Claims

1. A method for decarbonizing engines, comprising:

determining an initial set of decarbonization process parameters for a first engine;

performing a first engine decarbonization process upon the first engine, the first engine decarbonization process comprising:

introducing gaseous dry hydrogen into the first engine while the first engine is running, in accordance with the initial set of first engine decarbonization process parameters, the dry hydrogen being derived from a dry hydrogen source comprising a hydrogen gas canister, cartridge, or cassette;

automatically measuring first engine exhaust gas components while dry hydrogen is introduced into the first engine; and

automatically determining a set of lambda values based upon the measured exhaust gas components while dry hydrogen is introduced into the first engine, each lambda value corresponding to an air-to-fuel ratio for the first engine,

wherein the initial set of engine decarbonization process parameters includes a dry hydrogen flow rate or pressure,

wherein the first engine decarbonization process determines a temperature of the dry hydrogen source and adjusts the temperature of the dry hydrogen source before and/or during the first engine decarbonization process to establish or maintain a dry hydrogen flow rate or pressure in accordance with the initial set of first engine decarbonization process parameters.

~~2. The method of claim 1, wherein introducing dry hydrogen into the first engine comprises releasing dry hydrogen from a dry hydrogen source into the first engine, rather than introducing oxyhydrogen into the first engine.~~

~~3. The method of claim 1, wherein the initial set of engine decarbonization process parameters includes a dry hydrogen flow rate or pressure.~~

~~4~~2. The method of claim 1, wherein the initial set of engine decarbonization process parameters includes a first time period based upon at least some of first engine type, first engine capacity, and first engine odometer reading.

~~5~~3. The method of claim 1, further comprising adjusting a flow rate of dry hydrogen sourced from a dry hydrogen source to establish an initial dry hydrogen flow rate or pressure in accordance with the initial set of first engine decarbonization parameters.

~~6. The method of claim 5, further comprising:~~

~~determining a temperature of a dry hydrogen source from which the dry hydrogen is introduced into the first engine; and~~

~~adjusting the temperature of the dry hydrogen source before and/or during the first engine decarbonization process to establish or maintain a dry hydrogen flow rate or pressure in accordance with the initial set of first engine decarbonization process parameters.~~

~~7~~4. The method of claim 1, further comprising:

determining an updated set of first engine decarbonization process parameters based upon at least some of the determined lambda values; and

continuing the first engine decarbonization process by introducing dry hydrogen into the first engine in accordance with the updated set of first engine decarbonization process parameters.

~~8~~5. The method of claim ~~7~~4, wherein continuing the first engine decarbonization process in accordance with the updated set of first engine decarbonization parameters shifts first engine combustion conditions such that determined lambda values are at least approaching a target lambda value range, or remain within the target lambda value range.

~~9~~6. The method of claim ~~7~~4, wherein the updated set of first engine decarbonization process parameters includes an updated dry hydrogen flow rate.

~~107~~. The method of claim ~~74~~, wherein the updated set of first engine decarbonization process parameters includes a second time period based upon first engine type, first engine capacity, first engine odometer reading, and/or one or more determined lambda values determined during introduction of dry hydrogen into the first engine in accordance with the initial set of first engine decarbonization process parameters.

~~118~~. The method of claim 1, wherein determining the initial set of first engine decarbonization process parameters for the first engine decarbonization process comprises:

receiving at a remote engine decarbonization management system first engine information including at least one of first engine type, first engine capacity, and first engine odometer reading;

automatically determining the initial set of first engine decarbonization process parameters by the remote engine decarbonization management system in accordance with the first engine information; and

automatically communicating the initial set of first engine decarbonization process parameters from the remote engine decarbonization management system to a first local engine decarbonization unit configured for (a) introducing dry hydrogen into the first engine in accordance with the initial set of first engine decarbonization process parameters and (b) measuring first engine exhaust gas components.

~~129~~. The method of claim ~~118~~, further comprising:

performing a second engine decarbonization process upon a second engine, the second engine decarbonization process comprising:

determining an initial set of second engine decarbonization process parameters;

introducing dry hydrogen into the second engine while the second engine is running, in accordance with the initial set of second engine decarbonization process parameters;

measuring second engine exhaust gas components while dry hydrogen is introduced into the second engine; and

determining a set of lambda values based upon the measured exhaust gas components while dry hydrogen is introduced into the second engine, each lambda value corresponding to an air-to-fuel ratio for the second engine.

~~13~~10. The method of claim ~~12~~9, wherein introducing dry hydrogen into the second engine and measuring second engine exhaust gas components is performed by a second local engine decarbonization unit distinct from the first local engine decarbonization unit.

~~14~~11. The method of claim ~~13~~10, wherein the first and second engine decarbonization procedures are performed simultaneously.

~~15~~12. The method of claim ~~13~~10, wherein the first local engine decarbonization unit stores a first authorization code and the second local engine decarbonization unit stores a second authorization code, and wherein each of the first and second authorization codes is communicable to the remote decarbonization management system for automatic verification of the first local engine decarbonization unit and the second local engine decarbonization unit, respectively, by the remote decarbonization management system.

~~16~~13. The method of claim ~~13~~10, further comprising storing in a database associated with the remote engine decarbonization management system historical engine decarbonization information.

~~17~~14. The method of claim ~~16~~13, further comprising providing an Internet based vehicle manufacturing interface by which a vehicle manufacturer can access decarbonization process histories corresponding to vehicles they have manufactured, and/or categorical types of vehicles they and/or other manufacturers have manufactured.

~~18~~15. A system for decarbonizing engines, comprising:

a set of engine decarbonization units, each engine decarbonization unit comprising:

a hydrogen flow regulation unit couplable to a source of dry hydrogen, the source of dry hydrogen for each engine decarbonization unit comprising a set of hydrogen gas canisters, cartridges, or cassettes;

a hydrogen delivery line coupled to the hydrogen flow regulator and configured for introducing dry hydrogen into an engine;

an engine exhaust gas analyzer configured for measuring engine exhaust gas components and determining a set of corresponding lambda values, each lambda value corresponding to an air-to-fuel ratio of the engine;

a set of temperature sensors and a temperature regulation device for controlling a temperature of the source of dry hydrogen; and

a control unit configured for controllably introducing dry hydrogen into the engine while the engine is running in accordance with an initial set of engine decarbonization process parameters, wherein the initial set of engine decarbonization process parameters is based upon at least some of engine type, engine capacity, and engine odometer reading,

wherein each engine decarbonization unit further comprises a housing configured for removably receiving the set of solid state hydrogen gas canisters, cartridges, or cassettes and coupling the set of solid state hydrogen gas canisters, cartridges, or cassettes to the hydrogen flow regulation unit**.**

~~19~~16. The system of claim ~~18~~15, wherein the control unit of each engine decarbonization unit is further configured for adjusting a dry hydrogen flow rate into the engine in order to shift engine combustion conditions such that determined lambda values are at least approaching a target lambda value range, or remain within the target lambda value range.

~~20. The system of claim 18, wherein each engine decarbonization unit further comprises a set of temperature sensors and a temperature regulation device for controlling a temperature of the source of dry hydrogen.~~

~~21. The system of claim 18, wherein the source of dry hydrogen for each engine decarbonization unit comprises a set of solid state hydrogen gas canisters, cartridges, or~~

~~cassettes, and wherein each engine decarbonization unit further comprises a housing configured for removably receiving the set of solid state hydrogen gas canisters, cartridges, or cassettes and coupling the set of solid state hydrogen gas canisters, cartridges, or cassettes to the hydrogen flow regulation unit~~.

~~22~~17. The system of claim ~~18~~15, wherein each engine decarbonization unit further comprises a display device.

~~23~~18. The system of claim ~~18~~15, wherein each engine decarbonization unit further comprises a digital code reader.

~~24~~19. The system of claim ~~23~~18, wherein the digital code reader comprises a QR code reader.

~~25~~20. The system of claim ~~23~~18, wherein the system further comprises a decarbonization facility computer system having a digital code generation unit.

~~26~~21. The system of claim ~~25~~20, wherein the digital code generation unit comprises a QR code generation unit.

~~27~~22. The system of claim ~~18~~15, wherein the set of engine decarbonization units comprises a plurality of engine decarbonization units, and wherein the system further comprises a remote engine decarbonization management system coupled to each engine decarbonization unit by way of a computer network.

~~28~~23. The system of claim ~~27~~22, wherein the set of engine decarbonization units comprises a first set of engine decarbonization units located at a first decarbonization facility, and a second set of engine decarbonization units located at a second decarbonization facility that is geographically distinct from the first engine decarbonization facility.

~~29~~24. The system of claim ~~28~~23, wherein the system further comprises:

a first network gateway corresponding to the first decarbonization facility and configured for communication with the first set of engine decarbonization units and the remote engine decarbonization management system; and

a second network gateway corresponding to the second decarbonization facility and configured for communication with the second set of engine decarbonization units and the remote engine decarbonization management system.

~~30~~25. The system of claim ~~27~~22, wherein the remote engine decarbonization management system is configured for network communication with each engine decarbonization unit, the network communication comprising:

communicating from each engine decarbonization unit to the remote engine decarbonization management system a set of lambda values determined while dry hydrogen is introduced into the engine as part of a decarbonization process; and

communicating from the remote engine decarbonization management system to each engine decarbonization unit a set of updated engine decarbonization process parameters specifying a dry hydrogen flow rate for shifting combustion conditions of the engine associated with the engine decarbonization unit such that determined lambda values for the engine are at least approaching a target lambda value range, or remain within the target lambda value range.

~~31~~26. The system of claim ~~30~~25, wherein the network communication further comprises:

communicating engine information to the remote engine decarbonization management system, the engine information including at least some of engine type, engine capacity, and engine odometer reading; and

communicating from the remote engine decarbonization management system to each engine decarbonization unit a set of initial engine decarbonization process parameters based upon the engine information.

~~32~~27. The system of claim ~~27~~22, wherein the remote engine decarbonization management system is configured for verifying an authorization code corresponding to each engine decarbonization unit.

~~33~~28. The system of claim ~~27~~22, further comprising a database coupled to the remote engine decarbonization management system, and wherein the remote engine decarbonization management system is configured to store engine decarbonization histories corresponding to different types of engines in the database.

~~34~~29. The system of claim ~~27~~22, wherein the remote engine decarbonization management system provides an Internet based vehicle manufacturing interface by which a vehicle manufacturer can access decarbonization process histories corresponding to vehicles they have manufactured, and/or categorical types of vehicles they and/or other manufacturers have manufactured.