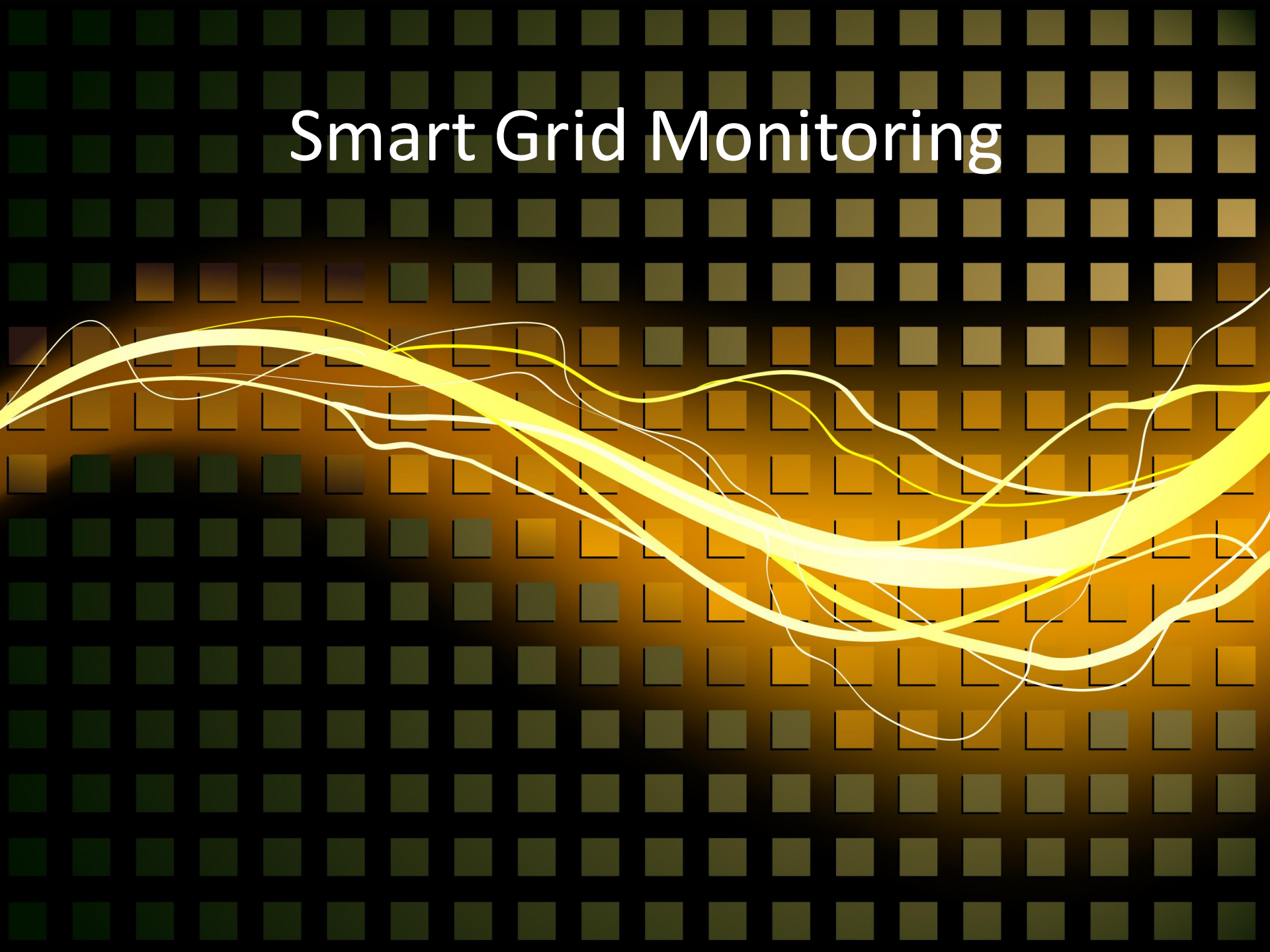
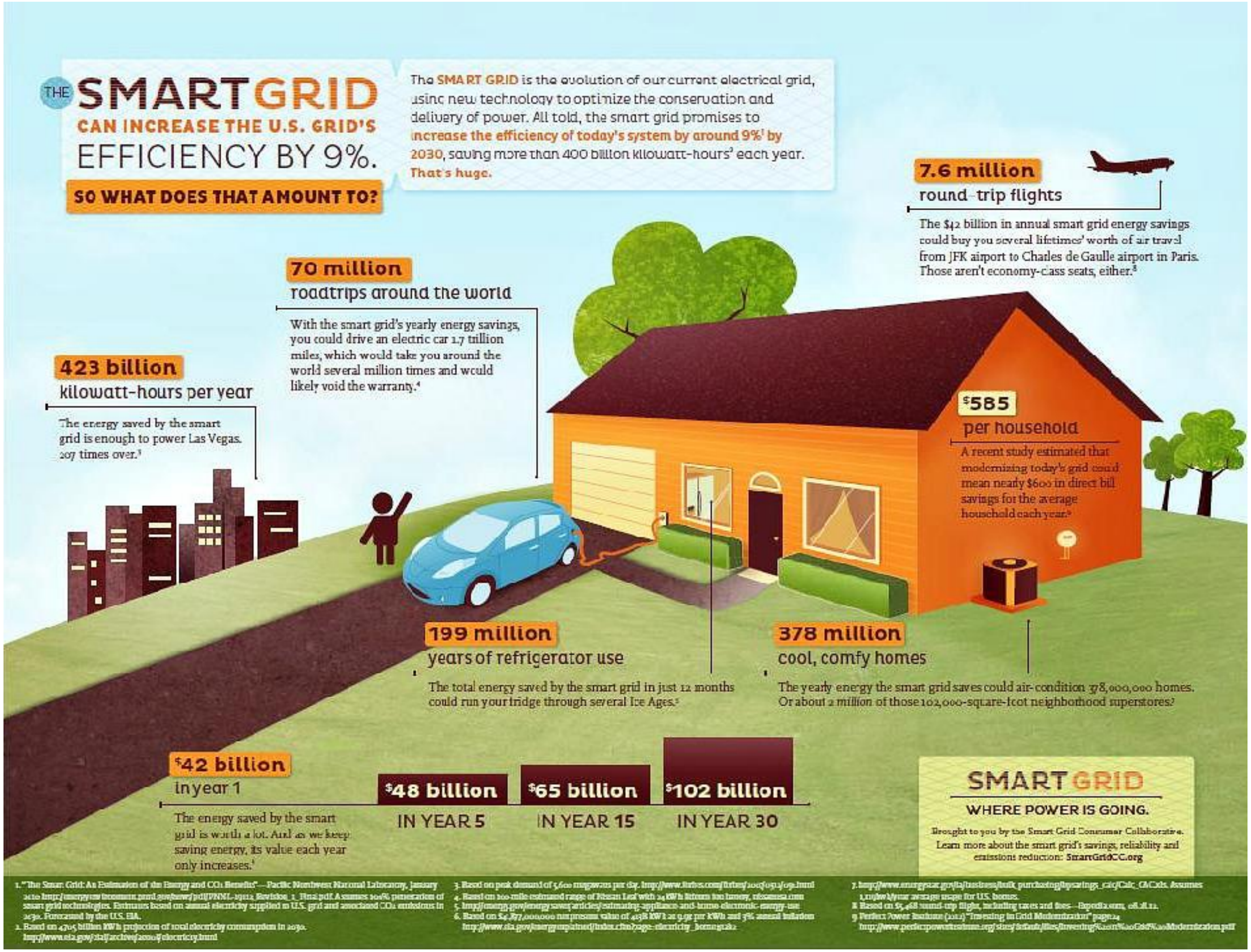
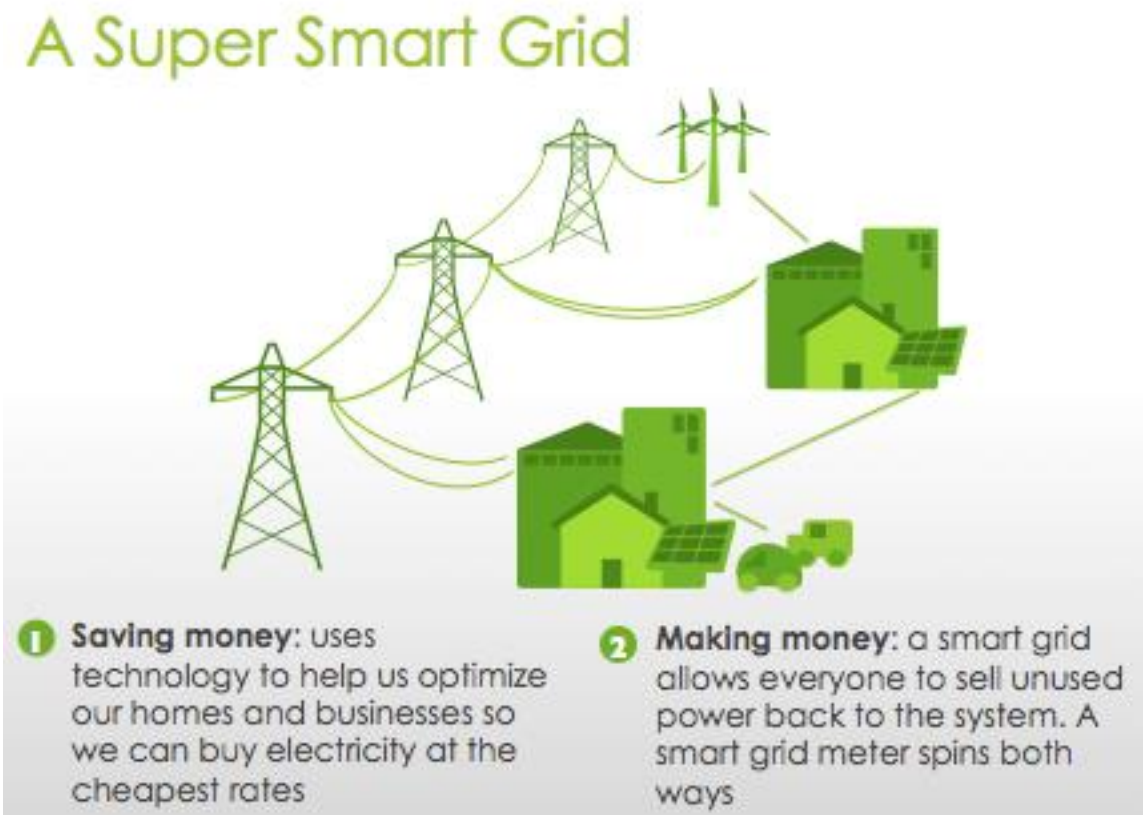
Smart Grid Monitoring

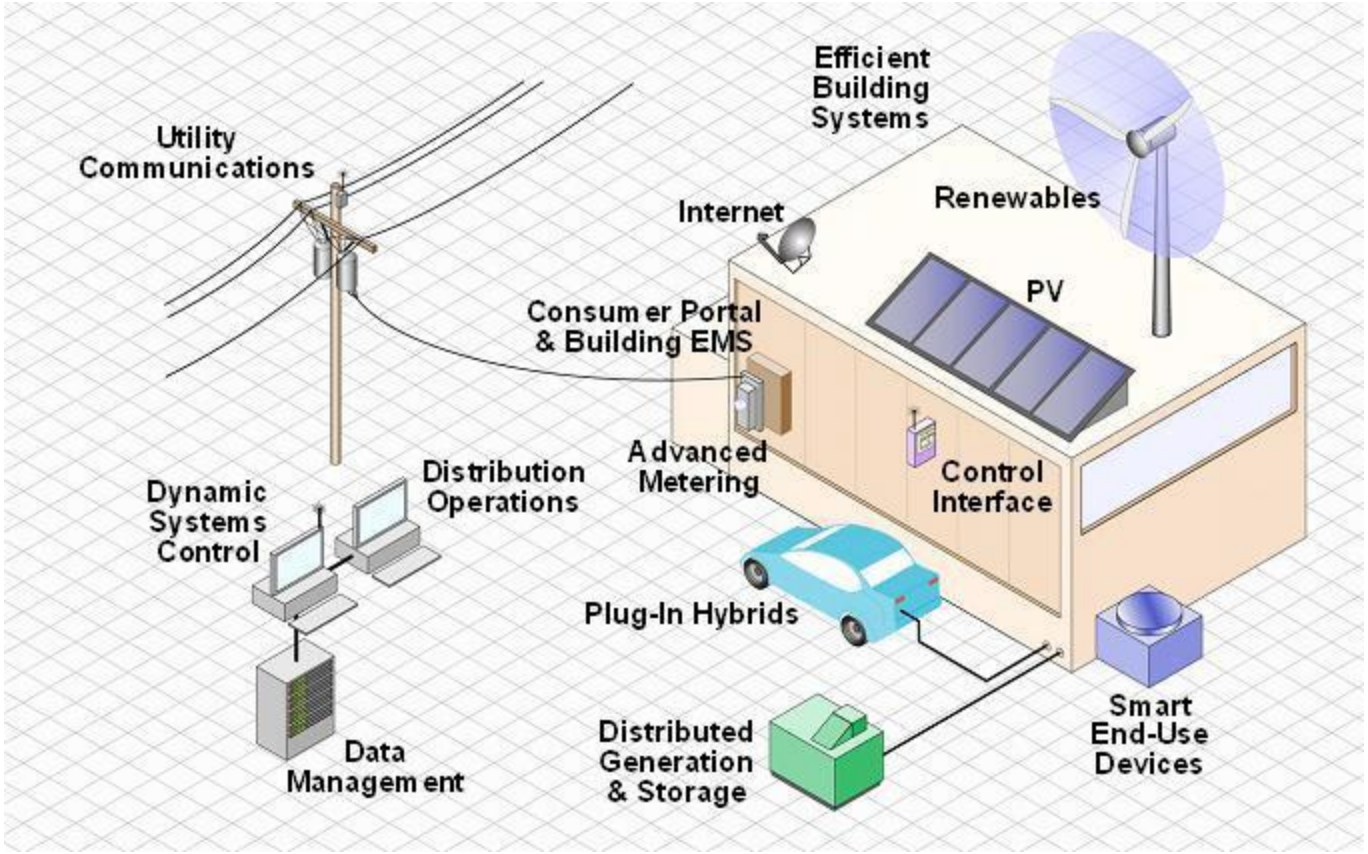



THE SMART GRID
CAN INCREASE THE U.S. GRID'S
EFFICIENCY BY 9%.
SO WHAT DOES THAT AMOUNT TO?
The SMART GRID is the evolution of our current electrical grid, using new technology to optimize the conservation and delivery of power. All told, the smart grid promises to increase the efficiency of today's system by around 9%[1] by 2030, saving more than 400 billion kilowatt-hours[2] each year. That's huge.
7.6 million
round-trip flights
The $42 billion in annual smart grid energy savings could buy you several lifetimes' worth of air travel from JFK airport to Charles de Gaulle airport in Paris. Those aren't economy-class seats, either.[8]
70 million
roadtrips around the world
With the smart grid's yearly energy savings, you could drive an electric car 1.7 trillion miles, which would take you around the world several million times and would likely void the warranty.[4]
423 billion
kilowatt-hours per year
The energy saved by the smart grid is enough to power Las Vegas 207 times over.[3]
$585
per household
A recent study estimated that modernizing today's grid could mean nearly $600 in direct bill savings for the average household each year.[9]
199 million
years of refrigerator use
The total energy saved by the smart grid in just 12 months could run your fridge through several Ice Ages.[5]
378 million
cool, comfy homes
The yearly energy the smart grid saves could air-condition 378,000,000 homes. Or about 2 million of those 102,000-square-foot neighborhood superstores.[7]
$42 billion
in year 1
The energy saved by the smart grid is worth a lot. And as we keep saving energy, its value each year only increases.[1]
$48 billion
IN YEAR 5
$65 billion
IN YEAR 15
$102 billion
IN YEAR 30
SMART GRID
WHERE POWER IS GOING.
Brought to you by the Smart Grid Consumer Collaborative.
Learn more about the smart grid's savings, reliability and emissions reduction: SmartGridCC.org
2. Based on 4705 billion kWh projection of total electricity consumption in 2030.
8. Based on $5,468 round-trip flight, including taxes and fees—Expedia.com, 08.18.12.
9. Perfect Power Institute (2012) "Investing in Grid Modernization" page 24

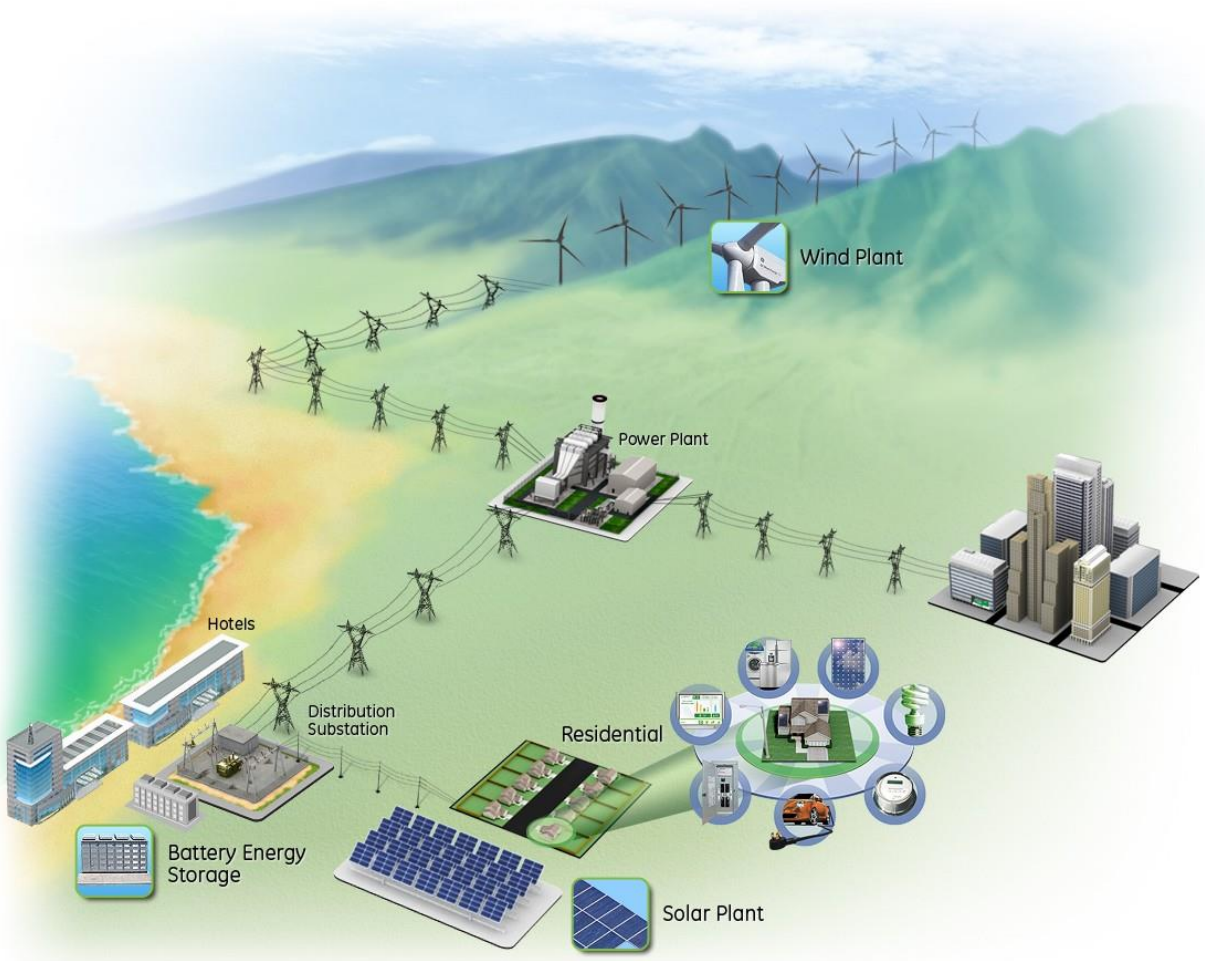
Benefits


A Super Smart Grid
1 Saving money: uses technology to help us optimize our homes and businesses so we can buy electricity at the cheapest rates
2 Making money: a smart grid allows everyone to sell unused power back to the system. A smart grid meter spins both ways

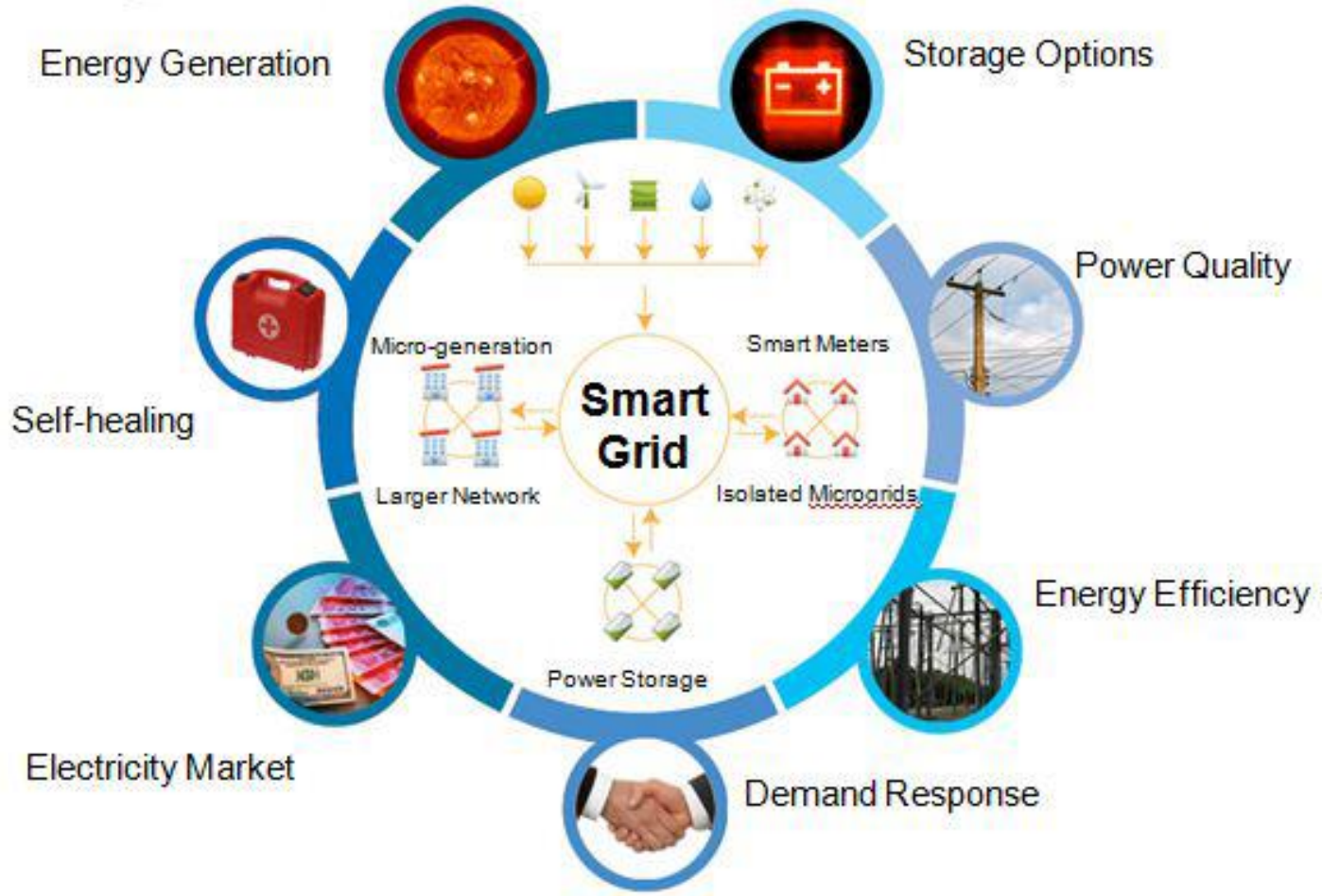
Smart Grid


Efficient
Building
Systems
Utility
Communications
Internet
Renewables
PV
Consumer Portal
& Building EMS
Advanced
Metering
Control
Interface
Distribution
Operations
Dynamic
Systems
Control
Plug-In Hybrids
Smart
End-Use
Devices
Distributed
Generation
& Storage
Data
Management

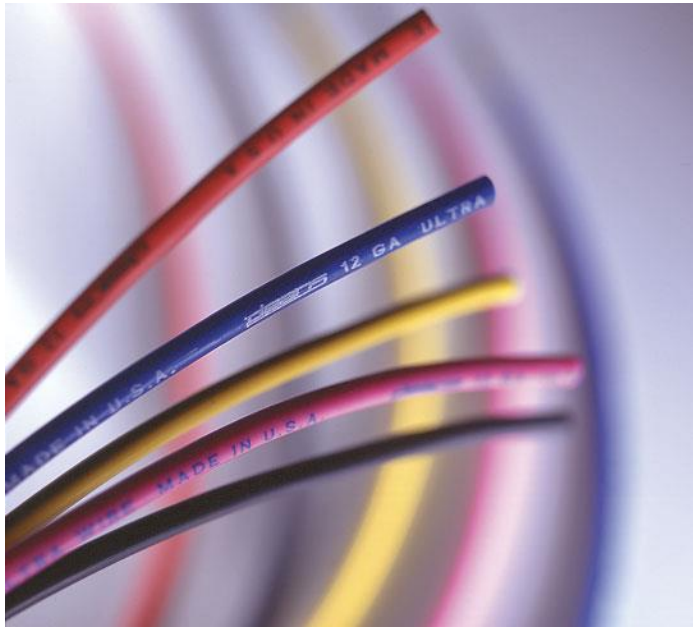

$/k21
$/k21
Multiple levels of integration – interoperability
Distributed Generation
Renewable Generation
Storage
Demand Response


Wind Plant
Power Plant
Hotels
Distribution Substation
Residential
Battery Energy Storage
Solar Plant

Features


Energy Generation
Storage Options
Power Quality
Self-healing
Micro-generation
Smart Meters
Smart Grid
Larger Network
Isolated Microgrids
Energy Efficiency
Power Storage
Electricity Market
Demand Response

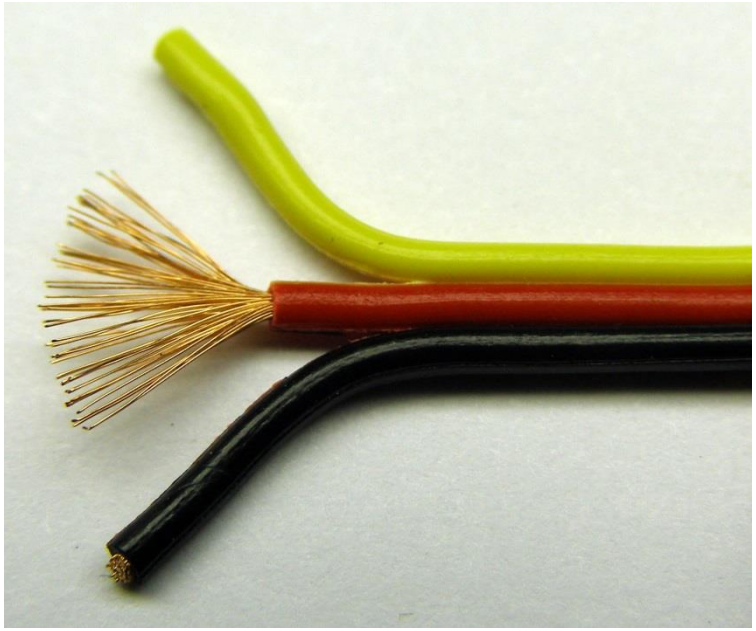
Power Buses used in a Smart Grid



AC Bus

Connects to:

1. AC Sources
2. AC Loads
3. AC – DC Converters



DC Bus

Connects to:

1. DC Sources
2. DC Loads
3. DC Storage (batteries)
4. DC – AC Converters

Requirements

Monitoring

Helps:

1. Consumers to understand the costs due to their appliances, identify devices consuming high power, thus helping them to reduce electric bill costs.
2. Allow researchers and industrialists to understand the energy usage pattern of consumers and accordingly engineer devices to enhance energy savings.
3. Empowers people to sell unused/generated energy to grid, store energy for peak hours.

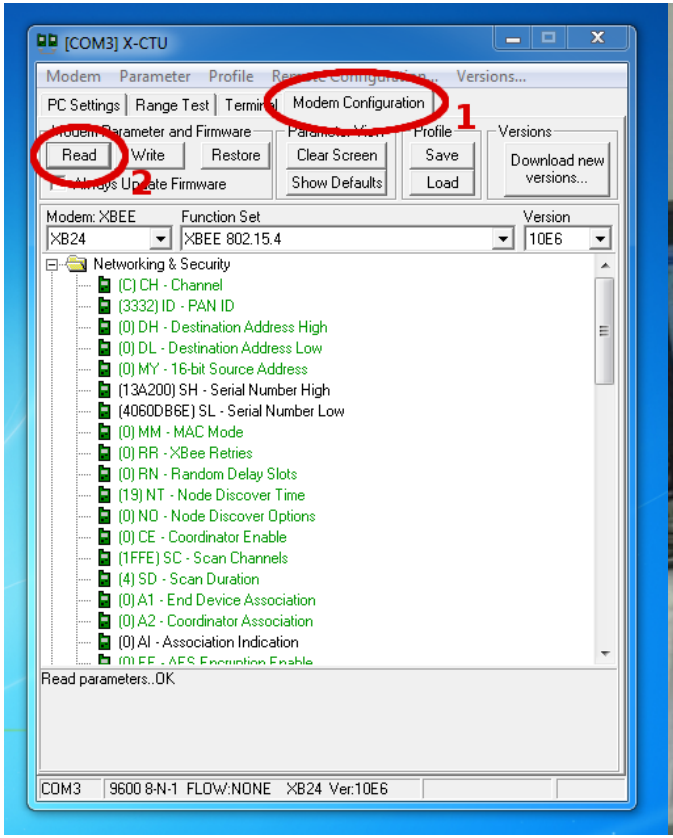
Control

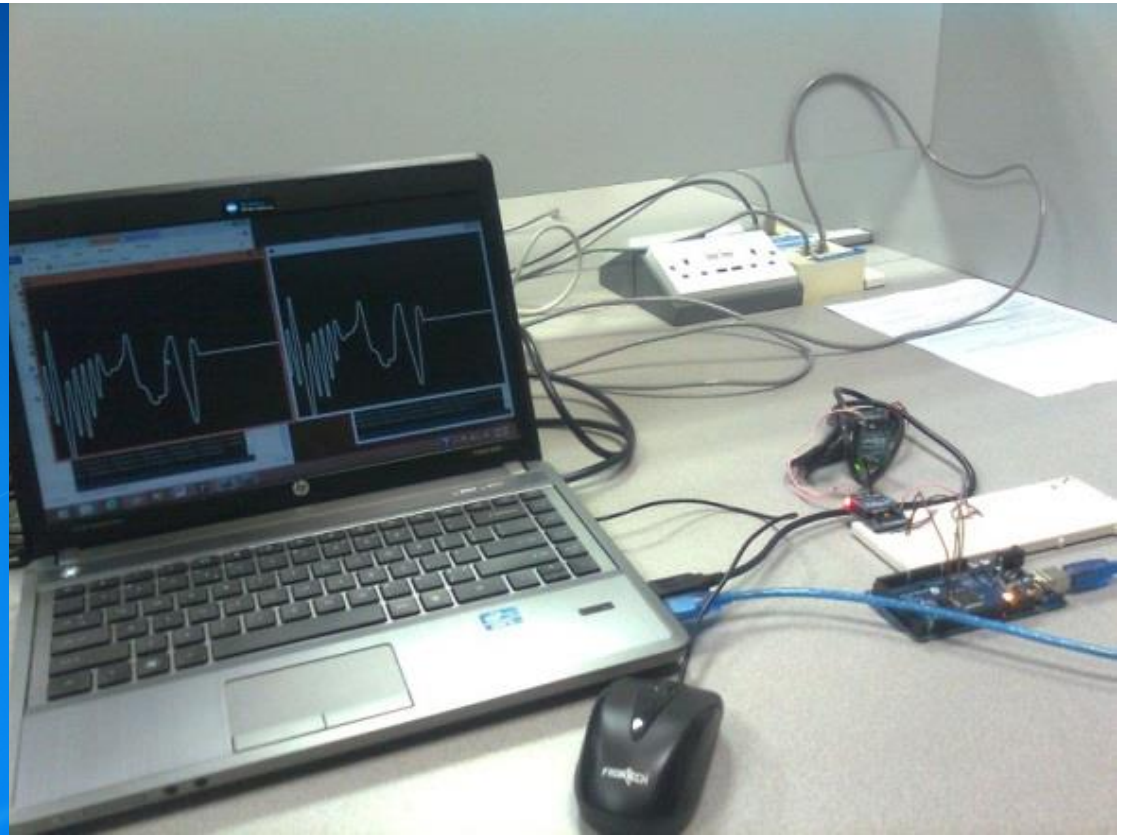
Helps:

1. Consumers to easily control their appliances, from anywhere in the world.
2. Control automation can lead to tremendous saving when the grid can automatically turn off devices to save energy. It can also be used to design self-healing electricity networks, thus ensuring reliability.
3. Control energy flow in the best possible way so as to minimize energy loss.

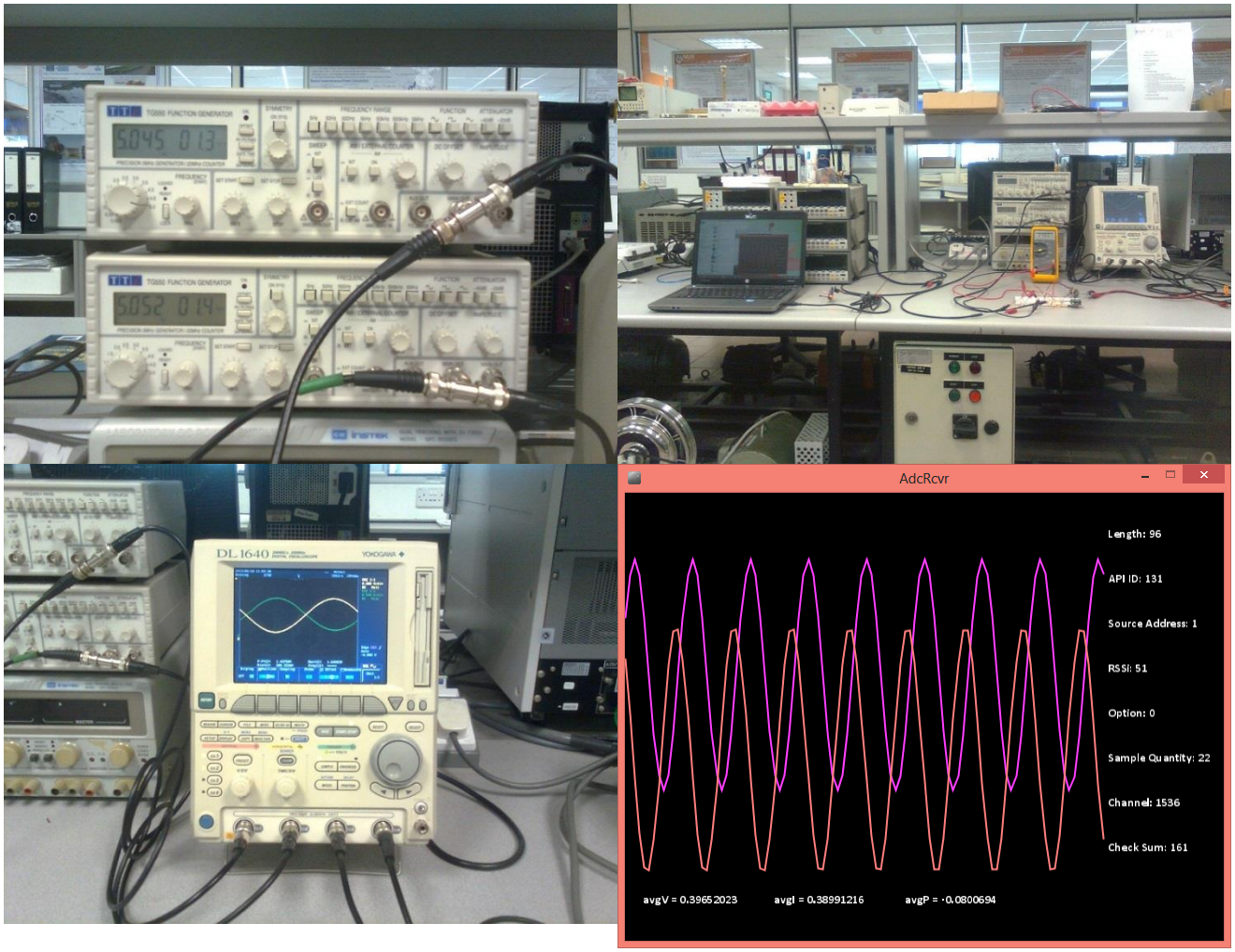
Steps to Smart Grid Monitoring

Sending and Receiving Manually generated signals wirelessly

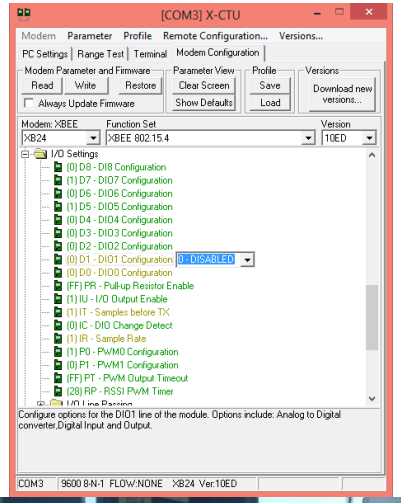


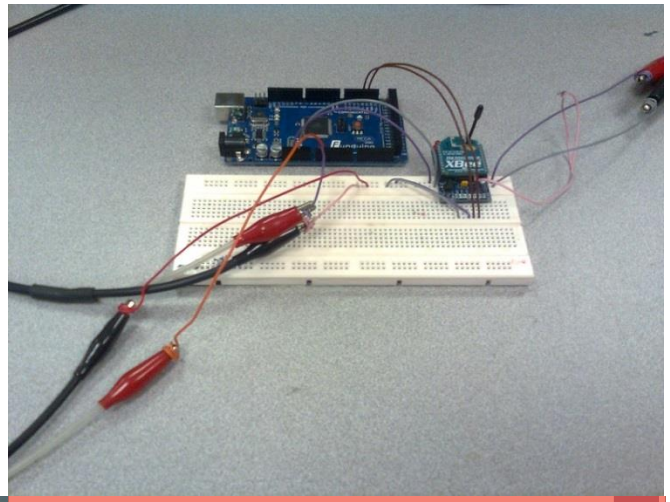


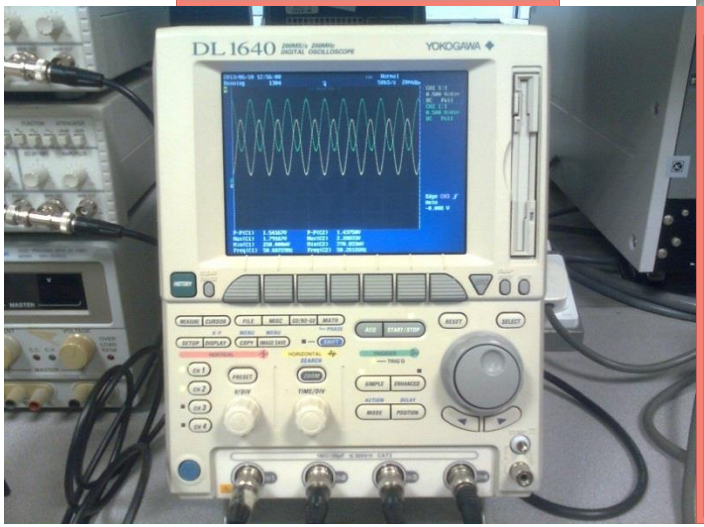
Monitoring Analog Signals wirelessly (using Xbee ADC)

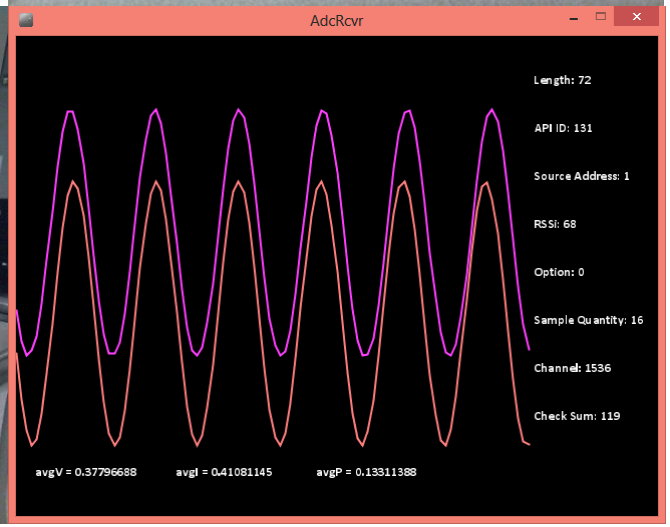


Monitoring Analog Signals wirelessly (using Arduino ADC)

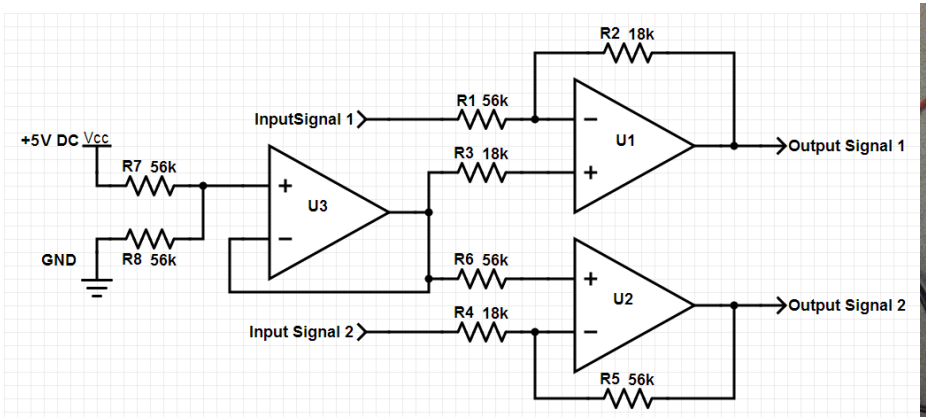


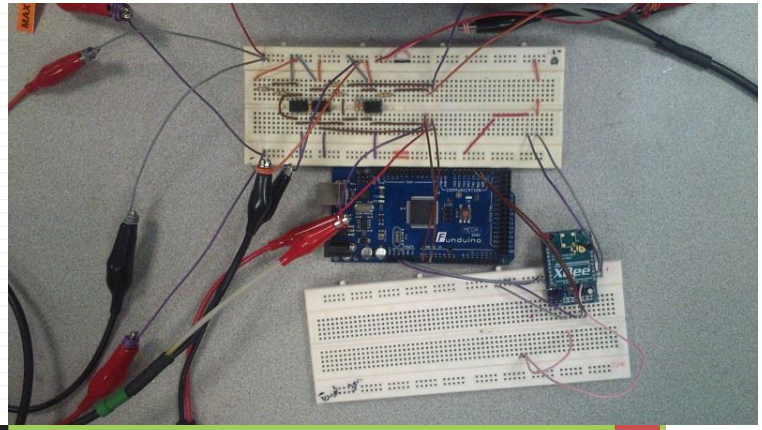


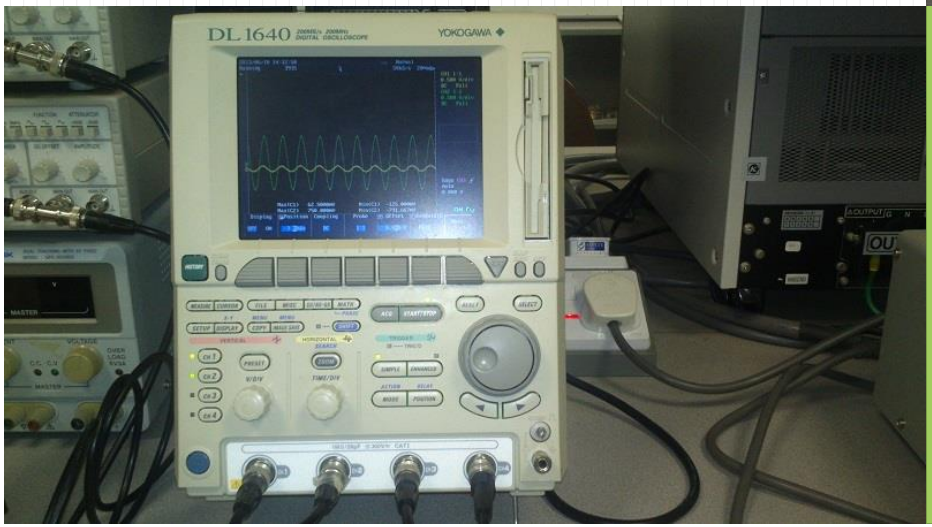




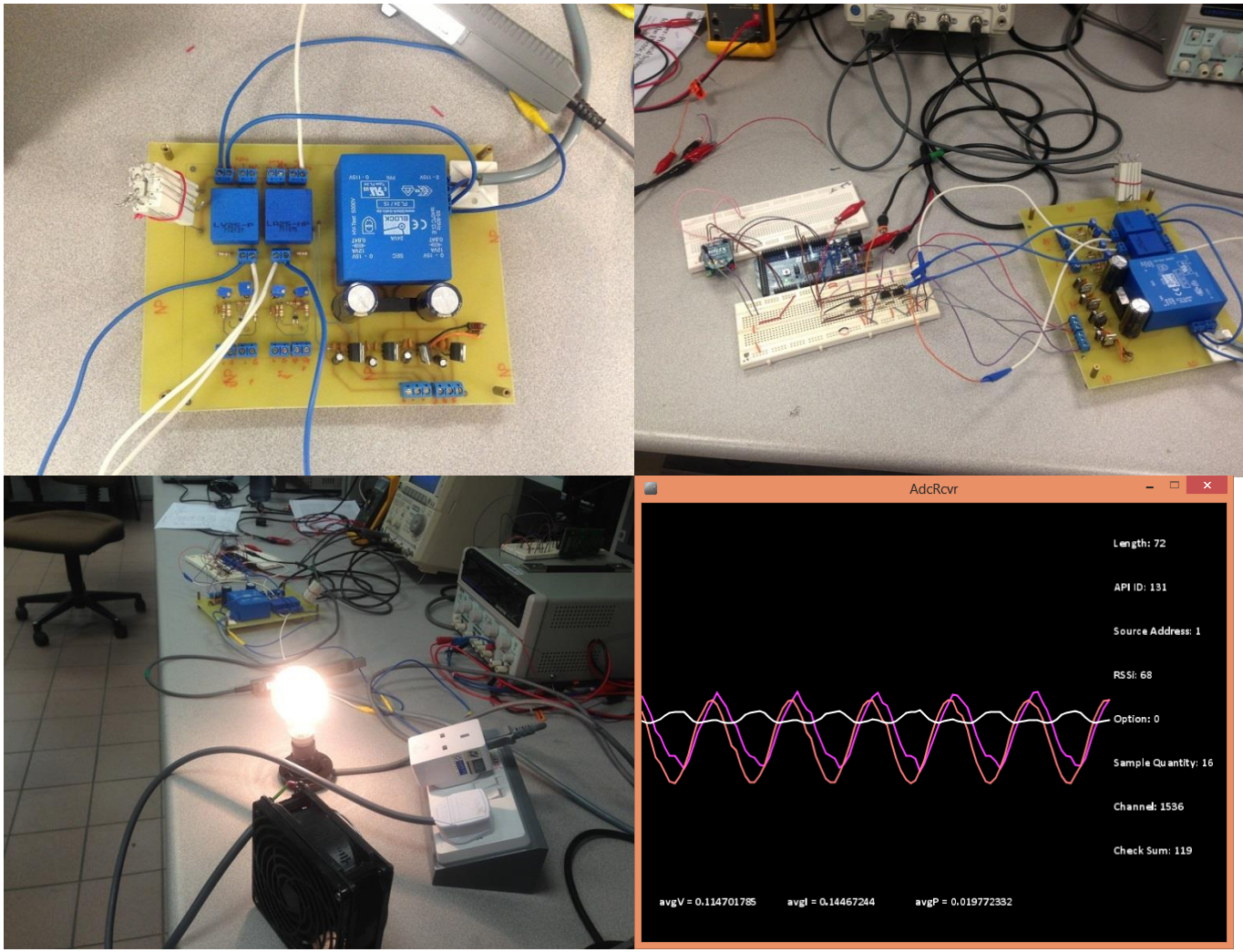
Monitoring Bipolar Analog Signals wirelessly (using Arduino ADC)



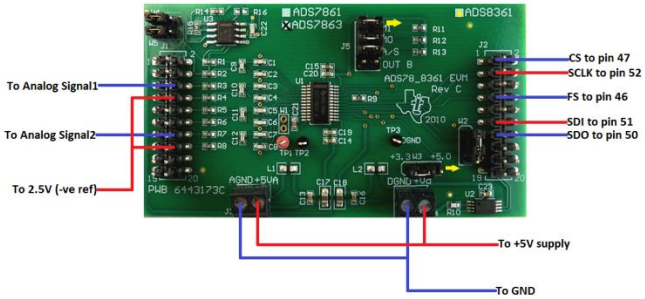


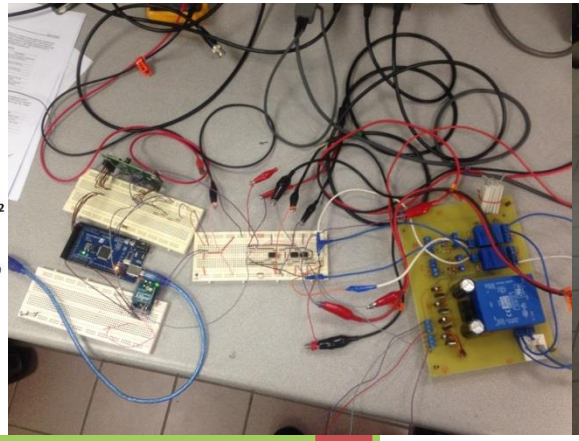


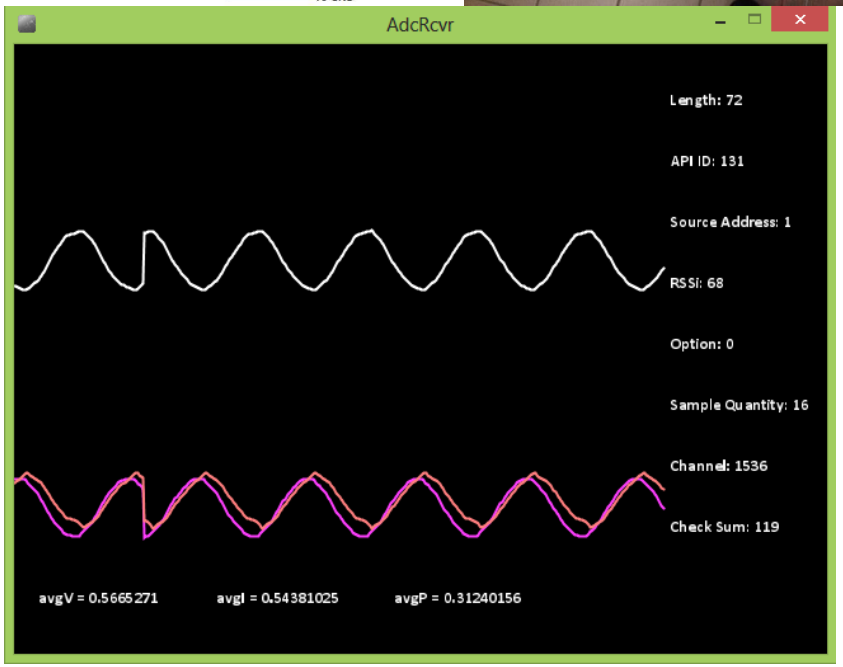
Monitoring Instantaneous Voltage, Current and Power usage on an AC socket wirelessly (using VI sensing circuit & Arduino ADC)

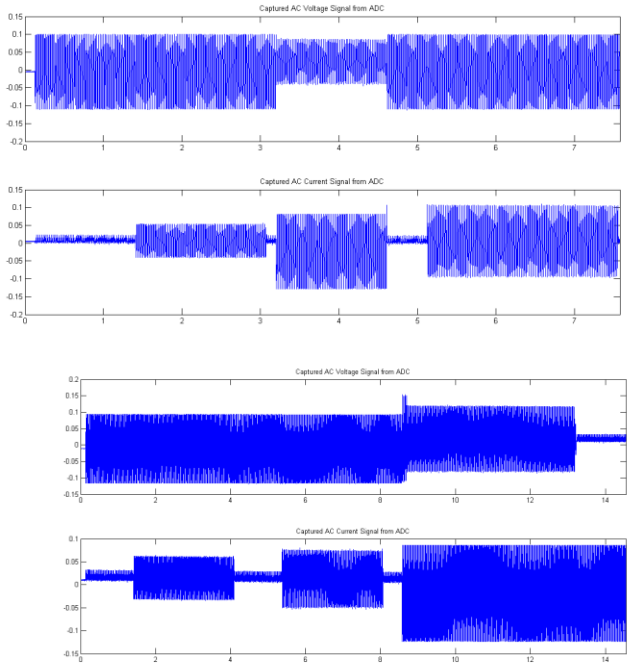


Monitoring Instantaneous Voltage, Current and Power usage with MATLAB on an AC socket wirelessly (using VI sensing circuit & Ext. ADC)

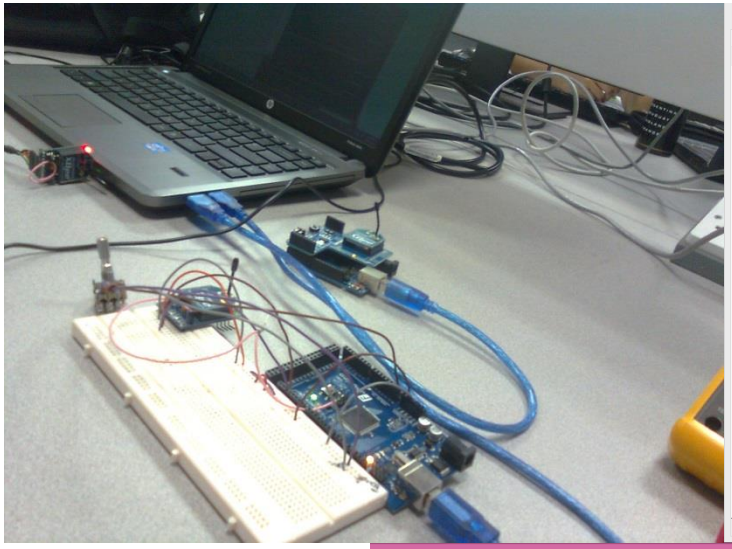


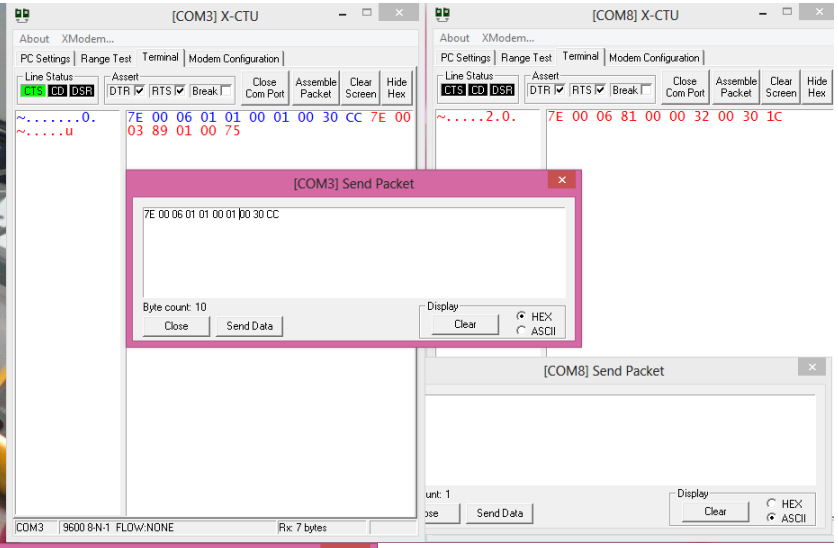


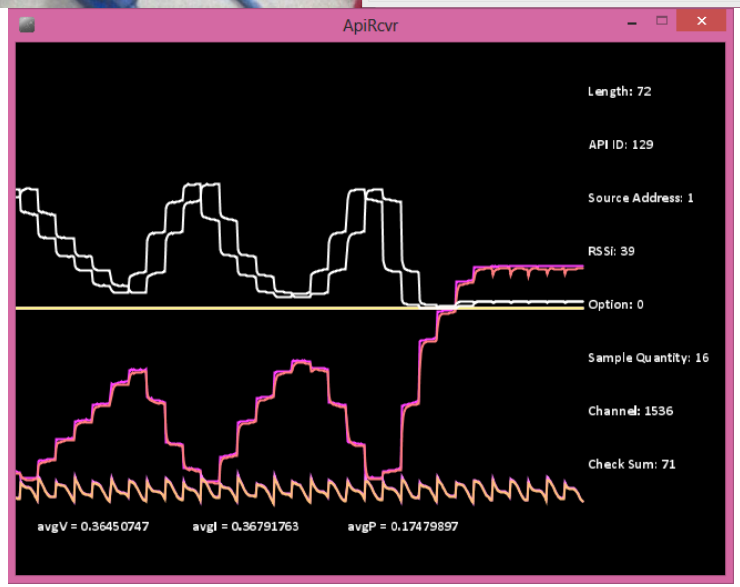




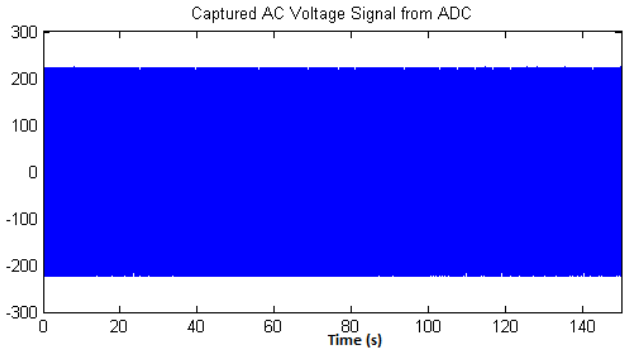
Monitoring Signals from Multiple nodes wirelessly

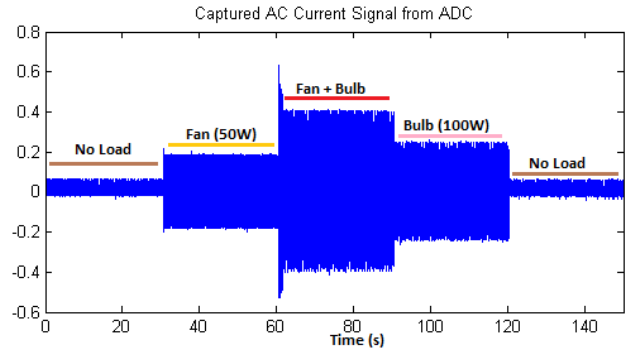


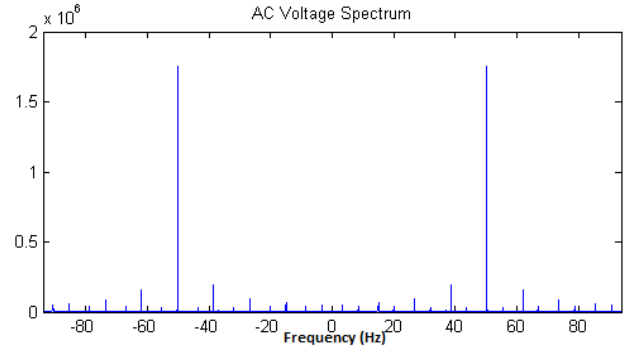


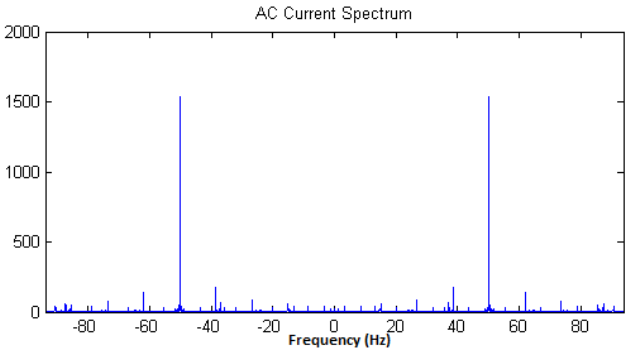


Obtaining spectrum of Voltage and Current in MATLAB









Monitoring Voltage, Current and Power from multiple (3) nodes