DNV GL - SOFTWARE

HECO

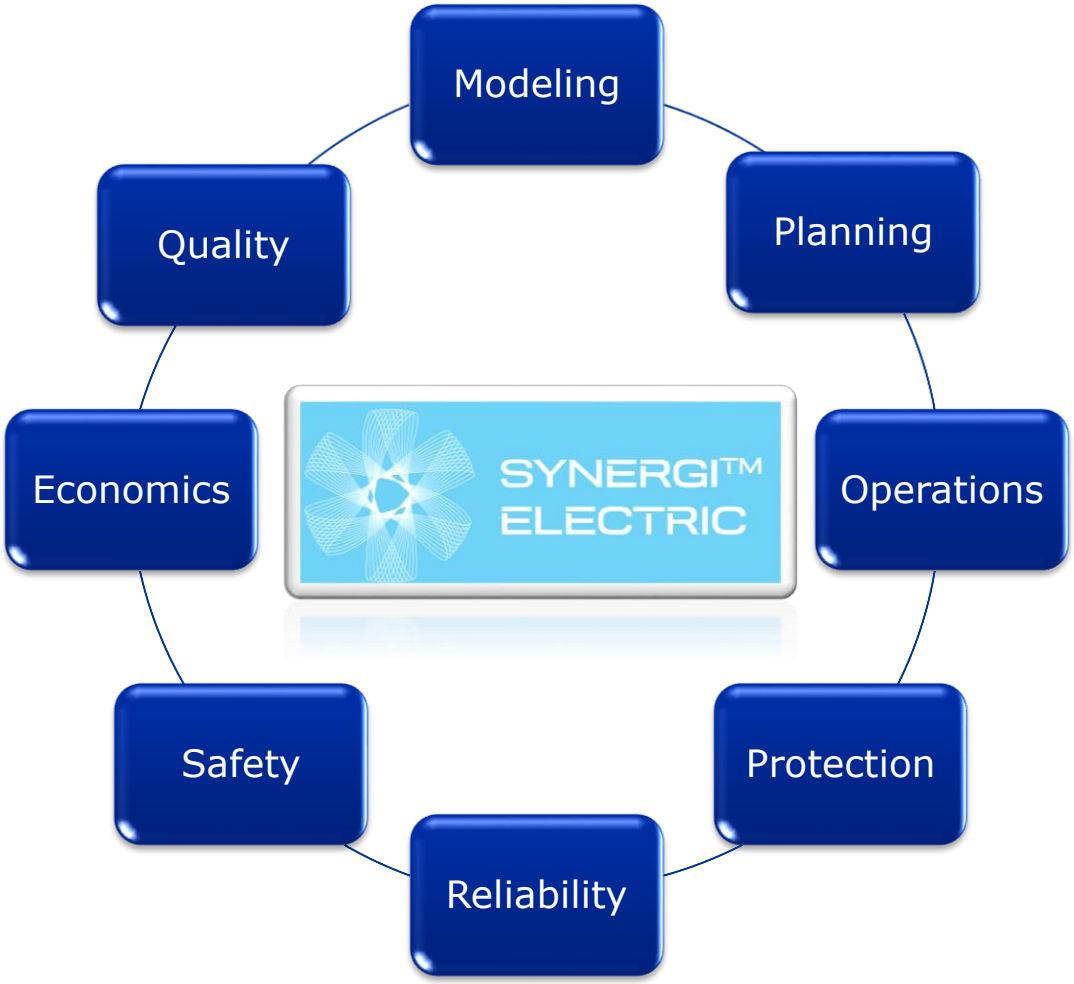
Modern Grid Technology & Leading Practices Workshop

Larry Trussell PhD EE

Senior Principal Electric Engineer – Synergi Electric

May 10, 2017

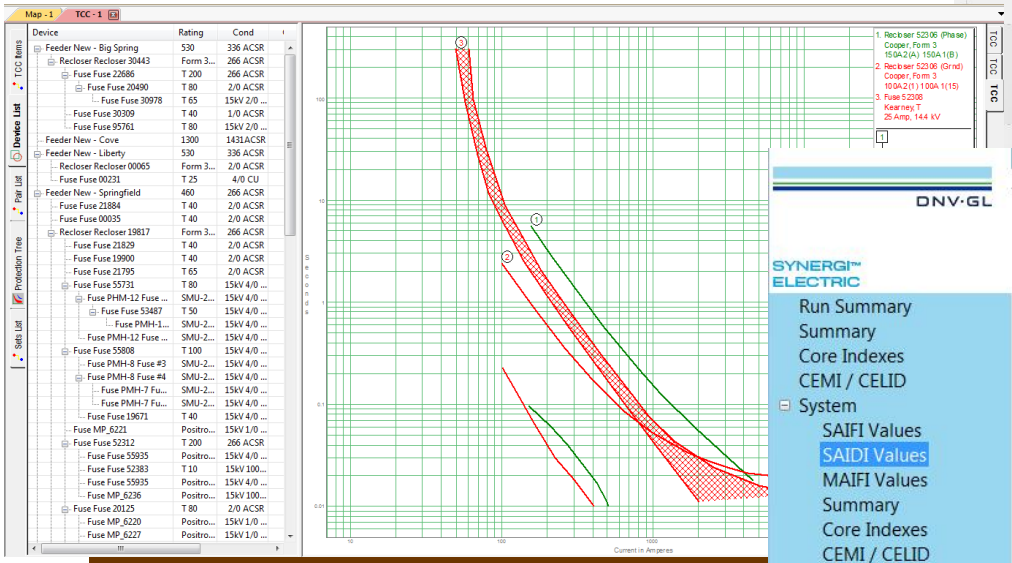
Synergi Electric Vision

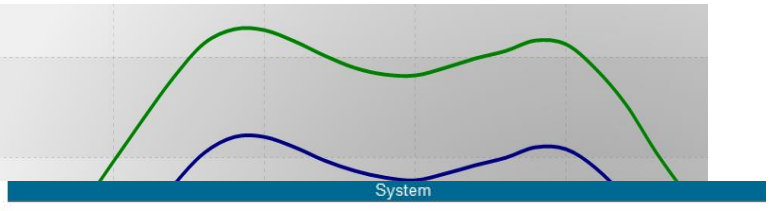


DER modeling

- Easy to use
- Easy to understand
- Easy to access
- Consistent
- Comprehensive
- Extensible

What is Synergi Electric





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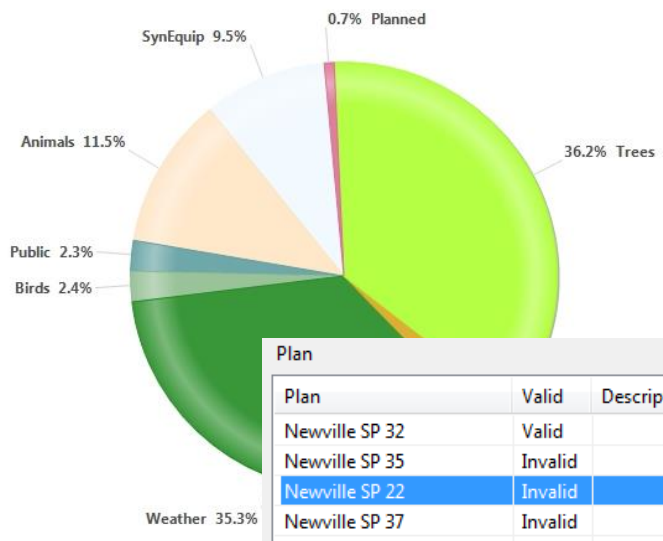
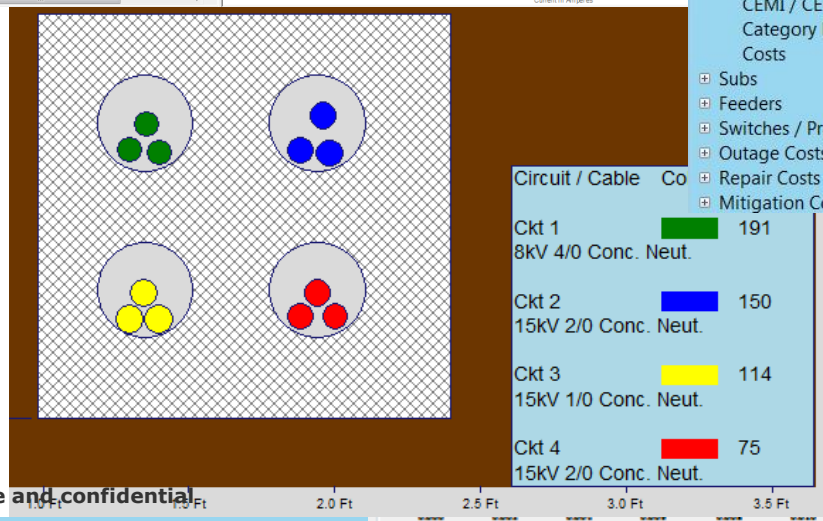
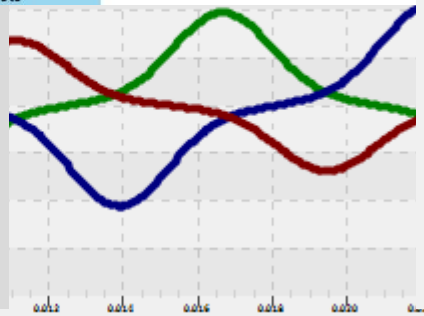
SYNERGI™ ELECTRIC

- Run Summary
- Summary
- Core Indexes
- CEMI / CELID
- System
  - SAIFI Values
  - SAIDI Values
  - MAIFI Values
  - Summary
  - Core Indexes
  - CEMI / CELID
  - Category Details
  - Costs
- Subs
- Feeders
- Switches / Protection
- Outage Costs
- Repair Costs
- Mitigation Costs







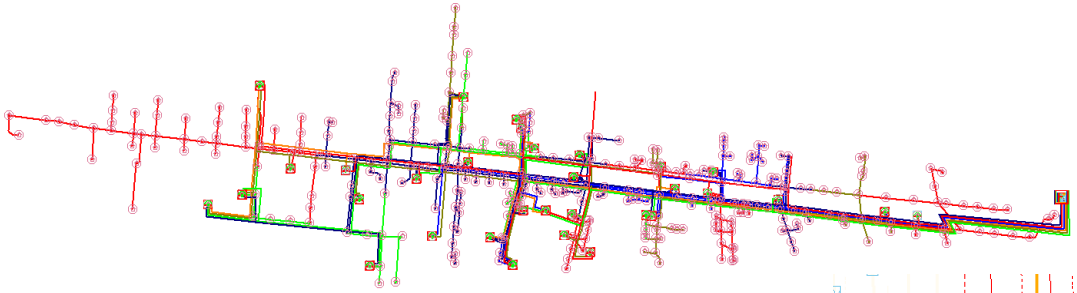
Plan

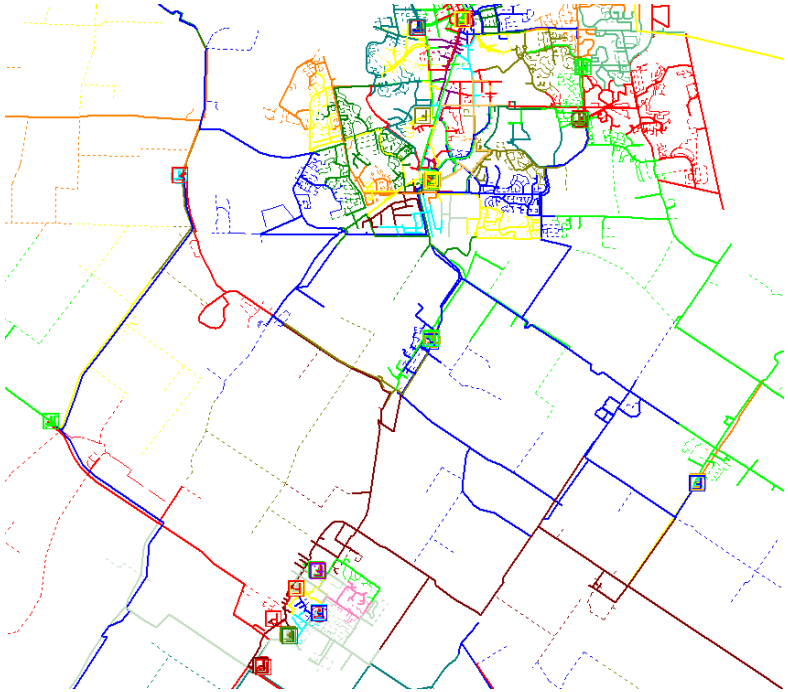
Plan	Valid	Description
Newville SP 32	Valid	
Newville SP 35	Invalid	
Newville SP 22	Invalid	
Newville SP 37	Invalid	
Ship SP 08	Valid	
Ship Proposed 09	Valid	

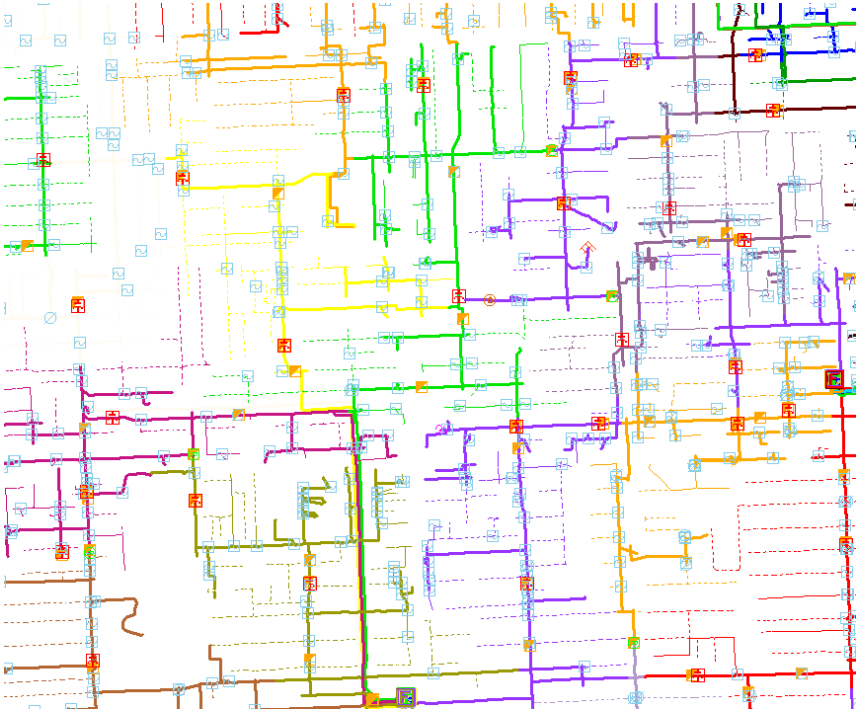
Switch steps

Step	Switch Na...	Switch ID	Operation
Step 1	KZ_3204	Subsct0144	Open
Step 2	KZ_3216	Subsct0143	Close
Step 3	KZ_3214	Subsct0142	Open
Step 4	SW 22630	22630	Close

Types of systems

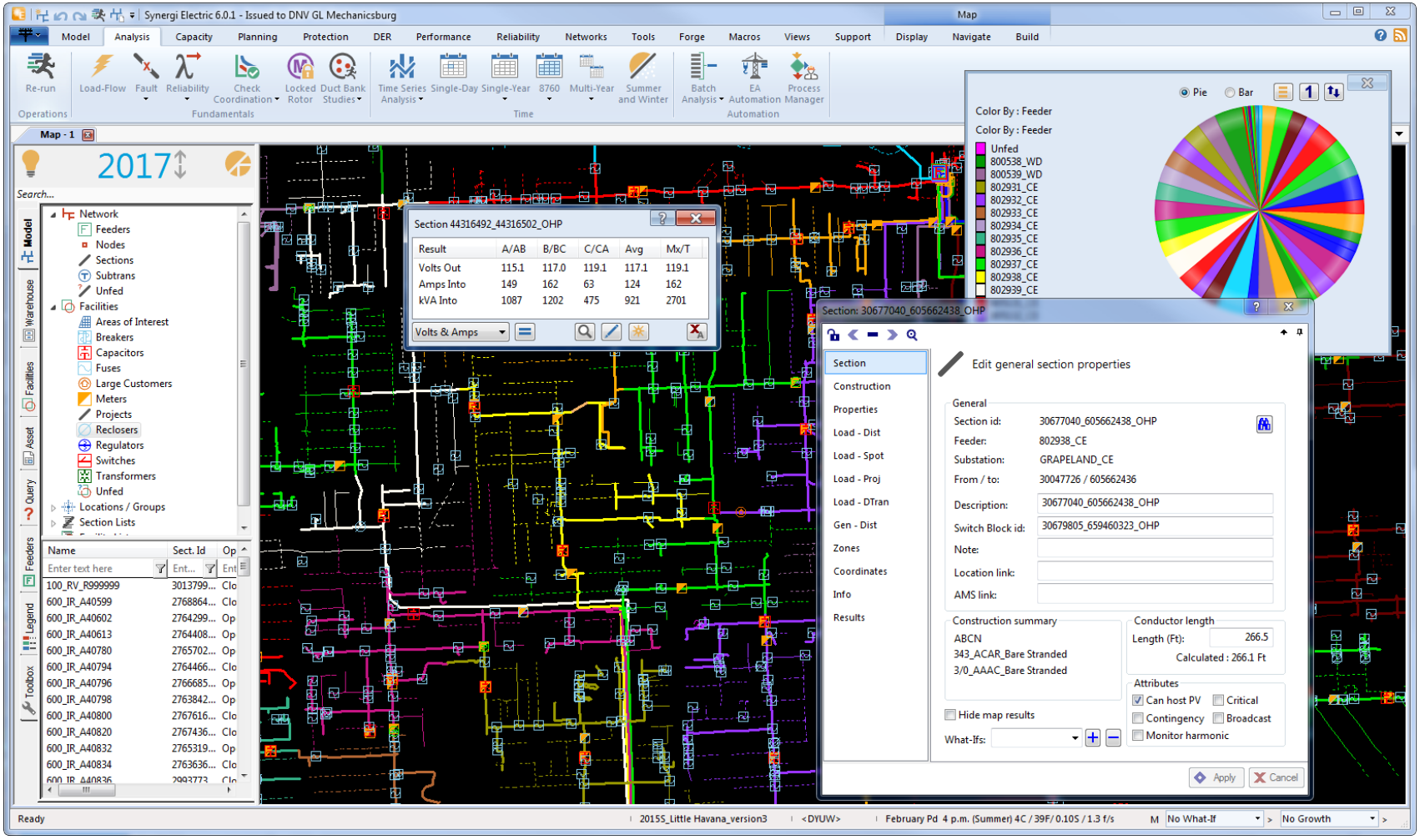






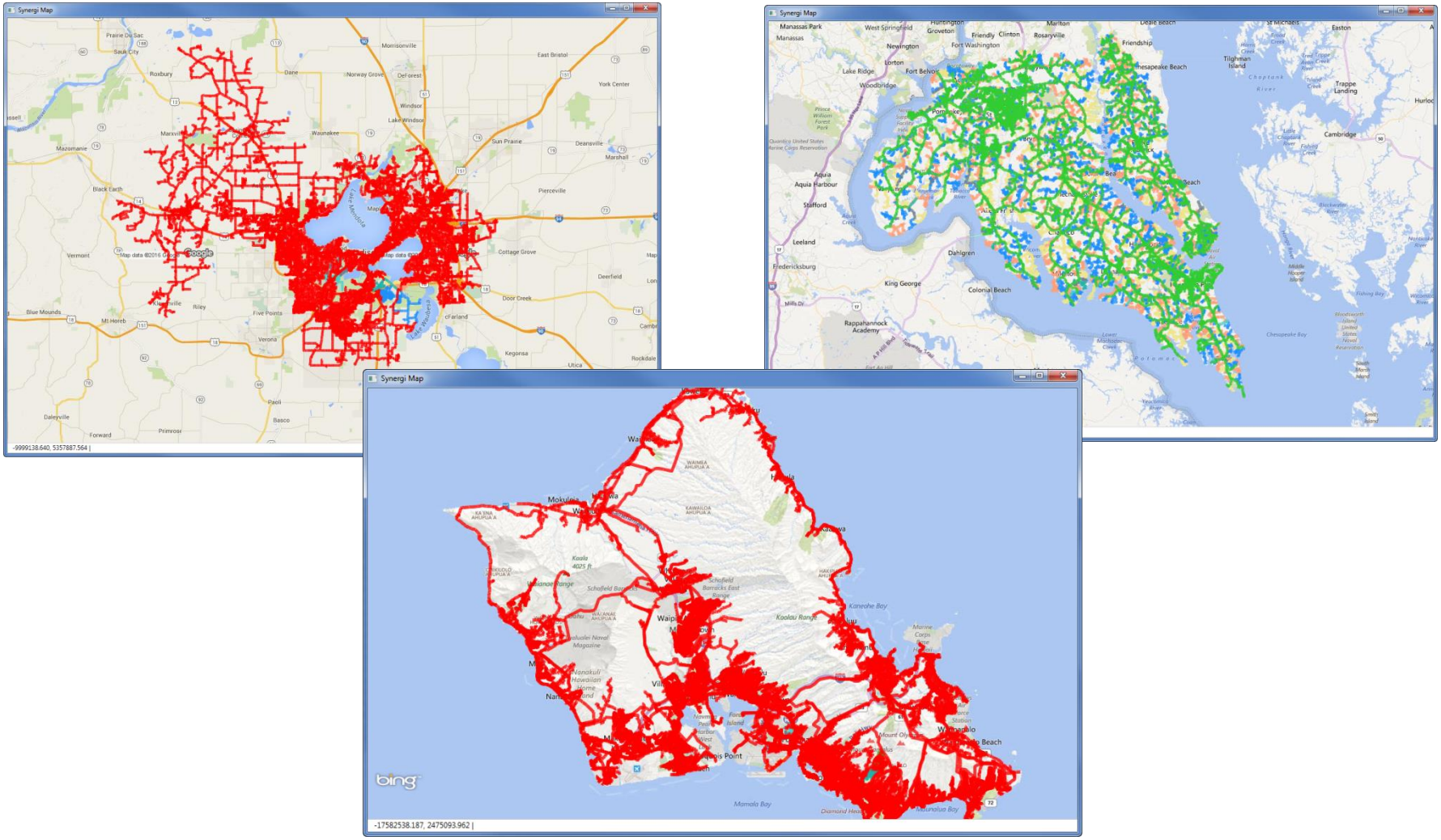
Private and confidential

Powerful tools for engineering simulation & analysis



Private and confidential

Results presented on maps



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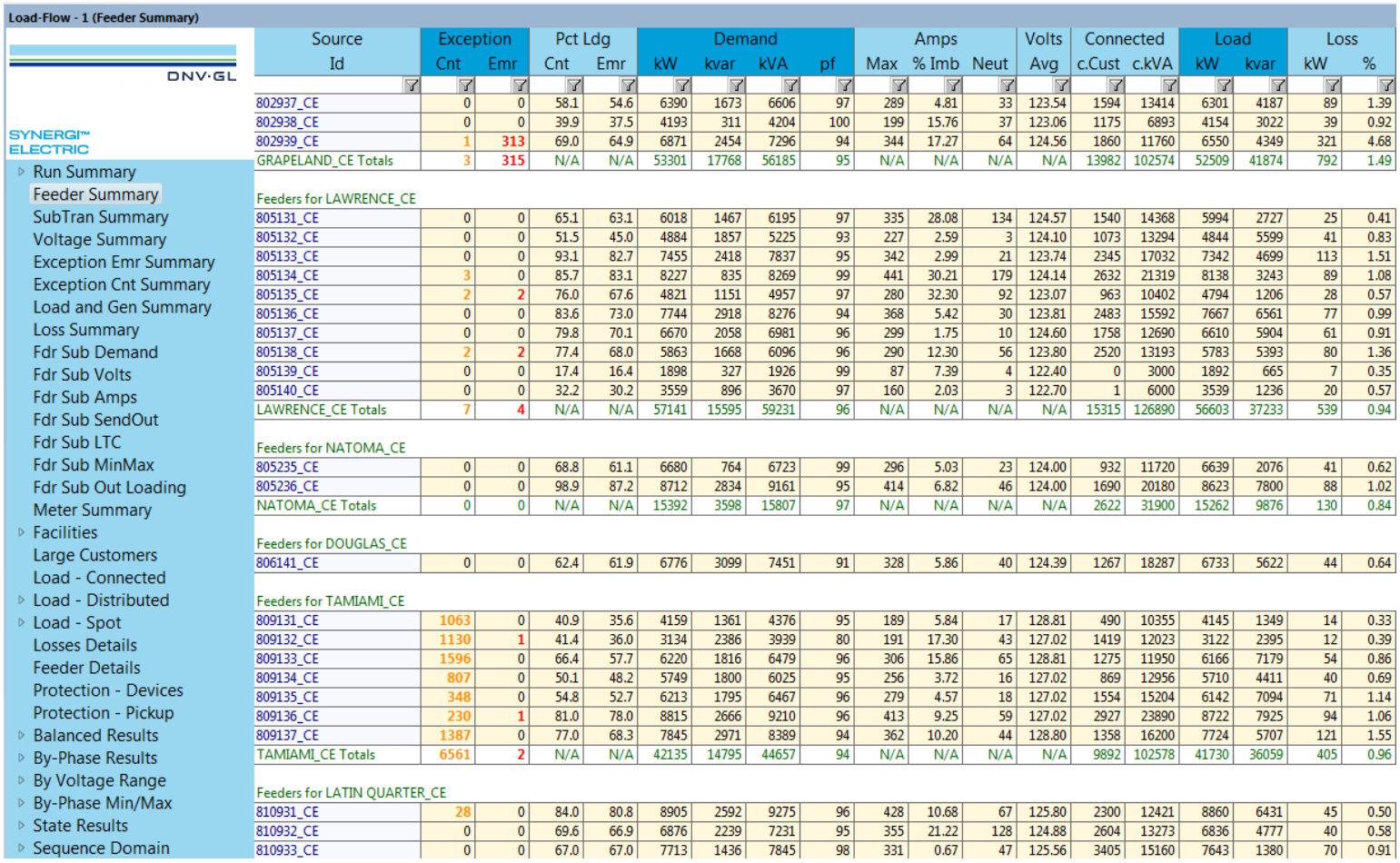
Results presented on reports



Load-Flow - 1 (Feeder Summary)

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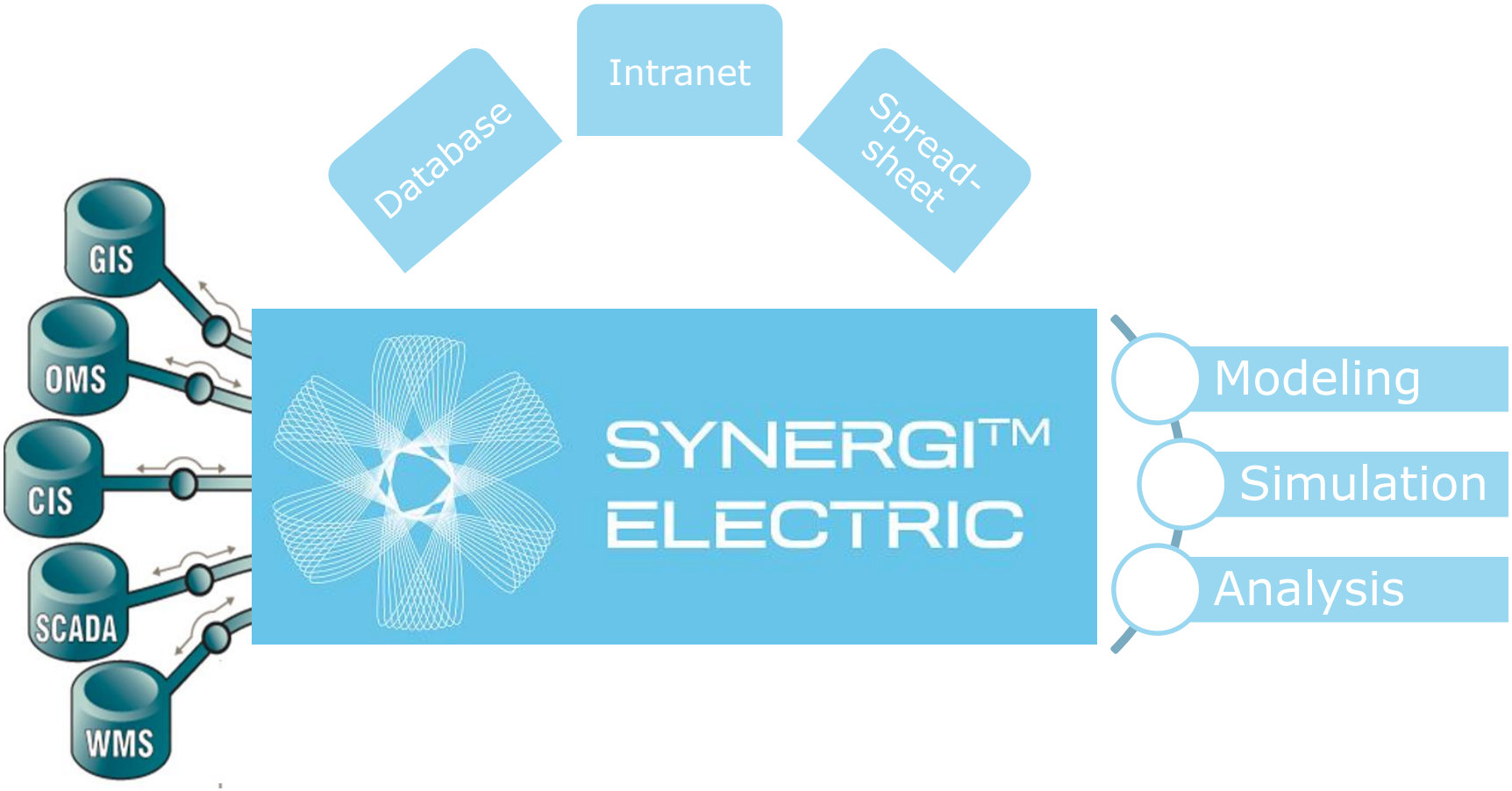
SYNERGI™ ELECTRIC

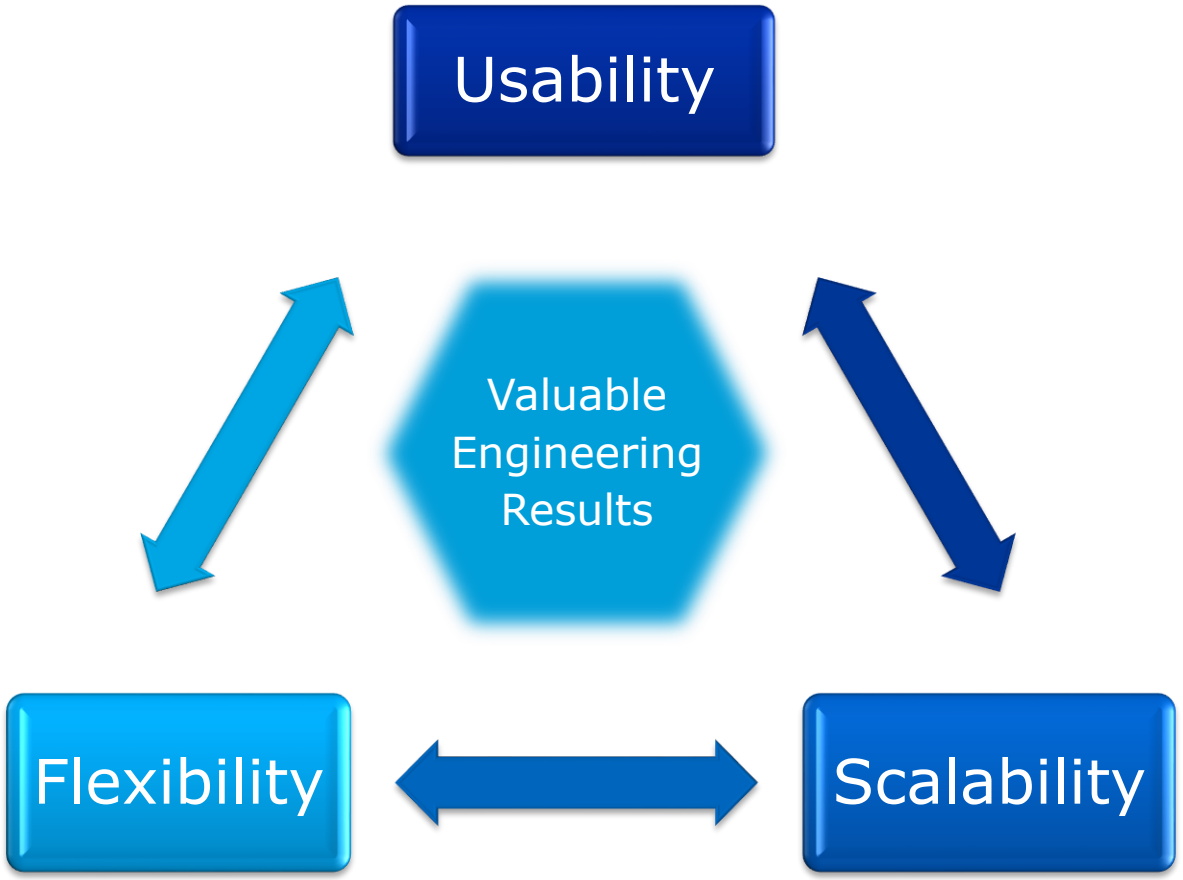
- Run Summary
- Feeder Summary
- SubTran Summary
- Voltage Summary
- Exception Emr Summary
- Exception Cnt Summary
- Load and Gen Summary
- Loss Summary
- Fdr Sub Demand
- Fdr Sub Volts
- Fdr Sub Amps
- Fdr Sub SendOut
- Fdr Sub LTC
- Fdr Sub MinMax
- Fdr Sub Out Loading
- Meter Summary
- Facilities
- Large Customers
- Load - Connected
- Load - Distributed
- Load - Spot
- Losses Details
- Feeder Details
- Protection - Devices
- Protection - Pickup
- Balanced Results
- By-Phase Results
- By Voltage Range
- By-Phase Min/Max
- State Results
- Sequence Domain

Source Id	Exception Cnt	Exception Emr	Pct Ldg Cnt	Pct Ldg Emr	Demand kW	Demand kvar	Demand kVA	Demand pf	Amps Max	Amps % Imb	Amps Neut	Volts Avg	Connected c.Cust	Connected c.kVA	Load kW	Load kvar	Loss kW	Loss %
802937_CE	0	0	58.1	54.6	6390	1673	6606	97	289	4.81	33	123.54	1594	13414	6301	4187	89	1.39
802938_CE	0	0	39.9	37.5	4193	311	4204	100	199	15.76	37	123.06	1175	6893	4154	3022	39	0.92
802939_CE	1	313	69.0	64.9	6871	2454	7296	94	344	17.27	64	124.56	1860	11760	6550	4349	321	4.68
GRAPELAND_CE Totals	3	315	N/A	N/A	53301	17768	56185	95	N/A	N/A	N/A	N/A	13982	102574	52509	41874	792	1.49
Feeders for LAWRENCE_CE																		
805131_CE	0	0	65.1	63.1	6018	1467	6195	97	335	28.08	134	124.57	1540	14368	5994	2727	25	0.41
805132_CE	0	0	51.5	45.0	4884	1857	5225	93	227	2.59	3	124.10	1073	13294	4844	5599	41	0.83
805133_CE	0	0	93.1	82.7	7455	2418	7837	95	342	2.99	21	123.74	2345	17032	7342	4699	113	1.51
805134_CE	3	0	85.7	83.1	8227	835	8269	99	441	30.21	179	124.14	2632	21319	8138	3243	89	1.08
805135_CE	2	2	76.0	67.6	4821	1151	4957	97	280	32.30	92	123.07	963	10402	4794	1206	28	0.57
805136_CE	0	0	83.6	73.0	7744	2918	8276	94	368	5.42	30	123.81	2483	15592	7667	6561	77	0.99
805137_CE	0	0	79.8	70.1	6670	2058	6981	96	299	1.75	10	124.60	1758	12690	6610	5904	61	0.91
805138_CE	2	2	77.4	68.0	5863	1668	6096	96	290	12.30	56	123.80	2520	13193	5783	5393	80	1.36
805139_CE	0	0	17.4	16.4	1898	327	1926	99	87	7.39	4	122.40	0	3000	1892	665	7	0.35
805140_CE	0	0	32.2	30.2	3559	896	3670	97	160	2.03	3	122.70	1	6000	3539	1236	20	0.57
LAWRENCE_CE Totals	7	4	N/A	N/A	57141	15595	59231	96	N/A	N/A	N/A	N/A	15315	126890	56603	37233	539	0.94
Feeders for NATOMA_CE																		
805235_CE	0	0	68.8	61.1	6680	764	6723	99	296	5.03	23	124.00	932	11720	6639	2076	41	0.62
805236_CE	0	0	98.9	87.2	8712	2834	9161	95	414	6.82	46	124.00	1690	20180	8623	7800	88	1.02
NATOMA_CE Totals	0	0	N/A	N/A	15392	3598	15807	97	N/A	N/A	N/A	N/A	2622	31900	15262	9876	130	0.84
Feeders for DOUGLAS_CE																		
806141_CE	0	0	62.4	61.9	6776	3099	7451	91	328	5.86	40	124.39	1267	18287	6733	5622	44	0.64
Feeders for TAMIAMI_CE																		
809131_CE	1063	0	40.9	35.6	4159	1361	4376	95	189	5.84	17	128.81	490	10355	4145	1349	14	0.33
809132_CE	1130	1	41.4	36.0	3134	2386	3939	80	191	17.30	43	127.02	1419	12023	3122	2395	12	0.39
809133_CE	1596	0	66.4	57.7	6220	1816	6479	96	306	15.86	65	128.81	1275	11950	6166	7179	54	0.86
809134_CE	807	0	50.1	48.2	5749	1800	6025	95	256	3.72	16	127.02	869	12956	5710	4411	40	0.69
809135_CE	348	0	54.8	52.7	6213	1795	6467	96	279	4.57	18	127.02	1554	15204	6142	7094	71	1.14
809136_CE	230	1	81.0	78.0	8815	2666	9210	96	413	9.25	59	127.02	2927	23890	8722	7925	94	1.06
809137_CE	1387	0	77.0	68.3	7845	2971	8389	94	362	10.20	44	128.80	1358	16200	7724	5707	121	1.55
TAMIAMI_CE Totals	6561	2	N/A	N/A	42135	14795	44657	94	N/A	N/A	N/A	N/A	9892	102578	41730	36059	405	0.96
Feeders for LATIN QUARTER_CE																		
810931_CE	28	0	84.0	80.8	8905	2592	9275	96	428	10.68	67	125.80	2300	12421	8860	6431	45	0.50
810932_CE	0	0	69.6	66.9	6876	2239	7231	95	355	21.22	128	124.88	2604	13273	6836	4777	40	0.58
810933_CE	0	0	67.0	67.0	7713	1436	7845	98	331	0.67	47	125.56	3405	15160	7643	1380	70	0.91

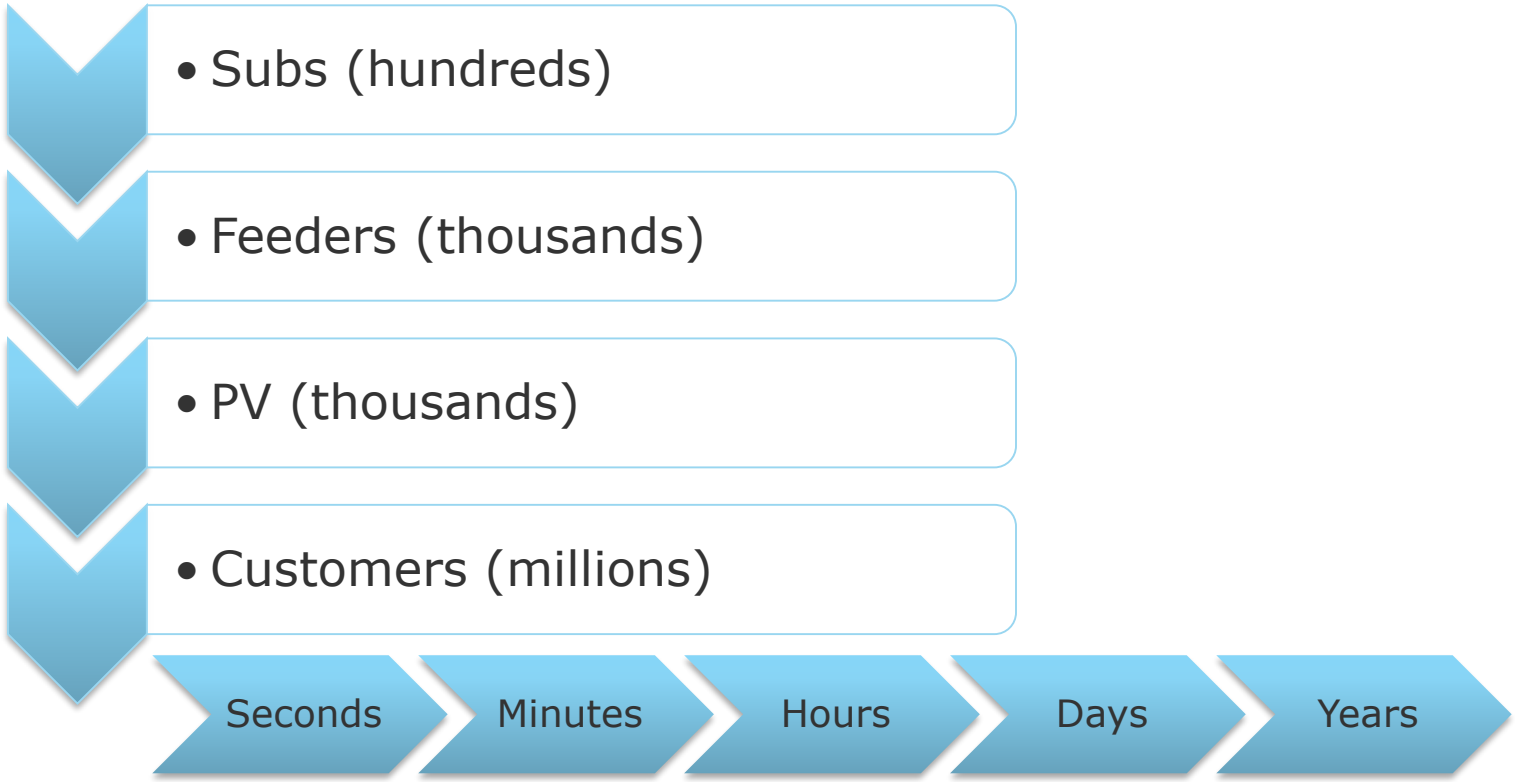
Synergi Electric integration



Engineering analysis challenge



The scale of PV analysis

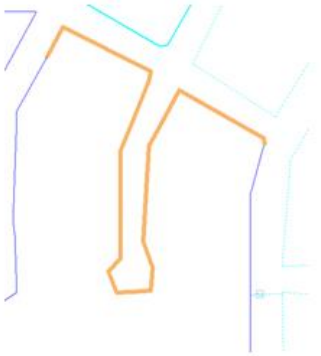


DATA ENTROPY

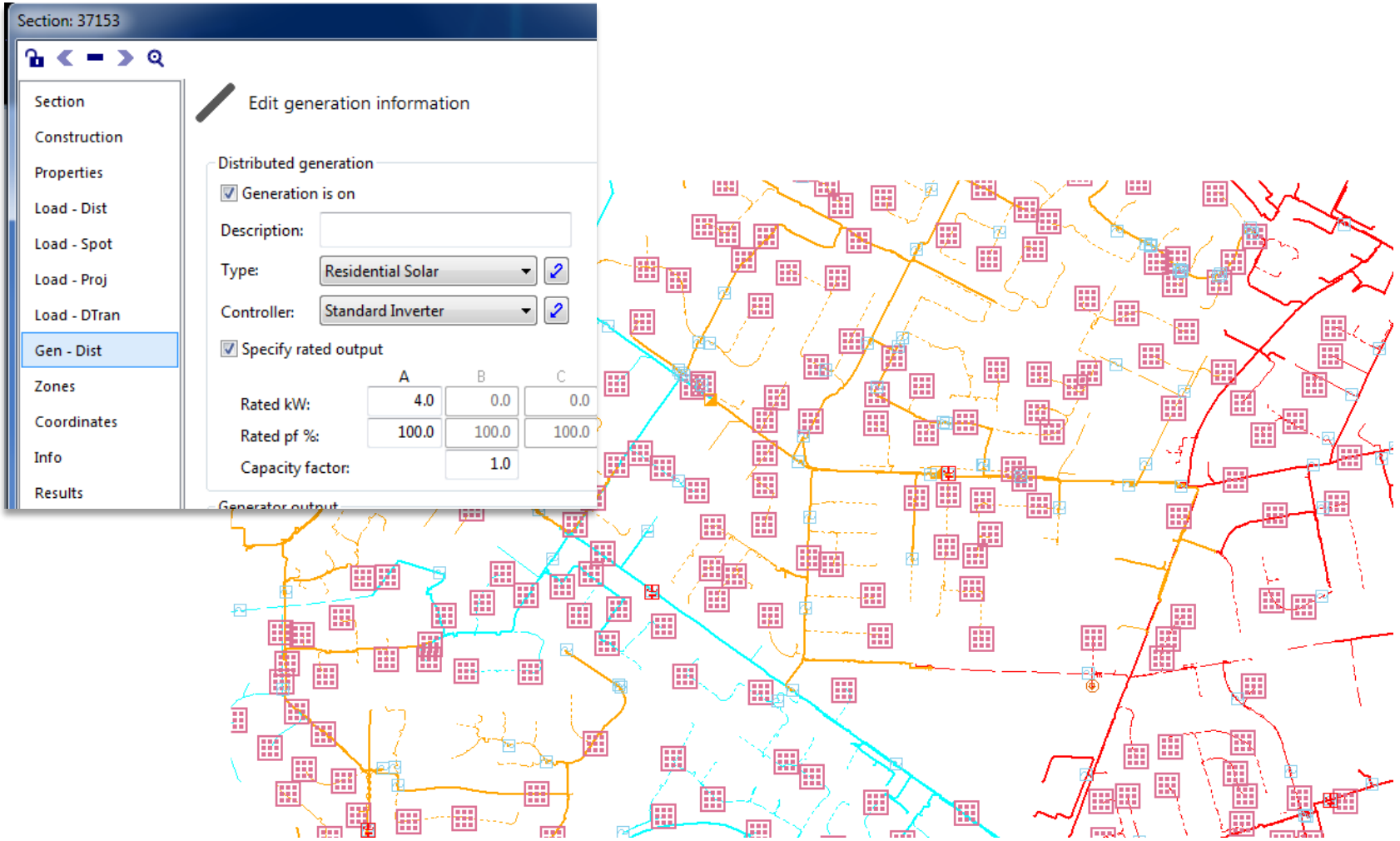
The addition of more and more data which leads to a wider array of uncertainty and degradation of confidence.

Distribution systems are big, complex, and data intensive

Three types of solar installations modelled with Synergi



Each section can host PV



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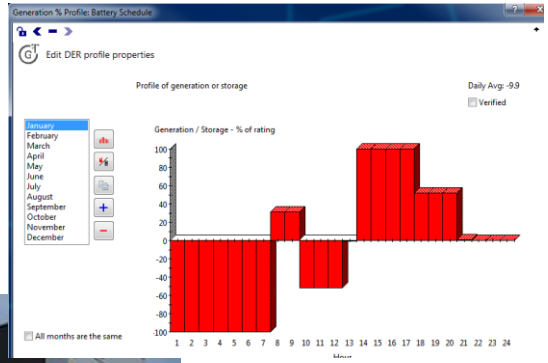
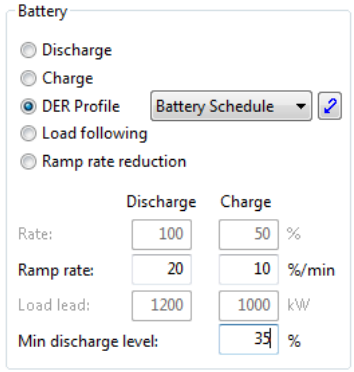
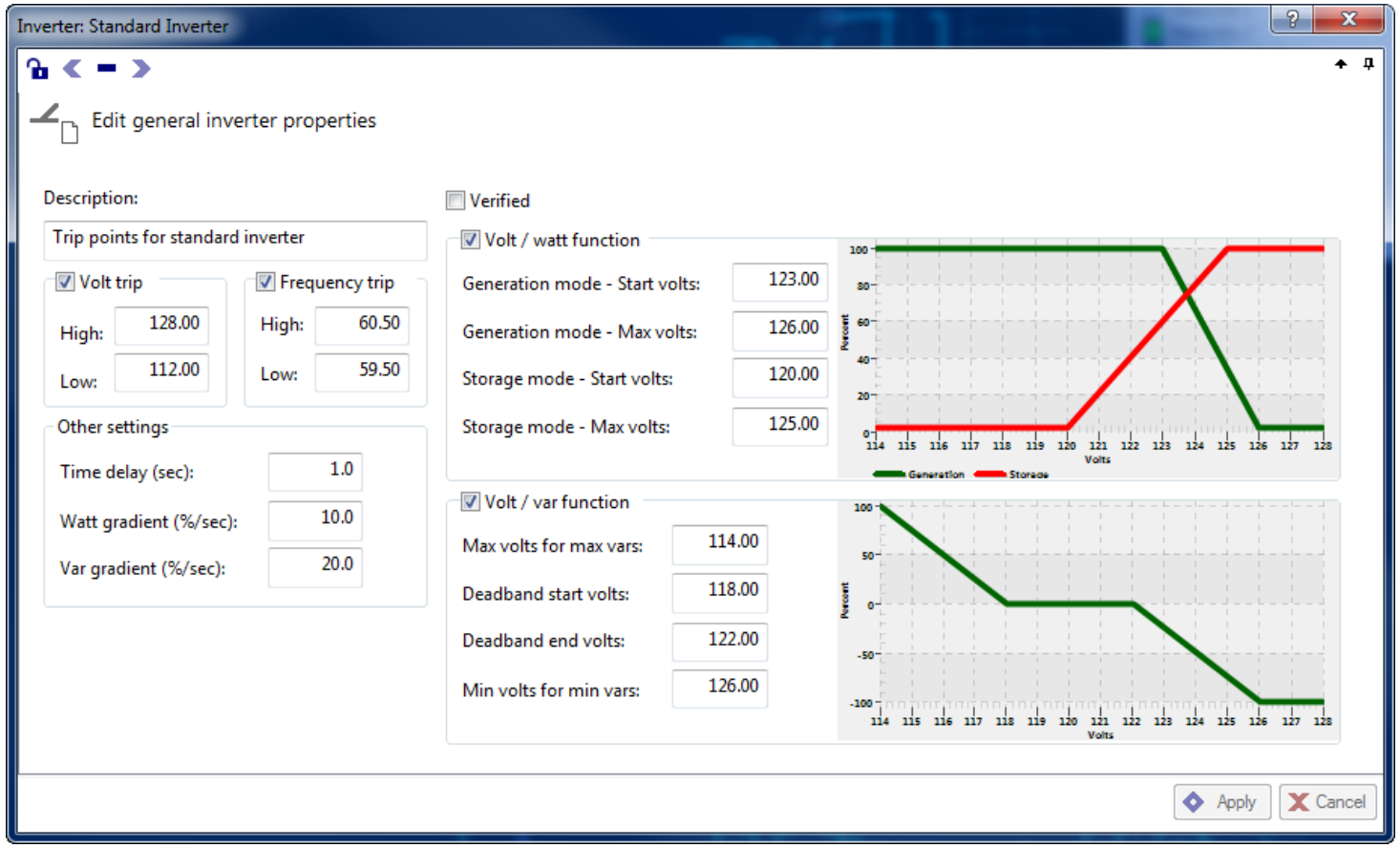
Wind and battery

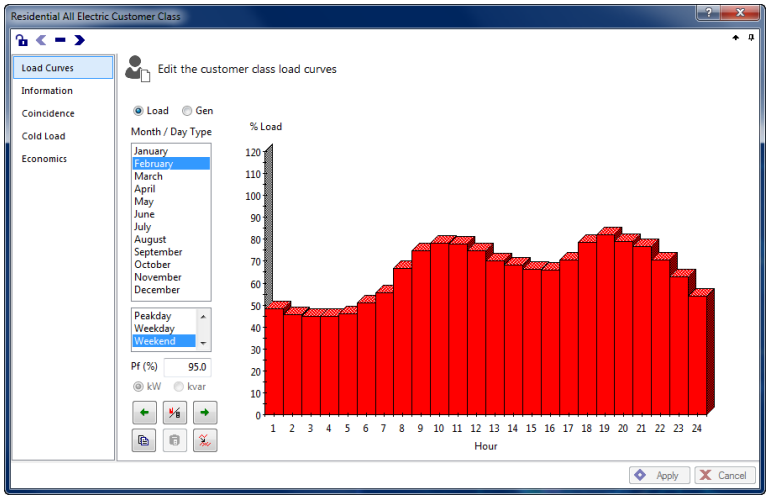


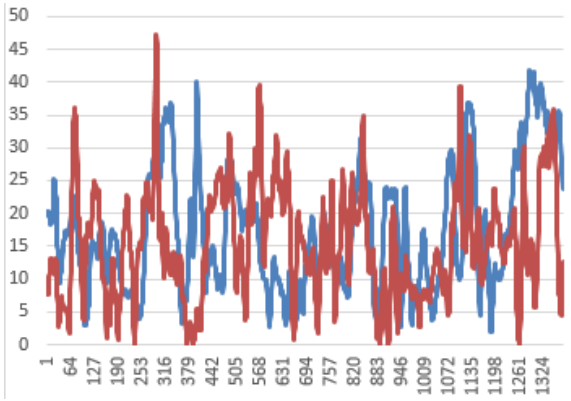


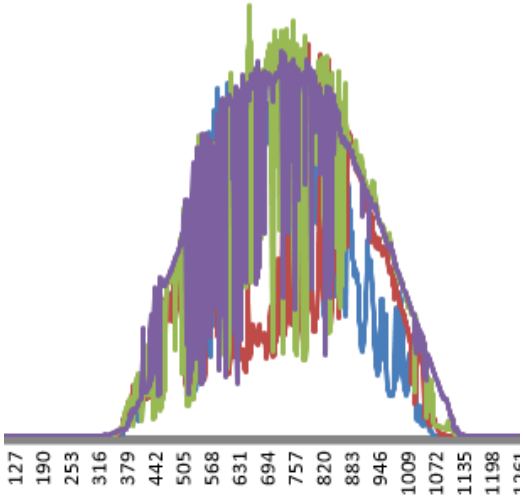
Inverter Controls

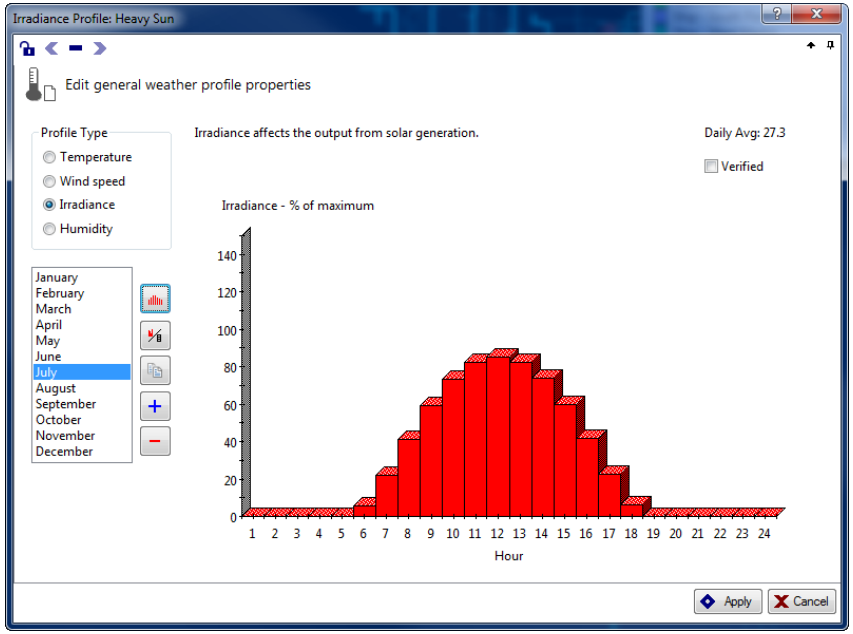


Time of day loads and weather

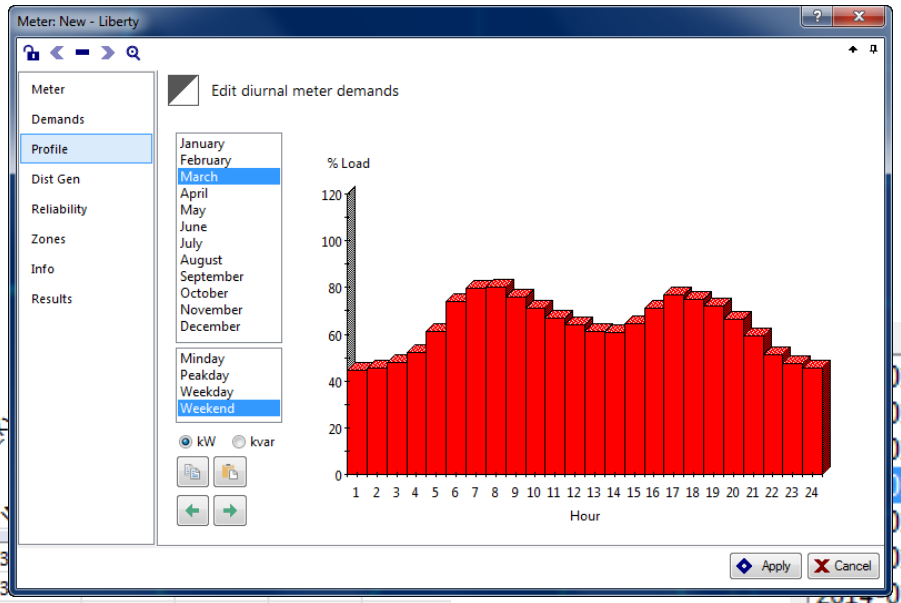




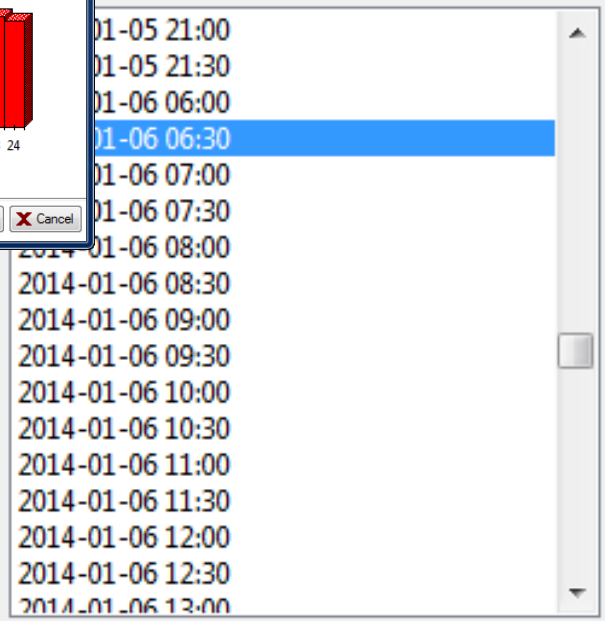




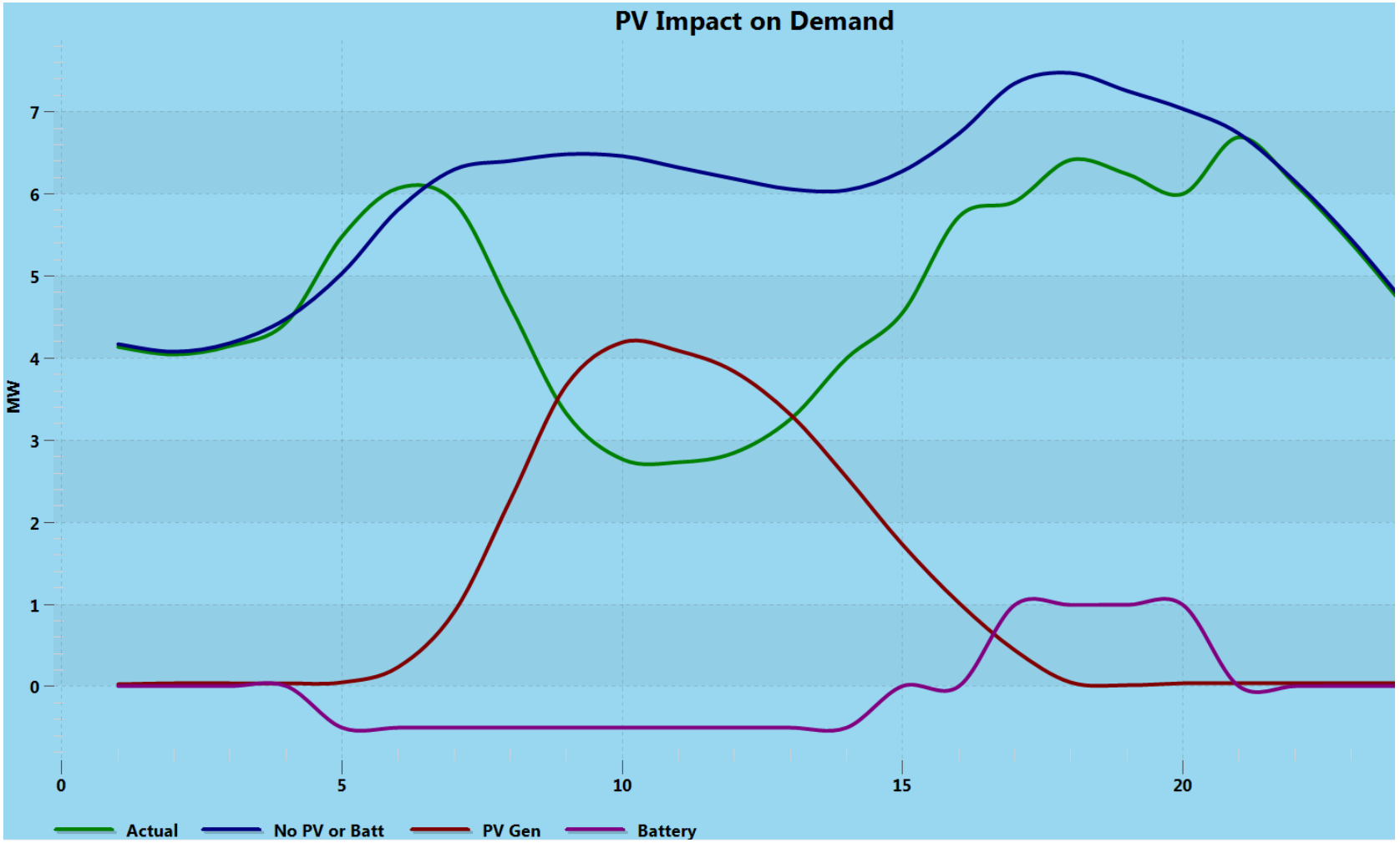
Feeders demands, AMI, metered values



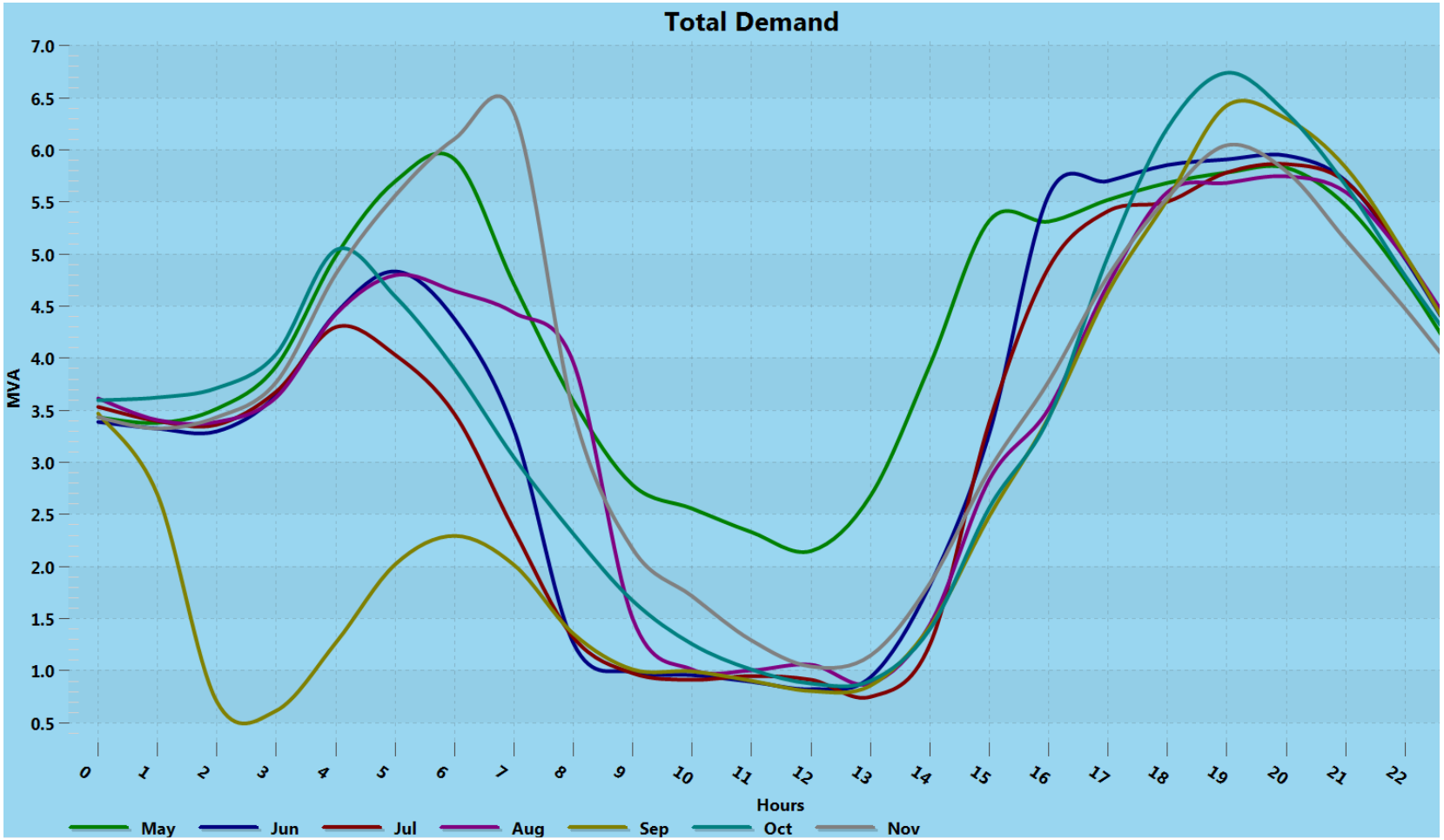
	IN_MTRDMD_KW_A_00B30						
Hour 460	3211.496	475.3045					
Hour 461	3493.333	575.3995					
Hour 462	4378.625	985.5362	4302.279	968.3524	4165.855	937.6463	279.0415
Hour 463	5134.468	1278.507	5176.838	1289.058	4774.567	1188.89	371.5755
Hour 464	5056.73	1282.264	5143.383	1304.237	4793.087	1215.41	464.1095
Hour 465	4462.913	1134.375	4443.15	1129.352	4196.886	1066.757	556.6435
Hour 466	3698.404	888.2863	3700.982	888.9055	3449.671	828.5454	665.3171
Hour 467	3628.369	901.7231	3632.094	902.6491	3500.673	869.9881	1317.981
Hour 468	3340.394	844.5736	3410.103	862.1986	3250.179	821.764	1383.428
Hour 469	3056.515	757.3527	3172.307	786.044	3034.892	751.995	1989.276
Hour 470	2598.766	532.577	2608.761	534.6253	2520.662	516.5708	2320.974
Hour 471	2655.728	586.6564	2663.326	588.3348	2533.709	559.7022	1976.279
Hour 472	2689.007	474.8821	2699.653	476.7621	2528.95	446.6157	1558.449
Hour 473	2756.339	406.0237	2771.88	408.3129	2648.516	390.1407	1104.377



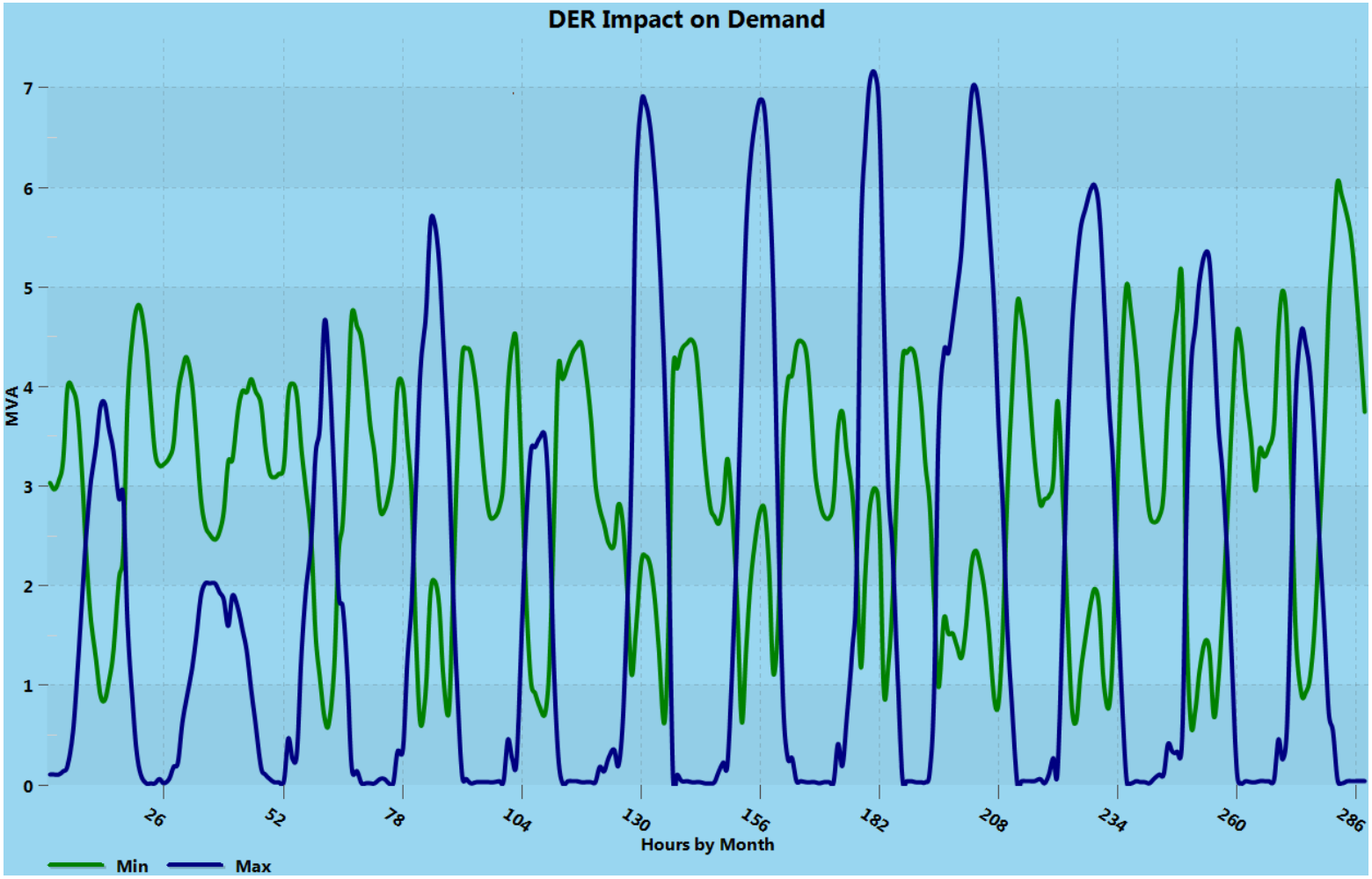
Single day analysis



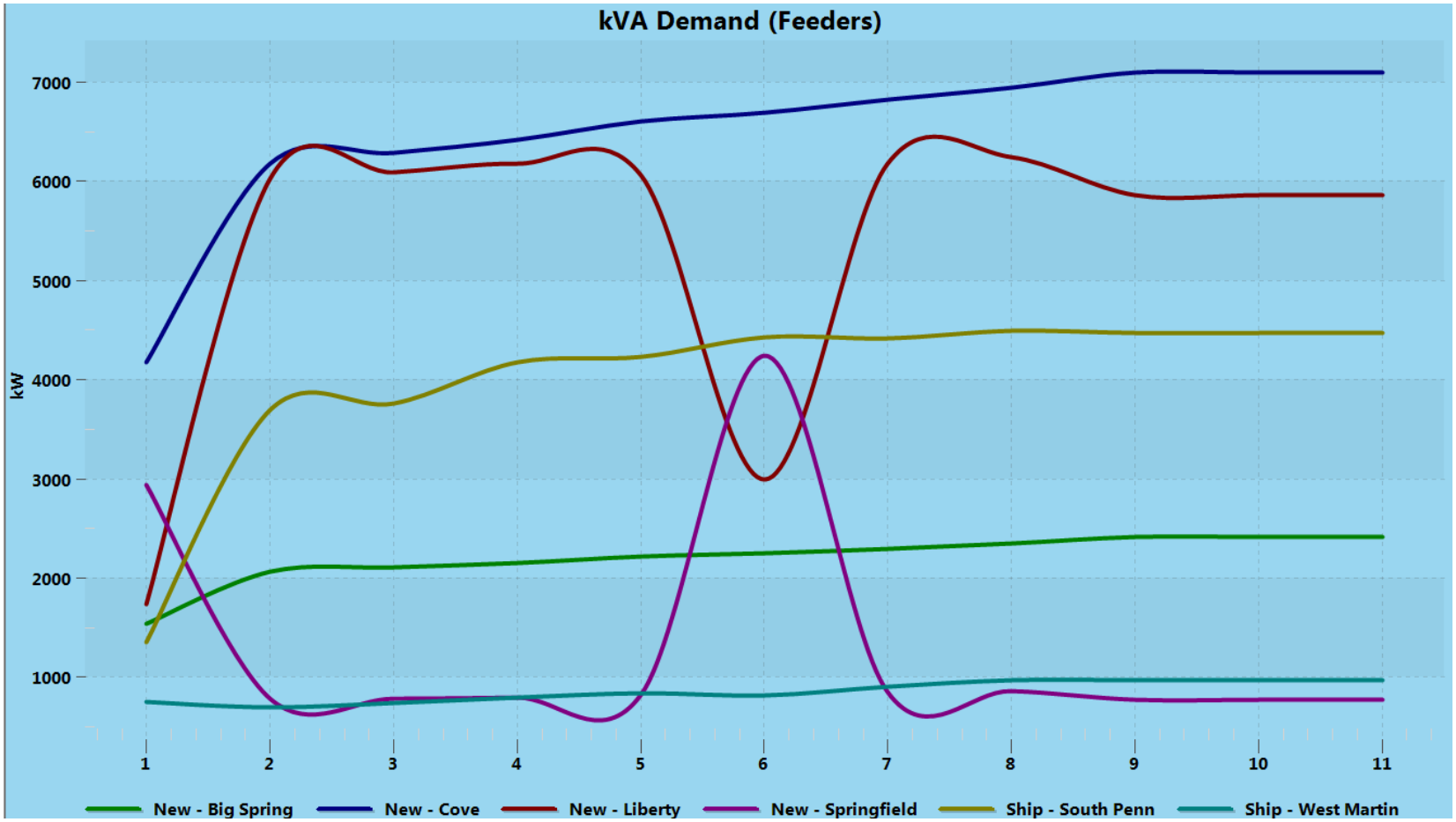
Single year analysis



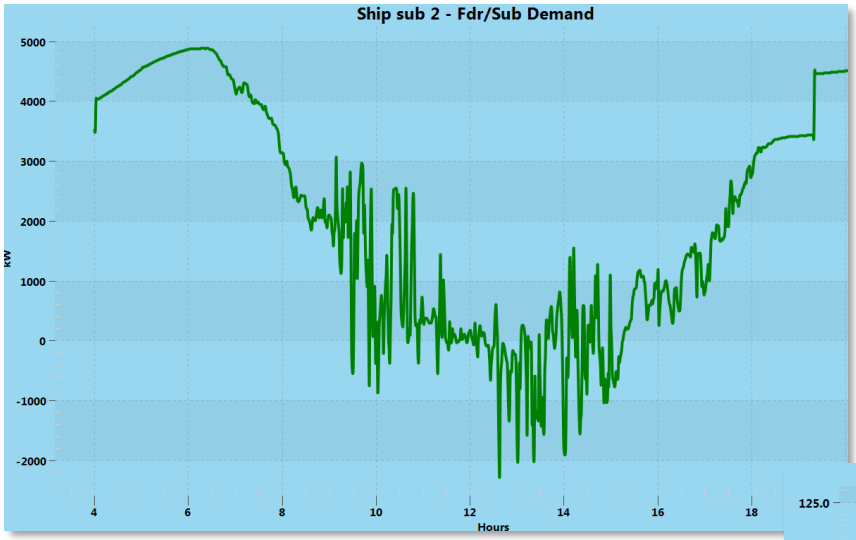
8760 Analysis

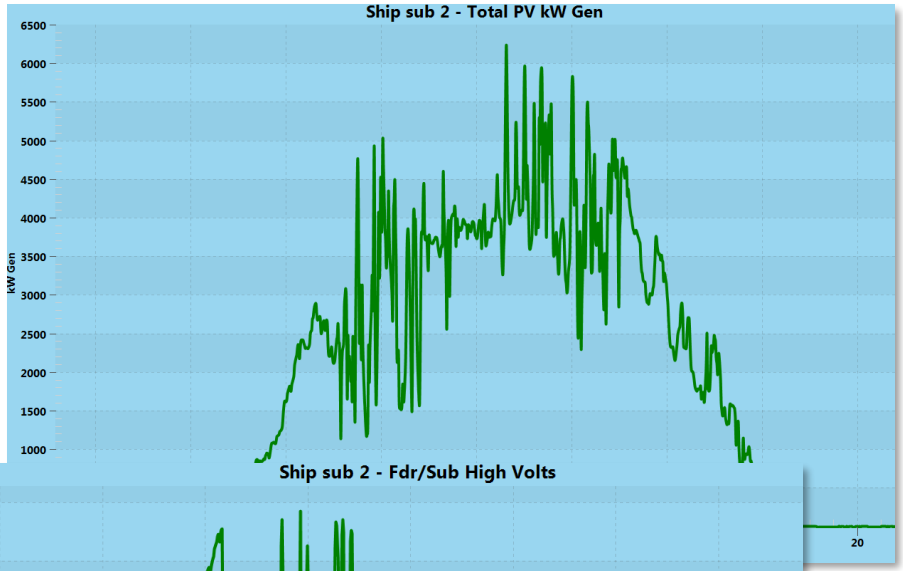


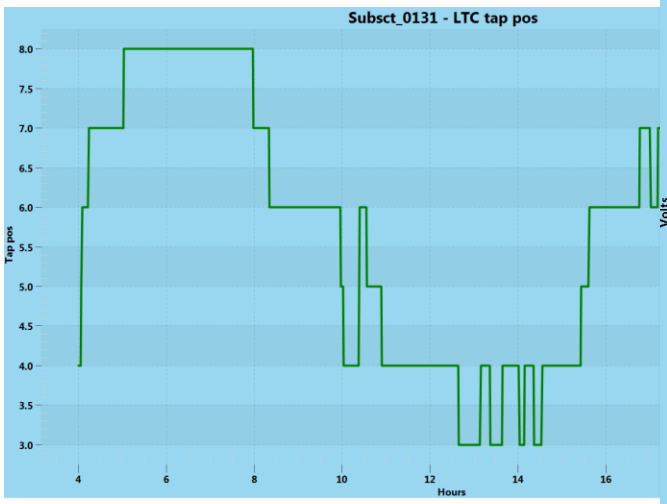
Multiple year analysis

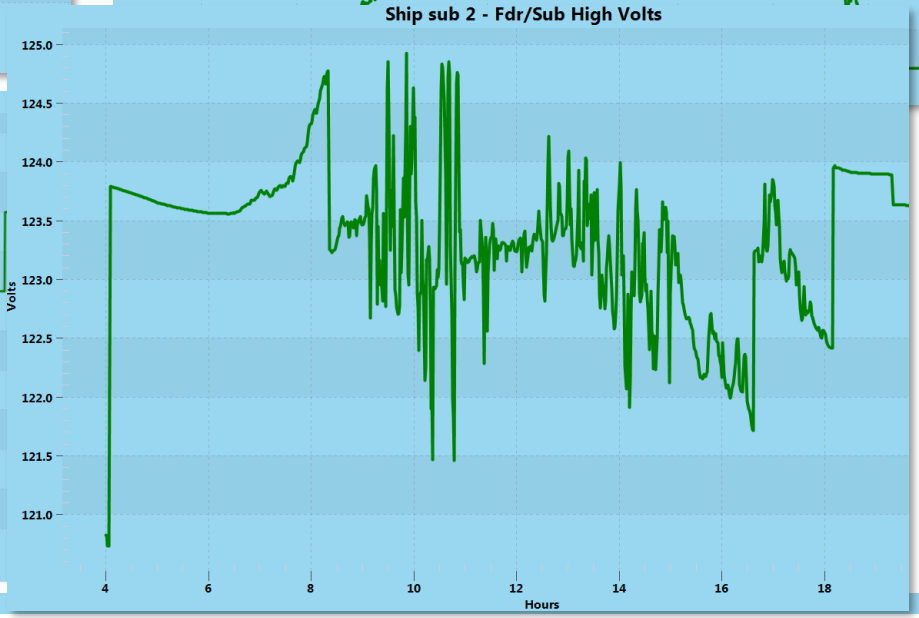


Time-series analysis

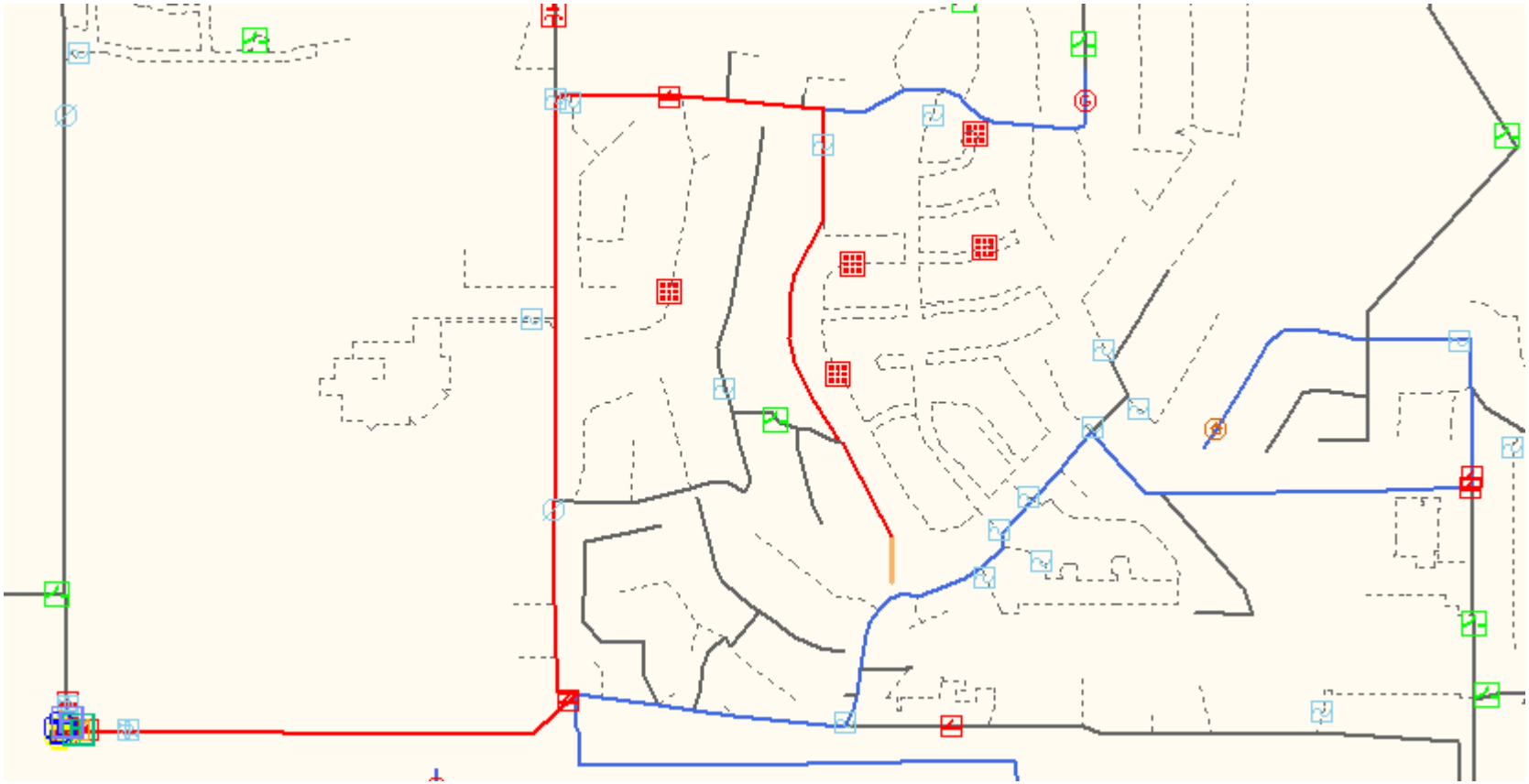








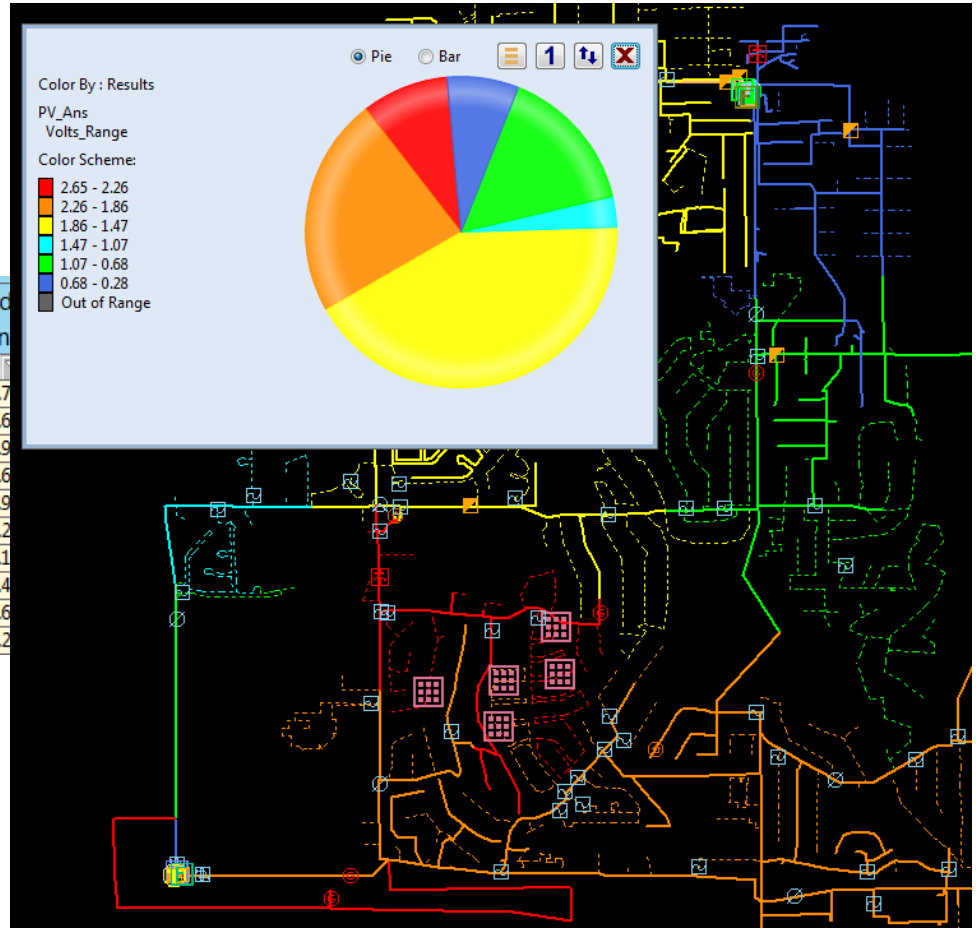
Fault and fault flow analysis



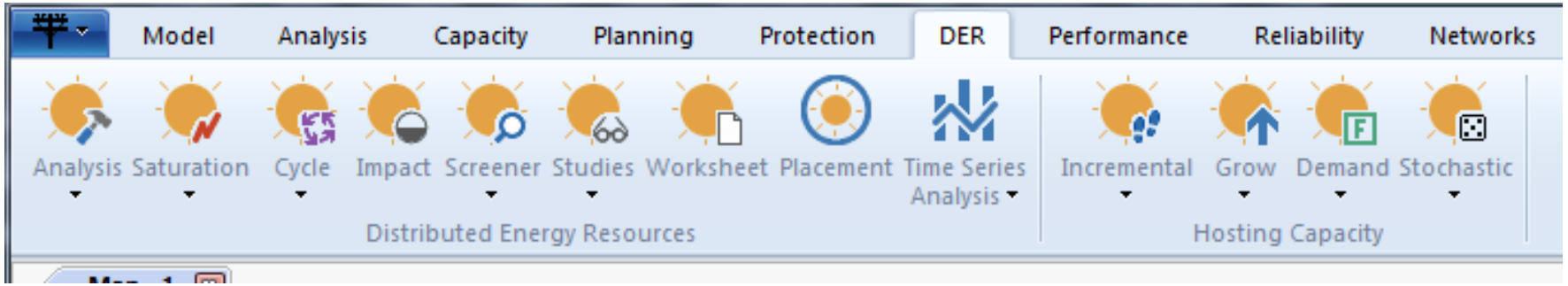
PV Analysis

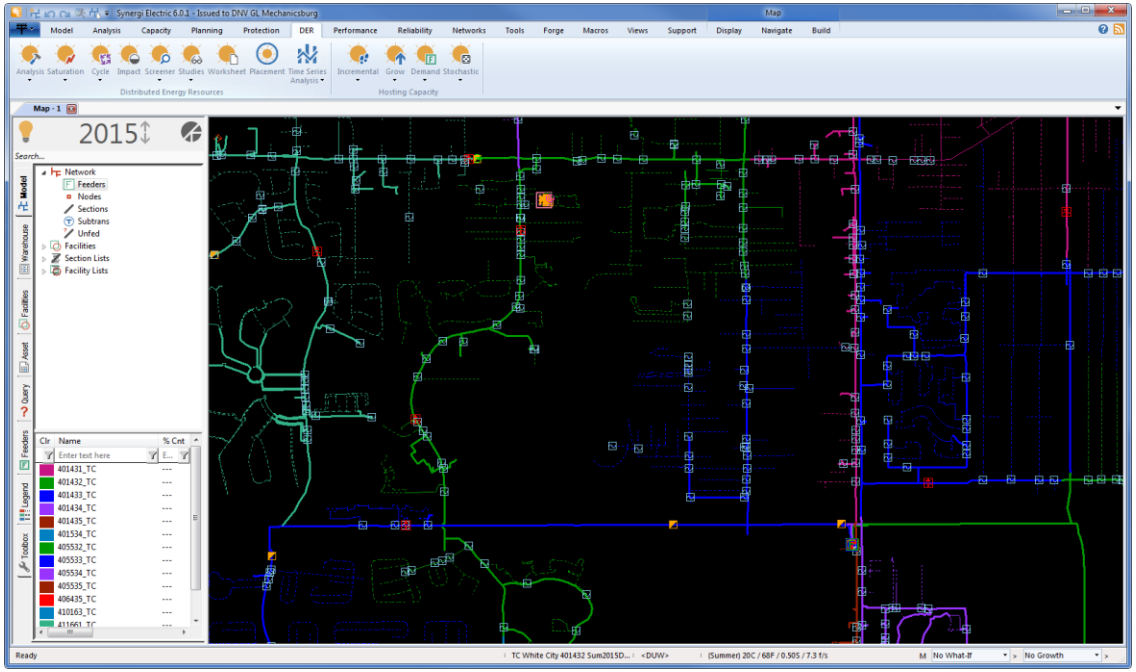
Randomly adjust PV output

SubTran ID	ID	kW Demand Avg	Min	Max	Delta	PctDelta	Pct Ld Avg	Min
Newville 1		7665	6004	7756	1752	23	51.10	40.7
	New - Liberty	2789	2321	2822	501	18	24.20	20.6
	New - Springfield	4738	3573	4797	1224	26	49.50	38.9
Newville 2		9373	7142	9495	2353	25	49.60	38.6
	New - Big Spring	4563	2349	4684	2335	51	44.40	26.9
	New - Cove	4678	4678	4688	10	0	16.20	16.2
Ship sub 1		4154	2232	4281	2049	49	37.70	22.1
	Ship - South Penn	4060	2156	4186	2030	50	36.80	21.4
Ship sub 2		4756	2416	4934	2519	53	41.30	22.6
	Ship - West Martin	4655	2339	4831	2492	54	46.50	25.2



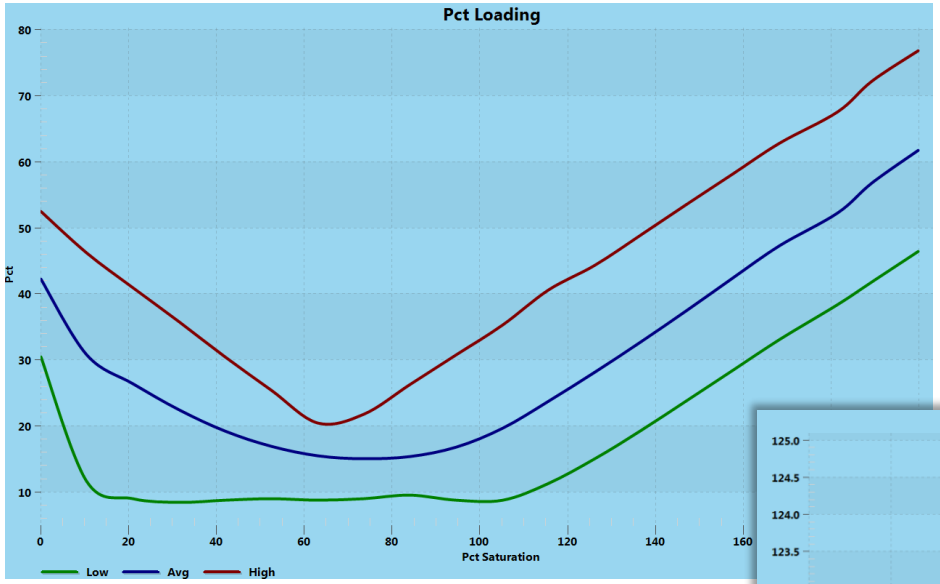
DER Applications

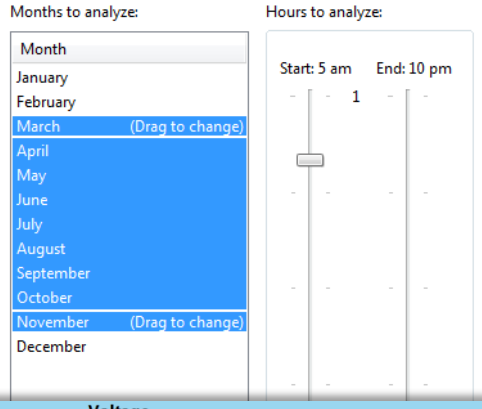


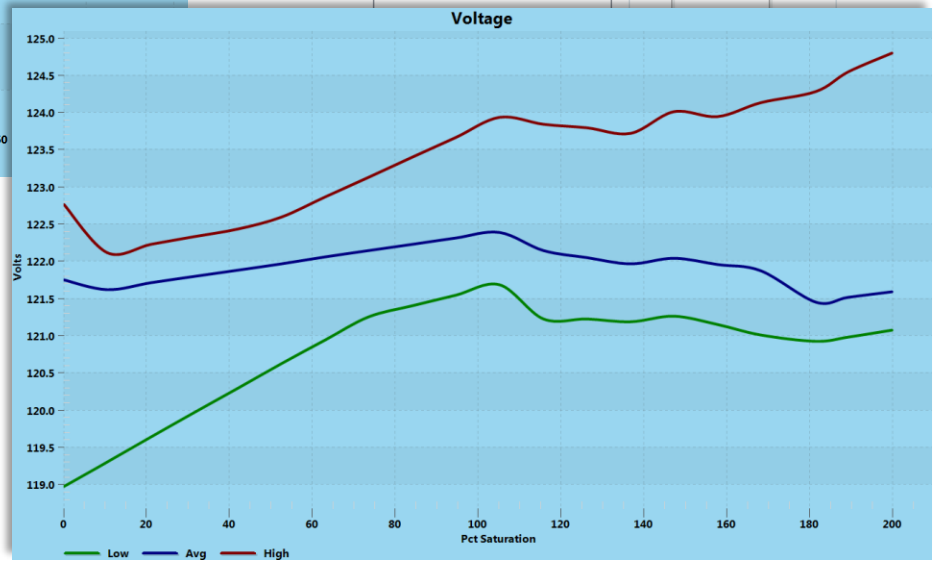


DNV·GL

PV Saturation

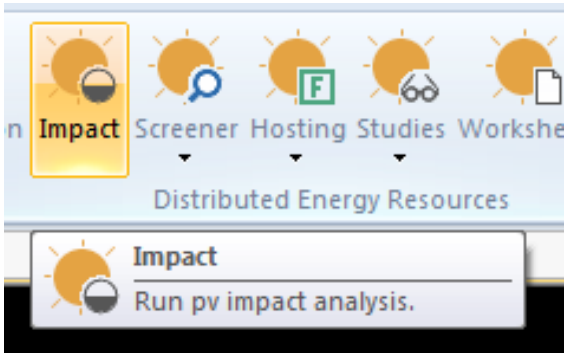






Grow PV and evaluate over time

PV Impact



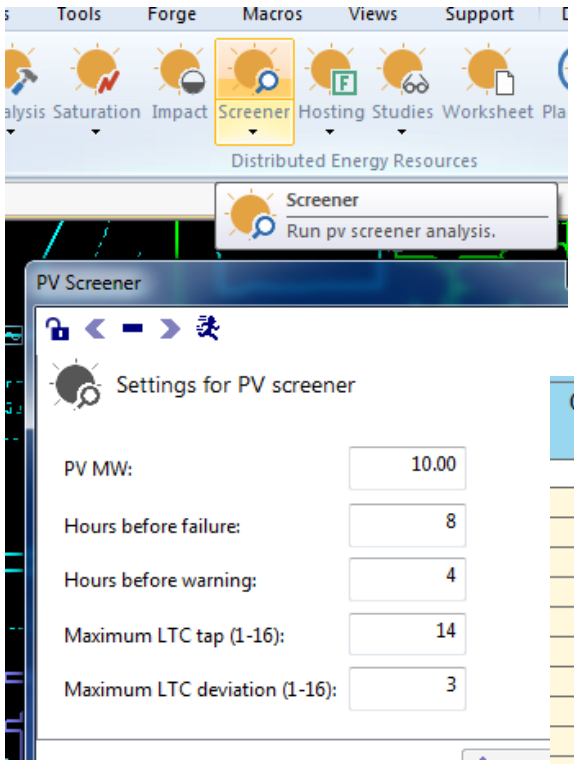
Turn PV on and off in various ways.

- Run Summary
- All Suddenly On - LTC
  - Normal Load
  - Light Load
- All Suddenly Off - LTC
- All Gradually On - LTC
  - Normal Load
  - Light Load
- All Gradually Off - LTC
- Unit On/Off - Feeder
- Unit On/Off - Sub
  - Normal Load
  - Light Load
- Unit On/Off - Sub Tran
- Unit On/Off - LTC
- Unit On/Off - Volts
- Unit On/Off - Losses
- Unit On/Off - Caps

Generator				Pct Loading		
Feeder	Type	Desc	ID	On	Off	PctDiff
Ship - West Martin	Generator	Gen S_4353132848	S_4353132848	22.6	30.2	8
Ship - West Martin	Sect DGen	37153	37153	22.6	22.7	0
Ship - West Martin	Sect DGen	37196	37196	22.6	22.6	0
Ship - West Martin	Sect DGen	37255	37255	22.6	22.6	0
Ship - West Martin	Generator	Gen 52540	36057	22.6	34.6	12
Ship - West Martin	Sect DGen	37469	37469	22.6	22.6	0
Ship - West Martin	Sect DGen	37465	37465	22.6	22.6	0

Transformer or Regulator					Max Tap					
Feeder	Facil	Type	Desc	ID	PV Off	PV 20%	PV 40%	PV 60%	PV 80%	PV 100%
Ship sub 2	Tran	PM 115/13 10MVA	Tran Subsct_0131	Subsct_0131	3	3	2	2	2	1

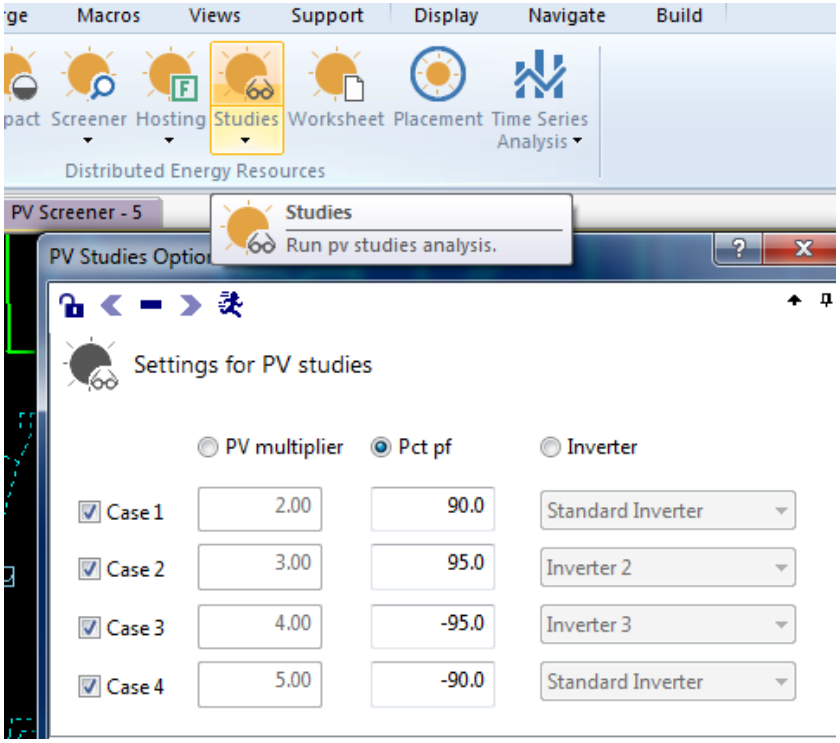
PV Screener



Evaluate PV at a specific location over specified months and hours.

Generation		Max Fdr Ldg		Max Line Ldg		Max Tran Ldg		Max LTC Rev Flow		Max Fdr Rev Flow		Max
kW	Pct	Pct	FailHrs	Pct	FailHrs	Pct	FailHrs	Pct	FailHrs	Pct	FailHrs	Pct
0	0	55.2	0	55.2	0	59.7	0					
1000	10	47.3	0	47.3	0	54.7	0					
2000	20	39.2	0	39.2	0	48.8	0					
3000	30	31.5	0	37.2	0	43.9	0					
4000	40	28.4	0	46.3	0	39.0	0					
5000	50	36.0	0	55.3	0	34.2	0					
6000	60	43.7	0	64.2	0	29.5	0					
7000	70	51.4	0	73.2	0	24.8	0			51.4	124	
8000	80	59.1	0	82.1	0	20.4	0			59.1	1016	
9000	90	66.8	0	91.0	0	17.9	0	17.9	446	66.8	1736	
10000	100	74.4	0	99.8	0	22.5	0	22.5	1067	74.4	2363	

PV Studies



Evaluate strategies with PV:

- Increased penetration
- Power factor settings
- Inverter settings

Feeder ID	Demand MW				
	Base	90 Pct Pf	95 Pct Pf	-95 Pct Pf	-90 Pct Pf
Newville 1		6.07	5.97	6.01	6.03
Newville 2		7.11	7.12	7.16	7.18
Ship sub 1		2.20	2.21	2.26	2.27
Ship sub 2		2.48	2.49	2.48	2.43
New - Big Spring		2.33	2.34	2.36	2.37
New - Cove		4.68	4.68	4.70	4.70

PV Hosting – Grow to feeder exception

Summary

Feeder ID	MI	Customers	PV Hosting Capacity Cap. MW	Remain MW	Remain Pct	Peak Demand MW	Peak Demand Time	Min net load MW	Min net load Time
Feeder New - Big Spring	13.32	1345	10.21	4.29	42.0	6.04	November Weekday 4 p.m.	4.17	July Weekend 5 a.m.
Feeder New - Cove	5.36	526	10.04	10.04	100.0	5.93	October Weekend 7 a.m.	4.10	July Weekend 5 a.m.
Feeder New - Liberty	6.65	1213	7.35	6.17	83.9	5.07	November Weekday 3 p.m.	2.28	August Weekend 11 a.m
Feeder New - Springfield	20.03	2283	9.87	6.91	70.0	5.64	October Weekend 7 a.m.	4.23	July Weekend 5 a.m.
Feeder Ship - South Penn	13.88	920	7.90	2.75	34.8	4.86	October Weekend 8 a.m.	3.05	July Weekend 5 a.m.
Feeder Ship - West Martin	28.01	3353	7.94	2.77	34.9	5.19	October Weekend 8 a.m.	2.75	July Weekend 5 a.m.

Calculate

- Peak demand
- Peak PV production

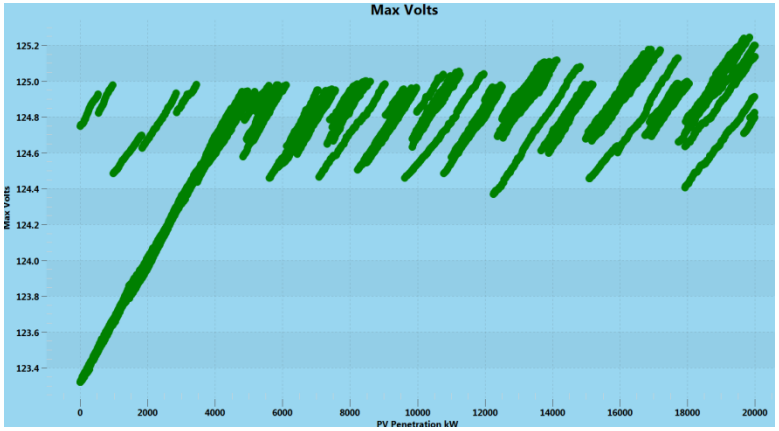
Grow to exception

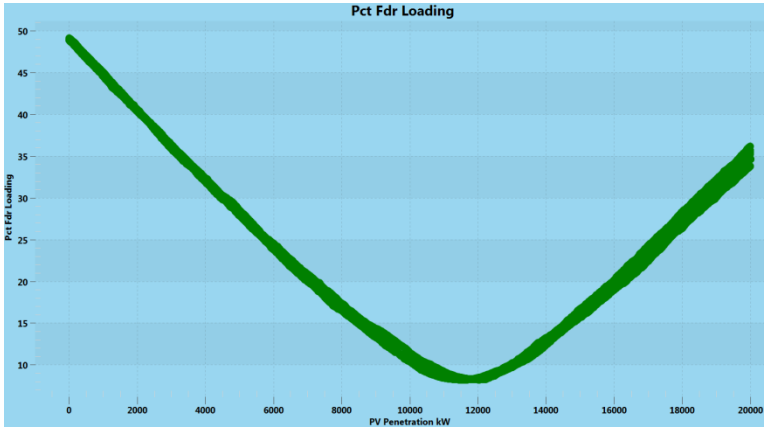
- Gradually add PV to circuits
- Stop when exceptions are found

Feeder ID	Load MW	PV MW Base	Max	PctSat	Remaining	Overload Exception Pct	Facility	Name	ID	High Volts Exception Volts	Facility	Name	ID	Reverse Flow Exception Pct	Facility	Name	ID
Feeder New - Big Spring	6.00	3.59	2.70	45	-0.89	---	---	---	---	126.1	Lin	20489	20489	---	---	---	---
Feeder New - Cove	5.20	2.17	15.90	305	13.73	---	---	---	---	---	---	---	---	---	---	---	---
Feeder New - Liberty	4.10	0.77	9.30	224	8.53	---	---	---	---	---	---	---	---	62.0	Feeder		New - Liberty
Feeder New - Springfield	5.50	1.89	6.60	120	4.71	103.2	Fse	Fuse 55731	55731	---	---	---	---	---	---	---	---
Feeder Ship - South Penn	4.70	3.15	3.60	76	0.45	103.7	Fse	Fuse 52308	52308	---	---	---	---	---	---	---	---
Feeder Ship - West Martin	5.00	4.01	5.70	115	1.69	102.7	Fse	Fuse 53822	53822	---	---	---	---	---	---	---	---

PV Hosting – Stochastic

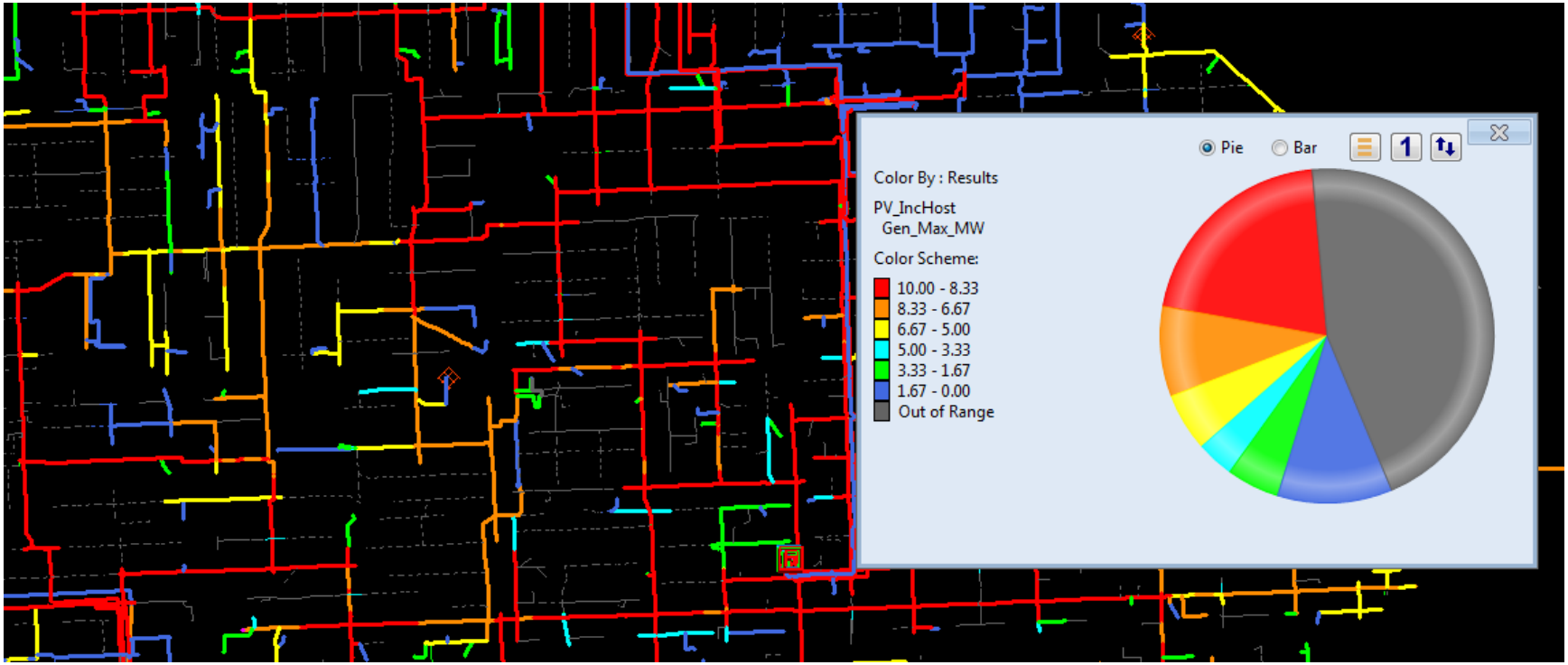
- Roll the dice for size and location
- Profile for residential and commercial systems
- Run multiple profiles





PV Hosting – Incremental capacity

- Maximum PV on each section
- Hours & months



PV Hosting – Incremental capacity

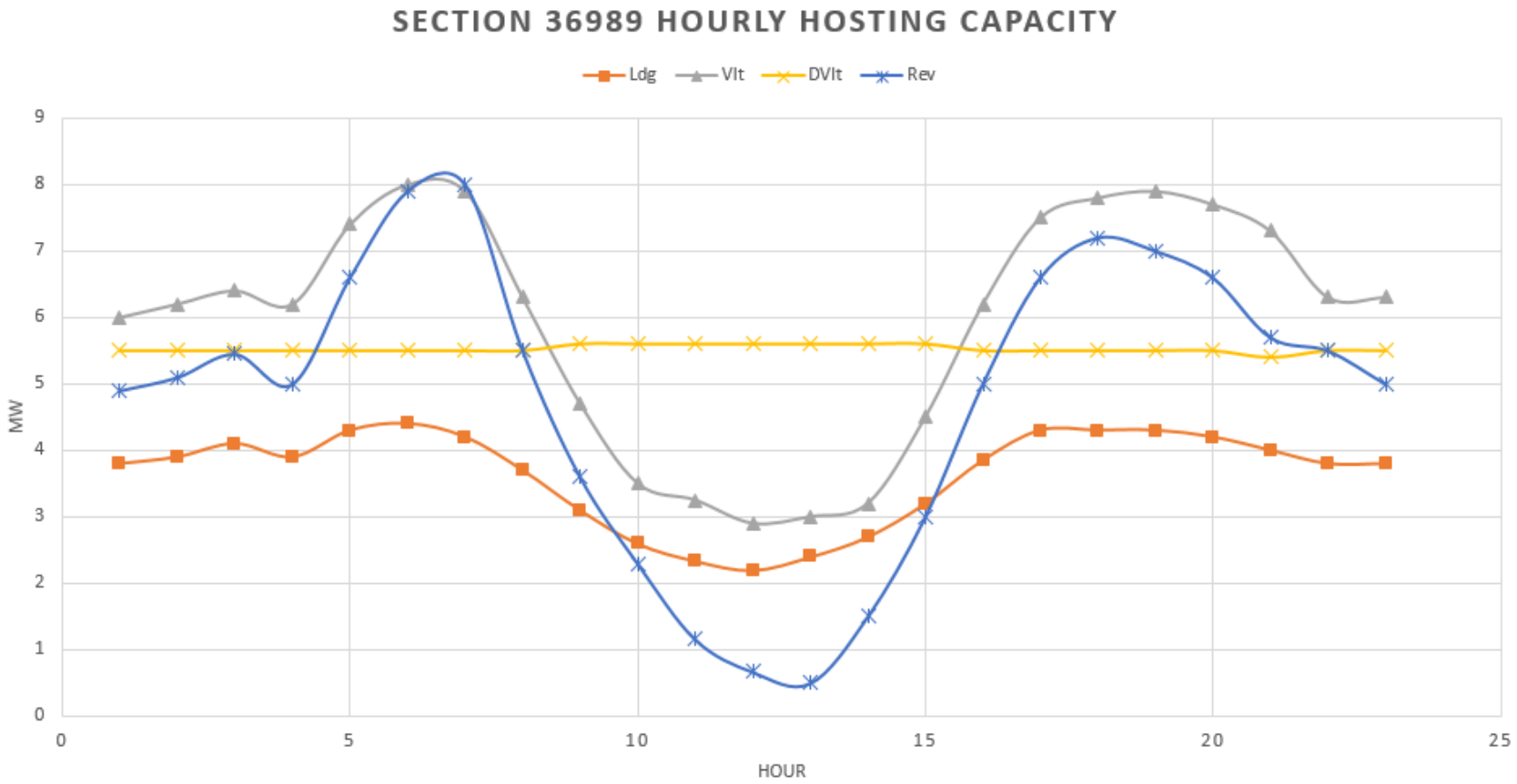
- Results pushed into a database

July	Weekend	10	1	1568.40664726875	Line
July	Weekend	11	1	1568.40664726875	Line
July	Weekend	12	1	1568.40664726875	Line
July	Weekend	13	1	1792.46473973572	Line
July	Weekday	9	0	2016.52283220268	Line
July	Weekday	10	1	1792.46473973572	Line
July	Weekday	11	1	1792.46473973572	Line
July	Weekday	12	1	1792.46473973572	Line
July	Weekday	13	1	1792.46473973572	Line
August	Weekend	9	0	2016.52283220268	Line

- Hourly hosting capacity
- Hourly limiting facility

OvldExcPct	HVExcPct	RevExcPct	DeltaVltPct
102.681317451678	0	0	0
102.788454557566	0	0	0
0	0	0	2.12806510503761
0	0	52.3743699104772	0
0	0	53.8475214801406	0
0	0	53.7469150492224	0

PV Hosting – Incremental capacity by hour



Ways to run analysis

- Engineering applications
- Batch analysis
- EA Automation (Full model -> Analysis -> Database)
- Solver (COM programming API)
- Python
- Macros

Thank you

Larry Trussell PhD EE
Senior Principal Electrical Engineer – Synergi Electric
Larry.trussell@dnvgl.com

www.dnvgl.com

SAFER, SMARTER, GREENER