SOME FACTS ABOUT DIESEL IN PAKISTAN

- Increase in price of FO (Pak Rs. per tonne):
  - **95%** from Jun-Jul 2001 to 2005
  - **117%** from June 2005 to June 2010
  - **325% from 2001 to 2010**

SOURCE: PAKISTAN ENERGY YEARBOOK 2010

IMPORTANCE OF BIO-DIESEL FOR PAKISTAN

- Diesel-substitution target of GoP
  - 5% by volume of total diesel consumption to be substituted by 2015 – 10% by 2025

"If 10 % of the diesel & furnace oil consumed by Pakistan (0.727 million tons of diesel & 0.90 million tons of FO) is switched to Bio-Diesel, the country's import bill can decline by US $ 1.00 billion. To achieve this target, land requirement will be 1.06 M Acres (640,000 hectares)" ..... GoP

- Pakistan has **9.09 M hectares** of cultivatable wasteland

IMPORTANCE OF BIO-DIESEL FOR PAKISTAN

- Bio-Diesel not an immediate threat to OMCs
  - Refining capacity for diesel in Pakistan is short of demand
  - Some quantities of diesel are smuggled in from neighboring countries like Iran
  - Diesel imported into Pakistan has high quantity of sulfur
- Fast-growing demand for diesel in Pakistan
  - Agriculture, industry, transport, domestic
- A rural development / poverty alleviation tool

BIO-DIESEL AS A RURAL DEVELOPMENT TOOL

- The woes of rural Pakistan
  - Poverty
  - Scant energy resources – dependence on diesel
    - Tube wells, tractors, generators, all need energy
    - Agricultural sector consumes 2% of total energy consumed in Pakistan
    - Most of the HSD is consumed in urban areas
    - Energy infrastructure / supplies not available - electricity scarce / non-existent in most rural locations
    - Cost of diesel prohibitive for the already poor farmers
  - Environmental hazards of using diesel

BIO-DIESEL AS A RURAL DEVELOPMENT TOOL

- Energy shortages result in:
  - Low agricultural output
  - Low income
  - Vicious cycle; lesser resources for future cultivation
  - Affects national economy

- Bio-diesel can partially contribute to improve the situation

BIO-DIESEL AS A RURAL DEVELOPMENT TOOL

- Use of Bio-diesel in rural areas will:
  - Provide the much-needed diesel alternative & a ready source of energy
  - Alleviate poverty at grass-root level
    - Money generation through untapped resources
  - Enhance agricultural produce & NTFPs
  - Fuel economic progress

Contd..

BIO-DIESEL AS A RURAL DEVELOPMENT TOOL

- Use of Bio-diesel in rural areas will:
  - Reduce damage to environment
  - Provide alternative to excessive cutting of trees
  - Increase cultivation / aforestation
  - Reduce oil imports
  - Build Bio-Diesel resource / feedstock
  - Be a small but meaningful step towards energy independence

BIO-DIESEL AS A RURAL DEVELOPMENT TOOL

- Suitability to Pakistani realities
  - Suitable climate
  - Rich in land & water resources
  - Rural communities are mostly farmers
  - Oil extraction techniques & skills native to our part of the world
    - No significant social barriers to adapting Bio-Diesel
  - Bio-Diesel resources are available

Contd..

BIO-DIESEL AS A RURAL DEVELOPMENT TOOL

- Suitability to Pakistani realities
  - Low-tech agricultural machinery does not require international quality fuel
    - Initially we need not aim at international quality fuel – NO TECHNICAL BARRIERS
    - Neat Bio-diesel can be used (without mixing with diesel) further reducing requirement of diesel
    - No transesterification required

BIO-DIESEL AS A RURAL DEVELOPMENT TOOL

- Small-to-medium-to-large-scale development will:
  - Require less investment
  - Build awareness & acceptance
  - Test & try viability
  - Mitigate risk
  - Incentivize growers / producers as cost-effectiveness / profitability is proven

Contd..

BIO-DIESEL AS A RURAL DEVELOPMENT TOOL

- Small-to-medium-to-large-scale development will:
  - Build capacity & supply chain mechanisms
  - Prepare rural sector for supplying for larger-scale projects in future
  - Not require governmental support in initial phases

CHALLENGES FOR BIO-DIESEL

1) Competition with food crops – the *"food or fuel"* debate
   - Energy markets are competing with food markets for scarce, arable land, resulting in higher food prices

2) Cutting forests to plant Bio-Diesel resources

CHALLENGES FOR BIO-DIESEL

3) Year-round sustained supply of feedstock

4) Cost of Bio-Diesel

- More significant for Pakistan – a developing country

ADDRESSING THE CHALLENGES

1) Competition with food crops

- Use & cultivate ***non-edible resources for Bio-Diesel***
- Those which can thrive on *marginal agricultural land* or *arid land*
- On such land many trees / crops will not grow or will give poor yields
- These lands will not divert agricultural resources from food crops

ADDRESSING THE CHALLENGES

2) Cutting forests to plant Bio-Diesel resource

- In other countries – Yes!
- In Pakistan – *No!*
- Compete neither with forest land nor with agricultural land

ADDRESSING THE CHALLENGES

3) Sustained supply of feedstock throughout the year

- Multiple native resources to provide year-round feedstock supply

- Increased seed yield to be stored for leaner period
  - Increased plantation of known resources
  - R&D to increase seed yield & oil content

ADDRESSING THE CHALLENGES

4) Cost of Bio-Diesel

- *Yes!!*
- A worldwide challenge for Bio-Diesel
- How to offset cost? – a major aim of project developers
  - Value addition to by-products
  - Use of seed cake – animal feed
  - Use of leaves, twigs etc. as biomass
  - NTFPs
  - Creation of Carbon Sinks
  - Keep the scale big!!
  - Increase oil yield per hectare

PROGRESS

1) Scattered small-scale Bio-Diesel production & consumption projects

2) Medium-to-large-scale Bio-Diesel projects – mainly private sector

3) Contribution of Government & Semi-Government sectors

1. SMALL-SCALE

- Projects for rural energy provision being developed in collaboration with donors
  - Rural closed-loop “Prosumer” models
  - Locations & resource identification in process
- Gradual increase to medium-scale production using indigenous feedstock

2. MEDIUM-TO-LARGE SCALE

- Private-sector interest in medium-to-large-scale Bio-Diesel production increasing
  - Prevailing energy crisis
  - Local diesel shortages & high demand
  - Lucrative Bio-Diesel export options
- Energy plantation
- Projects in pre-feasibility / feasibility stage

2. MEDIUM-TO-LARGE SCALE

- Imported feedstock options are available
  - Palm oil & WVO
  - Projects can be kick-started as of now
  - Indigenous resources to supplement feedstock in coming years
  - Incentives to various players along the value chain

- Already imported into Pakistan & used by cooking oil & soap industries
  - Import mechanisms in place
  - Permits required to use for Bio-Diesel production

3. SECTORS INVOLVED & THEIR CONTRIBUTION

- Government sector
  - *ALTERNATIVE ENERGY DEVELOPMENT BOARD (AEDB)*
    - Created in 2003
    - Mandate
      - Facilitate development of alternate energy for sustainable economic growth
      - Implement policies, programs, & projects in RE through private sector

Contd..

3. SECTORS INVOLVED & THEIR CONTRIBUTION

- Government sector
  - *AEDB*
    - Coordinates the National Bio-Diesel Program of the GoP
    - Formed an advisory committee involving stakeholders
    - Technical & commercial research projects conducted
      - Identification of resources
      - Research partners included universities, state-owned bodies, & private sector
  - Policy recommendations for use of Bio-Diesel as an alternative fuel

Contd..

3. SECTORS INVOLVED & THEIR CONTRIBUTION

- Government sector
  - *AEDB*
    - SRO for exemption of taxes & duties on Bio-Diesel-related equipment, machinery, & other items issued by the *FEDERAL BOARD OF REVENUE (FBR)* – May 2008

Contd..

3. SECTORS INVOLVED & THEIR CONTRIBUTION

- Government sector
  - *PAKISTAN STATE OIL (PSO)*
    - Jatropha nursery & Jatropha model farm in Sindh – plantation over 120 hectares
    - Bio-Diesel production & testing of various blends in *PSO*'s fleet vehicles & generators
    - Aim: blend 10% of Pakistan's total diesel consumption with Bio-Diesel

Contd..

3. SECTORS INVOLVED & THEIR CONTRIBUTION

- Government sector – Universities
  - *NATIONAL UNIVERSITY OF SCIENCES & TECHNOLOGY (NUST)*, Islamabad, Pakistan
  - *QUAID-I-AZAM UNIVERSITY,* Islamabad
  - *ARID AGRICULTURE UNIVERSITY*

Contd..

3. SECTORS INVOLVED & THEIR CONTRIBUTION

- Government sector – Universities
  - *NUST*, Islamabad, Pakistan
    - Jatropha-based Bio-Diesel
      - Jatropha plantation at *NUST* campus – model farm spread over 20 hectares
      - Testing of Jatropha oil properties vis-à-vis petro-diesel
      - *NUST* annual requirement of diesel was estimated at 50,000 liters – aim to substitute some portion with Bio-Diesel

Contd..

3. SECTORS INVOLVED & THEIR CONTRIBUTION

- Government sector – Universities
  - *NUST*, Islamabad, Pakistan
    - Development of bimodal nano-catalyst for fast-track Bio-Diesel production – patented
      - Conventional Bio-Diesel production process:
        - **90 minutes at 70-80˚C temperature**
        - **Bio-Diesel: 85%, Glycerine: 10-12%, Soap: 2-4%**
        - **Multiple steps to obtain refined Bio-Diesel**

Contd..

3. SECTORS INVOLVED & THEIR CONTRIBUTION

- Government sector – Universities
  - *NUST*, Islamabad, Pakistan
    - Development of bimodal nano-catalyst for fast-track Bio-Diesel production – patented
      - Fast-track Bio-Diesel production using nano-catalyst:
        - **Single-step reaction – improved kinetics of the reaction**
        - **No heating required: reaction takes place at 25˚C**
        - **Time savings: 05 minutes' process**
        - **Better conversion efficiency**
        - **99% Bio-Diesel, 1% Glycerine - increased yield –**
        - **More efficient & cost-effective Bio-Diesel production**

Contd..

3. SECTORS INVOLVED & THEIR CONTRIBUTION

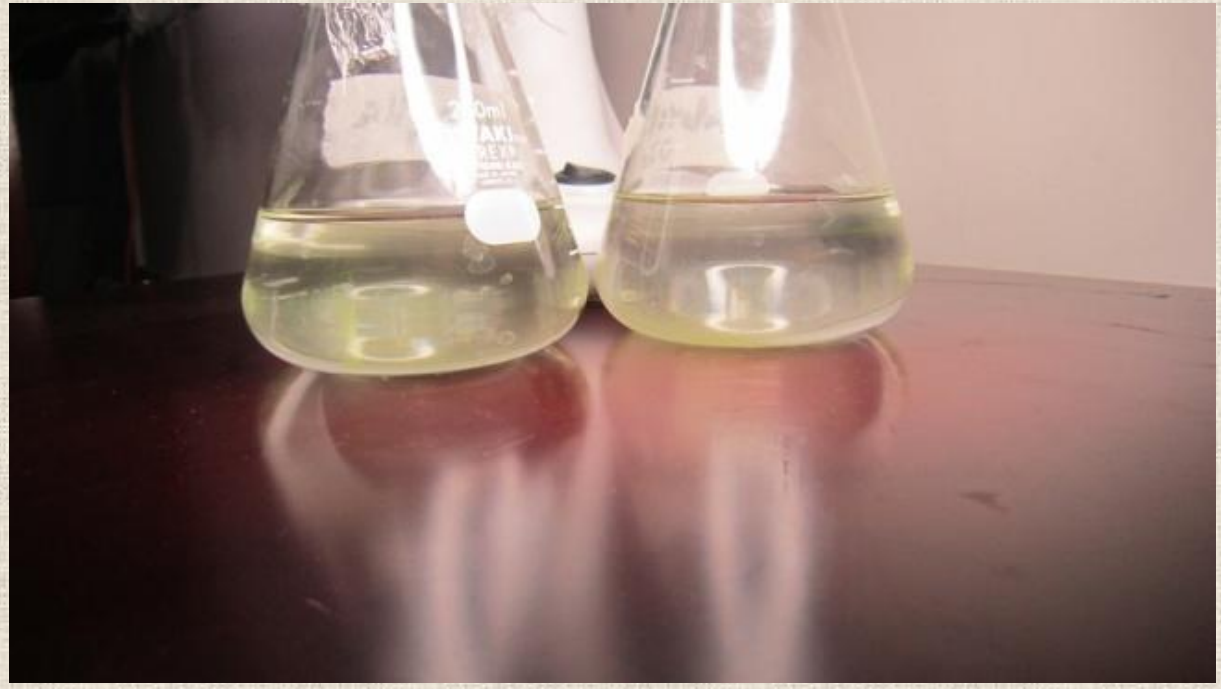
- Government sector – Universities
  - *NUST*, Islamabad, Pakistan
    - Development of bimodal nano-catalyst for fast-track Bio-Diesel production – patented
      - Small quantities required – 0.1% of volume of oil
      - Use of catalyst decreases amount of methanol required to be used
      - Eventually results in direct cost benefits for the consumer
      - Canada-based *NRG BIOFUELS* investing in pilot-scale production plant based on fast-track process
    - Batch Bio-Diesel pilot production using new catalyst
      - 120 ltrs per batch

Contd..

3. SECTORS INVOLVED & THEIR CONTRIBUTION

- Government sector – Universities
  - *NUST*, Islamabad, Pakistan
    - Bio-Diesel from algae
      - Indigenous species tested for lipid content
      - Chlorella found most promising – up to 45% oil yield – cultivation underway
      - Stimulated growth of algae using Tubular Photobioreactors (TBR)
      - Extraction of oil from algae using Super Critical Fluid (SCF) technology – pilot-scale SCFE unit is being developed at *NUST*

Contd..



Different Algae Species at *SCME, NUST*

3. SECTORS INVOLVED & THEIR CONTRIBUTION

- Government sector - Universities
  - *QUAID-I-AZAM UNIVERSITY (QAU),* Islamabad
    - Under the National Bio-Diesel Program of GoP, a Bio-diesel laboratory was established at *QAU*
    - South Asia's 2nd largest Herbarium – has different species of oil-yielding plants
    - Botanical garden with special emphasis on Bio-diesel yielding plants
    - MS / PhD programs in Biofuels technology

Contd..

Pongame Nursery at QAU

3. SECTORS INVOLVED & THEIR CONTRIBUTION

- Government sector – Universities
  - *QAU,* Islamabad
    - Identification of new indigenous plant resources for Bio-diesel
    - Cost-effective Bio-diesel production processes from different resources
    - Physio-chemical & QA certification lab for Bio-diesel products
    - Rural awareness & outreach program

Contd..

Bio-diesel Lab at QAU – Seed Bank

QAU – Tractor Run on Bio-Diesel

SARI/E COUNTRIES COLLABORATION OPPORTUNITIES

- R&D
- Establishment of linkages between academia / industry at both ends
- Student exchange programs
- Replication of projects
- Development / implementation of pilot projects
- Import / export of feedstock
- Bio-Diesel equipment (small-scale, medium-scale) supply, TOT