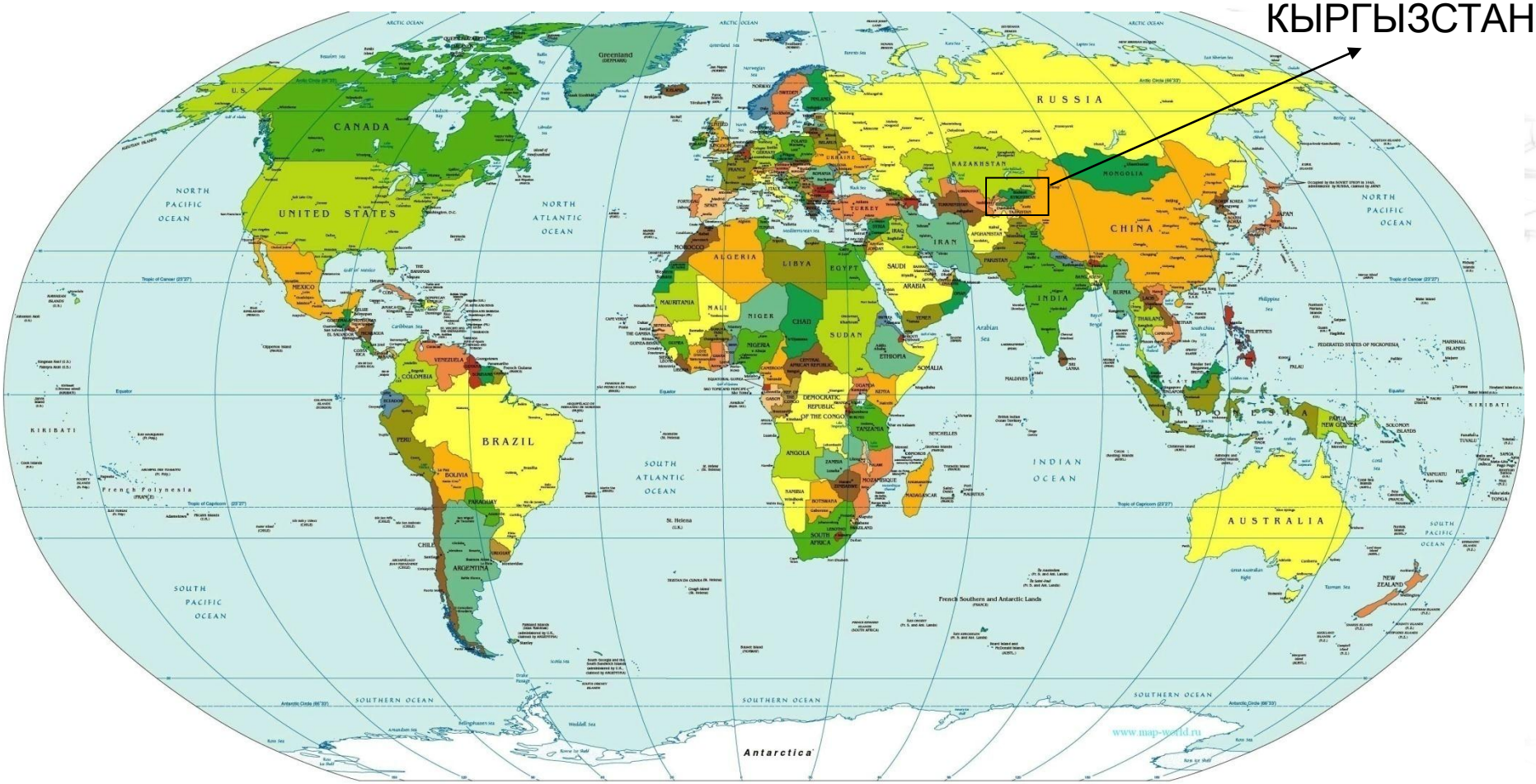
ОТКРЫТОЕ АКЦИОНЕРНОЕ ОБЩЕСТВО

север-электро

Свет и тепло в вашем доме



ОТКРЫТОЕ АКЦИОНЕРНОЕ ОБЩЕСТВО

север-электро

Свет и тепло в вашем доме

ОТКРЫТОЕ АКЦИОНЕРНОЕ ОБЩЕСТВО
северэлектро

Свет и тепло в вашем доме

Открытое Акционерное Общество «Северэлектро» образовано 01.07.2001году в результате реорганизации ОАО «Кыргызэнерго» Кыргызской Республики путем выделения из его состава имущественного комплекса электрических распределительных сетей Чуйского, Таласского и Бишкекского предприятий электрических сетей.

Распределительная компания ОАО «Северэлектро» – ведущая энергоснабжающая организация Кыргызской Республики.

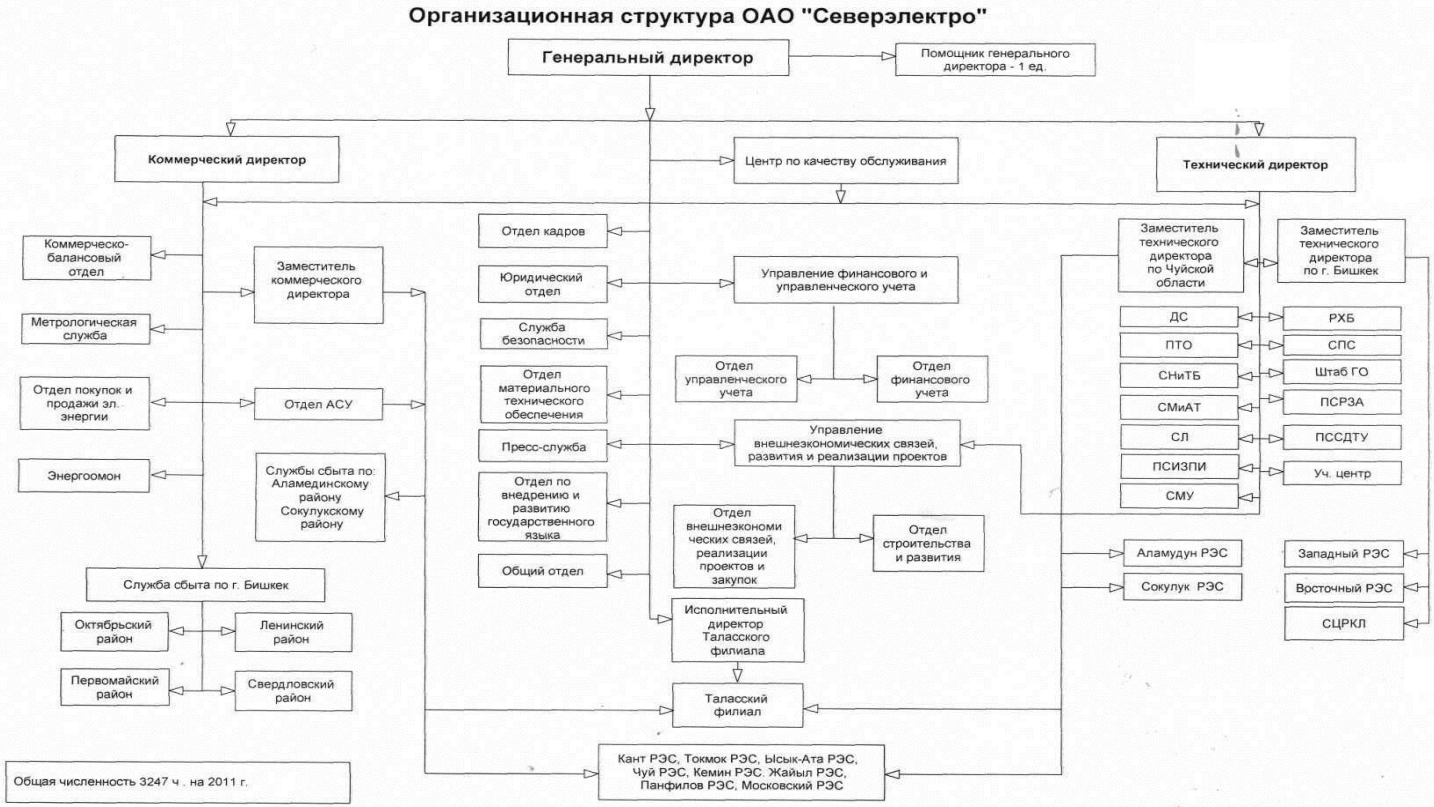
В настоящее время в условиях рыночной экономики компания осуществляет покупку, распределение и продажу электроэнергии в соответствии с получаемыми в установленном порядке лицензиями, ремонтно – эксплуатационное и оперативное обслуживание распределительных электрических сетей напряжением 35/6-10/0,4 кВ, находящихся в границах Чуйской, Таласской областей и столице Кыргызстана городе Бишкек.

ОТКРЫТОЕ АКЦИОНЕРНОЕ ОБЩЕСТВО

северэлектро

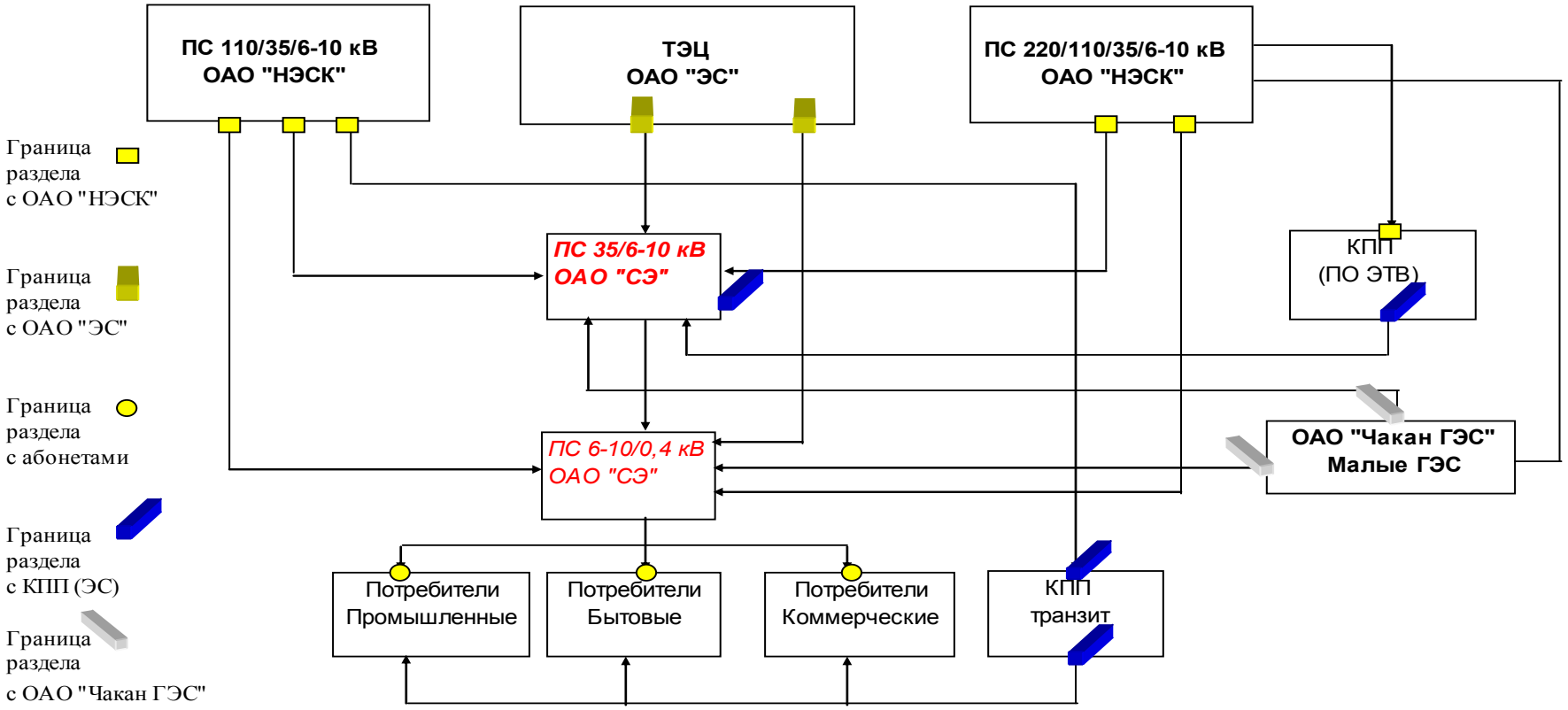
Свет и тепло в вашем доме

Организационная структура ОАО "Северэлектро"




Поступление электроэнергии в сети 35-10-6-0,4 кВ ОАО "Северэлектро"
млн.кВтч
6,000
5,000
4,000
3,000
2,000
1,000
0
5 076,7
4 598,5
4 129,9
4 394,1
2007
2008
2009
2010

Учет электроэнергии поступление и ее распределение ОАО "Северэлектро".



Ремонтно-эксплуатационное и оперативное обслуживание распределительных электрических сетей 0,4 – 10 кВ осуществляется по территориальному принципу.

в Чуйской области 10 районов электросетей (РЭС);

в городе Бишкек – 2 РЭС;

в Таласской области – 5 РЭС.

Ремонтно-эксплуатационное обслуживание распределительных электрических сетей 35 кВ по всей зоне ОАО «Северэлектро» осуществляется следующим образом:

***Службой подстанций* – понизительные подстанции 35 кВ, в состав которой входят:**

Московская группа ПС;
Кантская группа ПС;
Жайылская группа ПС;
Бишкекская группа ПС;
Кеминская группа ПС;

Службой Линий **– воздушные линии электропередачи напряжением 35 кВ.**

Диспетчерской Службой **ОАО «Северэлектро» осуществляется оперативное обслуживание электрических сетей 35 кВ в соответствии с их оперативной подчиненностью, в состав которой входят:**

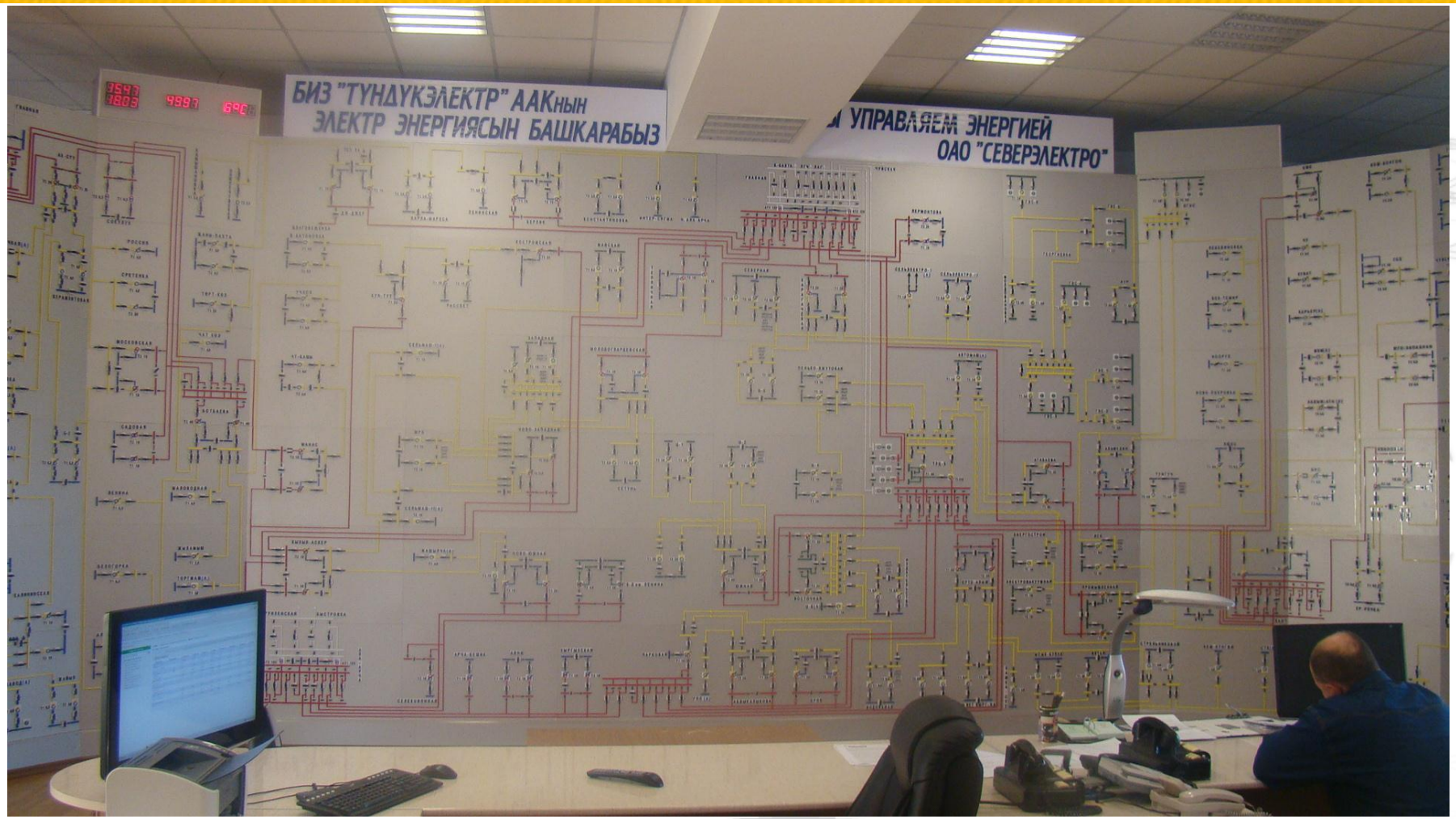
по Чуйской области – 12 РЭС;
по Таласской области – 5 РЭС;
по городу Бишкек – 2 РЭС.

Диспетчерские службы районов электрических сетей **осуществляют оперативное обслуживание электрических сетей напряжением 35/6-10/0,4кВ.**

ОТКРЫТОЕ АКЦИОНЕРНОЕ ОБЩЕСТВО

север/электро

Свет и тепло в вашем доме

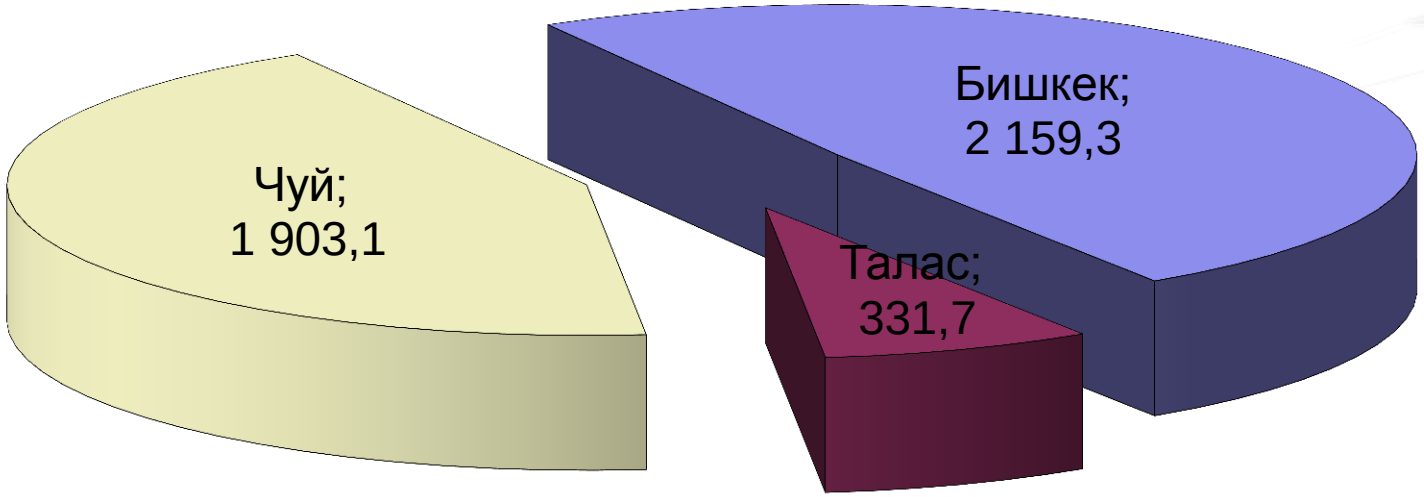


Основные технические показатели ОАО "Северэлектро" на 2011 год

№ п/п	Наименование	ед. изм.	ОАО "СЭ"	Чуй	Бишкек	Талас
1	**Количество ПС 35 кВ**	шт.	122	98	14	10
	Мощность	мВА	980,507			
2	**Протяженность ВЛ-35-0,4 кВ**	км	19853	12667	2766	4420
3	**Протяженность КЛ-35-0,4 кВ**	км	960	275	1685	0
	в т.ч. КЛ-35 кВ	км	59		59	
	КЛ-10 кВ	км	305	107	198	
	КЛ-6 кВ	км	734	44	690	
	КЛ-0,4 кВ		852	122	730	

№ п/п	Наименование	ед. изм.	ОАО "СЭ"	Чуй	Бишкек	Талас
4	**Количество отходящих фидеров**	шт.	2258	537	1 618	103
5	**Количество РП и ТП**	шт.	8385	5569	1630	1186
	мощность	мВА	2041	1060	773	208
	в т.ч. МТП	шт.	106	1		105
	КТП	шт.	6209	4691	437	1081
	закрытые	шт.	2071	878	1193	0
6	**Количество ТП на балансе абонентов**	шт	4289	2407	1390	492
	мощность	мВА	1025	523	447	55

Распределение электроэнергии в разрезе областей и г. Бишкек за 2010 г. в млн. кВтч



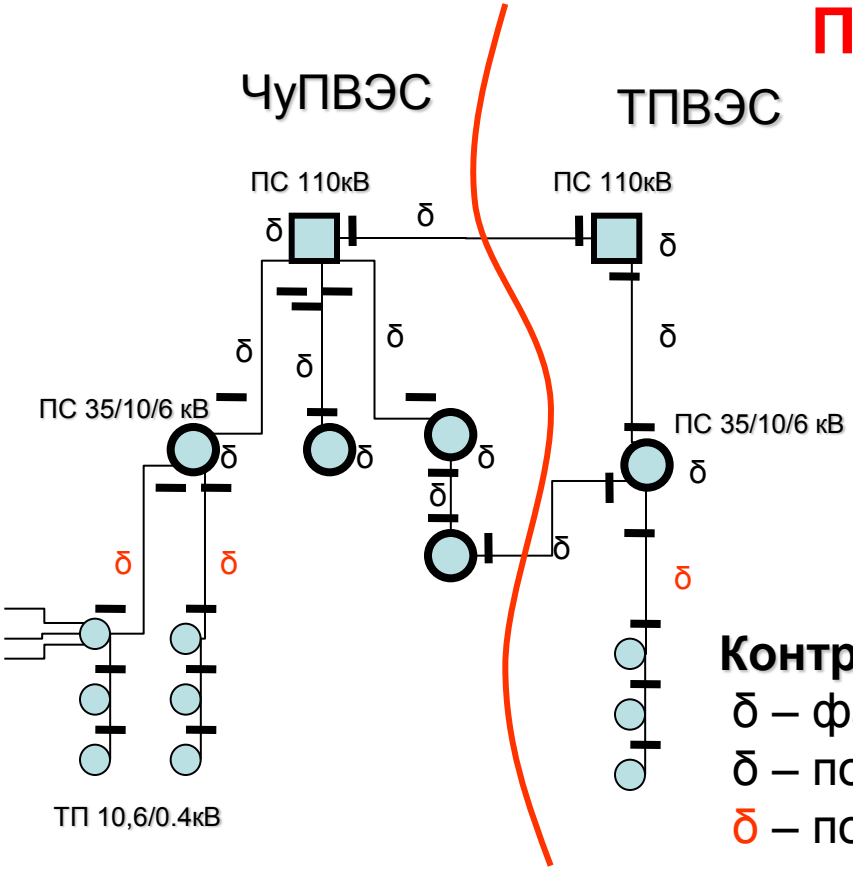
Итого поступление электроэнергии в сети ОАО «Северэлектро» за 2010 г. составило *4 394,1* млн. кВтч

ОАО «Северэлектро» было принято концепция по внедрению Автоматизированную Систему Управления Производством (АСУП) снижению потерь электроэнергии в сетях. Концепция включает в себя несколько этапов:

1. **Повышения ответственности инспекторов служб сбыта за полученную электроэнергию на фидер 6/10 кВ (закрепление индивидуально за каждым инспектором фидер и всех абонентов запитанных от этого фидера 6/10 кВ.);**

2. **Внедрение Автоматизированной Информационной Измерительной Системы (АИИСКУЭ) на всех подстанциях ОАО «Северэлектро» и границах балансовой принадлежности с ОАО «Национальная электрическая сеть Кыргызстана», ОАО «Электрические станции» и ОАО «Чакан ГЭС»;**

Принцип организации учёта



Для обеспечения наблюдаемости распределения электроэнергии, приборы учёта должны быть установлены по обе стороны контролируемого узла.

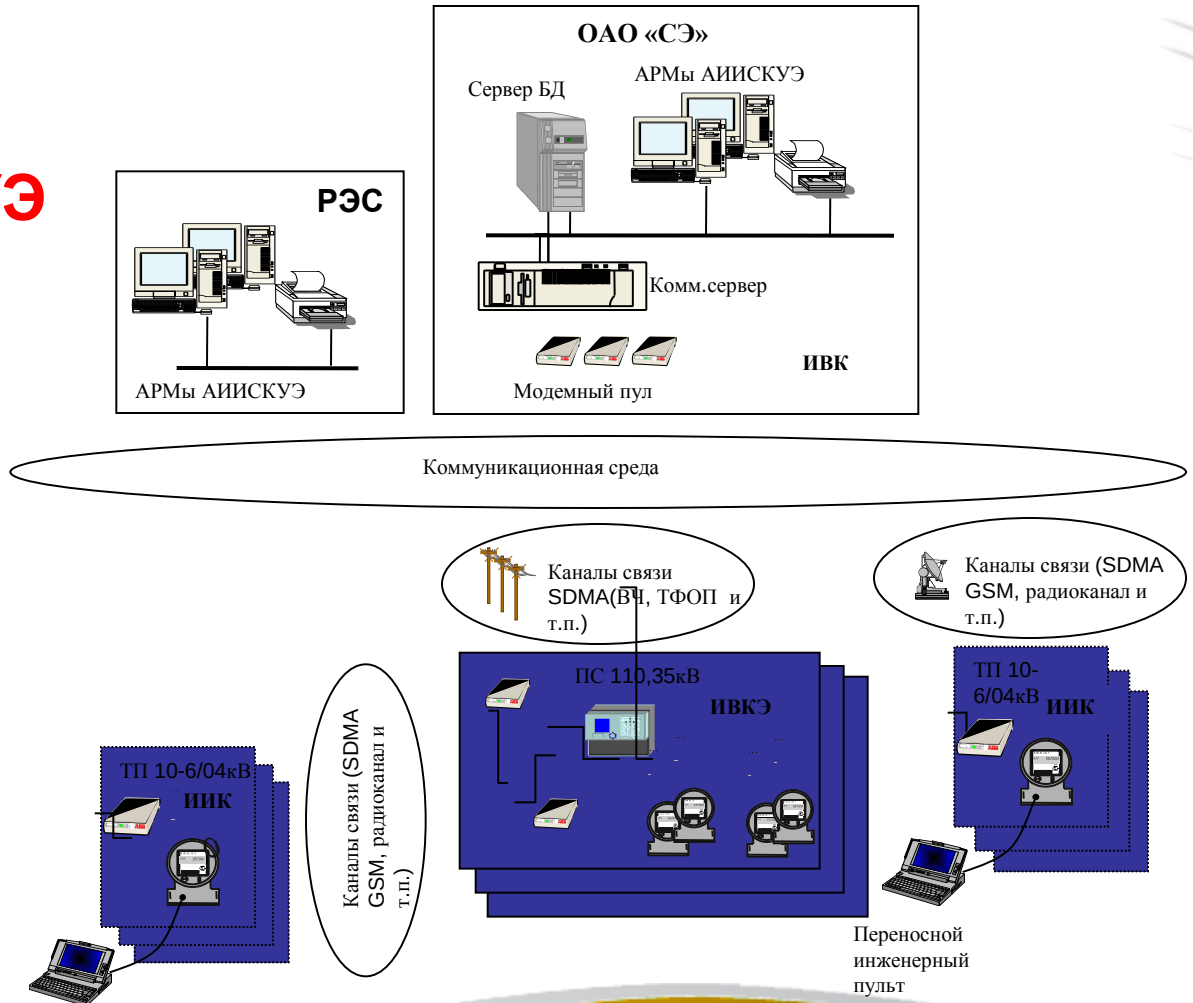
Контролируемые потери:

δ – фактический небаланс по ПС

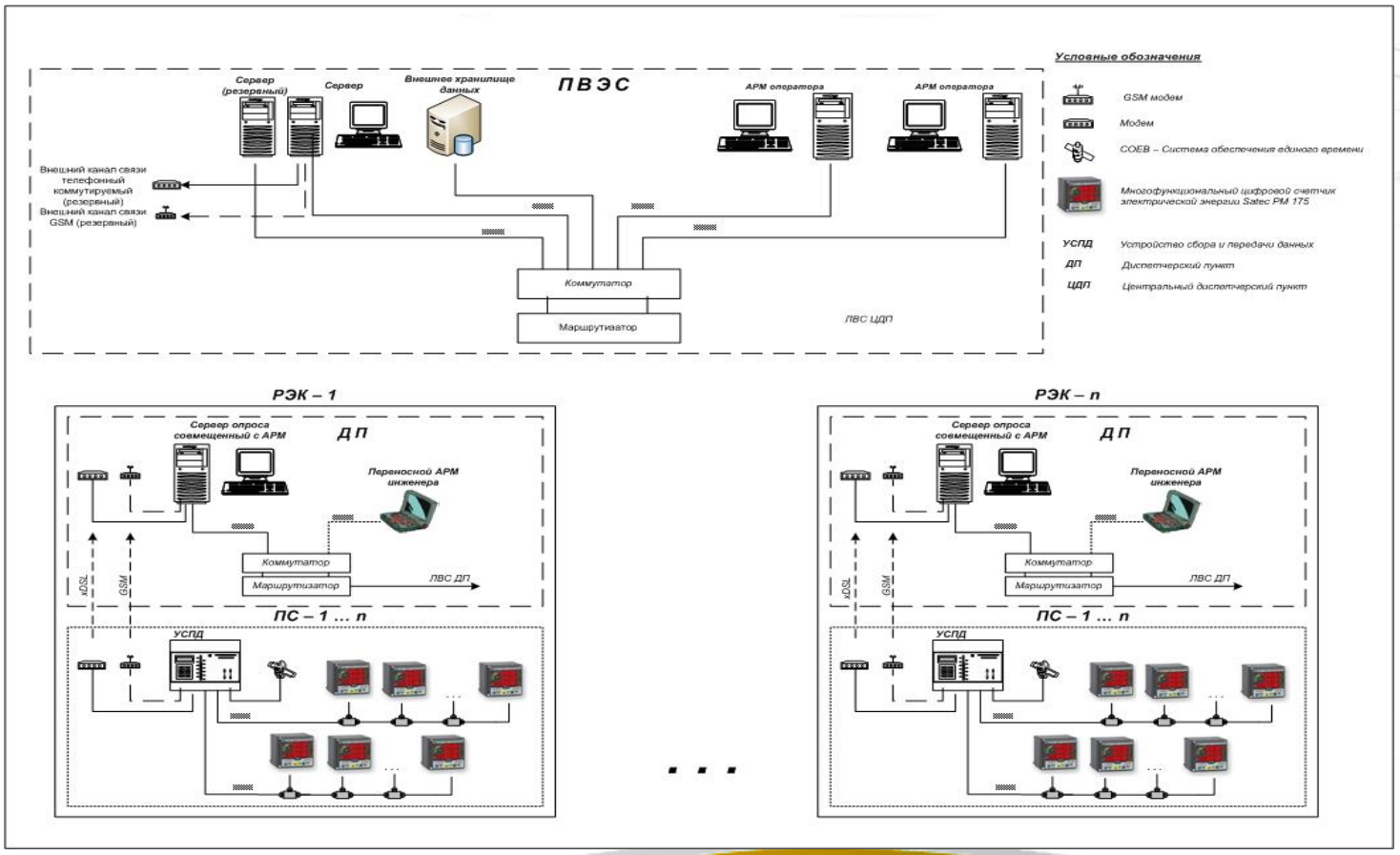
δ – потери в транзитных линиях

δ – потери в распределительных сетях 6,10 кВ

Общая схема АИИСКУЭ



Структурная схема АИИСКУЭ



ОТКРЫТОЕ АКЦИОНЕРНОЕ ОБЩЕСТВО

север электро

Свет и тепло в вашем доме

- Внедрение АИИСКУЭ предполагает собой замена и установка интеллектуальных приборов учета электроэнергии с цифровыми выходами RS-485 получения с них информации технических параметров по каждому присоединению с выводом всей информации в диспетчерские пункты районов электрических сетей компании;
- Установка щитов «Устройств Сбора и Передачи Данных» на всех подстанциях 220/110/35/6-10 кВ границ раздела между компаниями и подстанций ОАО «Северэлектро»;

3. Внедрение АИИСКУЭ на ТП 6-10/0,4 кВ.
4. Построение беспроводных технологических каналов связи на основе высокотехнологического оборудования:

- Транспортной сети – РЭСы и ОАО Северэлектро.
- Абонентской сети – подстанции 110/35/10-6/0,4 кВ и РЭСы.

5. Разработка и внедрение биллинговой системы адаптированной к АИИСКУЭ работающая в режиме реального времени:

6. При реконструкции и ремонте электрических сетей компании применение, новейших технологий, такие как Самонесущие Изолированные Провода (СИП) в сетях 0,4кВ.

7. Внедрение автоматизированных программ выполнения работ ремонтным персоналом для автоматизации производства.

В целях уменьшения технических и коммерческих потерь в сетях ОАО Северэлектро, в апреле 2010года было принято решение внедрения Автоматизированной Информационной Измерительной Системы Коммерческого Учета Электроэнергии (АИИСКУЭ), а также переход на Автоматизированную Систему Управления Производством (АСУП).

Основные преимущества внедрения системы:

- **Постоянный контроль качества электроэнергии;**
- **Обеспечение возможного перехода на расчет за электроэнергию с поставщиками по дифференцированным тарифам;**
- **Оперативное определение причин небаланса по всем цепям доставки электроэнергии в распределительных сетях 35/6-10/0,4 кВ;**
- **Повышение точности учета электроэнергии;**
- **Обнаружение и локализация очагов потерь электроэнергии;**
- **Повышение класса точности и чувствительности счетчиков электроэнергии;**
- **Сокращение количества инспекторов сбыта электроэнергии.**
- **Снижение уровня затрат на обслуживание точек учета и организацию выписки счетов;**
- **Повышение уровня ответственности абонентов за своевременную оплату платёжных счетов;**

- Своевременное выявление хищений электроэнергии;
- Отсутствие искажений при снятии показаний электросчетчиков за счёт исключения человеческого фактора;
- Обеспечение «прозрачности» процесса распределения электроэнергии между компаниями, районами электрических сетей;
- Повышение срока службы электрических сетей за счет оперативного контроля над симметрией нагрузок;
- Оперативное использование данных по электропотреблению в процессе принятия решения по закупке электроэнергии;
- Оперативный контроль положений коммутационного оборудования и телеуправление оборудованием.

Вышеуказанные мероприятия помогут значительно снизить потери в сетях ОАО Северэлектро, исключить влияние человеческого фактора при распределении электроэнергии, снизить дебиторскую задолженность что, несомненно, окажет позитивное влияние на финансовое положение энергетического сектора Кыргызской Республики.

Одним из первых шагов в 2010 году первым этапом был перевод контролеров в инспектора и закрепили за каждым, линию электропередач 6-10 кВ(отходящий фидер), также подписали с каждым договор о материальной ответственности за объем электроэнергии поступивший на этот фидер.

Пофидерный учет электроэнергии и его преимущества:

1. **Локализация очагов потерь электроэнергии;**
2. **Повышенная эффективность внедрения мероприятий по снижению потерь электроэнергии фидера 6-10 кВ;**
3. **Повышение ответственности инспекторов за поступившую электроэнергию на фидер 6-10 кВ.**

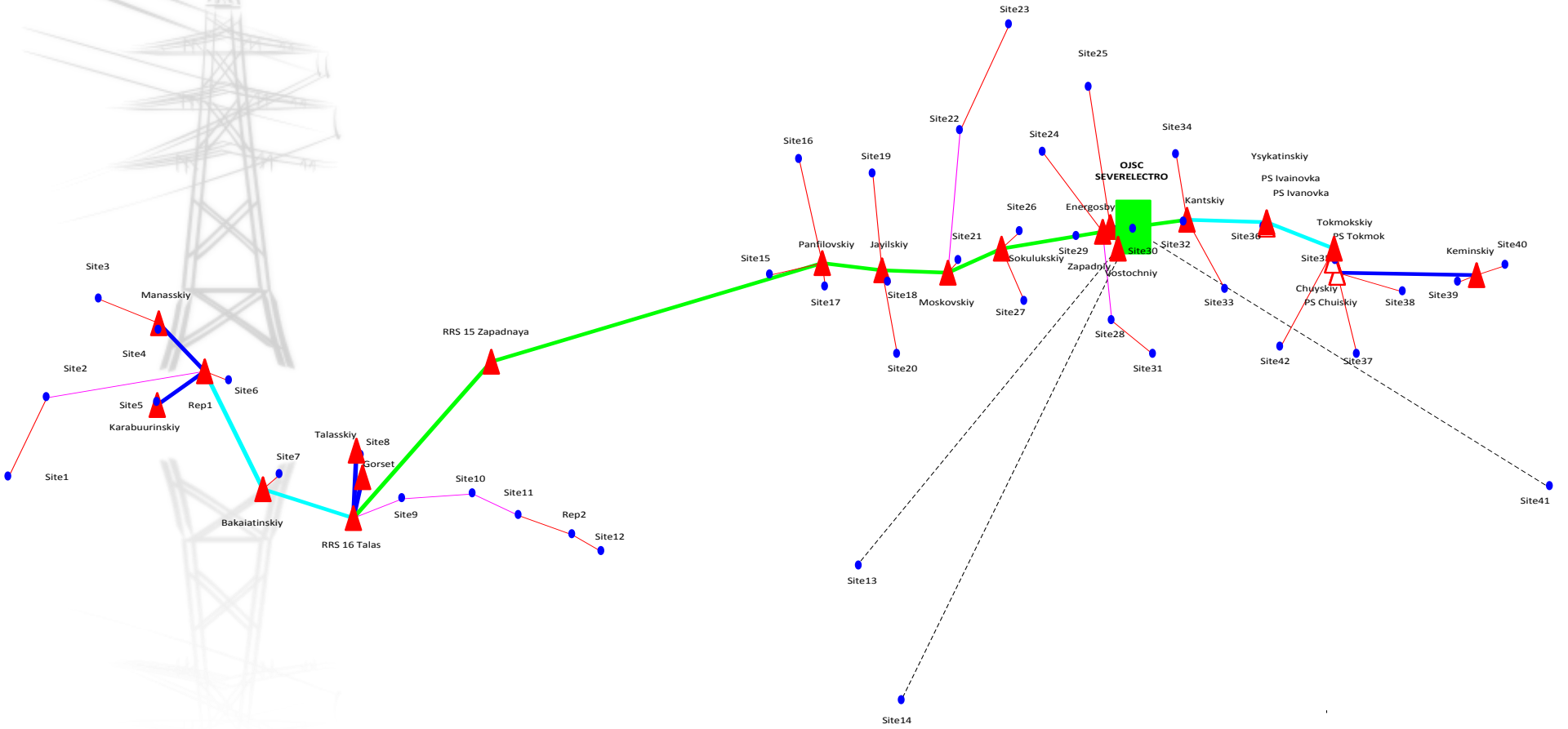
На сегодняшний день более 30 лет используемая связь в энергетическом секторе физически и морально устарела, отсутствует возможность реализации высоких технологий. Ввиду этого нашей компанией было принято решение организации высокотехнологических каналов связи.

Для реализации системы потребуется организация каналов связи с районами электросетей, подстанциями и абонентами Чуйской, Таласской области и г.Бишкек.

ОТКРЫТОЕ АКЦИОНЕРНОЕ ОБЩЕСТВО

север электро

Свет и тепло в вашем доме



Одним из способов реализации транспортной сети для нас, является построение Радиорелейных станций (РРС), с использованием существующих антенных мачт в РЭСах.

Реализация абонентской сети возможно по технологии CDMA, с размещением базовых станций по территории г. Бишкек, Чуйской и Таласской областей.

Также хотим отметить, после проведенного тендера методом неограниченных торгов, 28.12.2010 года между ОАО «Северэлектро» и корпорацией ZTE (Телекоммуникационные технологии и решения в области беспроводных каналов связи) Китайской Народной Республикой был подписан договор по построению беспроводного канала связи.

В связи с внедрением новых технологий ОАО «Северэлектро». Корпорация ZTE предоставляет технический кредит с рассрочкой выплат в течение двух лет после реализации проекта.

Этапы внедрения АИИС КУЭ (*установка интеллектуальных счетчиков*)

I этап - на границе поступления от поставщиков электроэнергии - **637** шт.

II этап - на границе между РЭС и собственных ПС 35/6-10 кВ - **1 163** шт.

III этап - установка на ТП 6-10/0,4 кВ - **13 000** шт.

Установка приборов учета электроэнергии на ТП 6-10/0,4 кВ его преимущества:

- **Локализация потерь эл.энергии до конкретного ТП 6-10/0,4 кВ;**
- **Точное балансовое определение тех. потерь по стороне 6-10 кВ;**
- **Повышение эффективности внедрения мероприятий по снижению тех.потерь электроэнергии;**
- **Оптимизация режимов сетей 6-10 кВ;**
- **Снижение аварийности оборудования за счет оперативности реагирования на отклонения режимов и тех.параметров сетей 6-10 кВ;**
- **Повышение качества электроэнергии поставляемого абонентам.**

IV этап - установка у потребителей - **492 370** шт.

Предполагаемый эффект от внедрения АИИС КУЭ - снижения потерь электроэнергии до 10 % после полного внедрения АИИС КУЭ.

Одним из следующих шагов для уменьшения потерь и снижения дебиторской задолженности нашей компанией начата реконструкция сетей 0,4 кВ с применением новых инновационных технологий, т.е. замена изношенных неизолированных проводов магистральных линий на современные самонесущие изолированные провода (СИП) большего сечения.

СИП начали применять в развитых европейских странах около 40 лет, назад, что зарекомендовало себя только с наилучшей стороны.

Так как изношенность сетей и электрооборудования составляет 85%, требуется срочная замена существующих ВЛ 10-0,4 кВ на самонесущие провода, сечение которых будет соответствовать нагрузкам с учетом перспективного развития районов. Это позволит снизить потери и обеспечить требуемый уровень надежности (такие как, отключения от короткого замыкания при сильных порывах ветра).

На сегодняшний день идет реконструкция в г.Бишкек, это район жилого массива Токульдош и Ошского рынка. Реконструкция предполагает замену магистральных линий 0,4 кВ от 12 ТП 10/0,4кВ общей протяженностью 44 км на общую сумму 29 785тыс.сом.

ОТКРЫТОЕ АКЦИОНЕРНОЕ ОБЩЕСТВО

север-электро

Свет и тепло
в
вашем доме

Для повышения надежности сетей 6-10 кВ так в 2011 году предполагается:

Установка и применение высоковольтных резисторов в количестве 30 шт;

Установка интеллектуальных реле в кабельных сетях 6-10 кВ в количестве 20 штук;

Установка терминалов защиты для трансформаторов 35/10-6 кВ в количестве 10 штук.

Предполагаемое снижение затрат - 20 млн.сомов в год.

Уменьшение аварийности в сетях 6-10 кВ на 26 %.

В этом году начинается реализация проекта «Меры по улучшению (Компонент Реконструкции Сети г.Бишкек) и Повышение Эффективности Энергетического Сектора ОАО «Северэлектро» за счет кредитных средств немецкого банка развития KFW с общим бюджетом 26 млн. евро.

Замена кабельных линий по городу Бишкек 35-6-10-0,4кВ общей протяженностью 2 173 км:

- **по 35-6-10 кВ – 111 км;**
- **по 0,4 кВ – 500 км**

на общую сумму 26 млн.евро, для полной реализации проекта по замене дополнительно требуется 13 млн. долларов.

Замена и установка микропроцессорных интеллектуальных приборов учета в количестве 110 136 шт с возможностью дистанционного доступа и отключения абонентов за дебиторскую задолженность.

Экономическая окупаемость проекта три года.

Ожидаемый эффект после внедрения проекта «Меры по улучшению (Компонент Реконструкции Сети г.Бишкек) и Повышение Эффективности Энергетического Сектора ОАО Северэлектро» снижение потерь по г.Бишкек составит по истечении 2 лет на 6%, по итогам 2011 года на 2,5%.

Все эти мероприятия направлены на снижение потерь и бесперебойное электроснабжение абонентов нашей компании.

Результаты от внедрения мероприятий:

- **Значительное снижение потерь электроэнергии с 24,7 % до 10-11 %;**
- **Улучшения финансового состояния компании;**
- **Модернизация и техническое перевооружение сетей;**
- **Возможность внедрения автоматизированных систем управления сетями;**
- **Улучшение электроснабжения потребителей;**
- **Значительное сокращение аварийных отключений;**
- **Сокращение времени на устранение неисправностей в сетях;**
- **Возможность увеличения благосостояния персонала компании;**
- **Повышение профессионального уровня работников компании;**
- **Повышение культуры обслуживания абонентов;**
- **Снижение человеческого фактора при обслуживании абонентов компании;**

- **Значительное сокращение ежегодных затрат на ремонтно-эксплуатационные работы в электрических сетях компании;**
- **Значительное сокращение несанкционированного отбора электроэнергии.**

Все эти вышеуказанные мероприятия и усилия нашей компании направлены на прозрачность и повышение эффективности системы энергетики, в связи, с чем нами внедряется АИИС КУЭ и АСУП современного высокотехнологического оборудования и организацию технологического канала связи.

СПАСИБО ЗА ВНИМАНИЕ

SmartSacramento®

March 23, 2011

Jaspal Deol, P.E.

Manager, Transmission and Distribution Substation Design, Construction, and Maintenance

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USEA United States Energy Association

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About SMUD

- 595,000 customers
- 900 sq mile service area
- Elected Board of Directors
- Not-for-Profit community utility
- 6th largest community-owned electric utility
- Committed to a high level of customer satisfaction

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The Current State of the Grid

- Current grid tends toward “dumb”
  - We typically learn about outages via phone
  - Many substations are not automated
  - Many functions are performed manually in the field
  - No automation in homes
  - By the time customers get their bill, it’s too late to do anything about it
- One benefit of the dumb grid—not as open to cyber attack

Smart Grid Vision

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SMUD's vision is to empower its customers with solutions and options that increase energy efficiency, protect the environment, reduce global warming, and reduce the cost to serve our region.

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Tangible Benefits of Smart Grid

- Reduce peak load
- Reduce losses
- Improve energy efficiency
- Faster outage restoration
- Promote distributed generation
- Improve air quality
- Integrate intermittent renewable resources

The Smart Grid Project allows customers to be part of the energy solution.

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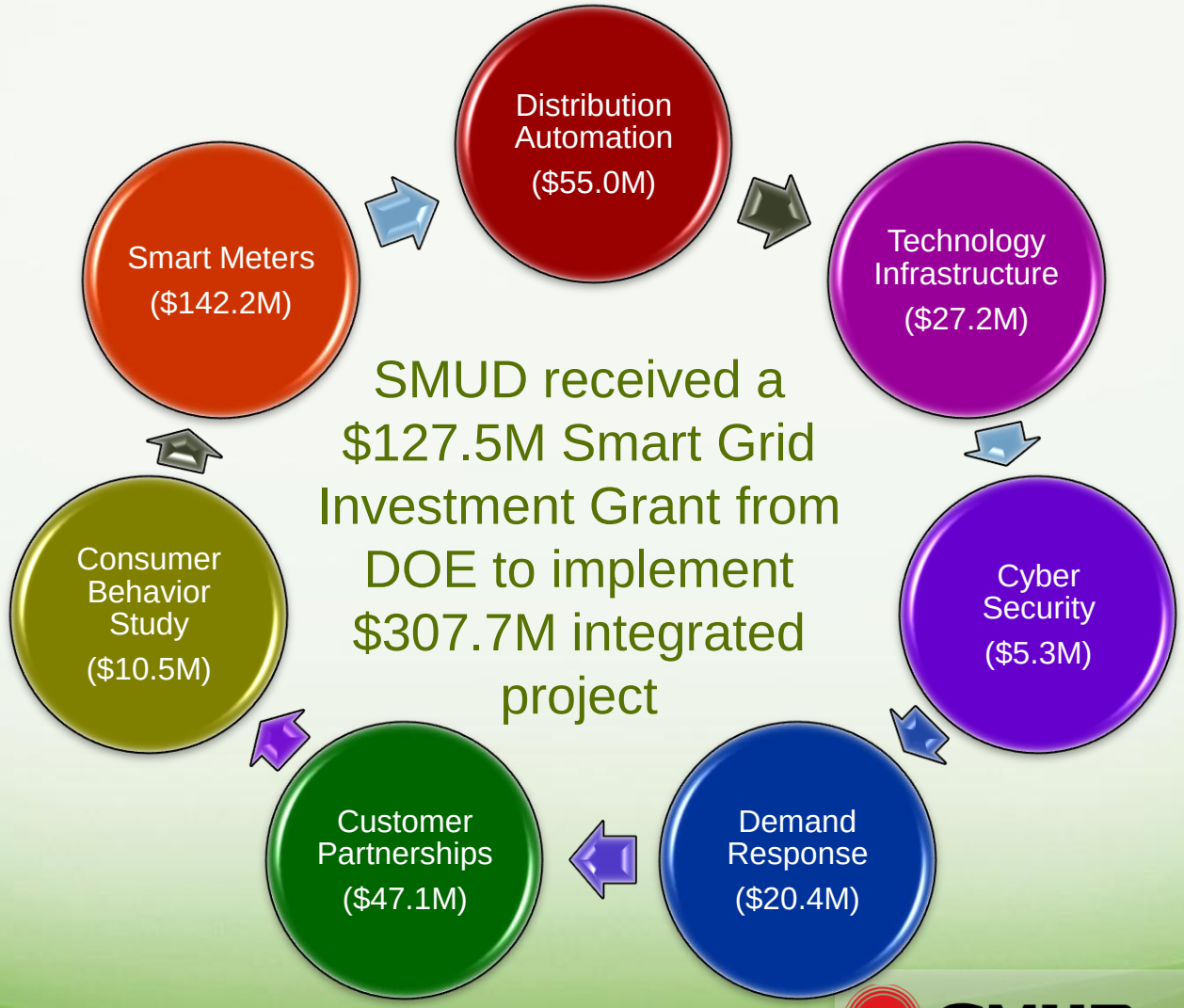
SmartSacramento® ARRA Grant



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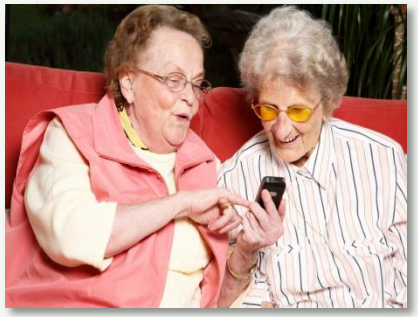
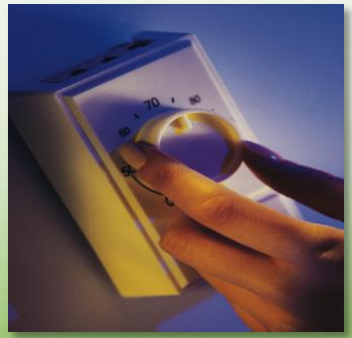
What SMUD is Doing?

- Smart meter installation
- Consumer behavior study
- Demand response
- Distribution automation
- Customer applications
- Technology infrastructure
- Cyber security
- R&D Projects





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Smart Meter Installation

- SMUD has installed over 184,000 meters to date.
- SMUD will install 615,000 Smart Meters by Q1 2012.
- Customers receive a letter & brochure before meter is installed.

- They don't have to do anything, except remove barriers to access.
- There is no need to be home for the meter installation.
- Customers won't notice any big changes at first.
- Customer Satisfaction Level – 95%

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Embarking On A New Journey With Our Customers

- SMUD customers are asking for:
  - More information and new tools to manage energy usage
  - More transparency and control
- We are partnering with customers to:
  - Reduce peak load
  - Improve energy efficiency
  - Promote distributed generation
  - Improve air quality
  - Integrate intermittent renewable resources

- The Smart Grid Project and other SMUD programs allow customers to be part of the energy solution

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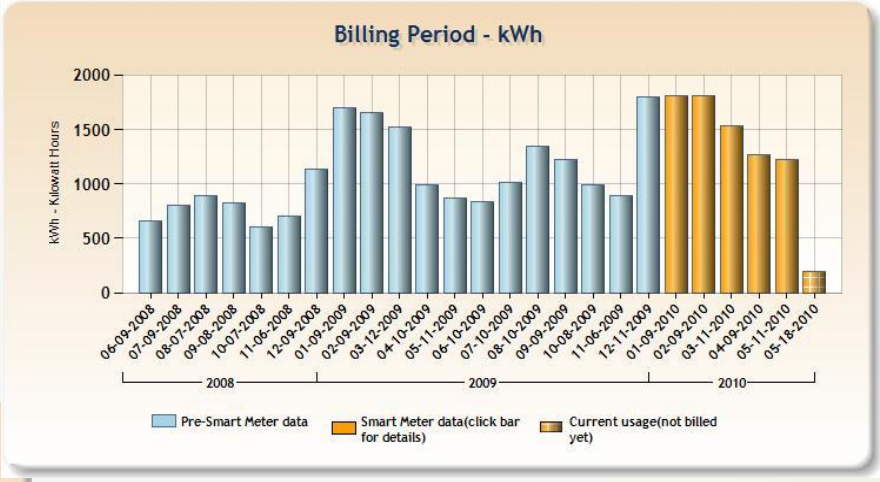
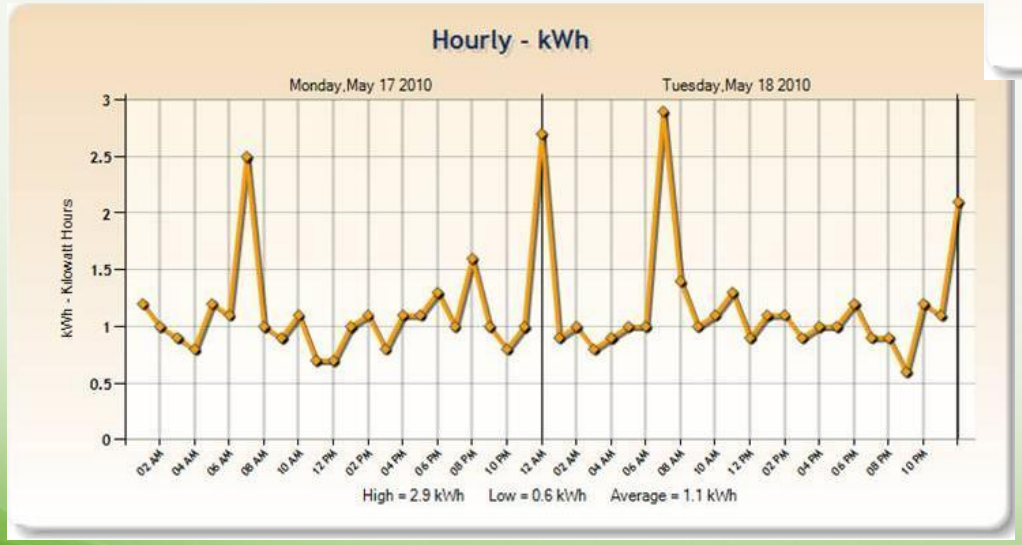
Better information for customers

- **Detailed energy information**
- **Yesterday's usage today**
- **Choices for managing energy**





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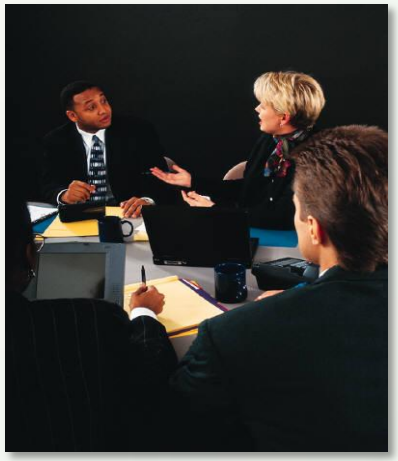
Consumer Behavior Study

- Conduct a consumer behavior study that will be used to develop strategies for rate design, provide information on automation, measure satisfaction by demographics, and measure value for the consumer and SMUD. The effort will provide a statistical measure of the ability to reduce electricity use, reduce peak demand, and determine the likelihood of participation by demographic.



- As part of the consumer behavior study, install a suitable number of programmable communicating thermostats to measure and study behavior.

Training for Smart Meter Presentations

- All Board members trained in presentation and Media
- 48 employees trained to be speakers (2 sessions)
- 103 employees attended Smart Grid-Smart Meter workshops to learn how to respond to questions

Outreach and Education

- **Smart Meter presentations to date (from Oct 2009)**
  - 116 customer presentations
  - 71 internal employee presentations
  - 7 SMUD Board members have given presentations
  - 37 different employees have given presentations
- **Presentations made or offered to:**
  - All six City Councils and the County Board of Supervisors
  - Individual elected officials and their staff.
  - Community Planning Councils
  - Chambers of Commerce
  - Neighborhood Associations
  - Social Civic Clubs (Lions, Rotary, Kiwanis, SIRs, etc)

Note: Not everyone wanted to hear from us! ☺

Feedback on Presentations

Customer Feedback

- Generally positive, like the idea of having choices to control energy use.
- Rate concerns, especially TOU Rates (Will this make my bill go up?)
- Privacy issues (How will the information be kept confidential?)
- Employees impact (What will happen to displaced workers?)
- Customer contact (How much notice and materials in other languages?)
- Customer control (Will SMUD try to remotely control my energy use?)
- Perceived benefits—liked not having meter readers in back yards, SMUD controlling costs, future outage information and new programs for EE.

Feedback on Presentations

Employee Feedback

- Positive, like SMUD “leading the way with technology.”
- Questions on employee impacts, return on investment, privacy concerns, timing for deployment, customer notification and impacts on work areas.

Customer Communications

Pre-Install

- Letter, brochure to customers
  - UPA contact info to make appt. (MED, special needs, etc.)
- News media/PR
- Web
- Community presentations
- Public health and safety organizations notified

Installation

- Door hangers
  - Install success
  - Unable to install- contact UPA
- UPA Contact Center
  - Supports 150 languages
- SMUD Contact Center
- Installer speaking points, FAQ booklet for customers

Ongoing

- Features on smud.org
- Customer Connections
- Community Engagement & events

Future

- Inclusion in advertising campaigns
- Promotions for new programs, services, pricing…

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Customer Experience

Letter & brochure in the mail 10 days before install

Meter installers knock on door, informs customer of install

UPA
Utility Partners of America

Install complete; door hanger left to inform customer

Unable to install to access, safety or other issue. Door hanger with UPA phone number left.

Customer contacts UPA to schedule appt or UPA makes additional attemp.

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Key Differences

- Financing project through O&M savings.
- Using DOE approved Cyber Security plan.
- Paying attention to the customer *EARLY*.
- Anticipating & preparing for problems.
- Contracting for the best customer service.
- Testing meters, asking for installation details.
- Fine tuning high bill process, a live person to take complaints, programs to help pay bills.

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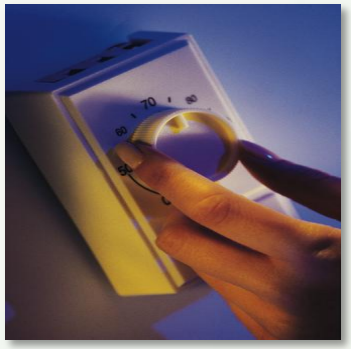
Demand Response



- Install Demand Response Management System software.
- Install up to 10,000 Home Area Network and energy management devices to allow homes and small commercial businesses to participate in direct load control and pricing programs.
- Design and deliver programs for medium & large commercial customers to automatically respond to peak prices by reducing load (Automatic Demand Response).

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Distribution Automation

- Retrofit 35 substations with SCADA.
- Install intelligent switching and monitoring equipment on 90 feeders (line automation).

- Install an advanced operations management system for voltage control and automatic restoration.

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Distribution Automation

- Enhance operating capability and increase the system efficiency.
- Improve reliability (20-25% reduction in the duration of outages.)

- Lower electricity use--flatter load curve. (0.5 MW load reduction)
- Optimize distribution network (6.2MW load reduction)
- Lower transmission & distribution losses (38.1 GHG reduction)

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Customer Applications

- Partner with California Department of General Services, California State University Sacramento, Los Rios Community College District, and County of Sacramento to design, procure and build energy management systems and plug-in electric vehicle charging stations.

- Develop services and solutions for residential and commercial customers that educate, inform, and enable them to access and use the information available through the smart grid system to better manage and control their energy use.

- Develop a pilot program to install up to 180 electric vehicle charging stations for residential customers.

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SMUD's Smart Grid Partners

SMUD is partnering with four public agencies to implement the Smart Grid grant.

Partners

SMUD – Sacramento Municipal Utility District

LRCCD – Los Rios Community College District

DGS – CA, Department of General Services

CSUS – California State University, Sacramento

Sacramento County – County of Sacramento

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Technology Infrastructure

- Install Enterprise Service Bus software platform to allow various systems to communicate; reduces the number, size, and complexity of integration interfaces between systems in order to reduce cost and improve speed of service to the customer.

- Install Customer Relationship Management System software that integrates customer service call center with back office billing system; provides customer representatives a real-time view of energy usage.

Cyber Security

- Perform ongoing cyber security assessments.
- Procure and install tools that will detect intrusions.

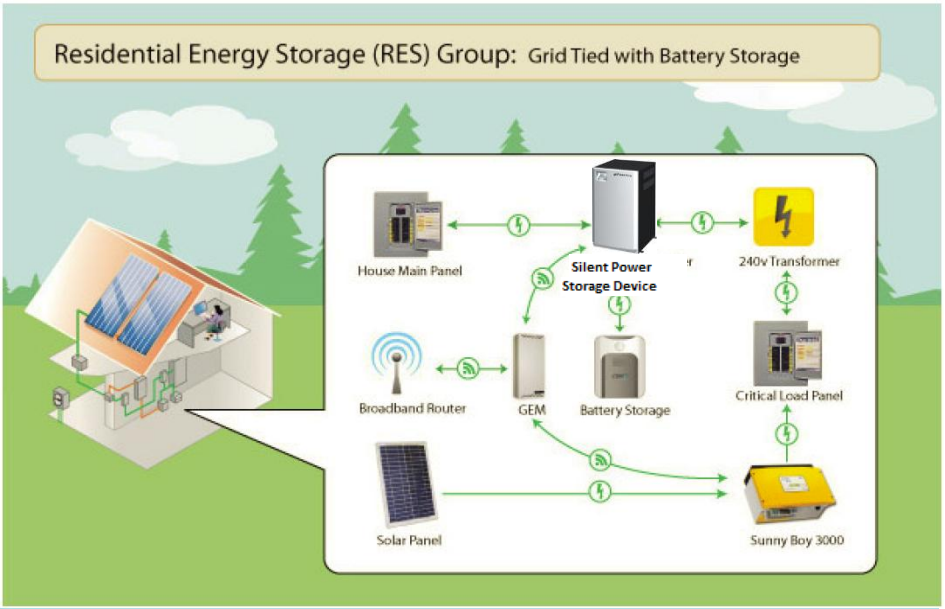
- Extend existing Security Event Information Manager.
- Procure and install vulnerability management tools that will maintain a secure computing environment.

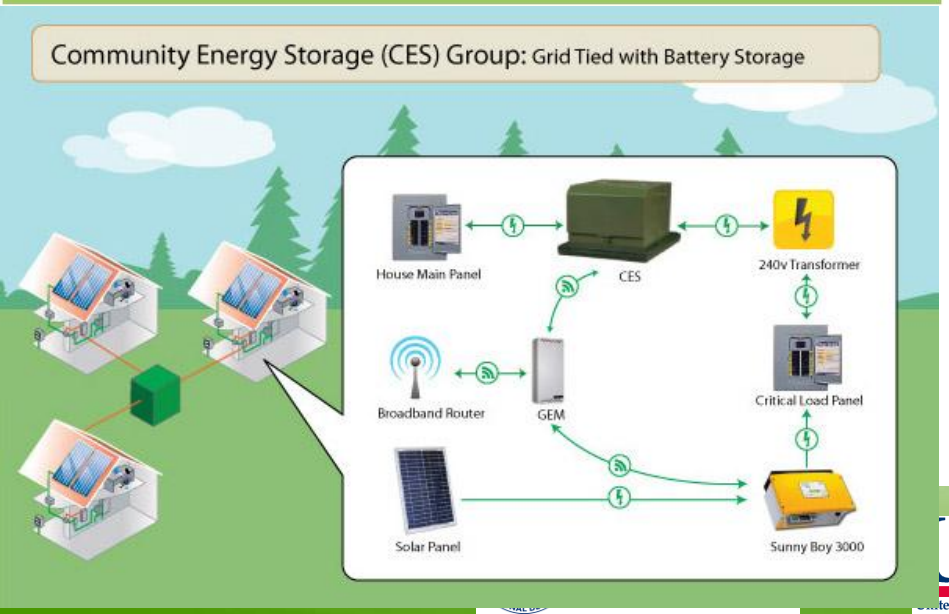
Other Grants and Projects

- Received several other smart grid-related grants
  - Accelerate renewables & waste biomass ($6.9 M)
  - High Penetration PV ($3.0 M)
  - PV and Energy Storage ($4.3 M)
  - CHP for Food Processing ($1.5 M)
  - Micro Grid ($1.6 M)
  - GM and Chrysler
  - Others as partner, not prime ($9.2 M)
- Focus for next three years will be on Stimulus/grant projects
- Smart Grid Plan will be developed to define direction beyond 3 years

SMUD PV & Smart Grid Pilot at Anatolia

ARRA FOA 85 Topic 4: High Penetration Solar Development

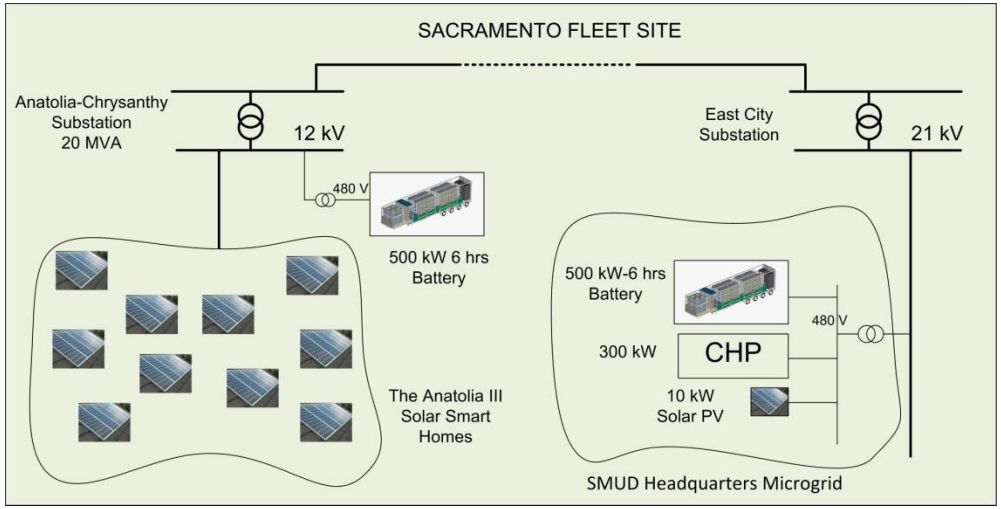




- Partners include GridPoint, SunPower, Navigant, NREL
- Will firm renewables, reduce peak load and improve reliability
- **Installing 15 RES and 3 CES units** in Anatolia SolarSmart^{SM} Homes that currently have 2kW PV systems
- Installing utility and customer portals to monitor PV, storage, customer load
- Sending price signals to affect changes in customer usage
- Developing specification for smart meter/inverter interface to enable management of distributed PV/storage system with AMI
- Quantifying costs and benefits of this storage deployment to gain insights to broader application for SMUD

Storage for Grid Support

ARRA FOA 36 Topic 2.3: Regional Smart Grid Demos



Benefit	Metric	Sacramento Fleet
Peak load reduction	Peak Load	5-10%
T&D loss reduction	T&D Losses	2%
Reduced cost of power interruption	CAIDI/SAIDI/SAIFI improvements	10%
Reduced damages as a result of lower GHG/carbon emissions	MWh served by renewable sources	TBD
Reduced cost to serve peak energy (energy arbitrage)	Hourly marginal cost data	70%

- Partners include Premium Power, National Grid, SAIC, NREL, Syracuse University
- Will firm renewables, reduce peak load and cost to serve peak, and improve reliability
- **Installing two 500kW, Zinc-Bromine, 6 hours systems**
- Operating as a fleet of distribution assets
- Quantifying costs and benefits of this storage deployment to gain insights to broader application for SMUD

Electric Vehicle Impact Study

- Purchasing battery system to test impacts of electric vehicles on distribution transformers
- Using load simulator to simulate reactive and resistive variable loads
- Will apply to most common transformers in the system – 25 kVA, 50 kVA and 75 kVA
- Will mount transformers at the Hedge Substation where our training facility is located

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Conclusions

- Smart grid is the biggest thing to happen to utilities in the past 100 years
- It will likely take 10-20 years to build out
- It will provide significant improvements in grid operations
- It will provide customers with much better control over their energy usage
- It will enable more renewables, higher levels of energy efficiency and better integration of distributed resources
- More R&D is needed

Question? Ideas?

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NDPL

NORTH DELHI POWER LIMITED

Distribution System Overview

Presented by -

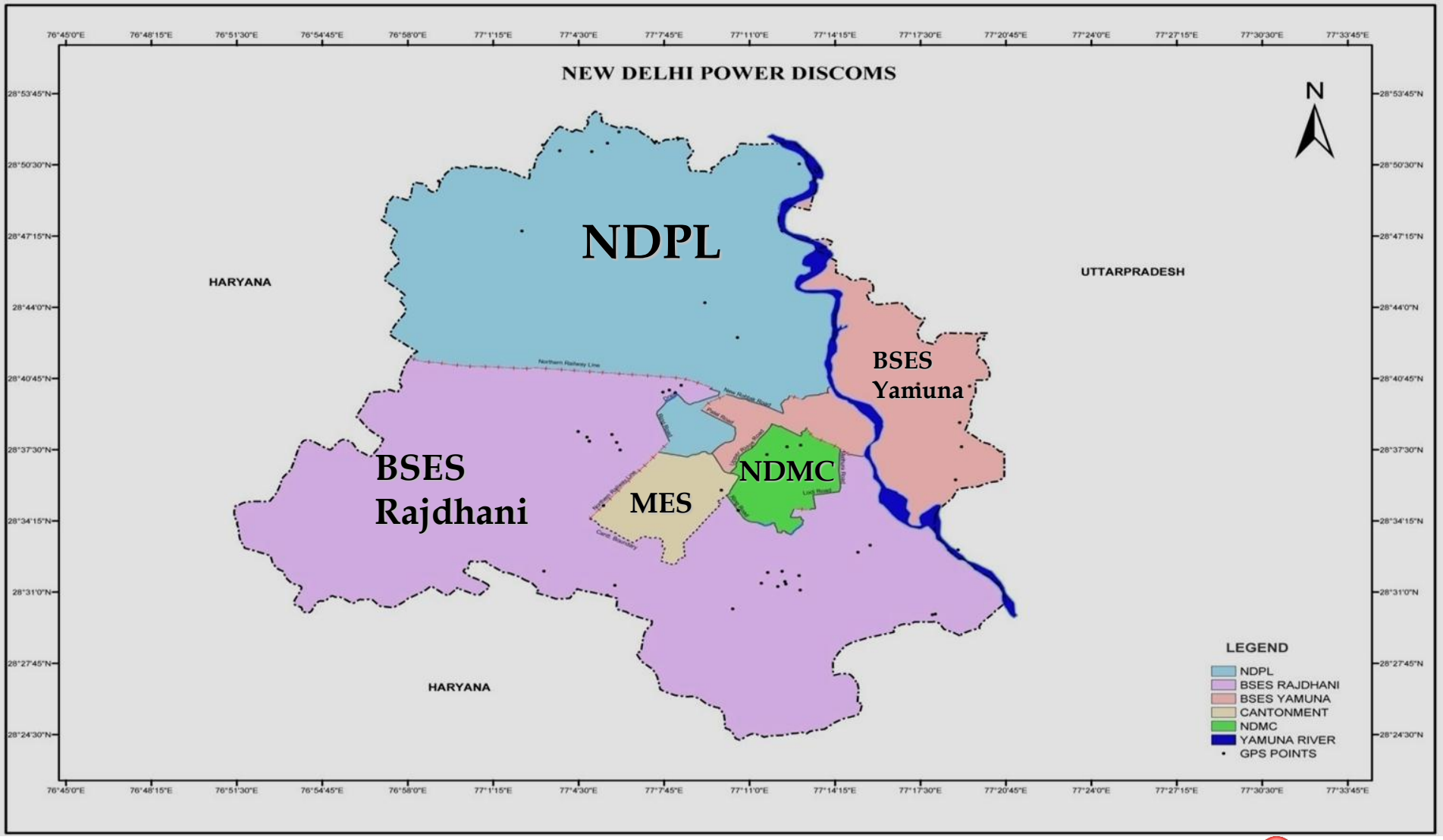
Abhishek Mukhija & Bubber Singh

Wednesday ,23rd March 2011

Contents

- NDPL Distribution System Overview
- Loss reduction programs.
- System planning and design.
- System operation and maintenance.
- Strategies for improving distribution circuits, automation, fault detection, transformer optimization.
- Improved metering and AMR.
- Outlook toward “Smart Grid”.
- Enhancing workforce capabilities.

NDPL Geographic Overview



Brief Introduction

NDPL was incorporated in July 2002 as a JV of Tata Power (51%)and Delhi Government(49%) (PPP model) to take over the power distribution activity of the ailing Delhi Vidyut Board (DVB) in North & North West of Delhi, as part of the sector reform process. NDPL's utility business is governed by the provisions of distribution and retail supply license issued by the DERC for the supply & distribution of Power in North & North West Delhi.

Brief Introduction

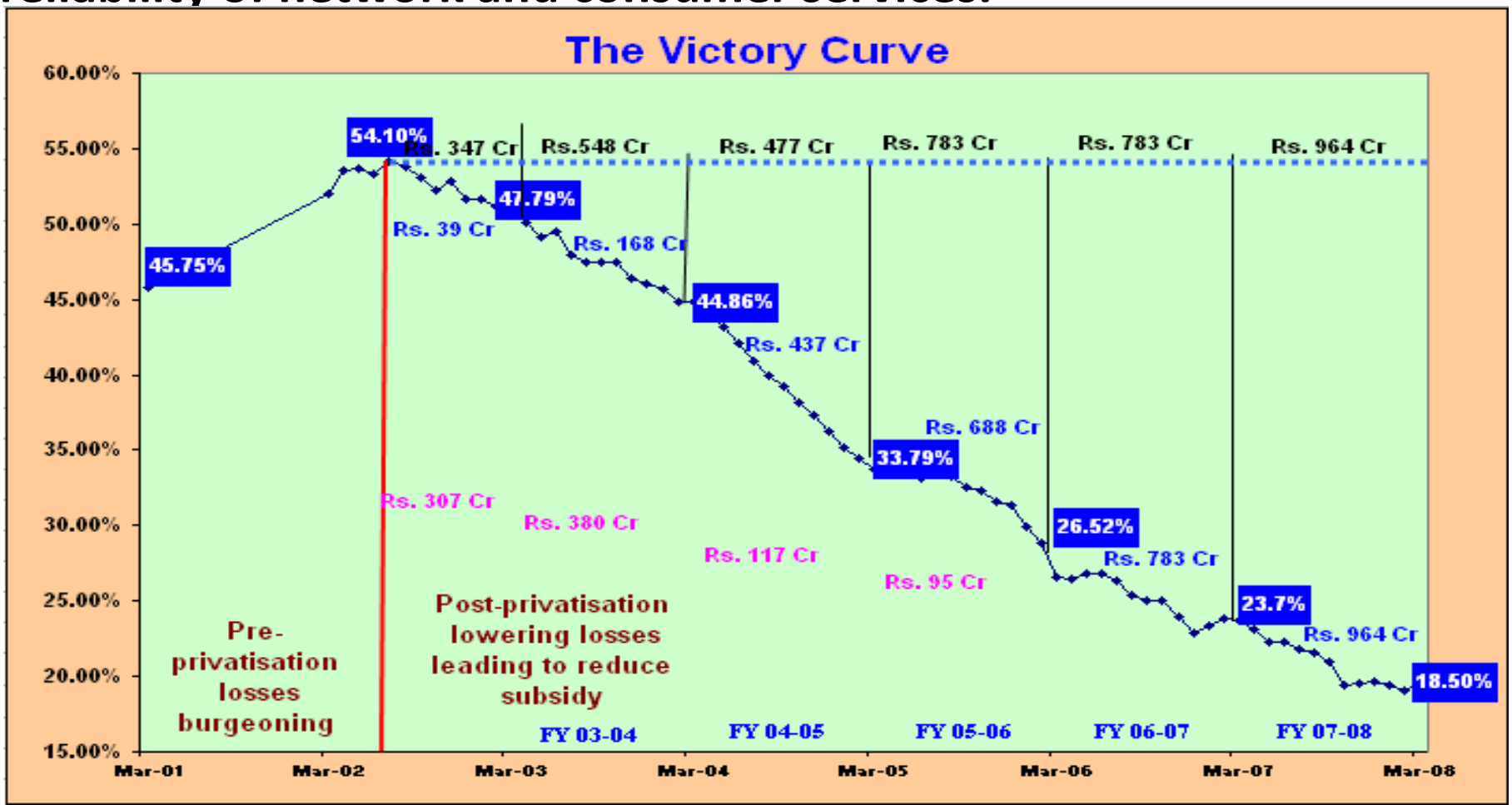
Turnover	INR 2783 crores
Peak Load	1313 MW
Estimated annual energy requirement	6911 Mn. Units
Total registered consumers	1.1 Mn.
Number of employees	3998
Area	510 Sq Kms
Population	5 Mn.
Per Capita Consumption (Units)	1266 (National Average of 612)
Number of consumers per Sq.Kms	2156 (Only Registered)

About NDPL Network

- The present assets base is of INR 3087.90 Crores
- Grid Stations - 58
  - Total - 58
  - Automated and Remotely Operated – 50
- Total ckt 9952 Kms
  - 66KV 276 KM
  - 33KV 427 KM
  - 11KV 3317 KM
  - LV 5932 KM
- Power Transformer
  - Capacity – 3189 MVA Nos. – 149
- Distribution Transformer
  - Capacity – 3125 MVA Nos. - 25000
- Ring Main Units – 2365 Capacitors- 856 MVAR

AT&C loss level Scenario

Over a short span of 8 years NDPL has brought down the AT&C loss level from 53% to 13.5% apart from major improvements in reliability of network and consumer services.



AT&C Loss Reduction Programme

- Replacement of Old electromechanical meters by electrostatic meters along-with old service cable .
- HVDS in Industrial area's (completely revamped & obsolete the conventional distribution system).
- Laying of LT ABC in place of bare LT conductor in highly theft prone area's.
- Reactive Power compensation through consumer awareness programme .
- Use of wedge connectors in place of outdated bolted connectors at Grid Substation / O/H Lines to reduce technical losses .

AT&C Loss Reduction Programme

- Attained N-1 configuration for Power Transformers / 11 KV feeders to achieve optimum technical losses.
- Installed New DT's / Relocation of DT's near of Load Centre.
- Improved number of 11kv / LV feeders with adequate size of conductors.
- Installation of capacitor panel at Grid level ,DT level (APFC) as per system requirement in an optimized way .
- Installation of Amorphous core DT's instead of CRGO type in system.

AT&C Loss Reduction Programmes

- Intra company / Inter Zonal exchange points metered and audited regularly.
- Replacement of old EM meters with Electronic meter.
- No un-metered supply.
- Bringing un-metered to metered category.
- Maximum bills on the basis of reading ,zero provisional billing.
- Effective Disconnection for payment defaulters.
- Ensuring 100% bill distribution through database of correct address ,e-bills, SMS intimation ,soft calling through call centre, spot billing etc.for increasing collection efficiency to 100%.
- 1150 Payment Collection Channels from just 20 in 3 years , average waiting time for consumers gone down many-fold. No queues…
- Introduction of online payment avenues ,ECS ,credit/debit card ,Drop box ,interactive kiosks etc.

Some initiatives to curb losses

- DT wise consumer Indexing.
- Conducting of Energy Audit on each DT/Feeder.
- Evaluation of Loss on each DT.
- Installation of AMR on DT check meters.
- 100% metering of Street Lighting System.
- Split Meters in Theft Prone area particularly in JJ clusters with provision of AMR/Remote metering.
- Pre-paid meters (1 & 3 Phase). In addition to this all Govt. connections up to 45 KW load are being given on pre-paid meters.

Some initiatives to curb losses

- Remote operated LT Switch for Load Shedding.
- Providing franchisees in un-electrified /Theft Prone Area.
- Providing Single Point Delivery Connections in Weekly Bazaar.
- High Priority to HRB(16 KW to 99 KW)/KCG(100 KW to 499 KW/Express consumers (Above 500 KW), with separate group to monitor these consumers .
- Walking sequence of consumers from DTs for proper reading.

System Planning and Design

- System study and load forecasting through CYMEdist .
- Grid Substation Automation System (GSAS) .
- Implementation of GIS .
- Optimum utilization of existing Network and asset.
- Switching schemes made standardized.
- Replacement of Old OCB panel with New SF6 panel and RMU's.

System Planning and Design

- Installation of Auto reclosuer's and Sectionalizes in rural areas as per system requirement in order to reduce the feeder length and improve the reliability.
- Systematic Study of future load growth as well as existing networks to meet the requirement in phased manner i.e. short, medium & long term.
- Integration of GIS-SAP-FAR.
- Implementation of SCADA ,Distribution Automation(DA),DMS and OMS.
- Installation of Capacitor Banks at Grid and DT level ,Implementation of CAP on TAP.

System Operation and Maintenance

- NDPL overall O&M has been grouped based on voltage level's ,66/11 KV & 33/11 KV is grouped into three Area Power Systems (comprising of Grid S/stn's and transmission Lines) and 11 kv downstream n/w into Distribution System which is further divided into 5 circles comprising of 12 districts sub–divided into 3-4 zones each .
- Remote Operation of 50 Grid out of total 58 through SCADA .
- Distribution Automation Implemented in 400 Distribution S/Stn's.
- Extensive Usage of GIS data as backbone for Various system functions.
- Implementation of SAP PMM,PS & MM .
- Implementation of BSC & Annual Maintenance Schedule ,**SAP PMM Driven Maintenance Philosophy** of all maintainable equipment with integration of GIS-SAP-FAR.
- For maintenance of grid S/stn equipments there is a dedicated separate team SMC (Special Maintenance Crew) & SLMC (Specialized Line Maintenance Crew).
- Overhauling, Drying out & Oil filtration of Power transformer at site itself and in-house workshop for DT's.

Strategies for Improving *Distribution Circuits*, Automation, Fault Detection & Transformer Optimization

- Systematic study of all the existing circuits in view point of meeting the future load growth in short , medium & long term .
- Explore all the possibilities of (N-1) plan ,scheme preparation and execute the same in time framed manner .
- Standardization of switching circuits .
- Replacement of OCB's with SF6 RMU and Breaker panels.
- 100% revamping of LV System i.e LT ACB ,MCCB ,LT cable, convert bare conductor to LT ABC cables ,LT Distribution box.
- Remote switching/operation of Street Lights.
- Installation of APFC panels.

Strategies for Improving Distribution Circuits, *Automation*, Fault Detection & Transformer Optimization

- Automation and un-manning of 50 Grid S/Stns out of 58.
- Implementation of state of the art technologies i.e SCADA, DMS, DA ,OMS,AMR,GIS.
- 100% Replacement of OCB's with SF6 RMU and Breaker panels along with motorization of the same .
- FPI installation at each end of feeder cable .
- Automatic Meter reading AMR.
- Installation of APFC panels.

Strategies for Improving Distribution Circuits, Automation, *Fault Detection* & Transformer Optimization

- FPI installed to give the exact section of faulty feeder, with the help of DA the supply is restored through alternate source and isolate the faulty section within 1 minute.
- FLC (Fault Locating Cell) pin point the fault location and maintenance crew maintain the circuit ,signature analysis of the sick underground cable done by FLC.
- Thermo scanning through IR camera's to locate HOT spot in the network.
- Accurate hierarchical protection system , replacement of old Electromechanical relays to Electrostatic relays.
- Application of Auto- reclosure and Sectionalizers.

Strategies for Improving Distribution Circuits, Automation, Fault Detection & *Transformer Optimization*

- N-1 at Grid Level achieved for PTR's .
- Installation of TMU (Transformer Monitoring Unit's) in Grid S/Stns to capture online real time PTR data.
- Erection of New Grids and installation of DT's near to load centre.
- Introducing Phase sequencing and Parallel operation of Power Transformers at Grid S/stn's .
- Induction of new DT rating's i.e 160 KVA & 315 KVA.

Improved Metering

Tampering in Electro Mechanical Meter.

- Loosening the connections of pressure wire and current wires.
- Reversal of Phases on secondary side of CTs.
- By providing wire in CT to make reverse Polarity of Circuit.
- Making Meter Sticky through body hammering.
- By providing thin PVC film through Window Glass to stop the dial disc.
- Tilting the meter & meter box.
- Use of CTs not compatible with CT Meter.
- Mistake in MF.

Action taken for improvement in CT Metering

- Installation of Electronic meters & replacement of old electromechanical meters(100%Electronic meters installed with AMR/Modems).
- Specially designed boxes with inbuilt CTs, No provision of TTB/Fixed terminals.
- Fixing of Standard CT meters in boxes at MMG back office.
- Sealing of Meter Terminals at MMG back office.
- Installation of Modem with accessories inside the meter box.

Action taken for improvement in CT Metering

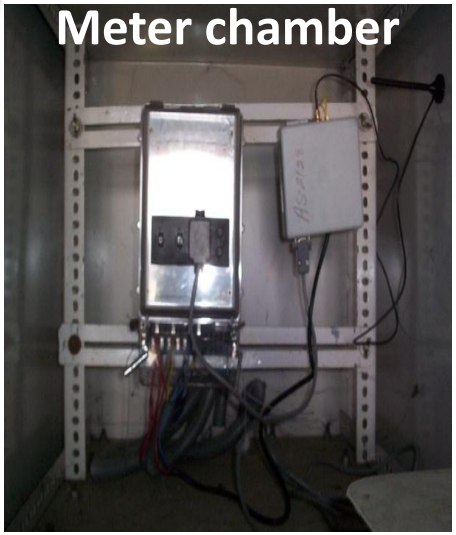
- Pre survey of site for required length of service line by Engineers.
- Installation of meters in presence of Site Engineers.
- Installation of standard size of armored service cables .
- No mismatch in CT meter & CT specification i.e. MF remains 1.
- AMR in 100% cases & analysis of data to check abnormality/tampering.
- Pre-testing of meters & CT box in NABL accredited NDPL Lab& Accuracy-check of all meters on site.

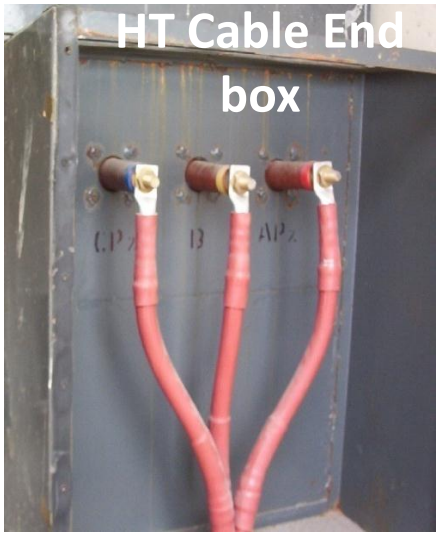
Single Phase Whole Current Electronic or Static Energy meter

Liquid Crystal Display (LCD) in static meters

Three Phase LT CT Operated Electronic Energy Meter

Indoor type HT Metering Cubicle with inbuilt resin cast CT & PT





Outdoor CT/PT Installation

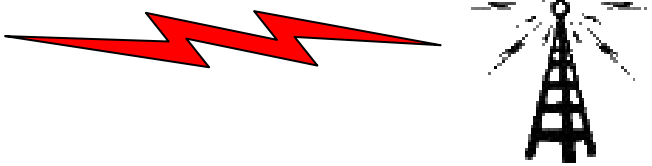
Standardizing Ranges, Rating & Accuracy Class

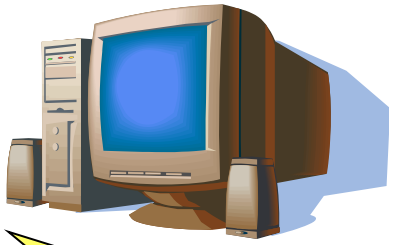
Category of consumers	Type of Meter Installed	Class	Rating of Conventional Meters Installed	Applied Load Factor
Domestic sector	Single phase	2	5-30A	Upto 5 Kw
	Three Phase Whole current	2	10-60 A	6-10 Kw
	Three Phase CT Operated	1	3x (30-60)A	11-15 Kw
			3x(60/5)A	15-37 Kw
			3x(100/5) A	37-50 Kw
			3x(200/5) A	50-100 Kw
Commercial Sector	Single phase	2	10-60 A	Upto 5 Kw
	Three Phase Whole current	2	20-60 A	6-10 Kw
	Three Phase CT Operated	1	3x (30-60)A	11-15 Kw
			3x(60/5) A	15-37 Kw
			3x(100/5) A	37-50 Kw
			3x(200/5) A	50-100 Kw
Small Industrial Power	Single phase	2	20-60 A	Upto 10 Kw
	Three Phase CT Operated	1	3x(60/5) A	11-37 Kw
			3x(100/5) A	37-50 Kw
			3x(200/5) A	50-100 Kw
Bulk supply (LT)	LT Trivector Meter	1	3x(200/5) A	Above 100 KW
	(Static Type)		3x(300/5) A	
			3x(400/5) A	
Bulk supply (HT)	HT Trivector Meter	0.5		Above 100 KW
	(Static Type)			

Automatic Meter Reading

- Meter with data transfer capabilities.
- Software for data collection.
- Modem
- Transmission media.

Transmission medium





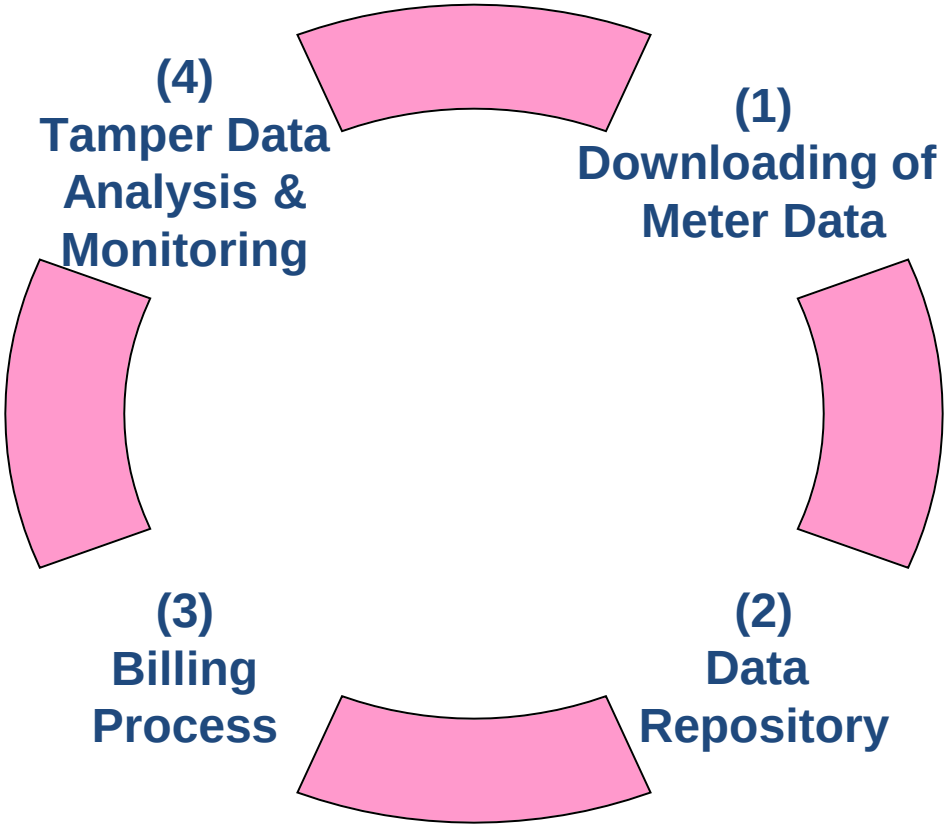
Utility Company Computer

MODEM unit

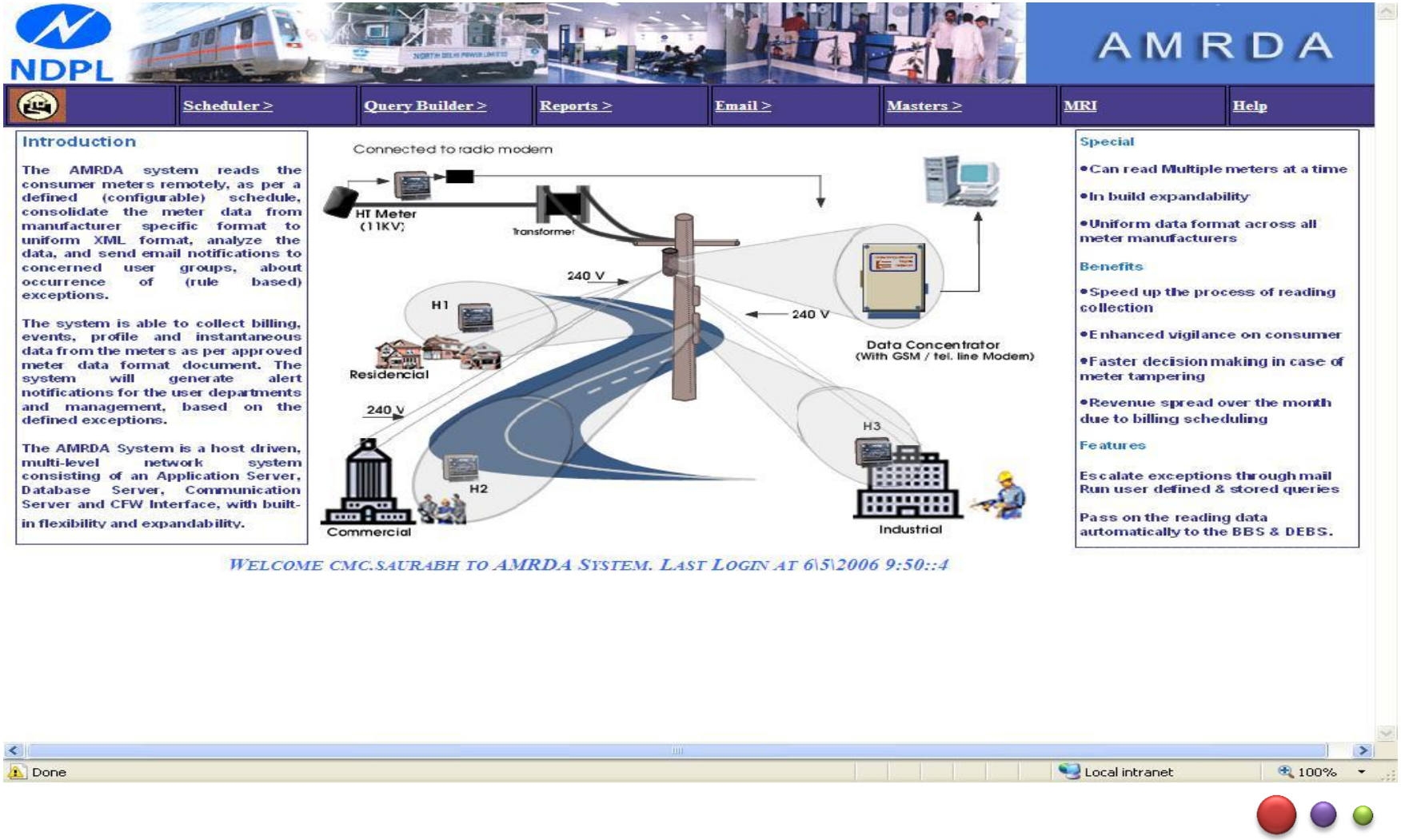
MODEM Unit

Meter reading instruments - CMRI

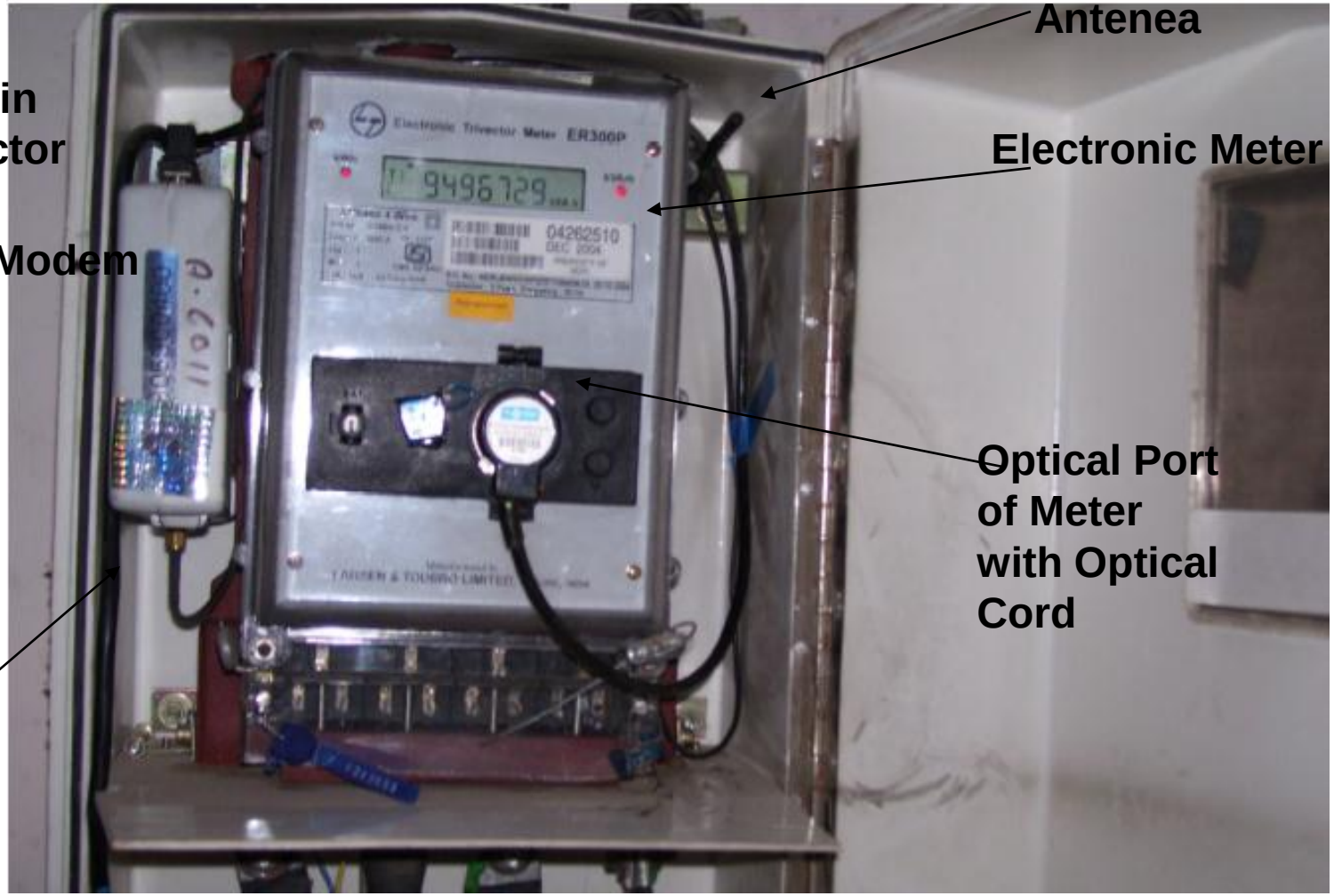
AMRDA CYCLE


(1)
Downloading of
Meter Data
(2)
Data
Repository
(3)
Billing
Process
(4)
Tamper Data
Analysis &
Monitoring

AMRDA


NDPL
AMRDA
Scheduler >
Query Builder >
Reports >
Email >
Masters >
MRI
Help
Introduction
The AMRDA system reads the consumer meters remotely, as per a defined (configurable) schedule, consolidate the meter data from manufacturer specific format to uniform XML format, analyze the data, and send email notifications to concerned user groups, about occurrence of (rule based) exceptions.
The system is able to collect billing, events, profile and instantaneous data from the meters as per approved meter data format document. The system will generate alert notifications for the user departments and management, based on the defined exceptions.
The AMRDA System is a host driven, multi-level network system consisting of an Application Server, Database Server, Communication Server and CFW Interface, with built-in flexibility and expandability.
Connected to radio modem
HT Meter (11KV)
Transformer
240 V
240 V
H1
Residencial
240 V
H2
Commercial
Data Concentrator (With GSM / tel. line Modem)
H3
Industrial
Special
•Can read Multiple meters at a time
•In build expandability
•Uniform data format across all meter manufacturers
Benefits
•Speed up the process of reading collection
•Enhanced vigilance on consumer
•Faster decision making in case of meter tampering
•Revenue spread over the month due to billing scheduling
Features
Escalate exceptions through mail
Run user defined & stored queries
Pass on the reading data automatically to the BBS & DEBS.
WELCOME CMC.SAURABH TO AMRDA SYSTEM. LAST LOGIN AT 6\5\2006 9:50::4
Done
Local intranet
100%

Electronic Meter and modem with Accessories

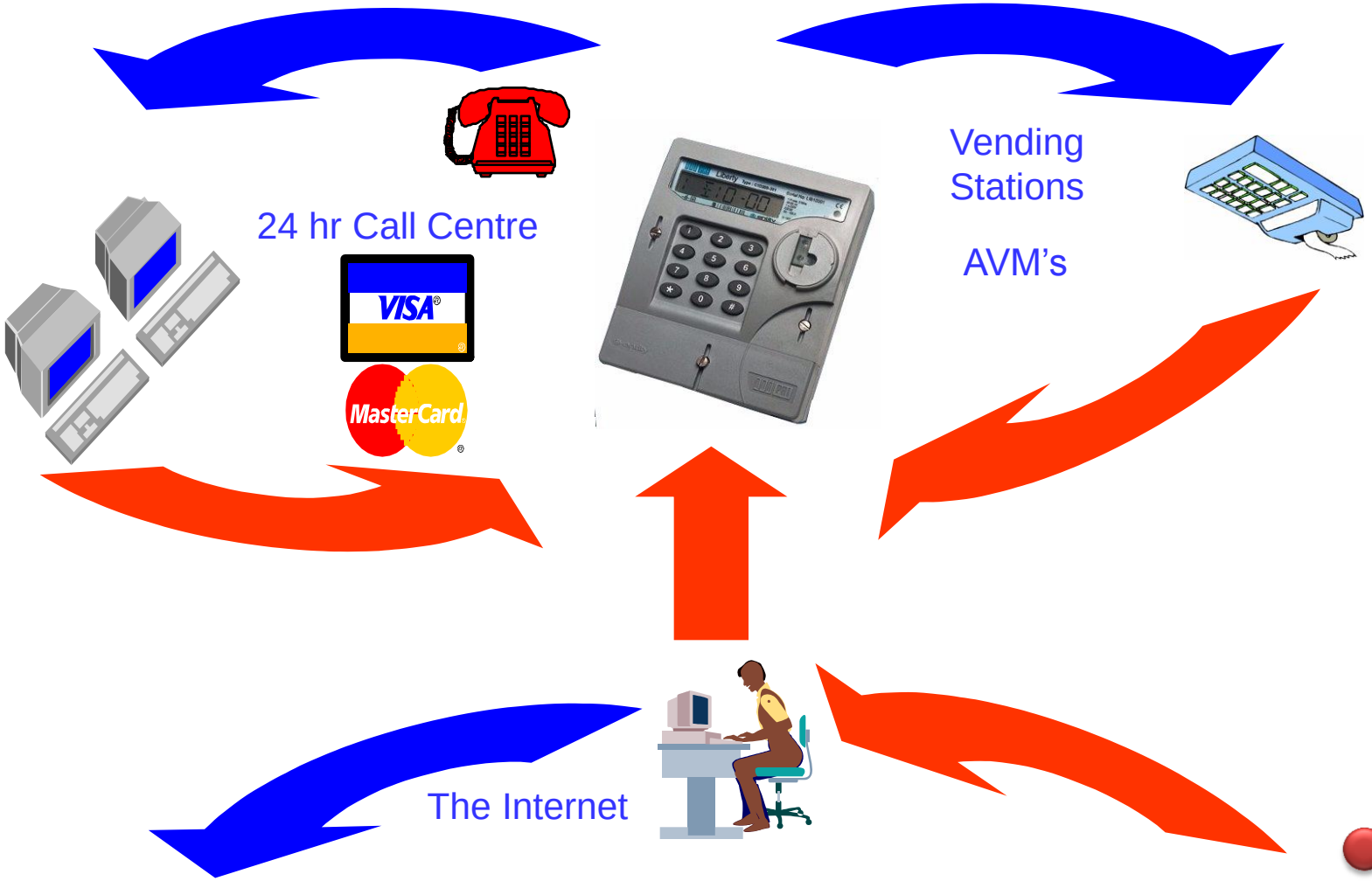


Prepaid Metering

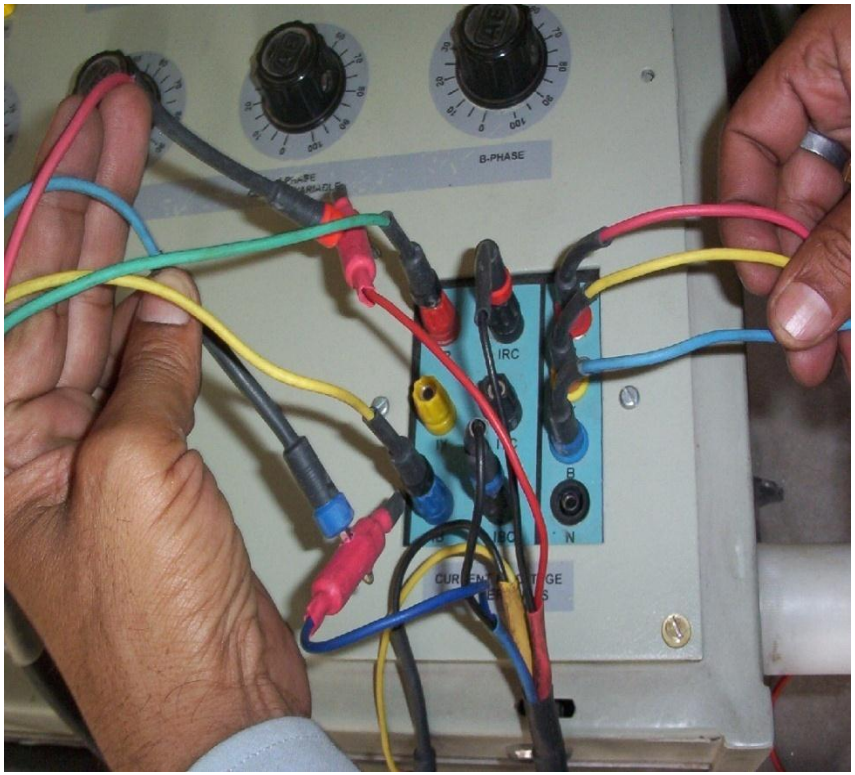
- **Traditional Metering**
  - ➢ Use electricity
  - ➢ Read meter
  - ➢ Prepare invoice
  - ➢ Collect money
  - ➢ Warn late payers
  - ➢ Disconnect non-payers

- ➢ **Pre-Payment Metering**
  - ➢ Collect money
  - ➢ Transfer credit to meter
  - ➢ Use electricity

PREPIAD METER-Keypad Vending



Testing & Calibration



Outlook toward “Smart Grid”

What is Smart Grid?

“SMART GIRD” is a set of technology implementation that uses advanced sensing, metering, communication, control, computation and reporting technologies to facilitate generation and distribution of electricity more effectively, economically and securely to achieve desired balancing of supply and demand.

Smart Grid : An evolving set of concepts and not a set of formulae.

SMART GRID CHARACTERISTICS . . .

The Smart Grid will:

- Enable active participation by consumers
- Accommodate all generation and storage options
- Enable new products, services and markets
- Provide power quality for the digital economy
- Optimize asset utilization and operate efficiently
- Anticipate & respond to system disturbances (self-heal)

The following technologies are required for implementing Smart Grid System-

- *Advanced Metering Infrastructure (AMI)*
- *Grid Substation Automation System (GSAS)*
- *Supervisory Control and Data Acquisition (SCADA)*
- *Geographical Information System (GIS)*
- *Distribution Management System (DMS)*
- *Distribution Automation (DA)*
- *Outage Management System (OMS)*
- *Communication Infrastructure*
- *Home Automation*
- *Demand Side Management (DSM)*

Enhancing Work force Capabilities

The workforce of NDPL is an amalgamation of employees from erstwhile DVB and new recruits after takeover. NDPL's workforce comprises of 3998 employees. Certain non persistent, fluctuating volume and low value added works e.g. network maintenance, consumer documentation, meters installation & reading, call centre, security, house-keeping etc. have been contracted to specialized agencies who are more cost effective and are governed by 'Performance / SLA based Contracts'.

NDPL is an equal opportunity employer and encourages diversity in experience, skills and background .60% of the employees are represented by a Union whose members are democratically elected.

NDPL has state of the art in house training centre "CENPEID" which is also undertaking DRUM training programs for executives from all other utilities across country.

NDPL is certified for an OHSAS 18001 System which ad-dresses health and safety related requirements .It is also the only utility to be certified for SA 8000:2008(addressing Social Accountability). Key workforce benefits are medical, scholarship, education sponsorship, car scheme, celebrations, benevolent scheme, etc.

Enhancing Work force Capabilities

Segment	Sub Segment	No of PG/Proffessionals	Key Expectations-Engagement Factors	Key Expectations-Satisfaction Factors
Executives	Sr. Mgmt (72)	72	Organisation pride	High-end exposure
			Concern for Customers	Work-life balance
	Middle Mgmt (57)	55	Empowerment	Competitive compensation
			Development & growth	Teamwork & cooperation
	Jr. Mgmt(1074)	750	Senior-subordinate relationship	Working conditions
			Reward & Recognition (R&R)	Avenues for higher education
Non Executives	Supervisor (789)	100	Avenues for higher education	Communication
			Reward & Recognition (R&R)	Working conditions
	Workmen(1933)	315	Organisation pride	Industrial Relations
			Job content (enrichment)	Working conditions
BA Employees	(Under direct supervision) (290)	190	Job/Role Clarity	Statutory compliances
			Working Condition	Training

Enhancing Work force Capabilities

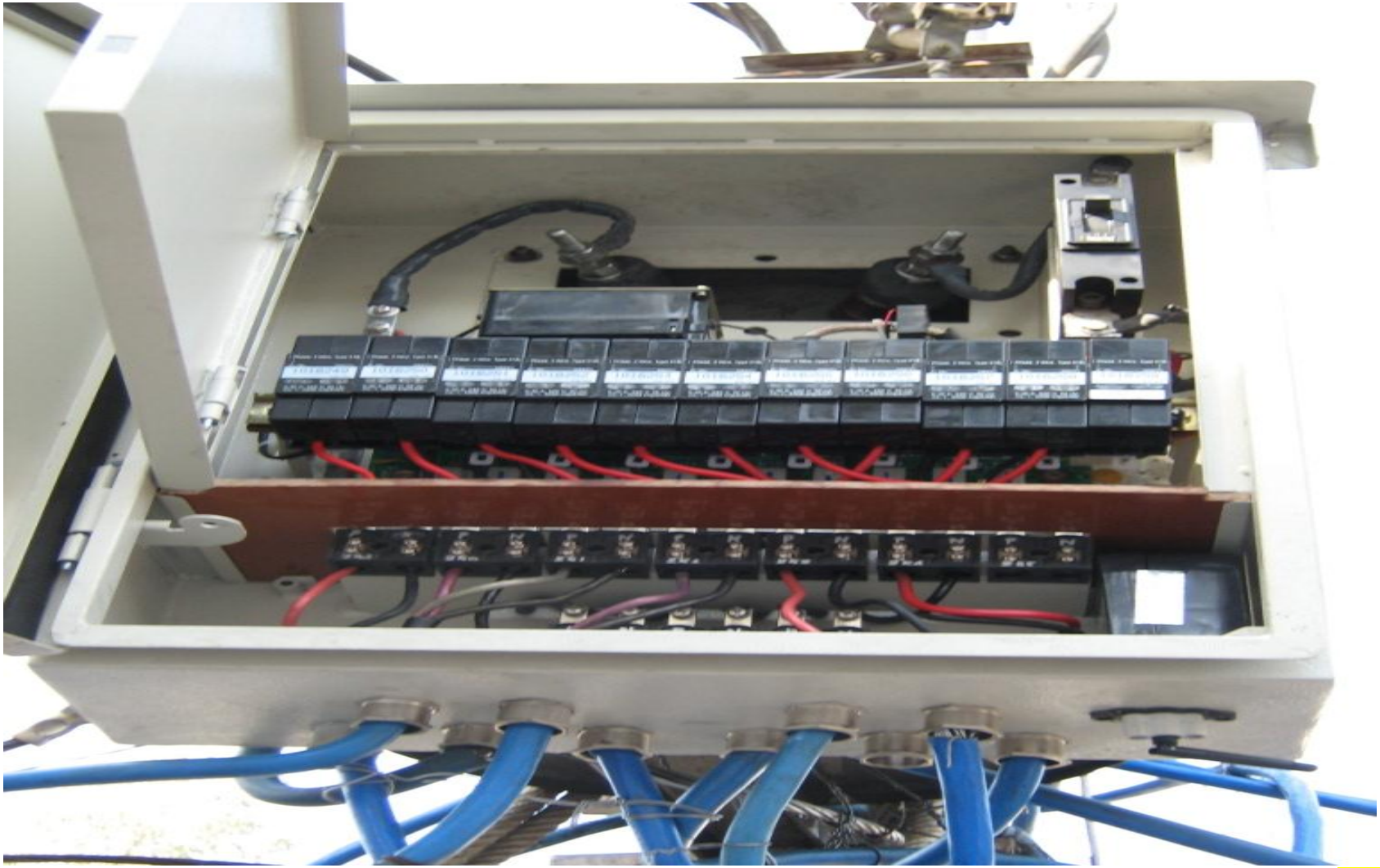
Various opportunities/platforms have been created for employee engagement with a focus towards improvement in system and achieving organizational goals .

Some of them are :

- SHINE Systematic and Holistic Improvement initiatives at NDPL through Employee Engagement.
- Knowledge sharing , Seekh Sessions .
- Six Sigma approach .
- Quality Circles .
- Innovation platforms :TATA Innoverse , Ndpl-Innoverse
- Energy Clubs by Corporate Sustainability Group .
- Various Functional , Managerial and other Trainings are being organized.
- Celebrating Safety week ,Ethics week ,Environment Week etc.

Thanks!

Split Metering Unit fixed on HVDS Transf. with remote reading facility



The *major cause for loss* of revenue is due to lack of seriousness in ensuring effective installation practices

Before

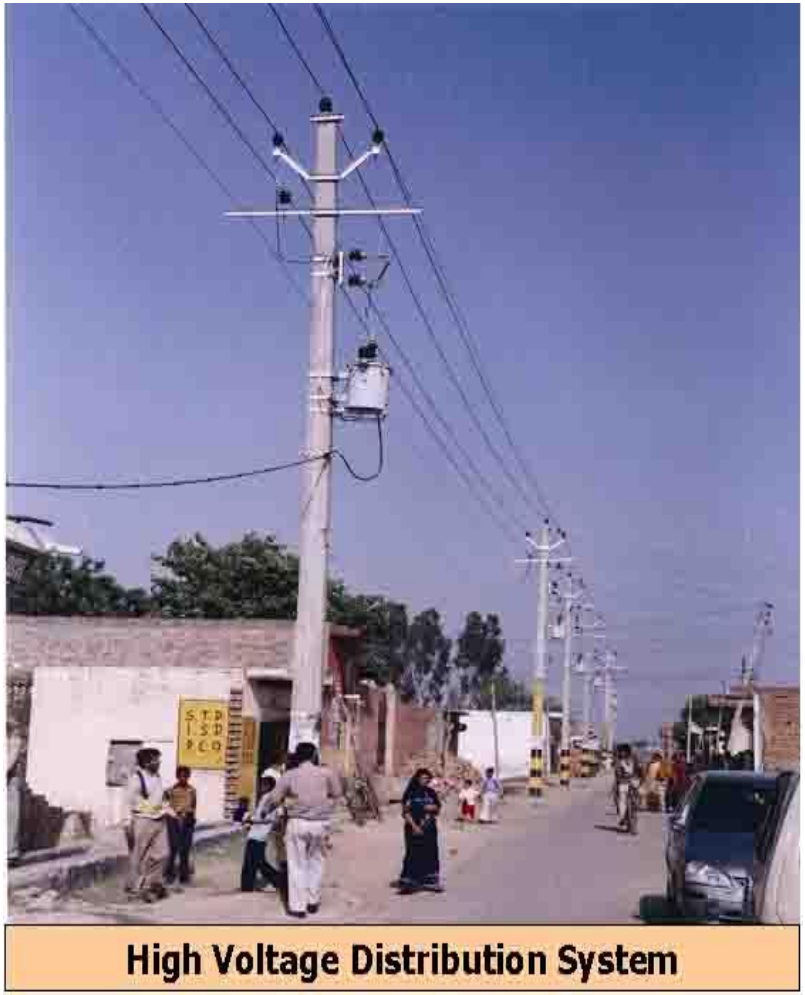
After

Aesthetic INSTALATION -Proper Bus bar arrangement to avoid direct theft.

Project Last Mile –LT pole cleaning….

Pole Cleaning Project

- Last Mile in Power Distribution

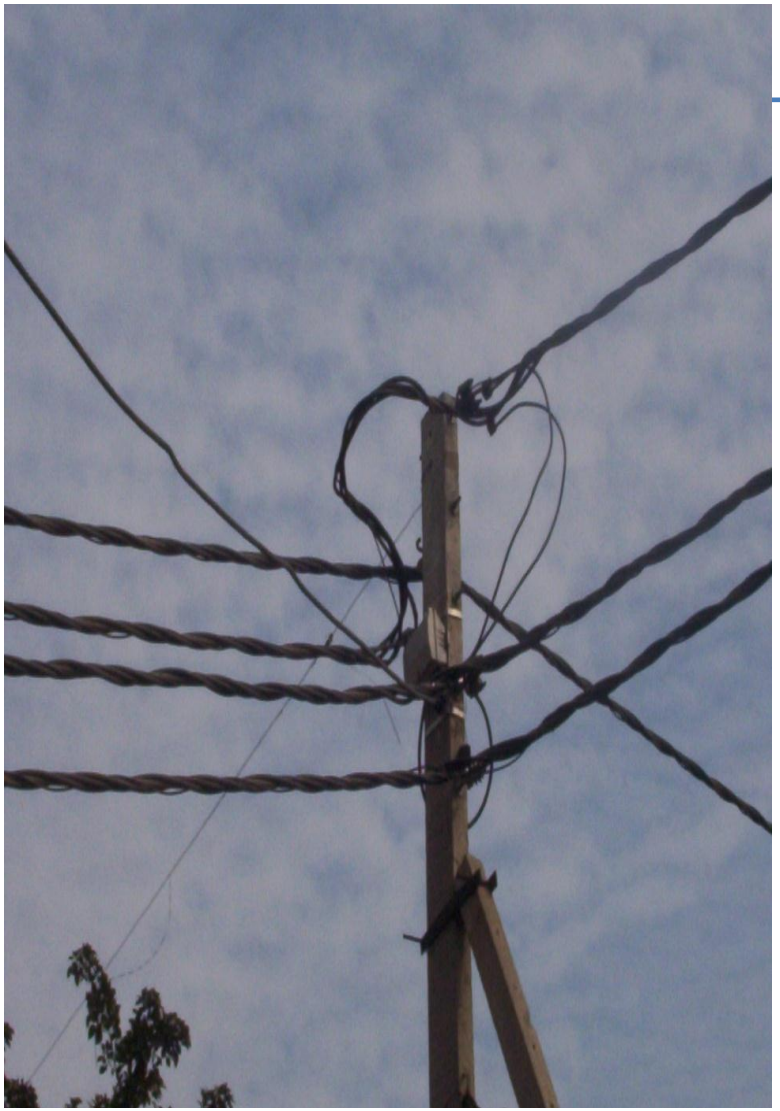


High Voltage Distribution System

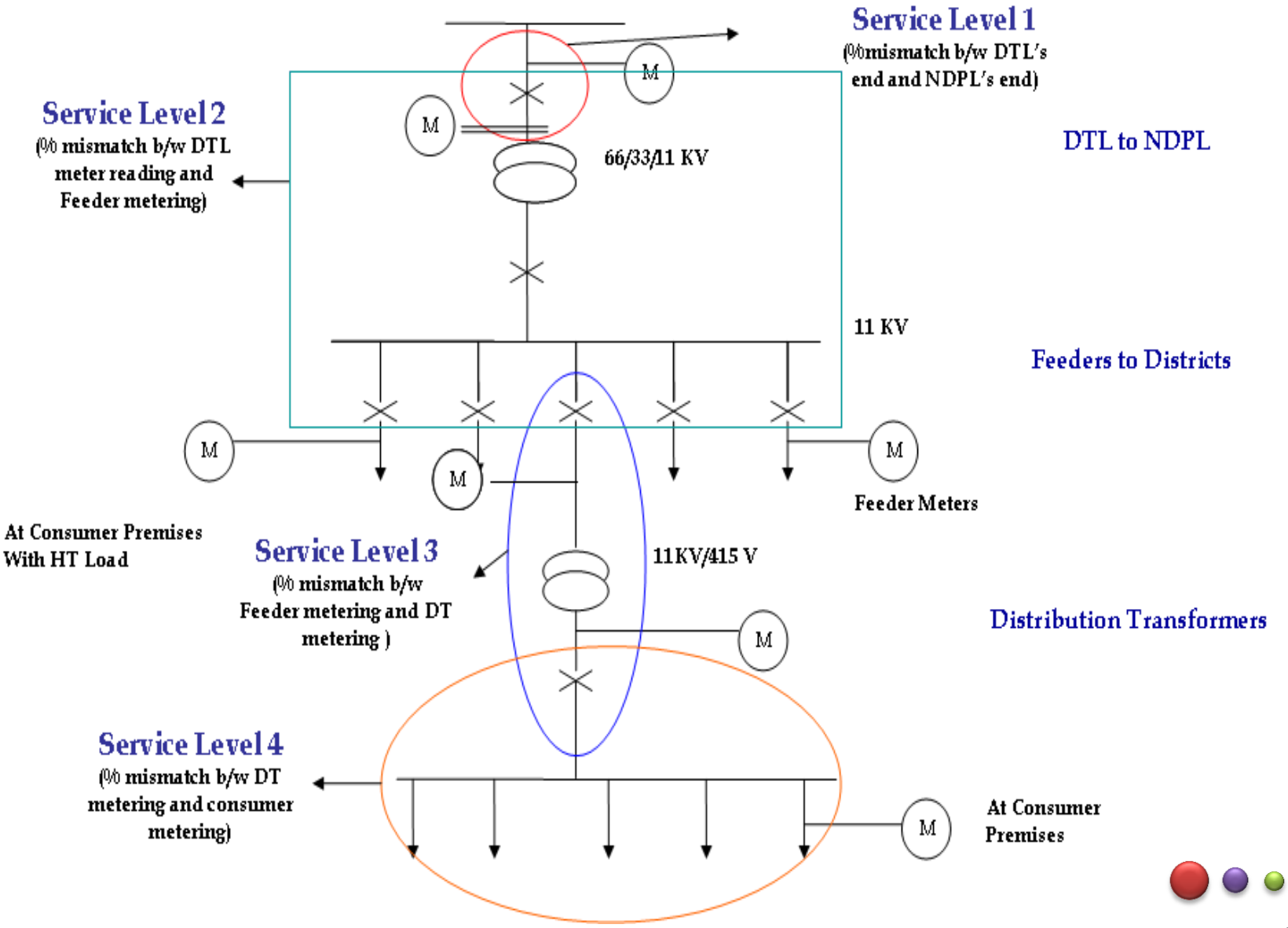
History makes way for the future…

Network Deliverance: Remote Operation of Street Light

LT ABC Installation



ENERGY AUDIT AND ACCOUNTING



CONDITION OF 11 KV SWITCHGEARS AS INHERITED ….(Before)

Circuit Breakers as inherited

NEWLY INSTALLED STATE OF

11 KV SWITCHGEARS.. (After)

Newly Installed State of Art VCB

11 KV AUTO RECLOSURE

Some NDPL Facilities

Fully networked Consumer Care Centers & Call Centre

Power Transformer's at NDPL

"Asset Management through GIS-SAP-FAR Integration"

Planning for new assets happens through the CRM, Network Analysis Tools and SAP applications. Thereafter the new asset creation is through SAP. GIS is populated with the existing and new assets. Maintenance of assets is controlled SAP's Plant Maintenance Module (SAP-PMM). The Fixed Asset Register (FAR) resides in SAP's Fixed Asset Module (SAP-FAM). The interfaces between each of those IT applications were manual and therefore each asset related transaction requires several manual updations of databases. Leading electricity Utilities have implemented all of those applications and continuously struggle in keeping all the databases synchronized because of the manual interfaces and same were true for NDPL also.

The main reasons for wrong identification of the Assets were

1. Asset description and quantity appearing in FAR is different from that of the field as those were defined by different user group.
2. It was also observed that some of the assets appearing in FAR were already retired though the same was available in field physically.
3. Asset Physical Location appearing in FAR is different. There is no process of flow of information about the movement of Asset to Finance for necessary Updation in FAR.

Analysis:

The above factors triggered to develop an innovative process of synchronization which will interlock GIS ID, Equipment Id & Asset Id to avoid the mismatch in any of the system and hence to have better control on the following business model:

Asset Management , Capital Expenditure Management , Operation & Maintenance Management, Commercial Management , Outage Management System.

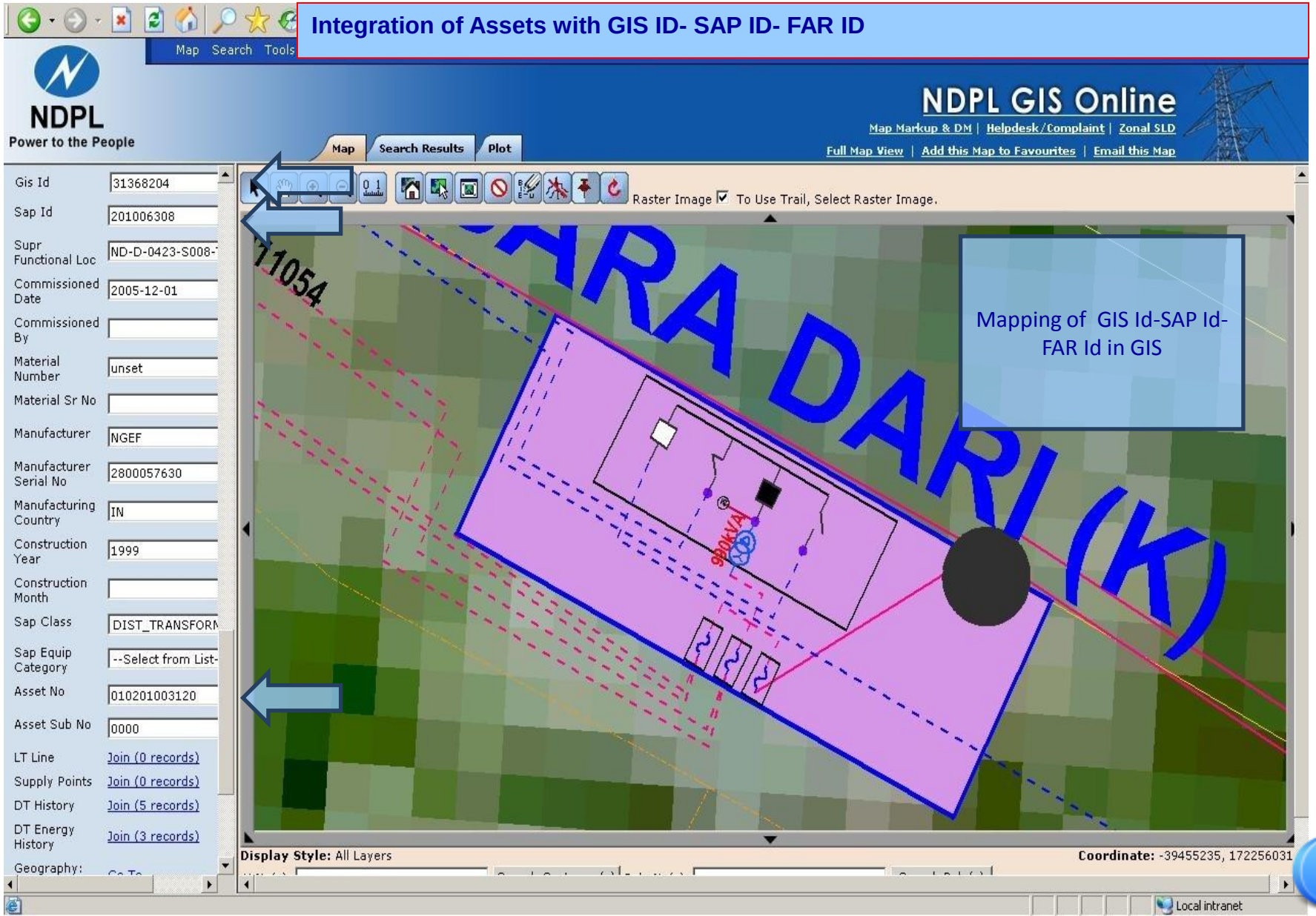
To overcome the above challenges, the innovative solution came to integrate all the Assets with GIS ID- Equipment ID – Asset ID through GIS-SAP integration. The following activities were carried out to integrate the above:

1.Physical verification of all assets through field survey and assign of GIS ID from GIS system.
2.Capture of equipment details through physical verification and assign of Equipment ID by creating / linking Equipment number in SAP (PM Module) system.
3.Through equipment details, assign Asset ID by linking Asset number from Fixed Asset Register in (SAP) system.

For all Assets, GIS ID-Equipment ID-Asset ID is interlocked in all business system using middle ware “SBI integrator” which integrates GIS-SAP. Any change in any business system triggers the event in other and restrict the users to carry out any further action unless it is done in other system. Hence, a systematic process has been innovated for carrying out business process as mentioned above. This is first of its kind in electric distribution utility.

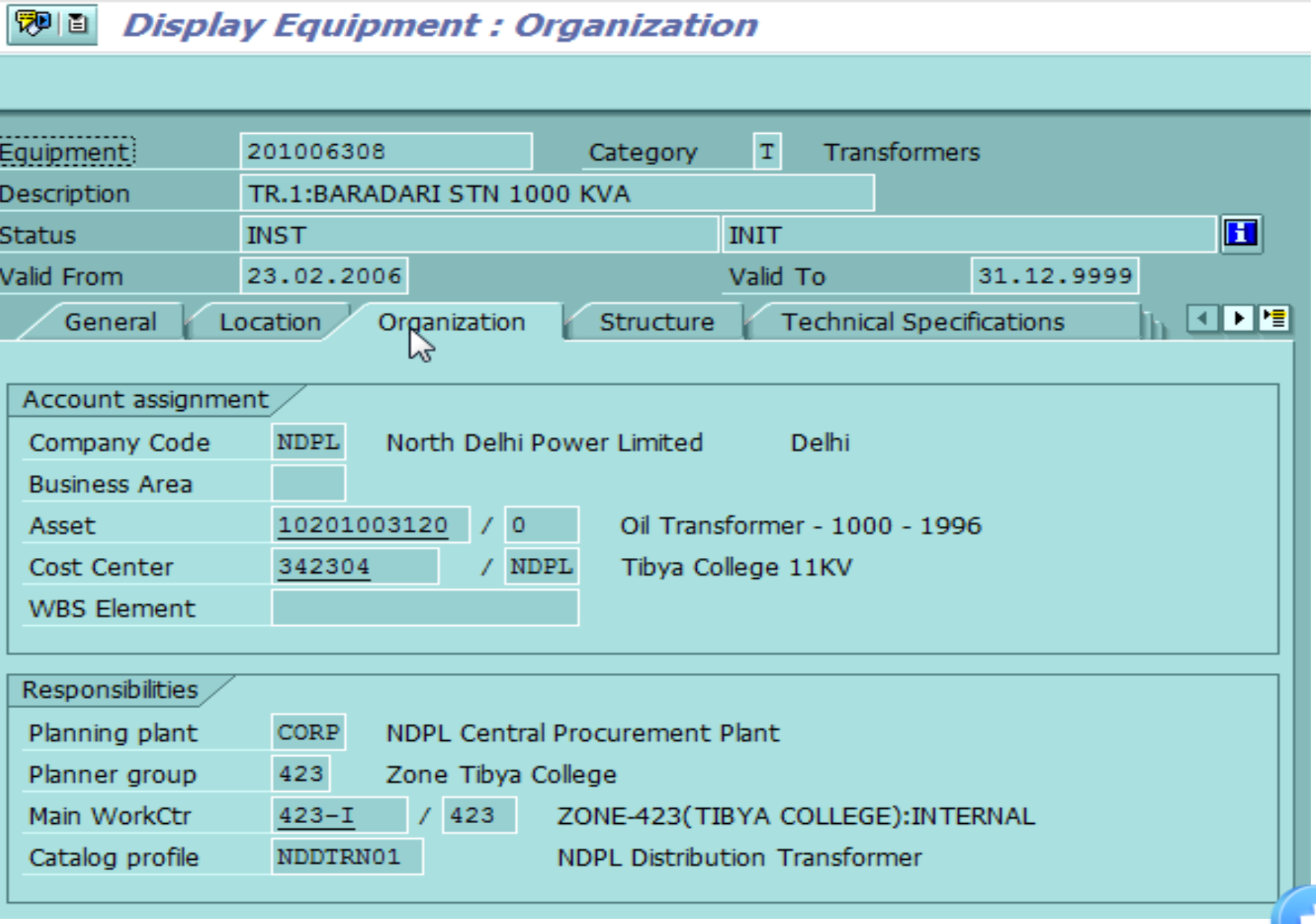
"Asset Management through “GIS-SAP-FAR Integration”

Integration of Assets with GIS ID- SAP ID- FAR ID



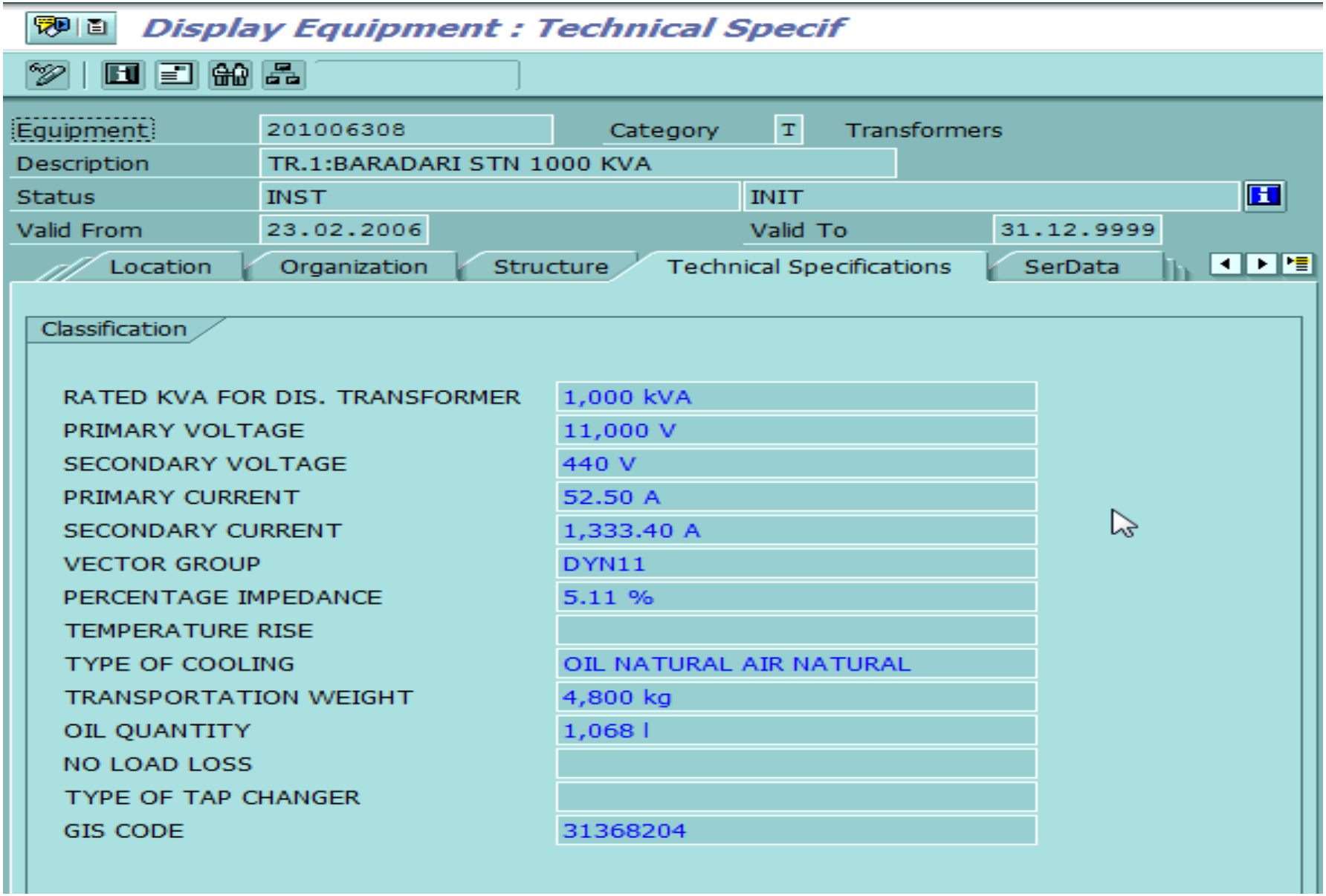
"Asset Management through "GIS-SAP-FAR Integration"

NDPL



"Asset Management through “GIS-SAP-FAR Integration”

NDPL



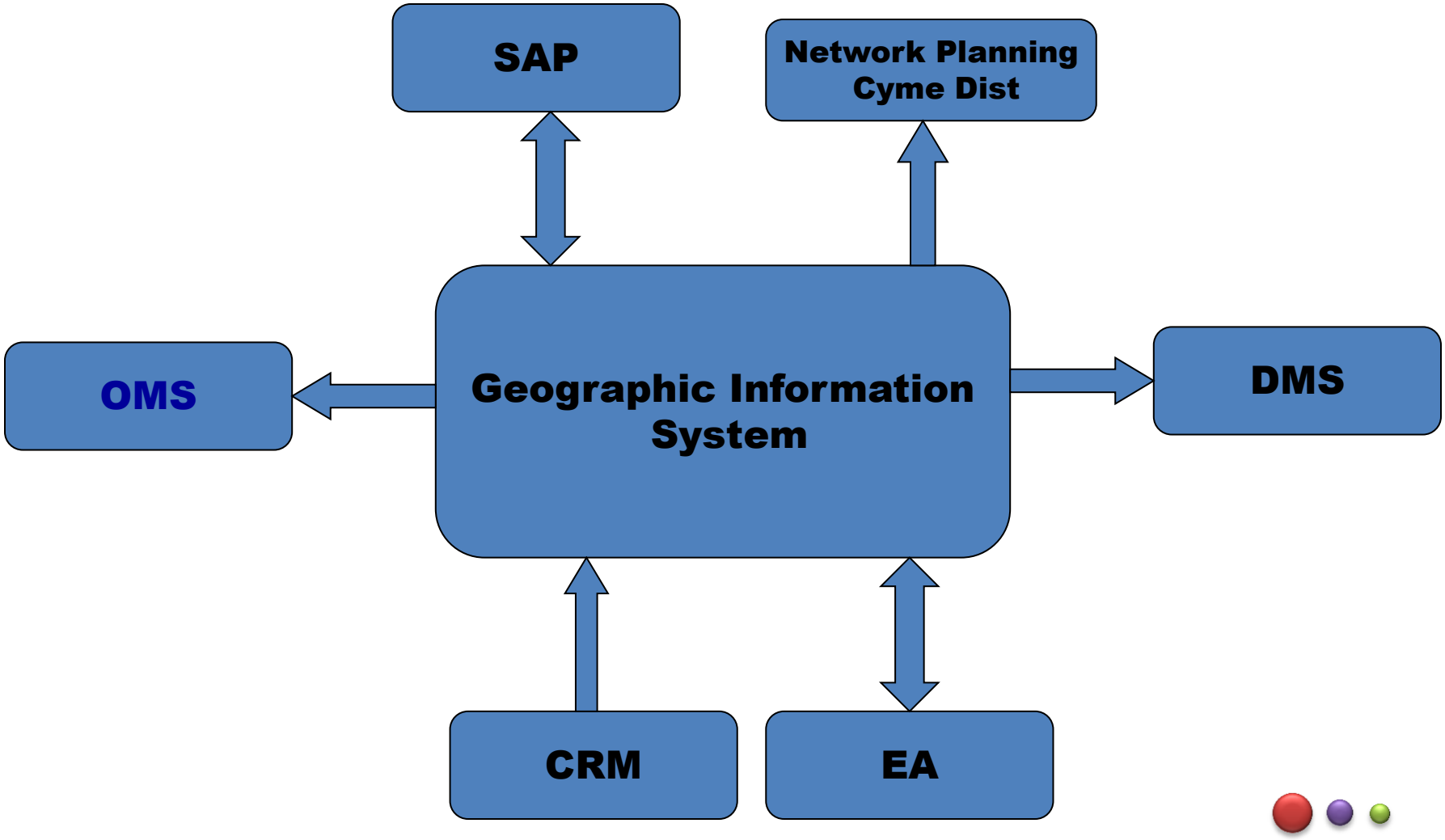
Thermo Vision Scanning

Use of state-of-the-art thermo vision cameras for detection & speedy rectification of hot spots in the network.

Benefits include: Detection of weak links & prevention of potential breakdowns and residual life extension.

TRAINING CENTRE - CENPEID

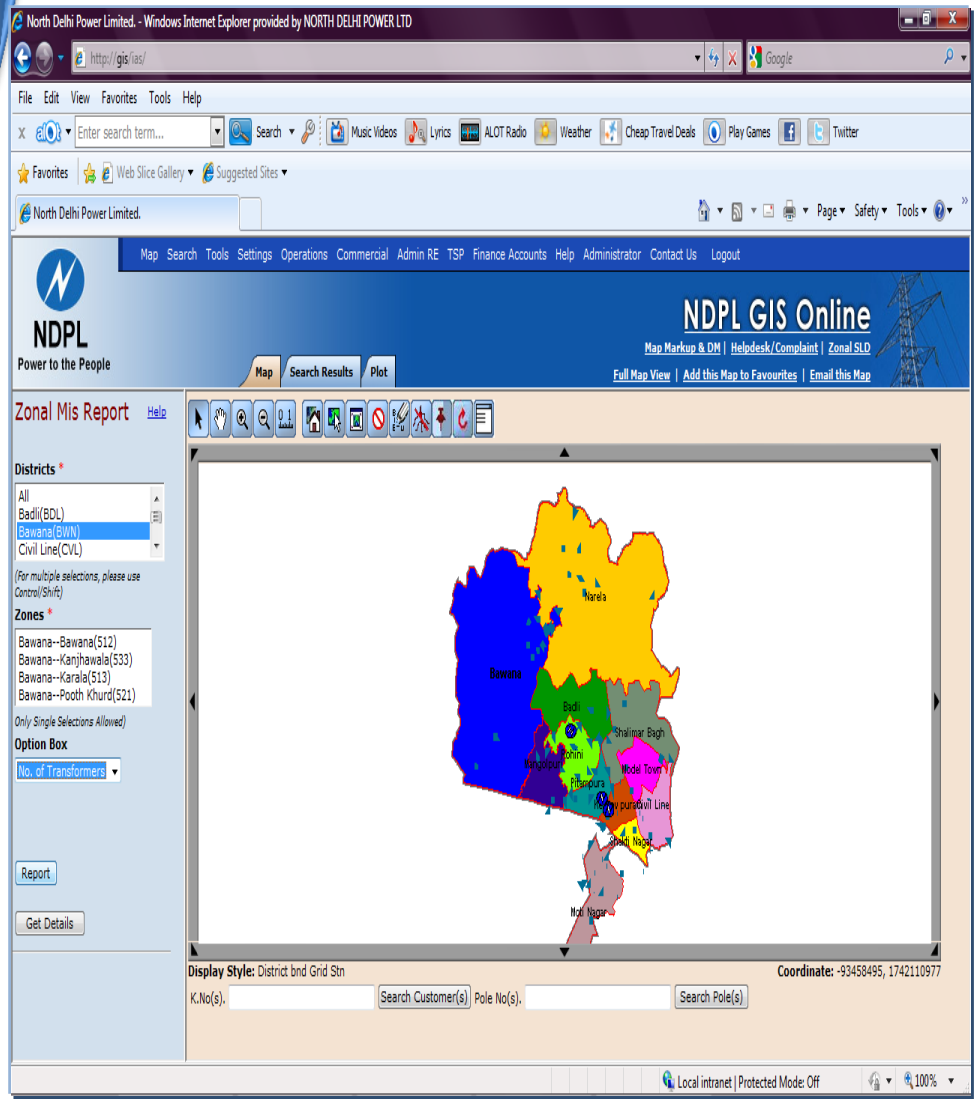
GIS Organization Resources

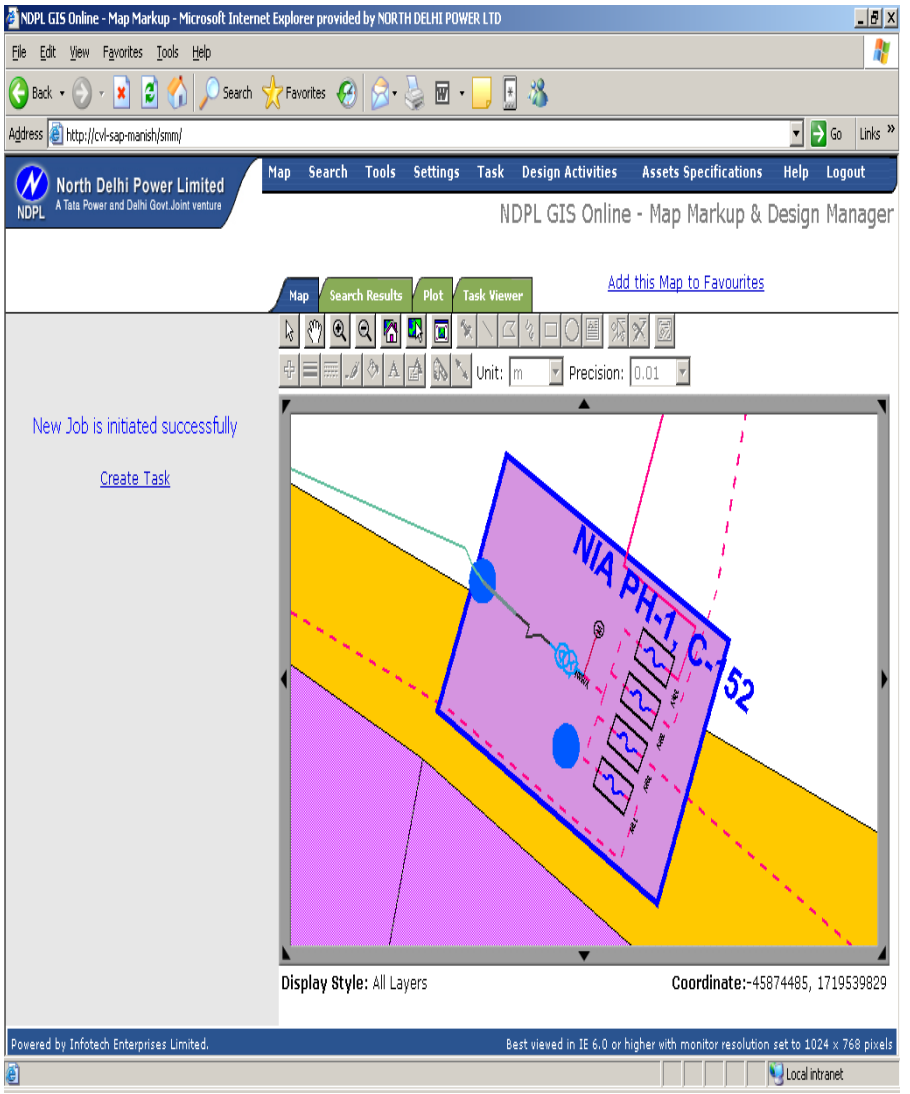


Usages Of GIS – In NDPL

- Network Planning & Scheme Design
- Project Engineering and Estimating Approval Process
- Integration with Customer Information
- Integration GIS-SAP-FAR.
- Integration with Distribution Management System
- Integration with Outage Management System
- Integration with Planning & Engineering
- Consumer Indexing
- Technical Feasibility of New Connection
- Meter Installation Route Management
- Corporate Building and Land Management
- Vehicle Location Tracking
- Energy Accounting

NDPL GIS Online





SAP Maintenance Process

MPG prepare AMS & Prepare Monthly Mtc Schedule of Equipments & accordingly create Mtc. Plan in system

For the scheduled date of maintenance, system generates the PM05 order for particular Equipment.

Order released by ZM/Grid Manager. As soon as order is released, reservation is created for materials

Work Execution. Material received by Stores as per reservation no.

Maintenance job is carried out as per Task List on the equipments ensuring safety

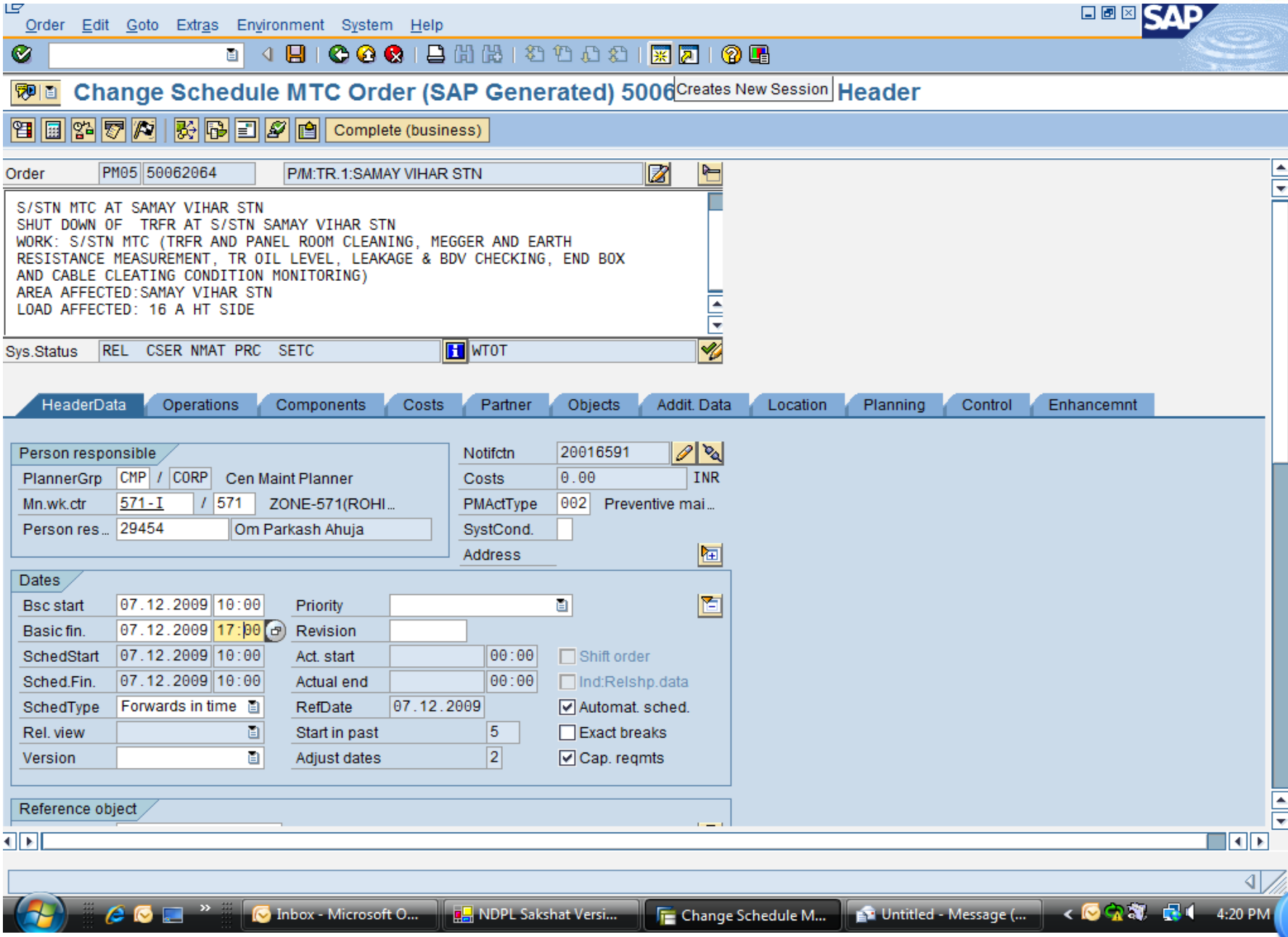
Power System approves outage and provides Permits to Work

ZM/Grid Engineer create measurement Document in SAP on equipment maintained so that history is maintained in SAP properly..

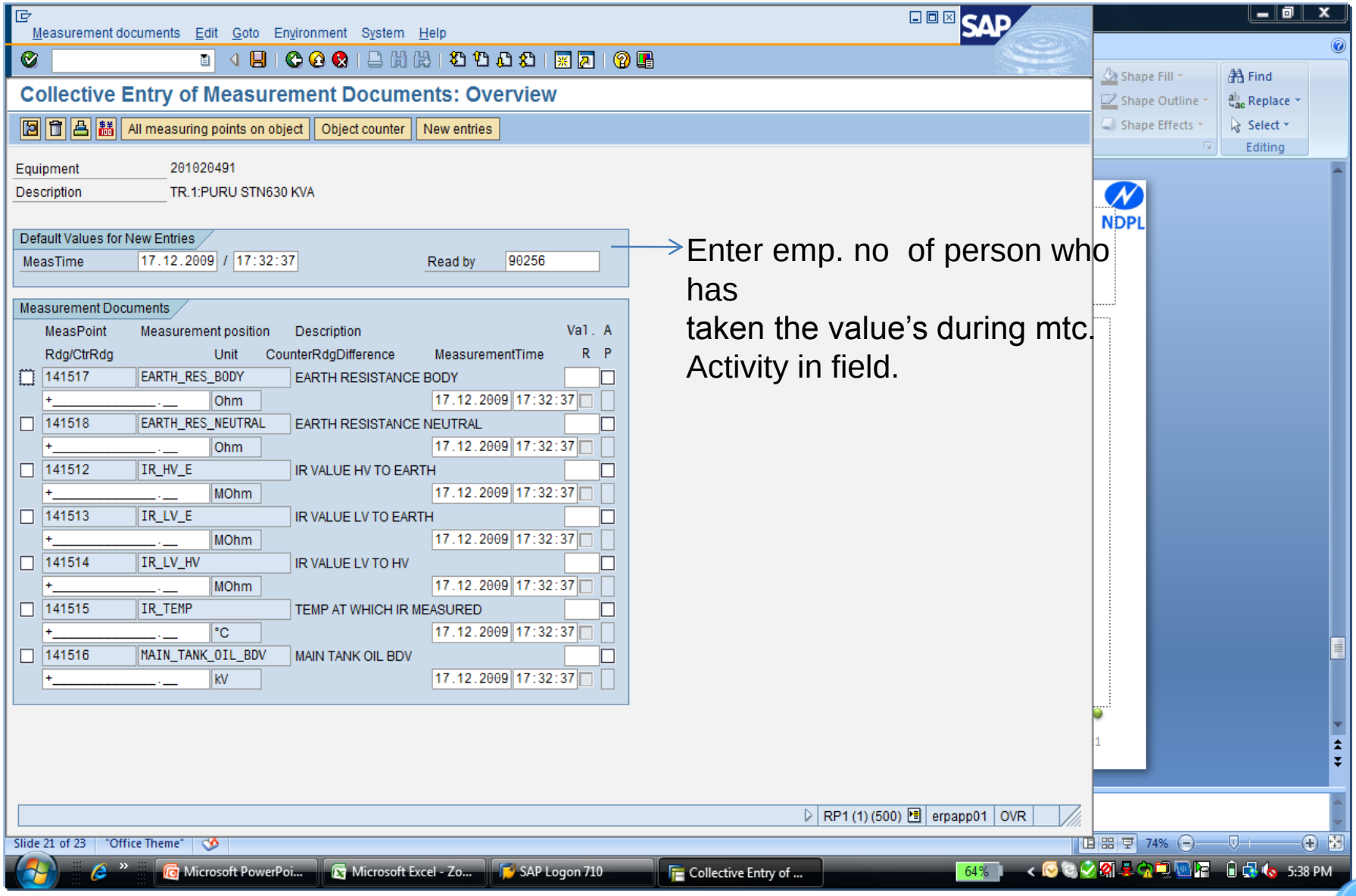
Order is closed by pressing the TECO button-Technical Closure

VIEWING PREVENTIVE MAINTENANCE ORDER IN SAP.

NDPL



MEASUREMENT DOCUMENT CREATION in SAP



Enter emp. no of person who has
taken the value's during mtc.
Activity in field.

DATA ANALYSIS USING MEASUREMENT DOCUMENT IN SAP

NDPL

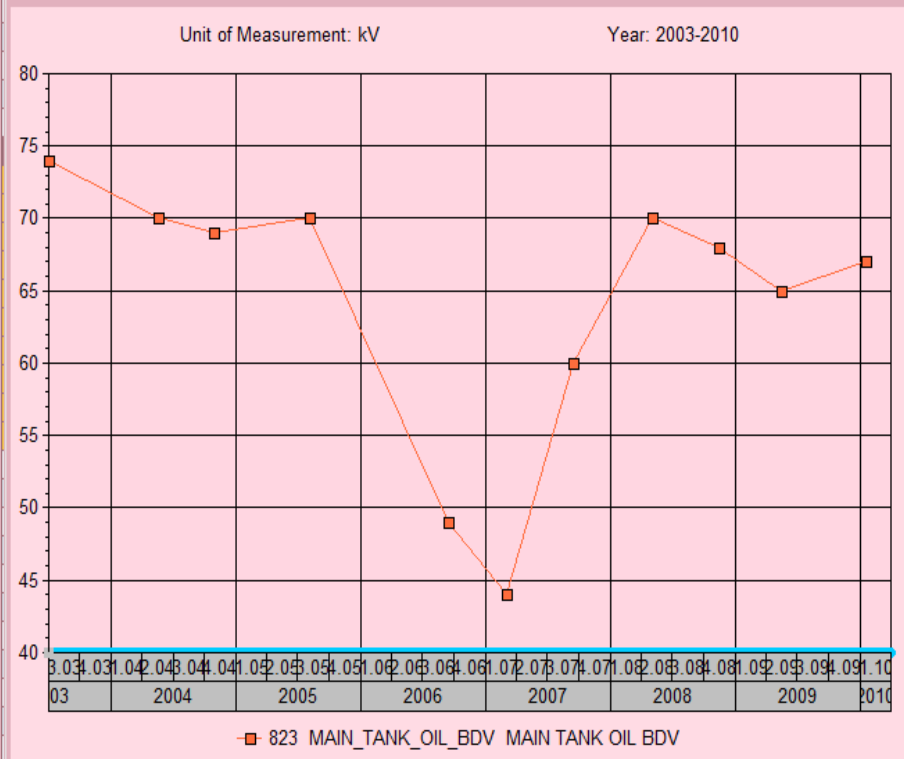
List Edit Goto Environment Settings System Help

SAP

Display Measurement Documents: Measurement Document List

Measurement Document | Measuring Point

Graphic Measurement Documents



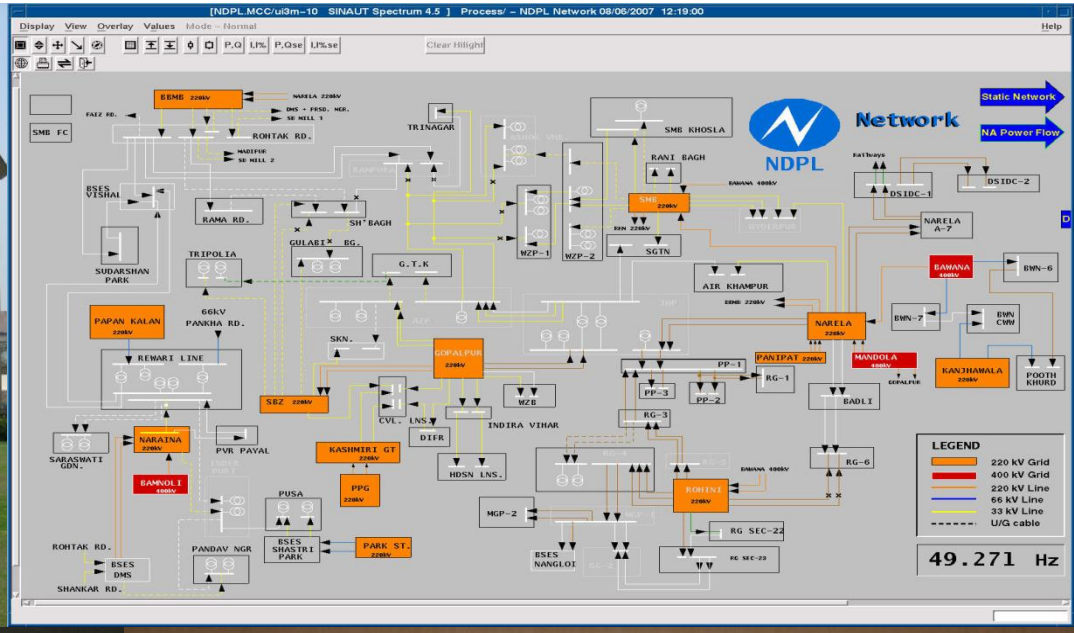
Name	Date	Equipment	Meas...	MeasPoint	Description of measuring point	Meas/TCRdg	DocMeasUnit	Upper range limit	Lower range
						5000.00	MOhm		3
						600.00	MOhm		3
						800.00	MOhm		5
						2000.00	MOhm		5
						5000.00	MOhm		5
						500.00	MOhm		5
						67.00	kV		
						65.00	kV		
						68.00	kV		
						70.00	kV		
						60.00	kV		
						44.00	kV		
						49.00	kV		
						70.00	kV		
						69.00	kV		
						70.00	kV		
						74.00	kV		
						0.00	ppm	120.00	
						18.26	ppm	120.00	
						0.00	ppm	120.00	
						3.20	ppm	120.00	
						1.00	ppm	120.00	
						0.00	ppm	120.00	
						0.00	ppm	120.00	
						5.00	ppm	120.00	
						13.00	ppm	120.00	
						6.00	ppm	120.00	
						7.00	ppm	120.00	
						7.00	ppm	120.00	

RP1 (2) (500) erpapp01 INS

Inbox - Microsoft O... | Functional Location... | Display Measureme... | Functional Location...

84% 1:24 PM

Commitment for Excellence -SCADA



Supervisory Control & Data Acquisition System

- **SCADA** :
  - Control & Monitoring of all grid stations
  - 50 Grid stations are Unmanned
  - Load shedding on predefined time from SCADA
  - ABT interfaced with load forecasting and load shedding
  - Grid/Area wise Energy Audit

Distribution Management System

- Centralized Monitoring of 11 kV Distribution system
- Decision making based on DMS Applications outcome , considering present state of Network condition for planned and unplanned work .

Distribution Automation

- Centralized control & remote operation of 11kV Switching Stations through ‘SIEMENS’ provided Central SCADA/DMS system.
- Provide Auto –changeover to alternate source for some vital consumers RMU.
- Faster identification of faults.
- Faster restoration of supply from remote.
- Improvement in reliability indices (SAIDI & SAIFI).

Outage Management System

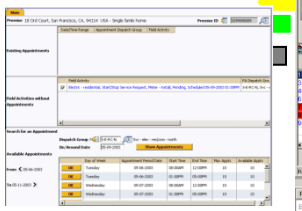
- Consumer trouble call management through SAP-ISU.
- Outage management using prediction logic.
- Crew management.
- Prioritization of outages through predefined logics.
- Planned outage management through SAP-PM.

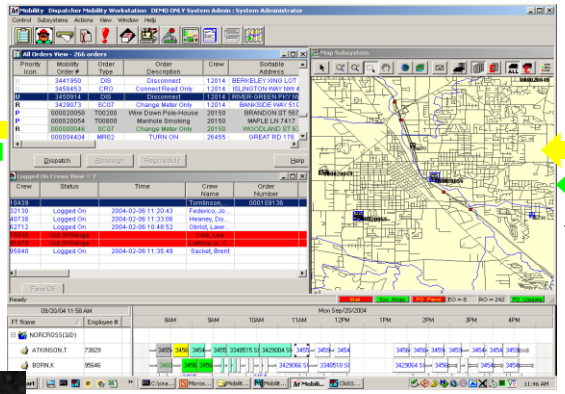
SYSTEM CONCEPT

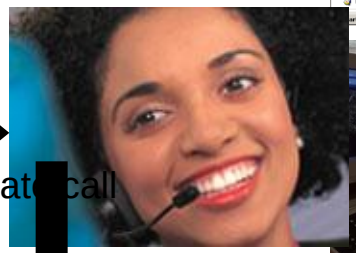
NDPL

PROPOSED
IN FUTURE

Customer calls
with service request







Call center generates call
tickets in
SAP-ISU

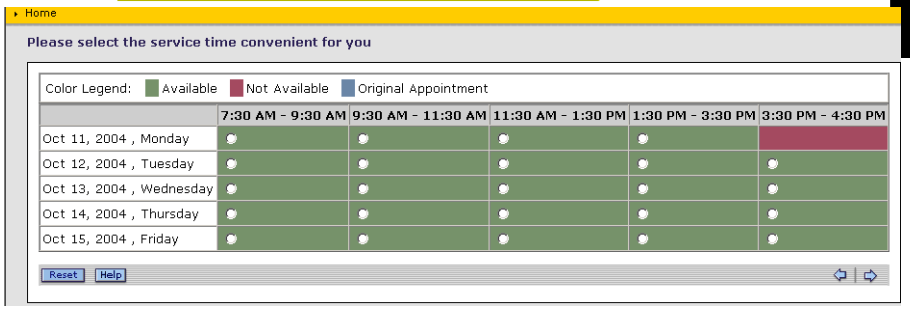
Enroute

MWM FSR Module

Onsite

Outage Management System

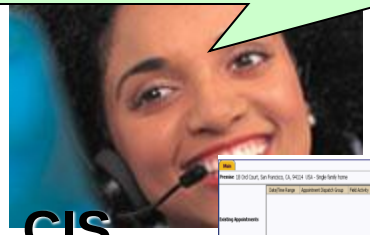
Worked



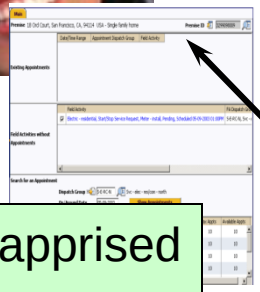
System Interfaces

NDPL

- Takes trouble calls
- Informs customers of restoration status



CIS
SAP-ISU

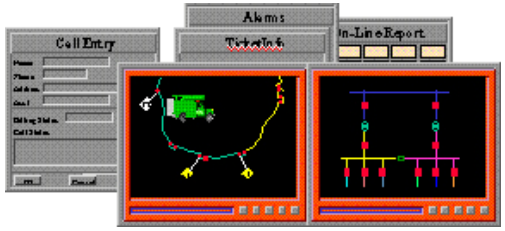


- Keeps OMS apprised of status on monitored devices

SCADA/DMS

- Call assignment
- Trouble prediction
- Switching
- Dispatching

Control Centre

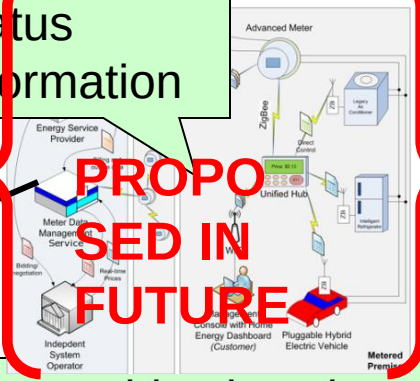


Outage Management System – for 1.8 million Customers

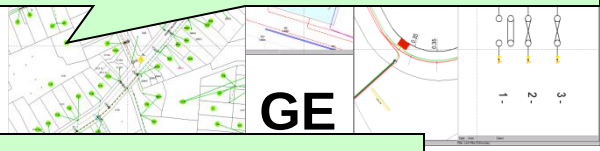
AMI

- Meter status information

PROPOSED IN FUTURE



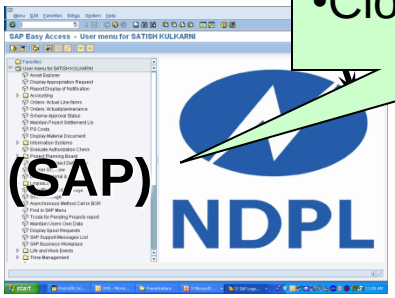
- Provides location
- Provides circuit data
- Provides routing



GE

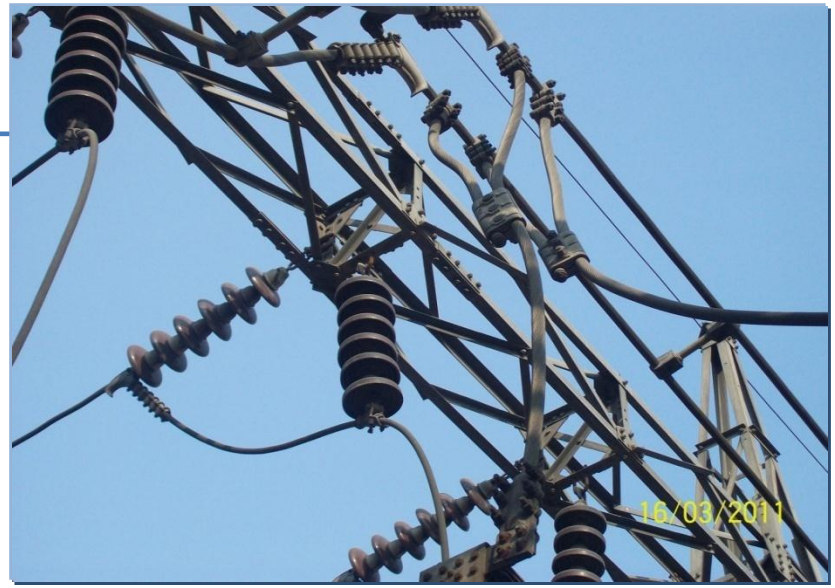
- Initiates work
- Tracks work status
- Closes jobs

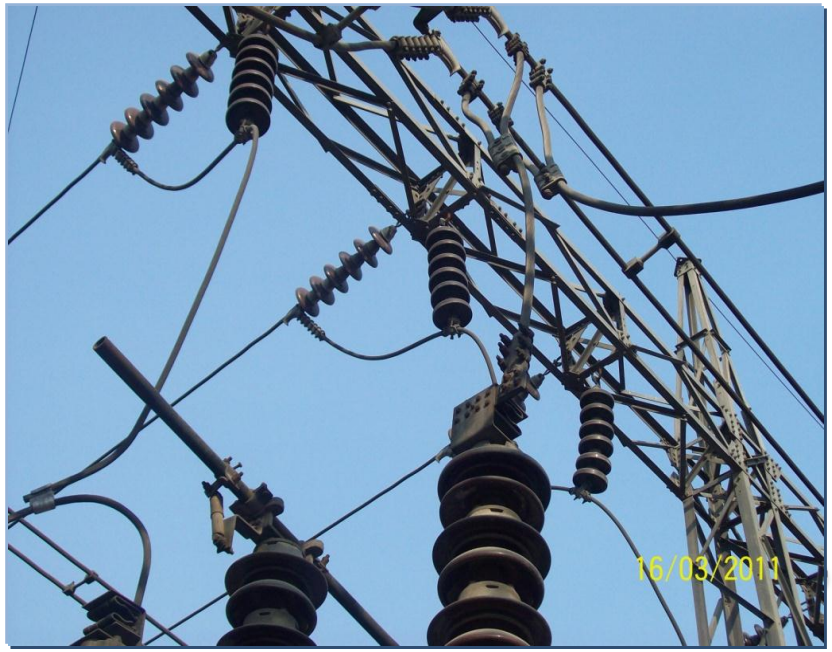
WMS (SAP)



NDPL

Wedge Connectors Installed to reduce losses





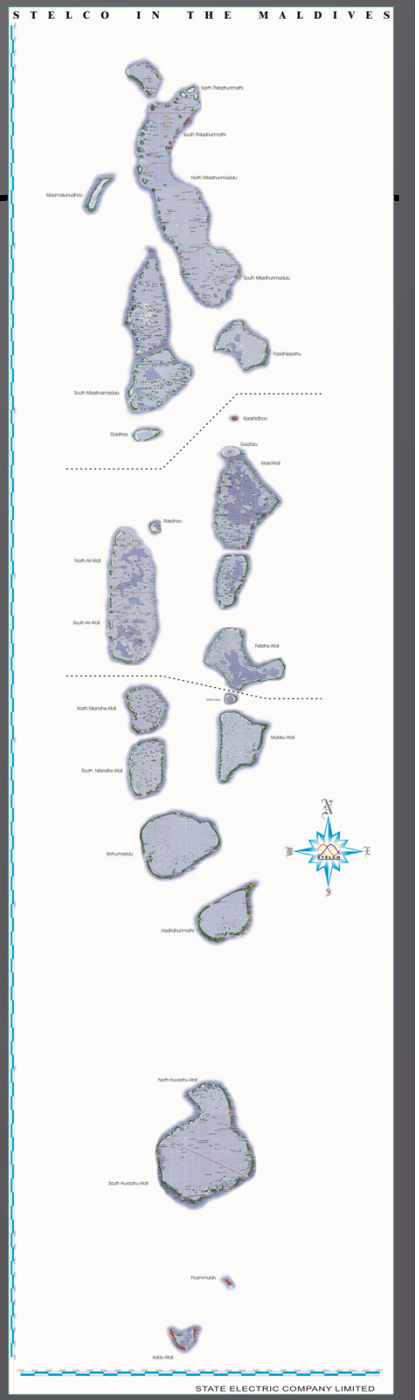
Maldives

State Electric Company Ltd

STELCO
STATE ELECTRIC COMPANY LIMITED

About Maldives

Population :	298,968 (march 2006)
Population Growth :	1.69
Geographical Area:	298 sqkm
Largest island :	5.17 sqkm
Total Number of islands :	1192
Inhabited Islands :	200
Average Ground level:	1.5m above sea level
Main Source Income :	Tourism



Capital City – Male'

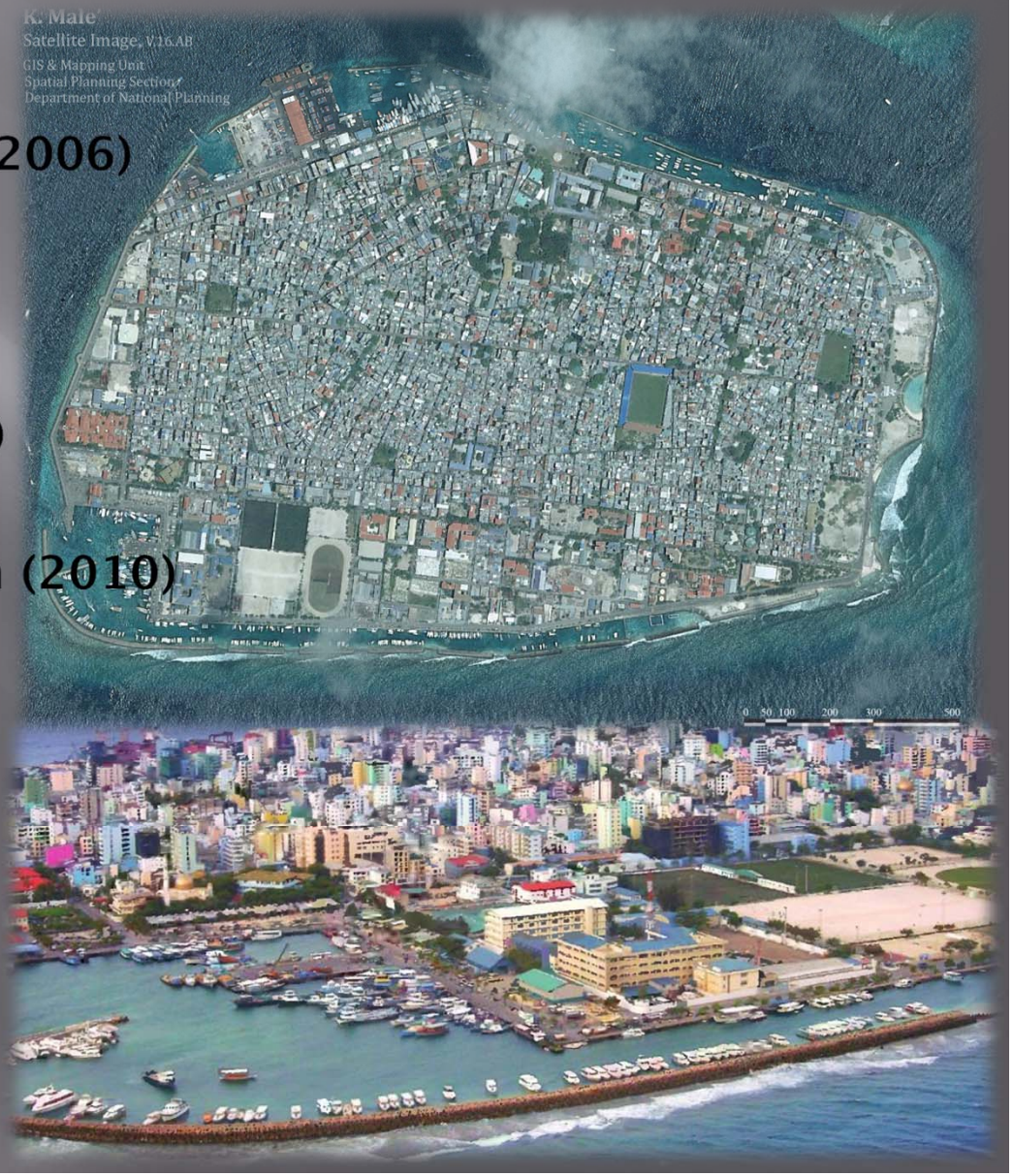
Population : 103,693 (march 2006)

Land Area: 1.97 sqkm

Power Demand: 38.7 (may 2010)

Electricity usage : 201,419 MWh (2010)

Number of Customers: 29,974



About STELCO

State Electric Company Ltd (STELCO) is a100% government owned company.

The Company emerged from modest beginnings in 1949 with an installed capacity of only 14 kW and providing electricity to just the residences in Male'.

Over the past five decades the company operated as a government department under different names like "Department of Electricity" and "Maldives Electricity Board" until 1997, when "State Electric Company", STELCO, was formed.

About STELCO

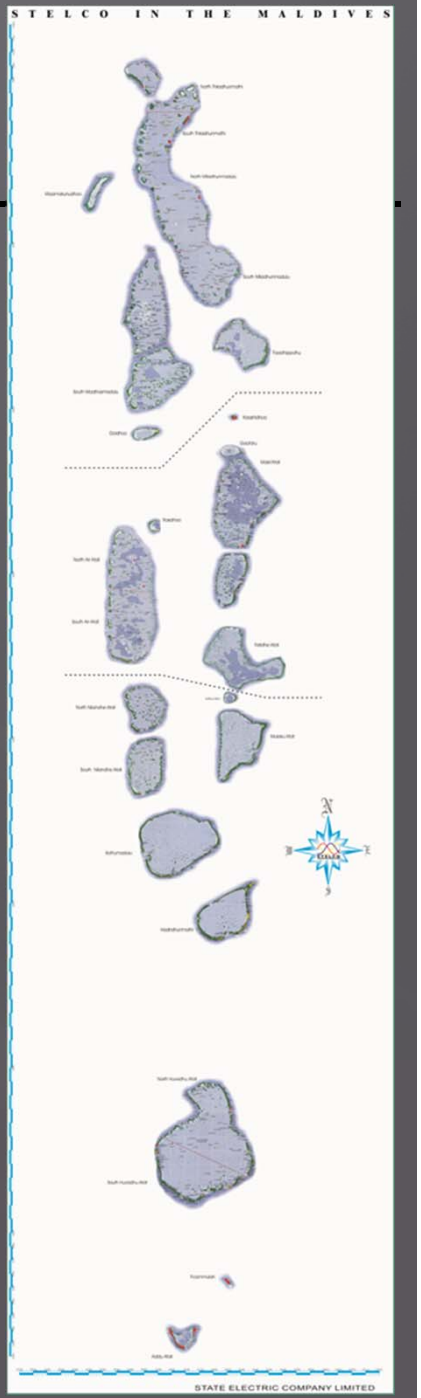
OPERATIONS ARE NOW BASED IN THE NORTH

CENTRAL PROVINCE

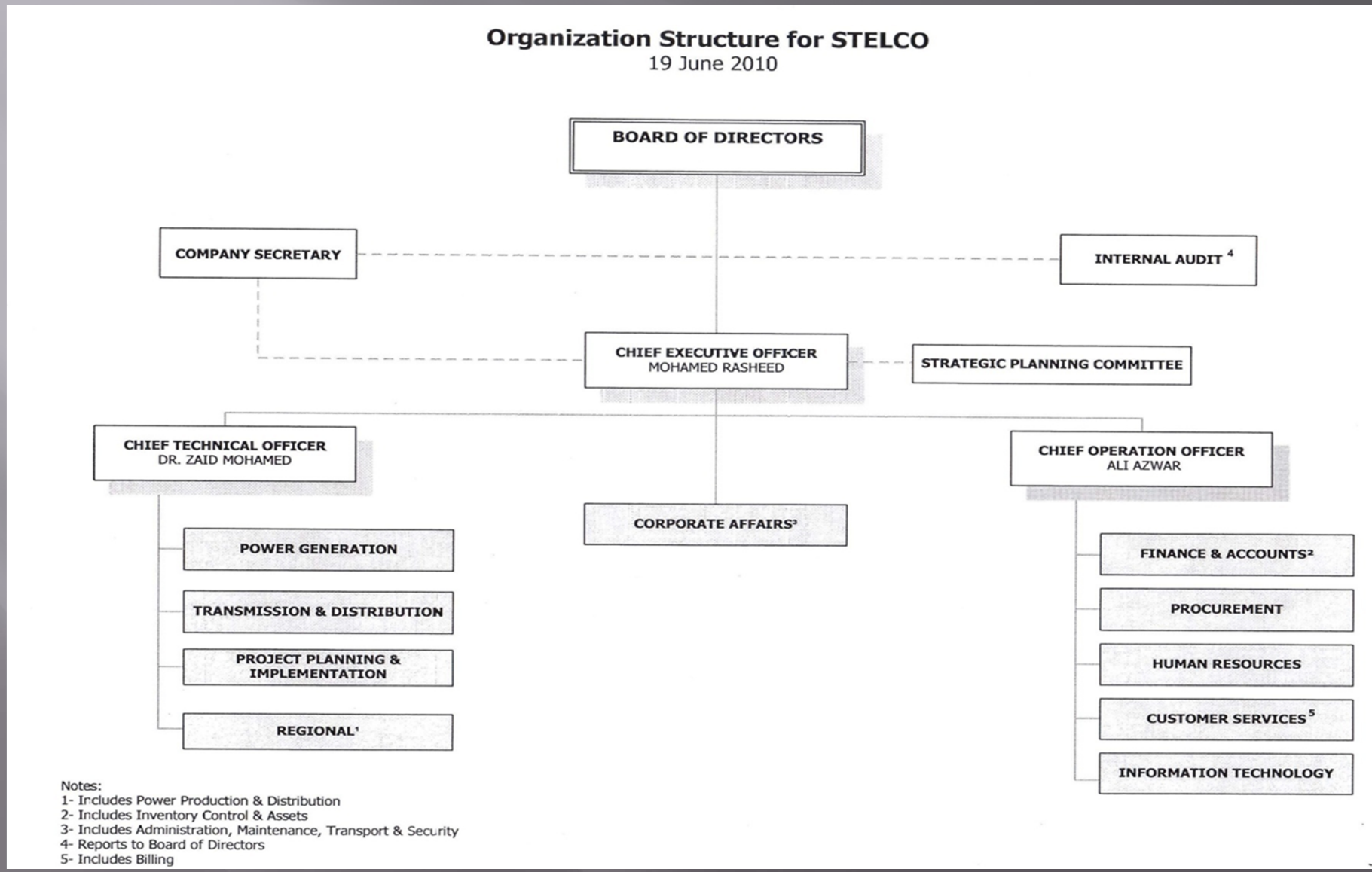
CURRENTLY OPERATES POWERSTATIONS &

DISTRIBUTION SYSTEMS IN 10 ISLANDS

STELCO HAS ITS LARGEST OPERATION IN MALE',



About STELCO



Male' – Power Station

Male' – Power Station

POWER IS GENERATED USING MEDIUM AND HIGH SPEED DIESEL GENERATORS

TOTAL INSTALLED CAPACITY – 49.96 MW

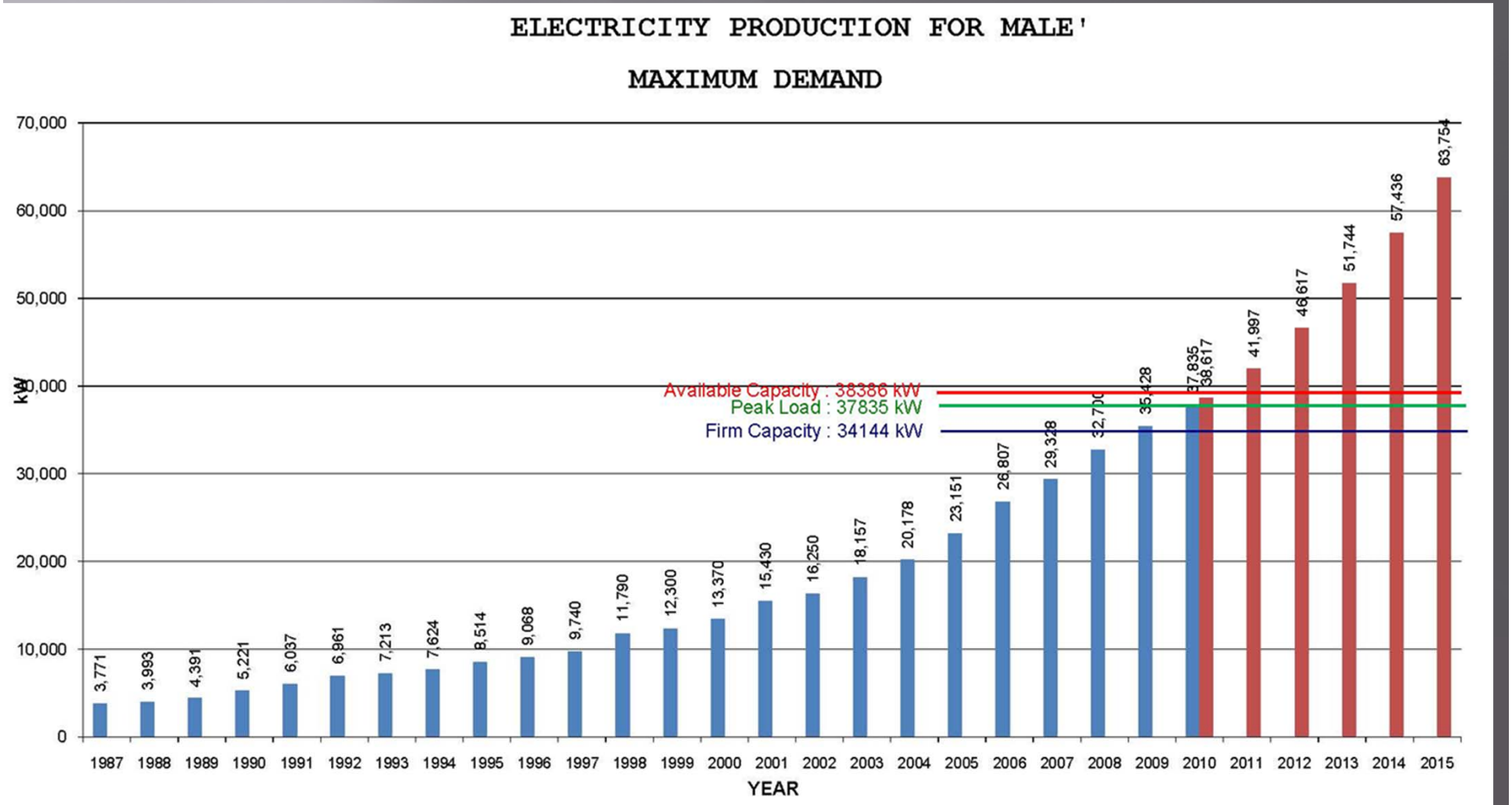
MAXIMUM DEMAND – 37.84 MW (4/5/2010)

A NEW POWERHOUSE IS CURRERNTLY UNDER CONSTRUCTION

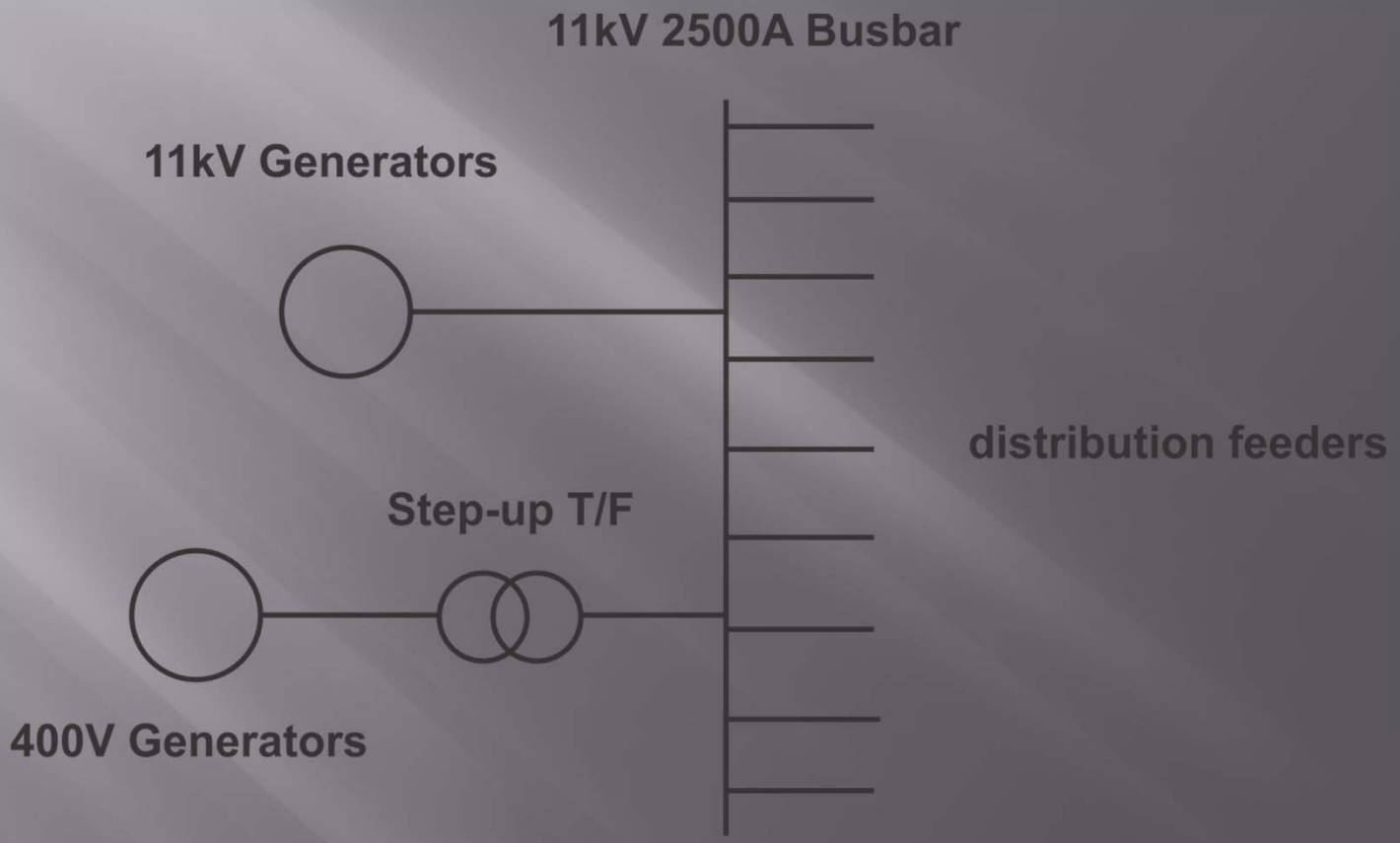
DESIGNED FOR 3 X 10MVA GENSETS & 11kV SWITCHGEAR SYSTEM.

EXPECTED TO BE COMPLETED BY 2012 (Q1)

Male' - Power Station



Male' - Power Station



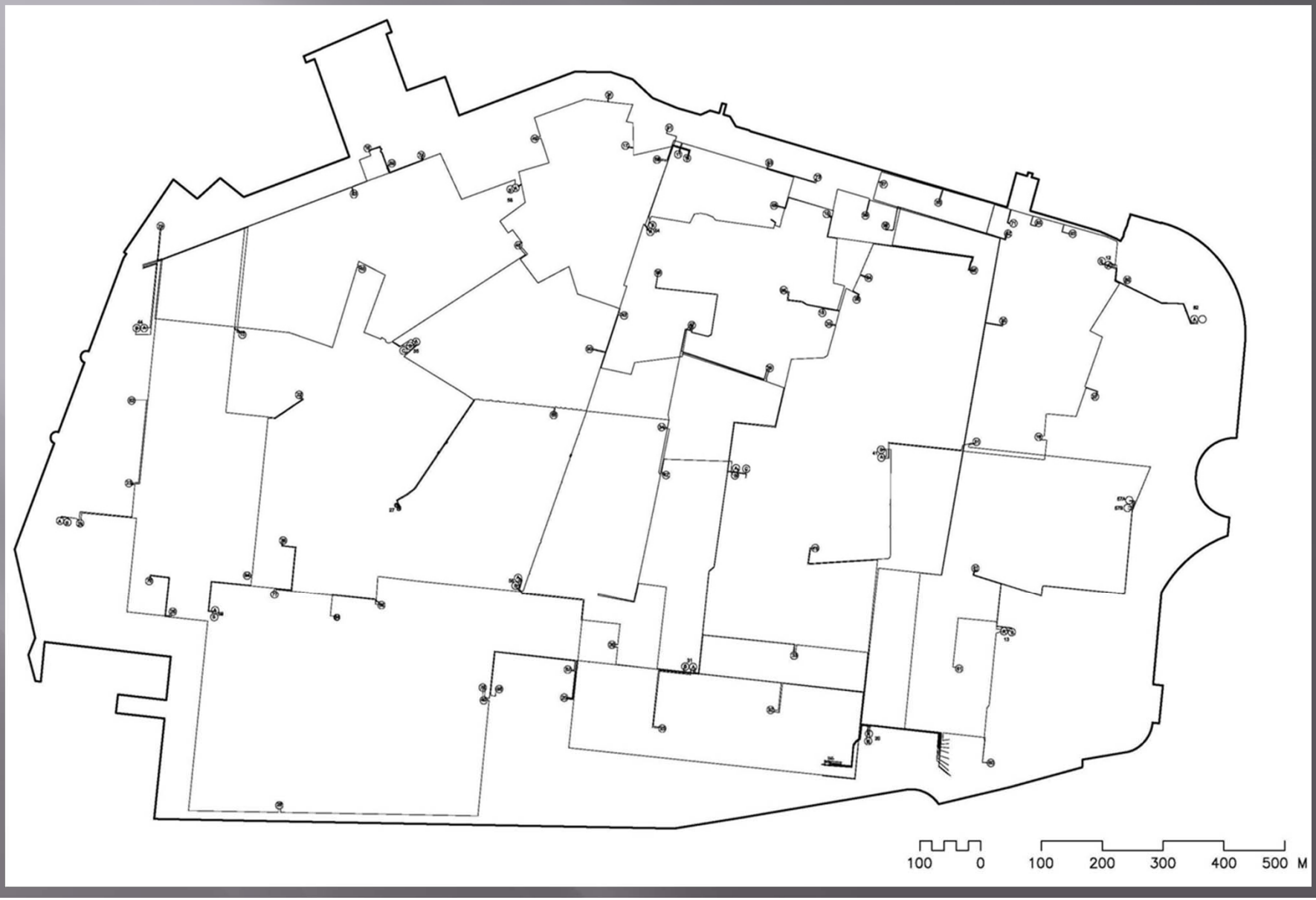
Male' – Power Distribution System

11KV DISTRIBUTION UNDERGROUND NETWORK

Consists of

- **9 MV Feeders**
  - ✓ **Max feeder capacity – 5.3MW**
- **28.5km Underground Cable Network**
- **106 Transformers (11/0.4 kV)**
  - ✓ **Capacities ranging from 100kVA – 2500kVA**
  - ✓ **69 Distribution Transformers**
  - ✓ **37 Privately Owned**
- Total Loss : 7.3%

Male' – Power Distribution System



Hulhumale' – Power System

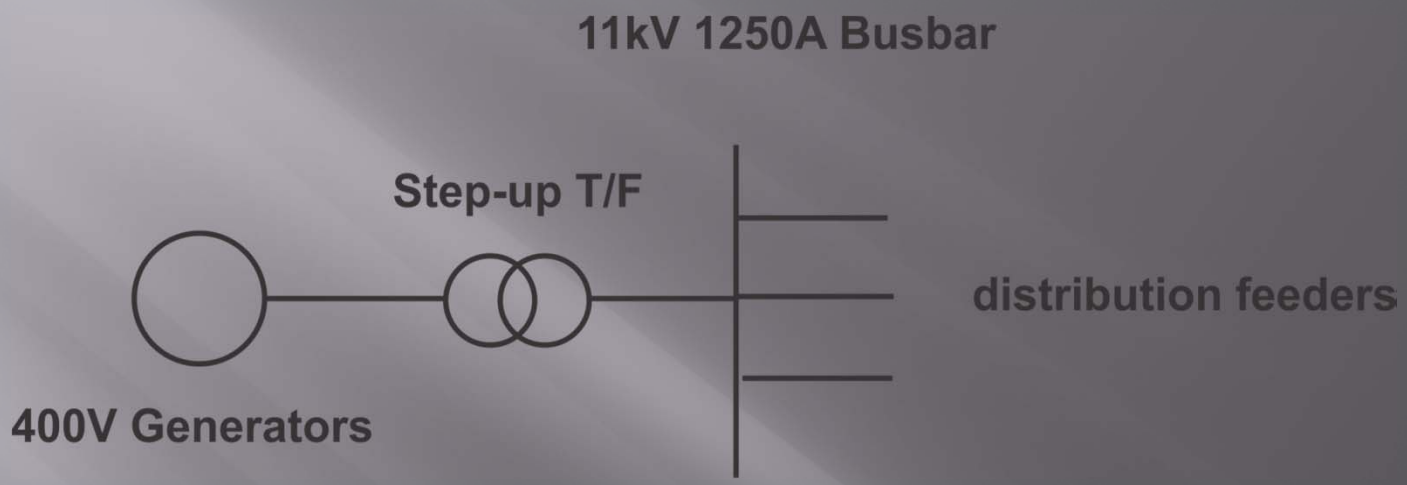
POWER IS GENERATED USING HIGH SPEED DIESEL GENERATORS

TOTAL INSTALLED CAPACITY – 4 MW

MAXIMUM DEMAND – 1.65 MW (APR 2010)

Number of Consumers - 1928

Hulhumale' – Power System

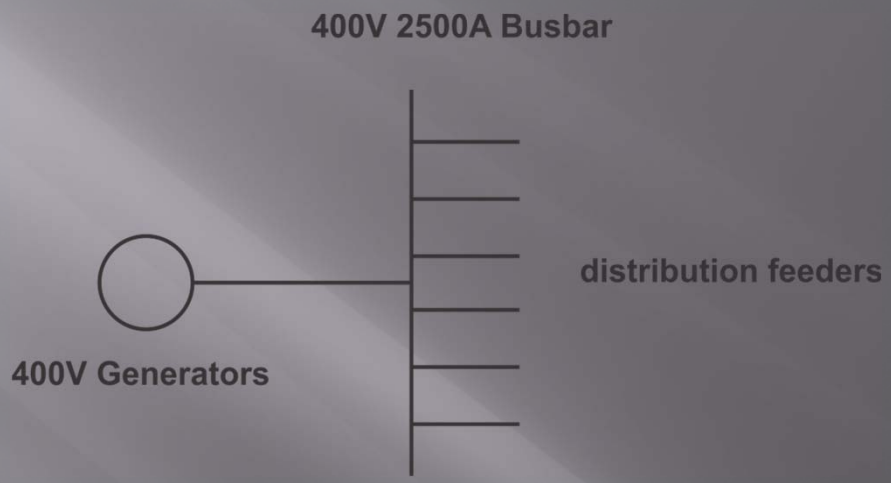


11KV DISTRIBUTION UNDERGROUND NETWORK

Consists of

- **3 MV Feeders**
- **11kV Underground Cable Network**
- **13 Distribution Transformers (11/0.4 kV)**
  - ✓ **Capacities ranging from 315kVA – 1000kVA**
- **Total Loss : 6.3%**

Minor Islands – Power System



80kW to 600kW High Speed Diesel Generators are used to supply power.

Three to Four Generators are installed in each island.

400V Underground Distribution Network

Total Loss : 4 - 6%

Challenges !

Male'

- **Overloading main distribution busbar & Feeders**
- **Maintenance of network is forced to do on off Peak hours (weekends) to avoid service interruption**
- **Overloading of distribution transformers due to increasing demand (past 3yrs avg growth rate 12%)**
- **Lack of space new generators / distribution transformers**
- **Power system stability analysis**

Hulhumale'

- **Lack of generation capacity**
- **Higher growth rate due to new development**
- **Redesigning of new powerhouse**

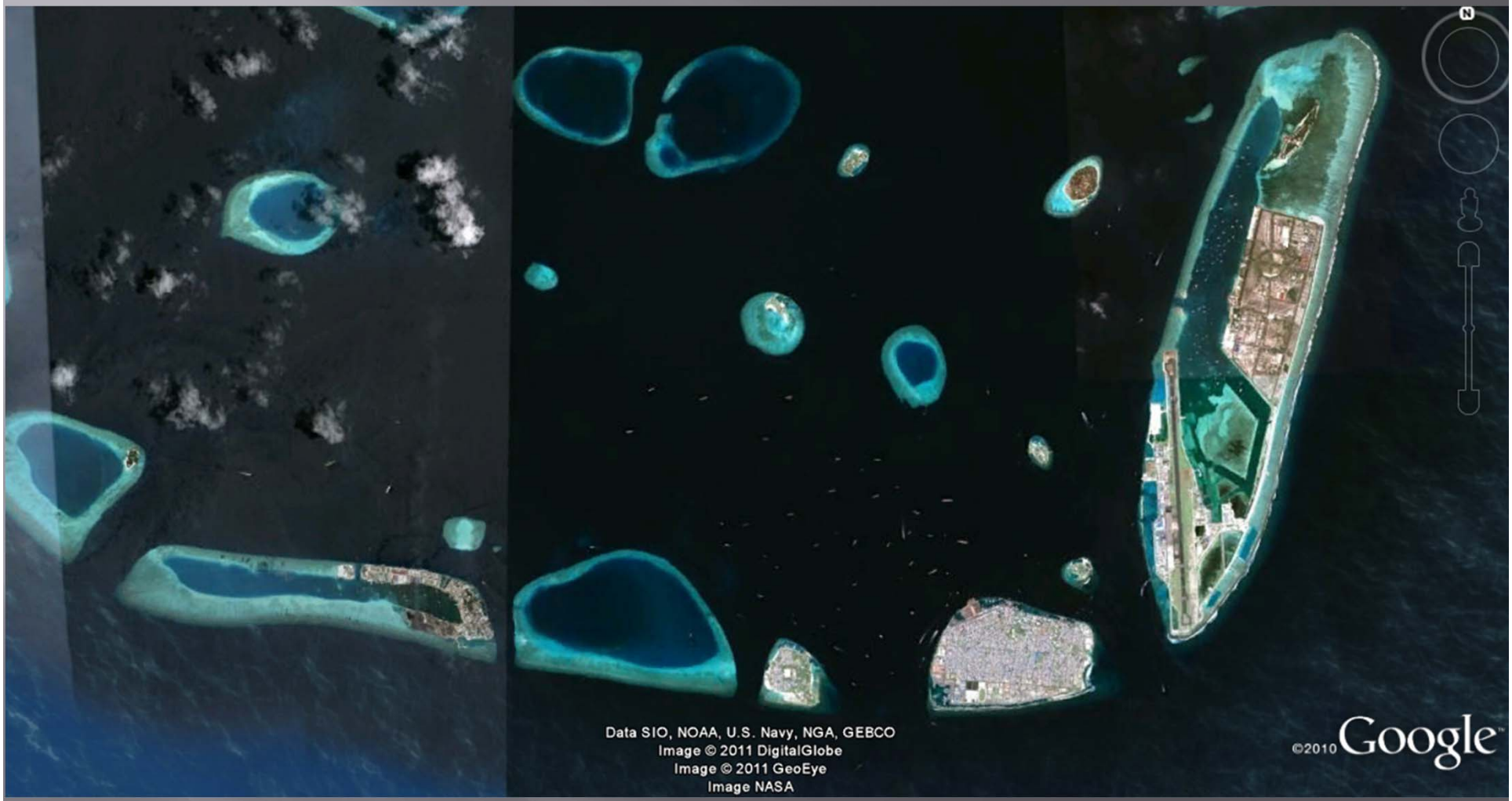
Interconnection of Greater Male' Region

PRE-FEASIBILITY STUDY HAS BEEN CONDUCTED BY USAID

INTERCONNECTION OF 4 ISLANDS BY A 132kV SUBMARINE CABLE

PROJECT FUNDING SOURCES YET TO BE SECURED

Interconnection of Greater Male' Region



Renewable Energy

GOVERNMENT IS COMMITTED FOR THE COUNTRY TO BE CARBON NEUTRAL BY 2020

STELCO IS LOOKING TO INCOPORATED RENEWABLE ENERGY SOURCES FOR GENERATION

ONGOING RENEWABLE ENERGY PROJECTS

- **400kW GRID CONNECTED PV PROJECT (JICA AID)**
- **GRID CONNECTED PV SYSTEM IN 5 ISLANDS WITH TOTAL CAPACITY OF 2MW (TENDER AWARDED, TOBE COMPLETED BY 2012)**

Questions ?

Thank for your kind attention

SMUD
SACRAMENTO MUNICIPAL UTILITY DISTRICT
The Power To Do More.©

BEST PRACTICES

An Overview of Best Practices in Electric System Performance (2011)

Presented by

Jaspal Deol, P.E.

Manager, T&D Substation Design,
Construction and Maintenance

Sacramento Municipal Utility District

Distribution Services

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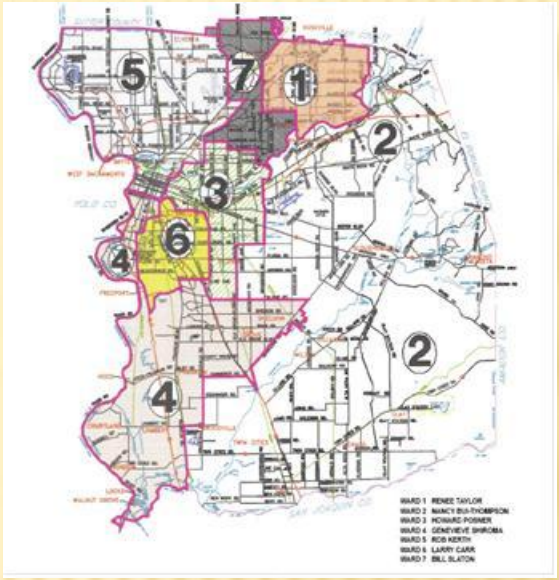
USEA
United States Energy Association

AGENDA

- System Overview
- System Planning
- Loss Reduction
- System Operations
- System Maintenance
- Conclusion

SYSTEM OVERVIEW

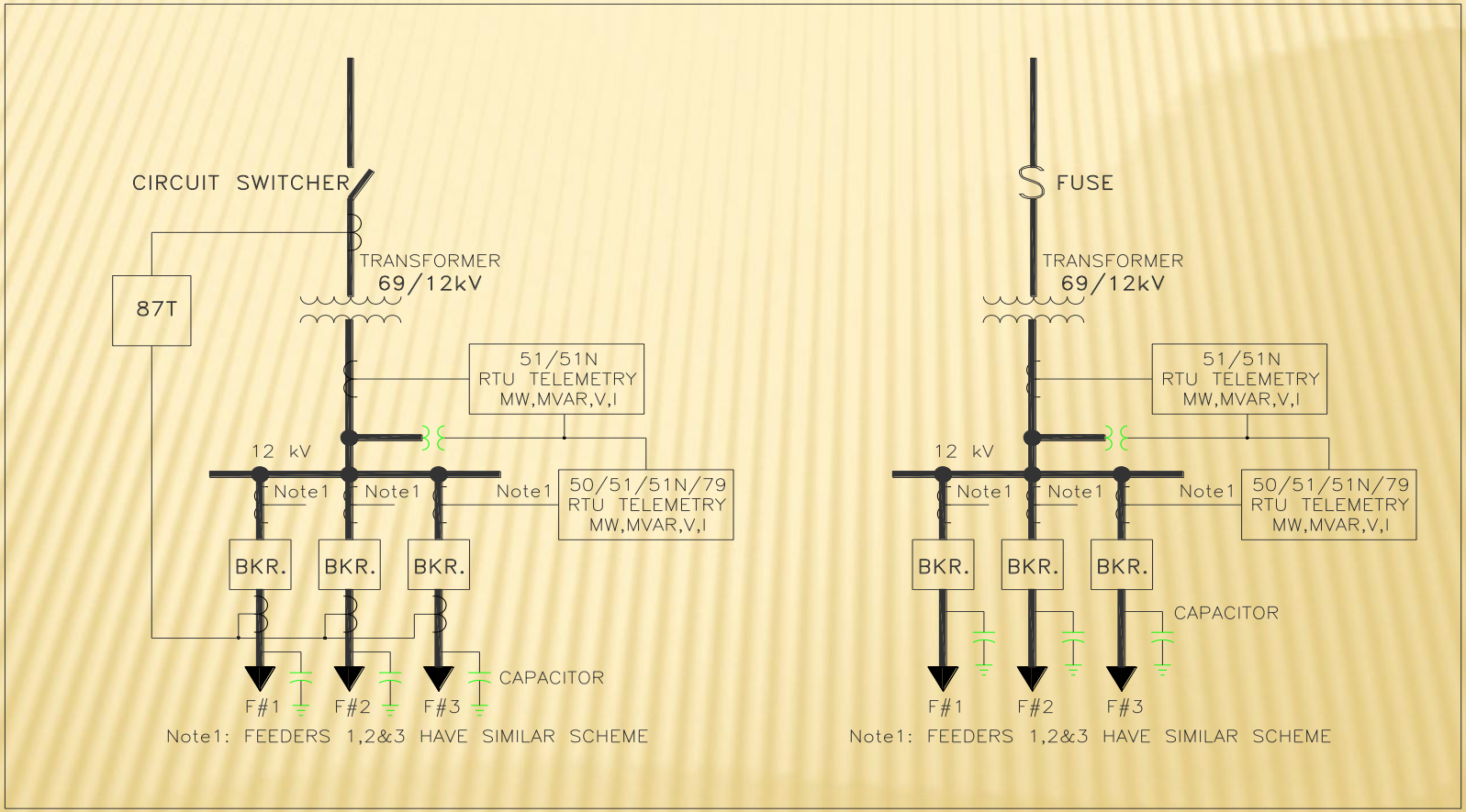
- Distribution System Overview
  - 2,331 square kilometers of service area
  - Total population of 1.4 million
  - Approaching 600,000 customers
  - 220+ Distribution substations with 275 transformers
  - 6,280 kilometers of overhead distribution
  - 9,520 kilometers of underground primary distribution
  - Almost 80,000 distribution line transformers
  - Poles – 150,000+



SYSTEM OVERVIEW - SUBSTATIONS

- Bulk Energy Substations (High Voltage)
  - 230/115kV -200MVA+
  - 230/69 kV – 200MVA+
  - 115/21/12kV – 25MVA+
- Distribution Substations (Med. Voltage)
  - 69/12kV – 3.25 MVA-25MVA
- Distribution Transformers (Med Voltage)
  - 69/12kV - <2500kVA
- Dist. Line Transformers (Low Voltage)
  - 21kV/480volt/240/120
  - 12.47kV/480volt/240/120

SYSTEM OVERVIEW - SUBSTATIONS



SYSTEM PLANNING

SYSTEM PLANNING

SYSTEM PLANNING

- **System Planning**
  - System planning, at its core, is developing a schedule of future system additions and changes to ensure reliable, efficient and safe system operation at the lowest possible cost
  - Many elements are involved and the levels of efficient and satisfactory performance and operation varies from utility to utility
  - Electric demand is one of the primary drivers of system planning
  - Reliability and power quality is another very important driving element

SYSTEM PLANNING

- **Design Criteria**
  - Service territory broken down into logical planning areas based on natural geographical boundaries and other general system considerations and sets the fundamental planning unit
  - System utilization and reliability metrics provide the benchmark for system planning
  - A design criteria is established based on acceptable operating and service limits

  - Reliability criteria is based on acceptable SAIFI and SAIDI levels

SYSTEM PLANNING

- Design Criteria (Loading)

LOADING CRITERIA			
	Normal	Emergency	Emergency (Short)
Planning Area	100%	110% (N-1)	125% (N-1)
Substation Transformer	100%	110%	125%
Underground Conductor	100%		
Overhead Conductor	100%		

SYSTEM PLANNING

- Design Criteria (Reliability)

RELIABILITY CRITERIA		
	Normal	Major Event
Outage Frequency Per Customer Per year (SAIFI)	0.85-1.14	0.99-1.33
Outage Duration Per Customer Per Year (SAIDI)	49.7-68.7	67.5-93.3

- Major events are typically defined as an extreme weather event such as a major windstorm or other natural disasters of a large magnitude and of a relatively rare occurrence

SYSTEM PLANNING

- **Load Analysis & Forecasting**
  - Load forecasting is a critical component of system planning
  - The system must be able to withstand the design criteria, which is based off of a percentage of peak demand
  - Peak demand typically occurs just a few days of the year, but the system has to be planned and built to accommodate this level of load
  - A multitude of variables affects peak demand, including temperature, economic conditions (both locally and nationally), population, etc.

SYSTEM PLANNING

- **Load Analysis & Forecasting**
  - Temperature and economic conditions play critical roles in load forecasting
  - Planning area and system-wide forecasts are done through linear trend lines (least-squared method) using historic growth (five years) and accounting for temperature variances and special economic conditions
  - A temperature adjustment is added to the trend to account for a 110 degree design temperature
  - This is done to equalize mild summer peaks up to what could be expected on warmer days

Temp	Factor
101	1.125
102	1.110
103	1.095
104	1.080
105	1.065
106	1.052
107	1.039
108	1.026
109	1.013
110	1.000

SYSTEM PLANNING

- **Economic Considerations and Bulk Loads**
  - Economic considerations and conditions are also taken into account for any system forecast
  - Major events such as recessions and "boom" periods have a marked impact on peak system demands and must be taken into account accordingly
  - Bulk loads are also treated differently and separately from the forecast trend

- Large future load additions (typically defined as loads exceeding 25% of the planning area growth) are manually added to the trend due to their relatively low frequency of occurrence and large magnitude

LOSS REDUCTION

LOSS REDUCTION

LOSS REDUCTION

- System Losses
  - System losses account for an often invisible but otherwise large revenue loss
  - Almost all components on the distribution system have resistive and reactive elements that "wastes" energy
  - Transformers, distribution lines, and other reactive loads account for the bulk of these losses over the life of operation
  - Additional revenue is lost due to increased capacity requirements of system components to accommodate these losses

LOSS REDUCTION

- System Losses
  - Total system delivery losses is 6%
  - Distribution and secondary system losses accounts for 4.5%
  - Transmission losses account for the remaining 1.5%
  - The distribution system represents the highest revenue loss component of the entire system

- Escalating energy and capital costs make minimizing system losses a priority!

LOSS REDUCTION

- Line Losses
  - Line losses account for a large proportion of energy loss on the distribution system
  - Line losses can be simply defined as: I^2R
  - Effective conductor sizing, voltage regulation, Var compensation, load characteristics, operational considerations and optimal system configuration all play important roles in line losses

- SMUD practices sound conductor sizing to minimize losses over the life of the installation
- Other distribution efficiency measures taken into account when determining the most cost/lost effective line system

LOSS REDUCTION

- Line Losses
  - Economical conductor sizing plays a critical and key role in minimizing losses
  - This is the first crucial step in minimizing expenditure losses due to line losses
  - Post installation fixes and adjustments can be costly if sized incorrectly
  - Cost studies are done to most economically choose conductor sizes in conjunction with voltage drop considerations

LOSS REDUCTION

- Line Losses
  - Method to analyze distribution line costs or annual line cost of a given size can be determined as:

$$TAC = AIC + AEC + ADC$$

Where :
TAC = Total annual equivalent cost of the conductor/cable ($/km)
AIC = Annual equivalent of investment cost of installed conductor/cable ($/km) ***(see next slide)***
AEC = Annual equivalent of energy cost due to I^2R losses ($/km) ***(see next slide)***
ADC = Annual equivalent of demand cost incurred to maintain adequate system capacity to supply I^2R losses ($/km) (the cost of useful system capacity lost in order to supply the line losses)

- The total annual line cost can be calculated and assessed
- Load and loss factors play a key role in assessing line costs
  - Since load varies with time, time-based loss calculations are needed
- Load factor is the average demand divided by the peak demand
- Loss factor (used to determine AEC) is empirically related to load factor

LOSS REDUCTION

- Line Losses
  - Annual equivalent investment cost (AIC):

$$AIC = IC_F(i_F)$$

Where :
AIC = Annual equivalent of investment cost of installed conductor/cable ($/km)
IC_F = Annual equivalent of investment cost of a given conductor/cable ($/km)
i_F = Annual fixed charged rate applicable to the conductor or carrying charge ($/km)

  - Charges such as capital, O&M, depreciation, taxes, etc., are typically included in the "carrying charge"

LOSS REDUCTION

- Line Losses
  - Annual equivalent of energy costs due to I^2R losses (AEC):

$$AEC = I^2R(LsF)$$

Where :

$$LsF = 0.15(LDF) + 0.85(LDF)^2$$

Where :
LDF = Load factor or average yearly load divided by peak load

  - Line load varies over time so there is no precise method to calculate losses over time
  - However, utilizing load factors (LDF) can give a good approximation suitable for economic assessments

LOSS REDUCTION

- **Transformer Losses**
  - 2010 mandates by the Department of Energy (DOE) governing distribution transformer efficiency
    - All oil-filled transformers must meet higher minimum efficiency standards (DOE Ruling 10 CFR 431, Part III)
  - As a result of these standards, initial costs likely to rise (copper costs, etc.) but gains in long-term operational costs positively impacted

  - SMUD utilizes total cost of ownership
    - This includes initial cost and cost of operation over the life of installation
  - Both costs must be thoroughly examined and weighed to determine the best cost/benefit ratio, taking into account all mitigating factors (i.e., operational, maintenance and reliability)

LOSS REDUCTION

- **Transformer Losses**
  - Cost of ownership and operation significant, both initially and over the life of operation
  - Initial cost heavily dependant on commodity values (i.e., Copper) and likely to increase due to commodity prices and efficiency standards
  - Two major operational costs of transformers:
    - No-load losses
    - Load losses

- Load losses represent I^2R losses while in operation
- No-load losses represent "energized" losses
  - Hysteresis losses: energy expended due to magnetic flux
  - Eddy current losses: energy expended due to circulating currents in the core

LOSS REDUCTION

- **Transformer Losses**
  - Marginal operational costs varies over time due to changes in generation costs
  - SMUD operational load-loss costs have increased exponentially over the last few years
    - In 2003 SMUD used $0.93 per load-loss watt and $3.9 per no-load loss watt
    - Today it has ballooned to $2.8/watt and $11.4/watt respectively

- Increases in costs due primarily to increases in energy costs and anticipated loading over the life of installation

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LOSS REDUCTION

CASE 1	Option 2				Option 3				Difference		
	1st Cost	NLL	LL	EnergyCosts	1st Cost	NLL	LL	Energy Costs	1st Cost	Energy Cost	CBR
50kVA Pole	$ 1,385	90	566	$ 2,662	$ 1,433	78	572	$ 2,542	$ 48	$ (119)	2.49
50kVA Pad	$ 2,379	91	603	$ 2,780	$ 2,492	84	541	$ 2,521	$ 113	$ (259)	2.29
300kVA Pad	$ 9,468	469	2646	$ 12,994	$ 9,820	454	2414	$ 12,152	$ 352	$ (841)	2.39
2500 Pad	$ 41,672	2749	14801	$ 74,113	$ 44,848	2377	$13,994	$ 67,540	$ 3,176	$ (6,573)	2.07

CASE 2	Option 1				Option 3				Difference		
	1st Cost	NLL	LL	EnergyCosts	1st Cost	NLL	LL	Energy Costs	1st Cost	Energy Cost	CBR
50kVA Pole	$ 1,356	92	568	$ 2,690	$ 1,433	78	572	$ 2,542	$ 77	$ (148)	1.92
50kVA Pad	$ 2,326	88	620	$ 2,795	$ 2,492	84	541	$ 2,521	$ 166	$ (274)	1.65
300kVA Pad	$ 8,815	425	3148	$ 13,943	$ 9,820	454	2414	$ 12,152	$ 1,005	$ (1,791)	1.78
2500 Pad	$ 38,826	2844	15202	$ 76,355	$ 44,848	2377	$13,994	$ 67,540	$ 6,022	$ (8,815)	1.46

- **Transformer Losses**
  - Shown here is an example of anticipated unit costs based on different efficiency standards and long-term load-loss costs
  - Cost/benefit ratio (CBR) is key
  - Some units have higher initial costs, but offer greater long-term load-loss costs (difference column)
  - Unknown variables (risk) in regards to long-term cost estimates

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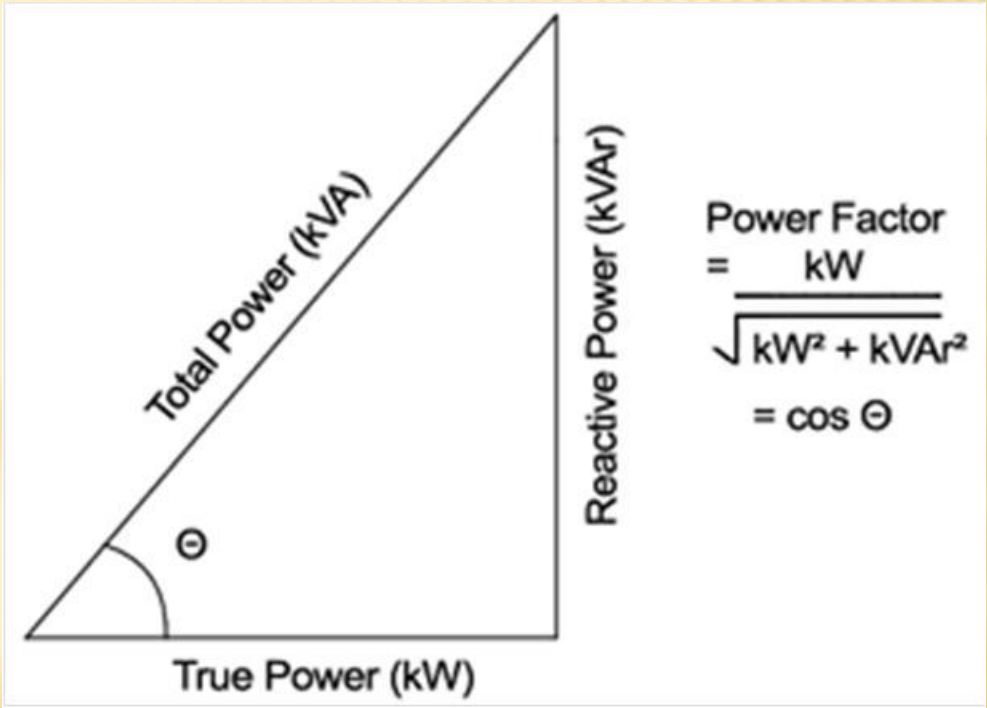
LOSS REDUCTION

- **Capacitor Banks**
  - Reactive power is one of the most important and controlled (or controllable) component on the distribution system
  - While vital to the system (e.g., motors, transformers, etc.), reactive power does no "real" work
  - Can have great benefits to distribution system efficiency/capacity
  - Not only are improvements seen in real losses, but vast gains can be achieved in overall equipment utilization by "freeing" up capacity



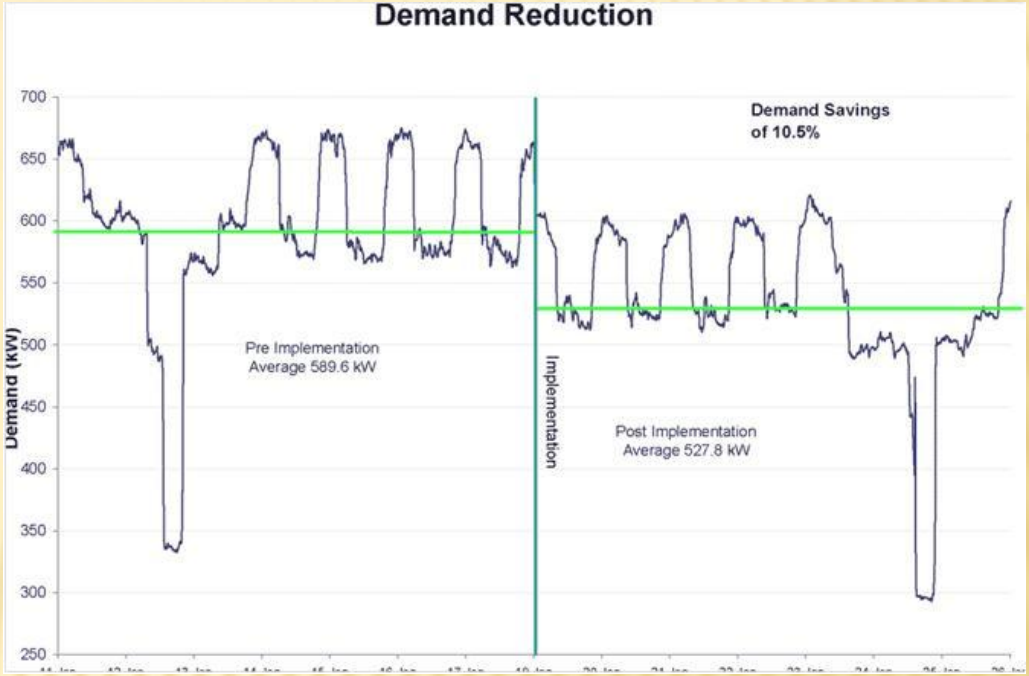
LOSS REDUCTION

- **Capacitor Banks**
  - Capacitor banks provide tremendous benefits to distribution system efficiency
  - Capacitors provide:
    - Power factor correction
    - Voltage support
    - Increased capacity
  - Two main distribution capacitor types:
    - Line
    - Substation
  - SMUD aggressively utilizes capacitor banks to minimize system losses and increase line capacity, greatly improving distribution system efficiency

- The increase in capacity helps to maximize system utilization, improving costs by postponing otherwise expensive capacity improvements

LOSS REDUCTION

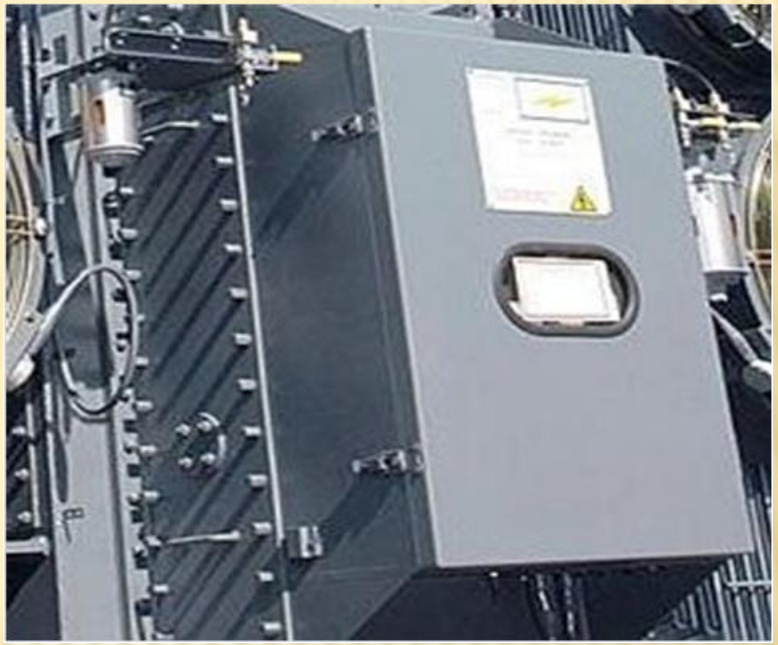
- **Voltage Regulation & Optimization**
  - Voltage regulation and optimization is a well known system and energy conservation and efficiency measure
  - Voltage controls can effectively reduce both real and reactive power demands anywhere from 2 to 10 percent



  - Voltage regulation improvements require THOROUGH system studies to meet all end-user's voltage requirements!

LOSS REDUCTION

- **Voltage Regulation & Optimization**
  - The most common SMUD control element is the transformer load tap changer (LTC)
  - The LTC controls the output voltage of the transformer
  - The LTC is SCADA operable
  - SMARTGRID, AMI and other technologies will help SMUD optimize Voltage/Var controls for greatest system efficiency improvements



- This will allow SMUD to integrate LTC controls with other efficiency devices (capacitor banks) to maximize voltage/Var regulation and optimization

LOSS REDUCTION

- **System Optimization**
  - SMUD employs a vast and integrated SCADA (Supervisory Control and Data Acquisition) system
  - SCADA allows us to control (automatically or manually) both voltage and capacitors banks for maximum efficiency improvements
  - Control elements greatly improves system efficiency
  - Data management and automation capabilities tuned specifically to efficiency improvements

- Intelligent alarming and control aspects greatly enhances distribution efficiency improvements

SYSTEM OPERATIONS

SYSTEM OPERATIONS

SYSTEM OPERATIONS

- **System Operations**
  - Distribution System Operations (DSO) manages and controls the entire distribution system
  - Primary responsibilities include:
    - Monitoring and ensuring the system is operating within allowable tolerances
    - Storm preparation and management
    - Managing outages
    - Switching and clearance orders
    - Accounting for any system changes or additions in real-time

SYSTEM OPERATIONS

- **System Management**
  - Ensuring the system is operating within acceptable and allowable tolerances is a critical component of system operations
  - Operating within loading guidelines is critical to safe and reliable system operations
  - Design guidelines from transformers to conductors are all strictly adhered to
  - Voltage and Var requirements are also closely monitored

- System changes are made to pre-empt or adjust to a system deficiency, alarm or operating constraint

SYSTEM OPERATIONS

- **Outage Management System (OMS)**
  - The Outage Management System (OMS) is an operating tool that assists in managing all facets of system operations during an outage
  - Used to predict the source and scope of any outage
  - Provides a means to manage and prioritize workload and resources relating to the outage
  - Up-to-date indicator of all jobs in the District in real-time

SYSTEM OPERATIONS

- **SCADA**
  - SCADA or Supervisory Control and Data Acquisition is a fundamental component of efficient system operations
  - Real-time indicator of system status
  - Monitor district loads on individual circuits
  - Open and close breakers remotely
  - Operate capacitor banks remotely / automatically
  - Has alarms to indicate when there is a problem on the system

SYSTEM OPERATIONS

- **Outage Process**
  - Customer Call Center (CCC) receives an outage notification
  - CCC Creates "Ticket" in SAP
  - Electronically transferred from SAP/IVR to OMS
  - If IVR, ticket goes to Service Dispatcher who calls customer
  - CCC and Service Dispatchers try to resolve call
  - If Dispatcher able to resolve, close ticket

SYSTEM OPERATIONS

- **Outage Process (cont.)**
  - If unable to resolve, ticket goes to Trouble Shooter
  - Trouble shooter fixes problem/identifies cause
  - Trouble shooter communicates to Customer
  - Tags come back to Service Dispatchers
  - If resolved, they log it
  - If unresolved, job is created for the appropriate work group to investigate and/or repair

SYSTEM OPERATIONS

- **Switching & Clearance Orders**
  - Managing the day-to-day operation of the system involves working closely with other groups
  - This involves managing switching and clearance orders to ensure segments of the system requiring work and/or maintenance are properly and safely de-energized

  - Clearance is an authorization to work on a section of line that has been de-energized and isolated from all sources of electrical potential

SYSTEM OPERATIONS

- **Switching & Clearance Orders**
  - No conflict with any other clearance scheduled for same time
  - Write clearance (switching steps needed to de-energize line)
  - Check correct switching steps and schedule the clearance
  - Direct trouble shooters or work crews through each step of the process to de-energize & tag out the line section and ensure safety
  - Report crew on section of line (hand it over to crew for work)
  - Crew completes work and returns section to operations

- Directs crew or T/S through process of restoring section of line to normal

SYSTEM OPERATIONS

- **Emergency Operations**
  - Emergency operations are triggered during the following events:
  - Sustained wind speeds are forecasted to be exceed 30 mph
  - Wind gusts forecasted to be at least 35 mph
  - Sustained high temperatures (100 degrees or above) are forecasted over multiple days and overnight low temperatures are forecasted to be 70 degrees or above

- There are ten or more unidentified or unassigned outages, impacting at least 500 customers

SYSTEM OPERATIONS

- **Emergency Operations**
  - 500 or more customers have been out of power for at least four hours and at least 500 customers are forecasted to be out of power for more than twelve hours
  - 10% or more of District customers are impacted or are anticipated to be impacted
  - Existing resources are insufficient to respond to the emergency in a safe and efficient manner and additional manpower is needed for 24/7 coverage

  - Duration of the event is expected to go beyond twelve hours
  - Major event is expected to result in extensive inquiries from the media and/or governmental agencies

SYSTEM OPERATIONS

- **Restoration and Dispatch Priorities**
  - Ensuring public safety is our number one goal and priority; restoration priorities take this goal into account
  - (1) Public and employee safety:
    - Downed "live" power lines
    - Public exposure to energized facilities
  - (2) Reliability of the District's portion of the SMUD Control Area Grid
    - Major generation facilities
    - Major transmission facilities
    - Major distribution facilities

SYSTEM OPERATIONS

- **Restoration and Dispatch Priorities**
  - (3) Critical infrastructure
    - Critical fire / law enforcement operations (city & county 911 facilities)
    - Critical pumping facilities (sewage pumping stations, storm pumping stations)
    - Hospitals
    - Mass transportation (Sacramento Airport & the Light Rail System)

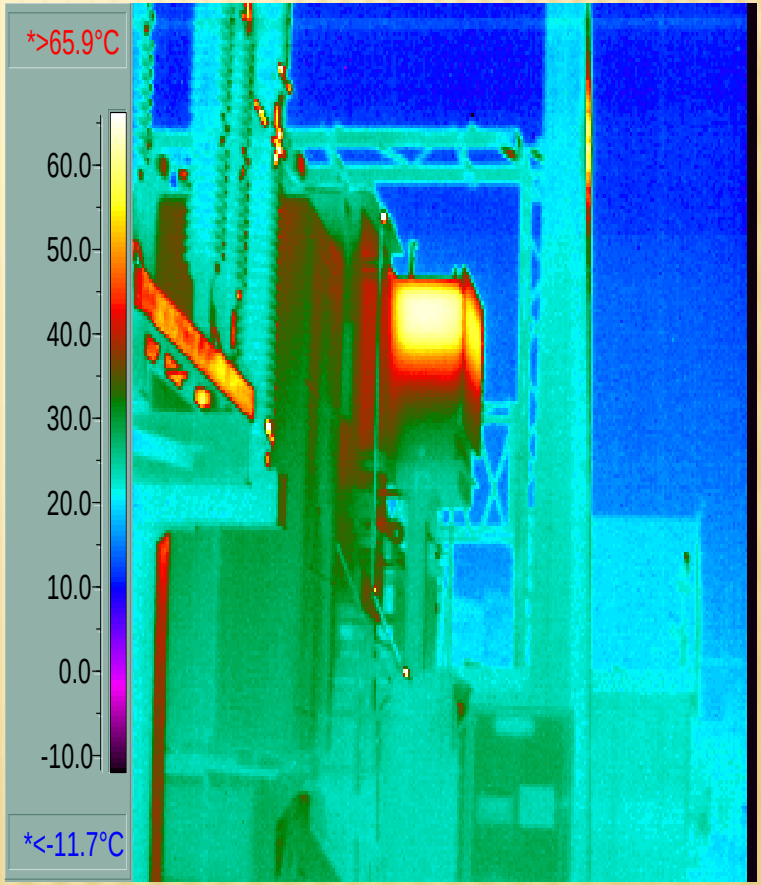
  - (4) Repairs that impact the largest amount of customers
  - (5) Individual customers

SYSTEM MAINTENANCE

SYSTEM MAINTENANCE

SYSTEM MAINTENANCE

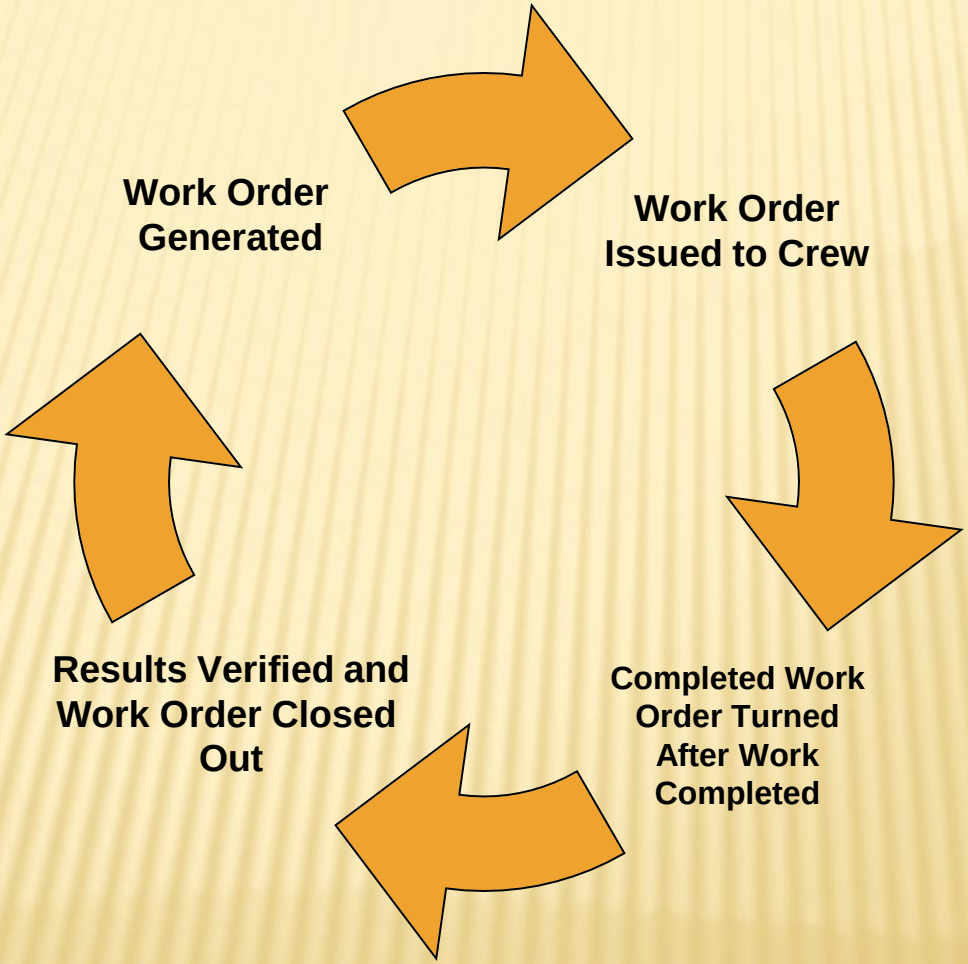
- Planned/Preventive/Scheduled Maintenance
  - Prevents problems (Better)
  - Desirable
  - Predictable
  - Condition Based
  - Risk/Criticality Model
- Unplanned/Corrective/Unscheduled Maintenance
  - Not desirable
  - Associated with outages or breakdowns
  - Costly



DISTRIBUTION PERFORMANCE STANDARDS

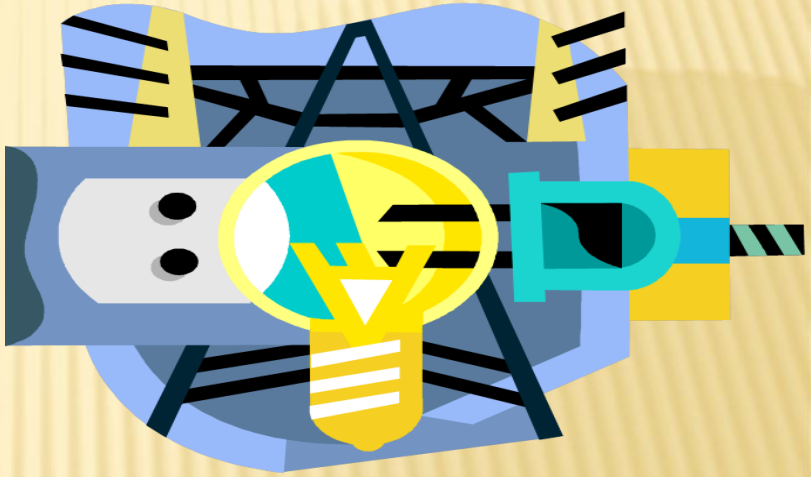
- CPUC Energy Reliability Program
  - Performance Standards (decision 96-09-045)
  - Three Measures of Outages
    - *SAIFI (System Average Interruption Frequency Index)*
    - *SAIDI (System Average Interruption Duration Index)*
    - *MAIFI (Momentary Average Interruption Frequency Index)*
- Inspection and Maintenance Standards
  - General Order 165
  - Patrol, detailed Inspection, Intrusive Inspection
- Tree Trimming/Vegetation Management Standards

SYSTEM MAINTENANCE – WORK FLOW



SYSTEM MAINTENANCE

- **Condition Based Maintenance**
  - Doing only the maintenance that is required
  - Uses predetermined "trigger" points
  - Monitors baseline limits
  - Substations Employs:
    - Oil analysis
    - DGA analysis
    - Megger/TTR
    - Vibration testing
    - Infrared thermography
    - Sweep frequency response analysis (SFRA)
    - Corona inspections
  - Line Inspections
    - Regulatory Compliance



  - Line Inspections
    - Poles/Towers
    - Underground vaults/manholes
    - Cross arms
    - Vegetation

SYSTEM MAINTENANCE

- **Condition Based Maintenance**
  - Tests and monitors the condition of the equipment at various frequency based on Asset Risk or Criticality
    - Impact to number of customers
    - Impact to critical customers (Sac International Airport, Hospitals, Large Commercial Load)
    - Restoration time
    - Redundancy
    - Historical trending of test results of the various Condition Monitoring Tasks

SYSTEM MAINTENANCE

- **Condition Based Maintenance**
  - Condition Monitoring Tasks (CMTs)
    - Monitoring tasks are performed to determine the condition of the equipment and monitor for changes in the condition
  - Condition Directed Maintenance (CDM)
    - Tasks performed to address changes in the equipment detected by the CMT

SYSTEM MAINTENANCE

- Condition Based Maintenance

Condition Based Maintenance – Condition Monitoring Tasks						
CMTs	2007 – 2010 CMT or High Risk Equipment Interval		2010 – Beyond (Medium Risk Equipment) Interval		2010 – Beyond (Low Risk Equipment) Interval	
	Equipment	Interval	Equipment	Interval	Equipment	Interval
Visual Inspection	All Substation Equipment	Monthly	All Substation Equipment	Monthly	All Substation Equipment	Monthly
Infrared Inspection	All Substation Equipment	Annual	All Substation Equipment	Annual	All Substation Equipment	Annual
TCA/TASA	Transformer/ Tap changer	Annual	Transformer/ Tap changer	2 Year	Transformer/ Tap changer	3 Year
DOBLE	Transformer	Baseline and time of high side protection	Transformer	Baseline and time of high side protection	Transformer	Baseline and time of high side protection
Ultrasonic Vibration	Transformer	Baseline and time of high side protection	Transformer	Baseline and time of high side protection	Transformer	Baseline and time of high side protection
TTR	Transformer	Baseline and time of high side protection	Transformer	Baseline and time of high side protection	Transformer	Baseline and time of high side protection
Megger	Transformer	Baseline and time of high side protection	Transformer	Baseline and time of high side protection	Transformer	Baseline and time of high side protection
SFRA	Transformer	Baseline and time of high side protection	Transformer	Baseline and time of high side protection	Transformer	Baseline and time of high side protection

SYSTEM MAINTENANCE

Condition Based Maintenance

Condition Based Maintenance – Condition Monitoring Tasks						
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SFRA	Transformer	Baseline and time of high side protection	Transformer	Baseline and time of high side protection	Transformer	Baseline and time of high side protection

SYSTEM MAINTENANCE

- **Parts, Process, and Stock**
  - A dedicated maintenance planning and scheduling group handles all maintenance parts and stock requirements
  - All maintenance processes incorporated into SAP work order system
  - Work order system incorporates parts requirements for each maintenance process
  - Every stock item needed for any particular maintenance work is recorded within the work order at the time of use

  - This work order system tracks all costs and also automatically replenishes stock based on pre-determined levels
  - Maintenance and material trends and other data assessments can be analyzed using this system

WORKFORCE

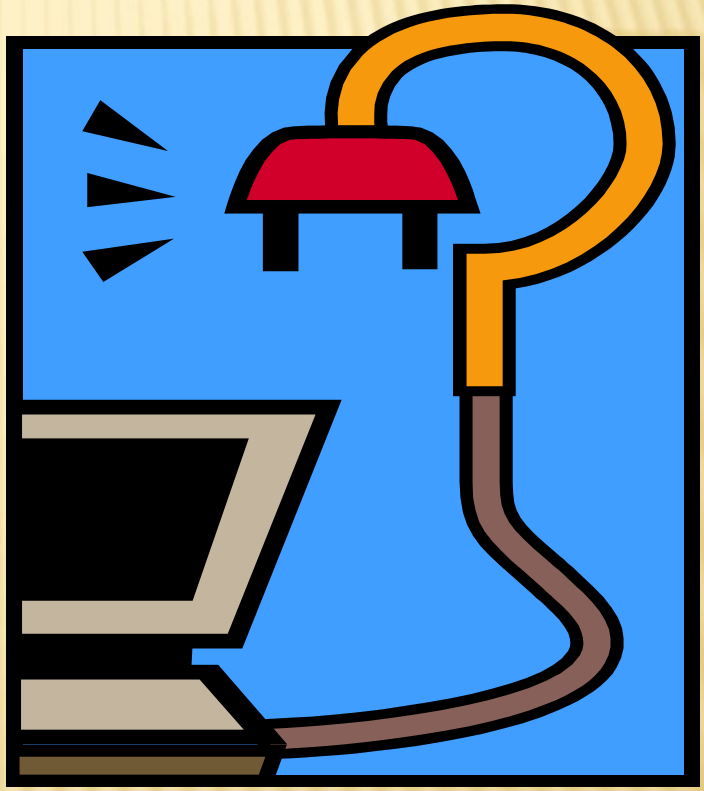
- Recruitment
- Enhancement
  - Skill Assessment
  - Technology edge
  - Training & re-training
  - Continuing education
- Industry leader
  - Establish best practices
  - Employee Engagement
- Retention
  - Keep the best
  - Training Facilities
  - SMUD a great place to work

CONCLUSION

- Closing Remarks
  - SMUD is presented with new challenges, new challenges related to efficiency and reliability (Example - AB 2061 – Smart Electricity Distribution and Efficiency Act)
  - Ensuring the system is planned, operated and maintained in the most efficient, reliable, and cost-effective and conscious manner
  - Continually evolve and strive to make improvements whenever possible

  - SMUD will be better prepared to face any new challenges as they arise, providing the greatest benefit to our ratepayers
  - Customer and Employees are engaged in the outcome everyday

QUESTIONS/COMMENTS



SMUD
SACRAMENTO MUNICIPAL UTILITY DISTRICT
The Power To Do More.©

THANK YOU

Lighting up Lives of People…

LECO

Lanka Electricity Company (Private) Limited

LOSS REDUCTION
&
RELATED DISTRIBUTION REFORMS

Rasanga Fernando
Lanka Electricity Company (Private) Limited
Sri Lanka

LECO was Established in 1983

SHAREHOLDING POSITION OF LECO	
Ceylon Electricity Board	54.8%
Government Treasury	43.6%
Urban Development Authority	0.8%
Local Authorities	0.8%

DISTRIBUTION ASSET SUMMARY	
Total Number of Customers	469,000
11kV line length	1,025 km
LV line length	3,933 km
11kV/400V substations	3,494

Our Journey…

- **Took over Distribution Systems of Local Authorities**
- **Carried out complete Rehabilitation of the run down distribution systems using ADB assistance**
- **New concept in power distribution was adopted introducing LV Arial Bundled Cable**

The Distribution System of LECO ....

Most Optimum solution was to use…

- **Bare Aluminum (AAC) for 11kV feeders**
- **Arial Bundled Cables (ABC) for LV feeders**

  Higher reliability, Easy Maintenance, Low Pilferage or theft on Electricity
- **Small Capacity Distribution Transformers (50-250kVA) with Short LV feeders**

  Reduced line losses

  Increased reliability of power

  Enhanced quality of power

The Distribution System of LECO ….

- **Joints & Bindings were replaced with**

  Crimped Joints

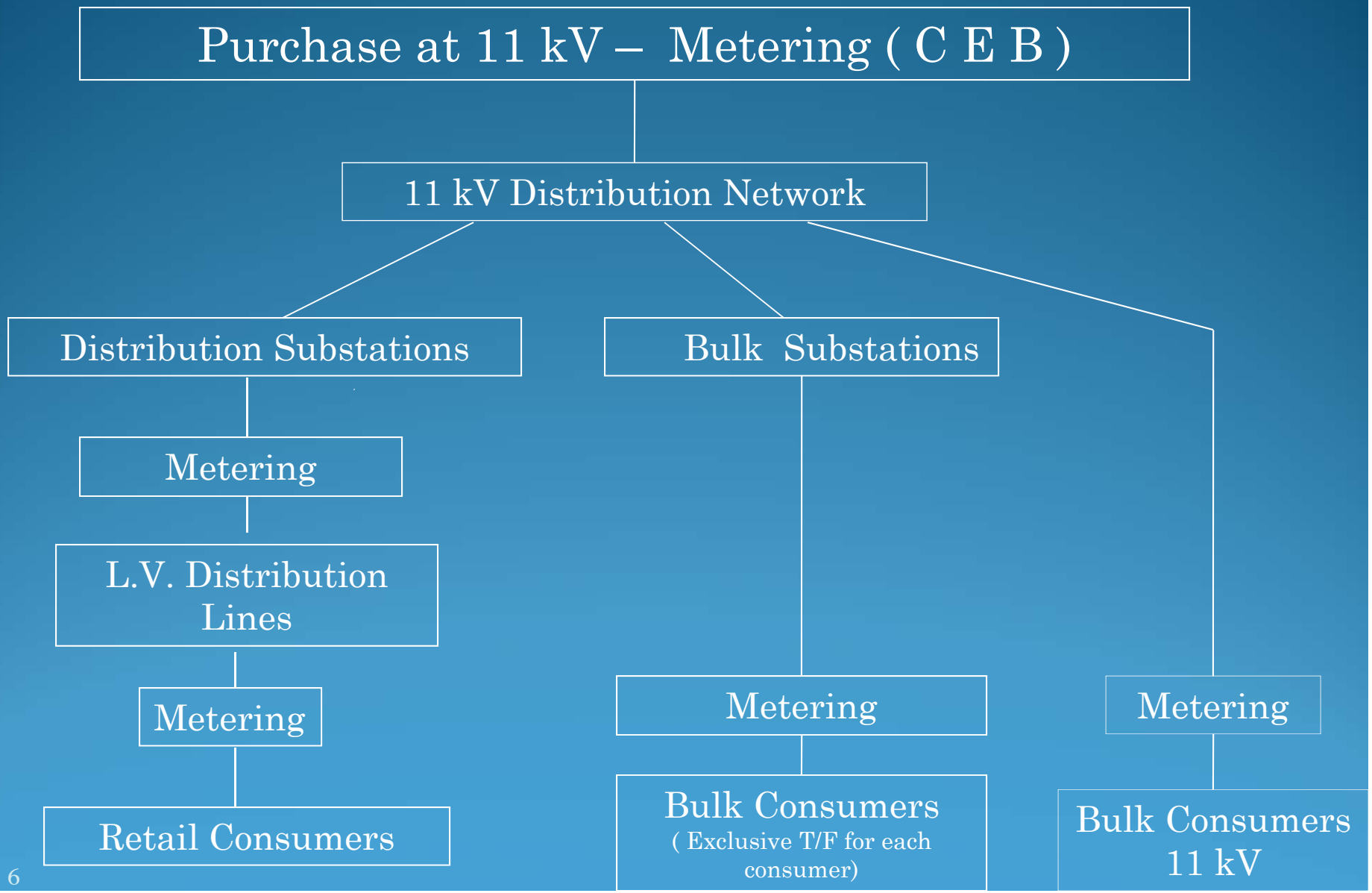
  H – Connectors : for Bare Conductors

  Piercing (T- off) Connectors : for ABC Conductors

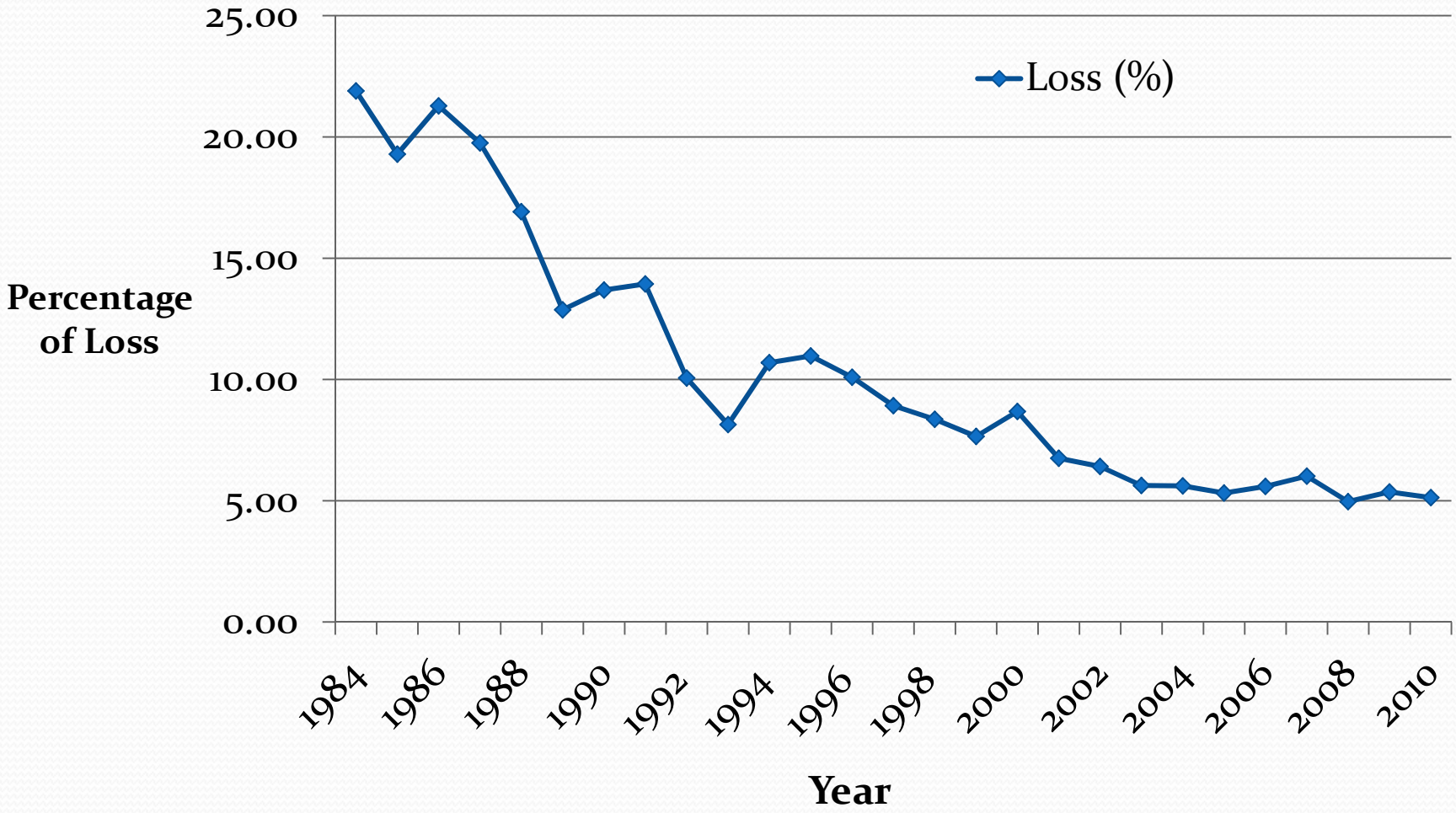
  Higher reliability

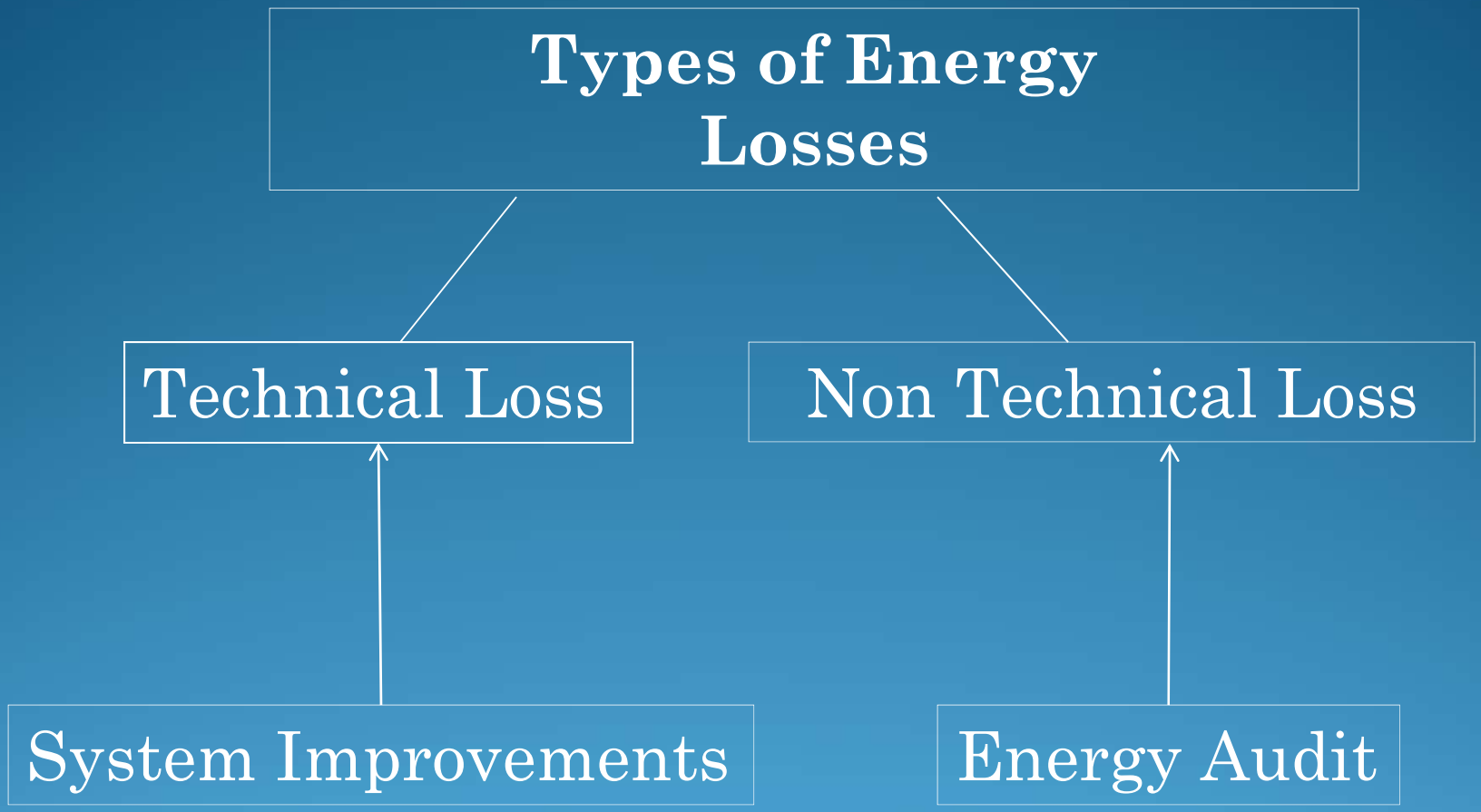
  Reduced losses

DISTRIBUTION SYSTEM of LECO



LECO Distribution System Energy Loss Variation




Types of Energy Losses
Technical Loss
Non Technical Loss
System Improvements
Energy Audit

Monitoring of Energy Losses

- Branch (Sub Division) overall loss
- CSC (Customer Service Center) wise loss
- Distribution Transformer wise loss

Branch Overall Energy Loss

- Purchases Vs Customer sales
- Monitoring Monthly, quarterly, 6 Month & annual loss figures
- Corrective measures are taken based on the above figures
- Act as a key performance indicator & set a target for the branch to achieve in reducing energy losses

CSC Wise Energy Loss

- Sub operating strategic units of a branch
- Measuring energy export & import across the boundaries
- Key performance indicator

Distribution Transformer Wise Energy Loss

- Measuring distribution transformer Purchases Vs Customer Sales
- High loss areas can be identified
- As smallest sub units - easy to take corrective measures

Energy Audit

To Minimize Non Technical Losses

- **Checking 11kV Purchase Meter accuracies**
  - ✓at Primary Sub Stations
  - ✓Accuracy class of 0.5
  - ✓Done it annually
- **Verifying accuracy of Bulk Consumer Meters**
  - ✓ 40% of total energy sales of LECO
  - ✓ Done it annually

➢ Testing of Retail Consumer Meters

- ✓ Where high loss areas are detected
- ✓ Check the meter at the Substation
- ✓ Consumer Meters are tested for accuracy
- ✓ Meters are Checked for Tampering
- ✓ Service Wire Down Run is checked for illegal tapping
- ✓ Check for unbilled / Un-metered connections
- ✓ Check for unauthorized street lamps
- ✓ Review the figure of loss percentage after taking corrective & preventive actions together with modifications

RELATED DISTRIBUTION REFORMS

- Electricity Distribution is a giant utility sector
- Present Scenario – Distribution Sector Largely Inefficient
- In a regulated environment the energy sector is made into clusters as;
  - Generation
  - Transmission
  - Distribution
- Each cluster has " Transfer Prices "
  - ✓ Generation to Transmission: Transmission Transfer Price
  - ✓ Transmission to Distribution: Bulk Transfer Price
- "Regulator" - a New Entity : Regulates the "Transfer Prices" & imposes "Performance Indicators "

- The New Act on Electricity in Sri Lanka was enacted in year 2009
- Utility Regulatory body PUCSL (Public Utilities Commission of Sri Lanka) was established
- When setting Transfer Prices or the " Tariff " PUCSL considers;
  - ✓ Allowed margin of loss percentage
  - ✓ Capital expenditure
  - ✓ Profit for the utility company
- If the utility company go beyond the allowed loss percentage the cost of loss has to bear by the utility

Things to be Considered while Regulating a Utility

- Legal Aspects or The Act of governing the utility & the Utility Classification
- Position of the Utility in the Reform Structure
- Procurement & the Energy Sector

Legal Aspects Defined By The Act....

- Loss reduction is a historical phenomena
- Modality of reducing losses almost same for all countries
- Technologies or engineering approaches are same for reducing technical losses
- Reducing the Non-technical or commercial losses - mainly focused on reducing Electricity Theft
- How to approach on theft – depends on the country's legal framework
- Major drawback on the " Law Enforcement" on " Non-Technical Losses"

Legal Aspects Defined By The Act....

Crown Property – State Department

- ✓ Assumes there will be no theft
- ✓ If it happens it is considered as a " Criminal Offence" or an " Unbailable – Offence"

Cooperate Property – State Organization

- ✓ Public law is applied
- ✓ Electricity theft is considered as similar to any other theft
- ✓ The law carries on the same way as done for any other commodity

Legal Aspects Defined By The Act….

Contract Property – Private Organization

- ✓ Utility supplier considered as a private organization
- ✓ Laws would be
  - Private-private law,
  - Private-cooperate law
  - Cooperate-cooperate law
- ✓ Through "Fundamental Rights"' Private-Private law has been Artificially Strengthened

- **New Act – utility considered as a Contract Property**

Reform Structure….

LECO is the one & only utility which was operated as a "Regulated Regime " in an "Unregulated Environment"

3-Type of Reform Structures

- ✓ Vertically Integrated Entity
  - Every cluster generation, transmission & distribution were handled & controlled is done by a single organization
  - At the take over LECO was "Vertically integrated"
  - Energy Losses usually in the range of 12% - 15% for these entities

- ✓ Regulated Entity
  - All organizations strive together to achieve predefined goals
  - Energy Losses usually in the range of 8% - 9%

Reform Structure….

✓De-Regulated Entity

- Initially LECO was inspirited in a de-regulated environment to be efficient more than larger organizations
- Which brought the low cost methods & increased its efficiency
- Under this loss reduction programs were introduced
- Energy Losses usually was in the range of 4% - 5%

Procurement & Distribution Reforms ....

- 95% from the utilities are built with the Infrastructure products & maintenance products
- The rest of the 5% is contributed from commodities
- To purchase infrastructure usually there is no proper specification or a guideline
- But every country has a **"National Procurement Guideline"** or a **"Limited National Biding procedure" (LNB)**
- It is mainly focused on 60% - 70% of non infrastructure & non-maintenance items

Procurement & Distribution Reforms ….

- Until recent times LECO was operated as a Public Owned – Private Company

- The reliability improvements & loss reduction programs were carried out without any difficulty in the past

- No user friendly procurement guideline for buying infrastructure
  - ✓ It has become very difficult to take prompt decisions
  - ✓ Procurement process for utility sector has become a very tedious process

- LECO has moved from Deregulated to Vertically Integrated System in the area of Procurement Procedures

Challenges to Overcome !

- Utility reformation should be done together with the Legal Framework reformation
- Utility should be considered as a crown property
- The laws should be reinforced to avoid electricity pilferage or theft
- Metering Electricity must be advanced metering technologies to mitigate theft & to do proper recovery of energy losses .
  - Proper Recording & Smart Metering
  - Electronic Meters & Remote Metering

Challenges to Overcome !

- Trying to reduce the technical losses the cost of capacity charges get increased
- Trying to reduce commercial losses or the non-technical losses, the cost of infrastructure get increased
- Cost of Electricity or energy is always has an ever lasting increasing trend

Challenges to Overcome !

- If someone has achieved an optimized figure at the loss reduction & willing to go further to reduce, it may (over optimization) cause higher increase in costs

- Strike Balance Between Loss & the Cost Of Loss reduction

- Preparing a favorable Procurement Guideline for Utilities

Conclusion

- Reformation of the structure of the utility reformation
- Match the property classification & the legal framework
- Proper technical & technology reformation
- Reformation of the procurement procedures for utilities
- Reformation of the external Socio & Legal environment

Thank You