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Energy Auditing System - Utilizing Network Management Systems for Loss Reduction

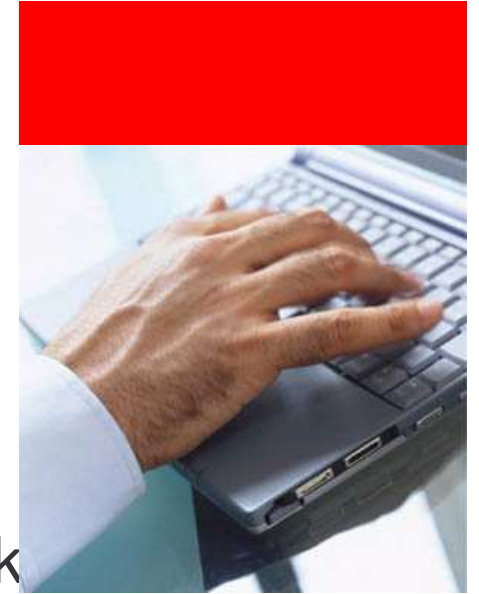
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Agenda

- Our Understanding of the Problem
- Loss Reduction Assessments
- Energy Auditing System (EAS) – Closer Look
- EAS – Implementation Approach
- Utilizing Oracle Network Management System (NMS) for EAS
- EAS to NMS Expansion





Indian Power Distribution Status

- Continuing mismatch in consumption and tariffs
- SEB revenue realization is only about 70%
- Much of electricity delivered is unaccounted for
 - High T & D losses ~30%
 - Commercial loss ~ 15 – 25 %
 - Distribution utility privatization initiative motivating factors
 - Improving services and reliability
 - Reduce commercial losses
 - High growth – Demand exceeds production



Reasons for High T & D Losses

- Technical Losses
 - Overloading – Too Much Demand – Not Enough Capacity
 - Aging Infrastructure
 - Too Much LV as Compared to HV (HV is more efficient) – LV Promotes Higher Technical Losses
 - Lack of Preventive Maintenance
- Commercial Losses
 - Inefficient metering, billing and collection Practice
 - Theft and meter tampering
 - Low accountability of employees
 - Lack of energy accounting and auditing

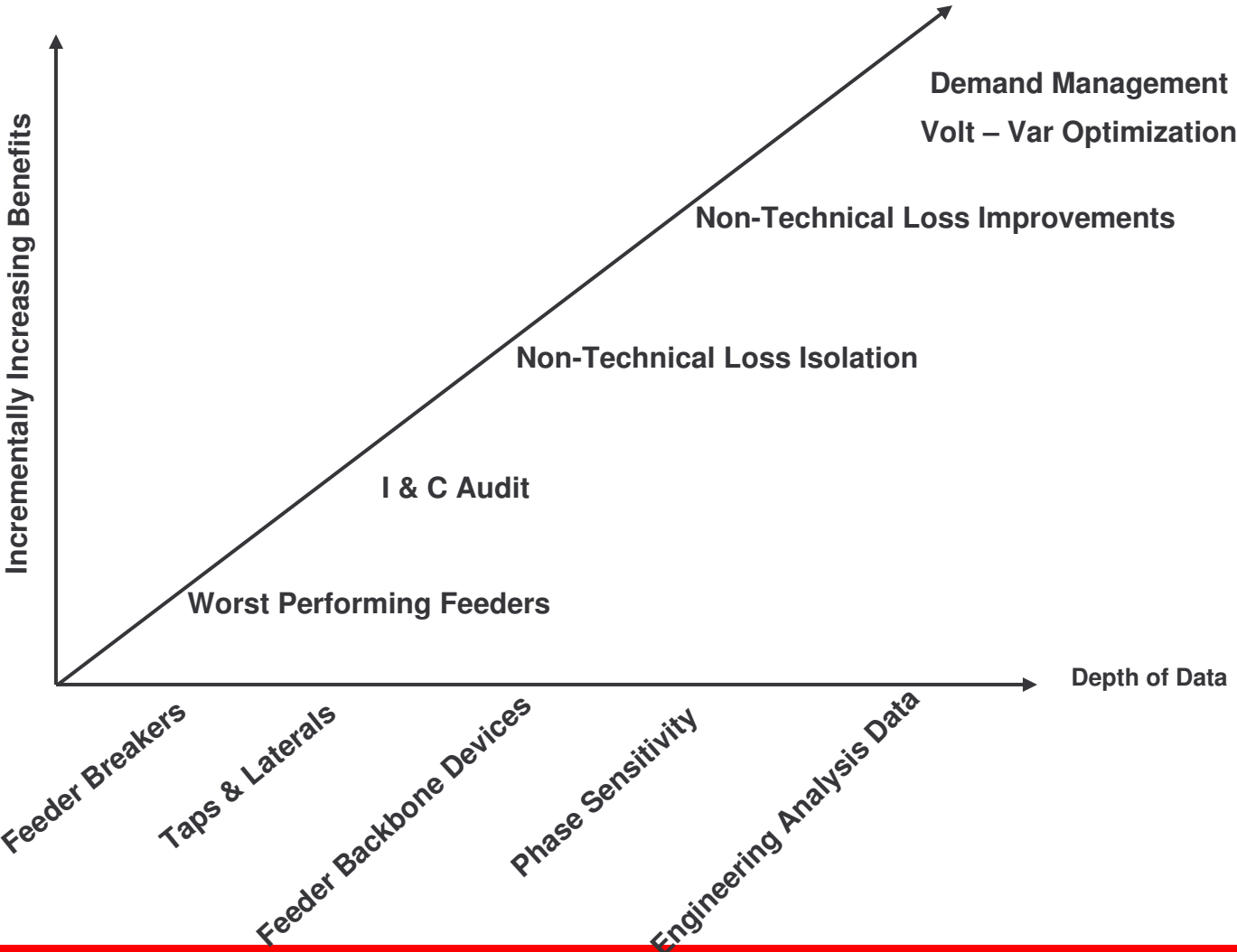


On-going efforts in India for Loss Reduction

- APDRP's (Accelerated Power Development & Reform Program) loss reduction measure initiative recommends:
 - Energy meters on 11 kv Distribution Feeders
 - Energy meters on distribution transformers
 - Reduce length of LT lines by reconfiguration and fewer LT lines
 - Digital mapping of field assets
 - Computerized Load Flow studies
- **Oracle recommends**
 - Staged and managed methodology based on available data and computer aided systems to systematically improve Technical and Non-Technical losses



Information Depth Increases Results



Loss Reduction Challenges

- Business Deficiencies
 - Past unavailability of meters resulting in direct connections
 - Deficient record keeping
 - Weak audit procedures
 - Improper account set-up
- Network Access
 - Large stretches of un-insulated secondary network offering easy access
 - Unsealed meters
 - Exposed, energized terminals when meters are withdrawn from service.





Current Limitations of Energy Audits

- Usually spreadsheet or database tables solution
- Inefficient usage of billing data to identify problem areas
- Does not easily correlate between revenue collected and consumption/delivery of power
- Data not updated continuously
- Does not take real-time network configuration and reconfiguration into consideration
- Lack of integration with other enterprise applications



Energy Auditing System Capabilities

- Centralized real-time integrated system
- Uses billing and available measurement data to identify problem areas
- Updated continuously
- Reflects real-time network configuration
- Integrates with major enterprise systems
- Is in the family of Network Management System products:
 - Distribution Management Systems
 - Outage Management Systems
 - Energy Auditing Systems
 - Business Intelligence

Energy Auditing System

- EAS provides the user tools to assess:
 - Feeder electrical connectivity view
 - Feeder load summary
 - Feeder revenue summary
- Provides an accurate assessment of energy use - visualizing the power lost through theft and technical losses
- Uses powerful mathematical algorithms with input from several data sources including the electrical network model to form an accurate picture of the state of the network and areas of concern
- Basic set of input data and can be configured to make optimal use of available measurements such as interval-based AMR reading or total energy consumption from billing records as provided by the Billing Systems





EAS – Recommended Approach

- Initial starting point
 - Customer model (maybe from a CIS)
 - Customer to feeder relationship (initially)
 - Customer to service transformer (desired)
 - Customer to transformer and phase (highly valuable)
 - Feeder model
 - Feeder breakers within substations
 - Backbone escalation chain (connectivity)
 - Taps and laterals (desired)
 - Phase sensitivity (highly valuable)
 - Manual measurements
 - Deploy loss reduction teams
 - Record and track measurements
 - Record and track investigations

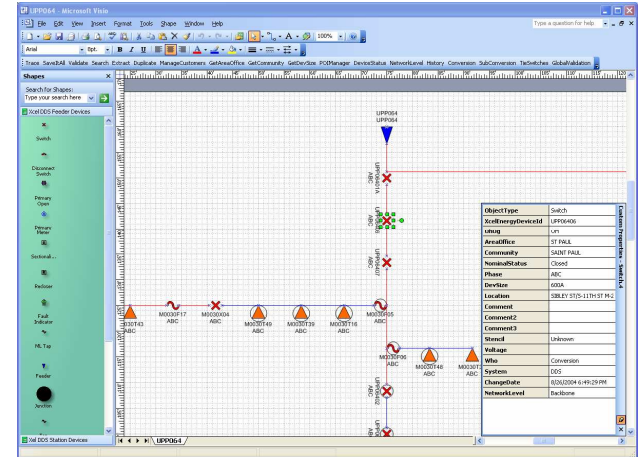


EAS Data Sources

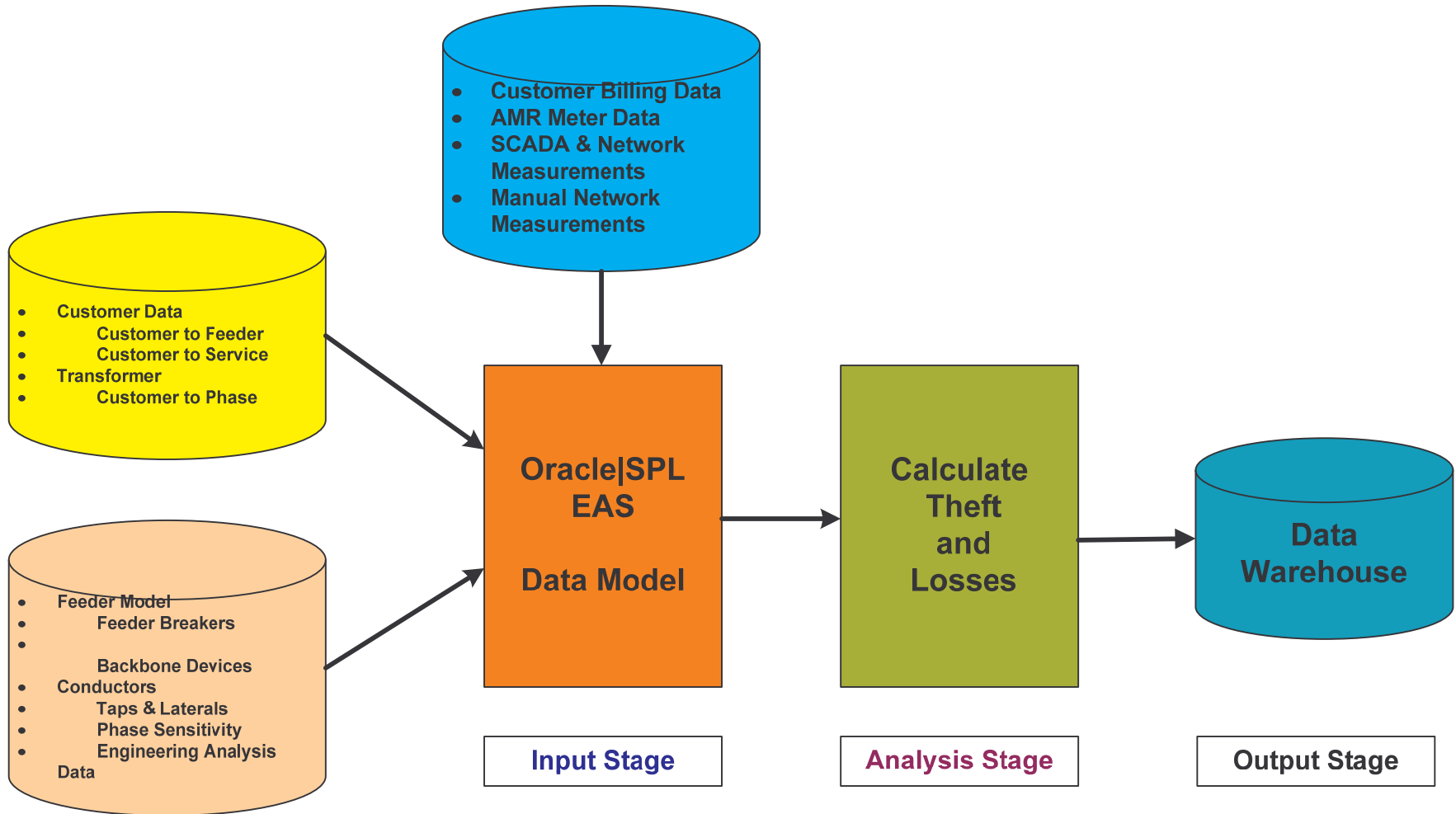
- A network connectivity model (from simple to complex)
- Association between
 - Customer to Meter
 - Meter to Transformer
 - Transformer to Feeder
- Initially can rely on periodic manual measurements
 - Loss Reduction Crew dispatch and scheduling capability
- Complement manual measurements over time with
 - SCADA measurements
 - AMR measurements
 - Other available measurements

EAS Approach

- Distribution network model
 - Build initial model of distribution network
 - Feeder Breakers within Substations
 - Backbone
 - Laterals
 - Phase Sensitivity
 - Does not need to be a complete model – evolve over time
- Customer Information System integration
 - Provides customer to feeder association
 - Initially establish customer to Dist. Transformer relationship
 - Desirable but not required to have service location to distribution transformer relationship by phase



EAS - Architecture





Correlation & Verification

- Correlation – against time-of-day
 - Feeder billing normalization (Rs. -> KWH)
 - Feeder delivery profile (KWH for hour)
 - Calculate magnitude differences
 - Show feeder statistics
 - Filter on worst performing feeders
- Verification
 - Manual measurement
 - Use NMS to schedule and dispatch the Loss Reduction Teams
 - Upload measurement results using SCADA Extensions
 - Prepare load profile for the feeder points
- Complement with
 - Feeder breaker energy meters
 - Existing system SCADA measurements
 - Other data sources of power delivery

Team Manual Readings and SCADA Measurements

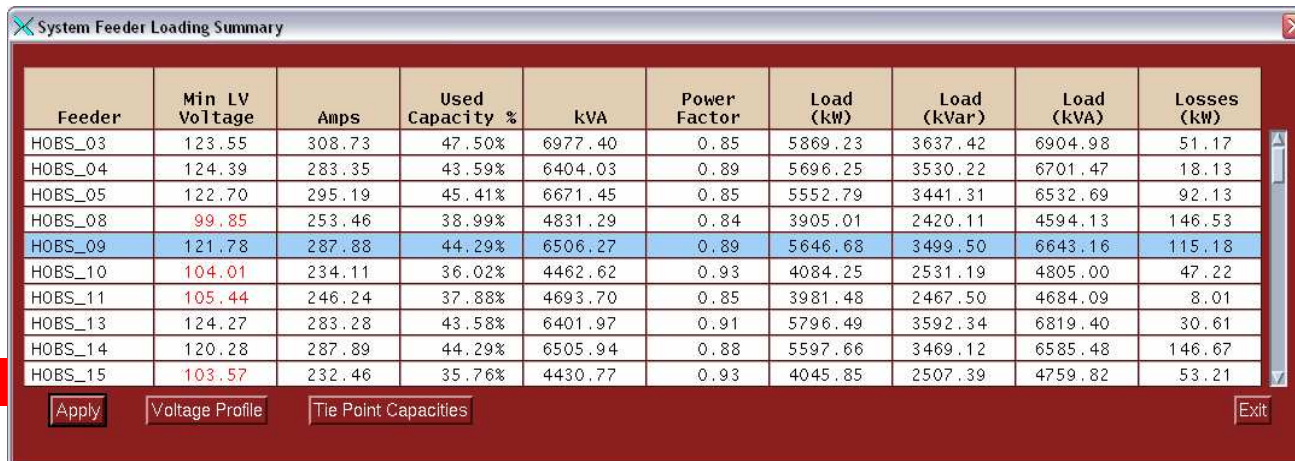
- SCADA provides Digital and Analog Measurements in real-time
- Non SCADA Device Measurements are Entered By Dispatchers from the Loss Reduction Teams

The screenshot displays the 'SCADA Summary' application window. The main window contains a table with the following columns: Feeder, Device, Attribute, Value, Qual, Units, Point Name, Type, and Comment. The table lists various feeders and their associated devices and attributes, with values mostly set to 0.00. A 'Manual Entry' dialog box is overlaid on the table, prompting for a 'New Value' with an input field and 'OK' and 'Cancel' buttons.

Feeder	Device	Attribute	Value	Qual	Units	Point Name	Type	Comment
ZS_HOBS-HV	HOBS_CB18	Amps_A	0.00		Amps	HOBS_CB18_Amps_A	Current (A) of A pha	
ZS_HOBS-HV	HOBS_CB18	Amps_B	0.00		Amps	HOBS_CB18_Amps_B	Current (A) of B pha	
ZS_HOBS-HV	HOBS_CB18	Amps_C	0.00		Amps	HOBS_CB18_Amps_C	Current (A) of C pha	
ZS_HOBS-HV	HOBS_CB19	Amps_A	0.00		Amps	HOBS_CB19_Amps_A	Current (A) of A pha	
ZS_HOBS-HV	HOBS_CB19	Amps_B	0.00		Amps	HOBS_CB19_Amps_B	Current (A) of B pha	
ZS_HOBS-HV	HOBS_CB19	Amps_C	0.00		Amps	HOBS_CB19_Amps_C	Current (A) of C pha	
ZS_HOBS-HV	HOBS_CB20	Amps_A	0.00		Amps	HOBS_CB20_Amps_A	Current (A) of A pha	
ZS_HOBS-HV	HOBS_CB20	Amps_B	0.00		Amps	HOBS_CB20_Amps_B	Current (A) of B pha	
ZS_HOBS-HV	HOBS_CB20	Amps_C	0.00		Amps	HOBS_CB20_Amps_C	Current (A) of C pha	
ZS_HOBS-HV	HOBS_CB21	Amps_A	0.00		Amps	HOBS_CB21_Amps_A	Current (A) of A pha	
ZS_HOBS-HV	HOBS_CB21	Amps_B	0.00		Amps	HOBS_CB21_Amps_B	Current (A) of B pha	
ZS_HOBS-HV	HOBS_CB21	Amps_C	0.00		Amps	HOBS_CB21_Amps_C	Current (A) of C pha	
ZS_PAUL-HV	PAPA_CB04	status	CLOSED		none		Topological Status	
ZS_PAUL-HV	PAPA_CB05	status	CLOSED		none		Topological Status	

Worst Performing Feeder Load Profile

- EAS generates Feeder Load Profile using available data
 - SCADA and manual measurements
 - Connected load profiles
- Users can determine
 - Worst performing feeders for auditing and field assessment
 - Incremental approach could help to narrow the likely location of the losses
 - Locations to dispatch loss reduction teams



The screenshot shows a software window titled "System Feeder Loading Summary" with a table of data for various feeders. The table has 10 columns: Feeder, Min LV Voltage, Amps, Used Capacity %, kVA, Power Factor, Load (kW), Load (kVar), Load (kVA), and Losses (kW). The data is as follows:

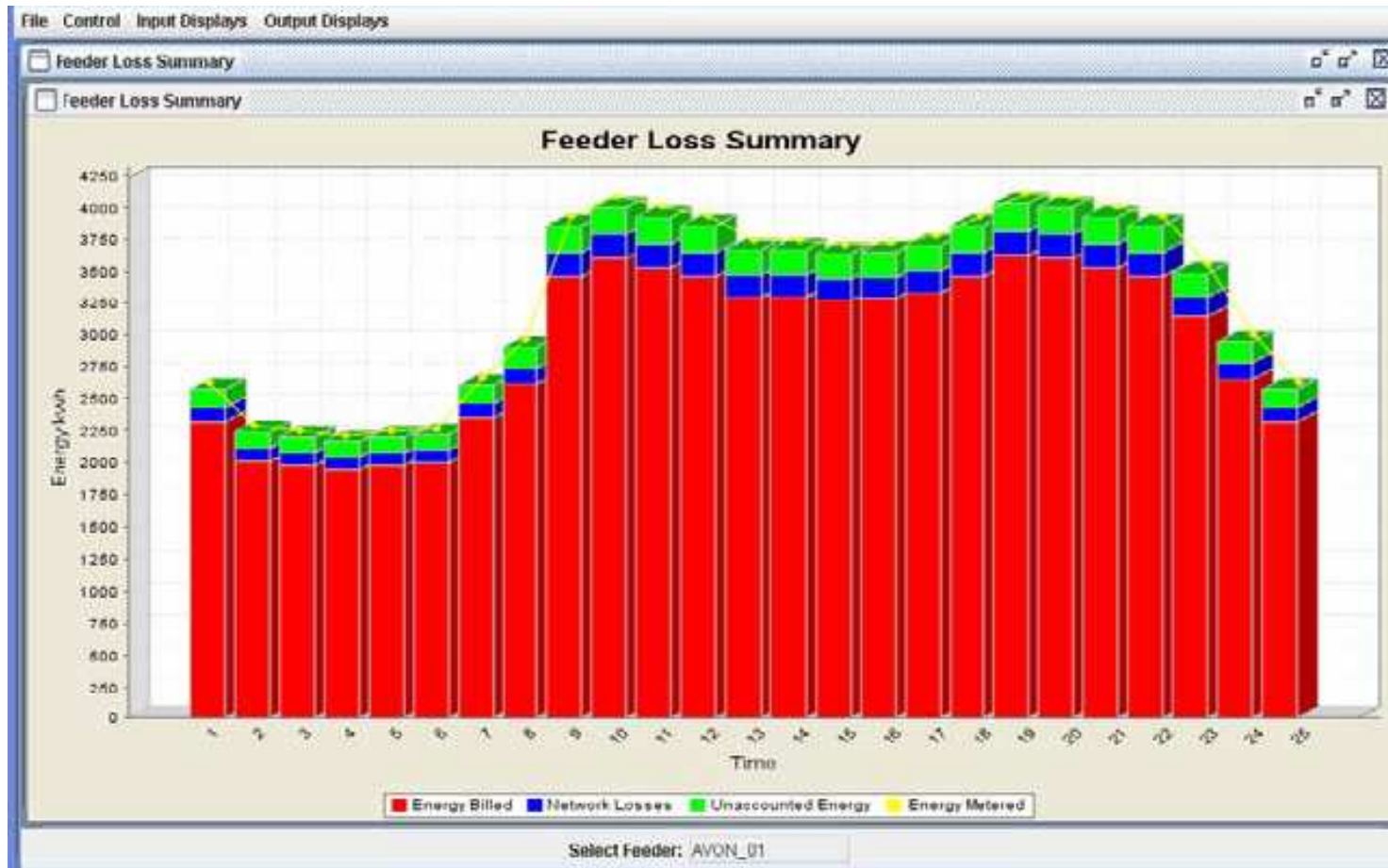
Feeder	Min LV Voltage	Amps	Used Capacity %	kVA	Power Factor	Load (kW)	Load (kVar)	Load (kVA)	Losses (kW)
HOBBS_03	123.55	308.73	47.50%	6977.40	0.85	5869.23	3637.42	6904.98	51.17
HOBBS_04	124.39	283.35	43.59%	6404.03	0.89	5696.25	3530.22	6701.47	18.13
HOBBS_05	122.70	295.19	45.41%	6671.45	0.85	5552.79	3441.31	6532.69	92.13
HOBBS_08	99.85	253.46	38.99%	4831.29	0.84	3905.01	2420.11	4594.13	146.53
HOBBS_09	121.78	287.88	44.29%	6506.27	0.89	5646.68	3499.50	6643.16	115.18
HOBBS_10	104.01	234.11	36.02%	4462.62	0.93	4084.25	2531.19	4805.00	47.22
HOBBS_11	105.44	246.24	37.88%	4693.70	0.85	3981.48	2467.50	4684.09	8.01
HOBBS_13	124.27	283.28	43.58%	6401.97	0.91	5796.49	3592.34	6819.40	30.61
HOBBS_14	120.28	287.89	44.29%	6505.94	0.88	5597.66	3469.12	6585.48	146.67
HOBBS_15	103.57	232.46	35.76%	4430.77	0.93	4045.85	2507.39	4759.82	53.21

At the bottom of the window, there are buttons for "Apply", "Voltage Profile", "Tie Point Capacities", and "Exit".

Example of the results of the CSS calculation of each feeder

File Control Input Displays Output Displays							
Feeder Loss Summary							
	Num Customers	Metered KWH	Billed KWH	Network Losses	%	Estimated Energy Losses	%
AVON_01	1623	83505.00	75154.50	3818.43	4.57	4532.07	5.43
AVON_02	591	40082.43	36074.19	637.66	1.59	3370.58	8.41
AVON_03	1565	78494.71	70645.24	10369.98	13.21	-2520.51	-3.21
AVON_05	611	26721.60	24049.44	925.81	3.46	1746.35	6.54
AVON_06	743	36185.50	32566.95	674.29	1.86	2944.26	8.14
AVON_08	593	21154.60	19039.14	403.67	1.91	1711.79	8.09
AVON_09	145	43979.32	39581.38	877.31	1.99	3520.62	8.01
AVON_11	1334	75154.52	67639.05	1770.84	2.36	5744.62	7.64
AVON_13	1727	72927.70	65634.94	2318.02	3.18	4974.74	6.82
CHEV_01	996	72705.05	65434.54	4632.21	6.37	2638.29	3.63
CHEV_03	1229	48989.60	44090.64	2277.38	4.65	2621.58	5.35
CHEV_04	1131	42309.20	38078.28	1393.40	3.29	2837.52	6.71
CHEV_05	644	41195.80	37076.22	1341.27	3.26	2778.31	6.74
CHEV_07	652	20597.91	18538.12	407.73	1.98	1652.07	8.02
CHEV_08	21	8907.21	8016.49	85.89	0.96	804.83	9.04
CHEV_09	979	42309.20	38078.28	1465.22	3.46	2765.70	6.54
ROSE_01	90	86845.22	78160.70	5321.65	6.13	3362.86	3.87
ROSE_02	259	11690.70	10521.63	226.75	1.94	942.32	8.06
ROSE_04	1511	80164.82	72148.34	3954.17	4.93	4062.31	5.07
ROSE_05	0	78494.70	70645.24	1585.51	2.02	6263.95	7.98
ROSE_06	91	105773.11	95195.77	2810.27	2.66	7767.07	7.34
ROSE_08	749	57896.81	52107.13	1534.05	2.65	4255.63	7.35
ROSE_09	82	94416.39	84974.77	4665.72	4.94	4775.90	5.06
ROSE_10	18	26164.92	23548.43	277.47	1.06	2339.02	8.94
ROSE_12	70	71814.38	64632.93	3852.33	5.36	3329.11	4.64

Feeder Loss Summary




Quantities shown in blue and green represent the network losses and the unaccounted energy, respectively

Benefits of EAS

- Works with existing utility data
- Determines network losses by feeder for the entire network
- Determine areas of network where theft of power is most likely occurring by feeder
- Business Intelligence tools provide accurate reporting to Management detailing use of energy from the injection point on the network down to the customer level
- Initial application with potential to expand into traditional Distribution Management and Outage Management applications utilizing a common data model and familiar user experience



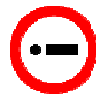


Additional Oracle Complementary Modules – NMS = DMS & OMS

- Oracle Utilities Network Management System (NMS)
 - Combination of Distribution Management Applications (DMS)
 - In conjunction with Outage Management Applications (OMS)
- Using a real-time connectivity model, simulates what's happening at all points in the network
- Monitors and alarms existing and potential problems based on the simulation
- Generates best-case switching and control action recommendations
- Manages Outages and Crew Dispatching
- Provides other operations engineering functions
- Out-of-the-box integration adapters based on industry standards
- Oracle Smart Grid Initiative – Smart Energy Alliance



Q&A



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