CLAIMS

1. A system for increasing photovoltaic device efficiency, comprising:

a voltage source circuit for supplying a voltage signal; and

a switching circuit for applying the supplied voltage signal as at least one voltage pulse with a positive amplitude to a photovoltaic device by alternating between applying the voltage signal the photovoltaic device during a first predetermined time interval and suspending application of the voltage signal to the photovoltaic device during a second predetermined time interval,

wherein the voltage signal generates an electric field across the photovoltaic device for increasing an output current produced by the photovoltaic device or an output power produced by the photovoltaic device.

2. The system of claim 1, wherein said voltage source circuit comprises a constant voltage source circuit for supplying the voltage signal as a constant voltage signal.

3. The system of claim 2,

wherein said constant voltage source circuit supplies the constant voltage signal with a potential between one hundred volts and five hundred volts, inclusively,

wherein said switching circuit alternates between closing a current path between said constant voltage source circuit during the first predetermined time interval and opening the current path during the second predetermined time interval, or

wherein said switching circuit comprises at least one mechanical switch, at least one solid state switch, at least one switching transistor or a combination thereof.

4. The system of claim 3, wherein said switching circuit applies the constant voltage signal to the photovoltaic device via the current path during the first predetermined time interval.

5. The system of claim 1, wherein the photovoltaic device is configured to provide the increased output current or the increased output power to a load.

6. The system of claim 5,

wherein said switching circuit is configured for coupling with the load, the photovoltaic device providing the increased output current or the increased output power to the load during the second predetermined time interval,

wherein said switching circuit comprises a double throw switching circuit with a first terminal for coupling with said voltage source circuit, a second terminal for coupling with the load and a common terminal for coupling with the photovoltaic device and being configured to provide a first current path between said voltage source circuit and the photovoltaic device during the first predetermined time interval and to provide second current path between and the photovoltaic device and the load during the second predetermined time interval, or

a combination thereof.

7. The system of claim 6, wherein said switching circuit is configured for providing the increased output current or the increased output power to the load during the first predetermined time interval.

8. The system of claim 1, wherein said voltage source circuit is electrically isolated from said switching circuit.

9. The system of claim 8, wherein said voltage source circuit further comprises an opto-isolator for electrically isolating said voltage source circuit from said switching circuit.

10. The system of claim 1, wherein said voltage source circuit comprises a controllable voltage source circuit for supplying the voltage signal as a controllable voltage signal, a periodic voltage source circuit for supplying the voltage signal as a periodic voltage signal, a controlled voltage source circuit for supplying the voltage signal as a time varying voltage signal or a combination thereof.

11. The system of claim 1, wherein said voltage source circuit applies the voltage signal to a plurality of photovoltaic devices during the first predetermined time interval, the voltage signal generating an electric field across the plurality of photovoltaic devices for increasing an output current produced by the photovoltaic device or an output power produced by the plurality of photovoltaic devices.

12. The system of claim 11, wherein the plurality of photovoltaic devices is disposed in a series device configuration, a parallel device configuration or a combination thereof.

13. The system of claim 1, further comprising:

a second voltage source circuit for alternating between applying a second voltage signal with a positive amplitude to a second photovoltaic device during a first predetermined time interval and suspending application of the second voltage signal to the second photovoltaic device during a second predetermined time interval,

wherein the second voltage signal generates a second electric field across the second photovoltaic device for increasing an output current produced by the second photovoltaic device or an output power produced by the second photovoltaic device.

14. The system of claim 13,

wherein said second voltage source circuit is synchronized with said voltage source circuit, wherein said second voltage source circuit applies the second voltage signal to the second photovoltaic device concurrently with said voltage source circuit applying the voltage signal to the photovoltaic device,

wherein said second voltage source circuit suspends application of the second voltage signal to the second photovoltaic device concurrently with said voltage source circuit suspending application of the voltage signal to the photovoltaic device or both,

wherein said second voltage source circuit is at least partially integrated with said voltage source circuit, or

a combination thereof.

15. The system of claim 1, wherein the at least one voltage pulse has an amplitude within an amplitude range between 100 Volts and 500 Volts, a frequency within a frequency range between 20 KHz and 200 KHz, a period within a period range between 5 microseconds and 50 microseconds, a nominal duty cycle in a duty cycle range between 0.1% and 10% or a combination thereof.

16. The system of claim 1, further comprising a control circuit for adjusting a first duration of the first predetermined time interval, a second duration of the second predetermined time interval, a duty cycle of the first and second predetermined time intervals, a first repetition rate of the first predetermined time interval, a second repetition rate of the second predetermined time interval or a combination thereof.

17. The system of claim 16,

wherein said control circuit adjusts the first duration to be in a first duration range between 10 nanoseconds and 2000 nanoseconds, the second duration to be in a second duration range between 10 nanoseconds and 2000 nanoseconds, the duty cycle of the voltage pulse to be within a duty cycle range between 0.1% and 10% or a combination thereof, or

wherein said control circuit is at least partially integrated with said voltage source circuit.

18. The system of claim 1, further comprising a control circuit for adjusting a frequency of the voltage signal applied to the photovoltaic device, a magnitude of the voltage signal applied to the photovoltaic device, a period of the voltage signal applied to the photovoltaic device, a repetition rate of the voltage signal applied to the photovoltaic device, a duty cycle of the voltage signal applied to the photovoltaic device, a duration of the voltage signal applied to the photovoltaic device or a combination thereof.

19. The system of claim 18,

wherein said control circuit adjusts the frequency to be within a frequency range between 20 KHz and 200 KHz, the magnitude to be within an amplitude range between 100 Volts and 500 Volts, the period to be within a period range between 5 microseconds and 50 microseconds, the duty cycle to be within a duty cycle range between 0.1% and 10%, the duration to be in a duration range between 10 nanoseconds and 2000 nanoseconds or a combination thereof,

wherein said control circuit adjusts the frequency, the magnitude, the period, the repetition rate, the duty cycle, the duration or the combination thereof based at least in part on the output current of the photovoltaic device, an output voltage of the photovoltaic device or both,

wherein said control circuit controls the electric field, the output current, the output power or a combination thereof by adjusting the voltage signal,

wherein said control circuit maximizes the output current of the photovoltaic device, the output power of the photovoltaic device or a combination thereof,

wherein said control circuit is at least partially integrated with said voltage source circuit,

further comprising a measuring circuit for measuring the output current of the photovoltaic device, an output voltage of the photovoltaic device or both, wherein said control circuit adjusts the frequency, the magnitude, the period, the repetition rate, the duty cycle, the duration or the combination thereof based at least in part upon the measured output current, the measured output voltage or both, or

a combination thereof.

20. The system of claim 19,

wherein said measuring circuit is at least partially integrated with said control circuit, or

wherein said measuring circuit includes a current sensor being configured to measure the output current and being coupled in series between the photovoltaic device and a load being driven by the photovoltaic device, a voltage probe being configured to measure the output voltage and being coupled across the photovoltaic device or a combination thereof.

21. The system of claim 5,

wherein the load converts the output current or the output power produced by the photovoltaic device into alternating current power or current,

wherein the load comprises an inverter,

wherein the load is electrically isolated from the photovoltaic device in the radio frequency domain,

wherein the load is electrically isolated from the photovoltaic device via a capacitor, an inductor, a battery or a combination thereof, or

a combination thereof.

22. The system of claim 5, further comprising an energy storage device for mitigating voltage drop-out at the load during the first predetermined time interval.

23. The system of claim 22,

wherein said energy storage device comprises a capacitor, an inductor, a battery or a combination thereof,

wherein said energy storage device stores the output current or the output power produced by the photovoltaic device during the second predetermined time interval,

wherein said energy storage device drives the load via the stored output power or the stored output current during the first predetermined time interval,

further comprising a choke circuit for electrically isolating the load from the photovoltaic device in the radio frequency domain as said energy storage device drives the load, or

a combination thereof.

24. The system of claim 23, wherein said choke circuit comprises a capacitor, an inductor, a battery or a combination thereof.

25. The system of claim 1,

wherein the increase in the output current or the output power produced by the photovoltaic device is based upon an intensity of light incident on the photovoltaic device, a thickness of the photovoltaic device, a duration of the voltage signal during the first predetermined time interval, a frequency of the voltage signal,

wherein the photovoltaic device comprises a solar cell, an array of solar cells, a solar panel, an array of solar panels or a combination thereof,

wherein said voltage source circuit is coupled with one or more existing electrodes of the photovoltaic device,

wherein said voltage source circuit applies the voltage signal to the photovoltaic device without structural modification of the photovoltaic device, or

a combination thereof.

26. The system of claim 1,

wherein generation of the electric field increases the output current or the output power produced by the photovoltaic device by up to fifty percent under low light conditions,

wherein generation of the electric field increases the output current or the output power produced by the photovoltaic device by more than fifty percent under low light conditions,

wherein generation of the electric field increases the output current or the output power produced by the photovoltaic device by up to twenty percent under high intensity light conditions,

wherein generation of the electric field increases the output current or the output power produced by the photovoltaic device between twenty percent and fifty percent, or

wherein generation of the electric field increases the output current or the output power produced by the photovoltaic device by more than fifty percent.

27. A method for increasing photovoltaic device efficiency, comprising:

coupling a voltage source circuit for supplying a voltage signal with switching circuit for applying the supplied voltage signal as at least one voltage pulse with a positive amplitude to a photovoltaic device by alternating between applying the voltage signal to the photovoltaic device during a first predetermined time interval and suspending application of the voltage signal to the photovoltaic device during a second predetermined time interval,

wherein the voltage signal generates an electric field across the photovoltaic device for increasing an output current produced by the photovoltaic device or an output power produced by the photovoltaic device.

28. A method for increasing photovoltaic device efficiency, comprising:

coupling a photovoltaic device with a switching circuit for applying a voltage signal supplied by a voltage source circuit as at least one voltage pulse with a positive amplitude to the photovoltaic device by alternating between applying the voltage signal to the photovoltaic device during a first predetermined time interval and suspending application of the voltage signal to the photovoltaic device during a second predetermined time interval,

wherein the voltage signal generates an electric field across the photovoltaic device for increasing an output current produced by the photovoltaic device or an output power produced by the photovoltaic device.

29. The method of claim 27, wherein the voltage source circuit comprises a constant voltage source circuit for supplying the voltage signal as a constant voltage signal.

30. The method of claim 29,

wherein the constant voltage source circuit supplies the constant voltage signal with a potential between one hundred volts and five hundred volts, inclusively,

wherein the switching circuit alternates between closing a current path between the constant voltage source circuit during the first predetermined time interval and opening the current path during the second predetermined time interval, or

wherein the switching circuit comprises at least one mechanical switch, at least one solid state switch, at least one switching transistor or a combination thereof.

31. The method of claim 30, wherein the switching circuit applies the constant voltage signal to the photovoltaic device via the current path during the first predetermined time interval.

32. The method of claim 27, wherein the at least one voltage pulse has an amplitude within an amplitude range between 100 Volts and 500 Volts, a frequency within a frequency range between 20 KHz and 200 KHz, a period within a period range between 5 microseconds and 50 microseconds, a nominal duty cycle in a duty cycle range between 0.1% and 10% or a combination thereof.

33. The method of claim 27, further comprising:

a second voltage source circuit for alternating between applying a second voltage signal with a positive amplitude to a second photovoltaic device during a first predetermined time interval and suspending application of the second voltage signal to the second photovoltaic device during a second predetermined time interval,

wherein the second voltage signal generates a second electric field across the second photovoltaic device for increasing an output current produced by the second photovoltaic device or an output power produced by the second photovoltaic device.

34. The method of claim 33,

wherein said second voltage source circuit is synchronized with the voltage source circuit,

wherein said second voltage source circuit applies the second voltage signal to the second photovoltaic device concurrently with the voltage source circuit applying the voltage signal to the photovoltaic device,

wherein said second voltage source circuit suspends application of the second voltage signal to the second photovoltaic device concurrently with the voltage source circuit suspending application of the voltage signal to the photovoltaic device or both,

wherein said second voltage source circuit is at least partially integrated with the voltage source circuit, or

a combination thereof.

35. The method of claim 27, wherein the photovoltaic device is configured to provide the increased output current or the increased output power to a load.

36. The method of claim 35,

wherein the switching circuit is configured for coupling with the load, the photovoltaic device providing the increased output current or the increased output power to the load during the second predetermined time interval,

wherein the switching circuit comprises a double throw switching circuit with a first terminal for coupling with the voltage source circuit, a second terminal for coupling with the load and a common terminal for coupling with the photovoltaic device and being configured to provide a first current path between the voltage source circuit and the photovoltaic device during the first predetermined time interval and to provide second current path between and the photovoltaic device and the load during the second predetermined time interval, or

a combination thereof.

37. The method of claim 35,

wherein the load converts the output current or the output power produced by the photovoltaic device into alternating current power or current,

wherein the load comprises an inverter,

wherein the load is electrically isolated from the photovoltaic device in the radio frequency domain,

wherein the load is electrically isolated from the photovoltaic device via a capacitor, an inductor, a battery or a combination thereof, or

a combination thereof.

38. The method of claim 35, further comprising an energy storage device for mitigating voltage drop-out at the load during the first predetermined time interval.

39. The method of claim 38,

wherein said energy storage device comprises a capacitor, an inductor, a battery or a combination thereof,

wherein said energy storage device stores the output current or the output power produced by the photovoltaic device during the second predetermined time interval,

wherein said energy storage device drives the load via the stored output power or the stored output current during the first predetermined time interval,

further comprising a choke circuit for electrically isolating the load from the photovoltaic device in the radio frequency domain as said energy storage device drives the load, or

a combination thereof.

40. The method of claim 39, wherein said choke circuit comprises a capacitor, an inductor, a battery or a combination thereof.

41. The method of claim 27,

wherein the increase in the output current or the output power produced by the photovoltaic device is based upon an intensity of light incident on the photovoltaic device, a thickness of the photovoltaic device, a duration of the voltage signal during the first predetermined time interval, a frequency of the voltage signal,

wherein the photovoltaic device comprises a solar cell, an array of solar cells, a solar panel, an array of solar panels or a combination thereof,

wherein the voltage source circuit is coupled with one or more existing electrodes of the photovoltaic device,

wherein the voltage source circuit applies the voltage signal to the photovoltaic device without structural modification of the photovoltaic device, or

a combination thereof.

42. The method of claim 27,

wherein generation of the electric field increases the output current or the output power produced by the photovoltaic device by up to fifty percent under low light conditions,

wherein generation of the electric field increases the output current or the output power produced by the photovoltaic device by more than fifty percent under low light conditions,

wherein generation of the electric field increases the output current or the output power produced by the photovoltaic device by up to twenty percent under high intensity light conditions,

wherein generation of the electric field increases the output current or the output power produced by the photovoltaic device between twenty percent and fifty percent, or

wherein generation of the electric field increases the output current or the output power produced by the photovoltaic device by more than fifty percent.

43. The method of claim 28, wherein the voltage source circuit comprises a constant voltage source circuit for supplying the voltage signal as a constant voltage signal.

44. The method of claim 43,

wherein the constant voltage source circuit supplies the constant voltage signal with a potential between one hundred volts and five hundred volts, inclusively,

wherein the switching circuit alternates between closing a current path between the constant voltage source circuit during the first predetermined time interval and opening the current path during the second predetermined time interval, or

wherein the switching circuit comprises at least one mechanical switch, at least one solid state switch, at least one switching transistor or a combination thereof.

45. The method of claim 44, wherein the switching circuit applies the constant voltage signal to the photovoltaic device via the current path during the first predetermined time interval.

46. The method of claim 28, wherein the at least one voltage pulse has an amplitude within an amplitude range between 100 Volts and 500 Volts, a frequency within a frequency range between 20 KHz and 200 KHz, a period within a period range between 5 microseconds and 50 microseconds, a nominal duty cycle in a duty cycle range between 0.1% and 10% or a combination thereof.

47. The method of claim 28, further comprising:

a second voltage source circuit for alternating between applying a second voltage signal with a positive amplitude to a second photovoltaic device during a first predetermined time interval and suspending application of the second voltage signal to the second photovoltaic device during a second predetermined time interval,

wherein the second voltage signal generates a second electric field across the second photovoltaic device for increasing an output current produced by the second photovoltaic device or an output power produced by the second photovoltaic device.

48. The method of claim 47,

wherein said second voltage source circuit is synchronized with the voltage source circuit, wherein said second voltage source circuit applies the second voltage signal to the second photovoltaic device concurrently with the voltage source circuit applying the voltage signal to the photovoltaic device,

wherein said second voltage source circuit suspends application of the second voltage signal to the second photovoltaic device concurrently with the voltage source circuit suspending application of the voltage signal to the photovoltaic device or both,

wherein said second voltage source circuit is at least partially integrated with the voltage source circuit, or

a combination thereof.

49. The method of claim 28, wherein the photovoltaic device is configured to provide the increased output current or the increased output power to a load.

50. The method of claim 49,

wherein the switching circuit is configured for coupling with the load, the photovoltaic device providing the increased output current or the increased output power to the load during the second predetermined time interval,

wherein the switching circuit comprises a double throw switching circuit with a first terminal for coupling with the voltage source circuit, a second terminal for coupling with the load and a common terminal for coupling with the photovoltaic device and being configured to provide a first current path between the voltage source circuit and the photovoltaic device during the first predetermined time interval and to provide second current path between and the photovoltaic device and the load during the second predetermined time interval, or

a combination thereof.

51. The method of claim 49,

wherein the load converts the output current or the output power produced by the photovoltaic device into alternating current power or current,

wherein the load comprises an inverter,

wherein the load is electrically isolated from the photovoltaic device in the radio frequency domain,

wherein the load is electrically isolated from the photovoltaic device via a capacitor, an inductor, a battery or a combination thereof, or

a combination thereof.

52. The method of claim 49, further comprising an energy storage device for mitigating voltage drop-out at the load during the first predetermined time interval.

53. The method of claim 52,

wherein said energy storage device comprises a capacitor, an inductor, a battery or a combination thereof,

wherein said energy storage device stores the output current or the output power produced by the photovoltaic device during the second predetermined time interval,

wherein said energy storage device drives the load via the stored output power or the stored output current during the first predetermined time interval,

further comprising a choke circuit for electrically isolating the load from the photovoltaic device in the radio frequency domain as said energy storage device drives the load, or

a combination thereof.

54. The method of claim 53, wherein said choke circuit comprises a capacitor, an inductor, a battery or a combination thereof.

55. The method of claim 28,

wherein the increase in the output current or the output power produced by the photovoltaic device is based upon an intensity of light incident on the photovoltaic device, a thickness of the photovoltaic device, a duration of the voltage signal during the first predetermined time interval, a frequency of the voltage signal,

wherein the photovoltaic device comprises a solar cell, an array of solar cells, a solar panel, an array of solar panels or a combination thereof,

wherein the voltage source circuit is coupled with one or more existing electrodes of the photovoltaic device,

wherein the voltage source circuit applies the voltage signal to the photovoltaic device without structural modification of the photovoltaic device, or

a combination thereof.

56. The method of claim 28,

wherein generation of the electric field increases the output current or the output power produced by the photovoltaic device by up to fifty percent under low light conditions,

wherein generation of the electric field increases the output current or the output power produced by the photovoltaic device by more than fifty percent under low light conditions,

wherein generation of the electric field increases the output current or the output power produced by the photovoltaic device by up to twenty percent under high intensity light conditions,

wherein generation of the electric field increases the output current or the output power produced by the photovoltaic device between twenty percent and fifty percent, or

wherein generation of the electric field increases the output current or the output power produced by the photovoltaic device by more than fifty percent.