Challenge and solutions with electrification of transportation and electric grid integration

Workshop On: Research challenges in Smart and Connected Communities presented by the rapid integration of mobility and electrical infrastructure

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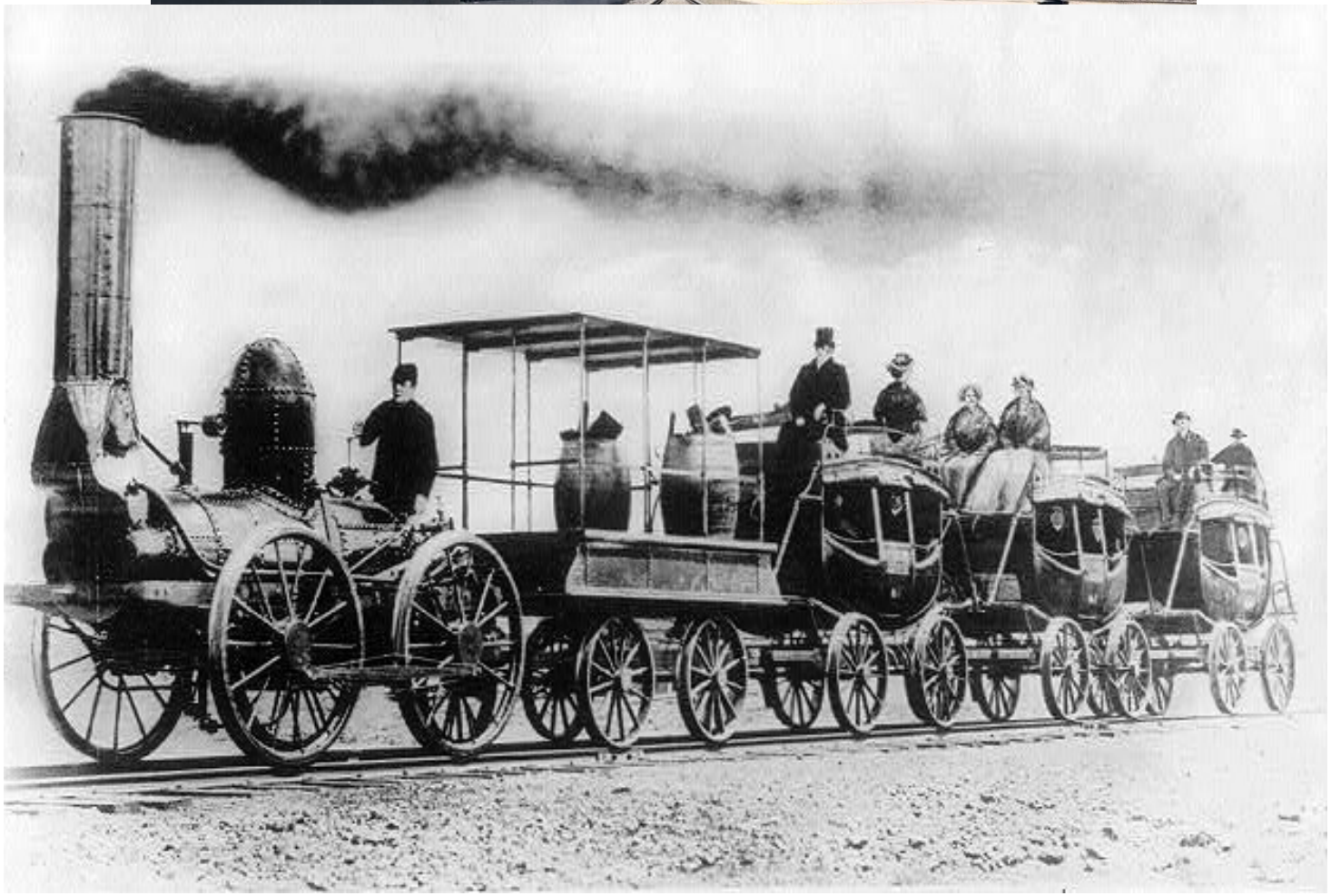
NSF PI Meeting

WASHINGTON STATE UNIVERSITY

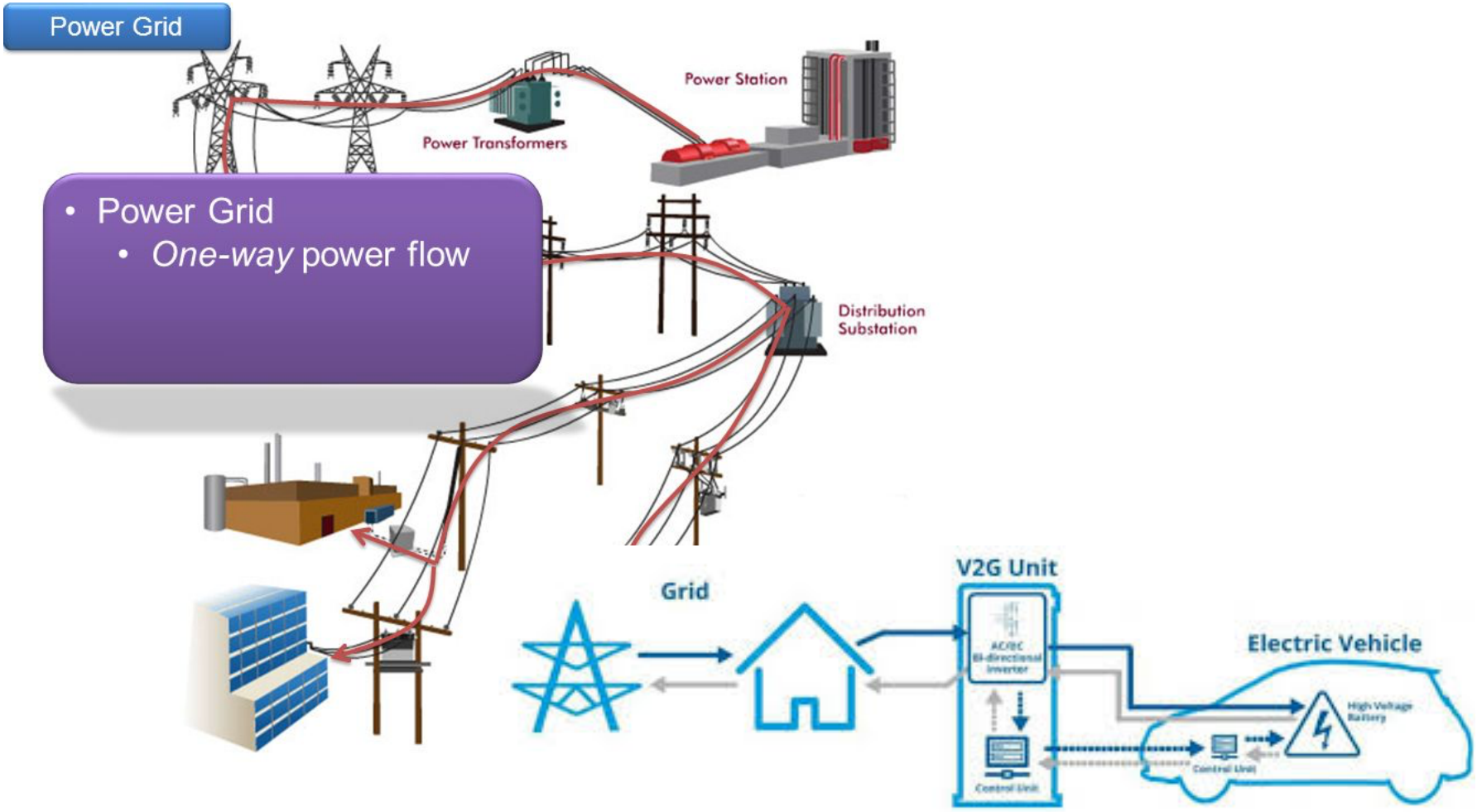
SGDRIL Smart Grid Demonstration & Research Investigation Lab, Washington State University, Pullman

ESIG

NSF



Challenge #1: Distribution Grid is designed for one-way power flow



FATAL ERROR MEMORY LIMIT ERROR IN WP

Challen

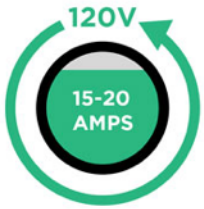
n Existing

Blue: Transmi
Green: Distributi
Black: Generati

Generating Station

Ge
Up

Level 1



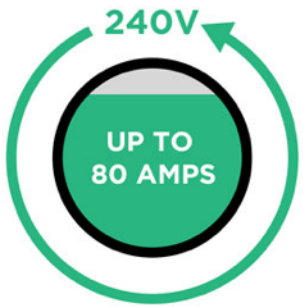
Level 1 charging or "trickle charging" uses standard 120V electrical outlets. 120V circuits are also used by most home electronics.

Tesla owners can charge on a regular outlet with the NEMA 5-15 adapter that comes with each new vehicle.

2 miles of Tesla range per hour charging

1.4 kW power delivery

Level 2



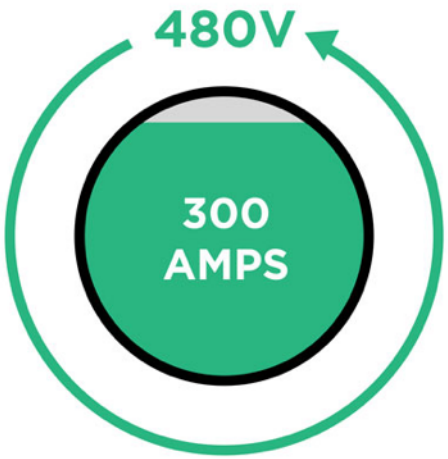
Level 2 chargers use 240V electrical circuits, similar to those used by electric dryers and stovetops.

Tesla "Connectors," Plugless' Tesla Wireless Charger, & most public charging stations are Level 2 chargers.

9-52 miles of Tesla range per hour charging

3.7 - 17.2 kW power delivery

Level 3



Level 3 direct current fast chargers use ultra high-power 480V circuits at public charging stations. Superchargers are Level 3 chargers.

Up to 170 mi of Tesla range in just 30 mins charging

Up to 140 kW power delivery

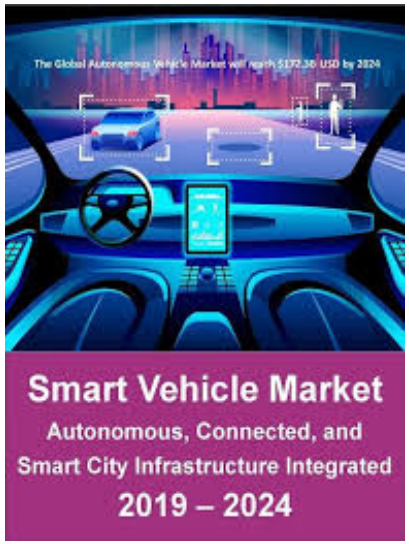
nsmission
stomer
and 69kV

Customer
and 4kV

ary Customer
and 240V

Challenge #3: Utilities can not control EVs

Electric Utility	X
City	X
State	X



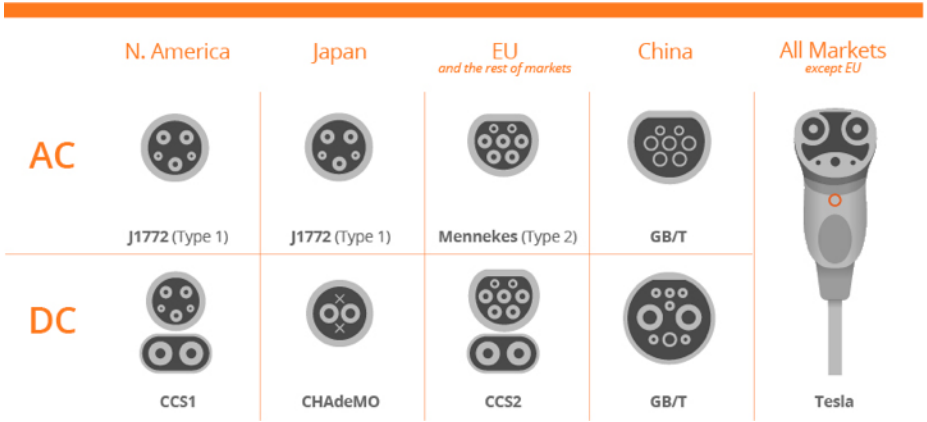
Challenge #4: EVs are mobile and Difficult to do Billing?

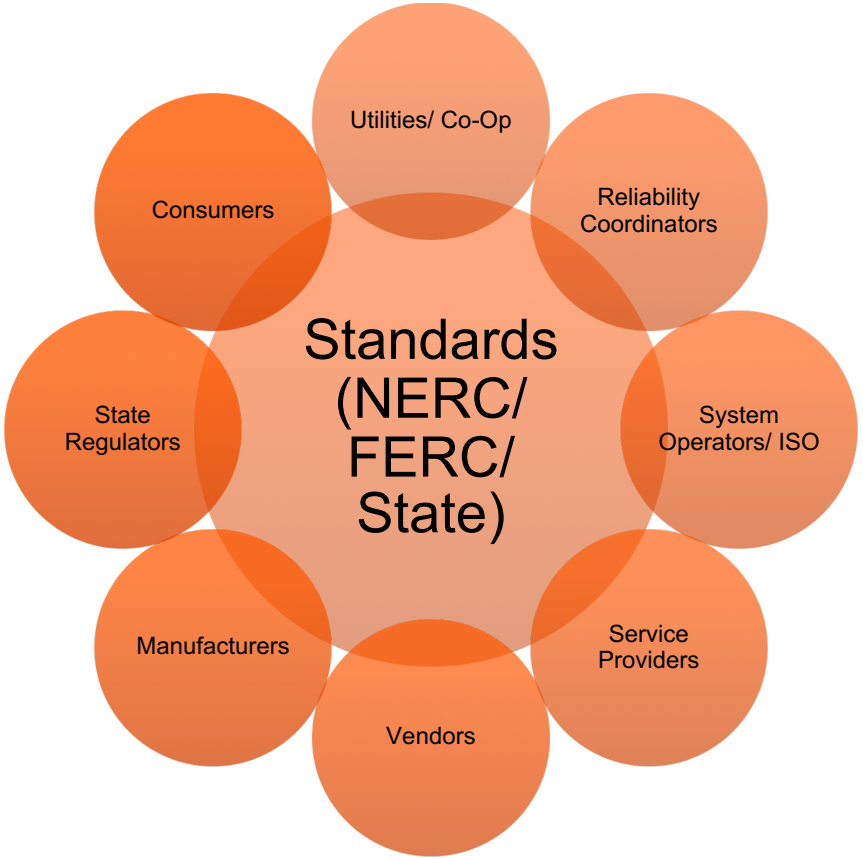
Moving Storage

Challenge #5: Grid is Driven by Economics and Standard

- Every utility is trying to be first to be second – Jeff Dagle, PNNL
- With EVs, Utility economics is poor, specially with two-way flow

Standard	Title/description
National Electric Code	Electric Vehicle Charging System
SAE J2293	Energy Transfer System for Electric Vehicles
SAE J2836	Recommended Practice for Communication between Plug-in and Vehicles and Utility Grid
SAE J1772	Electric Vehicle Conductive Charge Coupler
SAE J1773	Electric Vehicle Inductively Charge Coupler
IEC 62196	Plugs, socket outlets, vehicle couplers and vehicle inlets-Conductive charging of electric vehicles
IEEE 1547.3	Interconnecting Distributed Resources with Electric Power Systems





TODAY

SHARE THIS –

Sandy's angels: Victoria's Secret powers relief efforts

Nov. 5, 2012, 5:35 PM EST

By Scott Stump and Scott Stump and Scott Stump and Scott Stump

When the National Guard needed help during Hurricane Sandy, a company usually known for providing a different type of support came to the rescue.

Victoria's Secret and New York Army National Guard's 69th Infantry Regiment became bosom buddies when the power was knocked out at the National Guard's historic Lexington Armory, often used as an event space, during the storm. Employees for the lingerie brand had arrived just ahead of the storm in advance of the company's third annual fashion show at the Armory, and they brought more than just leggy supermodels and a runway. Instead of Adriana Lima electrifying the building, it was eight 500-kilowatt generators

Road Transporation Network

I-90, I-5, I -82 and other stateways enable transportation of inventory, mobilisation of repair crew and facililate repair and recovery after contigency events

Cyber Communication Network

BPA synchrophasor network, along with utility-scale deployment of Remote Terminal Units, feed data into SCADA systems for power grid monitoring and control

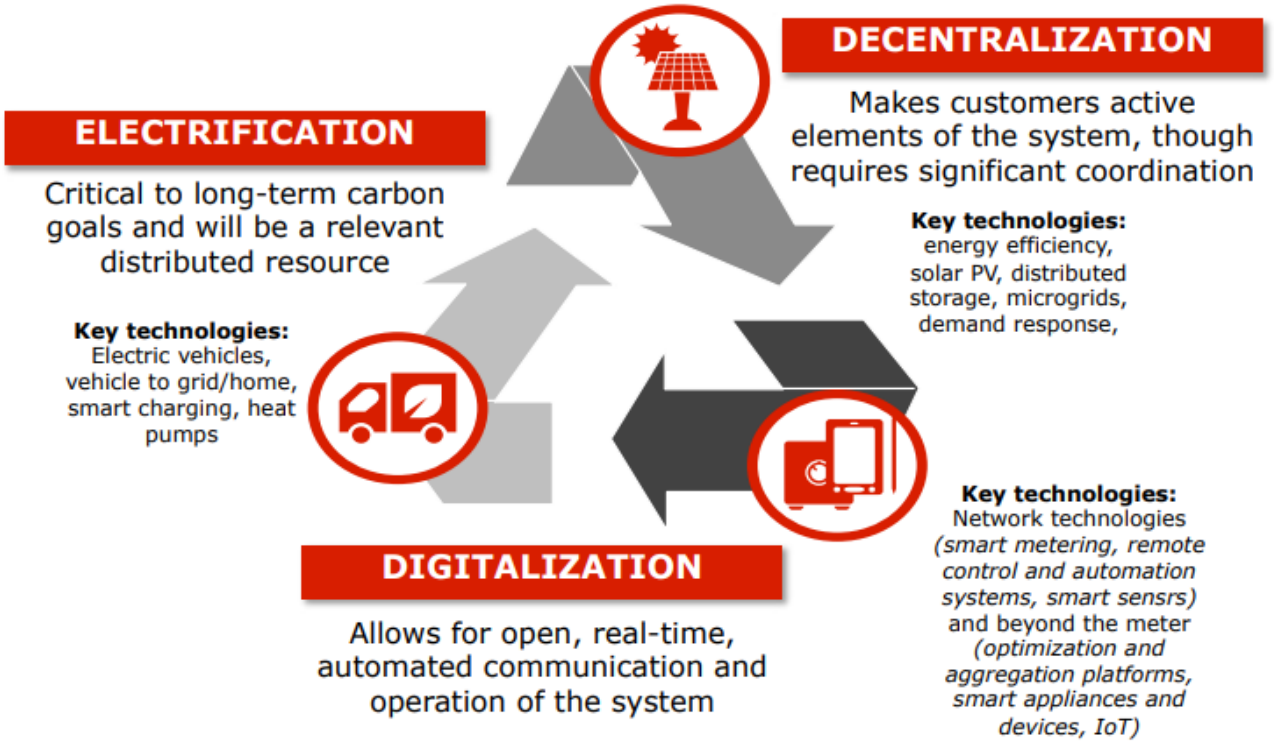
Power Grid Physical Network

Power lines, poles, and transmission lines across the state of Washington enable transmission and delivery of power to all businesses, customers, and critical infrastructure facilities

Inter-dependency and more and more EVs may not result into resiliency

FEMA Project and SETO project in SLC with PacificCorp

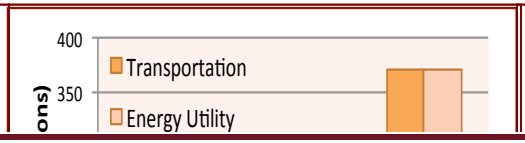
Opportunity # 2: Ancillary Services



Voltage control
Frequency control
Real Power Control
Reactive Power Control

Reliability
Stability

Transportation-en
and Associated C



Centralized

Local/ Distributed

Decentralized, Coordinated and Hierarchal

Fast

Scalable

Sub-Optimal

ault-tolerant

pports Big data

Supports IoT

ed Decision
ort System

Communication, Data, Computation, Control and optimization Layer

Fast Adaptive Observers

Polynomial Chaos Expansion

Switching Constraints

Cyber Events and Latencies

Delay-aware CPS

Adaptive MPC

PAC-X

Distributed Delay-aware Optimization

Controller

Distributed Delay-aware Control

Controller

3-Phase Unbalanced Networks

Mesh Networks with DER

Holon

Data Exchange

Learn/Inference

Knowledge Base

views

Control/Optimization

Knowledge management

- Deep Knowledge Learning
- Knowledge sharing as views
- Event/security analytics

Controller

Controller

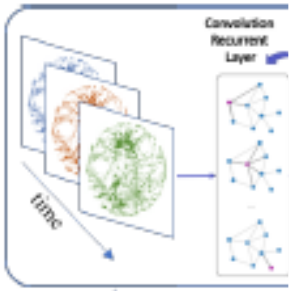
Controller

Cyber security

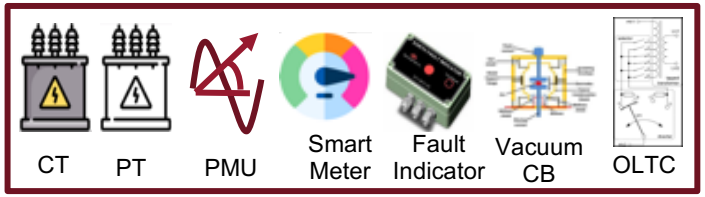
- Threat Info. Sharing
- Detection analytics
- Cyber mitigation

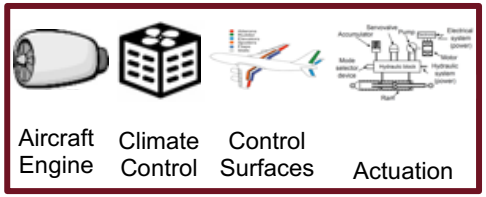
Computing Coordination

- Discovery
- Leader Election
- Consensus

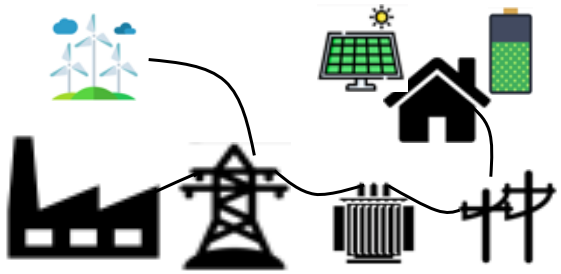


Sensor/ Actuator Layer

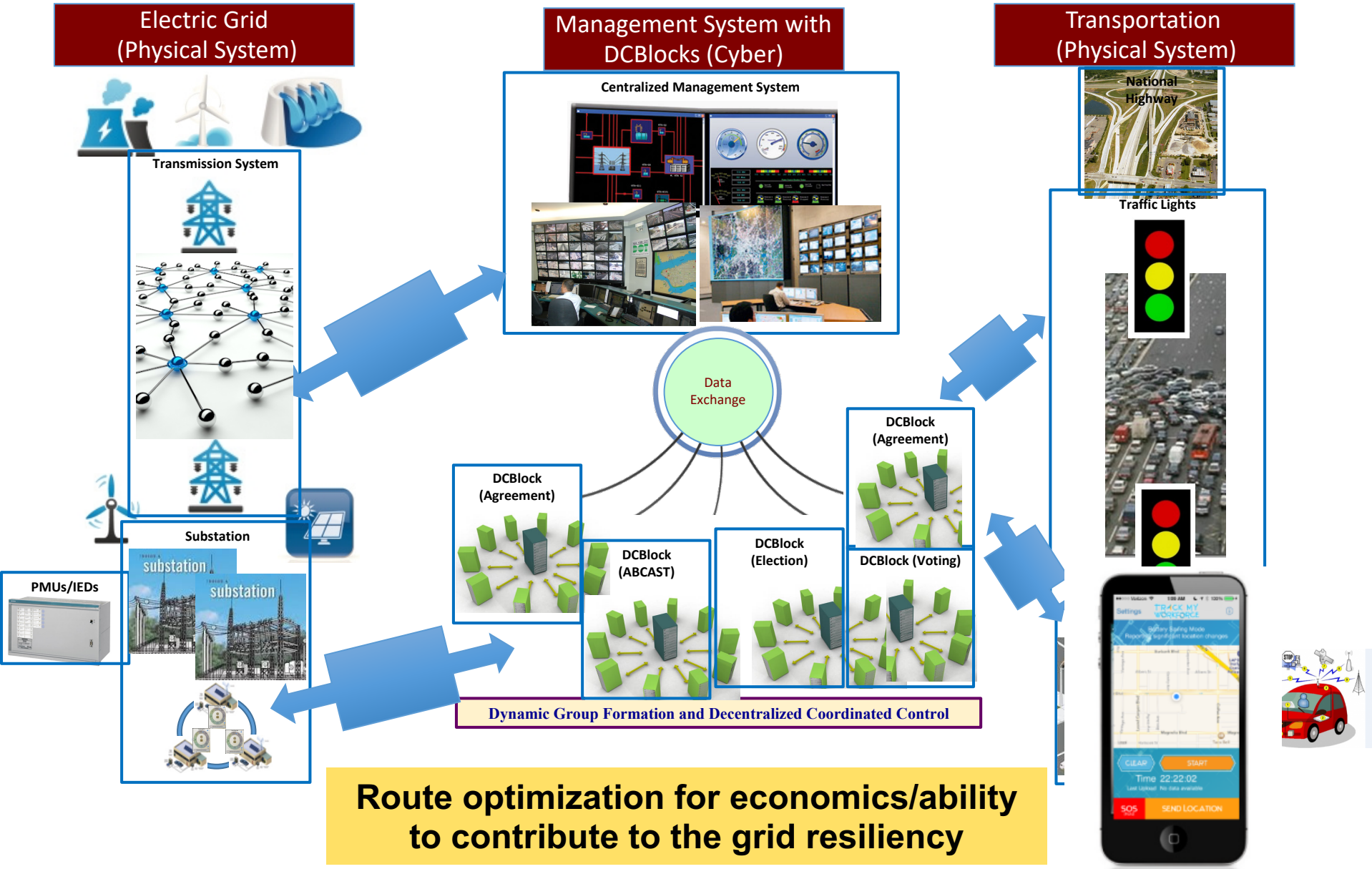




Physical Layer



Opportunity # 3: Integrated Transportation and Electric Grid Management



Oppo

Seattle Prepares for EV Influx

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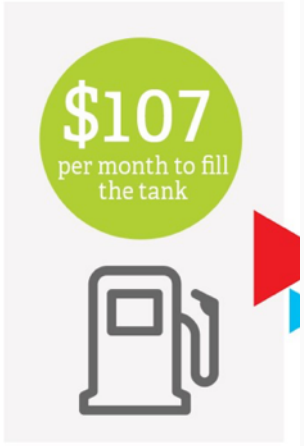

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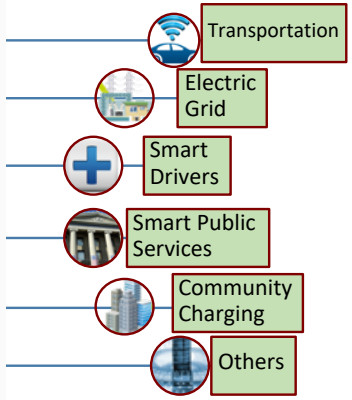

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Sep 19, 2019 2:14 am GMT
513 views

Yet another study has been released warning of the dangers electric vehicles pose to our grids. A joint effort of the Rocky Mountain Institute and Seattle City Light, the “Seattle City Light Transportation Electrification Strategy” concludes that neither Seattle nor most other big cities are prepared for the oncoming serge in EV use. The report isn’t all doom and gloom, however. The authors stress the importance of


DARN IT-EVERY TIME I TRY TO TEXT, MY SMART CAR PULLS TO THE SIDE OF THE ROAD.