

August 19, 2022

The Honorable Eric L. Lipman
Assistant Chief Administrative Law Judge
Office of Administrative Hearings
600 Robert Street North
P.O. Box 64620
Saint Paul, Minnesota 55164-0620

Re: In the Matter of the Possible Amendments to Rules Governing the Minnesota Residential Energy Code, Minnesota Rules, Chapter 1322; OAH Docket No. 8-9001-38469

Dear Judge Lipman:

In anticipation of the August 23, 2022, Webex hearing in the above-referenced matter, the Department electronically submits the following rulemaking documents to be placed into the hearing record pursuant to Minnesota Rules, Part 1400.2220, subpart 1 A-K. In addition to electronically filing these documents with the Office of Administrative Hearings, the Department will also post and make available for public review these documents on its Rulemaking Docket prior to the August 23, 2022, hearing. The Department will officially offer these e-filed exhibits and request that they be entered into the rulemaking record at the upcoming hearing.

Pursuant to Minnesota Rules, part 1400.2220, subpart 1, paragraphs A to K of this correspondence are keyed to items A to K of part 1400.2220. Each paragraph states whether the document is attached and, if the document is not attached, the reason that the document is not applicable. The Department notes that, because this is a pre-rulemaking hearing, a number of documents are not applicable in this case:

- A. Request for Comments (not attached because the purpose of the hearing is to receive public comment prior to initiating rulemaking);
- B. Petition for Rulemaking (not attached because no petition for rulemaking was received);
- C. Proposed Rule (not attached because the Department has not initiated rulemaking);
- D. Statement of Need and Reasonableness (not attached because the Department has not initiated rulemaking);
- E. Certificate of e-mailing the Statement of Need and Reasonableness to the Legislative Reference Library (not attached as the Department has not drafted a SONAR for this matter because the Department has not initiated rulemaking);
- F. The Notice of Hearing as mailed and published in the *State Register* on July 18, 2022 (attached);
- G. Certificate of accuracy of the mailing list for the mailing of the Notice of Hearing to the rulemaking list (attached);

Equal Opportunity Employer

- G.1. Certificate of mailing the Notice of Hearing to the rulemaking list (attached);
- G.2. Certificate of accuracy of the electronic rulemaking e-mail list and of e-mailing the Notice of Hearing to the electronic rulemaking e-mail list (attached);
- H. Certificate of e-mailing the Notice of Hearing to Additional Notice Plan (attached);
- I. Timely comments received by the Department during the comment period (not attached because the Department did not receive any comments);
- J. Letter requesting authorization to omit the text of the proposed rule and order authorizing such omission (not attached since no such authorization or order were sought in this rulemaking);
- K. Certificate of sending the Notice of Hearing to legislators and the legislative coordinating commission (attached);
- K.1. Final Determination Regarding Energy Efficiency Improvements in the 2021 International Energy Conservation Code (IECC) published in the *Federal Register* on July 28, 2021 (attached);
- K.2. Energy Savings Analysis: 2021 IECC for Residential Buildings prepared for the United States Department of Energy by Pacific Northwest National Laboratory (attached); and
- K.3. Cost-Effectiveness of the 2021 IECC for Residential Buildings in Minnesota prepared for the United States Department of Energy by Pacific Northwest National Laboratory.

Thank you for your attention to this matter. Please contact me if you have any questions, comments or concerns.

Sincerely,

/s/ Brittany Wysokinski

Brittany Wysokinski
General Counsel
Minnesota Department of Labor and Industry

| <p style="text-align: center;">Index to Exhibits</p> <p style="text-align: center;">Possible Amendments to Rules Governing the Minnesota Residential Energy Code, Minnesota Rules, Chapter 1322</p> <p style="text-align: center;">OAH Docket No. 8-9001-38469</p> | | |
|---|--|-----------------------------|
| <i>Exhibit</i> | <i>Document Title</i> | <i>Bates Stamp Location</i> |
| A | Not included | none |
| B | Not included | none |
| C | Not included | none |
| D | Not included | none |
| E | Not included | None |
| F | The Notice of Hearing as mailed and published in the State Register on July 18, 2022 | 000001 |
| G | Certificate of accuracy of the mailing list for the mailing of the Notice of Hearing to the rulemaking list | 000010 |
| G.1 | Certificate of mailing the Notice of Hearing to the rulemaking list | 000013 |
| G.2 | Certificate of accuracy of the electronic rulemaking e-mail list and of e-mailing the Notice of Hearing to the electronic rulemaking e-mail list | 000019 |
| H | Certificate of e-mailing the Notice of Hearing to additional notice plan | 000160 |
| I | Not included | none |
| J | Not included | none |
| K | Certificate of sending the Notice of Hearing to legislators and the legislative coordinating commission | 000168 |

| | | |
|-----|---|--------|
| K.1 | Final Determination Regarding Energy Efficiency Improvements in the 2021 International Energy Conservation Code (IECC) published in the Federal Register on July 28, 2021 | 000173 |
| K.2 | Energy Savings Analysis: 2021 IECC for Residential Buildings prepared for the United States Department of Energy by Pacific Northwest National Laboratory | 000180 |
| K.3 | Cost-Effectiveness of the 2021 IECC for Residential Buildings in Minnesota prepared for the United States Department of Energy by Pacific Northwest National Laboratory | 000255 |

Exhibit F

Minnesota Department of Labor and Industry

NOTICE OF HEARING

Possible Amendments to Rules Governing the Minnesota Residential Energy Code, Minnesota Rules, Chapter 1322; OAH Docket # 8-9001-38469

Public Hearing. The Minnesota Department of Labor and Industry (“Department”) will hold a virtual public hearing at **9:30 a.m. on Tuesday, August 23, 2022**, via WebEx, for the purposes of taking public comment and testimony regarding the appropriateness of amending the existing Minnesota Residential Energy Code, *Minnesota Rules*, chapter 1322, to adopt the residential provisions of the 2021 International Energy Conservation Code (“IECC”). All interested or affected persons will have an opportunity to participate by submitting oral or written comments, statements, or arguments.

For a video and audio connection, register to join the hearing through an internet connection, such as with a computer or tablet at: <https://tinyurl.com/1322hearing>

For audio connection only, join the hearing by phone:
Call: 1-855-282-6330 or 1-415-655-0003
Access code: 2480 297 4382.

Please note: If the public hearing must be postponed or re-scheduled for any reason, the Department will send a notice of such a change to its State Building Code Rulemaking List and the organizations listed on its additional notice plan. The Department will also post the notice of such a change on its website at: <https://www.dli.mn.gov/about-department/rulemaking/rulemaking-docket-minnesota-rules-chapter-1322-0>

Subject of Hearing and Statutory Authority. *Minnesota Statutes*, section 326B.106, subdivision 1 (d), requires the Commissioner to act in accordance with federal law on each new model residential energy code for which the United States Department of Energy has issued an affirmative determination of improved energy efficiency in compliance with *United States Code*, title 42, section 6833. On July 28, 2021, the United States Department of Energy issued an affirmative determination concerning the residential provisions of the 2021 IECC, concluding that buildings meeting that most recent revision would result in national site energy savings of 9.38 percent, national source energy savings of 8.79 percent, and national energy cost savings of approximately 8.66 percent of residential building energy consumption. This affirmative determination statement may be viewed in its entirety by contacting the agency contact person listed below for a copy of the same or by viewing it at: <https://www.govinfo.gov/content/pkg/FR-2021-07-28/pdf/2021-15969.pdf>.

Based on that affirmative determination, *United States Code*, title 42, section 6833 (a)(5)(B), now requires each state to review the provisions of its residential energy code to determine whether it is appropriate for the state to revise its current building code to meet or exceed the residential energy efficiency provisions of the 2021 IECC. *United States Code*, title

42, section 6833 (a)(2), further requires that this state determination be made after public notice and hearing, be based upon the record provided for at the hearing, and be made generally available to the public. Accordingly, the Department encourages comments and public participation at the hearing as scheduled above.

Public Comment. You and all interested or affected persons, including representatives of associations and other interested groups, will have an opportunity to participate. The administrative law judge will accept your views either orally at the WebEx hearing or in writing at any time before the close of the hearing record. Submit written comments to the administrative law judge at the address below or **via the [Office of Administrative Hearings Rulemaking eComments website https://minnesotaoah.granicusideas.com/discussions](https://minnesotaoah.granicusideas.com/discussions)**. All evidence that you present should relate to the issue identified above. You may also submit written material to the administrative law judge to be recorded in the hearing record for five working days after the public hearing ends. At the hearing, the administrative law judge may order this five-day comment period extended for a longer period but for no more than 20 calendar days. Following the comment period, there is a five-working-day rebuttal period during which the agency and any interested person may respond in writing to any new information submitted. No one may submit additional evidence during the five-day rebuttal period. The Office of Administrative Hearings must receive all comments and responses submitted to the administrative law judge no later than 4:30 p.m. on the due date. All comments or responses received are public and will be available for review at the Office of Administrative Hearings or on their website.

The agency requests that any person submitting written comments or data to the administrative law judge before the hearing or during the comment or rebuttal period also submit a copy of the written comments or data to the agency contact person at the address listed below.

Administrative Law Judge. Administrative Law Judge Eric L. Lipman will conduct the hearing on the date and at the time and place listed above. Judge Lipman's legal assistant, Michelle Severson, may be reached at the Office of Administrative Hearings, 600 North Robert Street, P.O. Box 64620, St. Paul, Minnesota 55164-0620, telephone (651) 361-7874, fax (651) 539-0310, and email: michelle.severson@state.mn.us.

Agency Contact Person. The agency contact person is: Amanda Spuckler at the Minnesota Department of Labor and Industry, 443 Lafayette Road North, St. Paul, Minnesota 55155, telephone (651) 284-5006, and email: dli.rules@state.mn.us.

Adoption Procedure after the Hearing. After the close of the hearing record, the administrative law judge will issue a Report and Recommendation to the Commissioner as to whether it is appropriate to revise existing *Minnesota Rules*, chapter 1322, to adopt the residential energy saving provisions of the 2021 IECC. You may ask to be notified of the date when the administrative law judge's Report and Recommendation will become available. You can make this request at the hearing or in writing to the administrative law judge. You may also ask to be notified of the date when the Commissioner issues her Final Order on the administrative law judge's Recommendation. You may make this request at the hearing or in writing to the agency contact person listed above. Copies of the administrative law judge's Report and Recommendation and the Commissioner's Final Order will also be made available for viewing on the agency's website at: <https://www.dli.mn.gov/about-department/rulemaking/rulemaking-docket-minnesota-rules-chapter-1322-0>.

If the Commissioner's Final Order determines that it is appropriate to revise the residential energy efficiency provisions of *Minnesota Rules*, chapter 1322, then the Commissioner will proceed with adopting the necessary amendments under the formal rulemaking provisions of Chapter 14, the Minnesota Administrative Procedures Act. If the Commissioner's Final Order determines that it is not appropriate at this time to revise the residential energy efficiency provisions of *Minnesota Rules*, chapter 1322, then the Commissioner will certify that determination and the reasons for the same to the United States Department of Energy as required by *United States Code*, title 42, section 6833 (a)(4). Copies of the Commissioner's Final Order will be made available for viewing on the agency's website at: <https://www.dli.mn.gov/about-department/rulemaking/rulemaking-docket-minnesota-rules-chapter-1322-0>.

Alternative Format/Accommodation. Upon request, this information can be made available in an alternative format, such as large print, braille, or audio. To make such a request or if you need an accommodation to make this hearing accessible, please contact the agency contact person at the address or telephone number listed above.

Lobbyist Registration. *Minnesota Statutes*, chapter 10A, requires each lobbyist to register with the State Campaign Finance and Public Disclosure Board. You should direct questions regarding this requirement to the Campaign Finance and Public Disclosure Board at: Suite #190, Centennial Building, 658 Cedar Street, St. Paul, Minnesota 55155, telephone (651) 539-1180 or 1-800-657-3889.

Order. I hereby order that the hearing be held at the date, time, and location listed above.

July 11, 2022

Date

Roslyn C. Robertson

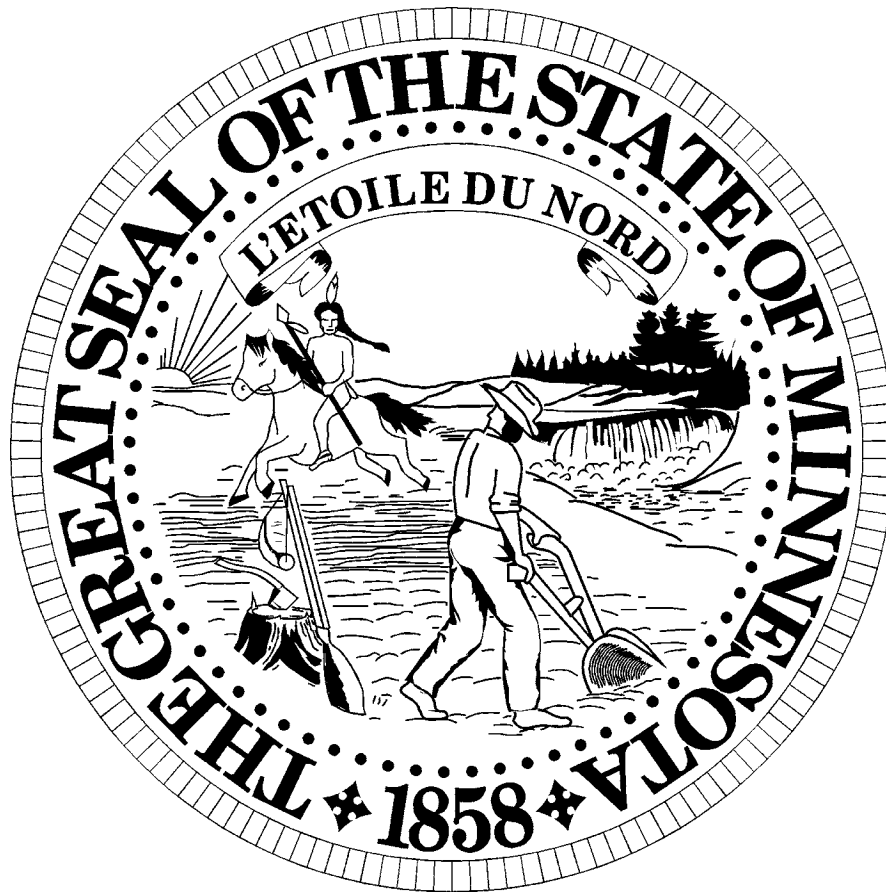
Roslyn Robertson

Commissioner

Minnesota Department of Labor and Industry

Minnesota State Register

Published every Monday (Tuesday when Monday is a holiday)



**Proposed, Adopted, Emergency, Expedited, Withdrawn, Vetoed Rules;
Executive Orders; Appointments; Commissioners' Orders; Revenue Notices;
Official Notices; State Grants & Loans; State Contracts; Non-State Public Bids,
Contracts and Grants**

**Monday 18 July 2022
Volume 47, Number 3
Pages 29 - 42**

Minnesota State Register

Judicial Notice Shall Be Taken of Material Published in the Minnesota State Register

The Minnesota State Register is the official publication of the State of Minnesota's Executive Branch of government, published weekly to fulfill the legislative mandate set forth in Minnesota Statutes, Chapter 14, and Minnesota Rules, Chapter 1400. It contains:

- Proposed Rules
- Adopted Rules
- Exempt Rules
- Expedited Rules
- Withdrawn Rules
- Executive Orders of the Governor
- Appointments
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- Vetoed Rules
- Commissioners' Orders
- Revenue Notices
- Official Notices
- State Grants and Loans
- Contracts for Professional, Technical and Consulting Services
- Non-State Public Bids, Contracts and Grants

Printing Schedule and Submission Deadlines

| Vol. 47 Issue Number | Publish Date | Deadline for: all Short Rules, Executive and Commissioner's Orders, Revenue and Official Notices, State Grants, Professional-Technical- Consulting Contracts, Non-State Bids and Public Contracts | Deadline for LONG, Complicated Rules (contact the editor to negotiate a deadline) |
|----------------------|------------------|---|---|
| #4 | Monday 25 July | Noon Tuesday 19 July | Noon Thursday 14 July |
| #5 | Monday 1 August | Noon Tuesday 26 July | Noon Thursday 21 July |
| #6 | Monday 8 August | Noon Tuesday 2 August | Noon Thursday 28 July |
| #7 | Monday 15 August | Noon Tuesday 9 August | Noon Thursday 4 August |

PUBLISHING NOTICES: We need to receive your submission ELECTRONICALLY in Microsoft WORD format. Submit ONE COPY of your notice via e-mail to: sean.plemmons@state.mn.us. State agency submissions must include a "State Register Printing Order" form, and, with contracts, a "Contract Certification" form. Non-State Agencies should submit ELECTRONICALLY in Microsoft WORD, with a letter on your letterhead stationery requesting publication and date to be published. Costs are \$13.50 per tenth of a page (columns are seven inches wide). One typewritten, double-spaced page = 6/10s of a page in the State Register, or \$81. About 1.5 pages typed, double-spaced, on 8-1/2"x11" paper = one typeset page in the State Register. Contact editor with questions (651) 201-3204, or e-mail: sean.plemmons@state.mn.us.

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<https://www.senate.mn/>

Minnesota State Court System

Court Information Office (651) 296-6043
MN Judicial Center, Rm. 135,
25 Rev. Dr. Martin Luther King Jr Blvd., St. Paul, MN 55155
<http://www.mncourts.gov>

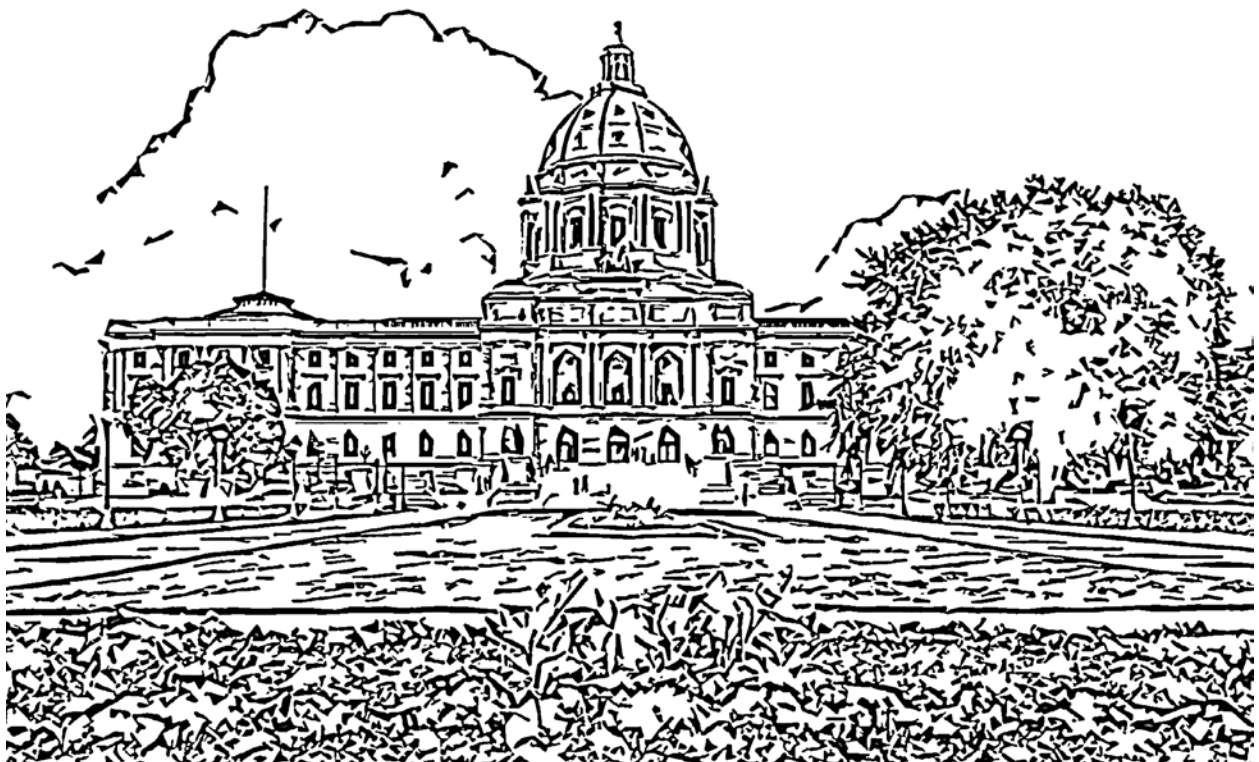
House Public Information Services

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State Office Building, Room 175
100 Rev. Dr. Martin Luther King Jr Blvd., St. Paul, MN 55155
<https://www.house.leg.state.mn.us/hinfo/hinfo.asp>

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Minnesota Department of Labor and Industry

NOTICE OF HEARING for Possible Amendments to Rules Governing the Minnesota Residential Energy Code, *Minnesota Rules*, Chapter 1322; OAH Docket # 8-9001-38469

Public Hearing. The Minnesota Department of Labor and Industry (“Department”) will hold a virtual public hearing at **9:30 a.m. on Tuesday, August 23, 2022**, via WebEx, for the purposes of taking public comment and testimony regarding the appropriateness of amending the existing Minnesota Residential Energy Code, *Minnesota Rules*, chapter 1322, to adopt the residential provisions of the 2021 International Energy Conservation Code (“IECC”). All interested or affected persons will have an opportunity to participate by submitting oral or written comments, statements, or arguments.

For a video and audio connection, register to join the hearing through an internet connection, such as with a computer or tablet at: <https://tinyurl.com/1322hearing>

For audio connection only, join the hearing by phone:
Call: 1-855-282-6330 or 1-415-655-0003
Access code: 2480 297 4382.

Please note: If the public hearing must be postponed or re-scheduled for any reason, the Department will send a notice of such a change to its State Building Code Rulemaking List and the organizations listed on its additional notice plan. The Department will also post the notice of such a change on its website at: <https://www.dli.mn.gov/about-department/rulemaking/rulemaking-docket-minnesota-rules-chapter-1322-0>

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Based on that affirmative determination, *United States Code*, title 42, section 6833 (a)(5)(B), now requires each state to review the provisions of its residential energy code to determine whether it is appropriate for the state to revise its current building code to meet or exceed the residential energy efficiency provisions of the 2021 IECC. *United States Code*, title 42, section 6833 (a)(2), further requires that this state determination be made after public notice and hearing, be based upon the record provided for at the hearing, and be made generally available to the public. Accordingly, the Department encourages comments and public participation at the hearing as scheduled above.

Public Comment. You and all interested or affected persons, including representatives of associations and other interested groups, will have an opportunity to participate. The administrative law judge will accept your views either orally at the WebEx hearing or in writing at any time before the close of the hearing record. Submit written comments to the administrative law judge at the address below or via the **Office of Administrative Hearings Rulemaking eComments website** <https://minnesotaoah.granicusideas.com/discussions>. All evidence that you present should relate to the issue identified above. You may also submit written material to the administrative law judge to be recorded in the hearing record for five working days after the public hearing ends. At the hearing, the administrative law judge may order this five-day comment period extended for a longer period but for no more than 20 calendar days. Following the comment period, there is a five-working-day rebuttal period during which the agency and any interested person may respond in writing to any new information submitted. No one may submit additional evidence during the five-day rebuttal period. The Office of Administrative Hearings must receive all comments and responses submitted to the administrative law judge no later than 4:30 p.m. on the due date. All comments or responses received are public and will be available for review at the Office of Administrative Hearings or on their website.

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Agency Contact Person. The agency contact person is: Amanda Spuckler at the Minnesota Department of Labor and Industry, 443 Lafayette Road North, St. Paul, Minnesota 55155, telephone (651) 284-5006, and email: dli.rules@state.mn.us.

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Order. I hereby order that the hearing be held at the date, time, and location listed above.

Date: July 11, 2022

Roslyn Robertson
Commissioner
Minnesota Department of Labor and Industry

Exhibit G

Minnesota Department of Labor and Industry

CERTIFICATE OF ACCURACY OF THE MAILING LIST

**Possible Amendments to Rules Governing the Minnesota Residential Energy Code,
Minnesota Rules, Chapter 1322**

I certify that the list of persons and associations who have requested that their names be placed on the Department of Labor and Industry rulemaking mailing list for the State Building Code under Minnesota Statutes, section 14.14, subdivision 1a, is accurate, complete, and current as of July 15, 2022. A copy of the mailing list is attached to this Certificate.

Sonya Herr

Sonya Herr
Legal Support Staff Supervisor

William Engelhardt
Engelhardt Design
1738 Irving Ave S
Minneapolis, MN 55403

James Filipek
City of Lonsdale
603 5th Street NE
Montgomery, MN 56069

Philip Garbe
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Todd Geske
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Loretto, MN 55357

Brian Hoffman
City of St. Louis Park
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Minneapolis, MN 55416

Gerald Manthey
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Cloquet, MN 55720

Lauren Sirotiak
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Duane Stensland
West Lakeland Township
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Stillwater, MN 55082

Michael Winiiecki
General Sprinkler Corporation
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White Bear Lake, MN 55110

John Quarnstrom
SMARCA, Inc.
6200 Shingle Creek Parkway, Suite 130
Brooklyn Center, MN 55430

James Fallon
4149 Baker Road
Minnetonka, MN 55305

David Skallet
City of St. Louis Park
5005 Minnetonka Blvd
St. Louis Park, MN 55416

Hon Siow
13849 Kendall Street NE
Columbus, MN 55025

Michael Ahern
Dorsey & Whitney
50 South 6th Street
Minneapolis, MN 55102

Grace Keliher
Builders Asso of Minnesota
525 Park Street #150
St. Paul, MN 55103

Bradley Dvorak
11450 Galtier Drive
Burnsville, MN 55337

Senator Justin D. Eichorn
95 University Avenue W.
Minnesota Senate Bldg, Room 3213
St. Paul, MN 55155

Penny Dinzeo
899 Rice Street
St. Paul, MN 55117

Meike Patten
Mackinaw Administrators
3500 American Blvd
Bloomington, MN 55431

Exhibit G.1

Minnesota Department of Labor and Industry

**CERTIFICATE OF ACCURACY OF THE MAILING LIST AND MAILING THE
NOTICE OF HEARING TO THE RULEMAKING MAILING LIST**

**Possible Amendments to Rules Governing the Minnesota Residential Energy Code,
Minnesota Rules, Chapter 1322**

I certify that on July 15, 2022, at least 33 days before the hearing date, at St. Paul, Ramsey County, Minnesota, I mailed the Notice of Hearing by depositing a copy in the State of Minnesota's central mail system for United States mail with postage prepaid to all persons and associations on the rulemaking mailing list for the State Building Code established by Minnesota Statutes, section 14.14, subdivision 1a. Copies of the Notice are attached to this Certificate.



Amanda Spuckler
Rules Specialist

Minnesota Department of Labor and Industry

NOTICE OF HEARING

Possible Amendments to Rules Governing the Minnesota Residential Energy Code, Minnesota Rules, Chapter 1322; OAH Docket # 8-9001-38469

Public Hearing. The Minnesota Department of Labor and Industry (“Department”) will hold a virtual public hearing at **9:30 a.m. on Tuesday, August 23, 2022**, via WebEx, for the purposes of taking public comment and testimony regarding the appropriateness of amending the existing Minnesota Residential Energy Code, *Minnesota Rules*, chapter 1322, to adopt the residential provisions of the 2021 International Energy Conservation Code (“IECC”). All interested or affected persons will have an opportunity to participate by submitting oral or written comments, statements, or arguments.

For a video and audio connection, register to join the hearing through an internet connection, such as with a computer or tablet at: <https://tinyurl.com/1322hearing>

For audio connection only, join the hearing by phone:
Call: 1-855-282-6330 or 1-415-655-0003
Access code: 2480 297 4382.

Please note: If the public hearing must be postponed or re-scheduled for any reason, the Department will send a notice of such a change to its State Building Code Rulemaking List and the organizations listed on its additional notice plan. The Department will also post the notice of such a change on its website at: <https://www.dli.mn.gov/about-department/rulemaking/rulemaking-docket-minnesota-rules-chapter-1322-0>

Subject of Hearing and Statutory Authority. *Minnesota Statutes*, section 326B.106, subdivision 1 (d), requires the Commissioner to act in accordance with federal law on each new model residential energy code for which the United States Department of Energy has issued an affirmative determination of improved energy efficiency in compliance with *United States Code*, title 42, section 6833. On July 28, 2021, the United States Department of Energy issued an affirmative determination concerning the residential provisions of the 2021 IECC, concluding that buildings meeting that most recent revision would result in national site energy savings of 9.38 percent, national source energy savings of 8.79 percent, and national energy cost savings of approximately 8.66 percent of residential building energy consumption. This affirmative determination statement may be viewed in its entirety by contacting the agency contact person listed below for a copy of the same or by viewing it at: <https://www.govinfo.gov/content/pkg/FR-2021-07-28/pdf/2021-15969.pdf>.

Based on that affirmative determination, *United States Code*, title 42, section 6833 (a)(5)(B), now requires each state to review the provisions of its residential energy code to determine whether it is appropriate for the state to revise its current building code to meet or exceed the residential energy efficiency provisions of the 2021 IECC. *United States Code*, title

42, section 6833 (a)(2), further requires that this state determination be made after public notice and hearing, be based upon the record provided for at the hearing, and be made generally available to the public. Accordingly, the Department encourages comments and public participation at the hearing as scheduled above.

Public Comment. You and all interested or affected persons, including representatives of associations and other interested groups, will have an opportunity to participate. The administrative law judge will accept your views either orally at the WebEx hearing or in writing at any time before the close of the hearing record. Submit written comments to the administrative law judge at the address below or **via the [Office of Administrative Hearings Rulemaking eComments website](https://minnesotaoah.granicusideas.com/discussions) <https://minnesotaoah.granicusideas.com/discussions>**. All evidence that you present should relate to the issue identified above. You may also submit written material to the administrative law judge to be recorded in the hearing record for five working days after the public hearing ends. At the hearing, the administrative law judge may order this five-day comment period extended for a longer period but for no more than 20 calendar days. Following the comment period, there is a five-working-day rebuttal period during which the agency and any interested person may respond in writing to any new information submitted. No one may submit additional evidence during the five-day rebuttal period. The Office of Administrative Hearings must receive all comments and responses submitted to the administrative law judge no later than 4:30 p.m. on the due date. All comments or responses received are public and will be available for review at the Office of Administrative Hearings or on their website.

The agency requests that any person submitting written comments or data to the administrative law judge before the hearing or during the comment or rebuttal period also submit a copy of the written comments or data to the agency contact person at the address listed below.

Administrative Law Judge. Administrative Law Judge Eric L. Lipman will conduct the hearing on the date and at the time and place listed above. Judge Lipman's legal assistant, Michelle Severson, may be reached at the Office of Administrative Hearings, 600 North Robert Street, P.O. Box 64620, St. Paul, Minnesota 55164-0620, telephone (651) 361-7874, fax (651) 539-0310, and email: michelle.severson@state.mn.us.

Agency Contact Person. The agency contact person is: Amanda Spuckler at the Minnesota Department of Labor and Industry, 443 Lafayette Road North, St. Paul, Minnesota 55155, telephone (651) 284-5006, and email: dli.rules@state.mn.us.

Adoption Procedure after the Hearing. After the close of the hearing record, the administrative law judge will issue a Report and Recommendation to the Commissioner as to whether it is appropriate to revise existing *Minnesota Rules*, chapter 1322, to adopt the residential energy saving provisions of the 2021 IECC. You may ask to be notified of the date when the administrative law judge's Report and Recommendation will become available. You can make this request at the hearing or in writing to the administrative law judge. You may also ask to be notified of the date when the Commissioner issues her Final Order on the administrative law judge's Recommendation. You may make this request at the hearing or in writing to the agency contact person listed above. Copies of the administrative law judge's Report and Recommendation and the Commissioner's Final Order will also be made available for viewing on the agency's website at: <https://www.dli.mn.gov/about-department/rulemaking/rulemaking-docket-minnesota-rules-chapter-1322-0>.

If the Commissioner's Final Order determines that it is appropriate to revise the residential energy efficiency provisions of *Minnesota Rules*, chapter 1322, then the Commissioner will proceed with adopting the necessary amendments under the formal rulemaking provisions of Chapter 14, the Minnesota Administrative Procedures Act. If the Commissioner's Final Order determines that it is not appropriate at this time to revise the residential energy efficiency provisions of *Minnesota Rules*, chapter 1322, then the Commissioner will certify that determination and the reasons for the same to the United States Department of Energy as required by *United States Code*, title 42, section 6833 (a)(4). Copies of the Commissioner's Final Order will be made available for viewing on the agency's website at: <https://www.dli.mn.gov/about-department/rulemaking/rulemaking-docket-minnesota-rules-chapter-1322-0>.

Alternative Format/Accommodation. Upon request, this information can be made available in an alternative format, such as large print, braille, or audio. To make such a request or if you need an accommodation to make this hearing accessible, please contact the agency contact person at the address or telephone number listed above.

Lobbyist Registration. *Minnesota Statutes*, chapter 10A, requires each lobbyist to register with the State Campaign Finance and Public Disclosure Board. You should direct questions regarding this requirement to the Campaign Finance and Public Disclosure Board at: Suite #190, Centennial Building, 658 Cedar Street, St. Paul, Minnesota 55155, telephone (651) 539-1180 or 1-800-657-3889.

Order. I hereby order that the hearing be held at the date, time, and location listed above.

July 11, 2022

Date

Roslyn C. Robertson

Roslyn Robertson

Commissioner

Minnesota Department of Labor and Industry

William Engelhardt
Engelhardt Design
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Minneapolis, MN 55403

James Filipek
City of Lonsdale
603 5th Street NE
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Senator Justin D. Eichorn
95 University Avenue W.
Minnesota Senate Bldg, Room 3213
St. Paul, MN 55155

Penny Dinzeo
899 Rice Street
St. Paul, MN 55117

Meike Patten
Mackinaw Administrators
3500 American Blvd
Bloomington, MN 55431

Exhibit G.2

Minnesota Department of Department of Labor and Industry

**CERTIFICATE OF ACCURACY OF THE E-MAILING LIST AND OF E-MAILING
THE NOTICE OF HEARING TO THE RULEMAKING E-MAILING LIST**

**Possible Amendments to Rules Governing the Minnesota Residential Energy Code,
Minnesota Rules, Chapter 1322**

I certify that the list of persons and associations who have requested that their names be placed on the Department of Labor and Industry rulemaking e-mailing list for the State Building Code under Minnesota Statutes, section 14.14, subdivision 1a, is accurate, complete, and current as of July 12, 2022. A copy of the mailing list is attached to this Certificate.

I further certify that on July 18, 2022, at least 30 days before the hearing date, at St. Paul, Ramsey County, Minnesota, I e-mailed the links to Notice of Hearing to all persons and associations on the rulemaking e-mailing list for the State Building Code established by Minnesota Statutes, section 14.14, subdivision 1a. A copy of the e-mail, the Notice, and the e-mailing list are attached to this Certificate.

/s/ Chris Thompson
Chris Thompson
Information Officer

Spuckler, Amanda (DLI)

From: Minnesota Department of Labor and Industry <MNDLI@public.govdelivery.com>
Sent: Monday, July 18, 2022 9:02 AM
To: Spuckler, Amanda (DLI)
Subject: Notice of Hearing: Possible amendments to rules governing the Minnesota Residential Energy Code



Notice of Hearing: Possible amendments to rules governing the Minnesota Residential Energy Code

Chapter 1322, Minnesota Residential Energy Code

You are receiving this email because you have registered to receive electronic rulemaking notices pertaining to the State Building Code.

The [Minnesota Department of Labor and Industry](#) will conduct a public hearing at 9:30 a.m. on Tuesday, Aug. 23, 2022, via Webex, for the purposes of taking public comment and testimony regarding the appropriateness of amending the existing Minnesota Residential Energy Code, Minnesota Rules, chapter 1322, to adopt the residential provisions of the 2021 International Energy Conservation Code (IECC).

The Notice of Hearing related to this hearing will be published in the July 18, 2022, edition of the *State Register*.

The Notice of Hearing provides details about the hearing and, with other information, is [available in the rulemaking docket](#).

Questions?

Contact us at dli.rules@state.mn.us.

Update your subscriptions, modify your password or email address or stop subscriptions at any time on your [Subscriber Preferences Page](#). You will need to use your email address to log in. If you have questions or problems with the subscription service, visit subscriberhelp.govdelivery.com.

This service is provided to you at no charge by [Minnesota Department of Labor and Industry](#).

This email was sent to amanda.spuckler@state.mn.us using GovDelivery Communications Cloud on behalf of: Minnesota Department of Labor and Industry · 443 Lafayette Road N. · Saint Paul, MN 55155



Minnesota Department of Labor and Industry

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Order. I hereby order that the hearing be held at the date, time, and location listed above.

July 11, 2022

Date

Roslyn C. Robertson

Roslyn Robertson

Commissioner

Minnesota Department of Labor and Industry

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Exhibit H

Minnesota Department of Labor and Industry

CERTIFICATE OF GIVING ADDITIONAL NOTICE UNDER THE ADDITIONAL NOTICE PLAN

Possible Amendments to Rules Governing the Minnesota Residential Energy Code, Minnesota Rules, Chapter 1322

I certify that on July 18, 2022, at St. Paul, Ramsey County, Minnesota, I e-mailed a link to the Notice of Hearing to the following entities listed in the chapter 1322 Additional Notice Plan:

- a. Association of Minnesota Building Officials
- b. Minnesota Mechanical Contractors' Association
- c. Minnesota Society of Professional Engineers
- d. Association of Minnesota Counties
- e. League of Minnesota Cities
- f. American Institute of Architects - Minnesota
- g. Building Owners and Managers of Minneapolis and St. Paul
- h. Minnesota Manufactured Home Association
- i. Minnesota Department of Commerce
- j. Builders Association of Minnesota
- k. Housing First Minnesota
- l. Minnesota Housing Finance Agency
- m. Minnesota Multi-Housing Association
- n. Association of Builders and Contractors
- o. Fresh Energy
- p. Responsible Energy Codes Alliance
- q. Center for Energy and the Environment
- r. Midwest Energy Efficiency Alliance

A copy of the e-mail, the Notice, and e-mailing list are attached to this certificate.

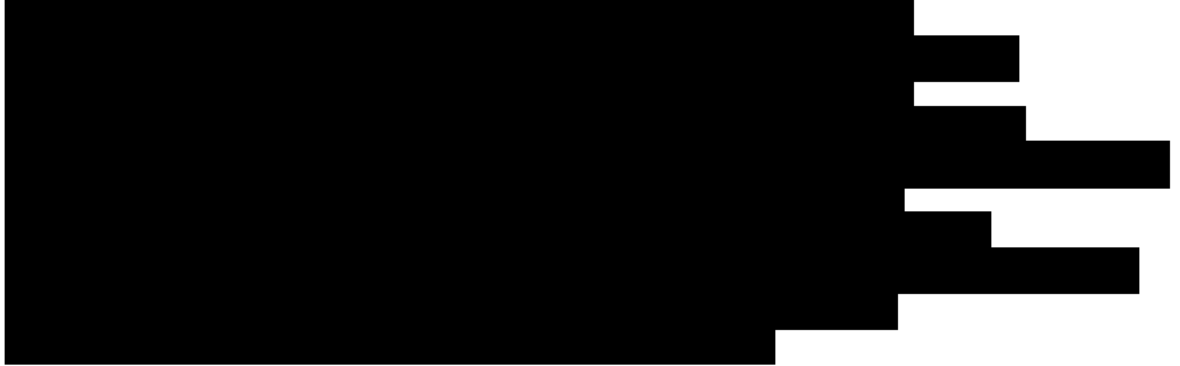


Amanda Spuckler
Rules Specialist

Spuckler, Amanda (DLI)

From: Spuckler, Amanda (DLI)
Sent: Monday, July 18, 2022 8:00 AM
To: Spuckler, Amanda (DLI)
Subject: Notice of Hearing: Possible amendments to rules governing the Minnesota Residential Energy Code

Bcc:



Notice of Hearing: Possible amendments to rules governing the Minnesota Residential Energy Code Chapter 1322, Minnesota Residential Energy Code

You are receiving this email because under the Minnesota Administrative Procedures Act, each Minnesota agency must make reasonable efforts to notify persons or classes of persons who may be significantly affected by any rulemaking. The Minnesota Department of Labor and Industry has identified you as a person or organization who may be affected by the amendments to the rule.

The [Minnesota Department of Labor and Industry](#) will conduct a public hearing at 9:30 a.m. on Tuesday, Aug. 23, 2022, via Webex, for the purposes of taking public comment and testimony regarding the appropriateness of amending the existing Minnesota Residential Energy Code, Minnesota Rules, chapter 1322, to adopt the residential provisions of the 2021 International Energy Conservation Code (IECC).

The Notice of Hearing related to this hearing will be published in the July 18, 2022, edition of the *State Register*.

The Notice of Hearing provides details about the hearing and, with other information, is [available in the rulemaking docket](#).

Questions?

Contact us at dli.rules@state.mn.us.

Amanda Spuckler

Rules Specialist and Outreach | Education, Rules and Code Development

Minnesota Department of Labor and Industry

443 Lafayette Road N., St. Paul, MN 55155

Phone: (651) 284-5361 | Web: www.dli.mn.gov



Minnesota Department of Labor and Industry

NOTICE OF HEARING

Possible Amendments to Rules Governing the Minnesota Residential Energy Code, Minnesota Rules, Chapter 1322; OAH Docket # 8-9001-38469

Public Hearing. The Minnesota Department of Labor and Industry (“Department”) will hold a virtual public hearing at **9:30 a.m. on Tuesday, August 23, 2022**, via WebEx, for the purposes of taking public comment and testimony regarding the appropriateness of amending the existing Minnesota Residential Energy Code, *Minnesota Rules*, chapter 1322, to adopt the residential provisions of the 2021 International Energy Conservation Code (“IECC”). All interested or affected persons will have an opportunity to participate by submitting oral or written comments, statements, or arguments.

For a video and audio connection, register to join the hearing through an internet connection, such as with a computer or tablet at: <https://tinyurl.com/1322hearing>

For audio connection only, join the hearing by phone:
Call: 1-855-282-6330 or 1-415-655-0003
Access code: 2480 297 4382.

Please note: If the public hearing must be postponed or re-scheduled for any reason, the Department will send a notice of such a change to its State Building Code Rulemaking List and the organizations listed on its additional notice plan. The Department will also post the notice of such a change on its website at: <https://www.dli.mn.gov/about-department/rulemaking/rulemaking-docket-minnesota-rules-chapter-1322-0>

Subject of Hearing and Statutory Authority. *Minnesota Statutes*, section 326B.106, subdivision 1 (d), requires the Commissioner to act in accordance with federal law on each new model residential energy code for which the United States Department of Energy has issued an affirmative determination of improved energy efficiency in compliance with *United States Code*, title 42, section 6833. On July 28, 2021, the United States Department of Energy issued an affirmative determination concerning the residential provisions of the 2021 IECC, concluding that buildings meeting that most recent revision would result in national site energy savings of 9.38 percent, national source energy savings of 8.79 percent, and national energy cost savings of approximately 8.66 percent of residential building energy consumption. This affirmative determination statement may be viewed in its entirety by contacting the agency contact person listed below for a copy of the same or by viewing it at: <https://www.govinfo.gov/content/pkg/FR-2021-07-28/pdf/2021-15969.pdf>.

Based on that affirmative determination, *United States Code*, title 42, section 6833 (a)(5)(B), now requires each state to review the provisions of its residential energy code to determine whether it is appropriate for the state to revise its current building code to meet or exceed the residential energy efficiency provisions of the 2021 IECC. *United States Code*, title

42, section 6833 (a)(2), further requires that this state determination be made after public notice and hearing, be based upon the record provided for at the hearing, and be made generally available to the public. Accordingly, the Department encourages comments and public participation at the hearing as scheduled above.

Public Comment. You and all interested or affected persons, including representatives of associations and other interested groups, will have an opportunity to participate. The administrative law judge will accept your views either orally at the WebEx hearing or in writing at any time before the close of the hearing record. Submit written comments to the administrative law judge at the address below or **via the [Office of Administrative Hearings Rulemaking eComments website](https://minnesotaoah.granicusideas.com/discussions) <https://minnesotaoah.granicusideas.com/discussions>**. All evidence that you present should relate to the issue identified above. You may also submit written material to the administrative law judge to be recorded in the hearing record for five working days after the public hearing ends. At the hearing, the administrative law judge may order this five-day comment period extended for a longer period but for no more than 20 calendar days. Following the comment period, there is a five-working-day rebuttal period during which the agency and any interested person may respond in writing to any new information submitted. No one may submit additional evidence during the five-day rebuttal period. The Office of Administrative Hearings must receive all comments and responses submitted to the administrative law judge no later than 4:30 p.m. on the due date. All comments or responses received are public and will be available for review at the Office of Administrative Hearings or on their website.

The agency requests that any person submitting written comments or data to the administrative law judge before the hearing or during the comment or rebuttal period also submit a copy of the written comments or data to the agency contact person at the address listed below.

Administrative Law Judge. Administrative Law Judge Eric L. Lipman will conduct the hearing on the date and at the time and place listed above. Judge Lipman's legal assistant, Michelle Severson, may be reached at the Office of Administrative Hearings, 600 North Robert Street, P.O. Box 64620, St. Paul, Minnesota 55164-0620, telephone (651) 361-7874, fax (651) 539-0310, and email: michelle.severson@state.mn.us.

Agency Contact Person. The agency contact person is: Amanda Spuckler at the Minnesota Department of Labor and Industry, 443 Lafayette Road North, St. Paul, Minnesota 55155, telephone (651) 284-5006, and email: dli.rules@state.mn.us.

Adoption Procedure after the Hearing. After the close of the hearing record, the administrative law judge will issue a Report and Recommendation to the Commissioner as to whether it is appropriate to revise existing *Minnesota Rules*, chapter 1322, to adopt the residential energy saving provisions of the 2021 IECC. You may ask to be notified of the date when the administrative law judge's Report and Recommendation will become available. You can make this request at the hearing or in writing to the administrative law judge. You may also ask to be notified of the date when the Commissioner issues her Final Order on the administrative law judge's Recommendation. You may make this request at the hearing or in writing to the agency contact person listed above. Copies of the administrative law judge's Report and Recommendation and the Commissioner's Final Order will also be made available for viewing on the agency's website at: <https://www.dli.mn.gov/about-department/rulemaking/rulemaking-docket-minnesota-rules-chapter-1322-0>.

If the Commissioner's Final Order determines that it is appropriate to revise the residential energy efficiency provisions of *Minnesota Rules*, chapter 1322, then the Commissioner will proceed with adopting the necessary amendments under the formal rulemaking provisions of Chapter 14, the Minnesota Administrative Procedures Act. If the Commissioner's Final Order determines that it is not appropriate at this time to revise the residential energy efficiency provisions of *Minnesota Rules*, chapter 1322, then the Commissioner will certify that determination and the reasons for the same to the United States Department of Energy as required by *United States Code*, title 42, section 6833 (a)(4). Copies of the Commissioner's Final Order will be made available for viewing on the agency's website at: <https://www.dli.mn.gov/about-department/rulemaking/rulemaking-docket-minnesota-rules-chapter-1322-0>.

Alternative Format/Accommodation. Upon request, this information can be made available in an alternative format, such as large print, braille, or audio. To make such a request or if you need an accommodation to make this hearing accessible, please contact the agency contact person at the address or telephone number listed above.

Lobbyist Registration. *Minnesota Statutes*, chapter 10A, requires each lobbyist to register with the State Campaign Finance and Public Disclosure Board. You should direct questions regarding this requirement to the Campaign Finance and Public Disclosure Board at: Suite #190, Centennial Building, 658 Cedar Street, St. Paul, Minnesota 55155, telephone (651) 539-1180 or 1-800-657-3889.

Order. I hereby order that the hearing be held at the date, time, and location listed above.

July 11, 2022

Date

Roslyn C. Robertson

Roslyn Robertson

Commissioner

Minnesota Department of Labor and Industry

- a. Association of Minnesota Building Officials Jerry Backlund, chair,
[REDACTED]
- b. Minnesota Mechanical Contractors' Association Gary Thaden, Government Affairs Director, [REDACTED]
- c. Minnesota Society of Professional Engineers Katie Jamieson, staff, [REDACTED]; Kerby Nester, President, [REDACTED];
- d. Association of Minnesota Counties Julie Ring, executive director, [REDACTED]
- e. League of Minnesota Cities David Unmacht, Executive Director, [REDACTED]
- f. American Institute of Architects - Minnesota Mary-Margaret Zindren, Executive Vice President, Ex Officio, [REDACTED]
- g. Building Owners and Managers of Minneapolis and St. Paul
[REDACTED] Sarah Anderson, President/CEO BOMA Mpls,
[REDACTED] Joe Spartz, President BOMA St. Paul,
[REDACTED] Tina Gassman; [REDACTED]
- h. Minnesota Manufactured Home Association [REDACTED] Mark Brunner, President, [REDACTED]
- i. Minnesota Department of Commerce Grace Arnold, Commissioner,
[REDACTED] Katherine Blauvelt, Assistant Commissioner of the Division of Energy Resources, [REDACTED]; Kevin Lee, Deputy Commissioner for Division of Energy Resources, [REDACTED]
- j. Builders Association of Minnesota [REDACTED]; Grace Keliher, BAM Executive Vice President, [REDACTED], Brian Halloran, BAM Lobbyist, [REDACTED]
- k. Housing First Minnesota [REDACTED]; James Vagle, Executive Director, [REDACTED]
- l. Minnesota Housing Finance Agency Jennifer Ho, Commissioner, [REDACTED]
- m. Minnesota Multi-Housing Association Cecil Smith, President & CEO, [REDACTED]
- n. Association of Builders and Contractors Adam Hanson, President of MN and ND chapter, [REDACTED]; Jennifer Ankeny, Vice President, Business Development & Membership, MN and ND chapter, [REDACTED]; [REDACTED]; Stephen Lewis, Director of Governance and Leadership. [REDACTED]
- o. Fresh Energy Michael Noble, Executive Director, [REDACTED]
- p. Responsible Energy Codes Alliance Eric Lacy, Chairperson, [REDACTED]
- q. Center for Energy and the Environment Chris Duffrin, President, [REDACTED]
- r. Midwest Energy Efficiency Alliance Stacey Paradis, Executive Director, [REDACTED]

Exhibit K

Minnesota Department Labor and Industry

**CERTIFICATE OF SENDING THE NOTICE OF HEARING TO LEGISLATORS AND
THE LEGISLATIVE COORDINATING COMMISSION**

**Possible Amendments to Rules Governing the Minnesota Residential Energy Code,
Minnesota Rules, Chapter 1322**

I certify that on July 15, 2022, when the Department mailed Notice of Hearing under Minnesota Statutes, section 14.14 or 14.22, I sent a copy of the Notice of Hearing to certain Legislators and the Legislative Coordinating Commission by depositing them in the State of Minnesota's central mail system for United States mail with postage prepaid or by sending an electronic copy via email. I mailed and e-mailed these documents to comply with Minnesota Statutes, section 14.116. A copy of the cover letter is attached to this Certificate.



Amanda Spuckler
Rules Specialist

July 15, 2022

Senator Eric Pratt, Chair, sen.eric.pratt@senate.mn
Senator Bobby Jo Champion, Ranking Democrat, sen.bobby.champion@senate.mn
Senate Jobs and Economic Growth Finance Committee

Senator Jason Rarick, Chair, sen.jason.rarick@senate.mn
Senator Jennifer McEwen, Ranking Democrat, sen.jennifer.mcewen@senate.mn
Senate Labor and Industry Committee

Senator Rich Draheim, sen.rich.draheim@senate.mn
Senator Kari Dziejczak, Ranking Democrat
Capitol Office
95 University Avenue W.
Minnesota Senate Building, Room 2203
Senate Housing Finance and Policy

Representative Mohamud Noor, Chair, rep.mohamud.noor@house.mn
Representative Rod Hamilton, Republican Lead, rep.rod.hamilton@house.mn
House Workforce and Business Development and Finance Policy

Representative Rob Ecklund, Chair, rep.rob.ecklund@house.mn
Representative Bob Dettmer, Republican Co-Lead, rep.bob.dettmer@house.mn
Representative Joe McDonald, Republican Co-Lead, rep.joe.mcdonald@house.mn
House Labor, Industry Veterans and Military Affairs Finance Policy

Representative Alice Hausman, Chair, rep.alice.hausman@house.mn
Representative Tama Theis, Republican Lead, rep.tama.theis@house.mn
House Housing Finance and Policy Division

Re: Possible Amendments to Rules Governing the Minnesota Residential Energy Code,
Minnesota Rules, Chapter 1322

Dear Legislators:

The Department of Labor and Industry will hold a public hearing at 9:30 a.m. on Tuesday, August 23, 2022, via WebEx, for the purposes of taking public comment and testimony regarding the appropriateness of amending the existing Minnesota Residential Energy Code, Minnesota Rules, chapter 1322, to adopt the residential provisions of the 2021 International Energy Conservation Code (“IECC”).

Minnesota Statutes, section 326B.106, subdivision 1(d), requires the Commissioner to act in accordance with federal law on each new model residential energy code for which the United States Department of Energy has issued an affirmative determination of improved energy

efficiency in compliance with *United States Code*, title 42, section 6833. The United States Department of Energy issued such an affirmative determination on July 28, 2021.

Based on that affirmative determination, *United States Code*, title 42, section 6833 (a)(5)(B), now requires each state to review the provisions of its residential energy code to determine whether it is appropriate for the state to revise its current building code to meet or exceed the residential energy efficiency provisions of the 2018 IECC. *United States Code*, title 42, section 6833 (a)(2), further requires that this state determination be made after public notice and hearing, be based upon the record provided for at the hearing, and be made generally available to the public.

In compliance with *United States Code*, title 42, section 6833 (a)(2), we plan to publish a Notice of Hearing in the July 18, 2022, edition of the State Register. Electronic copies of the Notice of Hearing and other information are available at <http://www.dli.mn.gov/about-department/rulemaking/rulemaking-docket-minnesota-rules-chapter-1322-0>.

If you have any questions about these rules, please contact me at amanda.spuckler@state.mn.us or (651) 284-5361.

Very truly yours,



Amanda Spuckler
Rules Specialist
Email: amanda.spuckler@state.mn.us
Phone: (651) 284-5361

Enclosures: Notice of Hearing

cc: Legislative Coordinating Commission, lcc@lcc.leg.mn

Spuckler, Amanda (DLI)

From: Spuckler, Amanda (DLI)
Sent: Friday, July 15, 2022 8:57 AM
To: lcc@lcc.leg.mn; sen.eric.pratt@senate.mn; sen.bobby.champion@senate.mn; sen.jason.rarick@senate.mn; sen.jennifer.mcewen@senate.mn; sen.rich.draheim@senate.mn; Rep. Mohamud Noor; rep.rod.hamilton@house.mn; rep.rob.ecklund@house.mn; rep.bob.dettmer@house.mn; rep.joe.mcdonald@house.mn; rep.alice.hausman@house.mn; rep.tama.theis@house.mn
Cc: Wysokinski, Brittany (DLI); Kate Perushek
Subject: Department of Labor and Industry Notice of Hearing – Possible Amendments to Minnesota Rules, Chapter 1322
Attachments: 1322_letter to legislators and LCC.pdf; 1322_Notice_hearing_draft-signed_final.pdf

Please review the attached cover letter and Notice of Hearing for the above-referenced matter. Additional information regarding the hearing is available in the [rulemaking docket](#).

Amanda Spuckler

Rules Specialist and Outreach | Education, Rules and Code Development

Minnesota Department of Labor and Industry

443 Lafayette Road N., St. Paul, MN 55155

Phone: (651) 284-5361 | Web: www.dli.mn.gov



Exhibit K.1

Paperwork Reduction Act of 1995

As part of its continuing effort to reduce paperwork and respondent burden, the Department provides the general public and Federal agencies with an opportunity to comment on proposed and continuing collections of information, in accordance with the Paperwork Reduction Act of 1995 (PRA) (44 U.S.C. 3506(c)(2)(A)). This helps ensure that: The public understands the Department's collection instructions, respondents can provide the requested data in the desired format, reporting burden (time and financial resources) is minimized, collection instruments are clearly understood, and the Department can properly assess the impact of collection requirements on respondents.

The final priorities and definitions contain information collection requirements that are approved by OMB under OMB control numbers 1894-0006. The Department will request OMB approval under 1894-0006 for the Early-phase grants program (84.411C) around the same time this document publishes.

Intergovernmental Review: This program is subject to Executive Order 12372 and the regulations in 34 CFR part 79. One of the objectives of the Executive order is to foster an intergovernmental partnership and a strengthened federalism. The Executive order relies on processes developed by State and local governments for coordination and review of proposed Federal financial assistance.

This document provides early notification of our specific plans and actions for this program.

Accessible Format: On request to the contact person listed under **FOR FURTHER INFORMATION CONTACT**, individuals with disabilities can obtain this document in an accessible format. The Department will provide the requestor with an accessible format that may include Rich Text Format (RTF) or text format, a thumb drive, an MP3 file, braille, large print, audiotope, or compact disc or other accessible format.

Electronic Access to This Document: The official version of this document is the document published in the **Federal Register**. You may access the official edition of the **Federal Register** and the Code of Federal Regulations at www.govinfo.gov. At this site you can view this document, as well as all other documents of this Department published in the **Federal Register**, in text or Portable Document Format (PDF). To use PDF you must have Adobe Acrobat Reader, which is available free at the site.

You may also access documents of the Department published in the **Federal**

Register by using the article search feature at www.federalregister.gov. Specifically, through the advanced search feature at this site, you can limit your search to documents published by the Department.

Ian Rosenblum,

Deputy Assistant Secretary for Policy and Programs Delegated the Authority to Perform the Functions and Duties of the Assistant Secretary, Office for Elementary and Secondary Education.

[FR Doc. 2021-16097 Filed 7-27-21; 8:45 am]

BILLING CODE 4000-01-P

DEPARTMENT OF ENERGY

[EERE-2021-BT-DET-0010]

Analysis Regarding Energy Efficiency Improvements in the 2021 International Energy Conservation Code (IECC)

AGENCY: Office of Energy Efficiency and Renewable Energy, Department of Energy.

ACTION: Notice of determination.

SUMMARY: The U.S. Department of Energy (DOE) has reviewed the 2021 International Energy Conservation Code (IECC) and determined the updated edition would improve energy efficiency in buildings subject to the code. DOE analysis indicates that buildings meeting the 2021 IECC, as compared with buildings meeting the 2018 IECC, would result in national site energy savings of 9.38 percent, source energy savings of 8.79 percent, and energy cost savings of approximately 8.66 percent of residential building energy consumption. Upon publication of this affirmative determination, each State must certify that it has reviewed the energy efficiency provisions of its residential building code and made a determination whether it is appropriate to revise the code to meet or exceed the updated edition of the IECC. Additionally, this notice provides guidance on State code review processes and associated certifications.

DATES: Certification statements provided by States shall be submitted by July 28, 2023.

ADDRESSES: A copy of the supporting analysis, as well as links to the Federal docket and public comments received, are available at: <https://www.energycodes.gov/development/determinations>.

Certification Statements must be addressed to the Building Technologies Office—Building Energy Codes Program Manager, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, 1000 Independence

Avenue SW, EE-5B, Washington, DC 20585.

FOR FURTHER INFORMATION CONTACT:

Jeremiah Williams; U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, 1000 Independence Avenue SW, EE-5B, Washington, DC 20585; (202) 441-1288; Jeremiah.Williams@ee.doe.gov.

For legal issues, please contact Matthew Ring; U.S. Department of Energy, Office of the General Counsel, 1000 Independence Avenue SW, GC-33, Washington, DC 20585; (202) 586-2555; Matthew.Ring@hq.doe.gov.

SUPPLEMENTARY INFORMATION:

- I. Background
- II. Public Participation
- III. Determination Statement
- IV. State Certification

I. Background

Title III of the Energy Conservation and Production Act (ECPA), as amended, establishes requirements for building energy conservation standards, which are administered by the DOE Building Energy Codes Program. (42 U.S.C. 6831 *et seq.*) Section 304(a), as amended, of ECPA provides that whenever the 1992 Council of American Building Officials (CABO) Model Energy Code, or any successor to that code, is revised, the Secretary of Energy (Secretary) must make a determination, no later than 12 months after such revision, whether the revised code would improve energy efficiency in residential buildings, and must publish notice of such determination in the **Federal Register**. (42 U.S.C. 6833(a)(5)(A)) If the Secretary determines that the revision of the CABO Model Energy Code, or any successor thereof, improves the level of energy efficiency in residential buildings then, not later than two years after the date of the publication of such affirmative determination, each State is required to certify that it has reviewed its residential building code regarding energy efficiency, and made a determination as to whether it is appropriate to revise its code to meet or exceed the provisions of the successor code. (42 U.S.C. 6833(a)(5)(B)).

The International Energy Conservation Code (IECC) is the contemporary successor to the CABO Model Energy Code specified in ECPA. The IECC is revised every three years through an established code development and consensus process administered by the International Code Council (ICC). As part of the ICC process, any interested party may submit proposals, as well as written comments or suggested changes to any

proposal, and make arguments before a committee of experts assembled by the ICC, with the collection of accepted proposals forming the revised edition of the IECC. More information on the ICC code development process is available at <https://www.iccsafe.org/codes-tech-support/codes/code-development-process/code-development-2/>.

In addition, on January 20, 2021, the President issued Executive Order 13990, "Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis." 86 FR 7037 (Jan. 25, 2021). The Executive Order directed DOE to consider publishing for notice and comment a proposed rule suspending, revising, or rescinding the final technical determination regarding the 2018 IECC by May 2021. *Id.* at 86 FR 7038. In response, DOE has reviewed the current 2021 IECC so that DOE's determination under Section 304(b) of ECPA reflects the most recent version of IECC, and to facilitate State and local adoption of the 2021 IECC, which will improve energy efficiency in the nation's residential buildings.

To meet the statutory requirement, and to satisfy the directive issued under Executive Order 13990, DOE issued a preliminary determination and published supporting analysis to quantify the expected energy savings associated with the 2021 IECC relative to the previous 2018 IECC version. Notice of this preliminary analysis was published in the **Federal Register** on May 16, 2021 (86 FR 26710), and is available at: <https://www.regulations.gov/document/EERE-2021-BT-DET-0010-0001>.

II. Public Participation

In a May 16, 2021 **Federal Register** notice, DOE requested public comments on its preliminary analysis of the 2021 IECC. (86 FR 26710) DOE received four public comments, all of which DOE considered in arriving at its final determination. DOE has now issued the final analysis of the expected energy savings associated with the 2021 IECC as compared to the 2018 IECC. A summary of public comments received, and DOE responses, is included in Appendix A of this Notice. The final analysis is available at: <https://www.energycodes.gov/development/determinations>.

III. Determination Statement

Residential buildings meeting the 2021 IECC (compared to the previous 2018 edition) are expected to incur the following savings on a weighted national average basis:

- 9.38 percent *site* energy savings
- 8.79 percent *source* energy savings

- 8.66 percent energy *cost* savings

DOE has rendered the conclusion that the 2021 IECC will improve energy efficiency in residential buildings, and, therefore, receives an affirmative determination under Section 304(a) of ECPA. States can experience significant benefits by updating their codes to reflect current construction standards, a total estimated \$74.61 billion in energy cost savings and 424.20 MMT of avoided CO₂ emissions in residential buildings (cumulative 2010 through 2040), or \$3.24 billion in annual energy cost savings and 18.50 MMT in annual avoided CO₂ emissions (annually by 2030). These benefits, including emissions reductions, are estimated in a revised 2021 interim report addressing building code impacts.¹ Though not quantified in the interim report, there may also be costs to regulated entities as a result of updated residential building codes.

IV. State Certification

Upon publication of this affirmative determination, each State is required to review the provisions of its residential building code regarding energy efficiency, and determine whether it is appropriate for such State to revise its building code to meet or exceed the energy efficiency provisions of the 2021 IECC. (42 U.S.C. 6833(a)(5)(B)) This action must be made not later than two years from the date of publication of a Notice of Determination, unless an extension is provided.

State Review and Update

The State determination must be: (1) Made after public notice and hearing; (2) in writing; (3) based upon findings and upon the evidence presented at the hearing; and (4) made available to the public. (42 U.S.C. 6833(a)(2)) States have discretion with regard to the hearing procedures they use, subject to providing an adequate opportunity for members of the public to be heard and to present relevant information. The Department recommends publication of any notice of public hearing through appropriate and prominent media outlets, such as in a newspaper of general circulation. States should also be aware that this determination does not apply to IECC chapters specific to nonresidential buildings, as defined in the IECC. Therefore, States must certify

¹ See https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-31437.pdf for the 2021 interim code impact report. Financial benefits are calculated by applying historical and future fuel prices to site energy savings and by discounting future savings to 2020 dollars. Historical and future real fuel prices are obtained through EIA's AEO 2015 report (EIA 2015).

their evaluations of their State building codes for residential buildings with respect to all provisions of the IECC, except for those chapters not affecting residential buildings. DOE determinations regarding earlier editions of the IECC are available on the DOE Building Energy Codes Program website.² Further national and State analysis is also available.³

State Certification Statements

State certifications are to be sent to the address provided in the **ADDRESSES** section, or may be submitted to BuildingEnergyCodes@ee.doe.gov, and must be submitted in accordance with the deadline identified in the **DATES** section. If a State makes a determination that it is not appropriate to revise the energy efficiency provisions of its residential building code, the State must submit to the Secretary, in writing, the reasons for this determination, which shall be made available to the public. (42 U.S.C. 6833(a)(4))

The DOE Building Energy Codes Program tracks and reports State code adoption and certifications.⁴ Once a State has adopted an updated residential code, DOE typically provides software, training, and support for the new code, as long as the new code is based on the national model code (*i.e.*, the 2021 IECC). DOE has issued previous guidance on how it intends to respond to technical assistance requests related to implementation resources, such as building energy code compliance software. (79 FR 15112) DOE is directed to provide incentive funding to States to implement the requirements of Section 304, and to improve and implement State residential and commercial building energy efficiency codes, including increasing and verifying compliance with such codes. (See 42 U.S.C. 6833(e)) Some States develop their own codes that are only loosely related to the national model codes, and DOE does not typically provide technical support for those codes. DOE does not prescribe how each State adopts and enforces its energy codes.

Requests for Extensions

Section 304(c) of ECPA requires that the Secretary permit an extension of the deadline for complying with the certification requirements described previously, if a State can demonstrate that it has made a good faith effort to

² Available at <https://www.energycodes.gov/regulations/determinations/previous>.

³ Available at https://www.energycodes.gov/development/residential/iecc_analysis.

⁴ Available at <https://www.energycodes.gov/adoption/states>.

comply with such requirements, and that it has made significant progress toward meeting its certification obligations. (42 U.S.C. 6833(c)) Such demonstrations could include one or both of the following: (1) A substantive plan for response to the requirements stated in Section 304; or (2) a statement that the State has appropriated or requested funds (within State funding procedures) to implement a plan that would respond to the requirements of Section 304 of ECPA. This list is not exhaustive. Requests are to be sent to the address provided in the **ADDRESSES** section, or may be submitted to BuildingEnergyCodes@ee.doe.gov.

Appendix A

DOE accepted public comments on the Notice of Preliminary Determination for the 2021 IECC until June 16, 2021, and received submissions from a total of 4 commenters. Responsive public comments and associated DOE answers are described as follows. DOE received comments on its preliminary determination and supporting analysis of the 2021 IECC from the following stakeholders:

- North American Insulation Manufacturers Association (NAIMA)
- Responsible Energy Code Alliance (RECA)
- Edison Electric Institute (EEI)
- Air-Conditioning, Heating and Refrigeration Institute (AHRI)

The comments are summarized as follows and are available at <https://www.regulations.gov/document/EERE-2021-BT-DET-0010-0001/comment>. DOE responded to all comments received. Several issues raised by commenters are distinct from the energy efficiency analysis DOE has undertaken pursuant to its statutory obligations. These include the social cost of carbon, life-cycle cost, and cost effectiveness; among these issues, social cost of carbon garnered the most attention from commenters and is therefore emphasized in the responses below.

North American Insulation Manufacturers Association (NAIMA)

Comment: NAIMA requested that DOE use the updated climate zone designations in the 2021 IECC and not 2018 IECC. DOE's preliminary analysis appears to leave out impact of the 2021 IECC climate zone designations in numerous counties across the United States. This shortfall could lead to an overestimation of the energy savings associated with the 2021 IECC.

DOE Response: DOE acknowledges that the residential provisions of the 2021 IECC incorporate several administrative changes introduced by the 2013 edition of ASHRAE Standard 169, *Climatic Data for Building Design Standards* (ASHRAE 2013a). ASHRAE 169–2013 redefined climate zones and moisture regimes based on recent weather data. As a result, a number of U.S. counties were reassigned to different zones/regimes, and a new, *extremely hot* Climate Zone 0 was added. (The addition of Climate Zone 0 has no impact on DOE's analysis, since it does not occur in the U.S.)

Approximately 400 U.S. counties out of more than 3,000 were reassigned, most to warmer climate zones. However, the reassignment of localities is considered an administrative action, based on long-established definitions of heating degree days and cooling degree days, and is handled consistently with how similar climate zone updates have been handled by previous DOE model energy code determinations. DOE also notes that the reassignment of climate zones is expected to occur in the future, based on updated weather and climate data, and associated updates to ASHRAE Standard 169.

Comment: NAIMA requested that DOE produce the equivalent cost-effectiveness document for the 2021 IECC as rapidly as possible after the publication of the final 2021 IECC determination. Additionally, NAIMA requested that DOE perform this analysis with a variety of down payment amounts to show cost-effectiveness with typical range of loans—a 0% down loan, a 10% down loan, and a 20% down loan.

DOE Response: In making its determination, DOE's directive under ECPA is to assess whether updated editions of the 2021 IECC would improve *energy efficiency* in residential buildings. Concepts such as life-cycle cost and cost effectiveness represent economic analysis and are therefore unique from energy efficiency analysis. However, DOE recognizes the value of such analysis in informing State and local decisions surrounding code review and update processes, as well as design decisions associated with specific buildings and systems. Distinct from its determination directive under ECPA, DOE provides a variety of additional analysis, including cost-effectiveness analysis. The established DOE methodology is currently designed around a single typical home mortgage scenario, and not multiple down payment scenarios, as requested by NAIMA. However, DOE will consider expanding its analysis in the future to further study a range of financing scenarios, including those experienced by low and moderate income (LMI) households.

Responsible Energy Codes Alliance (RECA)

Comment: RECA's first comment recommended that the DOE take actions to encourage, and provide additional support for, States and cities to adopt and implement the 2021 IECC in the months and years ahead.

DOE response: DOE is directed under ECPA to provide technical assistance supporting the implementation of building energy codes. Consistent with this directive, DOE intends to continue providing robust technical assistance supporting State and local implementation of buildings energy codes. DOE recognizes the importance of supporting the States and local governments who ultimately adopt and implement codes, as well as the wide range of industry stakeholders who rely upon energy codes and strive to achieve compliance in practice.

Comment: RECA's second comment stated that RECA agrees with and supports the methodology and conclusion in the preliminary analysis.

DOE response: DOE appreciates the support.

Comment: RECA's third comment recommended that DOE should implement the 2021 IECC into REScheck.

DOE response: DOE intends to support the implementation of the 2021 IECC into REScheck in the future.

Comment: RECA's fourth comment recommended that DOE remove pre-2015 IECC versions from REScheck.

DOE response: In maintaining its compliance resources, such as the REScheck software⁵, DOE typically supports the three most recent editions of the model codes. (79 FR 15112) Following the current determination, this is anticipated to include the 2021, 2018 and 2015 editions of the IECC. DOE intends to maintain consistency with this approach.

Comment: RECA's fifth comment recommended that DOE provide cost-effectiveness analysis.

DOE response: As outlined in previous responses, DOE notes that the current determination is focused on whether the 2021 IECC would improve *energy efficiency* in residential buildings. However, DOE recognizes the value of additional forms of technical analysis supporting building energy codes, and intends to continue to provide both national and State-level cost-effectiveness analysis of the 2021 IECC in the future.

Comment: RECA's sixth comment recommended that DOE provide *State-level* energy and cost analyses.

DOE response: Consistent with the previous comment response, DOE intends to provide State-level energy and cost analyses in the future.

Comment: RECA's seventh comment recommended that DOE provide implementation support for the 2021 IECC.

DOE response: Consistent with previous comment responses, DOE intends to continue providing robust support for States and local governments implementing building energy codes. DOE intends to provide additional resources supporting the 2021 IECC implementation in the future.

Edison Electric Institute (EEI)

Comment: EEI's first comment stated that the EPA greenhouse gas equivalencies calculator overstates the emissions impact.

DOE response: As outlined in previous responses, DOE notes that the current determination is focused solely on whether the revised Standard would improve energy efficiency in residential buildings, and CO₂ savings were not considered as part of DOE's ultimate determination of whether the revised Standard will improve energy efficiency. DOE is reporting estimated CO₂ savings only because it recognizes the value of additional forms of technical analysis supporting State implementation of building energy codes, including emissions analyses. DOE relies on greenhouse gas emission coefficients established by the Environmental Protection Agency (EPA) in estimating current year CO₂ savings. EPA's emission coefficients are designed to reflect marginal

⁵ REScheck is a software tool developed and maintained by DOE for the purpose of verifying compliance in residential buildings. See <https://www.energycodes.gov/rescheck>.

CO₂ savings from electricity savings occurring on the building site, which DOE considers appropriate for estimating and communicating the carbon savings stemming from an improved energy code. This approach is consistent with how DOE has performed similar calculations in previous determinations.

Comment: EEI's second comment recommended that DOE's determination should take into account the commitments utilities have made to reduce carbon emissions.

DOE response: As outlined in previous responses, DOE notes that the current determination is focused solely on whether the revised Standard would improve energy efficiency in residential buildings, and CO₂ savings were not considered as part of DOE's ultimate determination of whether the revised Standard will improve energy efficiency. DOE is reporting estimated CO₂ savings only because it recognizes the value of additional forms of technical analysis supporting State implementation of building energy codes, including emissions analyses. DOE's analysis is based on several metrics; energy cost, site energy, and source energy. In addition, DOE reports carbon emissions on a first-year basis. DOE recognizes the progress being made by utilities in decarbonizing the electric grid, and emphasizes that estimates provided in the supporting technical analysis are based on current emission levels and are subject to change in the future.

Air-Conditioning, Heating, and Refrigeration Institute (AHRI)

Comment: AHRI, p. 2–5. AHRI commented that historically DOE did not estimate emission reductions or apply a value to emission reductions as part of the results and basis for the determination. They further stated that including emission reductions or their value, including the SC–CO₂, as part of the basis for determination was outside DOE's authority to consider (42 U.S.C. 6833(a)(5)), because EPCA is an energy conservation statute and excludes environmental objectives (see 42 U.S.C. 6312 which excludes environmental objectives), and that DOE does not have the statutory authority to consider greenhouse gas estimates in determination of residential building codes. AHRI opined that the SC–CO₂ should only be included for rulemakings where DOE has clear statutory authority to do so and stated that it lacks such statutory authority as to building energy codes.

DOE response: In making its determination, DOE's directive under EPCA is to assess whether updated editions of the IECC would improve *energy efficiency* in residential buildings. 42 U.S.C. 6833(b)(2)(A) DOE emphasizes that the estimates pertaining to CO₂ are provided as supplemental information only and were not considered as part of DOE's final determination, which is based on energy efficiency as required under 42 U.S.C. 6833(5)(A). Climate benefits associated with the expected CO₂ emissions reductions are monetized using estimates of the social cost of carbon presented in the *Technical Support Document: Social Cost of Carbon, Methane,*

and Nitrous Oxide Interim Estimates under Executive Order 13990 (IWG 2021). DOE is reporting estimates related to CO₂ only because information on the carbon emissions associated with buildings are valued by many stakeholders, including States and local governments who ultimately implement building codes, and who have expressed a need for this information. These estimates are not considered as part of DOE's ultimate determination of whether the updated IECC will improve energy efficiency.

Comment: AHRI, p. 2, 5. AHRI stated that DOE is ignoring clear congressional intent in including emissions in the narrowly scoped building energy code review defined in the statutory text (42 U.S.C. 6833(b)(1)). AHRI further stated that congress could have added global climate change into a variable to weigh in the determination, but did not do so and so DOE should not include this in the determination.

DOE Response: See response to previous AHRI comment.

Comment: AHRI, p. 2. AHRI requested that DOE remove carbon emissions from the determination for building energy codes, including the 2021 IECC.

DOE Response: See response to previous AHRI comment.

Comment: AHRI p. 2. Irrespective of the authority consideration, AHRI requested that DOE must act to remedy inaccurate assumptions and conclusions on the social cost of carbon benefits analysis. AHRI opined that the benefits claimed from full fuel cycle and global impact of emissions and SC–CO₂ are speculative and tangential and that these are calculated over a time period (100 years) that greatly exceeds that used to measure economic costs.

DOE Response: In making its determination, DOE's directive under EPCA is to assess whether updated editions of the IECC would improve *energy efficiency* in residential buildings. 42 U.S.C. 6833(b)(2)(A) DOE emphasizes that the estimates pertaining to CO₂ are provided only as supplemental information and are not considered as part of the final determination, which is based on energy efficiency as required under 42 U.S.C. 6833(b)(2)(A).

In calculating related CO₂ impacts, DOE used the estimates for the SC–CO₂ from the most recent update of the Interagency Working Group on Social Cost of Greenhouse Gases, United States Government (IWG), from “Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990.” (February 2021 TSD). DOE has determined that the estimates from the February 2021 TSD, as described more below, are based upon sound analysis and provide well founded estimates for DOE's analysis of the impacts of CO₂ related to the reductions of emissions from updating the IECC to the 2021 edition.

These SC–CO₂ estimates are interim values developed under Executive Order (E.O.) 13990 for use until an improved estimate of the impacts of climate change can be developed based on the best available science and economics. The SC–CO₂ estimates used in this analysis were developed over many years, using a transparent process, peer-

reviewed methodologies, the best science available at the time of that process, and with input from the public. Specifically, an interagency working group (IWG) that included the EPA and other executive branch agencies and offices used three integrated assessment models (IAMs) to develop the SC–CO₂ estimates and recommended four global values for use in regulatory analyses. The SC–CO₂ estimates were first released in February 2010 and updated in 2013 using new versions of each IAM. In 2015, as part of the response to public comments received to a 2013 solicitation for comments on the SC–CO₂ estimates, the IWG announced a National Academies of Sciences, Engineering, and Medicine review of the SC–CO₂ estimates to offer advice on how to approach future updates to ensure that the estimates continue to reflect the best available science and methodologies. In January 2017, the National Academies released their final report, *Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide*, and recommended specific criteria for future updates to the SC–CO₂ estimates, a modeling framework to satisfy the specified criteria, and both near-term updates and longer term research needs pertaining to various components of the estimation process (National Academies 2017). On January 20, 2021, President Biden issued Executive Order 13990, which directed the IWG to ensure that the U.S. Government's (USG) estimates of the social cost of carbon and other greenhouse gases reflect the best available science and the recommendations of the National Academies (2017). The IWG was tasked with first reviewing the estimates currently used by the USG and publishing interim estimates within 30 days of E.O. 13990 that reflect the full impact of GHG emissions, including taking global damages into account.⁶ The interim SC–CO₂ estimates published in February 2021 are used here to estimate the climate benefits associated with this determination.

DOE acknowledges that there are a number of challenges in attempting to assess the incremental economic impacts of CO₂ emissions. The science and economic understanding of climate change and its impacts is improving over time; research focused on the assessment of climate damages and socioeconomic emissions projections is particularly important for reducing uncertainty in the calculation of the social cost of greenhouse gases (SC–GHG).⁷

⁶ The E.O. instructs the IWG to undertake a fuller update of the SC–GHG estimates by January 2022.

⁷ The social cost of greenhouse gases (SC–GHG) is the monetary value of the net harm to society associated with adding a small amount of that GHG to the atmosphere in a given year and, therefore, should reflect the societal value of reducing emissions of the gas in question by one metric ton. The marginal estimate of social costs will differ by the type of greenhouse gas (such as carbon dioxide, methane, and nitrous oxide) and by the year in which the emissions change occurs. The estimates of the social cost of carbon (SC–CO₂), social cost of methane (SC–CH₄), and social cost of nitrous oxide (SC–N₂O) published in the February 2021 TSD allow agencies to understand the social benefits of reducing emissions of each of these greenhouse gases, or the social costs of increasing such emissions, in the policy making process.

is quantifying and being transparent about where key uncertainties in the models remain. But contrary to AHRI's suggestion that uncertainty should cause DOE to discount or abandon monetization of the social benefits of reducing CO₂ emissions, as IWG has stated, due to a number of sources of uncertainty, there is a likelihood that the SC-CO₂ is an underestimate of the true social cost of emissions.⁸ Despite the limits of both quantification and monetization, SC-CO₂ estimates can be useful in estimating the social benefits of reducing CO₂ emissions. As a result, DOE has used the IWG's SC-CO₂ estimates in monetizing the social benefits of reducing CO₂ emissions. However, as discussed in previous comments, DOE's SC-CO₂ analysis using these estimates was not considered in DOE's ultimate determination of whether the 2021 IECC Standard will improve energy efficiency.

Comment: AHRI p. 2.3. As part of the rationale for not including SC-CO₂, AHRI further commented that DOE has acknowledged the uncertainty of SC-CO₂ estimates and stated that these are both provisional and revisable. Further, they noted that the interagency working group developing the SC-CO₂ noted that the underlying models were imperfect and incomplete and notes that the intergovernmental panel on climate change (IPCC) which the IWG relied on also stated in 2013 that no best estimate for equilibrium climate sensitivity could then be given because of the lack of agreement on values across assessed lines of evidence and studies.

DOE Response: In making its determination, DOE's directive under ECPA is to assess whether updated editions of the IECC would improve *energy efficiency* in residential buildings. 42 U.S.C. 6833(b)(2)(A) DOE emphasizes that the estimates pertaining to CO₂ are provided only as supplemental information and are not considered as part of the final determination, which is based on energy efficiency as required under 42 U.S.C. 6833(b)(2)(A).

As noted above, DOE determined that the estimates from the February 2021 TSD are based upon sound analysis and provide well founded estimates for DOE's analysis of the impacts of CO₂ related to the reductions of emissions from updating the 90.1 Standard to the 2019 edition. As explained in the February 2021 TSD and while the IWG works to assess how best to incorporate the latest, peer reviewed science to develop an updated set of SC-GHG estimates, the IWG has determined that it is appropriate for agencies to revert to the same set of four values drawn from the SC-GHG distributions based on three discount rates as were used in regulatory analyses between 2010 and 2016 and subject to public comment. For each discount rate, the IWG combined the distributions across models and socioeconomic emissions scenarios (applying equal weight to each) and then selected a set

of four values for use in benefit-cost analyses: An average value resulting from the model runs for each of three discount rates (2.5%, 3%, and 5%), plus a fourth value, selected as the 95th percentile of estimates based on a 3 percent discount rate. The fourth value was included to provide information on potentially higher-than-expected economic impacts from climate change, conditional on the 3% estimate of the discount rate. As explained in the February 2021 TSD, this update reflects the immediate need to have an operational SC-GHG for use in regulatory benefit-cost analyses and other applications that was developed using a transparent process, peer-reviewed methodologies, and the science available at the time of that process. Those estimates were subject to public comment in the context of dozens of proposed rulemakings as well as in a dedicated public comment period in 2013. However, as discussed in previous comments, DOE's SC-CO₂ analysis using these estimates was not considered in DOE's ultimate determination of whether the 2021 IECC Standard will improve energy efficiency.

Comment: AHRI, p. 3.5. AHRI commented that EPCA's focus is on benefits accruing with this nation, hence incorporation of SC-CO₂ at the global level is beyond the scope and authority of DOE. See 42 U.S.C. 6833(a)(1)–(5). They further noted that EPCA originally arose out of the 1970's oil embargo and that nothing in the subsequent amendments suggests a different statutory focus other than improving the energy economic within the United States. AHRI notes that DOE analyzes expected national [domestic] energy savings, but does not scale back reported SC-CO₂ calculations to reflect domestic impacts only.

DOE Response: In making its determination, DOE's directive under ECPA is to assess whether updated editions of the IECC would improve *energy efficiency* in residential buildings. 42 U.S.C. 6833(b)(2)(A) DOE emphasizes that the estimates pertaining to CO₂ are provided only as supplemental information and are not considered as part of the final determination, which is based on energy efficiency as required under 42 U.S.C. 6833(b)(2)(A).

As to the use of a SC-CO₂ value that includes impacts outside the boundaries of the United States, the February 2021 TSD provides a complete discussion of the IWG's initial review conducted under E.O. 13990. In particular, the IWG found that a global perspective is essential for SC-GHG estimates because climate impacts occurring outside U.S. borders can directly (and indirectly affect the welfare of U.S. citizens and residents. Thus, U.S. interests are affected by the climate impacts that occur outside U.S. borders. Examples of affected interests include: Direct effects on U.S. citizens and assets located abroad, international trade, and tourism, and spillover pathways such as economic and political destabilization and global migration. In addition, assessing the benefits of U.S. GHG mitigation activities requires consideration of how those actions may affect mitigation activities by other countries, as those international mitigation actions will

provide a benefit to U.S. citizens and residents by mitigating climate impacts that affect U.S. citizens and residents. Therefore, in this analysis DOE centers attention on a global measure of SC-GHG.

As noted above, DOE determined that the estimates from the February 2021 TSD are based upon sound analysis, and therefore, in analyzing the impacts of CO₂ related to the reductions of emissions from updating the 90.1 Standard to the 2019 edition, DOE has focused on a global measure of SC-CO₂. As noted in the February 2021 TSD, the IWG will continue to review developments in the literature, including more robust methodologies for estimating SC-GHG values based on purely domestic damages, and explore ways to better inform the public of the full range of carbon impacts, both global and domestic. As a member of the IWG, DOE will likewise continue to follow developments in the literature pertaining to this issue. However, as discussed in previous comments, DOE's SC-CO₂ analysis using these estimates was not considered in DOE's ultimate determination of whether the 2021 IECC Standard will improve energy efficiency.

Comment: AHRI, p.3.4. AHRI stated that DOE wrongly assumes that SC-CO₂ values increase over time in real dollars and states that this is contrary to "historical experience and to economic development science" and that the more economic development that occurs, the more adaptation and mitigation efforts a population living in a growing economy can afford to undertake (AHRI cites the IWG indicating that developed countries can eliminate 90% of the economic impacts and developing countries could eventually eliminate 50% of the economic impacts of climate change). They comment that they see no indication that DOE considered this separately.

DOE Response: In making its determination, DOE's directive under ECPA is to assess whether updated editions of Standard 90.1 would improve *energy efficiency* in commercial buildings. 42 U.S.C. 6833(b)(2)(A) DOE emphasizes that the estimates pertaining to CO₂ are provided only as supplemental information and are not considered as part of the final determination, which is based on energy efficiency as required under 42 U.S.C. 6833(b)(2)(A).

The model scenarios reported by the IWG demonstrate that the damage assessments and corresponding valuation (SC-CO₂), adjusted for inflation, increase through time. As explained in the February 2021 TSD, "[t]he SC-[CO₂] estimates increase over time within the models—i.e., the societal harm from one metric ton emitted in 2030 is higher than the harm caused by one metric ton emitted in 2025—because future emissions produce larger incremental damages as physical and economic systems become more stressed in response to greater climatic change, and because GDP is growing over time and many damage categories are modeled as proportional to GDP. As noted above, DOE determined that the estimates from the February 2021 TSD are based upon sound analysis and provide well founded estimates for DOE's analysis of the impacts of CO₂ related to the reductions of emissions

Collectively, these values are referenced as the "social cost of greenhouse gases" (SC-GHG).

⁸ See Interagency Working Group on Social Cost of Greenhouse Gases, *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide. Interim Estimates Under Executive Order 13990*, Washington, DC, February 2021.

from updating the 90.1 Standard to the 2019 edition in its building codes impact analysis. Accordingly, DOE incorporated the IWG's consideration in its analysis. However, as discussed in previous comments, DOE's SC-CO₂ analysis using these estimates was not considered in DOE's ultimate determination of whether the 2021 IECC Standard will improve energy efficiency.

Comment: AHRI, p. 4. AHRI argued that it is arbitrary and capricious to use different timeframes and assumptions for costs and benefits and notes that DOE must clarify precisely why and how it believes it has statutory authority under 42 U.S.C. 6833(a) to consider SC-CO₂ issues and cites why such action is legally arbitrary without sufficient documented reason for treating similar situations differently. AHRI notes that DOE, in clarifying why it believes it has such authority, can establish how it is acting consistently in terms of the analysis of benefits.

DOE Response: See previous response to AHRI comment on the issue of authority. On the issue of costs and benefits, DOE reemphasizes that its determination analysis is not assessing the costs and benefits associated with the updated 2021 IECC, that the determination is solely based on energy efficiency, and that the reported carbon emissions are reported only as supplemental information for the benefit of interested parties and in support of the directives of Executive Order 12866. To clarify the issue of timeframe, the emission estimates are based on one year (*i.e.*, the annual energy consumption estimated via the energy efficiency analysis). However, the step of projecting the associated CO₂ impacts captures the longer-term impact of those single-year emissions, as they persist in the atmosphere (and drive the damage impacts over the time they persist), which is then discounted to present value for the year when the emissions occur. DOE does not find an economic inconsistency in this approach to reporting emission benefits. Such a calculation is similar to life-cycle analysis, for instance, which is performed in a similar fashion, where a single year event occurs (*e.g.*, a purchase of more efficient equipment), but the energy savings are calculated over the time they exist (*e.g.*, the life of the equipment), and discounted back to the present value to reflect an overall life-cycle cost. DOE's reporting here of discounted damage impacts is consistent with that general approach.

Signing Authority

This document of the Department of Energy was signed on July 19, 2021, by Kelly Speakes-Backman, Principal Deputy Assistant Secretary and Acting Assistant Secretary for Energy Efficiency and Renewable Energy, pursuant to delegated authority from the Secretary of Energy. That document with the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE Federal Register Liaison Officer has been

authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the **Federal Register**.

Signed in Washington, DC, on July 22, 2021.

Treena V. Garrett,

Federal Register Liaison Officer, U.S. Department of Energy.

[FR Doc. 2021-15969 Filed 7-27-21; 8:45 am]

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DEPARTMENT OF ENERGY

[Case Number 2021-001; EERE-2021-BT-WAV-0001]

Energy Conservation Program: Notification of Petition for Waiver of Goodman Manufacturing Company, L.P. From the Department of Energy Central Air Conditioners and Heat Pumps Test Procedure and Notification of Grant of Interim Waiver

AGENCY: Office of Energy Efficiency and Renewable Energy, Department of Energy.

ACTION: Notification of petition for waiver and grant of an interim waiver; request for comments.

SUMMARY: This notification announces receipt of and publishes a petition for waiver and interim waiver from Goodman Manufacturing Company, L.P. ("Goodman") which seeks a waiver from the U.S. Department of Energy ("DOE") test procedure used for determining the efficiency of specified central air conditioner ("CAC") and heat pump ("HP") basic models. DOE also gives notification of an Interim Waiver Order that requires Goodman to test and rate specified CAC and HP basic models in accordance with the alternate test procedure set forth in the Interim Waiver Order. DOE solicits comments, data, and information concerning Goodman's petition and its suggested alternate test procedure to inform DOE's final decision on Goodman's waiver request.

DATES: The Interim Waiver Order is effective on July 28, 2021. Written comments and information are requested and will be accepted on or before August 27, 2021.

ADDRESSES: Interested persons are encouraged to submit comments using the Federal eRulemaking Portal at <https://www.regulations.gov>. Follow the instructions for submitting comments. Alternatively, interested persons may submit comments by email to the

following address:

Goodman2021WAV0001@ee.doe.gov. Include case number "2021-001" and Docket number "EERE-2021-BT-WAV-0001" in the subject line of the message. Submit electronic comments in WordPerfect, Microsoft Word, PDF, or ASCII file format, and avoid the use of special characters or any form of encryption.

Although DOE has routinely accepted public comment submissions through a variety of mechanisms, including postal mail and hand delivery/courier, the Department has found it necessary to make temporary modifications to the comment submission process in light of the ongoing coronavirus disease 2019 ("COVID-19") pandemic. DOE is currently accepting only electronic submissions at this time. If a commenter finds that this change poses an undue hardship, please contact Appliance Standards Program staff at (202) 586-1445 to discuss the need for alternative arrangements. Once the Covid-19 pandemic health emergency is resolved, DOE anticipates resuming all of its regular options for public comment submission, including postal mail and hand delivery/courier.

No telefacsimilies (faxes) will be accepted. For detailed instructions on submitting comments and additional information on this process, see the **SUPPLEMENTARY INFORMATION** section of this document.

Docket: The docket, which includes **Federal Register** notices, comments, and other supporting documents/materials, is available for review at <https://www.regulations.gov>. All documents in the docket are listed in the <https://www.regulations.gov> index. However, some documents listed in the index, such as those containing information that is exempt from public disclosure, may not be publicly available.

The docket web page can be found <https://www.regulations.gov/docket?D=EERE-2021-BT-WAV-0001>. The docket web page contains instruction on how to access all documents, including public comments, in the docket. See the **SUPPLEMENTARY INFORMATION** section for information on how to submit comments through <https://www.regulations.gov>.

FOR FURTHER INFORMATION CONTACT:

Ms. Lucy deButts, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, Mailstop EE-5B, 1000 Independence Avenue SW, Washington, DC 20585-0121. Email: *AS_Waiver_Request@ee.doe.gov*.

Exhibit K.2

PNNL-31440

Energy Savings Analysis: 2021 IECC for Residential Buildings

July 2021

V. Robert Salcido
Yan Chen
Yulong Xie
Z. Todd Taylor

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Energy Savings Analysis: 2021 IECC for Residential Buildings

July 2021

V. Robert Salcido
Yan Chen
Yulong Xie
Z. Todd Taylor

Prepared for
the U.S. Department of Energy
under Contract DE-AC05-76RL01830

Pacific Northwest National Laboratory
Richland, Washington 99354

Executive Summary

Section 304(a) of the Energy Conservation and Production Act (ECPA), as amended, directs the U.S. Secretary of Energy to review the International Energy Conservation Code (IECC)¹ and make a *determination* as to whether updated editions would improve energy efficiency in residential buildings. The IECC is developed by the International Code Council (ICC) through an established industry review and consensus process with updated editions typically published every 3 years. The U.S. Department of Energy (DOE) reviews the energy saving impacts of updated code editions and publishes its findings in the *Federal Register*. The DOE determination and accompanying technical analysis serve as useful guidance to state and local governments as they review and update their building codes.

The most recent edition, the 2021 IECC, was published on January 29, 2021, triggering the DOE review and determination process². DOE and Pacific Northwest National Laboratory (PNNL) conducted a technical analysis to determine energy savings for the 2021 IECC residential provisions relative to the previous edition, the 2018 IECC (ICC 2017). This report documents the methodology used to conduct the analysis and summarizes the results.

Methodology

The determination analysis is based on an established DOE Methodology (Taylor et al. 2015) and is consistent with the previously published determination (DOE 2019). The analysis entails a combination of *qualitative* and *quantitative* components to identify changes that have a direct impact on residential energy efficiency, and which can be reasonably quantified in estimating overall national average saving impacts. This process can be summarized as follows:

- **Qualitative Assessment:** A compilation of all code changes approved by the ICC for inclusion in the IECC. Individual changes are characterized to identify those expected to have a direct impact on energy efficiency in a significant portion of typical residential buildings.
- **Quantitative Assessment:** Code changes are filtered to retain those that could be reasonably quantified through energy modeling and analysis. The resulting collection is then further analyzed to estimate combined effects, with the results aggregated and weighted across the range of climates, building types, and foundation types to quantify the national average savings impacts of the updated code.

Results

A total of 114 approved code change proposals were identified and analyzed for the 2021 IECC. Analyses of those changes indicate the following:

- 35 changes with a direct impact on energy use in residential buildings—29 of these are expected to reduce energy use while 6 are expected to increase energy use
- 79 additional changes—changes in this category are administrative, impact non-energy portions of the code, or are otherwise not expected to have a direct impact on energy savings under the applied methodology

¹ ECPA originally recognized the 1992 Council of American Building Officials (CABO) Model Energy Code and its successor editions. The IECC is the contemporary successor to the CABO Model Energy Code.

² The publication of the 2021 IECC was delayed several months due to appeals.

Of the 35 code changes characterized as having a direct impact on energy efficiency, 11 are expected to impact a sufficient fraction of new homes to warrant further quantitative analysis to assess the overall magnitude of the 2021 IECC's impact. Those 11 changes are analyzed as part of the quantitative analysis, the results of which indicate that residential buildings meeting the 2021 IECC incur the following savings on a weighted national average basis:

- 9.38 percent of annual site energy use intensity (EUI);
- 8.79 percent of annual source EUI;
- 8.66 percent of annual energy cost; and
- 8.66 percent of carbon emissions.

Table ES.1 shows energy and resulting carbon savings results, tabulated by climate zone. Relative savings in terms of annual energy costs vary modestly across climate zones, ranging from 4.56 percent in climate zone 6 to 10.38 percent in climate zone 8. Table ES.2 and Table ES.3 summarize the estimated EUIs for the 2018 and 2021 IECC, respectively. Table ES.4, Table ES.5, and Table ES.6 show the results aggregated by building type.

Table ES.1. Energy Savings and CO₂ Emission Reductions of the 2021 IECC compared to the 2018 IECC by Climate Zone (percent)*

| Climate Zone | Weight (%) | Site EUI (%) | Source EUI (%) | Energy Costs (%) | CO ₂ Emissions (%) |
|--------------|------------|--------------|----------------|------------------|-------------------------------|
| 1 | 4.30 | 10.80 | 9.73 | 9.51 | 9.53 |
| 2 | 22.43 | 10.00 | 9.13 | 8.93 | 8.95 |
| 3 | 29.04 | 10.48 | 9.75 | 9.57 | 9.59 |
| 4 | 19.49 | 10.05 | 9.45 | 9.32 | 9.32 |
| 5 | 19.51 | 8.50 | 7.63 | 7.44 | 7.42 |
| 6 | 4.68 | 4.28 | 4.43 | 4.56 | 4.52 |
| 7 | 0.53 | 12.65 | 10.72 | 10.13 | 10.17 |
| 8 | 0.02 | 12.48 | 10.93 | 10.38 | 10.44 |
| National | 100.00 | 9.38 | 8.79 | 8.66 | 8.66 |

* DOE monetized carbon emission from model code adoption beginning in 2010 and ending in 2040 for all states included in the analysis using four SC-CO₂ estimate scenarios. See Section 4 and 5 of this TSD and the 2021 interim PNNL Report, https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-31437.pdf, for additional information.

Table ES.2. Energy Use and CO₂ Emissions of the 2018 IECC by Climate Zone

| Climate Zone | Weight (%) | Site EUI (kBtu/ft ² -yr) | Source EUI (kBtu/ft ² -yr) | Energy Costs (\$/residence-yr) | CO ₂ Emissions (tons/residence-yr) |
|--------------|------------|-------------------------------------|---------------------------------------|--------------------------------|---|
| 1 | 4.30 | 28.8 | 79.1 | 2,046 | 11.0 |
| 2 | 22.43 | 31.2 | 80.7 | 2,088 | 11.2 |
| 3 | 29.04 | 31.5 | 78.4 | 2,024 | 10.9 |
| 4 | 19.49 | 37.1 | 83.5 | 2,139 | 11.5 |
| 5 | 19.51 | 45.4 | 86.6 | 2,252 | 12.1 |
| 6 | 4.68 | 50.9 | 96.5 | 2,613 | 14.0 |
| 7 | 0.53 | 58.1 | 110.8 | 2,936 | 15.8 |
| 8 | 0.02 | 78.0 | 147.1 | 3,845 | 20.8 |
| National | 100.00 | 36.4 | 82.7 | 2,139 | 11.5 |

Table ES.3. Energy Use and CO₂ Emissions of the 2021 IECC by Climate Zone

| Climate Zone | Weight (%) | Site EUI (kBtu/ft ² -yr) | Source EUI (kBtu/ft ² -yr) | Energy Costs (\$/residence-yr) | CO ₂ Emissions (tons/residence-yr) |
|--------------|------------|-------------------------------------|---------------------------------------|--------------------------------|---|
| 1 | 4.30 | 25.7 | 71.4 | 1,851 | 9.9 |
| 2 | 22.43 | 28.1 | 73.3 | 1,902 | 10.2 |
| 3 | 29.04 | 28.2 | 70.8 | 1,830 | 9.8 |
| 4 | 19.49 | 33.3 | 75.6 | 1,940 | 10.4 |
| 5 | 19.51 | 41.5 | 80.0 | 2,084 | 11.2 |
| 6 | 4.68 | 48.7 | 92.2 | 2,494 | 13.4 |
| 7 | 0.53 | 50.7 | 98.9 | 2,638 | 14.2 |
| 8 | 0.02 | 68.3 | 131.1 | 3,445 | 18.6 |
| National | 100.00 | 33.0 | 75.4 | 1,954 | 10.5 |

Table ES.4. Energy Savings and CO₂ Emission Reductions of the 2021 IECC compared to the 2018 IECC by Building Type (percent)

| Building Type | Weight (%) | Site EUI (%) | Source EUI (%) | Energy Costs (%) | CO ₂ Emissions (%) |
|------------------|------------|--------------|----------------|------------------|-------------------------------|
| Single-family | 66.04 | 8.51 | 8.12 | 8.03 | 8.04 |
| Multifamily Unit | 33.96 | 12.56 | 11.21 | 10.91 | 10.91 |
| National | 100.00 | 9.38 | 8.79 | 8.66 | 8.66 |

Table ES.5. Energy Use and Carbon Emissions of the 2018 IECC by Building Type

| Building Type | Weight (%) | Site EUI (kBtu/ft ² -yr) | Source EUI (kBtu/ft ² -yr) | Energy Costs (\$/residence- yr) | CO ₂ Emissions (tons/residence -yr) |
|------------------|------------|--|--|---------------------------------------|--|
| Single-family | 66.04 | 35.9 | 81.4 | 2,534 | 13.6 |
| Multifamily Unit | 33.96 | 38.4 | 87.9 | 1,372 | 7.4 |
| National | 100.00 | 36.4 | 82.7 | 2,139 | 11.5 |

Table ES.6. Energy Use and Carbon Emissions of the 2021 IECC by Building Type

| Building Type | Weight (%) | Site EUI (kBtu/ft ² -yr) | Source EUI (kBtu/ft ² -yr) | Energy Costs (\$/residence- yr) | CO ₂ Emissions (tons/residence -yr) |
|------------------|------------|--|--|---------------------------------------|--|
| Single-family | 66.04 | 32.8 | 74.8 | 2,330 | 12.5 |
| Multifamily Unit | 33.96 | 33.6 | 78.0 | 1,222 | 6.6 |
| National | 100.00 | 33.0 | 75.4 | 1,954 | 10.5 |

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Acronyms and Abbreviations

| | |
|-----------------|--|
| ACH50 | air changes per hour at 50 pascals |
| AEO | Annual Energy Outlook |
| AFUE | annual fuel utilization efficiencies |
| AHRI | Air Conditioning, Heating, and refrigeration Institute |
| ASHRAE | American Society of Heating, Refrigerating, and Air-Conditioning Engineers |
| Btu | British thermal unit(s) |
| CABO | Council of American Building Officials |
| CF | cubic foot (feet) |
| CFL | compact fluorescent lamp |
| CFM | cubic feet per minute |
| DOE | U.S. Department of Energy |
| ECPA | Energy Conservation and Production Act |
| EER | energy efficiency ratio |
| EF | energy factor |
| EIA | U.S. Energy Information Administration |
| ERI | Energy Rating Index |
| EPA | U.S. Environmental Protection Agency |
| ERV | energy recovery ventilator |
| EUI | energy use intensity |
| °F | degree(s) Fahrenheit |
| ft ² | square foot(feet) |
| hr | hour(s) |
| HRV | heat recovery ventilator |
| HSPF | heating season performance factors |
| HVAC | heating, ventilating, and air conditioning |
| HWDS | hot water distribution system |
| IAM | integrated assessment model |
| ICC | International Code Council |
| IECC | International Energy Conservation Code |
| IgCC | International Green Construction Code |
| IPC | International Plumbing Code |
| IRC | International Residential Code |
| kWh | kilowatt-hour(s) |
| LED | light emitting diode |
| LF | linear fluorescent |

| | |
|--------------------|---------------------------------------|
| MEC | Model Energy Code |
| PNNL | Pacific Northwest National Laboratory |
| REC | Renewable Energy Certificate |
| RECS | Residential Energy Consumption Survey |
| SC-CO ₂ | Social cost of carbon |
| SEER | seasonal energy efficiency rating |
| SHGC | solar heat gain coefficient |
| SWH | service water heating |
| TDE | thermal distribution efficiency |
| W | watt |
| yr | year(s) |

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1.0 Introduction

The International Energy Conservation Code (IECC) is recognized by the U.S. Congress as the national model energy code for residential buildings under the Energy Conservation and Production Act, as amended (ECPA) (42 USC 6833). Section 304(a) of the ECPA provides that whenever the 1992 Council of American Building Officials (CABO) Model Energy Code (MEC) or any successor to that code is revised, the U.S. Secretary of Energy must make a *determination*, not later than 12 months after such revision, whether the revised code would improve energy efficiency in residential buildings and must publish notice of such determination in the *Federal Register* (42 U.S.C. 6833(a)(5)(A)). The IECC is the contemporary successor to the 1992 CABO MEC specified in the ECPA.

On December 10, 2019, the U.S. Department of Energy (DOE) issued an affirmative determination of energy savings for the 2018 IECC, the relevant successor to the 1992 MEC at the time, that concluded that the 2018 IECC would achieve greater energy efficiency in residential buildings than the 2015 IECC (84 FR 67435). Through this determination, the 2018 IECC became the national model energy code for residential buildings. Consequently, and consistent with previous determinations, the 2018 IECC also became the baseline to which future changes are compared, including the current review of the 2021 IECC.

To support DOE in fulfilling its statutory directive, Pacific Northwest National Laboratory (PNNL) conducted an analysis to determine energy savings for the 2021 IECC residential provisions compared to those of the 2018 IECC. This report documents the methodology used to conduct the analysis and provides a summary of results and findings.

Section 2.0 of this report provides an overview of the analysis, which is based on a combination of both qualitative and quantitative components. Section 3.0 provides the qualitative and quantitative analysis results. A comprehensive list of all code change proposals approved for inclusion in the 2021 IECC is included in Appendix A. Additionally, Appendix B and Appendix C detail weighting factors and updates to the energy savings calculation methodology related to *EnergyPlus* software updates. Appendix D details the modeling strategies used in the quantitative analysis.

2.0 Methodology

2.1 Overview

The current analysis is based on an established DOE Methodology (Taylor et al. 2015) and is consistent with previously published determinations (DOE 2019). The analysis is based on a combination of *qualitative* and *quantitative* components to identify changes that have a direct impact on residential energy efficiency that can be reasonably quantified in estimating overall savings impacts. This process can be summarized as follows:

- **Qualitative Assessment:** A compilation of all code changes approved by the ICC for inclusion in the IECC. Individual changes are characterized to identify those expected to have a direct impact on energy efficiency in a significant portion of typical residential buildings.
- **Quantitative Assessment:** Code changes are filtered to retain those that could be reasonably quantified through energy modeling and analysis. The resulting collection is then further analyzed to estimate combined effects, with the results aggregated and weighted across the range of climates and building types to quantify the national average impacts of the 2021 IECC.

The proceeding sections provide additional detail on the analysis methodology. Several individual changes warrant additional consideration and are discussed in Section 3.1.1. Findings resulting from the analysis are covered in Section 3.0.

2.2 Qualitative Assessment

The first step of the analysis is a qualitative assessment by which all approved code change proposals are categorized according to their effect on homes, with particular attention to their expected impact on energy use. Changes expected to have an impact on residential energy efficiency are characterized as follows:

1. *Decreases Energy Use:* The change is expected to have a beneficial efficiency impact on some or all homes complying with the code (increased energy efficiency and savings)
2. *Increases Energy Use:* The change is expected to have a detrimental efficiency impact on some or all homes complying with the code (decreased energy efficiency and savings).

Many changes do not have a direct impact on energy efficiency and therefore are not designated as falling into one of the above categories. Examples of such changes often include:

- Changes affecting only procedural aspects of complying with the code, such as those providing guidance on inspection protocols or modeling rulesets
- Changes where impacts are captured under a complementary code requirement, such as the relationship between air tightness testing, associated thresholds (e.g., 5 ACH50), and component air sealing requirements—this serves to avoid double-counting in the quantitative analysis
- Changes targeting non-energy aspects of the IECC, such as envelope efficiency requirements for performance compliance
- Administrative changes, including editorial corrections, new definitions, reordering or numbering of code sections, clarifications, and reference updates.

Code changes characterized as increasing or decreasing energy use are further evaluated as to whether they can be reasonably quantified through quantitative energy analysis. Appendix A contains a full list of all code changes included in the 2021 IECC and their categorizations.

2.3 Quantitative Assessment

The current analysis is based on an established DOE Methodology (Taylor et al. 2015) and builds on previous work by PNNL (DOE 2019). DOE has historically focused its review of model codes on changes that affect the *mandatory* and *prescriptive* requirements of the code because such changes are considered to have the most direct and quantifiable impact on energy efficiency in buildings and also historically have been viewed as the predominant compliance option employed by users of the IECC. While all changes are reviewed individually and assessed as to their anticipated impact during the qualitative analysis, only those changes with a direct and reasonably measurable energy impact are included in the quantitative assessment and therefore the final savings estimates.

Further, the 2021 IECC includes two performance-based compliance options (Performance and Energy Rating Index (ERI)). These are intended to provide increased flexibility while ensuring that the resulting building is designed to use less (or equal) energy compared to the standard reference baseline. Performance-based alternatives have received increased attention and emphasis in recent code updates. However, these are generally considered optional alternatives to the more traditional prescriptive requirements and in all cases remain subject to the mandatory code requirements.

Changes in the performance-based options can be difficult to reasonably quantify via commonly accepted methods or are speculative in terms of their expected uptake in practice (i.e., have not been widely implemented in the field to date). For this reason, performance-based changes are generally excluded from the quantitative assessment, in which case DOE often defers to the qualitative assessment of the individual change.

The following sections describe the analysis procedures and simulation models relied upon in the quantitative assessment.

2.3.1 Building Types and Model Prototypes

DOE's established methodology uses a suite of representative residential prototype buildings, including a single-family and a low-rise multifamily residential building, each with four different foundation types (i.e., slab-on-grade, vented crawlspace, heated basement, unheated basement) and four heating system types (i.e., gas furnace, electric resistance, heat pump, fuel oil furnace). The entire set of configurations is designed to represent the majority of the new residential building construction stock in the United States and was created based on construction data from the U.S. Census (Census 2010), the Residential Energy Consumption Survey (RECS 2013) and the National Association of Home Builders (NAHB 2009).

Thus, a total of 32 prototype buildings and configurations are represented (i.e., 2 building types, 4 foundation types, and 4 fuel/equipment types) resulting in 576 individual energy simulation models. Detailed descriptions of the prototype building models and their representative operational assumptions are documented by Mendon et al. (2013, 2015) and Mendon and Taylor (2014).

2.3.2 Climate Zones

The 2021 IECC incorporates several changes introduced by the 2013 edition of ASHRAE Standard 169, Climatic Data for Building Design Standards (ASHRAE 2013). ASHRAE 169-2013 redefined climate zones and moisture regimes based on a more recent period of weather data. As a result, a number of U.S. counties were reassigned to different zones/regimes, and a new, extremely hot climate zone 0, which does not occur in the United States, was added. Approximately 400 U. S. counties out of more than 3,000 were reassigned, most to warmer climate zones¹. The 2021 IECC now aligns the climate zone map with that of ASHRAE 90.1, ASHRAE 90.2, and the International Green Construction Code (IgCC). Standard 169-2013 includes nine thermal zones and three moisture regimes.

The U.S. climate zones and moisture regimes are shown in Figure 1.

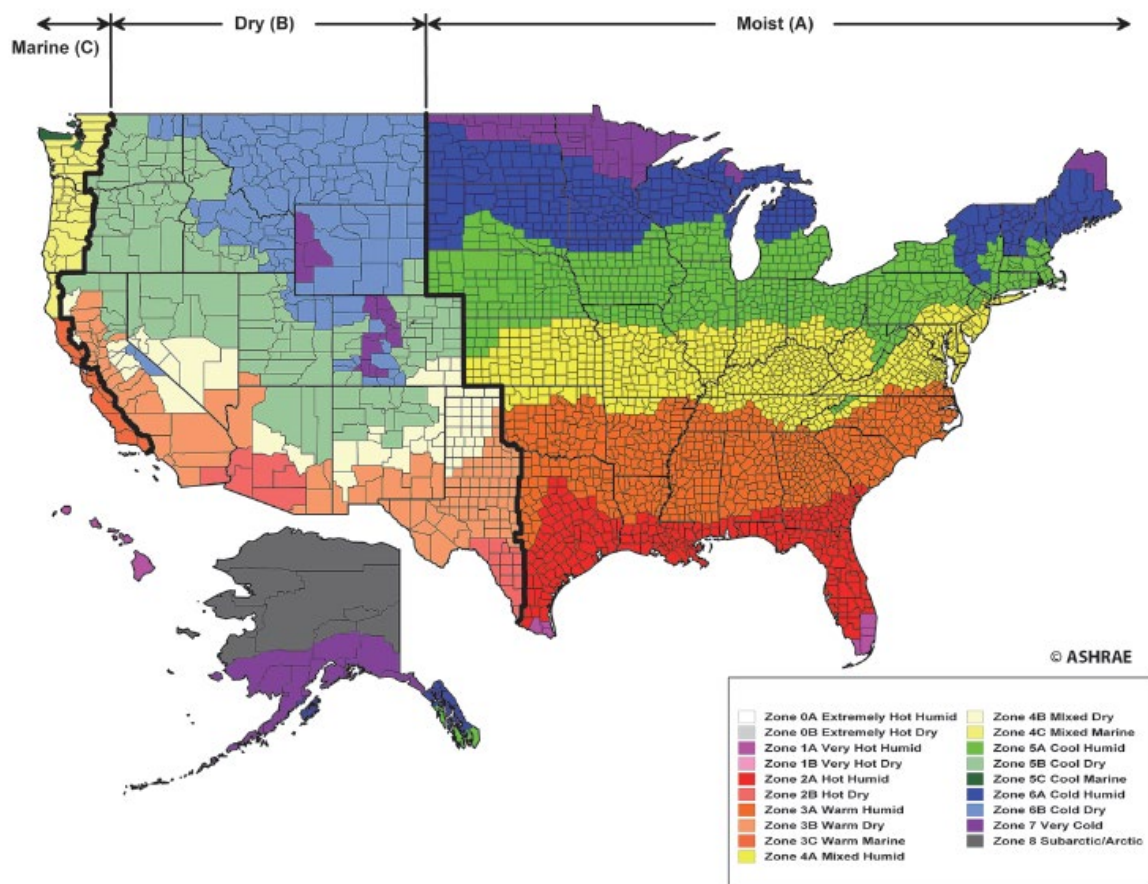


Figure 1. U.S. Climate Zone Map

Climate zones are divided into moist (A), dry (B), and marine (C) regions. However, not all the moisture regimes apply to all climate zones in the United States, and some zones have no moisture designations at all (zones 7 and 8 in the United States); thus, only 19 thermal-moisture zones exist in ASHRAE 169-2013, of which 16 are represented in the United States. In addition, the residential IECC includes a tropical climate designation with an alternative prescriptive compliance path for semi-conditioned buildings meeting certain criteria. Because the national

¹ <https://ibpsa-usa.org/index.php/ibpusa/article/view/389>.

analysis for DOE determinations looks only at the primary prescriptive compliance path, the alternative for tropical semi-conditioned buildings is not considered in this analysis. All homes in the tropical zone are modeled as complying with the prescriptive path. The appropriate state level analyses will include the parameters of the tropical semi-conditioned prescriptive requirements.

The IECC further defines a warm-humid region in the southeastern United States. This region is defined by humidity levels, whereas the moist (A) regime is more closely associated with rainfall. The warm-humid distinction affects only whether basement insulation is required in climate zone 3. This brings the total number of representative cities analyzed to 18.

For the quantitative analysis, a specific climate location (i.e., city) was selected as representative of each of the 18 climate/moisture zones found in the United States:

- 1A: Honolulu, Hawaii (tropical)
- 1A: Miami, Florida
- 2A: Tampa, Florida
- 2B: Tucson, Arizona
- 3A: Atlanta, Georgia
- 3A: Montgomery, Alabama (warm-humid)
- 3B: El Paso, Texas
- 3C: San Diego, California
- 4A: New York, New York
- 4B: Albuquerque, New Mexico
- 4C: Seattle, Washington
- 5A: Buffalo, New York
- 5B: Denver, Colorado
- 5C: Port Angeles, Washington
- 6A: Rochester, Minnesota
- 6B: Great Falls, Montana
- 7: International Falls, Minnesota
- 8: Fairbanks, Alaska

For the determination analysis, one set of prototype models was configured to represent construction practices as dictated by the 2018 IECC, another set was configured to represent the 2021 IECC, and then both sets were simulated in all the climate zones and moisture regimes defined in the IECC. Annual energy simulations were carried out for each of the 576 models using *EnergyPlus* version 9.5 (DOE 2020). The resulting energy use data were converted to energy costs using national average fuel prices, and the energy and energy cost results were weighted to the national level using weighting factors based on housing starts.

2.3.3 Weighting Factors

Weighting factors for each of the prototype buildings were developed for all U.S. climate zones using 2019 new residential construction starts¹ and residential construction details from the U.S. Census (Census 2010), the Residential Energy Consumption Survey (RECS 2013) and the National Association of Home Builders (NAHB 2009). The weights were fine-tuned by the revised county-to-climate zone map based on ASHRAE 169 climate zone changes. Table 1 through Table 4 summarize the weights aggregated to building type, foundation type, heating system, and climate zone levels. The detailed weighting factors for each prototype building are included in Appendix B.

¹ See the U.S. Census Bureau webpage at <https://www.census.gov/construction/bps/stateannual.html>.

Table 1. Weighting Factors by Building Type

| Building Type | Weight (%) |
|---------------|------------|
| Single-Family | 66.04 |
| Multifamily | 33.96 |
| Total | 100.00 |

Table 2. Weighting Factors by Foundation Type

| Foundation Type | Weight (%) |
|-------------------|------------|
| Crawlspace | 27.44 |
| Slab-on-Grade | 50.86 |
| Heated Basement | 11.77 |
| Unheated Basement | 9.93 |
| Total | 100.00 |

Table 3. Weighting Factors by Heating System

| Heating System Type | Weight (%) |
|---------------------|------------|
| Gas-Fired Furnace | 49.15 |
| Electric Furnace | 5.64 |
| Oil-fired Furnace | 1.28 |
| Heat Pump | 43.93 |
| Total | 100.00 |

Table 4. Weighting Factors by Climate Zone

| Climate Zone | Weight (%) |
|--------------|------------|
| 1 | 4.30 |
| 2 | 22.43 |
| 3 | 29.04 |
| 4 | 19.49 |
| 5 | 19.51 |
| 6 | 4.68 |
| 7 | 0.53 |
| 8 | 0.02 |
| Total | 100.00 |

2.4 Conversion of Energy Units

The determination analysis is based on three metrics of energy consumption:

1. *Site Energy*: The energy consumed at the end of the generation cycle within the building site, sometimes referenced as “behind the meter” or as shown on the building’s utility bill

2. *Source Energy*: The energy required to power a building including generation and distribution
3. *Energy Cost*: The total cost of energy required for building functions

In addition, the analysis reports *Carbon Emissions* based on the amount of carbon released to the atmosphere from source energy consumption, however, estimates pertaining to emissions are provided only as supplemental information and are not considered as part of the final determination.

The annual site energy results for total building energy use were converted to annual site EUIs based on the conditioned floor area of the residential prototype models. This conversion includes considering heating, cooling, fans, domestic water heating, lighting, appliances, plug loads, and ventilation from the simulation analysis of the residential prototype models that minimally comply with the prescriptive and mandatory requirements of the 2018 and 2021 IECC. The site energy use was converted to source energy (or primary energy), which accounts for the inefficiencies of generation and losses involved in delivering energy to the site.

The source-site conversion ratios for electricity and natural gas were calculated from the 2020 values reported in Table 2 of the 2021 Annual Energy Outlook produced by the U.S. Energy Information Administration (EIA 2021a). Table 5 and Table 6 summarize the source-site conversion factor calculations for electricity and natural gas, respectively. The EIA does not report similar losses associated with fuel oil. In absence of these data, a source-site conversion ratio of 1.1 is used for fuel oil based on the 2021 IECC.

Table 5. Calculation of the Source-Site Ratio for Electricity

| Electricity (quadrillion Btu) | Electricity- Related Losses (quadrillion Btu) | Source-Site Ratio ^(a) |
|-------------------------------|---|----------------------------------|
| 4.99 | 9.71 | 2.95 |

(a) Source-Site ratio= $(4.99+9.71)/4.99=2.95$

Table 6. Calculation of the Source-Site Ratio for Natural Gas

| Sum of Natural Gas Use, Pipeline, Lease and Plant Fuel (quadrillion Btu) | Delivered to Consumers (quadrillion Btu) | Source-Site Ratio ^(a) |
|--|--|----------------------------------|
| 30.41 | 27.79 | 1.09 |

(a) Source-Site ratio= $30.41/27.79= 1.09$

Finally, the annual energy results from the simulation analysis were converted to annual energy costs using the 2020 national average fuel prices from the EIA. To avoid seasonal fluctuations and regional variations in the price of electricity, the analysis used the average annual residential electricity price of 13.23 ¢/kWh (EIA 2020a). The EIA reports a national annual average cost of \$9.77/1,000 ft³ for natural gas and an average heat content of 1,037 Btu/ft³ for natural gas delivered to consumers in 2016 (EIA 2020b, 2020c). The resulting national average price of \$0.94/therm for natural gas was used in this analysis. In addition, the EIA reports a national annual average cost of \$2.519/gallon for No. 2 fuel oil (EIA 2020d). The heat content of

No. 2 fuel oil is assumed to be 138,500 Btu/gallon (EIA 2021b), resulting in a national average price of \$18.19/million Btu for fuel oil.

Carbon emissions in the quantitative analysis are based on the source energy consumption on a national scale. Carbon emission metrics are provided by the U.S. Environmental Protection Agency (EPA) Greenhouse Gas Equivalencies Calculator.¹ The Greenhouse calculator reports the national marginal carbon emission conversion factor for electricity at 7.07×10^{-4} metric tons CO₂/kWh. For natural gas, the carbon emission conversion factor is 0.0053 metric tons CO₂/therm. For oil, the carbon emission conversion factor is 10.243×10^{-3} metric tons CO₂/gallon. Table 7 summarizes the carbon emission factors.

Table 7. Carbon Emission Factors by Fuel Type

| Fuel Source | Carbon Emission Factor |
|-------------|---|
| Electricity | 7.07×10^{-4} metric tons CO ₂ /kWh |
| Natural Gas | 0.0053 metric tons CO ₂ /therm |
| Fuel Oil | 10.243×10^{-3} metric tons CO ₂ /gallon |

On January 20, 2021, President Biden issued E.O. 13990², which noted that it is essential that agencies capture the full costs of greenhouse gas emissions as accurately as possible, including by taking global damages into account and that doing so facilitates sound decision-making, recognizes the breadth of climate impacts, and supports the international leadership of the United States on climate issues. To that end, PNNL has estimated the cost savings of greenhouse gas emissions associated with improved model building energy codes. See Section 4.

The principal greenhouse gas emission associated with residential building energy use as examined in this analysis is carbon dioxide (CO₂). PNNL estimated the global societal benefits of CO₂ emission reductions due to improved model building energy codes using the SC-CO₂ estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990* (IWG 2021). The SC-CO₂ estimates used in this analysis were developed over many years, using a transparent process, peer-reviewed methodologies, the best science available at the time of that process, and with input from the public. Specifically, an interagency working group (IWG) that included DOE and other executive branch agencies and offices used three integrated assessment models (IAMs) to develop the SC-CO₂ estimates and recommended four global values for use in regulatory analyses. These SC-CO₂ estimates are interim values developed under Executive Order (E.O.) 13990 for use in benefit-cost analyses until an improved estimate of the impacts of climate change can be developed based on the best available science and economics. These SC-CO₂

¹ See the EPA webpage at <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>.

² Exec. Order No. 13990, 86 Fed. Reg. 7037 (January 20, 2021) <<https://www.federalregister.gov/documents/2021/01/25/2021-01765/protecting-public-health-and-the-environment-and-restoring-science-to-tackle-the-climate-crisis>> Exec. Order No. 13990, 86 Fed. Reg. 7037 (January 20, 2021), available at <https://www.federalregister.gov/documents/2021/01/25/2021-01765/protecting-public-health-and-the-environment-and-restoring-science-to-tackle-the-climate-crisis>.

estimates are the same as those used in the *Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866* (IWG 2016), but are updated to 2020\$.

The February 2021 Technical Support Document (TSD) provides a complete discussion of the IWG's initial review conducted under E.O. 13990. First, the IWG found that a global perspective is essential for SC-GHG estimates because climate impacts occurring outside U.S. borders can directly and indirectly affect the welfare of U.S. citizens and residents. Thus, U.S. interests are affected by the climate impacts that occur outside U.S. borders. In addition, assessing the benefits of U.S. GHG mitigation activities requires consideration of how those actions may affect mitigation activities by other countries, as those international mitigation actions will provide a benefit to U.S. citizens and residents by mitigating climate impacts that affect U.S. citizens and residents. Therefore, in this final action, DOE centers attention on a global measure of SC-GHG. This approach is the same as that taken in DOE analyses over 2009 through 2016. As noted in the February 2021 TSD, the IWG will continue to review developments in the literature, including more robust methodologies for estimating SC-GHG values based on purely domestic damages, and explore ways to better inform the public of the full range of carbon impacts, both global and domestic. As a member of the IWG, DOE will likewise continue to follow developments in the literature pertaining to this issue. Second, the IWG continued to conclude that the consumption rate of interest is the theoretically appropriate discount rate in an intergenerational context (IWG 2010, 2013, 2016a, 2016b), and recommended that discount rate uncertainty and relevant aspects of intergenerational ethical considerations be accounted for in selecting future discount rates. As a member of the IWG involved in the development of the February 2021 TSD, DOE agrees with this assessment, and will continue to follow developments in the literature pertaining to this issue.

As explained in the February 2021 TSD and while the IWG works to assess how best to incorporate the latest, peer reviewed science to develop an updated set of SC-GHG estimates, the IWG has determined that it is appropriate for agencies to revert to the same set of four values drawn from the SC-GHG distributions based on three discount rates as were used in regulatory analyses between 2010 and 2016 and subject to public comment. For each discount rate, the IWG combined the distributions across models and socioeconomic emissions scenarios (applying equal weight to each) and then selected a set of four values for use in benefit-cost analyses: an average value resulting from the model runs for each of three discount rates (2.5%, 3%, and 5%), plus a fourth value, selected as the 95th percentile of estimates based on a 3 percent discount rate. The fourth value was included to provide information on potentially higher-than-expected economic impacts from climate change, conditional on the 3% estimate of the discount rate. As explained in the February 2021 TSD, this update reflects the immediate need to have an operational SC-GHG for use in regulatory benefit-cost analyses and other applications that was developed using a transparent process, peer-reviewed methodologies, and the science available at the time of that process. Those estimates were subject to public comment in the context of dozens of proposed rulemakings as well as in a dedicated public comment period in 2013.

Table 8 summarizes the interim global SC-CO₂ estimates for a variety of years. For purposes of capturing uncertainty around the SC-CO₂ estimates in analyses, the IWG's February 2021 TSD emphasizes the importance of considering all four of the SC-CO₂ values.

Table 8 Social Cost of CO₂ in 2020 Dollars Per Metric Ton of CO₂

| Emissions Year | Discount Rate and Statistic | | | |
|----------------|-----------------------------|------------|--------------|--------------------------------|
| | 5% Average | 3% Average | 2.5% Average | 3% 95 th Percentile |
| 2020 | 14 | 51 | 76 | 152 |
| 2025 | 17 | 56 | 83 | 169 |
| 2030 | 19 | 62 | 89 | 187 |
| 2035 | 22 | 67 | 96 | 206 |
| 2040 | 25 | 73 | 103 | 225 |

3.0 Results

3.1 Qualitative Assessment

The approved code changes incorporated into the 2021 IECC that have a direct effect on energy use are listed Table 8. The following information is shown for each change:

1. **Proposal Number:** Change proposal designation assigned by the ICC
2. **Code Section(s):** Section numbers in the 2018 IECC that are affected by the code change¹
3. **Description of Change(s):** Descriptive summary of the change
4. **Impact on Energy Efficiency:** Qualitative characterization of those changes expected to increase or decrease energy use
5. **Included in Energy Analysis:** Indication whether the change can be reasonably assessed through further quantitative analysis
6. **Discussion:** A brief discussion expanding on the description providing additional rationale if appropriate.

¹ Because sections are often added or deleted, section numbers will often differ in the 2021 IECC.

Table 9. Qualitative Analysis of 2021 IECC Code Changes Affecting Energy Use

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|--|--|-----------------------------|-----------------------------|---|
| RE7 | R202 (IRC N1101.6), R404.1 (IRC N1104.1) | Changes definition of High-Efficacy Lamps to High-Efficacy Light Sources. Increases efficacy to 65 lumens per watt for lamps and 45 lumens per watt for luminaires. Also requires ALL permanently installed lighting fixtures be high-efficacy lighting sources. | Reduces energy use | Yes | Requires increased efficacy for light sources and provides separate thresholds for lamps vs luminaires. |
| RE29 | Table R402.1.2 (IRC N1102.1.2), Table R402.1.4 (IRC N1102.1.4) | Increases stringency of wood frame wall R-value requirements in climate zones 4 and 5. | Reduces energy use | Yes | |
| RE32 | Table R402.1.2 (IRC N1102.1.2) | Increases slab insulation R-value requirements and depth in climate zones 3-5. | Reduces energy use | Yes | |
| RE33 | Table R402.1.2 (IRC N1102.1.2), Table R402.1.4 (IRC N1102.1.4) | Increases stringency for ceiling insulation in climate zones 2-3. | Reduces energy use | Yes | |
| RE35 | Table R402.1.2 (IRC N1102.1.2), Table R402.1.4 (IRC N1102.1.4) | Increases stringency of fenestration U-factors in climate zones 3-4 and adds new requirement for minimum fenestration U-factor in climate zones 3-8. | Reduces energy use | Yes | |
| RE36 | Table R402.1.2 (IRC N1102.1.2), Table R402.1.4 (IRC N1102.1.4), R402.2.1 (IRC N1102.2.1) | Increases stringency of ceiling insulation requirements in climate zones 4-8 and adds new exception for what to do when there is not room for R-60 insulation in ceiling. | Reduces energy use | Yes | |
| RE133 | TABLE R403.6.1 (IRC N1103.6.1) | Increases whole-house mechanical ventilation system fan efficacy requirements for inline fans and bathroom/utility rooms. | Reduces energy use | Yes | Raises fan efficacy requirements to match current Energy Star 4.0 requirements. |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|--|--|-----------------------------|-----------------------------|---|
| RE139 | R403.6.1 (IRC N1103.6.1) (New) | Requires ventilation systems to be heat or energy recovery for climate zones 7-8. | Reduces energy use | Yes | Stipulates HRV or ERV requirements of 65% heat recovery efficiency at 32°F at a flow greater than or equal to the design airflow. |
| RE145 | R202, R404.1, R404.2 (New) | Increases efficacy in the definition of High-Efficacy Lamps to 70 lumens/watt. All permanently installed lighting must contain only High-Efficacy Lamps. Adds definitions of "dimmer" and "occupant sensor control" and requires automatic lighting controls in specific spaces. There is overlap with RE7 for high-efficacy lighting. | Reduces energy use | Yes | Adds a new requirement for residential lighting controls in the IECC. Savings expected through higher efficacy lighting and the use of automatic lighting controls to reduce lighting energy use. |
| RE148 | R404.1.1 (IRC N1104.1.1) (New) | Requires exterior lighting for Group R-2, R-3, or R-4 buildings comply with Section C405.4 of the IECC. | Reduces energy use | Yes | Requires exterior lighting power meets the commercial lighting power provisions for R-2, R-3, and R-4 buildings except for solar powered lamps and fixtures with motion sensors. |
| RE209 | R401.2, R401.2.1 (New), SECTION R408 (New), R408.1 (New), R408.2 (New), R408.2.1 (New), R408.2.2 (New), R408.2.3 (New), R408.2.4 (New), R408.2.5 (New) | Adds new section for Additional Efficiency Package Options to reduce energy use. Package options chosen based on compliance pathway that targets an energy use reduction of 5%. | Reduces energy use | Yes | Efficiency Package Options include: Enhanced Envelope Performance, Efficient HVAC, Efficient Hot Water Heating, Efficient Thermal Distribution, and Improved Air Sealing with Efficient Ventilation. For prescriptive compliance, one option is required for an estimated 5% reduction in energy use. Performance and ERI compliance must demonstrate a 5% reduction in energy cost or ERI score. |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|---|---|-----------------------------|-----------------------------|---|
| RE27 | Table R402.1.2 (IRC N1102.1.2) | Adds alternative wood frame wall options in all climates. | Reduces energy use | No | Adds cavity-only options for zones 7-8 and continuous-only options for all zones. Provides U-factor calculations showing that the new options are equal to or better than the U-factors required in Table R402.1.4. Not included in quantitative analysis since prescriptive wall insulation requirements remain unchanged. |
| RE34 | Table R402.1.2 (IRC N1102.1.2) | Eliminate footnote gas option for floor cavity insulation. | Reduces energy use | No | Footnote g allowed merely filling the cavity (but at least R19) if framing left insufficient space for the required insulation R-value. Floors must meet the prescriptive requirement with continuous insulation if cavity insulation will not meet the requirement. |
| RE37 | Table R402.1.2 (IRC N1102.1.2) | Adds new requirement for fenestration solar heat gain coefficient (SHGC) of 0.4 in climate zone 5 and marine 4. | Reduces energy use | No | Quantitative analysis assumed 0.4 SHGC as standard practice in prototypes for climate zones without SHGC requirements. |
| RE44 | R402.2.3 (IRC N1102.2.3) | Adds more specific requirements details to achieve a continuous eave baffle. | Reduces energy use | No | Potential for air leakage reduction and improved attic insulation coverage. Total air leakage requirements remain unchanged and thus not part of the quantitative analysis. |
| RE45 | R402.2.3 (IRC N1102.2.3) | Makes eave baffle requirement mandatory. | Reduces energy use | No | Not included in quantitative analysis as it was already a prescriptive requirement. |
| RE46 | R402.2.4 (IRC N1102.2.4) (New), R402.2.4 (IRC N1102.2.4) | Establishes separate design and installation requirements for attic hatches and doors, with the installation being mandatory. | Reduces energy use | No | Makes weatherstripping mandatory, leaves insulation requirement prescriptive. Total insulation and air leakage requirements remain unchanged and thus not part of the quantitative analysis. |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|--|---|-----------------------------|-----------------------------|---|
| RE52 | R402.2.7 (IRC N1102.2.7) | Deletes section on walls with partial structural sheathing that allows a reduction in continuous insulation of up to R-3. | Reduces energy use | No | Prescriptive wall insulation requirements remain unchanged and not factored in the quantitative analysis. |
| RE100 | R402.4.1.2 (IRC N1102.4.1.2), R402.2.13 (IRC N1102.2.13), R402.3.5 (IRC N1102.3.5) | Adds new air leakage and thermal isolation requirements for heated garages. | Reduces energy use | No | Adds a new requirement for heated garages that applies the same envelope requirements as sunrooms. Could show savings if garages are insulated minimally instead of not being insulated at all. However, prototypes do not include a garage. |
| RE105 | R402.5 (IRC N1102.5) | Lowers the maximum fenestration U-factor and SHGC requirements. | Reduces energy use | No | Lowers the allowable area-weighted SHGC for climate zones 1-3. Savings not captured in quantitative analysis because prototypes use prescriptive window requirements. |
| RE112 | R403.3.3 (IRC N1103.3.3), R403.3.4 (IRC N1103.3.4) | Removes duct testing exception for ducts located within the building thermal envelope and adds a new duct leakage testing requirement for such ducts. | Reduces energy use | No | Eliminates exception for testing ducts entirely within the building thermal boundary on the basis that these systems need to be tested to ensure long-term energy savings and that lack of testing entirely could lead to problems. Sets the total duct leakage rate for ducts within the thermal boundary to twice the leakage rate for systems not entirely in conditioned space. Prototype building duct location is either in the attic, crawlspace, or unconditioned basement. |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|--|--|-----------------------------|-----------------------------|--|
| RE134 | R403.6.1 (IRC N1103.6.1), TABLE R403.6.1 (IRC N1103.6.1) | Adds air-handler integrated ventilation system fan efficacy requirements to Table R403.6.1. | Reduces energy use | No | Removes exception for air handler integrated ventilation system to provide whole house ventilation and added fan efficacy requirements for such systems. Not included in the quantitative analysis because air-handler integrated ventilation systems are not part of typical homes as represented by the prototypes. |
| RE149 | R404.2 (IRC N1104.2) (New) | Adds 4 new automated control requirements for exterior lighting if installed lighting power is greater than 30 watts. | Reduces energy use | No | The exterior lighting schedules used for the single-family and multifamily prototypes have historically set all exterior lighting to off during daylight hours, meaning the current exterior lighting schedules already comply with the requirements of the 2021 IECC, so no changes to the prototypes were made. |
| RE162 | TABLE R405.5.2(1) [IRC N1105.5.2(1)] | Adds hot water distribution system (HWDS) compactness factor to the calculation of the proposed design hot water use (gallons/day) in Table R405.5.2(1). | Reduces energy use | No | Adds a methodology to show better design of hot water systems can reduce energy use. |
| RE163 | TABLE R405.5.2(1) [IRC N1105.5.2(1)] | Adjusts the calculation for service hot water consumption (gal/day) for the performance path proposed and standard designs which in effect lowers the overall hot water consumption. | Reduces energy use | No | Revises formula for estimating hot water usage for performance compliance, which has been unchanged since 1998. The new usage equation gives lower water usage (gal/day), which would decrease the importance of service water heating (SWH) efficiency compared to envelope efficiency. Both proposed and baseline buildings have the same reduced water usage. |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|------------------------------------|--|-----------------------------|-----------------------------|--|
| RE184 | R406.3 (IRC N1106.3) | Adds new requirement for ERI compliance stipulating any reduction in energy use from renewable energy shall not exceed 5% of total energy use. | Reduces energy use | No | In theory this limits builders' ability to trade down envelope efficiency in the ERI path. In practice, there is already an envelope backstop at the 2015 prescriptive levels, so this additional backstop may have little impact. A "backstop" is sometimes called a "mandatory minimum" and refers to a minimum efficiency level that cannot be violated even when compliance trade-offs are used. |
| RE192 | TABLE R406.4 (IRC N1106.4) | Reduces ERI compliance targets for all climate zones to the 2015 IECC levels. | Reduces energy use | No | Adjusts ERI compliance targets to be more stringent and specifies the ANSI/RESNET/ICC 301 Standard as the basis. Ventilation rates for the 301 ERI Reference Home are based on the International Mechanical Code. |
| RE218 | R503.1.4 | Revises exception for new lighting systems in alterations from 10% of luminaires to 50% of luminaires. | Reduces energy use | No | Exception allows more luminaires to be exempt from lighting requirements in alterations provided they do not increase the installed interior lighting power. |
| RE223 | Appendix RB (IRC Appendix Q) (New) | Adds Appendix RB for Zero Energy Residential Building Provisions. | Reduces energy use | No | Sets ERI thresholds for "zero energy." The ERI is 0 for analysis that includes on-site power production and varies from 43 to 47 for analysis that does not include on-site power production. Only reduces energy use if Appendix RB is adopted. |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|--|--|-----------------------------|-----------------------------|--|
| RE41 | Table R402.1.2 (IRC N1102.1.2), Table R402.1.4 (IRC N1102.1.4) | Adds footnote j that allows a maximum fenestration U-factor of 0.32 for climate zones Marine 4 and 5-8 for high elevations and wind prone areas. | Increases energy use | No | Increases allowed U-factor requirement from 0.30 to 0.32 for climate zone 4C to 8 for homes above 4,000 ft and wind prone regions. Fenestration at high altitude requires the ability for pressure equalization during transit while windborne protection requires laminated glass for durability. Both these requirements reduce thermal performance. |
| RE47 | R402.2.4 (IRC N1102.2.4) | Adds exception for horizontal pull-down stair-type access hatches and doors. | Increases energy use | No | While technically a reduction in R-value requirements for drop-down attic hatches, the practical argument that "field crafted detachable apparatuses" are usually used to achieve the current requirement means this change will have minimal impact. |
| RE53 | R402.2.8 (IRC N1102.2.8) | Expands on language of floor insulation installation for clarification | Increases energy use | No | The proposal reduces the floor-R requirements by allowing insulation sufficient to fill the available cavity space as an alternative to the required R-value. |
| RE96 | R402.4 (IRC N1102.4), R402.4.1 (IRC N1102.4.1), R402.4.1.1 (IRC N1102.4.1.1), R402.4.1.2 (IRC N1102.4.1.2), R402.4.1.3 (IRC N1102.4.1.3) (New) | Revises air leakage threshold from a mandatory to a prescriptive requirement, while preserving an absolute maximum air leakage rate of 5.0 air changes per hour at 50 pascals (ACH50). | Increases energy use | No | In effect makes air leakage rates eligible for performance tradeoffs, while leaving the testing requirement mandatory. Preserves 5.0 ACH50 backstop for performance compliance in all climate zones. |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|---|---|-----------------------------|-----------------------------|---|
| RE130 | R403.6.2 (IRC N1103.6.2) (New) | Adds testing requirements for mechanical ventilation systems. | Increases energy use | No | Adds new requirement for testing of mechanical ventilation systems, with exception for specific kitchen range hoods. Potential savings from identifying problems during testing, but potential energy increases due to pushing some systems to ventilate more than they would have. |
| CE160 P II | R403.10 (IRC N1103.10), R403.10.1 (IRC N1103.10.1), R403.10.3 (IRC N1103.10.3), R403.12 (IRC N1103.12) | Modifies pool and spa requirements to match the pool code. | Increases energy use | No | Primarily editorial but does include renewable systems that provide only 70% as opposed to 75% of energy. The renewable energy exception for pool and spa covers allows on-site or off-site renewable energy. |

(a) Proposal numbers are as assigned by the ICC (<http://media.iccsafe.org/code-development/group-b/2019-Group-B-CAH-compressed.pdf>)

(b) Code sections refer to the 2018 IECC. Sections may be renumbered by the ICC in the 2021 IECC.

3.1.1 Summary of Individual Changes

Figure 2 summarizes the changes to the 2021 IECC by category. Among a total of 114 changes, 35 were characterized as impacting energy use in residential buildings, 29 of which are expected to reduce energy use while 6 are expected to increase energy use. Eleven of the energy-impacting changes were included in further quantitative analysis to assess the national average energy savings impact that can be expected with the 2021 IECC. Among the other remaining changes approved for inclusion in the 2021 IECC, 79 were identified as administrative in nature.

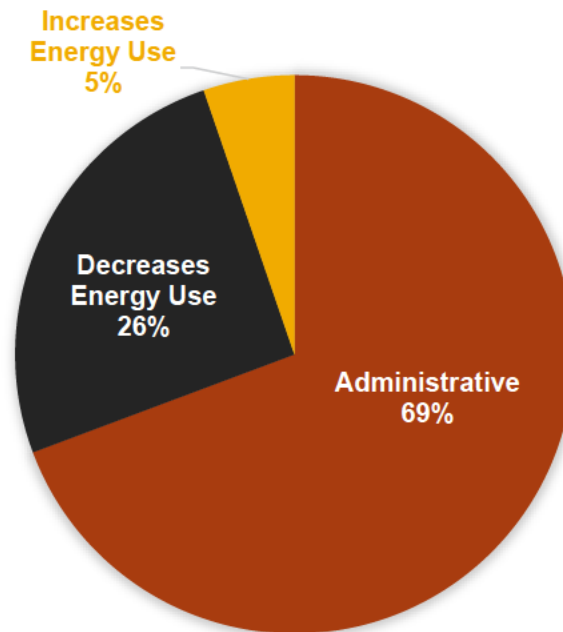


Figure 2. Categorization of Approved Code Changes

3.1.2 Additional Discussion of Significant Changes

All section numbers listed in the discussion are from the 2018 IECC and may not align with section numbers from the 2021 IECC.

3.1.2.1 Renewable Energy Definitions and Operation (CE31 Part II)

This code change updates the definition for “On-Site Renewable Energy” and adds a new definition for “Renewable Energy Resources.” There has been a definition for “On-Site Renewable Energy” in the commercial IECC since 2012 and the phrase was used in the 2018 IECC residential portion but not defined. The definition for “Renewable Energy Resources” adjusts the renewable sources to distinguish between systems that extract hot fluid or steam from the earth (which are considered renewable resources) and ground source heat pumps (which are not). The language used for the new definitions will bring consistency between IECC

(residential and commercial) and ASHRAE 90.1 while simplifying compliance for on-site renewable energy systems.

3.1.2.2 Updates Climate Zones to Correlate with ASHRAE Standard 169 (CE36 Part II)

As discussed in Section 2.3.2, the 2021 IECC incorporates several administrative changes introduced by the 2013 edition of ASHRAE Standard 169, Climatic Data for Building Design Standards (ASHRAE 2013a). ASHRAE 169-2013 redefined climate zones and moisture regimes based on a more recent period of weather data. As a result, a number of U.S. counties were reassigned to different zones/regimes, and a new, extremely hot climate zone 0 was added. Approximately 400 U.S. counties out of more than 3,000 were reassigned, most to warmer climate zones¹. Those jurisdictions that shifted to warmer climate zones will in some cases have less stringent insulation requirements independent of any other changes to the code. The administrative shifting of climate zones is not a focus of the current analysis, so the impacts on prescriptive requirements are not captured here. However, new construction weights were developed for each climate zone based on the new county-climate zone updates. Those construction weights were applied to both the IECC 2018 and IECC 2021 results. The addition of climate zone 0 has no impact, since it does not occur in the U.S.

3.1.2.3 Envelope Backstop for ERI with and without Renewables (RE182 & RE150)

RE182 sets the building thermal envelope backstop to the 2018 IECC for a home complying via the Energy Rating Index (ERI) where the building utilizes on-site renewable energy. RE152 stipulates where the ERI does not utilize on-site renewable energy, the design building thermal envelope total heat loss coefficient (UA value) shall be less than or equal to the building thermal envelope utilizing the prescriptive U-factors from the 2021 IECC multiplied by 1.15. In essence, the design building thermal envelope can be 85 percent as efficient as the 2021 IECC prescriptive envelope.

Homes employing on-site renewable energy systems can achieve significant reduction in ERI points and can use that credit to trade-off envelope efficiency to meet the target ERI requirements. There is concern in the industry that allowing envelope efficiency measures with a lifetime of 60 years to be equally traded with photovoltaic systems that have a much shorter lifetime will result in a failure to capture the code's energy conservation intent over the long-term. It could be problematic to allow ERI-based compliance of a home that contains substantial on-site renewable energy and a sub-standard thermal envelope.

3.1.2.4 Renewable Energy Limit for ERI to 5 Percent of Total Energy (RE184)

RE184 adds language that limits the amount of credit from on-site renewable energy to 5 percent of total home energy use when showing residential IECC compliance with the ERI. The ERI is an asset rating of a home based on the 2006 IECC as the standard reference home. It is defined as a numerical rating where 100 is equivalent to the 2006 IECC and 0 is equivalent to a zero-energy home. The lower the ERI score, the more energy efficient a home will perform.

This change aligns the limits on renewables in Section R-406.3 with the simulated performance in Section C403.3 and ASHRAE 90.1's Energy Cost Budget and Appendix G methodologies. Both commercial codes limit the credit from on-site renewable energy to 5 percent of the total energy cost or calculated energy cost budget.

¹ <https://ibpsa-usa.org/index.php/ibpusa/article/view/389>.

RE184 does not limit the amount of on-site renewable energy that can be installed or penalize a home for added renewable energy sources; it merely disallows taking credit for more than 5 percent in the calculation of the ERI. Like RE182, the intent of RE184 is to enforce high-efficiency envelope construction and reward the reduction of energy over the on-site production of energy.

3.1.2.5 Reduced ERI Compliance Targets to 2015 IECC Levels (RE192)

RE192 sets the 2021 IECC ERI targets for compliance back to the 2015 IECC levels (51–54 based on climate zone) to establish lower (more efficient) ERI target scores.

The ERI compliance path was added to the 2015 IECC for residential buildings, with the ERI scores methodology based on RESNET Standard 301-2014 (RESNET 2014). The 2015 ERI target scores were set based on analyses of one- and two-story homes built to the 2012 IECC combined with cost-effective, high-efficiency and service water heating equipment. The homes were modeled for optimized orientation and architecture and included an additional 10 percent reduction in energy use to account for higher efficiency equipment in the future.

The 2018 IECC made a few changes to the ERI compliance path. First, ERI targets were increased to make them easier to meet (57–62 based on climate zone). Second, language was added to reduce the mechanical ventilation of the ERI Reference Home (RESNET 2014). Finally, the 2018 IECC clarified that on-site power production was allowed in the calculation of the ERI. The result made the ERI compliance path easier to meet but increased energy use. The ventilation adjustment in the ERI Reference Home had the unintended consequence of increasing the ERI scores of all homes.

Given the increased stringency of the 2021 IECC ERI target scores with the ventilation change in the ERI Reference Home still in place, the ERI compliance path may require the most stringency to show compliance even with all its design flexibility and trade-off allowances.

3.1.2.6 RECs Definition and Requirement for ERI Credit (RE204)

RE204 adds two changes: sets a new definition for “Renewable Energy Certificate (REC)” and requires the homeowner be in ownership of the RECs for the home that utilizes on-site renewable energy towards credit for ERI compliance. Requiring the homeowner to own the RECs applies the environmental attributes of the renewable energy system to be counted only for the home in question while preventing another entity from selling the RECs to another party.

When a REC is sold to more than one party, there is a double counting of the energy generated as well as the environmental benefits of the on-site renewable energy system. The benefits of the RECs could be used for ERI compliance for one home while showing the same environmental benefit for another entity such as an electric power provider. For a specific home that has an on-site renewable energy system where the homeowner does not own the RECs, the power produced by the on-site power system would be unqualified as renewable energy.

3.1.2.7 Appendix RB for Zero Energy Residential Building Provisions (RE223)

RE 223 adds a new appendix to the 2021 IECC for zero energy residential buildings. Appendix RB: Zero Energy Residential Buildings outlines the ERI requirements to label the design home as a net zero energy building. This section is not required for compliance with the 2021 IECC

unless the jurisdiction specifically adopts Appendix RB to define the requirements for a net zero energy home.

To meet the provisions of Appendix RB, a home must meet or exceed two ERI targets. The first ERI target (43–47, depending on climate zone) must be achieved without accounting for any on-site power production; the second ERI target (zero by definition) must be achieved taking account of on-site power production. Both ERIs are to be calculated in accordance with RESNET 301 (RESNET 2014). In addition, the thermal envelope must meet the prescriptive efficiency levels of the 2015 IECC. Requiring that ERI scores without on-site power generation be in the 40s ensures a well-designed and energy efficient home as well as on-site power production.

3.2 Quantitative Assessment

Table 9 and Table 10 show the results in terms of relative energy savings (percent) of the 2021 IECC compared to the 2018 IECC by climate zone and by building type. These results are based on changes identified as impacting energy efficiency through the qualitative component of the analysis, and that could also be reasonably measured via the established energy modeling and simulation methodology. The 2021 IECC includes the following 11 changes which fit this classification:

- RE7 and RE145 – High-Efficacy Lighting
- RE29 – Increase Wall Insulation
- RE32 – Increase Slab Insulation
- RE33 & RE36 – Increase Ceiling Insulation
- RE35 – Improve Fenestration U-Factor
- RE133 – Improve Mechanical Ventilation Fan Efficacy
- RE139 – Heat Recovery Ventilation
- RE148 – Exterior Lighting Allowances
- RE209 – Additional Efficiency Package.

Results are shown in terms of three metrics—site EUI, source EUI, and energy cost. The energy cost metric is used by DOE in reporting its determinations of the energy savings of new code revisions; the other metrics are shown here for reference. The energy cost savings are lower at 8.66 percent relative to the site energy savings reflecting the greater impact of reduced heating loads when conversion costs of electricity are considered. CO₂ emissions savings are equal to energy cost savings at 8.66 percent nationally.

Relative savings in terms of annual energy costs vary from 4.56 percent in climate zone 6 to 10.38 percent in climate zone 8. The variations by climate zone reflect differences in the relative magnitudes of heating and cooling loads as well as nuances in the relative prevalence of building types, foundation types, and system types.

Table 11 through Table 14 show the raw energy savings values from which the percentages in Table 9 and Table 10 were calculated. The tables show the sum of the total building energy end uses (regulated and non-regulated) as calculated from the whole-building energy simulations.

Table 10. Energy Savings and CO₂ Emission Reductions of the 2021 IECC compared to the 2018 IECC by Climate Zone (percent)

| Climate Zone | Weight (%) | Site EUI (%) | Source EUI (%) | Energy Costs (%) | CO ₂ Emissions (%) |
|--------------|------------|--------------|----------------|------------------|-------------------------------|
| 1 | 4.30 | 10.80 | 9.73 | 9.51 | 9.53 |
| 2 | 22.43 | 10.00 | 9.13 | 8.93 | 8.95 |
| 3 | 29.04 | 10.48 | 9.75 | 9.57 | 9.59 |
| 4 | 19.49 | 10.05 | 9.45 | 9.32 | 9.32 |
| 5 | 19.51 | 8.50 | 7.63 | 7.44 | 7.42 |
| 6 | 4.68 | 4.28 | 4.43 | 4.56 | 4.52 |
| 7 | 0.53 | 12.65 | 10.72 | 10.13 | 10.17 |
| 8 | 0.02 | 12.48 | 10.93 | 10.38 | 10.44 |
| National | 100.00 | 9.38 | 8.79 | 8.66 | 8.66 |

Table 11. Energy Savings and CO₂ Emission Reductions of the 2021 IECC compared to the 2018 IECC by Building Type (percent)

| Building Type | Weight (%) | Site EUI (%) | Source EUI (%) | Energy Costs (%) | CO ₂ Emissions (%) |
|------------------|------------|--------------|----------------|------------------|-------------------------------|
| Single-family | 66.04 | 8.51 | 8.12 | 8.03 | 8.04 |
| Multifamily Unit | 33.96 | 12.56 | 11.21 | 10.91 | 10.91 |
| National | 100.00 | 9.38 | 8.79 | 8.66 | 8.66 |

Table 12. Energy Use and CO₂ Emissions of the 2018 IECC by Climate Zone

| Climate Zone | Weight (%) | Site EUI (kBtu/ft ² -yr) | Source EUI (kBtu/ft ² -yr) | Energy Costs (\$/residence-yr) | CO ₂ Emissions (tons/residence-yr) |
|--------------|------------|-------------------------------------|---------------------------------------|--------------------------------|---|
| 1 | 4.30 | 28.8 | 79.1 | 2,046 | 11.0 |
| 2 | 22.43 | 31.2 | 80.7 | 2,088 | 11.2 |
| 3 | 29.04 | 31.5 | 78.4 | 2,024 | 10.9 |
| 4 | 19.49 | 37.1 | 83.5 | 2,139 | 11.5 |
| 5 | 19.51 | 45.4 | 86.6 | 2,252 | 12.1 |
| 6 | 4.68 | 50.9 | 96.5 | 2,613 | 14.0 |
| 7 | 0.53 | 58.1 | 110.8 | 2,936 | 15.8 |
| 8 | 0.02 | 78.0 | 147.1 | 3,845 | 20.8 |
| National | 100.00 | 36.4 | 82.7 | 2,139 | 11.5 |

Table 13. Energy Use and CO₂ Emissions of the 2018 IECC by Building Type

| Building Type | Weight (%) | Site EUI (kBtu/ft ² -yr) | Source EUI (kBtu/ft ² -yr) | Energy Costs (\$/residence-yr) | CO ₂ Emissions (tons/residence-yr) |
|------------------|------------|-------------------------------------|---------------------------------------|--------------------------------|---|
| Single-family | 66.04 | 35.9 | 81.4 | 2,534 | 13.6 |
| Multifamily Unit | 33.96 | 38.4 | 87.9 | 1,372 | 7.4 |
| National | 100.00 | 36.4 | 82.7 | 2,139 | 11.5 |

Table 14. Energy Use and CO₂ Emissions of the 2021 IECC by Climate Zone

| Climate Zone | Weight (%) | Site EUI (kBtu/ft ² -yr) | Source EUI (kBtu/ft ² -yr) | Energy Costs (\$/residence-yr) | CO ₂ Emissions (tons/residence-yr) |
|--------------|------------|-------------------------------------|---------------------------------------|--------------------------------|---|
| 1 | 4.30 | 25.7 | 71.4 | 1,851 | 9.9 |
| 2 | 22.43 | 28.1 | 73.3 | 1,902 | 10.2 |
| 3 | 29.04 | 28.2 | 70.8 | 1,830 | 9.8 |
| 4 | 19.49 | 33.3 | 75.6 | 1,940 | 10.4 |
| 5 | 19.51 | 41.5 | 80.0 | 2,084 | 11.2 |
| 6 | 4.68 | 48.7 | 92.2 | 2,494 | 13.4 |
| 7 | 0.53 | 50.7 | 98.9 | 2,638 | 14.2 |
| 8 | 0.02 | 68.3 | 131.1 | 3,445 | 18.6 |
| National | 100.00 | 33.0 | 75.4 | 1,954 | 10.5 |

Table 15. Energy Use and CO₂ Emissions of the 2021 IECC by Building Type

| Building Type | Weight (%) | Site EUI (kBtu/ft ² -yr) | Source EUI (kBtu/ft ² -yr) | Energy Costs (\$/residence-yr) | CO ₂ Emissions (tons/residence-yr) |
|------------------|------------|-------------------------------------|---------------------------------------|--------------------------------|---|
| Single-family | 66.04 | 32.8 | 74.8 | 2,330 | 12.5 |
| Multifamily Unit | 33.96 | 33.6 | 78.0 | 1,222 | 6.6 |
| National | 100.00 | 33.0 | 75.4 | 1,954 | 10.5 |

3.3 Conclusion

A total of 114 approved code change proposals were analyzed for the 2021 IECC. The qualitative component of the analyses identified 35 changes with a direct impact on energy use in residential buildings—29 of which are expected to reduce energy use and 6 increase energy use. Further assessment of the 11 code changes included in the quantitative analysis:

- RE7 and RE145 – High-Efficacy Lighting
- RE29 – Increase Wall Insulation
- RE32 – Increase Slab Insulation
- RE33 & RE36 – Increase Ceiling Insulation
- RE35 – Improve Fenestration U-Factor
- RE133 – Improve Mechanical Ventilation Fan Efficacy
- RE139 – Heat Recovery Ventilation
- RE148 – Exterior Lighting Allowances
- RE209 – Additional Efficiency Package.

Suggest national average savings of approximately:

- 9.38 percent of annual site energy use intensity (EUI)
- 8.79 percent of annual source EUI
- 8.66 percent of annual energy cost
- 8.66 percent of carbon emissions

Based on these results, the 2021 IECC is expected to improve energy efficiency in residential buildings by almost 10 percent.

4.0 Monetized CO₂ Benefits from Adoption of Improved Residential Model Energy Codes

DOE's Building Energy Codes Program (BECP) periodically evaluates national and state-level impacts associated with energy codes in residential and commercial buildings. PNNL, funded by DOE, conducted an interim assessment of the impacts of adoption of national model building energy codes from 2010 through 2040. This assessment includes updates to residential model energy codes including the 2006 through 2021 editions of the International Energy Conservation Code (residential). Table 16 provides estimates of the monetized carbon emissions expected to result from model code adoption both annually in 2030 and 2040 and cumulative beginning in 2010 and ending in 2040 for all states included in the analysis using all four SC-CO₂ estimate scenarios¹. Table 17 provides estimates of the monetized energy bill savings expected to result from residential model code adoption both annually in 2030 and 2040, and cumulative beginning in 2010 and ending in 2040 for all states included in the analysis using a 5 percent discount rate. In addition, DOE estimates the cumulative energy cost savings from residential model code adoption beginning in 2010 and ending in 2040 for all states to be approximately 75.98 billion dollars (2020) at a 3-percent discount rate and 73.45 billion dollars (2020) at a 7-percent discount rate.

Table 16. Social Value of CO₂ Emissions Reduction for Residential Energy Codes (2020\$ billion)

| Analysis Time Frame | Monetized Carbon Benefits (2020\$) | | | |
|----------------------|------------------------------------|----------|----------|-----------------------------|
| | 5% | 3% | 2.5% | 3% |
| | Average | Average | Average | 95 th Percentile |
| Annual (2030) | \$0.358 | \$1.143 | \$1.656 | \$3.454 |
| Annual (2040) | \$0.533 | \$1.548 | \$2.181 | \$4.757 |
| Cumulative 2010-2040 | \$8.153 | \$25.920 | \$37.575 | \$78.354 |

Table 17. Monetized Energy Cost Savings for Residential Energy Codes (2020\$ billion)

| Analysis Time Frame | 5% Discount Rate |
|----------------------|------------------|
| Annual (2030) | \$3.24 |
| Annual (2040) | \$3.52 |
| Cumulative 2010-2040 | \$74.61 |

¹ See interim July 2021 PNNL report at http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-31437.pdf.

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Appendix A – Comprehensive List of Code Change Proposals Approved for Inclusion in the 2021 IECC

There were 114 formal code change proposals resulting in 35 classifiable changes to the IECC, as shown in Table A.1. Of the 35 changes impacting energy use (29 decreasing, 6 increasing), 11 were further analyzed by energy simulation to quantify their impact.

Table A.1. Summary of Approved Code Changes in the 2021 IECC

| Category of Change | Number |
|----------------------|--------|
| Decreases Energy Use | 29 |
| Increases Energy Use | 6 |
| Administrative | 79 |
| Total | 114 |

Table A.2 lists all the successful code change proposals incorporated into the 2021 IECC. For each proposal, the following six columns of information are shown:

1. **Proposal Number:** the change proposal designation assigned by the ICC
2. **Code Section(s):** a list of the section numbers in the 2018 IECC that are affected by the code change. Because sections are often added or deleted, section numbers will often differ in the 2021 IECC
3. **Description of Change(s):** a brief summary of the changes made by the proposal
4. **Category of Change:** the qualitative categorization of the nature of the change
5. **Included in Energy Analysis:** an indication whether the change was subjected to an additional energy analysis in the subsequent quantitative analysis
6. **Discussion:** a brief discussion expanding on the change categorization and providing additional rationale, for changes that impact energy use, explaining whether the change is to be included in the subsequent quantitative analysis.

Table A.2. Qualitative Analysis of All 2021 IECC Code Changes

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|--|--|-----------------------------|-----------------------------|---|
| RE7 | R202 (IRC N1101.6) R404.1 (IRC N1104.1) | Changes definition of High-Efficacy Lamps to High-Efficacy Light Sources. Increases efficacy to 65 lumens per watt for lamps and 45 lumens per watt for luminaires. Also requires ALL permanently installed lighting fixtures be high-efficacy lighting sources. | Reduces energy use | Yes | Requires increased efficacy for light sources and provides separate thresholds for lamps vs luminaires. |
| RE29 | Table R402.1.2 (IRC N1102.1.2) Table R402.1.4 (IRC N1102.1.4) | Increases stringency of wood frame wall R-value requirements in climate zones 4-5. | Reduces energy use | Yes | |
| RE32 | Table R402.1.2 (IRC N1102.1.2) | Increases slab insulation R-value requirements and depth in climate zones 3-5. | Reduces energy use | Yes | |
| RE33 | Table R402.1.2 (IRC N1102.1.2) Table R402.1.4 (IRC N1102.1.4) | Increases stringency for ceiling insulation in climate zones 2-3. | Reduces energy use | Yes | |
| RE35 | Table R402.1.2 (IRC N1102.1.2) Table R402.1.4 (IRC N1102.1.4) | Increases stringency of fenestration U-factors in climate zones 3-4 and adds new requirement for minimum fenestration U-factor in climate zones 3-8. | Reduces energy use | Yes | |
| RE36 | Table R402.1.2 (IRC N1102.1.2) Table R402.1.4 (IRC N1102.1.4) R402.2.1 (IRC N1102.2.1) | Increases stringency of ceiling insulation requirements in climate zones 4-8 and adds new exception for what to do when there is not room for R-60 insulation in ceiling. | Reduces energy use | Yes | |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|---|---|-----------------------------|-----------------------------|---|
| RE133 | TABLE R403.6.1 (IRC N1103.6.1) | Increases whole-house mechanical ventilation system fan efficacy requirements for inline fans and bathroom/utility rooms. | Reduces energy use | Yes | Raises fan efficacy requirements to match current Energy Star 4.0 requirements. |
| RE139 | R403.6.1 (IRC N1103.6.1) (New) | Requires ventilation systems to be heat or energy recovery for climate zones 7-8. | Reduces energy use | Yes | Stipulates HRV or ERV requirements of 65% heat recovery efficiency at 32°F at a flow greater than or equal to the design airflow. |
| RE145 | R202 R404.1 R404.2 (New) | Increases efficacy in the definition of High-Efficacy Lamps to 70 lumens/watt. All permanently installed lighting must contain only High-Efficacy Lamps. Adds definitions of "dimmer" and "occupant sensor control" and requires automatic lighting controls in specific spaces. There is overlap with RE7 for high-eficiency lighting. | Reduces energy use | Yes | Adds a new requirement for residential lighting controls in the IECC. Savings expected through higher efficacy lighting and the use of automatic lighting controls to reduce lighting energy use. |
| RE148 | R404.1.1 (IRC N1104.1.1) (New) | Requires exterior lighting for Group R-2, R-3, or R-4 buildings comply with Section C405.4 of the IECC. | Reduces energy use | Yes | Requires exterior lighting power meets the commercial lighting power provisions for R-2, R-3, and R-4 buildings except for solar powered lamps and fixtures with motion sensors. |
| RE209 | R401.2 R401.2.1 (New) SECTION R408 (New) R408.1 (New) R408.2 (New) R408.2.1 (New) R408.2.2 (New) R408.2.3 (New) R408.2.4 (New) R408.2.5 (New) | Adds new section for Additional Efficiency Package Options to reduce energy use. Package options chosen based on compliance pathway that targets an energy use reduction of 5%. | Reduces energy use | Yes | Efficiency Package Options include: Enhanced Envelope Performance, Efficient HVAC, Efficient Hot Water Heating, Efficient Thermal Distribution, and Improved Air Sealing with Efficient Ventilation. For prescriptive compliance, one option is required for an estimated 5% reduction. Performance and ERI compliance must demonstrate a 5% reduction in energy cost or ERI score. |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|--|---|-----------------------------|-----------------------------|---|
| RE27 | Table R402.1.2 (IRC N1102.1.2) | Adds alternative wood frame wall options in all climates. | Reduces energy use | No | Adds cavity-only options for zones 7-8 and continuous-only options for all zones. Provides U-factor calculations showing that the new options are equal to or better than the U-factors required in Table R402.1.4. Not included in quantitative analysis since prescriptive wall insulation requirements remain unchanged. |
| RE34 | Table R402.1.2 (IRC N1102.1.2) | Eliminate footnote gas option for floor cavity insulation. | Reduces energy use | No | Footnote g allowed merely filling the cavity (but at least R19) if framing left insufficient space for the required insulation R-value. Floors must meet the prescriptive requirement with continuous insulation if cavity insulation will not meet the requirement. |
| RE37 | Table R402.1.2 (IRC N1102.1.2) | Adds new requirement for fenestration SHGC of 0.4 in climate zone 5 and marine 4. | Reduces energy use | No | Quantitative analysis assumed 0.4 SHGC as standard practice in prototypes for climate zones without SHGC requirements. |
| RE44 | R402.2.3 (IRC N1102.2.3) | Adds more specific requirements details to achieve a continuous eave baffle. | Reduces energy use | No | Potential for air leakage reduction and improved attic insulation coverage. Total air leakage requirements remain unchanged and thus not part of the quantitative analysis. |
| RE45 | R402.2.3 (IRC N1102.2.3) | Makes eave baffle requirement mandatory. | Reduces energy use | No | Not included in quantitative analysis as it was already a prescriptive requirement. |
| RE46 | R402.2.4 (IRC N1102.2.4) (New) R402.2.4 (IRC N1102.2.4) | Establishes separate design and installation requirements for attic hatches and doors, with the installation being mandatory. | Reduces energy use | No | Makes weatherstripping mandatory, leaves insulation requirement prescriptive. Total insulation and air leakage requirements remain unchanged and thus not part of the quantitative analysis. |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|--|---|-----------------------------|-----------------------------|---|
| RE52 | R402.2.7 (IRC N1102.2.7) | Deletes section on walls with partial structural sheathing that allows a reduction in continuous insulation of up to R-3. | Reduces energy use | No | Prescriptive wall insulation requirements remain unchanged and not factored in the quantitative analysis. |
| RE100 | R402.4.1.2 (IRC N1102.4.1.2) R402.2.13 (IRC N1102.2.13) R402.3.5 (IRC N1102.3.5) | Adds new air leakage and thermal isolation requirements for heated garages. | Reduces energy use | No | Adds a new requirement for heated garages that applies the same envelope requirements as sunrooms. Could show savings if garages are insulated minimally instead of not being insulated at all. However, prototypes do not include a garage. |
| RE105 | R402.5 (IRC N1102.5) | Lowers the maximum fenestration U-factor and SHGC requirements. | Reduces energy use | No | Lowers the allowable area-weighted maximum U-factor for climate zones 4-8 and the allowable area-weighted SHGC for climate zones 1-3. Savings not captured in quantitative analysis because prototypes use prescriptive window requirements. |
| RE112 | R403.3.3 (IRC N1103.3.3) R403.3.4 (IRC N1103.3.4) | Removes duct testing exception for ducts located within the building thermal envelope and adds a new duct leakage testing requirement for such ducts. | Reduces energy use | No | Eliminates exception for testing ducts entirely within the building thermal boundary on the basis that these systems need to be tested to ensure long term energy savings and that lack of testing entirely could lead to problems. Sets the total duct leakage rate for ducts within the thermal boundary to twice the leakage rate for systems not entirely in conditioned space. Prototype building duct location is either in the attic, crawlspace, or unconditioned basement. |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|---|--|-----------------------------|-----------------------------|--|
| RE134 | R403.6.1 (IRC N1103.6.1) TABLE R403.6.1 (IRC N1103.6.1) | Adds air-handler integrated ventilation system fan efficacy requirements to Table R403.6.1. | Reduces energy use | No | Removes exception for air handler integrated ventilation system to provide whole house ventilation and added fan efficacy requirements for such systems. Not included in the quantitative analysis because air-handler integrated ventilation systems are not part of typical homes as represented by the prototypes. |
| RE149 | R404.2 (IRC N1104.2) (New) | Adds 4 new automated control requirements for exterior lighting if installed lighting power is greater than 30 watts. | Reduces energy use | No | The exterior lighting schedules used for the single-family and multifamily prototypes have historically set all exterior lighting to off during daylight hours, meaning the current exterior lighting schedules already comply with the requirements of the 2021 IECC, so no changes to the prototypes were made. |
| RE162 | TABLE R405.5.2(1) [IRC N1105.5.2(1)] | Adds hot water distribution system (HWDS) compactness factor to the calculation of the proposed design hot water use (gallons/day) in Table R405.5.2(1). | Reduces energy use | No | Adds a methodology to show better design of hot water systems can reduce energy use. |
| RE163 | TABLE R405.5.2(1) [IRC N1105.5.2(1)] | Adjusts the calculation for service hot water consumption (gal/day) for the performance path proposed and standard designs which in effect lowers the overall hot water consumption. | Reduces energy use | No | Revises formula for estimating hot water usage for performance compliance, which has been unchanged since 1998. The new usage equation gives lower water usage (gal/day), which would decrease the importance of service water heating (SWH) efficiency compared to envelope efficiency. Both proposed and baseline buildings have the same reduced water usage. |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|------------------------------------|--|-----------------------------|-----------------------------|--|
| RE184 | R406.3 (IRC N1106.3) | Adds new requirement for ERI compliance stipulating any reduction in energy use from renewable energy shall not exceed 5% of total energy use. | Reduces energy use | No | In theory this limits builders' ability to trade down envelope efficiency in the ERI path. In practice, there is already an envelope backstop at the 2015 prescriptive levels, so this additional backstop may have little impact. A "backstop" is sometimes called a "mandatory minimum" and refers to a minimum efficiency level that cannot be violated even when compliance trade-offs are used. |
| RE192 | TABLE R406.4 (IRC N1106.4) | Reduces ERI compliance targets for all climate zones to the 2015 IECC levels. | Reduces energy use | No | Adjusts ERI compliance targets to be more stringent and specifies the ANSI/RESNET/ICC 301 Standard as the basis. Ventilation rates for the 301 ERI Reference Home are based on the International Mechanical Code. |
| RE218 | R503.1.4 | Revises exception for new lighting systems in alterations from 10% of luminaires to 50% of luminaires. | Reduces energy use | No | Exception allows more luminaires to be exempt from lighting requirements in alterations provided they do not increase the installed interior lighting power. |
| RE223 | Appendix RB (IRC Appendix Q) (New) | Adds Appendix RB for Zero Energy Residential Building Provisions. | Reduces energy use | No | Sets ERI thresholds for "zero energy." The ERI is 0 for analysis that includes on-site power production and varies from 43 to 47 for analysis that does not include on-site power production. Only reduces energy use if Appendix RB is adopted. |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|---|---|-----------------------------|-----------------------------|--|
| RE41 | Table R402.1.2 (IRC N1102.1.2) Table R402.1.4 (IRC N1102.1.4) | Adds footnote j that allows a maximum fenestration U-factor of 0.32 for climate zones marine 4 and 5-8 for high elevations and wind prone areas. | Increases energy use | No | Increases allowed U-factor requirement from 0.30 to 0.32 for climate zone 4C to 8 for homes above 4,000 ft and wind prone regions. Fenestration at high altitude requires the ability for pressure equalization during transit while windborne protection requires laminated glass for durability. Both these requirements reduce thermal performance. |
| RE47 | R402.2.4 (IRC N1102.2.4) | Adds exception for horizontal pull-down stair-type access hatches and doors. | Increases energy use | No | While technically a reduction in R-value requirements for drop-down attic hatches, the practical argument that "field crafted detachable apparatuses" are usually used to achieve the current requirement means this change will have minimal impact. |
| RE53 | R402.2.8 (IRC N1102.2.8) | Expands on language of floor insulation installation for clarification. | Increases energy use | No | The proposal reduces the floor-R requirements by allowing insulation sufficient to fill the available cavity space as an alternative to the required R-value. |
| RE96 | R402.4 (IRC N1102.4) R402.4.1 (IRC N1102.4.1) R402.4.1.1 (IRC N1102.4.1.1) R402.4.1.2 (IRC N1102.4.1.2) R402.4.1.3 (IRC N1102.4.1.3) (New) | Revises air leakage threshold from a mandatory to a prescriptive requirement, while preserving an absolute maximum air leakage rate of 5.0 ACH50. | Increases energy use | No | In effect makes air leakage rates eligible for performance tradeoffs, while leaving the testing requirement mandatory. Preserves 5.0 ACH50 backstop for performance compliance in all climate zones. |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|--|--|-----------------------------|-----------------------------|---|
| RE130 | R403.6.2 (IRC N1103.6.2) (New) | Adds testing requirements for mechanical ventilation systems. | Increases Energy use | No | Adds new requirement for testing of mechanical ventilation systems, with exception for specific kitchen range hoods. Potential savings from identifying problems during testing, but potential energy increases due to pushing some systems to ventilate more than they would have. |
| CE160 P II | R403.10 (IRC N1103.10) R403.10.1 (IRC N1103.10.1) R403.10.3 (IRC N1103.10.3) R403.12 (IRC N1103.12) | Modifies pool and spa requirements to match the pool code. | Increases energy use | No | Primarily editorial but does include renewable systems that provide only 70% as opposed to 75% of energy. The renewable energy exception for pool and spa covers allows on-site or off-site renewable energy. |
| ADM31 P III | R106 R105.7 R105.7.1 | Reworks Notice of Approval and Revocation sections. | Administrative | No | |
| ADM40 P IV | R109 R109.1 R109.2 R109.3 R109.4 | Reworks Board of Appeals section. | Administrative | No | |
| ADM41 P IV | R108 R108.1 R108.2 R108.3 R108.4 | Reworks Stop Work Order section. | Administrative | No | |
| ADM46 P IV | R103.1 | Allows use of digital submissions where approved by building official. | Administrative | No | |
| CE10 P II | R102.1 | Adds requirement that "alternative methods or design must be approved" in General section. | Administrative | No | |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|---|---|-----------------------------|-----------------------------|---|
| CE12 P II | R102.1.1 (N1101.4) | Adds requirements for buildings meeting above code programs to meet mandatory requirements and the thermal envelope "backstop." Backstops are the 2009 IECC. | Administrative | No | |
| CE13 P II | R103.2 (IRC N1101.5) | Adds "energy compliance path" to list of items to be on construction documents. | Administrative | No | Allows plans examiner to target specific requirements based on compliance path. |
| CE19 P II | R202 (IRC N1101.6) | Adds new definition of "air-impermeable insulation" to code. | Administrative | No | Modifies current definition to include specific definition of "impermeable," including reference to ASTM E2178 or E283. |
| CE22 P II | R202 (IRC N1101.6) | Revises definition of "demand recirculation water system" to match IPC definition. | Administrative | No | |
| CE29 P II | R202 (IRC N1101.6) R303.3 (IRC N1101.12) R403.5.1 (IRC N1103.5.1) R403.10.1 (IRC N1103.10.1) | Removes definition of "accessible" and "readily accessible," adds definitions of "ready access (to)" and "access (to)," and makes corresponding changes where deleted terms are used in text. | Administrative | No | |
| CE31 P II | R202 (IRC N1101.6) | Updates definition for "on-site renewable energy" and adds new definition for "renewable energy resources." | Administrative | No | Adds and aligns definition for "on-site renewable energy" with the commercial IECC. Definition for "renewable energy resources" distinguishes between geothermal energy sources and ground source heat pumps. |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|---|---|-----------------------------|-----------------------------|---|
| CE36 P II | Figure R301.1 (IRC N1101.7) Table R301.1 (IRC N1101.7) R301.3 (IRC N1101.7.2) Table R301.3(1) [IRC N1101.7.2(1)] Table R301.3(2) [IRC N1101.7.2(2)] | Updates climate zones to correlate with ASHRAE Standard 169. | Administrative | No | The impact of shifting climate zones is not captured in analysis but the impacts of the climate zone weightings have been captured. Jurisdictions that shifted to warmer climate zones have less stringent requirements. |
| CE40 P II | R303.1.2 (IRC N1101.10.2) | Adds new requirement that for materials with an observable manufacturer's R-value mark, that an insulation certificate be left in a conspicuous location in the building. | Administrative | No | |
| CE42 P II | All Mandatory Requirements Sections | Clarifies which residential sections are mandatory and which prescriptive. | Administrative | No | Proposal eliminates the "mandatory" and "prescriptive" labels in favor of specific tables defining "requirements" (formerly mandatory requirements) associated with each performance path (old performance path and new ERI). This is intended to simply be a restructuring. Sections that were formerly labeled "mandatory" must now be defined as such in two different places, opening the possibility of their getting out of sync. |
| CE60 P II | R202 (IRC N1101.6) R402.1.3 (IRC N1102.1.3) | Adds definition of "cavity insulation" and specifies use of cavity insulation in R-value computation. | Administrative | No | Proposal is effectively clarification of how to sum R-values for cavity and continuous insulation. |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|---|---|-----------------------------|-----------------------------|--|
| CE151 P II | R202 (IRC N1101.6) R403.3.1 (IRC N1103.3.1) | Adds new definition of "thermal distribution efficiency (TDE)" and adds new requirements for underground ducts. | Administrative | No | Proposal also adds listing and labeling of ducts that use the TDE method. Savings may occur from using properly listed and labeled ducts in underground installations. |
| CE159 P II | R403.5.1.1 (IRC N1103.5.1.1) R403.5.2 (IRC N1103.5.2) | Relocates requirement that demand recirculating water systems have controls to limit temperature of water entering cold water piping. | Administrative | No | Move requirement for controls that limit water entering the cold-water piping to 104F from demand recirculating systems to all recirculating systems. |
| RE4 | R202 (IRC N1101.6) (New) | Adds new definition of "" cavity insulation." | Administrative | No | |
| RE6 | R202 (IRC N1101.6) (New) | Amends definition of "fenestration" to include skylights, tubular daylighting devices, and glazing materials in solariums, sunrooms, roofs, and sloped walls. | Administrative | No | Clarifies what constitutes as a "skylight." |
| RE9 P I | R202 (IRC N1101.6) | Editorial change to definition of "roof recover." | Administrative | No | |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|--|---|-----------------------------|-----------------------------|--|
| RE15 | R401.2 (IRC N1101.13) R401.2.1 (IRC N1101.13.1) R401.2.1 (IRC N1101.13.1) (New) R401.2.2 (IRC N1101.13.2) (New) R401.2.3 (IRC N1101.13.3) (New) R401.2.4 (IRC N1101.13.4) (New) R407 (IRC N1107) (New) R407.1 (IRC N1107.1) (New) | Clarifies compliance requirements in Chapter 4. | Administrative | No | Splits compliance pathway requirements into separate sections for clarity. |
| RE18 | R401.3 (IRC N1101.14) | Amends compliance certificate requirements to include on-site renewable systems when installed. | Administrative | No | Requires the specifications of on-site renewable systems on the compliance certificate for homebuyers, inspectors, and appraisal addendums. |
| RE20 | R401.3 (IRC N1101.14) | Amends compliance certificate requirements to add name of builder, code year complied with, and compliance path used. | Administrative | No | |
| RE21 | R401.3 (IRC N1101.14) | Amends compliance certificate requirements by adding ERI if applicable. | Administrative | No | Adding to ERI compliance path, the ERI must be shown with and without renewable energy generation for compliance purposes and future homeowners. |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|--|--|-----------------------------|-----------------------------|--|
| RE23 | Table R402.1.2 (IRC N1102.1.2) | Adds alternative basement wall and crawlspace wall options for cold climates. | Administrative | No | Moves detail from footnotes to table and adds text clarifying which R-values are cavity vs continuous. |
| RE28 | TABLE R402.1.2 (IRC N1102.1.2) | Clarifies wood frame wall, basement wall, and crawlspace wall insulation requirements in CZ 3-8. | Administrative | No | |
| RE38 | R402.1.2 (IRC N1102.1.2) TABLE R402.1.2 (IRC N1102.1.2) R402.1.3 (IRC N1102.1.3) (New) TABLE R402.1.4 (IRC N1102.1.4) R402.1.3 (IRC N1102.1.3) R402.1.4 (IRC N1102.1.4) R402.1.5 (IRC N1102.1.5) | Renders the U-factor compliance the default for prescriptive compliance. R-values are the alternative. | Administrative | No | No real change in the requirements. |
| RE42 | R402.2.1 (IRC N1102.2.1) R402.2.2 (IRC N1102.2.2) | Editorial changes to requirements for ceilings with and without attic spaces. | Administrative | No | |
| RE49 | R402.2.4 (IRC N1102.2.4) | Editorial changes to the access hatch door requirements. | Administrative | No | |
| RE50 | R202 (IRC N1101.6) R402.2.5 (IRC N1102.2.5) | Adds mass timber as a type of mass wall and adds definition of mass timber. | Administrative | No | |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|--|---|-----------------------------|-----------------------------|--|
| RE51 | Table 402.2.5 (IRC N1102.2.6) | Adds additional equivalents to Table R402.2.6 Steel-Frame Ceiling, Wall, and Floor Insulation R-values. | Administrative | No | |
| RE55 | R402.2.9 (IRC N1102.2.9) | Expands language of basement wall insulation installation requirements for walls associated with unconditioned basements. | Administrative | No | The exceptions outline the characteristics that must be present in an unconditioned basement to "willfully and knowingly" remove the basement from consideration as an extension of conditioned space. |
| RE58 | Table R402.4.1.1 (IRC N1102.4.1.1) | Removes redundant language from air barrier table. | Administrative | No | |
| RE59 | R402.2.9 (IRC N1102.2.9) (New) R402.2.9 (IRC N1102.2.9) | Establishes separate design and installation requirements for basement wall insulation, with the installation being mandatory. | Administrative | No | |
| RE60 | R402.2.10 R402.2.10.1 (IRC N1102.2.10.1) (New) | Establishes separate design and installation requirements for slab-on-grade insulation, with the installation being mandatory. | Administrative | No | Makes only the installation requirements mandatory without affecting the R-value/depth requirements. |
| RE62 | R402.2.11 (IRC N1102.2.11) (New) R402.2.11 (IRC N1102.2.11) | Establishes separate design and installation requirements for crawl space wall insulation, with the installation being mandatory. | Administrative | No | Clarifies the scope of the section and makes the installation requirements mandatory. |
| RE68 | Table R402.4.1.1 (IRC N1102.4.1.1) | Editorial changes to air sealing table (plumbing and wiring). | Administrative | No | |
| RE70 | Table R402.4.1.1 (IRC N1102.4.1.1) | Editorial changes to air sealing table (recessed lighting). | Administrative | No | |
| RE71 | Table R402.4.1.1 (IRC N1102.4.1.1) | Editorial changes to air sealing table (garage separation). | Administrative | No | |
| RE72 | Table R402.4.1.1 (IRC N1102.4.1.1) | Editorial changes to air sealing table (narrow cavities). | Administrative | No | |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|--|---|-----------------------------|-----------------------------|--|
| RE73 | Table R402.4.1.1 (IRC N1102.4.1.1) | Clarification of requirements for sealing and insulating around penetrations | Administrative | No | |
| RE74 | Table R402.4.1.1 (IRC N1102.4.1.1) | Editorial changes to air sealing table (crawl space walls, basement walls, and slabs). | Administrative | No | |
| RE82 | Table R402.4.1.1 (IRC N1102.4.1.1) | Editorial changes to air sealing table (rim joists). | Administrative | No | |
| RE86 | Table R402.4.1.1 (IRC N1102.4.1.1) | Editorial changes to air sealing table (shafts and penetrations). | Administrative | No | |
| RE88 | R202 (IRC N1101.6) R402.4.1.2 (IRC N1102.4.1.2) R403.6 (IRC N1103.6) | Adds definition for Dwelling Unit Enclosure Area and allows 0.30 cfm25/ft ² of Dwelling Unit Enclosure Area as an exception to 3 or 5 ACH50 for air leakage. | Administrative | No | Only allowed for attached dwelling units and buildings or dwelling units under 1,500 ft ² . The cfm25/ft ² of dwelling unit enclosure area removes the bias of large volume homes. |
| RE98 | R402.4.1.2 (IRC N1102.4.1.2) TABLE R405.5.2(1) [IRC N1105.5.2(1)] | Adds additional digit to the air leakage rate of the Standard Reference Design in Table R405.5.2(1) to eliminate roundoff error. | Administrative | No | This clarification supports code official compliance determination. |
| RE103 | R402.4.2 (New) R402.4.6 (New) | Adds explicit requirement for use of air-sealed electrical and communication outlet boxes. | Administrative | No | Explicitly requires that outlet boxes be tested using NEMA OS.4 and sets a maximum air leakage rate. Savings not captured in quantitative analysis because maximum ACH50 is unchanged. |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|--|--|-----------------------------|-----------------------------|---|
| RE106 | R403.1.1 (IRC N1103.1.1) | Clarifies programmable thermostat requirements and requires weekday/weekend operation for thermostats. | Administrative | No | Requires weekday/weekend functionality in thermostats, which may lead to potential savings for those buildings that did not use thermostats with this capability before. |
| RE108 | R403.2 (IRC N1103.2) | Expands options for hot water boiler temperature reset. | Administrative | No | |
| RE109 | R403.3 (IRC N1103.3) R403.3.1 (IRC N1103.3.1) R403.3.7 (IRC N1103.3.7) | Clarifies duct insulation requirements based on location. | Administrative | No | Requirements are unchanged. Added is a list of conditions that must be met for ducts to be considered "in conditioned space." Brings this section into closer coordination with the buried duct provisions. |
| RE111 | R403.3.1 (IRC N1103.3.1) R403.3.1.1 (IRC N1103.3.1.1) (New) R403.3.1.2 (IRC N1103.3.1.2) (New) R405.2 (IRC N1105.2) R406.2 (IRC N1106.2) | Revises and consolidates the duct insulation requirements into one section. | Administrative | No | |
| RE114 | R403.3.3 (IRC N1103.3.3) Chapter 6RE (IRC Chapter 44) (New) | Requires RESNET/ICC 380 or ASTM E1554 for duct testing. | Administrative | No | Introduces new reference standard for duct testing protocols. |
| RE118 | R403.3.3 (IRC N1103.3.3) | Editorial change to duct leakage requirements. | Administrative | No | |
| RE122 | R403.3.6.1 (IRC N1103.3.6.1) | Makes effective R-value of insulation of deeply buried ducts mandatory. | Administrative | No | |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|--------------------------------|---|-----------------------------|-----------------------------|---|
| RE123 | R403.4.1 (IRC N1103.4.1) | Makes protection of piping insulation mandatory. | Administrative | No | |
| RE125 | R403.5.2 (IRC N1103.5.2) | Makes hot water demand recirculation system control requirements mandatory. | Administrative | No | Provides clarification that the requirement only applies if these systems are installed. |
| RE127 | R403.5.3 (IRC N1103.5.3) | Clarifies hot water pipe insulation requirements. | Administrative | No | |
| RE129 | R403.5.4 (IRC N1103.5.4) | Makes drain water heat recovery unit testing and operating requirements mandatory. | Administrative | No | While making drain water heat recovery unit testing mandatory, it does not require drain water heat recovery be installed in homes. |
| RE132 P I | R403.6 (IRC N1103.6) | Editorial change to mechanical ventilation requirements. | Administrative | No | Changes "buildings" to "buildings and dwelling units" and "ventilation" to "mechanical ventilation." |
| RE132 P II | R303.4 | Requires dwelling units complying with Section N1102.4.1 to have whole-house mechanical ventilation in accordance with Section M1505.4. | Administrative | No | Ensures that homes meeting the air leakage requirements of N1102.4 are provided with mechanical ventilation according to M1505.4. This provides assurance in the future that air-tight dwelling units will be provided with mechanical ventilation. |
| RE136 | TABLE R403.6.1 (IRC N1103.6.1) | Adds test specifications (static pressure) for various ventilation system types. | Administrative | No | |
| RE137 | TABLE R403.6.1 (IRC N1103.6.1) | Editorial changes to Table R403.6.1 whole-house mechanical ventilation system fan efficacy requirements. | Administrative | No | Clarification and restructuring of requirements table while adding specific system type such as "balanced fans without HRV or ERV." Attempts to match up with ventilation types in code compliance software. |
| RE144 | R403.12 (IRC N1103.12) | Makes pool and spa requirements mandatory. | Administrative | No | |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|--|---|-----------------------------|-----------------------------|--|
| RE150 | R406.2 (IRC N1106.2) | Adjusts the UA backstop for the ERI compliance pathway to be Proposed UA <= Standard UA (2021 IECC) x 1.15. | Administrative | No | |
| RE151 | R405.2 (IRC N1105.2) ICC Chapter 6 (IRC Chapter 44) | Sets minimum envelope and SHGC efficiency requirements to meet 2009 IECC for the performance path. | Administrative | No | New envelope insulative backstop for performance compliance but minimal energy impact since the same overall level of efficiency to comply is unchanged. |
| RE157 | R405.4.2 (IRC N1105.4.2) | Removes allowance for batch sampling for multi-family units. | Administrative | No | There is no process or criteria defined within the IECC for "batch sampling." Could threaten compliance/enforcement as not all dwelling units will be inspected. |
| RE158 | R405.4.2 (IRC N1105.4.2) R405.4.2.1 (IRC N1105.4.2.1) R405.4.2.2 (IRC N1105.4.2.2) R405.4.3 (IRC N1105.4.3) | Re-write of Section R405.4.2 related to performance path compliance reporting. | Administrative | No | Rewrites sections on reports detailing the information to be supplied for permit applications and certificate of occupancy. |
| RE159 | R405.4.2.1 | Adds a statement that simulated performance path is being used to the compliance report requirements. | Administrative | No | |
| RE172 | R405.5.2.(1) [IRC N1105.5.2(1)] | Specifies that the duct location in both the Proposed and Standard Designs for performance compliance will be set to the Proposed Design duct location. | Administrative | No | |
| RE173 | TABLE R405.5.2(1) [IRC N1105.5.2(1)] | Adds a new section for dehumidistats. | Administrative | No | Adds a new section on dehumidistats and requires the proposed design and reference design to be the same. |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|--|--|-----------------------------|-----------------------------|---|
| RE178 | TABLE R405.5.2(1) [IRC N1105.5.2(1)] TABLE R403.6.1 (IRC N1103.6.1) | Specifies the mechanical ventilation type of the Standard Design shall be the same type as in the Proposed Design and efficacy is based on the ventilation type. | Administrative | No | |
| RE182 | R406.2 (IRC N1106.2) TABLE R406.4 (IRC N1106.4) | Changes building thermal envelope efficiency backstop for ERI compliance with renewable energy to the 2018 IECC. | Administrative | No | Since the 2018 is only slightly more efficient than the 2015, this will amount to a 1.7% improvement requirement in envelope efficiency based on the 2018 IECC Determination but overall ERI compliance targets remain unchanged. |
| RE199 | R406.5 (IRC N1106.5) | Expands on the requirements for the approved third-party person/entity that will verify the ERI compliance requirements have been met. | Administrative | No | This divides compliance verification between an approved third party for R406.4 and R406.6 (the base ERI and documentation thereof) and the authority having jurisdiction or approved third party inspection agency per Section R105.4 for R406.2 (mandatory requirements). |
| RE202 | R406.6.2 | Adds statement requiring the Energy Rating Index on title page of ERI compliance report. | Administrative | No | |
| RE204 | R202 (IRC N1101.6) R406.6.3 (IRC N1106.6.3) (New) | Adds definition for Renewable Energy Certificate (REC) and requiring documentation of the RECs for renewable energy credit in the ERI compliance path. | Administrative | No | Requires that a home with PV/renewable energy systems provide legal documentation that nobody else owns credit for the renewable energy capacity. |
| RE205 | R406.6.2 (IRC N1106.6.2) R406.6.2.1 (IRC N1106.6.2.1) (New) R406.6.2.2 (IRC N1106.6.2.2) (New) | Re-write of Section R406.6.2 related to ERI compliance path reporting. | Administrative | No | Makes extensive changes to the ERI report requirements for permit application or certificate of occupancy. Adds new language "proposed" to the rated design as well as "confirmed built dwelling" that both must meet the ERI score requirements. |

| Proposal Number ^(a) | Code Section(s) ^(b) | Description of Change(s) | Impact on Energy Efficiency | Included in Energy Analysis | Discussion |
|--------------------------------|---|---|-----------------------------|-----------------------------|---|
| RE215 | R503.1 (IRC N1109.1) | Removes redundant language related to Alterations. | Administrative | No | |
| RE221 | R505.1 (IRC N1107.1) R505.2 (IRC N1111.2) | Clarifies application section for spaces undergoing change in occupancy and spaces converted to dwelling units. | Administrative | No | |
| RE222 | RA103.1 (IRC AT103.1) RA103.5 (IRC AT103.5) (New) RA103.6 (IRC AT103.6) (New) | Adds clarification related to shading. | Administrative | No | Brings the IECC's solar-ready appendix into agreement with the IRC's, which was updated last cycle. |

(a) Proposal numbers are as assigned by the ICC (<http://media.iccsafe.org/codes/2015-2017/GroupB/CAH/IECC-R.pdf>).

(b) Code sections refer to the 2018 IECC. Sections may be renumbered by the ICC in the 2021 IECC.

Appendix B – Detailed Weighting Factors for Each Residential Prototype

| Building Type | Foundations | Heating Systems | CZ1 (%) | CZ2 (%) | CZ3 (%) | CZ4 (%) | CZ5 (%) | CZ6 (%) | CZ7 (%) | CZ8 (%) | Weights by Prototype |
|---------------|-------------------|-------------------|---------|---------|---------|---------|---------|---------|---------|---------|----------------------|
| Single-Family | Crawlspace | Gas-fired Furnace | 0.17 | 0.93 | 2.66 | 1.74 | 2.20 | 0.39 | 0.06 | 0.01 | 8.15 |
| Single-Family | Crawlspace | Electric Furnace | 0.03 | 0.39 | 0.35 | 0.11 | 0.06 | 0.01 | 0.00 | 0.00 | 0.95 |
| Single-Family | Crawlspace | Oil-fired Furnace | 0.00 | 0.00 | 0.01 | 0.02 | 0.05 | 0.02 | 0.00 | 0.00 | 0.10 |
| Single-Family | Crawlspace | Heat Pump | 0.29 | 1.30 | 4.73 | 1.96 | 0.65 | 0.14 | 0.03 | 0.00 | 9.09 |
| Single-Family | Slab-on-grade | Gas-fired Furnace | 0.59 | 5.23 | 4.62 | 1.95 | 2.46 | 0.42 | 0.06 | 0.00 | 15.35 |
| Single-Family | Slab-on-grade | Electric Furnace | 0.12 | 1.48 | 0.78 | 0.15 | 0.06 | 0.02 | 0.00 | 0.00 | 2.62 |
| Single-Family | Slab-on-grade | Oil-fired Furnace | 0.00 | 0.01 | 0.01 | 0.03 | 0.07 | 0.03 | 0.00 | 0.00 | 0.15 |
| Single-Family | Slab-on-grade | Heat Pump | 1.67 | 6.25 | 5.48 | 1.94 | 0.72 | 0.16 | 0.03 | 0.00 | 16.23 |
| Single-Family | Heated Basement | Gas-fired Furnace | 0.01 | 0.01 | 0.13 | 1.05 | 2.62 | 0.75 | 0.07 | 0.00 | 4.65 |
| Single-Family | Heated Basement | Electric Furnace | 0.00 | 0.00 | 0.01 | 0.05 | 0.06 | 0.03 | 0.00 | 0.00 | 0.15 |
| Single-Family | Heated Basement | Oil-fired Furnace | 0.00 | 0.00 | 0.00 | 0.02 | 0.09 | 0.04 | 0.00 | 0.00 | 0.15 |
| Single-Family | Heated Basement | Heat Pump | 0.01 | 0.04 | 0.32 | 1.03 | 0.73 | 0.30 | 0.03 | 0.00 | 2.46 |
| Single-Family | Unheated Basement | Gas-fired Furnace | 0.00 | 0.02 | 0.33 | 0.86 | 1.77 | 0.42 | 0.03 | 0.00 | 3.43 |
| Single-Family | Unheated Basement | Electric Furnace | 0.00 | 0.00 | 0.02 | 0.04 | 0.04 | 0.01 | 0.00 | 0.00 | 0.11 |
| Single-Family | Unheated Basement | Oil-fired Furnace | 0.00 | 0.00 | 0.00 | 0.03 | 0.19 | 0.06 | 0.00 | 0.00 | 0.29 |
| Single-Family | Unheated Basement | Heat Pump | 0.00 | 0.06 | 0.69 | 0.78 | 0.49 | 0.13 | 0.01 | 0.00 | 2.15 |

| Building Type | Foundations | Heating Systems | CZ1 (%) | CZ2 (%) | CZ3 (%) | CZ4 (%) | CZ5 (%) | CZ6 (%) | CZ7 (%) | CZ8 (%) | Weights by Prototype |
|------------------------|-------------------|-------------------|---------|---------|---------|---------|---------|---------|---------|---------|----------------------|
| Multifamily | Crawlspace | Gas-fired Furnace | 0.10 | 0.40 | 1.42 | 1.24 | 1.25 | 0.21 | 0.03 | 0.00 | 4.66 |
| Multifamily | Crawlspace | Electric Furnace | 0.02 | 0.17 | 0.13 | 0.06 | 0.03 | 0.01 | 0.00 | 0.00 | 0.43 |
| Multifamily | Crawlspace | Oil-fired Furnace | 0.00 | 0.00 | 0.00 | 0.02 | 0.05 | 0.01 | 0.00 | 0.00 | 0.09 |
| Multifamily | Crawlspace | Heat Pump | 0.14 | 0.55 | 1.69 | 1.10 | 0.39 | 0.09 | 0.01 | 0.00 | 3.97 |
| Multifamily | Slab-on-grade | Gas-fired Furnace | 0.30 | 2.10 | 2.49 | 1.28 | 1.36 | 0.25 | 0.03 | 0.00 | 7.80 |
| Multifamily | Slab-on-grade | Electric Furnace | 0.06 | 0.69 | 0.33 | 0.08 | 0.04 | 0.01 | 0.00 | 0.00 | 1.21 |
| Multifamily | Slab-on-grade | Oil-fired Furnace | 0.00 | 0.00 | 0.01 | 0.03 | 0.07 | 0.01 | 0.00 | 0.00 | 0.12 |
| Multifamily | Slab-on-grade | Heat Pump | 0.78 | 2.77 | 2.19 | 1.10 | 0.42 | 0.11 | 0.01 | 0.00 | 7.38 |
| Multifamily | Heated Basement | Gas-fired Furnace | 0.01 | 0.00 | 0.06 | 0.75 | 1.43 | 0.45 | 0.05 | 0.00 | 2.74 |
| Multifamily | Heated Basement | Electric Furnace | 0.00 | 0.00 | 0.00 | 0.03 | 0.03 | 0.02 | 0.00 | 0.00 | 0.09 |
| Multifamily | Heated Basement | Oil-fired Furnace | 0.00 | 0.00 | 0.00 | 0.03 | 0.08 | 0.02 | 0.00 | 0.00 | 0.13 |
| Multifamily | Heated Basement | Heat Pump | 0.00 | 0.01 | 0.12 | 0.62 | 0.41 | 0.21 | 0.03 | 0.00 | 1.39 |
| Multifamily | Unheated Basement | Gas-fired Furnace | 0.00 | 0.00 | 0.19 | 0.77 | 1.15 | 0.24 | 0.02 | 0.00 | 2.36 |
| Multifamily | Unheated Basement | Electric Furnace | 0.00 | 0.00 | 0.01 | 0.03 | 0.03 | 0.01 | 0.00 | 0.00 | 0.08 |
| Multifamily | Unheated Basement | Oil-fired Furnace | 0.00 | 0.00 | 0.00 | 0.04 | 0.18 | 0.03 | 0.00 | 0.00 | 0.26 |
| Multifamily | Unheated Basement | Heat Pump | 0.00 | 0.02 | 0.25 | 0.54 | 0.33 | 0.09 | 0.01 | 0.00 | 1.24 |
| Totals by Climate Zone | | | 4.30 | 22.43 | 29.04 | 19.49 | 19.51 | 4.68 | 0.53 | 0.02 | 100.00 |

Appendix C – Updates to the Energy Savings Calculation Methodology

Although the present analysis of the 2021 IECC builds on the previous 2018 IECC energy savings analysis, the methodology differs in a few ways:

1. Used a newer version of DOE's *EnergyPlus* building energy simulation software; this was done to accommodate the software update process and to incorporate software improvements and new data
2. Updated modeling strategy for air leakage, duct leakage, and ventilation
3. Updated weights
4. Updated fuel costs
5. Representative weather file changes resulting from climate zone changes
6. Bug fixes and other improvement were made to the prototype models.

These changes are important because they impact the 2018 IECC models which are the baseline for this analysis. To ensure that the current analysis was both up-to-date and the comparison between the 2018 and 2021 IECC versions was valid, all 2018 models were re-run incorporating these changes.

C.1 EnergyPlus Version Upgrade

DOE regularly updates the *EnergyPlus* software program twice a year. The 2018 determination of energy savings was accomplished using *EnergyPlus* V8.6. The determination of energy savings for the 2021 IECC was conducted using an adaptation of *EnergyPlus* version 9.4 where the source code was modified to allow additional zonal equipment while simultaneously simulating the detailed effects of duct leakage via the *EnergyPlus* Airflow network. The modified source code will be available in the *EnergyPlus* version 9.5 release.

C.2 Updated Modeling Strategy for Air Leakage, Duct Leakage and Ventilation

The energy impact of duct insulation and air leakage was calculated using the *EnergyPlus* Airflow network model which allows the creation of a detailed air-distribution system and the placement of ducts in various thermal zones. Prior to the Airflow network model enhancement, due to compatibility issues between the Airflow network objects and the other *EnergyPlus* objects, the duct and air leakage impact was calculated in isolation and incorporated through post-processing without the Airflow network model (Mendon et al. 2015). The single-family building prototypes now directly incorporate the Airflow network model while the multifamily prototype buildings still use the post-processing method due to the compatibility issue.

C.3 Updated Weights and Fuel Costs

Weighting factor and fuel cost changes have been updated to reflect current building permits and economic conditions. Weighting factors and fuel cost adjustments were summarized in Sections 2.3 and 2.4 in the report.

C.4 Representative weather file changes resulting from climate zone changes

As discussed in Section 2.3.2, the 2021 IECC has aligned the climate zone map with that from ASHRAE 169-2013. ASHRAE 169-2013 redefined climate zones and moisture regimes based on a more recent period of weather data. As a result, a number of U.S. counties were reassigned to different zones/regimes. Approximately 300 U. S. counties out of more than 3,000 were reassigned, most to warmer climate zones. A new county-to-climate zone map was built to match the climate zones to every county to assist in developing new residential weights. A new weather location for the new climate zone 5C (Port Angeles, Washington) was included in the quantitative analysis in addition to adjusting weather files to match the updated climate zones as discussed in Section 2.3.2.

C.5 Bug Fixes

During the 2021 IECC determination analysis, various bugs were fixed such as water heater tank size settings, calculation of envelope leakage area, and window area calculations for prototype models with basements. The water heating tank size issue resulted in the tank size being too small for oil furnace home. The calculations to set window area for homes with basements were incorrect, which set the window area to be lower than expected. Those corrections had a minor impact on total energy consumption.

Appendix D – Modeling of Individual Code Changes

This section describes the modeling strategies used for modeling the 11 code changes in the quantitative analysis.

D.1 RE7 & RE145: High-Efficacy Lighting Requirements

RE145 reduces the lighting energy consumption in homes by increasing the requirement of high-efficacy lighting from 90 percent of permanently installed lighting fixtures to 100 percent. RE7 defines high-efficacy lighting as lamps with an efficacy not less than 65 lumens per watt or luminaires with an efficacy not less than 45 lumens per watt.

Lighting energy in the DOE prototypes is calculated based on the Building America House Simulation Protocols as detailed by Mendon et al. (2013) and divided into hardwired, plug-in, exterior, and garage lighting. The Building America protocols establish a set of equations that can be used to calculate annual lighting energy consumption depending on the fraction of incandescent lamps, compact fluorescent lamps (CFLs), light emitting diodes (LEDs), and linear fluorescents (LFs) present in the home (Wilson et al. 2014). Because RE7 & RE145 apply only to permanently installed (hardwired) fixtures, the impact of this code change is calculated using Building America’s smart lamp replacement approach using Equations 3.1 and 3.2 and the fractions specified in Table D.1. With LEDs gaining popularity in the residential market, this analysis assumes that low-efficacy lighting is replaced with 80 percent LEDs and 20 percent CFLs—this yields a conservative estimate of energy savings from this measure.

$$\begin{aligned} \text{Baseline Interior Hardwired Lighting Energy (kWh/yr)} = \\ 0.8 \times (\text{Conditioned Floor Area} \times 0.542 + 334) \end{aligned} \quad (3.1)$$

$$\begin{aligned} \text{Interior Hardwired lighting energy (kWh/yr)} = L_{HW} \times \{[(F_{inc, HW} + 0.34) + (F_{CFL, HW} - 0.21) \\ \times 0.27 + F_{LED, HW} \times 0.30 + (F_{LF, HW} - 0.13) \times 0.17] \times \text{SAF} \times 0.9 + 0.1\} \end{aligned} \quad (3.2)$$

where

- L_{HW} = Baseline annual interior hardwired lighting energy from equation 3.1
- $F_{inc, HW}$ = Fraction of hardwired lamps that are incandescent
- $F_{CFL, HW}$ = Fraction of hardwired lamps that are CFLs
- $F_{LF, HW}$ = Fraction of hardwired lamps that are LFs
- $F_{LED, HW}$ = Fraction of hardwired lamps that are LEDs
- SAF = Smart replacement algorithm factor: $1.1 \times F_{inc}^4 - 1.9 \times F_{inc}^3 + 1.5 \times F_{inc}^2 - 0.7 \times F_{inc} + 1$

Table D.1. Lighting Type Fractions for the 2015 and 2018 IECC

| | 2018 IECC | 2021 IECC |
|--|-----------|-----------|
| Fraction Incandescent (F_{inc}) | 0.10 | 0.00 |
| Fraction CFL (F_{CFL}) | 0.77 | 0.20 |
| Fraction Linear Fluorescent (F_{LF}) | 0.13 | 0.00 |
| Fraction LED (F_{LED}) | 0.00 | 0.80 |

Table D.2 summarizes the resulting annual hardwired interior lighting energy consumption for the 2018 and 2021 IECC for the single-family building prototype and the multifamily prototype building unit. This value is converted to a lighting power density input for the models using the annual hours of use based on the lighting schedule. In addition to the direct reduction in lighting

energy use, the energy simulation also accounts for the interactive effects between the reduced internal gains from the high-efficacy lighting and the corresponding increase in heating energy and reduction in cooling energy. The IECC regulates only hardwired interior lighting but the residential prototypes incorporate unregulated plug-in lighting of the same magnitude across all code years.

Table D.2. Calculated Annual Interior Hardwired Lighting Energy for the 2018 and 2021 IECC by Building Type

| Building Type | 2018 IECC | 2021 IECC |
|------------------|-----------|-----------|
| Single-family | 783 kWh | 713 kWh |
| Multifamily Unit | 475 kWh | 433 kWh |

D.2 RE29: Increased Wood Frame Wall Insulation

RE29 increases wood frame wall insulation by adding an additional R-5 continuous insulation for climate zones 4 and 5. Table D.3 shows the changes between the wall insulation values between 2018 IECC and 2021 IECC. The exterior walls for the prototype models were simulated with R-20 cavity insulation with R-0 for sheathing insulation for the 2018 IECC. For the 2021 IECC, the sheathing insulation was increased to R-5.

Table D.3. Wall Insulation R-Values for Climate Zones 4-5 for the 2018 and 2021 IECC

| Climate Zone | 2018 IECC | 2021 IECC |
|--------------|-----------|-----------|
| 4 & 5 | 20 | 20+5ci |

D.3 RE32: Increased Slab Floor Insulation

RE32 adds slab insulation for slab-on-grade homes in climate zone 3 to R-10 at 2 ft of depth. Table D.4 illustrates the changes in the slab insulation between 2018 and 2021 IECC. For slab-on-grade homes in climate zones 4 and 5, the existing R-10 slab insulation depth was increased from 2 ft to 4 ft.

Table D.4. Slab Insulation R-Values for Climate Zones 3-5 for the 2018 and 2021 IECC

| Climate Zone | 2018 IECC | 2021 IECC |
|--------------|------------|------------|
| 3 | NR | R-10, 2 ft |
| 4 & 5 | R-10, 2 ft | R-10, 4 ft |

D.4 RE33 & RE36: Increased Ceiling Insulation

R33 and R36 increase the ceiling insulation levels depending on climate zone. R33 increases the ceiling insulation in climate zones 2 and 3 from R-38 to R-49 for the 2021 IECC. R36 increases the ceiling insulation in climates zones 4 through 8 from R-49 to R-60. The ceiling insulation for the prototype models for the 2021 IECC were adjusted as shown in Table D.5 while the 2018 IECC prototypes remained at R-38 and R-49 respectively.

Table D.5. Ceiling Insulation R-Values for Climate Zones 2-8 for the 2018 and 2021 IECC

| Climate Zone | 2018 IECC | 2021 IECC |
|--------------|-----------|-----------|
| 2 - 3 | R-38 | R-49 |
| 4 - 8 | R-49 | R-60 |

D.5 RE35: Increased Stringency of Fenestration U-Factors

RE35 improves fenestration U-factors in climate zones 3 and 4 from 0.32 to 0.30. All prototype window U-factors in climate zones 3, 4A, and 4B were reduced to 0.30. Table D.6 shows the fenestration U-factors in 2018 and 2021 IECC.

Table D.6. Ceiling insulation R-Values for Climate Zones 2-8 for the 2018 and 2021 IECC

| Climate Zone | 2018 IECC | 2021 IECC |
|--------------|-----------|-----------|
| 3, 4A & 4B | 0.32 | 0.30 |

D.6 RE133: Increase Mechanical Ventilation Fan Efficacy

RE133 adds new efficacy requirements for whole-house mechanical ventilation fans based on fan location. The residential prototypes utilize a simple bathroom exhaust fan running continuously. For the 2018 IECC, the fan efficacy was 1.4 cfm/watt. For 2021 IECC, the fan efficacy was increase to 2.8 cfm/watt. Table D.7 shows the fan efficacies used in the quantitative analysis.

Table D.7. Mechanical Fan Efficacies for the 2018 and 2021 IECC

| Climate Zone | 2018 IECC | 2021 IECC |
|--------------|--------------|--------------|
| 1-6 | 1.4 cfm/watt | 2.8 cfm/watt |

D.7 RE139: Requiring Heat Recovery Ventilators in Climate Zones 7-8

RE139 adds new language in the 2021 IECC requiring dwelling units in climate zones 7 and 8 be provided with a heat recovery or energy recovery ventilator. The ventilation system is to be balanced with a sensible heat recovery efficiency not less than 65 percent.

For the quantitative analysis, a heat recovery ventilator replaced the exhaust fan in both single family and multifamily prototypes as a balanced air system (one supply fan and one exhaust fan) within the airflow network. The HRV provides 45 cfm of continuous ventilation for the multifamily dwelling units and 60 cfm of continuous ventilation for the single-family home. The recovery efficiency was set to 65 percent and fan efficacy for both the supply and exhaust fans were each set to 2.4 cfm/watt so that the HRV system efficacy meets the required 1.2 cfm/watt. Table D.8 highlights the ventilation fan efficacies for the heat recovery ventilator

Table D.8. Heat Recovery Ventilation Fan Efficacy for the 2018 and 2021 IECC

| Exhaust System | 2018 IECC | 2021 IECC |
|-------------------------|-----------|--------------|
| HRV Fan Efficacy | NA | 1.2 cfm/watt |
| HRV Recovery Efficiency | NA | 65% |

D.8 RE148: Exterior Lighting Allowances

RE148 adds new language to the 2021 IECC that requires R-2, R-3, and R-4 buildings to comply with Section C405.5 of the IECC. Section C405.5 governs the exterior lighting power requirements based on the exterior lighting zone of the building. This proposal only applies to the multifamily prototypes in the quantitative analysis.

The exterior lighting configuration of the residential multifamily prototypes were aligned with the multifamily prototypes used in the commercial (ASHRAE 90.1) determination. Lighting allowances were selected from Exterior Lighting Zone 2, which consists of residential zoning. Three areas of exterior lighting were considered for the residential multifamily buildings: the base wattage allowance plus parking and façade lighting. Table D.9 highlights the exterior lighting allowances for each area.

Table D.9. Exterior lighting allowances for 2021 IECC

| Lighting Area | Area (ft ²) | 2021 IECC Allowance | Total Wattage |
|-----------------|-------------------------|-------------------------|---------------|
| Base Wattage | N/A | 400 W | 400 |
| Parking Area | 19,483 | 0.04 W/ft ² | 794 |
| Façade Lighting | 853 | 0.075 W/ft ² | 64 |

Residential editions of the IECC prior to the 2021 IECC did not regulate exterior lighting. As a result, any amount of connected power would be acceptable in both single family and multifamily buildings. However, past DOE analyses have assumed a modest level of exterior lighting in the residential prototypes. To implement the new requirements for the 2021 IECC only while maintaining the original exterior lighting power assumptions for the 2018 IECC and earlier codes would show an unrealistic increase in energy consumption. The unregulated exterior lighting power simulated for earlier energy codes was much lower than the lighting allowances in Section C405.5. Because of this, the decision was made to model the exterior lighting equally for the 2018 IECC and 2021 IECC according to Section C405.5. The result is zero lighting savings from exterior lighting. If the exterior lighting allowances are changed in future editions of the IECC, the energy savings (or losses) can be captured in the associated determination studies.

D.9 RE209: Additional Energy Efficiency Packages

RE209 adds Section R408 to the 2021 IECC to establish five efficiency packages with the goal of adding an additional 5 percent of energy efficiency by various means. For the prescriptive compliance path, one of the five additional efficiency packages must be utilized in the design home. The five efficiency packages are as follows:

- Enhanced Envelope Option: Proposed Design UA $\leq 0.95 \times$ Standard Design UA
- More Efficient HVAC Equipment Performance Option:

- Furnace \geq 95 AFUE and Air Conditioner \geq 16 SEER
- Heat Pump \geq 10 HSPF / 16 SEER
- Reduced Energy Use in Service Water Heating Option:
 - Fossil Fuel Water Heating System \geq 0.82 EF
 - Electric Water Heating System \geq 2.0 EF
 - Solar Water Heating System \geq 0.4 Solar Fraction
- More Efficient Duct Thermal Distribution System Option:
 - 100 percent of ducts located entirely within the building thermal envelope
 - 100 percent systems ductless or hydronic system located within building thermal envelope
- Improved Air Sealing and Efficient Ventilation System Option:
 - Measured air leakage \leq 3.0 ACH50
 - Heat/Energy Recovery Ventilator.

Based on PNNL discussions with directors of the ENERGY STAR New Homes Program, builders typically utilize high-efficiency water heating systems to meet the efficiency demands of the program. Builders found that installing high-efficiency water heaters were the most cost-effective way to meet the ERI target requirements for ENERGY STAR certification. Based on these discussions, the Reduced Energy Use in Service Water Heating Option was selected to represent this proposal. Factors considered were initial installation cost and builder choices for additional energy efficiency necessary to certify with the ENERGY STAR New Homes program.

The residential prototype water heaters are storage type water heaters and utilize the same fuel type as that for the space heating. The four space heating system types are gas furnace, oil furnace, electric furnace, and heat pump. Thus, there are two fossil fuel space heating and water heating systems and two electric space heating and water heating systems. Table D.10 shows the water heating systems set up for the 2021 IECC to represent reduced energy use in service water heating as compared to the 2018 IECC.

Table D.10. Water Heating Systems modeled for 2018 IECC and for the additional efficiency option package for 2021 IECC

| Space Heating Type | 2018 IECC Water Heating | 2021 IECC Water Heating |
|--------------------|-----------------------------------|-------------------------|
| Gas Furnace | Gas Storage, 0.58 EF, 40 gal | Gas Tankless, 0.82 EF |
| Oil Furnace | Oil Storage, 0.61 EF, 52 gal | HPWH, 2.0 EF, 50 gal |
| Electric Furnace | Electric Storage, 0.92 EF, 52 gal | HPWH, 2.0 EF, 50 gal |
| Heat Pump | Electric Storage, 0.92 EF, 52 gal | HPWH, 2.0 EF, 50 gal |

The reduced energy use in service water heating option allows an oil water heating system (tankless or storage) to be used in oil-heated homes. However, according to the Air Conditioning, Heating, and Refrigeration Institute (AHRI) directory,¹ the highest listed energy factor for oil water heaters is 0.68. Oil water heaters with an energy factor of 0.82 do not exist.

¹ <https://www.ahridirectory.org>

Research indicated that electric resistance water heaters are more common than oil-fired water heaters in new buildings heated by oil. Propane furnaces are more common currently in the northeast than oil furnaces. To represent new construction with oil furnaces, the decision was made to utilize a heat pump water heater to obtain the reduced energy for water heating. There was resistance to utilizing a gas water heater as having three fuel types in a single home is likely rare.

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Exhibit K.3

PNNL-31605

Cost-Effectiveness of the 2021 IECC for Residential Buildings in Minnesota

July 2021

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Cost-Effectiveness of the 2021 IECC for Residential Buildings in Minnesota

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Prepared for
the U.S. Department of Energy
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Highlights

The 2021 IECC provides cost-effective levels of energy efficiency and performance for residential buildings in Minnesota

Moving to the 2021 International Energy Conservation Code (IECC) is cost-effective for both single-family and low-rise multifamily residential buildings in Minnesota. The 2021 IECC will provide statewide energy savings of 9.1% across all climate zones compared to the current state energy code. This equates to \$ 231 of annual utility bill savings for the average Minnesota household. It will reduce statewide CO₂ emissions over 30 years by 9,524,000 metric tons, equivalent to the annual CO₂ emissions of 2,071,000 cars on the road (1 MMT CO₂ = 217,480 cars driven/year). Updating the state energy code based on the 2021 IECC will also stimulate the creation of high-quality jobs across the state. Adopting the 2021 IECC in Minnesota is expected to result in homes that are energy efficient, more affordable to own and operate, and based on current industry standards for health, comfort and resilience.

The average expected statewide economic impact (per dwelling unit) of upgrading to the 2021 IECC is shown in the tables below based on cost-effectiveness and carbon metrics established by the U.S. Department of Energy.¹

Consumer Impact

| Metric | Compared to the 2015 IECC with amendments |
|--|---|
| Life-cycle cost savings of the 2021 IECC | \$2,772 |
| Net annual consumer cash flow in year 1 of the 2021 IECC ² | \$76 |
| Annual (first year) energy cost savings of the 2021 IECC (\$) ³ | \$231 |
| Annual (first year) energy cost savings of the 2021 IECC (%) ⁴ | 9.1% |

¹ A weighted average is calculated across building configurations and climate zones.

² The annual cash flow is defined as the net difference between annual energy savings and annual cash outlays (mortgage payments, etc.), including all tax effects but excluding up-front costs (mortgage down payment, loan fees, etc.). First-year net cash flow is reported; subsequent years' cash flow will differ due to the effects of inflation and fuel price escalation, changing income tax effects as the mortgage interest payments decline, etc.

³ Annual energy savings is reported at time zero, before any inflation or price escalations are considered.

⁴ Annual energy savings is reported as a percentage of end uses regulated by the IECC (HVAC, water heating, and interior lighting).

Statewide Impact - Emissions

| Statewide Impact | First Year | 30 Years Cumulative |
|--|-------------------|----------------------------|
| Energy cost savings, \$ | 2,629,000 | 826,200,000 |
| CO ₂ emission reduction, Metric tons | 20,710 | 9,524,000 |
| CH ₄ emissions reductions, Metric tons | 1.44 | 661 |
| N ₂ O emissions reductions, Metric tons | 0.202 | 93 |
| NO _x emissions reductions, Metric tons | 14.71 | 6,764 |
| SO _x emissions reductions, Metric tons | 15.16 | 6,969 |

Statewide Impact – Jobs Created

| Statewide Impact | First Year | 30 Years Cumulative |
|---|-------------------|----------------------------|
| Jobs Created -- Reduction in Utility Bills | 110 | 2974 |
| Jobs Created -- Construction Related Activities | 317 | 8569 |

Acronyms and Abbreviations

| | |
|------------------|---|
| AVERT | U.S. EPA Avoided Emissions and GeneRation Tool |
| BC3 | Building Component Cost Community |
| BECP | Building Energy Codes Program |
| CH ₄ | Methane |
| CO ₂ | Carbon Dioxide |
| CPI | consumer price index |
| DOE | U.S. Department of Energy |
| E.O. | Executive Order |
| eGRID | EPA Emissions & Generation Resource Integrated Database dataset |
| EIA | Energy Information Administration |
| EPA | Environmental Protection Agency |
| ERI | Energy Rating Index |
| GHG | greenhouse gas |
| IAM | Integrated assessment models |
| ICC | International Code Council |
| IECC | International Energy Conservation Code |
| LCC | Life-Cycle Cost |
| NAHB | National Association of Home Builders |
| N ₂ O | Nitrous Oxide |
| NO _x | Nitrogen Oxides |
| PNNL | Pacific Northwest National Laboratory |
| SO _x | Sulfur Oxides |

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1.0 Cost-Effectiveness Results for the 2021 IECC for Minnesota

This section summarizes the cost-effectiveness analysis in terms of three primary economic metrics applicable to the homeowner:

- **Life-Cycle Cost (LCC):** Full accounting over a 30-year period of the cost savings, considering energy savings, the initial investment financed through increased mortgage costs, tax impacts, and residual values of energy efficiency measures
- **Consumer Cash Flow:** Net annual cost outlay (i.e., difference between annual energy cost savings and increased annual costs for mortgage payments, etc.)
- **Simple Payback Period:** Number of years required for energy cost savings to exceed the incremental first costs of a new code, ignoring inflation and fuel price escalation rates

LCC savings is the primary metric established by the U.S. Department of Energy (DOE) to assess the economic impact of residential building energy codes. Simple payback period and the Consumer Cash Flow analysis are reported to provide additional information to stakeholders, including states which have established a range of alternative economic metrics. Both the LCC savings and the year-by-year cash flow values from which it is calculated assume that initial costs are mortgaged, that homeowners take advantage of mortgage interest tax deductions, that individual efficiency measures are replaced with like measures at the end of their useful lifetimes, and that efficiency measures may retain a prorated residual value at the end of the 30-year analysis period.

Societal benefits such as benefits from energy codes as well as reduction of carbon emissions and jobs generated from moving to the 2021 IECC are discussed in Section 5.0.

A complete description of the DOE methodology for assessing the cost-effectiveness of building energy codes is available on energycodes.gov¹.

1.1 Life-Cycle Cost

The Life-Cycle Cost (LCC) analysis computes overall cost savings per dwelling unit resulting from implementing the efficiency improvements of a new energy code. LCC savings is based on the net change in overall cash flows (energy savings minus additional costs) resulting from implementing a new energy code, and balances incremental costs of construction against longer-term energy savings, including consideration for costs of operations and replacements, as needed. LCC savings is a sum over an analysis period of 30 years. Future cash flows, which vary from year to year, are discounted to present values using a discount rate that accounts for the changing value of money over time. LCC savings is the primary economic metric established by DOE for assessing the cost-effectiveness of building energy codes.

Table 1 shows the LCC savings (discounted present value) over the 30-year analysis period for the 2021 IECC compared to the 2015 IECC with amendments.

¹ https://www.energycodes.gov/sites/default/files/documents/residential_methodology_2015.pdf

Table 1. Life-Cycle Cost Savings of the 2021 IECC compared to the 2012 IECC with amendments

| Climate Zone | Life-Cycle Cost Savings (\$) |
|----------------------|------------------------------|
| 5A | 2,478 |
| 6A | 2,539 |
| 7 | 4,508 |
| State Average | 2,772 |

Note: Warm-humid climate zones are labeled "WH"

1.2 Consumer Cash Flow

The Consumer Cash Flow results are derived from the year-by-year calculations that underlie the Life-Cycle Cost savings values shown above. The specific cash flow values shown here allow an assessment of how annual cost outlays are compensated by annual energy savings and the time required for cumulative energy savings to exceed cumulative costs, including both increased mortgage payments and the down payment and other up-front costs.

Table 2 shows the per-dwelling-unit impact of the improvements in the 2021 IECC on Consumer Cash Flow compared to the 2012 IECC with amendments.

Table 2. Consumer Cash Flow from Compliance with the 2021 IECC Compared to the 2012 IECC with amendments

| | Cost/Benefit | 5A | 6A | 7 | State Average |
|---|--|-------|-------|-------|---------------|
| A | Incremental down payment and other first costs | \$361 | \$351 | \$556 | \$376 |
| B | Annual energy savings (year one) | \$220 | \$220 | \$376 | \$238 |
| C | Annual mortgage increase | \$125 | \$121 | \$192 | \$130 |
| D | Net annual cost of mortgage interest deductions, mortgage insurance, and property taxes (year one) | \$31 | \$30 | \$48 | \$32 |
| E | = Net annual cash flow savings (year one) [B-(C+D)] | \$65 | \$68 | \$136 | \$76 |
| F | = Years to positive savings, including up-front cost impacts [A/E] | 5 | 5 | 4 | 5 |

Note: Item D includes mortgage interest deductions, mortgage insurance, and property taxes for the first year. Deductions can partially or completely offset insurance and tax costs. As such, the "net" result appears relatively small or is sometimes even negative.

1.3 Simple Payback Period

The simple payback period is a straightforward metric including only the costs and benefits directly related to the implementation of energy-saving measures associated with a code change. It represents the number of years required for the energy savings to pay for the cost of the measures, without regard for inflation, changes in fuel prices, tax effects, measure replacements, resale values, etc. The simple payback period is useful for its ease of calculation and understandability. Because it focuses on the two primary characterizations of a code change—cost and energy performance—it allows an assessment of cost effectiveness that is easy to compare with other investment options and requires a minimum of input data. DOE reports the simple payback period because it is a familiar metric used in many contexts, and because some states have expressed the desire for this metric. However, because it ignores many of the longer-term factors in the economic performance of an energy-efficiency investment, DOE does not use the payback period as a primary indicator of cost effectiveness for its own decision-making purposes.

Table 3 shows the simple payback period for the 2021 IECC. The simple payback period is calculated by dividing the incremental construction cost by the annual energy cost savings assuming time-zero fuel prices. It estimates the number of years required for the energy cost savings to pay back the incremental cost investment without consideration of financing of the initial costs through a mortgage, the favored tax treatment of mortgages, the useful lifetimes of individual efficiency measures, or future escalation of fuel prices.

Table 3. Simple Payback Period for the 2021 IECC Compared to the 2012 IECC with amendments

| Climate Zone | Payback Period (Years) |
|----------------------|------------------------|
| 5A | 13.1 |
| 6A | 12.8 |
| 7 | 11.8 |
| State Average | 12.6 |

2.0 Overview of the Cost-Effectiveness Analysis Methodology

This analysis was conducted by Pacific Northwest National Laboratory (PNNL) in support of the DOE Building Energy Codes Program. DOE is directed by federal law to provide technical assistance supporting the development and implementation of residential and commercial building energy codes. The national model energy codes—the International Energy Conservation Code (IECC) and ANSI/ASHRAE/IES Standard 90.1—help adopting states and localities establish minimum requirements for energy-efficient building design and construction, as well as mitigate environmental impacts and ensure residential and commercial buildings are constructed to modern industry standards.

The current analysis evaluates the cost-effectiveness of the 2021 edition of the IECC, relative to the 2012 IECC with amendments. The analysis covers one- and two-family dwelling units, townhouses, and low-rise multifamily residential buildings covered by the residential provisions of the IECC. The analysis is based on the prescriptive requirements of the IECC. The IECC's simulated performance path (Section 405) and Energy Rating Index (ERI) path (Section 406) are not in the scope of this analysis, as they are generally based on the core prescriptive requirements of the IECC, and due to the unlimited range of building configurations that are allowed. Buildings complying via these paths are generally considered to provide equal or better energy performance compared to the prescriptive requirements, as the intent of these paths is to provide additional design flexibility and cost optimization, as dictated by the builder, designer or homeowner.

The current analysis is based on the methodology by DOE for assessing energy savings and cost-effectiveness of residential building energy codes (Taylor et al. 2015). The LCC analysis perspective described in the methodology appropriately balances upfront costs with longer term consumer costs and savings and is therefore the primary economic metric by which DOE evaluates the cost-effectiveness of building energy codes.

2.1 Estimation of Energy Usage and Savings

In order to estimate the energy impact of residential code changes, PNNL developed a single-family prototype building and a low-rise multifamily prototype building to represent typical new residential building construction (BECF 2012, Mendon et al. 2014, and Mendon et al. 2015). The key characteristics of these prototypes are:

- **Single-Family Prototype:** A two-story home with a roughly 30-ft by 40-ft rectangular shape, 2,376 ft² of conditioned floor area excluding the conditioned basement (if any), and window area equal to 15% of the conditioned floor area equally distributed toward the four cardinal directions.
- **Multifamily Prototype:** A three-story building with 18 dwelling units (6 units per floor), each unit having conditioned floor area of 1,200 ft² and window area equal to approximately 23% of the exterior wall area (not including breezeway walls) equally distributed toward the four cardinal directions.

These two building prototypes are further expanded to cover four common heating systems (natural gas furnace, heat pump, electric resistance, oil-fired furnace) and four common foundation types (slab-on-grade, heated basement, unheated basement, crawlspace), leading to an expanded set of 32 residential prototype building models. This set is used to simulate the

energy usage for typical homes built to comply with the requirements of the 2021 IECC and those built to comply with the requirements of the for one location in each climate zone¹ in the state using DOE's *EnergyPlus*TM software, version 9.5 (DOE 2021). Energy savings of the 2021 IECC relative to the 2015 IECC with amendments, including space heating, space cooling, water heating, lighting and plug loads are extracted from the simulation results.

2.2 Climate Zones

Climate zones are defined in ASHRAE Standard 169, as specified in ASHRAE Standard 90.1, and include eight primary climate zones in the United States, the hottest being climate zone 1 and the coldest being climate zone 8. Letters A, B, and C are applied in some cases to denote the level of moisture, with A indicating humid, B indicating dry, and C indicating marine. Figure 3 shows the national climate zones. For this state analysis, savings are analyzed for each climate zone in the state using weather data from a selected city within the climate zone and state, or where necessary, a city in an adjoining state with more robust weather data.

¹ One location is simulated for each combination of climate zone, moisture regime (Moist, Dry, Marine) and humidity designation (Warm-Humid, Not Warm-Humid) that exists in the state.

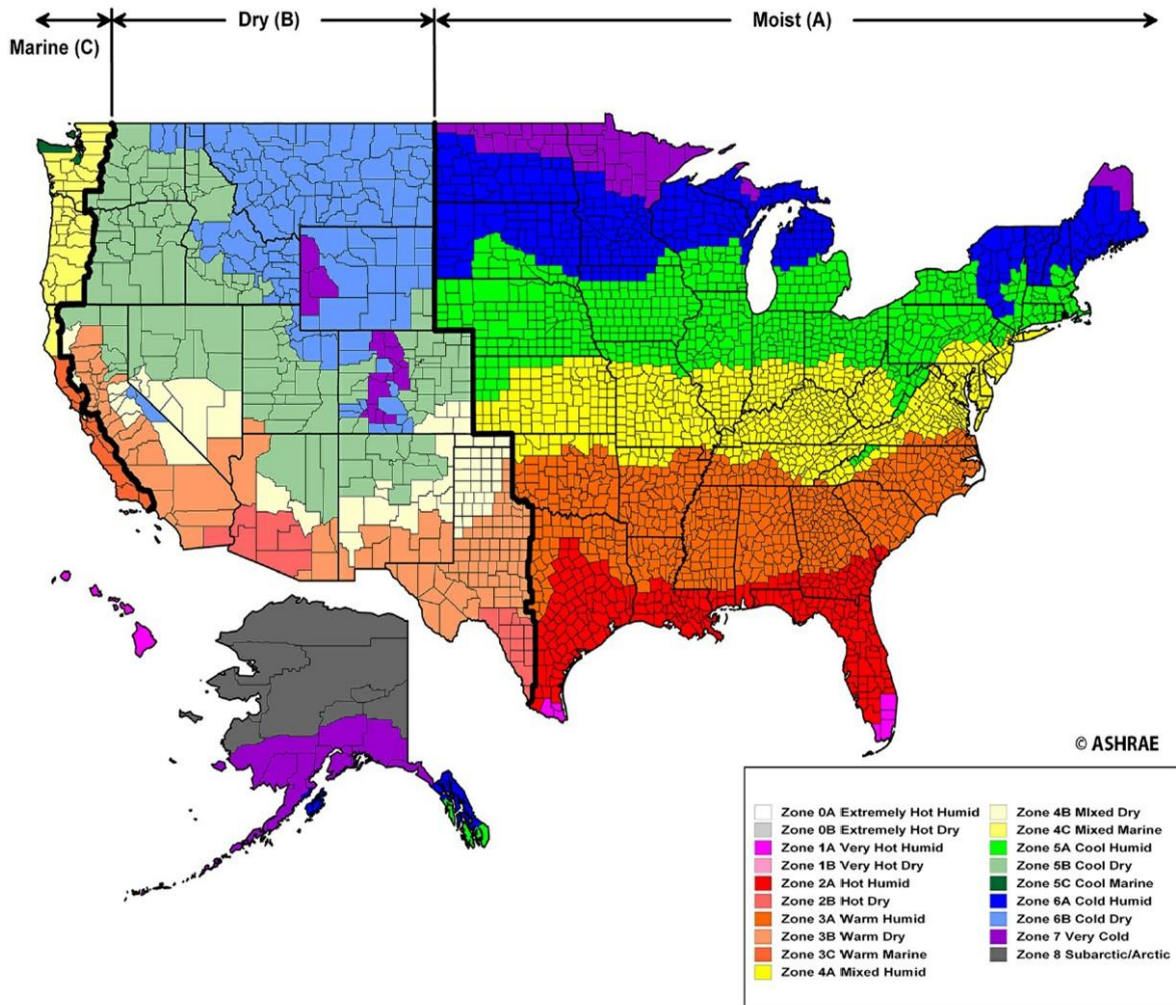


Figure 1. National Climate Zones

2.3 Fuel Prices

The energy savings from the simulation analysis are converted to energy cost savings using the most recent state-specific residential fuel prices from DOE’s Energy Information Administration (EIA 2020a, EIA 2020b, EIA 2020c). The fuel prices used in the analysis are shown in Table 4.

Table 4. Fuel Prices used in the Analysis

| Electricity (\$/kWh) | Gas (\$/Therm) | Oil (\$/MBtu) |
|-------------------------|-------------------|------------------|
| 0.135 | 0.713 | 2.279 |

2.4 Financial and Economic Parameters

The financial and economic parameters used in calculating the LCC and annual consumer cash flow are based on the latest DOE cost-effectiveness methodology (Taylor et al. 2015) to represent the current economic scenario. The parameters are summarized in Table 5 for reference.

Table 5. Economic Parameters Used in the Analysis

| Parameter | Value |
|--|-----------------------|
| Mortgage interest rate (fixed rate) | 3% |
| Loan fees | 1% of mortgage amount |
| Loan term | 30 years |
| Down payment | 12% of home value |
| Nominal discount rate (equal to mortgage rate) | 3% |
| Inflation rate | 1.4% |
| Marginal federal income tax | 12% |
| Marginal state income tax | 6.8% |
| Property tax | 1.05% |

2.5 Aggregation Scheme

Energy results, weighted by foundation and heating system type, are provided at the state level and separately for each climate zone within the state. The distribution of heating systems for Minnesota is derived from data collected by the National Association of Home Builders data (NAHB 2009) and is summarized in Table 6. The distribution of foundation types is derived from the Residential Energy Consumption Survey data (RECS 2013) and is summarized in Table 7. The single-family and multifamily results are combined for each climate zone in the state and the climate zone results are combined to calculate a weighted average for the state using 2019 new residential construction starts from the 2010 U.S. Census data (Census 2010). The distribution of single- and multifamily building starts is summarized in Table 8.

Table 6. Heating Equipment Shares

| Heating System | Share of New Homes (percent) | |
|---------------------|------------------------------|-------------|
| | Single-Family | Multifamily |
| Natural Gas | 59.2 | 59.2 |
| Heat Pump | 36.4 | 36.4 |
| Electric Resistance | 3.6 | 3.6 |
| Oil | 0.8 | 0.8 |

Table 7. Foundation Type Shares

| Foundation Type | Slab-on-grade | Heated Basement | Unheated Basement | Crawlspace |
|------------------------------|---------------|-----------------|-------------------|------------|
| Share of New Homes (percent) | 22 | 46.3 | 14.6 | 17.1 |

Table 8. Construction Shares by Climate Zone

| Climate Zone | Share of New Homes (percent) | |
|--------------|------------------------------|-------------|
| | Single-Family | Multifamily |
| 5A | 53.6 | 46.4 |
| 6A | 53.6 | 46.4 |
| 7 | 53.6 | 46.4 |

3.0 Incremental Construction Costs

In order to evaluate the cost-effectiveness of the changes introduced by the 2021 IECC over the 2015 IECC, PNNL estimated the incremental construction costs associated with these changes. For this analysis, cost data sources consulted by PNNL include:

- Building Component Cost Community (BC3) data repository (DOE 2012)
- Construction cost data collected by Faithful+Gould under contract with PNNL (Faithful + Gould 2012)
- RS Means Residential Cost Data (RSMeans 2020)
- National Residential Efficiency Measures Database (NREL 2014)
- Price data from nationally recognized home supply stores

The consumer price index (CPI) is used to adjust cost data from earlier years to the study year (U.S. Inflation Calculator 2021).

The estimated costs of implementing the prescriptive provisions of the 2021 IECC over the 2012 IECC with amendments are taken from earlier PNNL studies that evaluated the cost-effectiveness (Lucas et al. 2012), (Mendon et.al. 2015) and (Taylor et al. 2019). The national scope costs from those studies are adjusted to reflect local construction costs in using location factors provided by RSMeans (2020). The incremental costs of implementing the provisions of the 2021 IECC over the 2018 IECC are described in National Cost Effectiveness of the Residential Provisions of the 2021 IECC (Salcido et al. 2021).

Table 9 and Table 10 show the incremental construction costs associated with the 2021 IECC compared to the 2012 IECC with amendments for an individual dwelling unit. Table 9 shows results for a house and Table 10 shows results for an apartment or condominium. These have been adjusted using a construction cost multiplier, 1.0603, to reflect local construction costs based on location factors provided by RSMeans (2020).

Table 9. Total Single-Family Construction Cost Increase for the 2021 IECC Compared to the 2012 IECC with amendments (\$)

| Single-family Prototype House | | | | |
|-------------------------------|------------|-----------------|---------|-------------------|
| Climate Zone | Crawlspace | Heated Basement | Slab | Unheated Basement |
| 5A | \$3,703 | \$3,703 | \$4,248 | \$3,703 |
| 6A | \$3,703 | \$3,703 | \$3,703 | \$3,703 |
| 7 | \$5,294 | \$5,294 | \$5,294 | \$5,294 |

Table 10. Total Multifamily Construction Cost Increase for the 2021 IECC Compared to the 2012 IECC with amendments (\$)¹

| Multifamily Prototype Apartment/Condo | | | | |
|--|-------------------|------------------------|-------------|--------------------------|
| Climate Zone | Crawlspace | Heated Basement | Slab | Unheated Basement |
| 5A | \$1,602 | \$1,602 | \$1,682 | \$1,602 |
| 6A | \$1,602 | \$1,602 | \$1,602 | \$1,602 |
| 7 | \$3,192 | \$3,192 | \$3,192 | \$3,192 |

¹ In the multifamily prototype model, the heated basement is added to the building, and not to the individual apartments. The incremental cost associated with heated basements is divided among all apartments equally.

4.0 Energy Cost Savings

2012 IECC with amendments

Table 11 and Table 12 show the estimated the annual per-dwelling unit energy costs of end uses regulated by the IECC as well as miscellaneous end use loads, which comprise heating, cooling, water heating, lighting, fans, mechanical ventilation and plug loads that result from meeting the requirements of the 2021 IECC and the 2012 IECC with amendments

Table 11. Annual (First Year) Energy Costs for the 2012 IECC with amendments

| Climate Zone | 2012 IECC with amendments | | | | | | |
|----------------------|---------------------------|--------------|---------------|--------------|--------------|-------------|----------------|
| | Heating | Cooling | Water Heating | Lighting | Fans | Vents | Total |
| 5A | \$785 | \$160 | \$251 | \$188 | \$117 | \$77 | \$2,475 |
| 6A | \$812 | \$168 | \$251 | \$188 | \$119 | \$77 | \$2,511 |
| 7 | \$1,089 | \$90 | \$276 | \$188 | \$109 | \$77 | \$2,726 |
| State Average | \$844 | \$159 | \$254 | \$188 | \$117 | \$77 | \$2,536 |

Table 12. Annual (First Year) Energy Costs for the 2021 IECC

| Climate Zone | 2021 IECC | | | | | | |
|----------------------|--------------|--------------|---------------|--------------|--------------|-------------|----------------|
| | Heating | Cooling | Water Heating | Lighting | Fans | Vents | Total |
| 5A | \$827 | \$133 | \$109 | \$166 | \$107 | \$23 | \$2,261 |
| 6A | \$852 | \$142 | \$110 | \$166 | \$109 | \$23 | \$2,298 |
| 7 | \$952 | \$80 | \$122 | \$166 | \$92 | \$53 | \$2,361 |
| State Average | \$863 | \$135 | \$111 | \$166 | \$107 | \$26 | \$2,305 |

Table 13 shows the first-year energy cost savings as both a net dollar savings and as a percentage of the total regulated end use energy costs. Results are weighted by single- and multifamily housing starts, foundation type, and heating system type.

Table 13. Total Energy Cost Savings (First Year) for the 2021 IECC Compared to the 2012 IECC with amendments

| Climate Zone | First Year Energy Cost Savings | First Year Energy Cost Savings (percent) |
|----------------------|--------------------------------|--|
| 5A | \$214 | 8.6% |
| 6A | \$213 | 8.5% |
| 7 | \$365 | 13.4% |
| State Average | \$231 | 9.1% |

5.0 Societal Benefits

5.1 Benefits of Energy Codes

It is estimated that by 2060, the world will add 2.5 trillion square feet of buildings, an area equal to the current building stock. As a building's operation and environmental impact is largely determined by upfront decisions, energy codes present a unique opportunity to assure savings through efficient building design, technologies, and construction practices. Once a building is constructed, it is significantly more expensive to achieve higher efficiency levels through later modifications and retrofits. Energy codes ensure that a building's energy use is included as a fundamental part of the design and construction process; making this early investment in energy efficiency will pay dividends to residents of Minnesota for years into the future.

5.2 Greenhouse Gas Emissions

The urban built environment is responsible for 75% of annual global greenhouse gas (GHG) emissions while buildings alone account for 39%.¹ On January 20, 2021, President Biden issued Executive Order (E.O.) 13990,² which noted that it is essential that agencies capture the full costs of greenhouse gas emissions as accurately as possible, including by taking global damages into account and that doing so facilitates sound decision-making, recognizes the breadth of climate impacts, and supports the international leadership of the United States on climate issues.

While carbon dioxide emissions represent the largest share of greenhouse gas emissions, building electricity use and fossil fuel consumption on site also contribute to the release of other emissions, two of which, methane (CH₄) and nitrous oxide (N₂O) are significant greenhouse gases in their own right.

For natural gas and for fuel oil combusted on site, emission metrics are developed using nationwide emission factors from U.S. Environmental Protection Agency publications for CO₂, NO_x, SO₂, CH₄ and N₂O (EPA 2014). For electricity, marginal carbon emission factors are provided by the U.S. Environmental Protection Agency (EPA) AVoided Emissions and GeneRation Tool (AVERT) version 3.0 (EPA 2020). The AVERT tool forms the basis of the national marginal emission factors for electricity also published by EPA on its Greenhouse Gas Equivalencies Calculator website and are based on a portfolio of energy efficiency measures examined by EPA. AVERT is used here to provide marginal CO₂ emission factors at the State level.³ AVERT also provides marginal emission factor estimates for gaseous pollutants

¹ Architecture 2030

² Exec. Order No. 13990, 86 Fed. Reg. 7037 (January 20, 2021)

<<https://www.federalregister.gov/documents/2021/01/25/2021-01765/protecting-public-health-and-the-environment-and-restoring-science-to-tackle-the-climate-crisis>>

³ AVERT models avoided emissions in 14 geographic regions of the 48 contiguous United States and includes transmission and distribution losses. Where multiple AVERT regions overlap a state's boundaries, the emission factors are calculated based on apportionment of state electricity savings by generation across generation regions. The most recent AVERT 3.0 model uses EPA emissions data for generators from 2019. Note that AVERT estimates are based on marginal changes to demand and reflect current grid generation mix. Emission factors for electricity shown in **Error! Reference source not found.** do not take into account long term policy or technological changes in the regional generation mix that can impact the marginal emission benefits from new building codes.

associated with electricity production, including NO_x and SO₂ emissions. While not considered significant greenhouse gases, these are EPA tracked pollutants. The current analysis uses AVERT to provide estimates of corresponding emission changes for NO_x and SO₂ in physical units but does not monetize these.

AVERT does not develop associated marginal emissions factors for CH₄ or N₂O. To provide estimates for the associated emission reductions for CH₄ and N₂O, this report uses emission factors separately provided through the U.S. Environmental Protection Agency (EPA) Emissions & Generation Resource Integrated Database (eGRID) dataset. eGRID is a comprehensive source of data on the environmental characteristics of almost all electric power generated in the United States and the emission characteristics for electric power generation for each of the above emissions can also be found aggregated down to the state level in eGRID (EPA 2021a). The summary emission factor data provided by eGRID does not provide marginal emission factors, but instead summarizes emission factors in terms of total generation emission factors and non-baseload generation emission factors. Non-baseload emission factors established in eGRID are developed based on the annual load factors for the individual generators tracked by the EPA (EPA 2021b). Because changes in building codes are unlikely to significantly impact baseload electrical generators, the current analysis uses the 2019 non-baseload emission factors established in eGRID by state to estimate CH₄ or N₂O emission reductions due to changes in electric consumption.

Table 14 summarizes the marginal carbon emission factors available from AVERT, eGRID and the EPA Greenhouse Gas Equivalencies Calculator.

Table 14. Greenhouse Gas Emission Factors for Minnesota by Fuel Type

| GHG | Electricity lb/MWh | Natural Gas (lb/mmcf) | Fuel Oil (lb/1000 gal) |
|------------------|-------------------------------|----------------------------------|-----------------------------------|
| CO ₂ | 1,849 | 120,000 | 23,000 |
| SO ₂ | 1.624 | 0.6 | 12 |
| NO _x | 1.281 | 96 | 19 |
| N ₂ O | 0.022 | 0.23 | 0.45 |
| CH ₄ | 0.153 | 2.3 | 0.7 |

Table 15 shows the annual first year and projected 30-year energy cost savings. This table also shows first year and projected 30-year greenhouse gas (CO₂, CH₄, and N₂O) emission reductions, in addition to NO_x and SO₂ reductions.

Table 15. Societal Benefits of the 2021 IECC

| Statewide Impact | First Year | 30 Years Cumulative |
|--|------------|---------------------|
| Energy cost savings, \$ | 2,629,000 | 826,200,000 |
| CO ₂ emission reduction, Metric tons | 20,710 | 9,524,000 |
| CH ₄ emissions reductions, Metric tons | 1.44 | 661 |
| N ₂ O emissions reductions, Metric tons | 0.202 | 93 |
| NO _x emissions reductions, Metric tons | 14.71 | 6,764 |
| SO _x emissions reductions, Metric tons | 15.16 | 6,969 |

5.3 Jobs Creation through Energy Efficiency

Energy-efficient building codes impact job creation through two primary value streams:

1. Dollars returned to the economy through reduction in utility bills and resulting increase in disposable income, and;
2. An increase in construction-related activities associated with the incremental cost of construction that is required to produce a more energy efficient building.

When a home or building is built to a more stringent energy code, there is the long-term benefit of the home or building owner paying lower utility bills.

- This is partially offset by the increased cost of that efficiency, establishing a relationship between increased building energy efficiency and additional investments in construction activity.
- Since building codes are cost effective, (i.e., the savings outweigh the investment), a real and permanent increase in wealth occurs which can be spent on other goods and services in the economy, just like any other income, generating economic benefits in turn creating additional employment opportunities.

Table 16 also shows the number of jobs created because of efficiency gains in the 2021 IECC. Results are weighted by single- and multifamily housing starts, foundation type, and heating system type.

Table 16. Jobs Created from the 2021 IECC

| Statewide Impact | First Year | 30 Years Cumulative |
|---|------------|---------------------|
| Jobs Created -- Reduction in Utility Bills | 110 | 2974 |
| Jobs Created -- Construction Related Activities | 317 | 8569 |

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