Medição Fasorial em Smart Grid

Sérgio Luiz Zimath
Reason Tecnologia S.A.

ENERGYSHOW

Encontro de soluções tecnológicas para o setor energético

O que é Medição Fasorial ?

- Tecnologia de medição de fasores sincronizados
  - Ângulos podem ser comparados
  - Referência é o Sistema GPS
- Possibilita o desenvolvimento de uma série de novas aplicações
  1. Automação de sistemas elétricos
  2. Alívio de carga inteligente, (controle de demanda)
  3. Aumentar a confiabilidade de sistemas elétricos, detectando faltas incipientes e isolando-as ou redespachando o sistema
  4. Aumentar a qualidade da energia, corrigindo fontes de degradação
  5. Medição e controle de todo sistema simultaneamente

O que é Smart Grid ?

- Pode ser qualquer coisa!
- Definições Wikipedia:
  - Sistema elétrico usando tecnologia digital
  - Controlar cargas remotamente
  - Medição bidirecional com tarifação diferenciada -> Fontes renováveis
  - Redução do pico de consumo

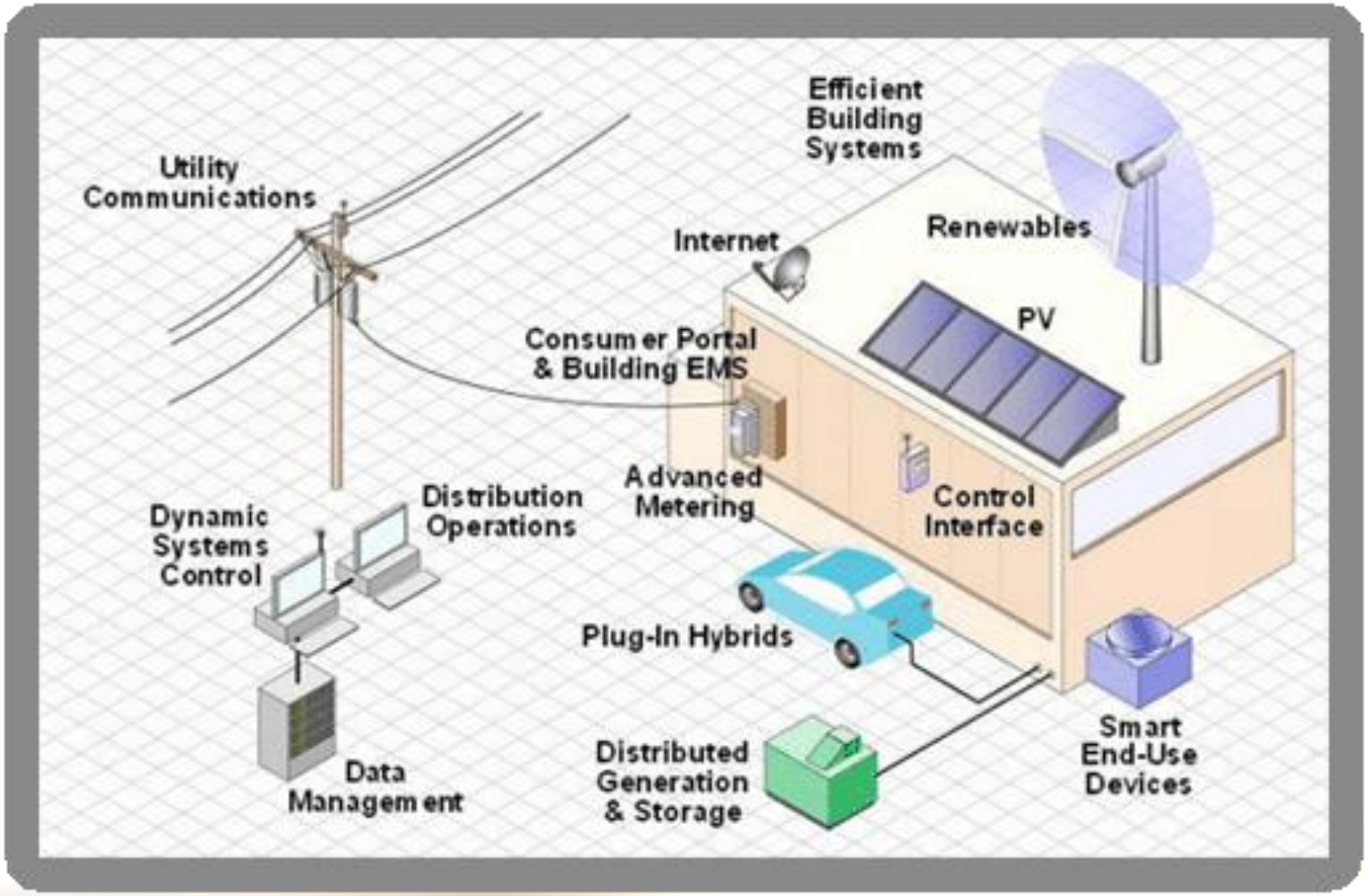
Medição fasorial em SmartGrid

Medição Fasorial	Smart Grid
Automação de sistemas	Redução do pico de carga, tarifação bidirecional
Alívio de Carga	Controlar cargas remotamente
Aumento de confiabilidade	?
Aumentar Qualidade	?
Medição e controle do Sistema	Redução do pico de carga

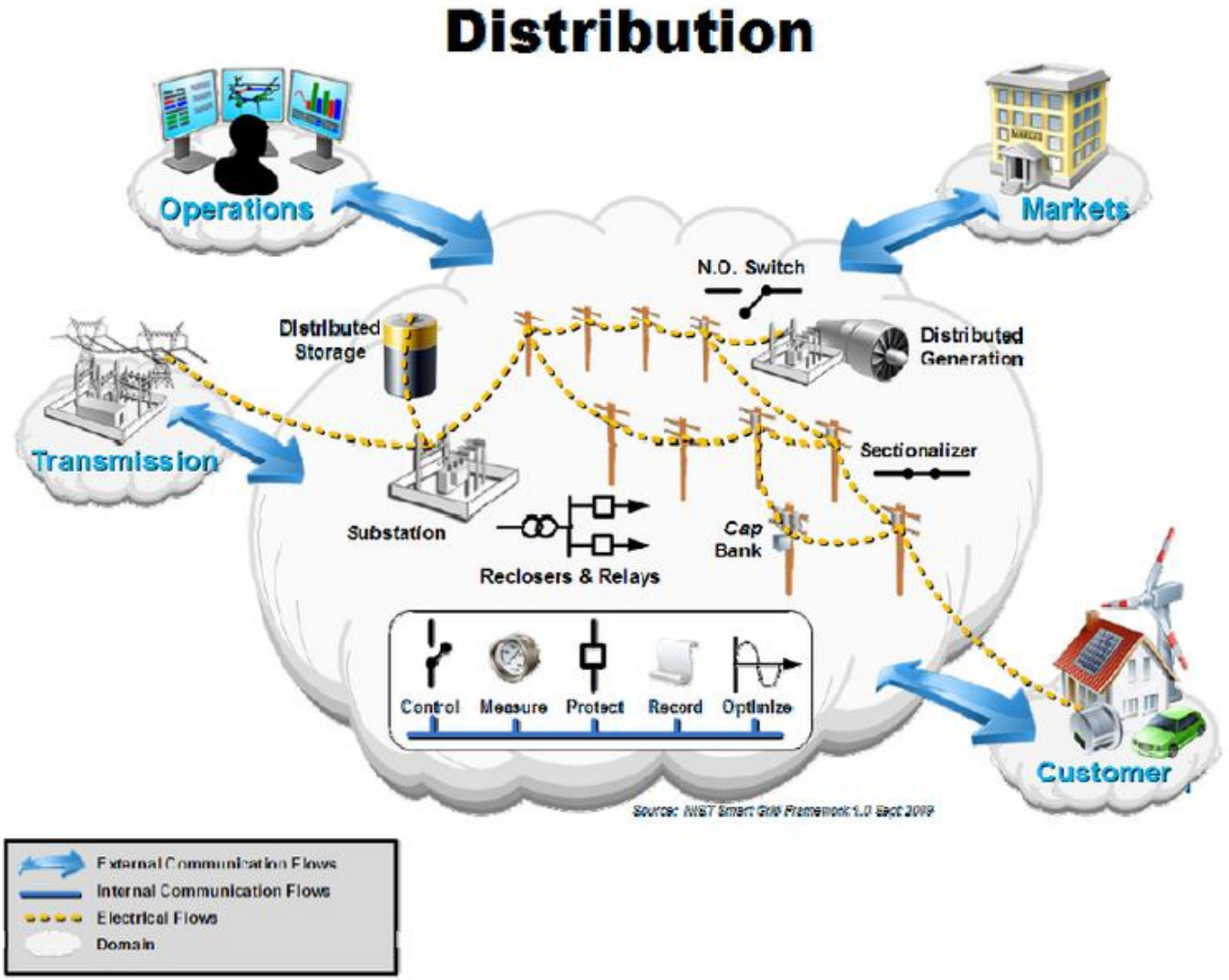
8 Technology

- 8.1 Integrated communications
- 8.2 Sensing and measurement
  - 8.2.1 Smart meters
  - 8.2.2 Phasor measurement units

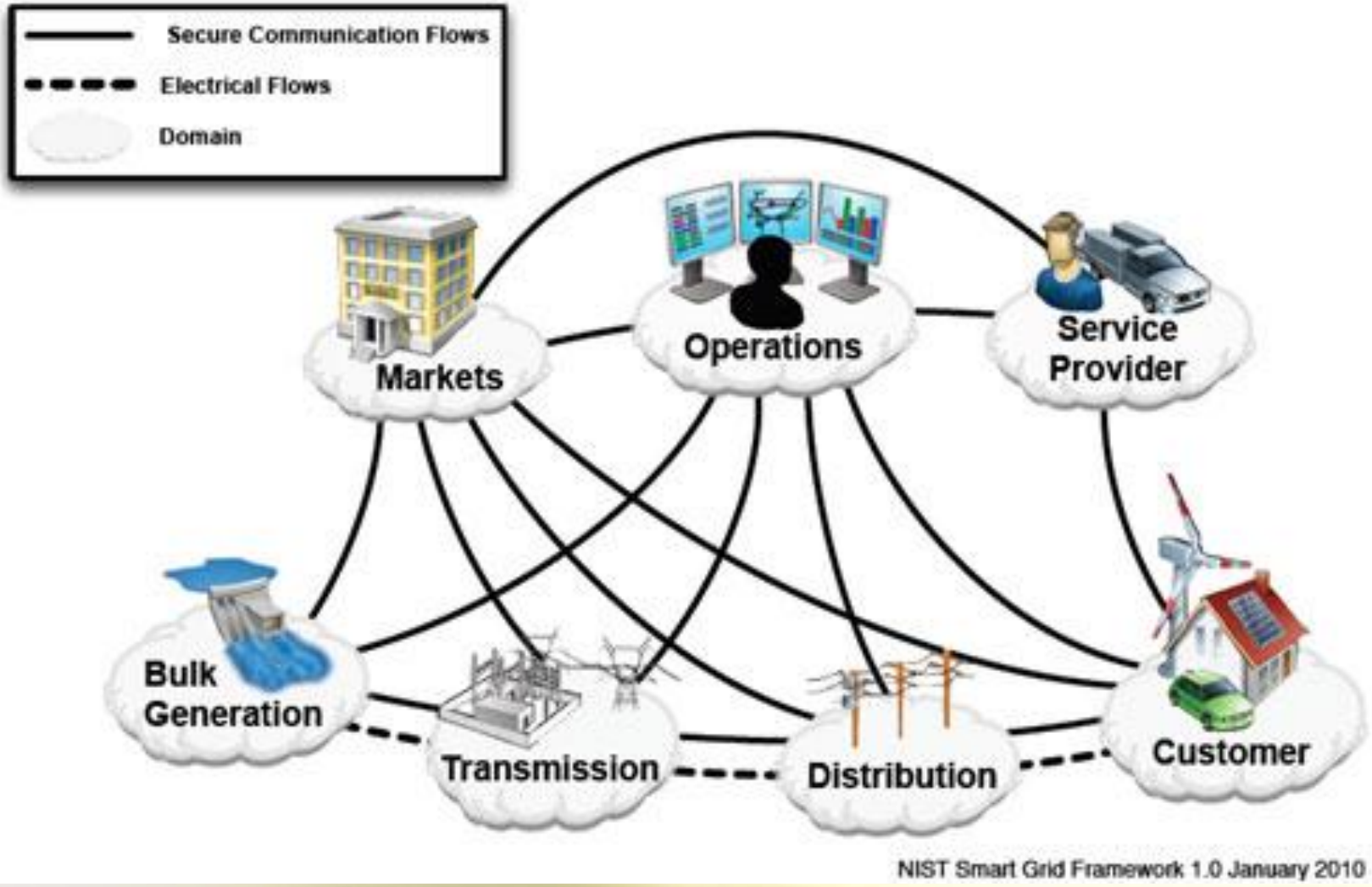
SmartGrid


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

SmartGrid


Distribution
Operations
Markets
N.O. Switch
Distributed Storage
Distributed Generation
Transmission
Sectionalizer
Substation
Cap Bank
Reclosers & Relays
Control
Measure
Protect
Record
Optimize
Customer
Source: NIST Smart Grid Framework 1.0 Sept 2009
External Communication Flows
Internal Communication Flows
Electrical Flows
Domain

Exemplo Americano



NIST Smart Grid Framework 1.0 January 2010

SmartGrid nos EUA

2007 Energy Independence and Security Act

- Define SmartGrid nos EUA
- NIST coordenará as normas
- Objetivo:
  - Diminuir dependência americana do petróleo
  - Preparar o sistema elétrico para geração distribuída
  - Aumentar a segurança do sistema

SmartGrid nos EUA

2009 Federal Energy Regulation Commision identifica 4 prioridades do SmartGrid

1. Wide Area Situational Awareness
2. Demand Response
3. Electricity Storage
4. Electric Vehicles

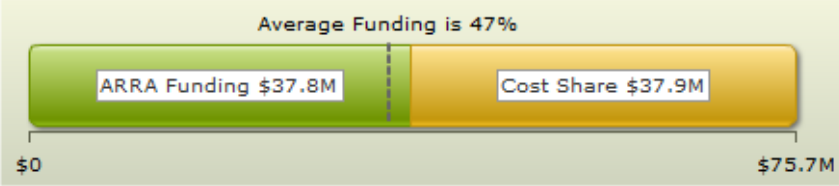
E duas aplicações:

1. Distribution Grid Management Initiatives
2. Advanced Metering Infrastructure

Stimulus Money

New York Independent System Operator, Inc. Smart Grid Project

Awardee	New York Independent System Operator, Inc.
Award Negotiation Status	Awarded
Headquarters Location for Lead Applicant	Rensselaer, New York
Recovery Act Funding Awarded	$37,828,825
Total Project Value Including Cost Share	$75,710,733
ARRA Funding Percentage	50.0%



Coverage Map

(Click on map to zoom)

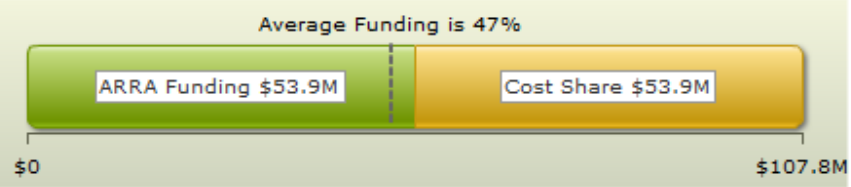
Company Overview

New York Independent System Operator, Inc., located in Rensselaer, New York, will receive $37 million in funding to develop a smarter energy grid. The U.S. Department of Energy selected New York Independent as one of 100 companies to receive federal stimulus funds as part of the American Recovery and Reinvestment Act of 2009. The stimulus funds will be used to deploy a range of smart grid technologies, including 35 new phasor measurement units and 19 phasor data concentrators, across NY to allow area-wide control, and an open, flexible, interoperable, secure, and expandable communciations system that will work in concert with the existing control and monitoring systems.

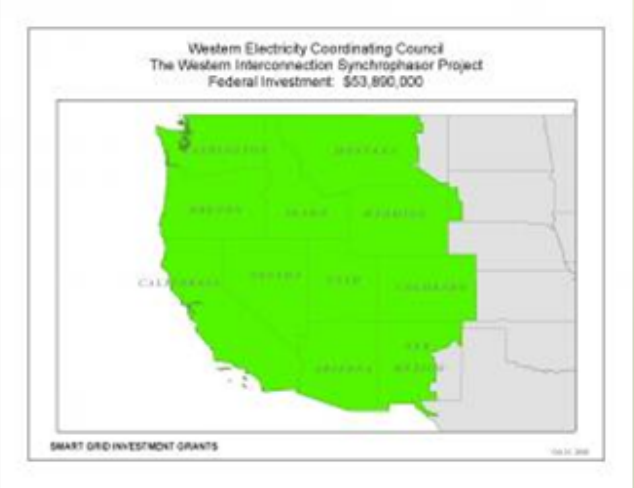
Stimulus Money

Western Electricity Coordinating Council Smart Grid Project

Awardee	Western Electricity Coordinating Council
Award Negotiation Status	Awarded
Headquarters Location for Lead Applicant	Salt Lake City, Utah
Recovery Act Funding Awarded	$53,890,000
Total Project Value Including Cost Share	$107,780,000
ARRA Funding Percentage	50.0%



Coverage Map



(Click on map to zoom)

Company Overview

Western Electricity Coordinating Council, located in Salt Lake City, Utah, will receive $53.9 million in funding to develop a smarter energy grid. The U.S. Department of Energy selected Western Electricity Coordinating Council as one of 100 companies to receive federal stimulus funds as part of the American Recovery and Reinvestment Act of 2009. The stimulus funds will be used to install over 250 phasor measurement units across the Western Interconnection and create a communications system to collect data for real-time situational awareness. Improve integrated systems operation across 11 utility organizations and in all or part of 14 western states, enhancing reliability and reducing energy loss.

Problemas abordados

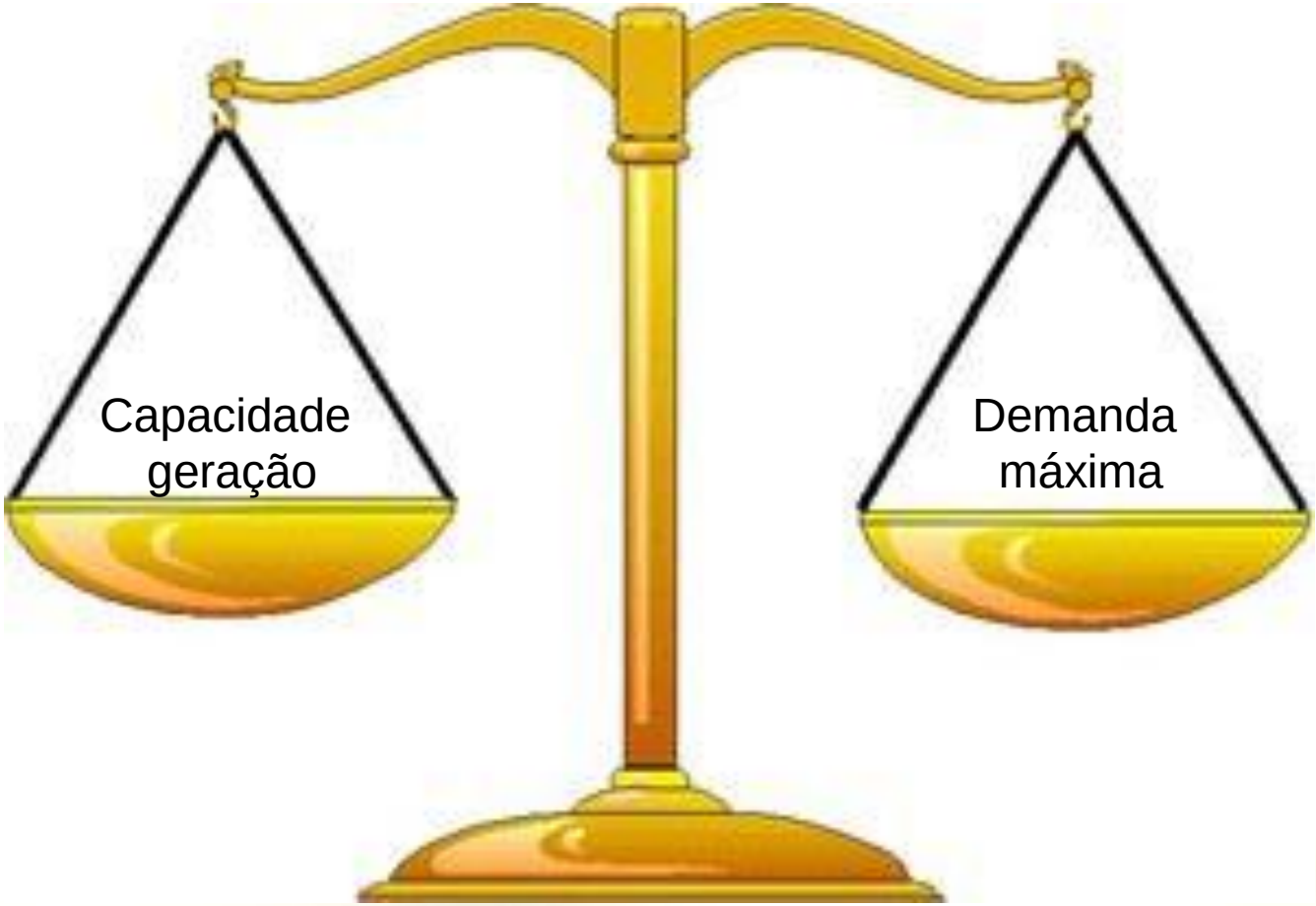
- Entrada de geração distribuída em larga escala
  - Geração distribuída intermitente
  - Como controlar um sistema assim?
- Entrada de carros elétricos no sistema
  - Como atender esta demanda?
- Solução:
  - Geração distribuída + carros elétricos

Atualização de normas NIST

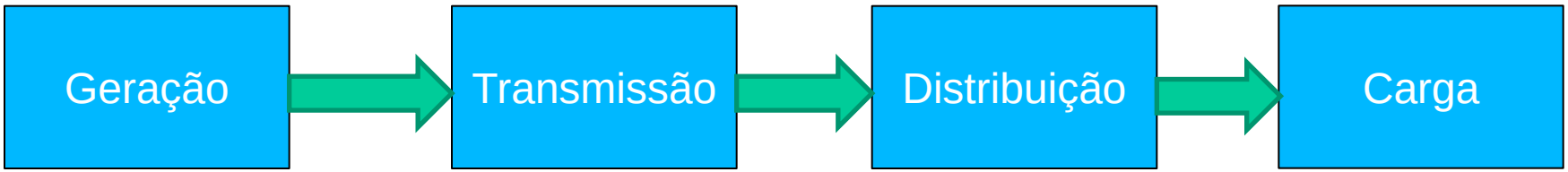
Meter Upgradeability Standard	Role of IP in the Smart Grid
Wireless Communications for the Smart Grid	Common Price Communication Model
Common Schedule Communication Mechanism	Standard Meter Data Profiles
Common Semantic Model for Meter Data Tables	Electric Storage Interconnection Guidelines
CIM for Distribution Grid Management	Standard DR and DER Signals
Standard Energy Usage Information	Common Object Models for Electric Transportation
IEC 61850 Objects/DNP3 Mapping	Time Synchronization, IEC 61850 Objects/IEEE C37.118 Harmonization
Transmission and Distribution Power Systems Model Mapping	Harmonize Power Line Carrier Standards for Appliance Communications in the Home
Wind Plant Communications	Facility Smart Grid Information Standard

IEC61850 e armazenamento

Balanço carga geração



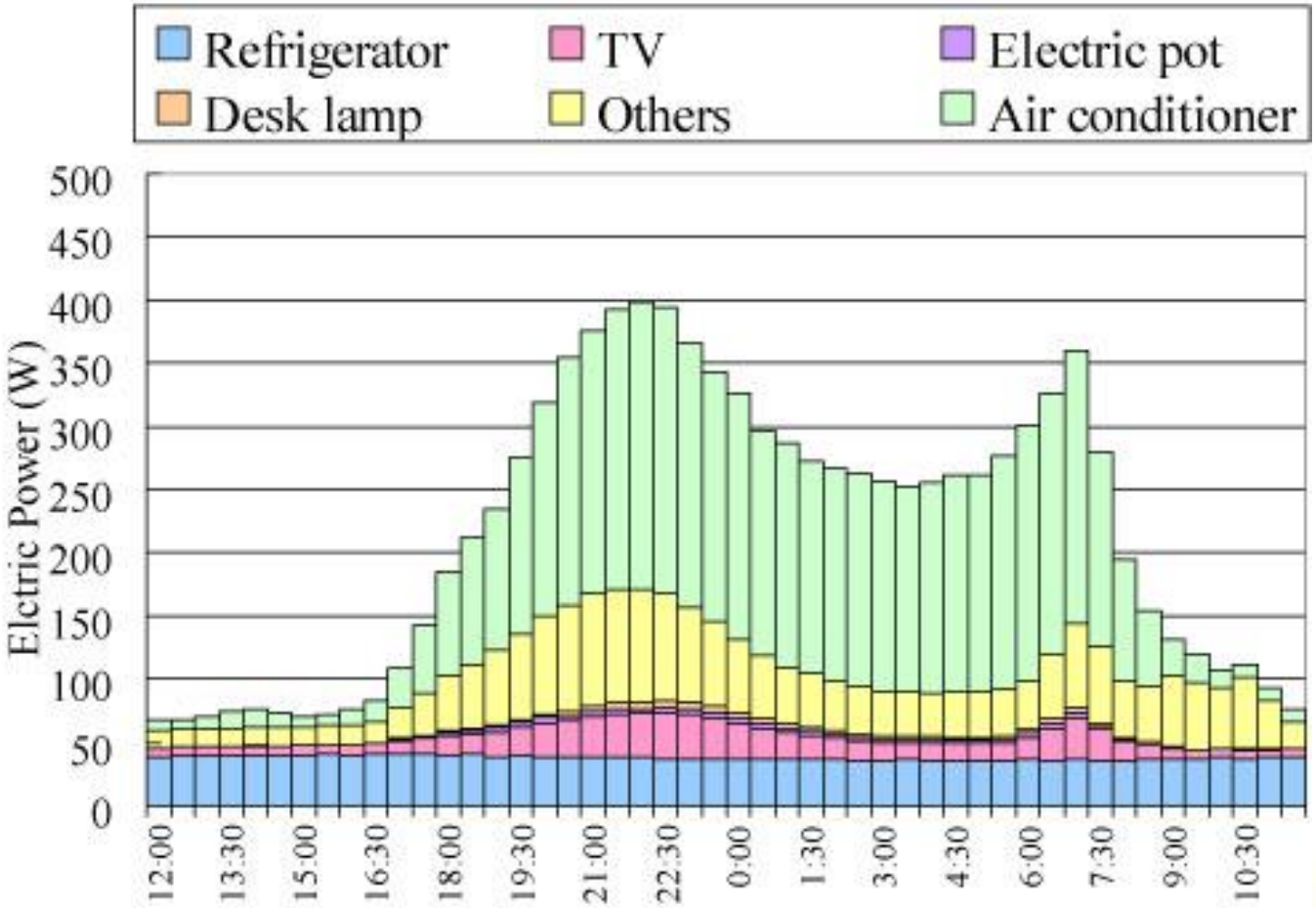
Fluxo tradicional de potência



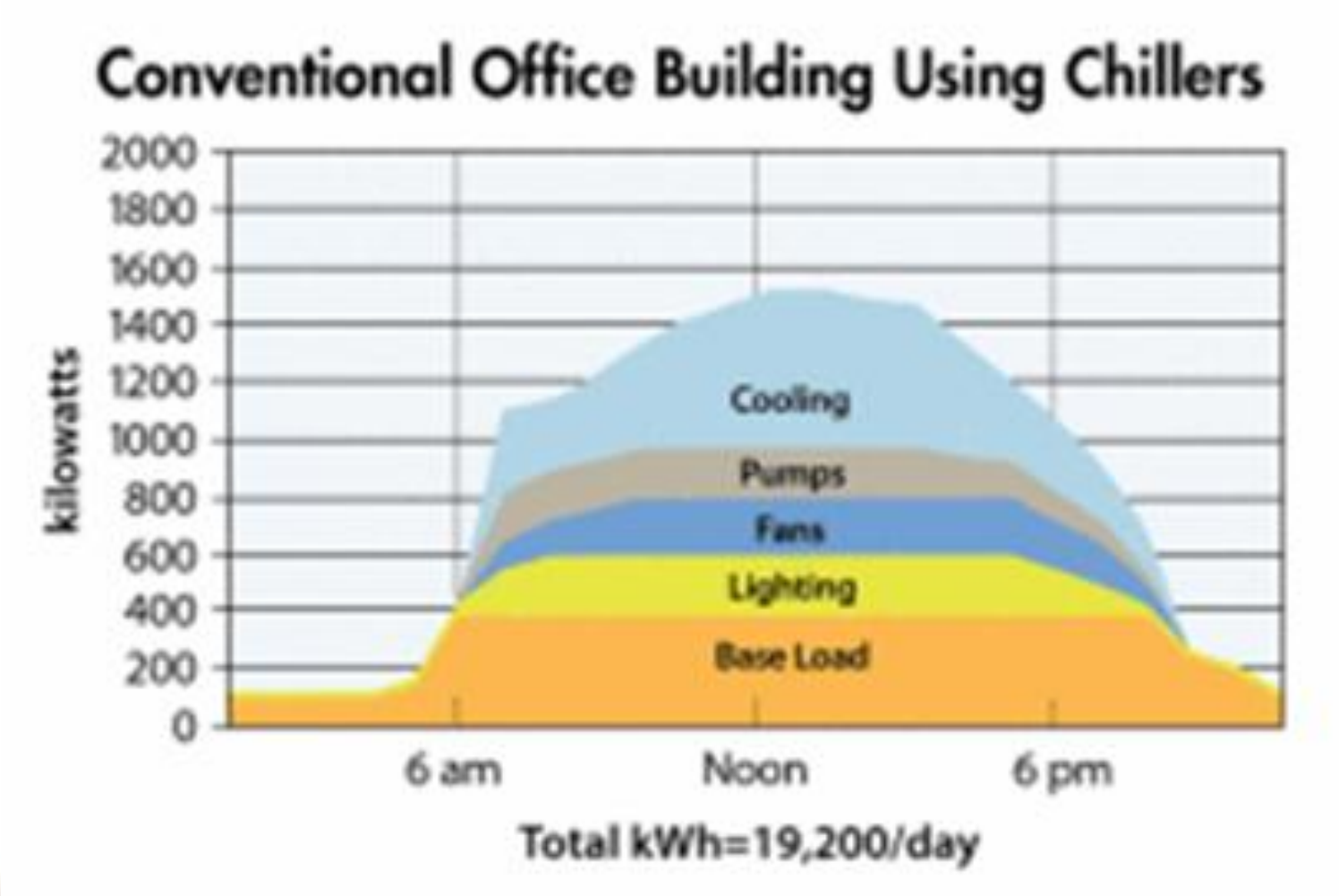
Usinas de bombeamento

- Ffestiniog Pumped Storage
- 1963
- 0 a 360MW em 60s

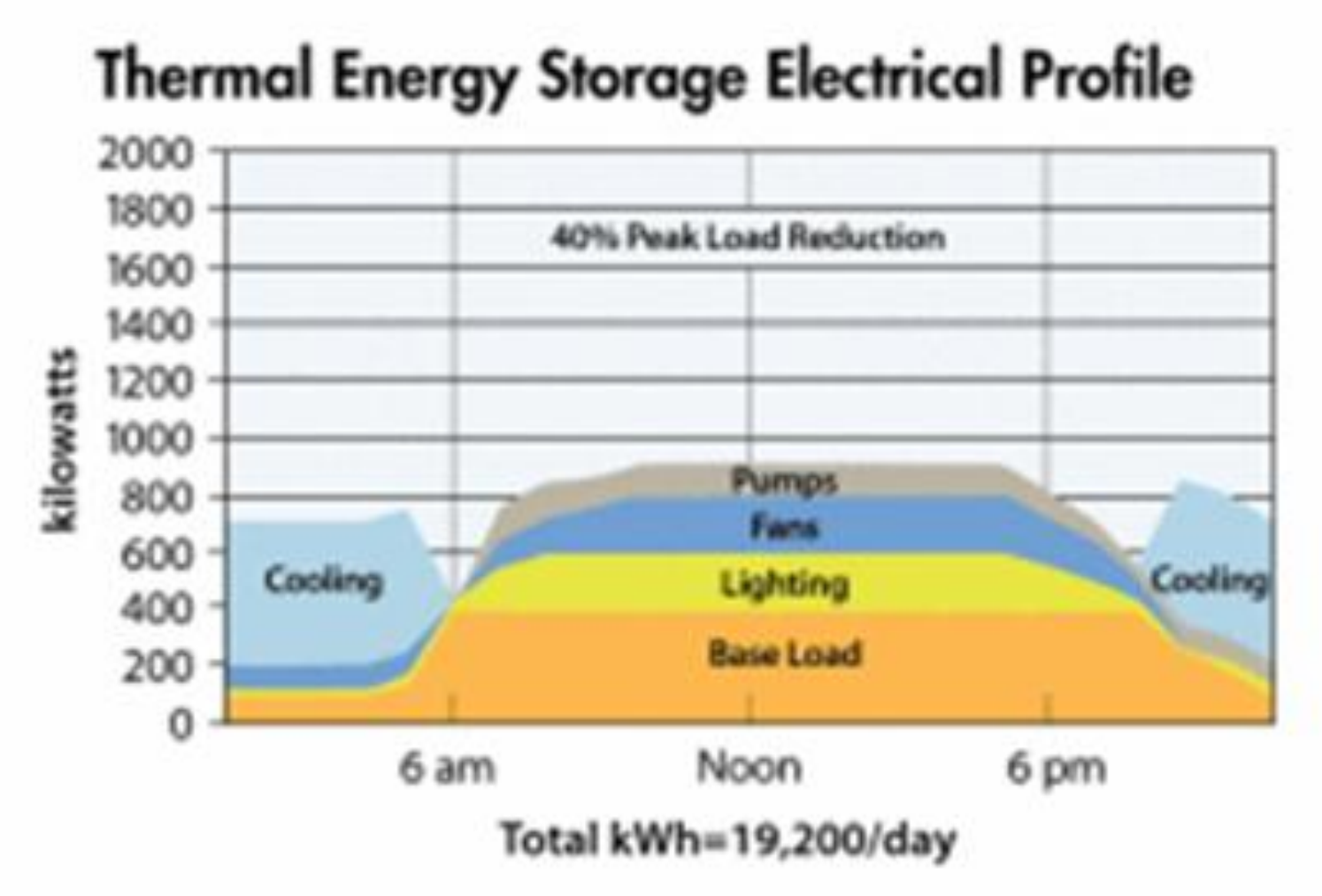
Curva de carga tradicional



Armazenamento de energia



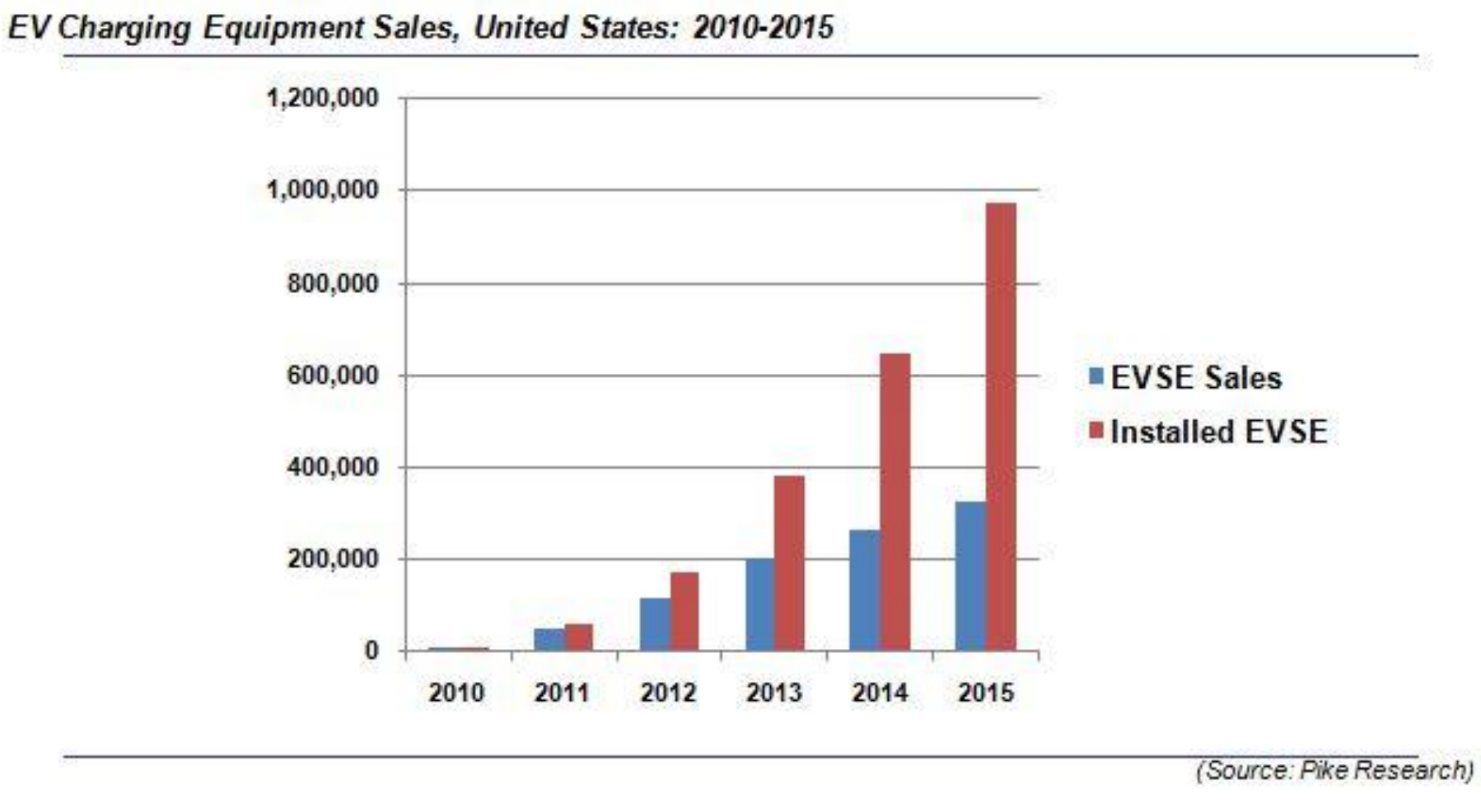
Armazenamento de energia



Geração distribuída

Carga-geração em SmartGrid

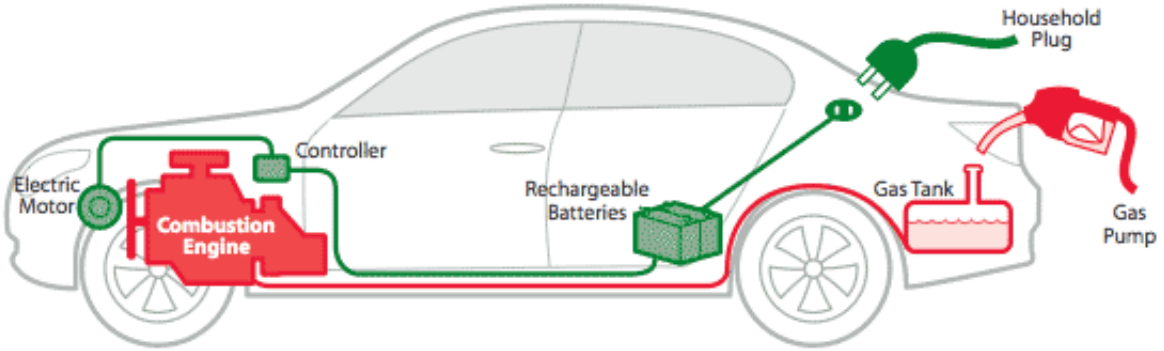
Demanda de carros elétricos



Elétrico x Gasolina

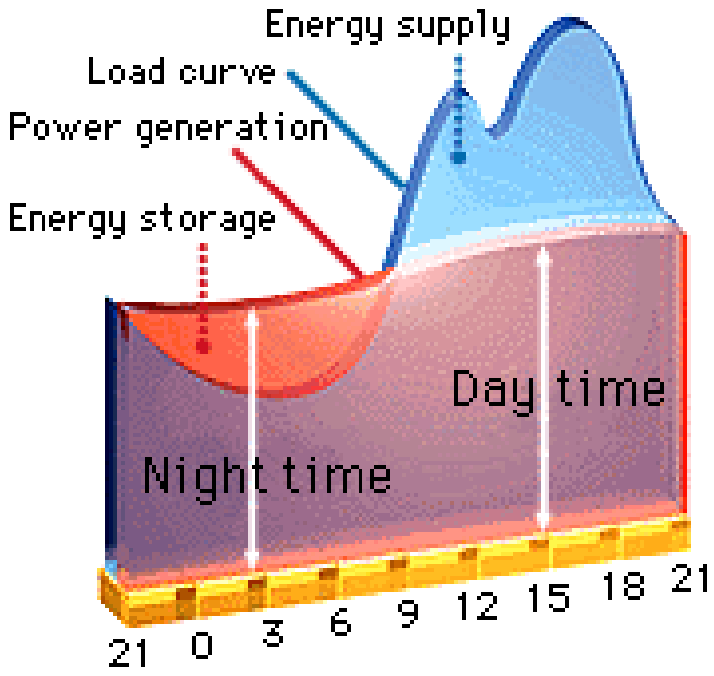
Electric vs. Gasoline

No Tailpipe Emissions	Greenhouse Gases/Pollution
Utility Company	OPEC
100+/- Mile Range	300+ Mile Range
Hours to Recharge	Minutes to Refuel
2 cents per mile	12 cents+ per mile

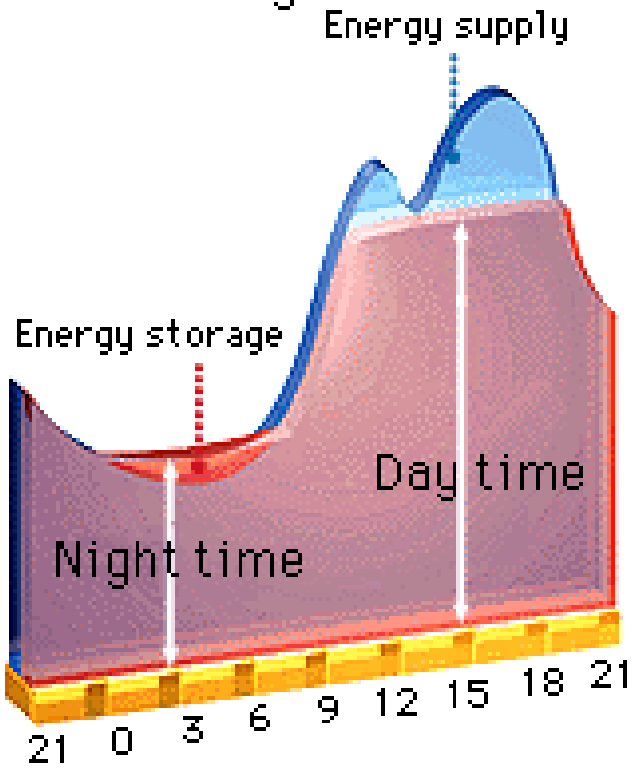


Carros elétricos em larga escala

- Load leveling



- Peak saving



Vai pegar mesmo ?

Compare Cars

Select up to three vehicles to compare side-by-side

	Ford Fusion Hybrid	Toyota Camry Hybrid	Toyota Prius
			
	Free price quote!	Free price quote!	Free price quote!
Price (base MSRP)	$28,800	$26,600	$22,800
Fuel Economy	41 / 36 MPG 5.74 / 6.53 L/100km	33 / 34 MPG 7.13 / 6.92 L/100km	51 / 48 MPG 4.7 / 4.9 L/100km
Estimated annual fuel cost	$923.08	$1,090.91	$720.00
Estimated annual fuel use	308 gallons a year	364 gallons a year	240 gallons a year
Estimated annual greenhouse gas emissions	5,846 pounds a year	6,909 pounds a year	4,560 pounds a year

500 mil híbridos em 2011!

March 2011 Hybrid Car Sales Numbers

Hybrids sold in the US (March 2011): **34,082**
Hybrid Take-Rate: **2.74%**

US hybrid sales for March 2011

Model	Units	vs. last month	vs. March 2010	CYTD	vs. CYTD 2010
Toyota Prius	18,605	↑ 37.4%	↑ 57.9%	42,779	↑ 51.5%
Honda Insight	2,782	↑ 61.6%	↑ 68.4%	6,058	↑ 21.8%
Lexus CT 200h	2,199	n/a	n/a	2,199	n/a
Honda CR-Z	1,685	↑ 54.4%	n/a	3,670	n/a
Ford Fusion	1,466	↑ 6.3%	↓ -12.2%	3,814	↓ -4.6%
Lexus RX450h	1,438	↑ 43.9%	↑ 14.9%	3,349	↑ 6.3%
Toyota Camry	1,437	↑ 44.7%	↓ -7.2%	3,290	↓ -4.0%
Ford Escape	1,195	↑ 50.3%	↑ 2.3%	2,510	↑ 0.0%

REASON REIVAX way2 ATMC
AQX Link Precision suntech achieving intelligence VIEIRA ISHIKAWA software

Vendas de elétricos

March 2011 Plug-in Electric Car Sales Numbers

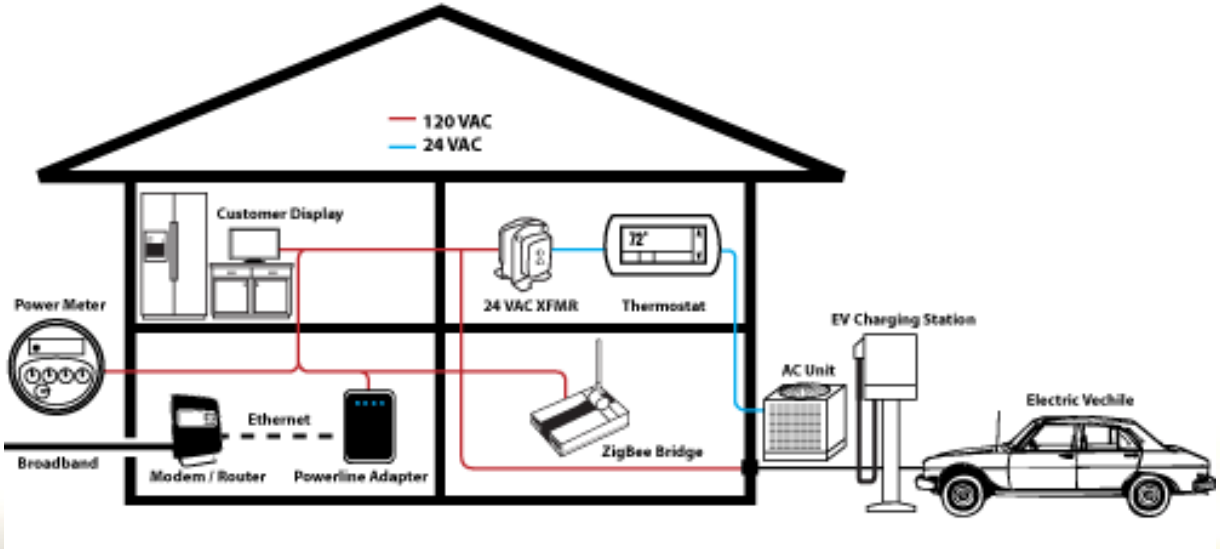
Plug-in cars sold in the US (March 2011): **906**
Plug-in Take-Rate: **0.07%**

US plug-in electric sales for March 2011

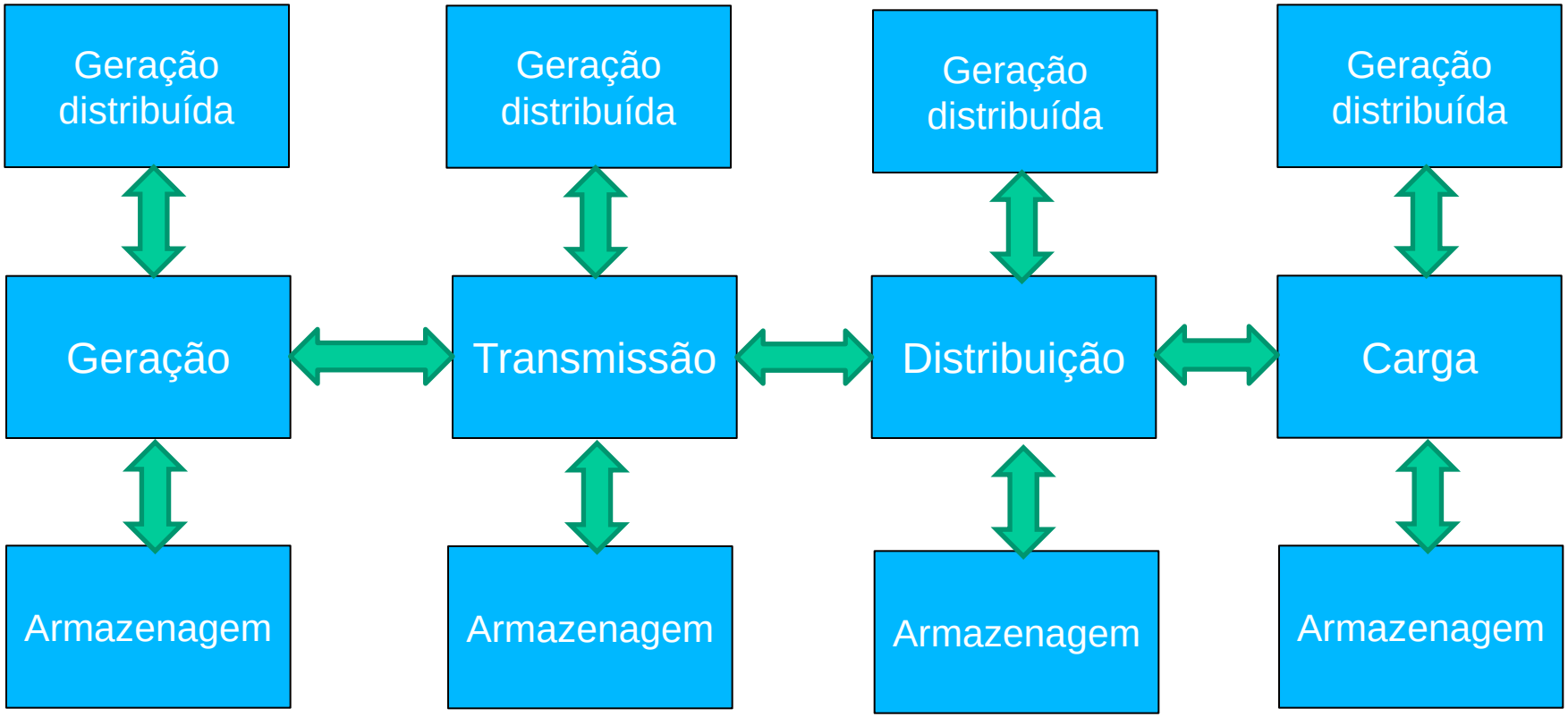
Model	Units	vs. last month	vs. March 2010	CYTD	vs. CYTD 2010
Chevrolet Volt	608	↑ 116.4%	n/a	1,210	n/a
Nissan LEAF	298	↑ 344.8%	n/a	452	n/a
Smart ED	0	100.0%	n/a	32	n/a
All plug-in cars	**906**	**↑ 146.9%**	**n/a**	**1,694**	**n/a**
All vehicles	**1,241,951**	**↑ 25.5%**	**↑ 16.8%**	**3,048,632**	**↑ 20.1%**

HomePlug Smart Appliance

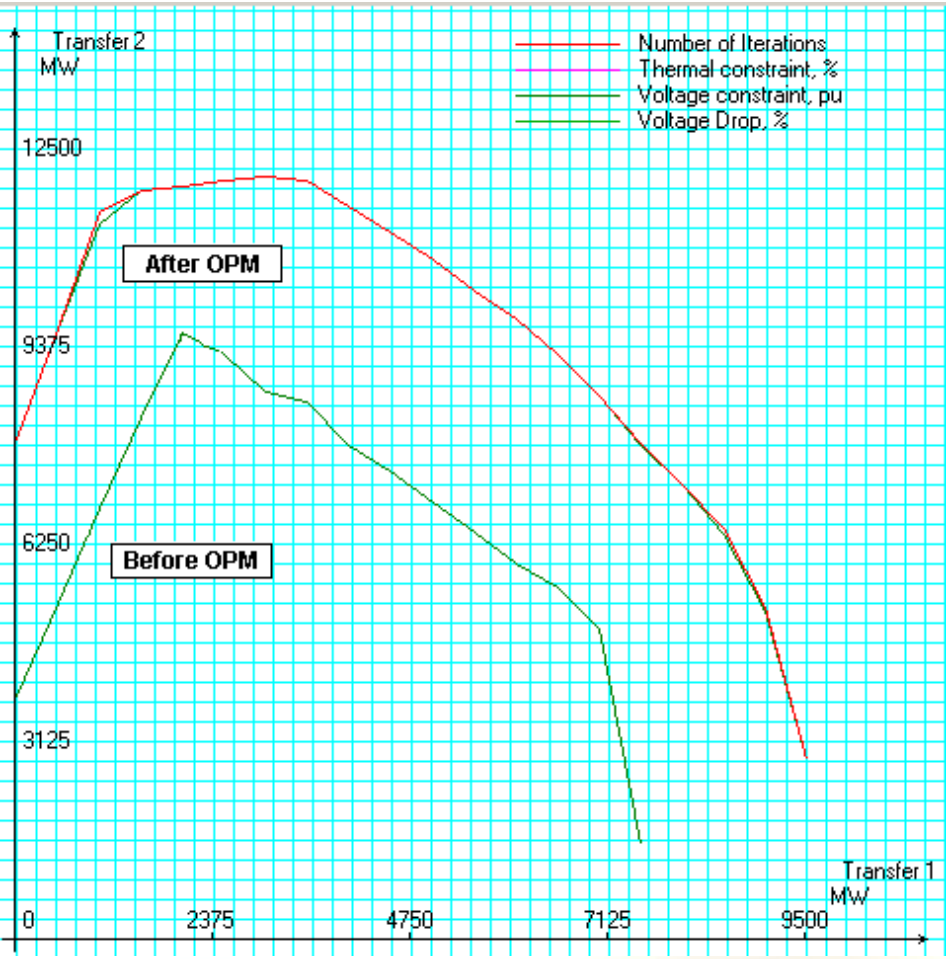
- Equipamentos inteligentes
  - Lavadora
  - Aquecedor
- Podem ser controlados pelo Operador



Novo fluxo de potência

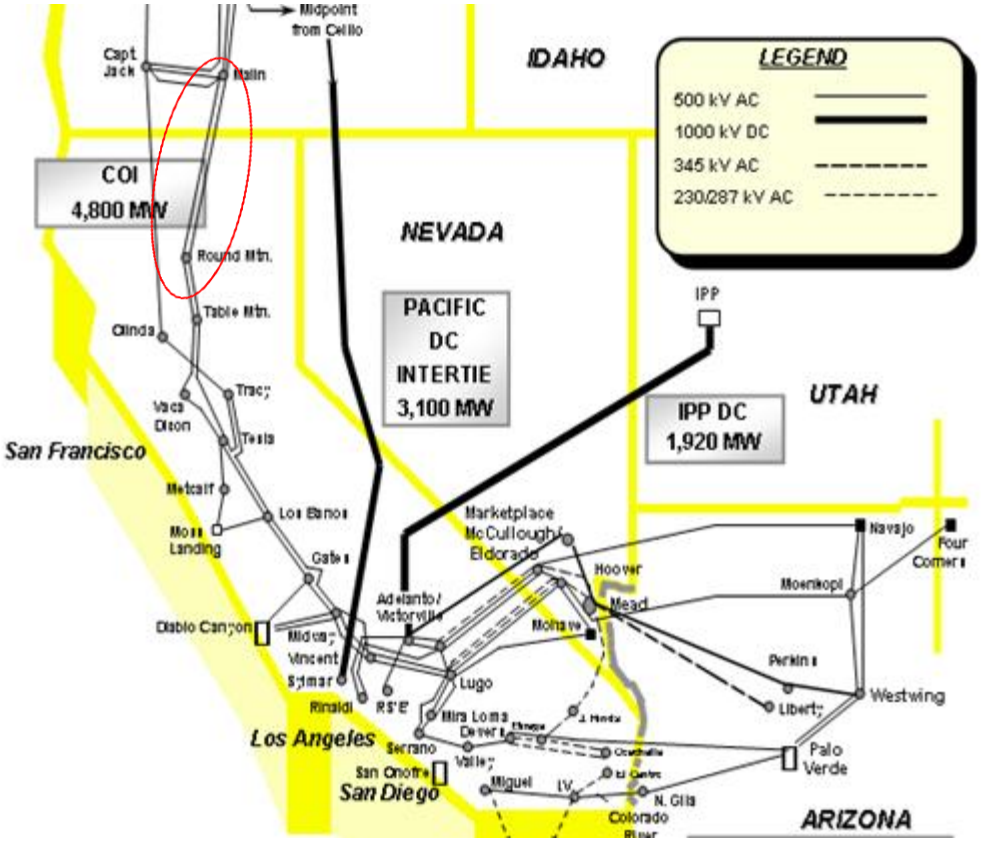


Novas ferramentas de operação



- MW dispatch
- MVAR dispatch
- Capacitor and reactor switching
- Operation of FACTS devices
- Transformer tap changes
- Line switching
- Adjustment of phase shifter settings
- Load curtailment
- Defined operating procedures
- Switching not-affected lines

Exemplo na California



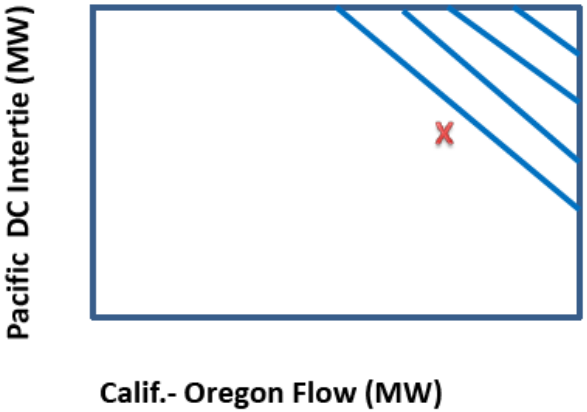
Limite transmissão dinâmico

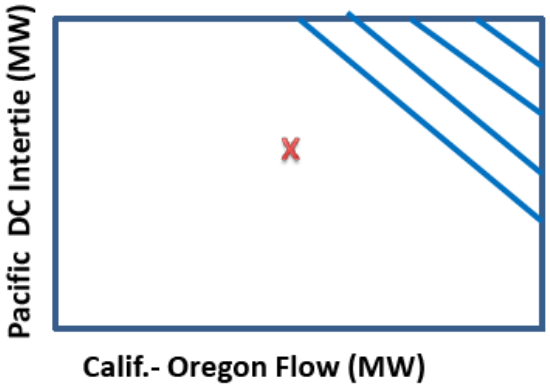
Static Nomograms

- Based on seasonal studies
- Transmission Owners' worst case scenarios; Preserve path ratings
- Assumptions may not reflect reality
- Operating zone is at best a conservative estimate

Dynamic Nomograms

- Validate Static Nomograms
- Monitor and track the actual path capability
- Help define margins accurately or lack of margin
- Dynamic Nomograms will allow operators to work with real margins instead of extra cautious assumptions





100MW = US$ 30 milhões

Onde entra Medição Fasorial

- Melhor conhecimento do sistema elétrico
- Futuras ações automáticas
- Controle automático de micro-grids (ilhamento)
- Despacho automático