December 2, 2011

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Mr Tyson Self
Manager Projects
Economic Regulation Authority of Western Australia
PO Box 8469, PERTH BC WA 6849
publicsubmissions@erawa.com.au

Re: Western Power Smart Grid Proposal for AA3

Dear Mr Self,

I am writing to endorse Western Power's Smart Grid Proposal [1] as outlined in Western Power's Proposed Revised Access Arrangement for 2012-2017 (AA3).

About Verdant Vision

Our company is a consultancy providing trusted, independent, expert advice on technology, policy and strategy for renewable electric transportation with smart infrastructure.

Our expert leadership team has a combined 20 years of experience working in this sector in both North America and Australia. This includes supporting several of Australia's most-notable smart grid developments including the Federal Government's Smart Grid, Smart Cities project; the Australian EV Standards process; the Queensland Government EV Recharging Management Initiative; and the AEMC Review of Energy Market Arrangements for Electric Vehicles. We have also delivered a series of electric vehicle-smart grid integration workshops for utility clients in the Asia-Pacific region.

Verdant Vision has strong ties to Western Australia (WA). Western Power has been one of our strategic consulting clients and we are formally affiliated with Curtin University through an Adjunct Research Fellowship in the Curtin University Sustainability Policy Institute. Curtin University also hosts the Western Power Chair in the Department of Electrical and Computer Engineering. Our relevant achievements in WA include:

- Invited submissions and public presentations on smart energy and transport networks for electric vehicles through the WA Strategic Energy Initiative process [2];
- An Electric Vehicle Policy Statement [3] with Western Power and other WA stakeholders;
- Numerous briefings [4] to staff from Western Power, the State Government Office of Energy and Department of Transport, and the Independent Market Operator;
- Invited expert speaker and organizing committee for the 2009 Curtin Smart Grid Forum.

Western Power's Smart Grid Proposal for AA3

We are pleased to endorse the Western Power Smart Grid Proposal on the basis that we believe it is a ***smart proposal*** by a ***smart company*** for a ***smarter grid*** in WA.

A Smarter Grid

The value of a smarter grid has been well-documented locally, nationally and globally.

Current drivers for a smarter grid in WA include:

- Exaggerated peak demand growth, accelerated network augmentation and declining network asset utilization [5];
- Rising network costs and retail tariffs as result of the above [5];
- Global standards development around smart grid architectures, interfaces and components;
- Global technology developments including current growing deployments locally of:
    - smarter appliances (for both energy use and ICT);
    - large scale intermittent renewables (e.g. wind) and distributed-scale intermittent renewables (e.g. PV);
    - future large scale forecast deployments of electric vehicles, distributed storage and other distributed energy systems [4, 6]

The overarching benefit of a smarter grid is that it will equip the WA energy network to become more resilient and adaptable such that it can better-serve the needs of WA's forecast continuing population, economic and total energy consumption growth. Direct benefits to Western Power will include improved operational efficiency, improved information to manage the network, more efficient ways of improving the reliability of services to customers, and more opportunities to manage peak demand through innovative new programs. Direct benefits to customers will include improved reliability performance, increased ability to manage their energy costs, and less upward pressure on network costs and retail tariffs over time.

The costs of investing in a smarter grid now are clearly justified for the future as demonstrated by Western Power's Cost-Benefit Analysis, and are the preferred approach rather than continuing to rely solely upon traditional network solutions. Smart grid benefits outweigh the costs based on improving the security and reliability of energy supply to the WA economy, improving asset utilization in the energy network, minimizing the cost of energy services delivered to customers, and enabling clean energy solutions that will minimize environmental externality costs.

On this basis a smarter grid in WA is entirely consistent with the four strategic goals of the State Government *Strategic Energy Initiative* that are for **secure**, **reliable**, **competitive** and **cleaner energy**.

A Smart Company

Since 2009 Verdant Vision has developed a close relationship with Western Power including its key executives, managers and staff and key programs in the smart grid arena. We enjoy working with the company and have repeatedly observed their efforts to understand smart grid developments and determine how to leverage smart grids to maximize the value of their services to customers.

Examples of Western Power's diligence in this regard include:

- Appointing and empowering new key staff in the smart grids area;
- Western Power's successful Smart Grid Foundation Program as part of Perth Solar City;
- Liaising with Horizon Power on smart grid topics;
- Links to relevant national and international efforts including the Federal Smart Grid – Smart City trial, Smart Grids Australia, the annual National Smart Grids Forum, the Electric Power Research Institute and the annual Smart Grids Asia Summit;
- Sponsoring the Western Power chair at Curtin University;

- Commissioning smart grid-related research and consultancies including projects with Verdant Vision and Curtin University;
- Active participation and sponsorship in relevant local events such as the 2009 Curtin Smart Grid Forum and the 2011 Innovative Smart Grid Technologies Conference.

Western Power has clearly committed itself to realizing the maximum potential of smart grids in WA and is well-qualified to make this proposal to commence its smart grid rollout during AA3.

A Smart Proposal

We have reviewed the Western Power Smart Grid Proposal and believe it provides a balanced and measured plan to initiate the smart grid deployment during AA3 and lay a foundation for system-wide deployment during AA4. This will allow Western Power to refine its smart grid services with a targeted group of customers in a full commercial setting during AA3 to ensure the full value can be realized for all customers during AA4 and beyond.

High-value components and key insights of the Western Power Smart Grid Proposal include:

- It leverages non-compliant and scheduled meter replacements to minimize additional costs;
- It targets high energy consumers with three-phase services for maximum impact;
- The constrained rather than accelerated rollout provides an appropriate balance between upfront costs vs. future benefits and network risks vs. return, especially given the rapid evolution of energy use patterns, technologies in the network and customer attitudes and behaviors at the present time;
- To achieve greatest efficiencies and benefits realization, it recognizes the need for:
    - parallel rollout of both communications/systems infrastructure and smart meters
    - smart grid rollout supported by education and behavioral change programs

It is also pertinent for us to note that, although Western Power has previously been a client of ours, we are not currently in any commercial relationship with Western Power. Our company prides itself on independent expertise and our support for this proposal is based on its merits alone.

Based on all of the above, we encourage the Economic Regulation Authority to consider the Western Power Smart Grid Proposal favorably. While we have not considered the full extent of Western Power's proposed revisions to its access arrangement, we are convinced that the smart grid elements of the broader proposal are worthy of approval.

Thank you for your consideration of our submission. Please do not hesitate to contact me by phone at 0424 016 248 or by email at andrew@verdantvisiongroup.com if you require further information.

Sincerely,

Dr Andrew Simpson
Managing Director, Verdant Vision
Adjunct Research Fellow, Curtin University Sustainability Policy Institute

References

[1] Western Power (2011) *Smart Grid Proposal*, submitted to the Economic Regulation Authority of Western Australia.

[2] A. Simpson (2010) *Electric Vehicles – a "silver bullet"?,* presented to the WA Strategic Energy Initiative Transport Forum, 30 June.

[3] Western Power (2010) *Electric Vehicle Policy Statement*.

[4] A. Simpson (2011) *An Update on the Western Australian EV Landscape*, presented to Western Power and the WA Office of Energy, 9 March.

[5] Western Power (2011) *Annual Planning Report 2011*.

[6] Western Power (2011) *Response to the AEMC Approach Paper On Market Arrangements for Electric and Natural Gas Vehicles*, submitted to the AEMC Review of Energy Market Arrangements for Electric and Natural Gas Vehicles.

Is WA ready for the electric car?

Supporting policy reform for electric vehicles

Electric Vehicles (EVs) have recently arrived on the Australian market with a significant uptake expected by 2030 if not sooner. With them comes the potential for us to revolutionise the way we travel and the way we manage our electricity networks.

To make the most of the potential of EVs, it is imperative that we get our planning right.

If we can do this, EVs will contribute significantly to the four goals of the Western Australian Government's Strategic Energy Initiative as follows:

- **Secure energy:** EVs can expand and diversify the State's transport fuel mix into abundant, indigenous, non-petroleum energy sources such as wind, solar, gas and coal.

- **Reliable energy:** In addition to diversifying the transport energy supply base, EVs can be part of a smarter network designed to manage peak loads and provide more grid ancillary services aimed at improving the stability and reliability of the energy network.

- **Competitive energy:** Electrified transport offers a significantly lower cost of operation than petroleum transport. Furthermore, EV recharging patterns can be shaped to help flatten the network demand curve and improve the utilisation of existing network assets and defer capacity expansion, thereby increasing the overall economic and energy efficiency of the network. This lowers energy costs for consumers.

- **Cleaner energy:** EVs can help eliminate motor pollution from our urban air and reduce net transport carbon emissions (even when recharged from existing baseload generation). Furthermore, EV recharging patterns can increase the overnight load to better utilise available wind resources, and decrease the use of high-emitting, fast-response generators for peak demand or contingent services. In the long term, EV batteries will also provide potential V2G (vehicle to grid) services such as exporting electricity from vehicles back to the grid during peak periods of demand (offsetting the need for further generation) and ancillary services such as frequency control. This amounts to the highly prized ability to store excess renewable energy for use when it's needed.

Central to this broad range of EV benefits is our electric power system, and EVs present enormous potential to improve the operation and efficiency of our electricity networks.

This range of network benefits will only be possible, however, if we implement a number of key policies to manage EV recharging behaviours, aggregate EVs as a potential grid resource, and progress the Smart Grid to a higher level of technological sophistication. Without at least these fundamental steps, EVs could – rather than offering a solution – become a major problem for our energy system. They could be the next wave of energy intensive appliances adding unsustainable loads to peak periods much in the way the widespread uptake of air conditioners have - only more so! Consider the effect of hundreds of thousands of drivers plugging their EVs into the grid for recharging just as they return home from work – right at the apex of the existing evening peak in electricity demand. Systems as they exist today could not accommodate this added demand and would collapse. This potential scenario of widespread blackouts or exorbitantly high levels of network investment can be avoided, however, with the right planning.

It is critical that we understand and manage the effects that EVs will have on our power system.

A significant portion (36 per cent) of the retail price of electricity relates to costs associated with the transmission and distribution of power from the generator (producer) to the customer (consumer). In Western Australia, these costs are incurred by Western Power (in the South West Interconnected System - SWIS) and Horizon Power (outside the SWIS). Unfortunately, however, the top 15 per cent of network capacity is only used less than one per cent of the time (less than three days per year). Therefore, from a networks' point of view, a key strategic objective is to flatten the demand curve to improve the utilisation of existing capacity. Flattening demand can also provide benefits to generators because of the avoided need to build specialist plant to supply electricity during peak periods of demand. Importantly, these benefits and their flow on effects are enjoyed by the whole community, not just generators and network operators, in a similar way to the wide spread improvements created by energy efficiency and conservation initiatives.

It is also critical that we understand and take advantage of the natural synergy that exists between large scale EV uptake and supplies of renewable energy.

Western Australia has committed to its share of the national renewable energy target of 20 per cent by 2020, and recently enacted measures to achieve this such as the significant expansion of wind generation in the SWIS (from five per cent to nine per cent) and the new residential net feed-in tariff scheme. While this expansion of renewable energy supply is strategically important, it will also bring higher levels of intermittent generation into the system and put increasing pressure on system management to balance supply and demand. This requires more demand-side response, more ancillary services and more grid-connected energy storage to balance the system – and EVs can potentially provide all of these. However, a networked EV charging system is necessary in order for fleets of EVs to be aggregated and controlled to provide demand-side response and ancillary services, and this control will also prove useful when EVs become capable of supplying power back into the grid. As a fringe benefit, used EVs will also provide a significant supply of second-use batteries that can be redeployed in lower-value stationary utility energy storage applications.

In order to achieve all of these potential benefits and avoid potential network disadvantages, a number of specific policy reforms are required including:

1. **Variable and cost-reflective electricity pricing:** to encourage EV recharging during off-peak periods (when power will also be cheapest).

2. **Incentives for smart recharging infrastructure:** to encourage a rollout of EV infrastructure that provides network operators with the ability to directly manage EV demand and aggregate EV network services.

3. **Increased contestability in ancillary services markets:** to allow new providers of lower-cost grid ancillary services (particularly networked EVs) to compete with traditional providers and monetize the value of those services.

4. **New regulatory frameworks for Smart Grid investments:** to allow network operators to develop a justification for Smart Grid investment that extends beyond traditional bottom-line impacts, in recognition of the Smart Grid benefits that are realised by the whole community.

A number of research institutions, car manufacturers, charging infrastructure providers and other associated service providers are steadily developing the EV industry in Australia. While this is happening it is critical that the right policy frameworks are put in place to maximise EV benefits and minimise their pitfalls. Since EVs are only just appearing in the local market, we have some time to intelligently plan for their increased uptake so that the whole community can benefit from the improved sustainability of our power system, reduced tailpipe as well as smoke stack emissions, and our reduced dependence on petroleum energy.

The organisations indicated below believe it will be crucial to implement policy reform as part of the Minister for Energy's Strategic Energy Initiative to take advantage of the energy opportunities presented by this new technology.

westernpower

EV CHARGE

EVNETWORK Electric Vehicle Network

SET Sustainable Electric Transport CRC Bid Group

western australian sustainable energy association inc

Curtin University

The University of Western Australia
Achieve International Excellence

RAC members are happier

synergy energy solutions you can use

MITSUBISHI MOTORS

CO_2Smart Pty Ltd

Curtin University of Technology

An Update on the Western Australian EV Landscape

Dr Andrew Simpson

Presentation to Western Power and WA Office of Energy – 9 March 2011

Curtin University Sustainability Policy (CUSP) Institute
PB-CUSP Alliance
www.sustainability.curtin.edu.au

http://sustainability.curtin.edu.au/renewable_transport

About CUSP's Renewable Transport Program

- Practitioners and trusted advisors in sustainability
  - Consultants to the full spectrum of EV stakeholders around Australia
  - PB-CUSP Alliance for applied research and consulting

- Expertise:
  - EV technology for private and public transport
  - EV policy barriers and opportunities, economics and market uptake
  - EV infrastructure including smart grid, renewables and vehicle-to-home/grid
  - EV lifecycle assessment including relative emissions and 2nd-use batteries

- Representation:
  - Standards Australia EV Working Group
  - Victorian EV Trial Planning Working Group
  - Queensland EV Roadmap Stakeholder Reference Group
  - Infrastructure Australia, Green Building Council, Environment Business Australia
  - Australian EV Alliance Executive Management Team

What's been happening overseas? EVs are on the market

Nissan Leaf - RRP US$32,780

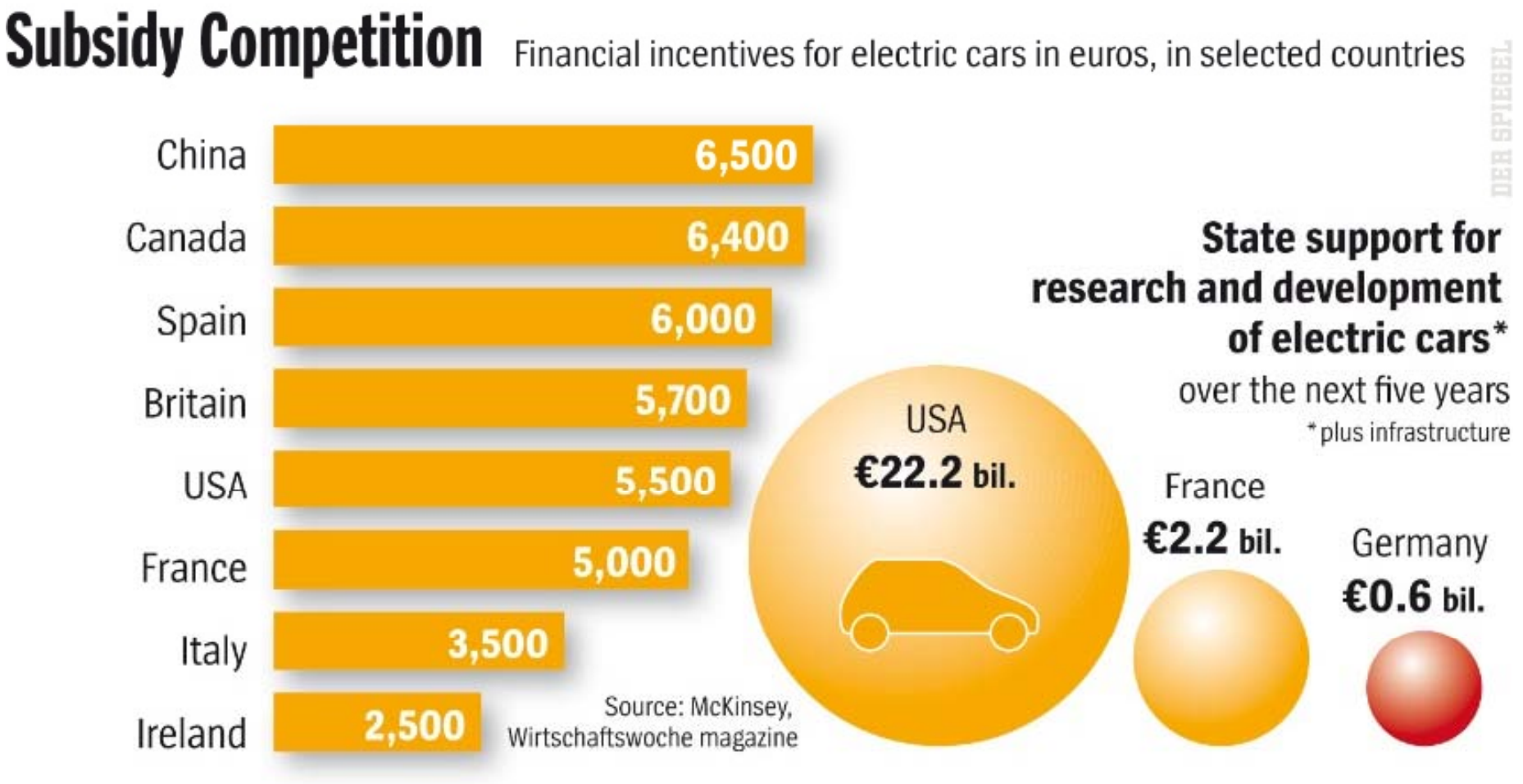
Chevy Volt - RRP US$41,000

Mitsubishi iMiEV – RRP £28,990

Renault Fluence ZE – RRP €26,300 plus battery lease

All of these prices are BEFORE government incentives

Government Investment



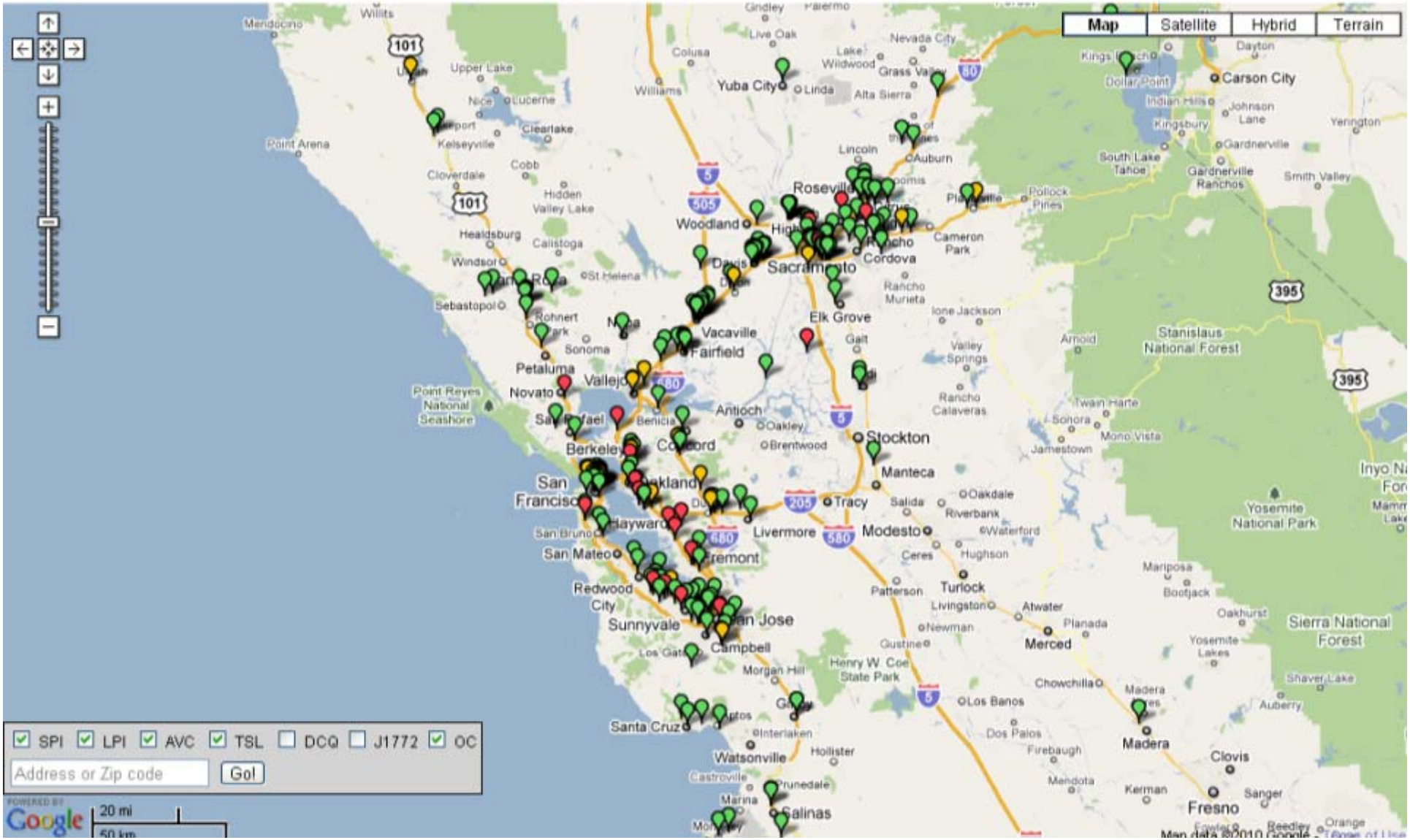
http://www.spiegel.de/international/business/bild-718867-82532.html

Infrastructure Rollout – USA

Project Get Ready Partner Cities

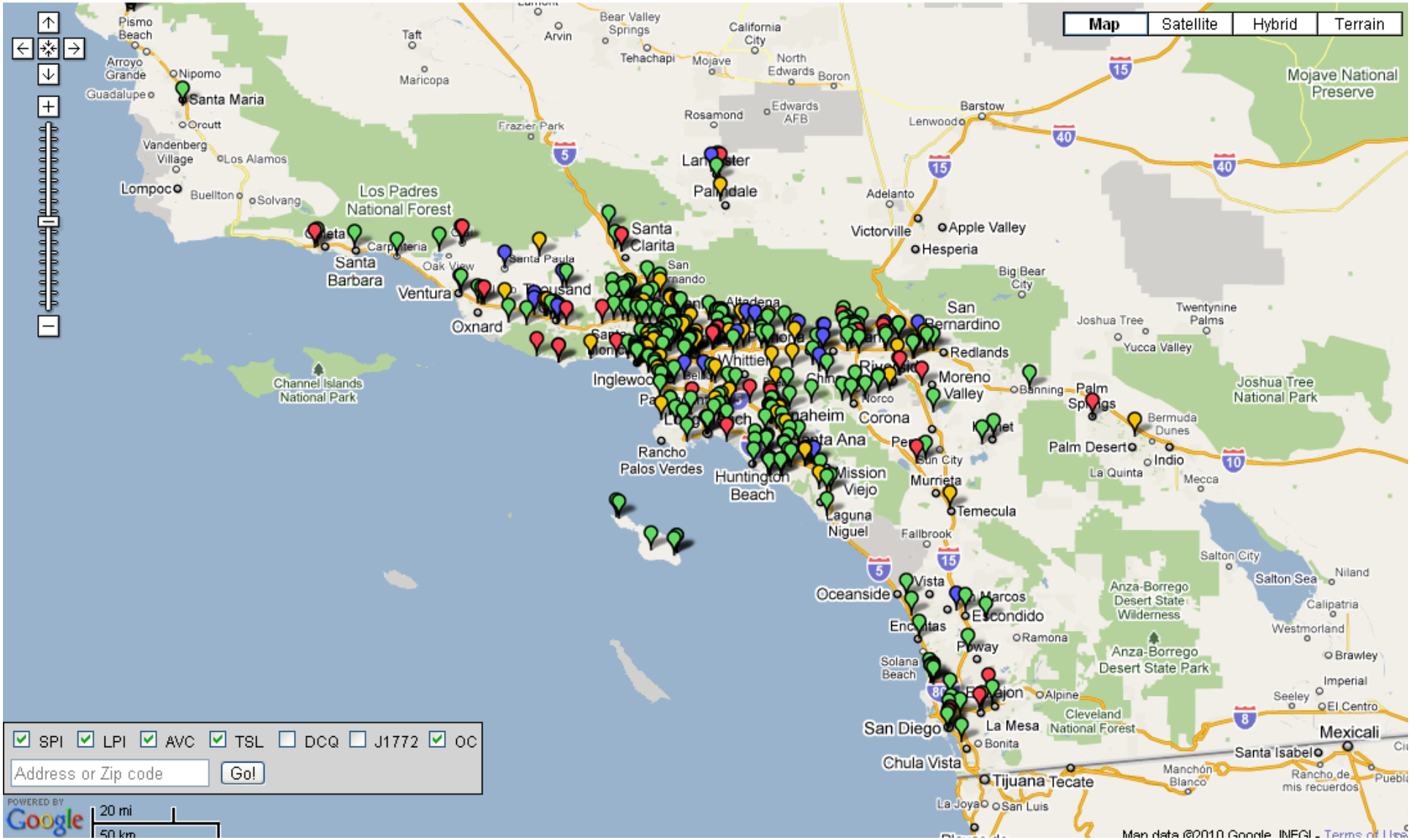
http://www.projectgetready.org

Infrastructure Rollout – Northern California



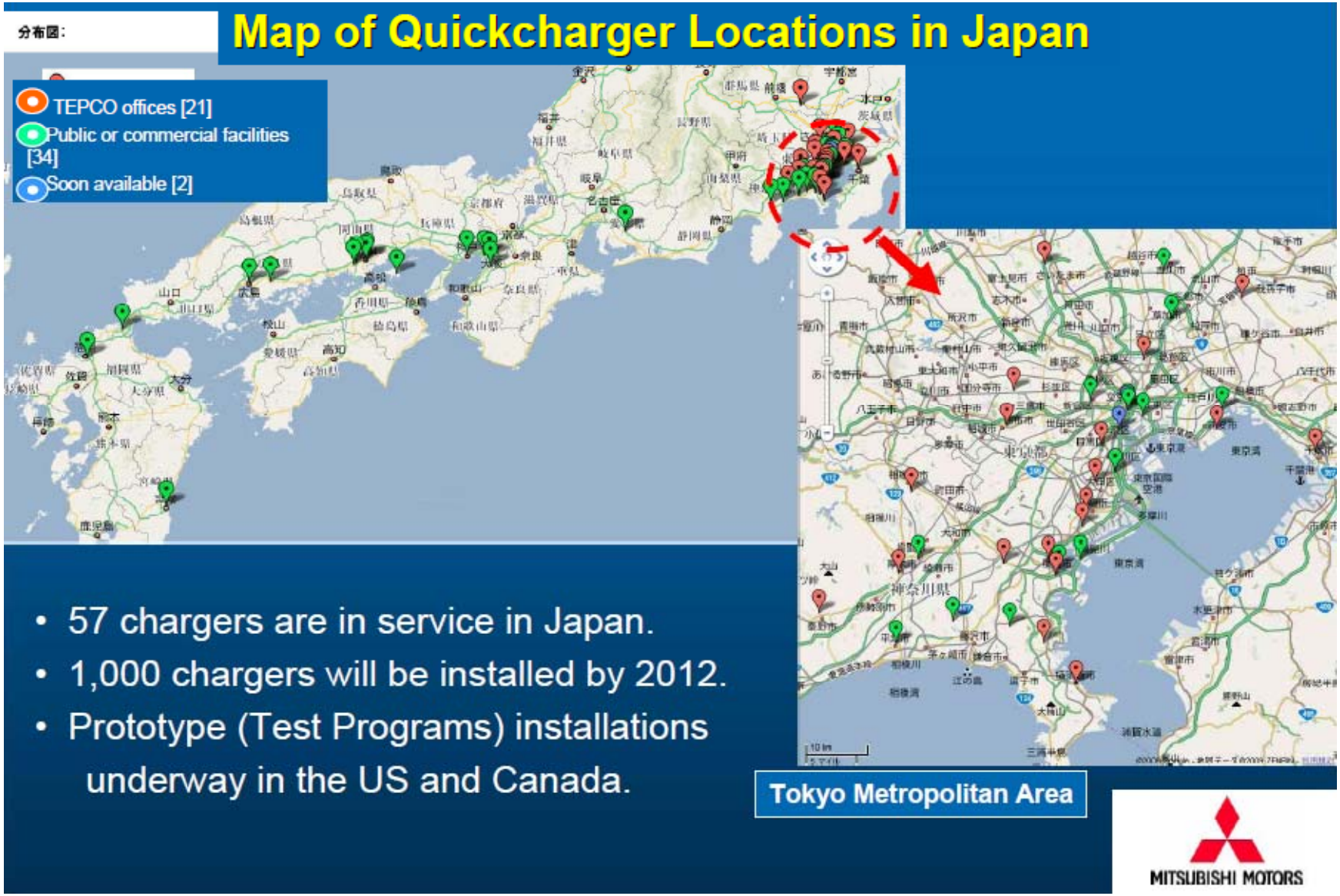
http://www.evchargermaps.com/

Infrastructure Rollout – Southern California



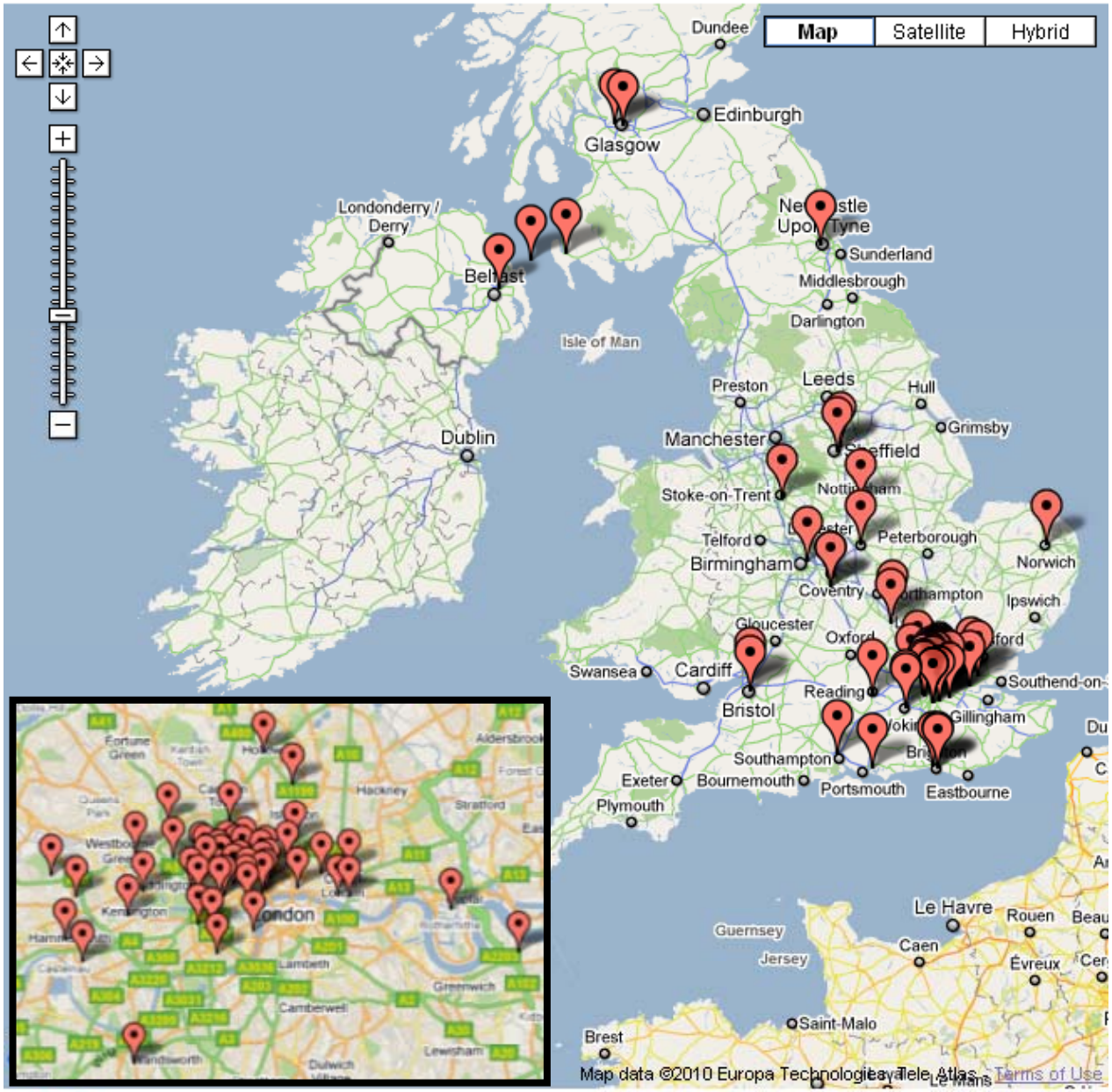
http://www.evchargermaps.com/

Infrastructure Rollout – Japan

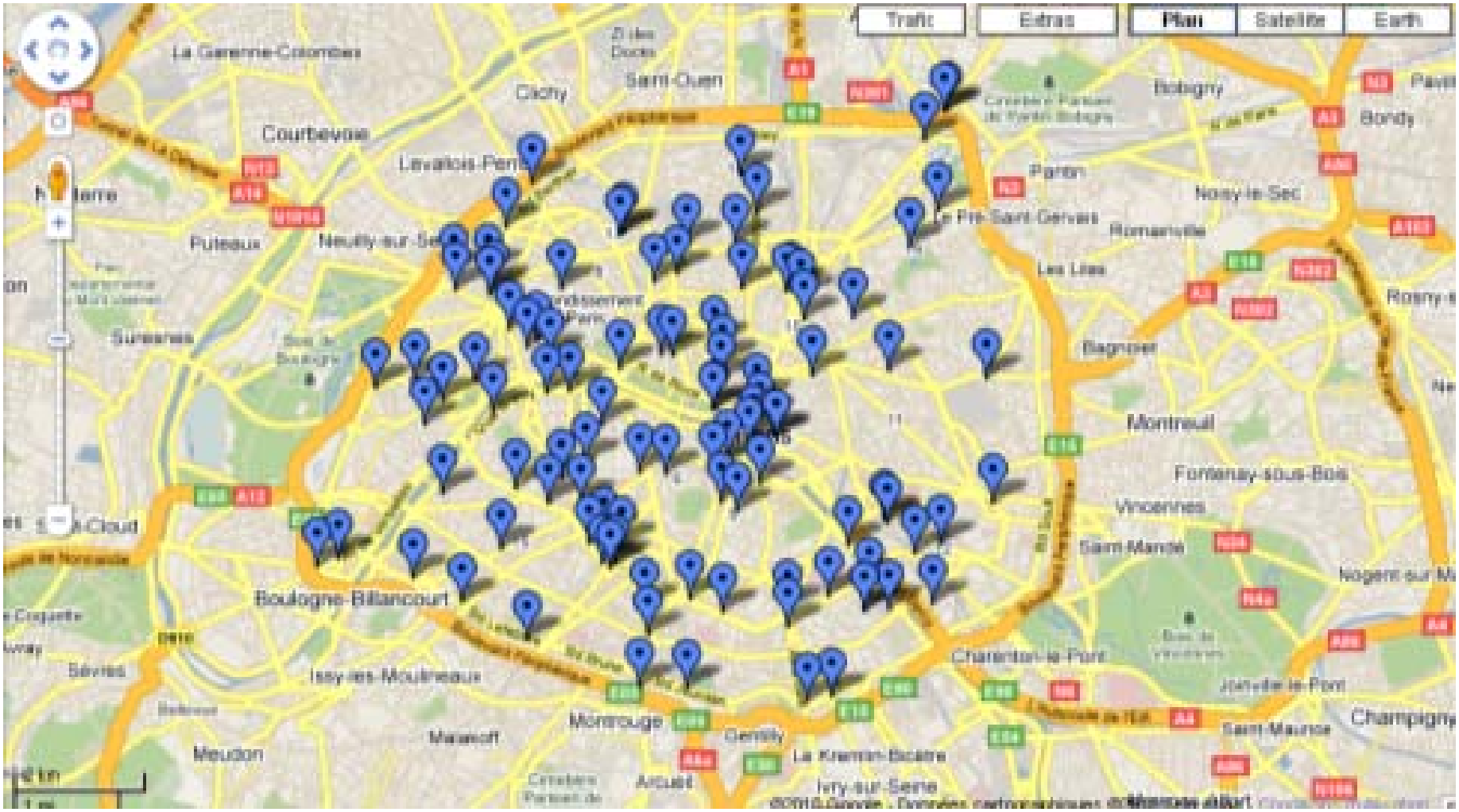


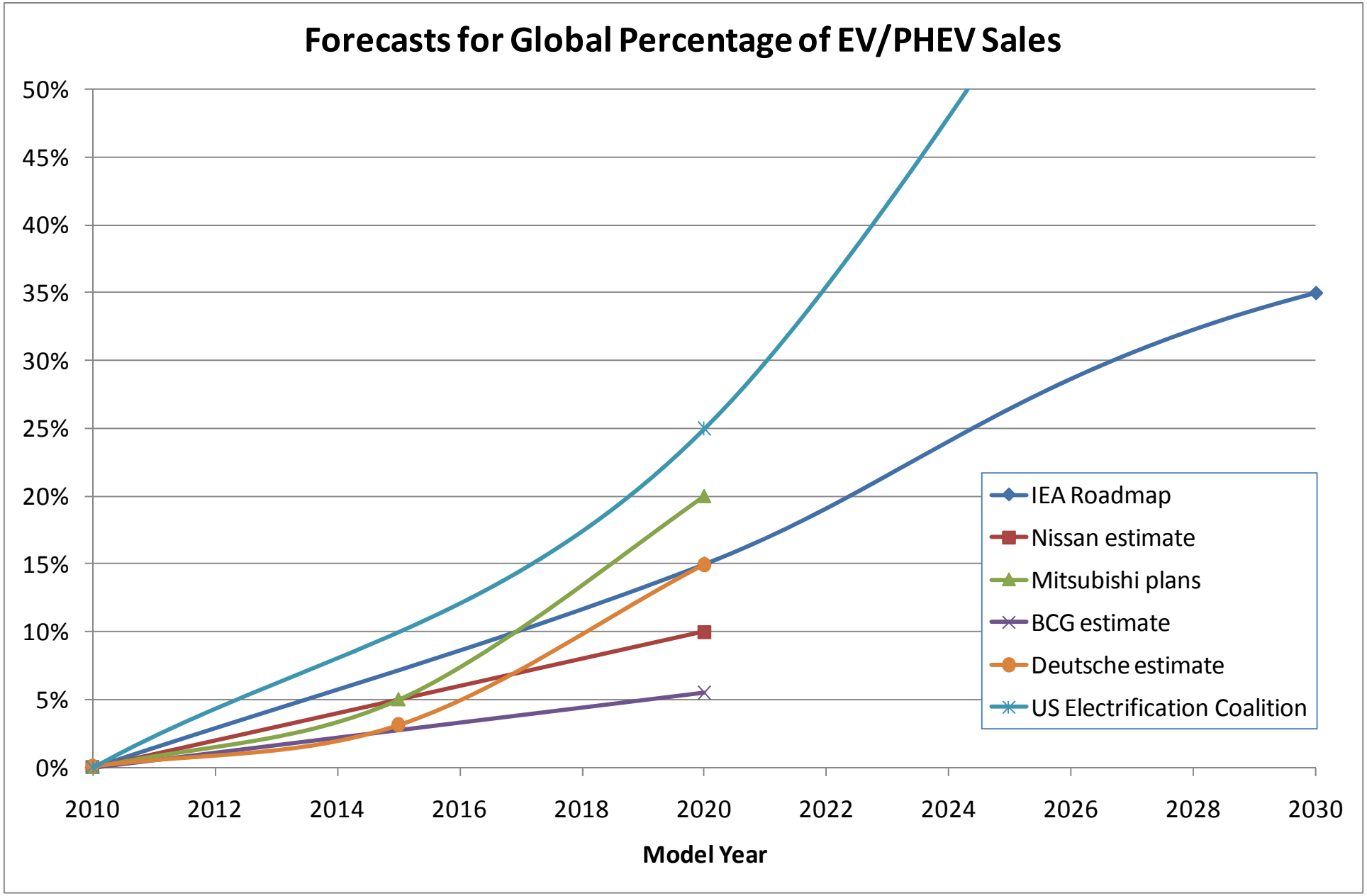
D. Patterson (2009) “First to Market”, Plug-In 2009 Conference, Long Beach.

Infrastructure Rollout – UK



Infrastructure Rollout – Paris




Forecasts for Global Percentage of EV/PHEV Sales
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
Model Year
IEA Roadmap
Nissan estimate
Mitsubishi plans
BCG estimate
Deutsche estimate
US Electrification Coalition

What's happening in Australia? EV trials

Victorian EV Trial

Western Australian EV Trial

i-MiEV Foundation Customers

Federal Smart Grid, Smart City

The litmus test is to simulate a real commercial deployment

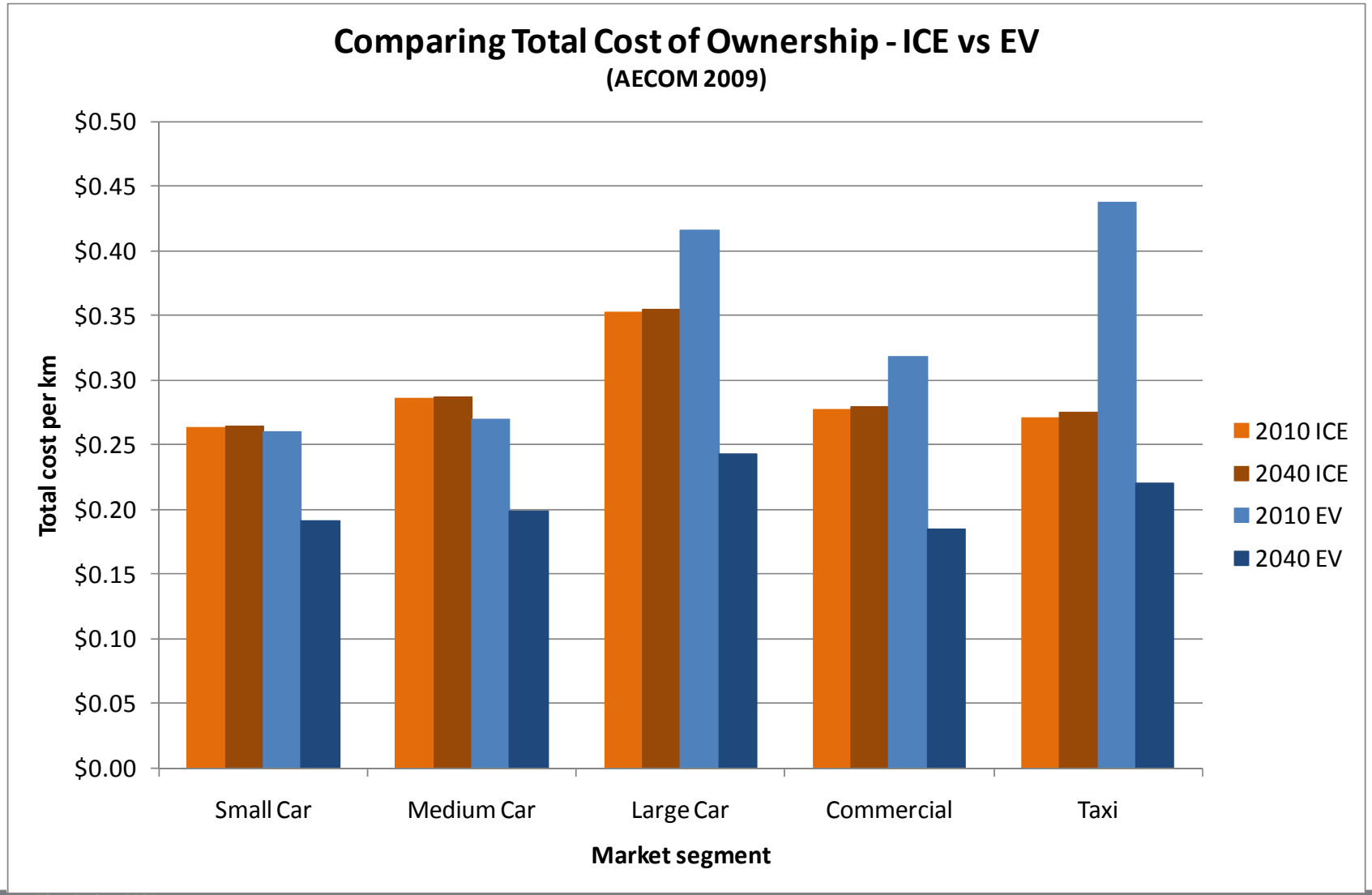
What's happening in Australia? first EV customers

Mitsubishi i-MiEV:
160km range, $1,740 p.m.

Blade Electron: 100km range,
$49,500 or $1,025p.m.

Tesla Roadster: 400km range, $206,188

What's happening in Australia? favourable EV economics



What's happening in Australia? breaking ground for EV infrastructure

Level 1 AC – Glebe NSW

Level 2 AC – West Perth WA

DC Fast Charge – Adelaide SA

Charging Level	Circuit Rating (per phase)	Power (kW per phase)	Charging Rate* (kph)	Charge Time* (mins. for 40km)
"Level 1"	AC - 240V / 15A	3.6	18	133
"Level 2"	AC - 240V / 30A	7.2	36	67
"Level 3"	DC - 500V / 125A	50	250	10

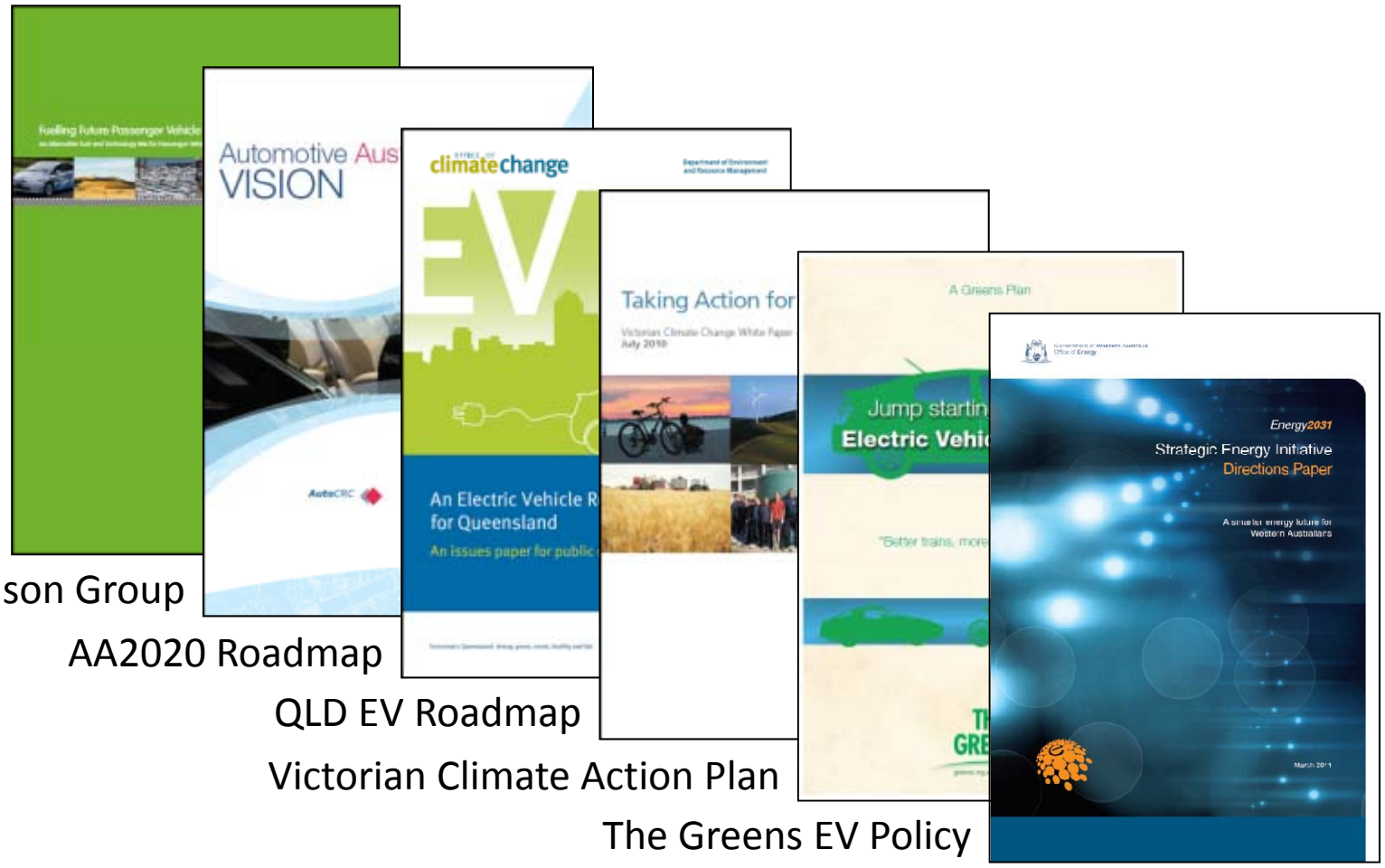
*assumes typical electric vehicle consumption of 200 Wh/km

What's happening in Australia? a vibrant EV aftermarket

EV Works' Electrokhana 2009

EV Festival Adelaide 2010

What's happening in Australia?
EV Vision Statements



Jamison Group

AA2020 Roadmap

QLD EV Roadmap

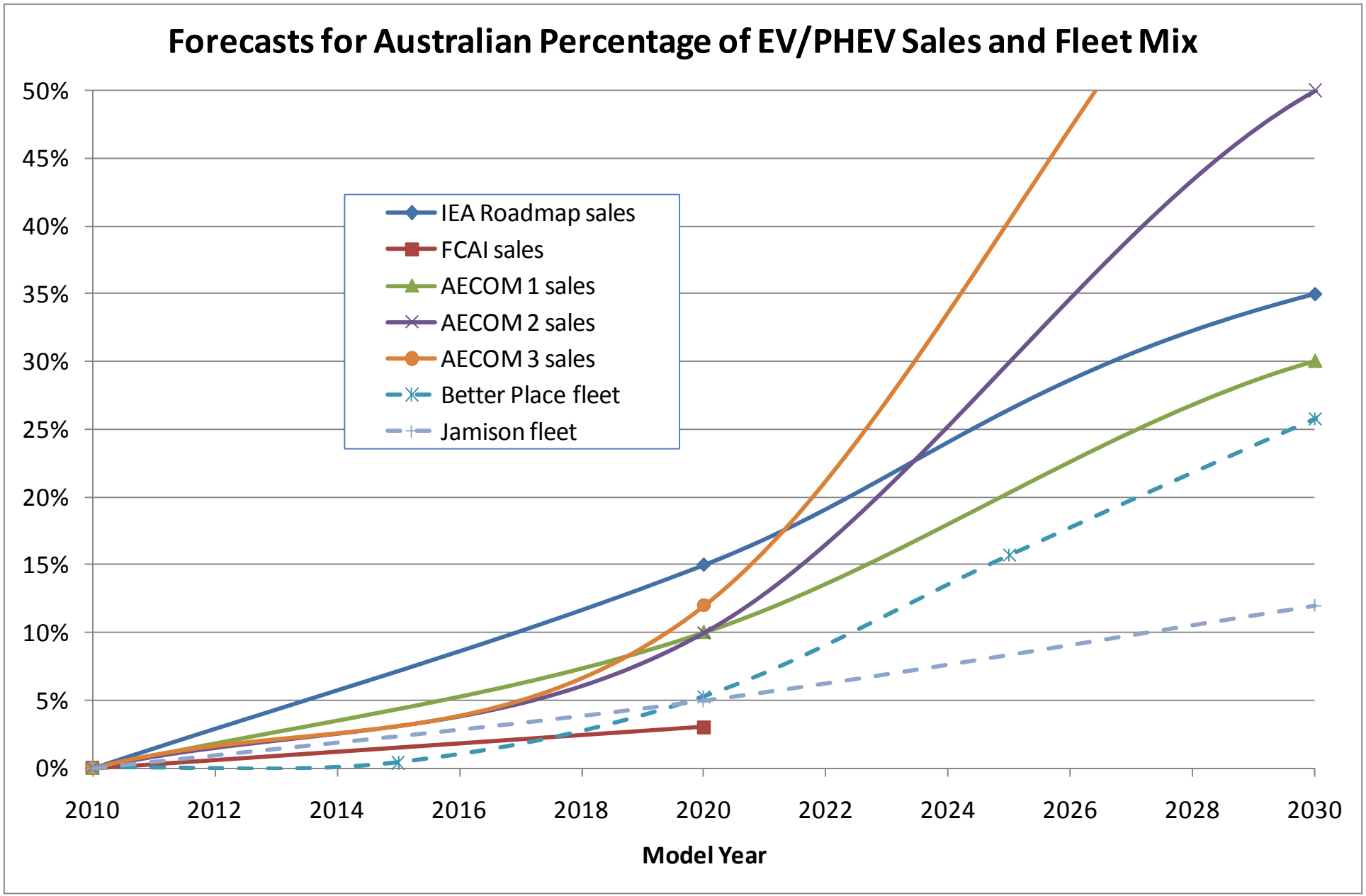
Victorian Climate Action Plan

The Greens EV Policy

WA Energy2031 Directions

What's happening in Australia? National EV Action

- Ministerial Council on Energy
  - ➔ "working to ensure Australia's energy markets and networks are ready to support the large-scale adoption of electric vehicles"
- Standards Australia EV Working Group
  - ➔ EV Standards Workplan to commence in 2011
- The Climate Group
  - ➔ EV Policy Roundtables were held in 2010 (QLD, NSW, SA)


Forecasts for Australian Percentage of EV/PHEV Sales and Fleet Mix
50%
45%
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5%
0%
2010
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2026
2028
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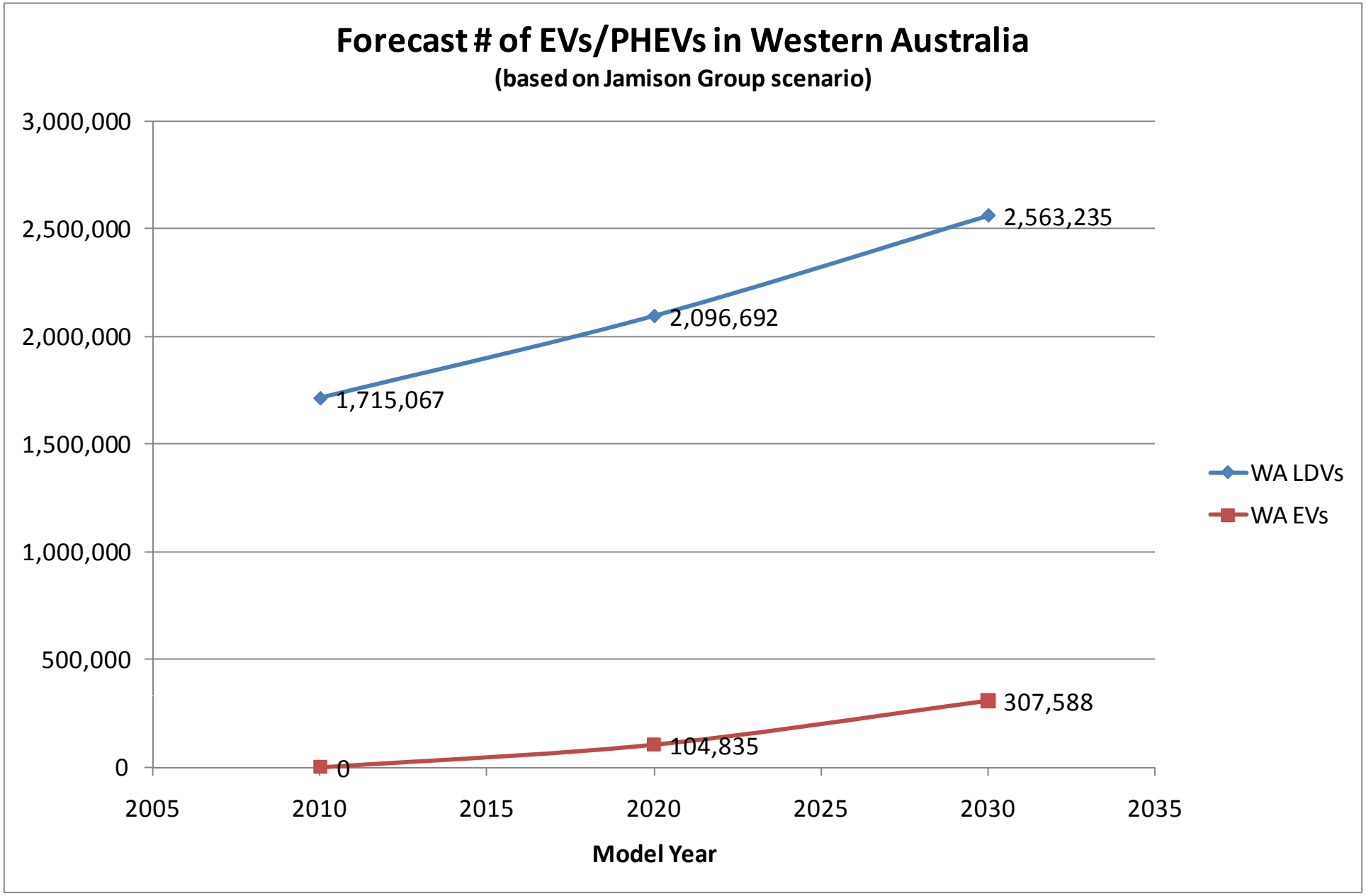
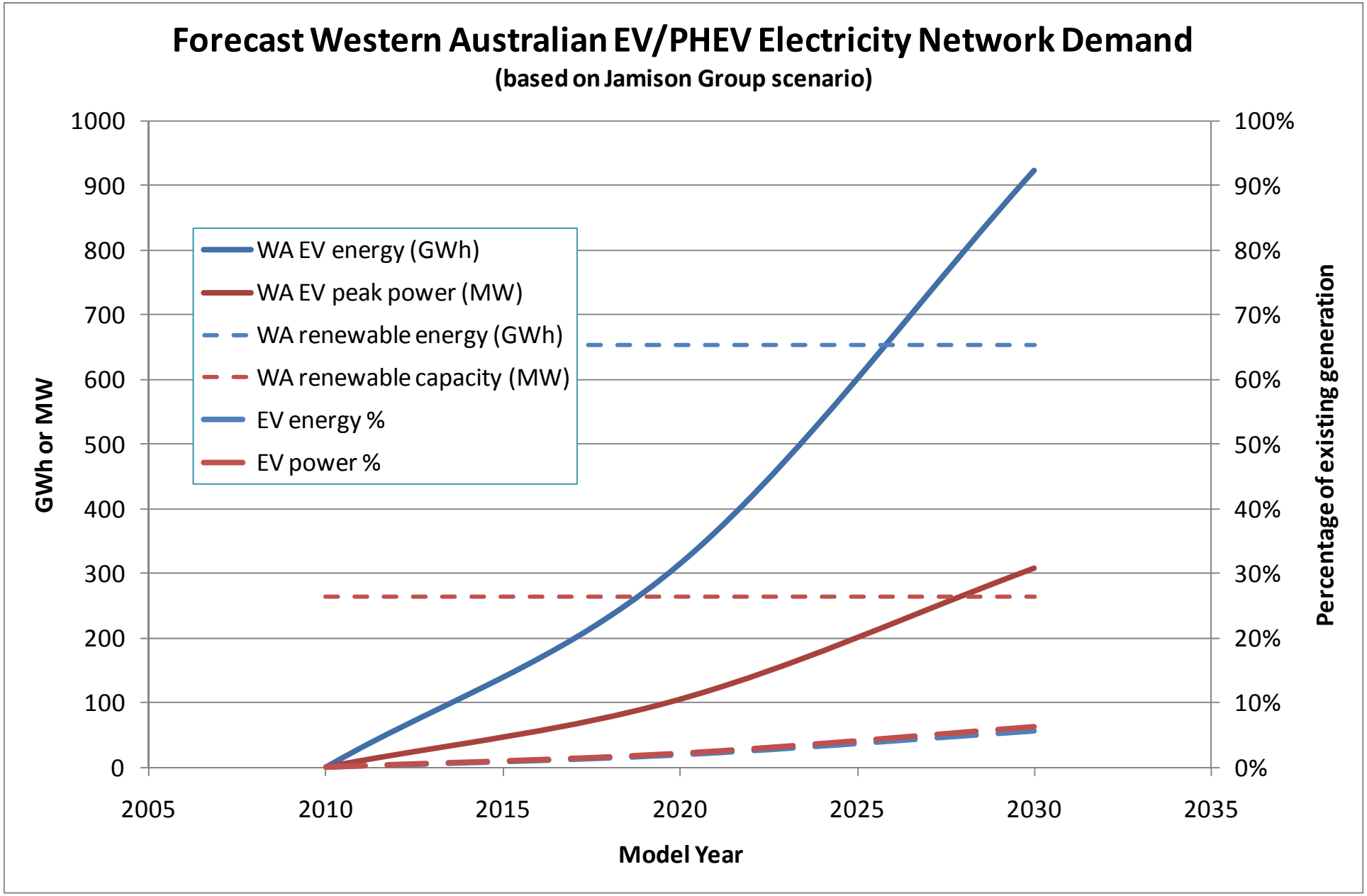
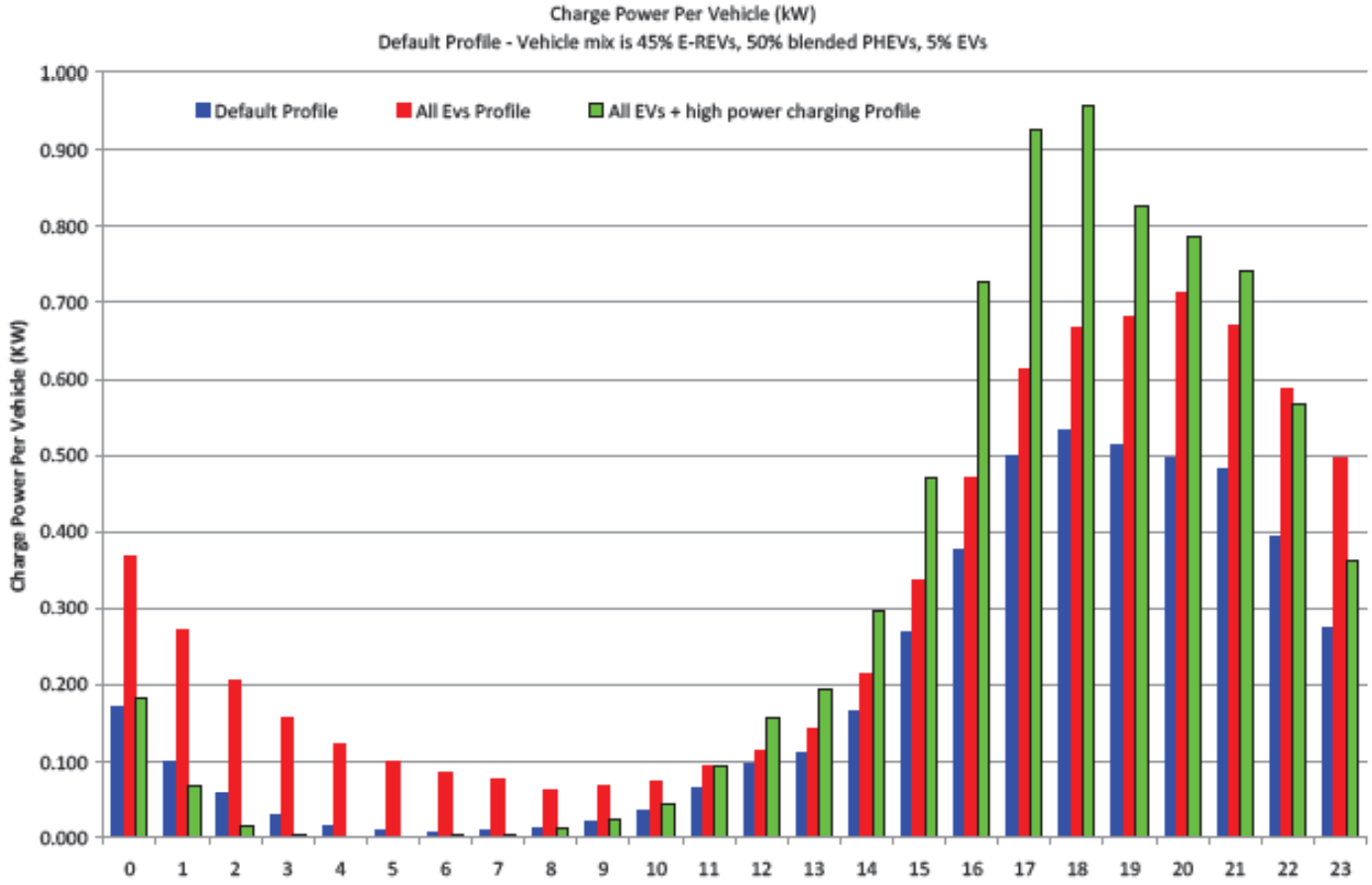
Model Year
IEA Roadmap sales
FCAI sales
AECOM 1 sales
AECOM 2 sales
AECOM 3 sales
Better Place fleet
Jamison fleet


Forecast # of EVs/PHEVs in Western Australia
(based on Jamison Group scenario)
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
2,563,235
2,096,692
1,715,067
307,588
104,835
0
2005
2010
2015
2020
2025
2030
2035
Model Year
WA LDVs
WA EVs


Forecast Western Australian EV/PHEV Electricity Network Demand
(based on Jamison Group scenario)
GWh or MW
Percentage of existing generation
Model Year
WA EV energy (GWh)
WA EV peak power (MW)
WA renewable energy (GWh)
WA renewable capacity (MW)
EV energy %
EV power %
1000
900
800
700
600
500
400
300
200
100
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2005
2010
2015
2020
2025
2030
2035

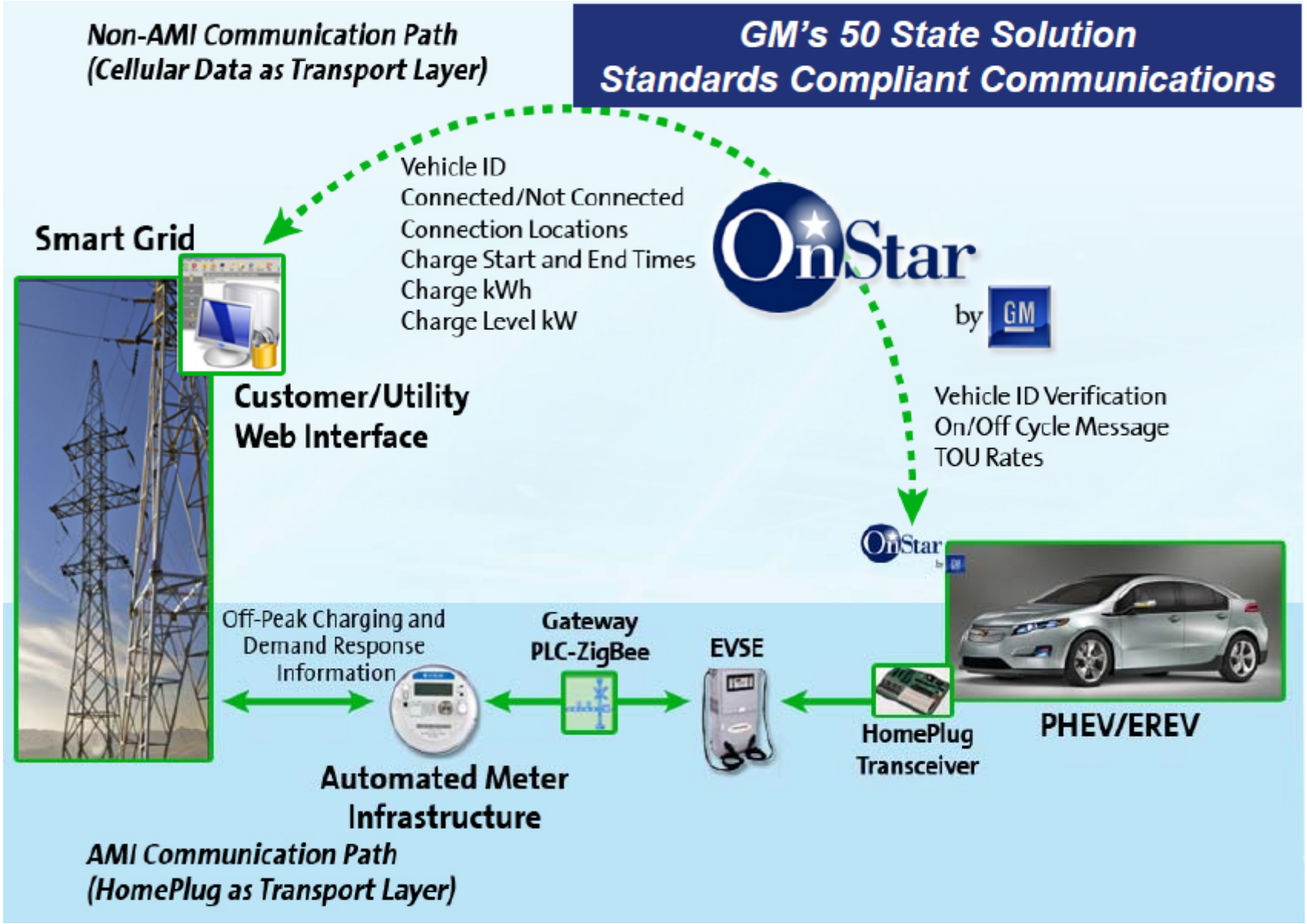
Power Demand for Uncontrolled Charging

- Default Profile:
  - 50% 1.44kW 120V
  - 20% 3.3kW 240V
  - 30% 6.6kW 240V
- This is closer to what would be expected in the near-term
- The peak load occurs at around 5-7, around 500W per vehicle, and lasts longer into the evening.
- If all the Vehicles are EV:
  - The peak load still occurs at around 5-7, but is about 700W per vehicle



A. Maitra (2009) “Effects of transportation electrification on the electricity grid”, Plug-In 2009 Conference, Long Beach.

Smart Grids and EVs



Smart Grids and EVs

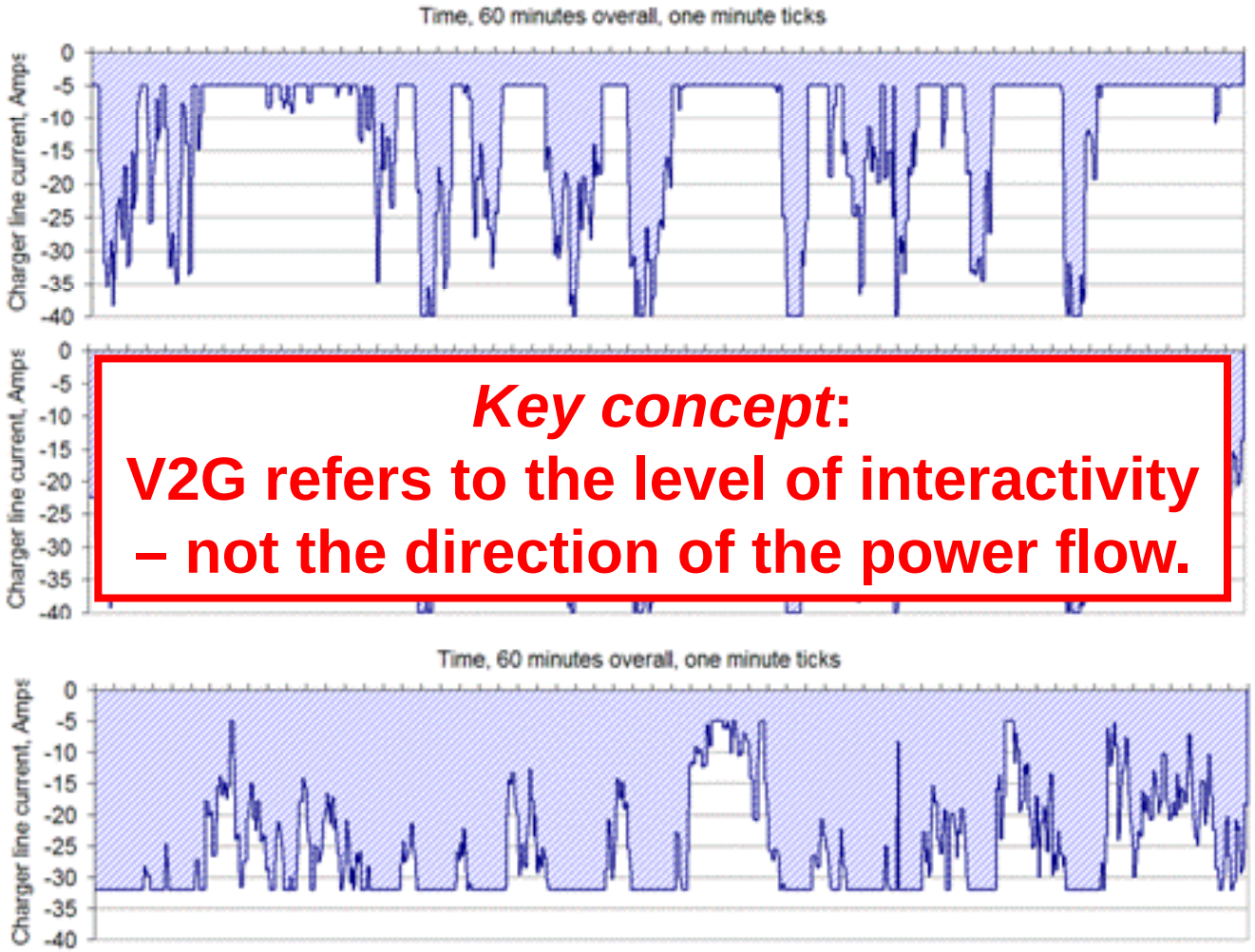
Coulomb Technologies

http://www.coulombtech.com

Smart Grids and EVs

B. McBeth (2010) "From concept to realization: customer centric e-mobility solutions", Plug-In 2010 Conference, San Jose.

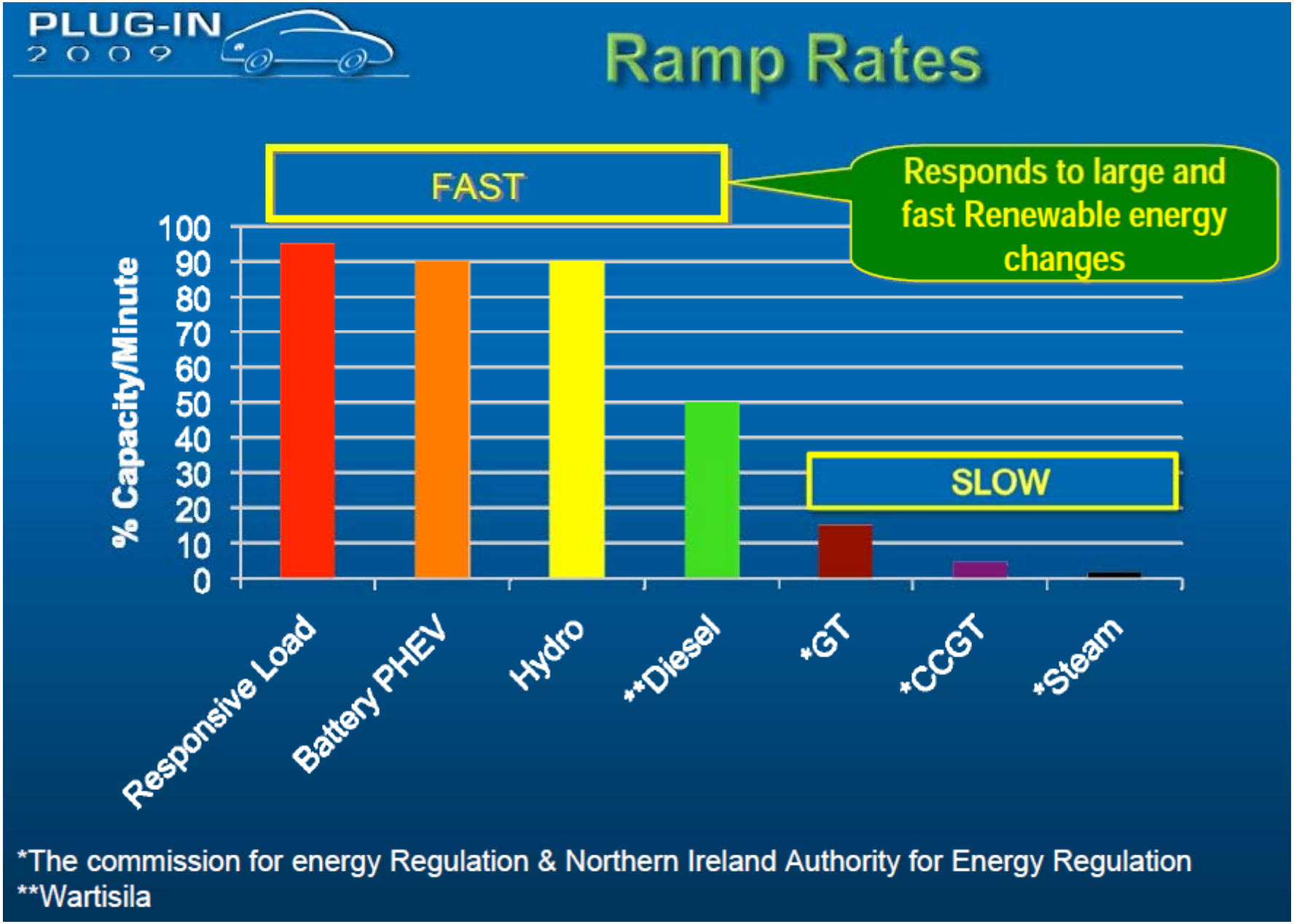
Smart Grids and EVs: V2G Ancillary Services



***Key concept*:**
V2G refers to the level of interactivity – not the direction of the power flow.

Smart charging of a Tesla Roadster to provide V2G ancillary services

Brooks and Thesen (2007) "PG&E and Tesla Motors: Vehicle to Grid Demonstration and Evaluation Program", Proc. EVS-23.



W. James (2009) "Plug-ins and the Grid in Australia", Plug-In 2009 Conference, Long Beach.

Smart Grids and EVs: Enabling Renewables

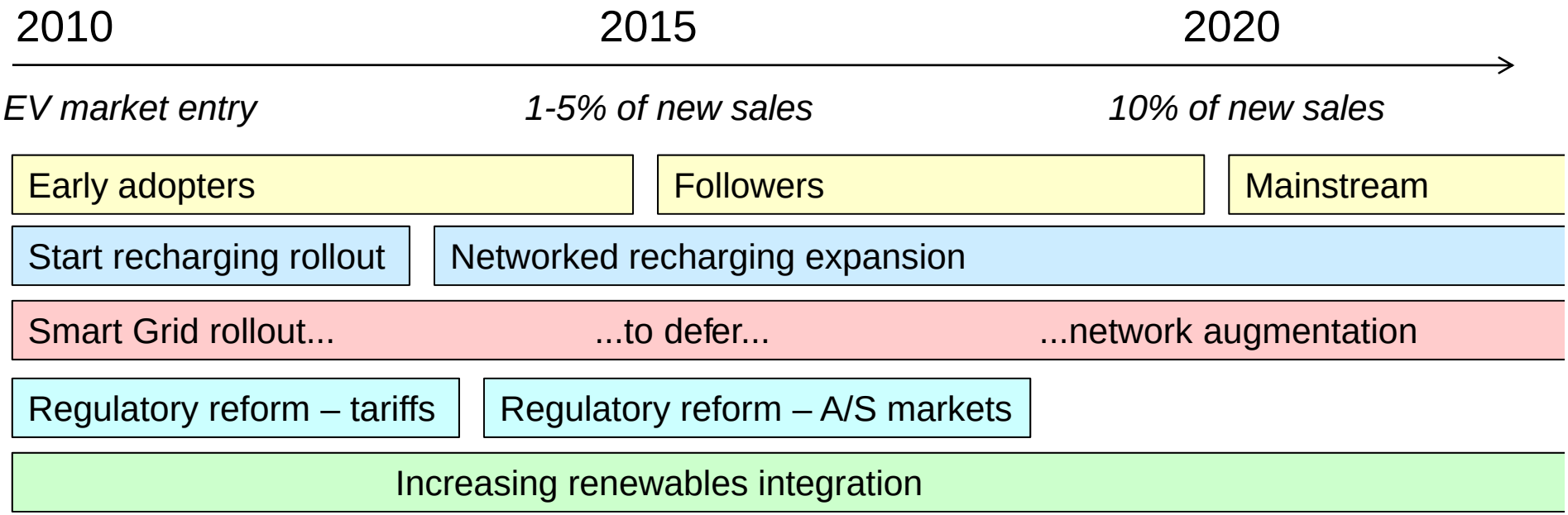
1MW turbine powers 1000 EVs

V2G enables 15 x 1MW turbines

A. Simpson (2009) “Environmental Attributes of Electric Vehicles in Australia”, CUSP discussion paper, Fremantle.

Enabling Renewables: Solar Recharging

A Strategic Plan for EV Energy Infrastructure



In order to achieve all of these potential benefits and avoid potential network disadvantages, a number of specific policy reforms are required including:

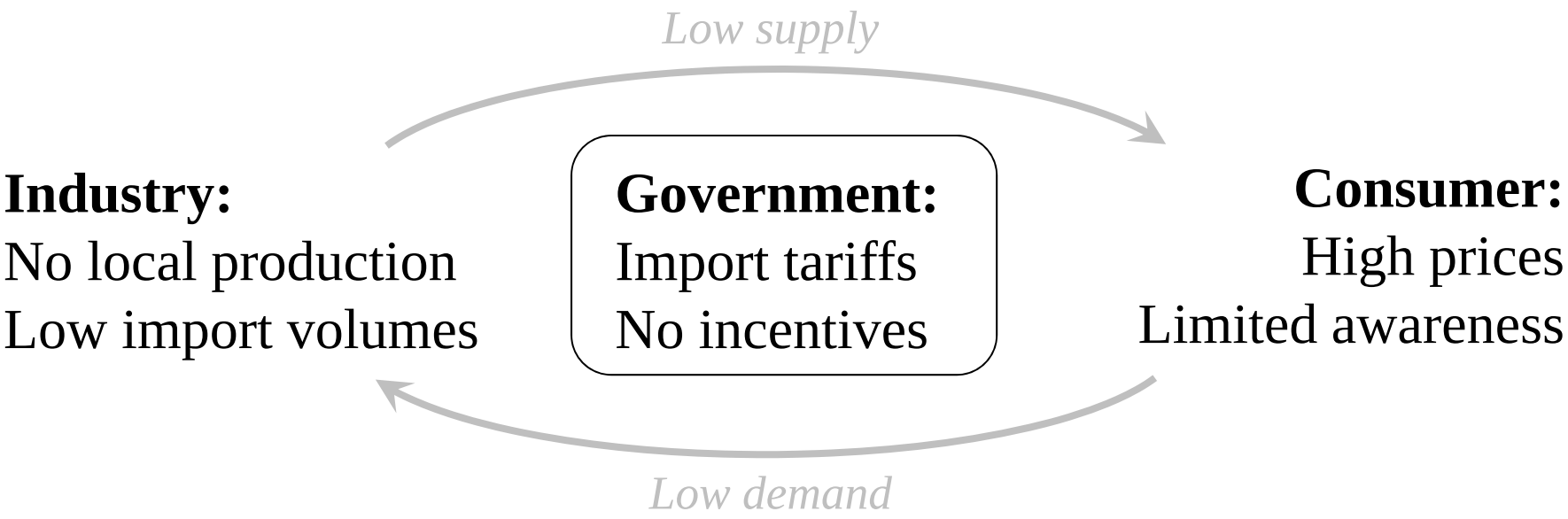
1. **Variable and cost-reflective electricity pricing:** to encourage EV recharging during off-peak periods (when power will also be cheapest).

2. **Incentives for smart recharging infrastructure:** to encourage a rollout of EV infrastructure that provides network operators with the ability to directly manage EV demand and aggregate EV network services.

3. **Increased contestability in ancillary services markets:** to allow new providers of lower-cost grid ancillary services (particularly networked EVs) to compete with traditional providers and monetize the value of those services.

4. **New regulatory frameworks for Smart Grid investments:** to allow network operators to develop a justification for Smart Grid investment that extends beyond traditional bottom-line impacts, in recognition of the Smart Grid benefits that are realised by the whole community.

What else needs to happen in Australia? EV incentives, availability, affordability and marketplace experience



i-MiEV in Oz market:
AU$62,600 equiv.
(no incentives)

i-MiEV in UK market:
AU$38,600
(with government incentives)

What else needs to happen in Australia? Local EV industry development

- Green Car Innovation Fund grants awarded:
  - $35M for Toyota to produce the Camry Hybrid in Australia
  - $149M for Holden to produce the four-cylinder Cruze in Australia
  - $42M for Ford to fit the EcoBoost engine technology to the Falcon
  - $0.4M for Orbital to develop direct-injection technology for China
  - $2.4M for SMR Automotive Australia to develop environmentally friendly mirrors
  - $1.0M for Century Yuasa to develop an advanced lead-acid starter battery
  - $63M for Toyota to produce its next-generation, four-cylinder engine in Altona
  - $3.5M for EV Engineering to complete 7 electric Commodore conversions

Program has just been scrapped

What else needs to happen in Australia?
Infrastructure planning and rollout

Our EV infrastructure providers need EVs to support!
How does EV infrastructure fit into the broader urban plan?

What still needs to happen in Australia? EV Standards

Standards Australia EV Workplan Priorities as of Oct 2010:

1. EV Vocabulary
2. Electrical safety
3. Aftermarket conversions
4. Recharging infrastructure
5. Labelling of EVs
6. Rescue and recovery
7. Battery safety and handling

Note that EV range/efficiency have been handled by new ADRs

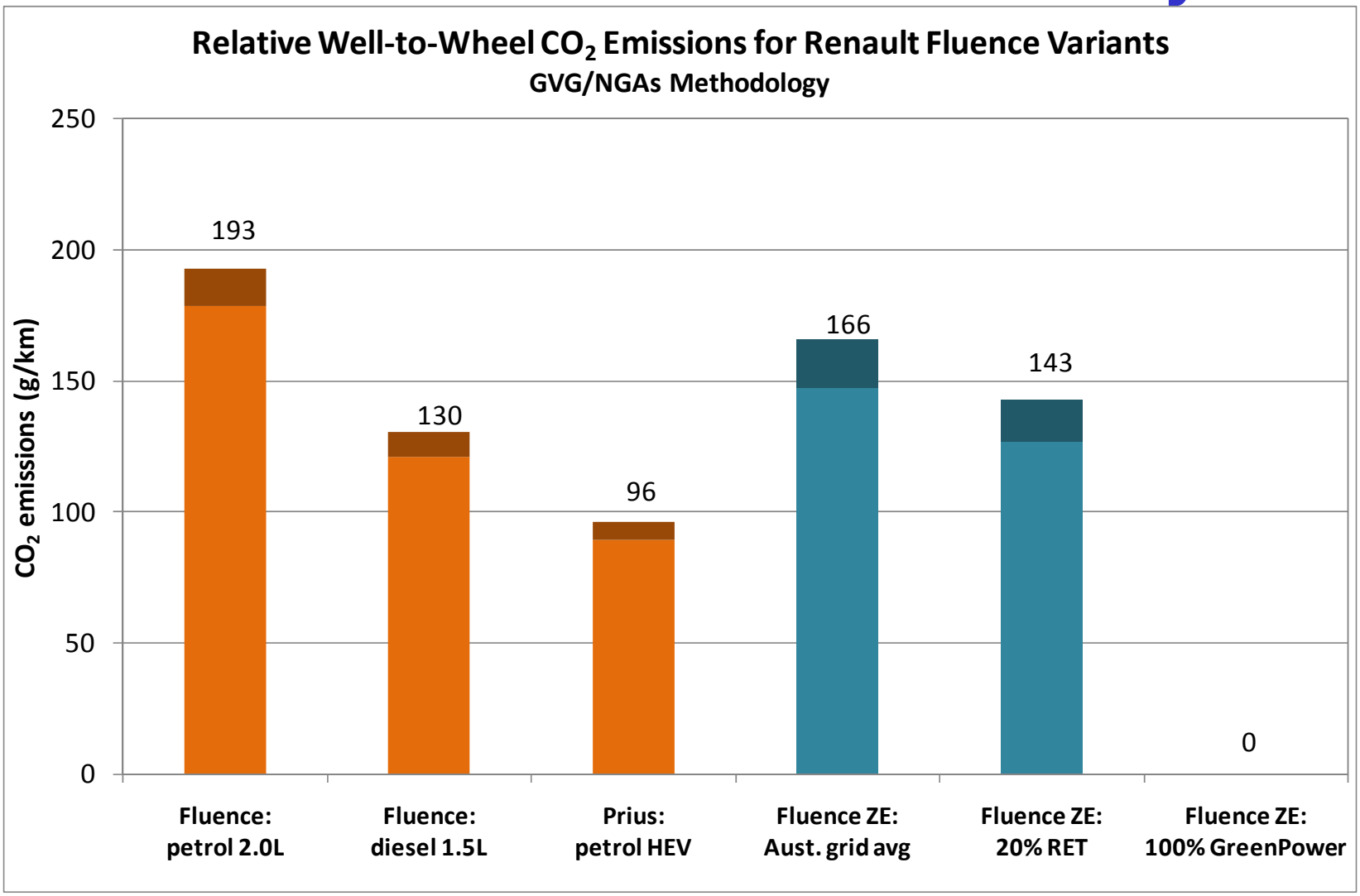
This work was supposed to commence in Feb 2011, but hasn't started yet.

What still needs to happen in Australia?
EV interoperability

Plug End Pinout					
Description	Standard 10A mains plug for double insulated appliances.	Standard 10A mains plug	10A mains plug with round earth pin	Standard 15A mains plug	Standard 20A mains plug.

Take your pick...

What still needs to happen in Australia? Bust the relative EV emissions myth!



http://sustainability.curtin.edu.au/local/docs/0907_Environmental_Attributes_EVs_Australia.pdf

What still needs to happen in Australia? Federal Ownership and National Vision

http://www.environment.gov.au/atmosphere/fuelquality/emerging/alternative/index.html

Electricity has not been recognised as a viable alternative road transport fuel!

What still needs to happen in Australia? Federal Ownership and National Vision

Responsibility for EVs in Australia is split across Federal Ministries:

- Minister for Resources and Energy
- Minister for Innovation, Industry, Science and Research
- Minister for Infrastructure and Transport
- Minister for Broadband, Communications and the Digital Economy
- Minister for Climate Change and Energy Efficiency
- Minister for Sustainability, Environment, Water, Population and Communities

There is no Federal "owner" responsible for Australia's EV adoption.
Because there is no owner, there is no plan.

Things to watch out for in 2011

- First marketplace reactions to state-of-the-art EVs and infrastructure
- Early EV trial results
- More EV product and pricing announcements
- More local industry development
- Expanded infrastructure rollout
- State and Federal EV policies?
- A National EV Alliance to help coordinate Australia's EV adoption

Important Quotes for EVs in Australia

"Australia needs to be prepared to face the changes arising from increased use of electric vehicles and, indeed, profit from them."

The Jamison Group, 2010

"At this stage we will only make EVs available to cities that have city charging infrastructure, service training and financial incentives plans in the pipeline."

Mark Perry, Nissan Motor Company, 2009

"To make Victoria an EV-friendly place"

Victorian EV Trial Objective, 2010

"If you build it, [they] will come."

Field of Dreams, Universal Studios, 1989

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Sustainability Policy Institute

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http://sustainability.curtin.edu.au/renewable_transport

Curtin University of Technology

Electric Vehicles – a "silver bullet"?

The 2011 Nissan Leaf US$33,000

Dr Andrew Simpson – 30 June 2010

WA Strategic Energy Initiative Transport Forum

Curtin University Sustainability Policy (CUSP) Institute
PB-CUSP Alliance
www.sustainability.curtin.edu.au

Jamison Group Report (NRMA) 2010

Part 1: An alternative fuel and technology mix for Australia – a comprehensive holistic approach is required:

1. *Travel demand management and mode shift*
2. *More-efficient petroleum vehicles*
3. *Biofuels*
4. *Gaseous fuels*
5. *Electric vehicles*

***Part 2: "The Electric Vehicles Revolution**, so titled as to reflect the Jamison Group's view that rapid changes in this direction are about to dominate the future of the motor car."*

Mass-Production Electric Vehicles


Chevy Volt


Renault Fluence EV

Mitsubishi iMiEV


Toyota Prius PHEV


Smart ed


Nissan Leaf


Mini E


Tesla Roadster


Toyota FT-EV


Ford Focus EV


Mercedes Bluezero EV

Th!nk City


Coda Automotive


Fisker Karma


Vauxhall Trixx


BYD E6


Chery S18

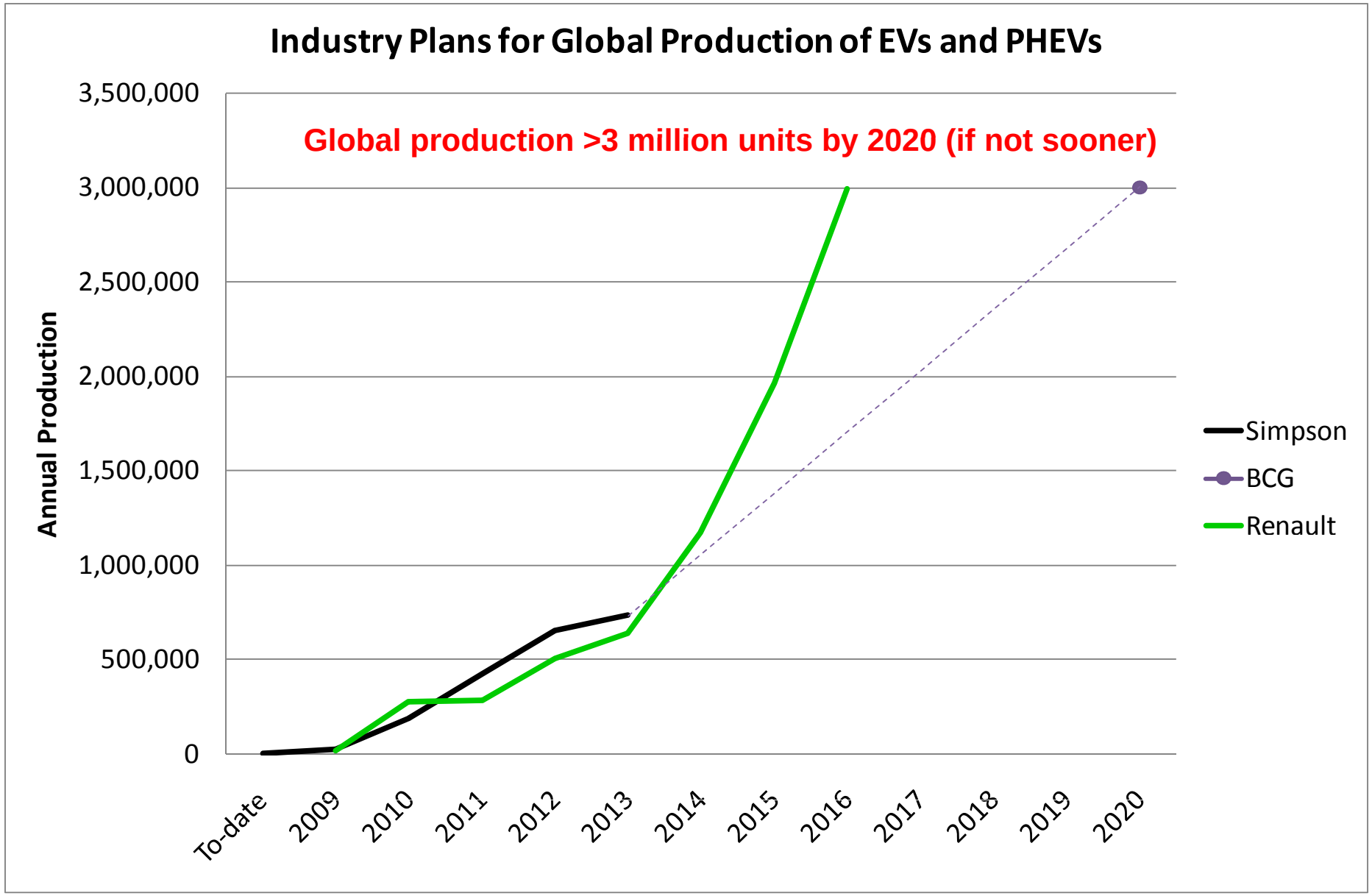

Detroit Electric


Dodge Circuit

Subaru Stella

Mass-Production Electric Vehicles

EV Production Ramp



Networked EV Infrastructure

JARI QuickCharger

Coulomb/Charge Point

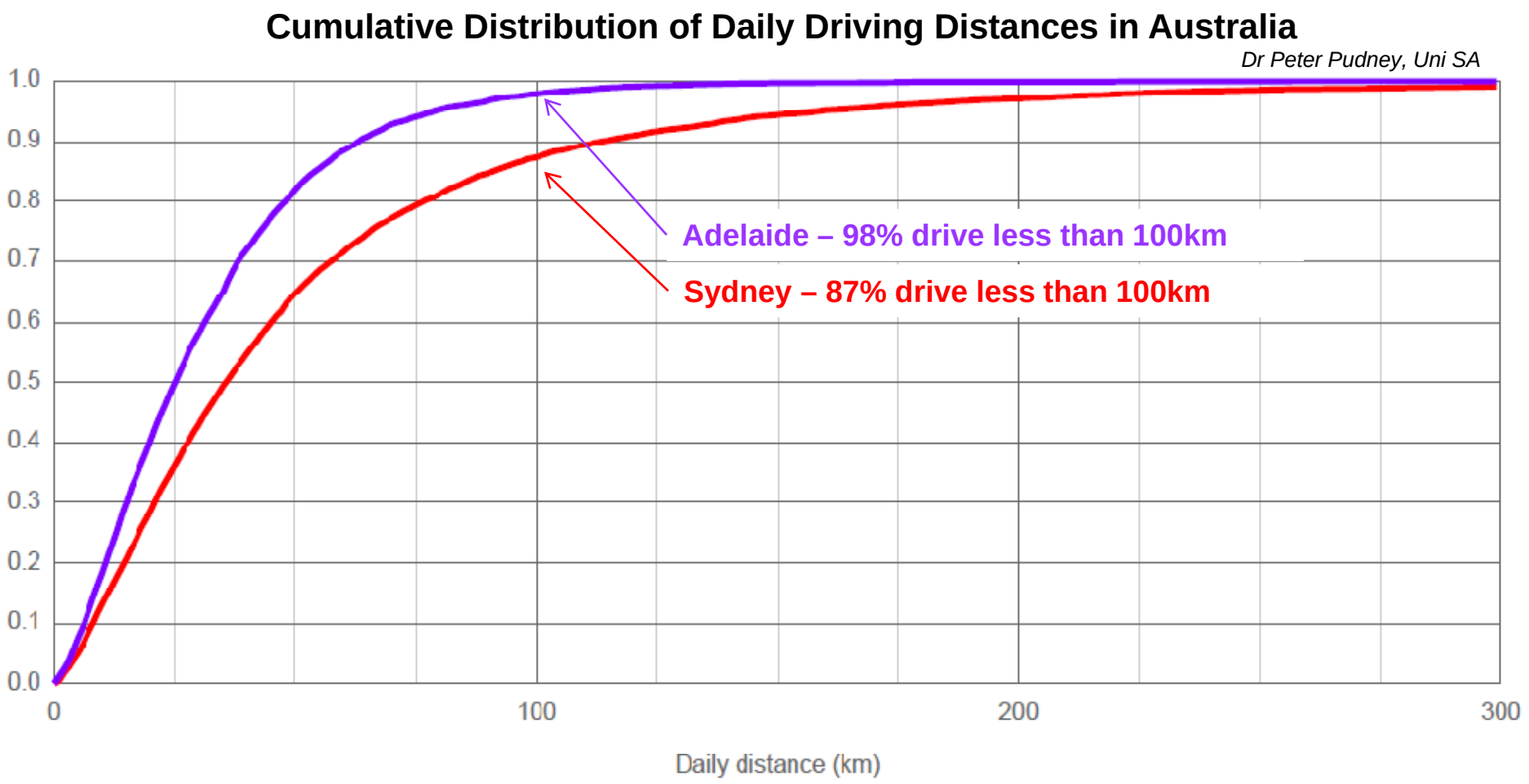
Better Place

ECOtality/eTec

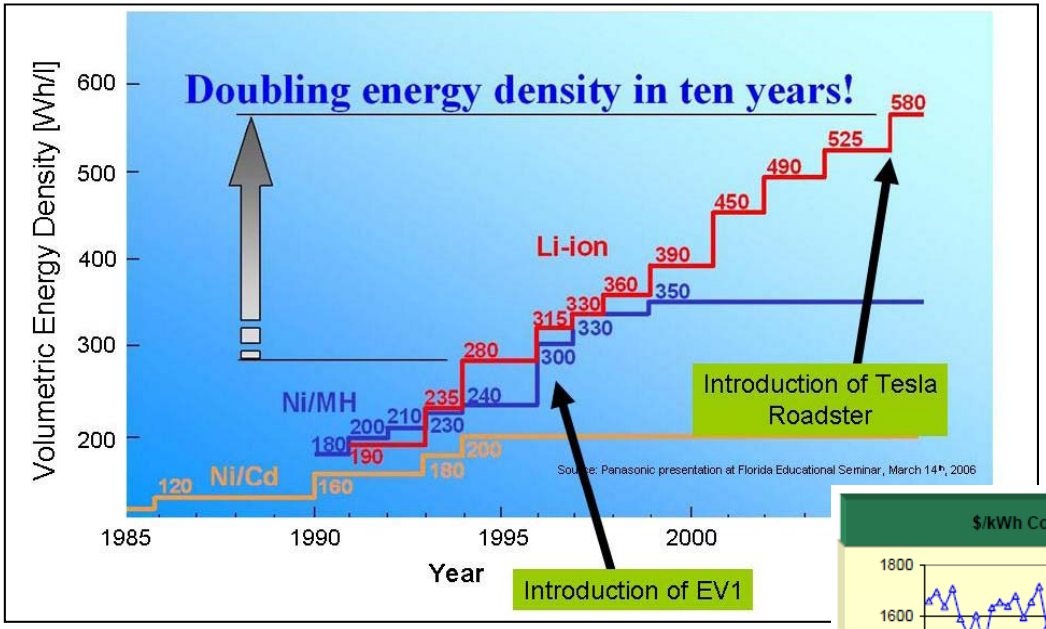
Toyota Industries

Elektromotive

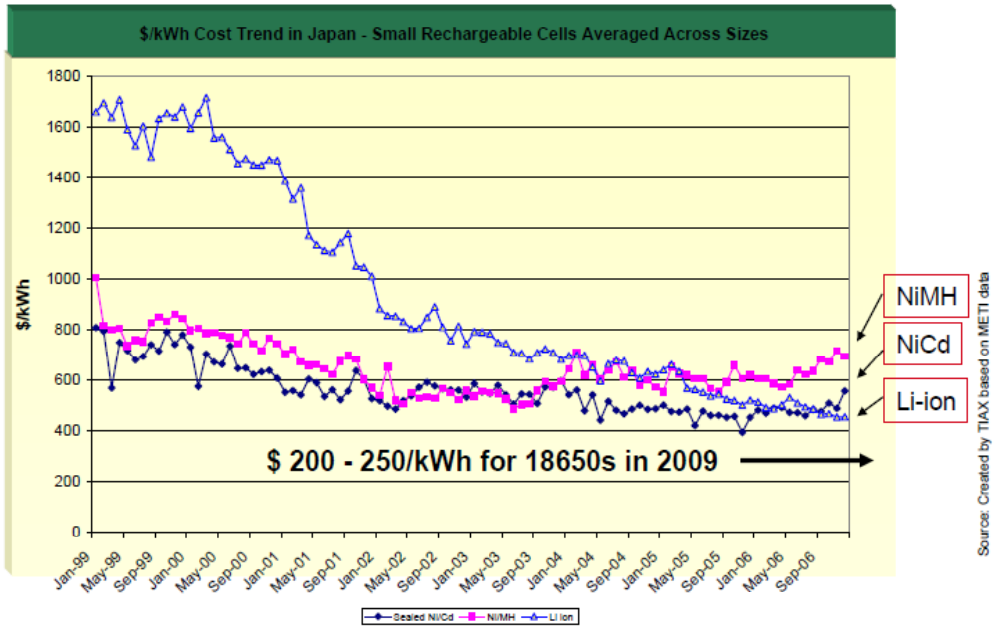
Driving Patterns



Battery Performance vs. Cost Trends



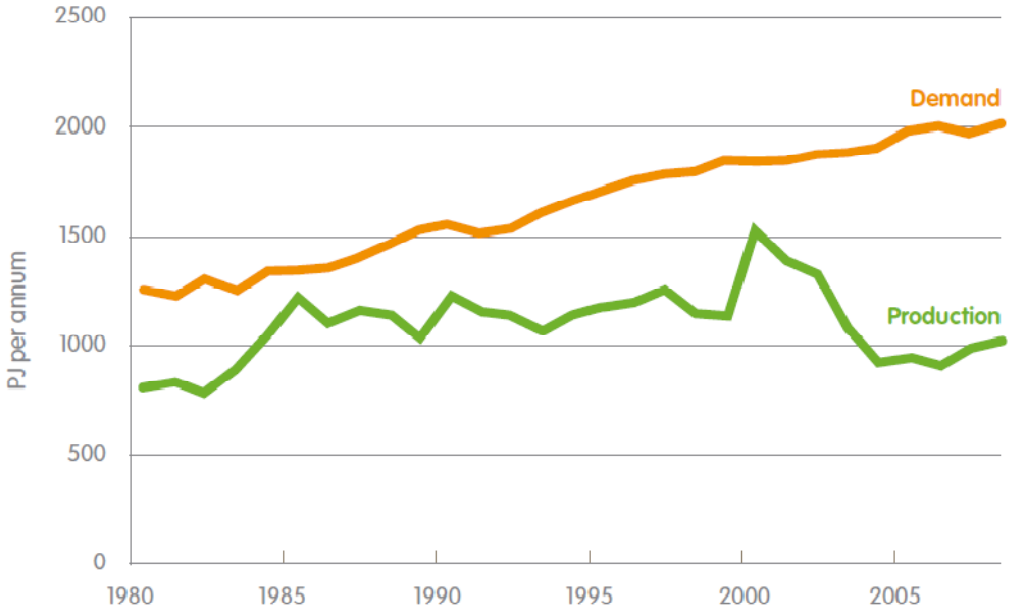
2X performance

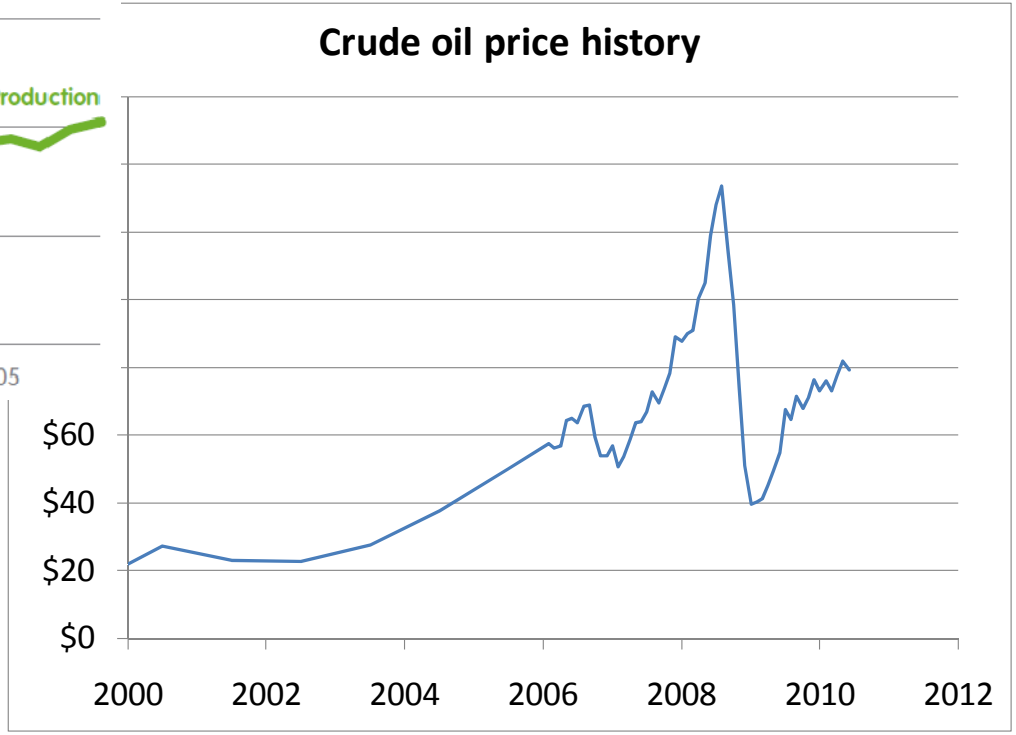


¼X cost

Oil vulnerability today...

Figure 4: Australian crude oil demand and production.[14]

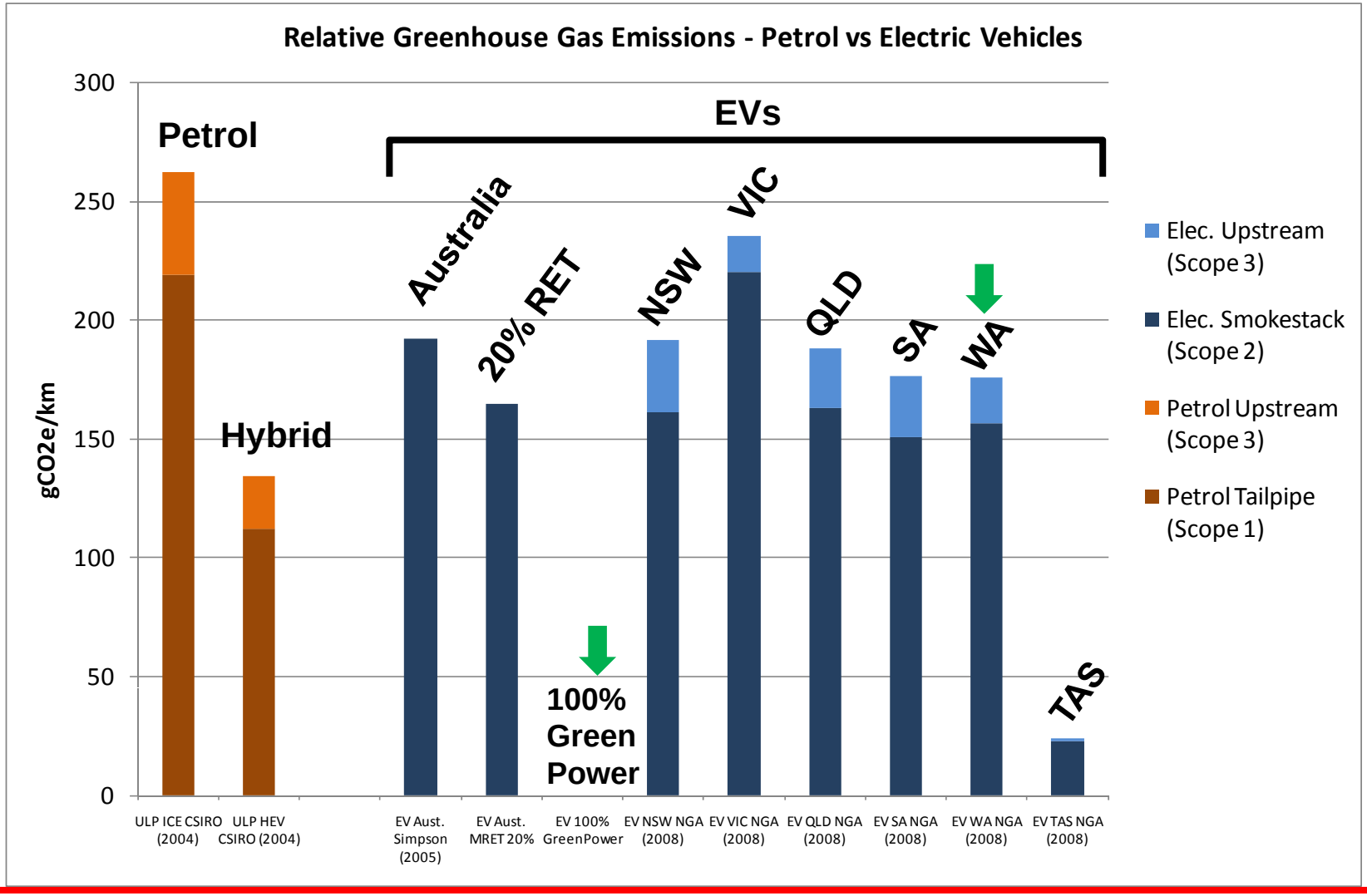




EVs do not need oil

...Climate Change tomorrow.

(Garnaut argued for >90% per-capita emissions reduction by 2050)



EVs are the only PROVEN technology that can provide 100% zero emissions.

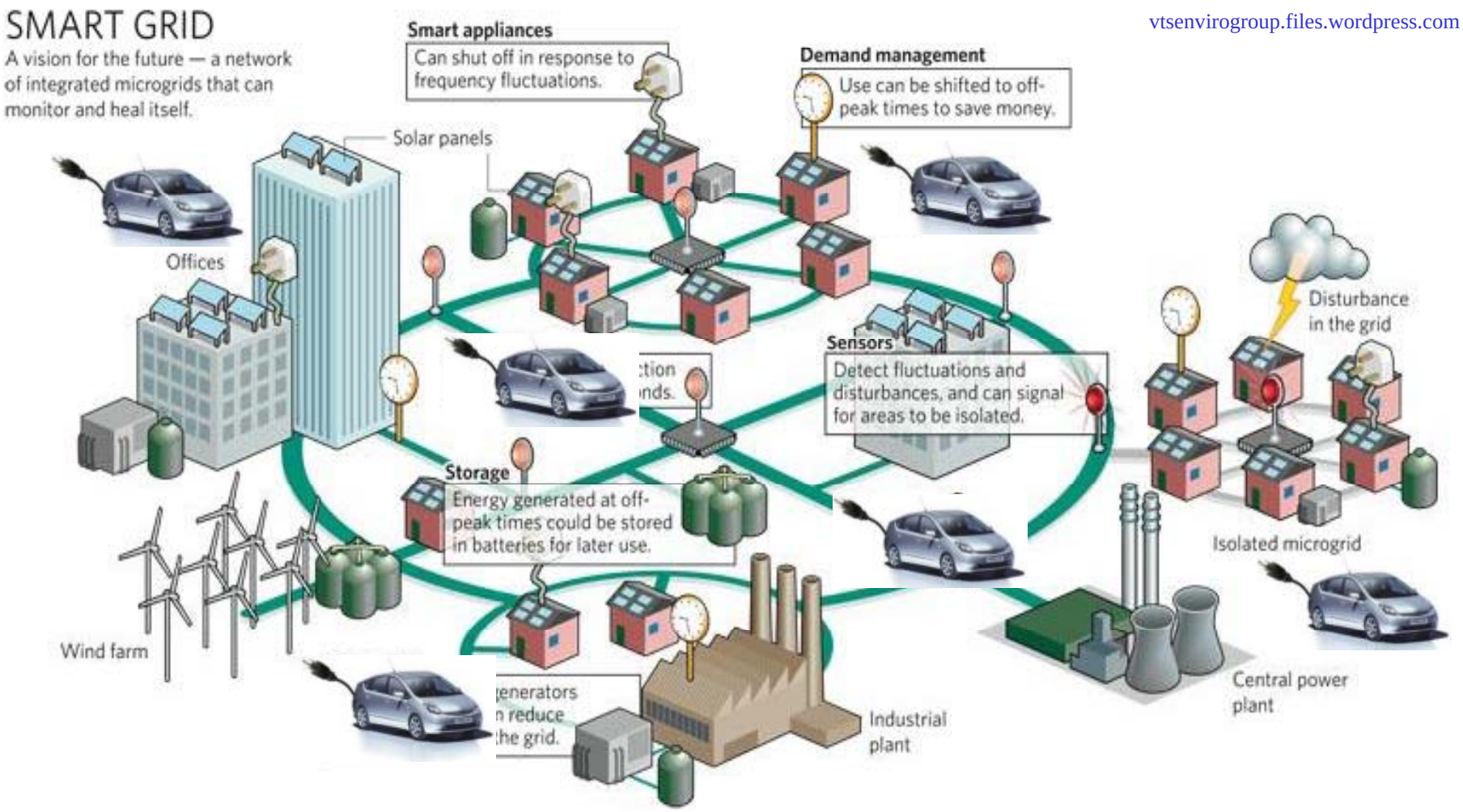
Hybrid/Electric Vehicle Economics in 2010

Vehicle		ICE	HEV	EV
Fuel		Petrol	Petrol	Aust. Grid
Vehicle price		$20,000	$37,000	$41,000
Total cost-of-ownership	($/km)	0.263	0.299	0.260
	($/yr)	**3945**	**4485**	**3900**
Oil imports	(BBL/yr)	7.4	5.0	0
(@US$70/BBL)	**($/yr)**	**606**	**413**	**0**
Air pollutants	(kg/yr)	155	84	9
	($/yr)	**331**	**178**	**20**
Greenhouse	(t/yr)	3.4	2.3	3.0
(@$50/t)	**($/yr)**	**168**	**114**	**152**
TOTAL	**($/yr)**	**5216**	**5281**	**4085**

+ $0.01/km for 100% GreenPower

EVs will save us money.

Electric Vehicles are also Smart Grid appliances

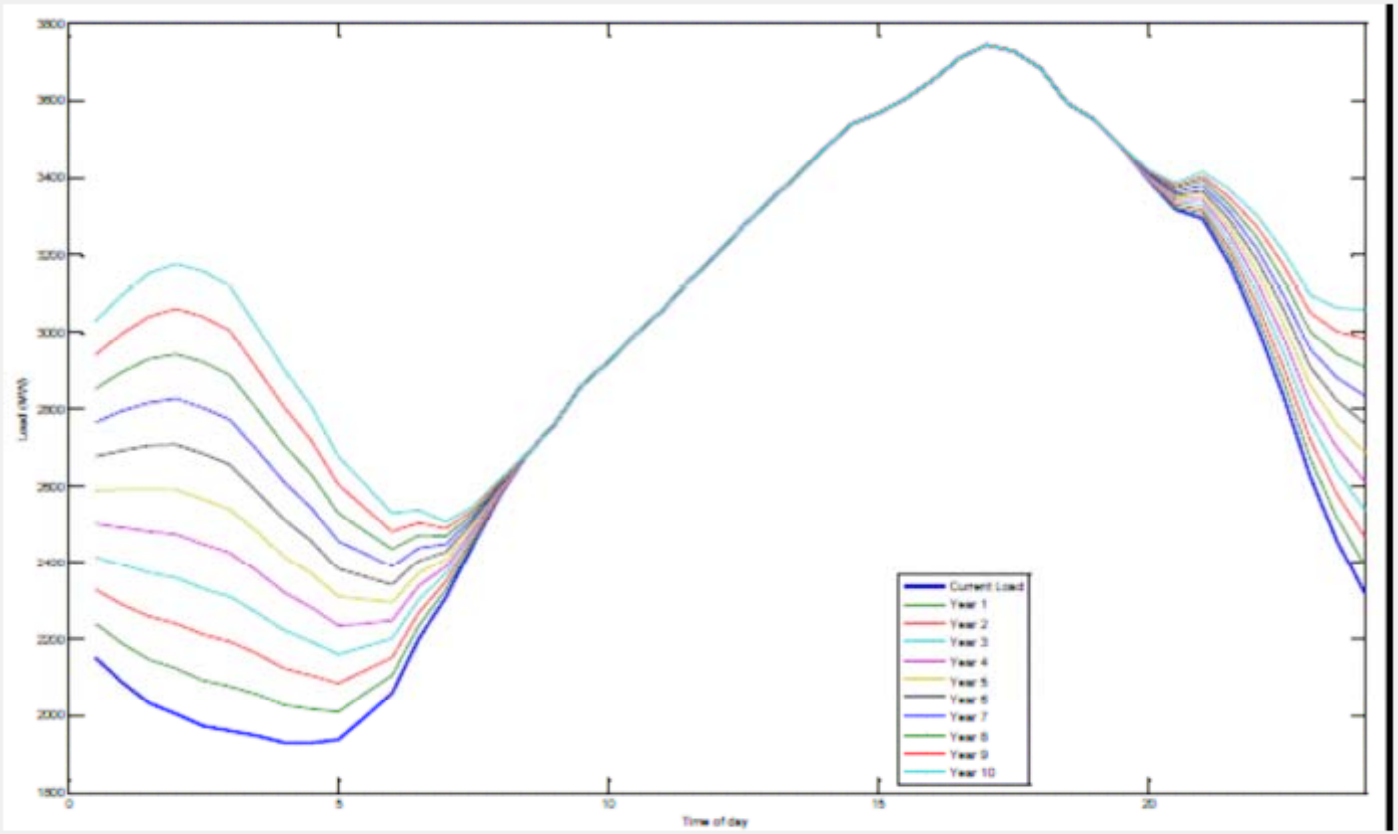


vtsenvirogroup.files.wordpress.com

The SWIS has ample excess capacity for EVs

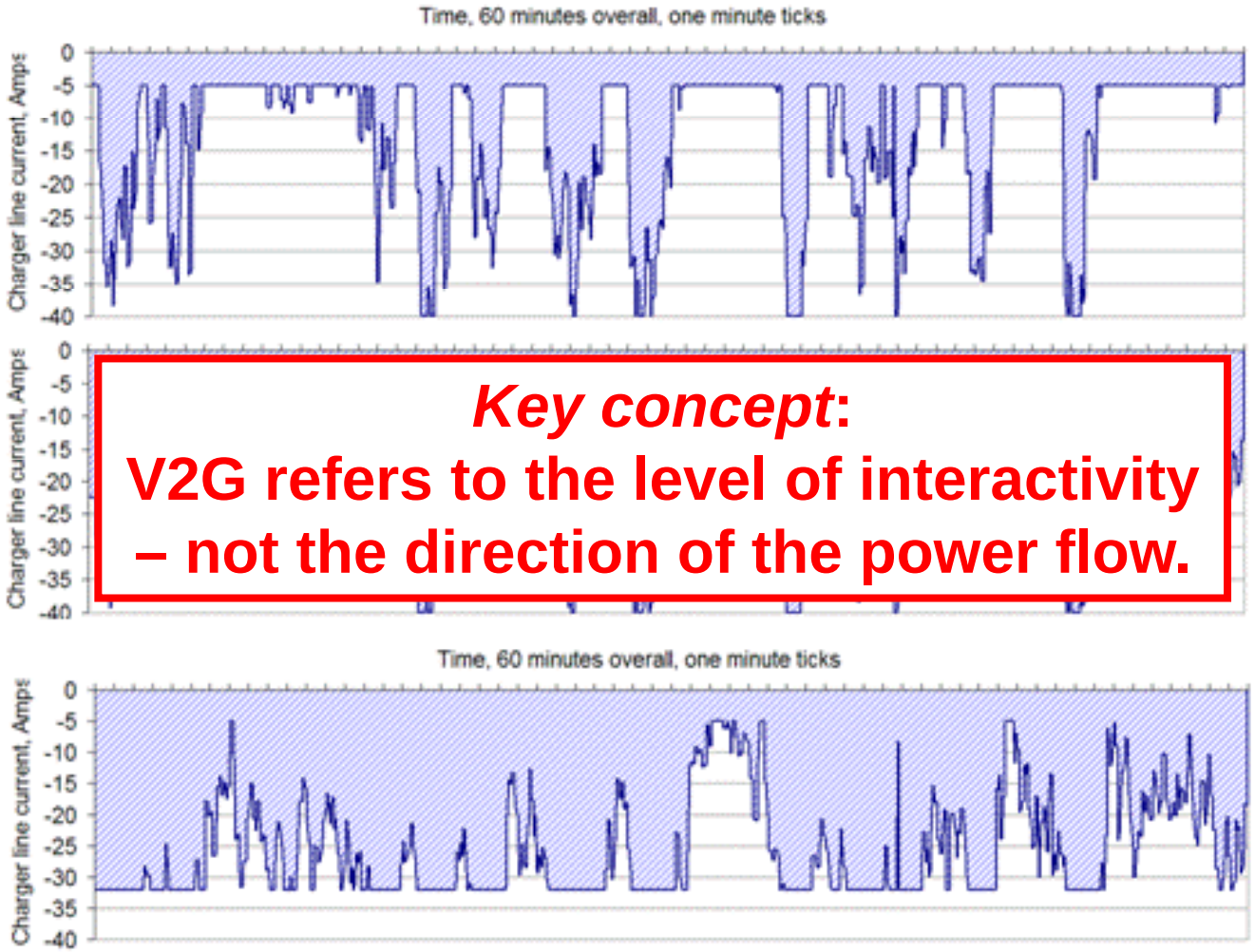
UWA REV Project

(2) Nighttime-Charging Energy Predictions (Jon Mullan)



Top line is for 900,000 vehicles – can sustain all 1.8M cars in WA

Aggregated EVs can help support the network



***Key concept*:**
V2G refers to the level of interactivity – not the direction of the power flow.

Smart charging of a Tesla Roadster to provide V2G ancillary services

Brooks and Thesen (2007) "PG&E and Tesla Motors: Vehicle to Grid Demonstration and Evaluation Program", Proc. EVS-23.

Smart Grids and EVs: Enabling Renewables

1MW turbine powers 1000 EVs

V2G enables 15 x 1MW turbines

A. Simpson (2009) "Environmental Attributes of Electric Vehicles in Australia", CUSP discussion paper, Fremantle.

Strategic Energy Initiative priorities in the context of large-scale EV uptake

1. Smart Grid
2. Regulatory reform – tariffs and A/S markets
3. Networked recharging infrastructure
4. Network augmentation

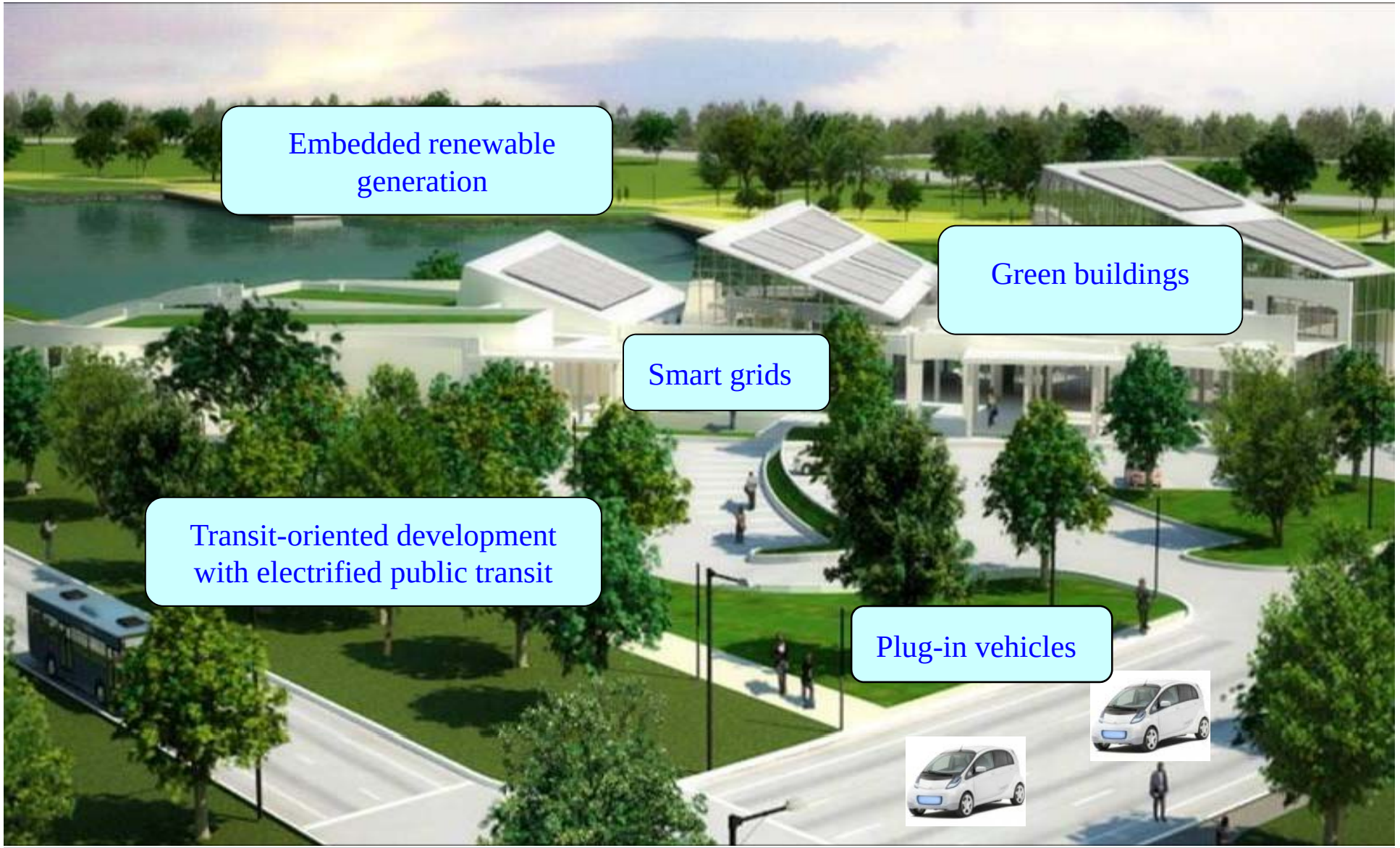
If we do this...

INTEGRATED GREEN INFRASTRUCTURE PLANNING

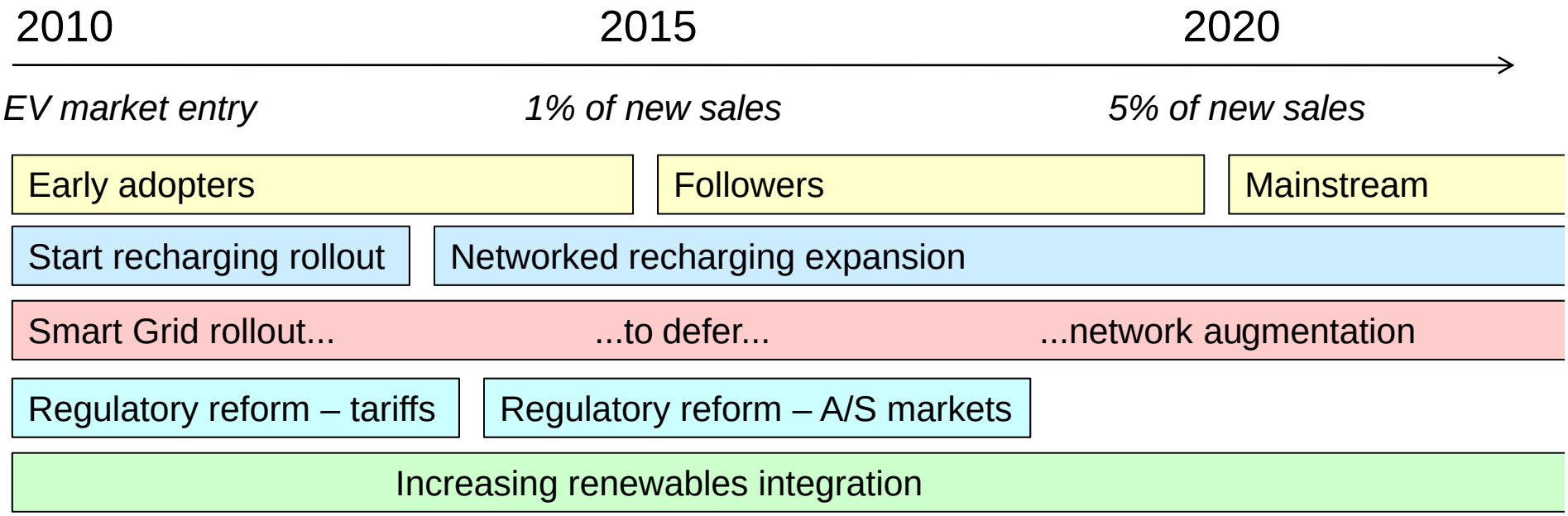
...we can achieve this

- More renewables integration
- No new baseload capacity (for the EVs at least)
- No new peaking capacity (for the EVs at least)
- **Renewable electric transport**

The CUSP vision for *Renewable Transport*



A Strategic Plan for EV Energy Infrastructure



National EV issues to be addressed during this period:

- Federal recognition, ownership and coordination of the National EV/recharge rollout
- EV/recharge standards
- Consumer and industry incentives
- Workforce skills and training
- Fuel excise revenues vs. societal costs of motoring

Conclusions

1. Electric vehicles are not “the silver bullet”, however, they are a game-changing technology of major strategic importance.

2. EVs are coming in large numbers, bringing significant potential benefits, so we might as well prepare for them.

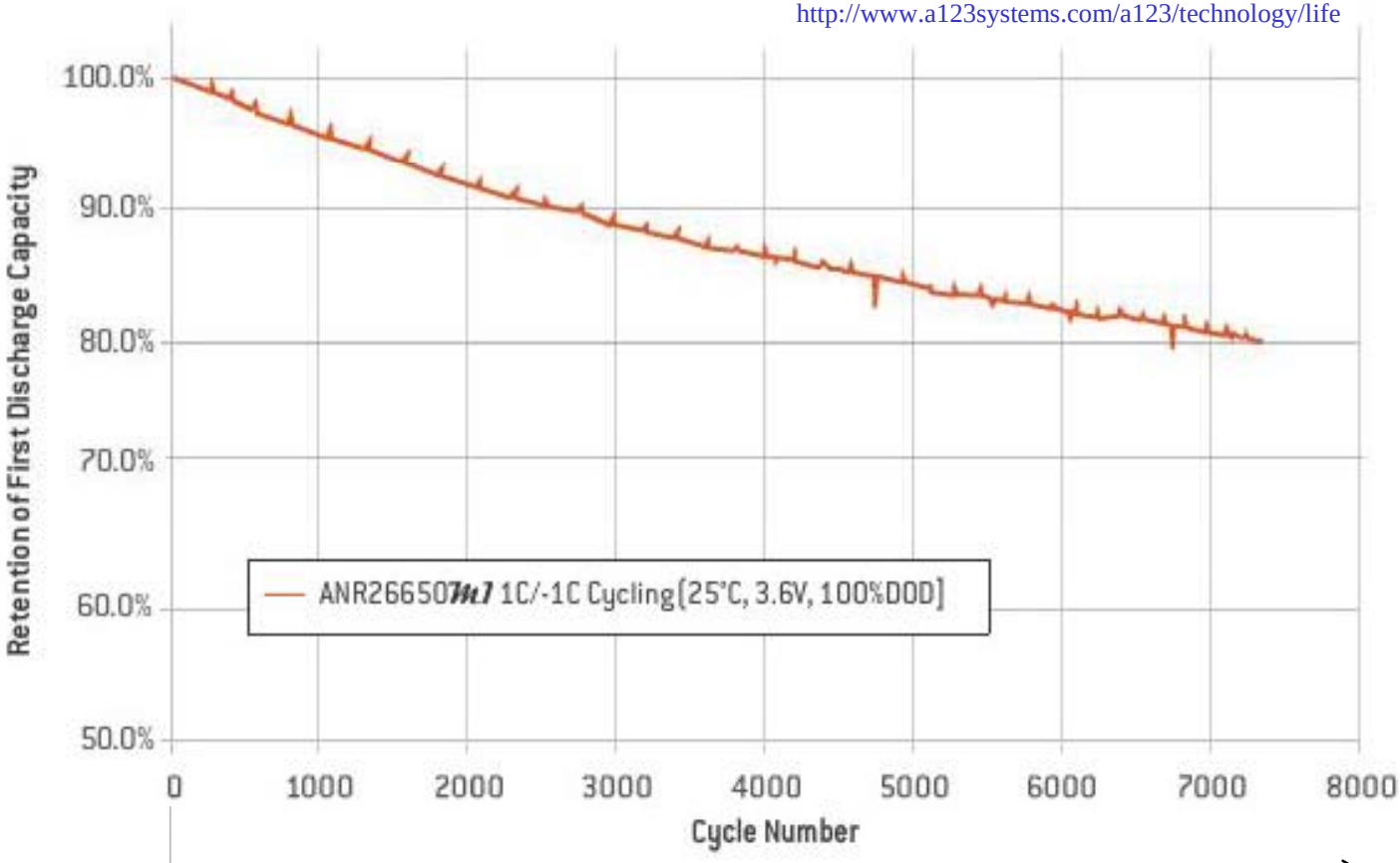
3. Through an integrated planning framework, EVs can help achieve both our transport and stationary energy goals.

4. EV network priorities should be highlighted in the WA Strategic Energy Initiative as critical infrastructure prior to 2020.

Backup Slides

Battery Life Trends

http://www.a123systems.com/a123/technology/life

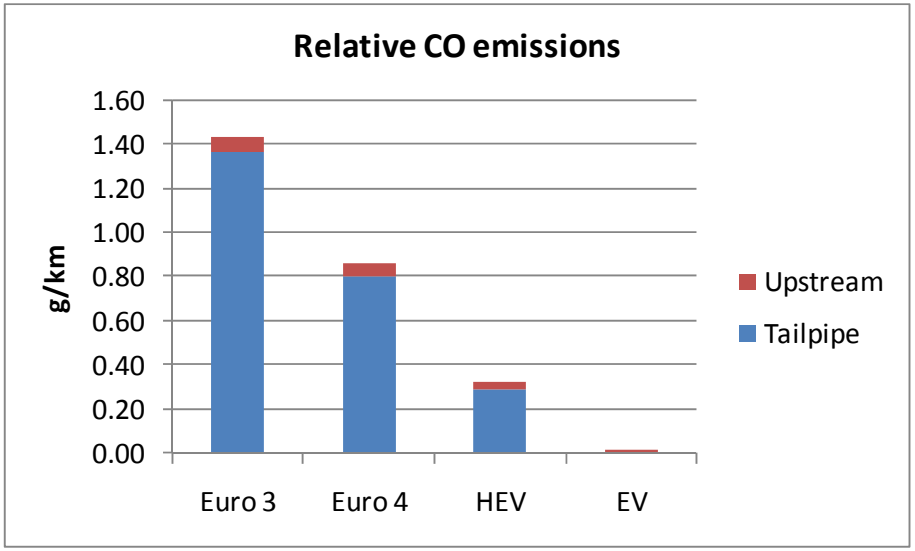


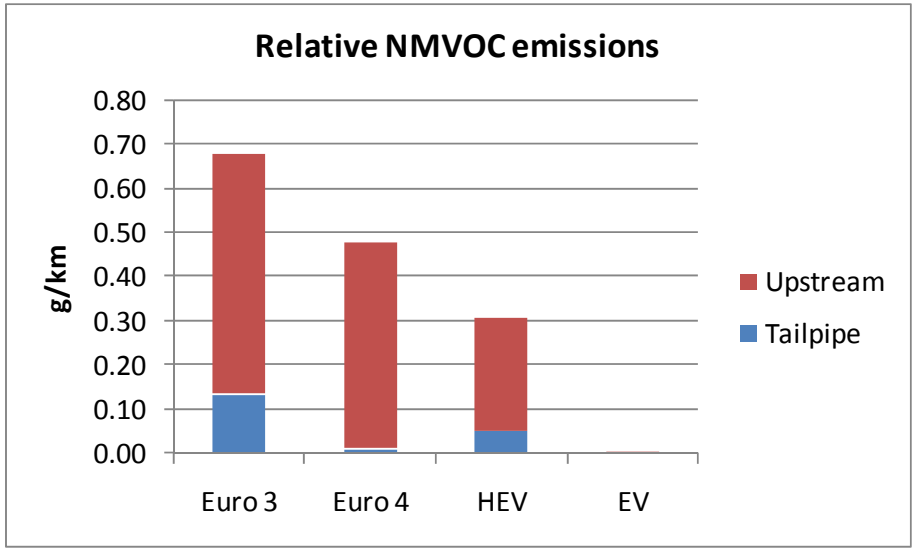
Hypothetical scenario:
EV with 100km range
driving 100km per day

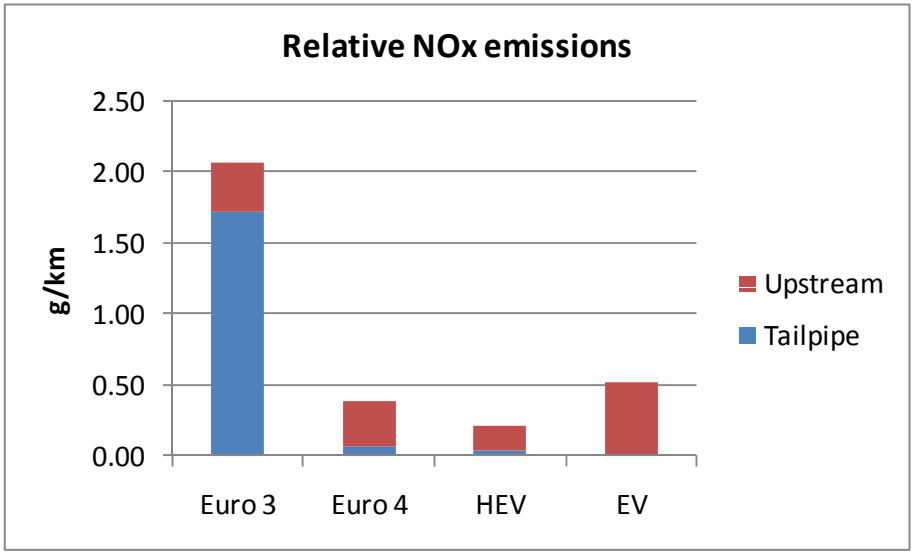
0k	100k	200k	300k	400k	500k	600k	700k	km
0		4		8		12		16		20	years

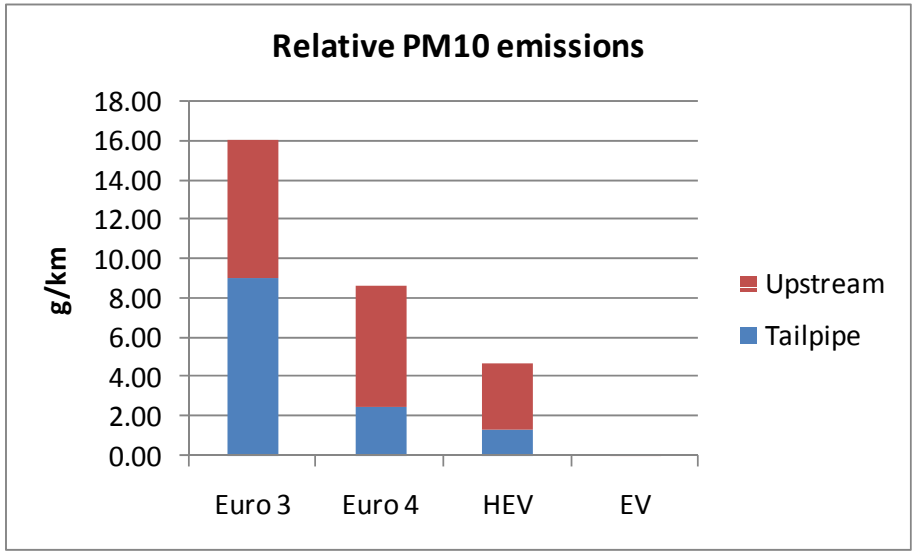
Note: Must also allow for calendar life, thermal extremes, misuse, etc.

Air Pollution

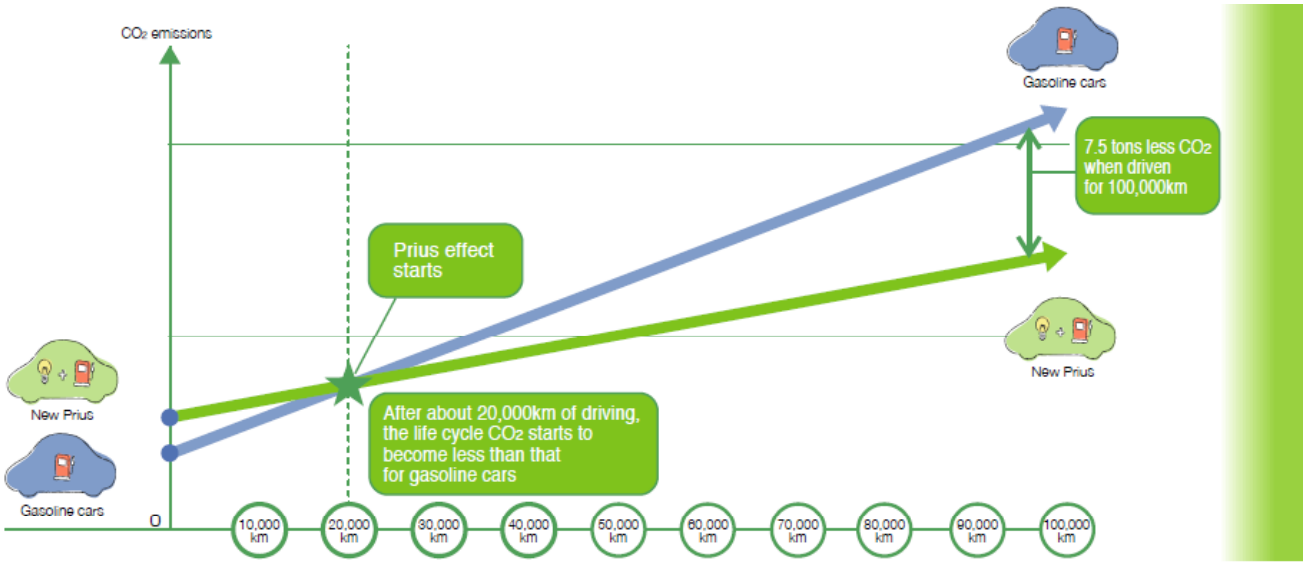








Lifecycle Analysis for EVs/PHEVs



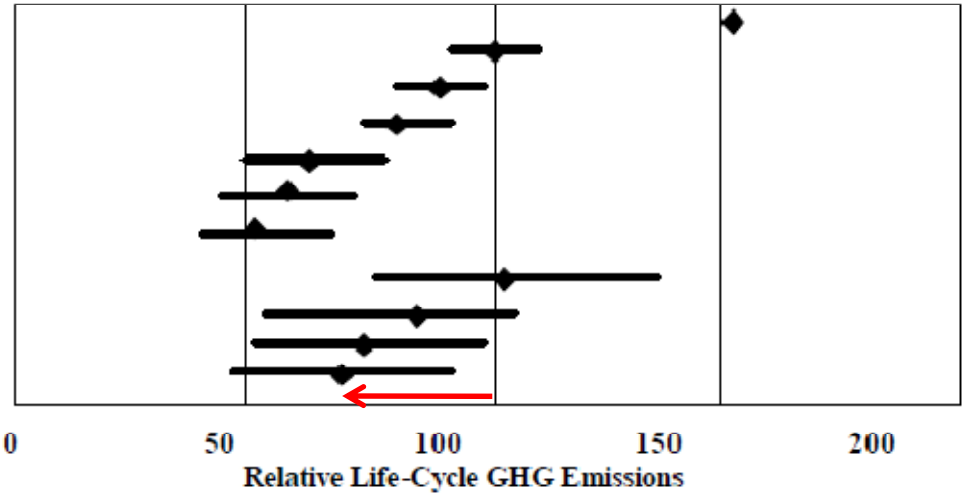
Toyota study of Prius HEV – a net winner after 20,000km.

MIT study of alt. vehicle technologies – EVs a net winner compared to ICE.

TECHNOLOGY

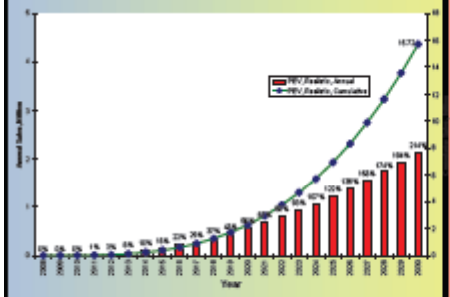
1996 Reference ICE
Baseline evolved ICE
Advanced gasoline ICE
Advanced diesel ICE
Gasoline ICE hybrid
Diesel ICE hybrid
CNG ICE hybrid
Gasoline FC hybrid
Methanol FC hybrid
Hydrogen FC hybrid
Battery electric

GREENHOUSE GAS EMISSIONS



Developing PHEV Scenarios

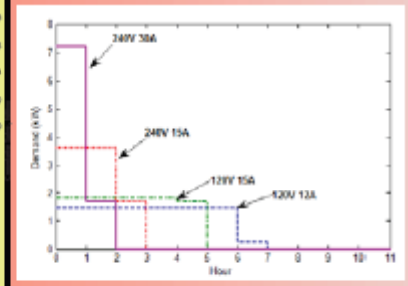
PEV Market Penetration



- DATA SOURCE

EPRI PRISM STUDY
EPRI NRDC STUDY
HYBRID SALES DATA
Dept. of Transportation

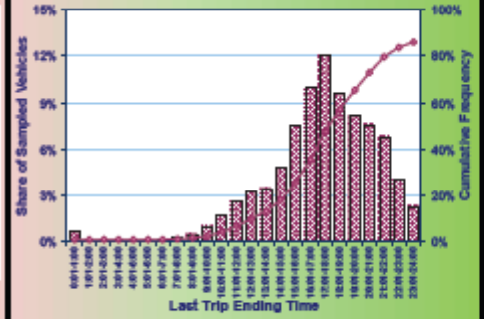
PEV Charge Spectrum & Profile



- DATA SOURCE

OEMs Data
SAE J1772
Argonne National Labs
LAB TESTING
EPRI NRDC STUDY

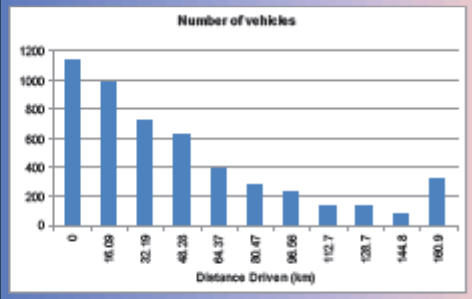
Time Profiles: Customer Charging Habits



- DATA SOURCE

National Household Travel Survey (2001)

Battery State of Charge based on miles Driven



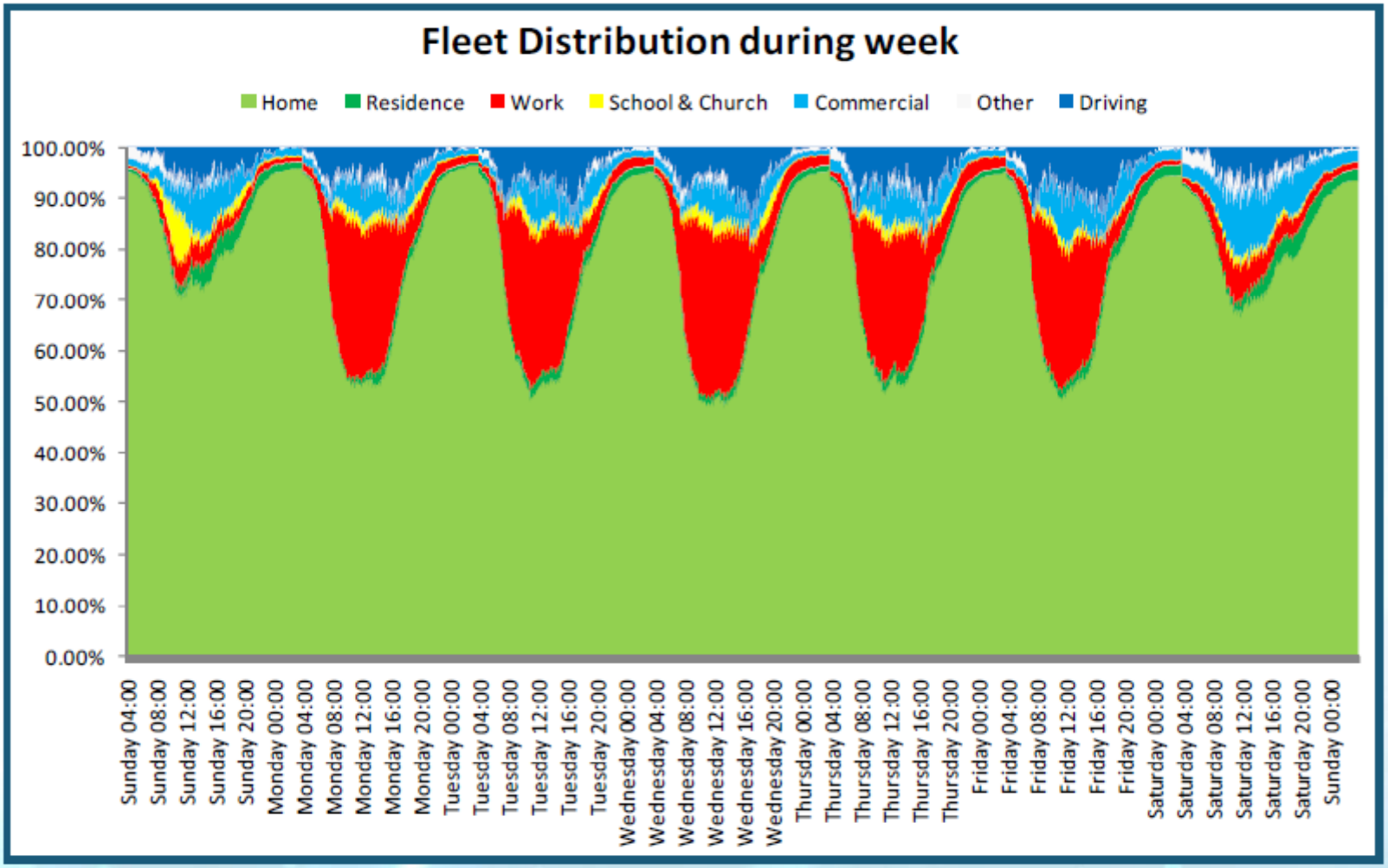
- DATA SOURCE

National Household Travel Survey (2001)

- Critical to take **driving patterns** into account in both "***High-Level Analysis***" & "***Micro-Level Analysis***" in order to get a correct view of load diversity

A. Maitra (2009) "Effects of transportation electrification on the electricity grid", Plug-In 2009 Conference, Long Beach.

Where Are the Cars?



Source of Data - 2001 National Household Travel Survey ; GM Data Analysis (Tate/Savagian) - SAE paper 2009-01-1311

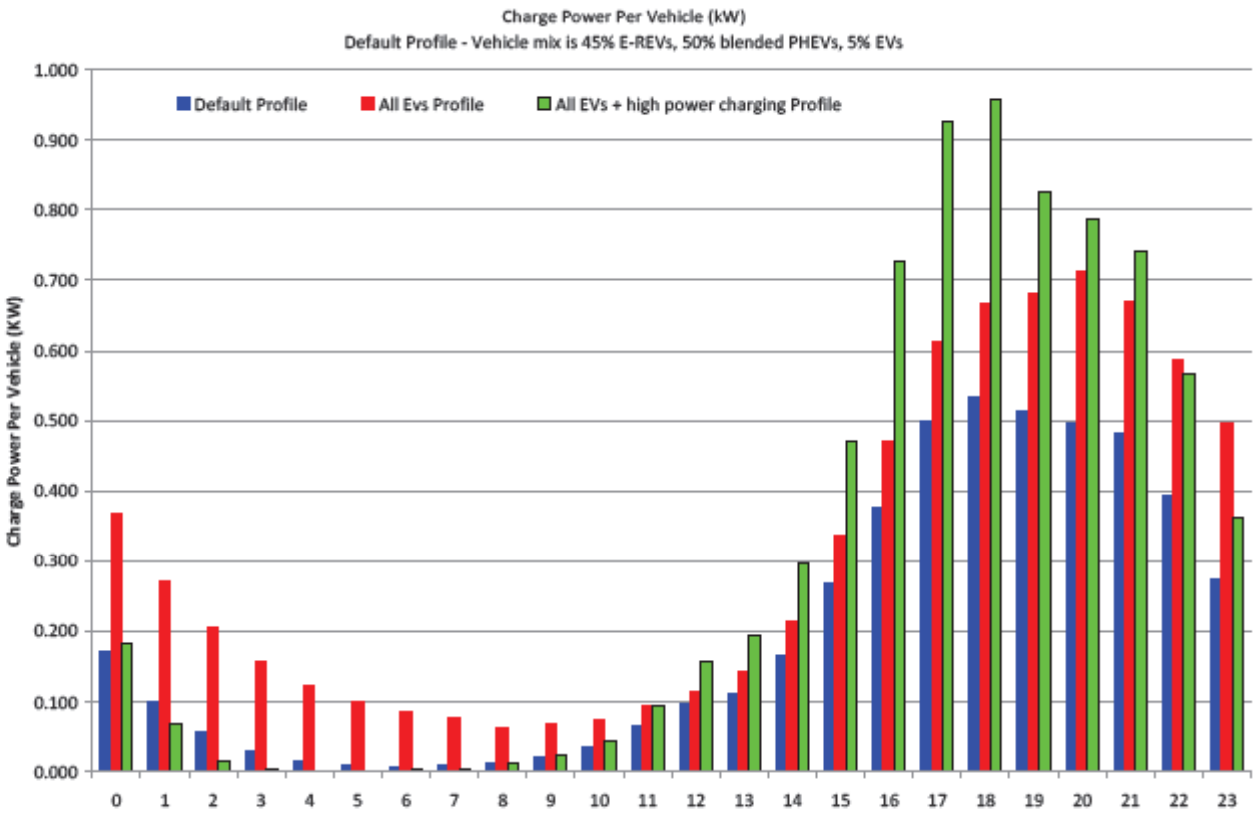
PLUG-IN 2009

GM

B. Gross (2009) "Plug-In Electric Vehicles Are Coming…Is Your Utility Ready?", Plug-In 2009 Conference, Long Beach.

Power Demand for Uncontrolled Charging

- Default Profile:
  - 50% 1.44kW 120V
  - 20% 3.3kW 240V
  - 30% 6.6kW 240V
- This is closer to what would be expected in the near-term
- The peak load occurs at around 5-7, around 500W per vehicle, and lasts longer into the evening.
- If all the Vehicles are EV:
  - The peak load still occurs at around 5-7, but is about 700W per vehicle



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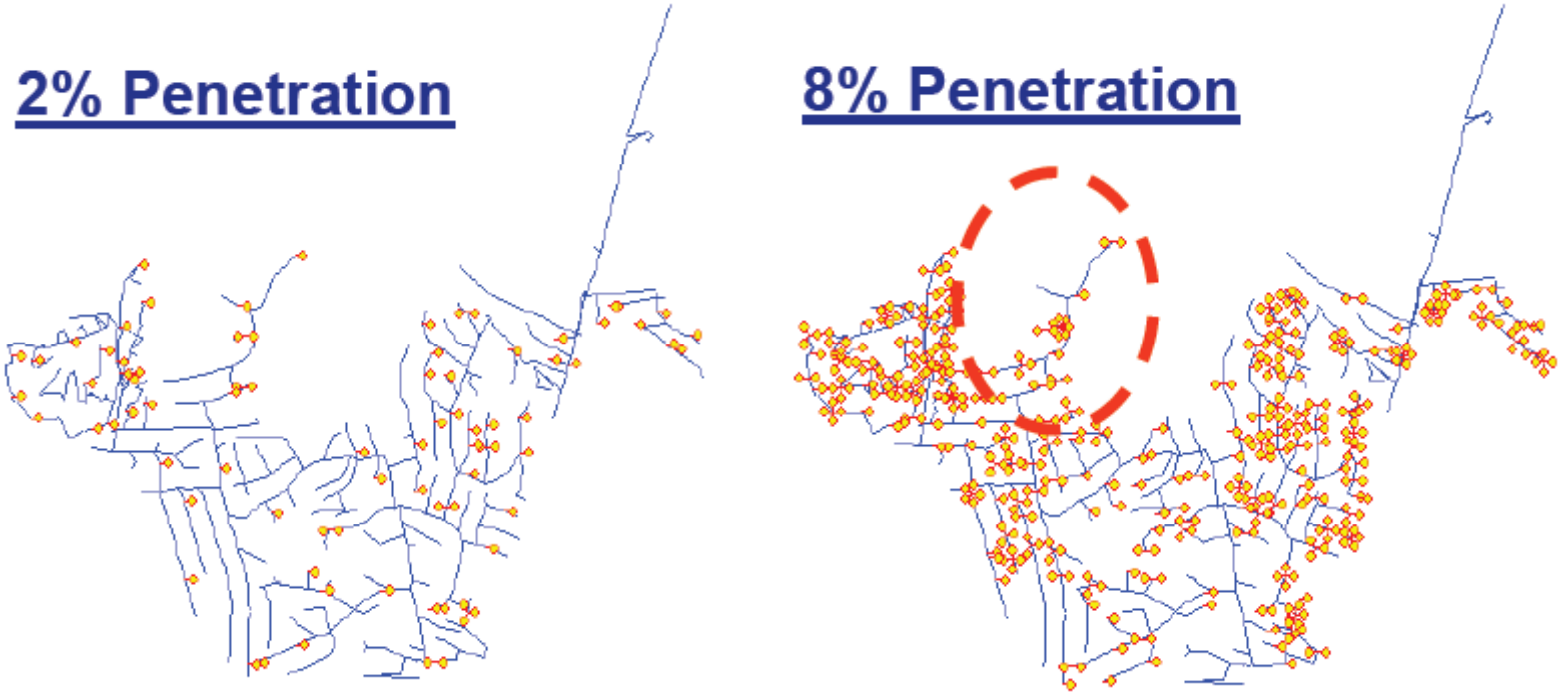

A. Maitra (2009) “Effects of transportation electrification on the electricity grid”, Plug-In 2009 Conference, Long Beach.