# Hybrid Electric Vehicles

## Contents


- 1 Objective
- 2 Hybrid electric vehicles
  - 2.1 Introduction
  - 2.2 Search
    - 2.2.1 Methodology
    - 2.2.2 Concept table
    - 2.2.3 Classification
      - 2.2.3.1 CPC/IPC Classes
      - 2.2.3.2 US Classes
      - 2.2.3.3 F-Term
- 3 Search Query
  - 3.1 German Language Search
  - 3.2 French Language Search
- 4 Insights on Complete Search Hits
  - 4.1 Key Assignees
  - 4.2 Publication Year Trend
  - 4.3 Priority Year Trend
  - 4.4 Priority Country
  - 4.5 Geographical Distribution
  - 4.6 Patent Status - Publication Year Wise
  - 4.7 Geographic Distribution - Publication Year Wise
- 5 Insights on Detailed Analysis for a Specific Set of Patent Documents
  - 5.1 Interactive Taxonomy
    - 5.1.1 Taxonomy Node Definitions
  - 5.2 Dolcera Dashboard for Patent Analysis
  - 5.3 Key Assignees (Selected Set)
  - 5.4 Publication Year Trend (Selected Set)
  - 5.5 Priority Year Trend (Selected Set)
  - 5.6 Granted Vs Published Assignee wise (Selected Set)
  - 5.7 Top Cited Assignees (Selected Set)
  - 5.8 Top Cited Patents
  - 5.9 Key Assignee Vs Countries
  - 5.10 Key Assignee Vs Publication Year
  - 5.11 Key Assignee Vs Type of Hybrid
  - 5.12 Key Assignee Vs Type of control
  - 5.13 Type of control Vs Publication Year
  - 5.14 Key Assignee Vs Energy Storage and Electric Power Converters
  - 5.15 Energy Storage Vs Publication Year
  - 5.16 Key Assignee Vs Type of transmission
  - 5.17 Alliance Mapping of Key Assignees
    - 5.17.1 Toyota
    - 5.17.2 Nissan Motors
    - 5.17.3 General Motors
    - 5.17.4 Daimler Ag
    - 5.17.5 ZF
    - 5.17.6 Volkswagen AG
    - 5.17.7 Hyundai Motors
    - 5.17.8 Ford Motors
    - 5.17.9 Denso Corporation


# Objective

This wiki is a demo which provides overall IP insights related to Hybrid Electric Vehicles. The wiki focuses on technological and IP related insights based on a set of selected patents.

# Hybrid electric vehicles

## Introduction

A hybrid electric vehicle (HEV) is a type of hybrid vehicle and electric vehicle which combines a conventional internal combustion engine (ICE) propulsion system with an electric propulsion system. The presence of the electric powertrain is intended to achieve either better fuel economy than a conventional vehicle or better performance. There are a variety of HEV types, and the degree to which they function as EVs varies as well. The most common form of HEV is the hybrid electric car, although hybrid electric trucks (pickups and tractors) and buses also exist. Modern HEVs make use of efficiency-improving technologies such as regenerative braking, which converts the vehicle's kinetic energy into electric energy to charge the battery, rather than wasting it as heat energy as conventional brakes do. Some varieties of HEVs use their internal combustion engine to generate electricity by spinning an electrical generator (this combination is known as a motor-generator), to either recharge their batteries or to directly power the electric drive motors. Many HEVs reduce idle emissions by shutting down the ICE when idle and restarting it when needed; this is known as a start-stop system. A hybrid-electric produces less emissions from its ICE than a comparably-sized gasoline car, since an HEV's gasoline engine is usually smaller than a comparably-sized pure gasoline-burning vehicle (natural gas and propane fuels produce lower emissions) and if not used to directly drive the car, can be geared to run at maximum efficiency, further improving fuel economy.Source HEV Wikipedia

Transportation accounts for 41% of the sources of global warming. Electric vehicles can help dramatically reduce the production of greenhouse gases. A hybrid electric vehicle combines the internal combustion engine with an electric propulsion system which helps it achieve better fuel economy than a conventional fuel engine based vehicle. Initially hybrid vehicles were considered unnecessary but with increase in the price of petroleum, automobile manufacturers started to release more hybrids. Now hybrid vehicles are expected to form a core segment of the automotive market in future. Over 6.8 million hybrid electric vehicles have been sold worldwide - with United States being the world's largest hybrid market followed by Japan. The most iconic hybrid vehicle brand has been **Toyota Prius** which also makes Toyota the market leader in hybrid vehicles followed by Honda.



**Toyota Prius**Source

## Search

### Methodology

- The search was run in Thomson innovation database.
- There was a narrow search and the keywords were restricted to Title,Abstract and Claims.
- A broad search in full text field and with broad classes, was also executed.
- The broad class search was restricted with keyword search.
- The search timeline is from 01st Jan 2010-31st Dec 2014.
- Relevant US, IPC, CPC and JP-F term classifications are used for searching patents.

### Concept table

| Hybrid electric vehicles | Vehicle | Electric Motor |
|---|---|---|
| HEV | Automotive | Electric motor |
| Hybrid Vehicles | Automobile | Electric-motor |
| Hybrid electric vehicles | Vehicle | Electric driven |
| hybridelectric | Motor-car | Electrically driven |
| Plug-In hybrid vehicles | Motor-vehicle | - |
| Charge-in hybrid vehicles | Motorcar | - |
| PHEV | Motorvehicle | - |

### Classification

#### CPC/IPC Classes

| CPC/IPC Class | Definition |
|---|---|
| B60K0001* | Vehicles in general ----- Arrangement or mounting of propulsion units or of transmissions in vehicles; Arrangement or mounting of plural diverse prime-movers; Auxiliary drives; instrumentation or dashboards for vehicles; Arrangements in connection with cooling, air intake, gas exhaust, or fuel supply, of propulsion units, in vehicles ----- Arrangement or mounting of electrical propulsion units |
| B60K2001* | Vehicles in general ----- Arrangement or mounting of propulsion units or of transmissions in vehicles; Arrangement or mounting of plural diverse prime-movers; Auxiliary drives; instrumentation or dashboards for vehicles; Arrangements in connection with cooling, air intake, gas exhaust, or fuel supply, of propulsion units, in vehicles ----- Arrangement or mounting of electrical propulsion units ----- {one motor mounted on a propulsion axle for rotating right and left wheels of this axle} |
| B60K00062* | Vehicles in general ----- Arrangement or mounting of propulsion units or of transmissions in vehicles; Arrangement or mounting of plural diverse prime-movers; Auxiliary drives; Instrumentation or dashboards for vehicles; Arrangements in connection with cooling, air intake, gas exhaust, or fuel supply, of propulsion units, in vehicle ----- Arrangement or mounting of plural diverse prime-movers for mutual or common propulsion, e.g. hybrid propulsion systems comprising electric motors and internal |

| | |
|---|---|
| | combustion engines ----- the prime-movers consisting of electric motors and internal combustion engines, e.g. HEVs |
| B60K2006262 | Vehicles in general ----- Arrangement or mounting of propulsion units or of transmissions in vehicles; Arrangement or mounting of plural diverse prime-movers; Auxiliary drives; Instrumentation or dashboards for vehicles; Arrangements in connection with cooling, air intake, gas exhaust, or fuel supply, of propulsion units, in vehicle ----- Arrangement or mounting of plural diverse prime-movers for mutual or common propulsion, e.g. hybrid propulsion systems comprising electric motors and internal combustion engines ----- the prime-movers consisting of electric motors and internal combustion engines, e.g. HEVs ----- characterised by apparatus, components or means specially adapted for HEVs ----- characterised by the motors or the generators ----- {the motor or generator are used as clutch, e.g. between engine and driveshaft} |
| B60K2006264 | Vehicles in general ----- Arrangement or mounting of propulsion units or of transmissions in vehicles; Arrangement or mounting of plural diverse prime-movers; Auxiliary drives; Instrumentation or dashboards for vehicles; Arrangements in connection with cooling, air intake, gas exhaust, or fuel supply, of propulsion units, in vehicle ----- Arrangement or mounting of plural diverse prime-movers for mutual or common propulsion, e.g. hybrid propulsion systems comprising electric motors and internal combustion engines ----- the prime-movers consisting of electric motors and internal combustion engines, e.g. HEVs ----- characterised by apparatus, components or means specially adapted for HEVs ----- characterised by the motors or the generators ----- {with outer rotor and inner stator} |
| B60K2006266 | Vehicles in general ----- Arrangement or mounting of propulsion units or of transmissions in vehicles; Arrangement or mounting of plural diverse prime-movers; Auxiliary drives; Instrumentation or dashboards for vehicles; Arrangements in connection with cooling, air intake, gas exhaust, or fuel supply, of propulsion units, in vehicle ----- Arrangement or mounting of plural diverse prime-movers for mutual or common propulsion, e.g. hybrid propulsion systems comprising electric motors and internal combustion engines ----- the prime-movers consisting of electric motors and internal combustion engines, e.g. HEVs ----- characterised by apparatus, components or means specially adapted for HEVs ----- characterised by the motors or the generators ----- {with two coaxial motors or generators} |
| B60K2006268 | Vehicles in general ----- Arrangement or mounting of propulsion units or of transmissions in vehicles; Arrangement or mounting of plural diverse prime-movers; Auxiliary drives; Instrumentation or dashboards for vehicles; Arrangements in connection with cooling, air intake, gas exhaust, or fuel supply, of propulsion units, in vehicle ----- Arrangement or mounting of plural diverse prime-movers for mutual or common propulsion, e.g. hybrid propulsion systems comprising electric motors and internal combustion engines ----- the prime-movers consisting of electric motors and internal combustion engines, e.g. HEVs ----- characterised by apparatus, components or means specially adapted for HEVs ----- characterised by the motors or the generators ----- {Electric drive motor starts the engine, i.e. used as starter motor} |
| B60K00063* | Vehicles in general ----- Arrangement or mounting of propulsion units or of transmissions in vehicles; Arrangement or mounting of plural diverse prime-movers; Auxiliary drives; Instrumentation or dashboards for vehicles; Arrangements in connection with cooling, air intake, gas exhaust, or fuel supply, of propulsion units, in vehicle ----- Arrangement or mounting of plural diverse prime-movers for mutual or common propulsion, e.g. hybrid propulsion systems comprising electric motors and internal combustion engines ----- the prime-movers consisting of electric motors and internal combustion engines, e.g. HEVs ----- characterised by apparatus, components or means specially adapted for HEVs ----- characterized by chargeable mechanical accumulators, e.g. flywheels |
| B60K2006381 | Vehicles in general ----- Arrangement or mounting of propulsion units or of transmissions in vehicles; Arrangement or mounting of plural diverse prime-movers; Auxiliary drives; Instrumentation or dashboards for vehicles; Arrangements in connection with cooling, air intake, gas exhaust, or fuel supply, of propulsion units, in vehicle ----- Arrangement or mounting of plural diverse prime-movers for mutual or common propulsion, e.g. hybrid propulsion systems comprising electric motors and internal combustion engines ----- the prime-movers consisting of electric motors and internal combustion engines, e.g. HEVs ----- characterised by apparatus, components or means specially adapted for HEVs ----- characterised by the driveline clutches ----- {characterized by driveline brakes} |
| B60K00064* | Vehicles in general ----- Arrangement or mounting of propulsion units or of transmissions in vehicles; Arrangement or mounting of plural diverse prime-movers; Auxiliary drives; Instrumentation or dashboards for vehicles; Arrangements in connection with cooling, air intake, gas exhaust, or fuel supply, of propulsion units, in vehicle ----- Arrangement or mounting of plural diverse prime-movers for mutual or common propulsion, e.g. hybrid propulsion systems comprising electric motors and internal combustion engines ----- the prime-movers consisting of electric motors and internal combustion engines, e.g. HEVs ----- characterised by the architecture of the hybrid electric vehicle |
| B60K20064808* | Vehicles in general ----- Arrangement or mounting of propulsion units or of transmissions in vehicles; Arrangement or mounting of plural diverse prime-movers; Auxiliary drives; Instrumentation or dashboards for vehicles; Arrangements in connection with cooling, air intake, gas exhaust, or fuel supply, of propulsion units, in vehicle ----- Arrangement or mounting of plural diverse prime-movers for mutual or common propulsion, e.g. hybrid propulsion systems comprising electric motors and internal combustion engines ----- the prime-movers consisting of electric motors and internal combustion engines, e.g. HEVs ----- characterised by the architecture of the hybrid electric vehicle ----- Parallel type ----- {Electric machine connected or connectable to gearbox output shaft} |
| B60K20064816 | Vehicles in general ----- Arrangement or mounting of propulsion units or of transmissions in vehicles; Arrangement or mounting of plural diverse prime-movers; Auxiliary drives; Instrumentation or dashboards for vehicles; Arrangements in connection with cooling, air intake, gas exhaust, or fuel supply, of propulsion units, in vehicle ----- Arrangement or mounting of plural diverse prime-movers for mutual or common propulsion, e.g. hybrid propulsion systems comprising electric motors and internal combustion engines ----- the prime-movers consisting of electric motors and internal combustion engines, e.g. HEVs ----- characterised by the architecture of the hybrid electric vehicle ----- Parallel type ----- {Electric machine connected or connectable to gearbox internal shaft} |
| B60K20064825 | Vehicles in general ----- Arrangement or mounting of propulsion units or of transmissions in vehicles; Arrangement or mounting of plural diverse prime-movers; Auxiliary drives; Instrumentation or dashboards for vehicles; Arrangements in connection with cooling, air intake, gas exhaust, or fuel supply, of propulsion units, in vehicle ----- Arrangement or mounting of plural diverse prime-movers for mutual or common propulsion, e.g. hybrid propulsion systems comprising electric motors and internal combustion engines ----- the prime-movers consisting of electric motors and internal combustion engines, e.g. HEVs ----- characterised by the architecture of the hybrid electric vehicle ----- Parallel type ----- {Electric machine connected or connectable to gearbox input shaft} |
| B60K20064833 | Vehicles in general ----- Arrangement or mounting of propulsion units or of transmissions in vehicles; Arrangement or mounting of plural diverse prime-movers; Auxiliary drives; Instrumentation or dashboards for vehicles; Arrangements in connection with cooling, air intake, gas exhaust, or fuel supply, of propulsion units, in vehicle ----- Arrangement or mounting of plural diverse prime-movers for mutual or common propulsion, e.g. hybrid propulsion systems comprising electric motors and internal combustion engines ----- the prime-movers consisting of electric motors and internal combustion engines, e.g. HEVs ----- characterised by the architecture of the hybrid electric vehicle ----- Parallel type ----- {Step up or reduction gearing driving generator, e.g. to operate generator in most efficient speed range} |

| | |
|---|---|
| B60K20064841 | Vehicles in general ----- Arrangement or mounting of propulsion units or of transmissions in vehicles; Arrangement or mounting of plural diverse prime-movers; Auxiliary drives; Instrumentation or dashboards for vehicles; Arrangements in connection with cooling, air intake, gas exhaust, or fuel supply, of propulsion units, in vehicle ----- Arrangement or mounting of plural diverse prime-movers for mutual or common propulsion, e.g. hybrid propulsion systems comprising electric motors and internal combustion engines ----- the prime-movers consisting of electric motors and internal combustion engines, e.g. HEVs ----- characterised by the architecture of the hybrid electric vehicle ----- Parallel type ----- {Step up or reduction gearing driving generator, e.g. to operate generator in most efficient speed range} ----- {the gear provides shifting between multiple ratios} |
| B60K00065* | Vehicles in general ----- Arrangement or mounting of propulsion units or of transmissions in vehicles; Arrangement or mounting of plural diverse prime-movers; Auxiliary drives; Instrumentation or dashboards for vehicles; Arrangements in connection with cooling, air intake, gas exhaust, or fuel supply, of propulsion units, in vehicle ----- Arrangement or mounting of plural diverse prime-movers for mutual or common propulsion, e.g. hybrid propulsion systems comprising electric motors and internal combustion engines ----- the prime-movers consisting of electric motors and internal combustion engines, e.g. HEVs ----- Architecture of the driveline characterised by arrangement or kind of transmission units |
| B60K2006541 | Vehicles in general ----- Arrangement or mounting of propulsion units or of transmissions in vehicles; Arrangement or mounting of plural diverse prime-movers; Auxiliary drives; Instrumentation or dashboards for vehicles; Arrangements in connection with cooling, air intake, gas exhaust, or fuel supply, of propulsion units, in vehicle ----- Arrangement or mounting of plural diverse prime-movers for mutual or common propulsion, e.g. hybrid propulsion systems comprising electric motors and internal combustion engines ----- the prime-movers consisting of electric motors and internal combustion engines, e.g. HEVs ----- Architecture of the driveline characterised by arrangement or kind of transmission units ----- Transmission for changing ratio ----- {without reverse ratio using instead electric reversing} |
| B60K2006542 | Vehicles in general ----- Arrangement or mounting of propulsion units or of transmissions in vehicles; Arrangement or mounting of plural diverse prime-movers; Auxiliary drives; Instrumentation or dashboards for vehicles; Arrangements in connection with cooling, air intake, gas exhaust, or fuel supply, of propulsion units, in vehicle ----- Arrangement or mounting of plural diverse prime-movers for mutual or common propulsion, e.g. hybrid propulsion systems comprising electric motors and internal combustion engines ----- the prime-movers consisting of electric motors and internal combustion engines, e.g. HEVs ----- Architecture of the driveline characterised by arrangement or kind of transmission units ----- Transmission for changing ratio ----- {with overdrive ratio} |
| B60L0008* | Vehicles in general ----- Electric equipment or propulsion of electrically-propelled vehicles; Magnetic suspension or levitation for vehicles; Electro-dynamic brake systems for vehicles, in general ----- Electric propulsion with power supply from force of nature, e.g. sun, wind |
| B60L0011* | Vehicles in general ----- Electric equipment or propulsion of electrically-propelled vehicles; Magnetic suspension or levitation for vehicles; Electro-dynamic brake systems for vehicles, in general ----- Electric propulsion with power supplied within the vehicle |
| B60L0011123 | Vehicles in general ----- Electric equipment or propulsion of electrically-propelled vehicles; Magnetic suspension or levitation for vehicles; Electrodynamic brake systems for vehicles, in general ----- Electric propulsion with power supplied within the vehicle ----- using engine-driven generators ----- with additional electric power supply, e.g. accumulator ----- {using range extenders, e. g. series hybrid vehicles} |
| B62M002302 | Land vehicles for travelling otherwise than on rails ----- Rider propulsion of wheeled vehicles or sledges; powered propulsion of sledges or cycles; Transmissions specially adapted for such vehicles ----- Transmissions characterised by use of other elements; other transmissions ----- characterised by the use of two or more dissimilar sources of power, e.g. transmissions for hybrid motorcycles |
| B60W001006 | Vehicles in general ----- Conjoint control of vehicle sub-units of different type or different function; Control systems specially adapted for hybrid vehicles; Road vehicle drive control systems for purposes not related to the control of a particular sub-unit ----- Conjoint control of vehicle sub-units of different type or different function ----- Including control of propulsion units ----- including control of combustion engines |
| B60W001008 | Vehicles in general ----- Conjoint control of vehicle sub-units of different type or different function; Control systems specially adapted for hybrid vehicles; Road vehicle drive control systems for purposes not related to the control of a particular sub-unit ----- Conjoint control of vehicle sub-units of different type or different function ----- Including control of propulsion units ----- including control of electric propulsion units, e.g. motors or generators |
| B60W0020* | Vehicles in general ----- Conjoint control of vehicle sub-units of different type or different function; Control systems specially adapted for hybrid vehicles; Road vehicle drive control systems for purposes not related to the control of a particular sub-unit ----- Control systems specially adapted for hybrid vehicles, i.e. vehicles having two or more prime movers of more than one type, e.g. electrical and internal combustion motors, all used for propulsion of the vehicle |
| Y10S0903* | Hybrid electric vehicles, HEVS |
| Y02T001062* | Climate change mitigation technologies related to transportation ----- Road transport of goods or passengers ----- Other road transportation technologies with climate change mitigation effect ( not used, see subgroups ) ----- Hybrid vehicles |

**US Classes**

| US Class | Definition |
|---|---|
| 18006521 | MOTOR VEHICLES ----- POWER ----- Electric ----- Hybrid vehicle |
| 903 | HYBRID ELECTRIC VEHICLES (HEVS) |

**F-Term**

| F-Term | Definition |
|---|---|
| 3D202 | HYBRID ELECTRIC VEHICLES |
| 3D235CC32 | ARRANGEMENT OR MOUNTING OF PROPULSION UNITS FOR VEHICLES ----- Internal combustion engines and electric motors |

| | |
|---|---|
| 3D301BA20 | VEHICLE BODY SUSPENSIONS --- Electrical vehicle, e.g. EV, HEV or FCEV |
| 5H601BB20 | IRON CORE OF ROTATING ELECTRIC MACHINES --- for EV drive including HEV and FCV |

## Search Query

- **Database**: Thomson Innovation
- **Timeline**: 1836/01/01 - 2014/12/31
- **Coverage**: US Grant, AU Innov, CA App, US App, AU Grant, FR App, EP Grant, AU App, DE Util, EP App, GB App, DE Grant, WO App, CA Grant, DE App, CN Util, ID Simple, KR Util , SG App, CN Grant, ID App, KR Grant, TH Grant, CN App, JP Util, KR App, VN Grant, IN Grant, JP Grant, MY Grant, VN App, IN App, JP App, SG Grant, Others

| S. No. | Search Concept | Class codes | Keywords | Hits |
|---|---|---|---|---|
| 1 | **Direct class codes of hybrid electric vehicles + keywords in full text** | Y10S0903* OR B60K2006542 OR B60K2006541 OR B60K00065* OR B60K20064841 OR B60K20064833 OR B60K20064825 OR B60K20064816 OR B60K20064808 OR B60K00064* OR B60K2006381 OR B60K00063* OR B60K2006268 OR B60K2006266 OR B60K2006264 OR B60K2006262 OR B60K00062* OR 903* OR 1800652* OR 3D202* OR 3D235CC32 | **Full Text=** ((((hybrid NEAR2 electric) OR hybridelectric OR electrichybrid) ADJ3 (vehicle* OR motorcar OR motorvehicle OR (motor ADJ1 (car OR vehicle)) OR automo*)) OR (HEV*2 OR PHEV*2) OR (((plug adj2 in) OR plugin OR charge-in) ADJ2 (hybridvehicle OR (hybrid ADJ2 (automo* OR vehicle* OR motorcar OR motorvehicle OR (motor ADJ1 (car OR vehicle))))))) **OR** ((hybrid ADJ2 (vehicle* OR motorcar OR motorvehicle OR (motor ADJ (car OR vehicle)) OR automo*)) AND ((electric*6 ADJ2 (machine*1 OR motor*1 OR drive*)) OR electricmotor OR electricdrive OR electricmachine)) | 45197 |
| 2 | **Electric propelled vehicles class codes + hybrid vehicles keywords** | B60W001008 OR B60L0011* OR B60L0008* OR B60K2001* OR B60K0001* | **Claims, Title, Abstract=** (hybrid NEAR2 (vehicle* OR motorcar OR motorvehicle OR (motor ADJ1 (car OR vehicle)) OR automo*)); | 70390 |
| 3 | **Broad class codes of hybrid vehicles + Electric drive keywords** | B62M002302 OR B60W0020* OR Y02T001062* | **Claims, Title, Abstract=** ((electric*6 ADJ2 (machine*1 OR motor*1 OR drive*)) OR electricmotor OR electricdrive OR electricmachine); | 39689 |
| 4 | **Miscellaneous (Controls of hybrid vehicles) class codes + HEV keywords** | B60W001006 OR B60L0011123 OR 3D301BA20 OR 5H601BB20 | **Claims, Title, Abstract=** ((((hybrid NEAR2 electric) OR hybridelectric OR electrichybrid) ADJ3 (vehicle* OR motorcar OR motorvehicle OR (motor ADJ1 (car OR vehicle)) OR automo*)) OR (HEV*2 OR PHEV*2) OR (((plug adj2 in) OR plugin OR charge-in) ADJ2 (hybridvehicle OR (hybrid ADJ2 (automo* OR vehicle* OR motorcar OR motorvehicle OR (motor ADJ1 (car OR vehicle))))))); | 7560 |
| 5 | **Only Hybrid Electric vehicle Keywords** | -- | **Claims, Title, Abstract=** ((((hybrid NEAR2 electric) OR hybridelectric OR electrichybrid) ADJ3 (vehicle* OR motorcar OR motorvehicle OR (motor ADJ1 (car OR vehicle)) OR automo*)) OR (HEV*2 OR PHEV*2) OR (((plug adj2 in) OR plugin OR charge-in) ADJ2 (hybridvehicle OR (hybrid ADJ2 (automo* OR vehicle* OR motorcar OR motorvehicle OR (motor ADJ1 (car OR vehicle))))))); | 74080 |
| 6 | **Combined query** | **1 OR 2 OR 3 OR 4 OR 5** | | **144885** |
| 7 | **Combined query for last 5 years** | **6 AND (DP>=(20100101) AND DP<=(20141231))** | | **87121 (36788 Unique INPADOC families)** |

## German Language Search

| S. No. | Search Concept | Class codes | German keyword Search | Hits |
|---|---|---|---|---|
| 1 | **Direct class codes of hybrid electric vehicles + keywords in full text** | Y10S0903* OR B60K2006542 OR B60K2006541 OR B60K00065* OR B60K20064841 OR B60K20064833 OR B60K20064825 OR B60K20064816 OR B60K20064808 OR B60K00064* OR B60K2006381 OR B60K00063* OR B60K2006268 OR B60K2006266 OR B60K2006264 OR B60K2006262 OR B60K00062* OR 903* OR 1800652* OR 3D202* OR | **Full Text=** (((hybrid NEAR2 elektrisch) OR ("Hybrid-Elektro") OR ("Elektro-Hybrid")) ADJ3 (Fahrzeug OR Fahrzeuge OR Automobil OR Motorwagen OR kraftfahrzeug OR KFZ OR Kraftwagen OR automotive OR Automoteur OR Kraftfahrzeugen OR (voiture ADJ1 motor))) OR (HEV*2 OR PHEV*2) OR (((plug ADJ2 in) OR plugin OR charge-in) ADJ2 (hybridvehicle OR (hybrid ADJ2 (Fahrzeug OR Fahrzeuge OR Automobil OR Motorwagen OR kraftfahrzeug OR KFZ OR Kraftwagen OR automotive OR Automoteur OR Kraftfahrzeugen OR (voiture ADJ1 motor))))) OR (((hybrid ADJ2 (Fahrzeug OR Fahrzeuge OR Automobil OR Motorwagen OR kraftfahrzeug OR KFZ OR Kraftwagen OR automotive OR Automoteur OR Kraftfahrzeugen OR (voiture ADJ1 motor))) OR (Hybridfahrzeugs OR Hybridfahrzeug OR "Hybrid-Kraftfahrzeug" OR "Hybrid-Fahrzeuge")) AND ((elektrisch ADJ2 (Maschine OR antrieb OR Laufwerk)) OR (Elektrische ADJ1 Drehmaschine) OR ElecktroAntriebsstrang OR Elektroantrieb OR Elektromotor OR (Elektrische ADJ1 Maschine))) OR HYBRIDANTRIEBSSTRANG OR (Hybrid ADJ1 Antriebsstrang) OR Hybridantriebes OR (Hybrid ADJ1 antriebes) OR ((Hybridsystem NEAR2 (Brennstoffzelle)) OR "FuelCELL-Hybrid" OR "Plug-In-Hybridtechnologie" OR Elektrohybridfahrzeuge OR | 11445 |

| | | | | |
|---|---|---|---|---|
| | | 3D235CC32 | "Hybrid-Elektrofahrzeuge" OR "Hybrid-Elektrokraftfahrzeugs" OR "Hybrid-Elektrofahrzeug" OR Elektrohybridfahrzeugs OR Elektrohybridfahrzeug) | |
| **2** | **Electric propelled vehicles class codes + hybrid vehicles keywords** | B60W001008 OR B60L0011* OR B60L0008* OR B60K2001* OR B60K0001* | **Claims, Title, Abstract**= ((hybrid ADJ2 (Fahrzeug OR Fahrzeuge OR Automobil OR Motorwagen OR kraftfahrzeug OR KFZ OR Kraftwagen OR automotive OR Automoteur OR Kraftfahrzeugen OR (voiture ADJ1 motor))) OR (Hybridfahrzeugs OR Hybridfahrzeug OR "Hybrid-Kraftfahrzeug" OR "Hybrid-Fahrzeuge")) OR (HYBRIDANTRIEBSSTRANG OR (Hybrid ADJ1 Antriebsstrang) OR Hybridantriebes OR (Hybrid ADJ1 antriebes)) | 4653 |
| **3** | **Broad class codes of hybrid vehicles + Electric drive keywords** | B62M002302 OR B60W0020* OR Y02T001062* | **Claims, Title, Abstract=** ((Elektrische ADJ1 Drehmaschine) OR ElecktroAntriebsstrang OR Elektroantrieb OR Elektromotor OR (Elektrische ADJ1 Maschine)) | 5978 |
| **4** | **Miscellaneous (Controls of hybrid vehicles) class codes + HEV keywords** | B60W001006 OR B60L0011123 OR 3D301BA20 OR 5H601BB20 | **Claims, Title, Abstract**=(((hybrid NEAR2 elektrisch) OR ("Hybrid-Elektro") OR ("Elektro-Hybrid")) ADJ3 (Fahrzeug OR Fahrzeuge OR Automobil OR Motorwagen OR kraftfahrzeug OR KFZ OR Kraftwagen OR automotive OR Automoteur OR Kraftfahrzeugen OR (voiture ADJ1 motor))) OR (HEV*2 OR PHEV*2) OR (((plug ADJ2 in) OR plugin OR charge-in) ADJ2 (hybridvehicle OR (hybrid ADJ2 (Fahrzeug OR Fahrzeuge OR Automobil OR Motorwagen OR kraftfahrzeug OR KFZ OR Kraftwagen OR automotive OR Automoteur OR Kraftfahrzeugen OR (voiture ADJ1 motor))))) OR (((hybrid ADJ2 (Fahrzeug OR Fahrzeuge OR Automobil OR Motorwagen OR kraftfahrzeug OR KFZ OR Kraftwagen OR automotive OR Automoteur OR Kraftfahrzeugen OR (voiture ADJ1 motor))) OR (Hybridfahrzeugs OR Hybridfahrzeug OR "Hybrid-Kraftfahrzeug" OR "Hybrid-Fahrzeuge")) AND ((elektrisch ADJ2 (Maschine OR antrieb OR Laufwerk)) OR (Elektrische ADJ Drehmaschine) OR ElecktroAntriebsstrang OR Elektroantrieb OR Elektromotor OR (Elektrische ADJ1 Maschine))) | 2041 |
| **5** | **Only Hybrid Electric vehicle Keywords** | -- | **Claims, Title, Abstract=** (((hybrid NEAR2 elektrisch) OR ("Hybrid-Elektro") OR ("Elektro-Hybrid")) ADJ3 (Fahrzeug OR Fahrzeuge OR Automobil OR Motorwagen OR kraftfahrzeug OR KFZ OR Kraftwagen OR automotive OR Automoteur OR Kraftfahrzeugen OR (voiture ADJ1 motor))) OR (HEV*2 OR PHEV*2) OR (((plug ADJ2 in) OR plugin OR charge-in) ADJ2 (hybridvehicle OR (hybrid ADJ2 (Fahrzeug OR Fahrzeuge OR Automobil OR Motorwagen OR kraftfahrzeug OR KFZ OR Kraftwagen OR automotive OR Automoteur OR Kraftfahrzeugen OR (voiture ADJ1 motor))))) OR (((hybrid ADJ2 (Fahrzeug OR Fahrzeuge OR Automobil OR Motorwagen OR kraftfahrzeug OR KFZ OR Kraftwagen OR automotive OR Automoteur OR Kraftfahrzeugen OR (voiture ADJ1 motor))) OR (Hybridfahrzeugs OR Hybridfahrzeug OR "Hybrid-Kraftfahrzeug" OR "Hybrid-Fahrzeuge")) AND ((elektrisch ADJ2 (Maschine OR antrieb OR Laufwerk)) OR (Elektrische ADJ1 Drehmaschine) OR ElecktroAntriebsstrang OR Elektroantrieb OR Elektromotor OR (Elektrische ADJ1 Maschine))) OR HYBRIDANTRIEBSSTRANG OR (Hybrid ADJ1 Antriebsstrang) OR Hybridantriebes OR (Hybrid ADJ1 antriebes) OR ((Hybridsystem NEAR2 (Brennstoffzelle)) OR "FuelCELL-Hybrid" OR "Plug-In-Hybridtechnologie" OR Elektrohybridfahrzeuge OR "Hybrid-Elektrofahrzeuge" OR "Hybrid-Elektrokraftfahrzeugs" OR "Hybrid-Elektrofahrzeug" OR Elektrohybridfahrzeugs OR Elektrohybridfahrzeug) | 17313 |
| **6** | **Combined query** | **1 OR 2 OR 3 OR 4 OR 5** | | **30648** |
| **7** | **Combined query for last 5 years** | **6 AND (DP>=(20100101) AND DP<=(20141231))** | | **17073** |

## French Language Search

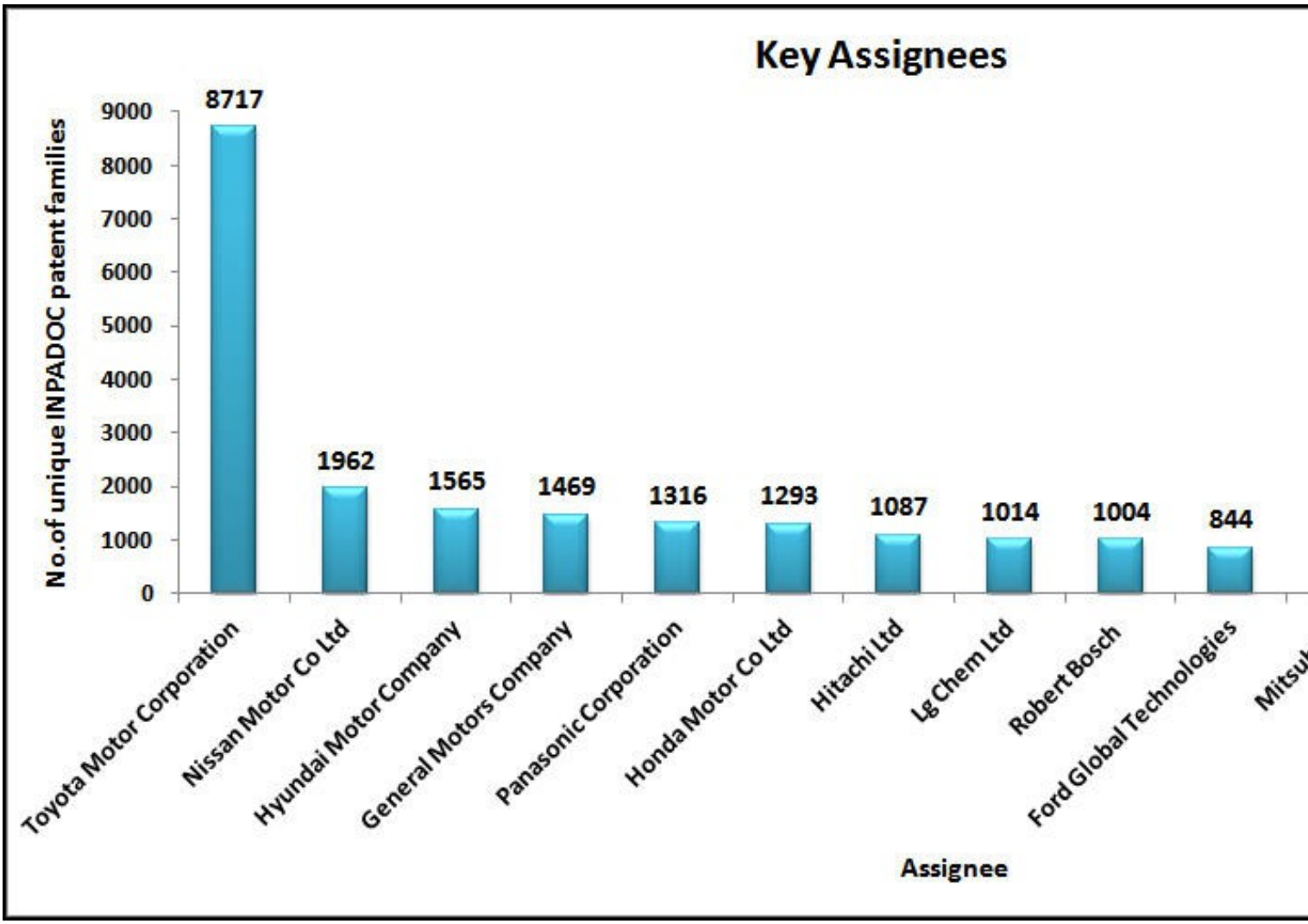
| S. No. | Search Concept | Class codes | French Keyword Search | Hits |
|---|---|---|---|---|
| **1** | **Direct class codes of hybrid electric vehicles + keywords in full text** | Y10S0903* OR B60K2006542 OR B60K2006541 OR B60K00065* OR B60K20064841 OR B60K20064833 OR B60K20064825 OR B60K20064816 OR B60K20064808 OR B60K00064* OR B60K2006381 OR B60K00063* OR B60K2006268 OR B60K2006266 OR B60K2006264 OR B60K2006262 OR B60K00062* OR 903* OR 1800652* OR 3D202* OR 3D235CC32 | **Full Text=** (((hybride NEAR2 ELECTRIQUE) OR ("ELECTRIQUE HYBRIDE") OR ("ELECTRIQUE HYBRIDES")) ADJ3 (AUTOMOBILE OR VEHICULES OR véhicule OR véhicules OR VEHICULE OR (Véhicule NEAR1 automobile) OR Automoteur OR (voiture ADJ motor))) OR (HEV*2 OR PHEV*2) OR (((plug adj2 in) OR plugin) ADJ2 ("véhicule hybride" OR (hybride ADJ2 (AUTOMOBILE OR VEHICULES OR véhicule OR véhicules OR VEHICULE OR (Véhicule NEAR1 automobile) OR Automoteur OR (voiture ADJ motor))))) OR (((hybrid ADJ2 (AUTOMOBILE OR VEHICULES OR véhicule OR véhicules OR VEHICULE OR (Véhicule NEAR1 automobile) OR Automoteur OR (voiture ADJ motor))) OR ("Système d?entraînement hybride" OR "Traction Hybride" OR "Propulsion Hybride" OR "GROUPE MOTOPROPULSEUR HYBRIDE" OR "Entraînement hybride")) AND ((ELECTRIQUE NEAR2 (Machine OR moteur OR (UN ADJ1 MOTEUR) OR (DE ADJ1 TRACTION) OR (entraînement) OR ("chaîne de traction"))) OR "entraînement électrique" OR "chaîne de traction électrique" OR "groupe motopropulseur électrique")) OR ("Pile à combustible HYBRIDE") OR ("Pile à combustible HYBRIDES") OR ("FuelCELL-hybride") OR (hybride ADJ2 rechargeable) OR ("HYBRIDEs ELECTRIQUE VEHICULES") OR ("HYBRIDE ELECTRIQUE véhicules") OR ("HYBRIDE ELECTRIQUE VEHICULES") | 8863 |
| **2** | **Electric propelled vehicles class** | B60W001008 OR B60L0011* OR B60L0008* OR B60K2001* OR B60K0001* | **Claims, Title, Abstract**= ((hybrid ADJ2 (AUTOMOBILE OR VEHICULES OR véhicule OR véhicules OR VEHICULE OR (Véhicule NEAR1 automobile) OR Automoteur OR (voiture ADJ motor))) OR ("Système d?entraînement hybride" | 3618 |

| | | | | |
|---|---|---|---|---|
| | **codes + hybrid vehicles keywords** | | OR "Traction Hybride" OR "Propulsion Hybride" OR "GROUPE MOTOPROPULSEUR HYBRIDE" OR "Entraînement hybride")) | |
| **3** | **Broad class codes of hybrid vehicles + Electric drive keywords** | B62M002302 OR B60W0020* OR Y02T001062* | **Claims, Title, Abstract=** (((ELECTRIQUE OR électrique) NEAR2 (Machine OR moteur OR (UN ADJ1 MOTEUR) OR (DE ADJ1 TRACTION) OR (entraînement) OR ("chaîne de traction"))) OR "entraînement électrique" OR "chaîne de traction électrique" OR "groupe motopropulseur électrique") | 9451 |
| **4** | **Miscellaneous (Controls of hybrid vehicles) class codes + HEV keywords** | B60W001006 OR B60L0011123 OR 3D301BA20 OR 5H601BB20 | **Claims, Title, Abstract**=(((hybride NEAR2 ELECTRIQUE) OR ("ELECTRIQUE HYBRIDE") OR ("ELECTRIQUE HYBRIDES")) ADJ3 (AUTOMOBILE OR VEHICULES OR véhicule OR véhicules OR VEHICULE OR (Véhicule NEAR1 automobile) OR Automoteur OR (voiture ADJ motor))) OR (HEV*2 OR PHEV*2) OR (((plug adj2 in) OR plugin) ADJ2 ("véhicule hybride" OR (hybride ADJ2 (AUTOMOBILE OR VEHICULES OR véhicule OR véhicules OR VEHICULE OR (Véhicule NEAR1 automobile) OR Automoteur OR (voiture ADJ motor))))) OR (((hybrid ADJ2 (AUTOMOBILE OR VEHICULES OR véhicule OR véhicules OR VEHICULE OR (Véhicule NEAR1 automobile) OR Automoteur OR (voiture ADJ motor))) OR ("Système d?entraînement hybride" OR "Traction Hybride" OR "Propulsion Hybride" OR "GROUPE MOTOPROPULSEUR HYBRIDE" OR "Entraînement hybride")) AND ((ELECTRIQUE NEAR2 (Machine OR moteur OR (UN ADJ1 MOTEUR) OR (DE ADJ1 TRACTION) OR (entraînement) OR ("chaîne de traction"))) OR "entraînement électrique" OR "chaîne de traction électrique" OR "groupe motopropulseur électrique")) OR ("Pile à combustible HYBRIDE") OR ("Pile à combustible HYBRIDES") OR ("FuelCELL-hybride") OR (hybride ADJ2 rechargeable) OR ("HYBRIDEs ELECTRIQUE VEHICULES") OR ("HYBRIDE ELECTRIQUE véhicules") OR ("HYBRIDE ELECTRIQUE VEHICULES") | 2153 |
| **5** | **Only Hybrid Electric vehicle Keywords** | -- | **Claims, Title, Abstract=** (((hybride NEAR2 ELECTRIQUE) OR ("ELECTRIQUE HYBRIDE") OR ("ELECTRIQUE HYBRIDES")) ADJ3 (AUTOMOBILE OR VEHICULES OR véhicule OR véhicules OR VEHICULE OR (Véhicule NEAR1 automobile) OR Automoteur OR (voiture ADJ motor))) OR (HEV*2 OR PHEV*2) OR (((plug adj2 in) OR plugin) ADJ2 ("véhicule hybride" OR (hybride ADJ2 (AUTOMOBILE OR VEHICULES OR véhicule OR véhicules OR VEHICULE OR (Véhicule NEAR1 automobile) OR Automoteur OR (voiture ADJ motor))))) OR (((hybrid ADJ2 (AUTOMOBILE OR VEHICULES OR véhicule OR véhicules OR VEHICULE OR (Véhicule NEAR1 automobile) OR Automoteur OR (voiture ADJ motor))) OR ("Système d?entraînement hybride" OR "Traction Hybride" OR "Propulsion Hybride" OR "GROUPE MOTOPROPULSEUR HYBRIDE" OR "Entraînement hybride")) AND ((ELECTRIQUE NEAR2 (Machine OR moteur OR (UN ADJ1 MOTEUR) OR (DE ADJ1 TRACTION) OR (entraînement) OR ("chaîne de traction"))) OR "entraînement électrique" OR "chaîne de traction électrique" OR "groupe motopropulseur électrique")) OR ("Pile à combustible HYBRIDE") OR ("Pile à combustible HYBRIDES") OR ("FuelCELL-hybride") OR (hybride ADJ2 rechargeable) OR ("HYBRIDEs ELECTRIQUE VEHICULES") OR ("HYBRIDE ELECTRIQUE véhicules") OR ("HYBRIDE ELECTRIQUE VEHICULES") | 16858 |
| **6** | **Combined query** | **1 OR 2 OR 3 OR 4 OR 5** | | **32686** |
| **7** | **Combined query for last 5 years** | **6 AND (DP>=(20100101) AND DP<=(20141231))** | | **18912** |

# Insights on Complete Search Hits

- Following are the insights obtained from the search results(taking unique INPADOC patent families) when restricted to the last 5 years (2010-2014).

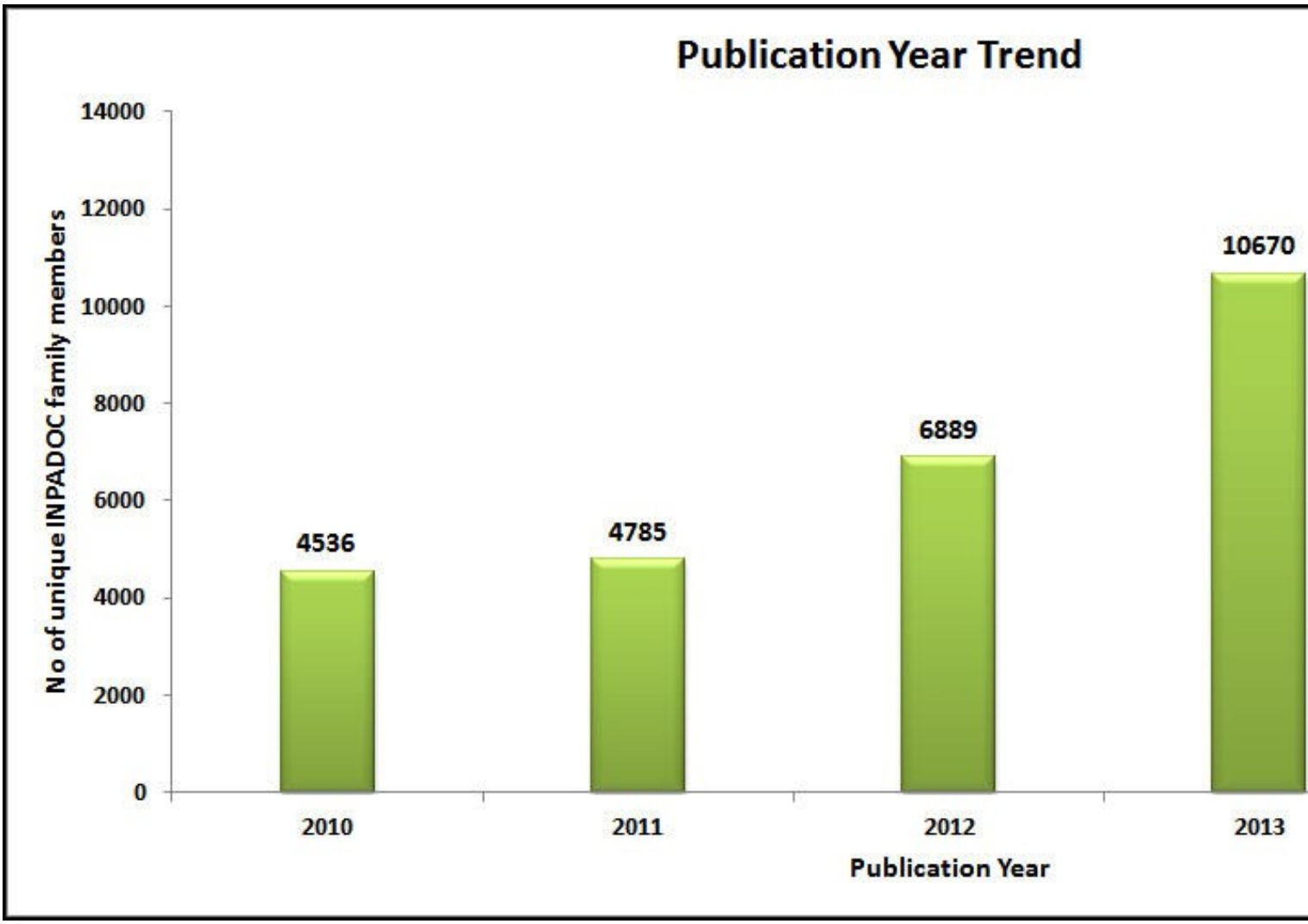
## Key Assignees




"Key Assignees in Hybrid Electric Vehicles"

- Toyota Motors has the highest number of published patents - with 8717 unique patent families, followed by Nissan Motors(1962), Hyundai Motors(1565) and General Motors(1469) respectively.
- There is a significant difference in patent publications between Toyota Motors and other assignees.

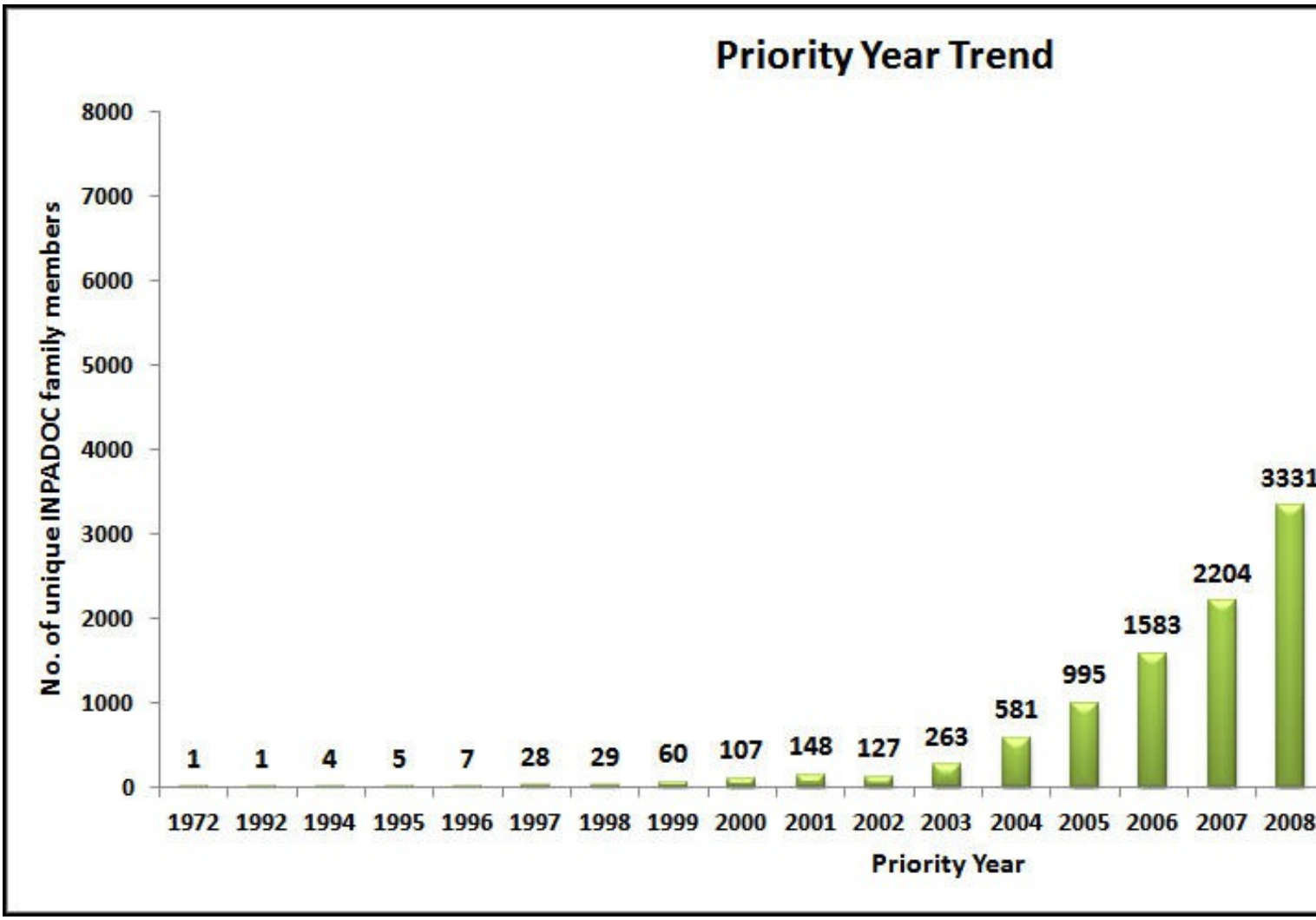
## Publication Year Trend




"Overall Publication year trend"

- There has been an increase in patent publication activity over the last 5 years.
- Major increase in patent publication activity is observed in the year 2013.

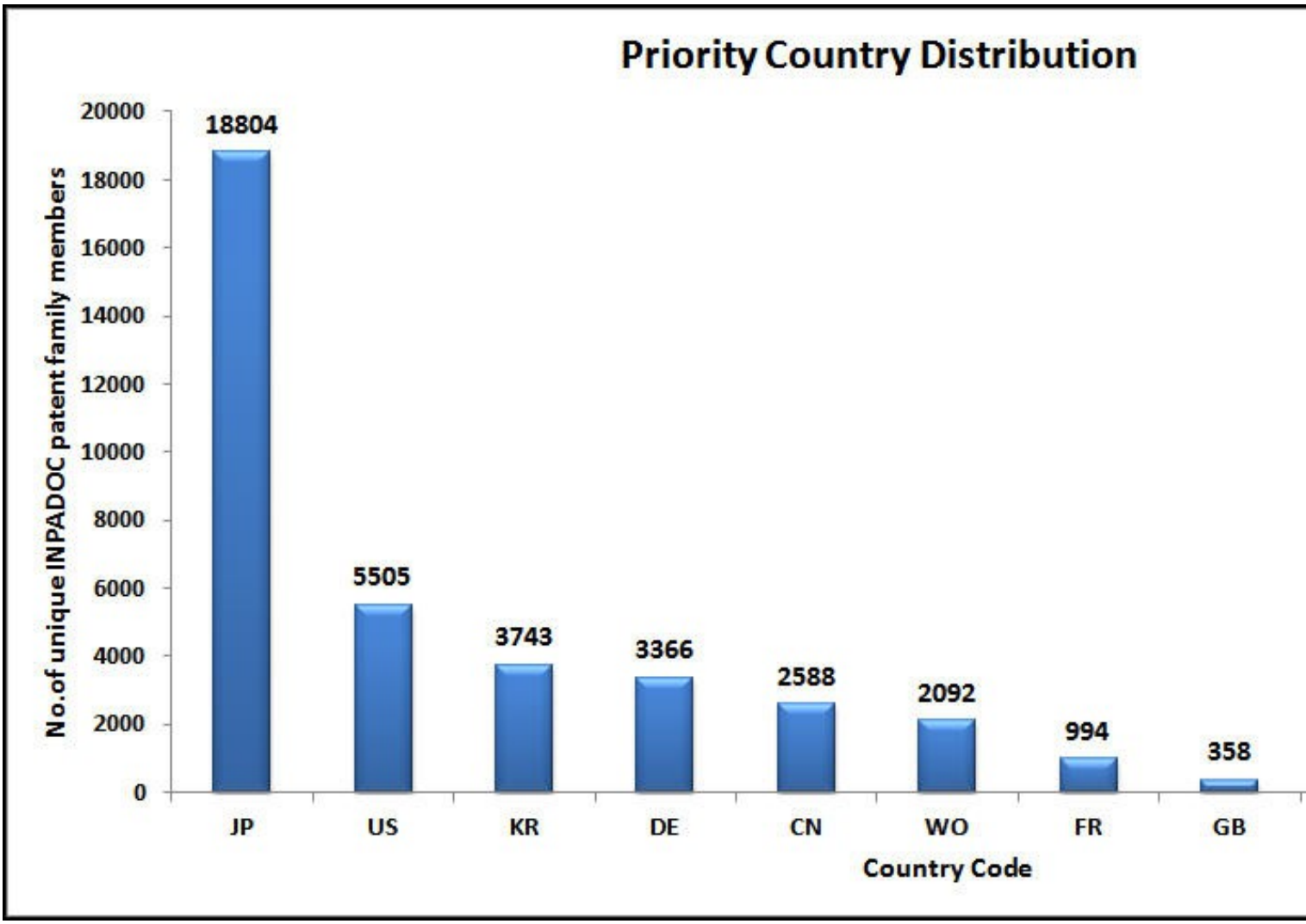
## Priority Year Trend



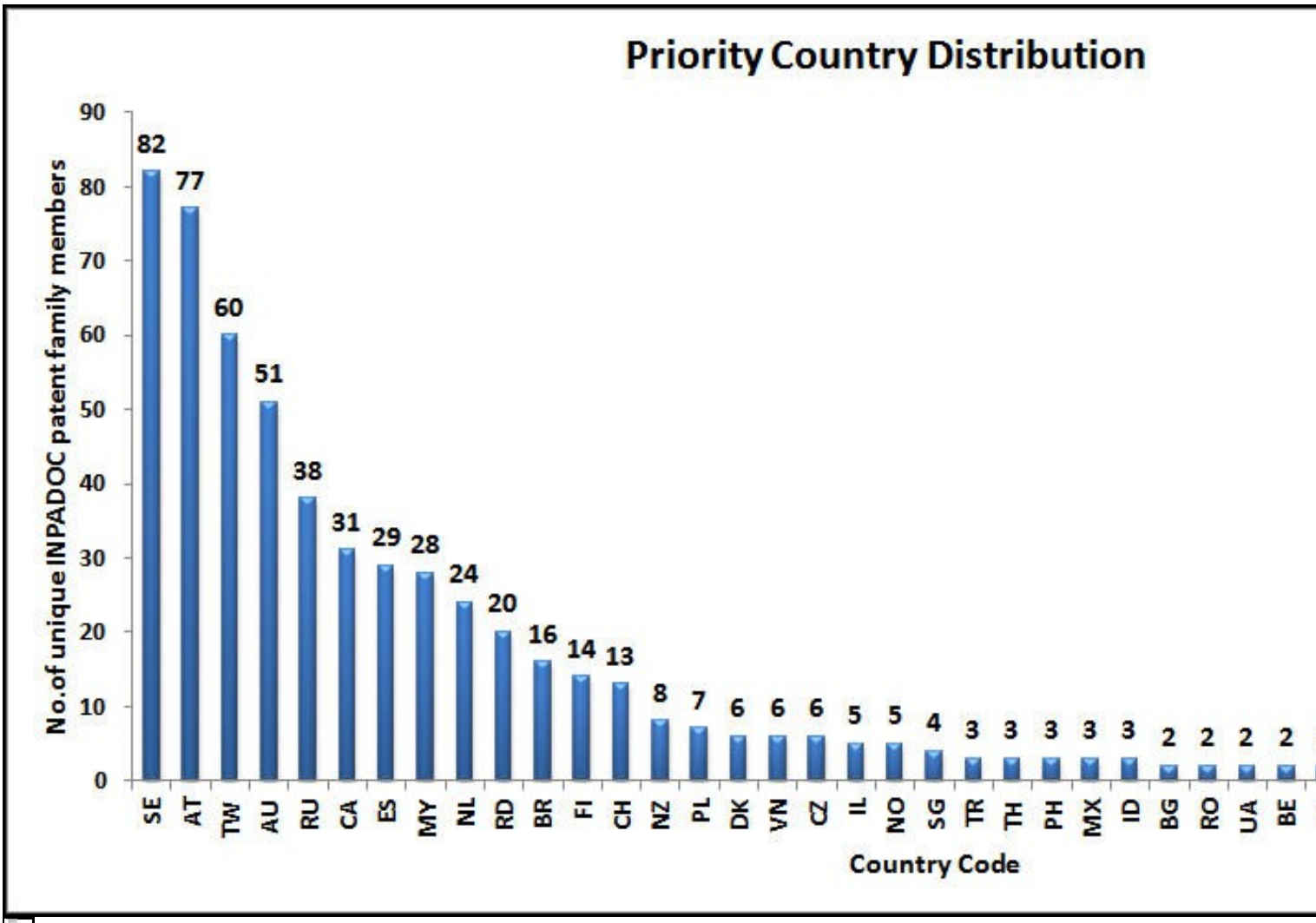

"Overall Priority year trend"

- The priority year wise graph shows an exponential growth in patent filings from 2002 to 2011.

## Priority Country




"Priority Country"

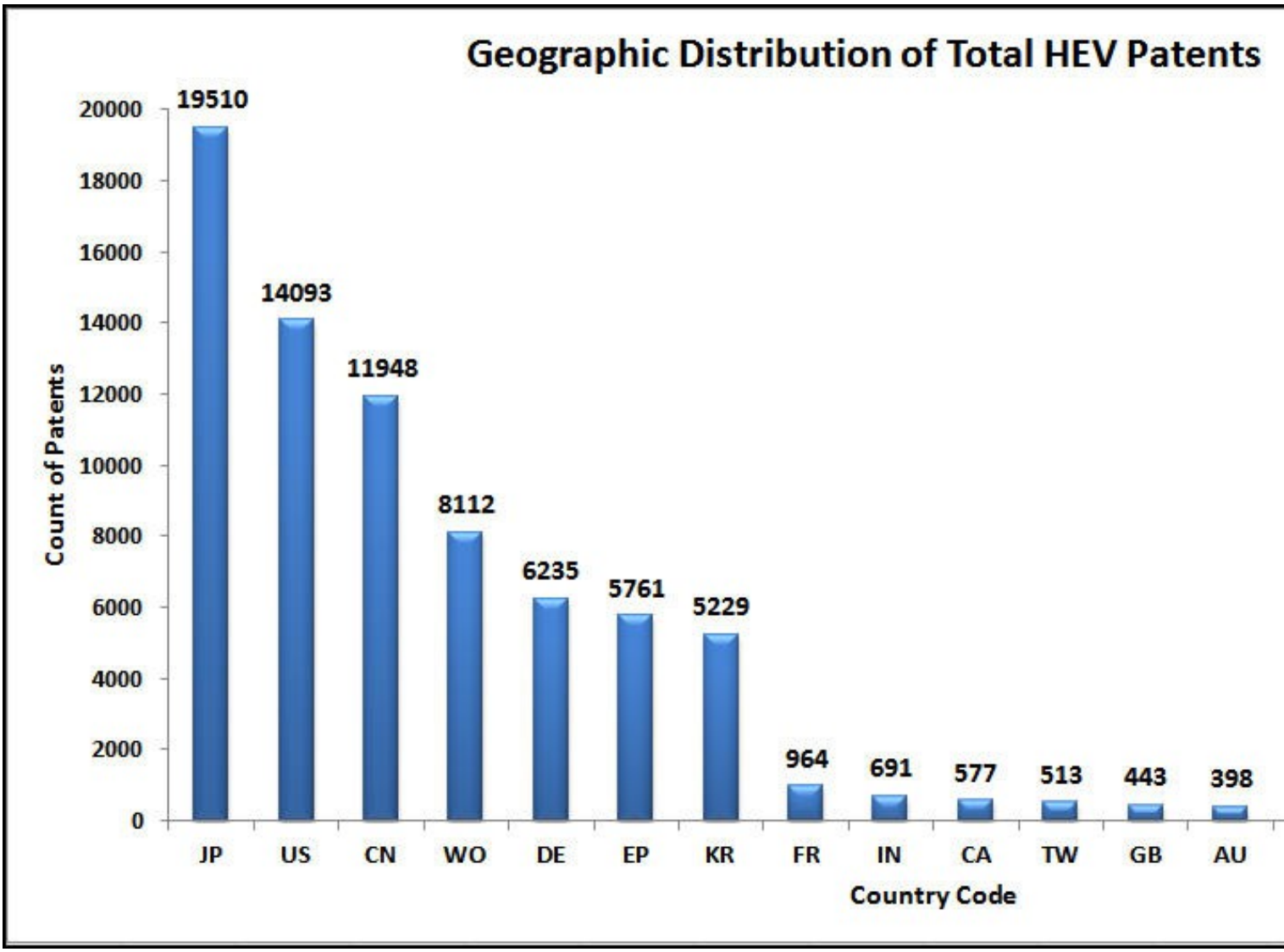



"Priority Country-contd"

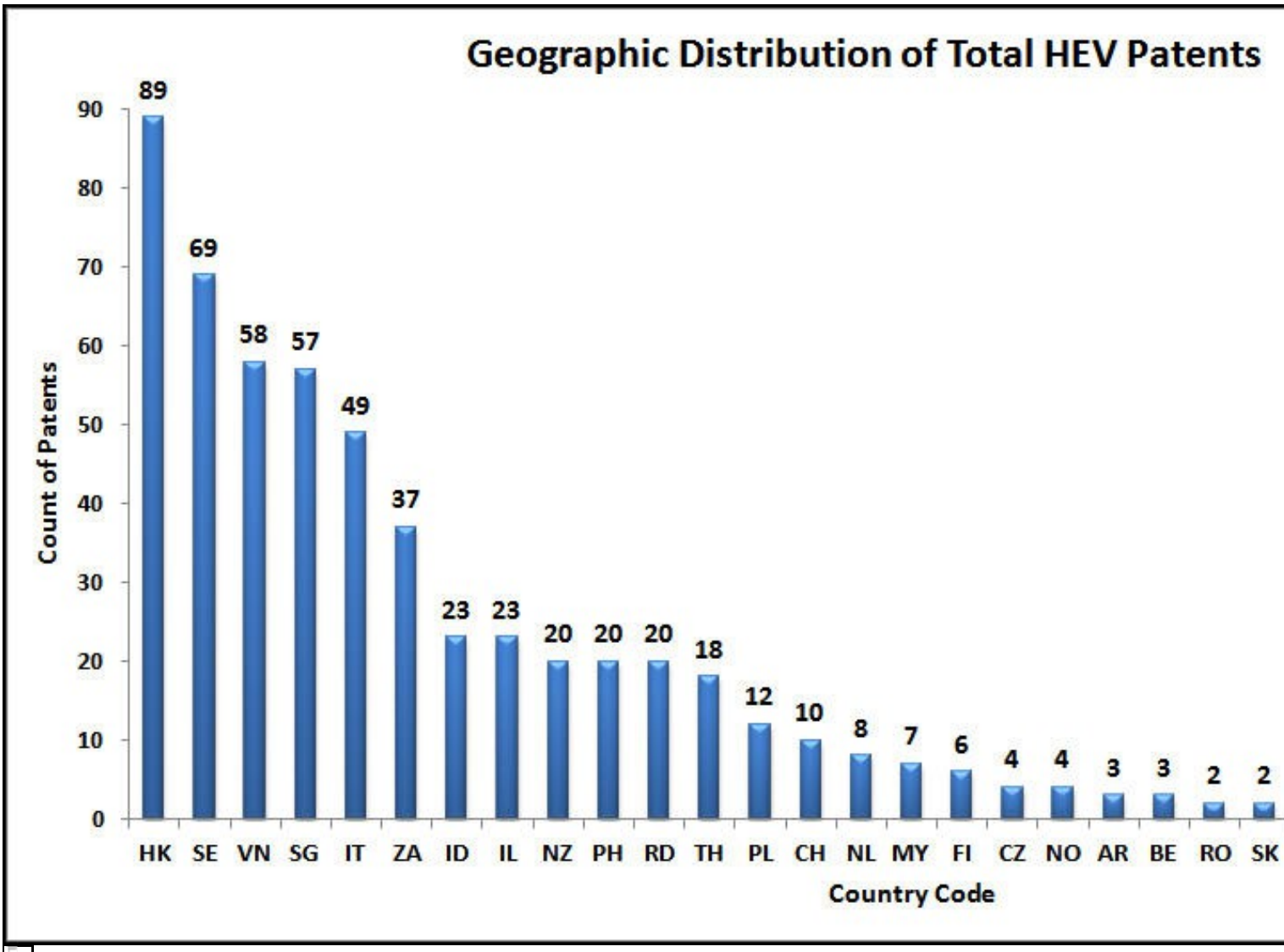
- The priority country with the highest number of first patent filings in the area of hybrid electric vehicles(HEV) is Japan.
- United States(5505), South Korea(3743), Germany(3366) and China(2588) follow Japan, but with a huge difference in first patent filings compared to Japan.

## Geographical Distribution

**Note:** While making the geographic distribution of patents, only the granted patents are considered and their publication is removed, thus eliminating the duplicates.



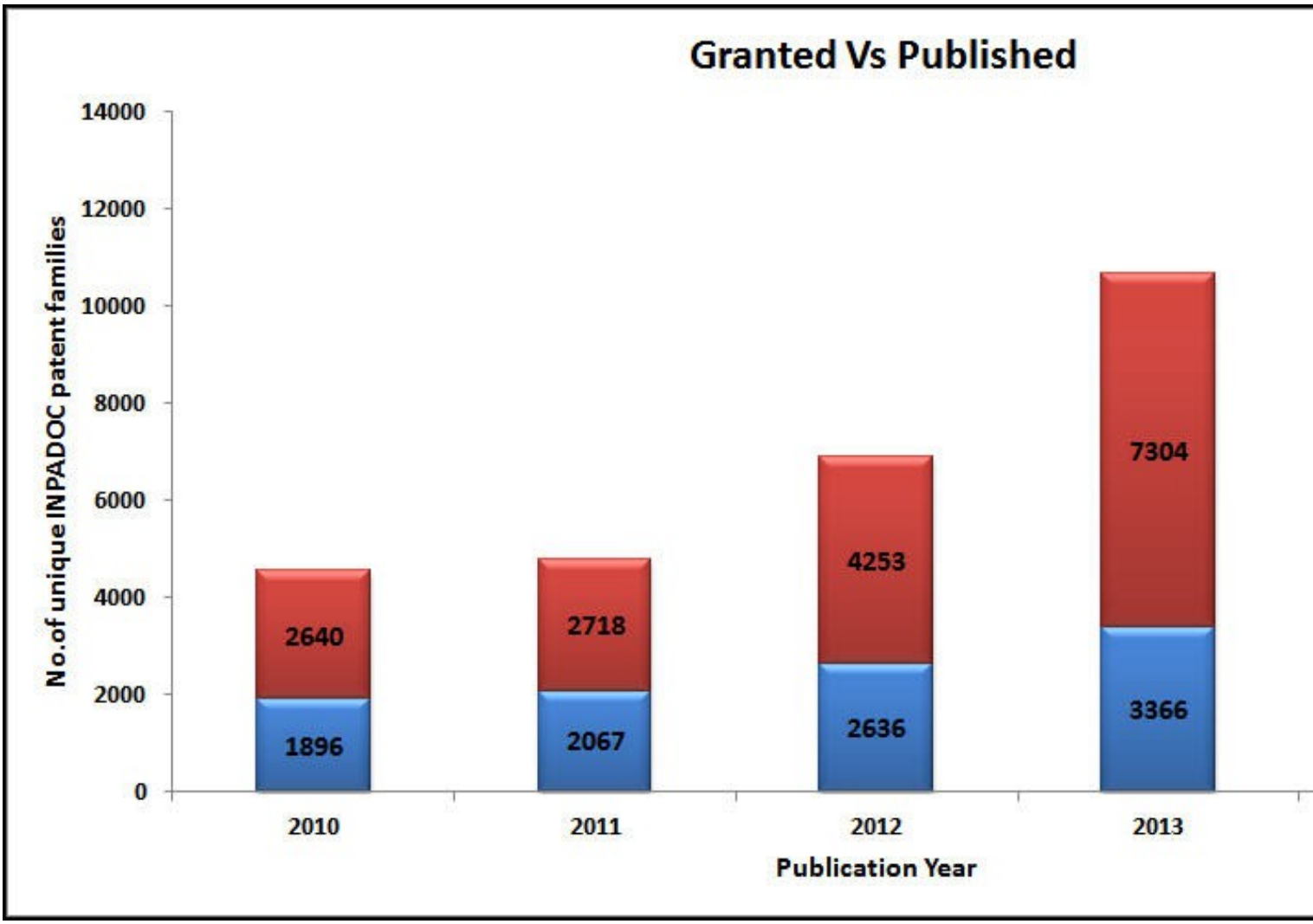

"Geographic Distribution"




"Geographic Distribution-contd"

- Majority of total number of INPADOC families spread in Japan, United States, China, Germany, Korea and WIPO,EP patent organizations.

## Patent Status - Publication Year Wise




"Patent status publication year wise"

- The year 2014 has the highest number of published and granted patents.
- The published to granted patents ratio has grown from 1.4 to 2 from 2010 to 2014.

## Geographic Distribution - Publication Year Wise

| Country/Year | 2010 | 2011 | 2012 | 2013 | 2014 | Grand Total |
|---|---|---|---|---|---|---|
| Argentina | 1 | 1 | 1 | | | 3 |
| Austria | 14 | 38 | 44 | 14 | 11 | 121 |
| Australia | 60 | 57 | 92 | 115 | 74 | 398 |
| Belgium | | 1 | 1 | 1 | | 3 |
| Brazil | 13 | 32 | 23 | 33 | 35 | 136 |
| Canada | 107 | 135 | 133 | 141 | 61 | 577 |
| Switzerland | 1 | 3 | 3 | 1 | 2 | 10 |
| China | 1320 | 1829 | 2712 | 3100 | 2987 | 11948 |
| Czech Republic | | | 1 | 1 | 2 | 4 |
| Germany | 930 | 971 | 1249 | 1573 | 1512 | 6235 |
| Denmark | | | | | 1 | 1 |
| Egypt | | | | 1 | | 1 |
| Europe | 806 | 923 | 1141 | 1415 | 1476 | 5761 |
| Spain | 21 | 34 | 39 | 40 | 28 | 162 |
| Finland | | 4 | | | 2 | 6 |
| France | 126 | 200 | 211 | 232 | 195 | 964 |
| Great Britain | 51 | 81 | 81 | 99 | 131 | 443 |
| Gulf Cooperation Council | 1 | | | | | 1 |
| Greece | | | 1 | | | 1 |
| Hongkong | | 11 | 26 | 28 | 24 | 89 |
| Indonesia | 5 | 1 | 5 | 12 | | 23 |
| IL | 3 | | 5 | 12 | 3 | 23 |
| India | 113 | 67 | 119 | 173 | 219 | 691 |
| Italy | 16 | 3 | 7 | 10 | 13 | 49 |
| Japan | 3336 | 3299 | 4031 | 4993 | 3851 | 19510 |
| Korea (South) | 604 | 871 | 820 | 1480 | 1454 | 5229 |



"Geographic distribution publication year wise"

| Country/Year | 2010 | 2011 | 2012 | 2013 | 2014 | Grand Total |
|---|---|---|---|---|---|---|
| Latvia | | | | | 1 | 1 |
| Mexico | 19 | 28 | 43 | 49 | 40 | 179 |
| Malaysia | | 1 | 5 | | 1 | 7 |
| Netherlands | 1 | 3 | 2 | 1 | 1 | 8 |
| Norway | | 1 | | 1 | 2 | 4 |
| New Zealand | 1 | 2 | 5 | 5 | 7 | 20 |
| Philippines | | 2 | 2 | 5 | 11 | 20 |
| Poland | | 6 | 3 | 2 | 1 | 12 |
| Portugal | | 1 | | | | 1 |
| Research Disclosure | 1 | 3 | 8 | 5 | 3 | 20 |
| Romania | | | 1 | | 1 | 2 |
| Russia | 48 | 53 | 46 | 88 | 77 | 312 |
| Sweden | 5 | 15 | 16 | 20 | 13 | 69 |
| Singapore | 14 | 7 | 11 | 14 | 11 | 57 |
| Slovenia | | 1 | | | | 1 |
| Slovakia | | | 1 | 1 | | 2 |
| Thailand | 5 | 6 | 5 | | 2 | 18 |
| Taiwan | 56 | 76 | 120 | 139 | 122 | 513 |
| Ukraine | | | 1 | 1 | | 2 |
| United States | 1961 | 2536 | 2981 | 3359 | 3256 | 14093 |
| Vietnam | 10 | 2 | 7 | 17 | 22 | 58 |
| WIPO | 989 | 1284 | 1764 | 2149 | 1926 | 8112 |
| South Africa | 5 | 9 | 6 | 10 | 7 | 37 |

"Geographic distribution publication year wise"

- In China, Germany, Europe, Great Britain and India an increase in publication activity is observed from 2010 to 2014.
- Major countries like Japan and US have seen a dip in patent publications from 2013 to 2014.
- Countries like Argentina, Belgium, Czech republic, Denmark, Egypt, Greece etc have very few filings.

# Insights on Detailed Analysis for a Specific Set of Patent Documents

- A set of 8721 patents out of the total search hits are selected. These patents are selected based on the primary CPC classification that exclusively talk about hybrid electric vehicles(HEVs). The patents are categorized into different technological areas of HEVs.
- The patent analysis is carried out using Dolcera's Proprietary ***automatic categorization tool***.
- The categorization of patents is carried out considering "***Title Abstract Claims***" Only.

## Interactive Taxonomy

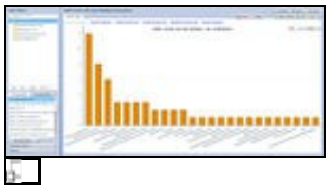
- *Use the mouse(click and drag/scroll up or down/click on nodes) to explore nodes in the detailed taxonomy*
- Click here to see the **Taxonomy node definition spreadsheet**

### Taxonomy Node Definitions

| Node | Definition |
|---|---|
| **Travel mode control (EV-HEV)** | The patents under this node include those which have a control system that switches the travelling mode from Pure Electric (EV) to Hybrid Electric (HEV) |
| **Start-Stop control** | The patents in this node talk about control system employed to control the start and stop of vehicle under different conditions. |
| **Speed control** | The patents under this node talk about control system provided to control the speed of the vehicle such as cruise control, acceleration control,etc. |

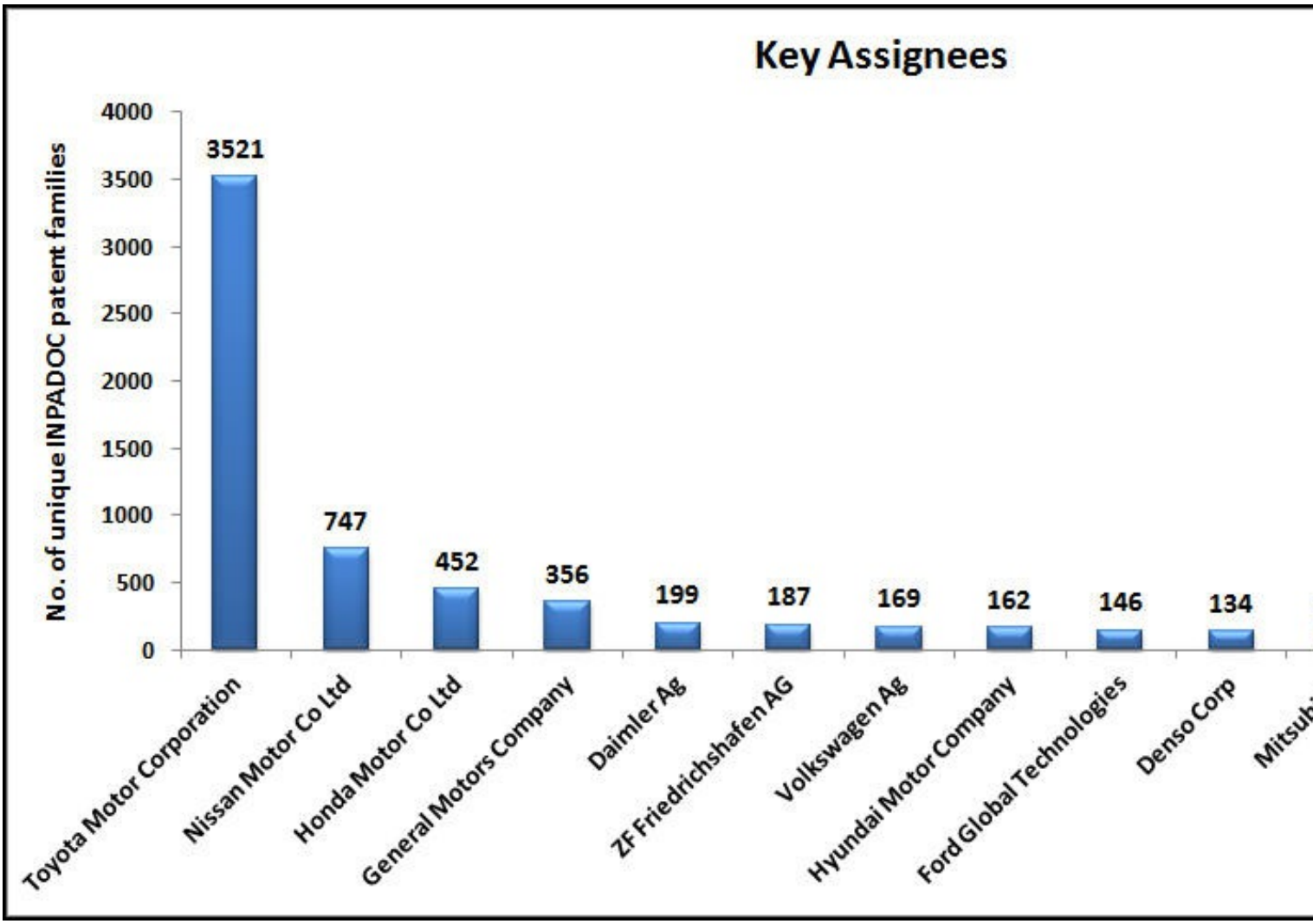
| | |
|---|---|
| **Braking control** | The patents in this category talk about control of braking the vehicle and brake fluid supply control. |
| **Regenerative braking control** | Patents under this node talk about regenerative braking energy recovery control. |
| **Radiator cooling control** | It is about control systems provided to control the temperature of radiator of the vehicle |
| **Power distribution between power sources** | Patents under this node talk about control system to switch or distribute the power from one power source to the other ICE and Motor) |
| **Motor control** | Motor control related patents include control techniques for motor torque, motor speed, rotor, generator, motor vibration, damping, motor cooling, motor components,etc. |
| **Engine control** | Engine control related patents include control techniques for engine speed, valve timing, EGR, exhaust gas refinement, engine torque, fuel injection, engine cooling, combustion control, catalytic converter, engine vibrations reduction, etc . |
| **Transmission control** | Transmission control related patents include control techniques for drive train and its components. |
| **Automatic transmission** | This node categorizes patents on automatic transmission such as torque converters, hydraulic transmission, CVT, etc. |
| **Mechanical transmission** | Mechanical transmission node include patents on transmission that have dual clutches, planetary gear train, sequential, infinitely variable, etc. |
| **Multi Stage transmission** | Patents under this node specifically talk about multi step or multi stage type transmission. |
| **Differential gear distribution type** | Patents under this node specifically talk about differential gear distribution type transmission. |
| **Charge discharge control** | This node include patents with techniques to control charging and discharging of various power sources. |
| **Power output control** | This node include patents with techniques to control power supplied from energy storage devices. |
| **Thermal** | Patents under this node include thermal management such as heating or cooling of energy storage devices on board. |
| **Electrical** | Patents under this node include protective measures employed to ensure safety of electrical energy storage devices from high voltage, high current, etc. |
| **Structural** | Structural protection patents include provisions to safeguard electrical energy storage devices during vehicle collision events. |
| **Fuel Cells** | Patents under this node include those which have fuel cell as one of the power source. |
| **Capacitors** | Patents with capacitor as energy storage device are categorized under this node. |
| **Electrical power converters** | Patents talking about electrical power converters such as AC-DC, DC-DC, etc. are categorized under this node. |

## Dolcera Dashboard for Patent Analysis

| | |
|---|---|
| **Dashboard for patents: Hybrid Electric Vehicles Landscape** |  |

**The dashboard contains patents categorized according to the taxonomy provided.**

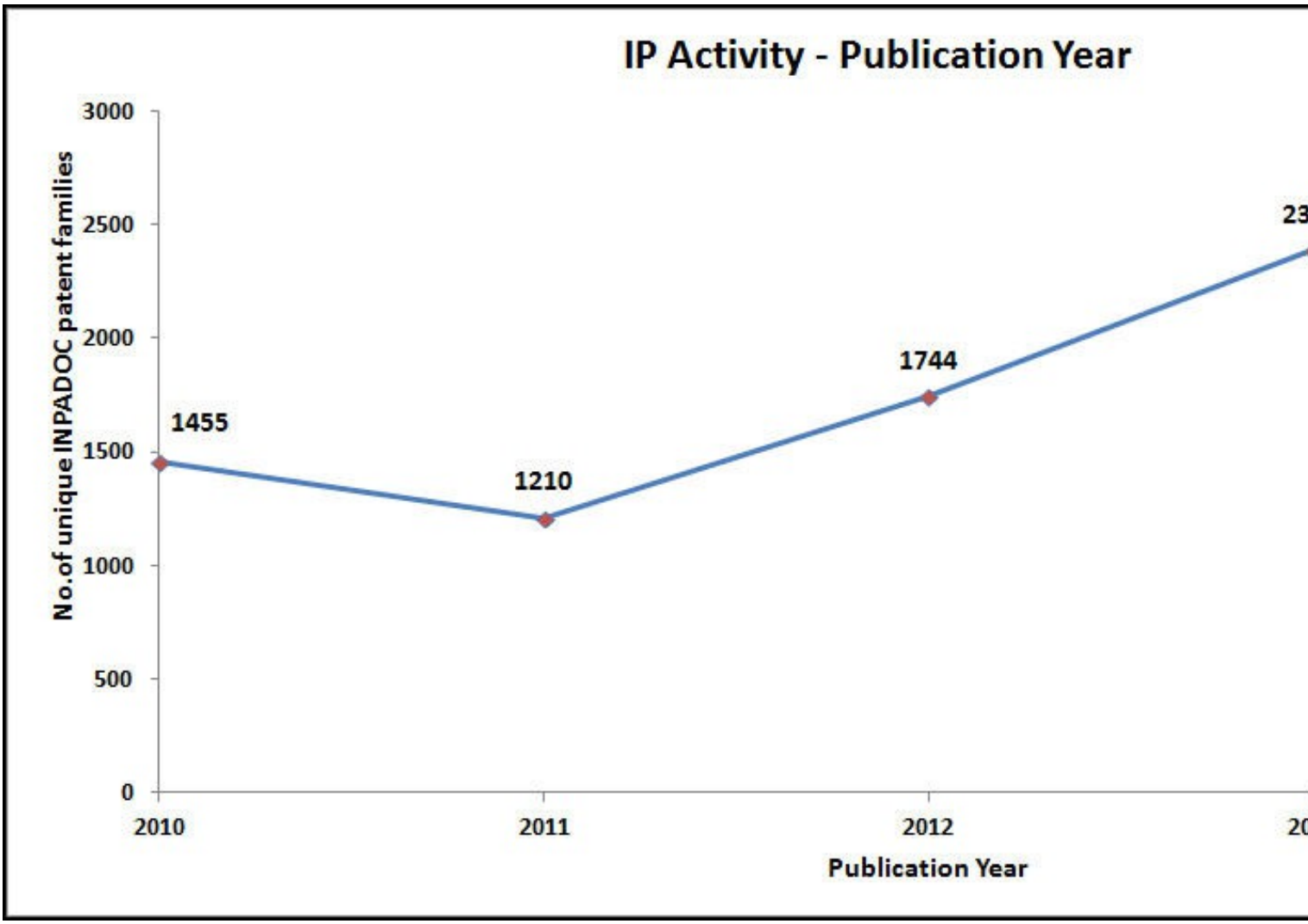
## Key Assignees (Selected Set)




"Key Assignees"

- The key assignee trend for the selected set of HEV patents differs slightly from that of the overall HEV patent trend.
- Toyota Motors has the highest number of published patents with 3521 unique patent families, followed by Nissan Motors(747), Honda Motors(452), General Motors(356) and Daimler(199) respectively.
- There is a huge difference in patent publications between Toyota Motors and the other assignees.

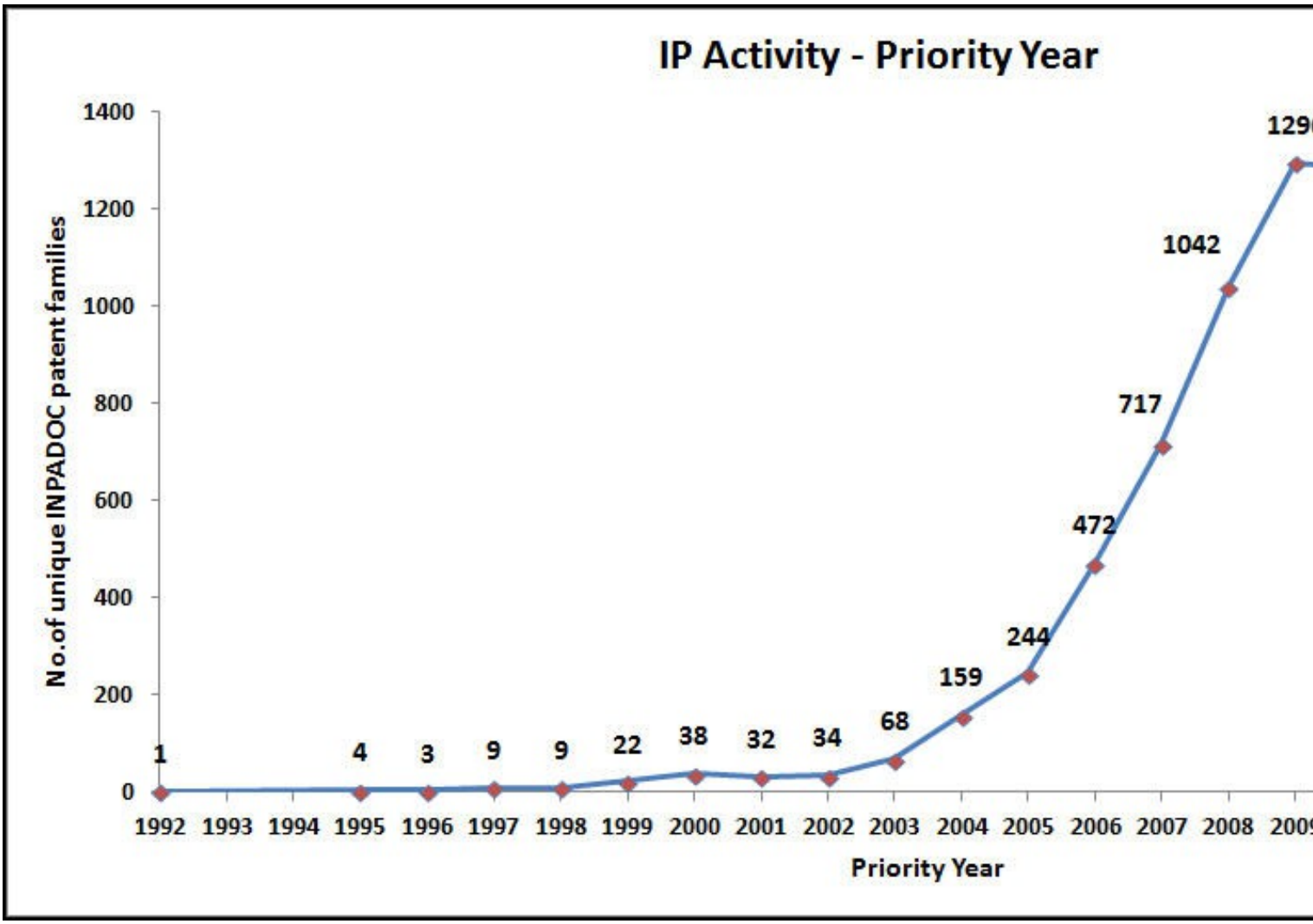
## Publication Year Trend (Selected Set)




"Publication year trend - Analyzed"

- In the specific set of patent documents selected for detailed analysis, highest number of patent publications are observed in the year 2013.
- There is a decrease in patent publications observed in the years 2011 and 2014 respectively.

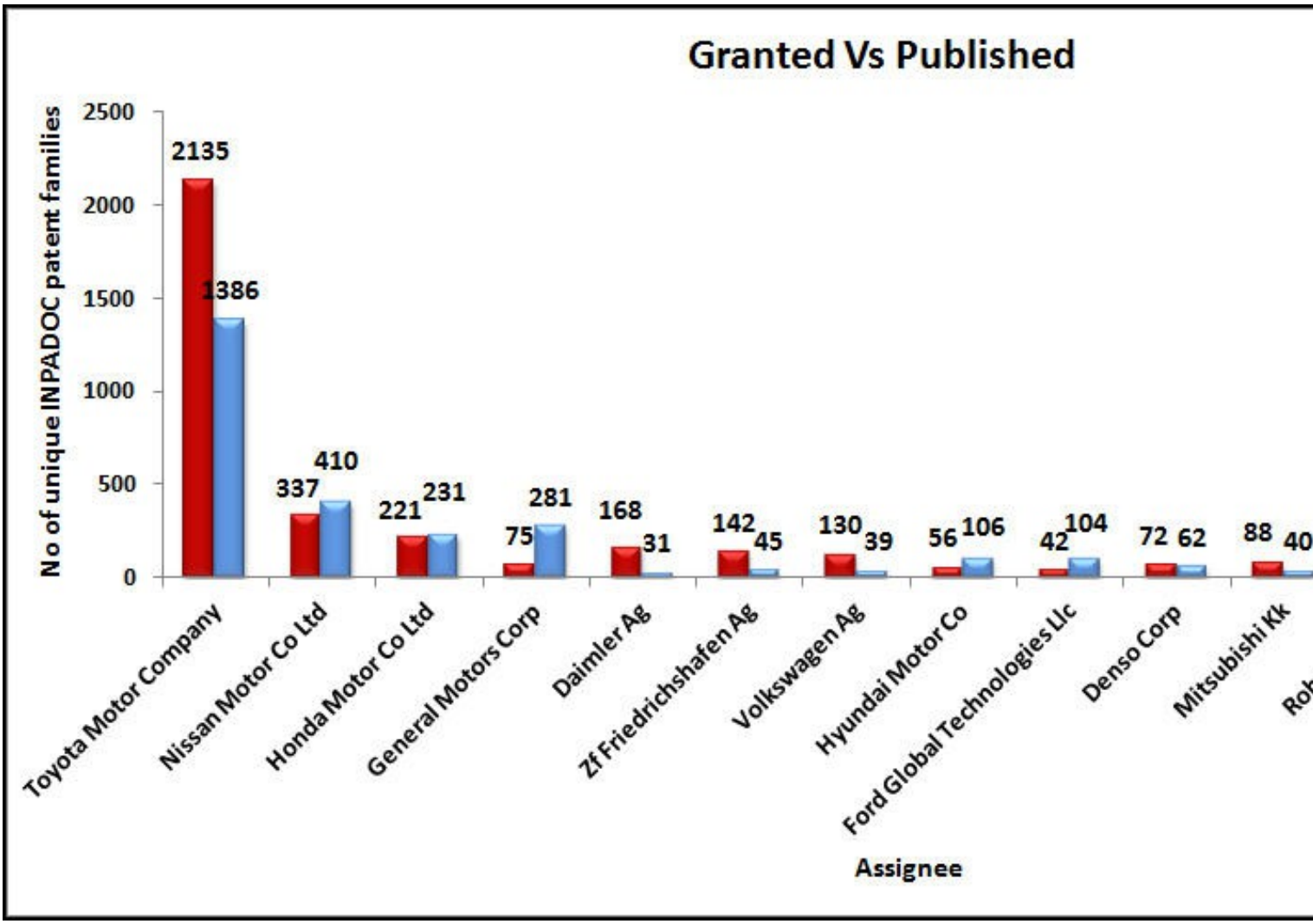
## Priority Year Trend (Selected Set)




"Priority year trend - Analyzed"

- For the set of specific patent documents selected for detailed analysis, priority year graph shows increase in filing activity from 2004 to 2009.
- The filing trend was almost constant for a period of 4 years from (2009-2012).

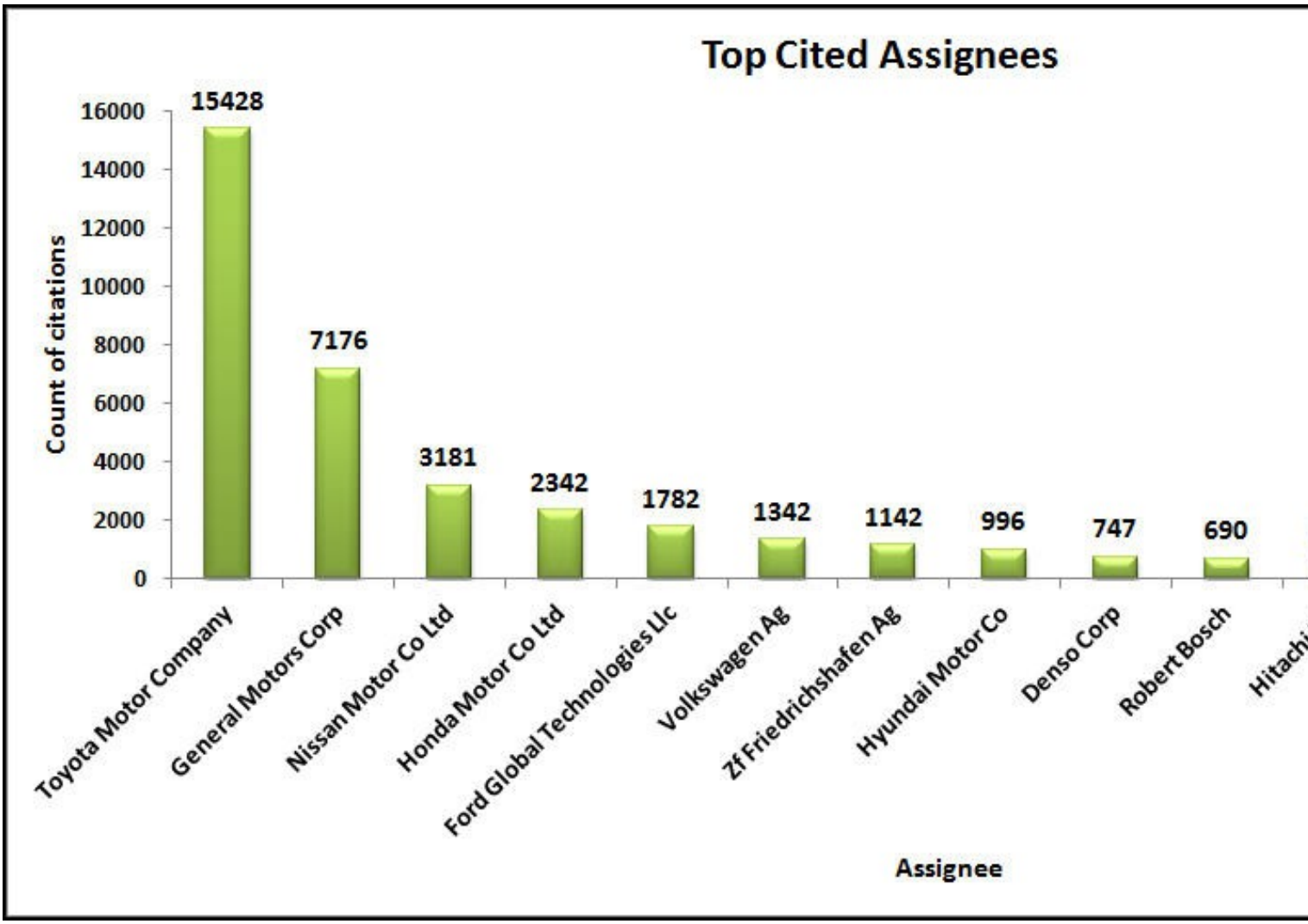
## Granted Vs Published Assignee wise (Selected Set)




"Granted Vs Published Assignee wise - Analysed"

- This graph is prepared for the selected set of patent documents considered for detailed analysis.
- The number of granted patents reveals the strength of the patent portfolio of a company.
- Toyota Motors has the highest number of granted(1386) and published(2135) patents.
- Nissan Motors, General Motors, Hyundai Motors, Ford Motors and Mazda Motors have more granted patents than published patents.
- Honda Motors, Denso Corp, Hitachi Ltd, Mazda Corp have almost equal number of granted and published patents.

## Top Cited Assignees (Selected Set)




"Top Cited Assignees"

- Toyota Motor Company has the highest number (15428) of patent citation counts. It is followed by General Motors(7176), Nissan Motors(3181), Honda Motors(2342) and Ford Motors(1782) respectively.

## Top Cited Patents

- Majority of the top cited patents of this technology are owned by General Motors. (For the selected set only)

| S.No | Publication No | Publication Date | Assignee/Applicant | Inventor First | Title | Count of citing patents |
|---|---|---|---|---|---|---|
| 1 | US7711460B2 | 2010-05-04 | OSHKOSH CORPORATION | Yakes, Christopher K. | Control system and method for electric vehicle | 475 |
| 2 | US8376906B2 | 2013-02-19 | BORGWARNER INC | Koenig, Melissa | Automatic transmission for a hybrid vehicle | 272 |
| 3 | US8448731B2 | 2013-05-28 | GENERAL MOTORS | Heap, Anthony H. | Method and apparatus for determination of fast actuating engine torque for a hybrid powertrain system | 236 |
| 4 | US8092339B2 | 2012-01-10 | GENERAL MOTORS | Heap, Anthony H. | Method and apparatus to prioritize input acceleration and clutch synchronization performance in neutral for a hybrid powertrain system | 233 |
| 5 | US7977896B2 | 2011-07-12 | GENERAL MOTORS | Heap, Anthony H. | Method of determining torque limit with motor torque and battery power constraints | 227 |
| 6 | US8414449B2 | 2013-04-09 | GENERAL MOTORS | Heap, Anthony H. | Method and apparatus to perform asynchronous shifts with oncoming slipping clutch torque for a hybrid powertrain system | 216 |
| 7 | US8285432B2 | 2012-10-09 | GENERAL MOTORS | Heap, Anthony H. | Method and apparatus for developing a control architecture for coordinating shift execution and | 214 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | engine torque control | |
| 8 | US8248023B2 | 2012-08-21 | GENERAL MOTORS | Schwenke, R. Travis | Method of externally charging a powertrain | 214 |
| 9 | US8204664B2 | 2012-06-19 | GENERAL MOTORS | Minarcin, Monika A | Method for controlling regenerative braking in a vehicle | 213 |
| 10 | US8630776B2 | 2014-01-14 | GENERAL MOTORS | Heap, Anthony H. | Method for controlling an engine of a hybrid powertrain in a fuel enrichment mode | 213 |
| 11 | US8504259B2 | 2013-08-06 | GENERAL MOTORS | Heap, Anthony H. | Method for determining inertia effects for a hybrid powertrain system | 213 |
| 12 | US8296027B2 | 2012-10-23 | GENERAL MOTORS | Heap, Anthony H. | Method and apparatus to control off-going clutch torque during torque phase for a hybrid powertrain system | 213 |
| 13 | US8827865B2 | 2014-09-09 | GENERAL MOTORS | Naqvi, Ali K. | Control system for a hybrid powertrain system | 212 |
| 14 | US8897975B2 | 2014-11-25 | GENERAL MOTORS | Heap, Anthony H. | Method for controlling a powertrain system based on penalty costs | 211 |
| 15 | US8847426B2 | 2014-09-30 | GENERAL MOTORS | Heap, Anthony H. | Method for managing electric power in a powertrain system | 211 |
| 16 | US8335623B2 | 2012-12-18 | GENERAL MOTORS | Heap, Anthony H. | Method and apparatus for remediation of and recovery from a clutch slip event in a hybrid powertrain system | 211 |
| 17 | US8489293B2 | 2013-07-16 | GENERAL MOTORS | Heap, Anthony H. | Method and apparatus to control input speed profile during inertia speed phase for a hybrid powertrain system | 211 |
| 18 | US8818660B2 | 2014-08-26 | GENERAL MOTORS | Heap, Anthony H. | Method for managing lash in a driveline | 211 |
| 19 | US8290681B2 | 2012-10-16 | GENERAL MOTORS | Kaminsky, Lawrence A. | Method and apparatus to produce a smooth input speed profile in mode for a hybrid powertrain system | 210 |
| 20 | US8548703B2 | 2013-10-01 | GENERAL MOTORS | Sah, Jy-Jen F. | Method and apparatus to determine clutch slippage in an electro-mechanical transmission | 209 |
| 21 | US8145397B2 | 2012-03-27 | GENERAL MOTORS | Heap, Anthony H. | Optimal selection of blended braking capacity for a hybrid electric vehicle | 209 |

## Key Assignee Vs Countries

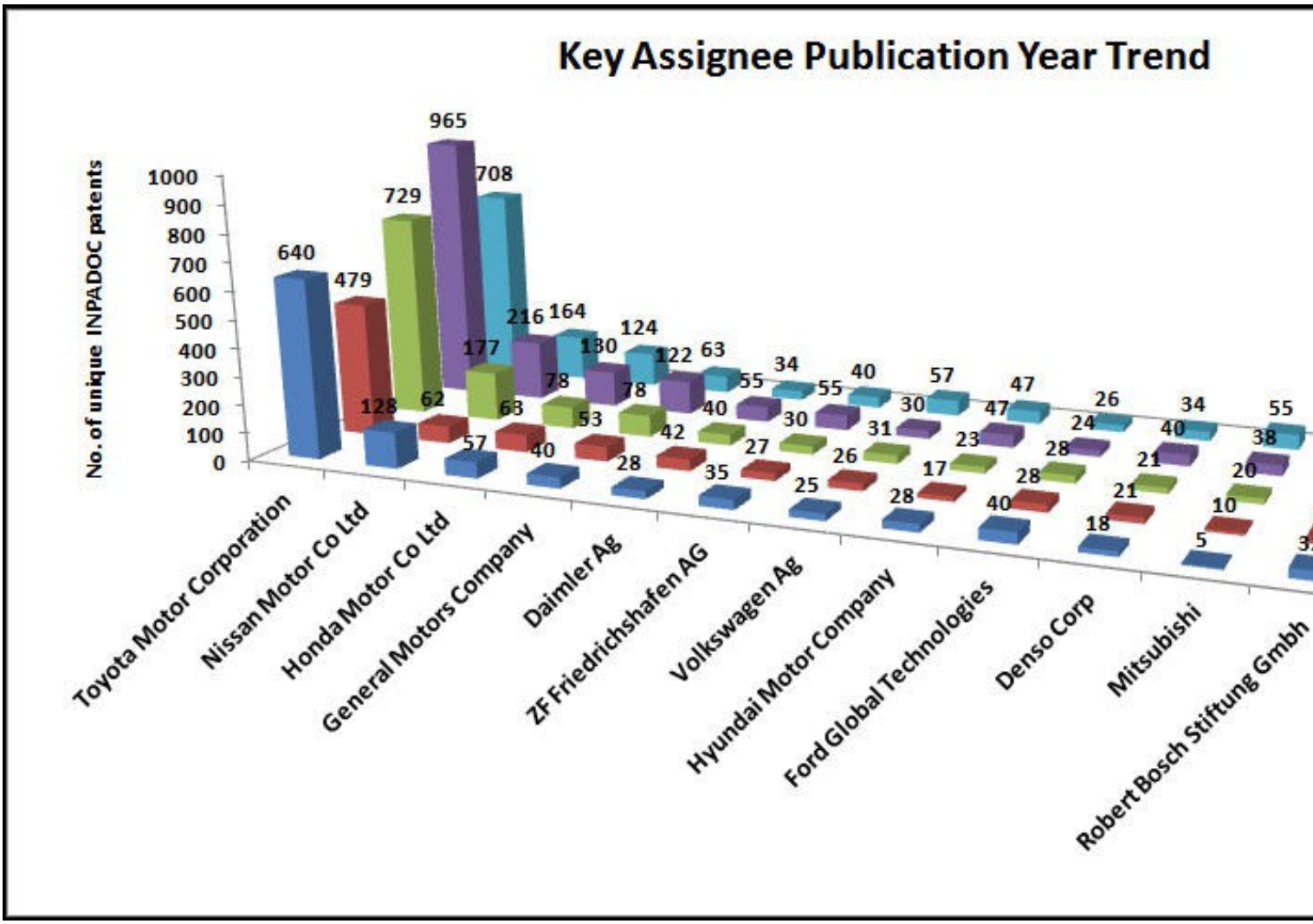
- This table has been prepared considering the total number of INPADOC patent families. Also only the granted patents are considered and its publication is removed, thus eliminating the duplicates.

| Country / Assignee/Applicant | Austria | Australia | Brazil | Canada | China | Germany | Europe | Spain | France |
|---|---|---|---|---|---|---|---|---|---|
| Toyota Motor Corporation | 14 | 15 | 22 | 22 | 521 | 302 | 321 | 14 | 7 |
| Nissan Motor Co. Ltd. | 3 | | | | 67 | 25 | 75 | | |
| Honda Motor Co., Ltd. | 6 | 3 | 4 | 20 | 79 | 43 | 53 | 11 | |
| General Motors Company | | 1 | 2 | | 271 | 218 | 56 | | |
| Daimler Ag | 1 | | | | 9 | 80 | 8 | | |
| ZF Friedrichshafen AG | 10 | | | | 35 | 177 | 51 | | |
| Volkswagen Ag | 3 | | 1 | | 29 | 142 | 24 | | 6 |
| Hyundai Motor Company | | | | | 50 | 40 | | | |
| Ford Global Technologies | | 2 | 1 | 2 | 98 | 81 | 12 | | |
| Denso Corp. | | | | | 9 | 14 | 4 | | 1 |
| Mitsubishi | | 2 | | | 13 | 7 | 14 | | 2 |
| Robert Bosch Stiftung Gmbh | 7 | | 1 | | 28 | 102 | 52 | | 2 |
| Hitachi Ltd. | 1 | 3 | | | 22 | 9 | 28 | | |
| Mazda Motor Corporation | | | | | 4 | 4 | 7 | | |

"Key Assignee Vs Countries"

- The above distribution is done only for the specific set of patent documents taken for detailed analysis.
- Toyota Motors has the highest number(3380) of patent publications in Japan. It has given almost equal importance to publishing patents in China(521) and United States(647).
- Nissan Motors has the highest number of patent publications(683) in Japan. It has almost equal number of patent publications in China(67), Europe(75) and United States(80).
- Honda Motors has also has the highest number of patent publications(426) in Japan.It has 108 patent publications in the United States.
- General Motors has the most number of publications in the United States(309). Also it has almost equal numbers published in China(271) and Germany(218).
- Honda Motors has patents in Argentina, Switzerland, Italy, Norway, Thailand, Taiwan and Vietnam. Volkswagen and Bosch has patents in Italy. Toyota and Bosch have patents in Poland. However, they are not shown in the table as the numbers are few.

## Key Assignee Vs Publication Year




"Key Assignee Vs Publication Year"

- Toyota Motors has the highest number of patent publications with 965 unique patent families in the year 2013.
- Nissan Motors(216), Honda Motors(130), General Motors(122) have the highest number of publications in the year 2013.
- Hyundai Motors(47), Ford Motors(26), Mitsubishi(55) and Volkswagen(57) have the highest number of publications in the year 2014.

## Key Assignee Vs Type of Hybrid

| Type of hybrid / Assignee/Applicant | SERIES | PARALLEL | SERIES-PARALLEL(POWER SPLIT) |
|---|---|---|---|
| Toyota Motor Corporation | 24 | 84 | 198 |
| Nissan Motor Co. Ltd. | 9 | 12 | 15 |
| Honda Motor Co., Ltd. | 2 | 19 | 23 |
| General Motors Company | 17 | 12 | 22 |
| Daimler Ag | 8 | 18 | 8 |
| ZF Friedrichshafen AG | | 31 | 3 |
| Volkswagen Ag | 8 | 20 | 4 |
| Hyundai Motor Company | 2 | 6 | 7 |
| Ford Global Technologies | 2 | 9 | 20 |
| Denso Corp. | 4 | 4 | 2 |
| Mitsubishi | 9 | 6 | 4 |
| Robert Bosch Stiftung Gmbh | 7 | 24 | 5 |
| Hitachi Ltd. | 7 | 1 | 6 |
| Mazda Motor Corporation | 4 | 6 | 1 |



"Key Assignee Vs Type of hybrid"

- A total of 1326 patents are categorized under this type of hybrid node.
- Toyota Motors has highest number of patents on power split type hybrid electric vehicles with 198 unique patent families, followed by parallel hybrid(84), Plug-in(55) and series type hybrid electric vehicles(24).
- Nissan Motors(15), Honda Motors(23), General motors(22) have also highest number of published patents on power split type hybrids.
- Daimler(18) and ZF friedrischshafen(31) have highest number of published patents on parallel type hybrid electrics.

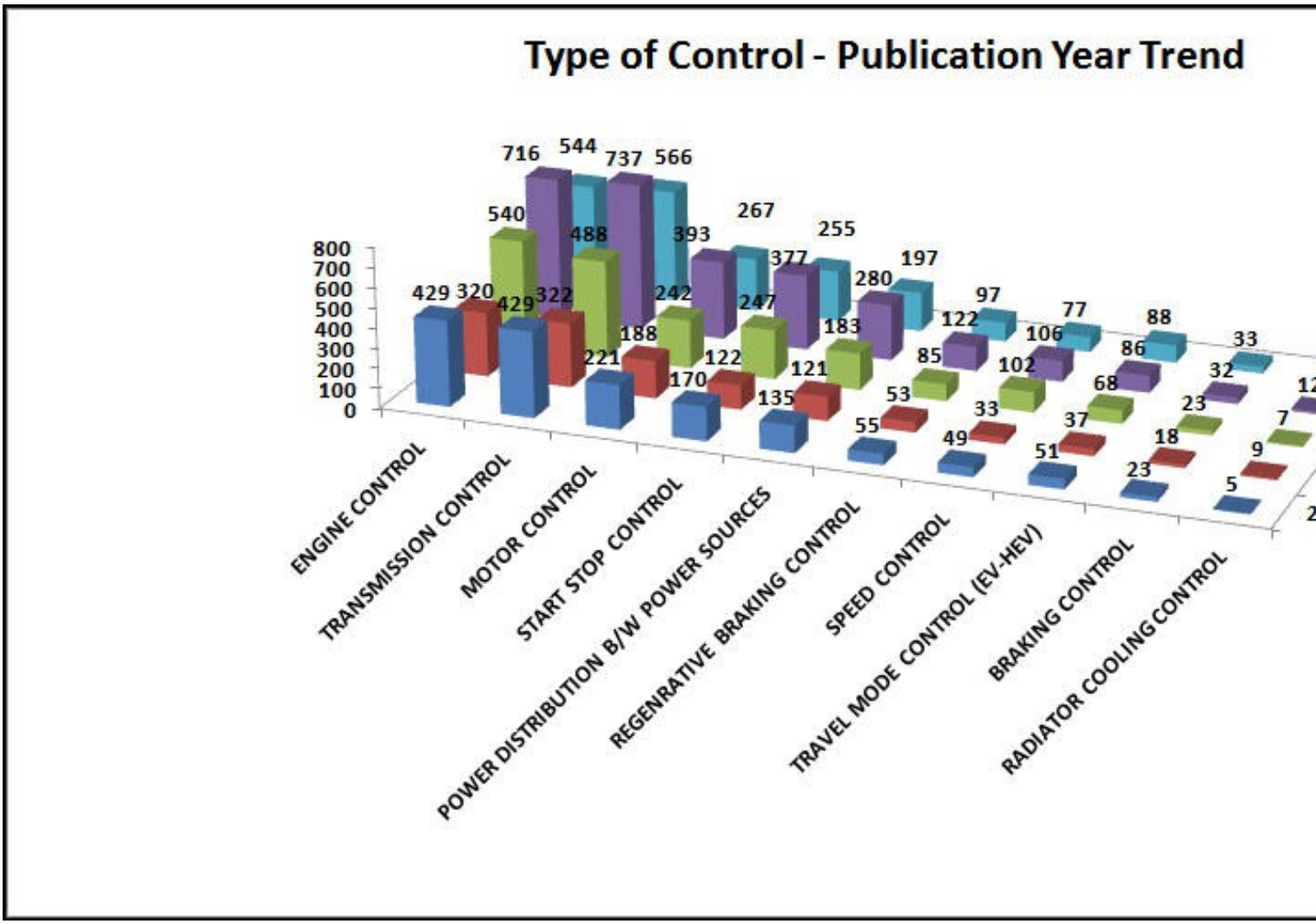
## Key Assignee Vs Type of control

| Type of control / Assignee/Applicant | TRAVEL MODE CONTROL (EV-HEV) | START STOP CONTROL | SPEED CONTROL | BRAKING CONTROL | REGENRATIVE BRAKING CONTROL | RADIATOR COOLING CONTROL | DI |
|---|---|---|---|---|---|---|---|
| Toyota Motor Corporation | 76 | 623 | 167 | 50 | 148 | 20 | |
| Nissan Motor Co. Ltd. | 72 | 200 | 73 | 20 | 56 | | |
| Honda Motor Co., Ltd. | 7 | 71 | 15 | 6 | 23 | | |
| General Motors Company | 15 | 9 | 4 | 1 | 12 | | |
| Daimler Ag | 6 | 41 | 12 | 5 | 26 | | |
| ZF Friedrichshafen AG | | 3 | 1 | | | 1 | |
| Volkswagen Ag | 1 | 1 | 3 | 1 | 1 | | |
| Hyundai Motor Company | 24 | 11 | 4 | 2 | 4 | | |
| Ford Global Technologies | 3 | 8 | 4 | 5 | 3 | | |
| Denso Corp. | 3 | 19 | 7 | | 5 | 4 | |
| Mitsubishi | 4 | 20 | 7 | 2 | 10 | 1 | |
| Robert Bosch Stiftung Gmbh | 7 | 3 | 1 | 1 | | | |
| Hitachi Ltd. | 5 | 13 | 6 | 1 | 5 | | |
| Mazda Motor Corporation | | 19 | 5 | 1 | 5 | 1 | |

"Key Assignee Vs Type of control"

- A total of 5942 patents are categorized under the "Type of control" node.
- Toyota Motors has the highest number of patents published on engine control with 1142 unique families, followed by transmission control(979), start-stop control(623) and motor control(502).
- Nissan Motors has the highest number(333) of patents published on transmission control techniques, followed by engine control(269), start-stop control(200) and motor control(175).
- Honda Motors has more patents on engine control with 124 unique families whereas General Motors has more patents on transmission control with 124 unique families.
- Other assignees have mainly concentrated on engine and transmission control techniques.
- Apart from Toyota; Nissan, Honda and Daimler have considerable number of patents on regenerative braking control.
- Toyota, Nissan, Honda and Daimler have a strong patent set on vehicle start stop control as well.
- Only Toyota and Nissan have done considerable work on travel mode control (Switching from EV to HEV).

## Type of control Vs Publication Year




"Type of Control Vs Publication Year"

- Highest no of patent publications related to engine control techniques is observed in the year 2013 with 716 unique families.
- Transmission control(737), Motor Control(393), Start-Stop Control(377) have highest number of patents published in the year 2013.
- All control types have highest number of patent publications in the year 2013.
- Travel mode control and braking control have increasing in publication activity over the years 2010-2014.
- Regenerative braking also has an increasing trend with a slight dip at the end.

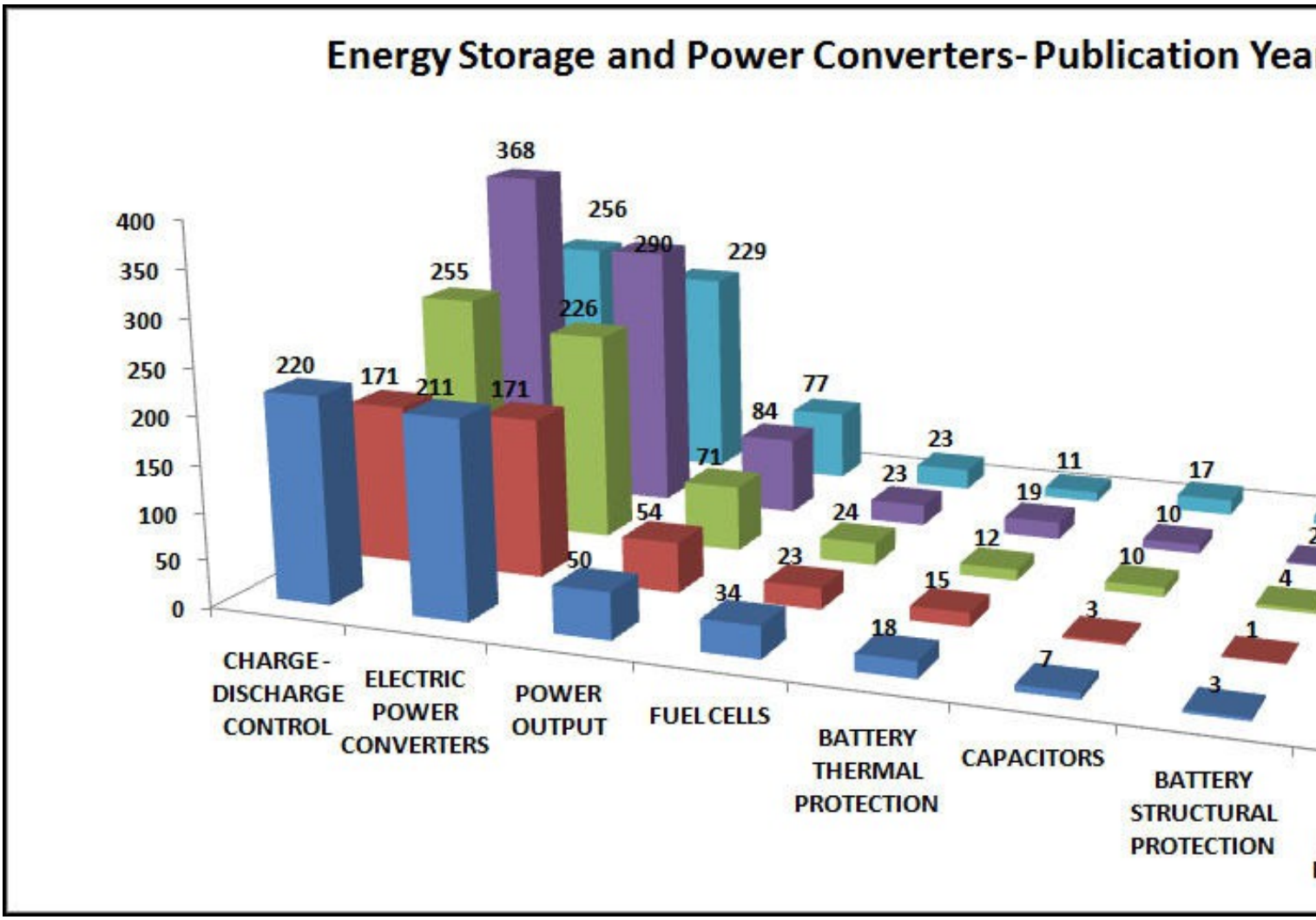
## Key Assignee Vs Energy Storage and Electric Power Converters

| Assignee/Applicant \ Energy storage | CHARGE - DISCHARGE CONTROL | POWER OUTPUT | BATTERY THERMAL PROTECTION | BATTERY ELECTRICAL PROTECTION | BATTERY STRUCTURAL PROTECTION |
|---|---|---|---|---|---|
| Toyota Motor Corporation | 462 | 103 | 32 | 10 | 3 |
| Nissan Motor Co. Ltd. | 104 | 26 | 3 | 2 | |
| Honda Motor Co., Ltd. | 41 | 11 | 2 | | 1 |
| General Motors Company | 38 | 6 | 1 | 1 | |
| Daimler Ag | 38 | 12 | | 1 | 2 |
| ZF Friedrichshafen AG | 1 | 1 | | | |
| Volkswagen Ag | 11 | 4 | | 1 | |
| Hyundai Motor Company | 18 | 3 | 4 | | 2 |
| Ford Global Technologies | 37 | 7 | | | |
| Denso Corp. | 37 | 5 | 2 | | |
| Mitsubishi | 38 | 3 | 5 | | |
| Robert Bosch Stiftung Gmbh | 5 | 4 | | | |
| Hitachi Ltd. | 17 | 3 | | | |
| Mazda Motor Corporation | 29 | 2 | 5 | | |

"Key Assignee Vs Energy storage and electrical power converters"

- A total of 2833 patents are categorized under both energy storage(1706) and power converter(1127) nodes combined.
- Toyota Motors has the highest number of patents on electrical power converters with 517 unique families, charge discharge control(462) and power output control(103).
- Nissan Motors(104), Honda Motors(41), General Motors(38), Daimler(38) have the highest number of patents on charge discharge control of electrical energy storage device.
- Toyota Motors has a lot of patents related to thermal(32), electrical(10), structural(3) protection of electrical energy storage devices.
- Except Toyota, General Motors, Volkswagen and Daimler, all the other assignees have no patent activity related to electric protection of energy storage device.

## Energy Storage Vs Publication Year




"Power Management Vs Publication Year"

- Charge discharge control(368), Electrical Power Converters(290), Power Output(84) have the highest number of patent publications in the year 2013.
- Fuel cells has an almost constant filing trend from 2011 -2014.

## Key Assignee Vs Type of transmission

| Type of transmission / Assignee/Applicant | AUTOMATIC TYPE TRANSMISSION | MECHANICAL TYPE TRANSMISSION | MULTI STAGE TRANSMISSION |
|---|---|---|---|
| Toyota Motor Corporation | 297 | 1033 | 156 |
| Nissan Motor Co. Ltd. | 126 | 263 | 42 |
| Honda Motor Co., Ltd. | 32 | 200 | 54 |
| General Motors Company | 41 | 187 | 78 |
| Daimler Ag | 9 | 62 | 19 |
| ZF Friedrichshafen AG | 18 | 109 | 30 |
| Volkswagen Ag | 6 | 63 | 13 |
| Hyundai Motor Company | 16 | 69 | 34 |
| Ford Global Technologies | 14 | 62 | 16 |
| Denso Corp. | 1 | 21 | 1 |
| Mitsubishi | 1 | 30 | 4 |
| Robert Bosch Stiftung Gmbh | 6 | 26 | 9 |
| Hitachi Ltd. | 3 | 16 | 5 |
| Mazda Motor Corporation | 13 | 20 | |



"Key Assignee Vs Type of hybrid"

- A total of 3312 patents are categorized under this node.
- Toyota Motors has highest number of patents published on mechanical type transmission with 1033 unique patent families, followed by automatic type transmission(297) and multistage transmission(156).
- Nissan Motors(263), Honda Motors(200), General Motors(187) also show a lot of patent activity in mechanical type transmission.
- Besides Toyota and Nissan; Honda, General Motors and Hyundai also have considerable number of patents on multi-stage transmission.
- Only Toyota has strong patent activity in Differential gear distribution type.

## Alliance Mapping of Key Assignees

### Toyota

| Partner | No of patents shared | Brief of the company |
|---|---|---|
| Denso Corp | 54 | Denso Corporation is a global automotive components manufacturer headquartered in the city of Kariya, Aichi Prefecture, Japan |
| Nippon Soken Inc | 19 | Nippon Soken Inc is a joint research institution of Denso Corporation and Toyota Motors. Soken engages research projects mainly in the fields of power trains, fuel cells, power electronics, information safety and thermal systems. |
| Fujitsu TEN LTD | 14 | Fujitsu Ten Ltd. is a Japanese company developing and manufacturing car audio, video, navigation and control systems. The headquarters is located in Kobe, Hy?go Prefecture, Japan. |
| Nippon Jidosha Buhin Sogo | 8 | Nippon Jidosha Buhin Sogo is a Japanese company designing and manufacturing power trains, engines, universal joints. The head office and factory are located in Ebina-shi (Kanagawa) and Moka-shi (Tochigi) Japan |
| Advics Co Ltd | 6 | ADVICS is a world class brake system supplier which provides advanced high quality brake systems and components to the global market. It offers ABS modulators, ESC modulators, integrated hydraulic |

| | | |
|---|---|---|
| | | boosters, brake boosters and master cylinders, load sensing proportioning valves, disc brakes, drum brakes, electric park brakes, foot release parking brake pedals, and brake components for motorcycles; and aftermarket products, such as brake pads. It has Headquarters in Japan. |
| Kyokuto Kaihatsu Kogyo Co Ltd | 3 | Kyokuto kaihatsu kogyo Corporation is a comprehensive manufacturer of special purpose trucks. It is headquartered in Nishinomiya, Japan. |
| Panasonic Inc | 2 | Panasonic Corporation is a Japanese multinational electronics corporation headquartered in Kadoma,Osaka, Japan. |
| NSK-Warner K.K | 2 | NSK-Warner KK develops and manufactures automotive parts. The Company provides one-way clutches, friction products, and clutch assembly products for automobiles and industrial machinery |
| Fuji Heavy Industries Ltd | 1 | Fuji Heavy Industries, Ltd., or FHI, is a Japanese multinational corporation and conglomerate primarily involved in aerospace and ground transportation manufacturing, known for its line of Subaru automobiles |
| University of Kyushu | 1 | Kyushu University, abbreviated to Kyudai, is a Japanese public university located in Fukuoka, Kyushu. |
| Kyushu Institute of Technology | 1 | KYUSHU INSTITUTE OF TECHNOLOGY is a public research institute situated in Kyushu city Japan |
| Tokai Rika Co Ltd | 1 | Tokai Rika Co., Ltd. manufactures and sells human machine interface systems, security systems, safety systems, electronics, and other products primarily in Japan and other Asian countries, North America, and Europe. |
| NOK Corp | 1 | NOK CORPORATION engages in manufacturing, importing, and selling seal products, industrial mechanical parts, hydraulic and pneumatic equipment, nuclear power equipment, synthetic chemicals, and electronic and other products. The company is headquartered in Tokyo, Japan. |
| Mitsubishi Motor Corp | 1 | Mitsubishi Motors Corporation is a multinational automotive manufacturer headquartered in Minato, Tokyo, Japan. |
| Yazaki Corporation | 1 | Yazaki is a global automotive parts supplier with a focus on wire harnesses and to a lesser degree instruments and components such as connectors and terminals. The company?s origin and headquarters are in Japan. |
| Sumitomo Wiring Systems Ltd | 1 | Sumitomo wiring system ltd product line includes manufacture and sales of wiring harnesses, harness components and other electric wires. It is headquartered in Japan. |
| Daihatsu Motor Co Ltd | 1 | Daihatsu Motor Co Ltd is the oldest Japanese car manufacturer, mostly known for its range of smaller models and off-road vehicles. The headquarters are located in Ikeda, Osaka Prefecture. |
| Toshiba | 1 | Toshiba is a Japanese multinational conglomerate corporation headquartered in Tokyo, Japan. Its diversified products and services include information technology and communications equipment and systems, electronic components and materials, power systems, industrial and social infrastructure systems, consumer electronics, household appliances, medical equipment, office equipment, lighting and logistics.. |

**Nissan Motors**

| Partner | No of patents shared | Brief of the company |
|---|---|---|
| Renault S.A | 6 | Renault S.A. is a French multinational vehicle manufacturer established in 1899. The company produces a range of cars and vans, and in the past has manufactured trucks, tractors, tanks, buses/coaches and autorail vehicles. |
| Hitachi Ltd | 4 | Hitachi, Ltd. is a Japanese multinational conglomerate company headquartered in Chiyoda, Tokyo, Japan. Hitachi is a highly diversified company that operates eleven business segments: Information & Telecommunication Systems, Social Infrastructure, High Functional Materials & Components, Financial Services, Power Systems, Electronic Systems & Equipment, Automotive Systems, Railway & Urban Systems, Digital Media & Consumer Products, Construction Machinery and Other Components & Systems |
| NOK CORPORATION | 1 | NOK CORPORATION engages in manufacturing, importing, and selling seal products, industrial mechanical parts, hydraulic and pneumatic equipment, nuclear power equipment, synthetic chemicals, and electronic and other products. The company is headquartered in Tokyo, Japan. |

**General Motors**

| Partner | No of patents shared | Brief of the company |
|---|---|---|
| BMW | 32 | Bayerische Motoren Werke AG, is a German automobile, motorcycle and engine manufacturing company founded in 1916. BMW is headquartered in Munich, Bavaria |
| Daimler Ag | 32 | Daimler AG is a German multinational automotive corporation. Daimler AG is headquartered in Stuttgart, Baden-Württemberg, Germany |

**Daimler Ag**

| Partner | No of patents shared | Brief of the company |
|---|---|---|

| | | |
|---|---|---|
| BMW | 32 | Bayerische Motoren Werke AG, is a German automobile, motorcycle and engine manufacturing company founded in 1916. BMW is headquartered in Munich, Bavaria |
| General Motors | 32 | General Motors Company, commonly known as GM, is an American multinational corporation headquartered in Detroit, Michigan, that designs, manufactures, markets and distributes vehicles and vehicle parts and sells financial services |

**ZF**

| Partner | No of patents shared | Brief of the company |
|---|---|---|
| Volswagen | 1 | Volkswagen is a German automobile manufacturer headquartered in Germany. Established in 1937, Volkswagen is the top-selling and namesake marque of the Volkswagen Group is now the biggest automaker in both Germany and Europe. |

**Volkswagen AG**

| Partner | No of patents shared | Brief of the company |
|---|---|---|
| Karlsruher Institut für Technologie | 1 | KIT was created in 2009 when the University of Karlsruhe (Universität Karlsruhe), founded in 1825 as public research university and also known as "Fridericiana", merged with the Karlsruhe Research Centre Forschungszentrum Karlsruhe. |
| Green propulsion | 1 | Green Propulsion is a Belgian research and development centre specialising in battery electric and hybrid vehicles. The Imperia GP car is developed by Green Propulsion. |
| Robert Bosch | 1 | Robert Bosch GmbH or Bosch, is a German multinational engineering and electronics company headquartered in Gerlingen, near Stuttgart, Germany. |
| ZF friedrichshafen | 1 | ZF Friedrichshafen AG, also known as ZF Group, is a German car parts maker headquartered in Friedrichshafen, in the south-west German region of Baden-Württemberg. |

**Hyundai Motors**

| Partner | No of patents shared | Brief of the company |
|---|---|---|
| RESEARCH & BUSINESS FOUNDATION SUNGKYUNKWAN UNIVERSITY | 1 | Sungkyunkwan University (also known as SKKU or simply Seongdae) is a private research university with campuses in Seoul and Suwon. |

**Ford Motors**

| Partner | No of patents shared | Brief of the company |
|---|---|---|
| Visteon Global | 1 | Visteon Corporation (VC) is an American global automotive parts supply company spun off from the Ford Motor Company in 2000. It is headquartered In Van Buren Township, Michigan, USA |

**Denso Corporation**

| Partner | No of patents shared | Brief of the company |
|---|---|---|
| Toyota | 54 | Toyota Motor Corporation is a Japanese automotive manufacturer headquartered in Toyota, Aichi, Japan |
| Nippon Soken Inc | 5 | Nippon Soken Inc is a joint research institution of Denso Corporation and Toyota Motors. Soken engages research projects mainly in the fields of power trains, fuel cells, power electronics, information safety and thermal systems. |
| Mazda Motor Corp | 2 | Mazda Motor Corporation is a Japanese automaker based in Fuch?, Aki District, Hiroshima Prefecture, Japan. |
| Nippon Jidosha Buhin Sogo | 2 | Nippon Jidosha Buhin Sogo is a Japanese company designing and manufacturing power trains, engines, universal joints. The head office and factory are located in Ebina-shi (Kanagawa) and Moka-shi (Tochigi) Japan |