CLAIMS

What is claimed is:

1. An apparatus comprising:

at least one processor; and

at least one memory including computer program code;

the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to:

receive, from a serving cell, a conditional handover configuration, wherein the conditional handover configuration is associated with an energy saving mode, wherein the conditional handover configuration comprises:

an indication of one or more candidate target cells, and

information for target cell selection;

after receiving the conditional handover configuration, receive, from the serving cell, an indication of activation of the energy saving mode at the serving cell; and

conditionally on receiving the indication of activation of the energy saving mode at the serving cell, select, from the one or more candidate target cells, a target cell for handover based on the information for target cell selection comprised in the conditional handover configuration.

2. The apparatus of claim 1, wherein the information for target cell selection comprises one or more execution conditions, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to:

evaluate the one or more execution conditions and select the target cell from the one or more candidate target cells based on evaluating the one or more execution conditions.

3. The apparatus of claim 1, wherein the information for target cell selection comprises one or more radio conditions to be evaluated.

4. The apparatus of any one of claims 1 through 3, wherein the indication of activation of the energy saving mode is included in a broadcast message.

5. The apparatus of any one of claims 1 through 4, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to:

disconnect from the serving cell; and

synchronize with the selected target cell.

6. The apparatus of any one of claims 1 through 5, wherein the conditional handover configuration further comprises an indication of one or more measurements to perform.

7. The apparatus of claim 6, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to:

perform at least one of the one or more measurements; and

select the target cell based, at least partially, on a result of the at least one performed measurement.

8. The apparatus of any one of claims 1 through 7, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to:

select the target cell based, at least partially, on one of:

predetermined information, located at the apparatus, that is associated with the target cell, or

the information for target cell selection, comprising at least one of:

a transmission configuration indicator state associated with the serving cell or the target cell,

a reference signal received power value associated with the serving cell or the target cell,

a downlink beam of the serving cell or the target cell, or

selection criteria.

9. The apparatus of any one of claims 1 through 8, wherein the apparatus is in a radio resource control connected state.

10. The apparatus of any one of claims 1 through 9, wherein the indication of activation of the energy saving mode at the serving cell comprises an indication of at least one of:

cell shutdown,

network transmit power reduction, or

multiple-in multiple-out transmit antenna element muting.

11. The apparatus of any one of claims 1 through 10, wherein the indication of the one or more candidate target cells is based, at least partially, on at least one of:

one or more network shutdown policies of the serving cell,

one or more frequency layers of the serving cell that are shut down,

an order of shutdown of the one or more frequency layers of the serving cell that are shut down, or

a frequency layer of a same power saving group as at least one of the one or more frequency layers of the serving cell that are shut down.

12. The apparatus of any one of claims 1 through 11, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to:

receive an indication of when the conditional handover configuration is to be applied, wherein the indication comprises at least one of:

the indication of activation of the energy saving mode at the serving cell,

a network offload indication,

an indication of an activation of the conditional handover configuration, or

an indication of a time for enforcement of the conditional handover configuration, comprising at least one of:

a system frame number,

a hyper frame number, or

a number of time units.

13. The apparatus of claim 12, wherein the network offload indication or the indication of an activation of the conditional handover configuration comprises one of:

downlink control information, or

a medium access control control element.

14. A method comprising:

receiving, with a user equipment from a serving cell, a conditional handover configuration, wherein the conditional handover configuration is associated with an energy saving mode, wherein the conditional handover configuration comprises:

an indication of one or more candidate target cells, and

information for target cell selection;

after receiving the conditional handover configuration, receiving, from the serving cell, an indication of activation of an energy saving mode at the serving cell; and

conditionally on receiving the indication of activation of the energy saving mode at the serving cell, selecting, from the one or more candidate target cells, a target cell for handover based on the information for target cell selection comprised in the conditional handover configuration.

15. The method of claim 14, wherein the information for target cell selection comprises one or more execution conditions, wherein the method further comprising:

evaluating the one or more execution conditions and selecting the target cell from the one or more candidate target cells based on evaluating the one or more execution conditions.

16. The method of claim 14, wherein the information for target cell selection comprises one or more radio conditions to be evaluated.

17. The method of any one of claims 14 through 16, wherein the indication of activation of the energy saving mode is included in a broadcast message.

18. The method of any one of claims 14 through 17, further comprising:

disconnecting the user equipment from the serving cell; and

synchronizing the user equipment with the selected target cell.

19. The method of any one of claims 14 through 18, wherein conditional handover configuration further comprises an indication of one or more measurements to perform.

20. The method of claim 19, further comprising:

performing at least one of the one or more measurements; and

selecting the target cell based, at least partially, on a result of the at least one performed measurement.

21. The method of any one of claims 14 through 20, wherein the selecting of the target cell comprises:

selecting the target cell based, at least partially, on one of:

predetermined information, located at the user equipment, that is associated with the target cell, or

the information for target cell selection, comprising at least one of:

a transmission configuration indicator state associated with the serving cell or the target cell,

a reference signal received power value associated with the serving cell or the target cell,

a downlink beam of the serving cell or the target cell, or

selection criteria.

22. The method of any one of claims 14 through 21, wherein the user equipment is in a radio resource control connected state.

23. The method of any one of claims 14 through 22, wherein the indication of activation of the energy saving mode at the serving cell comprises an indication of at least one of:

cell shutdown,

network transmit power reduction, or

multiple-in multiple-out transmit antenna element muting.

24. The method of any one of claims 14 through 23, wherein the indication of the one or more candidate target cells is based, at least partially, on at least one of:

one or more network shutdown policies of the serving cell,

one or more frequency layers of the serving cell that are shut down,

an order of shutdown of the one or more frequency layers of the serving cell that are shut down, or

a frequency layer of a same power saving group as at least one of the one or more frequency layers of the serving cell that are shut down.

25. The method of any of claims 14 through 24, further comprising:

receiving an indication of when the conditional handover configuration is to be applied, wherein the indication comprises at least one of:

the indication of activation of the energy saving mode at the serving cell,

a network offload indication,

an indication of an activation of the conditional handover configuration, or

an indication of a time for enforcement of the conditional handover configuration, comprising at least one of:

a system frame number,

a hyper frame number, or

a number of time units.

26. The method of claim 25, wherein the network offload indication or the indication of an activation of the conditional handover configuration comprises one of:

downlink control information, or

a medium access control control element.

27. A non-transitory computer readable medium comprising instructions stored thereon which, when executed by at least one processor, cause the at least one processor to perform at least the following:

receive, from a serving cell, a conditional handover configuration, wherein the conditional handover configuration is associated with an energy saving mode, wherein the conditional handover configuration comprises:

an indication of one or more candidate target cells, and

information for target cell selection;

after receiving the conditional handover configuration, receive, from the serving cell, an indication of activation of the energy saving mode at the serving cell; and

conditionally on receiving the indication of activation of the energy saving mode at the serving cell, select, from the one or more candidate target cells, a target cell for handover based on the information for target cell selection comprised in the conditional handover configuration.

28. The non-transitory computer readable medium of claim 27, wherein the information for target cell selection comprises one or more execution conditions, wherein the non-transitory computer readable medium further comprising instructions stored thereon which, when executed by the at least one processor, cause the at least one processor to perform the following:

evaluate the one or more execution conditions and select the target cell from the one or more candidate target cells based on evaluating the one or more execution conditions.

29. The non-transitory computer readable medium of claim 27, wherein the information for target cell selection comprises one or more radio conditions to be evaluated.

30. The non-transitory computer readable medium of any one of claims 27 through 29, wherein the indication of activation of the energy saving mode is included in a broadcast message.

31. The non-transitory computer readable medium of any one of claims 27 through 30, further comprising instructions stored thereon which, when executed by the at least one processor, cause the at least one processor to perform the following:

disconnect from the serving cell; and

synchronize with the selected target cell.

32. The non-transitory computer readable medium of any one of claims 27 through 31, wherein the conditional handover configuration further comprises an indication of one or more measurements to perform.

33. The non-transitory computer readable medium of claim 32, further comprising instructions stored thereon which, when executed by the at least one processor, cause the at least one processor to perform the following:

perform at least one of the one or more measurements; and

select the target cell based, at least partially, on a result of the at least one performed measurement.

34. The non-transitory computer readable medium of any one of claims 27 through 33, medium further comprising instructions stored thereon which, when executed by the at least one processor, cause the at least one processor to perform the following:

select the target cell based, at least partially, on one of:

predetermined information, located at the apparatus, that is associated with the target cell, or

the information for target cell selection, comprising at least one of:

a transmission configuration indicator state associated with the serving cell or the target cell,

a reference signal received power value associated with the serving cell or the target cell,

a downlink beam of the serving cell or the target cell, or

selection criteria.

35. The non-transitory computer readable medium of any one of claims 27 through 34, wherein the apparatus is in a radio resource control connected state.

36. The non-transitory computer readable medium of any one of claims 27 through 35, wherein the indication of activation of the energy saving mode at the serving cell comprises an indication of at least one of:

cell shutdown,

network transmit power reduction, or

multiple-in multiple-out transmit antenna element muting.

37. The non-transitory computer readable medium of any one of claims 27 through 36, wherein the indication of the one or more candidate target cells is based, at least partially, on at least one of:

one or more network shutdown policies of the serving cell,

one or more frequency layers of the serving cell that are shut down,

an order of shutdown of the one or more frequency layers of the serving cell that are shut down, or

a frequency layer of a same power saving group as at least one of the one or more frequency layers of the serving cell that are shut down.

38. The non-transitory computer readable medium of any one of claims 27 through 37, further comprising instructions stored thereon which, when executed by the at least one processor, cause the at least one processor to perform the following:

receive an indication of when the conditional handover configuration is to be applied, wherein the indication comprises at least one of:

the indication of activation of the energy saving mode at the serving cell,

a network offload indication,

an indication of an activation of the conditional handover configuration, or

an indication of a time for enforcement of the conditional handover configuration, comprising at least one of:

a system frame number,

a hyper frame number, or

a number of time units.

39. The non-transitory computer readable medium of claims 38, wherein the network offload indication or the indication of an activation of the conditional handover configuration comprises one of:

downlink control information, or

a medium access control control element.

40. An apparatus comprising:

at least one processor; and

at least one memory including computer program code;

the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to:

determine to activate an energy saving mode;

generate a conditional handover configuration, wherein the conditional handover configuration is associated with the energy saving mode, wherein the conditional handover configuration comprises:

an indication of one or more candidate target cells, and

information for target cell selection;

transmit, to a user equipment, the conditional handover configuration;

after transmitting the conditional handover configuration, initiate activation of the energy saving mode; and

transmit, to the user equipment, an indication of activation of the energy saving mode.

41. The apparatus of claim 40, wherein the information for target cell selection comprises one or more execution conditions.

42. The apparatus of claim 40, wherein the information for target cell selection comprises one or more radio conditions to be evaluated.

43. The apparatus of any one of claims 40 through,42 wherein the indication of activation of the energy saving mode is included in a broadcast message.

44. The apparatus of any one of claims 40 through 43, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to:

transmit, to at least one of the one or more candidate target cells, a respective energy saving conditional handover information request, wherein the respective energy saving conditional handover information request comprises an energy saving mode trigger; and

receive, from the at least one candidate target cell, a handover request acknowledgement.

45. The apparatus of any one of claims 40 through 44, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to:

transmit, to at least one of the one or more candidate target cells, a respective cell deactivation indication, wherein the respective cell deactivation indication comprises at least one of:

an energy saving conditional handover information request,

information about handover preparation for conditional handover, or

a list of currently active user equipments to be offloaded to a respective candidate target cell of the one or more candidate target cells; and

receive, from the one or more candidate target cells, a handover request acknowledgement.

46. The apparatus of any one of claims 40 through 45, wherein the conditional handover configuration further comprises an indication of one or more measurements to perform.

47. The apparatus of claim 46, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to:

receive, from the user equipment, an indication of a result of at least one of the one or more measurements;

determine a confidence that a target cell of the one or more candidate target cells will be selected at the user equipment for synchronization based, at least partially, on the indication of the result of the at least one of the one or more measurements;

compare the determined confidence with a threshold;

based on a determination that the determined confidence is greater than the threshold, indicate to the user equipment to: omit performance of the one or more measurements, and perform target cell selection based on at least one of:

predetermined information that is associated with the target cell, or

the information for target cell selection; and

based on a determination that the determined confidence is less than or equal to the threshold, indicate to the user equipment to perform target cell selection based on performing the one or more measurements.

48. The apparatus of any one of claims 40 through 47, wherein the information for target cell selection comprises at least one of:

a transmission configuration indicator state associated with the apparatus or a target cell,

a reference signal received power value associated with the apparatus or the target cell,

a downlink beam of the apparatus or the target cell, or

selection criteria.

49. The apparatus of any one of claims 40 through 48, wherein the energy saving mode comprises at least one of:

cell shutdown,

network transmit power reduction, or

multiple-in multiple-out transmit antenna element muting.

50. The apparatus of any one of claims 40 through 49, wherein the indication of the one or more candidate target cells is based, at least partially, on at least one of:

one or more network shutdown policies,

one or more frequency layers that are shut down,

an order of shutdown of the one or more frequency layers that are shut down, or

a frequency layer of a same power saving group as at least one of the one or more frequency layers that are shut down.

51. The apparatus of any one of claims 40 through 50, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to:

transmit, to the user equipment, an indication of when the conditional handover configuration is to be applied, wherein the indication comprises at least one of:

the indication of activation of the energy saving mode,

a network offload indication,

an indication of an activation of the conditional handover configuration, or

an indication of a time for enforcement of the conditional handover configuration, comprising at least one of:

a system frame number,

a hyper frame number, or

a number of time units.

52. The apparatus of claim 51, wherein the network offload indication or the indication of an activation of the conditional handover configuration comprises one of:

downlink control information, or

a medium access control control element.

53. A method comprising:

determining to activate an energy saving mode;

generating a conditional handover configuration, wherein the conditional handover configuration is associated with the energy saving mode, wherein the conditional handover configuration comprises:

an indication of one or more candidate target cells, and

information for target cell selection;

transmitting, to a user equipment, the conditional handover configuration;

after transmitting the conditional handover configuration, initiating activation of the energy saving mode; and

transmitting, to the user equipment, an indication of activation of the energy saving mode.

54. The method of claim 53, wherein the information for target cell selection comprises one or more execution conditions.

55. The method of claim 53, wherein the information for target cell selection comprises one or more radio conditions to be evaluated.

56. The method of any one of claims 53 through 55, wherein the indication of activation of the energy saving mode is included in a broadcast message.

57. The method of any one of claims 53 through 56, further comprising:

transmitting, to at least one of the one or more candidate target cells, a respective energy saving conditional handover information request, wherein the respective energy saving conditional handover information request comprises an energy saving mode trigger; and

receiving, from the at least one candidate target cell, a handover request acknowledgement.

58. The method of any one of claims 53 through 57, further comprising:

transmitting, to at least one of the one or more candidate target cells, a respective cell deactivation indication, wherein the respective cell deactivation indication comprises at least one of:

an energy saving conditional handover information request,

information about handover preparation for conditional handover, or

a list of currently active user equipments to be offloaded to a respective candidate target cell of the one or more candidate target cells; and

receiving, from the one or more candidate target cells, a handover request acknowledgement.

59. The method of any one of claims 53 through 58, wherein the conditional handover configuration further comprises an indication of one or more measurements to perform.

60. The method of claim 59, further comprising:

receiving, from the user equipment, an indication of a result of at least one of the one or more measurements;

determining a confidence that a target cell of the one or more candidate target cells will be selected at the user equipment for synchronization based, at least partially, on the indication of the result of the at least one of the one or more measurements;

comparing the determined confidence with a threshold;

based on a determination that the determined confidence is greater than the threshold, indicating to the user equipment to: omit performance of the one or more measurements, and perform target cell selection based on at least one of:

predetermined information that is associated with the target cell, or

the information for target cell selection; and

based on a determination that the determined confidence is less than or equal to the threshold, indicating to the user equipment to perform target cell selection based on performing the one or more measurements.

61. The method of any one of claims 53 through 60, wherein the information for target cell selection comprises at least one of:

a transmission configuration indicator state associated with the apparatus or a target cell,

a reference signal received power value associated with the apparatus or the target cell,

a downlink beam of the apparatus or the target cell, or

selection criteria.

62. The method of any one of claims 53 through 61, wherein the energy saving mode comprises at least one of:

cell shutdown,

network transmit power reduction, or

multiple-in multiple-out transmit antenna element muting.

63. The method of any one of claims 53 through 62, wherein the indication of the one or more candidate target cells is based, at least partially, on at least one of:

one or more network shutdown policies,

one or more frequency layers that are shut down,

an order of shutdown of the one or more frequency layers that are shut down, or

a frequency layer of a same power saving group as at least one of the one or more frequency layers that are shut down.

64. The method of any one of claims 53 through 62, further comprising:

transmitting, to the user equipment, an indication of when the conditional handover configuration is to be applied, wherein the indication comprises at least one of:

the indication of activation of the energy saving mode,

a network offload indication,

an indication of an activation of the conditional handover configuration, or

an indication of a time for enforcement of the conditional handover configuration, comprising at least one of:

a system frame number,

a hyper frame number, or

a number of time units.

65. The method of claim 64, wherein the network offload indication or the indication of an activation of the conditional handover configuration comprises one of:

downlink control information, or

a medium access control control element.

66. A non-transitory computer readable medium comprising instructions stored thereon which, when executed by at least one processor, cause the at least one processor to perform at least the following:

determine to activate an energy saving mode;

generate a conditional handover configuration, wherein the conditional handover configuration is associated with the energy saving mode, wherein the conditional handover configuration comprises:

an indication of one or more candidate target cells, and

information for target cell selection;

transmit, to a user equipment, the conditional handover configuration;

after transmitting the conditional handover configuration, initiate activation of the energy saving mode; and

transmit, to the user equipment, an indication of activation of the energy saving mode.

67. The non-transitory computer readable medium of claim 66, wherein the information for target cell selection comprises one or more execution conditions.

68. The non-transitory computer readable medium of claim 66, wherein the information for target cell selection comprises one or more radio conditions to be evaluated.

69. The non-transitory computer readable medium of any one of claims 66 through 68, wherein the indication of activation of the energy saving mode is included in a broadcast message.

70. The non-transitory computer readable medium of any one of claims 66 through 69, further comprising instructions stored thereon which, when executed by the at least one processor, cause the at least one processor to perform the following:

transmit, to at least one of the one or more candidate target cells, a respective energy saving conditional handover information request, wherein the respective energy saving conditional handover information request comprises an energy saving mode trigger; and

receive, from the at least one candidate target cell, a handover request acknowledgement.

71. The non-transitory computer readable medium of any one of claims 66 through 70, further comprising instructions stored thereon which, when executed by the at least one processor, cause the at least one processor to perform the following:

transmit, to at least one of the one or more candidate target cells, a respective cell deactivation indication, wherein the respective cell deactivation indication comprises at least one of:

an energy saving conditional handover information request,

information about handover preparation for conditional handover, or

a list of currently active user equipments to be offloaded to a respective candidate target cell of the one or more candidate target cells; and

receive, from the one or more candidate target cells, a handover request acknowledgement.

72. The non-transitory computer readable medium of any one of claims 66 through 71, wherein the conditional handover configuration further comprises an indication of one or more measurements to perform.

73. The non-transitory computer readable medium of claim 72, further comprising instructions stored thereon which, when executed by the at least one processor, cause the at least one processor to perform the following:

receive, from the user equipment, an indication of a result of at least one of the one or more measurements;

determine a confidence that a target cell of the one or more candidate target cells will be selected at the user equipment for synchronization based, at least partially, on the indication of the result of the at least one of the one or more measurements;

compare the determined confidence with a threshold;

based on a determination that the determined confidence is greater than the threshold, indicate to the user equipment to: omit performance of the one or more measurements, and perform target cell selection based on at least one of:

predetermined information that is associated with the target cell, or

the information for target cell selection; and

based on a determination that the determined confidence is less than or equal to the threshold, indicate to the user equipment to perform target cell selection based on performing the one or more measurements.

74. The non-transitory computer readable medium of any one of claims 66 through 73, wherein the information for target cell selection comprises at least one of:

a transmission configuration indicator state associated with the apparatus or a target cell,

a reference signal received power value associated with the apparatus or the target cell,

a downlink beam of the apparatus or the target cell, or

selection criteria.

75. The non-transitory computer readable medium of any one of claims 66 through 74, wherein the energy saving mode comprises at least one of:

cell shutdown,

network transmit power reduction, or

multiple-in multiple-out transmit antenna element muting.

76. The non-transitory computer readable medium of any one of claims 66 through 75, wherein the indication of the one or more candidate target cells is based, at least partially, on at least one of:

one or more network shutdown policies,

one or more frequency layers that are shut down,

an order of shutdown of the one or more frequency layers that are shut down, or

a frequency layer of a same power saving group as at least one of the one or more frequency layers that are shut down.

77. The non-transitory computer readable medium of any one of claims 66 through 76, further comprising instructions stored thereon which, when executed by the at least one processor, cause the at least one processor to perform the following:

transmit, to the user equipment, an indication of when the conditional handover configuration is to be applied, wherein the indication comprises at least one of:

the indication of activation of the energy saving mode,

a network offload indication,

an indication of an activation of the conditional handover configuration, or

an indication of a time for enforcement of the conditional handover configuration, comprising at least one of:

a system frame number,

a hyper frame number, or

a number of time units.

78. The non-transitory computer readable medium of claim 77, wherein the network offload indication or the indication of an activation of the conditional handover configuration comprises one of:

downlink control information, or

a medium access control control element.