PEV Integration Project

NYISO – Markets Issues Working Group

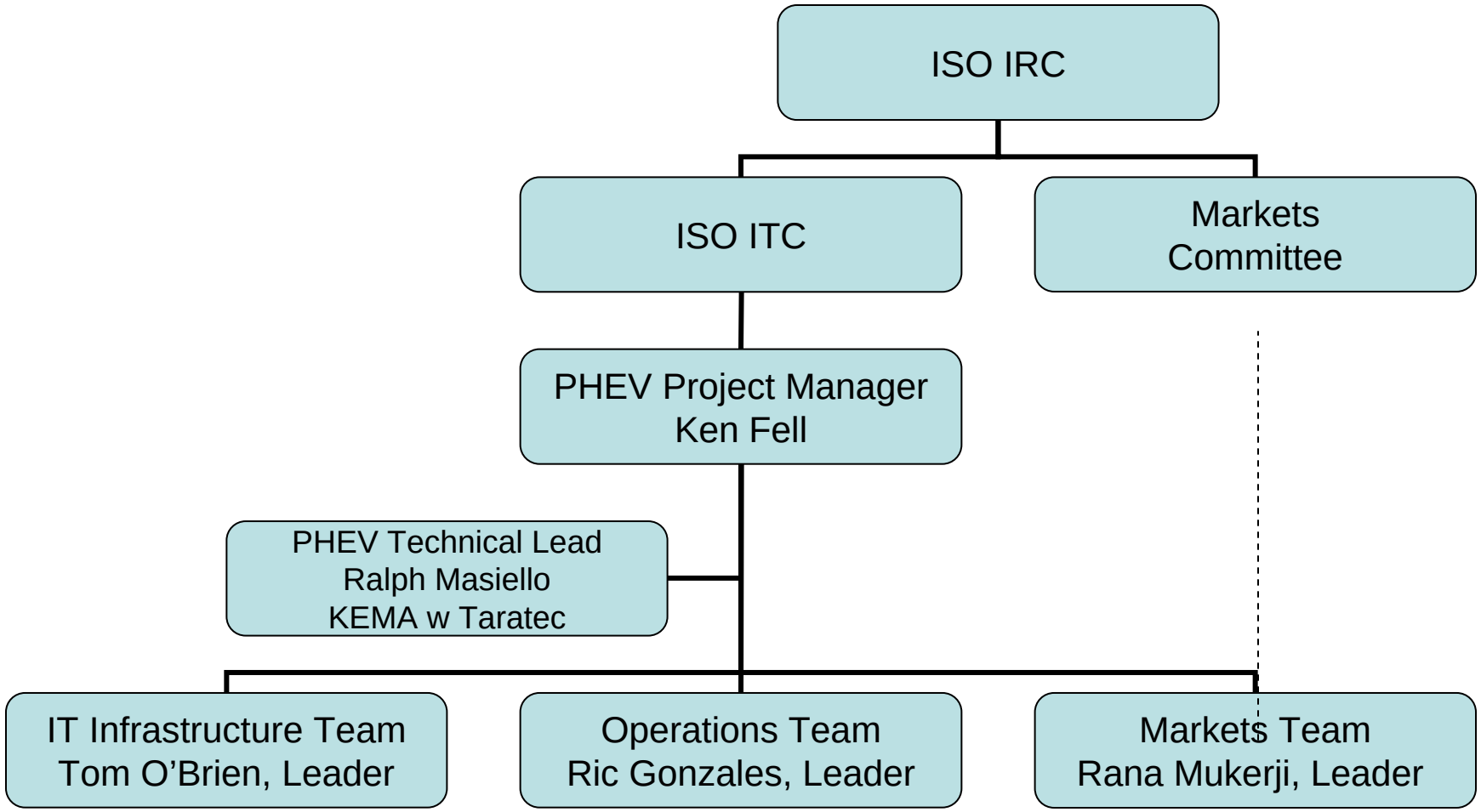
August 20th, 2009

Ken Fell: Project Manager and ITC Director
Ralph Masiello: Technical lead - KEMA

Project Charter

- IRC Sponsor: Gordon Van Welie, Chief Executive Officer, ISO New England
- Responsible Oversight Committee: Information Technology Committee
- Project Manager: Ken Fell, New York ISO
- Project Budget: $223,000
  (shared equally by 10 ISO/RTOs)

PHEV Project Organization



ISO/RTO Council

Project Purpose

Identify products and services that PHEVs could provide under existing market and reliability structures within the ISO/RTO markets, including recommendations and analysis of requirements that address:

- Reliability, Market Products and Services, Demand Response and Alternative Energy opportunities
- Technology, Communications, Security and protocol requirements, issues, constraints, costs and the accountable parties (vendors, regulatory, ISO/RTO staff, standard setting agencies (i.e. NAESB, NERC, NIST, etc.)
- Performance, Operability and Observability requirements and recommendation
- Requirements for ISO/RTOs to be the integrators of the aforementioned products and services
- Recommendations appropriate for the ISO/RTOs to have a consistent view, standards, and how the products and services would play across all of the markets.
- Project Plan including budget, timelines, schedule, resources, and organization

Project Goal

Provide specific conclusions and recommendations as follows:

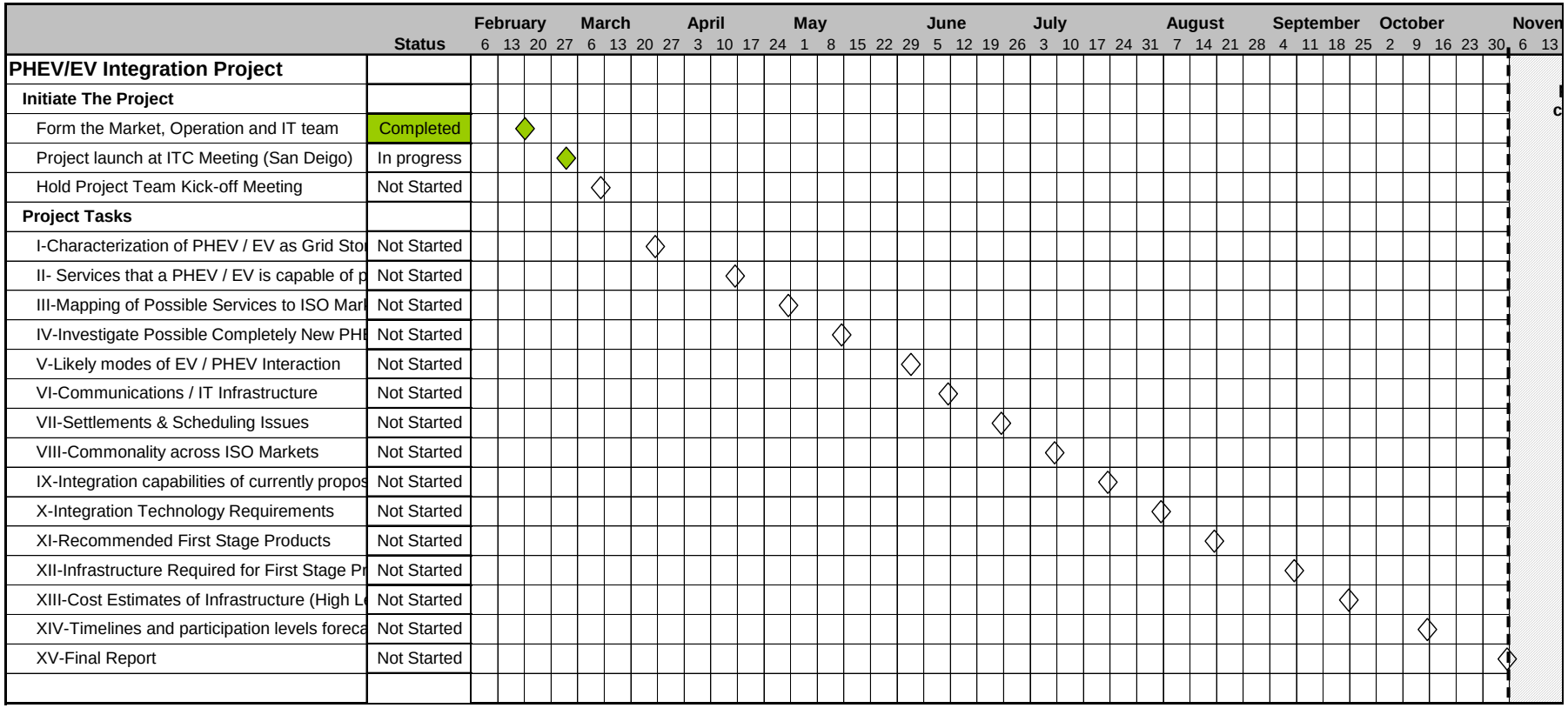
- Proposed market design and operational requirements
- Recommendations for the operational and market infrastructure development considering V2G, Demand Response and alternative Energy
- Results of detailed modeling and analysis as appropriate to demonstrate feasibility of recommendations and time lines
- Recommendations for development of operational and market infrastructure that provided for visibility to the system operator in real time and integration with EMS systems and pricing algorithms.
- Address Cyber Security, Field Safety, Vehicle Plug and Play Requirements, and the Uniform Grid Code

PHEV/EV Integration Project
Scope of Work

Scope of work

1. Characterization of the PHEV / EV as grid storage devices – assessment of technical capabilities.
2. Identification services that a PHEV / EV is capable of performing.
3. Mapping of possible services to ISO market products and adaptations required.
4. Identification of Possible new PHEV / EV products.
5. Identifying likely modes of EV / PHEV interaction with the ISO.
6. Identifying Communications / IT Infrastructure needs.
7. Identifying Settlements and Scheduling Issues associated with Vehicle to Grid products and services.
8. Identifying commonality and variations across the different ISO markets today and how these may affect Vehicle to Grid products and services.
9. Assessing the integration capabilities of currently proposed SAE and IEEE standards.
10. Identifying integration technology requirements.
11. Developing recommended first stage products and services for implementation.
12. Developing requirements for first stage infrastructure implementation.
13. Development of high level cost estimates of first stage infrastructure.
14. Development of potential timelines and participation levels.
15. Final Report and Presentation.

PHEV/EV Integration Project
High Level Project Schedule



ISO/RTO Council

Project Management and Team

Project manager is Ken Fell and the overall technical lead is Ralph Masiello, who will report to Ken. Ken and Ralph will meet with the team leads every two weeks (at minimum, more frequently if necessary).

The project manager will

- Provide overall guidance and reporting for the project
- Hold oversight meetings with the project team members on a regular basis (at minimum monthly project meetings, with every alternate meeting being in person).
- Provide monthly progress reports to the IRC, which will include a dashboard that speaks to progress (schedule, scope and budget) and risks/opportunities. This is the mechanism to highlight issues to the IRC.
- Work with the team leads and the Chairs of the Markets and IT Committee to ensure that there is consensus on the findings and recommendations in the report.

The overall technical lead will

- Provide overall technical guidance
- Provide the integration function amongst the teams and ensure technical consistency in the work product from the teams.

Project Structure

Project Structure

- The Project will consist of three teams, each reporting to the project manager. These teams include a Markets team, a PHEV Operations team and an IT team.
- Each participating ISO is expected to assign someone to each of the teams one person may be on more than one team)
- The Markets team will have a team lead assigned from one of the ISOs by the Chair of the Markets Committee, after consultation with the Markets Committee members.
- The PHEV Operations team lead is (R. Gonzales from the ISOs; Ed Ungar from Taratec for the project)
- The IT team lead will be assigned by the Chair of the ITC, after consultation with the ITC members.

Completed Task Summary

- Task 1 - Market Development & Characteristics of PEVs
- Task 2 – Description of services a PEV can provide to the grid acting as a controllable load
- Task 3 - Mapping possible services to existing ISO/RTO products and adoptions required
- Task 4 - Potentially new PEV services
- Task 5 - Likely modes of PEV interactions
- Task 6 - Communication / IT infrastructure

Tasks In Progress

Task 7 Impact on Settlements

Task 14* PEV market penetration study

** Note: Task 14 also considers accelerated market penetration*

Next Tasks

Task 8 Commonality acoss ISO Markets

Task 9 Integration capabilities of currently proposed SAE / IEEE Standards

** Note: Task 14 also considers accelerated market penetration*

External Linkages

- EPRI Infrastructure Working Group
  - Dave Hackett / Ken Huber are supporting / reporting
- NIST Smart Grid Standards
  - Many linkages; Ken Huber especially
  - Meeting with George Arnold at NIST (Ken, Tom O'Brien, Ralph Masiello) will lead to formalizing interaction and a formal role for IRC / ITC in NIST advisory committee
- FERC
  - Gordon / Tom have briefed Jamie Simler @ FERC
- EU Initiatives
  - Several; KEMA providing cross-fertilization to efforts in the NL and Germany

Additional Stakeholder Input

- Google announced PEV control software demo'd at KEMA conference last month
- IBM working in NL and Denmark on PEV integration with renewables
- Better Place promoting charging infrastructure and different business model

- Process: informal meetings for data gathering and feedback on an ongoing basis

USA Developing PEV Standards

- SAE Standards (evolving standards)
  - J1772 – Definition of the PHEV or EV standard connector
  - J2836 - Definition of the PEV interaction between Vehicle and charger/utility
  - J2847 – Definition of the messaging (format and content); tightly associated with J2836
- Opportunities to test connector (expecting UL approval in May 09 for level 1-2) and EVSE (charger)

IEC Standards / J1772 Harmonization

- Committee entertained 3 connectors from the international community (1 was withdrawn). Candidates are
  - US SAE J1772 (Single phase, 32 Amp, 230 VAC, 5 pins)
  - Germany/Several Europe countries – want single and three phase connectors (70 Amp (single phase) and 63 Amp (three phase), 500 VAC, 7 pins)
  - Italy (Single phase, 16 Amp, 230 VAC, 4-5 pins)
- Agreed to enter all three connector and vote on all at same time. Need at least 18 yes votes to be approved (out of 24 voting countries)
- Best case time frame for an international standard is March 2010; June – distributed
- Opportunity – Test the connector, charger and batteries

Task 4 Potential New Products

New Product	Acronym	Definition	Categorization	Duration	Technical Requirements	Market Issues	Operational Issues
Timed Energy Delivery	TED	target total energy over time period is scheduled but hourly energy is at ISO discretion	overall a new energy product; In some ISO/RTOs, the pump storage optimization techniques may be used to accommodate this service	diurnal at most; possibly as short as 3-4 hours	new clearing algorithms; command and control infrastrucucture to PEV;infrastructure to allow PEV interconnection at various locations	How to establish pricing viz other energy products and load; determining location of PEV	
Fast Reserves	FR	High speed DR response by PEV charging interruption	new ancillary product, could be locational	some time frame < 1 hour	communications and control; aggregation and validation;infrastructure to allow PEV interconnection at various locations	availability varies by hour - is sufficient available during peak hours to make this a useful product	verification and certainty; management of the restoration of PEV charging
Dynamic Pricing	DP	PEV respond directly to market price	new market product	hourly	price broadcast locationally and metering infrastructure to isolate PEV load;infrastructure to allow PEV interconnection at various locations	what price to broadcast; calculating uplifts; how to forecast price responsive load in day ahead clearing; determining location of PEV	forecasting effects
Demand as Regulation Resource	DRR	Varying PEV charging up and down rapidly from a baseline in response to regulation instructions but with zero net energy change from schedule; Typically bid with a service price and the price needs to met to participate.	Ancillary service	< hour	command and control infrastructure to PEV;infrastructure to allow PEV interconnection at various locations	price impact on market when sufficient PEV penetration exists; ensuring sufficient regulation when PEV not charging	must still deliver net energy
Green Charging	GC	Controlling the charging of PEV to match production from linked renewable resources	New kind of energy-load combination Maybe a signal to the market rather than a service	diurnal	monitoring of linked renewables; market / scheduling sw to establish linkage; command and control infrastructure to PEV	new paradigm that links load to resources directly instead of through market	
PEV Emergency Load Curtailment	ELC	First step in load reduction by reducing PEV charging when energy capacity approaching the minimum reliability limit	new product, could be locational	as required, normally the outage would not exceed a few hours	communications and control; aggregation and validation;infrastructure to allow PEV interconnection at various locations	determining the value point where the PEV Owner/ Aggregator will volunteer to be the first in line when emergency load shed is needed; determining location of PEV	Provides a first step before emergency load shed

Task 14: Objective

The objective of Task 14:

Develop projections of the market penetration of PEVs among the ISOs and RTOs, including their locations, to provide an understanding of the amount of PEV charging loads

- (a) overall, among the individual ISOs and RTOs
- (b) in concentrations that provide the opportunity for ISO and RTO demand response management

Agenda: A Preliminary Report

- Introduction: Our approach
  - Analogy to the Prius development pattern
  - Three PEV scenarios
- The Prius experience:
  - Where did the Prius deployment happen
  - What were the drivers
  - What do we learn for PEV projections at the ISO/RTO level
- Given the Prius data, where are the PEVs likely to be concentrated
  - Individual ISO/RTO views
- Moving from vehicles to available MWs
  - Key assumptions
  - Implications for urban areas
- Next steps

Reminder – Task 1: PEV Introduction "Windows"

We have defined three "windows" for PEV market development

1. **Initial market entry: 2009-2012**
   - Most major manufacturers introduce PEV vehicles
   - Very limited production

2. **Market development and growth: 2013-2017**
   - Additional vehicles introduced
   - Second generation vehicles introduced

3. **Mature market development and expansion: 2018-1030 and beyond**
   - Additional models, additional manufacturers enter the market
   - Third generation vehicles introduced
   - New technologies, advanced features, new charging capabilities

Reminder – Task 1: OEM PEV Introductions

OEM PEV Announcements						
Year	**OEM**	**Vehicle Type**	**Vehicle**	**Battery Size**	**All-Electric Range**	**Expected Volume**
2009	Tesla	BEV	Roadster		250 miles	Very limited production
	Fisker	PHEV	Karma (sedan)		50 miles	Planned to reach 15,000/yr
	Toyota	PHEV	Prius	?	10 miles	Introduction, limited 2010 sales
2010	GM	EREV	Chevy Volt	16 kWh	40 miles	Limited sales, expected to be initially 10,000/yr.
	GM	PHEV	Saturn View	8 kWh	TBD miles	Limited sales, TBD
	Ford	PHEV	Escape		30 miles	Electric utility PHEV demo
	Ford	BEV	Transit Connect (BEV Van)			Battery EV commercial van
	Chrysler	BEV	Dodge Circuit	30 kWh	150-200 miles	2-passenger, high performance
	BYD (China)	PHEV	F3DM	25-35 kWh	60 miles	First release in China, US in 2010
	BYD (China)	BEV	E6		180 miles	Release in Chna
	Think	BEV	Urban runabout (2-seater)		112 miles	First year in US-2,500 cars; eventual plan is 60,000/year
2011	Nissan	BEV	Small car	25-30 kWh	100 miles	40,000 vehicles for each of 1st 2 years
	Ford	BEV	Not defined		~100 miles (TBD)	
	Tesla	BEV	Model S (sedan)		150-300 miles	
2012	Ford	PHEV	TBD	TBD	TBD	

Taratec Methodology

The challenge

- How to project development of a PEV technology that has yet to be introduced?

The two issues

- Market size: How many, total
- Market distribution: How many, where

Approach - Market size

- Use Obama administration “1 million PEVs in 5 years” target

Approach - Market distribution

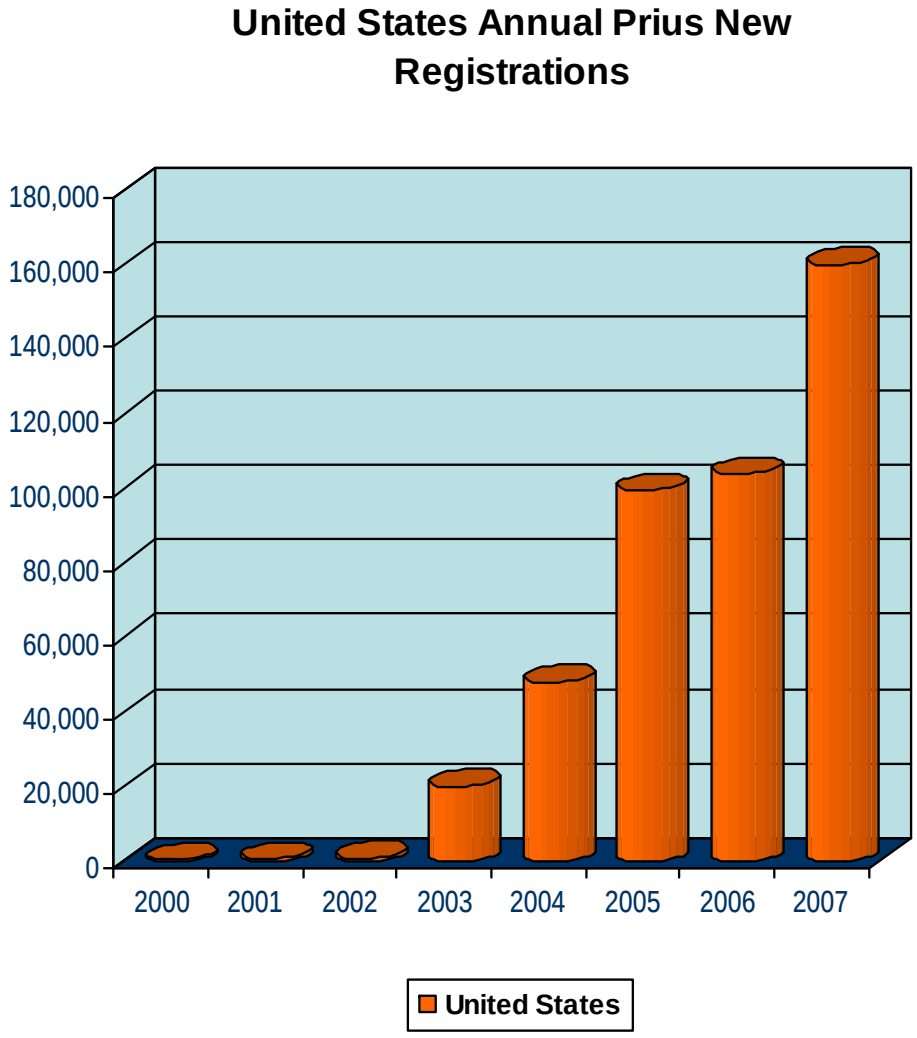
- ***Consumer choice:*** use Prius sales as a proxy for early adopter behavior and scale Prius choices to the “1 million vehicles” target
- ***Fleet vehicles:*** use major urban areas as “sweet spot” for BEV fleets
- ***BEVs:*** assume 85% of BEVs will be deployed in the largest urban areas, generally by fleet operators

Note: All Prius data provided by R. L. Polk

The Historical Data: The Pace of Prius Market Penetration

Prius sales illustrate the introduction of a new vehicle technology

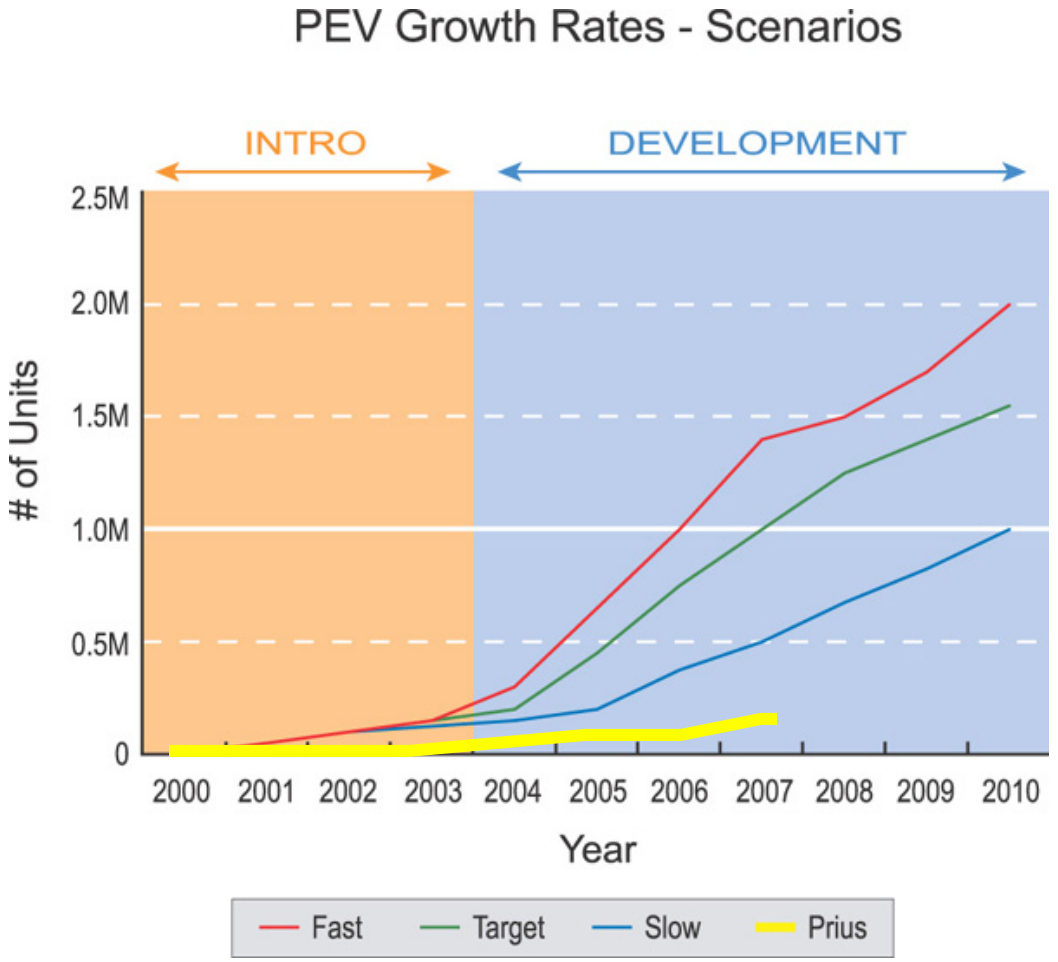
- ***Market introduction:*** first generation, limited capacity, high prices
- ***Market development:*** second generation, improved technology, expanded capacity, growing consumer interest and acceptance



When Will They Matter: The Pace of Market Development

We have assumed three scenarios for PEV market development

- ***Base case:*** Obama administration “1 million in five years”
- ***Slow case:*** Much slower consumer demand growth (1 million in eight years)
- ***Fast case:*** Much more rapid acceptance (1 million in four years)



Overview: What have we learned about Prius distribution?

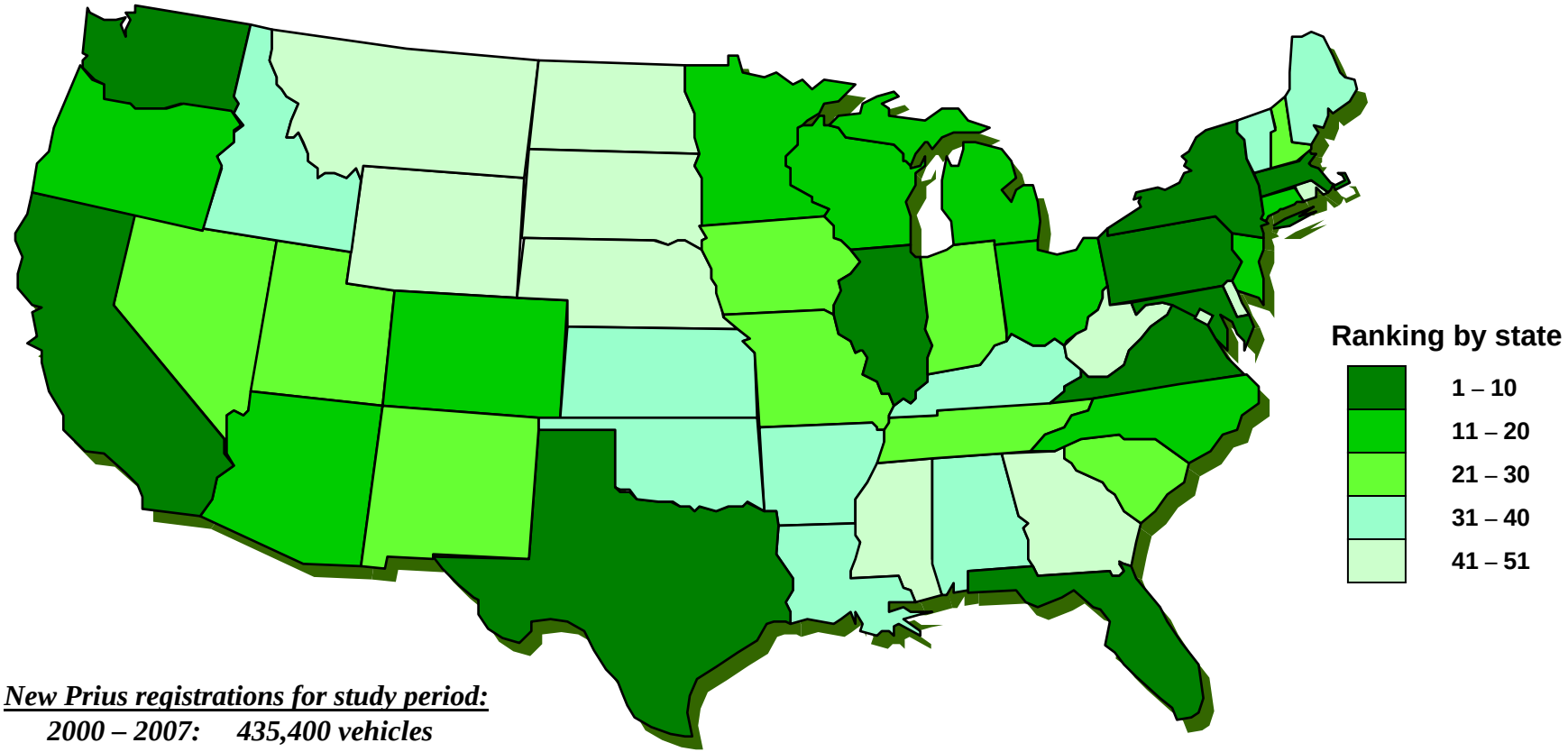
Where have the Prius sales gone?

What can we learn about ***possible differences in consumer preferences*** among the states and cities in the US, and among the ISO/RTO regions?

What can we learn about the possible ***overall size of PEV concentrations*** in the ISO/RTO regions and cities?

What have we learned about Prius early adopters?

*Prius Registrations – Total Prius Sales, 2000-2007**

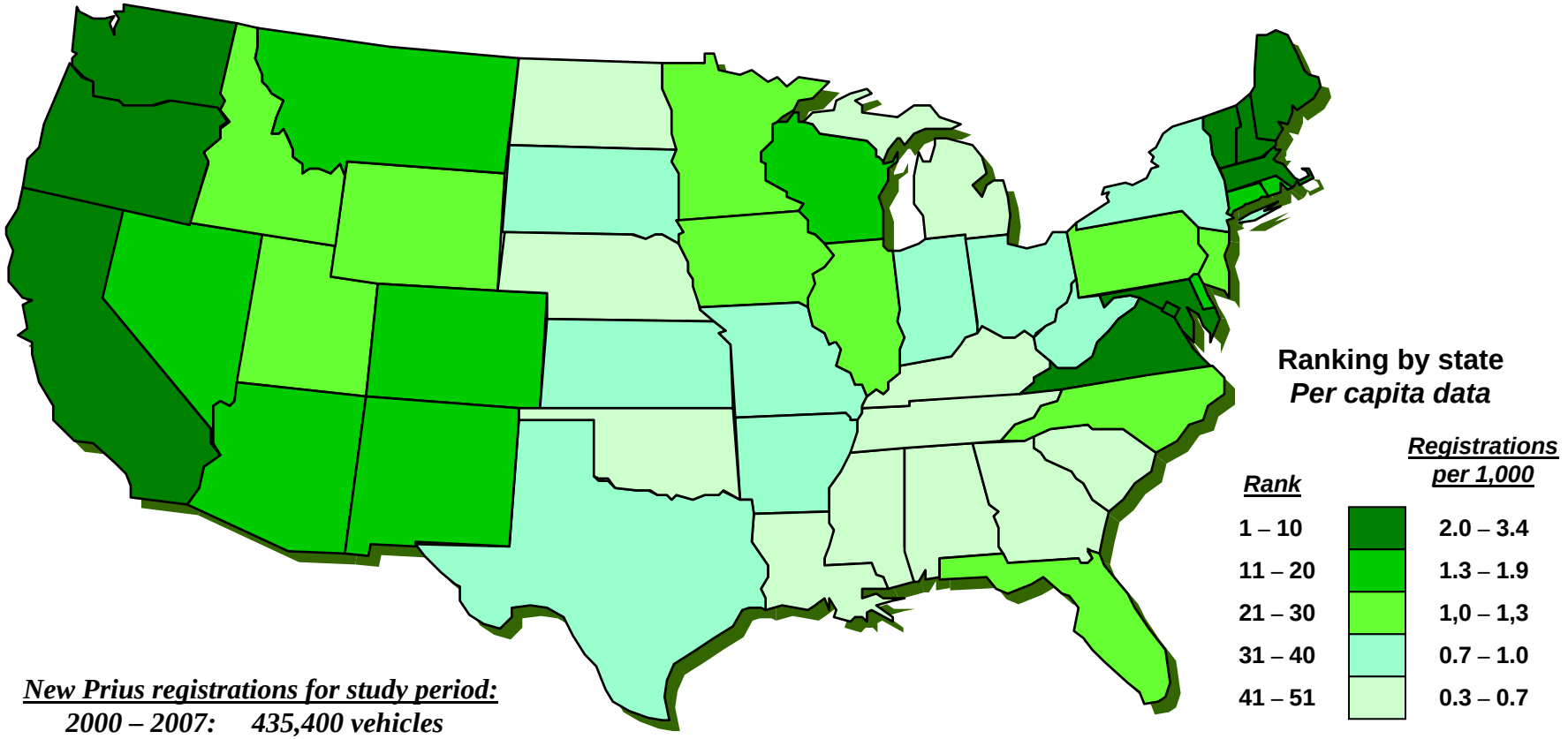


New Prius registrations for study period:
2000 – 2007: 435,400 vehicles

* Prius data provided by R. L. Polk

What have we learned about early Prius consumers?

*Prius Registrations – New Registrations Per Capita, 2000-2007**



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Buyer Demographics: Locations of New Registrations

Sales of the Prius were generally concentrated in states with the highest population – but the demographics of the Prius customer has a strong "coastal" character

States With Highest Prius Sales

Rank	State	Total New Registrations
1	CA	123,989
2	FL	20,596
3	TX	18,297
4	NY	18,033
5	VA	17,828
6	WA	16,459
7	PA	14,791
8	IL	14,660
9	MA	13,723
10	MD	12,040

States Where Prius Was Most Popular

Rank	State	Registrations per 1000 Residents
1	CA	3.37
2	VT	3.21
3	OR	3.04
4	NH	2.54
5	WA	2.51
6	DC	2.46
7	VA	2.29
8	MD	2.14
9	MA	2.11
10	ME	2.03

Buyer Demographics: Urban Concentrations

The distribution of the Prius sales and new registrations was heavily concentrated in the largest urban areas, which account for 31.6% of total U.S. sales

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Metro Areas Where Prius Was Most Popular

Rank	Metro Area	Total New Registrations	% of US
1	New York	18,622	3.7%
2	Los Angeles	52,700	10.4%
3	Chicago	9,400	1.9%
4	Wash., DC	15,100	8.4%
5	San Francisco	42,900	8.4%
6	Philadelphia	6,300	1.2%
7	Boston	13,200	2.6%
8	Detroit	3,000	0.6%
9	Dallas	3,200	0.6%
10	Houston	3,900	0.8%

The “Take-aways” From the Prius Review

1. Early adopters were ***NOT proportional*** to population size
   - Significant ***differences in per capita sales*** between states and regions
   - Some strong preferences, some distinct disinterest
2. TOTAL numbers driven by overall ***population size***
3. The ***“Coastal” phenomenon*** for this class of vehicle among early adopters is very clear – in both the per capita numbers and in the overall sales numbers

<u>Conclusions</u>

- Early adopters have a clear demographic ***locational component***
  - The so-called “coastal effect” appears valid
- BUT – from an ***ISO/RTO perspective***, where clusters of significant size are needed to provide a useful level of MW of connected PEVs, ***POPULATION SIZE*** matters more than almost any other criteria

PEVs: Where will they land?

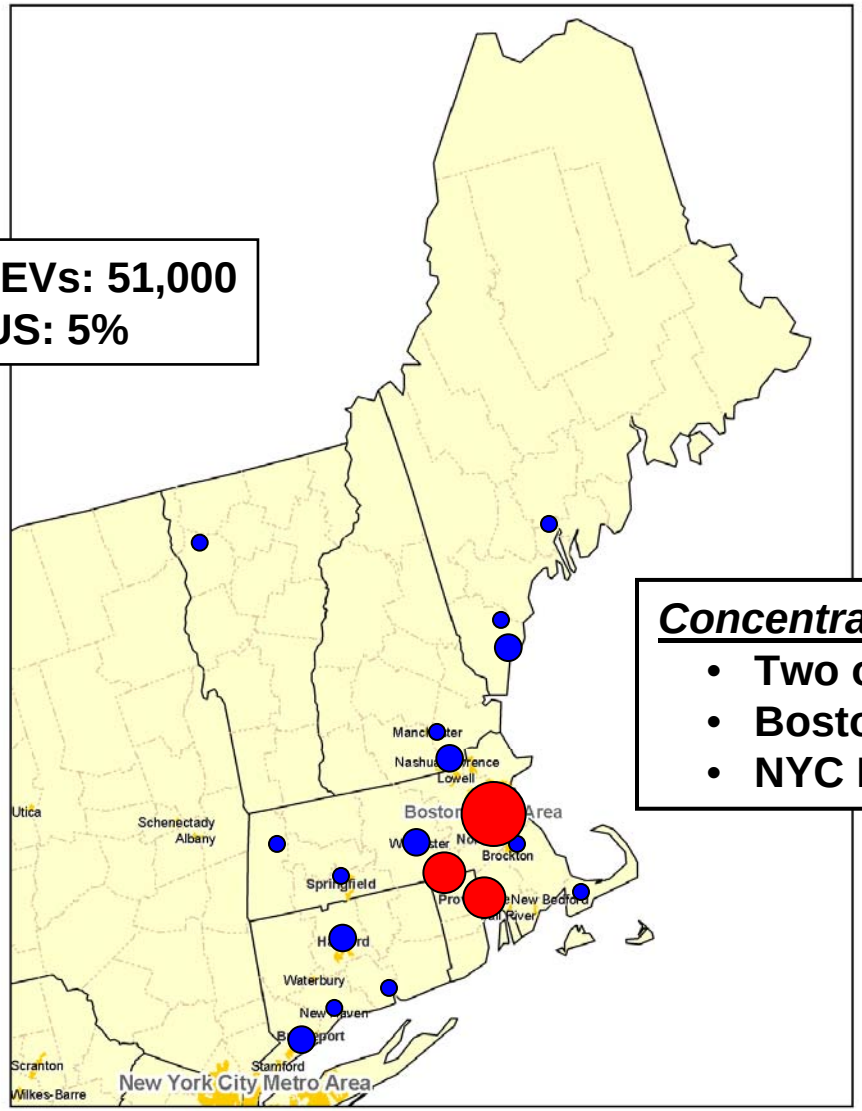
- Where are ***PEVs likely to be concentrated in significant numbers*** from an ISO/RTO perspective?

- Key to an ISO/RTO perspective
  - MW – ***concentrations*** of PEVs
    - One vehicle here and there doesn't count

- Where will PEVs wind up?
  - ***The consumer model:*** PHEVs and EREVs (and some BEVs)
    - The Prius analogy
  - ***The "fleet" model:*** BEVs
    - An "urban center" model

NE ISO

Projected PEVs: 51,000
% of Total US: 5%



>40,000
20,000 – 40,000
10,000 – 20,000
5,000 – 10,000
2,000 – 5,000
<2,000

Concentrations of PEVs

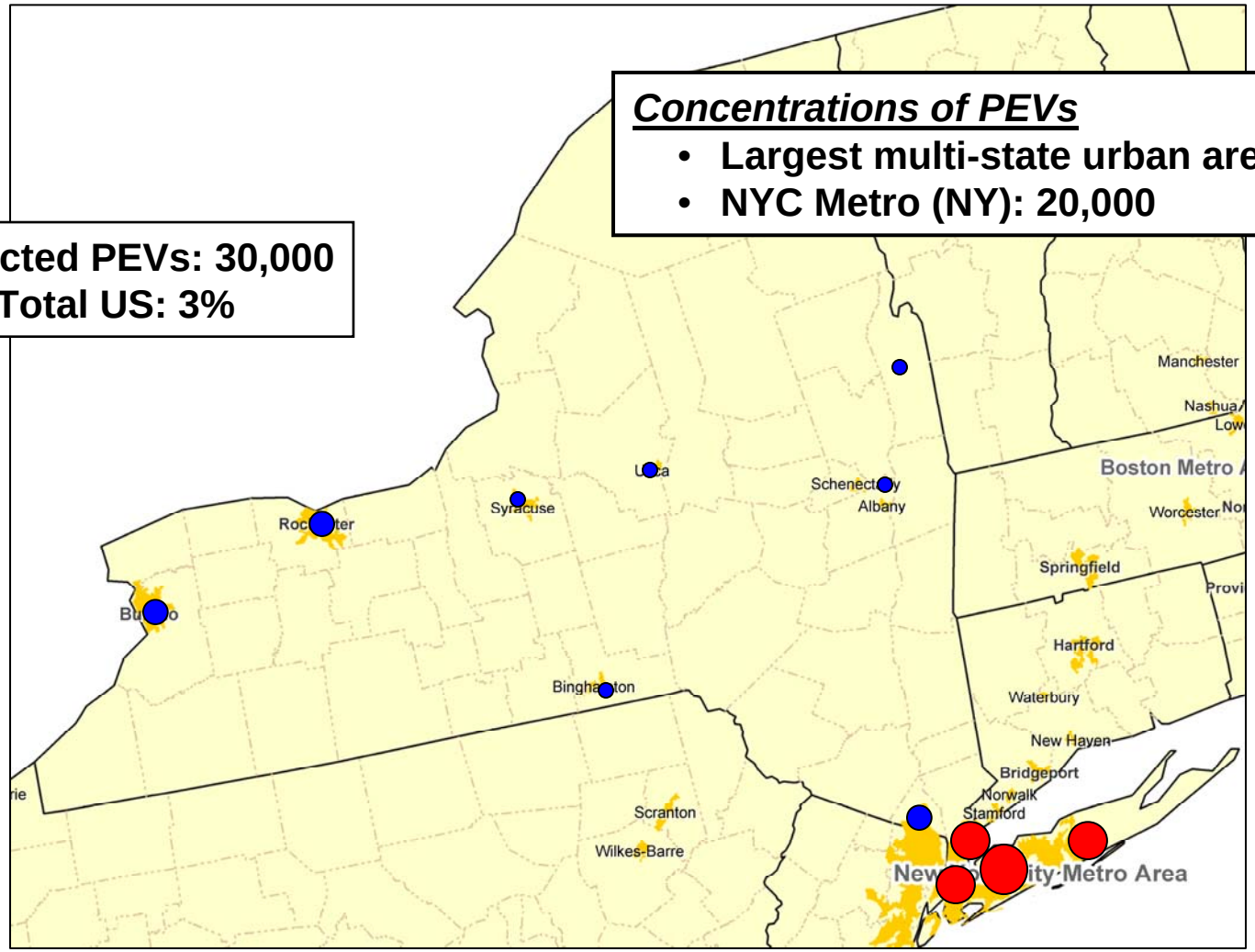
- **Two of top 10 urban areas**
- **Boston Metro: 27,000**
- **NYC Metro (CT): 7,000**

NY ISO

Projected PEVs: 30,000
% of Total US: 3%

Concentrations of PEVs

- **Largest multi-state urban area**
- **NYC Metro (NY): 20,000**



>40,000
20,000 – 40,000
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5,000 – 10,000
2,000 – 5,000
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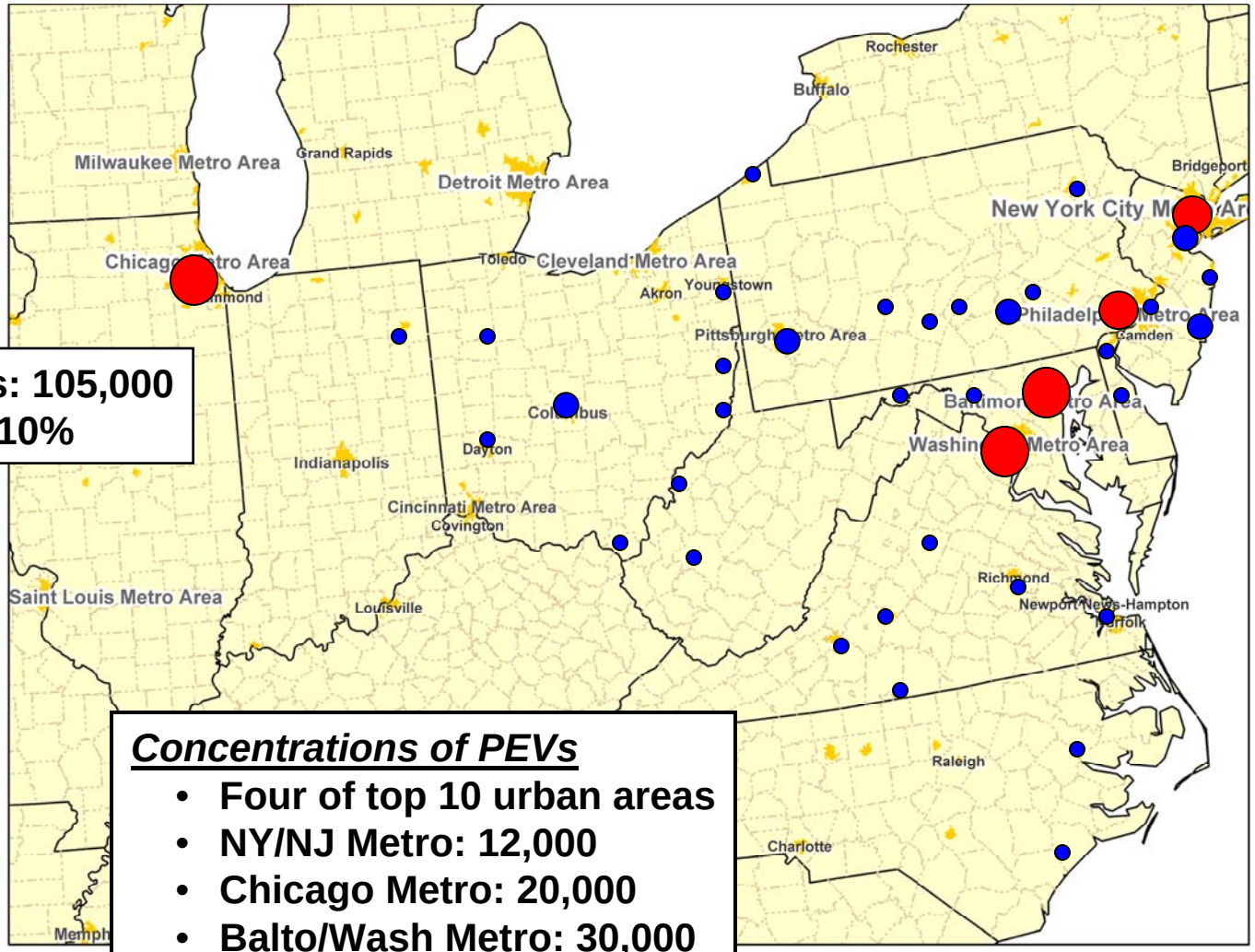
PJM

Projected PEVs: 105,000
% of Total US: 10%



>40,000
20,000 – 40,000
10,000 – 20,000
5,000 – 10,000
2,000 – 5,000
<2,000

Concentrations of PEVs

- **Four of top 10 urban areas**
- **NY/NJ Metro: 12,000**
- **Chicago Metro: 20,000**
- **Balto/Wash Metro: 30,000**
- **Philadelphia Metro: 14,000**

PEV Market: The ISO/RTO Share of PEV Market

Based on market share of US Prius registrations (new)

	Total Prius Registrations	% of Total US Registrations	ISO PEVs (Prius x 2)
ISO NE	25,390	4.99%	50,780
NY ISO	14,097	2.77%	28,194
PJM	51,562	10.14%	103,124
MISO	32,511	6.39%	65,022
SPP	9,233	1.82%	18,466
ERCOT	13,638	2.68%	27,276
CA ISO	118,849	23.37%	237,698
ISO/RTO Total	**239,890**	**47.16%**	**479,780**

Total US Prius registrations in sample: 508,658