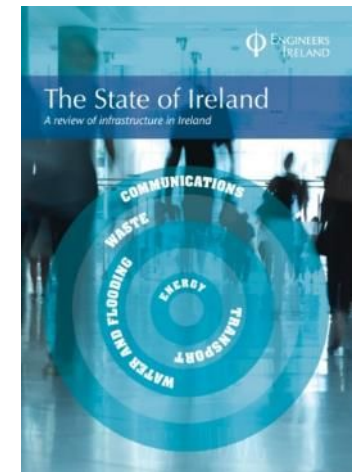
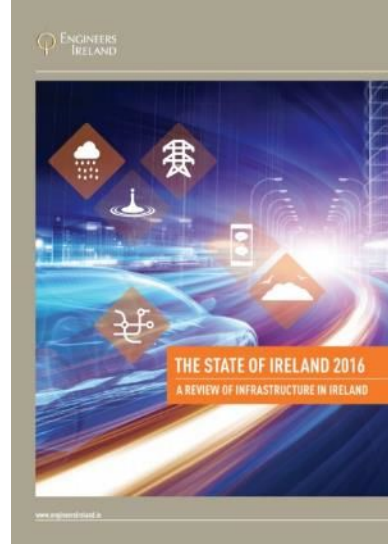


ROAD TRANSPORT IN IRELAND TO 2040 – EVOLUTION OR REVOLUTION ?

Dr. Kieran Feighan
September 28, 2017

THE STATE OF IRELAND



7th annual
independent
review of
infrastructure
in Ireland

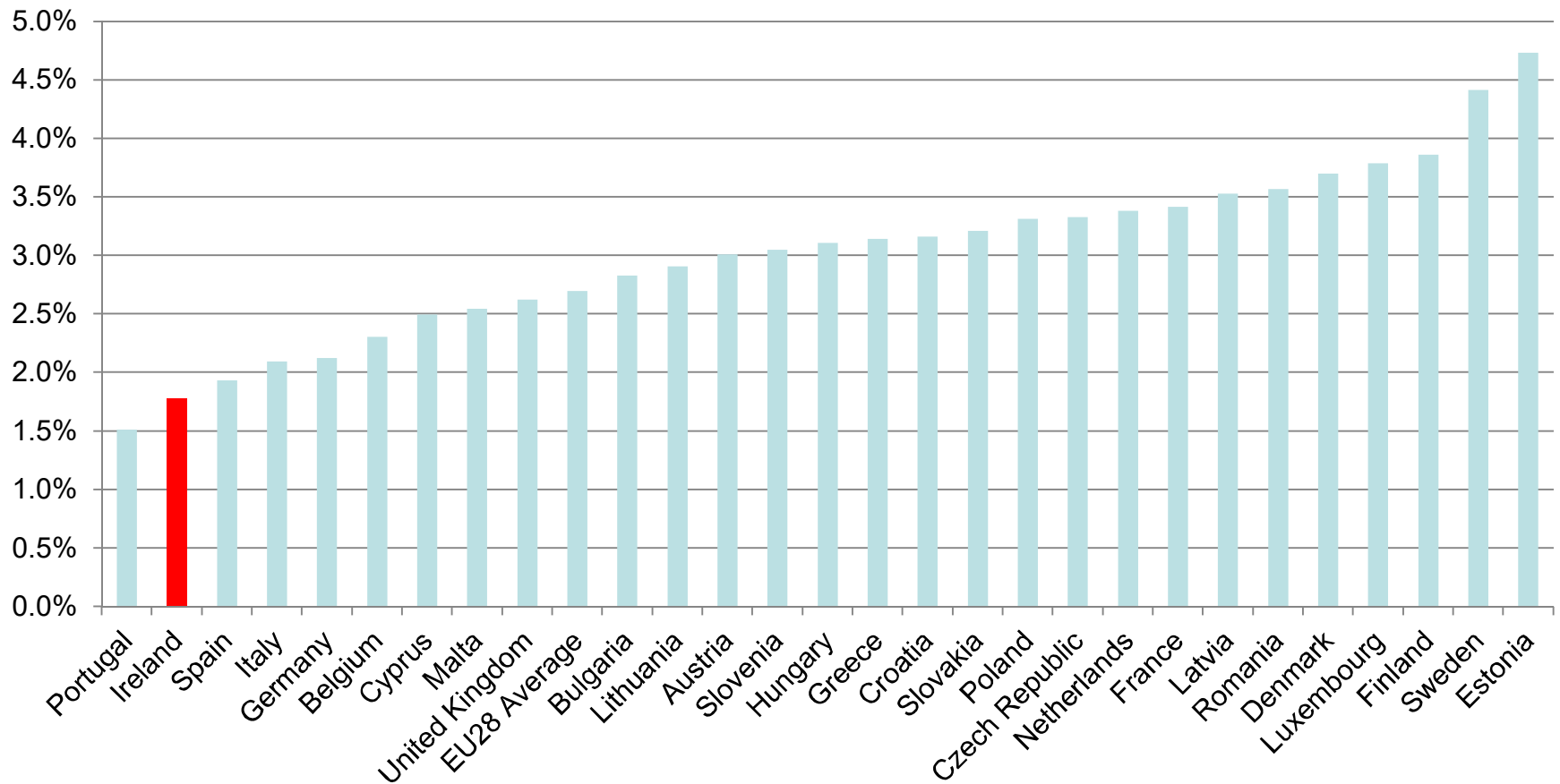
THE 'PERFECT STORM'

- Infrastructure is vital to enabling connectivity, health and wellbeing, and sustainable growth
- Yet we face a 'perfect storm' of pressures on our infrastructure
 - **Demographics:** population is expected to increase by over 750,000 in the next 20 years
 - **Climate action:** greenhouse gas emissions are behind targets
 - **Competitiveness:** congestion and future lack of capacity will hamper growth and employment in the coming years without swift action



THE 'PERFECT STORM'

Government investment in infrastructure (%GDP) in 2016
[Source: Eurostat]



Population Distribution

Year	Ireland	Global
	% in Cities	% in Cities
1961	33	29
1986	34	40
2016	34	54

Region	Area %	Population %
County Dublin	1	28
Rest of Leinster	27	27
Munster	35	27
Connacht/Ulster	36	18



An Phríomh-Oifig Staidrimh
Central Statistics Office

CENSUS 2016

Commuting
in Ireland

**census
2016**
RESULTS
www.cso.ie

COMMUTING TO WORK



28.2 minutes
**Average travel time
of commuting workers**

(26.6 minutes in 2011)



1,875,773
**Workers
commuting**

↑ up 11%



1,229,966
**commuted
by car**

↑ up 8%



175,080
**walking
commuters**

↑ up 3%



174,569
**public
transport
users**

↑ up 21%



56,837
**cycling
commuters**

↑ up 43%

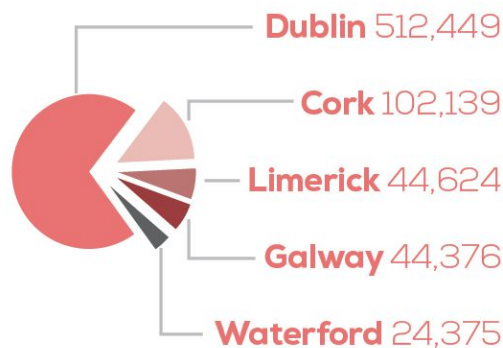
Cross Border Commuters



9,336
**commuting
to NI**

3,531
**commuting
outside island
of Ireland**

Working in the City



STUDENT COMMUTING



**Primary
Students**



**Secondary
Students**



**Third-level
Students**

Modes of Transport Used

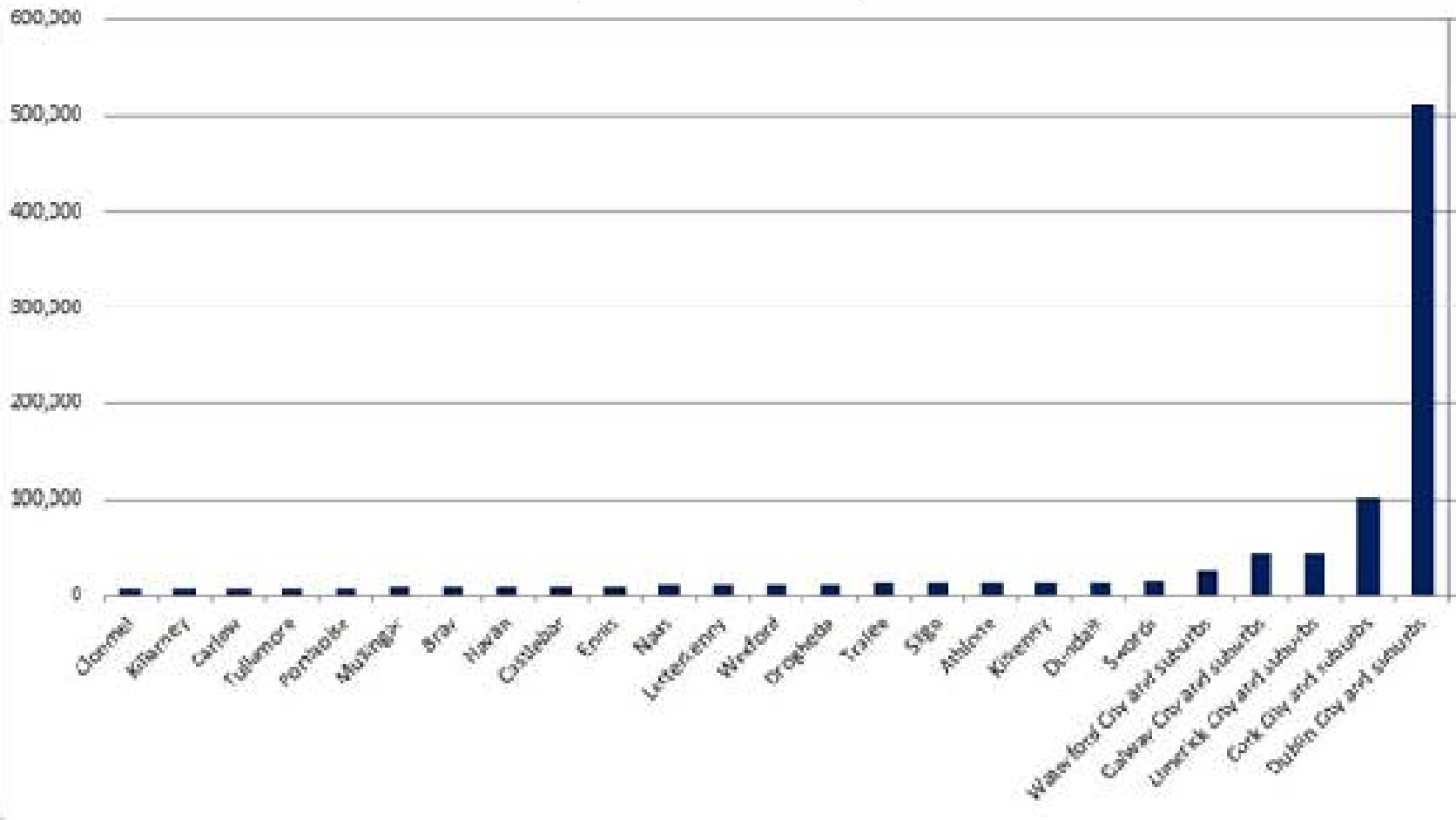


60% | 10% | 24%

43% | 28% | 21%

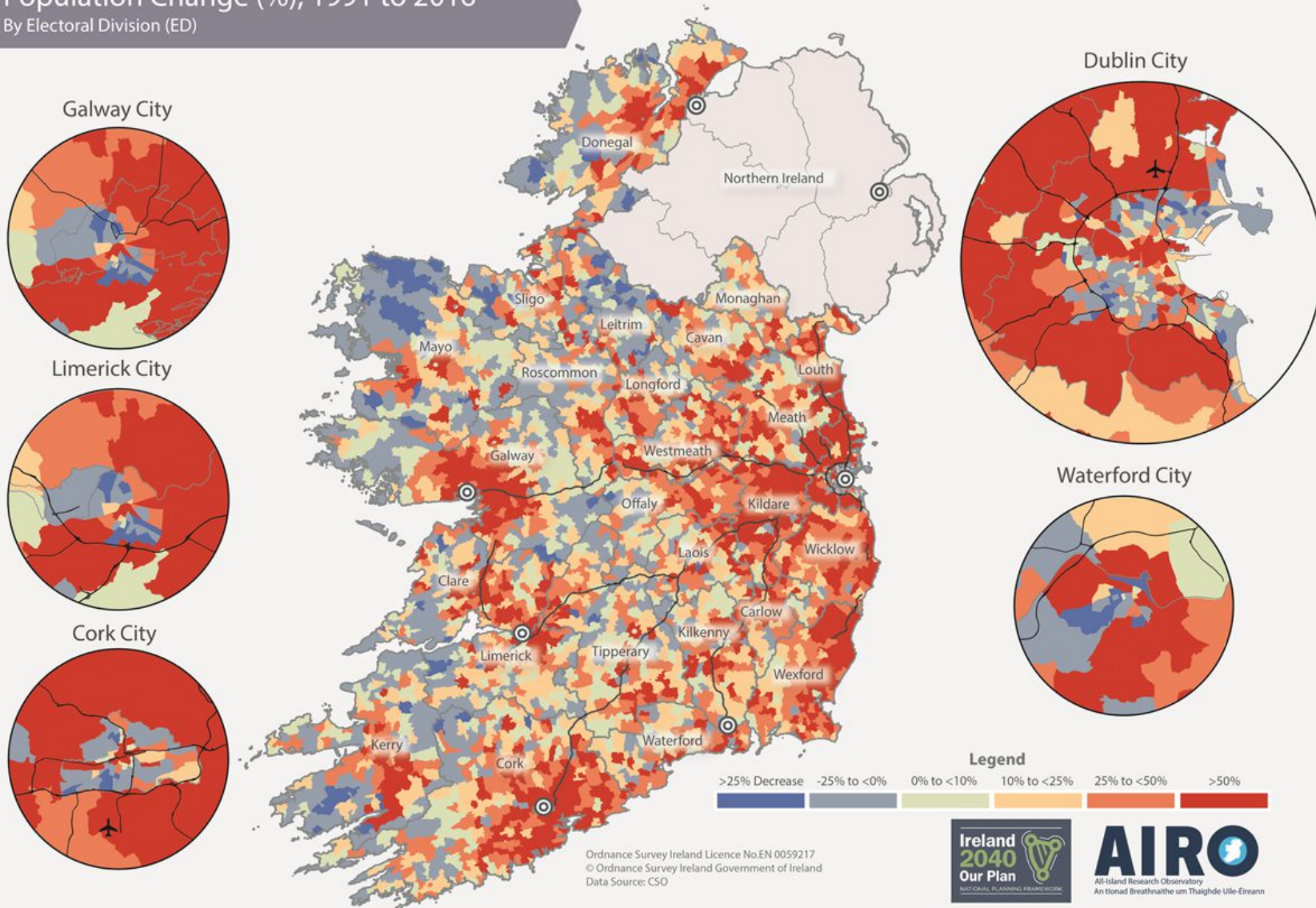
34% | 24% | 26%

Distribution of daytime workforce in 25 largest Irish towns and cities



Population Change

Population Change (%), 1991 to 2016
By Electoral Division (ED)



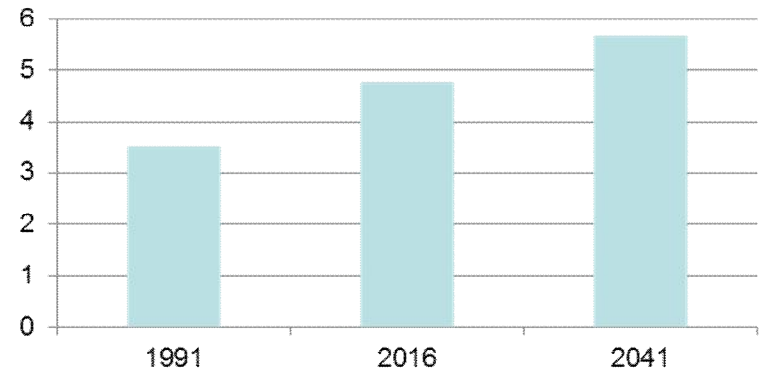
ESRI Analysis

- **Examines trends** - output, income, population, employment, jobs
- **Makes projections** - 'business as usual' baseline

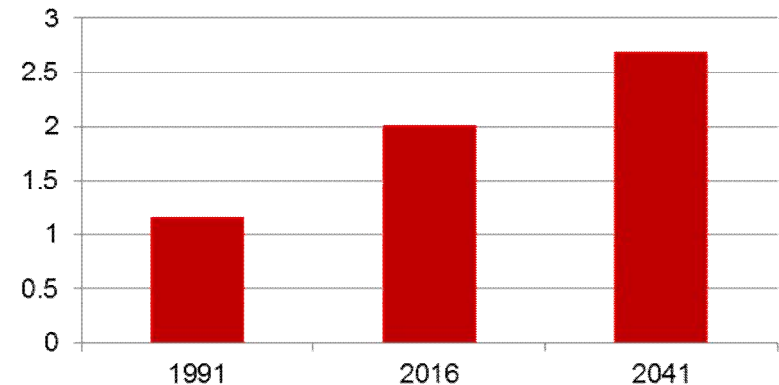
	2016	2040
Population	4.76	5.63 (million)
Jobs	2.02	2.67 (million)
Homes	2.00	2.55 (million)

- Assumes trends **accommodated**, also applies **regionally**

Population 1991-2040



Jobs 1991-2040



Major part of Ireland 2040: at least 600k of +1million pop by 2040 will be urban

Business as Usual:

- Dublin: 2011 – 1.1m 2040: 1.4m (fastest growth at edge)
- Cork: 2011 – 200k 2040: 240k (ring towns)
- Limerick: 2011 – 96k 2040: 115k (edges could grow fastest)
- Galway: 2011 – 93k 2040: 110k (eastwards growth)

Most cities have high potential for infill – limit “leakage” to surrounding rural areas

Create the conditions for urban regeneration, infill, densification

- **Governance** We need better consistency and collaboration across all levels of government in achieving agreed national and regional development outcomes.
 - **Regional development:** Our cities are crucial for regional development working with our towns and villages outside cities.
 - **National Infrastructure:** Co ordination of national infrastructure investment and place making. Broadband; integrated public transport systems between cities and towns/airports
-

- **Built Environment:** Recurring messages about increased density, building heights and compact approach, when done well, can make high quality living environment.
 - **All island approach** to growth and development (Brexit backdrop).
 - **Energy:** Clear desire to move towards renewables in general and greater certainty in decisions but less clarity about 'where' they should locate.
 - **Rural Development:** Importance of rural community development and big emphasis on role of towns
-

Energy Generation Storage

By Domestic, For Domestic

IT'S SOLAR ROOFS JIM – BUT NOT AS WE KNOW IT!



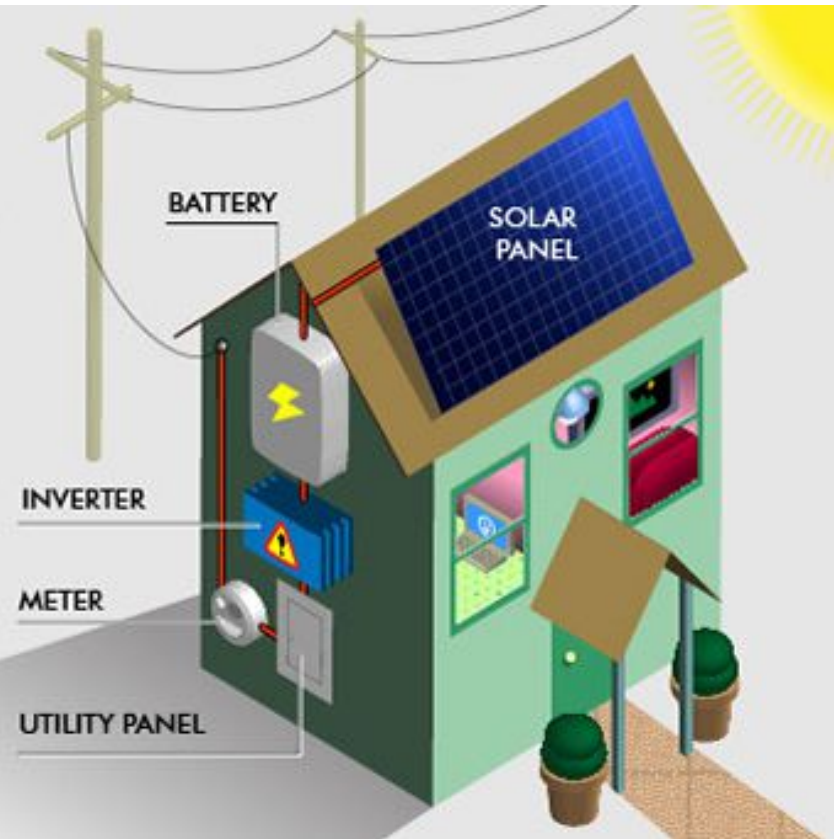
HOW POWERWALL WORKS

What's a solar battery like Powerwall for? If you have solar panels, these battery systems allow you to store the energy of the sun for use at night.

Without a battery, excess power is sent back to the power company.

- Solar panels turn the sun's energy into direct current (DC), which is stored in the battery.
- The stored power travels from the battery to an inverter.
- The inverter converts DC to alternating current (AC), which is what your home uses.
- The power goes directly into your home's main utility panel.

howstuffworks.com



CONSUMER pays for generation and storage
AC version for immediate consumption
DC version for charging at night

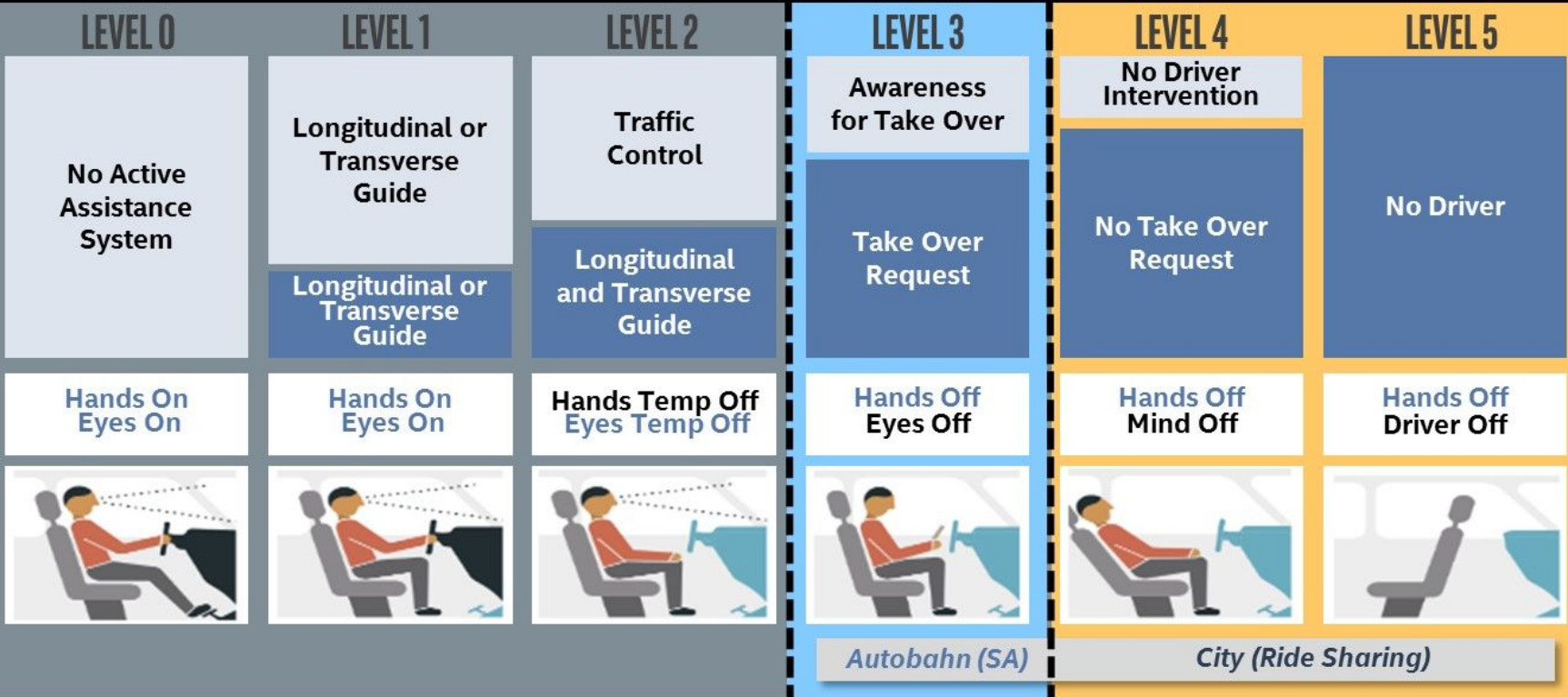


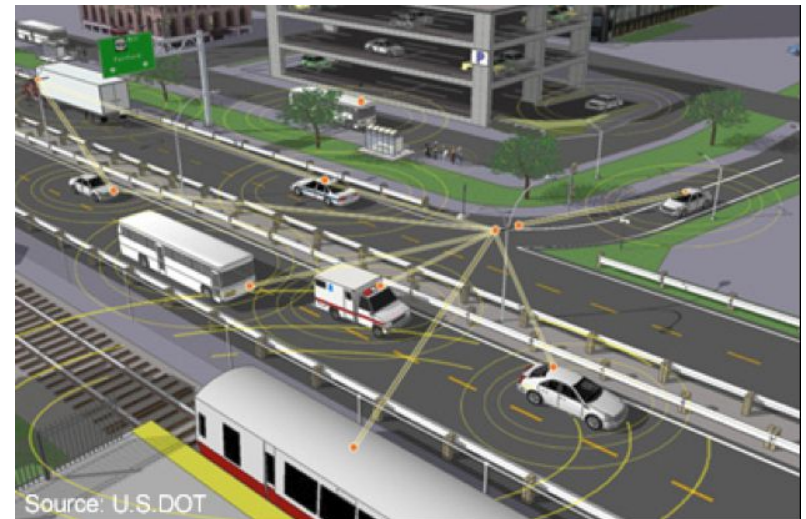
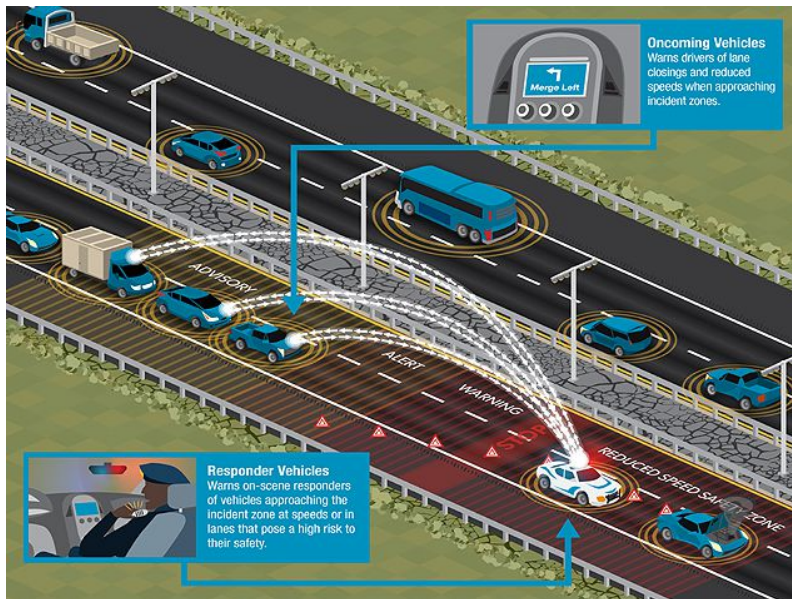
- If Elon Musk vision is correct
 - Much reduced excise duties on transport energy (no diesel or petrol)
 - Who pays for maintenance upkeep ?
 - User charging – per kilometre ?
 - Variable charging – M50, city centre, rural low volume ?
 - Who keeps the money ?
 - Who builds the controlling systems for billing and monitoring ? Irish Water 2 ???
-

Autonomous Vehicles

Human

Machine





GOOGLE CONCEPT VEHICLE



THE SHAPE OF THINGS TO COME?



“DRIVERLESS” TRUCK CONVOYS





First Mile/Last Mile connect to Public Transport

Engineering Complexity

- Interaction between AV and conventional cars
 - Interaction between AV and other road users (cyclists, motorcyclists, trucks, buses, taxis)
 - Interaction between AV and pedestrians
 - Interaction between AV and central controlling systems
 - Consistency of Signs and Markings
-



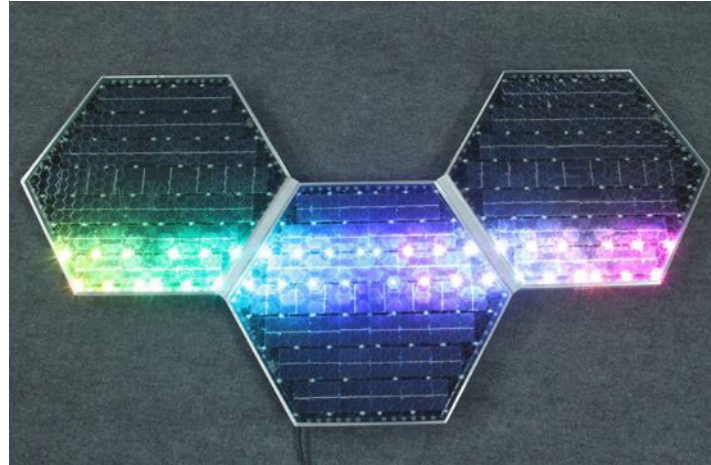
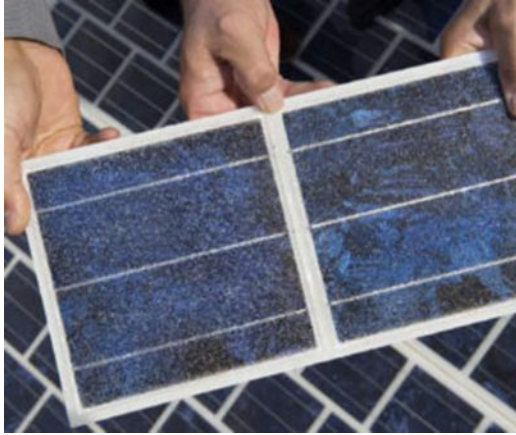


Transport Authority as Energy Supplier

SOLAR ROAD – COLAS, FRANCE



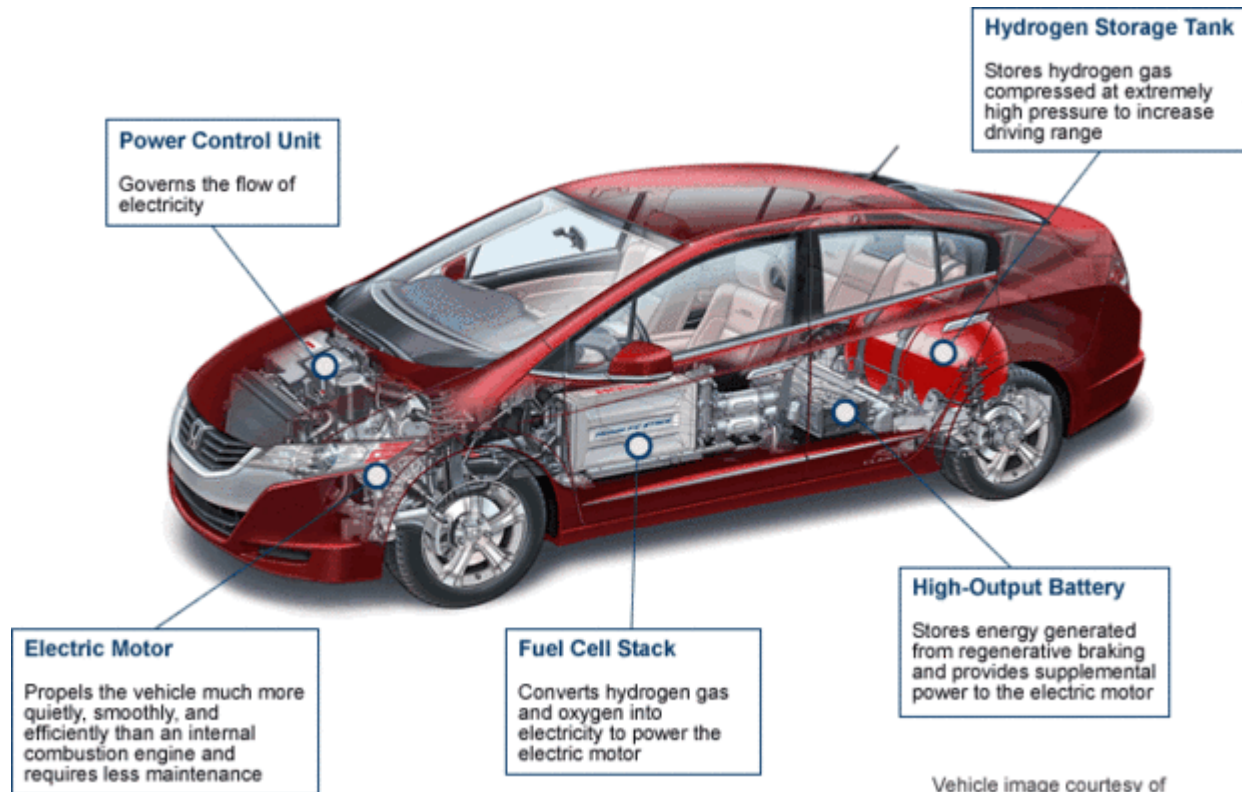
SOLAR ROADWAYS - USA



-
- Colas Project - €5 million per lane-km
 - Flat, not tilted to sun – problems at higher latitudes (like Ireland)
 - Blocked by Heavy Traffic
 - Blocked (potentially) by dirt, snow, water
 - Skid Resistance
 - Maintenance Costs
-

RETAIL OUTLETS – FUTURE??





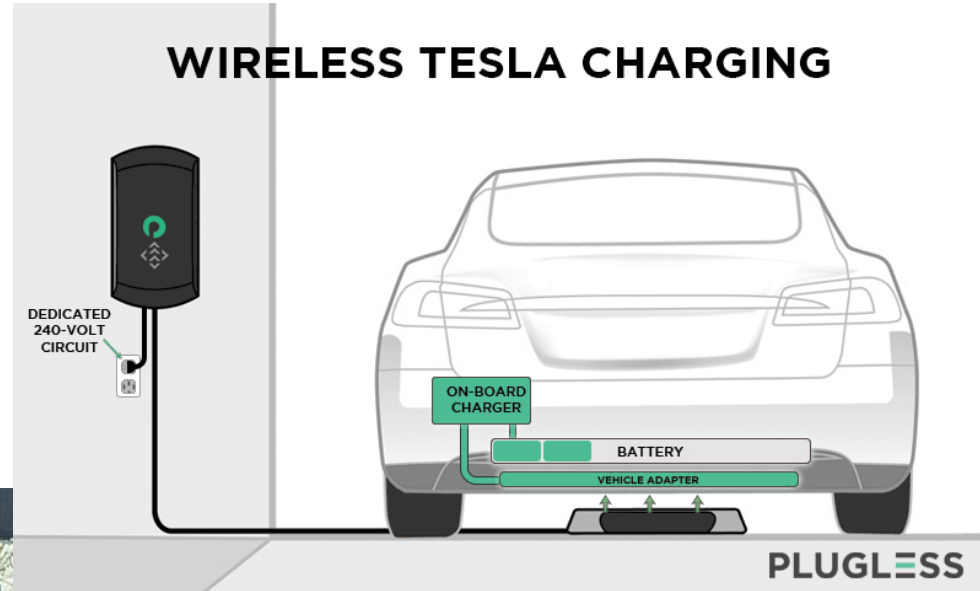


Dublin, September
2017

- H2USA – Public Private Partnership
 - Its mission is to promote the introduction and widespread adoption of fuel cell electric vehicles across the U.S.
 - Audi, Honda, Toyota, Hyundai, Chevy, Mercedes-Benz all with working Hydrogen Fuel Cells
 - 500 km before refill
-

- Drop in Carbon Fuel outlets in Ireland – c. 1800 retail outlets in 2016
 - Time to fill 60l tank: 2 minutes
 - ESB – currently 1200 charging points nationally
 - Fast Charge: 80% in 20 to 30 minutes
 - Home Charge: c. 6 hours
 - Hydrogen Fuel Cell
 - 5,000 psi (half tank) and 10,000 psi (full tank)
 - Time to fill tank: c. 4 to 6 minutes
-

WIRELESS CHARGING - STATIC





- Coils placed just beneath the pavement surface – Copper Wire and Semiconductors needed – Qualcomm already developing
- Trucks and Buses – much smaller batteries
- Railroads of the 21st century ?

- Safety - Transmitter coils emit significant power
- Cost – Install in new build quite cheaply, but retrofit to existing roads, very expensive.
- Charging for Charging – New infrastructure required – how to charge for “non-registered” vehicles.
- Who owns and maintains the infrastructure ?
Transport Authority/Electricity Provider/ Private Operator ?

Changing Face of Transport and Energy

-
- Batteries and Storage
 - Charging Devices
 - Hydrogen Production
 - Energy Efficiency Management
 - Smart Grids
 - Smart Sensors and Monitoring
 - Better, Faster, Smaller, All New
 - IOT – communication between Transport vehicles and Central control – Big Data – AV/CV
 - MAAS – Mobility as a Service
-

Crystal Ball Gazing 1

- Greater Dublin Area will have greater population, greater density, more non-road public transport, many more EV, AV may be constrained by legal and public policy issues
 - Road-based public transport will still be the primary mode of transport in Dublin and all other Irish cities
 - Waterford, Cork, Limerick – improved road linkages
 - Northwest to Dublin – improved road linkages
 - Regional City growth and densification will determine where the new people and new jobs will be
-

Crystal Ball Gazing 2

- Signs, lines, markings, guiderails, crash barriers – growth industry
 - Vehicle management systems, asset management systems, tolling systems, ITS, Smart Cities – growth industry
 - Driverless truck convoys – maybe – small distances to cover in Ireland
 - AV/CV to act as links to high density rail corridors for cities - likely
 - Charge as you go for buses and trucks – competing with CNG and Hydrogen
 - Lower Carbon-based vehicle usage - definitely
-

EVOLUTION OR REVOLUTION ?

- Evolution – vehicle types
 - Evolution – Autonomous Vehicles
 - Revolution – Fuel Types
 - Revolution – Fuel Supply
 - Evolution – Pavement Materials (Bitumen)
 - Evolution/Revolution – Connected Vehicles, Road Tolling
-