中国工程建设协会标准

建筑碳排放计量标准

Standard for measuring, accounting and reporting of carbon emission from buildings

CECS 374：2014

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中国工程建设标准化协会公告

第 176 号

关于发布《建筑碳排放计量标准》的公告

根据中国工程建设标准化协会《关于印发〈2010 年第二批工程建设协会标准制订、修订计划〉的通知》(建标协字〔2010〕91 号)的要求，由中国建筑设计研究院等单位编制的《建筑碳排放计量标准》，经本协会组织审查，现批准发布，编号为 CECS 374：2014，自 2014 年 12 月 1 日起施行。

本标准的英文版同时出版发行。

中国工程建设标准化协会

二〇一四年七月二十五日

前　言

根据中国工程建设标准化协会《关于印发〈2010年第二批工程建设协会标准制订、修订计划〉的通知》(建标协字〔2010〕91号)的要求，标准编制组经广泛调查研究，认真总结各地实践经验，参考有关国内外标准，并在广泛征求各方意见的基础上，制定本标准。

本标准共分5章和3个附录，主要内容包括：总则、术语、基本规定、清单统计法、信息模型法等。

本标准由中国工程建设标准化协会归口管理，由中国建筑设计研究院国家住宅与居住环境工程技术研究中心(地址：北京市西城区车公庄大街19号，邮政编码：100044)负责解释。在使用中如发现需要修改和补充之处，请将意见和资料寄送解释单位。

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1 总　　则

1.0.1 为规范建筑碳排放数据的采集、核算与发布，做到方法科学、数据可靠、流程清晰、操作简便，制定本标准。

1.0.2 本标准适用于新建、改建和扩建建筑以及既有建筑的全生命周期碳排放计量。

1.0.3 本标准针对建筑全生命周期各阶段由于消耗能源、资源和材料所排放的二氧化碳（CO_2）进行计量，《京都议定书》规定的其他温室气体计量也可按本标准执行。

1.0.4 建筑碳排放计量，除应符合本标准外，尚应符合国家现行有关标准的规定。

2 术　　语

2.0.1 建筑全生命周期　　life cycle of buildings

建筑从材料生产至最终拆解、回收的一系列前后衔接的阶段，包括材料生产阶段、施工建造阶段、运行维护阶段、拆解阶段和回收阶段。

2.0.2 建筑碳足迹　　carbon footprint of buildings

在建筑全生命周期内产生的温室气体排放的总和，以二氧化碳当量表示。

2.0.3 建筑碳排放计量　　measuring, accounting and reporting of carbon emission from buildings

对建筑碳足迹数据进行采集、核算与发布的过程。

2.0.4 建筑碳排放单元过程　　unit process of carbon emitted from buildings

为量化建筑在全生命周期各阶段消耗的能源、资源和材料而确定的基本活动过程，是构成建筑碳足迹的基本单位。

2.0.5 活动水平数据　　activity data

反映人为活动导致温室气体排放情况的定量数据，针对建筑碳排放，主要包括材料、能源以及资源的消耗量。

2.0.6 碳排放因子　　carbon emission factor

将活动水平数据与碳排放量相对应的系数，用于量化单位活动水平数据的碳排放量。

2.0.7 清单统计法　　measuring account by inventory

通过采集建筑碳排放单元过程中的各项活动水平数据及相应的碳排放因子，按照规定的方法进行统计核算，得到建筑碳足迹的方法。

2.0.8 信息模型法　　measuring account by information modeling

通过建筑信息模型计算、管理建筑全生命周期各阶段消耗的能源、资源和材料等数据并进行核算，得到建筑碳足迹的方法。

2.0.9 全球变暖潜能值　　global warming potential

在规定的时间段内，将单位质量的温室气体辐射强度影响与等量的二氧化碳辐射强度影响相关联的系数。

2.0.10 二氧化碳当量　　carbon dioxide equivalent

用于比较不同温室气体对温室效应影响的量度单位，单位为CO_{2e}，其数值等于温室气体的质量乘以其全球变暖潜能值。

2.0.11 建筑碳汇　　carbon sink of buildings

在划定的建筑物范围内，绿化、植被从空气中吸收并存储的二氧化碳量。

3 基本规定

3.0.1 建筑碳排放计量应覆盖建筑全生命周期，以碳排放单元过程为基本单位进行数据采集与核算。

3.0.2 建筑碳排放计量应遵守相关性、完整性、一致性、准确性和透明性的原则。

3.0.3 建筑碳排放计量方法包括清单统计法和信息模型法，应根据建筑的设计建造及运行管理的实际情况进行选择。针对以常规方式设计建造及运行管理的建筑的碳排放计量，宜采用清单统计法；针对以信息模型为载体，进行信息采集、阶段信息传递及信息核算的建筑的碳排放计量，宜采用信息模型法。当不具备单独使用条件时，可结合采用两种方法。

3.0.4 建筑碳排放计量应按下列步骤进行：

1 界定建筑物的范围和区域；

2 界定建筑碳排放单元过程；

3 采集碳排放单元过程的活动水平数据；

4 采集碳排放单元过程的相关碳排放因子；

5 按照本标准规定的方法核算建筑碳排放量；

6 按照规定对外发布计量结果。

3.0.5 界定建筑碳排放单元过程应符合下列规定：

1 宜选择对建筑碳排放量有明显影响的单元过程进行计量；

2 每个单元过程应保持独立，避免重复计量；

3 对占全生命周期碳排放比重小、技术上无法量化或量化成本过高的单元过程可不计量，但应说明其对计量结果的影响。

3.0.6 材料生产阶段的主要碳排放单元过程应包括下列内容：

1 建筑主体结构材料、构件的使用；

2 建筑围护结构材料、构件、部品的使用；

3 建筑填充体材料、构件、部品、设备的使用。

3.0.7 施工建造阶段的主要碳排放单元过程应包括下列内容：

1 建筑材料、构件、部品、设备的运输；

2 施工机具的运行；

3 施工现场办公。

3.0.8 运行维护阶段的主要碳排放单元过程应包括下列内容：

1 建筑设备系统的运行；

2 建筑材料、构件、部品、设备的维护与更替；

3 更替的建筑材料、构件、部品、设备的运输。

3.0.9 拆解阶段的主要碳排放单元过程应包括下列内容：

1 拆解机具的运行；

2 废弃物的运输。

3.0.10 回收阶段的主要碳排放单元过程应包括下列内容：

1 建筑主体结构可循环材料、构件的回收；

2 建筑围护结构可循环材料、构件的回收；

3 建筑填充体可循环材料、构件的回收。

3.0.11 建筑碳排放计量的相关数据应经过质量审定，并保存相应核查或证明文件。数据的属性信息应被完整记录，具体应包括下列内容：

1 时间跨度：数据的年份以及所收集数据的时间跨度；

2 地域范围：数据所适用的地域；

3 代表性：数据集合反映的行业覆盖面的定性描述；

4 完整性：测量或估算所占的比例；

5 数据源：提供数据的机构、产品的碳标识或数据采集的渠道；

6 数据精度：数据来源、模型和假设的局限性。

3.0.12 碳排放计量结果应以吨二氧化碳（tCO_2）为单位表示，其他温室气体计量结果应以吨二氧化碳当量（tCO_{2e}）表示。

4 清单统计法

4.1 一般规定

4.1.1 清单统计法计量应按碳排放单元过程进行碳排放数据的汇编与量化，得到建筑全生命周期碳足迹。

4.1.2 采用清单统计法进行建筑碳排放计量时，建筑材料及能源的计量单位应符合国际单位制(SI)的要求。对于建筑材料及构配件应采用单位质量或单位体积；能源应采用单位质量或单位能量。

4.2 数据采集

4.2.1 数据采集应针对具体碳排放单元过程，采集内容为单元过程中反映能源、资源和材料消耗特征的活动水平数据以及相应的碳排放因子。

4.2.2 采集的活动水平数据应包括下列方面：

1 材料生产阶段：建筑主体结构、围护结构和填充体使用的材料、构件、部品、设备种类及数量；

2 施工建造阶段：材料、构件、部品、设备运输的耗能量，施工机具运行的耗能量、耗水量，施工现场办公的耗能量；

3 运行维护阶段：建筑运行的耗能量、耗水量，可再生能源的种类及使用量，维护更替活动的材料消耗量，维护更替活动的耗能量；

4 拆解阶段：拆解机具运行的耗能量，拆解废弃物运输的耗能量；

5 回收阶段：从建筑主体结构、围护结构和填充体中回收的建材、构件、部品及设备的种类及回收量。

4.2.3 活动水平数据的采集方式包括仪表监测、资料查询和分析

测算，应根据活动水平数据的类型、重要性、采集条件等因素，按下列规定合理选用：

1 当活动水平数据具备自动监测条件时，宜采用仪表监测方式进行采集，保证数据的完整性、连续性和准确性；

2 当活动水平数据不具备自动连续监测条件时，应通过查询工程建设相关技术资料、备档文件、缴费账单、财务报表等资料进行采集；

3 当活动水平数据无法通过仪表监测和资料查询的方式采集获取时，可按相关公式分析测算得到。

4.2.4 材料生产阶段中，建筑各部位使用的材料、构件、部品、设备种类及数量，应通过查询材料决算清单、施工图纸、采购清单等工程建设相关技术资料确定，并按本标准附录 A 表 A-1 进行记录。

4.2.5 施工建造阶段中，各活动水平数据应按下列方式进行采集，并按本标准附录 A 表 A—2 进行记录：

1 材料、构件、部品、设备运输的活动水平数据应通过查询能源缴费账单或工程建设财务报表得到；

2 施工机具运行的、耗水量和施工现场办公的活动水平数据宜根据施工现场的监测仪表自动记录确定；当施工现场没有安装监测仪表时，可通过查询缴费账单、财务报表进行采集。

4.2.6 施工建造阶段中，当各活动水平数据记录无法通过仪表监测，且相关资料数据难以获取或不完整时，可按下列规定进行测算，并按本标准附录 A 表 A-2 进行记录：

1 材料、构件、部品、设备运输的耗油量：

$$AD_{YS} = \sum_{i=1}^{n} \frac{G_i}{ZG_i} \cdot L_i \cdot Q_{si} \qquad (4.2.6\text{-}1)$$

式中：AD_{YS}——材料、构件、部品、设备运输的总耗油量(t)；

G_i——第 i 种类材料、构件、部品、设备使用量(t)；

ZG_i——运输第 i 种材料、构件、部品、设备的交通工具平

均载重量(t)；

Q_{si}——运输第 i 种材料、构件、部品、设备的交通工具单位耗油量(t/km)；

L_i——第 i 种材料、构件、部品、设备的运输距离(km)；

i——运输的材料、构件、部品、设备的种类代号。

2 施工机具运行的耗电量：

$$AD_{JXD} = \sum_{i=1}^{n} P_{di} \cdot T_{di} \cdot N_i \qquad (4.2.6\text{-}2)$$

式中：AD_{JXD}——施工机具的总耗电量(kWh)；

P_{di}——第 i 种施工机具的电功率(kW)；

T_{di}——第 i 种施工机具的运行小时数(h)；

N_i——第 i 种施工机具的数量(台)；

i——施工工具的种类代号。

3 施工机具运行的耗油量：

$$AD_{JXY} = \sum_{i=1}^{n} P_{yi} \cdot T_{yi} \cdot N_i \qquad (4.2.6\text{-}3)$$

式中：AD_{JXY}——施工机具的总耗油量(t)；

P_{yi}——第 i 种施工机具每台班的平均耗油量(t/台班)；

T_{yi}——第 i 种施工机具的运行台班数(次)；

N_i——第 i 种施工机具的数量(台)；

i——施工工具的种类代号。

4 施工机具运行的耗水量：

$$AD_{JXS} = \sum_{i=1}^{n} P_{si} \cdot T_{si} \cdot N_i \qquad (4.2.6\text{-}4)$$

式中：AD_{JXS}——施工机具的总耗水量(t)；

P_{si}——第 i 种施工机具每台班的平均耗水量(t/台班)；

T_{si}——第 i 种施工机具的运行台班数(次)；

N_i——第 i 种施工机具的数量(台)；

i——施工工具的种类代号。

5　施工现场办公的耗电量：

$$AD_{BGD} = \sum_{i=1}^{n} P_{di} \cdot T_{di} \cdot N_i \qquad (4.2.6\text{-}5)$$

式中：AD_{BGD}——现场办公的总耗电量(kW·h)；

P_{di}——第 i 种办公电气设备的电功率(kW)；

T_{di}——第 i 种办公电气设备的运行小时数(h)；

N_i——第 i 种办公电气设备的数量(台)；

i——办公电气设备的种类代号。

4.2.7　运行维护阶段中，建筑运行的耗能量应按现行行业标准《民用建筑能耗数据采集标准》JGJ/T 154—2007 中第 5.2.1、5.2.2、5.3.1、5.3.2 条的规定进行采集，耗水量应根据建筑冷水量总表数据进行采集，并按本标准附录 A 表 A-3 进行记录。

4.2.8　运行维护阶段中，对于没有安装监测仪表的建筑，建筑运行的耗能量可根据能耗设备系统的类型、运行参数、运行时间等信息，按下列规定进行测算，并按本标准附录 A 表 A-3 进行记录：

1　建筑运行的耗电量：

$$AD_{YXD} = \sum_{i=1}^{n} (l_i \cdot P_{di} \cdot T_{di} \cdot N_i) \qquad (4.2.8\text{-}1)$$

式中：AD_{YXD}——建筑运行的耗电量(kW·h)；

P_{di}——第 i 类设备系统的电功率(kW)；

T_{di}——第 i 类设备系统的年平均运行小时数(h/a)；

N_i——第 i 类设备系统的数量(台)；

l_i——第 i 类设备系统运行的时间年限(a)；

i——设备系统的种类代号。

2　建筑运行的燃油及燃气耗量：

$$AD_{YXYQ} = \sum_{i=1}^{n} (l_i \cdot P_{yqi} \cdot T_{yqi} \cdot N_i) \qquad (4.2.8\text{-}2)$$

式中：AD_{YXYQ}——建筑运行的燃油量(t)或燃气耗量(Nm^3)；

P_{yqi}——第 i 类设备系统的平均每小时燃油量(t/h)或燃

气耗量(Nm^3/h)；

T_{yqi}——第 i 类设备系统的年平均运行小时数(h/a)；

N_i——第 i 类设备系统的数量(台)；

l_i——第 i 类设备系统运行的时间年限(a)；

i——设备系统的种类代号。

3 建筑运行的耗煤量：

$$AD_{YXM} = \sum_{i=1}^{n}(l_i \cdot P_{mi} \cdot N_i) \qquad (4.2.8\text{-}3)$$

式中：AD_{YXM}——建筑运行的耗煤量(t)；

P_{mi}——第 i 类设备系统的年平均煤耗量(t/a)；

N_i——第 i 类设备系统的数量(台)；

l_i——第 i 类设备系统运行的时间年限(a)；

i——设备系统的种类代号。

4 建筑运行外购的蒸汽及热水耗能量：

$$AD_{YXZR} = \frac{Q_{ZR}l}{\eta \cdot h_{dw}} \qquad (4.2.8\text{-}4)$$

式中：AD_{YXZR}——建筑运行外购的蒸汽量(t)或热水折合的一次能源量(Nm^3)；

Q_{ZR}——每年外购的蒸汽或热水量(MJ/a)；

η——热力站制备蒸汽或热水的平均热效率(%)；

h_{dw}——热力站制备蒸汽或热水所用一次能源的低位发热量(MJ/t 或 MJ/Nm^3)；

l——建筑运行的时间年限(a)。

4.2.9 运行维护阶段中，对于没有安装冷水量总表的建筑，耗水量可按现行国家标准《建筑给水排水设计规范》GB 50015 的相关规定进行测算后采集。

4.2.10 运行维护阶段中，可再生能源的种类及使用量应优先根据可再生能源系统的监测系统自动记录确定；当没有安装监测系统或系统尚未运行，可通过查询可再生能源系统设计技术文件确

定。

4.2.11 运行维护阶段中，维护更替活动产生的材料消耗量和耗能量应通过查询维护更替方案确定，并按本标准附录 A 表 A-3 进行记录。

4.2.12 拆解阶段的能源消耗量应根据能源缴费清单确定，当无法获得或记录不全时，可根据建筑拆解方案，按式(4.2.6-1)～式(4.2.6-5)进行计算，并按本标准附录 A 表 A-4 进行记录。

4.2.13 回收阶段的采集对象应为建筑在拆解后主体结构、围护结构、填充体中相关材料、构件、部品、设备种类的可回收率或实际回收数量，宜根据建筑设计的材料设备清单或实际回收过程中的记录文件确定，并按本标准附录 A 表 A-5 进行记录。

4.2.14 碳排放计量所需的碳排放因子应来自公认的可靠来源，优先采用最新发布的数据，在未有完善的建筑碳排放因子数据库前，碳排放因子可从下列信息源中获取：

1 权威机构连续发布的正式出版文献；

2 经认证的学术机构研究报告；

3 各类统计年鉴和报表；

4 有关基础数据手册；

5 工厂内部的工艺信息；

6 部分能源的碳排放因子可按本标准附录 B 和附录 C 选取。

4.3 数据核算

4.3.1 建筑全生命周期的碳排放量应为材料生产阶段、施工建造阶段、运行维护阶段、拆解阶段、回收阶段中各单元过程碳排放量的总和。

4.3.2 每个碳排放单元过程的排放量应为碳排放单元过程的活动水平数据与碳排放因子的乘积，并按本标准附录 A 中表 A-6 进行记录。

4.3.3 材料生产阶段建筑碳排放量应按下式进行计算：

$$E_{SC} = \sum_{i=1}^{n}(AD_{ZTi} \cdot EF_{ZTi}) + \sum_{i=1}^{n}(AD_{WHi} \cdot EF_{WHi}) + \sum_{i=1}^{n}(AD_{TCi} \cdot EF_{TCi}) \quad (4.3.3)$$

式中：E_{SC}——材料生产阶段建筑碳排放量(tCO_2)；

AD_{ZT}——主体结构材料用量(t)；

EF_{ZT}——主体结构材料碳排放因子(tCO_2/t)；

AD_{WH}——围护结构材料用量(t)；

EF_{WH}——围护结构材料碳排放因子(tCO_2/t)；

AD_{TC}——填充体材料用量(t)；

EF_{TC}——填充体材料碳排放因子(tCO_2/t)；

i——材料种类。

4.3.4 施工建造阶段建筑碳排放量应按下式进行计算：

$$E_{SG} = \sum_{i=1}^{n}(AD_{SGDi} \cdot EF_{D}) + \sum_{i=1}^{n}(AD_{SGYi} \cdot EF_{Y}) + \sum_{i=1}^{n}(AD_{SGMi} \cdot EF_{M}) + \sum_{i=1}^{n}(AD_{SGQi} \cdot EF_{Q}) + \sum_{i=1}^{n}(AD_{SGQTi} \cdot EF_{QT}) + \sum_{i=1}^{n}(AD_{SGSHi} \cdot EF_{SH}) \quad (4.3.4)$$

式中：E_{SG}——施工建造阶段建筑碳排放量(tCO_2)；

AD_{SGD}——施工建造阶段某单元过程中的耗电量(kW·h)；

EF_{D}——电力碳排放因子[$tCO_2/(kW \cdot h)$]；

AD_{SGY}——施工建造阶段某单元过程中的耗油量(t)；

EF_{Y}——燃油碳排放因子(tCO_2/t)；

AD_{SGM}——施工建造阶段某单元过程中的耗煤量(t)；

EF_{M}——燃煤碳排放因子(tCO_2/t)；

AD_{SGQ}——施工建造阶段某单元过程中的耗燃气量(Nm^3)；

EF_Q——燃气碳排放因子(tCO_2/Nm^3)；

AD_{SGQT}——施工建造阶段某单元过程中的其他能源消耗量(tce)；

EF_{QT}——其他能源碳排放因子(tCO_2/tce)；

AD_{SGSH}——施工建造阶段某单元过程中的耗水量(t)；

EF_{SH}——水碳排放因子(tCO_2/t)；

i——单元过程种类。

4.3.5 运行维护阶段中能耗产生的碳排放量应按下式进行计算：

$$E_{YXNH} = \sum_{i=1}^{n}(AD_{YXD_i} \cdot EF_D) + \sum_{i=1}^{n}(AD_{YXY_i} \cdot EF_Y) + \sum_{i=1}^{n}(AD_{YXM_i} \cdot EF_M) + \sum_{i=1}^{n}(AD_{YXQ_i} \cdot EF_Q) + \sum_{i=1}^{n}(AD_{YXQT_i} \cdot EF_{QT}) + \sum_{i=1}^{n}(AD_{YXSH_i} \cdot EF_{SH}) - E_{ZSHJ} \quad (4.3.5\text{-}1)$$

$$E_{ZSHJ} = \sum_{j=1}^{n}(AD_{KZSji} \times EF_{KZSj} \times l) \quad (4.3.5\text{-}2)$$

式中：E_{YXNH}——运行维护阶段建筑碳排放量(tCO_2)；

AD_{YXD}——运行维护阶段某单元过程中的耗电量($kW \cdot h$)；

EF_D——电力碳排放因子[$tCO_2/(kW \cdot h)$]；

AD_{YXY}——运行维护阶段某单元过程中耗油量(t)；

EF_Y——燃油碳排放因子(tCO_2/t)；

AD_{YXM}——运行维护阶段某单元过程中耗煤量(t)；

EF_M——燃煤碳排放因子(tCO_2/t)；

AD_{YXQ}——运行维护阶段某单元过程中耗燃气量(Nm^3)；

EF_Q——燃气碳排放因子(tCO_2/Nm^3)；

AD_{YXQT}——运行维护阶段某单元过程中其他能源消耗量(tce)；

EF_{QT}——其他能源碳排放因子(tCO_2/tce)；

AD_{YXSH}——运行维护阶段某单元过程中耗水量(t)；

EF_{SH}——水碳排放因子(tCO_2/t)；

E_{ZSHJ}——建筑全生命周期中使用可再生能源的碳核减量(tCO_2)；

i——单元过程种类；

AD_{KZS_j}——可再生能源年使用量(kW·h/年或kJ/年)；

EF_{KZS}——被可再生能源替代的常规能源的碳排放因子；

l——可再生能源供应时长(a)；

j——可再生能源的种类。

4.3.6 运行维护阶段中材料构件更替产生的碳排放量应按下式进行计算：

$$E_{YXGT} = \sum_{i=1}^{n}(AD_{ZTi} \cdot EF_{ZTi}) + \sum_{i=1}^{n}(AD_{WHi} \cdot EF_{WHi}) + \sum_{i=1}^{n}(AD_{TCi} \cdot EF_{TCi}) \quad (4.3.6)$$

式中：E_{YXGT}——材料、构件更替的碳排放量(tCO_2)；

AD_{ZTi}——主体结构材料用量(t)；

EF_{ZT}——主体结构材料碳排放因子(tCO_2/t)；

AD_{WH}——围护结构材料用量(t)；

EF_{WH}——围护结构材料碳排放因子(tCO_2/t)；

AD_{TC}——填充体材料用量(t)；

EF_{TC}——填充体材料碳排放因子(tCO_2/t)；

i——材料种类。

4.3.7 拆解阶段建筑碳排放量应按下式进行计算：

$$E_{CJ} = \sum_{i=1}^{n}(AD_{CJDi} \cdot EF_{D}) + \sum_{i=1}^{n}(AD_{CJYi} \cdot EF_{Y}) + \sum_{i=1}^{n}(AD_{CJMi} \cdot EF_{M}) + \sum_{i=1}^{n}(AD_{CJQi} \cdot EF_{Q}) + \sum_{i=1}^{n}(AD_{CJQTi} \cdot EF_{QT}) + \sum_{i=1}^{n}(AD_{CJSHi} \cdot EF_{SH}) \quad (4.3.7)$$

式中：E_{CJ}——拆解阶段建筑碳排放量(tCO_2)；

AD_{CJD}——拆解阶段某单元过程中的耗电量(kW·h)；

EF_D——电力碳排放因子[$tCO_2/(kW \cdot h)$]；

AD_{CJY}——拆解阶段某单元过程中的耗油量(t)；

EF_Y——燃油碳排放因子(tCO_2/t)；

AD_{CJM}——拆解阶段某单元过程中的耗煤量(t)；

EF_M——燃煤碳排放因子(tCO_2/t)；

AD_{CJQ}——拆解阶段某单元过程中的耗燃气量(Nm^3)；

EF_Q——燃气碳排放因子(tCO_2/Nm^3)；

AD_{CJQT}——拆解阶段某单元过程中的其他能源消耗量(tce)；

EF_{QT}——其他能源碳排放因子(tCO_2/tce)；

AD_{CJSH}——拆解阶段某单元过程中的耗水量(t)；

EF_{SH}——水碳排放因子(tCO_2/t)；

i——单元过程种类。

4.3.8 回收阶段建筑碳排放量应按下式进行计算：

$$E_{HS} = \sum_{i=1}^{n} (AD_{HSi} \cdot \eta_{HSi} \cdot EF_{HSi}) \tag{4.3.8}$$

式中：E_{HS}——回收阶段建筑碳排放量(tCO_2)；

AD_{HS}——材料数量(t)；

η_{HS}——材料的回收比例(%)；

EF_{HS}——回收材料的碳排放因子(tCO_2/t)；

i——材料种类。

4.3.9 建筑全生命周期碳排放量应按下式进行计算：

$$E_{LC} = E_{SC} + E_{SG} + E_{YXNH} + E_{YXGT} + E_{CJ} - E_{HS} - E_{TH} \tag{4.3.9}$$

式中：E_{LC}——建筑全生命周期碳排放量(tCO_2)；

E_{TH}——建筑碳汇(tCO_2)。

4.3.10 年单位建筑面积碳排放量应按下式进行计算：

$$E_A = \frac{E_{LC}}{A \cdot l} \tag{4.3.10}$$

式中：E_A——建筑年单位建筑面积碳排放量（tCO_2/m^2）；

A——建筑面积（m^2）；

l——建筑运行使用年限（a）。

4.3.11 建筑全生命周期各阶段碳排放量比率应按下式进行计算：

$$\varphi_i = \frac{E_i}{E_{LC}} \tag{4.3.11}$$

式中：φ_i——建筑全生命周期各阶段碳排放量比率（%）；

E_i——建筑全生命周期各阶段碳排放量（tCO_2）；

E_{LC}——建筑全生命周期碳排放量（tCO_2）。

4.4 数据发布

4.4.1 建筑碳排放计量结果应以碳排放计量报告的形式对外发布。

4.4.2 建筑碳排放计量报告应包括下列内容及相应的假设条件和数据来源。

1 计量报告机构信息；

2 建筑的功能及运行情况；

3 单元过程碳排放量的计算过程；

4 建筑的碳排放清单；

5 数据采集方法以及来源渠道。

4.4.3 计量报告机构信息应包含下列内容：

1 报告机构的性质；

2 计量报告工作的目的及任务来源；

3 报告机构联系人及计量参与者。

4.4.4 建筑的功能及运行情况应包含下列内容：

1 建筑所在地及其范围；

2 建筑的类型及功能用途；

3 碳排放计量覆盖的生命周期阶段；

4 各生命周期阶段包含的单元过程；

5 建筑的运行使用年限。

4.4.5 计量建筑的碳排放清单应包含下列内容：

1 建筑各单元过程碳排放量；

2 建筑各生命周期阶段碳排放量；

3 建筑当前生命周期累计碳排放量；

4 建筑全生命周期碳排放总量；

5 年单位建筑面积碳排放量；

6 建筑各生命周期阶段碳排放量比率。

5 信息模型法

5.1 一般规定

5.1.1 信息模型法应以信息模型为载体，进行信息采集、阶段信息传递及信息核算，并记录全生命周期的管理过程，追踪碳足迹，通过信息管理碳排放活动。

5.1.2 信息模型法应以建筑材料、构件、部品、设备信息等数据库为基础，配以碳排放计量所需的人员分工、操作流程、信息标准，得到计量结果。计量过程中的数据单位标准可按本标准第4.1.2条执行。

5.1.3 在采用信息模型法时，应在合适的软硬件平台条件下，建立、管理信息模型，将信息从建筑材料、构件、部品、设备生产线传递到建设、管理全过程，从开发、竣工、管理阶段信息模型中，采集材料生产阶段、施工建造阶段、运行维护阶段、拆解阶段、回收阶段信息并核算，最后对核算结果进行发布。

5.2 数据采集

5.2.1 信息模型法应从信息模型中采集活动水平数据。信息模型中宜写入各单元过程实际产生的活动水平数据，在无法获得实际产生的活动水平数据时，可采用模拟信息。

5.2.2 材料生产阶段采集的基本信息应与清单统计法采集的活动水平数据保持一致。在建立信息模型时，应由设计方准确提供输入建筑材料、构件、部品、设备等基本信息，还应预留实际产生的材料量的信息属性。

5.2.3 材料生产阶段应在信息模型中对采集到的基本信息进行统计处理，采集输出的数据信息应包括下列项目：

AD_{ZT}——主体结构材料用量(t)；

AD_{WH}——围护结构材料用量(t)；

AD_{TC}——填充体材料用量(t)。

5.2.4 施工建造阶段采集的基本信息应与清单统计法采集的活动水平数据保持一致。在建立信息模型时，应由施工管理方提供施工方案模拟基本条件信息并输入信息模型，还应预留实际能源消耗量值的信息属性。

5.2.5 施工建造阶段应在信息模型中对采集到的基本信息进行模拟、估算，采集输出的数据信息应包括下列项目：

AD_{SGD}——施工建造阶段某单元过程中的耗电量(kW·h)；

AD_{SGY}——施工建造阶段某单元过程中的耗油量(t)；

AD_{SGM}——施工建造阶段某单元过程中的耗煤量(t)；

AD_{SGQ}——施工建造阶段某单元过程中的耗燃气量(Nm^3)；

AD_{SGQT}——施工建造阶段某单元过程中的其他能源消耗量(tce)；

AD_{SGSH}——施工建造阶段某单元过程中的耗水量(t)。

5.2.6 运行维护阶段采集的基本信息应与清单统计法采集的活动水平数据保持一致。在建立信息模型时，应对运行的能源消耗基本信息进行定义并输入信息模型，还可预留实际运行监测能源消耗量值的信息属性。

5.2.7 运行维护阶段应在信息模型中对采集到的能源消耗基本信息进行模拟、估算，采集输出的数据信息应包括下列项目：

AD_{YXD}——运行维护阶段某单元过程中的耗电量(kW·h)；

AD_{YXY}——运行维护阶段某单元过程中的耗油量(t)；

AD_{YXM}——运行维护阶段某单元过程中的耗煤量(t)；

AD_{YXQ}——运行维护阶段某单元过程中的耗燃气量(Nm^3)；

AD_{YXQT}——运行维护阶段某单元过程中其他能源消耗量(tce)；

AD_{YXSH}——运行维护阶段某单元过程中的耗水量(t)。

5.2.8 运行维护阶段在建立信息模型时，应对需维护更替的建筑材料、构件、部品、设备系统基本信息进行定义，并输入信息模型的构配件、设备信息属性，还可预留实际维护更替情况的信息属性。

5.2.9 运行维护阶段应在信息模型中对采集到的需维护更替的建筑材料、构件、部品、设备系统基本信息进行估算，采集输出的数据信息应包括下列项目：

AD_{ZT}——主体结构材料用量(t)；

AD_{WH}——围护结构材料用量(t)；

AD_{TC}——填充体材料用量(t)。

5.2.10 拆解阶段采集的基本信息应与清单统计法采集的活动水平数据保持一致。在建立信息模型时，应由拆解施工管理方提供拆解施工方案模拟基本条件信息并输入信息模型，还应预留实际能源消耗量值的信息属性。

5.2.11 拆解阶段应在信息模型中对采集到的基本信息进行估算，采集输出的数据信息应包括下列项目：

AD_{CJD}——拆解阶段某单元过程中的耗电量(kW·h)；

AD_{CJY}——拆解阶段某单元过程中的耗油量(t)；

AD_{CJM}——拆解阶段某单元过程中的耗煤量(t)；

AD_{CJQ}——拆解阶段某单元过程中的耗燃气量(Nm^3)；

AD_{CJQT}——拆解阶段某单元过程中的其他能源消耗量(tce)；

AD_{CJSH}——拆解阶段某单元过程中的耗水量(t)。

5.2.12 回收阶段采集的基本信息应与清单统计法采集的活动水平数据保持一致。在建立信息模型时，应对可回收建筑材料、构件、部品、设备等基本条件信息进行定义并输入信息模型，还可在信息模型中的相应位置预留实际回收情况的信息属性。

5.2.13 回收阶段应在信息模型中对采集到的基本信息进行估算，采集输出的数据信息应包括下列项目：

AD_{HS}——材料数量(t)；

η——材料的回收比例(%)。

5.3 数据核算

5.3.1 通过调用建筑信息模型内部存储的活动水平数据与外部文件存储的碳排放因子，按本标准第 4.3.2 条核算建筑碳排放量。

5.3.2 信息模型法对各单元过程、建筑全生命周期、单位建筑面积全生命周期、建筑全生命周期某阶段碳排放量的数据核算应按本标准第 4.3 节的规定执行。

5.4 数据发布

5.4.1 采用信息模型法进行碳排放量计量的项目，应与清单统计法发布格式统一，并按附录 A 所规定的格式进行发布。

5.4.2 采用信息模型法进行数据发布时，应报告所采用的数据来源，若采用模拟数据，应报告模拟的设置方案。

5.4.3 采用信息模型法进行数据发布时，应报告碳排放因子的外部存储和调用方式。

5.4.4 采用信息模型法进行数据发布时，应报告各项模型的责任人。

5.4.5 采用信息模型法进行数据发布时，应报告所使用各项软件名称及其版本，若采用自主研发的软件，应报告软件算法和数据处理过程，并对其核心算法进行合理性论证。

附录 A　清单统计法工作表

表 A-1　活动水平数据采集记录表(材料生产阶段)

基本信息	建筑名称					
	所在地区					
	使用性质			1—居住建筑;2—公共建筑;3—其他		
	建成/设计时间					
	设计寿命					
材料生产阶段	活动水平数据		单位	主体结构	围护结构	填充体
	建筑材料耗量	材料 1				
		材料 2				
		材料 3				
		……				
	建筑构件耗量	构件 1				
		构件 2				
		构件 3				
		……				
	建筑部品耗量	部品 1				
		部品 2				
		部品 3				
		……				
	建筑设备耗量	设备 1				
		设备 2				
		设备 3				
		……				

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表 A-2　活动水平数据采集记录表(施工建造阶段)

基本信息	建筑名称					
	所在地区					
	使用性质		1—居住建筑;2—公共建筑;3—其他			
	建成/设计时间					
	设计寿命					
施工建造阶段	活动水平数据		单位	材料、构件、部品、设备的运输	施工机具运行	施工现场办公
	能源耗量	煤				
		天然气				
		液化石油气				
		汽油				
		柴油				
		煤油				
		电力				
		外购蒸汽				
		外购热水				
		……				
	资源耗量	水				
		……				

(纸面不敷,可另增页)

表 A-3　活动水平数据采集记录表(运行维护阶段)

基本信息	建筑名称					
	所在地区					
	使用性质			1—居住建筑;2—公共建筑;3—其他		
	建成/设计时间					
	设计寿命					
运行维护阶段	活动水平数据		单位	设备系统运行	材料、构件、部品、设备的维护与更替	更替的建筑材料、构件、部品、设备的运输
	能源耗量	煤				
		天然气				
		液化石油气				
		汽油				
		柴油				
		煤油				
		电力				
		外购蒸汽				
		外购热水				
		……				
	资源耗量	水				
		……				
	维护更替材料耗量	材料 1				
		材料 2				
		材料 3				
		……				
	维护更替构件耗量	构件 1				
		构件 2				
		构件 3				
		……				

续表 A-3

运行维护阶段	维护更替部品耗量	部品 1				
		部品 2				
		部品 3				
		……				
	维护更替设备耗量	设备 1				
		设备 2				
		设备 3				
		……				

（纸面不敷，可另增页）

表 A-4 活动水平数据采集记录表（拆解阶段）

基本信息	建筑名称				
	所在地区				
	使用性质		1—居住建筑；2—公共建筑；3—其他		
	建成/设计时间				
	设计寿命				
拆解阶段	活动水平数据		单位	拆解机具的运行	废弃物运输
	能源耗量	煤			
		天然气			
		液化石油气			
		汽油			
		柴油			
		煤油			
		电力			
		外购蒸汽			
		外购热水			
		……			
	资源耗量	水			
		……			

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表 A-5　活动水平数据采集记录表(回收阶段)

基本信息	建筑名称					
	所在地区					
	使用性质		1—居住建筑;2—公共建筑;3—其他			
	建成/设计时间					
	设计寿命					
回收阶段	活动水平数据		单位	主体结构	围护结构	填充体
	建筑材料回收量	材料 1				
		材料 2				
		材料 3				
		……				
	建筑构件回收量	构件 1				
		构件 2				
		构件 3				
		……				
	建筑部品回收量	部品 1				
		部品 2				
		部品 3				
		……				
	建筑设备回收量	设备 1				
		设备 2				
		设备 3				
		……				

(纸面不敷,可另增页)

表 A-6　建筑物碳排放计算表

基本信息	建筑名称							
	所在地区							
	使用性质			1--居住建筑;2—公共建筑;3—其他				
	建成/设计时间							
	设计寿命							
	计量生命周期阶段			1—材料生产阶段,2—施工建造阶段,3—运行维护阶段,4—拆解阶段,5—回收阶段				
类别	种类		活动数据		排放因子		排放量 (tCO_2)	备注
			单位	消耗量	单位	因子值		
能源消耗	煤							
	天然气							
	液化石油气							
	汽油							
	柴油							
	煤油							
	电							
	外购蒸汽							
	外购热水							
	……							
资源消耗	水							
	……							
材料消耗	建筑材料	材料 1						
		……						
	建筑构件	构件 1						
		……						
	建筑部品	部品 1						
		……						
	建筑设备	设备 1						
		……						
合　计			—	—	—	—		

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填 表 人：_____　　审核人：_____

填表日期：_____

附录 B　常用能源的碳排放因子

表 B　常用能源的碳排放因子

能源种类	能源名称	碳排放因子	数据来源	备注
燃煤	无烟煤	98.3kgCO_2/GJ	《IPCC 国家温室气体清单编制指南》（2006 年）	国际组织
	炼焦煤	94.6kgCO_2/GJ		
	褐煤	101kgCO_2/GJ		
	焦炭	107kgCO_2/GJ		
电力	华北区域电网	1.246kgCO_2/(kW·h)	《省级温室气体清单编制指南(试行)》（国家发展和改革委员会发布）	政府部门
	东北区域电网	1.096kgCO_2/(kW·h)		
	华东区域电网	0.928kgCO_2/(kW·h)		
	华中区域电网	0.801kgCO_2/(kW·h)		
	西北区域电网	0.997kgCO_2/(kW·h)		
	南方区域电网	0.714kgCO_2/(kW·h)		
	海南	0.917kgCO_2/(kW·h)		
燃油	原油	73.3kgCO_2/GJ	《IPCC 国家温室气体清单编制指南》（2006 年）	国际组织
	车用汽油	69.3kgCO_2/GJ		
	航空汽油	70.0kgCO_2/GJ		
	煤油	71.5kgCO_2/GJ		
	柴油	74.1kgCO_2/GJ		
	液化石油气	63.1kgCO_2/GJ		
	燃料油	77.4kgCO_2/GJ		
燃气	天然气	56.1kgCO_2/GJ		
	煤气	44.4kgCO_2/GJ		

注：表中数据应按年份更新，以保持时效性。

附录C　常用能源热值

表C　常用能源热值

能源种类	能源名称	平均低位发热量	数据来源
燃煤	无烟煤	26700kJ/kg	《IPCC国家温室气体清单编制指南》（2006年）
	炼焦煤	28200kJ/kg	
	褐煤	11900kJ/kg	
	原煤	20908kJ/kg	《综合能耗计算通则》GB/T 2589—2008
	焦炭	28435kJ/kg	
燃油	原油	41816kJ/kg	
	燃料油	41816kJ/kg	
	汽油	43070kJ/kg	
	煤油	43070kJ/kg	
	柴油	42652kJ/kg	
	煤焦油	33453kJ/kg	
	渣油	41816kJ/kg	
	液化石油气	50179kJ/kg	
燃气	炼厂干气	46055kJ/kg	
	油田天然气	38931kJ/Nm^3	
	气田天然气	35544kJ/Nm^3	
	煤矿瓦斯气	14636kJ/Nm^3～16726kJ/Nm^3	
	焦炉煤气	16726kJ/Nm^3～17981kJ/Nm^3	
	高炉煤气	3763kJ/Nm^3	

本标准用词说明

1　为便于在执行本标准条文时区别对待，对要求严格程度不同的用词说明如下：

1）表示很严格，非这样做不可的：

正面词采用“必须”，反面词采用“严禁”；

2）表示严格，在正常情况下均应这样做的：

正面词采用“应”，反面词采用“不应”或“不得”；

3）表示允许稍有选择，在条件许可时首先应这样做的：

正面词采用“宜”，反面词采用“不宜”；

4）表示有选择，在一定条件下可以这样做的，采用“可”。

2　条文中指明应按其他有关标准执行的写法为：“应符合……的规定”或“应按……执行”。

引用标准名录

《建筑给水排水设计规范》GB 50015

《综合能耗计算通则》GB/T 2589

《民用建筑能耗数据采集标准》JGJ/T 154—2007

《环境管理-生命周期评价-原则与框架》ISO 14040：2006

《温室气体-产品碳足迹-量化和信息交流的要求与指南》ISO/TS 14067：2013

《温室气体-第一部分：体组织层次上对温室气体排放和清除的量化和报告的规范与指南》ISO 14064—1：2006

中国工程建设协会标准

建筑碳排放计量标准

CECS 374：2014

条 文 说 明

目　　次

1 总　　则

1.0.1 随着国际社会对建筑碳排放的日益关注，如何实现建筑碳排放的科学计量成为亟待解决的问题。目前国际上还未形成统一的建筑碳排放计量方法。只有德国、英国及美国等少数西方发达国家，提出或正在制定基于本国建筑设计建造标准及产品材料数据库的建筑碳排放计量或评估方法。我国的建筑立项设计施工运营管理体系与上述发达国家差异显著，需要建立和形成自己的方法和体系，以满足相关部门和人员的技术需求。

本标准是基于“十二五”国家科技支撑计划项目“城镇低碳发展关键技术集成研究与示范”(2011BAJ07B00)中的第二课题“城镇建筑碳排放计量标准及低碳设计关键技术集成研究与示范”(2011BAJ07B02)的研究成果，以国际碳排放计量通则为基础，针对建筑全生命周期碳排放的数据采集、数据核算以及数据发布等方面提出相关标准，对于实现我国建筑碳排放的规范化计量，推动建筑领域的节能减排有着重要意义。

1.0.2 对于新建建筑，可对不同建筑方案的全生命周期碳排放量进行分析比较，为选择和优化建筑设计、材料选用、施工、运行维护、拆解及回收方案提供依据；对于改、扩建和既有建筑，可用于报告已经历的生命周期阶段碳排放情况，明确碳排放控制的关键环节，比较不同的建筑运行与改造方案碳排放情况，实现对未来生命周期阶段碳排放的预测及管理，减少建筑碳排放。

1.0.3 根据《IPCC 第四次评估报告》(IPCC AR4，2007)，不同温室气体对全球温室效应的贡献率不同。其中二氧化碳(CO_2)为 76%，甲烷(CH_4)为 14.3%，氧化亚氮(N_2O)为 7.9%，氟类及其他气体为 1.8%，二氧化碳是最主要的温室气体。本标准针对建筑全生命周

期中由能源和材料消耗产生二氧化碳(CO_2)进行计量。

在建筑碳排放活动过程中，还会涉及其他温室气体。根据《IPCC 国家温室气体清单指南》(2006)，建筑碳排放的活动过程涉及能源活动、工业生产过程以及废弃物处理等多个类别，每个类别需要评估的温室气体如表 1 所示：

表 1　与建筑碳排放相关的活动过程及温室气体名称

关键类别分析中应评估的源和汇类别		需评估的气体
类别代码	类别名称	
能源活动		
1A2	燃料燃烧活动(制造工业和建筑)	CO_2、CH_4、N_2O
1A3a	燃料燃烧活动(民航运输)	CO_2、CH_4、N_2O
1A3b	燃料燃烧活动(公路运输)	CO_2、CH_4、N_2O
1A3c	燃料燃烧活动(铁路运输)	CO_2、CH_4、N_2O
1A3d	燃料燃烧活动(水运航行运输)	CO_2、CH_4、N_2O
工业生产过程		
2A1	水泥生产(采掘工业)	CO_2
2A2	石灰生产(采掘工业)	CO_2
2A3	玻璃生产(采掘工业)	CO_2
2C1	钢铁生产(金属工业)	CO_2、CH_4
2C3	铝生产(金属工业)	CO_2、PFCs
2F1	作为臭氧耗损物质替代物的使用(制冷和空调)	HFCs、PFCs
废弃物处置		
4A	固体废弃物填埋处理	CH_4
4C	废弃物的焚化和露天燃烧	CO_2、N_2O、CH_4

注：本表摘选自《IPCC 国家温室气体清单指南》(2006)第 1 卷，第 4 章。

从表 1 可以看出，除 CO_2 以外，CH_4、N_2O、HFCs、PFCs 等温室气体也与建筑碳排放相关。当需要对上述温室气体排放进行量化及报告时，可参照本标准中的相关规定执行。

2 术　　语

2.0.1　建筑全生命周期是指建筑从材料生产至最终拆解、回收的全过程，这也是建筑碳排放的主要时间范围。

2.0.3　开展建筑碳排放计量，应先对建筑碳足迹的数据进行采集，然后对采集的碳排放数据进行汇编与量化，最终通过碳排放计量报告的形式进行发布以完成碳排放计量过程。

2.0.10　二氧化碳为人类活动最常产生的温室效应气体，为了统一度量整体温室效应的结果，规定以二氧化碳当量为度量温室效应的基本单位。

3 基本规定

3.0.1 本条规定了建筑碳排放计量的基本框架。一是要覆盖全生命周期。建筑在材料生产、施工建造、运行维护、拆解直至回收的生命过程中，每个阶段都产生能源及材料的消耗，引起直接或间接的碳排放，对自然环境造成影响，如果只针对部分生命周期阶段的碳排放计量，难以全面了解建筑碳排放行为对自然界产生的影响，也无法对未来碳排放情况进行预判并进行控制。二是要以碳排放单元过程为基本单位开展计量。在每个具体的碳排放单元过程中，每种能源和材料的输入和输出都是相对清晰和独立的，按单元过程进行计量工作，可逐一进行数据的采集与量化核算，实现对建筑碳足迹的全面追踪。

3.0.2 “相关性”、“完整性”、“一致性”、“准确性”和“透明性”是国际上开展碳排放量化和报告的核心要求。针对建筑碳排放计量，“相关性”是指应确保在量化建筑碳排放时所采用的边界、资料、数据以及方法，能适当地反映有关建筑碳排放状况，并满足相关需要；“完整性”是指在选定的建筑和计量边界内，应量化和报告所有的碳排放信息，任何例外均应该说明；“一致性”是指对量化和报告不同生命周期阶段的碳排放，有关计算范围、边界及方法的变化均应采用相同的方法，并记录清楚；“准确性”是指应保证建筑碳排放信息来源和计算过程的可靠和正确；“透明性”是指应充足、充分、透明地发布建筑碳排放信息的支撑材料。

3.0.3 本标准提出了两种可用于建筑碳排放的计量方法，可满足按照常规方式或采用建筑信息模型技术设计建造及运行管理的建筑进行碳排放数据采集、核算以及发布的需要。

3.0.4 本条文规定了开展建筑碳排放计量工作的相关步骤。其

中界定建筑物的范围和区域、界定建筑碳排放单元过程是开展碳排放计量工作的前提。首先是要明确计量建筑物的范围和区域，在划定区域范围内的能源、资源和材料消耗将进行计量，例如可选择建筑物的红线或是围绕建筑的道路中心线进行划定。界定建筑碳排放单元过程，是为了明确建筑能源、资源和材料消耗的具体活动过程，便于逐项去进行数据的采集与核算。

3.0.5 建筑全生命周期内与碳排放相关的单元过程复杂多样，难以将所有单元过程都纳入计量。应优先对建筑碳排放量贡献率大、比重高的单元过程进行计量，将部分无法量化、碳排放量较少或量化成本过高的单元过程排除在外，减轻工作量，提高标准的可操作性，但是需要对简化单元过程对计量结果的影响进行分析说明。

3.0.6 建筑材料、构件、部品、设备从原料开采、加工制造，直至最终形成成品，各个环节都会消耗能源，因此可认为每一个建材、构件、部品、设备，都是碳排放固化的产物，都有其固化的碳排放量(embodied carbon)。对于建筑，材料生产阶段的碳排放就在于使用了一定数量的材料、构件、部品、设备，因而导致碳排放的产生。

建筑中的材料、构件、部品、设备根据使用功能的不同，通常分为主体结构、围护结构以及填充体三部分。主体结构主要包括基础、梁、板、柱、承重墙体等支撑建筑整体框架的部位，主要起承重作用；围护结构主要包括屋面、墙体、门窗、地面等部位，主要起围合与隔断作用；填充体主要包括建筑内的装饰、厨卫设备、电气设备、通风空调设备、电梯、管线等部分，主要起装饰、建筑功能及室内环境维持作用。

3.0.7 在进行建筑及其附属设施的建造，以及配套线路、管道、设备的安装活动过程中，建筑材料、构件、部品、设备的运输以及施工机具的运行是产生能耗的主要单元过程，此外在施工现场办公活动也会产生一定量的能耗，也应予以计量。

3.0.8 建筑在竣工投入使用后，为了维持建筑正常运转，空调、照

明、电梯、供水、炊事等设备系统的运行，都会产生能耗并产生碳排放，而在运行期内，部分材料或构件达到自然寿命需要对其维护或更换，替换材料的消耗以及安装、维护过程也会产生碳排放。

3.0.9 拆解过程中机具的运行和废弃物的运输是产生碳排放的主要活动，应对其进行计量。

3.0.10 建筑碳排放计量必须将材料的循环利用及可再生性考虑在内。对于可循环材料，虽然在生产过程中产生了碳排放，但在回收并进行循环再利用后，这部分碳排放又进入到了新的建筑生命周期中，没有对环境造成实际影响，应予以核减。由于量小且不易采集，本标准不考虑回收活动（如分拣机械使用）产生的碳排放。

3.0.11 本条文对碳排放计量相关数据的质量控制进行了规定。数据质量对于碳排放计量结果可靠度有着至关重要的影响，为了确保计量结果客观合理，相关数据必须经过质量审定，验证数据的相关性、完整性、一致性、准确性以及透明性，并将数据所包括的属性信息完整记录下来，以分析数据对计量结果的影响。

3.0.12 当参照本标准对《京都议定书》中规定的其他温室气体进行计量时，应将每种气体的排放量乘以各自的全球变暖潜能值（GWP），统一核算至二氧化碳当量（CO_{2e}）进行表示。表 2 列出了主要温室气体的全球变暖潜能值（GWP）供参考。

表 2 主要温室气体的全球变暖潜能值

温室气体名称		温室效应潜能值	数据来源
二氧化碳（CO_2）		1	《IPCC 第四次评估报告》（IPCC AR4，2007）
甲烷（CH_4）		25	
氧化亚氮（N_2O）		298	
氢氟碳化物（HFCs）	HFC-23	14800	
	HFC-32	675	
	HFC-125	3500	
	HFC-134a	1430	
	HFC-143a	4470	

续表 2

温室气体名称		温室效应潜能值	数据来源
氢氟碳化物（HFCs）	HFC-152a	124	《IPCC 第四次评估报告》（IPCC AR4，2007）
	HFC-227ea	3220	
	HFC-236fa	9810	
	HFC-245fa	1030	
全氟化碳（PFCs）	CF_4	7390	
	C_2F_6	9200	
六氟化硫（SF_6）		23900	

4 清单统计法

4.1 一般规定

4.1.1 作为建筑碳排放计量方法之一，清单统计法的特点在于计量过程与建筑碳排放活动顺序一致，输入和输出对象清晰，可以逐一进行汇编及量化，相关数据以建筑项目的工程设计资料及运行管理文件为基础，最大限度地保证计量结果的可靠性，专业技术人员易于掌握。

4.1.2 本条文规定了采用清单统计法时对相关数据计量单位的要求。

4.2 数据采集

4.2.2 本条规定的建筑在材料生产阶段、施工建造阶段、运行维护阶段、拆解阶段和回收阶段中需要采集的活动水平数据，是基于建筑全生命周期阶段通常包括的单元过程（见本标准第3.0.6条～第3.0.10条）。由于建筑的种类及用途差异，纳入计量的碳排放单元过程有可能存在不同，需要根据计量建筑的实际情况进行具体分析。

4.2.3 采集建筑碳排放单元过程的活动水平数据是碳排放计量的重要步骤，活动水平数据的质量与详尽程度对计量结果可靠性有着重要影响。

4.2.6 本条规定施工建造阶段主要的活动水平数据的分析测算公式，以实现在无法通过仪表监测和资料查询获取相关数据的情况下，对该阶段主要活动水平数据的采集。

材料、构件、部品、设备从生产地或销售地运送至施工现场大都采用车辆运输，少部分采用海运或空运，运输能耗均为燃油，可

通过采集运输工具的台班数、运输距离以及运输工具单位距离的耗油量来测算整个运输环节的耗油量；对于施工机具的电功率、运行台班数、运行时长、每台班耗水量等主要运行工况参数，与承建商的施工方案、技术水平和管理水平有着密切关系，可根据施工方案、工程量统计清单或当地建筑工程定额确定。

4.2.8 对于建筑运行消耗的一次能源，根据相应计算公式计算，相关建筑设备系统的电功率、平均每小时燃油或燃气耗量、年平均耗煤量等运行参数应根据建筑设计方案或实际选用设备的技术条件确定。

对于建筑运行期内外部购买蒸汽、热水等二次能源，是由建筑范围之外的集中热力站通过消耗燃煤、燃气、燃油等一次能源转化得到，应根据当地热力站一、二次能源转化热效率以及相关一次能源的低位发热量计算出消耗的一次能源实物量后再进行碳排放计量。

4.2.11 建筑运行期中，部分材料或构件达到自然寿命后，便需要对其进行替换，替换材料产生的碳排放可参照材料生产阶段碳排放数据采集的方法进行。

4.2.13 建筑在拆解后，相当一部分材料、构件、部品以及设备可通过回收再利用进入其他建筑的生命周期循环中，在进行建筑全生命周期碳排放计量时，应当扣除这部分材料所固化的碳排放量。对于尚未实际拆解的建筑，可通过采集主体结构、围护结构、填充体中材料、构件、部品及设备的可回收率，然后根据各部分的材料用量，测算出在回收阶段可扣除的碳排放量；对于已经拆解的建筑，则需要通过记录实际回收的材料用量来确定扣除的碳排放量。

4.2.14 碳排放因子是计量的重要基础数据。碳排放因子包括两方面，一是材料、构件、部品、设备的碳排放因子，即单位数量材料、构件、部品、设备所固化的碳排放量(embodied carbon)；二是各种能源所对应的碳排放因子。目前我国尚未建立起能够满足建筑全生命周期碳排放计量的因子数据库(尤其是各种材料、构件、部品、设备的碳排放因子)，为了满足碳排放计量工作的实际需要，可从

条文中所规定的信息来源中引用相关因子，但需要对数据来源进行详细记录，以便对计量结果进行评估。

另外，针对材料、构件、部品、设备的碳排放因子的选用，应当注意因子边界的统一。由于数据来源的多样性，各类因子的边界范围可能存在差异，例如，钢材碳排放因子数值的高低，除了与生产全过程能源、资源与材料消耗有关外，也与钢材的可回收率密切相关。在某些数据来源中，钢材碳排放因子就已经将按照可回收比例进行了修正，而某些数据来源则没有考虑回收修正，因此同样是钢材，也因为边界差异，导致碳排放因子数值相差较大。本标准所提出的建筑碳排放计量方法，已经考虑在建筑生命末期，对主体结构、围护结构和填充体中回收的建材、构件、部品及设备碳排放量进行抵扣，因此建议选用材料、构件、部品、设备的碳排放因子不应包括可回收率的修正，以避免重复抵扣。

4.3 数据核算

4.3.3 材料生产阶段建筑的碳排放量包括主体结构材料、围护结构材料和填充体材料的碳排放量，本条给出了相应的计算公式。

4.3.4 施工建造阶段建筑的碳排放量包括施工机具等设备运行消耗的电能、燃油、燃煤、燃气、其他能源和水所产生的碳排放量，本条给出了相应的计算公式。

4.3.5 建筑在运行维护阶段的能耗主要为设备系统运行消耗的电能、燃油、燃煤、燃气等能源以及水资源消耗，另外在建筑全生命周期中，可再生能源替代常规能源的使用从而核减部分碳排放量，本条给出了相应的计算公式。

4.3.6 维护更替所用材料、构件、部品、设备的碳排放量，按照主体结构、围护结构和填充体分别计算，本条给出了相应的计算公式。

4.3.7 拆解阶段建筑的碳排放量包括拆解机具运行消耗的电能、燃油、其他能源和水所产生的碳排放量，本条给出了相应的计算公式。

4.3.8 回收阶段建筑的碳排放量为回收材料所产生的碳排放量，

本条给出了相应的计算公式。

4.3.9 建筑碳汇主要来源于建筑物范围内的绿化植被对二氧化碳的吸收，应当在环境排放中减去绿化植被的碳汇量。目前农林业已开发出相关方法学，具体包括国家林业局印发的《竹林项目碳汇计量与监测方法学》、《造林项目碳汇计量与监测指南》等，针对建筑绿化植被碳汇量方法学也正在开发当中。

4.3.10 在碳排放核算时，如果只考虑生命周期碳排放量的绝对数值，是无法比较不同规模建筑的碳排放情况。将生命周期排放总量折合至单位建筑面积，并且将建筑的运行年限纳入计算，从而满足对不同规模建筑的碳排放分析比较的需求。

4.3.11 建筑全生命周期各阶段碳排放量比率是碳排放核算的重要指标。由于建筑在生命周期内不同阶段的碳排放量差别很大，因此采取比率计算的方法更能快速、准确的对不同阶段碳排放量进行横向比较与量化分析。

4.4 数据发布

4.4.1 为了使数据发布的内容明了清晰，建筑碳排放计量结果的发布形式应为附有图表、文字说明等必要信息的计量报告，而不是单纯的计量结果。

4.4.2 建筑碳排放计量报告是数据发布的核心内容，包括计量报告机构信息、建筑的功能及运行情况和建筑的碳排放清单。除此之外碳计量时的假设条件和碳排放因子等数据的来源都是非常重要的信息，应予以提供。

4.4.3 建筑碳排放计量报告的机构是开展碳排放计量的主体，它开展计量的目的和数据的采集方法等信息与计量的准确度和精度紧密相关，应在计量报告中提供准确的机构信息。

4.4.4 建筑的功能及运行情况规定了建筑碳排放计量覆盖的生命周期阶段和各生命周期阶段所包含的单元过程，是碳排放采集与核算的重要边界基础，应提供详细的信息。

5 信息模型法

5.1 一般规定

5.1.1 由于制造业等行业信息化水平较高，建筑材料、构件、部品、设备等工业化产品在材料生产阶段的信息比较完整，这些信息能够以信息模型为载体，在建筑全生命周期中传递、管理，达到信息有效利用的目的。

本标准采用信息模型法作为建筑碳排放计量方法之一，其优势在于信息管理的完整性，信息采集、处理的先进性，更能够避免遗漏、重复统计等错误出现。

更进一步地，在信息模型内预先较完整地写入碳排放计量标准算法，即可参照已有的同类项目计算材料量、施工消耗量、运行消耗量、维护消耗量、拆解消耗量、回收材料量等，实现新项目碳排放量估算。在策划阶段就能够预先得到不同建筑设计方案的碳排放计量结果，为选择和优化提供依据。

5.1.2 人员分工指建模人员、计量人员、协调人员及管理人员等的工作内容；数据库包括建筑材料、构件、部品、设备信息数据库、碳排放因子数据库等；信息标准包括制图标准、项目内一致的命名规范、一致的信息交换标准等。

5.1.3 以信息模型法进行碳排放计量，优先采用已有信息模型。对应用信息模型建设的新建建筑，本方法仅对数据类型作出要求；对既有建筑需应用信息模型法的，需在采集前建立信息模型，并参考本方法规范信息模型数据属性。

信息模型法涉及的数据信息及计算方法应与清单统计法保持一致。

根据现行建筑项目建设管理流程，模型可分为设计（开发）模

型、竣工模型、管理模型三类，数据应从上述三类模型中取得。但考虑到三类模型信息有不统一的可能性，应在碳排放计量前进行信息整理，以保证数据在传递过程中的一致性，计算出准确的结果。用于碳排放量计算的各项信息模型宜支持执行 IFC(Industry Foundation Classes 工业基础类标准)中有关信息存储、传递的规定。

应用信息模型法进行信息采集的项目，应使用含有产品基本碳排放量、运输距离、使用寿命等信息的建筑构件、部品、设备，以信息模型的方式传递到项目信息模型中，并遵循一定的标准、规范进行传递、更新，可提高数据采集效率及准确度。在使用信息模型法进行碳排放计量的过程中，如发现信息采集、核算错误或与实际情况存在矛盾处，应及时核对相关图纸和文件，并予以修正，保证信息的正确性和一致性。

5.2 数据采集

5.2.1 信息模型法与清单统计法有共同的采集对象：单元过程中反映能源及材料消耗特征的活动水平数据以及相应的碳排放因子。但两种采集法对数据、信息的存储、提取、管理方式却不同。信息模型法在建筑全生命周期内均从信息模型中采集信息。按照建筑现行项目建设管理模式，材料生产阶段、施工建造阶段单元过程信息可在设计(开发)、竣工模型中采集，运行维护阶段、拆解阶段、回收阶段单元过程信息可在管理模型中采集。

在有实际产生的活动水平数据的情况下，信息模型可视作建筑全生命周期内的数据信息管理平台，在无法获得实际产生的数据信息的情况下，信息模型可产生模拟信息进行替代计量。

无法获得实际产生的活动水平数据的情况可能包括：既有建筑档案不全或不够详细；新建、改建和扩建建筑仍处于设计阶段，尚未实施至建造、运行等阶段。

采用的模拟信息可包括：材料量估算值、施工进度模拟结果、施工耗能量估算值、运行能耗模拟结果、维护更替估算值、拆解进

度模拟结果、拆解耗能估算值、可再生能源模拟结果、可回收材料估算值等。

5.2.2 本标准第4.2.2条规定，材料生产阶段采集到的基本信息应包括：建筑主体结构、围护结构和填充体使用的材料、构件、部品、设备种类及数量。

从理论上说，上述信息在竣工模型建立后，从信息模型中提取到的值应该与实际产生的材料量误差较小，但考虑到我国地域广阔、施工水平相差大等因素，在信息模型中除了统计建筑材料、构配件信息之外，还应预留实际产生的材料量的信息属性，供数据采集人员在按本标准第4.2.4条规定，采集到实际产生的材料量信息后写入信息模型，以备信息统一管理使用，如产品基本碳排放量、运输距离等信息，使其能够纳入信息统计和计算过程。

另外，考虑到可根据信息模型统计、估算材料量的需求，应在信息模型建立过程中：①对建筑各部分进行定义，区分主体结构、围护结构、填充体；②对材料进行统一命名，命名应按照建材类型规格进行。

5.2.3 在应用信息模型对主体结构材料用量(t)、围护结构材料用量(t)、填充体材料用量(t)进行信息统计时，应对材料体积、材料量等基础信息进行适当处理，得到所需材料用量结果，如：

某类材料用量(t)＝此类材料体积(m^3)×此类材料容重(t/m^3)

某类构配件材料用量(t)＝此类构配件单个材料量(t)×此类构配件个数

5.2.4 按本标准第4.2.2条规定，施工建造阶段采集到的基本信息应包括：材料、构件、部品、设备运输的耗能量、施工机具运行的耗能量、耗水量、施工现场办公的耗能量；施工辅助材料的使用量及周转次数。

施工建造阶段材料及构配件运输的耗能量、施工机具运行的耗电量、耗油量、施工现场管理的耗电量等信息可根据施工进度模拟、施工耗能量估算等方式获得，考虑到地域、施工方法、工人素质

等差异，不能判断实际工程施工建造过程能源消耗量与估算值差异大小，而施工建造现场管理也是碳排放的重要一环，故应在使用模拟信息的基础上，对施工建造现场有实际能源消耗量记录的情况，优先使用实际能源消耗量值并写入信息模型，供信息统一管理使用。实际施工建造阶段能源消耗量及基本测算方法采集应按照本标准第 4.2.5、4.2.6 条的规定执行。

考虑到施工模拟需求，应在信息模型建立过程中，对影响施工进度的结构、构配件、部品、设备进行细化处理，处理后的信息基本单位应对应实际施工建造中的基本单位。

5.2.5 基于信息模型的施工模拟需要从信息模型中读取准确的建筑材料、构件、部品、设备等信息，再利用软件分析平台，分析施工步骤，模拟施工方案，并对施工方案中涉及的耗电、耗油、耗煤、耗气、耗水及其他能源消耗进行模拟估算。

5.2.6 按本标准第 4.2.2 条规定，运行维护阶段采集到的运行基本信息应包括：建筑运行的耗能量、耗水量、可再生能源的种类及使用量。

当建筑碳排放计量从运行维护阶段开始时，早期的基本信息和活动水平数据有时难以获取，标准提出以模拟或预留的方式，根据本标准第 4.2.7～4.2.10 条规定分步写入信息。

5.2.7 基于信息模型的运行能耗模拟需要从信息模型中读取准确的建筑围护结构情况、设备系统等信息，再利用软件分析平台，分析设备系统运行要求，模拟运行情况，并以年为单位，在建筑设计使用期限内分季节、使用要求对运行耗电、耗油、耗煤、耗气、耗水及其他能源消耗进行模拟估算。个别不能以年为运行记录周期的特殊建筑类型，可按照该建筑类型运行能耗相似周期对运行耗能量进行模拟、计量。

在现有模拟分析技术水平支撑下，可再生能源系统运行情况宜单独进行模拟分析，并独立存储模拟结果信息。

5.2.8 按本标准第 4.2.2 条规定，运行维护阶段采集到的维护基

本信息应包括：维护更替活动的材料消耗量、更换材料、构件、部品和设备的耗能量估算。

运行维护阶段涉及的建筑构配件、部品、设备系统均有其产品使用寿命规定，这些规定与实际情况基本相符，因此，其在建筑全生命周期内的维护更替次数是可模拟、估算的。运行维护阶段材料消耗量及能源消耗量采集应按本标准第 4.2.11 条的规定执行。

考虑到运行维护阶段材料消耗量及能源消耗量模拟与估算值很大程度上依赖于产品信息，因此，在信息模型的建筑构配件、部品、设备中，应包含产品基本碳排放量、运输距离、使用寿命等信息属性。

5.2.9 项目所用产品包含建筑内所有材料、构件、部品、设备信息，应预先写入信息模型。通过信息模型内含有的材料、构件、部品、设备的用量、使用寿命等基本信息，计算维护与更替次数，估算获得建筑维护更替碳排放量。

维护更替材料用量(t)＝每次维护与更替所需材料用量(t)×维护与更替次数

5.2.10 按照本标准 4.2.2 条规定，拆解阶段参与采集的模型信息应包括：拆解机具运行的耗能量、拆解废弃物运输的耗能量等。

与施工阶段类似，拆解阶段能源消耗量很大程度上依赖于现场施工方案，因此，对拆解施工现场有实际能源消耗量记录的情况，优先使用实际能源消耗量值并写入信息模型，供信息统一管理使用。拆解阶段能源消耗量采集应按照本标准第 4.2.12 条规定执行。在无实际拆解阶段能源消耗量数据信息记录的情况下，可按照拆解进度模拟结果、拆解耗能估算值等信息进行模拟。

考虑到拆解施工模拟需求，应在信息模型建立过程中，对影响拆解施工进度的结构、构配件、部品、设备进行细化处理，处理后的信息基本单位应对应实际拆解施工建造中的基本单位。

5.2.11 拆解进度模拟结果、拆解耗能估算值信息与施工建造阶段模拟类似，需要从信息模型中读取准确的建筑材料、构件、部品、设备等信息，利用软件分析平台，分析拆解施工步骤，模拟拆解施

工方案，并对拆解施工方案中涉及的耗电、耗油、耗水及其他能源消耗进行模拟估算。

5.2.12 按本标准第4.2.2条规定，回收阶段参与采集的模型信息应包括：从建筑主体结构、围护结构和填充体中回收的建材、构件、部品及设备的种类及回收量。

在对已完成回收的案例进行碳排放量计量时，实际回收情况应体现在信息模型的建筑构配件、部品、设备信息中，并在信息模型中按材料类别进行统计。回收阶段实际使用材料量采集应按本标准第4.2.13条的规定执行。在对未进入回收阶段的案例进行碳排放量计量时，可使用信息模型对回收材料量进行模拟、估算。

与材料生产阶段类似，为保证材料量统计、模拟、估算的准确，应在建立信息模型时，对材料、构配件、部品、设备信息按照回收统计类别进行分类定义，并明确回收信息。

5.2.13 在信息模型中对建筑使用状况进行模拟分析，模拟出材料的回收比例，在利用材料的回收比例及材料数量对回收材料数量进行估算。

5.3 数据核算

5.3.1、5.3.2 信息模型法数据核算的计算方法应与清单统计法保持一致，但应充分利用信息模型便捷的信息处理平台，将计算方法信息化，并与信息模型采集的数据建立联系，使得数据采集与数据核算联动，避免重复工作造成的核算误差。

5.4 数据发布

5.4.1 为便于项目间碳排放量比对，信息模型法对于发布格式的要求应同清单统计法保持一致。在进行建筑碳排放计量及校核的过程中，局部信息的修改不可避免，其对计量结果的发布时间造成一定影响。信息模型法进行发布的优势在于信息模型设定完成后，可对结果进行即时发布，局部信息的修改并不会拖延计量结果

的发布时间。

5.4.2 公布所采用数据的来源和模拟或估算方法的说明，能有效追溯碳排放量计算过程，使公布的数据具有科学的理论依据和客观的数据基础。建筑全生命周期各阶段碳排放计量所采用的数据有些是可以从模型直接获取的，如建筑材料、构件、部品、选用产品的型号和使用量等；有些数据是通过模拟或估算获得，如建筑运行时能耗分析等。若采用模拟或估算数据，应报告模拟或估算的方法和说明，包括：采用数据的原因、边界条件设置、数据的计算结果、数据的计算精度和可能产生的偏差等。

另外，由于信息模型的详细程度对模拟结果有很大的影响，在报告模拟的设置方案时，应报告信息模型的 LOD(Level of Development 建筑信息模型的完成度分级)水平。

5.4.3 碳排放因子是在建筑碳排放计量过程中交换需求的源数据或核心算法中的参数的一部分，其采集与核算方式应按本标准第 4.2.14 条和第 5.3.1 条的规定执行。碳排放因子要在源数据或核心算法参数中进行描述。因为碳排放因子可能是公开发布的数据存在，可能是以数据库的形式存在，它们的调用方式也不相同，碳排放因子的存储和调用方式，有可能会对碳排放计量核算的效率及误差产生影响，故应对碳排放因子的存储和调用方式作出说明，这样整个方法才具有可参考性和可操作性。

5.4.4 建筑碳排放计量过程需要大量的建模、数据录入、核算等人工工作，其中因为存在人为的操作，所以可能产生的误差和疏忽，应报告建筑信息模型的建模、数据录入、核算责任人，保证数据的可追溯性。

5.4.5 在建筑碳排放计量过程中可使用公开发布的软件或自行开发工具软件。公开发布的工具/软件会随着版本的更新，其数据处理过程和算法可能会发生变更，所以应报告工具/软件的名称和版本；对于自主研发的工具软件，也应报告数据处理过程和软件算法，并论证其合理性，保障数据的可信度、可比较性、可追溯性。

CECS Standard

Standard for measuring, accounting and reporting of carbon emission from buildings

CECS 374 : 2014

Drafted by: China Architecture Design and Research Group
Approved by: China Association for Engineering Construction Standardization
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Announcement of China Association for Engineering Construction Standardization

No. 176

Announcement of Publishing *Standard for Measuring, Accounting and Reporting of Carbon Emission from Buildings*

According to the requirements of Document JIANBIAOXIE-ZI〔2010〕No. 91 issued by China Association for Engineering Construction (CECS)-Notice on printing and disrtibuting *Development and Revision Plan* Ⅱ *of CECS Standards in* 2010, *Standard for Measuring, Accounting and Reporting of Carbon Emission from Buildings* which is drafted in chief by China Architecture Design and Research Group has been approved as a CECS standard with a serial number of CECS 374 : 2014 by China Association for Engineering Construction Standardization after comprehensive review and will be implemented on December 1, 2014.

The English version of the Standard will be published and issued simultaneously.

25, July, 2014

China Association for Engineering Construction Standardization

Foreword

According to the requirements of Document JIANBIAOXIE-ZI [2010] No. 91 issued by China Association for Engineering Construction (CECS)-Notice on printing and distributing *Development and Revision Plan* Ⅱ *of CECS Standards in* 2010, the Standard Drafting Panel have developed this Standard based on extensive survey and research, summary of past experience, reference of relevant domestic and international standards and solicitation of public opinions.

This Standard consists of five chapters and three appendixes, covering, General Provisions, Terms, Basic Requirements, Measuring Account by Inventory, Measuring Account by Information Modeling.

This Standard is under the routine management of CECS. The power of interpretation resides with the National Engineering Research Center for Human Settlement (CNECHS) under China Architecture Design and Research Group (Address: No. 19 Chegongzhuang Avenue, Xicheng District, Beijing Zip Code: 100044). Any suggestions or comments should be sent to CNECHS.

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Contents

1 General Provisions

1.0.1 This Standard has been formulated in order to standardize the measuring, accounting and reporting of carbon emission from buildings and ensure scientific approach, reliable data, clear procedure and convenient operation.

1.0.2 This Standard is applicable to the measurement of the carbon emissions during the life cycle of newly constructed buildings, reconstructed buildings and existing buildings.

1.0.3 This Standard is set to measure the carbon dioxide (CO_2) emitted from the consumption of energy, resources and materials at each period during the life cycle of buildings. It is also applicable to the measurement of other green house gases set forth in the Kyoto Protocol.

1.0.4 The measuring, accounting and reporting of carbon emission from buildings shall abide by this Standard as well as other current national and professional standards.

2 Terms

2.0.1 Life cycle of buildings

The life cycle of buildings refer to a series of integrated stages from production of materials to dismantling and recycling, including the stages of material production, engineering and construction, operation and maintenance, dismantling and recycling.

2.0.2 Carbon footprint of buildings

Carbon footprint of buildings refers to the total amount of greenhouse gases emitted in the life cycle of buildings measured in carbon dioxide equivalent.

2.0.3 Measuring, accounting and reporting of carbon emission from buildings

It refers to the measuring, accounting and reporting of the data of carbon footprint of building.

2.0.4 Unit process of carbon emitted from buildings

Unit process of carbon emitted from buildings refers to the basic process used to quantify the consumption of energy, resources and materials at each stage during the life cycle of buildings. Unit process is the basic unit of the carbon footprint of buildings.

2.0.5 Activity data

Activity data refer to the quantitative data on the greenhouses gases resulted from human activities, especially the carbon emitted from buildings, including consumption of materials, energy and recourses.

2.0.6 Carbon emission factor

Carbon emission factor is the coefficient between activity data and carbon emission, used to quantify the carbon emission per unit of activity data.

2.0.7 Measuring account by inventory

Measuring account by inventory refers to the method of calculating carbon footprint of buildings by measuring the activity data and carbon emission factor of the unit process of carbon emitted from buildings.

2.0.8 Measuring account by information modeling

Measuring account by information modeling refers to the method of calculating carbon footprint of buildings by calculating and managing the data on consumption of energy, resources and materials at each stage of the life cycle of buildings through information modeling.

2.0.9 Global warming potential

Global Warming Potential refers to the coefficient that compares the amount of heat trapped by a certain mass of the greenhouse gases in question to the amount of heat trapped by a similar mass of carbon dioxide.

2.0.10 Carbon dioxide equivalent

Carbon dioxide equivalent is used to measure and compare the greenhouse effect of different greenhouse gases. Its unit is CO_{2e} and it is calculated as the mass of the greenhouse gas multiplied by its Global Warming Potential.

2.0.11 Carbon sink of buildings

Carbon sink of Buildings refers to the amount of carbon dioxide that landscaping and vegetation absorb and store from the air within the designated building scope.

3 Basic Requirements

3.0.1 The measuring, accounting and reporting of carbon emission from buildings shall cover the whole life cycle of buildings, and unit process of carbon emission shall be used to conduct data collection and calculation.

3.0.2 Measuring, accounting and reporting of carbon emission from buildings shall follow the principles of relevance, completeness, consistency, accuracy and transparency.

3.0.3 The methods for measuring, accounting and reporting of carbon emission from buildings include measuring account by inventory and measuring account by information modeling. Such method shall be selected according to the real circumstances of the design, construction, operation and management of the buildings. For buildings with regular design, construction, operation and management, measuring account by inventory shall be adopted. For buildings whose information is measured, delivered and accounted through information modeling, the method of measuring account by information modeling is preferred. The two methods can be combined together when neither of them can work solely.

3.0.4 The measuring, accounting and reporting of carbon emission from buildings shall adhere to the following steps:

1 Define the area and scope of the buildings;

2 Define the unit process of carbon emitted from buildings;

3 Collect the activity data of the unit process of carbon

emission;

4 Collect the carbon emission factor relevant to the unit process of carbon emission;

5 Account the carbon emission from buildings as per the requirements set forth in this Standard;

6 Disclose the results to the public accordingly.

3.0.5 The following requirements shall be applied when defining the unit processes of carbon emitted from buildings:

1 Priority shall be given to the measuring of the unit processes that have significant effect on the carbon emission from buildings;

2 Each unit process shall be kept separate to avoid repetitive measuring;

3 Unit processes that have a small weight in the carbon emission throughout the life cycle, or that are unable or too costly to be quantified may be omitted from the measuring of the carbon emission. However, the impact of such omission shall be accounted for in the report.

3.0.6 The primary unit processes during the material production stage shall include the following contents:

1 The use of materials and components in the bearing structure of buildings;

2 The use of materials components and parts in the building envelope;

3 The use of materials, components, parts and equipment in the building infill.

3.0.7 The primary unit processes during the building construction stage shall include the following contents:

1 Transportation of materials, components, parts and

equipments of buildings;

2 Operation of the construction machines and tools;

3 Work at the construction sites.

3.0.8 The primary unit processes during the operation and maintenance stage shall include the following contents:

1 Operation of the equipment system of the buildings;

2 Maintenance and replacement of the materials, components, parts and equipment of buildings;

3 Transportation of the materials, components, parts and equipment replaced for the buildings.

3.0.9 The primary unit processes during the dismantling stage shall include the following contents:

1 Operation of the dismantling machines and tools;

2 Transportation of waste.

3.0.10 The primary unit processes during the recycling stage shall include the following contents:

1 Recycling of the recyclable materials and components of the bearing structure of buildings;

2 Recycling of the recyclable materials and components of the building envelope;

3 Recycling of the recyclable materials and components of the building infill.

3.0.11 Relevant data for the measuring, accounting and reporting of carbon emission from buildings shall be reviewed to ensure quality and the relevant accounting and review documents shall be preserved. The properties of the data shall be completely recorded, including the following contents:

1 Time span: year of the data and the time span of the data;

2 Geographical scope: regions where the data is applicable;

3 Representativeness: a qualitative description of the industry coverage reflected by the data;

4 Completeness: the ratio of the measurement or estimation;

5 Source of data: institution that have provided the data, the carbon label of the products or the channel for data collection;

6 Precision of the data: the limitation in the source of data, modeling and hypothesis.

3.0.12 The results for the measuring, accounting and reporting of carbon emission shall be calculated in tons of carbon dioxide (tCO_2) and results for other greenhouse gases shall be calculated in tons of carbon dioxide equivalent (tCO_{2e}).

4 Measuring Account by Inventory

4.1 General Requirements

4.1.1 The method of measuring account by inventory shall calculate the carbon footprint during the life cycle of buildings by collecting and quantifying the amount of carbon emission from the unit processes.

4.1.2 When adopting the method of measuring account by inventory for measuring, accounting and reporting of carbon emission from buildings, the measurement unit of the materials and energy consumption of buildings shall follow the requirements of SI. The materials, parts and components of buildings shall be measured by unit mass or unit volume while energy consumption shall be measured by unit mass or unit energy.

4.2 Data Measuring

4.2.1 Data measuring shall be focused on the unit processes of carbon emission. Relevant data includes the activity data that reflects the consumption feature of energy, resources and materials in the unit processes and the corresponding carbon emission factor.

4.2.2 The activity data shall include the following contents:

1 During the material production stage: the types and quantity of the materials, components, parts and equipment used in the bearing structure of buildings, building envelope and building infill;

2 During the building construction stage: the energy consumption during the transportation of the materials, components, parts and equipment, the energy consumption and water consumption during the operation of construction machines and tools, and the energy consumption of onsite work;

3 During the operation and maintenance stage: the energy consumption and water consumption during the operation of the buildings, the types and quantities of the renewable energy, the material consumption in the maintenance and replacement, as well as the energy consumption during the maintenance and replacement;

4 During the dismantling stage: the energy consumption during the operation of the dismantling machines and tools, the energy consumption during the transportation of the waste from dismantling;

5 During the recycling stage: the types and amounts of building materials, components, parts and equipment recycled from the bearing structure of buildings, building envelope and building infill.

4.2.3 Based on the types, importance and measurement conditions, of the activity data can be collected and measured by monitoring instruments, data review, analysis and calculation according to the following requirements:

1 When the activity data can be automatically monitored, the method of monitoring instruments should be adopted to ensure the completeness, continuity and accuracy of the data;

2 If the activity data cannot be automatically and continuously monitored, data shall be collected and measured by reviewing the technical documents, files, payment bills, financial re-

ports and other documents of the engineering construction projects;

3 If the activity data cannot be collected and measured through the aforementioned methods, the data shall be measured by analysis and estimation as per relevant formulas.

4.2.4 During the material production stage, the types and quantities of the materials, components, parts and equipments of buildings shall be determined by reviewing the material auditing lists, construction drawings, purchase lists and other technical documents relevant to engineering construction, and such information shall be recorded as per Table A-1.

4.2.5 During the building construction stage, the activity data shall be measured as follows and recorded as per Table A-2:

1 The activity data on the transportation of materials, components, parts and equipments shall be obtained by reviewing the energy bills or financial statements of engineering construction;

2 The activity data on the operation of construction machines and tools, water consumption and work on construction sites shall be determined by the automatic recordings of the monitoring instruments on the work site. If the construction site is not equipped with monitoring instrument, such data shall be measured by reviewing the payment bills and financial statements.

4.2.6 During the building construction stage, if the activity data cannot be obtained through monitoring instrument, or if the relevant data is hard to get or is incomplete, the following method may be used for estimation, and such information shall be recorded as per Table A-2:

1 Fuel consumption of the transportation of materials, components, parts and equipment:

$$AD_{YS} = \sum_{i=1}^{n} \frac{G_i}{ZG_i} \cdot L_i \cdot Q_{si} \qquad (4.2.6\text{-}1)$$

Where AD_{YS}—Total fuel consumption for the transportation of materials, components, parts and equipment (t);

G_i— The total consumption of materials, components, parts, equipment of item i (t);

ZG_i—Average carrying capacity of the vehicle used to transport type i materials, components, parts and equipment (t);

Q_{si}— Unit fuel consumption of the vehicle used to transport type i materials, components, parts and equipment (t/km);

L_i—Distance of transportation of type i materials, components, parts and equipment (km);

i—The code for the type of materials, components, parts, equipment being transported.

2 Power consumption of the operation of the construction machines and tools:

$$AD_{JXD} = \sum_{i=1}^{n} P_{di} \cdot T_{di} \cdot N_i \qquad (4.2.6\text{-}2)$$

Where AD_{JXD}—Total power consumption of the construction machines and tools (kWh);

P_{di}—Electric power of the type i construction machines and tools (kW);

T_{di}— Operating hours of type i construction machines and tools (h);

N_i—Number of type i construction machines and tools (units);

i—The code for the type of construction machines and tools.

3 Fuel consumption of the operation of construction machines and tools:

$$AD_{JXY} = \sum_{i=1}^{n} P_{yi} \cdot T_{yi} \cdot N_i \qquad (4.2.6\text{-}3)$$

Where AD_{JXY}—Total fuel consumption of the construction machines and tools (t);

P_{yi}—Average fuel consumption of each type i construction machines and tools per shift (t/shift);

T_{yi}—The number (shifts) of type i construction machines and tools under operation;

N_i—Number of type i construction machines and tools (units);

i—The code for the type of construction machines and tools.

4 Water consumption of the operation of the construction machines and tools:

$$AD_{JXS} = \sum_{i=1}^{n} P_{si} \cdot T_{si} \cdot N_i \qquad (4.2.6\text{-}4)$$

Where AD_{JXS}—Total water consumption of the construction machines and tools (t);

P_{si}—Average water consumption of each type i construction machines and tools per shift (t/shift);

T_{si}—The number (shifts) of type i construction ma-

chines and tools under operation;

N_i—Number of type i construction machines and tools (units);

i—The code for the type of construction machines and tools.

5 Power consumption on the worksite of the construction:

$$AD_{BGD} = \sum_{i=1}^{n} P_{di} \cdot T_{di} \cdot N_i \qquad (4.2.6\text{-}5)$$

Where AD_{BGD}——Total power consumption of onsite work (kW · h);

P_{di}——Electric power of type i electric equipment for onsite office work (kW);

T_{di}——Operating hours of type i electric equipment for onsite office work (h);

N_i——Number of type i electric equipment for onsite office work (units);

i——The code for the type of equipment for onsite office work.

4.2.7 During the operation and maintenance stage, the data on energy consumption for the operation of the buildings shall be measured according to articles 5.2.1、5.2.2、5.3.1、5.3.2 of the Standard on Measuring the Data on *Standard for energy consumption survey of civil buildings* (JGJ/T 154—2007), which is the current professional standard, and data on the water consumption shall be measured based on the cold water meter of the buildings and recorded as per Table A-3 of this Standard.

4.2.8 During operation and maintenance, if the buildings are not equipped with monitoring instrument, the energy consumption during the operation of the buildings shall be estimated ac-

cording to the types of the energy consuming equipment, operation parameters, operation period and other relevant information. Relevant information shall be recorded as per Table A-3:

1 Power consumption of the operation of buildings:

$$AD_{YXD} = \sum_{i=1}^{n} (l_i \cdot P_{di} \cdot T_{di} \cdot N_i) \qquad (4.2.8\text{-}1)$$

Where AD_{YXD}—Total power consumption during the operation of buildings; (kW · h);

P_{di}— Electric power of type i equipment system (kW);

T_{di}—Average operating hours of type i equipment system (h/a);

N_i—Number of type i equipment system (units);

l_i—Year of operation of type i equipment system (a);

i—The code for the type of equipment system.

2 Fuel and gas consumption of the operation of the buildings:

$$AD_{YXYQ} = \sum_{i=1}^{n} (l_i \cdot P_{yqi} \cdot T_{yqi} \cdot N_i) \qquad (4.2.8\text{-}2)$$

Where AD_{YXYQ}—Fuel consumption (t) or gas consumption (Nm^3) during the operation of the buildings;

P_{yqi}—Average fuel consumption per hour (t/h) or gas consumption per hour (Nm^3/h) for type i equipment system;

T_{yqi}—Average operating hours of type i equipment system (h/a);

N_i—Number of type i equipment system (units);

l_i—Year of operation of type i equipment system

(a);

i—The code for the type of equipment system.

3 Coal consumption for the operation of buildings:

$$AD_{YXM} = \sum_{i=1}^{n} (l_i \cdot P_{mi} \cdot N_i) \qquad (4.2.8\text{-}3)$$

Where AD_{YXM}—Coal consumption for the operation of buildings (t);

P_{mi}—Average coal consumption for type i equipment system (t/a);

N_i—Number of type i equipment system (units);

l_i—Year of operation of type i equipment system (a);

i—The code for the type of equipment system.

4 Energy consumption for the steam and hot water purchased from vendors:

$$AD_{YXZR} = \frac{Q_{ZR} l}{\eta \cdot h_{dw}} \qquad (4.2.8\text{-}4)$$

Where AD_{YXZR}—Primary energy of the steam (t) or hot water purchased from vendors during operation of buildings (Nm^3);

Q_{zr}—Annual amount of steam or hot water purchased from vendors (MJ/a);

η—Average thermal efficiency of the steam or hot water produced in heating station (%);

h_{dw}—Lowering heating value of the primary energy used by heating station to produce steam or hot water(MJ/t, MJ/Nm^3);

l—Years of operation of buildings (a).

4.2.9 During the operation and maintenance stage, for build-

ings that are not equipped with cold water meter, water consumption can be estimated according to the relevant requirements of the current national Standard *Code for design of building water supply and drainage* (GB 50015).

4.2.10 During the operation and maintenance stage, the types and amount of renewable energy shall be determined according to the automatic record of the monitoring system on renewable energy. If the monitoring system is not in place or is not under operation, such information can be confirmed by reviewing the technical documents on the design of the renewable energy system.

4.2.11 During operation and maintenance, data on material consumption and energy consumption from maintenance and replacement shall be determined by reviewing the maintenance and replacement plan and recorded as per Table A-3 of this Standard.

4.2.12 Energy consumption during the dismantling stage shall be determined by the energy bills. If the energy bills are not available or incomplete, it shall be calculated by Formula 4.2.6-1 to 4.2.6-5 based on the building dismantling plan and shall be recorded as per Table A-4 of this Standard.

4.2.13 During recycling, the recycle ratio or actual recycled quantity of the materials, components, parts and equipment of the bearing structure, building envelope and building infill shall be decided based on the material and equipment list of the building design or the record of the actual recycling. Such information shall be recorded as per Table A-5.

4.2.14 Carbon emission factor for the measuring, accounting and reporting of carbon emission shall come from recognized and reliable source. The most recently published data is preferred.

Before the establishment of a complete data base on carbon emission factors, the following sources are recommended for obtaining carbon emission factors:

1 Literature that is formally and consecutively published by authoritative institutions;

2 Research reports from certified academic research institutions;

3 Statistics yearbooks and reports;

4 Relevant handbooks on raw data;

5 Information on work flow process of factories;

6 Appedix B and C in this standard can be used as a reference for part of energy.

4.3 Data Accounting

4.3.1 Carbon emission throughout the life cycle of buildings shall be the total amount of carbon emission of the unit processes during the stages of material production, building construction, operation and maintenance, dismantling and recycling.

4.3.2 The carbon emission of each of the unit process shall be the product of the activity data and carbon emission factor of the unit process. Such information shall be recorded as per Table A-6.

4.3.3 During the material production stage, carbon emission from buildings shall be calculated as per following formula:

$$E_{SC} = \sum_{i=1}^{n} (AD_{ZTi} \cdot EF_{ZTi}) + \sum_{i=1}^{n} (AD_{WHi} \cdot EF_{WHi}) + \sum_{i=1}^{n} (AD_{TCi} \cdot EF_{TCi}) \quad (4.3.3)$$

Where E_{SC}—Carbon emission from buildings during material production (tCO_2);

AD_{ZT}—Consumption of materials for bearing structure (t);

EF_{ZT}—Carbon emission factor of the materials for bearing structure(tCO_2/t);

AD_{WH}—Consumption of materials for building envelope (t);

EF_{WH}—Carbon emission factor of the materials for building envelope (tCO_2/t);

AD_{TC}—Consumption of materials for building infill (t);

EF_{TC}—Carbon emission factor of the materials for building infill (tCO_2/t);

i—Types of materials.

4.3.4 During the building construction stage, carbon emission from buildings shall be calculated as per following formulas:

$$E_{SG} = \sum_{i=1}^{n}(AD_{SGDi} \cdot EF_{D}) + \sum_{i=1}^{n}(AD_{SGYi} \cdot EF_{Y}) + \sum_{i=1}^{n}(AD_{SGMi} \cdot EF_{M}) + \sum_{i=1}^{n}(AD_{SGQi} \cdot EF_{Q}) + \sum_{i=1}^{n}(AD_{SGQTi} \cdot EF_{QT}) + \sum_{i=1}^{n}(AD_{SGSHi} \cdot EF_{SH}) \quad (4.3.4)$$

Where E_{SG}—Carbon emission from buildings during building construction (tCO_2);

AD_{SGD}—Power consumption of the unit processes during building construction (kW · h);

EF_{D}—Carbon emission factor of electricity [tCO_2/(kW · h)];

AD_{SGY}—Fuel consumption of the unit process during building construction (t);

EF_Y—Carbon emission factor of fuel (tCO_2/t);

AD_{SGM}—Coal consumption of the unit process during building construction (t);

EF_M—Carbon emission factor of coal (tCO_2/t);

AD_{SGQ}—Gas consumption of the unit process during building construction (Nm^3);

EF_Q—Carbon emission factor of gas (tCO_2/Nm^3);

AD_{SGQT}—Other energy consumption of the unit process during building construction (tce);

EF_{QT}—Carbon emission factor of other energy (tCO_2/tce);

AD_{SGSH}—Water consumption of the unit process during building construction (t);

EF_{SH}—Carbon emission factor of water (tCO_2/t);

i—Types of unit processes.

4.3.5 During the operation and maintenance stage, carbon emission from buildings shall be calculated as per following formulas:

$$E_{YXNH} = \sum_{i=1}^{n}(AD_{YXDi} \cdot EF_D) + \sum_{i=1}^{n}(AD_{YXYi} \cdot EF_Y) + \sum_{i=1}^{n}(AD_{YXMi} \cdot EF_M) + \sum_{i=1}^{n}(AD_{YXQi} \cdot EF_Q) + \sum_{i=1}^{n}(AD_{YXQTi} \cdot EF_{QT}) + \sum_{i=1}^{n}(AD_{YXSHi} \cdot EF_{SH}) - E_{ZSHj} \quad (4.3.5\text{-}1)$$

$$E_{ZSHj} = \sum_{j=1}^{n}(AD_{KZSj} \cdot EF_{KZSj} \cdot l) \quad (4.3.5\text{-}2)$$

Where E_{YXNH}—Carbon emission from buildings during operation and maintenance (tCO_2);

AD_{YXD}—Power consumption of the unit processes during operation and maintenance (kW · h);

EF_D—Carbon emission factor of electricity [tCO_2/(kW · h)];

AD_{YXY}—Fuel consumption of the unit process during operation and maintenance (t);

EF_Y—Carbon emission factor of fuel (tCO_2/t);

AD_{YXM}—Coal consumption of the unit process during operation and maintenance (t);

EF_M—Carbon emission factor of coal (tCO_2/t);

AD_{YXQ}—Gas consumption of the unit process during operation and maintenance (Nm^3);

EF_Q—Carbon emission factor of gas (tCO_2/ Nm^3);

AD_{YXQT}—Other energy consumption of the unit process during operation and maintenance (tce);

EF_{QT}—Carbon emission factor of other energy (tCO_2/tce);

AD_{YXSH}—Water consumption of the unit process during operation and maintenance (t);

EF_{SH}—Carbon emission factor of water (tCO_2/ t);

E_{ZSHJ}—Carbon emission reduction from the use of renewable energy throughout the life cycle of buildings (tCO_2);

i—Types of unit processes;

AD_{KZS}—Annual consumption of renewable energy (kW · h/year or kJ/year);

EF_{KZS}—The carbon emission factor of the fossil fuel replaced by the use of renewable energy;

l—Length of the supply of renewable energy (a);

j—Types of renewable energy.

4.3.6 During the operation and maintenance stage, carbon emission from the replacement of materials and components shall be calculated as per following formula:

$$E_{YXGT} = \sum_{i=1}^{n}(AD_{ZTi} \cdot EF_{ZTi}) + \sum_{i=1}^{n}(AD_{WHi} \cdot EF_{WHi}) + \sum_{i=1}^{n}(AD_{TCi} \cdot EF_{TCi}) \quad (4.3.6)$$

Where E_{YXGT}—Carbon emission of the replaced materials and components (tCO_2);

AD_{ZT}—Materials consumption of bearing structure(t);

EF_{ZT}—Carbon emission factor of the materials of the bearing structure (tCO_2/t);

AD_{WH}— Materials consumption of building envelope (t);

EF_{WH}—Carbon emission factor of the materials of the building envelope (tCO_2/t);

AD_{TC}—Materials consumption of building infill (t);

EF_{TC}—Carbon emission factor of the materials of the building infill (tCO_2/t);

i—Types of materials.

4.3.7 During the dismantling stage, carbon emission from buildings shall be calculated as per following formula:

$$E_{CJ} = \sum_{i=1}^{n}(AD_{CJDi} \cdot EF_{D}) + \sum_{i=1}^{n}(AD_{CJYi} \cdot EF_{Y}) + \sum_{i=1}^{n}(AD_{CJMi} \cdot EF_{M}) + \sum_{i=1}^{n}(AD_{CJQi} \cdot EF_{Q}) + \sum_{i=1}^{n}(AD_{CJQTi} \cdot EF_{QT}) + \sum_{i=1}^{n}(AD_{CJSHi} \cdot EF_{SH}) \quad (4.3.7)$$

Where E_{CJ}—Carbon emission from buildings During dismantling (tCO_2);

AD_{CJD}—Carbon emission from buildings during dismantling (kW · h);

EF_D—Carbon emission factor of electricity [tCO_2/(kW · h)];

AD_{CJY}—Fuel consumption of the unit process during dismantling (t);

EF_Y—Carbon emission factor of fuel (tCO_2/t);

AD_{CJM}—Coal consumption of the unit process during dismantling (t);

EF_M—Carbon emission factor of coal (tCO_2/t);

AD_{CJQ}—Gas consumption of the unit process during dismantling (Nm^3);

EF_Q—Carbon emission factor of gas (tCO_2/Nm^3);

AD_{CJQT}—Other energy consumption of the unit process during dismantling (tce);

EF_{QT}—Carbon emission factor of other energy (tCO_2/tce);

AD_{CJSH}—Water consumption of the unit process during dismantling (t);

EF_{SH}—Carbon emission factor of water (tCO_2/t);

i—Types of unit processes.

4.3.8 During the recycling stage, carbon emission from buildings shall be calculated as per following formula:

$$E_{HS} = \sum_{i=1}^{n} (AD_{HSi} \cdot \eta_{HSi} \cdot EF_{HSi}) \qquad (4.3.8)$$

Where E_{HS}—Carbon emission from buildings during recycling (tCO_2);

AD_{HS}—Quantity of materials (t);

η_{HS}—Recycle ratio of materials (%);

EF_{HS}—Carbon emission factor of the recycled materials (tCO_2/t);

i—Types of materials.

4.3.9 Carbon emission throughout the life cycle of buildings shall be calculated as per following formula:

$$E_{LC} = E_{SC} + E_{SG} + E_{YXNH} + E_{YXGT} + E_{CJ} - E_{HS} - E_{TH} \quad (4.3.9)$$

Where E_{LC}—Carbon emission throughout the life cycle of buildings (tCO_2);

E_{TH}—Carbon sink (tCO_2).

4.3.10 Annual carbon emission per unit of gross floor area shall be calculated as per following formula:

$$E_A = \frac{E_{LC}}{A \cdot l} \quad (4.3.10)$$

Where E_A—Annual carbon emission per unit of gross floor area (tCO_2/m^2);

A—Gross floor area (m^2);

l—Operating years of the buildings (a).

4.3.11 The ratio of the carbon emission of different periods in life cycle of buildings shall be calculated as per following formula:

$$\varphi_i = \frac{E_i}{E_{LC}} \quad (4.3.11)$$

Where φ_i—Ratio of the carbon emission of different periods in life cycle of buildings (%);

E_i—Carbon emission of period i in the life cycle of building (tCO_2);

E_{LC}——Carbon emission throughout the life cycle of building (tCO_2).

4.4 Data Reporting

4.4.1 The results of the measuring, accounting and reporting of carbon emission from buildings shall be disclosed to the public in the form of carbon emission report.

4.4.2 The report on carbon emission from buildings shall include the following contents, hypothesis and source of data:

1 The institution that develops the report;

2 The functions and operating status of the buildings;

3 The process of the calculation of the carbon emission of unit processes;

4 The carbon emission list of the buildings;

5 The method of data measuring and source of data.

4.4.3 The information on the institution that develops the report shall include the following contents:

1 Nature of the institution;

2 Purpose of the report and where the task of measuring, accounting and reporting of carbon emission comes from;

3 The contact person of the institution and people involved in the process.

4.4.4 The function and operating status of the buildings shall include the following information:

1 Location and scope of the building;

2 Type, function and purpose of the building;

3 The period in the life cycle covered by the report;

4 The unit processes of each period in the life cycle;

5 Operation years of the building.

4.4.5 The carbon emission list of the buildings shall include the following information:

1 Carbon emission of different unit processes of the buildings;

2 Carbon emissions of different stages in the life cycle of the buildings;

3 The cumulative carbon emission of buildings till present day;

4 Total amount of carbon emission throughout the life cycle of buildings;

5 Annual carbon emission per unit of gross floor area;

6 Ratio of carbon emission of different stages in the life cycle of buildings.

5 Measuring Account by Information Modeling

5.1 General Requirements

5.1.1 The method of measuring account by information modeling refers to the process of measuring, delivering and accounting data and making records on life cycle management through information modeling. It tracks the carbon footprint and manages carbon emission through information.

5.1.2 Measuring account by information modeling shall be based on the database of the information on the materials, components, parts and equipment, as well as the division of labor, operation procedure, information standard for the measuring, accounting and reporting of carbon emission. The measurement unit of the data shall follow the standard set forth in Article 4.1.2 of this standard.

5.1.3 When the method of measuring account by information modeling is adopted, information model shall be developed and managed on appropriate platforms to deliver the information on materials, components, parts, equipment production lines to the whole process of construction and management, collect information during the stages of material production, building construction, operation and maintenance, dismantling and recycling, and publish the results in the end.

5.2 Data Measuring

5.2.1 When measuring account by information modeling, ac-

tivity data shall be collected and measured by information models. The actual activity data of the unit processes shall be preferred to be used in the information models. When the actual activity data is unavailable, simulated information may also be used.

5.2.2 The basic information collected and measured during the material production stage shall be consistent with the activity data collected by the method of measuring account by inventory. When developing the information models, the designer of the building shall offer accurate information on the materials, components, parts and equipment of buildings. The information properties on the actual consumption of materials shall be reserved in the models.

5.2.3 During the material production stage, data shall be processed by the information models. The required information includes the following items:

AD_{ZT}—Materials consumption on the bearing structure(t);

AD_{WH}—Materials consumption on building envelope (t);

AD_{TC}—Materials consumption on building infill (t).

5.2.4 The basic information collected and measured during the building construction stage shall be consistent with the activity data collected by the method of measuring account by inventory. When developing information models, the constructor of the building shall offer the construction plan and the simulated data. The information properties on the actual consumption of energy shall be reserved in the models.

5.2.5 During the building construction stage, the basic information shall be simulated and estimated in the information models. The required information includes the following items:

AD_{SGD}—Power consumption of the unit processes during building construction (kW · h);

AD_{SGY}—Fuel consumption of the unit process during building construction (t);

AD_{SGM}—Coal consumption of the unit process during building construction (t);

AD_{SGQ}—Gas consumption of the unit process during building construction (Nm^3);

AD_{SGQT}—Other energy consumption of the unit process during building construction (tce);

AD_{SGSH}—Water consumption of the unit process during building construction (t).

5.2.6 The basic information collected and measured during the operation and maintenance stage shall be consistent with the activity data collected by the method of measuring account by inventory. When developing information models, the basic information on operational energy consumption shall be defined and input to the information models. The information properties on the actual energy consumption monitored during operation shall also be reserved in the models.

5.2.7 During the operation and maintenance stage, the basic information on energy consumption shall be simulated and estimated in the information models. The required information includes the following items:

AD_{YXD}—Power consumption of the unit processes during operation and maintenance (kW · h);

AD_{YXY}—Fuel consumption of the unit processes during operation and maintenance (t);

AD_{YXM}—Coal consumption of the unit processes during opera-

tion and maintenance (t);

AD_{YXQ}—Gas consumption of the unit processes during operation and maintenance (Nm^3);

AD_{YXQT}—Other energy consumption of the unit processes during operation and maintenance (tce);

AD_{YXSH}—Water consumption of the unit processes during operation and maintenance (t).

5.2.8 When developing information models for the operation and maintenance stage, the materials, components, parts and equipment that require maintenance and replacement shall be defined and the information properties of parts, components and equipment shall be input into the model. The information properties on the actual maintenance and replacement may also be reserved in the models.

5.2.9 During the operation and maintenance stage, the basic information on the materials, components, parts and equipment that require maintenance and replacement shall be estimated in the information models. The required information includes the following items:

AD_{ZT}——Materials consumption on the bearing structure(t);

AD_{WH}——Materials consumption on the building envelope (t);

AD_{TC}——Materials consumption on the building infill (t).

5.2.10 The basic information collected and measured during the dismantling stage shall be consistent with the activity data collected by the method of measuring account by inventory. When formulating the information models, dismantling managers shall provide the dismantling work plan and input such information to the information models. The information properties on the actual energy consumption shall also be reserved.

5.2.11 During the dismantling stage, the basic information shall be estimated in the information models. The required information includes the following items:

AD_{CJD}—Power consumption of the unit processes during dismantling (kW · h);

AD_{CJY}—Fuel consumption of the unit processes during dismantling (t);

AD_{CJM}—Coal consumption of the unit processes during dismantling (t);

AD_{CJQ}—Gas consumption of the unit processes during dismantling (Nm^3);

AD_{CJQT}—Other energy consumption of the unit processes during dismantling (tce);

AD_{CJSH}—Water consumption of the unit processes during dismantling (t).

5.2.12 The basic information collected and measured during the recycling stage shall be consistent with the activity data collected by the method of measuring account by inventory. When formulating the information models, basic information on recyclable building materials, parts, components and equipment shall be defined and input to the information models. The information property on the actual recycling shall also be reserved in the models.

5.2.13 During recycling, the basic information shall be estimated in the information models. The required information includes the following items:

AD_{HS}——Quantity of materials (t);

η——Recycling ratio of the materials (%).

5.3 Data Accounting

5.3.1 Carbon emission from buildings shall be accounted by using the activity data stored internally in the building information models and the carbon emission factor that can be found in external documents according to Article 4.3.2 of this Standard.

5.3.2 If the method of measuring account by information modeling is adopted, data accounting on the carbon emission for each unit process, carbon emission throughout the life cycle of buildings, per unit carbon emission throughout the life cycle of buildings, carbon emission in each period in the life cycle of buildings shall be conducted in accordance with the Section 4.3 of this Standard.

5.4 Data Reporting

5.4.1 The form of the carbon emission report for projects that adopt the method of measuring account by information modeling shall be consistent with the form of the carbon emission reports that use the method of measuring account by inventory, the forms are shown in Appendix A.

5.4.2 When reporting the data using the method of measuring account by information modeling, the report shall include source of data; when reporting under the method of information modeling, the simulation procedure shall be included.

5.4.3 When reporting the data using the method of measuring account by information modeling, the external source and application of the carbon emission factors shall be included.

5.4.4 When reporting the data using the method of measuring account by information modeling, information on the people in

charge of each model shall be included.

5.4.5 When reporting the data using the method of measuring account by information modeling, information on the names and versions of the software shall be included. If the software is developed internally, the algorithm and data processing process shall be included and the rationality of the core algorithm shall be justified.

Appendix A Worksheets for Measuring Account by Inventory

Table A-1 Record sheet on activity data measurement (during material production)

Basic information	Name of the building					
	Location					
	Nature of the building			1—residential, 2—public, 3—others		
	Time of construction/design					
	Designed life span					
During material production	Activity data		Unit	Bearing structure	Building envelope	Building infill
	Materials consumption of buildings	Material 1				
		Material 2				
		Material 3				
		……				
	Components consumption of buildings	Component 1				
		Component 2				
		Component 3				
		……				
	Consumption of parts of buildings	Part 1				
		Part 2				
		Part 3				
		……				
	Consumption of equipment of buildings	MEP 1				
		MEP 2				
		MEP 3				
		……				

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Table A-2 Record sheet on activity data measurement (during building construction)

Basic information	Name of the building					
	Location					
	Nature of the building			1—residential, 2—public, 3—others		
	Time of construction/design					
	Designed life span					
During construction	Activity data		Unit	Data on the transportation of materials, components, parts and equipment	Data on the operation of the construction machines and tools	Data on the onsite work
	Energy consumption	Coal				
		Natural gas				
		Liquefied petroleum gas				
		Petroleum				
		Diesel				
		Kerosene				
		Electricity				
		Steam purchased from vendor				
		Hot water purchased from vendor				
		.....				
	Resource consumption	Water				
		.....				

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Table A-3 Record sheet on activity data measurement (during operation and maintenance)

Basic information	Name of the building					
	Location					
	Nature of the building		1—residential, 2—public, 3—others			
	Time of construction/design					
	Designed life span					
Operation and maintenance	Activity data		Unit	Data on the operation of the equipment system	Data on the maintenanc and replacement of the materials, components, parts and equipment	Data on the transportation of the materials, components, parts and equipment
	Energy consumption	Coal				
		Natural gas				
		Liquefied petroleum gas				
		Petroleum				
		Diesel				
		Kerosene				
		Electricity				
		Steam purchased from vendor				
		Hot water purchased from vendor				
		.....				

Table A-3 (continued)

Operation and maintenance	Resource consumption	Water			
		Other			
	Materials used for maintenance and replacement	Material 1			
		Material 2			
		Material 3			
		.....			
	Components used for maintenance and replacement	Component 1			
		Component 2			
		Component 3			
		.....			
	Parts used for maintenance and replacement	Part 1			
		Part 2			
		Part 3			
		.....			
	Equipment used for maintenance and replacement	MEP 1			
		MEP 2			
		MEP 3			
		.....			

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Table A-4 Record sheet on activity data measurement (during dismantling)

Basic information	Name of the building				
	Location				
	Nature of the building			1—residential, 2—public, 3—others	
	Time of construction/design				
	Designed life span				
Dismantling	Activity data		Unit	Data on the operation of the dismantling machines and tools	Data on the transportation of waste
	Energy consumption	Coal			
		Natural gas			
		Liquefied petroleum gas			
		Petroleum			
		Diesel			
		Kerosene			
		Electricity			
		Steam purchased from vendor			
		Hot water purchased from vendor			
		.....			
	Resource consumption	Water			
		.....			

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Table A-5 Record on activity data measurement (during recycle)

Basic information	Name of the building					
	Location					
	Nature of the building			1—residential, 2—public, 3—others		
	Time of construction/design					
	Designed life span					
During recycle	Activity data		Unit	Bearing structure	Building envelope	Building infill
	Amount of recycled materials of buildings	Material 1				
		Material 2				
		Material 3				
		.....				
	Amount of recycled components of buildings	Component 1				
		Component 2				
		Component 3				
		.....				
	Amount of recycled parts of buildings	Part 1				
		Part 2				
		Part 3				
		.....				
	Amount of recycled equipment of buildings	MEP 1				
		MEP 2				
		MEP 3				
		.....				

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Table A-6 Calculation of Carbon Emission from Buildings

Basic information	Name of the building							
	Location							
	Nature of the building			1—residential, 2—public, 3—others				
	Time of construction/design							
	Designed life span							
	Periods throughout the life cycle			1—During material production, 2—During building construction, 3—During operation and maintenance, 4—During dismantling, 5—During recycling				
Category	Item	Activity data		Carbon emission factor		Carbon emission ($t CO_2$)	Note	
		Unit	Consumption	Unit	Factor			
Energy consumption	Coal							
	Natural gas							
	Liquefied petroleum gas							
	Petroleum							
	Diesel							
	Kerosene							
	Electricity							
	Steam purchased from vendor							
	Hot water purchased from vendor							
	……							
Resource consumption	Water							
	……							
Consumption of materials	Building materials	Material 1						
		……						

Table A-6 (continued)

Consumption of materials	Building components	Component 1						
		.....						
	Building parts	Part 1						
		.....						
	Building equipment	MEP 1						
		.....						
Total			—	—	—	—		

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Preparedby: _____ Reviewed by: _____

Date of completion: _____

Appendix B Carbon Emission Factors for Common Energy

Table B Carbon Emission Factors for Common Energy

Category	Name of the energy	Carbon emission factor	Source of data	Note
Coal	Anthracite coal	98.3kgCO_2/GJ	*IPCC Standard on National Greenhouse Gas List*(2006)	International organization
	Coking coal	94.6kgCO_2/GJ		
	Lignitic coal	101kgCO_2/GJ		
	Carbon coke	107kgCO_2/GJ		
Electricity	North China power grid	1.246kgCO_2/(kW·h)	*Guidelines on Provincial Greenhouse Gas List (Tentative)* launched by National Development and Reform Commission	Government departments
	Northeast China power grid	1.096kgCO_2/(kW·h)		
	East China power grid	0.928kgCO_2/(kW·h)		
	Middle China power grid	0.801kgCO_2/(kW·h)		
	Northwest power grid	0.997kgCO_2/(kW·h)		
	South China power grid	0.714kgCO_2/(kW·h)		
	Hainan	0.917kgCO_2/(kW·h)		

Table B (continued)

Category	Name of the energy	Carbon emission factor	Source of data	Note
Fuel	Crude oil	73.3kgCO_2/GJ	*IPCC Standard on National Greenhouse Gas List*(2006)	International organization
	Motor gasoline	69.3kgCO_2/GJ		
	Aviation fuel	70.0kgCO_2/GJ		
	Coal fuel	71.5kgCO_2/GJ		
	Diesel	74.1kgCO_2/GJ		
	Liquefied petroleum gas	63.1kgCO_2/GJ		
Gas	Fuel oil	77.4kgCO_2/GJ		
	Natural gas	56.1kgCO_2/GJ		
	Coal gas	44.4kgCO_2/GJ		

Note: The statistics in the chart shall be updated on a yearly basis to ensure effectiveness.

Appendix C Heat Value of Common Energy

Table C Heat Value of Common Energy

Category	Name of the energy	Average lower heating value	Source of data
Coal	Anthracite coal	26700kJ/kg	*IPCC Standard on National Greenhouse Gas List* (2006)
	Coking coal	28200kJ/kg	
	Lignitic coal	11900kJ/kg	
	Raw coal	20908kJ/kg	*General principles for calculation of the comprehensive energy consumption* (GB/T 2589—2008)
	Carbon coke	28435kJ/kg	
Fuel oil	Crude oi	41816kJ/kg	
	Fuel oil	41816kJ/kg	
	Petroleum	43070kJ/kg	
	Coal oil	43070kJ/kg	
	Diesel	42652kJ/kg	
	Coal tar	33453kJ/kg	
	Residual oil	41816kJ/kg	
	Liquefied petroleum gas	50179kJ/kg	
Fuel gas	Refinery gas	46055kJ/kg	
	Natural gas from oil field	38931kJ/Nm^3	
	Natural gas from gas field	35544kJ/Nm^3	
	Methane gas from coal bed	14636kJ/Nm^3—16726kJ/Nm^3	
	Coke oven gas	16726kJ/Nm^3—17981kJ/Nm^3	
	Blast furnace gas	3763kJ/Nm^3	

Explanation of Wording in This Standard

1 Words used for different degrees of strictness are explained as follows in order to mark the differences in implementing the requirements of this standard:

1) Words denoting a very strict or mandatory requirement:

"Must" is used for affirmation; "must not" for negation.

2) Words denoting a strict requirement under normal conditions:

"Shall" is used for affirmation; "shall not" for negation.

3) Words denoting a permission of a slight choice or an indication of the most suitable choice when conditions permit:

"Should" is used for affirmation; "should not" for negation.

4) "May" is used to express the option available, sometimes with the conditional permit.

2 "Shall comply with…" or "Shall meet the requirements of…" is used in this standard to indicate that it is necessary to comply with the requirements stipulated in other relative standards and codes.

List of quoted Standards

Code for Design of Building Water Supply and Drainage (GB 50015)

General Principles for Calculation of the Comprehensive Energy Consumption (GB/T 2589—2008)

Standard for Energy Consumption Survey of Civil Buildings (JGJ/T 154—2007)

Environmental management-Life cycle assessment-principles and framework (ISO 14040：2006)

Greenhouse gases-Carbon footprint of products-Requirements and guidelines for quantification and communication (ISO/TS 14067：2013)

Greenhouse gases-Part 1：*Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals* (ISO 14064—1：2006)

CECS Standard

Standard for measuring, accounting and reporting of carbon emission from buildings

CECS 374 : 2014

Explanation of Provisions

Contents

1 General Provisions

1.0.1 Carbon emission from buildings is arousing increasing attention of international community, so how to scientifically measure it has been an urgent issue. At present there are no international standard methods for measuring, accounting and reporting carbon emission from buildings. Only a few western developed countries, including Germany, the UK and the USA, are proposing to develop or are in the process of developing such methods or assessment systems based on their own architectural design and construction standards and product material databases. The management system for establishment, design, construction and operation of a construction project in China is quite different from those in the developed countries mentioned above. We need to deveop and form our own methods and system so as to satisfy the technical demands of relevant departments and personnel.

This standard is based on the research findings of *Standard on Measuring, Accounting and Reporting of Carbon Emission from Urban Buildings and Research and Demonstration of Key Technologies Integration in Low Carbon Design for Urban Buildings* (2011BAJ07B02), which is one of the 7 topics of *Research and Demonstration of Key Technologies Integration in Urban Low Carbon Development* (2011*BAJ*07*B*00), a research project supported by the state in the 12th Five-year Plan. This standard is based on the international general principles for mea-

suing, accounting and reporting of carbon emission. It sets out relevant standards for data measuring, data accounting and data reporting in respect of carbon emission throughout the life cycle of buildings and plays a significant role in developing standardized methods of measuring, accounting and reporting of carbon emission from buildings in China as well as saving energy and reducing emissions in the field of architecture.

1.0.2 With regard to newly constructed buildings, carbon emissions throughout the life cycle of buildings in various construction proposals shall be analyzed and compared so as to provide a basis for making decisions and optimizing architectural design, material selection, construction, operating maintenance, deconstruction and recycling plans; with regard to reconstructed and existing buildings, actual carbon emission at the past life-cycle phases shall be reported. Key Links shall be identified to control carbon emissions. Comparisons of carbon emissions in different building operation and reconstruction plans shall be made to forecast and manage carbon emissions in the future life cycle phases and reduce emission.

1.0.3 According to *the IPCC Fourth Assessment Report* (IPCC AR4, 2007), different greenhouse gases have different contribution rate to the greenhouse effect. For example, the percentage contribution of CO_2, CH_4, N_2O, and Fluorine and other gases is 76%, 14.3%, 7.9%, and 1.8% respectively. Carbon dioxide is the primary greenhouse gas. This Standard aims to measure carbon dioxide (CO_2) generated from energy and material consumption throughout the life cycle of buildings.

In the activities and processes of carbon emissions from building, other greenhouse gases will be emitted as well. Ac-

cording to *IPCC Guidelines for National Greenhouse Gas Inventories* (2006), such activities and processes involve several categories including energy activity, industrial production processes and waste disposal etc.. Table 1 sets out relevant greenhouse gases to be assessed in each category.

Table 1 Activities and Processes Involving Carbon Emissions and Relevant Greenhouse Gases

Source and Sink Categories to be Assessed in Key Category Analysis		Gases to be Assessed
Category Code	Category Title	
Energy Code		
1A2	Fuel Combustion Activities-Manufacturing Industries and Construction	CO_2、CH_4、N_2O
1A3a	Fuel Combustion Activities-Transport-Civil Aviation	CO_2、CH_4、N_2O
1A3b	Fuel Combustion Activities-Transport-Road Transport	CO_2、CH_4、N_2O
1A3c	Fuel Combustion Activities-Transport-Railways	CO_2、CH_4、N_2O
1A3d	Fuel Combustion Activities-Transport-Water-borne Navigations	CO_2、CH_4、N_2O
Industrial Production Processes		
2A1	Mineral Industry-Cement Production	CO_2
2A2	Mineral Industry-Lime Production	CO_2
2A3	Mineral Industry-Glass Production	CO_2
2C1	Metal Industry-Iron & Steel Production	CO_2、CH_4
2C3	Metal Industry-Aluminium Production	CO_2、PFCs
2F1	Product Uses as Substitutes for Ozone Depleting Substances-Refrigeration and Air Conditioning	HFCs、PFCs

Table 1 (continued)

Waste Disposal		
4A	Solid Waste Disposal	CH_4
4C	Incineration and Open Burning of Waste	CO_2、N_2O、CH4

Note: *IPCC Guidelines for National Greenhouse Gas Inventories*, Volume 1; Chapter 4(2006).

As shown in the table, in addition to CO_2, other greenhouse gases including CH_4、N_2O、HFCs、and PFCs also relate to carbon emissions from building. Therefore relevant requirements set forth in this Standard can also be used as a reference to quantify and report the emissions of the greenhouse gases listed above.

2 Terms

2.0.1 The life cycle of buildings refers to the whole process from the material production to dismantling and recycling, which is the main timescale of carbon emissions from buildings.

2.0.3 The practice of measuring, accounting and reporting carbon emissions from building consists of three steps. Firstly, collect data on carbon footprints of buildings; secondly, compile and quantify such data; and finally, release a report on carbon emissions.

2.0.10 Carbon dioxide is the primary greenhouse gas emitted through human activities. In order to standardize the measurement of overall greenhouse effect, carbon dioxide equivalent is used as a unit of measurement herein.

3 Basic Requirements

3.0.1 This provision sets out a basic framework for measuring, accounting and reporting of carbon emission from buildings. Firstly, such framework shall cover the whole life cycle of buildings, including the processes of material production, building construction, operation and maintenance, dismantling and recycling. At each of these stages, there is energy and material consumption that could result in direct or indirect carbon emission and have an impact on the natural environment. If the practice of measuring , accounting and reporting of carbon emission is only limited to part of these life-cycle stages, neither could we have an overall understanding on how carbon emission activities impact the nature nor make anticipations or control of carbon emission in the future. Secondly, the carbon emission unit process shall be used as the unit of measurement. During each specific carbon emission unit process, the input and output of each type of energy and material is relatively clear and independent. The measurement based on unit process is to collect and quantitatively calculate data relating to each process so as to fully track carbon footprints of buildings.

3.0.2 "Relevance", "completeness", "consistency", "accuracy" and "transparency" are the core requirements for quantifying and reporting carbon emission as set out by the international society. In the context of measuring, accounting and reporting carbon emission from buildings, "relevance" shall mean that the

chosen boundary, materials, data and methods for quantifying carbon emission from buildings can appropriately reflect the situation of relevant carbon emissions from buildings and satisfy relevant requirements; "completeness" shall mean that given the chosen building and measurement boundary, all information on carbon emission should be quantified and reported. Any exclusion needs to be justified; "consistency" shall mean that consistent methodologies should be adopted to quantify and report carbon emission at various life-cycle stages. Any changes to calculation scope, boundary or methods should be documented in the same way and recorded clearly; "accuracy" shall mean that any data sources and calculation methodologies in respect of carbon emission from buildings shall be on an reliable and accurate basis; "transparency" shall mean that any references to information on carbon emission from buildings should be reported in an adequate, sufficient and transparent manner.

3.0.3 This Standard sets out two measuring methods in respect of carbon emission from buildings which could satisfy the needs of data measuring, data accounting and data reporting on carbon emission from buildings that are designed, constructed, operated and managed either in a regular manner or based on an information modeling.

3.0.4 This provision sets out relevant steps for measuring, accounting and reporting of carbon emission from buildings, of which the steps to define the area and scope of the buildings and define the unit process of carbon emission from the buildings are the preconditions of undertaking such work. The first step is to define the area and scope of the buildings and then measure the consumption of energy, resources and materials within such de-

fined area and scope. For example, the red lines of the buildings or the road centerlines surrounding the buildings could be used to define such area and scope. The unit process of carbon emission from buildings is defined so as to identify each specific activity process of energy, resources and material consumption and facilitate date measuring and accounting thereof.

3.0.5 The unit processes relating to carbon emission throughout the life cycle of buildings are complex and diverse. Therefore it is quite difficult to include all unit processes in the measurement. Priority shall be given to measuring the unit processes with a high contribution to and a big weight in carbon emission from buildings, excluding those that cannot be quantified, have low carbon emission or require high costs for quantification so as to reduce workload and enhance operability of this Standard. However, the impact of simplifying these unit processes on the measurement results shall be analyzed and interpreted.

3.0.6 In the production of building materials, components, parts and equipments, energy consumption exists in each process ranging from raw material production, manufacturing to finished products production. Therefore each building material, component, part and equipment can be treated as an outcome in the solidification process of carbon emission, the production of which involves embodied carbon emission. With regard to buildings, carbon emission in the material production process is caused by the use of materials, components, parts and equipments.

The materials, components, parts and equipments used in buildings can be categorized into three parts based on their different functions, i. e. those used in the bearing structure of buildings, those used in the building envelop and those used in the

building infill. The bearing structure of buildings includes the parts that support the braced frame of the buildings, including the base, beams, boards, pillars and load-bearing walls, the role of which is to bear load; the building envelop includes the roofs, walls, doors and windows, floors etc, the role of which is to form an enclosed space and make partitions; the building infill includes decorations, equipments used in kitchen and bathroom, electrical equipments, ventilation and air-conditioning equipments, elevators and pipelines within the buildings, the role of which is to decorate, allow functional uses of the buildings and maintain a good indoor environment therein.

3.0.7 At the construction stage of the buildings and related facilities, and the installation process of associated lines, pipelines and equipments, the transportation of building materials, components, parts and equipments as well as the operation of construction machines and tools is the main unit processes with energy consumption. In addition, working at the construct site would also result in energy consumption which should be measured.

3.0.8 After the buildings are completed and put into use, the equipment systems including air conditioners, lightening, elevators, water supply system and cooking equipment will run well to maintain the normal operation of the buildings, which could result in energy consumption and carbon emission. At the operation stage, certain materials or components may need to be maintained and replaced after they reach their natural life span. The consumption of replaced materials and installation and maintenance would also result in carbon emission.

3.0.9 The operation of machines and tools and transportation

of waste during the dismantling of buildings are the main activities that could result in carbon emission, which should be measured.

3.0.10 The measuring, accounting and reporting of carbon emission from buildings should take into account the recycling and renewability of materials. With regard to recyclable materials, notwithstanding carbon emission is generated during the production process, it will be reincorporated into the life cycle of new buildings, with no actual effect on the environment. Thus it should be excluded in the measurement. This Standard shall not take into account the carbon emission generated by recycling activities (such as the use of sorting machines) as this kind of emission is small and difficult to collect.

3.0.11 This provision sets out the requirements to ensure quality control of relevant data for measuring, accounting and reporting of carbon emission from buildings. The quality of data is of considerable importance to ensure the credibility of the measurement results. In order to generate objective and reasonable measurement results, the quality of relevant data must be examined and approved and the relevance, completeness, consistency, accuracy and transparency of such data must be verified. Meanwhile, any information contained in such data must be documented so as to analyze its effect on the measurement results.

3.0.12 When other greenhouse gas emissions as specified in the *Kyoto Protocol* is measured by reference to this Standard, the carbon dioxide equivalent (CO_{2e}), which equals to the emission of each gas multiplied by its own Global Warming Potential (GWP), shall be used. The GWP of major greenhouse gas in Table 2 can be used as a reference.

Table 2 Global Warming Potential of Major Greenhouse Gases

Name of the greenhouse gases		Global Warming Potential	Source of data
CO_2		1	*Report on the 4th Review by IPCC* (AR4, 2007)
CH_4		25	
N_2O		298	
HFCs	HFC-23	14800	
	HFC-32	675	
	HFC-125	3500	
	HFC-134a	1430	
	HFC-143a	4470	
	HFC-152a	124	
	HFC-227ea	3220	
	HFC-236fa	9810	
	HFC-245fa	1030	
PFCs	CF_4	7390	
	C_2F_6	9200	
SF_6		23900	

4 Measuring Account by Inventory

4.1 General Requirements

4.1.1 As one of the methods of measuring, accounting and reporting of carbon emission from buildings, the feature of measuring account by inventory is that the measuring procedure is sequentially consistent with the activities of carbon emission from buildings. The input and output objects are clear and can be assembled and quantified one by one. Relevant data is generated based on the engineering design materials and operational management documentation of the construction projects so as to secure maximum credibility of the measurement results. It is easy for professionals to master this method.

4.1.2 This provision sets out the requirements on the measurement units of relevant data when adopting the method of measuring account by inventory.

4.2 Data Measuring

4.2.2 For the purpose of this provision, the activity data that should be collected and measured at the stages of material production, building construction, operation and maintenance, dismantling and recycling shall be based on the unit processes (see Provisions 3.0.6—3.0.10) generally contained throughout the life cycle of buildings. Due to different types and purposes of buildings, the unit processes of carbon emission that are included in the measurement may be different, depending on the actual

conditions of the buildings.

4.2.3 The collecting and measuring of activity data in the unit processes of carbon emission from buildings is an important step in the practice of measuring, accounting and reporting of carbon emission. The quality and detailedness of such activity data is of significant importance to the credibility of the measurement results.

4.2.6 This provision sets out formulas for analyzing and calculating the main activity data at the building construction stage in the event that relevant data cannot be obtained through monitoring instruments or queries.

Most materials, components, parts and equipments are transported from their places of production or sale to the construction sites through vehicles. While a small number of them are transported by sea or air. Nevertheless, in each case energy is generated from fuel consumption. The total fuel consumption for the transportation can be calculated by measuring the number and shifts of transport machines, the length of transportation and the unit fuel consumption of each of such machines. Some main operation parameters including electric power of construction machines and tools, the number and shifts used, the operating hours and the water consumption of such construction machines and tools are closely linked with the construction proposals, technical skills and management level of the contractors, which can be determined based on construction proposals, bill of quantity or the local building engineering quota.

4.2.8 The consumption of primary energy during the operation of buildings shall be calculated in accordance with relevant formulas. The operation parameters of relevant building equipment

systems including electric power, fuel oil or gas consumption per hour and average coal consumption per annum shall be determined based on design proposals of the buildings and technical conditions of the chosen equipments.

The secondary energy such as steam and hot water purchased from vendors during the operation of the buildings is transferred from the consumption of primary energy including coal, fuel gas and fuel oil through centralized thermal power stations outside the scope of the buildings. Thus the measuring, accounting and reporting of carbon emission shall be based on the calculation of primary energy consumption which relates to the thermal energy conversion efficiency from primary energy into secondary energy of the local thermal power stations and lowering heating value of relevant primary energy.

4.2.11 During the operation of the buildings, some materials or components may have reached their natural life span and need to be replaced. Data on carbon emission generated from the production of such replaced materials shall be collected and measured in line with the method specified at the material production stage.

4.2.13 After dismantling, a large number of materials, components, parts and equipments can be incorporated into the life cycle of other buildings through recycling. The practice of measuring, accounting and reporting of carbon emission from buildings throughout their life cycle shall not include the carbon emission caused by solidification of such materials. With regard to buildings that have not been dismantled, the carbon emission to be excluded at the recycling stage shall be calculated based on the recycle ratio of the materials, components, parts and equipment

of the bearing structure, building envelope and building infill and the quantity of materials actually used. With regard to buildings that have been dismantled, the carbon emission to be excluded shall be determined by the actually recycled quantity of materials.

4. 2. 14 Carbon emission factor is an important base data for measuring, accounting and reporting of carbon emission, which includes two aspects. The first is the carbon emission factors of materials, components, parts and equipments, i. e. embodied carbon generated from solidification of such materials, components, parts and equipments per unit thereof; the second is the carbon emission factors of various types of energy. At present, no data base on carbon emission factors (particularly the factors of various materials, components, parts and equipments) has been established in our country that can be used in the measuring, accounting and reporting of carbon emission from buildings throughout their life cycle. In order to satisfy the actual needs of undertaking the work of measuring, accounting and reporting carbon emission, relevant factors can be obtained from the information sources recommended in this provision. However, the data source needs to be recorded in detail so as to assess the measurement results.

In addition, the boundaries of the chosen carbon emission factors of materials, components, parts and equipments must be consistent. Due to the diversity of data sources, the boundaries of each carbon emission factor may be different. For example, the value of the carbon emission factor of steel relates to both the consumption of energy, resources and materials during the whole production process and the recycle ratio of such steel. In some

data sources, the carbon emission factor of steel has been adjusted by taking into account the recycle ratio; while in some other data sources the ratio has not been taken into account. Therefore even for the same steel, the value of carbon emission factors could be quite different due to different boundaries. The method for measuring, accounting and reporting of carbon emission from buildings as set out in this Standard has taken into account the exclusion of carbon emission generated by the recycling of materials, components, parts and equipments of the bearing structure, building envelope and building infill in the final life-cycle phase of buildings. Thus the chosen carbon emission factors of materials, components, parts and equipments should not be adjusted by taking into account the recycle ratio so as to avoid double reduction.

4.3 Data Accounting

4.3.3 Carbon emission from building at the material production stage shall include the amount of carbon emitted from materials used in the bearing structure, building envelope and building infill. This provision sets out relevant formulas for calculation.

4.3.4 Carbon emission from buildings at the construction stage shall include the amount of carbon emitted from the consumption of electricity, fuel oil, coal, fuel gas, other energy and water for operation of equipments, such as the construction machines and tools. This provision sets out relevant formulas for calculation.

4.3.5 Energy consumption at the operation and maintenance stage of the buildings mainly include the consumption of electricity, fuel oil, coal, fuel gas and water for operation equipment systems. In addition, certain carbon emission shall be excluded

from the measurement due to the use of renewable energy throughout the life cycle of buildings. This provision sets out relevant formulas for calculation.

4.3.6 Carbon emission generated from the replacement of materials, components, parts and equipments used in the bearing structure, building envelope and building infill shall be calculated separately. This provision sets out relevant formulas for calculation.

4.3.7 Carbon emission from building at the dismantling stage shall include those generated from the consumption of electricity, fuel oil, other energy and water for operation of dismantling machines and tools. This provision sets out relevant formulas for calculation.

4.3.8 Carbon emission from buildings at the recycling stage is generated from recycled materials. This provision sets out relevant formulas for calculation.

4.3.9 Carbon sink is mainly sourced from the absorption of carbon dioxide by vegetation within the building scope, which should be excluded from the carbon emission into the environment. At present the agriculture and forestry industry has developed relevant methodologies including *Methodology of Measuring and Monitoring Carbon Sink of Bamboo Forest Projects* and *Guidelines on Measuring and Monitoring Carbon Sink of Forestation Projects* published by the State Forestry Administration. Some mythologies on the carbon sink of building vegetation are also under development.

4.3.10 In the accounting of carbon emission, the absolute amount of carbon emission throughout the life cycle is not sufficient to compare the emissions of buildings of different sizes. In

order to analyze and compare carbon emissions from building of different sizes, the calculation shall be based on unit construction area converted from the total amount throughout the life cycle and the operating years of the buildings.

4.3.11 The ratio of carbon emission at each stage of the whole building lifecycle is an important index in the accounting of carbon emission. Due to the fact that the amount of carbon emitted during different life-cycle phases is quite different, the calculation of such ratio can make the horizontal comparison and quantitative analysis of carbon emission generated in different phases faster and more accurate.

4.4 Data Reporting

4.4.1 To ensure clarity, the results of the measuring, accounting and reporting of carbon emission from buildings shall be published in the form of a report with data, graphs, captions and other necessary information.

4.4.2 The report on carbon emission from buildings is the core content of data reporting, including the institution that develops the report, functions and operating status of the buildings and lists of carbon emission of the buildings. Furthermore, the hypothesis and source of data including carbon emission factors are very important information, which shall be provided.

4.4.3 The institution that develops the report on carbon emission from buildings is the main body that undertakes the work of measuring, accounting and reporting of carbon emission. The accuracy and precision of the measurement is closely linked with the purposes of such work and the methods of collecting data. Thus accurate information about the institution must be included

in the report.

4.4.4 The function and operating status of the buildings determines the life cycle and unit processes in each life cycle stage that shall be covered by the measuring, accounting and reporting of carbon emission from buildings. They are important boundary bases for the measuring and accounting work, which should be provided in detail.

5 Measuring Account by Information Modeling

5.1 General Requirements

5.1.1 Due to the high informationization level of manufacturing industry, the information on industrial products including building materials, components, parts and equipments at the material production stage is relatively complete. The information model is a carrier of such information which will be delivered and managed throughout the life cycle of buildings for the purpose of effective use.

This Standard adopts the method of measuring account by information modeling as one of the methods in the practice of measuring, accounting and reporting of carbon emission from buildings. Its advantage is that the completeness of information management and advancement of information collecting and processing can better avoid errors such as omissions and redundant accounting.

Furthermore, a standard algorithm for measuring, accounting and reporting of carbon emission shall be completely incorporated into the information model in advance so as to calculate the carbon emission of new projects based on the quantity of materials, consumption during construction, consumption during operation, consumption during maintenance, consumption during dismantling and the quantity of recycled materials of existing projects of the same type. At the planning stage, the carbon emissions of various architectural design plans shall be estimated

so as to provide a base for better selection and optimization.

5.1.2 Division of labor means the separation of work into various tasks that will be undertaken by modelers, metrologists, coordinators and managers. Data bases shall include the data base of information on building materials, components, parts and equipments, and the data base of carbon emission factors etc. Information standards shall include the standards of graphics, consistent naming conventions within the project and consistent standards for exchange of information etc..

5.1.3 Measuring account by information modeling for measuring, accounting and reporting of carbon emission shall give priority to existing information models. With regard to newly constructed buildings based on information modeling, this method only sets out requirements on the type of data. With regard to existing buildings based on information modeling, the information model needs to be established before collecting and relevant data thereof shall be standardized in line with this method.

The data information and calculation method adopted for measuring account by information modeling shall be consistent with that used in the method of measuring account by inventory.

According to the current construction and management procedures of building projects, there are three categories of models: the design (development) model, the completed model and the management model. Data shall be obtained from such models. In the event that the information obtained therefrom is not consistent, such information shall need to be collated before measuring, accounting and reporting of carbon emission so as to ensure consistency of the data during the delivery process and produce accurate results. Any information model that is used to

measure carbon emission should satisfy the requirements on information storage and delivery as set forth in the IFC (Industry Foundation Classes).

The projects in respect of which the method of measuring account by information modeling is adopted for information collecting should use the building components, parts and equipments that contain relevant information on basic carbon emission of the products, length of transportation and service life. Such information shall be incorporated into the information model of the projects by information modeling. The delivery and updating of such information shall abide by relevant standards and requirements to improve the efficiency and accuracy of data collecting. In the practice of measuring account by information modeling for measuring, accounting and reporting of carbon emission, verification of relevant graphics and documentation may be needed to make corrections in the event that errors are found in the process of information collecting or accounting or information collected is inconsistent with the real situation so as to ensure accuracy and consistency of the information.

5.2 Data Measuring

5.2.1 The methods of measuring account by information modeling and measuring account by inventory have the same collection objects: the activity data that reflects consumption of energy and materials and their respective carbon emission factors but with different ways of storing, extracting and managing data and information. When measuring account by information modeling, information shall be collected from information models throughout the life cycle of the buildings. Under the current construction

and management mode of buildings, information in the unit processes at the production and construction stages shall be collected from the design (development) and completed models. While the information in the unit processes at the operation and maintenance, dismantling and recycling stages shall be collected from the management model.

In the event that actual activity data can be obtained, the information model shall be deemed as a data and information management platform throughout the life cycle of the buildings. In the event that actual activity data cannot be obtained, simulated information generated from the information model shall be used.

The circumstances where actual activity data is not available shall include: the existing file of the buildings is incomplete or lacks detail; the newly constructed or reconstructed buildings are still under design and development. Construction or operation has not occurred.

Simulated information used may include: estimated quantity of materials, simulated results of construction progress, estimated value of energy consumption, simulated results of energy consumption during operation, estimated value for maintenance and replacement, simulated results of dismantling progress, estimated value of energy consumption during dismantling, simulated results of renewable energy and estimated quantity of recycled materials etc..

5.2.2 Provision 4.2.2 of this Standard stipulates that: the basic information collected at the material production stage shall include: materials, components, parts and equipments used in bearing structure, building envelope and building infill and the quantity thereof.

In theory, there will be very small error between the values obtained from information models and the actual consumption of materials in respect of the above information when the completed model is established. However, due to various factors including the vast territory of our country and different construction techniques, the information model shall also contain information on actual material consumption in addition to that on building materials, components and parts. The information on actual material consumption collected under Provision 4. 2. 4 of this Standard shall be incorporated into the information model by data collectors to allow for unified management and use. Information on the basic carbon emission of products and length of transportation etc shall be collected and included in the calculation.

In addition, as the quantity of materials can be estimated based on information modeling, the process of establishing information models shall include: 1) defining each part of the buildings and distinguishing the bearing structure, building envelope and building infill; 2) naming the materials in accordance with the types and specifications of building materials.

5. 2. 3 When obtaining the information on material consumption of the bearing structure(t), material consumption of the building envelope (t) and material consumption of the buildings infill (t) from information models, the basic information on the volume and quantity of each material shall be processed appropriately to calculate the material consumption thereof as follows:

The consumption of certain material (t) = the volume of such material (m^3) × the volume-weight of such material (t/m^3)

The consumption of certain component (t) = the weight of a single component (t) × the total number of such component

5.2.4 Under the Provision 4.2.2 of this Standard, the basic information obtained at the construction stage shall include: energy consumption in the transportation of materials, components, parts and equipments, energy and water consumption in the operation of construction machines and tools and energy consumption resulted from working at construction site; consumption of auxiliary materials in construction and times of turnover.

The information on energy consumption during the transportation of materials, components and parts, electricity and oil consumption during the operation of construction machines and tools as well as electricity consumption during the management of construction site at the construction stage can be obtained by simulating the construction progress and estimating energy consumption of construction. Due to the differences in geography, construction technique and skill of construction workers, it is impossible to sort out the difference between the actual energy consumption at the construction stage and the estimated one. The management of construction site also plays a crucial role in generating carbon emission. In the event that information on actual energy consumption at the construction site has been recorded, such information shall be used in preference to simulated information and incorporated into information models to allow for unified management and use. The measuring of energy consumption at the construction stage and basic measuring methods are set out in Provisions 4.2.5—4.2.6 of this Standard.

For the purposes of construction simulation, the information on structures, components, parts and equipments that can affect the construction progress shall be refined and measured by using the basic units that will be used in actual construction.

5.2.5 In construction simulation based on information modeling, accurate information on building materials, components, parts and equipments shall be obtained from information models. A software analysis platform shall be used to analyze the construction steps, simulate construction proposals and estimate the consumption of electricity, oil, coal, gas, water and other energy in the construction proposals.

5.2.6 Under Provision 4.2.2 of this Standard, the basic information for operation to be collected at the operation and maintenance stage shall include: energy consumption, water consumption, types of renewable energy and the consumption thereof for the purposes of operation of the buildings.

In the event that the practice of measuring, accounting and reporting of carbon emission from buildings starts from the operation and maintenance stage, it is quite difficult to obtain the basic information and activity data of earlier stages. Therefore this Standard proposes to use simulation or reserve a space for later input. Information shall be incorporated step by step in line with Provisions 4.2.7—4.2.10 of this Standard.

5.2.7 In the simulation of energy consumption during operation based on information modeling, accurate information on the building envelops and equipment systems shall be obtained from the information models. A software analysis platform shall be used to analyze the requirements on the operation of equipment systems, simulate the operation process and estimate the consumption of electricity, oil, coal, gas, water and other energy during operation. The amount of consumption shall be calculated on a year-over-year basis, for different seasons and by various operating requirements within the design working life of build-

ings. With regard to some special buildings whose operation is not on a year-over-year basis, the simulation and calculation of energy consumption during operation shall be based on an equivalent operating period of such buildings.

Supported by the current simulation and analysis technology, the operation of renewable energy systems shall be simulated and analyzed separately. The simulation results shall be stored separately as well.

5.2.8 Under Provision 4.2.2 of this Standard, the basic information for maintenance to be collected at the operation and maintenance stage shall include: consumption of materials for maintenance and replacement, estimated energy consumption for replacing materials, components, parts and equipments.

Components, parts and equipment systems used at the operation and maintenance stage have their own requirements on service life. Such requirements are basically consistent with the actual situation. Therefore, the times of maintenance and replacement of such products throughout the life cycle of the buildings can be simulated and estimated. The consumption of materials and energy at the operation and maintenance stage shall be measured in line with Provision 4.2.11 of this Standard.

The simulated and estimated amount of consumption of materials and energy at the operation and maintenance stage shall largely rely on product information. Therefore, the information on basic carbon emission, length of transportation and service life in respect of components, parts, equipments shall be included in information models.

5.2.9 The information on all materials, components, parts and equipments within the buildings used in the projects shall be in-

corporated into information models in advance. The times of maintenance and replacement shall be calculated based on the basic information on consumption and service life of the materials, components, parts and equipments contained in the information models so as to estimate carbon emission resulted from such maintenance and replacement.

The consumption of materials for maintenance and replacement (t) = the consumption of materials used for a single maintenance and replacement (t) × the times of maintenance and replacement.

5.2.10 Under Provision 4.2.2 of this Standard, the information to be collected at the dismantling stage shall include: energy consumption during the operation of dismantling machines and tools, and energy consumption during the transportation of dismantling wastes etc..

Similar to the construction stage, energy consumption at the dismantling stage shall largely rely on the dismantling work plan. Therefore, in the event that actual energy consumption during dismantling has been recorded, such information shall be used preferentially and incorporated into information models to allow for unified management and use. The energy consumption at the dismantling stage shall be measured in line with Provision 4.2.12 of this Standard. In the event that actual energy consumption during dismantling has not be recorded, a simulation shall be conducted based on simulated results of dismantling progress and estimated energy consumption thereof.

For the purposes of dismantling simulation, the information on structures, components, parts and equipments that can affect the dismantling progress shall be refined and measured by using

the basic units that will be used in actual dismantling work.

5.2.11 The information on simulated results of dismantling progress and estimated energy consumption during dismantling is similar to that at the construction stage. Accurate information on building materials, components, parts and equipments shall be obtained from information models. A software analysis platform shall be used to analyze the dismantling steps, simulate dismantling work plans and estimate the consumption of electricity, oil, coal, gas, water and other energy in such plans.

5.2.12 Under Provision 4.2.2 of this Standard, the information to be collected at the recycling stage shall include: the types and quantities of recycled building materials, components, parts and equipments from the bearing structure, building envelope and building infill.

In the practice of measuring, accounting and reporting of carbon emission in circumstances where recycling work has been completed, the actual recycling information shall be reflected in the formation on components, parts and equipments as contained in information models. Such information shall be collected based on various metals in the models. The actual consumption of materials at the dismantling stage shall be measured in line with Provision 4.2.13 of this Standard. In circumstances where recycling work has not started, the consumption of recyclable materials shall be simulated and estimated through information modeling.

Similar to the material production stage, the information on materials, components, parts and equipments shall be defined based on various recycling categories in the process of establishing information models so as to accurately measure, simulate

and estimate the consumption of materials. Information on recycling shall be clarified.

5. 2. 13 Simulation and analysis on the service conditions of buildings shall be conducted through information modeling to estimate the recycle ratio of materials. The quantities of recyclable materials shall be calculated based on the recycle ratio and quantities of such materials.

5.3 Data Accounting

5.3.1、5.3.2 Data accounting under the method of measuring account by information modeling shall be consistent with that under the method of measuring account by inventory. Nevertheless, in this case a convenient information processing platform under information modeling should be given full play to informationizing calculation methods and establishing a link with the data collected through information modeling. Data measuring and data accounting shall be linked to avoid esrrors caused by repetitive work.

5.4 Data Reporting

5.4.1 In order to easily compare carbon emissions of different projects, the format of report developed through the method of measuring account by information modeling shall be consistent with that developed through the method of measuring account by inventory. During the processes of measuring, accounting and reporting of carbon emission and verification, corrections to certain information are unavoidable and will affect the time of reproting the measurement results. The advantage of adopting the method of measuring account by information modeling is that re-

sults can be published immediately after the establishment of information models. Corrections to certain information shall not delay the time of reporting measurement results.

5.4.2 The sources of data and explanations as to simulation or estimation methods shall be released for the purpose of effectively tracking the process of measuring, accounting and reporting of carbon emission and providing a scientific theoretical foundation and objective base for such data. Some of the data on carbon emission during each life — cycle phase of the buildings is obtained directly from models, such as the models and quantities of building materials, components, parts and chosen products; While some is obtained through simulation and estimation, such as analysis on energy consumption during the operation of buildings. In the event that simulated or estimated data is used, explanations as to the simulation or estimation method shall be reported including: reasons for using such data, defining of boundaries, calculated results of data, calculation precision of data and possible deviations etc..

In addition, whether the information models are detailed has a great effect on simulation results. Thus, the LOD (Level of Development) of such models shall be disclosed when reporting simulation procedures.

5.4.3 Carbon emission factors are part of the source data or parameters in the core algorithm required for conversion in the process of measuring, accounting and reporting of carbon emission from buildings. The collecting and accounting of such factors shall be in line with Provisions 4.2.14, 5.3.1of this Standard. The carbon emission factors shall be described in source data or the core algorithm. They may be publicly available or exist

in database. The application of carbon emission factors may differ as well. The different methods of storage and application may affect the efficiency of the measuring and accounting of carbon emission and result in errors. Therefore, the external source and application of carbon emission factors shall be explained to ensure credibility and feasibility.

5.4.4 In the process of measuring, accounting and reporting of carbon emission from buildings, manual work shall be needed to establish models, incorporate data and undertake accounting work, which may result in possible errors or omissions. Information on the people in charge of the above shall be reported to ensure traceability of data.

5.4.5 Both publicly released software or in-house-developed tools and software can be used in measuring, accounting and reporting of carbon emission from buildings. The data processing and algorithm of publicly released tools/software may change as its version is updated. Therefore, information on the names and versions of such tools/software shall be reported. With regard to in-house-developed tools and software, the data processing process and algorithm shall be reported as well and its rationality needs to be proved to ensure credibility, comparability and traceability of data.

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