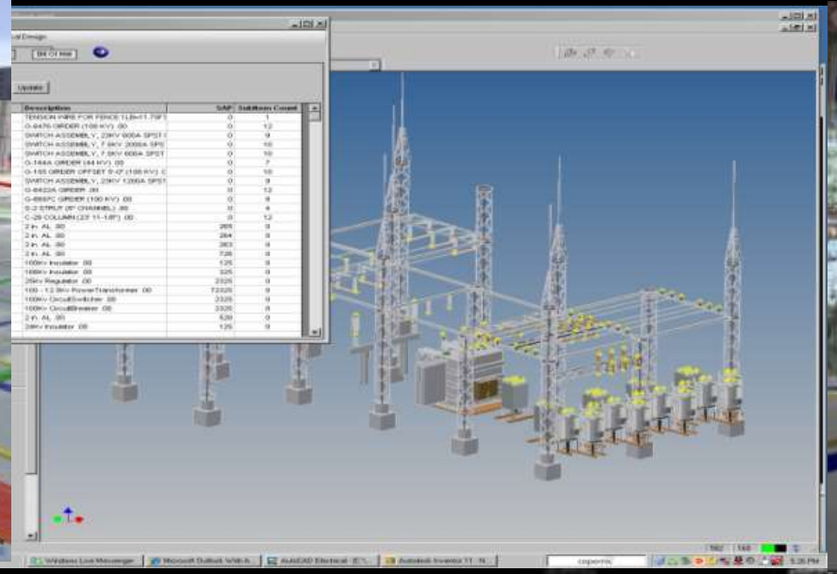


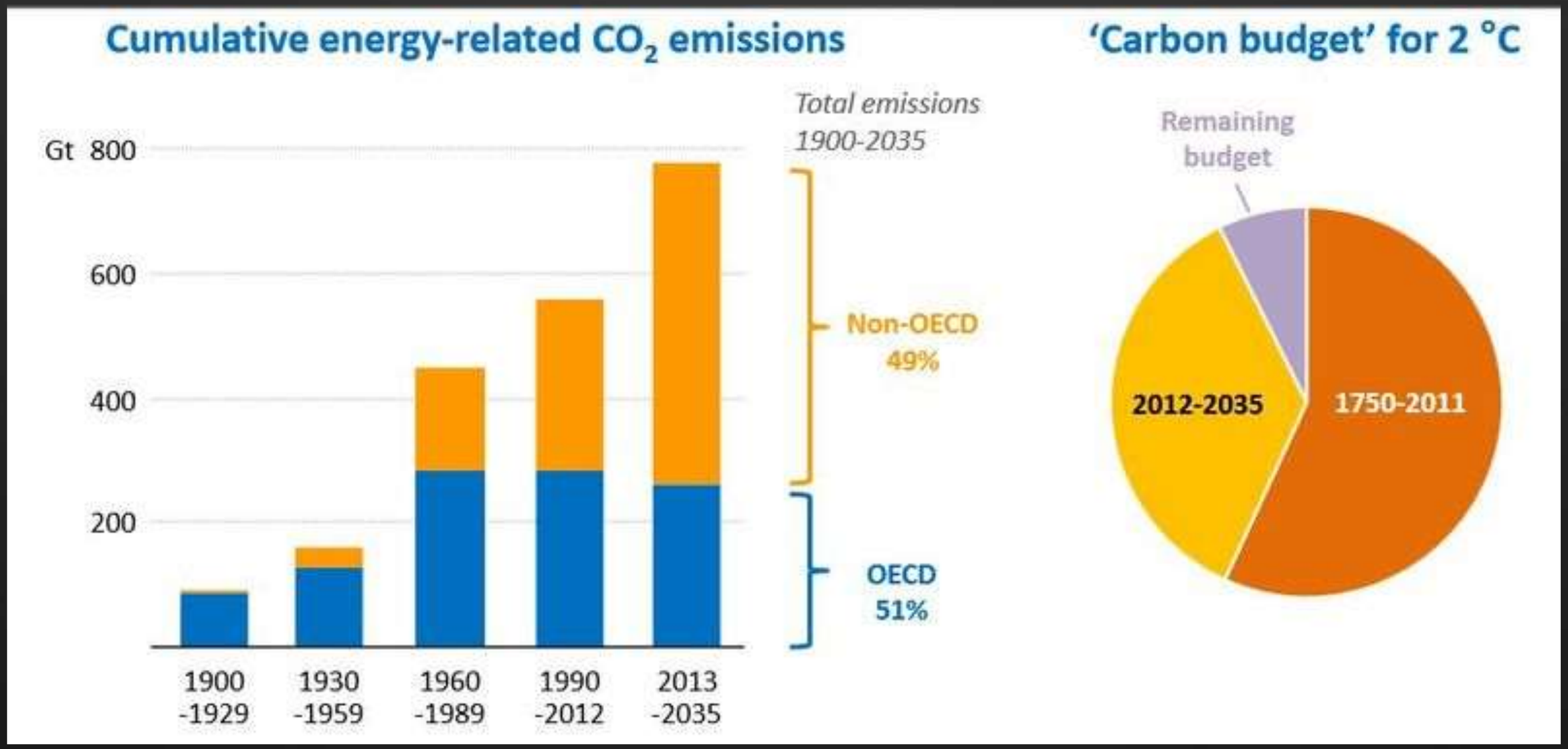
Grid 3.0: Growing Opportunities for Geospatial

Geoff Zeiss
Principal
Between The Poles

Energy demand expected to increase by a third by 2035 – IEA World Energy Outlook 2013

- China is the primary driver for increased demand through 2020.
- India becomes the primary driver after 2020.

Energy-related CO2 emissions will increase by 20% by 2035 – IEA World Energy Outlook 2013



- IEA estimates that this will lead to a long-term average temperature increase of 3.6° C.

Distributed energy generation (DER) changes the utility business model

Hawaiian Utilities: The challenge to the traditional business model of selling electricity

Exponential rise in rooftop solar PV

Dramatic drop in load is during daytime hours

Utility has been experiencing a reduction in net load and revenue.

DER drives alternative utility business models

New York State REV - future utility industry

- Distributed system platform (DSP) providers – own and maintain grid infrastructure, but do not sell energy.
- Energy market - many energy providers including bulk power generators and rooftop solar panels.

Sacramento Municipal Utilities District (SMUD)

- Getting out of the business of selling electricity
- Plans to become a distributed utility providing localized grid services.

Maryland - Energy Future Coalition (EFC) recommendations

- New utility business model decouples utility revenue from selling electric power

Sacramento Municipal Utilities District (SMUD),

SMUD - one of the most forward-looking utilities in North America.

- First California utility to reach 20% renewable power and the first to commit to 33% renewables.

Past: Centralized utility with a business model based on selling electricity

Future: Distributed utility providing localized grid services

- SMUD is getting out of the business of selling electricity, and into the business of selling grid services.

New SMUD business model

SMUD charges flat infrastructure fee.

- Currently every customer pays $18/month for the grid, independent of how much power they consume
- $28 is the breakeven point where the cost of maintaining the grid is covered by infrastructure fees

Solar power program

- Customers can buy into solar power without the bother of having to install solar panels on their roofs.

Distributed energy generation

Consumers are driving change

"*Advances in technology and the desire we are seeing at the consumer level to have control and the ability to know that they can ensure the reliability of their system within their home, business, microgrid or their community.*

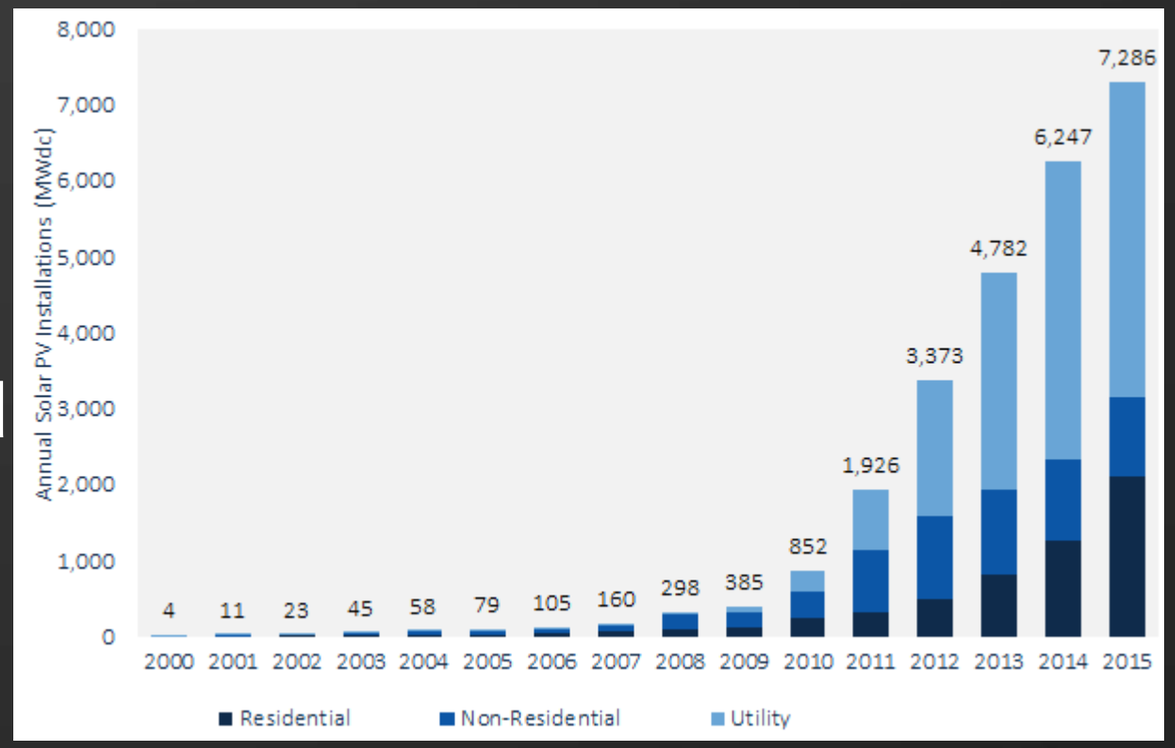
People are going to continue to drive towards having these kinds of technologies available to them. And once that happens through the technologies and the entrepreneurial spirit we are seeing with these companies coming in, I just don't see how we can continue with the same model we have had for the last 100 or 150 years."

Disruptive

Jon Wellinghof, ex-Chairman of FERC

In 2015 new solar PV capacity exceeded new natural gas additions

- GTM Research and the Solar Energy Industries Association
- New solar PV capacity in the United States set a new record in 2015.
- 7.3 gigawatts (GW) of solar photovoltaics (PV) were installed
- Exceeded new natural-gas capacity additions for the first time.
- In 2015 solar was up 17% over 2014
- Almost a third of new electric generating capacity additions in the U.S.



Hawaiian Utilities: Renewables

Governor of Hawaii has committed to 100% renewables by 2045 and 65% by 2030

Already 487 MW of solar PV capacity, 90% of which is residential rooftop panels.

Planning variety of renewable energy resources

Hawaiian Power Utilities

“Keep a close watch on the Hawaiian power utilities (HECO) because Hawaii has committed to 100% renewables by 2045 and 65% by 2030. “

Sharon Allan, CEO of the Smart Grid Interoperability Panel

HECO Renewable energy generation portfolio

Planning for

- Solar
- Wind
- Ocean Energy
- Biomass
- Geothermal
- Waste to energy

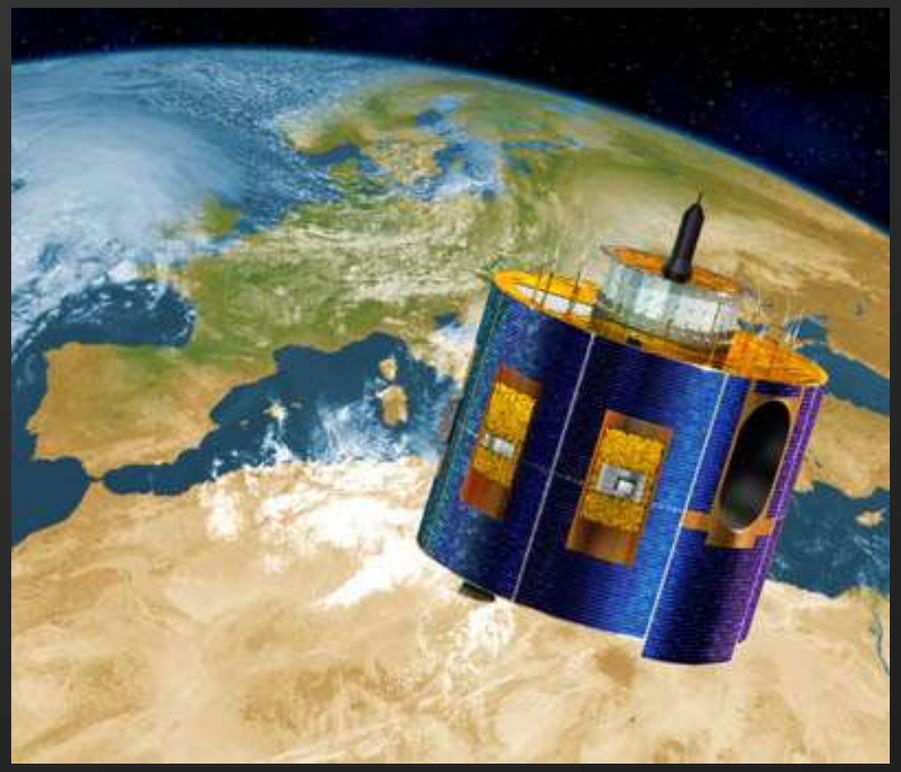
Increasingly the key to intermittent energy sources is storage

- Battery storage

Predicting generation: “Nowcasting”

Nowcasting - mapping detailed description of the current weather along with forecasts up to 3–4 hours.

- Essential for grid operators in order to guarantee the grid stability for intermittent sources (wind and solar)
- Very high temporal resolution (a forecast every 10 or 15 minutes)
- Based on time series processing of meteorological measured data,



Meteosat Second Generation(MSG) monitor meteorological information in near real time.

- MSG generates multispectral imagery of the Earth's surface and cloud systems every 15 minutes for twelve spectral channels

Predicting generation: Weather maps

- Maps of irradiance and wind velocity
- Temperature maps are also important because the efficiency of solar panels depends on temperature.
- The more accurate the weather forecasts are, the more predictable the generation.

Examples of data collected by Hawaiian power utilities, most includes location

Sources

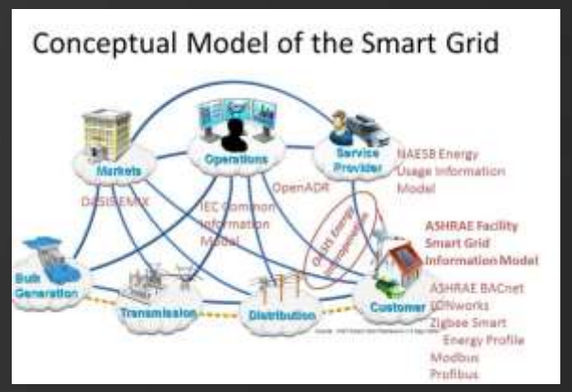
- weather forecasts,
- customer sited PV
- consumer/public resources
- Phasors (PMU)
- renewables power quality
- feeders
- irradiance meters
- generator and substations power quality
- SCADA
- forecasts from Independent Power Producers (IPPs).

Reporting frequency

- PMUs sampling 30 times per second,
- SCADA reporting every 2 seconds,
- calculated gross load every 2 seconds
- PV inverter data reporting every 5 minutes (aggregated monthly)
- weather forecast reporting every 15 minutes (aggregated daily}
- transformers collecting data every 15 mins (aggregated monthly)
- smart meters reporting every 15 minutes (aggregated quarterly)

Geospatial is key to integrating data from many different sources including internal operational data, sensors, and external data such as weather

Navigant predicts that geospatial will become a foundational technology of smart grid



"The smart grid is all about situation awareness and effective anticipation of and response to events that might disrupt the performance of the power grid. Since spatial data underlies everything an electric utility does, <u>GIS is the only foundational view that can potentially link every operational activity</u> of an electric utility including design and construction, asset management, workforce management, and outage management as well as supervisory control and data acquisition (SCADA), distribution management systems (DMSs), renewables, and strategy planning."

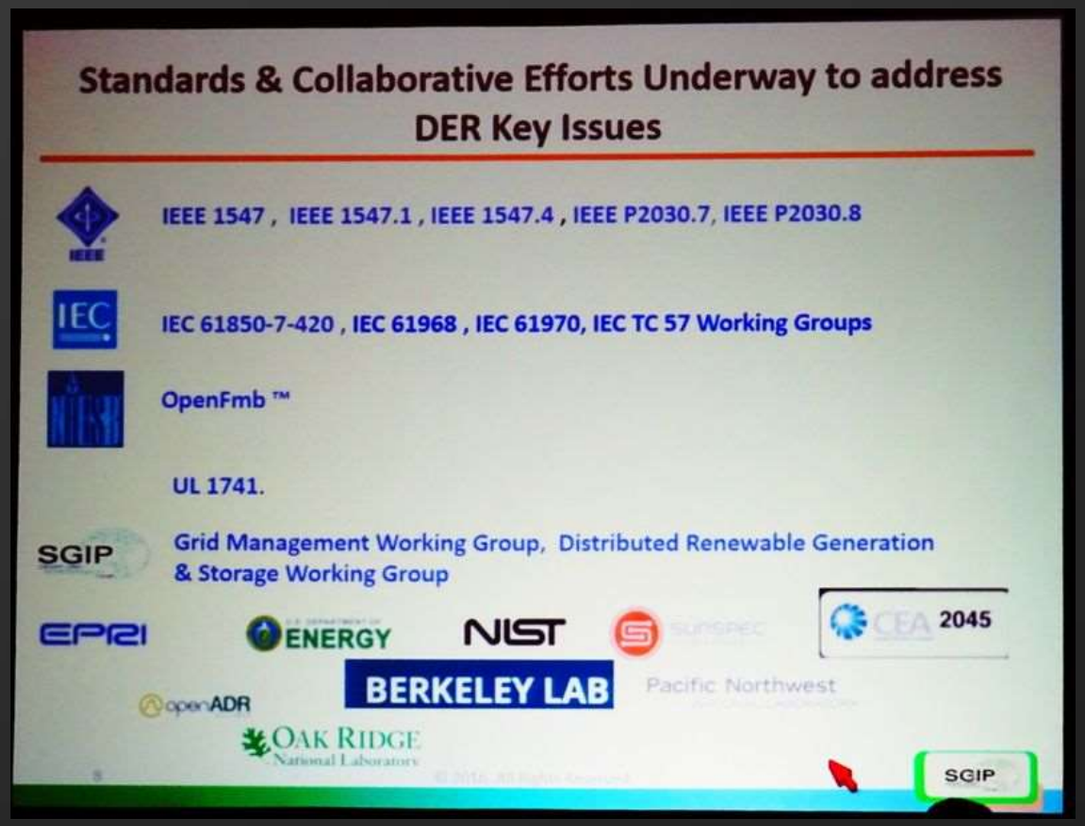
http://www.navigantresearch.com/research/utility-geographic-information-systems

The Next Big Thing ?

Transactive energy

Market forces control the flow of energy

Sharon Allan, CEO of Smart Grid Interoperability Panel (SGIP) "*get ready for transactive energy, this is real, this is not hype*."



Toward a *shared common vision of the utility of the future –*

IEEE, IEC, and SGIP; Department of Energy, ARPA-E and Pacific NW National Lab (PNNL); and EPRI.

Transactive energy

Gartner utility industry forecast

"By 2020, the largest energy company in the world (by market cap) will not own any network (grid) or generation assets."

Disruptive

- It will just manage information about energy sources and consumers

- Analogous to **Uber** and **Airbnb** in their markets.

Zarko Sumic, Distinguished Analyst, Gartner

ACROSS THE UNITED STATES

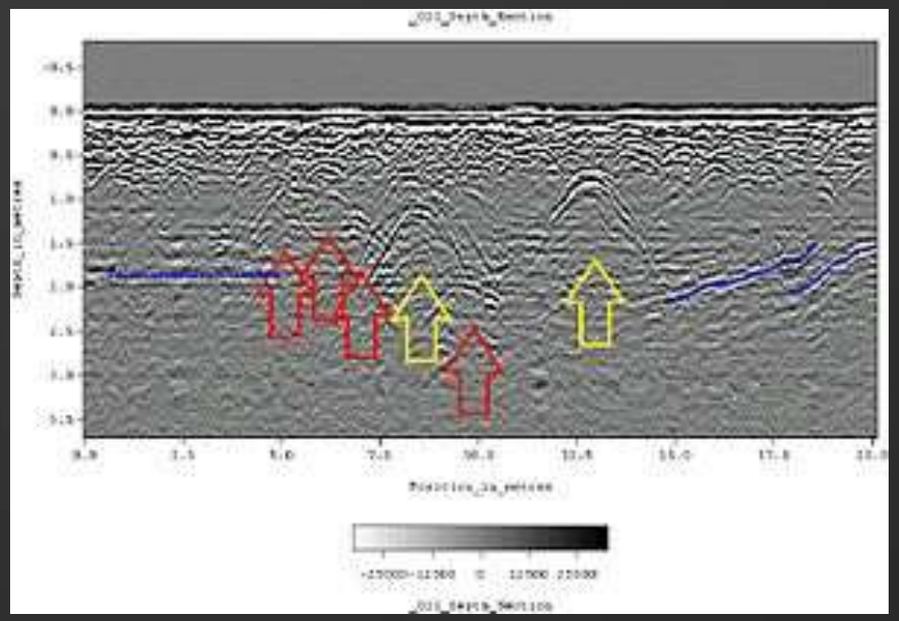
THE CONCERNS

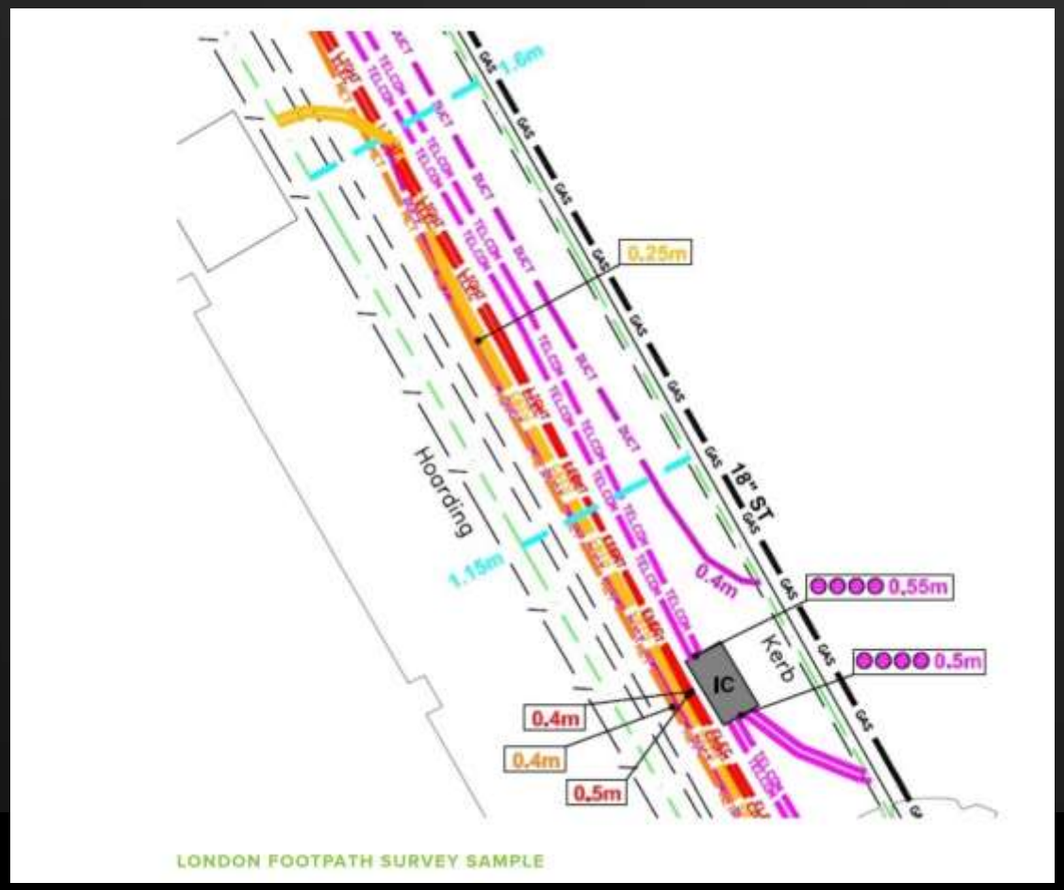
- UNDERGROUND UTILITY LINE HIT EVERY 60 SEC
- ANNUAL COST DUE TO UTILITY DAMAGE RANGES IN THE BILLION$

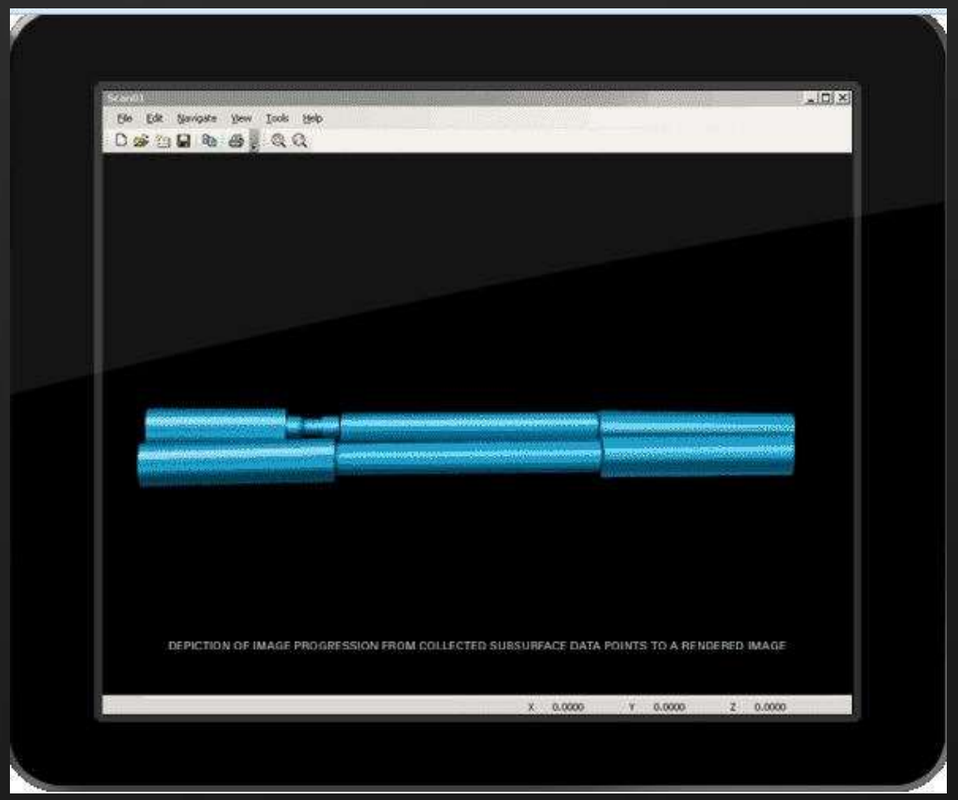
- INACCURATE RECORDS AND LOCATING
- UTILITIES NOT MARKED
- CROWDING WITHIN THE RIGHT OF WAY

Ground penetrating radar (GPR)

Image:Ditch Witch







Geotec

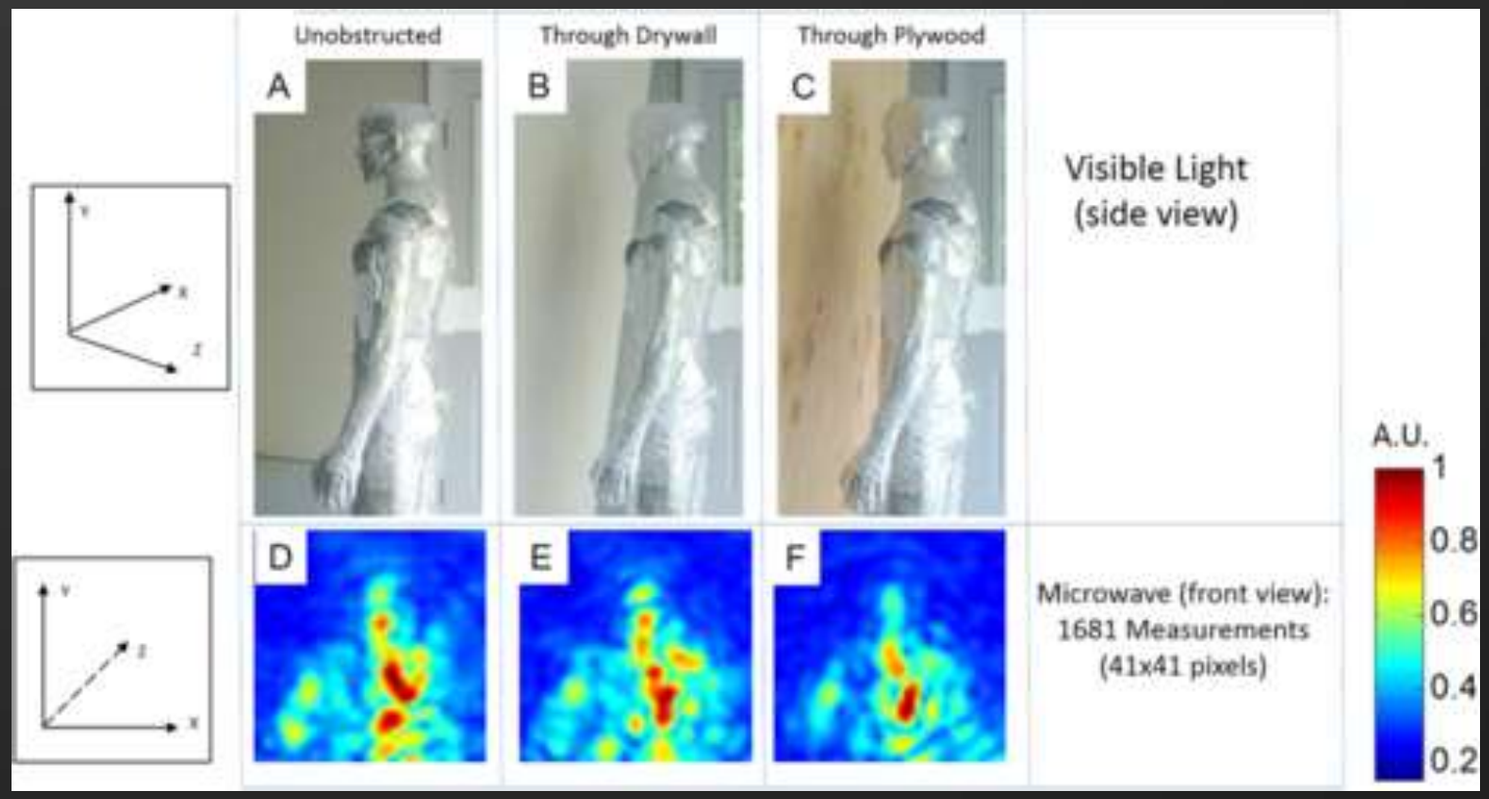
Newest remote sensing domain: Detecting features underground

- Electromagnetic conductivity (EM)
- Ground penetrating radar (GPR)
- Very low frequency (VLF) profiling
- Electrical resistivity imaging
- Borehole geophysical and video logging
- Crosshole seismic testing
- Seismic tomography
- Microgravity surveys
- Seismic refraction
- Magnetometry

Latest MIT technology scans through walls in 3D

Time-of-Flight Microwave Camera

- Uses time of flight to create a 3D image of an object.
- Technology similar to radar and XBox Kinect work.
- Sends out bursts of microwaves and tracks time it takes for the microwaves to be reflected and return to the sensor.
- Time resolution of 200 picoseconds (a picosecond is one trillionth of a second).
- Camera can resolve distances within 6 cm.



To test the prototype MIT placed a mannequin covered in aluminum foil behind a drywall wall and a sheet of plywood.

http://www.nature.com/articles/srep14709

Las Vegas 3D infrastructure model

International Efforts to Geolocate Underground Facilities

- France – A nation-wide multi-billion euro project is underway to map France's underground utility infrastructure to 40 cm.
- Penang, Malaysia – Penang-s Sutra D'Bank(Penang State Government Subterranean Data Bank is maintained by a joint venture company EQUARATER (PENANG).
- Bahrain - Bahrain's Intelligent Decision Support System (iDSS) provides single repository for all underground facilities.
- Sao Paulo, Brazil – The City of Sao Paulo's GeoCONVIAS project integrates data from 20 to 30 utilities which operate in the city of Sao Paulo.
- Rio de Janeiro, Brazil - The City of Rio de Janeiro has a similar project GeoVias funded by the government of the City of Rio de Janeiro and four utilities.

International Efforts to Geolocate Underground Facilities (cont.)

- Tokyo, Japan (now deployed in major Japanese cities) – Many years ago Tokyo developed the mainframe-based Road Administration Information Center (ROADIC) system
- Sarajevo, Bosnia – Over 40 years ago as part of the permitting process, Sarajevo mandated the recording the location of all utility and telecommunications infrastructure in the city.
- Calgary, Alberta – A number of years ago the City Government passed a by-law which mandated that all utilities and telecoms working within city limits must provide data showing the geolocation of their infrastructure to the city's Joint Utility Mapping Project (JUMP).
- State of Jalisco, Mexico - The Instituto de Información Territorial del Estado de Jalisco developed an integrated infrastructure database for the State of Jalisco.
- Edmonton, Alberta - Edmonton, Alberta has a shared facilities mapping database.

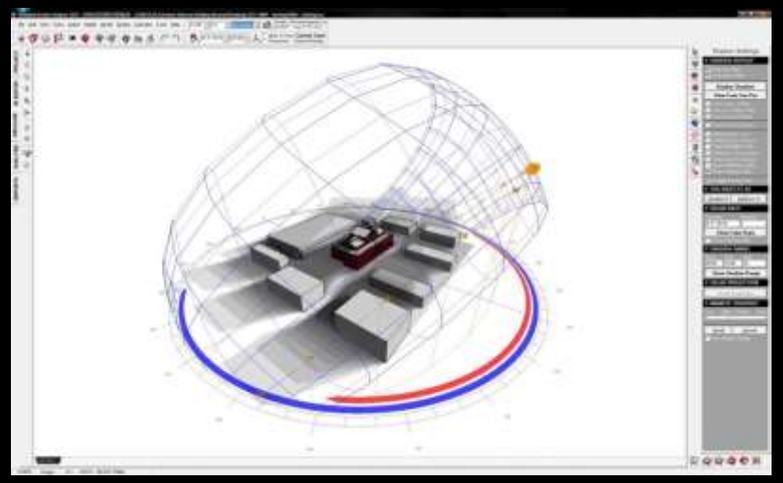
ROI of improving geolocation accuracy for underground utilities

- USDOT/Purdue University - **US$4.62** in avoided costs for every US$1.00 spent
- Ontario Sewer and Watermain Contractors Association /University of Toronto in 2004 – ROI **$3.41** for each $ spent
- Pennsylvania DoT/Pennsylvania State University in 2007 - ROI **US$ 21.00** saved for every US$1.00 spent elevating the quality level of subsurface utility information
- University of Toronto – ROI ranged from $**2.05 to $6.59** for every dollar spent on improving underground utility location data.
- Lombardy, Italy – ROI of **€16** for every € invested in improving the reliability of information about underground infrastructure.

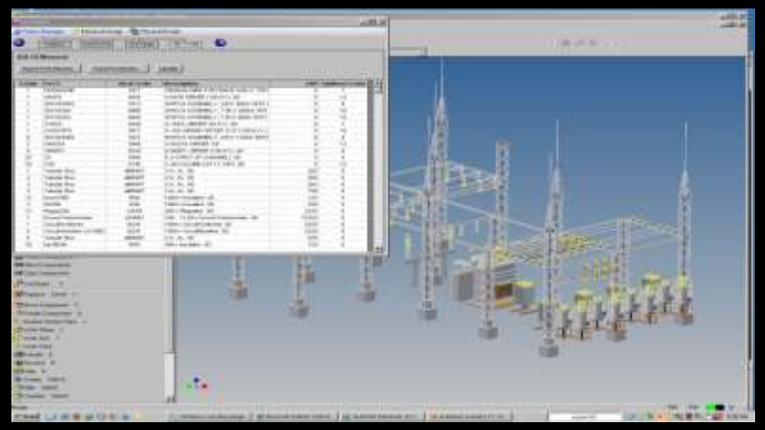
Some takeaways

The next big thing (s)

- Transactive energy
- Geolocatiing underground utilities



Grid 3.0 represents a new utility business model



Geospatial is <u>foundational</u> for Grid 3.0

- DER generation - nowcasting and forecasting
- Integrating “big data” from multitude of sources

Geospatial Media

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http://geospatial.blogs.com