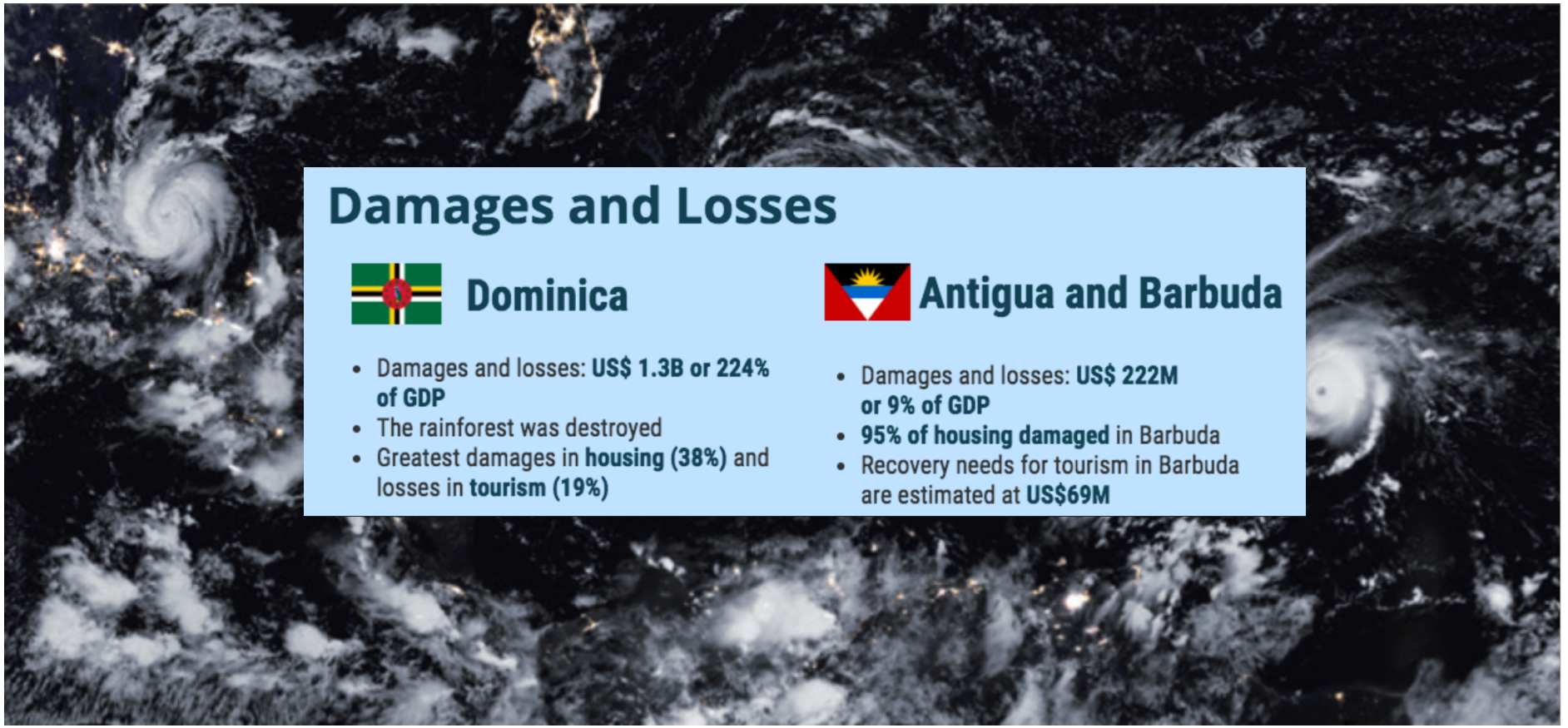
Curtis Boodoo
Ph.D

The University of Trinidad and Tobago

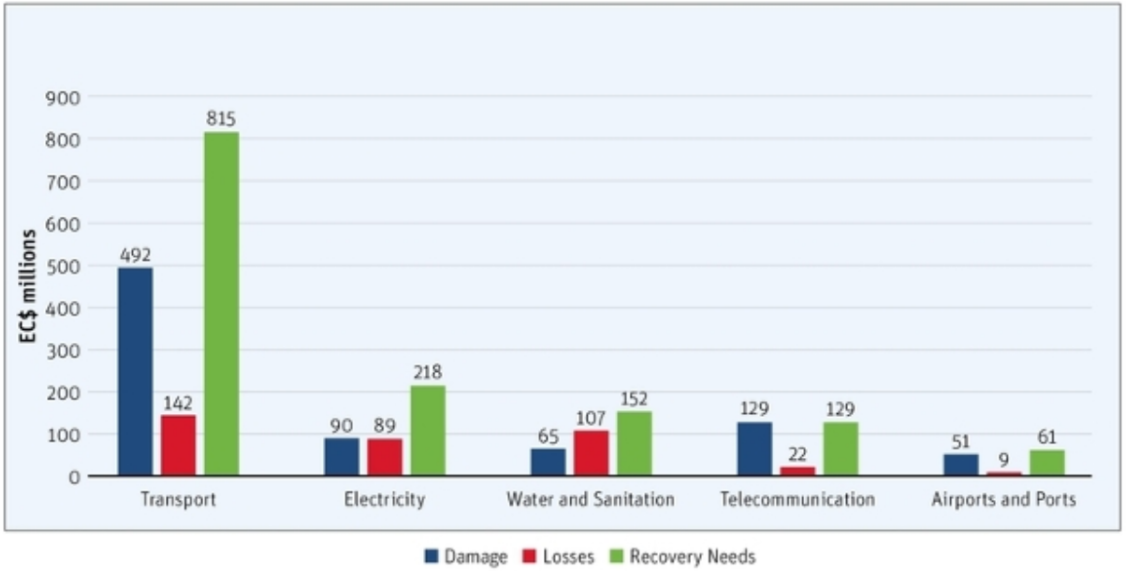
The Need for Resilience



Dominica

INFRASTRUCTURE SECTOR

Figure 3: Damage, Losses and Recovery Needs by Infrastructure Subsectors (in EC$ M)



Source: Wold Bank Post Disaster Report

"…..Electricity Service failed due to widespread damages to Transmission and Distribution Network. 75% of the Network is down.

80% to 90% Of Transformers damage or cannot be repaired"

Damage to three(3) Generating units at Fond Cole

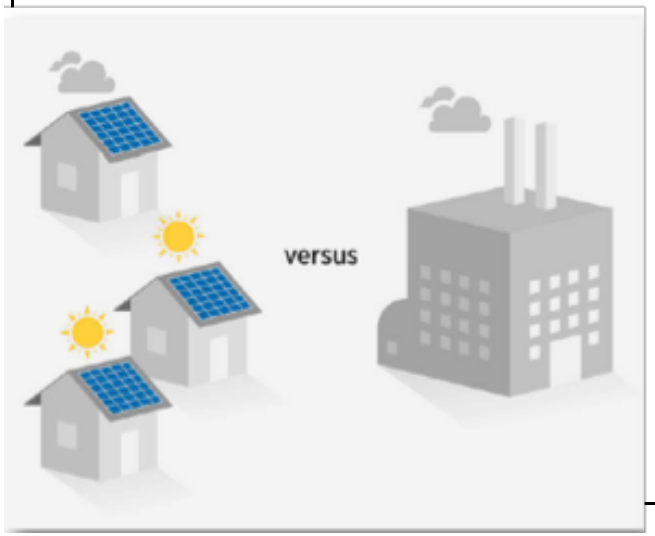
Renewable Energy and Resilience

Renewable energy-based generation can enhance resilience

1) modular nature allows for spatial diversification of energy supplies

2) operate in severe weather when designed to do so

3) lack of fossil fuel requirements.



Source: Solar Under Storm

RE + Microgrid = Resilience

Microgrids capable of islanding based on distributed RE can disconnect from the central grid during a major climate event to allow energy to be diverted to critical loads.

This allows utilities flexibility

1) restoring generation stations
2) responding to critical outages,
3) shutting down systems before a major event to prevent damage.

Transportation: EVs and Resilience – 2011 Earthquake Japan

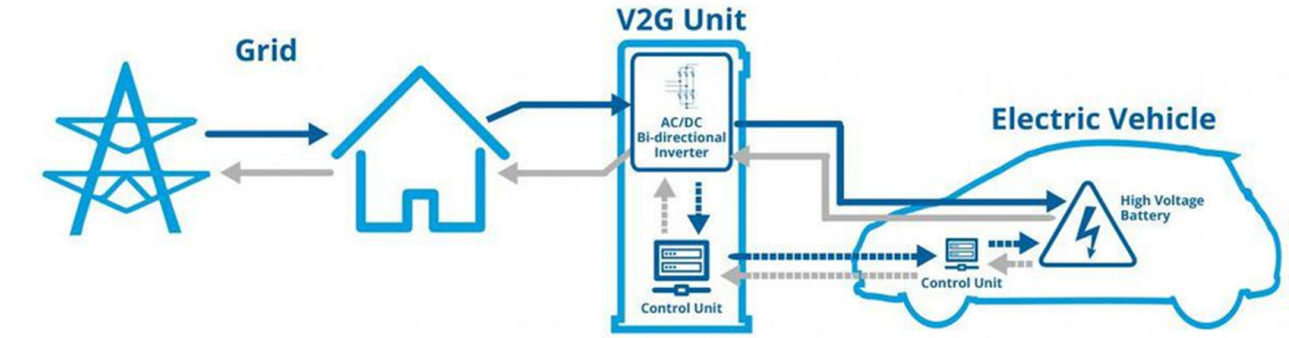
Oil refineries out of commission.
Japan's Self-Defense Forces had to truck in gasoline and diesel fuel from China.
Clogged roadways slowed deliveries.
Sendai electricity returned within days.

EVs and Resilience – cont'd

Image from Reuters Jonathan Drake

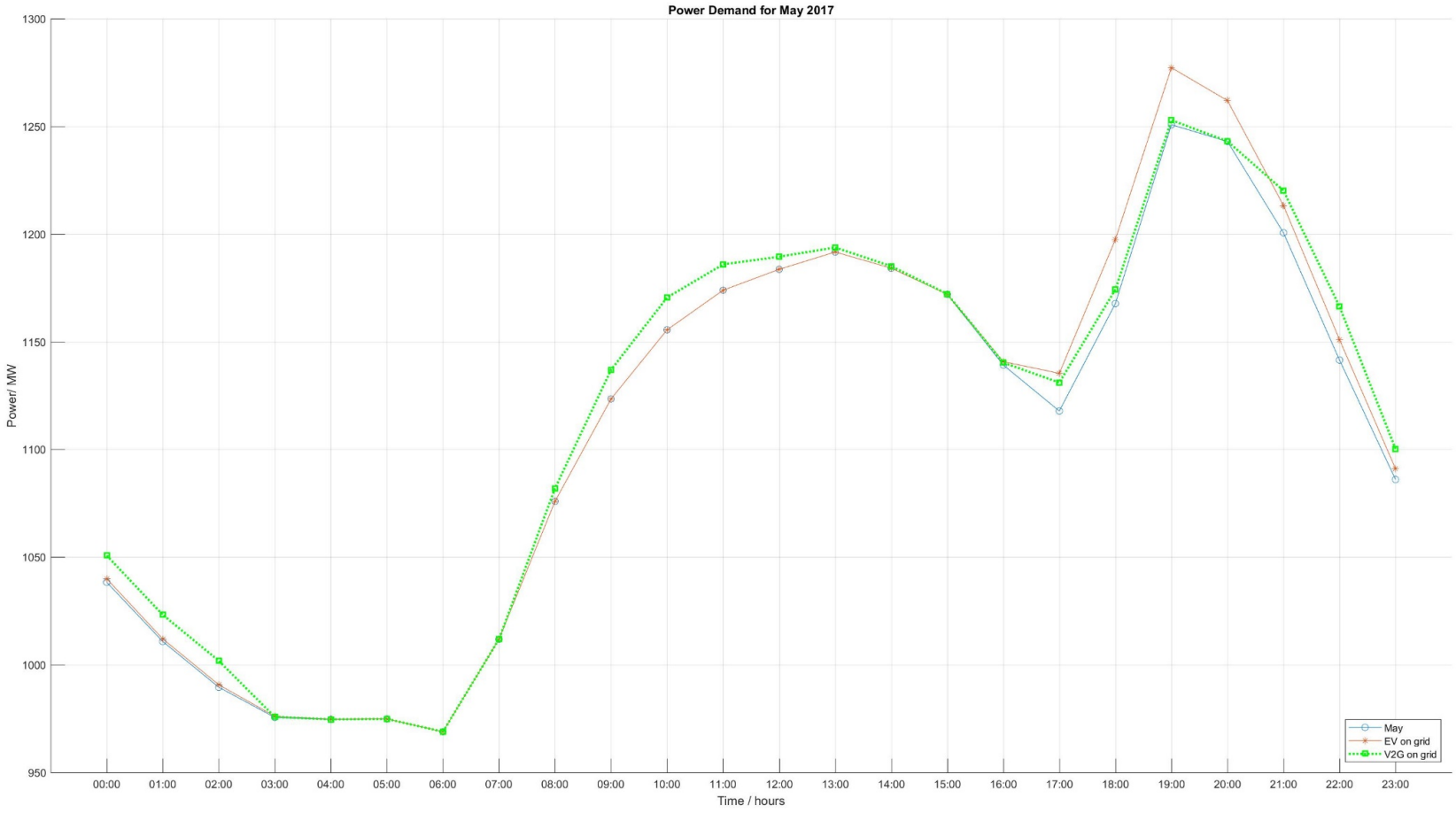
Image from Sinovoltaics

EVs and Resilience – V2G / V2H



Ancillary grid services:

- Frequency control
- Demand response
- Spinning reserves
- Smooth the variable output from renewable electricity generation,
- Utilize surplus RE when supply exceeds demand


Power Demand for May 2017
Power/ MW
Time / hours
1300
1250
1200
1150
1100
1050
1000
950
00:00
01:00
02:00
03:00
04:00
05:00
06:00
07:00
08:00
09:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
May
EV on grid
V2G on grid

V2G - Continued

Domestic Average Daily consumption: 5.73kWh*
2018 40kwh Nissan Leaf:

6.5 days back up.

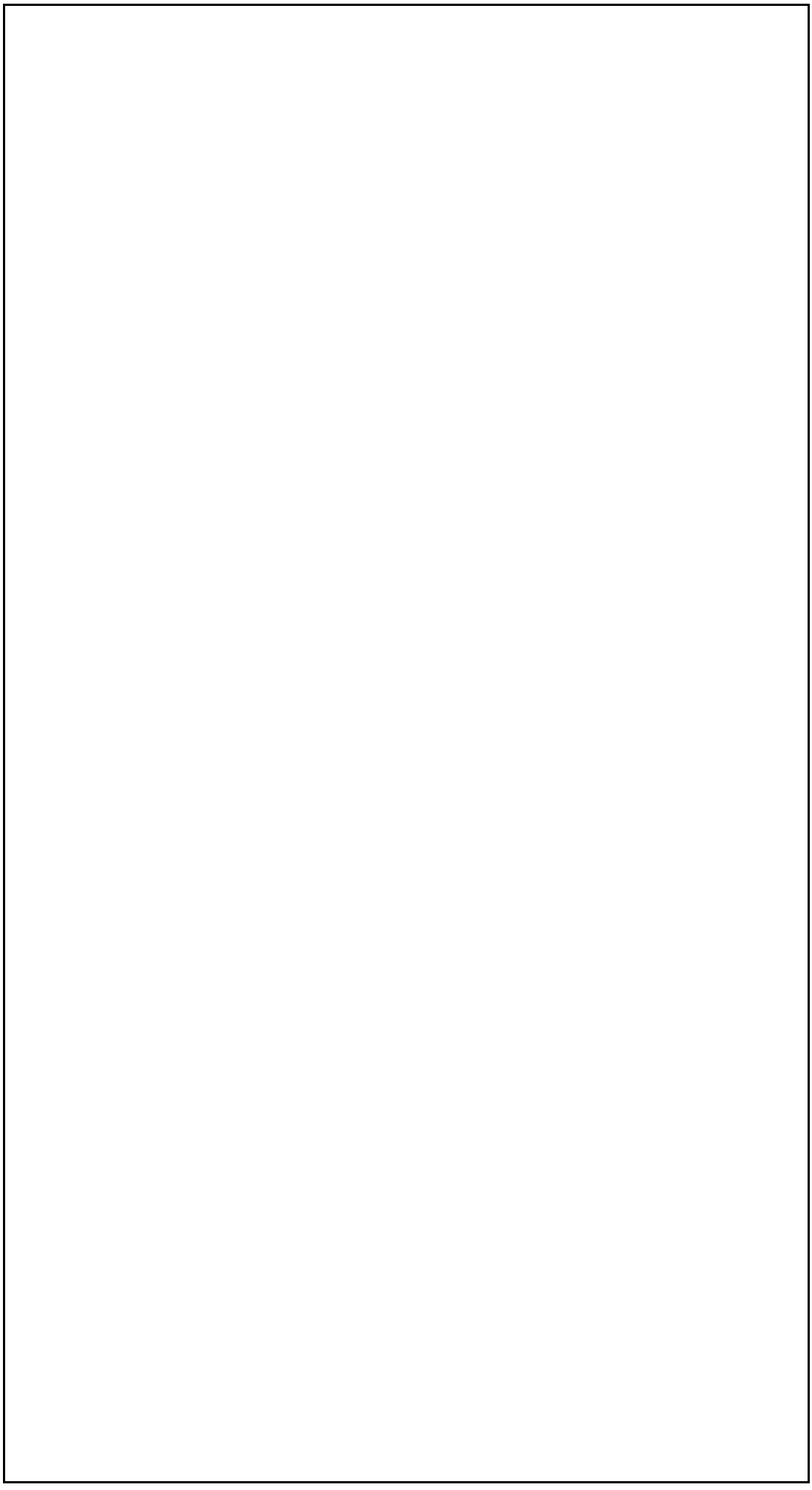
First Phase: Public Transportation – Electric Buses and V2G

	Trinidad and Tobago	Barbados
50% Electric Bus fleet	168 buses	90 buses
Total Potential V2G power output	10.08MW	5.4MW
Peak Demand	1357 MW	155.2 MW
V2G/Peak demand (%)	0.7%	3.5%

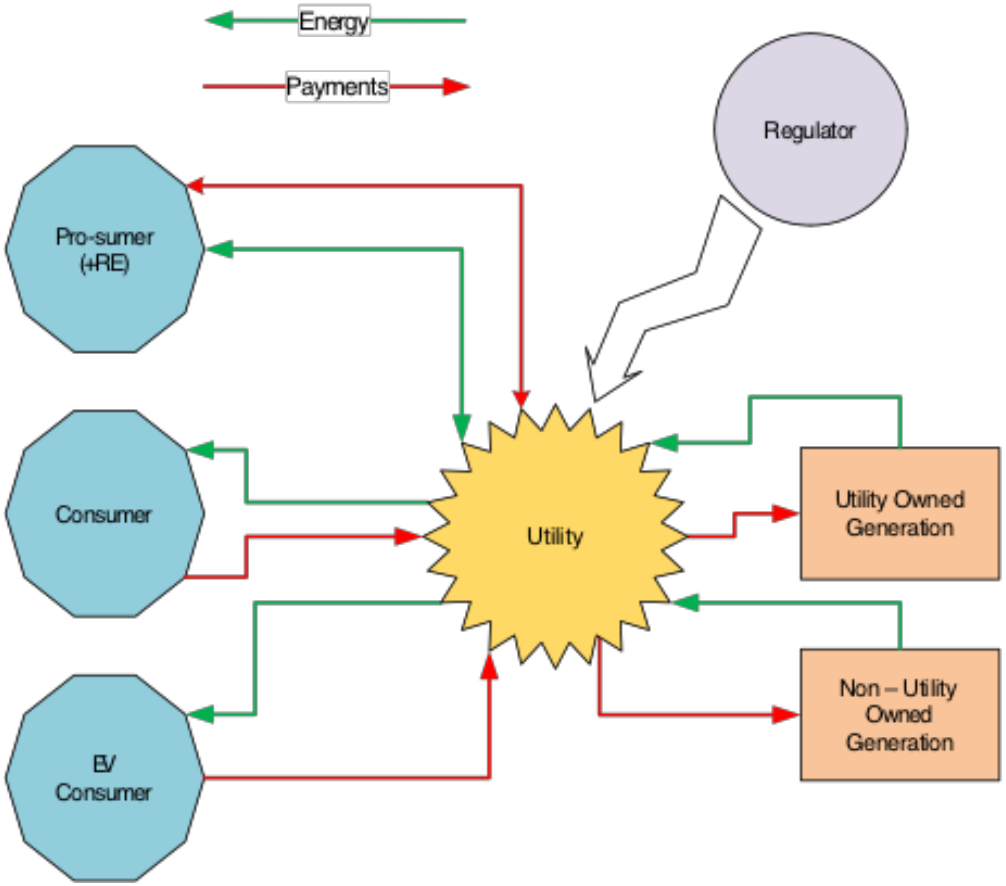
* LUCELEC 2018 ANNUAL REPORT | TRANSFORMING THE ELECTRICITY SECTOR

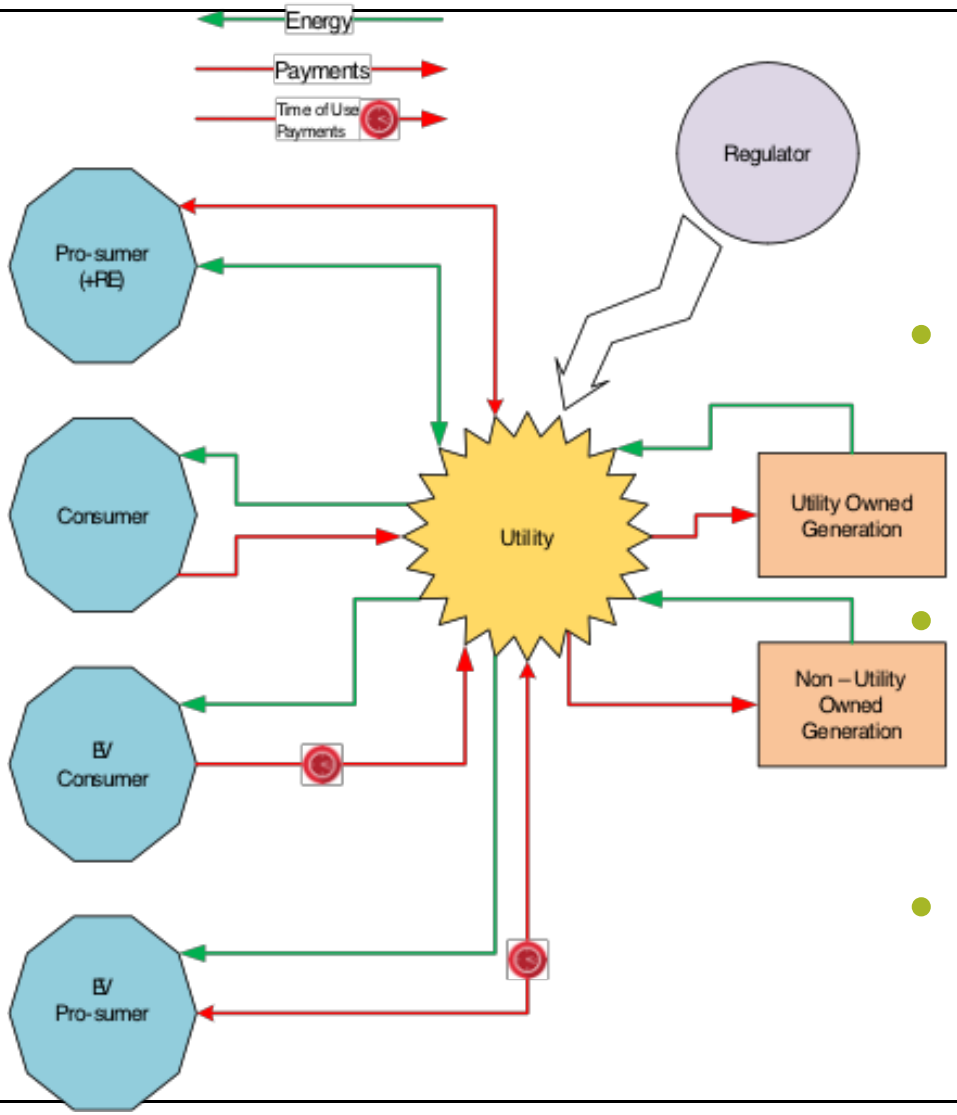
V2G Challenges

- Regulation and energy markets prohibit EVs participation in ancillary services.
- Requires policy makers, utility companies, and EV manufacturers to work together
- An EV battery is expensive. Battery / EV manufacturers hesitant to honour warranty.
- V2G affects battery life?



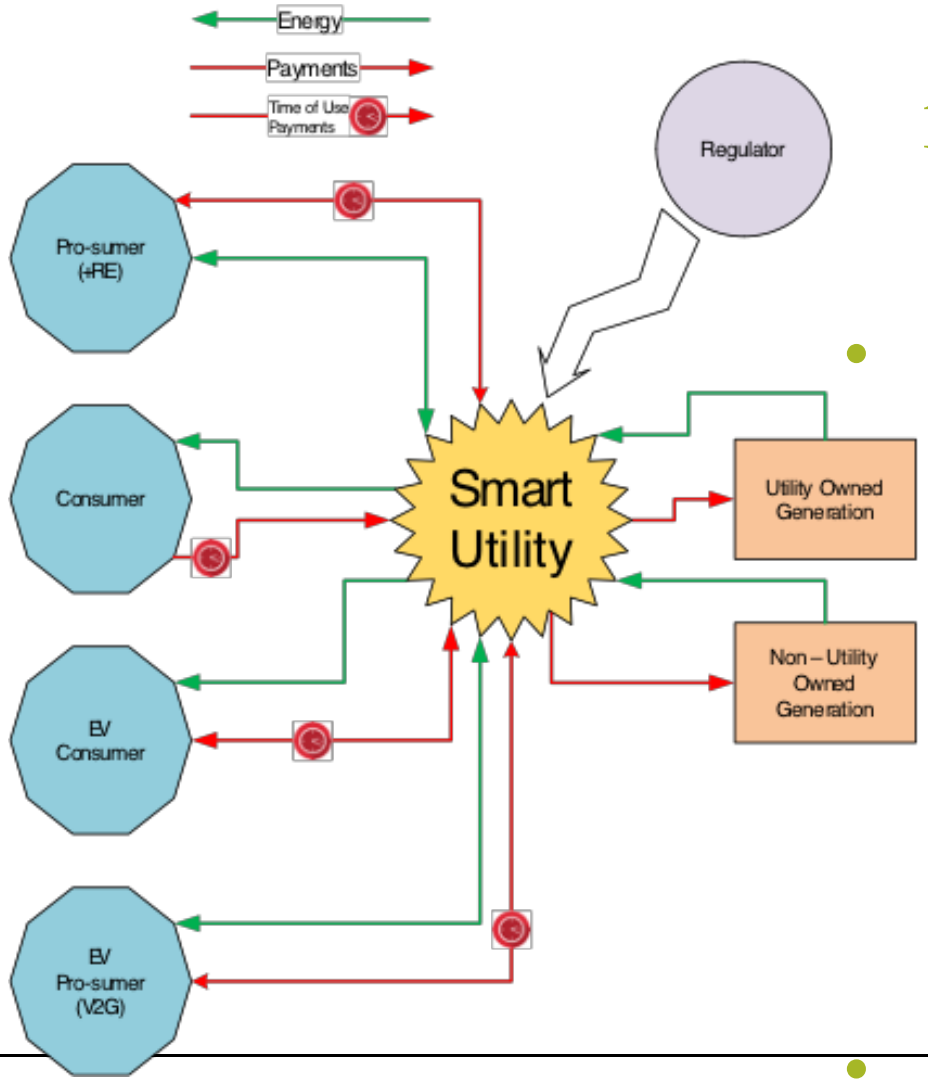
Archetype 1 - Current Status





Archetype 2 – Time of Use Tariff

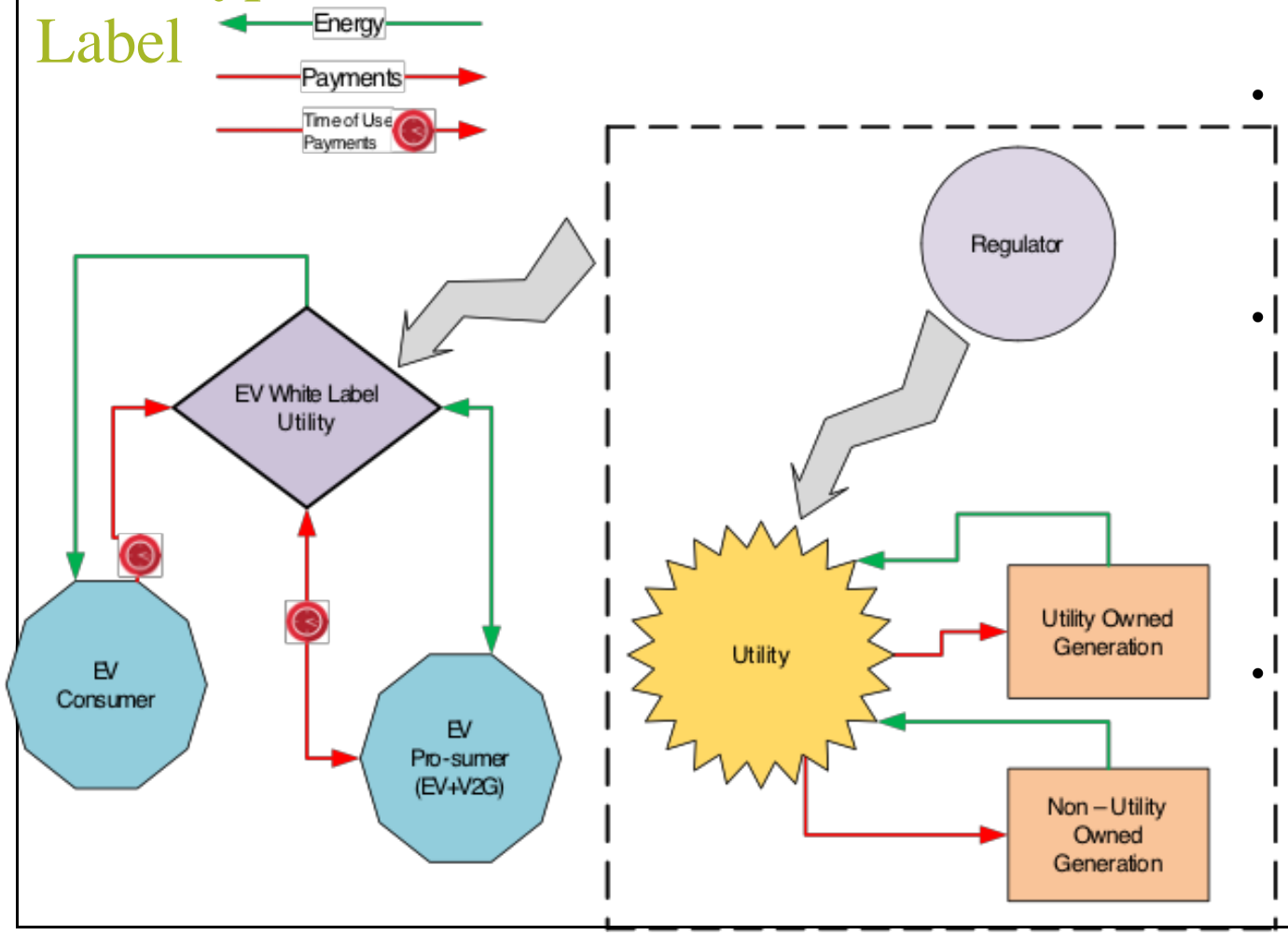
- Can use an energy tariff that is cheaper outside peak times.
- CO2 reduction as higher loads are shifted away from inefficient and polluting Peaker generation
- Equity issues – a high electricity user and EV owner can be potentially charged a lower tariff.



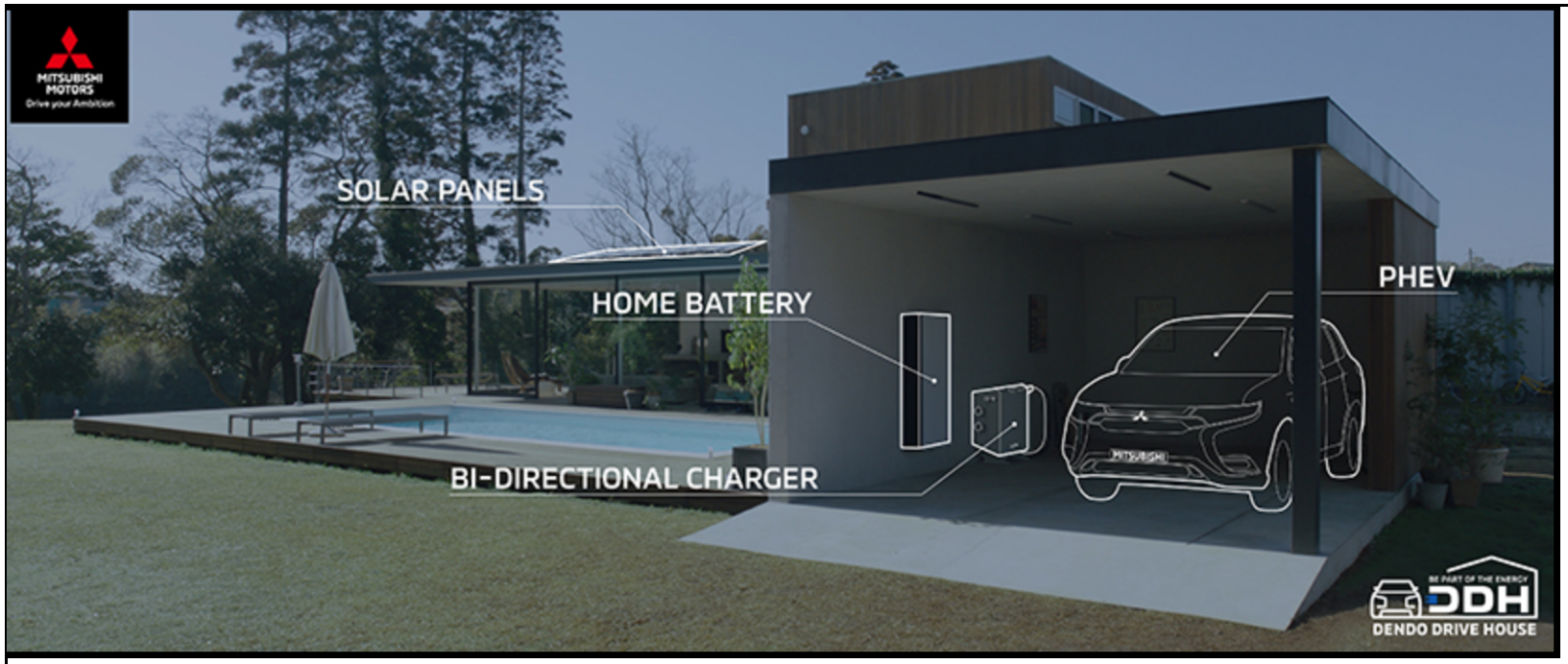
Archetype 3 – The Smart Utility

- The Utility manages charging to optimise the use of the EV. The Utility can interrupt or dial down charging for reasons which include: distribution network stress, balance of supply position and ancillary services. The EV customer can override the system but at a price penalty.
- Greater utilization of existing

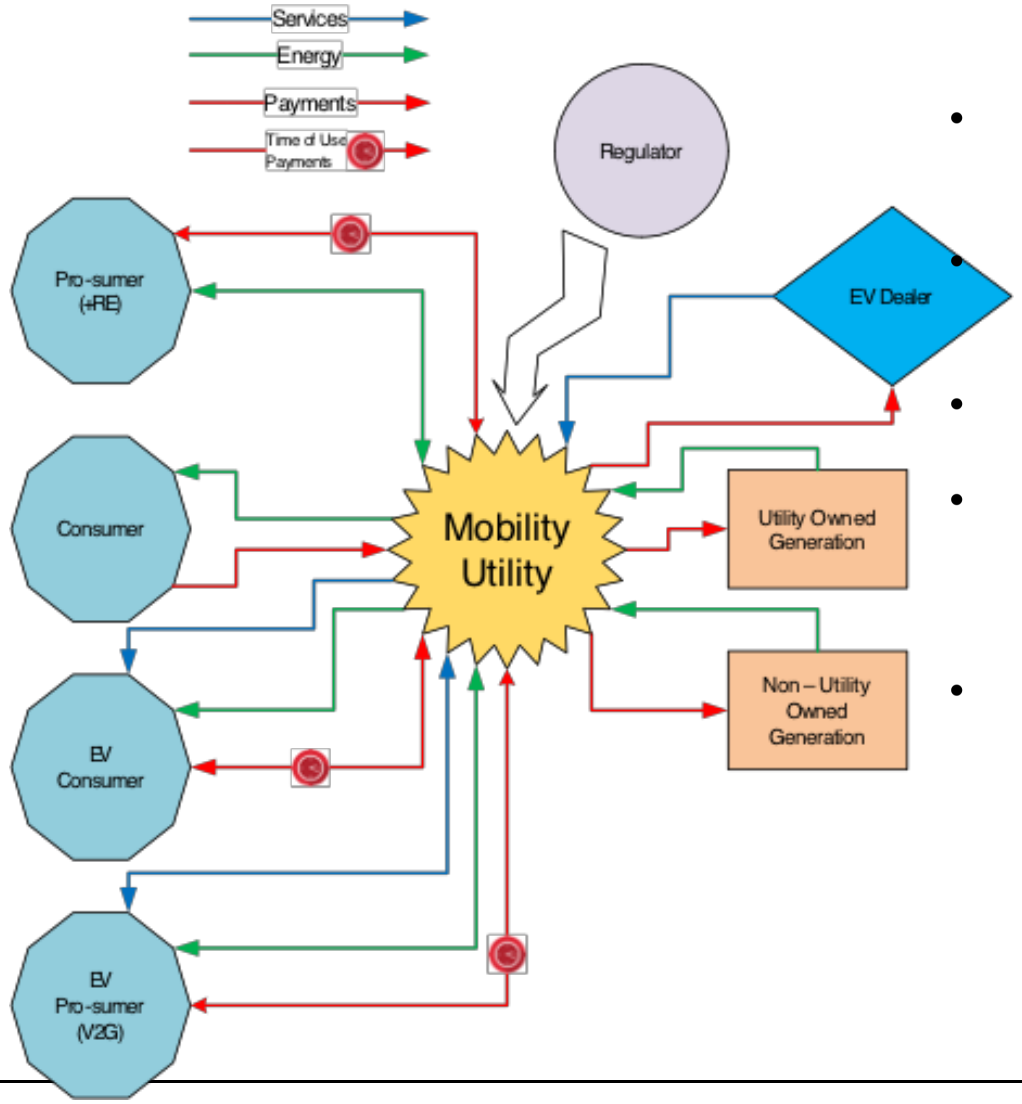
Archetype 4 -EV White Label



- In this archetype the private or commercial EV user purchases the vehicle and is offered an electricity tariff branded by the EV maker or official dealer.
- Vehicle to grid and vehicle to home services both become available, the energy utility in partnership with the vehicle manufacturer can offer battery condition guarantees to users in the same way other parts are covered by guarantee.
- consumers may trust vehicle manufacturer's more than utility companies to optimise the vehicle for energy market participation.



- One-stop shopping service that bundles together the sale, installation and after-maintenance of the system components.
- The package allows the customer to charge their EV/PHEV at home using solar generated power, and to supply electricity from their EV/PHEV to the home



Archetype 5: Mobility Utility

- Private and commercial EV users no longer purchase the vehicles but lease them via the electricity utility via special tariff.
- As the utility now owns both vehicle and battery, it can optimise electricity market functions against battery degradation concerns.
- Vehicle to grid and vehicle to home services both become available.
- Reduction of consumer risk this model offered as a positive for users adopting a new technology, particularly in the form of upfront purchase price barriers.
- This model has high potential to support the market for renewable power as a guaranteed off-peak load would exist for intermittent renewables.

Mobility Utility

- Work with EV manufacturers / dealers to get deals on EVs.
- Assist with deals on car insurance and tyres.
- Provide Smart Home Charger that offers 1/10 electricity rate during off-peak.
- Powerloop: lease new Nissan leaf, free V2G charging station.

Innovative Utility Business Models. – Electric Buses Chile

- 100 BYD Electric Buses
- Financed by the local subsidiary of the Italian power utility Enel Generacion Chile SA
- Leased by Enel to Metbus, a private Chilean company.

- 100 Zhengzhou Yutong Electric Buses.
- Financed by French energy generation firm Engie Energia Chile SA.

THANK YOU FOR LISTENING